



Technical Memorandum

June 28, 2025

Project# 28476

To: Ozzy Arce, Senior Transportation Planner
City of Palo Alto, Office of Transportation

From: Kittelson & Associates, Inc.

CC: Sylvia Star-Lack, Transportation Planning Manager

RE: Bicycle and Pedestrian Transportation Plan Update – Collision and Safety Analysis

COLLISION AND SAFETY ANALYSIS

The City of Palo Alto (City) is updating the 2012 Bicycle and Pedestrian Transportation Plan (BTP). This BTP Update will serve as a comprehensive action plan for the City to provide improved bicycle and pedestrian facilities for its residents, employees, and visitors. As part of the baseline conditions and needs assessment, Kittelson & Associates, Inc. (Kittelson) is analyzing the most recent complete five years of pedestrian- and bicyclist-involved collisions. This memorandum (memo) details the methodology and assumptions used and presents the results of the analyses. The memo is organized into the following sections:

- Safety Analysis Methodology
- Data, Assumptions, and Limitations
- Safety Analysis Results
- Key Terms and Acronyms

The results of the analysis will inform project development and prioritization by identifying the locations and severity of pedestrian- and bicyclist-involved collisions.

SAFETY ANALYSIS METHODOLOGY

Analysis Steps

The following steps describe the basic analysis approach to conducting descriptive collision analysis and identifying the high-risk locations for pedestrian and bicycle collisions.

- **STEP 1:** Establish the safety analysis database using the data described above. The analysis will evaluate collisions that occurred on public streets within the City's limits and at ramp

terminal intersections of freeways. It will exclude collisions occurring on the freeway mainlines.

- **STEP 2:** Map the location and severity of pedestrian and bicycle involved collisions to identify the spatial relationship of the collisions.
- **STEP 3:** Conduct descriptive collision analysis to identify and describe citywide bicycle and pedestrian collision patterns and trends.

Steps 2 through 3 will be conducted separately for pedestrian and bicycle collisions. The results will be compared to see where the collisions for each may overlap, providing additional emphasis for safety improvements citywide.

Collision Profiles and Risk Factors

Kittelson will conduct a descriptive collision analysis to identify collision profiles. The collision analysis explores factors contributing to all pedestrian and bicycle collisions across the City and the most common factors (i.e., risk factors) associated with higher numbers of severe collisions (i.e., fatal or serious injury). We will review the historical collision data to identify trends and recurring characteristics that may contribute to a higher likelihood of pedestrian and/or bicycle collisions. In this instance, risk is defined as common traffic or physical characteristics shared by the worst performing roadway segments and intersections. The presence of these common characteristics indicates a potentially higher risk for collisions.

Kittelson will develop collision profiles by evaluating these risk factors and describing Citywide collision patterns and trends and highlight locations of the most common collision factors (e.g., alcohol involved, speeding) and collision types (e.g., right hooks, left hooks, and angle collisions). These collision profiles provide a better understanding of some of the most common issues, and where and how efforts should be focused to most effectively make streets safer for all users.

The collision profiles and risk factors will be used to assist in identifying treatments, or countermeasures, to reduce the frequency and severity of collisions at these, and similar, locations. This analysis can be used to identify locations where the risk factors are present, allowing for proactive improvements and reduced potential for future collisions.



DATA, ASSUMPTIONS, AND LIMITATIONS

The data that will be used in the analysis are shown in Table 1.

Table 1: Data Requirements and Assumptions

Data/Input Requirement	Data Availability/Assumptions
Roadway centerline and intersections	Kittelson will utilize the street centerline file provided by the City. The dataset will be reviewed for accuracy and updated, as needed, based on a work session with City staff. Intersection locations will be developed as a separate shapefile based on the centerline shapefile. Kittelson will provide the roadway and intersection data to the SS4A team who will confirm geolocation of collision data along a roadway based on reported distance from a reference intersection.
Posted speed	Kittelson will utilize speed limit data provided by the City in shapefile format.
Median presence	Kittelson will apply these manually based on Google Earth review on an as-needed basis.
Transit stop presence	Kittelson will utilize GTFS data as needed
Pedestrian and bicyclist-involved collisions	Kittelson will utilize collision data provided by the SS4A team. The underlying collision data will include pedestrian- and bicyclist-involved collision for the most recent five-year period (2018-2022).
Intersection traffic control	Signal presence and type data provided by the City will be overlaid to distinguish signalized versus unsignalized intersections.
California Active Transportation Program (ATP) Webtool	Kittelson used the California ATP webtool ¹ to visualize the community heat map for collision intensity

SAFETY ANALYSIS RESULTS

This analysis provides a snapshot of pedestrian and bicycle involved collisions over the last ten years (2011-2022) and provides a more detailed and descriptive analysis of pedestrian and bicycle data on from 2018 through 2022, the most recently available five-year period of collision data available through the Transportation Injury Mapping System (TIMS). TIMS reports injury collisions from the Statewide Integrated Traffic Records System (SWITRS) but excludes collisions that cause

¹ TIMS - Transportation Injury Mapping System (berkeley.edu)



property damage only (PDO) and no injuries. The collision data was provided by the Safe Streets For All Safety Action Plan project team for use by the BPTP Update project team. It is important to note the limitations of the collision data. Not every collision is reported, and collision records are only as reliable as the person filling them out. Data like party race, party at fault, or the primary collision factor (PCF) are determined by the reporting officer. This may lead to inaccurate or incomplete information.

The severity of collisions is classified based on the highest level of injury sustained. The analysis includes the following severity levels, listed in descending order:

- **Fatal:** This category refers to collisions where individuals involved in the incident sustained injuries that resulted in death.
- **Severe Injury:** This category includes collisions where individuals suffered significant injuries such as broken bones, severe lacerations, or injuries beyond what are classified as "visible injuries" according to the reporting officer's assessment.
- **Moderate Injury (Visible Injury):** This category encompasses collisions where individuals sustained injuries that are evident to observers at the collision scene, such as bruises or minor lacerations. These injuries are considered less severe than those in the severe injury category.
- **Minor Injury (Complaint of Pain):** This category pertains to collisions where individuals report experiencing pain or discomfort, even though there may not be any visible injuries. These injuries are categorized as complaints of pain and do not involve severe physical trauma or visible injuries.

The results of the safety analysis are presented in this section. Figure 1 presents the ten-year (2013 – 2022) snapshot of pedestrian and bicycle collisions within the City of Palo Alto by severity. The figure indicates that pedestrian and bike collisions exhibit similar patterns. The collisions fluctuated during the first seven years (2012 – 2018); afterwards, there was a significant drop in the number of collisions over the most recent four-year period. Table 2 presents a five-year overview of the collision data. Throughout the five years under review, a total of 104 pedestrian and 257 bicycle collisions were reported in the city of Palo Alto, with three collisions involving both pedestrians and bicyclists. Around 12%, or 12, of the pedestrian collisions resulted in a fatality (3 collisions) or severe injury (9 collisions). Around 5%, or 13, of the bicycle collisions resulted in a fatality (one collision) or severe injury (12 collisions). These collisions are mapped in Figure 2 and Figure 4.



