



City of Martinez Local Roadway Safety Plan



March 5, 2024

THIS PAGE LEFT INTENTIONALLY BLANK

CONTENTS

1.0 ENGINEERS SEAL 1

2.0 INTRODUCTION AND EXECUTIVE SUMMARY 2

 INTRODUCTION 2

 SUMMARY 3

3.0 VISION AND GOALS 7

4.0 SAFETY PARTNERS 8

5.0 PROCESS 9

 ANALYSIS TECHNIQUES 10

6.0 DATA SUMMARY AND ANALYSIS 11

 6.1 CRASH DATA 11

 6.2 ALL CRASHES 11

7.0 CRASH SAFETY TRENDS 12

 7.1 TYPES OF COLLISIONS 12

 7.2 FATALITIES AND SERIOUS INJURIES 12

 7.3 PRIMARY CAUSE OF COLLISIONS 13

 7.4 VULNERABLE USERS 13

 7.4.1 Pedestrians 13

 7.4.2 Bicyclists 14

 7.5 INITIAL FINDINGS 15

8.0 EMPHASIS AREAS 16

 8.1 EMPHASIS AREA #1: VULNERABLE ROAD USERS (PEDESTRIANS & BICYCLISTS) 16

 8.2 EMPHASIS AREA #2: SPEEDING 16

 8.3 EMPHASIS AREA #3: AGGRESSIVE DRIVERS 17

 8.4 EMPHASIS AREA #4: LIGHTING CONDITIONS 17

9.0 COUNTERMEASURES IDENTIFIED TO ADDRESS SAFETY ISSUES 17

 9.1 COUNTERMEASURES FOR EMPHASIS AREA #1: VULNERABLE ROAD USERS
 (PEDESTRIANS & BICYCLISTS) 18

 9.2 COUNTERMEASURES FOR EMPHASIS AREA #2: SPEEDING 19

 9.3 COUNTERMEASURES FOR EMPHASIS AREA #3: AGGRESSIVE DRIVERS 21

 9.4 COUNTERMEASURES FOR EMPHASIS AREA #4: IMPROVE LIGHTING 22

10.0 RECOMMENDED BEST PRACTICES FOR FUTURE IMPROVEMENTS 22

11.0 FUNDING, IMPLEMENTATION & EVALUATION STRATEGIES 23

 11.1 FUNDING OPPORTUNITIES 23

 11.2 IMPLEMENTATION STRATEGIES 24

 11.3 EVALUATION STRATEGIES 24

REFERENCES 25

LIST OF TABLES

Table 1: Top 12 High Frequency Collision Corridors (2017-2021) 15
 Table 2: Potential Pedestrians & Bicycle Countermeasures 19
 Table 3: Potential Speed Reduction Countermeasures (Major Streets) 20
 Table 4: Potential Speed Reduction Countermeasures (Minor Streets) 20
 Table 5: Potential Countermeasures on Aggressive Drivers 21
 Table 6: Potential Countermeasures to Improve Lighting 22

LIST OF FIGURES

Figure 1: Protected Intersections 4
 Figure 2: LRSP Process 9
 Figure 3: Total Annual Collisions by Year (2017 - 2021) 12
 Figure 4: Types of Collisions 12
 Figure 5: Primary Collision Factors 13
 Figure 6: Pedestrian Collisions (2017-2021) 13
 Figure 7: Bicycle Collisions (2017-2021) 14
 Figure 8: Top 10 High Crash Intersections 15
 Figure 9: Survey Responses to Biggest Safety Concerns 16

LIST OF APPENDICES

APPENDIX A SURVEYS SUMMARY 26
APPENDIX B COLLISION TRENDS 27
APPENDIX C COLLISION DIAGRAMS 28

1.0 ENGINEERS SEAL

(Per section 148 of Title 23, United States Code [23 U.S.C. §148(h) (4)]: REPORTS DISCOVERY AND ADMISSION INTO EVIDENCE OF CERTAIN REPORTS, SURVEYS, AND INFORMATION — Notwithstanding any other provision of law, reports, surveys, schedules, lists, or data compiled or collected for any purpose relating to this section, shall not be subject to discovery or admitted into evidence in a Federal or State court proceeding or considered for other purposes in any action for damages arising from any occurrence at a location identified or addressed in the reports, surveys, schedules, lists, or other data.)



Signature Line



By signing and stamping this Local Road Safety Plan, the engineer is attesting to this report's technical information and engineering data upon which local agency's recommendations, conclusions, and decisions are made.

2.0 INTRODUCTION AND EXECUTIVE SUMMARY

INTRODUCTION

The City of Martinez is located within the “East Bay” of the San Francisco Bay Area and contains a rich history. It has a population of nearly 40,000 residents and is a vital community due to its transportation links, administrative services, and recreational amenities. Serving as county seat since 1850, the City of Martinez is the administrative center for the 19 cities within Contra Costa County, with a population of about 1.2 million.

This Local Road Safety Plan (LRSP) identifies emphasis areas in Martinez and evaluates safety countermeasures that can be implemented to address some issues identified in the city’s transportation network. These emphasis areas were identified through reviews of the trends and patterns identified in the crash analysis and the notable relationships between crash history and current efforts to reduce collisions. The LRSP analyzes crash data on an aggregate basis as well as at specific locations to identify high-crash locations, high-risk locations, and city-wide trends and patterns.

The analysis of crash history (2017-2021) throughout the City’s transportation network allows for opportunities to:

1. Identify factors in the transportation network that inhibit safety for all roadway users,
2. Improve safety at specific high-crash locations, and
3. Develop safety measures using the five E’s of safety:
 - Engineering
 - Enforcement
 - Education
 - Emergency Services
 - Emerging Technologies to encourage safer driver behavior and better severity outcomes

The process and analysis performed for the City’s LRSP including initial vision and goals for the LRSP development, crash history analysis, and emphasis areas is included in this Plan. The information compiled will provide a foundation for decision making and prioritization for safety countermeasures and projects that enhance safety for all modes.

The intent of the LRSP is to:

- Enhance the safety of the City’s roadway system
- Improve transportation safety by reducing the number of incidents and their severity
- Identify high need areas and stakeholder priorities and establish LRSP vision and goals
- Review potential solutions and countermeasures
- Prioritize implementation of traffic safety

SUMMARY

Based on the results of the evaluation, the following is a summary of our findings:

Collision Trends

Review of five-years of Statewide Integrated Traffic Records System (SWITRS) collision data indicated the following trends or patterns.

- Annual collisions total average is 143.
- The most common occurring crash types were Sideswipes¹ (24%), Head-Ons (18%), and Rear-Ends (18%).
- The highest cause of crashes in Martinez is Improper Turning at 40%, and the second highest cause is Unsafe Speed (30%).
- 41 crashes occurred involving pedestrians. 32% of the crashes recorded that the pedestrian was either crossing not in a crosswalk or they were in the road. 39% occurred where the pedestrian was utilizing a crosswalk.
- Twenty-nine (29) bicycle-involved crashes were recorded during the study period. Nine of the twenty-nine crashes resulted in fatalities and severe injuries.

Initial Findings

The top 10 roadway corridors and intersections with most significant crashes are:

Top 10 Corridors	Top 10 Intersections
1. Alhambra Avenue	1. Morello Avenue/Arnold Drive
2. Arnold Drive	2. Green Street/Berrellessa Street
3. Morello Avenue	3. Alhambra Avenue/C Street
4. Berrellessa Street	4. Alhambra Avenue/H Street
5. Marina Vista Avenue	5. Alhambra Avenue/Virginia Hills Drive
6. Pine Street	6. Alhambra Avenue/Brown Street
7. Center Avenue	7. Alhambra Avenue/Walnut Avenue
8. Muir Road	8. Center Avenue/Muir Road
9. Howe Road	9. Alhambra Avenue/B Street
10. Pacheco Boulevard	10. Alhambra Avenue/D Street

Emphasis Areas

Emphasis Areas are types of safety trends where Martinez can strategically focus efforts in order to have a larger impact on transportation safety. There are:

- Emphasis Area #1: Vulnerable Road Users (Pedestrians & Bicyclists)
- Emphasis Area #2: Speeding
- Emphasis Area #3: Aggressive Drivers
- Emphasis Area #4: lighting conditions

¹ A sideswipe accident is a collision between two vehicles that are traveling in the same direction and typically occur because one of the two vehicles involved moved out of the lane it was traveling in when it was unsafe to do so.

Countermeasures Identified

Several high benefits to cost countermeasures for improving safety performance at locations with high collisions along the corridor were identified for the following Emphasis Area.

Emphasis Area #1: Vulnerable Road Users (Pedestrians & Bicyclists)

- ✓ Add Leading Pedestrian Interval (LPI) to traffic signal phases
- ✓ Install a Bicycle Box²
- ✓ No right-turn dynamic sign³
- ✓ Protected Intersections (see example in **Figure 1**)⁴
- ✓ Install pedestrian crossing at uncontrolled locations (if warranted)
- ✓ Install Rectangular Rapid Flashing Beacon (RRFB)⁵
- ✓ Install Pedestrian Hybrid Beacon (HAWK)⁶
- ✓ Install advance stop bar before crosswalk
- ✓ Improve intersection lighting
- ✓ Install curb extensions
- ✓ Bike Activation for green lights at traffic signals
- ✓ Buffer Bike Lanes⁷
- ✓ Separated Bikeline (Class 4 Cycle Track)⁸
- ✓ Class II Bike Lane
- ✓ Class III Bike Route



Figure 1: Protected Intersections

Emphasis Area #2: Speeding

For Major Streets

- ✓ Increase Yellow Change Interval (YCI) & All Red Time to traffic signal phases
- ✓ Add Leading Pedestrian Interval (LPI) to traffic signal phases
- ✓ Install dynamic/variable speed warning signs⁹
- ✓ Provide advanced dilemma zone detection¹⁰ for high-speed approaches
- ✓ Improve pavement friction (High Friction Surface Treatments)

² It is a green box on the road with a white bicycle symbol inside. Typically includes bicycle lanes approaching from the box.

³ Dynamic electronic signs restricting right turns on red - reduces conflicts between turning vehicles and pedestrians and bicyclists.

⁴ At protected intersections, the bikeway is set back from the parallel motor vehicle traffic. Unlike at conventional bike intersections, people biking are not forced to merge into mixed traffic. Instead, bicyclists are given a dedicated path through the intersection, and have the right of way over turning motor vehicles.

⁵ RRFB is a traffic control device that warns drivers of pedestrians crossing the street. RRFBs are activated by pedestrians, who can push a button underneath the sign to activate the lights. The high-intensity, rapid-flashing amber LED lights are designed to increase driver awareness of pedestrians crossing roadways.

⁶ A HAWK beacon (high-intensity activated crosswalk beacon) is a traffic control device used to stop road traffic and allow pedestrians to cross safely. The purpose of a HAWK beacon is to allow protected pedestrian crossings, stopping vehicular traffic only as needed.

⁷ A buffered bike lane is a regular bike lane with a buffer space between it and the travel lane for motor vehicles.

⁸ A bikeway for the exclusive use of bicycles and includes a separation required between the separated bikeway and the through vehicular traffic. The separation may include, but is not limited to, grade separation, flexible posts, inflexible posts, inflexible barriers, or on-street parking.

⁹ Dynamic speed warning signs are traffic control devices that communicate a message to drivers when they exceed a certain speed threshold. It is also known as driver feedback signs or speed display signs.

¹⁰ Advanced dilemma zone detection systems improve safety at signalized intersections by changing the timing of traffic control signals. This is done to reduce the number of drivers who have trouble deciding whether to stop or proceed during a yellow phase.

- ✓ Install Separated Bike Lanes
- ✓ Reduce lane width to 11-foot
- ✓ Coordinate signals at lower speed
- ✓ Apply Assembly Bill (AB) 43 methodology to lower speed limits¹¹

For Minor Streets

- ✓ Reduce lane width to 10 or 11-foot
- ✓ Apply Assembly Bill (AB) 43 methodology to lower speed limits
- ✓ Install dynamic/variable speed warning signs
- ✓ Install edge-lines and centerlines
- ✓ Install raised pedestrian crossing
- ✓ Install Rectangular Rapid Flashing Beacon (RRFB)
- ✓ Install Curb Extensions
- ✓ Install traffic circles

Emphasis Area #3: Aggressive Drivers

- ✓ High Visibility Enforcement
- ✓ Driver education and media campaign
- ✓ Coordinate signals at lower speed
- ✓ Provide advanced dilemma zone detection for high-speed approaches

Emphasis Area #4: Improve Lighting Condition

- ✓ Check and Add intersection lighting
- ✓ Adopt City street lighting guidelines
- ✓ Improve signal hardware: lenses, back-plates
- ✓ Install flashing beacons as advance warning
- ✓ Install raised pavement markers
- ✓ Add signal heads where needed for improved visibility
- ✓ Install striping through intersections where lanes are offset

¹¹ AB 43 provides cities added control and ability in lowering speed limits, specifically in areas that may be more prone to traffic safety concerns, especially sections of a town with frequent pedestrian or bicycle traffic. And lower speed limits beyond the 85th percentile on streets with high injuries and fatalities; limits the need for updated traffic surveys on certain streets; provides more flexibility in setting school speed limits and allows for 25 mph speed limits in downtowns without the need for a speed survey if some factors are met.

Recommended Best Practices for Future Improvements

The following are recommended roadway safety best practices which could become safety policies or guidelines for implementing roadway designs and improvement in the future.

Intersection Level

- Add leading pedestrian interval (LPI)
- Yellow retroreflective frame strip backplates for traffic signals
- Add intersection lighting
- Provide advanced dilemma zone detection for high-speed approaches.
- High visibility crosswalks¹²

Pedestrian and Bicycle

- Install advance stop bar before crosswalk
- Install a Bicycle Box
- Check feasibility for Protected Intersections
- Include Class 4 Cycle Track or Buffer Bike Lanes¹³
- Raised medians and pedestrian islands¹⁴
- Provide sidewalk continuity where missing segments exist

Roadway Level

- When appropriate use 11-foot lanes.
- Limit uncontrolled full access on arterial roadways¹⁵. Target a minimum of 660 ft spacing between two consecutive unsignalized accesses along a minor arterial.

¹² High-visibility crosswalks use patterns (i.e., bar pairs, continental, ladder) that are visible to both the driver and pedestrian from farther away compared to traditional transverse line crosswalks. Typically agencies use materials such as inlay or thermoplastic tape, instead of paint or brick, for highly reflective crosswalk markings.

¹³ A buffered bike lane is a conventional bicycle lane with a buffer space to separate from the adjacent traffic lane. It is designed to provide a more comfortable space for cyclists than a conventional bike lane.

¹⁴ A pedestrian island, or a refuge island, or crossing island, is a raised area in the middle of the street at an intersection or midblock.

¹⁵ An arterial road is a high-capacity urban road. It is designed for unimpeded high-speed movement. Traffic signals are used at most major intersections and typically are four lanes or more. Speed limits typically range from 45 to 55 mph.

3.0 VISION AND GOALS

The Vision of this LRSP plan is to strive towards reducing traffic fatalities and severe injuries, while increasing safe, healthy, and equitable mobility for all, especially the more vulnerable pedestrian and bicycle users.

Following discussions with Martinez staff and a review of existing plans and policies for the area, the following Goals and Objectives were established for this project.

Goal #1: Identify High Need Areas and Stakeholder Priorities

Objectives:

- Identify areas of emphasis
- Identify intersections and segments that are a safety concern for all travelers
- Listen to stakeholder concerns and identify emphasis areas that would benefit from countermeasures

Goal #2: Enhance Safety of Roadways for All Users

Objectives:

- Identify locations with high pedestrian and bicycle collisions
- Identify solutions for all roadway users, especially vulnerable users (Pedestrians and Bicyclists)
- Consult policies and plans in Conty Bicycle & Pedestrian Master Plan

Goal #3: Identify Potential Countermeasures

Objectives:

- Review and recommend effective countermeasures
- Include countermeasures which will enable city to be successful in grant applications



4.0 SAFETY PARTNERS

As part of the LRSP, local stakeholders were included in the process to ensure the local perspective was kept at the forefront of this study effort. The stakeholder group was composed of representatives from Martinez Police, County Connection, Martinez Unified School District, Mt. Diablo Unified School District, Martinez Chamber of Commerce, Downtown Martinez, CCTA as well as City Staff. A community outreach meeting was conducted to discuss and provide feedback for this LRSP¹⁶. All stakeholder feedback regarding the plan and recommendations were reviewed and incorporated into the study process for the development of the LRSP.

In addition, two month-long online surveys were conducted, and comments received were reviewed and discussed with city staff.¹⁷ The two surveys received 141 and 543 responses respectively. A summary of survey responses is contained in **Appendix A**.



¹⁶ An online meeting was conducted on August 19, 2023

¹⁷ Surveys were conducted in January and October 2023

5.0 PROCESS

Guidance on the LRSP process is provided at both the national (FHWA) and state (Caltrans) level. Both of these agencies have developed a general framework of data and recommendations to be included in an LRSP. These processes evolve and change due to incorporating changing priorities.

FHWA encourages:

- The establishment of a working group (Stakeholders) to participate in developing an LRSP.
- Review crash, traffic, and roadway data to identify areas of concern.
- Establish goals, priorities, and countermeasures to recommend improvements at spot locations, systemically, and comprehensively.

Caltrans guidance follows a similar outline with the following steps:

- Establish leadership
- Analyze the safety data
- Determine emphasis areas
- Identify strategies
- Prioritize and incorporate strategies
- Evaluate and update the LRSP

This LRSP documents the results of data and information obtained, including the preliminary vision and goals for the LRSP, existing safety efforts, initial crash analysis, and developed emphasis areas. The development of the LRSP

recommendations considers the five E's of traffic safety defined by the California Strategic Highway Safety Plan (SHSP): Engineering, Enforcement, Education, Emergency Response, and Emerging Technologies throughout its process.



Figure 2: LRSP Process

Reference Materials

The following section describes the analysis process undertaken to evaluate safety within Martinez at a systemic level. Using a network screening process, locations within the City that will most likely benefit from safety enhancements will be identified. Using historic crash data, crash risk factors for the entire network are derived. The outcomes will help identify and prioritize engineering and non-infrastructure safety measures. The goal is to address certain roadway characteristics and related behaviors that contribute to vehicle crashes with active transportation users.

Local Road Safety Manual

Based on the *Local Roadway Safety Manual: A Manual for California's Local Road Owners* (Version 1.6, April 2022), the purpose is to encourage local agencies to pursue a proactive approach to identify as well as analyze safety issues and prepare to compete for project funding

opportunities. A proactive approach is defined as analyzing the safety of the entire roadway network through a systemic analysis of the roadway network.¹⁸

According to the *Local Roadway Safety Manual (LRSM)*, “The California Department of Transportation (Caltrans) – Division of Local Assistance is responsible for administering California’s federal safety funding intended for local safety improvements.”

To provide the most benefit and to be competitive for funding, the analysis leading to countermeasure selection should focus on both intersections and roadway segments and consider roadway characteristics and traffic volumes. The result should be a list of locations that are most likely to benefit from cost-effective countermeasures, preferably prioritized by benefit/cost ratio. The manual suggests using a mixture of quantitative and qualitative measures to identify and rank locations that considers both crash frequency and crash rates. These findings should then be screened for patterns such as crash types and severity to aid in the determination of issues causing higher numbers of crashes and the potential countermeasures that could be most effective. Qualitative analysis should include field visits and a review of existing roadway characteristics and devices. The specific roadway context can then be used to assess what conditions may increase safety risk at the site and systematic level.

Countermeasure selection should be supported using Crash Modification Factors (CMFs). These factors are the peer reviewed product of before and after research that quantifies the expected rate of crash reduction that can be expected from a given countermeasure. If more than one countermeasure is under consideration, the LRSM provides guidance on how to apply CMFs appropriately.

Downtown Martinez Community Based Transportation Plan

The City adopted the Downtown Martinez Community Based Transportation Plan (Downtown CBTP) in January 2020. The primary goal is to continue its effort in making the city safer for all users and expanding its pedestrian, bicyclist, and transit infrastructure. The Plan includes both visionary, yet implementable projects, programs, and policies to work towards making this goal a reality.

AMG reviewed the Downtown CBTP and will incorporate some of the issues identified to make Martinez streets safer for the more vulnerable bicycle and pedestrian modes of travel.

ANALYSIS TECHNIQUES

The initial steps of the crash analysis established subsets of roadway segments and intersections that have similar characteristics. The network screening process ranks intersections and roadway segments by the number of crashes that occurred at each one over the analysis period, and then identifies areas that had more of a given type of crash than would be expected for that type of location.

Typically, some of the crash type factors could include:

¹⁸ *Local Roadway Safety Manual (Version 1.6) 2022, Page 6.*

1. crash injury (fatal, serious injury, other visible injury, complaint of pain, property damage only),
2. crash type (broadside, rear-end, sideswipe, head-on, hit object, overturned, bicycle, pedestrian, other),
3. environmental factors (lighting, wet roads),
4. driver behavior (impaired, aggressive, and distracted driving).

With these additional factors, the locations were further analyzed, and the top 10 corridors and intersections were identified.

From the results of the network screening analyses, a short-list of locations was chosen based on crash activity, crash severity, crash patterns, location type, and area of the City of Martinez to provide the greatest variety of locations covering the widest range of safety opportunities for toolbox development. The intent is to populate the safety toolbox with mitigation measures that will be applicable to most of the crash activity in the city. As a part of the area of emphasis process, the top 10 corridors and intersections were also identified for countermeasure analysis.

6.0 DATA SUMMARY AND ANALYSIS

As a data driven process, utilizing the most recent and accurate data is crucial. The following section describes the data inputs used for the analysis process of this LRSP.

6.1 CRASH DATA

Crash data was collected from SWITRS for the period from January 1, 2017, through December 31, 2021 (complete 2023 data was not available at time of publication of this document), in order to have a complete set of crash data for analysis. We utilize five years of data instead of three to provide more history to evaluate trends or patterns. Analysis of the raw crash data is the first step in understanding the specific and systemic challenges faced throughout the city. Analyzing the five years of data provided insight on the following crash trends and patterns.

Using a systemic approach, our team analyzed the data sets for crash trends and crash concentrations, crash types and overall numbers, then identified top locations of total crashes including fatalities and severe injuries for the selected corridors.

Using 2021 household income information¹⁹, AMG overlay it with the five years collision data and the results indicated that key concentrations of collisions are generally located along key arterials as shown in the heat map contained in **Appendix B**. These collision hot spots areas are generally located within lower median household income.

6.2 All Crashes

From January 2017 through December 2021, 715 crashes occurred within Martinez, in which 32 crashes involved fatalities or serious injuries. **Figure 3** shows the total number of collisions by year. Although there was a decline in crashes from 2017 to 2020, the total number of crashes was

¹⁹ Martinez Census Tracts information

trending upwards again in 2021. Some anomalies due to the Covid-19 pandemic may influence the data.

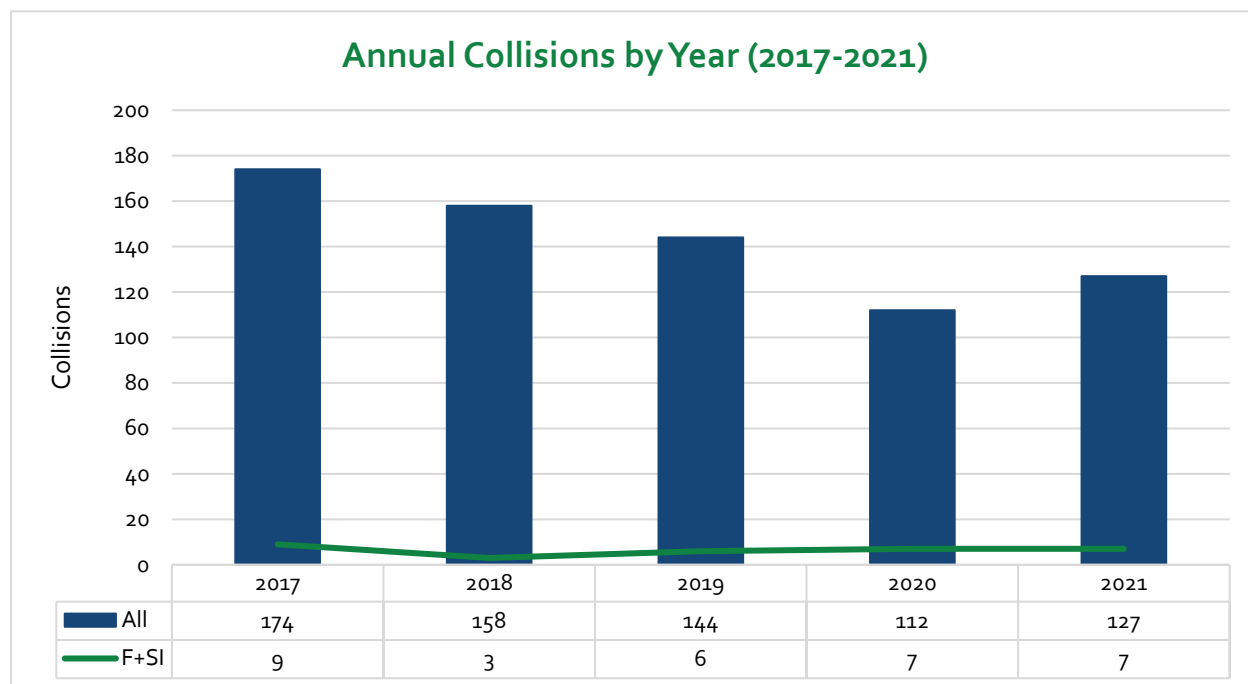


Figure 3: Total Annual Collisions by Year (2017 - 2021)

7.0 CRASH SAFETY TRENDS

The following section breaks down the crash data for the period from January 1, 2017, through December 2021. This information will be used to highlight areas of concern for the city.

7.1 TYPES OF COLLISIONS

Figure 4 shows the types of collisions within Martinez. During the study period, the most common occurring crash types were Sideswipes (24%), Rear Ends (18%), and Hit Objects (18%). The rest of the types of collisions are broken down **Figure 3**.

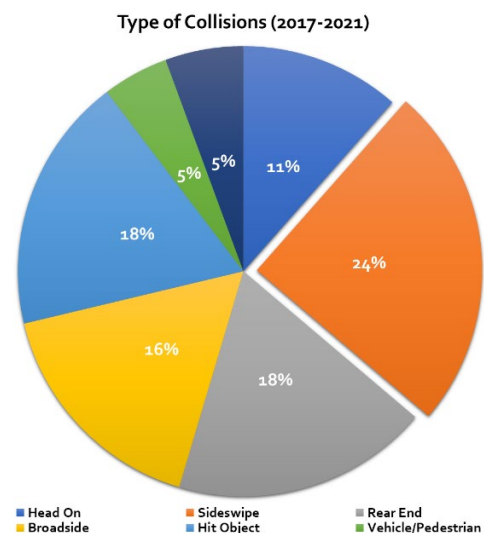


Figure 4: Types of Collisions

7.2 FATALITIES AND SERIOUS INJURIES

The total number of fatal and severe injury collisions is approximately 32 within the study period. Of these, 7 are

fatalities, and 25 severe injuries – of these, there were nine and five sever collisions involving bicycles and pedestrians, respectively.

7.3 PRIMARY CAUSE OF COLLISIONS

The highest cause of crashes in Martinez is Improper turning at 40%, and the second highest cause is unsafe speed (30%). The third and fourth highest proportion of crashes are ignoring traffic signals and signs (11%) and unsafe starting or backing (10%), respectively. A breakdown of crashes by cause is shown in **Figure 5**.

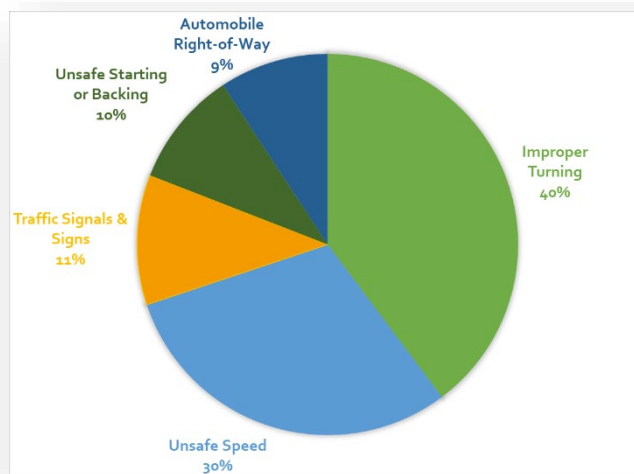


Figure 5: Primary Collision Factors

7.4 VULNERABLE USERS

Understanding the safety concerns of vulnerable users is important to plan for transportation improvements at all levels.

7.4.1 PEDESTRIANS

Over the study period, 38 crashes occurred involving pedestrians. 32% of the crashes recorded that the pedestrian was either crossing not in a crosswalk or they were in the road. 39% occurred where the pedestrian was utilizing a crosswalk. 10% of crashes were recorded as “not in road”.

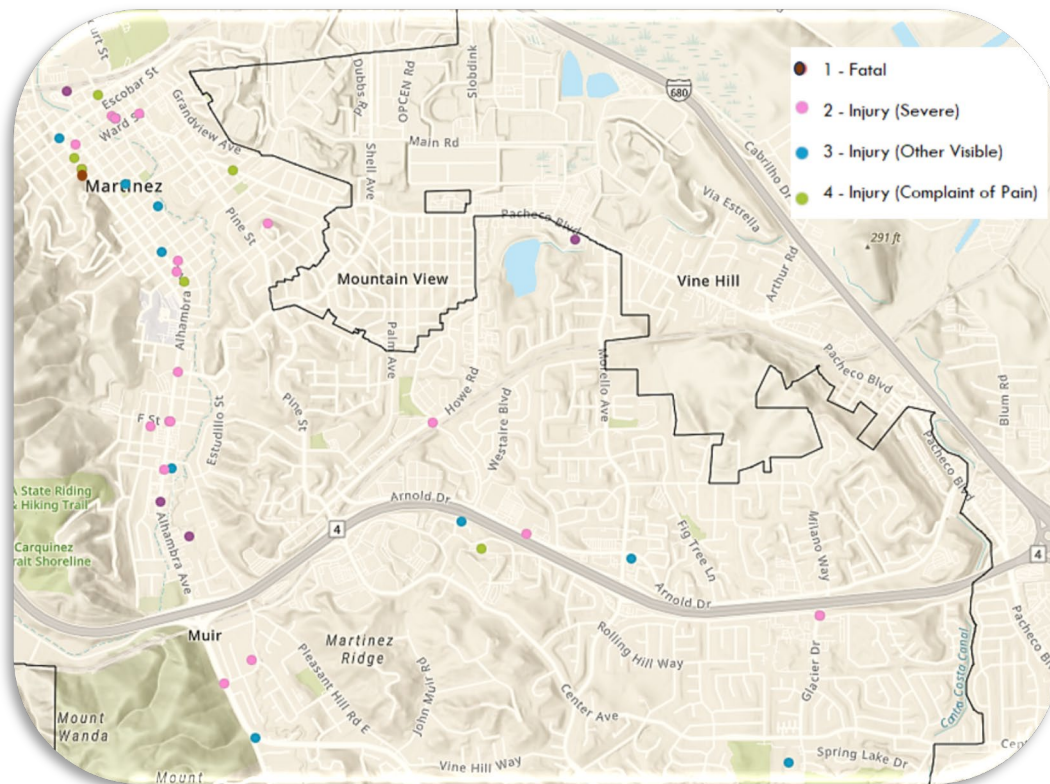


Figure 6: Pedestrian Collisions (2017-2021)

Five (5) of the pedestrian crashes resulted in fatalities or severe injuries. Pedestrian crashes are concentrated along major corridors (Alhambra Avenue, Berrellesa Street, Main Street, and Ward Street). **Figure 6** shows all the pedestrian collisions.

7.4.2 BICYCLISTS

Twenty-nine (29) bicycle-involved crashes were recorded during the study period. Nine of the twenty-nine crashes resulted in fatalities and severe injuries. Nearly half of the crashes occurred at or adjacent to an intersection. Bicyclist crashes were concentrated along major corridors (Alhambra Avenue, Arnold Drive, Pine Street, Center Avenue). **Figure 7** shows all the bicyclist collisions²⁰.

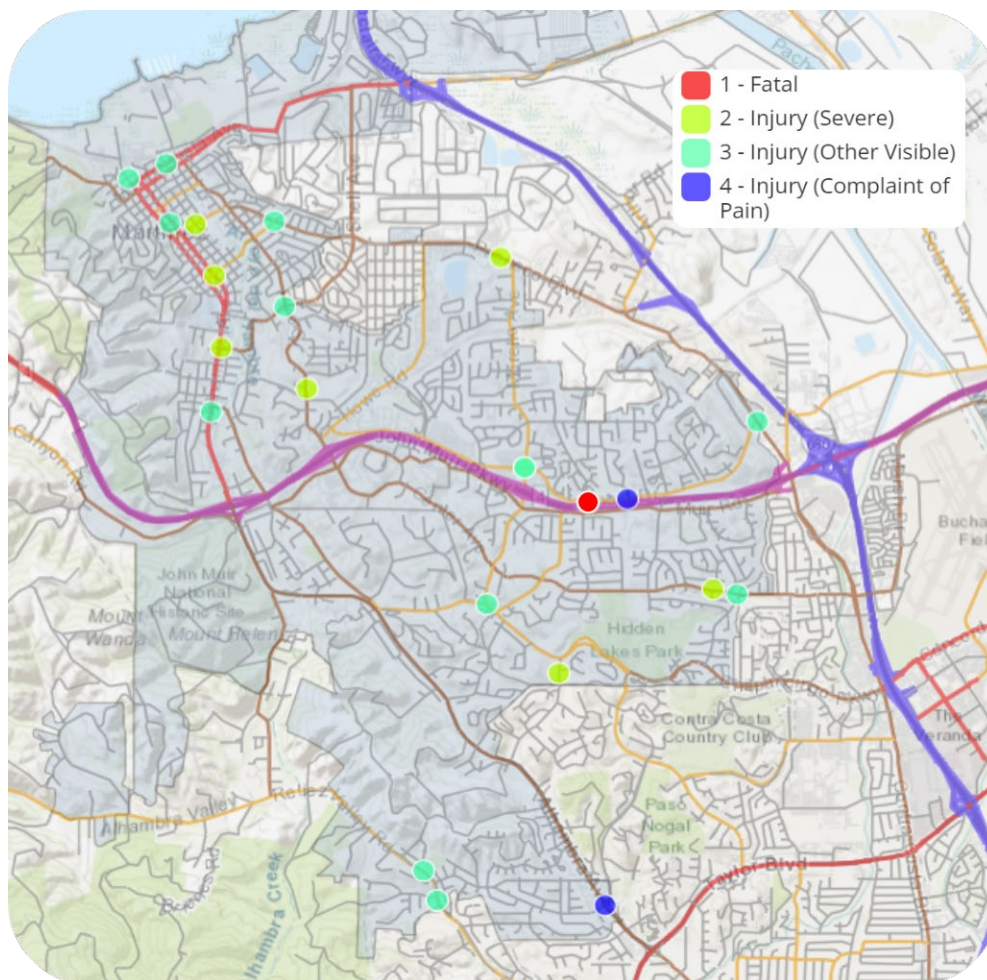


Figure 7: Bicycle Collisions (2017-2021)

Additional collision trends, heat map and other key information are contained in **Appendix B**.

²⁰ Note not all collisions are shown on the map as coordinate information are missing for some data.

7.5 INITIAL FINDINGS

Through the initial crash and network screening analysis an initial rank of locations was identified. The top 12 roadway segments with most significant crashes are shown in **Table 1**.

Table 1: Top 12 High Frequency Collision Corridors (2017-2021)

Corridor Name	Total Crashes	Fatal + Severe Injury	Other Injury
Alhambra Ave (Buckley to Bertola)	63	1	28
Alhambra Ave (Bertola to Hwy 4)	48	3	19
Alhambra Ave (Hwy 4 to e/o City Limits)	46	3	18
Arnold Dr	39	3	18
Morello Ave	34	1	9
Berrellessa St	33	0	15
Marina Vista Ave	29	4	6
Pine Street	27	1	7
Center Ave	25	2	6
Muir Rd	23	1	8
Howe Rd	18	1	7
Pacheco Blvd	18	1	7

Based on these corridors, crash and network screening analysis, the top 10 intersection locations are shown in the following:

1. Morello Ave & Arnold Dr
2. Green St & Berrellessa St
3. Alhambra Ave & C St
4. Alhambra Ave & H St
5. Alhambra Ave & Virginia Hills Dr (note shown on map)
6. Alhambra Ave & Brown St
7. Alhambra Ave & Walnut Ave
8. Center Ave & Muir Rd
9. Alhambra Ave & B St
10. Alhambra Ave & D St

The list of intersections is also shown in **Figure 8**.

Detailed collision diagrams of the intersections are contained in **Appendix C**.

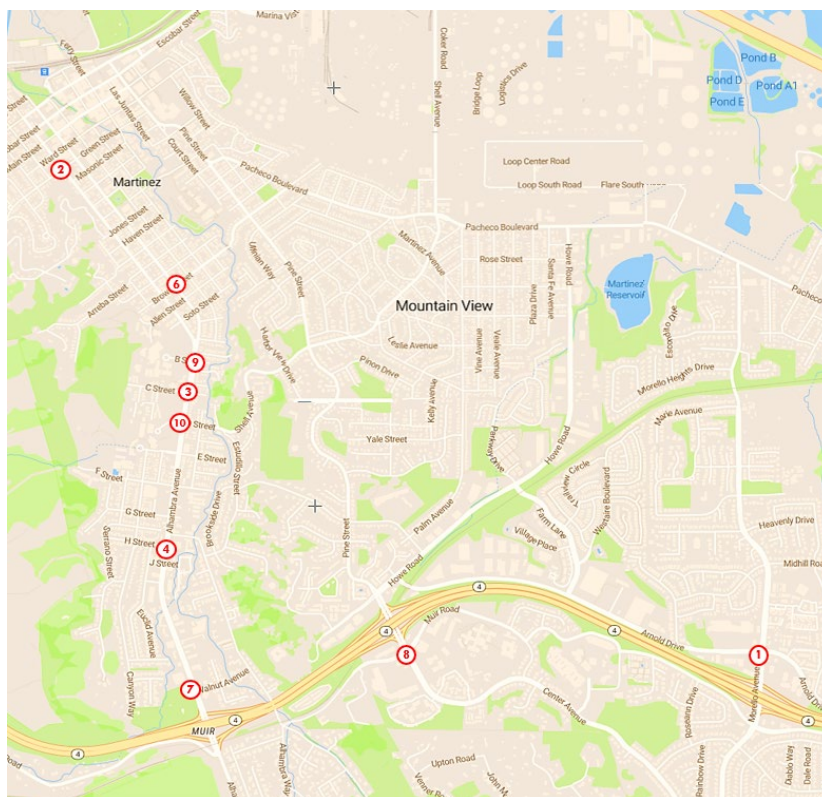


Figure 8: Top 10 High Crash Intersections

8.0 EMPHASIS AREAS

Emphasis Areas are types of safety trends where Martinez can strategically focus efforts in order to have a larger impact on transportation safety. Emphasis areas were developed by revisiting the Vision and Goals developed at the onset of this planning process and comparing them with the trends and patterns identified in the crash analysis. Where these areas aligned, or major challenges were observed, Emphasis Areas and strategies were developed.

8.1 EMPHASIS AREA #1: VULNERABLE ROAD USERS (PEDESTRIANS & BICYCLISTS)

Pedestrians and bicyclists are classified by Caltrans as vulnerable users, meaning they have the highest potential for severe harm during a crash. These groups need appropriate infrastructure to travel to key destinations such as schools, workplaces, and core commercial areas. The City’s General Plan 2035 and the Downtown CBTP provided recommendations for future non-motorized networks. Future roadway facilities are planned on key City roads to accommodate active transportation infrastructures such as buffer or separated bike lanes, intersection control, and speed controls that help provide a safe and comfortable environment for active transportation users. Of the 32 total fatal and sever injury crashes in Martinez throughout the study period, 14 were vulnerable road users (44%). Therefore, the city should focus on countermeasures which will provide protection for these users.

