Presented by

Kimley»Horn

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CITY OF MILPITAS

CITYWIDE TRAVEL SAFETY PLAN

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FINAL

PREPARED FOR:

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CITY OF MILPITAS

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STATUTORY NOTICE

23 U.S.C. § 409: US Code - Section 409: Discovery and admission as evidence of certain reports and surveys

Notwithstanding any other provision of law, reports, surveys, schedules, lists, or data compiled or collected for the purpose of identifying, evaluating, or planning the safety enhancement of potential accident sites, hazardous roadway conditions, or railway- highway crossings, pursuant to sections 130, 144, and 148 of this title or for the purpose of developing any highway safety construction improvement project which may be implemented utilizing Federal-aid highway funds 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 mentioned or addressed in such reports, surveys, schedules, lists, or data.

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LIST OF ACRONYMS

AASHTO	American Association of State Highway and Transportation Officials
ADT	Average Daily Traffic
ARIDE	Advanced Roadside Impaired Driving Enforcement
Caltrans	California Department of Transportation
CCR	Critical Crash Rate
CHP	California Highway Patrol
CMF	Crash Modification Factor
CRF	Crash Reduction Factor
DRE	Drug Recognition Expert
EPDO	Equivalent Property Damage Only
FHWA	Federal Highway Administration
GIS	Geographic Information System
HFST	High Friction Surface Treatment
HSM	Highway Safety Manual
K+SI	Fatal and Severe Injury Crashes
NHTSA	National Highway Traffic Safety Administration
PDO	Property Damage Only
RRFB	Rectangular Rapid Flashing Beacon
SHSP	Strategic Highway Safety Plan
SWITRS	Statewide Integrated Traffic Records System

1. INTRODUCTION

The City of Milpitas' Citywide Travel Safety Plan has several notable purposes. The first is to identify traffic safety improvements based on a review of crash data and input from City staff, stakeholders, and the community. This project also provides the City with a foundation for a decision-making framework so that it can identify, prioritize, and implement proven safety countermeasures from the City's toolbox in the following years. This report can also serve as an ongoing resource as City staff identify and pursue funding through various programs to implement the identified safety improvements.

This Citywide Travel Safety Plan summarizes the existing safety context for the City of Milpitas based on crash records obtained from the California Highway Patrol (CHP) Statewide Integrated Traffic Records System (SWITRS) database. This data has been used to identify Citywide safety trends, high-crash locations, and locations with unusual crash patterns or high-crash severities. The analysis was conducted using a network screening process for the City-maintained roadway system using crash records spanning a five-year period from January 1, 2017 through December 31, 2021. Section 3 of the report describes the analysis techniques that were used and why these methods were chosen.

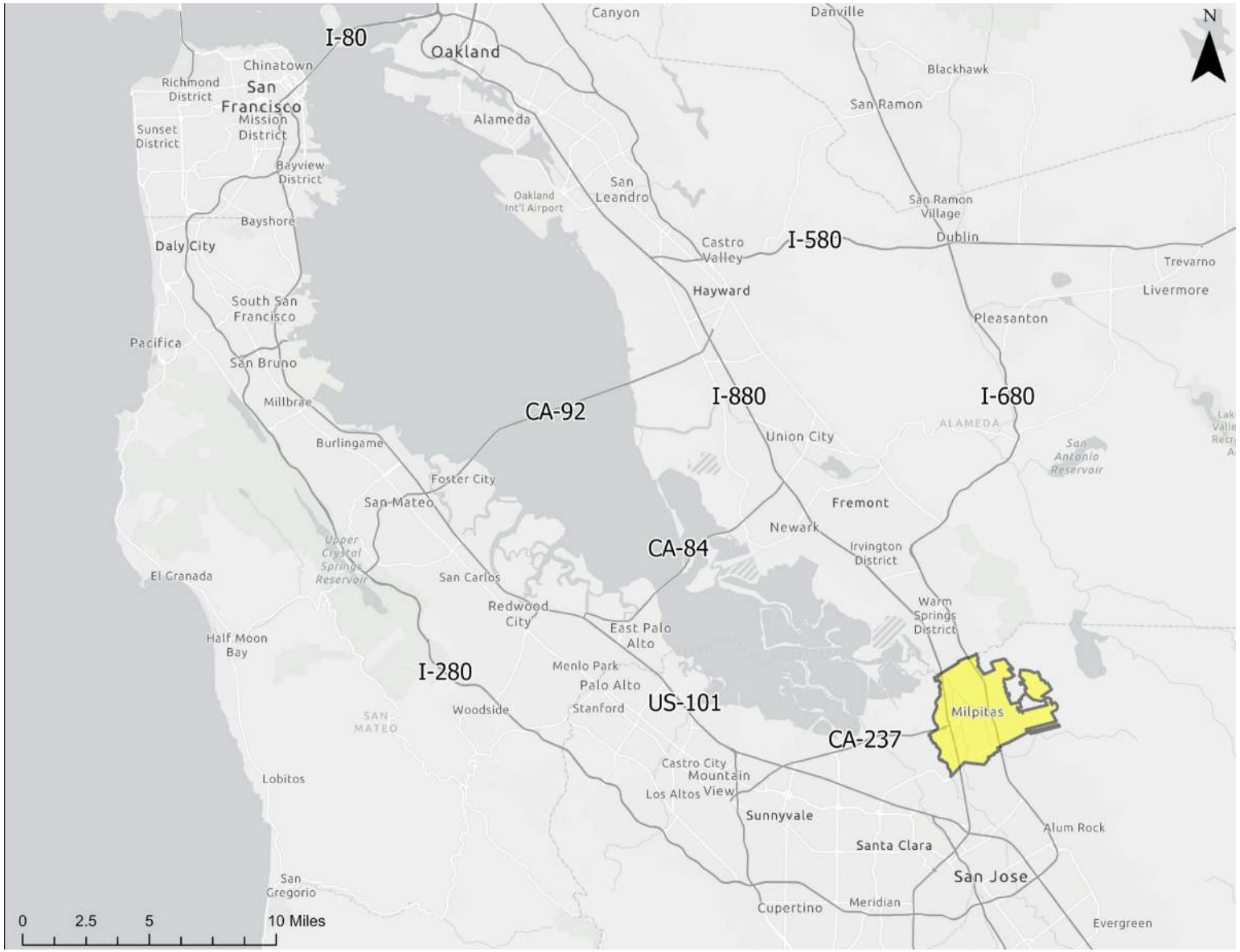
1.1. Background

The City of Milpitas is located in the Bay Area in northern California and is the northeastern gateway to Santa Clara County (see **Figure 1**). Situated north of San Jose, Milpitas residents live within 15 miles of technology employers within the Silicon Valley. Milpitas is home to over 80,000 residents (as of 2020). There are two high schools serving Milpitas residents: Milpitas High School and Calaveras Hills High School. Major retail destinations within the City include the Great Mall Shopping Center, McCarthy Ranch, Milpitas Square, and The Seasons Marketplace. Milpitas is home to many jobs, with the largest employers being Cisco Systems, KLA Corporation, Flex, Western Digital (SanDisk), and Linear Technology.

Milpitas has a vast transportation network that ranges from local access via neighborhood streets and collectors, to regional access via freeways and expressways through the City. Interstate 880 (I-880) runs north-south through the western portion of the City and connects Alameda County to Silicon Valley. Interstate 680 (I-680) runs north-south through the eastern portion of the City and connects Contra Costa County to Silicon Valley. Used as a primary connector for regional traffic, Calaveras Boulevard (State Route 237) runs east-west between I-880 and I-680 and approximately 80% of the trips do not start or end in Milpitas. State Route 237 (SR-237), which begins in the City of Milpitas, connects to US-101 and El Camino Real in the Peninsula. Due to its location, the I-880 and SR-237 interchange is often congested during peak periods of travel, resulting in vehicle queues and delay onto City streets. Other major roadways in Milpitas providing regional traffic include Montague Expressway and Great Mall Parkway/ Tasman Drive/Capitol Avenue.

For public transportation, BART recently opened the Milpitas BART Station in June 2020, which provides access to the rest of the BART network, which serves major cities such as San Francisco, Oakland, Fremont, Dublin/ Pleasanton, Richmond, and Pittsburg. The Santa Clara Valley Transportation Authority (VTA) also provides light rail train and bus service in Milpitas, connecting the City to the rest of Santa Clara County.

Figure 1: Location of Milpitas



1.2. Commute Patterns

Based on the US Census Bureau American Community Survey (ACS) data from 2017-2021, the City of Milpitas has the following commute trends:

1.2.1. Commute modes

Mode of Travel	%
Motorcycle	0.2%
Taxi	0.3%
Bicycle	0.3%
Work From Home	15.3%
Other Transit	0.7%
Walk	0.7%
Public Transit	2.6%
Drive (carpool)	11.0%
Drive (alone)	68.9%

Source: US Census Bureau ACS 5-year 2017-2021

The majority of the working population in Milpitas drive to work alone. An additional 11% of the working population will carpool to work and 15% or the working population will work from home. Therefore, less than 5% of the working population will use alternative modes of transportation to driving a car (both alone and carpool).

1.2.2. Commute Travel Time

Commute Time to Work	%
Less than 5 minutes	0.8%
5 to 9 minutes	5.3%
10 to 14 minutes	12.1%
15 to 19 minutes	16.1%
20 to 24 minutes	16.1%
25 to 29 minutes	6.5%
30 to 45 minutes	25.4%
45 to 60 minutes	9.1%
60 to 89 minutes	6.1%
More than 90 minutes	2.5%

Source: US Census Bureau ACS 5-year 2017-2021

As shown above, the median travel time for Milpitas residents is 25 minutes, with over 55% of residents having a commute travel time of less than 30 minutes.

This report is organized into the following sections:

- **Section 1** presents an introduction to the technical memorandum.
- **Section 2** presents the data sources used in the analysis.
- **Section 3** describes the guiding materials and analysis techniques for the data analysis.
- **Section 4** provides a summary of safety trends.
- **Section 5** provides an overview of the public engagement process.
- **Section 6** presents a summary of the online community engagement feedback.
- **Section 7** includes potential engineering and non-infrastructure countermeasures.
- **Section 8** lists the priority locations identified and the recommended countermeasures.
- **Section 9** describes how the safety plan can be implemented and monitored.
- **Appendices**

2. DATA SOURCES

The following data was obtained from the City for use in crash data analysis.

2.1. Roadway Network

The crash analysis, which is described in detail in **Section 3 (Data Analysis)**, used California Department of Transportation's (Caltrans') roadway classification system. The roadway network classification was assigned to each corridor roadway segment as either a major arterial, minor arterial, collector, or local road to develop crash rates specific to the functional design and capacity. Comparative statistics were stratified by roadway classification (i.e., only major arterials are compared to major arterials).

2.2. Intersections

Intersections throughout the City were grouped by control type as either signalized or non-signalized. The safety analysis is similarly stratified with similar control types (i.e., signalized intersections are only compared to signalized intersections). Note that intersection crashes include those which reportedly occurred within a 250-foot radius of the intersection; all other crashes are considered to be segment crashes in the safety data analysis.

2.3. Crashes

Crash data for the five-year period from January 1, 2017 through December 31, 2021 was used for the network screening analysis. Using data for the past five-year period is sufficient in identifying potential trends in crashes by location and type, while not being outdated as to have data that would include long-term technology and cultural changes. The Transportation Injury Mapping System (TIMS), maintained by the Safe Transportation Research and Education Center (SafeTREC) at UC Berkeley, maps all injury crashes in California using data obtained through SWITRS. This dataset includes injury crashes but does not include property damage only (PDO) crashes. The latest data available from SWITRS was used in this analysis (ending in December 2021) as it typically takes CHP 12-18 months to upload and process the crash data.

In total, 928 crashes were reported on the City's transportation network from January 1, 2017 to December 31, 2021. These crash records contained GPS data and were used in the statistical analysis.

2.4. Annual Average Daily Traffic

Traffic volume data was collected in 2022 as part of the City's Traffic Modeling and Operations Analysis. This data included average daily traffic (ADT) values for roadway segments throughout the City for use in development of crash rates.

3. DATA ANALYSIS

Using a network screening process, locations within the City that would most likely benefit from safety enhancements were identified. The outcome of this analysis helps inform the identification and prioritization of engineering and non-infrastructure safety countermeasures that are most likely to improve roadway safety in the City of Milpitas. This method was selected because it is well established and condusive to large-scale safety analyses, such as citywide safety assessments.The network screening process ranks intersections and roadway segments by the number of crashes that occurred at each location over the analysis period, and then identifies areas that had more of a given type of crashes than would be expected for that type of location. Analysis methods such as the critical crash rate and equivalent property damage only were also used to determine crash frequency and severity at each location. Using historic crash data, crash risk factors for the entire City were explored. The following sections describe the data analysis process.

3.1. Guiding Materials

3.1.1. Local Roadway Safety Manual

The purpose of *Local Roadway Safety Manual: A Manual for California's Local Road Owners* (Version 1.6, April 2022) is to encourage local agencies to pursue a proactive approach to identifying and analyzing safety issues, while preparing to compete for project funding opportunities. A proactive approach is defined as analyzing the safety of the entire roadway network by through either a one-time, network wide analysis, or by routine analyses of the roadway network.[1]

These methods are focused on identifying systemic issues that can be addressed through countermeasures that are applied more universally than just applying spot treatments every time there is a crash. This process aims to match the identified issues with potential countermeasures. Each countermeasure comes with a Crash Modification Factor (CMF), a multiplicative factor used to compute the number of expected crashes after the implementation of a given countermeasure. The CMFs are used to calculate benefit/cost ratios.

3.1.2. Highway Safety Manual

The first edition of the *Highway Safety Manual* (HSM) was published by the American Association of State Highway and Transportation Officials (AASHTO) in 2010. The HSM presents numerous methods for quantitatively estimating the frequency and severity of crashes at a variety of road and intersection types.[2] This four-part manual is divided into Parts: A) Introduction, Human Factors, and Fundamentals, B) Roadway Safety Management Process, C) Predictive Method, D) Crash Modification Factors.

Chapter 4 of Part B of the HSM discusses the Network Screening process. The Network Screening Process is a tool for an agency to analyze their entire network and identify/rank locations that (based on the implementation of a countermeasure) are most likely to least likely to realize a reduction in the frequency of crashes.

The HSM identifies five steps in this process:[3]

1. **Establish Focus:** Identify the purpose or intended outcome of the network screening analysis. This decision will influence data needs, the selection of performance measures and the screening method that can be applied.
2. **Identify Network and Establish Reference Populations:** Specify the types of sites or facilities being screened (i.e., segments, intersections, geometrics) and identify groupings of similar sites or facilities.
3. **Select Performance Measures:** There are a variety of performance measures available to evaluate the potential to reduce crash frequency at a site. In this step, the performance measure is selected as a function of the screening focus and the data and analytical tools available.

[1] Local Roadway Safety Manual (Version 1.3) 2016. Page 5.
[2] AASHTO, Highway Safety Manual, 2010, Washington D.C., http://www.highwaysafetymanual.org/Pages/About.aspx
[3] AASHTO. Highway Safety Manual. 2010. Washington, DC. Page 4-2.

4. **Select Screening Method:** There are three principal screening methods described in this chapter (i.e., ranking, sliding window, peak searching). Each method has advantages and disadvantages; the most appropriate method for a given situation should be selected.
5. **Screen and Evaluate Results:** The final step in the process is to conduct the screening and analysis and evaluate the results.

The HSM provides several statistical methods for screening roadway networks to identify high risk locations based on overall crash histories. In addition to flat crash quantities, the method used in this study is referred to as Critical Crash Rate (CCR).

3.2. Analysis Techniques

3.2.1. Crash Analysis

The initial steps of the crash analysis involved establishing sub-populations of roadway segments and intersections that have similar characteristics. For this study, intersections were grouped by their control type (Signalized and Unsignalized) and segments by their roadway category (Major Arterial, Minor Arterial, Collector, Other). Individual crash rates were calculated for each sub-population. The population level crash rates were then used to assess whether a specific location has more or fewer crashes than expected. These sub-populations were also used to determine typical crash patterns to help identify locations where unusual numbers of specific crash types are identified.

3.2.2. Network Screening Analysis

The network screening process ranks intersections and roadway segments by the number of crashes that occurred at each location over the analysis period, and then identifies areas that had more of a given type of crashes than would be expected for that type of location. These crash type factors were 1) crash injury (fatal injuries, major injuries, other visible injuries, complaint of pain) 2) crash type (broadside, rear-end, sideswipe, head-on, hit object, overturned, bicycle, pedestrian, other), 3) environmental factors (lighting, wet roads), and 4) driver behavior (impaired and aggressive driving). With these additional factors, the locations were further analyzed and assigned a new rank.

From the results of the network screening analyses, a short-list of locations was chosen based on crash activity, crash severity, crash patterns, location type, and area of the City to provide a variety of locations covering a wide cross section of safety challenges and improvement opportunities. The intent is to populate the safety countermeasure toolbox with mitigation measures that will be applicable to most of the crash activity in the City. Twenty-five locations have been selected for mitigation analysis and project sheets with site-specific improvements were developed. Section 8 presents the priority locations and the listed improvements, which are found in greater detail in Appendix E.

The results of the network screening analysis are shown in Appendix A and Appendix B. Appendix A presents all of the intersections with three or more crashes, and Appendix B presents the roadway segments with three or more crashes. The appendices are color-coded to highlight crash trends and emphasis areas for further study and countermeasure development.

3.3. Critical Crash Rate (CCR) Analysis

The Highway Safety Manual (HSM), developed by AASHTO, describes the CCR method, which provides a statistical review of locations to determine where risk is higher than that experienced by other similar locations. It is also the first step in analyzing for patterns that may suggest systemic issues that can be addressed at that location, and proactively at others to prevent new safety challenges from emerging.

The CCR analysis compares the observed crash rate to the expected crash rate at a particular location based on facility type and traffic volume using a locally calculated average crash rate for the specific type of intersection or roadway segment being analyzed. Based on traffic volumes and a weighted Citywide crash rate for each facility type, a critical crash rate threshold is established at the 95% confidence level to determine locations with higher

crash rates that are unlikely to be random. The threshold is calculated for each location individually based on its traffic volume and the crash profile of similar facilities. A CCR differential value of greater than zero reflects a location that has a higher crash rate than facilities with similar volumes, while a negative CCR differential value signifies a below-average crash rate. It should be noted that the CCR does not reflect the severity of the crashes occurring at the location, but rather the number of crashes for the given volume.

Figure 2 presents the intersections and roadway segments according to their crash rate.

The top three roadway segments with the highest CCR differential values with three or more crashes were:

- Barber Lane between Bellew Dr and Alder Dr with a total of 3 crashes and a local critical crash rate differential of 1.44.
- S Main Street between Corning Avenue and Curtis Avenue, which has a total of 8 crashes and a local critical crash rate differential of 0.62.
- Ranch Drive between McCarthy Blvd and the McCarthy Ranch Shopping Center Driveway with a total of 5 crashes and a local critical crash rate differential of 0.45.

The top three intersections with the highest CCR differential values with 3 or more crashes were:

- Butler St and West Calaveras Blvd, with 14 crashes and a local critical crash rate differential of 2.10.
- Edsel Dr and S Temple Dr, with a total of 4 crashes and a local critical crash rate differential of 0.75
- Great Mall Pkwy and Montague Expy, with a total of 35 crashes and a local critical crash rate differential of 0.69

CRITICAL CRASH RATE FORMULA

$$R_{c,i} = R_a + \left[P \times \sqrt{\frac{R_a}{MEV_i}}\right] + \left[\frac{1}{(2\times(MEV_i))}\right]$$

Where,

$R_{c,i}$ = Critical crash rate for intersection *i*

R_a = Weighted average crash rate for reference population

P = P-value for corresponding confidence level

MEV_i = Million entering vehicles for intersection *i*

Source: Highway Safety Manual

DATA NEEDS

CCR is calculated using:

- Daily Entering Volume (DEV) for intersections, or Vehicle Miles Traveled (VMT) for roadway segments
- Intersection control types to separate them into like populations
- Roadway functional classification to separate them into like populations
- Crash records in Geographic Information Systems (GIS) or tabular form including coordinates or linear measures

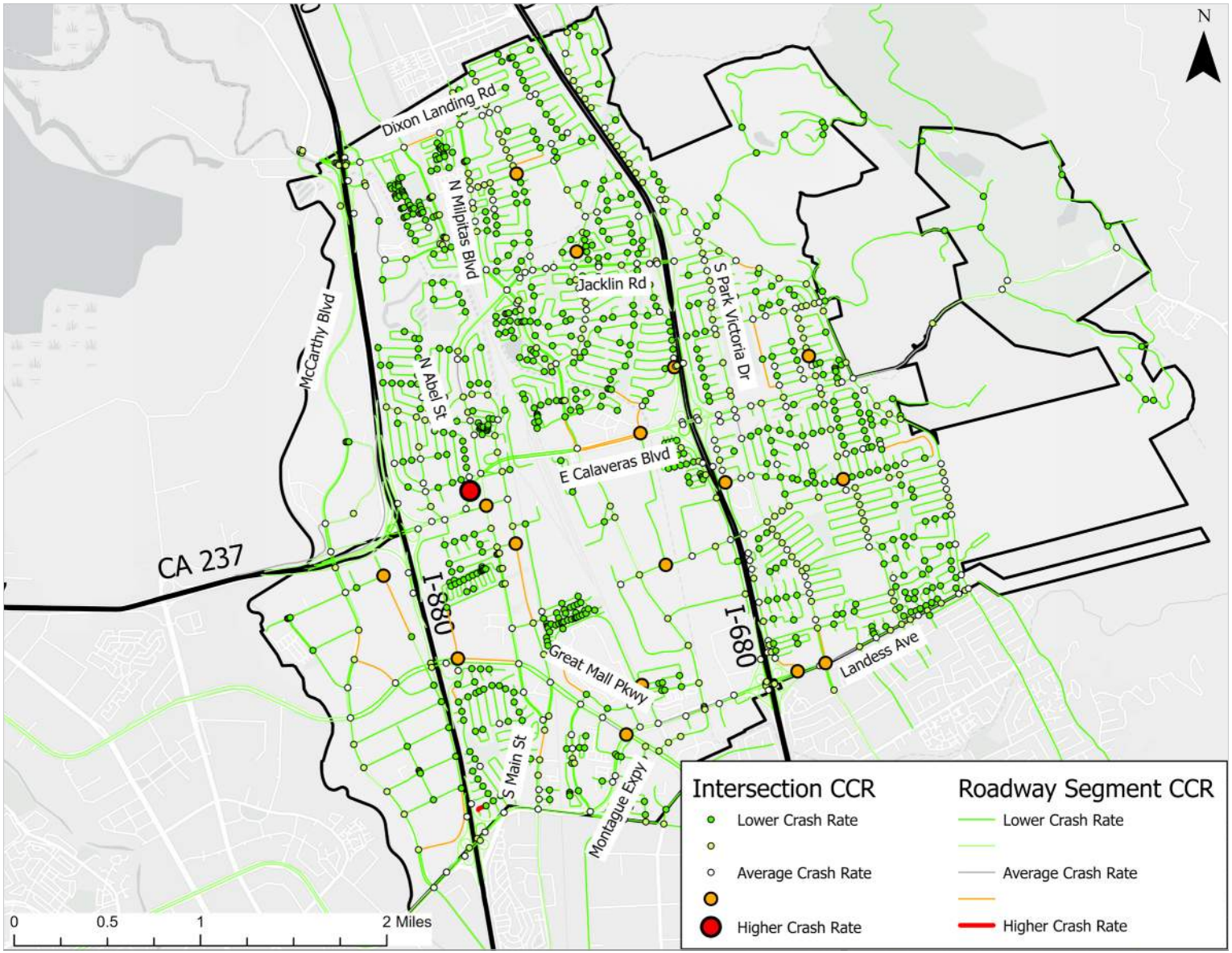
STRENGTHS

- Reduces low volume exaggeration
- Considers variance
- Establishes comparison threshold

WEAKNESSES

- Does not account for regression to the mean bias

Figure 2: Citywide Critical Crash Rate Map



3.4. Equivalent Property Damage Only (EPDO)

The Equivalent Property Damage Only (EPDO) method is described in the Highway Safety Manual (HSM). This method assigns weighting factors to crashes based on injury level (fatal, severe injury, other visible injury, complaint of pain) to develop a property damage only score. An EPDO score allows for a fair comparison of crash severity across years or study periods, as this normalized unit takes into account inflation and cost escalation. For example, the cost to society for all injury crashes increased by 12.7% between the 2020 edition of the Local Roadway Safety Manual and the 2022 edition. Using the EPDO methodology normalizes the data and accounts for the increase in cost from inflation. In this analysis, the injury crash costs were calculated for each location (based on the latest Caltrans injury costs). This value is then divided by the injury cost for a property damage only crash. The resulting number is the equivalent number of property damage only crashes at each site. This value allows all locations to be compared based on injury crash costs (HSM, Chapter 4).

EPDO FORMULA

$$EPDO = \frac{(N_F + N_S) * 2{,}843{,}000 + (N_O * 159{,}900) + (N_C * 90{,}900)}{14{,}900}$$

Where,

EPDO = Equivalent Property Damage Only (in units of crashes)

N_F = Number of fatal crashes

N_S = Number of severe injury crashes

N_O = Number of other visible injury crashes

N_C = Number of complaint of pain crashes

The cost to society for each crash type along roadway segments is as follows:

- Fatal: $2,843,000
- Severe: $2,843,000
- Other Visible Injury: $159,900
- Complaint of Pain: $90,900
- Property Damage Only: $14,900

Source: Highway Safety Manual

Locations with fatal and severe injury crashes will have a higher EPDO value compared to locations with less severe injury crashes. **Figure 3** presents the EPDO value of intersections and roadway segments in the City.

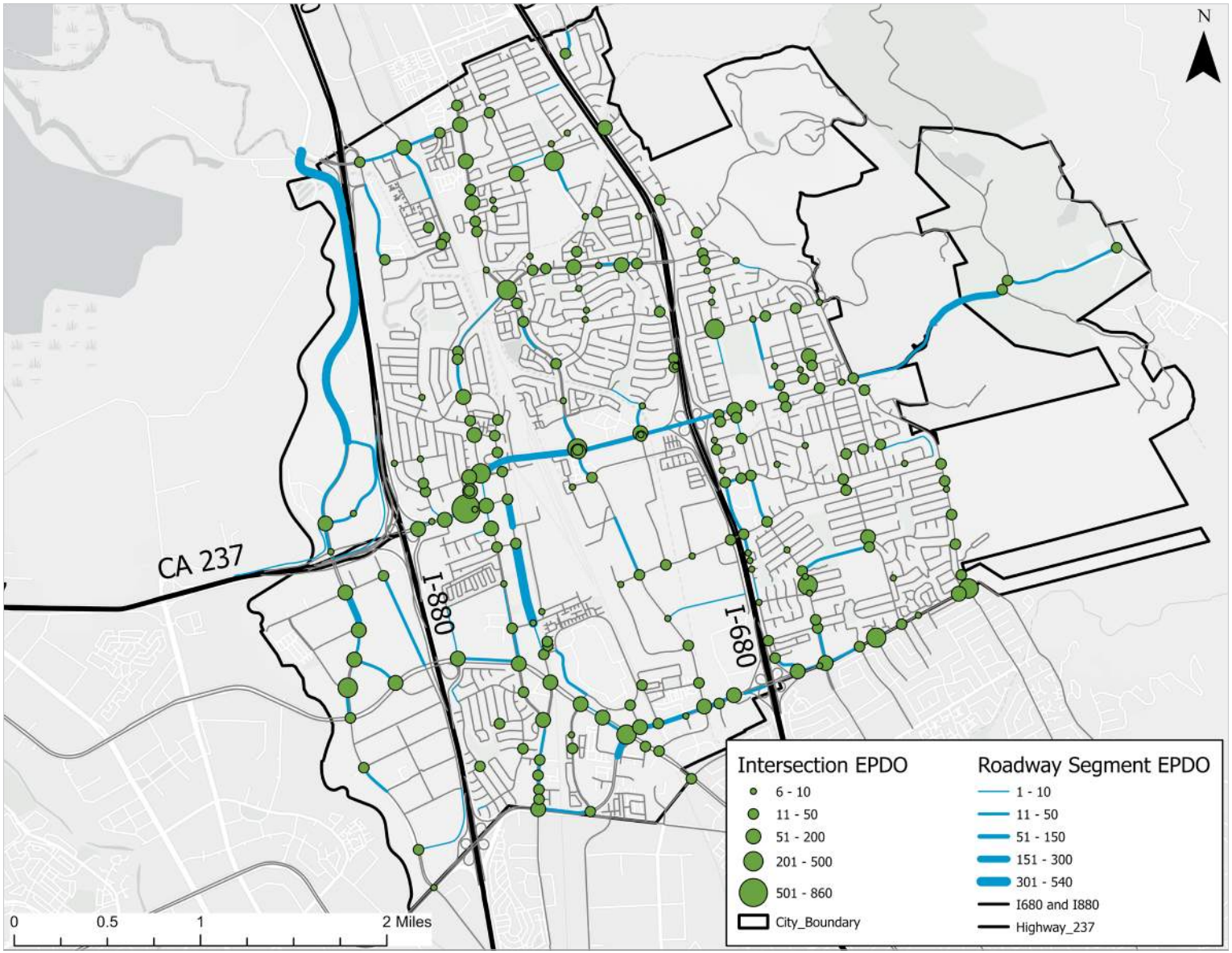
The top three intersections with the highest EPDO values are:

- The intersection with the highest EPDO value was W Calaveras Boulevard and Serra Way, with an EPDO value of 859 (4 Severe Injury crashes).
- Great Mall Pkwy and Montague Expy, with an EPDO value of 374 (1 severe injury crash).
- N Milpitas Blvd and N Abel St, with an EPDO value of 327 (1 fatal and 1 severe injury crash).

The top three roadway segments with the highest EPDO values are:

- Main Street between W Curtis Avenue and Corning Avenue, with an EPDO value of 540 (1 Fatal Crash, 2 Severe Injury crashes).
- N McCarthy Blvd between Dixon Landing Rd and the Sprig Center Driveway, with an EPDO value of 355 (2 severe injury crashes)
- E Calaveras Blvd between N Abel St and N Milpitas Blvd (1 severe injury crash)

Figure 3: Citywide Intersection Roadway Segment EPDO Map



4. SAFETY TRENDS

The following sections contain the results of the safety data analysis process which include evaluation of the City of Milpitas' fatal and severe injury (K+SI) crashes compared against the statewide K+SI crashes. Other evaluations included are crashes by cause, pedestrian and bicycle crashes, and primary collision factor. This is a general comparison of the Citywide level to the statewide to gauge the general trends within the City.

4.1. Severity Level

Knowing the impacts of the crash (the injuries or type of damage which occurred) is a key part of assessing the environment and safety factors around the site of the crash. The National Safety Council developed the "KABCO" injury scale, which is frequently used by law enforcement for classifying injuries. The KABCO scale is referenced below:

- K – Fatal
- A – Severe injury
- B – Other Visible Injury
- C – Complaint of Pain
- O – No injury (property damage only)

Table 1 presents crash severity by facility type—signalized intersections, non-signalized intersections, and roadway segments. Fifty-three percent (53%) of crashes occurred at signalized intersections, followed by 26% at non-signalized intersections. The remaining 22% of crashes occurred along roadway segments. This trend is typical for urban areas with high traffic volumes and more densely spaced intersections.

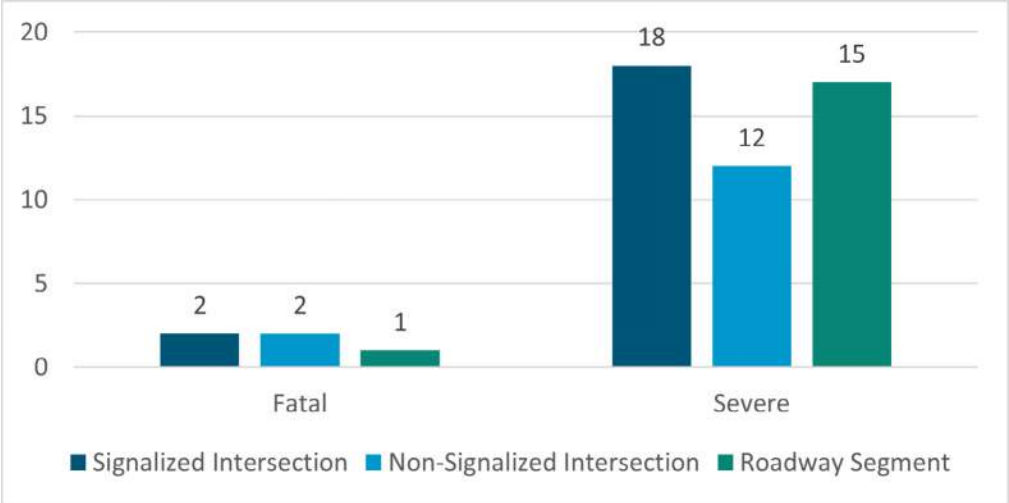
Table 1: Crashes by Severity

Severity	Signalized Intersection		Non-Signalized Intersection		Roadway Segment		Total	
	Crashes	%	Crashes	%	Crashes	%	Crashes	%
Fatal	2	<1%	2	1%	1	<1%	5	1%
Severe Injury	18	4%	12	5%	15	8%	45	5%
Other Visible Injury	151	31%	99	41%	77	39%	327	35%
Complaint of Pain	324	65%	130	53%	97	52%	551	59%
Total	***495***	***53%***	***243***	***26%***	***204***	***22%***	***928***	***100%***

Source: Statewide Integrated Traffic Records System (2017 – 2021).

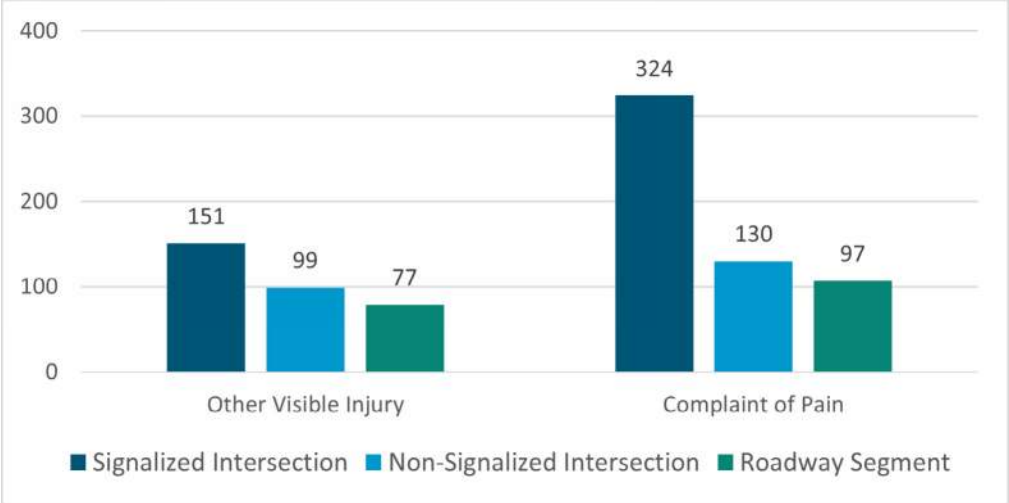
One percent (1%) of crashes recorded in the study period were fatal, and 5% resulted in severe injuries. Crashes resulting in the various severity levels are presented in **Figure 4** and **Figure 5**.

Figure 4: Crashes by Severity (Fatal and Severe)



Source: Statewide Integrated Traffic Records System (2017 – 2021).

Figure 5: Crashes by Severity (Other Injury and Complaint of Pain)



Source: Statewide Integrated Traffic Records System (2017 – 2021).

Figure 6 on the following page illustrates the injury crashes throughout the City, broken down by intersection and roadway segment crashes. **Figure 7** illustrates the fatal and severe injury crashes.

The top three roadway segments with the highest number of crashes are:

- E Calaveras Blvd (N Milpitas Blvd to S Hillview Dr) – 14 Crashes
- E Calaveras Blvd (N Abel St to N Milpitas Blvd) – 9 Crashes
- S Main St (W Curtis Ave to Corning Ave) – 8 crashes

The top three intersections with the highest number of crashes are:

- Great Mall Pkwy and Montague Expy – 35 Crashes
- Great Mall Pkwy and Thompson St – 23 Crashes
- E Calaveras Blvd and N Milpitas Blvd – 21 Crashes

Figure 6: Injury Crash Map

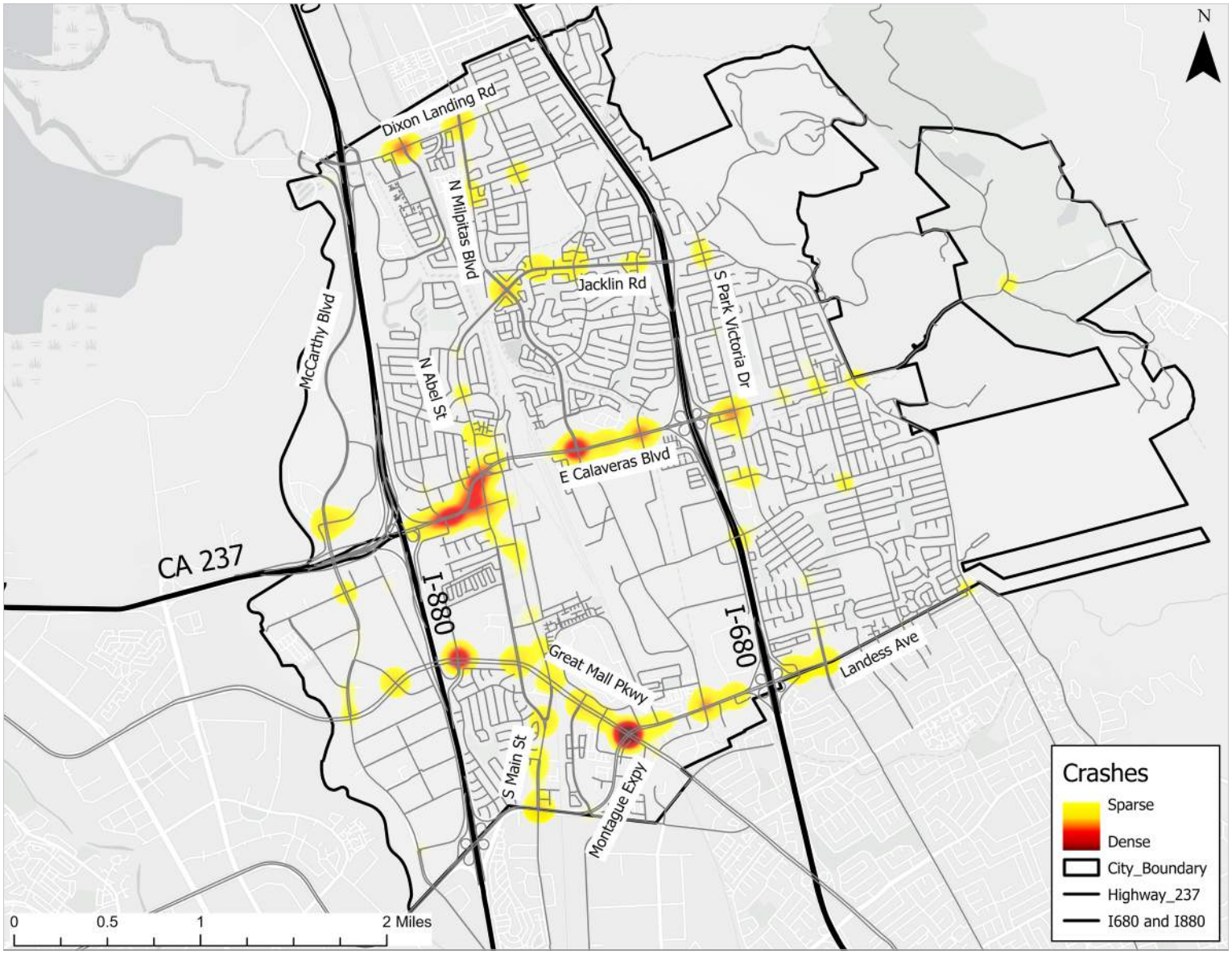
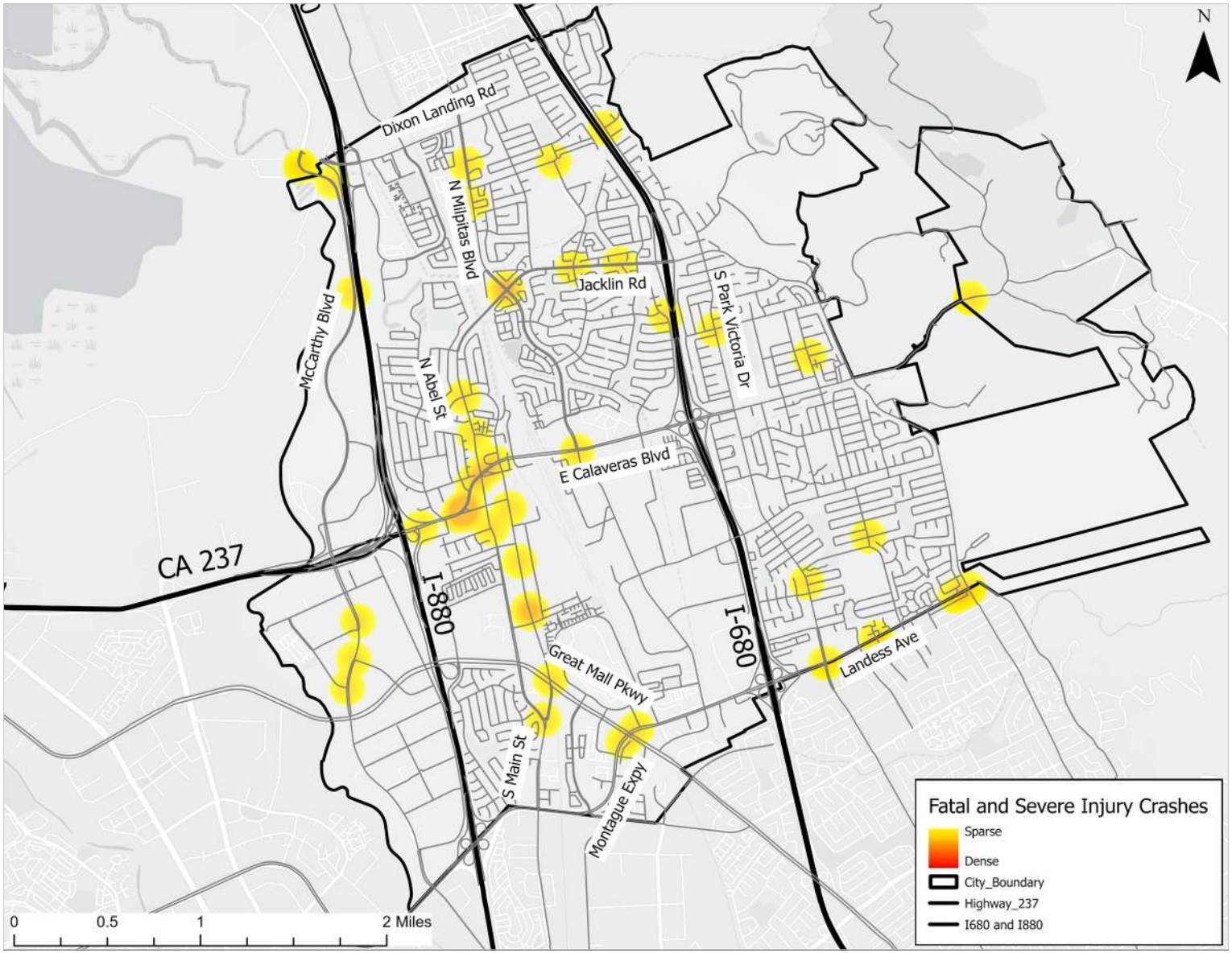


Figure 7: Fatal and Severe Injury Crash Map



4.2. City of Milpitas K+SI Crashes Compared to Statewide K+SI Crashes

The California Strategic Highway Safety Plan (SHSP) focuses on 16 challenge areas identified by the SHSP Executive Leadership and Steering Committees after an in-depth analysis of California K+SI (fatal and severe injury) crash data as well as an extensive statewide outreach process that involved hundreds of diverse traffic stakeholders around the state. **Table 2** contains a comparison of the City of Milpitas' K+SI crashes to the statewide K+SI crashes and reflects SWITRS data. The City ranks higher than the statewide average percentages in regards to the intersection, aggressive driving, and pedestrians challenge areas. The City is also slightly higher than the Statewide average in the bicyclists, motorcyclists, impaired driving and work zones challenge areas. **Table 2** also presents the summary of the challenge areas and percentages for the City and statewide averages.

Table 2: City of Milpitas K+SI Crashes Compared to Statewide K+SI Crashes

California SHSP Challenge Areas	Statewide Average Percentages	City of Milpitas	Percentage Difference
Percentage of K+SI Crashes Higher in the City of Milpitas			
Intersections	23.6%	31.1%	7.5%
Aggressive Driving	33.1%	36.7%	3.6%
Pedestrians	19.2%	22.2%	3.0%
Bicyclists	8.3%	10.0%	1.7%
Motorcyclists	21.0%	22.2%	1.2%
Impaired Driving	25.3%	25.6%	0.3%
Work Zones	1.4%	1.7%	0.2%
Percentage of K+SI Crashes Lower in Milpitas			
Distracted Driving	5.0%	2.8%	-2.2%
Commercial Vehicles	6.4%	3.9%	-2.5%
Young Drivers	13.1%	10.0%	-3.1%
Lane Departure	43.3%	38.9%	-4.4%
Aging Drivers	12.4%	7.8%	-4.6%
Driver Licensing*	24.7%	18.9%	-5.7%
Occupant Protection	14.2%	5.6%	-8.7%

Source: Statewide Integrated Traffic Record (SWITRS, 2009 – 2018).

Notes:

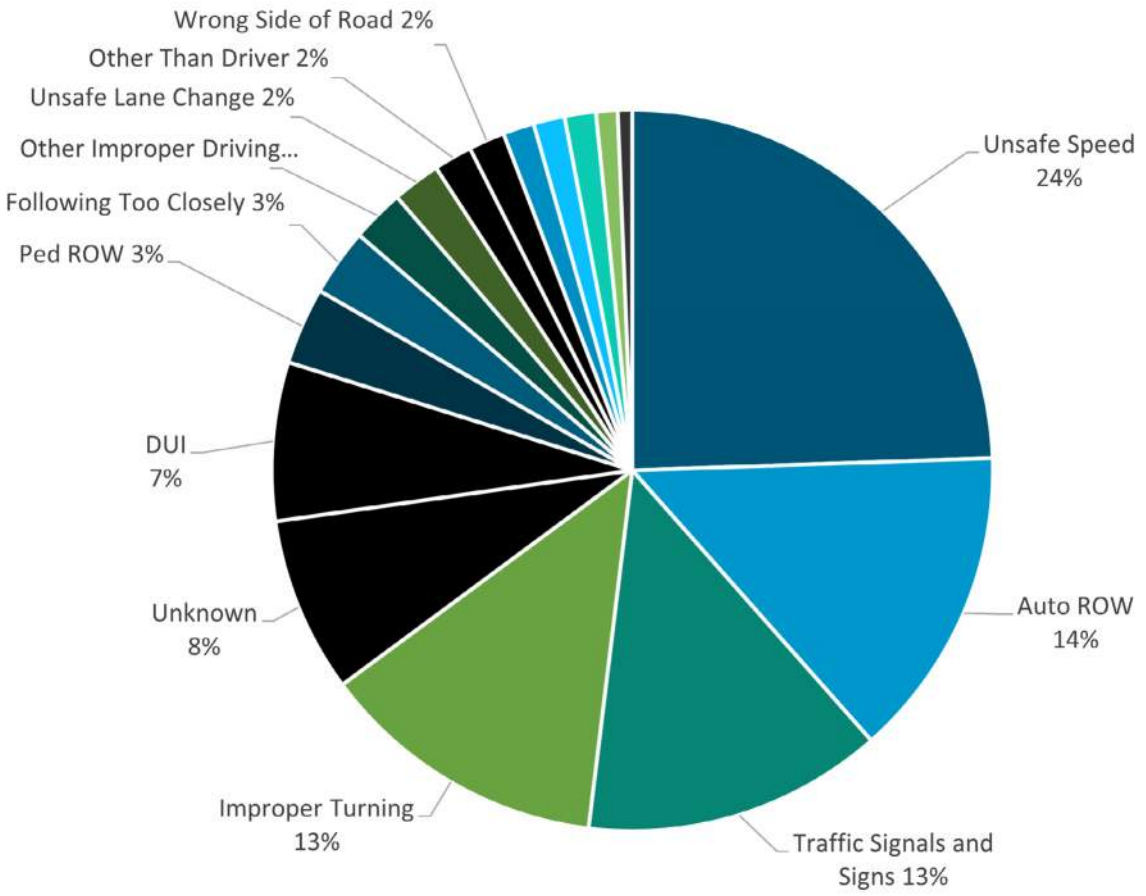
1. *Percentages will not add up to 100%, as a fatality or severe injury could have involved multiple Challenge Areas (i.e., a young driver that was impaired and unrestrained)*
2. *California SHSP does not have reported crash data for the following two challenge areas: Emergency Response and Emerging Technology*

**Driver Licensing data available for fatal crashes only from the Fatality Analysis Reporting System (FARS)*

4.3. Primary Collision Factor

The leading crash causes during the study period were unsafe speed (24%), automobile right-of-way violation (14%), traffic signals and signs (13%), and improper turning (13%). These trends are presented in **Figure 8** and are consistent with **Table 2**, which identified intersection crashes and aggressive driving as emphasis areas.

Figure 8: Crashes by Primary Collision Factor



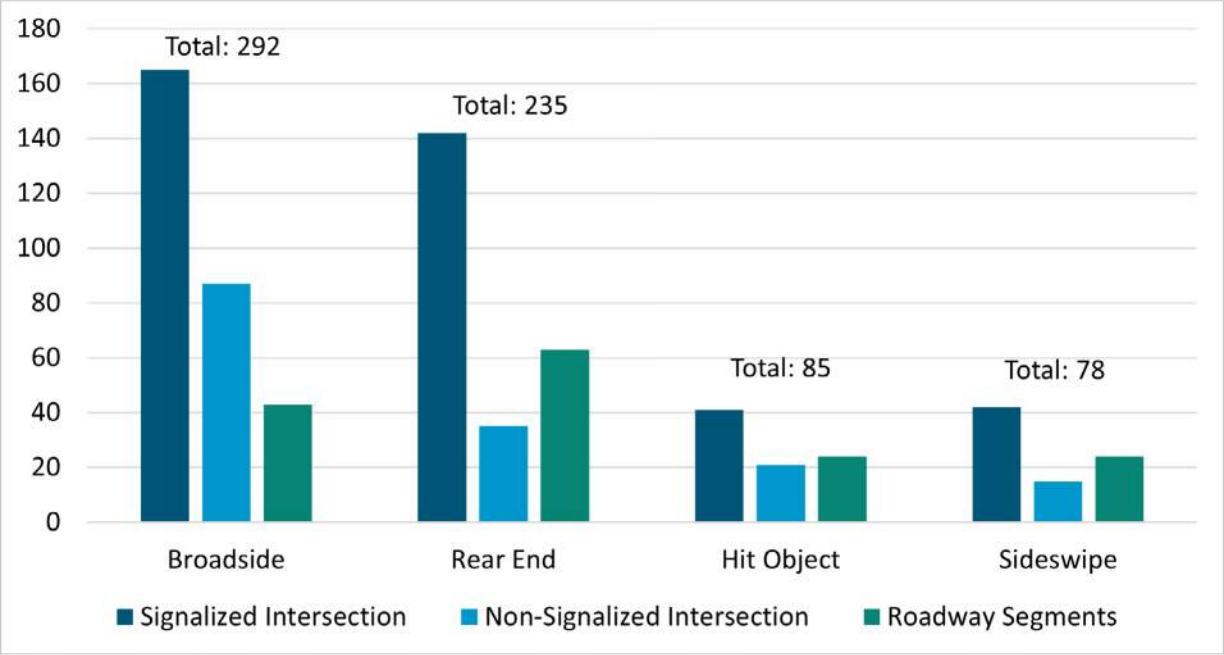
Source: Statewide Integrated Traffic Records System (2017 – 2021).

The following crash causes accounted for less than 2% of crashes individually: unsafe starting or backing, other hazardous violation, not stated, pedestrian violation, and improper passing.

4.4. Highest Occurring Crash Types

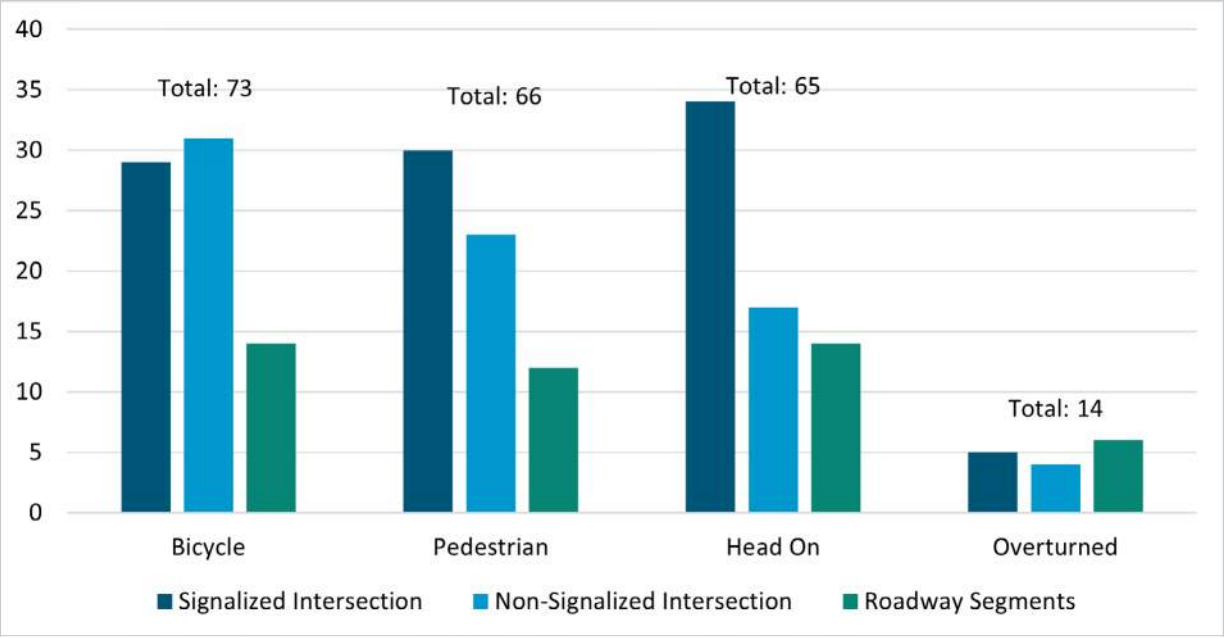
According to the reported data, approximately 928 crashes occurred within the City of Milpitas during the five-year study period which had clear, discernible spatial data that did not occur on private property. As shown in **Figure 9** and **Figure 10**, the most common crash types were broadsides, rear ends and hit object crashes. Approximately 2% of crashes did not have a reported crash type.

Figure 9: Crashes by Type (Broadsides, Rear Ends, Hit Object, and Sideswipes)



Source: Statewide Integrated Traffic Records System (2017 – 2021).

Figure 10: Crashes by Type (Bicycles, Pedestrians, Head On, and Overturned)



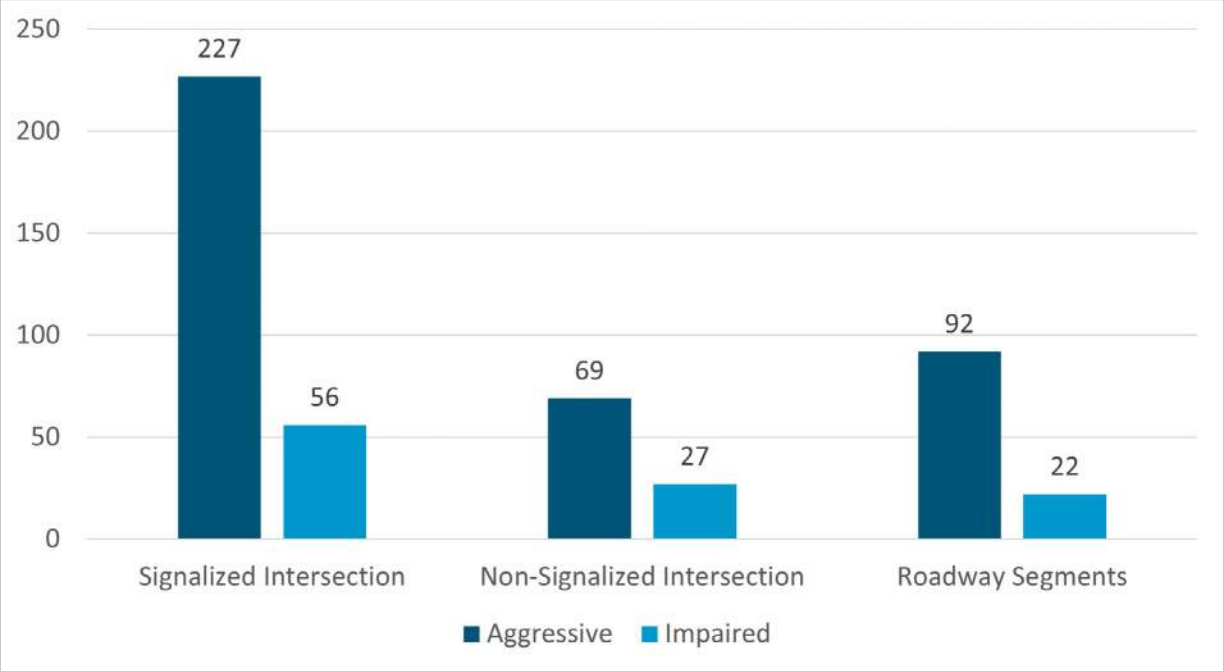
Source: Statewide Integrated Traffic Records System (2017 – 2021).

4.5. Aggressive and Impaired Driving Crashes

Aggressive driving was a contributing factor for 380 crashes in the study period, resulting in one fatal crash and fifteen severe injury crashes. Aggressive driving crashes include behaviors such as unsafe speed, following too closely, or disregarding traffic signals and signs. Aggressive driving crashes occurred mostly at signalized intersections, followed by roadway segments and non-signalized intersections.

Crashes involving drugs or alcohol include all crashes where there was any evidence of drug or alcohol use by the driver. This is different from impaired driving statistics in that drivers do not need to exceed the legally defined threshold of intoxication to be considered. Caltrans considers any level of alcohol consumption to have the potential to impact driver responsiveness and decision making. There were 105 impaired driving crashes between 2017 and 2021, one of which was fatal and 15 of which resulted in severe injuries. **Figure 11** below shows the distribution of impaired driving crashes across intersections and roadway segments.

Figure 11: Aggressive and Impaired Driving Crashes



Source: Statewide Integrated Traffic Records System (2017 – 2021).

Figure 12 presents a map of impaired driving crashes throughout the City. **Figure 13** presents a map of aggressive driving crashes in Milpitas. Aggressive and impaired driving crashes can be seen occurring along the primary arterials including Calaveras Blvd, Great Mall Pkwy, Montague Expressway, Abel St, and Main Street.

The top three intersections with aggressive driving crashes are:

- Great Mall Pkwy and Montague Expy (16 aggressive driving crashes)
- Great Mall Pkwy and Thompson St (14 aggressive driving crashes)
- E Calaveras Blvd and N Milpitas Blvd (12 aggressive crashes)

The top three roadway segments with aggressive driving crashes are:

- Calaveras Blvd between N Milpitas Blvd and S Hillview Dr (9 aggressive driving crashes)
- E Calaveras Blvd between N Abel St and Milpitas Blvd (7 aggressive driving crashes)
- S Main St between W Curtis Ave and Corning Ave (3 aggressive crashes)

Figure 12: Aggressive Driving Crash Map

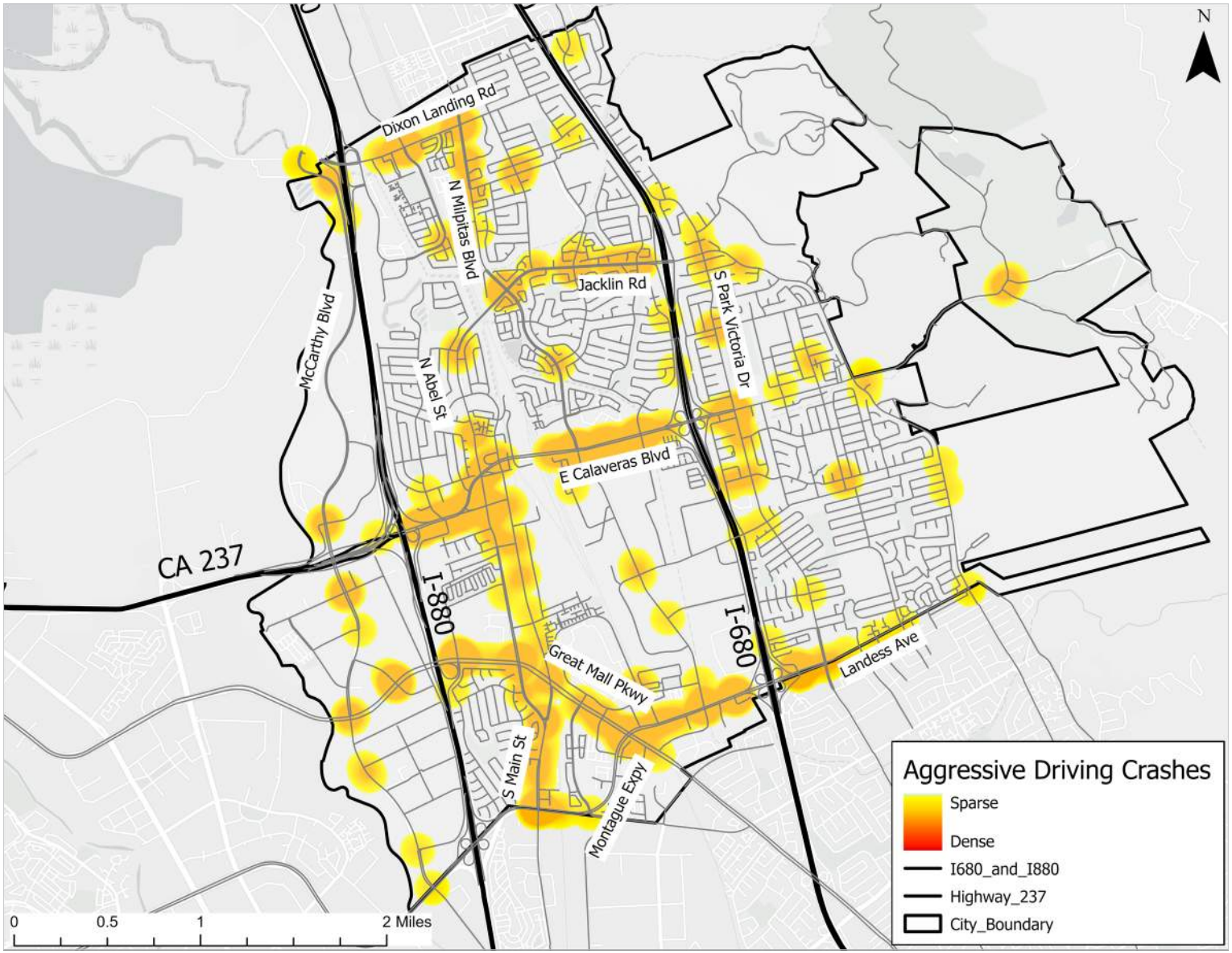
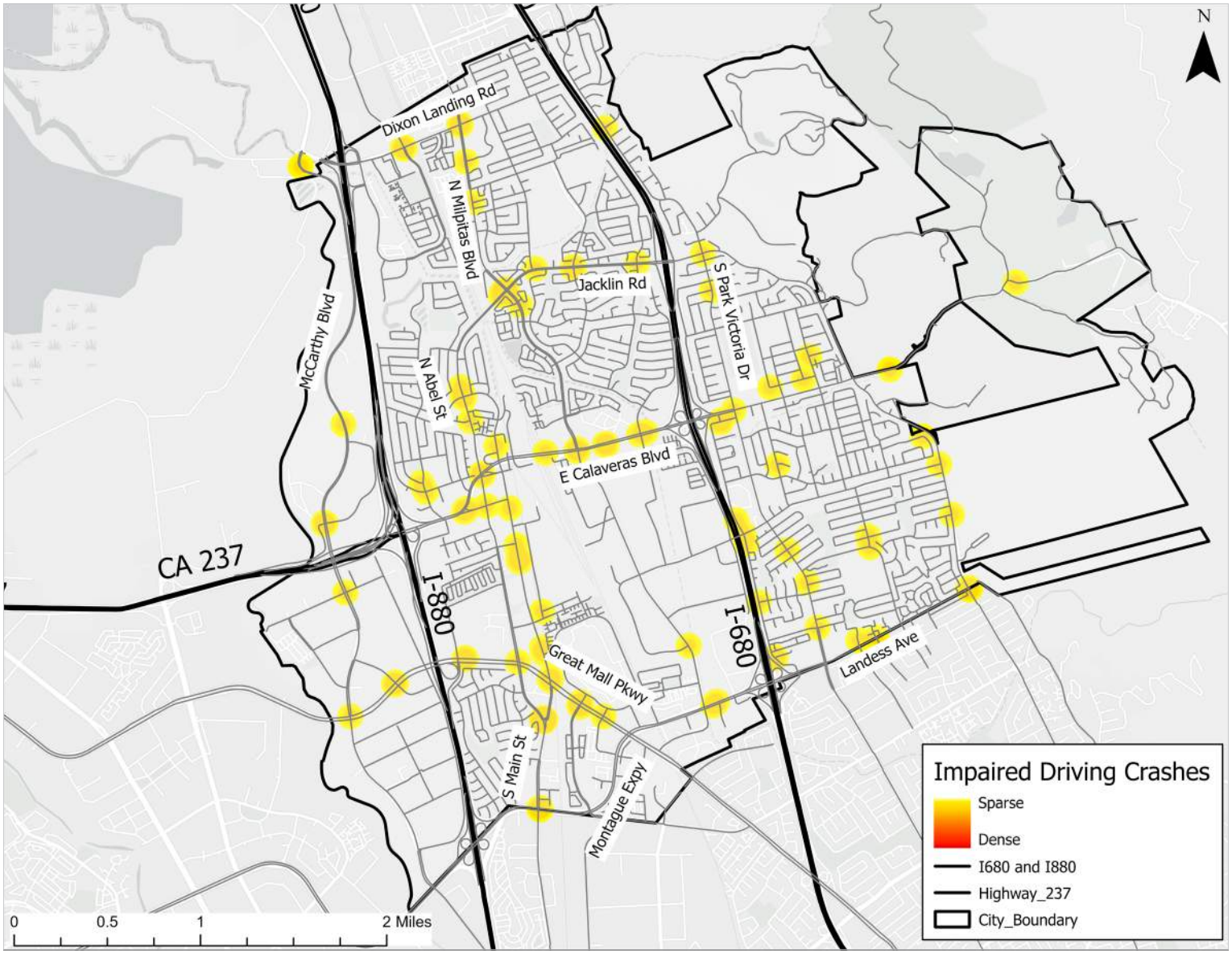


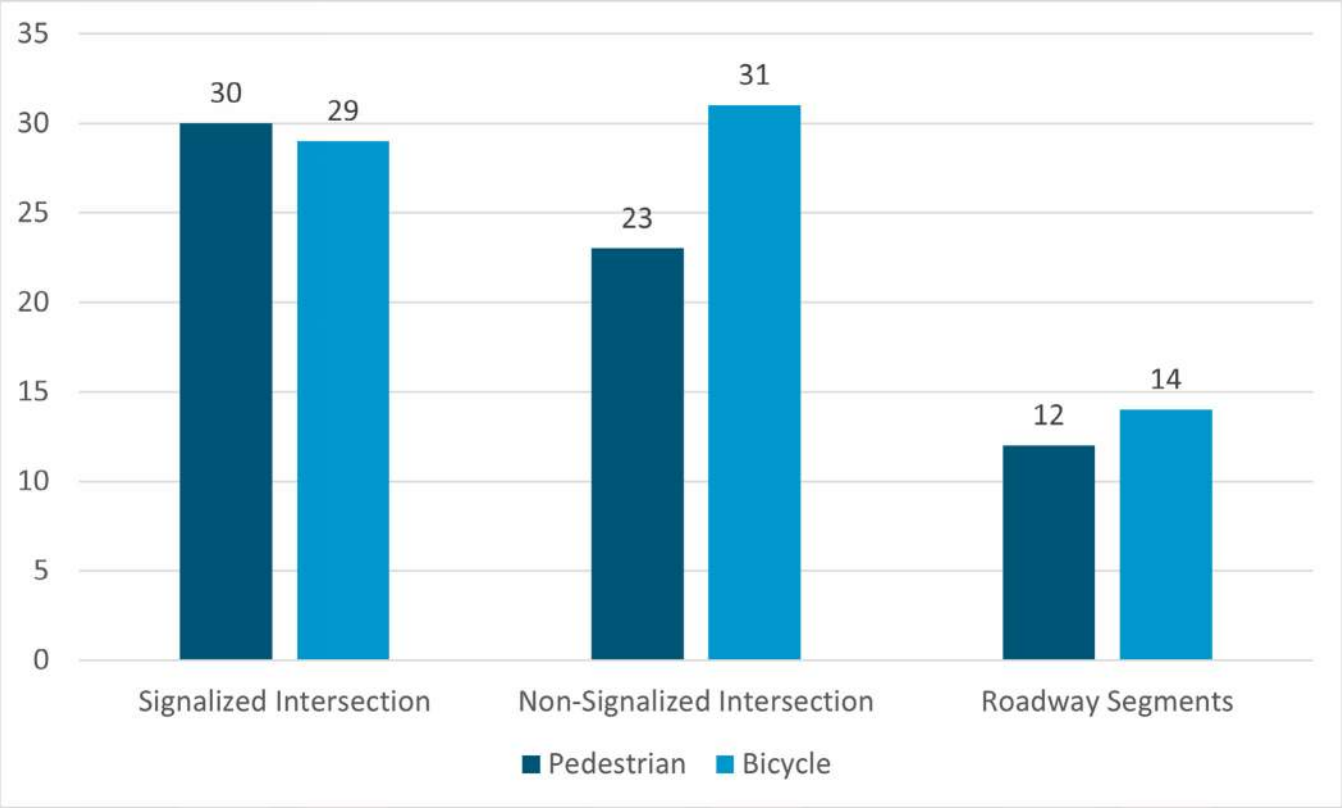
Figure 13: Impaired Driving Crash Map



4.6. Vulnerable Road User Crashes

Figure 14 presents a breakdown of vulnerable road user crashes. Bicycle crashes were more common at non-signalized intersections, and pedestrian crashes were most common at signalized intersections.

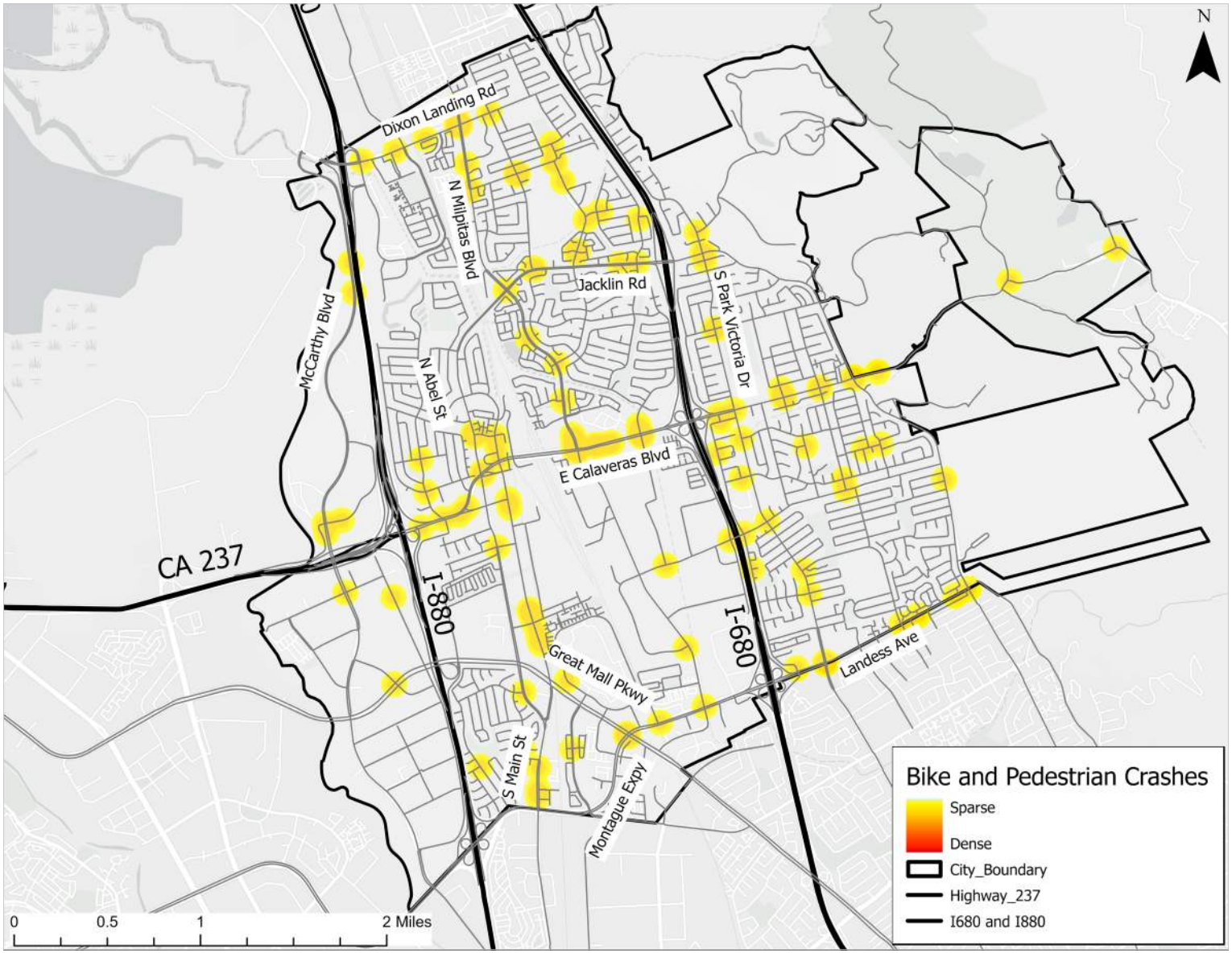
Figure 14: Vulnerable Road User Crashes



Source: Statewide Integrated Traffic Records System (2017 – 2021).

