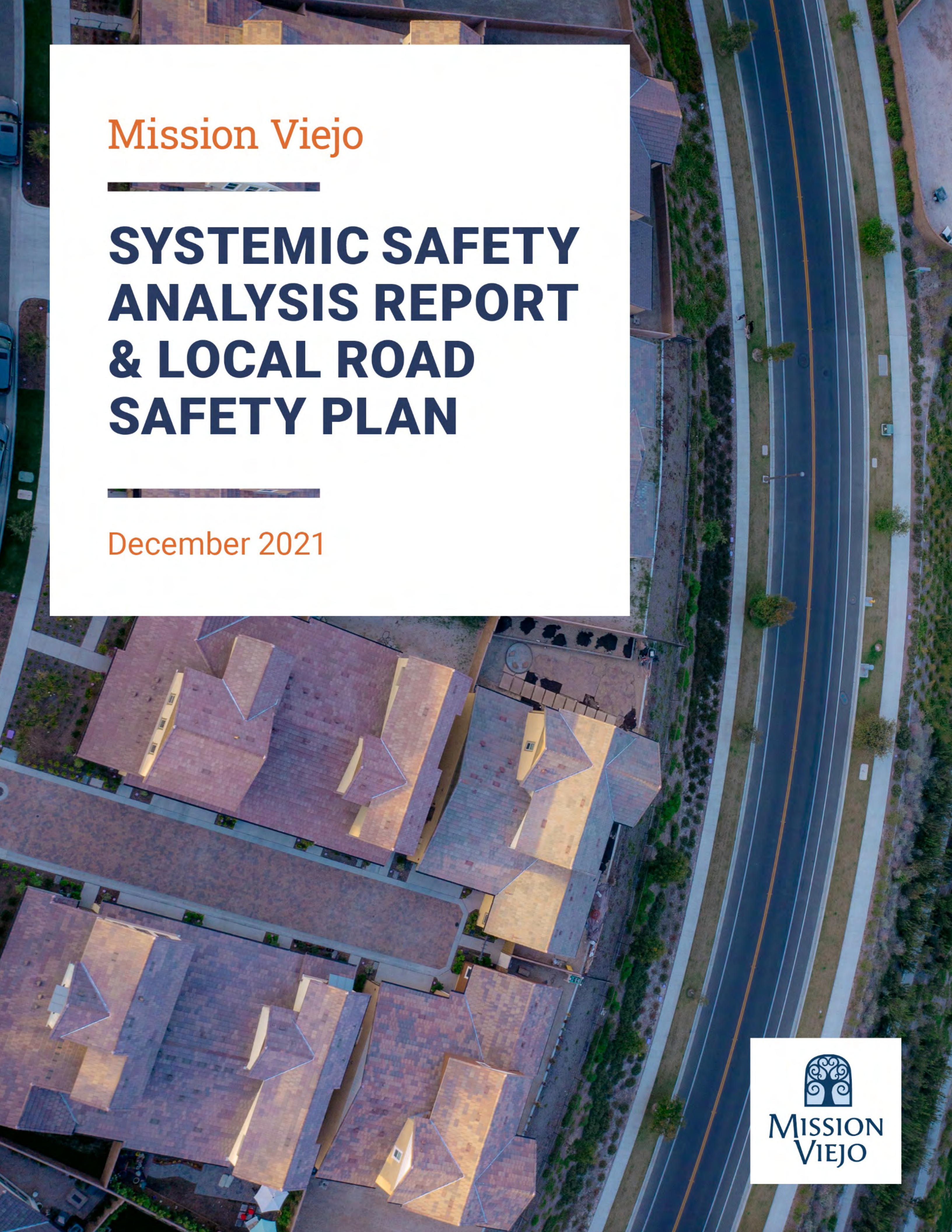

Mission Viejo

SYSTEMIC SAFETY ANALYSIS REPORT & LOCAL ROAD SAFETY PLAN

December 2021

MISSION VIEJO SSAR/LRSP

Mission Viejo, CA

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December 22, 2021

ENGINEER’S SEAL:

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

STATEMENT OF PROTECTION OF DATA FROM DISCOVERY AND ADMISSIONS:

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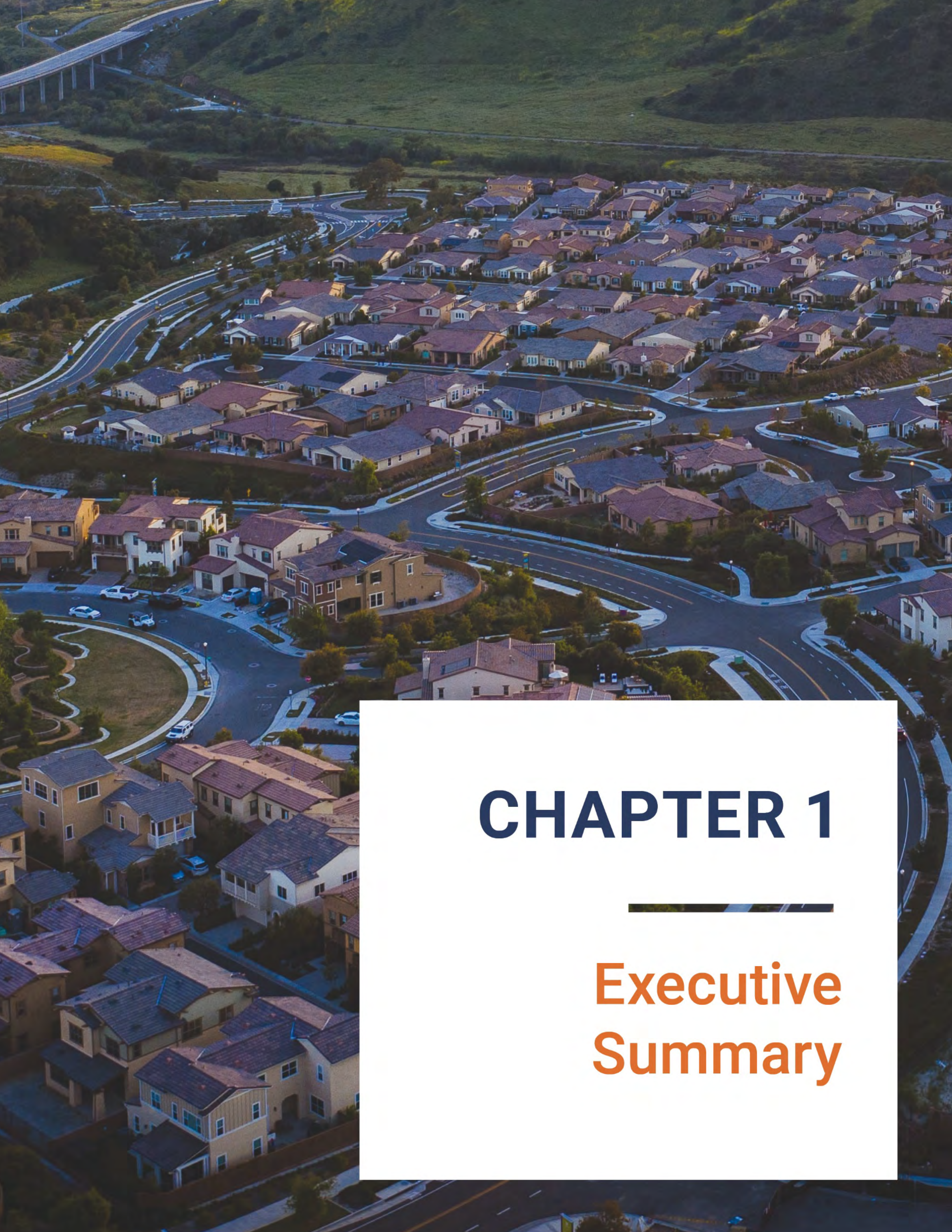


CHAPTER 1

Executive Summary

EXECUTIVE SUMMARY

PURPOSE

The purpose of this report is to provide the City of Mission Viejo (City) and its partners information and direction on strategies and treatments most likely to improve roadway safety performance within the city. This report presents the following:

- Vision and goals specific to the City's approach to traffic safety on their roadways
- Descriptive and spatial collision data information
- Emphasis areas for safety improvements and investments
- Suggested multidisciplinary safety strategies that would be most impactful to reducing future collisoin risk
- Proposed safety improvements for the highest priority intersections within Mission Viejo
- A basis for informing roadway safety performance improvements over the next three to five years
- A framework which the City can use to update its roadway safety performance analysis and produce updated local road safety plans in the future

The content of this report was developed in collaboration with the City and its multidisciplinary partners in implementation.

VISION & GOALS

MISSION VIEJO'S VISION FOR ROADWAY SAFETY

Improve roadway safety performance by investing in strategies and improvements that reduce the risk of fatal and injury collisions occurring on public roadways within the city.

Specific goals aimed at helping the City achieve its vision are:

- Reduce the annual number of fatal and severe injury collisions.
- Reduce the annual number of bicyclist- and pedestrian-involved collisions.
- Use data-informed analysis and community needs to identify and prioritize opportunities to improve transportation safety.
- Implement systemic countermeasures to target emphasis areas identified in this report.
- Conduct yearly assessments of collision data, locations, and trends.
- Strengthen partnership with traffic safety stakeholders to promote transportation safety and exchange information and ideas specific to roadway safety.
- Use local safety performance trends to plan and implement targeted education and enforcement efforts to promote roadway safety.
- Apply a safety lens to all roadway projects by incorporating safety in project development and project review processes.

KEY FINDINGS

Collision Patterns and Trends

There were 1,406 reported collisions on City of Mission Viejo streets between 2017 and 2020.

Five percent of reported collisions resulted in fatality (11) or serious injury (66).

The three most frequent collision types for all reported collisions are:

- broadside (28 percent),
- rear-end (28 percent)
- hit-object (21 percent)

The three most frequent collision types for fatal and severe injury collisions are:

- broadside (36 percent),
- hit-object (18 percent)
- vehicle-pedestrian (13 percent)

The four most frequently reported Primary Collision Factors *(PCFs) among total reported collisions* are:

- unsafe speed[1] (20 percent),
- improper turning[2] (19 percent),
- driving or bicycling under the influence of alcohol or drugs[3] (13 percent)
- traffic signals and signs[4] (13 percent).

DATA

Kittelson & Associates, Inc. (Kittelson) used reported collision date from January 1, 2016 through December 31, 2020 to inform the findings in the Systemic Safety Analysis Report and Local Road Safety Plan. The descriptive analysis of citywide trends examined 2017 to 2020 collisions, while the spatial analysis also included 2016 collisions (assessing the five-year 2016 to 2020 period). Key findings from the analysis are provided below. Greater detail about the findings as well as recommended strategies and improvements to reduce fatal and injury collisions are presented in this report.

[1] This is a reported PCF that indicated one of several California Vehicle Violation codes indicating unsafe speeding on a highway.
[2] This is a reported PCF that indicated one of several California Vehicle Violation codes indicating a failure while turning from a direct course without reasonable safety or not signaling appropriately.
[3] This is a reported PCF that indicated one of several California Vehicle Violation codes indicating the driver was under the influence of alcohol.
[4] This is a reported PCF that indicated one of several California Vehicle Violation codes indicating running a red light or failure to stop at a stop sign.

The three most frequently reported PCFs among fatal and severe injury collisions are:

- traffic signals and signs (16 percent),
- improper turning (14 percent)
- automobile right-of-way[5] (14 percent).

The number of intersection collisions is generally four times the number of midblock collisions.

High Priority Locations

Kittelson identified priority intersections using the annualized collision severity scores based on collision locations and severity of collisions between January 1, 2016, and December 31, 2020. The five locations that ranked the highest are:

- Alicia Parkway/Jeronimo Road
- Alicia Parkway/Marguerite Parkway
- Oso Parkway/Marguerite Parkway
- Olympiad Road/Marguerite Parkway
- Crown Valley Parkway/Doctor Guevara Way/Medical Center Drive

Many of the unsignalized intersections and corridors with higher annualized collision severity scores are addressed by the systemic countermeasures identified.

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

Collision Risk Factor Findings

Kittelson identified the following roadway characteristics as collision risk factors based on total reported collisions. Risk factors are roadway characteristics potentially associated with more frequent or severe collisions. These help identify certain features of a roadway that can be systemically treated to prevent future collision risk at locations that may or may not have a history of collisions.

- Thirty-five percent of the priority intersections are signalized, and 65 percent are unsignalized, with nine of the top ten intersections all signalized.
- Thirty-two of the 40 priority intersections are intersections where at least one leg is a multi-lane arterial road (as opposed to a two-lane local residential street).
- Of those 32 intersections priority intersections, 14 are signalized intersections where two or more arterial roads intersect or where a multi-lane roadway intersects a residential street, and 18 are unsignalized intersections where a side street intersects a multi-lane arterial road.
- Eight of the 40 priority intersections are intersections where all legs consist of local residential streets.
- Thirteen of the 40 priority intersections are located on Marguerite Parkway.
- Approximately 87 percent of the priority segment mileage is along arterial roadways, while the remaining 13 percent is along local roads.

Emphasis Areas

Using input from the stakeholder group and the analysis results, six emphasis areas were identified for Mission Viejo. Mitigation measures specific to each emphasis area were selected based on the City's collision patterns and trends as well as roadway characteristics indicative of increasing collision risk. Kittelson used the Caltrans Local Road Safety Manual, California MUTCD, and national resources related to roadway safety to identify potential mitigation measures. The six emphasis areas and supporting project locations or grouping selected for each emphasis area are:

SIGNALIZED INTERSECTIONS

- Alicia Parkway/Jeronimo Road
- Alicia Parkway/Marguerite Parkway
- Oso Parkway/Marguerite Parkway
- Olympiad Road/Marguerite Parkway
- Crown Valley Parkway/Doctor Guevara Way/Medical Center Drive

CITYWIDE SYSTEMIC MEASURES

- Speed Management Treatments
- Intersection Treatments
- Intersection Approach Treatments
- Roadside Conditions Treatments

CITYWIDE SIGNALIZED PEDESTRIAN MITIGATION MEASURES

- **Type 1**: Three- or four-legged intersections on an arterial roadway near a retail/commercial area
- **Type 2**: Three- or four-legged intersections on an arterial roadway near a school or residential area

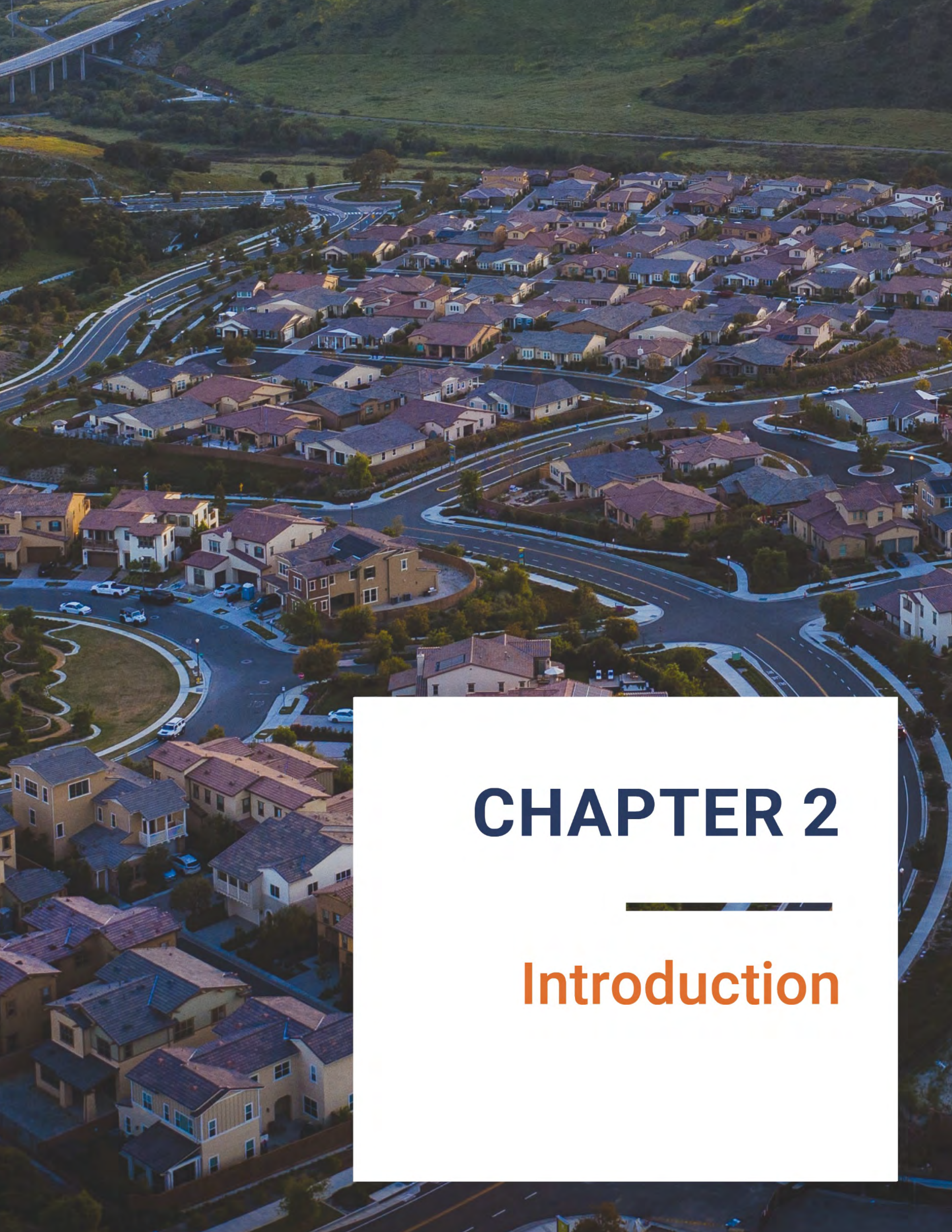
CITYWIDE BICYCLE MITIGATION MEASURES

- Type 1: Four-legged intersections
- Type 2: Three-legged T-intersections
- Type 3: Skewed four-legged intersections

CROSSWALK ENHANCEMENT LOCATIONS

- Via Linda/Medero
- Pradera Drive/Pericia Drive
- Herencia/Anaya
- Mustang Run/Portola Plaza

INTEGRATE NON-ENGINEERING STRATEGIES



CHAPTER 2

Introduction

INTRODUCTION

PURPOSE

The purpose of this report is to provide the City of Mission Viejo (City) and its partners information and direction on strategies and treatments most likely to improve roadway safety performance within the city. The content of this report was developed in collaboration with the City and its multidisciplinary partners in implementation.

The development of this report is funded by the City's Systemic Safety Analysis Report (SSAR) Program grant funds from Caltrans. The scope of the analysis and contents of this report fulfill the requirements for a SSAR to be eligible for future state funding and were expanded to also address Caltrans' more recent Local Road Safety Plan (LRSP) requirements.

This report speaks to citywide collision patterns and trends and strategies to address traffic safety issues specific to Misison Viejo. At the beginning, this report sets forth a vision and goals specific to the City's approach to traffic safety on their roadways. From there, the report provides descriptive and spatial collision data information, identifies emphasis areas for safety improvements and investments, suggests multidisciplinary safety strategies that would be most impactful to reducing future collision risk, and presents proposed safety improvements for the highest priority intersections within the city.

This report establishes a basis for informing roadway safety performance improvements over the next three to five years and also provides a framework the City can use to update its roadway safety performance analysis and produce updated local road safety plans in the future.

PROCESS

The content of this report is informed by data analysis as well as input from key agency stakeholders. In developing the content of the report, the City engaged a stakeholder group at key milestones to review and provide input on draft results, recommendations, and deliverables. The stakeholder group included representatives from the City of Mission Viejo, local police and fire departments, school districts, and the local community college.

ORGANIZATION

The remainder of this document is organized into the following sections:

Vision & Goals

Presents the City's vision and goals specific to roadway safety performance and reducing the number of fatal and severe collisions.

Safety Partners

Summarizes the partner agencies involved in providing input into this report.

Previous Efforts

Presents the previous efforts the City has undertaken to improve roadway safety performance.

Data Analysis Techniques and Results

Discusses the approach used and findings from detailed collision and data analysis performed for this SSAR/LRSP.

Emphasis Areas

Presents the City collision focus areas based on priority collision patterns and trends as well as locations to address. This section includes engineering and non-engineering strategies that can be used to mitigate collision risk, frequency, or severity.

Evaluation and Implementation

Describes performance measures and approaches to gauge progress in addressing traffic safety issues in the city and outlines a process for future updates to this analysis and report.

ADDITIONAL PROJECT COMPONENTS

The grant obtained from Caltrans also included the opportunity for the City to make additional investments in traffic safety. These additional components include:

Citywide Collision Location Pin Maps

Pin map graphics were prepared for the reported collisions in years 2017, 2018, 2019, and 2020. These graphics show the frequency of collisions at their location within the city's roadway network. The collision pin maps created are provided as Appendix A.

Collision Diagrams

Collision diagrams for locations that experienced five or more collisions in years 2017, 2018, 2019, and 2020 were developed. This effort helps identify trends at specific locations to inform recommendations and treatments. The collision diagrams were used to support the intersection modifications identified in this report and include additional locations for reference. The collision diagrams created are provided as Appendix B.

Collision Reporting Software Purchase

Funding was provided for the City to purchase software to manage collision data reporting and tracking. Having current and accurate data is an important part of being able to identify traffic safety issues and prioritize improvement locations. The initial purchase of the software will include installation, licensing, and training for City staff.

Unsignalized Intersection Signal Watch List Update

The City's Intersection Watch List contains a list of unsignalized intersections throughout Mission Viejo that are ranked based on a priority rating system. This rating is used to make recommendations for the installation of traffic signals under various City improvement programs and to evaluate various intersections that have been identified by residents as needing a traffic signal. The current Watch List contains 36 intersections. The evaluation and ratings for each intersection was completed, and the Intersection Watch List was updated accordingly. The documentation is provided as Appendix C.

Traffic Signal Design Plans

Traffic signal design plans, specifications, and cost estimates were created for the following three locations: Marguerite Parkway/Claro, Marguerite Parkway/La Sierra Drive, and Alicia Parkway/Po Avenue. A left-turn phasing analysis was performed to evaluate the appropriate left-turn phase to use at each intersection approach. The final design plans and supporting information were provided to City staff.

Olympiad Road Special Event Planning

A temporary traffic control plan concept was developed to be utilized for special events that occur at either Lake Mission Viejo or Marty Russo Youth Athletic Park. The proposed concept is provided as Appendix G. Near the intersection of Olympiad Road and the entrance to these facilities, there is parking on both sides of Olympiad Road as well as parking lots for the lake and the park that become fully occupied during special events. There is an increase in pedestrian activity level and particularly with pedestrians crossing Olympiad Road at the side-street stop-controlled intersection. The temporary traffic control plan can be used or modified accordingly to direct vehicle and pedestrian flows during special event planning. Further data for weekend and event volumes would be needed to assess if permanent improvements are warranted at the intersection.

CHAPTER 3

Vision & Goals

VISION & GOALS

VISION

MISSION VIEJO'S VISION FOR ROADWAY SAFETY

Improve roadway safety performance by investing in strategies and improvements that reduce the risk of fatal and injury collisions occurring on public roadways within the city.

GOALS

The following presents specific goals aimed at helping the City achieve its vision.

- Reduce the annual number of fatal and severe injury collisions.
- Reduce the annual number of bicyclist- and pedestrian-involved collisions.
- Use data-informed analysis and community needs to identify and prioritize opportunities to improve transportation safety.
- Implement systemic countermeasures to target emphasis areas identified in this report.
- Conduct yearly assessments of collision data, locations, and trends.
- Strengthen partnership with traffic safety stakeholders to promote transportation safety and exchange information and ideas specific to roadway safety.
- Use local safety performance trends to plan and implement targeted education and enforcement efforts to promote roadway safety.
- Apply a safety lens to all roadway projects by incorporating safety in project development and project review processes.