Figure 1: Collisions by Severity Level (2012-2022)

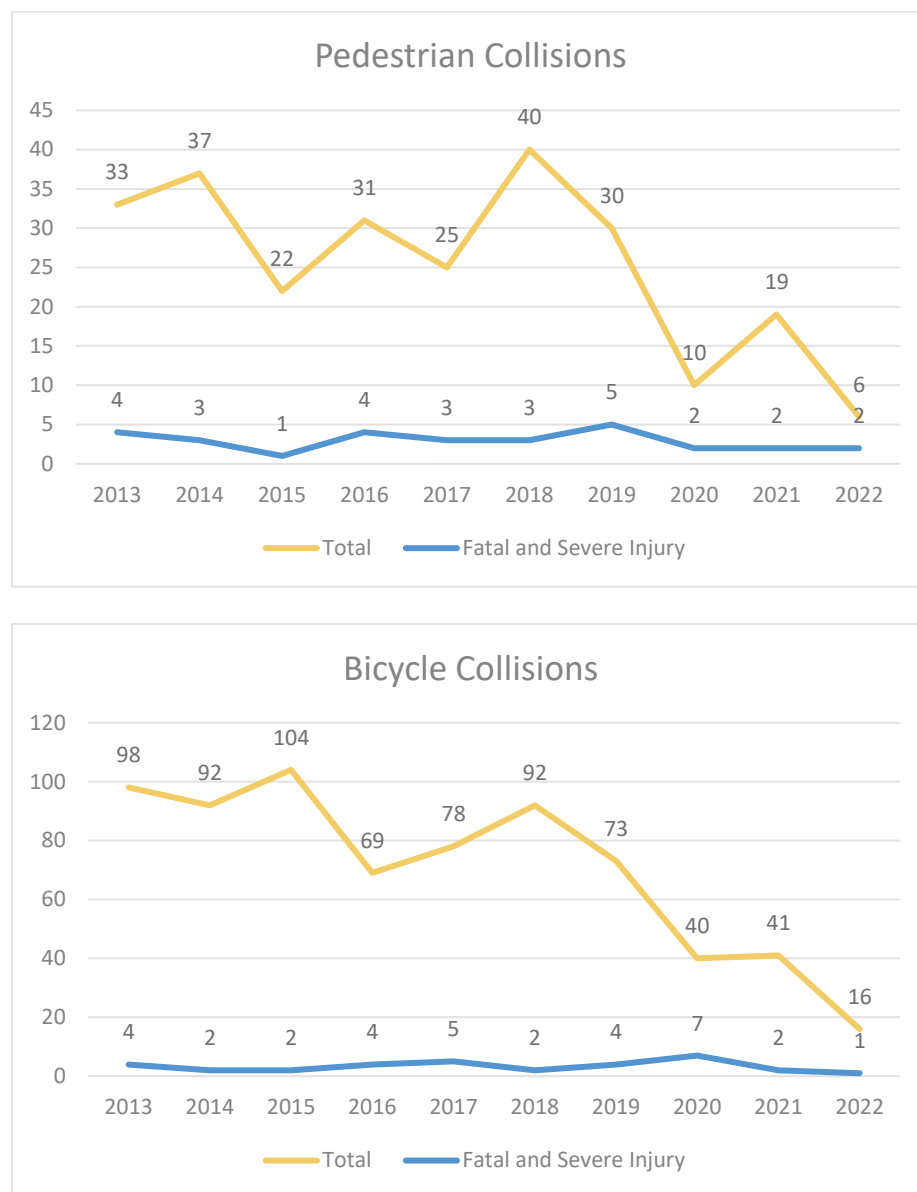


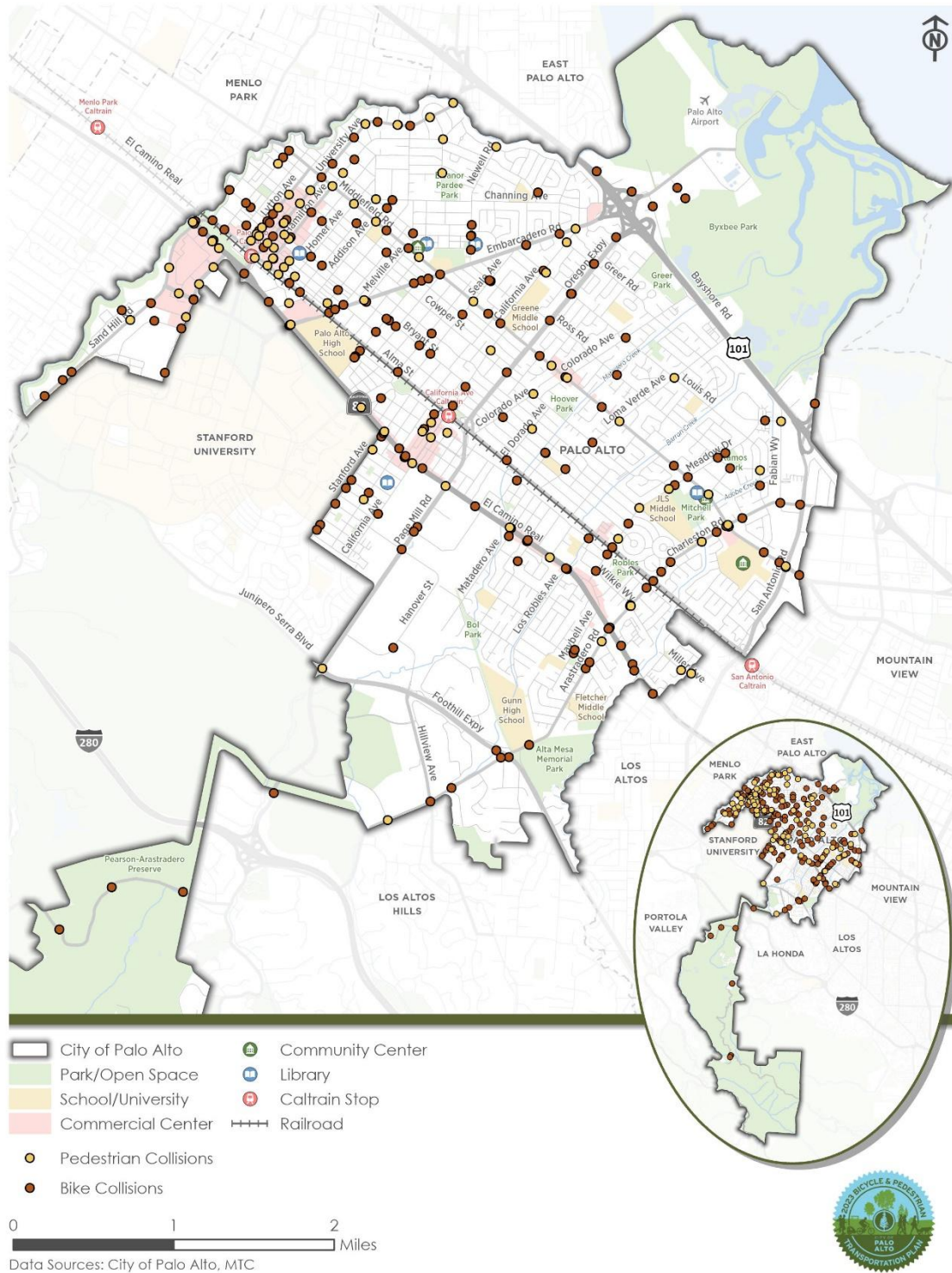
Table 2: Collision Data Summary (2018-2022)