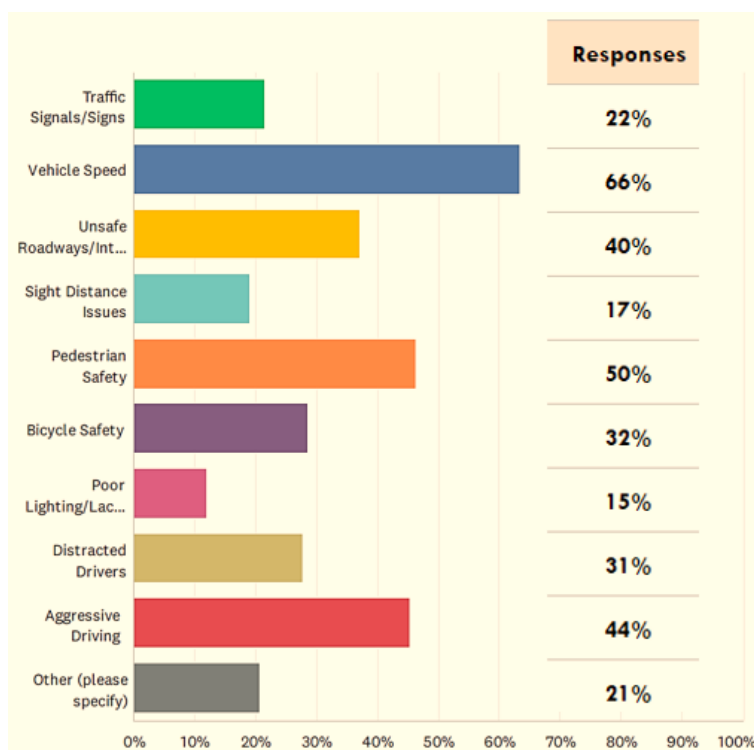


Figure 9: Survey Responses to Biggest Safety Concerns

The two online survey request respondents to select their top 3 concerns/complaints. Based on the responses from the two online surveys (684), nearly 50% and 32% indicated their biggest safety concerns respectively for pedestrian and bicycle safety as shown in Figure 9.

8.2 EMPHASIS AREA #2: SPEEDING

Many collisions due to excessive speeds occur along major arterials in the city. Vehicular speeds are particularly high during the evening commute periods, when the city’s arterials serve both local traffic as well as cut-through commute traffic. Nearly 21% of all collisions are due to

speeding. Nearly 68% of survey responses indicated speeding to be a major concern as shown in **Figure 8**.

8.3 EMPHASIS AREA #3: AGGRESSIVE DRIVERS

42% of survey respondents to the online survey conducted by the city indicated aggressive drivers being a major safety concern. Aggressive driving behavior could involve driving at excessive speeds, tailgating, not yielding to pedestrians, driving too close to bicyclists or running the red light.

Some of these aggressive driving behaviors could pose a serious challenge to roadway safety especially to the more vulnerable pedestrians and bicycle modes. Nearly 44% of survey responses indicated aggressive drivers to be a major concern as shown in **Figure 9**.

8.4 EMPHASIS AREA #4: LIGHTING CONDITIONS

While most nighttime collisions occurred where streetlights were present, the quality of the lighting can vary widely. Streetlights can be insufficiently bright or placed too widely apart. Nearly 243 collisions or 34% of the collisions are due to lighting conditions.

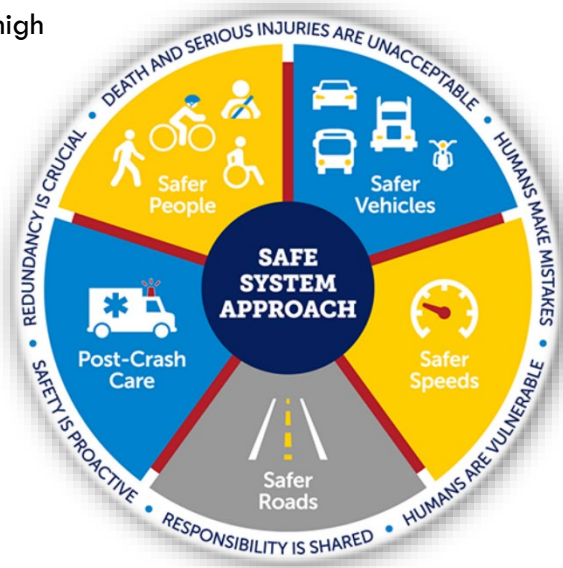
9.0 COUNTERMEASURES IDENTIFIED TO ADDRESS SAFETY ISSUES

Based on extensive analysis of collision trends, types of high collisions at intersections and corridors, the following are several high benefits to cost countermeasures for improving safety performance at locations with high collisions along the corridor.

We have also conducted review of detailed collision diagrams to determine any deficiencies of existing roadway infrastructure, traffic control devices, signing and striping or traffic operations.

Countermeasures can be engineering-based physical improvements, many of which have low-cost or quick-build versions, but they can also be non-engineering strategies in areas such as education, enforcement, and outreach.

The safety strategies of a few elements of a Safe System Approach are used:



- ✓ Safe Roads,
- ✓ Safe Speeds and
- ✓ Safe Road Users

In ensure eligibility for potential future grant funding application, many of the countermeasures recommended were based on information contained in the “Local Roadway Safety, A Manual for California’s Local Road Owners (LRSM).”²¹

9.1 COUNTERMEASURES FOR EMPHASIS AREA #1: VULNERABLE ROAD USERS (PEDESTRIANS & BICYCLISTS)

There are clusters of pedestrian collisions along Alhambra Avenue near Downtown Martinez, near Alhambra High School, and near Martinez Adult Education/shopping centers. Countermeasures should heighten the presence of pedestrians and make improvements that will help serve pedestrian desire lines. It is also important to improve street lighting and add traffic calming to reduce vehicle speeds.

There are currently Class 2 (many not continuous) or 3 bike lanes on several key roadways in the city. If space is available, adding buffer or separated bike lanes to facilitate east-west and north-south travel in the city would be a significant improvement for bike travel and the related benefit is that it will also calm the speed of traffic along these major commute arterials (e.g., some segments of Alhambra Avenue, Arnold Avenue, or Howe Road).

Based on responses received from the survey, the following are some of the major comments:

- Sidewalks are uneven - tripping hazards
- Lack of marked cross walks, no sidewalk
- Lack of sidewalks for kids walking to school
- Incomplete and substandard bicycle and pedestrian infrastructure
- Pacheco Boulevard is a primary bike route - needs protected bike lane
 - bike lanes too narrow or nonexistent
- Inconsistent sidewalks or no crosswalks:
 - On Alhambra Way between Alhambra and Muir Station
 - Shell Ave between Pine St and Bundros Court
 - Pine Street between Shell Ave and Bush St
 - Berrellesa Street

Several potential pedestrian and bicycle countermeasures are shown in **Table 2**. The column under “LRSM #” shows the specific countermeasures in the Local Roadway Safety Manual. A copy is contained in **Appendix C**. These are measures which could be funded under state grants such as HSIP. These strategies will be implemented by the city, while partnering with Caltrans and other community partners. Funding sources for these strategies may include Local Highway Safety

²¹ “Local Roadway Safety, A Manual for California’s Local Road Owners”, April 2022

Improvement Program (HSIP), Active Transportation Program (ATP), California Office of Traffic Safety (OTS), and Safe Streets and Roads for All (SS4A) grant programs.

Table 2: Potential Pedestrians & Bicycle Countermeasures

	Potential Countermeasures	LRSM #
Pedestrian Safety		
1	Add Leading Pedestrian Interval (LPI)	S21PB
2	Install Bicycle Box	S20PB
3	Install advance stop bar before crosswalk	NA
4	No right-turn dynamic sign	NA
5	Protected Intersections	NA
6	Install pedestrian crossing at uncontrolled locations	S18PB
7	Install Rectangular Rapid Flashing Beacon (RRFB)	NS22PB
8	Install Pedestrian Hybrid Beacon (HAWK)	NS23PB
Bike Safety		
1	Install Bicycle Box	S20PB
2	Install advance stop bar before crosswalk	NA
3	Bike Activation	NA
4	Add Leading Pedestrian Interval (LPI)	S21PB
5	Protected Intersections	NA
6	Buffer Bike Lanes	R32PB
7	Class 4 Cycle Track	R33PB

Notes:
LRSM - Local Roadway Safety Manual, April 2022

Detailed descriptions of countermeasures from the LRSM are contained in **Appendix C**.

9.2 COUNTERMEASURES FOR EMPHASIS AREA #2: SPEEDING

Nearly 21% of the collisions are due to speeding. To slow traffic in areas with pervasive speeding, several actions could be taken including traffic calming measures as well as evaluating where speed limits could be lowered in conjunction with new AB 43 allowances.

It is a common experience that typically vehicles travel at higher speeds along long wide or multi-lane streets, especially during non-commute hours such as during early morning or late evening hours. Research data indicated that as the width of a lane increases, the speed of the road increases – when lane widths are 3.3 feet greater, streets are predicted to be 9.4 mph faster.²²

²² NACTO Urban Street Design Guide Street Design Elements based on Identify Design Factors That Affect Driver Speed and Behavior by Kay Fitzpatrick, P.E., Paul J. Carlson, P.E, Texas TI

There are several engineering based as well as non-engineering potential countermeasures to slowing traffic. Coordinating traffic signals at a lower speed has been shown to be effective. Speeds during nighttime are usually higher so signals could be coordinated at a lower speed. Several potential speed reduction countermeasures for major streets are shown in **Table 3**.

Table 3: Potential Speed Reduction Countermeasures (Major Streets)

	Potential Speeding Countermeasures (Major Street)	LRSM #
1	Increase Yellow Change Interval (YCI) & All Rd Time	NA
2	Add Leading Pedestrian Interval (LPI)	S21PB
3	Install dynamic/variable speed warning signs	R26
4	Provide advanced dilemma zone detection for high speed approaches	S04
5	Improve pavement friction (High Friction Surface Treatments)	R21
6	Install Separated Bike Lanes	R33PB
7	Reduce lane width to 11-foot	NA
8	Coordinate signals at lower speed	NA
9	Apply Assembly Bill (AB) 43 methodology to lower speed limits	NA

Note:
LRSM - Local Roadway Safety Manual, April 2022

Based on responses received from the survey, the following are some of the major locations along minor streets which do not have signals and experiencing excessive speeds:

- Vista Way and Mountain View
- Brown Street from Alhambra Avenue to Pacheco Boulevard
- Alhambra Ave after they pass Bertola Street (northbound)
- Center Avenue between Glacier Dr and Vine Hill

Several potential speed reduction countermeasures for traffic calming are shown in **Table 4**. Detailed descriptions of countermeasures from the LRSM are contained in **Appendix C**.

Table 4: Potential Speed Reduction Countermeasures (Minor Streets)

	Potential Speeding Countermeasures (Minor Street)	LRSM #
1	Reduce lane width to 10 or 11-foot	NA
2	Apply Assembly Bill (AB) 43 methodology to lower speed limits	NA
3	Install dynamic/variable speed warning signs	R26
4	Install edge-lines and centerlines	R28
5	Install raised pedestrian crossing	R15
6	Install Rectangular Rapid Flashing Beacon (RRFB)	R16
7	Install Curb Extensions	NA
8	Install traffic circles	NA

9.3 COUNTERMEASURES FOR EMPHASIS AREA #3: AGGRESSIVE DRIVERS

Aggressive drivers could pose a serious challenge to roadway safety and the efficacy of safety features. Nearly 45% of survey responses indicated aggressive driving to be a safety concern.²³ Non-engineering interventions, such as targeted enforcement and automated enforcement, could be deployed to address these challenges, but they may be supplemented with other countermeasures listed in **Table 5** which are general ways to enhance safety.

Vehicular speeds are particularly high during the evening commute periods, when the city’s arterials serve both local traffic as well as cut-through commute traffic.

According to National Highway Traffic Safety Administration (NHTSA)²⁴ research, high-visibility enforcement is one of the most effective enforcement strategies for safety outcomes. It is designed to be a highly visible approach that generates publicity on traffic safety laws through highly visible patrols, such as checkpoints, saturation patrols, or message boards. The goal of high-visibility enforcement is to promote voluntary compliance with traffic laws and it is one of the most effective enforcement strategies for safety outcomes.

Office of Traffic Safety (OTS) provides three grant funding sources to supplement CHP in their high-visibility enforcement goals:

- Get Education and Ride Safe III (GEARS III) is to reduce the number of motorcycle-involved fatalities and serious collisions.
- The Safer Highways Statewide grant is to reduce the number of alcohol-involved fatalities and serious collisions.
- The Regulate Aggressive Driving and Reduce Speed V (RADARS V) grant is to reduce the number of victims killed or injured due to speed, or reckless driving-related collisions.

Other potential countermeasures are shown in **Table 5**.

Table 5: Potential Countermeasures on Aggressive Drivers

	Potential Aggressive Drivers Countermeasures	LRSM #
1	High Visibility Enforcement	NA
2	Driver education and media campaign	NA
3	Coordinate signals at lower speed	NA
4	Provide advanced dilemma zone detection for high speed approaches	S04

Note:
LRSM - Local Roadway Safety Manual, April 2022

²³ Online survey conducted in January and October 2023

²⁴ Countermeasures That Work: A Highway Safety Countermeasure Guide for State Highway Safety Offices, 9th Edition. National Highway Traffic Safety Administration

9.4 COUNTERMEASURES FOR EMPHASIS AREA #4: IMPROVE LIGHTING CONDITION

Nearly 35% of collisions occurred during nighttime. It is noted that collisions tend to be more severe at night due to a variety of factors, including reduced visibility or higher speeds.

Also, typically collisions that occur during nighttime also could affect more seriously those people walking or biking due to higher speeds. While most nighttime collisions occurred where streetlights were present, the quality of the lighting can vary widely. Streetlights can be insufficiently bright, or placed too widely apart, and the quality of lighting may be especially poor for people walking or on the sidewalk, as streetlights are often designed primarily with vehicles in travel lanes in mind.

There is much innovation and upgrade in street and intersection lighting technology. Many cities use the Illuminating Engineering Society of North America (IESNA, or IES) as guidelines or threshold. IES provides recommended exterior lighting for various roadway classifications.

In addition to street lighting, intersection controls such as lack of visibility of traffic signals, unclear striping through intersections or lack of advance warning could contribute to these collisions.

Some of the potential countermeasures are shown in **Table 6**.

Table 6: Potential Countermeasures to Improve Lighting

	Potential Lighting Condition Countermeasures	LRSM #
1	Check and Add intersection lighting	S01
2	Adopt City street lighting guidelines (or based use IES)	NA
3	Improve signal hardware: lenses, back-plates	S02
4	Install flashing beacons as advance warning	S10
5	Install raised pavement markers & striping (Through Intersection)	S09
6	Add signal heads where needed for improved visibility	NA

Notes:

LRSM - Local Roadway Safety Manual, April 2022

IES - Illuminating Engineering Society of North America

10.0 RECOMMENDED BEST PRACTICES FOR FUTURE IMPROVEMENTS

Traffic safety best practices are constantly being improved as more research and newer technologies evolve to help make streets safer for all modes of travel. As a part of incorporating the Safe System Approach, future planning and design of roadways in Martinez should include best practice in the designs which will advance the concept of safe roads and safe speeds for all road users.

The following are recommended roadway safety best practices which could become safety policies or guidelines that Martinez could adopt for implementing roadway designs and improvement in the future.

Intersection Level

- Add leading pedestrian interval (LPI).
- Yellow backplates retroreflective frame strip for traffic signals.
- High visibility crosswalks.
- Provide advanced dilemma zone detection for high-speed approaches.

Pedestrian and Bicycle

- Install advance stop bar before crosswalk (Bicycle Box).
- Check feasibility for Protected Intersections.
- Include Class 4 Cycle Track or Buffer Bike Lanes.
- Raised medians and pedestrian islands.
- Install HAWK control as warranted.

Roadway Level

- When appropriate use 11-foot lanes.
- Limit uncontrolled full access on arterial roadways. Target a minimum of 660 ft spacing between two consecutive unsignalized accesses along a minor arterial.
- All roadway lighting should meet best practice exterior lighting standard.

11.0 FUNDING, IMPLEMENTATION & EVALUATION STRATEGIES

This chapter identifies funding and implementation considerations that will be important to City staff as they pursue funding opportunities to implement the recommended safety projects.

11.1 FUNDING OPPORTUNITIES

There are a variety of regional, state, and federal sources to fund safety improvements.

- Safe Streets and Roads for All (SS4A)
- Congestion Mitigation and Air Quality (CMAQ) Improvement Program
- Highway Safety Improvement Program (HSIP)
- Active Transportation Program (ATP)
- SB-1 Transportation Funding
- MTC One Bay Area Grant (OBAG) Program
- Caltrans Sustainable Transportation Planning Grant Program
- California Office of Traffic Safety (OTS)
- Affordable Housing and Sustainable Communities (AHSC)
- Community Development Block Grant (CDBG) Program

11.2 IMPLEMENTATION STRATEGIES

Implementation of the LRSP is a vital step in the process where identified strategies and projects are executed. Successful implementation requires sustained and coordinated support from project stakeholders, elected officials, safety partners and City staff.

- Pursue funding opportunities and submit competitive projects
- Continued communication with stakeholders as appropriate
- Prioritized list of countermeasures and projects with near-term, mid-term, and long-term implementation goals

11.3 EVALUATION STRATEGIES

This LRSP Final Report is a living document that is recommended to be updated every three to five years to utilize the latest data and safety trends. Collision data can be used to evaluate the success of the plan. It is recommended that City staff update this LRSP Final Report in consultation with the project stakeholders and safety partners and monitor the implementation of the plan and strategies in each emphasis area.

- Update the Plan periodically
- Identify Target Metrics and Measure Goal Performance in Priority Areas
- Continue Engagement with Stakeholders and Safety Partners

REFERENCES

1. City of Martinez Figure 6-3. Existing and Proposed County-Wide Bicycle and Pedestrian Trail Network
2. Local Roadway Safety Manual (Version 1.6) 2022
3. Martinez General Plan Circulation Element, 2022
4. Downtown Martinez Community-Based Transportation Plan, 2020
5. City of Martinez Engineering Traffic Survey, 2022
6. Caltrans, Traffic Volumes Annual Average Daily Traffic (AADT) on California State Highways
7. SWITRS data, 2017-2021

Advanced Mobility Group

Christopher Thnay, PE, AICP
Joy Bhattacharya, PE, PTOE
Vasavi Pannala, PE
Andrea Flores, EIT
Robert Furger

Persons Consulted

Joe Enke, PE	Director of Public Works, City of Martinez
Ali Hatefi, PE	Assistant City Engineer, City of Martinez
Lynne B. Filson, PE, PLS	Traffic Engineer, City of Martinez

Appendix A

Surveys Summary



City of Martinez Local Road Safety Plan Online Survey Questionnaire

1. Do you live in the City of Martinez?

- Yes
- No

2. If yes, what street do you live on? (address not required) _____

3. What are your primary modes of transportation while using City of Martinez's road network? (check all that apply)

- Personal Car
- Carpool/Rideshare
- Walking
- Bicycle
- Bus
- Amtrak/Bart
- Other (please specify) _____

4. What are your biggest concerns related to transportation safety? (check up to three)

- Traffic Signals/Signs
- Vehicle Speed
- Unsafe Roadways/Intersections
- Sight Distance Issues
- Pedestrian Safety
- Bicycle Safety
- Poor Lighting/Lack of Lighting
- Distracted Drivers
- Aggressive Driving
- Other (Please Specify) _____



5. Are you aware of how transportation safety issues are currently being addressed in your community?

Yes

No

6. Are you aware of streets where vehicles cut through neighborhoods?

Yes

No

If yes, which streets? _____

7. List any locations where you think crosswalks should be considered _____

8. List any intersections where you have observed vehicles frequently running the red light? _____

9. List any intersections where you have observed vehicles frequently running the Stop sign? _____

10. List any locations where you think crossing guards might be helpful to aid school crossings? _____

11. List any other specific locations within City limits you have concerns for traffic and pedestrian/bicycle safety (specify location and concern) _____

12. Do you have any additional comments related to transportation safety within the City of Martinez? _____



Cuidad de Martinez Local Road Safety Plan Encuesta/Cuestionario En línea

1. ¿Vives en la ciudad de Martinez?

- Si
- No

2. ¿Si vives en Martinez, en cual calle vives? (dirección especifica no es requerida)

**3. ¿Cuáles son sus principales modos de transportarse por la red de calles en Martinez?
(marca un ✓ a todos los que aplican)**

- Automóvil personal
- Carpool/Viajes compartidos
- Caminar
- Bicicleta
- Bus
- Amtrak/Bart
- Otro modo de transportarse (por favor especificarse) _____

**4. ¿Cuáles son sus mayores preocupaciones relacionadas con la seguridad en cuanto a la
transportación? (marca un ✓ a los 3 que más aplican)**

- Señales de Tráfico/Semáforos
- Velocidad de los Automóviles
- Inseguridad en las calles/intersecciones
- Dificultades para ver el tráfico o la calle por obstáculos
- Seguridad Peatonal
- Seguridad de los ciclistas o las bicicletas
- Mala/Poca iluminación
- Conductores distraídos
- Conductores agresivos
- Otra preocupación (por favor especificarse) _____



5. ¿Estas consciente de cómo se abordan/tratan actualmente los problemas de seguridad en transportación en su comunidad?

- Si
- No

6. ¿Conoce las calles en su vecindario que usan los vehículos para acortar el tráfico?

- Si
- No

¿Si las conoce, cuales calles son? _____

7. Haga una lista de lugares donde cree que debería haber cruces para peatones.

8. Haga una lista de intersecciones donde haya visto que vehículos frecuentemente se pasan el semáforo en rojo. _____

9. Haga una lista de intersecciones donde haya visto que vehículos frecuentemente se pasen el signo de "STOP" _____

10. Haga una lista de los lugares donde cree que los patrulleros escolares (crossing guards) podrían ser útiles para ayudar en los cruces escolares. _____

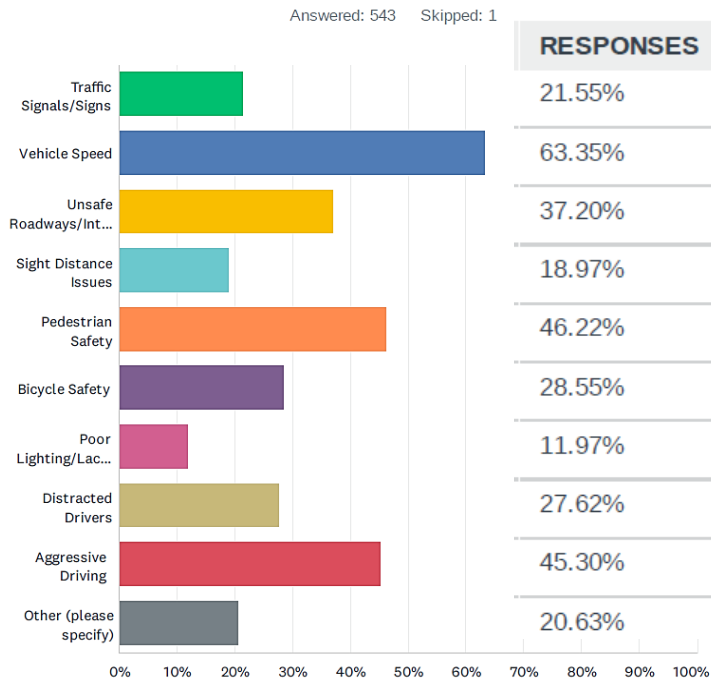
11. Haz una lista de cualquier otra ubicación específica dentro de los límites de la ciudad que le preocupe en cuanto al tráfico y la seguridad de peatones y ciclistas (especifica la ubicación y la inquietud). _____

12. ¿Tiene algún comentario adicional relacionado a la transportación o la seguridad en cuanto la transportación en la ciudad de Martinez? _____

October 2023 Survey

City of Martinez Local Road and Safety Plan Online Survey/Questionnaire

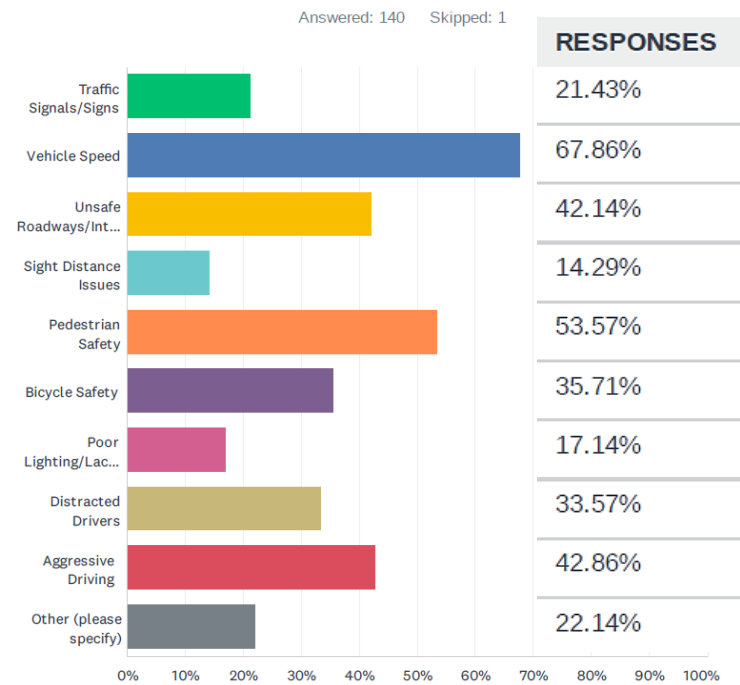
Q4 What are your biggest concerns related to transportation safety?
(check up to three)



January 2023 Survey

City of Martinez Local Road and Safety Plan Online Survey Questionnaire

Q4 What are your biggest concerns related to transportation safety?
(check up to three)



Martinez LRSP
Summary of Surveys (Jan. 2023 & Oct. 2023)

Q6 Are you aware of streets where vehicles cut through neighborhoods?

	Street	# responses
1	Brown St.	54
2	Alhambra Way	41
3	Pine St.	40
4	Estudillo St.	25
5	Castro St.	24
6	Village Oaks Dr.	19
7	Macalvey Dr.	14
8	Green St.	14
9	Pleasant Hill Rd. East	12
10	Palm Ave.	11
11	Shell Ave.	11
12	Center Ave.	10
13	Alhambra Ave.	9
14	Elderwood Dr.	8
15	Midhill Rd./Midway Dr./Milano Way	9
16	Morello Ave.	9
17	Shell Ave.	9
18	Bush St.	8
19	Tahoe Dr.	7
20	Shadowfalls Dr.	6

Q7 List any locations where you think crosswalks should be considered

	Intersection	# responses
1	Alhambra Ave. (throughout roadway)	27
2	Berrellesa St. (throughout roadway)	20
3	Alhambra Ave. & Franklin Canyon Rd. (Mt. Wanda Trail)	9
4	Pacheco Blvd. (throughout roadway)	9
5	Brown St. & Pine St.	8
6	Pine St. & Shell Ave.	8
7	Church St. & Valley Ave. (Nancy Boyd Park)	5
8	Midhill Rd. & Fig Tree Ln./Sunnyslopes Dr. (Creekside Church)	5
9	Alhambra Ave. & G St.	4
10	Alhambra Ave. & Brown St.	4
11	Berrellesa St. & Green St.	4
12	Center Ave. & Glacier Dr. (Lighted crosswalk)	4
13	Center Ave. & Morello Ave.	4
14	Pacheco Blvd. and Bush St.	4
15	Alhambra Ave. & Truitt Ave.	3
16	Morello Ave. & Morbello Ave./Chilpancingo Pkwy.	3
17	Pacheco Blvd. & Brown St.	3
18	Estudillo St. & Alhambra Way	3
19		
20		

Q8 List any intersections where you have observed vehicles frequently running the red light

	Intersection	# responses
1	Arnold Dr. & Morello Ave.	28
2	Alhambra Ave. & D St./Shell Ave.	19
3	Alhambra Ave. (throughout roadway where there is a signal)	16
4	Hwy 4 and Alhambra. (Both Lights for on/off ramps)	14
5	Alhambra Ave. & Alhambra Valley Rd.	13
6	Hwy 4 and Morello Ave. (Both Lights for on/off ramps)	12
7	Center Ave./Pine St. & Howe Rd. (Hwy 4 on/off ramp (Both Lights for on/off ramps)	11
8	Alhambra Ave. & F St.	7
9	Center Ave. & Muir Rd. /Muir Station Rd.	7
10	Alhambra Ave. & Macalvey Dr.	6
11	Morello Ave. & Muir Rd.	6
12	Pacheco Blvd. & Morello Ave.	6
13	Pacheco Blvd. & Shell Ave.	6
14	Alhambra Ave. & B St.	5
15	Alhambra Ave. & Taylor Blvd.	4
16	Alhambra Ave. & Virginia Hills Dr.	4
17	Arnold Dr. & Old Orchard Rd.	4
18	Morello Ave. (throughout roadway where there is a signal)	4
19	Pacheco Blvd. & Howe Rd.	4
20	John Muir Rd. & Alhambra Ave	4

Q9 List intersections where you have observed vehicles frequently running the Stop sign?

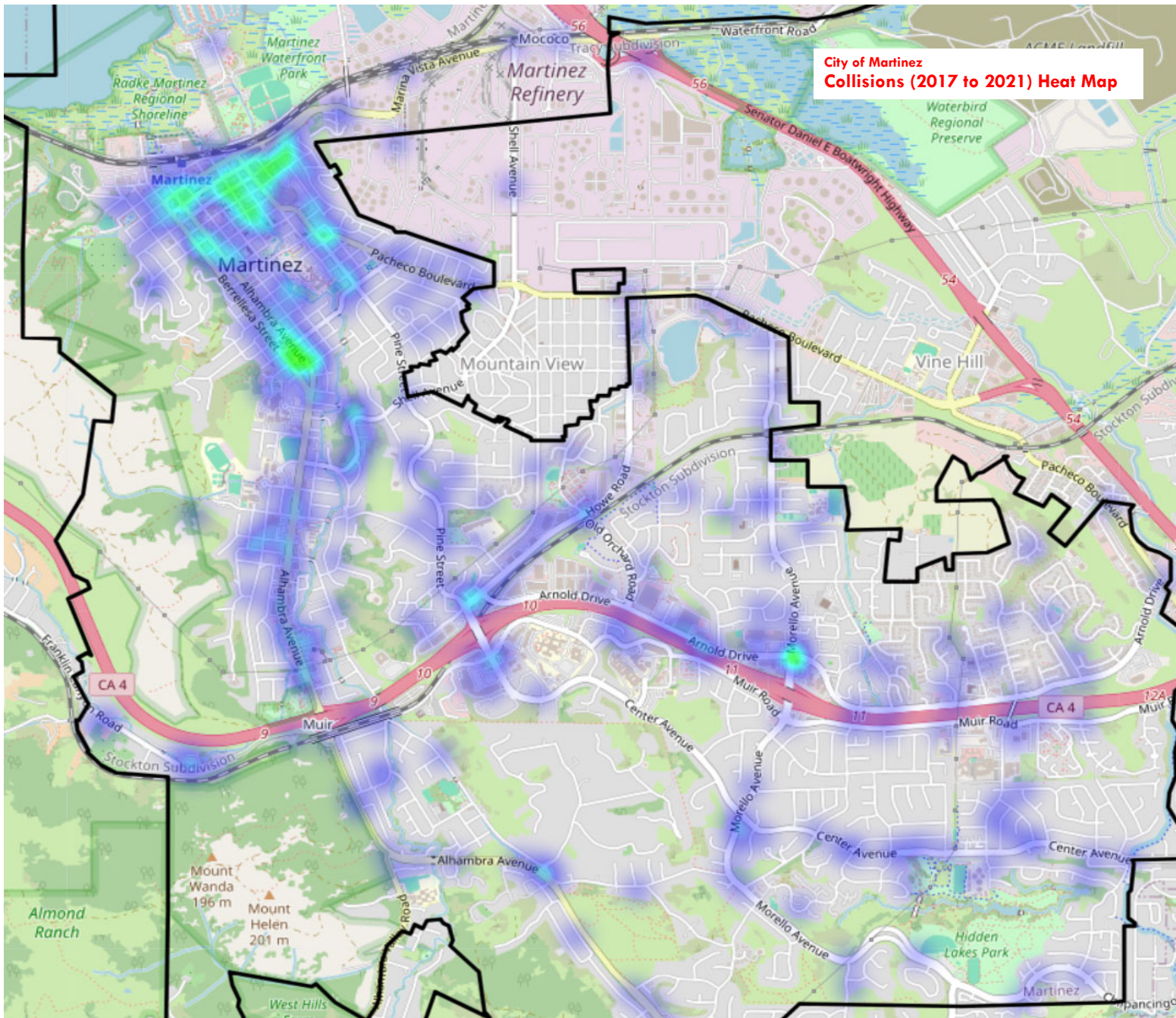
	Intersection	# responses
1	Center Ave. & Glacier Dr.	20
2	Pine St. & Shell Ave.	18
3	Midhill Rd./Village Oaks Dr. & Morello Ave.	17
4	Pine St. (throughout roadway where there is a stop sign)	15
5	Howe Rd. & Old Orchard Rd./Parkway Dr.	14
6	Brown St. (throughout roadway where there is a stop sign)	12
7	Pine St. & Brown St.	12
8	Palm Ave. & Vista Way	11
9	Morello Ave. & Heavenly Dr./Palisade Dr.	10
10	Alhambra Ave. (throughout roadway where there is a stop sign)	9
11	Center Ave. (throughout roadway where there is a stop sign)	8
12	Center Ave. & Hidden Lakes Dr. (near Trail)	8
13	Morello Ave. (throughout roadway where there is a stop sign)	8
14	Reliez Valley Rd. & Blue Ridge Dr.	8
15	Alhambra Ave. & Brown St.	7
16	Green St. & Talbart St.	7
17	Pine St. & Vista Way	7
18	Berrellesa St. (throughout roadway where there is a stop sign)	6
19	Morello Ave. & Vine Hill Way	6
20	Pleasant Hill Rd. East & Church St.	6

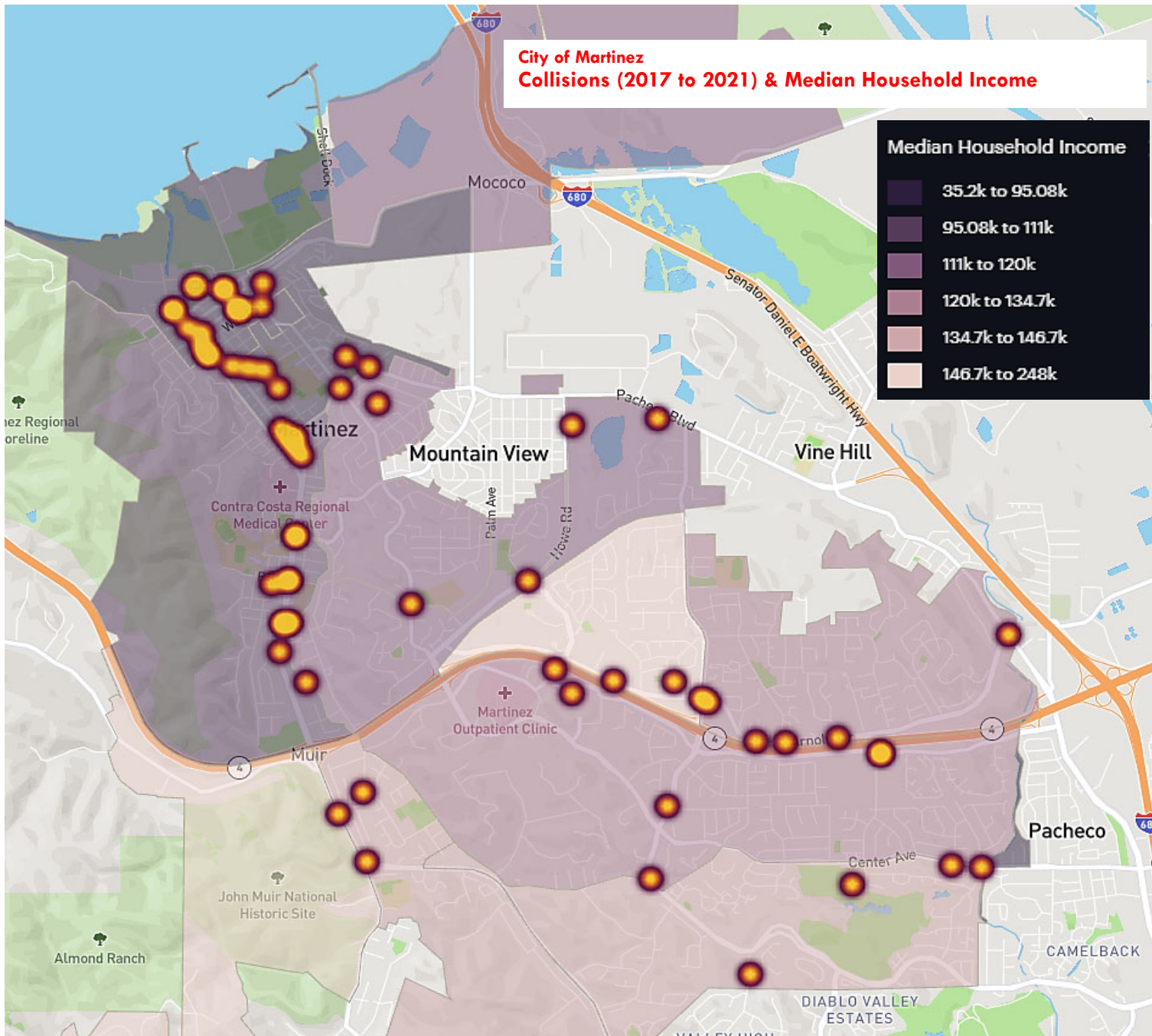
Q10 List any locations where you think crossing guards might be helpful to aid school crossings?

