APPENDIX D

# Safety Countermeasure Toolbox

City of Sacramento Vision Zero Action Plan Update:

# Top Collision Profiles and Countermeasures

*Last Updated: September 2025*

## Introduction

The purpose of this memorandum is to identify countermeasures that will help the City of Sacramento address the top collision profiles described in the previous crash analysis memo. The crash analysis memo identified six top collision profiles using contextual data as well as crash data from 2013 to 2022.[1] A recap of those collision profiles are noted in a subsection below for easy reference. Following that recap is an explanation of how the countermeasures in this memorandum were identified. Subsequent sections of the memorandum describe each collision profile and the priority countermeasures to help address those profiles. The countermeasures contained in this memorandum are intended to be used on the City's High Injury Network, primarily arterial and collector streets.

## Recap of Collision Profiles

A total of six collision profiles were identified from the most recent 10 years of collision data, and many of them were similar to collision profiles identified in the 2018 Action Plan, as summarized in **Table 1** below.

[1] Please refer to the memorandum *"Collision Landscape Summary and Collision Profiles" submitted separately to the City for detailed data source information.*

**Table 1: Collision Profile Comparisons: 2025 vs 2018**

| 2025 Collision Profile | 2018 Collision Profile[a] |
|---|---|
| 1. **Collisions Involving People Walking and Biking** | 60+ Year Old Pedestrians;<br>Pedestrian Crashes Near Transit Stops;<br>Broadside Crashes – Bicycle Involved;<br>Driver Making Left or Right Turn – Bicycle/ Pedestrian Involved;<br>Pedestrian Crossing Outside of an Intersection or Crosswalk |
| 2. **Broadside Collisions at Intersections in Commercial Areas** | Crashes in Commercial Areas;<br>Broadside Crashes – Bicycle Involved |
| 3. **Lack of Conflict Management at Intersections** | Driver Making Left Or Right Turn – Bicycle/ Pedestrian Involved |
| 4. **Collisions Near Transit Stops** | Pedestrian Crashes Near Transit Stops |
| 5. **Collisions Near Parks and Schools** | *[Not included]* |
| 6. **Unsafe Speed Collisions on Arterials** | Unsafe Speed on Non-Local Streets;<br>35+ MPH Streets |

[a]Source: City of Sacramento Vision Zero Action Plan (2018).

# Approach to Identifying Countermeasures

The Safe System Approach[2] (SSA) was used as the basis to inform the countermeasure toolbox and selection described further below. The SSA identifies kinetic energy risk as the primary factor in the number and severity of crashes and as a result, effectively managing kinetic energy risk on the street network is a key step in reducing the number and severity of crashes. Kinetic energy risk is made up of three components:

- **Exposure:** Where and how far people travel generally on the street network as well as, at a street or intersection level, the distance road users must travel to cross a street or intersection. The more people travel, particularly by vehicle, and the wider the streets, the greater the exposure road users experience.
- **Likelihood:** Where conflicts occur along a street and at an intersection. A conflict or conflict point is the location where two or more paths of travel of any mode cross. The more conflict points present the greater the likelihood a crash could occur.
- **Severity:** Determined by vehicle speed and vehicle mass. The higher speeds and heavier vehicles results in more severe injury outcomes particularly when people walking or biking are involved.

[2] An overview of the Safe System Approach is provided on the U.S. Department of Transportation's website: https://www.transportation.gov/safe-system-approach

The countermeasures discussed below were selected based on their effectiveness in addressing one or more of those three components.

Countermeasures can be implemented through a hierarchical approach of reducing demand, severity, then conflict. By doing so, locations will be designed to prioritize crash prevention and not just mitigation. Countermeasures should begin by reducing demand, which include supporting mode shift, shortening trips, or eliminating trips. Reducing demand directly decreases the number of potential conflicts and lays the foundation for a safer system.

Once demand is minimized, the next priority is to reduce the severity of potential collisions. This is typically achieved through speed management strategies that bring vehicle speeds closer to context-sensitive target speeds with geometric and operational changes. Lower speeds not only reduce the risk of serious injury or death but also create safer conditions for all road users, especially those who are most vulnerable.

After addressing exposure and severity, conflict management strategies should be employed to separate users in space and time. These strategies focus on separating or simplifying movements—such as through access management, dedicated turn lanes, or signal phasing.

# Countermeasure Toolbox

The countermeasure toolbox was created to equip the city with meaningful strategies to eliminate transportation fatalities and severe injuries. Countermeasures can be categorized into engineering and non-engineering strategies.

## Engineering Countermeasures

Based on the collision profiles, Fehr & Peers drew on industry best practice resources, such as the Federal Highway Administration (FHWA) Safe System Design Hierarchy, FHWA Proven Safety Countermeasures, Caltrans Local Roadway Safety Manual, and Crash Modification Factors (CMF) Clearinghouse to identify and prioritize engineering countermeasures. Each countermeasure documents relevant information such as implementation considerations, effectiveness of the treatment, and relative cost. Countermeasures, or "tools," from the Engineering Countermeasure Toolbox are organized into tables in this memo based on the collision issue addressed. The full Engineering Countermeasure Toolbox is included in **Attachment A**.

The countermeasures are generally organized by their relative effectiveness based on the Safe System Roadway Design Hierarchy (Hierarchy). The Hierarchy provides guidance in contextualizing and assessing infrastructure-based countermeasures and strategies on their alignment with the principles of the Safe System Approach, classifying countermeasures into four tiers, from most to least aligned with Safe System principles:

1. **Removing severe conflicts**, which can act to eliminate high-risk conditions that involve users with different speeds or moving in different directions sharing space. This tier can include countermeasures that remove potential points of conflict (for example, removing conflicting turning movements), and those that separate vulnerable users from vehicles in space (for example, protecting people biking through a separated bike lane).

2. **Reducing vehicle speeds**, which reduces the kinetic energy present within systems and thereby reduces the severity of crashes that do occur. As driver behavior, especially when it comes to speed, is highly influenced by roadway features, countermeasures that reduce prevailing speeds can include lane narrowing and features that channelize vehicle traffic such as median islands.

3. **Managing conflicts in time**, which covers instances (such as intersections) where space needs to be shared between different users, but where they can be separated in time. An example is the Leading Pedestrian Interval, which allows people walking to have a "head start" at a signalized intersection before conflicting vehicle traffic enters the crosswalk.

4. **Increasing attentiveness and awareness**, which involves alerting users to conflicts and potential risks, can involve such countermeasures as intersection daylighting and warning signage.

# Non-Engineering Countermeasures

Non-infrastructure countermeasures include policies, process, and programmatic changes that support safety education, encouragement, enforcement, and evaluation. These strategies draw on best practice information from FHWA, National Highway Traffic Safety Administration's (NHTSA) *Countermeasures that Work*, and other national guidance. **Attachment B** contains a description of these types of non-engineering countermeasures.

# Collision Profile Countermeasures

This section outlines the key characteristics of each collision profile and presents targeted countermeasure[3] recommendations for each.

## #1: Collisions Involving People Walking and Biking

Collisions where at least one party was walking or biking

**Figure 1** shows where collisions within this profile occurred in the City of Sacramento.

### Statistics

- 18% of injury collisions (3,581) involve people walking or biking
  - 9% of injury collisions (1,709) involve people walking
  - 9% of injury collisions (1,872) involve people biking
- 46% of KSI collisions (682) involve people walking or biking
  - 31% of KSI collisions (455) involve people walking
  - 15% (227) involve people biking

### Engineering Countermeasures

For **Collisions Involving People Walking and Biking**, the strategies below focus on eliminating the most severe types of conflicts through physical separation, kinetic energy reduction, and enhanced crossing safety. Vulnerable road users are at the highest risk in environments where they must share space with motorists. The selected countermeasures aim to create dedicated, protected spaces for walking and biking, while also improving crossing design and visibility.

Recommended engineering countermeasures are organized by the subtopics below.

#### Separate Road Users in Space

Construction of sidewalks, shared-use paths, and separated bike networks for people walking and biking, with connection to the existing networks, will enable a continuous and protected environment regardless of vehicle speed or vehicle sizes on the street. This includes building protected intersections to provide for the separation of people walking and biking up to and through an intersection.

[3] Engineering Countermeasures are referenced from Fehr & Peers' Safety Countermeasure Toolbox, and Programmatic Countermeasures are reference from *The Countermeasures That Work: A Highway Safety Countermeasure Guide for State Highway Safety Offices*, 11th Edition, National Highway Traffic Safety Administration (NHTSA), 2023.

| Countermeasures to Separate Users in Space | Safe System Hierarchy Tiers | | | |
|---|---|---|---|---|
| | 1 – Remove Severe Conflicts | 2 – Reduce Vehicle Speeds | 3 – Manage Conflicts in Time | 4 – Increase Attentiveness and Awareness |
| Protected Intersection | ✓ | ✓ | ✓ | ✓ |
| Add Sidewalk | ✓ | | | |
| Shared-Use Path | ✓ | | | |
| Separated Bikeway | ✓ | | | |
| Buffered Bike Lane | ✓ | | | |
| Bike Lane | ✓ | | | |
| Bicycle Ramp | ✓ | | | |
| Landscape Buffer | ✓ | | | |
| Driveway Consolidation | ✓ | | | |
| Through Bike Lane at Intersection | ✓ | | | ✓ |
| Curbside Management | | | ✓ | |
| Conflict Zone Striping | | | | ✓ |
| Door Zone Markings | | | | ✓ |
| Upgrade Striping | | | | ✓ |

## Manage Vehicle Speeds

Lowering vehicle speeds through slower signal progression (e.g., 20 MPH 'green waves'), installing roundabouts, constructing slow-turn wedges, installing speed feedback signs, and a variety of other countermeasures can encourage drivers to slow down and thus reduce the likelihood and severity of crashes when drivers interact with people walking or biking. At certain times, especially at nighttime, traffic signals can be designed to stay red until a vehicle approaches (semi-actuated). These signals can be designed to reward drivers who follow the speed limit, so that the light stays red until the driver comes to a stop if a car is driving too fast. On the other hand, for drivers driving at or below the speed limit, it will turn green before the car arrives at the signal and allow for smooth passing. Speed management is especially critical when separate space is not provided for people biking (e.g., bike routes or bike boulevards[4]) or people walking.

[4] The City's recently adopted Neighborhood Connections Plan also has a traffic-calming toolbox that details these countermeasures: https://www.cityofsacramento.gov/content/dam/portal/pw/Transportation/streets-for-people/SacramentoNC_Final_Report_WithAppendix.pdf

| Countermeasures to Manage Vehicle Speeds | Safe System Hierarchy Tiers | | | |
|---|---|---|---|---|
| | 1 – Remove Severe Conflicts | 2 – Reduce Vehicle Speeds | 3 – Manage Conflicts in Time | 4 – Increase Attentiveness and Awareness |
| Roundabout | ✓ | ✓ | | |
| Protected Intersection | ✓ | ✓ | ✓ | ✓ |
| Road Diet/Lane Reduction | ✓ | ✓ | | |
| Speed Limit Reduction | | ✓ | | ✓ |
| Slow Turn Wedge | | ✓ | | ✓ |
| Signal Interconnectivity and Coordination / Green Wave | | ✓ | ✓ | |
| Speed Lumps | | ✓ | | |
| Speed Hump / Speed Table | | ✓ | | |
| Splitter Island | | | | ✓ |
| Speed Feedback Sign | | | | ✓ |
| Bicycles May Use Full Lane Sign | | | | ✓ |

## Separate Road Users in Time

Adjusting signal timing at traffic signals to allow for things like leading pedestrian intervals, right-turn-on-red prohibitions, camera detection for people walking and biking for automatic recall of the signal, extend time push button, and/or separate signal phases so people walking and biking can cross without conflicting vehicle turning movements.

| Countermeasures to Separate Users in Time | Safe System Hierarchy Tiers | | | |
|---|---|---|---|---|
| | 1 – Remove Severe Conflicts | 2 – Reduce Vehicle Speeds | 3 – Manage Conflicts in Time | 4 – Increase Attentiveness and Awareness |
| Traffic Signal | | | ✓ | |
| Pedestrian Scramble | ✓ | | ✓ | |
| Pedestrian Signal | | | ✓ | ✓ |
| Prohibit Right-Turn-on-Red | ✓ | | ✓ | |
| Leading Pedestrian Interval and Pedestrian Recall | | | ✓ | |

| Countermeasures to Separate Users in Time | Safe System Hierarchy Tiers | | | |
|---|---|---|---|---|
| | 1 – Remove Severe Conflicts | 2 – Reduce Vehicle Speeds | 3 – Manage Conflicts in Time | 4 – Increase Attentiveness and Awareness |
| Prohibit Turns During Pedestrian Phase | | | ✓ | |
| Separate Right-Turn Phasing | | | ✓ | |
| Extend Pedestrian Crossing Time | | | ✓ | |
| Bicycle Signal/ Exclusive Bike Phase | | | ✓ | |
| Pedestrian Countdown Timer | | | | ✓ |
| Extend Time Push Button | | | ✓ | |
| Shorten Cycle Length | | | ✓ | |
| All-Red Signal Time | | | ✓ | |
| Flashing Beacon as Advance Warning | | | | ✓ |

## Enhance Crossing Infrastructure

Continued application of the City's *Pedestrian Crossing Guidelines (April 2021)* will be helpful to steadily improve crossing conditions for people walking and biking. Features such as refuge islands, curb extensions/bulb-outs, bus bulbs, all shorten the crossing distances to cross the street. These features also help to slow motorists' speeds by physically and visually narrowing the street width. Raised medians and refuge islands allow pedestrians to cross one direction of traffic at a time, reducing exposure to vehicles. These can be supplemented with additional traffic control like pedestrian signals at locations with higher vehicle volumes, higher vehicle speeds, and/or multiple vehicle lanes to cross. Improvements should also consider enhancing sight lines and visibility of people walking and biking, particularly near intersections and crossings. Citywide implementation of Assembly Bill (AB) 413, which prohibits parking within 20 feet of crosswalks (or 15 feet if a bulb-out is present), will support these goals by improving visibility and safety at crossing infrastructures generally.

| Countermeasures to Enhance Crossing Infrastructure | Safe System Hierarchy Tiers | | | |
|---|---|---|---|---|
| | 1 – Remove Severe Conflicts | 2 – Reduce Vehicle Speeds | 3 – Manage Conflicts in Time | 4 – Increase Attentiveness and Awareness |
| Refuge Island | ✓ | ✓ | | |
| Bicycle Ramp | ✓ | | | |

| Countermeasures to Enhance Crossing Infrastructure | Safe System Hierarchy Tiers | | | |
|---|---|---|---|---|
| | 1 – Remove Severe Conflicts | 2 – Reduce Vehicle Speeds | 3 – Manage Conflicts in Time | 4 – Increase Attentiveness and Awareness |
| Curb Extensions | | ✓ | | ✓ |
| Raised Crosswalk | | ✓ | | ✓ |
| Raised Intersection | | ✓ | | ✓ |
| Pedestrian Signal | | | ✓ | ✓ |
| Pedestrian Hybrid Beacon | | | ✓ | ✓ |
| Rectangular Rapid Flashing Beacon | | | ✓ | ✓ |
| Pedestrian Detection | | | ✓ | |
| Extend Pedestrian Crossing Time | | | ✓ | |
| Bike Detection | | | ✓ | |
| Extend Green Time for Bikes | | | ✓ | |
| High-Visibility Crosswalk | | | | ✓ |
| Conflict Zone Striping | | | | ✓ |
| Remove Obstructions for Sightlines | | | | ✓ |
| Yield To Pedestrian Sign | | | | ✓ |
| Bicycle Crossing | | | | ✓ |
| Straighten Crosswalk | | | | ✓ |
| Yield Markings | | | | ✓ |

## New or Improved Lighting

Installation or upgrading street lighting at intersections helps to improve the visibility of people walking or biking to drivers when there is insufficient natural light.

| Countermeasures to Improve Lighting | Safe System Hierarchy Tiers | | | |
|---|---|---|---|---|
| | 1 – Remove Severe Conflicts | 2 – Reduce Vehicle Speeds | 3 – Manage Conflicts in Time | 4 – Increase Attentiveness and Awareness |
| Street Lighting | | | | ✓ |
| Intersection Lighting | | | | ✓ |

| Countermeasures to Improve Lighting | Safe System Hierarchy Tiers | | | |
|---|---|---|---|---|
| | 1 – Remove Severe Conflicts | 2 – Reduce Vehicle Speeds | 3 – Manage Conflicts in Time | 4 – Increase Attentiveness and Awareness |
| Upgrade Lighting to LED | | | | ✓ |

## Non-Engineering Countermeasures

Recommendations for non-engineering countermeasures include:

### Automated Enforcement

Pending state legislation that allows broader use of speed safety cameras and red light cameras, such technology could be used to help manage vehicle speeds particularly in the areas of the city where people are walking and biking.

