September 2020

SYSTEMIC LOCAL ROADWAY SAFETY PLAN

FRESNO, CA

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JLB Traffic Engineering, Inc.

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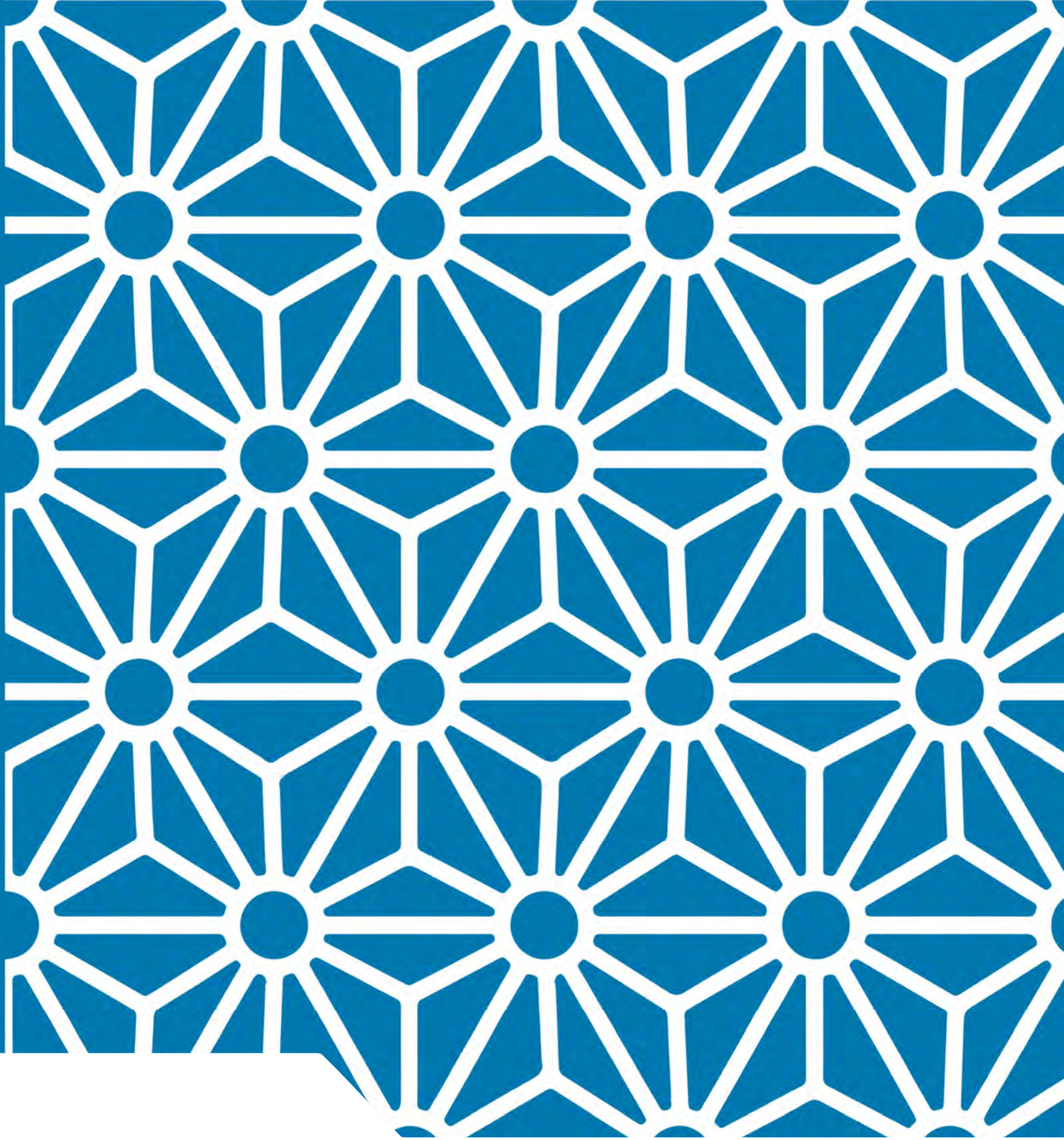


EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

BACKGROUND AND PURPOSE

Kittelson & Associates, Inc. (Kittelson), Toole Design Group, and JLB Traffic Engineering, Inc. worked with the City of Fresno (City) to analyze transportation safety data and identify roadway improvements to reduce collision risk in the City. The work was funded through a Caltrans Systemic Safety Analysis Report (SSAR) Program. This Systemic Local Roadway Safety Plan combines the requirements of the Caltrans SSAR program requirements as well as serving as the City's Local Roadway Safety Plan by establishing a vision and goals for transportation safety. This report includes safety project scopes that may be competitive if advanced into grant applications for Highway Safety Improvement Program (HSIP) grant funding.

VISION & GOALS

The City's vision for improving roadway safety includes a Citywide roadway safety program and interjurisdictional working group that:

Goal 1.1: Reduce the number of fatal and severe injury collisions.

Goal 1.2: Implement systemic countermeasures to target safety emphasis areas identified in this report.

Goal 2.1: Coordinate with the Fresno Police Department (Fresno PD), Fresno County Public Health Department, Caltrans, Fresno County, City of Clovis, Fresno Unified School District, Clovis Unified School District, Sanger Unified School District, Central Unified, Washington School District, Orange Center School District, West Park School District, City College, Fresno State University, and California Highway Patrol (CHP).

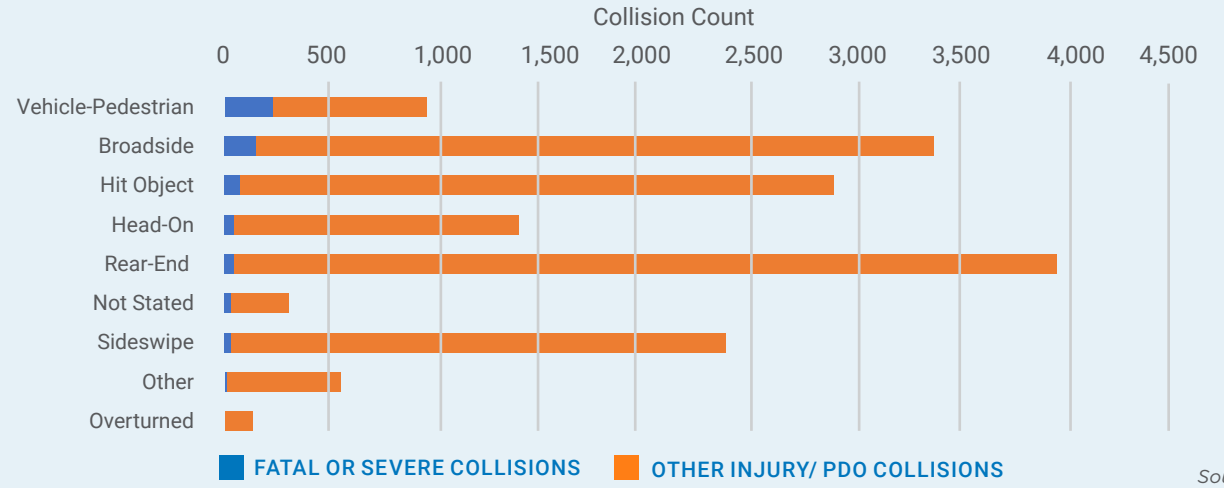
Goal 2.2: Use local safety performance trends to inform non-engineering solutions for peer departments and partners to implement targeted education, encouragement, and enforcement efforts.

COLLISON ANALYSIS

Kittelson worked with the City to build and analyze a database of the most recent five complete years of reported collisions, representing January 1, 2014 through December 31, 2018. Supplementary contextual data included bus stop locations, posted speed limits, and arterial roadway segment lane configuration and median presence.

Kittelson identified high-priority intersections and corridors for potential safety improvements using the collision severity score network screening performance measure from the American Association of State Highway Transportation (AASHTO) *Highway Safety Manual* (HSM). This performance measure weights collisions by their severity to identify locations with the greatest severity-weighted frequency.

Figure ES1: Reported Collisions by Type and Severity, City of Fresno, 2014-2018



Source: City of Fresno.

Note: 24 collisions manually added from fatal logs did not include a collision type and are not provided in this chart.

FINDINGS

Pedestrians are involved in **6%** of collisions and **38% of fatal and injury collisions.** **Bicyclists** are involved in **4%** of collisions and **11% of fatal and injury collisions.**

TOP 3 COLLISION TYPES

Vehicle-Pedestrian **Broadside** **Hit Object**

Together they account for **70% of fatal and severe injury collisions** in the City.

- Among fatal or severe injury pedestrian collisions, 47% occurred while a pedestrian was crossing a roadway outside a crosswalk.
- Among broadside collisions where location information was available, 94% were intersection collisions. Intersection-related broadside collisions occur with roughly the same frequency at signalized and unsignalized intersections (56% and 44%, respectively).
- Among hit object collisions where location information was available, 86% were at intersections. Of these, 67% occurred at unsignalized intersections.

SYSTEMIC RISK FACTORS

Risk factors identify location types with the potential for increased frequency and severity of collisions for the City. Each risk factor is a unique roadway characteristic that may indicate an increased risk for collisions.

- Unsignalized three-way intersections with one local street leg intersecting an arterial or collector street.
- Signalized intersections where at least one approaching roadway has a posted speed of 40 mph or higher.
- Expressways and arterials with 4+lane cross sections and posted speeds of 40 mph or greater, including roadways with and without raised medians.

PEDESTRIAN AND BICYCLIST RISK FACTORS

- Arterial roadway network of wide roadways (4+lane cross sections).
- Multilane arterial roadways without turn lanes at minor cross streets.
- Stop-controlled minor cross streets intersecting multilane arterials.
- Permissive left-turn signal phasing.
- High pedestrian and bicycle demand areas, (e.g. commercial destinations or bus stops) without pedestrian scale lighting and limited or no bicycle facilities.

PRIORITY CORRIDORS AND INTERSECTIONS

Based on network screening results that calculated a collision severity score for roadways throughout the City, Kittelson identified the top twenty locations and grouped them by location type:

- Arterial-arterial or arterial-collector signalized intersection
- Unsignalized intersections with access management and opportunities to improve pedestrian conditions
- Rural intersections
- Urban/suburban roadway segment corridors

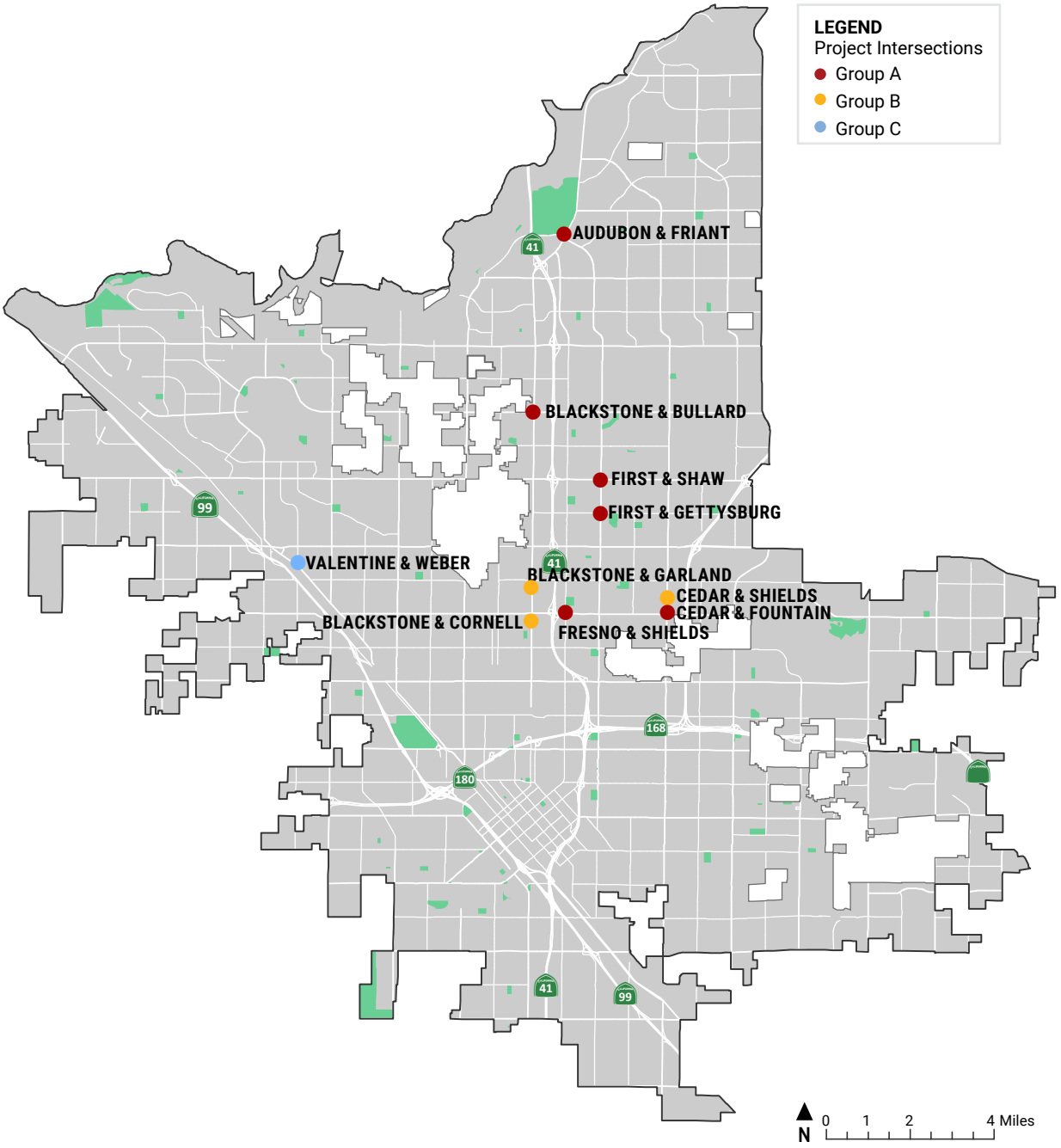
TOP TWENTY HIGH RISK CORRIDORS AND INTERSECTIONS SORTED BY GROUP

LOCATION	GROUP	ANNUALIZED COLLISION SEVERITY SCORE	SEGMENT/ INTERSECTION
First Street and Shaw Avenue	A	118.6	Intersection
Blackstone Avenue and Shields Avenue	A	98.8	Intersection
Blackstone Avenue and Bullard Avenue	A	92.8	Intersection
Fresno Street and Shields Avenue	A	90.7	Intersection
First Street and Gettysburg Avenue	A	86.1	Intersection
Audubon Drive and Friant Road	A	85	Intersection
Cedar Avenue and Shields Avenue	A	79.1	Intersection
Blackstone Avenue and Sierra Avenue	A	58.8	Intersection
Blackstone Avenue and Garland Avenue	B	119.6	Intersection
Blackstone Avenue and Cornell Avenue	B	85	Intersection
Cedar Avenue and Fountain Way	B	80.6	Intersection
Ashlan Avenue and Effie Street	B	78.7	Intersection
Fourth Street and Sierra Madre Avenue	B	78.7	Intersection
Valentine Avenue and Weber Avenue	C	84.6	Intersection
G Street and Santa Clara Street	C	80.4	Intersection
Jensen Avenue and West Avenue	C	79.7	Intersection
Shaw Avenue (between Feland Avenue and Shaw Lane)	D	70	Segment
Shields Avenue (between Sierra Fwy Eastern On/Off Ramps and N Recreation Avenue)	D	69.9	Segment
Clinton Avenue (between N Fresno Street and N First Street)	D	69.9	Segment
Jensen Avenue (between S Walnut Avenue and S MLK Jr Boulevard)	D	69.9	Segment

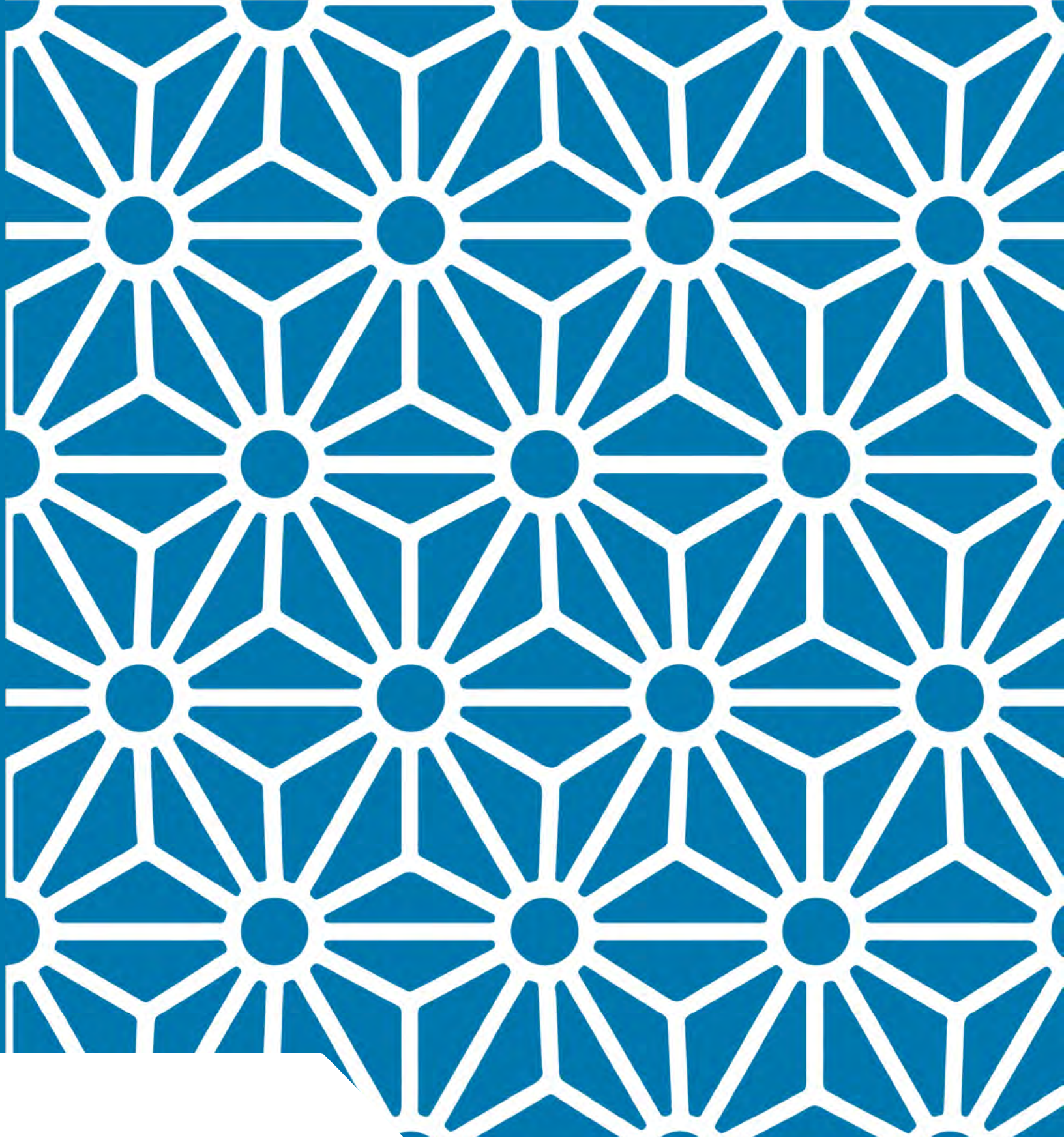
Note: Bold font indicates the ten locations identified for safety project scoping.

Safety Project Development

Using the collision analysis findings and through discussion with City staff, the project team developed ten project scopes the City could implement to reduce the risk for all road users. For each location, the project scope describes the project location, type of improvements, justification, and a concept design for the project. The ten locations are shown in the map.



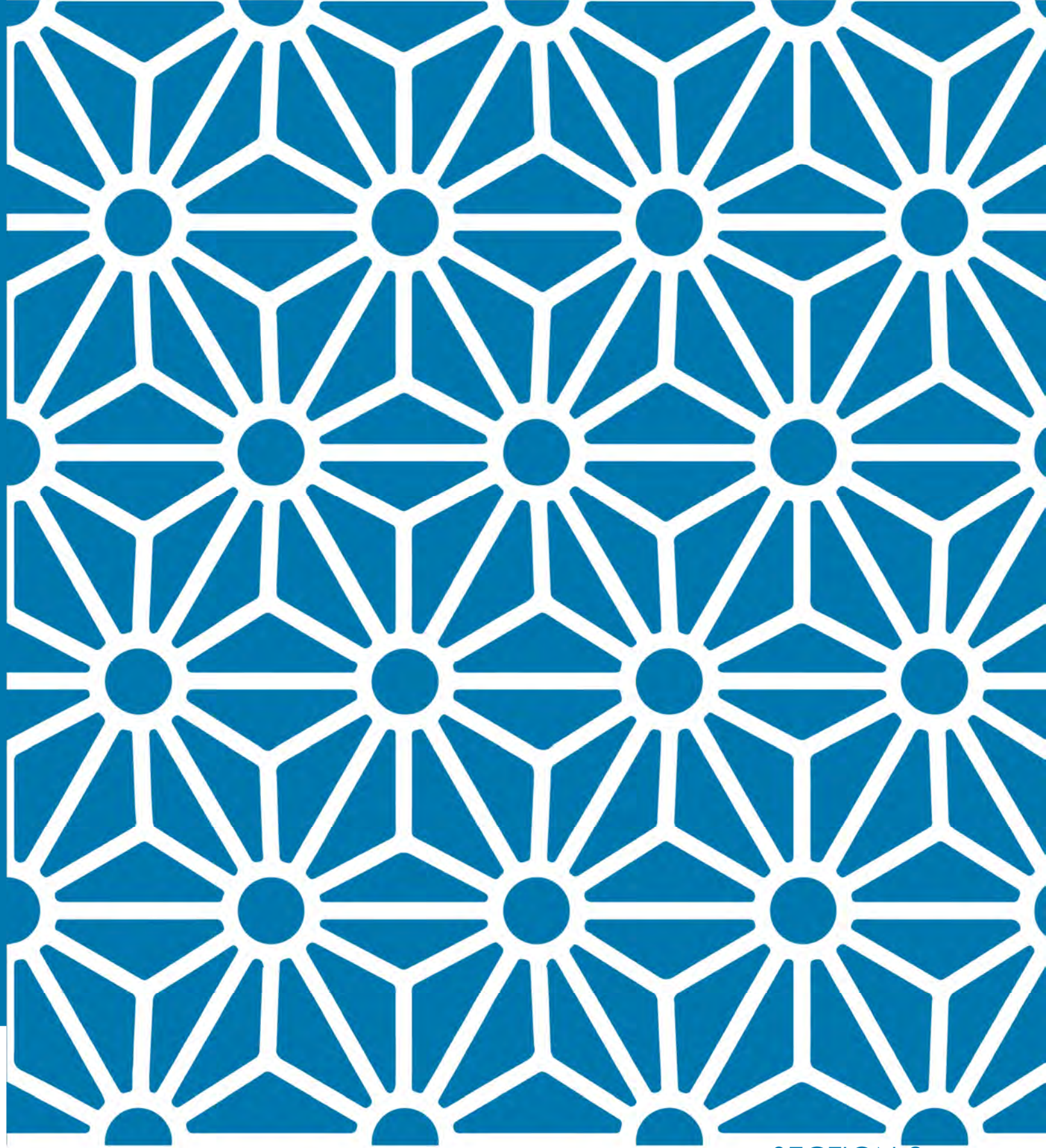
Coordinate System: NAD 1983 StatePlane California IV FIPS 0404 Feet
Data Source: City of Fresno



ENGINEER'S SEAL

1. ENGINEER'S SEAL

By signing and stamping this document, Erin M. Ferguson, P.E., attests to this report's technical information and engineering data upon which local agency's recommendations, conclusions, and decisions are made.

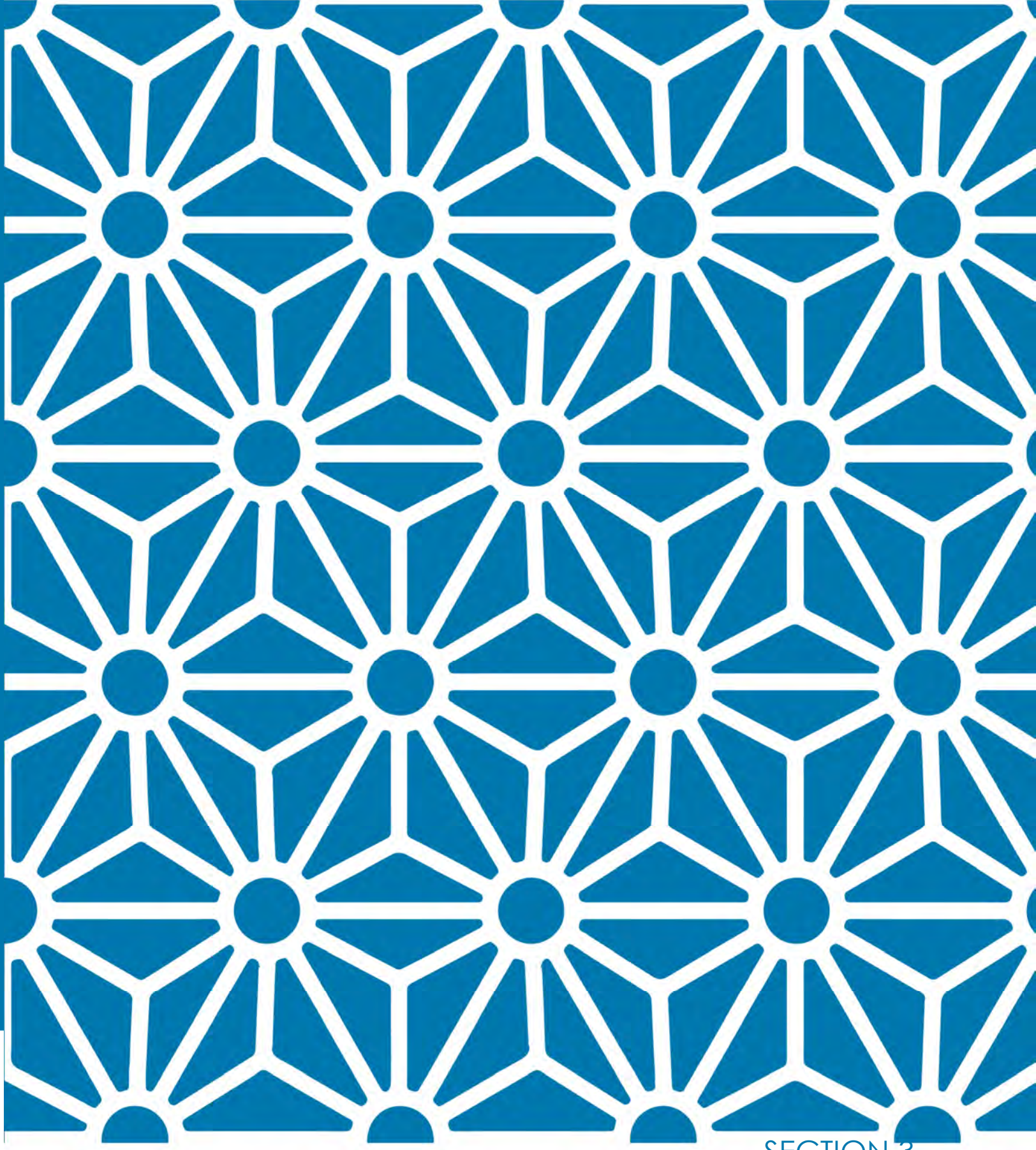


SECTION 2

STATEMENT OF PROTECTION OF DATA FROM DISCOVERY AND ADMISSIONS

2. STATEMENT OF PROTECTION OF DATA FROM DISCOVERY AND ADMISSIONS

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.



SECTION 3

INTRODUCTION

3. INTRODUCTION

This report documents the City of Fresno's work to assess and improve transportation safety conditions citywide. According to the five most recent years of available collision data, approximately 3,164 reported collisions occur on City streets annually, 4% of which result in fatality or severe injury (37 annual deaths and 94 annual severe injury collisions).

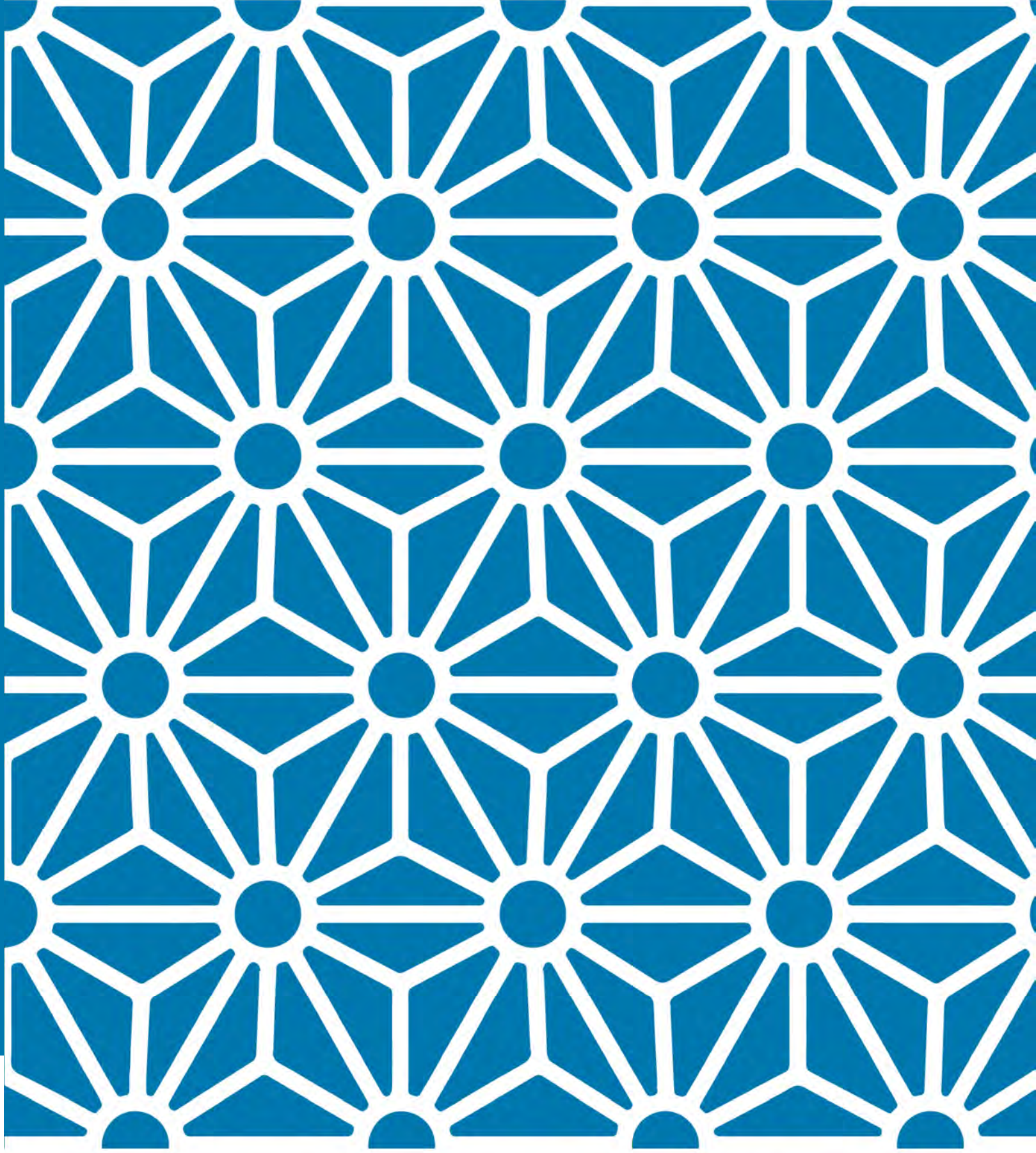
The City has analyzed the data and engaged local partners to identify emphasis areas, including engineering and non-engineering solutions, to improve transportation safety for all road users. This transportation safety report documents that effort and has been adapted to meet Caltrans SSAR Program requirements and align with the LRSP Program. This report provides a roadmap to improve upon the trends of the past five years into the future.

This report also documents the City's transportation safety vision of a citywide transportation safety program and team that:

1. Uses data-driven analysis to identify and prioritize opportunities to improve transportation safety
2. Collaborates across agencies to foster a culture of continuous transportation safety improvement

This report describes the work conducted under the SSAR Program to improve transportation safety, including:

- Vision and goals
- Outreach and coordination with transportation safety partners
- Previous and ongoing City efforts to improve transportation safety
- Data analysis
- Collision analysis, including the highest-occurring collision types
- Engineering emphasis areas, including systemic countermeasures and project scopes
- Non-engineering emphasis areas
- Proposed evaluation and implementation



SECTION 4

VISION & GOALS

4. VISION & GOALS

The City's vision for improving transportation safety includes a citywide transportation safety program and interjurisdictional working group that:

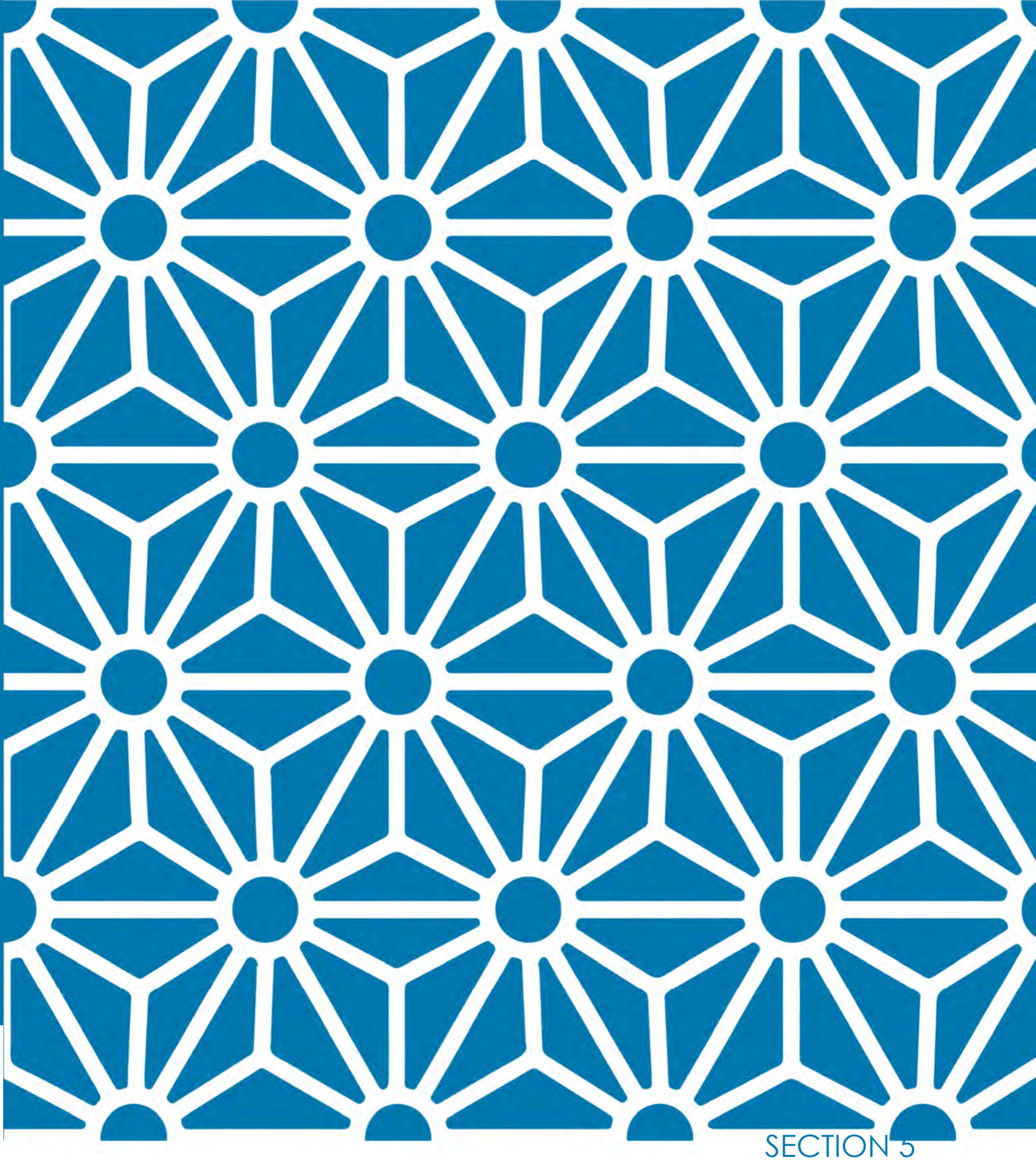
1. **Uses data-driven analysis to identify and prioritize opportunities to improve transportation safety**

   Goal 1.1: Reduce the number of fatal and severe injury collisions
   Goal 1.2: Implement systemic countermeasures to target emphasis areas identified in this report

2. **Collaborates across agencies to foster a culture of continuous transportation safety improvement**

   Goal 2.1: Coordinate with the Fresno Police Department (Fresno PD), Fresno County Public Health Department, Caltrans, Fresno County, City of Clovis, Fresno Unified School District, Clovis Unified School District, Sanger Unified School District, Central Unified School District, Washington School District, Orange Center School District, West Park School District, City College, Fresno State University, and California Highway Patrol (CHP)
   Goal 2.2: Use local safety performance trends to inform non-engineering solutions for peer departments and partners to implement targeted education, encouragement, and enforcement efforts

The following report sections provide substantiation for how these goals were identified, more detail on the emphasis areas, and associated recommendations.



SECTION 5

SAFETY PARTNERS

5.SAFETY PARTNERS

To promote collaboration across agencies to create a transportation safety culture, the following agencies would be valuable partners to engage:

- Fresno PD, which would allow collaborative enforcement priorities based on trends in collision data (i.e., spatial trends in speeding or driving under the influence). Fresno PD could also administer identified programs intended to affect transportation safety outcomes (e.g., speed trailers, active speed monitors; see Section Enforcement).
- School districts within the City, such as Fresno Unified School District, Clovis Unified School District, Sanger Unified School District, Central Unified School District, Washington School District, Orange Center School District, and West Park School District, which could administer educational and encouragement programs for students, staff, and families related to safe transportation behavior
- Fresno Area Express, which could help identify emphasis areas related to safety in transit access and operations
- The Fresno County Health Department, which could help coordinate emergency response needs and provide collaboration on safe routes to school, health impact assessments, and transportation safety programs
- Other community groups and local organizations; for example, health advocacy or active transportation groups such as the Fresno Bicycle and Pedestrian Advisory Committee (BPAC) and Disability Advisory Commission

As part of this project, the City has already engaged and consulted with Fresno PD on pedestrian safety issues and outreach.

SECTION 6

EXISITNG EFFORTS

6. EXISTING EFFORTS

Prior to this project, the City addressed transportation safety through a number of previous and existing plans, projects, and programs, which are discussed in this section.

6.1 GENERAL PLAN: MOBILITY AND TRANSPORTATION ELEMENT

Resource Link: https://www.fresno.gov/darm/wp-content/uploads/sites/10/2019/07/General-Plan-4-Mobility-and-Transportation-7-19.pdf

The City's General Plan was adopted in 2014 and presents strategies to address identified existing conditions in the City and to promote growth and reinvestment. Its mobility and transportation chapter includes policies and recommendations related to transportation safety.

The General Plan includes discussion of bicycle and pedestrian issues, including the following recommendations for supportive infrastructures:

- New or improved pedestrian crossings and "additional industry standard" safety features, including pedestrian refuges, raised or lighted crossings, and signals, with an emphasis on areas with relatively high pedestrian volumes
- Improvements, including grade-separated crossings where freeways and railroads create barriers
- Lighting, with an emphasis on areas with relatively high pedestrian volumes
- Continuous sidewalk requirements along both sides of new developments

The General Plan establishes the following objectives and relevant policies directly related to transportation safety:

- **Objective MT-1: Create and maintain a transportation system that is safe and efficient, provides access in an equitable manner, and optimizes travel by all modes**

  Relevant policies include:

  - **Policy MT-1-g: Complete Streets Concept Implementation.** This policy includes encouraging conversion of one-way streets to two-way streets to improve safety.
  - **Policy MT-1-j: Transportation Improvements Consistent with Community Character**. This policy includes provision of traffic calming and safety improvements.

- **Objective MT-2: Make efficient use of the City's existing and proposed transportation system and strive to ensure the planning and provision of adequate resources to operate and maintain it**

  - **Policy MT-2-e: Driveway and Access Consolidation.** This policy encourages opportunities to consolidate driveways along major roadways associated with a change in development and to promote transportation operations and safety.

- **Objective MT-4: Establish and maintain a continuous, safe, and easily accessible bikeway system throughout the metropolitan area to reduce vehicle use, improve air quality and quality of life, and provide public health benefits**

  - **Policy MT-4-j: Street Maintenance for Bicycle Safety**. This policy promotes regular sweeping and maintenance of bikeways to promote their safe use.

- **Objective MT-5: Establish a well-integrated network of pedestrian facilities to accommodate safe, convenient, practical, and inviting travel by walking, including for those with physical mobility and vision impairments**
  - **Policy MT-5-d: Pedestrian Safety.** This policy promotes prioritizes minimizing vehicular and pedestrian conflicts through intersection and roadway design. The policy also promotes increased accessibility through the installation of Accessible Pedestrian Signals at signalized intersections.

The General Plan does not make specific location or programmatic safety recommendations, but through its vision, goals, objectives, and policies, it establishes priorities for other safety planning and implementation efforts.

6.2 ACTIVE TRANSPORTATION PLAN

Resource Link: https://www.fresno.gov/publicworks/wp-content/uploads/sites/17/2016/09/170022FresnoATPFinal012017.pdf

The City's Active Transportation Plan, adopted in 2016, outlines actions, policies, procedures, and programs to support active transportation. The plan builds on the General Plan Mobility and Transportation element objectives and actions and articulates a planned network of pedestrian and bicycle infrastructure.

The Active Transportation Plan's goals include:

- Equitably improving the safety and perceived safety of walking and bicycling in Fresno
- Increasing walking and bicycling trips in Fresno by creating user-friendly facilities
- Improving the geographic equity of access to walking and bicycling facilities in Fresno
- Filling key gaps in Fresno's walking and bicycling networks

After its adoption, the City adopted an Active Transportation prioritization tool which allows the City to incorporate various criteria to identify project implementation priorities.

6.3 SAFE ROUTES TO SCHOOL ACTION PLAN

Resource Link: https://www.saferoutespartnership.org/sites/default/files/fresno_srts_action_plan_final.pdf

In 2018, the City published a Safe Routes to School Action Plan. For this plan, the City worked with a number of agencies, organizations, stakeholders, and community members to promote safe walking, biking, and rolling to schools. The Action Plan focuses on the Southeast area of Fresno and was developed in close collaboration with Cultiva La Salud, a community organization. It incorporates the Safe Routes to School Six Es framework: education, encouragement, engineering, enforcement, evaluation, and equity. The plan presents short-term and long-term implementation steps and a discussion of funding for implementation.

In January 2020, the City approved a Safe Routes to School Resolution, which was one of the recommendations of the Active Transportation Plan.

6.4 RECOMMENDATIONS TO IMPROVE PEDESTRIAN SAFETY (2015 SAFETREC REPORT)

Resource Link: https://safetrec.berkeley.edu/sites/default/files/fresno-cpst-recommendations_final_1.pdf

The City collaborated with the University of California, Berkeley's Safe Transportation Research & Education Center (SafeTREC) to publish the 2015 plan *Recommendations to Improve Pedestrian Safety in the City of Fresno*. The report

includes an assessment of existing pedestrian safety needs based on community workshops and a walkability assessment. Recommendations included in the report are listed in the following subsections.

6.4.1 COMMUNITY RESIDENT RECOMMENDATIONS

- Ensure sidewalk continuity and prioritize filling sidewalk gaps
- Prioritize sidewalk repair and maintenance
- Install additional pedestrian crossings with accompanying signals or beacons mid-block
- Upgrade crosswalk markings to high-visibility patterns
- Install lighting, including pedestrian-scale lighting
- Evaluate systemically and readjust pedestrian crossing times as needed
- Retrofit driveways that impact BRT stops
- Strengthen coordination with school district for pedestrian safety improvements

6.4.2 SAFETREC RECOMMENDATIONS

- Pursue grant funding for pedestrian access to transit planning and implementation of improvements
- Establish comprehensive midblock and uncontrolled crossing policy
- Install curb extensions and bus bulb-outs
- Refine the walkability assessment process

6.5 PREVIOUS HSIP PROJECTS

The City has received approximately $4.3 million in Highway Safety Improvement Program (HSIP) grant funds over the previous two HSIP cycles (2016-2018), targeting pedestrian safety improvements.

6.5.1 HSIP CYCLE 8

The City was awarded funds for three safety projects in Caltrans HSIP Cycle 8, released in 2016. These three projects totaled $929,200 in improvements and included the following:

- Installation of pedestrian countdown heads at along two corridors:
  - 23 signalized intersections along 10 miles of Herndon Avenue from Golden State Boulevard to Willow Avenue
  - 14 signalized intersections along five miles of Shaw Avenue from West Avenue to Chestnut Avenue
- Installation of a protected left-turn phase at the Dakota Avenue/West Avenue intersection

6.5.2 HSIP CYCLE 9

The City was awarded funds for three safety projects in Caltrans HSIP Cycle 9, released in 2018. These three projects totaled $3,422,600 in improvements and included the following:

- Upgrading pedestrian countdown equipment at 108 signalized intersections along the following corridors:
  - Belmont Avenue, from Delno Avenue to Clovis
  - Olive Avenue, from Fruit Avenue to Clovis
  - Various locations in the Tower District
  - First Street, from Ventura Avenue to Nees Avenue
- Installation of the following pedestrian safety improvements along Fresno Street:
  - Pedestrian hybrid beacons for crossing Fresno Street at Thomas Street and at San Jose Avenue
  - Protected left turn signals and upgraded pedestrian countdown equipment at R Street, Clinton Avenue, and intersections between B Street and Friant Road

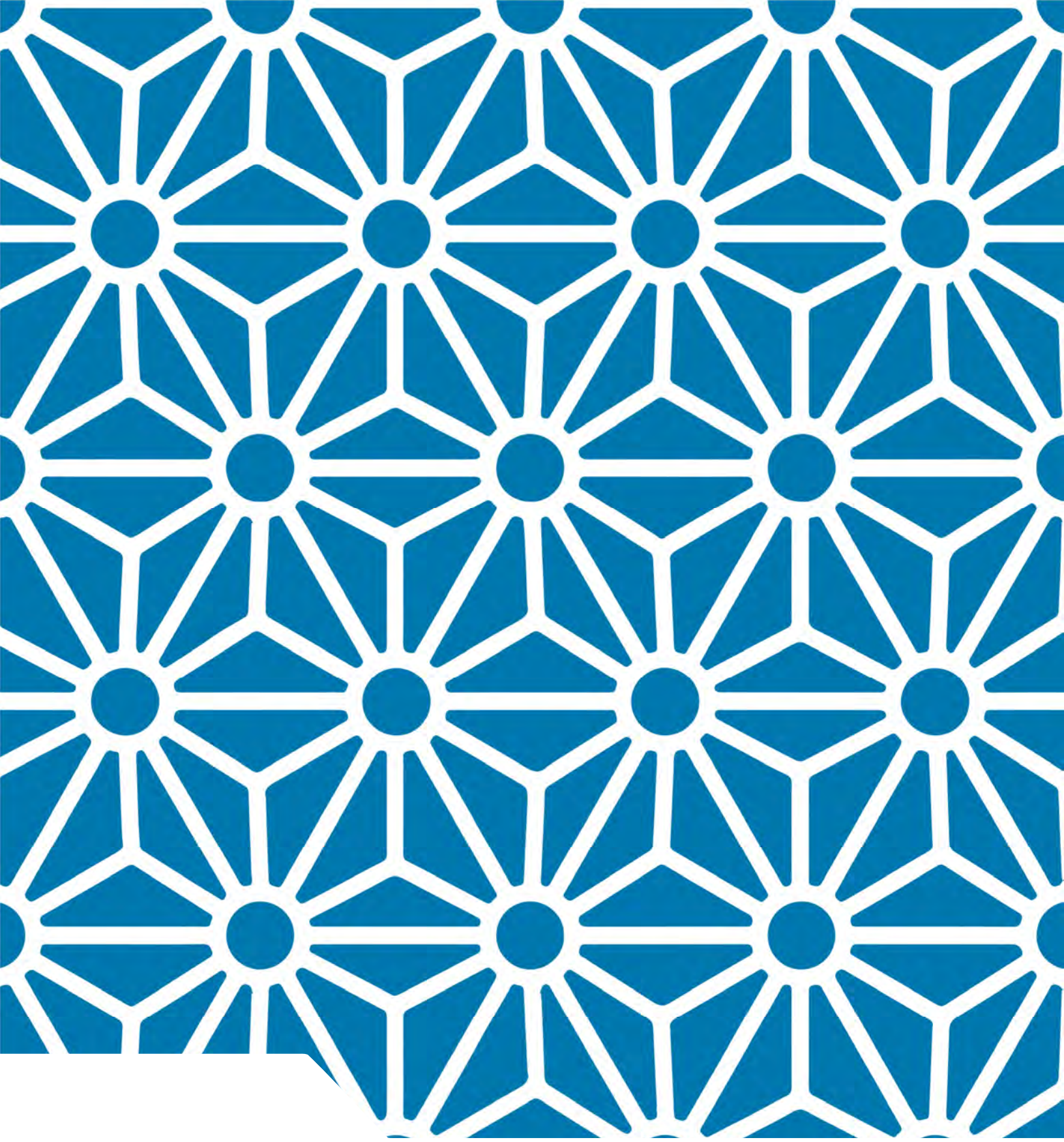
6.6 OTHER EFFORTS

In October 2019, the City adopted a complete streets policy, with the stated purpose of "solidify[ing] current City practices and [ensuring] consistency in the application."[1]

The City has a Bicycle and Pedestrian Advisory Committee (BPAC) to support staff in developing strong and supportive bicycle and pedestrian policies. One of the BPAC's primary charges is to participate in education efforts to promote bicycle and pedestrian safety. The BPAC has sponsored bicycle and pedestrian campaigns, including a public service announcement, bus advertisements, television and radio advertisements, and billboards. For these efforts, BPAC has partnered with the Fresno Police Department.

The City's Parks Department conducts safety outreach funded by grants from the California Office of Traffic Safety and the Active Transportation Program.

[1] The policy is available online at https://www.fresno.gov/publicworks/wp-content/uploads/sites/17/2019/10/Complete-Streets-091119.pdf.



DATA ANALYSIS TECHNIQUES AND RESULTS

7.DATA ANALYSIS TECHNIQUES AND RESULTS

The following section describes the methods and results for citywide collision patterns and trends and network screening and systemic evaluation analyses. The focus of the collision patterns and trends analysis is to identify behavioral and roadway patterns associated with injury and fatal collision outcomes. For the network screening and systemic evaluation analyses, the focus is to identify locations in the City that would benefit the most from transportation safety improvements. Findings from these analyses identify emphasis areas, help establish and measure progress toward goals, and inform the systemic countermeasures and projects described in subsequent sections of this report. A screening tool was developed as part of this process to update the analyses in the future as new crash data become available.

7.1 SAFETY DATA ANALYZED

This section documents the data assembled for analysis.