	Intersection	# responses
1	Alhambra Ave. & D St./Shell Ave. (Alhambra High School)	9
2	Pine St. & Haven St. (MJHS)	8
3	Center Ave. & Glacier Dr. (Hidden Valley Elementary)	8
4	Center Ave. & Redwood Dr. (Hidden Valley Elementary/Park)	7
5	Pine St. & Brown St. (MJHS)	7
6	Pine St. & Warren St. (MJHS)	7
7	Alhambra Ave. & Alhambra Valley Rd. (John Swett Elementary School)	6
8	Pacheco Blvd. & Pine St./Jones St. (MJHS)	6
9	Pacheco Blvd. & Warren St. (MJHS)	6
10	Alhambra Ave. & C St. (Alhambra High School)	5
11	Alhambra Ave. & E St. (Alhambra High School)	5
12	Morello Ave. & Morello Park Dr./Morello Hills Dr. (Morello Park Elementary School)	5
13	Alhambra Ave. & Susana St.	3
14	Berrellesa St. & Susana St.	3
15	Pine St. & Vista Way (John Muir Elementary School)	3
16	Pacheco Blvd. near MJHS	3
17	-	
18	-	
19	-	
20	-	

Appendix B

Collision Trends





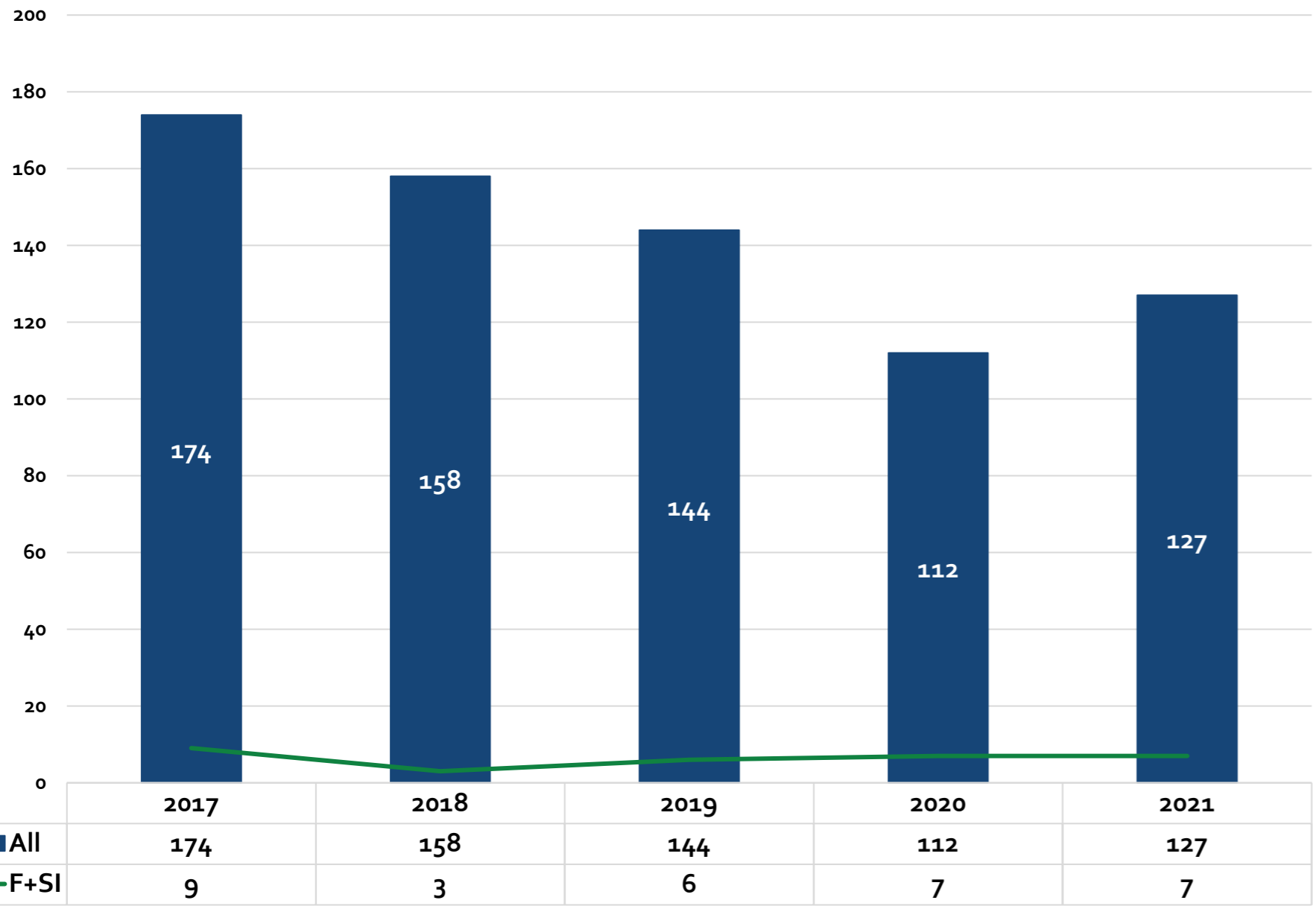
Collision Analysis



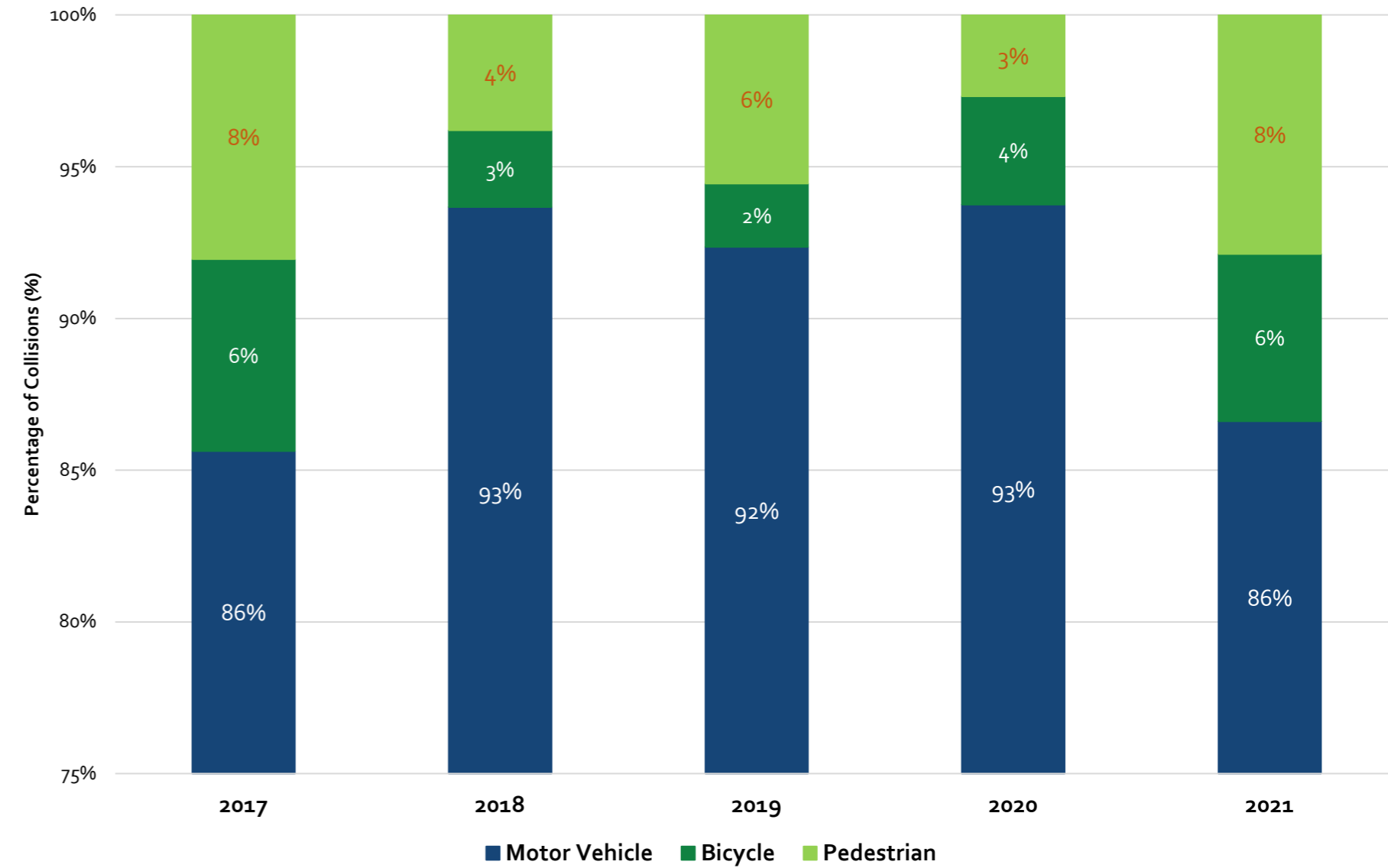
Total Collisions (2017 to 2021) – **715**

Fatal & Severe Injury - **32**

Annual Collisions by Year (2017-2021)



Annual Collisions by Year & Mode



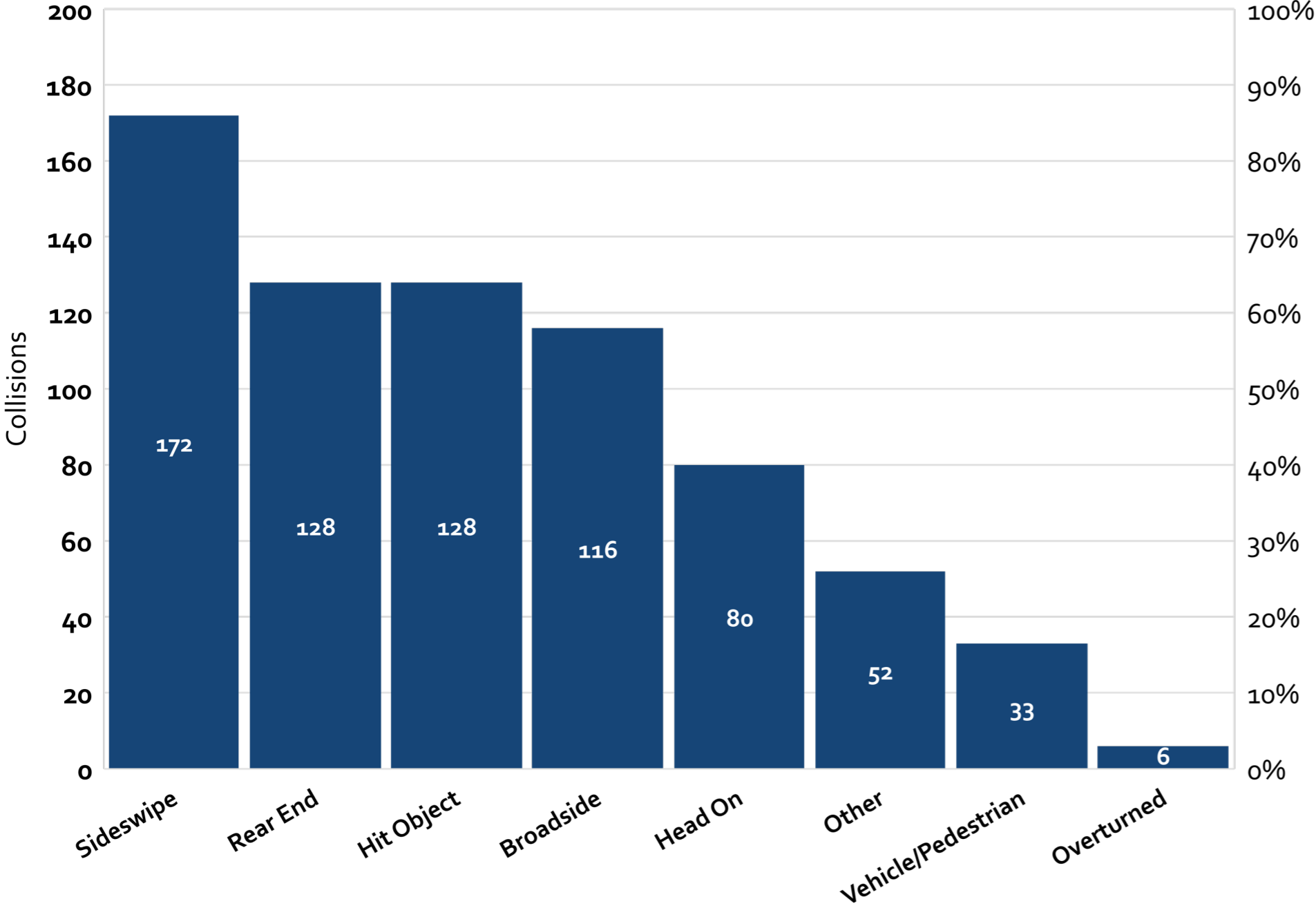
Redefining Mobility.



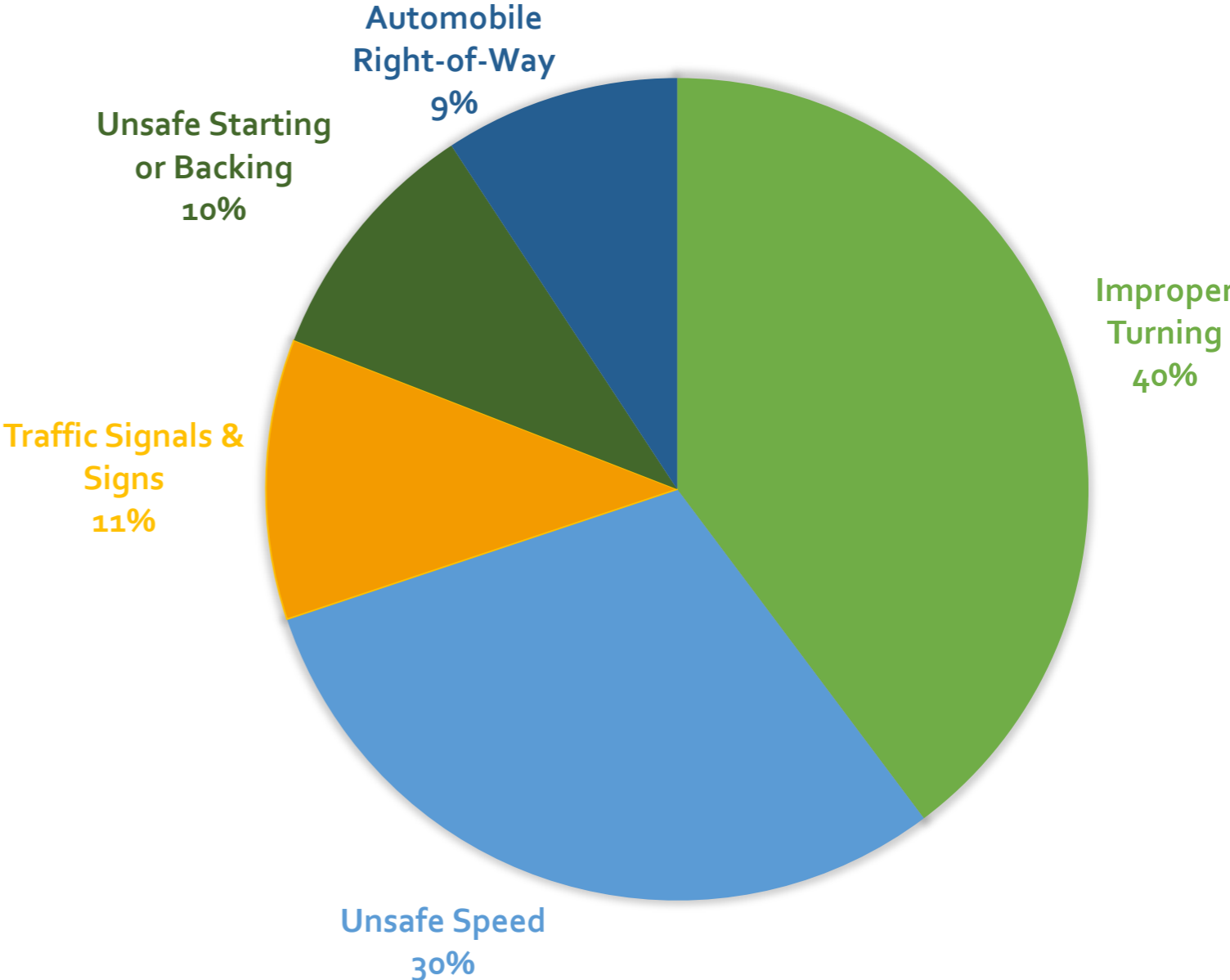
Collision Analysis



Types of Collision (2017 - 2021)



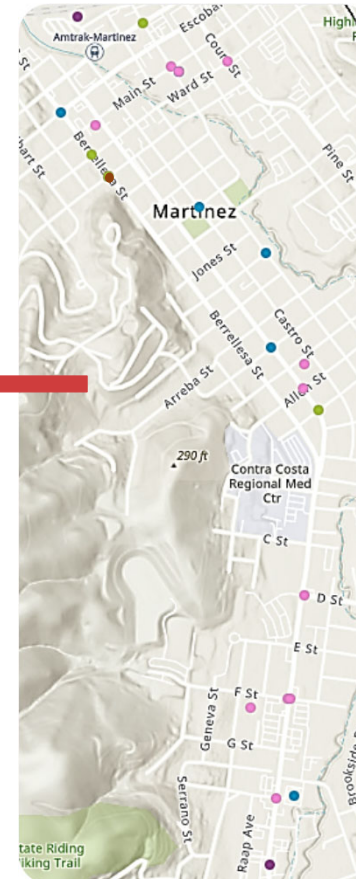
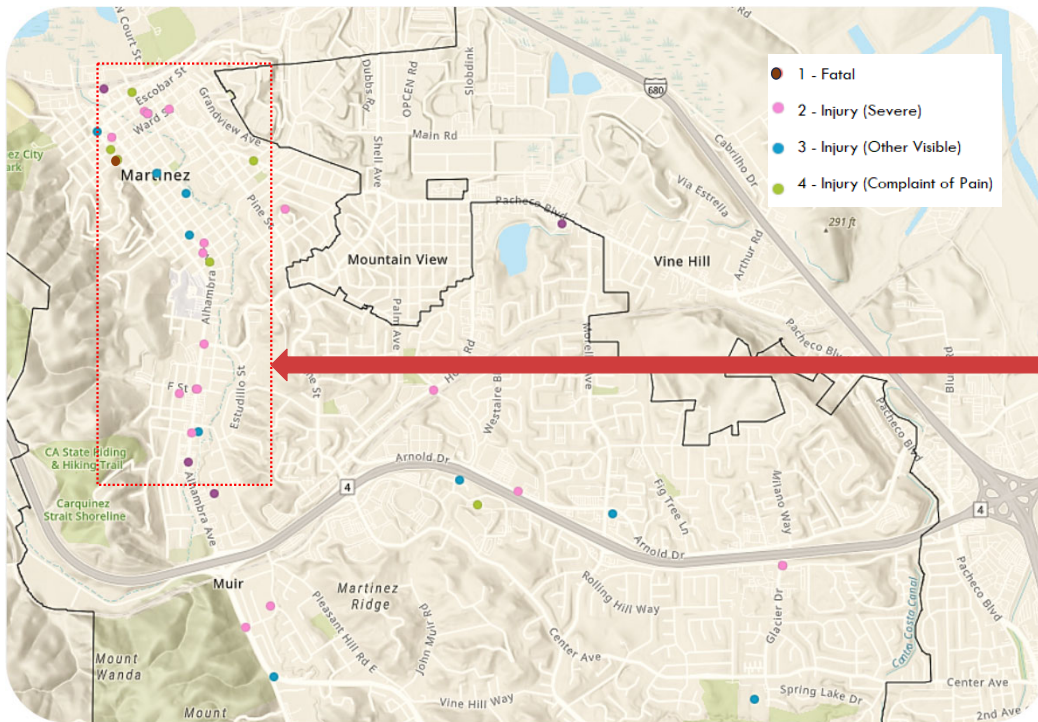
Top Five Collisions by Primary Collision Factors



Redefining Mobility.



Collision Analysis – Pedestrians



Total Collisions (2017 to 2022) – **38**

Fatal & Severe Injury – **5**

Collision Hotspots

Alhambra Avenue

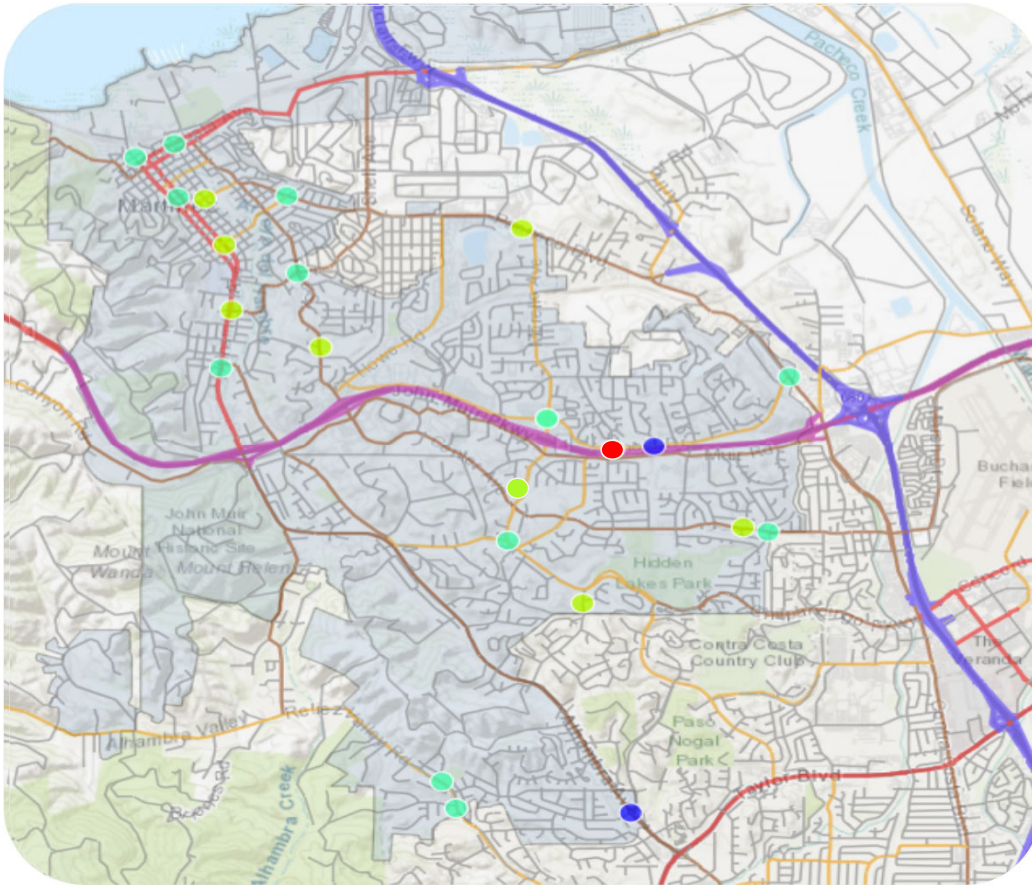
Berrellesa Street

Main Street

Ward Street

Redefining Mobility.

Collision Analysis – Bicycles

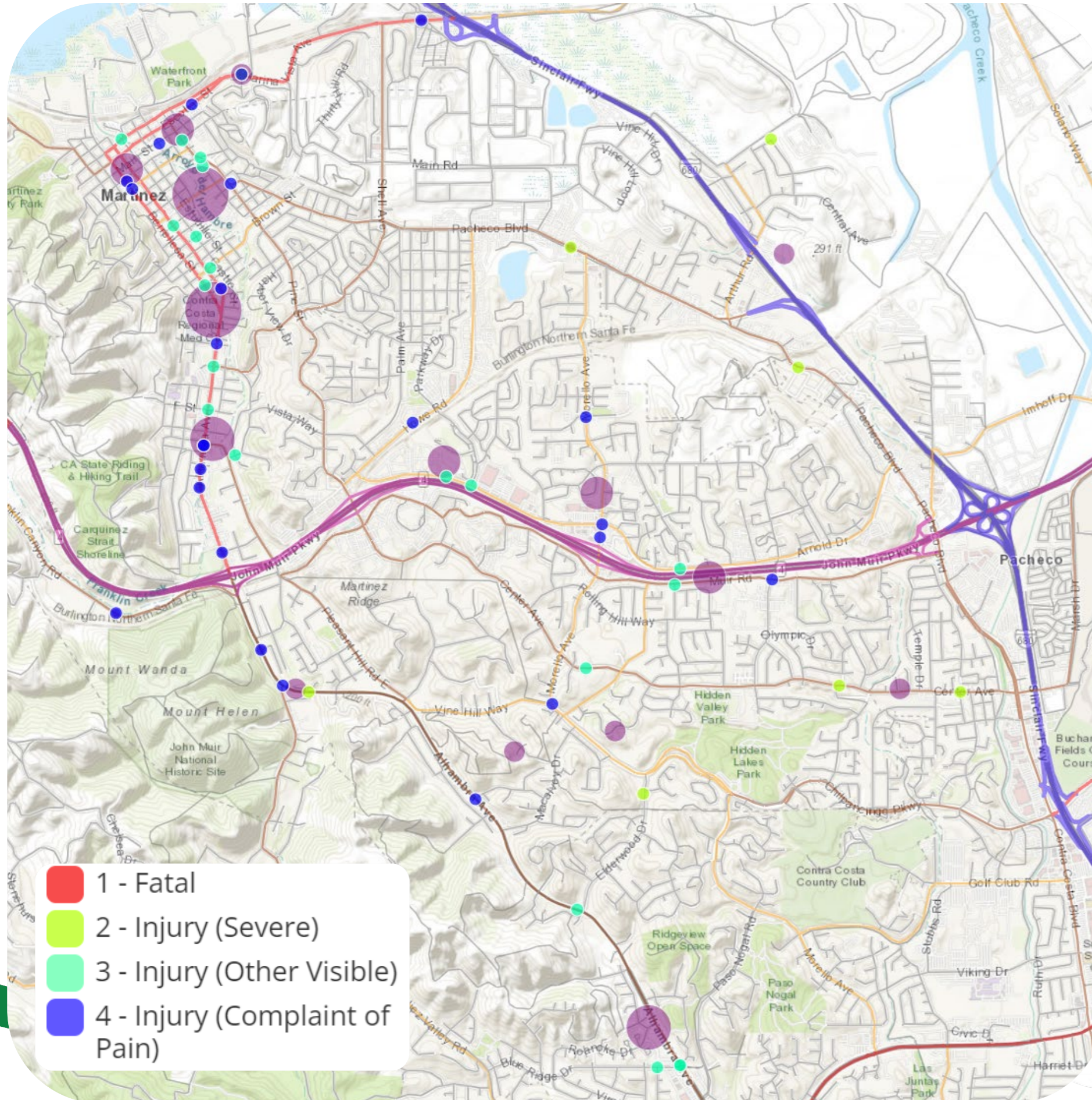


Total Collisions (2017 to 2022) – **29**
Fatal & Severe Injury – **9**

Collision Hotspots
Alhambra Avenue
Arnold Drive
Morello Avenue
Center Avenue

Redefining Mobility.

Collision Analysis - Speeding



Total Collisions (2017 to 2022) - **153**

Fatal & Severe Injury - **6**

Collision Hotspots

Alhambra Avenue

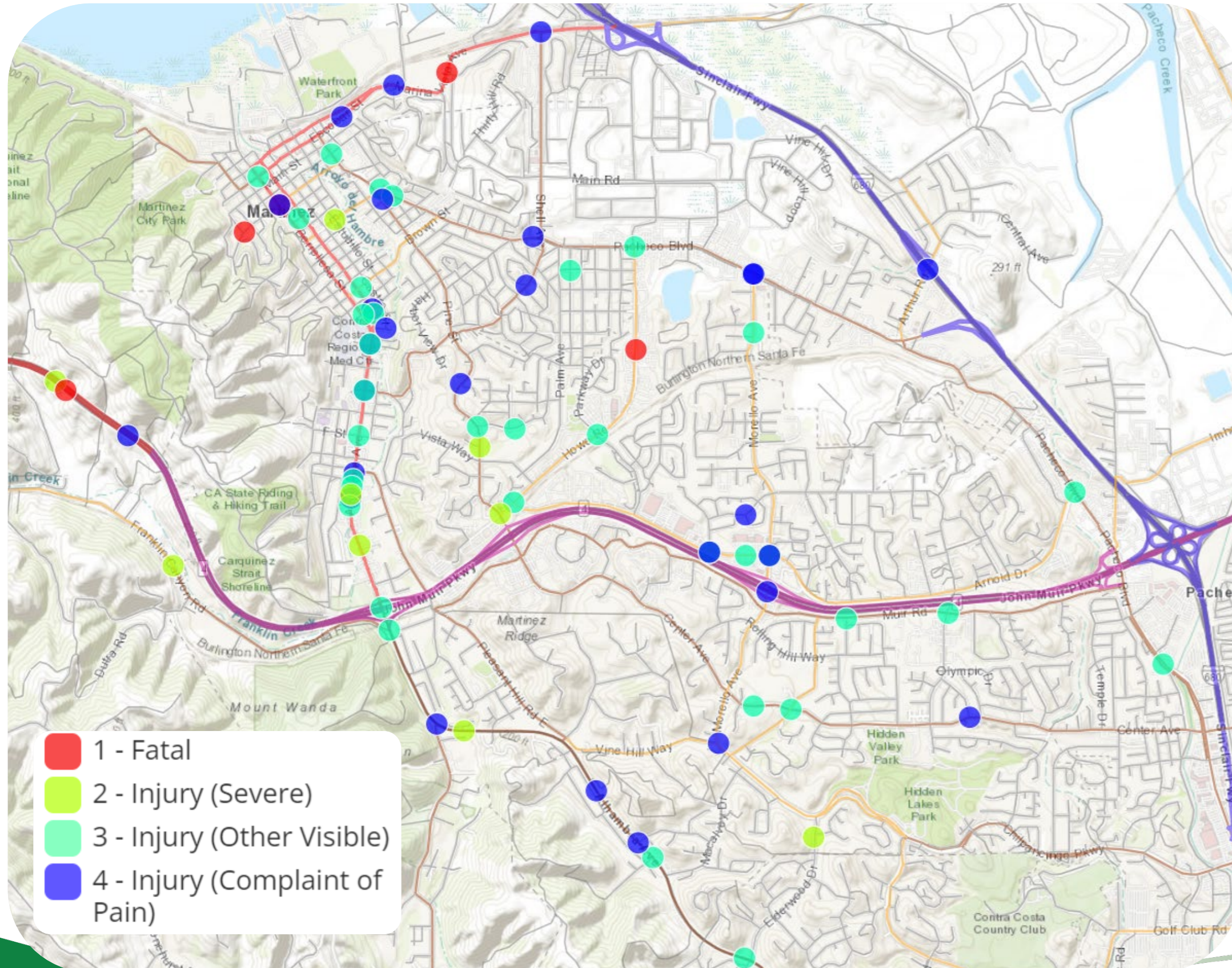
Arnold Drive

Morello Avenue

Center Avenue



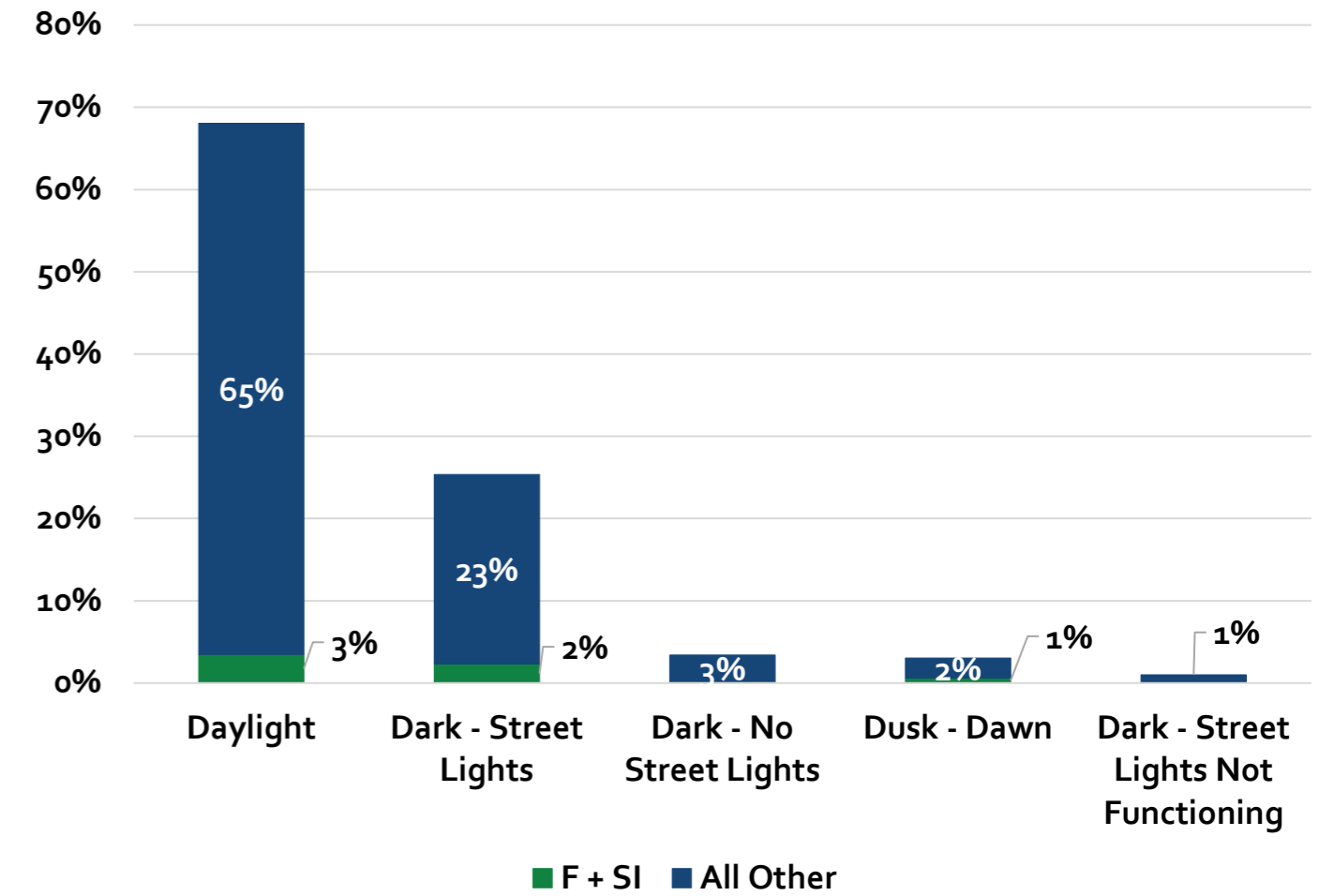
Collision Analysis – Lighting Conditions



Total **Dusk-Dawn/Dark** Collisions (2017 to 2021) – **79** (not including Property Damage)

Fatal & Severe Injury - **14**

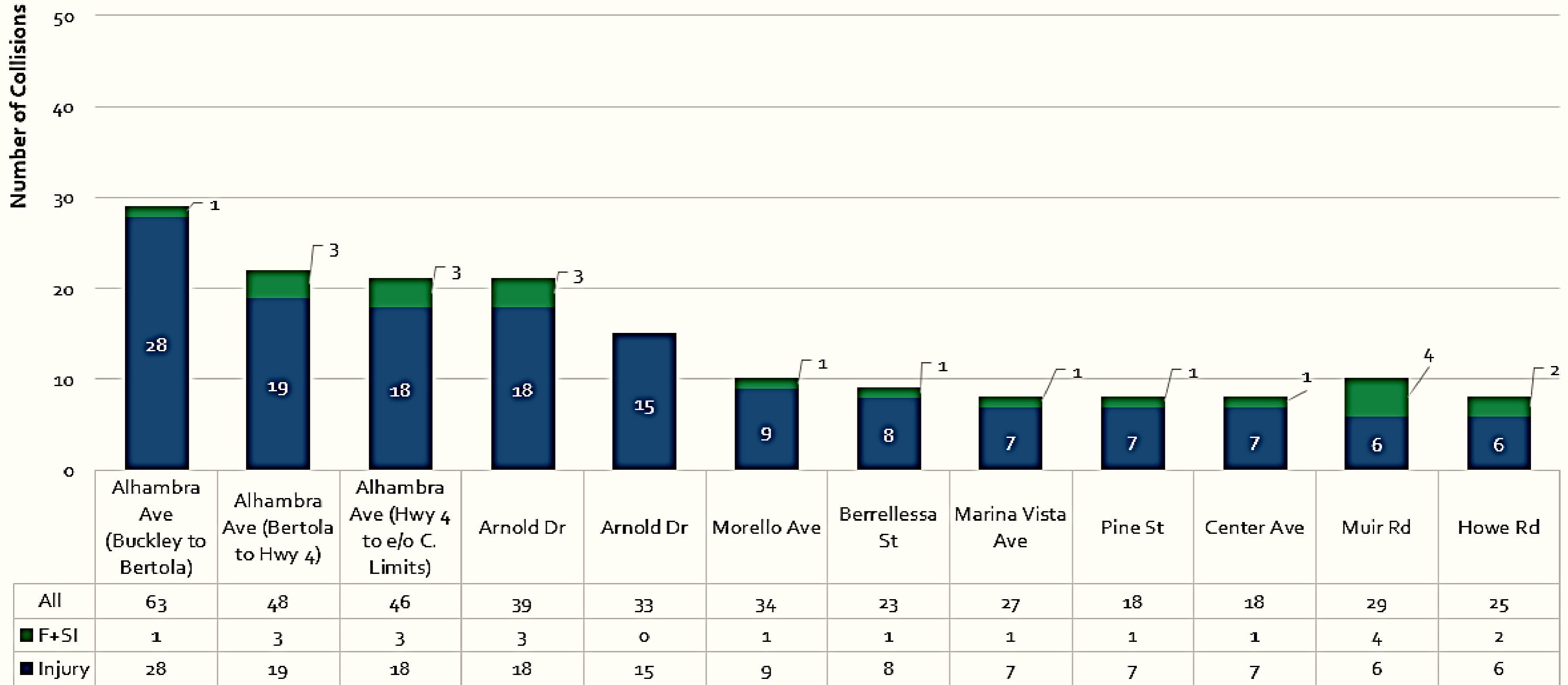
Collisions by Lighting Conditions



Re-defining Mobility.



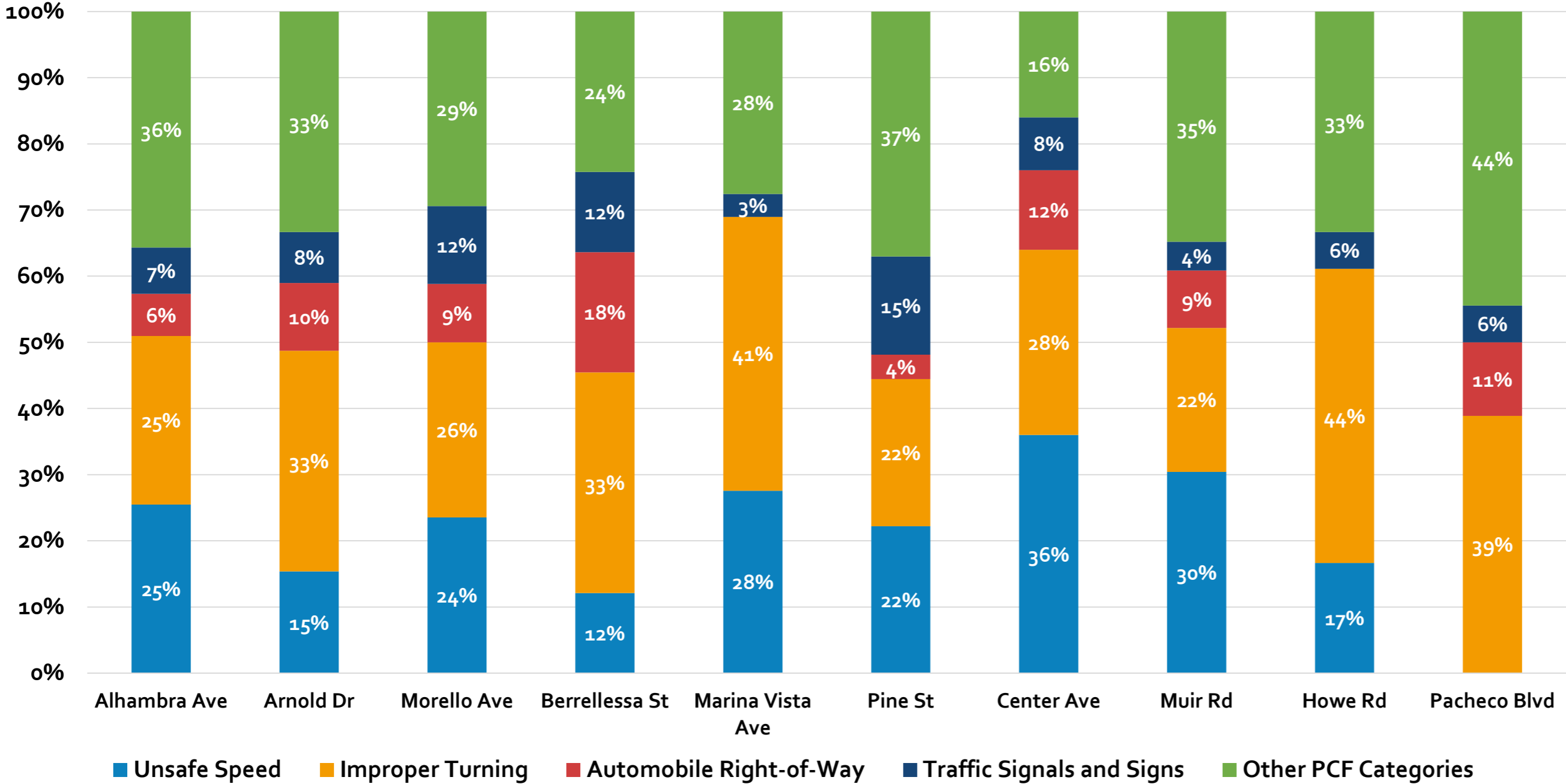
Collision Analysis – Top 12 Corridors



Collision Analysis – Top 10 Corridors



Top 10 High Collision Corridors by Highest PCF Categories (2017-2021)



Total Collisions – 403
(2017 to 2022)
Fatal & Severe Injury - 21

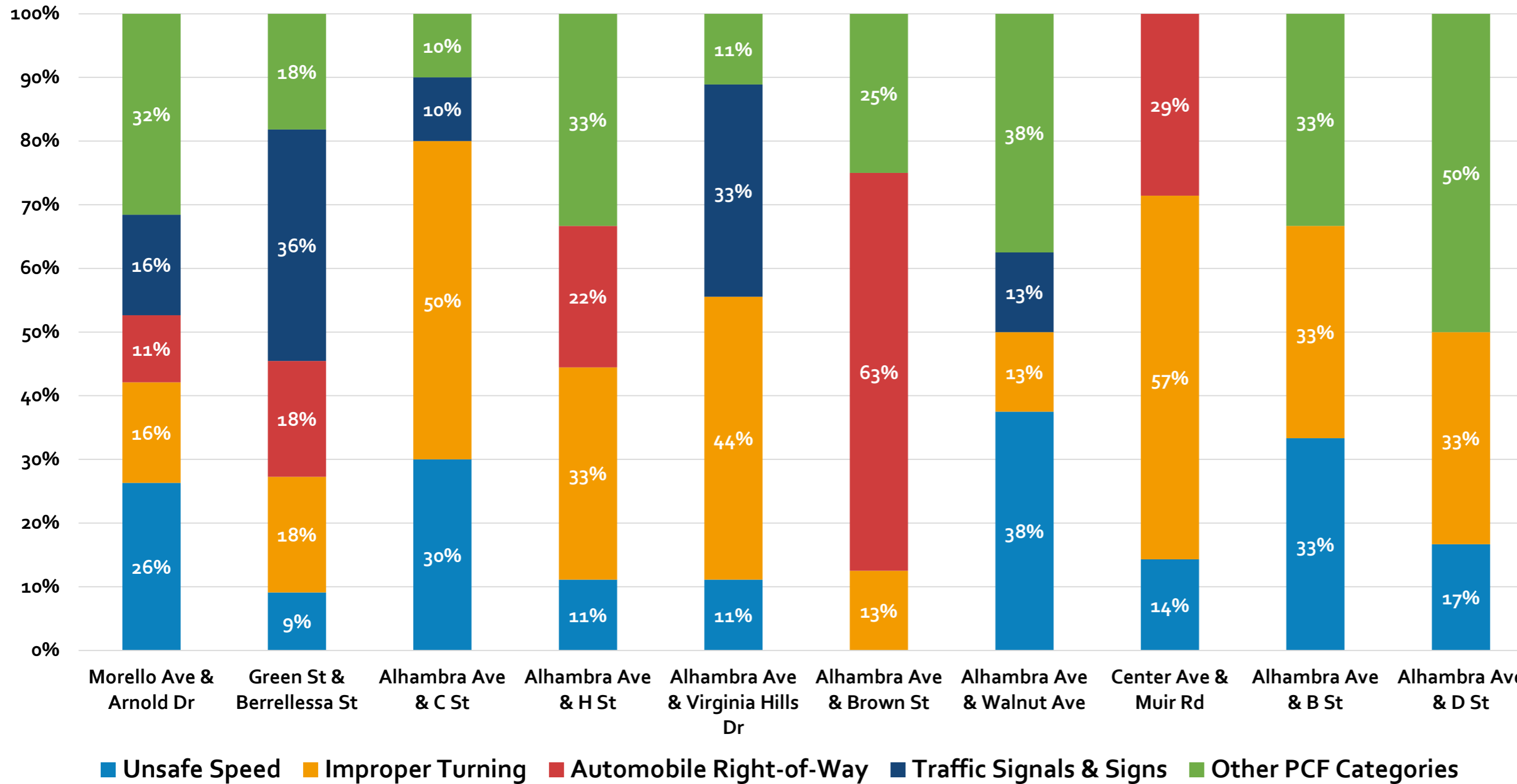
Redefining Mobility.