CHAPTER 4

Safety Partners

SAFETY PARTNERS

AGENCY PARTNERS ENGAGED

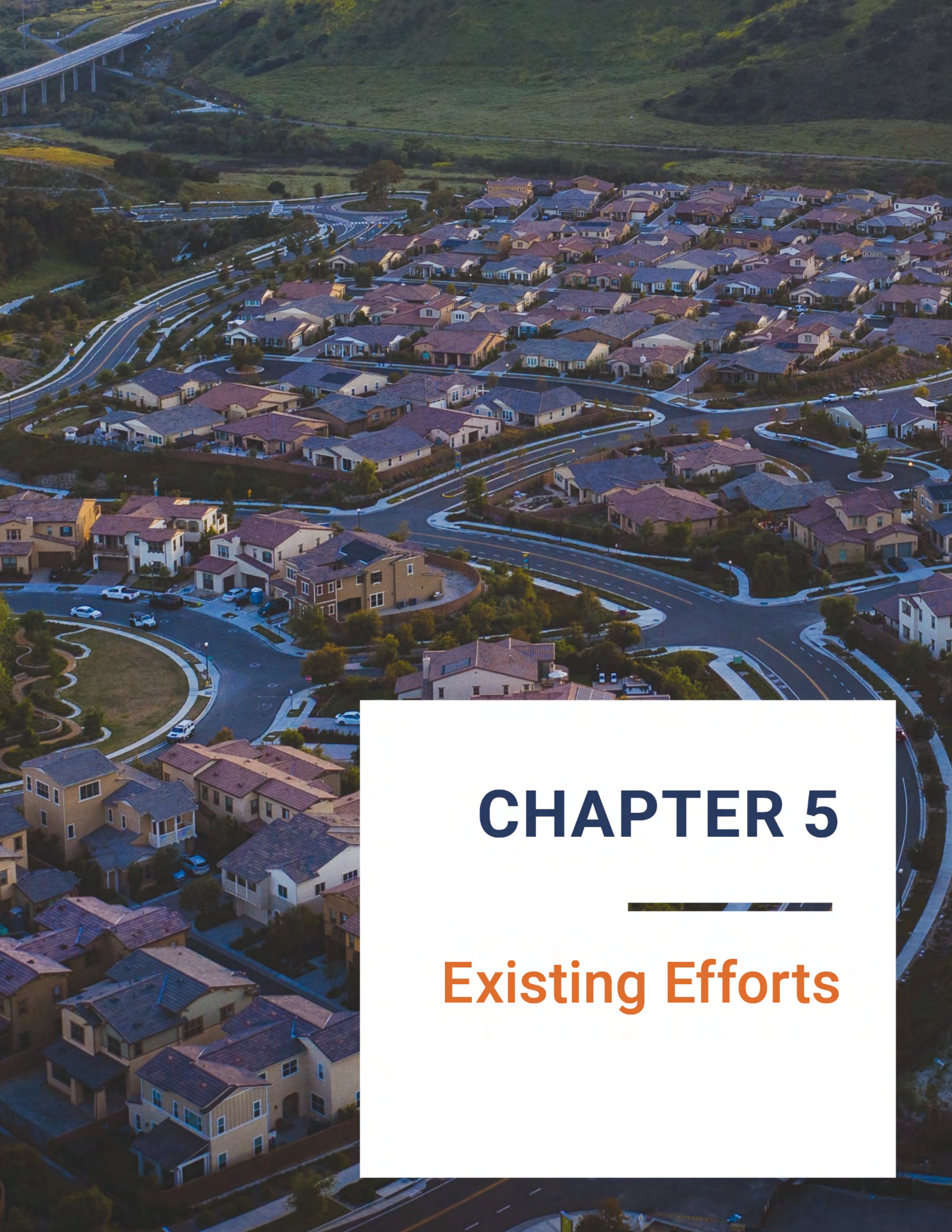
The City assembled and engaged several stakeholders to provide input at key points in the SSAR/LRSP development process. Stakeholders included representatives from the following:

- City of Mission Viejo Public Works Department
- City of Mission Viejo Chamber of Commerce
- City of Mission Viejo Traffic Committee
- Orange County Sheriff's Department
- Orange County Fire Authority
- Saddleback Valley Unified School District
- Capistrano Valley Unified School District
- Saddleback College

INPUT GATHERED

The stakeholders met three times throughout the project's development and was provided the opportunity to review the draft version of this report. During this process, the stakeholders provided input on the following topics over the course of this report's development:

- Existing and past efforts targeting roadway safety performance including specific projects, treatments, planning efforts, educational related messages, and enforcement activities.
- Review of the collision data analysis findings and supporting anecdotal information regarding collision patterns and trends across the city and at specific locations identified as higher priority for improvements.
- Development of the vision, goals, and emphasis areas prepared to guide future roadway safety improvements.
- Feedback on recommended engineering and non-engineering strategies identified in this report.
- Feasibility and coordination efforts planned for implementation of systemic and specific safety improvement treatments identifed in this report.



CHAPTER 5

Existing Efforts

EXISTING EFFORTS

ABOUT

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

OCTA District 5 Bikeways Strategies Report (2015)

OCTA prepared this strategy report for District 5, which includes the cities of Aliso Viejo, Dana Point, Laguna Beach, Laguna Hills, Laguna Niguel, Laguna Woods, Lake Forest, Mission Viejo, Rancho Santa Margarita, San Clemente, and San Juan Capistrano, as well as portions of Irvine and unincorporated county. The report is a result of a collaborative effort to identify and prioritize potential regional bikeways throughout south Orange County. The report identifies nine regional bikeway corridors, of which the following travel through or adjacent to Mission Viejo:

- Corridor C (El Toro/Alicia/Laguna Canyon)
- Corridor D (Portola/Santa Margarita)
- Corridor E (Aliso Creek)
- Corridor F (Muirlands/Cabot/Camino Capistrano)
- Corridor G (Oso Parkway)

Corridor C (El Toro/Alicia/Laguna Canyon) and Corridor F (Muirlands/Cabot/Camino Capistrano) were among the top three ranked corridors in the report, based on the following evaluation criteria:

- Trip demand
- Level of traffic stress (LTS)
- Reported collisions
- Public support
- Physical constraints
- Completes the corridor
- Completes the network
- Economic efficiency

The report includes near-term action plans, funding strategies, and recommended programs to enhance the bicycle network for users of all abilities.

Mission Viejo Comprehensive Bikeway Master Plan (2019)

The City's Comprehensive Bikeway Master Plan serves as a guide for developing a safe, efficient and convenient system of bikeways in the city in order to enhance and promote bicycling as a viable alternative to driving. The plan's recommendations build upon a robust public outreach program. The goals of the plan are as follows:

- Promote safe bicycle riding.
- Increase bicycle riding and trail usage.
- Improve access to the regional bikeway networks.
- Increase public awareness of safe bike riding as a form of transportation and recreation, and reinforce the health benefits.
- Bring awareness to residents on bike trail etiquette.

Mission Viejo General Plan Circulation Element (2013)

The Mission Viejo General Plan is the community's overarching policy document that defines a vision for future change and guides the location and character of development. The intent of the General Plan is enhancing the local economy, improving public services and safety, conserving resources, and fostering community well-being.

The Circulation Element establishes the following goals and relevant policies directly related to transportation safety.

GOAL 1
Manage and optimize a balanced, multimodal transportation network that meets the needs of all users of streets, roads, and highways for safe and convenient travel in a manner that is based upon, and is in balance with, the Land Use Element of the City of Mission Viejo General Plan.

POLICY 1.4
Maintain and implement circulation system standards for all users, such as roadway and intersection classifications, rights-of-way width, pavement width, pavement conditions, design speed, warrant requirements, capacity, maximum grades, green streets, and associated roadway features. All users means users of streets, roads, and highways, including bicyclists, children, persons with disabilities, motorists, movers of commercial goods, pedestrians, users of public transportation, and seniors.

GOAL 4

Preserve the residential character of local neighborhoods by minimizing through traffic and regulating vehicular speed.

POLICY 4.2

Identify alternatives, develop strategies, and implement traffic calming measures to minimize through traffic on existing local and collector streets.

GOAL 5

Facilitate the safe and efficient movement of people and vehicles to and from school sites.

POLICY 5.1

Identify and promote strategies to minimize conflicts between pedestrians, bicyclists, and vehicles at local schools.

POLICY 5.2

Coordinate with school districts, local schools, the Orange County Sheriff's Department, parent-school organizations and the community in identifying school transportation issues and in developing and implementing traffic calming/traffic management strategies and safe school routes at local schools.

GOAL 7

Evaluate, monitor and implement operational improvements and traffic control measures to maximize efficiency of the City's arterial circulation system.

POLICY 7.4

Provide for safe operations of traffic by adhering to national standards and uniform practices.

POLICY 7.5

Design and employ traffic control measures to ensure City streets and roads function with safety and efficiency.

GOAL 14

Protect and encourage non-motorized transportation such as bicycle, pedestrian, and equestrian travel.

POLICY 14.2

Provide for safety of pedestrians, bicycles, and equestrians by adhering to national standards and uniform practices.

Citywide Collision Analysis

The City of Mission Viejo reviewed 2016 collision data to determine if there were any patterns or conditions at locations where strategies could be applied to improve transportation safety. The City reviewed 2016 data (supplemented by 2014 and 2015 data) from the City's Accident Inventory System (AIS) and the Statewide Integrated Traffic Records System (SWITRS).

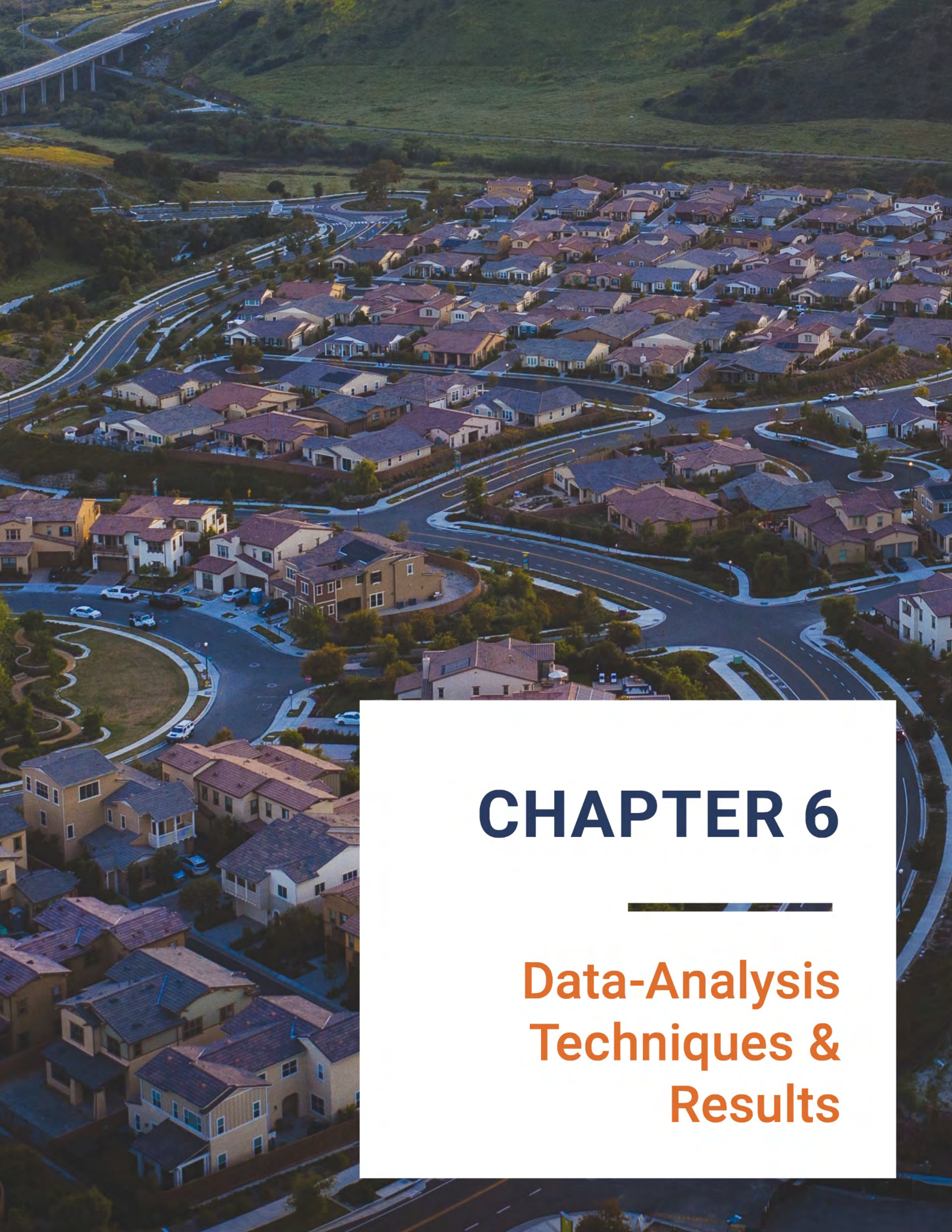
The report included the following components:

- Review of collision trends such as severity, type, and collision factors
- Identification of high-collision intersections and preparation of collision diagrams
- Preparation of collision pin maps

Documentation of the 2016 Citywide Collision Analysis is provided in Appendix D and was utilized in this project while determining priority locations for recommending improvements.

Intersection Watch list

The City maintains a watch list of unsignalized intersections throughout the city that may warrant the installation of traffic signals. At this time, the watchlist consists of 36 unsignalized intersections. Through its monitoring, the City reviews factors such as number of lanes, 85th percentile speeds, collisions, proximity to other signals, and other special conditions to determine if each intersection satisfies technical traffic signal warrants based on the most current California Manual of Uniform Traffic Control Devices (MUTCD). As noted in the introduction section, the Intersection Watch List was updated as part of this project's efforts. The City plans to continue to update and monitor the intersections in future years using this process.



CHAPTER 6

Data-Analysis Techniques & Results

DATA ANALYSIS TECHNIQUES & RESULTS

ABOUT

The following section describes the methods and results for citywide collision patterns and trends and network screening and systemic evaluation analyses. Findings from these analyses inform relevant emphasis areas, establish datapoints to measure progress toward data-driven goals, and inform the systemic countermeasures and projects described in subsequent sections of this report.

The focus of the collision patterns and trends analysis is to identify behavioral and roadway patterns associated with injury and fatal collision outcomes.

For the network screening and systemic evaluation analyses, the focus is to identify locations in the city that would benefit the most from transportation safety improvements.

SAFETY DATA ANALYZED

This section documents the collision and roadway data assembled for analysis.

Collision Data

The project team worked with the City to build a database of the five most recent complete years of reported collisions, representing January 1, 2016 through December 31, 2020. Reported collisions were obtained from the University of California, Berkeley, Transportation Injury Mapping System (TIMS) database, and the California Statewide Integrated Traffic Records System (SWITRS) database. The City also provided a log of fatal collisions with which the project team supplemented the database.

The collision data analyzed do not include collisions that occurred along grade-separated freeways or ramps in the city (I-5 and SR-241). However, the project team retained collisions occurring at or within the influence area of ramp terminal intersections for analysis. The project team identified and removed duplicate records by inspecting the recorded time, date, and location. The database provided by the City were geolocated with coordinates for spatial analysis. The project team used two methods to geolocate the remaining collisions that had no spatial information.

Where possible, the project team:

- Matched collisions with an associated record from the publicly available UC Berkeley Transportation Injury Mapping System (TIMS) database, which includes spatial information for reported injury and fatal collisions.
- Used reference data saved in each collision record for primary and secondary streets, and associated distance and direction from intersection to geocode and manually offset collisions.
- Geolocated all reported fatal collisions in the database.

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

The descriptive analysis of citywide trends examined 2017 to 2020 collisions, while the spatial analysis also included 2016 collisions (assessing the five-year 2016 to 2020 period).

Roadway Characteristic Data

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

- Signalized and unsignalized intersections
- Roadway segment functional classifications

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

CITYWIDE COLLISION PATTERNS & TRENDS

Kittelson analyzed reported collisions across motor vehicles, pedestrians, and bicyclists. Trends and findings for the four-year 2017 to 2020 analysis period are presented based on the following:

- Collision severity
- Collision type
- Primary collision factor
- Fatal collision characteristics
- Intersection and midblock collisions
- Pedestrian collisions
- Bicycle collisions

Bicycle and pedestrian collisions are included in the following charts and tables. Specific characteristics unique to bicycle and pedestrian collisions are also discussed in separate sub-sections.

Collision Severity

Collisions are classified by severity based on their most severe outcome, arranged in descending order of severity: fatal, severe injury, other visible injury, complaint of pain injury, and property damage only (PDO).

COLLISION SEVERITY BY ROAD USER

TABLE 1 presents reported collisions, organized by severity level and road user. Notable trends include:

- Pedestrians are overrepresented in fatal and severe injury collisions. Pedestrians are involved in 3 percent of reported collisions but are involved in 14 percent of fatal and severe injury collisions.
- Bicyclists are also overrepresented in fatal and severe injury collisions. Bicyclists are involved in 3 percent of reported collisions but are involved in 11 percent of fatal and severe injury collisions.
- Fatal and severe injury collisions represent 5 percent of reported collisions.

TABLE 1: COLLISION SEVERITY BY ROAD USER INVOLVED (2017-2020)

Road Users Involved	Fatal (% of column)	Severe Injury (% of column)	Visible Injury (% of column)	Complaint of Pain (% of column)	Property Damage Only (% of column)	Total (% of column)
Pedestrian-Involved	2 (18%)	9 (14%)	12 (4%)	12 (4%)	2 (0.3%)	37 (3%)
Bicycle-Involved	1 (9%)	7 (11%)	18 (6%)	8 (3%)	3 (0.4%)	37 (3%)
Vehicle Only or Vehicle-Fixed Object	8 (73%)	50 (75%)	251 (90%)	294 (93%)	728 (99%)	1331 (94%)
Reported Collisions	11 (100%)	66 (100%)	281 (100%)	314 (100%)	733 (100%)	1406 (100%)
Severity Share of Reported Collisions	1%	5%	20%	22%	52%	100%

Source: SWITRS, TIMS, OCSD, Kittelson, 2021.

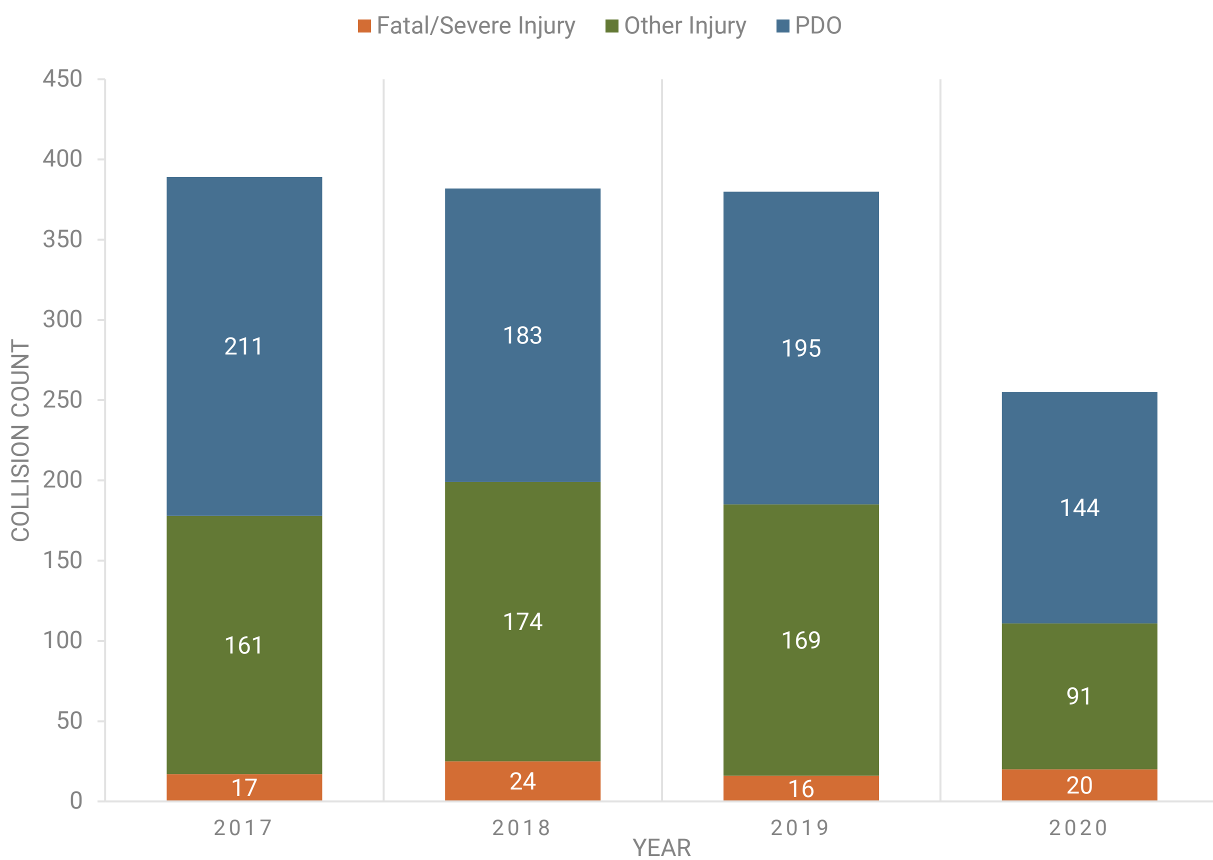
COLLISION SEVERITY BY YEAR

Figure 1 shows year-over-year trends in the data by severity. The first three years in the study period have similar numbers of collisions, each recording between 380 and 390 reported collisions per year. The fourth year in the study period has far fewer reported collisions at 255. The year 2020 has significantly fewer collisions than the prior three years, which may be due to lower traffic levels or different travel patterns during the COVID-19 pandemic. The 2020-year data may also be impacted by processing delays in adding 2020 collision data to the statewide database. The average number of collisions per year is 352, and there are 20 fatal or severe injury collisions on average per year. The following are trends in severity levels:

- **Fatal Collisions**: During the four-year study period, fatal collisions accounted for 1 percent of total reported collisions. Year over year, this percentage has remained fairly constant, with the highest percentage reaching 2 percent in 2020.
- **Severe Injury Collisions**: During the four-year study period, severe injury collisions accounted for 5 percent of total reported collisions. Year over year, this percentage has remained fairly constant, with the lowest level at 4 percent in 2017 and 2019, and the highest level at 5 percent in 2020.

- **Other Injury Collisions**: During the four-year study period, other injury collisions accounted for 42 percent of total reported collisions. Year over year, this percentage has varied, with the lowest level at 36 percent in 2020 and the highest level at 46 percent in 2018.
- **PDO Collisions**: During the four-year study period, property damage only collisions accounted for 52 percent of total reported collisions. Year over year, this percentage has varied slightly, with the lowest level at 48 percent in 2018 and the highest level at 56 percent in 2020.

FIGURE 1: COLLISION SEVERITY BY YEAR



Source: SWITRS, TIMS, Kittelson, 2021.
Note: "Other injury" includes "Other visible injury" and "Complaint of pain" collisions. "PDO" = property damage only.

Collision Type

The reported collision type provides an indication of the movements most frequently involved in collisions and in severe outcomes.

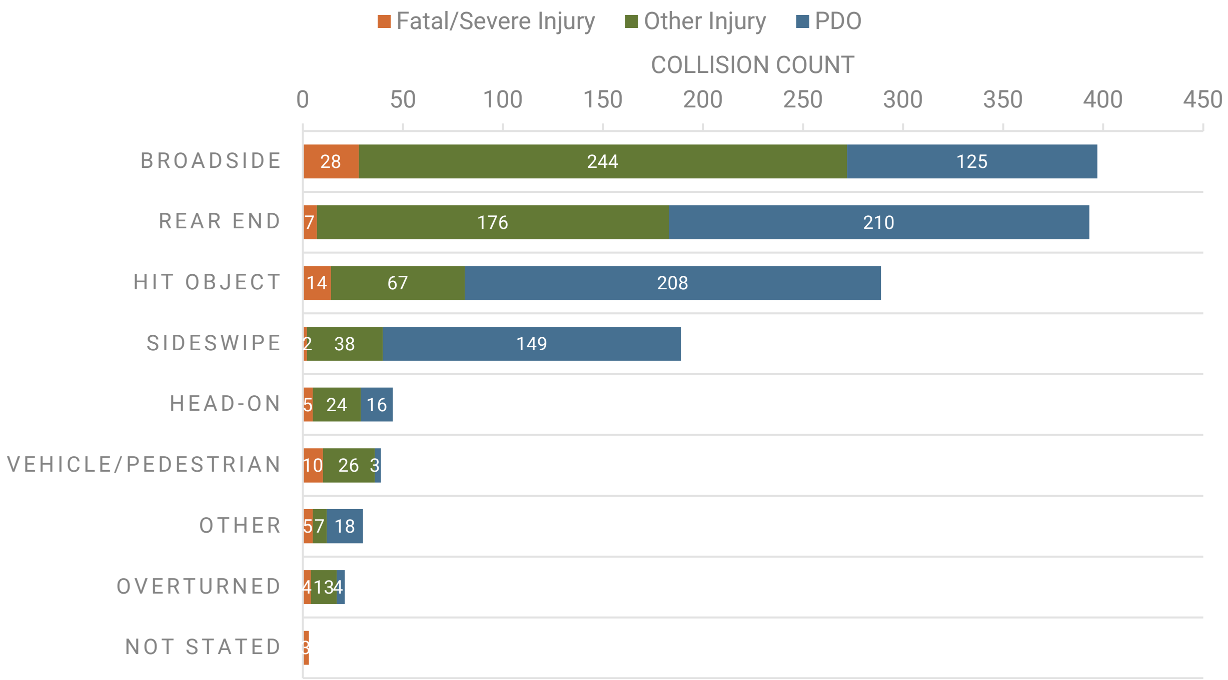
Figure 2 displays the most frequently reported collision types for the 2017-2020 study period, organized by severity.