Figure 15 illustrates the locations of vulnerable road user crashes within the City. Additional information on pedestrian and bicycle crashes is provided in the following sections. Bicycle and pedestrian crashes accounted for 60% of all fatal crashes and 23% of all severe injury crashes during the study period.

Figure 15: Vulnerable Road User Crashes



4.6.1. Pedestrian Crashes

Over the span from 2017 to 2021, a total of 65 pedestrian-involved crashes occurred across the City. Of the pedestrian-involved injury crashes, 2 were fatal, 10 were reported with severe injuries, 37 with other visible injuries, and 16 with complaints of pain.

The following intersections each experienced two pedestrian crashes:

- E Calaveras Blvd and N Milpitas Blvd
- E Calaveras Blvd and N Abel St/Carlo St
- Weller Ln and N Abel St
- Calaveras Rd and S Temple Dr

The top three roadway segments with pedestrian driving crashes are:

- S Main St between W Curtis Ave and Corning Ave (2 pedestrian crashes)
- E Calaveras Blvd between N Abel St and Milpitas Blvd (1 pedestrian crash)
- Calaveras Rd between Evans Rd/Piedmont Rd and Vista Ridge Dr (1 pedestrian crash)

4.6.2. Bicycle Crashes

There were 73 bicycle-involved crashes that occurred across the City over the study period. Of the bicycle-involved injury crashes, 1 was fatal, 1 was reported with severe injuries, 43 with other visible injuries, and 28 with complaints of pain.

The following intersections each had three bicycle crashes:

- Great Mall Pkwy and Montague Expy
- Dixon Landing Rd and N Milpitas Blvd
- E Calaveras Blvd and S Hillview Dr
- Altamont Dr and Escuela Pkwy

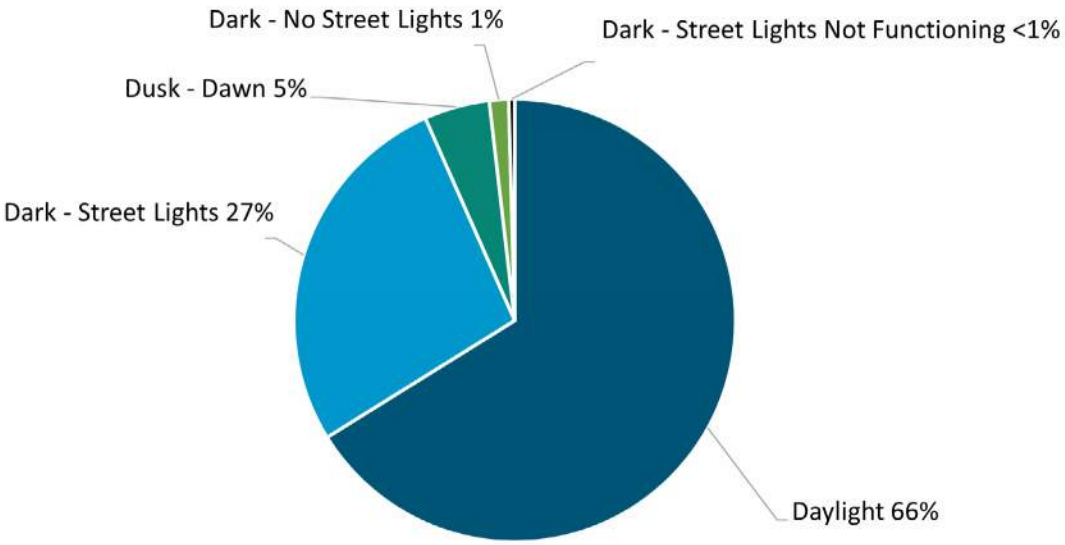
The top three roadway segments with bicycle driving crashes are:

- E Calaveras Blvd between N Milpitas Blvd and S Hillview Dr (3 bicycle crashes)
- N Milpitas Blvd between Beresford Ct and E Calaveras Blvd (2 bicycle crashes)
- Ranch Dr between McCarthy Blvd and the McCarthy Ranch Shopping Center Driveway (1 bicycle crash)

4.7. Crashes by Lighting Condition

The majority of crashes occurred during daylight (66%), followed by crashes occurring at night but with lighting present. A minority of crashes occurred during dark conditions with no lighting present. **Figure 16** presents a breakdown of crashes by lighting conditions.

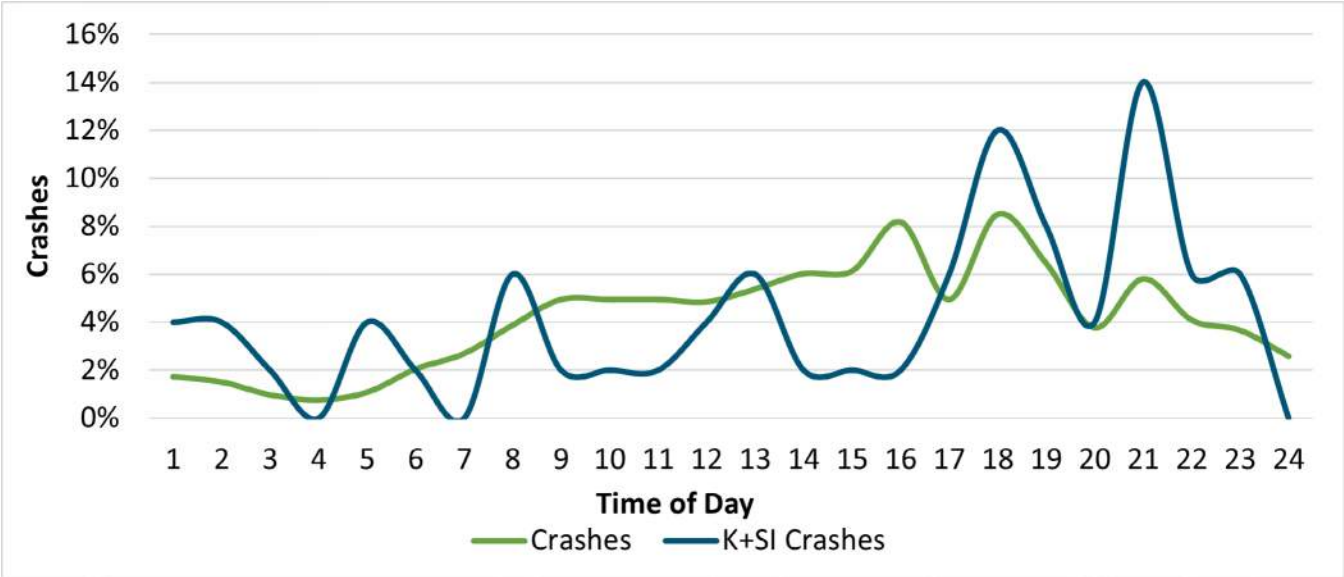
Figure 16: Crashes by Lighting Condition



4.8. Crashes by Time of Day

Crashes were plotted based on the time of day. The frequency of crashes peaks in the afternoon hours between 4 PM and 6 PM. The number of fatal and severe injury crashes peaks between 6 PM and 9 PM. **Figure 17** presents the percentage of crashes occurring by time of day.

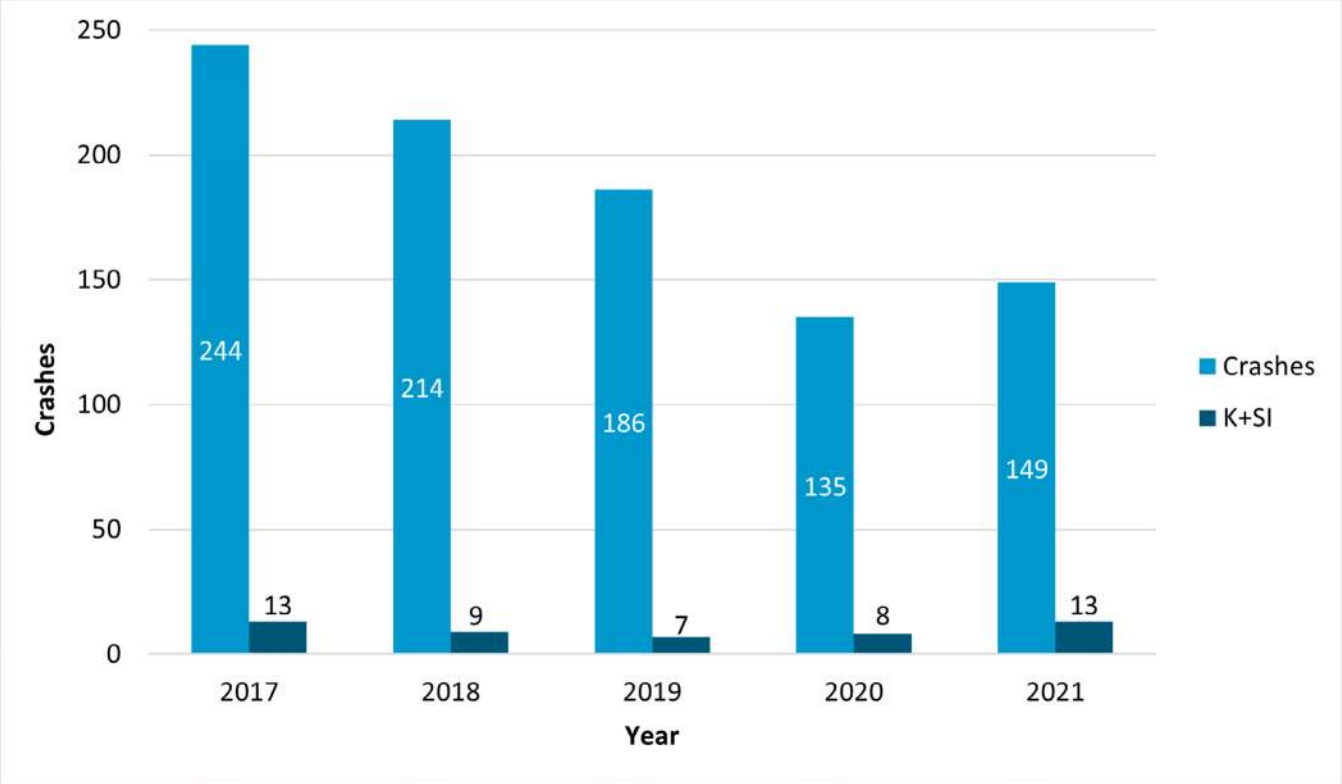
Figure 17: Crashes by Time of Day



4.9. Crashes by Year

Year 2017 experienced the most crashes of any year within the study period, with crashes trending downwards between 2017 and 2020. Crashes decreased by 44% between 2017 and 2020, with reduced travel during the COVID-19 pandemic likely being a contributing factor. The number of crashes trended slightly upwards from 2020 to 2021 in correlation with traffic patterns trending back towards pre-pandemic levels. **Figure 18** presents crashes by year.

Figure 18: Crashes by Year (2017 - 2021)



5. PUBLIC ENGAGEMENT

5.1. Introduction

Kimley-Horn's Public Engagement Plan for the City of Milpitas' Citywide Travel Safety Plan included strategies and activities to reach a broad cross-section of the community throughout the city. The plan included two main rounds of engagement, the first of which focused on identifying corridor and intersection safety needs and opportunities which is further detailed in this report.

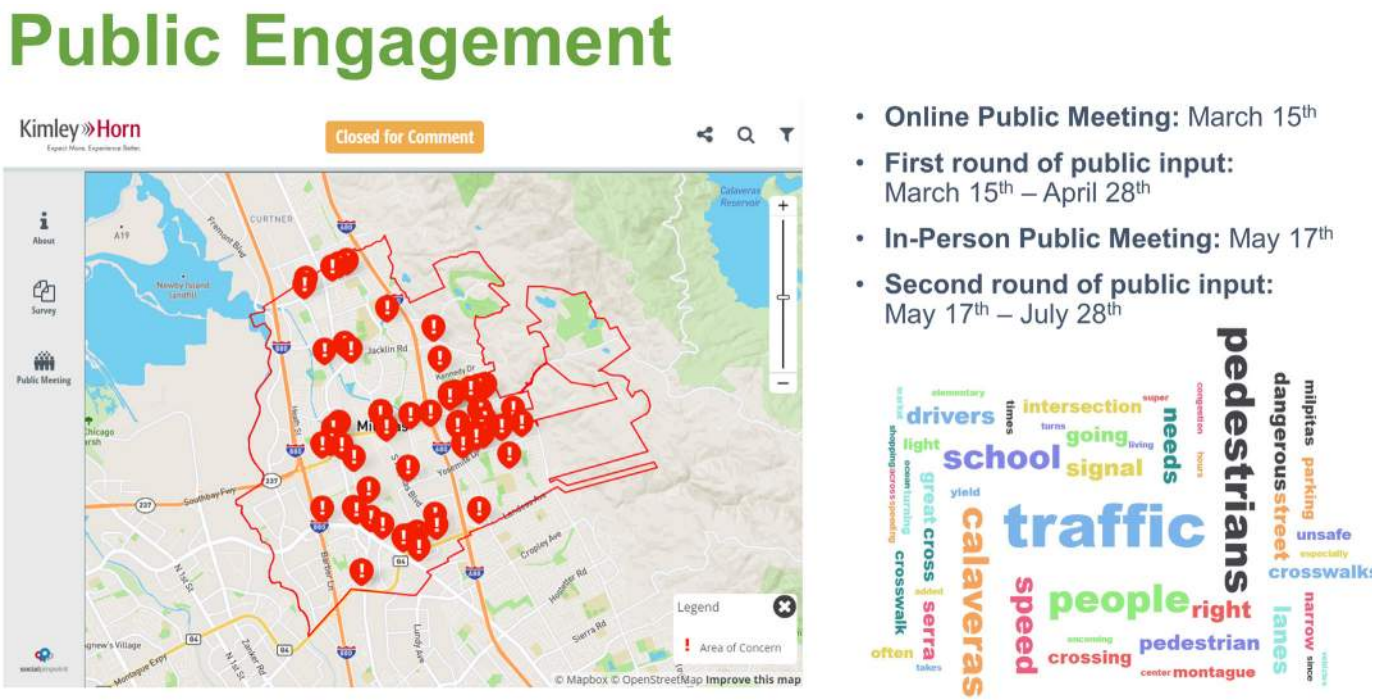
Prior to launching the public-facing effort, the City of Milpitas and Kimley-Horn teams met to discuss and plan out key project deliverables and how public engagement would inform and support these efforts.

The first round of outreach occurred between March and April 2023 and consisted of two main components:

1. Online Public Meeting held on March 15, 2023 through Zoom
2. Launch of the first round of online public input (March 15, 2023 through April 28, 2023)
    a. Milpitas Traffic Safety Survey & Interactive Map hosted on *Social Pinpoint*

The second round of outreach occurred between May and July 2023 and included the following engagement touchpoints:

1. In-Person Public Meeting held at the Milpitas Library on May 17, 2023
2. Promotion of the second round of online public input (May 17, 2023 through July 28, 2023)
    a. Countermeasure Toolbox Survey & Interactive Map hosted on *Social Pinpoint*



Round 1 of public engagement included an ***online survey*** and interactive mapping tool which was made public on March 15, 2023 following the online Public Meeting, and remained open for six weeks, until April 28, 2023.

The public meeting and online survey were promoted through the City of Milpitas' various communication channels, including a webpage, Milpitas Matters e-newsletters, Twitter, Next Door, and Facebook (pictured below).

MILPITAS MATTERS • GENERAL INFORMATION

MILPITAS TRAFFIC SAFETY STUDY PUBLIC MEETING

Do you live, work, study or shop in the City of Milpitas? A citywide traffic safety study is underway to identify areas of improvement. We need your input about the challenges you have experienced driving, biking, walking, or using other transportation modes within the City.

Join the virtual public meeting and learn about the safety data collected to date, ask questions and share your experience!

Wednesday, March 15, 2023
6:00 to 7:30 p.m.
ZOOM link

We look forward to hearing your valuable feedback into this important safety study!

6. ONLINE COMMUNITY SURVEY RESPONSES

With over 1,000 total page visits, the online engagement resulted in a total of 98 survey respondents. Approximately 300 unique users visited the interactive website and 80 site-specific comments recorded.

MILPITAS TRAFFIC SAFETY SURVEY

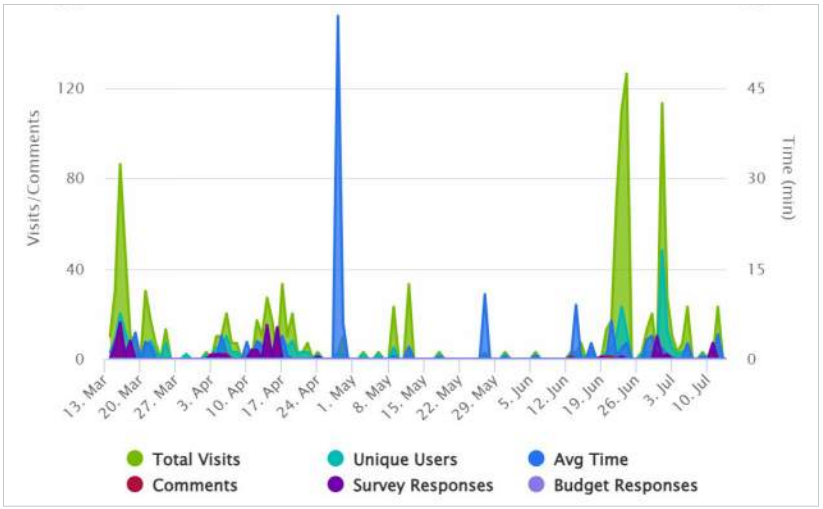
- 16 Surveys completed
- 8 Comments

INTERACTIVE MAP SURVEY: SAFETY CHALLENGES

- 75 Surveys completed

COUNTERMEASURES SURVEY

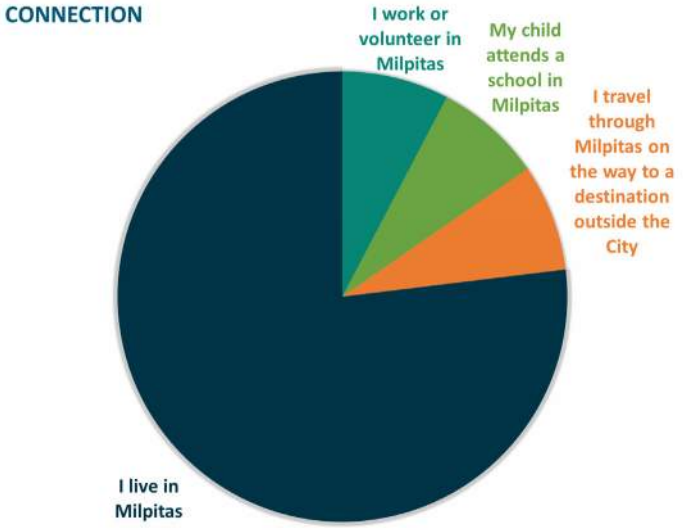
- 13 Surveys completed

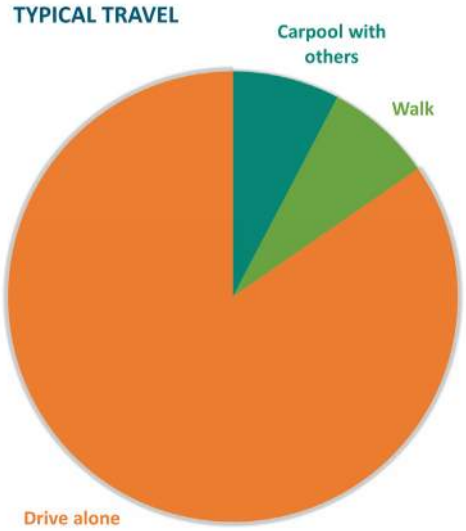


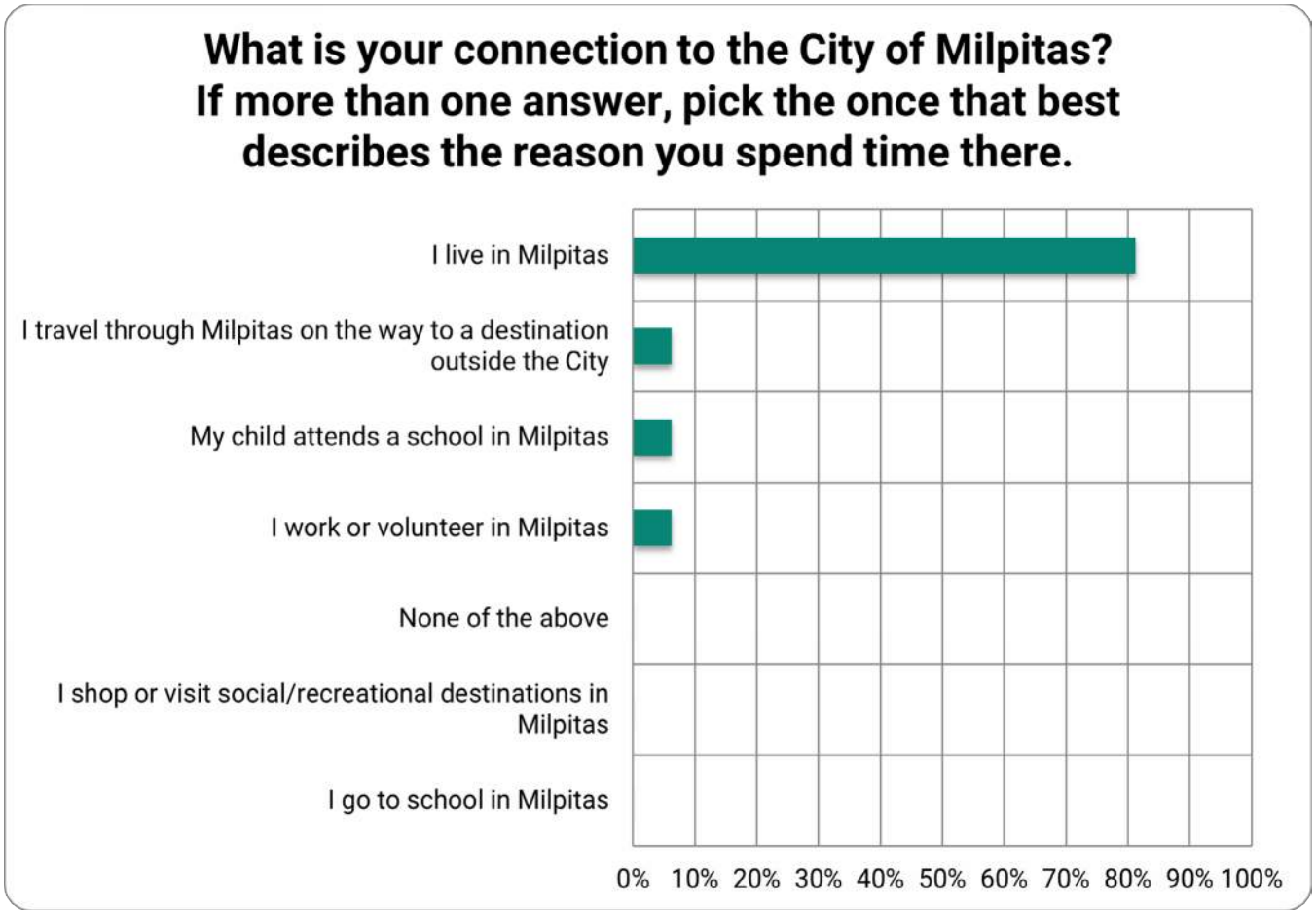
6.1. Milpitas Traffic Safety Survey

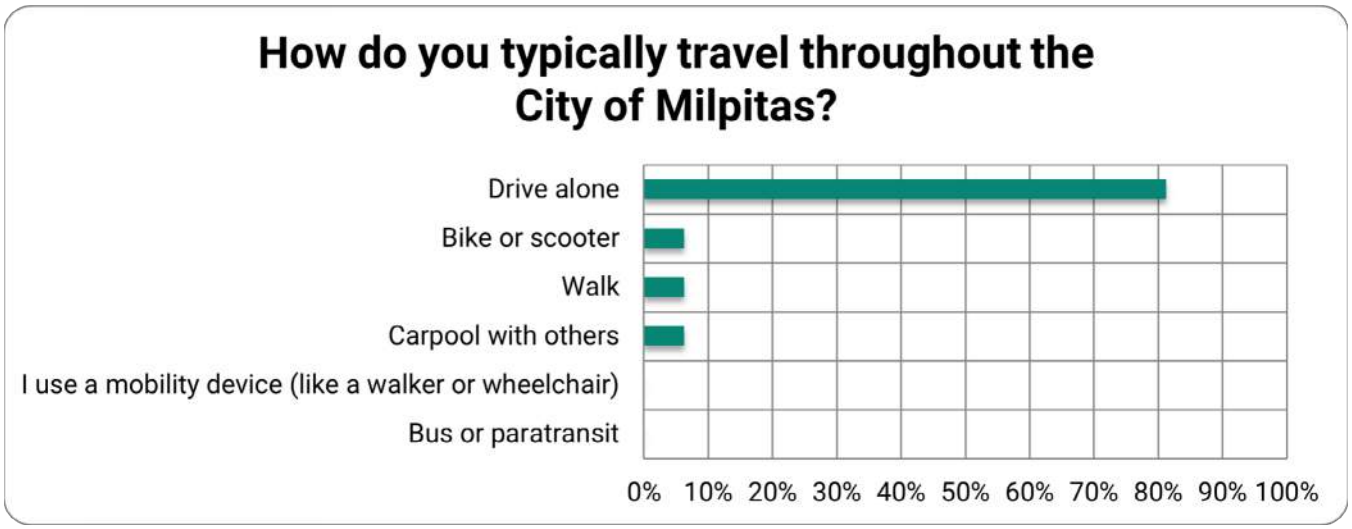
Online and paper surveys collected from various efforts revealed that over three quarters of the respondents live within the City of Milpitas. Most respondents noted that they mainly depend on vehicles as their primary mode of travel. When asked to identify their top three traffic safety challenge areas when it came to traveling throughout Milpitas, most individuals noted concerns with aggressive driving, traffic signals, and pedestrian crossings.

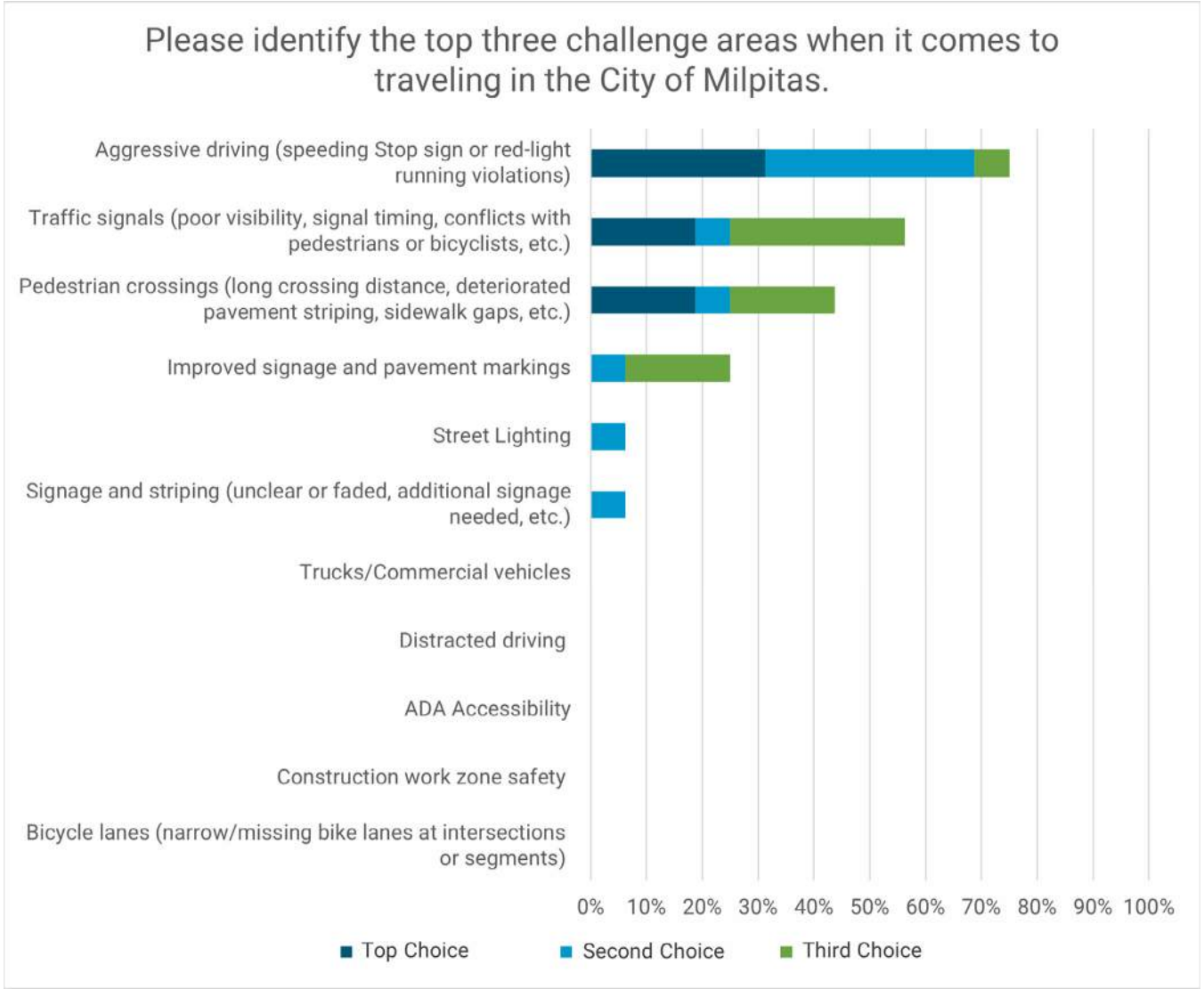
Survey Participants

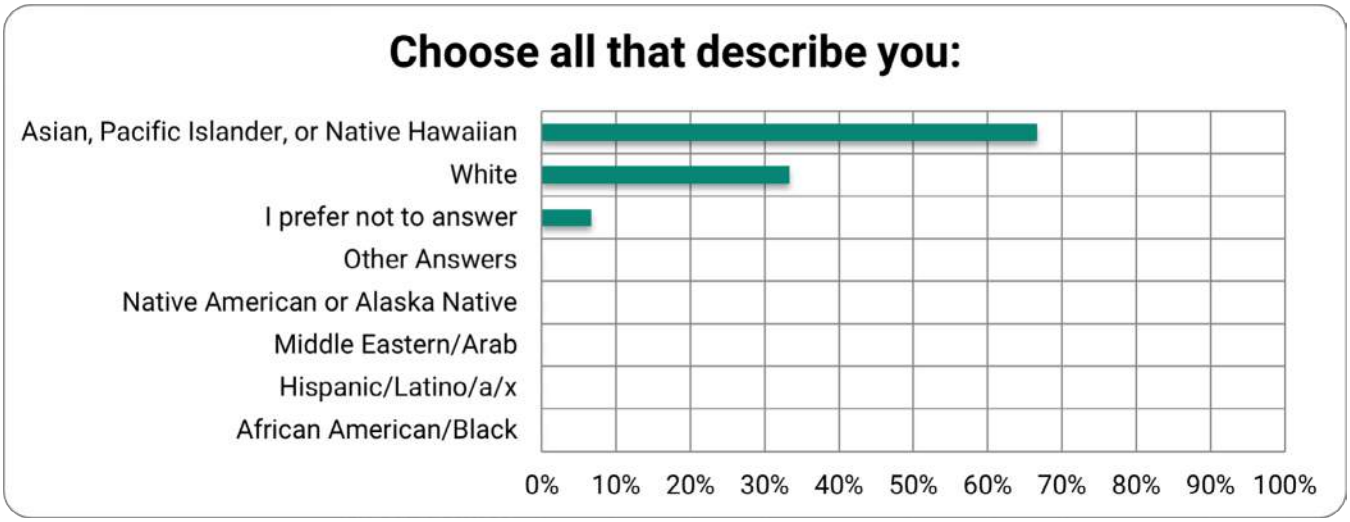


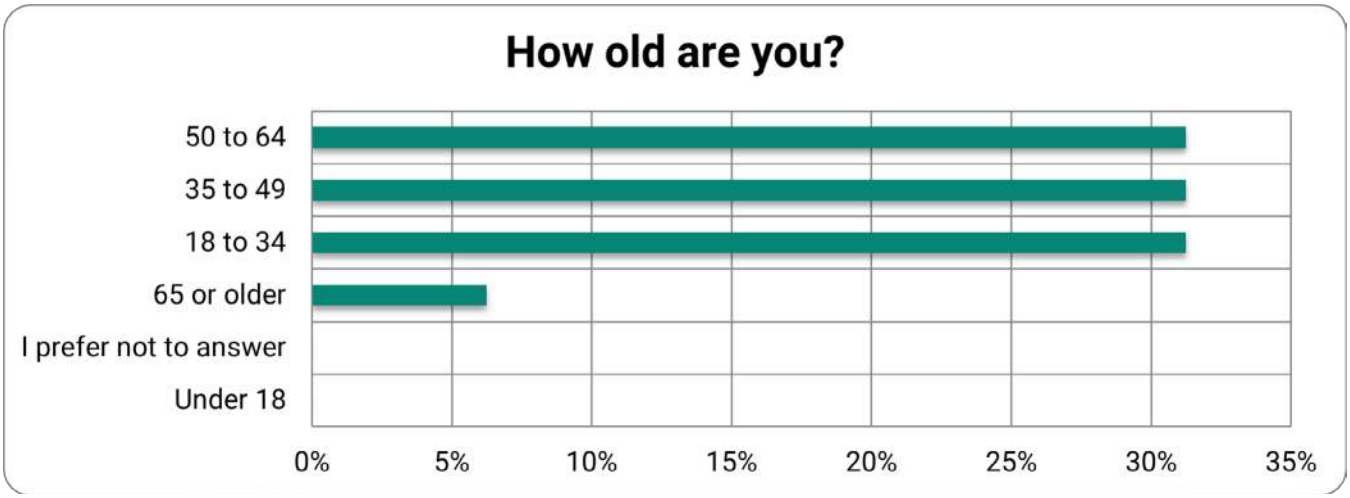


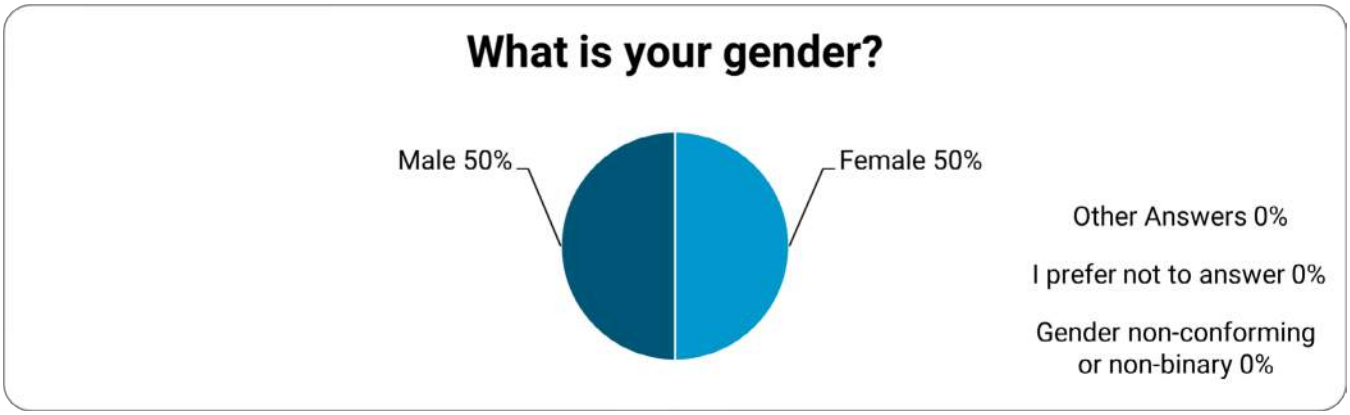


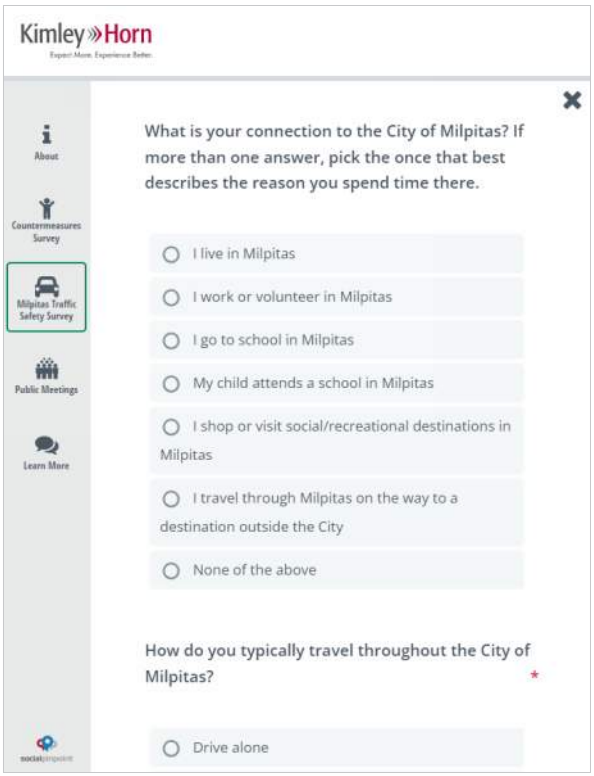

How do you typically travel throughout the City of Milpitas?
Drive alone
Bike or scooter
Walk
Carpool with others
I use a mobility device (like a walker or wheelchair)
Bus or paratransit
0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%


Please identify the top three challenge areas when it comes to traveling in the City of Milpitas.
Aggressive driving (speeding Stop sign or red-light running violations)
Traffic signals (poor visibility, signal timing, conflicts with pedestrians or bicyclists, etc.)
Pedestrian crossings (long crossing distance, deteriorated pavement striping, sidewalk gaps, etc.)
Improved signage and pavement markings
Street Lighting
Signage and striping (unclear or faded, additional signage needed, etc.)
Trucks/Commercial vehicles
Distracted driving
ADA Accessibility
Construction work zone safety
Bicycle lanes (narrow/missing bike lanes at intersections or segments)
0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%
Top Choice
Second Choice
Third Choice


Choose all that describe you:
Asian, Pacific Islander, or Native Hawaiian
White
I prefer not to answer
Other Answers
Native American or Alaska Native
Middle Eastern/Arab
Hispanic/Latino/a/x
African American/Black
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%


How old are you?
50 to 64
35 to 49
18 to 34
65 or older
I prefer not to answer
Under 18
0%
5%
10%
15%
20%
25%
30%
35%


What is your gender?
Male 50%
Female 50%
Other Answers 0%
I prefer not to answer 0%
Gender non-conforming or non-binary 0%



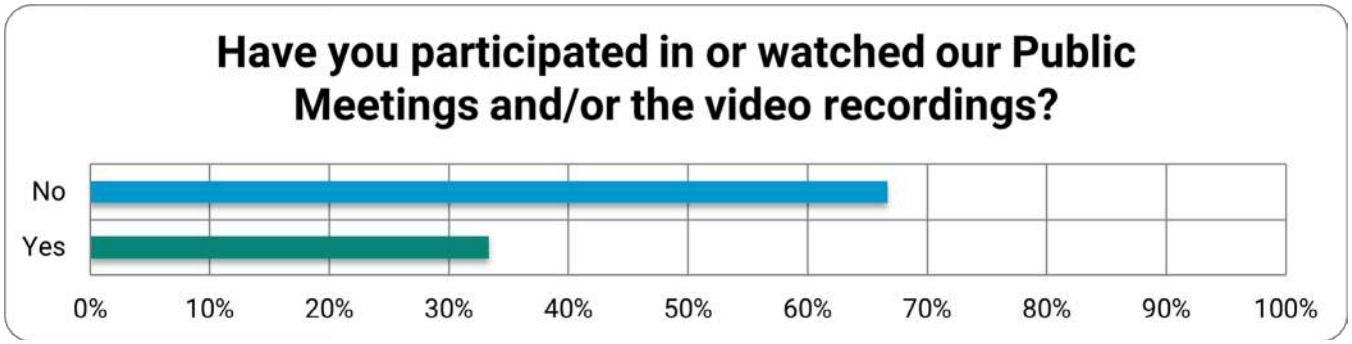
6.1.1. Key Themes from the Milpitas Traffic Safety Survey

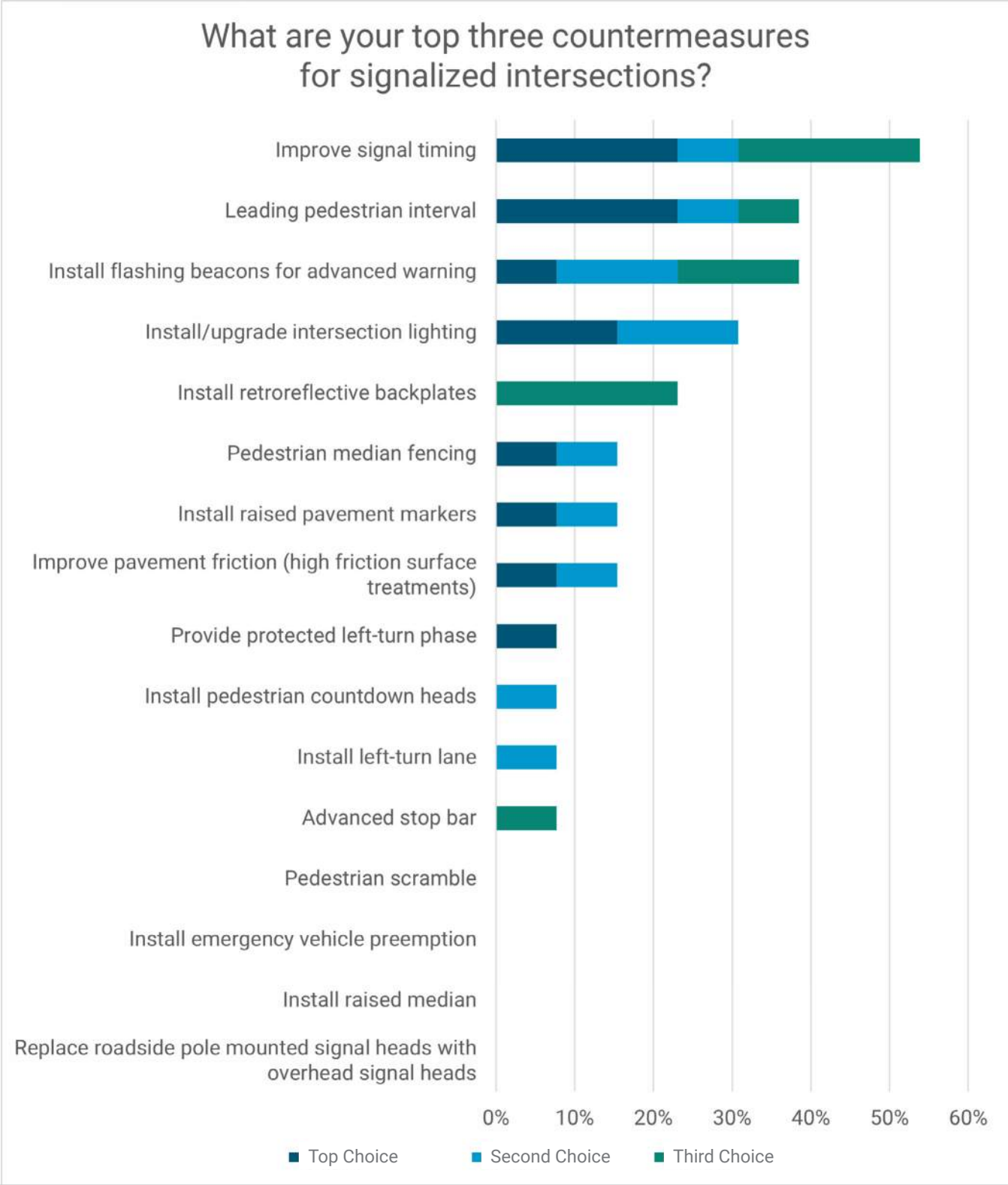
- *I think most people who take these surveys prioritize traffic volume and speed over pedestrian and bicycle safety. Please find ways to make walking and running safer in Milpitas.*
- *I would like to bike to more destinations in Milpitas, but the bike lanes along busy roads like Milpitas Boulevard and Montague Expressway are unprotected and intimidating with the 50+ MPH traffic. There are no biking alternatives to these arterials in the Great Mall area.*
- *I would like to see signal timing improved. I would like traffic police to site infractions, right turn on red no one stops anymore, and it is a safety issue all around.*
- *Lot of parked vehicles on side of road create big blind spots when taking left as well as right turns, find the solutions to not to park on the main roads like S Park Victoria Drive*
- *Traffic issues in Milpitas span far and wide. Not only are the roads not well maintained, but the bicycle network is also non-existent and unsafe on many of the main roads. People cannot bike or walk safely. Drivers also are extremely aggressive and there are little to no Complete Streets built into the city at all. Please make it easier for folks to get around outside of vehicles.*

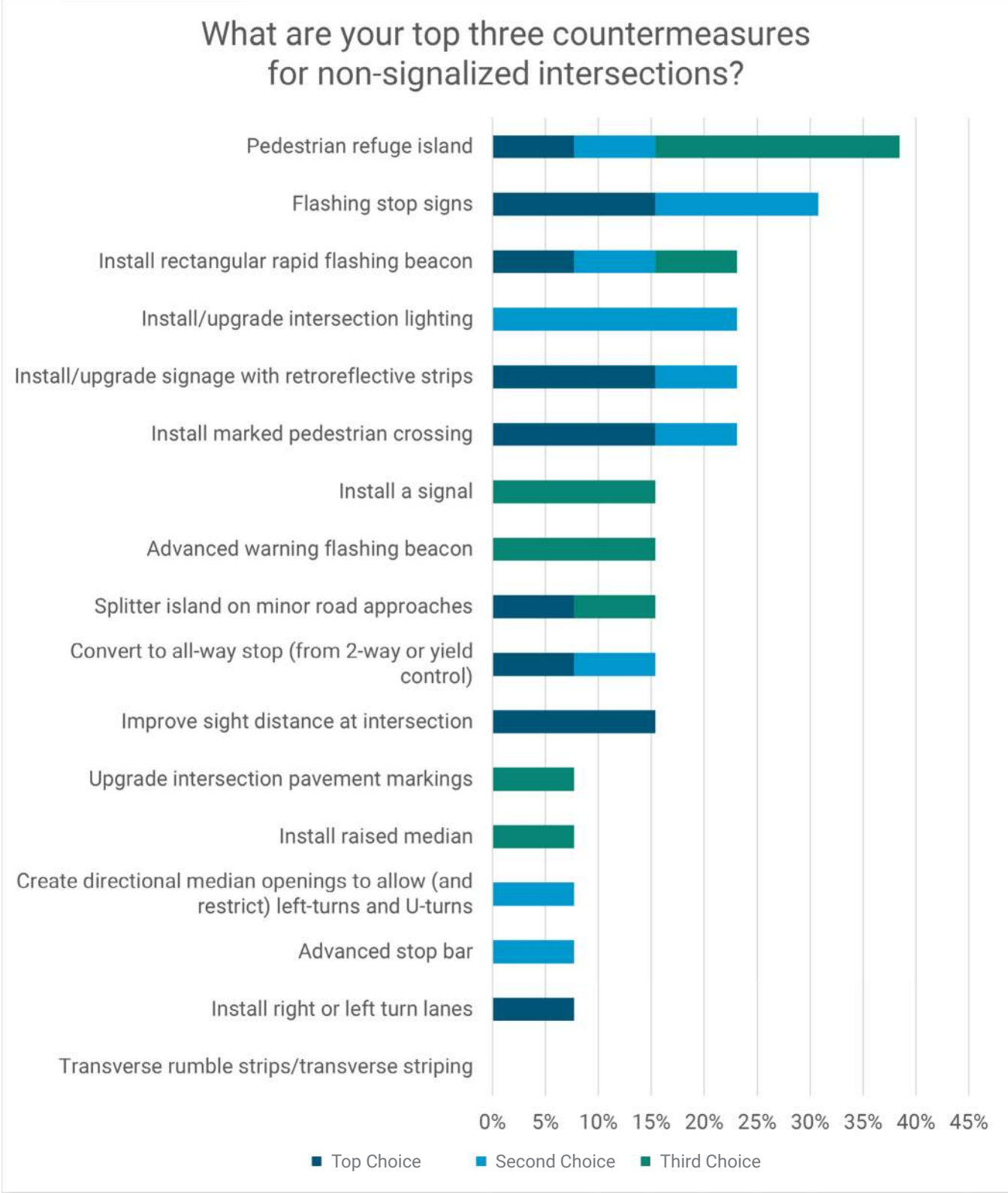
6.2. Countermeasure Toolbox Survey

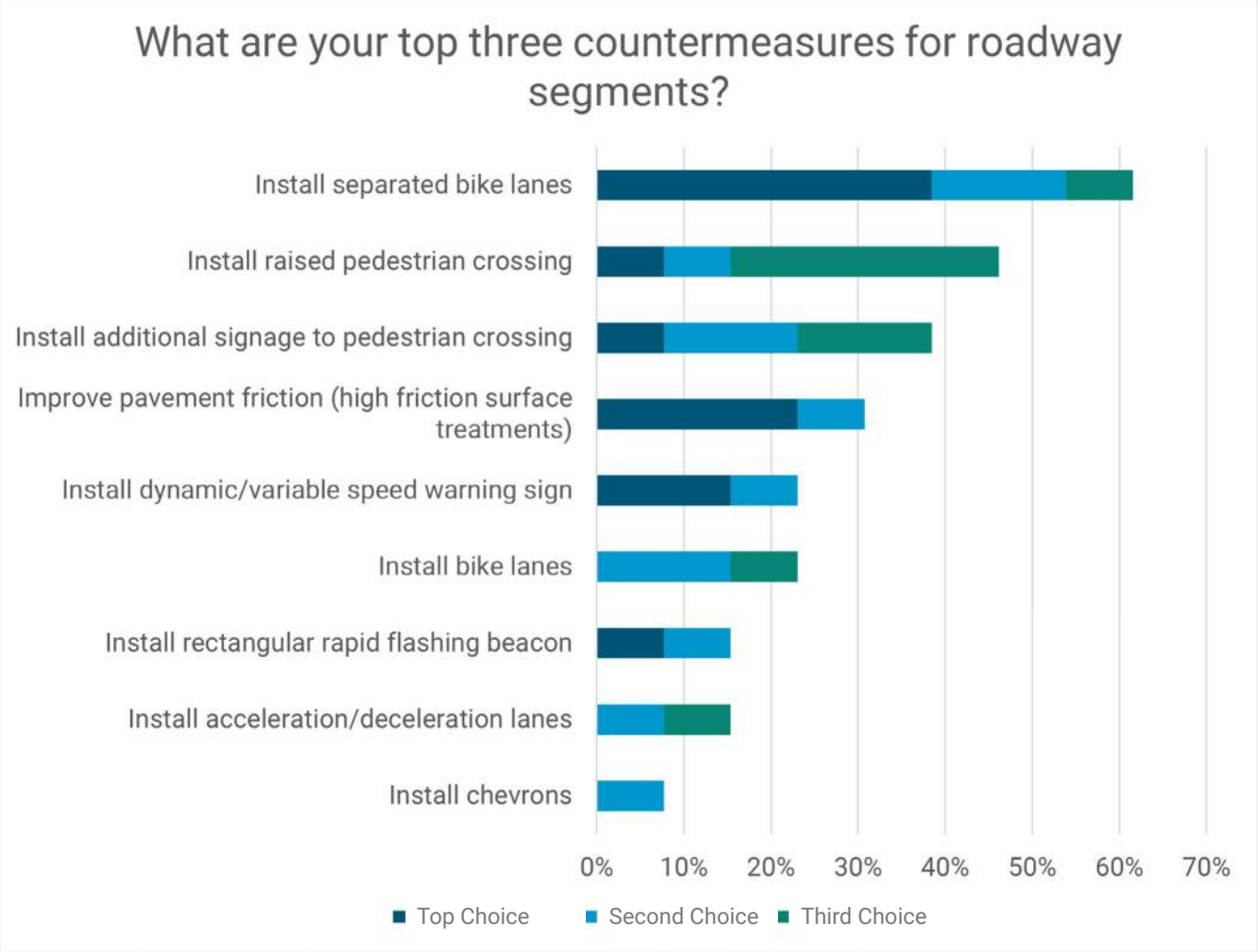
The release of the Countermeasure Toolbox Survey marked the second round of engagement and was released following the in-person public meeting on May 17, 2023. The survey was paired with the Traffic Safety Project June 2023 Update Video that provided a project overview and summary of the completed efforts to date. Participants were then asked to respond to a brief survey that summarized their understanding of the countermeasures for signalized intersections, non-signalized intersections, and roadway segments.

During this second round of public engagement, most survey participants noted that they had not previously attended or watched the public meeting. Users were then asked to rank their top three safety countermeasures for each of the different facility types - intersections and roadway segments. For signalized intersections, most participants highlighted opportunities to improve signal timing, implement leading pedestrian interval, and install flashing beacons for advanced warning sign as their first, second, and third choice among the safety countermeasures, respectively. Pedestrian refuge island and flashing stop signs were the top two countermeasures for non-signalized intersections, followed by both the installation/upgrade of signage with retroreflective strips and the installation of marked pedestrian crossings. Participants noted that their top three countermeasures for roadway segments were installation of separated bike lanes, installation of raised pedestrian crossings, and installation of additional signage at pedestrian crossings.




What are your top three countermeasures for signalized intersections?
Improve signal timing
Leading pedestrian interval
Install flashing beacons for advanced warning
Install/upgrade intersection lighting
Install retroreflective backplates
Pedestrian median fencing
Install raised pavement markers
Improve pavement friction (high friction surface treatments)
Provide protected left-turn phase
Install pedestrian countdown heads
Install left-turn lane
Advanced stop bar
Pedestrian scramble
Install emergency vehicle preemption
Install raised median
Replace roadside pole mounted signal heads with overhead signal heads
0%
10%
20%
30%
40%
50%
60%
Top Choice
Second Choice
Third Choice

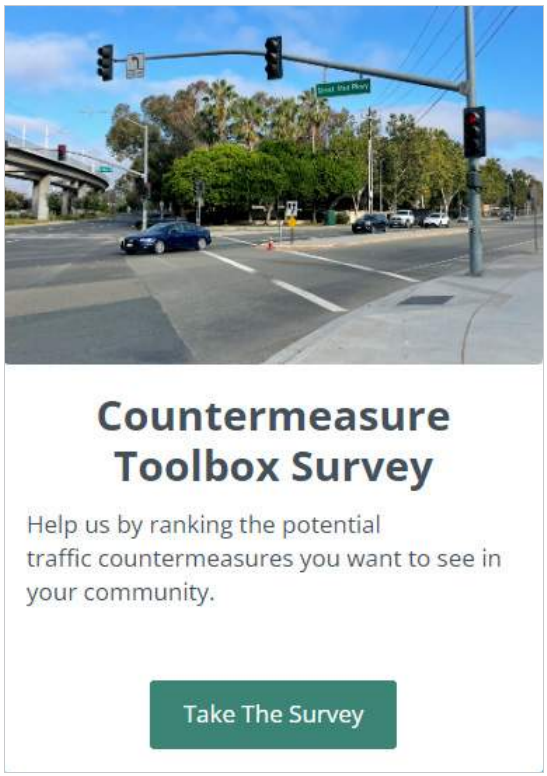

What are your top three countermeasures for non-signalized intersections?
Pedestrian refuge island
Flashing stop signs
Install rectangular rapid flashing beacon
Install/upgrade intersection lighting
Install/upgrade signage with retroreflective strips
Install marked pedestrian crossing
Install a signal
Advanced warning flashing beacon
Splitter island on minor road approaches
Convert to all-way stop (from 2-way or yield control)
Improve sight distance at intersection
Upgrade intersection pavement markings
Install raised median
Create directional median openings to allow (and restrict) left-turns and U-turns
Advanced stop bar
Install right or left turn lanes
Transverse rumble strips/transverse striping
0%
5%
10%
15%
20%
25%
30%
35%
40%
45%
Top Choice
Second Choice
Third Choice

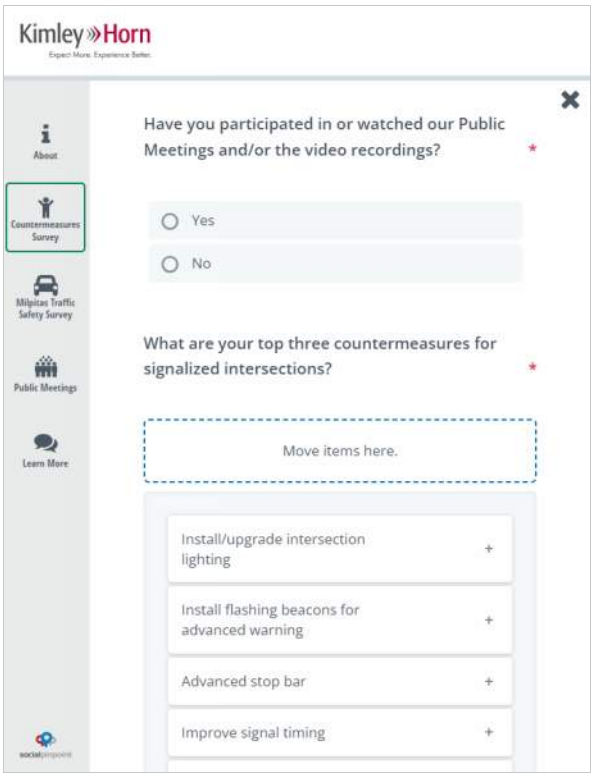

What are your top three countermeasures for roadway segments?
Install separated bike lanes
Install raised pedestrian crossing
Install additional signage to pedestrian crossing
Improve pavement friction (high friction surface treatments)
Install dynamic/variable speed warning sign
Install bike lanes
Install rectangular rapid flashing beacon
Install acceleration/deceleration lanes
Install chevrons
0%
10%
20%
30%
40%
50%
60%
70%
Top Choice
Second Choice
Third Choice

6.2.1. Key Themes from the Countermeasures Survey

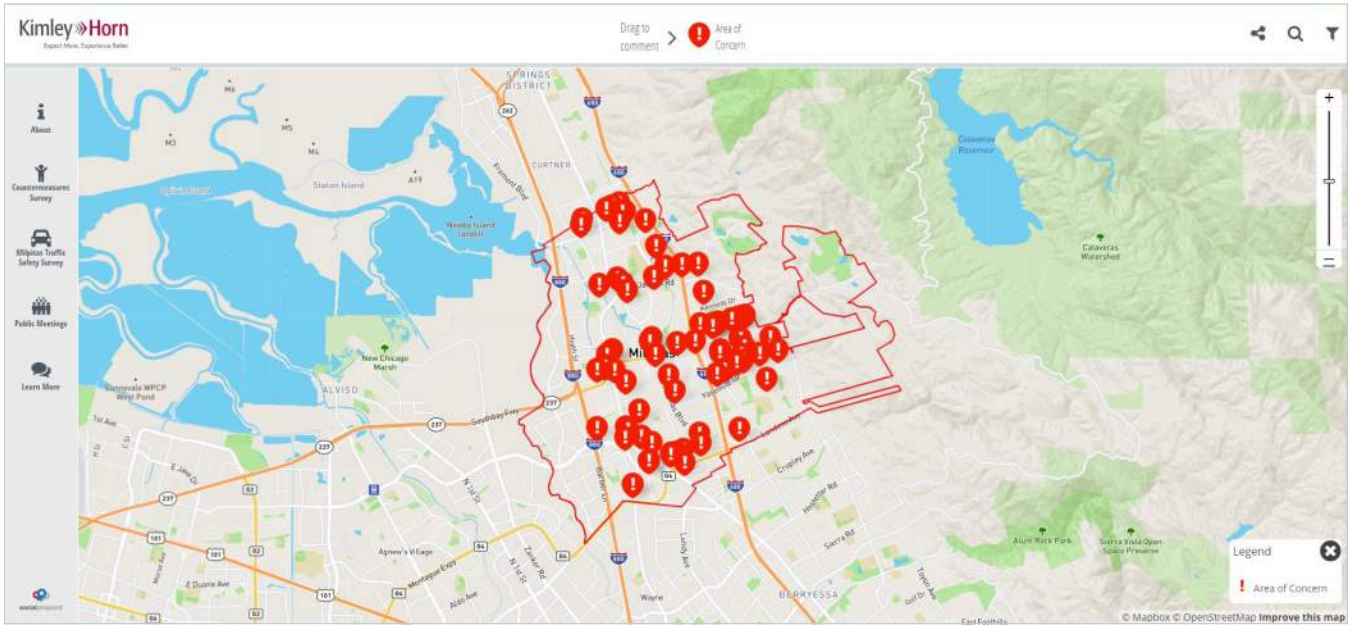
From all the comments received from the on-line map, key areas of focus and themes were as follows:

- *High traffic areas need attention and new lanes before things get worse.*
- *Signal malfunction takes a long time to turn green.*
- *I would like to bike to more destinations in Milpitas, but the bike lanes along busy roads are unprotected and intimidating with the 50+ MPH traffic.*
- *Would be grateful if residents park their vehicles in their garage or driveway during school drop off & dismissal hours, as it gets very hard to find parking.*
- *Dangerous area due to a very curvy & narrow road with a signal that is hard to see.*
- *New lane needs to be added due to traffic congestion. Lots of traffic & no place to park during school hours.*
- *High traffic zone that needs road expansion on East Calaveras Blvd because everyone wants to go to SR-237.*
- *Please find ways to make walking and running safer in Milpitas.*

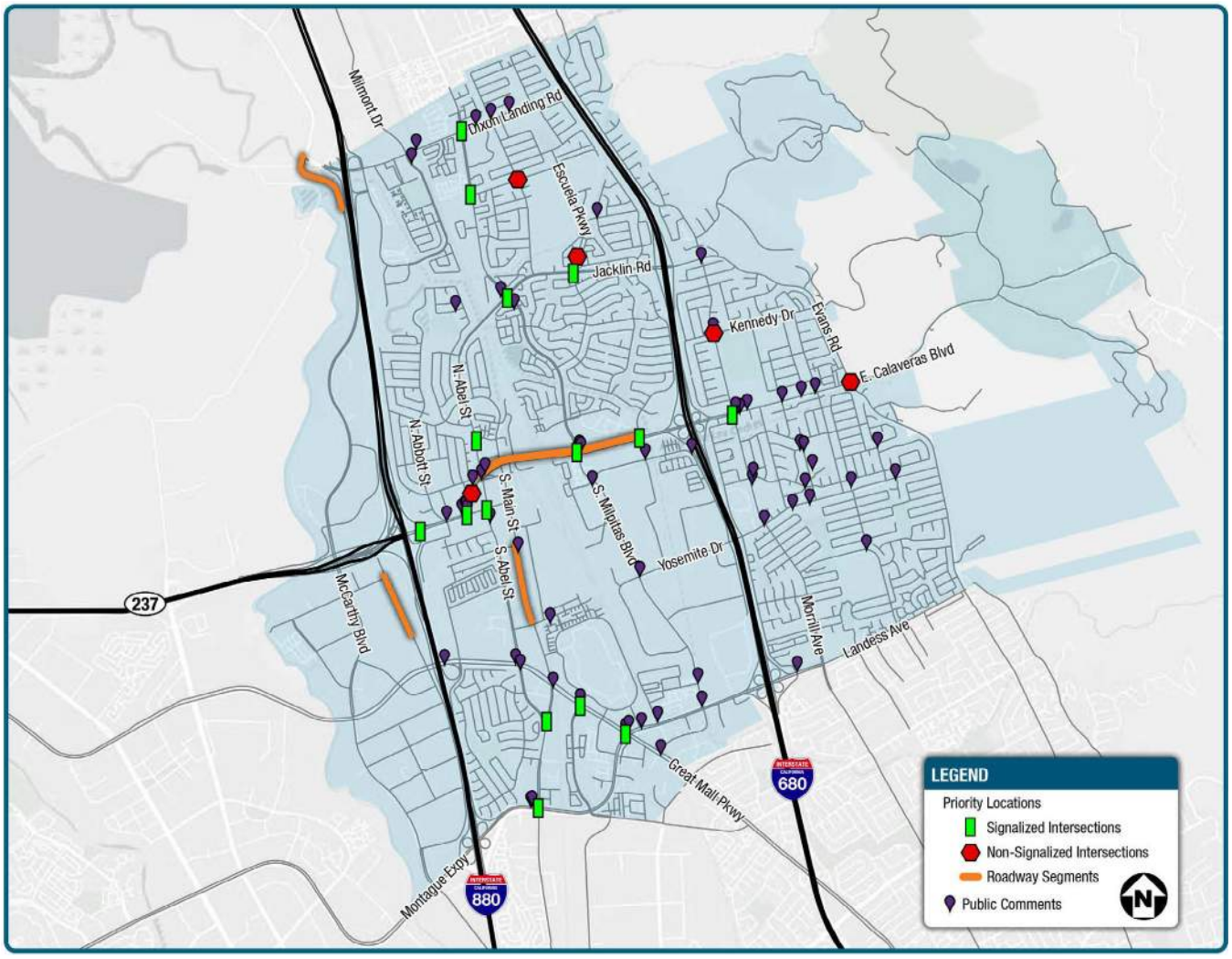




SCREENSHOT OF INTERACTIVE MAPPING SURVEY VIA SOCIAL PINPOINT PLATFORM



SUMMARIZED PUBLIC COMMENTS COMPILED WITH COUNTERMEASURE LOCATIONS



SAFETY CHALLENGES IDENTIFIED THROUGH SOCIAL PINPOINT

The online interactive map survey asked participants to geographically locate areas of concern or traffic safety challenges that they experience within the City of Milpitas. This was then followed by one question survey that sought to identify the specific challenges experienced at each location. Most participants identified aggressive driver behavior as the top traffic safety challenge experienced throughout the city.

A full list of legible comments is provided in **Appendix C**.

All feedback received from Round 1 Public Engagement was cross referenced with the proposed countermeasures for signalized intersections, non-signalized, and roadway segments and was used to inform recommended safety treatments presented in the following sections of the report.

7. COUNTERMEASURES

The following sections provide more information on potential engineering and non-infrastructure safety countermeasures that might address conditions that were observed to contribute to crash activity in the City.

7.1. Engineering Countermeasures

While there are many safety countermeasures that could be used to systemically improve roadway safety, the following sections provide countermeasures for consideration by the City of Milpitas. The following sections contain a description of Crash Modification Factors (CMFs) and Crash Reduction Factors (CRFs) associated with the engineering countermeasures toolbox.

7.1.1. Crash Modification Factors and Crash Reduction Factors

When identifying potential systemic safety improvements, it is important to look at CMFs for the proposed improvements. The CMF Method is found in Part D of the HSM. CMFs are defined as the ratio of effectiveness of one condition in comparison to another condition and represent the relative change in crash frequency due to a change in one specific condition. In other words, a CMF is a multiplicative factor used to compute the expected number of crashes after implementing a given countermeasure at a specific site. Countermeasures with CMFs less than one are expected to reduce crashes if applied, while those countermeasures with CMFs greater than one are expected to increase crashes. **Figure 19** illustrates the definition of CMFs.

Figure 19: CMF Calculation

$$CMF = \frac{\text{EXPECTED CRASHES WITH TREATMENT}}{\text{EXPECTED CRASHES WITHOUT TREATMENT}}$$

CMF = 1.0	Expected to have no impact on safety
CMF < 1.0	Expected to reduce crashes
CMF > 1.0	Expected to increase crashes

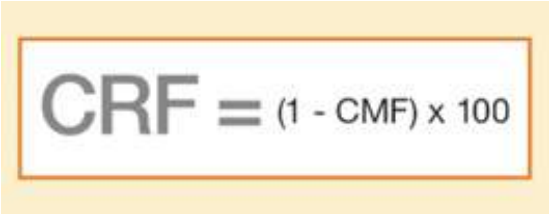
The CMF Method is used to calculate the expected number of crashes by taking the observed number of crashes and multiplying those crashes by the applicable CMF for the proposed countermeasure. It is recommended that CMFs be applied to a minimum of three years of crash data for urban and suburban sites and five years of crash data for a rural site. **Figure 20** is a sample calculation of the CMF method with one CMF being applied to a particular site for a single year.

Figure 20: CMF Method Sample Calculation

10.1 crashes / year x 0.91 (CMF) =	9.2 crashes / year: a reduction of 0.9 total crashes per year and a CRF of 9%

A CRF is similar to a CMF but stated in different terms. A CRF is defined as a percentage of crash reduction that might be expected after the implementation of a given countermeasure at a specific site. **Figure 21** shows how a CRF is calculated in relationship to a CMF.

Figure 21: CRF Calculation



Caution should be used in the selection of appropriate CMFs. The following guidance should be considered when selecting CMFs for predictive crash analysis:

- CMFs should be selected from the HSM Part D, The *Local Roadway Safety Manual: A Manual for California's Local Road Owners* (Version 1.5, April 2020), or from the Federal Highway Administration's (FHWA) CMF Clearinghouse website (http://www.cmfclearinghouse.org).
- Read the countermeasure abstract to determine if the CMF is applicable to the proposed improvement.
- Only CMFs with a four-star rating or higher should be considered for use in analysis.
- Be sure the selected CMF is applicable to the set of crash data being used for analysis. Some CMFs may only be applicable to a subset of the crash data.
- The application of multiple CMFs can overestimate the expected crash reduction. Unless each CMF addresses independent crash types, multiple CMFs should not be used. It is suggested that no more than three independent CMFs be applied to a particular site.

The countermeasures proposed in this document were chosen because of their effectiveness in reducing crashes.

7.1.2. Engineering Countermeasures Toolbox

The systemic improvements identified as most likely effective for the City are listed in Appendix D and include low-cost and higher-cost items that can be implemented in phases where appropriate. CRFs have been provided for reference to aid the City in understanding potential reductions from crashes by different countermeasures. Implementation considerations and other factors such as effectiveness range and crash types addressed are also included in the toolbox.

7.2. Non-Infrastructure Countermeasures

The National Highway Traffic Safety Administration (NHTSA) *Countermeasures that Work, Ninth Edition*, is a reference to assist safety stakeholders in selecting effective, science-based non-infrastructure traffic safety countermeasures for major highway safety problem areas. While many of the countermeasures are more appropriate to apply at the state-level or require legislative modifications to implement, **Table 3** contains countermeasures that have demonstrated effectiveness and could be applied at the City level. Access to Drug Recognition Experts (DREs) and Advanced Roadside Impaired Driving Enforcement (ARIDE) training for law enforcement is not included in the document but is something that could also be considered for the City.

Table 3: City of Milpitas Non-Infrastructure Countermeasures Toolbox

Countermeasure	Effectiveness	Cost to Implement	Use	Time to Implement
Aggressive Driving				
Automated enforcement systems	*****	$$$†	Medium	Medium
Impaired Driving				
Publicized Sobriety Checkpoints	*****	$$$	Medium	Short
High-Visibility Saturation Patrols	****	$$	High	Short
Occupant Protection (Seat Belts, Helmets, Child Seats)				
Short-term high visibility enforcement	*****	$$$	Medium	Medium
Integrated nighttime seat belt enforcement	****	$$$	Unknown	Medium
Distracted Driving				
High visibility cellphone/text messaging enforcement	****	$$$	Low	Medium

Effectiveness:

****** Demonstrated to be effective by several high-quality evaluations with consistent results*
***** Demonstrated to be effective in certain situations*

Cost to Implement:

$$$ Requires extensive new facilities, staff, equipment, or publicity, or makes heavy demands on current resources
$$ Requires some additional staff time, equipment, facilities, and/or publicity
$ Can be implemented with current staff, perhaps with training; limited costs for equipment, facilities, and publicity
†Can be covered by income from citations

Use:

High: More than two-thirds of States, or a substantial majority of communities
Medium: Between one-third and two-thirds of States or communities
Low: Less than one-third of States or communities
Unknown: Data not available

Time to Implement:

Long: More than 1 year
Medium: More than 3 months but less than 1 year
Short: 3 months or less

8. PRIORITY LOCATIONS

As a result of the Citywide network screening analysis, 25 project case study locations were selected for further analysis and development of site-specific safety improvement recommendations. Project sheets were developed to provide a menu of potential safety countermeasures that the City can choose from when applying for funding. Pursuant to section 15262 in the California Code of Regulations, this plan is exempt from CEQA and does not require the preparation of an Environmental Impact Report (EIR) or a negative declaration. However, the CEQA requirements for each site-specific safety improvement project will need to be evaluated on a case-by-case basis prior to implementation. These locations were identified through the analysis process based on their crash histories, the observed crash patterns, and their differing characteristics to provide the most insight into potential systemic safety countermeasures that the City can employ to achieve the most cost-effective safety benefits.

Each project sheet includes location maps with a crash data summary, field notes, and list of recommended safety countermeasures with corresponding CMFs, number of crashes anticipated to be reduced, 10-year crash reduction estimate and benefit, and planning level construction cost estimates. The potential safety countermeasures identified reflect safety improvements that can be applied to reduce the likelihood of future crashes. Countermeasures were subjected to a benefit/cost assessment to determine their potential return on investment. These case studies can be used to select the most appropriate countermeasure(s), and to potentially phase improvements over the longer-term. The potential benefit of these countermeasures at locations with similar design characteristics can then be extrapolated regardless of crash history. These project sheets can also be used to position the City for future grant funding opportunities.

Table 4 presents a summary of recommended safety countermeasures identified for each priority location, the corresponding benefit/cost ratio, funding source, and timeline for implementation. The funding sources recommended in Table 4 are not limited to the source(s) listed, as other funding sources may be available. A summary of potential funding sources is included in Section 9.5 “Funding”. A project sheet was developed for each of the priority locations containing additional information and are included in **Appendix E**.