Collision Analysis – Top 10 Intersections



Top 10 High Collision Intersections by **Highest PCF Categories** (2017-2021)



Total Collisions – 93
(2017 to 2022)
Fatal & Severe Injury - 4

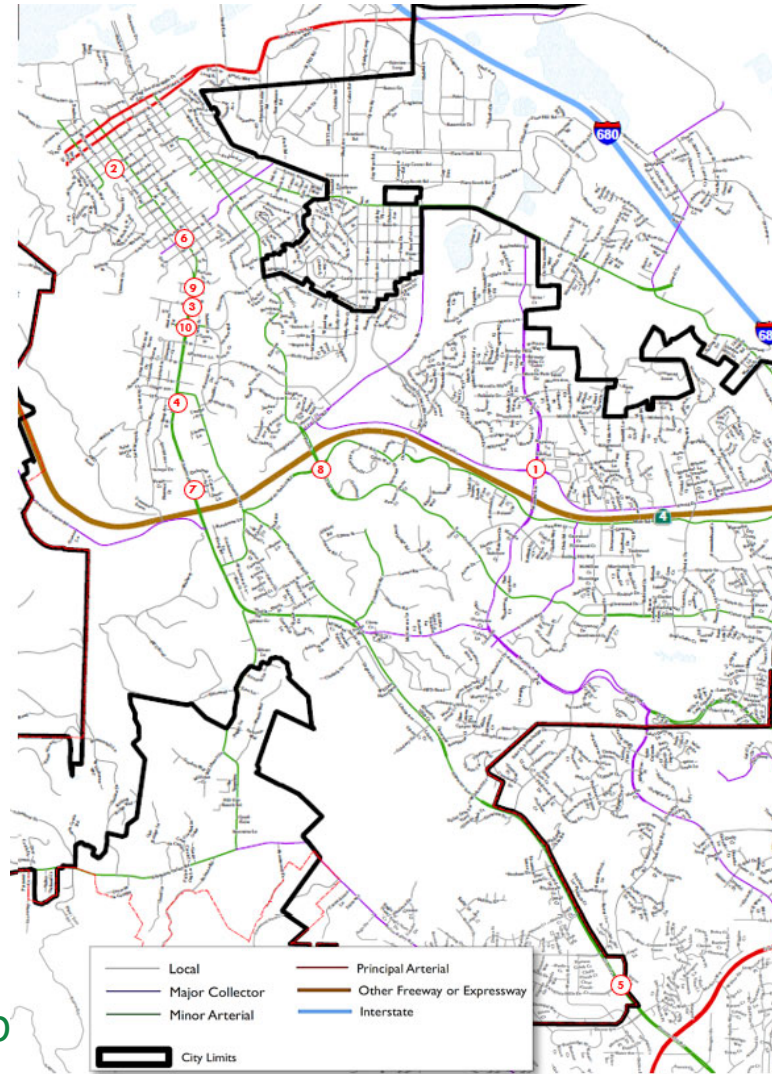
Redefining Mobility.



Top 10 High Collision Intersections

(2017-2021)

1	Morello Ave & Arnold Dr
2	Green St & Berrellessa St
3	Alhambra Ave & C St
4	Alhambra Ave & H St
5	Alhambra Ave & Virginia Hills Dr
6	Alhambra Ave & Brown St
7	Alhambra Ave & Walnut Ave
8	Center Ave & Muir Rd
9	Alhambra Ave & B St
10	Alhambra Ave & D St



Appendix C

Collision Diagrams

Table 2. Countermeasures for Non-Signalized Intersections

No.	Type	Countermeasure Name	Crash Type	CRF	Expected Life (Years)	HSIP Funding Eligibility	Systemic Approach Opportunity?
NS01	Lighting	Add intersection lighting (NS.I.)	Night	40%	20	90%	Medium
NS02	Control	Convert to all-way STOP control (from 2-way or Yield control)	All	50%	10	90%	High
NS03	Control	Install signals	All	30%	20	90%	Low
NS04	Control	Convert intersection to roundabout (from all way stop)	All	Varies	20	90%	Low
NS05	Control	Convert intersection to roundabout (from stop or yield control on minor road)	All	Varies	20	90%	Low
NS05mr*	Control	Convert intersection to mini-roundabout	All	30%	20	90%	Medium
NS06	Operation/ Warning	Install/upgrade larger or additional stop signs or other intersection warning/regulatory signs	All	15%	10	90%	Very High
NS07	Operation/ Warning	Upgrade intersection pavement markings (NS.I.)	All	25%	10	90%	Very High
NS08	Operation/ Warning	Install Flashing Beacons at Stop-Controlled Intersections	All	15%	10	90%	High
NS09	Operation/ Warning	Install flashing beacons as advance warning (NS.I.)	All	30%	10	90%	High
NS10	Operation/ Warning	Install transverse rumble strips on approaches	All	20%	10	90%	High
NS11	Operation/ Warning	Improve sight distance to intersection (Clear Sight Triangles)	All	20%	10	90%	High
NS12	Operation/ Warning	Improve pavement friction (High Friction Surface Treatments)	All	55%	10	90%	Medium
NS13	Geometric Mod.	Install splitter-islands on the minor road approaches	All	40%	20	90%	Medium
NS14	Geometric Mod.	Install raised median on approaches (NS.I.)	All	25%	20	90%	Medium
NS15	Geometric Mod.	Create directional median openings to allow (and restrict) left-turns and u-turns (NS.I.)	All	50%	20	90%	Medium
NS16	Geometric Mod.	Reduced Left-Turn Conflict Intersections (NS.I.)	All	50%	20	90%	Medium
NS17	Geometric Mod.	Install right-turn lane (NS.I.)	All	20%	20	90%	Low
NS18	Geometric Mod.	Install left-turn lane (where no left-turn lane exists)	All	35%	20	90%	Low
NS19PB	Ped and Bike	Install raised medians / refuge islands (NS.I.)	P & B	45%	20	90%	Medium
NS20PB	Ped and Bike	Install pedestrian crossing at uncontrolled locations (new signs and markings only)	P & B	25%	10	90%	High
NS21PB	Ped and Bike	Install/upgrade pedestrian crossing at uncontrolled locations (with enhanced safety features)	P & B	35%	20	90%	Medium
NS22PB	Ped and Bike	Install Rectangular Rapid Flashing Beacon (RRFB)	P & B	35%	20	90%	Medium
NS23PB	Ped and Bike	Install Pedestrian Signal (including Pedestrian Hybrid Beacon (HAWK))	P & B	55%	20	90%	Low

*CM NS05mr is a new countermeasure added for HSIP Cycle 11 Call-for-projects.

Table 1. Countermeasures for Signalized Intersections

No.	Type	Countermeasure Name	Crash Type	CRF	Expected Life (Years)	HSIP Funding Eligibility	Systemic Approach Opportunity?
S01	Lighting	Add intersection lighting (S.I.)	Night	40%	20	90%	Medium
S02	Signal Mod.	Improve signal hardware: lenses, back-plates with retroreflective borders, mounting, size, and number	All	15%	10	90%	Very High
S03	Signal Mod.	Improve signal timing (coordination, phases, red, yellow, or operation)	All	15%	10	50%	Very High
S04*	Signal Mod.	Provide Advanced Dilemma Zone Detection for high speed approaches	All	40%	10	90%	High
S05	Signal Mod.	Install emergency vehicle pre-emption systems	Emergency Vehicle	70%	10	90%	High
S06	Signal Mod.	Install left-turn lane and add turn phase (signal has no left-turn lane or phase before)	All	55%	20	90%	Low
S07	Signal Mod.	Provide protected left turn phase (left turn lane already exists)	All	30%	20	90%	High
S08	Signal Mod.	Convert signal to mast arm (from pedestal-mounted)	All	30%	20	90%	Medium
S09	Operation/ Warning	Install raised pavement markers and striping (Through Intersection)	All	10%	10	90%	Very High
S10	Operation/ Warning	Install flashing beacons as advance warning (S.I.)	All	30%	10	90%	Medium
S11	Operation/ Warning	Improve pavement friction (High Friction Surface Treatments)	All	55%	10	90%	Medium
S12	Geometric Mod.	Install raised median on approaches (S.I.)	All	25%	20	90%	Medium
S13PB	Geometric Mod.	Install pedestrian median fencing on approaches	P & B	35%	20	90%	Low
S14	Geometric Mod.	Create directional median openings to allow (and restrict) left-turns and u-turns (S.I.)	All	50%	20	90%	Medium
S15	Geometric Mod.	Reduced Left-Turn Conflict Intersections (S.I.)	All	50%	20	90%	Medium
S16	Geometric Mod.	Convert intersection to roundabout (from signal)	All	Varies	20	90%	Low
S17PB	Ped and Bike	Install pedestrian countdown signal heads	P & B	25%	20	90%	Very High
S18PB	Ped and Bike	Install pedestrian crossing (S.I.)	P & B	25%	20	90%	High
S19PB	Ped and Bike	Pedestrian Scramble	P & B	40%	20	90%	High
S20PB	Ped and Bike	Install advance stop bar before crosswalk (Bicycle Box)	P & B	15%	10	90%	Very High
S21PB	Ped and Bike	Modify signal phasing to implement a Leading Pedestrian Interval (LPI)	P & B	60%	10	90%	Very High

*CM S04 has been deleted in HSIP Cycle 11 Call-for-projects.

Table 3. Countermeasures for Roadways

No.	Type	Countermeasure Name	Crash Type	CRF	Expected Life (Years)	HSIP Funding Eligibility	Systemic Approach Opportunity?
R01	Lighting	Add segment lighting	Night	35%	20	90%	Medium
R02	Remove/ Shield Obstacles	Remove or relocate fixed objects outside of Clear Recovery Zone	All	35%	20	90%	High
R03	Remove/ Shield Obstacles	Install Median Barrier	All	25%	20	90%	Medium
R04	Remove/ Shield Obstacles	Install Guardrail	All	25%	20	90%	High
R05	Remove/ Shield Obstacles	Install impact attenuators	All	25%	10	90%	High
R06	Remove/ Shield Obstacles	Flatten side slopes	All	30%	20	90%	Medium
R07	Remove/ Shield Obstacles	Flatten side slopes and remove guardrail	All	40%	20	90%	Medium
R08	Geometric Mod.	Install raised median	All	25%	20	90%	Medium
R09	Geometric Mod.	Install median (flush)	All	15%	20	90%	Medium
R10PB	Geometric Mod.	Install pedestrian median fencing on approaches	P & B	35%	20	90%	Low
R11	Geometric Mod.	Install acceleration/ deceleration lanes	All	25%	20	90%	Low
R12	Geometric Mod.	Widen lane (initially less than 10 ft)	All	25%	20	90%	Medium
R13	Geometric Mod.	Add two-way left-turn lane	All	30%	20	90%	Medium
R14	Geometric Mod.	Road Diet (Reduce travel lanes and add a two way left-turn and bike lanes)	All	35%	20	90%	Medium
R15	Geometric Mod.	Widen shoulder	All	30%	20	90%	Medium
R16	Geometric Mod.	Curve Shoulder widening (Outside Only)	All	45%	20	90%	Medium
R17	Geometric Mod.	Improve horizontal alignment (flatten curves)	All	50%	20	90%	Low
R18	Geometric Mod.	Flatten crest vertical curve	All	25%	20	90%	Low
R19	Geometric Mod.	Improve curve superelevation	All	45%	20	90%	Medium
R20	Geometric Mod.	Convert from two-way to one-way traffic	All	35%	20	90%	Medium
R21	Geometric Mod.	Improve pavement friction (High Friction Surface Treatments)	All	55%	10	90%	High

Table 3. Countermeasures for Roadways (Continued)

No.	Type	Countermeasure Name	Crash Type	CRF	Expected Life (Years)	HSIP Funding Eligibility	Systemic Approach Opportunity?
R22	Operation/ Warning	Install/Upgrade signs with new fluorescent sheeting (regulatory or warning)	All	15%	10	90%	Very High
R23	Operation/ Warning	Install chevron signs on horizontal curves	All	40%	10	90%	Very High
R24	Operation/ Warning	Install curve advance warning signs	All	25%	10	90%	Very High
R25	Operation/ Warning	Install curve advance warning signs (flashing beacon)	All	30%	10	90%	High
R26	Operation/ Warning	Install dynamic/variable speed warning signs	All	30%	10	90%	High
R27	Operation/ Warning	Install delineators, reflectors and/or object markers	All	15%	10	90%	Very High
R28	Operation/ Warning	Install edge-lines and centerlines	All	25%	10	90%	Very High
R29	Operation/ Warning	Install no-passing line	All	45%	10	90%	Very High
R30	Operation/ Warning	Install centerline rumble strips/stripes	All	20%	10	90%	High
R31	Operation/ Warning	Install edgeline rumble strips/stripes	All	15%	10	90%	High
R32PB	Ped and Bike	Install bike lanes	P & B	35%	20	90%	High
R33PB	Ped and Bike	Install Separated Bike Lanes	P & B	45%	20	90%	High
R34PB	Ped and Bike	Install sidewalk/pathway (to avoid walking along roadway)	P & B	80%	20	90%	Medium
R35PB	Ped and Bike	Install/upgrade pedestrian crossing (with enhanced safety features)	P & B	35%	20	90%	Medium
R36PB	Ped and Bike	Install raised pedestrian crossing	P & B	35%	20	90%	Medium
R37PB	Ped and Bike	Install Rectangular Rapid Flashing Beacon (RRFB)	P & B	35%	20	90%	Medium
R38	Animal	Install animal fencing	Animal	80%	20	90%	Medium

Appendix B: Detailed Tables of Countermeasures

The intent of the information contained in this appendix is to provide local agency safety practitioners with a list of effective countermeasures that are appropriate remedies to many common safety issues. The tables in Section 4.2 present a quick summary of the specific values that the Caltrans Division of Local Assistance uses to assess and select projects for its calls-for-projects. In addition to the same information as in Section 4.2, this appendix also includes notes for Caltrans HSIP calls-for-projects and "General information" regarding where the countermeasure should be used, why it works, the general qualities that can be used to suggest the potential complexity of installation, and information from FHWA CMF Clearinghouse on the type of crashes where the countermeasure is best used and a range of their expected overall effectiveness.

The countermeasures have been sorted into 3 categories: Signalized Intersection, Non-Signalized Intersection, and Roadway Segment. Pedestrian and bicycle related countermeasures have been included in each of these categories.

Caltrans gives careful consideration to the fair application of its calls-for-projects process. Starting in 2012, the award of safety funding has been solely based on a determined benefit-to-cost ratio for each project. The fixed set of countermeasures and CRFs included in these tables are intended to allow for all projects to be evaluated consistently and fairly throughout the project selection process. However, at this time, there are no CRFs/CMFs available for several safety improvements, such as: "dynamic/variable speed regulatory signs", "non-motorized signs and markings (regulatory and warning)", "Square-up (reduce curve radius) turn lanes" and non-infrastructure elements. These safety improvement items can be included in project applications, but they will not be included into the B/C ratio calculations, unless the safety improvements meet the intent of other separate countermeasures included in the attached lists. Caltrans is interested in adding these countermeasures (and many others) to these tables once CRFs/CMFs have been established. Caltrans will continue to periodically update this list of allowable countermeasures and CRFs as new safety research data becomes available. With this in mind, Caltrans is interested in feedback and suggestions from local agency safety practitioners on the overall countermeasure list as well as specific details of individual countermeasures, including locally developed safety effectiveness information.

Caltrans used the following references to assist its team in developing the information shown in the following tables. Safety Practitioners are encouraged to utilize these references for a more expansive list of countermeasures and CRFs / CMFs.

The Crash Modification Factors Clearinghouse

<https://www.cmfclearinghouse.org/>

NCHRP Report 500 Series: Volumes 4, 5, 6, 7, 10, 12, 13, and others

<https://www.trb.org/Main/Blurbs/152868.aspx>

Highway Safety Manual (HSM)

<http://www.highwaysafetymanual.org>

Pedestrian and Bicycle - Tools to Diagnose and Solve the Problem

https://safety.fhwa.dot.gov/ped_bike/tools_solve/

FHWA Local and Rural Road / Training, Tools, Guidance and Countermeasures for Locals

https://safety.fhwa.dot.gov/local_rural/training/

For each countermeasure (CM):

(Title) CM No., CM Name

- CM No. is
 - S01 through S21PB for Intersection Countermeasures – Signalized,
 - NS01 through NS23PB for Intersection Countermeasures – Unsignalized, or
 - R01 through R38 for Roadway Countermeasures.

For HSIP Calls-for-projects:

- **Funding Eligibility** - 90% or 50%.
- **Crash Types Addressed** - “All”, “Pedestrian and Bicycle”, “Night”, “Emergency Vehicle”, or “Animal”.
- **CRF** - Crash Reduction Factor used for HSIP calls-for-projects.
- **Expected Life** - 10 years or 20 years.
- **Notes** - Specific requirements are provided for utilizing the countermeasure on applications for Caltrans statewide calls-for-projects.
-

General Information:

- **Where to use** – Roadway segments and intersections with specific common characteristics can be addressed with similar countermeasures that are most effective.
- **Why it works** – A discussion of the benefit of a countermeasure is important to determine its appropriateness in addressing certain roadway crash types at areas with specific issues as determined by the data and roadway features.
- **General Qualities (Time, Cost and Effectiveness)** – This category is more subjective and can vary substantially. ‘Time’ refers to the approximate relative time it can take to implement the countermeasure. Costs can vary considerably due to local conditions, so ‘cost’ represents the relative cost of applying a countermeasure. A relative overall ‘effectiveness’ is also provided for some countermeasures. All of this subjective information may not be applicable to the unique circumstances for the agency and should not be utilized without verification by the safety practitioner.

- **FHWA CMF Clearinghouse**

- **Crash Types Addressed** – In order to effectively reduce the number and severity of roadway crashes, it is necessary to match countermeasures to the crash types they are intended to address. Depending on the type of problem, one or more of a range of countermeasures could be the most effective way to reduce the number and severity of future crashes.
- **Crash Reduction Factor** – The crash reduction factor (CRF) is an indication of the effectiveness of a particular treatment, measured by the percentage of crashes it is expected to reduce. Note: As mentioned earlier in this section, the effectiveness of a countermeasure can also be expressed as a Crash Modification Factor (CMF), which is defined mathematically as $1 - \text{CRF}$. However, this document uses CRFs as they can be more insightful when analyzing roadways for potential “reductions” in crashes. There is a range of CRF values that exist for each of the countermeasures (or similar countermeasures). The range of CRFs is provided to give local safety practitioners a clear understanding that they may need to go to the FHWA CMF Clearinghouse to find the most appropriate countermeasure and CRF for their specific projects and local prioritization.

B.1 Intersection Countermeasures – Signalized

S01, Add intersection lighting (Signalized Intersection => S.I.)

For HSIP Cycle 11 Call-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	"night" crashes	40%	20 years
Notes:	This CM only applies to "night" crashes (all types) occurring within limits of the proposed roadway lighting 'engineered' area.		
General information			
Where to use:			
Signalized intersections that have a disproportionate number of night-time crashes and do not currently provide lighting at the intersection or at its approaches. Crash data should be studied to ensure that safety at the intersection could be improved by providing lighting (this strategy would be supported by a significant number of crashes that occur at night).			
Why it works:			
Providing lighting at the intersection itself, or both at the intersection and on its approaches, improves the safety of an intersection during nighttime conditions by (1) making drivers more aware of the surroundings at an intersection, which improves drivers' perception-reaction times, (2) enhancing drivers' available sight distances, and (3) improving the visibility of non-motorists. Intersection lighting is of particular benefit to non-motorized users. Lighting not only helps them navigate the intersection, but also helps drivers see them better.			
General Qualities (Time, Cost and Effectiveness):			
A lighting project can usually be completed relatively quickly, but generally requires at least 1 year to implement because the lighting system must be designed and the provision of electrical power must be arranged. The provision of lighting involves both a fixed cost for lighting installation and an ongoing maintenance and power cost which results in a moderate to high cost. Some locations can result in high B/C ratios, but due to higher costs, these projects often result in medium to low B/C ratios.			
FHWA CMF Clearinghouse:	Crash Types Addressed:	Night, All	CRF: 20-74%

S02, Improve signal hardware: lenses, back-plates with retroreflective borders, mounting, size, and number

For HSIP Cycle 11 Call-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	All	15%	10 years
Notes:	This CM only applies to crashes occurring on the approaches / influence area of the upgraded signals. This CM does not apply to improvements like "battery backup systems", which do not provide better intersection/signal visibility or help drivers negotiate the intersection (unless applying past crashes that occurred when the signal lost power). If new signal mast arms are part of the proposed project, CM "S2" should not be used and the signal improvements would be included under CM "S7".		
General information			
Where to use:			
Signalized intersections with a high frequency of right-angle and rear-end crashes occurring because drivers are unable to see traffic signals sufficiently in advance to safely negotiate the intersection being approached. Signal intersection improvements include new LED lighting, signal back plates, retro-reflective tape outlining the back plates, or visors to increase signal visibility, larger signal heads, relocation of the signal heads, or additional signal heads.			
Why it works:			
Providing better visibility of intersection signals aids the drivers' advance perception of the upcoming intersection. Visibility and clarity of the signal should be improved without creating additional confusion for drivers.			
General Qualities (Time, Cost and Effectiveness):			
Installation costs and time should be minimal as these type strategies are classified as low cost and implementation does not typically require the approval process normally associated with more complex projects. When considered at a single location, these low cost improvements are usually funded through local funding by local maintenance crews. However, This CM can be effectively and efficiently implemented using a systematic approach with numerous locations, resulting in low to moderate cost projects that are more appropriate to seek state or federal funding.			
FHWA CMF Clearinghouse:	Crash Types Addressed:	Rear-End, Angle	CRF: 0-46%

S03, Improve signal timing (coordination, phases, red, yellow, or operation)

For HSIP Cycle 11 Call-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
50%	All	15%	10 years
Notes:	<p>This CM only applies to crashes occurring on the approaches / influence area of the new signal timing. For projects coordination signals along a corridor, the crashes related to side-street movements should not be applied. This CM does not apply to projects that only 'study' the signal network and do not make physical timing changes, including corridor operational studies and improvements to Traffic Operation Centers (TOCs).</p> <p>In Caltrans calls for projects, this CM has a HSIP reimbursement ratio of 50%, considering that it will improve the signal operation rather than merely the safety.</p>		
General information			
Where to use:			
Locations that have a crash history at multiple signalized intersections. Signalization improvements may include adding phases, lengthening clearance intervals, eliminating or restricting higher-risk movements, and coordinating signals at multiple locations. Understanding the corridor or roadway's crash history can provide insight into the most appropriate strategy for improving safety.			
Why it works:			
Certain timing, phasing, and control strategies can produce multiple safety benefits. Sometimes capacity improvements come along with the safety improvements and other times adverse effects on delay or capacity occur. Corridor improvements often have the highest benefit but may take longer to implement. Projects focused on capacity improvements (without a separate focus on signal timing safety needs) may not result in a reduction in future crashes.			
General Qualities (Time, Cost and Effectiveness):			
In general, these low-cost improvements to multiple signalized intersections can be implemented in a short time. Typically these low cost improvements are funded through local funding by local maintenance crews. However, some projects requiring new interconnect infrastructure can have moderate to high costs making them more appropriate to seek state or federal funding. The expected effectiveness of this CM must be assessed for each individual project.			
FHWA CMF Clearinghouse:	Crash Types Addressed:	All	CRF: 0 - 41%

S04, Provide Advanced Dilemma-Zone Detection for high speed approaches

For HSIP Cycle 11 Call-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	All	40%	10 years
Notes:	<p>This CM only applies to crashes occurring on the approaches / influence area of the new detection and signal timing.</p>		
General information			
Where to use:			
More rural/remote areas that have a high frequency of right-angle and rear-end crashes. The Advanced Dilemma-Zone Detection system enhances safety at signalized intersections by modifying traffic control signal timing to reduce the number of drivers that may have difficulty deciding whether to stop or proceed during a yellow phase. This may reduce rear-end crashes associated with unsafe stopping and angle crashes due to illegally continuing into the intersection during the red phase.			
Why it works:			
Clearance times provide safe, orderly transitions in ROW assignment between conflicting streams of traffic. An Advanced Dilemma-Zone Detection system has several benefits relative to traditional multiple detector systems, which have upstream detection for vehicles in the dilemma zone but do not take the speed or size of individual vehicles into account. These benefits include: Reducing the frequency of red-light violations; Reducing the frequency of crashes associated with the traffic signal phase change (for example, rear-end and angle crashes); Reducing delay and stop frequency on the major road and a reduction in overall intersection delay.			
General Qualities (Time, Cost and Effectiveness):			
Installation costs should be low and the time to implement short. Additional modifications to the traffic signal controller may also necessary. In general, This CM can be very effective and can be considered on a systematic approach. Video detection equipment is now available for this purpose, making installation and maintenance more efficient.			
FHWA CMF Clearinghouse:	Crash Types Addressed:	All	CRF: 39%

S05, Install emergency vehicle pre-emption systems

For HSIP Cycle 11 Call-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	Emergency Vehicle - only	70%	10 years
Notes:	This CM only applies to "E.V." crashes occurring on the approaches / influence area of the new pre-emption system.		
General information			
Where to use:			
Corridors that have a history of crashes involving emergency response vehicles. The target of this strategy is signalized intersections where normal traffic operations impede emergency vehicles and where traffic conditions create a potential for conflicts between emergency and nonemergency vehicles. These conflicts could lead to almost any type of crash, due to the potential for erratic maneuvers of vehicles moving out of the paths of emergency vehicles			
Why it works:			
Providing emergency vehicle preemption capability at a signal or along a corridor can be a highly effective strategy in two ways; any type of crash could occur as emergency vehicles try to navigate through intersections and as other vehicles try to maneuver out of the path of the emergency vehicles. In addition, a signal preemption system can decrease emergency vehicle response times therefore decreasing the time in receiving emergency medical attention, which is critical in the outcome of any crash. When data is not available for past crashes with emergency vehicles, an agency may consider combining the E.V. pre-emption improvements into a comprehensive project that also makes significant signal hardware and/or signal timing improvements.			
General Qualities (Time, Cost and Effectiveness):			
Costs for installation of a signal preemption system will vary from medium to high, based upon the number of signalized intersections at which preemption will be installed and the number of emergency vehicles to be outfitted with the technology. The number of detectors, a requirement for new signal controllers, and the intricacy of the preemption system could increase costs. This CM is considered systemic as it is usually implemented on a corridor-basis.			
FHWA CMF Clearinghouse:	Crash Types Addressed:	Emergency Vehicle - only	CRF: 70%

S06, Install left-turn lane and add turn phase (signal has no left-turn lane or phase before)

For HSIP Cycle 11 Call-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	All	55%	20 years
Notes:	This CM only applies to crashes occurring on the approaches / influence area of the new left turn lanes. This CM does NOT apply to converting a single-left into double-left turn.		
General information			
Where to use:			
Intersections that do not currently have a left turn lane or a related left-turn phase that are experiencing a large number of crashes. Many intersection safety problems can be traced to difficulties in accommodating left-turning vehicles, in particular where there is currently no accommodation for left turning traffic. A key strategy for minimizing collisions related to left-turning vehicles (angle, rear-end, sideswipe) is to provide exclusive left-turn lanes and the appropriate signal phasing, particularly on high-volume and high-speed major-road approaches. Agencies need to document their consideration of the MUTCD, Section 4D.19 guidelines; the section on implementing protected left-turn phases.			
Why it works:			
Left-turn lanes allow separation of left-turn and through-traffic streams, thus reducing the potential for rear-end collisions. Left-turn phasing also provides a safer opportunity for drivers to make a left-turn. The combination of left-turn storage and a left turn signal has the potential to reduce many collisions between left-turning vehicles and through vehicles and/or non-motorized road users.			
General Qualities (Time, Cost and Effectiveness):			
Implementation time may vary from months to years. At some locations, left-turn lanes can be quickly installed simply by restriping the roadway. At other locations, widening of the roadway, acquisition of additional right-of-way, and extensive environmental processes may be needed. Such projects require a substantial time for development and construction. Costs are highly variable and range from very low to high. Installing a protected left turn lane and phase where none exists results in a high Crash Reduction Factor and is often highly effective.			
FHWA CMF Clearinghouse:	Crash Types Addressed:	All	CRF: 17 - 58 %

S07, Provide protected left turn phase (left turn lane already exists)

For HSIP Cycle 11 Call-for-projects				
Funding Eligibility	Crash Types Addressed	CRF	Expected Life	
90%	All	30%	20 years	
Notes:	This CM only applies to crashes occurring on the approaches / influence area of the new left turn phases. This CM does NOT apply to converting a single-left into double-left turn (unless the single left is unprotected and the proposed double left will be protected).			
General information				
Where to use:				
Signalized intersections (with existing left turns pockets) that currently have a permissive left-turn or no left-turn protection that have a high frequency of angle crashes involving left turning, opposing through vehicles, and non-motorized road users. A properly timed protected left-turn phase can also help reduce rear-end and sideswipe crashes between left-turning vehicles and the through vehicles as well as vehicles behind them. Protected left-turn phases are warranted based on such factors as turning volumes, delay, visibility, opposing vehicle speed, distance to travel through the intersection, presence of non-motorized road users, and safety experience of the intersections. Agencies need to document their consideration of the MUTCD, Section 4D.19 guidelines; the section on implementing protected left-turn phases.				
Why it works:				
Left turns are widely recognized as the highest-risk movements at signalized intersections. Providing Protected left-turn phases (i.e., the provision for a specific phase for a turning movement) for signalized intersections with existing left turn pockets significantly improve the safety for left-turn maneuvers by removing the need for the drivers to navigate through gaps in oncoming/opposing through vehicles. Where left turn pockets are not protected, the pedestrian and bicyclist crossing phase often conflicts with these left turn maneuvers. Drivers focused on navigating the gaps of oncoming cars may not anticipate and/or perceive the non-motorized road users.				
General Qualities (Time, Cost and Effectiveness):				
If the existing traffic signal only requires a minor modification to allow for a protected left-turn phase, then the cost would also be low. The time to implement this countermeasure is short because there is no actual construction that has to take place. In-house signal maintainers can perform this operation once the proper signal phasing is determined so the cost is low. In addition, the countermeasure is tried and proven to be effective. Has the potential of being applied on a systemic/systematic approach.				
FHWA CMF Clearinghouse:	Crash Types Addressed:	Rear-End, Sideswipe, Broadside	CRF:	16 - 99%

S08, Convert signal to mast arm (from pedestal-mounted)

For HSIP Cycle 11 Call-for-projects				
Funding Eligibility	Crash Types Addressed	CRF	Expected Life	
90%	All	30%	20 years	
Notes:	This CM only applies to crashes occurring on the approaches / influence area of the converted signal heads that are relocated from median and/or outside shoulder pedestals to signal heads on master arms over the travel-lanes. Projects using CM "S7" should not also apply "S2" in the B/C calc.			
General information				
Where to use:				
Intersections currently controlled by pedestal mounted traffic signals (in medians and/or on outside shoulder) that have a high frequency of right-angle and rear-end crashes occurring because drivers are unable to see traffic signals in advance to safely negotiate the intersection. Intersections that have pedestal-mounted signals may have poor visibility and can result in vehicles not being able to stop in time for a signal change. Care should be taken to place the new signal heads (with back plates) as close to directly over the center of the travel lanes as possible.				
Why it works:				
Providing better visibility of intersection signs and signals aids the drivers' advance perception of the upcoming intersection. Visibility and clarity of the signal should be improved without creating additional confusion or distraction for drivers.				
General Qualities (Time, Cost and Effectiveness):				
Dependent on the scope of the project. Costs are generally moderate for this type of project. There is usually no right-of-way costs, minimal roadway reconstruction costs, and a shorter project development timeline. At the same time, new mast arms can be expensive. Some locations can result in high B/C ratios, but due to moderate costs, some locations may result in medium to low B/C ratios.				
FHWA CMF Clearinghouse:	Crash Types Addressed:	Rear-End, Angle	CRF:	12 - 74%

S09, Install raised pavement markers and striping (Through Intersection)

For HSIP Cycle 11 Call-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	All	10%	10 years
Notes:	This CM only applies to crashes occurring in the intersection and influence areas of the new pavement markers and/or markings.		
General information			
Where to use:			
Intersections where the lane designations are not clearly visible to approaching motorists and/or intersections noted as being complex and experiencing crashes that could be attributed to a driver's unsuccessful attempt to navigate the intersection. Driver confusion can exist in regard to choosing the proper turn path or where through-lanes do not line up. This is especially relevant at intersections where the overall pavement area of the intersection is large, and multiple turning lanes are involved or other unfamiliar elements are presented to the driver.			
Why it works:			
Adding clear pavement markings can guide motorists through complex intersections. When drivers approach and traverse through complex intersections, drivers may be required to perform unusual or unexpected maneuvers. Providing more effective guidance through an intersection will minimize the likelihood of a vehicle leaving its appropriate lane and encroaching upon an adjacent lane.			
General Qualities (Time, Cost and Effectiveness):			
Costs of implementing this strategy will vary based on the scope and number of applications. Applying raised pavement markers is relatively low cost but can be variable and determined largely by the material used for pavement markings (paint, thermoplastic, epoxy, RPMs etc.). When using this type delineators, an issue of concern is the cost-to-service-life of the material. (Note: When HSIP safety funding is used for these installations in high-wear-locations, the local agency is expected to maintain the improvement for a minimum of 10 years.) When considered at a single location, these low cost improvements are usually funded through local funding by local maintenance crews. However, This CM can be effectively and efficiently implemented using a systematic approach with numerous locations, resulting in moderate cost projects that are more appropriate to seek state or federal funding.			
FHWA CMF Clearinghouse:	Crash Types Addressed:	Wet, Night, All	CRF: 10 - 33%

S10, Install flashing beacons as advance warning (S.I.)

For HSIP Cycle 11 Call-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	All	30%	10 years
Notes:	This CM only applies to crashes occurring on the approaches / influence area of the new flashing beacons.		
General information			
Where to use:			
At signalized intersections with crashes that are a result of drivers being unaware of the intersection or are unable to see the traffic control device in time to comply.			
Why it works:			
Increased driver awareness of an approaching signalized intersection and an increase in the driver's time to react. Driver awareness of both downstream intersections and traffic control devices is critical to intersection safety. Crashes often occur when the driver is unable to perceive an intersection, signal head or the back of a stopped queue in time to react. Advance flashing beacons can be used to supplement and call driver attention to intersection control signs. Most advance warning flashing beacons can be powered by solar, thus reducing the issues relating to power source.			
General Qualities (Time, Cost and Effectiveness):			
Before choosing this CM, the agency needs to confirm the ability to provide power to the site (solar may be an option). Flashing beacons can be constructed with minimal design, environmental and right-of-way issues and have relatively low costs. This combined with a relatively high CRF, can result in high B/Cs for locations with a history of crashes and lead to a high effectiveness.			
FHWA CMF Clearinghouse:	Crash Types Addressed:	Rear End, Angle	CRF: 36 - 62%

S11, Improve pavement friction (High Friction Surface Treatments)

For HSIP Cycle 11 Call-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	All	55%	10 years
Notes:	This CM only applies to crashes occurring within the limits of the improved friction overlay. This CM is not intended to apply to standard chip-seal or open-graded maintenance projects for long segments of corridors or structure repaving projects intended to fix failed pavement.		
General information			
Where to use:			
Nationally, this countermeasure is referred to as "High Friction Surface Treatments" or HFST. Signalized Intersections noted as having crashes on wet pavements or under dry conditions when the pavement friction available is significantly less than needed for the actual roadway approach speeds. This treatment is intended to target locations where skidding and failure to stop is determined to be a problem in wet or dry conditions and the target vehicle is unable to stop due to insufficient skid resistance.			
Why it works:			
Improving the skid resistance at locations with high frequencies of wet-road crashes and/or failure to stop crashes can result in reductions of 50 percent for wet-road crashes and 20 percent for total crashes. Applying HFST can double friction numbers, e.g. low 40s to high 80s. This CM represents a special focus area for both FHWA and Caltrans, which means there are extra resources available for agencies interested in more details on High Friction Surface Treatment projects.			
General Qualities (Time, Cost and Effectiveness):			
This strategy can be relatively inexpensive and implemented in a short timeframe. The installation would be done by either agency personnel or contractors and can be done by hand or machine. In general, This CM can be very effective and can be considered on a systematic approach.			
FHWA CMF Clearinghouse:	Crash Types Addressed:	Wet, Night, ALL	CRF: 10 - 62 %

S12, Install raised median on approaches (S.I.)

For HSIP Cycle 11 Call-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	All	25%	20 years
Notes:	This CM only applies to crashes occurring on the approaches / influence area of the new raised median. All new raised medians funded with HSIP funding should not include the removal of the existing roadway structural section and should be doweled into the existing roadway surface. This requirement is being implemented to maximize the safety-effectiveness of the limited HSIP funding and to minimize project impacts. Landscaping, if included in the project, is considered non-participating.		
General information			
Where to use:			
Intersections noted as having turning movement crashes near the intersection as a result of insufficient access control. Application of this CM should be based on current crash data and a clearly defined need to restrict or accommodate the movement.			
Why it works:			
Raised medians next to left-turn lanes at intersections offer a cost-effective means for reducing crashes and improving operations at higher volume intersections. The raised medians prohibit left turns into and out of driveways that may be located too close to the functional area of the intersection.			
General Qualities (Time, Cost and Effectiveness):			
Raised medians at intersections may be most effective in retrofit situations where high volumes of turning vehicles have degraded operations and safety, and where more extensive CMs would be too expensive because of limited right-of-way and the constraints of the built environment. The result is This CM can be very effective and can be considered on a systematic approach. Raised medians can often be installed directly over the existing pavement. When agencies opt to install landscaping in conjunction with new raised medians, the portion of the cost for landscaping and other non-safety related items that exceeds 10% of the project total cost is not federally participated and must be funded by the applicant.			
FHWA CMF Clearinghouse:	Crash Types Addressed:	Angle	CRF: 21 - 55 %

S13PB, Install pedestrian median fencing on approaches

For HSIP Cycle 11 Call-for-projects					
Funding Eligibility		Crash Types Addressed		CRF	Expected Life
90%		Pedestrian and Bicycle		35%	20 years
Notes:	This CM only applies to "Ped & Bike" crashes occurring on the approaches/influence area of the new pedestrian median fencing.				
General information					
Where to use:					
Signalized Intersections with high pedestrian-generators nearby (e.g. transit stops) may experience a high volumes of pedestrians J-walking across the travel lanes at mid-block locations instead of walking to the intersection and waiting to cross during the walk-phase. When this safety issue cannot be mitigated with signal timing and shoulder/sidewalk treatments, then installing a continuous pedestrian barrier in the median may be a viable solution.					
Why it works:					
Adding pedestrian median fencing has the opportunity to enhance pedestrian safety at locations noted as being problematic involving pedestrians running/darting across the roadway outside the intersection crossings. Pedestrian median fencing can significantly reduce this safety issue by creating a positive barrier, forcing pedestrians to the designated pedestrian crossing.					
General Qualities (Time, Cost and Effectiveness):					
Costs associated with this strategy will vary widely depending on the type and placement of the median fencing. Impacts to transit and other land uses may need to be considered and controversy can delay the implementation. In general, this CM can be effective as a spot-location approach.					
FHWA CMF Clearinghouse:	Crash Types Addressed:	Pedestrian, Bicycle	CRF:	25- 40%	

S14, Create directional median openings to allow (and restrict) left-turns and U-turns (S.I.)