Parties Involved	Fatal	Severe Injury	Moderate Injury	Minor Injury	Reported Total
Pedestrian	3 (2.9%)	9 (8.7%)	49 (47.1%)	43 (41.3%)	104
Bicyclist	1 (0.4%)	12 (4.7%)	175 (68.1%)	69 (26.8%)	257

Source: TIMS data from January 1, 2018, through December 31, 2022

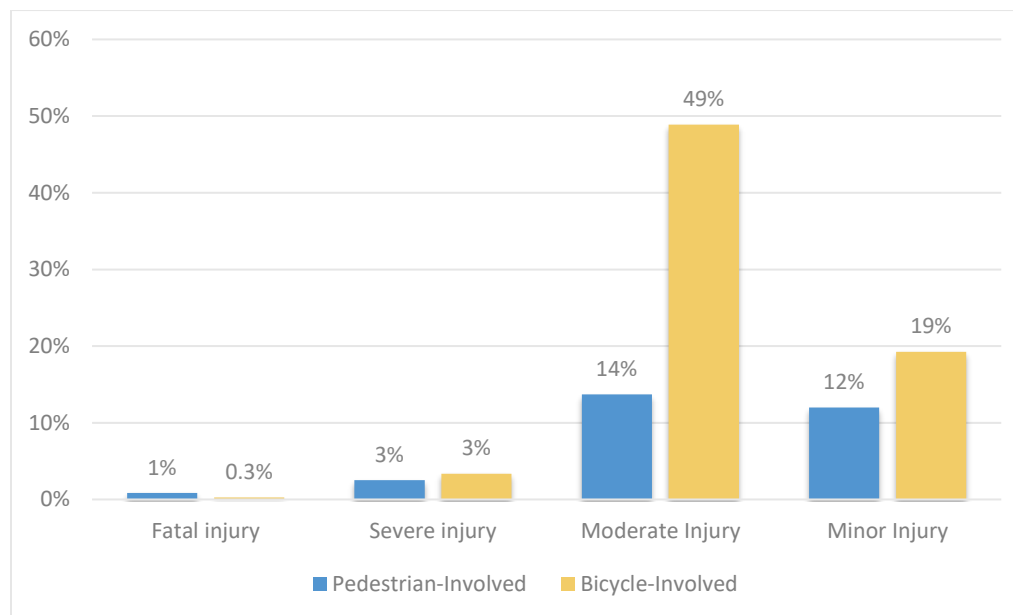


Figure 2: Five-Year Collision Data (2018 – 2022)



Pedestrians and cyclists are particularly vulnerable to collisions, as they lack the protection afforded to them by being inside a motor vehicle. As a result, collisions involving people walking or biking are more likely to result in injury and fatality. Figure 3 visually depicts the distribution of collision percentages based on user type and severity. The figure presents the breakdown of collisions in terms of severity for different road users.

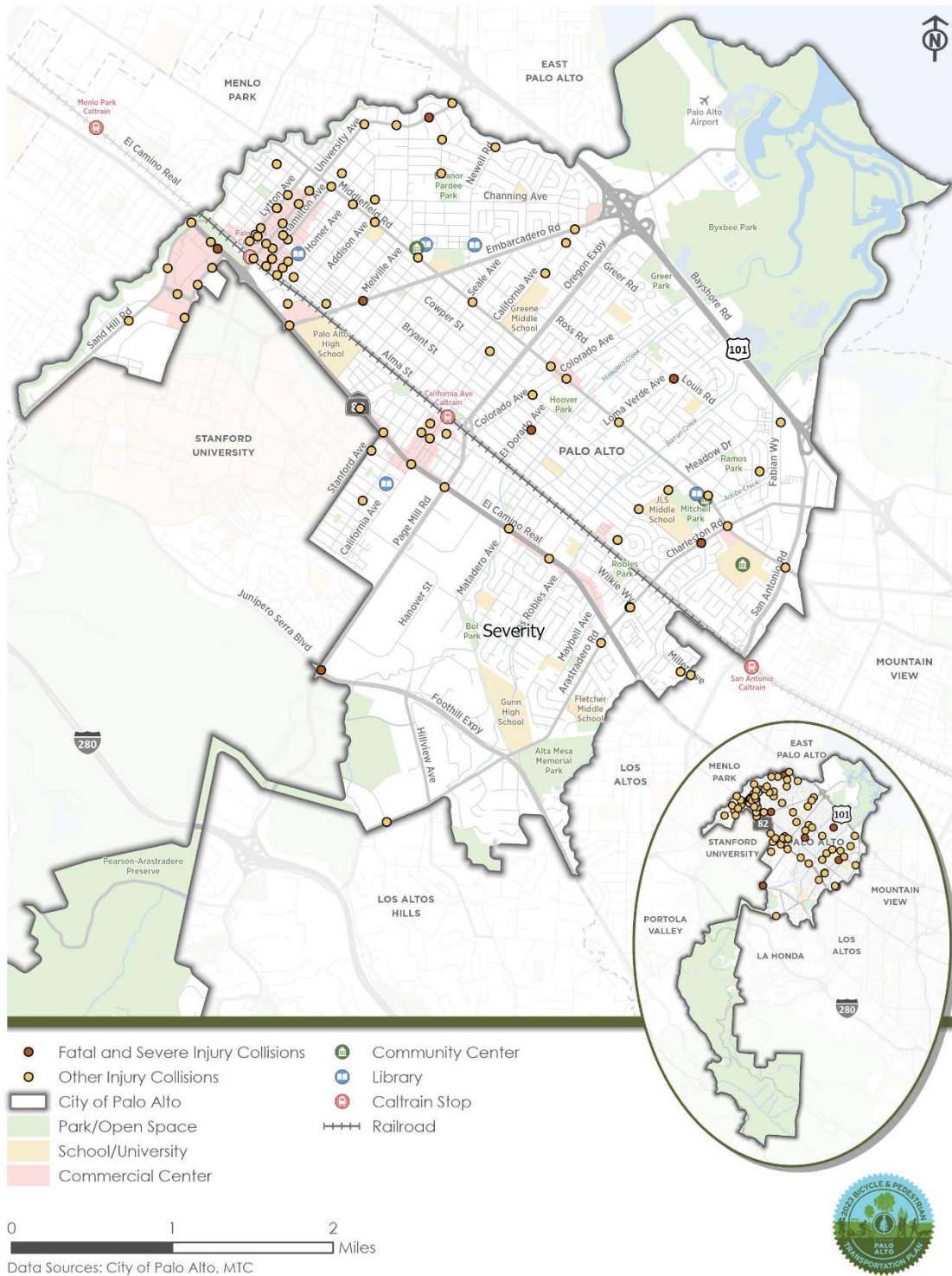
Figure 3. Percentage of Collisions by User and Severity



Pedestrian Collision Analysis

In the five-year study period, there were 104 pedestrian collisions reported in the City of Palo Alto; 12 collisions (12%) resulted in a fatality or severe injury. The pedestrian collisions are mapped in Figure 4.