Table 4: Priority Locations

SIGNALIZED INTERSECTIONS				
Location	**Improvements**	**B/C***	**Funding**	**Implementation**
Great Mall Pkwy & Montague Expy	Implement Leading Pedestrian Interval (LPI) to increase pedestrian crossing time	9.0	HSIP	Near-Term
	Install retroreflective backplates on traffic signal heads	79.5	HSIP	Near-Term
	Install advance stop bar	86.1	Local	Near-Term
	Install pedestrian median fencing on Northern approach to address jaywalking	0.3	SS4A	Mid-Term
	Install APS (accessible pedestrian signals)	-	SS4A	Mid-Term
	ADA ramp upgrades	-	SS4A	Mid-Term
E Calaveras Blvd & N Milpitas Blvd	Install retroreflective backplates on traffic signal heads	122.9	HSIP	Near-Term
	Modify signal phasing to implement a Leading Pedestrian Interval (LPI)	87.4	HSIP	Near-Term
	Install advance stop bar (all approaches)	607.2	Local	Near-Term
	Install traffic signal ahead flashing beacon on the EB Calaveras approach to intersection	401.7	Local	Near-Term
	ADA ramp upgrades	-	SS4A	Mid-Term

**B/C is calculated using the crash reduction factor associated with the countermeasure. The economic benefit resulting from the reduction in crashes is divided by the cost of the improvement. The specific values are listed in Appendix D. Improvements without a B/C are beneficial but do not have a corresponding crash reduction factor in the LRSM at this time.*

Location	Improvements	B/C*	Funding	Implementation
W Calaveras Blvd & Serra Wy	Install retroreflective backplates on traffic signal heads. Upgrade 8" heads to 12" heads	27.4	HSIP	Near-Term
	Modify signal phasing to implement a Leading Pedestrian Interval (LPI)	49.4	HSIP	Near-Term
	Install advance stop bar/yield lines at crosswalk approaches	1,238.2	Local	Near-Term
	Install pavement legends and signage indicating which lanes lead to NB/SB I-880 to prevent drivers needing to make late lane changes	621.8	Local	Near-Term
	Implement protected left turn phase on Serra/Driveway approaches	112.9	HSIP	Mid-Term
	Install additional safety lighting to Serra Approach	172.7	SS4A	Long-Term
	Redesign curb ramps and crossings to be ADA compliant	-	SS4A	Mid-Term
	Update crosswalk striping per MUTCD school zone striping requirement.	-	Local	Near-Term
	Upgrade median islands to be appropriate height, currently too low.	-	Local	Long-Term
E Calaveras Blvd & S Hillview Dr	Modify signal phasing to implement a Leading Pedestrian Interval (LPI)	16.8	HSIP	Near-Term
	Install advance stop bars (all approaches)	571.1	Local	Near-Term
	Install retroreflective backplates on traffic signal heads	50.7	HSIP	Near-Term
	Install APS (accessible pedestrian signals)	-	SS4A	Mid-Term

**B/C is calculated using the crash reduction factor associated with the countermeasure. The economic benefit resulting from the reduction in crashes is divided by the cost of the improvement. The specific values are listed in Appendix D. Improvements without a B/C are beneficial but do not have a corresponding crash reduction factor in the LRSM at this time.*

Location	Improvements	B/C*	Funding	Implementation
N Milpitas Blvd & N Abel St	Install retroreflective backplates on traffic signal heads. Install additional signal head to through lanes on Abel St/Jacklin Rd	71.0	HSIP	Near-Term
	Add an overlap phase to the westbound right-turn	145.5	HSIP	Near-Term
	Modify signal phasing to implement a Leading Pedestrian Interval (LPI)	2.4	HSIP	Near-Term
	Install cat-tracks for NBL lane to guide vehicles through the intersection	3,581.4	Local	Near-Term
	Implement green conflict zone striping for bike lanes	0.4	SS4A	Near-Term
	Redesign the median to provide a NACTO compliant pedestrian refuge area, or consider removal of pedestrian push buttons	-	SS4A	Long-Term
	Improve sight distance for vehicles turning right from N Abel St to N Milpitas Blvd by trimming vegetation on the South corner	-	Local	Near-Term
	ADA ramp upgrades	-	SS4A	
	At the Northwest corner: Install a R1-5 sign at the pedestrian crossing. Install a W4-2 sign and merge pavement markings on SB Abel St South of the intersection.	-	Local	Near-Term
Serra Wy & S Abel St	Install retroreflective backplates on traffic signal heads	31.9	HSIP	Near-Term
Dixon Landing Rd & N Milpitas Blvd	Implement advance stop bar and green conflict zone striping for bike lanes	3.5	SS4A	Near-Term
	Install buffered bike lanes and standard pavement markings on the Dixon Landing intersection approaches	4.6	SS4A	Mid-Term
	Install additional safety lighting to EB Dixon Landing Rd	11.2	SS4A	Mid-Term
	Install retroreflective backplates on traffic signal heads	26.4	HSIP	Near-Term
	Re-orient the pedestrian countdown head on the West leg of the intersection to face South	-	Local	Near-Term
	Straighten out the crosswalk across the North leg of the intersection to provide more distance between cars travelling WB on Dixon Landing Rd and pedestrians in the crosswalk	-	Local	Near-Term

**B/C is calculated using the crash reduction factor associated with the countermeasure. The economic benefit resulting from the reduction in crashes is divided by the cost of the improvement. The specific values are listed in Appendix D. Improvements without a B/C are beneficial but do not have a corresponding crash reduction factor in the LRSM at this time.*

Location	Improvements	B/C*	Funding	Implementation
W Calaveras Blvd & I-880 Ramps	Upgrade 8" signal heads to 12" signal heads.	13.6	HSIP	Near-Term
	Install yield lines at pedestrian crossing at I-880 ramps and stripe high visibility crossings	53.0	Local	Near-Term
	Install RRFB at pedestrian crossing across the EB Calaveras to I-880 On-Ramp	1.2	SS4A	Near-Term
Great Mall Pkwy & McCandless Dr	Install retroreflective backplates on traffic signal heads	24.9	HSIP	Near-Term
	Install advance stop bars and continental crosswalk across the north leg of the intersection (across Great Mall Pkwy)	-	Local	Near-Term
	Remove Bott's Dotts and install thermoplastic lane markings on Great Mall Pkwy approaches	-	Local	Mid-Term
	Install APS (accessible pedestrian signals)	-	SS4A	Mid-Term
S Main St & Montague Expy	Install retroreflective backplates on traffic signal heads	22.2	HSIP	Near-Term
	Coordinate traffic signal with the traffic signal at Montague Expy and McCandless Dr/Trade Zone Blvd	26.6	Local	Near-Term
	Install merge warning sign (MUTCD W4-2) on SBR movement, Install merge pavement markings	201.1	Local	Near-Term
	Install W3-3 traffic signal ahead sign on EB Montague Expy	850.6	Local	Near-Term
	ADA ramp upgrades (north and south sidewalks, and at private driveway splitter island)	-	SS4A	Mid-Term
	Upgrade median islands to be appropriate height, currently too low.	-	SS4A	Long-Term

**B/C is calculated using the crash reduction factor associated with the countermeasure. The economic benefit resulting from the reduction in crashes is divided by the cost of the improvement. The specific values are listed in Appendix D. Improvements without a B/C are beneficial but do not have a corresponding crash reduction factor in the LRSM at this time.*

Location	Improvements	B/C*	Funding	Implementation
S Main St & Abel St	Install additional SBL signal head for better visibility. Add retroreflective borders to all signal heads.	59.1	HSIP	Near-Term
	Restripe limit lines to allow for 4-feet of clearance	-	Local	Near-Term
	Install additional safety lighting to the SB Main St approach	72.9	SS4A	Mid-Term
	Install emergency vehicle pre-emption	2.7	HSIP	Mid-Term
	Restripe limit lines to allow for 4-feet of clearance	-	Local	Near-Term
	Study lighting levels to determine if the existing lamp poles provide sufficient lighting, or if additional luminaires are required	-	SS4A	Long-Term
E Calaveras & S Park Victoria	Install retroreflective backplates and upgrade to 12" signal heads	2.1	HSIP	Mid-Term
	Install continental crosswalks and advance stop bars	8.5	Local	Near-Term
	Install APS (accessible pedestrian signals)	-	SS4A	Mid-Term
	Restripe the receiving lanes on NB S Park Victoria	-	Local	Near-Term
Escuela Pkwy & Jacklin Rd	Install retroreflective backplates and upgrade to 12" signal heads	5.4	HSIP	Near-Term
	Implement green conflict zone striping for bike lanes on Escuela Pkwy	-	SS4A	Near-Term
	Redesign the median to provide a NACTO compliant pedestrian refuge area, or consider removal of pedestrian push buttons	-	SS4A	Long-Term

**B/C is calculated using the crash reduction factor associated with the countermeasure. The economic benefit resulting from the reduction in crashes is divided by the cost of the improvement. The specific values are listed in Appendix D. Improvements without a B/C are beneficial but do not have a corresponding crash reduction factor in the LRSM at this time.*

Location	Improvements	B/C*	Funding	Implementation
Weller Ln & N Abel St	Install retroreflective backplates and upgrade to 12" signal heads	7.9	HSIP	Near-Term
	Install advance stop bar before crosswalk	785.1	Local	Near-Term
	Install thermoplastic pavement marking as intersection approaches. Additionally, stripe a bike lane though the intersection on SB Abel St to support bicyclist safety and provide a buffer between SB vehicles and the pedestrian facilities.	96.7	Local	Near-Term
	Modify signal phasing to implement leading pedestrian interval (LPI)	55.4	HSIP	Near-Term
	Install pedestrian countdown signal heads	32.2	HSIP	Mid-Term
	Install APS (accessible pedestrian signals) for crosswalks across Abel St	-	SS4A	Mid-Term
Washington Dr & N Milpitas Blvd	Install retroreflective backplates and upgrade to 12" signal heads	5.1	HSIP	Near-Term
	Install advance stop bars on N Milpitas Blvd	97.9	Local	Near-Term
	Install thermoplastic pavement marking at intersection approaches.	35.8	Local	Near-Term
	Modify signal phasing to implement lead pedestrian interval (LPI)	8.4	Local	Near-Term
	Install pedestrian countdown signal heads	3.7	HSIP	Mid-Term
	Install APS (accessible pedestrian signals)	-	SS4A	Mid-Term
	Redesign the median to provide a NACTO compliant pedestrian refuge area, or consider removal of pedestrian push buttons	-	SS4A	Long-Term

**B/C is calculated using the crash reduction factor associated with the countermeasure. The economic benefit resulting from the reduction in crashes is divided by the cost of the improvement. The specific values are listed in Appendix D. Improvements without a B/C are beneficial but do not have a corresponding crash reduction factor in the LRSM at this time.*

UNSIGNALIZED INTERSECTIONS				
Location	**Improvements**	**B/C***	**Funding**	**Implementation**
Butler St & W Calaveras Blvd	Update pavement markings, adding a pedestrian crosswalk and advance stop bar	491.2	HSIP	Mid-Term
	Install splitter island on west leg channeling vehicles into right turn with pedestrian refuge (north leg)	20.4	SS4A	Mid-Term
	ADA ramp upgrades	-	SS4A	Mid-Term
	Install bulb outs (NW and SW corners)	-	SS4A	Mid-Term
Washington Drive & Arizona Ave	Install retroreflective strips on stop sign posts	246.4	HSIP	Mid-Term
	Install stop ahead warning signs ahead of intersection on Arizona Avenue	273.8	HSIP	Near-Term
	Install stop ahead pavement markings on Arizona Avenue	553.5	HSIP	Near-Term
	Install centerline pavement marker (Caltrans Standard Plan A20A, Detail 21) on all approaches	293.4	HSIP	Near-Term
	Install bulb outs on all corners	-	SS4A	Mid-Term
	Install new road signs at the NW corner	-	Local	Near-Term
Altamont Dr & Escuela Pkwy	Install centerline pavement marker (Caltrans Standard Plan A20A, Detail 21) on all approaches	228.4	Local	Near-Term
	Install bulb outs on all corners	-	SS4A	Mid-Term
	Install retroreflective strips on stop sign posts	383.8	HSIP	Near-Term
	Install school zone pedestrian crossing across Escuela Pkwy	57.1	SS4A	Near-Term
	Add green bike lane pavement marking in conflict areas across Altamont Dr	66.6	SS4A	Near-Term
	Install stop bar on side street and install school zone pedestrian crossing striping across Altamont Dr	55.7	Local	Near-Term
	Install bulb outs on all corners	-	SS4A	Mid-Term

**B/C is calculated using the crash reduction factor associated with the countermeasure. The economic benefit resulting from the reduction in crashes is divided by the cost of the improvement. The specific values are listed in Appendix D. Improvements without a B/C are beneficial but do not have a corresponding crash reduction factor in the LRSM at this time.*

Location	Improvements	B/C*	Funding	Implementation
Calaveras Rd & Evans Rd	Install advance stop bars and green conflict zone bike lane treatment at intersection approaches	4.5	SS4A	Near-Term
	Install supplemental intersection safety lighting	1.7	SS4A	Long-Term
	Install raised median on EB Calaveras Blvd approach	2.9	SS4A	Mid-Term
	Install retroreflective strips on stop sign posts	150.5	HSIP	Near-Term
Kennedy Dr & N Park Victoria Dr	Install reflective strips on stop sign posts	1,084.7	HSIP	Near-Term
	Install R1-5b signs at advance stop bars and install R1-6a signs in the medians on the Southbound and Northbound approaches.	873.6	Local	Near-Term
	Install buffered bike lanes and standard pavement markings on N Park Victoria including the intersection approaches	33.0	SS4A	Mid-Term
ROADWAY SEGMENT				
Location	**Improvements**	**B/C***	**Funding**	**Implementation**
E Calaveras Blvd (N Milpitas Blvd – Hillview Dr)	Install retroreflective backplates on traffic signal heads	38.9	HSIP	Near-Term
	Coordinate the traffic signal at Town Center Dr with the signals at Milpitas Blvd and Hillview Dr	20.4	HSIP	Near-Term
	Install buffered bike lane. Install green bike lane striping in conflict areas.	1.1	SS4A	Near-Term
E Calaveras Blvd (Abel St – Milpitas Blvd)	Install yield lines at pedestrian crossing at Calaveras off-ramp to Main Street and stripe high visibility crossing	186.6	Local	Near-Term
	Install W3-3 traffic signal ahead sign on EB Calaveras Blvd	2,309.5	Local	Near-Term
	Install RRFB at pedestrian crossing at Calaveras off-ramp to Main Street	2.1	SS4A	Mid-Term
	Install high friction surface treatment on intersection approaches	8.4	Local	Long-Term

**B/C is calculated using the crash reduction factor associated with the countermeasure. The economic benefit resulting from the reduction in crashes is divided by the cost of the improvement. The specific values are listed in Appendix D. Improvements without a B/C are beneficial but do not have a corresponding crash reduction factor in the LRSM at this time.*

Location	Improvements	B/C*	Funding	Implementation
S Main St (W Curtis Ave – Corning Ave)	Install pedestrian refuge island and high-visibility crosswalk	62.7	SS4A	Long-Term
	Restrict parking at pedestrian crossings to improve sight distance	1,375.1	Local	Near-Term
	Install roadway lighting at the pedestrian crossings	22.9	SS4A	Long-Term
S McCarthy (Dixon Landing – Sprig Center Dwy)	Install solar, radar speed feedback sign at NB curve	139.1	Local	Near-Term
	Install High Friction Surface Treatment (HFST)	20.8	HSIP	Mid-Term
	Install roadway lighting at the horizontal curves	91.6	HSIP	Long-Term
	Install chevrons on NB McCarthy Blvd	3,132.2	Local	Near-Term
	Install edgeline rumble strips on NB McCarthy Blvd	25.8	HSIP	Mid-Term
	Refresh Intersection Striping with high visibility thermoplastic	40.3	Local	Near-Term
Barber Ln (Bellew Dr – Alder Dr)	Install buffered bike lane with raised element EB & WB (removing parking). Install green bike lane striping in conflict areas.	2.9	SS4A	Mid-Term
	Install raised median along Barber Ln with directional median openings	0.2	Local	Mid-Term
	Install pedestrian refuge island at mid-block crossing	1.7	SS4A	Long-Term
	Install Left-turn lane on NB Barber Lane at the intersection with Bellew Dr	6.8	Local	Mid-Term

**B/C is calculated using the crash reduction factor associated with the countermeasure. The economic benefit resulting from the reduction in crashes is divided by the cost of the improvement. The specific values are listed in Appendix D. Improvements without a B/C are beneficial but do not have a corresponding crash reduction factor in the LRSM at this time.*

The countermeasures in **Appendix E** can be considered as near-term, mid-term and long-term improvements. Near-term improvements are lower cost and can be implemented most readily. Mid-term improvements are higher cost improvements, while long-term improvements are the highest cost and may require engineering design and permitting to implement.

Table 5: Near-Term, Mid-Term, and Long-Term Improvements

Near-Term Improvements (0-3 Years)	Mid-Term Improvements (3-5 Years)	Long-Term Improvements (5+ Years)
Install retroreflective backplates	Install rumble strips (edgeline and centerline)	Install left turn lane and add left turn phase
Install retroreflective strips	Install intersection lighting	Convert signal from pedestal mounted to mast arm
Install raised pavement markings and striping	Install emergency vehicle preemption	Install high-friction surface treatment
Install pedestrian countdown signal heads	Install protected left turn phase	Install signal
Advanced stop bars	Install raised median	Curb extensions and bulb-outs
Improve signal timing	Create directional median openings	Remove/relocate fixed object out of clear recovery zone
Implement Leading Pedestrian Interval	Install flashing beacons in advanced warning or curve or intersection	Install separated bike lanes
Implement All-Way-Stop-Control at intersection	Install pedestrian median fencing	Install acceleration/deceleration lanes
Install/Upgrade intersection warning/regulatory signs	Install splitter islands on minor road approaches	Add two-way left turn lane/ Implement road diet
Clear sight triangles	Install RRFB	Install pedestrian refuge island or raised pedestrian crossing
Install/upgrade pedestrian crossing	Install bike lane	
Colored bicycle lanes		
Install/upgrade signs with new fluorescent sheeting (regulatory or warning)		
Install delineators, reflectors and/or object markers		

9. IMPLEMENTATION GUIDE

9.1. Evaluation

The success of the Travel Safety Plan will be evaluated using the preliminary process outlined below. This process will be useful to ensure proper implementation of goals and to determine when updates are needed.

- Progress meetings are recommended to be conducted to track the implementation of the plan. In addition, the success of the plan will be evaluated on a reoccurring basis.
- An update to the plan should be considered after no more than five to seven years.
- Continued monitoring and recording of traffic incidents on local roadways by law enforcement.
- Maintain a list of focus areas where there are transportation safety concerns, based on historical crash data.

9.2. Implementation

Implementation of the Travel Safety Plan can be accomplished through several avenues including development of improvement projects, the establishment of new policies and programs, and development/strengthening of relationships with stakeholders.

With regard to projects, the following identifies potential focus areas for the City in the near-to-mid-term.

9.2.1. Near- and Mid-Term Focus Areas

The opportunities identified in this Travel Safety Plan provide more of the systemic countermeasures that can be applied within the City. Over the next three to five years, it is recommended that the City concentrate its efforts on the following emphasis areas:

- Intersections
- Aggressive Driving
- Pedestrians

Analysis conducted at the citywide level indicated that these factors were some of the most frequent influences contributing to K+SI crashes within the City. The countermeasure opportunities previously discussed in this safety plan for both systemic and project-specific improvements can be used as a basis for developing projects at locations where addressing these focus areas would be of the most benefit. Projects that address these focus areas can be developed with a high benefit-to-cost ratio (by applying citywide crash rates), allowing competitive projects to be developed even at sites with little to no direct crash history, but with conditions that might contribute to future crashes.

9.3. Policy Update

The City has taken meaningful steps to prioritize road safety and has successfully integrated these approaches into numerous Citywide programs, policies, and practices. This Travel Safety Plan includes an assessment of both the City's existing and the identified opportunities to enhance programs, policies, and practices to address road safety more comprehensively. **Appendix F** provides a summary of the existing programs, policies, and practices, as well as the recommended enhancements. The City and stakeholders should collaborate to discuss these policy modifications and set tangible goals for implementation.

9.4. Updates to the Citywide Travel Safety Plan

The following steps outline the process for updating the Citywide Travel Safety Plan every 5 to 7 years.

1. Access necessary data
   - Roadway and intersection classification/configurations
   - Average Daily Traffic Volumes (Collected from counts where available)
   - Collision history
2. Network screening
   - Calculate the CCR for each roadway functional classification and intersection control type
   - Rank for each facility type
     i. Roadway Segment
        (1) Primary
        (2) Secondary
        (3) Local
     ii. Intersection
        (1) Signalized
        (2) Unsignalized
3. Select locations
   - Identify the location with a higher CCR than what is typical of comparable facility types within City
   - Analyze the collision history and work with local officials to understand any significant exterior influences on the location
4. Countermeasures
   - Using the Engineering Countermeasures Toolbox (**Appendix D**) and Non-Infrastructure Toolbox (**Table 3**), identify potential countermeasures that can be applied to the local to enhance safety features
5. Calculate the benefit and the cost of each applicable countermeasure using Highway Safety Improvement Program (HSIP) tool and identified countermeasures. If those are not available, refer to other resources such as the CMF Clearinghouse and follow a similar calculation (using 20-year cost and benefit numbers).

Additional items the City can do to keep the Travel Safety Plan current are:

1. When new or reconstruction projects arise, use the data processed to identify locations with similar characteristics and apply countermeasures which proved effective
2. Proactively update its roadway and transportation design standards to incorporate systemic safety improvements identified in the Citywide Travel Safety Plan

9.5. Funding

Competitive funding resources are available to assist in the development and implementation of safety projects in the City of Milpitas. The City should continue to seek available funding and grant opportunities from local, state, and federal resources to accelerate their ability to implement safety improvements throughout Milpitas. The following is a high-level introduction into some of the main funding programs and grants for which the City can apply.

9.5.1. Highway Safety Improvement Program (HSIP)

The Highway Safety Improvement Program (HSIP) is a Federal program housed under Fixing America's Surface Transportation (FAST) Act. This program apportions funding as a lump sum for each state, which is then divided

among apportioned programs. These flexible funds can be used for projects to preserve or improve safety conditions and performance on any Federal-aid highway, bridge projects on any public road, facilities for non-motorized transportation, and other project types. Safety improvement projects eligible for this funding include:

- New or upgraded traffic signals
- Upgraded guardrails
- Marked pedestrian crosswalks

California's local HSIP focuses on infrastructure projects with national recognized crash reduction factors. Normally HSIP call-for-projects is made at an interval of one to two years. The applicant must be a city, a county, or a tribal government federally recognized within the State of California.

Additional information regarding this program at the Federal level is available at: https://safety.fhwa.dot.gov/hsip. California specific HSIP information – including dates for upcoming call for projects – is available at: http://www.dot.ca.gov/hq/LocalPrograms/hsip.html.

9.5.1.1. HSIP ANALYZER

As of 2021, the preferred way to calculate the BCR for the HSIP program uses the Caltrans HSIP Analyzer tool in the form of an active PDF. The PDF tool contains 4 sections which are used to calculate the Benefit Cost Ratio for the Highway Safety Improvement Program.

This tool can be accessed on the Caltrans website:

https://dot.ca.gov/programs/local-assistance/fed-and-state-programs/highway-safety-improvement-program/apply-now

Projects appropriate for other state grant programs can be analyzed using the Life-Cycle Benefit Cost Analysis Model (CalB/C) which has a much more comprehensive benefit assessment tool set.

9.5.1.2. HSIP ELIGIBILITY

Per Chapter 9 of the Highway Safety Improvement Program, funds are eligible for projects that improve the safety of its users on any public road or publicly owned bicycle or pedestrian pathway or trail, or on tribal lands for general use of tribal members.

HSIP looks for safety projects that can be designed and constructed expeditiously and do not require significant acquisition of rights-of-way. Proposed projects should not require extensive environmental review and mitigation. Additional information on the HSIP project selection criteria can be accessed online:

- Benefit Cost Ratio Applications
  https://dot.ca.gov/-/media/dot-media/programs/local-assistance/documents/hsip/2020/hsipanalyzerinstructions2020bcr.pdf
- Funding Set-asides (Non-Benefit Cost Ratio Applications)
  https://dot.ca.gov/-/media/dot-media/programs/local-assistance/documents/hsip/2020/hsipanalyzerinstructions2020sa.pdf

HSIP project eligibility is subject to the California SHSP. The SHSP identifies statewide challenge areas that correspond to safety concerns at the statewide level and potential countermeasure to address them and determine HSIP project eligibility. SHSP's are developed in compliance with FHWA requirements. A list of eligible project types can be seen in the current HSIP Analyzer. More information can be accessed online at the Caltrans HSIP grant website:

https://dot.ca.gov/programs/local-assistance/fed-and-state-programs/highway-safety-improvement-program/apply-now

9.5.2. Caltrans Active Transportation Program (ATP)

Caltrans Active Transportation Program (ATP) is a statewide funding program, created in 2013, consolidating several federal and state programs. The ATP funds projects that encourage increased mode share for walking and bicycling, improve mobility and safety for non-motorized users, enhance public health, and decrease greenhouse gas emissions. Projects eligible for this funding include:

- Bicycle and pedestrian infrastructure projects
- Bicycle and pedestrian planning projects (e.g. safe routes to school)
- Non-infrastructure programs (education and enforcement)

This program funding is provided annually. The ATP call for projects typically comes out in the spring. Information on this program and cycles can be found online:

http://www.dot.ca.gov/hq/LocalPrograms/atp

9.5.3. State Transportation Improvement Program (STIP)

The State Transportation Improvement Program (STIP) provides state and federal gas tax money for improvements both on and off the state highway system. STIP programming occurs every two years. The programming cycle begins with the release of a proposed fund estimate, followed by California Transportation Commission (CTC) adoption of the fund estimate. The fund estimate serves to identify the amount of new funds available for the programming of transportation projects. Once the fund estimate is adopted, Caltrans and the regional planning agencies prepare transportation improvement plans for submittal. Caltrans prepares the Interregional Transportation Improvement Program (ITIP) using Interregional Improvement Program (IIP) funds, and regional agencies prepare Regional Transportation Improvement Programs (RTIPs) using Regional Improvement Program (RIP) funds. The STIP is then adopted by the CTC.

9.5.4. California Senate Bill 1 (SB 1)

SB 1 is a transportation investment to rebuild California by fixing neighborhood streets, freeways and bridges in communities across California and targeting funds toward transit and congested trade and commute corridor improvements.

California's state-maintained transportation infrastructure will receive roughly half of SB 1 revenue: $26 billion. The other half will go to local roads, transit agencies and an expansion of the state's growing network of pedestrian and cycle routes. Each year, this new funding will be used to tackle deferred maintenance needs both on the state highway system and the local road system, including:

- Bike and Pedestrian Projects: $100 million
  - This funding will go to cities, counties, and regional transportation agencies to build or convert more bike paths, crosswalks, and sidewalks. It is a significant increase in subsidy for these projects through the Active Transportation Program (ATP).
- Local Planning Grants: $25 million

9.5.5. California Office of Traffic Safety (OTS) Grants

This program has funding for projects related to traffic safety, including transportation safety education and encouragement activities. Grants applications must be supported by local crash data (such as the data analyzed in this plan) and must relate to the following priority program areas:

- Alcohol Impaired Driving
- Distracted Driving
- Drug-Impaired Emergency Medical Services
- Motorcycle Safety
- Occupant Protection
- Pedestrian and Bicycle Safety
- Police Traffic Services
- Public Relations, Advertising, and Marketing Program
- Roadway Safety and Traffic Records

APPENDIX A

INTERSECTION NETWORK SCREENING RESULTS

Intersection	Crashes	Local CCR Differential[1]	EPDO[2]	*Fatal*	*Severe Injury*	*Other Visible Injury*	*Complaint of Pain*	Broadside	Sideswipe	Rear End	Head On	Hit Object	Overturned	Pedestrian	Bicycle	Aggressive	Impaired	Dark	Wet	Priority Location	KH Notes
Signalized Intersections																					
Great Mall Pkwy & Montague Expy	**35**	0.69	374	0	1	10	24	15	5	6	3	4	1	0	3	16	0	9	3	X	EPDO, Dark, 3 Bike
Great Mall Pkwy & Thompson St	**23**	0.28	182	0	0	9	14	14	3	6	0	0	0	0	0	14	2	4	2		
E Calaveras Blvd & N Milpitas Blvd	**21**	0.09	259	0	1	5	14	7	2	5	0	3	0	2	2	12	2	8	2	X	EPDO, Dark, Bike, Ped
W Calaveras Blvd & Serra Way	**19**	0.07	576	0	4	1	14	9	1	4	1	2	0	1	1	9	2	9	1	X	4 Severe, High EPDO, Dark
W Calaveras Blvd & S Abbott Ave	**18**	0.01	128	0	0	4	14	7	4	7	0	0	0	1	0	8	0	6	0		Rear Ends, Broadsides, Dark
E Calaveras Blvd & S Hillview Dr	**17**	0.13	136	0	0	7	10	4	1	6	2	0	0	1	3	7	2	3	3	X	Ped, 3 Bike
E Calaveras Blvd & N Abel St/Carlo St	**16**	0.03	221	0	1	2	13	5	1	7	1	0	0	2	0	6	2	4	2		
N Milpitas Blvd & N Abel St	**14**	-0.01	327	1	1	3	9	6	2	3	0	2	0	1	0	8	5	6	1	X	Fatal, Severe, Impaired
Dixon Landing Rd & Milmont Dr	**13**	0.04	98	0	0	4	9	5	1	5	1	1	0	0	0	7	2	4	2		
Dixon Landing Rd & N Milpitas Blvd	**13**	0.08	89	0	0	2	11	5	1	5	1	0	0	1	3	5	2	3	2	X	1 Ped, 3 Bike
Serra Way & S Abel St	**13**	0.25	107	0	0	6	7	8	1	2	0	1	0	0	0	8	1	3	0	X	Majority Broadsides
Mccarthy Blvd & Ranch Rd	**12**	-0.05	66	0	0	1	9	3	1	3	1	1	1	0	1	3	2	3	0		
W Calaveras Blvd & Ramp_108867	**12**	-0.02	196	0	1	2	9	4	1	7	0	0	0	0	1	10	0	2	0	X	1 Severe, Rear Ends
Great Mall Pkwy & S Abel St	**12**	-0.04	96	0	0	5	7	7	1	3	0	0	1	0	0	10	1	3	1		
Great Mall Pkwy & Mccandless Dr	**12**	0.00	92	0	0	4	8	4	0	3	4	1	0	0	0	2	3	3	1	X	4 Head On
S Main St & Montague Expy	**11**	0.03	86	0	0	4	7	2	0	8	0	0	0	0	0	7	2	3	3	X	
S Milpitas Blvd & Montague Expy	**11**	0.06	110	0	0	4	11	2	2	8	0	1	0	0	1	8	1	8	0		
Alder Dr & Tasman Dr	**11**	0.02	86	0	0	4	7	5	0	5	0	0	0	1	0	6	2	3	2		
S Main St & S Abel St	**11**	-0.01	199	0	1	4	6	1	0	0	4	4	1	0	0	5	7	10	2	X	Severe, Impaired, Dark, Head on, Hit Object
Calaveras Rd & S Park Victoria Dr	**11**	-0.08	81	0	0	3	8	4	1	5	0	0	0	1	0	5	1	2	1	X	Rear Ends
Pecten Ct & Montague Expy	**9**	-0.01	64	0	0	2	7	6	0	3	0	0	0	0	0	9	0	0	2		
Great Mall Pkwy & S Main St	**9**	-0.07	178	0	1	2	6	4	0	2	1	2	0	0	0	3	2	3	0		Severe
Escuela Pkwy & Jacklin Rd	**9**	0.07	169	0	1	0	8	1	4	2	1	1	0	0	0	4	2	3	1	X	Severe
Landess Ave & Dempsey Rd	**9**	0.13	64	0	0	2	7	5	0	2	0	1	0	1	0	8	0	2	0		
Mustang Dr/Center Pointe Dr & Great Mall Pkwy	**8**	0.00	67	0	0	4	4	4	0	2	0	1	0	0	0	4	1	1	0		
Technology Dr & McCarthy Blvd	**7**	0.02	57	0	0	3	4	3	0	1	2	0	0	1	0	4	1	6	0		
Weller Ln & N Abel St	**7**	0.01	170	0	1	3	3	2	2	1	0	1	0	2	1	3	0	0	0	X	2 Bike, Ped, Severe
Landess Ave & Morrill Ave	**7**	0.10	157	0	1	0	6	0	0	2	2	2	0	1	1	2	0	5	0		
Washington Dr & N Milpitas Blvd	**6**	-0.09	50	0	0	3	3	2	0	4	0	0	0	0	2	3	0	2	0	X	2 Ped
Jacklin Rd & Arizona Ave	**6**	0.04	50	0	0	3	3	3	1	0	1	1	0	1	1	2	1	2	1		
N Hillview Dr & Jacklin Rd	**6**	-0.02	50	0	0	3	3	1	1	3	0	0	0	0	1	4	1	1	1		
Mccarthy Blvd & E Tasman Dr	**5**	0.09	31	0	0	0	5	3	0	1	1	0	0	0	0	3	1	1	0		
Great Mall Dr_Spur_1 & S Main St	**5**	-0.10	40	0	0	2	3	1	0	2	1	1	0	0	0	1	2	1	2		
Jacklin Rd & N Park Victoria Dr	**5**	-0.13	49	0	0	4	1	3	1	0	1	0	0	0	2	2	1	0	0		2 Bike

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Intersection	Crashes	Local CCR Differential[1]	EPDO[2]	*Fatal*	*Severe Injury*	*Other Visible Injury*	*Complaint of Pain*	Broadside	Sideswipe	Rear End	Head On	Hit Object	Overturned	Pedestrian	Bicycle	Aggressive	Impaired	Dark	Wet	Priority Location	KH Notes
Edsel Dr & S Park Victoria Dr	**5**	0.01	35	0	0	1	4	1	1	2	1	0	0	0	0	2	0	1	0		
Calaveras Rd & S Temple Dr	**5**	-0.08	44	0	0	3	2	1	0	1	1	0	0	2	0	0	0	4	2		Severe
Barber Ln & Mccarthy Blvd	**4**	-0.15	29	0	0	1	3	2	0	1	0	0	1	0	0	1	0	0	0		
Sunnyhills Ct & N Milpitas Blvd	**4**	0.00	143	1	0	1	2	1	0	2	0	0	0	1	0	3	1	1	1		Fatal
N Abel St & Marylinn Dr	**4**	-0.12	143	0	1	1	2	1	2	1	0	0	0	0	0	0	2	0	0		Severe
Serra Way & S Main St	**4**	-0.03	34	0	0	2	2	0	0	1	1	1	0	1	0	1	0	1	0		
Cedar Way & S Main St	**4**	-0.12	34	0	0	2	2	2	0	2	0	0	0	0	0	2	0	2	2		
S Main St & Mihalakis Dr	**4**	-0.13	34	0	0	2	2	0	0	2	0	1	0	1	0	2	0	2	1		
S Main St & Mihalakis Dr	**4**	-0.05	34	0	0	2	2	0	0	2	0	1	0	1	0	2	0	2	1		
Sumac Dr & Mccarthy Blvd	**3**	-0.17	141	0	1	2	0	2	0	1	0	0	0	0	0	1	0	0	0		
Redwood Ave & N Abel St	**3**	-0.15	18	0	0	0	3	0	1	1	1	0	0	0	0	2	0	0	0		
Junipero Dr & S Abel St	**3**	-0.14	137	0	1	1	1	1	1	1	0	0	0	0	0	2	0	0	1		
Corning Ave & S Abel St	**3**	-0.15	18	0	0	0	3	1	1	1	0	0	0	0	1	1	0	0	0		
W Curtis Ave & S Abel St	**3**	-0.01	18	0	0	0	3	2	0	0	0	1	0	0	0	0	0	0	0		
W Capitol Ave & S Abel St	**3**	0.03	28	0	0	2	1	2	0	0	0	1	0	0	1	2	0	1	0		
Los Coches St & S Milpitas Blvd	**3**	-0.14	18	0	0	0	3	2	0	0	0	1	0	0	0	0	0	3	1		
S Milpitas Blvd & E Capitol Ave	**3**	-0.15	23	0	0	1	2	1	1	1	0	0	0	0	0	1	0	1	0		
Garden St & S Milpitas Blvd	**3**	-0.14	18	0	0	0	3	2	0	1	0	0	0	0	0	1	0	0	1		
Yosemite Dr & Sinclair Frontage Rd_Frontage_1	**3**	-0.03	23	0	0	1	2	0	0	0	1	0	0	1	0	0	0	1	0		
Yosemite Dr & Dempsey Rd	**3**	-0.08	28	0	0	2	1	2	0	0	0	0	0	1	0	1	1	3	1		
Yosemite Dr & S Park Victoria Dr	**3**	-0.14	23	0	0	1	2	1	0	2	0	0	0	1	0	1	0	1	0		
Calaveras Rd & S Gadsden Dr	**3**	-0.14	28	0	0	2	1	1	1	0	0	0	0	1	1	0	0	1	1		
Big Basin Dr & S Park Victoria Dr	**3**	-0.15	23	0	0	1	2	1	0	1	0	1	0	0	0	0	1	2	0		
Landess Ave & Yellowstone Ave	**3**	-0.14	23	0	0	1	2	1	1	0	0	0	0	1	0	1	0	1	0		
Unsignalized Intersections																					
Butler St & W Calaveras Blvd	**14**	2.10	102	0	0	5	8	10	1	0	0	1	0	0	0	1	0	2	0	X	Broadsides, CCR
Washington Dr & Arizona Ave	**6**	0.43	55	0	0	4	2	5	0	0	0	0	0	1	2	3	0	3	2	X	Broadsides, 2 Bike, Ped, Dark
Jacklin Rd & Hamilton Ave	**5**	0.00	44	0	0	3	2	4	0	0	1	0	0	0	0	0	0	0	0		
Montague Exwy & Piper Dr	**5**	-0.01	40	0	0	2	3	0	2	3	0	0	0	0	1	2	0	0	0		
Calaveras Rd & Downing Rd	**4**	0.08	34	0	0	2	2	1	0	0	1	0	1	0	1	2	1	0	0		
Mccarthy Blvd & Murphy Ranch Rd	**4**	0.04	214	0	1	1	2	2	1	0	0	0	0	0	0	0	0	2	1		Severe
Corning Ave & S Main St	**4**	0.11	29	0	0	1	3	1	0	2	0	0	0	0	0	2	1	1	0		
Altamont Dr & Escuela Pkwy	**4**	0.17	43	0	0	4	0	1	0	1	1	0	0	0	3	1	0	0	0	X	3 Bike
Montague Expy & Trade Zone Blvd/Mccandless Dr	**4**	-0.04	29	0	0	1	3	2	1	1	0	0	0	0	0	1	0	1	0		
E Calaveras Blvd & Dempsey Way	**4**	-0.03	29	0	0	1	3	1	0	3	0	0	0	0	1	2	0	0	0		Fatal

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Intersection	Crashes	Local CCR Differential[1]	EPDO[2]	*Fatal*	*Severe Injury*	*Other Visible Injury*	*Complaint of Pain*	Broadside	Sideswipe	Rear End	Head On	Hit Object	Overturned	Pedestrian	Bicycle	Aggressive	Impaired	Dark	Wet	Priority Location	KH Notes
Edsel Dr & S Temple Dr	**4**	0.75	38	0	0	3	1	1	1	0	0	0	0	1	0	3	0	1	0		
Calaveras Rd & Evans Rd	**4**	0.00	34	0	0	2	2	3	1	0	0	0	0	0	2	0	0	1	1	X	2 Bike
Landess Ave & Piedmont Rd	**4**	-0.01	209	1	0	0	3	1	0	1	0	0	0	1	0	1	2	2	1		Fatal
Heath St & S Abbott Ave	**3**	0.03	23	0	0	1	2	1	0	1	0	0	0	1	0	1	1	1	0		
Dixon Rd & Arizona Ave	**3**	-0.03	23	0	0	1	2	2	0	0	0	0	0	0	1	0	0	1	1		
Yosemite Dr & S Hillview Dr	**3**	0.15	18	0	0	0	3	2	1	0	0	0	0	0	1	0	0	0	1		
Country Club Dr & N Park Victoria Dr	**3**	0.04	32	0	0	3	0	2	0	0	0	1	0	0	1	1	0	0	0		
Kennedy Dr & N Park Victoria Dr	**3**	0.02	208	1	0	1	1	1	0	0	0	0	0	0	2	3	0	0	0	X	Fatal, 2 Bike
Edsel Dr & Dempsey Rd	**3**	0.25	12	0	0	0	2	2	0	0	0	0	0	0	0	1	0	0	1		
Dempsey Rd & S Park Victoria Dr	**3**	0.02	18	0	0	0	3	2	0	1	0	0	0	0	0	2	0	0	0		
Canton Dr & S Park Victoria Dr	**3**	0.04	28	0	0	2	1	1	0	0	2	0	0	1	0	2	0	1	0		
Calaveras Rd & Downing Rd	**3**	-0.01	23	0	0	1	2	1	0	0	0	0	1	0	1	2	0	0	0		

1. Local Critical Crash Rate Differential

2. Equivalent Property Damage Only Crashes

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APPENDIX B

SEGMENT NETWORK SCREENING RESULTS

Facility	Cross Street 1	Cross Street 2	Crashes	Local CCR Differential[1]	EPDO[2]	*Fatal*	*Severe Injury*	*Other Visible Injury*	*Complaint of Pain*	Broadside	Sideswipe	Rear End	Head On	Hit Object	Overturned	Pedestrian	Bicycle	Aggressive	Impaired	Dark	Wet	Priority Locations	KH Notes
Principal Arterial																							
E Calaveras Blvd	N Milpitas Blvd	S Hillview Dr	**14**	0.31	113	0	0	6	8	3	0	7	0	0	0	1	3	9	2	3	2	X	Can combine segments into one corridor
E Calaveras Blvd	N Abel St	N Milpitas Blvd	**9**	0.04	232	0	1	4	4	0	0	6	0	1	0	1	0	7	1	1	0	X	Can combine segments into one corridor
E Calaveras Blvd	S Hillview Dr	Dempsey Rd	**3**	0.00	18	0	0	0	3	0	1	1	0	1	0	0	0	2	0	1	1		
N Milpitas Blvd	Beresford Ct	E Calaveras Blvd	**3**	0.40	23	0	0	1	2	0	0	0	0	1	0	0	2	0	0	0	0		
Minor Arterial																							
Dixon Landing Rd	California Cir	Milmont Dr	**6**	0.29	50	0	0	3	3	3	0	2	0	0	0	0	1	2	0	0	1		
Great Mall Pkwy	Abel St	Thompson St	**4**	0.11	29	0	0	1	3	0	1	1	0	1	1	0	0	2	0	1	1		
Calaveras Rd	Evans Rd/Piedmont Rd	Vista Ridge Dr	**4**	0.05	197	0	1	3	0	0	1	0	1	1	0	1	0	1	1	1	0		
Dixon Landing Rd	Milmont Dr	Village Pkwy	**3**	0.11	28	0	0	2	1	1	0	1	0	0	0	0	1	1	0	2	0		
Major Colletor																							
S Main St	W Curtis Ave	Corning Ave	**8**	0.63	540	1	2	3	2	0	1	4	0	1	0	2	0	3	2	1	0	X	Fatal, Severe Injuries
Local Roads																							
N McCarthy Blvd	Dixon Landing Rd	Sprig Center Dwy	**6**	0.09	355	0	2	0	4	1	0	0	0	4	1	0	0	4	1	4	2	X	Severe Injuries
Ranch Dr	McCarthy Blvd	McCarthy Ranch Shopping Center Dwy	**5**	0.45	40	0	0	2	3	4	0	0	0	0	0	0	1	0	0	2	0		
N McCarthy Blvd	Ranch Dr	Sprig Center Dwy	**4**	-0.12	188	0	1	1	2	0	0	0	2	0	0	1	1	1	1	1	1		
Barber Ln	Bellew Dr	Alder Dr	**3**	1.45	28	0	0	2	1	1	0	0	0	0	0	1	0	0	0	0	0	X	High CCR Value
N McCarthy Blvd	N Ranch Dr	S Ranch Dr	**3**	-0.07	28	0	0	2	1	1	1	0	0	0	1	0	0	0	0	0	0		

1. Local Critical Crash Rate Differential

2. Equivalent Property Damage Only Crashes

APPENDIX C

SURVEY COMMENTS

APPENDIX C – SURVEY COMMENTS

What traffic safety challenge(s) do you experience at this location? (Other Answers)

1. Yield signal .. nobody yields to oncoming vehicle
2. Limited parking during school drop off and pick up
3. Cars doing donuts
4. Medians at Serra and Calaveras also do not have ramps. Hard for wheel chair or stroller
5. Way too many things to fix about Calaveras. Not sure if this is City of Caltrans jurisdiction since it is technically 237, but so many things need to be changed to make this more accessible for all forms of transportation.

Is there anything else related to this survey you would like to share?

1. Cars turning left onto S Milpitas Blvd from Los Coches never yield to oncoming vehicles. As there are more homes in this area now, I request that the yield light changed to the one with left arrows.
2. Would be really grateful if residents park their vehicles in their garage or driveway during school drop off and dismissal hours, as it gets very hard to find parking.
3. Lots of potholes here
4. Wouldn't feel safe to bike here.
5. Cars do donuts in the intersection.
6. Unrecognized people living in the cars and is not safe for anyone who walks from bus stop to the signal. Area is very sketchy and very dirty.
7. Homeless people living in junk cars unsafe for pedestrians.
8. Very curvy and narrow road and hard to see signal. Dangerous area
9. Neighbourhood looks very unsafe. Houses are not well maintained.
10. Narrow road and traffic congestion. When school finished construction this area will be challenging for cars to cross the roads
11. This area needs to be preplanned to avoid huge traffic before school starts to run.
12. New lane needs to be added for people going to ocean supermarket traffic slows down when people abruptly take right turn to shop at ocean supermarket.
13. High traffic area needs attention in adding new lanes before things get worse.
14. Signal mal function takes long time to turn green.
15. New lane needs to be added due to traffic congestion. Lot of traffic and no place to park during school timings.
16. Unsafe sidewalk. Sketchy area to walk on the side way. Not safe for pedestrians. Poor road sight and low light area.
17. Bad neighborhood junk car parking.
18. Narrow road and high traffic.
19. I other used people selling stuff on road drivers get distracted.
20. High traffic zone city of Milpitas residents need road expansion on east Calavares Blvd. because everyone wants to go to 237 via east Calavares road. Sit to population increase road expansion is vital for city developments.
21. People drive very fast on S Park Victoria since it's a wide 4-lane street. But this is actually a residential neighborhood with elementary school. Some traffic calming measures should be placed here.

22. Many people do not come to a complete stop.
23. Speeding cars near school
24. Cars fail to yield to pedestrians.
25. Long trains cause traffic during commute hours
26. Most drivers don't come to a complete stop.
27. Failure to yield to pedestrians.
28. Pedestrians cross in the middle when leaving or going to the bus.
29. Lights along parallel to the train are consistently poor and cause traffic build-ups during peak commuting times.
30. Vehicle speeding in the residential area.
31. With no barrier for bike lane, I do not feel safe riding a bike as drivers aren't paying attention.
32. Need speed bump.
33. Road is starting to show signs of wear, including parts where the pavement is sinking and cracking.
34. Intersection is dangerous for pedestrians to cross the streets.
35. Constantly people running a red light at the intersection of Milpitas BLVD and 237
36. Speeding around the corner on Sin Clair Frontage
37. Required Ped crossing marks.
38. School Areas: mostly driver do not stop.
39. Many pedestrians jay walk from 7-11 to apartments regardless of oncoming traffic
40. "People who are too impatient to wait in the middle lane will often use the right turn only lane to go straight and cut over to the 680 N ramp. I've been almost hit many times.
41. Please enforce the turn only restriction better or change the intersection.
42. Speed bumps, Edsel Drive, to slow down traffic from Roswell to Carnegie. Narrow lanes with cars parked and pedestrian crossing mid-block are in peril to these driver's speed.
43. Very unsafe for pedestrians to cross near this intersection. Needs a stop sign.
44. Cars slow down due to turns near ocean supermarket. Needs a new lane to avoid accidents.
45. Lot of traffic congestion due to fewer lanes
46. Poor signal timing to turn left. Long wait times.
47. If no new lanes will be added people will move out of this place due to high signal wait times
48. Narrow curved road extremely dangerous and high traffic area. City needs to consider this area seriously before doing any economic activities to attract business and retail stores.
49. The unprotected bike lane here is really dangerous with the pull-in for the great mall. Cars regularly go by at 50+ MPH and swerve around cyclists- each one passing with only a few feet to spare.
50. Very long walk across Great Mall Parkway. Drivers often make rolling stops with pedestrians in the crosswalk. Even the 40-second pedestrian timer can feel short.
51. People regularly jaywalk across all 10 lanes of Montague to get between the Great Mall and the bus/BART station. Both the crosswalk at Capitol and pedestrian bridge at the Edge are inconveniently far away
52. Lots of people exiting the great mall turn left from great mall onto Montague heading towards 680, which creates a backup. People often run yellow or red lights aggressively because they have to wait 2-3 cycles to make it, even with 2 turning lanes.
53. Drivers turning right onto Great Mall from the southbound Montague expressway don't see pedestrians crossing because they are looking left for oncoming traffic and have a pocket turn lane. I've seen a fair number of near-misses because of the high speeds coming off of Montague and the generous turn lane.

54. Crossing Montague and S. Milpitas in any direction takes a long time, and the little concrete porkchops feel like scant protection from the 50+MPH traffic passing by. The unprotected bike lanes are a joke when cars are going that fast- especially when they have to cross over for right turns.
55. Southbound cars on South Milpitas often don't notice the stoplight here and sideswipe northbound cars turning left onto Garden Street, or eastbound cars on Garden Street who are trying to turn right.
56. Traffic blocking the other cars form going through.
57. Streets are very wide making it easy for drivers to speed at an unsafe rate way past speed limit.
58. Parking on school side of street shouldn't be allowed during drop-off and pick up time so cars going into school can stay near sidewalk and allow through traffic to continue.
59. Drivers fail to stop often at this 4-way stop.
60. Needs a crossing guard during school hours.
61. Crosswalk going from shopping center parking lot to Calaveras crosswalks at Serra is very dangerous. Cars going from Calaveras to Serra take the exit at high speed and do not stop for pedestrians trying to access Calaveras crosswalks.
62. Crosswalk from shopping center to Calaveras crosswalks is very dangerous. Cars exiting to Serra do not stop for pedestrians. Speed bump, lower speed right turns to Serra, or flashing pedestrian signal could help.
63. Crossing Calaveras as a pedestrian can take up to 4 crosswalks and a lot of time. There should be two crosswalks across Calaveras at Serra instead of just one. Especially since there is an elementary school on the north side of Calaveras with many students attending from the south side.
64. There should be crosswalks for pedestrians at Abbott and Calaveras. Walking to 880 or Serra to cross with a pedestrian signal takes a very long time.
65. Abel between Calaveras and Corning should have bike lanes.
66. Crosswalk from shopping center parking lot to Calaveras Blvd. is dangerous. Visibility is low, and cars do not stop for pedestrians because of high rate of speed for traffic. Consider speed bump, flashing pedestrian signal, or slower right turn from Calaveras to Serra instead - especially since elementary on N. side of Calaveras has many students living on S. side of the street.
67. Road is crumbling all along Main Street
68. Yellow light for cars on Main Street is too short. You can enter the intersection on green and not get through before it turns red.
69. Lots of red-light runners on right turn on red.
70. 4-way stop desperately needed at this intersection. All turns from Newbury onto McCandless are severely occluded by roadside parked vehicles and median landscaping. Drivers on McCandless regularly speed well in excess of posted limits.
71. Dangerous pedestrian crossing. Design speed on this section of road very high (50mph with limited visibility due to curve) and entitled motorists. Encourage to install protected pedestrian crossing with traffic lights and request button.
72. Dangerous pedestrian crossing despite dedicated traffic light.
73. 4-way stop needed at McCandless & Newbury intersection. Turns onto McCandless from Newbury are severely occluded by roadside parked vehicles and median bushes. Vehicles regularly speed well in excess of posted limits through this intersection.
74. How does one of the main streets into the city (Calaveras) NOT have bike lanes and a sidewalk on only one side. We need to encourage other forms of transportation OUTSIDE of cars.
75. Cars park so close to the school crossing, that children and other pedestrians approaching the school crossing are not seen until it is too late. My child and I have almost been hit several times on the way to school by car is not seeing us until they have blown through the crosswalk.

76. There is a box truck that keeps parking on this corner, impeding view of oncoming traffic coming down Arizona and site of pedestrians who may be looking to cross, as they are not visible, until the driver starts to make the turn.
77. Despite a clearly marked loading/fire lane, parents continue to park their cars and walk away impeding traffic flow, and causing a safety issue as some cars are driving around parked cars, while children and their parents are crossing the parking lot to get to the sidewalk on Boulder Ave. In addition, many people park in the fire lane on boulder which impedes visibility for traffic trying to leave the parking lot. Thus, putting both drivers and pedestrians at risk.
78. Non-ADA compliant corner. No curb ramp for people using wheelchairs on one corner here. It has been this way since I can recall as an elementary school student.
79. Homeless people in the cars very sketchy area to walk here.
80. People taking right turn to ocean supermarket and causing accidents.
81. Why two back-to-back signals?
82. Gaps of pedestrian sidewalks along S Milpitas Blvd

APPENDIX D

CITY OF MILPITAS ENGINEERING COUNTERMEASURE TOOLBOX

City of Milpitas

ROADWAY SAFETY ENGINEERING COUNTERMEASURE TOOLBOX

Presented by

Kimley»Horn

Expect More. Experience Better.

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** Countermeasure is applicable at multiple facility types*

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ENGINEERING COUNTERMEASURE TOOLBOX

SIGNALIZED INTERSECTION ENGINEERING SAFETY COUNTERMEASURE	Crash Types Addressed							
	Rear-Ends	Broadsides	Sideswipes	Head-Ons	Hit Object	Dark	Bike+Ped	Emergency Vehicles
Install/Upgrade Intersection Lighting	✓		✓		✓	✓	✓	
Install Retroreflective Backplates	✓					✓	✓	
Provide Protected Left-Turn Phase		✓	✓	✓				
Improve Signal Timing	✓	✓					✓	✓
Raised Pavement Markers			✓	✓				
Flashing Warning Beacons	✓					✓		
Improve Pavement Friction (High Friction Surface Treatments)	✓		✓		✓			
Install Left-Turn or Right-Turn Lane	✓	✓	✓					
Replace Roadside Pole Mounted Signal Heads with Overhead Signal Heads	✓	✓						
Install Emergency Vehicle Preemption								✓
Install Raised Median								
Pedestrian Scramble							✓	
Advanced Stop Bar							✓	
Leading Pedestrian Interval (LPI)							✓	
Pedestrian Median Fencing							✓	
Install Pedestrian Countdown Heads							✓	
Close Slip Lane							✓	

ENGINEERING COUNTERMEASURE TOOLBOX

NON-SIGNALIZED INTERSECTION ENGINEERING SAFETY COUNTERMEASURE	Crash Types Addressed							
	Rear-Ends	Broadsides	Sideswipes	Head-Ons	Hit Object	Dark	Bike+Ped	Emergency Vehicles
Install/Upgrade Intersection Lighting	✓		✓		✓	✓	✓	
Install Improved Signage and/or Reflective Strips	✓	✓				✓		
Install Stop Signs with Flashing LEDs	✓	✓				✓	✓	
Flashing Warning Beacons	✓	✓				✓	✓	
Install Transverse Rumble Strips on Approaches	✓	✓						
Convert 2-way Stop or Yield Control to All-Way Stop	✓	✓					✓	
Install Traffic Signal		✓		✓		✓	✓	
Upgrade Intersection Pavement Markings	✓		✓	✓		✓		
Install Splitter Island on Minor Road Approaches		✓		✓				
Create Directional Median Openings to Allow (and restrict) Left-Turns and U-Turns	✓	✓	✓	✓				
Install Marked Pedestrian Crossing at Uncontrolled Location							✓	
Install Pedestrian Refuge Island							✓	
Install Rectangular Rapid Flashing Beacon (RRFB)							✓	
Improve Sight Distance at Intersection		✓						
Install Right or Left Turn Lanes	✓	✓	✓					
Install Raised Median		✓	✓	✓				

ENGINEERING COUNTERMEASURE TOOLBOX

ROADWAY SEGMENT ENGINEERING SAFETY COUNTERMEASURE	Crash Types Addressed							
	Rear-Ends	Broadsides	Sideswipes	Head-Ons	Hit Object	Dark	Bike+Ped	Emergency Vehicles
Install/Upgrade Roadway Lighting	✓	✓	✓	✓	✓	✓	✓	
Install Median Barrier				✓				
Install Curve Advanced Warning Signs			✓	✓	✓	✓		
Install Delineators, Reflectors or Object Markers			✓		✓	✓		
Install a Two-Way Left-Turn Lane	✓							
Road Diet							✓	
Upgrade Signs with Fluorescent Sheeting			✓	✓	✓	✓		
Install Edgelines and Centerlines			✓	✓	✓	✓		
Install Rumble Strips			✓	✓	✓			
Install Dynamic/Variable Speed Warning Sign	✓	✓	✓	✓	✓	✓		
Improve Pavement Friction (High Friction Surface Treatments)			✓	✓	✓			
Install Acceleration/Deceleration Lanes	✓	✓	✓					
Install Chevron Signs on Horizontal Curves					✓	✓		
Install Bike Lanes							✓	
Install Separated Bike Lanes							✓	
Install Additional Signage to Pedestrian Crossing							✓	
Install Raised Pedestrian Crossing							✓	
Install Rectangular Rapid Flashing Beacon							✓	

Install/Upgrade Intersection Lighting

Installing intersection safety lighting (new or upgraded) is a proven safety countermeasure which can prevent crashes occurring at night. Drivers are made more aware of their surroundings and of the presence of the intersection, roadway conditions, and other vehicles or active transportation users during nighttime conditions. This countermeasure is applicable at signalized intersections without lighting or with insufficient lighting, where crashes are known to be occurring at night. Providing adequate safety lighting should be considered as a preventative measure to reduce the likelihood of nighttime crashes at intersections.

Relevant Design Guides: *Illuminating Engineering Society of North America RP-8-21: Design of Roadway Facility Lighting; Caltrans Roadway Lighting Manual (July 27, 2021).*

- **CRF:** 40% (applies to nighttime crashes)
- **Cost:** $$
- **Expected Life:** 20 yrs
- **Crash Types:** Rear-Ends, Sideswipes, Hit Objects, Bike+Ped, Dark

IMPLEMENTATION CONSIDERATIONS:

- Signalized intersections should have at least one luminaire per corner. Photometric analysis is recommended to confirm number and location of luminaires needed to achieve minimum light levels.
- Intersections where existing light levels do not meet recommended standards, see Table 12-1 in RP-8-21, Table D in Caltrans Roadway Lighting Manual

Install Reflective Backplates

Installation of traffic signal head backplates with yellow retroreflective borders provides enhanced signal head visibility. While this countermeasure is applicable to all drivers, backplates with retroreflective borders are particularly useful for preventing crashes involving aging drivers, impaired drivers, or crashes occurring at night. This can be achieved either by applying retroreflective tape to the existing backplates or mounting new reflective backplates. This countermeasure can be effectively implemented on a systemic level at signalized intersections.

Guiding Documents: *Intersection Proven Safety Countermeasure: Technical Summary: Backplates with Retroreflective Borders FHWA.*

- **CRF:** 15%
- **Cost:** $
- **Expected Life:** 10 yrs
- **Crash Types:** Rear-Ends, Bike+Ped, Dark

IMPLEMENTATION CONSIDERATIONS:

- Signalized intersections with a pattern of nighttime or rear-end crashes
- Prioritize intersections with higher crash rates/EPDO
- Install reflective backplates when retrofitting or replacing existing signals
- Locations where drivers experience glare at sunset/sunrise
- Traffic signals without battery backup units

Provide Protected Left-Turn Phase

Protected left-turn phases are demonstrated to reduce the frequency of broadside crashes by reducing conflicts between turning vehicles and oncoming traffic. This countermeasure is applicable especially at intersections with higher vehicle volumes and/or approach speeds, and is most effectively used in tandem with a dedicated left-turn lane.

Guiding Documents: *Manual on Uniform Traffic Control Devices, Chapter 4D, Caltrans Traffic Signal Operations Manual (January 31, 2020), FHWA, Signalized Intersections Informational Guide (July, 2013).*

- **CRF:** 30%
- **Cost:** $$
- **Expected Life:** 30 yrs
- **Crash Types:** Broadsides, Head-Ons, Sideswipes

IMPLEMENTATION CONSIDERATIONS:

- Left turn volume exceeds 240 vehicles per hour
- Daily left turn volume multiplied by the opposing through movement volume exceeds 50,000 (for one opposing through lane), 90,000 (for two opposing through lanes), or 110,000 (for any number of opposing through lanes)
- Left turn lanes exceeds one lane

Improve Signal Timing

Signal timing improvements can reduce the frequency of crashes at signalized intersections. Improvements include coordinating traffic signals, extending red and yellow clearance intervals, or adding phases. For example, coordinating traffic signals that are closely spaced together has been proven to improve traffic flow and progression while reducing the number of rear-end crashes occurring at the intersection.

Guiding Documents: *California Manual on Uniform Traffic Control Devices, Chapter 4; Caltrans Traffic Signal Operations Manual (January 31, 2020), FHWA Traffic Signal Timing Manual.*

- **CRF:** 15%
- **Cost:** $
- **Expected Life:** 10 yrs
- **Crash Types:** Broadsides, Head-Ons, Rear-Ends, Bikes+Peds

IMPLEMENTATION CONSIDERATIONS:

- Signals should generally be coordinated along corridors with closely spaced traffic signals with volumes of 300 veh/hr/lane or higher
- Review and update timing every 3-5 years, or more regularly if there is significant changes to traffic patterns
- Review clearance intervals at locations with regular crashes or changes to roadway speeds

Raised Pavement Markers

Raised pavement markers increase lane visibility and create an audible rumble when driven over by vehicle tires to alert drivers. Enhanced striping can guide drivers though intersections and are effective at intersections with dual left-turn lanes or offset lanes. Examples include cat-track striping, line extensions, botts dots, and raised reflective markers. These enhanced striping features can reduce the frequency of lane departure crashes (such as sideswipes and head-ons).

Guiding Documents: *California Manual on Uniform Traffic Control Devices, Chapter 3B*

CRF: *10%*

- **Cost:** : $$
- **Expected Life:** 20 yrs
- **Crash Types:** Head-Ons, Sideswipes

IMPLEMENTATION CONSIDERATIONS:

- Best applied systemically as part of pavement resurfacing or striping programs
- Intersections with crash trends related to lane departure (sideswipes, head-ons, broadsides)
- Intersections with offset lanes, dual left-turn lanes, or other lane geometry that may result in driver confusion

*Flashing Beacons**

Flashing beacons installed in tandem with warning signage are proven to raise driver awareness that they are approaching a traffic signal. They are especially effective in situations where direct line of sight is limited, such as at horizontal curves or when a fixed object obscures view of the intersection. In the situation where traffic queues extend beyond the intersection and contribute to rear-end crashes, LED flashing beacon raise driver awareness of the approaching traffic signal and that they should expect potential traffic queues. The CAMUTCD provides guidance on considerations for intersection control LED flashing beacons.

Guiding Documents: *California Manual on Uniform Traffic Control Devices, Chapter 4L.*

- **CRF:** 30%
- **Cost:** $$
- **Expected Life:** 10 yrs
- **Crash Types:** Rear-Ends, Dark

IMPLEMENTATION CONSIDERATIONS:

- Poor visibility of the intersection (sharp curves, sight obstructions, fog, etc)
- Crash history due to non-compliance or lack of awareness of the signal
- Locations with inadequate sight distance
- Locations with high rate of driver non-compliance of traffic control device

** Countermeasure is applicable at multiple facility types*

Improve Pavement Friction (High Friction Surface Treatments)

This countermeasure is applicable at intersections where skidding or failure to stop is contributing to crashes and sharp curves where vehicles may break excessively. Over time, the pavement surface around horizontal curves may wear down and contribute to vehicles losing control when turning abruptly or braking excessively. Increasing the pavement friction enables cars to have more traction with the road and safely maneuver through a turning movement or decelerate.

Guiding Documents: *Federal Highway Administration, High Friction Surface Treatments.*

- **CRF:** 55%
- **Cost:** $$
- **Expected Life:** 10 yrs
- **Crash Types:** Hit Object, Rear-Ends, Sideswipes

IMPLEMENTATION CONSIDERATIONS:

Applicable at spot locations such as:

- Interchange ramps
- High volume intersection approaches
- Segments of steep grade
- Two-lane urban or rural horizontal curves

Install Left-Turn or Right Turn Lane

This countermeasure is recommended at intersections where the major road approach does not have a left or right turn lane, and which are experiencing a high number of broadside or rear-end crashes. Providing a dedicated left-turn lane improves traffic flow and reduces the potential for rear-end crashes by providing a dedicated space for left-turn vehicles to decelerate and wait to turn left while outside of the through lane. Dedicated left and right turn lanes are recommended at signalized intersection approaches where turning volumes warrant consideration and there is adequate right-of-way.

Guiding Documents: *See attachments for Warrants.*

- **CRF:** 55%
- **Cost:** $$
- **Expected Life:** 20 yrs
- **Crash Types:** Rear-Ends, Broadsides, Sideswipes

IMPLEMENTATION CONSIDERATIONS:

- Left turn volume, opposing volume, and advancing volume meet the left turn lane warrants based on design speed of roadway (see Attachments for Left turn warrants)
- Right turn and advancing volumes meet the right turn lane warrants based on design speed of roadway (see Attachments for warrants)

Replace Pedestal Mounted Signal Heads with Mast Arms

This countermeasure is applicable at signalized intersections with exclusive pedestal mounted traffic signals. Mast-arm mounted signal heads located overhead are standard design features per the CAMUTCD. They are more perceptible by approaching drivers and can reduce the frequency and severity of rear-end crashes related to poor visibility and broadside crashes due to late entries into the intersection during the yellow interval and red interval violations.

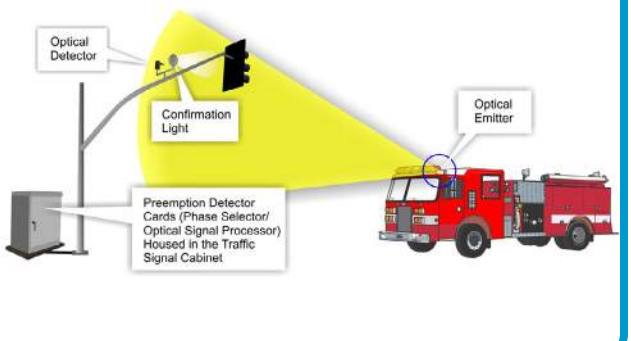
Guiding Documents: *California Manual on Uniform Traffic Control Devices, Chapter 4D: Caltrans Electrical Systems Design Manual.*

- **CRF:** 30%
- **Cost:** $$$
- **Expected Life:** 20 yrs
- **Crash Types:** Rear-Ends, Broadsides

IMPLEMENTATION CONSIDERATIONS:

- Install at all signalized intersection approaches
- Refer to MTUCD Table 4D-1 for recommended number of signal faces along roadway with posted speeds of 45 mph or greater

Install Emergency Vehicle Preemption



Emergency vehicle pre-emption systems communicate with the traffic signal controller to terminate conflicting traffic phases and movements so that emergency vehicles can safely and efficiently progress through the intersection. These systems are recommended at all traffic signals on arterials and collectors for enhanced emergency response and traffic safety at signalized intersections.

Guiding Documents: *Federal Highway Administration.*

- **CRF:** 70%
- **Cost:** $$
- **Expected Life:** 10 yrs
- **Crash Types:** Emergency Vehicles

IMPLEMENTATION CONSIDERATIONS:

- At intersections where traffic may delay the routes of emergency vehicles to a scene
- At key routes used by emergency responders such as major corridors and locations in close proximity to fire stations and hospitals

*Install Raised Median**

Installing raised medians at intersection approaches is proven to reduce the frequency of head-on crashes by providing an extra buffer between queued vehicles and turning vehicles. Raised medians can also provide space for pedestrian refuge islands or improved street lighting, both discussed further in this document. Raised medians provide enhanced access control and reduce broadside crashes related to proximate driveways.

Guiding Documents: *Safety Benefits of Raised Medians and Pedestrian Refuge Areas, FHWA, 2013.*

- **CRF:** 10%
- **Cost:** $$$
- **Expected Life:** 20 yrs
- **Crash Types:** Broadsides, Head-Ons, Sideswipes

IMPLEMENTATION CONSIDERATIONS:

- At intersections with two or more through lanes to separate opposing streams of traffic and restrict turning movements
- In areas with mixtures of significant pedestrian and vehicle traffic (more than 12,000 ADT) and speeds above 30 MPH.
- Continuous raised medians are not always appropriate as they can contribute to increased vehicle speeds by increasing driver perception of safety.

Pedestrian Scramble

A pedestrian scramble is a signal phasing strategy deployed at a traffic signal where all vehicular traffic is stopped, allowing pedestrians and bikes to cross in any direction. This countermeasure is most effectively applied at locations with very high pedestrian volumes, such as downtown, business districts, adjacent to schools and other high pedestrian traffic generating land uses, high crossing demand for diagonal movements, and frequent pedestrian and vehicle conflicts.

Guiding Documents: *California Manual on Uniform Traffic Control Devices, Chapter 4.*

- **CRF:** 40%
- **Cost:** $$
- **Expected Life:** 20 yrs
- **Crash Types:** Bike+Ped

IMPLEMENTATION CONSIDERATIONS:

- At locations with high volumes of pedestrians and bicycles particularly during peak hours such as downtown
- Consider the overall operational impact, particularly if the intersection and adjacent intersections are operating close to or at capacity

** Countermeasure is applicable at multiple facility types*

Advanced Stop Bar

Advanced stop bars are applicable at signalized intersections with crosswalks, and are recommended at locations with higher pedestrian volumes. Vehicles are required to stop at the stop bar, providing a buffer between vehicles and pedestrians.

Guiding Documents: *USDOT, Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations, July 2018.*

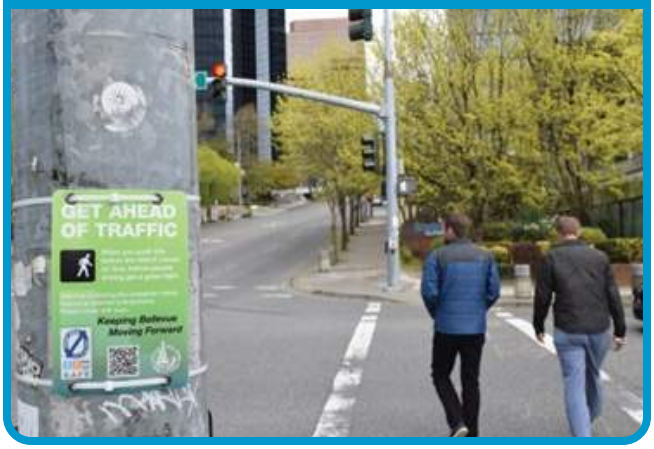
- **CRF:** 15%
- **Cost:** $
- **Expected Life:** 10 yrs
- **Crash Types:** Bike+Ped

IMPLEMENTATION CONSIDERATIONS:

Advanced stop bars are recommended on roads with

- Four or more lanes
- Three lane roads with
  - AADT>15,000
  - AADT between 9,000 and 15,000 and posted speed of greater than 30 mph
- Advanced stop bars may also be considered on roads with posted speeds of 30 mph or less, with AADT<15,000
- Advanced stop bars can be installed as part of the regular resurfacing /restriping efforts

Implement Leading Pedestrian Interval (LPI)



This signal timing strategy provides pedestrians with a 3-5 second head start to cross the road, enhancing their visibility and reinforcing pedestrian right of way. Drivers are more likely to see and yield to pedestrians already in the crosswalk than pedestrians that are looking to begin crossing. LPIs can be implemented at locations with higher pedestrian volumes, crash history, vulnerable populations, and limited intersection visibility.

Implementation Guide: *FHWA, Leading Pedestrian Interval (LPI) Safe Transportation For Every Pedestrian Countermeasure Tech Sheet; California Manual on Uniform Traffic Control Devices, Chapter 4E.06; Caltrans Traffic Safety Bulletin 21-01: Leading Pedestrian Interval Implementation Guidelines.*

- **CRF:** 60%
- **Cost:** $
- **Expected Life:** 10 yrs
- **Crash Types:** Bike+Ped

IMPLEMENTATION CONSIDERATIONS:

- Intersections with high pedestrian volumes and heavy conflicting vehicular turning volumes
- Intersections with school-aged children or elderly
- Limited or restricted crosswalk visibility (geometry, stopped vehicles, vegetation, streetside features
- Locations with multiple crashes or a history of severe injury/ fatal crashes over the last 3 years

Pedestrian Median Fencing

Pedestrian median fencing is applicable at locations where there is a history of pedestrian jaywalking. Median fencing on the intersection approaches is a proven strategy to encourage pedestrians to cross at the designated marked crossings by providing a raised barrier to discourage jaywaking at undesirable and unsafe locations.

Implementation Guide: *Caltrans Highway Design Manual, Chapter 700.*

- **CRF:** 35%
- **Cost:** $$
- **Expected Life:** 20 yrs
- **Crash Types:** Bike+Ped

IMPLEMENTATION CONSIDERATIONS:

- Consider the number of jaywalking pedestrians per day or during peak hours, especially school age children
- Intersections with raised medians on the approaches

Install Pedestrian Countdown Heads

Pedestrian countdown heads are recommended at all signalized intersections. These signal heads are standard design features which display how much time pedestrians have remaining to cross the road, enabling pedestrians to make informed decisions about if they should cross the road and signaling to drivers that pedestrians have the right of way.