7.1.1 COLLISION DATA

The project team worked with the City to build a database of the five most recent complete years of reported collisions, representing January 1, 2014 through December 31, 2018. Reported collisions were provided by the City from Crossroads, an internal City-maintained database. Public databases that are typically used for this analysis appear to underrepresent collision frequency. The City also provided a log of fatal collisions with which the project team supplemented the database.

The collision data analyzed do not include collisions that occurred along grade-separated freeways or ramps in the City (Highways 41, 99, 168, and 180). However, the project team retained collisions occurring at or within the influence area of ramp terminal intersections for analysis. The project team identified and removed duplicate records by inspecting the recorded time, date, and location. A portion of the entries in the database provided by the City were geolocated with coordinates for spatial analysis. The project team used two methods to geolocate the remaining collisions that had no spatial information.

Where possible, the project team:

- Matched collisions with an associated record from the publicly available UC Berkeley Transportation Injury Mapping System (TIMS) database, which includes spatial information for reported injury and fatal collisions
- Used reference data saved in each collision record for primary and secondary streets, and associated distance and direction from intersection to geocode and manually offset collisions
- Geolocated collisions that could not be matched to a TIMS record. Of the 15,822 collisions in the database, 13,478 (85%) were successfully geolocated.
- Geolocated all reported fatal collisions in the database

The project team retained collisions that could not be geolocated for the descriptive analysis of citywide trends. However, the project team was not able to include them in spatial analysis or in analysis characterizing their association to roadway characteristics.

7.1.2 ROADWAY CHARACTERISTICS DATA

For this analysis, the project team assembled a spatial database to supplement the collision data with roadway characteristics and contextual data. The supplementary contextual data included data provided by the City and data collected by the project team. These were:

- **Bus stop locations:** The City provided a spatial database of Fresno Area Express transit stop locations citywide, separated by route number.
- **Posted speed limit:** The City provided the posted speed for public roadways.
- **Roadway segment lane configuration:** The project team identified roadways classified as arterial, super arterial or expressway on the City's roadway network, and used aerial imagery to collect the number of lanes per direction along roadway segments. The data represent lanes at mid-block locations and do not include exclusive turn lanes or acceleration lanes at intersections.
- **Median presence:** Along roadway segments for which roadway lane configuration was collected, the project team also collected median type and presence.

Traffic volume data were not available and thus are not incorporated in analysis or findings.

7.2 CITYWIDE COLLISION PATTERNS AND TRENDS

Trends and findings for all road users are presented under the following categories:

- Collision severity
- Collision location
- Collision type
- Primary collision factor
- Time of day
- Lighting conditions
- Alcohol and drug involvement

The Federal Highway Administration (FHWA) designated the City of Fresno as a Pedestrian-Bicycle Focus City in 2015. Such cities are selected based on number of pedestrian/bicyclist fatalities and a fatality rate per population higher than average. Given this designation, bicycle and pedestrian collisions are included in the following section and are also discussed in further detail in Section 7.2.1.2, beginning on page 34.

Collision Severity

Collisions are classified by severity based on their most severe outcome, arranged in descending order of severity: fatal, severe injury, other visible injury, complaint of pain injury, and property damage only (PDO).[2] Table 7-1 presents collisions by severity and by the road users involved (e.g., pedestrian, bicyclist, motorist).

[2] California Highway Patrol has added three additional classifications of injury status based on the Model Minimum Uniform Crash Criteria 5th Edition. This change occurred after the data for this document was analyzed and thus is not reflected in this analysis.

Table 7-1: Road Users Involved and Collision Severity, City of Fresno, 2014-2018

Road Users Involved in Collisions	Fatal (% of column)	Severe Injury (% of column)	Other Visible Injury (% of column)	Complaint of Pain (% of column)	Property Damage Only (% of column)	Total (% of column)
Bicyclist Involved	15 (8%)	54 (11%)	204 (14%)	235 (6%)	113 (1%)	621 (4%)
Pedestrian Involved	95 (51%)	156 (33%)	310 (21%)	325 (8%)	140 (1%)	1026 (6%)
Vehicle-Vehicle or Vehicle-Other (e.g., Fixed-Object)	76 (41%)	262 (56%)	930 (64%)	3301 (85%)	9608 (97%)	14177 (90%)
Reported Collisions (% of Total)	**186 (1%)**	**471 (3%)**	**1443 (9%)**	**3861 (24%)**	**9861 (62%)**	**15,822 (100%)**

Source: City of Fresno
Note: Percentages may not total to 100% due to rounding. Two collisions involve both a bicyclist and a pedestrian, and thus columns may not sum to totals.

- Among reported collisions, 657 (4%) resulted in either a severe injury or a fatality.
- The share of injuries and fatalities among pedestrian- and bicyclist-involved collisions is higher than their respective share among collisions overall.
  - Pedestrians are involved in 6% of reported collisions and 38% of fatal and severe injury collisions.
  - Bicyclists are involved in 4% of reported collisions and 11% of fatal and severe injury collisions.

Collision Location

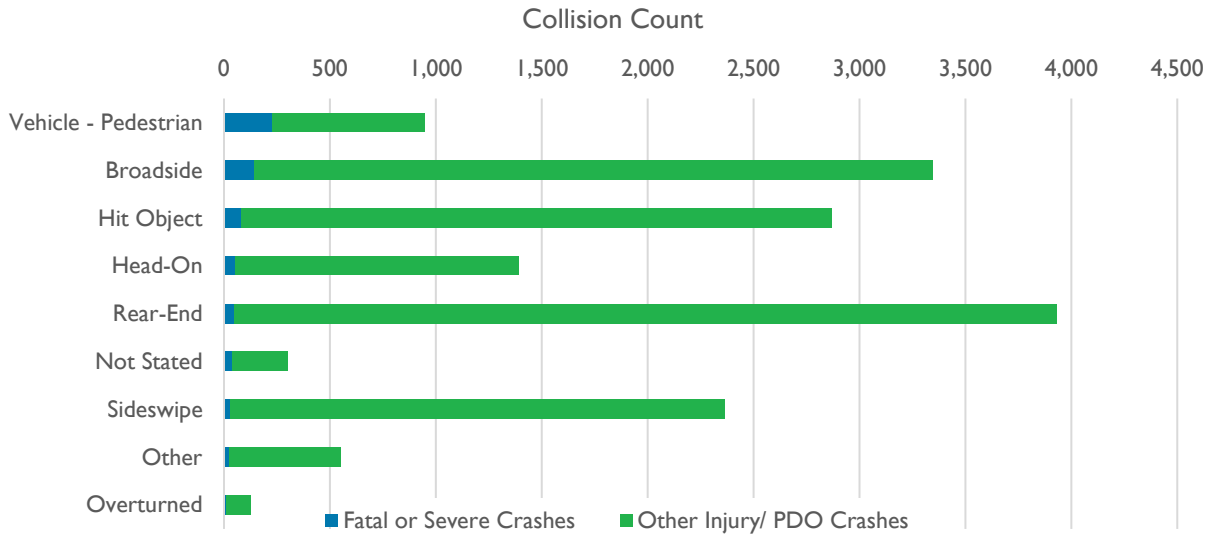
The project team divided and analyzed collisions by location, with intersection collision defined as occurring within a 250-foot influence area of an intersection. Collisions outside of this standard influence area were defined as segment collisions. The following are key collision location findings:

- 89% of geolocated collisions occurred at intersections, and 11% occurred along segments.
- The proportion of segment collisions resulting in a fatality (19%) is higher than the proportion of segment collisions among collisions of all severity levels (11%). This indicates that segment collisions are less common but are more likely to result in a fatality when they do occur.

Collision Type

Figure 7-1 presents collisions by reported type and severity, arranged in descending order by frequency of fatal and severe injury collisions.

Figure 7-1: Reported Collisions by Type and Severity, City of Fresno, 2014-2018



Source: City of Fresno
Note: Twenty-four collisions manually added from fatal logs did not include a collision type and are not provided in this chart.

As Figure 7-1 demonstrates, fatal and severe injury share does not directly correlate with number of total reported collisions by type. For example, even though rear-end collisions are the most frequently reported crash type, they have the fifth highest share of fatal and severe injuries.

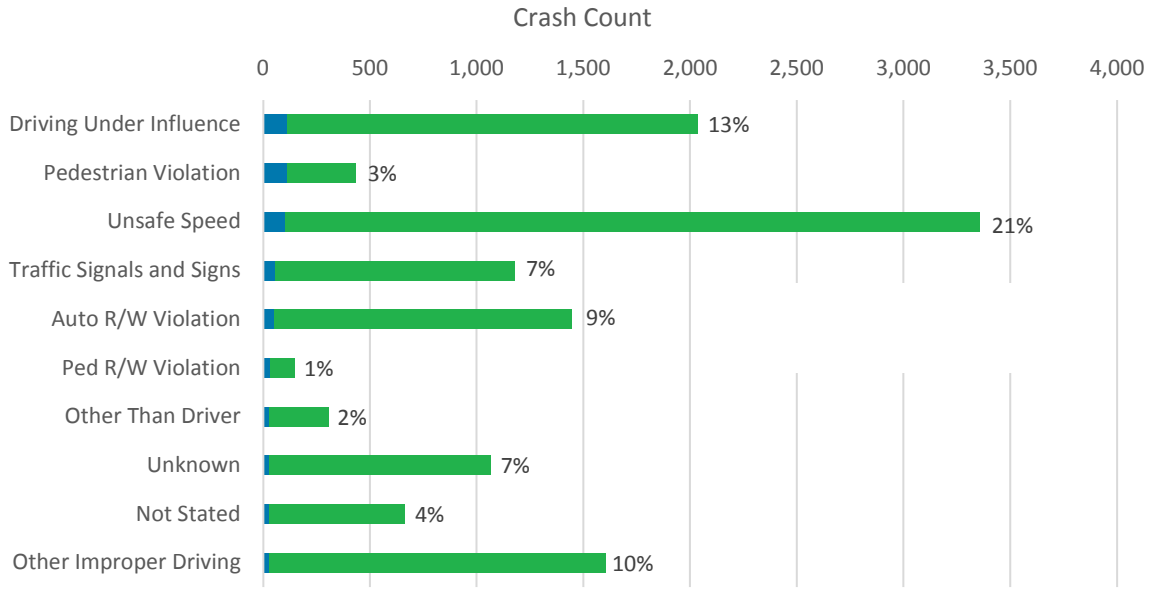
- The three most frequent collision types were:
  - Rear-end (25% of reported collisions)
  - Broadside (21% of reported collisions)
  - Hit object (18% of reported collisions)
- The three most frequent collision types resulting in fatal and severe injuries were:
  - Vehicle-pedestrian (35% of reported fatal and severe injury collisions)
  - Broadside (22% of reported fatal and severe injury collisions)
  - Hit object (13% of fatal and severe injury collisions)

These three collision types—vehicle-pedestrian, broadside, and hit object—account for 70% of fatal and severe injury collisions in Fresno and are discussed in more detail in subsequent sections of this report. Vehicle-bicycle crashes are not identified as a separate collision type in the collision data. Those collisions are recorded based on the actions of the parties involved and are included in the traditional collision types (e.g., broadside, turning, rear-end, sideswipe, etc.). While vehicle-bicycle collisions are not a distinct collision type, it is important to note that collisions involving a bicyclist account for 4% of total collisions and 10% of fatal and severe injury collisions. Pedestrian and bicycle collisions are discussed in Section 7.2.1.2 of this report.

Primary Collision Factor

Figure 7-2 presents reported collisions with the top 10 most frequently cited primary collision factors (PCFs). The figure is arranged in descending order by frequency of fatal and severe injury collisions.

Figure 7-2: Collisions by Reported Primary Collision Factor, City of Fresno, 2014-2018



Source: City of Fresno
Note: Percentages shown are percentages of total crashes for each primary collision factor.

- Driving under the influence and pedestrian violation[3] were the most frequently cited collision factors among fatal and severe collisions (each with 112 collisions).
- Unsafe speed was the most frequently cited collision factor overall (3,330 reported collisions).

Each of these collision factors correspond with California Vehicle Code (CVC) violations. The prevalence of these collision factors and associated CVC violations among the key collision types is analyzed below.

Primary Collision Factor Among Key Collision Types

Three key collision types—vehicle-pedestrian, broadside, and hit object—account for 70% of fatal and severe injury collisions. Broadside and hit object collisions are analyzed in more detail below; pedestrian collisions are discussed in the *Bicycle and Pedestrian Collisions* section (Section 7.2.1.2) of this report. The discussion of the primary collision factors accounts for collisions where the primary collision factor was cited as involving drugs and/or alcohol.

Broadside Collisions

A broadside collision is one in which a vehicle strikes another vehicle at an angle greater than that of a sideswipe. Broadside collisions account for 21% of reported collisions and 22% of fatal and severe injury collisions. Among broadside collisions where location information was available, 94% were intersection collisions. To isolate patterns among broadside collisions leading to severe outcomes, the project team analyzed exclusively fatal and severe injury broadside intersection collisions, organized by the most frequent primary collision factors and cited (CVC) violations. Table 7-2 presents this analysis.

[3] This is a reported PCF that indicated one of several CVCs involving a pedestrian failure to yield the right of way to other vehicles.

- Intersection-related broadside collisions occur more frequently at signalized than at unsignalized intersections (56% and 44%, respectively). They are frequently the result of traffic signals and signs[4] or motor vehicle right-of-way[5] violations.
- Twenty-nine fatal and severe injury broadside collisions were the result of a driver running a red light at a signalized intersection. This accounts for 5% of the 541 fatal and severe injury collisions at intersections. One of these 29 collisions was also cited as involving drugs and/or alcohol.

Hit Object Collisions

A hit object collision is one in which a vehicle strikes a fixed object or other object. Hit object collisions account for 18% of reported collisions and 13% of fatal and severe injury collisions. Among hit object collisions where location information was available, 86% were at intersections. To isolate patterns among hit object collisions leading to severe outcomes, the project team analyzed exclusively fatal and severe injury hit object intersection collisions, organized by the most frequent primary collision factors and cited (CVC) violations. Table 7-3 presents this analysis.

- Of those geolocated, 67% of intersection-related hit object collisions occurred at unsignalized intersections.
- The most common violation of a fatal and severe injury hit object collision was unsafe speed.
- Sixteen collisions were fatal and severe injury hit object collisions at unsignalized intersections with unsafe speed cited as a collision factor. This represents 3% of the 541 total fatal and severe injury intersection collisions.

[4] This is a reported PCF that indicated one of several CVCs involving a failure to adhere to traffic control (e.g., running a stop sign).

[5] This is a reported PCF that indicated one of several CVCs involving a failure to yield right of way to oncoming traffic.

Table 7-2: Intersection Fatal and Severe Broadside Collisions and Associated PCFs

California Vehicle Code (CVC)	Primary Collision Factor (PCF)	Description of CVC	Intersection Type			
			Signalized	Unsignalized	Unknown/ Other[1]	Total

[1]This includes collisions where precise location data was inconsistent.
Source: City of Fresno
Note: This table does not include the 24 fatal collisions that were manually added in, as they did not contain a reported collision type.

Table 7-3: Intersection Fatal and Severe Hit Object Collisions and Associated PCFs

California Vehicle Code (CVC)	Primary Collision Factor (PCF)	Description of CVC	Intersection Type		
			Signalized	Unsignalized	Total
VC 22350	Unsafe Speed	Driving at a speed greater than is reasonable or prudent for given conditions	8	16	24
VC 23152 (A and B)	Driving Under Influence	Driving under the influence of alcohol	9	15	24
VC 23153.A		Driving under the influence and performing an illegal act	1	3	4
VC 23152.(f)		Driving under the influence of drugs	1	3	4
Other	-	-	3	5	8
Total	**-**	**-**	**22**	**42**	**64**

[1]This includes collisions where precise location data was inconsistent or not available.
Source: City of Fresno
Note: This table does not include the 24 fatal collisions that were manually added in, as they did not contain a reported collision type.

Time of Day

Table 7-4 presents reported collisions by time of day and day of week, and Figure 7-3 presents reported collisions by vehicle type and time of day. Time of day analysis can be used to inform education programs (e.g., messaging about being alert under dark conditions), enforcement strategies, and lighting priorities.

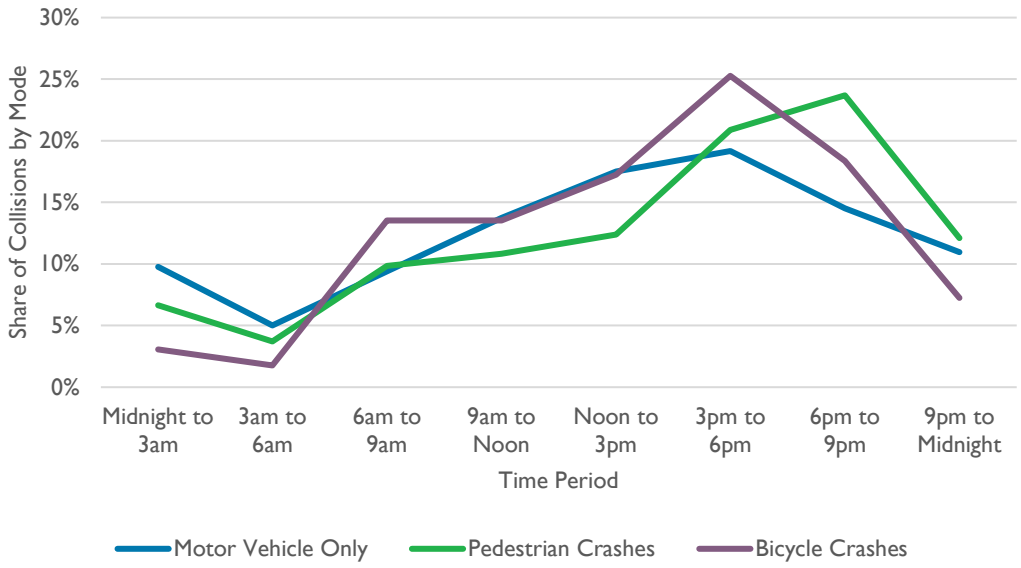
Table 7-4: Reported Collisions by Hour and Day of Week, City of Fresno, 2014-2018

Time of Day	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
12:00 a.m. - 12:59 a.m.	70	48	67	52	64	92	128
01:00 a.m. - 01:59 a.m.	60	41	44	46	55	110	132
02:00 a.m. - 02:59 a.m.	51	32	44	30	48	111	143
03:00 a.m. - 03:59 a.m.	27	29	23	24	33	78	75
04:00 a.m. - 04:59 a.m.	18	12	20	20	24	45	75
05:00 a.m. - 05:59 a.m.	18	25	16	40	36	69	53
06:00 a.m. - 06:59 a.m.	46	46	72	50	52	38	24
07:00 a.m. - 07:59 a.m.	105	109	114	110	99	46	42
08:00 a.m. - 08:59 a.m.	81	110	92	91	99	50	39
09:00 a.m. - 09:59 a.m.	84	114	116	84	84	63	62
10:00 a.m. - 10:59 a.m.	108	96	92	106	109	91	77
11:00 a.m. - 11:59 a.m.	127	126	136	117	145	106	98
12:00 p.m. - 12:59 p.m.	118	144	137	129	146	126	95
01:00 p.m. - 01:59 p.m.	128	133	139	126	136	100	89
02:00 p.m. - 02:59 p.m.	165	152	142	144	167	99	99
03:00 p.m. - 03:59 p.m.	147	170	154	168	163	104	92
04:00 p.m. - 04:59 p.m.	127	167	165	145	164	112	106
05:00 p.m. - 05:59 p.m.	175	178	158	180	194	118	101
06:00 p.m. - 06:59 p.m.	139	125	119	132	123	144	147
07:00 p.m. - 07:59 p.m.	85	86	106	108	145	123	118
08:00 p.m. - 08:59 p.m.	86	82	100	99	124	97	126
09:00 p.m. - 09:59 p.m.	75	84	81	94	117	139	107
10:00 p.m. - 10:59 p.m.	56	65	71	64	104	115	75
11:00 p.m. - 11:59 p.m.	42	55	60	50	78	115	75

Source: City of Fresno

- The weekday (Monday through Friday) hours with the highest frequency of reported collisions were 3:00-4:00 p.m. and 5:00-6:00 p.m. This temporal trend is relatively common across communities as these are the hours of the day when there is more vehicle traffic due to the end of school day and traditional evening commutes home from work.
- The weekend (Saturday and Sunday) hours with the highest frequency of reported collisions were 2:00-3:00 a.m. and 6:00-7:00 p.m.
    - 52% of weekend collisions occurred between 5:00 p.m. and 3:00 a.m.

Figure 7-3: Share of Collisions by Vehicle Type and Time of Day, City of Fresno, 2014-2018



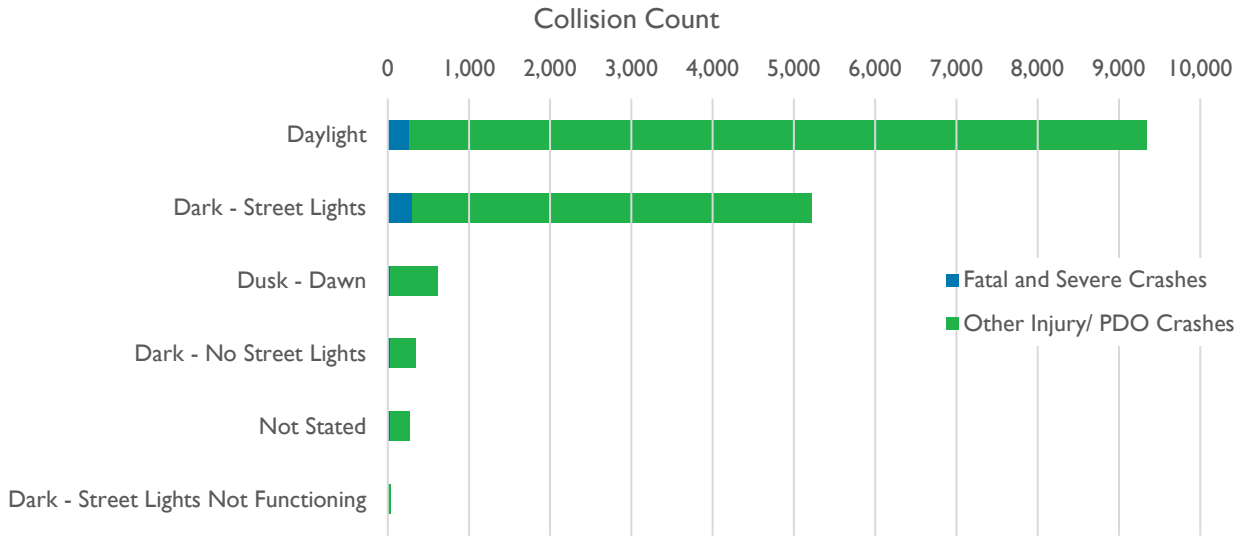
Source: City of Fresno

- Bicycle and motor vehicle-only collisions peak between 3:00 p.m. and 6:00 p.m.
- Collisions involving pedestrians peak later (6:00 p.m. to 9:00 p.m.).

Lighting

Figure 7-4 presents reported collisions by lighting and severity.

Figure 7-4: Reported Collisions by Lighting, City of Fresno, 2014-2018



Source: City of Fresno

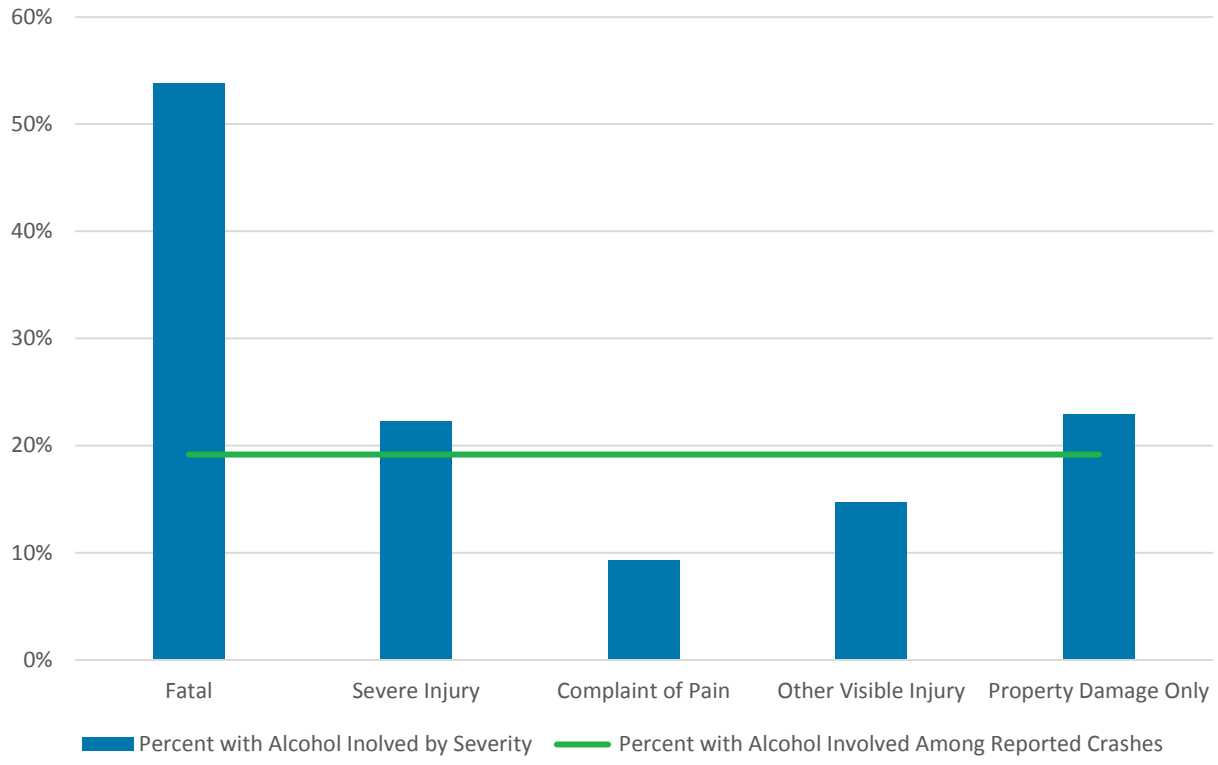
Note: This graph does not include the 24 fatal collisions that were manually added in, as they did not contain a reported lighting field.

- Collisions that occurred under dark conditions account for 35% of total reported collisions and 52% of fatal and severe injury collisions.
- Of the collisions that occurred under dark conditions, 93% were reported in locations with streetlights present. Even with streetlights present, motorists have a more difficult time judging speed of on-coming vehicles as well as more difficult time seeing pedestrians at night due to factors, such as headlight glare, shadows, or dark spots that can be created by inadequate lighting.
- Of the collisions that occurred under dark conditions, 7% involved a pedestrian. These collisions are discussed further in the "Lighting" subsection of the *Bicycle and Pedestrian Collisions* section (Section 7.2.1.2) of this report.
- Of the 105 fatal collisions that occurred under dark conditions, 18 occurred where there were either no streetlights or streetlights that were reported as not functioning.

Alcohol and Drug Involvement

Figure 7-5 presents reported collisions by severity and the percentage of collisions in which alcohol was involved.

Figure 7-5: Reported Collisions by Severity and Percentage with Alcohol Involved, City of Fresno, 2014-2018



Source: City of Fresno

Among total reported collisions, the share involving some level of alcohol was 19%. Among fatal collisions, the share involving some level of alcohol was 54%.

7.2.1 BICYCLE AND PEDESTRIAN COLLISIONS

Similar analyses for bicycle and pedestrian collisions are presented under the following categories:

- Movements preceding collision
- Primary collision factor
- Collision location
- Lighting conditions
- Hit-and-run violations
- Posted speed

Movements Preceding Collision

Bicyclist Collisions

Table 7-5 highlights the proportional distribution of severity between vehicle movement directions among reported collisions that involved a bicyclist.

To contextualize these collision dynamics, Table 7-5 provides the most frequent combinations of bicycle/vehicle trajectories and movements preceding collision. These results are sorted by the share of fatal and severe injury bicyclist-involved collisions.

Table 7-5: Bicycle and Vehicle Movement Combinations, City of Fresno, 2014 - 2018

Relative Direction	Bicycle Movement	Vehicle Movement	Fatal or Severe Injury Collision Count	Total Collision Count
Same Direction	Proceeding Straight	Proceeding Straight	13 (19%)	37 (6%)
Perpendicular	Proceeding Straight	Proceeding Straight	8 (12%)	92 (15%)
Not Stated	Proceeding Straight	Proceeding Straight	3 (4%)	19 (3%)
Not Stated	Proceeding Straight	Making Left Turn	3 (4%)	14 (2%)
Not Stated	Proceeding Straight	(blank)	3 (4%)	14 (2%)
Perpendicular	Proceeding Straight	Making Right Turn	2 (3%)	59 (10%)
Perpendicular	Entering Traffic	Proceeding Straight	2 (3%)	12 (2%)
Same Direction	Making Left Turn	Proceeding Straight	2 (3%)	12 (2%)
Not Stated	Entering Traffic	Proceeding Straight	2 (3%)	7 (1%)
Not Stated	Other	Proceeding Straight	2 (3%)	6 (1%)
Same Direction	Proceeding Straight	(blank)	2 (3%)	5 (1%)
Not Stated	(blank)	(blank)	2 (3%)	4 (1%)
Head On	Traveling Wrong Way	Proceeding Straight	2 (3%)	4 (1%)
Not Stated	Traveling Wrong Way	Proceeding Straight	2 (3%)	3 (0%)
Perpendicular	Proceeding Straight	Making Left Turn	1 (1%)	32 (5%)
Total			69 (100%)	620 (100 %)

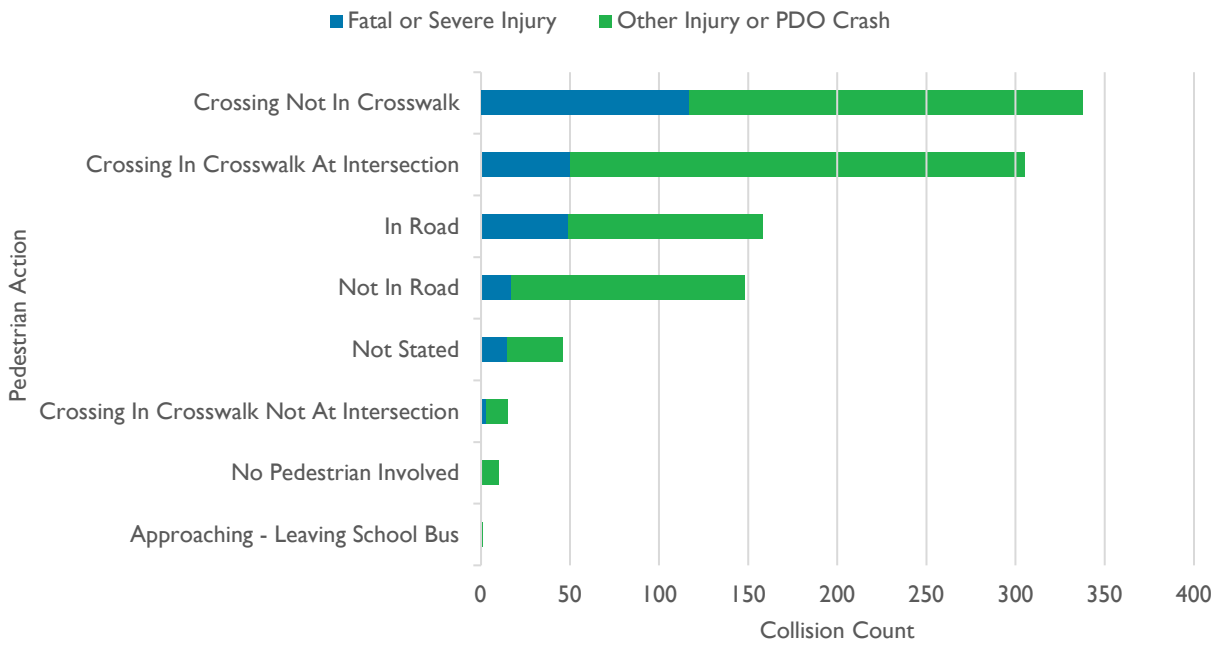
Source: City of Fresno

- Although 49% of reported bicycle collisions involved perpendicular movements, these movements were underrepresented in the fatal and severe injury collisions (26%).
- Same-direction collisions were overrepresented in the high-severity collisions, which could point to these collisions involving higher impact speeds.
- For overall bicycle collisions, the most frequent movement dynamics were:
  - Parties traveling perpendicular to one another, while both proceeding straight (92 collisions, 15%)
  - Parties traveling perpendicular, bicycle proceeding straight, motor vehicle making right turn (59 collisions, 10%); this collision type is sometimes referred to as a "right-hook" collision.
  - Parties traveling in the same direction, both proceeding straight (37 collisions, 6%)
- For fatal and severe injury bicycle collisions, the most frequent movement dynamics are:
  - Parties traveling in the same direction, both proceeding straight (13 fatal and severe injury collisions, 19%)
  - Parties traveling perpendicular, both proceeding straight (8 fatal and severe injury collisions, 12%)

Pedestrian Collisions

Figure 7-6 presents pedestrian-involved collisions by preceding pedestrian action and by severity.

Figure 7-6: Pedestrian Action Preceding Collision by Severity, City of Fresno, 2014 - 2018



Source: City of Fresno

- Crossing on a roadway outside of a crosswalk was the pedestrian action accounting for 26% of total reported pedestrian collisions and 47% of fatal or severe injury pedestrian collisions.
- The second and third most common pedestrian actions preceding a collision included crossing in a crosswalk at an intersection (30%) and pedestrian in roadway (15%).

To contextualize these pedestrian actions, Table 7-6 shows the most frequent combinations of pedestrian actions and vehicle movements preceding collision. This table is sorted by the total pedestrian-involved collision share. It includes the top 15 ranked combinations and the five most prevalent combinations for fatal and severe injury collisions.

Table 7-6: Pedestrian Action and Vehicle Movement Preceding Collision, City of Fresno, 2014 - 2018

Pedestrian Action	Vehicle Movement	Fatal or Severe Injury Collision Count	Collision Count
Crossing Not in Crosswalk	Proceeding Straight	106 (42%)	268 (26%)
In Road	Proceeding Straight	37 (15%)	103 (10%)
Crossing in Crosswalk at Intersection	Proceeding Straight	32 (13%)	101 (10%)
Crossing in Crosswalk at Intersection	Making Left Turn	12 (5%)	107 (10%)
Not Stated	Not Stated	11 (4%)	12 (1%)
Not in Road	Proceeding Straight	6 (2%)	46 (5%)
Not Stated	Proceeding Straight	4 (2%)	17 (2%)
Crossing Not in Crosswalk	(blank)	4 (2%)	7 (1%)
Crossing in Crosswalk at Intersection	Making Right Turn	3 (1%)	75 (7%)
In Road	Making Left Turn	3 (1%)	9 (1%)
In Road	(blank)	3 (1%)	9 (1%)
Not in Road	Backing	2 (1%)	49 (5%)
Crossing Not in Crosswalk	Making Left Turn	2 (1%)	17 (2%)
Not in Road	Making Left Turn	2 (1%)	13 (1%)
In Road	Making Right Turn	2 (1%)	10 (1%)

Source: City of Fresno
Note: Crossing Not in Crosswalk refers to crossing a roadway outside of either a marked or unmarked crosswalk. California vehicle code defines a crosswalk as "portion of a roadway included within the prolongation or connection of the boundary lines of sidewalks at intersections where the intersecting roadways meet at approximately right angles" (California Vehicle Code, DIVISION 1. WORDS AND PHRASES DEFINED [275]).

According to this analysis, the most common movements resulting in pedestrian injury or death are:

- Pedestrians crossing outside of a crosswalk being hit by vehicles proceeding straight. These are 26% of reported pedestrian collisions (268) and 42% of fatal or severe injury pedestrian collisions (106).
- Pedestrians crossing in crosswalk at intersections being hit by vehicles making left turns. These are 10% of reported pedestrian collisions (107 collisions) and 5% of fatal and severe injury pedestrian collisions (12).
- Pedestrians in the road being hit by vehicles proceeding straight. These are 10% of pedestrian collisions (103) but 15% of fatal and severe injury pedestrian collisions (37).
- Pedestrians crossing in crosswalks at intersections being hit by vehicles proceeding straight. These are 10% of reported pedestrian collisions (101) and 13% of fatal and severe injury pedestrian collisions (32).

Primary Collision Factor

Bicycle Collisions

Table 7-7 highlights the five most frequently reported primary factors associated with bicycle collisions in Fresno. The table sorts total collisions by movement and by the party cited at fault.

Table 7-7: Bicycle Collisions by Five Most Frequent PCFs by Cited at Fault, City of Fresno, 2014 - 2018

Primary Collision Factor (PCF)	**Bicyclist** (% of Bicycle Collisions with Bicyclist Cited at Fault)	**Driver** (% of Bicycle Collisions with Driver Cited at Fault)	**Parked Vehicle** (% of Bicycle Collisions with Parked Vehicle Cited at Fault)	**Unknown** (% of Bicycle Collisions with Unknown Cited at Fault)	**Total** (% of Bicycle Collisions)
Traffic Signals and					
Improper Turning					
Other Hazardous Movement					
Total (Top 5 PCF Share of Total Bicycle Collisions)					

Source: City of Fresno

Note: Total does not sum to 100% in all cases because only the top five primary collision factors are included; thus, the table is not inclusive of all reported bicycle collisions.

- The top five primary collision factors for bicycle collisions account for 61% of reported collisions involving a bicyclist.
- Bicyclists were most frequently cited as at fault, associated with 73% of total reported bicyclist collisions. Among the collisions in which the bicyclist was identified as the party most at fault, the top three primary collision factors were traveling down the wrong side of the road, traffic signals and signs[6], and motor vehicle right-of-way[7] violation.

Table 7-8 presents the five most common CVC violations for bicycle collisions.

Table 7-8: Most Common CVC Violations for Bicycle Collisions

Primary Collision Factor (PCF)	Description of CVC	Number of Pedestrian Collisions (% of Total Pedestrian Collisions)
CVC 21650	Failure to drive on the right half of the roadway	128 (21%)
CVC 22107	Turning a vehicle without reasonable safety or signal	51 (8%)
CVC 21453.A	Driver failure to stop at marked limit line or crosswalk at a red signal	49 (8%)
CVC 21804.A	Driver failure to yield right-of-way when approaching a highway	36 (6%)
CVC 21202.A	Bicyclist failure to travel at a reasonable speed as close to the right-hand curb or edge of roadway	32 (5%)

Source: City of Fresno

Pedestrian Collisions

Table 7-9 presents the primary collision factors most frequently associated with pedestrian collisions in Fresno. The table sorts total collisions by movements and by the party cited at fault.

[6] This is a reported PCF indicating one of several CVCs involving a failure to adhere to traffic control (e.g., running a stop sign).

[7] This is a reported PCF indicating one of several CVCs involving a failure to yield right of way to oncoming traffic.

Table 7-9: Pedestrian Collisions by Five Most Frequent PCFs by Cited at Fault, City of Fresno, 2014 - 2018

Primary Collision Factor (PCF)	**Pedestrian** (% of Pedestrian Collisions with Pedestrian Cited at Fault)	**Driver** (% of Pedestrian Collisions with Driver Cited at Fault)	**Other** (% of Pedestrian Collisions with Other Cited at Fault)	**Unknown /Not Stated** (% of Pedestrian Collisions with Unknown Cited at Fault)	**Total Percent** (% of Pedestrian Collisions)
Other Improper Driving					
Other Than Driver					
Total (Top 5 PCF Share of Total Bicycle Collisions)					

Source: City of Fresno
Note: Total does not sum to 100% in all cases because only the top five primary collision factors are included; thus, the table does not include all bicycle collisions.

- The top five primary collision factors accounted for 769 collisions, or 75% of total reported pedestrian collisions.
- Pedestrians were most frequently cited as at fault, associated with 96% of total reported pedestrian collisions. Among the collisions in which the pedestrian was identified as the party most at fault, the top three primary collision factors were pedestrian violation[8], pedestrian right-of-way violation[9], and other improper driving.

Table 7-10 presents the five most common CVC violations for pedestrian collisions.

Table 7-10: Most Common CVC Violations for Pedestrian Collisions

Primary Collision Factor (PCF)	Description of CVC	Number of Pedestrian Collisions (% of Total Pedestrian Collisions)
CVC 21954.A	Pedestrian failure to yield right-of-way to vehicles when outside of a crosswalk (marked or unmarked at an intersection)	194 (19%)
CVC 21950.A	Vehicle failure to yield right-of-way to a pedestrian crossing the roadway within any marked crosswalk or within any unmarked crosswalk at an intersection	125 (12%)
CVC 21950.B	Pedestrian suddenly entering into roadway or into path of a vehicle to create an immediate hazard	86 (8%)
CVC 22350	Unsafe speed	65 (6%)
CVC 21955	Pedestrians crossing roadway outside of a crosswalk	35 (3%)

Source: City of Fresno

Collision Location

Bicyclist Collisions

A total of 620 bicyclist-involved collisions occurred in the Fresno area between 2014 and 2018. Of these, 510 occurred within 250 feet of intersections, and 52 occurred at mid-block segments. The location of the remaining 58 collisions could not be identified using the information available.

[8] This is a reported PCF that indicated one of several CVCs involving a pedestrian failure to yield the right of way to other vehicles.

[9] This is a reported PCF that indicated one of several CVCs involving a failure of a driver of a vehicle to yield the right of way to a pedestrian.

Unknown location types reflect collisions that were outside the 250-foot buffer zone of intersections or segments. For example, they were likely located on private property, such as parking lots, or the geographic information provided in the police report was insufficient to identify the specific location.

Table 7-11 highlights the distribution of bicycle collisions by location type.

Table 7-11: Bicycle Collisions by Location Type by Severity, City of Fresno, 2014 - 2018

Location Type	Fatal or Severe Injury	Other Injury or PDO	Grand Total
Unsignalized Intersection	34 (49%)	218 (40%)	252 (41%)
Signalized Intersection	23 (33%)	235 (43%)	258 (42%)
Mid-Block Segment	8 (12%)	44 (8%)	52 (8%)
Unknown	4 (6%)	54 (10%)	58 (9%)
Total	**69 (100%)**	**551 (100%)**	**620 (100%)**

Source: City of Fresno

- Most of the bicycle collisions (83%) took place at intersections and are roughly evenly divided between signalized and unsignalized intersections. Of the fatal and severe injury collisions, 82% occurred at intersections. Collisions resulting in a fatal or severe injury were 16% higher at unsignalized intersections.
- Eight percent of overall bicycle collisions and 12% of fatal and severe collisions were located in mid-block roadway segments.
- This suggests that for bicycle collisions, both signalized and unsignalized intersection collisions were more likely to result in severe injuries or fatalities.

Pedestrian Collisions

Collisions that involved a pedestrian were more common at intersections rather than in mid-block segments. Table 7-12 highlights collisions that involved a pedestrian by location type and severity.

Table 7-12: Pedestrian Collisions by Location Type and Severity, City of Fresno, 2014 - 2018

Type	Fatal of Severe Injury	Other Injury or PDO	Grand Total
Unsignalized Intersection	113 (45%)	253 (33%)	366 (36%)
Signalized Intersection	77 (31%)	326 (42%)	403 (39%)
Mid-Block Segment	43 (17%)	79 (10%)	122 (12%)
Unknown	18 (7%)	112 (15%)	130 (13%)
Total	**251 (100%)**	**770 (100%)**	**1021 (100%)**

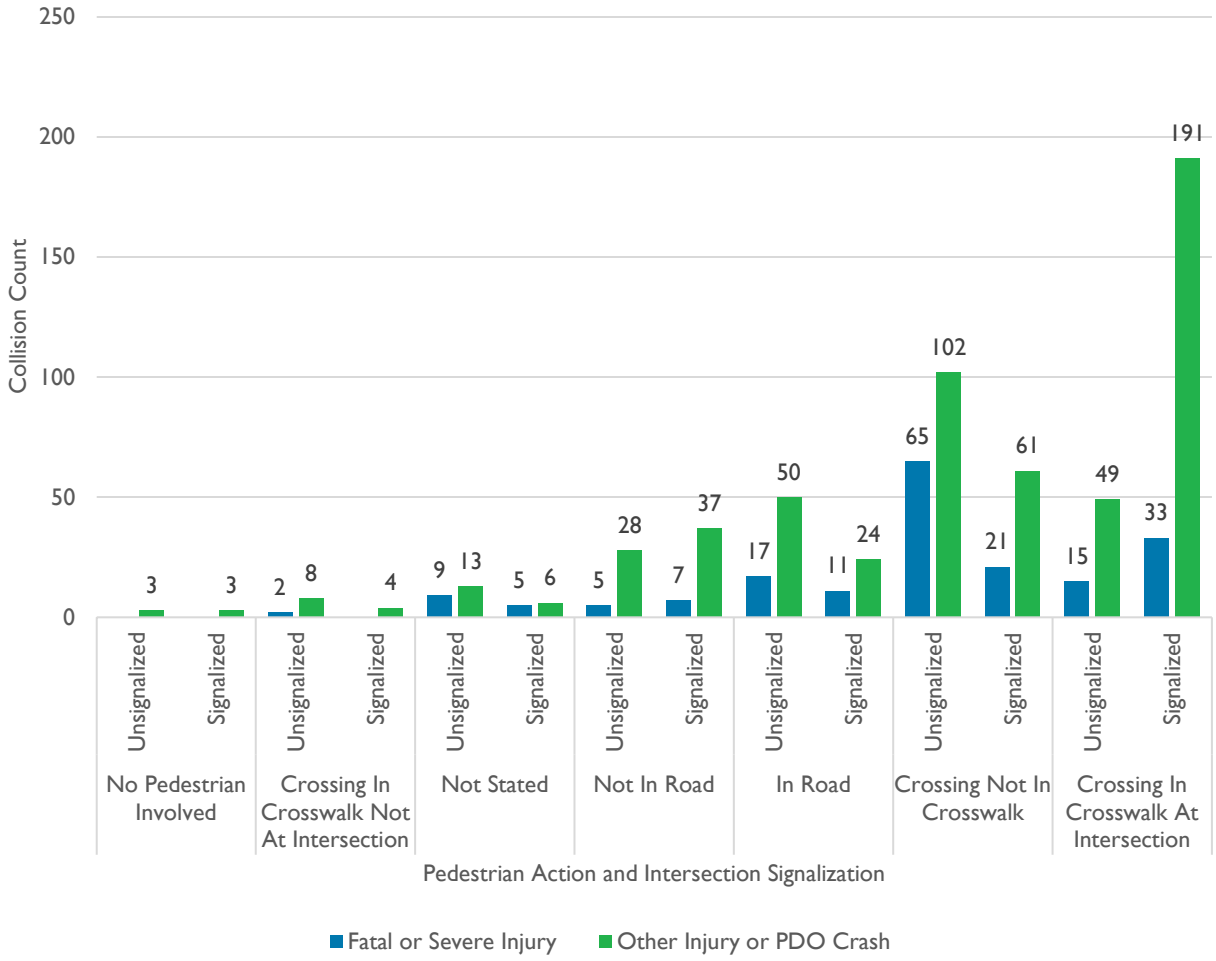
Source: City of Fresno

- Approximately 75% of total pedestrian-involved collisions occurred at intersections, which was consistent among collisions that resulted in a fatality or severe injury (75%), as well as collisions that resulted in less than severe injuries or property damage only (75%). In other words, intersection pedestrian collisions did not result in disproportionately more or less fatal or severe injury collisions.
- Pedestrian collisions at unsignalized intersections were disproportionately severe, comprising 45% of fatal and severe injury pedestrian collisions.

This analysis was not able to determine the location type for 13% of collisions. This is because some collisions were outside of the 250-foot search zone around segments and intersections or had insufficient geographic information to be accurately located.

Figure 7-7 highlights the distribution of pedestrian-involved collisions at intersections by pedestrian action preceding a collision at signalized versus unsignalized intersections and by severity.

Figure 7-7: Pedestrian Collisions at Intersections by Pedestrian Action and Severity, City of Fresno, 2014 - 2018



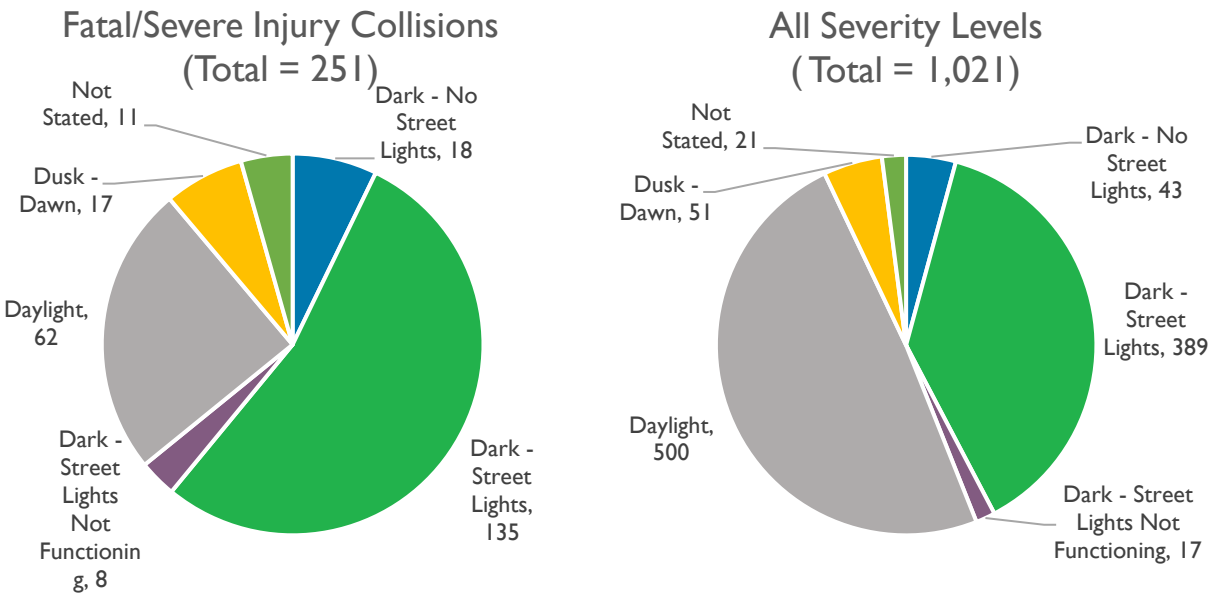
Source: City of Fresno

- The majority of pedestrian-involved collisions occurred while a pedestrian was crossing at an intersection, either in a crosswalk or outside of a crosswalk.
- A disproportionally high number (167) of pedestrian-involved collisions involved a pedestrian crossing outside of a crosswalk, and occurred at unsignalized intersections.
  - Unsignalized intersections were the site of 34% of collisions that resulted in a fatality or severe injury compared to 11% at signalized intersections.
- Even with crosswalks present, the frequency of fatal and severe injury collisions occurring at unsignalized intersections was higher compared to signalized intersections.

Lighting

The presence of lighting influences pedestrian safety. Figure 7-8 depicts the distribution of pedestrian collisions resulting in fatal and severe injury collisions versus total reported collisions.