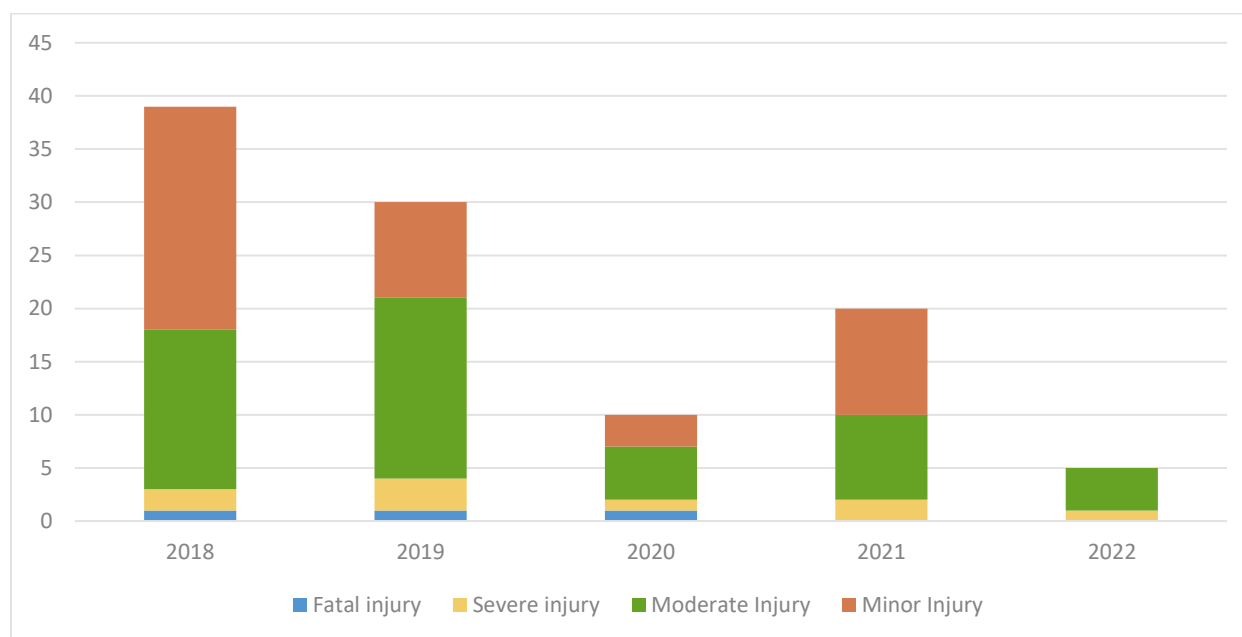
Figure 4. Pedestrian Collisions by Severity (2018 – 2022)



Collisions by Year

Figure 5 illustrates the temporal trends of pedestrian collisions in the City of Palo Alto for different severity levels. The number of pedestrian collisions has been decreasing over the most recent five-year period (2018-2022). In 2020, a substantial drop in reported pedestrian collisions occurred, likely reflecting the impact of the COVID-19 pandemic on traffic patterns. There were no reported pedestrian fatalities in 2021 or 2022.

Figure 5. Total Number of Pedestrian Collisions by Year and Severity

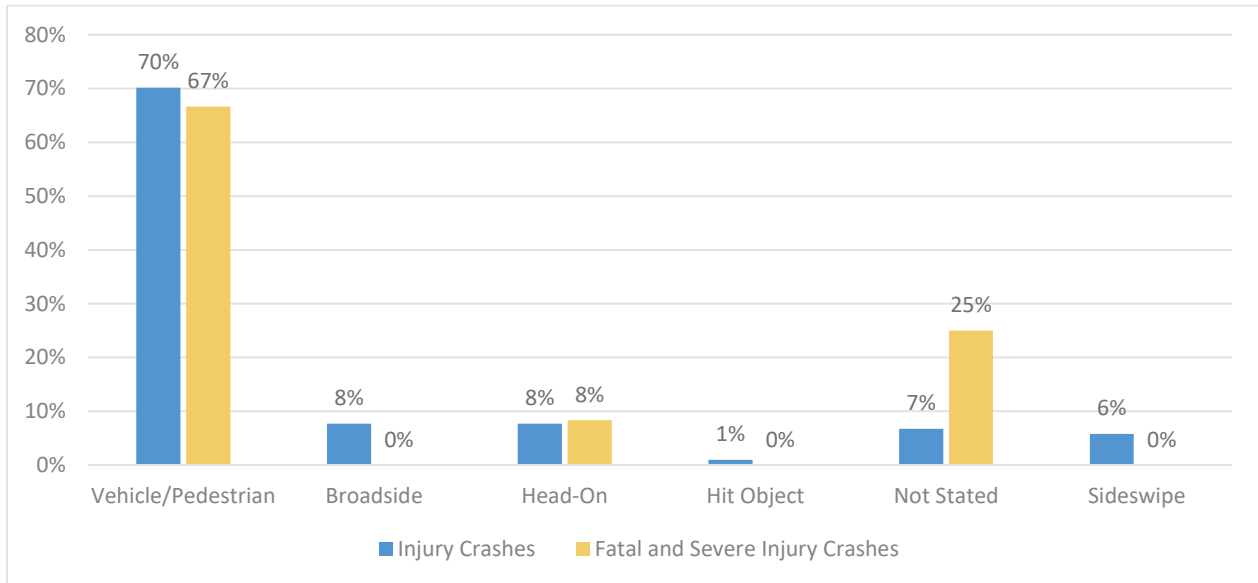


Collisions by Type

Focusing on collision types, Figure 6 provides an overview of the different types of pedestrian collisions, encompassing both injury collisions and those resulting in fatal or severe injuries. As shown, the most common collision types across all pedestrian collisions in the City of Palo Alto are vehicle/pedestrian collisions at 70% (73 collisions), followed by broadside and head-on collisions at 8% (8 collisions) each.