Among total reported collisions for the 2017-2020 period, the top three most frequent collision types are **broadside** (28 percent), **rear-end** (28 percent), and **hit-object** (21 percent). These three collision types account for 77 percent of reported collisions in the city.

Among fatal/severe injury collisions for the 2017-2020 period, the top three most frequent collision types are **broadside** (36 percent), **hit-object** (18 percent), and **vehicle-pedestrian** (13 percent). These three collision types account for 67 percent of reported fatal/severe injury collisions in the city.

Among fatal collisions for the 2017-2020 period, the top three most frequent collision types are **broadside** (36 percent), **hit-object** (27 percent), and **vehicle pedestrian** (18 percent). These three collision types account for 75 percent of reported fatal collisions in the city.

FIGURE 2: COLLISION TYPE AND SEVERITY (2017-2020)



Source: SWITRS, TIMS, OCSD, Kittelson, 2021.
Note: “Other injury” includes “Other visible injury” and “Complaint of pain” collisions. “PDO” = property damage only.

Primary Collision Factor

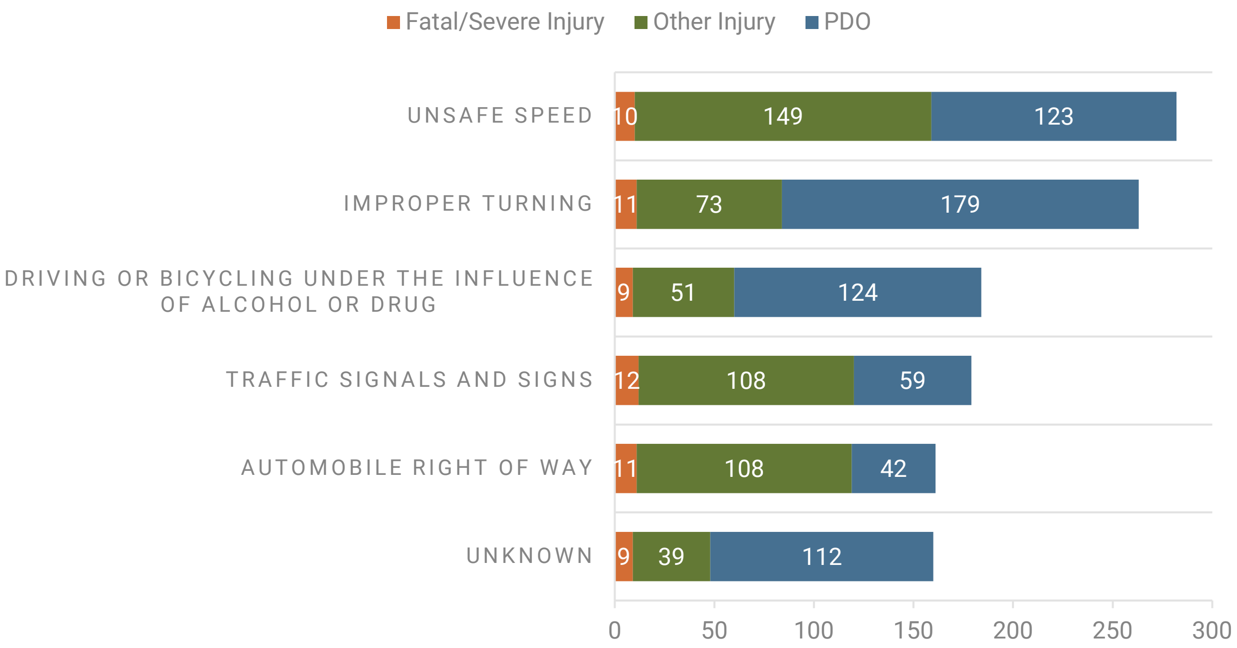
Reporting officers identify a primary collision factor (PCF) for each collision. There are several different PCFs from which they can select. It is up to the officer's judgement and the information available at the scene for them to select the factor that is most relevant. Officers select one from among a list of PCFs based on violations and road user behavior. Figure 3 presents the most frequently cited PCFs for collisions in the city. Figure 4 presents the most frequently cited PCFs for fatal and severe injury collisions in the city.

> The four most frequently reported PCFs among total reported collisions for the 2017-2020 period include **unsafe speed**[6] (20 percent), **improper turning**[7] (19 percent), **driving or bicycling under the influence of alcohol or drugs**[8] (13 percent), and **traffic signals and signs**[9] (13 percent). These four PCFs account for 65 percent of reported collisions.
>
> The three most frequently reported PCFs among fatal and severe injury collisions for the 2017-2020 period include **traffic signals and signs** (16 percent), **improper turning** (14 percent), and **automobile right-of-way**[10] (14 percent). These three PCFs account for 44 percent of reported fatal and severe injury collisions.
>
> The two most frequently reported PCFs among fatal collisions for the 2017-2020 period include **driving or bicycling under the influence of alcohol or drugs** (27 percent) and **pedestrian violation[11]** (18 percent). These two PCFs account for 45 percent of reported fatal collisions.

---

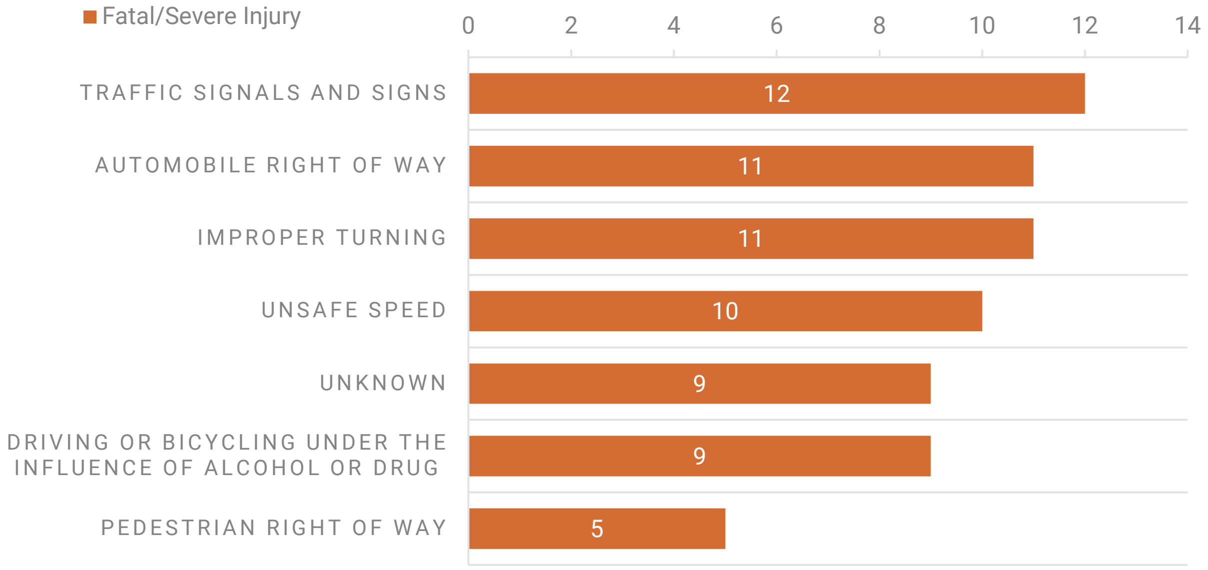
[6] This is a reported PCF that indicated one of several California Vehicle Violation codes indicating unsafe speeding on a highway.
[7] This is a reported PCF that indicated one of several California Vehicle Violation codes indicating a failure while turning from a direct course without reasonable safety or not signaling appropriately.
[8] This is a reported PCF that indicated one of several California Vehicle Violation codes indicating the driver was under the influence of alcohol.
[9] This is a reported PCF that indicated one of several California Vehicle Violation codes indicating running a red light or failure to stop at a stop sign.
[10] This is a reported PCF that indicated one of several California Vehicle Violation codes indicating a driver turning failed to yield right-of-way to oncoming traffic.
[11] This is a reported PCF that indicated one of several California Vehicle Violation codes indicating a pedestrian failure to yield the right-of-way to other vehicles.

FIGURE 3: TOP PRIMARY COLLISION FACTOR AND SEVERITY (2017-2020)



Source: SWITRS, TIMS, OCSD, Kittelson, 2021.
Note: "Other injury" includes "Other visible injury" and "Complaint of pain" collisions. "PDO" = property damage only. Primary collision factors with fewer than 50 collisions are not shown for clarity.

FIGURE 4: TOP PRIMARY COLLISION FACTOR FOR FATAL/SEVERE INJURY COLLISIONS (2017-2020)



Source: SWITRS, TIMS, OCSD, Kittelson, 2021.
Note: Primary collision factors with fewer than five collisions are not shown for clarity.

Fatal Collision Characteristics

There were 11 fatal collisions that occurred on public streets in Mission Viejo between 2017 and 2020. There were two fatal collisions in 2017, four in 2018, one in 2019, and four in 2020. These collisions are investigated and documented by M.A.R.T (Major Accident Reconstruction Team) – the Orange County Sherriff's special team for fatal, high profile, or complex incidents.

The following is a summary of the 11 fatal collisions between 2017 and 2020 on public streets. Some collisions shown below have incomplete information because final collision reports were not available at the time of this analysis. Additional information regarding the fatal collisions (if available) are also documented in the table. This information is based on the collision reports provided by the City.

As shown in the table, of the fatal collisions that had information regarding the circumstances of the collision, their attributes included:

- Three collisions involved driving or bicycling under the influence of drugs or alcohol
- Two collisions involved pedestrians
- Four collisions were broadside collisions
- Three collisions were hit-object collisions

TABLE 2: FATAL COLLISION DESCRIPTIONS

Location	Primary Collision Factor	Type of Collision	Year	Detailed Description
Alicia Parkway & Althea Avenue	Unsafe Speed	Broadside	2017	N/A
Oso Parkway & San Rafael	Unknown	Unknown	2017	N/A
Alicia Parkway & Via Burgos	Driving or Bicycling Under the Influence of Alcohol or Drug	Hit-Object	2018	The driver, who was under the influence of drugs, fatally hit a bicyclist and caused them to roll over top of the vehicle. The driver also hit multiple trees and curbs before and after the moment of impact with the bicyclist.
Jeronimo Road & Peter A Hartman Way	Traffic Signals and Signs	Broadside	2018	N/A
Crown Valley Parkway & Puerta Real	Unknown	Broadside	2018	N/A
Mustang Run & Los Alisos Boulevard	Unknown	Unknown	2018	N/A
La Paz Road & Olympiad Road	Driving or Bicycling Under the Influence of Alcohol or Drug	Broadside	2019	A driver was involved in an assault and battery and fled the scene driving. The driver was also under the influence of drugs or alcohol. The driver entered the intersection against a red light and was broadsided by another vehicle proceeding straight through a green light. The vehicle then collided with the front end of a second vehicle. The driver was transported to the hospital and pronounced deceased shortly after.

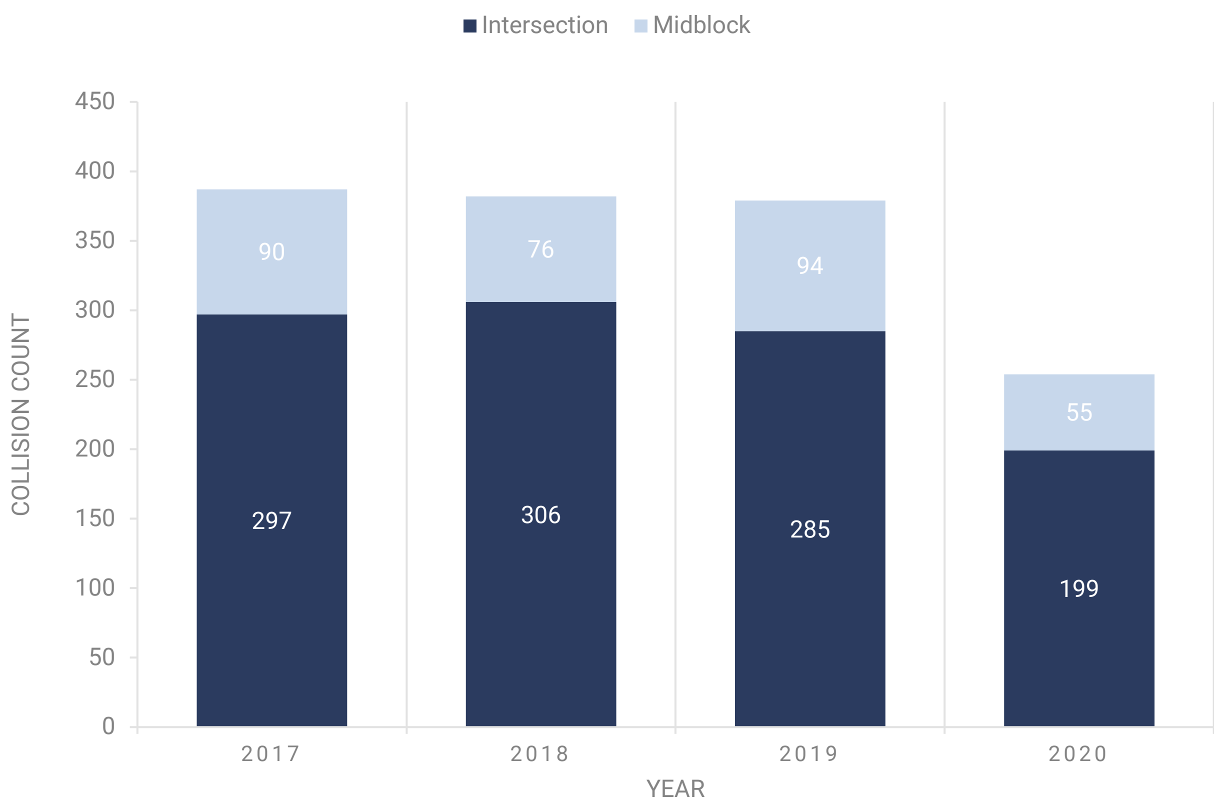
Location	Primary Collision Factor	Type of Collision	Year	Detailed Description
Marguerite Parkway & Alerzal	Pedestrian Violation	Vehicle-Pedestrian	2020	A driver was driving southbound on Marguerite Parkway as a pedestrian was walking eastbound across the same street. The pedestrian was struck by the vehicle and launched into the air due to the force of the collision. The pedestrian was pronounced deceased on-scene. The collision was cited as being caused by the pedestrian who violated section 21954(a) of the California Vehicle Code which states that "every pedestrian on a roadway other than within a marked crosswalk or within an unmarked crosswalk at an intersection shall yield the right-of-way to vehicles upon the roadway so near as to constitute an immediate hazard."
Muirlands Boulevard & Troy Street	Unknown	Hit-Object	2020	The investigation for this collision is ongoing. According to OCSD, based on preliminary evidence, the vehicle was traveling northbound on Muirlands Boulevard south of Troy Street. The vehicle drove over the east curb and collided with a utility box and wall before overturning. At this time, a medical condition is suspected as a contributing factor.
Crown Valley Parkway & Medical Center Road	Pedestrian Violation	Vehicle-Pedestrian	2020	The investigation for this collision is ongoing. According to OCSD, based on preliminary evidence, the vehicle was traveling eastbound on Crown Valley Parkway through Medical Center Drive when it struck a person on the road.
Jeronimo Road & Casa Nuevo Lane	Driving or Bicycling Under the Influence of Alcohol or Drug	Hit-Object	2020	A driver was driving southbound on Jeronimo Road and drove over the west curb and collided with a wall of a residence. The driver was under the influence of alcohol and had failed to fasten their seat belt. The driver was pronounced deceased on scene. There were no other injuries involved.

Source: SWITRS, TIMS, OCSD, Kittelson, 2021.

Intersection and Midblock Collisions

Figure 5 shows year-over-year trends in the number of intersection and midblock collisions. Intersection collisions are defined as occurring within 250 feet of an intersection. The proportion of intersection and midblock collisions stays fairly constant across the years, ranging from 77 percent intersection collisions and 23 percent midblock collisions, to 80 percent intersection collisions and 20 percent midblock collisions. The number of intersection collisions is generally four times the number of midblock collisions. This order of magnitude difference is to be expected given intersections are where conflicting movements occur.

FIGURE 5: INTERSECTION AND MIDBLOCK COLLISIONS (2017-2020)

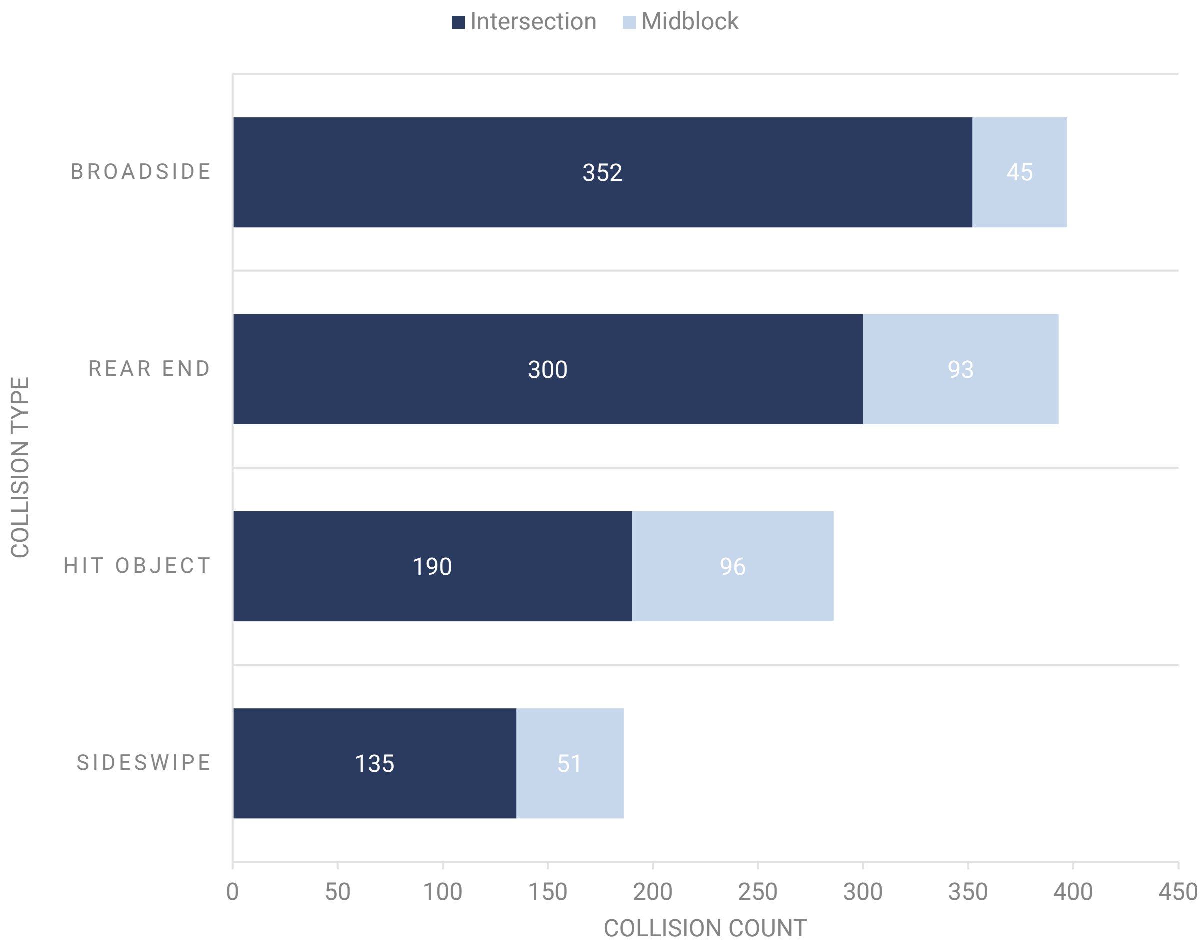


Source: SWITRS, TIMS, OCSD, Kittelson, 2021.

INTERSECTION AND MIDBLOCK COLLISIONS BY COLLISION TYPE

Figure 6 reports the most frequent reported collision types for the 2017-2020 study period, organized by location type. For all collision types, intersection collisions are more common than midblock collisions. The collision types with the highest proportion of intersection collisions include broadside (89 percent) and rear-end (80 percent). The collision types with the highest proportion of midblock collisions include hit-object (29 percent) and sideswipe (26 percent). These trends remain relatively consistent for each individual year, with slight variation in top collision types and proportions of intersection and midblock collisions.

FIGURE 6: COLLISION TYPES FOR INTERSECTION AND MIDBLOCK COLLISIONS (2017-2020)



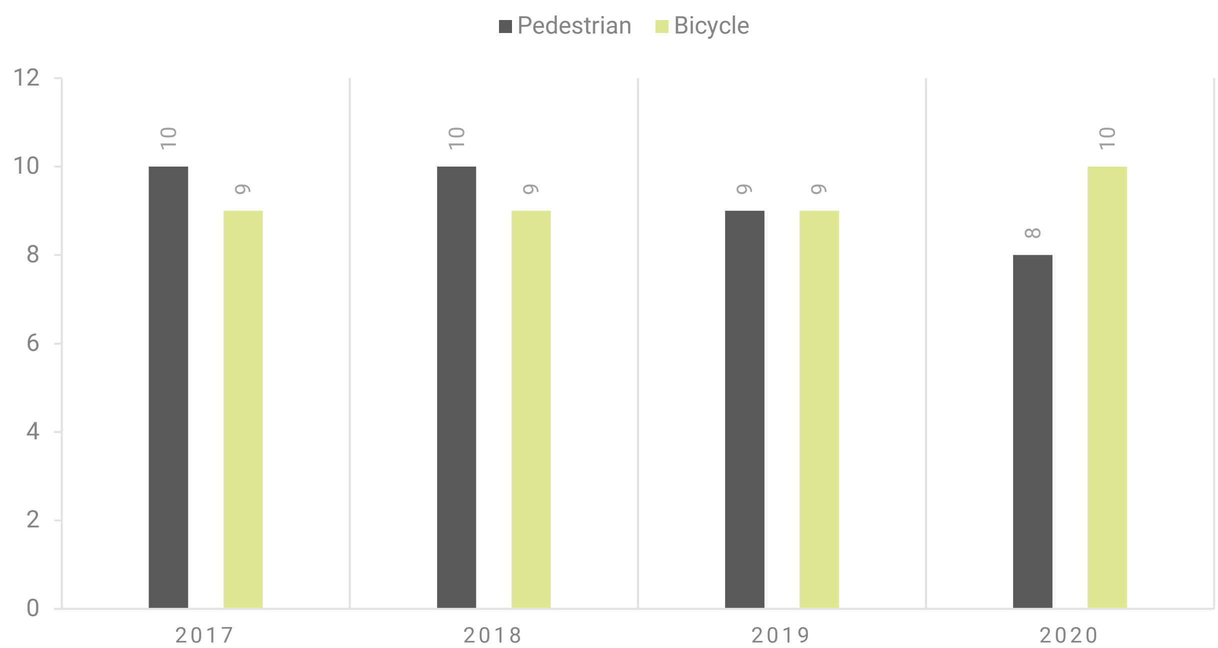
Source: SWITRS, TIMS, OCSD, Kittelson, 2021.

Note: Collision types with fewer than 50 collisions are not shown here for clarity.

Pedestrian and Bicycle Collisions

Across the four study years (2017-2020) there were a total of 37 pedestrian-involved collisions and 37 bicycle-involved collisions. The average number of collisions per year for each of these user types is nine. The number of collisions per year for both user types is consistent, with the largest variation from year to year being one collision.

FIGURE 7: NUMBER OF PEDESTRIAN AND BICYCLE COLLISIONS BY YEAR



Source: SWITRS, TIMS, OCSD, Kittelson, 2021.

PEDESTRIAN COLLISIONS—SEVERITY

Table 3 shows the distribution of pedestrian collisions by severity for each year in the study period as well as for all four years combined. Of the 37 total pedestrian collisions reported in Mission Viejo, 29 percent resulted in a fatality or severe injury. This share is almost four times higher than the fatal and severe injury share of total reported collisions (6 percent). Five percent of pedestrian collisions resulted in a fatality.

PEDESTRIAN COLLISIONS—PRIMARY COLLISION FACTOR

Table 4 summarizes the primary collision factors for the reported pedestrian collisions by year.

TABLE 3: PEDESTRIAN-INVOLVED COLLISION SEVERITY

Year	Fatal (%)	Severe Injury (%)	Visible Injury (%)	Complaint of Pain (%)	Property Damage Only (%)	Total (%)
2017	0 (0%)	3 (30%)	4 (40%)	2 (20%)	1 (10%)	10 (100%)
2018	0 (0%)	3 (30%)	3 (30%)	3 (30%)	1 (10%)	10 (100%)
2019	0 (0%)	2 (22%)	4 (44%)	3 (33%)	0 (0%)	9 (100%)
2020	2 (25%)	1 (13%)	1 (13%)	4 (50%)	0 (0%)	8 (100%)
2017-2020	2 (5%)	9 (24%)	12 (32%)	12 (32%)	2 (5%)	37 (100%)

Source: SWITRS, TIMS, OCSD, Kittelson, 2021.