### Pair Education with Engineering Countermeasures

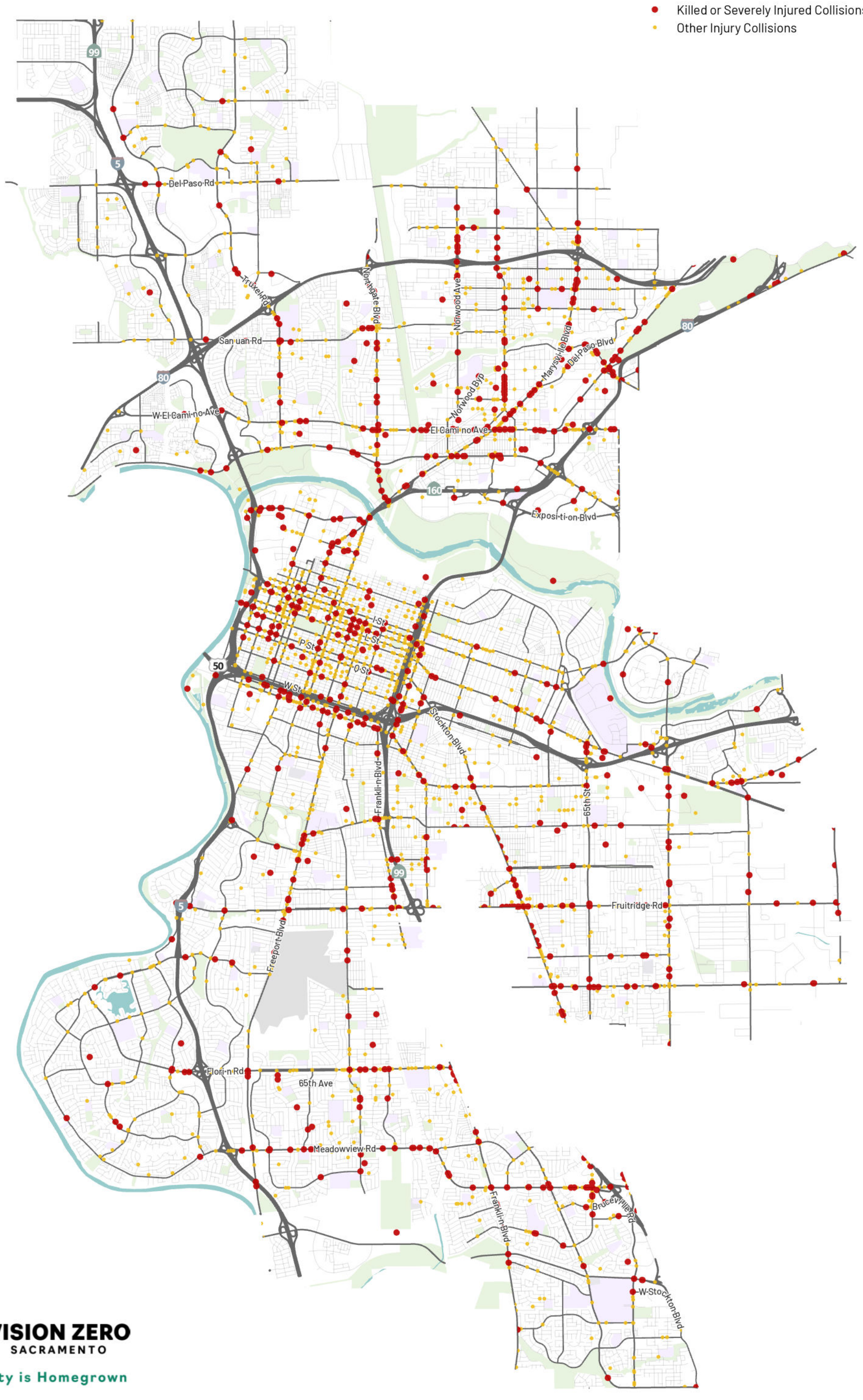
Educational materials can be used to help people become more familiar and comfortable with less frequently used countermeasures, such as roundabouts or separated bikeways.

### Education & Public Awareness Campaigns Targeted at Increasing Motorists' Awareness of People Walking and Biking

Coordinating with public communications staff/public information officers to help establish ongoing public education on social media.

Figure 1

# Collisions Involving Walking and Biking

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# #2: Broadside Collisions Near Intersections in Commercial Areas

Broadside-type ("T-Bone") collisions within 150 feet of an intersection and within 250 feet of a commercial area

**Figure 2** shows where collisions meeting this profile occurred in the City of Sacramento.

## Statistics

- 25% of injury collisions (4,758 collisions)
- 17% of KSI collisions (244 collisions)

## Engineering Countermeasures

For **Broadside Collisions Near Intersections in Commercial Areas**, the strategies below focus on reducing the number of conflict points on streets in commercial areas, improving management of the conflict points present, slowing vehicle speeds, and supplementing with treatments intended to increase road user awareness and attentiveness. Commercial corridors often feature multilane roadways with multiple driveways and larger signalized intersections, all of which increase the risk of broadside crashes.

Recommendations for engineering countermeasures include:

### Enhance Conflict Management at Intersections

At existing signalized intersections, implementing protected left-turn phasing separates left-turning vehicles from opposing through vehicle movement in time and has been found to significantly reduce the likelihood of broadside crashes. At existing unsignalized intersections, implementing roundabouts helps significantly reduce the number of conflicts or crossing paths of travel at intersections, which has been found to improve safety outcomes. Roundabouts also facilitate U-turn movements which are beneficial on commercial corridors with raised medians and access management. Finally, roundabouts have notably lower maintenance costs than traffic signals.

| Countermeasures to Enhance Intersection Conflict Management | Safe System Hierarchy Tiers | | | |
|---|---|---|---|---|
| | 1 – Remove Severe Conflicts | 2 – Reduce Vehicle Speeds | 3 – Manage Conflicts in Time | 4 – Increase Attentiveness and Awareness |
| Roundabout | ✓ | ✓ | | |
| Protected Intersection | ✓ | ✓ | ✓ | ✓ |
| Reduced Left-Turn Conflict Intersection | ✓ | | | |
| Prohibit Left Turn | ✓ | | | |

| Countermeasures to Enhance Intersection Conflict Management | Safe System Hierarchy Tiers | | | |
|---|---|---|---|---|
| | 1 – Remove Severe Conflicts | 2 – Reduce Vehicle Speeds | 3 – Manage Conflicts in Time | 4 – Increase Attentiveness and Awareness |
| All-Way Stop Control | | | ✓ | ✓ |
| Traffic Signal | | | ✓ | |
| Protected Left Turns | | | ✓ | |
| Bicycle Signal/Exclusive Bike Phase | | | ✓ | |
| Leading Pedestrian Interval and Pedestrian Recall | | | ✓ | |
| Advanced Dilemma Zone Detection | | | ✓ | |
| Flashing Yellow Turn Phase | | | | ✓ |
| Time-Based Turn Restriction | | | | ✓ |
| Striping Through Intersection | | | | ✓ |

## Reduce Conflicts between Intersections

Installing raised medians (with landscaping when feasible) and consolidating access driveways help limit the number of vehicle interactions and turning movements between and near intersections, thereby reducing the likelihood of broadside crashes.

| Countermeasures to Reduce Conflicts between Intersections | Safe System Hierarchy Tiers | | | |
|---|---|---|---|---|
| | 1 – Remove Severe Conflicts | 2 – Reduce Vehicle Speeds | 3 – Manage Conflicts in Time | 4 – Increase Attentiveness and Awareness |
| Raised Median | ✓ | | | |
| Driveway Consolidation | ✓ | | | |
| Directional Median Openings to Restrict Left Turns | ✓ | | | |
| Median Barrier | ✓ | | | |

## Reduce Vehicle Turning Speeds at Intersections

Countermeasures such as centerline hardening, tighter curb radii, and slow turn wedges help slow vehicles and improve visibility at conflict points. Removing right-turn slip lanes also helps slow vehicle speeds through intersections.

| Countermeasures to Reduce Intersection Vehicle Turning Speeds | Safe System Hierarchy Tiers | | | |
|---|---|---|---|---|
| | 1 – Remove Severe Conflicts | 2 – Reduce Vehicle Speeds | 3 – Manage Conflicts in Time | 4 – Increase Attentiveness and Awareness |
| Centerline Hardening | ✓ | | | ✓ |
| Close Slip Lane | | ✓ | | |
| Raised Intersection | | ✓ | | ✓ |
| Slow Turn Wedge | | ✓ | | ✓ |
| Intersection Reconstruction and Tightening | | ✓ | | ✓ |
| Upgrade Striping | | | | ✓ |

## Enhance Guidance and Visibility of Traffic Control Devices

Treatments like retroreflective tape on signals, upgrading intersection pavement markings, and high-visibility crosswalks can improve driver's awareness and compliance.

| Countermeasures to Enhance Guidance and Visibility of Traffic Control Devices | Safe System Hierarchy Tiers | | | |
|---|---|---|---|---|
| | 1 – Remove Severe Conflicts | 2 – Reduce Vehicle Speeds | 3 – Manage Conflicts in Time | 4 – Increase Attentiveness and Awareness |
| High-Visibility Crosswalk | | | | ✓ |
| Upgrade Intersection Pavement Markings | | | | ✓ |
| Upgrade Signs with Fluorescent Sheeting | | | | ✓ |
| Upgrade Signal Heads | | | | ✓ |
| Red Light Camera | | | | ✓ |
| Retroreflective Tape on Signals | | | | ✓ |
| Supplemental Signal Heads | | | | ✓ |

## Non-Engineering Countermeasures

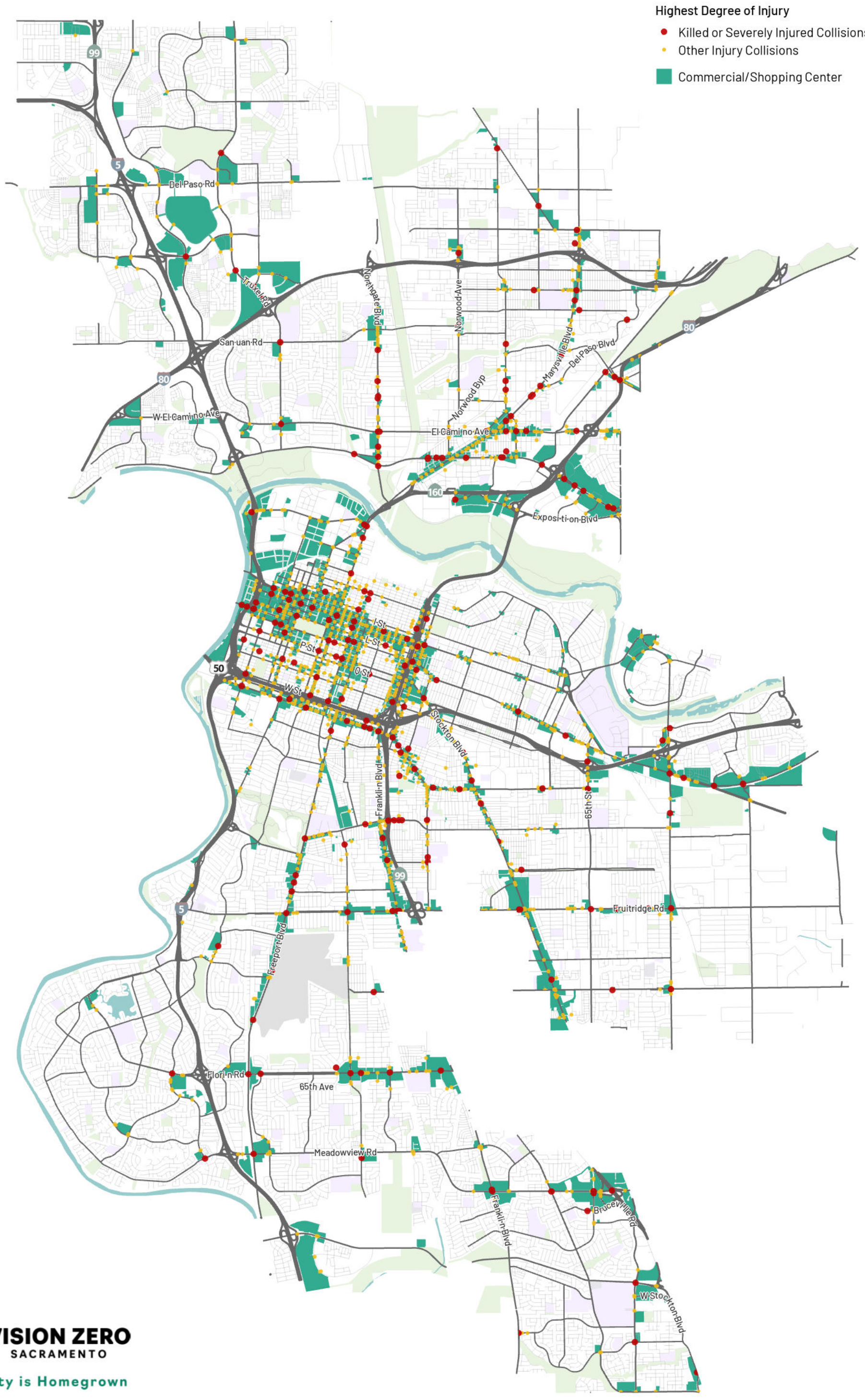
Recommendations on non-engineering countermeasures include:

### Automated Enforcement

Automated enforcement devices such as red-light cameras installed at intersections or speed safety cameras installed between intersections, can help improve motorists' compliance with traffic control devices and speed limits. The use of speed safety cameras is dependent upon state legislation allowing for broader use in California.

Figure 2

# Broadside Collisions Near Intersections in Commercial Area

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# #3: Lack of Conflict Management at Intersections

Collisions within 150 feet of an intersection with primary collision factors (PCF) of auto right-of-way or traffic signals and signs

**Vehicle Right-of-Way Violations** occur when a driver fails to properly yield to another road user who has the legal right-of-way (e.g., failing to yield to oncoming traffic when making a turn, not stopping properly at stop signs, and improperly entering a roadway). These violations can also involve interactions with people walking and bicycling such as failing to yield when turning right on red or not stopping for a person in a crosswalk.

**Traffic Signals and Signs Violations** indicate failures to comply with traffic control devices, including stop signs and traffic signals. Typical violations include running red lights, failing to stop at limit lines, and proceeding through an intersection without following posted signs.

**Figure 3** shows where collisions meeting this profile occurred in the City of Sacramento.

## Statistics

- 33% of all injury collisions (6,328 collisions)
- 21% of KSI collisions (307 collisions)

## Engineering Countermeasures

**Conflict Management at Intersections** helps reduce the likelihood of crashes. Conflicts occur whenever one road user's path through an intersection crosses another. Traffic control devices such as signals, roundabouts, and stop signs help to assign right of way to different road users as a means for managing those conflicts. Some traffic control devices are more effective at conflict management than others. And some traffic control devices, such as traffic signals, can be adjusted to more actively manage conflicts between road users (e.g., converting permitted left-turns to protected left-turns). Conflict management at intersections is particularly important on streets where vehicles are traveling above 25 mph, where there is demand for people to walk and bike, and/or where vehicle volumes are above 2,500 vehicles/day.

Therefore, the selected countermeasures focus on eliminating the conflicts altogether through intersection design changes or managing the conflicts in time using signal phasing or timing changes. There are also countermeasures noted below to help manage speeds and increase driver awareness.