Figure 7-8: Pedestrian Collisions and Lighting Conditions, City of Fresno, 2014 – 2018



Source: City of Fresno

- Forty-four percent of reported pedestrian collisions (449 collisions) and 64% of fatal or severe injury pedestrian collisions (161 collisions) occurred under dark conditions.
- Over half of fatal and severe injury pedestrian collisions occurred under dark conditions at locations with streetlights.

Hit-and-Run Violations

Nearly 15% of bicycle and pedestrian collisions involved a violation in which the party at fault left the scene without providing personal information to the police or returning to the police to provide their information.

Bicycle Collisions

- Twenty percent of fatal and severe injury bicycle collisions involved a felony hit-and-run violation.
- Fourteen percent of injury or PDO collisions involved a misdemeanor hit-and-run violation.

Pedestrian Collisions

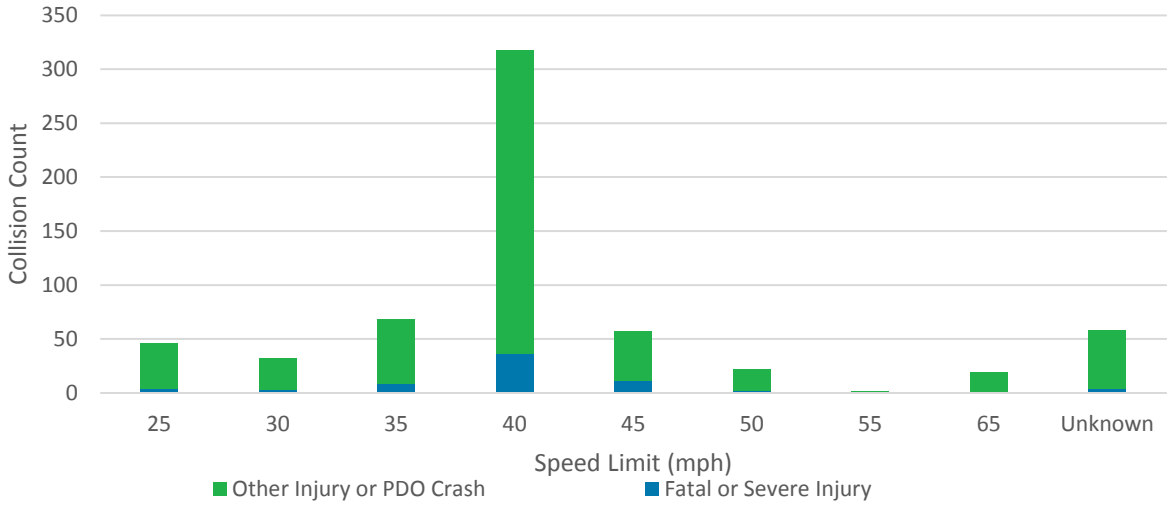
- Seventy percent of pedestrian collisions that resulted in a fatality or severe injury did not involve a hit-and-run violation. This trend is similar among other pedestrian collisions that resulted in a less than severe injury or did not result in a fatality. However, a quarter (25%) of the collisions that resulted in a fatality or severe injury involved a felony hit-and-run violation.
- Ten percent of injury or PDO collisions included a hit-and-run misdemeanor violation.

Posted Speed

Bicycle Collisions

Figure 7-9 depicts the highest speed limit in vicinities where bicycle collisions occurred.

Figure 7-9: Bicycle Collisions by Posted Speed, City of Fresno, 2014 - 2018



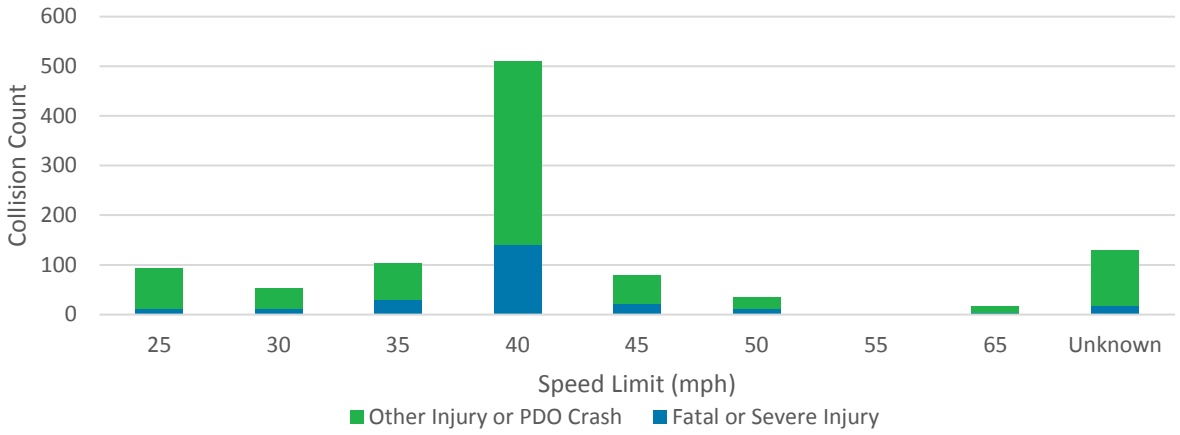
Source: City of Fresno

- Most bicyclist-involved collisions occurred on streets or intersections with a posted speed limit of 40 mph.

Pedestrian Collisions

Figure 7-10 depicts the highest speed limit in vicinities where pedestrian collisions occurred.

Figure 7-10: Pedestrian Collisions by Speed Limit, City of Fresno, 2014 - 2018



Source: City of Fresno

The analysis indicates the following:

- Streets with posted speeds of 40 mph were most frequently the site of pedestrian collisions, accounting for 50% of pedestrian collisions and 56% of fatal and severe injury pedestrian collisions.
- Higher speeds tend to lead to more severe outcomes, as 15% of pedestrian collisions on streets with posted speeds of 25 mph led to a fatality or severe injury, while 28% of pedestrian collisions on streets with posted speeds of 35 mph or greater led to a fatality or severe injury. The decrease in the number of collisions occurring on roadways with posted speed of 45 mph or greater is due to the limited number of road miles within the City where such posted speed limits exist.

7.3 NETWORK ANALYSIS AND SYSTEMIC FINDINGS

7.3.1 DATA AND NETWORK SCREENING APPROACH

This section describes the network screening and systemic evaluation of the Fresno roadway network. The project team identified the intersections and segments with the highest collision severity using the Equivalent Property Data Only (EPDO) network screening performance measure from the *Highway Safety Manual* (*HSM*). The project team performed the EPDO screening calculation for all public at-grade locations (intersections and roadway segments) within the City. Private roads and grade separated highways were excluded from the analysis. The EPDO performance measure is described below and moving forward throughout this document will be referred to as a "collision severity score."

The collision severity score assigns weight to individual collisions by collision severity and location of the collision (Table 7-13). Weights, provided by the 2018 Caltrans Local Roadway Safety Manual, are based on the cost of PDO collisions, assigning each collision a score relative to a PDO collision.[10]

Table 7-13. Collision Weights by Severity and Location Type

Location Type	Collision Weights by Severity				
	Fatal	Severe Injury	Other Visible Injury	Complaint of Pain	Property Damage Only
Signalized Intersection	123.73	123.73	10.72	6.09	1
Unsignalized Intersection	195.76	195.76	10.72	6.09	1
Roadway	169.49	169.49	10.72	6.09	1

Source: Caltrans, *Local Roadway Safety: A Manual for California's Local Road Owners* (Version 1.4), 2018.

The weights prioritize fatal and severe injury collisions equally to recognize that a death versus a severe injury is often a function of the individual involved or of emergency response time. Therefore, both outcomes represent locations where the City may want to prioritize improvements. Collision weights vary by location due to the relative costs associated with the collision severity at the location types. Specifically, unsignalized intersections have a higher cost for fatal and severe collisions because fatal and severe collisions at these locations tend to result in more severe injuries on average.

Intersection Methodology

The project team identified signalized and unsignalized intersections in the Fresno road network and then defined collisions as intersection or segment collisions.

[10] Note that since the analysis for the Fresno SSAR was conducted, a new version of the Local Roadway Safety Manual was released in April 2020. However, the revised version does not significantly adjust collision costs used to generate the collision severity score.

As previously described, an intersection collision is defined as a collision within a 250-foot influence area of an intersection. These collisions were spatially joined and summarized in GIS software to summarize the total number of collisions by severity at each intersection. Where intersections were less than 500 feet from each other, collisions were assigned to the nearest of the two intersections. Collisions occurring more than 250 feet from any intersection were separated to be used in the segment analysis discussed below.

The project team calculated the collision severity score for the intersections by multiplying each collision severity total by associated weight (by intersection type) and summing the results, using the following formula:

Collision Severity Score = (Fatal weight) x (# of fatal collisions) + (severe injury weight) x (# of severe injury collisions) +(other visible injury weight) x (# of other visible injury collisions) + (complaint of pain injury weight) x (# of complaint of pain injury weight collisions) + (PDO collisions)

The project team annualized the collision severity score by dividing the score by the number of years (five) of collision data used in the analysis.

Roadway Segment Methodology

The project team used the collisions that occurred more than 250 feet from the nearest intersection to conduct a separate segment analysis. The project team used a Python script in ArcGIS to split the Fresno street network into overlapping half-mile segments, incrementing the segments by one-quarter (1/4) of a mile. This methodology helps to identify portions of roadway with the greatest potential for safety improvements.

After splitting the network, the Python script spatially joined non-intersection collisions to each segment. Similar to the intersection methodology above, the project team summarized the collisions by severity and multiplied the totals by the collision severity weights for roadway segments. The weighted severity scores of the collisions were totaled and annualized by the number of years of collision data (five) to generate an annualized collision severity score.

Road Users

The project team performed the intersection and roadway segment screenings described above twice. They conducted intersection and segment screenings of collisions involving bicyclists or pedestrians to identify locations with a relatively high frequency and severity of collisions involving those road users. Separately, the project team conducted a network screening to identify relatively high-collision, high-severity locations among the remaining collisions that involved motor vehicles but not pedestrians or bicyclists.

Risk Factor Data and Approach

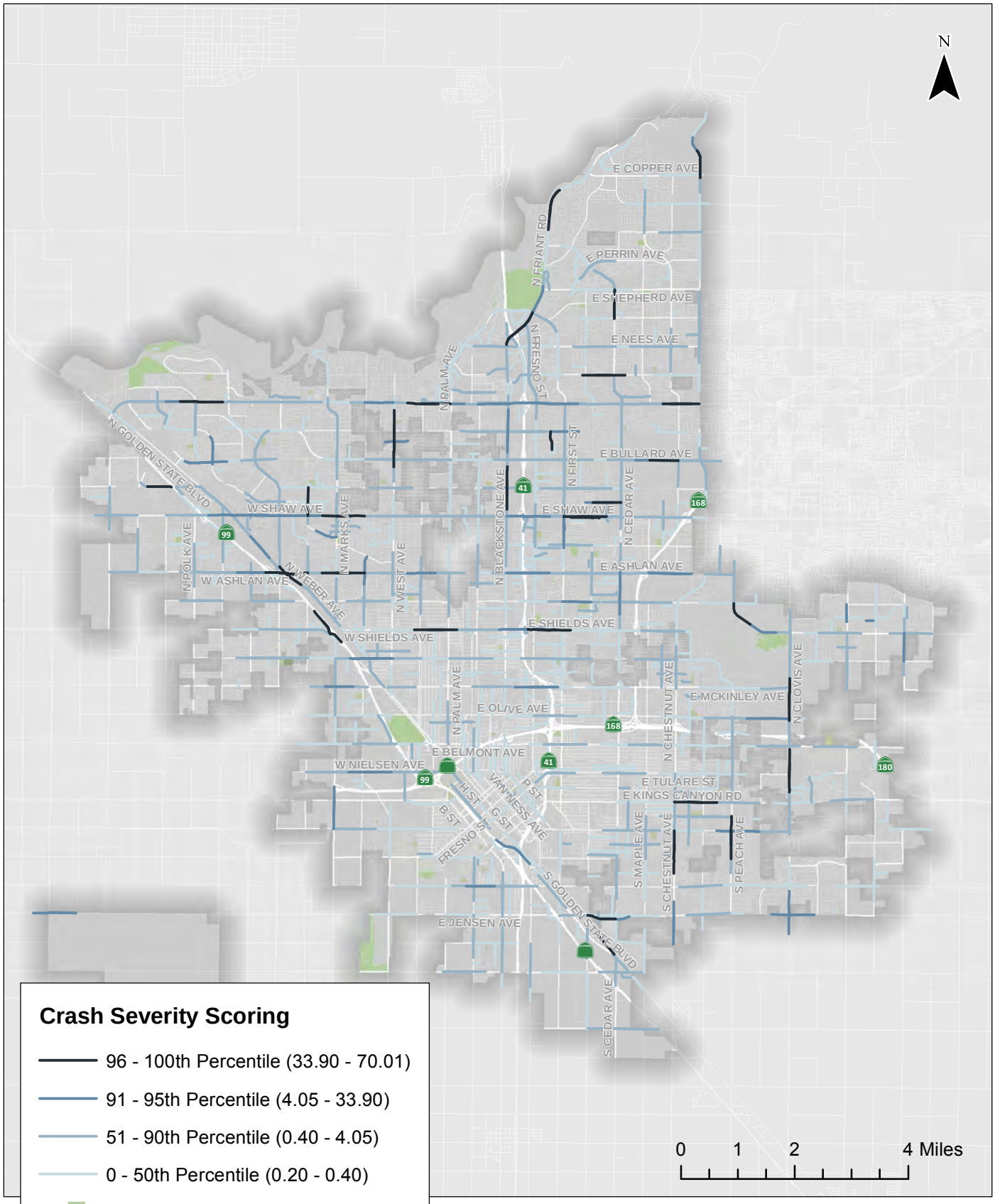
The project team conducted a systemic analysis of collision trends to identify risk factors, using the location and roadway characteristics previously described and analyzed. Risk is defined as common traffic or physical characteristics shared by the top corridors and intersections. Based on this commonality, the presence of risk factors is indicative of a potentially higher risk for collisions in Fresno. This analysis does not prove causality; its goal is to show potential connections and contributing factors.

The project team used the risk factors during project identification and development to assist in identifying potential treatments to reduce collision frequency and severity. These risk factors can also be used to identify additional similar locations where collisions could potentially occur but have not yet. The location of collisions is, to a degree, inherently random; therefore, this methodology is intended to help address potential causes of collisions rather than simply respond to collisions that have occurred. These results can help identify opportunities to implement low-cost improvements to locations with risk factors and reduce the potential for future collisions.

7.3.2 MOTOR VEHICLE FINDINGS

The project team identified priority intersections and segments using the annualized collision severity scores; the results are presented below. For intersection locations, the collision severity scores ranged from zero (no reported collisions during the five years) to 118.6.[11] For the half-mile roadway segments, the collision severity scores ranged from zero to 70.0[12]. Figure 7-11 and Figure 7-12 show the results of the collision severity scoring by percentiles for roadway segment and intersection locations, respectively. No collisions were reported at intersections or segments shown as not falling within one of the quartiles.

[11] For reference, the location with a collision severity score of 118.6 was associated with the following outcomes: four fatal/severe injury collisions and eight complaint of pain injury collisions.
[12] For reference, the location with a collision severity score of 70.0 was associated with the following outcomes: two fatal/severe injury collisions and one complaint of pain injury collision.



Crash Severity Scoring

- 96 - 100th Percentile (33.90 - 70.01)
- 91 - 95th Percentile (4.05 - 33.90)
- 51 - 90th Percentile (0.40 - 4.05)
- 0 - 50th Percentile (0.20 - 0.40)
- Parks
- City Boundary

Segment Screening
Crash Severity Scores
City of Fresno SSAR

Figure
7-11

KITTELSON & ASSOCIATES

Coordinate System: NAD 1983 StatePlane California IV FIPS 0404 Feet
Data Source: City of Fresno

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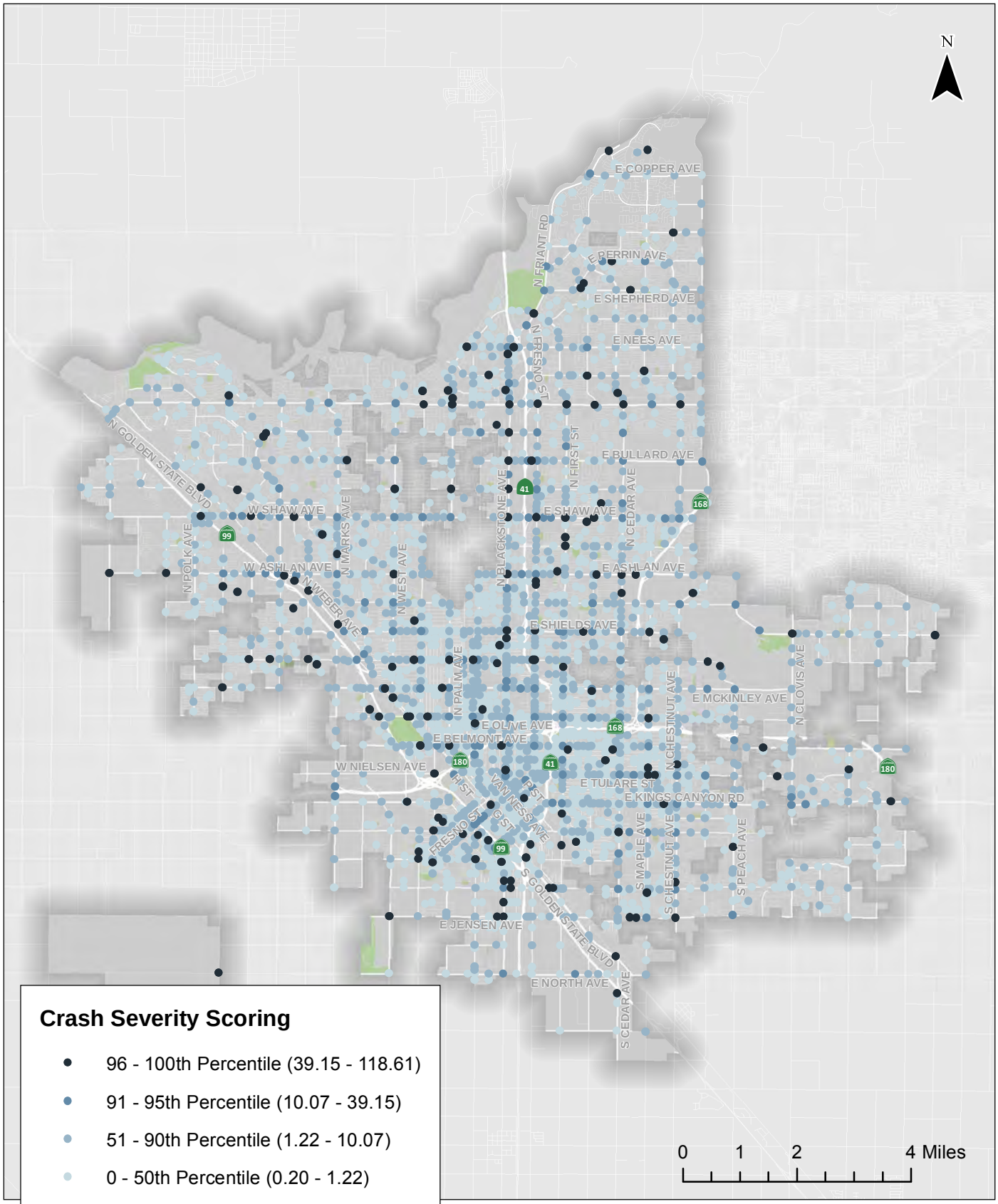

Crash Severity Scoring

- 96 - 100th Percentile (39.15 - 118.61)
- 91 - 95th Percentile (10.07 - 39.15)
- 51 - 90th Percentile (1.22 - 10.07)
- 0 - 50th Percentile (0.20 - 1.22)
- Parks
- City Boundary

Intersection Screening
Crash Severity Scores
City of Fresno SSAR

Exhibit
Figure
7212

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KITTELSON & ASSOCIATES

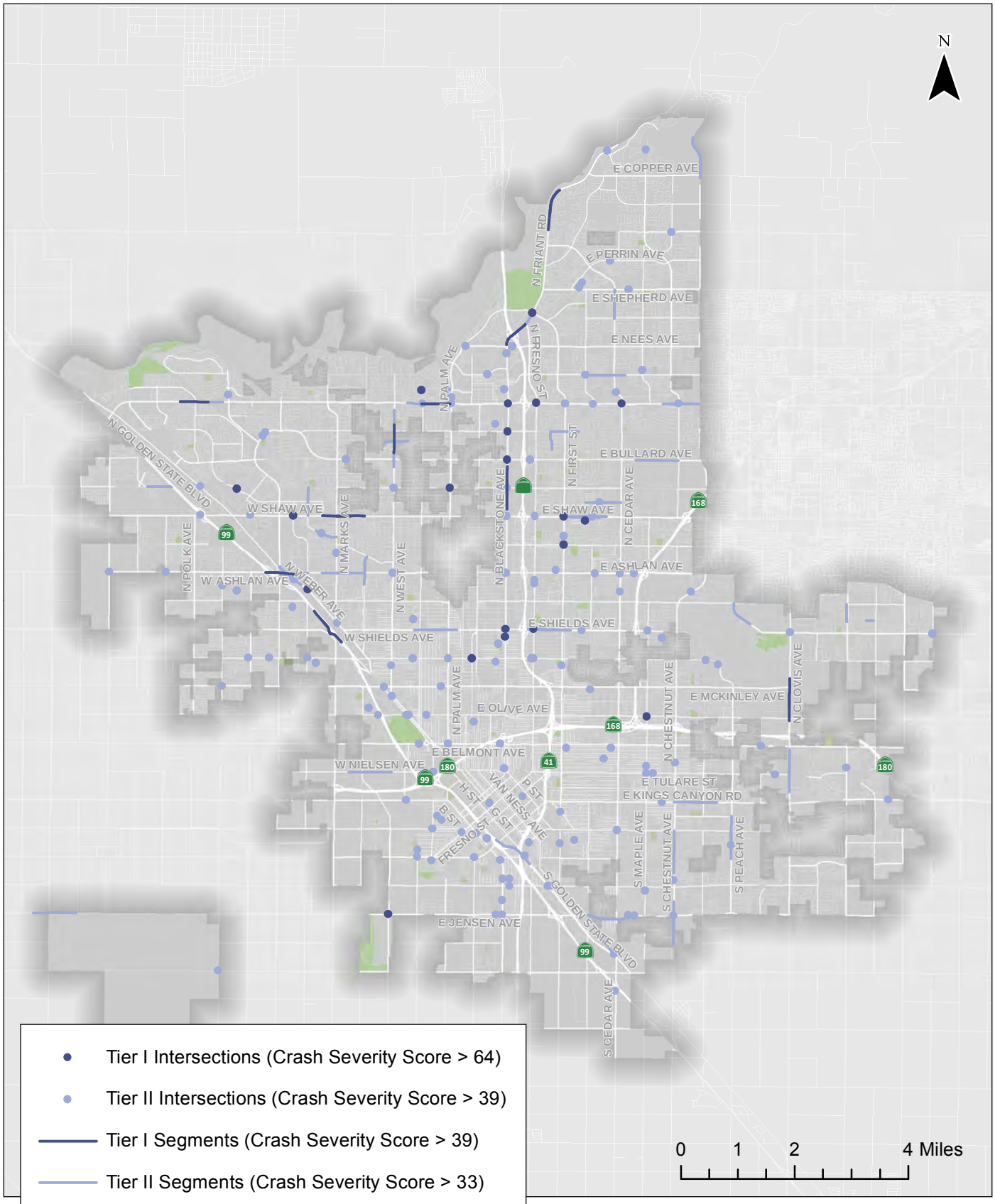
Coordinate System: NAD 1983 StatePlane California IV FIPS 0404 Feet
Data Source: City of Fresno

Motor Vehicle Priority Locations

The project team identified priority intersections and segments using the annualized collision severity score for intersections and segments. The top 5% of intersections and of segments were used as a starting point to identify priority locations: a total of 164 intersections and 73 roadway segments. Then, the project team created a focused list of the top 20 intersections and 15 roadway segments by collision severity score, collision types, and collision factors (Tier I locations). This refined list of priority locations is provided in Table 7-14 and Figure 7-13. The remaining 144 intersections and 58 segments represent other eligible locations (Tier II locations) where a systemic approach could be taken.

Table 7-14. Motor Vehicle Screening Priority Locations

Location	Annualized Collision Severity Score
Intersections	
First Street and Shaw Avenue	118.6
Blackstone Avenue and Shield Avenue	98.8
Blackstone Avenue and Bullard Avenue	92.8
Fresno Street and Shields Avenue	90.7
First Street and Gettysburg Avenue	86.1
Blackstone Avenue and Cornell Avenue	85.0
Audubon Drive and Friant Road	85.0
Valentine Avenue and Weber Avenue	84.6
Jensen Avenue and West Avenue	79.7
Fourth Street and Sierra Madre Avenue	78.7
Fruit Avenue and Locust Avenue	78.3
Salinas Avenue and San Jose Avenue	78.3
Marty Avenue and Shaw Avenue	78.2
Blackstone Avenue and Herndon Avenue	76.7
Blackstone Avenue and Sierra Avenue	72.5
Clinton Avenue and Wishon Avenue	67.4
Maple Avenue and Olive Avenue	66.5
Cedar Avenue and Herndon Avenue	65.4
Barstow Avenue and Palm Avenue	64.5
Fresno Street and Herndon Avenue	63.8
Segments	
Shaw Avenue (between Feland Avenue and Shaw Lane)	70.0
Shaw Avenue (between Marks Avenue and Hughes Avenue)	69.0
Friant Road (980 feet south of Lakeview Drive to 1,660 feet north of Lakeview Drive)	67.8
Friant Road (340 feet north of Lakeview Drive to 2,980 feet north of Lakeview Drive)	67.8
Parkway Drive (between Shields Avenue and Valentine Avenue)	67.8
Parkway Drive (between Shields Avenue and 99 SB on-ramp)	67.8
West Avenue (between Calimyrna Avenue and 600 feet north of Sierra Avenue)	67.8
Blackstone Avenue (between Bullard Avenue and Barstow Avenue)	42.6
Blackstone Avenue (between Barstow Avenue and Shaw Avenue)	42.4
Friant Road (between Fresno Street and Nees Avenue)	40.9
Clovis Avenue (between Olive Avenue and McKinley Avenue)	40.1
Clovis Avenue (between Lamona Avenue and Clinton Avenue)	40.0
Herndon Avenue (from 1,440 feet west of Spruce Avenue to 1,195 feet east of Spruce Avenue)	39.6
Herndon Avenue (between Fruit Avenue and Palm Avenue)	39.0
Ashlan Avenue (between Parkway Drive and Marty Avenue)	38.5



Priority Locations
Crash Severity Scores
City of Fresno SSAR

Figure
7313

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KITTELSON & ASSOCIATES

Coordinate System: NAD 1983 StatePlane California IV FIPS 0404 Feet
Data Source: City of Fresno

Motor Vehicle Risk Factors

The project team reviewed the roadway characteristics among the Tier I and II intersections and segments identified through the network screening to determine potential risk factors. Roadway characteristics were identified for locations using the roadway characteristics shapefile combined with review of the top locations.

Intersection Risk Factors

- **Unsignalized three-way intersections with one local street leg intersecting an arterial or collector street.** These are generally minor street and stop controlled with high-speed arterials or collectors (40 mph or above). **Among Tier I and II intersections** identified in the network screening, 33% of unsignalized intersections had this characteristic.
- **Signalized intersections at the junction of two arterials with posted speeds of 40 mph or higher:** 24% of **Tier I and II signalized intersections** identified in the network screening had this characteristic.
- **Signalized intersections at the junction of collector and arterial roadways with posted speeds of 40 mph or higher:** 27% of signalized intersections in the **top two tiers of intersections** identified in the network screening had this characteristic.

Segment Risk Factors

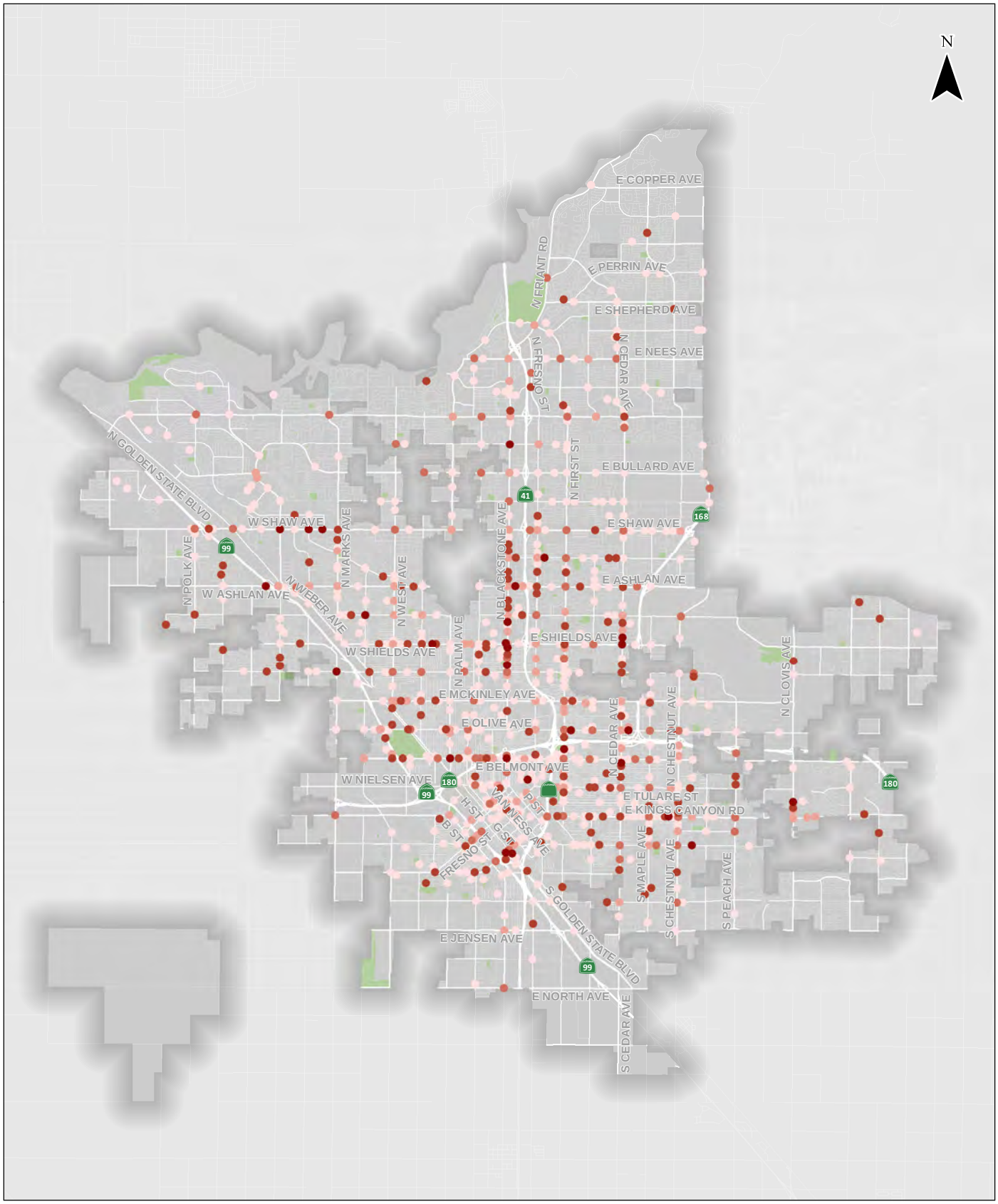
- **Expressways and arterials with four-or-more-lane cross-sections and posted speeds of 40 mph or greater:** 77% of Tier I and II segments identified in the network screening had this characteristic.
- **Roadways with raised medians.** Raised medians were a common characteristics of four-or-more-lane roadways with high speeds. In general, raised medians or other median barriers tend to reduce head-on and opposite direction sideswipe collisions and increase hit object and same direction sideswipe collisions.

7.3.3 BICYCLE AND PEDESTRIAN FINDINGS

The project team identified the top priority bicycle and pedestrian locations by applying the same collision severity weighting values to reported bicycle and pedestrian collisions, aggregating these totals at the intersection level, and using a half-mile sliding window to identify segments, as discussed above. These top ranked intersections are the most competitive locations to seek grant funding for bicycle and pedestrian safety improvements and can be used to help justify funding at similar locations through systemic project applications to apply the same set of countermeasures at multiple sites.

Figure 7-14 highlights collisions involving bicycles and pedestrians at intersections by collision severity score. The intersections were partitioned into five groups based on the distribution of annualized collision severity score.

- The first category includes 470 intersections that scored within 2% of the maximum collision severity score among intersections (119.6).
- The second category includes 94 intersections that scored from 2% to 5% of the maximum collision severity score.
- The third category includes 131 intersections that scored from 5% to 26% of the maximum collision severity score.
- The fourth category includes 131 intersections that scored from 26% to 35% of the maximum collision severity score.
- The fifth and final category includes 29 intersections that scored from 35% to 100% of the maximum collision severity score.



Intersection (Crash Severity Score)
- 0-59th Percentile score (0.2-2.4)
- 60-69th Percentile score (2.5-6.4)
- 70th-79th Percentile score (6.5-31.1)
- 80-97th Percentile score (31.2-42.0)
- 97-100th Percentile score (42.1-19.6)
- **City Boundary**

Bicycle and Pedestrian Collisions at Intersections by Crash Severity Score, 2014 - 2018

Figure 7414

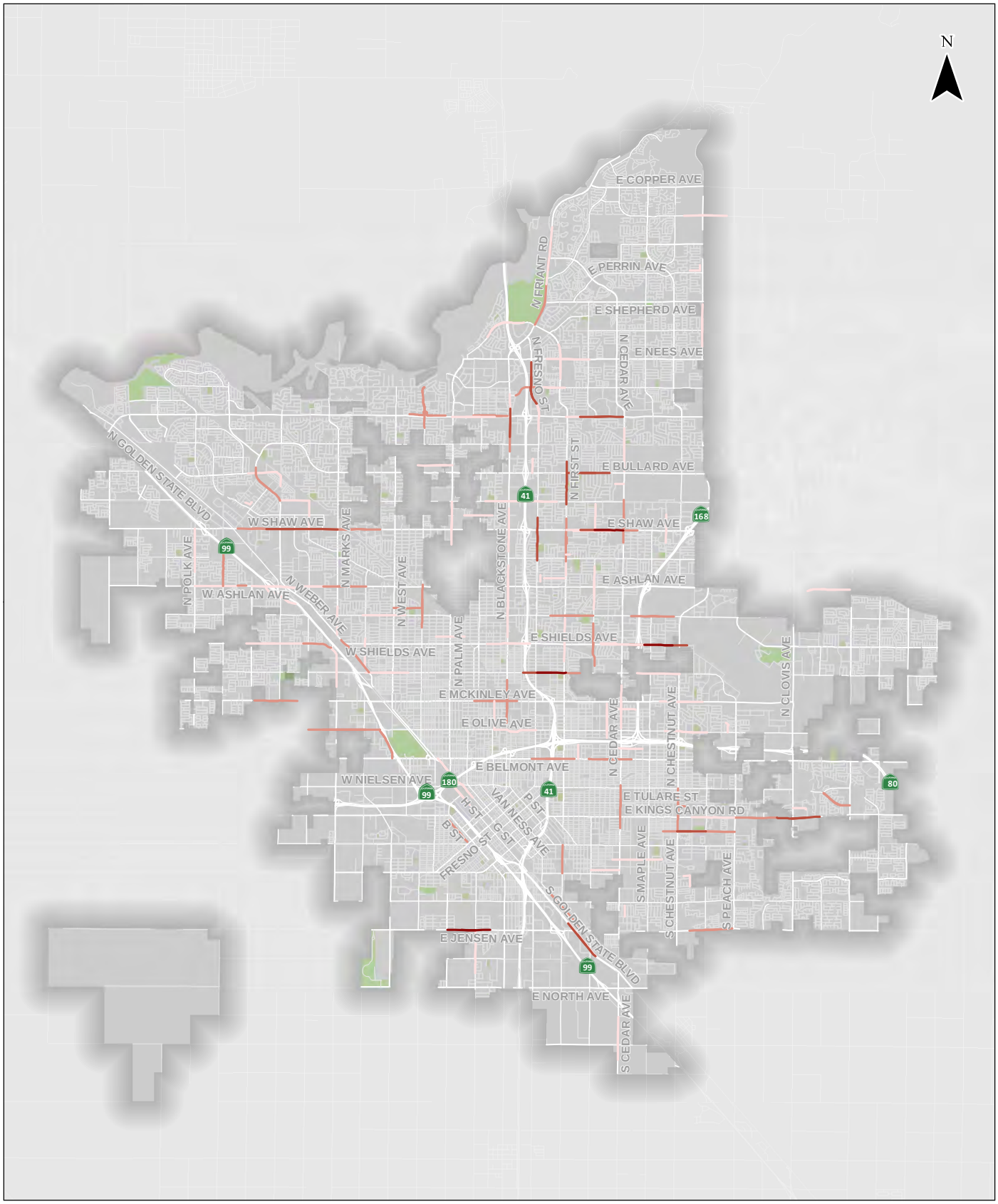
Coordinate System: NAD 1983 StatePlane California IV FIPS 0404 Feet
Data Source: City of Fresno

KITTELSON & ASSOCIATES

The results reveal several key corridors with multiple intersections that exhibited a relatively high number of collisions during the study period. For example, a collection of intersections in the top categories are located along North Blackstone Avenue. Other key corridors include East Belmont Avenue and West Shaw Avenue. Several other locations in Fresno can be identified as collections of intersections with high collision severity scores—particularly near Ventura Street and G Street.

Figure 7-15 highlights collisions involving bicycles and pedestrians along segments by collision severity score. The segments were partitioned into four groups based on collision severity scores.

- The first category includes 132 segments that scored within 3% of the maximum collision severity score among segments (69.9).
- The second category includes 77 segments with that scored from 3% to 49% of the maximum collision severity score.
- The third category includes 22 segments that scored from 49 to 97% of the total maximum collision severity score.
- The final category includes segments that scored from 97 to 100% of the maximum collision severity score, or five total segments.



Road Segment (Crash Severity Score)
- 0-55th Percentile score (0.2-2.2)
- 56th-88th Percentile score (2.3-34.8)
- 88-97th Percentile score (34.9-67.8)
- 98-100th Percentile score (67.9-69.9)

City Boundary

Bicycle and Pedestrian Collisions on Segments by Crash Severity Score, 2014 - 2018

Exhibit Figure 7-15

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KITTELSON & ASSOCIATES

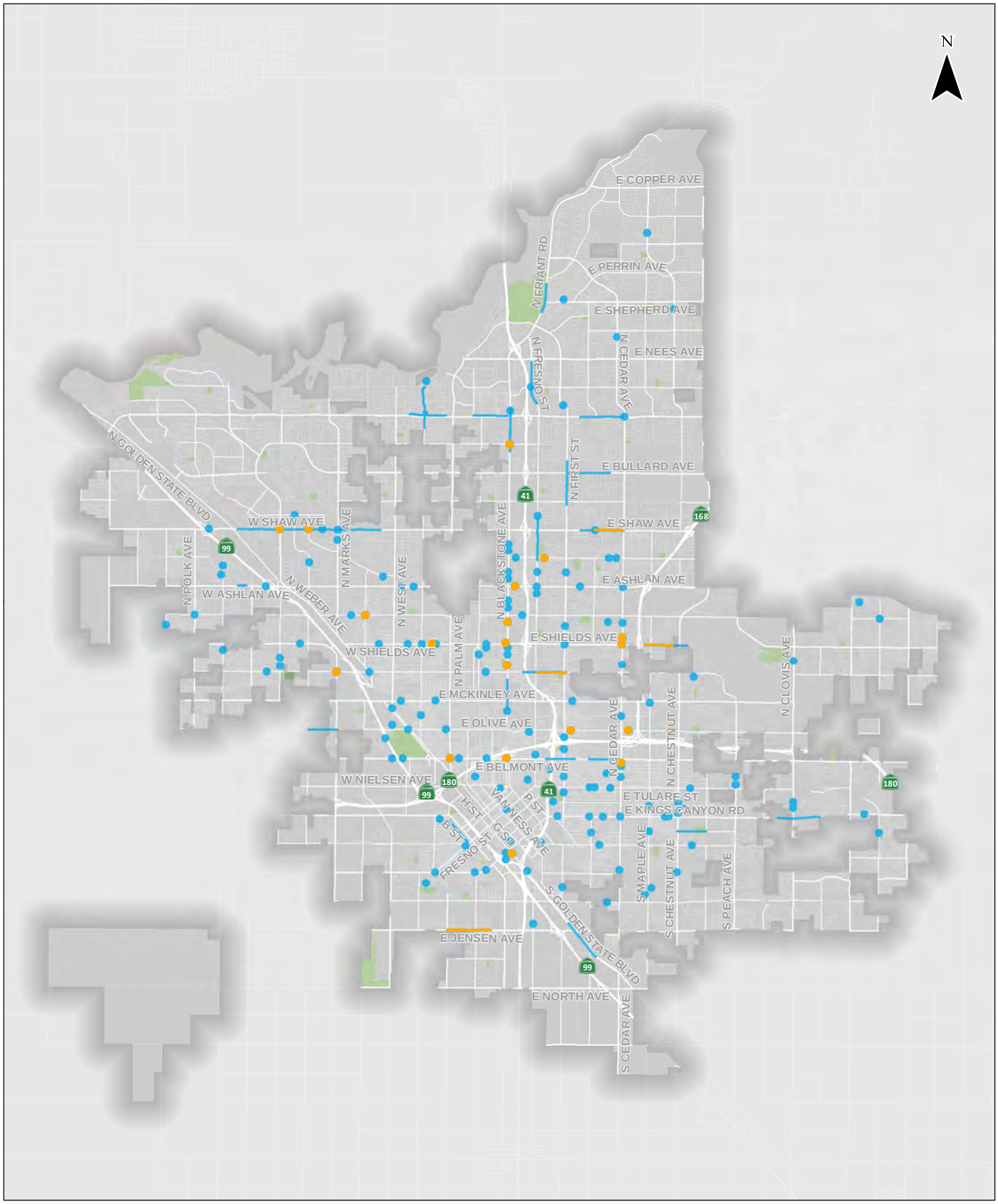
Coordinate System: NAD 1983 StatePlane California IV FIPS 0404 Feet
Data Source: City of Fresno

Bicycle and Pedestrian Priority Locations

Considering the above results, the top priority intersections and segments are depicted in Figure 7-14 and Figure 7-15, as well as in Table 7-15. Figure 7-16 shows Tier II priority bicycle and pedestrian locations, or those that fall into the top 20% of segments and intersections by bicycle and pedestrian collision severity score. These are locations where systemic application of countermeasures could be implemented according to the similarities to the highest collision density locations. Figure 7-16 and Table 7-15 depict Tier I priority bicycle and pedestrian locations. These reflect the top 25 locations from a combined list of intersections and segments, ranked by annualized bicycle and pedestrian collision severity score. Given the higher level of injuries at these locations, safety investments made are likely to have a high benefit/cost ratio and are therefore well suited to be combined with additional locations in a systemic application of countermeasures.

Table 7-15: High-Priority Locations for Bicycle and Pedestrian Safety by Collision History, City of Fresno, 2014 - 2018

Location	Annualized Collision Severity Score
Intersections	
Blackstone Avenue and Garland Avenue	119.6
Cedar Avenue and Fountain Way	80.6
G Street and Santa Clara Street	80.4
Cedar Avenue and Shields Avenue	79.1
Ashlan Avenue and Effie Street	78.7
Adoline Avenue and Shields Avenue	78.3
Fisher Street and Olive Avenue	78.3
Olive Avenue and Recreation Avenue	78.3
Olive Avenue and Rowell Avenue	78.3
Cedar Avenue and Madison Avenue	78.3
Augusta Street and Gettysburg Avenue	78.3
Eklund Avenue and Shields Avenue	78.3
Blackstone Avenue and Harvard Avenue	78.3
Blackstone Avenue and Sierra Avenue	58.8
Shaw Avenue and Valentine Avenue	58.6
Brawley Avenue and Shaw Avenue	56.2
Dakota Avenue and Hughes Avenue	52.0
Belmont Avenue and Blackstone Avenue	51.9
Clinton Avenue and Marks Avenue	51.9
Belmont Avenue and Palm Avenue	51.6
Segments	
Shields Avenue (between Sierra Freeway Eastern on-/off-ramps and N Recreation Avenue)	69.9
Clinton Avenue (between N Fresno Street and N First Street)	69.9
Jensen Avenue (between S Walnut Avenue and S MLK Jr Boulevard)	69.9
Jensen Avenue (between S Clara Avenue and mid-block between S Walnut Avenue and S MLK Jr Boulevard)	69.9
Shaw Avenue (between N 6th Street and N Cedar Avenue)	68



City Boundary
Tier I Intersection
Tier I Segment
Tier II Intersection
Tier II Segment

Priority Bicycle and Pedestrian Crash Locations

Figure 7-16

Coordinate System: NAD 1983 StatePlane California IV FIPS 0404 Feet
Data Source: City of Fresno

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Pedestrian and Bicycle Risk Factors

The project team used two approaches to identify risk factors (i.e., roadway characteristics that appear associated with increased collision risk) for collisions involving bicycles and pedestrians. The project team evaluated variables available in GIS formats across collisions to identify patterns. Total collisions and fatal and severe injury collisions were considered in this analysis. This analysis was supplemented with a desktop review of roadway conditions for the top 25 intersections when ranked by the bicycle and pedestrian collision severity score. These locations are the most likely to be competitive for HSIP funding. Therefore, the conditions at these locations can help inform where additional projects might be developed based on similar risk factors. Overarching risk factor patterns are summarized in this section; the specific characteristics of each intersection are described in the next section.

To complement this GIS-based analysis, the project team conducted a qualitative visual analysis (e.g., observations in Google Earth and Street View) for the 25 locations (intersections and roadway segments) with the highest severity scores for bicycle and pedestrian-involved collisions. This qualitative analysis was used to infer what characteristics might be associated with more frequent and more severe collisions at these locations.

The top 25 intersections and segments are distributed throughout the City (Figure 7-16). However, while geographically dispersed, a majority of these intersections and segments share common characteristics, which range from roadway geometry and operations to surrounding land uses.

The following identifies the general characteristics of the top 25 locations measured by collision severity score, which is discussed in greater detail below.

Intersection and Segment Risk Factors

- **Wide roadways (4+ lanes).** Roadways in Fresno commonly have four or more lanes of through traffic (i.e., four lanes total or two per direction), plus auxiliary turn lanes at intersections, resulting in curb-to-curb widths that frequently exceed 80 feet.
- **Arterial superblock roadway network.** Only multilane arterial roadways provide direct north-south and east-west connectivity. It is common for arterials to be spaced a half-mile from one another.
- **Multilane arterial roadways without turn lanes at minor cross streets.** As part of the superblock roadway network, arterials generally only have signalized intersections and designated turn lanes when crossing other arterial roadways. At minor cross streets, turn lanes and traffic signals are rare.
- **Stop-controlled minor cross streets intersecting wide, multilane arterials.** The superblock roadway network emphasizes throughput of large volumes of vehicular traffic on high-capacity arterials. To maintain their vehicular capacity, intersections with minor cross streets are not signalized.
- **High-demand areas.** Intersections in areas with major destinations result in high vehicle, pedestrian, and bicycle volumes.
- **Bus stops.** Fresno's bus network operates on a grid for the most part, with routes following the City's major north-south and east-west arterials. Transfers from one bus route to another are common at arterial intersections, so passengers can easily travel from one part of the City to another.
- **Permissive signal phasing.** Intersections commonly have permissive signal phasing in which turning vehicles must yield to oncoming traffic before executing turns.
- **Widely spaced or no lighting.** Outside of the Downtown area, most of Fresno's roadways have large, widely spaced lighting standards or no lighting at all. Specific inventory of illumination poles and placement was not available for further analysis.
- **Few bicycle facilities.** In general, within the City of Fresno, bicycle facilities are limited, and those that are present tend to be bicycle facilities on high-speed, high-volume arterials.

Blackstone Avenue is representative of a typical high-speed, high-volume Fresno arterial with high-frequency and high-severity collisions. In fact, Blackstone Avenue has five of the 25 intersections with the highest collision severity score. Blackstone Avenue is characterized by the following:

- Long crossings (crossings frequently exceed 100 feet because Blackstone Avenue has six through lanes, plus additional turn lanes at intersections)
- Long distances between marked crosswalks (quarter-mile or half-mile crosswalk spacing is typical)
- Lack of traffic signals or turn lanes at intersections of minor cross streets; high-demand areas (e.g., Manchester Shopping Center)
- Junctions of multiple bus routes
- Permissive signal phasing on collector roadways intersecting Blackstone Avenue
- Widely spaced highway-style lighting; and minimal bicycle facilities

All five intersections on Blackstone Avenue in the top 25 are either clustered in the vicinity of the Manchester Shopping Center or other areas with commercial land uses.

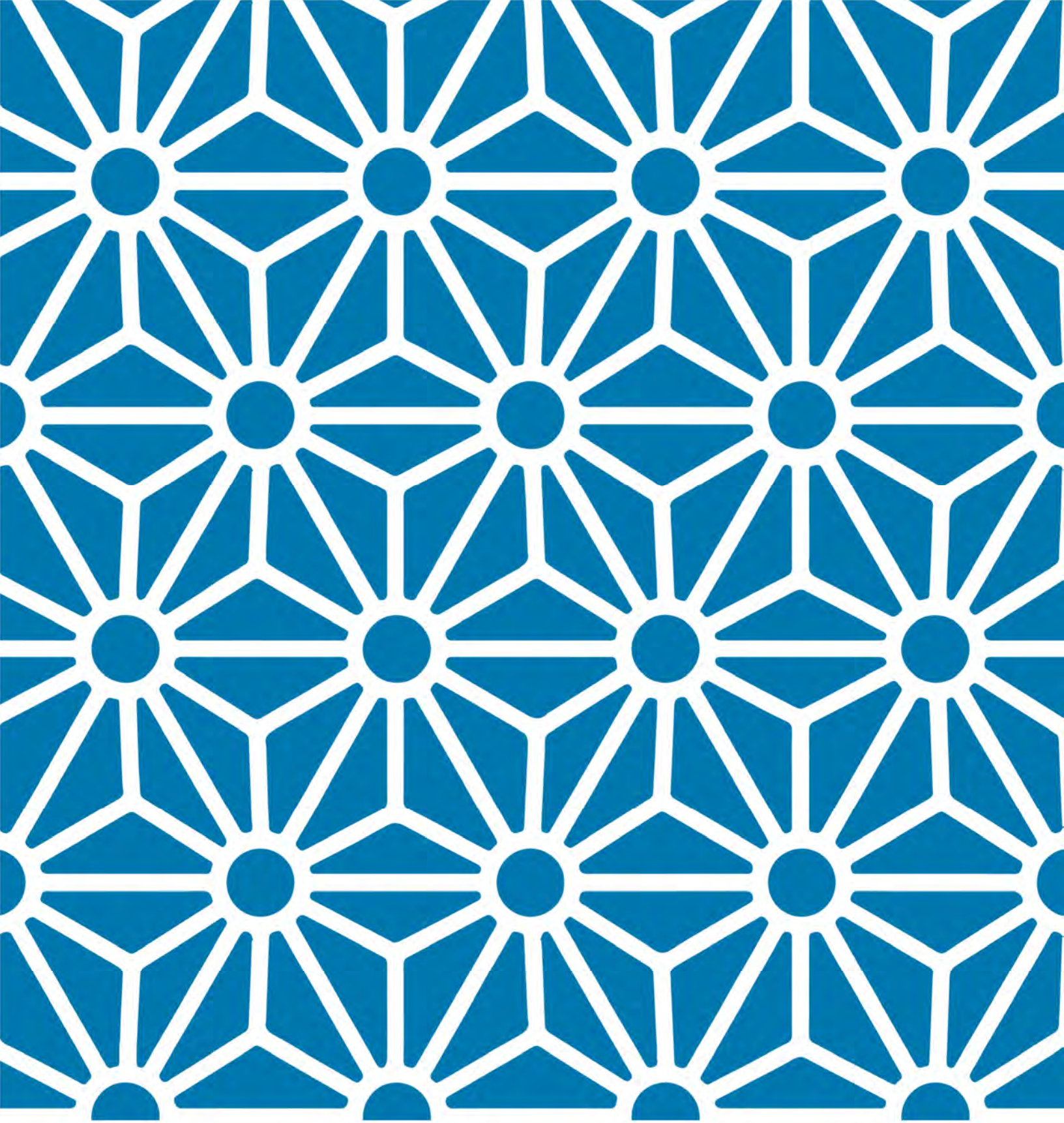
7.3.4 COMBINED LOCATIONS

The preceding analysis was organized by road user and allows for subsequent work to begin on the basis of understanding collision risk relative to a certain group of road users (i.e., motorists, bicyclists, or pedestrians). Some locations may present risk for all road users and can be addressed with multimodal improvements.