TABLE 4: PRIMARY COLLISION FACTORS FOR PEDESTRIAN COLLISIONS

Primary Collision Factor	Number of Reported Pedestrian Collisions				
	2017	2018	2019	2020	Total
Motorist Failure to Yield to Pedestrians	3	6	4	1	14
Unsafe Speed	1			1	2
Automobile Right-of-Way		1	1		2
Pedestrian Failure to Yield to Motorist	1	1	3	3	8
Motorists Disobey Traffic Signals/Signs	1				1
Improper Turning	1			1	2
Other Hazardous Violation				1	1
Unknown	3	2	1	1	7
Total	10	10	9	8	37

Source: SWITRS, TIMS, OCSD, Kittelson, 2021.

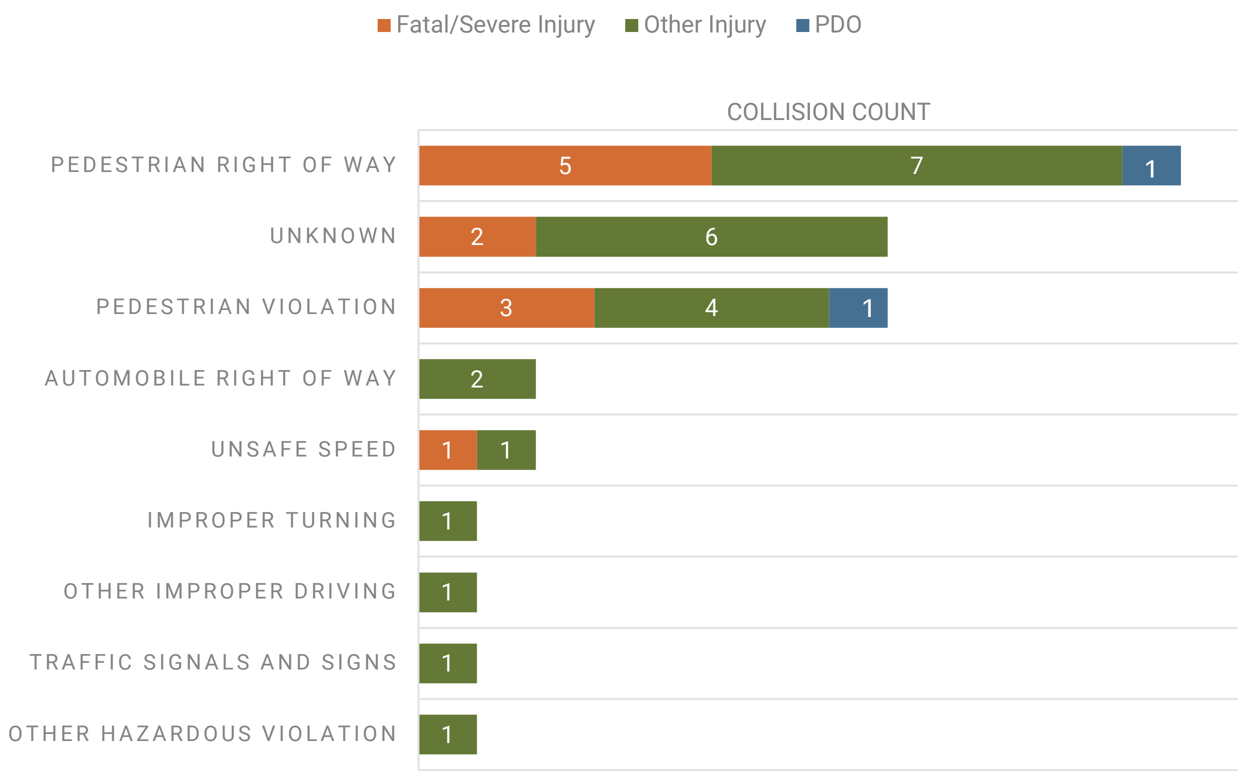
Figure 8 presents the reported primary collision factor among pedestrian collisions.

The most frequently cited PCF is **pedestrian right-of-way**[12] (35 percent).

The second most common PCF is **pedestrian violation** (14 percent).

The four PCFs which resulted in fatal or severe injury collisions include **pedestrian right-of-way** (five collisions), **pedestrian violation** (three collisions), **unsafe speed** (one collision) and **unknown** (two collisions).

FIGURE 8: PEDESTRIAN INVOLVED COLLISION PRIMARY COLLISION FACTOR (2017-2020)



Source: SWITRS, TIMS, OCSD, Kittelson, 2021.
Note: "Other injury" includes "Other visible injury" and "Complaint of pain" collisions. "PDO" = property damage only.

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12 This is a reported PCF that indicated one of several California Vehicle Violation codes indicating a driver failed to yield right-of-way to a pedestrian.

PEDESTRIAN COLLISIONS—PRECEDING ACTION

For pedestrian collisions, data are recorded that indicate the reporting officer's best judgement about the person's location and action preceding the collision.

Figure 9 reports these trends in the city.

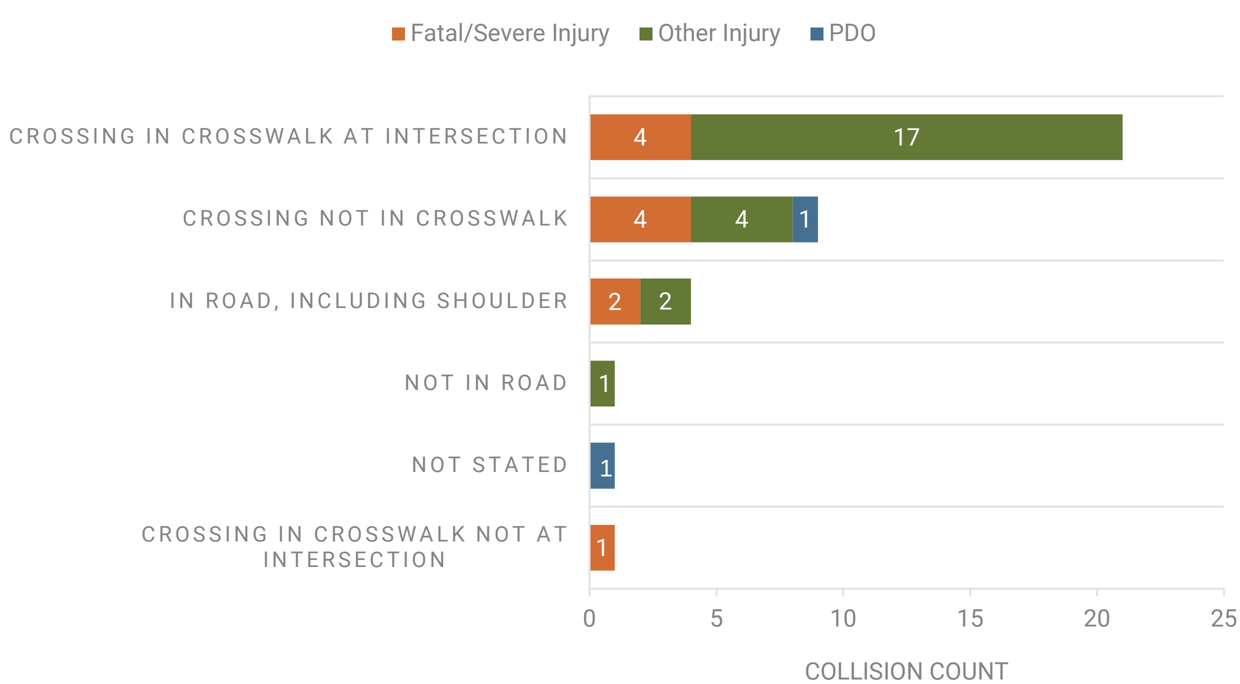
The three most common pedestrian actions preceding all pedestrian collisions included:

- **Crossing in a crosswalk at an intersection** (57 percent)
- **Crossing not in a crosswalk** (24 percent)
- **In road including shoulder** (11 percent)

Among the 11 fatal/severe injury pedestrian collisions, 36 percent occurred while a pedestrian was **crossing in a crosswalk at an intersection**. An additional 36 percent occurred while a pedestrian was **crossing not in a crosswalk**.

These three pedestrian actions account for 92 percent of reported pedestrian involved collisions.

FIGURE 9: PEDESTRIAN INVOLVED COLLISIONS BY ACTION AND LOCATION (2017-2020)

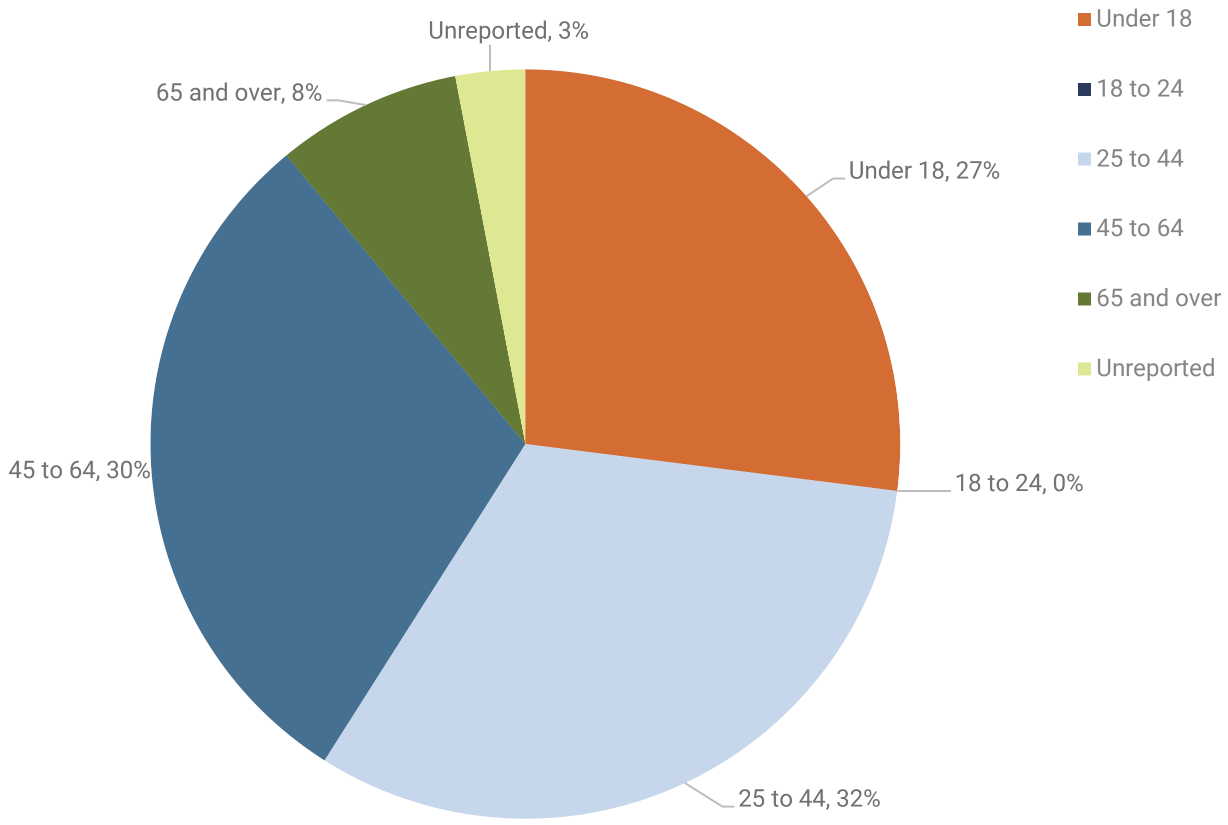


Source: SWITRS, TIMS, OCSD, Kittelson, 2021.
Note: "Other injury" includes "Other visible injury" and "Complaint of pain" collisions. "PDO" = property damage only.

PEDESTRIAN COLLISIONS—AGES OF PARTIES INVOLVED

Figure 10 shows the age ranges of pedestrians involved in collisions for the 2017 to 2020 period. The most frequent age range (accounting for 13 collisions) is **25–44** which is closely followed by **45–64** (accounting for 12 collisions) and **under 18** (accounting for 10 collisions). There are no reported pedestrians in the **18–24** age range.

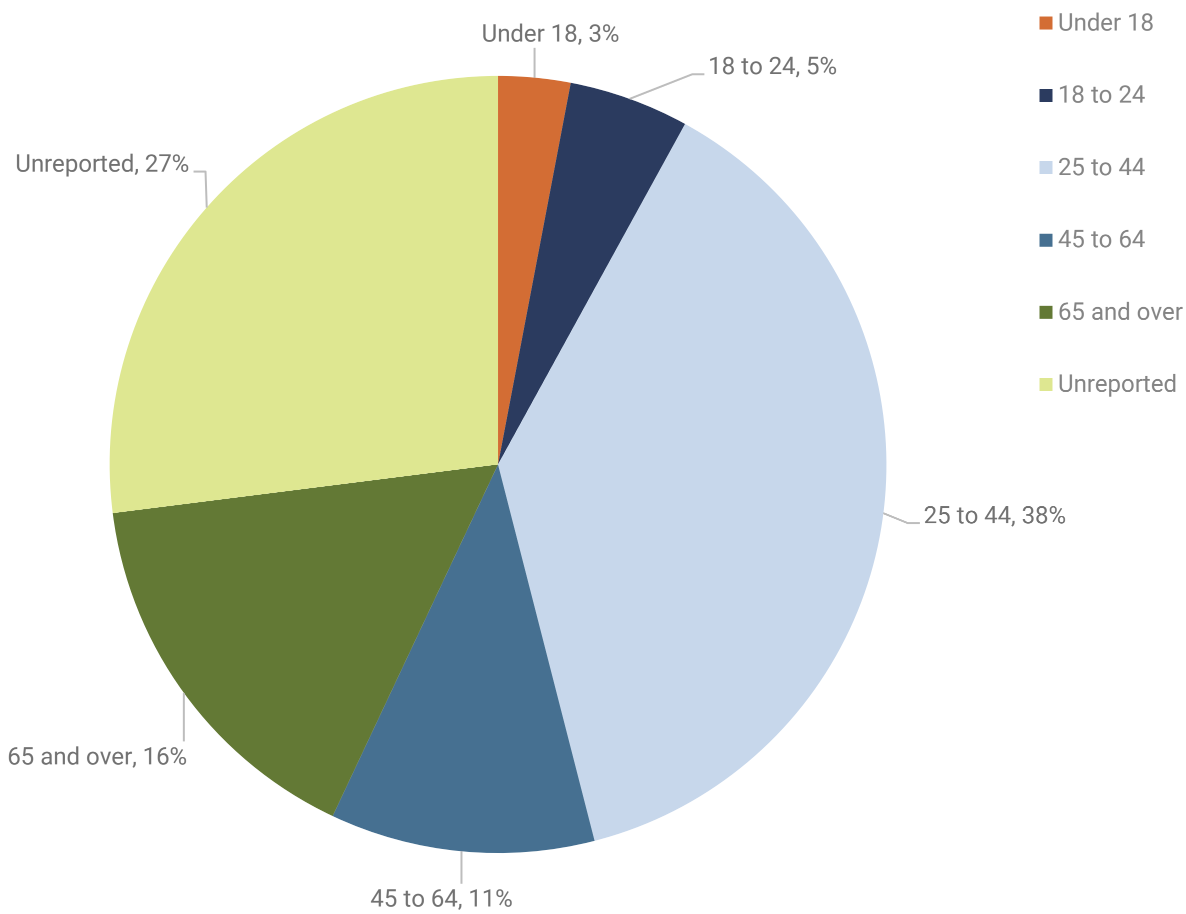
FIGURE 10: AGE OF PEDESTRIANS INVOLVED IN COLLISIONS (2017–2020)



Source: SWITRS, TIMS, OCSD, Kittelson, 2021.

Figure 11 shows the age ranges of drivers involved in pedestrian collisions for the 2017 to 2020 period. The most frequent age range (accounting for 14 collisions) is **25–44**. The next most frequent age group involved is **65 and over** (accounting for six collisions).

FIGURE 11: AGE OF DRIVERS INVOLVED IN PEDESTRIAN COLLISIONS (2017–2020)



Source: SWITRS, TIMS, OCSD, Kittelson, 2021.

BICYCLE COLLISIONS – SEVERITY

Table 5 shows the distribution of bicycle-involved collisions by severity for each year in the study period as well as for all the years combined. Of the 37 total bicycle-involved collisions reported in Mission Viejo, 22 percent resulted in a fatality or severe injury. Three percent of bicycle collisions resulted in a fatality.

TABLE 5: BICYCLE-INVOLVED COLLISION SEVERITY

Year	Fatal (%)	Severe Injury (%)	Visible Injury (%)	Complaint of Pain (%)	Property Damage Only (%)	Total (%)
2017	0 (0%)	0 (0%)	6 (67%)	3 (33%)	0 (0%)	9 (100%)
2018	1 (11%)	1 (11%)	3 (33%)	3 (33%)	1 (11%)	9 (100%)
2019	0 (0%)	1 (11%)	5 (56%)	2 (22%)	1 (11%)	9 (100%)
2020	0 (0%)	5 (50%)	4 (40%)	0 (0%)	1 (10%)	10 (100%)
2017-2020	1 (3%)	7 (19%)	18 (49%)	8 (22%)	3 (8%)	37 (100%)

Source: SWITRS, TIMS, OCSD, Kittelson, 2021.

BICYCLE COLLISIONS – PRIMARY COLLISION FACTOR

Table 6 summarizes the primary collision factors for the reported bicycle collisions by year.

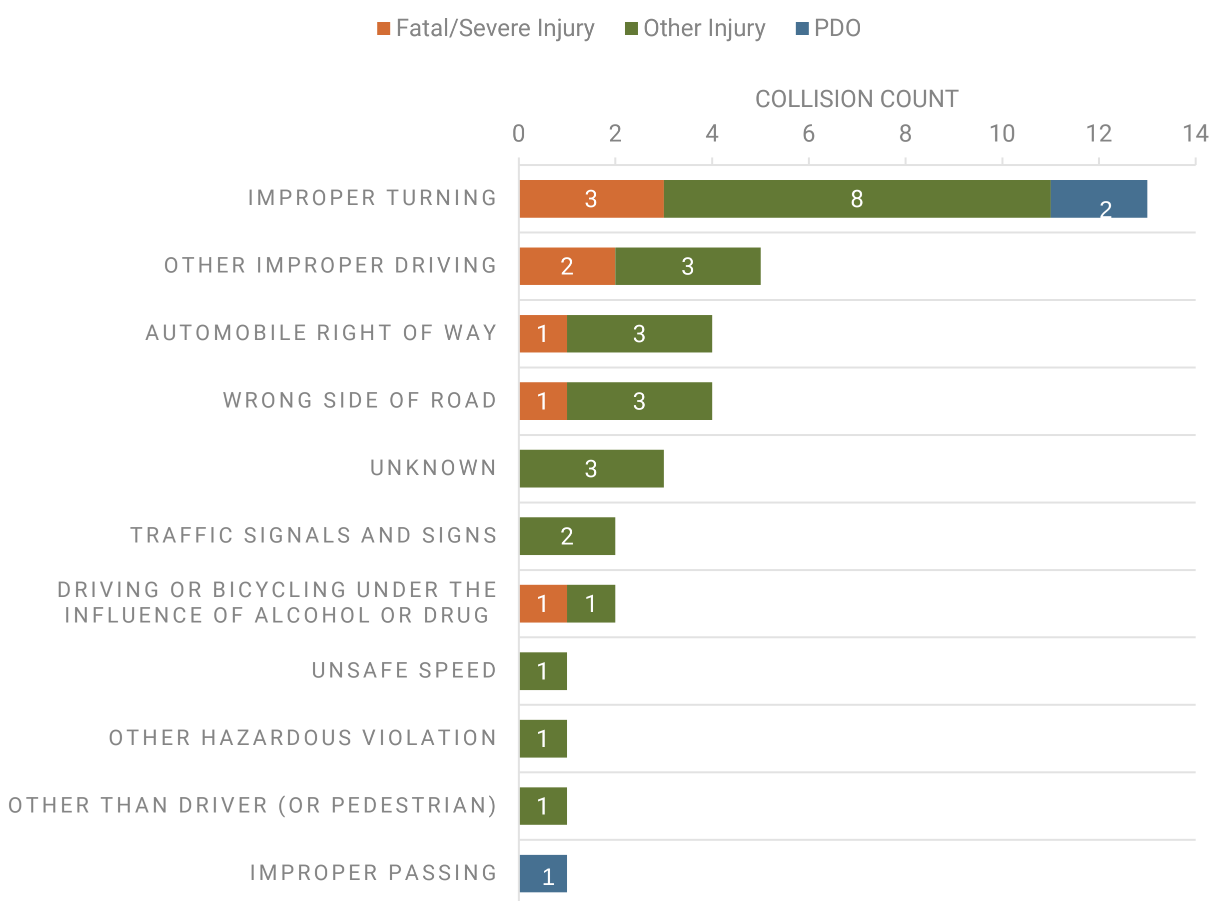
TABLE 6: PRIMARY COLLISION FACTORS FOR BICYCLE COLLISIONS

Primary Collision Factor	Number of Reported Pedestrian Collisions				
	2017	2018	2019	2020	Total
Bicycling Under the Influence of Alcohol or Drugs	1				1
Unsafe Speed				1	1
Automobile Right-of-Way		1		3	4
Bicyclist on Wrong Side of Road	1	1	1	1	4
Motorists Disobey Traffic Signals/Signs	2				2
Improper Turning	3	4	4	4	15
Other Improper Driving		3	2	1	6
Other Hazardous Violation	1		1		2
Unknown	1		1		2
Total	9	9	9	10	37

Source: SWITRS, TIMS, OCSD, Kittelson, 2021.

Figure 12 presents the reported primary collision factor among bicycle collisions. The most frequently cited PCF is **improper turning** (35 percent). The second most common PCF is **other improper driving**[13] (14 percent). The five PCFs which resulted in fatal or severe injury collisions include **improper turning** (three collisions), **other improper driving** (two collisions), **automobile right-of-way** (one collision), **wrong side of road**[14] (one collision) and **driving or bicycling under influence of alcohol or drugs** (one collision).

FIGURE 12: BICYCLE-INVOLVED COLLISION PRIMARY COLLISION FACTOR (2017-2020)



Source: SWITRS, TIMS, OCSD, Kittelson, 2021.
Note: “Other injury” includes “Other visible injury” and “Complaint of pain” collisions. “PDO” = property damage only.

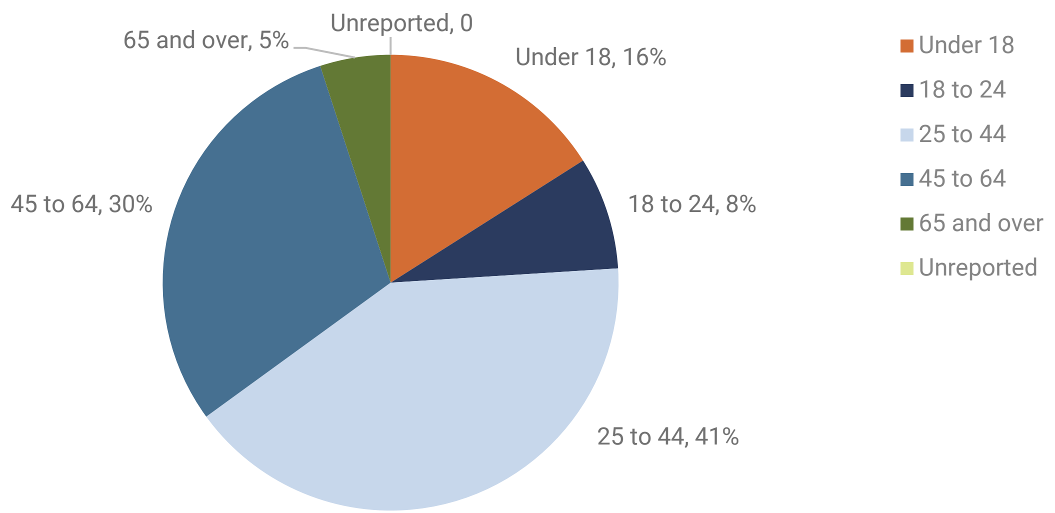
[13] This is a reported PCF that indicated one of several California Vehicle Violation codes indicating driving from a direct course without reasonable safety or not signaling appropriately.
[14] This is a reported PCF that indicated one of several California Vehicle Violation codes indicating the driver/rider was on the wrong side of the road.

BICYCLE COLLISIONS—AGES OF PARTIES INVOLVED

Figure 13 shows the age groups of bicyclists involved in collisions during the 2017-2020 period. The most frequent age range involved (accounting for 15 collisions) is **25–44**. **Under age 18** accounted for seven collisions.