Recommendations for engineering countermeasures are listed below.

### Eliminate Severe Conflicts

Intersection design changes that eliminate crossing conflicts and/or conflicts between motorists and people walking and biking lead to substantive improvements in safety outcomes because they fundamentally reduce the number of points in an intersection where a crash could occur. Roundabouts are one strong example of this where a traditional four-legged intersection has 32 vehicle-vehicle conflict points compared to a four-legged roundabout which has 8 vehicle-vehicle conflict points. Protected intersections are another example where there is strong emphasis on eliminating conflict points between motorists' and people walking and biking.

| Countermeasures to Eliminate Severe Intersection Conflicts | Safe System Hierarchy Tiers | | | |
|---|---|---|---|---|
| | 1 – Remove Severe Conflicts | 2 – Reduce Vehicle Speeds | 3 – Manage Conflicts in Time | 4 – Increase Attentiveness and Awareness |
| Roundabout | ✓ | ✓ | | |
| Protected Intersection | ✓ | ✓ | ✓ | ✓ |
| Reduced Left-Turn Conflict Intersection | ✓ | | | |

## Access Management

Access management reduces conflict points and improves safety at intersections and along corridors. Countermeasures such as raised medians limit turning movements, reducing mid-block conflicts and improving traffic control. At intersections, applying turn restrictions, such as prohibiting left-turn movements, also reduces the likelihood of related collisions. Consolidation of driveways decreases the number of access points, reducing turning conflicts, especially when close to intersections. These measures are effective in high-volume areas with frequent driveways or closely spaced intersections.

| Access Management Countermeasures | Safe System Hierarchy Tiers | | | |
|---|---|---|---|---|
| | 1 – Remove Severe Conflicts | 2 – Reduce Vehicle Speeds | 3 – Manage Conflicts in Time | 4 – Increase Attentiveness and Awareness |
| Raised Median | ✓ | | | |
| Driveway Consolidation | ✓ | | | |
| Prohibit Left Turn | ✓ | | | |
| Prohibit Right-Turn-on-Red | ✓ | | ✓ | |
| Reduced Left-turn Conflict Intersection | ✓ | | | |
| Upgrade Striping | | | | ✓ |

## Manage Conflicts in Time through Signal Timing and Phasing

Measures like protected left-turn phases and prohibiting right-turn-on-red separate conflicting movements in time and help reduce the likelihood of severe collisions. Similarly, providing separate signal phases for people walking and biking to cross the street helps reduce the likelihood of someone being hit by a turning vehicle. Turn restrictions such as prohibiting left-turn movements at

an intersection also reduces the likelihood related collisions. This type of strategy is most effective when evaluated and implemented in consideration of the surrounding street network.

| Signal Timing and Phasing Countermeasures | Safe System Hierarchy Tiers | | | |
|---|---|---|---|---|
| | 1 – Remove Severe Conflicts | 2 – Reduce Vehicle Speeds | 3 – Manage Conflicts in Time | 4 – Increase Attentiveness and Awareness |
| Prohibit Right-Turn-on-Red | | | ✓ | |
| Bicycle Signal/ Exclusive Bike Phase | | | ✓ | |
| Leading Pedestrian Interval and Pedestrian Recall | | | ✓ | |
| Prohibit Turns During Pedestrian Phase (Blank-out Signs) | | | ✓ | |
| Protected Left Turns | | | ✓ | |
| Advanced Dilemma Zone Detection | | | ✓ | |
| Red Light Camera | | | | ✓ |

## Enhance Visibility and Clarity of Traffic Control Devices

Improvements such as retroreflective tape on signals and upgraded intersection striping are designed to make traffic signals and signs more visible to motorists. These treatments can improve motorists' awareness and attentiveness.

| Traffic Control Device Visibility Countermeasures | Safe System Hierarchy Tiers | | | |
|---|---|---|---|---|
| | 1 – Remove Severe Conflicts | 2 – Reduce Vehicle Speeds | 3 – Manage Conflicts in Time | 4 – Increase Attentiveness and Awareness |
| Upgrade Intersection Pavement Markings | | | | ✓ |
| Retroreflective Tape on Signals | | | | ✓ |
| Upgrade Signal Head | | | | ✓ |

## Non-Engineering Countermeasures

Recommendations for non-engineering countermeasures include:

### Automated Enforcement

Automated enforcement devices such as red-light cameras installed at intersections or speed safety cameras installed between intersections can help improve motorists' compliance with traffic control devices and speed limits. Vehicle speeds on approach to and through intersections directly determine the severity of a collision when they do occur. Speed management on approach to and through intersections is critical for improved safety outcomes since intersections are where all modes cross paths of travel with other modes. The use of speed safety cameras in Sacramento is dependent upon state legislation allowing for broader use in California.

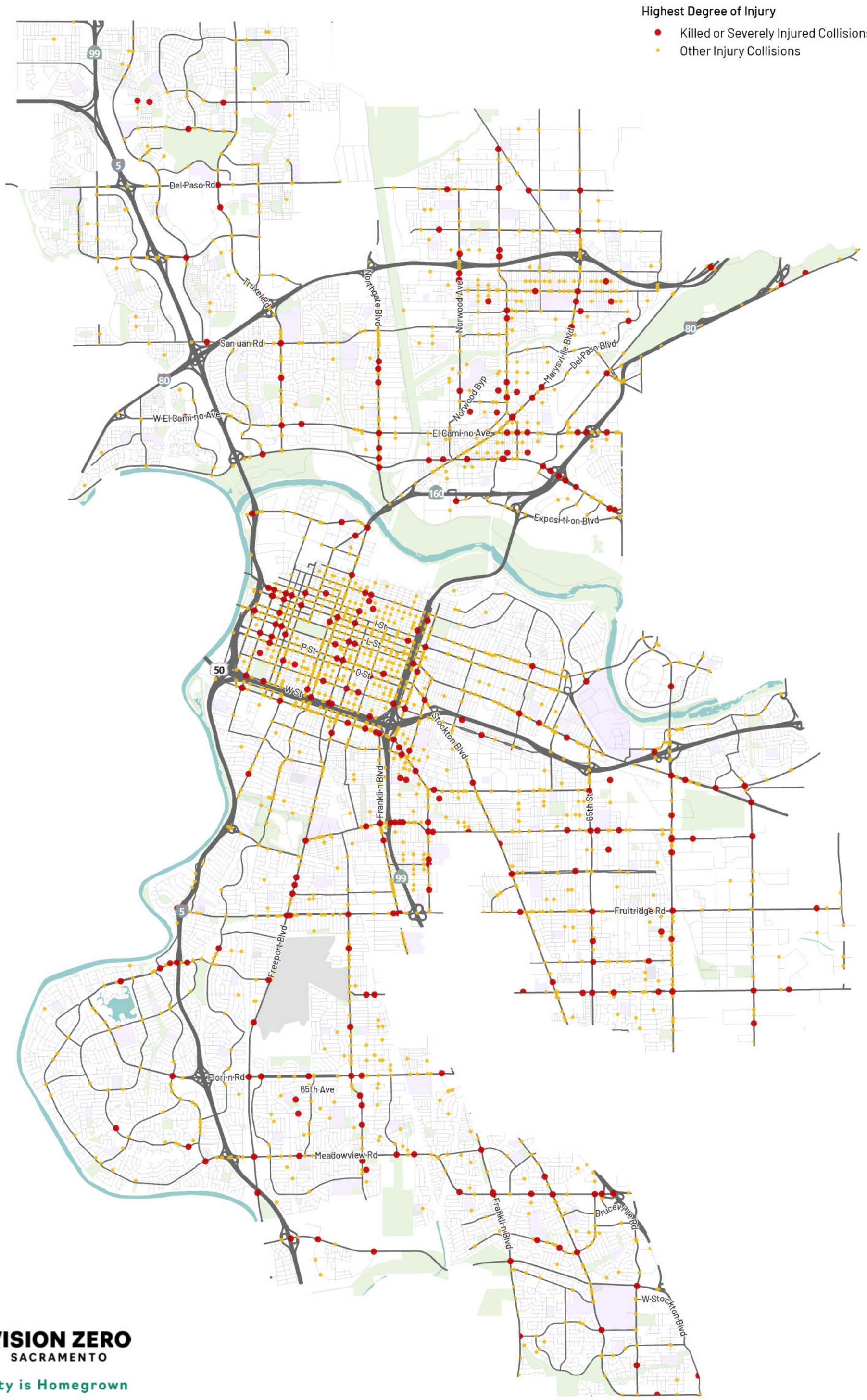
### Education Campaigns about New Intersection Treatments

Coordinating with public communications staff/public information officers to use existing social media accounts (e.g. Facebook, NextDoor, Instagram, etc.) can help establish an ongoing public education campaign focused on making motorists aware of new no right-turn-on red rules and how to use roundabouts, both of which are not regularly encountered in the City.

Figure 3

# Conflict Management at Intersections

Auto Right of Way & Traffic Signals and Signs Primary Collision Factors + within 150 feet of an intersection

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# #4: Collisions Near Transit Stops

Collisions within 250 feet of a bus stop or light rail station

**Figure 4** shows where collisions meeting this profile occurred in the City of Sacramento.

## Statistics

- 43% of injury collisions (8,329 collisions)
- 42% of the KSI collisions (612) occurred

## Engineering Countermeasures

**Collisions Near Transit Stops** are addressed through countermeasures that actively manage or reduce the number of conflict points between buses, motorists, and people biking and walking as a means for reducing the likelihood of crashes occurring. Some of the strategies below also help manage motorists' speeds which helps to reduce potential severity of crashes. Transit riders need to be able to safely access transit stops. Thus, there is a focus on providing well-designed crossings and sidewalks that connect to the transit stops. As well as strategies to reduce crossing distances and more actively manage crossing conflicts.

Recommendations for engineering countermeasures include:

### Co-locate Bus/Transit Stops and Appropriately Designed Crossings

Co-locating bus/transit stops with appropriately designed crossings for people walking helps improve conflict management and reduce likelihood of crashes between motorists and people walking. The City's *Pedestrian Crossing Guidelines (April 2021)* are a good resource for determining specific crossing design features based on vehicle speeds, number of lanes, and vehicle volumes. In some instances, it may be more appropriate to move bus/transit stop to be closer to an existing crossing. Moving bus/transit stops to the far side of intersections also decreases instances in which riders must cross in front of the bus and oncoming traffic after disembarking, improving visibility and reducing mid-block crossings. Far side bus/transit stop placement can also improve transit system efficiency. Additional pedestrian crossing improvements such as pedestrian detection systems at existing traffic signals can be placed near busier bus stops/transit stations to provide responsive (e.g., lower wait times for people walking) "WALK" opportunities, especially along high-volume transit corridors.

| Transit Stop / Crossing Countermeasures | Safe System Hierarchy Tiers | | | |
|---|---|---|---|---|
| | 1 – Remove Severe Conflicts | 2 – Reduce Vehicle Speeds | 3 – Manage Conflicts in Time | 4 – Increase Attentiveness and Awareness |
| Far-Side Bus Stop | ✓ | | | ✓ |
| Co-Locate Bus Stops and Marked Pedestrian Crossings | | | | ✓ |
| Pedestrian Detection | | | ✓ | |

## Improve Visibility of and for Transit Riders and Reduce Crossing Distance

Countermeasures such as bus bulbs and bus boarding islands help reduce crossing distances and also improve visibility of and for people accessing transit. Bus boarding islands help maintain separation between buses and people biking by removing the conflict that can otherwise occur when buses cross a bike lane to pull to the curb at a bus stop.

| Countermeasures to Improve Transit Rider Visibility | Safe System Hierarchy Tiers | | | |
|---|---|---|---|---|
| | 1 – Remove Severe Conflicts | 2 – Reduce Vehicle Speeds | 3 – Manage Conflicts in Time | 4 – Increase Attentiveness and Awareness |
| Floating Transit Island or Bus Boarding Island | ✓ | ✓ | | |
| Curb Extensions | | ✓ | | ✓ |

## Provide Sidewalk and Bicycle Facilities to Bus/Transit Stops

Countermeasures such as building sidewalks or implementing bicycle facilities that connect to bus/transit stops help create separate space for transit riders who are walking or biking to access transit service. Constructing those complete connections within a ¼ to ½ mile of any given bus/transit stop helps reduce the likelihood of crashes involving people accessing transit via active modes.

| Sidewalk and Bike Connection Countermeasures | Safe System Hierarchy Tiers | | | |
|---|---|---|---|---|
| | 1 – Remove Severe Conflicts | 2 – Reduce Vehicle Speeds | 3 – Manage Conflicts in Time | 4 – Increase Attentiveness and Awareness |
| Add Sidewalk | ✓ | | | |
| Bike Lane | ✓ | | | |
| Shared-Use Path | ✓ | | | |
| Separated Bikeway | ✓ | | | |

## Non-Engineering Countermeasures

Recommendations for non-engineering countermeasures include:

### Continued Automated Enforcement

SacRT has recently deployed automated bus stop parking enforcement with bus-mounted camera systems. Unauthorized parking in bus stops makes it challenging for bus operators to safely pull up to curbs, often forcing passengers to board or exit buses away from the designated stop area, which can increase crash exposure for riders, create accessibility challenges, and generally increase inconvenience for transit riders.

### Education Campaigns for Motorists

The City can partner with SacRT to develop and implement education campaigns to raise motorist awareness about proper behavior around buses, bus stops, and light rail stations. This could include messaging on buses and/or on signs at stops or bus shelters as well as via social media or other media outlets.

Figure 4

# Collisions Near Transit Facilities


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# #5: Collisions Near Parks and Schools

Collisions within 250 feet of a park or school

**Figure 5** shows where collisions meeting this profile occurred in the City of Sacramento.

## Statistics

- 19% of injury collisions (3,716 collisions)
- 21% of KSI collisions (312 collisions)

## Engineering Countermeasures

For **Collisions Near Parks and Schools**, the countermeasures aim to separate vulnerable road users such as children walking and biking from vehicles and reduce vehicle speeds on streets adjacent to parks and schools. Slowing vehicle speeds is paramount given the younger age of road users that tend to be concentrated around parks and schools. Ideally, near parks and schools, vehicles speed would be 25 mph or slower. Slow vehicle speeds greatly reduces the potential of severe crashes.