Blackstone Avenue and Sierra Avenue was identified as a Tier I location in the motor vehicle and bicycle/pedestrian network screening results, with collision severity scores of 72.5 and 58.8, respectively. This location matches descriptive risk factors for motorized and non-motorized road user groups:

- Signalized intersection at the junction of collector and arterial roadways with posted speeds of 40 mph or higher
- Arterial superblock roadway network
- Wide roadways (i.e., four-or-more-lane cross-sections)
- Bus stops
- Few bicycle facilities

In view of its collision history, this location represents an opportunity to identify potentially overlapping safety improvements for all road user types. In general, there are many countermeasures that have been found to benefit all road users' safety. Road diets, for example, provide safety benefits across all modes by helping to slow vehicle speeds and designate separate space for different road users. Another countermeasure example is providing protected signal phasing at intersections to reduce conflicts between vehicle-vehicle movements as well as vehicle-pedestrian and vehicle-bicycle movements.



SECTION 8

EMPHASIS AREAS

8. EMPHASIS AREAS

Using the analysis described in the preceding section, the project team identified five major emphasis areas for the City. Each is discussed in more detail in the sections that follow.

Collision Type:

1. Broadside collisions (discussed in Section 8.1.1)
2. Hit object collisions (discussed in Section 8.1.1)
3. Vehicle-pedestrian collisions (discussed in Section 8.1.1)

Roadway/Infrastructure:

4. Signalized arterial-arterial or arterial-collector intersections with wide roadways (i.e., four-or-more-lane cross-sections) and posted speeds of 40 mph or higher (discussed in Section 8.1.2)

Transportation Safety Culture:

5. Collision data reporting and monitoring. There is an apparent drastic undercount of collisions in the publicly available Statewide Integrated Traffic Records System (SWITRS) and TIMS collision data compared to the internally maintained City collision data for the 2014-2018 time period used in the analysis for this project. Reporting collisions to the statewide SWITRS database is essential to allow all interested parties and stakeholders to monitor transportation safety performance and identify trends.

8.1 ENGINEERING EMPHASIS

8.1.1 HIGHEST OCCURING COLLISION TYPES

As identified in Chapter 7, the following collision types were most frequent:

- Rear-end (25% of reported collisions)
- Broadside (21% of reported collisions)
- Hit object (18% of reported collisions)

However, the three most frequent collisions types *among fatal and severe injury collisions* have been chosen as emphasis areas:

- **Vehicle-pedestrian** (35% of reported fatal and severe injury collisions): Among fatal or severe injury pedestrian collisions, 47% occurred while a pedestrian was crossing a roadway outside of a crosswalk, which was disproportionately higher than the share of the same pedestrian action among the total reported pedestrian collisions (26%).
- **Broadside** (22% of reported fatal and severe injury collisions): Among broadside collisions that were located, 94% were intersection collisions. Intersection-related broadside collisions occur with roughly

the same frequency at signalized and unsignalized intersections (56% and 44%, respectively). They are frequently the result of traffic signals and signs[13] or auto right-of-way[14] violations.

- **Hit object** (13% of fatal and severe injury collisions): Hit object collisions account for 18% of reported collisions and 13% of fatal and severe injury collisions. Among located hit object collisions, 86% were at intersections. Of those geolocated, 67% of intersection-related hit object collisions occurred at unsignalized intersections. The most common violation associated with a fatal and severe injury hit object collision type was unsafe speed.

  These three collision types together account for 70% of fatal and severe injury collisions in Fresno.

A shared goal across all three collision type emphasis areas is to identify both systemic countermeasures and potential capital project locations that are eligible and competitive for grant funding to reduce the frequency and severity of these collision types.

8.1.2 HIGH-RISK CORRIDORS AND INTERSECTIONS

According to the network screening results, the top 20 locations by collision severity score were identified and grouped based on location type (Table 8-1):

- Group A: Arterial-arterial or arterial-collector signalized intersections
- Group B: Unsignalized intersections with access management and opportunities to improve pedestrian conditions
- Group C: Rural intersections
- Group D: Urban/suburban roadway segment corridors

Group A represents an identified emphasis area for the City of Fresno. This section presents an opportunity to advance capital projects that improve transportation safety at these emphasis area locations.

[13] This is a reported PCF that indicated one of several CVCs involving a failure to adhere to traffic control (e.g. running a stop sign).

[14] This is a reported PCF that indicated one of several CVCs involving a failure to yield right of way to oncoming traffic.

Table 8-1. Top 20 High-Risk Corridors and Intersections

Location	Group	Annualized Collision Severity Score	Segment/ Intersection
First Street and Shaw Avenue	A	118.6	Intersection
Blackstone Avenue and Shields Avenue	A	98.8	Intersection
Blackstone Avenue and Bullard Avenue	A	92.8	Intersection
Fresno Street and Shields Avenue	A	90.7	Intersection
First Street and Gettysburg Avenue	A	86.1	Intersection
Audubon Drive and Friant Road	A	85	Intersection
Cedar Avenue and Shields Avenue	A	79.1	Intersection
Blackstone Avenue and Sierra Avenue	A	58.8	Intersection
Blackstone Avenue and Garland Avenue	B	119.6	Intersection
Blackstone Avenue and Cornell Avenue	B	85	Intersection
Cedar Avenue and Fountain Way	B	80.6	Intersection
Ashlan Avenue and Effie Street	B	78.7	Intersection
Fourth Street and Sierra Madre Avenue	B	78.7	Intersection
Valentine Avenue and Weber Avenue	C	84.6	Intersection
G Street and Santa Clara Street	C	80.4	Intersection
Jensen Avenue and West Avenue	C	79.7	Intersection
Shaw Avenue (between Feland Avenue and Shaw Lane)	D	70	Segment
Shields Avenue (between Sierra Fwy (SR 168) Eastern on-/off ramps and N Recreation Avenue)	D	69.9	Segment
Clinton Avenue (between N Fresno Street and N First Street)	D	69.9	Segment
Jensen Avenue (between S Walnut Avenue and S MLK Jr Boulevard)	D	69.9	Segment

Note: Bold font indicates the 10 locations that were identified for safety project scopes.

8.1.3 COUNTERMEASURES IDENTIFIED

This section presents the engineering safety countermeasures identified to address the systemic collision trends documented in Section 7.

The project team compiled a list of 103 engineering countermeasures and prioritized these (Tier I through Tier IV) with the following considerations:

- **Relevance to Fresno.** Countermeasures included in the Caltrans Local Roadway Safety Manual (and funded by the HSIP program) that appear most relevant for the City of Fresno. For example, pedestrian supportive or urban speed management treatments were prioritized, whereas treatments more applicable to a rural highway (e.g., truck climbing lane) were deemed low priority.
- **HSIP eligibility.** Countermeasures that have been eligible for HSIP funding in previous cycles (note that this may change in future HSIP cycles).
- **Alignment with collision analysis findings.** Countermeasures that most directly relate to the three emphasis area collision types: broadside, hit object, and vehicle-pedestrian collisions.
- **Collision reduction potential, cost, and systemic application potential.** Low-cost countermeasures with: (a) high documented collision reduction potential; and (b) an ability to be applied systemically throughout the City.

This prioritization identified 32 Tier I engineering countermeasures. These countermeasures are applicable where collisions have occurred (retroactively) and in locations with similar characteristics to proactively reduce collision risk. *Attachment A* includes a memorandum deliverable documenting the countermeasures and presenting a prioritized list of all 103 engineering countermeasures considered. Cost estimate assumptions for select countermeasures are also included.

The project team grouped countermeasures into the following categories: roadway treatments, intersection treatments, and bicycle and pedestrian treatments. A summary of the 32 Tier I proposed engineering countermeasures is shown in Table 8-2. The costs shown do not include overhead or soft costs.

Table 8-2. Summary of the Prioritized Systemic Treatments and Related Information

Proposed Countermeasure	CM ID*	Documented Collision Reduction Factor**	Federal Funding Eligibility***	Cost Estimate	Page Reference
Roadway Treatments					
Remove or relocate fixed objects outside of clear recovery zone	R02	0.35	90%	$200-$10,000 per object	66
Road Diet (Reduce travel lanes from 4 to 3 and add a two-way left-turn and bike lanes)	R14	0.3	90%	$69 per ft	67
Widen shoulder (paved)	R15	0.3	90%	$10 per ft added width per ft lane	68
Improve pavement friction (high friction surface treatments)	R21	0.55	100%	$1 per sf	69

Proposed Countermeasure	CM ID*	Documented Collision Reduction Factor**	Federal Funding Eligibility***	Cost Estimate	Page Reference
Intersection Treatments					
Bicycle and Pedestrian Treatments					
Install high-visibility crosswalk markings	NA	0.48	90%	< $2,500 per crossing	85

Proposed Countermeasure	CM ID*	Documented Collision Reduction Factor**	Federal Funding Eligibility***	Cost Estimate	Page Reference
Install advance yield lines	NA	0.25	90%	< $2,500 per yield line	86
Install raised medians (refuge islands)	NS19PB	0.45	90%	$120 per ft	87
Install pedestrian crossing at uncontrolled locations (signs and markings only)	NS20PB	0.25	100%	$2,600 each	88
Install/upgrade pedestrian crossing at uncontrolled locations (with enhanced safety features)	NS21PB	0.35	100%	$60,000-$160,000 each	89
Install pedestrian signal or pedestrian hybrid beacon (PHB)	NS23PB	0.55	100%	$83,300 per System	90
Install bike lanes	R32PB	0.35	90%	$50 per ft[15]	91
Install sidewalk/pathway (to avoid walking along roadway)	R34PB	0.8	90%	$25 per ft	92
Install/upgrade pedestrian crossing (with enhanced safety features)	R35PB	0.35	90%	$60,000-$160,000 each	93
Install raised pedestrian crossing	R36PB	0.35	90%	$5,000 each	94
Install pedestrian countdown signal heads	S17PB	0.25	100%	$1,800 per signal head	95
Install pedestrian crossing (S.I.)	S18PB	0.25	100%	$8,200 per crossing	96
Modify signal phasing to implement a leading pedestrian interval (LPI)	S21PB	0.6	50%	< $2,500 per signal	97

*CM ID refers to the Countermeasure ID from the Caltrans Local Roadway Safety Manual (April 2020).
** All documented collision education factors are derived from the Caltrans Local Roadway Safety Manual (April 2020).
*** Funding eligibility indicates the designated federal contribution level for approved HSIP projects in California associated with Caltrans HSIP Cycle 9. This is subject to change from year to year and should be confirmed with the HSIP coordinator.

[15] Cost assumes bike lane striping is thermoplastic.

8.1.3.1 Roadway Treatments

Remove or relocate fixed objects outside of clear recovery zone (R02)

Summary of Countermeasure: Removing or relocating roadside fixed objects such as utility poles, drainage, trees, or other fixed objects provides a clear recovery zone that allows drivers to correct their path of travel when they leave the roadway. This treatment is particularly effective outside of curves, along lane drops and in traffic islands where fixed object collisions are more common. A clear recovery zone should be developed in more rural context roadways, as space is available. The City is only able to address sight obstructions within City right of way. Where public right of way is limited, steps should be taken to request assistance from property owners.

Collision Types Addressed	Documented Collision Reduction Factor	Federal Funding Eligibility	Cost Estimate
Hit object	0.35	90%	$200-$10,000 per object

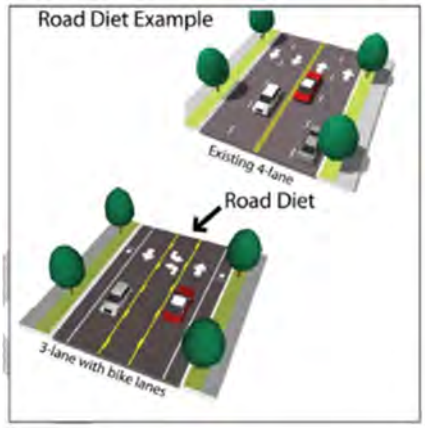
Why was this chosen for City of Fresno? Hit object collisions are among the top three collision types resulting in a fatality or severe injury. The most common collision factor among fatal and severe injury hit object collisions was *unsafe speed*. Removing or relocating fixed objects outside of a clear recovery zone would provide an opportunity for drivers to correct their path of travel and can proactively address a history of hit object collisions.

Image Source: Federal Highway Administration (FHWA)

Road diet (reduce travel lanes from four to three and add a two-way left-turn lane and bike lanes) (R14)

Summary of Countermeasure: A road diet reduces the number of vehicle lanes on a roadway to manage vehicle speeds and reduce risk of collisions for all road users. A common road diet is to convert a four-lane undivided roadway to a three-lane cross-section with one lane in each direction and median treatment. This opens up space for bicycle lanes and sidewalks. An example four-lane to three-lane cross-section conversion, i.e., road diet, is shown below.

Collision Types Addressed	Documented Collision Reduction Factor	Federal Funding Eligibility	Cost Estimate
All	0.3	90%	$69 per ft



Why was this chosen for City of Fresno? Broadside and vehicle-pedestrian collisions are among the top three collision types resulting in a fatality or severe injury. Auto right-of-way[16] violations, improper turning, and unsafe speed were among the top five most common collision factors in fatal or severe injury broadside collisions. Road diets may help eliminate speed-related collisions while also providing reduced collision risk for turning vehicles and people walking or biking.

Image Sources: FHWA, Google Maps

[16] This is a reported PCF that indicated one of several CVCs indicating a failure to yield right of way to oncoming traffic.

Widen shoulder (R16)

Summary of Countermeasure: Widening the shoulder gives a driver who is in the travel way more time and space to correct and move back into the travel lane. It provides a buffer space from objects such as guardrails, trees, and signs, reducing the likelihood of hit object and run-off-road collisions. A paved shoulder, where available, provides a consistent road surface for recovery. If widening a shoulder by paving is not an option due to a restricted right of way or adjacent objects/trees, a shoulder could also be added or widened by striping edge lines and reducing the vehicular lane width.

Collision Types Addressed	Documented Collision Reduction Factor	Federal Funding Eligibility	Cost Estimate
Hit object, Run-off-road, sideswipe	0.3	90%	$10 per ft added width per ft lane

Why was this chosen for City of Fresno? Hit object collisions are among the top three collision types resulting in a fatality or severe injury. The most common violation among fatal and severe injury hit object collisions was *unsafe speed*. Providing additional paved shoulder width can address areas with a history of hit object collisions and can help give drivers time and space to react when veering off the roadway.

Image Source: Google Maps

Improve pavement friction (high friction surface treatments) (R21)

Summary of Countermeasure: Improving pavement friction or skid resistance gives a driver who is skidding more control and time to react. It is particularly effective in areas where pavement conditions contribute to collisions, such as wet pavement or inadequate pavement for posted roadway speeds; areas also include curves, loop ramps, and areas with short stopping distances.

Collision Types Addressed	Documented Collision Reduction Factor	Federal Funding Eligibility	Cost Estimate
Wet, rear-end, all	0.55	100%	$1 per sf

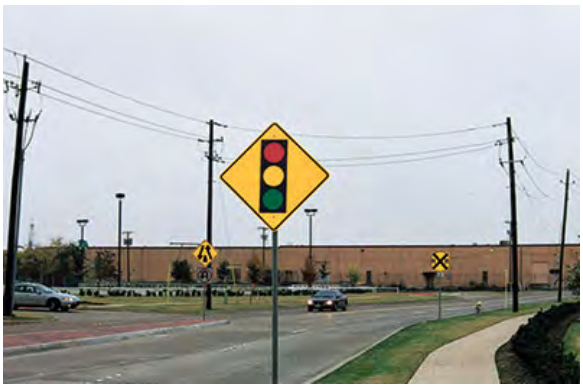
Why was this chosen for City of Fresno? Hit object and broadside collisions are among the top three collision types resulting in a fatality or severe injury, and *unsafe speed* was among the top five most common collision factors for both types of collisions. Improving pavement friction or introducing other high friction surface treatments would provide added resistance and improve recovery for drivers who depart the roadway.

Image Sources: FHWA

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

Summary of Countermeasure: Installing and/or upgrading signs with fluorescent sheeting provides drivers with a visual warning of the presence of a specific roadway feature or regulatory requirement they may have missed with existing signs. This treatment is appropriate on roadway segments with a history of head-on, nighttime, non-intersection, run-off-road, and sideswipe collisions. This treatment should be installed in combination with additional treatments, such as installing or adding chevrons, warning signs, delineators, markers and beacons, and relocating existing signs.

Collision Types Addressed	Documented Collision Reduction Factor	Federal Funding Eligibility	Cost Estimate
Head-on, run-off-road, sideswipe, night	0.15	100%	$500 per sign



Why was this chosen for City of Fresno? Hit object collisions are among the top three collision types resulting in fatality or severe injury. The most common violation among fatal and severe injury hit object collisions was *unsafe speed*. Furthermore, collisions that occurred under dark conditions accounted for 35% of total reported collisions and 52% of fatal and severe injury collisions. Installing and/or upgrading signs with new fluorescent sheeting would provide drivers with increased awareness of changing roadway elements.

Image Sources: FHWA, 3M

Install chevron signs on horizontal curves (R23)

Summary of Countermeasure: Chevron signs provide a visual cue to drivers that they are about to navigate a horizontal curve. This treatment is appropriate for locations where relatively sharp curves have resulted in collisions. Chevrons should be installed in combination with additional treatments such as advance warning signs, delineators, and pavement markers to provide increased awareness of the curved roadway alignment.

Collision Types Addressed	Documented Collision Reduction Factor	Federal Funding Eligibility	Cost Estimate
Run-off-road, all	0.4	100%	$500 per sign

Why was this chosen for City of Fresno? Hit object collisions are among the top three collision types resulting in a fatality or severe injury. The most common violation among fatal and severe injury hit object collisions was *unsafe speed*. Providing chevron signage in addition to other treatments can address curve-related collisions which often result in hit object or run-off-road collisions.

Image Sources: Kittelson & Associates, Inc.

Install curve advance warning signs (R24)

Summary of Countermeasure: Curve advance warning signs provide a visual cue to drivers that they are approaching a horizontal curve. This treatment is appropriate for locations where relatively sharp curves have resulted in collisions. Curve advance warning signs should be installed in combination with additional treatments, such as chevron signs, delineators, and pavement markers, to provide increased awareness of the curved roadway alignment.

Collision Types Addressed	Documented Collision Reduction Factor	Federal Funding Eligibility	Cost Estimate
All	0.25	100%	$500 per sign

Why was this chosen for City of Fresno? Hit object collisions are among the top three collision types resulting in a fatality or severe injury. The most common violation among fatal and severe injury hit object collisions was *unsafe speed*. Providing curve advance warning signs in addition to other treatments can address curve-related collisions which often result in hit object or run-off-road collisions.

Image Sources: Google Maps

Install curve advance warning signs (flashing beacon) (R25)

Summary of Countermeasure: Flashing beacon curve advance warning signs provide a visual cue and inform drivers that they are approaching a horizontal curve. This treatment is appropriate for locations where relatively sharp curves have resulted in collisions. This treatment should be installed in combination with additional treatments such as regular curve advance warning signs, chevron signs, delineators, and pavement markers to provide increased awareness of the curved roadway alignment.

Collision Types Addressed	Documented Collision Reduction Factor	Federal Funding Eligibility	Cost Estimate
All	0.3	100%	$16,600 each

Why was this chosen for City of Fresno? Hit object collisions are among the top three collision types resulting in a fatality or severe injury. The most common violation among fatal and severe injury hit object collisions was *unsafe speed*. Providing curve advance warning signs in addition to other treatments can address curve-related collisions which often result in hit object or run-off-road collisions.

Image Source: FHWA

Install dynamic/variable speed warning signs (R26)

Summary of Countermeasure: Dynamic/variable speed warning signs provide a visual warning to drivers of their speed. This helps address collisions involving motorists traveling around curves.

Collision Types Addressed	Documented Collision Reduction Factor	Federal Funding Eligibility	Cost Estimate
All	0.30	100%	$43,600 each

Why was this chosen for City of Fresno? Hit object collisions are among the top three collision types resulting in a fatality or severe injury. The most common violation among fatal and severe injury hit object collisions was *unsafe speed*. Providing appropriate signing can address curve-related collisions which often result in hit object or run-off-road collisions.

Image Source: Kittelson & Associates, Inc.

Install delineators, reflectors and/or object markers (R27)

Summary of Countermeasure: Delineators, reflectors, and/or object markers clarify the path of travel through a horizontal alignment and call driver attention to fixed objects along the roadside. This treatment is appropriate for locations where relatively sharp curves have resulted in collisions. They may be installed in combination with additional treatments such as chevron signs and curve advance warning signs to provide increased awareness of a curved roadway alignment.

Collision Types Addressed	Documented Collision Reduction Factor	Federal Funding Eligibility	Cost Estimate
All	0.15	100%	$75 each

Why was this chosen for City of Fresno? Hit object collisions are among the top three collision types resulting in fatality or severe injury. The most common violation among fatal and severe injury hit object collisions was *unsafe speed*. Providing appropriate signing can address curve-related collisions which often result in hit object or run-off-road collisions.

Image Source: FHWA

Install edgelines and centerlines (R28)

Summary of Countermeasure: Installing edgelines and centerlines helps clarify and increase visibility of the road and lane boundaries. These treatments help drivers who may depart the roadway or travel lane. Additional enhancements can boost visibility, including thermoplastic application with audible disks or bumps, or raised/reflective pavement markers.

Collision Types Addressed	Documented Collision Reduction Factor	Federal Funding Eligibility	Cost Estimate
Head-on, run-off-road, all	0.25	100%	$4 per ft

Why was this chosen for City of Fresno? Hit object collisions are among the top three collision types resulting in a fatality or severe injury. The most common violation among fatal and severe injury hit object collisions was *unsafe speed*. Installing edgeline rumble strips/stripes would provide positive guidance for drivers to stay within the travel lane and roadway.

Image Source: Texas A&M Transportation Institute

Install edgeline rumble strips/stripes (R31)

Summary of Countermeasure: Edgeline rumble strips alert drivers who are drifting out of their travel lane before they depart the roadway, giving them time to correct and stay in their lane. The Caltrans Local Roadway Safety Manual recommends installing rumble strips along an entire corridor, instead of in intermittent spots. Rumble *stripes*—so called when the pavement marking is in the rumble strip—provide enhanced marking in wet or dark conditions.

Collision Types Addressed	Documented Collision Reduction Factor	Federal Funding Eligibility	Cost Estimate
Run-off-road	0.15	100%	$10 per ft

Why was this chosen for City of Fresno? Hit object collisions are among the top three collision types resulting in fatality or severe injury. The most common violation among fatal and severe injury hit object collisions was *unsafe speed*. Installing edgeline rumble strips/stripes would provide positive guidance to drivers to stay within the travel lane and roadway.

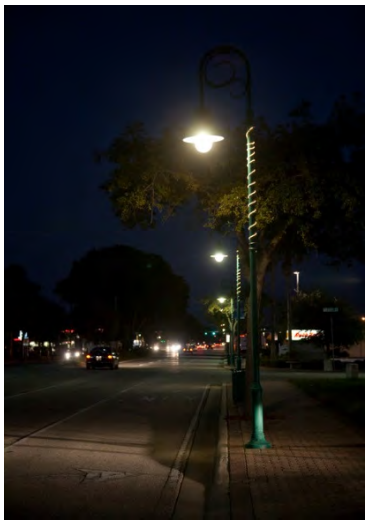
Image Source: FHWA

8.1.3.2 Intersection Treatments

Install intersection lighting (S01/NS01)

Summary of Countermeasure: Adding intersection lighting for signalized and non-signalized intersections improves the visibility of the intersection and potential conflicts. Adequately illuminating the intersection, including pedestrian crossings, helps motorists and pedestrians navigate the intersection and be aware of the location of other road users and potential conflicts. Appropriate lighting levels and consistency in the level of illumination are important in reducing glare and dark spots. This continues to be crucial with the increased use of LED lighting as some high-intensity LED lighting designs emit a large amount of blue light (which appears white to the naked eye) and can create worse nighttime glare compared to conventional lighting. [17]

Collision Types Addressed	Documented Collision Reduction Factor	Federal Funding Eligibility	Cost Estimate
Night	0.4	100%	$7000 per light



Why was this chosen for City of Fresno? Darkness was a factor in 44% of reported pedestrian collisions and in 64% of fatal and severe injury pedestrian collisions. Increased visibility would contribute to both pedestrian and motorist safety, allowing approaching drivers to more easily see pedestrians.

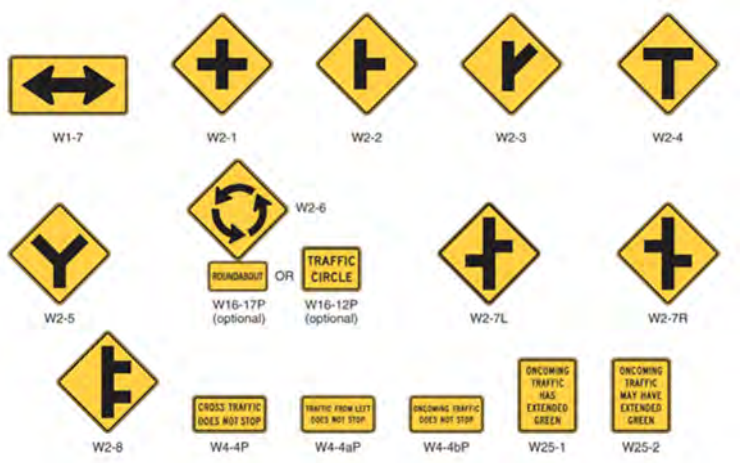
Image Source: Kittelson & Associates, Inc.

[17] Source: American Medical Association, https://www.ama-assn.org/press-center/press-releases/ama-adopts-guidance-reduce-harm-high-intensity-street-lights

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

Summary of Countermeasure: Installing larger warning or regulatory signs at or in advance of an intersection can increase driver awareness of the intersection. The effectiveness of this strategy is greatest when implementation involves a combination of regulatory and warning signs appropriate for the conditions at an unsignalized intersection approach.

Collision Types Addressed	Documented Collision Reduction Factor	Federal Funding Eligibility	Cost Estimate
All	0.15	100%	$500 per sign



Why was this chosen for City of Fresno? Broadside collisions are among the top three collision types resulting in a fatality or severe injury. Broadside collisions at unsignalized intersections often have the primary collision factor listed as *traffic signals and signs*[18] *or auto right-of-way*[19] violation. Making intersections more conspicuous would help promote driver compliance at intersections.

Image Source: FHWA

[18] This is a reported PCF that indicated one of several CVCs, indicating a failure to adhere to traffic control (e.g., running a stop sign).

[19] This is a reported PCF that indicated one of several CVCs, indicating a failure to yield right of way to oncoming traffic.

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

Summary of Countermeasure: Upgrades to intersection pavement markings include "stop ahead" markings and the addition of centerlines and stop bars for stop-controlled approaches. Providing visible stop bars and clearer lane delineation on minor road approaches to unsignalized intersections can help direct the attention of drivers to the intersection.

Collision Types Addressed	Documented Collision Reduction Factor	Federal Funding Eligibility	Cost Estimate
All	0.25	100%	$4,000 per intersection

Why was this chosen for City of Fresno? Broadside collisions are among the top three collision types resulting in fatality or severe injury. Broadside collisions at unsignalized intersections often have the primary collision factor listed as *traffic signals and signs*[20] *or auto right-of-way*[21] violation. Making intersections more conspicuous would help promote driver compliance at intersections.

Image Source: Kittelson & Associates, Inc.

[20] This is a reported PCF that indicated one of several CVCs involving a failure to adhere to traffic control (e.g., running a stop sign).

[21] This is a reported PCF that indicated one of several CVCs involving a failure to yield right of way to oncoming traffic.

Install transverse rumble strips on approaches (NS10)

Summary of Countermeasure: Transverse rumble strips provide an audible and tactile warning for motorists approaching an intersection, managing speed by indicating changing conditions or the presence of an intersection. They can be used at any stop or yield approach intersection, often in combination with advance signing to warn of the intersection ahead. Installing these on streets adjacent to and/or approaching schools can be effective in bringing motorists' attention to the need to slow down and be alert for school activities (e.g., drop-off/pick-up activities, children crossing the street or walking/biking along the street).

Collision Types Addressed	Documented Collision Reduction Factor	Federal Funding Eligibility	Cost Estimate
All	0.2	90%	$600 per approach

Why was this chosen for City of Fresno? Broadside collisions are among the top three collision types resulting in a fatality or severe injury. Broadside collisions at unsignalized intersections often have the primary collision factor listed as *traffic signals and signs*[22] *or auto right-of-way*[23] violation. Making intersections more conspicuous would help promote driver compliance at intersections.

Image Source: Kittelson & Associates, Inc., 2019

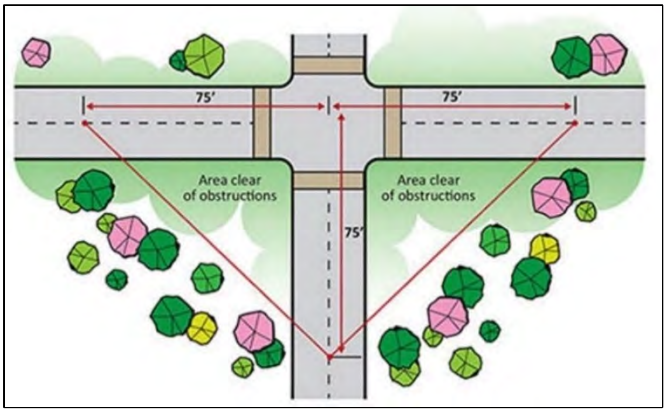
[22] This is a reported PCF that indicated one of several CVCs involving a failure to adhere to traffic control (e.g., running a stop sign).

[23] This is a reported PCF that indicated one of several CVCs involving a failure to yield right of way to oncoming traffic.

Improve sight distance to intersection (clear sight triangles) (NS11)

Summary of Countermeasure: Sight distance improvements can often be achieved by clearing sight triangles to restore sight distance obstructed by vegetation, roadside appurtenances, buildings, bus stations, and other objects in the right of way. The other strategy to improve sight distance is to eliminate on-street parking (e.g., marking curbs red to prohibit parking, maintaining or clearing vegetation) that restricts sight distance, especially on approach to or adjacent to intersections.

Collision Types Addressed	Documented Collision Reduction Factor	Federal Funding Eligibility	Cost Estimate
All	0.2	90%	$200-$50,000



Why was this chosen for City of Fresno? Broadside collisions are among the top three collision types resulting in a fatality or severe injury. Broadside collisions at unsignalized intersections often have the primary collision factor listed as *traffic signals and signs*[24] *or auto right-of-way*[25] violation. Making intersections more conspicuous would help to promote driver compliance at intersections.

Image Source: http://www.mikeontraffic.com/sight-distance-explained/

[24] This is a reported PCF that indicated one of several CVCs involving a failure to adhere to traffic control (e.g., running a stop sign).

[25] This is a reported PCF that indicated one of several CVCs involving a failure to yield right of way to oncoming traffic.

Install splitter islands on the minor road approaches (NS13)

Summary of Countermeasure: A splitter island creates physical separation between vehicles turning onto the stop-controlled approach and vehicles stopped on that same approach. The splitter island also makes the intersection more visible and provides space for a second stop sign on the approach. Splitter islands must be designed to accommodate appropriate design vehicles while still being large enough to be visible to drivers and to allow refuge for pedestrians.

Collision Types Addressed	Documented Collision Reduction Factor	Federal Funding Eligibility	Cost Estimate
Angle, broadside, rear-end	0.4	90%	$10,000 per approach

Why was this chosen for City of Fresno? Broadside collisions are among the top three collision types resulting in a fatality or severe injury. Broadside collisions at unsignalized intersections often have the primary collision factor listed as *traffic signals and signs*[26] *or auto right-of-way*[27] violation. Making intersections more conspicuous would help to promote driver compliance at intersections.

Image Source: Mid-Ohio Regional Planning Commission

[26] This is a reported PCF that indicated one of several CVCs involving a failure to adhere to traffic control (e.g., running a stop sign).

[27] This is a reported PCF that indicated one of several CVCs involving a failure to yield right of way to oncoming traffic.

Improve signal hardware: lenses, backplates, mounting, size, and number (S02)

Summary of Countermeasure: Improving visibility of intersection signals helps drivers become aware of upcoming intersections. Improvements include new LED lighting, signal backplates, retroreflective tape outlining the backplates or visors to increase signal visibility, larger signal heads, relocation of the signal heads, or additional signal heads.

Collision Types Addressed	Documented Collision Reduction Factor	Federal Funding Eligibility	Cost Estimate
Angle, rear-end	0.15	100%	$1,500 per signal head

Why was this chosen for City of Fresno? Broadside collisions are among the top three collision types resulting in a fatality or severe injury. Broadside collisions at signalized intersections often have the primary collision factor listed as *traffic signals and signs*[28] *or auto right-of-way*[29] violation. Making intersections more conspicuous would help promote driver compliance at intersections.

Image Source: FHWA, 2018

[28] This is a reported PCF that indicated one of several CVCs involving a failure to adhere to traffic control (e.g., running a stop sign).

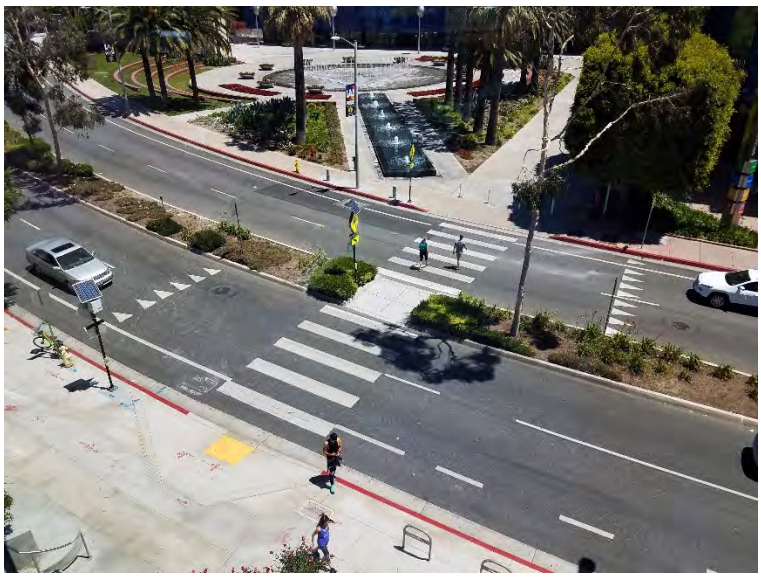
[29] This is a reported PCF that indicated one of several CVCs involving a failure to yield right of way to oncoming traffic.

8.1.3.3 Pedestrian and Bicycle Treatments

Install high-visibility crosswalk markings

Summary of Countermeasure: High-visibility crosswalk markings, such as continental or ladder-style, warn drivers to expect pedestrian crossings and clarify that drivers are expected to yield right of way to crossing pedestrians. At uncontrolled locations, high-visibility crosswalk markings identify a preferred crossing location for pedestrians. Specific to Fresno, the City has a policy regarding high-visibility crosswalk installation based on considerations such as ADT, land use, number of vehicle lanes, and other context specific characteristics. This recommendation supports consistent use of that existing policy.

Collision Types Addressed	Documented Collision Reduction Factor	Federal Funding Eligibility	Cost Estimate
Ped & bike	0.48	90%	<$2,500 per crossing



Why was this chosen for City of Fresno? Pedestrian crossing outside a crosswalk is the top pedestrian collision type resulting in a fatality or severe injury. The primary collision factor is often listed as *pedestrian violation* [30]. Vehicles were most commonly proceeding straight for this collision type. High-visibility crosswalk markings create designated areas for pedestrians to cross and warn drivers to expect pedestrian crossings.

Image Source: Toole Design Group

[30] This is a reported PCF that indicated one of several CVCs involving a pedestrian failure to yield right of way to vehicles.

Install advance yield lines

Summary of Countermeasure: Advance yield lines are pavement markings placed 20 to 50 feet in advance of an uncontrolled and unsignalized pedestrian or bicycle crossing. This treatment increases the distance between where drivers stop or yield and the crosswalk or bicycle crossing. This improves the visibility of crossing pedestrians and bicyclists and helps reduce multiple-threat collisions. Advanced yield lines also discourage drivers from encroaching into the crosswalk.

Collision Types Addressed	Documented Collision Reduction Factor	Federal Funding Eligibility	Cost Estimate
Ped & bike	0.25	90%	<$2,500 per yield line

Why was this chosen for City of Fresno? Pedestrians crossing in road is among the top three pedestrian collision types resulting in a fatality or severe injury. Vehicles were most commonly proceeding straight for this collision type. Installing advance yield lines would increase the distance between the crosswalk and where drivers stop or yield and prevents drivers from encroaching into crosswalks.

Image Source: Toole Design Group

Install raised medians (refuge islands) (NS19PB)

Summary of Countermeasure: Raised medians with pedestrian refuge islands are roadway treatments designed to provide dedicated areas for pedestrians and bicyclists between vehicle travel lanes at intersections and mid-block locations. They must have a minimum width of 6 feet to meet pedestrian accessibility requirements. To provide bicyclists refuge and to accommodate larger groups of pedestrians, the minimum should be increased to 8 feet.

This treatment can improve safety for pedestrians and bicyclists by reducing crossing distances and creating a place of refuge to allow multiple-stage crossings. They are particularly beneficial at uncontrolled crossings, large signalized crossings, or complex intersections where people may have difficulty completing crossings. They may also be helpful for pedestrians who are unable to judge gaps in traffic accurately or who travel slower than the design pedestrian (typically walking at least 3.5 ft/s). Refuge islands can be designed with a Z-crossing to require people to face oncoming traffic which may increase visibility and eye contact. Refuge islands that extend up to or beyond crosswalks can also slow left-turning drivers, providing the same benefit as hardened centerlines or medians. Temporary pedestrian refuge islands can be installed using low-cost materials (e.g., paint, bollards, or even rubberized platforms) for demonstration and evaluation purposes.

Collision Types Addressed	Documented Collision Reduction Factor	Federal Funding Eligibility	Cost Estimate
Ped & bike	0.45	90%	$120 per ft

Why was this chosen for City of Fresno? Pedestrians crossing in road is among the top three pedestrian collision types resulting in a fatality or severe injury. The primary collision factor is often listed as *pedestrian violation*,[31] which can indicate the need for improved pedestrian crossings. Vehicles were most commonly proceeding straight for this collision type. Installing refuge islands would provide a space for pedestrians to safely wait during multiple-stage crossings.

Image Source: Toole Design Group

[31] This is a reported PCF that indicated one of several CVCs involving a pedestrian failure to yield right of way to vehicles.

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

Summary of Countermeasure: Pedestrian crossing signs and bicycle crossing signs paired with high-visibility crosswalk markings reinforce legal crossings at intersections and create legal crossings at non-intersection locations. These signs and crosswalk markings warn drivers to expect pedestrian and bicycle crossings and clarify that drivers are expected to yield right of way to crossing pedestrians and bicyclists. At uncontrolled locations, pedestrian and bicycle crossing signs and markings identify a preferred crossing location for pedestrians and bicyclists. Incorporating advance yield lines provides an extra safety buffer and can be effective in reducing multiple-threat danger to pedestrians.

Collision Types Addressed	Documented Collision Reduction Factor	Federal Funding Eligibility	Cost Estimate
Ped & bike	0.25	100%	$2,600 each

Why was this chosen for City of Fresno? Pedestrian collisions at unsignalized locations is the top pedestrian collision type resulting in a fatality or severe injury. Pedestrian crossing signs and markings at uncontrolled intersections warn drivers to expect pedestrian and bicycle crossings and clarify that drivers are expected to yield right of way to crossing pedestrians and bicyclists.

Image Source: Toole Design Group

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

Summary of Countermeasure: In combination with high-visibility crosswalk markings, curb extensions, and raised medians, beacons and lighting reduce pedestrian collision risk by delineating a portion of the roadway for pedestrian crossing and increasing driver yielding rates.

In particular, rectangular rapid flashing beacons (RRFB) have been shown to significantly increase driver yielding behavior at uncontrolled crosswalks, with driver yield rates ranging from 34% to over 90%. Studies have also associated RRFBs with reduced pedestrian-vehicle conflicts, increased stopping distance, and reductions in the number of pedestrians trapped in roadway (Thomas et al. 2016)[32]. These safety benefits likely extend to bicyclists crossing at RRFB locations. RRFBs are generally more appropriate at two-lane locations, whereas pedestrian hybrid beacons (PHB) are best suited to higher-speed or multi-lane contexts or locations with limited sight distance.

Collision Types Addressed	Documented Collision Reduction Factor	Federal Funding Eligibility	Cost Estimate
Ped & bike	0.35	100%	$60,000-$160,000 each

Why was this chosen for City of Fresno? Pedestrian collisions at unsignalized locations is the top pedestrian collision type resulting in a fatality or severe injury. Installing enhanced pedestrian crossings at uncontrolled intersections will warn drivers to expect pedestrian and bicycle crossings and clarify that drivers are expected to yield right of way to crossing pedestrians and bicyclists.

Image Source: Toole Design Group

[32] Thomas, L., N.J. Thirsk, and C.V. Zegeer. *Application of Pedestrian Crossing Treatments for Streets and Highways* (Project No. 20-05 (Topic 46-10)). 2016. Transportation Research Board, Washington, DC.

Install pedestrian signal or Pedestrian Hybrid Beacon (PHB) (NS23PB)

Summary of Countermeasure: PHBs are signals installed at unsignalized major street pedestrian and bicyclist crossing locations to help pedestrians cross the street safely. PHBs may be used in locations where side street traffic volumes do not warrant a conventional signal, or in situations where there are concerns a conventional signal may encourage additional motor vehicle traffic on the minor street. PHBs typically include the following elements:

- Overhead beacons with three sections (circular yellow signal indication centered below two horizontally aligned circular red signals) facing both directions on the major street
- Overhead signs labeled "CROSSWALK STOP ON RED" to indicate that the location is associated with a pedestrian crosswalk
- A marked crosswalk on the major street
- Countdown pedestrian signal heads to control pedestrian crossings at the crosswalk

Collision Types Addressed	Documented Collision Reduction Factor	Federal Funding Eligibility	Cost Estimate
Ped & bike	0.55	100%	$83,300 per system

Why was this chosen for City of Fresno? Pedestrian collisions at intersections are the top pedestrian collision type resulting in a fatality or severe injury. The primary collision factor is often listed as *pedestrian violation*,[33] which can indicate the need for improved pedestrian crossing opportunities. PHBs would warn drivers to expect pedestrian and bicycle crossings and clarify that drivers are expected to yield right of way to crossing pedestrians and bicyclists.

Image Source: Toole Design Group

[33] This is a reported PCF that indicated one of several CVCs involving a pedestrian failure to yield right of way to vehicles.

Install bike lanes (R32PB)

Summary of Countermeasure: Class II bicycle facilities, also known as bike lanes, are established along streets and defined by pavement striping and signage to delineate a portion of a roadway for bicycle travel. Bike lanes are one-way facilities, typically striped adjacent to vehicle traffic traveling in the same direction. Buffered bike lanes provide greater separation from an adjacent traffic lane or on-street parking by using painted chevrons or diagonal markings. Buffered bike lanes may be desirable on streets with higher vehicle speeds or volumes.

Collision Types Addressed	Documented Collision Reduction Factor	Federal Funding Eligibility	Cost Estimate
Ped & bike	0.35	90%	$50 per ft[34]

Why was this chosen for City of Fresno? *Auto right-of-way*[35] violation is among the top three collision factors most frequently associated with bicycle collisions. The most common violation involved drivers being at fault. Installing bike lanes would allocate a portion of the roadway to bicyclists and separates them from the vehicle travel lane.

Image Source: Toole Design Group

[34] Cost assumes bike lane striping is thermoplastic.

[35] This is a reported PCF that indicated one of several CVCs involving a failure to yield right of way to oncoming traffic.

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

Summary of Countermeasure: Sidewalks and walkways provide a dedicated space for pedestrians to travel that is separated from roadway vehicles. The presence of sidewalks on both sides of the street has been found to reduce the collision risks associated with pedestrians walking along the roadways as compared to locations where no sidewalks or walkways exist. The presence of sidewalks and walkways can reduce these types of pedestrian collisions by 50% to 90%. Guidance signs and markings directing pedestrians and bicyclists on appropriate travel paths and signs and markings warning drivers of pedestrians and bicyclists should be used in conjunction with sidewalks and walkways.

Collision Types Addressed	Documented Collision Reduction Factor	Federal Funding Eligibility	Cost Estimate
Ped & bike	0.8	90%	$25 per ft

Why was this chosen for City of Fresno? *Pedestrian right-of-way*[36] violation is among the top three collision factors most frequently associated with pedestrian collisions. The most common violation involved drivers being at fault. Installing sidewalks and walkways would provide a dedicated space for pedestrians to travel that is separated from vehicle travel lanes.

Image Source: FHWA

[36] This is a reported PCF that indicated one of several CVCs involving a failure of a driver of a vehicle to yield the right of way to a pedestrian.

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

Summary of Countermeasure: Pedestrian crossings with enhanced safety features such as high-visibility crosswalk markings, curb extensions, raised medians, beacons, and lighting delineate the portion of the roadway to be used by crossing pedestrians. The features warn drivers of the presence of pedestrians and bicyclists crossing the roadway and encourage them to yield. The enhanced improvements added to the crossing also increase the likelihood that pedestrians will cross at a location visible to and predictable for motorists. They are useful in aligning pedestrian behavior with driver expectations at mid-block crossings. Guidance signs and markings should be used in combination with the enhanced pedestrian crossing to guide pedestrians and bicyclists along appropriate travel paths.

Collision Types Addressed	Documented Collision Reduction Factor	Federal Funding Eligibility	Cost Estimate
Ped & bike	0.35	90%	$60,000-$160,000 each

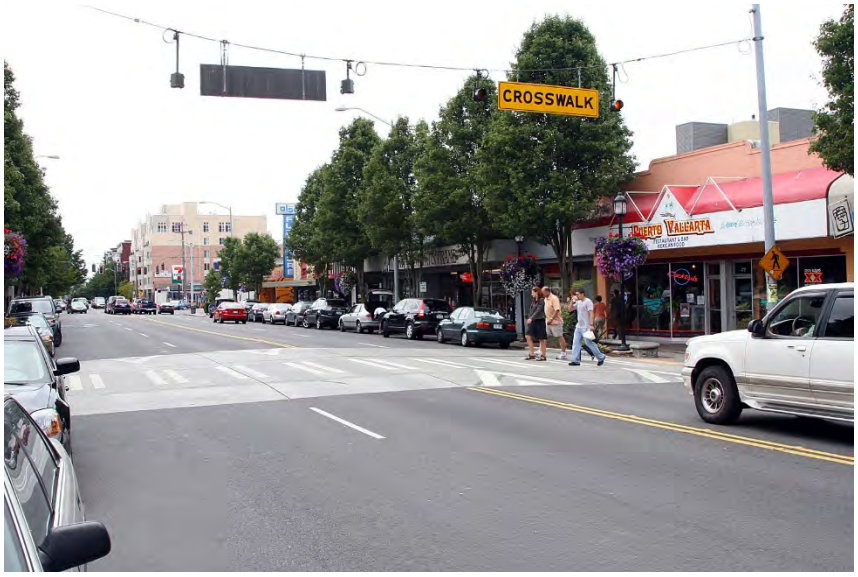
Why was this chosen for City of Fresno? Pedestrian/bicycle collision in a mid-block segment is among the top three collision types resulting in a fatality or severe injury. The primary collision factor is often listed as *pedestrian violation*. Installing enhanced mid-block pedestrian crossings would warn drivers to expect pedestrian and bicycle crossings and clarify that drivers are expected to yield right of way to crossing pedestrians and bicyclists.

Image Source: Toole Design Group

Install raised pedestrian crossing (R36PB)

Summary of Countermeasure: A raised crossing is a vertical traffic control measure that can reduce vehicle speeds, improve pedestrian visibility to approaching drivers, and improve pedestrian and bicyclist crossing safety. The raised crossing encourages drivers to reduce their speed and provides improved delineation for the portion of the roadway that is designated for pedestrian crossing. Signs and markings directing pedestrians and cyclists along appropriate travel paths should be used in combination with this countermeasure.

Collision Types Addressed	Documented Collision Reduction Factor	Federal Funding Eligibility	Cost Estimate
Ped & bike	0.35	90%	$5,000 each



Why was this chosen for City of Fresno? Pedestrian crossing in crosswalk at an intersection is among the top three pedestrian collision types resulting in a fatality or severe injury. Vehicles were most commonly proceeding straight for this collision type. Installing raised pedestrian crossings would slow drivers down and improve the visibility of pedestrians and bicyclists to drivers.

Image Source: Toole Design Group

Install pedestrian countdown signal heads (S17PB)

Summary of Countermeasure: Pedestrian countdown signals contain a timer display and count down the remaining number of seconds 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 push button rather than cross illegally.

Collision Types Addressed	Documented Collision Reduction Factor	Federal Funding Eligibility	Cost Estimate
Ped & bike	0.25	100%	$1,800 per signal head

Why was this chosen for City of Fresno? *Pedestrian violation* is the top collision factor associated with pedestrian collisions. This violation most commonly involves pedestrians being at fault. Installing pedestrian countdown signals would help pedestrians cross intersections in the designated time and allow vehicles to proceed.