For HSIP Cycle 11 Call-for-projects					
Funding Eligibility		Crash Types Addressed		CRF	Expected Life
90%		All		50%	20 years
Notes:	This CM only applies to crashes occurring in the intersection / influence area of the new directional openings.				
General information					
Where to use:					
Crashes related to turning maneuvers include angle, rear-end, pedestrian, and sideswipe (involving opposing left turns) type crashes. If any of these crash types are an issue at an intersection, restriction or elimination of the turning maneuver may be the best way to improve the safety of the intersection.					
Why it works:					
Restricting turning movement into and out of an intersection can help reduce conflicts between through and turning traffic. The number of access points, coupled with the speed differential between vehicles traveling along the roadway, contributes to crashes. Affecting turning movements by either allowing them or restricting them, based on the application, can ensure safe movement of traffic.					
General Qualities (Time, Cost and Effectiveness):					
Turn prohibitions that are implemented by closing a median opening can be implemented quickly. The cost of this strategy will depend on the treatment. Impacts to businesses and other land uses must be considered and controversy can delay the implementation. In general, This CM can be very effective and can be considered on a systematic approach.					
FHWA CMF Clearinghouse:	Crash Types Addressed:	All	CRF:	51%	

S15, Reduced Left-Turn Conflict Intersections (S.I.)

For HSIP Cycle 11 Call-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	All	50%	20 years
Notes:	This CM only applies to crashes occurring in the intersection / influence area of the new Reduced Left-Turn Conflict.		
General information			
Where to use and Why it works:			
<p>Reduced left-turn conflict intersections are geometric designs that alter how left-turn movements occur in order to simplify decisions and minimize the potential for related crashes. Two highly effective 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).</p> <p>Restricted Crossing U-turn (RCUT): The RCUT intersection modifies the direct left-turn and through movements from cross-street approaches. Minor road traffic makes a right turn followed by a U-turn at a designated location (either signalized or unsignalized) to continue in the desired direction. The RCUT is suitable for a variety of circumstances, including along rural, high-speed, four-lane, divided highways or signalized routes. It also can be used as an alternative to signalization or constructing an interchange. RCUTs work well when consistently used along a corridor, but also can be used effectively at individual intersections.</p> <p>Median U-turn (MUT) The MUT intersection modifies direct left turns from the major approaches. Vehicles proceed through the main intersection, make a U-turn a short distance downstream, followed by a right turn at the main intersection. The U-turns can also be used for modifying the cross-street left turns. The MUT is an excellent choice for heavily traveled intersections with moderate left-turn volumes. When implemented at multiple intersections along a corridor, the efficient two-phase signal operation of the MUT can reduce delay, improve travel times, and create more crossing opportunities for pedestrians and bicyclists.</p> <p><i>MUT and RCUT Can Reduce Conflict Points by 50%</i></p>			
General Qualities (Time, Cost and Effectiveness):			
Implementing this strategy may take from months to years, depending on whether additional R/W is required. Such projects require a substantial time for development and construction. Costs are highly variable and range from very low to high. The expected effectiveness of this CM must be assessed for each individual location.			
FHWA CMF Clearinghouse:	Crash Types Addressed:	Angle/Left-turn/Rear-End/All	CRF: 34.8-100%

S16, Convert intersection to roundabout (from signal)

For HSIP Cycle 11 Call-for-projects				
Funding Eligibility	Crash Types Addressed	CRF	Expected Life	
90%	All	Varies	20 years	
Notes:	This CM only applies to crashes occurring in influence area of the new roundabout. This CM is not intended for mini-roundabouts. The benefit of this CM is calculated using Caltrans procedure. The CRF is dependent on the ADT, project location (Rural/Urban) and the roundabout type (1 lane or 2 lanes). The benefit comes from both the reduction in the number and the severity of the crashes.			
General information				
Where to use:				
Signalized intersections that have a significant crash problem and the only alternative is to change the nature of the intersection itself. Roundabouts can also be very effective at intersections with complex geometry and intersections with frequent left-turn movements.				
Why it works:				
The types of conflicts that occur at roundabouts are different from those occurring at conventional intersections; namely, conflicts from crossing and left-turn movements are not present in a roundabout. The geometry of a roundabout forces drivers to reduce speeds as they proceed through the intersection. This helps keep the range of vehicle speed narrow, which helps reduce the severity of crashes when they do occur. Pedestrians only have to cross one direction of traffic at a time at roundabouts, thus reducing their potential for conflicts.				
General Qualities (Time, Cost and Effectiveness):				
Provision of a roundabout requires substantial project development. The need to acquire right-of-way is likely and will vary from site to site and depends upon the geometric design. These activities may require up to 4 years or longer to implement. Costs are variable, but construction of a roundabout to replace an existing signalized intersection are relatively high. The result is this CM may have reduced relative-effectiveness compared to other CMs.				
FHWA CMF Clearinghouse:	Crash Types Addressed:	All	CRF:	35 - 67%

S17PB, Install pedestrian countdown signal heads

For HSIP Cycle 11 Call-for-projects				
Funding Eligibility	Crash Types Addressed	CRF	Expected Life	
90%	Pedestrian and Bicycle	25%	20 years	
Notes:	This CM only applies to "Ped & Bike" crashes occurring in the intersection/crossing with the new countdown heads.			
General information				
Where to use:				
Signals that have signalized pedestrian crossing with walk/don't walk indicators and where there have been pedestrian vs. vehicle crashes.				
Why it works:				
A pedestrian countdown signal contains a timer display and counts down the number of seconds left to finish crossing the street. Countdown signals can reassure pedestrians who are in the crosswalk when the flashing "DON'T WALK" interval appears that they still have time to finish crossing. Countdown signals begin counting down either when the "WALK" or when the flashing "DON'T WALK" interval appears and stop at the beginning of the steady "DON'T WALK" interval. These signals also have been shown to encourage more pedestrians to use the pushbutton rather than jaywalk.				
General Qualities (Time, Cost and Effectiveness):				
Costs and time of installation will vary based on the number of intersections included in this strategy and if it requires new signal controllers capable of accommodating the enhancement. When considered at a single location, these low cost improvements are usually funded through local funding by local crews. However, This CM can be effectively and efficiently implemented using a systematic approach with numerous locations, resulting in moderate cost projects that are more appropriate to seek state or federal funding.				
FHWA CMF Clearinghouse:	Crash Types Addressed:	Pedestrian, Bicycle	CRF:	25%

S18PB, Install pedestrian crossing (S.I.)

For HSIP Cycle 11 Call-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	Pedestrian and Bicycle	25%	20 years
Notes:	This CM only applies to "Ped & Bike" crashes occurring in the intersection/crossing with the new crossing. This CM is not intended to be used for high-cost aesthetic enhancements to intersection crosswalks (i.e. stamped concrete or stamped asphalt).		
General information			
Where to use:			
Signalized Intersections with no marked crossing and pedestrian signal heads, where pedestrians are known to be crossing intersections that involve significant turning movements. They are especially important at intersections with (1) multiphase traffic signals, such as left-turn arrows and split phases, (2) school crossings, and (3) double-right or double-left turns. At signalized intersections, pedestrian crossings are often safer when the left turns have protected phases that do not overlap the pedestrian walk phase.			
Why it works:			
Adding pedestrian crossings has the opportunity to enhance pedestrian safety at locations noted as being problematic. Nearly one-third of all pedestrian-related crashes occur at or within 50 feet of an intersection. Of these, 30 percent may involve a turning vehicle. Another 22 percent of pedestrian crashes involve a pedestrian either running across the intersection or darting out in front of a vehicle whose view was blocked just prior to the impact. Finally, 16 percent of these intersection-related crashes occur because of a driver violation (e.g., failure to yield right-of-way). When agencies opt to install aesthetic enhancement to intersection crosswalks like stamped concrete/asphalt, the project design and construction costs can significantly increase. For HSIP applications, these costs must be accounted for in the B/C calculation, but these costs (over standard crosswalk markings) must be tracked separately and are not federally reimbursable and will increase the agency's local-funding share for the project costs.			
General Qualities (Time, Cost and Effectiveness):			
Costs associated with this strategy will vary widely, depending if curb ramps and sidewalk modifications are required with the crossing. When considered at a single location, these low cost improvements may be funded through local funding by local crews. However, This CM can be effectively and efficiently implemented using a systematic approach with numerous locations, resulting in moderate to high cost projects that are appropriate to seek state or federal funding.			
FHWA CMF Clearinghouse:	Crash Types Addressed:	Pedestrian, Bicycle	CRF: 25%

S19PB, Pedestrian Scramble

For HSIP Cycle 11 Call-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	Pedestrian and Bicycle	40%	20 years
Notes:	This CM only applies to "Ped & Bike" crashes occurring in the intersection with the new pedestrian crossing.		
General information			
Where to use:			
Pedestrian Scramble is a form of pedestrian "WALK" phase at a signalized intersection in which all vehicular traffic is required to stop, allowing pedestrians/bicyclists to safely cross through the intersection in any direction, including diagonally. Pedestrian Scramble may be considered at signalized intersections with very high pedestrian/bicycle volumes, e.g. in an urban business district.			
Why it works:			
Pedestrian Scramble has been shown to reduce injury risk and increase bicycle ridership due to its perceived safety and comfort.			
General Qualities (Time, Cost and Effectiveness):			
Not involving any additional R/W, Pedestrian Scramble should not require a long development process and should be implemented reasonably soon. A systemic approach may be used in implementing this CM, resulting in cost efficiency with low to moderate cost.			
FHWA CMF Clearinghouse:	Crash Types Addressed:	Pedestrian, Bicycle	CRF: -10% to 51%

S20PB, Install advance stop bar before crosswalk (Bicycle Box)

For HSIP Cycle 11 Call-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	Pedestrian and Bicycle	15%	10 years
Notes:	This CM only applies to "Ped & Bike" crashes occurring in the intersection-crossing with the new advanced stop bars.		
General information			
Where to use:			
Signalized Intersections with a marked crossing, where significant bicycle and/or pedestrians volumes are known to occur.			
Why it works:			
Adding advance stop bar before the striped crosswalk has the opportunity to enhance both pedestrian and bicycle safety. Stopping cars well before the crosswalk provides a buffer between the vehicles and the crossing pedestrians. It also allows for a dedicated space for cyclists, making them more visible to drivers (This dedicated space is often referred to as a bike-box.)			
General Qualities (Time, Cost and Effectiveness):			
Costs and time of installation will vary based on the number of intersections included in this strategy and if it requires new signal controllers capable of accommodating the enhancement. When considered at a single location, these low cost improvements are usually funded through local funding by local crews. However, This CM can be effectively and efficiently implemented using a systematic approach with numerous locations, resulting in moderate cost projects that are more appropriate to seek state or federal funding.			
FHWA CMF Clearinghouse:	Crash Types Addressed:	Pedestrian, Bicycle	CRF: 35%

S21PB, Modify signal phasing to implement a Leading Pedestrian Interval (LPI)

For HSIP Cycle 11 Call-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	Pedestrian and Bicycle	60%	10 years
Notes:	This CM only applies to "Ped & Bike" crashes occurring in the intersections with signalized pedestrian crossing with the newly implemented Leading Pedestrian Interval (LPI).		
General information			
Where to use:			
Intersections with signalized pedestrian crossing that have high turning vehicles volumes and have had pedestrian vs. vehicle crashes.			
Why it works:			
A leading pedestrian interval (LPI) gives pedestrians the opportunity to enter an intersection 3-7 seconds before vehicles are given a green indication. With this head start, pedestrians can better establish their presence in the crosswalk before vehicles have priority to turn left. LPIs provide (1) increased visibility of crossing pedestrians; (2) reduced conflicts between pedestrians and vehicles; (3) Increased likelihood of motorists yielding to pedestrians; and (4) enhanced safety for pedestrians who may be slower to start into the intersection.			
General Qualities (Time, Cost and Effectiveness):			
Costs for implementing LPIs are very low, since only minor signal timing alteration is required. This makes it an easy and inexpensive countermeasure that can be incorporated into pedestrian safety action plans or policies and can become routine agency practice. When considered at a single location, the LPI is usually local-funded. However, This CM can be effectively and efficiently implemented using a systematic approach with numerous locations, resulting in moderate cost projects that are more appropriate to seek state or federal funding.			
FHWA CMF Clearinghouse:	Crash Types Addressed:	Pedestrian, Bicycle	CRF: 59%

B.2 Intersection Countermeasures – Non-signalized

NS01, Add intersection lighting (NS.I.)

For HSIP Cycle 11 Call-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	Night	40%	20 years
Notes:	This CM only applies to "night" crashes (all types) occurring within limits of the proposed roadway lighting 'engineered' area.		
General information			
Where to use:			
Non-signalized intersections that have a disproportionate number of night-time crashes and do not currently provide lighting at the intersection or at its approaches. Crash data should be studied to ensure that safety at the intersection could be improved by providing lighting (this strategy would be supported by a significant number of crashes that occur at night).			
Why it works:			
Providing lighting at the intersection itself, or both at the intersection and on its approaches, improves the safety of an intersection during nighttime conditions by (1) making drivers more aware of the surroundings at an intersection, which improves drivers' perception-reaction times, (2) enhancing drivers' available sight distances, and (3) improving the visibility of non-motorists. Intersection lighting is of particular benefit to non-motorized users as lighting not only helps them navigate the intersection, but also helps drivers see them better.			
General Qualities (Time, Cost and Effectiveness):			
A lighting project can usually be completed relatively quickly, but generally requires at least 1 year to implement because the lighting system must be designed and the provision of electrical power must be arranged. The provision of lighting involves both a fixed cost for lighting installation and an ongoing maintenance and power cost. For rural intersections, studies have shown the installation of streetlights reduced nighttime crashes at unlit intersections and can be more effective in reducing nighttime crashes than either rumble strips or overhead flashing beacons. Some locations can result in high B/C ratios, but due to higher costs, these projects often result in medium to low B/C ratios.			
FHWA CMF Clearinghouse:	Crash Types Addressed:	Night, All	CRF: 25- 50%

NS02, Convert to all-way STOP control (from 2-way or Yield control)

For HSIP Cycle 11 Call-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	All	50%	10 years
Notes:	This CM only applies to crashes occurring in the intersection and/or influence area of the new control. CA-MUTCD warrant must be met.		
General information			
Where to use:			
Unsignalized intersection locations that have a crash history and have no controls on the major roadway approaches. However, all-way stop control is suitable only at intersections with moderate and relatively balanced volume levels on the intersection approaches. Under other conditions, the use of all-way stop control may create unnecessary delays and aggressive driver behavior. MUTCD warrants should always be followed.			
Why it works:			
All-way stop control can reduce right-angle and turning collisions at unsignalized intersections by providing more orderly movement at an intersection, reducing through and turning speeds, and minimizing the safety effect of any sight distance restrictions that may be present. Advance public notification of the change is critical in assuring compliance and reducing crashes.			
General Qualities (Time, Cost and Effectiveness):			
The costs involved in converting to all-way stop control are relatively low. All-way stop control can normally be implemented at multiple intersections with just a change in signing on intersection approaches, and typically are very quick to implement. When considered at a single location, these low cost improvements are usually funded through local funding by local maintenance crews. However, This CM can be effectively and efficiently implemented using a systematic approach with numerous locations, resulting in moderate cost projects that are more appropriate to seek state or federal funding.			
FHWA CMF Clearinghouse:	Crash Types Addressed:	Left-turn, Angle	CRF: 6 - 80%

NS03, Install signals

For HSIP Cycle 11 Call-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	All	30%	20 years
Notes:	This CM only applies to crashes occurring in the intersection and/or influence area of the new signals. All new signals must meet MUTCD "safety" warrants: 4, 5 or 7. Given the over-arching operational changes that occur when an intersection is signalized, no other intersection CMs can be applied to the intersection crashes in conjunction with this CM.		
General information			
Where to use:			
Traffic signals can be used to prevent the most severe type crashes (right-angle, left-turn). Consideration to signalize an unsignalized intersection should only be given after (1) less restrictive forms of traffic control have been utilized as the installation of a traffic signal often leads to an increased frequency of crashes (rear-end) on major roadways and introduces congestion and (2) signal warrants have been met. Refer to the CA MUTCD, Section 4C.01, Studies and Factors for Justifying Traffic Control Signals.			
Why it works:			
Traffic signals have the potential to reduce the most severe type crashes but will likely cause an increase in rear-end collisions. A reduction in overall injury severity is likely the largest benefit of traffic signal installation.			
General Qualities (Time, Cost and Effectiveness):			
Typical traffic signal costs fall in the medium to high category and are affected by application, type of signal and right-of-way considerations. Projects of this magnitude should only be considered after alternate and lesser means of correction have been evaluated. Some locations can result in high B/C ratios, but due to higher costs, these projects often result in medium to low B/C ratios.			
FHWA CMF Clearinghouse:	Crash Types Addressed:	All	CRF: 0 - 74%

NS04, Convert intersection to roundabout (from all way stop)

For HSIP Cycle 11 Call-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	All	Varies	20 years
Notes:	This CM only applies to crashes occurring in the intersection and/or influence area of the new control. The benefit of this CM is calculated using Caltrans procedure. The CRF is dependent on the ADT, project location (Rural/Urban) and the roundabout type (1 lane or 2 lanes). The benefit comes from both the reduction in the number and the severity of the crashes.		
General information			
Where to use:			
Intersections that have a high frequency of right-angle and left-turn type crashes. Whether such intersections have existing crash patterns or not, a roundabout provides an alternative to signalization. The primary target locations for roundabouts should be moderate-volume unsignalized intersections. Roundabouts may not be a viable alternative in many suburban and urban settings where right-of-way is limited.			
Why it works:			
Roundabouts provide an important alternative to signalized and all-way stop-controlled intersections. Modern roundabouts differ from traditional traffic circles in that they operate in such a manner that traffic entering the roundabout must yield the right-of-way to traffic already in it. Roundabouts can serve moderate traffic volumes with less delay than all-way stop-controlled intersections and provide fewer conflict points. Crashes at roundabouts tend to be less severe because of the speed constraints and elimination of left-turn and right-angle movements.			
General Qualities (Time, Cost and Effectiveness):			
Construction of roundabouts are usually relatively costly and major projects, requiring the environmental process, right-of-way acquisition, and implementation under an agency's long-term capital improvement program. (For this reason, roundabouts may not be appropriate for California's Federal Safety Programs that have relatively short delivery requirements.) Even with roundabouts higher costs, they still can have a relatively high effectiveness.			
FHWA CMF Clearinghouse:	Crash Types Addressed:	Left-turn, Angle	CRF: 12 - 78 %

NS05, Convert intersection to roundabout (from 2-way stop or Yield control)

For HSIP Cycle 11 Call-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	All	Varies	20 years
Notes:	This CM only applies to crashes occurring in the intersection and/or influence area of the new control. The benefit of this CM is calculated using Caltrans procedure. The CRF is dependent on the ADT, project location (Rural/Urban) and the roundabout type (1 lane or 2 lanes). The benefit comes from both the reduction in the number and the severity of the crashes.		
General information			
Where to use:			
Intersections that have a high frequency of right-angle and left-turn type crashes. Whether such intersections have existing crash patterns or not, a roundabout provides an alternative to signalization. The primary target locations for roundabouts should be moderate-volume unsignalized intersections. Roundabouts may not be a viable alternative in many suburban and urban settings where right-of-way is limited.			
Why it works:			
Roundabouts provide an important alternative to signalized and all-way stop-controlled intersections. Modern roundabouts differ from traditional traffic circles in that they operate in such a manner that traffic entering the roundabout must yield the right-of-way to traffic already in it. Roundabouts can serve moderate traffic volumes with less delay than all-way stop-controlled intersections and provide fewer conflict points. Crashes at roundabouts tend to be less severe because of the speed constraints and elimination of left-turn and right-angle movements.			
General Qualities (Time, Cost and Effectiveness):			
Construction of roundabouts are usually relatively costly and major projects, requiring the environmental process, right-of-way acquisition, and implementation under an agency's long-term capital improvement program. (For this reason, roundabouts may not be appropriate for California's Federal Safety Programs that have relatively short delivery requirements.) Even with roundabouts higher costs, they still can have a relatively high effectiveness.			
FHWA CMF Clearinghouse:	Crash Types Addressed:	Left-turn, Angle	CRF: 12 - 78 %

NS05mr, Convert intersection to mini-roundabout

For HSIP Cycle 11 Call-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	All	30%	20 years
Notes:	This CM only applies to crashes occurring in the intersection and/or influence area of the new control.		
General information			
Where to use:			
Mini-roundabouts are characterized by a small diameter (45-90 ft) and traversable islands (central island and splitter islands). Mini-roundabouts offer most of the benefits of regular roundabouts with the added benefit of a smaller footprint. They are best suited to environments where speeds are already low and environmental constraints would preclude the use of a larger roundabout. Mini-roundabouts are most effective in lower speed environments in which all approaching roadways have posted speed of 30 mph or less and an 85th-percentile speed of less than 35 mph near the proposed yield and/or entrance line. For any location with an 85th-percentile speed above 35 mph, the mini-roundabout can be included as part of a broader system of traffic calming measures to achieve an appropriate speed environment.			
Why it works:			
Mini-roundabouts may be an optimal solution for a safety or operational issue at an existing intersection where there is insufficient right-of-way for a standard roundabout installation. The benefits of mini-roundabouts are the Compact size, operational efficiency, traffic safety improvement and traffic Calming.			
General Qualities (Time, Cost and Effectiveness):			
Construction costs for mini-roundabouts vary widely depending upon the extent of sidewalk modifications or other geometric improvements and the types of materials used. In most cases, mini-roundabouts have been installed with little or no pavement widening and with only minor changes to curbs and sidewalks. Construction costs can be minimum for an installation consisting entirely of pavement markings and signage or moderate for mini-roundabouts that include raised islands and pedestrian improvements.			
FHWA CMF Clearinghouse:	Crash Types Addressed:	NA	CRF: NA

NS06, Install/upgrade larger or additional stop signs or other intersection warning/regulatory signs

For HSIP Cycle 11 Call-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	All	15%	10 years
Notes:	This CM only applies to crashes occurring in the influence area of the new signs. The influence area must be determined on a location by location basis.		
General information			
Where to use:			
The target for this strategy should be approaches to unsignalized intersections with patterns of rear-end, right-angle, or turning collisions related to lack of driver awareness of the presence of the intersection.			
Why it works:			
The visibility of intersections and, thus, the ability of approaching drivers to perceive them can be enhanced by installing larger regulatory and warning signs at or prior to intersections. A key to success in applying this strategy is to select a combination of regulatory and warning sign techniques appropriate for the conditions on a particular unsignalized intersection approach.			
General Qualities (Time, Cost and Effectiveness):			
Signing improvements do not require a long development process and can typically be implemented quickly. Costs for implementing this strategy are nominal and depend on the number of signs. When considered at a single location, these low cost improvements are usually funded through local funding by local maintenance crews. However, This CM can be effectively and efficiently implemented using a systematic approach with numerous locations, resulting in moderate cost projects that are more appropriate to seek state or federal funding.			
FHWA CMF Clearinghouse:	Crash Types Addressed:	All	CRF: 11 - 55%

NS07, Upgrade intersection pavement markings (NS.I.)

For HSIP Cycle 11 Call-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	All	25%	10 years
Notes:	This CM only applies to crashes occurring on the approaches / influence area of the new pavement markings. This CM is not intended to be used for general maintenance activities (i.e. the replacement of existing pavement markings in-kind) and must include upgraded safety features over the existing pavement markings and striping.		
General information			
Where to use:			
Unsignalized intersections that are not clearly visible to approaching motorists, particularly approaching motorists on the major road. The strategy is particularly appropriate for intersections with patterns of rear-end, right-angle, or turning crashes related to lack of driver awareness of the presence of the intersection. Also at minor road approaches where conditions allow the stop bar to be seen by an approaching driver at a significant distance from the intersection. Typical improvements include "Stop Ahead" markings and the addition of Centerlines and Stop Bars.			
Why it works:			
The visibility of intersections and, thus, the ability of approaching drivers to perceive them can be enhanced by installing appropriate pavement delineation in advance of and at intersections will provide approaching motorists with additional information at these locations. Providing visible stop bars on minor road approaches to unsignalized intersections can help direct the attention of drivers to the presence of the intersection. Drivers should be more aware that the intersection is coming up, and therefore make safer decisions as they approach the intersection.			
General Qualities (Time, Cost and Effectiveness):			
Pavement marking improvements do not require a long development process and can typically be implemented quickly. Costs for implementing this strategy are nominal and depend on the number of markings. When considered at a single location, these low cost improvements are usually funded through local funding by local maintenance crews. However, This CM can be effectively and efficiently implemented using a systematic approach with numerous locations, resulting in moderate cost projects that are more appropriate to seek state or federal funding. Note: When federal safety funding is used for these installations in high-wear-locations, the local agency is expected to maintain the improvement for a minimum of 10 years.			
FHWA CMF Clearinghouse:	Crash Types Addressed:	All	CRF: 13 - 60%

NS08, Install Flashing Beacons at Stop-Controlled Intersections

For HSIP Cycle 11 Call-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	All	15%	10 years
Notes:	This CM only applies to crashes occurring on the stop-controlled approaches / influence area of the new beacons.		
General information			
Where to use:			
Flashing beacons can reinforce driver awareness of the Non-Signalized intersection control and can help mitigate patterns of right-angle crashes related to stop sign violations. Post-mounted advanced flashing beacons or overhead flashing beacons can be used at stop-controlled intersections to supplement and call driver attention to stop signs.			
Why it works:			
Flashing beacons provide a visible signal to the presence of an intersection and can be very effective in rural areas where there may be long stretches between intersections as well as locations where night-time visibility of intersections is an issue.			
General Qualities (Time, Cost and Effectiveness):			
Flashing beacons can be constructed with minimal design, environmental and right-of-way issues and have relatively low costs. Before choosing this CM, the agency needs to confirm the ability to provide power to the site (solar may be an option). In general, This CM can be very effective and can be considered on a systematic approach.			
FHWA CMF Clearinghouse:	Crash Types Addressed:	Angle, Rear-End	CRF: 5-34%

NS09, Install flashing beacons as advance warning (NS.I.)

For HSIP Cycle 11 Call-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	All	30%	10 years
Notes:	This CM only applies to crashes occurring on the approaches / influence area of the new beacons placed in advance of the intersection.		
General information			
Where to use:			
Non-Signalized Intersections with patterns of crashes that could be related to lack of a driver's awareness of approaching intersection or controls at a downstream intersection.			
Why it works:			
Advance flashing beacons can be used to supplement and call driver attention to intersection control signs. Flashing beacons are intended to reinforce driver awareness of the stop or yield signs and to help mitigate patterns of crashes related to intersection regulatory sign violations. Most advance warning flashing beacons can be powered by solar, thus reducing the issues relating to power source.			
General Qualities (Time, Cost and Effectiveness):			
Use of flashing beacons requires minimal development process, allowing flashing beacons to be installed within a short time period. Before choosing this CM, the agency needs to confirm the ability to provide power to the site (solar may be an option). In general, This CM can be very effective and can be considered on a systematic approach.			
FHWA CMF Clearinghouse:	Crash Types Addressed:	Angle, Rear-End	CRF: 36 - 62%

NS10, Install transverse rumble strips on approaches

For HSIP Cycle 11 Call-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	All	20%	10 years
Notes:	This CM only applies to crashes occurring on the approaches / influence area of the new rumble strips.		
General information			
Where to use:			
Transverse rumble strips are installed in the travel lane for the purposes of providing an auditory and tactile sensation for each motorist approaching the intersection. They can be used at any stop or yield approach intersection, often in combination with advance signing to warn of the intersection ahead. Due to the noise generated by vehicles driving over the rumble strips, care must be taken to minimize disruption to nearby residences and businesses.			
Why it works:			
When motorists are traveling along the roadway, they are sometimes unaware they are approaching an intersection. This is especially true on rural roads, as there may be fewer clues indicating an intersection ahead. Transverse rumble strips warn motorists that something unexpected is ahead that they need to pay attention to.			
General Qualities (Time, Cost and Effectiveness):			
Use of transverse rumble strips requires minimal development process, allowing transverse rumble strips to be installed within a short time period. In general, This CM can be very effective and can be considered on a systematic approach, although care should be taken to not over-use this CM. Note: When federal safety funding is used for these installations in high-wear-locations, the local agency is expected to maintain the improvement for a minimum of 10 years.			
FHWA CMF Clearinghouse:	Crash Types Addressed:	All	CRF: 0 - 35%

NS11, Improve sight distance to intersection (Clear Sight Triangles)

For HSIP Cycle 11 Call-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	All	20%	10 years
Notes:	This CM only applies to crashes occurring on the approaches / influence area of the significantly improved new sight distance. Minor/incidental improvements to sight distance would not likely result in the CRF shown below.		
General information			
Where to use:			
Unsignalized intersections with restricted sight distance and patterns of crashes related to lack of sight distance where sight distance can be improved by clearing roadside obstructions without major reconstruction of the roadway.			
Why it works:			
Adequate sight distance for drivers at stop or yield-controlled approaches to intersections has long been recognized as among the most important factors contributing to overall safety at unsignalized intersections. By removing sight distance restrictions (e.g., vegetation, parked vehicles, signs, buildings) from the sight triangles at stop or yield-controlled intersection approaches, drivers will be able see approaching vehicles on the main line, without obstruction and therefore make better decisions about entering the intersection safely.			
General Qualities (Time, Cost and Effectiveness):			
Projects involving clearing sight obstructions on the highway right-of-way can typically be accomplished quickly, assuming the objects are readily moveable. Clearing sight obstructions on private property requires more time for discussions with the property owner. Costs will generally be low, assuming that in most cases the objects to be removed are within the right-of-way. In general, this CMs can be very effective and can be implemented by agencies' maintenance staff and/or implemented on a systematic approach. Usually only high-cost removals would be good candidates for Caltrans Federal Safety Funding. Note: When federal safety funding is used to remove vegetation that has the potential to grow back, the local agency is expected to maintain the improvement for a minimum of 10 years.			
FHWA CMF Clearinghouse:	Crash Types Addressed:	All	CRF: 11 - 56%

NS12, Improve pavement friction (High Friction Surface Treatments)

For HSIP Cycle 11 Call-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	All	55%	10 years
Notes:	This CM only applies to crashes occurring within the limits of the improved friction overlay. This CM is not intended to apply to standard chip-seal or open-graded maintenance projects for long segments of corridors or structure repaving projects intended to fix failed pavement.		
General information			
Where to use:			
Nationally, this countermeasure is referred to as "High Friction Surface Treatments" or HFST. Non-signalized Intersections noted as having crashes on wet pavements or under dry conditions when the pavement friction available is significantly less than needed for the actual roadway approach speeds. This treatment is intended to target locations where skidding and failure to stop is determined to be a problem in wet or dry conditions and the target vehicle is unable to stop due to insufficient skid resistance.			
Why it works:			
Improving the skid resistance at locations with high frequencies of wet-road crashes and/or failure to stop crashes can result in reductions of 50 percent for wet-road crashes and 20 percent for total crashes. Applying HFST can double friction numbers, e.g. low 40s to high 80s. This CM represents a special focus area for both FHWA and Caltrans, which means there are extra resources available for agencies interested in more details on High Friction Surface Treatment projects.			
General Qualities (Time, Cost and Effectiveness):			
This strategy can be relatively inexpensive and implemented in a short timeframe. The installation would be done by either agency personnel or contractors and can be done by hand or machine. In general, This CM can be very effective and can be considered on a systematic approach.			
FHWA CMF Clearinghouse:	Crash Types Addressed:	Wet, Night, ALL	CRF: 10 - 62 %

NS13, Install splitter-islands on the minor road approaches

For HSIP Cycle 11 Call-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	All	40%	20 years
Notes:	This CM only applies to crashes occurring on the approaches / influence area of <u>the new splitter island on the minor road approaches.</u>		
General information			
Where to use:			
Minor road approaches to unsignalized intersections where the presence of the intersection or the stop sign is not readily visible to approaching motorists. The strategy is particularly appropriate for intersections where the speeds on the minor road are high. In creation of a splitter island allows for an additional stop sign to be placed in the median for the minor approach.			
Why it works:			
The installation of splitter islands allows for the addition of a stop sign in the median to make the intersection more conspicuous. Additionally, the splitter island on the minor-road provides for a positive separation between turning vehicles on the through road and vehicles stopped on the minor road approach.			
General Qualities (Time, Cost and Effectiveness):			
Splitter islands at non-signalized intersections can usually be installed with minimal roadway reconstruction and relatively quickly. In general, This CM can be very effective and can be considered on a systematic approach.			
FHWA CMF Clearinghouse:	Crash Types Addressed:	Angle, Rear-End	CRF: 35 - 100 %

NS14, Install raised median on approaches (NS.I)

For HSIP Cycle 11 Call-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	All	25%	20 years
Notes:	This CM only applies to crashes occurring on the approaches / influence area of the new raised median. All new raised medians funded with federal HSIP funding should not include the removal of the existing roadway structural section and should be doweled into the existing roadway surface. This requirement is being implemented to maximize the safety-effectiveness of the limited HSIP funding and to minimize project impacts. Landscaping, if included in the project, is considered non-participating.		
General information			
Where to use:			
Where related or nearby turning movements affect the safety and operation of an intersection. Effective access management is key to improving safety at, and adjacent to, intersections. The number of intersection access points coupled with the speed differential between vehicles traveling along the roadway often contributes to crashes. Any access points within 250 feet upstream and downstream of an intersection are generally undesirable.			
Why it works:			
Raised medians with left-turn lanes at intersections offer a cost-effective means for reducing crashes and improving operations at higher volume intersections. The raised medians also prohibit left turns into and out of driveways that may be located too close to the functional area of the intersection.			
General Qualities (Time, Cost and Effectiveness):			
Raised medians at intersections may be most effective in retrofit situations where high volumes of turning vehicles have degraded operations and safety, and where more extensive approaches would be too expensive because of limited right-of-way and the constraints of the built environment. Because raised medians limit property access to right turns only, the need for providing alternative access ways should be considered. In general, This CM can be very effective and can be considered on a systematic approach. When agencies opt to install landscaping in conjunction with new raised medians, the portion of the cost for landscaping and other non-safety related items that exceeds 10% of the project total cost is not federally participated and must be funded by the applicant.			
FHWA CMF Clearinghouse:	Crash Types Addressed:	All	CRF: 20 - 39 %

NS15, Create directional median openings to allow (and restrict) left-turns and u-turns (NS.I)

For HSIP Cycle 11 Call-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	All	50%	20 years
Notes:	This CM only applies to crashes occurring in the intersection / influence area of the new directional openings.		
General information			
Where to use:			
Crashes related to turning maneuvers include angle, rear-end, pedestrian, and sideswipe (involving opposing left turns) type crashes. If any of these crash types are an issue at an intersection, restriction or elimination of the turning maneuver may be the best way to improve the safety of the intersection. Because raised medians limit property access to right turns only, they should be used in conjunction with efforts to provide alternative access ways and promote driveway spacing objectives.			
Why it works:			
Agencies are increasingly using access management techniques on urban and suburban arterials to manage the number of conflicts experienced at an intersection. A key element of access management is to restrict certain movements, create directional median openings, or close median openings that are deemed too close to an intersection.			
General Qualities (Time, Cost and Effectiveness):			
Turn prohibitions that are implemented by closing a median opening can usually be implemented quickly. Costs are highly variable but in many cases could be considered low. In some cases this strategy may involve acquiring access or constructing replacement access; those actions will significantly increase the cost of the project. Impacts to businesses and other land uses must be considered and controversy can delay the implementation. In general, This CM can be very effective and can be considered on a systematic approach.			
FHWA CMF Clearinghouse:	Crash Types Addressed:	All	CRF: 51%

NS16, Reduced Left-Turn Conflict Intersections (NS.I.)

For HSIP Cycle 11 Call-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	All	50%	20 years
Notes:	This CM only applies to crashes occurring in the intersection / influence area of the new Reduced Left-Turn Conflict.		
General information			
Where to use and Why it works:			
<p>Reduced left-turn conflict intersections are geometric designs that alter how left-turn movements occur in order to simplify decisions and minimize the potential for related crashes. Two highly effective 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).</p> <p>Restricted Crossing U-turn (RCUT): The RCUT intersection modifies the direct left-turn and through movements from cross-street approaches. Minor road traffic makes a right turn followed by a U-turn at a designated location (either signalized or unsignalized) to continue in the desired direction. The RCUT is suitable for a variety of circumstances, including along rural, high-speed, four-lane, divided highways or signalized routes. It also can be used as an alternative to signalization or constructing an interchange. RCUTs work well when consistently used along a corridor, but also can be used effectively at individual intersections.</p> <p>Median U-turn (MUT) The MUT intersection modifies direct left turns from the major approaches. Vehicles proceed through the main intersection, make a U-turn a short distance downstream, followed by a right turn at the main intersection. The U-turns can also be used for modifying the cross-street left turns. The MUT is an excellent choice for heavily traveled intersections with moderate left-turn volumes. When implemented at multiple intersections along a corridor, the efficient two-phase signal operation of the MUT can reduce delay, improve travel times, and create more crossing opportunities for pedestrians and bicyclists.</p> <p><i>MUT and RCUT Can Reduce Conflict Points by 50%</i></p>			
General Qualities (Time, Cost and Effectiveness):			
Implementing this strategy may take from months to years, depending on whether additional R/W is required. Such projects require a substantial time for development and construction. Costs are highly variable and range from very low to high. The expected effectiveness of this CM must be assessed for each individual location.			
FHWA CMF Clearinghouse:	Crash Types Addressed:	Angle/Left-turn/Rear-End/All	CRF: 34.8-100%

NS17, Install right-turn lane (NS.I.)