Recommendations for engineering countermeasures include:

### Separate Road Users in Space and Time

Construction of sidewalks, shared-use paths, and separated bike networks for people walking and biking, with connection to the existing biking and walking networks, will enable a continuous and protected environment regardless of vehicle speed or vehicle sizes on the street. This includes building protected intersections to provide for the separation of people walking and biking up to and through an intersection. It also includes adjusting signal timing at traffic signals to allow for things like leading pedestrian intervals, right-turn on red prohibitions, detection for people walking and biking, automatic recall, and/or separate signal phases so people walking and biking are able to cross without conflicting vehicle turning movements.

| Countermeasures that Separate Users in Space and Time | Safe System Hierarchy Tiers | | | |
|---|---|---|---|---|
| | 1 – Remove Severe Conflicts | 2 – Reduce Vehicle Speeds | 3 – Manage Conflicts in Time | 4 – Increase Attentiveness and Awareness |
| Add Sidewalk | ✓ | | | |
| Shared-Use Path | ✓ | | | |
| Separated Bikeway | ✓ | | | |
| Protected Intersection | ✓ | ✓ | ✓ | ✓ |
| Prohibit Right-Turn-on-Red | ✓ | | ✓ | |
| Leading Pedestrian Interval and Pedestrian Recall | | | ✓ | |

| Countermeasures that Separate Users in Space and Time | Safe System Hierarchy Tiers | | | |
|---|---|---|---|---|
| | 1 – Remove Severe Conflicts | 2 – Reduce Vehicle Speeds | 3 – Manage Conflicts in Time | 4 – Increase Attentiveness and Awareness |
| Pedestrian Detection | | | ✓ | |
| Pedestrian Scramble | | | ✓ | |
| Pedestrian Signal | | | ✓ | |
| Bicycle Signal/ Exclusive Bike Phase | | | ✓ | |

## Manage Vehicle Speeds

Managing vehicle speeds with signal progression, installing roundabouts, installing speed lumps or humps,, and creating landscape buffers can encourage drivers to slow down and thus reduce the likelihood and severity of crashes when drivers interact with people walking or biking. Speed management is especially critical when separate space is not provided for people walking or biking (e.g., bike routes or bike boulevards).

| Countermeasures that Mange Vehicle Speeds | Safe System Hierarchy Tiers | | | |
|---|---|---|---|---|
| | 1 – Remove Severe Conflicts | 2 – Reduce Vehicle Speeds | 3 – Manage Conflicts in Time | 4 – Increase Attentiveness and Awareness |
| Protected Intersection | ✓ | ✓ | ✓ | ✓ |
| Roundabout | ✓ | ✓ | | |
| Road Diet/Lane Reduction | ✓ | ✓ | | |
| Landscape Buffer | ✓ | | | |
| Signal Interconnectivity and Coordination/ Green Wave | | ✓ | ✓ | |
| Speed Limit Reduction | | ✓ | | ✓ |
| Slow Turn Wedge | | ✓ | | ✓ |
| Speed Lumps | | ✓ | | |
| Speed Hump or Speed Table | | ✓ | | |
| Speed Feedback Sign | | | | ✓ |
| Splitter Island | | | | ✓ |

## Enhance Crossing Infrastructure

Continued application of the City's *Pedestrian Crossing Guidelines (April 2021)* will be helpful to steadily improve crossing conditions for people walking and biking. Features such as refuge islands, curb extensions/bulb-outs, bus bulbs, all shorten the crossing distances to cross the street. These features also help to slow motorists' speeds by physically and visually narrowing the street width. Raised medians and refuge islands allow pedestrians to cross one direction of traffic at a time, reducing exposure to vehicles. These can be supplemented with additional traffic control like pedestrian signals at locations with higher vehicle volumes, higher vehicle speeds, and/or multiple vehicle lanes to cross.

| Countermeasures that Enhance Crossing Infrastructure | Safe System Hierarchy Tiers | | | |
|---|---|---|---|---|
| | 1 – Remove Severe Conflicts | 2 – Reduce Vehicle Speeds | 3 – Manage Conflicts in Time | 4 – Increase Attentiveness and Awareness |
| Pedestrian Signals | | | ✓ | |
| Curb Extensions | | ✓ | | ✓ |
| Raised Crosswalk | | ✓ | | ✓ |
| Raised Intersection | | ✓ | | ✓ |
| Refuge Island | ✓ | ✓ | | |
| Remove Obstructions for Sightlines | | | | ✓ |
| Extend Pedestrian Crossing Time | | | ✓ | |
| Pedestrian Hybrid Beacon | | | ✓ | ✓ |
| Co-Locate Bus Stops and Pedestrian Crossings | | | | ✓ |
| Restripe Crosswalk | | | | ✓ |
| Pedestrian Signal | | | ✓ | ✓ |
| Upgrade Striping | | | | ✓ |

## Lower Speed Limits

Using AB 321, the City of Sacramento has already implemented 15 mph school zone speed limits and/or 25 mph extended school zone speed limits across 225 road segments near 115 schools. Other streets in proximity to schools or parks could use the provisions from AB 43, now incorporated into the CA MUTCD, to lower speeds if they are on the Safety Corridor/High-Injury Network and/or are within a quarter mile of land uses that generate a demand for walking and/or biking.

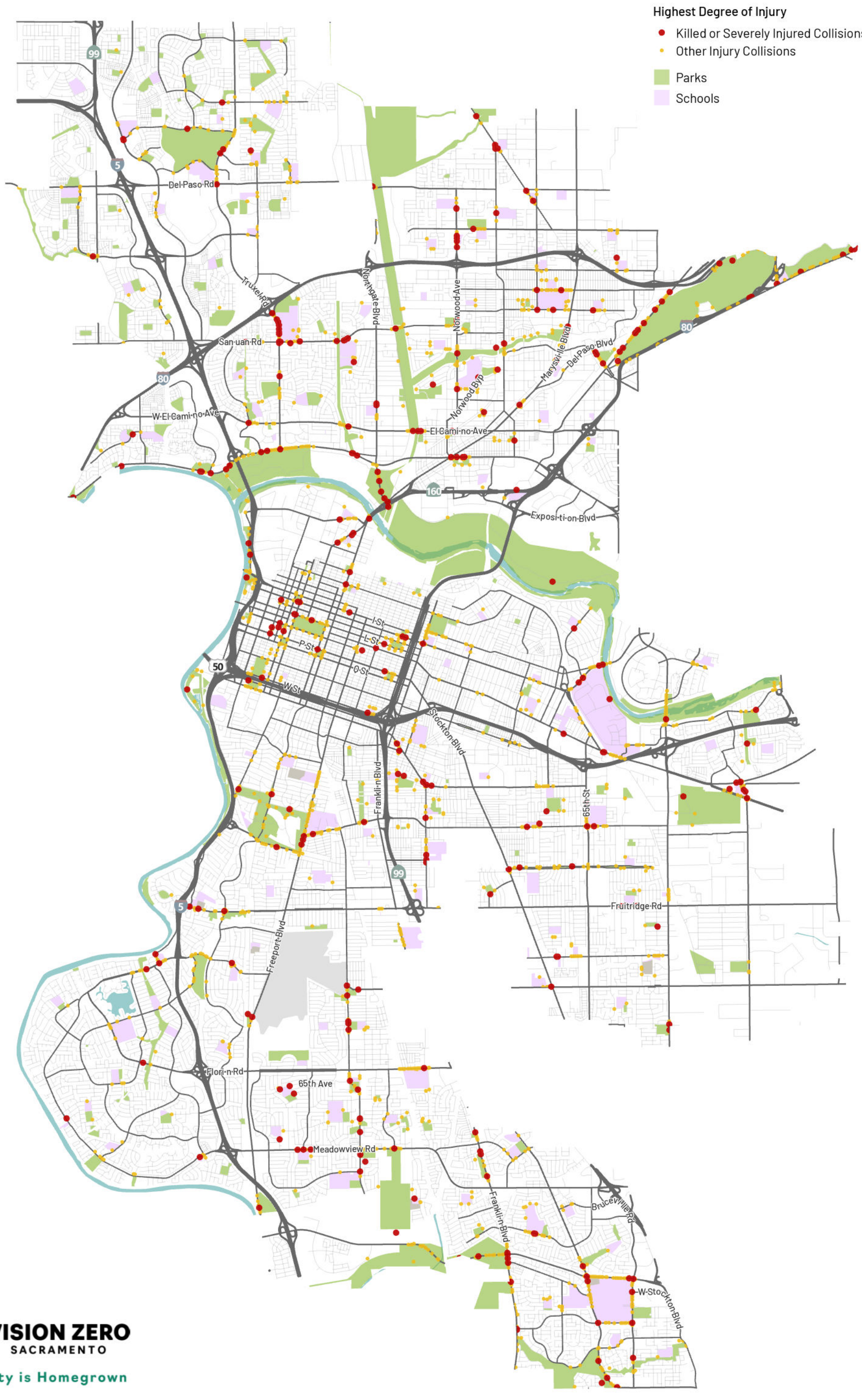
## Non-Engineering Countermeasures

Recommendations for non-engineering countermeasures could include Safe Routes to School or Safe Routes to Parks programs. Currently, the Sacramento City Council has declined to support City-managed SRTS programs, but non-profits and school districts could step in to provide programming in the future.

Programming could include: Walk to School Day and Bike to School day, safe walking and biking maps, community walks and rides, creation of promotional materials, parent champion training, and more to promote active transportation and reduce traffic-related injuries and fatalities among school-aged children. The more children walk and bike to school, the less vehicles are on the roadway network, thus decreasing exposure of kinetic energy risk for all on the network, with the goal of creating a healthy, active, and safer transportation culture.

Figure 5

# Collisions Near Parks or Schools

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# #6: Unsafe Speed Collisions on Arterial Roadways

Collisions with a primary collision factor of unsafe speed that occurred on an arterial or expressway.

**Unsafe Speed Violations** occur when motorists operate a vehicle at a speed that exceeds what is considered safe given roadway conditions, including weather, visibility, traffic volume, and road surface characteristics. This violation does not only mean exceeding the posted speed limit but driving at a speed that poses a risk to other road users.

**Figure 6** shows where collisions meeting this profile occurred in the City of Sacramento.

## Statistics

- 17% of injury collisions (3,315)
- 8% of the KSI collisions (120)

*Arterials only make up a small portion of the total roadway network (approximately 11%).*

## Engineering Countermeasures

For **Unsafe Speed Collisions on Arterial Streets**, the countermeasures are aimed at reducing vehicle speeds and conflict management. Speed is a primary contributing factor in the severity of all crashes that occur. Crashes that occur at slower speeds are more likely to result in minor or no injuries. Speed management on arterials can help reduce the likelihood of severe outcomes while still allowing for motorists to travel along the street. The countermeasures discussed below employ strategies for both street segments as well as at intersections.

Recommendations for engineering countermeasures include:

### Roadway Space Reallocation

Countermeasures such as road diets and lane narrowing encourages motorists to drive at lower speeds and creates more space for other uses (e.g., bike facilities, wider sidewalks, space for transit) as well as turn lanes at intersections. Visual narrowing techniques, including adding street trees, vertical lighting elements, street furniture, special paving treatments, or roadway markings, can also help to slow speeds and increase driver attentiveness.

| Countermeasures that Reallocate Roadway Space | Safe System Hierarchy Tiers | | | |
|---|---|---|---|---|
| | 1 – Remove Severe Conflicts | 2 – Reduce Vehicle Speeds | 3 – Manage Conflicts in Time | 4 – Increase Attentiveness and Awareness |
| Landscape Buffer | ✓ | | | |
| Road Diet/Lane Reduction | ✓ | ✓ | | |
| Lane Narrowing | | ✓ | | |

| Countermeasures that Reallocate Roadway Space | Safe System Hierarchy Tiers | | | |
|---|---|---|---|---|
| | 1 – Remove Severe Conflicts | 2 – Reduce Vehicle Speeds | 3 – Manage Conflicts in Time | 4 – Increase Attentiveness and Awareness |
| Delineators, Reflectors, and/or Object Markers | | | | ✓ |
| Upgrade Striping | | | | ✓ |
| Median Barrier | ✓ | | | |

## Modifying Existing Signal Operations

For corridors with signals spaced sufficiently close to one another can be re-timed and coordinated such that vehicles are encouraged to travel at a slower speed to reach a series of traffic signals during their green phase. Signals timed for a slow green wave of 15 mph or 25 mph can help reduce the potential for severe crashes as motorists progress more slowly through the corridor. In off-peak periods, traffic signals can be programmed to rest in red which has also been shown to slow vehicle speeds during off peak time periods.

| Countermeasures that Modify Signal Operations | Safe System Hierarchy Tiers | | | |
|---|---|---|---|---|
| | 1 – Remove Severe Conflicts | 2 – Reduce Vehicle Speeds | 3 – Manage Conflicts in Time | 4 – Increase Attentiveness and Awareness |
| Signal Interconnectivity and Coordination/ Green Wave | | ✓ | ✓ | |
| Speed Sensitive Rest in Red Signal | | ✓ | ✓ | |
| Advanced Dilemma Zone Detection | | | ✓ | |
| Red Light Camera | | | | ✓ |

## Change in Intersection Traffic Control

Roundabouts are effective intersection traffic control devices that slow vehicle speeds along a corridor while also eliminating severe conflicts at the intersection. Roundabouts also have notably lower maintenance costs than traffic signals while often being able to adequately serve similar traffic volumes as a traffic signal. Roundabouts can be implemented in place of existing signals or stop controlled (either two-way or all-way) intersections.

There also may be instances where installing *new signals* may be beneficial for enabling coordinating slow vehicle speed progression (see slow green wave above); however, new signals need to meet CA MUTCD warrant to be installed.

| Countermeasures that Change Intersection Traffic Control | Safe System Hierarchy Tiers | | | |
|---|---|---|---|---|
| | 1 – Remove Severe Conflicts | 2 – Reduce Vehicle Speeds | 3 – Manage Conflicts in Time | 4 – Increase Attentiveness and Awareness |
| Roundabout | ✓ | ✓ | | |
| Traffic Signal | | | ✓ | |

## Reduce Vehicle Turning Speeds at Intersections

Countermeasures such as centerline hardening, tighter curb radii, and slow turn wedges help slow vehicles and improve visibility at conflict points. Removing right-turn slip lanes also helps slow vehicle speeds through intersections.

| Countermeasures that Reduce Vehicle Turning Speeds at Intersections | Safe System Hierarchy Tiers | | | |
|---|---|---|---|---|
| | 1 – Remove Severe Conflicts | 2 – Reduce Vehicle Speeds | 3 – Manage Conflicts in Time | 4 – Increase Attentiveness and Awareness |
| Centerline Hardening | ✓ | | | ✓ |
| Slow Turn Wedge | | ✓ | | ✓ |
| Close Slip Lane | | ✓ | | |
| Intersection Reconstruction and Tightening | | ✓ | | ✓ |
| Flashing Beacon as Advance Warning | | | | ✓ |

## Speed Limit Adjustment and Feedback

Implementing a lower posted speed limit (per allowances introduced by AB 43 and included in the CA MUTCD) and installing speed feedback signs helps alert drivers when they are driving above the speed limit to encourage voluntary compliance.

| Countermeasures that Adjust Speed Limits | Safe System Hierarchy Tiers | | | |
|---|---|---|---|---|
| | 1 – Remove Severe Conflicts | 2 – Reduce Vehicle Speeds | 3 – Manage Conflicts in Time | 4 – Increase Attentiveness and Awareness |
| Speed Limit Reduction | | ✓ | | ✓ |
| Speed Feedback Sign | | | | ✓ |

### Access Management

While access management does not directly address unsafe speeds, it can help reduce the severity of collisions on high-speed arterial roadways by limiting conflict points. As discussed in the Lack of Conflict Management at Intersections collision profile above, countermeasures like raised medians and driveway consolidation remove the opportunity for mid-block turning movements. These treatments are particularly effective on busy, high-speed arterials with frequent access points.

| Countermeasure | Safe System Hierarchy Tiers | | | |
|---|---|---|---|---|
| | 1 – Remove Severe Conflicts | 2 – Reduce Vehicle Speeds | 3 – Manage Conflicts in Time | 4 – Increase Attentiveness and Awareness |
| Driveway Consolidation | ✓ | | | |
| Raised Median | ✓ | | | |
| Impact Attenuators | ✓ | | | ✓ |

## Non-Engineering Countermeasures

Recommendations for non-engineering countermeasures include:

### Automated Enforcement

Pending state legislation that allows broader use of speed safety cameras, speed safety cameras could be used to help manage vehicle speeds particularly on arterials streets within the City.

### Education & Public Awareness Campaigns Targeted at Speeding

Coordinating with public communications staff/public information officers to help establish ongoing public education on social media.

Figure 6

# Unsafe Speed Collisions on Arterial Roads

Primary Collision Factor of Unsafe Speed + On an Arterial


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# Conclusion

Each profile is designed to target specific contributing factors and contextual conditions, such as right-of-way violations, unsafe speeds, pedestrian conflicts, and proximity to schools, parks, transit stops, and intersections. The related recommended countermeasures focus on eliminating kinetic energy risk through a combination of eliminating or improved management of conflicts, slowing vehicle speeds, and/or increasing road user attentiveness. These are consistent with the Safe System Roadway Design Hierarchy. Additional countermeasures as well as greater detail on the countermeasures mentioned above are available in **Attachments A** and **B**.