Figure 6. Pedestrian Collisions by Type

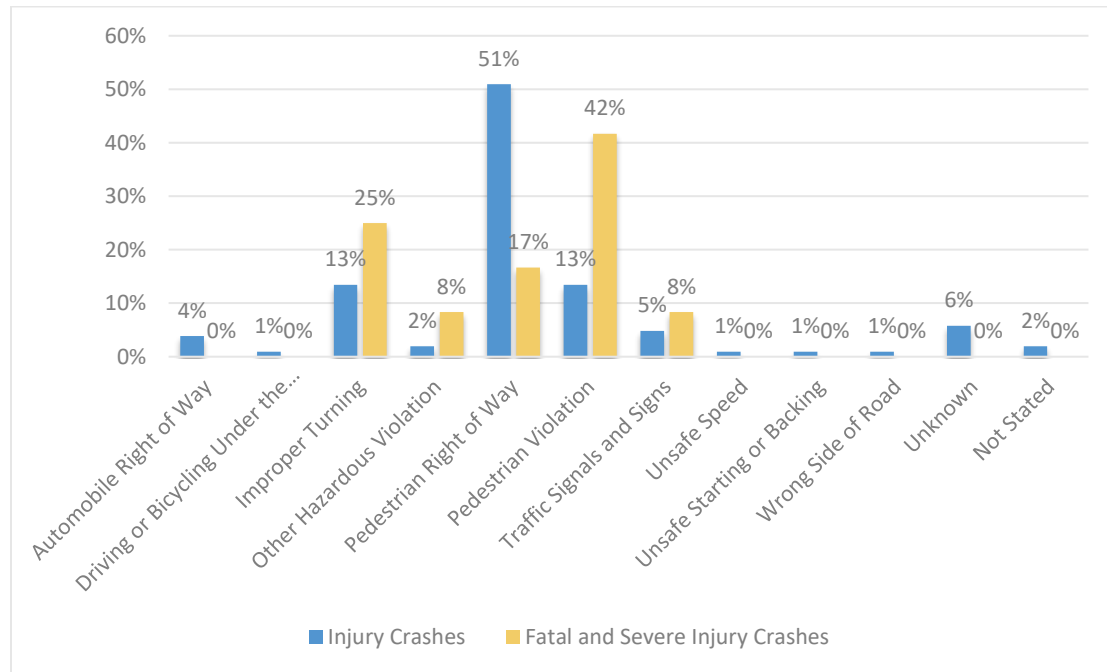


Collisions by Primary Collision Factor

Figure 7 illustrates the distribution of pedestrian collisions categorized by each PCF. It is important to note that PCFs do not encompass contextual information about the design aspects of the collision location, which could have been primary or secondary contributors to a collision. The most common PCFs were pedestrian right of way, accounting for 51% (53 collisions) of the reported collisions, followed by pedestrian violation and improper turning, each at 13% (14 collisions). When considering fatal and severe injury collisions, the breakdown is slightly different: the most common PCF was pedestrian violation at 42% (5 collisions), followed by improper turning at 25% (3 collisions), and then pedestrian right of way at 17% (2 collisions).



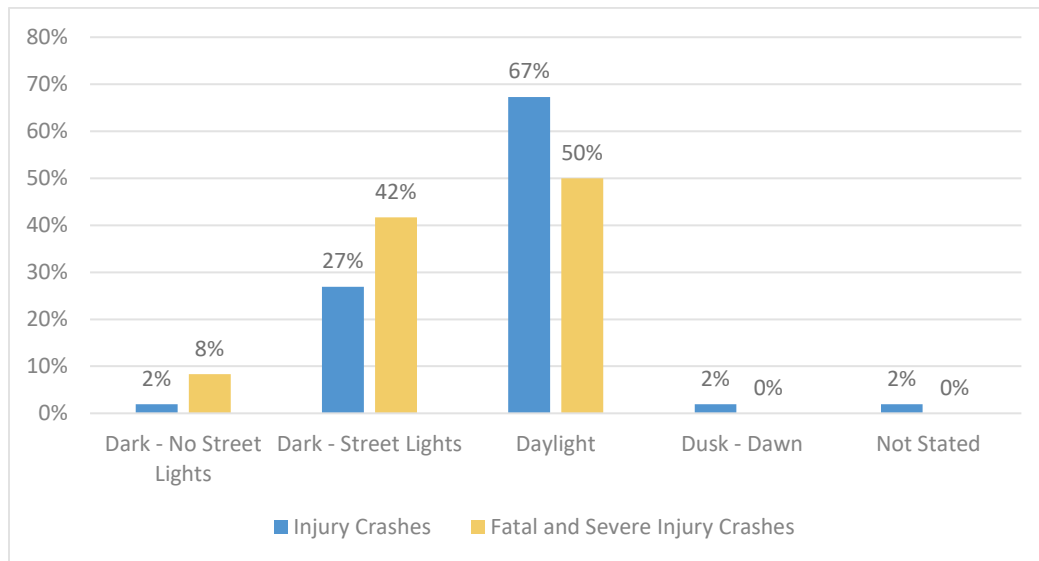
Figure 7. Pedestrian Collisions by Primary Collision Factor



Collisions by Lighting Conditions

Figure 8 illustrates the share of pedestrian collisions by lighting conditions. As shown, collisions tend to be more severe at night, around 29% (30 collisions) of the injury pedestrian collisions and almost half (6 collisions) of the fatal and severe injury pedestrian collisions occur at night. Although the majority of nighttime collisions take place in areas with streetlights, the effectiveness of this lighting is inconsistent. Often, streetlights may not be bright enough or may be spaced too far apart. This issue particularly affects pedestrians and those on sidewalks, as streetlights are often designed primarily with vehicles in travel lanes in mind. Among the dark condition collisions, approximately 8% (one collision) of the fatal and severe injury collisions occurred in areas where streetlights were absent.