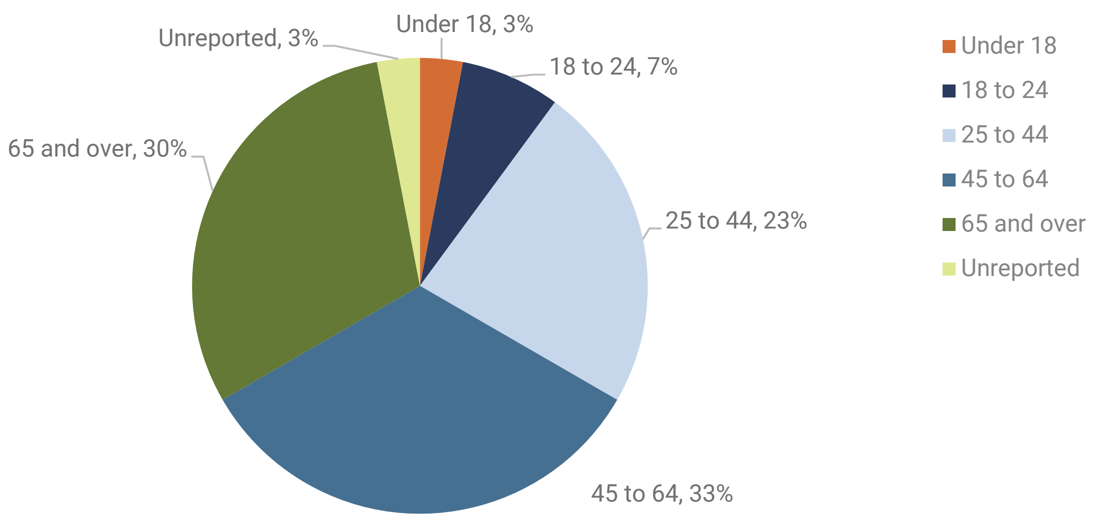
shows the age groups of drivers involved in bicycle collisions during the 2017-2020 period. The most frequent age range involved (accounting for 11 collisions) is **45–64** which is closely followed by **65 and over** (accounting for 10 collisions).

FIGURE 13: AGE OF BICYCLISTS INVOLVED IN COLLISIONS (2017–2020)



Source: SWITRS, TIMS, OCSD, Kittelson, 2021.

FIGURE 14: AGE OF DRIVERS INVOLVED IN BICYCLE COLLISIONS (2017–2020)



Source: SWITRS, TIMS, OCSD, Kittelson, 2021.

NETWORK ANALYSIS & SYSTEMIC FINDINGS

This section describes the network screening and systemic evaluation of the Mission Viejo roadway network. In addition to the network screening, Kittelson also reviewed risk factors and physical characteristics at the priority intersections and roadway segments. Note, year 2016 collisions are also included in this section's analysis.

Data and Network Screening Approach

Kittelson identified the intersections and segments with the highest collision severity using the Equivalent Property Data Only (EPDO) network screening performance measure from the AASHTO *Highway Safety Manual (HSM)*. The EPDO calculation was performed for all public intersections and roadway segments. Private roads and grade-separated highways were excluded from the analysis. The EPDO performance measure is described below. Moving forward throughout this document, the EPDO performance measure is referred to as a collision severity score.

The collision severity score assigns weight to individual collisions based on the collision severity and location of the collision. Weights, provided by the 2020 Caltrans *Local Roadway Safety Manual*, are based on the cost of property-damage-only (PDO) collisions, assigning each collision with a score relative to a PDO collision.
Table 7 summarizes the weight assigned to each severity.

TABLE 7: COLLISION WEIGHTS BY SEVERITY AND LOCATION TYPE

Location Type	Collision Weight by Severity				
	Fatal	Severe Injury	Other Visible Injury	Complaint of Pain	Property Damage Only
Signalized Intersection	119.55	119.55	10.70	6.08	1.00
Unsignalized Intersection	190.23	190.23	10.70	6.08	1.00
Roadway	164.66	164.66	10.70	6.08	1.00

Source: Caltrans, Local Roadway Safety: A Manual for California's Local Road Owners (Version 1.5), 2020.

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

INTERSECTION METHODOLOGY

Kittelson first identified signalized and unsignalized intersections in the City road network and then defined collisions as intersection or segment collisions. An intersection collision is defined as a collision that occurs within 250 feet of the intersection. These collisions were spatially joined and summarized in ArcGIS to show the total number of collisions by severity at each intersection. Where intersections were less than 500 feet from each other, collisions were assigned to the nearest of the two intersections. Collisions occurring more than 250 feet from any intersection were separated to be used in the segment analysis discussed below.

The intersections' collision severity score was calculated by multiplying each collision severity total by the associated weight (by intersection type) and summing the results. Kittelson annualized the collision severity score by dividing the score by the years (five) of collision data analyzed.

COLLISION SEVERITY SCORE

= Fatal weight

× # of fatal collisions

+ severe injury weight

× # of severe injury collisions

+ other visible injury weight

× # of other visible injury collisions

+ complaint of pain injury weight

× # of complaint of pain injury weight collisions

+ PDO collisions

ROADWAY SEGMENT METHODOLOGY

After completing the intersection analysis, Kittelson used the collisions reported more than 250 feet from the nearest intersection to conduct a separate segment analysis. A Python script in ArcGIS allowed for splitting the Mission Viejo street network into overlapping half-mile segments, incrementing the segments by one quarter (0.25) of a mile. This methodology helps to identify portions of roadway with the greatest potential for safety improvements.

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

Network Screening Findings

Kittelson identified priority intersections and segments using the annualized collision severity scores; the results are presented in the following figures. For intersection locations, the collision severity scores ranged from zero (no reported collisions during the five years) to 171.51. For the half-mile roadway segments, the collision severity scores ranged from zero to 103.05. Figure 15 and Figure 16 show the results of the collision severity scoring by percentiles for intersection locations and roadway segments, respectively. Intersections or segments shown as not falling within one of the quartiles indicates that there were no reported collisions at that location during the five-year period.

PRIORITY LOCATIONS

Kittelson identified priority intersections and segments using the annualized collision severity score for intersections and segments. The top scoring intersections and segments were reviewed to determine priority locations. Establishing natural break points in the collision severity score, the top 40 intersections (top 10th percentile) and 17 roadway segments (top 20th percentile) were identified. The resulting list of priority locations is provided in Table 8 and Table 9 and shown in Figure 17. Given that some roadway segments consist of multiple overlapping half-mile segments, a range of severity scores are provided for some priority roadway segments.

RISK FACTORS

Operational and physical attributes of the priority locations include the following:

- Thirty-five percent of the priority intersections are signalized, and 65 percent are unsignalized, with nine of the top ten intersections all signalized.
- Thirty-two of the 40 priority intersections are intersections where at least one leg is a multi-lane arterial road (as opposed to a two-lane local residential street).
- Of those 32 intersections, 14 are signalized intersections where two or more arterial roads intersect or where a multi-lane roadway intersects a residential street, and 18 are unsignalized intersections where a side street intersects a multi-lane arterial road.
- Eight of the 40 priority intersections are intersections where all legs consist of local residential streets.
- Thirteen of the 40 priority intersections are located on Marguerite Parkway.
- Approximately 87 percent of the priority segment mileage is along arterial roadways, while the remaining 13 percent is along local roads.

Figure 15: Intersection Collision Severity Score Screening by Percentile Group

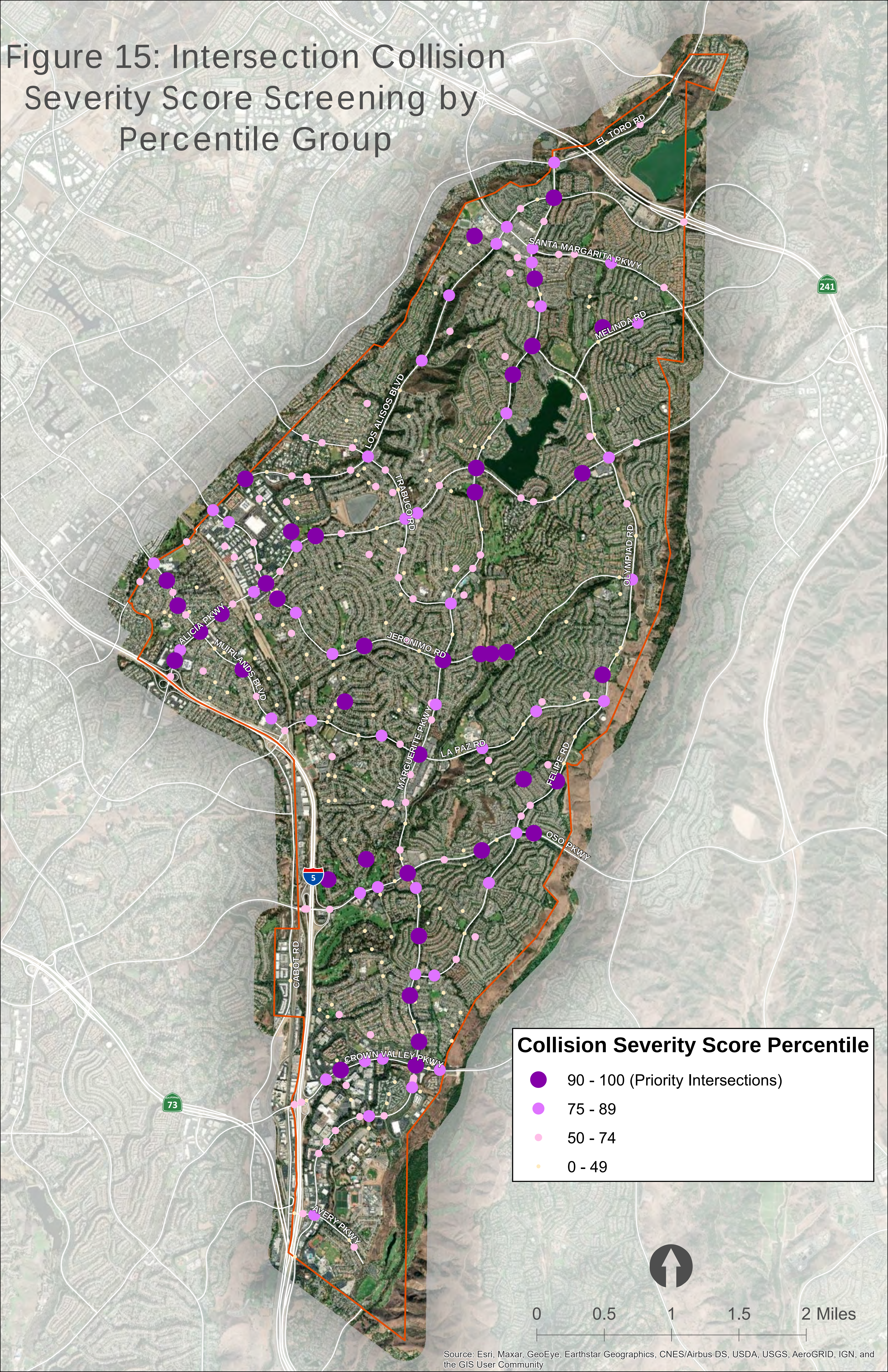


Figure 16: Segment Collision Severity Score Screening by Percentile Group

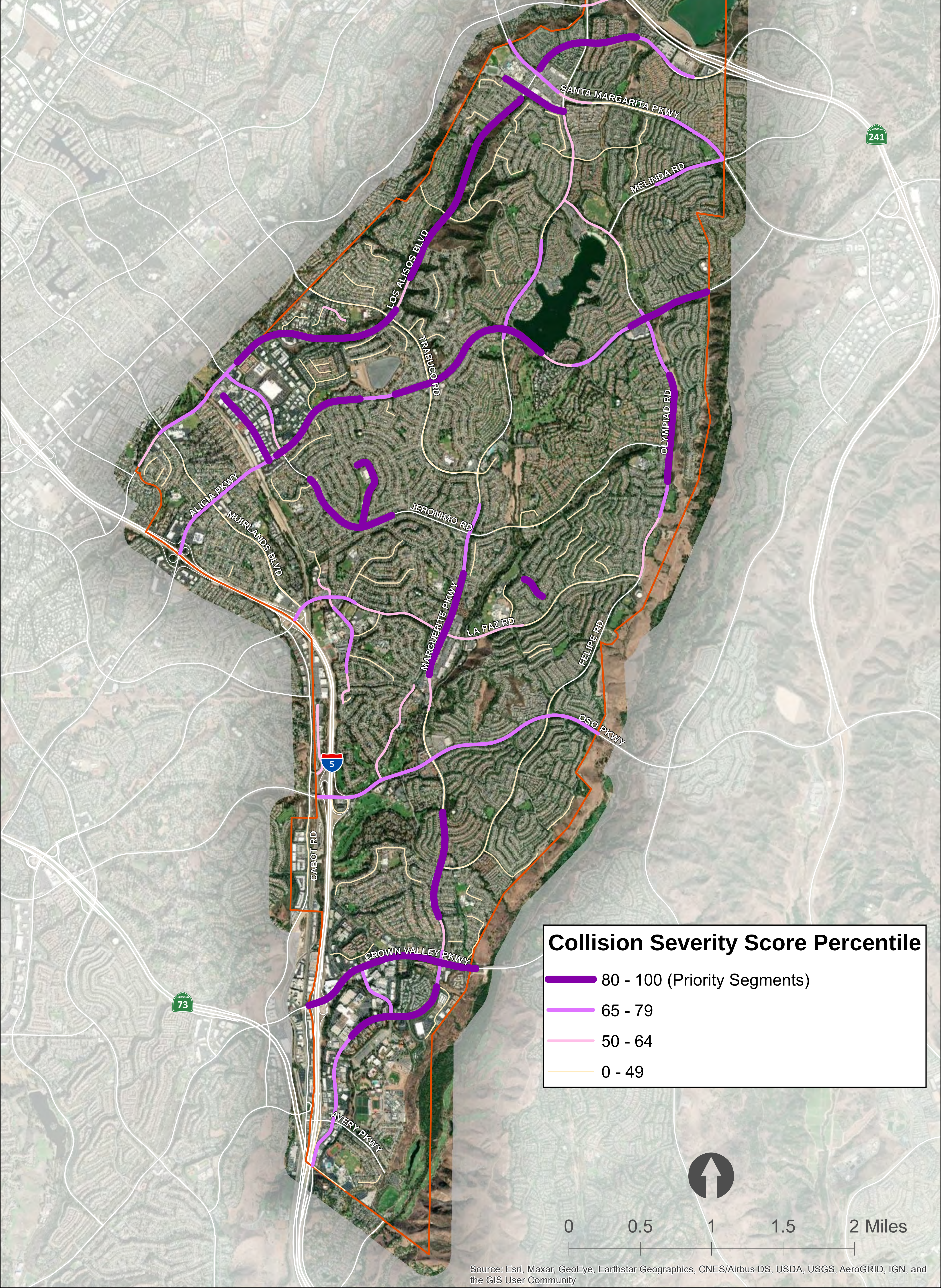


TABLE 8: PRIORITY INTERSECTIONS BY COLLISION SEVERITY SCORE

Intersection	Traffic Control	Annualized Collision Severity Score
Alicia Parkway & Jeronimo Road	Signalized	171.51
Oso Parkway & Marguerite Parkway	Signalized	92.45
Alicia Parkway & I-5 NB On-Ramp/Retail Driveway	Unsignalized	82.59
Marguerite Parkway & Alicia Parkway	Signalized	76.04
Marguerite Parkway & Olympiad Road	Signalized	59.40
Crown Valley Parkway & Doctor Guevara Way	Signalized	58.24
Oso Parkway & San Rafael	Signalized	57.47
Marguerite Parkway & Crown Valley Parkway	Signalized	55.33
Alicia Parkway & Coronel Drive	Signalized	53.32
Muirlands Boulevard & Marathon Street	Signalized	51.58
Alicia Parkway & Althea Avenue	Unsignalized	49.93
Alicia Parkway & Muirlands Boulevard	Signalized	48.14
Alicia Parkway & Lanzarote	Unsignalized	45.36
Marguerite Parkway & Alarcon	Unsignalized	43.74
Marguerite Parkway & Vista Del Lago	Unsignalized	41.40
Jeronimo Road & Carranza Drive	Unsignalized	41.40
Marguerite Parkway & Venado Drive	Unsignalized	40.98
Marguerite Parkway & Los Alisos Blvd	Signalized	40.80
Marguerite Parkway & La Sierra Drive	Unsignalized	40.58
Muirlands Boulevard & Heath Avenue	Unsignalized	40.38
Jeronimo Road & Casa Nuevo Lane	Unsignalized	40.18
Los Alisos Boulevard & Madero	Signalized	39.75
Marguerite Parkway & Mesilla	Unsignalized	39.66
Oso Parkway & Lalin	Unsignalized	39.46
Jeronimo Road & Arbolitos	Unsignalized	39.26
Jeronimo Road & Via Albeniz	Unsignalized	39.26
Muirlands Boulevard & Troy Street	Unsignalized	39.26
Marguerite Parkway & La Paz Road	Signalized	39.03
Marguerite Parkway & Jeronimo Road	Signalized	38.41
Via Linda & Madero	Unsignalized	38.25
Jeronimo Road & Via San Fernando	Unsignalized	38.25
Alicante Drive & Saddleback Drive	Unsignalized	38.25
Felipe Road & Hawk Hill	Unsignalized	38.25
Aguilar & Genil	Unsignalized	38.05
Herencia & Anaya	Unsignalized	38.05
Marguerite Parkway & Alerzal	Unsignalized	38.05
Tabuenca & Lanuza	Unsignalized	38.05
Baccara Drive & Fieldcrest	Unsignalized	38.05
Montanoso Drive & Serenata Drive	Unsignalized	38.05
Via Marejada & Via Oceano	Unsignalized	38.05

Source: Kittelson, 2021.

TABLE 9: PRIORITY SEGMENTS BY COLLISION SEVERITY SCORE

Location	Functional Classification	Annualized Collision Severity Score
Crown Valley Parkway (Western City Limits to Eastern City Limits)	Arterial	35.97 - 103.05
El Toro Road (Glenn Ranch Way to SR-241)	Arterial	32.93 - 102.35
Marguerite Parkway (Moro Azul to Cordova Canyon)	Arterial	69.42 - 69.62
Alicia Parkway (Finisterra to Via Leon)	Arterial	34.35 - 67.48
Marguerite Parkway (Aldeano Drive to Village Center S)	Arterial	40.05 - 43.69
Marguerite Parkway (Center Drive to S Deck Drive)	Arterial	36.69 - 40.97
Olympiad Road (Stoneridge to Beebe Park)	Arterial	32.93 - 37.21
Mustang Run (Aguilar to Crucero)	Local	36.69
Alicia Parkway (Via Logrono to Jeronimo Road)	Arterial	35.07 - 36.49
Alicia Parkway (Eastern City Limits to Olympiad Plaza)	Arterial	34.35 - 36.49
Los Alisos Boulevard (Trabuco Road to Jeronimo Road)	Arterial	33.33 - 36.29
Via Fabricante (Peter A Hartman Way to Alicia Parkway)	Local	35.27
Los Alisos Boulevard (Mustang Run to Via Santa Lucia)	Arterial	32.93 - 35.57
Los Alisos Boulevard (Fidel Trail to Santa Margarita Parkway)	Arterial	32.93
Carrillo (Vejar Lane to Papagayo Drive)	Local	32.93
Hayuco (Bocina to Ruisenor)	Local	32.93
Jeronimo Road (Cordillera Drive to Carranza Drive)	Arterial	32.93

Source: Kittelson, 2021.

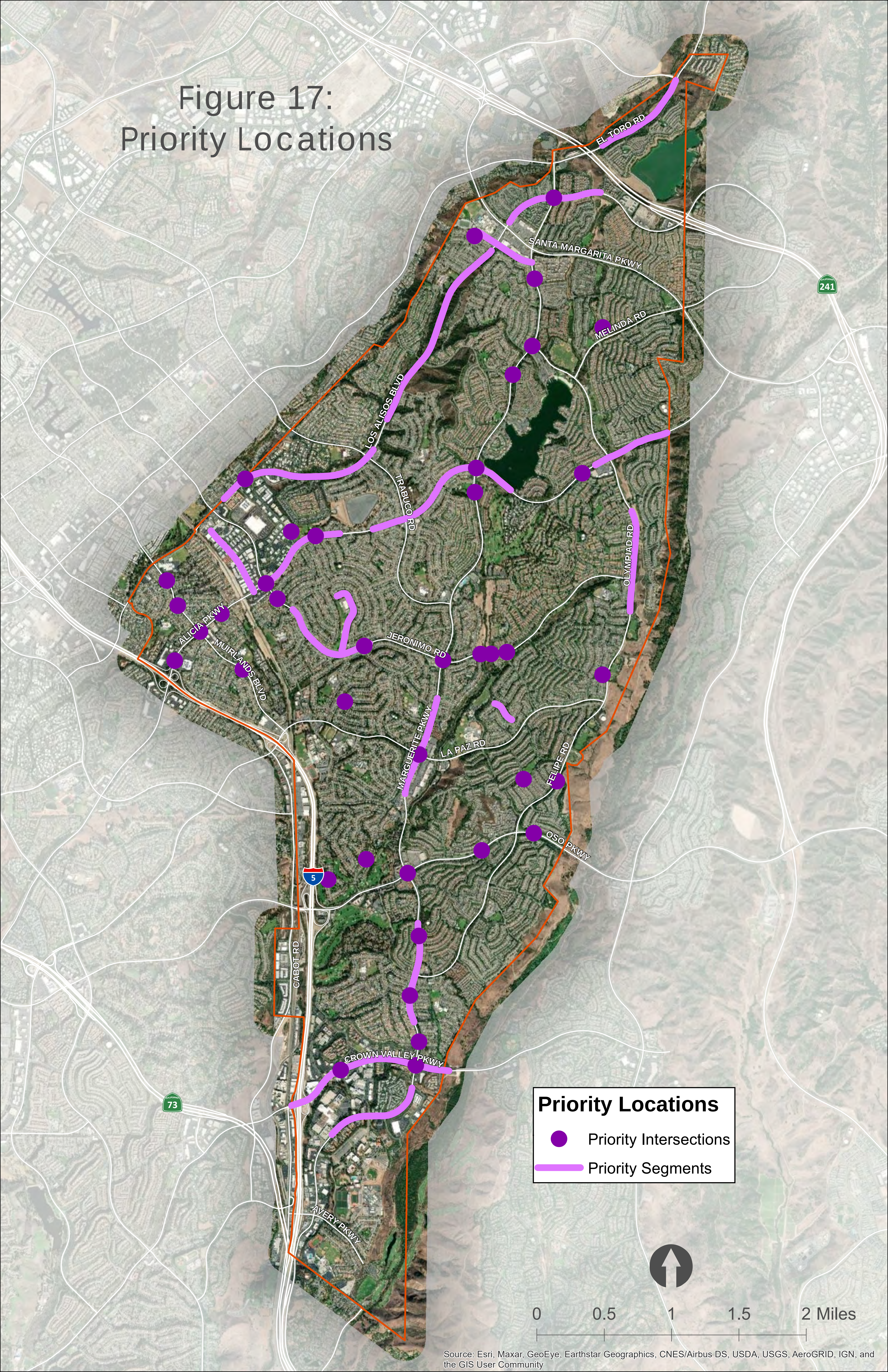
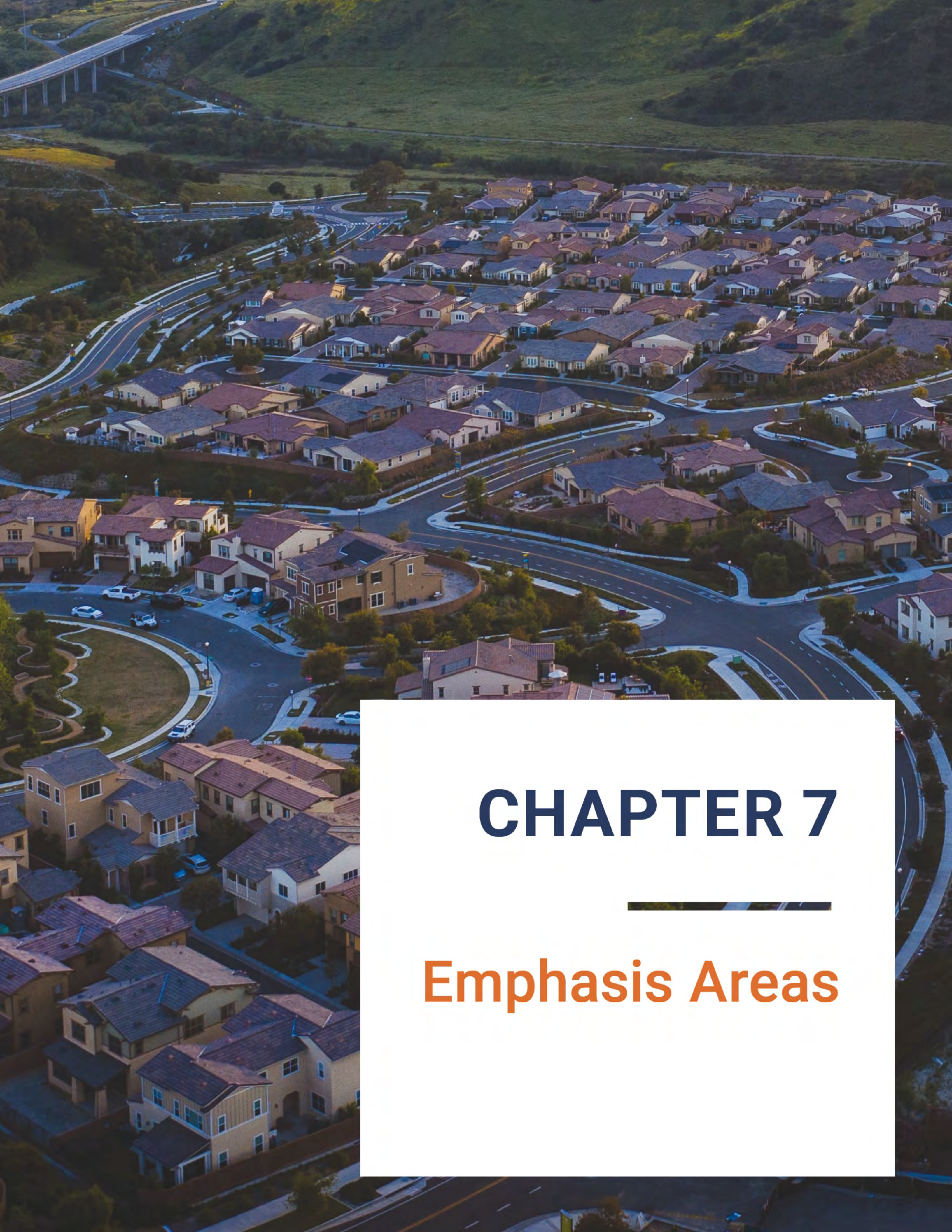


Figure 17:
Priority Locations
Priority Locations
Priority Intersections
Priority Segments
EL TORO RD
SANTA MARGARITA PKWY
MELINDA RD
LOS ALISOS BLVD
TRABUCO RD
OLYMPIAD RD
ALICIA PKWY
MUIRLANDS BLVD
JERONIMO RD
MARGUERITE PKWY
LA PAZ RD
FELIPE RD
OSO PKWY
CABOT RD
CROWN VALLEY PKWY
AVERY PKWY
241
5
73
0
0.5
1
1.5
2 Miles
Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community



CHAPTER 7

Emphasis Areas

EMPHASIS AREAS

Using input from the stakeholder group and the analysis described in the preceding section, six emphasis areas were identified for Mission Viejo. Each emphasis area is discussed in more detail in the following subsections.