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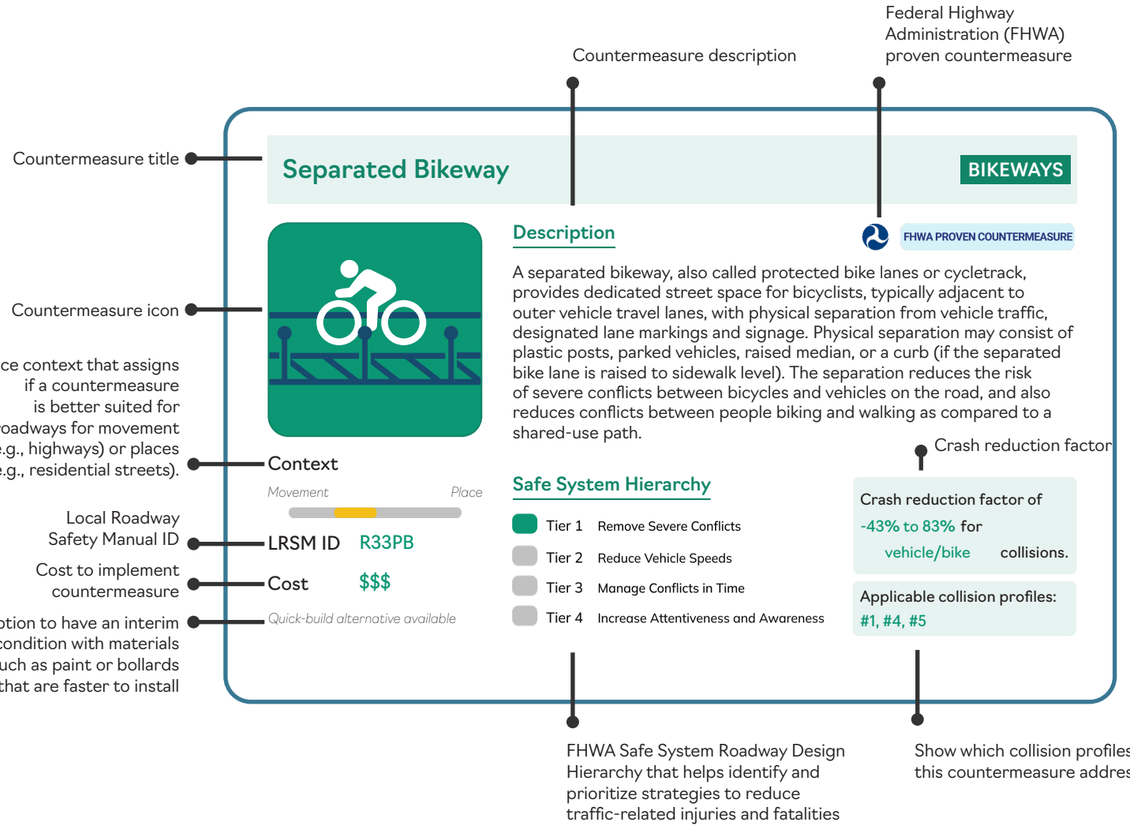
Attachment A

# Engineering Countermeasure Toolbox

## What Is The Engineering Countermeasure Toolbox?

The purpose of this Engineering Countermeasure Toolbox is to establish a shared understanding of key strategies available to address roadway safety issues that align with the Safe System Approach. The Toolbox describes a variety of countermeasures and how they can be applied to improve safety. It also includes general information about each tool's application, typical placement contexts, estimated costs, and tiers within the FHWA Safety System Hierarchy.

The countermeasure toolbox includes:



# Countermeasure Toolbox List

## A. Bikeways

Bicycle Crossing (Solid Green Paint)
Bicycle Ramp
Bicycle Signal/Exclusive Bike Phase
Bicycles May Use Full Lane Sign
Bike Detection
Bike Lane
Buffered Bike Lane
Conflict Zone Striping
Door Zone Markings
Extend Green Time For Bikes
Floating Transit Island or Bus Boarding Island
Separated Bikeway
Shared-Use Path
Through Bike Lane at Intersection

## B. Pedestrian Facilities

Add Sidewalk
Co-Locate Bus Stop and Marked Pedestrian Crossings
Curb Extensions
Extend Time Push Button
High-Visibility Crosswalk
Landscape Buffer
Leading Pedestrian Interval and Pedestrian Recall
Pedestrian Countdown Timer
Pedestrian Detection
Pedestrian Hybrid Beacon
Pedestrian Signals
Rectangular Rapid Flashing Beacon
Restripe Crosswalk

## C. Intersections & Roadways

All-Way Stop Control
Centerline Hardening
Close Slip Lane
Directional Median Openings to Restrict Left Turns
Intersection Lighting
Intersection Reconstruction and Tightening
Lane Narrowing
Median Barrier
Protected Intersection
Raised Crosswalk
Raised Intersection
Raised Median
Reduced Left-Turn Conflict Intersection
Refuge Island
Road Diet/Lane Reduction
Roundabout
Slow Turn Wedge
Speed Hump or Speed Table
Speed Lump
Splitter Island
Straighten Crosswalk
Traffic Signal

## D. Signals

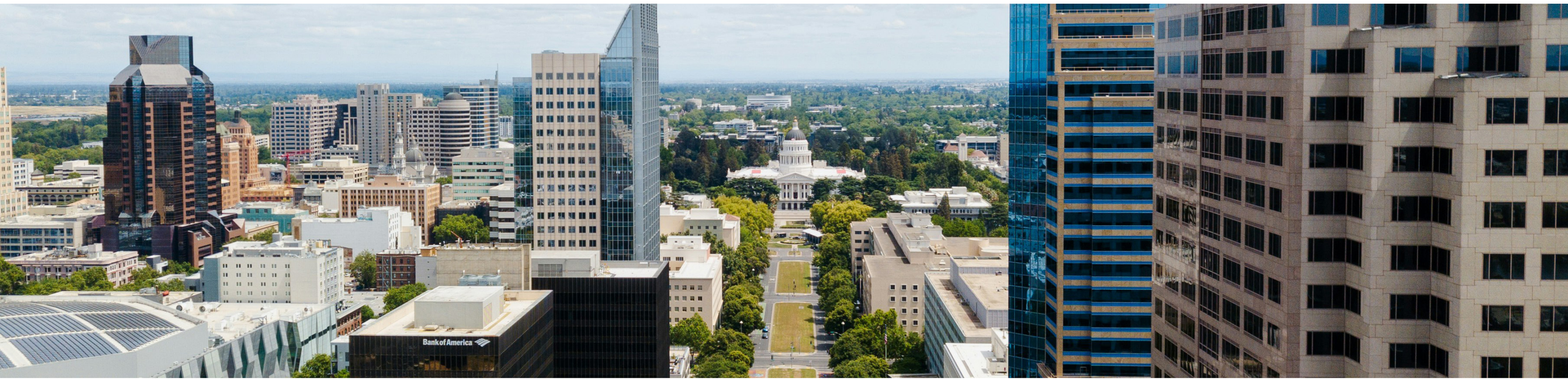
Advanced Dilemma Zone Detection
All-Red Signal Time
Extend Pedestrian Crossing Time
Flashing Yellow Turn Phase
Pedestrian Scramble
Prohibit Left Turn
Prohibit Right-Turn-on-Red
Prohibit Turns During Pedestrian Phase
Protected Left Turns
Retroreflective Tape on Signals
Separate Right-Turn Phasing
Shorten Cycle Length
Signal Interconnectivity and Coordination / Green Wave
Speed Sensitive Rest in Red Signal
Supplemental Signal Heads
Upgrade Signal Head

## E. Signing & Striping

Flashing Beacon as Advance Warning
Speed Feedback Sign
Striping Through Intersection
Time-Based Turn Restriction
Upgrade Intersection Pavement Markings
Upgrade Signs with Fluorescent Sheeting
Upgrade Striping
Yield Markings
Yield To Pedestrians Sign

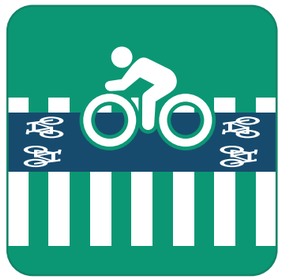
## F. Others

Driveway Consolidation
Street Lighting
Curbside Management
Far-Side Bus Stop
Delineators, Reflectors, and/or Object Markers
Impact Attenuators
Speed Limit Reduction
Remove Obstructions For Sightlines
Upgrade Lighting to LED
Red Light Camera



## Bicycle Crossing (Solid Green Paint)

BIKEWAYS



### Description

FHWA PROVEN COUNTERMEASURE

Solid green paint across an intersection that signifies the bicycle crossing. Increases the visibility of bicyclists' anticipated path of travel.

**Context**

*Movement* — *Place*

LRSM ID N/A

Cost $

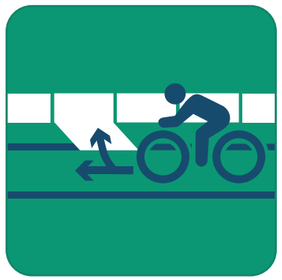
### Safe System Hierarchy

- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- **Tier 4 Increase Attentiveness and Awareness**

Applicable collision profiles: #1

## Bicycle Ramp

BIKEWAYS



### Description

A ramp, typically at intersections, that connects on-street bike lanes to a shared-use path or sidewalk-level separated bikeway.

**Context**

*Movement* — *Place*

LRSM ID N/A

Cost $

### Safe System Hierarchy

- **Tier 1 Remove Severe Conflicts**
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Applicable collision profiles: #1

## Bicycle Signal/Exclusive Bike Phase

BIKEWAYS

### Description

FHWA PROVEN COUNTERMEASURE

A traffic signal that directs bicycle traffic across an intersection. Separates bicycle movements in time from conflicting motor vehicle, transit, or pedestrian movements. Most applicable for separated bikeway facilities or shared-use paths.

**Context**

*Movement* — *Place*

LRSM ID N/A

Cost $$$

### Safe System Hierarchy

- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- **Tier 3 Manage Conflicts in Time**
- Tier 4 Increase Attentiveness and Awareness

Applicable collision profiles: #1, #2, #3, #5

## Bicycles May Use Full Lane Sign

BIKEWAYS


### Description

FHWA PROVEN COUNTERMEASURE

A sign placed on roadways categorized as bike routes to indicate that bicyclists may occupy the full travel lane. Intended to encourage motorists to slow and yield to bicyclists until it is safe to pass. Also encourages bicyclists not to ride within the door zone if on-street parking is present.

**Context**

*Movement* — *Place*

LRSM ID N/A

Cost $

### Safe System Hierarchy

- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- **Tier 4 Increase Attentiveness and Awareness**

Applicable collision profiles: #1

## Bike Detection

BIKEWAYS

### Description

FHWA PROVEN COUNTERMEASURE

Bike detection is technology used at signalized intersections—in the form of of push buttons, in-pavement loops, or video/infrared cameras—to initiate a green light for bicyclists and reduce delay for bicycle travel. Discourages bicyclists from running red lights and increases the convenience of bicycling.

Context

*Movement* — *Place*

LRSM ID N/A

Cost $$

### Safe System Hierarchy

- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Applicable collision profiles: #1

## Bike Lane

BIKEWAYS

### Description

FHWA PROVEN COUNTERMEASURE

Bike lanes designate an exclusive space for bicyclists using pavement markings and signage. The bike lane is located adjacent to motor vehicle travel lanes and flows in the same direction as motor vehicle traffic. Bike lanes are typically on the right side of the street, between the adjacent travel lane and curb, road edge, or parking lane.

Context

*Movement* — *Place*

LRSM ID R32PB

Cost $$

### Safe System Hierarchy

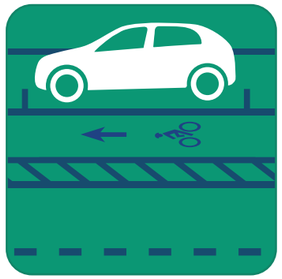
- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Crash reduction factor of 14% to 56% for vehicle/bike collisions.

Applicable collision profiles: #1, #4

## Buffered Bike Lane

BIKEWAYS



### Description

FHWA PROVEN COUNTERMEASURE

Buffered bike lanes have a designated painted buffer space, creating addtional horizontal distance from the adjacent motor vehicle travel lane and/or parking lane. Buffers provide greater space for bicycling without making the bike lane appear so wide that it might be mistaken for a travel lane.

Context

*Movement* — *Place*

LRSM ID R32PB

Cost $$

*Quick-build alternative available*

### Safe System Hierarchy

- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Applicable collision profiles: #1

## Conflict Zone Striping

BIKEWAYS

### Description

FHWA PROVEN COUNTERMEASURE

Conflict striping is green pavement markings in a dashed pattern that extend across bike lanes, specifically when approaching an intersection and/or going through an intersection or major driveway. Improves awareness bicycle-car conflict points.

Context

*Movement* — *Place*

LRSM ID N/A

Cost $

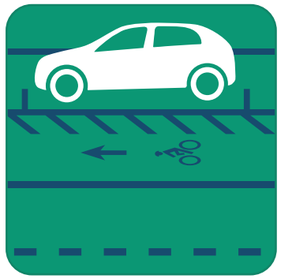
### Safe System Hierarchy

- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Applicable collision profiles: #1

## Door Zone Markings

BIKEWAYS



### Description

These pavement markings denote the door zone of parked vehicles, to raise awareness for both bicyclists and motorists of the conflict area—in which an open car door could obstruct the path of a passing bicyclist.

Context

*Movement* — *Place*

LRSM ID N/A

Cost $

### Safe System Hierarchy

- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Applicable collision profiles: #1

## Floating Transit Island or Bus Boarding Island

BIKEWAYS

### Description

Transit/bus boarding islands allow bicycles to pass between the sidewalk and transit boarding area, thereby avoiding bus-bike conflicts at the transit stop. These islands can be used in combination with a bike lane, buffered bike lane, or separated bikeway. The treatment can reduce vehicle speeds, as the island itself visually narrows the roadway and can have a traffic calming effect in combination with in lane bus stops.

Context

*Movement* — *Place*

LRSM ID N/A

Cost $$

*Quick-build alternative available*

### Safe System Hierarchy

- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Applicable collision profiles: #4

## Extend Green Time For Bikes

BIKEWAYS

### Description

A longer green phase when bicyclists are present provides additional time for bicyclists to clear the intersection. It can occur automatically in the signal phasing, or be prompted with bicycle detection. Topography should be considered in clearance time.

Context

*Movement* — *Place*

LRSM ID S03

Cost $

### Safe System Hierarchy

- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Applicable collision profiles: #1

## Separated Bikeway

BIKEWAYS

FHWA PROVEN COUNTERMEASURE

### Description

A separated bikeway, also called protected bike lanes or cycletrack, provides dedicated street space for bicyclists, typically adjacent to outer vehicle travel lanes, with physical separation from vehicle traffic, designated lane markings and signage. Physical separation may consist of plastic posts, parked vehicles, raised median, or a curb (if the separated bike lane is raised to sidewalk level). The separation reduces the risk of severe conflicts between bicycles and vehicles on the road, and also reduces conflicts between people biking and walking as compared to a shared-use path.

Context

*Movement* — *Place*

LRSM ID R33PB

Cost $$$

*Quick-build alternative available*

### Safe System Hierarchy

- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Crash reduction factor of -43% to 83% for vehicle/bike collisions.

Applicable collision profiles: #1, #4, #5

## Shared-Use Path

BIKEWAYS

### Description

FHWA PROVEN COUNTERMEASURE

Shared-use paths or trails are off-street facilities that provide exclusive use for nonmotorized travel, including bicyclists and pedestrians. They can be located alongside a roadway (referred to as a Side Path), or exist in a separate right-of-way.

Context

*Movement* — *Place*

LRSM ID N/A

Cost $$$

### Safe System Hierarchy

- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Crash reduction factor of 25% for vehicle/bike collisions.

Applicable collision profiles: #1, #4, #5

## Through Bike Lane at Intersection

BIKEWAYS


### Description

FHWA PROVEN COUNTERMEASURE

A through bike lane is a striping layout for intersections with a dedicated right-turn pocket, designed to allow for space for bicyclists to travel to the left side of right-turning vehicles.

Context

*Movement* — *Place*

LRSM ID N/A

Cost $

### Safe System Hierarchy

- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Applicable collision profiles: #1

## Add Sidewalk

PEDESTRIAN FACILITIES

### Description

FHWA PROVEN COUNTERMEASURE

Sidewalks provide a separated facility for pedestrians, that follows along the roadway but is outside of the traveled way or shoulder.