Implementation Guide: *California Manual on Uniform Traffic Control Devices, Chapter 4E.07; SRTS Guide, Traffic Signals.*

- **CRF:** 25%
- **Cost:** $$
- **Expected Life:** 20 yrs
- **Crash Types:** Bike+Ped

IMPLEMENTATION CONSIDERATIONS:

- Install at new signals (and modified) with pedestrian phases

Close Slip Lane

IMPLEMENTATION CONSIDERATIONS:

- Locations with slip lanes where bike/pedestrian crashes are occurring are candidate locations
- A traffic study should be conducted to estimate the impact of removing the slip lane
- It is generally not recommended to remove slip lanes connected to highway ramps as there is potential for rear-end crashes if the vehicle queue extends onto the highway

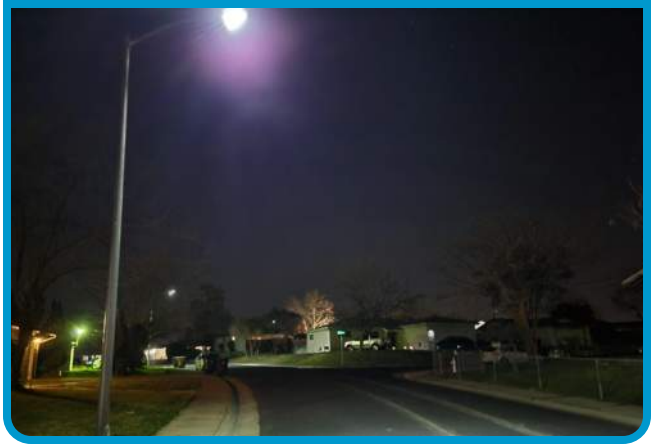
Slip lanes (or channelized right turns) are intended to improve traffic flow by reducing delay for vehicles making right turns. However, slip lanes can lead to conflicts between cars and pedestrians as vehicles are able to turn right without stopping, and minimal reduction in speed, depending on the circumstance. In order to improve pedestrian safety and reinforce pedestrian right of way, some agencies support closing channelized right turn lanes. The CMF Clearinghouse does not yet include a crash reduction factor for this countermeasure.

In order to improve pedestrian and bicycle safety and reinforce active transportation right of way, agencies and associations like NACTO support removing slip lanes and tightening up the intersection by reducing curb radii to slow vehicles turning across cycle and pedestrian paths. For added safety, intersections with slip lanes and bike lanes can be reconfigured as protected intersections to provide raised separation between vehicles and bicycles and reduce pedestrian crosswalk lengths. Signalized turn lanes for vehicles can be used in leu of slip lanes to improve traffic flow for right-turn movements.

Implementation Guide: *California Highway Design Manual Section 405.3; Slip Lane Guidelines: Well Designed Right–Turn Slip Lanes, FHWA; Improved Right-Turn Slip-Lane Design, PEDSAFE; Major Intersection: Cycle Protection, Global Street Design Guide.*

- **CRF:** --
- **Cost:** $$$
- **Expected Life:** --
- **Crash Types:** Bike+Ped

Install/Upgrade Intersection Lighting



Installing intersection safety lighting (new or upgraded) is a proven safety countermeasure which can prevent crashes occurring at night. Drivers are made more aware of their surroundings and of the presence of the intersection, roadway conditions, and other vehicles or active transportation users during nighttime conditions. This countermeasure is applicable at signalized intersections without lighting or with insufficient lighting, where crashes are known to be occurring at night. Providing adequate safety lighting should be considered as a preventative measure to reduce the likelihood of nighttime crashes at intersections.

Relevant Design Guides: *Illuminating Engineering Society of North America RP-8-21: Design of Roadway Facility Lighting; Caltrans Roadway Lighting Manual.*

- **CRF:** 40% (Applies to Nighttime Crashes)
- **Cost:** $$$
- **Expected Life:** 20 yrs
- **Crash Types:** Rear-End, Sideswipes, Hit Object, Dark, Bike+Ped

IMPLEMENTATION CONSIDERATIONS:

- Install at least 2 luminaires (one on each receiving lane corner) at intersections with 2-lane streets. Photometric analysis is recommended to confirm number and location of luminaires needed to achieve minimum light levels.
- Install one luminaire per corner at intersections with 4-lane streets
- Intersections where existing light levels do not meet recommended standards, see Table 12-1 in RP-8-21, Table D in Caltrans Roadway Lighting Manual

Install Improved Signage and/or Reflective Strips

At locations where vehicles are known to be running stop signs or where line of sight to the intersection traffic control device (i.e. regulatory sign) is limited, additional warning signage, reflective strips or similar features can be applied to raise driver awareness. Solutions such as supplemental stop signs (on left hand side) or reflective strips on posts provide additional warning and raise driver awareness of the presence of the stop sign and can be an effective tool to increase compliance. Additional or new reflective signage and strips are a low-cost initial improvement that can be implemented by City forces.

Relevant Design Guides: *CMUTCD Chapter 2A, 2C.*

- **CRF:** 15% (applies to night crashes)
- **Cost:** $
- **Expected Life:** 10 yrs
- **Crash Types:** Broadsides, Rear-Ends, Dark

IMPLEMENTATION CONSIDERATIONS:

- Locations where drivers are observed to be running stop signs, where line of sight to the stop sign is limited, lighting is poor, or near schools.
- Intersections where regulatory or warning sign compliance is disregarded or observed to be poor
- Intersections with patterns of crashes related to stop sign violations

Install Stop Signs with Flashing LEDs

Stop signs with flashing LED beacons provide enhanced visibility and can improve driver compliance with the traffic control device. This countermeasure is applicable at intersections with low stop sign compliance, particularly where crashes have been occurring at night, and/or where there are higher volumes of vulnerable road users.

Relevant Design Guides: *California Manual on Uniform Traffic Control Devices Chapter 2A.07.*

- **CRF:** 15% (applies to night crashes)
- **Cost:** $$
- **Expected Life:** 10 yrs
- **Crash Types:** Broadsides, Rear-Ends, Dark, Bike+Ped

IMPLEMENTATION CONSIDERATIONS:

Flashing stop signs are recommended in the following scenarios:

- Reflective signage and/or strips have been installed but additional crash reduction is desired
- Intersections which experience a disproportionately higher percentage of driver non-compliance with stop signs, where line of sight to the stop sign is limited, or near schools.
- Intersections with patterns of crashes related to stop sign violations

*Flashing Beacons**

Flashing beacons installed in tandem with warning signage are proven to raise driver awareness that they are approaching stop-controlled intersection when direct line of sight is limited. Flashing beacons are especially effective in situations where a horizontal curve or a fixed object obscures view to the intersection. If traffic queues extend beyond the intersection and lead to rear-end crashes, this LED flashing beacon raising driver awareness of the approaching intersection and of the potential need to stop.

Guiding Documents: *California Manual on Uniform Traffic Control Devices, Chapter 2A.15 & 4L.05; Unsignalized Intersection Improvement Guide, Treatment ID No. 007.*

- **CRF:** 30%
- **Cost:** $$
- **Expected Life:** 10 yrs
- **Crash Types:** Broadsides, Rear-Ends, Dark, Bike+Ped

IMPLEMENTATION CONSIDERATIONS:

- Existing STOP sign is not conspicuous
- Poor visibility of the intersection
- Crash history due to non-compliance or lack of awareness of intersection traffic control
- Locations with high rate of driver non-compliance of traffic control device

** Countermeasure is applicable at multiple facility types*

Install Transverse Rumble Strips on Approach

Transverse rumble strips are appropriate at locations where drivers may be unaware that they are approaching an intersection or areas prone to speeding. Transverse rumble strips alert drivers with an auditory and tactile warning as they drive over them on the approach to the intersection.

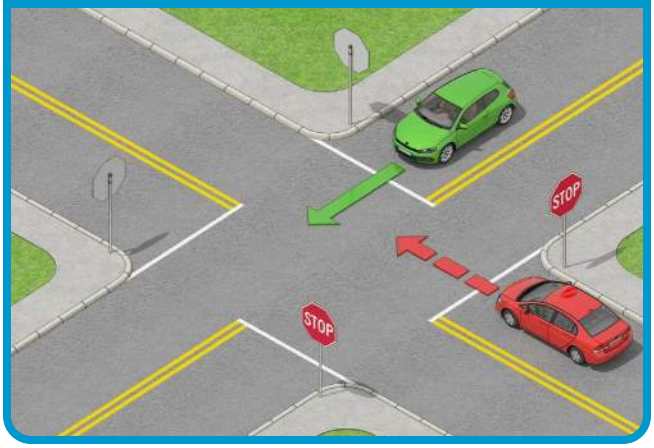
Guiding Documents: *California Manual on Uniform Traffic Control Devices Chapter 6F.87.*

- **CRF:** 20%
- **Cost:** $$
- **Expected Life:** 10 yrs
- **Crash Types:** : Rear-Ends, Broadsides

IMPLEMENTATION CONSIDERATIONS:

- Transverse rumble strips are not recommended in residential areas due to the noise
- Rumble strips can be milled-in, rolled-in, or raised and can be installed as part of regular resurfacing projects or as a separate improvement.
- Rumble strips should be used in combination with advance warning signs

Convert 2-way Stop or Yield Control to All-Way Stop



Side street stop (or yield controlled) controlled intersections with high frequencies of broadside crashes may benefit from all-way stop control. However, because this traffic control has operational considerations, the side-street volume would need to meet all-way stop warrants.

Guiding Documents: *California Manual on Uniform Traffic Control Devices, Chapter 2B.07.*

- **CRF:** 50%
- **Cost:** $
- **Expected Life:** 10 yrs
- **Crash Types:** : Rear-Ends, Broadsides, Bike+Ped

IMPLEMENTATION CONSIDERATIONS:

- Intersection experiences 5 or more collisions in a 12-month period
- Volumes exceed stop-warrant thresholds (see Attachments for All-way Stop Control Warrants)
- Sight Distance requirements not met (see Attachments for Sight Distance Requirements)

Install Traffic Signal

Traffic signals are a traffic control device which can provide significant safety and operational benefits including reduction in travel time and delay. Signalized intersections also provide opportunities for controlled pedestrian crossings. Traffic signals can also reduce conflicts leading to broadside and head-on crashes. An intersection must meet signal warrants established in the California Manual on Uniform Traffic Control Devices.

Guiding Documents: *California Manual on Uniform Traffic Control Devices Chapter 4C.*

- **CRF:** 50%
- **Cost:** $$$
- **Expected Life:** 20 yrs
- **Crash Types:** Broadsides, Head-Ons, Dark, Bike+Ped

IMPLEMENTATION CONSIDERATIONS:

- Meets one or more of the signal warrants (See Attachments for Traffic Signal Warrants)
- Intersection experiences 5 or more collisions in a 12-month period

Upgrade Intersection Pavement Markings

Upgraded pavement markings and enhanced striping are proven to raise driver awareness of the presence of the intersection and guide drivers though intersections.

Guiding Documents: *California Manual on Uniform Traffic Control Devices, Chapter 3B, Caltrans Standard Plans.*

- **CRF:** 25%
- **Cost:** $$
- **Expected Life:** 10 yrs
- **Crash Types:** Rear-Ends, Head-Ons, Sideswipes, Dark

IMPLEMENTATION CONSIDERATIONS:

- Visually inspect traffic striping and pavement markings yearly and refresh if faded
  - Thermoplastic striping typically lasts approximately 4-7 years
  - Water-based paints typically lasts approximately 6-12 months
- Ensure traffic striping width meets Caltrans 6” minimum and is in conformance to the Caltrans Standard Plans

Install Splitter Island on Minor Road Approaches

Splitter islands separate entering from exiting traffic, deflect and guide traffic into the intersection, and improve the visibility of signage on the intersection approach Splitter islands are best suited for side street stop-controlled intersections, though they can be effective at all-way stop controlled intersections.

Guiding Documents: *California Manual on Uniform Traffic Control Devices, Chapter 3B.*

- **CRF:** 25%
- **Cost:** $$
- **Expected Life:** 10 yrs
- **Crash Types:** Broadsides, Head-Ons

IMPLEMENTATION CONSIDERATIONS:

- Truck turning paths and the size of the median should be considered in the design of the splitter island
- Splitter islands should be paired with pavement markings, raised pavement markers, and proper signage to enhance visibility and reduce the likelihood of being struck

Create Directional Median Openings to Allow (and Restrict) Left-Turns and U-Turns

Directional median openings allow left-turns from major street while restricting left and through movements from minor street onto the major street. The number of conflict points is reduced with implementation of this access control strategy. Additional benefits include increased traffic capacity and improved operations.

- **CRF:** 50%
- **Cost:** $$
- **Expected Life:** 20 yrs
- **Crash Types:** Rear-Ends, Broadsides, Head-Ons, Sideswipes

IMPLEMENTATION CONSIDERATIONS:

- Crash history or observed conflicts involving left-turning vehicles
- Provide downstream U-turn location
- Consider if side-street delay exceeds 50 seconds
- Consider if the major road is three lanes or more in each direction

Install Marked Pedestrian Crossing at Uncontrolled Location

This countermeasure is applicable at non-signalized intersections without marked pedestrian crossings, where there is significant traffic volumes, high travel speeds, and pedestrians are known to be crossing.

Guiding Documents: *California Manual on Uniform Traffic Control Devices, Chapter 3B, USDOT; Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations, July 2018; Menlo Park, Citywide Crosswalk Policy, September 2016.*

- **CRF:** 25%
- **Cost:** $
- **Expected Life:** 20 yrs
- **Crash Types:** Bike+Ped

IMPLEMENTATION CONSIDERATIONS:

- Consider when crossing is on a direct route to/from a significant pedestrian generator
- Consider when 20 pedestrians cross during the peak hour or 60 pedestrians cross during any consecutive 4-hour period (children and seniors may count as 1.5 pedestrians)
- Consider sight distance of crossing pedestrians and conflicting vehicles
- Consider an engineering study
- Continental crosswalks per Caltrans Standard Plans are recommended at new uncontrolled locations. Existing uncontrolled crosswalks can be enhanced with ladder crosswalk markings as part of regular restriping efforts, and can be marked as continental crosswalks as part of regular resurfacing efforts

Install Pedestrian Refuge Island

Pedestrian refuge islands provide a designated space for pedestrians to wait as they cross multi-lane roads in a two-stage crossing. Refuge islands are applicable at marked pedestrian crossings where pedestrians have to cross multiple lanes on each approach. Pedestrians have time to judge conflicts separately or wait for an adequate gap in traffic before crossing.

Guiding Documents: *California Highway Design Manual Chapter 400, California Manual on Uniform Traffic Control Devices, Chapter 3B FHWA Proven Safety Countermeasures, Medians and Pedestrian Refuge Islands in Urban and Suburban Areas, USDOT, Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations, July 2018.*

- **CRF:** 45%
- **Cost:** $$
- **Expected Life:** 20 yrs
- **Crash Types:** Bike+Ped

IMPLEMENTATION CONSIDERATIONS:

Examples of locations are mid-block crossings, approaches to multilane intersections, and areas near transit stops, parks, or other pedestrian focused sites. Medians or pedestrian refuge islands should be considered:

- Urban/suburban multilane roads with curbs, roadways with volumes over 9,000 ADT, travel speeds of 35 mph or greater.
- The USDOT recommends that pedestrian refuge islands be considered on roads with 4+ lanes without a raised median, (when AADT<9000 and Posted Speed >30 mph) and on roads with AADT>9000.

The preferred median width is 8 feet (minimum recommended width is 4 ft). Safety lighting should be used to installed at the intersection to enhance pedestrian visibility.

*Install Rectangular Rapid Flashing Beacon (RRFB)**

Rectangular Rapid Flashing Beacons (RRFBs) increase driver awareness of a pedestrian crossing the road in a marked crosswalk. The pedestrian-activated LED flashing beacons accompany a pedestrian crossing warning sign and are applicable at roads with higher design speed and multilane crossings. RRFBs are also an effective traffic control device near schools, parks, or where larger volumes of pedestrians are known to be crossing.

Guiding Documents: *FHWA, Proven Safety Countermeasures Rectangular Rapid Flashing Beacons (RRFB), FHWA; Rectangular Rapid Flashing Beacon Safe Transportation For Every Pedestrian Countermeasure Tech Sheet, USDOT; Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations, July 2018.*

- **CRF:** 35%
- **Cost:** $$
- **Expected Life:** 20 yrs
- **Crash Types:** Bike+Ped

IMPLEMENTATION CONSIDERATIONS:

Consider RRFBs at marked crosswalks on roadways that meet the following criteria:

- Two lane roads (and three lane roads with a median) with AADT<9,000 and posted speed of greater than or equal to 40 mph.
- Roads with more than two lanes (with or without a median) with AADT 9,000-15,000 and posted speed of greater than or equal to 35 mph.
- Four lane roads (with or without a median) with AADT>15,000 and posted speed of 30 mph.
- Three lane roads with a median with ADT>15,000 and posted speed of 35mph.

RRFBs are applicable at intersections where there is moderate to high pedestrian activity. Consideration should also be given to locations where pedestrians cross an uncontrolled approach at a non-signalized intersection

Improve Sight Distance at Intersection

Intersections where sight distance is limited due to removable objects, vegetation, or parked cars can benefit from improved sight distance. This countermeasure is particularly applicable for turning vehicles at stop-controlled side-streets which intersect higher volume, higher speed roadways. Improving driver visibility to provide adequate stopping sight distance is an effective strategy to reduce the potential for broadside crashes.

Guiding Documents: *City of Milpitas Standard Drawing No. 405; Caltrans Highway Design Manual Chapter 400 topic 405.*

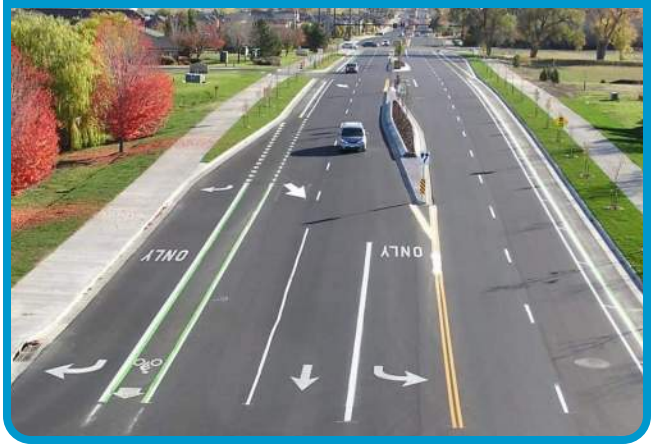
- **CRF:** 20%
- **Cost:** $
- **Expected Life:** 10 yrs
- **Crash Types:** Broadsides

IMPLEMENTATION CONSIDERATIONS:

- Conduct a sight distance evaluation using AASHTO, A Policy on Geometric Design of Highway and Street

** Countermeasure is applicable at multiple facility types*

Install Right or Left Turn Lanes



This countermeasure is recommended at intersections where the approach does not have a left turn lane, and which are experiencing a high number of broadside or rear-end crashes. Providing a dedicated turn lane improves traffic flow and reduces the potential for rear-end crashes by providing a dedicated space for turning vehicles to decelerate and wait to turn while outside of the through lane. Dedicated left and right turn lanes are recommended at unsignalized intersection approaches where turning volumes warrant consideration and there is adequate right-of-way.

- **CRF:** 20%
- **Cost:** $$
- **Expected Life:** 20 yrs
- **Crash Types:** Rear-Ends, Broadsides, Sideswipes

IMPLEMENTATION CONSIDERATIONS:

- Left turn and opposing and advancing volumes meet the left turn lane warrants based on design speed of roadway (see Attachments for Left turn warrants)
- Right turn and advancing volumes meet the right turn lane warrants based on design speed of roadway (see Attachments for Right turn warrants)

Install Raised Median*

Installing raised medians at intersection approaches is proven to reduce the frequency of head-on crashes by providing an extra buffer between queued vehicles and turning vehicles. Raised medians can also provide space for pedestrian refuge islands or improved street lighting, both discussed further in this document. Raised medians provide enhanced access control and reduce broadside crashes related to proximate driveways.

Guiding Documents: *: Safety Benefits of Raised Medians and Pedestrian Refuge Areas , FHWA, 2013.*

- **CRF:** 25%
- **Cost:** $$
- **Expected Life:** 20 yrs
- **Crash Types:** Head-On, Broadsides, Sideswipes

IMPLEMENTATION CONSIDERATIONS:

- At locations where crashes or near-misses occur near driveways proximate to the intersection approaches
- At intersections with two or more through lanes to separate opposing streams of traffic and restrict turning movements
- In areas with mixtures of significant pedestrian and vehicle traffic (more than 12,000 ADT) and speeds above 30 MPH.
- Continuous raised medians are not always appropriate as they can contribute to increased vehicle speeds by increasing driver perception of safety.

** Countermeasure is applicable at multiple facility types*

Install/Upgrade Roadway Lighting

Installing intersection safety lighting (new or upgraded) is a proven safety countermeasure which can prevent crashes occurring at night. Drivers are made more aware of their surroundings and of the presence of the intersection, roadway conditions, and other vehicles or active transportation users during nighttime conditions. This countermeasure is applicable along roadway segments without lighting or with insufficient lighting, where crashes are known to be occurring at night. Providing adequate safety lighting should be considered as a preventative measure to reduce the likelihood of nighttime crashes along segments.

Guiding Documents: *1) Illuminating Engineering Society of North America RP-8-21: Design of Roadway Facility Lighting 2) City of Milpitas Standard Drawing No. 441, 442 3) Caltrans Roadway Lighting Manual.*

- **CRF:** 35%
- **Cost:** $$$
- **Expected Life:** 20 yrs
- **Crash Types:** Rear-End, Broadsides, Head-Ons, Sideswipes, Hit Object, Bike+ Ped, Dark

IMPLEMENTATION CONSIDERATIONS:

- Roadways where existing light levels do not meet recommended standards, see Table 11-1 in RP-8-21, Table C in Caltrans Roadway Lighting Manual
- Photometric analysis is recommended to confirm number and location of luminaires needed to achieve minimum light levels

Install Median Barrier

Median barriers provide enhanced safety by providing a raised physical barrier between opposing lanes of traffic. The presence of the median reduces the likelihood of head-on crashes as a result of vehicle lane departure. This countermeasure should be considered based on the amount of right of way available and is applicable along collector and arterial roadways.

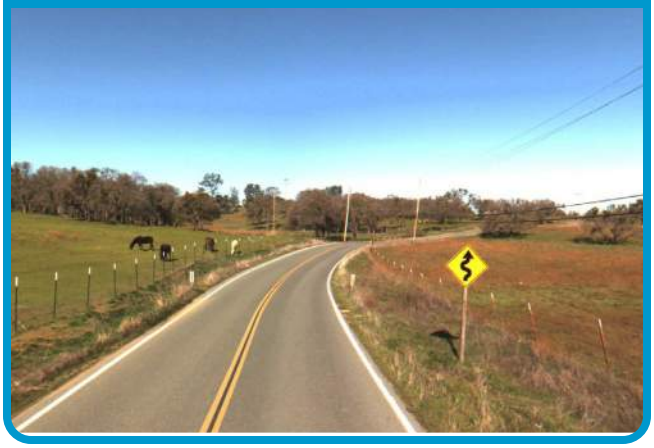
Guiding Documents: *FHWA Proven Safety Countermeasures, Medians and Pedestrian Refuge Islands in Urban and Suburban Areas.*

- **CRF:** 25%
- **Cost:** $$
- **Expected Life:** 20 yrs
- **Crash Types:** Head-Ons

IMPLEMENTATION CONSIDERATIONS:

- Median barriers can contribute to increased vehicle speeds by increasing driver perception of safety
- Median barriers can restrict pedestrian access and vehicular turning movements
- Median barriers can also inherently result in increased jaywalking as it provides a pedestrian refuge

Install Curve Advanced Warning Signs



Advanced curve warning signs provide enhanced driver awareness of an approaching roadway condition (i.e. unexpected or sharp curve). The CAMUTCD details under what circumstances curve warning signs are required or recommended, and how far in advance the signs should be placed in advance of curve based on roadway speeds.

Guiding Documents: *California Manual on Uniform Traffic Control Devices, Chapter 2C.*

- **CRF:** 25%
- **Cost:** $
- **Expected Life:** 10 yrs
- **Crash Types:** Head-Ons, Sideswipes, Dark, Hit Object

IMPLEMENTATION CONSIDERATIONS:

- MUTCD requirements/recommendations
- Consider after completing a sight distance evaluation

Install Delineators, Reflectors or Object Markers

Delineators, reflectors, and object markers are intended to provide guidance and warn drivers of an approaching curve, transition, or fixed object. They can also be used to guide drivers along a curve in the road or a horizontal offset. These items may be used as a preventative measure or in response to a crash. Delineator posts are often used in conjunction with bike lanes and crosswalks to enhance their visibility.

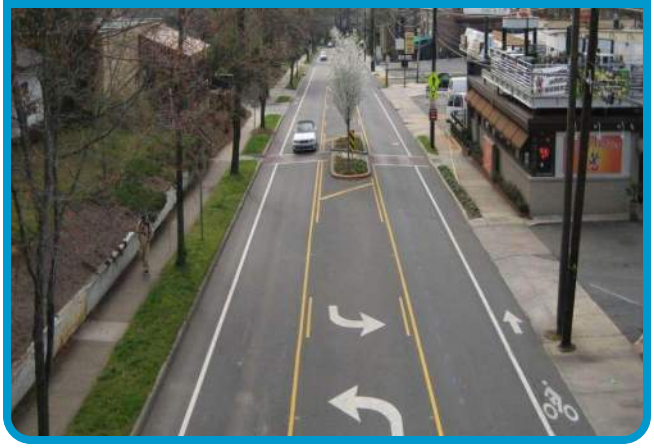
Guiding Documents: *California Manual on Uniform Traffic Control Devices, Chapter 2C.*

- **CRF:** 15%
- **Cost:** $
- **Expected Life:** 10 yrs
- **Crash Types:** Hit Objects, Sideswipes, Dark

IMPLEMENTATION CONSIDERATIONS:

- Install object markers to mark obstructions or conditions within or adjacent to the roadway
- Delineator posts can be installed to enhance visibility of features within the roadway, but often require routine maintenance to address post knock-down.
- Recommend consultation with operations and maintenance staff as these traffic control devices may be knocked down and/or present maintenance challenges (i.e. street sweeping)

Install a Two-Way Left-Turn Lane



Two-way left-turn lanes provide a buffer between opposing directions of travel, and also separate left-turns from through traffic. This countermeasure is applicable along roadway segments with driveway access, provided that sufficient sight distance and right of way is available.

Guiding Documents: *California Manual on Uniform Traffic Control Devices, Chapter 3.*

- **CRF:** 30%
- **Cost:** $$
- **Expected Life:** 20 yrs
- **Crash Types:** Rear-End

IMPLEMENTATION CONSIDERATIONS:

- Consider along roadways where:
  - AADT < 28,000
  - Posted speed of <45 mph
  - Majority of driveways are commercial
  - <20% of vehicles left turning vehicles during peak hour

Road Diet

Before **After**

Implementation of a road diet reduces travel lanes by reallocating a portion of the street right of way to enhanced bike facilities (i.e. Class II bike lanes, buffered bike lanes), new/expanded pedestrian facilities (i.e. sidewalk, path), and other roadway features which improve multi-modal safety and access. It is important that a study is completed to determine the impact of the road diet on traffic operations prior to implementation.

Guiding Documents: *1) Federal Highway Administration Road Diet Information Guide 2) FHWA Proven Safety Countermeasures, Road Diet Informational Guide 3) USDOT, Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations, July 2018.*

- **CRF:** 35%
- **Cost:** $$$
- **Expected Life:** 20 yrs
- **Crash Types:** Bike+Ped

IMPLEMENTATION CONSIDERATIONS:

A road diet is a candidate treatment on roads with total of 4+ lanes (with or without raised medians).

- Complete basic volume warrant for roadway segment capacity (a more thorough traffic study would be needed to confirm operations)

Upgrade Signs with Fluorescent Sheeting

Signs (including object markers) with fluorescent retroreflective sheeting provide enhanced visibility and driver awareness. This countermeasure is best applied at a systemic level and encompasses considerations such as sign size, retroreflectivity, and sign placement.

Guiding Documents: *California Manual on Uniform Traffic Control Devices.*

- **CRF:** 15%
- **Cost:** $
- **Expected Life:** 10 yrs
- **Crash Types:** Head-Ons, Sideswipes, Hit Object, Dark

IMPLEMENTATION CONSIDERATIONS:

- Prioritize roads located adjacent to schools or corridors with high crash rates
- Program a regular review of signage

Install Edgelines and Centerlines

Roadway edgeline and centerline pavement markings with high visibility thermoplastic provide enhanced visibility and driver awareness of both lane and roadway. This standard design feature is proven to address lane departure crashes.

Guiding Documents: *California Standard Plans, California Manual on Uniform Traffic Control Devices, Chapter 3B.01 & 3B.07.*

- **CRF:** 25%
- **Cost:** $
- **Expected Life:** 10 yrs
- **Crash Types:** Head-Ons, Hit Object, Sideswipe, Dark

IMPLEMENTATION CONSIDERATIONS:

Install Edgelines:

- On rural arterials or collectors with traveled way is >=20 ft in width and ADT is >= 3,000 veh/day

Install Centerlines:

- On an urban arterials or collectors when traveled way is >=20 ft in width and ADT is >= 4,000 veh/day
- On rural arterials or collectors with traveled way of >=18 ft and ADT is >=3,000 veh/day
- On two-way streets with three or more lanes

Install Rumble Strips

Centerline and edgeline rumble strips provide drivers with an auditory indication and tactile rumble when driven on, alerting drivers when they drift out of their travel lane. Centerline rumble strips are applicable along roadway segments with patterns of head-on crashes or sideswipes, while edgeline rumble strips are applicable along roadway segments with patterns of hit object or other lane departure crashes.

Guiding Documents: *1) Caltrans, Traffic Safety Bulletin 20-07: Rumble Strip Guidelines. 2) Decision Support Guide For The Installation Of Center Line And Shoulder Rumble Strips. 3) NCHRP 641: Guidance for the Design and Application of Shoulder and Center Line Rumble Strips*

- **CRF:** 15-20%
- **Cost:** $$
- **Expected Life:** 10 yrs
- **Crash Types:** Head-Ons, Sideswipes, Hit Object

IMPLEMENTATION CONSIDERATIONS:

- Rumble strips are not recommended on roads with speed limits of 35 mph or less, commercial areas, or in areas with high volume turning movements.
- Caltrans requires a minimum clearance of five feet for the shoulder if bike lanes are present. Smaller rumble strips can also be used to better accommodate cyclists
- Milled sinusoidal rumble strips are recommended in urban contexts because they produce less sound, while still providing drivers with a tactile alert when driven on
- Raised rumble strips can be considered in contexts where milled rumble strips are not feasible, such as thin surface treatments

Install Dynamic/Variable Speed Warning Sign

Dynamic/variable speed warning signs provide drivers with a visual display of their travel speeds and provides warning when traveling faster than the recommended speed for an approaching curve. This countermeasure is recommended approaching curves with speed-related crashes, but does not apply to general roadway segments with speed feedback signs.

Guiding Documents: *Unsignalized Intersection Improvement Guide.*

- **CRF:** 30%
- **Cost:** $$
- **Expected Life:** 10 yrs
- **Crash Types:** Broadside, Rear-Ends, Hit Object, Ped & Bike, Sideswipes, Head-Ons, Dark

IMPLEMENTATION CONSIDERATIONS:

- Locations with history of speeding
- Change in speed limit, roadway condition or land use
- Changeable speed limit by time and day of the week

Improve Pavement Friction (High Friction Surface Treatments)

This countermeasure is applicable along roadways where skidding or failure to stop is contributing to crashes. Increasing the pavement friction enables cars to grip the road more effectively and safely maneuver through a turning movement or decelerate. High friction surface treatments are effective along roads with horizontal curves. HFST is different from typical asphalt overlay treatments in that it should not be used as a pavement preservation treatment.

Guiding Documents: *Federal Highway Administration, High Friction Surface Treatments.*

- **CRF:** 55%
- **Cost:** $$
- **Expected Life:** 10 yrs
- **Crash Types:** Hit Object, Sideswipes, Head-Ons

IMPLEMENTATION CONSIDERATIONS:

Applicable at spot locations such as:

- Interchange ramps
- High volume intersection approaches
- Segments of steep grade

Install Acceleration/Deceleration Lanes

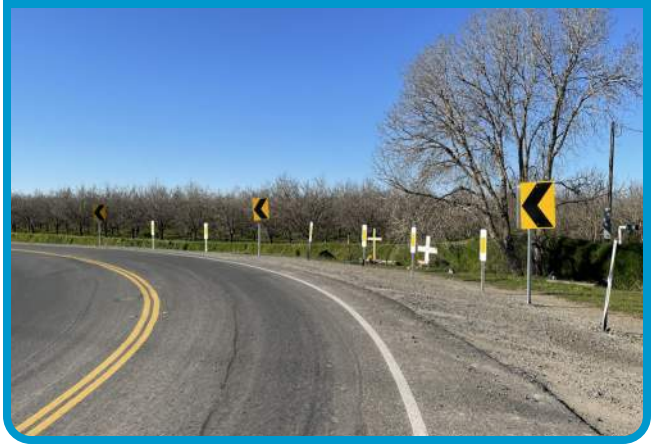
This improvement provides space for vehicles to accelerate and safely merge into traffic, or to slow down before a turn without impacting traffic flow. This is demonstrated to prevent rear-end crashes between cars at speed and slower vehicles. This countermeasure is most applicable on roads with higher speeds, or where there are higher volumes of vehicles turning right onto the cross street.

- **CRF:** 25%
- **Cost:** $$$
- **Expected Life:** 20 yrs
- **Crash Types:** Rear-Ends, Broadsides, Sideswipes

IMPLEMENTATION CONSIDERATIONS:

- Crash history or observed conflicts involving left-turning vehicles
- Provide downstream U-turn location
- Consider if side-street delay exceeds 50 seconds
- Consider if the major road is three lanes or more in each direction

Install Chevron Signs on Horizontal Curves



Post-mounted chevrons warn drivers of an approaching curve and prepares them to safely maneuver the curve. These items may be used as a preventative measure or in response to a crash on a location with relatively sharp curves in periods of light and darkness.

Guiding Documents: *MUTCD Chapter 2C.*

- **CRF:** 40%
- **Cost:** $
- **Expected Life:** 10 yrs
- **Crash Types:** Hit Object, Dark

IMPLEMENTATION CONSIDERATIONS:

- Chevrons are required at curves with an advisory speed differential of 15 mph or more
- Chevrons are recommended at curves with a differential of 5 or 10 mph.

Install Bike Lanes

Dedicates a portion of the road's width for bicyclists only, rather than having cyclists ride in the same lane as traffic. Class II bike lanes are required to have a minimum width of 4 feet, except when adjacent to on street parking (5 feet) or on roads with posted speeds of greater than 40 mph (6 feet). Sufficient roadway width is required to accommodate a bike lane safely.

Guiding Documents: *Caltrans Highway Design Manual Chapter 300; FHWA Proven Safety Countermeasures, Bicycle Lanes. FHWA Bikeway Selection Guide.*

- **CRF:** 35%
- **Cost:** $$
- **Expected Life:** 20 yrs
- **Crash Types:** Bike+Ped

IMPLEMENTATION CONSIDERATIONS:

- Consider if roadway speeds are between 25 mph and 35 mph
- Consider if roadway vehicular volumes are between 3,000 vehicles per day and 7,000 vehicles per day

Install Separated Bike Lanes

Separating vehicular traffic from bicycles provides cyclists with additional safety and comfort.

Guiding Documents: *City of Milpitas Bicycle/Pedestrian and Trails Plan.*

- **CRF:** 45%
- **Cost:** $$
- **Expected Life:** 20 yrs
- **Crash Types:** Bike+Ped

IMPLEMENTATION CONSIDERATIONS:

- Consider if roadway speeds are greater than 35 mph
- Consider if roadway vehicular volumes are greater than 3,000 vehicles per day

Install Additional Signage to Pedestrian Crossing

Additional signage at pedestrian crossings Increase warning and awareness for motorists at a crossing. USDOT recommends in-street pedestrian crossing signs be considered on two and three lane roads with sped limits of less than or equal to 30 mph.

Relevant Design Guides: *USDOT, Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations, July 2018.*

- **CRF:** 35% (applies to nighttime crashes)
- **Cost:** $
- **Expected Life:** 20 yrs
- **Crash Types:** Bike+Ped

IMPLEMENTATION CONSIDERATIONS:

- In-Street pedestrian crossing signs (R1-6, R1-6a) are recommended on two and three lane roadways with speed limits of less than or equal to 30 mph.
- Advanced yield/stop here to pedestrian signs (R1-5, R1-5a) are recommended for 3 lane roads with raised medians (except for AADT<9000 and posted speed less than or equal to 30 mph) as well as on 4 lane roads.

Install Raised Pedestrian Crossing

USDOT defines raised pedestrian crossings as "Ramped speed tables spanning the entire width of the roadway, often placed at midblock crossing locations". Raised crossings encourage drivers to reduce their speed as they approach the crosswalk. Raised crossings clearly mark the limits and location of the crossing and also allow pedestrians to cross the road at a constant grade

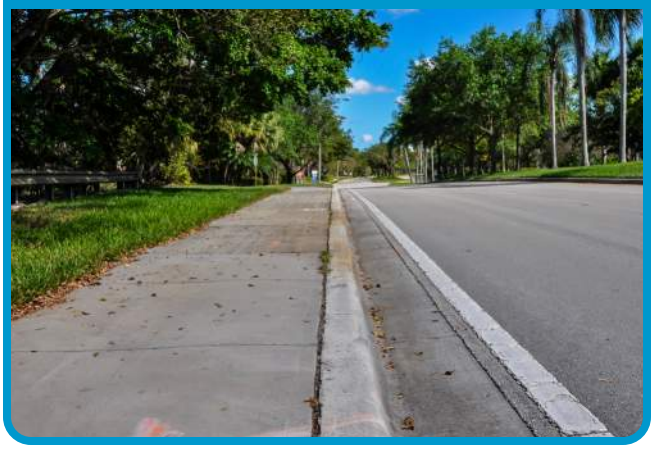
Guiding Documents: *USDOT, Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations, July 2018.*

- **CRF:** 35%
- **Cost:** $$
- **Expected Life:** 20 yrs
- **Crash Types:** Bike+Ped

IMPLEMENTATION CONSIDERATIONS:

- According to the USDOT, raised crosswalks are a candidate treatment for two and three lane roads with AADT below 9000 and speeds less than or equal to 30 mph.
- Should be accompanied by speed hump markings (MUTCD 3B.25)
- Generally avoid installing raised crossings on truck routes, emergency routes, arterial streets

Install Sidewalk



Sidewalks provide pedestrians with dedicated facilities at a separated grade. Pedestrian facilities are recommended by FHWA and ITE to be a minimum of 5' wide. Curb ramps and grades should be ADA accessible.

Guiding Documents: *USDOT, Office of Safety Proven Safety Countermeasures: Walkways, July 2018.*

- **CRF:** 80%
- **Cost:** $$$
- **Expected Life:** 20 yrs
- **Crash Types:** Bike+Ped

IMPLEMENTATION CONSIDERATIONS:

- Locations without sidewalks or pedestrian facilities that also have significant pedestrian volumes
- Roadway segments with trends of pedestrian crashes and no sidewalks

*Install Rectangular Rapid Flashing Beacon (RRFB)**

Rectangular Rapid Flashing Beacons (RRFBs) increase driver awareness of pedestrians crossing the road in a marked crosswalk. The pedestrian-activated LED flashing beacons accompany a pedestrian crossing warning sign and are applicable at roads with higher design speeds and multilane crossings. RRFBs are also an effective traffic control device near schools, parks, or where larger volumes of pedestrians are known to be crossing.

Guiding Documents: *1) FHWA, Proven Safety Countermeasures Rectangular Rapid Flashing Beacons (RRFB), 2) FHWA, Rectangular Rapid Flashing Beacon Safe Transportation For Every Pedestrian Countermeasure Tech Sheet, 3) USDOT, Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations, July 2018.*

- **CRF:** 35%
- **Cost:** $$
- **Expected Life:** 20 yrs
- **Crash Types:** Bike+Ped

IMPLEMENTATION CONSIDERATIONS:

Consider RRFBs at marked crosswalks on roadways that meet the following criteria:

- Two lane roads (and three lane roads with a median) with AADT<9,000 and posted speed of greater than or equal to 40 mph; and with ADT 9,000-15,000 and posted speed of greater than or equal to 40 mph
- Roads with more than two lanes (with or without a median) with AADT 9,000-15,000 and posted speeds of 35 mph.
- Three lane roads with a median with ADT>15,000 and posted speed of 35mph.
- Four lane roads (with or without a median) with AADT>15,000 and posted speed of 30 mph.
- Three lane roads with medians, with AADT>15,000 and design speed of 35 mph

RRFBs are applicable at intersections where there is moderate to high pedestrian activity. Consideration should also be given to locations where pedestrians cross an uncontrolled approach at a non-signalized intersection.

** Countermeasure is applicable at multiple facility types*

COUNTERMEASURE TOOLBOX ATTACHMENT

ANSI IES RP-8-21 TABLE 12-1

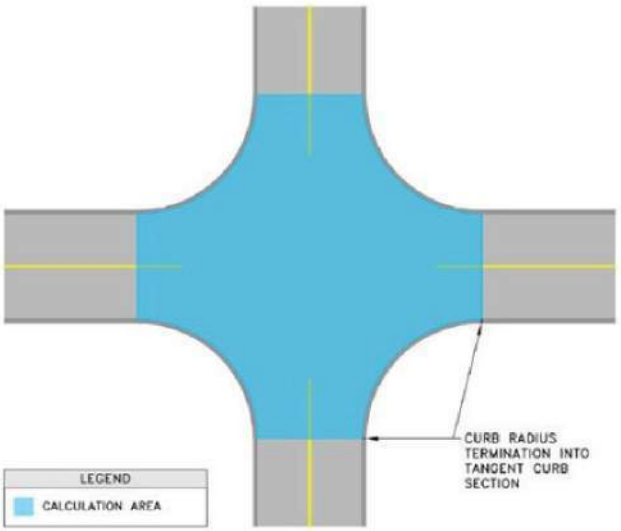


Figure 12-4. Intersection extents as defined by curb returns.

Some intersections may include some of these elements on certain legs and not others. In these cases, the above ranked criteria shall be utilized for each leg.

Within the area defined above, some elements may be left out of the intersection calculation as these elements do not contain a potential point of conflict as shown in **Figure 12-1** (see **Section 12.1.2**).

These elements include:

- **Islands.** Painted and raised islands areas should be precluded from the intersection calculation area, as these are not intended to be accessed by vehicular traffic.
- **Channelized right turn only lanes.** As this type of lane does not contain conflict points, there is no need to light it to intersection lighting levels or to include it within the intersection area.

12.3.2.2 Full Intersection Lighting. The values for full intersection lighting are based on the principle that the amount of light should be proportional to the classification of the intersecting roadways and equal to the sum of the values used for each separate roadway.

The values included in **Table 12-1** are the recommended average maintained illuminance levels for fully lighted intersections of continuously lighted roadways, based on street classification and pedestrian volumes. The recommendations assume an R2 or R3 pavement type. If the intersecting streets are not continuously lighted, a partial lighting system may be utilized.

Because of the nature of intersection calculations, the veiling luminance ratio is not a valid requirement because it cannot be calculated. However, it is recommended that in order to minimize glare, the use of luminaires with high-angle-candlepower should be avoided in all instances of full intersection lighting.

Pole placement: In most cases, the recommended horizontal illuminance levels for intersections can be achieved by using combination signal and luminaire poles. Where full roadway lighting that ties into the intersection is present, the spacing of the poles on the approach road should be designed to synchronize with the pole locations for the intersection.

Light poles should be positioned in advance of the crosswalks to improve visibility in the crosswalk by providing improved vertical illuminance and positive contrast. **Figure 12-5** shows the general arrangements.

Table 12-1. Pavement Illuminance Criteria for Full Intersection Lighting (Lux/Fc)

Functional Classification	Pedestrian Activity Level Classification			E_{avg}/E_{min}
	High	Medium	Low	
Major/Major	34/3.2	26/2.4	18/1.7	3.0
Major/Collector	29/2.7	22/2.0	15/1.4	3.0
Major/Local	26/2.4	20/1.9	13/1.2	3.0
Collector/Collector	24/2.2	18/1.7	12/1.1	4.0
Collector/Local	21/2.0	16/1.5	10/0.9	4.0
Local/Local	18/1.7	14/1.3	8/0.7	6.0

COUNTERMEASURE TOOLBOX ATTACHMENT

CALTRANS ROADWAY LIGHTING MANUAL

Roadway Lighting Manual

Division of Traffic Operations, First Edition, July 2021

Acknowledgments

The *Roadway Lighting Manual* was developed through the dedication and efforts of the following Caltrans staff:

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Elenita Stickler – Structural Design Detailing
Michael Slayton - Structural Design Detailing
My Nguyen – Structural Design Detailing

Table of Contents

Introduction

The Roadway Lighting Manual is the culmination of extensive research and effort by Caltrans staff to develop guidelines for roadway lighting designs. This publication does not constitute a standard, specification or regulation. Field and economic conditions may call for variation from this publication's requirements and may be subject to approval by designated levels of management in the district. This publication is neither a textbook nor a substitute for engineering knowledge, experience or judgment.

The information in this manual is written to assist Caltrans roadway lighting designers in preparing uniform and standard designs of roadway lighting systems.

The *Roadway Lighting Manual* supersedes all prior versions of the *Traffic Manual*, Chapter 9, Sections 9-06 through 9-12.

Purpose

The purpose of this manual is to provide a comprehensive source of information concerning Caltrans policies for roadway lighting within the State Highway System and to develop uniformity in designing roadway lighting systems.

The illumination requirements are based on Federal Highway Administration (FHWA), the American National Standards Institute/Illuminating Engineering Society of North America Recommended Practice (ANSI/IES RP) 8-18 guidelines, and industry practices and recommendations.

The *Roadway Lighting Manual* provides guidance for the following:

- Installing uniform lighting for various applications within the State right-of-way (including freeways, highways, expressways, intersections, bicycle and pedestrian facilities, roundabouts, park and ride lots, bus stops, and railroad crossings).
- The standardization of lighting structures.
- Adjusting luminaire spacing and light fixture characteristics for a more uniform lighting distribution.
- Evaluating lighting levels using computer-based lighting software.
- Updating Caltrans' lighting practices and standards (plans and specifications).

The terms used in this manual are defined in Appendix D.

Chapter 1 – Lighting Development Procedures

Chapter 1.1 – Introduction

The design of freeway and highway lighting should comply with the most current version of the following publications:

- *Roadway Lighting Manual*
- *Construction Contract Standards*
- *Construction Contract Development Guide*
- *Highway Design Manual* (*HDM*)
- *Plans Preparation Manual*
- *Cooperative Agreement Handbook*
- *Project Development Procedures Manual*
- *Electrical Systems Design Manual*
- *California Manual on Uniform Traffic Control Devices* (*CA MUTCD*)
- *Highway Safety Improvement Program Guidelines*
- *Caltrans Standard Environmental Reference (SER)*

Lighting standards for installation on State highways will normally be one of the types shown in the Standard Plans. The exception is where a local agency uses a different type of lighting standard and either of the following:

- Has existing lighting that is being replaced due to State highway construction; or
- Desires the inclusion of their roadway lighting into a State highway project.

The types, applications and mast arm lengths of the roadway luminaires are as follows:

Luminaire Standards

Type 15

Type 15 and 15D standards are used:

- On highways and expressways.
- At intersections of freeway ramps with surface streets.
- On structures in lieu of a Type 21 standard where a lower mounting height is desired.

A 12 feet mast arm is normally used on Type 15 and 21 standards, but lengths of 6, 8, 10, and 15 feet are also available. A 15-foot mast arm is not available for Type 15D and 21D standards.

Type 21

Type 21 and 21D standards are used on structures and may be mounted on a barrier railing or a retaining wall.

Types 30, 31 and 32

Type 30, 31, and 32 standards are used on freeways and in freeway interchange areas.

A Type 30 standard is used where the standard cannot be located further than 18 feet from the edge of the traveled way. The normal mast arm length for Type 30 is 15 feet, but lengths of 6, 8, 10, and 12 feet are available.

A Type 31 standard is available only with a mast arm of 20 feet and should be located a minimum of 20 feet from the edge of the traveled way.

A Type 32 standard is available only with a 30-foot mast arm and without a slip base and should be located a minimum of 30 feet from the edge of the traveled way.

Luminaire Placement

Placement of luminaire standards should comply with the latest Caltrans Highway Design Manual, Section 309.1, “Horizontal Clearances for Highways.”

Foundations

The foundation and installation details for each lighting standard are shown in the Standard Plans. Location of foundations are described in the following section:

Lateral (Set Back)

In general, lighting standards should normally be set as far from the right or left edge of the pavement as conditions permit. Exceptions to this occur in cut or fill sections with slopes steeper than 4:1; foundation locations for these conditions are shown in the Standard Plans. On curved ramps, lighting standards should be located on the inside of the curve.

Longitudinal

- Typical spacing for Type 21, 30, 31 and 32 standards is 180 feet. The typical spacing for a Type 15 is 150 feet.
- The typical location of standards for each application is shown in Appendix A. Designers should adjust the spacing to achieve required lighting levels in the conflict area using lighting software.

Structures

On structures and retaining walls, lighting standards should be located at least five feet from the structure expansion joints or hinges. Care should be taken in locating standards on lower roadways or structures to avoid creating glare to vehicles on a higher structure.

Slip bases shall be installed with Type 30 and 31 standards and with Type 15 standards on freeways, expressways, and highways within the Clear Recovery Zone (CRZ) as defined in the Caltrans High Design Manual. Exceptions to this policy are that slip bases are not used under signal standards with lighting or under lighting standards located in the following areas:

- On or behind structures, retaining walls, or sound walls;
- Behind guard rail or barrier railing;
- In sidewalk areas;

- Where pedestrians would be close enough to be endangered by a pole knockdown;

Chapter 1.2 – Project Report

General requirements for developing lighting projects are noted in the *Project Development Procedures Manual*. The cost of lighting on Federal Aid highway projects is eligible for federal participation under certain conditions.

The *FHWA Lighting Handbook* describes recommendations for roadway lighting and requirements for federal aid eligibility. This manual is in substantial conformance with the *FHWA Lighting Handbook* to ensure federal aid eligibility.

For scoping and programming purposes, the preparation of a Project Initiation Document is required for all projects that include lighting. The *Project Development Procedures Manual* and the corresponding Project Manager should be consulted to determine specific reporting requirements.

The following data is required to determine the need for highway lighting installation and shall be included in the Project Initiation Document.

Traffic Counts–Both pedestrian and vehicular traffic counts shall be shown for any single hour that may be in darkness during winter months. Traffic counts shall be shown on Figure 4C-101 (CA) and Figure 4C-102 (CA) of the CA MUTCD. For Figure 4C-101 and Figure 4C-102 the single-hour traffic count shall be measured during a period of darkness that shows the highest traffic count. Pedestrian traffic counts should be shown on each crosswalk for the same periods as the vehicular count.

Vehicle Speed–This shows the posted speed limit or 85th percentile speed of vehicles on approaches to the intersection.

Electrical Service–This is a statement on the availability of electrical service. Where the cost of establishing electrical service is excessively high due to line extension, consider alternate sources of power or deferring the installation.

Other Data–This includes the following documentation:

a. Location map;
b. Condition diagram showing existing conditions;
c. Summary of accidents and the collision diagram;
d. Figure 4C-101 (CA), Figure 4C-102 (CA), or Figure 4C-103 (CA) (Traffic Signal Warrants Sheet [sheets 1 to 5] from CA MUTCD);
e. Applicable warrant in Table 4C-1, Table 4C-2, Table 4C-3, and Table 4C-4, and Figure 4C-102 (CA) from CA MUTCD;
f. Improvement diagram showing existing and proposed lighting, channelization, and other proposed improvements. This may be combined with (b), (c), (d), and (e) on a single plan;
g. Estimate of cost; and
h. Explanation of confusing or unsatisfactory conditions to be improved by the lighting.

Chapter 1.3 – Utility Coordination

During the design stage, the local electrical utility should be contacted to determine the location and type of service available.

Chapter 1.4 – Financing

General Policy

Caltrans participation in financing is based on the use of standard equipment in accordance with Caltrans standard plans and standard specifications. If local agencies plan to use more expensive equipment, the additional cost over the standard equipment shall be at 100 percent local agency expense except as noted below.

Freeways

The cost of installing lighting on freeways is at 100 percent Caltrans expense. If other agencies desire to provide lighting between interchange areas, such lighting may be included in the State's project. However, Caltrans will not be responsible for installation costs. Caltrans will maintain and operate the lighting at 100 percent local agency expense.

On Federal Aid projects, federal participation will be requested when one or more of the traffic volume warrants in Chapter 2.2 are met.

At the intersections of freeway ramps with local streets, the installation cost of lighting shall be at 100 percent Caltrans expense if it is found to be warranted at any time within five years after the date the freeway is opened to traffic. Lighting that meets the warrants stated in Chapter 2.2 may be installed at Caltrans expense on new frontage roads and local streets constructed as part of a freeway project when such lighting will be owned by a local agency. Lighting design may conform to the established design standards of the local agency.

Existing Highway Intersections

Highway lighting to be installed at existing intersections shall be financed jointly by Caltrans and the local agency in the same ratio as the number of legs under each jurisdiction bears to the total number of legs at the intersection.

The District Director may approve installing warranted utility-owned lighting without submitting a Project Initiation Document to Headquarters.

Normally, the monthly charges for utility-owned lighting installed at the request of Caltrans should be shared jointly with the local agency, as stated above or as indicated on the District Maintenance Agreement.

New Highway Intersections

The installation cost of highway lighting at new intersections on a State highway because of a State highway project shall be at 100 percent Caltrans expense. The installation cost of highway

lighting at new intersections on a State highway because of a local agency project shall be at 100 percent local agency expense.

Railroad Grade Crossings

The cost of installing and maintaining lighting at railroad grade crossings on State highways shall be at 100 percent Caltrans expense.

Chapter 1.5 – Lighting by Local Agencies and Others

Where a local agency proposes to install lighting on a State highway, an encroachment permit is required. Lighting may also be installed at the intersection of a State highway and private driveway by a private property owner under an encroachment permit. However, the local agency should also obtain an encroachment permit agreeing to own and maintain the lighting installed by a private party. Such lighting shall in no way detract from the effectiveness of existing State lighting or in any way interfere with the safe movement of traffic. On existing roadways, except expressways or freeways, the lighting may be installed on wood poles with overhead wiring for temporary construction. On expressways and freeways, the equipment shall meet Caltrans standards, i.e., steel standards and underground wiring. Where a local agency proposes to install continuous lighting using luminaires of higher light output than the existing highway luminaires, the project should include replacing the existing units with new luminaires with the higher light output. Caltrans will review the design of such lighting. The installation may be performed by local agency forces, a contractor, or an electrical utility.

Caltrans will only be responsible for the costs of installing or upgrading, maintaining, and operating lighting as warranted in Chapter 2.2 and Chapter 3.2.

Chapter 1.6 – Reconstruction of Existing Facilities

Freeways

When affected by State freeway construction, existing street lighting facilities shall be replaced in kind at 100 percent Caltrans expense, using salvaged material where feasible, under the following conditions:

a. Existing lighting was installed under permit; and
b. Existing lighting was warranted for installation; and
c. Existing lighting is owned by a local agency.

In the event the local agency requests to have the relocated lighting system owned by the local agency reconstructed to an improved standard as part of the State contract, the difference in cost between replacement in kind and the construction requested shall be estimated and the agency shall agree to reimburse the State for the additional cost.

The reconstruction of existing street lighting facilities owned by a private utility is the responsibility of the utility and will be handled by the Division of Right of Way (see Chapter 2.2 for more information).

Highways

When affected by construction on a State highway, existing street lighting facilities owned by a city, county, or lighting district shall be reconstructed at the sole expense of the owner unless prior rights can be established.

In the event a local agency desires to have an existing continuous lighting system along a State highway reconstructed to an improved standard, or a new system built above Caltrans standards, the cost to Caltrans shall be limited to its share of the lighting at those locations where lighting is warranted.

Chapter 1.7 – Lighting Levels

The level of illumination on freeways, expressways, and controlled intersections are dictated by the roadway classification and pedestrian volumes.

See appropriate tables A through G in Appendix B for information on Average Maintained Illuminance, Uniformity Ratio, and lighting levels for pedestrian crosswalks.

Chapter 1.8 – Lighting Area

Freeway or Highway

Critical points are the points in the highway or freeway where the driver will have to decide on which through lane to follow or where there is a conflict. The following are critical points:

a. Decision point – location where the motorist must decide on which lane to follow.
   (i) Example 1: The decision point is at the location where one through lane transitions into two through lanes or where one through lane transitions into one through lane and an exit ramp.
   (ii) Example 2: The beginning of the exit ramp gore is the decision point.
b. Merge point – location where two or more lanes merge into one. The merge point is where the merging lane becomes 9 feet wide.

Lateral means going along the direction of travel of the highway (parallel to the highway).

Longitudinal means going across the highway (perpendicular to the highway).

The minimum lighting areas for conventional highway, expressway, and freeway are defined as follows:

a. Decision point:
   i. Lateral boundary: Starts 90 feet upstream the merge point and ends 270 feet downstream the merge point.
   ii. Longitudinal boundary: Starts at the right-side edge of travel way and ends at the left-side edge of travel way for a 4 or lower lane highway. For wider highways, the boundary starts at the right-side edge of travel way and ends 48 feet across the highway. The usual ending boundary is at the lane line between the 4th and 5th lane

if the lane widths are the standard width of 12 feet. (The 48 feet is for 4 lanes: 4*12 feet=48 feet.)

b. Merge point:
   i. Lateral boundary: Starts 90 feet upstream the merge point and ends 90 feet downstream the merge point.
   ii. Longitudinal boundary: Starts at the right-side edge of travel way and ends at the left-side edge of travel way for a 4 or lower lane highway. For wider highways, the boundary starts at the right-side edge of travel way and ends 48 feet across the highway. The usual ending boundary is at the lane line between the 4th and 5th lane if the lane widths are the standard width of 12 feet. (The 48 feet is for 4 lanes: 4*12 feet=48 feet.)

For examples, see Appendix A.

The lighting area lateral boundary is extended if ramp traffic meets the volumes shown in Appendix B, Table F, during one hour of darkness.

Intersection

The lighting area for intersection is defined by the area bounded by the crosswalks. Where there are no crosswalks, the lighting area is defined by the area normally bounded by the crosswalks.

Chapter 1.9 – Plans, Coordination, and Processing

General requirements for submitting plans, specifications, and estimates (PS&E) are noted in the *Project Development Procedures Manual* and the Caltrans *Construction Contract Development Guide*.

The designer should coordinate with the Division of Engineering Services, Office of Structure Design to coordinate with a structure engineer for the exact location of luminaires and pull boxes, foundation details, and conduit routes through the bridge structure to ensure proper design is included for all structures within the project limits.

Chapter 1.10 – Environmental Coordination

Coordination between Design and Environmental should begin early in the project development process and continue through construction. The Project Development Team (PDT) should work together to identify potential lighting impacts or requirements related to environmental resources ensuring that the project complies with applicable state and federal laws and regulations. Potential lighting impacts can include disturbances to bird nestings or sensitive habitats, or work that is within a coastal zone or historic district. The designer should consult with their District Environmental / Biology offices and the Caltrans Standard Environmental Reference (SER) for potential lighting mitigation measures.

Some potential lighting mitigation measures may include:

a. Utilizing roadway lighting analysis software to perform lighting level analysis in areas of concern such as Environmentally Sensitive Areas (ESA).

b. Reducing correlated color temperature (CCT) of proposed lighting fixtures. See Appendix D for definition. Current Caltrans Standard Specifications require a nominal CCT of 3000 K. Document changes in project design files.
c. Lowering luminaire mounting heights. (Consult HQ Structures if non-standard lighting standards are used)
d. Installation of luminaire glare shields.

Chapter 2 – Freeway Lighting

Chapter 2.1 – Introduction

In general, freeway lighting includes the following characteristics:

- Freeway lighting refers to lighting that is provided for freeways, expressways, and limited-access roadways.
- Freeway lighting consists of complete interchange lighting, including all ramps, mainlines, cross streets, gore areas, and intersections.
- Freeway lighting serves to illuminate areas of potential vehicle conflict and to delineate exit ramps, entrance ramps, and gore areas.
- The designer may consider extending the limits of the conflict area to include side-specific areas, such as intersections, points of access, means of egress, curves, and steep hills.
- Lighting shall be installed where unusual freeway geometrics exist and traffic volume warrants are met. Current enhanced conspicuity standards for signage, markings, and delineation make it feasible in such situations to defer the installation of lighting facilities until required by increased traffic.

Chapter 2.2 – Warrants

Definitions

a. Urban, Suburban, and Rural Conditions. Urban conditions exist in areas designated on maps approved by the FHWA. Suburban conditions exist in areas contiguous to the designated urban areas. Rural conditions exist in all other areas.
b. Average daily traffic (ADT) is the average calculated for up to five years after the freeway is opened to traffic.
c. Arterial[1] roadways provide a high level of mobility, often in the form of fully or partially controlled access highways, with no or very few intersecting roadways to hinder traffic flow.
d. Collector[1] roadways provide a more balanced blend of mobility and access to land and residence. (Collectors “collect” traffic from local roads and connect traffic to arterial roadways.)
e. Local[1] roadways provide a high level of accessibility, provide direct access to adjacent land (e.g. low-density residential, multiple properties) and higher systems (e.g., collector, arterial), and may carry no through traffic movement.

[1] Road Definition (Arterial, Collector, Local) is defined in the FHWA: *Highway Functional Classification Concepts, Criteria and Procedures, 2013 Edition*.

Freeway Interchange Lighting

Freeway Interchange lighting is warranted under either of the following conditions:

a. Where the total sum of the ADT ramp traffic entering and leaving the freeway within the interchange area exceeds 5,000 under urban conditions, 3,000 under suburban conditions, and 1,000 under rural conditions. The above numbers refer to the total sum of the ADT for the normal four ramps at an interchange. Where the number of ramps connecting with the freeway is less than four, the above total sum of ADT may be reduced proportionately.
b. Where the ADT on the freeway exceeds 25,000 for urban conditions, 20,000 for suburban conditions, and 10,000 for rural conditions.

Freeway Interchange Lane Lighting

Freeway interchange lanes are the acceleration lane (entrance ramp), deceleration lanes (exit ramp), or any extra lane(s) that starts from an entrance ramp and ends at the next exit ramp. Lighting for freeway interchange lanes should be considered to illuminate the full-length of the lane if it is shorter than ½ mile.

Freeway Ramp and Surface Street Intersection Lighting

Lighting at the intersection of a freeway ramp and a surface street is warranted if either of the conditions in Freeway Interchange Lighting (a) or (b) above are satisfied.

Typically, two luminaires are placed at each freeway exit ramp and one luminaire at each freeway entrance ramp. Typical locations are shown in Appendix A Figure A-1 and A-2. Typical locations for luminaires at the intersections of freeway ramps and surface streets are shown in Appendix A Figure A-2. One or more additional luminaires may be installed when justified by geometrics, traffic patterns, background ambient lighting and/or freeway ramp traffic volumes. This configuration should light the lighting area to the appropriate level shown in the Appendix B tables.

Freeway Structures Lighting

Lighting on or under a freeway (underpass) structure is warranted under either of the following conditions:

a. The lighting is illuminating acceleration lanes, deceleration lanes, weaving areas, or walkways.
b. It is a part of local street lighting as stated in Chapter 2.5.

Provisions for future lighting may be installed in structures for freeway illumination only if there is a definite requirement to install lighting, as warranted above in Freeway Structures Lighting (a) or (b). Provisions for future lighting consist of conduits, pull boxes, foundations with anchor bolts, and flush soffit luminaires. The Project Engineer shall coordinate with the Division of Engineering Services, Office of Design and Technical Services.

Structures considered to be an underpass are those in which the length and physical configuration of the structure do not substantially limit the driver's ability to see objects ahead. No supplemental daytime lighting is required for these underpasses.

Short underpasses, such as those encountered where a roadway goes beneath two- or four-lane roadways, can generally be lighted with the standard luminaires for nighttime illumination only, if warranted.

Long underpasses, where overlapping of the lighting from the street luminaires cannot be accomplished, requires special treatment. When the lighting levels and uniformity on the roadway pavement are getting affected by the structure, then the underpass can be classified as “long” and will require additional daytime and nighttime lighting. And, if the pedestrian's lanes or sidewalks are included as part of the underpass then pedestrian lighting should be considered as per ANSI/IES RP-8-18 requirements.

Chapter 2.3 – Entrance/Exit Ramps

This section includes general requirements for installing lighting on freeways.

Freeway entrance and exit ramps lighting includes:

- Freeway entrance and exit ramps (freeway ramps and connections)
- Freeway interchange
- Freeway ramps at single point interchange
- Freeway ramp meters

Typically, two luminaires are placed at each freeway exit ramp, starting at the full width of the exit lane, and a second luminaire placed at 180 feet downstream from it. This configuration should light the lighting area to the appropriate level shown in Appendix B tables. The luminaire position is to notify drivers of the decision point to exit the freeway.

Typically for each freeway entrance ramp, one luminaire is placed at the point where the on-ramp lane is tapered to nine feet wide and the adjoining freeway through lane is 12 feet. The luminaire position is to caution drivers of the merging freeway traffic to oncoming vehicles.

Typical locations for luminaires at the intersections of freeway ramps and surface streets are shown in Appendix A, Figure A-1 and A-2 (Partial Cloverleaf Interchange or Diamond Interchange). The lighting area can be increased when justified by geometrics, traffic patterns, background ambient lighting, or freeway ramp traffic volumes.

For metered freeway entrance ramps, a minimum of one luminaire should be placed at the limit line of metered-entrance ramp lanes.

The luminaire spacing and quantity of poles used for the entrance and exit ramps should be adjusted to achieve the lighting level shown in Appendix B.

Chapter 2.4 – Freeway to Freeway Connections

Luminaires at freeway to freeway connections should be located as shown in Appendix A, Figure A-5. The typical advanced locations for luminaires at the diversion from one freeway to another is to warn drivers of the following:

a. When additional lanes are added or reduced from the freeway or highway.
b. Merging traffic between vehicles toward their destination routes.

Chapter 2.5 – Lighting of Local Streets Within Limits of Freeway Projects

Chapter 2.5A – Lighting of Existing Local Streets Within Limits of Freeway Projects

The lighting of existing local streets within the limits of a freeway project, including lighting on local streets over or under the freeway, is warranted if:

- The local street is lit to modern standards up to the freeway right of way and the local agency agrees to assume ownership and cost of maintenance; or
- The local street is not lit to modern standards and the local agency agrees to assume ownership and all costs of installation and maintenance.

If a local agency indicates that it proposes to install lighting on the local street within five years after construction is completed, the following should be installed on the project at 100 percent State expense:

- Conduits and other equipment in and under paved areas.
- Provisions for future structure lighting as stated in Chapter 2.2 under Freeway Structure Lighting.

Chapter 2.5B – Lighting of New Local Streets Within Limits of Freeway Projects

Installing lighting on new local streets, including new frontage roads, that are constructed on a new alignment for a local agency shall be governed by the following:

- Lighting may be installed when requested by the local agency, only if there is existing lighting in the area and if that lighting is owned by the local agency. The lighting design and financing shall follow the guidelines in Chapter 1.5.
- Where the existing lighting is owned by a private utility, only equipment that will be in or under paved areas shall be installed by Caltrans (see Chapter 1.5).

If no lighting exists in the area, new lighting shall be installed only if the local agency agrees to finance the installation and to assume the cost of ownership and maintenance.

Chapter 3 – Highway Lighting

Chapter 3.1 – Introduction

The purpose of highway lighting is to promote the safe and orderly movement of traffic by illuminating certain permanent features or conditions that are unusual and require additional care and alertness to navigate.

When highway lighting is to be installed at an intersection, the “Basic” illumination requirements are provided as shown in Appendix B.

Lighting on highways and expressways shall be limited to lighting requirements at the intersection with traffic signals, flashing beacons, stop/yield controls, and locations where lighting is warranted, as shown in Chapter 3.2.

The existence of an intersection is not itself a justification for lighting.

A minimum of two luminaires should be placed on the downstream side of the intersection. The luminaire position is to notify drivers the perimeter of the intersection, past the approaching limit line, as well as the surrounding geometrics of the area (see Appendix A, Figure A-3, and A-4).

For each signalized intersection, a minimum of one luminaire should be placed at each corner to illuminate the pedestrian crosswalk. The lighting level emphasizes the middle of the intersection to all turning and oncoming vehicles.

Chapter 3.2 – Warrants

1. Existing Intersections.

   Lighting may be provided at existing intersections on expressways and highways if one of the following conditions is fulfilled:

   a. Warrant 1, Condition A (Minimum Vehicular Volume) and Condition B (Interruption of Continuous Traffic) (See Figure 4C-101 (CA) Traffic Warrants Sheet Worksheet (Sheet 1 of 5)), or Warrant 4, Part 1, Section B (Pedestrian Volume) (See Figure 4C-101 (CA) Traffic Warrants Sheet Worksheet (Sheet 3 of 5) and Figures 4C-7 and 4C-8 from CA MUTCD) is satisfied for any single hour, which may be in darkness during winter Months.
   b. Four or more nighttime accidents in any recent consecutive 12-month interval or six or more nighttime accidents in any recent consecutive 24-month interval.
   c. Where a traffic signal or an intersection flashing beacon is installed.
   d. Where a controlled pedestrian crossing (e.g., Pedestrian Hybrid Beacon System) is installed.
   e. Where combinations of sight distance, horizontal or vertical curvature of the roadway, channelization, or other factors constitute a confusing or unsatisfactory condition that may be improved with lighting. The Project Initiation Document covering such lighting should include an explanation of the factors constituting the confusing or unsatisfactory condition.

2. New Intersections
    a. Lighting may be provided at new intersections on expressways or highways if there are indications that any of the warrants listed in 1(a) above will be fulfilled within five years after the opening of the project to traffic.
3. Replacement of Lighting Owned by Other Agencies (see Chapter 1).
4. Warrants for Continuous Highway Lighting

Continuous lighting may be provided with uniformity and average illuminance values in accordance with the current edition of ANSI/IES RP-8.

If one of the lighting warrants shown below is satisfied, then continuous lighting should be considered:

- Where a new pedestrian/bikeway is installed in an expressway
- If a crash analysis indicates that both the following conditions exist:
    a. At least 30% of crashes occur at night over the last 5 years
    b. High vehicle speed/volume sections with pedestrians/bikeway facilities

Chapter 4 – Special Lighting Applications

Chapter 4.1 – Introduction

Chapter 4 sets guidelines for special lighting applications used in projects. These applications entreat specific considerations that may differ depending on funding, available right of way, nearby electrical power, surrounding climate, etc. The special lighting applications include the following types:

- Bike paths
- Roundabouts
- Railroad grade crossings
- Park and ride lots
- Bus stops
- Signs
- Chain on/off areas
- Falseworks
- Tunnels
- High masts
- Temporary

Chapter 4.2 – Bike Paths

The location of bike paths parallel to a freeway ramp and crossing and parallel to a roadway may warrant lighting.

This section covers the information needed for designing a lighting system that can be used for bike paths and/or pedestrian walkways and that are within the Caltrans right of way.

Roadway lighting improves the visibility for drivers, pedestrians and bicyclists near a freeway ramp or roadway. Lighting is considered warranted if a crash analysis indicates that at least 30% of crashes occur at night within last 5 years.

Lighting may be considered if either:

a. A new pedestrian/bikeway is installed in an expressway
b. High vehicle speed/volume sections exist with pedestrians/bikeway facilities

Light levels vary with the functional classification of the highway, the development of the adjacent area, and the level of nighttime activity.

Refer to Appendix B, Table B, C, and D.

Chapter 4.3– Roundabouts

For a roundabout to work effectively, motorists should be able to enter the roundabout, move through the circulating traffic, and separate from the circulating stream in an efficient manner. To accomplish this, motorists should be able to see the general layout and operation of the

intersection in time to make the appropriate maneuvers. Adequate lighting should therefore be provided at all roundabouts.

When lighting a roundabout, key decision points and conflict areas should be illuminated. Crosswalks should be considered a part of the roundabout. Lighting poles should be placed in advance of a crosswalk to provide positive contrast for pedestrians. See Appendix A, Figure A-6 for the conflict area of a roundabout.

Roundabout lighting is also intended to identify:

a. Central island parameters
b. Splitter island nose radii and offsets
c. Merging and diverging traffic

The advantage of providing positive contrast is that the vehicle headlights help increase contrast and improve the visibility of pedestrians in the crosswalk.

Additional lighting should be provided on the approach nose of the splitter islands at all conflict areas where traffic is entering the roundabout and all places where the traffic exits the roundabout.

The recommended lighting levels for roundabouts is shown in Appendix B, Table E.

Chapter 4.4 – Railroad Grade Crossings

The purpose of railroad grade crossings lighting is to light the conflict area of the railroad crossings.

The conflict area includes the shoulders to 100 feet in front of the crossings in both directions.

Lighting poles should:

a. Not be located closer than 33 feet from the railroad right of way.
b. Be installed away from the tracks to avoid falling onto the tracks if knocked down.
c. Not block visibility of the traffic signals used to warn drivers of approaching trains.

Designers should be familiar with road geometrics, including sidewalks, bikeways, signage, underground/overhead utilities, and railroad geometrics and crossing features.

Lighting may be provided at railroad grade crossings where a substantial amount of railroad operation is conducted at night, particularly where train speeds are low, where crossings are blocked for long periods, or a study indicates that motorists have trouble seeing trains or traffic control devices during the hours of darkness. For further information, see the CA MUTCD.

The recommended lighting levels for intersections with railroad crossings are shown in Appendix B, Tables A to G.

Chapter 4.5 – Park and Ride Lots

Lighting for park and ride lots should be considered carefully. There may be several reasons why lighting is not provided, e.g., in a rural area where power line extension charges would be excessive.

The following guidelines should be used in determining the amount of lighting to be installed where it has been determined that providing lighting without excessive cost is feasible:

- Design the lighting to provide minimum 0.2 fc (E_{min})
- Maximum uniformity ratio (E_{max}/E_{min}) of 20:1
- Design for all-night illumination.

Chapter 4.6 – Bus Stops

Bus stops qualify as major activity areas and are warranted for lighting. Particularly, bus stops within State highways, such as areas between Interchanges and at State-owned park & ride lots, should be lit. At locations within an interchange area where a special ramp for buses and a bus stop are provided, a minimum of one luminaire should be provided. Illumination should be provided at bus turn-outs, passenger loading areas, passenger benches, shelters, and crosswalks.