Image Source: Toole Design Group

Install pedestrian crossing (S.I.) (S18PB)

Summary of Countermeasure: Installing pedestrian crossings at intersections can improve pedestrian and bicycle safety by designating a dedicated portion of the roadway for pedestrian and bicycle crossing. This helps reduce pedestrian-related collisions within 50 feet of an intersection. High-visibility crosswalk markings, pedestrian countdown signals, and appropriate signs can enhance pedestrian and bicycle safety at pedestrian crossings.

Collision Types Addressed	Documented Collision Reduction Factor	Federal Funding Eligibility	Cost Estimate
Ped & bike	0.25	100%	$8,200 per crossing

Why was this chosen for City of Fresno? Pedestrian collision at a signalized location is among the top three pedestrian collision types resulting in a fatality or severe injury. Signalized intersections tend to be the intersections with the greatest concentration of road user activity (higher vehicle volumes to warrant a signal, where people tend to go to cross the street) so the presence of conflicts between modes is greater at signalized intersections. Reducing and managing those conflicts through signal phasing adjustments and designating separate space for each mode help to reduce crash risk. The primary collision factor is often listed as *pedestrian violation*. Installing enhanced pedestrian crossings at controlled intersections would provide pedestrians and bicyclists with a designated portion of the roadway to cross intersections and force vehicles to yield to crossing pedestrians and bicyclists.

Image Source: Toole Design Group

Modify signal phasing to implement a leading pedestrian interval (LPI) (S21PB)

Summary of Countermeasure: A leading pedestrian interval (LPI) provides pedestrians with an opportunity to establish their presence in the crosswalk before drivers start turning and provides additional crossing time for those who need it. This head start increases the percentage of drivers who yield the right of way to pedestrians and can minimize conflicts between pedestrians crossing a roadway and turning vehicles.

Collision Types Addressed	Documented Collision Reduction Factor	Federal Funding Eligibility	Cost Estimate
Ped & bike	0.6	50%	<$2,500 per signal

Why was this chosen for City of Fresno? *Pedestrian right-of-way*[37] violation is among the top five collision factors associated with pedestrian collisions. The most common violation involved drivers being at fault. Installing LPIs will allow pedestrians to establish their presence in a crosswalk and encourage drivers to yield to crossing pedestrians.

Image Source: Toole Design Group

[37] This is a reported PCF that indicated one of several CVCs involving a failure of a vehicle driver to yield the right of way to a pedestrian.

8.1.4 VIABLE PROJECT SCOPES AND PRIORITIZED LIST OF SAFETY PROJECTS

The project team identified competitive groupings of locations for potential Highway Safety Improvement Program (HSIP) applications and capital improvement projects to reduce the risk of collisions in the City. A total of 10 locations were moved forward into scoping, and several have been grouped by similar characteristics. The project scopes and groupings developed are listed below.

- Group A: Arterial/arterial or arterial/collector signalized intersections
  - First Street and Shaw Avenue
  - Blackstone Avenue and Bullard Avenue
  - Fresno Street and Shields Avenue
  - First Street and Gettysburg Avenue
  - Audubon Drive and Friant Road
  - Cedar Avenue and Shields Avenue
- Group B: Unsignalized intersections on collectors or arterials with pedestrian crossing improvements
  - Blackstone Avenue and Garland Avenue
  - Blackstone Avenue and Cornell Avenue
  - Cedar Avenue and Fountain Way
- Group C: Rural[38] unsignalized intersections
  - Valentine Avenue and Weber Avenue

The scoping structure has been written to support potential use for HSIP grants. This includes a summary of the site, recommended improvements, collision history, and justification of the safety improvements proposed. The collision history shown per location includes all reported crashes specific to the location. Planning-level cost estimates and benefit-to-cost ratios derived from HSIP Cycle 10 Guidelines are also provided for each location. The planning-level cost estimates do include a 30% contingency for construction items and estimates for environmental, PS&E, right-of-way engineering, and construction engineering. Details can be found in *Attachment B.*

[38] Rural is based on adjacent land uses and existing condition of the roadway.

Group A: Arterial/arterial or arterial/collector signalized intersections

First Street & Shaw Avenue

The First Street and Shaw Avenue intersection is signalized with protected left-turn phasing on all approaches. First Street is a four-lane arterial divided by a raised median with dual left-turn lanes and right-turn lanes on both approaches. Shaw Avenue is a six-lane arterial divided by a raised median with dual left-turn lanes and right-turn lanes on both approaches. Retail/commercial land uses characterize all corners of this intersection, including gasoline/service stations with convenience markets on the northeast and southeast corners, a shopping center on the southwest corner and a bank on the northwest corner. The intersection has marked crosswalks (transverse lines) across all approaches and pedestrian curb ramps, walkways, and lighting on all corners. First Street has a Class III bike route south of Shaw Avenue. Transit stops exist along Shaw Avenue on the northwest and southeast corners and along First Street on the northwest corner. Table 8-3 provides an overview of reported collision history data from 2014 to 2018 including total collisions, injury severity, time of day, party involvement and collision severity score.

Table 8-3. Collision History (2014-2018), First Street & Shaw Avenue

	Annual Collision Severity Score	Total Collisions	Fatal	Severe Injury	Moderate Injury	Minor Injury	Property Damage Only
Total Collisions	118.6	50	0	4	4	14	28
Nighttime		16	0	2	0	5	9
Ped / Bike		9	0	0	2	6	1

Source: Calculations by the project team using data from City of Fresno and SWITRS.

Proposed Project

- The proposed project includes the following safety treatments, as shown in Figure 8-1:
  - Provide pedestrian-scale intersection lighting to increase visibility of the intersection and pedestrians at the crossings. This treatment is intended to address nighttime collisions. Sixteen of 50 collisions occurred in dark conditions. (S1)
  - Install retroreflective backing on signal heads to improve visibility of the signal indications. This treatment is intended to address right-angle and rear-end collisions. Twenty-seven of 50 collisions were either rear-end or broadside collisions. (S2)
  - Install regulatory signage (right) turning vehicles yield to pedestrian (R10-15). This treatment is intended to address pedestrian-involved collisions. Nine of 50 collisions involved a pedestrian or bicyclist. (NS6)
  - Install advanced dilemma zone detection. This treatment is intended to reduce rear-end collisions and red light running. Fifteen of 50 collisions were rear-end collisions. Eleven of 50 collisions resulted from running a red light. (S4)
  - Install advanced stop bars on all approaches to further separate vehicles from crossing pedestrians and to provide dedicated space for bicyclists. (S20PB)
  - Modify signal phasing to implement a leading pedestrian interval. This treatment is intended to address pedestrian-involved collisions. Nine of 50 collisions involved a pedestrian or bicyclist. (S21PB)
  - Install advanced intersection warning signs to inform motorists of the approaching intersection (NS6)
- Cost Estimate: $354,700
- Planning-Level B/C Ratio: 35.962

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Blackstone Avenue & Bullard Avenue

The Blackstone Avenue and Bullard Avenue intersection is signalized with protected left-turn phasing on all approaches. Blackstone Avenue is a six-lane arterial divided by a raised median with dual left-turn lanes and right-turn lanes on both approaches. Bullard Avenue is a four-lane arterial divided by a raised median with dual left-turn lanes and right-turn lanes on both approaches. Existing signage prohibits U-turns along Bullard Avenue. All corners of this intersection support retail/commercial land uses including a gasoline/service station with convenience market on the northeast corner, car dealerships on the southeast and southwest corners, and a convenience market on the northwest corner. The intersection has marked crosswalks (transverse lines) across all approaches and pedestrian curb ramps, walkways, and lighting on all corners. Transit stops are not present at (or near) the intersection. Table 8-4 provides an overview of reported collision history data from 2014 to 2018 including total collisions, injury severity, time of day, party involvement and collision severity score.

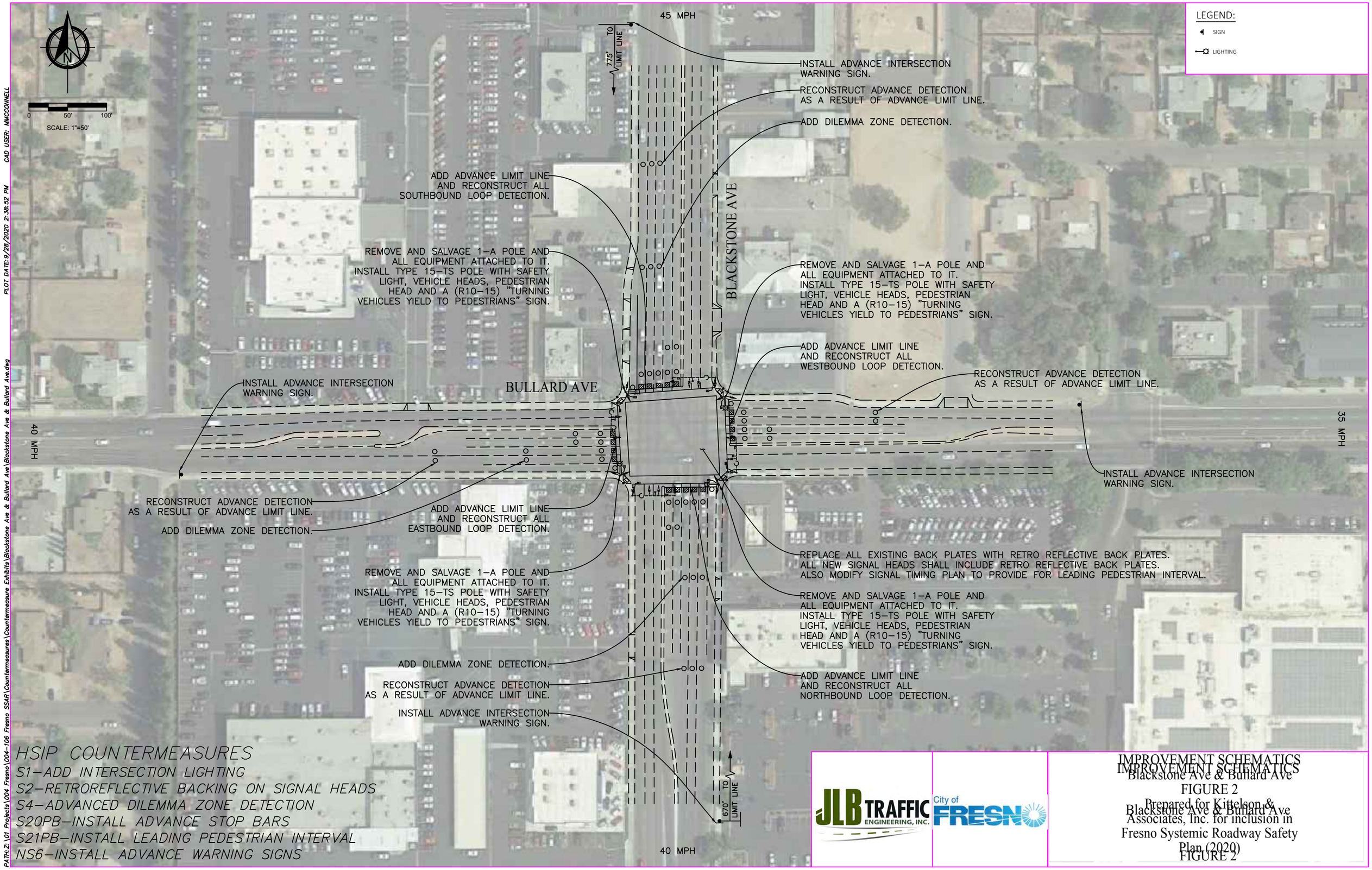
Table 8-4. Collision History (2014-2018), Blackstone Avenue & Bullard Avenue

	Annual collision severity score	Total Collisions	Fatal	Severe Injury	Moderate Injury	Minor Injury	Property Damage Only
Total Collisions	92.8	28	0	3	4	9	12
Nighttime		14	0	3	2	3	6
Ped / Bike		2	0	0	1	1	0

Source: Calculations by the project team using data from City of Fresno and SWITRS.

Proposed Project

- The proposed project includes the following safety treatments, as shown in Figure 8-2:
  - Provide pedestrian-scale intersection lighting to increase visibility of the intersection and pedestrians at the crossings. This treatment is intended to address nighttime collisions. Fourteen of 28 collisions occurred in dark conditions. (S1)
  - Install retroreflective backing on signal heads to improve visibility of the signal indications. This treatment is intended to address right-angle and rear-end collisions. Eighteen of 28 collisions were either rear-end or broadside. (S2)
  - Install regulatory signage (right) turning vehicles yield to pedestrian (R10-15). This treatment is intended to address pedestrian-involved collisions. Two of 28 collisions involved a pedestrian or bicyclist. (NS6)
  - Install advanced dilemma zone detection. This treatment is intended to reduce rear-end collisions and red light running. Nine of 28 collisions were rear-end collisions. Six of 28 collisions resulted from running a red light. The specific location of the dilemma zone detection is further upstream from the signal. (S4)
  - Install advanced stop bars on all approaches to further separate vehicles from crossing pedestrians and to provide dedicated space for bicyclists (S20PB)
  - Modify signal phasing to implement a leading pedestrian interval. This treatment is intended to address pedestrian-involved collisions. Two of 28 collisions involved a pedestrian or bicyclist. (S21PB)
  - Install advanced intersection warning signs to inform motorists of the approaching intersection (NS6)
- Cost Estimate: $327,100
- Planning-Level B/C Ratio: 38.51



IMPROVEMENT SCHEMATICS
Blackstone Ave & Bullard Ave
FIGURE 2

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Fresno Street & Shields Avenue

The Fresno Street and Shields Avenue intersection is signalized with protected left-turn phasing on all approaches. Fresno Street is a four-lane collector divided by a raised median with left-turn lanes on both approaches. Shields Avenue is a five-lane arterial divided by a raised median with left-turn lanes on both approaches and a right-turn lane on the eastbound approach only. The Dry Creek canal runs along the south side of Shields Avenue. The proposed Midtown trail will be located along the canal. Retail/commercial land uses occupy all corners of this intersection, including a bank on the northeast corner, an office building on the southeast corner, a fire station on the southwest corner, and a shopping center on the northwest corner. The intersection has marked crosswalks (transverse lines) across all approaches and pedestrian curb ramps and lighting on all corners. Pedestrian walkways exist along Fresno Street and along the north side of Shields Avenue only. East of Fresno Street, Shields Avenue has Class II bike lanes and a Class I bike path along the north. Transit stops exist along Shields Avenue on the northwest and southeast corners. Table 8-5 provides an overview of reported collision history data from 2014 to 2018 including total collisions, injury severity, time of day, party involvement, and collision severity score.

Table 8-5. Collision History (2014-2018), Fresno Street & Shields Avenue

	Annual collision severity score	Total Collisions	Fatal	Severe Injury	Moderate Injury	Minor Injury	Property Damage Only
Total Collisions	90.7	36	2	1	2	11	20
Nighttime		15	1	0	1	2	11
Ped / Bike		5	0	0	1	3	1

Source: Calculations by the project team using data from City of Fresno and SWITRS.

Proposed Project

- The proposed project includes the following safety treatments, as shown in Figure 8-3:
  - Provide pedestrian-scale intersection lighting to increase visibility of the intersection and pedestrians at the crossings. This treatment is intended to address nighttime collisions. Fifteen of 36 collisions occurred in dark conditions. (S1)
  - Install retroreflective backing on signal heads to improve visibility of the signal indications. This treatment is intended to address right-angle and rear-end collisions. Twenty of 36 collisions were either rear-end or broadside collisions. (S2)
  - Install regulatory signage (right) turning vehicles yield to pedestrian (R10-15). This treatment is intended to address pedestrian-involved collisions. Five of 36 collisions involved a pedestrian or bicyclist. (NS6)
  - Install advanced dilemma zone detection. This treatment is intended to reduce rear-end collisions and red light running. Fifteen of 36 collisions were rear-end collisions. Six of 36 collisions resulted from running a red light. (S4)
  - Install advanced stop bars on all approaches to further separate vehicles from crossing pedestrians and provide dedicated space for bicyclists (S20PB)
  - Modify signal phasing to implement an LPI. This treatment is intended to address pedestrian-involved collisions. Five of 36 collisions involved a pedestrian or bicyclist. (S21PB)
  - Install advanced intersection warning signs to inform motorists of the approaching intersection (NS6)
- Cost Estimate: $273,400
- Planning-Level B/C Ratio: 31.28

N

0 50' 100'

SCALE: 1"=50'

40 MPH

LEGEND:

SIGN

LIGHTING

RECONSTRUCT ADVANCE DETECTION AS A RESULT OF ADVANCE LIMIT LINE.

ADD DILEMMA ZONE DETECTION.

INSTALL ADVANCE INTERSECTION WARNING SIGN.

290' TO LIMIT LINE

FRESNO ST

ADD ADVANCE LIMIT LINE AND RECONSTRUCT ALL SOUTHBOUND LOOP DETECTION.

REMOVE AND SALVAGE 1–A POLE AND ALL EQUIPMENT ATTACHED TO IT. INSTALL TYPE 15–TS POLE WITH SAFETY LIGHT, VEHICLE HEADS, PEDESTRIAN HEAD AND A (R10–15) "TURNING VEHICLES YIELD TO PEDESTRIANS" SIGN.

REMOVE EXISTING PEDESTRIAN HEAD.

INSTALL TYPE 15–TS POLE WITH SAFETY LIGHT, VEHICLE HEADS, PEDESTRIAN HEAD AND A (R10–15) "TURNING VEHICLES YIELD TO PEDESTRIANS" SIGN.

ADD ADVANCE LIMIT LINE AND RECONSTRUCT ALL WESTBOUND LOOP DETECTION.

ADD DILEMMA ZONE DETECTION.

RECONSTRUCT ADVANCE DETECTION AS A RESULT OF ADVANCE LIMIT LINE.

INSTALL ADVANCE INTERSECTION WARNING SIGN.

SHIELDS AVE

350' TO LIMIT LINE

40 MPH

40 MPH

380' TO LIMIT LINE

INSTALL ADVANCE INTERSECTION WARNING SIGN.

RECONSTRUCT ADVANCE DETECTION AS A RESULT OF ADVANCE LIMIT LINE.

ADD DILEMMA ZONE DETECTION.

ADD ADVANCE LIMIT LINE AND RECONSTRUCT ALL EASTBOUND LOOP DETECTION.

INSTALL TYPE 15–TS POLE WITH SAFETY LIGHT, VEHICLE HEADS, PEDESTRIAN HEAD AND A (R10–15) "TURNING VEHICLES YIELD TO PEDESTRIANS" SIGN.

RECONSTRUCT CURB RAMP TO MEET CURRENT ADA STANDARDS.

REMOVE EXISTING PEDESTRIAN HEAD.

ADD DILEMMA ZONE DETECTION.

RECONSTRUCT ADVANCE DETECTION AS A RESULT OF ADVANCE LIMIT LINE.

INSTALL ADVANCE INTERSECTION WARNING SIGN.

280' TO LIMIT LINE

REPLACE ALL EXISTING BACK PLATES WITH RETRO REFLECTIVE BACK PLATES. ALL NEW SIGNAL HEADS SHALL INCLUDE RETRO REFLECTIVE BACK PLATES. ALSO MODIFY SIGNAL TIMING PLAN TO PROVIDE FOR LEADING PEDESTRIAN INTERVAL.

REMOVE AND SALVAGE 1–A POLE AND ALL EQUIPMENT ATTACHED TO IT. INSTALL TYPE 15–TS POLE WITH SAFETY LIGHT, VEHICLE HEADS, PEDESTRIAN HEAD, PEDESTRIAN PUSH BUTTON AND A (R10–15) "TURNING VEHICLES YIELD TO PEDESTRIANS" SIGN.

ADD ADVANCE LIMIT LINE AND RECONSTRUCT ALL NORTHBOUND LOOP DETECTION.

40 MPH

HSIP COUNTERMEASURES

S1–ADD INTERSECTION LIGHTING
S2–RETROREFLECTIVE BACKING ON SIGNAL HEADS
S4–ADVANCED DILEMMA ZONE DETECTION
S20PB–INSTALL ADVANCE STOP BARS
S21PB–INSTALL LEADING PEDESTRIAN INTERVAL
NS6–INSTALL ADVANCE WARNING SIGNS

JLB TRAFFIC ENGINEERING, INC.

City of FRESNO

IMPROVEMENT SCHEMATICS

Fresno St & Shields Ave

FIGURE 3

Prepared for: Kittelson & Associates, Inc. for inclusion in Fresno Systemic Roadway Safety Plan (2020)

IMPROVEMENT SCHEMATICS
Fresno St & Shields Ave
FIGURE 3

First Street & Gettysburg Avenue

The First Street and Gettysburg Avenue intersection is signalized with protected left-turn phasing on all approaches. First Street is a four-lane arterial divided by a raised median with left-turn and right-turn lanes on both approaches. Gettysburg Avenue is a two-lane undivided collector west of First Street and a three-lane collector divided by a two-way left-turn lane east of First Street. Gettysburg Avenue has left-turn lanes on both approaches and a right-turn lane on the westbound approach only. Retail/commercial land uses occupy all corners of this intersection, including a gasoline/service station with convenience market on the northeast corner, a shopping center on the southeast corner, a gasoline/service station with convenience market on the southwest corner, and an office building on the northwest corner. The intersection has marked crosswalks (transverse lines) across all approaches and pedestrian curb ramps, walkways and lighting on all corners. Both First Street and Gettysburg Avenue have Class II bike lanes. Transit stops exist along First Street on the northeast and southwest corners. Table 8-6 provides an overview of reported collision history data from 2014 to 2018, including total collisions, injury severity, time of day, party involvement, and collision severity score.

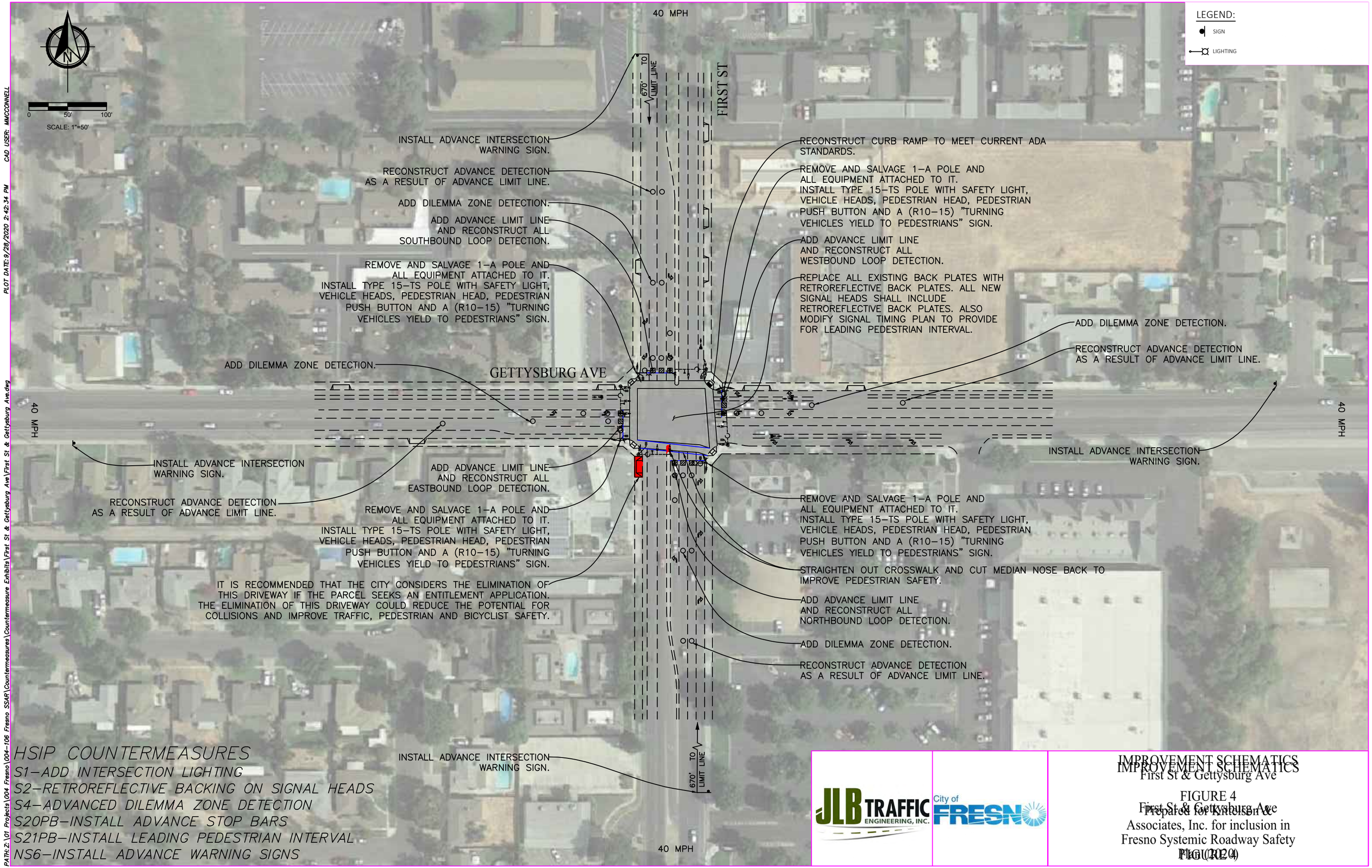
Table 8-6. Collision History (2014-2018), First Street & Gettysburg Avenue

	Annual collision severity score	Total Collisions	Fatal	Severe Injury	Moderate Injury	Minor Injury	Property Damage Only
Total Collisions	86.1	34	1	3	1	6	23
Nighttime		16	0	2	0	2	12
Ped / Bike		2	0	1	1	0	0

Source: Calculations by the project team using data from City of Fresno and SWITRS.

Proposed Project

- The proposed project includes the following safety treatments, as shown in Figure 8-4:
  - Provide pedestrian-scale intersection lighting to light the corners of the intersection and conflict points with turning vehicles and increase visibility of the intersection and pedestrians at the crossings. This treatment is intended to address nighttime collisions. Sixteen of 34 collisions occurred in dark conditions. (S1)
  - Install retroreflective backing on signal heads to improve visibility of the signal indications. This treatment is intended to address right-angle and rear-end collisions. Seventeen of 34 collisions were either rear-end or broadside collisions. (S2)
  - Install regulatory signage (right) turning vehicles yield to pedestrian (R10-15). This treatment is intended to address pedestrian-involved collisions. Two of 34 collisions involved a pedestrian or bicyclist. (NS6)
  - Install advanced dilemma zone detection. This treatment is intended to reduce rear-end collisions and red light running. Ten of 34 collisions were rear-end collisions. Six of 34 collisions resulted from running a red light. (S4)
  - Install advanced stop bars on all approaches to further separate vehicles from crossing pedestrians and to provide dedicated space for bicyclists (S20PB)
  - Modify signal phasing to implement a leading pedestrian interval. This treatment is intended to address pedestrian-involved collisions. Two of 34 collisions involved a pedestrian or bicyclist. (S21PB)
  - Install advanced intersection warning signs to inform motorists of the approaching intersection (NS6)
- Cost Estimate: $321,200
- Planning-Level B/C Ratio: 35.42



HSIP COUNTERMEASURES

S1-ADD INTERSECTION LIGHTING
S2-RETROREFLECTIVE BACKING ON SIGNAL HEADS
S4-ADVANCED DILEMMA ZONE DETECTION
S20PB-INSTALL ADVANCE STOP BARS
S21PB-INSTALL LEADING PEDESTRIAN INTERVAL
NS6-INSTALL ADVANCE WARNING SIGNS

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IMPROVEMENT SCHEMATICS
First St & Gettysburg Ave

FIGURE 4
First St & Gettysburg Ave
Prepared for Kittelson & Associates, Inc. for inclusion in Fresno Systemic Roadway Safety Plan (2024)

IMPROVEMENT SCHEMATICS

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Friant Road & Audubon Drive

The Friant Road and Audubon Drive intersection is signalized with protected left-turn phasing on all approaches. Friant Road is a six-lane scenic expressway north of Audubon Drive and is a seven-lane super arterial south of it. Friant Road is divided by a raised median and has dual left-turn lanes and right-turn lanes on both approaches. Audubon Drive is a four-lane scenic collector west of Friant Road and a four-lane scenic arterial east of Friant Road. Audubon Drive is divided by a raised median and has dual left-turn lanes and right-turn lanes on both approaches. The corners of this intersection support a variety of land uses including a residential neighborhood on the northeast corner, a vacant property (planned for retail/commercial land uses) on the southeast corner, an office building on the southwest corner, and Woodward Park on the northwest corner. The intersection has marked crosswalks (transverse lines) across all approaches and pedestrian curb ramps, walkways and lighting on all corners. Friant Road south of Audubon Drive and Audubon Drive have Class II bike lanes. Friant Road and Audubon Drive west of Friant Road have Class I bike paths. Transit stops are not present at (or near) the intersection. Table 8-7 provides an overview of reported collision history data from 2014 to 2018 including total collisions, injury severity, time of day, party involvement, and collision severity score.

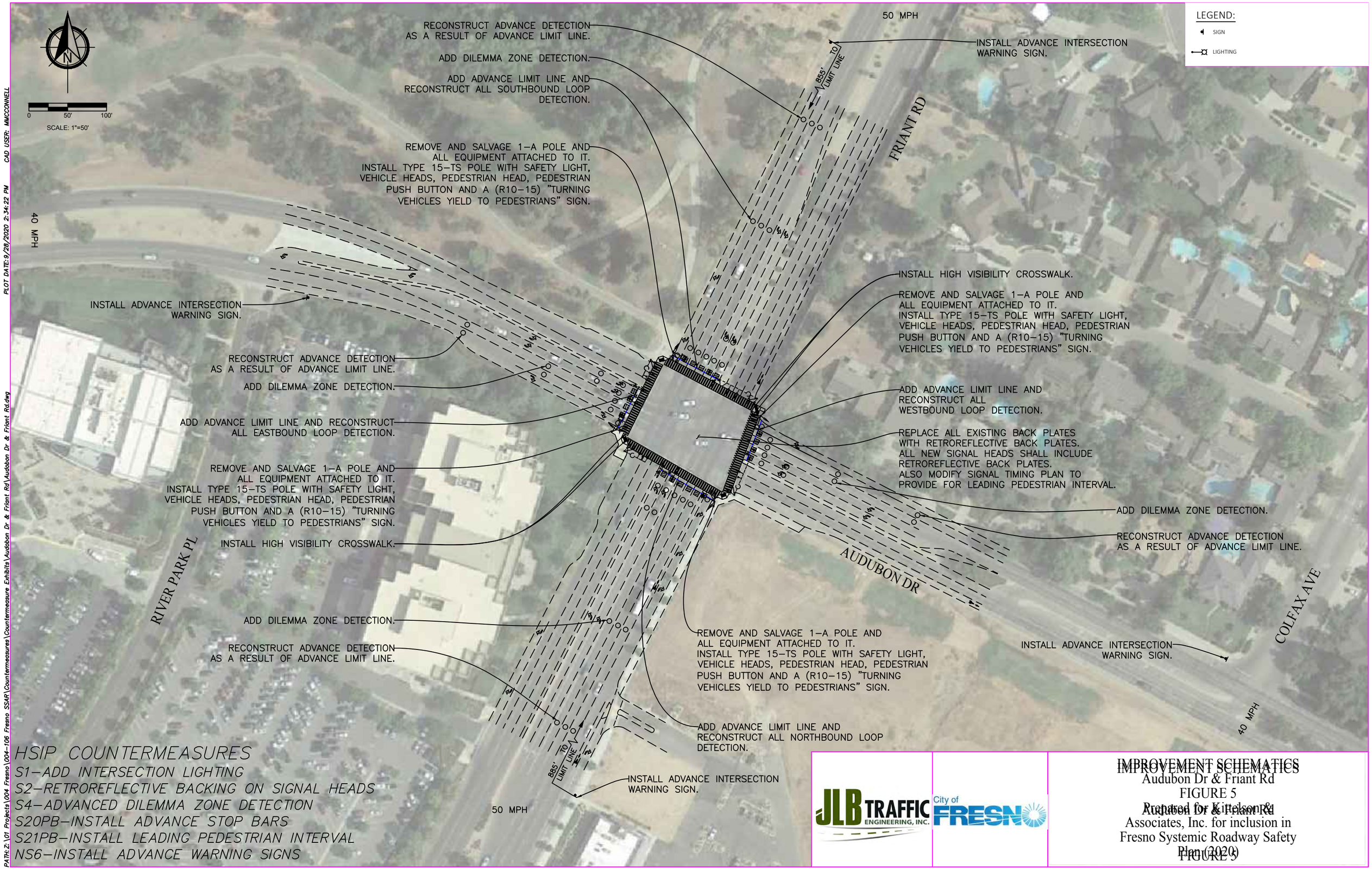
Table 8-7. Collision History (2014-2018), Audubon Drive & Friant Road

	Annual collision severity score	Total Collisions	Fatal	Severe Injury	Moderate Injury	Minor Injury	Property Damage Only
Total Collisions	85.0	25	0	3	3	4	15
Nighttime		11	0	0	1	1	9
Ped / Bike		3	0	0	1	1	1

Source: Calculations by the project team using data from City of Fresno and SWITRS.

Proposed Project

- The proposed project includes the following safety treatments, as shown in Figure 8-5:
  - Provide pedestrian-scale intersection lighting to light the corners of the intersection and conflict points with turning vehicles and increase visibility of the intersection and pedestrians at the crossings. This treatment is intended to address nighttime collisions. Eleven of 25 collisions occurred in dark conditions. (S1)
  - Install retroreflective backing on signal heads to improve visibility of the signal indications. This treatment is intended to address right-angle and rear-end collisions. Fifteen of 25 collisions were either rear-end or broadside. (S2)
  - Install regulatory signage (right) turning vehicles yield to pedestrian (R10-15). This treatment is intended to address pedestrian-involved collisions. Three of 25 collisions involved a pedestrian or bicyclist. (NS6)
  - Install advanced dilemma zone detection. This treatment is intended to reduce rear-end collisions and red light running. Eleven of 25 collisions were rear-end collisions. Three of 25 collisions resulted from running a red light. (S4)
  - Install advanced stop bars on all approaches to further separate vehicles from crossing pedestrians and to provide dedicated space for bicyclists (S20PB)
  - Modify signal phasing to implement an LPI. This treatment is intended to address pedestrian-involved collisions. Three of 25 collisions involved a pedestrian or bicyclist. (S21PB)
  - Install advance intersection warning signs to inform motorists of the approaching intersection (NS6)
- Cost Estimate: $416,200
- Planning-Level B/C Ratio: 14.46



HSIP COUNTERMEASURES

S1-ADD INTERSECTION LIGHTING
S2-RETROREFLECTIVE BACKING ON SIGNAL HEADS
S4-ADVANCED DILEMMA ZONE DETECTION
S20PB-INSTALL ADVANCE STOP BARS
S21PB-INSTALL LEADING PEDESTRIAN INTERVAL
NS6-INSTALL ADVANCE WARNING SIGNS

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IMPROVEMENT SCHEMATICS
Audubon Dr & Friant Rd
FIGURE 5
Prepared for Kittelson & Associates, Inc. for inclusion in Fresno Systemic Roadway Safety Plan (2020)

IMPROVEMENT SCHEMATICS
Audubon Dr & Friant Rd
FIGURE 5

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Cedar Avenue & Shields Avenue

The Cedar Avenue and Shields Avenue intersection is signalized with protected left-turn phasing on all approaches. Cedar Avenue is a four-lane arterial divided by a raised median with left-turn lanes and right-turn lanes on both approaches. Shields Avenue is a four-lane arterial divided by a raised median with left-turn lanes on both approaches. All corners of this intersection support retail/commercial land uses, including gasoline/service stations with convenience markets and shopping centers. The intersection has decorative paving, marked crosswalks (transverse lines) across all approaches and pedestrian curb ramps, walkways, and lighting on all corners. Both Cedar Avenue and Shields Avenue have Class II bike lanes. Transit stops exist along Cedar Avenue on the northwest and northeast corners. Table 8-8 provides an overview of reported collision history data from 2014 to 2018 including total collisions, injury severity, time of day, party involvement, and collision severity score.

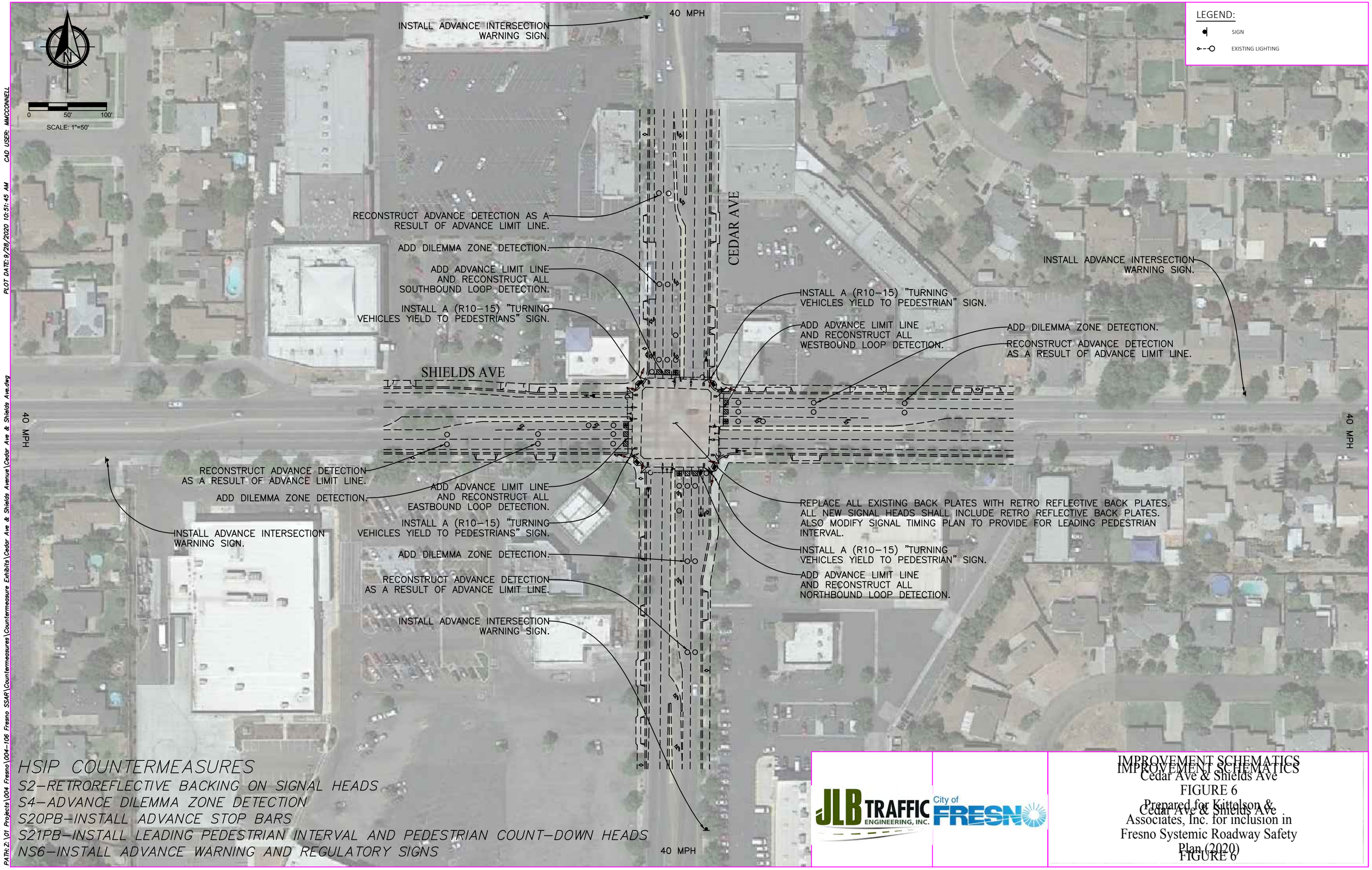
Table 8-8. Collision History (2014-2018), Cedar Avenue & Shields Avenue

	Annual collision severity score	Total Collisions	Fatal	Severe Injury	Moderate Injury	Minor Injury	Property Damage Only
Total Collisions	79.1	31	0	3	2	7	19
Nighttime		19	0	2	1	5	11
Ped / Bike		7	0	3	0	4	0

Source: Calculations by the project team using data from City of Fresno and SWITRS.

Proposed Project

- The proposed project includes the following safety treatments, as shown in Figure 8-6:
  - Install retroreflective backing on signal heads to improve visibility of the signal indications. This treatment is intended to address right-angle and rear-end collisions. Fifteen of 31 collisions were either rear-end or broadside collisions. (S2)
  - Install regulatory signage (right) turning vehicles yield to pedestrian (R10-15). This treatment is intended to address pedestrian-involved collisions. Seven of 31 collisions involved a pedestrian or bicyclist. (NS6)
  - Install advanced dilemma zone detection. This treatment is intended to reduce rear-end collisions and red light running. Nine of 31 collisions were rear-end collisions. Four of 31 collisions resulted from running a red light. (S4)
  - Install advanced stop bars on all approaches to further separate vehicles from crossing pedestrians and to provide dedicated space for bicyclists (S20PB)
  - Modify signal phasing to implement a leading pedestrian interval and pedestrian count-down signal heads. This treatment is intended to address pedestrian-involved collisions. Seven of 31 collisions involved a pedestrian or bicyclist. (S21PB)
  - Install advanced intersection warning signs to inform motorists of the approaching intersection (NS6)
- Cost Estimate: $190,800
- Planning-Level B/C Ratio: 34.25



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IMPROVEMENT SCHEMATICS
Cedar Ave & Shields Ave
FIGURE 6
Prepared for Kittelson & Associates, Inc. for inclusion in Fresno Systemic Roadway Safety Plan (2020)

IMPROVEMENT SCHEMATICS
Cedar Ave & Shields Ave
FIGURE 6

Group B: Unsignalized intersections on collectors or arterials with pedestrian crossing improvements

Blackstone Avenue & Garland Avenue

The Blackstone Avenue and Garland Avenue intersection is a two-way stop-controlled intersection with stop controls on Garland Avenue. Blackstone Avenue is a six-lane arterial divided by a raised median with left-turn lanes on both approaches. Garland Avenue is a two-lane undivided local roadway. Existing signage prohibits pedestrians from crossing Blackstone Avenue at the intersection. All corners of this intersection support retail/commercial land uses, including shopping centers on the northeast and southeast corners, a bank on the southwest corner, and a gasoline/service station with convenience market on the northwest corner. The intersection has marked crosswalks (transverse lines) across both Garland Avenue approaches and pedestrian curb ramps, walkways, and lighting on all corners. Bicycle facilities are not present along these roadways. Transit stops are not present at (or near) the intersection. Table 8-9 provides an overview of reported collision history data from 2014 to 2018 including total collisions, injury severity, time of day, party involvement, and collision severity score.

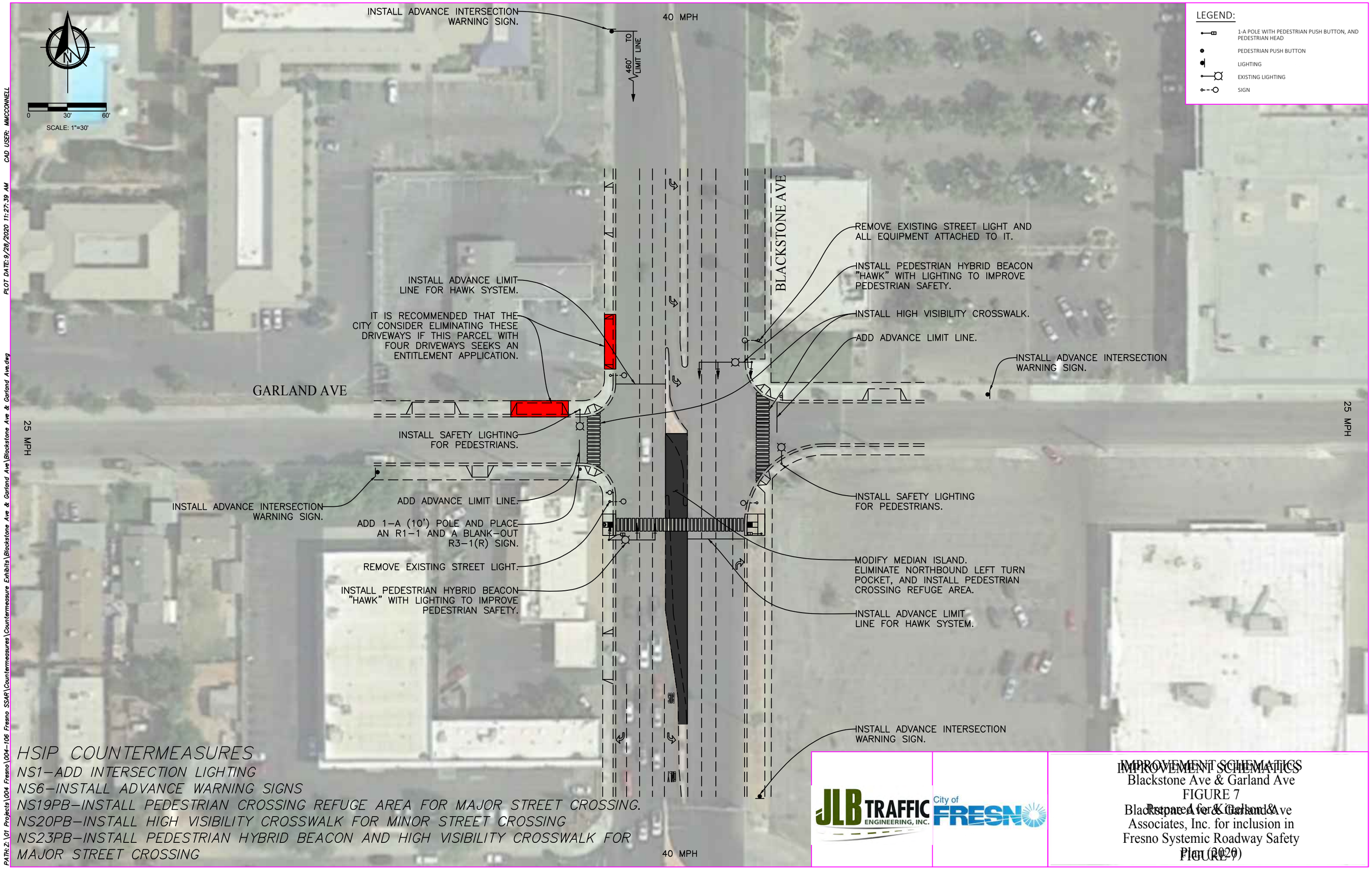
Table 8-9. Collision History (2014-2018), Blackstone Avenue & Garland Avenue

	Annual collision severity score	Total Collisions	Fatal	Severe Injury	Moderate Injury	Minor Injury	Property Damage Only
Total Collisions	119.6	14	0	3	2	2	7
Nighttime		7	0	2	2	0	3
Ped / Bike		4	0	3	1	0	0

Source: Calculations by the project team using data from City of Fresno and SWITRS.

Proposed Project

- The proposed project includes the following safety treatments, as shown in Figure 8-7:
  - Provide pedestrian-scale intersection lighting to increase to light the corners of the intersection and conflict points with turning vehicles providing visibility of the intersection and pedestrians at the crossings. This treatment is intended to address nighttime collisions. Seven of 14 collisions occurred in dark conditions. (NS1)
  - Install advance warning signs to inform motorists of the approaching intersection (NS6)
  - Remove the northbound left-turn pocket on Blackstone Avenue to provide for a pedestrian crossing refuge area (NS19PB)
  - Install high-visibility crosswalks across both Garland Avenue approaches (NS20PB)
  - Install PHB and high-visibility crosswalks across Blackstone Avenue. This treatment is intended to address pedestrian-involved collisions. Four of 14 collisions involved a pedestrian. (NS22PB)
- Cost Estimate: $565,400
- Planning-Level B/C Ratio: 48.40



HSIP COUNTERMEASURES

NS1–ADD INTERSECTION LIGHTING

NS6–INSTALL ADVANCE WARNING SIGNS

NS19PB–INSTALL PEDESTRIAN CROSSING REFUGE AREA FOR MAJOR STREET CROSSING.

NS20PB–INSTALL HIGH VISIBILITY CROSSWALK FOR MINOR STREET CROSSING

NS23PB–INSTALL PEDESTRIAN HYBRID BEACON AND HIGH VISIBILITY CROSSWALK FOR MAJOR STREET CROSSING

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IMPROVEMENT SCHEMATICS

Blackstone Ave & Garland Ave

FIGURE 7

Prepared for City of Fresno & Blackstone Ave & Garland Ave Associates, Inc. for inclusion in Fresno Systemic Roadway Safety Plan (2020)

IMPROVEMENT SCHEMATICS

FIGURE 7

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Blackstone Avenue & Cornell Avenue

The Blackstone Avenue and Cornell Avenue intersection is a two-way, stop-controlled intersection with stop controls on Cornell Avenue. Blackstone Avenue is a six-lane arterial divided by a raised median with left-turn lanes on both approaches. Cornell Avenue is a two-lane undivided local roadway. Existing signage prohibits pedestrians from crossing Blackstone Avenue at the intersection. All corners of this intersection support retail/commercial land uses including a fast-food restaurant with drive-through on the northeast corner, a gasoline/service station with convenience market on the southwest corner, and office buildings on the southeast and northwest corners. The intersection has unmarked crosswalks on all approaches and pedestrian curb ramps and walkways on all corners. Lighting is present on the northeast and southwest corners only. Bicycle facilities are not present along these roadways. Transit stops are not present at (or near) the intersection. Table 8-10 provides an overview of reported collision history data from 2014 to 2018 including total collisions, injury severity, time of day, party involvement, and collision severity score.

Table 8-10. Collision History (2014-2018), Blackstone Avenue & Cornell Avenue

	Annual collision severity score	Total Collisions	Fatal	Severe Injury	Moderate Injury	Minor Injury	Property Damage Only
Total Collisions	85.0	11	2	1	0	5	3
Nighttime		4	1	1	0	0	2
Ped / Bike		1	1	0	0	0	0

Source: Calculations by Kittelson & Associates, Inc. using data from City of Fresno and SWITRS

Proposed Project

- The proposed project includes the following safety treatments, as shown in Figure 8-8:
  - Provide pedestrian-scale intersection lighting to light the corners of the intersection and conflict points with turning vehicles and increase visibility of the intersection and pedestrians at the crossings. This treatment is intended to address nighttime collisions. Four of 11 collisions occurred in dark conditions. (NS1)
  - Install/upgrade additional stop signs or other warning regulatory signs to improve awareness of the approaching intersection (NS6)
  - Install high-visibility crosswalks across both Cornell Avenue approaches (NS20PB)
  - Install pedestrian hybrid beacon and high-visibility crosswalks across Blackstone Avenue. This treatment is intended to address pedestrian-involved collisions. One of 11 collisions involved a pedestrian. (NS22PB)
- Cost Estimate: $580,200
- Planning-Level B/C Ratio: 24.60

HSIP COUNTERMEASURES

NS1–ADD INTERSECTION LIGHTING

NS6–INSTALL ADVANCE WARNING SIGNS

NS20PB–INSTALL HIGH VISIBILITY CROSSWALK FOR MINOR STREET CROSSING

NS23PB–INSTALL PEDESTRIAN HYBRID BEACON AND HIGH VISIBILITY CROSSWALK FOR MAJOR STREET CROSSING

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IMPROVEMENT SCHEMATICS

Blackstone Ave & Cornell Ave

FIGURE 8

Prepared for City of Fresno by JLB Traffic Engineering, Inc. and Quad Knopf, Inc.