Context

*Movement* — *Place*

LRSM ID R34PB

Cost $$$

### Safe System Hierarchy

- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Crash reduction factor of 40% for vehicle/pedestrian collisions.

Applicable collision profiles: #1, #4, #5

## Co-Locate Bus Stop and Marked Pedestrian Crossings

PEDESTRIAN FACILITIES

### Description

Bus stops should be placed near marked pedestrian crossings (ideally high-visibility or signalized crosswalks) so that people using transit can more easily and safely cross the street. When crossings are well-designed and close to bus stops, it makes travel more convenient and reduces the risk of crashes involving pedestrians.

Context

*Movement* — *Place*

LRSM ID N/A

Cost $

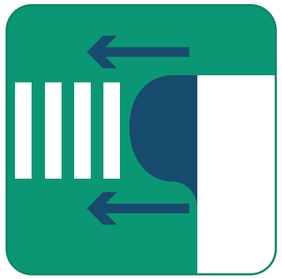
### Safe System Hierarchy

- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Applicable collision profiles: #4, #5

## Curb Extensions

PEDESTRIAN FACILITIES



### Description

FHWA PROVEN COUNTERMEASURE

Curb extensions are sidewalk widenings at corners or crosswalks that make it safer and easier for people to cross the street. They shorten the distance pedestrians have to walk and improve visibility between drivers and people crossing—especially when parked cars might block the view. Paint and plastic curb extensions are a quick and low-cost way to try out this safety feature before making it permanent.

Context

*Movement* — *Place*

LRSM ID NS21PB

Cost $$

*Quick-build alternative available*

### Safe System Hierarchy

- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Crash reduction factor of 37% for all collisions.

Applicable collision profiles: #1, #4, #5

## Extend Time Push Button

PEDESTRIAN FACILITIES

### Description

Some crosswalks have a special push button that lets people request extra time to cross the street. This is especially helpful for older adults or anyone who may need a bit more time. These buttons are often placed near places like senior centers, medical offices, or assisted living communities.

Context

*Movement* — *Place*

LRSM ID N/A

Cost $

### Safe System Hierarchy

- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Applicable collision profiles: #1

## High-Visibility Crosswalk

PEDESTRIAN FACILITIES

### Description

FHWA PROVEN COUNTERMEASURE

High-visibility crosswalks use bold, striped patterns made from durable, reflective materials like thermoplastic. The City of Sacramento typically uses ladder-style or "triple four" style high-visibility crosswalk designs. These markings make crosswalks easier for drivers to see, especially at night or in bad weather, and serve as a clear signal that pedestrians may be present crossing the street.

Context

*Movement* — *Place*

LRSM ID S18/NS20

Cost $

### Safe System Hierarchy

- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Crash reduction factor of 40% for vehicle/pedestrian collisions.

Applicable collision profiles: #1, #2

## Landscape Buffer

PEDESTRIAN FACILITIES

### Description

Adding a landscaped buffer between the road, sidewalks, and/or bikeways creates more space between drivers and people walking or biking. This separation not only makes everyone feel safer, but it also encourages drivers to slow down, which helps reduce the severity of crashes.

Context

*Movement* — *Place*

LRSM ID N/A

Cost $$

*Quick-build alternative available*

### Safe System Hierarchy

- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Applicable collision profiles: #1, #5, #6

## Leading Pedestrian Interval and Pedestrian Recall

PEDESTRIAN FACILITIES

### Description

FHWA PROVEN COUNTERMEASURE

At busy intersections with lots of turning vehicles and pedestrian activity, a leading pedestrian interval (LPI) gives people walking a 3–7 second head start to begin crossing before cars get a green light. This helps pedestrians become more visible in the crosswalk. Pedestrian recall automatically activates the walk signal during every light cycle so pedestrians don't have to press a button to get a walk signal.

Context

*Movement* — *Place*

LRSM ID S21PB

Cost $

### Safe System Hierarchy

- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Crash reduction factor of 10% for all collisions.

Applicable collision profiles: #1, #2, #3, #5

## Pedestrian Countdown Timer

PEDESTRIAN FACILITIES

### Description

Countdown pedestrian signals show how many seconds are left to finish crossing the street. These timers help people walking make safer decisions about when to cross. These timers are now required on all new traffic signals that include signalized pedestrian crossings.

Context

*Movement* — *Place*

LRSM ID S17PB

Cost $$

### Safe System Hierarchy

- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Crash reduction factor of 9% for all collisions.

Applicable collision profiles: #1

## Pedestrian Detection

PEDESTRIAN FACILITIES

### Description

These sensors can detect when a person is at an intersection waiting to cross, then automatically trigger the "WALK" signal without the person needing to press a button. This helps reduce unsafe crossings and ensures that pedestrians get enough time to cross the street safely.

Context

*Movement* — *Place*

LRSM ID N/A

Cost $$

### Safe System Hierarchy

- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Applicable collision profiles: #1, #4, #5

## Pedestrian Hybrid Beacon

PEDESTRIAN FACILITIES

### Description

FHWA PROVEN COUNTERMEASURE

A Pedestrian Hybrid Beacon (PHB) is a special type of crossing signal used on roadways with higher volumes and speeds at mid-block crosswalks or unsignalized intersections. It stays off (dark) until a person presses a button or is detected waiting to cross. Then, it lights up with a sequence of yellow and red lights to alert drivers to stop and let the pedestrian cross safely.

Context

*Movement* — *Place*

LRSM ID NS23PB

Cost $$$

### Safe System Hierarchy

- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Crash reduction factor of 12% for all collisions.

Applicable collision profiles: #1, #5

## Pedestrian Signals

PEDESTRIAN FACILITIES

### Description

Pedestrian signals operate similarly to traffic signals with red, yellow, and green lights for pedestrians and walking signals for pedestrians. Pedestrian signals are used at mid-block crosswalks on roadways with higher volumes and speeds.

Context

*Movement* — *Place*

LRSM ID N/A

Cost $$$

### Safe System Hierarchy

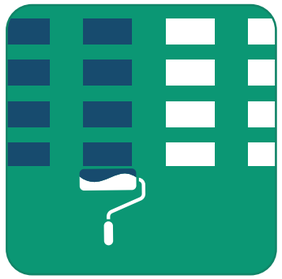
- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Crash reduction factor of Varies for All collisions.

Applicable collision profiles: #1, #5

## Restripe Crosswalk

PEDESTRIAN FACILITIES



### Description

FHWA PROVEN COUNTERMEASURE

Crosswalks need to be repainted regularly to stay visible to drivers and pedestrians. Over time, markings can fade due to weather and traffic. When repainting, using high-visibility designs like ladder and triple four markings can make crosswalks easier to see and help improve pedestrian safety.

Context

*Movement* — *Place*

LRSM ID N/A

Cost $

### Safe System Hierarchy

- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Applicable collision profiles: #5

## Rectangular Rapid Flashing Beacon

PEDESTRIAN FACILITIES

### Description

FHWA PROVEN COUNTERMEASURE

A Rectangular Rapid Flashing Beacon (RRFB) is a special flashing light that pedestrians can activate when they want to cross the street. It's paired with signs to alert drivers that someone is crossing. The bright, flashing lights make the crosswalk more visible and remind drivers to yield to people walking.

Context

*Movement* — *Place*

LRSM ID NS22PB

Cost $$

### Safe System Hierarchy

- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Crash reduction factor of 69% for vehicle/pedestrian collisions.

Applicable collision profiles: #1

## All-Way Stop Control

INTERSECTIONS & ROADWAYS


### Description

An all-way stop-controlled intesection requires all vehicles to stop before crossing an intersection. This reduces the risk of severe conflicts by eliminating high speed movements through an intersection. The MUTCD (Manual on Uniform Traffic Control Devices) includes information on when and how to implement "All-Way" Or "Multi-Way" stop control intersections.

Context

*Movement* — *Place*

LRSM ID NS02

Cost $

### Safe System Hierarchy

- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Crash reduction factor of 70% for all collisions.

Applicable collision profiles: #2

## Centerline Hardening

INTERSECTIONS & ROADWAYS

### Description

Centerline hardening involves placing plastic bollards and/or rubber curbs along a roadway's centerline. When used at intersections, they can be effective at requiring motorists to make left-turn movements at angles closer to 90-degrees, thereby slowing vehicle turning speeds and improving motorists' visibility of the crosswalks. When used along a roadway segment, they can be effective access control preventing undesirable left-turns and/or U-turns between intersections.

### Context

*Movement* — *Place*

LRSM ID N/A

Cost $

*Quick-build alternative available*

### Safe System Hierarchy

- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Applicable collision profiles: #2, #6

## Close Slip Lane

INTERSECTIONS & ROADWAYS

### Description

A close slip lane modifies the corner of an intersection to remove the sweeping right turn lane for vehicles. This results in shorter crossings for pedestrians, reduced speed for turning vehicles, and better sight lines.

### Context

*Movement* — *Place*

LRSM ID N/A

Cost $$$

*Quick-build alternative available*

### Safe System Hierarchy

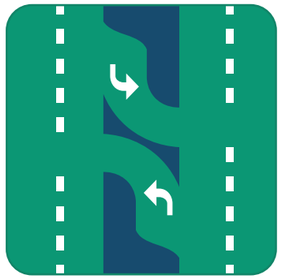
- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Crash reduction factor of -13% to 57% for all collisions.

Applicable collision profiles: #2, #6

## Directional Median Openings to Restrict Left Turns

INTERSECTIONS & ROADWAYS



### Description

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

### Context

*Movement* — *Place*

LRSM ID S14

Cost $$

### Safe System Hierarchy

- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Crash reduction factor of -13% to 57% for all collisions.

Applicable collision profiles: #2

## Intersection Lighting

INTERSECTIONS & ROADWAYS

### Description

Extra lighting at intersections and crosswalks makes it easier for drivers to see people walking, biking, or driving—especially at night or in dim conditions. However, it's important to design the lighting carefully. If it creates glare or lights up pedestrians from behind, it can actually make them harder for drivers to see.

### Context

*Movement* — *Place*

LRSM ID NS01

Cost $$

### Safe System Hierarchy

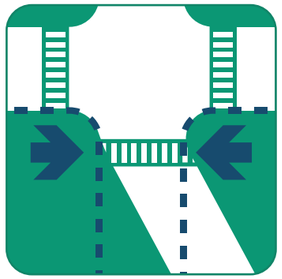
- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Crash reduction factor of 12% for night time collisions.

Applicable collision profiles: #1

## Intersection Reconstruction and Tightening

INTERSECTIONS & ROADWAYS



### Description

Skewed intersections have a greater likelihood of collisions due to restricted sight lines and high speed turn movements. “Squaring up” the intersection as close to 90 degrees as possible helps reduce the likelihood of collisions. The process requires intersection reconstruction and approach realignment to provide better visibility for all road users. It also reduces high speed turns, reduces length exposure for vehicles and/or bikes passing through the intersection, and reduces pedestrian crossing length.

Context

*Movement* — *Place*

LRSM ID N/A

Cost $$$

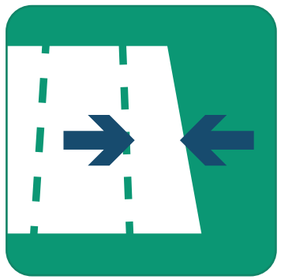
### Safe System Hierarchy

- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Applicable collision profiles: #2, #3, #6

## Lane Narrowing

INTERSECTIONS & ROADWAYS



### Description

Lane narrowing reduces the width of the marked vehicle lanes to encourage motorists to travel at slower speeds. Lane narrowing can also help reallocate existing roadway space to other road users.

Context

*Movement* — *Place*

LRSM ID N/A

Cost $

*Quick-build alternative available*

### Safe System Hierarchy

- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Crash reduction factor of 15% to 56% for all collisions.

Applicable collision profiles: #6

## Median Barrier

INTERSECTIONS & ROADWAYS

### Description

A median barrier in the center of the roadway physically separates opposing vehicular traffic. Median barriers can also help control access to and from side streets and driveways, reducing the number of conflict points.

Context

*Movement* — *Place*

LRSM ID R03

Cost $$$

### Safe System Hierarchy

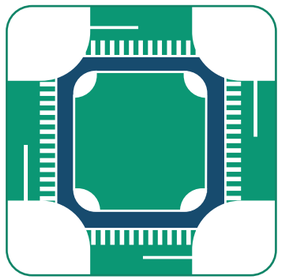
- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Crash reduction factor of Varies for all collisions.

Applicable collision profiles: #2, #6

## Protected Intersection

INTERSECTIONS & ROADWAYS



FHWA PROVEN COUNTERMEASURE

### Description

Protected intersections use corner islands, curb extensions, and colored paint to delineate bicycle and pedestrian movements, and physically separate bicycles from pedestrians and moving vehicles. The delineations/separations reduce the likelihood of conflicts, reduce driving speeds and shorten crossing distances for pedestrians.

Context

*Movement* — *Place*

LRSM ID N/A

Cost $$$

### Safe System Hierarchy

- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Crash reduction factor of 39% for all collisions.

Applicable collision profiles: #1, #2, #3, #5

## Raised Crosswalk

INTERSECTIONS & ROADWAYS

### Description

A raised pedestrian crosswalk is elevated above the road, either by a few inches, or at sidewalk level. This type of crosswalk and increases pedestrian visibility and slows motorists.

Context

*Movement* — *Place*

LRSM ID R36PB

Cost $$

### Safe System Hierarchy

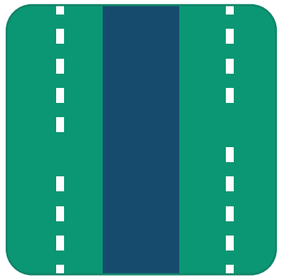
- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Crash reduction factor of 36% for all collisions.

Applicable collision profiles: #1, #5

## Raised Median

INTERSECTIONS & ROADWAYS



### Description

FHWA PROVEN COUNTERMEASURE

Raised medians are curbed sections in the center of the roadway that create physical separation between opposing vehicular traffic. They can also help control access to and from side streets and driveways, reducing conflict points.

Context

*Movement* — *Place*

LRSM ID S12/NS14/R08

Cost $$

### Safe System Hierarchy

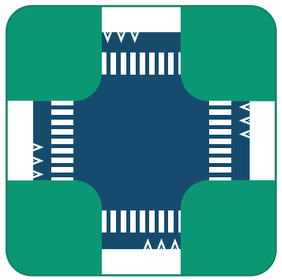
- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Crash reduction factor of 71% for all collisions.

Applicable collision profiles: #2, #3, #6

## Raised Intersection

INTERSECTIONS & ROADWAYS



### Description

A raised intersection bring vehicles up to the sidewalk level. This serves as a traffic calming measure by slowing drivers and increasing awarenss of the pedestrian activity.

Context

*Movement* — *Place*

LRSM ID N/A

Cost $$$

### Safe System Hierarchy

- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Applicable collision profiles: #1, #2, #5

## Reduced Left-Turn Conflict Intersection

INTERSECTIONS & ROADWAYS

### Description

These are geometric designs that alter how left-turn movements occur. They can simplify decisions and minimize the potential for left-turn related crashes. Two designs that rely on U-turns to complete certain left-turn movements are known as the restricted crossing U-turn (RCUT) and the median U-turn (MUT) intersections. Both designs require some out-of-direction travel for vehicles.

Context

*Movement* — *Place*

LRSM ID NS16

Cost $$$

### Safe System Hierarchy

- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Crash reduction factor of 36% for all collisions.

Applicable collision profiles: #2, #3

## Refuge Island

INTERSECTIONS & ROADWAYS

### Description

FHWA PROVEN COUNTERMEASURE

A refuge island is a raised, curbed median in the center of the roadway that provides a place for pedestrians to wait until there is a gap in traffic to finish crossing the intersection. This reduces pedestrians' exposure to traffic by allowing them to cross the intersection in multiple stages. Pedestrian refuge areas constructed from paint and plastic may be implemented as part of a low-cost/quick build project.

Context

*Movement* — *Place*

LRSM ID NS19PB

Cost $$

*Quick-build alternative available*

### Safe System Hierarchy

- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Crash reduction factor of 26% for all collisions.