Figure 8. Pedestrian Collisions by Lighting Conditions

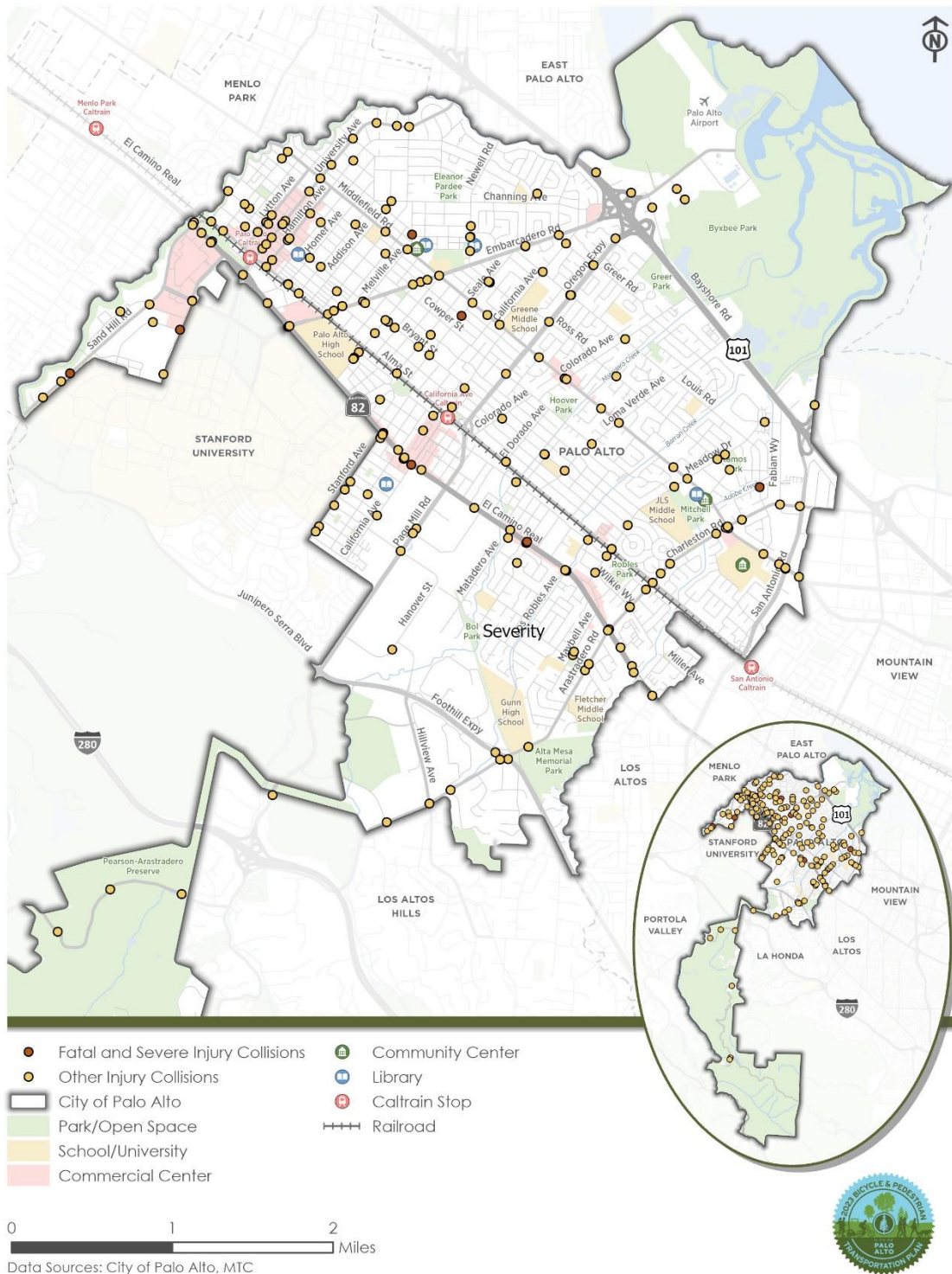


Bicycle Collision Analysis

In the five-year study period, there were 257 bicycle collisions reported in the City of Palo Alto; 13 collisions (5%) resulted in a fatality or severe injury. The bicycle collisions are mapped in Figure 9.

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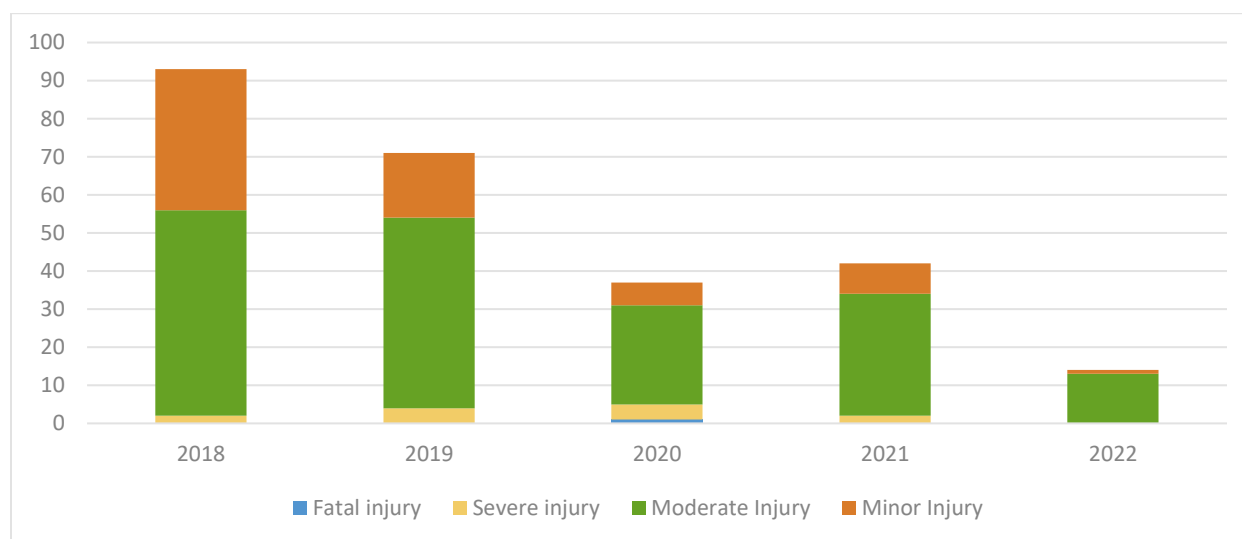
Figure 9. Bicycle Collision by Severity (2018 – 2022)



Collisions by Year

Figure 10 illustrates the temporal trends of bicycle collisions in the City of Palo Alto for different severity levels. Similar to the pattern observed in pedestrian collisions, the number of bicycle collisions has been steadily decreasing from 2018 to 2022. In 2020, there was a significant reduction in reported collisions, reflecting the impact of the COVID-19 pandemic on traffic patterns. A slight increase was observed in 2021, but the total number of bicycle collisions decreased again in 2022, resulting in 14 collisions, there were no fatal or severe injury collisions. During the five-year period, there was one fatal bicycle collision, which occurred in 2020, and the number of severe injury bicycle collisions has remained relatively low throughout these years, experiencing only minor fluctuations.