Lighting design should include bus turn-outs, passenger loading areas, passenger benches and shelters, and crosswalks.

The responsibility for lighting at bus stops may be shared with the local agency. The designer should consider illuminating bus stops with shelters as they usually result in higher passenger usage.

Illumination requirements are often a policy of individual local agencies; however, installing lighting that provides between 2 to 3 fc is the general recommendation.

A co-op agreement or maintenance agreement between Caltrans and the local Agency would ensure that operations and maintenance of lighting at bus stops are proportionally shared by the jurisdictions.

Chapter 4.7 – Overhead Signs

In general, all new Overhead sign panels will come with ASTM Type XI retroreflective sheeting that will not require lighting. See Traffic Operations Policy Directive 14-02 Revision 1.

However, lighting for overhead signs may be needed if a location meets one of the following criteria:

- Signs skewed with angles greater than 25 degrees and are not legible when illuminated by vehicle headlights.
- Signs adjacent to other signs requiring or having sign lighting.
- Signs located along a horizontal curve with a radii of 880 feet or less in rural areas and radii of 2,500 feet or less in urban areas.

- Where vertical sag curves 1,000 feet or closer to overhead sign panels will limit vehicle headlight illumination of signs.

The sign lighting equipment, number of fixtures, and installation details are shown in the Standard Plans.

Chapter 4.8 – Chain On/Off Areas

The purpose of lighting chain on/off areas is to improve safety for the travelling public when they are installing or removing chains. Lighting should illuminate pedestrians working along the roadside immediately adjacent to traffic. Increasing the lighting levels and lighting uniformity at chain on/off areas improves visibility for motorists.

- Design the lighting to provide minimum 3.0 fc (E_{avg})
- Maximum uniformity of 3:1 (E_{avg}/E_{min})

Chapter 4.9 – Falsework

Falsework lighting should be considered for all passageways, including pedestrian openings through or under falsework. The faces of all falsework and forms located within or adjacent to the traveled way should be illuminated on the approach sides during the hours of darkness.

Refer to Standard Specification Section 48-2 for more details on falsework lighting.

The illumination levels for falsework during construction activities are shown in Appendix B, Table G.

Chapter 4.10 – Tunnels

Tunnels should have sufficient illumination during the day so that vehicles inside the tunnel may be seen by approaching motorists. All interior walls and ceilings of tunnels to be lighted should be painted or tiled in a light color. All concrete surfaces to be painted should have a Class 1 finish. Tunnels less than 300 feet long normally do not require daytime lighting but interior walls and ceilings should be painted. Day and night lighting should be installed for tunnels that:

- Have vertical or horizontal curves in the road that may obstruct visibility;
- Are over 300 feet long; or
- Include walkways, pedestrians, or bicycle paths.

The recommended lighting level for tunnels is shown in Appendix B, Table C.

Designers should consult with the Division of Engineering Services, Office of Structure Design when designing non-standard poles and sign structures, modifying existing standards, and designing new traffic signal poles with special loading.

The Project Engineer should coordinate with the Office of Design and Technical Services to ensure that the proper structure design approach is included in the PS&E phase of the project.

To request the special design application, designers should complete and submit the “Signs and Overhead Structures” form to the Division of Engineering Services a minimum of three months

prior to the Ready to List phase of the project. Designers should also provide all required forms and supporting documents (layouts, cross sections, photos, etc.).

Chapter 4.11 – High Masts

The use of high mast lighting systems may be considered where regular lighting standards are difficult to install and maintain. However, high mast lighting should not be applied in substantially developed residential areas to avoid lighting trespass.

Selection between conventional and high mast units should consider several factors: installation and maintenance costs, traffic volume, and possibility of lighting pollution.

Conventional lighting often requires lower installation costs on non-interchange roadway segments, while high mast lighting is less expensive for interchange areas because of reduced conduits and conductors, and requirements for fewer lighting fixtures and poles.

Maintaining high mast lighting also costs less because it involves less extensive lane closures.

Regardless of whether high mast or conventional lighting are used, the same lighting levels and uniformity ratios should be used.

Chapter 4.12 – Temporary

A temporary lighting system may be used to light the work area and the adjacent roadway. These systems use existing or temporary poles to mount luminaires and may include high-mast lighting. Standard roadway luminaries are usually installed. Installing a temporary lighting system allows for uniform spacing of luminaires at high mounting heights, resulting in uniform lighting with low glare.

Temporary roadway lighting should be considered for the following circumstances:

- Abrupt changes in the roadway alignment, including lane reductions
- A medium or high pedestrian activity is present
- Locations with high traffic volumes
- Presence of a fixed roadway lighting system in the work area (existing light levels should be maintained, possibly augmented)
- The work area location is identified as having operational problems (e.g., a high nighttime crash rate)

Maintain required illumination during all construction activities, except when shutdown is permitted to allow for alterations or final removal of the system per the Project Engineer. Site preparation, widening, drainage, guardrail installation, or other work can easily impact existing conduit runs or luminaire locations. Also, changed conditions, such as merging, weaving, or unusual alignment due to traffic control, often require additional temporary illumination.

Note: The same lighting requirements apply whether a condition is temporary or permanent.

Chapter 5 – Structure Lighting Facilities

Chapter 5.1 – Introduction

Designers should consult with the Division of Engineering Services, Structure Design, Office of Electrical, Mechanical, Water & Wastewater (EMWW) for the following lighting applications. These lighting applications are:

1. Road tunnels
2. Exclusive pedestrian facilities
   2.1. Undercrossings
   2.2. Overcrossings
3. Transportation-related facilities:
   3.1. Safety roadside rest areas
   3.2. Commercial vehicle enforcement facilities (truck inspections)
   3.3. Toll plazas
   3.4. Agriculture inspection facilities
   3.5. Maintenance stations
   3.6. Transportation labs

Conduit on structure should be run either parallel to or at right angles to the structure girders. A variation of ±15 degrees is acceptable. Except for sidewalk joints, a conduit expansion fitting should be installed at each structure joint, hinge or abutment where a longitudinal movement of 0.5 inches or greater may occur. Where a lateral movement of 0.25 inches or greater may occur, an expansion-deflection fitting should be installed. Details for placement of expansion fittings and expansion-deflection fittings are shown in the Standard Plans.

Chapter 5.2 – Road Tunnels

The new tunnel lighting systems should be designed and installed to comply with the following applicable codes:

1. California Electrical Code
2. ANSI/IES RP-8-18 (Chapter 14-Tunnels)

Lighting for new road tunnels located in rural areas and lighting upgrades to existing road tunnels will be evaluated on case-by-case basis to determine if meeting specific design features is feasible and cost effective.

The road tunnel lighting fixtures must comply with the following criteria:

1. LED type
2. Addressable for remote monitoring and control
3. Continuously dimmable (from 10 percent to maximum output)

Road tunnel lighting consists of lighting for the tunnel approach and roadway inside the tunnel. The tunnel lighting control system should also be upgraded. Road tunnel lighting levels shall be evaluated using lighting software.

Chapter 5.3 – Exclusive Pedestrian Facilities

The lighting for exclusive pedestrian facilities within the freeway project is warranted at the following locations:

a. Pedestrian undercrossings
b. Pedestrian overcrossings

Lighting shall be provided on pedestrian undercrossings and overcrossings where the local agency agrees to assume ownership and cost of maintenance. Pedestrian undercrossings (no vehicular traffic) shall be provided with adequate daytime and nighttime illumination. The designer should coordinate with the Division of Engineering Services, Office of Design and Technical Services.

a. Pedestrian Undercrossing

Lighting for long undercrossings should be considered carefully. The purpose of this lighting is for safety and security considerations. Undercrossings should also have daytime lighting.

The recommended maintained illuminance values for undercrossings are shown in table 5.1.

Table 5.1: Maintained Illuminance Values for Pedestrian Undercrossing

	Minimum E_{avg} (fc)	Maximum Uniformity E_{avg}/E_{min}
Day	9.3	3.0
Night	3.7	3.0

b. Pedestrian Overcrossings

This section provides information needed for designing lighting systems used for pedestrian overcrossings. Pedestrian overcrossings are facilities that provide a connection between pedestrian walkways as well as connecting the bike paths. Therefore, the use of pedestrian overcrossings is limited to pedestrians and bicyclists.

In general, lighting is required to be installed on pedestrian overcrossings within Caltrans right of ways.

The location of the proposed overcrossing requires special consideration for lighting levels due to environmentally sensitive areas, such as rivers, creeks, and wetlands. Lighting installed on the overcrossing may produce glare that should be shielded from spreading to the structure where light can be a distraction for motorists using the highway and frontage road.

The design criteria for pedestrian overcrossings are based on horizontal and vertical illuminance. The required minimum for maintained horizontal illuminance provides visibility of bikeways and walkways surfaces and their boundaries for their respective users.

Table 5.2: Maintained Illuminance Values for Pedestrian Overcrossing

Mixed Pedestrian and Bicyclist	Minimum E_{avg} (fc)	Maximum Uniformity E_{avg}/E_{min}
	0.5	4.0

Consider limited hours of lighting or user-actuated lighting design to minimize unnecessary emissions when the bridge is not in use.

Chapter 5.4 – Transportation-Related Facilities

Lighting design for new transportation-related facilities and major renovations should be designed and constructed to exceed 15 percent of the applicable version of Title 24, Part 6 Building Energy Efficiency Standards.

Lighting for the transportation-related facilities consists of interior building lighting and exterior walkway or parking lot lighting for these facilities. The foot-candle requirements for interior spaces within these facilities should be as listed in the Maintenance Station Design Manual. The exterior walkway or parking lot lighting should follow the guidelines listed in the ANSI/IES RP-8-18.

In addition, the controls for interior and exterior lighting should meet all the mandatory and perceptive requirements of Title 24, Part 6.

Chapter 6 – Luminaires

Chapter 6.1 – Roadway Luminaires

Utility-owned semi-cutoff type luminaires should be provided with glare shields in rural areas.

Chapter 6.2 – Soffit Luminaires

Normally, the fixtures should not be located over the traveled way on freeways.

Chapter 6.3 – Wall Luminaires

Wall luminaires are fixtures designed to be surface mounted on vertical surfaces. However, a simple right-angle bracket permits mounting them from a horizontal surface such as the bottom slab of a box girder. They are used with the same lamps as soffit luminaires.

Chapter 7 – Lighting Software

Chapter 7.1 – Introduction

With this manual, Caltrans introduces a new tool to assist designers with designing roadway lighting. Lighting software applications will replace the old technique of using the Isofootcandle templates. The lighting industry is using lighting design analysis software that allows the importing of roadway CAD files. These CAD files typically contain roadway properties on different layers (e.g. edge of pavement, road shoulder, stationing, structures, curbs, sidewalks). Designers will need to eliminate and combine the layers into one layer, confirming the scales and units used in the files.

Chapter 7.2 – Lighting Design Using Software Applications

There are four basic steps to roadway lighting design using lighting analysis software applications:

1. Perform an initial assessment to become familiar with the project location and the specific design requirements;
2. Select the types of fixtures and poles to be used;
3. Determine lighting pole placements for constructability and maintainability; and
4. Perform appropriate lighting analysis to ensure conformance to design criteria and lighting levels.

Designers will utilize roadway CAD files and the lighting manufacturers' photometric files to calculate lighting levels for a roadway segment or an intersection. These photometric files are files with an IES file extension. The IES files include the photometric characteristics produced for each luminaire.

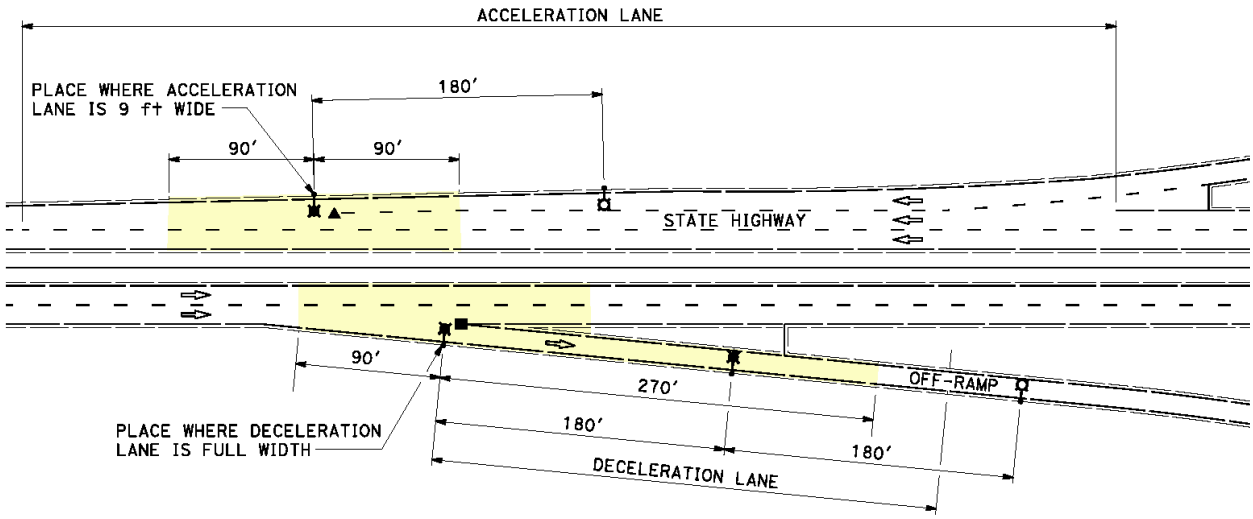
Chapter 7.3 – Software Applications and Validation

If time allows, field lighting measurements should be taken for a lighting project once it is installed and over time as the system ages. The Department should periodically validate luminaire photometrics, ensuring that the luminaires are providing the expected light output and distribution, and to confirm that lighting levels and lighting uniformity comply with recommended practice and design specifications.

ANSI/IES RP-8-18 “Recommended Practice for Design and Maintenance of Roadway and Parking Facility Lighting,” provides detailed instruction on how lighting measurements should be conducted in the field.

Appendix A – Figures and Diagrams (Typical)

Figure A - 1: Freeway Lighting



NOTE:

LUMINAIRE PLACEMENT IS TYPICAL. THE DESIGN ENGINEER SHOULD ADJUST THE LUMINAIRE LOCATIONS AND NUMBER TO MEET THE LIGHTING LEVELS SHOWN IN APPENDIX B.

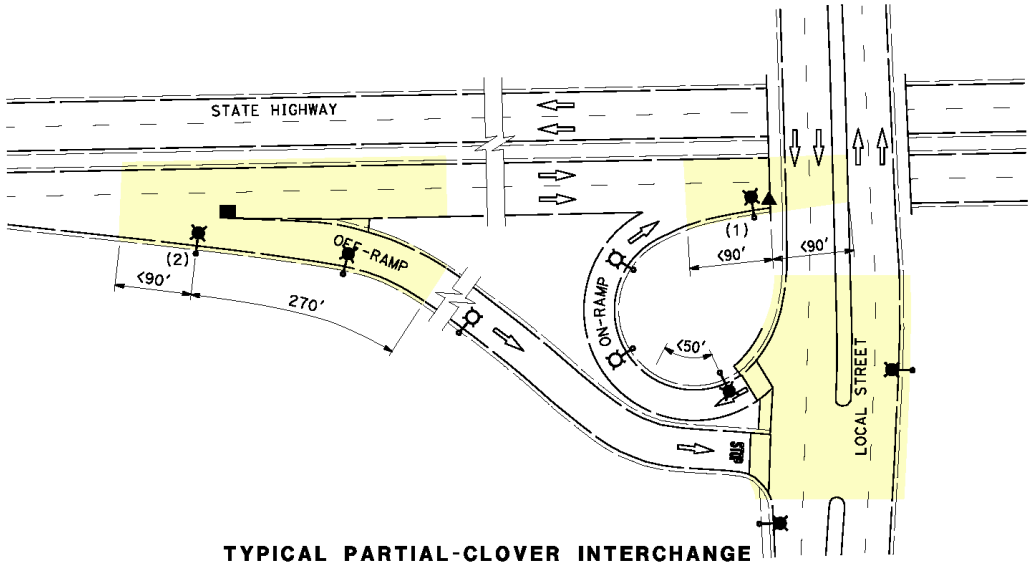
LEGEND:

- BASIC ELECTROLIER
- ADDITIONAL ELECTROLIER (WHEN REQUIRED)
- CONFLICT AREA
- DECISION POINT
- MERGE POINT

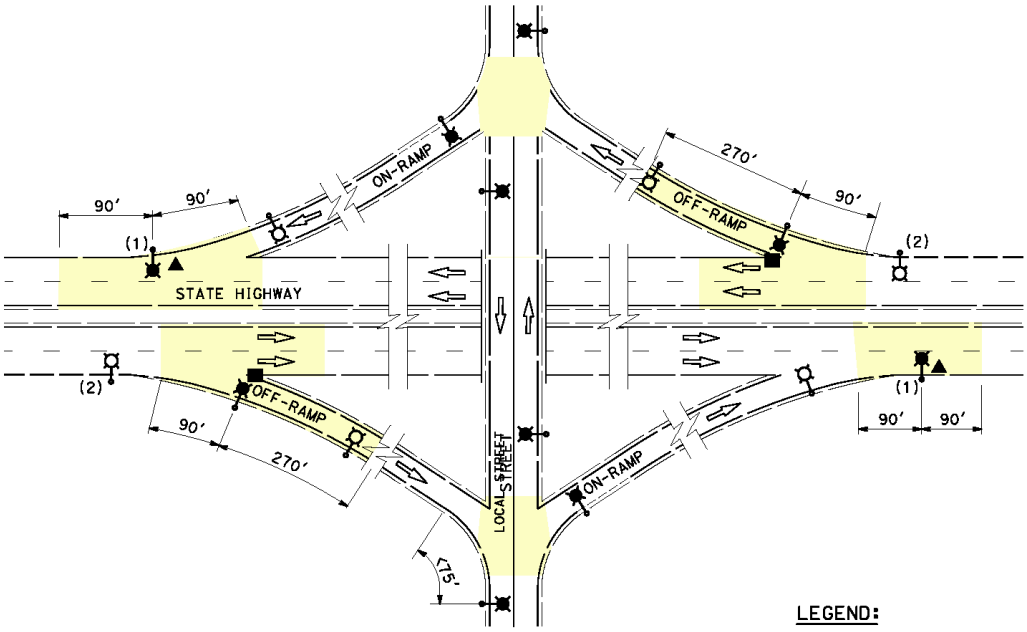
FIGURE A-1:
FREEWAY LIGHTING

NO SCALE

Figure A - 2: Freeway Lighting



TYPICAL PARTIAL-CLOVER INTERCHANGE



DIAMOND INTERCHANGE

FIGURE A-2: FREEWAY LIGHTING

NO SCALE

NOTES:
(1) PLACE WHERE ACCELERATION LANE IS 9 ft WIDE.
(2) PLACE WHERE DECELERATION LANE IS FULL WIDTH.
(3) LUMINAIRE PLACEMENT IS TYPICAL. THE DESIGN ENGINEER SHOULD ADJUST THE LUMINAIRE LOCATIONS AND NUMBER TO MEET THE LIGHTING LEVELS SHOWN IN APPENDIX B.

LEGEND:
- BASIC ELECTROLIER
- ADDITIONAL ELECTROLIER (WHEN REQUIRED)
- CONFLICT AREA
- DECISION POINT
- MERGE POINT

Figure A - 3: Intersection Lighting

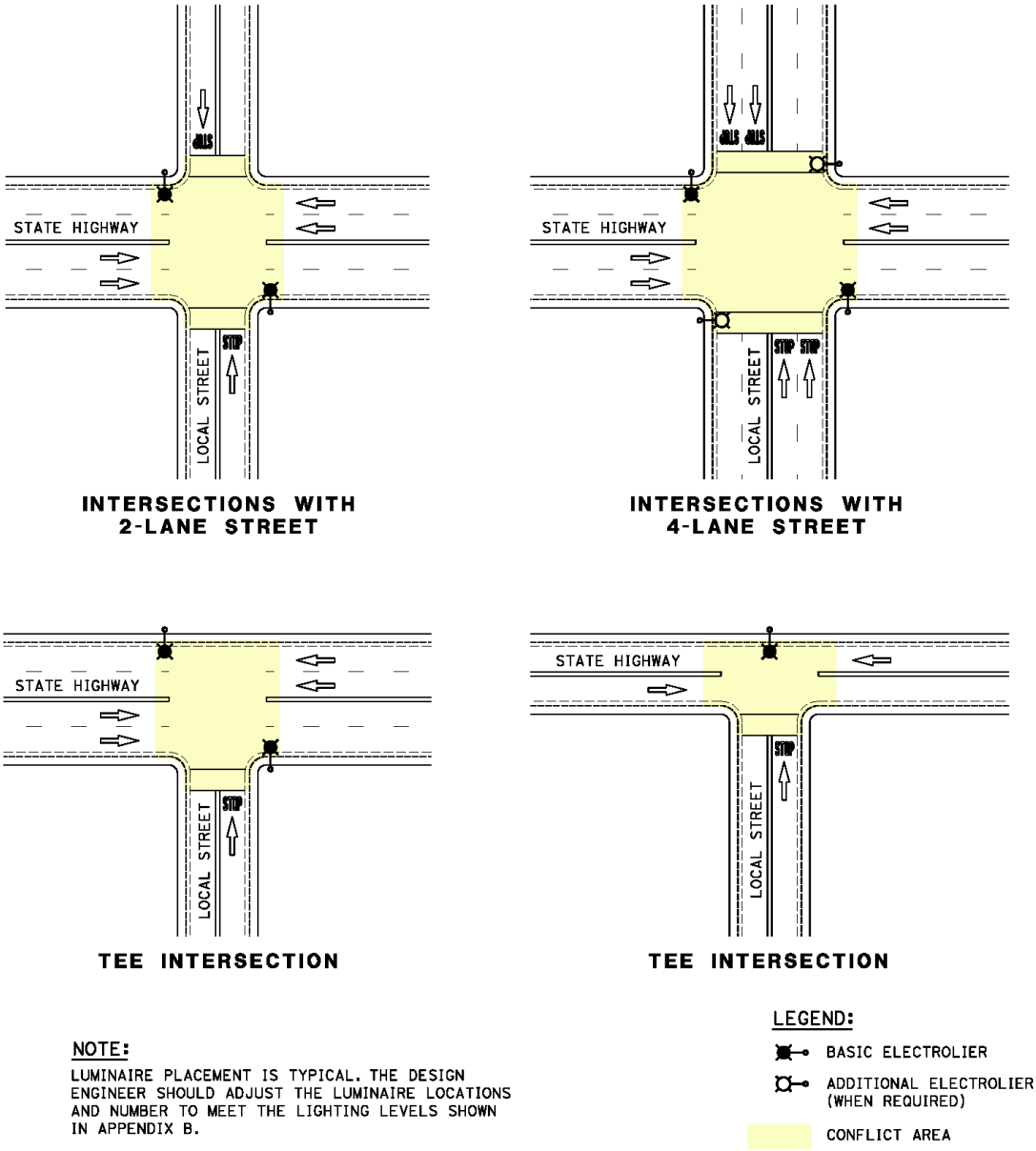


FIGURE A-3:
INTERSECTION LIGHTING
NO SCALE

Figure A - 4: Railroad Crossing and Intersection Lighting

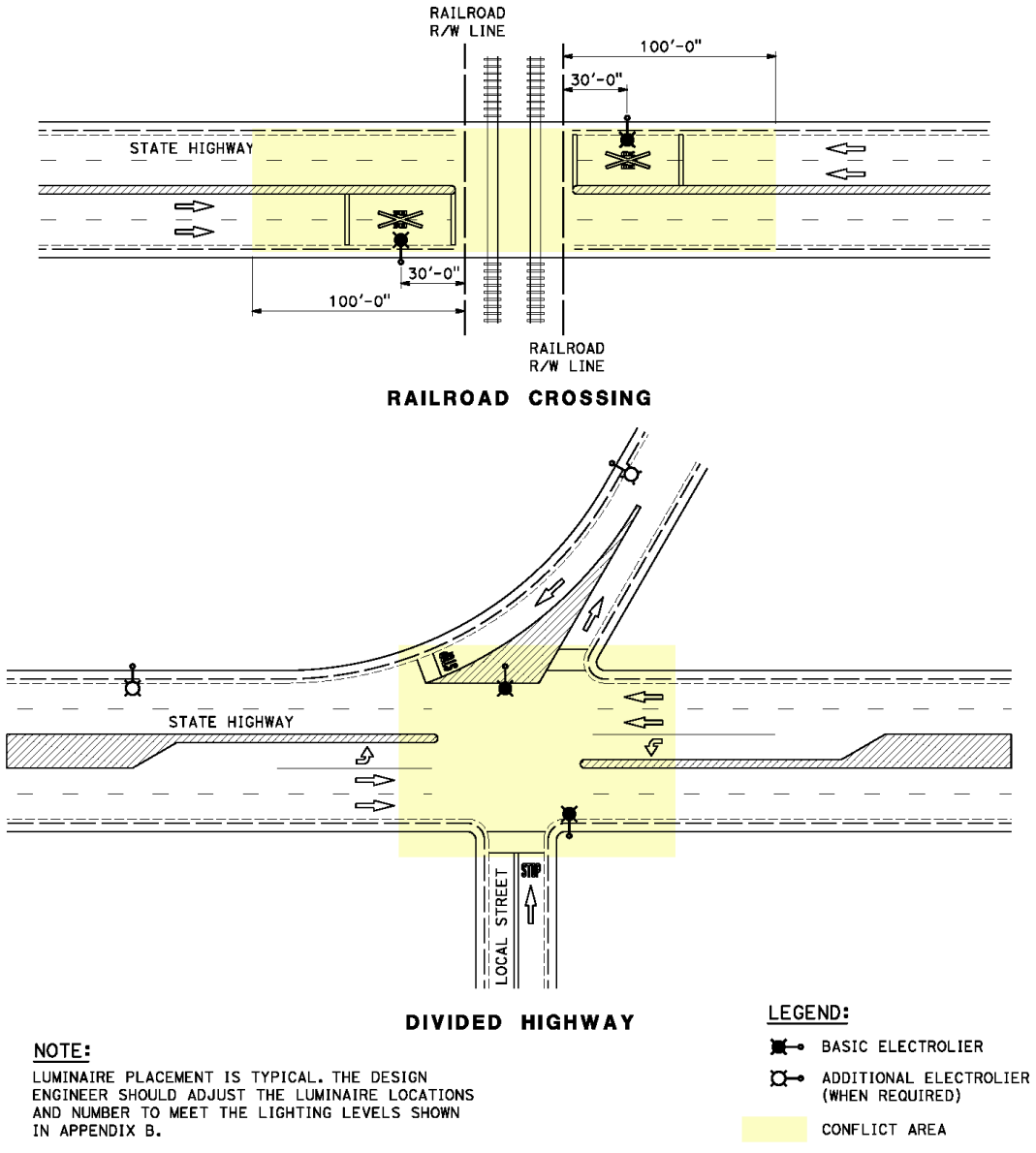


FIGURE A-4:
RAILROAD CROSSING AND INTERSECTION LIGHTING
NO SCALE

Figure A - 5: Freeway to Freeway Connections

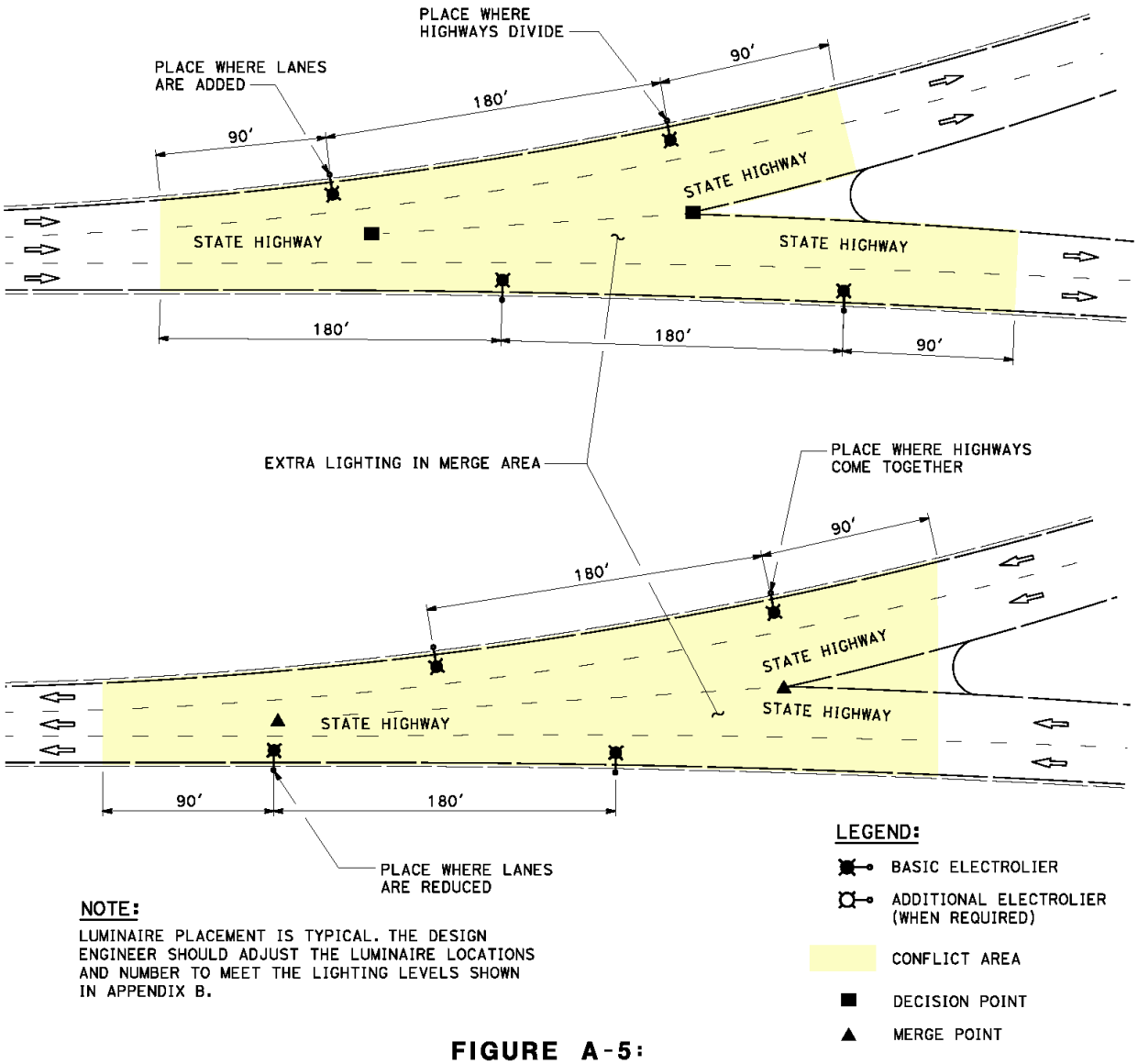
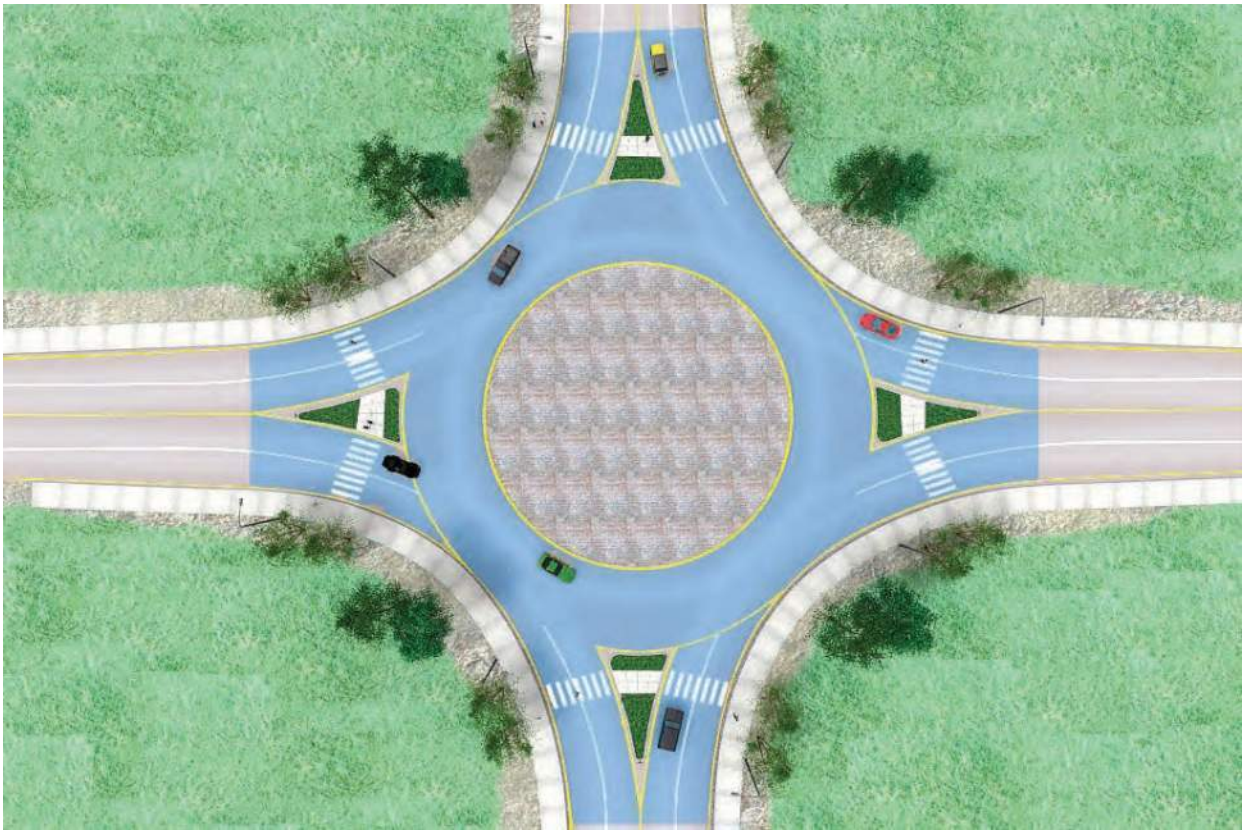


FIGURE A-5:
FREEWAY TO FREEWAY CONNECTIONS
NO SCALE

Figure A - 6: Roundabout Lighting



Note:

For Guidance on Luminaire Placement, See Chapter 4.3, Roundabouts

Drawing Source: ANSI/IES RP-8-18

LEGEND

CONFLICT AREA

FIGURE A - 6:

ROUNDABOUT LIGHTING

NO SCALE

Appendix B – Tables

Lighting Design Criteria for Highways

Freeway lighting levels shown in Table A are based on roadways with limited access and low (or even no) significant pedestrian or bicyclist activity.

Expressway lighting levels are higher than freeway lighting levels. This is due to the increase in conflict points at intersections and driveways and a low level (less than 100 per hour) of pedestrian presence.

All lighting levels shown are in illuminance. The 2018 Illumination Engineering Society (IES)/ANSI RP8 recommends luminance for some values, but illuminance is chosen for Caltrans, since it is simpler to verify in the field. 2018 ANSI/IES RP8 chapter 3.2 gives luminance to illuminance conversion for R2 or R3 class roadway surface[2]. The conversion factor is 1 cd/m^2 to 1.39 fc. The calculation is shown below.

$$1\ \frac{cd}{m^2} * \frac{15\ lux}{1\frac{cd}{m^2}} * \frac{1\ fc}{10.76\ lux} = 1.39\ fc$$

Roadway 10 (R10) luminaires are typically mounted on Type 15 standards for conventional highway lighting.

Roadway 11 (R11) luminaires are typically mounted on Type 15 standards for expressways.

Roadway 12 (R12) luminaires are typically mounted on non-Type 15 standards for freeways.

[2] R2 or R3 class roadway surfaces represent asphalt road surfaces. These are the worst-case scenario for light reflectance. For more information, see 2018 Illumination Engineering Society (IES)/ANSI RP8 publication 3.1.5 pavement classification.

Table A[3]: Design Criteria for Highways

Roadway Classification	Minimum E_{avg} (fc)	Maximum Uniformity E_{avg}/E_{min}
Freeway	0.8	3.5
Expressway	1.4	3.0
Conventional	1.4	3.0

[3] Reference to 2018 Illumination Engineering Society (IES)/ANSI RP8 publication, table 10-1: Example: freeway and expressway, with no or low pedestrian (i.e. less than 10 pedestrians per hour at nighttime).

Lighting Design Criteria for Isolated Intersection

Lighting may be required at an isolated intersection where continuous lighting does not exist. Lighting levels for isolated intersections should meet the light levels for the type of road where the intersection is located. The values included in Table B are based on R2 and R3 pavement classifications.

When the intersection roadways have different classification, the intersection is classified as the higher ADT classification.

Table B[4]: Lighting Design Criteria for Isolated Intersection Lighting

Roadway Classification	PED/hr	Minimum E_{avg} (fc)	Maximum Uniformity E_{avg}/E_{min}
Major Intersection	< 100	0.8	3.0
Collector Intersection	< 100	0.6	4.0
Local Intersection	< 100	0.4	6.0

[4] Reference to 2018 IES/ANSI RP8 publication, table 12-2: Example: freeway and expressway, with low or medium pedestrian (i.e. less than 100 pedestrians per hour).

Lighting Design Criteria for Streets

Street lighting is provided for roads where pedestrians and bicyclists are present. These roads can range from major to collector streets and require different lighting levels based on the expected pedestrian volumes. The recommended values for street lighting are shown in Table C.

Table C[5]. Lighting Design Criteria for Streets

Roadway Classification	PED/hr	Minimum E_{avg} (fc)	Maximum Uniformity E_{avg}/E_{min}
Major	> 100	1.67	3.0
Collector	> 100	1.11	3.0

Illumination for Intersections

The recommended lighting levels for intersections of continuously lit roadways are based on the functional classifications of the intersecting roadways and level of pedestrian use. The values are taken from Table 11-1 in ANSI/IES RP-8-18 “Recommended Practice for Design and Maintenance of Roadway and Parking Facility Lighting.” The functional classifications of roadways are based on the Institute of Transportation Engineers (ITE) Guidelines for Residential Subdivision Street Design:

- Major – Over 3,500 ADT
- Collector – 1,501 to 3,500 ADT
- Local – 100 to 1,500 ADT

[5] Based on RP8, table 11-1: Use the table based on the number of pedestrians (medium or high).

Table D[6]: Pavement Illuminance Criteria for Full Intersection Lighting

Roadway Intersection Classification	PED/hr	Minimum E_{avg} (fc)	Maximum Uniformity E_{avg}/E_{min}
Major/Major or Major/Collector or Major/Local	> 100	3.2	3.0
Major/Major or Major/Collector or Major/Local	< 100	2.4	3.0
Collector/Collector or Collector/Local or Local/Local	> 100	2.2	4.0
Collector/Collector or Collector/Local or Local/Local	< 100	1.7	4.0

Table D should be used for Full Intersections Lighting with high pedestrian level, e.g., community facilities; libraries; recreation centers; near major airport; truck, rail, or bus terminals; activity centers, such as a central business center to large town centers, shopping center, or malls; large colleges; medical complexes; military bases and large institutional facilities; major industrial or commerce centers; and major recreational areas.

[6] Based on RP8, table 12-1 for intersections with a high pedestrian level.
For high pedestrian locations the pedestrian volumes are more than 100 pedestrians/hour at nighttime. For medium pedestrian locations the pedestrian volumes are within 11 to 100 pedestrians/hour at nighttime. For low pedestrian locations the pedestrian volumes are less than 10 pedestrians/hour at nighttime for isolated locations.

Table E[7]: Recommended Pavement Illuminance for Roundabouts, Based on Pedestrian Activity Classification

Roadway Classification	Ped/hr	Minimum E_{avg} (fc)	Maximum Uniformity E_{avg}/E_{min}
Major/Major or Major/Local or Major/Collector	> 100	3.2	3.0
Major/Major or Major/Local or Major/Collector	< 100	2.4	3.0
Collector/Collector or Collector/Local or Local/Local	> 100	2.2	4.0
Collector/Collector or Collector/Local or Local/Local	< 100	1.7	4.0
Local/Local & Isolated	> 100	1.7	6.0
Local/Local & Isolated	< 100	1.3	6.0

Table F – Criteria for Lighting Area Longitudinal Addition at Exit and Entrance Ramps

Freeway ADT	Exit Ramp Volume		Entrance Ramp Volume	
>75,000	>300 vph	+90 feet downstream	>300 vph	+90 feet upstream
>150,000	>700 vph	+180 feet downstream	>700 vph	+180 feet upstream

[7] Based on the ANSI/IES RP8 Table 12-4. The lighting levels are recommended for continuously lighted streets. For roundabouts on roadways that are not continuously lighted, the values for the local/local classifications should be used.

Table G – Falsework Illumination Levels

The minimum average illumination levels for falsework during construction are shown in the following table:

Minimum Average Illumination Levels

Illumination Area	Minimum E_{avg} (fc)
Pavement	0.8
Portal	1.0
Pedestrian Walkway	2.0

Table H – Relationship Between Older LED Luminaires and LED Newer Luminaires Usage

Roadway Intersection Classification	PED/hr	Typical Older Luminaire	Typical Newer Luminaire
Major/Major or Major/Local or Major/Collector	> 100	Roadway 2	Int L – A or Int M – A
Major/Major or Major/Local or Major/Collector	< 100	Roadway 2	Int L – B or Int M – B
Collector/Collector or Collector/Local or Local/Local	> 100	Roadway 2	Int M – A
Collector/Collector or Collector/Local or Local/Local	< 100	Roadway 2	Int M – B
Isolated Major Intersection	< 100	Roadway 2	Int L – C
Isolated Collector Intersection	< 100	Roadway 2	Int M – C
Isolated Local Intersection	< 100	Roadway 2	Int S – C
Conventional Highway		Roadway 1	Roadway 11
Expressway		Roadway 1	Roadway 11
Freeway		Roadway 2	Roadway 12

Appendix C – Application Policies

Lighting policies

Breakaway/Slip Base Under Standards Located Along Freeways, Expressways, and Conventional Highways – 10/15/1987

Nonstandard Lighting Poles on Conventional State Highway Installed and Maintained by Others – 1/25/1991

Catwalks on Overhead Sign Structures – 8/16/1991

Clarification on Lighting of Sag Vertical Curves with Nonstandard Stopping Sight Distance – 5/11/1993

Lighting for Nonstandard Sag Vertical Curves – 6/16/1993

Updated Managed Lane Design TOPD – 4/7/2011

Overhead Guide Sign Policy on the State Highway System – 12/11/2014: Revision 1 and Follow-up memo dated 8/24/2015 for Implementation of Retroreflective Sheeting (Types VIII, IX, or XI) for Fluorescent Orange

Appendix D – Definition of Terms

adaptation: process by which the visual system becomes accustomed to different light intensity or different light colors than it was exposed to previously. It results in a change in the sensitivity of the eye to light.

ambient lighting: general lighting used to provide visibility in a built environment. Ambient lighting includes both artificial and natural lighting and does not include task lighting and accent lighting.

arterial: see Roadway Classification - Major

ballast: device used with an electric-discharge lamp to obtain the necessary circuit conditions (voltage, current, and waveform) for starting and operating.

bikeway: any road, street, path, or way that in some manner is specifically designated as being open to bicycle travel, regardless of whether such facilities are designated for the exclusive use of bicycles or are to be shared with other transportation modes.

brightness: see luminance and subjective brightness.

conflict: occurs whenever the paths followed by vehicles diverge, merge, or cross.

conflict area: area of a roadway where the motorist's special attention is required to interpret the functional features (e.g. bullnose) and/or activities (e.g. pedestrians, turning vehicles, railroad grade crossing) of the roadway, to decide on their driving routine. It is that area which encompasses all the conflict points.

conflict point: point at which conflicts can occur.

continuous lighting: fixed overhead lighting system designed to provide a specific level of illuminance, luminance and uniformity of light on the roadway throughout a highway complex.

contrast: see **luminance contrast**.

correlated color temperature (CCT): unlike the color rendering index (CRI), which describes how faithfully a light source represents other objects, the correlated color temperature (CCT) describes the color output of the lamp itself. Some common CCT values include:

- 2700K, with a warm tinge of yellow that creates appealing and relaxing environments
- 4000K, a neutral white tone that strikes just the right balance between relaxation and concentration
- 6500K, with a slight tinge of blue, which has an energizing effect

Although the correct technical term is correlated color temperature, it is often shortened to only color temperature. It is also important to note that the CCT is not the real operating temperature of a lamp; it is the temperature to which you would have to heat a black body to make it glow with the same color. For example, an LED bulb with a CCT of 5000K glows in the same color as a black body heated to a real temperature of 5000K, but the LED bulb itself does not reach that temperature.

crosswalk: see pedestrian crosswalk.

darkness: any time from one-half hour after sunset to one-half hour before sunrise and any other time when visibility is not sufficient to render clearly discernible any person or vehicle on the highway at a distance 1,000 feet.

discomfort glare: glare producing discomfort. It does not necessarily interfere with visual performance or visibility.

expressway: divided highway with partial control of access.

footcandle, fc: unit of illuminance when a foot is taken as the unit of length. It is the illuminance on a surface that is one square foot in area, on which there is a uniformly distributed flux of one lumen. Or, it is the illuminance produced on a surface of all points that are one foot from a directionally uniform point source of one candela.

glare: sensation produced by luminance within the visual field that is sufficiently greater than the luminance to which the eyes are adapted to cause annoyance, discomfort, or loss in visual performance and visibility. Visual impairment caused by a bright source of light, directly visible or reflected by a surface. There are two types of glare:

- Discomfort glare causes an instinctive reaction to close the eyes and look away. This is the type of glare felt when exposed to a potent HID light or when the sun is directly visible through a window.
- Disability glare impairs vision but does not cause the same reaction as discomfort glare. If a light source gets reflected on your laptop screen, for example, it does not bother your eyes but distinguishing objects on the screen may be impossible.

high-intensity discharge (HID): type of lighting often used for industrial and outdoor settings due to its powerful output. Some examples of HID lighting are mercury-vapor, metal-halide, xenon, high-pressure sodium, and low-pressure sodium lamps.

high mast lighting: illumination of a large area by means of a group of luminaires that are designed to be mounted in fixed orientation at the top of a high support or pole (generally 20 meters or higher).

high-pressure sodium (HPS): subtype of HID lighting where excited sodium vapor is the source of light. The lighting output of HPS lamps is characterized by its warm yellow hue, and are commonly used in cobra-head street lights.

Illuminating Engineering Society of North America (IESNA): technical authority in the lighting industry, with dozens of publications to its credit. IESNA has members and recognition throughout the world.

illuminance: density of luminous flux incident on a surface, measured in footcandles, or fc (or lux, lx). One footcandle is the illumination of a surface one square foot in area on which there is a uniformly distributed luminous flux of one lumen. One footcandle is 10.76 lux. The illuminance requirements of built environments are determined by their intended purpose, and there are two common units of measurement:

- Lux - Equivalent to one lumen per square meter.
- Footcandle - Equivalent to one lumen per square foot.

Higher illuminance levels make surfaces appear brighter to the human eye and improve visibility.

interchange: road junction that uses grade separation, and typically one or more ramps, to permit traffic on at least one highway to pass through the junction without interruption from other crossing traffic streams.

intersection: general area where two or more roadways (highways) join or cross, including the roadway and roadside facilities for traffic movement within it.

isolated Interchange: separated roadway crossing with one or more ramp connections between the crossing roadways, which is lighted and is not part of a continuous roadway system.

isolated Intersection: lighted area in which two or more non-continuously lighted roadways join or cross at the same level

kelvin (K): measurement unit for temperature, although in the lighting industry it is more commonly used to indicate the CCT of light sources.

kilowatt (kW): measurement unit for electric power, equivalent to 1000 watts; thus, a 10kW light = 10,000 watts. This term should not be confused with kilowatt-hour. See watt.

kilowatt-hour (kWh): measurement unit for energy consumption. As implied by its name, it is equivalent to the amount of energy consumed by a one-kilowatt appliance running for one hour. Electric utility bills are often calculated based on kilowatt-hour consumption per month. This term should not be confused with kilowatt.

L70: extrapolated life in hours of the luminaire when the luminous output depreciates 30 percent from the initial values.

lamp: a generic term for an artificial source of light.

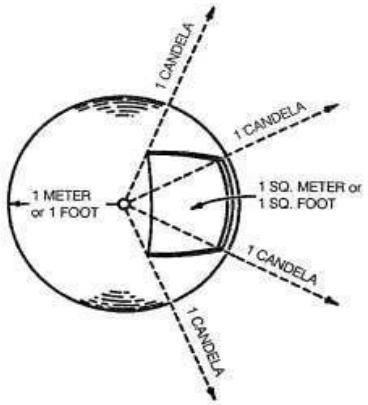


Figure 2 – Relationship between candelas, lumens, lux, and footcandles:

A uniform point source (luminous intensity or candlepower = one candela) is shown at the center of a sphere of unit radius whose surface has a reflectance of zero. The illuminance at any point on the sphere is one lux (one lumen per square meter) when the radius is one meter, or one footcandle (one lumen per square foot) when the radius is one foot. The solid angle subtended by the area A, B, C, D is one steradian. The flux density is therefore one lumen per steradian, which corresponds to a luminous intensity of one candela as originally assumed. The sphere has a total area of 4 (or 12.57) square units (square meters or square feet), and there is a luminous flux of one lumen falling on each unit area. Thus, the source provides a total of 12.57 lumens.

lamp lumen depreciation factor (LLD): multiplier to be used in calculations to relate the initial rated output of light sources to the anticipated minimum output based on the relamping program to be used.

LED (light-emitting diode): solid-state component that emits light when exposed to electric current. LED lighting represents the state-of-the-art in the industry, outclassing most other types of lighting in terms of energy efficiency, design flexibility, and colors of light available.

light: visually evaluated radiant energy.

lighting standard: pole and mast arm supporting the luminaire.

lumen: measurement unit for the lighting output of lamps or fixtures. The total lumens emitted and their spatial distribution are of paramount importance when creating appealing and luxurious indoor spaces. In lighting, lumens can be compared to miles traveled and watts can be compared to fuel consumption. Radiometrically, it is determined from the radiant power. Photometrically, it is the luminous flux emitted within a unit solid angle (one steradian) by a point source having a uniform luminous intensity of one candela.

luminance, L (cd/m2): quotient of the luminous flux at an element of the surface surrounding the point and propagated in directions defined by an elementary cone containing the given direction, by the product of the solid angle of the cone and area of the orthogonal projection of the element of the surface on a plane perpendicular to the given direction. The luminous flux may be leaving, passing through, and/or arriving at the surface. Note: In common usage the term "brightness" usually refers to the strength of sensation which results from viewing surfaces or spaces from which light comes to the eye. This sensation is determined in part by the measurable luminance defined above and in part by conditions of observation such as the state of adaptation of the eye.

luminance (photometric brightness): quantity of luminous flux emitted, reflected, or transmitted from a surface in a direction, measured in cd/feet2 or cd/m2. This is the property of light we can visibly see with our eyes.

Term	Symbol	English Unit	Metric Unit	Relationship
Luminous Intensity	I	candela (cd)		$I = \phi/\omega$, $\omega = A/r^2$
Luminous Flux	ϕ	lumens (lm)		$\phi = I\,\omega$
Luminous Exitance	M	lm/ft^2	lm/m^2	$M = \phi'/A$
Illuminance	E	$fc = lm/ft^2$	$lx = lm/m^2$	$E = \varphi/A$ 1 fc=10.76 lx
Luminance	L	cd/ft^2	cd/m^2	$L = I/A \cos\theta$

luminaire: includes the lamp, the ballast or driver, internal wiring, reflectors, lens and any additional components required to deliver light. A complete lighting unit consisting of a lamp or lamps together with the parts designed to distribute the light, to position and protect the lamps and to connect the lamps to the power supply. Sometimes includes ballasts and photocells. Assembly that houses the light source and controls the light emitted from the light source.

luminaire cycle: distance between two luminaires along one side of the roadway. Note: this may not be the same as luminaire spacing along the centerline considering both sides of the road. (See spacing.)

luminous flux: luminous flux is the measure of the total amount of energy radiated per second from a light source in all directions**.** It is measured in lumens. One lumen is defined as the luminous flux of the uniform point light source having a luminous intensity of 1 candela

luminous flux density at a surface: luminous flux per unit area at a point on a surface. Note: this need not be a physical surface; it may equally well be a mathematical plane.

luminous intensity: lighting emission in a specific direction, measured in candelas. Luminous intensity changes depending on the viewing angle. Not to be confused with luminous flux.

lux: SI unit for illuminance, or lumens per unit of area. One lux is equivalent to one lumen per square meter. A key component of lighting designed is achieving a suitable illuminance level depending on the application at hand. It is the illuminance on a surface one square meter in area on which there is a uniformly distributed flux of one lumen, or the illuminance produced at a surface all points that are at a distance of one meter from a uniform point source of one candela. Conversion Formula: fc x 10.8 = Lux.

mercury lamp: subtype of HID lamp that produces its lighting output by stimulating mercury vapor, hence its name. Mercury lamps may use a phosphor coating to enhance lighting performance and are commonly used in outdoor and industrial lighting applications.

mounting height: vertical distance between the roadway surface and the center of the apparent light source of the luminaire.

overcrossings (For pedestrians/Bikeway): overcrossing is a facility that provides a connection between pedestrian walkways/bikeways or roads open to pedestrian walkways/bicycling.

pedestrian classification:

high: areas with significant numbers of pedestrians expected to be on the sidewalks or crossing the streets during darkness. Examples are downtown retail areas, near theaters, concert halls, stadiums, and transit terminals.

medium: areas where lesser numbers of pedestrians use the streets at night. Typical are downtown office areas blocks with libraries, apartments, neighborhood shopping, industrial, older city areas, and streets with transit lines.

low: areas with very low volumes of night pedestrian usage. These can occur in any of the cited roadway classifications but may be typified by suburban single-family streets, very low-density residential developments, and rural or semi-rural areas.

pedestrian crosswalk: area designated by markings for pedestrians to cross the roadway.

pull box: box with a cover that is installed in an accessible place in a conduit run to facilitate pulling in wires or cables.

roadway classification:

major: part of the roadway system that serves as the principal network for through-traffic flow. The routes connect areas of principal traffic generation and important rural roadways leaving the city. Also, often known as “arterials,” “thoroughfares,” or “preferential.”

collector: roadways servicing traffic between major and local streets. These are streets used mainly for traffic movements within residential, commercial, and industrial areas. They do not handle long, through trips.

local: local streets are used primarily for direct access to residential, commercial, industrial, or other abutting property.

spacing: distance between successive luminaires measured along the center line of the street. See luminaire cycle.

subjective brightness: subjective attribute of any light sensation given rise to the perception of luminous intensity, including the whole scale of qualities of being bright, lightness, brilliant, dim, or dark.

surface street: street that is not a freeway and has at-grade intersections with other surface streets.

tunnel: as defined by the American Association of State Highway and Transportation Officials (AASHTO) Technical Committee for Tunnels (T-20) are enclosed roadways with vehicle access that is restricted to portals regardless of the structure type or construction method. The committee further defines road tunnels not to include enclosed roadways created by highway bridges, railroad bridges, or other bridges. This definition applies to all types of tunnel structures and tunnels, mined and bored tunnels in rock and soft ground, and immersed tunnels.

undercrossing (pedestrians crossing/bikeway): pedestrian undercrossing and bicycle undercrossing are facilities that provide a connection between pedestrian walkways/bikeways or roads open to pedestrian walkways/bicycling.

visibility: quality or state of being perceivable by the eye. In many outdoor applications, visibility is sometimes defined in terms of the distance at which an object can be just perceived by the eye. In indoor and outdoor applications, it is usually defined in terms of the contrast or size of a standard test object, observed under standardized viewing conditions, having the same threshold as the given object.

walkway: sidewalk or pedestrian way.

warrant: threshold condition based upon average or normal conditions that, if found to be satisfied as part of an engineering study, shall result in analysis of other traffic conditions or factors to determine whether a traffic control device or other improvement is justified. Warrants are not a substitute for engineering judgment. The fact that a warrant for a traffic control device is met is not conclusive justification for the installation of the device.

watt: measurement unit for the electric power consumption of lighting fixtures, or any other appliance that runs with electricity. In lighting, lumens can be compared to miles traveled and watts can be compared to fuel consumption**.**

Appendix E – References

California Department of Transportation. *Traffic Manual*. November 2002. Sacramento.

Illuminating Engineering Society. *American National Standard Practice for Design and Maintenance of Roadway and Parking Facility Lighting – ANSI/IES RP-8-18*. 2018. New York, NY.

U.S. Department of Transportation, Federal Highway Administration. *Roundabouts: An Informational Guide*. June 2000. Washington D.C.

COUNTERMEASURE TOOLBOX ATTACHMENT

CALTRANS ROADWAY LIGHTING MANUAL TABLE D

Table D[6]: Pavement Illuminance Criteria for Full Intersection Lighting

Roadway Intersection Classification	PED/hr	Minimum E_{avg} (fc)	Maximum Uniformity E_{avg}/E_{min}
Major/Major or Major/Collector or Major/Local	> 100	3.2	3.0
Major/Major or Major/Collector or Major/Local	< 100	2.4	3.0
Collector/Collector or Collector/Local or Local/Local	> 100	2.2	4.0
Collector/Collector or Collector/Local or Local/Local	< 100	1.7	4.0

Table D should be used for Full Intersections Lighting with high pedestrian level, e.g., community facilities; libraries; recreation centers; near major airport; truck, rail, or bus terminals; activity centers, such as a central business center to large town centers, shopping center, or malls; large colleges; medical complexes; military bases and large institutional facilities; major industrial or commerce centers; and major recreational areas.

[6] Based on RP8, table 12-1 for intersections with a high pedestrian level.
For high pedestrian locations the pedestrian volumes are more than 100 pedestrians/hour at nighttime. For medium pedestrian locations the pedestrian volumes are within 11 to 100 pedestrians/hour at nighttime. For low pedestrian locations the pedestrian volumes are less than 10 pedestrians/hour at nighttime for isolated locations.

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LEFT TURN LANE WARRANTS - AASHTO GREEN BOOK 2018

9.7.3 Design Treatments for Left-Turn Maneuvers

9.7.3.1 Guidelines for Provision and Design of Left-Turn and Bypass Lanes

Many factors enter into the choice of type of intersection and the extent of design of a given type, but the principal controls are the design-hour traffic volume, the character or composition of traffic, and the design speed. The character of traffic and design speed affects many details of design, but in choosing the type of intersection they are not as significant as the traffic volume. Of particular significance are the actual and relative volumes of traffic involved in various turning and through movements.

In designing an intersection, left-turning traffic should be removed from the through lanes, whenever practical. Therefore, provisions for left turns (i.e., left-turn lanes) have widespread application. Ideally, left-turn lanes should be provided at driveways and street intersections along major arterial and collector roads wherever left turns are permitted. In some cases or at certain locations, providing for indirect left turns (jughandles, U-turn lanes, and diagonal roadways) may be appropriate to reduce crash frequencies and preserve capacity. The provision of left-turn lanes has been found to reduce crash rates anywhere from 20 to 65 percent (*18*). Left-turn facilities should be established on roadways where traffic volumes are high enough or crash histories are sufficient to warrant them. They are often needed to provide adequate service levels for the intersections and the various turning movements.

Figures 9-5B and 9-6B provide examples of bypass lanes, which are added to the outside edge of the approach, allowing through vehicles to pass left-turning vehicles on the right, while Figures 9-5C and 9-6C show traditional left-turn lanes. Regardless of the treatment, consideration of traffic demand, delay savings, crash reduction, and construction costs are all key factors in determining whether to install a left-turn lane or a bypass lane. Research on left-turn accommodations at unsignalized intersections (*16*) produced warrants for the installation of left-turn lanes and bypass lanes that account for those factors. Traffic-volume-based guidelines for where left-turn lanes should be provided are presented in:

- Table 9-24 and Figure 9-35 for arterials in urban areas
- Table 9-25 and Figure 9-36 for two-lane highways in rural area
- Table 9-26 and Figure 9-37 for four-lane highways in rural areas

These tables and figures are applicable at unsignalized intersections with streets and driveways where the major road is uncontrolled and the minor-road approaches are stop- or yield-controlled. Several documents for both signalized and unsignalized intersections provide guidance on left-turn lanes (*19*, *28*, *34*). These guidelines discuss the need for left-turn lanes based upon (a) the number of arterial lanes, (b) design and operating speeds, (c) left-turn volumes, and (d) opposing traffic volumes. The volume-based guidelines or warrants presented below indicate situations where a left-turn lane may be desirable, not necessarily situations where a left-turn lane is definitely needed.

Table 9-24. Suggested Left-Turn Lane Guidelines Based on Results from Benefit–Cost Evaluations for Unsignalized Intersections on Arterials in Urban Areas (*16*)

Left-Turn Lane Peak-Hour Volume (veh/h)	Three-Leg Intersection, Major-Road Volume (veh/h/ln) that Warrants a Left-Turn Lane	Four-Leg Intersection, Major-Road Volume (veh/h/ln) that Warrants a Left-Turn Lane
5	450	50
10	300	50
15	250	50
20	200	50
25	200	50
30	150	50
35	150	50
40	150	50
45	150	< 50
50 or More	100	< 50

Note: These guidelines apply where the major road is uncontrolled and the minor-road approaches are stop- or yield-controlled. Both the left-turn peak-hour volume and the major-road volume warrants should be met as shown in Figure 9-35.

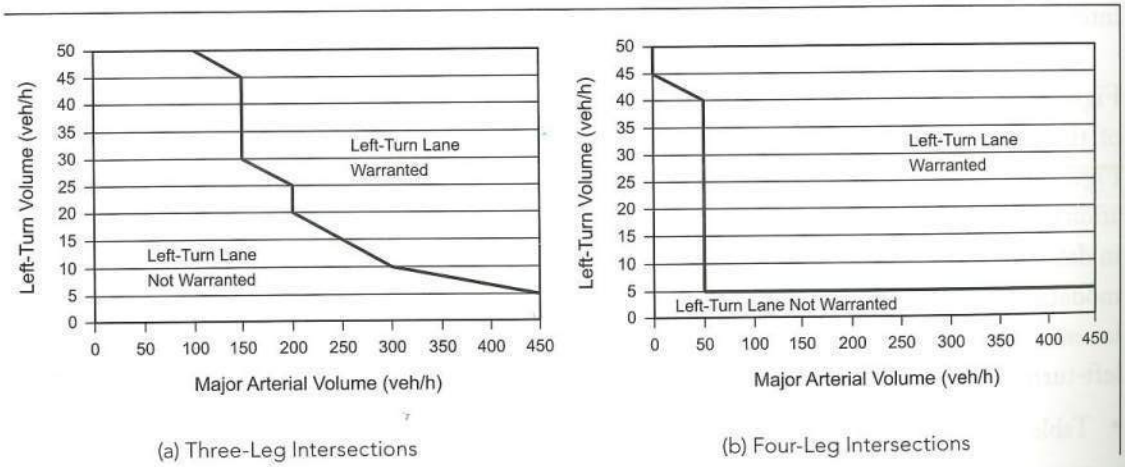


Figure 9-35. Suggested Left-Turn Lane Warrants Based on Results from Benefit–Cost Evaluations for Intersections on Arterials in Urban Areas (*16*)

Table 9-25. Suggested Left-Turn Treatment Guidelines Based on Results from Benefit–Cost Evaluations for Intersections on Two-Lane Highways in Rural Areas (*16*)

Left-Turn Lane Peak-Hour Volume (veh/h)	Three-Leg Intersection, Major-Road Two-Lane Highway Peak-Hour Volume (veh/h/ln) that Warrants a Bypass Lane	Three-Leg Intersection, Major-Road Two-Lane Highway Peak-Hour Volume (veh/h/ln) that Warrants a Left-Turn Lane	Four-Leg Intersection, Major-Road Two-Lane Highway Peak-Hour Volume (veh/h/ln) that Warrants a Left-Turn Lane
5	50	200	150
10	50	100	50
15	< 50	100	50
20	< 50	50	< 50
25	< 50	50	< 50
30	< 50	50	< 50
35	< 50	50	< 50
40	< 50	50	< 50
45	< 50	50	< 50
50 or More	< 50	50	< 50

Note: These guidelines apply where the major road is uncontrolled and the minor-road approaches are stop- or yield-controlled. Both the left-turn peak-hour volume and the major-rad volume warrants should be met as shown in Figure 9-36.

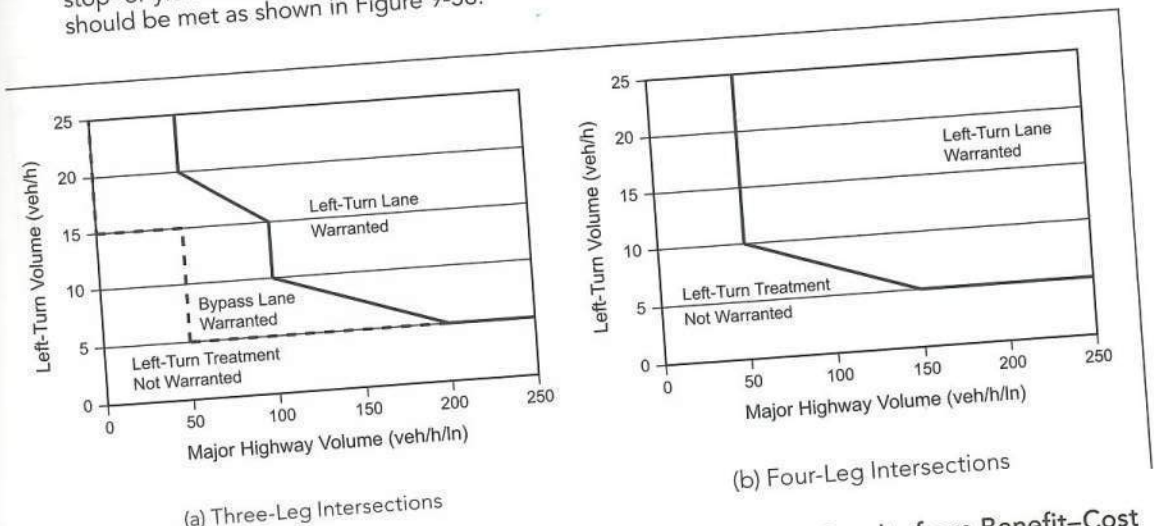


Figure 9-36. Suggested Left-Turn Treatment Warrants Based on Results from Benefit–Cost Evaluations for Intersections on Two-Lane Highways in Rural Areas (*16*)

Table 9-26. Suggested Left-Turn Lane Guidelines Based on Results from Benefit–Cost Evaluations for Unsignalized Intersections on Four-Lane Highways in Rural Areas (*16*)

Left-Turn Lane Peak-Hour Volume (veh/h)	Three-Leg Intersection, Major-Road Four-Lane Highway Peak-Hour Volume (veh/h/ln) that Warrants a Left-Turn Lane	Four-Leg Intersection, Major-Road Four-Lane Highway Peak-Hour Volume (veh/h/ln) that Warrants a Left-Turn Lane
5	75	50
10	75	25
15	50	25
20	50	25
25	50	< 25
30	50	< 25
35	50	< 25
40	50	< 25
45	50	< 25
50 or More	50	< 25

Note: These guidelines apply where the major road is uncontrolled and the minor-road approaches are stop- or yield-controlled. Both the left-turn peak-hour volume and the major-road volume warrants should be met as shown in Figure 9-37.

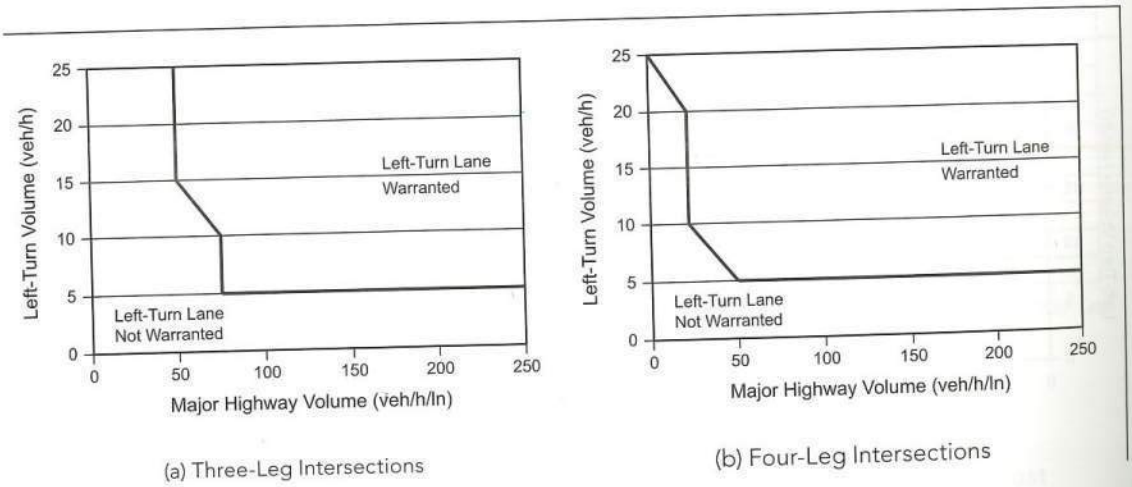


Figure 9-37. Suggested Left-Turn Lane Warrants Based on Results from Benefit–Cost Evaluations for Intersections on Four-Lane Highways in Rural Areas (*16*)

In addition to using guidance presented in the previous tables and figures, site-specific conditions need to be evaluated to determine the economic feasibility of adding a turn lane. Physical constraints along the roadside, particularly in urban areas, may make the addition of a turn lane impractical.

The HCM (*49*) indicates that exclusive left-turn lanes at signalized intersections should be installed as follows:

- Exclusive left-turn lanes should be provided where exclusive left-turn signal phasing is provided;
- Exclusive left-turn lanes should be considered where left-turn volumes exceed 100 veh/h (left-turn lanes may be provided for lower volumes as well based on the roadway agency's assessment of the need, the state of local practice, or both); and
- Double left-turn lanes should be considered where left-turn volumes exceed 300 veh/h.

Additional information on left-turn lanes, including their suggested lengths, can be found in NCHRP Synthesis 225, NCHRP Report 279, and NCHRP Report 745 (*15, 30, 34*). In the case of double left-turn lanes, a capacity analysis of the intersection should be performed to determine what traffic controls are needed in order for it to function properly.

Local conditions and the cost of right-of-way often influence the type of intersection selected as well as many of the design details. Limited sight distance, for example, may make it desirable to control traffic by yield signs, stop signs, or traffic signals when the traffic densities are less than those ordinarily considered appropriate for such control. The alignment and grade of the intersecting roads and the angle of intersection may make it advisable to channelize or use auxiliary pavement areas, regardless of the traffic densities. In general, traffic service, roadway design designation, physical conditions, and cost of right-of-way are considered jointly in choosing the type of intersection.

For the general benefit of through-traffic movements, the number of crossroads, intersecting roads, or intersecting streets should be minimized. Where intersections are closely spaced on a two-way facility, it is seldom practical to provide signals for completely coordinated traffic movements at reasonable speeds in opposing directions on that facility. At the same time, the resultant road or street patterns should permit travel on roadways other than the predominant roadway without too much inconvenience. Traffic analysis is needed to determine whether the road or street pattern, left open across the predominate roadway, is adequate to serve normal traffic plus the traffic diverted from any terminated road or street.

The functional classification of the road, the patterns of traffic movement at the intersections and the volume of traffic, including pedestrians and bicyclists, on each approach during one or more peak periods of the day are indicative of the type of traffic control devices needed, the roadway widths needed (including auxiliary lanes), and where applicable, the degree of channel-

COUNTERMEASURE TOOLBOX ATTACHMENT

LEFT TURN LANE WARRANTS - SDDOT TRAFFIC MANUAL

The desired roundabout Level of Service is C; the minimum Level of Service is D.

For detailed turn lane, roundabout, and median geometric design information refer to Chapter 7 – Cross Sections or Chapter 12 – Intersections.

TURN LANE WARRANTS

Turn Lane Study Guidelines

At a minimum, turn lane analysis reports should include the following:

- A thorough evaluation of each of the warrant criteria.
- Discussion of access management considerations.
- Recommendations as to whether or not turn lanes are appropriate. Note that even though conditions may or may not meet certain criterion, the ultimate deciding factor is the engineer's judgment. Factors that could influence the decision include conflict analysis results, benefit/cost analysis results, right-of-way cost considerations, constructability, etc.
- The recommended storage length if a turn lane is appropriate. The estimated 95th percentile queue value should be used for the recommended length. Queue values should be determined using an acceptable analysis software method.

Left Turn Lane Criteria – Unsignalized Intersections

Generally, left turn lanes should be considered (1) when the hourly volume of turns has a significant negative effect on traffic operations, or, (2) when historical crash analysis shows that a crash trend could be correctable by providing a turn lane.