For HSIP Cycle 11 Call-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	All	20%	20 years
Notes:	This CM only applies to crashes occurring on the approaches / influence area of the new right-turn lanes. This CM is not eligible for use at existing all-way stop intersections.		
General information			
Where to use:			
Many collisions at unsignalized intersections are related to right-turn maneuvers. A key strategy for minimizing such collisions is to provide exclusive right-turn lanes, particularly on high-volume and high-speed major-road approaches. When considering new right-turn lanes, potential impacts to non-motorized users should be considered and mitigated as appropriate. When considering new right-turn lanes, potential impacts to non-motorized users should be considered and mitigated as appropriate.			
Why it works:			
The strategy is targeted to reduce the frequency of rear-end collisions resulting from conflicts between vehicles turning right and following vehicles and vehicles turning right and through vehicles coming from the left on the cross street. Right-turn lanes also remove slow vehicles that are decelerating to turn right from the through-traffic stream, thus reducing the potential for rear-end collisions. Right-turn lanes can increase the length of the intersection crossing and create an additional potential conflict point for non-motorized users.			
General Qualities (Time, Cost and Effectiveness):			
Implementing this strategy may take from months to years. At some locations, right-turn lanes can be quickly and simply installed by restriping the roadway. At other locations, widening of the roadway, acquisition of additional right-of-way, and extensive environmental processes may be needed. Such projects require a substantial time for development and construction. Costs are highly variable and range from very low to high. The expected effectiveness of this CM must be assessed for each individual location.			
FHWA CMF Clearinghouse:	Crash Types Addressed:	All	CRF: 14 - 26 %

NS18, Install left-turn lane (where no left-turn lane exists)

For HSIP Cycle 11 Call-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	All	35%	20 years
Notes:	This CM only applies to crashes occurring on the approaches / influence area of the new left-turn lanes. This CM does NOT apply to converting a single-left into double-left turn. This CM is not eligible for use at existing all-way stop intersections.		
General information			
Where to use:			
Many collisions at unsignalized intersections are related to left-turn maneuvers. A key strategy for minimizing such collisions is to provide exclusive left-turn lanes, particularly on high-volume and high-speed major-road approaches. When considering new left-turn lanes, potential impacts to non-motorized users should be considered and mitigated as appropriate.			
Why it works:			
Adding left-turn lanes remove vehicles waiting to turn left from the through-traffic stream, thus reducing the potential for rear-end collisions. Because they provide a sheltered location for drivers to wait for a gap in opposing traffic, left-turn lanes may encourage drivers to be more selective in choosing a gap to complete the left-turn maneuver. This strategy may reduce the potential for collisions between left-turn and opposing through vehicles.			
General Qualities (Time, Cost and Effectiveness):			
Implementing this strategy may take from months to years. At some locations, left-turn lanes can be quickly and simply installed by restriping the roadway. At other locations, widening of the roadway, acquisition of additional right-of-way, and extensive environmental processes may be needed. Such projects require a substantial time for development and construction. Costs are highly variable and range from very low to high. The expected effectiveness of this CM must be assessed for each individual location.			
FHWA CMF Clearinghouse:	Crash Types Addressed:	All	CRF: 9 -55 %

NS19PB, Install raised medians (refuge islands)

For HSIP Cycle 11 Call-for-projects					
Funding Eligibility		Crash Types Addressed		CRF	Expected Life
90%		Pedestrian and Bicycle		45%	20 years
Notes:	This CM only applies to "Ped & Bike" crashes occurring in the crossing with the new islands. All new raised medians funded with federal HSIP funding should not include the removal of the existing roadway structural section and should be doweled into the existing roadway surface. This requirement is being implemented to maximize the safety-effectiveness of the limited HSIP funding and to minimize project impacts. Landscaping, if included in the project, is considered non-participating.				
General information					
Where to use:					
Intersections that have a long pedestrian crossing distance, a higher number of pedestrians, or a crash history. Raised medians decrease the level of exposure for pedestrians and allow pedestrians to concentrate on (or cross) only one direction of traffic at a time.					
Why it works:					
Raised pedestrian refuge islands, or medians at crossing locations along roadways, are another strategy to reduce exposure between pedestrians and motor vehicles. Refuge islands and medians that are raised (i.e., not just painted) provide pedestrians more secure places of refuge during the street crossing. They can stop partway across the street and wait for an adequate gap in traffic before completing their crossing.					
General Qualities (Time, Cost and Effectiveness):					
Median and pedestrian refuge areas are a low-cost countermeasure to implement. This cost can be applied to retrofit improvements or if it is a new construction project, implementing this countermeasure is even more cost-effective. In general, This CM can be very effective and can be considered on a systematic approach. When agencies opt to install landscaping in conjunction with new raised medians, the portion of the cost for landscaping and other non-safety related items that exceeds 10% of the project total cost is not federally participated and must be funded by the applicant.					
FHWA CMF Clearinghouse:		Crash Types Addressed:		CRF:	30 - 56 %
		Pedestrian and Bicycle			

NS20PB, Install pedestrian crossing at uncontrolled locations (signs and markings only)

For HSIP Cycle 11 Call-for-projects					
Funding Eligibility		Crash Types Addressed		CRF	Expected Life
90%		Pedestrian and Bicycle		25%	10 years
Notes:	This CM only applies to "Ped & Bike" crashes occurring in the intersection/crossing with the new crossing. This CM is not intended to be used for high-cost aesthetic enhancements to intersection crosswalks (i.e. stamped concrete or stamped asphalt).				
General information					
Where to use:					
Non-signalized intersections without a marked crossing, where pedestrians are known to be crossing intersections that involve significant vehicular traffic. They are especially important at school crossings and intersections with right and/or left turns pockets. See Zegeer study (Safety Effects of Marked vs. Unmarked Crosswalks at Uncontrolled Locations) for additional guidance regarding when to install a marked crosswalk.					
Why it works:					
Adding pedestrian crossings has the opportunity to enhance pedestrian safety at locations noted as being problematic. Pavement markings delineate a portion of the roadway that is designated for pedestrian crossing. These markings will often be different for controlled verses uncontrolled locations. The use of "ladder", "zebra" or other enhanced markings at uncontrolled crossings can increase both pedestrian and driver awareness to the increased exposure at the crossing. Incorporating advanced "stop" or "yield" markings provides an extra safety buffer and can be effective in reducing the 'multiple-threat' danger to pedestrians. Nearly one-third of all pedestrian-related crashes occur at or within 50 feet of an intersection. Of these, 30 percent may involve a turning vehicle. There are several types of pedestrian crosswalks, including: continental, ladder, zebra, and standard. When agencies opt to install aesthetic enhancement to intersection crosswalks like stamped concrete/asphalt, the project design and construction costs can significantly increase. For HSIP applications, these costs must be accounted for in the B/C calculation, but these costs (over standard crosswalk markings) must be tracked separately and are not federally reimbursable and will increase the agency's local-funding share for the project costs.					
General Qualities (Time, Cost and Effectiveness):					
Costs associated with this strategy will vary widely, depending upon if curb ramps and sidewalk modifications are required with the crossing. When considered at a single location, these low cost improvements are usually funded through local funding by local crews. However, This CM can be effectively and efficiently implemented using a systematic approach with numerous locations, resulting in moderate cost projects that are more appropriate to seek state or federal funding.					
FHWA CMF Clearinghouse:		Crash Types Addressed:		CRF:	25 %
		Pedestrian and Bicycle			

NS21PB, Install/upgrade pedestrian crossing at uncontrolled locations (with enhanced safety features)

For HSIP Cycle 11 Call-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	Pedestrian and Bicycle	35%	20 years
Notes:	This CM only applies to "Ped & Bike" crashes occurring in the new crossing (influence area) with enhanced safety features. This CM is not intended to be used for high-cost aesthetic enhancements to intersection crosswalks (i.e. stamped concrete or stamped asphalt).		
General information			
Where to use:			
Non-signalized intersections where pedestrians are known to be crossing intersections that involve significant vehicular traffic. They are especially important at school crossings and intersections with turn pockets. Based on the Zegeer study (Safety Effects of Marked vs. Unmarked Crosswalks at Uncontrolled Locations) at many locations, a marked crosswalk alone may not be sufficient to adequately protect non-motorized users. In these cases, flashing beacons, curb extensions, advanced "stop" or "yield" markings, and other safety features should be added to complement the standard crossing elements.			
Why it works:			
Adding pedestrian crossings that include enhanced safety features has the opportunity to enhance pedestrian safety at locations noted as being especially problematic. The enhanced safety elements help delineate a portion of the roadway that is designated for pedestrian crossing. Incorporating advanced "yield" markings provide an extra safety buffer and can be effective in reducing the 'multiple-threat' danger to pedestrians. Nearly one-third of all pedestrian-related crashes occur at or within 50 feet of an intersection. When agencies opt to install aesthetic enhancement to intersection crosswalks like stamped concrete/asphalt, the project design and construction costs can significantly increase. For HSIP applications, these costs must be accounted for in the B/C calculation, but these costs (over standard crosswalk markings) must be tracked separately and are not federally reimbursable and will increase the agency's local-funding share for the project costs.			
General Qualities (Time, Cost and Effectiveness):			
Costs associated with this strategy will vary widely, depending upon the types of enhanced features that will be combined with the standard crossing improvements. The need for new curb ramps and sidewalk modifications will also be a factor. This CM may be effectively and efficiently implemented using a systematic approach with more than one location and can have relatively high B/C ratios based on past non-motorized crash history.			
FHWA CMF Clearinghouse:	Crash Types Addressed:	Pedestrian and Bicycle	CRF: 37%

NS22PB, Install Rectangular Rapid Flashing Beacon (RRFB)

For HSIP Cycle 11 Call-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	Pedestrian and Bicycle	35%	20 years
Notes:	This CM only applies to "Ped & Bike" crashes occurring in the influence area (expected to be a maximum of within 250') of the crossing which includes the RRFB.		
General information			
Where to use:			
Rectangular Rapid Flashing Beacon (RRFB) includes pedestrian-activated flashing lights and additional signage that enhance the visibility of marked crosswalks and alert motorists to pedestrian crossings. It uses an irregular flash pattern that is similar to emergency flashers on police vehicles. RRFBs are installed at unsignalized intersections and mid-block pedestrian crossings.			
Why it works:			
RRFBs can enhance safety by increasing driver awareness of potential pedestrian conflicts and reducing crashes between vehicles and pedestrians at unsignalized intersections and mid-block pedestrian crossings. The addition of RRFB may also increase the safety effectiveness of other treatments, such as crossing warning signs and markings.			
General Qualities (Time, Cost and Effectiveness):			
RRFBs are a lower cost alternative to traffic signals and hybrid signals. This CM can often be effectively and efficiently implemented using a systematic approach with numerous locations.			
FHWA CMF Clearinghouse:	Crash Types Addressed:	Pedestrian, Bicycle	CRF: 7 – 47.4%

NS23PB, Install Pedestrian Signal (including Pedestrian Hybrid Beacon (HAWK))

For HSIP Cycle 11 Call-for-projects				
Funding Eligibility	Crash Types Addressed		CRF	Expected Life
90%	Pedestrian and Bicycle		55%	20 years
Notes:	This CM only applies to "Ped & Bike" crashes occurring in the intersection/crossing with the new signal. For HAWK or other pedestrian signals, the justification may be Warrant 4, 5 and/or 7, or passing the test in Figure 4F-1/4F-2 in Chapter 4F of CA MUTCD. Please refer to Chapter 4F of CA MUTCD for more details			
General information				
Where to use:				
Intersections noted as having a history of pedestrian vs. vehicle crashes and in areas where the likelihood of the pedestrian presence is high. Corridors should also be assessed to determine if there are adequate safe opportunities for non-motorists to cross and if a pedestrian signal, or a Pedestrian Hybrid Beacon (PHB) (also called High-Intensity Activated crossWalk beacon (HAWK)) are needed to provide an active warning to motorists when a pedestrian is in the crosswalk.				
Why it works:				
Adding a pedestrian signal has the opportunity to greatly enhance pedestrian safety at locations noted as being problematic. Nearly one-third of all pedestrian-related crashes occur at or within 50 feet of an intersection. In combination with this CM, better guidance signs and markings for non-motorized and motorized roadway users should be considered, including: sign and markings directing pedestrians and cyclists on appropriate/legal travel paths and signs and markings warning motorists of non-motorized uses of the roadway that should be expected.				
General Qualities (Time, Cost and Effectiveness):				
The cost of improvements are generally high, but can vary dependent on the type of signal and overall scope of the project. In most cases the project duration can be short. The expected effectiveness of this CM must be assessed for each individual location.				
FHWA CMF Clearinghouse:	Crash Types Addressed:	Pedestrian and Bicycle	CRF:	15 - 69%

B.3 Roadway Countermeasures

R01, Add Segment Lighting

For HSIP Cycle 11 Call-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	Night	35%	20 years
Notes:	This CM only applies to "night" crashes (all types) occurring within limits of the proposed roadway lighting 'engineered' area.		
General information			
Where to use:			
Where to use: Noted substantial patterns of nighttime crashes. In particular, patterns of rear-end, right-angle, turning or roadway departure collisions on the roadways may indicate that night-time drivers can be unaware of the roadway characteristics.			
Why it works:			
Providing roadway lighting improves the safety during nighttime conditions by (1) making drivers more aware of the surroundings, which improves drivers' perception-reaction times, (2) enhancing drivers' available sight distances to perceive roadway characteristic in advance of the change, and (3) improving non-motorist's visibility and navigation.			
General Qualities (Time, Cost and Effectiveness):			
It expected that projects of this type may be constructed in a year or two and are relatively costly. There are several types of costs associated with providing lighting, including the cost of providing a permanent source of power to the location, the cost for the luminaire supports (i.e., poles), and the cost for routinely replacing the bulbs and maintenance of the luminaire supports. Some locations can result in high B/C ratios, but due to higher costs, these projects often result in medium to low B/C ratios.			
FHWA CMF Clearinghouse:	Crash Types Addressed:	Night, All	CRF: 18 - 69 %

R02, Remove or relocate fixed objects outside of Clear Recovery Zone

For HSIP Cycle 11 Call-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	All	35%	20 years
Notes:	This CM only applies to crashes occurring within the limits of the new clear recovery zone (per Caltrans' HDM).		
General information			
Where to use:			
Known locations or roadway segments prone to collisions with fixed objects such as utility poles, drainage structures, trees, and other fixed objects, such as the outside of a curve, end of lane drops, and in traffic islands. A clear recovery zone should be developed on every roadway, as space is available. In situations where public right-of-way is limited, steps should be taken to request assistance from property owners, as appropriate.			
Why it works:			
While this strategy does not prevent the vehicle leaving the roadway, it does provide a mechanism to reduce the severity of a resulting crash. A clear zone is an unobstructed, traversable roadside area that allows a driver to stop safely or regain control of a vehicle that has left the roadway. Removing or moving fixed objects, flattening slopes, or providing recovery areas reduces the likelihood of a crash.			
General Qualities (Time, Cost and Effectiveness):			
Projects involving removing fixed objects from highway right-of-way can typically be accomplished quickly, assuming the objects are readily moveable. Clearing objects on private property requires more time for discussions with the property owner. Costs will generally be low, assuming that in most cases the objects to be removed are within the right-of-way. This CMs can be very effective and can be implemented by agencies' maintenance staff and/or implemented on a systematic approach. High-cost removals or removals implemented using a systematic approach would be good candidates for Caltrans Federal Safety Funding.			
FHWA CMF Clearinghouse:	Crash Types Addressed:	Fixed Object	CRF: 17 - 100 %

R03, Install Median Barrier

For HSIP Cycle 11 Call-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	All	25%	20 years
Notes:	Note: For Caltrans' statewide Calls-for-Projects, this CM only applies to crashes occurring within the limits of the new barrier.		
General information			
Where to use:			
Areas where crash history indicates drivers are unintentionally crossing the median and the cross-overs are resulting in high severity crashes. The installation of median barriers can increase the number of PDO and non-severe injuries. The net result in safety from this countermeasure is connected more to reducing the severity of crashes not the number of crashes. It is recommended to review the warrants as outlined in Chapter 7 of the Caltrans Traffic Manual when considering whether to install median barriers.			
Why it works:			
This strategy is designed to prevent head-on collisions by providing a barrier between opposing lanes of traffic. The variety of median barriers available makes it easier to choose a site-specific solution. The main advantage is the reduction of the severity of the crashes. The key to success would be in selecting an appropriate barrier based on the site, previous crash history, maintenance needs, and median width.			
General Qualities (Time, Cost and Effectiveness):			
This strategy would in many cases be possible to implement within a short period after site selection. Costs will vary depending on the type of median barrier selected and whether the strategy is implemented as a stand-alone project or incorporated as part of a reconstruction or resurfacing effort. Maintenance costs and worker exposure will also vary depending on the type of barrier selected. The expected effectiveness of this CM must be assessed for each individual location.			
FHWA CMF Clearinghouse:	Crash Types Addressed:	Head-on	CRF: 0 - 94 %

R04, Install Guardrail

For HSIP Cycle 11 Call-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	All	25%	20 years
Notes:	This CM only applies to crashes occurring within the limits of the new guardrail. This CM is not intended to be used for general maintenance activities (i.e. the replacement of existing damaged rail). For projects proposing to upgrade existing guardrail to current standards, this CM and corresponding CRF should only be applied to locations where past crash data or engineering judgment applied to the existing rail conditions suggests the upgraded guardrail may result in fewer or less severe crashes (justifying the use of the 25% CRF for this CM).		
General information			
Where to use:			
Guardrail is installed to reduce the severity of lane departure crashes. However, guardrail can reduce crash severity only for those conditions where striking the guardrail is less severe than going down an embankment or striking a fixed object. Guardrail should only be installed where it is clear that crash severity will be reduced, or there is a history of run-off-the-road crashes at a given location that have resulted in severe crashes. New and upgraded guardrail and end-treatments must meet current safety standards; see Method for Assessing Safety Hardware (MASH) for more information. Caltrans (or other national accepted guidance) slope/height criteria need to be considered and documented.			
Why it works:			
Guardrail redirects a vehicle away from embankment slopes or fixed objects and dissipates the energy of an errant vehicle.			
General Qualities (Time, Cost and Effectiveness):			
Strategies range from relatively inexpensive too costly. Costly projects may include those that upgrade existing guardrail applications to more semi-rigid and rigid barrier systems over extended distances. In general, this CMs can be effective and can be implemented by agencies' maintenance staff and/or implemented on a systematic approach.			
FHWA CMF Clearinghouse:	Crash Types Addressed:	Fixed Object, Run-off Road	CRF: 11 - 78 %

R05, Install impact attenuators

For HSIP Cycle 11 Call-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	All	25%	10 years
Notes:	This CM only applies to crashes occurring within the limits of the new attenuators. This CM is not intended to be used for general maintenance activities (i.e. the replacement of existing damaged attenuators). For projects proposing to upgrade existing attenuators to current standards, this CM and corresponding CRF should only be applied to locations where past crash data or engineering judgment applied to the existing attenuator conditions suggests the upgraded attenuators may result in fewer or less severe crashes (justifying the use of the 25% CRF for this CM).		
General information			
Where to use:			
Impact attenuators are typically used to shield rigid roadside objects such as concrete barrier ends, steel guardrail ends and bridge pillars from oncoming automobiles. Attenuators should only be installed where it is impractical for the objects to be removed. New and upgraded barrier end-treatments must meet current safety standards; see MASH for more information.			
Why it works:			
Attenuators bring an errant vehicle to a more-controlled stop or redirect the vehicle away from a rigid object. Attenuators are effective at absorbing impact energy and increasing occupant safety. They also tend to draw attention to the fixed object, which helps drivers steer clear of the fixed objects.			
General Qualities (Time, Cost and Effectiveness):			
Costs depending on the scope of the project, type(s) used, and associated ongoing maintenance costs. Time to install is fairly quick once site is identified.			
FHWA CMF Clearinghouse:	Crash Types Addressed:	Fixed Object, Run-off Road	CRF: 5 - 50 %

R06, Flatten side slopes

For HSIP Cycle 11 Call-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	All	30%	20 years
Notes:	This CM only applies to crashes occurring within the limits of the new side slopes. Minor/incidental flattening of side slopes would not likely result in the CRF shown below and may not be appropriate for use in Caltrans B/C calculations.		
General information			
Where to use:			
Roadways experiencing frequent lane departure crashes that result in roll-over type crashes as a result of the roadway slope being so severe as to not accommodate a reasonable degree of driver correction. When there is a need to reduce the severity of lane departure crashes without installing a barrier system that could result in increased numbers of crashes.			
Why it works:			
Flattened slopes provide a greater area for a driver to regain control of a vehicle. Steep slopes, ditches or unprotected hazardous drops-offs adjacent to a travel lane offer little opportunities to correct an inappropriate action by a driver and can result in severe crashes.			
General Qualities (Time, Cost and Effectiveness):			
Roadside modifications range from relatively inexpensive to very costly. Strategies that include creating safer side slopes where none exists can be moderately expensive based on the scope of the project and the associated clearing, grading, etc. The potential for high environmental and right-of-way impacts is high which can take several years to clear. In other cases This CM can be effective and can be implemented by agencies' maintenance staff and/or implemented on a systematic approach.			
FHWA CMF Clearinghouse:	Crash Types Addressed:	Fixed Object, Run-off Road	CRF: 5 - 62 %

R07, Flatten side slopes and remove guardrail

For HSIP Cycle 11 Call-for-projects					
Funding Eligibility		Crash Types Addressed		CRF	Expected Life
90%		All		40%	20 years
Notes:	This CM only applies to crashes occurring within the limits of both the removed guardrail and the new side slopes.				
General information					
Where to use:					
Locations where high number of crashes originate as a lane departure and result in collision with guardrail or a fixed object located on the side slope shielded by guardrail. The guardrail may or may not meet current standards. Even though guardrails are generally installed to reduce the severity of departure crashes, they still can result in severe crashes in some locations.					
Why it works:					
Flattened side slopes and an unobstructed clear zone provide a greater area for a driver to regain control of a vehicle. The existing guardrail may help protect the steep slopes, fixed objects, or unprotected hazardous drops-offs adjacent to a travel lane, but removing all of these obstacles generally improves safety.					
General Qualities (Time, Cost and Effectiveness):					
Roadside modifications range from relatively inexpensive to very costly. Strategies that include creating safer side slopes where none exists can be moderately expensive based on the scope of the project and the associated clearing, grading, etc. The potential for high environmental and right-of-way impacts is high which can take several years to clear.					
FHWA CMF Clearinghouse:	Crash Types Addressed:	Roll Over, Fixed Object	CRF:	42%	

R08, Install raised median

For HSIP Cycle 11 Call-for-projects					
Funding Eligibility		Crash Types Addressed		CRF	Expected Life
90%		All		25%	20 years
Notes:	This CM only applies to crashes occurring within the limits of the new raised median. All new raised medians funded with federal HSIP funding should not include the removal of the existing roadway structural section and should be doweled into the existing roadway surface. This requirement is being implemented to maximize the safety-effectiveness of the limited HSIP funding and to minimize project impacts. Landscaping, if included in the project, is considered non-participating.				
General information					
Where to use:					
Areas experiencing head-on collisions that may be affected by both the number of vehicles that cross the centerline and by the speed of oncoming vehicles. Installing a raised median is a more restrictive approach in that it represents a more rigid barrier between opposing traffic. Application of raised medians on roadways with higher speeds is not advised - instead a median barrier should be considered. Including landscaping in new raised medians can be counterproductive to the HSIP safety goals and should only be done in ways that do not increase drivers' exposure to fixed objects and that will maintain driver's sight distance needs throughout the life of the proposed landscaping. Agencies need to consider and document impacts of additional turning movements at nearby intersections.					
Why it works:					
Adding raised medians is a particularly effective strategy as it adds to or reallocates the existing cross section to incorporate a buffer between the opposing travel lanes and reinforces the limits of the travel lane. Raised median may also be used to limit unsafe turning movements along a roadway.					
General Qualities (Time, Cost and Effectiveness):					
In some cases this strategy may be a retrofit into the existing roadway by utilizing a portion of the existing paved shoulder. These raised medians can be installed directly over the existing pavement. Cost and time to implement could significantly increase if the paved area is not sufficient to include a median. The surface treatment of the raised median also significantly affects their cost-effectiveness: standard concrete or other hardscape surfaces are usually more cost effective than landscaped medians. When agencies opt to install landscaping in conjunction with new raised medians, the project design and construction costs can significantly increase due to excavation, backfill/top-soil, water-connection, irrigation, planting, maintenance needed for the landscaping. When agencies opt to install landscaping in conjunction with new raised medians, the portion of the cost for landscaping and other non-safety related items that exceeds 10% of the project total cost is not federally participated and must be funded by the applicant.					
FHWA CMF Clearinghouse:	Crash Types Addressed:	Head-on	CRF:	20 - 75 %	

R09, Install median (flush)

For HSIP Cycle 11 Call-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	All	15%	20 years
Notes:	This CM only applies to crashes occurring within the limits of the new flush median. The new median must be a minimum of 4 feet wide (or "wider" if a narrow median exists before the proposed project).		
General information			
Where to use:			
Areas experiencing head-on collisions that may be affected by both the number of vehicles that cross the centerline and by the speed of oncoming vehicles. Roadways with oversized lanes offer an opportunity to restripe the roadway to reduce the lanes to standard widths and use the extra width for the median.			
Why it works:			
Adding medians is a particularly effective strategy as it adds to or reallocates the existing cross section to incorporate a narrow buffer median between opposing flows, thereby providing a greater opportunity to correct an errant maneuver and further reinforce the limits of the travel lane. Application widths can vary based on the available cross section and intended application. Additional safety can be provided by combining this CM with rumble strips.			
General Qualities (Time, Cost and Effectiveness):			
In some cases this strategy may be retrofitted into the existing roadway by utilizing a portion of the existing paved shoulder and can ultimately be as simple as restriping the roadway. Costs and time to implement could significantly increase if the paved area is not sufficient to include a median.			
FHWA CMF Clearinghouse:	Crash Types Addressed:	All	CRF: 15 - 78 %

R10PB, Install pedestrian median fencing

For HSIP Cycle 11 Call-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	Pedestrian and Bicycle	35%	20 years
Notes:	This CM only applies to "Ped & Bike" crashes occurring on the approaches/influence area of the new pedestrian median fencing.		
General information			
Where to use:			
Roadway segments with high pedestrian-generators and pedestrian-destinations nearby (e.g. transit stops) may experience a high volume of pedestrians J-walking across the travel lanes at mid-block locations instead of walking to the nearest intersection or designated mid-block crossing. When this safety issue cannot be mitigated with shoulder, sidewalk and/or crossing treatments, then installing a continuous pedestrian barrier in the median may be a viable solution.			
Why it works:			
Adding pedestrian median fencing has the opportunity to enhance pedestrian safety at locations noted as being problematic involving pedestrians running/darting across the roadway outside designated pedestrian crossings. Pedestrian median fencing can significantly reduce this safety issue by creating a positive barrier, forcing pedestrians to the designated pedestrian crossing.			
General Qualities (Time, Cost and Effectiveness):			
Costs associated with this strategy will vary widely depending on the type and placement of the median fencing. Impacts to transit and other land uses may need to be considered and controversy can delay the implementation. In general, this CM can be effective as a spot-location approach.			
FHWA CMF Clearinghouse:	Crash Types Addressed:	Pedestrian, Bicycle	CRF: 25 - 40%

R11, Install acceleration/ deceleration lanes

For HSIP Cycle 11 Call-for-projects					
Funding Eligibility		Crash Types Addressed		CRF	Expected Life
90%		All		25%	20 years
Notes:	This CM only applies to crashes occurring within the limits of the new accel/decel lanes on high speed roadways. Significant improvements to the merge length for lane-drop locations is also an acceptable use of this CM.				
General information					
Where to use:					
Areas proven to have crashes that are the result of drivers not being able to turn onto a high speed roadway to accelerate until the desired roadway speed is reached and areas that do not provide the opportunity to safely decelerate to negotiate a turning movement. This CM can also be used to improve the safety of merging vehicles at a lane-drop location.					
Why it works:					
A lane that does not provide enough deceleration length and storage space for turning traffic may cause the turn queue to back up into the adjacent through lane. This can contribute to rear-end and sideswipe crashes. An acceleration lane is an auxiliary or speed-change lane that allows vehicles to accelerate to highway speeds (high speed roadways) before entering the through-traffic lanes of a highway. Additionally, if acceleration by entering traffic takes place directly on the traveled way, it may disrupt the flow of through-traffic and cause rear-end and sideswipe collisions.					
General Qualities (Time, Cost and Effectiveness):					
Costs are highly variable. Where sufficient median or shoulder space exists it may be possible to provide acceleration/deceleration lanes at a moderate cost. Where the roadway must be widened and additional right-of-way must be acquired, higher costs and a lengthy time-to-construct are likely. The expected effectiveness of this CM must be assessed for each individual location.					
FHWA CMF Clearinghouse:	Crash Types Addressed:	Sideswipe, Rear-End	CRF:	10 - 75 %	

R12, Widen lane (initially less than 10 ft)

For HSIP Cycle 11 Call-for-projects					
Funding Eligibility		Crash Types Addressed		CRF	Expected Life
90%		All		25%	20 years
Notes:	Note: For Caltrans' statewide Calls-for-Projects, this CM only applies to crashes occurring within the limits of the widened lanes. Widening must a minimum of 1 foot.				
General information					
Where to use:					
Horizontal curves or tangents and low speed or high speed roadways identified as having lane departure crashes, sideswipe or head-on crashes that can be attributed to an existing pavement width less than 10 feet.					
Why it works:					
Increasing pavement width can affect almost all crash types. A common practice is to widen the traveled way on horizontal curves to make operating conditions on curves comparable to those on tangents. Speed is a primary consideration when evaluating potential adverse impacts of lane width on safety. On high-speed, rural two-lane highways, an increased risk of cross-centerline head-on or cross-centerline sideswipe crashes is a concern because drivers may have more difficulty staying within the travel lane.					
General Qualities (Time, Cost and Effectiveness):					
Costs will depend on the amount of reconstruction necessary and on whether additional right-of-way is required. In general, this is one of the higher-cost strategies recommended, but it can also be very beneficial. Since this is a relatively expensive treatment, one of the keys to creating a cost effective project with at least a medium B/C ratio is targeting higher-hazard roadways.					
FHWA CMF Clearinghouse:	Crash Types Addressed:	All	CRF:	5 - 70 %	

R13, Add two-way left-turn lane

For HSIP Cycle 11 Call-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	All	30%	20 years
Notes:	This CM only applies to crashes occurring within the limits of the new lane, where an existing median did not already exist.		
General information			
Where to use:			
Roadways having a high frequency of drivers being rear-ended while attempting to make a left turn across oncoming traffic. Also can be effective for drivers crossing the centerline of an undivided multilane roadway inadvertently.			
Why it works:			
Two-way left-turn lanes provide a buffer between opposing directions of travel and separate left turning traffic from through traffic. They can also help to allow vehicles to begin to accelerate before entering the through-traffic lanes. They reduce the disruption of flow of through-traffic and reducing rear-end and sideswipe collisions. For some roadways the option of converting a four-lane undivided arterials to two-vehicle-lane roadways with a center left-turn lane and bike lanes should be considered (see "Road Diet" CM.)			
General Qualities (Time, Cost and Effectiveness):			
In some cases this strategy may be retrofitted into the existing roadway by utilizing a portion of the existing paved shoulder and can ultimately be as simple as restriping the roadway. Costs and time to implement could significantly increase if the paved area is not sufficient to include a median, requiring new right-of-way, and having significant environmental impacts. The expected effectiveness of this CM must be assessed for each individual location as the B/C ratios will vary from low to high.			
FHWA CMF Clearinghouse:	Crash Types Addressed:	All	CRF: 8 - 50 %

R14, Road Diet (Reduce travel lanes and add a two way left-turn and bike lanes)

For HSIP Cycle 11 Call-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	All	35%	20 years
Notes:	This CM only applies to crashes occurring within the limits of the new lane striping. "Intersection" crashes can only be applied when they resulted from turning movements that had no designated turn lanes/phases in the existing condition and the Road Diet will provide turn lanes/phases for these movements. This CM does not apply to roadway sections that already included left turn lanes or two way left turn lanes before the lane reductions. New bike lanes are also expected to be part of these projects. If any pavement is planned to be removed for the purpose of adding landscaping, planter-boxes, or other non-roadway user features, the cost should be non-participating.		
General information			
Where to use:			
Areas noted as having a higher frequency of head-on, left-turn, and rear-end crashes with traffic volumes that can be handled by only 2 free flowing lanes. Using this strategy in locations with traffic volumes that are too high could result in diversion of traffic to routes less safe than the original four-lane design. It may also result in congestion levels that contribute to other crashes.			
Why it works:			
The application of this strategy usually reduces the roadway segment speeds and serious head-on crashes. In many cases the extra pavement width can be used for the installation of bike lanes. In addition to increasing bicycle safety, these bike lanes can improve the safety of on-street parking.			
General Qualities (Time, Cost and Effectiveness):			
Implementation would require more time than in other low-cost treatments to complete environmental analyses, traffic studies and public input. Projects that only require new lane markings and minor signalization modifications will have relatively low cost and can be very effective and can be considered on a systematic approach. These striping and signal modification costs should be considered part of this CM and not an additional CM. (If additional signal hardware improvements are being made, over what is needed for the road diet, then the Improve Signal Hardware CM may also be used.) Often road diet projects need a seal-coat placed on the roadway to fully remove the old striping. These seal coats are considered part of the proper installation of this CM. In contrast, structural-overlays should not be considered part of this CM and are not considered eligible for funding in the California Local HSIP.			
FHWA CMF Clearinghouse:	Crash Types Addressed:	All	CRF: 26 - 43 %

R15, Widen shoulder

For HSIP Cycle 11 Call-for-projects					
Funding Eligibility		Crash Types Addressed		CRF	Expected Life
90%		All		30%	20 years
Notes:	This CM only applies to crashes occurring within the limits of the new paved shoulder. A minimum of 2 feet width must be added and the new/resulting shoulders must be a minimum of 4 feet wide. This CM is not eligible unless it is done as the last step of an "incremental approach", for which the agency documents that: 1) they have already pursued and installed lower cost and lower impact CMs (i.e. signing/stripping upgrades to MUTCD standards/recommendations, rumble strips, etc.), 2) they have already monitored the crash occurrences after these improvements were installed, and 3) the 'after' crash rate is still unacceptably high. This 'incremental approach' (or a special exception from the HSIP program manager) must be documented in the Narrative Questions in the application and a summary of the 'before' and 'after' crash analysis must be attached to the application.				
General information					
Where to use:					
Roadways that have a frequent incidence of vehicles leaving the travel lane resulting in an unsuccessful attempt to reenter the roadway. The probability of a safe recovery is increased if an errant vehicle is provided with an increased paved area in which to initiate such a recovery.					
Why it works:					
Based on the best available research, adding shoulder or widening an existing shoulder provides a greater area to regain control of a vehicle, as well as lateral clearance to roadside objects such as guardrail, signs and poles. They may also provide space for disabled vehicles to stop or drive slowly, provide increased sight distance for through vehicles and for vehicles entering the roadway, and in some cases reduce passing conflicts between motor vehicles and bicyclists and pedestrians. The likely safety benefits for adding or widening an existing shoulder generally increase as the widening width increases - practitioners should refer to NCHRP Report 500 Series, the CMF Clearinghouse or other references for more details.					
General Qualities (Time, Cost and Effectiveness):					
Shoulder widening costs would depend on whether new right-of-way is required and whether extensive roadside modification is needed. Since shoulder widening can be a relatively expensive treatment, one of the keys to creating a cost effective project with at least a medium B/C ratio is targeting higher-hazard roadways.					
FHWA CMF Clearinghouse:	Crash Types Addressed:	Fixed Object, Run-off Road, Sideswipe	CRF:	15 - 75 %	

R16, Curve Shoulder widening (Outside Only)

For HSIP Cycle 11 Call-for-projects					
Funding Eligibility		Crash Types Addressed		CRF	Expected Life
90%		All		45%	20 years
Notes:	This CM only applies to crashes occurring within the limits (or influence area) of the new shoulder widening at curves. A minimum of 2-4 feet width must be added to the outside of horizontal curves and the new traversable shoulder must be a minimum of 4 feet wide.				
General information					
Where to use:					
Roadway curves noted as having frequent lane departure crashes due to inadequate or no shoulders, resulting in an unsuccessful attempt to reenter the roadway.					
Why it works:					
Adding shoulders (outside only) creates a recovery area in which a driver can regain control of a vehicle, as well as lateral clearance to roadside objects.					
General Qualities (Time, Cost and Effectiveness):					
To minimize the R/W needs and the cost, only outside shoulder at curves is to be widened. This CM can be implemented in a relatively short timeframe.					
FHWA CMF Clearinghouse:	NA				

R17, Improve horizontal alignment (flatten curves)

For HSIP Cycle 11 Call-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	All	50%	20 years
Notes:	This CM only applies to crashes occurring within the limits (or influence area) of the improved alignment. This CM is not eligible unless it is done as the last step of an "incremental approach", including: the agency documents that: 1) they have already pursued and installed lower cost and lower impact CMs (i.e. signing/stripping upgrades to MUTCD standards/recommendations, rumble strips, etc.), 2) they have already monitored the crash occurrences after these improvements were installed, and 3) the 'after' crash rate is still unacceptably high. This 'incremental approach' (or a special exception from the HSIP program manager) must be documented in the Narrative Questions in the application and a summary of the agency's 'before' and 'after' crash analysis must be attached to the application.		
General information			
Where to use:			
Roadways with horizontal curves that have experienced lane departure crashes as a result of a roadway segment having compound curves or a severe radius. This strategy should generally be considered only when less expensive strategies involving clearing of specific sight obstructions or modifying traffic control devices have been tried and have failed to ameliorate the crash patterns.			
Why it works:			
Increasing the radius of a horizontal curve can be very effective in improving the safety performance of the curve. Curve modification reduces the likelihood of a vehicle leaving its lane, crossing the roadway centerline, or leaving the roadway at a horizontal curve; and minimizes the adverse consequences of leaving the roadway. Horizontal alignment improvement projects are expected to include standard/improved superelevation elements, which should be considered part of this CM and not an additional CM.			
General Qualities (Time, Cost and Effectiveness):			
This strategy is a long-term, higher-cost alternative for improving the safety of a horizontal curve because it usually involves total reconstruction of the roadway. It may also require acquisition of additional right-of-way and an environmental review. This strategy, albeit costly, has shown that increasing the radius of curvature can significantly reduce total curve-related crashes by up to 80 percent. The expected effectiveness of this CM must be assessed for each individual location.			
FHWA CMF Clearinghouse:	Crash Types Addressed:	All	CRF: 24 - 90%

R18, Flatten crest vertical curve

For HSIP Cycle 11 Call-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	All	25%	20 years
Notes:	This CM only applies to crashes occurring within the limits (or influence area) of the improved alignment. This CM is not eligible unless it is done as the last step of an "incremental approach", including: the agency documents that: 1) they have already pursued and installed lower cost and lower impact CMs (i.e. signing/stripping upgrades to MUTCD standards/recommendations, rumble strips, etc.), 2) they have already monitored the crash occurrences after these improvements were installed, and 3) the 'after' crash rate is still unacceptably high. This 'incremental approach' (or a special exception from the HSIP program manager) must be documented in the Narrative Questions in the application and a summary of the agency's 'before' and 'after' crash analysis must be attached to the application.		
General information			
Where to use:			
The target for this strategy is usually unsignalized intersections with restricted sight distance due to vertical geometry and with patterns of crashes related to that lack of sight distance that cannot be ameliorated by less expensive methods. This strategy should generally be considered only when less expensive strategies involving clearing of specific sight obstructions or modifying traffic control devices have been tried and have failed to ameliorate the crash patterns.			
Why it works:			
Adequate sight distance for drivers at stopped approaches to intersections has long been recognized as among the most important factors contributing to overall intersection safety. Vertical alignment improvement projects are expected to include standard/improved superelevation elements, which should be considered part of this CM and not an additional CM.			
General Qualities (Time, Cost and Effectiveness):			
Projects involving changing the horizontal and/or vertical alignment to provide more sight distance are quite extensive and usually take several years to accomplish. If additional right-of-way is required or environmental impacts are expected, these projects will require a substantial period of time. Since this is usually an expensive treatment, one of the keys to creating a cost effective project with at least a medium B/C ratio is targeting higher-hazard locations.			
FHWA CMF Clearinghouse:	Crash Types Addressed:	All	CRF: 20 - 51 %

R19, Improve curve superelevation

For HSIP Cycle 11 Call-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	All	45%	20 years
Notes:	This CM only applies to crashes occurring within the limits (or influence area) of the improved superelevation. This CM does not apply to sections of roadways where the horizontal or vertical alignments are changing via another CM.		
General information			
Where to use:			
Roadways noted as having frequent lane departure crashes and inadequate or no superelevation. Safety can be enhanced when the superelevation is improved or restored along curves where the actual superelevation is less than the optimal.			
Why it works:			
Superelevation works with friction between the tires and pavement to counteract the forces on the vehicle associated with cornering. Many curves may have inadequate superelevation because of vehicles traveling at higher speeds than were originally designed for, because of loss of effective superelevation after resurfacing, or because of changes in design policy after the curve was originally constructed.			
General Qualities (Time, Cost and Effectiveness):			
This strategy can be a higher-cost alternative for improving the safety of a curve because it involves reconstruction to some degree. Other projects may be able to be constructed by simple overlays and minimal reconstruction of roadway features. When simple overlay fixes are pursued, a systematic installation approach may be appropriate. The expected effectiveness of this CM must be assessed for each individual location.			
FHWA CMF Clearinghouse:	Crash Types Addressed:	Run-off Road, All	CRF: 40 - 50 %

R20, Convert from two-way to one-way traffic

For HSIP Cycle 11 Call-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	All	35%	20 years
Notes:	This CM only applies to crashes occurring within the limits of the new one-way sections.		
General information			
Where to use:			
One-way streets can offer improved signal timing and accommodate odd-spaced signals. One-way streets can simplify crossings for pedestrians, who must look for traffic in only one direction. While studies have shown that conversion of two-way streets to one-way generally reduces pedestrian crashes and the number of conflict points, one-way streets tend to have higher speeds which creates new problems. Care must be taken not to create conditions that cause driver confusion and erratic maneuvers.			
Why it works:			
Studies have shown a 10 to 50-percent reduction in total crashes after conversion of a two-way street to one-way operation. While studies have shown that conversion of two-way streets to one-way generally reduces pedestrian crashes, one-way streets tend to have higher speeds which creates new problems. At the same time, this strategy (1) increases capacity significantly and (2) can have safety-related drawbacks including pedestrian confusion and minor sideswipe crashes.			
General Qualities (Time, Cost and Effectiveness):			
The costs will vary depending on length of treatment and if the conversion requires modification to signals. Conversion costs can be high to build "crossovers" where the one-way streets convert back to two-way streets and to rebuild traffic signals. It's also likely that these types of modifications will require public involvement and could significantly add to the time it takes to complete the project. The expected effectiveness of this CM must be assessed for each individual location.			
FHWA CMF Clearinghouse:	Crash Types Addressed:	All	CRF: 26 - 43 %

R21, Improve pavement friction (High Friction Surface Treatments)

For HSIP Cycle 11 Call-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	All	55%	10 years
Notes:	This CM only applies to crashes occurring within the limits of the improved friction overlay. This CM is not intended to apply to standard chip-seal or open-graded maintenance projects for long segments of corridors or structure repaving projects intended to fix failed pavement.		
General information			
Where to use:			
Nationally, this countermeasure is referred to as "High Friction Surface Treatments" or HFST. Areas as noted having crashes on wet pavements or under dry conditions when the pavement friction available is significantly less than actual roadway speeds; including but not limited to curves, loop ramps, intersections, and areas with short stopping or weaving distances. This treatment is intended to target locations where skidding is determined to be a problem, in wet or dry conditions and the target vehicle is one that runs (skids) off the road or is unable to stop due to insufficient skid resistance.			
Why it works:			
Improving the skid resistance at locations with high frequencies of wet-road crashes and/or failure to stop crashes can result in a reduction of 50 percent for wet-road crashes and 20 percent for total crashes. Applying HFST can double friction numbers, e.g. low 40s to high 80s. This CM represents a special focus area for both FHWA and Caltrans, which means there are extra resources available for agencies interested in more details on High Friction Surface Treatment projects.			
General Qualities (Time, Cost and Effectiveness):			
This strategy can be relatively inexpensive and implemented in a short timeframe. The installation would be done by either agency personnel or contractors and can be done by hand or machine. In general, This CM can be very effective and can be considered on a systematic approach.			
FHWA CMF Clearinghouse:	Crash Types Addressed:	Wet, Rear-End, All	CRF: 17 - 68 %

R22, Install/Upgrade signs with new fluorescent sheeting (regulatory or warning)