Applicable collision profiles: #1, #5

## Roundabout

INTERSECTIONS & ROADWAYS

### Description

FHWA PROVEN COUNTERMEASURE

A roundabout is a circular intersection where traffic flows in one direction around a central island, and vehicles must yield at entrance lanes. Unlike conventional intersections, roundabouts eliminate severe conflicts from crossing and left-turn movements. The design of a roundabout forces drivers to slow down, which narrows the range of vehicle speeds and reduces the severity of crashes. Additionally, pedestrians only need to cross one direction of traffic at a time, minimizing their exposure to vehicles.

Context

*Movement* — *Place*

LRSM ID S16/NS04

Cost $$$

### Safe System Hierarchy

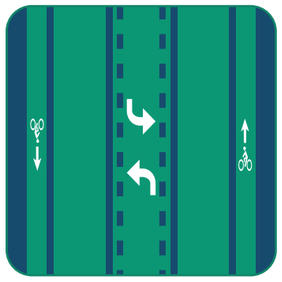
- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Crash reduction factor of 51% for all collisions.

Applicable collision profiles: #1, #2, #3, #5, #6

## Road Diet/Lane Reduction

INTERSECTIONS & ROADWAYS



### Description

FHWA PROVEN COUNTERMEASURE

A road diet reconfigures roadway space originally dedicated to vehicle travel lanes and creates room for bicycle facilities, wider sidewalks, and/or center turn lanes. This reduces vehicle speeds and creates designated space for all road users.

Context

*Movement* — *Place*

LRSM ID R14

Cost $$

*Quick-build alternative available*

### Safe System Hierarchy

- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Crash reduction factor of 47% for all collisions.

Applicable collision profiles: #1, #6

## Slow Turn Wedge

INTERSECTIONS & ROADWAYS

### Description

A slow turn wedge uses paint and delineators to extend the curb at intersections. This helps slow turns by restricting the turning radii of turning vehicles, expanding the field of vision for drivers, and increasing the visibility of pedestrians.

Context

*Movement* — *Place*

LRSM ID N/A

Cost $

*Quick-build alternative available*

### Safe System Hierarchy

- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Applicable collision profiles: #1, #2, #6

## Speed Hump or Speed Table

INTERSECTIONS & ROADWAYS

### Description

A speed hump or speed table is a raised area of pavement designed to slow down vehicles. Typically, speed humps and speed tables are wider and less abrupt than speed bumps, providing a gentler way to reduce vehicle speeds in residential areas or near schools. They help improve safety by encouraging drivers to maintain lower speeds and lessen kinetic energy.

Context

*Movement* — *Place*

LRSM ID N/A

Cost $

*Quick-build alternative available*

### Safe System Hierarchy

- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Crash reduction factor of 40% to 50% for all collisions.

Applicable collision profiles: #1, #5

## Splitter Island

INTERSECTIONS & ROADWAYS

### Description

A splitter island is a raised area that separates the two directions of travel on the minor street approach at an unsignalized intersection or roundabout. It helps channelize traffic in opposing directions and improves the visibility of the intersection for approaching drivers. Additionally, it provides a refuge for pedestrians crossing the street.

Context

*Movement* — *Place*

LRSM ID NS13

Cost $$

### Safe System Hierarchy

- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Crash reduction factor of 40% for all collisions.

Applicable collision profiles: #1, #5

## Speed Lump

INTERSECTIONS & ROADWAYS

### Description

Similar to speed humps or tables, speed cushions or lumps are raised areas of pavement designed to slow down vehicles. Typically, speed cushions/lumps are required, as emergency vehicle access requires 'cut-outs' on higher-volume roadways.

Context

*Movement* — *Place*

LRSM ID N/A

Cost $

### Safe System Hierarchy

- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Applicable collision profiles: #1, #5

## Straighten Crosswalk

INTERSECTIONS & ROADWAYS

### Description

Straightening crosswalks improves sight lines, making pedestrians more visible to oncoming drivers. It can also shorten the crossing distance, reducing the time pedestrians need to cross an intersection.

Context

*Movement* — *Place*

LRSM ID N/A

Cost $

### Safe System Hierarchy

- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Applicable collision profiles: #1

## Traffic Signal

INTERSECTIONS & ROADWAYS

### Description

FHWA PROVEN COUNTERMEASURE

Traffic signals at intersections manage traffic flow by assigning right-of-way to different movements at specific times. For instance, protected left-turn signal phasing is more effective at preventing severe left-turn collisions compared to permitted left-turn signal phasing. Additionally, traffic signals significantly enhance safety for pedestrians crossing large intersections.

Context

*Movement* — *Place*

LRSM ID S03

Cost $$$

### Safe System Hierarchy

- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Crash reduction factor of 16% for all collisions.

Applicable collision profiles: #1, #2, #6

## All-Red Signal Time

SIGNALS

### Description

Including a phase of all-red signals gives drivers and bicyclists a few extra seconds to safely get through an intersection before other traffic is allowed to move. This added time at the end of a signal phase helps reduce the risk of collisions, especially for people who are already in the intersection when the light changes.

Context

*Movement* — *Place*

LRSM ID S03

Cost $

### Safe System Hierarchy

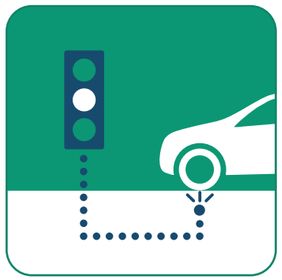
- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Crash reduction factor of 20% for all collisions.

Applicable collision profiles: #1

## Advanced Dilemma Zone Detection

SIGNALS



### Description

The Advanced Dilemma-Zone Detection system helps make intersections safer by adjusting when the yellow light turns on. It detects where cars are and how fast they're going. Then, the signal controller decides whether to activate or delay the yellow light. This helps drivers avoid the tricky situation where they're not sure if they should stop or keep going when the light changes. The goal is to reduce broadside collisions at signalized intersections.

Context

*Movement* — *Place*

LRSM ID S04

Cost $$

### Safe System Hierarchy

- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Crash reduction factor of 39% for rural collisions.

Applicable collision profiles: #2, #3, #6

## Extend Pedestrian Crossing Time

SIGNALS

### Description

Extending the pedestrian walk signal time beyond the minimum required by national guidelines gives people more time to cross the street. This is especially helpful for vulnerable groups, like children, older adults, and people with disabilities, who may need extra time to cross safely.

Context

*Movement* — *Place*

LRSM ID S03

Cost $

### Safe System Hierarchy

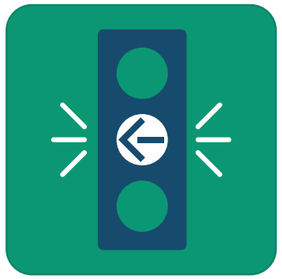
- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Crash reduction factor of 51% for vehicle/pedestrian collisions.

Applicable collision profiles: #1, #5

## Flashing Yellow Turn Phase

SIGNALS



### Description

A flashing yellow turn arrow tells drivers they can make a permissive turn. They must wait for a clear gap in oncoming traffic before turning. This signal is used only when no pedestrians are crossing. When pedestrians are present, the signal should use a protected-only turn phase, where turning vehicles must wait for a green arrow to ensure pedestrian safety.

Context

*Movement* *Place*

LRSM ID N/A

Cost $$

### Safe System Hierarchy

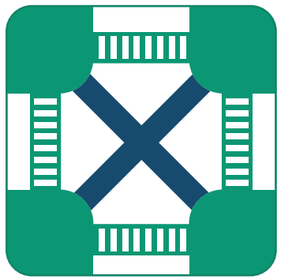
- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Crash reduction factor of 60% for all collisions.

Applicable collision profiles: #2, #3

## Pedestrian Scramble

SIGNALS



### Description

A pedestrian "WALK" phase, called a pedestrian scramble or all-way walk, stops all vehicle traffic at an intersection. This gives pedestrians the chance to cross in any direction, including diagonally, all at once. It removes conflicts by completely separating turning cars from crossing pedestrians in time. It can be especially effective in busy areas with lots of foot traffic.

Context

*Movement* *Place*

LRSM ID S03

Cost $$

### Safe System Hierarchy

- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Crash reduction factor of 35% for vehicle/pedestrian collisions.

Applicable collision profiles: #1, #5

## Prohibit Left Turn

SIGNALS

### Description

Left turns may be restricted at certain intersections to improve safety. This is especially important where turning vehicles might conflict with pedestrians in the crosswalk or where there's heavy oncoming traffic. These restrictions can be enforced using signs or raised center medians that physically prevent the turn.

Context

*Movement* *Place*

LRSM ID S15/NS16

Cost $

### Safe System Hierarchy

- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Crash reduction factor of 72% for all collisions.

Applicable collision profiles: #2, #3

## Prohibit Right-Turn-on-Red

SIGNALS


### Description

Prohibiting right turns on red should be considered at locations with unusual layouts, such as skewed intersections, or where there are pedestrian scrambles or leading pedestrian intervals (LPIs). Preventing right turns on red in these situations can reduce the risk of crashes between turning vehicles and pedestrians, as well as crashes with vehicles traveling through the intersection from the cross street.

Context

*Movement* *Place*

LRSM ID N/A

Cost $

### Safe System Hierarchy

- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Applicable collision profiles: #1, #3, #5

## Prohibit Turns During Pedestrian Phase

SIGNALS

### Description

Prohibiting left and right turns while pedestrians are crossing helps prevent conflicts between turning vehicles and people in the crosswalk. These turn restrictions are often shown using special electronic signs, called blank-out signs, which light up only when the restriction is active.

Context

*Movement* — *Place*

LRSM ID N/A

Cost $$

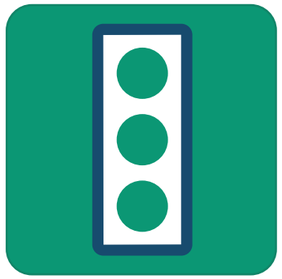
### Safe System Hierarchy

- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Applicable collision profiles: #1, #3

## Retroreflective Tape on Signals

SIGNALS



### Description

Retroreflective borders are bright, reflective outlines added around traffic signals to make them easier to see—especially for older drivers or those with color vision difficulties. These borders help drivers quickly recognize which light is on. They're also useful during power outages, because they reflect headlights and make the signal visible even when it's not working.

Context

*Movement* — *Place*

LRSM ID S02

Cost $

### Safe System Hierarchy

- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Crash reduction factor of 15% for all collisions.

Applicable collision profiles: #2, #3

## Protected Left Turns

SIGNALS

### Description

Adding protected left-turn phases at intersections reduces broadside crashes and pedestrian crashes. These signals give drivers a dedicated green arrow so they don't have to wait for a gap in oncoming traffic, or worry about people crossing the street at the same time.

Context

*Movement* — *Place*

LRSM ID S06/S07

Cost $$

### Safe System Hierarchy

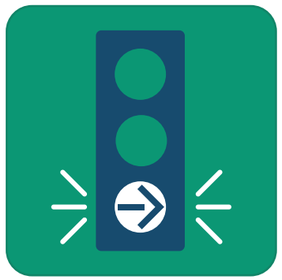
- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Crash reduction factor of 6% for all collisions.

Applicable collision profiles: #2, #3

## Separate Right-Turn Phasing

SIGNALS



### Description

A green arrow for right turns phase helps prevent conflicts with pedestrians and bicyclists who may be crossing the street on the right side of the intersection.

Context

*Movement* — *Place*

LRSM ID N/A

Cost $$$

### Safe System Hierarchy

- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Applicable collision profiles: #1

## Shorten Cycle Length

SIGNALS

### Description

The traffic signal cycle length—how long it takes to go through all the green, yellow, and red lights—can greatly affect how easy and pleasant it is to walk, bike, drive, or take transit. When signals stay red for too long, especially at several intersections in a row, it can make even short trips feel slow and frustrating. Shorter signal cycles, ideally between 60 and 90 seconds, are better for urban areas because they help keep people moving and make streets more welcoming for everyone.

Context

*Movement* *Place*

LRSM ID N/A

Cost $

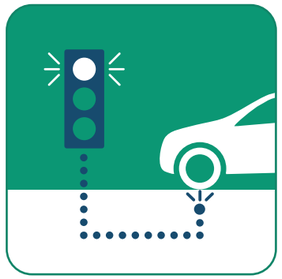
### Safe System Hierarchy

- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Applicable collision profiles:
#1

## Speed Sensitive Rest in Red Signal

SIGNALS



### Description

At certain times—like late at night—some traffic signals stay red until a vehicle approaches. These signals are designed to reward drivers who follow the speed limit. If a car is going too fast, the light stays red until the driver comes to a stop. But if the car is going at or below the speed limit, the light turns green before the car arrives, allowing it to pass through smoothly. This encourages safe driving and can be combined with electronic speed signs that warn drivers if they're going too fast.

Context

*Movement* *Place*

LRSM ID R26

Cost $$

### Safe System Hierarchy

- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Applicable collision profiles:
#6

## Signal Interconnectivity and Coordination / Green Wave

SIGNALS


### Description

Improving how traffic signals are timed can make streets safer. One approach is called a "green wave," where signals are coordinated to let people driving and people on bikes move smoothly through several intersections without stopping at a set desired speed, typically lower than the speed limit and in line with typical bicycle travel speeds. The slow green wave can be accompanied by signs that alert the drivers and help slow down cars, which can reduce the risk of severe collisions.

Context

*Movement* *Place*

LRSM ID S03

Cost $$

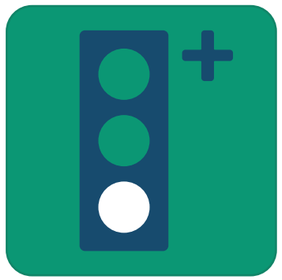
### Safe System Hierarchy

- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Applicable collision profiles:
#1, #5, #6

## Supplemental Signal Heads

SIGNALS



### Description

Supplemental signal heads are extra traffic lights placed in addition to the main signal. They help drivers see the signal more clearly, especially when the intersection is hard to see—like when it's hidden behind vertical curve or around a horizontal curve.

Context

*Movement* *Place*

LRSM ID S02

Cost $$

### Safe System Hierarchy

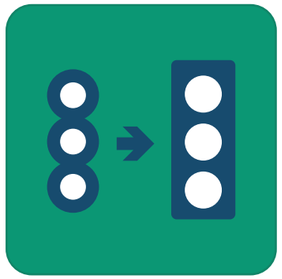
- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Crash reduction factor of 28% for all collisions.

Applicable collision profiles:
#2

## Upgrade Signal Head

SIGNALS



### Description

Upgrading signal heads means replacing smaller 8-inch traffic lights with larger 12-inch ones, as recommended by California's MUTCD. The larger signal heads are easier for drivers to see, especially from a distance. This helps drivers notice intersections sooner and respond more safely to traffic signals.

**Context**

*Movement* — *Place*

LRSM ID S02

Cost $

### Safe System Hierarchy

- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- **Tier 4 Increase Attentiveness and Awareness**

Crash reduction factor of 29% for all collisions.

Applicable collision profiles: #2, #3

## Speed Feedback Sign

SIGNING & STRIPING


### Description

FHWA PROVEN COUNTERMEASURE

A speed feedback sign displays a driver's current speed alongside the posted speed limit, encouraging voluntary speed reduction. It serves as a real-time visual cue to promote speed awareness and compliance, particularly in areas with speeding concerns.

**Context**

*Movement* — *Place*

LRSM ID N/A

Cost $

### Safe System Hierarchy

- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- **Tier 4 Increase Attentiveness and Awareness**

Crash reduction factor of 5% for all collisions.

Applicable collision profiles: #1, #6

## Flashing Beacon as Advance Warning

SIGNING & STRIPING

### Description

A flashing beacon is a blinking light paired with signage used as advanced warning to alert drivers to an upcoming intersection or crosswalk. This tool increases driver awareness and provides additional time to slow down or yield to pedestrians, enhancing safety at conflict points.