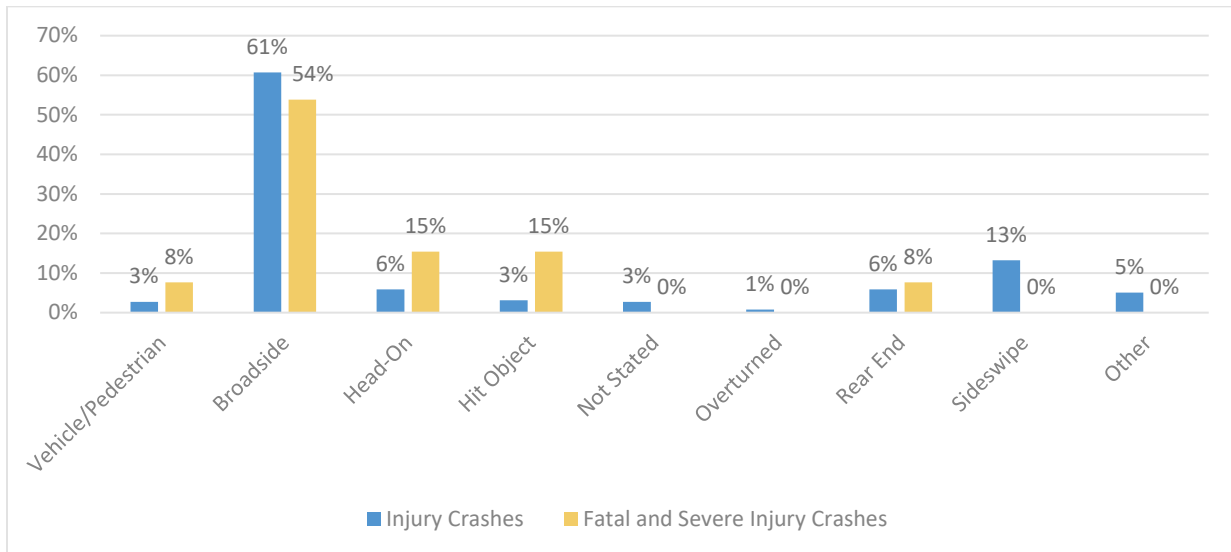
Figure 10. Total Number of Bicycle Collisions by Year and Severity



Collisions by Type

Figure 11 presents the types of bicycle collisions, including injury collisions and those leading to fatal or severe injuries only. The data shows that the most frequent type of bicycle collisions in the City of Palo Alto are broadside, constituting 61% (156 collisions), followed by sideswipe collisions at 13% (34 collisions). Considering fatal and severe injury bicycle collisions, broadside collisions make up 54% (7 collisions), while head-on and hit object collisions comprise 15% (2 collisions) each. Overall, broadside collisions are the most common incidents involving fatal or severe injuries.

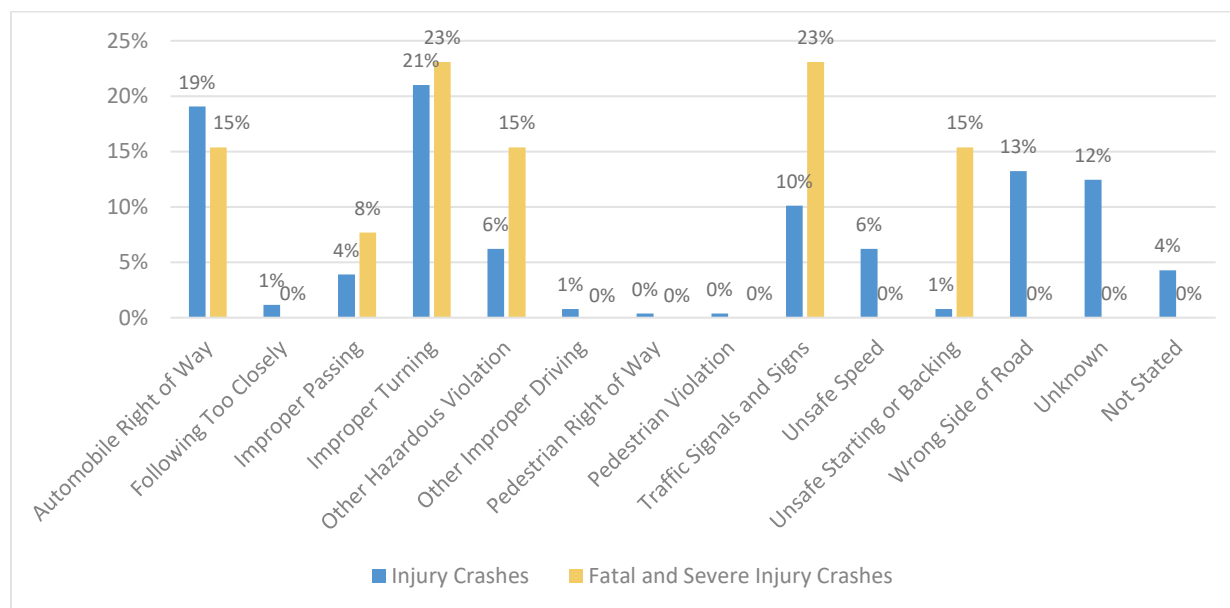
Figure 11. Bicycle Collisions by Type



Collisions by Primary Collision Factor

Figure 12 illustrates the breakdown of bicycle collisions by each PCF. The leading PCFs for bicycle collisions were improper turning and automobile right of way, constituting 21% (54 collisions) and 19% (49 collisions) of the reported incidents, respectively, followed by riding on the wrong side of the road at 13% (34 collisions). In the context of fatal and severe injury collisions involving bicycles, the distribution changes: improper turning, and traffic signals and signs become the most frequent PCFs at 23% (3 collisions) each, followed by automobile right of way, unsafe starting or backing, and other hazardous violations, each accounting for 15% (2 collisions).

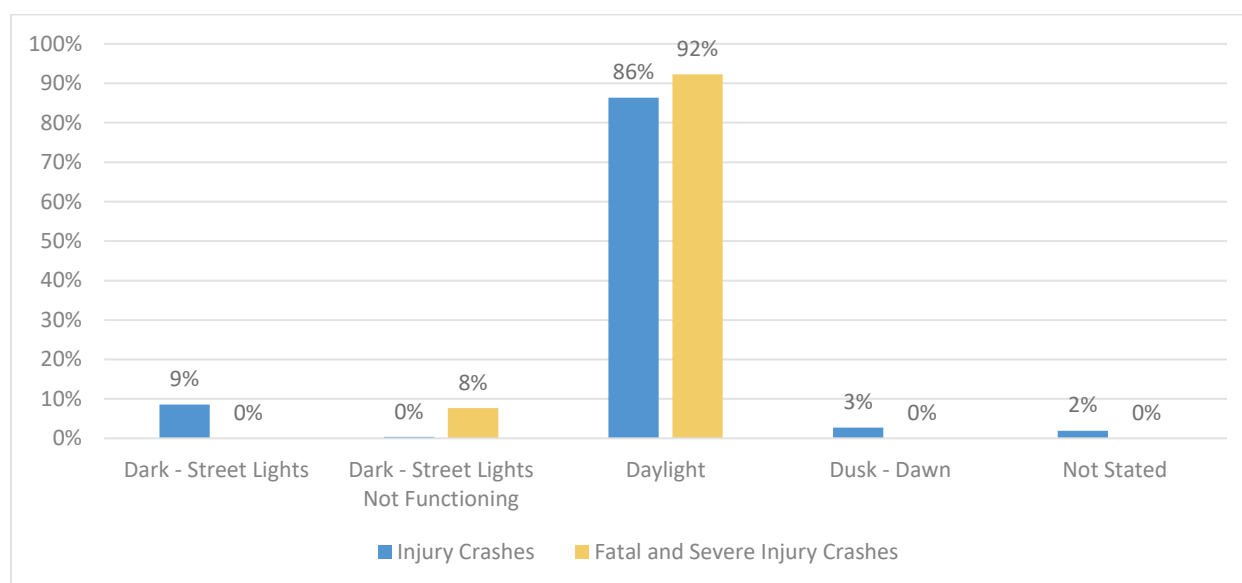
Figure 12. Bicycle Collisions by Primary Collision Factor



Collisions by Lighting Conditions

Figure 13 illustrates the distribution of pedestrian collisions by lighting conditions. It shows that around 9% (22 collisions) of the injury bicycle collisions and 8% (one collision) of the fatal and severe injury bicycle collisions occur at night. Notably, the fatal and severe injury collisions predominantly occurred in areas where streetlights were absent.