Left Turn Lane Evaluation Process

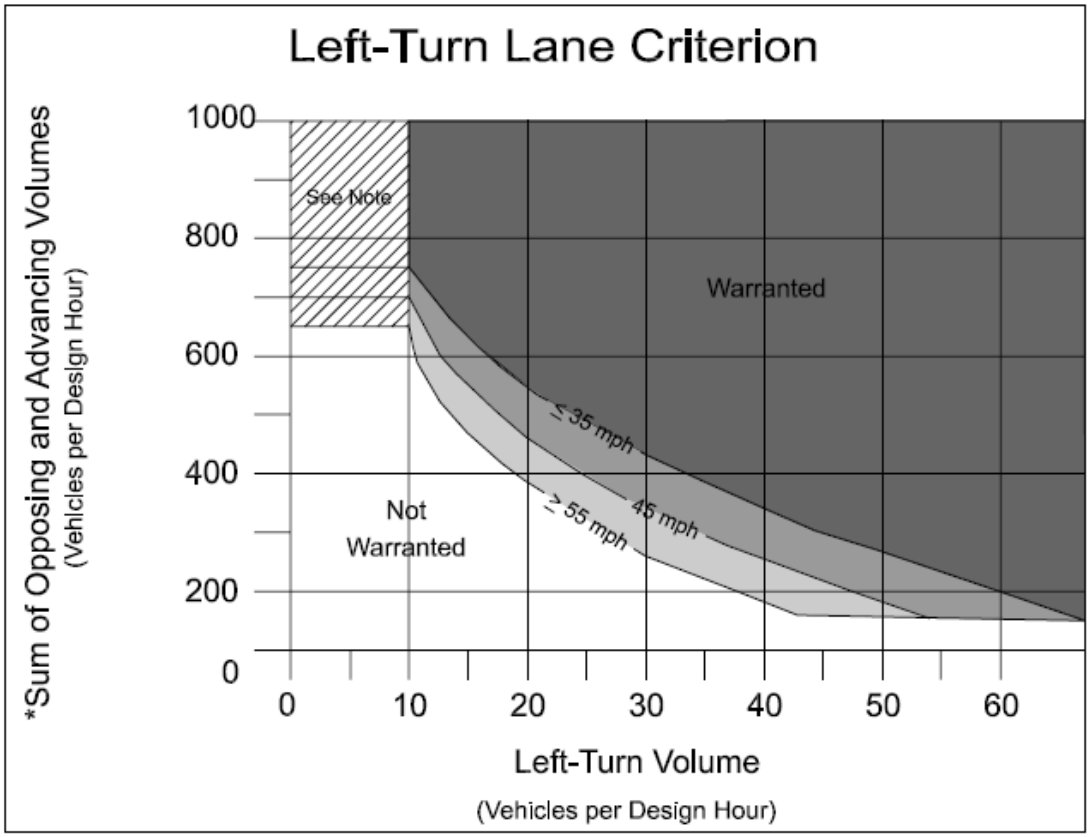
- A left turn lane should be installed if Criterion 1 (Volume), 2 (Crash), or 3 (Special Cases) are met; and

- The left turn lane complies with access management spacing standards; and

- The left turn lane conforms to appropriate design guidelines.

Criterion 1: Vehicular Volume

The vehicular volume criterion is intended for application where the volume of intersecting traffic is the principal reason for considering installation of a left turn lane. The volume criteria are determined by the Texas Transportation Institute (TTI) curves in Figure 15-2.



Source: Oregon DOT Analysis Procedures Manual 2008

*(Advancing Vol/ # of Advancing Through Lanes)+
(Opposing Vol/ # of Opposing Through Lanes)

Note: The criterion is not met from zero to ten left turn vehicles per hour, but careful consideration should be given to installing a left turn lane due to the increased potential for crashes in the through lanes. While the turn volumes are low, the adverse safety and operational impacts may require installation of a left turn. The final determination will be based on a field study.

Figure 15-2 Left Turn Lane Volume Warrant

Criterion 2: Crash Experience

The crash experience criterion is satisfied when either Condition 1 or 2 are met, and Condition 3 is met:

1. A history of crashes of the type susceptible to correction by a left turn lane (e.g. rear-end crashes involving turning vehicles). A separate left turn lane may be warranted if three or more reported intersection related crashes occur within a 12 month period. The geometry for warranted turn lanes be used for locations meeting these criteria (see Chapter 12 - Intersections).

2. An economic analysis using predictive measures consistent with the AASHTO Highway Safety Manual (HSM) shows a benefit/cost ratio ≥ 1.0 and at least two crashes in the last ten years are of the type susceptible to correction by a left turn

lane (e.g. rear-end crashes involving turning vehicles), or based on the Highway Safety Engineer's recommendation to add a turn lane. The geometry for warranted turn lanes will be used for locations meeting these criteria (see Chapter 12 - Intersections).

3. The installation of the left turn lane does not adversely impact the operations of the intersection.

Criterion 3: Special Cases

1. Railroad Crossings: If a railroad is parallel to the roadway, then the likelihood of train movements preventing left turns and creating stopped queues on the highway should be taken into consideration. The provided left turn lane storage length will be dependent on the duration that the side road is closed, the expected number of vehicle arrivals, and the location of the crossing. The analysis should consider all of the variables influencing the design of the left turn lane, and may allow a design for conditions other than the worst case storage requirements, provided safety is not compromised.

2. Geometric/Safety Concerns: Sight distance, alignment, operating speed, adjacent access points, and other safety related concerns should be taken into consideration.

3. Non-Traversable Median: A left turn lane may be considered to be installed at a break in a non-traversable median where left turns are not prohibited and either of the following conditions exist:

    a. If Criterion 1 (Vehicular Volume) is not met but there is a significant amount of left turn movements; or

    b. If Criterion 2 (Crash Experience) is not met but there has been a pattern of crashes that has occurred, and a left turn lane would prevent or limit those types of crashes to occur if installed.

Left Turn Lane Volume Criterion Example

Figure 15-2a shows an unsignalized intersection with a shared through-right lane and a shared through-left lane on the highway. The peak hour volumes and lane configurations are shown in the figure. The 85th percentile speed is 45 mph. Does the intersection meet the volume criterion for a left turn lane in either the NB or SB direction?

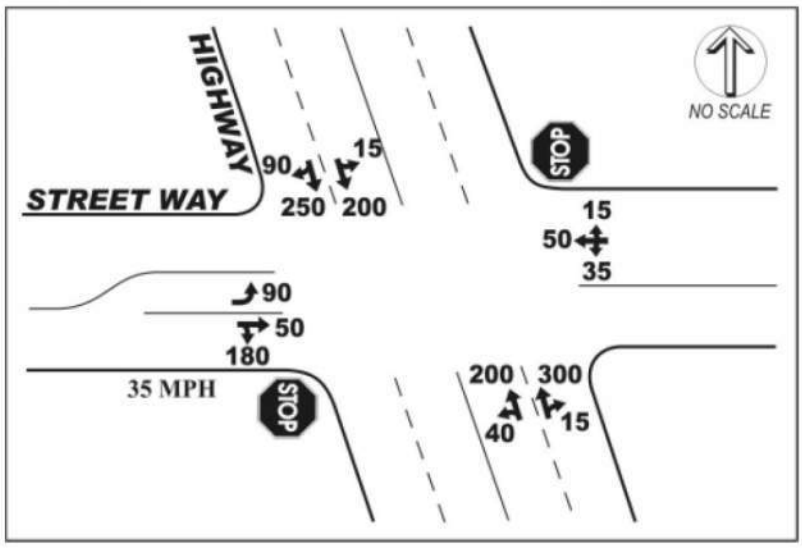


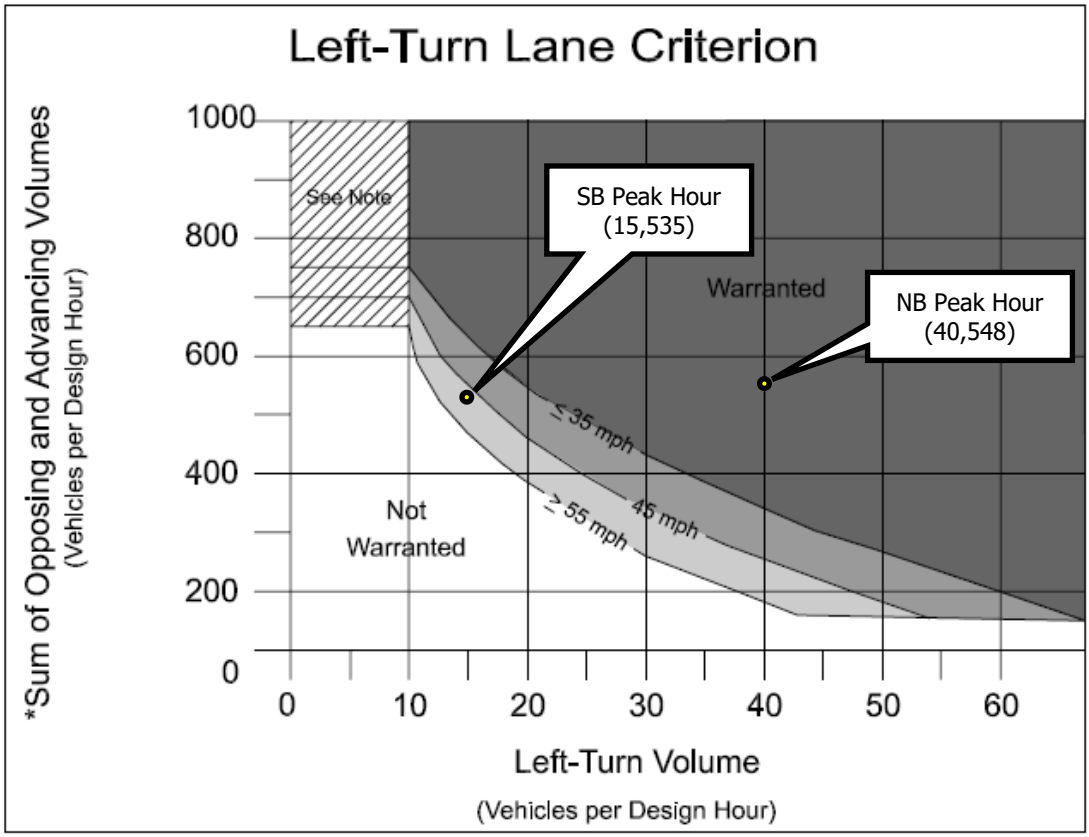
Figure 15-2a Left Turn Lane Example Volumes

- Southbound: The SB advancing volume is 555 (90+250+200+15) and the NB opposing volume is 515 vehicles (the opposing left turns are not counted as opposing volumes). The volume for the Y-axis on Figure 15-2 is determined using the equation:

  Y-axis volume = ((Advancing Vol/# of Advancing Lanes)+
  (Opposing Vol/Number of Opposing Lanes))
  = (555/2 + 515/2) = 535

  To determine if the SB left turn volume criterion is met, use the 45 mph curve in Figure 15-2, 535 for the y-axis, and 15 left-turns for the x-axis. The volume criterion is not met in the SB direction.

- Northbound: The NB advancing volume is 555 (40+200+300+15) and the SB opposing volume is 540 vehicles (the opposing left turns are not counted as opposing volumes). The volume for the Y-axis on Figure 15-2 is (555/2+540/2) = 548. To determine if the SB left turn volume criterion is met, use the 45 mph curve in Figure 15-2, 548 for the y-axis, and 40 left turns for the x-axis. The volume criterion is met in the NB direction.



Source: Oregon DOT Analysis Procedures Manual 2008

*(Advancing Vol/ # of Advancing Through Lanes)+
(Opposing Vol/ # of Opposing Through Lanes)

Note: The criterion is not met from zero to ten left turn vehicles per hour, but careful consideration should be given to installing a left turn lane due to the increased potential for crashes in the through lanes. While the turn volumes are low, the adverse safety and operational impacts may require installation of a left turn. The final determination will be based on a field study.

Figure 15-2b Left Turn Lane Example Criterion Graph

Right Turn Lane Criteria – Unsignalized Intersections

The purpose of a right turn lane at an unsignalized intersection is to reduce the speed differential between the right turning vehicles and the other vehicles on the roadway. Research has shown that this will increase roadway capacity and reduce certain types of crashes.

Right Turn Lane Evaluation Process

- A right turn lane should be considered if criterion 1 (Volume), 2 (Crash), or 3 (Special Cases) is met; and
- The right turn lane complies with access management spacing standards; and
- The right turn lane conforms to the appropriate design guidelines.

Criterion 1: Vehicular Volume

The vehicular volume criterion is intended for application where the volume of intersecting traffic is the principal reason for considering installation of a right turn lane. The vehicular volume criterion is determined using the curve in Figure 15-3.

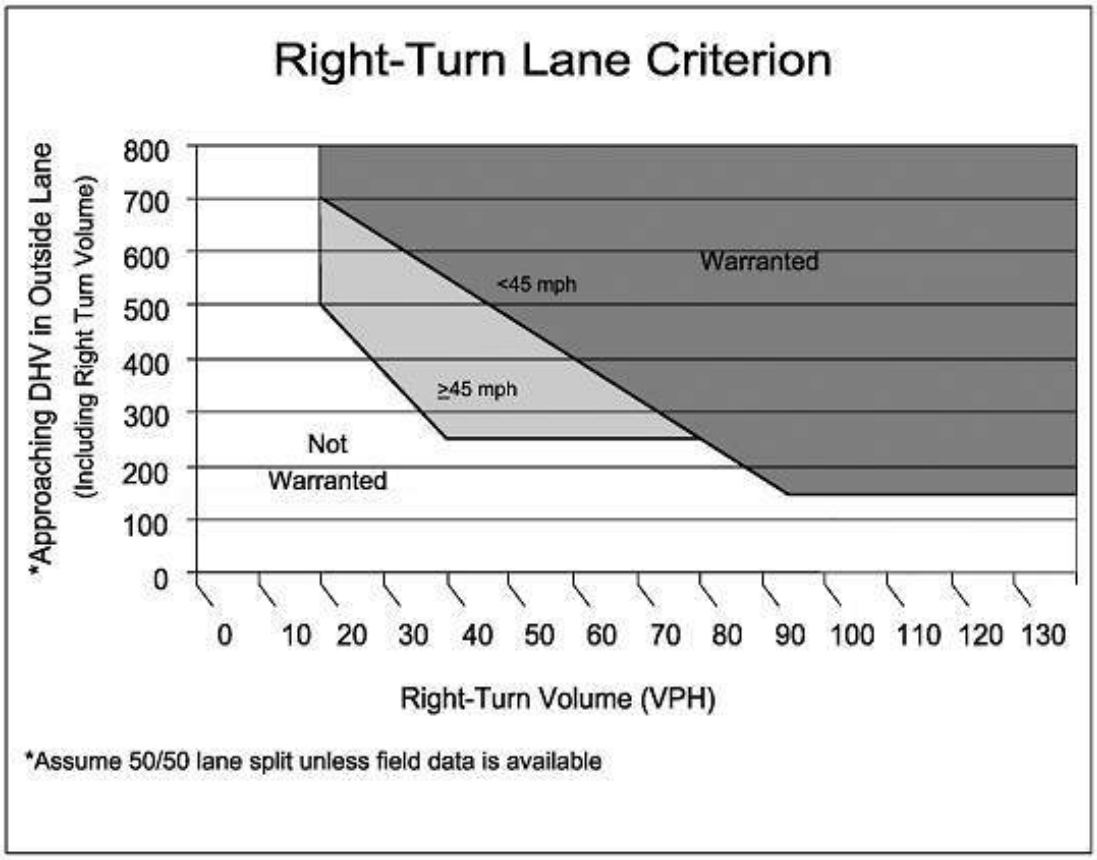


Figure 15-3 Right Turn Lane Volume Warrant

Criterion 2: Crash Experience

The crash experience criterion is satisfied when either Condition 1 or 2 are met and Condition 3 is met:

1. A history of crashes of the type susceptible to correction by a right turn lane (e.g. rear-end crashes involving turning vehicles). A separate right turn lane may be warranted if three or more reported intersection- related crashes occur within a 12 month period. The geometry for warranted turn lanes will be used for locations meeting these criteria (see Chapter 12 -Intersections).

2. An economic analysis using predictive measures consistent with the HSM shows a benefit/cost ratio ≥ 1.0 and at least two crashes in the last ten years are of the type susceptible to correction by a left turn lane (e.g. rear-end crashes involving turning vehicles), or based on the Highway Safety Engineer's recommendation to add a turn lane. The geometry for unwarranted turn lanes will be used for locations meeting these criteria (see Chapter 12 - Intersections).

3. The installation of the right turn lane does not adversely affect bicyclists or pedestrians.

Criterion 3: Special Cases

1. Railroad Crossings: If a railroad is parallel to the roadway, then the likelihood of train movements preventing right turns and creating stopped queues on the highway should be taken into consideration. The provided right turn lane storage length will be dependent on the duration that the side road is closed, the expected number of vehicle arrivals, and the location of the crossing. The analysis should consider all the variables influencing the design of the right turn lane and may allow a design for conditions other than the worst-case storage requirements, provided safety is not compromised.

2. Geometric/Safety Concerns: Sight distance, alignment, operating speeds, adjacent access points and other safety related concerns should be taken into consideration.

Right Turn Lane Volume Criterion Example

Figure 15-3a shows an unsignalized intersection with a shared through-right lane and a shared though-left land on the highway. The peak hour volumes and lane configurations are shown in the figure. The 85^{th} percentile speed is 45 mph. Does the intersection meet the volume criterion for a right turn lane in either the NB or SB direction?

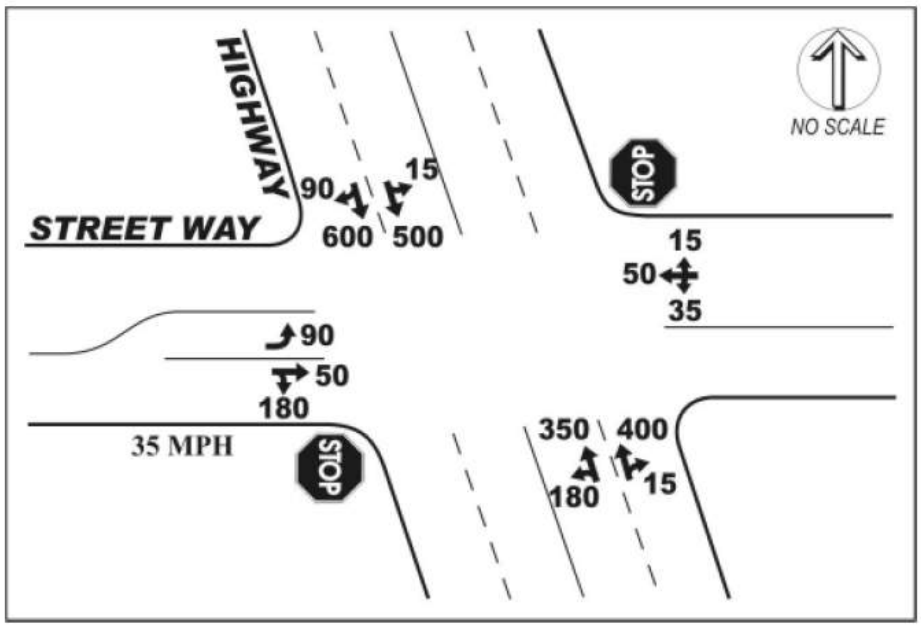


Figure 15-3a Right Turn Lane Example Volumes

- The NB outside lane has 400 through vehicles and 15 right turning vehicles for a total of 415 vehicles. Using the 45 mph curve in Figure 15-3, along with 415 approaching vehicles and 15 right turning vehicles we find that the vehicle volume criterion is not met.

- The SB outside lane has 600 through vehicles and 90 right turning vehicles for a total of 690 vehicles. Using the 45 mph curve in Figure 15-3, along with 690 approaching vehicles and 90 right turning vehicles we find the vehicular volume criterion is met.

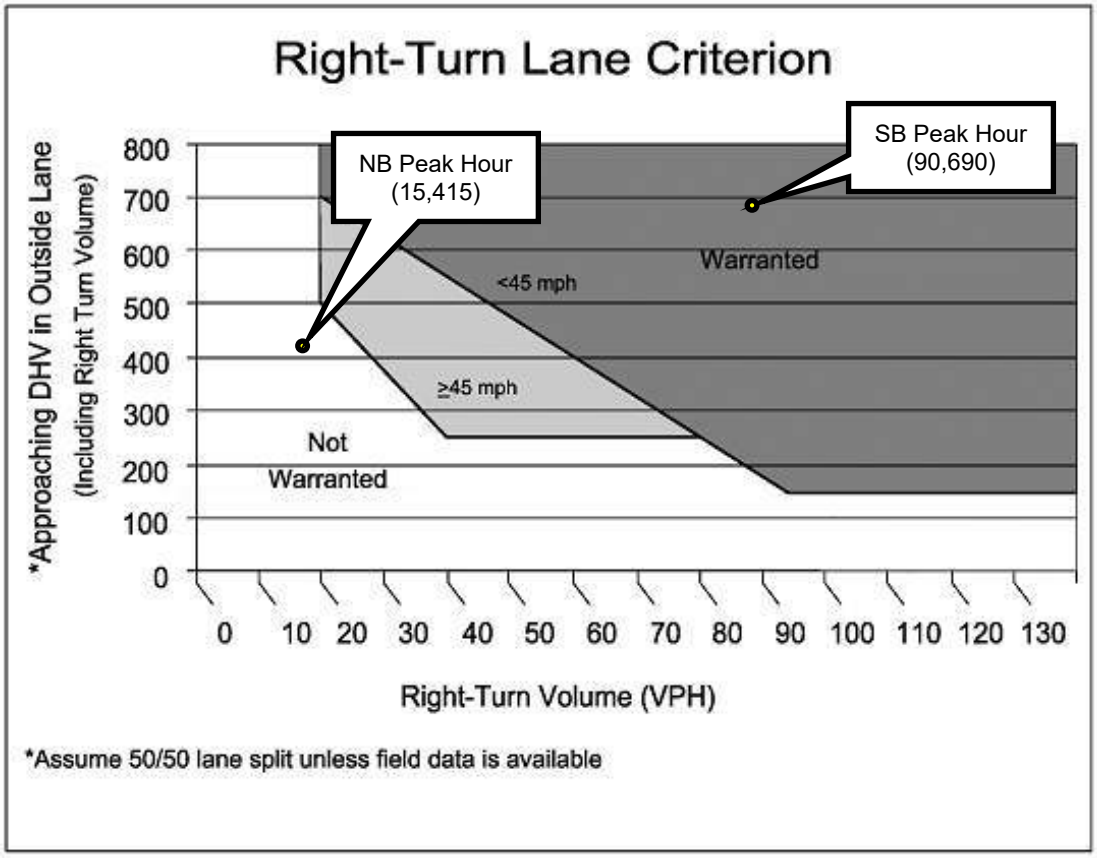


Figure 15-3b Right Turn Lane Example Criterion Graph

Turn Lane Criteria – Signalized Intersections

The need for turn lanes at signalized intersections is determined differently than at unsignalized intersections. Left and right turn lanes at signalized intersections should be considered if:

1. A reduction in intersection delay can be demonstrated. Intersection analyses will be in accordance with the HCM; or

2. The benefit/cost ratio for the improvement is greater than 1.0.

The operational analysis of dual turn lanes will take into account forecast imbalances in lane utilization.

COUNTERMEASURE TOOLBOX ATTACHMENT

SIGNAL WARRANT – CAMUTCD 2014

CHAPTER 4C. TRAFFIC CONTROL SIGNAL NEEDS STUDIES

Section 4C.01 Studies and Factors for Justifying Traffic Control Signals

Standard:

01 **An engineering study of traffic conditions, pedestrian characteristics, and physical characteristics of the location shall be performed to determine whether installation of a traffic control signal is justified at a particular location.**

01a **On State highways, the engineering study shall include consideration of a roundabout (yield control). If a roundabout is determined to provide a viable and practical solution, it shall be studied in lieu of, or in addition to a traffic control signal.**

Guidance:

01b *On local streets and highways, the engineering study should include consideration of a roundabout (yield control). If a roundabout is determined to provide a viable and practical solution, it should be studied in lieu of, or in addition to a traffic control signal.*

Support:

01c Refer to Caltrans' website (http://www.dot.ca.gov/hq/traffops/liaisons/ice.html) for more information on the Traffic Operations Policy Directive 13-02, Intersection Control Evaluation (ICE), and other resources for the evaluation of intersection traffic control strategies.

02 **The investigation of the need for a traffic control signal shall include an analysis of factors related to the existing operation and safety at the study location and the potential to improve these conditions, and the applicable factors contained in the following traffic signal warrants:**

Warrant 1, Eight-Hour Vehicular Volume
Warrant 2, Four-Hour Vehicular Volume
Warrant 3, Peak Hour
Warrant 4, Pedestrian Volume
Warrant 5, School Crossing
Warrant 6, Coordinated Signal System
Warrant 7, Crash Experience
Warrant 8, Roadway Network
Warrant 9, Intersection Near a Grade Crossing

03 **The satisfaction of a traffic signal warrant or warrants shall not in itself require the installation of a traffic control signal.**

Support:

04 Sections 8C.09 and 8C.10 contain information regarding the use of traffic control signals instead of gates and/ or flashing-light signals at highway-rail grade crossings and highway-light rail transit grade crossings, respectively.

Guidance:

05 *A traffic control signal should not be installed unless one or more of the factors described in this Chapter are met.*

06 *A traffic control signal should not be installed unless an engineering study indicates that installing a traffic control signal will improve the overall safety and/or operation of the intersection.*

07 *A traffic control signal should not be installed if it will seriously disrupt progressive traffic flow.*

08 *The study should consider the effects of the right-turn vehicles from the minor-street approaches. Engineering judgment should be used to determine what, if any, portion of the right-turn traffic is subtracted from the minor-street traffic count when evaluating the count against the signal warrants listed in Paragraph 2.*

09 *Engineering judgment should also be used in applying various traffic signal warrants to cases where approaches consist of one lane plus one left-turn or right-turn lane. The site-specific traffic characteristics should dictate whether an approach is considered as one lane or two lanes. For example, for an approach with one lane for through and right-turning traffic plus a left-turn lane, if engineering judgment indicates that it should be considered a one-lane approach because the traffic using the left-turn lane is minor, the total traffic volume approaching the intersection should be applied against the signal warrants as a one-lane approach. The*

approach should be considered two lanes if approximately half of the traffic on the approach turns left and the left-turn lane is of sufficient length to accommodate all left-turn vehicles.

10 *Similar engineering judgment and rationale should be applied to a street approach with one through/left-turn lane plus a right-turn lane. In this case, the degree of conflict of minor-street right-turn traffic with traffic on the major street should be considered. Thus, right-turn traffic should not be included in the minor-street volume if the movement enters the major street with minimal conflict. The approach should be evaluated as a one-lane approach with only the traffic volume in the through/left-turn lane considered.*

11 *At a location that is under development or construction and where it is not possible to obtain a traffic count that would represent future traffic conditions, hourly volumes should be estimated as part of an engineering study for comparison with traffic signal warrants. Except for locations where the engineering study uses the satisfaction of Warrant 8 to justify a signal, a traffic control signal installed under projected conditions should have an engineering study done within 1 year of putting the signal into stop-and-go operation to determine if the signal is justified. If not justified, the signal should be taken out of stop-and-go operation or removed.*

12 *For signal warrant analysis, a location with a wide median, even if the median width is greater than 30 feet, should be considered as one intersection.*

Option:

13 At an intersection with a high volume of left-turn traffic from the major street, the signal warrant analysis may be performed in a manner that considers the higher ~~of the major-street left-turn volumes as the "minor-street" volume and the corresponding single direction of opposing traffic on the major street as the "major-street" volume~~ volume of the major-street left-turn volumes plus the higher volume minor-street approach as the "minor street" volume and both approaches of the major street minus the higher of the major-street left-turn volume as "major street" volume.

14 For signal warrants requiring conditions to be present for a certain number of hours in order to be satisfied, any four sequential 15-minute periods may be considered as 1 hour if the separate 1-hour periods used in the warrant analysis do not overlap each other and both the major-street volume and the minor-street volume are for the same specific one-hour periods.

15 For signal warrant analysis, bicyclists may be counted as either vehicles or pedestrians.

Support:

16 When performing a signal warrant analysis, bicyclists riding in the street with other vehicular traffic are usually counted as vehicles and bicyclists who are clearly using pedestrian facilities are usually counted as pedestrians.

Option:

17 Engineering study data may include the following:

A. The number of vehicles entering the intersection in each hour from each approach during 12 hours of an average day. It is desirable that the hours selected contain the greatest percentage of the 24-hour traffic volume.
B. Vehicular volumes for each traffic movement from each approach, classified by vehicle type (heavy trucks, passenger cars and light trucks, public-transit vehicles, and, in some locations, bicycles), during each 15-minute period of the 2 hours in the morning and 2 hours in the afternoon during which total traffic entering the intersection is greatest.
C. Pedestrian volume counts on each crosswalk during the same periods as the vehicular counts in Item B and during hours of highest pedestrian volume. Where young, elderly, and/or persons with physical or visual disabilities need special consideration, the pedestrians and their crossing times may be classified by general observation.
D. Information about nearby facilities and activity centers that serve the young, elderly, and/or persons with disabilities, including requests from persons with disabilities for accessible crossing improvements at the location under study. These persons might not be adequately reflected in the pedestrian volume count if the absence of a signal restrains their mobility.
E. The posted or statutory speed limit or the 85th-percentile speed on the uncontrolled approaches to the location.
F. A condition diagram showing details of the physical layout, including such features as intersection geometrics, channelization, grades, sight-distance restrictions, transit stops and routes, parking conditions,

pavement markings, roadway lighting, driveways, nearby railroad crossings, distance to nearest traffic control signals, utility poles and fixtures, and adjacent land use.

G. A collision diagram showing crash experience by type, location, direction of movement, severity, weather, time of day, date, and day of week for at least 1 year.

18 The following data, which are desirable for a more precise understanding of the operation of the intersection, may be obtained during the periods described in Item B of Paragraph 17:

A. Vehicle-hours of stopped time delay determined separately for each approach.

B. The number and distribution of acceptable gaps in vehicular traffic on the major street for entrance from the minor street.

C. The posted or statutory speed limit or the 85th-percentile speed on controlled approaches at a point near to the intersection but unaffected by the control.

D. Pedestrian delay time for at least two 30-minute peak pedestrian delay periods of an average weekday or like periods of a Saturday or Sunday.

E. Queue length on stop-controlled approaches.

Standard:

19 **Delay, congestion, approach conditions, driver confusion, future land use or other evidence of the need for right of way assignment beyond that which could be provided by stop sign shall be demonstrated.**

Support:

20 Figure 4C–101(CA) and 4C-103(CA) are examples of warrant sheets.

Guidance:

21 *Figure 4C-103(CA) should be used only for new intersections or other locations where it is not reasonable to count actual traffic volumes.*

Section 4C.02 Warrant 1, Eight-Hour Vehicular Volume

Support:

01 The Minimum Vehicular Volume, Condition A, is intended for application at locations where a large volume of intersecting traffic is the principal reason to consider installing a traffic control signal.

02 The Interruption of Continuous Traffic, Condition B, is intended for application at locations where Condition A is not satisfied and where the traffic volume on a major street is so heavy that traffic on a minor intersecting street suffers excessive delay or conflict in entering or crossing the major street.

03 It is intended that Warrant 1 be treated as a single warrant. If Condition A is satisfied, then Warrant 1 is satisfied and analyses of Condition B and the combination of Conditions A and B are not needed. Similarly, if Condition B is satisfied, then Warrant 1 is satisfied and an analysis of the combination of Conditions A and B is not needed.

Standard:

04 **The need for a traffic control signal shall be considered if an engineering study finds that one of the following conditions exist for each of any 8 hours of an average day:**

A. The vehicles per hour given in both of the 100 percent columns of Condition A in Table 4C-1 exist on the major-street and the higher-volume minor-street approaches, respectively, to the intersection; or

B. The vehicles per hour given in both of the 100 percent columns of Condition B in Table 4C-1 exist on the major-street and the higher-volume minor-street approaches, respectively, to the intersection.

In applying each condition the major-street and minor-street volumes shall be for the same 8 hours. On the minor street, the higher volume shall not be required to be on the same approach during each of these 8 hours.

Option:

05 If the posted or statutory speed limit or the 85th-percentile speed on the major street exceeds 40 mph, or if the intersection lies within the built-up area of an isolated community having a population of less than 10,000, the traffic volumes in the 70 percent columns in Table 4C-1 may be used in place of the 100 percent columns.

Guidance:

06 *The combination of Conditions A and B is intended for application at locations where Condition A is not satisfied and Condition B is not satisfied and should be applied only after an adequate trial of other alternatives that could cause less delay and inconvenience to traffic has failed to solve the traffic problems.*

Standard:

07 **The need for a traffic control signal shall be considered if an engineering study finds that both of the following conditions exist for each of any 8 hours of an average day:**

A. The vehicles per hour given in both of the 80 percent columns of Condition A in Table 4C-1 exist on the major-street and the higher-volume minor-street approaches, respectively, to the intersection; and

B. The vehicles per hour given in both of the 80 percent columns of Condition B in Table 4C-1 exist on the major-street and the higher-volume minor-street approaches, respectively, to the intersection.

These major-street and minor-street volumes shall be for the same 8 hours for each condition; however, the 8 hours satisfied in Condition A shall not be required to be the same 8 hours satisfied in Condition B. On the minor street, the higher volume shall not be required to be on the same approach during each of the 8 hours.

Option:

08 If the posted or statutory speed limit or the 85th-percentile speed on the major street exceeds 40 mph, or if the intersection lies within the built-up area of an isolated community having a population of less than 10,000, the traffic volumes in the 56 percent columns in Table 4C-1 may be used in place of the 80 percent columns.

Section 4C.03 Warrant 2, Four-Hour Vehicular Volume

Support:

01 The Four-Hour Vehicular Volume signal warrant conditions are intended to be applied where the volume of intersecting traffic is the principal reason to consider installing a traffic control signal.

Standard:

02 **The need for a traffic control signal shall be considered if an engineering study finds that, for each of any 4 hours of an average day, the plotted points representing the vehicles per hour on the major street (total of both approaches) and the corresponding vehicles per hour on the higher-volume minor-street approach (one direction only) all fall above the applicable curve in Figure 4C-1 for the existing combination of approach lanes. On the minor street, the higher volume shall not be required to be on the same approach during each of these 4 hours.**

Option:

03 If the posted or statutory speed limit or the 85th-percentile speed on the major street exceeds 40 mph, or if the intersection lies within the built-up area of an isolated community having a population of less than 10,000, Figure 4C-2 may be used in place of Figure 4C-1.

Section 4C.04 Warrant 3, Peak Hour

Support:

01 The Peak Hour signal warrant is intended for use at a location where traffic conditions are such that for a minimum of 1 hour of an average day, the minor-street traffic suffers undue delay when entering or crossing the major street.

Standard:

02 **This signal warrant shall be applied only in unusual cases, such as office complexes, manufacturing plants, industrial complexes, or high-occupancy vehicle facilities that attract or discharge large numbers of vehicles over a short time.**

03 **The need for a traffic control signal shall be considered if an engineering study finds that the criteria in either of the following two categories are met:**

A. If all three of the following conditions exist for the same 1 hour (any four consecutive 15-minute periods) of an average day:

1. The total stopped time delay experienced by the traffic on one minor-street approach (one direction only) controlled by a STOP sign equals or exceeds: 4 vehicle-hours for a one-lane approach or 5 vehicle-hours for a two-lane approach; and

2. The volume on the same minor-street approach (one direction only) equals or exceeds 100 vehicles per hour for one moving lane of traffic or 150 vehicles per hour for two moving lanes; and

3. The total entering volume serviced during the hour equals or exceeds 650 vehicles per hour for intersections with three approaches or 800 vehicles per hour for intersections with four or more approaches.

B. The plotted point representing the vehicles per hour on the major street (total of both approaches) and the corresponding vehicles per hour on the higher-volume minor-street approach (one direction only) for 1 hour (any four consecutive 15-minute periods) of an average day falls above the applicable curve in Figure 4C-3 for the existing combination of approach lanes.

Option:

04 If the posted or statutory speed limit or the 85th-percentile speed on the major street exceeds 40 mph, or if the intersection lies within the built-up area of an isolated community having a population of less than 10,000, Figure 4C-4 may be used in place of Figure 4C-3 to evaluate the criteria in the second category of the Standard.

05 If this warrant is the only warrant met and a traffic control signal is justified by an engineering study, the traffic control signal may be operated in the flashing mode during the hours that the volume criteria of this warrant are not met.

Guidance:

06 *If this warrant is the only warrant met and a traffic control signal is justified by an engineering study, the traffic control signal should be traffic-actuated.*

Section 4C.05 Warrant 4, Pedestrian Volume

Support:

01 The Pedestrian Volume signal warrant is intended for application where the traffic volume on a major street is so heavy that pedestrians experience excessive delay in crossing the major street.

Standard:

02 **The need for a traffic control signal at an intersection or midblock crossing shall be considered if an engineering study finds that one of the following criteria is met:**

A. For each of any 4 hours of an average day, the plotted points representing the vehicles per hour on the major street (total of both approaches) and the corresponding pedestrians per hour crossing the major street (total of all crossings) all fall above the curve in Figure 4C-5; or

B. For 1 hour (any four consecutive 15-minute periods) of an average day, the plotted point representing the vehicles per hour on the major street (total of both approaches) and the corresponding pedestrians per hour crossing the major street (total of all crossings) falls above the curve in Figure 4C-7.

Option:

03 If the posted or statutory speed limit or the 85th-percentile speed on the major street exceeds 35 mph, or if the intersection lies within the built-up area of an isolated community having a population of less than 10,000, Figure 4C-6 may be used in place of Figure 4C-5 to evaluate Criterion A in Paragraph 2, and Figure 4C-8 may be used in place of Figure 4C-7 to evaluate Criterion B in Paragraph 2.

Standard:

04 **The Pedestrian Volume signal warrant shall not be applied at locations where the distance to the nearest traffic control signal or STOP sign controlling the street that pedestrians desire to cross is less than 300 feet, unless the proposed traffic control signal will not restrict the progressive movement of traffic.**

05 **If this warrant is met and a traffic control signal is justified by an engineering study, the traffic control signal shall be equipped with pedestrian signal heads complying with the provisions set forth in Chapter 4E.**

Guidance:

06 *If this warrant is met and a traffic control signal is justified by an engineering study, then:*

A. If it is installed at an intersection or major driveway location, the traffic control signal should also control the minor-street or driveway traffic, should be traffic-actuated, and should include pedestrian detection.

B. If it is installed at a non-intersection crossing, the traffic control signal should be installed at least 100 feet from side streets or driveways that are controlled by STOP or YIELD signs, and should be pedestrian-actuated. If the traffic control signal is installed at a non-intersection crossing, at least one of the signal faces should be over the traveled way for each approach, parking and other sight obstructions should be prohibited for at least 100 feet in advance of and at least 20 feet beyond the crosswalk or site

accommodations should be made through curb extensions or other techniques to provide adequate sight distance, and the installation should include suitable standard signs and pavement markings.

C. Furthermore, if it is installed within a signal system, the traffic control signal should be coordinated.

Option:

07 The criterion for the pedestrian volume crossing the major street may be reduced as much as 50 percent if the 15th-percentile crossing speed of pedestrians is less than 3.5 feet per second.

08 A traffic control signal may not be needed at the study location if adjacent coordinated traffic control signals consistently provide gaps of adequate length for pedestrians to cross the street.

Section 4C.06 Warrant 5, School Crossing

Support:

01 The School Crossing signal warrant is intended for application where the fact that schoolchildren cross the major street is the principal reason to consider installing a traffic control signal. For the purposes of this warrant, the word "schoolchildren" includes elementary through high school students.

Standard:

02 **The need for a traffic control signal shall be considered when an engineering study of the frequency and adequacy of gaps in the vehicular traffic stream as related to the number and size of groups of schoolchildren at an established school crossing across the major street shows that the number of adequate gaps in the traffic stream during the period when the schoolchildren are using the crossing is less than the number of minutes in the same period (see Section 7A.03) and there are a minimum of 20 schoolchildren during the highest crossing hour.**

03 **Before a decision is made to install a traffic control signal, consideration shall be given to the implementation of other remedial measures, such as warning signs and flashers, school speed zones, school crossing guards, or a grade-separated crossing.**

04 **The School Crossing signal warrant shall not be applied at locations where the distance to the nearest traffic control signal along the major street is less than 300 feet, unless the proposed traffic control signal will not restrict the progressive movement of traffic.**

Guidance:

05 *If this warrant is met and a traffic control signal is justified by an engineering study, then:*

A. If it is installed at an intersection or major driveway location, the traffic control signal should also control the minor-street or driveway traffic, should be traffic-actuated, and should include pedestrian detection.

B. If it is installed at a non-intersection crossing, the traffic control signal should be installed at least 100 feet from side streets or driveways that are controlled by STOP or YIELD signs, and should be pedestrian-actuated. If the traffic control signal is installed at a non-intersection crossing, at least one of the signal faces should be over the traveled way for each approach, parking and other sight obstructions should be prohibited for at least 100 feet in advance of and at least 20 feet beyond the crosswalk or site accommodations should be made through curb extensions or other techniques to provide adequate sight distance, and the installation should include suitable standard signs and pavement markings.

C. Furthermore, if it is installed within a signal system, the traffic control signal should be coordinated.

Section 4C.07 Warrant 6, Coordinated Signal System

Support:

01 Progressive movement in a coordinated signal system sometimes necessitates installing traffic control signals at intersections where they would not otherwise be needed in order to maintain proper platooning of vehicles.

Standard:

02 **The need for a traffic control signal shall be considered if an engineering study finds that one of the following criteria is met:**

A. On a one-way street or a street that has traffic predominantly in one direction, the adjacent traffic control signals are so far apart that they do not provide the necessary degree of vehicular platooning.

B. On a two-way street, adjacent traffic control signals do not provide the necessary degree of platooning and the proposed and adjacent traffic control signals will collectively provide a progressive operation.

Guidance:

03 *The Coordinated Signal System signal warrant should not be applied where the resultant spacing of traffic control signals would be less than 1,000 feet.*

Section 4C.08 Warrant 7, Crash Experience

Support:

01 The Crash Experience signal warrant conditions are intended for application where the severity and frequency of crashes are the principal reasons to consider installing a traffic control signal.

Standard:

02 **The need for a traffic control signal shall be considered if an engineering study finds that all of the following criteria are met:**

A. Adequate trial of alternatives with satisfactory observance and enforcement has failed to reduce the crash frequency; and

B. Five or more reported crashes, of types susceptible to correction by a traffic control signal, have occurred within a 12-month period, each crash involving personal injury or property damage apparently exceeding the applicable requirements for a reportable crash; and

C. For each of any 8 hours of an average day, the vehicles per hour (vph) given in both of the 80 percent columns of Condition A in Table 4C-1 (see Section 4C.02), or the vph in both of the 80 percent columns of Condition B in Table 4C-1 exists on the major-street and the higher-volume minor-street approach, respectively, to the intersection, or the volume of pedestrian traffic is not less than 80 percent of the requirements specified in the Pedestrian Volume warrant. These major-street and minor-street volumes shall be for the same 8 hours. On the minor street, the higher volume shall not be required to be on the same approach during each of the 8 hours.

Option:

03 If the posted or statutory speed limit or the 85th-percentile speed on the major street exceeds 40 mph, or if the intersection lies within the built-up area of an isolated community having a population of less than 10,000, the traffic volumes in the 56 percent columns in Table 4C-1 may be used in place of the 80 percent columns.

Section 4C.09 Warrant 8, Roadway Network

Support:

01 Installing a traffic control signal at some intersections might be justified to encourage concentration and organization of traffic flow on a roadway network.

Standard:

02 **The need for a traffic control signal shall be considered if an engineering study finds that the common intersection of two or more major routes meets one or both of the following criteria:**

A. The intersection has a total existing, or immediately projected, entering volume of at least 1,000 vehicles per hour during the peak hour of a typical weekday and has 5-year projected traffic volumes, based on an engineering study, that meet one or more of Warrants 1, 2, and 3 during an average weekday; or

B. The intersection has a total existing or immediately projected entering volume of at least 1,000 vehicles per hour for each of any 5 hours of a non-normal business day (Saturday or Sunday).

03 **A major route as used in this signal warrant shall have at least one of the following characteristics:**

A. It is part of the street or highway system that serves as the principal roadway network for through traffic flow.

B. It includes rural or suburban highways outside, entering, or traversing a city.

C. It appears as a major route on an official plan, such as a major street plan in an urban area traffic and transportation study.

Section 4C.10 Warrant 9, Intersection Near a Grade Crossing

Support:

01 The Intersection Near a Grade Crossing signal warrant is intended for use at a location where none of the conditions described in the other eight traffic signal warrants are met, but the proximity to the intersection of a

grade crossing on an intersection approach controlled by a STOP or YIELD sign is the principal reason to consider installing a traffic control signal.

Guidance:

02 *This signal warrant should be applied only after adequate consideration has been given to other alternatives or after a trial of an alternative has failed to alleviate the safety concerns associated with the grade crossing. Among the alternatives that should be considered or tried are:*

A. Providing additional pavement that would enable vehicles to clear the track or that would provide space for an evasive maneuver, or

B. Reassigning the stop controls at the intersection to make the approach across the track a non-stopping approach.

Standard:

03 **The need for a traffic control signal shall be considered if an engineering study finds that both of the following criteria are met:**

A. A grade crossing exists on an approach controlled by a STOP or YIELD sign and the center of the track nearest to the intersection is within 140 feet of the stop line or yield line on the approach; and

B. During the highest traffic volume hour during which rail traffic uses the crossing, the plotted point representing the vehicles per hour on the major street (total of both approaches) and the corresponding vehicles per hour on the minor-street approach that crosses the track (one direction only, approaching the intersection) falls above the applicable curve in Figure 4C-9 or 4C-10 for the existing combination of approach lanes over the track and the distance D, which is the clear storage distance as defined in Section 1A.13.

Guidance:

04 *The following considerations apply when plotting the traffic volume data on Figure 4C-9 or 4C-10:*

A. Figure 4C-9 should be used if there is only one lane approaching the intersection at the track crossing location and Figure 4C-10 should be used if there are two or more lanes approaching the intersection at the track crossing location.

B. After determining the actual distance D, the curve for the distance D that is nearest to the actual distance D should be used. For example, if the actual distance D is 95 feet, the plotted point should be compared to the curve for D = 90 feet.

C. If the rail traffic arrival times are unknown, the highest traffic volume hour of the day should be used.

Option:

05 The minor-street approach volume may be multiplied by up to three adjustment factors as provided in Paragraphs 6 through 8.

06 Because the curves are based on an average of four occurrences of rail traffic per day, the vehicles per hour on the minor-street approach may be multiplied by the adjustment factor shown in Table 4C-2 for the appropriate number of occurrences of rail traffic per day.

07 Because the curves are based on typical vehicle occupancy, if at least 2% of the vehicles crossing the track are buses carrying at least 20 people, the vehicles per hour on the minor-street approach may be multiplied by the adjustment factor shown in Table 4C-3 for the appropriate percentage of high-occupancy buses.

08 Because the curves are based on tractor-trailer trucks comprising 10% of the vehicles crossing the track, the vehicles per hour on the minor-street approach may be multiplied by the adjustment factor shown in Table 4C-4 for the appropriate distance and percentage of tractor-trailer trucks.

Standard:

09 **If this warrant is met and a traffic control signal at the intersection is justified by an engineering study, then:**

A. The traffic control signal shall have actuation on the minor street;

B. Preemption control shall be provided in accordance with Sections 4D.27, 8C.09, and 8C.10; and

C. The grade crossing shall have flashing-light signals (see Chapter 8C).

Guidance:

10 *If this warrant is met and a traffic control signal at the intersection is justified by an engineering study, the grade crossing should have automatic gates (see Chapter 8C).*

Section 4C.101(CA) Criterion for School Crossing Traffic Signals

01 **Standard:**

A. The signal shall be designed for full-time operation.

B. Pedestrian signal faces of the International Symbol type shall be installed at all marked crosswalks at signalized intersections along the "Suggested Route to School."

C. If an intersection is signalized under this guideline for school pedestrians, the entire intersection shall be signalized.

D. School area traffic signals shall be traffic actuated type with push buttons or other detectors for pedestrians.

Option:

02 Non-intersection school pedestrian crosswalk locations may be signalized when justified.

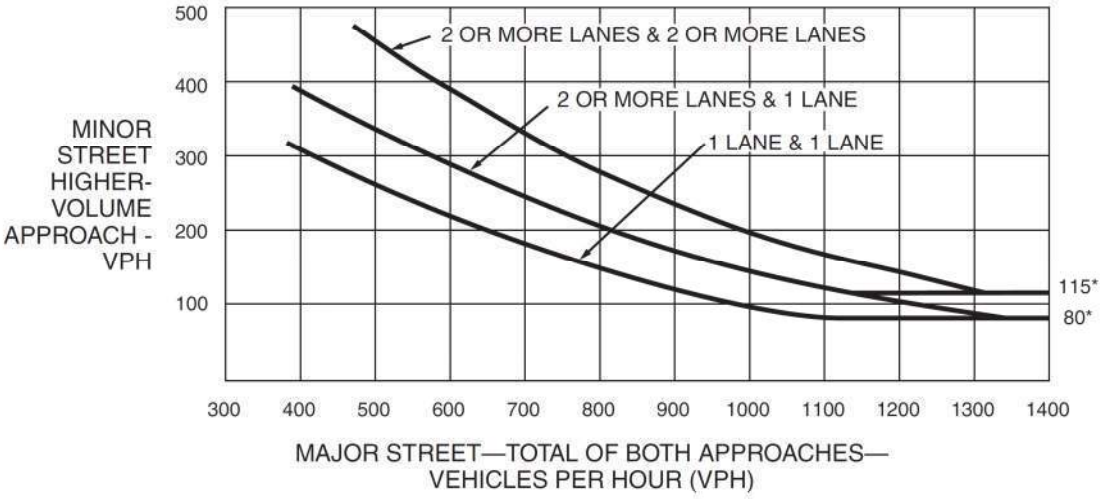
Section 4C.102(CA) Bicycle Signal Warrant

Guidance:

01 *A bicycle signal should be considered for use only when the volume and collision or volume and geometric warrants have been met:*

1. *Volume; When W = B x V and W ≥ 50,000 and B ≥ 50.*
   Where: W is the volume warrant. B is the number of bicycles at the peak hour entering the intersection. V is the number of vehicles at the peak hour entering the intersection. B and V shall use the same peak hour.
2. *Collision; When 2 or more bicycle/vehicle collisions of types susceptible to correction by a bicycle signal have occurred over a 12-month period and the responsible public works official determines that a bicycle signal will reduce the number of collisions.*
3. *Geometric;*
   (a) Where a separate bicycle/ multi use path intersects a roadway.
   (b) At other locations to facilitate a bicycle movement that is not permitted for a motor vehicle.

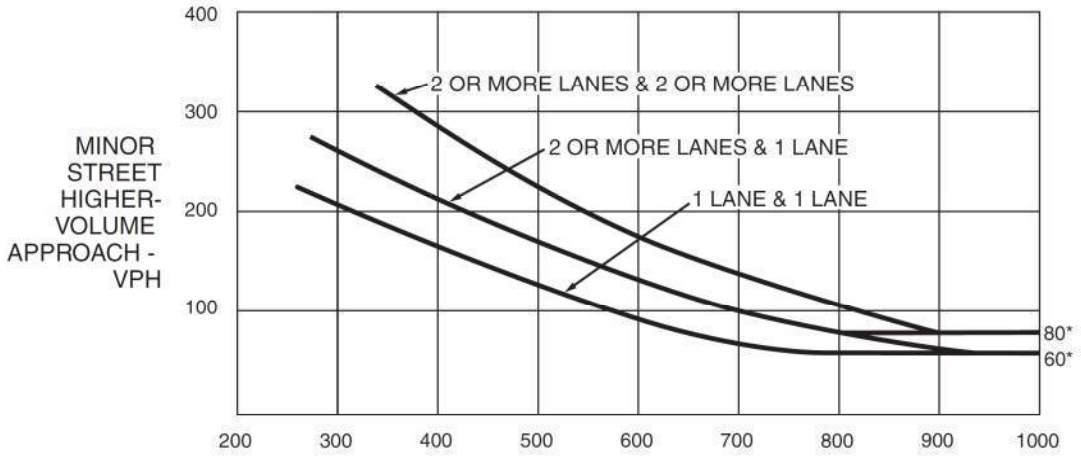
Figure 4C-1. Warrant 2, Four-Hour Vehicular Volume



*Note: 115 vph applies as the lower threshold volume for a minor-street approach with two or more lanes and 80 vph applies as the lower threshold volume for a minor-street approach with one lane.

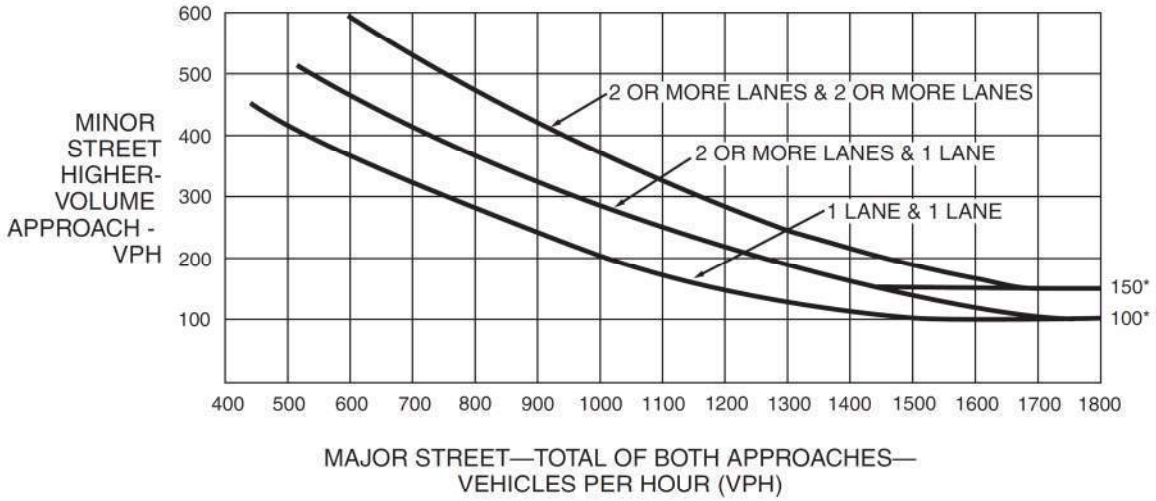
Figure 4C-2. Warrant 2, Four-Hour Vehicular Volume (70% Factor)

(COMMUNITY LESS THAN 10,000 POPULATION OR ABOVE 40 MPH ON MAJOR STREET)



*Note: 80 vph applies as the lower threshold volume for a minor-street approach with two or more lanes and 60 vph applies as the lower threshold volume for a minor-street approach with one lane.

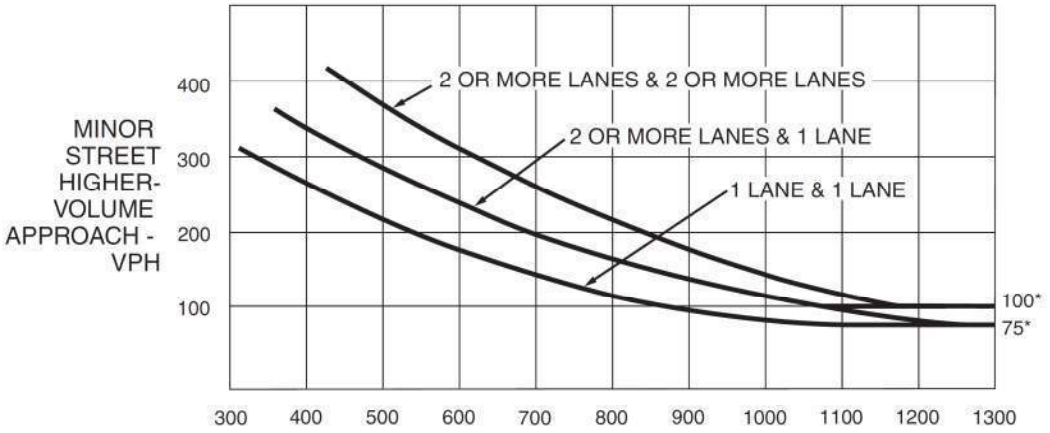
Figure 4C-3. Warrant 3, Peak Hour



*Note: 150 vph applies as the lower threshold volume for a minor-street approach with two or more lanes and 100 vph applies as the lower threshold volume for a minor-street approach with one lane.

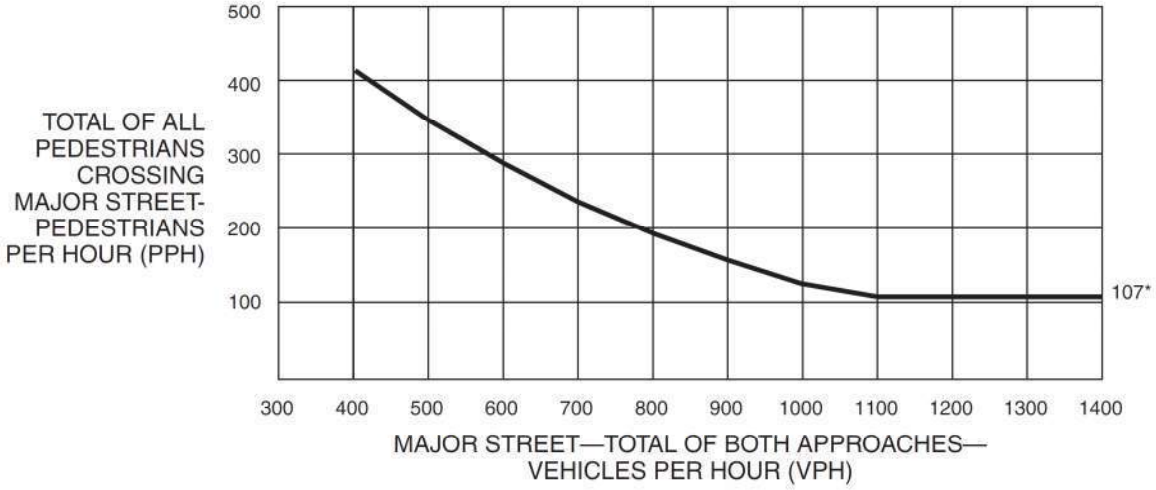
Figure 4C-4. Warrant 3, Peak Hour (70% Factor)

(COMMUNITY LESS THAN 10,000 POPULATION OR ABOVE 40 MPH ON MAJOR STREET)



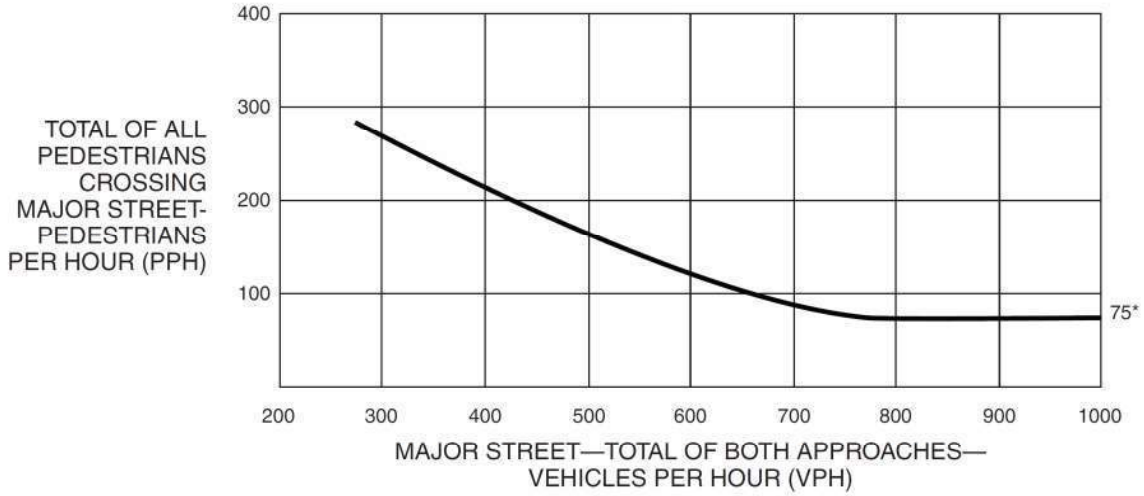
*Note: 100 vph applies as the lower threshold volume for a minor-street approach with two or more lanes and 75 vph applies as the lower threshold volume for a minor-street approach with one lane.

Figure 4C-5. Warrant 4, Pedestrian Four-Hour Volume



*Note: 107 pph applies as the lower threshold volume.

Figure 4C-6. Warrant 4, Pedestrian Four-Hour Volume (70% Factor)



*Note: 75 pph applies as the lower threshold volume.

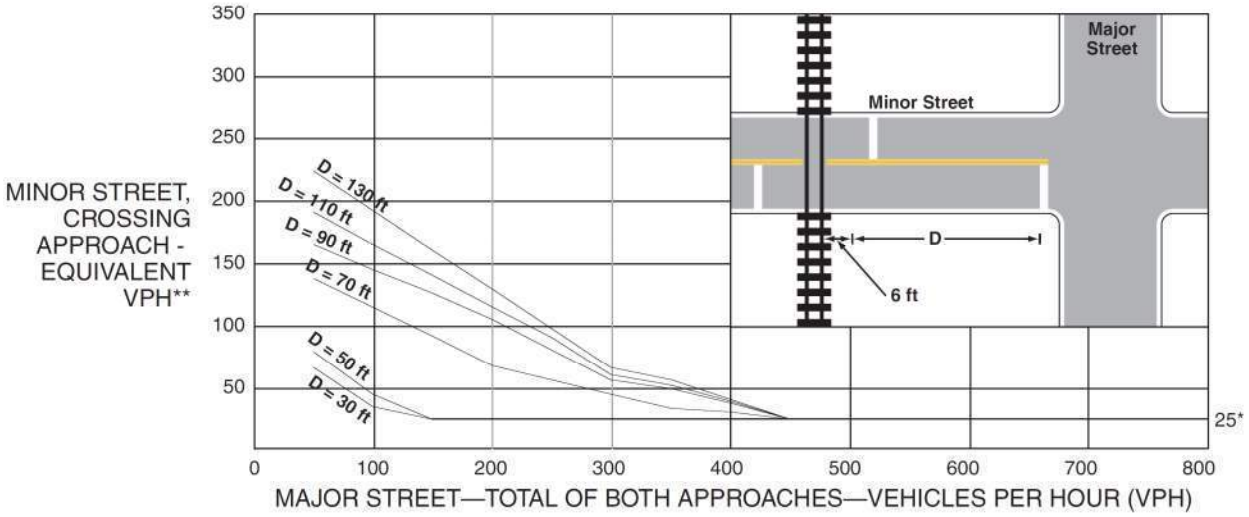
Figure 4C-7. Warrant 4, Pedestrian Peak Hour

*Note: 133 pph applies as the lower threshold volume.

Figure 4C-8. Warrant 4, Pedestrian Peak Hour (70% Factor)

*Note: 93 pph applies as the lower threshold volume.

Figure 4C-9. Warrant 9, Intersection Near a Grade Crossing (One Approach Lane at the Track Crossing)



* 25 vph applies as the lower threshold volume

** VPH after applying the adjustment factors in Tables 4C-2, 4C-3, and/or 4C-4, if appropriate

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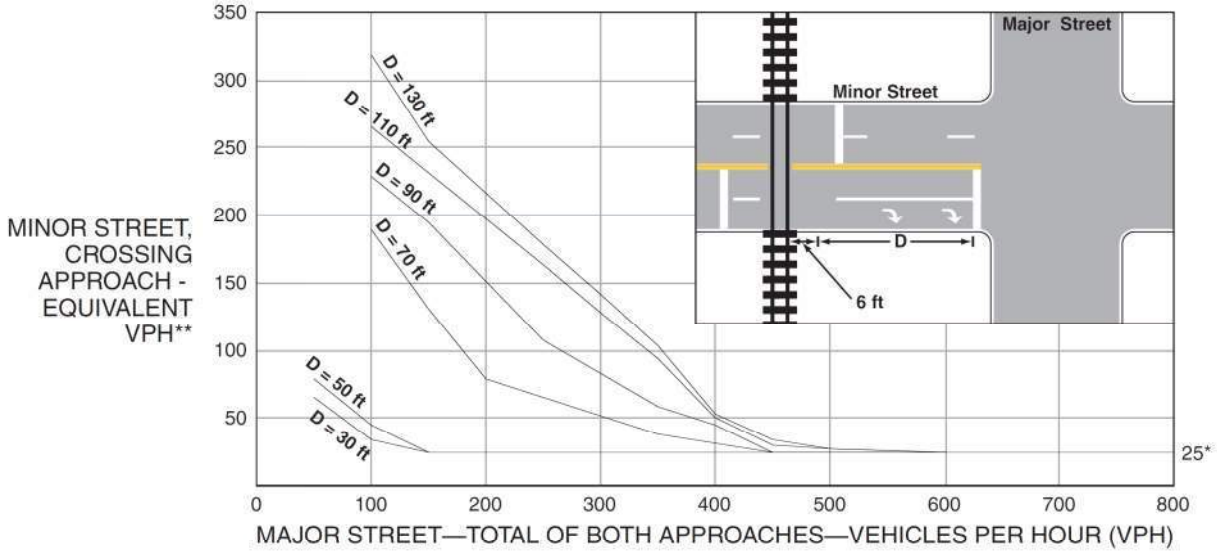
Figure 4C-10. Warrant 9, Intersection Near a Grade Crossing (Two or More Approach Lanes at the Track Crossing)



* 25 vph applies as the lower threshold volume

** VPH after applying the adjustment factors in Tables 4C-2, 4C-3, and/or 4C-4, if appropriate

Figure 4C-101 (CA). Traffic Signal Warrants Worksheet (Sheet 1 of 5)

DIST _____ CO _____ RTE _____ PM _____

COUNT DATE _____
CALC _____ DATE _____
CHK _____ DATE _____

Major St: _____ Critical Approach Speed _____ mph
Minor St: _____ Critical Approach Speed _____ mph

Speed limit or critical speed on major street traffic > 40 mph..... ☐
or
In built up area of isolated community of < 10,000 population..... ☐
} RURAL (R)

☐ URBAN (U)

WARRANT 1 - Eight Hour Vehicular Volume **SATISFIED YES ☐ NO ☐**
(Condition A or Condition B or combination of A and B must be satisfied)

Condition A - Minimum Vehicle Volume **100% SATISFIED YES ☐ NO ☐**
80% SATISFIED YES ☐ NO ☐

	MINIMUM REQUIREMENTS (80% SHOWN IN BRACKETS)				
	U	R	U	R	
APPROACH LANES	1		2 or More		Hour
Both Approaches Major Street	500 (400)	350 (280)	600 (480)	420 (336)	
Highest Approach Minor Street	150 (120)	105 (84)	200 (160)	140 (112)	

Condition B - Interruption of Continuous Traffic **100% SATISFIED YES ☐ NO ☐**
80% SATISFIED YES ☐ NO ☐

	MINIMUM REQUIREMENTS (80% SHOWN IN BRACKETS)				
	U	R	U	R	
APPROACH LANES	1		2 or More		Hour
Both Approaches Major Street	750 (600)	525 (420)	900 (720)	630 (504)	
Highest Approach Minor Street	75 (60)	53 (42)	100 (80)	70 (56)	

Combination of Conditions A & B **SATISFIED YES ☐ NO ☐**

REQUIREMENT	CONDITION	✓	FULFILLED
TWO CONDITIONS SATISFIED 80%	A. MINIMUM VEHICULAR VOLUME		Yes ☐ No ☐
	AND, B. INTERRUPTION OF CONTINUOUS TRAFFIC		
AND, AN ADEQUATE TRIAL OF OTHER ALTERNATIVES THAT COULD CAUSE LESS DELAY AND INCONVENIENCE TO TRAFFIC HAS FAILED TO SOLVE THE TRAFFIC PROBLEMS			Yes ☐ No ☐

The satisfaction of a traffic signal warrant or warrants shall not in itself require the installation of a traffic control signal.

Figure 4C-101 (CA). Traffic Signal Warrants Worksheet (Sheet 2 of 5)

WARRANT 2 - Four Hour Vehicular Volume **SATISFIED* YES ☐ NO ☐**

Record hourly vehicular volumes for any four hours of an average day.

APPROACH LANES	One	2 or More	Hour			
Both Approaches - Major Street						
Higher Approach - Minor Street						

*All plotted points fall above the applicable curve in Figure 4C-1. (URBAN AREAS)	Yes ☐ No ☐
OR, All plotted points fall above the applicable curve in Figure 4C-2. (RURAL AREAS)	Yes ☐ No ☐

WARRANT 3 - Peak Hour **SATISFIED YES ☐ NO ☐**
(Part A or Part B must be satisfied)

PART A **SATISFIED YES ☐ NO ☐**

(All parts 1, 2, and 3 below must be satisfied for the same one hour, for any four consecutive 15-minute periods)

1. The total delay experienced by traffic on one minor street approach (one direction only) controlled by a STOP sign equals or exceeds four vehicle-hours for a one-lane approach, or five vehicle-hours for a two-lane approach; AND	Yes ☐ No ☐
2. The volume on the same minor street approach (one direction only) equals or exceeds 100 vph for one moving lane of traffic or 150 vph for two moving lanes; AND	Yes ☐ No ☐
3. The total entering volume serviced during the hour equals or exceeds 800 vph for intersections with four or more approaches or 650 vph for intersections with three approaches.	Yes ☐ No ☐

PART B **SATISFIED YES ☐ NO ☐**

APPROACH LANES	One	2 or More	Hour
Both Approaches - Major Street			
Higher Approach - Minor Street			

The plotted point falls above the applicable curve in Figure 4C-3. (URBAN AREAS)	Yes ☐ No ☐
OR, The plotted point falls above the applicable curve in Figure 4C-4. (RURAL AREAS)	Yes ☐ No ☐

The satisfaction of a traffic signal warrant or warrants shall not in itself require the installation of a traffic control signal.

Figure 4C-101 (CA). Traffic Signal Warrants Worksheet (Sheet 3 of 5)

WARRANT 4 - Pedestrian Volume
(Parts 1 and 2 Must Be Satisfied)

SATISFIED YES ☐ NO ☐

Part 1 (Parts A or B must be satisfied)

	Hours - - ->				
A.	Vehicles per hour for any 4 hours				
	Pedestrians per hour for any 4 hours				

Figure 4C-5 or Figure 4C-6
SATISFIED YES ☐ NO ☐

	Hours - - ->				
B.	Vehicles per hour for any 1 hour				
	Pedestrians per hour for any 1 hour				

Figure 4C-7 or Figure 4C-8
SATISFIED YES ☐ NO ☐

Part 2 **SATISFIED YES ☐ NO ☐**

AND, The distance to the nearest traffic signal along the major street is greater than 300 ft	Yes ☐ No ☐
OR, The proposed traffic signal will not restrict progressive traffic flow along the major street.	Yes ☐ No ☐

WARRANT 5 - School Crossing
(Parts A and B Must Be Satisfied)

SATISFIED YES ☐ NO ☐

Part A
Gap/Minutes and # of Children

SATISFIED YES ☐ NO ☐

		Hour
Gaps vs Minutes	Minutes Children Using Crossing	
	Number of Adequate Gaps	
School Age Pedestrians Crossing Street / hr		

Gaps < Minutes YES ☐ NO ☐
AND Children > 20/hr YES ☐ NO ☐

AND, Consideration has been given to less restrictive remedial measures.	Yes ☐ No ☐

Part B **SATISFIED YES ☐ NO ☐**

The distance to the nearest traffic signal along the major street is greater than 300 ft	Yes ☐ No ☐
OR, The proposed signal will not restrict the progressive movement of traffic.	Yes ☐ No ☐

The satisfaction of a traffic signal warrant or warrants shall not in itself require the installation of a traffic control signal.

Figure 4C-101 (CA). Traffic Signal Warrants Worksheet (Sheet 4 of 5)

WARRANT 6 - Coordinated Signal System **SATISFIED YES ☐ NO ☐**
(All Parts Must Be Satisfied)

MINIMUM REQUIREMENTS	DISTANCE TO NEAREST SIGNAL	
≥ 1000 ft	N _____ ft, S _____ ft, E _____ ft, W _____ ft	Yes ☐ No ☐
On a one-way street or a street that has traffic predominantly in one direction, the adjacent traffic control signals are so far apart that they do not provide the necessary degree of vehicular platooning.		Yes ☐ No ☐
OR, On a two-way street, adjacent traffic control signals do not provide the necessary degree of platooning and the proposed and adjacent traffic control signals will collectively provide a progressive operation.		

WARRANT 7 - Crash Experience Warrant **SATISFIED YES ☐ NO ☐**
(All Parts Must Be Satisfied)

Adequate trial of alternatives with satisfactory observance and enforcement has failed to reduce the crash frequency.			Yes ☐ No ☐
REQUIREMENTS	Number of crashes reported within a 12 month period susceptible to correction by a traffic signal, and involving injury or damage exceeding the requirements for a reportable crash.		Yes ☐ No ☐
5 OR MORE			
REQUIREMENTS	CONDITIONS	✓	Yes ☐ No ☐
ONE CONDITION SATISFIED 80%	Warrant 1, Condition A - Minimum Vehicular Volume		
	OR, Warrant 1, Condition B - Interruption of Continuous Traffic		
	OR, Warrant 4, Pedestrian Volume Condition Ped Vol ≥ 80% of Figure 4C-5 through Figure 4C-8		

WARRANT 8 - Roadway Network **SATISFIED YES ☐ NO ☐**
(All Parts Must Be Satisfied)

MINIMUM VOLUME REQUIREMENTS	ENTERING VOLUMES - ALL APPROACHES	✓	FULFILLED
1000 Veh/Hr	During Typical Weekday Peak Hour _____ Veh/Hr and has 5-year projected traffic volumes that meet one or more of Warrants 1, 2, and 3 during an average weekday.		Yes ☐ No ☐
	OR During Each of Any 5 Hrs. of a Sat. or Sun _____ Veh/Hr		

CHARACTERISTICS OF MAJOR ROUTES	MAJOR ROUTE A	MAJOR ROUTE B	
Hwy. System Serving as Principal Network for Through Traffic			
Rural or Suburban Highway Outside Of, Entering, or Traversing a City			
Appears as Major Route on an Official Plan			
Any Major Route Characteristics Met, Both Streets			Yes ☐ No ☐

The satisfaction of a traffic signal warrant or warrants shall not in itself require the installation of a traffic control signal.

Figure 4C-101 (CA). Traffic Signal Warrants Worksheet (Sheet 5 of 5)

WARRANT 9 - Intersection Near a Grade Crossing **SATISFIED YES ☐ NO ☐**
(Both Parts A and B Must Be Satisfied)

PART A A grade crossing exists on an approach controlled by a STOP or YIELD sign and the center of the track nearest to the intersection is within 140 feet of the stop line or yield line on the approach. Track Center Line to Limit Line _____ ft	Yes ☐ No ☐
PART B **There is one minor street approach lane at the track crossing -** During the highest traffic volume hour during which rail traffic uses the crossing, the plotted point falls above the applicable curve in Figure 4C-9. Major Street - Total of both approaches: _____ VPH Minor Street - Crosses the track (one direction only, approaching the intersection): _____ VPH X AF (Use Tables 4C-2, 3, & 4 below to calculate AF) = _____ VPH	Yes ☐ No ☐
OR, There are two or more minor street approach lanes at the track crossing - During the highest traffic volume hour during which rail traffic uses the crossing, the plotted point falls above the applicable curve in Figure 4C-10. Major Street - Total of both approaches : _____ VPH Minor Street - Crosses the track (one direction only, approaching the intersection): _____ VPH X AF (Use Tables 4C-2, 3, & 4 below to calcualte AF) = _____ VPH	

The minor street approach volume may be multiplied by up to three following adjustment factors (AF) as described in Section 4C.10.