IMPROVEMENT SCHEMATICS

Blackstone Ave & Cornell Ave

FIGURE 8

Prepared for City of Fresno by JLB Traffic Engineering, Inc. and Quad Knopf, Inc.

Blackstone Ave & Cornell Ave

Associates, Inc. for inclusion in

Fresno Systemic Roadway Safety

Plan (2020)

FIGURE 8

Cedar Avenue & Fountain Way

The Cedar Avenue and Fountain Way intersection is a two-way stop-controlled intersection with stop controls on Fountain Way. Cedar Avenue is a four-lane arterial divided by a raised median with left-turn lanes on both approaches. Fountain Way is a two-lane undivided local roadway. All corners of this intersection support retail/commercial land uses including a sit-down restaurant on the northeast corner, a vacant building on the southeast corner, a fast-food restaurant with drive-through on the southwest corner, and a convenience market on the northwest corner. The intersection has unmarked crosswalks on all approaches and pedestrian curb ramps and walkways on all corners. Lighting is present on the northeast and southwest corners only. Transit stops are not present at (or near) the intersection. Table 8-11 provides an overview of reported collision history data from 2014 to 2018 including total collisions, injury severity, time of day, party involvement, and collision severity score.

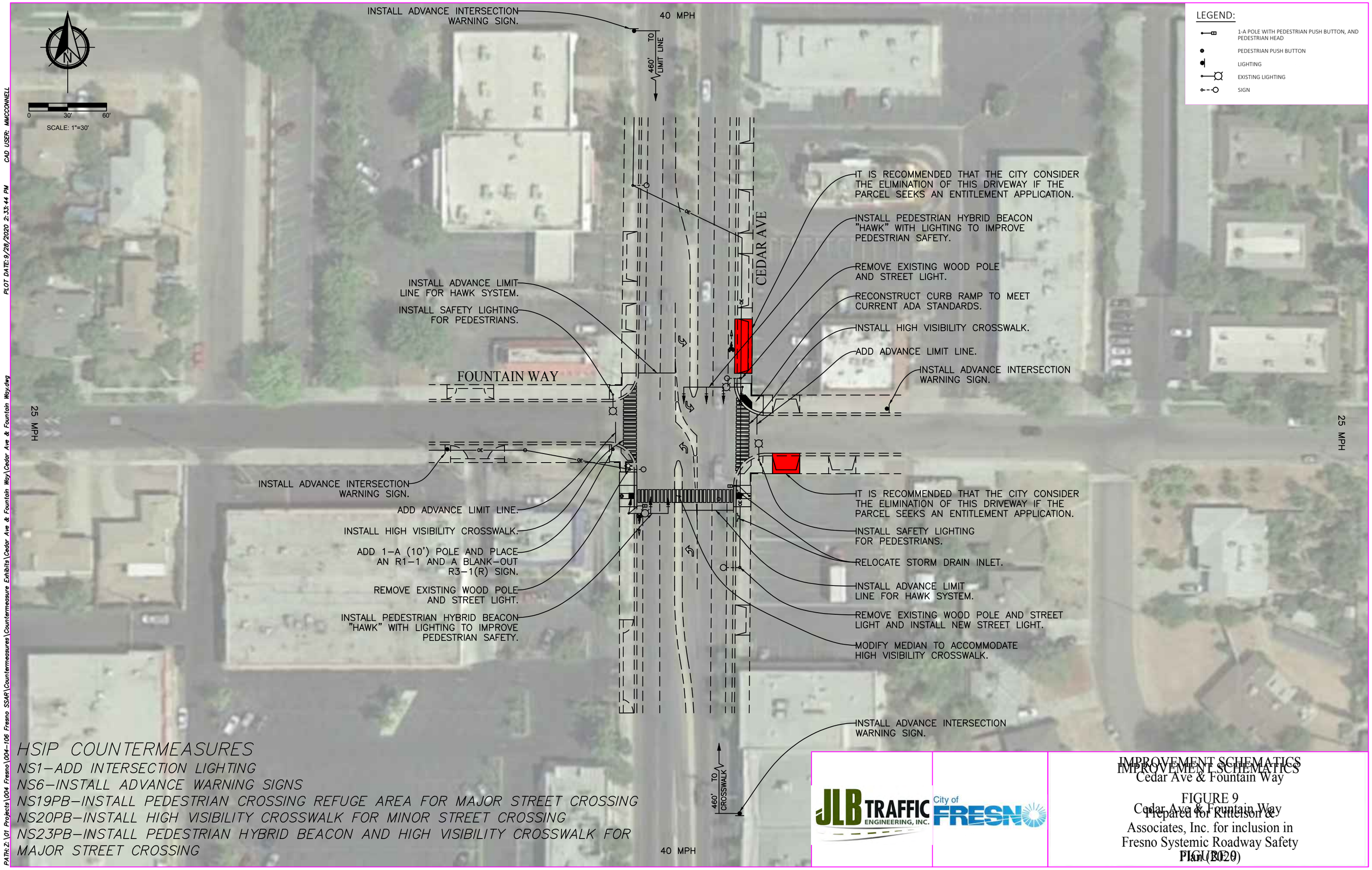
Table 8-11. Collision History (2014-2018), Cedar Avenue & Fountain Way

	Annual collision severity score	Total Collisions	Fatal	Severe Injury	Moderate Injury	Minor Injury	Property Damage Only
Total Collisions	80.6	11	1	1	1	3	5
Nighttime		6	1	1	1	0	3
Ped / Bike		4	1	1	1	0	1

Source: Calculations by the project team using data from City of Fresno and SWITRS.

Proposed Project

- The proposed project includes the following safety treatments, as shown in Figure 8-9:
  - Provide pedestrian-scale intersection lighting to light the corners of the intersection and conflict points with turning vehicles to increase visibility of the intersection and pedestrians at the crossings. This treatment is intended to address nighttime collisions. Six of 11 collisions occurred in dark conditions. (NS1)
  - Install/upgrade additional stop signs or other warning regulatory signs to improve awareness of the approaching intersection (NS6)
  - Modify the median island on the south leg of Cedar Avenue to provide for a pedestrian crossing refuge area (NS19PB)
  - Install high-visibility crosswalks across both Fountain Way approaches (NS20PB)
  - Install PHB and high-visibility crosswalks across Cedar Avenue. This treatment is intended to address pedestrian-involved collisions. Four of 11 collisions involved a pedestrian. (NS22PB)
- Cost Estimate: $499,400
- Planning-Level B/C Ratio: 42.12



HSIP COUNTERMEASURES

NS1–ADD INTERSECTION LIGHTING

NS6–INSTALL ADVANCE WARNING SIGNS

NS19PB–INSTALL PEDESTRIAN CROSSING REFUGE AREA FOR MAJOR STREET CROSSING

NS20PB–INSTALL HIGH VISIBILITY CROSSWALK FOR MINOR STREET CROSSING

NS23PB–INSTALL PEDESTRIAN HYBRID BEACON AND HIGH VISIBILITY CROSSWALK FOR MAJOR STREET CROSSING

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IMPROVEMENT SCHEMATICS

Cedar Ave & Fountain Way

FIGURE 9

Prepared for Kittelson & Associates, Inc. for inclusion in Fresno Systemic Roadway Safety Plan (2020)

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Group C: Rural unsignalized intersections

Valentine Avenue & Weber Avenue

The Valentine Avenue and Weber Avenue intersection is a one-way stop-controlled intersection with a one-way stop on Valentine Avenue. Weber Avenue is an existing two-lane undivided arterial. Valentine Avenue is an existing two-lane undivided collector. Union Pacific Railroad (UPRR) rail lines run parallel to Weber Avenue on the southwest side of the roadway. The northwest corner has a water detention basin. The northeast corner is primarily vacant, although a service center is located further north. The intersection has unmarked crosswalks on all approaches and lacks curb returns, walkways, and lighting on all corners. Both Valentine Avenue and Weber Avenue have Class II bike lanes. Transit stops are not present at (or near) the intersection. Table 8-12 provides an overview of reported collision history data from 2014 to 2018, including total collisions, injury severity, time of day, party involvement, and collision severity score.

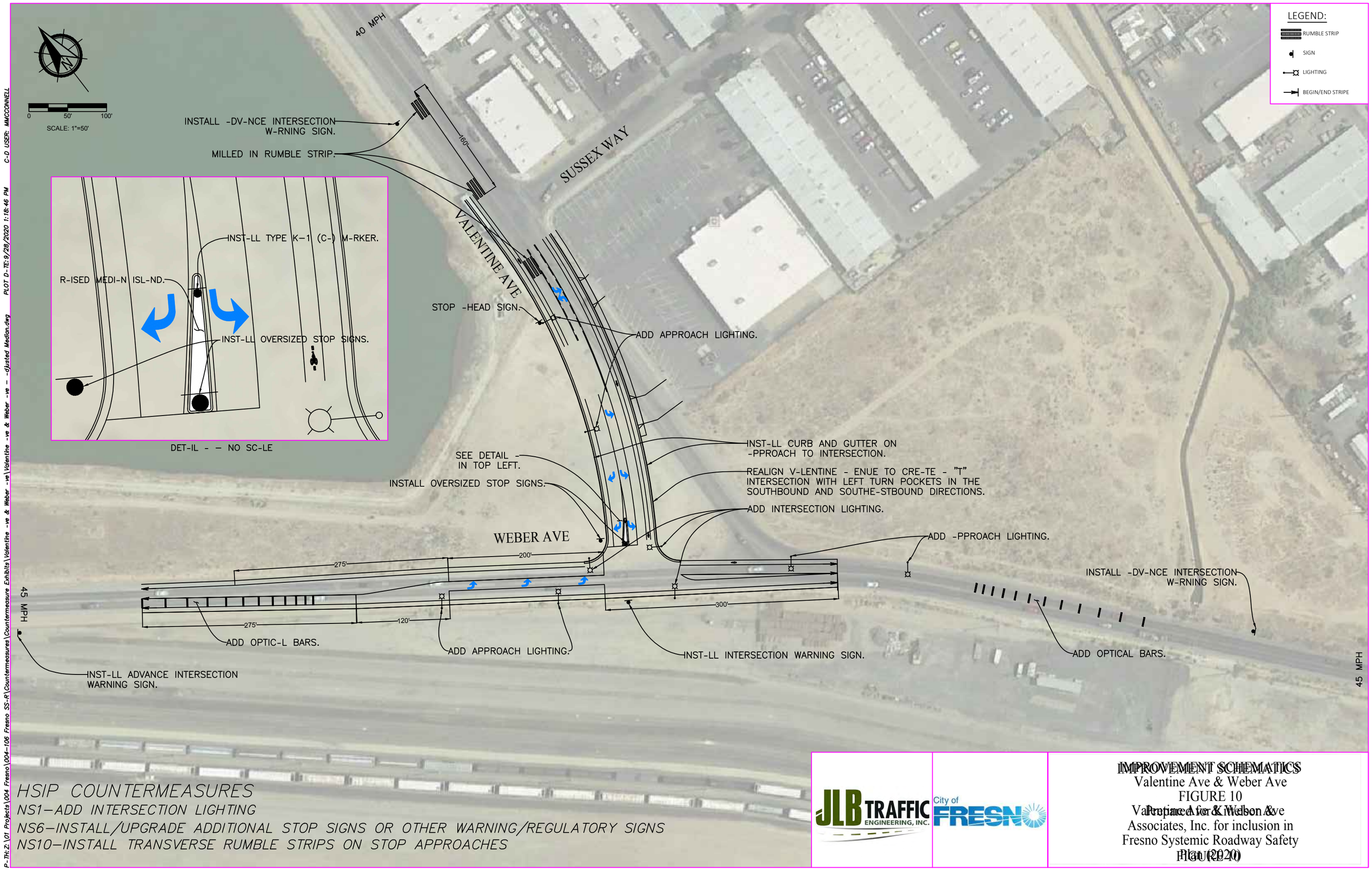
Table 8-12. Collision History (2014-2018), Valentine Avenue & Weber Avenue

	Annual collision severity score	Total Collisions	Fatal	Severe Injury	Moderate Injury	Minor Injury	Property Damage Only
Total Collisions	84.6	10	1	1	3	1	4
Nighttime		3	0	1	1	1	0
Ped / Bike		1	0	0	1	0	0

Source: Calculations by the project team using data from City of Fresno and SWITRS.

Proposed Project

- The proposed project includes the following safety treatments, as shown in Figure 8-10:
  - Install approach and intersection lighting to illuminate the intersection. This treatment is intended to address nighttime collisions. Three of 10 collisions occurred in dark conditions. (NS1)
  - Install/upgrade additional stop signs or other warning regulatory signs to improve awareness of the intersection ahead (NS6)
  - Install transverse rumble strips on the southbound Valentine Avenue approach to inform motorist of the intersection ahead (NS10)
  - Install curb and gutter on all approaches to the intersection (N/A)
  - Install optical bars on Weber Avenue to improve awareness of the intersection ahead and help reduce traffic speed. (N/A)
  - Realign Valentine Avenue to connect to Weber Avenue at a 90-degree angle. Add left-turn pockets on southeast-bound Weber Avenue and southbound Valentine Avenue. This treatment is intended to address right-angle and rear-end collisions. Seven of 10 collisions were either rear-end or broadside. (N/A)
- Cost Estimate: $2,178,100
- Planning-Level B/C Ratio: 3.35



HSIP COUNTERMEASURES

NS1–ADD INTERSECTION LIGHTING

NS6–INSTALL/UPGRADE ADDITIONAL STOP SIGNS OR OTHER WARNING/REGULATORY SIGNS

NS10–INSTALL TRANSVERSE RUMBLE STRIPS ON STOP APPROACHES

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IMPROVEMENT SCHEMATICS

Valentine Ave & Weber Ave

FIGURE 10

Prepared for & Weber Ave Associates, Inc. for inclusion in Fresno Systemic Roadway Safety Plan (2020)

IMPROVEMENT SCHEMATICS

FIGURE 10

8.2 NON-ENGINEERING EMPHASIS

This section presents non-engineering transportation safety countermeasures identified to address the systemic collision trends documented in Chapter 7. These countermeasures are intended to complement the engineering countermeasures described above and generally are intended to address behavioral factors contributing to collision risk. Countermeasures are grouped into law enforcement approaches, community enforcement approaches, and education approaches. While non-engineering countermeasures are not eligible for HSIP funding, they can be funded through various other grant programs, including:

- **Active Transportation Program (ATP):** The California ATP provides funding for projects that improve walking and bicycling around the state, including both infrastructure and non-infrastructure projects. The Cycle 5 Call for Projects was released in Spring 2020 with $400 million of funding allocated.[39]
- **Office of Traffic Safety (OTS):** The California OTS offers grant funding for a wide variety of non-infrastructure traffic safety countermeasures. The next grant application period will open in December 2020.[40]

The strategies discussed in this section would be best implemented in coordination with the transportation safety partners listed in Chapter 5.

8.2.1 ENFORCEMENT

Law Enforcement Approach

Enforcement is traditionally one of the three major components of transportation safety, alongside engineering and education. However, leveraging enforcement to achieve transportation safety goals does create some challenges. Below we discuss approaches to address those challenges.

- **Coordination and Collaboration:** Enforcement is outside of the control of the agency leading transportation safety efforts because the primary actions are taken by external departments (i.e., the local police department or sheriff's office). This report's proposed coordination across agencies can help address this challenge. Working together, the departments can agree upon strategies and priorities. The departments can also work together to identify additional funding to support different enforcement related programs and trainings. Ultimately, the allocation of resources (toward transportation safety in general and spatially within the City) are not at the discretion of the Department of Public Works; the coordination and collective agreement on the role of enforcement to help educate and encourage safe roadway behavior can be helpful in establishing and furthering a roadway safety culture in Fresno.
- **Employing Strategies Less Susceptible to Racial Biases:** Based on 2018 ACS data, 72% of Fresno's population identify as a person of color (49% Hispanic/Latino, 7% African American, and 16% other people of color). Recent national dialogue as well as supporting studies have renewed and broadened awareness of the potential for traffic stops and police enforcement to reinforce or exacerbate existing racial inequities. Studies of police traffic stops have shown racial biases nationwide in who gets stopped and subsequently searched, with Black and Hispanic drivers more likely to be searched than people of other races and ethnicities.[41,42] Given these considerations, enforcement activities undertaken in Fresno to further roadway safety should be pursued in an equitable and unbiased manner. Some of the strategies presented below do not require the presence of officers and therefore reduces the risk of bias. Others do require officers and police resources and should be

[39] https://dot.ca.gov/programs/local-assistance/fed-and-state-programs/active-transportation-program/cycle5

[40] https://www.ots.ca.gov/grants/program-information/

[41] Stanford Open Policing Project. Retrieved from: https://openpolicing.stanford.edu/findings

[42] Pierson, E., Simoiu, C., Overgoor, J. et al. A large-scale analysis of racial disparities in police stops across the United States. Nat Hum Behav 4, 736–745 (2020). https://doi.org/10.1038/s41562-020-0858-1

carefully weighed for the risk that they could erode community relations and undercut broader efforts for community health and safety. Even among the strategies that lessen the risks of enforcement bias like automated camera enforcement, other factors can result in inequities. For example, flat-rate ticket or court fees place a larger burden on low-income residents as a relative share of their income. The following complementary solutions are recommended to accompany enforcement strategies:

- Use of encouragement strategies to educate and provide learning and/or more positive interactions with police and public regarding desired road user behavior
- Incorporating social equity in camera placement using available data
- Pursue tiered fines for moving violations based on ability to pay
- Allocate enforcement revenue with dedicated funding for outreach and engagement with community groups
- Increase access and expand referrals to driver diversion classes and a DUI intensive supervision program as an alternative to traditional sanctions[43]

Speed Trailers

Portable speed trailers visually display a driver's real-time speed compared to the speed limit and may be effective at reducing speeds and increasing awareness of local speed limits. Portable speed trailers are most effective when the trailer flashes "SLOW DOWN" or flashes a bright white light that mimics a photo speed camera or a blue and red light that mimics a police car when drivers are moving too fast. In some cases, back-up speed enforcement by officers may be needed when radar speed trailers are used. If a driver fails to slow when the sign tells them that they are violating the law, an officer may stop the driver. The City of Fresno is exploring creating a program around using the existing portable signs they have available.

Campaign Type: Vehicle

Condition Addressed: Unsafe speed

Benefits

- Provides immediate feedback
- Does not require officer to be present
- Relatively low cost
- Can be moved to varying locations

Considerations

- Best used in residential areas and can be used in conjunction with neighborhood speed watch programs or other safety education programs
- Need to be placed in locations where they do not block pedestrians, bicyclists, motor vehicle traffic or other vital traffic control signs
- Not substitutes for permanent actions, such as traffic-calming treatments, to address neighborhood speeding issues

Relative Cost: Low to medium ($8,000 - $15,000)

[43] Sandra C. Lapham, Laura Ring Kapitula, Janet C'de Baca, Garnett P. McMillan. Impaired-driving recidivism among repeat offenders following an intensive court-based intervention. Accident Analysis & Prevention, Volume 38, Issue 1, 2006. Pages 162-169. https://doi.org/10.1016/j.aap.2005.08.009.

Resource Links
Countermeasures That Work: A Highway Safety Countermeasure Guide for State Highway Safety Offices, Eighth Edition, 2017 https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/documents/812478_countermeasures-that-work-a-highway-safety-countermeasures-guide-.pdf

Safe Routes to School Guide http://guide.saferoutesinfo.org/

Active Speed Monitors

Active speed monitors are permanent devices to keep drivers aware of their speeds and the need to slow down. They are typically mounted on a speed limit sign and visually display drivers' real-time speeds as they pass. Drivers see how fast they are driving compared to the posted speed limit. Some active speed monitors are solar-powered.

Campaign Type: Vehicle

Condition Addressed: Unsafe speed

Benefits

- Provides immediate feedback
- Does not require officer to be present

Considerations

- Cannot be moved around easily

Relative Cost: Low ($3,000 - $4,000)

Resource Links
Safe Routes to School Guide http://guide.saferoutesinfo.org/

Traffic Complaint Hotlines

A traffic complaint hotline allows community members to report traffic problems directly to police. It is used to identify the worst traffic problem areas and the most frequent traffic complaints. Police follow up with enforcement in the identified area and schedule additional enforcement if needed.

Campaign Type: All

Condition Addressed: All

Benefits

- Enables police to quickly identify issues
- Enables public to be engaged

Relative Cost: Low

Resource Links
Safe Routes to School Guide http://guide.saferoutesinfo.org/

Speed Enforcement in School Zones

Enforcing speed laws in school zones is one law enforcement tool that can improve safety for children walking and bicycling to school as well as for drivers. A zero-tolerance policy for speeders in school zones and even an increase in fines for drivers who violate the posted school zone speed limit are potential approaches.

Campaign Type: Vehicle

Condition Addressed: Unsafe speed

Benefits

- Can be high visibility through media coverage
- Can quickly identify offenders
- Consequences are often enough to deter behaviors.

Considerations

- Requires police resources, which may include overtime pay
- Needs to be done at regular intervals
- Should be reserved for serious offenses

Relative Cost: Low to medium

Resource Links
Safe Routes to School Guide http://guide.saferoutesinfo.org/

Community Enforcement Approach

Neighborhood Speed Watch Programs

Neighborhood Speed Watch programs, a traffic-related variation of Neighborhood Watch or Crime Watch, encourage citizens to take an active role in changing driver behavior on their neighborhood streets by helping raise public awareness and educate drivers about the negative impact of speeding. In these programs, residents record speed data in their neighborhood using radar units borrowed from a city or county law enforcement agency. Residents record the speed and license plate information of speeding motor vehicles. This information, along with a letter, is sent to the owner of the vehicle informing them of the observed violation and encouraging them or other drivers of their vehicle to drive at or below the posted speed limit.

Campaign Type: Vehicle

Condition Addressed: Unsafe speed

Benefits

- Encourages speeding drivers to slow down
- Residents become aware of local traffic issues.
- Police gain additional information regarding problems.
- Drivers also learn that residents will not tolerate speeding in their neighborhoods.

Considerations

- Needs police personnel to work with neighborhoods
- Requires radar guns or other

Relative Cost: Low to medium

Resource Links
Safe Routes to School Guide http://guide.saferoutesinfo.org/

Adult School Crossing Guards

Adult school crossing guards can play a key role in promoting safe driver and pedestrian behaviors at crosswalks near schools. They help children safely cross the street and remind drivers of the presence of pedestrians. A guard helps children develop the skills to cross streets safely at all times. Adult school crossing guards can be parent volunteers, school staff, or paid personnel.

Campaign Type: Pedestrian

Condition Addressed: Pedestrian right of way

Benefits

- Can control behaviors at high-risk locations
- Can make parents more comfortable in allowing children to walk or bicycle to school

Considerations

- Requires dedicated funding or reliable volunteer system
- Requires annual classroom and field training for adult school crossing guards as well as special uniforms or equipment to increase visibility

Relative Cost: Low to medium

Resource Links

Safe Routes to School Guide http://guide.saferoutesinfo.org/

8.2.2 EDUCATION

Bicyclists, pedestrians, and/or drivers can be misinformed regarding traffic laws, which may lead to risky or reckless behavior. Education can provide information to roadway users and help motivate a change in specific behaviors to reduce the risk of injuries.

There are several broad approaches to education that can be conducted with moderate resources. They include:

- Highlighting when introducing new infrastructure configurations, such as novel pedestrian or bicycle treatments
- Conducting internal campaigns within the organization to build staff support for roadway safety programs
- Incorporating transportation safety messages into public relations efforts
- Developing relationships with relevant state agencies and statewide consumer groups
- Marketing alternative travel modes

There are three specific types of educational campaigns:

1. **Public awareness—**Public awareness campaigns are a great example of a method for garnering public support. An effective campaign can lay the groundwork for subsequent transportation safety initiatives and can increase the likelihood of their success. Campaigns to target groups are usually aimed at changing behavior patterns in specific groups of people (e.g., drivers, schoolchildren).
2. **Targeted campaigns—**Since changing behavior in these groups can be a long and arduous task, these campaigns tend to be ongoing efforts aimed at long-term results. Individual campaigns differ from campaigns at target groups because the audience is reached through an intermediary.
3. **Individual campaigns—**Intervention occurs at an individual level through public safety officers, crossing guards, doctors, and other authority figures. Using these different approaches in concert reaches a broader audience and increases the likelihood of long-term success in changing attitudes and behaviors.

Considerations

- Educational messages should encourage people to think about their own travel attitudes and behaviors and make more informed choices.
- Educational campaigns must be a part of a long-term and ongoing traffic safety program.
- As with other education and enforcement initiatives, a long-term commitment is required to reinforce learned behaviors and to accommodate new bicyclists and drivers.
- Educational programs and materials should be sensitive of different demographic groups of people.
- Outreach material should be interesting and involve visual as well as written messages.
- Gaining the political support needed to ensure a comprehensive program can be difficult.
- Introducing safety education within an established school system curricula can be difficult.
- Once implemented, the program's effectiveness should be evaluated.

Resource Links

Safe Routes to School Guide http://guide.saferoutesinfo.org/

Conspicuity Enhancements & Education

The purpose of enhancing conspicuity for pedestrians is to increase the opportunity for drivers to see and avoid pedestrians, particularly when it is dark. Over 70% of national pedestrian fatalities occur under dark conditions, and pedestrians who are more visible are less likely to be struck. Educating pedestrians to wear reflective clothing and walk in well-lit areas can be implemented as targeted campaigns.

Campaign Type: Pedestrian

Condition Addressed: Lighting

Benefits

There is some limited evidence to suggest that a program aimed at increasing conspicuous and protective clothing could be successful. A study conducted in Australia found that the observed proportion of riders wearing full body protection increased in the month following an enforcement/educational campaign with an emphasis on conspicuous and protective clothing (among other safety issues). However, it is unclear whether any potential benefits were sustained (Baldock et al., 2012).

Considerations

- The literature on retroreflective and reflective clothing shows that these tactics are effective at increasing pedestrian visibility and thereby reducing the likelihood of pedestrian collisions. However, it may not be the best option to encourage a culture where the responsibility of pedestrian visibility and safety falls entirely on pedestrians. Instead of attempting to solve the problem solely by encouraging pedestrians to wear high-visibility clothing, driver training and other programs can be implemented. These programs can teach drivers about the dangers of reduced visibility at night and to spread the responsibility for pedestrian safety.
- A proper campaign, including market research, message development and testing, and implementation, will require at least six months to plan and implement.

Relative Cost: Low

Resource Links

Countermeasures That Work: A Highway Safety Countermeasure Guide for State Highway Safety Offices, Eighth Edition, 2017 https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/documents/812478_countermeasures-that-work-a-highway-safety-countermeasures-guide-.pdf

8.2.2.2 Bicycle Safety Education for Children

Bicycle education teaches children basic bicycle handling skills, traffic laws, how to ride on streets with traffic present, proper helmet use, bicycle safety checks, and bicycle maintenance. As part of a regular school curriculum, education can reach every student. Providing training outside of school settings, such as through parks and recreation departments, community centers or faith-based organizations, may be more feasible in some circumstances. Community-based programs could also provide greater flexibility in tailoring to meet specific community needs.

Campaign Type: Bicycle

Condition Addressed: Bicycle right of way

Benefits

- Can increase children's knowledge of laws and safe behaviors
- Can improve safe riding behaviors and enjoyment for children
- Can be effective at increasing observed helmet use

Considerations

- Unlikely to be effective in reducing collisions without comprehensive and sustained efforts to improve the cycling environment
- A high-quality evaluation conducted in Brazil by Bacchieri, Barros, dos Santos, Goncalves, & Gigante (2010) concluded that "isolated educational programs, attempting to only change individual behavior, are not effective in reducing accidents." Furthermore, it stated that "the number of accidents will not considerably decrease without actions that also include improved road infrastructure and the effective application of legislation (with comprehensive and systematic law enforcement)" (Bacchieri et al., 2010).
- Time to implement may be short with existing material or medium to develop and disseminate a training curriculum with material.

Relative Cost: Low to medium

Resource Links
Countermeasures That Work: A Highway Safety Countermeasure Guide for State Highway Safety Offices, Eighth Edition, 2017 https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/documents/812478_countermeasures-that-work-a-highway-safety-countermeasures-guide-.pdf

8.2.2.3 Bicycle Safety Education for Adults

Bicycle safety education for adult bicycle commuters improves knowledge of laws, risks, and cycling best practices, to support desired cycling behaviors. This includes riding predictably and use of safety materials such as reflective clothing and helmets. Common elements of a bicycle education program include safety ads (e.g., radio, TV, outdoor), dissemination of safety materials, bike "ambassadors" and social supports, individual skills training or workshops, and coordination with enforcement officers to reinforce safe behaviors.

In communities that have existing bikeshare programs or are considering implementing new programs, bicycle safety education can extend to use of the bikeshare system. Existing stategies include bikeshare operators posting safety information and "rules of the road" on their websites, operators including safety information in user agreements when new users sign up, and providing safety information stickers directly on bikes so riders can review before bicycling. The City can encourage bikeshare operators to further publicize safety tips, such as incorporating this information on existing signage at bikeshare stations.

Campaign Type: Bicycle

Condition Addressed: Bicycle right of way

Benefits

- Can improve safe riding behaviors and enjoyment for adults
- Can be effective at increasing observed helmet use

Considerations

- Unlikely to be effective in reducing collisions without comprehensive and sustained efforts to improve the cycling environment
- A high-quality evaluation conducted in Brazil by Bacchieri, Barros, dos Santos, Goncalves, & Gigante (2010) concluded that "isolated educational programs, attempting to only change individual behavior, are not effective in reducing accidents." Furthermore, it stated that "the number of accidents will not considerably decrease without actions that also include improved road infrastructure and the effective application of legislation (with comprehensive and systematic law enforcement)" (Bacchieri et al., 2010).
- A comprehensive education program could require several months of startup time to plan and develop program materials.

Relative Cost: Medium

Resource Links
Countermeasures That Work: A Highway Safety Countermeasure Guide for State Highway Safety Offices, Eighth Edition, 2017 https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/documents/812478_countermeasures-that-work-a-highway-safety-countermeasures-guide-.pdf

8.2.2.4 Active Lighting and Rider Conspicuity

Improving bicyclist conspicuity makes bicyclists more visible to drivers and allows drivers more opportunity to see and avoid collisions with bicyclists. A common contributing factor for collisions involving bicyclists in the roadway is the failure of the driver to notice the bicyclist, particularly at night. The idea behind these efforts is to correct assumptions (e.g., that white clothing is sufficient for visibility at night) and provide tips following the latest findings about conspicuity. Efforts related to active lighting and conspicuity may include educational trainings, giveaways at events, media campaigns, and handing out bike lights and reflectors in historically high-injury locations.

Campaign Type: Bicycle

Condition Addressed: Lighting

Benefits

- Can improve driver detection of bicyclists during the day and at night
- Can reduce vehicle-bicycle collisions and injuries

Considerations

- Conspicuity-enhancing equipment, such as retroreflective wrist and ankle straps or small active front and back lights, are sometimes distributed for free as part of school and community educational efforts.
- Brochures and flyers for a bicycle safety education campaign highlighting conspicuity can be created quickly. Often an extra line or two about rider conspicuity can be added to existing educational materials and/or reinforced at community events.
- It can take several months to design, produce, and implement the communications and outreach program and law enforcement training for enforcing active lighting laws.

Relative Cost: Low

Resource Links
Countermeasures That Work: A Highway Safety Countermeasure Guide for State Highway Safety Offices, Eighth

Edition, 2017 https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/documents/812478_countermeasures-that-work-a-highway-safety-countermeasures-guide-.pdf

8.2.2.5 High-Visibility Cell Phone and Text Messaging Media Campaign

The High-Visibility Enforcement model combines dedicated law enforcement with paid and earned media supporting the enforcement activity. Paid media includes advertisements on TV, radio, online, and via billboards, while earned media includes press events and news releases covering the efforts. Media supports enforcement activity by helping the general public be aware of the enforcement activity and creating the impression violators will be caught.

Campaign Type: Vehicle

Condition Addressed: Distracted Driving

Benefits

- Can reduce collisions involving drivers using handheld cell phones

Considerations

- Requires four to six months to plan and implement

Relative Cost: High

Resource Links
Countermeasures That Work: A Highway Safety Countermeasure Guide for State Highway Safety Offices, Eighth Edition, 2017 https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/documents/812478_countermeasures-that-work-a-highway-safety-countermeasures-guide-.pdf

8.2.2.6 DUI and Distracted Driving Educational Presentations/Trainings

These types of presentations are often given by local police departments or non-profits to educate students on the dangers of driving under the influence and distracted driving. Multimedia presentations include real life accounts of incidents to personalize the impacts.

Campaign Type: Vehicle

Condition Addressed: Driving under the influence (DUI)

Benefits

- Can reduce the number of alcohol- and drug-involved collisions
- Can reduce hit-and-fun collisions
- Can reduce nighttime collisions
- Can reduce collisions involving drivers using handheld cell phones

Considerations

- Public relations opportunities and press coverage are needed to raise awareness.
- Media campaign may include freeway bulletins, wall boards, and posters.
- Campaigns must be sensitive of different demographic groups of people.
- Increased police enforcement may be needed in specific locations to compliment the media campaign.

Relative Cost: Unknown

Resource Links
City of Bakersfield Police Department
http://www.bakersfieldcity.us/gov/depts/police/get_involved/a_life_interrupted/default.htm

California Office of Traffic Safety https://www.ots.ca.gov/ots-and-traffic-safety/links/

8.2.2.7 Safe Stopping Educational Campaign

This type of educational campaign focuses on educating drivers and reinforcing good habits on proper stopping locations near crosswalks to prevent pedestrians from being hit by automobiles.

Campaign Type: Pedestrian

Condition Addressed: Crossing in crosswalk at intersection

Benefits

- Can reduce vehicle-pedestrian collisions
- Can increase the incidence of vehicles yielding to pedestrians

Considerations

- Public relations opportunities and press coverage are needed to raise awareness.
- Media campaign may include freeway bulletins, wall boards, and posters.
- Campaigns must be sensitive of different demographic groups of people.
- Increased police enforcement may be needed in specific locations to compliment the media campaign.

Relative Cost: Unknown

Resource Links

San Francisco Municipal Transportation Agency (SFMTA)
https://www.sfmta.com/about-sfmta/blog/%E2%80%98it-stops-here%E2%80%99-campaign-safer-streets-wins-communicator-award

https://www.sfmta.com/about-sfmta/blog/safe-streets-sf-0

8.2.2.8 Pedestrian Gap Acceptance Training

The purpose of pedestrian gap acceptance training is to help pedestrians learn to make better road crossing decisions, which may reduce the incidence of crossing-related injuries and fatalities. This can include video-based training and feedback geared towards improving pedestrian judgment of speed and/or distance of oncoming traffic.

Campaign Type: Pedestrian

Condition Addressed: Unsafe speed; pedestrian right of way

Benefits

- This countermeasure has been examined in few research studies. While there is some evidence that certain approaches may lead to limited positive outcomes, there is insufficient evaluation data available to conclude that the countermeasure is effective.

Considerations

- Environmental treatments, such as allowing sufficient time for the pedestrian crossing in signal timing, median refuges, and careful attention to sidewalk accessibility issues, are also important to older pedestrians who may have mobility issues.
- It may require more than three months for training materials to be developed and integrated into existing educational channels for adult and senior pedestrians.

Relative Cost: Medium

Resource Links

Countermeasures That Work: A Highway Safety Countermeasure Guide for State Highway Safety Offices, Eighth Edition, 2017 https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/documents/812478_countermeasures-that-work-a-highway-safety-countermeasures-guide-.pdf

8.2.2.9 Share the Road Awareness

The purpose of Share the Road programs is to increase drivers' awareness of bicyclists, as well as improve bicyclist and driver compliance with relevant traffic laws.

Campaign Type: Bicycle

Condition Addressed: Rear end

Benefits

- Share the Road awareness educational materials can be effective in increasing knowledge and appropriate attitudes, but as with other awareness programs, there is limited evidence of behavior change, and no evidence of reductions in collisions.

Considerations

- Will require at least six months to plan and implement

Relative Cost: Medium

Resource Links
Countermeasures That Work: A Highway Safety Countermeasure Guide for State Highway Safety Offices, Eighth Edition, 2017 https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/documents/812478_countermeasures-that-work-a-highway-safety-countermeasures-guide-.pdf

8.2.2.10 Bicycle Helmet Encouragement

The purpose of bicycle helmet promotions is to increase use of helmets and thereby decrease the number of severe and fatal brain injuries to bicyclists involved in collisions. Bicycle helmet promotions are frequent, but are usually aimed at child bicyclists only, often through youth health organizations and schools. Promotions can target various barriers to helmet use, including absence of a helmet, child and families' lack of understanding of the importance of helmet use, and negative attitudes or beliefs about helmet use. Programs that provide helmets can include sponsoring organizations and often involve law enforcement and schools to deliver helmets, fit the helmets, and teach proper fitting and use. Promotions can be conducted through single events or extended campaigns to promote helmet distribution and use.

The Bicycle Helmet Safety Institute has extensive information on helmets, purchasing a helmet, helmet fit, when to buy a new helmet, helmet recalls, and the difference between helmet brands, see www.helmets.org/

Campaign Type: Bicycle

Condition Addressed: Bicycle right of way

Benefits

- Bicycle helmets are proven to reduce injuries and fatalities.
- Helmet promotions are successful in getting more helmets into the hands of bicyclists.
- A helmet promotion may increase helmet wearing rates and commitment to wearing a helmet among adult bicyclists.
- Programs that increase proper use of helmets would be expected to reduce injuries in the event of a bicycle collision.

Considerations

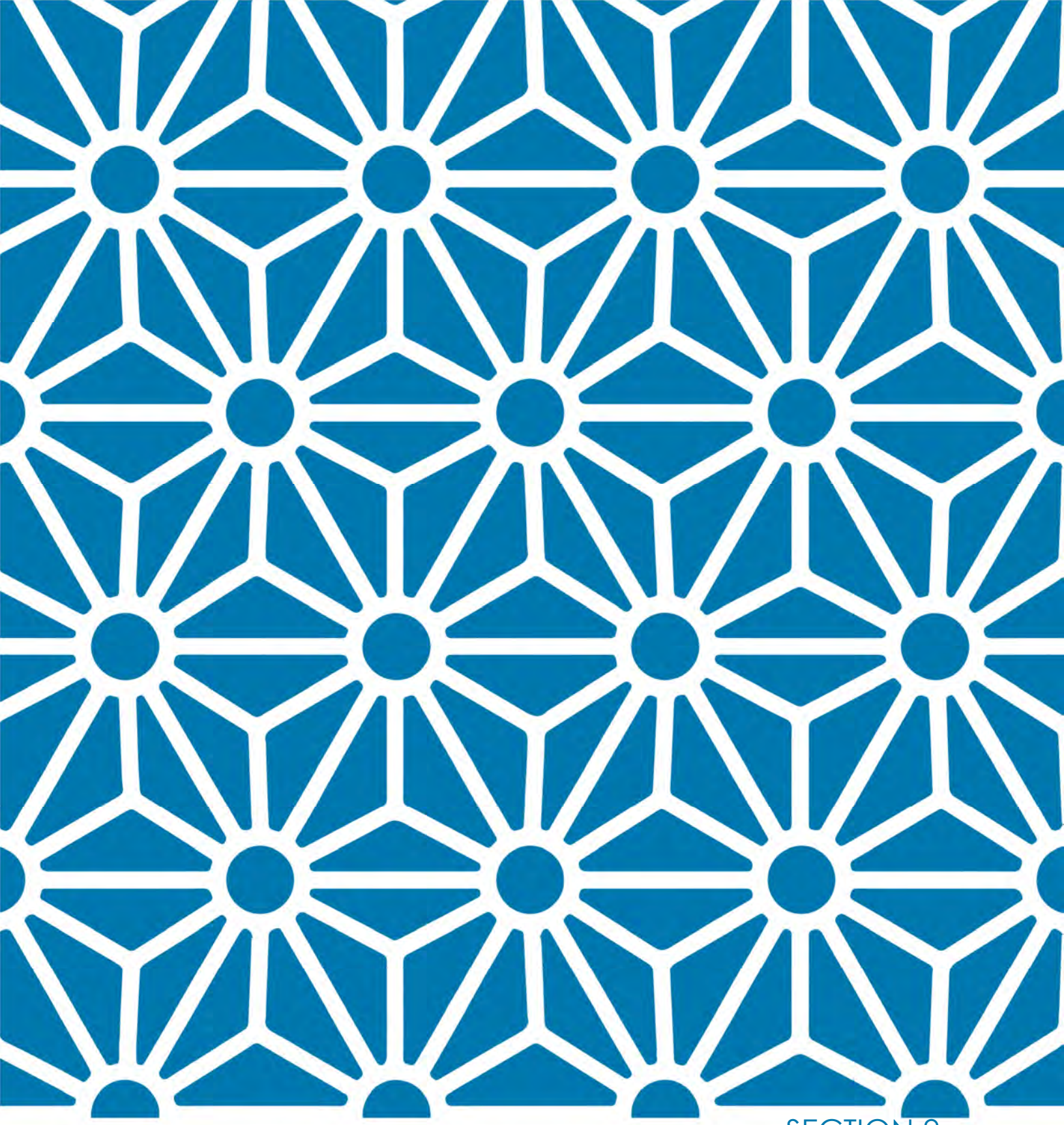
- While bicycle helmet encouragement may be beneficial, mandatory helmet laws for adults have been shown to discourage bicycling overall.
- The promotion must include instruction on how to properly fit the helmet and the importance of wearing helmets on every trip.
- Programs might also need to target differences in tendency to adopt helmet use for different riding purposes (recreational versus commuting).
- Efforts are needed to encourage parents and authority figures (e.g., law enforcement officers, school officials and staff, and health-care professionals) to reinforce and model desired behaviors.
- A good campaign, including market research, material development, and message placement, will require at least six months to plan and implement.

Relative Cost: High

Resource Links
Countermeasures That Work: A Highway Safety Countermeasure Guide for State Highway Safety Offices, Eighth Edition, 2017 https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/documents/812478_countermeasures-that-work-a-highway-safety-countermeasures-guide-.pdf

8.2.3 FUTURE OUTREACH

Many of the non-engineering solutions discussed above would not be the responsibility of the City to implement. The City can work with the recommended safety partners in Chapter 5 to develop an approach for when and how some of these could be implemented.



SECTION 9

EVALUATION & IMPLEMENTATION

9. EVALUATION & IMPLEMENTATION

This chapter describes the steps the City may take to evaluate the success of this plan and steps needed to update the plan in the future.

9.1 PERFORMANCE MEASURES

Measures the City can use to evaluate its ongoing success in improving safety performance include:

- Total number of fatal and severe injury collisions on bity roads
- Number of fatal and severe injury collisions on City roads by the following categories:
  - Broadside collisions
  - Hit object collisions
  - Pedestrian-involved collisions
  - Collisions at the intersections and on the roadways listed in Section 8.1.2

Fatal and severe injury collisions may be reported annually, and performance should be evaluated within the context of the latest five-year annual average to normalize for random fluctuations in collisions on a year-over-year basis.

9.2 UPDATING THE PLAN

This plan relies on collision data from 2014 through 2018. The City should review collision data for the key findings and performance measures to track progress annually. More substantial updates to the safety plan can occur at longer intervals (approximately every five years).

The City, in conjunction with its safety partners, can assess the plan, consider new trends and technologies, and determine if an update to the plan is needed. As new strategies are identified, the group of safety partners may update goals and should assign champions for specific strategies and action items.

SECTION 10

ATTACHMENTS

Attachment A: Countermeasure Memorandum

KITTELSON & ASSOCIATES

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P 906.266.2190

MEMORANDUM

Date: March 6, 2020

To: Jon Bartel, City of Fresno

From: Kittelson & Associates, Inc.
Toole Design Group, LLC
JLB Traffic Engineering, Inc.

Project: Fresno Systemic Safety Analysis Report (SSAR) Project

Subject: Draft Task 3 Memo: Countermeasure Identification

Kittelson & Associates, Inc. (Kittelson), Toole Design Group (Toole), and JLB Traffic Engineering (JLB) are working with the City of Fresno (City) to identify countermeasures to improve roadway safety performance; this work is being funded as part of the Caltrans Systemic Safety Analysis Report Program (SSARP) Grant the City received. This memorandum summarizes the systemic treatments that could be implemented across the City and education and enforcement strategies that could complement engineering projects to reduce the risk of crashes.

The following memo summarizes systemic treatments identified for Fresno. Table 1 provides a summary of the systemic treatments, planning-level cost range, and potential safety effectiveness of the treatment in the form of crash modification factor (CMF). Section 0 presents proposed engineering countermeasures identified throughout the City. Section 2 presents proposed non-engineering countermeasures identified.

This memorandum is organized as follows:

1 | PROPOSED ENGINEERING COUNTERMEASURES

This section presents the engineering safety countermeasures identified to address the systemic crash trends documented in the Task 2 Memorandum.

Kittelson began with a list of 103 engineering countermeasures and prioritized these (Tier 1 through Tier 4) based on the following considerations:

- **Relevance to Fresno.** We deprioritized some countermeasures included in the Caltrans Local Roadway Safety Manual (and funded by the HSIP program) which do not appear to be relevant for the City.
- **HSIP eligibility.** We prioritized countermeasures that have been eligible for HSIP funding in previous cycles (note that this may change somewhat in the upcoming cycle).
- **Alignment with crash analysis findings.** We prioritized countermeasures that most directly relate to the top three crash types associated with fatalities and severe injuries: broadside, hit object, and vehicle-pedestrian crashes.
- **Crash reduction potential, cost, and systemic application potential.** We prioritized low-cost countermeasures with (a) high documented crash reduction potential and (b) an ability to be applied systemically throughout the City.

This prioritization identified 32 Tier 1 engineering countermeasures. These countermeasures are applicable where crashes have occurred (retroactively) and in locations with similar characteristics to proactively reduce crash risk. *Attachment A* contains the prioritized list of all 103 engineering countermeasures considered.

Countermeasures were grouped into the following categories: roadway treatments, intersection treatments, and bicycle and pedestrian treatments. A summary of the 32 Tier 1 proposed engineering countermeasures is shown in Table 1. The full list of prioritized countermeasures is included as an attachment to this memo in the excel workbook titled "Fresno SSAR Countermeasures." *Attachment B* contains cost estimate assumptions for select engineering countermeasures.

Table 1. Summary of the Prioritized Systemic Treatments and Related Information

Proposed Countermeasure	CM ID*	Documented Crash Reduction Factor**	Federal Funding Eligibility***	Cost Estimate	Page Reference
Roadway Treatments					
Remove or relocate fixed objects outside of Clear Recovery Zone	R2	0.35	90%	$200-$10,000 per Object	5
Road Diet (Reduce travel lanes from 4 to 3 and add a two-way left-turn and bike lanes)	R15	0.3	90%	$69 per FT	6
Widen shoulder (paved)	R16	0.3	90%	$10 per FT added width per FT lane	7

Proposed Countermeasure	CM ID*	Documented Crash Reduction Factor**	Federal Funding Eligibility***	Cost Estimate	Page Reference
Widen shoulder (unpaved)	R17	0.2	90%	$3 per FT added width per FT lane	8
Improve pavement friction (High Friction Surface Treatments)	R24	0.4	100%	$1 per SF	9
Install/Upgrade signs with new fluorescent sheeting (regulatory or warning)	R26	0.15	100%	$500 per Sign	10
Install chevron signs on horizontal curves	R27	0.4	100%	$500 per Sign	11
Install curve advance warning signs	R28	0.25	100%	$500 per Sign	12
Install curve advance warning signs (flashing beacon)	R29	0.3	100%	$16,600 each	13
Install dynamic/variable speed warning signs	R30	0.3	100%	$43,600 each	14
Install delineators, reflectors and/or object markers	R31	0.15	100%	$75 each	15
Install edge-lines and centerlines	R32	0.25	100%	$4 per FT	16
Install edgeline rumble strips/stripes	R35	0.15	100%	$10 per FT	17
Intersection Treatments					
Install/upgrade larger or additional stop signs or other intersection warning/regulatory signs	NS5	0.15	100%	$500 per Sign	18
Upgrade intersection pavement markings (NS.I.)	NS6	0.25	100%	$4,000 per Intersection	19
Install transverse rumble strips on approaches	NS9	0.2	90%	$600 per Approach	20
Improve sight distance to intersection (Clear Sight Triangles)	NS10	0.2	90%	$200-$50,000	21
Install splitter-islands on the minor road approaches	NS11	0.4	90%	$10,000 per Approach	22
Improve signal hardware: lenses, back-plates, mounting, size, and number	S2	0.15	100%	$1,500 per Signal Head	23
Bicycle and Pedestrian Treatments					
Install Leading Pedestrian Interval (LPI)	NA	0.59	50%	< $2,500 per signal	24

Proposed Countermeasure	CM ID*	Documented Crash Reduction Factor**	Federal Funding Eligibility***	Cost Estimate	Page Reference
Install high-visibility crosswalk markings	NA	0.48	90%	< $2,500 per crossing	25
Install advance yield lines	NA	0.25	90%	< $2,500 per yield line	26
Install raised medians / refuge islands (NS.I.)	NS16	0.45	90%	$120 per FT	27
Install pedestrian crossing at uncontrolled locations (new signs and markings only)	NS17	0.25	100%	$2,600 each	28
Install pedestrian crossing at uncontrolled locations (with enhanced safety features)	NS18	0.35	100%	$60,000-$160,000 each	29
Install Pedestrian Hybrid Beacon	NS19	0.55	100%	$83,300 per System	30
Install bike lanes	R36	0.35	90%	$50 per FT[1]	31
Install sidewalk/pathway (to avoid walking along roadway)	R37	0.8	90%	$25 per FT	32
Install pedestrian crossing (with enhanced safety features)	R38	0.3	90%	$60,000-$160,000 each	33
Install raised pedestrian crossing	R39	0.35	90%	$5,000 each	34
Install pedestrian countdown signal heads	S19	0.25	100%	$1,800 per Signal Head	35
Install pedestrian crossing (S.I.)	S20	0.25	100%	$8,200 per Crossing	36

*CM ID refers to the Countermeasure ID from the Caltrans *Local Roadway Safety Manual (April 2018)*.
**All documented crash education factors are derived from the Caltrans *Local Roadway Safety Manual (April 2018)*.
***Funding eligibility indicates the designated federal contribution level for approved HSIP projects in California associated with Caltrans HSIP Cycle 9. This is subject to change from year to year and should be confirmed with the HSIP coordinator.

[1] Cost assumes bike lane striping is thermoplastic.

1.1 ROADWAY TREATMENTS

1.1.1 REMOVE OR RELOCATE FIXED OBJECTS OUTSIDE OF CLEAR RECOVERY ZONE (R2)

Summary of Countermeasure: Removing or relocating roadside fixed objects such as utility poles, drainage, trees, or other fixed objects provides a clear recovery zone that allows drivers to correct their path of travel when they leave the roadway. This treatment is particularly effective outside of curves, along lane drops and in traffic islands where fixed object crashes are more common. A clear recovery zone should be developed on more rural context roadways, as space is available. The City is only able to address sight obstructions within City right-of-way. Where public right-of-way is limited, steps should be taken to request assistance from property owners.