**Context**

*Movement* — *Place*

LRSM ID S10

Cost $$

### Safe System Hierarchy

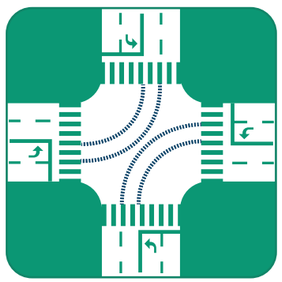
- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- **Tier 4 Increase Attentiveness and Awareness**

Crash reduction factor of 47% to 69% for vehicle/pedestrian collisions.

Applicable collision profiles: #1, #6

## Striping Through Intersection

SIGNING & STRIPING



### Description

Clear pavement markings within complex intersections help guide motorists through lane assignments and turning movements. This treatment is especially effective at locations where lane designations are unclear due to horizontal offsets or multiple turning lanes.

**Context**

*Movement* — *Place*

LRSM ID S09

Cost $

### Safe System Hierarchy

- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- **Tier 4 Increase Attentiveness and Awareness**

Crash reduction factor of 57% for all collisions.

Applicable collision profiles: #2

## Time-Based Turn Restriction

SIGNING & STRIPING


### Description

Restricts left turns or right turns during certain time periods when there may be increased potential for conflict (e.g., peak periods, school hours).

Context

*Movement* *Place*

LRSM ID N/A

Cost $

### Safe System Hierarchy

- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Applicable collision profiles: #2

## Upgrade Intersection Pavement Markings

SIGNING & STRIPING


### Description

Upgrading intersection pavement markings, such as stop ahead markings, centerlines, and stop bars, improves visibility for drivers approaching and entering intersections.

Context

*Movement* *Place*

LRSM ID NS07

Cost $

### Safe System Hierarchy

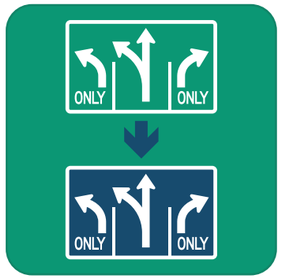
- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Crash reduction factor of 5% to 8% for all collisions.

Applicable collision profiles: #2, #3

## Upgrade Signs with Fluorescent Sheeting

SIGNING & STRIPING




### Description

Upgrading signs with fluorescent sheeting enhances nighttime visibility by reflecting headlight beams more effectively, making warnings clearer for drivers.

Context

*Movement* *Place*

LRSM ID R22

Cost $

### Safe System Hierarchy

- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Crash reduction factor of 18% to 35% for all collisions.

Applicable collision profiles: #2

## Upgrade Striping

SIGNING & STRIPING

### Description

Restriping lanes with reflective materials such as thermoplastic and pavement markers improves visibility and helps clarify lane assignments, especially where lane configurations change.

Context

*Movement* *Place*

LRSM ID N/A

Cost $

### Safe System Hierarchy

- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Crash reduction factor of Varies for all collisions.

Applicable collision profiles: #1, #2, #3, #5, #6

## Yield Markings

SIGNING & STRIPING

### Description

Yield lines, also known as shark's teeth, are pavement markings placed 20 to 50 feet before multi-lane pedestrian crossings. They improve pedestrian visibility and help reduce the risk of multiple-threat crashes, where one vehicle stops for a pedestrian but another in an adjacent lane does not.

Context

*Movement* — *Place*

LRSM ID N/A

Cost $

### Safe System Hierarchy

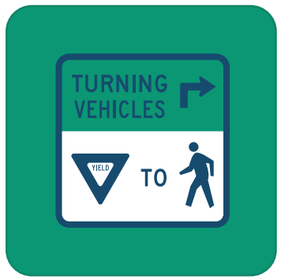
- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Crash reduction factor of 25% for vehicle/pedestrian collisions.

Applicable collision profiles: #1

## Yield To Pedestrians Sign

SIGNING & STRIPING




### Description

"Yield Here to Pedestrians" signs alert drivers to pedestrian crossings and are required when advance yield lines are used. Additional smaller, flexible, warning signs can also be placed on the roadway centerline to enhance visibility.

Context

*Movement* — *Place*

LRSM ID NS06

Cost $

### Safe System Hierarchy

- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Crash reduction factor of 11% for all collisions.

Applicable collision profiles: #1

## Driveway Consolidation

OTHER

### Description

Consolidating driveways reduces conflict points between vehicles entering/exiting the roadway and pedestrians, bicyclists, and vehicles traveling along the roadway. Particular attention should be considered to driveways within 250 feet of intersections.

Context

*Movement* — *Place*

LRSM ID N/A

Cost $$

*Quick-build alternative available*

### Safe System Hierarchy

- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Applicable collision profiles: #1, #2, #3, #6

## Street Lighting

OTHER

### Description

Adding street lighting helps drivers see better at night or in low-light conditions, and makes it easier to spot other people, vehicles, or objects on the road.

Context

*Movement* — *Place*

LRSM ID R01

Cost $$

### Safe System Hierarchy

- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Crash reduction factor of 32% for night time collisions.

Applicable collision profiles: #1

## Curbside Management

OTHER

### Description

Curbside management helps prioritize and align different uses of the space along curbs that would otherwise be in conflict with one another. This includes the location of bus stops, bicycle infrastructure, space for freight deliveries, passenger pick-ups/drop-offs, green stormwater infrastructure, public spaces, and parking spaces.

Context

*Movement* *Place*

LRSM ID N/A

Cost $

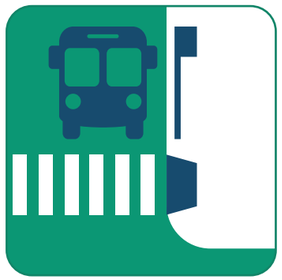
### Safe System Hierarchy

- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Applicable collision profiles: #1

## Far-Side Bus Stop

OTHER



### Description

Far-side bus stops are placed just after an intersection, so the bus crosses the street before picking up or dropping off passengers. This setup helps in a few ways: it keeps traffic moving more smoothly, makes it easier for pedestrians to be seen by drivers when crossing the street, and can help buses stay on schedule. It also encourages people to cross behind the bus, which is usually safer.

Context

*Movement* *Place*

LRSM ID N/A

Cost $

*Quick-build alternative available*

### Safe System Hierarchy

- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Crash reduction factor of -45% to 45% for all collisions.

Applicable collision profiles: #4

## Delineators, Reflectors, and/or Object Markers

OTHER

### Description

Delineators, reflectors, and object markers are visual cues installed in a roadway, intended to warn drivers of an approaching curve or fixed object that cannot easily be removed. They are generally less costly than signage.

Context

*Movement* *Place*

LRSM ID R27

Cost $

### Safe System Hierarchy

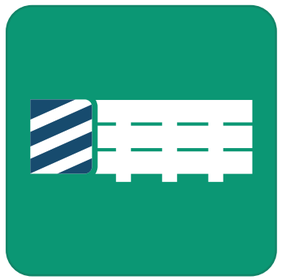
- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Crash reduction factor of -19% to 15% for all collisions.

Applicable collision profiles: #6

## Impact Attenuators

OTHER



### Description

Impact attenuators are safety devices placed on roads to help stop or slow down vehicles that accidentally leave their lane. Instead of crashing into something hard like a concrete wall or a bridge pillar, the vehicle hits the attenuator, which absorbs the impact and reduces the damage. These devices are often used in places where it's not possible to remove the dangerous object, so they act as a protective crash cushion.

Context

*Movement* *Place*

LRSM ID R05

Cost $$

### Safe System Hierarchy

- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Crash reduction factor of 69% for fixed object collisions.

Applicable collision profiles: #6

## Speed Limit Reduction

OTHER


### Description

Lower speeds help reduce the risk and severity of crashes. New industry standards for speed limits consider factors like roadway characteristics, adjacent land use context, as well as the presence of people walking and biking. Speed limit reductions must follow restrictions set forth in the California Vehicle Code.

Context

*Movement* — *Place*

LRSM ID N/A

Cost $

### Safe System Hierarchy

- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Crash reduction factor of 33% for KSI collisions.

Applicable collision profiles: #1, #6

## Upgrade Lighting to LED

OTHER

### Description

LED street lights are brighter and more effictient than older high-pressure sodium lights. Upgrading street lights improves visibility—especially at crosswalks—by providing better color contrast and lighting a wider area. As a result, it becomes easier for drivers to see people walking.

Context

*Movement* — *Place*

LRSM ID N/A

Cost $$

### Safe System Hierarchy

- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Applicable collision profiles: #1

## Remove Obstructions For Sightlines

OTHER

### Description

Removing visual obstacles near intersections helps drivers and pedestrians see each other more easily, and allows for drivers to have adequate stopping sight distance. This might include painting red curbs to stop cars from parking too close to corners (a practice known as "daylighting"), trimming overgrown trees or bushes, or moving signs or other objects that may block the view.

Context

*Movement* — *Place*

LRSM ID NS11

Cost $

### Safe System Hierarchy

- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Applicable collision profiles: #1, #5

## Red Light Camera

OTHER

### Description

Red light cameras help enforce traffic laws by taking a photo of any vehicle that drives through an intersection after the light has turned red. These cameras work automatically, and the photos they take are used by authorities to issue tickets to drivers who run red lights.

Context

*Movement* — *Place*

LRSM ID N/A

Cost $$

### Safe System Hierarchy

- Tier 1 Remove Severe Conflicts
- Tier 2 Reduce Vehicle Speeds
- Tier 3 Manage Conflicts in Time
- Tier 4 Increase Attentiveness and Awareness

Crash reduction factor of 20% for all collisions.

Applicable collision profiles: #2, #3, #6

VISION ZERO
SACRAMENTO

Our Safety is Homegrown

Attachment B

# Non-Engineering Countermeasure Toolbox

## What Is the Non-Engineering Countermeasure Toolbox?

Non-engineering countermeasures include education, enforcement, and other strategies that influence collision likelihood and severity. *Countermeasures That Work: A Highway Safety Countermeasure Guide for State Highway Safety Offices, 11th Edition*, published by the National Highway Traffic Safety Administration (NHTSA) in 2023, served as a resource for the programmatic/non-engineering countermeasures presented in this section.

### Public Health Partnerships on DUI Prevention

#### Description

Prevention and education policies focus on mobilizing and educating the community and intervening before driving under the influence takes place. According to NHTSA research, alcohol problem assessment and treatment programs, as well as alcohol intervention in settings such as a doctor's office, are highly effective strategies for improving safety outcomes. Health departments could partner with partner agency police and sheriff departments to share information and conduct screenings.

#### Resources

***Behavior Change Campaigns to Improve Traffic Safety Toolkit***

***Countermeasures that Work, 11th Edition***

### Collision History-Based Enforcement

#### Description

Called an Enforcement Priorities Mandate, use collision history and emphasis area corridors as to direct enforcement efforts, with a focus on driving under the influence, distracted driving, and dangerous driving. This may require additional funding for California Highway Patrol, County Sheriff, and Local Police Departments

#### Resources

***Evidence-Based Behavior Change Campaigns to Improve Traffic Safety Toolkit*** (AAA Foundation, https://aaafoundation.org/evidence-based-behavior-change-campaigns-to-improve-traffic-safety-toolkit/)

***Countermeasures that Work, 11th Edition***

## Education & Public Awareness Campaigns Targeted at Speeding, Driving Under the Influence, and Increasing Awareness of People Walking and Biking

### Description

Coordinating with public communications staff/public information officers to use existing social media accounts (e.g. Facebook, NextDoor, Twitter, etc.) can help establish an ongoing public education campaign focused on safe and responsible driving, discouraging drinking and driving, and increasing awareness of pedestrians and bicyclists. Campaigns could also involve yard signs, wall boards/posters along high-injury corridors and neighborhoods, ads on bus exteriors, radio ads, etc. in English and Spanish.

Potential partners include local Health Departments, community-based organizations, local media outlets, and OTS Go Safely California Campaign.

### Resources

The ***OTS Go Safely California*** campaign has free resources for local agencies to use in implementing public awareness campaigns.

OTS Go Safely California campaign example


## Pair Education with Engineering Countermeasures

### Description

Educational materials can be used to teach people how to use new and unfamiliar safety countermeasures, such as roundabouts or protected bikeways. These materials can consist of informational signs or demonstration videos, and should be presented in multiple languages, including English and Spanish. The California Office of Traffic (OTS) has grants to support these educational campaigns.

### Resources

***City of San Francisco Informational Signs***
The San Francisco Municipal Transportation Agency (SFMTA) posted signs with a brief explanation next to a newly installed protected bike lane in multiple languages as part of their Vision Zero SF initiative. This approach was also applied to educate people about pedestrian scrambles and bulb outs.

***City of Sacramento Bicycling videos:***
The City has already previously used demonstration videos to engage residents in bicycling safety procedures. The videos feature a series of safety improvements such as protected bike lanes, bike boxes, and bike signals, and inform residents how to use these new roadway features, both as a bicyclist and a driver.

## High-Visibility Enforcement for DUI

### Description

Deterrence policies, such as high visibility enforcement, focus on raising the actual and perceived risk of high-risk behaviors. County sheriffs and local police departments should implement high visibility enforcement for DUIs to deter and increase awareness of the risks of this behavior.

High visibility enforcement for driving under the influence, such as publicized sobriety checkpoints and saturation patrols, has been found to be effective to improve safety outcomes. Officers can focus their efforts along corridors with a history of speeding-related collisions since they must observe driving behavior on the road.

Integrated enforcement would include coordination with Public Awareness Campaigns. For example, widespread dissemination of multi-lingual educational messaging and promotion of safe rides home opportunities in advance of major DUI enforcement efforts.

### Resources

***Massachusetts Saving Lives – Enforcement Strategies***, https://solutions.edc.org/solutions/prevention-solutions
This program combines community engagement events, high-visibility enforcement including sobriety checkpoints, and media communication to discourage DUI.

## Safe Ride Home Program

### Description

Safe Ride Home programs require developing partnerships between the public works and police department, Transportation Network Company (TNC) operators, and local businesses to offer promotional codes for free or discounted rides home from establishments or events throughout the reservation to reduce the potential for DUI, drowsy driving, or distracted driving. This program could be especially important during weekends, holidays, and other special events.

### Resources

***Portland Bureau of Transportation Safe Ride Home Program,*** https://www.portlandoregon.gov/transportation/76611

PBOT partnered with the Portland Police Bureau, TriMet, Old Town Hospitality Group, and Portland cab companies Radio Cab, Broadway Cab, New Rose City Cab and United Independent Cab, as well as transportation network companies Lyft and Uber to provide promo codes for discounted rides. The program is funded by a 50-cent fee charged for every taxi and TNC ride in Portland.

## Speed Limit Modification

### Description

California Assembly Bill (AB) 43 was passed in 2021 to provide a means to lower speed limits on corridors that meet certain criteria. AB 43 focused on giving local jurisdictions more flexibility in setting speed limits, especially regarding vulnerable road users:

- Speed Limit Reduction: Reduction of additional 5 mph based on several factors, including designation of Safety Corridors, as described in Chapter 3
- Prima Facie Speed Limits: Options for 15 and 25 mph in certain areas such as school zones depending on context
- Business Activity Districts: Option for 20 or 25 mph speed limits

In particular, the designation of "Safety Corridors" could be applied to roadways where the highest number of serious injury and fatality crashes occur, identifying specific locations or corridor-level segments with high crash occurrences and stratified by mode. These designations must be approved by a professional engineer.

The most recent California Manual on Uniform Traffic Control Devices (MUTCD) is the document that provides guidance on how to re-evaluate posted speed limits in light of these changes.

**The City is currently in the process of updating speed limit setting procedures in alignment with AB 43 and evaluating which streets are eligible for reduced posted speed limits based on AB 43.**

## Automated Enforcement

### Description

Automated enforcement, such as red-light cameras or speed cameras, target the specific drivers who are behaving dangerously. Red light cameras are allowed in California. Automated speed detection devices are currently only allowed on a pilot basis in six cities in California, but may be allowed to be implemented in all cities in the future.

A strictly data-driven approach to automated enforcement might place red-light or speed cameras in locations with the highest number of collisions. However, given that many low-income neighborhoods have historically received fewer infrastructure investments, which often results in a higher rate of collisions, a strictly data-driven approach could lead to a disproportionate burden of enforcement. Therefore, automated enforcement should be implemented evenly across a jurisdiction at problem locations.