1- Number of Rail Traffic per Day_____ Adjustment factor from table 4C-2____

2- Percentage of High-Occupancy Buses on Minor Street Approach_____ Adjustment factor from table 4C-3____

3- Percentage of Tractor-Trailer Trucks on Minor Street Approach_____ Adjustment factor from table 4C-4____

NOTE: If no data is availale or known, then use AF = 1 (no adjustment)

Figure 4C-102 (CA). Traffic Count Worksheet

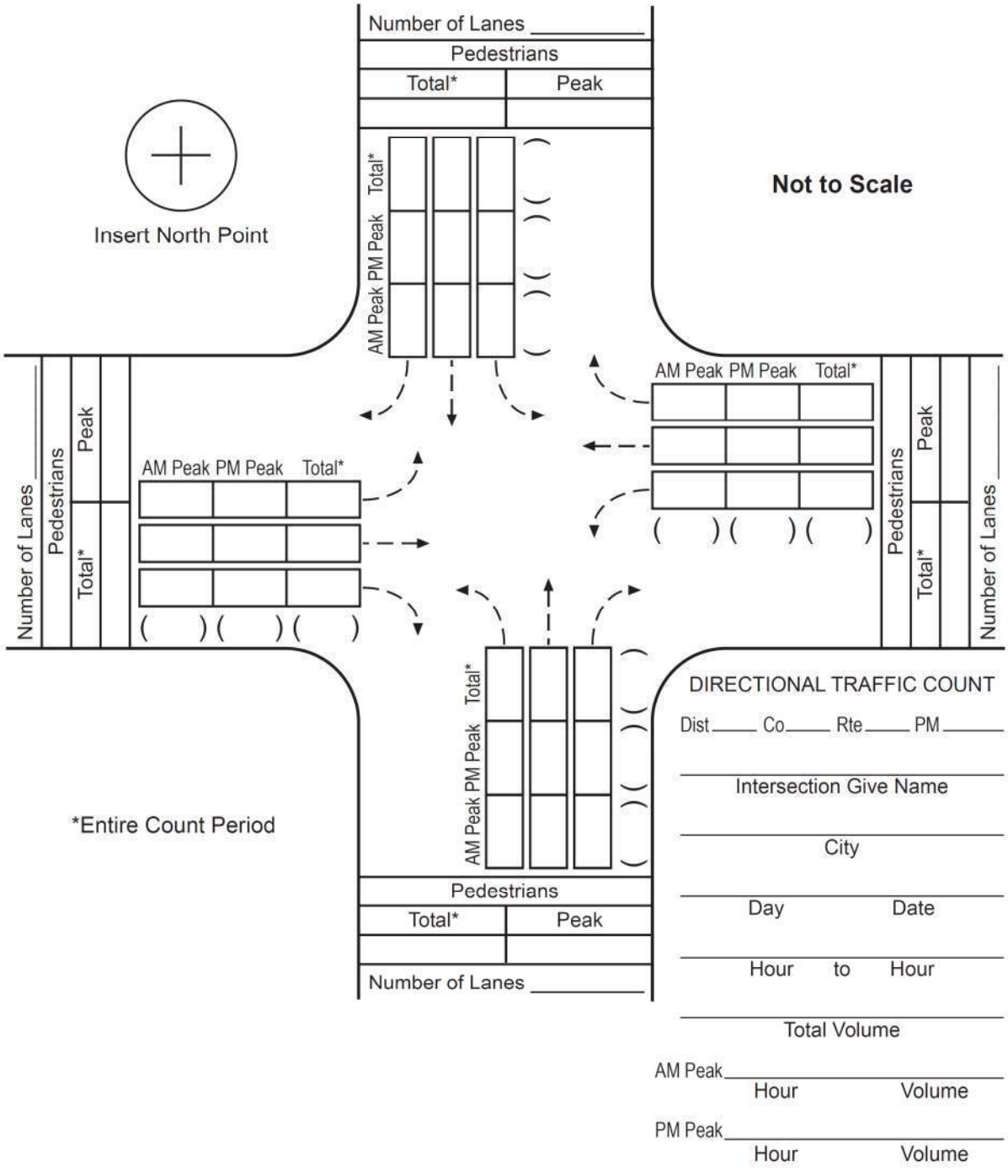


Figure 4C-103 (CA). Traffic Signal Warrants Worksheet (Average Traffic Estimate Form)

COUNT DATE _____

_____ _____ _____ _____
DIST CO RTE PM

CALC _____ DATE _____
CHK _____ DATE _____

Major St: _____ Critical Approach Speed _____ mph
Minor St: _____ Critical Approach Speed _____ mph

Speed limit or critical speed on major street traffic > 40 mph..... ☐
or } **RURAL (R)**
In built up area of isolated community of < 10,000 population..... ☐
☐ **URBAN (U)**

(Based on Estimated Average Daily Traffic - See Note)

URBAN..... RURAL.....

CONDITION A - Minimum Vehicular Volume

Satisfied _____ Not Satisfied _____

Number of lanes for moving traffic on each approach

Major Street	Minor Street
1.....	1.....
2 or More.....	1.....
2 or More.....	2 or More.....
1.....	2 or More.....

Minimum Requirements EADT			
Vehicles Per Day on Major Street (Total of Both Approaches)		Vehicles Per Day on Higher-Volume Minor Street Approach (One Direction Only)	
Urban	Rural	Urban	Rural
8,000	5,600	2,400	1,680
9,600	6,720	2,400	1,680
9,600	6,720	3,200	2,240
8,000	5,600	3,200	2,240

CONDITION B - Interruption of Continuous Traffic

Satisfied _____ Not Satisfied _____

Number of lanes for moving traffic on each approach

Major Street	Minor Street
1.....	1.....
2 or More.....	1.....
2 or More.....	2 or More.....
1.....	2 or More.....

Vehicles Per Day on Major Street (Total of Both Approaches)		Vehicles Per Day on Higher-Volume Minor Street Approach (One Direction Only)	
Urban	Rural	Urban	Rural
12,000	8,400	1,200	850
14,400	10,080	1,200	850
14,400	10,080	1,600	1,120
12,000	8,400	1,600	1,120

Combination of CONDITIONS A + B

Satisfied _____ Not Satisfied _____

No one condition satisfied, but following conditions fulfilled 80% or more..... _____ (A) _____ (B)

2 CONDITIONS 80%	2 CONDITIONS 80%

Note: To be used only for NEW INTERSECTIONS or other locations where it is not reasonable to count actual traffic volumes.

The satisfaction of a traffic signal warrant or warrants shall not in itself require the installation of a traffic control signal.

Table 4C-1. Warrant 1, Eight-Hour Vehicular Volume

Condition A—Minimum Vehicular Volume

Number of lanes for moving traffic on each approach		Vehicles per hour on major street (total of both approaches)				Vehicles per hour on higher-volume minor-street approach (one direction only)			
Major Street	Minor Street	100%[a]	80%[b]	70%[c]	56%[d]	100%[a]	80%[b]	70%[c]	56%[d]
1	1	500	400	350	280	150	120	105	84
2 or more	1	600	480	420	336	150	120	105	84
2 or more	2 or more	600	480	420	336	200	160	140	112
1	2 or more	500	400	350	280	200	160	140	112

Condition B—Interruption of Continuous Traffic

Number of lanes for moving traffic on each approach		Vehicles per hour on major street (total of both approaches)				Vehicles per hour on higher-volume minor-street approach (one direction only)			
Major Street	Minor Street	100%[a]	80%[b]	70%[c]	56%[d]	100%[a]	80%[b]	70%[c]	56%[d]
1	1	750	600	525	420	75	60	53	42
2 or more	1	900	720	630	504	75	60	53	42
2 or more	2 or more	900	720	630	504	100	80	70	56
1	2 or more	750	600	525	420	100	80	70	56

[a] Basic minimum hourly volume
[b] Used for combination of Conditions A and B after adequate trial of other remedial measures
[c] May be used when the major-street speed exceeds 40 mph or in an isolated community with a population of less than 10,000
[d] May be used for combination of Conditions A and B after adequate trial of other remedial measures when the major-street speed exceeds 40 mph or in an isolated community with a population of less than 10,000

Table 4C-2. Warrant 9, Adjustment Factor for Daily Frequency of Rail Traffic

Rail Traffic per Day	Adjustment Factor
1	0.67
2	0.91
3 to 5	1.00
6 to 8	1.18
9 to 11	1.25
12 or more	1.33

Table 4C-3. Warrant 9, Adjustment Factor for Percentage of High-Occupancy Buses

% of High-Occupancy Buses* on Minor-Street Approach	Adjustment Factor
0%	1.00
2%	1.09
4%	1.19
6% or more	1.32

* A high-occupancy bus is defined as a bus occupied by at least 20 people.

Table 4C-4. Warrant 9, Adjustment Factor for Percentage of Tractor-Trailer Trucks

% of Tractor-Trailer Trucks on Minor-Street Approach	Adjustment Factor	
	D less than 70 feet	D of 70 feet or more
0% to 2.5%	0.50	0.50
2.6% to 7.5%	0.75	0.75
7.6% to 12.5%	1.00	1.00
12.6% to 17.5%	2.30	1.15
17.6% to 22.5%	2.70	1.35
22.6% to 27.5%	3.28	1.64
More than 27.5%	4.18	2.09

COUNTERMEASURE TOOLBOX ATTACHMENT

STOP WARRANT – CAMUTCD 2014

Support:

17 Caltrans will grant such permission only when an investigation indicates that the STOP (R1-1) sign will benefit traffic.

Section 2B.06 STOP Sign Applications

Guidance:

01 *At intersections where a full stop is not necessary at all times, consideration should first be given to using less restrictive measures such as YIELD signs (see Sections 2B.08 and 2B.09).*

02 *The use of STOP signs on the minor-street approaches should be considered if engineering judgment indicates that a stop is always required because of one or more of the following conditions:*

A. The vehicular traffic volumes on the through street or highway exceed 6,000 vehicles per day;

B. A restricted view exists that requires road users to stop in order to adequately observe conflicting traffic on the through street or highway; and/or

C. Crash records indicate that three or more crashes that are susceptible to correction by the installation of a STOP sign have been reported within a 12-month period, or that five or more such crashes have been reported within a 2-year period. Such crashes include right-angle collisions involving road users on the minor-street approach failing to yield the right-of-way to traffic on the through street or highway.

Support:

03 The use of STOP signs at grade crossings is described in Sections 8B.04 and 8B.05.

Section 2B.07 Multi-Way Stop Applications

Support:

01 Multi-way stop control can be useful as a safety measure at intersections if certain traffic conditions exist. Safety concerns associated with multi-way stops include pedestrians, bicyclists, and all road users expecting other road users to stop. Multi-way stop control is used where the volume of traffic on the intersecting roads is approximately equal.

02 The restrictions on the use of STOP signs described in Section 2B.04 also apply to multi-way stop applications.

Guidance:

03 *The decision to install multi-way stop control should be based on an engineering study.*

04 *The following criteria should be considered in the engineering study for a multi-way STOP sign installation:*

A. Where traffic control signals are justified, the multi-way stop is an interim measure that can be installed quickly to control traffic while arrangements are being made for the installation of the traffic control signal.

B. Five or more reported crashes in a 12-month period that are susceptible to correction by a multi-way stop installation. Such crashes include right-turn and left-turn collisions as well as right-angle collisions.

C. Minimum volumes:

1. The vehicular volume entering the intersection from the major street approaches (total of both approaches) averages at least 300 vehicles per hour for any 8 hours of an average day; and

2. The combined vehicular, pedestrian, and bicycle volume entering the intersection from the minor street approaches (total of both approaches) averages at least 200 units per hour for the same 8 hours, with an average delay to minor-street vehicular traffic of at least 30 seconds per vehicle during the highest hour; but

3. If the 85th-percentile approach speed of the major-street traffic exceeds 40 mph, the minimum vehicular volume warrants are 70 percent of the values provided in Items 1 and 2.

D. Where no single criterion is satisfied, but where Criteria B, C.1, and C.2 are all satisfied to 80 percent of the minimum values. Criterion C.3 is excluded from this condition.

Option:

05 Other criteria that may be considered in an engineering study include:

A. The need to control left-turn conflicts;

B. The need to control vehicle/pedestrian conflicts near locations that generate high pedestrian volumes;

C. Locations where a road user, after stopping, cannot see conflicting traffic and is not able to negotiate the intersection unless conflicting cross traffic is also required to stop; and

D. An intersection of two residential neighborhood collector (through) streets of similar design and operating characteristics where multi-way stop control would improve traffic operational characteristics of the intersection.

Section 2B.08 YIELD Sign (R1-2)

Standard:

01 **The YIELD (R1-2) sign (see Figure 2B-1) shall be a downward-pointing equilateral triangle with a wide red border and the legend YIELD in red on a white background.**

Support:

02 The YIELD sign assigns right-of-way to traffic on certain approaches to an intersection. Vehicles controlled by a YIELD sign need to slow down to a speed that is reasonable for the existing conditions or stop when necessary to avoid interfering with conflicting traffic.

Section 2B.09 YIELD Sign Applications

Option:

01 YIELD signs may be installed:

A. On the approaches to a through street or highway where conditions are such that a full stop is not always required.

B. At the second crossroad of a divided highway, where the median width at the intersection is 30 feet or greater. In this case, a STOP or YIELD sign may be installed at the entrance to the first roadway of a divided highway, and a YIELD sign may be installed at the entrance to the second roadway.

C. For a channelized turn lane that is separated from the adjacent travel lanes by an island, even if the adjacent lanes at the intersection are controlled by a highway traffic control signal or by a STOP sign.

D. At an intersection where a special problem exists and where engineering judgment indicates the problem to be susceptible to correction by the use of the YIELD sign.

E. Facing the entering roadway for a merge-type movement if engineering judgment indicates that control is needed because acceleration geometry and/or sight distance is not adequate for merging traffic operation.

Standard:

02 **A YIELD (R1-2) sign shall be used to assign right-of-way at the entrance to a roundabout. YIELD signs at roundabouts shall be used to control the approach roadways and shall not be used to control the circulatory roadway.**

03 **Other than for all of the approaches to a roundabout, YIELD signs shall not be placed on all of the approaches to an intersection.**

Section 2B.10 STOP Sign or YIELD Sign Placement

Standard:

01 **The STOP or YIELD sign shall be installed on the near side of the intersection on the right-hand side of the approach to which it applies. When the STOP or YIELD sign is installed at this required location and the sign visibility is restricted, a Stop Ahead sign (see Section 2C.36) shall be installed in advance of the STOP sign or a Yield Ahead sign (see Section 2C.36) shall be installed in advance of the YIELD sign.**

02 **The STOP or YIELD sign shall be located as close as practical to the intersection it regulates, while optimizing its visibility to the road user it is intended to regulate.**

02a **YIELD signs shall not be erected upon the approaches to more than one of the intersecting streets. Refer to CVC 21356.**

03 **STOP signs and YIELD signs shall not be mounted on the same post.**

04 **No items other than inventory stickers, sign installation dates, and bar codes shall be affixed to the fronts of STOP or YIELD signs, and the placement of these items shall be in the border of the sign.**

05 **No items other than official traffic control signs, inventory stickers, sign installation dates, anti-vandalism stickers, and bar codes shall be mounted on the backs of STOP or YIELD signs.**

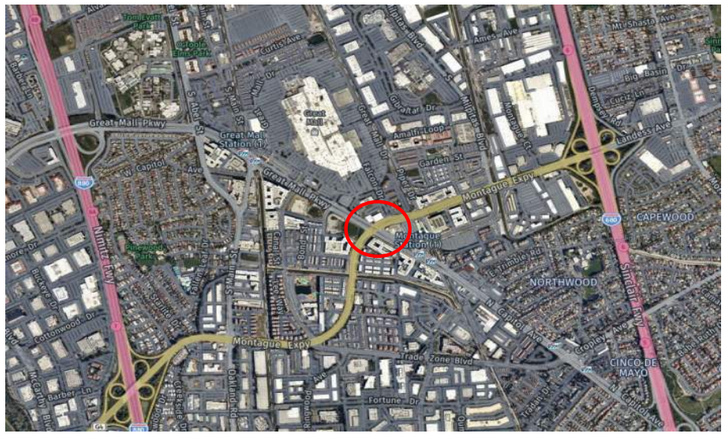
06 **No items other than retroreflective strips (see Section 2A.21) or official traffic control signs shall be mounted on the fronts or backs of STOP or YIELD signs supports.**

APPENDIX E

PROJECT SHEETS

Signalized Intersection

Location: Great Mall Pkwy & Montague Expy
Agency Name: City of Milpitas
Contact Name: Nolen Ugalde
E-mail: nugalde@milpitas.gov



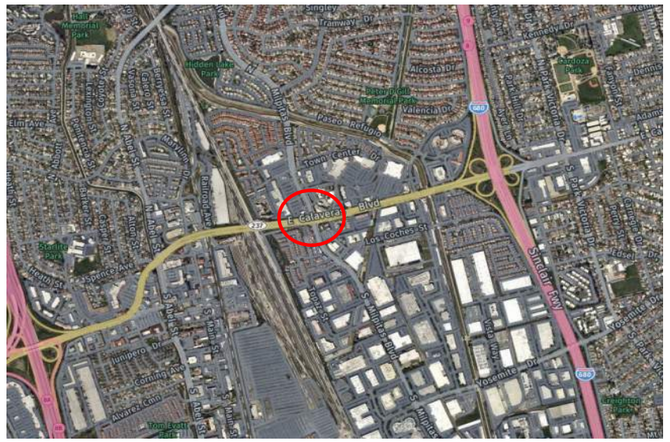
Total Crashes	35
Local CCR Differential	0.69
Equivalent Property Damage Only	374
Fatal	0
Severe Injury	1
Other Visible Injury	10
Complaint of Pain	24
Crash Type	
Broadside	15
Sideswipe	5
Rear End	6
Head On	3
Hit Object	4
Overturned	1
Non-Motorist Crashes	
Pedestrian	0
Bicycle	3
Contributing Factors	
Aggressive	16
Impaired	0
Crash Conditions	
Dark	9
Wet	3

NOTES	COLLISION TYPE	RECOMMENDATION	LOCAL ROADWAY SAFETY MANUAL (LRSM) COUNTERMEASURE	LRSM #	Expected Life (Years)	CMF	CALTRANS FUNDING	NUMBER OF CRASHES (2017-2021)		NUMBER OF HISTORIC CRASHES REDUCED	10-YEAR CRASH REDUCTION ESTIMATE	CRASH SEVERITY COST	10-YEAR CRASH REDUCTION BENEFIT (2022 $)	TOTAL 10-YEAR CRASH REDUCTION BENEFIT	QUANTITY/ NUMBER OF UNITS	UNIT COST (2023 $)	COST ESTIMATE (2023 $)	BENEFIT/COST
Includes cost of controller updates and design	Bike + Ped	Implement Leading Pedestrian Interval (LPI) to increase pedestrian crossing time	Modify signal phasing to implement a Leading Pedestrian Interval (LPI)	S21PB	10	0.40	90%	FATAL	0	0	0.00	$ 1,787,000	$ -	$ 410,040	1 Lump Sum	$ 45,600	$ 45,600	**9.0**
								SEVERE	0	0	0.00	$ 1,787,000	$ -				
								OTHER VISIBLE	1	0.6	1.20	$ 159,900	$ 191,880					
								COMPLAINT OF PAIN	2	1.2	2.40	$ 90,900	$ 218,160					
-	All	Install retroreflective backplates	Improve signal hardware: lenses, back-plates with retroreflective borders, mounting, size, and number	S02	10	0.85	90%	FATAL	0	0	0.00	$ 1,787,000	$ -	$ 1,670,280	28 Backplates	$ 750	$ 21,000	**79.5**
								SEVERE	1	0.15	0.30	$ 1,787,000	$ 536,100					
								OTHER VISIBLE	10	1.5	3.00	$ 159,900	$ 479,700					
								COMPLAINT OF PAIN	24	3.6	7.20	$ 90,900	$ 654,480					
-	Bike + Ped	Install advanced stop bar	Install advance stop bar before crosswalk (bicycle box)	S20PB	10	0.85	90%	FATAL	0	0	0.00	$ 1,787,000	$ -	$ 102,510	170 SQFT of Striping	$ 7	$ 1,190	**86.1**
								SEVERE	0	0	0.00	$ 1,787,000	$ -					
								OTHER VISIBLE	1	0.15	0.30	$ 159,900	$ 47,970					
								COMPLAINT OF PAIN	2	0.3	0.60	$ 90,900	$ 54,540					
-	Bike + Ped	Install pedestrian median fencing on Northern approach to address jaywalking	Install pedestrian median fencing on approaches	S13PB	20	0.90	65%	FATAL	0	0	0.00	$ 1,787,000	$ -	$ 68,340	2000 LF	$ 100	$ 200,000	**0.3**
								SEVERE	0	0	0.00	$ 1,787,000	$ -					
								OTHER VISIBLE	1	0.1	0.20	$ 159,900	$ 31,980					
								COMPLAINT OF PAIN	2	0.2	0.40	$ 90,900	$ 36,360					
-	Bike + Ped	Implement green conflict zone striping for bike lanes	Install advance stop bar before crosswalk (Bicycle Box)	S20PB	10	0.85	90%	FATAL	0	0	0.00	$ 2,843,000	$ -	$ 102,510	6000 SQFT Striping	$ 6	$ 36,000	**2.8**
								SEVERE	0	0	0.00	$ 2,843,000	$ -					
								OTHER VISIBLE	1	0.15	0.30	$ 159,900	$ 47,970					
								COMPLAINT OF PAIN	2	0.3	0.60	$ 90,900	$ 54,540					
-	Bike + Ped	Install APS (accessible pedestrian signals)	-	-	-	-	-	FATAL	-	-	-	-	-	$ -	4 Crosswalks	$ 2,000	$ 16,000	-
								SEVERE	-	-	-	-	-					
								OTHER VISIBLE	-	-	-	-	-					
								COMPLAINT OF PAIN	-	-	-	-	-					
-	Bike + Ped	ADA ramp upgrades	-	-	-	-	-	FATAL	-	-	-	-	-	$ -	3 Curb Ramps	$ 5,000	$ 15,000	-
								SEVERE	-	-	-	-	-					
								OTHER VISIBLE	-	-	-	-	-					
								COMPLAINT OF PAIN	-	-	-	-	-					

Total Cost	$ 334,790

Signalized Intersection

Location: E Calaveras Blvd & N Milpitas Blvd
Agency Name: City of Milpitas
Contact Name: Nolen Ugalde
E-mail: nugalde@milpitas.gov

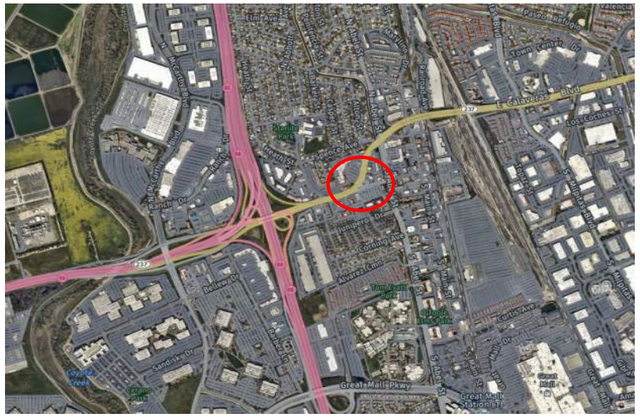


Total Crashes	21
Local CCR Differential	0.09
Equivalent Property Damage Only	330
Fatal	0
Severe Injury	1
Other Visible Injury	5
Complaint of Pain	14
Crash Type	
Broadside	7
Sideswipe	2
Rear End	5
Head On	0
Hit Object	3
Overturned	0
Non-Motorist Crashes	
Pedestrian	2
Bicycle	2
Contributing Factors	
Aggressive	12
Impaired	2
Crash Conditions	
Dark	8
Wet	2

NOTES	COLLISION TYPE	RECOMMENDATION	LOCAL ROADWAY SAFETY MANUAL (LRSM) COUNTERMEASURE	LRSM #	Expected Life (Years)	CMF	CALTRANS FUNDING	NUMBER OF CRASHES (2017-2021)		NUMBER OF HISTORIC CRASHES REDUCED	10-YEAR CRASH REDUCTION ESTIMATE	CRASH SEVERITY COST	10-YEAR CRASH REDUCTION BENEFIT (2022 $)	TOTAL 10-YEAR CRASH REDUCTION BENEFIT	QUANTITY/ NUMBER OF UNITS	UNIT COST (2023 $)	COST ESTIMATE (2023 $)	BENEFIT/COST
-	All	Install retroreflective backplates on traffic signal heads	Improve signal hardware: lenses, back-plates with retroreflective borders, mounting, size, and number	S02	10	0.85	90%	FATAL	0	0	0.00	$ 2,843,000	$ -	$ 1,474,530	16 Backplates	$ 750	$ 12,000	**122.9**
								SEVERE	1	0.15	0.30	$ 2,843,000	$ 852,900					
								OTHER VISIBLE	5	0.75	1.50	$ 159,900	$ 239,850					
								COMPLAINT OF PAIN	14	2.1	4.20	$ 90,900	$ 381,780					
Includes cost of controller updates and design	Bike + Ped	Implement LPI	Modify signal phasing to implement a Leading Pedestrian Interval (LPI)	S21PB	10	0.40	90%	FATAL	0	0	0.00	$ 2,843,000	$ -	$ 3,987,240	1 Lump Sum	$ 45,600	$ 45,600	**87.4**
								SEVERE	1	0.6	1.20	$ 2,843,000	$ 3,411,600					
								OTHER VISIBLE	3	1.8	3.60	$ 159,900	$ 575,640					
								COMPLAINT OF PAIN	0	0	0.00	$ 90,900	$ -					
-	Bike + Ped	Install advanced stop bar (all approaches)	Install advance stop bar before crosswalk (bicycle box)	S20PB	10	0.85	90%	FATAL	0	0	0.00	$ 1,787,000	$ -	$ 680,010	160 SQFT of Striping	$ 7	$ 1,120	**607.2**
								SEVERE	1	0.15	0.30	$ 1,787,000	$ 536,100					
								OTHER VISIBLE	3	0.45	0.90	$ 159,900	$ 143,910					
								COMPLAINT OF PAIN	0	0	0.00	$ 90,900	$ -					
Includes unit cost, installation and design	All	Install traffic signal ahead flashing beacon on the EB Calaveras approach to intx	Install flashing beacon as advance warning (S.I.)	S10	10	0.70	90%	FATAL	0	0	0.00	$ 1,787,000	$ -	$ 4,097,100	1 Lump Sum	$ 10,200	$ 10,200	**401.7**
								SEVERE	1	0.3	0.60	$ 1,787,000	$ 1,072,200					
								OTHER VISIBLE	5	1.5	3.00	$ 159,900	$ 479,700					
								COMPLAINT OF PAIN	14	14	28.00	$ 90,900	$ 2,545,200					
-	Bike + Ped	ADA ramp upgrades	-	-	-	-	-	FATAL	-	-	-	-	-	$ -	14 Curb Ramps	$ 5,000	$ 70,000	**-**
								SEVERE	-	-	-	-	-					
								OTHER VISIBLE	-	-	-	-	-					
								COMPLAINT OF PAIN	-	-	-	-	-					
																Total Cost	**$ 138,920**	

Signalized Intersection

Location: W Calaveras Blvd & Serra Wy
Agency Name: City of Milpitas
Contact Name: Nolen Ugalde
E-mail: nugalde@milpitas.gov



Total Crashes	19
Local CCR Differential	0.07
Equivalent Property Damage Only	576
Fatal	0
Severe Injury	4
Other Visible Injury	1
Complaint of Pain	14
Crash Type	
Broadside	9
Sideswipe	1
Rear End	4
Head On	1
Hit Object	2
Overturned	0
Non-Motorist Crashes	
Pedestrian	1
Bicycle	1
Contributing Factors	
Aggressive	9
Impaired	2
Crash Conditions	
Dark	9
Wet	1

NOTES	COLLISION TYPE	RECOMMENDATION	LOCAL ROADWAY SAFETY MANUAL (LRSM) COUNTERMEASURE	LRSM #	Expected Life (Years)	CMF	CALTRANS FUNDING	NUMBER OF CRASHES (2017-2021)		NUMBER OF HISTORIC CRASHES REDUCED	10-YEAR CRASH REDUCTION ESTIMATE	CRASH SEVERITY COST	10-YEAR CRASH REDUCTION BENEFIT (2022 $)	TOTAL 10-YEAR CRASH REDUCTION BENEFIT	QUANTITY/ NUMBER OF UNITS	UNIT COST (2023 $)	COST ESTIMATE (2023 $)	BENEFIT/COST
-	All	Install retroreflective backplates on traffic signal heads. Upgrade 8'' heads to 12'' heads	Improve signal hardware: lenses, back-plates with retroreflective borders, mounting, size, and number	S02	10	0.85	90%	FATAL	0	0	0.00	$ 2,843,000	$ -	$ 3,841,350	16 Signal Heads	$ 8,750	$ 140,000	**27.4**
								SEVERE	4	0.6	1.20	$ 2,843,000	$ 3,411,600					
								OTHER VISIBLE	1	0.15	0.30	$ 159,900	$ 47,970					
								COMPLAINT OF PAIN	14	2.1	4.20	$ 90,900	$ 381,780					
Includes cost of controller updates and design	Bike + Ped	Implement Leading Pedestrian Interval (LPI)	Modify signal phasing to implement a Leading Pedestrian Interval (LPI)	S21PB	10	0.40	90%	FATAL	0	0	0.00	$ 1,787,000	$ -	$ 2,253,480	1 Lump Sum	$ 45,600	$ 45,600	**49.4**
								SEVERE	1	0.6	1.20	$ 1,787,000	$ 2,144,400					
								OTHER VISIBLE	0	0	0.00	$ 159,900	$ -					
								COMPLAINT OF PAIN	1	0.6	1.20	$ 90,900	$ 109,080					
-	Bike + Ped	Install advanced stop bar/yield Lines at crosswalk approaches	Install advance stop bar before crosswalk (bicycle box)	S20PB	10	0.85	90%	FATAL	0	0	0.00	$ 1,787,000	$ -	$ 563,370	65 SQFT of Striping	$ 7	$ 455	**1,238.2**
								SEVERE	1	0.15	0.30	$ 1,787,000	$ 536,100					
								OTHER VISIBLE	0	0	0.00	$ 159,900	$ -					
								COMPLAINT OF PAIN	1	0.15	0.30	$ 90,900	$ 27,270					
-	All	Install pavement legends and signage indicating which lanes lead to NB/SB I-880 to prevent drivers needing to make late lane changes	Install raised pavement markers and striping (through intersection)	S09	10	0.90	90%	FATAL	0	0	0.00	$ 1,787,000	$ -	$ 1,716,100	180 SQFT of Striping	$ 7	$ 2,760	**621.8**
								SEVERE	4	0.4	0.80	$ 1,787,000	$ 1,429,600					
								OTHER VISIBLE	1	0.1	0.20	$ 159,900	$ 31,980					
								COMPLAINT OF PAIN	14	1.4	2.80	$ 90,900	$ 254,520					
Includes the cost of new sign, signal head installation and design.	All	Implement protected left turn phase on Serra/Driveway approaches	Provide protected left turn phase	S07	20	0.70	90%	FATAL	0	0	0.00	$ 1,787,000	$ -	$ 5,148,300	1 lump sum	$ 45,600	$ 45,600	**112.9**
								SEVERE	4	1.2	2.40	$ 1,787,000	$ 4,288,800					
								OTHER VISIBLE	1	0.3	0.60	$ 159,900	$ 95,940					
								COMPLAINT OF PAIN	14	4.2	8.40	$ 90,900	$ 763,560					
-	Dark	Install additional safety lighting to Serra Approach	Add intersection lighting	S01	20	0.60	90%	FATAL	0	0	0.00	$ 1,787,000	$ -	$ 3,368,240	1 Luminaire	$ 19,500	$ 19,500	**172.7**
								SEVERE	2	0.8	1.60	$ 1,787,000	$ 2,859,200					
								OTHER VISIBLE	0	0	0.00	$ 159,900	$ -					
								COMPLAINT OF PAIN	7	2.8	5.60	$ 90,900	$ 509,040					
-	All	Redesign curb ramps and crossings to be ADA compliant	-	-	-	-	-	FATAL	-	-	-	-	-	-	5 Curb Ramps	$ 5,000	$ 25,000	**-**
								SEVERE	-	-	-	-	-					
								OTHER VISIBLE	-	-	-	-	-					
								COMPLAINT OF PAIN	-	-	-	-	-					

Signalized Intersection

Location: W Calaveras Blvd & Serra Wy
Agency Name: City of Milpitas
Contact Name: Nolen Ugalde
E-mail: nugalde@milpitas.gov

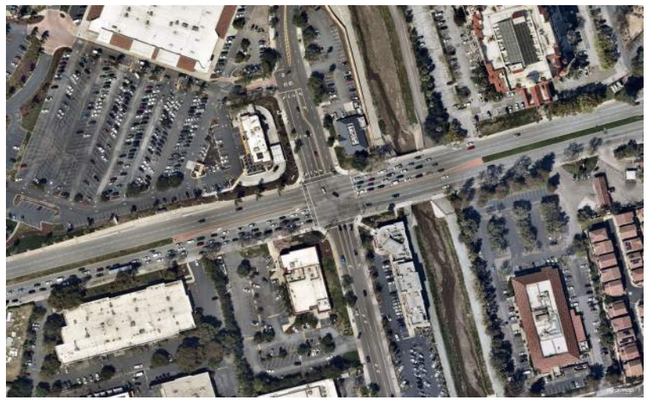
Total Crashes	19
Local CCR Differential	0.07
Equivalent Property Damage Only	576
Fatal	0
Severe Injury	4
Other Visible Injury	1
Complaint of Pain	14
Crash Type	
Broadside	9
Sideswipe	1
Rear End	4
Head On	1
Hit Object	2
Overturned	0
Non-Motorist Crashes	
Pedestrian	1
Bicycle	1
Contributing Factors	
Aggressive	9
Impaired	2
Crash Conditions	
Dark	9
Wet	1

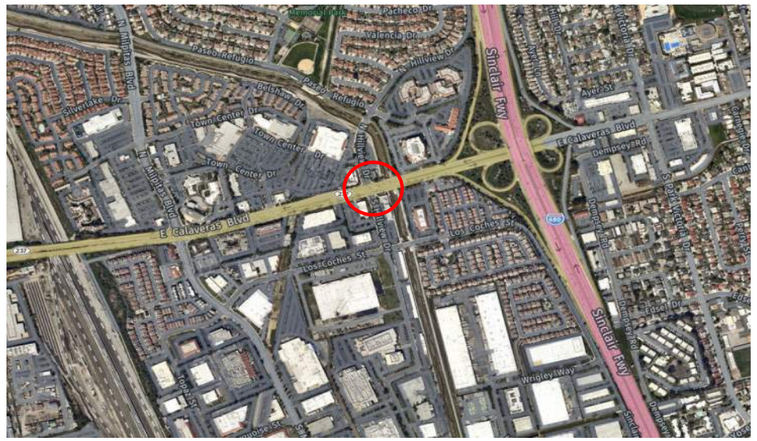
NOTES	COLLISION TYPE	RECOMMENDATION	LOCAL ROADWAY SAFETY MANUAL (LRSM) COUNTERMEASURE	LRSM #	Expected Life (Years)	CMF	CALTRANS FUNDING	NUMBER OF CRASHES (2017-2021)		NUMBER OF HISTORIC CRASHES REDUCED	10-YEAR CRASH REDUCTION ESTIMATE	CRASH SEVERITY COST	10-YEAR CRASH REDUCTION BENEFIT (2022 $)	TOTAL 10-YEAR CRASH REDUCTION BENEFIT	QUANTITY/ NUMBER OF UNITS	UNIT COST (2023 $)	COST ESTIMATE (2023 $)	BENEFIT/COST
-	Bike + Ped	Update crosswalk striping per MUTCD school zone striping requirement.	-	-	-	-	-	FATAL	-	-	-	-	-	-	180 SQFT	$ 10	$ 1,800	-
								SEVERE	-	-	-	-	-					
								OTHER VISIBLE	-	-	-	-	-					
								COMPLAINT OF PAIN	-	-	-	-	-					
Cost includes materials and soft costs, and 20% contingency	All	Upgrade median islands to be appropriate height, currently too low.	-	-	-	-	-	FATAL	-	-	-	-	-	-	1 Lump sum	$ 1,528,000	$ 1,528,000	-
								SEVERE	-	-	-	-	-					
								OTHER VISIBLE	-	-	-	-	-					
								COMPLAINT OF PAIN	-	-	-	-	-					

Total Cost	$ 1,808,715

Signalized Intersection

Location: E Calaveras Blvd & S Hillview Dr
Agency Name: City of Milpitas
Contact Name: Nolen Ugalde
E-mail: nugalde@milpitas.gov





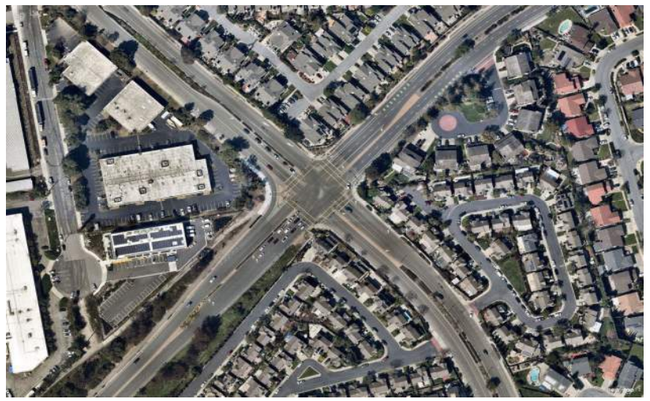
Total Crashes	17
Local CCR Differential	0.13
Equivalent Property Damage Only	136
Fatal	0
Severe Injury	0
Other Visible Injury	7
Complaint of Pain	10
Crash Type	
Broadside	4
Sideswipe	1
Rear End	6
Head On	2
Hit Object	0
Overturned	0
Non-Motorist Crashes	
Pedestrian	1
Bicycle	3
Contributing Factors	
Aggressive	7
Impaired	2
Crash Conditions	
Dark	3
Wet	3

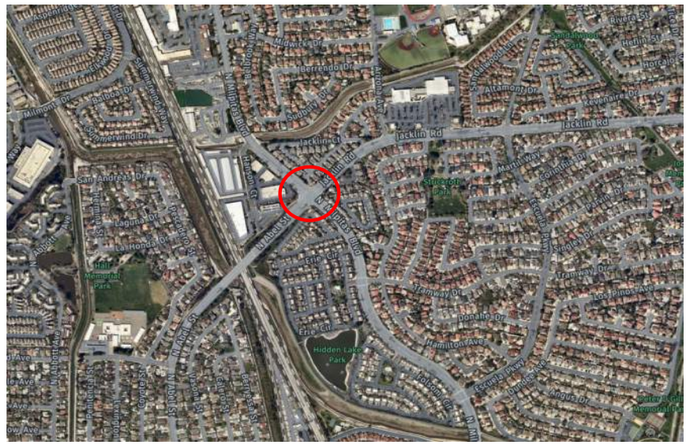
NOTES	COLLISION TYPE	RECOMMENDATION	LOCAL ROADWAY SAFETY MANUAL (LRSM) COUNTERMEASURE	LRSM #	Expected Life (Years)	CMF	CALTRANS FUNDING	NUMBER OF CRASHES (2017-2021)		NUMBER OF HISTORIC CRASHES REDUCED	10-YEAR CRASH REDUCTION ESTIMATE	CRASH SEVERITY COST	10-YEAR CRASH REDUCTION BENEFIT (2022 $)	TOTAL 10-YEAR CRASH REDUCTION BENEFIT	QUANTITY/ NUMBER OF UNITS	UNIT COST (2023 $)	COST ESTIMATE (2023 $)	BENEFIT/COST
Includes cost of controller updates and design	Bike + Ped	Implement Leading Pedestrian Interval (LPI)	Modify signal phasing to implement a Leading Pedestrian Interval (LPI)	S21PB	10	0.40	90%	FATAL	0	0	0.00	$ 1,787,000	$ -	$ 767,520	1 Lump Sum	$ 45,600	$ 45,600	**16.8**
								SEVERE	0	0	0.00	$ 1,787,000	$ -				
								OTHER VISIBLE	4	2.4	4.80	$ 159,900	$ 767,520				
								COMPLAINT OF PAIN	0	0	0.00	$ 90,900	$ -				
-	Bike + Ped	Install advance stop bars (all approaches)	Install advance stop bar before crosswalk (bicycle box)	S20PB	10	0.85	90%	FATAL	0	0	0.00	$ 1,787,000	$ -	$ 191,880	48 SQFT of Striping	$ 7	$ 336	**571.1**
								SEVERE	0	0	0.00	$ 1,787,000	$ -				
								OTHER VISIBLE	4	0.6	1.20	$ 159,900	$ 191,880				
								COMPLAINT OF PAIN	0	0	0.00	$ 90,900	$ -				
-	All	Install retroreflective border for signal heads	Improve signal hardware: lenses, back-plates with retroreflective borders, mounting, size, and number	S02	10	0.85	90%	FATAL	0	0	0.00	$ 1,787,000	$ -	$ 608,490	16 Backplates	$ 750	$ 12,000	**50.7**
								SEVERE	0	0	0.00	$ 1,787,000	$ -				
								OTHER VISIBLE	7	1.05	2.10	$ 159,900	$ 335,790				
								COMPLAINT OF PAIN	10	1.5	3.00	$ 90,900	$ 272,700				
-	Bike + Ped	Install APS (accessible pedestrian signals)	-	-	-	-	-	FATAL	-	-	-	-	-	$ -	4 Crosswalks	$ 2,000	$ 16,000	**-**
								SEVERE	-	-	-	-	-					
								OTHER VISIBLE	-	-	-	-	-					
								COMPLAINT OF PAIN	-	-	-	-	-					

Total Cost	$ 73,936

Signalized Intersection

Location: N Milpitas Blvd & N Abel St
Agency Name: City of Milpitas
Contact Name: Nolen Ugalde
E-mail: nugalde@milpitas.gov



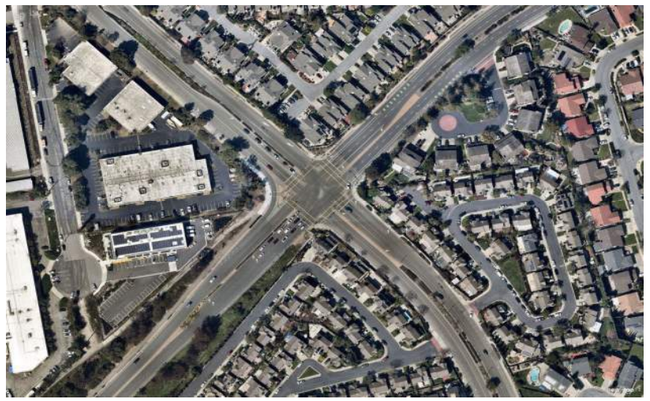


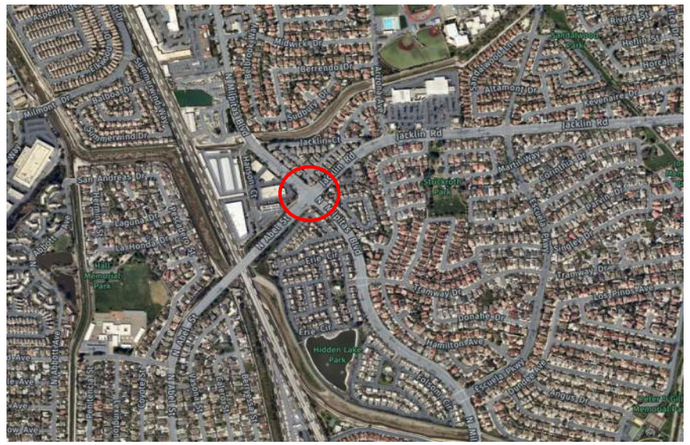
Total Crashes	**14**
Local CCR Differential	-0.01
Equivalent Property Damage Only	469
Fatal	1
Severe Injury	1
Other Visible Injury	3
Complaint of Pain	9
Crash Type	
Broadside	6
Sideswipe	2
Rear End	3
Head On	0
Hit Object	2
Overturned	0
Non-Motorist Crashes	
Pedestrian	1
Bicycle	0
Contributing Factors	
Aggressive	8
Impaired	5
Crash Conditions	
Dark	6
Wet	1

NOTES	COLLISION TYPE	RECOMMENDATION	LOCAL ROADWAY SAFETY MANUAL (LRSM) COUNTERMEASURE	LRSM #	Expected Life (Years)	CMF	CALTRANS FUNDING	NUMBER OF CRASHES (2017-2021)		NUMBER OF HISTORIC CRASHES REDUCED	10-YEAR CRASH REDUCTION ESTIMATE	CRASH SEVERITY COST	10-YEAR CRASH REDUCTION BENEFIT (2022 $)	TOTAL 10-YEAR CRASH REDUCTION BENEFIT	QUANTITY/ NUMBER OF UNITS	UNIT COST (2023 $)	COST ESTIMATE (2023 $)	BENEFIT/COST
-	All	Install retroreflective backplates on traffic signal heads. Install additional signal head to through lanes on Abel St/Jacklin Rd	Improve signal hardware: lenses, back-plates with retroreflective borders, mounting, size, and number	S02	10	0.85	90%	FATAL	1	0.15	0.30	$ 2,843,000	$ 852,900	$ 2,095,140	16 Backplates and 2 Signal Heads	Lump Sum	$ 29,500	**71.0**
								SEVERE	1	0.15	0.30	$ 2,843,000	$ 852,900					
								OTHER VISIBLE	3	0.45	0.90	$ 159,900	$ 143,910					
								COMPLAINT OF PAIN	9	1.35	2.70	$ 90,900	$ 245,430					
Includes cost of controller updates and design	All	Add an overlap phase to the westbound right-turn	Improve signal timing (coordination, phases, red, yellow, or operation)	S03	10	0.85	50%	FATAL	1	0.15	0.30	$ 2,843,000	$ 852,900	$ 2,095,140	1 Lump Sum	$ 7	$ 14,400	**145.5**
								SEVERE	1	0.15	0.30	$ 2,843,000	$ 852,900					
								OTHER VISIBLE	3	0.45	0.90	$ 159,900	$ 143,910					
								COMPLAINT OF PAIN	9	1.35	2.70	$ 90,900	$ 245,430					
Includes cost of controller updates and design	Bike + Ped	Implement LPI	Modify signal phasing to implement a Leading Pedestrian Interval (LPI)	S21PB	10	0.40	90%	FATAL	0	0	0.00	$ 2,843,000	$ -	$ 109,080	1 Lump Sum	$ 45,600	$ 45,600	**2.4**
								SEVERE	0	0	0.00	$ 2,843,000	$ -					
								OTHER VISIBLE	0	0	0.00	$ 159,900	$ -					
								COMPLAINT OF PAIN	1	0.6	1.20	$ 90,900	$ 109,080					
-	All	Install cat-tracks for NBL lane to guide vehicles through the intersection	Install raised pavement markers and striping (through intersection)	S09	20	0.90	90%	FATAL	1	0.1	0.20	$ 2,843,000	$ 568,600	$ 1,396,760	130 LF of Striping	$ 3	$ 390	**3,581.4**
								SEVERE	1	0.1	0.20	$ 2,843,000	$ 568,600					
								OTHER VISIBLE	3	0.3	0.60	$ 159,900	$ 95,940					
								COMPLAINT OF PAIN	9	0.9	1.80	$ 90,900	$ 163,620					
-	Bike + Ped	Implement green conflict zone striping for bike lanes	Install advance stop bar before crosswalk (Bicycle Box)	S20PB	10	0.85	90%	FATAL	0	0	0.00	$ 2,843,000	$ -	$ 27,270	12000 SQFT Striping	$ 6	$ 72,000	**0.4**
								SEVERE	0	0	0.00	$ 2,843,000	$ -					
								OTHER VISIBLE	0	0	0.00	$ 159,900	$ -					
								COMPLAINT OF PAIN	1	0.15	0.30	$ 90,900	$ 27,270					
-	Bike + Ped	Redesign the median to provide a NACTO compliant pedestrian refuge area, or consider removal of pedestrian push buttons	-	-	-	-	-	FATAL	-	-	-	-	-	$ -	-	-	-	-
								SEVERE	-	-	-	-	-					
								OTHER VISIBLE	-	-	-	-	-					
								COMPLAINT OF PAIN	-	-	-	-	-					
-	All	Improve sight distance for vehicles turning right from N Abel St to N Milpitas Blvd by trimming vegetation on the South corner	-	-	-	-	-	FATAL	-	-	-	-	-	$ -	1 Lump Sum	$ 1,250	$ 1,250	-
								SEVERE	-	-	-	-	-					
								OTHER VISIBLE	-	-	-	-	-					
								COMPLAINT OF PAIN	-	-	-	-	-					

Signalized Intersection

Location: N Milpitas Blvd & N Abel St
Agency Name: City of Milpitas
Contact Name: Nolen Ugalde
E-mail: nugalde@milpitas.gov





Total Crashes	**14**
Local CCR Differential	-0.01
Equivalent Property Damage Only	469
Fatal	1
Severe Injury	1
Other Visible Injury	3
Complaint of Pain	9
Crash Type	
Broadside	6
Sideswipe	2
Rear End	3
Head On	0
Hit Object	2
Overturned	0
Non-Motorist Crashes	
Pedestrian	1
Bicycle	0
Contributing Factors	
Aggressive	8
Impaired	5
Crash Conditions	
Dark	6
Wet	1

NOTES	COLLISION TYPE	RECOMMENDATION	LOCAL ROADWAY SAFETY MANUAL (LRSM) COUNTERMEASURE	LRSM #	Expected Life (Years)	CMF	CALTRANS FUNDING	NUMBER OF CRASHES (2017-2021)		NUMBER OF HISTORIC CRASHES REDUCED	10-YEAR CRASH REDUCTION ESTIMATE	CRASH SEVERITY COST	10-YEAR CRASH REDUCTION BENEFIT (2022 $)	TOTAL 10-YEAR CRASH REDUCTION BENEFIT	QUANTITY/ NUMBER OF UNITS	UNIT COST (2023 $)	COST ESTIMATE (2023 $)	BENEFIT/COST
-	Bike + Ped	ADA ramp upgrades	-	-	-	-	-	FATAL	-	-	-	-	-	$ -	7 Curb Ramps	$ 5,000	$ 35,000	-
								SEVERE	-	-	-	-	-					
								OTHER VISIBLE	-	-	-	-	-					
								COMPLAINT OF PAIN	-	-	-	-	-					
-	All	At the Northwest corner: Install a R1-5 sign at the pedestrian crossing. Install a W4-2 sign and merge pavement markings on SB Abel St South of the intersection.	-	-	-	-	-	FATAL	-	-	-	-	-	$ -	2 Signs and Pavement Markings	Lump Sum	$ 1,719	-
								SEVERE	-	-	-	-	-					
								OTHER VISIBLE	-	-	-	-	-					
								COMPLAINT OF PAIN	-	-	-	-	-					
																Total Cost	**$**	**199,859**

Signalized Intersection

Location: Dixon Landing Rd & N Milpitas Blvd
Agency Name: City of Milpitas
Contact Name: Nolen Ugalde
E-mail: nugalde@milpitas.gov

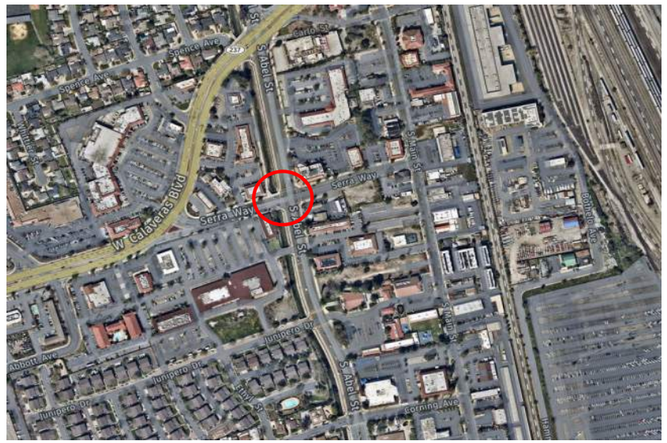
Total Crashes	13
Local CCR Differential	0.08
Equivalent Property Damage Only	89
Fatal	0
Severe Injury	0
Other Visible Injury	2
Complaint of Pain	11
Crash Type	
Broadside	5
Sideswipe	1
Rear End	5
Head On	1
Hit Object	0
Overturned	0
Non-Motorist Crashes	
Pedestrian	1
Bicycle	3
Contributing Factors	
Aggressive	5
Impaired	2
Crash Conditions	
Dark	3
Wet	2

NOTES	COLLISION TYPE	RECOMMENDATION	LOCAL ROADWAY SAFETY MANUAL (LRSM) COUNTERMEASURE	LRSM #	Expected Life (Years)	CMF	CALTRANS FUNDING	NUMBER OF CRASHES (2017-2021)		NUMBER OF HISTORIC CRASHES REDUCED	10-YEAR CRASH REDUCTION ESTIMATE	CRASH SEVERITY COST	10-YEAR CRASH REDUCTION BENEFIT (2022 $)	TOTAL 10-YEAR CRASH REDUCTION BENEFIT	QUANTITY/ NUMBER OF UNITS	UNIT COST (2023 $)	COST ESTIMATE (2023 $)	BENEFIT/COST
-	Bike + Ped	Implement advance stop bar and green conflict zone striping for bike lanes	Install advance stop bar before crosswalk (bicycle box)	R32PB	20	0.65	90%	FATAL	0	0	0.00	$ 2,843,000	$ -	$ 254,520	12075 SQFT Striping	$ 6	$ 72,450	**3.5**
								SEVERE	0	0	0.00	$ 2,843,000	$ -				
								OTHER VISIBLE	0	0	0.00	$ 159,900	$ -				
								COMPLAINT OF PAIN	4	1.4	2.80	$ 90,900	$ 254,520				
Includes unit cost, installation and design	Bike + Ped	Install buffered bike lanes and standard pavement markings on the Dixon Landing intersection approaches	Install separated bike lanes	R33PB	20	0.55	90%	FATAL	0	0	0.00	$ 2,461,000	$ -	$ 327,240	0.85 Mile	$ 84,000	$ 71,400	**4.6**
								SEVERE	0	0	0.00	$ 2,461,000	$ -				
								OTHER VISIBLE	0	0	0.00	$ 159,900	$ -				
								COMPLAINT OF PAIN	4	1.8	3.60	$ 90,900	$ 327,240				
-	Dark	Install additional safety lighting to EB Dixon Landing Rd	Add intersection lighting	S01	20	0.60	90%	FATAL	0	0	0.00	$ 1,787,000	$ -	$ 218,160	1 Luminaire	$ 19,500	$ 19,500	**11.2**
								SEVERE	0	0	0.00	$ 1,787,000	$ -				
								OTHER VISIBLE	0	0	0.00	$ 159,900	$ -				
								COMPLAINT OF PAIN	3	1.2	2.40	$ 90,900	$ 218,160				
-	All	Install retroreflective backplates	Improve signal hardware: lenses, back-plates with retroreflective borders, mounting, size, and number	S02	10	0.85	90%	FATAL	0	0	0.00	$ 1,787,000	$ -	$ 395,910	20 Backplates	$ 750	$ 15,000	**26.4**
								SEVERE	0	0	0.00	$ 1,787,000	$ -				
								OTHER VISIBLE	2	0.3	0.60	$ 159,900	$ 95,940				
								COMPLAINT OF PAIN	11	1.65	3.30	$ 90,900	$ 299,970				
-	Bike + Ped	Re-orient the pedestrian countdown head on the West leg of the intersection to face South	-	-	-	-	-	FATAL	-	-	-	-	-	$ -	1 Lump Sum	Lump Sum	$ 1,250	-
								SEVERE	-	-	-	-	-				
								OTHER VISIBLE	-	-	-	-	-				
								COMPLAINT OF PAIN	-	-	-	-	-				
-	Bike + Ped	Straighten out the crosswalk across the North leg of the intersection to provide more distance between cars travelling WB on Dixon Landing Rd and pedestrians in the crosswalk	-	-	-	-	-	FATAL	-	-	-	-	-	$ -	1 Lump Sum	Lump Sum	$ 3,000	-
								SEVERE	-	-	-	-	-				
								OTHER VISIBLE	-	-	-	-	-				
								COMPLAINT OF PAIN	-	-	-	-	-				
																Total Cost	**$ 182,600**	

City of Milpitas Citywide Travel Safety Plan

Signalized Intersection

Location: Serra Wy & S Abel St
Agency Name: City of Milpitas
Contact Name: Nolen Ugalde
E-mail: nugalde@milpitas.gov



Total Crashes	13
Local CCR Differential	0.25
Equivalent Property Damage Only	107
Fatal	0
Severe Injury	0
Other Visible Injury	6
Complaint of Pain	7
Crash Type	
Broadside	8
Sideswipe	1
Rear End	2
Head On	0
Hit Object	1
Overturned	0
Non-Motorist Crashes	
Pedestrian	0
Bicycle	0
Contributing Factors	
Aggressive	8
Impaired	1
Crash Conditions	
Dark	3
Wet	0

NOTES	COLLISION TYPE	RECOMMENDATION	LOCAL ROADWAY SAFETY MANUAL (LRSM) COUNTERMEASURE	LRSM #	Expected Life (Years)	CMF	CALTRANS FUNDING	NUMBER OF CRASHES (2017-2021)		NUMBER OF HISTORIC CRASHES REDUCED	10-YEAR CRASH REDUCTION ESTIMATE	CRASH SEVERITY COST	10-YEAR CRASH REDUCTION BENEFIT (2022 $)	TOTAL 10-YEAR CRASH REDUCTION BENEFIT	QUANTITY/ NUMBER OF UNITS	UNIT COST (2023 $)	COST ESTIMATE (2023 $)	BENEFIT/COST
-	All	Install retroreflective backplates	Improve signal hardware: lenses, back-plates with retroreflective borders, mounting, size, and number	S02	10	0.85	90%	FATAL	0	0	0.00	$ 1,787,000	$ -	$ 478,710	20 Backplates	$ 750	$ 15,000	**31.9**
								SEVERE	0	0	0.00	$ 1,787,000	$ -					
								OTHER VISIBLE	6	0.9	1.80	$ 159,900	$ 287,820					
								COMPLAINT OF PAIN	7	1.05	2.10	$ 90,900	$ 190,890					
																Total Cost	**$ 15,000**	

Kimley»Horn

Signalized Intersection

Location: W Calaveras Blvd & I-880 Ramps
Agency Name: City of Milpitas
Contact Name: Nolen Ugalde
E-mail: nugalde@milpitas.gov

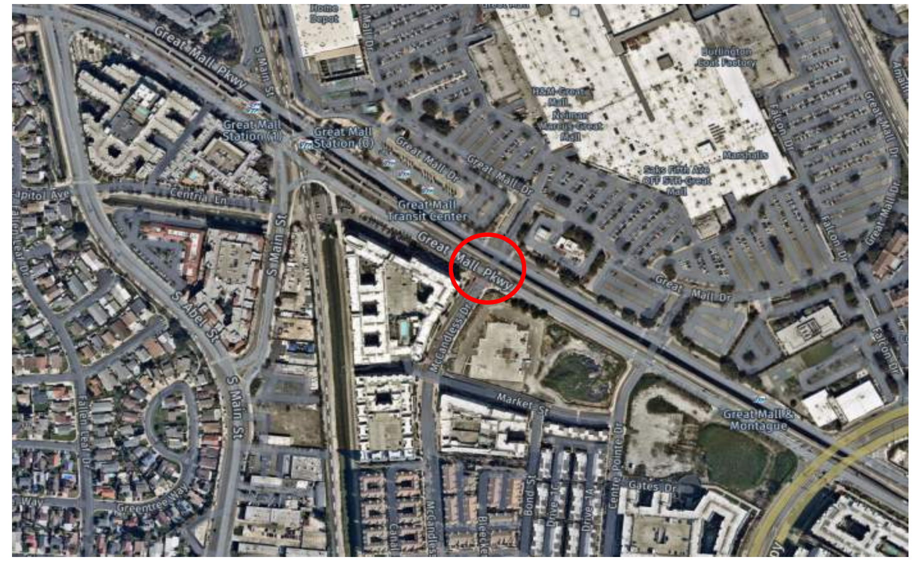
Total Crashes	12
Local CCR Differential	-0.02
Equivalent Property Damage Only	267
Fatal	0
Severe Injury	1
Other Visible Injury	2
Complaint of Pain	9
Crash Type	
Broadside	4
Sideswipe	1
Rear End	7
Head On	0
Hit Object	0
Overturned	0
Non-Motorist Crashes	
Pedestrian	0
Bicycle	1
Contributing Factors	
Aggressive	10
Impaired	0
Crash Conditions	
Dark	2
Wet	0

NOTES	COLLISION TYPE	RECOMMENDATION	LOCAL ROADWAY SAFETY MANUAL (LRSM) COUNTERMEASURE	LRSM #	Expected Life (Years)	CMF	CALTRANS FUNDING	NUMBER OF CRASHES (2017-2021)		NUMBER OF HISTORIC CRASHES REDUCED	10-YEAR CRASH REDUCTION ESTIMATE	CRASH SEVERITY COST	10-YEAR CRASH REDUCTION BENEFIT (2022 $)	TOTAL 10-YEAR CRASH REDUCTION BENEFIT	QUANTITY/ NUMBER OF UNITS	UNIT COST (2023 $)	COST ESTIMATE (2023 $)	BENEFIT/COST
-	All	Upgrade 8" signal heads to 12" signal heads.	Improve signal hardware; lenses, back plate with retroreflective borders, mounting, size, and number	S02	20	0.85	90%	FATAL	0	0	0.00	$ 2,843,000	$ -	$ 1,194,270	11 Signal Heads	$ 8,000	$ 88,000	**13.6**
								SEVERE	1	0.15	0.30	$ 2,843,000	$ 852,900					
								OTHER VISIBLE	2	0.3	0.60	$ 159,900	$ 95,940					
								COMPLAINT OF PAIN	9	1.35	2.70	$ 90,900	$ 245,430					
-	Bike + Ped	Install yield lines at pedestrian crossing at I-880 ramps and stripe high visibility crossings	Install/Upgrade pedestrian crossing at uncontrolled locations (with enhanced safety features)	NS21PB	20	0.65	90%	FATAL	0	0	0.00	$ 2,461,000	$ -	$ 63,630	200 SQFT of Striping	$ 6	$ 1,200	**53.0**
								SEVERE	0	0	0.00	$ 2,461,000	$ -					
								OTHER VISIBLE	0	0	0.00	$ 159,900	$ -					
								COMPLAINT OF PAIN	1	0.35	0.70	$ 90,900	$ 63,630					
-	Bike + Ped	Install RRFB at pedestrian crossing across the EB Calaveras to I-880 On-Ramp	Install rectangular rapid flashing beacon (RRFB)	NS22PB	20	0.65	90%	FATAL	0	0	0.00	$ 2,461,000	$ -	$ 63,630	1 RRFB	$ 54,000	$ 54,000	**1.2**
								SEVERE	0	0	0.00	$ 2,461,000	$ -					
								OTHER VISIBLE	0	0	0.00	$ 159,900	$ -					
								COMPLAINT OF PAIN	1	0.35	0.70	$ 90,900	$ 63,630					

Total Cost	$ 143,200

Signalized Intersection

Location: Great Mall Pkwy & McCandless Dr
Agency Name: City of Milpitas
Contact Name: Nolen Ugalde
E-mail: nugalde@milpitas.gov

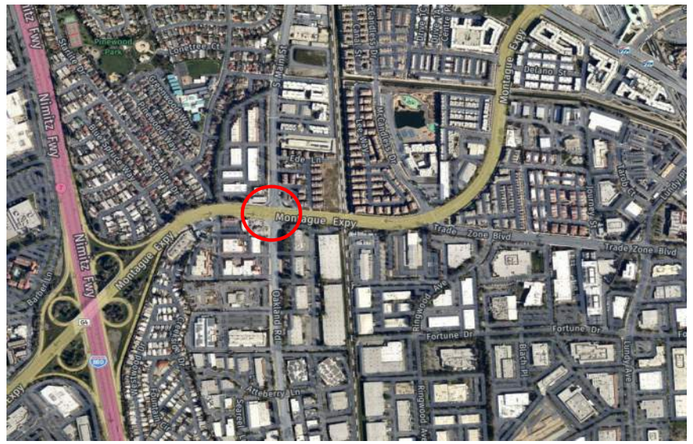


Total Crashes	12
Local CCR Differential	0.00
Equivalent Property Damage Only	92
Fatal	0
Severe Injury	0
Other Visible Injury	4
Complaint of Pain	8
Crash Type	
Broadside	4
Sideswipe	0
Rear End	3
Head On	4
Hit Object	1
Overturned	0
Non-Motorist Crashes	
Pedestrian	0
Bicycle	0
Contributing Factors	
Aggressive	2
Impaired	3
Crash Conditions	
Dark	3
Wet	1

NOTES	COLLISION TYPE	RECOMMENDATION	LOCAL ROADWAY SAFETY MANUAL (LRSM) COUNTERMEASURE	LRSM #	Expected Life (Years)	CMF	CALTRANS FUNDING	NUMBER OF CRASHES (2017-2021)		NUMBER OF HISTORIC CRASHES REDUCED	10-YEAR CRASH REDUCTION ESTIMATE	CRASH SEVERITY COST	10-YEAR CRASH REDUCTION BENEFIT (2022 $)	TOTAL 10-YEAR CRASH REDUCTION BENEFIT	QUANTITY/ NUMBER OF UNITS	UNIT COST (2023 $)	COST ESTIMATE (2023 $)	BENEFIT/COST
-	All	Install retroreflective backplates	Improve signal hardware: lenses, back-plates with retroreflective borders, mounting, size, and number	S02	10	0.85	90%	FATAL	0	0	0.00	$ 1,787,000	$ -	$ 410,040	22 Backplates	$ 750	$ 16,500	**24.9**
								SEVERE	0	0	0.00	$ 1,787,000	$ -					
								OTHER VISIBLE	4	0.6	1.20	$ 159,900	$ 191,880					
								COMPLAINT OF PAIN	8	1.2	2.40	$ 90,900	$ 218,160					
-	Bike + Ped	Install advanced stop bars and continental crosswalk across the north leg of the intersection (across Great Mall Pkwy)	-	-	-	-	-	FATAL	-	-	-	-	-	$ -	2000 LF	$ 15	$ 30,000	-
								SEVERE	-	-	-	-	-					
								OTHER VISIBLE	-	-	-	-	-					
								COMPLAINT OF PAIN	-	-	-	-	-					
-	All	Remove Bott's Dotts and install thermoplastic lane markings on Great Mall Pkwy approaches	-	-	-	-	-	FATAL	-	-	-	-	-	$ -	900 LF	$ 40	$ 36,000	-
								SEVERE	-	-	-	-	-					
								OTHER VISIBLE	-	-	-	-	-					
								COMPLAINT OF PAIN	-	-	-	-	-					
-	Bike + Ped	Install APS (accessible pedestrian signals)	-	-	-	-	-	FATAL	-	-	-	-	-	$ -	4 Crosswalks	$ 2,000	$ 16,000	-
								SEVERE	-	-	-	-	-					
								OTHER VISIBLE	-	-	-	-	-					
								COMPLAINT OF PAIN	-	-	-	-	-					
																Total Cost	$ 98,500	

Signalized Intersection

Location: S Main St & Montague Expy
Agency Name: City of Milpitas
Contact Name: Nolen Ugalde
E-mail: nugalde@milpitas.gov

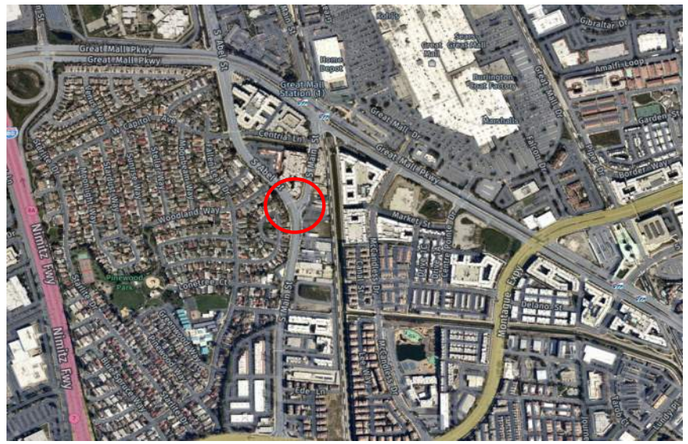


Total Crashes	11
Local CCR Differential	0.03
Equivalent Property Damage Only	86
Fatal	0
Severe Injury	0
Other Visible Injury	4
Complaint of Pain	7
Crash Type	
Broadside	2
Sideswipe	0
Rear End	8
Head On	0
Hit Object	0
Overturned	0
Non-Motorist Crashes	
Pedestrian	0
Bicycle	0
Contributing Factors	
Aggressive	7
Impaired	2
Crash Conditions	
Dark	3
Wet	3

NOTES	COLLISION TYPE	RECOMMENDATION	LOCAL ROADWAY SAFETY MANUAL (LRSM) COUNTERMEASURE	LRSM #	Expected Life (Years)	CMF	CALTRANS FUNDING	NUMBER OF CRASHES (2017-2021)		NUMBER OF HISTORIC CRASHES REDUCED	10-YEAR CRASH REDUCTION ESTIMATE	CRASH SEVERITY COST	10-YEAR CRASH REDUCTION BENEFIT (2022 $)	TOTAL 10-YEAR CRASH REDUCTION BENEFIT	QUANTITY/ NUMBER OF UNITS	UNIT COST (2023 $)	COST ESTIMATE (2023 $)	BENEFIT/COST
-	All	Install retroreflective backplates	Improve signal hardware: lenses, back-plates with retroreflective borders, mounting, size, and number	S02	10	0.85	90%	FATAL	0	0	0.00	$ 2,461,000	$ -	$ 382,770	23 Backplates	$ 750	$ 17,250	**22.2**
								SEVERE	0	0	0.00	$ 2,461,000	$ -				
								OTHER VISIBLE	4	0.6	1.20	$ 159,900	$ 191,880				
								COMPLAINT OF PAIN	7	1.05	2.10	$ 90,900	$ 190,890				
Includes cost of controller updates and design	All	Coordinate traffic signal with the traffic signal at Montague Expy and McCandless Dr/Trade Zone Blvd	Improve signal timing (coordination, phases, red, yellow, or operation)	S03	10	0.85	50%	FATAL	0	0	0.00	$ 2,461,000	$ -	$ 382,770	1 lump sum	$ 14,400	$ 14,400	**26.6**
								SEVERE	0	0	0.00	$ 2,461,000	$ -				
								OTHER VISIBLE	4	0.6	1.20	$ 159,900	$ 191,880				
								COMPLAINT OF PAIN	7	1.05	2.10	$ 90,900	$ 190,890				
	All	Install merge warning sign (MUTCD W4-2) on SBR movement, install merge pavement markings	Install raised pavement markers and striping (through intersection)	S09	10	0.90	90%	FATAL	0	0	0.00	$ 2,461,000	$ -	$ 255,180	1 Lump Sum	-	$ 1,269	**201.1**
								SEVERE	0	0	0.00	$ 2,461,000	$ -				
								OTHER VISIBLE	4	0.4	0.80	$ 159,900	$ 127,920				
								COMPLAINT OF PAIN	7	0.7	1.40	$ 90,900	$ 127,260				
-	All	Install W3-3 traffic signal ahead sign on EB Montague Expy	Install/Upgrade signs with new fluoresent sheeting	R22	10	0.85	90%	FATAL	0	0	0.00	$ 2,461,000	$ -	$ 382,770	1 Signs	$ 450	$ 450	**850.6**
								SEVERE	0	0	0.00	$ 2,461,000	$ -				
								OTHER VISIBLE	4	0.6	1.20	$ 159,900	$ 191,880				
								COMPLAINT OF PAIN	7	1.05	2.10	$ 90,900	$ 190,890				
-	Bike+Ped	ADA ramp upgrades (north and south sidewalks, and at private driveway splitter island)	-	-	-	-	-	FATAL	-	-	-	-	-	-	11 ADA Ramps	$ 5,000	$ 55,000	-
								SEVERE	-	-	-	-	-					
								OTHER VISIBLE	-	-	-	-	-					
								COMPLAINT OF PAIN	-	-	-	-	-					
Cost includes materials and soft costs, and 20% contingency	All	Upgrade median islands to be appropriate height, currently too low.	-	-	-	-	-	FATAL	-	-	-	-	-	-	1 Lump Sum	Lump Sum	$ 334,000	-
								SEVERE	-	-	-	-	-					
								OTHER VISIBLE	-	-	-	-	-					
								COMPLAINT OF PAIN	-	-	-	-	-					
																Total Cost	**$**	**422,369**

Signalized Intersection

Location: S Main St & S Abel St
Agency Name: City of Milpitas
Contact Name: Nolen Ugalde
E-mail: nugalde@milpitas.gov

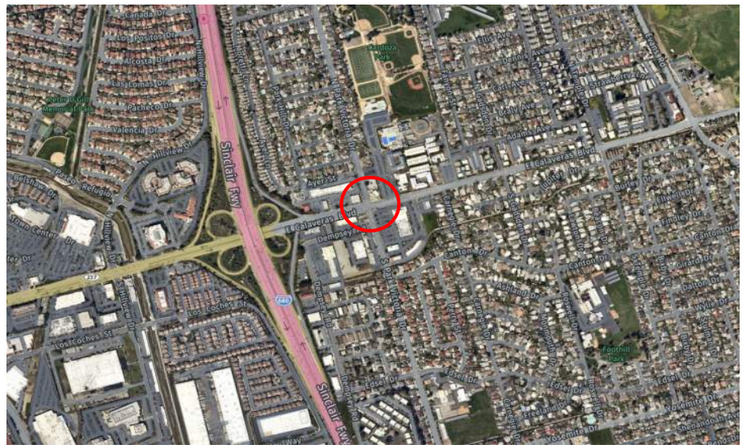


Total Crashes	11
Local CCR Differential	-0.01
Equivalent Property Damage Only	245
Fatal	0
Severe Injury	1
Other Visible Injury	4
Complaint of Pain	6
Crash Type	
Broadside	1
Sideswipe	0
Rear End	0
Head On	4
Hit Object	4
Overturned	1
Non-Motorist Crashes	
Pedestrian	0
Bicycle	0
Contributing Factors	
Aggressive	5
Impaired	7
Crash Conditions	
Dark	10
Wet	2