Crash Types Addressed	Documented Crash Reduction Factor	Federal Funding Eligibility	Cost Estimate
Hit Object	0.35	90%	$200-$10,000 per Object

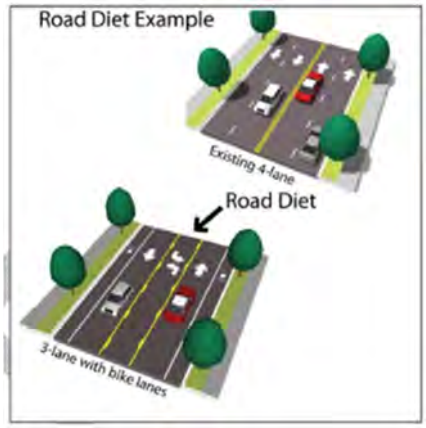
Why was this Chosen for City of Fresno? Hit object crashes are among the top three crash types resulting in a fatality or severe injury. The most common collision factor among fatal and severe injury hit object crashes was *unsafe speeding on a highway*. Removing or relocating fixed objects outside of a clear recovery zone would provide an opportunity for drivers to correct their path of travel and can proactively address a history of hit object crashes.

Image Sources: FHWA

1.1.2 ROAD DIET (REDUCE TRAVEL LANES FROM 4 TO 3 AND ADD A TWO-WAY LEFT-TURN AND BIKE LANES) (R15)

Summary of Countermeasure: A road diet reduces the number of vehicle lanes on a roadway to manage vehicle speeds and reduce risk of crashes for all road users. A common road diet is to convert a four-lane undivided roadway to a three-lane cross-section, with one lane in each direction and a two-way center left turn lane. This enables space for bicycles lanes and sidewalks. An example four-lane to three-lane cross-section conversion, i.e. road diet is shown below.

Crash Types Addressed	Documented Crash Reduction Factor	Federal Funding Eligibility	Cost Estimate
All	0.3	90%	$69 per FT



Example of a Road Diet on Southern Blvd, Bronx, NY
Source: NYCDOT

Why was this Chosen for City of Fresno? Broadside and vehicle-pedestrian crashes are among the top three crash types resulting in a fatality or severe injury. *Auto right-of-way*[2] violations, *improper turning*, and *unsafe speed* were among the top five most common collision factors of a fatal and severe injury broadside crash. Road diets may help eliminate speed-related crashes while also providing reduce crash risk for turning vehicles and people walking or biking.

Image Sources: FHWA, NYCDOT

[2] This is a reported PCF that indicated one of several California Vehicle Violation codes indicating a failure to yield right-of-way to oncoming traffic.

1.1.3 WIDEN SHOULDER (PAVED) (R16)

Summary of Countermeasure: Widening the shoulder gives a driver who is veering off the roadway more time and space to correct and move back into the travel lane. It provides a buffer space from objects such as guardrails, trees, and signs, reducing the likelihood of hit object and run-off the road collisions. A paved shoulder where available provides a consistent road surface for recovery. If widening a shoulder by paving is not an option due to a restricted right-of-way or adjacent objects/trees, a shoulder could also be added or widened by striping edge lines and reducing the vehicular lane width.

Crash Types Addressed	Documented Crash Reduction Factor	Federal Funding Eligibility	Cost Estimate
Hit Object, Run-off Road, Sideswipe	0.3	90%	$10 per FT added width per FT lane

Why was this Chosen for City of Fresno? Hit object crashes are among the top three crash types resulting in a fatality or severe injury. The most common violation among fatal and severe injury hit object crashes was *unsafe speeding on a highway*. Providing additional paved shoulder width can address areas with a history of hit object crashes and can help give drivers time and space to react when veering off the roadway.

Image Sources: Bike East Bay

1.1.4 WIDEN SHOULDER (UNPAVED) (R17)

Summary of Countermeasure: Widening the shoulder gives a driver who is veering off the roadway more time and space to correct and move back into the travel lane. It provides a buffer space from objects such as guardrails, trees, and signs, reducing the likelihood of hit object and run-off the road collisions. An unpaved shoulder, if properly graded, will still provide a sufficient recovery opportunity for drivers leaving the roadway.

Crash Types Addressed	Documented Crash Reduction Factor	Federal Funding Eligibility	Cost Estimate
All	0.2	90%	$3 per FT added width per FT lane

Why was this Chosen for City of Fresno? Hit object crashes are among the top three crash types resulting in a fatality or severe injury. The most common violation among fatal and severe injury hit object crashes was *unsafe speeding on a highway*. Providing additional unpaved shoulder width can address areas with a history of hit object crashes and can help give drivers time and space to react when veering off the roadway.

Image Source: Sharper Brothers Contractors

1.1.5 IMPROVE PAVEMENT FRICTION (HIGH FRICTION SURFACE TREATMENTS) (R24)

Summary of Countermeasure: Improving the pavement friction or skid resistance gives a driver who is skidding off of the road more control and time to react. It is particularly effective for 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 curves, loop ramps, and areas with short stopping distances.

Crash Types Addressed	Documented Crash Reduction Factor	Federal Funding Eligibility	Cost Estimate
Wet, Rear-End, All	0.4	100%	$1 per SF

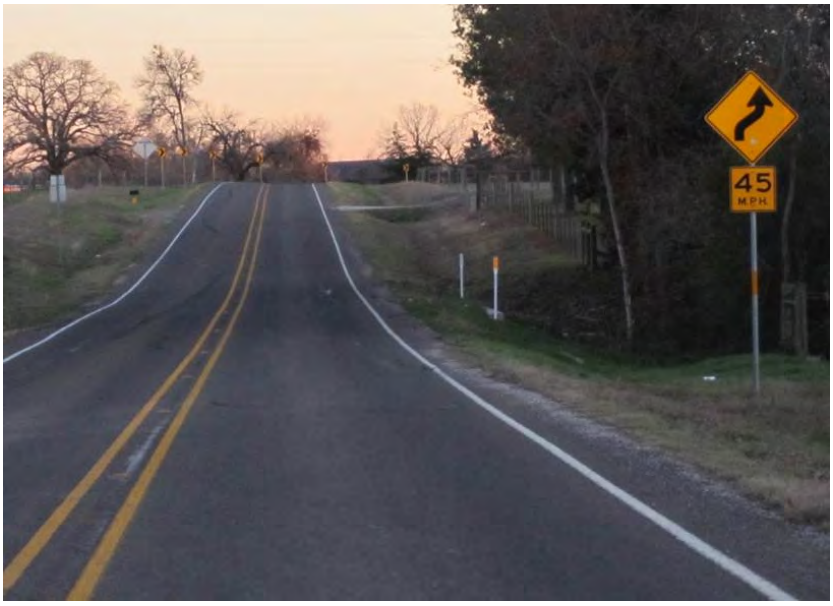
Why was this Chosen for City of Fresno? Hit object and broadside crashes are among the top three crash types resulting in a fatality or severe injury, and *unsafe speed* was among the top five most common collision factors for both types of crashes. Improving pavement friction or other high friction surface treatments would provide added resistance and improve recovery for drivers, given citywide trends of hit object crashes (i.e., departing the roadway).

Image Sources: FHWA

1.1.6 INSTALL/UPGRADE SIGNS WITH NEW FLUORESCENT SHEETING (REGULATORY OR WARNING) (R26)

Summary of Countermeasure: Installing and/or or upgrading signs with fluorescent sheeting provides drivers with a visual warning of the presence of a specific roadway feature or regulatory requirement that they may have missed with existing signs. This treatment is appropriate on roadway segments with a history of head-on, nighttime, non-intersection, run-off road, and sideswipe crashes. This treatment should be installed in combination with additional treatments such as installing or adding chevrons, warning signs, delineators, markers, beacons, and relocating existing signs.

Crash Types Addressed	Documented Crash Reduction Factor	Federal Funding Eligibility	Cost Estimate
Head-on, Run-off road, Sideswipe, Night	0.15	100%	$500 per Sign



Why was this Chosen for City of Fresno? Hit object crashes are among the top three crash types resulting in a fatality or severe injury. The most common violation among fatal and severe injury hit object crashes was *unsafe speeding on a highway*. Furthermore, crashes that occurred in the dark made up 35% of total reported crashes but accounted for 52% of fatal and severe injury crashes. Installing and/or upgrading signs with new fluorescent sheeting would provide drivers with increased awareness of changing roadway elements.

Image Sources: FHWA

1.1.7 INSTALL CHEVRON SIGNS ON HORIZONTAL CURVES (R27)

Summary of Countermeasure: Chevron signs provide a visual cue to drivers that they are about to navigate a horizontal curve. This treatment is appropriate for locations where relatively sharp curves have resulted in crashes. This treatment should be installed in combination with additional treatments such as advance warning signs, delineators, and pavement markers to provide increased awareness of the curved roadway alignment.

Crash Types Addressed	Documented Crash Reduction Factor	Federal Funding Eligibility	Cost Estimate
Run-off Road, All	0.4	100%	$500 per Sign

Why was this Chosen for City of Fresno? Hit object crashes are among the top three crash types resulting in a fatality or severe injury. The most common violation among fatal and severe injury hit object crashes was *unsafe speeding on a highway*. Providing chevron signage in addition to other treatments can address curve-related crashes which often result in hit object or run-off road crashes.

Image Source: FHWA, Texas Transportation Institute

1.1.8 INSTALL CURVE ADVANCE WARNING SIGNS (R28)

Summary of Countermeasure: Curve advance warning signs provide a visual cue to drivers that they are approaching a horizontal curve. This treatment is appropriate for locations where relatively sharp curves have resulted in crashes. This treatment should be installed in combination with additional treatments such as chevron signs, delineators, and pavement markers to provide increased awareness of the curved roadway alignment.

Crash Types Addressed	Documented Crash Reduction Factor	Federal Funding Eligibility	Cost Estimate
All	0.25	100%	$500 per Sign

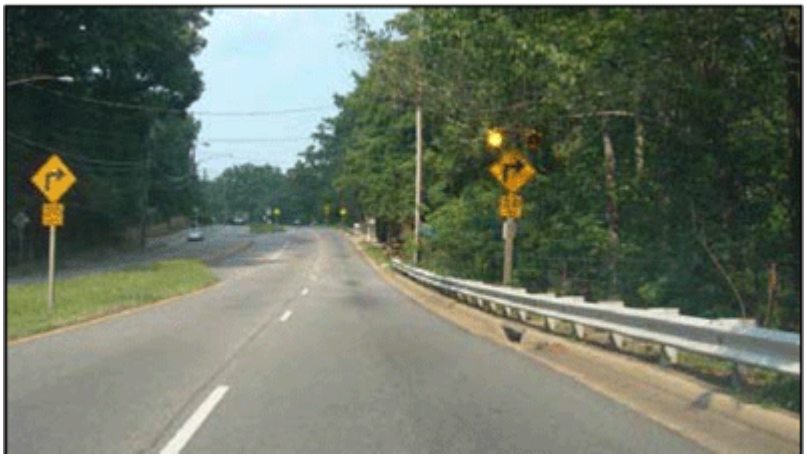
Why was this Chosen for City of Fresno? Hit object crashes are among the top three crash types resulting in a fatality or severe injury. The most common violation among fatal and severe injury hit object crashes was *unsafe speeding on a highway*. Providing curve advance warning signs in addition to other treatments can address curve-related crashes which often result in hit object or run-off road crashes.

Image Sources: Flickr, KAI 2018

1.1.9 INSTALL CURVE ADVANCE WARNING SIGNS (FLASHING BEACON) (R29)

Summary of Countermeasure: Flashing Beacon curve advance warning signs provide a visual cue and get drivers attention that they are approaching a horizontal curve. This treatment is appropriate for locations where relatively sharp curves have resulted in crashes. This treatment should be installed in combination with additional treatments such as regular curve advance warning signs, chevron signs, delineators, and pavement markers to provide increased awareness of the curved roadway alignment.

Crash Types Addressed	Documented Crash Reduction Factor	Federal Funding Eligibility	Cost Estimate
All	0.3	100%	$16,600 each



Why was this Chosen for City of Fresno? Hit object crashes are among the top three crash types resulting in a fatality or severe injury. The most common violation among fatal and severe injury hit object crashes was *unsafe speeding on a highway*. Providing curve advance warning signs in addition to other treatments can address curve-related crashes which often result in hit object or run-off road crashes.

Image Source: FHWA

1.1.10 INSTALL DYNAMIC/VARIABLE SPEED WARNING SIGNS (R30)

Summary of Countermeasure: Dynamic/variable speed warning signs provide a visual warning to drivers of their speed while approaching sharp curves. It helps address crashes involving motorists traveling around curves.

Crash Types Addressed	Documented Crash Reduction Factor	Federal Funding Eligibility	Cost Estimate
All	0.30	100%	$43,600 each

Why was this Chosen for City of Fresno? Hit object crashes are among the top three crash types resulting in a fatality or severe injury. The most common violation among fatal and severe injury hit object crashes was *unsafe speeding on a highway*. Providing appropriate signing can address curve-related crashes which often result in hit object or run-off road crashes.

Image Source: Kittelson & Associates, 2018

1.1.11 INSTALL DELINEATORS, REFLECTORS AND/OR OBJECT MARKERS (R31)

Summary of Countermeasure: Delineators, reflectors, and/or object markers clarify the path of travel through a horizontal alignment and call driver attention to fixed objects along the roadside. This treatment is appropriate for locations where relatively sharp curves have resulted in crashes. They may be installed in combination with additional treatments such as chevron signs and curve advance warning signs to provide increased awareness of a curved roadway alignment.

Crash Types Addressed	Documented Crash Reduction Factor	Federal Funding Eligibility	Cost Estimate
All	0.15	100%	$75 each

Why was this Chosen for City of Fresno? Hit object crashes are among the top three crash types resulting in a fatality or severe injury. The most common violation among fatal and severe injury hit object crashes was *unsafe speeding on a highway*. Providing appropriate signing can address curve-related crashes which often result in hit object or run-off road crashes.

Image Source: FHWA

1.1.12 INSTALL EDGE-LINES AND CENTERLINES (R32)

Summary of Countermeasure: Installing edge-lines and centerline helps clarify and increase visibility of the road and lane boundaries. These treatments help drivers who may depart the roadway or travel lane. Additional enhancements can help boost visibility, including thermoplastic application with audible disks or bumps, or raised/reflective pavement markers.

Crash Types Addressed	Documented Crash Reduction Factor	Federal Funding Eligibility	Cost Estimate
Head-on, run-off road, All	0.25	100%	$4 per feet

Why was this Chosen for City of Fresno? Hit object crashes are among the top three crash types resulting in a fatality or severe injury. The most common violation among fatal and severe injury hit object crashes was *unsafe speeding on a highway*. Installing edgeline rumple strips/ stripes would provide positive guidance to drivers to stay within the travel lane and roadway.

Image Source: Texas A&M Transportation Institute

1.1.13 INSTALL EDGELINE RUMBLE STRIPS/STRIPES (R35)

Summary of Countermeasure: Edgeline rumble strips alert drivers that are drifting out of their travel lane before they depart the roadway, providing the driver time to correct and stay in their lane. The Caltrans *Local Roadway Safety Manual* recommends installing rumble strips along an entire corridor, instead of just in certain spots. Rumble *stripes* –so called when the pavement marking is in the rumble strip—provide enhanced marking in wet or dark conditions.

Crash Types Addressed	Documented Crash Reduction Factor	Federal Funding Eligibility	Cost Estimate
Run-off Road	0.15	100%	$10 per FT

Why was this Chosen for City of Fresno? Hit object crashes are among the top three crash types resulting in a fatality or severe injury. The most common violation among fatal and severe injury hit object crashes was *unsafe speeding on a highway*. Installing edgeline rumple strips/ stripes would provide positive guidance to drivers to stay within the travel lane and roadway.

Image Source: FHWA

1.2 INTERSECTION TREATMENTS

1.2.1 INSTALL/UPGRADE LARGER OR ADDITIONAL STOP SIGNS OR OTHER INTERSECTION WARNING/REGULATORY SIGNS (NS5)

Summary of Countermeasure: Installing larger warning or regulatory signs at or in advance of an intersection can increase the visibility of the intersection, thereby increasing the ability of approaching drivers to perceive the intersection. The effectiveness of this strategy is greatest when implementation involves a combination of regulatory and warning signs appropriate for the conditions on an unsignalized intersection approach.

Crash Types Addressed	Documented Crash Reduction Factor	Federal Funding Eligibility	Cost Estimate
All	0.15	100%	$500 per sign

Why was this Chosen for City of Fresno? Broadside crashes are among the top three crash types resulting in a fatality or severe injury. Broadside crashes at unsignalized intersections often have the primary collision factor listed as *traffic signals and signs*[3] *or auto right-of-way*[4] violation. Increasing intersection conspicuity would help to promote driver compliance at intersections.

Image Source: South Carolina DOT

[3] This is a reported PCF that indicated one of several California Vehicle Violation codes indicating a failure to adhere to traffic control (e.g. running a stop sign).
[4] This is a reported PCF that indicated one of several California Vehicle Violation codes indicating a failure to yield right-of-way to oncoming traffic.

1.2.2 UPGRADE INTERSECTION PAVEMENT MARKINGS (NS.I.) (NS6)

Summary of Countermeasure: Upgrades to intersection pavement markings include "Stop Ahead" markings and the addition of centerlines and stop bars for stop-controlled approaches. Providing visible stop bars and clearer delineation of lanes on minor road approaches to unsignalized intersections can help direct the attention of drivers to the presence of the intersection.

Crash Types Addressed	Documented Crash Reduction Factor	Federal Funding Eligibility	Cost Estimate
All	0.25	100%	$4,000 per intersection

Why was this Chosen for City of Fresno? Broadside crashes are among the top three crash types resulting in a fatality or severe injury. Broadside crashes at unsignalized intersections often have the primary collision factor listed as *traffic signals and signs*[5] *or auto right-of-way*[6] violation. Increasing intersection conspicuity would help to promote driver compliance at intersections.

Image Source: ITE Unsignalized Intersection Improvement Guide

[5] This is a reported PCF that indicated one of several California Vehicle Violation codes indicating a failure to adhere to traffic control (e.g. running a stop sign).
[6] This is a reported PCF that indicated one of several California Vehicle Violation codes indicating a failure to yield right-of-way to oncoming traffic.

1.2.3 INSTALL TRANSVERSE RUMBLE STRIPS ON APPROACHES (NS9)

Summary of Countermeasure: Transverse rumble strips provide an auditory and tactile sensation for motorists approaching an intersection, providing speed management by indicating changing conditions or the presence of an intersection. They can be used at any stop or yield approach intersection, often in combination with advance signing to warn of the intersection ahead.

Crash Types Addressed	Documented Crash Reduction Factor	Federal Funding Eligibility	Cost Estimate
All	0.2	90%	$600 per approach

Why was this Chosen for City of Fresno? Broadside crashes are among the top three crash types resulting in a fatality or severe injury. Broadside crashes at unsignalized intersections often have the primary collision factor listed as *traffic signals and signs*[7] *or auto right-of-way*[8] violation Increasing intersection conspicuity would help to promote driver compliance at intersections.

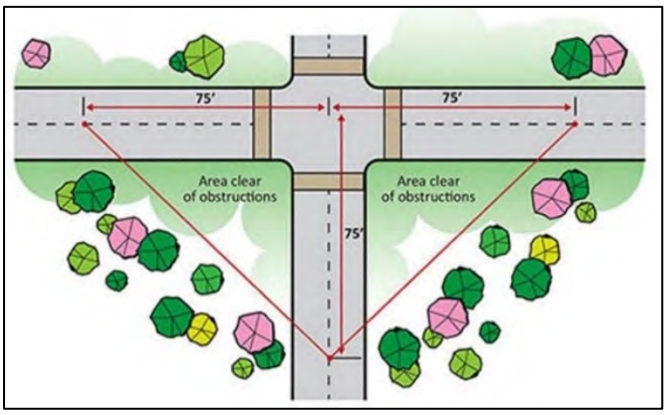
Image Source: Kittelson & Associates, 2019

[7] This is a reported PCF that indicated one of several California Vehicle Violation codes indicating a failure to adhere to traffic control (e.g. running a stop sign).
[8] This is a reported PCF that indicated one of several California Vehicle Violation codes indicating a failure to yield right-of-way to oncoming traffic.

1.2.4 IMPROVE SIGHT DISTANCE TO INTERSECTION (CLEAR SIGHT TRIANGLES) (NS10)

Summary of Countermeasure: Sight distance improvements can often be achieved by clearing sight triangles to restore sight distance obstructed by vegetation, roadside appurtenances, buildings, bus stations, and other objects which are in the right-of-way. The other strategy to improve sight distance is to eliminate on-street parking that restricts sight distance especially on approach to or adjacent to intersections.

Crash Types Addressed	Documented Crash Reduction Factor	Federal Funding Eligibility	Cost Estimate
All	0.2	90%	$200-$50,000



Why was this Chosen for City of Fresno? Broadside crashes are among the top three crash types resulting in a fatality or severe injury. Broadside crashes at unsignalized intersections often have the primary collision factor listed as *traffic signals and signs*[9] *or auto right-of-way*[10] violation Increasing intersection conspicuity would help to promote driver compliance at intersections.

Image Source: http://www.mikeontraffic.com/sight-distance-explained/

[9] This is a reported PCF that indicated one of several California Vehicle Violation codes indicating a failure to adhere to traffic control (e.g. running a stop sign).
[10] This is a reported PCF that indicated one of several California Vehicle Violation codes indicating a failure to yield right-of-way to oncoming traffic.

1.2.5 INSTALL SPLITTER-ISLANDS ON THE MINOR ROAD APPOACHES (NS11)

Summary of Countermeasure: A splitter-island creates physical separation between vehicles turning onto the stop-controlled approach and vehicles stopped on that same approach. The splitter-island also makes the intersection more visible and provides space for a second stop sign on the approach. Splitter-islands must be designed to accommodate appropriate design vehicles while still being large enough to be visible to drivers and to allow refuge area for pedestrians.

Crash Types Addressed	Documented Crash Reduction Factor	Federal Funding Eligibility	Cost Estimate
Angle, Broadside, Rear-End	0.4	90%	$10,000 per Approach

Why was this Chosen for City of Fresno? Broadside crashes are among the top three crash types resulting in a fatality or severe injury. Broadside crashes at unsignalized intersections often have the primary collision factor listed as *traffic signals and signs*[11] *or auto right-of-way*[12] violation. Increasing intersection conspicuity would help to promote driver compliance at intersections.

Image Source: Mid-Ohio Regional Planning Commission

[11] This is a reported PCF that indicated one of several California Vehicle Violation codes indicating a failure to adhere to traffic control (e.g. running a stop sign).
[12] This is a reported PCF that indicated one of several California Vehicle Violation codes indicating a failure to yield right-of-way to oncoming traffic.

1.2.6 IMPROVE SIGNAL HARDWARE: LENSES, BACK-PLATES, MOUNTING, SIZE, AND NUMBER (S2)

Summary of Countermeasure: Providing better visibility of intersection signals aids the drivers' advance perception of the upcoming 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.

Crash Types Addressed	Documented Crash Reduction Factor	Federal Funding Eligibility	Cost Estimate
Angle, Rear-end	0.15	100%	$1,500 per Signal Head

Why was this Chosen for City of Fresno? Broadside crashes are among the top three crash types resulting in a fatality or severe injury. Broadside crashes at signalized intersections often have the primary collision factor listed as *traffic signals and signs*[13] *or auto right-of-way*[14] violation. Increasing intersection conspicuity would help to promote driver compliance at intersections.

Image Source: FHWA, 2018

[13] This is a reported PCF that indicated one of several California Vehicle Violation codes indicating a failure to adhere to traffic control (e.g. running a stop sign).
[14] This is a reported PCF that indicated one of several California Vehicle Violation codes indicating a failure to yield right-of-way to oncoming traffic.

1.3 PEDESTRIAN AND BICYCLE TREATMENTS

1.3.1 INSTALL LEADING PEDESTRIAN INTERVAL (LPI)

Summary of Countermeasure: A leading pedestrian interval (LPI) provides pedestrians with an opportunity to establish their presence in the crosswalk before drivers start turning and provides additional crossing time for those who need it. This head start increases the percentage of drivers who yield the right of way to pedestrians and can minimize conflicts between pedestrians crossing a roadway and turning vehicles.

Crash Types Addressed	Documented Crash Reduction Factor	Federal Funding Eligibility	Cost Estimate
Ped & Bike	59%	50%	<$2,500 per signal

Why was this Chosen for City of Fresno? *Pedestrian right-of-way*[15] violation is among the top five collision factors most frequently associated with pedestrian crashes. The most common violation involved drivers being at fault. Installing LPIs will allow pedestrians to establish their presence in a crosswalk and encourage drivers to yield to crossing pedestrians.

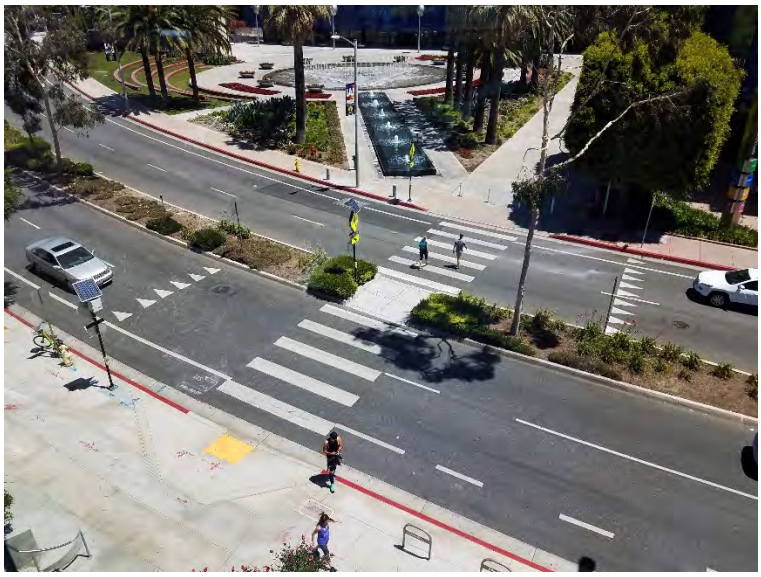
Image Source: Toole Design Group

[15] This is a reported PCF that indicated one of several California Vehicle Violation codes indicating a failure of a driver of a vehicle to yield the right-of-way to a pedestrian.

1.3.2 INSTALL HIGH-VISIBILITY CROSSWALK MARKINGS

Summary of Countermeasure: High-visibility crosswalk markings, such as continental or ladder-style, warn drivers to expect pedestrian crossings and clarify that drivers are expected to yield right-of-way to crossing pedestrians. At uncontrolled locations, high-visibility crosswalk markings identify a preferred crossing location for pedestrians.

Crash Types Addressed	Documented Crash Reduction Factor	Federal Funding Eligibility	Cost Estimate
Ped & Bike	48%	90%	<$2,500 per crossing



Why was this Chosen for City of Fresno? Pedestrians crossing outside a crosswalk is the top pedestrian crash type resulting in a fatality or severe injury. The primary collision factor is often listed as *pedestrian violation* [16]. Vehicles were most commonly proceeding straight for this crash type. Installing high-visibility crosswalk markings provide designated areas for pedestrian crossings and warn drivers to expect pedestrian crossings.

Image Source: Toole Design Group

[16] This is a reported PCF that indicated one of several California Vehicle Violation codes indicating a pedestrian failure to yield right-of-way to other vehicles.

1.3.3 INSTALL ADVANCE YIELD LINES

Summary of Countermeasure: Advance yield lines are pavement markings placed 20 to 50 feet in advance of an uncontrolled and unsignalized pedestrian or bicycle crossing. This treatment increases the distance between where drivers have stopped or yielded and the crosswalk or bicycle crossing, which improves the visibility of crossing pedestrians and bicyclists to drivers and helps to reduce multiple-threat crashes. Advanced yield lines also discourage drivers from encroaching into the crosswalk.

Crash Types Addressed	Documented Crash Reduction Factor	Federal Funding Eligibility	Cost Estimate
Ped & Bike	25%	90%	<$2,500 per yield line

Why was this Chosen for City of Fresno? Pedestrians crossing in road is among the top three pedestrian crash types resulting in a fatality or severe injury. Vehicles were most commonly proceeding straight for this crash type. Installing advance yield lines increases the distance between the crosswalk and where drivers have stopped or yielded and prevent drivers from encroaching into crosswalks.

Image Source: Toole Design Group

1.3.4 INSTALL RAISED MEDIANS/REFUGE ISLANDS (NS16)

Summary of Countermeasure: Raised medians with pedestrian refuge islands are roadway treatments designed to provide refuge for pedestrians and bicyclists between vehicle travel lanes at intersections and midblock locations. To provide pedestrian refuge, they must be a minimum width of 6 feet to meet pedestrian accessibility requirements. To provide bicyclists refuge and to accommodate larger groups of pedestrians, the minimum should be increased to 8 feet.

They can improve safety for pedestrians and bicyclists by reducing crossing distances and creating a place of refuge to allow multiple-stage crossings. They are particularly beneficial at uncontrolled crossings, large signalized crossings, or complex intersections where people may have difficulty completing crossings. They may also be helpful for pedestrians who are unable to judge gaps in traffic accurately or who travel slower than the design pedestrian (typically walking at least 3.5 ft/s). Refuge islands can be designed with a Z-crossing to require people to face oncoming traffic which may increase visibility and eye contact. Refuge islands that extend up to or beyond crosswalks can also slow left turning drivers, providing the same benefit as hardened centerlines or medians. Temporary pedestrian refuge islands can be installed using low-cost materials (paint, bollards, or even rubberized platforms) for demonstration and evaluation purposes.

Crash Types Addressed	Documented Crash Reduction Factor	Federal Funding Eligibility	Cost Estimate
Ped & Bike	45%	90%	$120 per FT

Why was this Chosen for City of Fresno? Pedestrians crossing in road is among the top three pedestrian crash types resulting in a fatality or severe injury. The primary collision factor is often listed as *pedestrian violation*,[17] which can indicate the need for improved pedestrian crossings. Vehicles were most commonly proceeding straight for this crash type. Installing refuge islands provides a space for pedestrians to safely wait during multiple crossing stages.

Image Source: Toole Design Group

[17] This is a reported PCF that indicated one of several California Vehicle Violation codes indicating a pedestrian failure to yield right-of-way to other vehicles.

1.3.5 INSTALL PEDESTRIAN CROSSING AT UNCONTROLLED LOCATIONS (WITH NEW SIGNS AND MARKINGS ONLY) (NS17)

Summary of Countermeasure: Pedestrian crossing signs and bicycle crossing signs paired with high-visibility crosswalk markings reinforce legal crossings at intersections and create legal crossings at non-intersection locations. These signs and crosswalk markings warn drivers to expect pedestrian and bicycle crossings and clarify that drivers are expected to yield right-of-way to crossing pedestrians and bicyclists. At uncontrolled locations, pedestrian and bicycle crossing signs and markings identify a preferred crossing location for pedestrians and bicyclists. Incorporating advanced yield lines provides an extra safety buffer and can be effective in reducing the 'multiple-threat' danger to pedestrians.

Crash Types Addressed	Documented Crash Reduction Factor	Federal Funding Eligibility	Cost Estimate
Ped & Bike	25%	100%	$2,600 each

Why was this Chosen for City of Fresno? Pedestrian crashes at unsignalized locations is the top pedestrian crash type resulting in a fatality or severe injury. Installing pedestrian crossings at uncontrolled intersections warn drivers to expect pedestrian and bicycle crossings and clarify that drivers are expected to yield right-of-way to crossing pedestrians and bicyclists.

Image Source: Toole Design Group

1.3.6 INSTALL PEDESTRIAN CROSSING AT UNCONTROLLED LOCATIONS (WITH ENHANCED SAFETY FEATURES) (NS18)

Summary of Countermeasure: In combination with high-visibility crosswalk markings, curb extensions, raised medians, beacons, and lighting reduce pedestrian crash risk by delineating a portion of the roadway that is designated for pedestrian crossing and increasing driver yielding rates.

Rectangular rapid flash beacons (RRFB) in particular have been shown to significantly increase driver yielding behavior at uncontrolled crosswalks, with driver yield rates ranging from 34 percent to over 90 percent.Studies have also demonstrated reduced pedestrian-vehicle conflicts, increased stopping distance, and reductions in pedestrians trapped in roadway associated with RRFBs (Thomas et al. 2016)[18]. These safety benefits likely extend to bicyclists crossing at RRFB locations. Compared with PHBs, RRFBs are generally more appropriate at two-lane locations, whereas PHBs are best suited to higher speed or multilane contexts or locations with limited sight distance

Crash Types Addressed	Documented Crash Reduction Factor	Federal Funding Eligibility	Cost Estimate
Ped & Bike	35%	100%	$60,000-$160,000 each

Why was this Chosen for City of Fresno? Pedestrian crashes at unsignalized locations is the top pedestrian crash type resulting in a fatality or severe injury. Installing enhanced pedestrian crossings at uncontrolled intersections warn drivers to expect pedestrian and bicycle crossings and clarify that drivers are expected to yield right-of-way to crossing pedestrians and bicyclists.

Image Source: Toole Design Group

[18] Thomas, L., Thirsk, N. J., & Zegeer, C. V. (2016). *Application of Pedestrian Crossing Treatments for Streets and Highways* (No. Project 20-05 (Topic 46-10)).

1.3.7 INSTALL PEDESTRIAN SIGNALPHB (NS19)

Summary of Countermeasure: Pedestrian Hybrid Beacons (PHBs) are signals installed at unsignalized major street pedestrian and bicyclist crossing locations to help pedestrians cross the street safely. PHBs may be used in locations where side-street volumes do not warrant a conventional traffic signal, or in situations where there are concerns that a conventional signal may encourage additional motor vehicle traffic on the minor street. PHBs typically include the following elements:

- Overhead beacons with three sections (circular yellow signal indication centered below two horizontally aligned circular red signals) facing both directions on the major street
- Overhead signs labeled "CROSSWALK STOP ON RED" to indicate that the location is associated with a pedestrian crosswalk
- A marked crosswalk on the major street
- Countdown pedestrian signal heads to control pedestrian crossings at the crosswalk

Crash Types Addressed	Documented Crash Reduction Factor	Federal Funding Eligibility	Cost Estimate
Ped & Bike	55%	100%	$83,300 per system

Why was this Chosen for City of Fresno? Pedestrian crashes at intersections is the top pedestrian crash type resulting in a fatality or severe injury. The primary collision factor is often listed as *pedestrian violation*,[19]which can indicate the need for improved pedestrian crossing opportunities. Installing pedestrian signals or HAWKs at intersections warn drivers to expect pedestrian and bicycle crossings and clarify that drivers are expected to yield right-of-way to crossing pedestrians and bicyclists.

Image Source: Toole Design Group

[19] This is a reported PCF that indicated one of several California Vehicle Violation codes indicating a pedestrian failure to yield right-of-way to other vehicles.

1.3.8 INSTALL BIKE LANES (R36)

Summary of Countermeasure: Class II Bicycle Facilities, also known as bike lanes, are established along streets, defined by pavement striping and signage to delineate a portion of a roadway for bicycle travel. Bike lanes are one-way facilities, typically striped adjacent to vehicle traffic traveling in the same direction. Buffered bike lanes provide greater separation from an adjacent traffic lane or on-street parking by using painted chevrons or diagonal markings. Buffered bike lanes may be desirable on streets with higher vehicle speeds or volumes.

Crash Types Addressed	Documented Crash Reduction Factor	Federal Funding Eligibility	Cost Estimate
Ped & Bike	35%	90%	$50 per FT[20]

Why was this Chosen for City of Fresno? *Auto right-of-way*[21] violation is among the top three collision factors most frequently associated with bicycle crashes. The most common violation involved drivers being at fault. Installing bike lanes designates a portion of the roadway to bicyclists and provides separation of bicyclists from the vehicle travel lane.

Image Source: Toole Design Group

[20] Cost assumes bike lane striping is thermoplastic.
[21] This is a reported PCF that indicated one of several California Vehicle Violation codes indicating a failure to yield right-of-way to oncoming traffic.

1.3.9 INSTALL SIDEWALK/PATHWAY (TO AVOID WALKING ALONG ROADWAY) (R37)

Summary of Countermeasure: Sidewalks and walkways provide a dedicated space for pedestrians to travel that is separated from roadway vehicles. The presence of sidewalks on both sides of the street has been found to reduce the crash risks associated with pedestrians walking along the roadways as compared to locations where no sidewalks or walkways exist. The presence of sidewalks and walkways can reduce these types of pedestrian crashes by 50 to 90 percent. Guidance signs and markings directing pedestrians and bicyclists on appropriate travel paths and signs and markings warning drivers of pedestrians and bicyclists should be used in conjunction with sidewalks and walkways.

Crash Types Addressed	Documented Crash Reduction Factor	Federal Funding Eligibility	Cost Estimate
Ped & Bike	80%	90%	$25 per FT

Why was this Chosen for City of Fresno? *Pedestrian right-of-way*[22] violation is among the top three collision factors most frequently associated with pedestrian crashes. The most common violation involved drivers being at fault. Installing sidewalks and walkways provides a dedicated space for pedestrians to travel that is separated from vehicle travel lanes.

Image Source: Toole Design Group

[22] This is a reported PCF that indicated one of several California Vehicle Violation codes indicating a failure of a driver of a vehicle to yield the right-of-way to a pedestrian.

1.3.10 INSTALL PEDESTRIAN CROSSING (WITH ENHANCED SAFETY FEATURES) (R38)

Summary of Countermeasure: Pedestrians crossings, with enhanced safety features such as high-visibility crosswalk markings, curb extensions, raised medians, beacons, and lighting, delineate the portion of the roadway that is designated for pedestrian crossing. This warns drivers of the presence of pedestrians and bicyclists crossing the roadway and encourages drivers to yield to pedestrians and bicyclists in the crosswalk. The enhanced improvements added to the crossing also increase the likelihood of pedestrians crossing in a location visible and predictable for motorists, and are useful at mid-block crossing locations to align pedestrian behavior with driver expectations. Guidance signs and markings should be used in combination with the enhanced pedestrian crossing to guide pedestrians and bicyclists on appropriate travel paths.

Crash Types Addressed	Documented Crash Reduction Factor	Federal Funding Eligibility	Cost Estimate
Ped & Bike	30%	90%	$60,000-$160,000 each

Why was this Chosen for City of Fresno? Pedestrian and bicycle crashes in mid-block segments is among the top three crash types resulting in a fatality or severe injury. The primary collision factor is often listed as *pedestrian violation*. Installing enhanced mid-block pedestrian crossings warns drivers to expect pedestrian and bicycle crossings and clarifies that drivers are expected to yield right-of-way to crossing pedestrians and bicyclists.

Image Source: Toole Design Group

1.3.11 INSTALL RAISED PEDESTRIAN CROSSING (R39)

Summary of Countermeasure: Raised crossings are a vertical traffic control measure that can reduce vehicle speeds, improve pedestrian visibility to approaching drivers, and improve pedestrian and bicyclist crossing safety by improving drivers yielding. The raised crossing encourages drivers to reduce their speed and provides improved delineation for the portion of the roadway that is designated for pedestrian crossing. Signs and markings directing pedestrians and cyclists on appropriate travel paths should be used in combination with this countermeasure.

Crash Types Addressed	Documented Crash Reduction Factor	Federal Funding Eligibility	Cost Estimate
Ped & Bike	35%	90%	$5,000 each

Why was this Chosen for City of Fresno? Pedestrians crossing in crosswalk at intersections is among the top three pedestrian crash types resulting in a fatality or severe injury. Vehicles were most commonly proceeding straight for this crash type. Installing raised pedestrian crossings slow drivers down and improve the visibility of pedestrians and bicyclists to drivers.

Image Source: Toole Design Group

1.3.12 INSTALL PEDESTRIAN COUNTDOWN SIGNAL HEADS (S19)

Summary of Countermeasure: Pedestrian countdown signals contain a timer display and count 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 cross illegally.

Crash Types Addressed	Documented Crash Reduction Factor	Federal Funding Eligibility	Cost Estimate
Ped & Bike	25%	100%	$1,800 per signal head

Why was this Chosen for City of Fresno? *Pedestrian violation* is the top collision factor most frequently associated with pedestrian crashes. This violation most commonly involves pedestrians being at fault. Installing pedestrian countdown signals helps pedestrians to cross intersections in the designated time and allow vehicles to proceed.

Image Source: Toole Design Group

1.3.13 INSTALL PEDESTRIAN CROSSING (S.I.) (S20)

Summary of Countermeasure: Installing pedestrian crossings at intersections can improve pedestrian and bicycle safety by designating a dedicated portion of the roadway for pedestrian and bicycle crossing. This helps to reduce pedestrian-related crashes that occur within 50 feet of an intersection. The use of high-visibility crosswalk markings, pedestrian countdown signals, and appropriate signs can enhance pedestrian and bicycle safety at pedestrian crossings.

Crash Types Addressed	Documented Crash Reduction Factor	Federal Funding Eligibility	Cost Estimate
Ped & Bike	25%	100%	$8,200 per crossing

Why was this Chosen for City of Fresno? Pedestrian crashes at signalized locations is among the top three pedestrian crash types resulting in a fatality or severe injury. The primary collision factor is often listed as *pedestrian violation*. Installing enhanced pedestrian crossings at controlled intersections provides pedestrians and bicyclists with a designated portion of the roadway to cross intersections and forces vehicles to yield to crossing pedestrians and bicyclists.

Image Source: Toole Design Group

2 | PROPOSED NON-ENGINEERING COUNTERMEASURES

This section presents the non-engineering safety countermeasures identified to address the systemic crash trends documented in the Task 2 Memorandum. These countermeasures are intended to complement the engineering countermeasures described above, and generally are intended to address behavioral factors behind crashes. Countermeasures are grouped into law enforcement approaches, community enforcement approaches, and education approaches. While non-engineering countermeasures are not eligible for Highway Safety Improvement Program (HSIP) funding, they can be funded through various other grant programs, including:

- Active Transportation Program (ATP): The California ATP provides funding for projects that improve walking and bicycling around the state, including both infrastructure and non-infrastructure projects. The Cycle 5 Call for Projects is expected to be released in Spring 2020 with $400 million of funding allocated[23].
- Office of Traffic Safety (OTS): The California OTS offers grant funding for a wide variety of non-infrastructure traffic safety countermeasures. The next grant application period will open in December 2020[24].

2.1 ENFORCEMENT

2.1.1 LAW ENFORCEMENT APPROACH

Even when engineering countermeasures are implemented, road users failing to adhere to traffic laws can result in crashes of varying severity. Police enforcement can increase driver awareness and consequently reduce traffic crashes.

Considerations

- Police officers need to be trained properly beforehand.
- Campaigns must be tailored to suit the needs of different neighborhoods and demographics, and need to be designed and carried out to avoid targeting disadvantaged communities.
- Enforcement should be conducted with the help of staff support and awareness of the courts.
- Enforcement operations should begin with warnings and flyers before moving on to issuing citations for violations.

2.1.1.1 Speed Trailers

Portable speed trailers visually display a driver's real-time speed compared to the speed limit and may be effective in reducing speeds and increasing awareness of local speed limits. Portable speed trailers are most effective when the trailer flashes "SLOW DOWN" or flashes a bright white light that mimics a photo speed camera or a blue and red light that mimics a police car when drivers are moving too fast. In some

[23] https://dot.ca.gov/programs/local-assistance/fed-and-state-programs/active-transportation-program/cycle5
[24] https://www.ots.ca.gov/grants/program-information/

cases, back-up speed enforcement by officers may be needed when radar speed trailers are used. If a driver fails to slow when the sign tells them that they are violating the law, an officer may stop the driver.

Campaign Type: Vehicle

Condition Addressed: Unsafe Speed

Benefits

- Provides immediate feedback.
- Does not require officer to be present.
- Relatively low cost.
- Can be moved to varying locations.

Considerations

- Best used in residential areas and can be used in conjunction with neighborhood speed watch programs or other safety education programs.
- Need to be placed in locations where they do not block pedestrians, bicyclists, motor vehicle traffic or other vital traffic control signs.
- Not substitutes for permanent actions, such as traffic-calming treatments to address neighborhood speeding issues.

Relative Cost: Low to Medium ($8,000 - $15,000)

Resource Links
Countermeasures That Work: A Highway Safety Countermeasure Guide for State Highway Safety Offices, Eighth Edition, 2017 https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/documents/812478_countermeasures-that-work-a-highway-safety-countermeasures-guide-.pdf

Safe Routes to School Guide http://guide.saferoutesinfo.org/

2.1.1.2 Active Speed Monitors

Active speed monitors are permanent devices to keep drivers aware of their speeds and the need to slow down. They are typically mounted on a speed limit sign and visually display drivers' real-time speeds as they pass. Drivers see how fast they are driving compared to the posted speed limit. Some active speed monitors are solar-powered.

Campaign Type: Vehicle

Condition Addressed: Unsafe Speed

Benefits

- Provides immediate feedback.
- Does not require officer to be present.

Considerations

- Cannot be moved around easily.

Relative Cost: Low ($3,000 - $4,000)

Resource Links
Safe Routes to School Guide http://guide.saferoutesinfo.org/

2.1.1.3 Traffic Complaint Hotlines

A traffic complaint hotline allows community members to report traffic problems directly to police. It is used to identify the worst traffic problem areas and the most frequent traffic complaints. Police follow up with enforcement in the identified area and schedule additional enforcement if needed.

Campaign Type: All

Condition Addressed: All

Benefits

- Enables police to quickly identify issues.
- Enables public to be engaged.

Relative Cost: Low

Resource Links
Safe Routes to School Guide http://guide.saferoutesinfo.org/

2.1.1.4 'Pedestrian Decoy' Operations

A 'pedestrian decoy' is when police officers in highly visible civilian clothes pose as pedestrians crossing the street while other hidden officers observe their attempts. This serves to bring attention to problems with drivers not yielding to pedestrians. If a driver violates safe crossing rules by failing to yield to the pedestrian, the hidden officers pursue and apprehend violators. Because it is such a highly visible approach, it often garners media interest and publicizes the need for drivers to be aware of pedestrians.

Campaign Type: Vehicle

Condition Addressed: Pedestrian Right-of-Way

Benefits

- Can be high visibility through media coverage.
- Can quickly identify offenders.
- Poses no threat to actual pedestrians.

Considerations

- Requires police resources, which may include overtime pay.
- Needs to be done at regular intervals.

Relative Cost: Low to Medium

Resource Links
Safe Routes to School Guide http://guide.saferoutesinfo.org/

2.1.1.5 Progressive Ticketing

Progressive ticketing is a method for introducing ticketing through a three-staged process. Issuing tickets is the strongest strategy of an enforcement program and it is usually reserved for changing unsafe behaviors that other strategies failed to change or that pose a real threat to the safety of road users.

There are three main steps of an effective progressive ticketing program:

1. Educating - Establish community awareness of the problem. The public needs to understand that drivers are speeding and the consequences of this speeding for road safety. Raising awareness about the problem will change some behaviors and create public support for the enforcement efforts to follow.
2. Warning - Announce what action will be taken and why. Give the public time to change behaviors before ticketing starts. Fliers, signs, newspaper stories and official warnings from officers can all serve as reminders.
3. Ticketing – After the "warning" period, hold a press conference announcing when and where the police operations will occur. If offenders continue their unsafe behaviors, officers issue tickets.

Campaign Type: Vehicle

Condition Addressed: Unsafe Speed

Benefits

- Can be high visibility through media coverage.
- Can quickly identify offenders.
- Consequences are often sufficient to deter behaviors.

Considerations

- Requires police resources, which may include overtime pay.
- Needs to be done at regular intervals.
- Should be reserved for serious offenses.

Relative Cost: Low to Medium

Resource Links
Safe Routes to School Guide http://guide.saferoutesinfo.org/

2.1.1.6 Speed Enforcement in School Zones

Strict enforcement of speed laws in school zones is one law enforcement tool that can improve the safety for children walking and bicycling to school as well as drivers. A 'zero tolerance' policy for speeders in school zones and even an increase in fines for drivers who violate the posted school zone speed limit are potential approaches.

Campaign Type: Vehicle

Condition Addressed: Unsafe Speed

Benefits

- Can be high visibility through media coverage.
- Can quickly identify offenders.
- Consequences are often enough to deter behaviors.

Considerations

- Requires police resources, which may include overtime pay.
- Needs to be done at regular intervals.
- Should be reserved for serious offenses.

Relative Cost: Low to Medium

Resource Links
Safe Routes to School Guide http://guide.saferoutesinfo.org/

2.1.1.7 High Visibility Saturation Patrols

A saturation patrol (also called a blanket patrol or dedicated DWI patrol) consists of a large number of law enforcement officers patrolling a specific area to look for drivers who may be impaired. These patrols usually take place at times and locations where impaired driving crashes commonly occur. Like publicized sobriety checkpoint programs, the primary purpose of publicized saturation patrol programs is to deter driving after drinking by increasing the perceived risk of arrest.

Campaign Type: Vehicle

Condition Addressed: Driving Under the Influence (DUI)

Benefits

- Can be effective in reducing alcohol-related fatal crashes when accompanied by extensive publicity.
- Can be implemented within three months if officers are trained in detecting impaired drivers and in Standardized Field Sobriety Test (SFST).
- Can be very effective in arresting impaired drivers.
- Can also be effective in detecting other driving and criminal offenses.

Considerations

- As with sobriety checkpoints, saturation patrols should be highly visible and publicized extensively to be effective in deterring impaired driving.
- Communication and enforcement plans should be coordinated.
- Messages should clearly and unambiguously support enforcement.
- Paid media may be necessary to complement news stories and other earned media, especially in a continuing saturation patrol program.

Relative Cost: Medium to High

Resource Links
Countermeasures That Work: A Highway Safety Countermeasure Guide for State Highway Safety Offices, Eighth Edition, 2017 https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/documents/812478_countermeasures-that-work-a-highway-safety-countermeasures-guide-.pdf

2.1.2 COMMUNITY ENFORCEMENT APPROACH

2.1.2.1 Neighborhood Speed Watch Programs

Neighborhood Speed Watch programs, a traffic-related variation of Neighborhood Watch or Crime Watch, encourage citizens to take an active role in changing driver behavior on their neighborhood streets by helping raise public awareness and educate drivers about the negative impact of speeding. In these programs, residents record speed data in their neighborhood using radar units borrowed from a city or county law enforcement agency. Residents record the speed and license plate information of speeding motor vehicles. This information along with a letter is sent to the owner of the vehicle informing them of the observed violation and encouraging them or other drivers of their vehicle to drive at or below the posted speed limit.

Campaign Type: Vehicle

Condition Addressed: Unsafe Speed

Benefits

- Encourages speeding drivers to slow down.
- Residents become aware of local traffic issues.
- Police gain additional information regarding problems.
- Drivers also learn that residents will not tolerate speeding in their neighborhoods.

Considerations

- Needs police personnel to work with neighborhoods.
- Requires radar guns or other

Relative Cost: Low to Medium

Resource Links
Safe Routes to School Guide http://guide.saferoutesinfo.org/

2.1.2.2 Adult School Crossing Guards

Adult school crossing guards can play a key role in promoting safe driver and pedestrian behaviors at crosswalks near schools. They help children safely cross the street and remind drivers of the presence of pedestrians. A guard helps children develop the skills to cross streets safely at all times. Adult school crossing guards can be parent volunteers, school staff or paid personnel.