- High Priority Signalized Intersections
- Citywide Systemic Measures
- Citywide Signalized Pedestrian Mitigation Measures
- Citywide Bicycle Mitigation Measures
- Crosswalk Enhancement Mitigation Measures
- Integrate Non-Engineering Strategies

EMPHASIS AREA DEVELOPMENT

Highest Occuring Collision Types

The following collision types were most frequent:

- Broadside (28 percent)
- Rear-end (28 percent)
- Hit-object (21 percent)

However, Kittelson with input from the project management team (PMT) reviewed the three most frequent collision types among fatal and severe injury collisions when developing emphasis areas:

- Broadside (36 percent of reported fatal and severe injury collisions)
- Hit-object (18 percent of reported fatal and severe injury collisions)
- Vehicle-pedestrian (13 percent of reported fatal and severe injury collisions)

These three collision types account for 67 percent of Mission Viejo's fatal and severe injury collisions.

This document identifies systemic countermeasures and potential capital projects that may be eligible and competitive for grant funding to reduce the frequency and severity of these collision types.

High-Risk Intersections and Corridors

Kittelson identified priority intersections using the annualized collision severity scores shown in Table 9 and based on collision locations and severity between January 1, 2016, and December 31, 2020. The five locations that ranked the highest are:

- Alicia Parkway/Jeronimo Road
- Alicia Parkway/Marguerite Parkway
- Oso Parkway/Marguerite Parkway
- Olympiad Road/Marguerite Parkway
- Crown Valley Parkway/Doctor Guevara Way/Medical Center Drive

Many of the unsignalized intersections and corridors with higher annualized collision severity scores are addressed by the systemic countermeasures identified.

ENGINEERING COUNTERMEASURES

This section presents the engineering countermeasures identified to address the systemic collision trends documented in the previous section. Kittelson compiled a list of engineering countermeasures with the following considerations:

Relevance to Mission Viejo
Countermeasures included in the Caltrans Local Roadway Safety Manual (LRSM) (and funded by the HSIP program) that appear most relevant for Mission Viejo. For example, pedestrian supportive or urban speed management treatments were prioritized, whereas treatments more applicable to a rural highway (e.g., truck climbing lane) were not included.

HSIP eligibility
Countermeasures that have been eligible for HSIP funding in previous cycles (note that this may change in future HSIP cycles).

Alignment with collision analysis findings
Countermeasures that most directly relate to the highest occuring collision types among fatal and severe injury collisoins: broadside, hit-object, and vehicle-pedestrian.

Collision reduction potential, cost, and systemic application potential
Low-cost countermeasures with: (a) high documented collision reduction potential; and (b) an ability to be applied systemically throughout the city.

Countermeasures are grouped into the following categories:

- Intersection countermeasures
- Roadway countermeasures
- Bicycle and pedestrian countermeasures

A summary of the countermeasures chosen under each category is provided and followed by a description of each countermeasure and why it was selected for the City. The crash reduction factor (CRF) noted for each is taken from the LRSM unless indicated otherwise; some countermeasures do not have a documented CRF to report but reflect industry best practices. The federal funding eligibility and percentage is based on the LRSM and is subject to change in future HSIP cycles.

Intersection Countermeasures

Engineering intersection countermeasures include:

- Add pedestrian-scale lighting at intersections
- Improve signal hardware: lenses, back-plates with retroreflective border, mounting, size, and number
- Extend yellow and red clearance intervals
- Provide advanced dilemma-zone detection for high-speed approaches
- Restrict right turns on red
- Eliminate parking adjacent to intersection
- Restrict cross-median access

ADD PEDESTRIAN-SCALE LIGHTING AT INTERSECTIONS (S1/NS1)

Eligible for Federal Funding: Yes (100%)

Potential Effectiveness at Reducing Collision Frequency and/or Severity: CRF = 40%. Collision reduction only applies to nighttime collisions occurring within the influence area of the intersection.

Brief Description: This countermeasure involves installing or modifying lighting at signalized or unsignalized intersections. This is done to improve the visibility of non-motorized users to drivers and reduce potential conflicts and collisions. Illuminating crosswalks helps make pedestrians visible for approaching drivers and assists pedestrians in navigating the crossing. Adding new lighting may require upgrades to the poles supporting them and could have larger dimensions and deeper foundations. An example of the countermeasure is shown in Figure 18.

REASONING

This countermeasure was selected for Mission Viejo because darkness was a factor in 35% of reported total collisions and 29% of reported fatal and severe injury collisions. Increased visibility would contribute to pedestrian, bicycle, and motorist safety, allowing drivers to see the activity at an upcoming intersection, especially illumination of non-motorized users.

FIGURE 18: EXAMPLE OF PEDESTRIAN-SCALE LIGHTING

Source: Federal Highway Administrati Source: Federal Highway Administration Lighting Handbook August 2012

IMPROVE SIGNAL HARDWARE: LENSES, BACKPLATES WITH RETROREFLECTIVE BORDER, MOUNTING, SIZE, OR NUMBER (S2)

Eligible for Federal Funding: Yes (100%)

Potential Effectiveness at Reducing Collision Frequency and/or Severity: CRF=15%. Collision reduction applies to collisions occurring on approaches and within the influence area of the intersection.

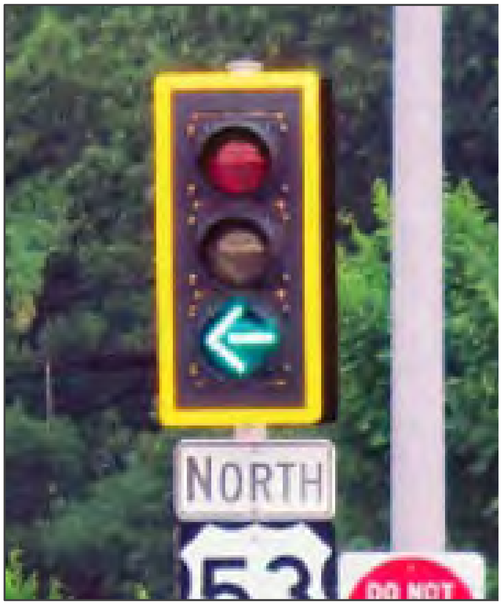
Brief Description: This countermeasure improves the visibility of traffic signal indications by increasing the size, location, number, or design of the signal heads. Increasing the location or number of signal heads may not be immediately feasible at certain locations due to the maximum mast arm loads of the existing poles. In these instances, new poles should be considered for feasibility. Increasing the signal heads to be more visible for all drivers and aligned with travel lanes provides clarity, especially on multi-lane approaches and those with limited visibility.

Retroreflective backplates improve the visibility of the illuminated face of the traffic signal by introducing a controlled-contrast background. Signal heads with backplates equipped with retroreflective borders or larger signal heads are more visible in daytime and nighttime conditions, and help drivers become aware of the upcoming signalized intersections. This countermeasure is more effective when it is adopted as a standard countermeasure for signalized intersections across the town or jurisdiction (FHWA, 2018). An example of the countermeasure is shown in Figure 19.

REASONING

This countermeasure was selected for Mission Viejo because broadside collision was the top collision type resulting in a fatality or severe injury with 36% of the reported collisions and because darkness was a factor in 35% of reported total collisions. Making intersection signal heads more visible would help promote driver compliance at intersections, particularly for larger intersections.

FIGURE 19: EXAMPLE OF SIGNAL BACKPLATE FRAMED WITH A RETROREFLECTIVE BORDER



Source: FHWA, 2018

EXTEND YELLOW AND RED CLEARANCE INTERVALS (S3)

Eligible for Federal Funding: Yes (50%)

Potential Effectiveness at Reducing Collision Frequency and/or Severity: CRF = 15%. Collision reduction applies to collisions occurring on approaches and within the influence area of the intersections where this countermeasure has been applied.

Brief Description: Clearance times provide transitions in vehicle right-of-way assignment between conflicting streams of traffic. Too short of clearance intervals can contribute to rear-end collisions related to drivers stopping abruptly and broadside collisions resulting from signal violations. Adjustments to yellow or red intervals may affect coordinated timing plans and should be reviewed as a network. Increasing clearance times may impact overall intersection operations and should be balanced with the need for anticipated safety benefits. A photograph of a yellow signal indication is shown in Figure 20.

REASONING

This countermeasure was selected for Mission Viejo because broadside collision was the top collision type representing 28% of total reported collisions and 36% of reported fatal and severe injury collisions. Having appropriately timed yellow and red intervals reduces the risk of collision, for instance, when a driver is in the dilemma zone or does not comply with yellow signal indications, particularly at larger signalized intersections.

FIGURE 20: PHOTOS OF YELLOW SIGNAL CLEARANCE INTERVAL

Source: FHWA, 2021

PROVIDE ADVANCED DILEMMA-ZONE DETECTION (S4)

Eligible for Federal Funding: Yes (100%)

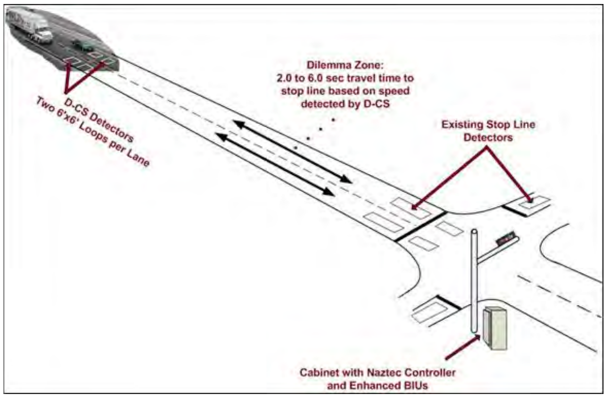
Potential Effectiveness at Reducing Collision Frequency and/or Severity: CRF = 40%. Collision reduction applies to collisions occurring on approaches and within the influence area of the intersections where this countermeasure has been applied.

Brief Description: This countermeasure consists of adding new advance detection and signal hardware to detect vehicles that may approach the intersection in the "dilemma zone" of deciding whether to stop or proceed during a yellow phase. The detection system modifies the signal timing to reduce the number of drivers needing to make this decision and the potential for conflicts due to phase changes. It is most effective on high-speed approaches. This countermeasure should be considered when high frequencies of collisions involve hard-stopping vehicles resulting in rear-end collisions, or when there is a pattern of collisions related to late-entering vehicles or vehicles running red lights. Figure 21 shows an example layout of advanced dilemma-zone detection at an intersection. Detection systems available include loop, radar, and video technologies. The applicability and prices of the systems vary depending on the situation.

REASONING

This countermeasure was selected for Mission Viejo because rear-end and broadside collisions each account for 28% of the total reported collisions in the city. This countermeasure can help reduce conflicts due to late-entering vehicles proceeding through the intersection or conflicts arising from hard-stopping vehicles due to dilemma of whether to proceed or stop during the yellow phase of a signal.

FIGURE 21: EXAMPLE LAYOUT OF DILEMMA-ZONE DETECTION



Source: FHWA, 2021

RESTRICT RIGHT TURNS ON RED

Eligible for Federal Funding: No

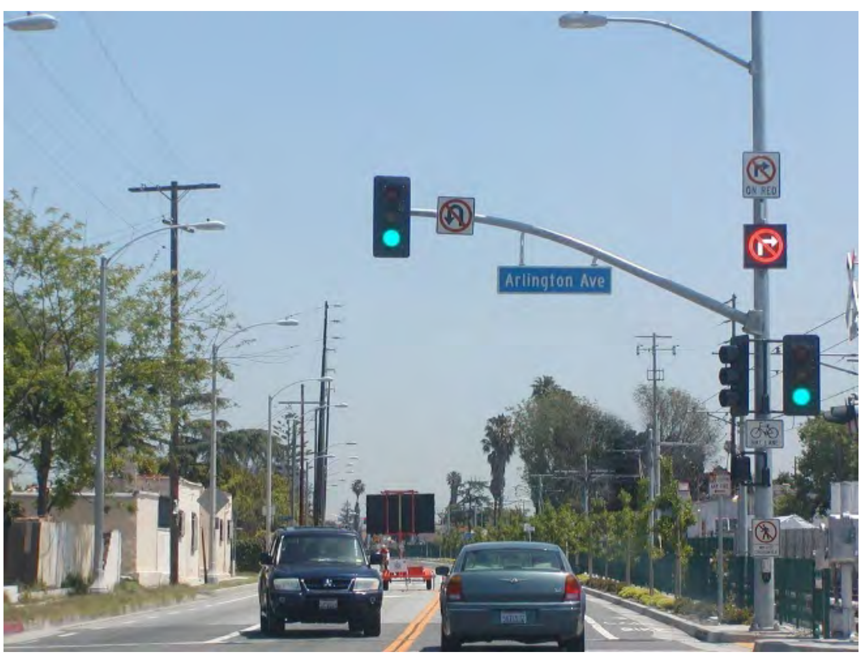
Potential Effectiveness at Reducing Collision Frequency and/or Severity: CRF = 9% (ODOT, 2021).

Brief Description: This countermeasure restricts vehicles from turning right on a red light by use of signage or a red arrow signal indication. The restriction can be for all times of day, applied to certain times of day, or dynamic dependent on a pedestrian's activation of the push button. Prohibiting right turn on red reduces collisions related to limited sight distance and right turns into pedestrians. It can also be effective where weaving or other conflicts are evident downstream of the right turn. It encourages motorists to stop at red lights. An example of the countermeasure is shown in Figure 22.

REASONING

This countermeasure was selected for Mission Viejo because vehicle-pedestrians was a top three collision type for fatal and severe injuries with 13% of reported collisions and because improper turning was a factor in 19% of reported total collisions and 14% of reported fatal and severe injury collisions. Restricting right-turn movements increases driver compliance with traffic signals and would reduce potential for conflicts between vehicles and pedestrians.

FIGURE 22: EXAMPLE OF DYNAMIC RIGHT TURN ON RED RESTRICTION



Source: Flickr, 2018

RESTRICT CROSS-MEDIAN ACCESS

Eligible for Federal Funding: No

Potential Effectiveness at Reducing Collision Frequency and/or Severity: N/A

Brief Description: This countermeasure prohibits left turns crossing the median near intersections. Reducing cross-median access can eliminate conflicts in broadside and rear-end collisions. This can be accomplished by using a raised median, signage, and striping. Alternative access possibilities should be considered and may consist of a U-turn at the next signalized intersection. Finding and allowing alternative locations for the restricted turning maneuvers is key and should not create their own safety issues. An example of the countermeasure is shown in Figure 23.

REASONING

This countermeasure was selected for Mission Viejo because 78% of reported collisions occurred within an intersection influence area and 28% of total reported collisions were broadside. Managing access near intersections would reduce potential conflict points, especially where motorists may attempt to cross multiple lanes of opposing travel or queued vehicles.

FIGURE 23: EXAMPLE OF CROSS-MEDIAN ACCESS RESTRICTIONS

Source: Google Maps, Mission Viejo Jeronimo Road/Alicia Parkway

ELIMINATE PARKING ADJACENT TO INTERSECTION

Eligible for Federal Funding: No

Potential Effectiveness at Reducing Collision Frequency and/or Severity: N/A

Brief Description: This countermeasure prohibits parking on intersection approaches, particularly when there is not a right-turn lane. Having parking near intersection approaches may present a safety hazard by blocking sight distance or allowing maneuvers that contribute to rear-end and sideswipe collisions. This is most applicable to collector and arterial roadways but can also be considered on local roadways where collisions may be influenced by parked vehicles. An example of the countermeasure is shown in Figure 24.

REASONING

This countermeasure was selected for Mission Viejo because 78% of reported collisions occurred within an intersection influence area and 28% of total reported collisions were rear-end. Removing parking near intersections would reduce potential conflict between vehicles parking or re-entering the roadway from parking and vehicles that are continuing straight at a higher speed.

FIGURE 24: EXAMPLE OF PARKING RESTRICTION SIGN ON INTERSECTION APPROACHES

Source: California Manual on Uniform Traffic Control Devices

Roadway Countermeasures

Engineering roadway countermeasures include:

Install dynamic regulatory speed warning signs and speed feedback trailers

Roadway street lighting

Install/upgrade signs with new fluorescent sheeting

Road diet

Remove or relocate fixed objects outside of Clear Recovery Zone

INSTALL DYNAMIC REGULATORY SPEED WARNING SIGNS AND SPEED FEEDBACK TRAILERS

Eligible for Federal Funding: No

Potential Effectiveness at Reducing Collision Frequency and/or Severity: N/A

Brief Description: These countermeasures are used to reduce motorist speeds in urban and suburban areas. They provide a message to drivers exceeding a certain speed threshold (or posted speed limit) in urban areas. The intent of these countermeasures is to get drivers' attention and provide them with a visual warning that they may be traveling over the recommended speed on the roadway. An example of this countermeasure is shown in Figure 25.

REASONING

This countermeasure was selected for Mission Viejo because unsafe speed was the top primary contributing factor (20%) of total reported collisions. Providing speed feedback signing can address speed-related collisions in the urban areas.

FIGURE 25: EXAMPLE OF DYNAMIC REGULATORY WARNING SIGN AND SPEED TRAILERS

Sources: City of Bellevue Transportation Department; Safe Routes to School Online Guide, 2021.

ROADWAY STREET LIGHTING (R1)

Eligible for Federal Funding: Yes (100%)

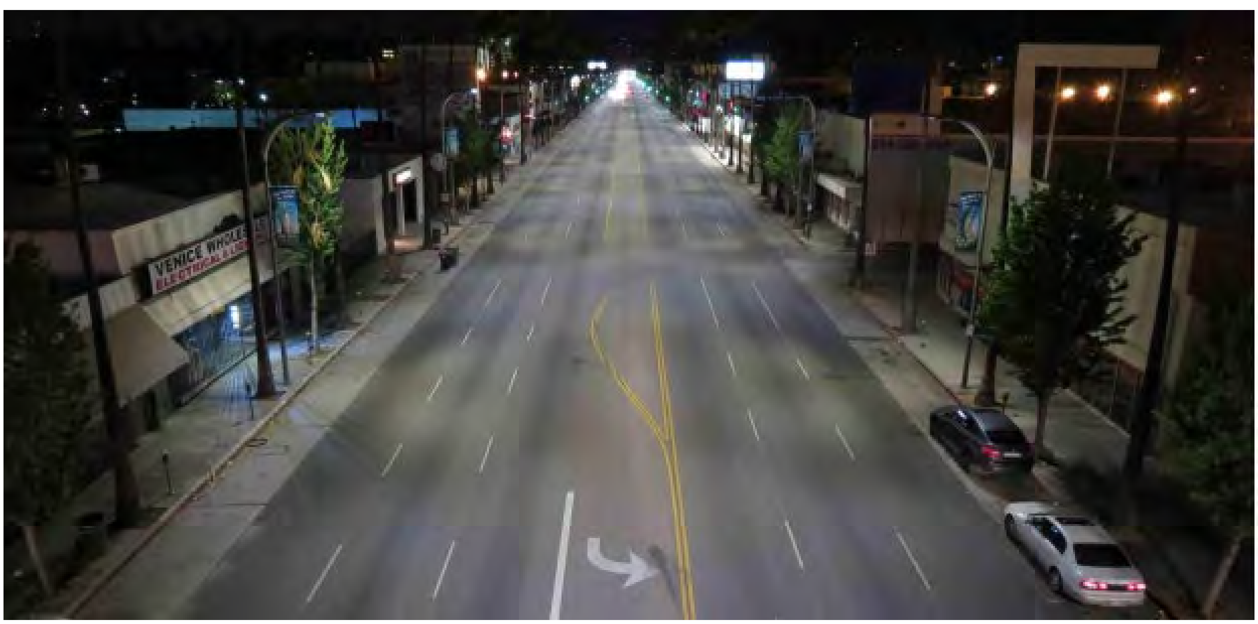
Potential Effectiveness at Reducing Collision Frequency and/or Severity: CRF = 35%. Collision reduction only applies to nighttime collisions occurring within the limits of the roadway.

Brief Description: This countermeasure involves installing or modifying lighting on roadway segments. This is done to improve the visibility of non-motorized users to drivers and reduce potential conflicts and collisions. Providing roadway lighting improves the drivers' perception-reaction times, enhances drivers' available sight distances to perceive roadway characteristics in advance of the change, and enhances non-motorized users' visibility and navigation. An example of the countermeasure is shown in Figure 26.

REASONING

This countermeasure was selected for Mission Viejo because darkness was a factor in 35% of reported total collisions and 29% of reported fatal and severe injury collisions. Increased visibility would contribute to drivers more easily seeing pedestrians, bicyclists, and other vehicles using the roadway. Consideration should be taken before implementation to account for maintenance and electrical costs that occur after implementation.

FIGURE 26: EXAMPLE LIGHTING ON THE ROADWAY



Source: FHWA

INSTALL/UPGRADE SIGNS WITH NEW FLUORESCENT SHEETING (R22)

Eligible for Federal Funding: Yes (100%)

Potential Effectiveness at Reducing Collision Frequency and/or Severity: CRF = 15%.

Brief Description: This countermeasure involves installing and/or upgrading signs with fluorescent sheeting, which provides drivers with a visual warning of the presence of a specific roadway feature or regulatory requirement they may have missed with existing signs. This countermeasure is appropriate on roadway segments with a history of head-on, nighttime, non-intersection, run-off-road, and sideswipe collisions. This countermeasure should be installed in combination with additional countermeasures, such as installing or adding chevrons, warning signs, delineators, markers and beacons, and relocating existing signs. An example countermeasure is shown in Figure 27.

REASONING

This countermeasure was selected for Mission Viejo because hit-object collisions are among the top three collision types resulting in a fatality or severe injury (18%). Furthermore, collisions that occurred during dark conditions accounted for 35% of the total reported collisions and 29% of the reported fatal and severe injury collisions. Installing and/or upgrading signs with new fluorescent sheeting would provide drivers with increased awareness of changing roadway elements.