NOTES	COLLISION TYPE	RECOMMENDATION	LOCAL ROADWAY SAFETY MANUAL (LRSM) COUNTERMEASURE	LRSM #	Expected Life (Years)	CMF	CALTRANS FUNDING	NUMBER OF CRASHES (2017-2021)		NUMBER OF HISTORIC CRASHES REDUCED	10-YEAR CRASH REDUCTION ESTIMATE	CRASH SEVERITY COST	10-YEAR CRASH REDUCTION BENEFIT (2022 $)	TOTAL 10-YEAR CRASH REDUCTION BENEFIT	QUANTITY/ NUMBER OF UNITS	UNIT COST (2023 $)	COST ESTIMATE (2023 $)	BENEFIT/COST
-	All	Install additional SBL signal head for better visibility. Add retroreflective borders to all signal heads.	Improve signal hardware: lenses, backplates with retroreflective borders, mounting, size, and number.	S02	10	0.85	90%	FATAL	0	0	0.00	$ 2,461,000	$ -	$ 1,093,800	1 Lump Sum	-	$ 18,500	**59.1**
								SEVERE	1	0.15	0.30	$ 2,461,000	$ 738,300					
								OTHER VISIBLE	4	0.6	1.20	$ 159,900	$ 191,880					
								COMPLAINT OF PAIN	6	0.9	1.80	$ 90,900	$ 163,620					
-	Dark	Install additional safety lighting to the SB Main St approach	Add intersection lighting (Signalized Intersection => S.I.)	S01	20	0.60	90%	FATAL	0	0	0.00	$ 2,461,000	$ -	$ 2,844,080	2 Luminaires	$ 19,500	$ 39,000	**72.9**
								SEVERE	1	0.4	0.80	$ 2,461,000	$ 1,968,800					
								OTHER VISIBLE	4	1.6	3.20	$ 159,900	$ 511,680					
								COMPLAINT OF PAIN	5	2	4.00	$ 90,900	$ 363,600					
Includes unit cost, installation and design	Emergency Vehicles	Install emergency vechicle pre-emption	Install emergency vehicle pre-emption systems	S05	10	0.30	90%	FATAL	0	0	0.00	$ 2,461,000	$ -	$ 223,860	1 Lump Sum	$ 84,000	$ 84,000	**2.7**
								SEVERE	0	0	0.00	$ 2,461,000	$ -					
								OTHER VISIBLE	1	0.7	1.40	$ 159,900	$ 223,860					
								COMPLAINT OF PAIN	0	0	0.00	$ 90,900	$ -					
-	Bike+Ped	Restripe limit lines to allow for 4-feet of clearance	-					FATAL	-	-	-	-	-	$ -	47.5 SQFT of Striping	$ 10	$ 475	**-**
								SEVERE	-	-	-	-	-					
								OTHER VISIBLE	-	-	-	-	-					
								COMPLAINT OF PAIN	-	-	-	-	-					
-	Dark	Study lighting levels to determine if the existing lamp poles provide sufficient lighting, or if additional luminaires are required	-					FATAL	-	-	-	-	-	$ -	-	-	-	**-**
								SEVERE	-	-	-	-	-					
								OTHER VISIBLE	-	-	-	-	-					
								COMPLAINT OF PAIN	-	-	-	-	-					
																Total Cost	**$**	**141,975**

Signalized Intersection

Location: Calaveras Blvd & S Park Victoria Dr
Agency Name: City of Milpitas
Contact Name: Nolen Ugalde
E-mail: nugalde@milpitas.gov

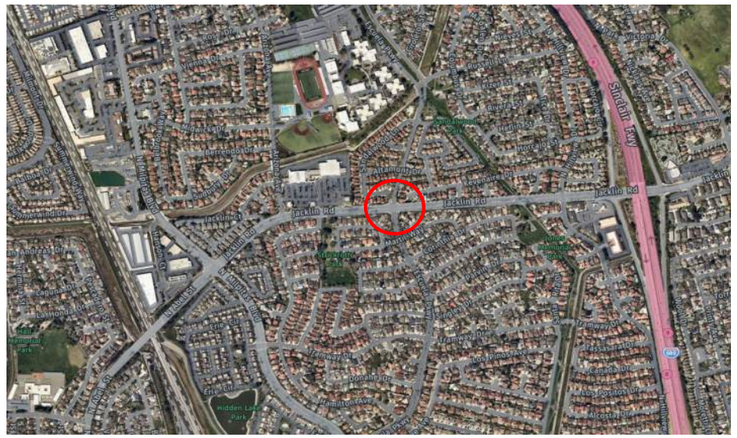


Total Crashes	11
Local CCR Differential	-0.08
Equivalent Property Damage Only	81
Fatal	0
Severe Injury	0
Other Visible Injury	3
Complaint of Pain	8
Crash Type	
Broadside	4
Sideswipe	1
Rear End	5
Head On	0
Hit Object	0
Overturned	0
Non-Motorist Crashes	
Pedestrian	1
Bicycle	0
Contributing Factors	
Aggressive	5
Impaired	1
Crash Conditions	
Dark	2
Wet	1

NOTES	COLLISION TYPE	RECOMMENDATION	LOCAL ROADWAY SAFETY MANUAL (LRSM) COUNTERMEASURE	LRSM #	Expected Life (Years)	CMF	CALTRANS FUNDING	NUMBER OF CRASHES (2017-2021)		NUMBER OF HISTORIC CRASHES REDUCED	10-YEAR CRASH REDUCTION ESTIMATE	CRASH SEVERITY COST	10-YEAR CRASH REDUCTION BENEFIT (2022 $)	TOTAL 10-YEAR CRASH REDUCTION BENEFIT	QUANTITY/ NUMBER OF UNITS	UNIT COST (2023 $)	COST ESTIMATE (2023 $)	BENEFIT/COST
-	All	Install retroreflective backplates and upgrade to 12'' signal heads	Improve signal hardware: lenses, back-plates with retroreflective borders, mounting, size, and number	S02	10	0.85	90%	FATAL	0	0	0.00	$ 1,787,000	$ -	$ 362,070	20 Signal Heads	$ 8,750	$ 175,000	**2.1**
								SEVERE	0	0	0.00	$ 1,787,000	$ -					
								OTHER VISIBLE	3	0.45	0.90	$ 159,900	$ 143,910					
								COMPLAINT OF PAIN	8	1.2	2.40	$ 90,900	$ 218,160					
-	Bike + Ped	Install continental crosswalks and advance stop bars	Install pedestrian crossing	S18PB	20	0.75	90%	FATAL	0	0	0.00	$ 1,787,000	$ -	$ 79,950	1562.5 SQFT of Striping	$ 6	$ 9,375	**8.5**
								SEVERE	0	0	0.00	$ 1,787,000	$ -					
								OTHER VISIBLE	1	0.25	0.50	$ 159,900	$ 79,950					
								COMPLAINT OF PAIN	0	0	0.00	$ 90,900	$ -					
-	-	Install APS (accessible pedestrian signals)	-	-	-	-	-	FATAL	-	-	-	-	-	$ -	4 Crosswalks	$ 2,000	$ 16,000	-
								SEVERE	-	-	-	-	-					
								OTHER VISIBLE	-	-	-	-	-					
								COMPLAINT OF PAIN	-	-	-	-	-					
-	-	Restripe the receiving lanes on NB S Park Victoria	-	-	-	-	-	FATAL	-	-	-	-	-	$ -	250 Feet	$ 3	$ 750	-
								SEVERE	-	-	-	-	-					
								OTHER VISIBLE	-	-	-	-	-					
								COMPLAINT OF PAIN	-	-	-	-	-					
																Total Cost	**$ 201,125**	

Signalized Intersection

Location: Escuela Pkwy & Jacklin Rd
Agency Name: City of Milpitas
Contact Name: Nolen Ugalde
E-mail: nugalde@milpitas.gov

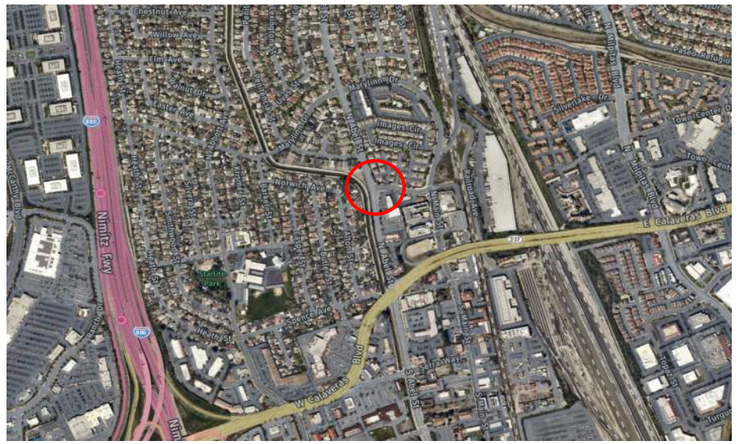


Total Crashes	9
Local CCR Differential	0.07
Equivalent Property Damage Only	169
Fatal	0
Severe Injury	1
Other Visible Injury	0
Complaint of Pain	8
Crash Type	
Broadside	1
Sideswipe	4
Rear End	2
Head On	1
Hit Object	1
Overturned	0
Non-Motorist Crashes	
Pedestrian	0
Bicycle	0
Contributing Factors	
Aggressive	4
Impaired	2
Crash Conditions	
Dark	3
Wet	1

NOTES	COLLISION TYPE	RECOMMENDATION	LOCAL ROADWAY SAFETY MANUAL (LRSM) COUNTERMEASURE	LRSM #	Expected Life (Years)	CMF	CALTRANS FUNDING	NUMBER OF CRASHES (2017-2021)		NUMBER OF HISTORIC CRASHES REDUCED	10-YEAR CRASH REDUCTION ESTIMATE	CRASH SEVERITY COST	10-YEAR CRASH REDUCTION BENEFIT (2022 $)	TOTAL 10-YEAR CRASH REDUCTION BENEFIT	QUANTITY/ NUMBER OF UNITS	UNIT COST (2023 $)	COST ESTIMATE (2023 $)	BENEFIT/COST
-	All	Install retroreflective backplates and upgrade to 12'' signal heads	Improve signal hardware: lenses, back-plates with retroreflective borders, mounting, size, and number	S02	10	0.85	90%	FATAL	0	0	0.00	$ 1,787,000	$ -	$ 754,260	16 Signal Heads	$ 8,750	$ 140,000	**5.4**
								SEVERE	1	0.15	0.30	$ 1,787,000	$ 536,100					
								OTHER VISIBLE	0	0	0.00	$ 159,900	$ -					
								COMPLAINT OF PAIN	8	1.2	2.40	$ 90,900	$ 218,160					
Based on the School Safety Assessment	Bike + Ped	Implement green conflict zone striping for bike lanes on Escuela Pkwy	Install advance stop bar before crosswalk (bicycle box)	R32PB	20	0.65	90%	FATAL	0	0	0.00	$ 2,843,000	$ -	$ -	12000 SQFT Striping	$ 6	$ 72,000	**0.0**
								SEVERE	0	0	0.00	$ 2,843,000	$ -					
								OTHER VISIBLE	0	0	0.00	$ 159,900	$ -					
								COMPLAINT OF PAIN	0	0	0.00	$ 90,900	$ -					
-	-	Redesign the median to provide a NACTO compliant pedestrian refuge area, or consider removal of pedestrian push buttons	-	-	-	-	-	FATAL	-	-	-	-	-	$ -	-	-	-	-
								SEVERE	-	-	-	-	-					
								OTHER VISIBLE	-	-	-	-	-					
								COMPLAINT OF PAIN	-	-	-	-	-					
																Total Cost	**$**	**212,000**

Signalized Intersection

Location: Weller Ln & N Abel St
Agency Name: City of Milpitas
Contact Name: Nolen Ugalde
E-mail: nugalde@milpitas.gov

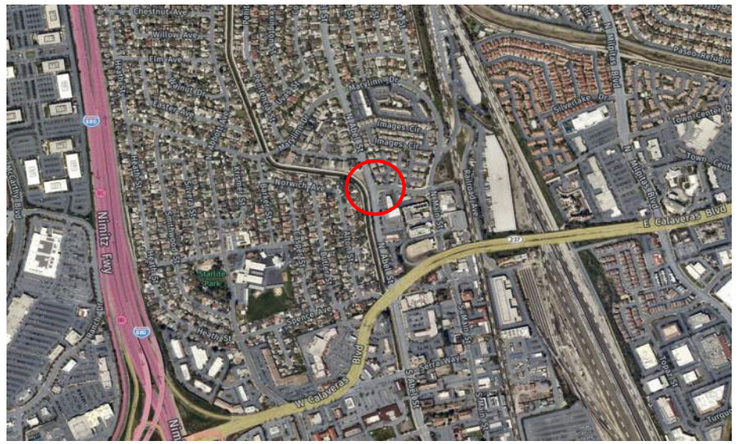


Total Crashes	7
Local CCR Differential	0.01
Equivalent Property Damage Only	170
Fatal	0
Severe Injury	1
Other Visible Injury	3
Complaint of Pain	3
Crash Type	
Broadside	2
Sideswipe	2
Rear End	1
Head On	0
Hit Object	1
Overturned	0
Non-Motorist Crashes	
Pedestrian	2
Bicycle	1
Contributing Factors	
Aggressive	3
Impaired	0
Crash Conditions	
Dark	0
Wet	0

NOTES	COLLISION TYPE	RECOMMENDATION	LOCAL ROADWAY SAFETY MANUAL (LRSM) COUNTERMEASURE	LRSM #	Expected Life (Years)	CMF	CALTRANS FUNDING	NUMBER OF CRASHES (2017-2021)		NUMBER OF HISTORIC CRASHES REDUCED	10-YEAR CRASH REDUCTION ESTIMATE	CRASH SEVERITY COST	10-YEAR CRASH REDUCTION BENEFIT (2022 $)	TOTAL 10-YEAR CRASH REDUCTION BENEFIT	QUANTITY/ NUMBER OF UNITS	UNIT COST (2023 $)	COST ESTIMATE (2023 $)	BENEFIT/COST
-	All	Install retroreflective backplates and upgrade to 12'' signal heads	Improve signal hardware: lenses, back-plates with retroreflective borders, mounting, size, and number	S02	10	0.85	90%	FATAL	0	0	0.00	$ 1,787,000	$ -	$ 761,820	11 Signal Heads	$ 8,750	$ 96,250	**7.9**
								SEVERE	1	0.15	0.30	$ 1,787,000	$ 536,100					
								OTHER VISIBLE	3	0.45	0.90	$ 159,900	$ 143,910					
								COMPLAINT OF PAIN	3	0.45	0.90	$ 90,900	$ 81,810					
-	Bike + Ped	Install advance stop bar.	Install advance stop bar before crosswalk	S20PB	10	0.85	90%	FATAL	0	0	0.00	$ 1,787,000	$ -	$ 632,040	115 SQFT of Striping	$ 7	$ 805	**785.1**
								SEVERE	1	0.15	0.30	$ 1,787,000	$ 536,100					
								OTHER VISIBLE	2	0.3	0.60	$ 159,900	$ 95,940					
								COMPLAINT OF PAIN	0	0	0.00	$ 90,900	$ -					
-	All	Install thermoplastic pavement marking as intersection approaches. Additionally, stripe a bike lane though the intersetion on SB Abel St to support bicyclist safety and provide a buffer between SB vehicles and the pedestrian facilities.	Install raised pavement markers and striping (through intersection)	S09	10	0.90	90%	FATAL	0	0	0.00	$ 1,787,000	$ -	$ 507,880	750 SQFT of Striping	$ 7	$ 5,250	**96.7**
								SEVERE	1	0.1	0.20	$ 1,787,000	$ 357,400					
								OTHER VISIBLE	3	0.3	0.60	$ 159,900	$ 95,940					
								COMPLAINT OF PAIN	3	0.3	0.60	$ 90,900	$ 54,540					
Includes cost of controller updates and design	Bike + Ped	Implement LPI	Modify signal phasing to implement leading pedestrian interval (LPI)	S21PB	10	0.40	90%	FATAL	0	0	0.00	$ 1,787,000	$ -	$ 2,528,160	1 Lump Sum	$ 45,600	$ 45,600	**55.4**
								SEVERE	1	0.6	1.20	$ 1,787,000	$ 2,144,400					
								OTHER VISIBLE	2	1.2	2.40	$ 159,900	$ 383,760					
								COMPLAINT OF PAIN	0	0	0.00	$ 90,900	$ -					
Includes unit cost, installation and design.	Bike + Ped	Install pedestrian countdown signal heads	Install pedestrian countdown signal heads	S17PB	20	0.75	90%	FATAL	0	0	0.00	$ 1,787,000	$ -	$ 1,053,400	6 Pedestrian Signal Heads	$ 5,460	$ 32,760	**32.2**
								SEVERE	1	0.25	0.50	$ 1,787,000	$ 893,500					
								OTHER VISIBLE	2	0.5	1.00	$ 159,900	$ 159,900					
								COMPLAINT OF PAIN	0	0	0.00	$ 90,900	$ -					

Signalized Intersection

Location: Weller Ln & N Abel St
Agency Name: City of Milpitas
Contact Name: Nolen Ugalde
E-mail: nugalde@milpitas.gov



Total Crashes	7
Local CCR Differential	0.01
Equivalent Property Damage Only	170
Fatal	0
Severe Injury	1
Other Visible Injury	3
Complaint of Pain	3
Crash Type	
Broadside	2
Sideswipe	2
Rear End	1
Head On	0
Hit Object	1
Overturned	0
Non-Motorist Crashes	
Pedestrian	2
Bicycle	1
Contributing Factors	
Aggressive	3
Impaired	0
Crash Conditions	
Dark	0
Wet	0

NOTES	COLLISION TYPE	RECOMMENDATION	LOCAL ROADWAY SAFETY MANUAL (LRSM) COUNTERMEASURE	LRSM #	Expected Life (Years)	CMF	CALTRANS FUNDING	NUMBER OF CRASHES (2017-2021)		NUMBER OF HISTORIC CRASHES REDUCED	10-YEAR CRASH REDUCTION ESTIMATE	CRASH SEVERITY COST	10-YEAR CRASH REDUCTION BENEFIT (2022 $)	TOTAL 10-YEAR CRASH REDUCTION BENEFIT	QUANTITY/ NUMBER OF UNITS	UNIT COST (2023 $)	COST ESTIMATE (2023 $)	BENEFIT/COST
-	Bike + Ped	Install APS (accessible pedestrian signals) for crosswalks across Abel St	-	-	-	-	-	FATAL	-	-	-	-	-	$ -	4 Push Buttons	$ 2,000	$ 8,000	-
								SEVERE	-	-	-	-	-					
								OTHER VISIBLE	-	-	-	-	-					
								COMPLAINT OF PAIN	-	-	-	-	-					
																Total Cost	**$ 188,665**	

Kimley»Horn

Signalized Intersection

Location: Washington Dr & N Milpitas Blvd
Agency Name: City of Milpitas
Contact Name: Nolen Ugalde
E-mail: nugalde@milpitas.gov

Total Crashes	6
Local CCR Differential	-0.09
Equivalent Property Damage Only	50
Fatal	0
Severe Injury	0
Other Visible Injury	3
Complaint of Pain	3
Crash Type	
Broadside	2
Sideswipe	0
Rear End	4
Head On	0
Hit Object	0
Overturned	0
Non-Motorist Crashes	
Pedestrian	0
Bicycle	2
Contributing Factors	
Aggressive	3
Impaired	0
Crash Conditions	
Dark	2
Wet	0

NOTES	COLLISION TYPE	RECOMMENDATION	LOCAL ROADWAY SAFETY MANUAL (LRSM) COUNTERMEASURE	LRSM #	Expected Life (Years)	CMF	CALTRANS FUNDING	NUMBER OF CRASHES (2017-2021)	NUMBER OF HISTORIC CRASHES REDUCED	10-YEAR CRASH REDUCTION ESTIMATE	CRASH SEVERITY COST	10-YEAR CRASH REDUCTION BENEFIT (2022 $)	TOTAL 10-YEAR CRASH REDUCTION BENEFIT	QUANTITY/ NUMBER OF UNITS	UNIT COST (2023 $)	COST ESTIMATE (2023 $)	BENEFIT/COST

Signalized Intersection

Location: Washington Dr & N Milpitas Blvd
Agency Name: City of Milpitas
Contact Name: Nolen Ugalde
E-mail: nugalde@milpitas.gov

Total Crashes	6
Local CCR Differential	-0.09
Equivalent Property Damage Only	50
Fatal	0
Severe Injury	0
Other Visible Injury	3
Complaint of Pain	3
Crash Type	
Broadside	2
Sideswipe	0
Rear End	4
Head On	0
Hit Object	0
Overturned	0
Non-Motorist Crashes	
Pedestrian	0
Bicycle	2
Contributing Factors	
Aggressive	3
Impaired	0
Crash Conditions	
Dark	2
Wet	0

NOTES	COLLISION TYPE	RECOMMENDATION	LOCAL ROADWAY SAFETY MANUAL (LRSM) COUNTERMEASURE	LRSM #	Expected Life (Years)	CMF	CALTRANS FUNDING	NUMBER OF CRASHES (2017-2021)		NUMBER OF HISTORIC CRASHES REDUCED	10-YEAR CRASH REDUCTION ESTIMATE	CRASH SEVERITY COST	10-YEAR CRASH REDUCTION BENEFIT (2022 $)	TOTAL 10-YEAR CRASH REDUCTION BENEFIT	QUANTITY/ NUMBER OF UNITS	UNIT COST (2023 $)	COST ESTIMATE (2023 $)	BENEFIT/COST
-	Dark	Install additional safety lighting to Washington Dr receiving lanes	Add intersection lighting	S01	20	0.60	90%	FATAL	0	0	0.00	$ 1,787,000	$ -	$ 200,640	1 Luminaire	$ 19,500	$ 19,500	**10.3**
								SEVERE	0	0	0.00	$ 1,787,000	$ -				
								OTHER VISIBLE	1	0.4	0.80	$ 159,900	$ 127,920				
								COMPLAINT OF PAIN	1	0.4	0.80	$ 90,900	$ 72,720				
-	All	Install retroreflective backplates and upgrade to 12'' signal heads	Improve signal hardware: lenses, back-plates with retroreflective borders, mounting, size, and number	S02	10	0.85	90%	FATAL	0	0	0.00	$ 1,787,000	$ -	$ 225,720	5 Signal Heads and 16 Retroreflective Backplates	$8,000 and $250	$ 44,000	**5.1**
								SEVERE	0	0	0.00	$ 1,787,000	$ -				
								OTHER VISIBLE	3	0.45	0.90	$ 159,900	$ 143,910				
								COMPLAINT OF PAIN	3	0.45	0.90	$ 90,900	$ 81,810				
-	Bike + Ped	Install advance stop bars on N Milpitas Blvd	Install advance stop bar before crosswalk	S20PB	10	0.85	90%	FATAL	0	0	0.00	$ 1,787,000	$ -	$ 95,940	140 SQFT of Striping	$ 7	$ 980	**97.9**
								SEVERE	0	0	0.00	$ 1,787,000	$ -				
								OTHER VISIBLE	2	0.3	0.60	$ 159,900	$ 95,940				
								COMPLAINT OF PAIN	0	0	0.00	$ 90,900	$ -				
-	All	Install thermoplastic pavement marking at intersection approaches.	Install raised pavement markers and striping (through intersection)	S09	10	0.90	90%	FATAL	0	0	0.00	$ 1,787,000	$ -	$ 150,480	600 SQFT of Striping	$ 7	$ 4,200	**35.8**
								SEVERE	0	0	0.00	$ 1,787,000	$ -				
								OTHER VISIBLE	3	0.3	0.60	$ 159,900	$ 95,940				
								COMPLAINT OF PAIN	3	0.3	0.60	$ 90,900	$ 54,540				
Includes cost of controller updates and design	Bike + Ped	Implement LPI	Modify signal phasing to implement lead pedestrian interval (LPI)	S21PB	10	0.40	90%	FATAL	0	0	0.00	$ 1,787,000	$ -	$ 383,760	1 Lump Sum	$ 45,600	$ 45,600	**8.4**
								SEVERE	0	0	0.00	$ 1,787,000	$ -				
								OTHER VISIBLE	2	1.2	2.40	$ 159,900	$ 383,760				
								COMPLAINT OF PAIN	0	0	0.00	$ 90,900	$ -				
Includes unit cost, installation and design.	Bike + Ped	Install pedestrian countdown signal heads	Install pedestrian countdown signal heads	S17PB	20	0.75	90%	FATAL	0	0	0.00	$ 1,787,000	$ -	$ 159,900	8 Pedestrian Signal Heads	$ 5,460	$ 43,680	**3.7**
								SEVERE	0	0	0.00	$ 1,787,000	$ -				
								OTHER VISIBLE	2	0.5	1.00	$ 159,900	$ 159,900				
								COMPLAINT OF PAIN	0	0	0.00	$ 90,900	$ -				
-	-	Install APS (accessible pedestrian signals)	-	-	-	-	-	FATAL	-	-	-	-	-	$ -	8 Push Buttons	$ 2,000	$ 16,000	**-**
								SEVERE	-	-	-	-	-				
								OTHER VISIBLE	-	-	-	-	-				
								COMPLAINT OF PAIN	-	-	-	-	-				

Signalized Intersection

Location: Washington Dr & N Milpitas Blvd
Agency Name: City of Milpitas
Contact Name: Nolen Ugalde
E-mail: nugalde@milpitas.gov

Total Crashes	6
Local CCR Differential	-0.09
Equivalent Property Damage Only	50
Fatal	0
Severe Injury	0
Other Visible Injury	3
Complaint of Pain	3
Crash Type	
Broadside	2
Sideswipe	0
Rear End	4
Head On	0
Hit Object	0
Overturned	0
Non-Motorist Crashes	
Pedestrian	0
Bicycle	2
Contributing Factors	
Aggressive	3
Impaired	0
Crash Conditions	
Dark	2
Wet	0

NOTES	COLLISION TYPE	RECOMMENDATION	LOCAL ROADWAY SAFETY MANUAL (LRSM) COUNTERMEASURE	LRSM #	Expected Life (Years)	CMF	CALTRANS FUNDING	NUMBER OF CRASHES (2017-2021)		NUMBER OF HISTORIC CRASHES REDUCED	10-YEAR CRASH REDUCTION ESTIMATE	CRASH SEVERITY COST	10-YEAR CRASH REDUCTION BENEFIT (2022 $)	TOTAL 10-YEAR CRASH REDUCTION BENEFIT	QUANTITY/ NUMBER OF UNITS	UNIT COST (2023 $)	COST ESTIMATE (2023 $)	BENEFIT/COST
-	Bike + Ped	Redesign the median to provide a NACTO compliant pedestrian refuge area, or consider removal of pedestrian push buttons	-	-	-	-	-	FATAL	-	-	-	-	-	$ -	-	-	-	-
								SEVERE	-	-	-	-	-					
								OTHER VISIBLE	-	-	-	-	-					
								COMPLAINT OF PAIN	-	-	-	-	-					

Total Cost	$ 173,960

Unsignalized Intersection

Location: Butler St & W Calaveras Blvd
Agency Name: City of Milpitas
Contact Name: Nolen Ugalde
E-mail: nugalde@milpitas.gov

Total Crashes	14
Local CCR Differential	2.10
Equivalent Property Damage Only	102
Fatal	0
Severe Injury	0
Other Visible Injury	5
Complaint of Pain	8
Crash Type	
Broadside	10
Sideswipe	1
Rear End	0
Head On	0
Hit Object	1
Overturned	0
Non-Motorist Crashes	
Pedestrian	0
Bicycle	0
Contributing Factors	
Aggressive	1
Impaired	0
Crash Conditions	
Dark	2
Wet	0

NOTES	COLLISION TYPE	RECOMMENDATION	LOCAL ROADWAY SAFETY MANUAL (LRSM) COUNTERMEASURE	LRSM #	Expected Life (Years)	CMF	CALTRANS FUNDING	NUMBER OF CRASHES (2017-2021)		NUMBER OF HISTORIC CRASHES REDUCED	10-YEAR CRASH REDUCTION ESTIMATE	CRASH SEVERITY COST	10-YEAR CRASH REDUCTION BENEFIT (2022 $)	TOTAL 10-YEAR CRASH REDUCTION BENEFIT	QUANTITY/ NUMBER OF UNITS	UNIT COST (2023 $)	COST ESTIMATE (2023 $)	BENEFIT/COST
-	All	Update pavement markings, adding a pedestrian crosswalk and advance stop bar	Upgrade intersection pavement markings.	NS07	10	0.75	90%	FATAL	0	0	0.00	$ 2,843,000	$ -	$ 763,350	222 SQFT of Striping	$ 7	$ 1,554	**491.2**
								SEVERE	0	0	0.00	$ 2,843,000	$ -				
								OTHER VISIBLE	5	1.25	2.50	$ 159,900	$ 399,750				
								COMPLAINT OF PAIN	8	2	4.00	$ 90,900	$ 363,600				
Includes unit cost, installation and design	All	Install splitter island on west leg chanelling vehicles into right turn with pedestrian refuge (north leg)	Install splitter-islands on minor road approaches	NS13	20	0.60	90%	FATAL	0	0	0.00	$ 2,843,000	$ -	$ 1,221,360	1 Lump Sum	$ 60,000	$ 60,000	**20.4**
								SEVERE	0	0	0.00	$ 2,843,000	$ -				
								OTHER VISIBLE	5	2	4.00	$ 159,900	$ 639,600				
								COMPLAINT OF PAIN	8	3.2	6.40	$ 90,900	$ 581,760				
-	-	ADA ramp upgrades	-	-	-	-	-	FATAL	-	-	-	-	-	-	4 ADA Ramps	$ 5,000	$ 20,000	-
								SEVERE	-	-	-	-	-				
								OTHER VISIBLE	-	-	-	-	-				
								COMPLAINT OF PAIN	-	-	-	-	-				
-	-	Install bulb outs (NW and SW corners)	-	-	-	-	-	FATAL	-	-	-	-	-	-	2 Bulb Outs	$ 10,000	$ 20,000	-
								SEVERE	-	-	-	-	-				
								OTHER VISIBLE	-	-	-	-	-				
								COMPLAINT OF PAIN	-	-	-	-	-				
																Total Cost	**$ 101,554**	

Unsignalized Intersection

Location: Washington Drive & Arizona Ave
Agency Name: City of Milpitas
Contact Name: Nolen Ugalde
E-mail: nugalde@milpitas.gov

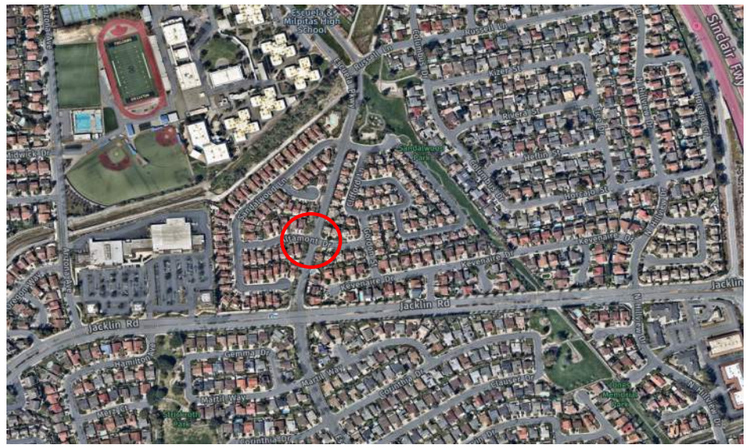
Total Crashes	6
Local CCR Differential	0.43
Equivalent Property Damage Only	55
Fatal	0
Severe Injury	0
Other Visible Injury	4
Complaint of Pain	2
Crash Type	
Broadside	5
Sideswipe	0
Rear End	0
Head On	0
Hit Object	0
Overturned	0
Non-Motorist Crashes	
Pedestrian	1
Bicycle	2
Contributing Factors	
Aggressive	3
Impaired	0
Crash Conditions	
Dark	3
Wet	2

NOTES	COLLISION TYPE	RECOMMENDATION	LOCAL ROADWAY SAFETY MANUAL (LRSM) COUNTERMEASURE	LRSM #	Expected Life (Years)	CMF	CALTRANS FUNDING	NUMBER OF CRASHES (2017-2021)		NUMBER OF HISTORIC CRASHES REDUCED	10-YEAR CRASH REDUCTION ESTIMATE	CRASH SEVERITY COST	10-YEAR CRASH REDUCTION BENEFIT (2022 $)	TOTAL 10-YEAR CRASH REDUCTION BENEFIT	QUANTITY/ NUMBER OF UNITS	UNIT COST (2023 $)	COST ESTIMATE (2023 $)	BENEFIT/COST
-	All	Install retroreflective strips on stop sign posts	Install/Upgrade larger or additional stop signs or other intersection warning/regulatory signs	NS06	10	0.85	90%	FATAL	0	0	0.00	$ 2,843,000	$ -	$ 246,420	4 Retroflective Strip	$ 250	$ 1,000	**246.4**
								SEVERE	0	0	0.00	$ 2,843,000	$ -				
								OTHER VISIBLE	4	0.6	1.20	$ 159,900	$ 191,880				
								COMPLAINT OF PAIN	2	0.3	0.60	$ 90,900	$ 54,540				
-	All	Install stop ahead warning signs ahead of intersection on Arizona Avenue	Install/Upgrade larger or additional stop signs or other intersection warning/regulatory signs	NS06	10	0.85	90%	FATAL	0	0	0.00	$ 2,843,000	$ -	$ 246,420	2 Signs	$ 450	$ 900	**273.8**
								SEVERE	0	0	0.00	$ 2,843,000	$ -				
								OTHER VISIBLE	4	0.6	1.20	$ 159,900	$ 191,880				
								COMPLAINT OF PAIN	2	0.3	0.60	$ 90,900	$ 54,540				
-	All	Install stop ahead pavement markings on Arizona Avenue	Upgrade intersection pavement markings	NS07	10	0.75	90%	FATAL	0	0	0.00	$ 2,843,000	$ -	$ 410,700	106 SQFT of Striping	$ 7	$ 742	**553.5**
								SEVERE	0	0	0.00	$ 2,843,000	$ -				
								OTHER VISIBLE	4	1	2.00	$ 159,900	$ 319,800				
								COMPLAINT OF PAIN	2	0.5	1.00	$ 90,900	$ 90,900				
-	All	Install centerline pavement marker (Caltrans Standard Plan A20A, Detail 21) on all approaches	Upgrade intersection pavement markings	NS07	10	0.75	90%	FATAL	0	0	0.00	$ 2,843,000	$ -	$ 410,700	200 SQFT of Striping	$ 7	$ 1,400	**293.4**
								SEVERE	0	0	0.00	$ 2,843,000	$ -				
								OTHER VISIBLE	4	1	2.00	$ 159,900	$ 319,800				
								COMPLAINT OF PAIN	2	0.5	1.00	$ 90,900	$ 90,900				
-	-	Install bulb outs on all corners	-	-	-	-	-	FATAL	-	-	-	-	-	-	4 Bulb Outs	$ 10,000	$ 40,000	-
								SEVERE	-	-	-	-	-				
								OTHER VISIBLE	-	-	-	-	-				
								COMPLAINT OF PAIN	-	-	-	-	-				
-		Install new road signs at the NW corner	-	-	-	-	-	FATAL	-	-	-	-	-	-	2 Signs	$ 450	$ 900	-
								SEVERE	-	-	-	-	-				
								OTHER VISIBLE	-	-	-	-	-				
								COMPLAINT OF PAIN	-	-	-	-	-				

Total Cost	$ 44,942

Unsignalized Intersection

Location: Altamont Drive & Escuela Pkwy
Agency Name: City of Milpitas
Contact Name: Nolen Ugalde
E-mail: nugalde@milpitas.gov



Total Crashes	4
Local CCR Differential	0.17
Equivalent Property Damage Only	42.9
Fatal	0
Severe Injury	0
Other Visible Injury	4
Complaint of Pain	0
Crash Type	
Broadside	1
Sideswipe	0
Rear End	1
Head On	1
Hit Object	0
Overturned	0
Non-Motorist Crashes	
Pedestrian	0
Bicycle	3
Contributing Factors	
Aggressive	1
Impaired	0
Crash Conditions	
Dark	0
Wet	0

NOTES	COLLISION TYPE	RECOMMENDATION	LOCAL ROADWAY SAFETY MANUAL (LRSM) COUNTERMEASURE	LRSM #	Expected Life (Years)	CMF	CALTRANS FUNDING	NUMBER OF CRASHES (2017-2021)		NUMBER OF HISTORIC CRASHES REDUCED	10-YEAR CRASH REDUCTION ESTIMATE	CRASH SEVERITY COST	10-YEAR CRASH REDUCTION BENEFIT (2022 $)	TOTAL 10-YEAR CRASH REDUCTION BENEFIT	QUANTITY/ NUMBER OF UNITS	UNIT COST (2023 $)	COST ESTIMATE (2023 $)	BENEFIT/COST
-	All	Install centerline pavement marker (Caltrans Standard Plan A20A, Detail 21) on all approaches	Upgrade intersection pavement markings	NS07	10	0.75	90%	FATAL	0	0	0.00	$ 2,843,000	$ -	$ 319,800	200 SQFT of Striping	$ 7	$ 1,400	**228.4**
								SEVERE	0	0	0.00	$ 2,843,000	$ -				
								OTHER VISIBLE	4	1	2.00	$ 159,900	$ 319,800				
								COMPLAINT OF PAIN	0	0	0.00	$ 90,900	$ -				
-	All	Install retroreflective strips on stop sign posts	Install/Upgrade larger or additional stop signs or other intersection warning/regulatory signs	NS06	10	0.85	90%	FATAL	0	0	0.00	$ 2,843,000	$ -	$ 191,880	2 Retroflective Strip	$ 250	$ 500	**383.8**
								SEVERE	0	0	0.00	$ 2,843,000	$ -				
								OTHER VISIBLE	4	0.6	1.20	$ 159,900	$ 191,880				
								COMPLAINT OF PAIN	0	0	0.00	$ 90,900	$ -				
-	Bike + Ped	Install school zone pedestrian crossing across Escuela Pkwy	Install pedestrian crossing at uncontrolled locations (sign and markings only)	NS20PB	10	0.75	90%	FATAL	0	0	0.00	$ 2,461,000	$ -	$ 239,850	600 SQFT of Striping	$ 7	$ 4,200	**57.1**
								SEVERE	0	0	0.00	$ 2,461,000	$ -				
								OTHER VISIBLE	3	0.75	1.50	$ 159,900	$ 239,850				
								COMPLAINT OF PAIN	0	0	0.00	$ 90,900	$ -				
-	All	Install stop bar on side street and install school zone pedestrian crossing striping across Altamont Dr	Upgrade intersection pavement markings	NS07	10	0.75	90%	FATAL	0	0	0.00	$ 2,843,000	$ -	$ 319,800	820 SQFT of Striping	$ 7	$ 5,740	**55.7**
								SEVERE	0	0	0.00	$ 2,843,000	$ -				
								OTHER VISIBLE	4	1	2.00	$ 159,900	$ 319,800				
								COMPLAINT OF PAIN	0	0	0.00	$ 90,900	$ -				
-	Bike + Ped	Add green bike lane pavement marking in conflict areas across Altamont Dr	Install advance stop bar before crosswalk (bicycle box)	R32PB	20	0.65	90%	FATAL	0	0	0.00	$ 2,461,000	$ -	$ 335,790	720 SQFT of Striping	$ 7	$ 5,040	**66.6**
								SEVERE	0	0	0.00	$ 2,461,000	$ -				
								OTHER VISIBLE	3	1.05	2.10	$ 159,900	$ 335,790				
								COMPLAINT OF PAIN	0	0	0.00	$ 90,900	$ -				
-	-	Install bulb outs on all corners	-	-	-	-	-	FATAL	-	-	-	-	-	-	4 Bulb Outs	$ 10,000	$ 40,000	**-**
								SEVERE	-	-	-	-	-				
								OTHER VISIBLE	-	-	-	-	-				
								COMPLAINT OF PAIN	-	-	-	-	-				
																	$ 56,880	

Unsignalized Intersection

Location: Calaveras Rd & Evans Rd
Agency Name: City of Milpitas
Contact Name: Nolen Ugalde
E-mail: nugalde@milpitas.gov

Total Crashes	4
Local CCR Differential	0.00
Equivalent Property Damage Only	34
Fatal	0
Severe Injury	0
Other Visible Injury	2
Complaint of Pain	2
Crash Type	
Broadside	3
Sideswipe	1
Rear End	0
Head On	0
Hit Object	0
Overturned	0
Non-Motorist Crashes	
Pedestrian	0
Bicycle	2
Contributing Factors	
Aggressive	0
Impaired	0
Crash Conditions	
Dark	1
Wet	1

NOTES	COLLISION TYPE	RECOMMENDATION	LOCAL ROADWAY SAFETY MANUAL (LRSM) COUNTERMEASURE	LRSM #	Expected Life (Years)	CMF	CALTRANS FUNDING	NUMBER OF CRASHES (2017-2021)		NUMBER OF HISTORIC CRASHES REDUCED	10-YEAR CRASH REDUCTION ESTIMATE	CRASH SEVERITY COST	10-YEAR CRASH REDUCTION BENEFIT (2022 $)	TOTAL 10-YEAR CRASH REDUCTION BENEFIT	QUANTITY/ NUMBER OF UNITS	UNIT COST (2023 $)	COST ESTIMATE (2023 $)	BENEFIT/COST
-	Bike+Ped	Install advance stop bars and green conflict zone bike lane treatment at intersection approaches	Install advance stop bar before crosswalk (bicycle box)	R32PB	20	0.65	90%	FATAL	0	0	0.00	$ 2,461,000	$ -	$ 175,560	6000 SQFT of Striping	$ 7	$ 39,000	**4.5**
								SEVERE	0	0	0.00	$ 2,461,000	$ -					
								OTHER VISIBLE	1	0.35	0.70	$ 159,900	$ 111,930					
								COMPLAINT OF PAIN	1	0.35	0.70	$ 90,900	$ 63,630					
Includes unit cost, installation, design and photometric.	Night	Install supplemental intersection safety lighting	Add intersection lighting	NS01	20	0.60	90%	FATAL	0	0	0.00	$ 2,461,000	$ -	$ 72,720	1 Lump Sum	$ 43,200	$ 43,200	**1.7**
								SEVERE	0	0	0.00	$ 2,461,000	$ -					
								OTHER VISIBLE	0	0	0.00	$ 159,900	$ -					
								COMPLAINT OF PAIN	1	0.4	0.80	$ 90,900	$ 72,720					
Includes cost of installation and design	All	Install raised median on EB Calaveras Blvd approach	Install raised median on approaches	NS14	20	0.75	90%	FATAL	0	0	0.00	$ 2,461,000	$ -	$ 250,800	250 LF	$ 350	$ 87,500	**2.9**
								SEVERE	0	0	0.00	$ 2,461,000	$ -					
								OTHER VISIBLE	2	0.5	1.00	$ 159,900	$ 159,900					
								COMPLAINT OF PAIN	2	0.5	1.00	$ 90,900	$ 90,900					
-	All	Install retroreflective strips on stop sign posts	Install/Upgrade larger or additional stop signs or other intersection warning/regulatory signs	NS06	10	0.85	90%	FATAL	0	0	0.00	$ 2,843,000	$ -	$ 150,480	4	$ 250	$ 1,000	**150.5**
								SEVERE	0	0	0.00	$ 2,843,000	$ -					
								OTHER VISIBLE	2	0.3	0.60	$ 159,900	$ 95,940					
								COMPLAINT OF PAIN	2	0.3	0.60	$ 90,900	$ 54,540					

Total Cost	$ 170,700

Unsignalized Intersection

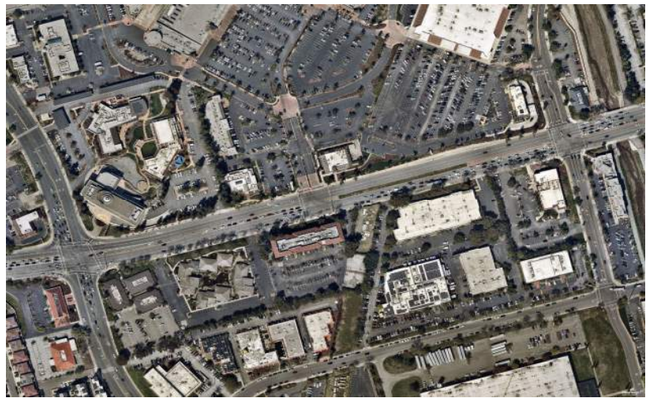
Location: Kennedy Dr & N Park Victoria Dr
Agency Name: City of Milpitas
Contact Name: Nolen Ugalde
E-mail: nugalde@milpitas.gov

Total Crashes	3
Local CCR Differential	0.02
Equivalent Property Damage Only	2
Fatal	1
Severe Injury	0
Other Visible Injury	1
Complaint of Pain	1
Crash Type	
Broadside	1
Sideswipe	0
Rear End	0
Head On	0
Hit Object	0
Overturned	0
Non-Motorist Crashes	
Pedestrian	0
Bicycle	2
Contributing Factors	
Aggressive	3
Impaired	0
Crash Conditions	
Dark	0
Wet	0

NOTES	COLLISION TYPE	RECOMMENDATION	LOCAL ROADWAY SAFETY MANUAL (LRSM) COUNTERMEASURE	LRSM #	Expected Life (Years)	CMF	CALTRANS FUNDING	NUMBER OF CRASHES (2017-2021)		NUMBER OF HISTORIC CRASHES REDUCED	10-YEAR CRASH REDUCTION ESTIMATE	CRASH SEVERITY COST	10-YEAR CRASH REDUCTION BENEFIT (2022 $)	TOTAL 10-YEAR CRASH REDUCTION BENEFIT	QUANTITY/ NUMBER OF UNITS	UNIT COST (2023 $)	COST ESTIMATE (2023 $)	BENEFIT/COST
-	All	Install reflective strips on stop sign posts	Install/Upgrade signs with new fluoresent sheeting	R22	10	0.85	90%	FATAL	1	0.15	0.30	$ 2,461,000	$ 738,300	$ 813,540	3 Signs	$ 250	$ 750	**1,084.7**
								SEVERE	0	0	0.00	$ 2,461,000	$ -					
								OTHER VISIBLE	1	0.15	0.30	$ 159,900	$ 47,970					
								COMPLAINT OF PAIN	1	0.15	0.30	$ 90,900	$ 27,270					
-	Bike + Ped	Install R1-5b signs at advanced stop bars and install R1-6a signs in the medians on the Southbound and Northb ound approaches.	Install/Upgrade pedestrian crossing at uncontrolled locations (with enhanced safety features)	NS21PB	20	0.55	90%	FATAL	1	0.45	0.90	$ 2,461,000	$ 2,214,900	$ 2,358,810	6 Signs	$ 450	$ 2,700	**873.6**
								SEVERE	0	0	0.00	$ 2,461,000	$ -					
								OTHER VISIBLE	1	0.45	0.90	$ 159,900	$ 143,910					
								COMPLAINT OF PAIN	0	0	0.00	$ 90,900	$ -					
Includes unit cost, installation and design	Bike + Ped	Install buffered bike lanes and standard pavement markings on N Park Victoria including the intersection approaches	Install separated bike lanes	R33PB	20	0.55	90%	FATAL	1	0.45	0.90	$ 2,461,000	$ 2,214,900	$ 2,358,810	0.85 Mile	$ 84,000	$ 71,400	**33.0**
								SEVERE	0	0	0.00	$ 2,461,000	$ -					
								OTHER VISIBLE	1	0.45	0.90	$ 159,900	$ 143,910					
								COMPLAINT OF PAIN	0	0	0.00	$ 90,900	$ -					
																Total Cost	**$**	**74,850**

Roadway Segment

Location: E Calaveras Blvd (btw N Milpitas Blvd and Hillview Dr)
Agency Name: City of Milpitas
Contact Name: Nolen Ugalde
E-mail: nugalde@milpitas.gov



Total Crashes	14
Local CCR Differential	0.31
Equivalent Property Damage Only	113
Fatal	0
Severe Injury	0
Other Visible Injury	6
Complaint of Pain	8
Crash Type	
Broadside	3
Sideswipe	0
Rear End	7
Head On	0
Hit Object	0
Overturned	0
Non-Motorist Crashes	
Pedestrian	1
Bicycle	3
Contributing Factors	
Aggressive	9
Impaired	2
Crash Conditions	
Dark	3
Wet	2

NOTES	COLLISION TYPE	RECOMMENDATION	LOCAL ROADWAY SAFETY MANUAL (LRSM) COUNTERMEASURE	LRSM #	Expected Life (Years)	CMF	CALTRANS FUNDING	NUMBER OF CRASHES (2017-2021)		NUMBER OF HISTORIC CRASHES REDUCED	10-YEAR CRASH REDUCTION ESTIMATE	CRASH SEVERITY COST	10-YEAR CRASH REDUCTION BENEFIT (2022 $)	TOTAL 10-YEAR CRASH REDUCTION BENEFIT	QUANTITY/ NUMBER OF UNITS	UNIT COST (2023 $)	COST ESTIMATE (2023 $)	BENEFIT/COST
-	All	Install retroreflective backplates	Improve signal hardware: lenses, back-plates with retroreflective borders, mounting, size, and number	S02	10	0.85	90%	FATAL	0	0	0.00	$ 2,461,000	$ -	$ 505,980	13 Backplates	$ 1,000	$ 13,000	**38.9**
								SEVERE	0	0	0.00	$ 2,461,000	$ -				
								OTHER VISIBLE	6	0.9	1.80	$ 159,900	$ 287,820				
								COMPLAINT OF PAIN	8	1.2	2.40	$ 90,900	$ 218,160				
Includes cost of controller updates and design	All	Coordinate the traffic signal at Town Center Dr with the signals at Milpitas Blvd and Hillview Dr	Improve signal timing (coordination, phases, red, yellow, or operation)	S03	10	0.85	50%	FATAL	0	0	0.00	$ 2,461,000	$ -	$ 505,980	3 Intersections	$ 8,250	$ 24,750	**20.4**
								SEVERE	0	0	0.00	$ 2,461,000	$ -				
								OTHER VISIBLE	6	0.9	1.80	$ 159,900	$ 287,820				
								COMPLAINT OF PAIN	8	1.2	2.40	$ 90,900	$ 218,160				
-	Bike + Ped	Install buffered bike lane. Install green bike lane striping in conflict areas.	Install separated bike lanes	R33PB	20	0.55	90%	FATAL	0	0	0.00	$ 2,461,000	$ -	$ 513,540	1 Lump Sum	$ 455,000	$ 455,000	**1.1**
								SEVERE	0	0	0.00	$ 2,461,000	$ -				
								OTHER VISIBLE	3	1.35	2.70	$ 159,900	$ 431,730				
								COMPLAINT OF PAIN	1	0.45	0.90	$ 90,900	$ 81,810				
																Total Cost	**$ 492,750**	

Roadway Segment

Location: E Calaveras Blvd (btw Abel St and N Milpitas Blvd)
Agency Name: City of Milpitas
Contact Name: Nolen Ugalde
E-mail: nugalde@milpitas.gov

Total Crashes	9
Local CCR Differential	0.04
Equivalent Property Damage Only	232
Fatal	0
Severe Injury	1
Other Visible Injury	4
Complaint of Pain	4
Crash Type	
Broadside	0
Sideswipe	0
Rear End	6
Head On	0
Hit Object	1
Overturned	0
Non-Motorist Crashes	
Pedestrian	1
Bicycle	0
Contributing Factors	
Aggressive	7
Impaired	1
Crash Conditions	
Dark	1
Wet	0

NOTES	COLLISION TYPE	RECOMMENDATION	LOCAL ROADWAY SAFETY MANUAL (LRSM) COUNTERMEASURE	LRSM #	Expected Life (Years)	CMF	CALTRANS FUNDING	NUMBER OF CRASHES (2017-2021)		NUMBER OF HISTORIC CRASHES REDUCED	10-YEAR CRASH REDUCTION ESTIMATE	CRASH SEVERITY COST	10-YEAR CRASH REDUCTION BENEFIT (2022 $)	TOTAL 10-YEAR CRASH REDUCTION BENEFIT	QUANTITY/ NUMBER OF UNITS	UNIT COST (2023 $)	COST ESTIMATE (2023 $)	BENEFIT/COST
-	Bike + Ped	Install yield lines at pedestrian crossing at Calaveras off-ramp to Main Street and stripe high visibility crossing	Install/Upgrade pedestrian crossing at uncontrolled locations (with enhanced safety features)	NS21PB	20	0.65	90%	FATAL	0	0	0.00	$ 2,461,000	$ -	$ 111,930	100 SQFT of Striping	$ 6	$ 600	**186.6**
								SEVERE	0	0	0.00	$ 2,461,000	$ -				
								OTHER VISIBLE	1	0.35	0.70	$ 159,900	$ 111,930				
								COMPLAINT OF PAIN	0	0	0.00	$ 90,900	$ -				
-	All	Install W3-3 traffic signal ahead sign on EB Calaveras Blvd	Install/Upgrade signs with new fluoresent sheeting	R22	10	0.85	90%	FATAL	0	0	0.00	$ 2,461,000	$ -	$ 1,039,260	1 Signs	$ 450	$ 450	**2,309.5**
								SEVERE	1	0.15	0.30	$ 2,461,000	$ 738,300				
								OTHER VISIBLE	4	0.6	1.20	$ 159,900	$ 191,880				
								COMPLAINT OF PAIN	4	0.6	1.20	$ 90,900	$ 109,080				
Includes unit cost, installation and design	Bike + Ped	Install RRFB at pedestrian crossing at Calaveras off-ramp to Main Street	Install Rectangular Rapid Flashing Beacon (RRFB)	NS22PB	20	0.65	90%	FATAL	0	0	0.00	$ 2,461,000	$ -	$ 111,930	1 RRFB	$ 54,000	$ 54,000	**2.1**
								SEVERE	0	0	0.00	$ 2,461,000	$ -				
								OTHER VISIBLE	1	0.35	0.70	$ 159,900	$ 111,930				
								COMPLAINT OF PAIN	0	0	0.00	$ 90,900	$ -				
Includes unit cost, installation and design	All	Install high friction surface treatment on intersection approaches	Improve pavement friction (high friction surface treatments)	NS12	10	0.55	90%	FATAL	0	0	0.00	$ 2,461,000	$ -	$ 3,117,780	2 Intersection Approaches	$ 186,000	$ 372,000	**8.4**
								SEVERE	1	0.45	0.90	$ 2,461,000	$ 2,214,900				
								OTHER VISIBLE	4	1.8	3.60	$ 159,900	$ 575,640				
								COMPLAINT OF PAIN	4	1.8	3.60	$ 90,900	$ 327,240				
																Total Cost	**$**	**427,050**

Roadway Segment

Location: S Main St (btw W Curtis Ave and Corning Ave)
Agency Name: City of Milpitas
Contact Name: Nolen Ugalde
E-mail: nugalde@milpitas.gov

Total Crashes	8
Local CCR Differential	0.71
Equivalent Property Damage Only	540
Fatal	1
Severe Injury	2
Other Visible Injury	3
Complaint of Pain	2
Crash Type	
Broadside	0
Sideswipe	1
Rear End	4
Head On	0
Hit Object	1
Overturned	0
Non-Motorist Crashes	
Pedestrian	2
Bicycle	1
Contributing Factors	
Aggressive	3
Impaired	2
Crash Conditions	
Dark	1
Wet	0

NOTES	COLLISION TYPE	RECOMMENDATION	LOCAL ROADWAY SAFETY MANUAL (LRSM) COUNTERMEASURE	LRSM #	Expected Life (Years)	CMF	CALTRANS FUNDING	NUMBER OF CRASHES (2017-2021)		NUMBER OF HISTORIC CRASHES REDUCED	10-YEAR CRASH REDUCTION ESTIMATE	CRASH SEVERITY COST	10-YEAR CRASH REDUCTION BENEFIT (2022 $)	TOTAL 10-YEAR CRASH REDUCTION BENEFIT	QUANTITY/ NUMBER OF UNITS	UNIT COST (2023 $)	COST ESTIMATE (2023 $)	BENEFIT/COST
-	Bike + Ped	Install pedestrian refuge island and high-visibility crosswalk	Install/upgrade pedestrian crossing (with enhanced safety features)	R35PB	20	0.65	90%	FATAL	1	0.35	0.70	$ 2,461,000	$ 1,722,700	$ 3,509,030	2 Lump Sum	$ 28,000	$ 56,000	**62.7**
								SEVERE	1	0.35	0.70	$ 2,461,000	$ 1,722,700					
								OTHER VISIBLE	0	0	0.00	$ 159,900	$ -					
								COMPLAINT OF PAIN	1	0.35	0.70	$ 90,900	$ 63,630					
-	All	Restrict parking at pedestrian crossings to improve sight distance	Improve sight distance to intersection (clear sight triangles)	NS11	10	0.80	90%	FATAL	1	0.2	0.40	$ 2,461,000	$ 984,400	$ 3,217,800	480 LF of Striping	$ 3	$ 2,340	**1,375.1**
								SEVERE	2	0.4	0.80	$ 2,461,000	$ 1,968,800					
								OTHER VISIBLE	3	0.6	1.20	$ 159,900	$ 191,880					
								COMPLAINT OF PAIN	2	0.4	0.80	$ 90,900	$ 72,720					
Includes unit cost, installation, design and photometric.	Dark	Install roadway lighting at the pedestrian crossings	Add segment lighting	R01	20	0.65	90%	FATAL	0	0	0.00	$ 2,461,000	$ -	$ 1,722,700	4 Luminaires	$ 19,500	$ 78,000	**22.1**
								SEVERE	1	0.35	0.70	$ 2,461,000	$ 1,722,700					
								OTHER VISIBLE	0	0	0.00	$ 159,900	$ -					
								COMPLAINT OF PAIN	0	0	0.00	$ 90,900	$ -					
																Total Cost	**$**	**136,340**

Roadway Segment

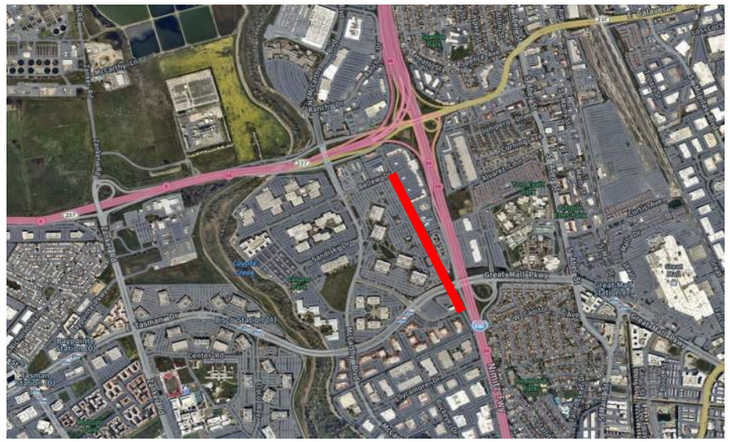
Location: S McCarthy Blvd (btw Dixon Landing Rd and Sprig Center Dwy)
Agency Name: City of Milpitas
Contact Name: Nolen Ugalde
E-mail: nugalde@milpitas.gov

Total Crashes	6
Local CCR Differential	0.09
Equivalent Property Damage Only	355
Fatal	0
Severe Injury	2
Other Visible Injury	0
Complaint of Pain	4
Crash Type	
Broadside	1
Sideswipe	0
Rear End	0
Head On	0
Hit Object	4
Overturned	1
Non-Motorist Crashes	
Pedestrian	0
Bicycle	0
Contributing Factors	
Aggressive	4
Impaired	1
Crash Conditions	
Dark	4
Wet	2

NOTES	COLLISION TYPE	RECOMMENDATION	LOCAL ROADWAY SAFETY MANUAL (LRSM) COUNTERMEASURE	LRSM #	Expected Life (Years)	CMF	CALTRANS FUNDING	NUMBER OF CRASHES (2017-2021)		NUMBER OF HISTORIC CRASHES REDUCED	10-YEAR CRASH REDUCTION ESTIMATE	CRASH SEVERITY COST	10-YEAR CRASH REDUCTION BENEFIT (2022 $)	TOTAL 10-YEAR CRASH REDUCTION BENEFIT	QUANTITY/ NUMBER OF UNITS	UNIT COST (2023 $)	COST ESTIMATE (2023 $)	BENEFIT/COST
-	All	Install retroreflective backplates on traffic signal heads. Install additional signal head for through lanes on N McCarthy Blvd	Improve signal hardware: lenses, back-plates with retroreflective borders, mounting, size, and number	S02	10	0.85	90%	FATAL	0	0	0.00	$ 2,843,000	$ -	$ 1,814,880	12 Backplates and 2 Signal Heads	Lump Sum	$ 26,500	**68.5**
								SEVERE	2	0.3	0.60	$ 2,843,000	$ 1,705,800					
								OTHER VISIBLE	0	0	0.00	$ 159,900	$ -					
								COMPLAINT OF PAIN	4	0.6	1.20	$ 90,900	$ 109,080					
Includes unit cost, installation and design	All	Install solar, radar speed feedback sign at NB curve	Install dynamic/variable speed warning signs	R26	10	0.70	90%	FATAL	0	0	0.00	$ 2,461,000	$ -	$ 3,171,360	1 Lump Sum	$ 22,800	$ 22,800	**139.1**
								SEVERE	2	0.6	1.20	$ 2,461,000	$ 2,953,200					
								OTHER VISIBLE	0	0	0.00	$ 159,900	$ -					
								COMPLAINT OF PAIN	4	1.2	2.40	$ 90,900	$ 218,160					
Includes unit cost, installation and design	All	Install High Friction Surface Treatment (HFST)	Improve pavement friction (High Friction Surface Treatments)	R21	10	0.45	90%	FATAL	0	0	0.00	$ 2,461,000	$ -	$ 5,814,160	10670 SQYD	$ 26	$ 280,088	**20.8**
								SEVERE	2	1.1	2.20	$ 2,461,000	$ 5,414,200					
								OTHER VISIBLE	0	0	0.00	$ 159,900	$ -					
								COMPLAINT OF PAIN	4	2.2	4.40	$ 90,900	$ 399,960					
Includes unit cost, installation, design and	Dark	Install roadway lighting at the horizontal curves	Add segment lighting	R01	20	0.65	90%	FATAL	0	0	0.00	$ 2,461,000	$ -	$ 3,572,660	2 Luminaires	$ 19,500	$ 39,000	**91.6**
								SEVERE	2	0.7	1.40	$ 2,461,000	$ 3,445,400					
								OTHER VISIBLE	0	0	0.00	$ 159,900	$ -					
								COMPLAINT OF PAIN	2	0.7	1.40	$ 90,900	$ 127,260					
-	All	Install chevrons on NB McCarthy Blvd	Install chevron signs on horizontal curves	R23	10	0.60	90%	FATAL	0	0	0.00	$ 2,461,000	$ -	$ 4,228,480	3 Chevrons	$ 450	$ 1,350	**3,132.2**
								SEVERE	2	0.8	1.60	$ 2,461,000	$ 3,937,600					
								OTHER VISIBLE	0	0	0.00	$ 159,900	$ -					
								COMPLAINT OF PAIN	4	1.6	3.20	$ 90,900	$ 290,880					
-	All	Install edgeline rumble strips on NB McCarthy Blvd	Install edgeline rumble strips/stripes	R31	10	0.85	90%	FATAL	0	0	0.00	$ 2,461,000	$ -	$ 1,585,680	0.8 Miles	$ 76,800	$ 61,440	**25.8**
								SEVERE	2	0.3	0.60	$ 2,461,000	$ 1,476,600					
								OTHER VISIBLE	0	0	0.00	$ 159,900	$ -					
								COMPLAINT OF PAIN	4	0.6	1.20	$ 90,900	$ 109,080					
-	All	Refresh Intersection Striping with high visibility thermoplastic	Install raised pavement markers and striping (through intersection)	S09	10	0.90	90%	FATAL	0	0	0.00	$ 2,461,000	$ -	$ 1,057,120	3750 SQFT of Striping	$ 7	$ 26,250	**40.3**
								SEVERE	2	0.2	0.40	$ 2,461,000	$ 984,400					
								OTHER VISIBLE	0	0	0.00	$ 159,900	$ -					
								COMPLAINT OF PAIN	4	0.4	0.80	$ 90,900	$ 72,720					
																Total Cost	**$**	**457,428**

Roadway Segment

Location: Barber Ln (btw Bellew Dr and Alder Dr)
Agency Name: City of Milpitas
Contact Name: Nolen Ugalde
E-mail: nugalde@milpitas.gov



Total Crashes	3
Local CCR Differential	3.50
Equivalent Property Damage Only	28
Fatal	0
Severe Injury	0
Other Visible Injury	2
Complaint of Pain	1
Crash Type	
Broadside	1
Sideswipe	0
Rear End	0
Head On	0
Hit Object	0
Overturned	0
Non-Motorist Crashes	
Pedestrian	1
Bicycle	0
Contributing Factors	
Aggressive	0
Impaired	0
Crash Conditions	
Dark	0
Wet	0

NOTES	COLLISION TYPE	RECOMMENDATION	LOCAL ROADWAY SAFETY MANUAL (LRSM) COUNTERMEASURE	LRSM #	Expected Life (Years)	CMF	CALTRANS FUNDING	NUMBER OF CRASHES (2017-2021)		NUMBER OF HISTORIC CRASHES REDUCED	10-YEAR CRASH REDUCTION ESTIMATE	CRASH SEVERITY COST	10-YEAR CRASH REDUCTION BENEFIT (2022 $)	TOTAL 10-YEAR CRASH REDUCTION BENEFIT	QUANTITY/ NUMBER OF UNITS	UNIT COST (2023 $)	COST ESTIMATE (2023 $)	BENEFIT/COST
-	Bike+Ped	Install buffered bike lane with raised element EB & WB (removing parking). Install green bike lane striping in conflict areas.	Install separated bike lanes	R33PB	20	0.55	90%	FATAL	0	0	0.00	$ 2,461,000	$ -	$ 143,910	3350 Feet	$ 15	$ 50,250	**2.9**
								SEVERE	0	0	0.00	$ 2,461,000	$ -				
								OTHER VISIBLE	1	0.45	0.90	$ 159,900	$ 143,910					
								COMPLAINT OF PAIN	0	0	0.00	$ 90,900	$ -					
Includes cost of installation and design	All	Install raised median along Barber Ln with directional median openings	Install raised median	R08	20	0.75	90%	FATAL	0	0	0.00	$ 2,461,000	$ -	$ 205,350	3330 Feet	$ 324	$ 1,078,920	**0.2**
								SEVERE	0	0	0.00	$ 2,461,000	$ -				
								OTHER VISIBLE	2	0.5	1.00	$ 159,900	$ 159,900				
								COMPLAINT OF PAIN	1	0.25	0.50	$ 90,900	$ 45,450				
-	All	Install pedestrian refuge island at mid-block crossing	Install/upgrade pedestrian crossing (with enhanced safety features)	R35PB	10	0.85	90%	FATAL	0	0	0.00	$ 2,461,000	$ -	$ 47,970	1 Lump Sum	$ 28,000	$ 28,000	**1.7**
								SEVERE	0	0	0.00	$ 2,461,000	$ -				
								OTHER VISIBLE	1	0.15	0.30	$ 159,900	$ 47,970				
								COMPLAINT OF PAIN	0	0	0.00	$ 90,900	$ -				
Assumes only new striping is required	All	Install Left-turn lane on NB Barber Lane at the intersection with Bellew Dr	Install left-turn lane (where no left-turn lane exists)	NS18	10	0.65	90%	FATAL	0	0	0.00	$ 2,461,000	$ -	$ 287,490	1 Lump sum	$ 42,000	$ 42,000	**6.8**
								SEVERE	0	0	0.00	$ 2,461,000	$ -				
								OTHER VISIBLE	2	0.7	1.40	$ 159,900	$ 223,860				
								COMPLAINT OF PAIN	1	0.35	0.70	$ 90,900	$ 63,630				
																Total Cost	**$**	**1,199,170**

APPENDIX F

POLICY UPDATE

Table 1: Summary of Programs, Policies, and Practices for the City of Milpitas

Topic	Current Status	Implement or Enhance
Complete Streets Policy	Metropolitan Transportation Commission (MTC) has a Complete Streets Policy (Resolution No. 4493: MTC's Complete Streets Policy). Santa Clara County likewise adopted 2016 Measure B Complete Streets reporting requirements.	It is recommended that the City of Milpitas continue to support MTC and VTA's Complete Streets policies, and consider adopting its own policy.
Traffic Impact Fees	City levies development impact fees	Consider safety impacts and potential projects that enhance safety for future fee updates
Safe Routes to School Funding	Milpitas directed Measure B funds to SRTS project at two elementary schools	Seek grant funding opportunities to create a SRTS plan that includes the remaining elementary schools in Milpitas
Traffic Safety Education	Included in SRTS program; No active program	Work with education and PD to develop traffic safety education programs in public areas and schools (including bicycle and pedestrian components)
Program for Reviewing Crash Activity	City has no active monitoring program; MTC reviews crash data in BayViz dashboard	Set up formal program for reviewing crash activity at a fixed time interval (1 or 2 years); Update database for future LRSP analyses & updates
Crossroads Database Updates	MTC does not use Crossroads database	Continue cooperation with County staff and MTC, and consider implementing Crossroads database so property damage only crashes can be tracked
City Enforcement on Bicycle Rules	Anyone under 18 is required to wear a bike helmet C.V.C. 21212; Bicycles are regulated by the PD and require licenses to ride, Municipal Code V-100-16	City transportation division should engage with PD in enforcement and education at strategic locations based on collision patterns, community events, and safety priorities
Sobriety / Seatbelt Checks	Conducted by City Police Department	City transportation division should engage with PD in planning and implementing sobriety and & seatbelt checks based on collision patterns, community events, and safety priorities
City Law Enforcement Coordinate with Adjacent Jurisdictions	No	PD coordinate with CHP and Santa Clara County Sheriff's departments and look for opportunities for joint educational and enforcement campaigns

Topic	Current Status	Implement or Enhance
Speed Surveys	Not posted online	Continue to implement regular surveying as required by California Vehicle Code; Review new guidance from Assembly Bill 43
Speed Limits	Not posted online	Continue to update as required by California Vehicle Code; Exercise context-based flexibility offered under Assembly Bill 43
Traffic Calming Policies	Milpitas Policy 1-7 Revision 1	Identify neighborhood cut-through corridors and implement traffic calming strategies as appropriate
Transit Vehicles Accommodation of Bicycles	Bikes are permitted on VTA buses and light rail, and on BART. Micromobility bikes are not permitted on VTA/BART vehicles.	Continue to accommodate bicycles on transit to promote multi-modal trips
Coordination of Transit Providers and City Staff	Yes	Continue coordination; Work to identify areas for improvements particularly with first and last mile connections
Bicycle and Pedestrian Master Plans	Yes	Continue tracking bike and pedestrian crashes, and implementing identified projects with high need and high feasibility
General Plan Addresses Multimodal Traffic Safety	Included in Circulation Element of General Plan	Continue to implement recommendations under General Plan; Regularly assess progress and areas for improvement; Avoid projects that prioritize operational improvements over multimodal safety
Inventory of Bicycle, Pedestrian, Parking, and other facilities	No	Start inventory program of facilities; Digitize inventory through GIS database
Traffic Safety Audit Program	Included in Circulation Element of General Plan, but No formal program	Implement a traffic safety audit program to regularly identify traffic safety issues citywide in coordination with County LRSP update and monitoring program
Coordination between Emergency Response and City Transportation Planning	Yes, emergency vehicle preemption has been implemented at key corridors. The Milpitas Traffic Safety Project includes PD and FD stakeholders	Continue engaging emergency response in transportation planning processes; Include membership in project technical advisory committees where appropriate

Topic	Current Status	Implement or Enhance
Coordination between Local Health Agencies and City Transportation Planning	Not posted online	Continue engaging local health agencies in transportation planning processes; Include membership in project technical advisory committees where appropriate
Resident Feedback	Yes, comment form available on City website	Continue to seek out resident feedback; Review comments for trends and patterns that may suggest opportunities for systemic safety improvement
Maintenance of Roadway Surfaces	Yes	Continue regular maintenance of roadway surfaces; integrate safety improvements such as bike lanes and advanced stop bars
Transportation Demand Management Policies/Programs	MTC and VTA have developed Transportation Demand Management Programs. The C/CAG-VTA Countywide Travel Demand Model was used in the update to the general plan	Coordinate with VTA and review MTC strategies to implement local Transportation Demand Management programs
Use of overlays, specific plans, redevelopment areas to encourage infill development to reduce VMT	City follows direction in SB 743 I effort to reduce VMT.	Identify areas where infill development will require safety improvements; Coordinate with County to ensure connectivity and continuation of safety amenities with other municipalities
Regular Collection of Traffic / Bicycle / Pedestrian Volumes	On a case-by-case basis	Require bicycle and pedestrian counts as part of routine traffic counting policies for the City when traffic impact studies or environmental documents are being developed
Program for Installing Wayfinding Signage	Yes (On a project basis)	Utilize solar-powered digital bulletin boards to advertise traffic safety best practices or wayfinding. with County to implement branded wayfinding program; Identify key City destinations and access routes
Warrants for Traffic Control Devices	Uses CA MUTCD.	Continue to use CA MUTCD warrants; Where frequent citizen requests are not covered by existing warrants, consider developing local warrants to facilitate decision making
School Zone Safety	Enforced by PD.	Continue enforcement of road safety in school zones; Seek grant funding opportunities for additional personnel in school zones

Topic	Current Status	Implement or Enhance
Crosswalk Safety	Crossing guard program overseen by PD. Additional crossing guard warrants completed in 2022 in partnership with City Engineering staff.	Increase enforcement of safe driving and active transportation behaviors near busy crosswalk locations; Update pedestrian crossing design standards in accordance with latest best practices Seek grant funding for additional enforcement near high pedestrian activity locations