For HSIP Cycle 11 Call-for-projects				
Funding Eligibility	Crash Types Addressed		CRF	Expected Life
90%	All		15%	10 years
Notes:	This CM only applies to crashes occurring within the influence area of the new/upgraded signs. This CM is not intended for maintenance upgrades of street-name, parking, guide, or any other signs without a primary focus on roadway safety. This CM is not eligible unless it is done as part of a larger sign audit project, including the study of: 1) the existing signs' locations, sizes and information per MUTCD standards, 2) missing signs per MUTCD standards, and 3) sign retroreflectivity. The overall sign audit scope (or a special exception from the HSIP program manager) must be documented in the Narrative Questions in the application. Based on the scope of the project/audit, it may be appropriate to combine other CMs in the B/C calculation.			
General information				
Where to use:				
The target for this strategy should be on roadway segments with patterns of head on, nighttime, non-intersection, run-off road, and sideswipe crashes related to lack of driver awareness of the presence of a specific roadway feature or regulatory requirement. Ideally this type of safety CM would be combined with other sign evaluations and upgrades (install chevrons, warning signs, delineators, markers, beacons, and relocation of existing signs per MUTCD standards.)				
Why it works:				
This strategy primarily addresses crashes caused by lack of driver awareness (or compliance) roadway signing. It is intended to get the drivers attention and give them a visual warning by using fluorescent yellow sheeting (or other retroreflective material).				
General Qualities (Time, Cost and Effectiveness):				
Signing improvements do not require a long development process and can typically be implemented quickly. Costs for implementing this strategy are nominal and depend on the number of signs. When considered at a single location, these low cost improvements are usually funded through local funding by local maintenance crews. However, This CM can be effectively and efficiently implemented using a systematic approach with numerous locations, resulting in moderate cost projects that are more appropriate to seek state or federal funding. When considering any type of federally funded sign upgrade project, California local agencies are encouraged to consider "Roadway Safety Signing Audit (RSSA) and Upgrade Projects". Including RSSAs in the development phase of sign projects are expected to identify non-standard (per MUTCD) sign features and missing signs that may otherwise go unnoticed. More information on RSSA is available on the Local Assistance HSIP webpage.				
FHWA CMF Clearinghouse:	Crash Types Addressed:	Head on, Run-off road, Sideswipe, Night	CRF:	18 - 35%

R23, Install chevron signs on horizontal curves

For HSIP Cycle 11 Call-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	All	40%	10 years
Notes:	This CM only applies to crashes occurring within the influence area of the new signs. (i.e. only through the curve).		
General information			
Where to use:			
Roadways that have an unacceptable level of crashes on relatively sharp curves during periods of light and darkness. Ideally this type of safety CM would be combined with other sign evaluations and upgrades (install warning signs, delineators, markers, beacons, and relocation of existing signs per MUTCD standards.)			
Why it works:			
Post-mounted chevrons are intended to warn drivers of an approaching curve and provide tracking information and guidance to the drivers. While they are intended to act as a warning, it should also be remembered that the posts, placed along the roadside, represent a possible object with which an errant vehicle can crash into. Design of posts to minimize damage and injury is an important part of the considerations to be made when selecting these treatments.			
General Qualities (Time, Cost and Effectiveness):			
Signing improvements do not require a long development process and can typically be implemented quickly. Costs for implementing this strategy are nominal and depend on the number of signs. When considered at a single location, these low cost improvements are usually funded through local funding by local maintenance crews. However, This CM can be effectively and efficiently implemented using a systematic approach with numerous locations, resulting in moderate cost projects that are more appropriate to seek state or federal funding. When considering any type of federally funded sign upgrade project, California local agencies are encouraged to consider "Roadway Safety Signing Audit (RSSA) and Upgrade Projects". Including RSSAs in the development phase of sign projects are expected to identify non-standard (per MUTCD) sign features and missing signs that may otherwise go unnoticed. More information on RSSA is available on the Local Assistance HSIP webpage.			
FHWA CMF Clearinghouse:	Crash Types Addressed:	Run-off Road, All	CRF: 6 - 64 %

R24, Install curve advance warning signs

For HSIP Cycle 11 Call-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	All	25%	10 years
Notes:	This CM only applies to crashes occurring within the influence area of the new signs. (i.e. only through the curve)		
General information			
Where to use:			
Roadways that have an unacceptable level of crashes on relatively sharp curves during periods of light and darkness. This countermeasure may also include horizontal alignment and/or advisory speed warning signs. Ideally this type of safety CM would be combined with other sign evaluations and upgrades (install warning signs, chevrons, delineators, markers, beacons, and relocation of existing signs per MUTCD standards.)			
Why it works:			
This strategy primarily addresses problem curves, and serves as an advance warning of an unexpected or sharp curve. It provides advance information and gives drivers a visual warning that their added attention is needed.			
General Qualities (Time, Cost and Effectiveness):			
Signing improvements do not require a long development process and can typically be implemented quickly. Costs for implementing this strategy are nominal and depend on the number of signs. When considered at a single location, these low cost improvements are usually funded through local funding by local maintenance crews. However, This CM can be effectively and efficiently implemented using a systematic approach with numerous locations, resulting in moderate cost projects that are more appropriate to seek state or federal funding. When considering any type of federally funded sign upgrade project, California local agencies are encouraged to consider "Roadway Safety Signing Audit (RSSA) and Upgrade Projects". Including RSSAs in the development phase of sign projects are expected to identify non-standard (per MUTCD) sign features and missing signs that may otherwise go unnoticed. More information on RSSA is available on the Local Assistance HSIP webpage.			
FHWA CMF Clearinghouse:	Crash Types Addressed:	Run-off Road, All	CRF: 20 - 30 %

R25, Install curve advance warning signs (flashing beacon)

For HSIP Cycle 11 Call-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	All	30%	10 years
Notes:	This CM only applies to crashes occurring within the influence area of the new signs. (i.e. only through the curve)		
General information			
Where to use:			
Roadways that have an unacceptable level of crashes on relatively sharp curves. Flashing beacons in conjunction with warning signs should only be used on horizontal curves that have an established severe crash history to help maintain their effectiveness.			
Why it works:			
This strategy primarily addresses problem curves, and serves as an enhanced advance warning of an unexpected or sharp curve. It provides advance information and gives drivers a visual warning that their added attention is needed. Flashing beacons are an added indication that a curve may be particularly challenging.			
General Qualities (Time, Cost and Effectiveness):			
Use of flashing beacons requires minimal development process, allowing flashing beacons to be installed within a short time period. Before choosing this CM, the agency needs to confirm the ability to provide power to the site (solar may be an option). In general, This CM can be very effective and can be considered on a systematic approach.			
FHWA CMF Clearinghouse:	Crash Types Addressed:	All	CRF: 30 %

R26, Install dynamic/variable speed warning signs

For HSIP Cycle 11 Call-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	All	30%	10 years
Notes:	This CM only applies to crashes occurring within the influence area of the new signs. (i.e. through the curve) {This CM does not apply to dynamic regulatory speed warning signs. There are currently no nationally accepted CRFs for dynamic regulatory signs (also known as Radar Speed Feedback Signs). CRFs are being developed and Caltrans hopes to include these CMs and CRFs in future calls for projects.}		
General information			
Where to use:			
Curvilinear roadways that have an unacceptable level of crashes due to excessive speeds on relatively sharp curves.			
Why it works:			
This strategy primarily addresses crashes caused by motorists traveling too fast around sharp curves. It is intended to get the drivers attention and give them a visual warning that they may be traveling over the recommended speed for the approaching curve. Care should be taken to limit the placement of these signs to help maintain their effectiveness.			
General Qualities (Time, Cost and Effectiveness):			
Use of dynamic speed warning signs requires minimal development process, allowing them to be installed within a short time period. Before choosing this CM, the agency needs to confirm the ability to provide power to the site (solar may be an option). In general, This CM can be very effective and can be considered on a systematic approach.			
FHWA CMF Clearinghouse:	Crash Types Addressed:	All	CRF: 0 - 41 %

R27, Install delineators, reflectors and/or object markers

For HSIP Cycle 11 Call-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	All	15%	10 years
Notes:	This CM only applies to crashes occurring within the limits / influence area of the new features. {This is not a striping-related CM}		
General information			
Where to use:			
Roadways that have an unacceptable level of crashes on curves (relatively flat to sharp) during periods of light and darkness. Any road with a history of fixed object crashes is a candidate for this treatment, as are roadways with similar fixed objects along the roadside that have yet to experience crashes. If a fixed object cannot be relocated or made break-away, placing an object marker can provide additional information to motorists. Ideally this type of safety CM would be combined with other sign evaluations and upgrades (install warning signs, chevrons, beacons, and relocation of existing signs per MUTCD standards.)			
Why it works:			
Delineators, reflectors and/or object markers are intended to warn drivers of an approaching curve or fixed object that cannot easily be removed. They are intended to provide tracking information and guidance to the drivers. They are generally less costly than Chevron Signs as they don't require posts to place along the roadside, avoiding an additional object with which an errant vehicle can crash into.			
General Qualities (Time, Cost and Effectiveness):			
These improvements do not require a long development process and can typically be implemented quickly. Costs for implementing this strategy are nominal and depend on the number of locations. When considered at a single location, these low cost improvements are usually funded through local funding by local maintenance crews. However, This CM can be effectively and efficiently implemented using a systematic approach with numerous locations, resulting in low to moderate cost projects that are more appropriate to seek state or federal funding. When considering any type of federally funded sign upgrade project, California local agencies are encouraged to consider "Roadway Safety Signing Audit (RSSA) and Upgrade Projects". Including RSSAs in the development phase of sign projects are expected to identify non-standard (per MUTCD) sign features and missing signs that may otherwise go unnoticed. More information on RSSA is available on the Local Assistance HSIP webpage.			
FHWA CMF Clearinghouse:	Crash Types Addressed:	All	CRF: 0 - 30 %

R28, Install edge-lines and centerlines

For HSIP Cycle 11 Call-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	All	25%	10 years
Notes:	This CM only applies to crashes occurring within the limits of the new centerlines and/or edge-lines. This CM is not intended to be used for general maintenance activities (i.e. the replacement of existing striping and RPMs in-kind) and must include upgraded safety features over the existing striping. For two lane roadways allowing passing, a striping audit must be done to ensure the passing limits meeting the MUTCD standards. Both the centerline and edge-lines are expected to be upgraded, unless prior approval is granted by Caltrans staff in writing and attached to application.		
General information			
Where to use:			
Any road with a history of run-off-road right, head-on, opposite-direction-sideswipe, or run-off-road-left crashes is a candidate for this treatment - install where the existing lane delineation is not sufficient to assist the motorist in understanding the existing limits of the roadway. Depending on the width of the roadway, various combinations of edge line and/or center line pavement markings may be the most appropriate. Incorporating raised/reflective pavement markers (RPMs) into centerlines (and edge-lines) should be considered as it has been shown to improve safety.			
Why it works:			
Installing edge-lines and centerlines where none exists or making significant upgrades to existing lines (paint to thermoplastic, adding audible disks/bumps in the thermoplastic stripes, or adding RPMs) are intended/designed to help drivers who might leave the roadway because of their inability to see the edge of the roadway along the horizontal edge of the pavement or cross-over the centerline of the roadway into oncoming traffic. New pavement marking products tend to be more durable, are all-weather, more visible, and have a higher retroreflectivity than traditional pavement markings.			
General Qualities (Time, Cost and Effectiveness):			
These improvements do not require a long development process and can typically be implemented quickly. Costs for implementing this strategy are nominal and depend on the number and length of locations. This CM can be effectively and efficiently implemented using a systematic approach with numerous and long locations, resulting in low to moderate cost projects that are more appropriate to seek state or federal funding. When considering any type of federally funded striping upgrade project, California local agencies are encouraged to consider "Roadway Safety Striping Audit and Upgrade Projects". Including wide-scale striping audits in the development phase of striping projects are expected to identify non-standard (per MUTCD) striping/markings features, no-passing zone limits needing adjustment, and missing striping/markings that may otherwise go unnoticed. More information on this concepts is available on the Local Assistance HSIP webpage under an RSSA example document. Note: When federal safety funding is used for these installations in high-wear-locations, the local agency is expected to maintain the improvement for a minimum of 10 years.			
FHWA CMF Clearinghouse:	Crash Types Addressed:	Head-on, Run-off Road, All	CRF: 0 - 44 %

R29, Install no-passing line

For HSIP Cycle 11 Call-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	All	45%	10 years
Notes:	This CM only applies to crashes occurring within the limits of the new or extended no-passing zones.		
General information			
Where to use:			
Roadways that have a high percentage of head-on crashes suggesting that many head-on crashes may relate to failed passing maneuvers. No-passing lines should be installed where drivers "passing sight distance" is not available due to horizontal or vertical obstructions. General restriping projects can be good opportunities to reevaluate and incorporate new no-passing zones limits. The incorporation 'No Passing Zone' pennants should also be considered when reevaluating the limits of no-passing zones. Installing no-passing limits in areas that are not warranted may reduce the overall safety of the corridor as drivers may become frustrated and attempt passing maneuvers at other locations without the necessary sight distance.			
Why it works:			
When the centerline markings do not differentiate between passing and no-passing areas, drivers may have difficulty determining where passing maneuvers can be completed safely. Providing clear and engineered passing and no-passing areas can encourage drivers to wait patiently for safe passing areas and avoid aggressively looking for passing opportunities.			
General Qualities (Time, Cost and Effectiveness):			
These improvements do not require a long development process and can typically be implemented quickly. Costs for implementing this strategy are nominal and depend on the number and length of locations. When considered at a single location, these low cost improvements are usually funded through local funding by local maintenance crews. However, This CM can be effectively and efficiently implemented using a systematic approach with numerous and long locations, resulting in low to moderate cost projects that are more appropriate to seek state or federal funding.			
FHWA CMF Clearinghouse:	Crash Types Addressed:	Head-on, Side-swipe	CRF: 40 - 53%

R30, Install centerline rumble strips/stripes

For HSIP Cycle 11 Call-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	All	20%	10 years
Notes:	This CM only applies to crashes occurring within the limits of the new rumble strips/stripes.		
General information			
Where to use:			
Center Line rumble strips/stripes can be used on virtually any roadway – especially those with a history of head-on crashes. It is recommended that rumble strips/stripes be applied systematically along an entire route instead of only at spot locations. For all rumble strips/stripes, pavement condition should be sufficient to accept milled rumble strips. Care should be taken when considering installing rumble strips in locations with residential land uses or in areas with high bicycle volumes.			
Why it works:			
Rumble strips provide an auditory indication and tactile rumble when driven on, alerting drivers that they are drifting out of their travel lane, giving them time to recover before they depart the roadway or cross the center line. Additionally, rumble strips (pavement marking in the rumble itself) provide an enhanced marking, especially in wet dark conditions.			
General Qualities (Time, Cost and Effectiveness):			
These improvements do not require a long development process and can typically be implemented quickly. Costs for implementing this strategy are nominal and depend on the number and length of locations. This CM can be effectively and efficiently implemented using a systematic approach with numerous and long locations, resulting in moderate cost projects that are more appropriate to seek state or federal funding.			
FHWA CMF Clearinghouse:	Crash Types Addressed:	Head-on, Side-swipe, All	CRF: 15 - 68%

R31, Install edgeline rumble strips/stripes

For HSIP Cycle 11 Call-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	All	15%	10 years
Notes:	This CM only applies to crashes occurring within the limits of the new rumble strips/stripes.		
General information			
Where to use:			
Shoulder and edge line milled rumble strips/stripes should be used on roads with a history of roadway departure crashes. It is recommended that rumble strips/stripes be applied systematically along an entire route instead of only at spot locations. For all rumble strips/stripes, pavement condition should be sufficient to accept milled rumble strips. Special requirements may apply and care should be taken when considering installing rumble strips in locations with residential land uses or in areas with high bicycle volumes.			
Why it works:			
Rumble strips provide an auditory indication and tactile rumble when driven on, alerting drivers that they are drifting out of their travel lane, giving them time to recover before they depart the roadway or cross the center line. Additionally, rumble stripes (pavement marking in the rumble itself) provide an enhanced marking, especially in wet dark conditions.			
General Qualities (Time, Cost and Effectiveness):			
These improvements do not require a long development process and can typically be implemented quickly. Costs for implementing this strategy are nominal and depend on the number and length of locations. This CM can be effectively and efficiently implemented using a systematic approach with numerous and long locations, resulting in moderate cost projects that are more appropriate to seek state or federal funding.			
FHWA CMF Clearinghouse:	Crash Types Addressed:	Run-off Road	CRF: 10 - 41%

R32PB, Install bike lanes

For HSIP Cycle 11 Call-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	Pedestrian and Bicycle	35%	20 years
Notes:	This CM only applies to "Ped & Bike" crashes occurring within the limits of the Class II (not Class III) bike lanes. When an off-street bike-path is proposed that is not adjacent to the roadway, the applicant must document the engineering judgment used to determine which "Ped & Bike" crashes to apply.		
General information			
Where to use:			
Roadway segments noted as having crashes between bicycles and vehicles or crashes that may be preventable with a buffer/shoulder. Most studies suggest that bicycle lanes may provide protection against bicycle/motor vehicle collisions. Striped bike lanes can be incorporated into a roadway when is desirable to delineate which available road space is for exclusive or preferential use by bicyclists.			
Why it works:			
Most studies present evidence that bicycle lanes provide protection against bicycle/motor vehicle collisions. Bicycle lanes provide marked areas for bicyclist to travel along the roadway and provide for more predictable movements for both bicyclist and motorist. Evidence also shows that riding with the flow of vehicular traffic reduces bicyclists' chances of collision with a motor vehicle. Locations with bicycle lanes have lower rates of wrong-way riding. In combination with this CM, better guidance signs and markings for non-motorized and motorized roadway users should be considered, including: sign and markings directing cyclists on appropriate/legal travel paths and signs and markings warning motorists of non-motorized uses of the roadway that should be expected.			
General Qualities (Time, Cost and Effectiveness):			
Adding striped bicycle lanes can range from the simply restriping the roadway and minor signing to projects that require roadway widening, right-of-way, and environmental impacts. It is most cost efficient to create bike lanes during street reconstruction, street resurfacing, or at the time of original construction. The expected effectiveness of this CM must be assessed for each individual location. For simple installation scenarios, This CM can be very effective and can be considered on a systematic approach.			
FHWA CMF Clearinghouse:	Crash Types Addressed:	Pedestrian, Bicycle	CRF: 0 - 53 %

R33PB, Install Separated Bike Lanes

For HSIP Cycle 11 Call-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	Pedestrian and Bicycle	45%	20 years
Notes:	This CM only applies to "Ped & Bike" crashes occurring within the limits of the separated bike lanes. When an off-street bike-path is proposed that is not adjacent to the roadway, the applicant must document the engineering judgment used to determine which "Ped & Bike" crashes to apply.		
General information			
Where to use:			
Separated bikeways are most appropriate on streets with high volumes of bike traffic and/or high bike-vehicle collisions, presumably in an urban or suburban area. Separation types range from simple, painted buffers and flexible delineators, to more substantial separation measures including raised curbs, grade separation, bollards, planters, and parking lanes. These options range in feasibility due to roadway characteristics, available space, and cost. In some cases, it may be possible to provide additional space in areas where pedestrian and bicyclists may interact, such as the parking buffer, or loading zones, or extra bike lane width for cyclists to pass one another.			
Why it works:			
Separated bike lanes provide increased safety and comfort for bicyclists beyond conventional bicycle lanes. By separating bicyclists from motor traffic, "protected" or physically separated bike lanes can offer a higher level of comfort and are attractive to a wider spectrum of the public. Intersections and approaches must be carefully designed to promote safety and facilitate left-turns for bicyclists from the primary corridor to cross street. In combination with this CM, better guidance signs and markings for non-motorized and motorized roadway users should be considered, including: sign and markings directing cyclists on appropriate/legal travel paths and signs and markings warning motorists of non-motorized uses of the roadway that should be expected.			
General Qualities (Time, Cost and Effectiveness):			
The cost of Installing separated bike lanes can be low to medium or high, depending on whether roadway widening, right-of-way and environmental impacts are involved. It is most cost efficient to create bike lanes during street reconstruction, street resurfacing, or at the time of original construction. The expected effectiveness of this CM must be assessed for each individual location.			
FHWA CMF Clearinghouse:	Crash Types Addressed:	Pedestrian, Bicycle	CRF: 3.7 - 100 %

R34PB, Install sidewalk/pathway (to avoid walking along roadway)

For HSIP Cycle 11 Call-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	Pedestrian and Bicycle	80%	20 years
Notes:	This CM only applies to "Ped & Bike" crashes occurring within the limits of the new walkway. This CM is not intended to be used where an existing sidewalk is being replaced with a wider one, unless prior Caltrans approval is included in the application. When an off-street multi-use path is proposed that is not adjacent to the roadway, the applicant must document the engineering judgment used to determine which "Ped & Bike" crashes to apply.		
General information			
Where to use:			
Areas noted as not having adequate or no sidewalks and a history of walking along roadway pedestrian crashes. In rural areas asphalt curbs and/or separated walkways may be appropriate.			
Why it works:			
Sidewalks and walkways provide people with space to travel within the public right-of-way that is separated from roadway vehicles. The presence of sidewalks on both sides of the street has been found to be related to significant reductions in the "walking along roadway" pedestrian crash risk compared to locations where no sidewalks or walkways exist. Reductions of 50 to 90 percent of these types of pedestrian crashes. In combination with this CM, better guidance signs and markings for non-motorized and motorized roadway users should be considered, including: sign and markings directing pedestrians and cyclists on appropriate/legal travel paths and signs and markings warning motorists of non-motorized uses of the roadway that should be expected.			
General Qualities (Time, Cost and Effectiveness):			

Costs for sidewalks will vary, depending upon factors such as width, materials, and existing of curb, gutter and drainage. Asphalt curbs and walkways are less expensive, but require more maintenance. The expected effectiveness of this CM must be assessed for each individual location. These projects can be very effective in areas of high-pedestrian volumes with a past history of crashes involving pedestrians.

FHWA CMF Clearinghouse:	Crash Types Addressed:	Pedestrian, Bicycle	CRF:	65 - 89 %
--------------------------------	------------------------	---------------------	------	-----------

R35PB, Install/upgrade pedestrian crossing (with enhanced safety features)

For HSIP Cycle 11 Call-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	Pedestrian and Bicycle	35%	20 years
Notes:	This CM only applies to "Ped & Bike" crashes occurring in the influence area (expected to be a maximum of within 250') of the new crossing which includes new enhanced safety features. Note: This CM is not intended to be combined with the "Install raised pedestrian crossing" when calculating the improvement's B/C ratio. This CM is not intended to be used for high-cost aesthetic enhancements (i.e. stamped concrete or stamped asphalt).		

General information			
Where to use:			
Roadway segments with no controlled crossing for a significant distance in high-use midblock crossing areas and/or multilane roads locations. Based on the Zegeer study (Safety Effects of Marked vs. Unmarked Crosswalks at Uncontrolled Locations) at many locations, a marked crosswalk alone may not be sufficient to adequately protect non-motorized users. In these cases, flashing beacons, curb extensions, medians and pedestrian crossing islands and/or other safety features should be added to complement the standard crossing elements. For multi-lane roadways, advance "yield" markings can be effective in reducing the 'multiple-threat' danger to pedestrians.			
Why it works:			
Adding pedestrian crossings has the opportunity to greatly enhance pedestrian safety at locations noted as being problematic. The enhanced safety elements, which may include curb extensions, medians and pedestrian crossing islands, beacons, and lighting, combined with pavement markings delineating a portion of the roadway that is designated for pedestrian crossing. Care must be taken to warn drivers of the potential for pedestrians crossing the roadway and enhanced improvements added to the crossing increase the likelihood of pedestrians crossing in a safe manner. In combination with this CM, better guidance signs and markings for non-motorized and motorized roadway users should be considered, including: sign and markings directing pedestrians and cyclists on appropriate/legal travel paths and signs. When agencies opt to install aesthetic enhancement to crossing like stamped concrete/asphalt, the project design and construction costs can significantly increase. For HSIP applications, these costs must be accounted for in the B/C calculation, but these costs (over standard crosswalk markings) must be tracked separately and are not federally reimbursable and will increase the agency's local-funding share for the project costs.			
General Qualities (Time, Cost and Effectiveness):			
Costs associated with this strategy will vary widely, depending on the extent of the curb extensions, raised medians, flashing beacons, and other pedestrian safety elements that are needed with the crossing. When considered at a single location, these improvements can sometimes be low cost and funded through local funding by local crews. This CM can often be effectively and efficiently implemented using a systematic approach with numerous locations, resulting in moderate to high cost projects that are appropriate to seek state or federal funding.			
FHWA CMF Clearinghouse:	Crash Types Addressed:	Pedestrian, Bicycle	CRF: 8 - 56%

R36PB, Install raised pedestrian crossing

For HSIP Cycle 11 Call-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	Pedestrian and Bicycle	35%	20 years
Notes:	This CM only applies to "Ped & Bike" crashes occurring in the area with the new raised crossing. Note: This CM is not intended to be combined with the "Install pedestrian crossing (with enhanced safety features)" when calculating the improvement's B/C ratio.		
General information			
Where to use:			
On lower-speed roadways, where pedestrians are known to be crossing roadways that involve significant vehicular traffic. Based on the Zegeer study (Safety Effects of Marked vs. Unmarked Crosswalks at Uncontrolled Locations) at many locations, a marked crosswalk alone, may not be sufficient to adequately protect non-motorized users. In these cases, raised crossings can be added to complement the standard crossing elements. Special requirements may apply and extra care should be taken when considering installing raised crossings to ensure unintended safety issues are not created, such as: emergency vehicle access or truck route issues.			
Why it works:			
Adding a raised pedestrian crossing has the opportunity to enhance pedestrian safety at locations noted as being especially problematic. The raised crossing encourages motorists to reduce their speed and provides improved delineation for the portion of the roadway that is designated for pedestrian crossing. In combination with this CM, better guidance signs and markings for non-motorized and motorized roadway users should be considered, including: sign and markings directing pedestrians and cyclists on appropriate/legal travel paths.			
General Qualities (Time, Cost and Effectiveness):			
Costs associated with this strategy will vary widely, depending upon the elements of the raised crossing and the need for new curb ramps and sidewalk modifications. This CM may be effectively and efficiently implemented using a systematic approach with more than one location and can have medium to high B/C ratios based on past non-motorized crash history.			
FHWA CMF Clearinghouse:	Crash Types Addressed:	Pedestrian, Bicycle	CRF: 30 - 46%

R37PB, Install Rectangular Rapid Flashing Beacon (RRFB)

For HSIP Cycle 11 Call-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	Pedestrian and Bicycle	35%	20 years
Notes:	This CM only applies to "Ped & Bike" crashes occurring in the influence area (expected to be a maximum of within 250') of the crossing which includes the RRFB.		
General information			
Where to use:			
Rectangular Rapid Flashing Beacon (RRFB) includes pedestrian-activated flashing lights and additional signage that enhance the visibility of marked crosswalks and alert motorists to pedestrian crossings. It uses an irregular flash pattern that is similar to emergency flashers on police vehicles. RRFBs are installed at unsignalized intersections and mid-block pedestrian crossings.			
Why it works:			
RRFBs can enhance safety by increasing driver awareness of potential pedestrian conflicts and reducing crashes between vehicles and pedestrians at unsignalized intersections and mid-block pedestrian crossings. The addition of RRFB may also increase the safety effectiveness of other treatments, such as crossing warning signs and markings.			
General Qualities (Time, Cost and Effectiveness):			
RRFBs are a lower cost alternative to traffic signals and hybrid signals. This CM can often be effectively and efficiently implemented using a systematic approach with numerous locations.			
FHWA CMF Clearinghouse:	Crash Types Addressed:	Pedestrian, Bicycle	CRF: 7 - 47.4%

R38, Install Animal Fencing

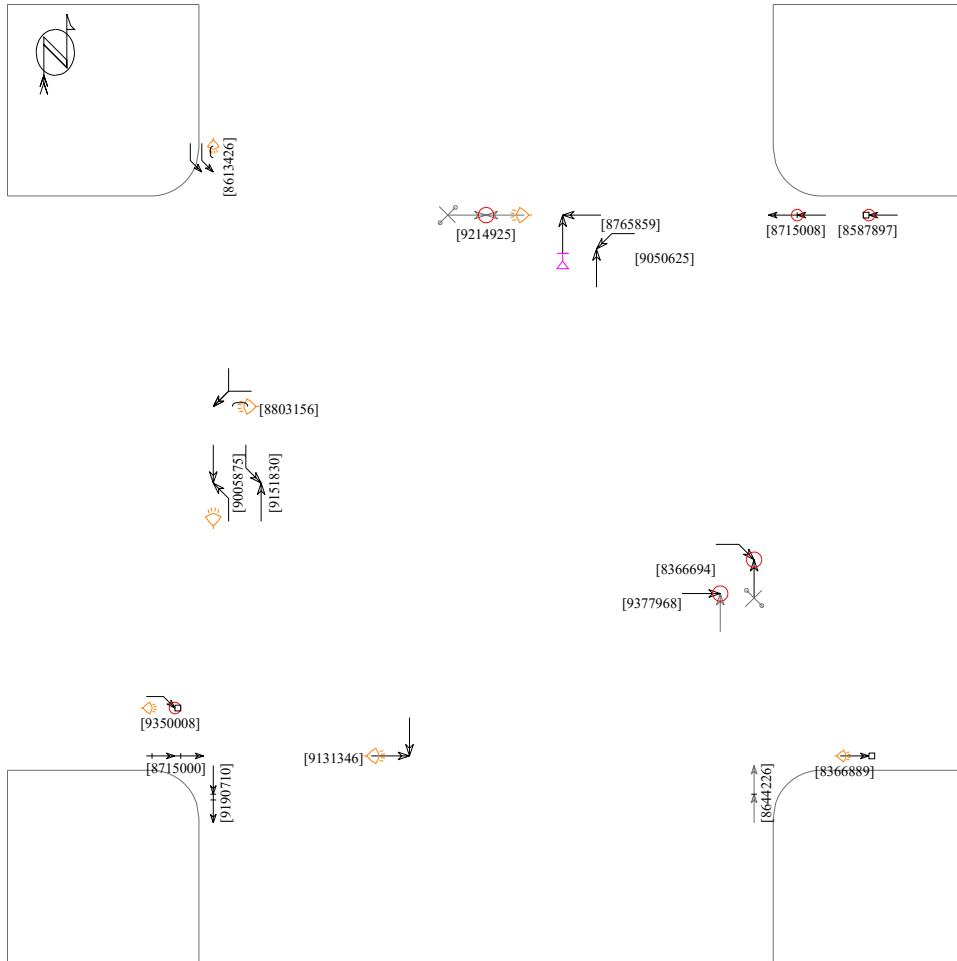
For HSIP Cycle 11 Call-for-projects			
Funding Eligibility	Crash Types Addressed	CRF	Expected Life
90%	Animal	80%	20 years
Notes:	This CM only applies to "animal" crashes occurring within the limits of the new fencing.		
General information			
Where to use:			
At locations with high percent of vehicular/animal crashes (reactive) or where there is a known high percent of animals crossing due to migratory patterns (proactive).			
Why it works:			
Animal fencing helps to channelize the identified animals to a natural or man-made crossing, eliminating the conflict between vehicles and animals on the same place. Animal fencing is typically installed at a bridge location with its "run of need" dependent on the surrounding terrain.			
General Qualities (Time, Cost and Effectiveness):			
Time to install fencing can be moderate to lengthy depending on the environmental commitments and agreed upon solution to mitigating project impacts. Costs will be fairly low and depend on the "run of need" length. There will be minimal reoccurring maintenance costs on keeping the fence intact. The expected effectiveness of this CM must be assessed for each individual location.			
FHWA CMF Clearinghouse:	Crash Types Addressed:	Animal	CRF: 70 - 90 %

ARNOLD DR & MORELLO AV

2017 - 2021

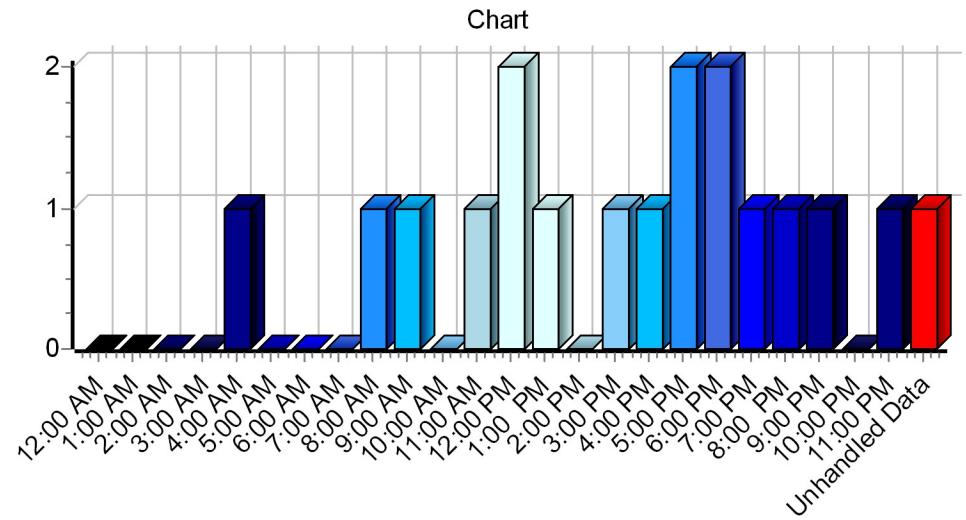
18 Crashes

Clear

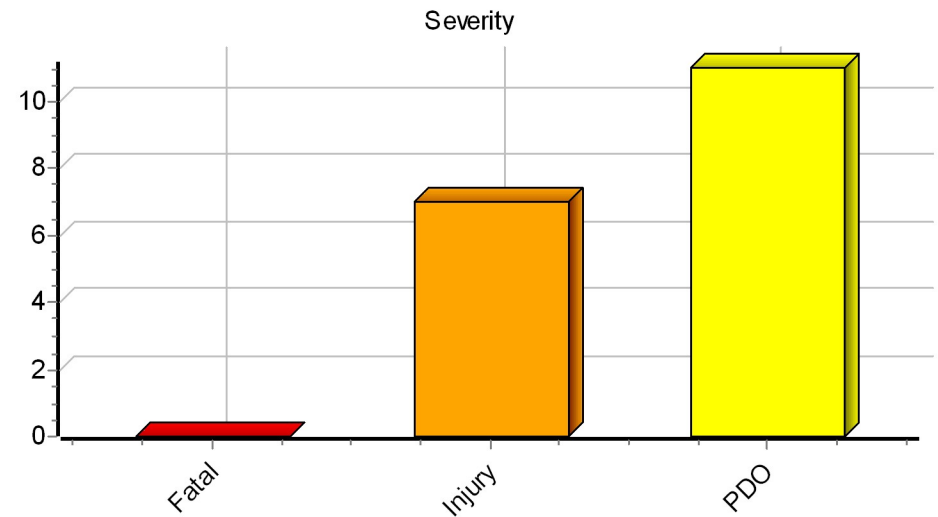


- (1) crashes could not be placed in this schematic
- | | | | |
|--------------|------------------|--------------|----------------|
| ← Straight | ▭ Parked | ⊗ Pedestrian | Fixed objects: |
| ←+ Stopped | ⤿ Erratic | ⊗ Bicycle | □ General |
| ← Unknown | ⤿ Out of control | ○ Injury | ▣ Signal |
| ↔ Backing | ↘ Right turn | ● Fatality | ▣ Tree |
| ↔ Overtaking | ↙ Left turn | 👤 Nighttime | ⊠ Pole |
| ↔ Sideswipe | ↻ U-turn | 🚲 DUI | ⊠ Curb |
| | | | ⊠ Animal |
| | | | ◀ 3rd vehicle |
| | | | * Extra data |

Crash Magic Online 11/15/2022



(Clear)
ARNOLD DR & MORELLO AV

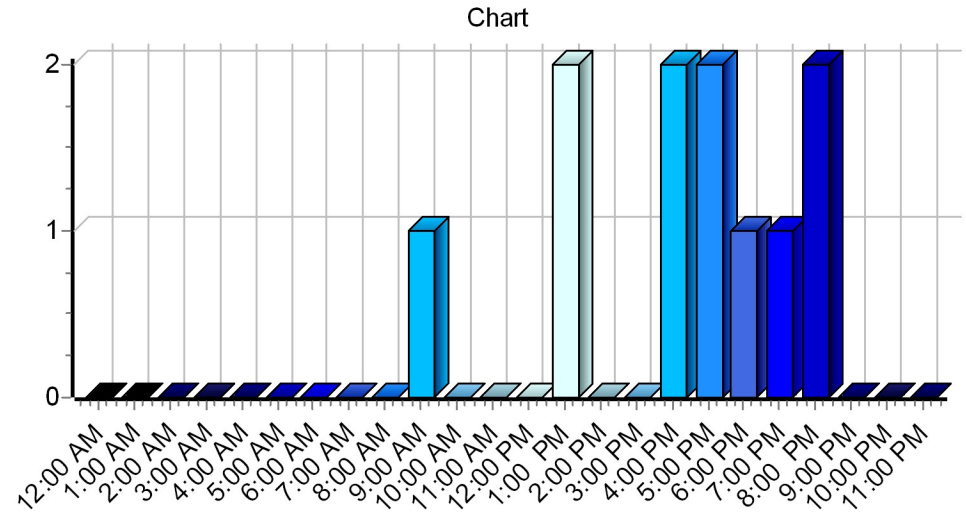
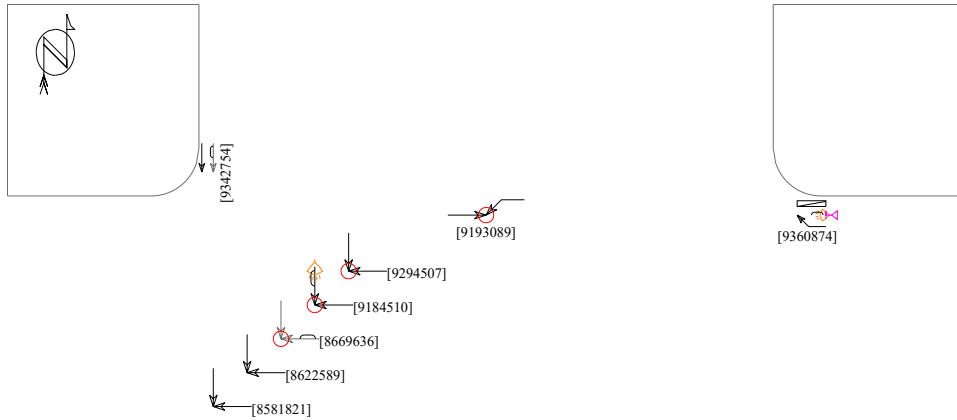


(Clear)
ARNOLD DR & MORELLO AV

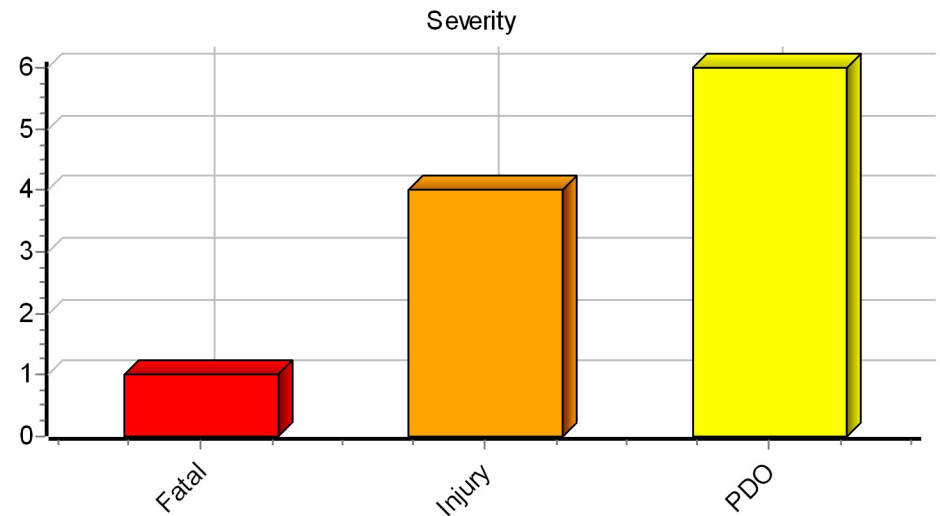
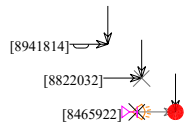
Greet Street & Berrellessa Street

11 Crashes

Clear



(Clear)
Greet Street & Berrellessa Street



(Clear)
Greet Street & Berrellessa Street

- | | | | |
|--------------|------------------|--------------|----------------|
| ← Straight | ▭ Parked | × Pedestrian | Fixed objects: |
| ←+ Stopped | ⤿ Erratic | ⚙ Bicycle | □ General |
| ← Unknown | ⤿ Out of control | ○ Injury | ▣ Signal |
| ↔ Backing | ↗ Right turn | ● Fatality | ▣ Tree |
| ↔ Overtaking | ↖ Left turn | ⏰ Nighttime | ▣ Pole |
| ↔ Sideswipe | ↻ U-turn | ⚡ DUI | ▣ Curb |
| | | | ▣ Animal |
| | | | ◀ 3rd vehicle |
| | | | * Extra data |