FIGURE 27: EXAMPLE SIGNS WITH FLUORESCENT SHEETING

Source: FHWA

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

Eligible for Federal Funding: Yes (90%)

Potential Effectiveness at Reducing Collision Frequency and/or Severity: CRF = 35%.

Brief Description: Removing or relocating roadside fixed objects such as utility poles, drainage, trees, or other fixed objects provides a clear recovery zone that allows drivers to correct their path of travel when they leave the roadway. This countermeasure is particularly effective outside of curves, along lane drops and in traffic islands where fixed object collisions are more common. A clear recovery zone should be developed in more rural context roadways, as space is available. The jurisdictions are only able to address sight obstructions within jurisdiction's right-of-way. Where public right-of-way is limited, steps should be taken to request assistance from property owners. An example of this countermeasure is shown in Figure 28.

REASONING

This countermeasure was selected for Mission Viejo because hit-object collisions are among the top three collision types resulting in a fatality or severe injury (21%). Removing or relocating fixed objects outside of a clear recovery zone would provide an opportunity for drivers to correct their path of travel and can proactively address a history of hit-object collisions.

FIGURE 28: EXAMPLE OF REMOVING OR RELOCATING FIXED OBJECT

Source: FHWA

ROAD DIET (R14)

Eligible for Federal Funding: Yes (90%)

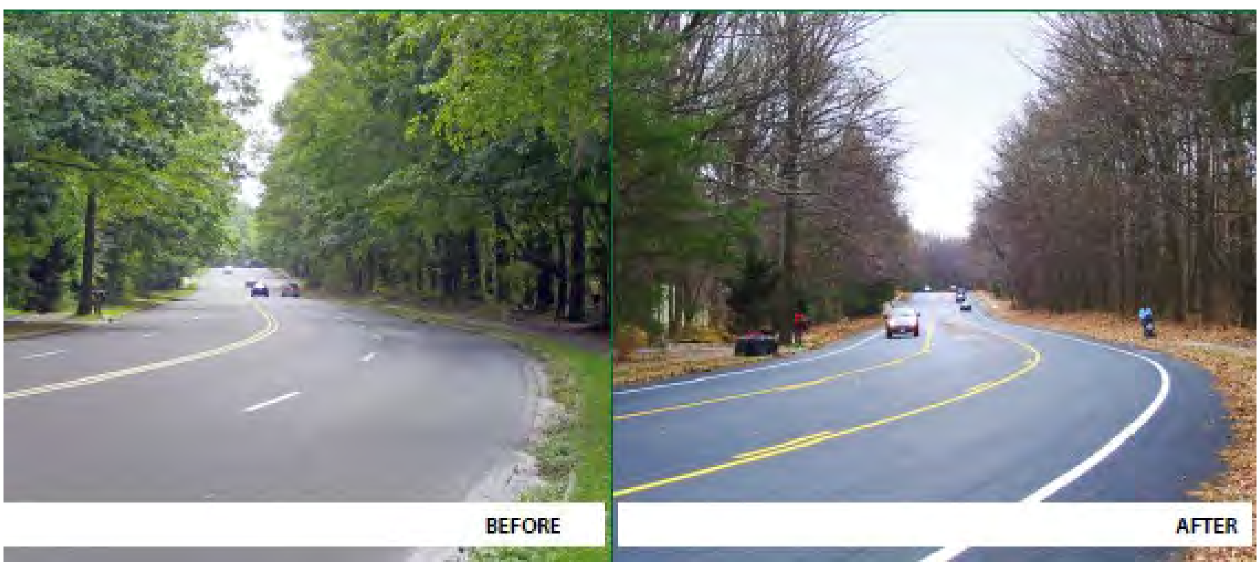
Potential Effectiveness at Reducing Collision Frequency and/or Severity: CRF = 30%.

Brief Description: Reduce the number of vehicle lanes on a roadway to manage vehicle speeds and reduce risk of collisions for all road users. A common road diet is to convert a four-lane undivided roadway to a three-lane cross-section, with one lane in each direction and a two-way center left-turn lane. This enables space for bicycle lanes and sidewalks. An example three-lane cross-section road diet is shown in Figure 29.

REASONING

This countermeasure was selected for Mission Viejo because unsafe speed was the top primary collision factor (20%) among all reported collisions. Performing a road diet would reduce motorist speeds, provide additional space for bicyclists and/or pedestrians, and help provide vehicular access into and out of various driveways.

FIGURE 29: EXAMPLE OF ROAD DIET



Source: FHWA

Bicycle and Pedestrian Countermeasures

Engineering bicycle and pedestrian countermeasures include:

- Install/upgrade pedestrian crossing at uncontrolled locations (with enhanced features)
- Modify signal phasing to implement a leading pedestrian interval
- Install bike lanes
- Install audible pedestrian push buttons
- Install bicycle push buttons
- Install bicycle lane extension through intersection
- Install bike boxes
- Install combined bike lane/turn lane
- Install bicycle two-stage left-turn queue boxes
- Install truncated domes on pedestrian ramps
- Install pedestrian refuge islands
- Provide protected left-turn phase/lane

INSTALL/UPGRADE PEDESTRIAN CROSSING AT UNCONTROLLED LOCATIONS (WITH ENHANCED SAFETY FEATURES) (NS21 PB)

Eligible for Federal Funding: Yes (90-100%)

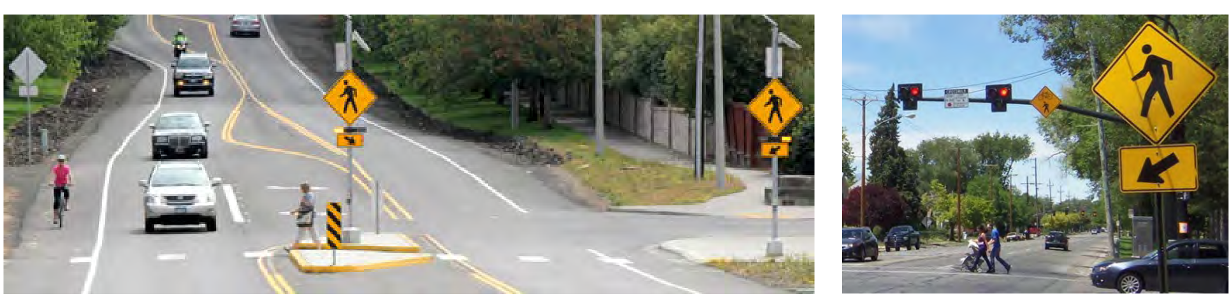
Potential Effectiveness at Reducing Collision Frequency and/or Severity: CRF = 35%. Collision reduction only applies to pedestrian and bicycle collisions occurring within the influence area of the intersection.

Brief Description: This countermeasure involves installing pedestrian crossings with enhanced safety features such as high visibility crosswalk markings, curb extensions, raised medians, beacons, and lighting to delineate the portion of the roadway to be used by crossing pedestrians. The features help indicate preferred locations for pedestrians to cross and increase the visibility of a crossing location. These countermeasures increase both pedestrian and driver awareness and help reinforce drivers' requirement to yield the right-of-way to crossing pedestrians. Rectangular rapid flashing beacons (RRFB) have been shown to significantly increase driver yielding behavior at uncontrolled crosswalks, with driver yield rates ranging from 34 percent to over 90 percent. RRFBs are generally more appropriate at two-lane locations. Pedestrian hybrid beacons (PHB) are best suited to higher-speed or multi-lane contexts or locations with limited sight distance. . shows an example of the countermeasure.

REASONING

This countermeasure was selected for Mission Viejo because vehicle-pedestrian collisions accounted for 13% of the fatal and severe injury collisions. Pedestrians crossing in a crosswalk at an intersection is the top contributing factor (57% of total reported collisions and 36% of reported fatal and severe injury collisions) associated with pedestrian collisions. Installing enhanced pedestrian crossings can help increase drivers' yielding behavior and reduce the risk of pedestrian and bicycle collisions.

FIGURE 30: EXAMPLE OF ENHANCED PEDESTRIAN CROSSING



Source: Washington County, NACTO

MODIFY SIGNAL PHASING TO IMPLEMENT A LEADING PEDESTRIAN INTERVAL (S21 PB)

Eligible for Federal Funding: Yes (100%)

Potential Effectiveness at Reducing Collision Frequency and/or Severity: CRF = 60%. Collision reduction only applies to pedestrian and bicycle collisions occurring within the influence area of the intersection.

Brief Description: This countermeasure involves implementing leading pedestrian interval (LPI) which improves driver awareness of pedestrians at intersections. LPIs provide pedestrians a head start when crossing at a signalized intersection. LPIs can be easily programmed into existing signals to give pedestrians the “Walk” signal a minimum of three to seven seconds before motorists are given a green indication. With this head start, pedestrians can better establish their presence in the crosswalk before motorists are given a green indication to turn left or right at the intersection. LPIs can be provided automatically with each phase or provided only when actuated (actively or passively). An example of the countermeasure is shown in Figure 31.

REASONING

This countermeasure was selected for Mission Viejo because vehicle-pedestrian fatal and severe injury collisions (13%) are overrepresented for signalized and unsignalized intersections. Leading Pedestrian Intervals may be considered at signalized intersections with medium to high vehicle-turning volumes and pedestrian volumes.

FIGURE 31: EXAMPLE OF A LEADING PEDESTRIAN INTERVAL

Source: PedBikeInfo

INSTALL BIKE LANES (R32 PB)

Eligible for Federal Funding: Yes (90%)

Potential Effectiveness at Reducing Collision Frequency and/or Severity: CRF = 35%.

Brief Description: This countermeasure designates a portion of roadway for the preferential or exclusive use of bicyclists through striping, signage, and pavement markings. Bike lanes typically run in the same direction of traffic, though they may be configured in the contra-flow direction on low-traffic corridors for the connectivity of a particular bicycle route. Buffered bike lanes provide greater separation from an adjacent traffic lane or on-street parking by using painted chevrons or diagonal markings. Buffered bike lanes may be desirable on streets with higher vehicle speeds or volumes. Solid or dashed green pavement marking is often used to delineate conflict areas as bike lanes approach an intersection. The green painted areas provide visual cues to a driver that a bicyclist may be present. An example of this countermeasure is shown in Figure 32.

REASONING

This countermeasure was selected for Mission Viejo because bicycle fatal and severe injury collisions (6%) are overrepresented. The use of bike lanes helps bicyclists to ride at their preferred speed without interference from prevailing traffic conditions and facilitates predictable behavior and movements between motorists and bicyclists.

FIGURE 32: EXAMPLE OF BUFFERED BIKE LANE APPROACHING AN INTERSECTION

Source: Kittelson & Associates, Inc.

INSTALL AUDIBLE PEDESTRIAN PUSH BUTTONS

Eligible for Federal Funding: Yes (100%)

Potential Effectiveness at Reducing Collision Frequency and/or Severity: N/A

Brief Description: This countermeasure involves installing audible pedestrian push buttons for crosswalks at signalized intersections or crosswalks with enhanced pedestrian features. Audible pedestrian push buttons provide information in non-visual formats and can include messages such as “WAIT”, “WALK SIGN IS ON”, and countdown of remaining walk time. These audible cues assist visually impaired pedestrians but can also benefit all pedestrian users. An example of the countermeasure is shown in Figure 33. It is recommended to install audible pedestrian push buttons when using leading pedestrian intervals; otherwise, a pedestrian may miss the start of the walk signal because there is no vehicle sound to indicate that it has begun early.

REASONING

This countermeasure was selected for Mission Viejo because vehicle-pedestrian collisions accounted for 13% of the fatal and severe injury collisions. Pedestrians crossing in a crosswalk at an intersection is the top contributing factor (57% of total reported collisions and 36% of reported fatal and severe injury collisions) associated with pedestrian collisions. Installing audible pedestrian push buttons would assist in informing pedestrians of the walk indication status during their phase of a controlled crossing.

FIGURE 33: EXAMPLE OF PEDESTRIAN COUNTDOWN SIGNAL HEAD AT AN INTERSECTION

Source: City of Roseville, California

INSTALL BICYCLE PUSH BUTTONS

Eligible for Federal Funding: No

Potential Effectiveness at Reducing Collision Frequency and/or Severity: N/A

Brief Description: This countermeasure uses bicycle push buttons for bicycle detection. Bicycle detection is used at actuated signals to alert the signal controller of bicycle-crossing demand on a particular approach. Bicycle detection occurs either by push buttons or automated means (e.g., in-pavement loops, video, microwave, etc.). Proper bicycle detection meets two primary criteria: 1) accurately detects bicyclists; and 2) provides clear guidance to bicyclists on how to actuate detection (e.g., what button to push, where to stand). Bicycle push buttons are user-activated buttons mounted on a pole facing the street. The push button activation should be located so bicyclists can activate the signal without dismounting. They should also have a supplemental sign facing the bicyclist's approach to increase visibility. An example of the countermeasure is shown in Figure 34.

REASONING

This countermeasure was selected for Mission Viejo because bicycle fatal and severe injury collisions (6%) are overrepresented. The use of bicycle push buttons increases convenience and safety of bicycling and helps establish bicycling as a feasible mode of transportation.

FIGURE 34: EXAMPLE OF BICYCLIST PUSH BUTTON

Source: NACTO

INSTALL BIKE LANE EXTENSION THROUGH INTERSECTION

Eligible for Federal Funding: No

Potential Effectiveness at Reducing Collision Frequency and/or Severity: CRF = 39% (ODOT, 2021).

Brief Description: Bicycle pavement markings through intersections indicate the intended path of bicyclists through an intersection. They guide bicyclists on a safe and direct path through the intersection and provide clear boundary between paths of bicyclists and motorists. This countermeasure reinforces that the through bicyclists have priority in that space over motor vehicles. An example of the countermeasure is shown in Figure 35.

REASONING

This countermeasure was selected for Mission Viejo because bicycle fatal and severe injury collisions (6%) are overrepresented. High visibility bike lane markings are intended to provide notice to drivers and bicyclists of areas where the two may come into conflict. Since the effectiveness of markings depends entirely on their visibility, maintaining markings should be a priority where this countermeasure is considered.

FIGURE 35: EXAMPLE OF BIKE LANE EXTENSION THROUGH INTERSECTION

Source: NACTO

INSTALL BIKE BOXES

Eligible for Federal Funding: No

Potential Effectiveness at Reducing Collision Frequency and/or Severity: CRF = 35% (ODOT, 2021).

Brief Description: This countermeasure involves installing a bike box, which is a designated area at the head of the traffic lane at a signalized intersection. This is to provide bicyclists with a safe and visible way to get ahead of the motor vehicle queuing traffic during the red signal phase. Bike boxes increase the visibility of bicyclists at an intersection and helps prevent right-hook or left-hook conflicts with turning motor vehicles at the start of the green indication. An example of the countermeasure is shown in Figure 36.

REASONING

This countermeasure was selected for Mission Viejo because bicycle fatal and severe injury collisions (6%) are overrepresented. Bike boxes are intended to provide notice to drivers and bicyclists of areas where the two may come into conflict at intersections and allow for a better queue space for bicyclists to be visible to motor vehicle traffic.

FIGURE 36: EXAMPLE OF BIKE BOX

Source: NACTO

INSTALL COMBINED BIKE LANE/TURN LANE

Eligible for Federal Funding: No

Potential Effectiveness at Reducing Collision Frequency and/or Severity: N/A

Brief Description: This countermeasure involves establishing a combined bike lane/turn lane to designate shared space for bicyclists and vehicles. Shared lane markings or conventional bicycle stencils with a dashed line can delineate the space for bicyclists and motorists within the shared lane or indicate the intended path for through bicyclists. This treatment includes signage advising motorists and bicyclists of proper positioning within the lane. An example of the countermeasure is shown in Figure 37.

REASONING

This countermeasure was selected for Mission Viejo because bicycle fatal and severe injury collisions (6%) are overrepresented. Combined bike lane/turn lanes are intended to provide notice to drivers and bicyclists of areas where the two may come into conflict at intersections and provide guidance for bicyclists approaching intersections where the bike lane has been terminated.

FIGURE 37: EXAMPLE OF A COMBINED BIKE LANE/TURN LANE

Source: NACTO

INSTALL BICYCLE TWO-STAGE LEFT-TURN QUEUE BOXES

Eligible for Federal Funding: No

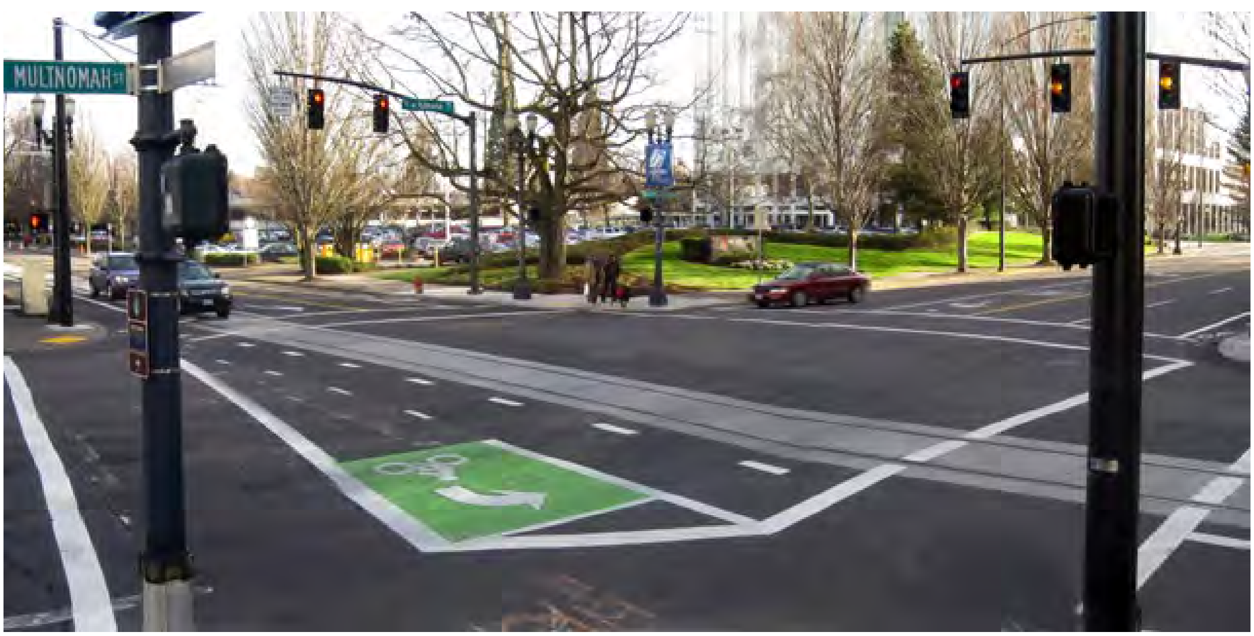
Potential Effectiveness at Reducing Collision Frequency and/or Severity: CRF = 35% (ODOT, 2021).

Brief Description: This countermeasure involves installing a bike box, which is a designated area at the head of the traffic lane at a signalized intersection. This is to provide bicyclists with a safe and visible way to get ahead of the motor vehicle queuing traffic during the red signal phase. Bike boxes increase the visibility of bicyclists at an intersection and helps prevent right-hook or left-hook conflicts with turning motor vehicles at the start of the green indication. Multiple positions are available for queuing boxes depending on the intersection configuration. An example of the countermeasure is shown in Figure 38.

REASONING

This countermeasure was selected for Mission Viejo because bicycle fatal and severe injury collisions (6%) are overrepresented. Bike boxes allow for a better accommodation of turning bicycle traffic and are most beneficial along multi-lane roadways with high speeds and signalized intersections.

FIGURE 38: EXAMPLE OF BICYCLE TWO-STAGE LEFT-TURN QUEUE BOX



Source: NACTO

INSTALL TRUNCATED DOMES ON PEDESTRIAN RAMPS

Eligible for Federal Funding: No

Potential Effectiveness at Reducing Collision Frequency and/or Severity: N/A

Brief Description: This countermeasure installs truncated domes on pedestrian curb ramps. These bumps, which can either be installed individually or together on a tile or detectable warning pad, are large enough to be felt underfoot or detected with a walking cane yet small enough as to not create any tripping hazards. Truncated dome tiles also make a distinct audible noise when using a guidance cane, marking a difference between the sidewalk and the ADA detectable warning. Further adding another level of detectability, tactile panels and detectable warning systems are required to provide a stark visual contrast. This means if the domes are being applied on a light surface, the truncated domes must be a darker color or vice versa. An example of the countermeasure is shown in Figure 39.

REASONING

This countermeasure was selected for Mission Viejo because vehicle-pedestrian collisions accounted for 13% of the fatal and severe injury collisions. Pedestrians crossing in a crosswalk at an intersection is the top contributing factor (57% of total reported collisions and 36% of reported fatal and severe injury collisions) associated with pedestrian collisions. Installing truncated domes would assist in informing pedestrians they are entering the roadway and provide visual cues of crosswalk locations.

FIGURE 39: EXAMPLE OF TRUNCATED DOMES ON A PEDESTRIAN RAMP

Source: FHWA

INSTALL PEDESTRIAN REFUGE ISLANDS (NS19 PB)

Eligible for Federal Funding: Yes (90%)

Potential Effectiveness at Reducing Collision Frequency and/or Severity: CRF = 45%. Collision reduction only applies to pedestrian and bicycle collisions occurring within the influence area of the intersection.

Brief Description: This countermeasure involves using raised medians with pedestrian refuge islands designed to provide dedicated areas for pedestrians and bicyclists between vehicle travel lanes at intersections and midblock locations. The refuge area must have a minimum width of 6 feet to meet pedestrian accessibility requirements. To provide bicyclists refuge and to accommodate larger groups of pedestrians, the minimum should be increased to 8 feet. This countermeasure improves the safety for pedestrians and bicyclists by reducing crossing distances and creating a place of refuge to allow multiple-stage crossings. They are particularly beneficial at uncontrolled crossings, large signalized crossings, or complex intersections where people may have difficulty completing crossings. An example of the countermeasure is shown in Figure 40.

REASONING

This countermeasure was selected for Mission Viejo because vehicle-pedestrian collisions accounted for 13% of the fatal and severe injury collisions. The second most common primary collision factor is listed pedestrian violation, which can indicate the need for improved pedestrian crossings. These countermeasures would provide a space for pedestrians to wait on longer crossings to allow multiple-stage crossings.

FIGURE 40: EXAMPLE OF A RAISED MEDIAN PEDESTRIAN REFUGE AREA

Source: FHWA

PROVIDE PROTECTED LEFT-TURN PHASE/LANE

Eligible for Federal Funding: Yes (90-100%, depending on whether a left-turn lane currently exists or not)

Potential Effectiveness at Reducing Collision Frequency and/or Severity: 30% - 55%, depending on whether a left-turn lane currently exists or not.

Brief Description: This treatment consists of adding a new protected left-turn phase to a signal where left-turns are currently permitted and, if no left-turn currently exists, adding a left-turn lane to allow left-turning vehicles to queue separately from through movement traffic. This treatment includes both adjustments to signal timing as well as new signal hardware to provide for the protected movement. This treatment may be considered at any signalized intersection where left-turn phases are currently permissive or protected-permissive. Figure 41 shows an example of this treatment.

REASONING

This countermeasure was selected for Mission Viejo because rear-end and broadside collisions each account for 28% of the total reported collisions and vehicle-pedestrian collisions accounted for 13% of the fatal and severe injury collisions. Providing protected left-turn phases allows for dedicated time for left-turn vehicles and pedestrian phases.

FIGURE 41: EXAMPLE OF A PROTECTED LEFT-TURN PHASE AND LANE

Source: Google Earth

VIABLE PROJECT SCOPES AND PRIORITIZED LIST OF SAFETY PROJECTS

Kittelson identified competitive groupings of locations for potential Highway Safety Improvement Program (HSIP) applications and capital improvement projects to reduce the collision risks. These groupings include a mix of location-specific capital improvement projects as well as systemic treatments that can be applied at locations throughout the city. For the systemic projects, applicable locations are identified in each subsection, and example locations and concepts are provided.

Mitigation measures were selected based on the city's collision patterns and trends as well as roadway characteristics indicative of increasing collision risk. Kittelson used the Caltrans Local Road Safety Manual, April 2020 Version 1.5, (LRSM) as well as the California MUTCD, and national resources related to roadway safety (e.g., FHWA's CMF Clearinghouse) to identify potential mitigation measures. As the City advances forward in considering and implementing roadway safety improvements, the following content is offered as ideas for consideration. There may be site-specific conditions or other reasons the City may choose to implement mitigation measures other than those presented and discussed below.