Campaign Type: Pedestrian

Condition Addressed: Pedestrian Right-of-Way

Benefits

- Can control behaviors at high-risk locations.
- Can make parents more comfortable allowing children to walk or bicycle to school.

Considerations

- Requires dedicated funding or reliable volunteer system.
- Requires annual classroom and field training for adult school crossing guards as well as special uniforms or equipment to increase visibility.

Relative Cost: Low to Medium

Resource Links

Safe Routes to School Guide http://guide.saferoutesinfo.org/

2.2 EDUCATION

Bicyclists, pedestrians and/or drivers can be misinformed regarding traffic laws, which may lead to risky or reckless behavior. Education can provide information to roadway users and help motivate a change in specific behaviors to reduce the risk of injuries.

There are several broad approaches to education that can be conducted with moderate resources. They include:

- highlighting when introducing new infrastructure configurations, such as novel pedestrian or bicycle treatments;
- conducting internal campaigns within the organization to build staff support for roadway safety programs;
- incorporating roadway safety messages into public relations efforts;
- developing relationships with relevant state agencies and statewide consumer groups; and
- marketing alternative travel modes.

Three specific types of educational campaigns exist:

1. Public awareness - Public awareness campaigns are a great example of a method for garnering public support. An effective campaign can lay the groundwork for subsequent roadway safety initiatives and can increase the likelihood of their success. Campaigns to target groups are usually aimed at changing behavior patterns in specific groups of people (e.g., drivers, schoolchildren).
2. Targeted campaigns - Since changing behavior in these groups can be a long and arduous task, these campaigns tend to be ongoing efforts aimed at long-term results. Individual campaigns differ from campaigns at target groups because the audience is reached through an intermediary.
3. Individual campaigns - Intervention occurs at an individual level through public safety officers, crossing guards, doctors, and other authority figures. Using these different approaches in concert reaches a broader audience and increases the likelihood of long-term success in changing attitudes and behaviors.

Considerations

- Educational messages should encourage people to think about their own travel attitudes and behaviors and make more informed choices.
- Educational campaigns must be a part of a long-term and ongoing traffic safety program.
- As with other education and enforcement initiatives, a long-term commitment is required, both to reinforce learned behaviors and to accommodate new bicyclists and drivers.
- Educational programs and materials should be sensitive of different groups of people.
- Outreach material should be interesting and involve visual as well as written messages.
- Difficulty in gaining political support needed to ensure a comprehensive program.
- Difficulty in introducing safety education within established school system curricula.
- Once implemented, program effectiveness should be evaluated.

Resource Links

Safe Routes to School Guide http://guide.saferoutesinfo.org/

2.2.1 CONSPICUITY ENHANCEMENTS & EDUCATION

The purpose of enhancing conspicuity for pedestrians is to increase the opportunity for drivers to see and avoid pedestrians, particularly when it is dark. Over 70% of national pedestrian fatalities occur in the dark, and pedestrians who are more visible are less likely to be struck. Educating pedestrians to wear reflective clothing and walk in well-lit areas can be implemented as targeted campaigns.

Campaign Type: Pedestrian

Condition Addressed: Lighting

Benefits

The use of high visibility clothing and protective gear enhances safety. There is some limited evidence to suggest that a program aimed at increasing conspicuous and protective clothing could be successful. An Australian study found that the observed proportion of riders wearing full body protection increased in the month following an enforcement/educational campaign with an emphasis on conspicuous and protective clothing (among other safety issues). However, it is unclear whether any potential benefits were sustained (Baldock et al., 2012).

Considerations

- While the literature on retro-reflective and reflective clothing shows that these tactics are effective at increasing pedestrian visibility and thereby reducing the likelihood of pedestrian collisions, it should be noted that it may not best the best option to encourage a culture where the responsibility of pedestrian visibility and safety falls entirely on pedestrians. Instead of attempting to solve the problem solely by encouraging pedestrians to wear high-visibility clothing, driver training and other programs can be implemented to teach drivers about the dangers of reduced visibility at night and to spread the responsibility of pedestrian safety.
- A proper campaign, including market research, message development and testing, and implementation, will require at least 6 months to plan and implement.

Relative Cost: Low

Resource Links
Countermeasures That Work: A Highway Safety Countermeasure Guide for State Highway Safety Offices, Eighth Edition, 2017 https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/documents/812478_countermeasures-that-work-a-highway-safety-countermeasures-guide-.pdf

2.2.2 BICYCLE SAFETY EDUCATION FOR CHILDREN

The purpose of bicycle education is to teach children basic bicycle handling skills, traffic laws, how to ride on streets with traffic present, proper helmet use, bicycle safety checks, and bicycle maintenance. As part of a regular school curriculum, education can reach every student, but providing training outside of school settings such as through parks and recreation departments, community centers or faith-based organizations may be more feasible in some circumstances. Community-based programs could also provide greater flexibility in tailoring to meet the needs of specific target groups.

Campaign Type: Bicycle

Condition Addressed: Bicycle Right-of-Way

Benefits

- Can increase children's knowledge of laws and safe behaviors.
- Can improve safe riding behaviors and enjoyment of riding in children.
- Can be effective at increasing observed helmet use.

Considerations

- Unlikely to be effective in reducing crashes without comprehensive and sustained efforts to improve the cycling environment.
- A high-quality evaluation conducted in Brazil by Bacchieri, Barros, dos Santos, Goncalves, & Gigante (2010) concluded that "isolated educational programs, attempting to only change individual behavior, are not effective in reducing accidents" and that "the number of accidents will not considerably decrease without actions that also include improved road infrastructure and the effective application of legislation (with comprehensive and systematic law enforcement)" (Bacchieri et al., 2010).
- Time to implement may be short, for existing material; medium, to develop and disseminate a training curriculum with material.

Relative Cost: Low to Medium

Resource Links
Countermeasures That Work: A Highway Safety Countermeasure Guide for State Highway Safety Offices, Eighth Edition, 2017 https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/documents/812478_countermeasures-that-work-a-highway-safety-countermeasures-guide-.pdf

2.2.3 BICYCLE SAFETY EDUCATION FOR ADULTS

The goal of bicycle safety education for adult bicycle commuters is to improve knowledge of laws, risks, and cycling best practices, and to lead to safer cycling behaviors, including riding predictably and use of safety materials such as reflective clothing and helmets. Common elements of a bicycle education program include safety ads (e.g., radio, TV, outdoor), dissemination of safety materials, bike "ambassadors" and social supports, individual skills training or workshops, and coordination with enforcement officers to reinforce safe behaviors.

In communities with existing bikeshare programs or considering implementing new programs, bicycle safety education can extend to use of the bikeshare system. Existing stategies include bikeshare operators posting safety information and "rules of the road" on their websites, operators including safety information in user agreements when new users sign up, and providing safety information stickers directly on bikes so riders can review before bicycling. The County can encourage bikeshare operators to further publicize safety tips, such as incorporating this information on existing signage at bikeshare stations.

Campaign Type: Bicycle

Condition Addressed: Bicycle Right-of-Way

Benefits

- Can improve safe riding behaviors and enjoyment of riding in adults.
- Can be effective at increasing observed helmet use.

Considerations

- Unlikely to be effective in reducing crashes without comprehensive and sustained efforts to improve the cycling environment.

- A high-quality evaluation conducted in Brazil by Bacchieri, Barros, dos Santos, Goncalves, & Gigante (2010) concluded that "isolated educational programs, attempting to only change individual behavior, are not effective in reducing accidents" and that "the number of accidents will not considerably decrease without actions that also include improved road infrastructure and the effective application of legislation (with comprehensive and systematic law enforcement)" (Bacchieri et al., 2010).
- A comprehensive education program could require several months of startup time to plan and develop program materials.

Relative Cost: Medium

Resource Links
Countermeasures That Work: A Highway Safety Countermeasure Guide for State Highway Safety Offices, Eighth Edition, 2017 https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/documents/812478_countermeasures-that-work-a-highway-safety-countermeasures-guide-.pdf

2.2.4 ACTIVE LIGHTING AND RIDER CONSPICUITY

Improving bicyclist conspicuity is intended to make bicyclists more visible to drivers and to allow drivers more opportunity to see and avoid collisions with bicyclists. A common contributing factor for crashes involving bicyclists in the roadway is the failure of the driver to notice the bicyclist, particularly at night. The idea behind these efforts is to correct assumptions (e.g., that white clothing is sufficient for visibility at night) and provide tips following the latest findings about conspicuity. Efforts related to active lighting and conspicuity may include educational trainings, giveaways at events, media campaigns, and handing out bike lights and reflectors in historically high-injury locations.

Campaign Type: Bicycle

Condition Addressed: Lighting

Benefits

- Can improve driver detection of bicyclists during the day and at night.
- Can reduce vehicle-bicycle crashes and injuries. be reduced.

Considerations

- Conspicuity-enhancing equipment, such as retroreflective wrist and ankle straps, or small active front and back lights, are sometimes distributed for free as part of school and community educational efforts.
- Brochures and flyers for a bicycle safety education campaign highlighting conspicuity can be created quickly. Often an extra line or two about rider conspicuity can be added to existing educational materials and/or reinforced at community events.
- Several months can be taken up by designing, producing, and implementing the communications and outreach and law enforcement training for enforcing active lighting laws.

Relative Cost: Low

Resource Links
Countermeasures That Work: A Highway Safety Countermeasure Guide for State Highway Safety Offices, Eighth Edition, 2017 https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/documents/812478_countermeasures-that-work-a-highway-safety-countermeasures-guide-.pdf

2.2.5 HIGH-VISIBILITY CELL PHONE AND TEXT MESSAGING MEDIA CAMPAIGN

The High Visibility Enforcement model combines dedicated law enforcement with paid and earned media supporting the enforcement activity. Paid media includes advertisements on TV, radio, online, and via billboards, while earned media includes things like press events and news releases covering the efforts. Both types of media support enforcement activity by helping to ensure the general public is aware of the enforcement activity, and to create the impression that violators will be caught.

Campaign Type: Vehicle

Condition Addressed: Distracted Driving

Benefits

- Can reduce crashes involving drivers using handheld cell phones.

Considerations

- Requires 4 to 6 months to plan and implement.

Relative Cost: High

Resource Links
Countermeasures That Work: A Highway Safety Countermeasure Guide for State Highway Safety Offices, Eighth Edition, 2017 https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/documents/812478_countermeasures-that-work-a-highway-safety-countermeasures-guide-.pdf

2.2.6 DUI AND DISTRACTED DRIVING EDUCATIONAL PRESENTATIONS/TRAININGS

These types of presentations are often given by local Police Departements or non-profits to educate students on the dangers of driving under the influence and distracted driving. The multi-media presentations include real life accounts of incidents to personalize the impacts.

Campaign Type: Vehicle

Condition Addressed: Driving Under the Influence (DUI)

Benefits

- Can reduce the number of alcohol- and drug-involved crashes.
- Can reduce hit-and-fun crashes.
- Can reduce nighttime crashes
- Can reduce crashes involving drivers using handheld cell phones.

Considerations

- Public relations opportunities and press coverage are needed to raise awareness
- Media campaign may include freeway bulletins, wall boards and posters.
- Campaigns must be sensitive of different groups of people.
- Increased police enforcement may be needed in specific locations to compliment media campaign.

Relative Cost: Unknown

Resource Links
City of Bakersfield Police Department
http://www.bakersfieldcity.us/gov/depts/police/get_involved/a_life_interrupted/default.htm

California Office of Traffic Safety https://www.ots.ca.gov/ots-and-traffic-safety/links/

2.2.7 SAFE STOPPING EDUCATIONAL CAMPAIGN

This type of educational campaign focuses on educating drivers and reinforcing good habits on proper stopping locations near crosswalks to prevent pedestrians from being hit by automobiles.

Campaign Type: Pedestrian

Condition Addressed: Crossing in Crosswalk at Intersection

Benefits

- Can reduce vehicle-pedestrian crashes.
- Can increase the incidence of vehicles yielding to pedestrians.

Considerations

- Public relations opportunities and press coverage are needed to raise awareness
- Media campaign may include freeway bulletins, wall boards and posters.
- Campaigns must be sensitive of different groups of people.
- Increased police enforcement may be needed in specific locations to compliment media campaign.

Relative Cost: Unknown

Resource Links
San Francisco Municipal Transportation Agency (SFMTA)
https://www.sfmta.com/about-sfmta/blog/%E2%80%98it-stops-here%E2%80%99-campaign-safer-streets-wins-communicator-award

https://www.sfmta.com/about-sfmta/blog/safe-streets-sf-0

2.2.8 PEDESTRIAN GAP ACCEPTANCE TRAINING

The purpose of pedestrian gap acceptance training is to help pedestrians learn to make better road crossing decisions, which may reduce the incidence of crossing-related injuries and fatalities. This can include video-based training and feedback geared towards improving pedestrian judgment of speed and/or distance of oncoming traffic.

Campaign Type: Pedestrian

Condition Addressed: Unsafe Speed; Pedestrian Right-of-Way

Benefits

This countermeasure has been examined in few research studies. While there is some evidence that certain approaches may lead to limited positive outcomes, there is insufficient evaluation data available to conclude that the countermeasure is effective.

Considerations

- Environmental treatments such as allowing sufficient time for the pedestrian crossing in signal timing, median refuges, and careful attention to sidewalk accessibility issues are also important to older pedestrians who may have mobility declines.
- May require more than three months for training materials to be developed and integrated into existing educational channels for adult and senior pedestrians.

Relative Cost: Medium

Resource Links
Countermeasures That Work: A Highway Safety Countermeasure Guide for State Highway Safety Offices, Eighth Edition, 2017 https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/documents/812478_countermeasures-that-work-a-highway-safety-countermeasures-guide-.pdf

2.2.9 SHARE THE ROAD AWARENESS

The purpose of Share the Road programs is to increase drivers' awareness of bicyclists, as well as improve both bicyclist and driver compliance with relevant traffic laws.

Campaign Type: Bicycle

Condition Addressed: Rear End

Benefits

Share the Road awareness educational materials can be effective in increasing knowledge and appropriate attitudes, but as with other awareness programs, there is limited evidence of behavior change, and no evidence of reductions in crashes.

Considerations

- Will require at least 6 months to plan and implement.

Relative Cost: Medium

Resource Links
Countermeasures That Work: A Highway Safety Countermeasure Guide for State Highway Safety Offices, Eighth Edition, 2017 https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/documents/812478_countermeasures-that-work-a-highway-safety-countermeasures-guide-.pdf

2.2.10 BICYCLE HELMET ENCOURAGEMENT

The purpose of bicycle helmet promotions is to increase use of helmets and thereby decrease the number of severe and fatal brain injuries to bicyclists involved in crashes. Bicycle helmet promotions are frequent, but are usually aimed at child bicyclists only, often through youth health organizations and schools. Promotions can target various barriers to helmet use, including absence of a helmet, child and families' lack of understanding of the importance of helmet use, and negative attitudes or beliefs about helmet use. Programs that provide helmets can include sponsoring organizations and often involve law enforcement and schools to deliver helmets, fit the helmets, and teach proper fitting and use. Promotions can be conducted through single events or extended campaigns to promote helmet distribution and use.

The Bicycle Helmet Safety Institute has extensive information on helmets, purchasing a helmet, helmet fit, when to buy a new helmet, helmet recalls, and the difference between helmet brands, see www.helmets.org/

Campaign Type: Bicycle

Condition Addressed: Bicycle Right-of-Way

Benefits

- Bicycle helmets are proven to reduce injuries and fatalities.
- Helmet promotions are successful in getting more helmets into the hands of bicyclists.
- May increase helmet wearing rates and commitment to wearing a helmet among adult bicyclists.
- Programs that increase proper use of helmets would be expected to reduce injuries in the event of a bicycle crash.

Considerations

- While bicycle helmet encouragement may be beneficial, mandatory helmet laws for adults have been shown to discourage bicycling overall.
- Must include instruction on how to properly fit the helmet and the importance of wearing helmets on every trip.
- Programs might also need to target differences in tendency to adopt helmet use for different riding purposes (recreational versus commuting).
- Efforts are needed to encourage parents and authority figures (e.g., law enforcement officers, school officials and staff, and health-care professionals) to reinforce and model desired behaviors.
- A good campaign, including market research, material development, and message placement, will require at least 6 months to plan and implement.

Relative Cost: High

Resource Links

Countermeasures That Work: A Highway Safety Countermeasure Guide for State Highway Safety Offices, Eighth Edition, 2017 https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/documents/812478_countermeasures-that-work-a-highway-safety-countermeasures-guide-.pdf

3 | CONCLUSION

This memorandum summarizes the prioritized engineering and non-engineering countermeasures that could be implemented across the City. The prioritization of engineering countermeasures includes 32 Tier 1 countermeasures, which were further grouped into roadway treatments, intersection treatments, and pedestrian/ bicycle treatments. Non-engineering countermeasures include enforcement and education strategies that could complement the engineering projects to reduce the risk of crashes.

Attachment A Complete List of Engineering Countermeasures

CM ID	Sub Type	Countermeasure Name	Documented Crash Reduction Factor (CRF)	Expected Life (Years)	Crash Type (for HSIP applications)	Federal Funding Eligibility (Based on HSIP Cycle 9)	Cost Estimate	Cost Assumptions	Clarifying Details	Priority Tier
NA	Mod.	Install mixing zone treatment	NA	NA	Ped & Bike	N/A	>$2,500 per intersection	combination of treatments	bicyclists.	3
NA	Control	Install parking restrictions at crossing locations	0.3	NA	Ped & Bike	N/A	<$2,500	Assume removal of parking edge line and possibly adding red curb	For all crash types	3
NA	Geometric Mod.	Install protected intersections	NA	NA	Ped & Bike	N/A	$2,500 - $150,000	Cost depends on the amount and type of treatments installed; paint and flexposts vs. concrete	Look for turning crashes involving motorists and pedestrians/bicyclists, also instances of bicyclist riding through signalized intersections	3
NA	Signal Mod.	Install protected signal phases (left-turn/ right-turn arrows)	0.36	NA	Ped & Bike	N/A	$2,500-$150,000	Cost varies depending on signal installation needs; adjusting signal phasing of existing signals is very low cost. Cost increases with the installation of new signals and the complexity of the phasing ($8,000 to $150,000)	Look for turning crashes involving motorists and pedestrians/bicyclists.	3
NA	Geometric Mod.	Upgrade bike facilities (buffered/separated bike lanes)	0.59	NA	Ped & Bike	90%	$50,000-$500,000 per mile	Cost depends on type of treatment installed; use of striping, parking, flexposts, bollards, planters, medians, concrete barriers etc.	Look for turning crashes involving motorists and pedestrians/bicyclists, instances of bicyclsist riding through signalized intersections, and midblock issues like dooring, sideswipes etc.	2
NA	Signal Mod.	Install Leading Pedestrian Interval (LPI)	0.59	NA	Ped & Bike	50%	< $2,500 per signal	Assume pedestrians signals with countdown timers are already available; only need to reprogram. However, the average cost of a countdown timer is $740, and a signal head is $550	Look for turning crashes involving vehicles and pedestrians	1
NA	Operation/ Warning	Install high-visibility crosswalk markings	0.48	NA	Ped & Bike	90%	< $2,500 per crossing	Cost depends on type of markings, materials and widthof crossing	For turning crashes, failure to yield, and motorists/bicyclists running through STOP.	1
NA	Operation/ Warning	Install advance yield lines	0.25	NA	Ped & Bike	90%	< $2,500 per yield line	Asssume striping only	Look for crashes where motorists and/or pedestrians fail to yield. Also where bicyclists ride through STOP sign.	1
NA	Signal Mod.	Install exclusive pedestrian phase (scramble crosswalk)	0.34	NA	Ped & Bike	N/A	< $2,500 for reprogramming	Assume pedestrians signals with countdown timers are already available; only need to reprogram and add striping to intersection.	Look for turning crashes involving vehicles and pedestrians, high pedestrian volumes	3
NA	Signal Mod.	Install bike signal	NA	NA	Ped & Bike	N/A	$5,000-$50,000 per signal	Cost of a single signal head is about $5,000, cost increases with the number of signal heads needed and the addition of loop	Applicable at locations with potential for phase separation between bicycles and motor vehicles, particularly in Class IV bikeways.	3
NA	Signal Mod.	Install Leading Bicycle Interval (LBI)	NA	NA	Ped & Bike	N/A	$5,000-$50,000 per signal	Cost of a single signal head is about $5,000, cost increases with the number of signal heads needed and the addition of loop	Look for turning crashes involving vehicles and bicyclists	3
NA	Control	Install No Right Turn on Red	0.03	NA	Ped & Bike	N/A	<$1,000 per static sign (>$2,500 for dynamic signs)	Cost depends on type of signs used. Static signs costs about $200 each. Dynamic/ electronic	Look for crashes involving right turning motorists and pedestrians/bicyclists	3

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NA	Geometric Mod.	Install curb extensions	NA	NA	Ped & Bike	90%	$2,500-$50,000 per extension	Cost depends on design and materials used; curb extensions using just paint and/or flexposts will be in the lower cost range, while concrete designs will cost	For turning crashes, failure to yield, and motorists/bicyclists running through STOP.	3
NA	Geometric Mod.	Install bike lane extension through intersection	NA	NA	Ped & Bike	90%	< $2,500 per intersection	Cost of installing colored pavement markings depends on surface area of marking and type of material used	Look for crashes where bicyclists cross controlled/uncontrolled motorists. Also where motorists make right/left turns in direction of bicyclists.	3
NA	Operation/ Warning	Install in-street pedestrian crossing signs (R1-6)	NA	NA	Ped & Bike	100%*	< $2,500 per sign	Assume signing only. Cost depends on sign vendor	For crashes involving failure to yield, and motorists/bicyclists running through STOP	3
NA	Signal Mod.	Install passive bicycle signal detection	NA	NA	Ped & Bike	N/A	>$5,000	Cost of detection loops ranges from $1,000 to $7,000. Cost increases with purchase of bike signal heads where there are none (about $5,000 each).	For instances where bicyclists ride through signalized intersections	3
NA	Geometric Mod.	Install two-stage bicycle turn queue box	NA	NA	Ped & Bike	N/A	<$2,500 per box	Cost is approximately $1,000 per box for pavement markings and green thermoplastic	For crashes involving motorists turning right into the bicyclists.	3
NS1	Lighting	Add intersection lighting (NS.I.)	0.4	20	Night	100%	$7000 per Light		Must be night-time crashes, no lighting present.	2
NS10	Operation/ Warning	Improve sight distance to intersection (Clear Sight Triangles)	0.2	10	All	90%	$200-$50000	Could be anything from tree removal ($200) to excavating hillside ($50000)	Pertains to "automobile right of way" crashes -- angle, broadside, etc.	1
NS11	Geometric Mod.	Install splitter-islands on the minor road approaches	0.4	20	All	90%	$10000 per Approach	Assume 100' long raised median (width =5') with 0.5' stamped	Look for minor street with relatively high speed; visibility issues	1
NS12	Geometric Mod.	Install raised median on approaches (NS.I.)	0.25	20	All	90%	$10000 per Approach	Assume 100' long raised median (width =5') with 0.5' stamped	Access management -- look for intersections with turning movement crashes and access in influence area.	2
NS13	Geometric	Create directional median openings to allow (and	0.5	20	All	90%	$20000 per Opening	Assume remove 100' raised median (width=12') with 0.5' AC and 1.5' AB, no curb, gutter, or sidewalk	A cluster of similar turning movement related crashes may indicate a candidate movement to restrict	3
NS14	Geometric Mod.	Install right-turn lane (NS.I.)	0.2	20	All	90%	$20000 per Lane	Assume 200' long right turn lane (width=12') with 0.5' AC and 1.5' AB, no curb, gutter, or sidewalk	Rear-end crashes, crashes associated with following too closely	2
NS15	Geometric Mod.	Install left-turn lane (where no left-turn lane exists)	0.35	20	All	90%	$20000 per Lane	Assume 200' long left turn lane (width=12') with 0.5' AC and 1.5' AB	Look for turning collisions. Cannot be at all-way stop.	2
NS16	Ped and Bike	Install raised medians / refuge islands (NS.I.)	0.45	20	Ped & Bike	90%	$120 per FT	Assume 6' wide median with 0.5' stamped concrete, 1.5' AB and 6" curb	Locations with long crossings, pedestrian crash history, and/or high ped activity.	1
NS17	Ped and Bike	Install pedestrian crossing at uncontrolled locations (new signs and markings only)	0.25	10	Ped & Bike	100%	$2,600 each	Assume four signs and 100' crosswalk pavement marking	For unsignalized intersections with no existing marked crosswalk on an approach.	1
NS18	Ped and Bike	Install pedestrian crossing at uncontrolled locations (with enhanced safety features)	0.35	20	Ped & Bike	100%	$60,000-160,000 each	Assume flashing beacon or similar enhanced warning device	For unsignalized intersections with no existing marked crosswalk on an approach.	1
NS19	Ped and Bike	Install pedestrian signal or HAWK	0.55	20	Ped & Bike	100%	$83,300 per System		Viability depends on existence of nearby locations to cross, and whether the roadway is wider/higher-speed than where an RRFB or equivalent may suffice.	1

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NS2	Control	Convert to all-way STOP control (from 2-way or Yield control)	0.5	10	All	100%	$2800 per Intersection		None	2
NS20	Operation/ Warning	Improve pavement friction (High Friction Surface Treatments)	0.4	10	All	100%	$1 per SF	Based on Caltrans Cost Data for Sand Cover (Seal)	Wet-pavement condition crashes or "failure to stop" crashes	2
NS3	Control	Install signals	0.25	20	All	100%	$278,400 per Intersection	Assumes 4-leg intersection	None	3
NS4A	Control	Convert intersection to roundabout (from all way stop)	0.5	20	All	100%	$4000000-$8000000 per Intersection	Source: https://safety.fhwa.dot.gov/intersection/innovative/roundabouts/case_studies/fhwasa09018/	None	3
NS4B	Control	Convert intersection to roundabout (from stop or yield control on minor road)	0.5	20	All	100%	$4000000-$8000000 per Intersection	Source: https://safety.fhwa.dot.gov/intersection/innovative/roundabouts/case_studies/fhwasa09018/	CRF varies based on ADT, location type, and roundabout type.	3
NS5	Operation/ Warning	Install/upgrade larger or additional stop signs or other intersection warning/regulatory signs	0.15	10	All	100%	$500 per Sign	Cost is to manufacture and install sign. Assume one post sign.	Rear-end, right angle, or turning collisions -- indicating visibility of stop presence	1
NS6	Operation/ Warning	Upgrade intersection pavement markings (NS.I.)	0.25	10	All	100%	$4,000 per Intersection		Rear-end, right angle, or turning collisions -- indicating visibility of stop presence	1
NS7	Operation/ Warning	Install Flashing Beacons at Stop-Controlled Intersections	0.15	10	All	100%	$103,800 per Intersection	Assumes 4-leg intersection	Look for turning collisions -- or PCF of "traffic signals and signs"	4
NS8	Operation/ Warning	Install flashing beacons as advance warning (NS.I.)	0.3	10	All	100%	$39,600 per Approach		Rear-end, right angle, or turning collisions -- indicating visibility issues of intersection.	4
NS9	Operation/ Warning	Install transverse rumble strips on approaches	0.2	10	All	90%	$600 per Approach	Assume ground in rumble strip	Rear-end, right angle, or turning collisions -- indicating visibility issues of intersection.	1
R1	Lighting	Add segment lighting	0.35	20	Night	100%	$7000 per Light		Night crashes, particularly rear-end, right-angle, turning or roadway departure collisions. Consider impact to visibility for non-motorists.	2
R10	Geometric Mod.	Install median (flush)	0.15	20	All	90%	$100 per FT	Assume 12' wide median with 0.5' AC, 1.5' AB, and striping	Applicable where lanes can be restriped at thinner width.	3
R11	Geometric Mod.	Install acceleration/ deceleration lanes	0.25	20	All	90%	$100 per FT	Assume 12' wide lane with 0.5' AC, 1.5' AB, and striping	Check for indication that merging vehicles are traveling at different speed from through traffic. For exiting traffic check if turn queues are backing up into adjacent through lanes.	3
R12	Geometric Mod.	Install climbing lane (where large difference between car and truck speed)	NA	NA	NA	Not Eligible	$2000 per FT	Assume 12' wide lane with 0.5' AC, 1.5' AB, and striping	None	4
R13	Geometric Mod.	Widen lane (initially less than 10 ft)	0.25	20	All	90%	$10 per FT added width per FT lane	Assume 0.5' AC, 1.5' AB, and striping	Look for cases of lane departure, sideswipe or head-on crashes and lane widths of less than 10 ft. Common at horizontal curves. Viewed as high cost / high potential benefit strategy.	3
R14	Geometric Mod.	Add two-way left-turn lane (without reducing travel lanes)	0.3	20	All	90%	$100 per FT	Assume 12' wide lane with 0.5' AC, 1.5' AB, and striping	Applicable in cases where high frequency of drivers being rear-ended while turning left across traffic.	3
R15	Geometric Mod.	Road Diet (Reduce travel lanes from 4 to 3 and add a two way left-turn and bike lanes)	0.3	20	All	90%	$69 per FT	Assume restriping only	Appropriate for high frequency of head-on, left-turn, and rear-end crashes that can be handled with only 2 free flow lanes (cut-off for volumes not defined in guidance). If corresponding signal changes are minor, should be considered part of this CM.	1
R16	Geometric Mod.	Widen shoulder (paved)	0.3	20	All	90%	$10 per FT added width per FT lane	Assume 0.5' AC, 1.5' AB, and striping	Consider if shoulder is needed for safe passage around vehicles that are pulled to edge of road.	1

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R17	Geometric Mod.	Widen shoulder (unpaved)	0.2	20	All	90%	$3 per FT added width per FT lane	Assume 0.5' AB with grading	Roadway departure crashes	1
R18	Geometric Mod.	Pave existing shoulder	0.15	20	All	90%	$6 per FT added width per FT lane	Assume 0.5' AC, 1.5' AB, and striping (no grading)	None	2
R19	Geometric Mod.	Improve horizontal alignment (flatten curves)	0.5	20	All	90%	$250000-$500000 per Curve	Assume reconstructing 1000' long curve. Cost range covers different types of terrain	Consult "Notes" field.	3
R2	Remove/ Shield Obstacles	Remove or relocate fixed objects outside of Clear Recovery Zone	0.35	20	All	90%	$200-$10000 per Object	Could be anything from tree removal ($200) to utility pole relocation ($10000)	Need to reference Caltrans' HDM or limits of clear recovery zone. Goal of minimizing harm to riders if vehicle leaves road.	1
R20	Geometric Mod.	Flatten crest vertical curve	0.25	20	All	90%	$250000-$500000 per Curve	Assume reconstructing 1000' long curve. Cost range covers different types of terrain	Consult "Notes" field.	3
R21	Geometric Mod.	Improve horizontal and vertical alignments	0.6	20	All	90%	$250000-$500000 per Curve	Assume reconstructing 1000' long curve. Cost range covers different types of terrain	Agency must already have pursued and installed lower cost CMs at this location.	3
R22	Geometric Mod.	Improve curve superelevation	0.45	20	All	90%	$250000 per Curve	Assume reconstructing 1000' long curve	Frequent lane departures, also look at speeding	3
R23	Geometric Mod.	Convert from two-way to one-way traffic	0.35	20	All	90%	$55 per FT	Assume restriping only with signs	None	3
R24	Geometric Mod.	Improve pavement friction (High Friction Surface Treatments)	0.4	10	All	100%	$1 per SF	Based on Caltrans Cost Data for Sand Cover (Seal)	Wet-pavement condition crashes or "failure to stop" crashes	1
R25	None listed	Provide Tapered Edge for Pavement Drop-off	NA	NA	NA	Not Eligible	$5 per FT		None	3
R26	Operation/ Warning	Install/Upgrade signs with new fluorescent sheeting (regulatory or warning)	0.15	10	All	100%	$500 per Sign	Cost is to manufacture and install sign. Assume one post sign.	Intended to enhance existing signage -- Only eligible as part of a larger sign audit project. See 'notes' for more details.	1
R27	Operation/ Warning	Install chevron signs on horizontal curves	0.4	10	All	100%	$500 per Sign	Cost is to manufacture and install sign. Assume one post sign.	Consider appropriate combinations with other CMs.	1
R28	Operation/ Warning	Install curve advance warning signs	0.25	10	All	100%	$500 per Sign	Cost is to manufacture and install sign. Assume one post sign.	Consider appropriate combinations with other CMs.	1
R29	Operation/ Warning	Install curve advance warning signs (flashing beacon)	0.3	10	All	100%	$16,600 each		Consider appropriate combinations with other CMs.	1
R3	Remove/ Shield Obstacles	Install Median Barrier	0.25	20	All	100%	$150 per FT		Targeted towards avoiding head-on collisions / minimizing severity.	3
R30	Operation/ Warning	Install dynamic/variable speed warning signs	0.3	10	All	100%	$43,600 each		Curved roadways -- Consider appropriate combinations with other CMs.	1
R31	Operation/ Warning	Install delineators, reflectors and/or object markers	0.15	10	All	100%	$75 each		Curved roadways and roadways with fixed object crashes -- consider combining with other appropriate CMs.	1

CM ID	Sub Type	Countermeasure Name	Documented Crash Reduction Factor (CRF)	Expected Life (Years)	Crash Type (for HSIP applications)	Federal Funding Eligibility (Based on HSIP Cycle 9)	Cost Estimate	Cost Assumptions	Clarifying Details	Priority Tier
R32	Operation/ Warning	Install edge-lines and centerlines	0.25	10	All	100%	$4 per FT		Run-off road or wrong side of road crashes -- anywhere that the delineation is not obvious and helpful to drivers	1
R33	Operation/ Warning	Install no-passing line	0.45	10	All	100%	$4 per FT		Head-on crashes or crashes resulting from passing maneuvers.	3
R34	Operation/ Warning	Install centerline rumble strips/stripes	0.2	10	All	100%	$10 per FT		Consider impact to bicyclists of rumble strips.	3
R35	Operation/ Warning	Install edgeline rumble strips/stripes	0.15	10	All	100%	$10 per FT		Consider impact to bicyclists of rumble strips.	1
R36	Ped and Bike	Install bike lanes	0.35	20	Ped & Bike	90%	$50 per FT	Assume 5' wide lane with 0.5' AC, 1.5' AB, and striping	None	1
R37	Ped and Bike	Install sidewalk/pathway (to avoid walking along roadway)	0.8	20	Ped & Bike	90%	$25 per FT	Assume 5' wide path with 0.33' AC, 0.5' AB or 5' wide concrete 0.33' thick	None	1
R38	Ped and Bike	Install pedestrian crossing (with enhanced safety features)	0.3	10	Ped & Bike	90%	$60,000-160,000 each	Assume flashing beacon or similar enhanced warning device	None	1
R39	Ped and Bike	Install raised pedestrian crossing	0.35	10	Ped & Bike	90%	$5000 each	http://guide.saferoutesinfo.org/engineering/raised_pedestrian_crosswalks.cfm	None	1
R4	Remove/ Shield Obstacles	Install Guardrail	0.25	20	All	100%	$100 per FT		Benefit measured as reduction in severity relative to vehicle leaving roadway.	2
R40	Animal	Install animal fencing	0.8	20	Animal	90%	$80 per FT		None	3
R41	None listed	Install Truck Escape Ramp	NA	NA	NA	Not Eligible	$40000 each	Assume 800' long truck escape ramp (width=12') with 1' AB	None	4
R42	Geometric Mod.	Install pedestrian median fencing on approaches	0.35	20	Ped & Bike	90%	$100 per FT		None	4
R5	Remove/ Shield Obstacles	Install impact attenuators	0.25	10	All	100%	$5000 each		Valuable in cases where fixed object cannot be moved. Benefit measurement depend on whether new or upgrade/replacement. Upgrade/replacement is valued only on value relative to existing attenuator.	2
R6	Remove/ Shield Obstacles	Flatten side slopes	0.3	20	All	90%	$500 per FT	Assumes flattening 5' high embankment from 2:1 to 4:1 slope	Treatment is for drop-offs (not steep inclines).	3
R7	Remove/ Shield Obstacles	Flatten side slopes and remove guardrail	0.4	20	All	90%	$2000 per FT	Assumes flattening 10' high embankment from 2:1 to 4:1 slope	If it is possible to remove guardrail and dangerous conditions beyond guardrail, this generally results in safer conditions than maintaining guardrail.	3
R8	Remove/ Shield Obstacles	Upgrade Bridge Railing	NA	NA	NA	Not Eligible	$250 per FT	Assume concrete barrier	None	3
R9	Geometric Mod.	Install raised median	0.25	20	All	90%	$200 per FT	Assume 12' wide median with 0.5' stamped concrete, 1.5' AB and 6" curb	Application of raised medians on roadways with higher speeds is not advised. Including landscaping can be counterproductive to safety goals. Effective for eliminating unsafe turning movements.	3
S1	Lighting	Add intersection lighting (S.I.)	0.4	20	Night	100%	$7000 per Light		Must be night-time crashes, no lighting present.	2
S10	[None listed]	Install cameras to detect red-light running	N/A	N/A	N/A	Not Eligible	$80000 per System		Look for "Traffic signals and signs" crashes at signalized intersections.	3
S11	Operation/ Warning	Improve pavement friction (High Friction Surface Treatments)	0.4	10	All	100%	$1 per SF	Based on Caltrans Cost Data for Sand Cover (Seal)	Wet-pavement condition crashes or "failure to stop" crashes	2

CM ID	Sub Type	Countermeasure Name	Documented Crash Reduction Factor (CRF)	Expected Life (Years)	Crash Type (for HSIP applications)	Federal Funding Eligibility (Based on HSIP Cycle 9)	Cost Estimate	Cost Assumptions	Clarifying Details	Priority Tier
S12	Geometric Mod.	Install raised median on approaches (S.I.)	0.25	20	All	90%	$10000 per Approach	Assume 100' long raised median (width =5') with 0.5' stamped concrete, 1.5' AB and 6" curb	Applicable for turning-movement crashes related to access points near an intersection.	2
S13	Geometric Mod.	Create directional median openings to allow (and restrict) left-turns and u-turns (S.I.)	0.5	20	All	90%	$20000 per Opening	Assume remove 100' raised median (width=12'), and add 100'	A clustering of similar turning movement-related crashes may indicate a candidate movement to restrict.	2
S14	Geometric Mod.	Install right-turn lane (NS.I.)	NA	NA	NA	Not Eligible	$20000 per Lane	Assume 200' long right turn lane (width=12') with 0.5' AC and 1.5' AB, no curb, gutter, or sidewalk	Look for multiple rear-end collisions on an approach associated with turning or slowing vehicles.	3
S15	Geometric	Install left-turn lane (signal has no left-turn phase -- before and after)	NA	NA	NA	Not Eligible	$20000 per Lane	Assume 200' long left turn lane (width=12') with 0.5' AC and 1.5'	Look for multiple rear-end crashes on approach associated with stopping or slowing vehicles.	3
S16	Geometric Mod.	Install left-turn lane (signal has a left-turn phase -- before and after)	NA	NA	NA	Not Eligible	$25000 per Lane	Assume 200' long left turn lane (width=12') with 0.5' AC and 1.5' AB. Install vehicle detectors and move signal head	Look for multiple rear-end crashes on approach associated with stopping or slowing vehicles.	3
S17	Geometric Mod.	Install left-turn lane and add turn phase (signal has no left-turn lane or phase before)	0.55	20	All	90%	$50000 per Lane	Assume 200' long left turn lane (width=12') with 0.5' AC and 1.5' AB. Install vehicle detectors, signal equipment, and signal programing	Look for rear-end crashes and/or crashes involving non-motorized users (driver may be looking for gaps and not paying attention to pedestrian).	2
S18	Geometric Mod.	Convert intersection to roundabout (from signal)	0.5	20	All	100%	$4000000-$8000000 per Intersection	Source: https://safety.fhwa.dot.gov/intersection/innovative/roundabouts/case_studies/fhwasa09018/	Significant crash history, complex geometry.	2
S19	Ped and Bike	Install pedestrian countdown signal heads	0.25	20	Ped & Bike	100%	$1,800		For marked crossings with no pedestrian countdown indicator.	1
S2	Signal Mod.	Improve signal hardware: lenses, back-plates, mounting, size, and number	0.15	10	All	100%	$1500 per Signal Head		Applicable with high frequency of right-angle or read-end crashes that can be attributed to signal visibility.	1
S20	Ped and Bike	Install pedestrian crossing (S.I.)	0.25	20	Ped & Bike	100%	$8,200	striping and push button	For signalized intersections with no existing marked crosswalk on an approach.	1
S21	Ped and Bike	Install advance stop bar before crosswalk (Bicycle Box)	0.15	10	Ped & Bike	100%	$9,200		None	2
S22	Ped and Bike	Install pedestrian overpass/underpass	NA	NA	Ped & Bike	Not Eligible	$1000000-$300000 each		None	3
S23	Geometric Mod.	Install pedestrian median fencing on approaches	0.35	20	Ped & Bike	90%	$100 per FT		None	4
S3	Signal Mod.	Improve signal timing (coordination, phases, red, yellow, or operation)	0.15	10	All	50%	$5000 per Intersection		Applicable with multiple signalized intersections with crash history.	3
S4	Signal Mod.	Provide Advanced Dilemma Zone Detection for high speed approaches	0.4	10	All	100%	$5,600 per System		Applicable with rear-end crashes associated with unsafe stopping and angle crashes based on red-light running.	3
S5	Signal Mod.	Install emergency vehicle pre-emption systems	0.7	10	Emergency vehicle	100%	$6000 per System		Only applies to emergency vehicle crashes.	3
S6	Signal Mod.	Provide protected left turn phase (left turn lane already exists)	0.3	20	All	100%	$35,100 per Lane	Install vehicle detectors, signal equipment, and signal programing	Applicable to crashes involving left-turning vehicles -- may be angle, head-on, sideswipe or rear end. Also may include pedestrian crashes.	2
S7	Signal Mod.	Convert signal to mast arm (from pedestal-mounted)	0.3	20	All	100%	$32,400 per Signal		Must be on based on crashes on approach with pedestal-mounted signal; look for right-angle and rear-end crashes.	3
S8	Operation/ Warning	Install raised pavement markers and striping (Through Intersection)	0.1	10	All	100%	$2,200 per Intersection	Assume 100' wide intersection, 8 stripes with markers at $2/ft	Beneficial for intersections with large footprints and/or multiple turn lanes on an approach.	3
S9	Operation/ Warning	Install flashing beacons as advance warning (S.I.)	0.3	10	All	100%	$16,600 per Approach		None	4

Attachment B Cost Assumptions

Cost Assumptions for Tier 1 Locations

Note: Not all cost breakdowns for Tier 1 locations are provided below.

S19: Install Pedestrian Countdown Signal Heads

Sig Hardware	Ped Head	EA	$1,000.00	1	$1,000.00
Conductor Splicing		EA	$500.00	1	$500.00
Contingency			15.00%		$300.00
Total Cost					**$1,800.00**

S20: Install Pedestrian Crossing (S.I.)

Sig Hardware	Ped Head	EA	$1,000.00	2	$2,000.00
	ADA Ped PPB	EA	$500.00	2	$1,000.00
Poles	PPB Post	EA	$500.00	2	$1,000.00
Cards	222 Cards	EA	$200.00	1	$200.00
Cables	5c Signal Cable	LF	$2.00	175	$350.00
	3c Signal Cable	LF	$1.75	175	$306.25
Conductor Splicing		EA	$1,000.00	1	$1,000.00
Striping	12" White	LF	$6.00	200	$1,200.00
Contingency			15.00%		$1,100.00
Total Cost					**$8,200.00**

NS6: Upgrade Intersection Pavement Markings (N.S.I.)

Signs/Markings	Stop Marking	EA	$550.0	4	$2,200.0
Striping	12" White	LF	$6.0	200	$1,200.0
Contingency			15.00%		$600.00
Total Cost					**$4,000.0**

NS17: Install Pedestrian Crossing at Uncontrolled Locations

Signs/Markings	Install W11-2 Sign and Post	EA	$400.0	2	$800.00
	W16-7P	EA	$100.0	2	$200.00
Striping	12" White	LF	$6.0	200	$1,200.0
Contingency			15.00%		$400.00
Total Cost					**$2,600.00**

NS18: Install Pedestrian Hybrid Beacon

PHB Estimate from 008-004					
Trenching/Conduit		LF	$26.00	200	$5,200.00
Foundations	Controller	EA	$2,500.00	1	$2,500.00
	Service Enclosure	EA	$500.00	1	$500.00
	Mast Arm Pole	EA	$4,700.00	2	$9,400.00
Pull Boxes	No. 5E	EA	$500.00	1	$500.00
	No. 6E	EA	$1,500.00	4	$6,000.00
Poles	35' MA	EA	$8,500.00	2	$17,000.00
Sig Hardware	12"x3 Head	EA	$1,000.00	6	$6,000.00
	Luminaires	EA	$500.00	2	$1,000.00
	ADA Ped PPB	EA	$500.00	2	$1,000.00
	Ped Head	EA	$1,000.00	2	$2,000.00
Signs	Misc Mast Arm Sign	EA	$350.00	6	$2,100.00
Control	Cabinet & Controller	EA	$10,000.00	1	$10,000.00
	Service Enclosure	EA	$2,500.00	1	$2,500.00
	Photoelectric Unit Control	EA	$50.00	1	$50.00
ITS	Astro-brack and pole (MT-PEL-1)	EA	$265.00	6	$1,590.00
Conductors	Installed and Spliced	LS	$5,000.00	1	$5,000.00
Contingency			15.00%		$10,900.00
Total Cost					**$83,300.00**

R15: Road Diet

Cost Estimate:

KAI59	Using 300' Distance and 70' Road Width						
	Remove Exist. Striping		Stripes	LF	$2.00	900	$1,800.00
	New Striping		Stripes	LF	$2.00	1800	$3,600.00
	Type IV Arrow			EA	$500.00	2	$1,000.00
	Bike Lane Marking			EA	$500.00	2	$1,000.00
	Slurry Seal			SF	$0.50	21000	$10,500.00
	Contingency				15.00%		$2,700.00
							$20,600.00
	Total Cost	Total divided by 300'					**$69.00**

R29: Install Curve Advance Warning Signs (Flashing beacon)

Cost Estimate:

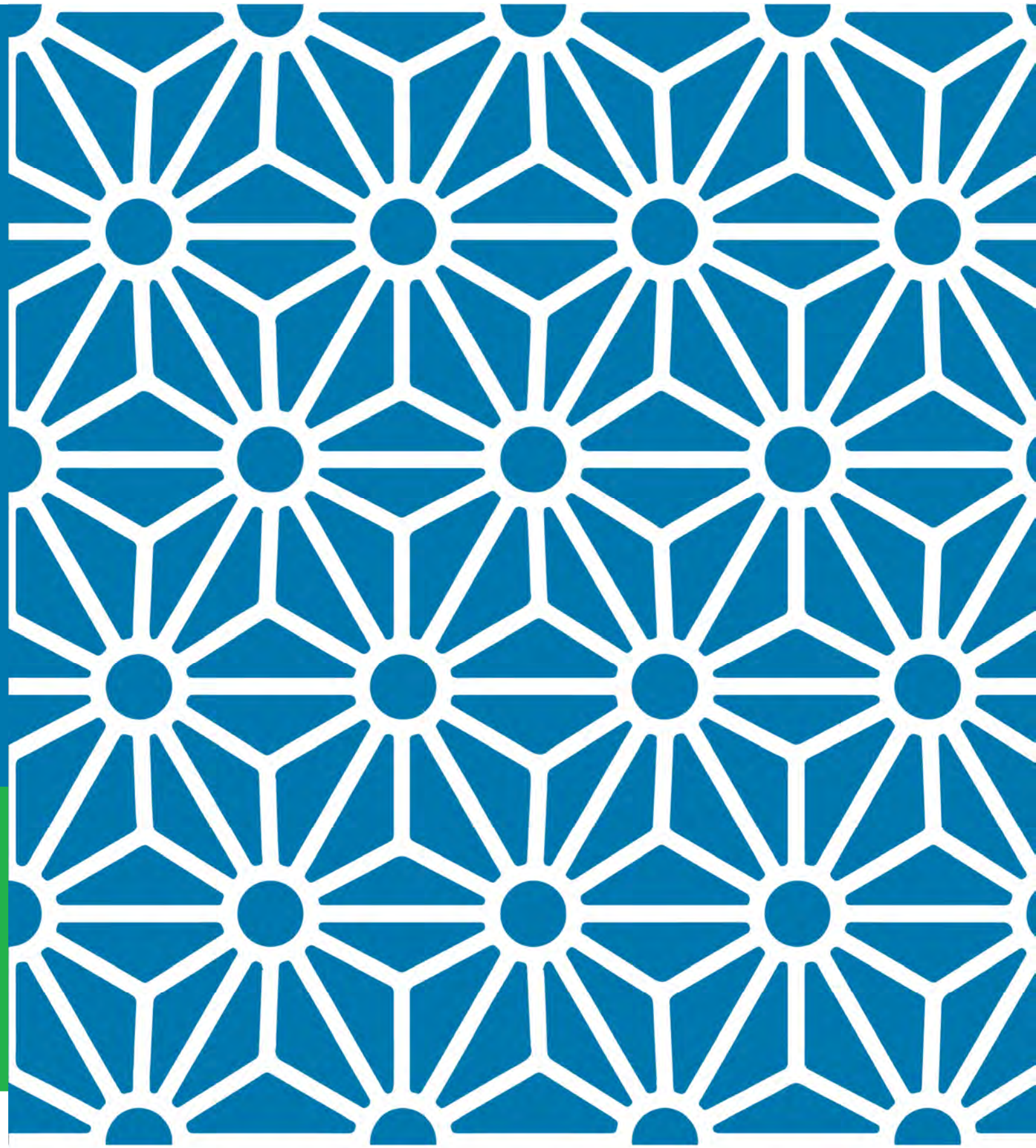
KAI73	Trenching/Conduit		LF	$36.00	100	$3,600.00
	Pull Boxes	No. 5ET	EA	$650.00	4	$2,600.00
	Poles	1-B	EA	$1,000.00	2	$2,000.00
	Sig Hardware	12"x1 Head	EA	$500.00	4	$2,000.00
	Foundations	1-B/A Poles	EA	$1,100.00	2	$2,200.00
	Conductor Splicing		EA	$2,000.00	1	$2,000.00
	Contingency			15.00%		$2,200.00
	Total Cost					**$16,600.00**

R30: Install Dynamic/ Variable Speed Warning Signs

Cost Estimate:

KAI74	Trenching/Conduit		LF	$25.00	500	$12,500.00
	Pull Boxes	No. 5ET	EA	$650.00	5	$3,250.00
	Poles	1-B	EA	$1,000.00	1	$1,000.00
	Sig Hardware	Speed Feedback Sign	EA	$4,000.00	1	$4,000.00
	Foundations	1-B/A Poles	EA	$1,100.00	1	$1,100.00
	PG&E POS		EA	$15,000.00	1	$15,000.00
	Conductor Splicing		EA	$1,000.00	1	$1,000.00
	Contingency			15.00%		$5,700.00
	Total Cost					**$43,600.00**

Attachment B: Cost Estimates and Benefit-Cost Calculations



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