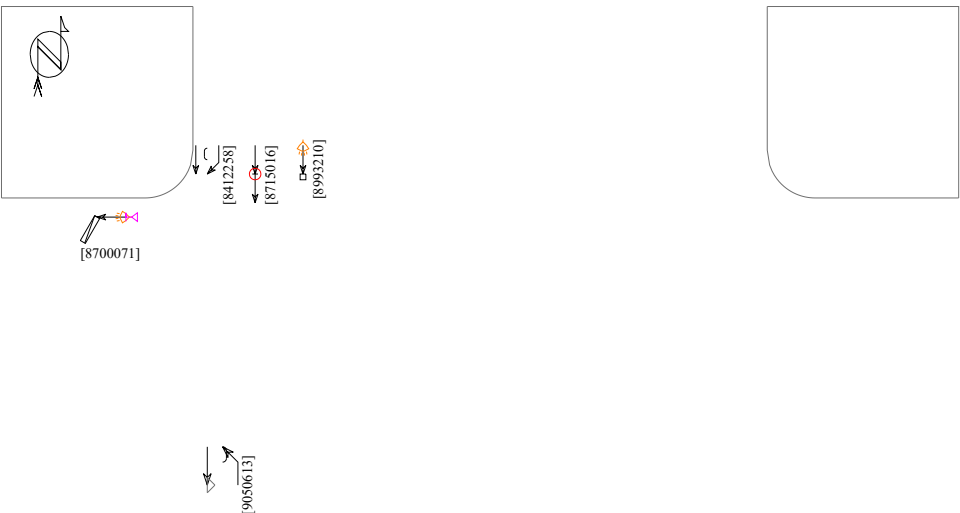
Crash Magic Online 11/15/2022

C ST & ALHAMBRA AV

2017 - 2021

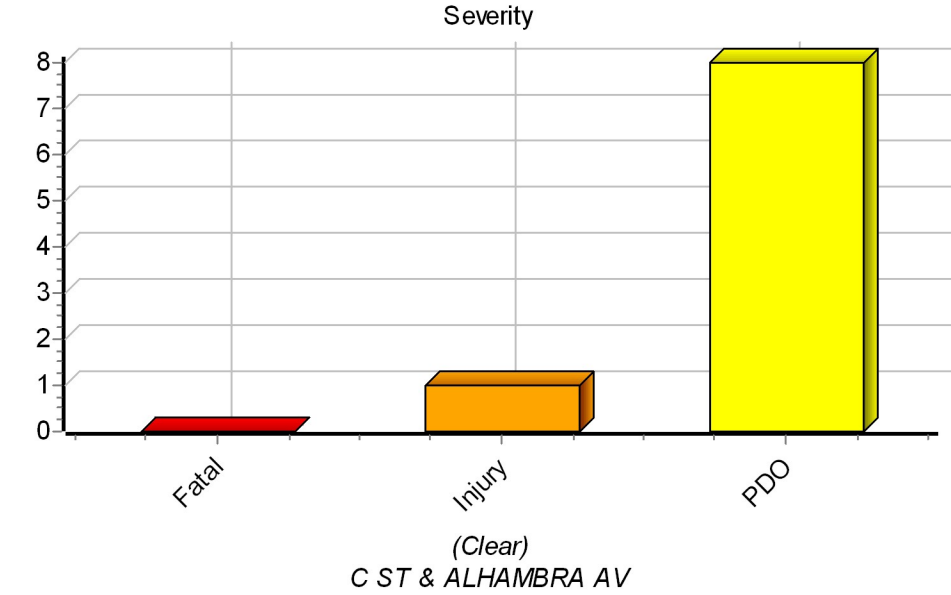
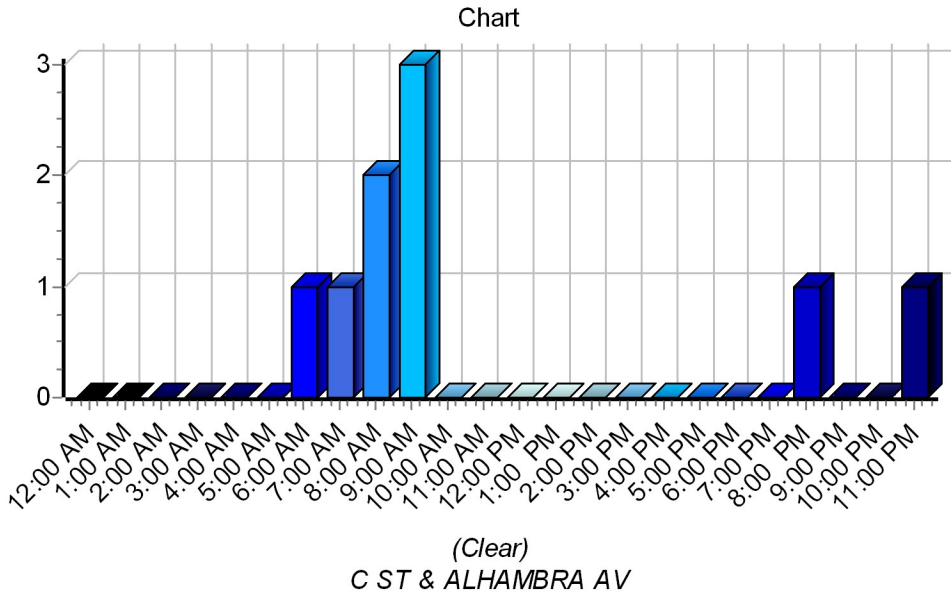
9 Crashes

Clear



- ← Straight
- ←+ Stopped
- ← Unknown
- ↔ Backing
- ↔ Overtaking
- ↔ Sideswipe
- ▭ Parked
- ↪ Erratic
- ↪ Out of control
- ↪ Right turn
- ↪ Left turn
- ↪ U-turn
- ⊗ Pedestrian
- ⊗ Bicycle
- Injury
- Fatality
- ⚡ Nighttime
- ⚡ DUI
- Fixed objects:
- General
- ▣ Signal
- ▣ Tree
- Pole
- ▣ Curb
- ⊗ Animal
- ◁ 3rd vehicle
- * Extra data

Crash Magic Online 11/15/2022

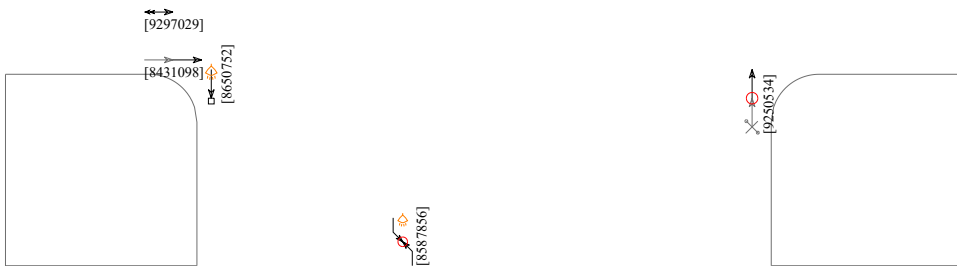


H ST & ALHAMBRA AV

2017 - 2021

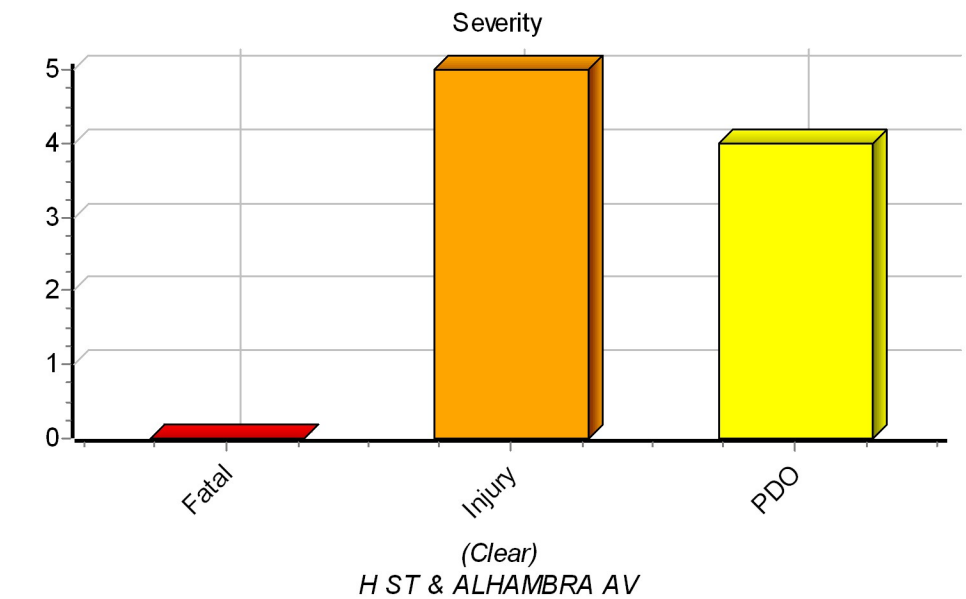
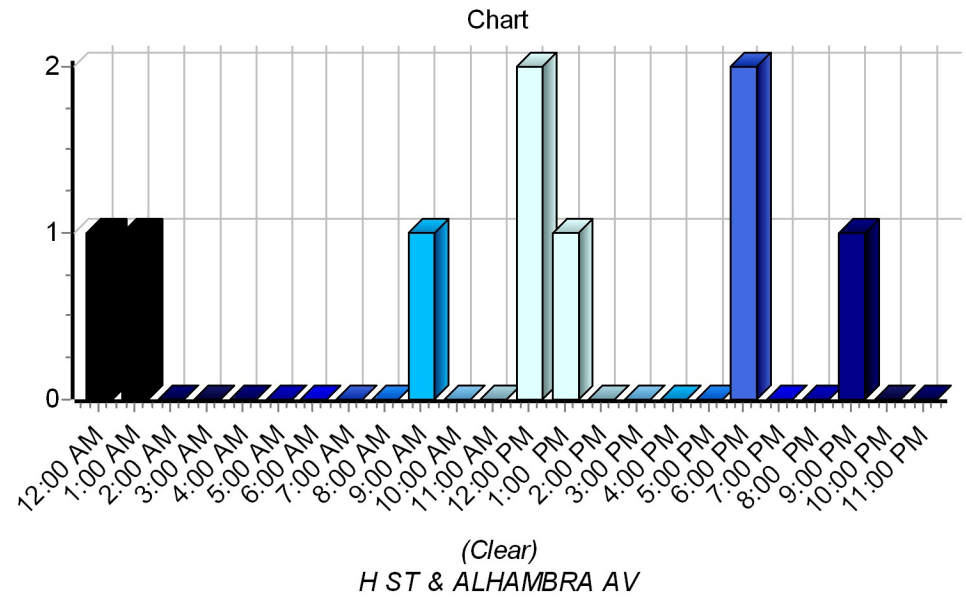
9 Crashes

Clear



- | | | | |
|--------------|------------------|--------------|----------------|
| ← Straight | ▭ Parked | × Pedestrian | Fixed objects: |
| ↔ Stopped | ↪ Erratic | ⚡ Bicycle | □ General |
| ← Unknown | ↪ Out of control | ○ Injury | ▣ Signal |
| ↔ Backing | ↪ Right turn | ● Fatality | ▣ Tree |
| ↔ Overtaking | ↪ Left turn | ⚡ Nighttime | ▣ Pole |
| ↔ Sideswipe | ↪ U-turn | ⚡ DUI | ▣ Curb |
| | | | ▣ Animal |
| | | | ◁ 3rd vehicle |
| | | | * Extra data |

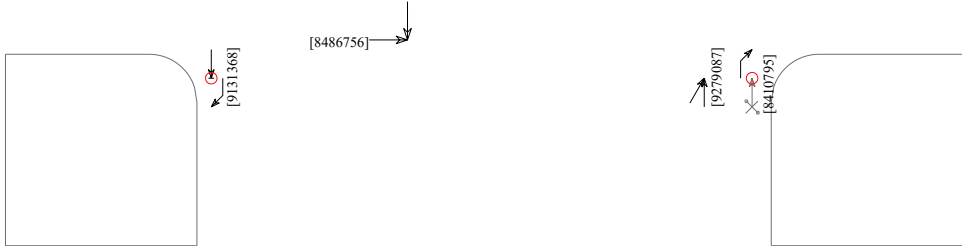
Crash Magic Online 11/15/2022



Alhambra Ave & Virginia Hills Dr

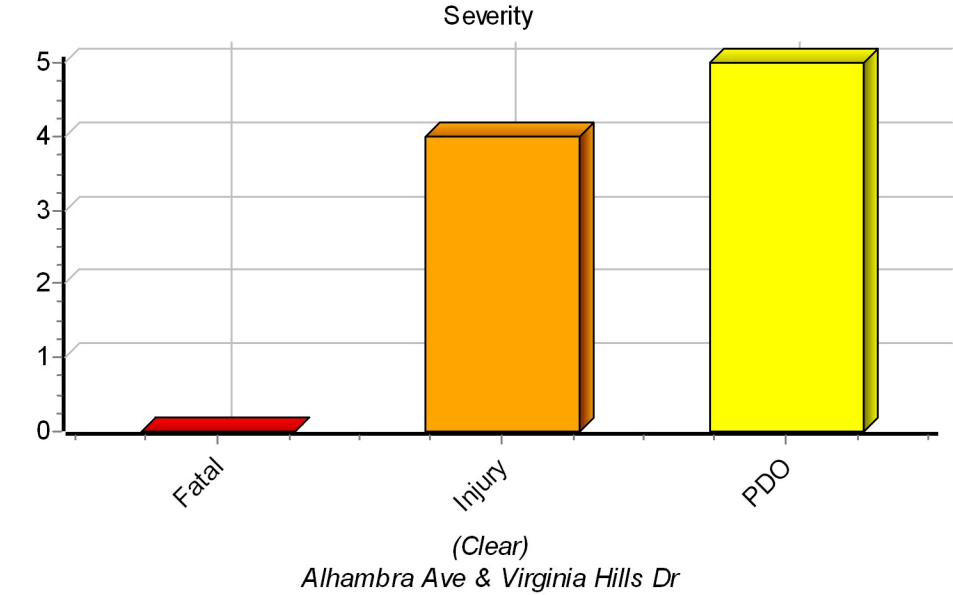
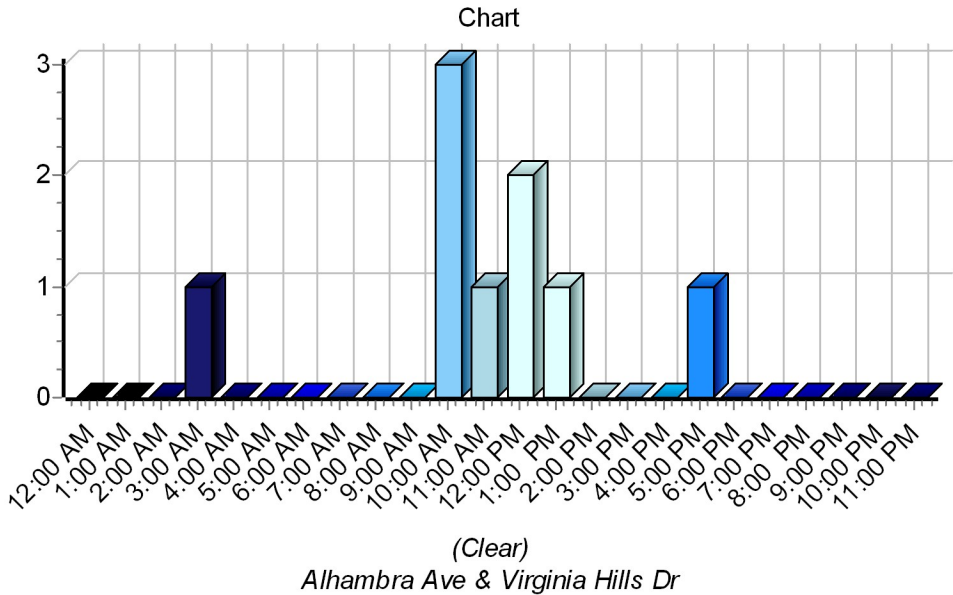
9 Crashes

Clear



- | | | | |
|--------------|------------------|--------------|----------------|
| ← Straight | ▭ Parked | × Pedestrian | Fixed objects: |
| ↔ Stopped | ⤿ Erratic | ⚡ Bicycle | □ General |
| ← Unknown | ⤿ Out of control | ○ Injury | ▣ Signal |
| ↔ Backing | ↘ Right turn | ● Fatality | ▣ Tree |
| ↔ Overtaking | ↙ Left turn | 👤 Nighttime | ▣ Pole |
| ↔ Sideswipe | ↻ U-turn | 🚗 DUI | ▣ Curb |
| | | | ▣ Animal |
| | | | ◀ 3rd vehicle |
| | | | * Extra data |

Crash Magic Online 11/15/2022

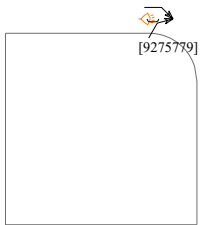
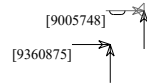
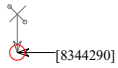
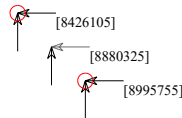
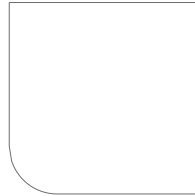
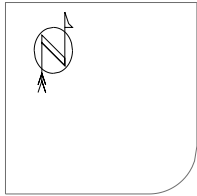


BROWN ST & ALHAMBRA AV

2017 - 2021

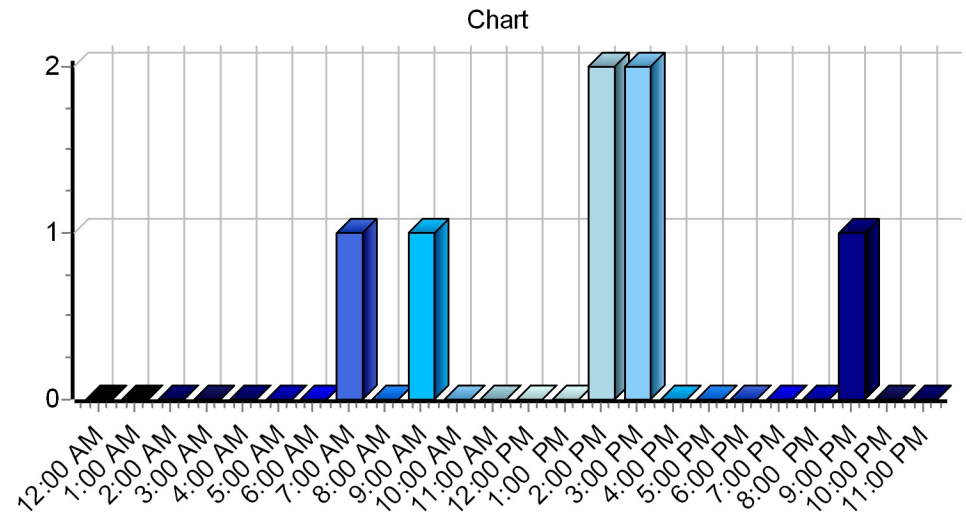
7 Crashes

Clear

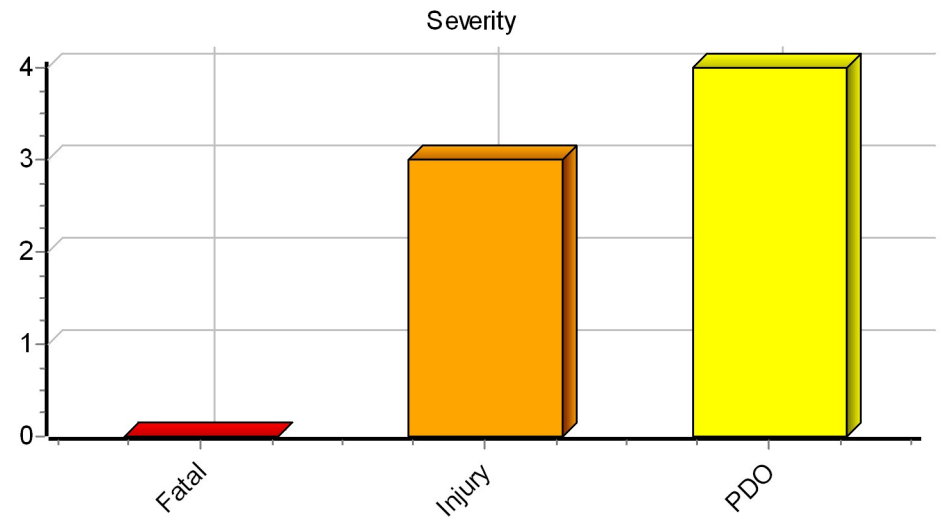


- | | | | |
|--------------|------------------|--------------|----------------|
| ← Straight | ▭ Parked | × Pedestrian | Fixed objects: |
| ←+ Stopped | ⤿ Erratic | ⊗ Bicycle | □ General |
| ← Unknown | ⤿ Out of control | ○ Injury | ▣ Signal |
| ↔ Backing | ↗ Right turn | ● Fatality | ▣ Tree |
| ↔ Overtaking | ↖ Left turn | 🕒 Nighttime | ▣ Pole |
| ↔ Sideswipe | ↻ U-turn | 🚔 DUI | ▣ Curb |
| | | | ▣ Animal |
| | | | ◀ 3rd vehicle |
| | | | * Extra data |

Crash Magic Online 11/15/2022



(Clear)
BROWN ST & ALHAMBRA AV



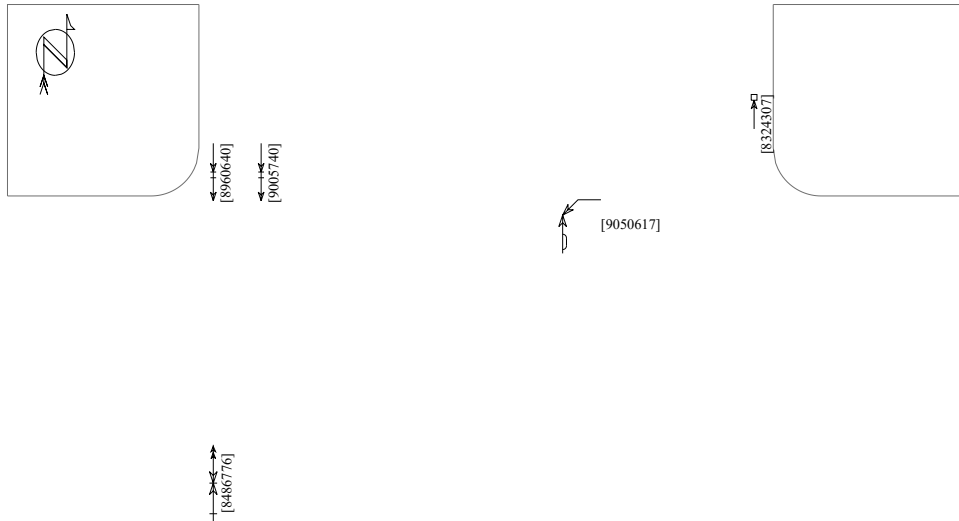
(Clear)
BROWN ST & ALHAMBRA AV

WALNUT AV & ALHAMBRA AV

2017 - 2021

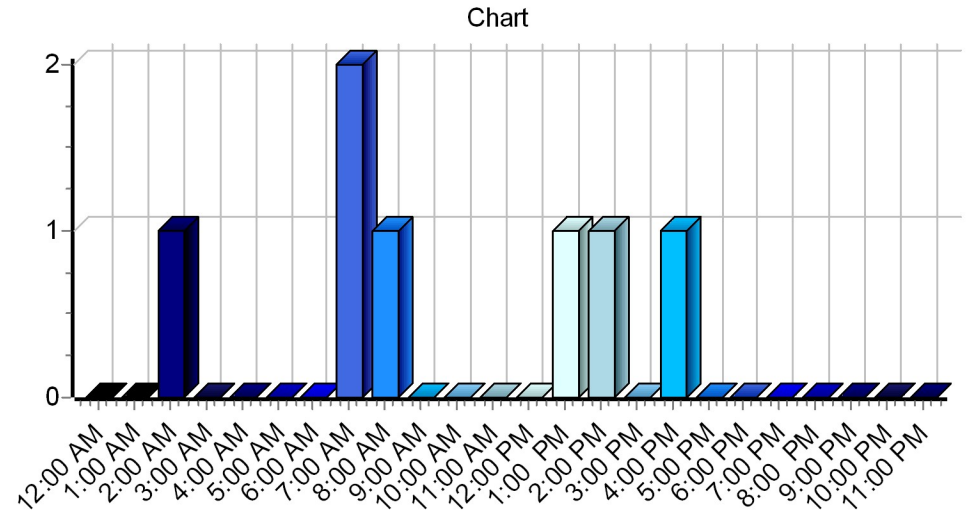
7 Crashes

Clear

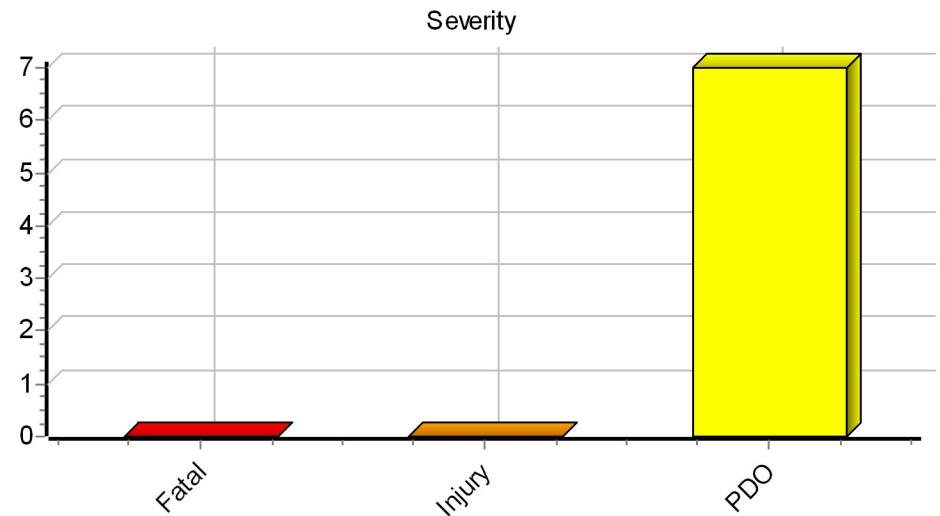


- | | | | |
|--------------|------------------|--------------|----------------|
| ← Straight | ▭ Parked | × Pedestrian | Fixed objects: |
| ←+ Stopped | ⤿ Erratic | ⚡ Bicycle | □ General |
| ← Unknown | ⤿ Out of control | ○ Injury | ▣ Signal |
| ↔ Backing | ↘ Right turn | ● Fatality | ▣ Tree |
| ↔ Overtaking | ↙ Left turn | 👤 Nighttime | ▣ Pole |
| ↔ Sideswipe | ↻ U-turn | ⚡ DUI | ▣ Curb |
| | | | ▣ Animal |
| | | | ◀ 3rd vehicle |
| | | | * Extra data |

Crash Magic Online 11/15/2022



(Clear)
WALNUT AV & ALHAMBRA AV

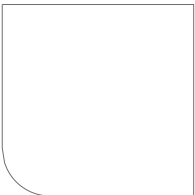
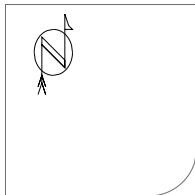


(Clear)
WALNUT AV & ALHAMBRA AV

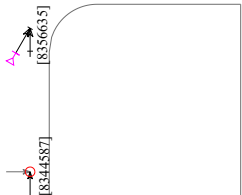
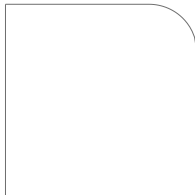
CENTER AV & MUIR RD 2017 - 2021

7 Crashes

Clear



- [8489258]
- [8700031]
- [8748473]
- [8803191]

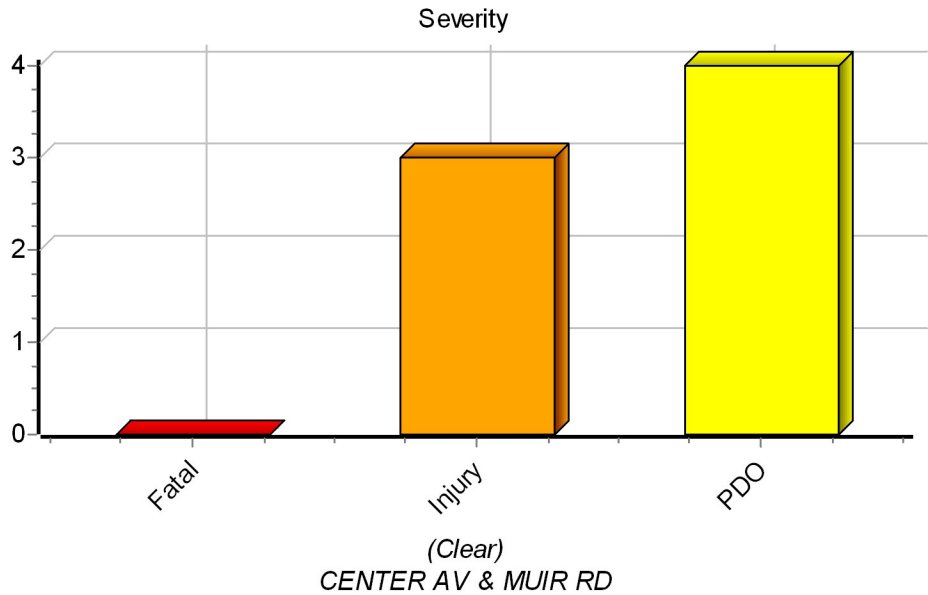
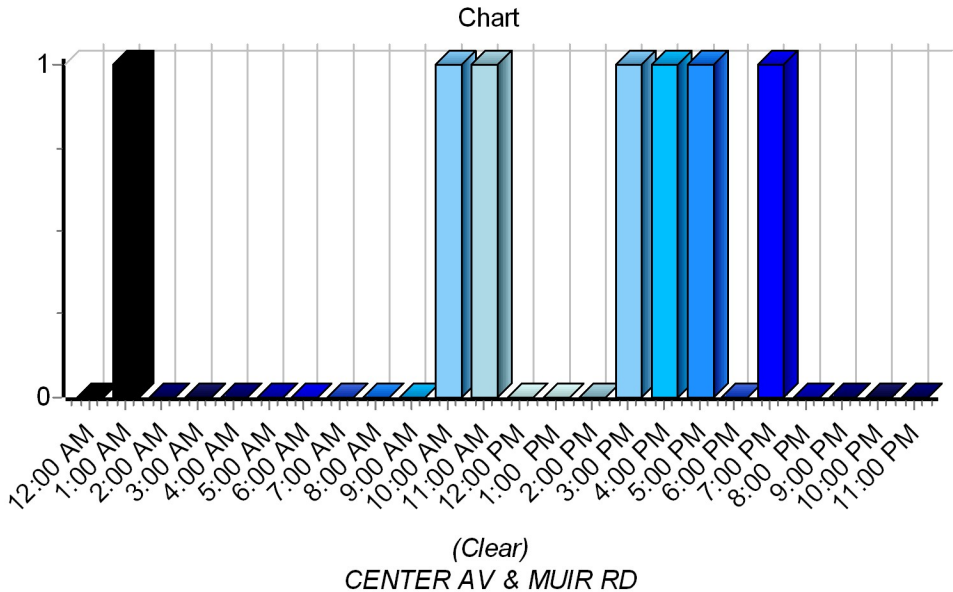


- | | | |
|------------|----------------|------------|
| Straight | Parked | Pedestrian |
| Stopped | Erratic | Bicycle |
| Unknown | Out of control | Injury |
| Backing | Right turn | Fatality |
| Overtaking | Left turn | Nighttime |
| Sideswipe | U-turn | DUI |

(1) crashes could not be placed in this schematic

- Fixed objects:
- | | |
|-------------|--------|
| General | Pole |
| Signal | Curb |
| Tree | Animal |
| 3rd vehicle | |
| Extra data | |

Crash Magic Online 11/15/2022

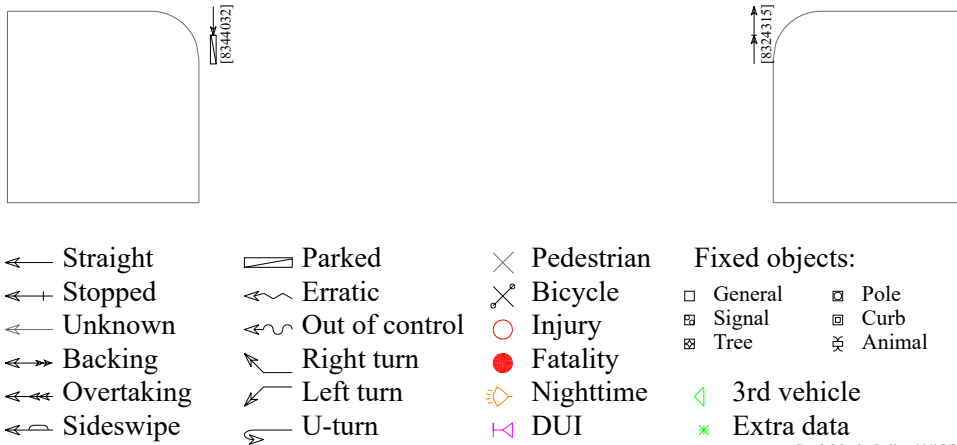
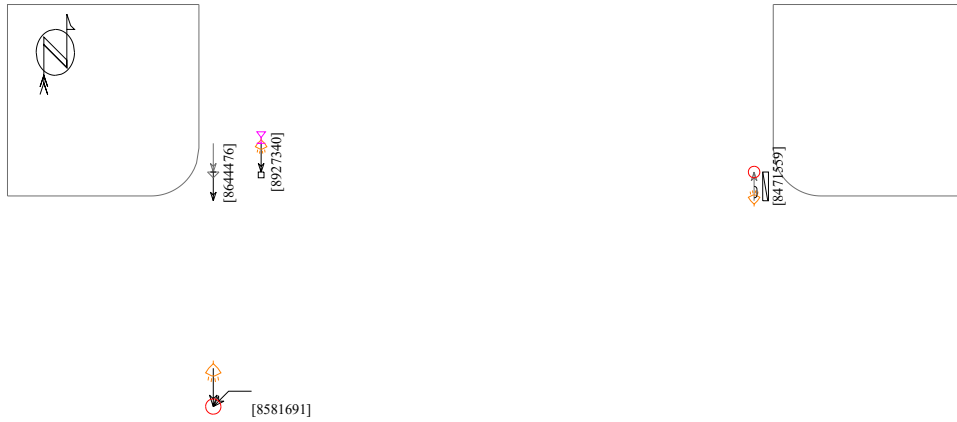


B ST & ALHAMBRA AV

2017 - 2021

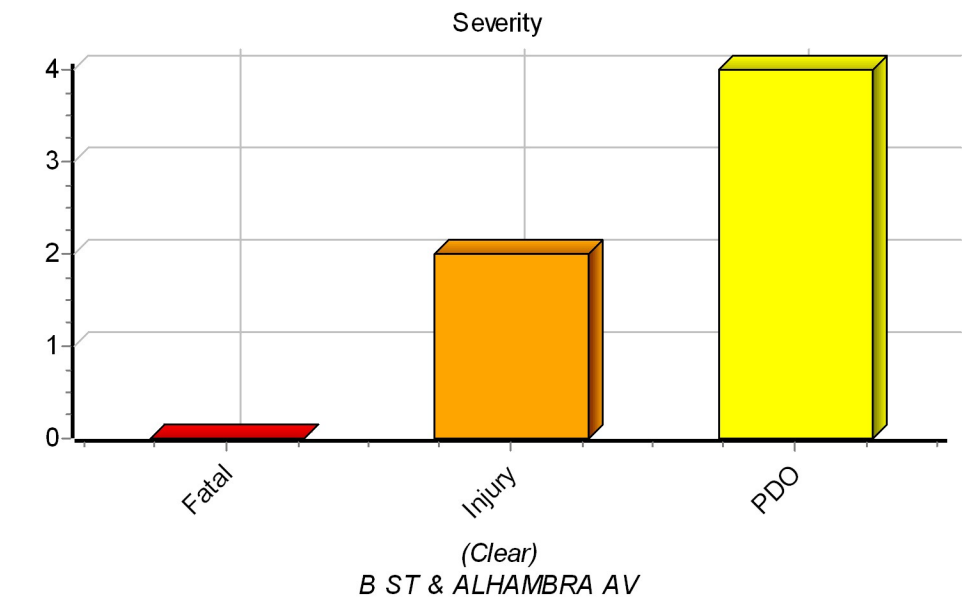
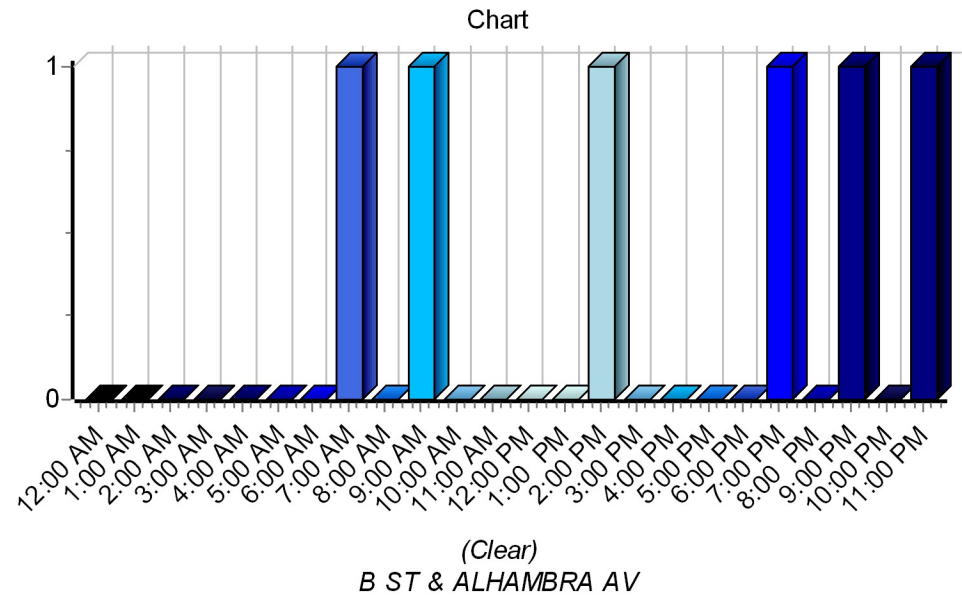
6 Crashes

Clear



- | | | | |
|--------------|------------------|--------------|----------------|
| ← Straight | ▭ Parked | × Pedestrian | Fixed objects: |
| ↔ Stopped | ↪ Erratic | ⚡ Bicycle | □ General |
| ← Unknown | ↪ Out of control | ○ Injury | ▣ Signal |
| ↔ Backing | ↪ Right turn | ● Fatality | ▣ Tree |
| ↔ Overtaking | ↪ Left turn | 👤 Nighttime | ▣ Pole |
| ↔ Sideswipe | ↪ U-turn | 🚗 DUI | ▣ Curb |
| | | | ▣ Animal |
| | | | ◀ 3rd vehicle |
| | | | * Extra data |

Crash Magic Online 11/15/2022

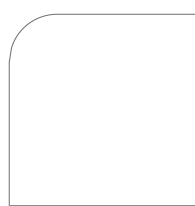
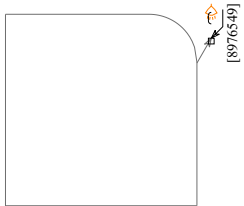
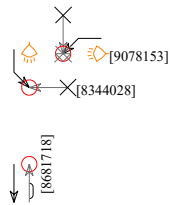
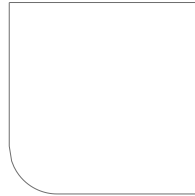
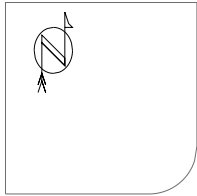


D ST & ALHAMBRA AV

2017 - 2021

6 Crashes

Clear



(2) crashes could not be placed in this schematic

- ← Straight
- ←+ Stopped
- ← Unknown
- ↔ Backing
- ↔ Overtaking
- ↔ Sideswipe
- ▭ Parked
- ↔ Erratic
- ↔ Out of control
- ↔ Right turn
- ↔ Left turn
- ↔ U-turn
- × Pedestrian
- ⊗ Bicycle
- Injury
- Fatality
- ⚡ Nighttime
- ⚡ DUI

- Fixed objects:
- General
 - ▣ Signal
 - ▣ Tree
 - ▣ Pole
 - ▣ Curb
 - ▣ Animal
 - ◀ 3rd vehicle
 - * Extra data

Crash Magic Online 11/15/2022