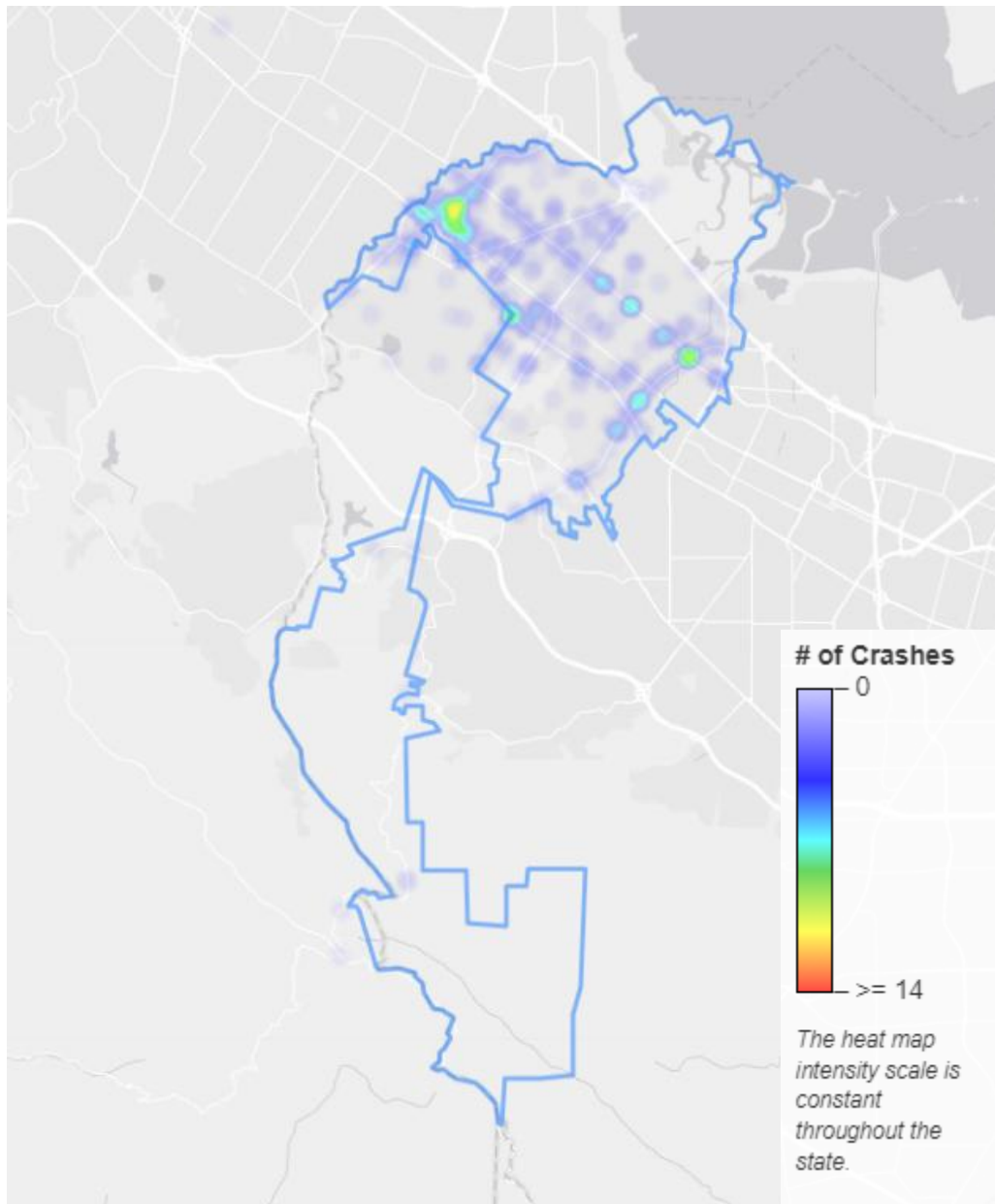
Figure 13. Bicycle Collisions by Lighting Conditions



California ATP Webtool

As a supplemental analysis to support Active Transportation Program grant applications, Kittelson will use the California ATP webtool² to visualize the community heat map for collision intensity. The Citywide collision heat map is presented in Figure 14.

Figure 14. Collision Heat Map for City of Palo Alto



² TIMS - Transportation Injury Mapping System (berkeley.edu)

KEY TERMS AND ACRONYMS

Automobile Right of Way

Violations of California Vehicle Code (CVC) 21800 through CVC 21804 are generally associated with automobile right of way violations. For non-highway collisions in the city, automobile right of way violations are mostly correlated with broadside, head-on and vehicle/bicyclist collision types.

Improper Turning

Improper turning violations are generally associated with a violation of CVC 22107. For non-highway collisions in the city, improper turning violations are mostly correlated with sideswipe, hit object, and rear-end collision types.

Other Hazardous Violation

Other Hazardous Violations encompass a range of unsafe driving behaviors not exclusively covered by specific sections of the CVC but may include violations such as unsafe lane changes, following too closely, or engaging in distracted driving practices.

Pedestrian Right of Way

Pedestrian Right of way violations are mostly associated with CVC code 21950 (Failure to yield to a pedestrian).

Pedestrian Violation

Pedestrian Violations refer to instances where pedestrians fail to adhere to laws designed for their safety, such as jaywalking (crossing the road unlawfully), ignoring pedestrian signals at intersections, or walking along highways.

SWITRS

Statewide Integrated Traffic Records System

TIMS

Transportation Injury Mapping System (from UC Berkeley SafeTREC)

Traffic Signals and Signs

Traffic Signals and Signs violations are mostly associated with CVC code 21453 (Running a red light) and 22450 (Running a stop sign). For non-highway collisions in the city, traffic signals and signs collision factor are correlated with vehicle/bicyclist, not stated and broadside collision types.

Unsafe Speed



Unsafe Speed violations occur when a driver exceeds the posted speed limit or drives too fast for current road conditions, violating CVC 22350 (Basic Speed Law).

Unsafe Starting or Backing

Unsafe starting or backing are mostly associated with CVC code 22106. For non-highway collisions in the city, unsafe starting or backing collision factor is correlated with other, hit object and rear-end collision types.

Wrong Side of Road

Wrong Side of Road violations are associated with CVC code 21650 that requires motorists to drive on the right side of the road, unless an exception to the law applies. These violations refer to driving against traffic, either by entering a one-way street in the wrong direction or crossing over into oncoming traffic lanes.