The project locations or grouping selected for each emphasis area are listed below:

SIGNALIZED INTERSECTIONS

Alicia Parkway/Jeronimo Road
Alicia Parkway/Marguerite Parkway
Oso Parkway/Marguerite Parkway
Olympiad Road/Marguerite Parkway
Crown Valley Parkway/Doctor Guevara Way/Medical Center Drive

CITYWIDE SYSTEMIC MEASURES

Speed Management Treatments
Intersection Treatments
Intersection Approach Treatments
Roadside Conditions Treatments

CROSSWALK ENHANCEMENT LOCATIONS

Via Linda/Madero
Pradera Drive/Pericia Drive
Herencia/Anaya
Mustang Run/Portola Plaza

CITYWIDE SIGNALIZED PEDESTRIAN MITIGATION MEASURES

Type 1: Three- or four-legged intersections on an arterial roadway near a retail/commercial area
Type 2: Three- or four-legged intersections on an arterial roadway near a school or residential area

CITYWIDE BICYCLE MITIGATION MEASURES

Type 1: Four-legged intersections
Type 2: Three-legged T-intersections
Type 3: Skewed four-legged intersections

Signalized Intersections

Five signalized intersections were advanced into project scoping. The section below includes a summary of existing conditions at the intersection, collision history, applicable countermeasures, preliminary design concepts, and engineering cost estimates. Planning level cost estimates include 20 percent of construction cost estimated for engineering and construction support and 25 percent contingency.

ALICIA PARKWAY/JERONIMO ROAD

EXISTING CONDITIONS

Alicia Parkway is a six-lane arterial divided by a raised median, and Jeronimo Road is a four-lane arterial divided by a raised median. The Alicia Parkway at Jeronimo Avenue intersection has two left-turn lanes and a right-turn lane on each approach in addition to the through lanes.

This intersection has marked crosswalks on three of the four legs. In 2017, the City removed the crosswalk on the west leg (crossing Alicia Parkway) to improve vehicle operations and intersection coordination with adjacent signals because the southbound vehicle volumes were not high enough to need the green time allocated during pedestrian walk time requirements. Class II bicycle lanes are provided on both Alicia Parkway and Jeronimo Road and terminate prior to the intersection at all approaches to make room for the right-turn lanes. Bus stops are located on the northwest and southeast corners of the intersection, each about 150 feet from the intersection crosswalk.

There is a gas station located at the northwest corner of the intersection with driveways on each roadway less than 100 feet from the corner. There are retail centers southwest and northwest of the intersection, office space northeast of the intersection, and residential dwellings southeast.

COLLISION HISTORY

Table 10 provides an overview of this intersection's reported collision history data from January 2016 through December 2020. The collision history indicates there has been reduced collisions in the past three years, but it is still one of the most frequent locations in the city. Collision data shows there has been a pattern of red-light-running in all directions. Rear-ends are also a notable collision type and could be related to queues from the signalized intersection located 450 feet west of this intersection.

TABLE 10: COLLISION HISTORY (2016 THROUGH 2020), ALICIA PARKWAY/JERONIMO ROAD

	Total Collisions	Fatal	Severe Injury	Moderate Injury	Minor Injury	Property Damage Only
Alicia/Jeronimo by Severity	56	0	5	10	22	19
	2016	**2017**	**2018**	**2019**	**2020**	
Alicia/Jeronimo by Year	17	18	9	5	7	
	Pedestrian-Involved	**Bicycle-Involved**				
Alicia/Jeronimo by User	0	3				

Source: Kittelson, 2021

RECOMMENDATIONS

Proposed countermeasures are primarily focused on improving signal operations, increasing awareness and visibility of the signal and lane assignments, and improving accommodations for vulnerable roadway users. Enforcement of signal operations may be helpful in addition to the proposed engineering countermeasures.

A design concept for the intersection of Alicia Parkway/Jeronimo Road includes the following safety treatments, as shown in Figure 42:

Install retroreflective backplates on all signal heads, all approaches.
This treatment is intended to address right-angle and rear-end collisions by improving visibility of the signal indications. Forty-two of the 56 collisions were either rear-end or broadside collisions. This treatment aligns with LRSM countermeasure ID S02.

Install additional signal heads for Alicia Parkway through movements.
This treatment is intended to address right-angle and rear-end collisions by improving visibility of the current signal indication. Alicia Parkway approaches at this intersection currently have one overhead signal head and one pole-mounted signal head for three through lanes of traffic. An additional signal head on the mast arm would allow placement of signal heads to be more visible for each of the through lanes. The additional signal load on the mast arm would require an upgrade to the existing pole. Forty-two of the 56 collisions were either rear-end or broadside collisions. This treatment aligns with LRSM countermeasure ID S02.

Install white solid lane markings 150 feet upstream of the intersection on Alicia Parkway.
This treatment encourages drivers to maintain their lane as they approach the intersection. Five of the 56 collisions were sideswipe collisions.

Install advanced stop bar on each approach that has a crosswalk.
This treatment further separates vehicles from crossing pedestrians. While none of the reported collisions involved a pedestrian, this treatment is an industry best practice for helping to reduce the risk of pedestrians being struck by vehicles. This treatment aligns with LRSM countermeasure ID S20PB.

Restripe pedestrian crossings with high visibility continental pattern or similar.
This treatment improves driver awareness when approaching a crosswalk and encourages pedestrians to cross at the designated locations. While none of the reported collisions involved a pedestrian, this treatment is an industry best practice for helping to reduce the risk of pedestrians being struck by vehicles.

Install bicyclist push buttons at all corners of the intersection.
This treatment provides an opportunity for bicyclists to provide the signal indication that they are present and ready to cross. Three of the 56 collisions involved bicyclists. Installation of bicyclist push buttons throughout the city was identified as a priority treatment to better accommodate bicyclists at the signalized intersections.

Install conflict zone markings for the bike lane to right-turn lane transition and pavement markings indicating a shared space for bicyclists within the right-turn lanes for all approaches.
This treatment provides bicyclists guidance as they approach the intersection and visually alerts drivers as to where to look for/expect bicyclists. This treatment provides information to bicyclists and drivers to help both road users better manage potential conflicts. The existing configuration terminates the bicycle lanes prior to the right-turn lane without further indication of where a bicyclist should be within the roadway. Three of the 56 collisions involved bicyclists.

Install bicycle lane markings through the intersection.
This treatment directs bicyclists through the intersection to the bike lane on the opposite side of the intersection with dedicated space. Three of the 56 collisions involved bicyclists.

Install two-stage left-turn bike queue boxes on all approaches.
This treatment provides space for a bicyclist to stage and provides an opportunity to make a left turn from one major roadway to another without having to cross several lanes of traffic. Three of the 56 collisions involved bicyclists.

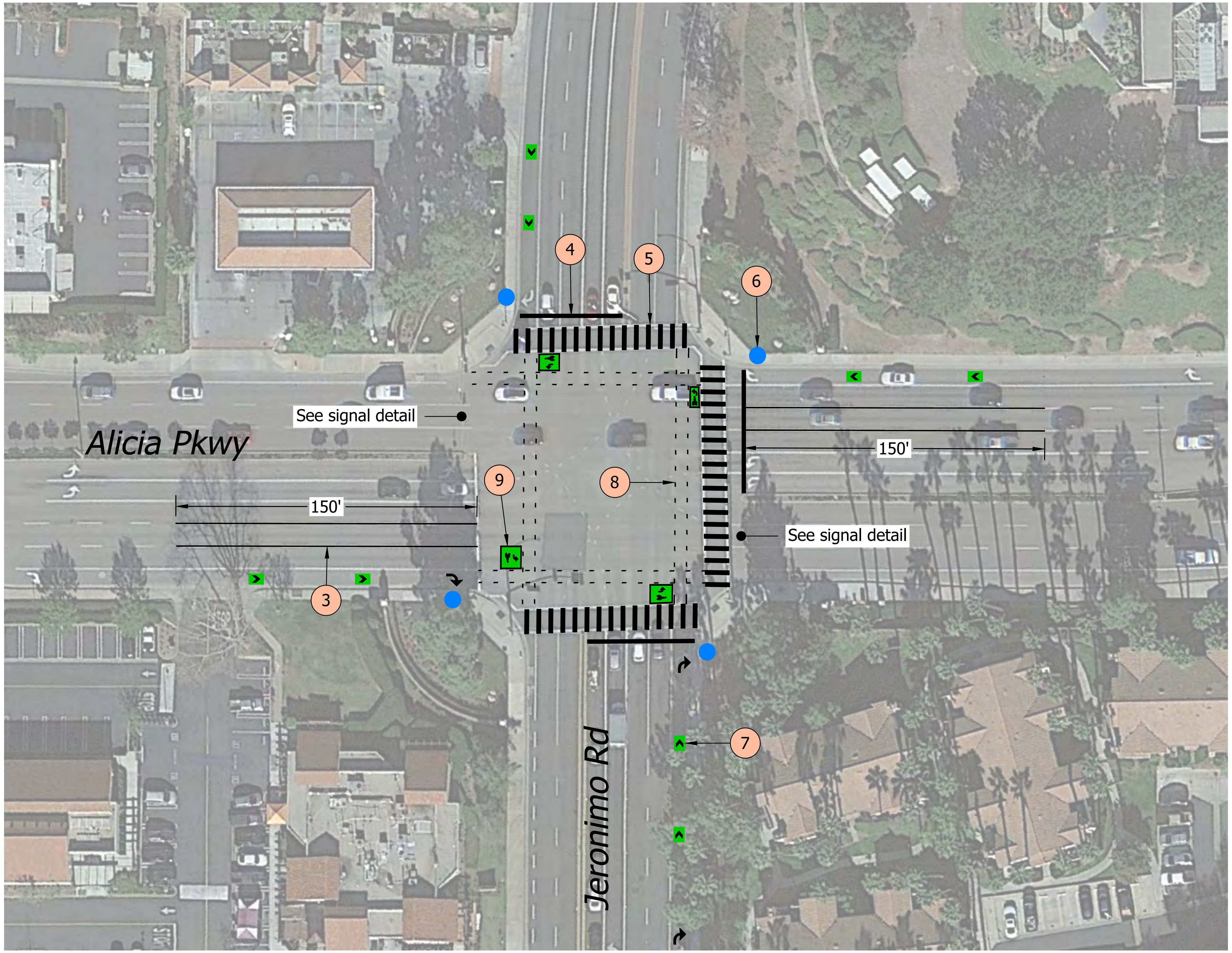
COST ESTIMATE

The total estimated cost for construction of the recommended improvements is shown below. An estimate of the eligible project costs for HSIP funding reimbursement is provided below as well. The estimate is based on the HSIP Cycle 10 guidelines and current funding eligibility percentages. A local match is often required for grant applications, which would be the difference between the two values below or as required by the specific grant.

COST

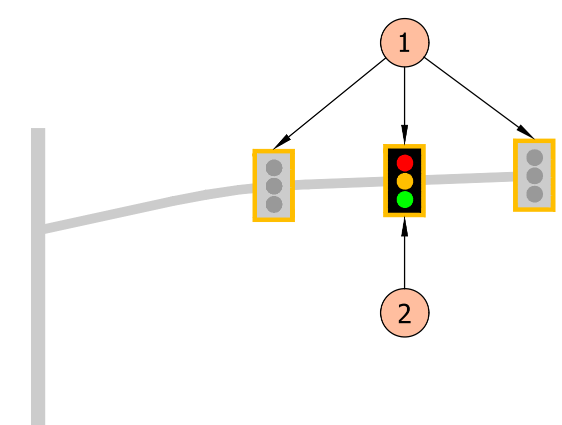
Total Estimated Cost:
$193,140

Estimated Eligible for HSIP Funding:
$70,280



Summary of Treatments

1. Install retroreflective backplates on all signal heads, all approaches (LRSM ID: S02)
2. Add additional signal head for Alicia Pkwy through movements (LRSM ID: S02)
3. Add solid white marks on Alicia Pkwy for 150 feet approaching intersection
4. Install advanced stop bar before crosswalk (LRSM ID: S20PB)
5. Install High Visibility Crosswalks
6. Install bike push buttons, all intersection corners
7. Add conflict zone markings and convert right turn lane to a combined bike/right turn lane with shared lane markings, all approaches
8. Add bike crossing markings through intersection
9. Install two-stage left turn bike queue boxes



N

Scale: 1" = 60'

60 30 0 60

Note

Proposed white pavement markings are shown in black for clarity.

Intersection Treatments
Alicia Parkway / Jeronimo Road
Mission Viejo, CA

Figure 42

OSO PARKWAY/MARGUERITE PARKWAY

EXISTING CONDITIONS

Oso Parkway is an eight-lane arterial divided by a raised median, and Marguerite Parkway is a four-lane arterial divided by a raised median. The intersection has two left-turn lanes and a shared through-right lane on the Oso Parkway approaches and two left-turn lanes and a right-turn lane on the Marguerite Parkway approaches.

This intersection has marked crosswalks across all approaches. Class II bicycle lanes are provided on both Oso Parkway and Marguerite Parkway. The bicycle lanes on Marguerite Parkway terminate prior to the intersection to make room for the right-turn lanes. A bus stop is located along Marguerite Parkway on the southwest corner of the intersection.

The surrounding land use consists of retail, office, residential, and a church. Driveways are located within 250 feet of the intersection along three of the four approaches and departures.

COLLISION HISTORY

Table 11 provides an overview of this intersection's reported collision history data from January 2016–December 2020. Collision data show that unsafe speed has been a common primary collision factor at this intersection. The northbound approach has experienced multiple hit-object collisions. There is often high potential for collisions at intersections with a large number of vehicle lanes and where relatively high volume of vehicles are intersecting each other.

TABLE 11: COLLISION HISTORY (2016–2020), OSO PARKWAY/MARGUERITE PARKWAY

	Total Collisions	Fatal	Severe Injury	Moderate Injury	Minor Injury	Property Damage Only
Oso/Marguerite by Severity	23	0	3	6	5	9
	2016	**2017**	**2018**	**2019**	**2020**	
Oso/Marguerite by Year	7	4	5	5	2	
	Pedestrian-Involved	**Bicycle-Involved**				
Oso/Marguerite by User	0	0				

Source: Kittelson, 2021

RECOMMENDATIONS

Proposed countermeasures are primarily focused on increasing awareness and visibility of the traffic signal and improving accommodations for vulnerable roadway users. Based on the history of unsafe speeds, enforcement may be helpful in addition to the proposed engineering countermeasures.

A design concept for the intersection of Oso Parkway/Marguerite Parkway includes the following safety treatments, as shown in Figure 43:

Install retroreflective backplates on all signal heads, all approaches.

This treatment is intended to address right-angle and rear-end collisions by improving visibility of the signal indications. Thirteen of the 23 collisions were either rear-end or broadside collisions. This treatment aligns with the LRSM countermeasure ID S02.

Install advanced stop bar on each approach.

This treatment further separates vehicles from crossing pedestrians. While none of the reported collisions involved a pedestrian, this treatment is an industry best practice for helping to reduce the risk of pedestrians being struck by vehicles. This treatment aligns with LRSM countermeasure ID S20PB.

Restripe pedestrian crossings with high visibility continental pattern or similar.

This treatment improves driver awareness to alert them that they are approaching a crosswalk and encourages pedestrians to cross at the designated locations. While none of the reported collisions involved a pedestrian, this treatment is an industry best practice for helping to reduce the risk of pedestrians being struck by vehicles.

Install pedestrian-scale intersection lighting.

This treatment increases intersection visibility and pedestrians at the crossings to address nighttime collisions. Eight of the 23 collisions occurred in dark conditions. This treatment aligns with LRSM countermeasure ID S01. Lighting upgrades would require Type 15 poles at all corners.

Install bicyclist push buttons at all corners of the intersection.

This treatment provides an opportunity for bicyclists to inform the signal indication that they are present and ready to cross. Installation of bicyclist push buttons throughout the city was identified as a priority treatment to better accommodate bicyclists at the signalized intersections.

Install conflict zone markings for the bike lane to right-turn lane transition and pavement markings indicating a shared space for bicyclists within the right-turn lanes on Marguerite Parkway.
This treatment provides bicyclists guidance as they approach the intersection and visually alerts drivers as to where to look for/expect bicyclists. This treatment provides information to bicyclists and drivers to help both road users better manage potential conflicts. The existing configuration terminates the bicycle lanes prior to the right-turn lane without further indication of where a bicyclist should be within the roadway. While none of the reported collisions involved a bicyclist, this treatment is an industry best practice for helping to reduce the risk of bicyclists being struck by vehicles.

Install bicycle lane markings through the intersection.
This treatment directs bicyclists through the intersection to the bike lane on the opposite side of the intersection with dedicated space. While none of the reported collisions involved a bicyclist, this treatment is an industry best practice for helping to reduce the risk of bicyclists being struck by vehicles.

Install two-stage left-turn bike queue boxes on all approaches.
This treatment provides space for a bicyclist to stage and provides an opportunity to make a left turn from one major roadway to another without having to cross several lanes of traffic. While none of the reported collisions involved a bicyclist, this treatment is an industry best practice for helping to reduce the risk of bicyclists being struck by vehicles.

Install green conflict zone markings for the bike lanes on Oso Parkway as they approach the intersection.
This treatment provides visual indication that the bicycle lane is sharing space with right-turning vehicles as they approach the intersection. While none of the reported collisions involved a bicyclist, this treatment is an industry best practice for helping to reduce the risk of bicyclists being struck by vehicles.

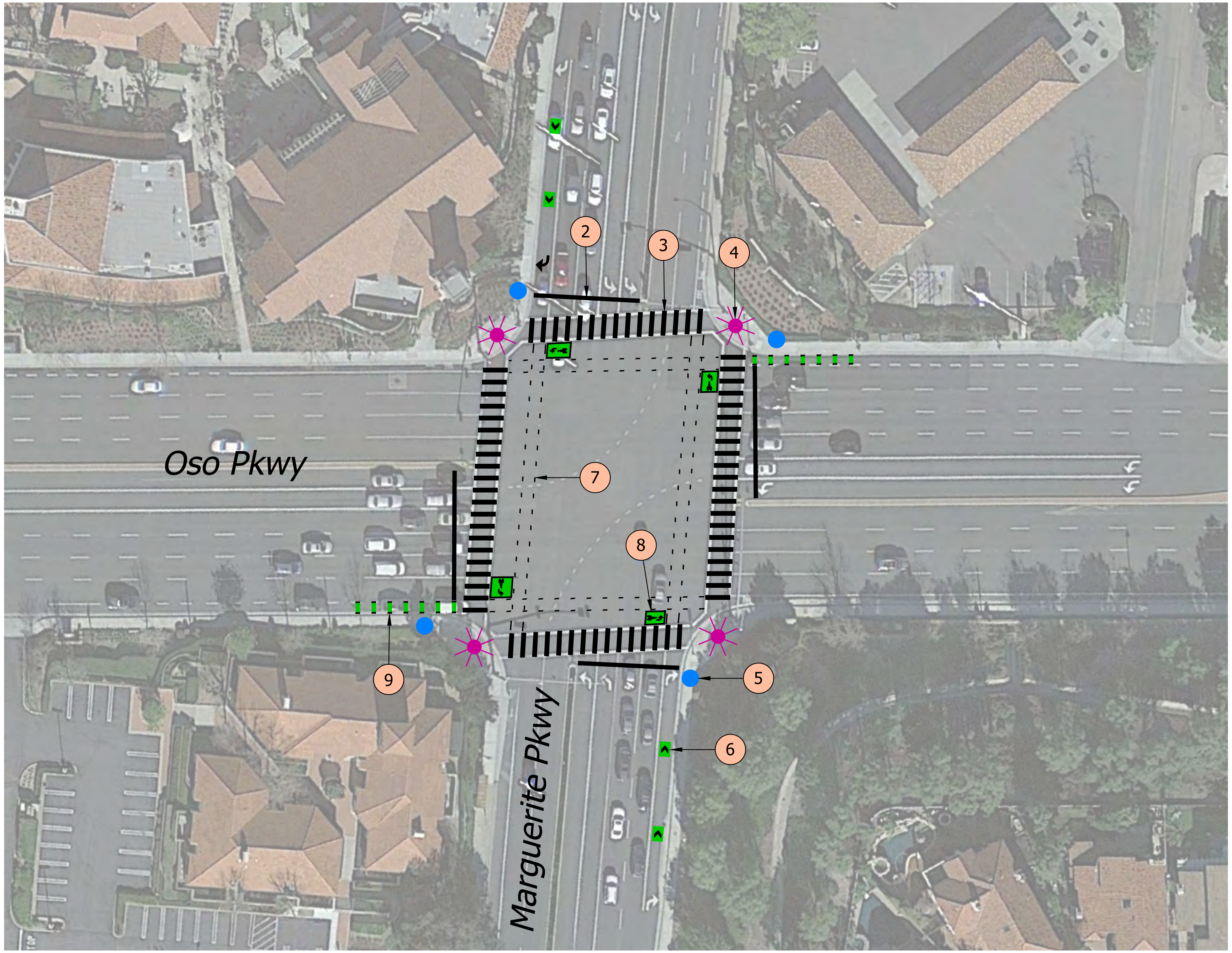
COST ESTIMATE

The total estimated cost for construction of the recommended improvements is shown below. An estimate of the eligible project costs for HSIP funding reimbursement is provided below as well. The estimate is based on the HSIP Cycle 10 guidelines and current funding eligibility percentages. A local match is often required for grant applications, which would be the difference between the two values below or as required by the specific grant.

COST

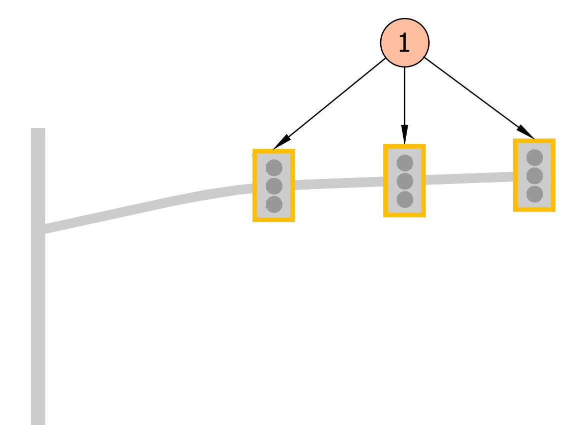
Total Estimated Cost:
$201,195

Estimated Eligible for HSIP Funding:
$190,525



Summary of Treatments

1. Install retroreflective backplates on all signal heads, all approaches (LRSM ID: S02)
2. Install advanced stop bar before crosswalk (LRSM ID: S20PB)
3. Install High Visibility Crosswalk
4. Install pedestrian-scale lighting (LRSM ID: S01)
5. Install bike push buttons, all intersection corners
6. Add conflict zone markings and convert right turn lane to a combined bike/right turn lane with shared lane markings
7. Add bike crossing markings through intersection
8. Install two-stage left turn bike queue boxes
9. Install green conflict zone marking



N

Scale: 1" = 60'

60 30 0 60

Note

Proposed white pavement markings are shown in black for clarity.

Intersection Treatments
Oso Parkway / Marguerite Parkway
Mission Viejo, CA

Figure
43

KITTELSON & ASSOCIATES

ALICIA PARKWAY/MARGUERITE PARKWAY

EXISTING CONDITIONS

Alicia Parkway is a six-lane arterial divided by a raised median; Marguerite Parkway is a four-lane arterial divided by a raised median. The intersection has one left-turn lane and right-turn lane on the Marguerite Parkway approaches and two left-turn lanes with shared through-right lanes on the Alicia Parkway approaches. Recent improvements at this location added the third eastbound through lane and second westbound left-turn lane. There is a southbound right-turn overlap phase that runs concurrent with eastbound left turns, restricting U-turns.

This intersection has marked crosswalks across all approaches. Class II bicycle lanes are provided on both Alicia Parkway and Marguerite Parkway. The bicycle lanes on Marguerite Parkway terminate prior to the intersection to make room for the right-turn lanes. Bus stops are located on each corner of the intersection.

The surrounding land use is primarily residential with a small office building on the southeast corner. The only driveways near the intersection are right-in, right-out driveways to serve that office building.

COLLISION HISTORY

Table 12 provides an overview of this intersection's reported collision history data from January 2016 through December 2020. Collision data show that unsafe speed has been a common primary collision factor. Alicia Parkway also curves on each side of this intersection which could contribute to speeding vehicles not providing enough time to identify and react to the traffic signal indicators or vehicles at the intersection.

TABLE 12: COLLISION HISTORY (2016–2020), ALICIA PARKWAY/MARGUERITE PARKWAY

	Total Collisions	Fatal	Severe Injury	Moderate Injury	Minor Injury	Property Damage Only
Alicia/Marguerite by Severity	35	0	2	8	6	19
	2016	**2017**	**2018**	**2019**	**2020**	
Alicia/Marguerite by Year	6	13	7	4	5	
	Pedestrian-Involved	**Bicycle-Involved**				
Alicia/Marguerite by User	1	0				

Source: Kittelson, 2021

RECOMMENDATIONS

Proposed countermeasures are primarily focused on increasing awareness and visibility of the traffic signal and lane assignments, and improving accommodations for vulnerable roadway users. Based on the history of unsafe speeds, enforcement may be helpful in addition to the proposed engineering countermeasures.

A design concept for the intersection of Alicia Parkway/Marguerite Parkway includes the following safety treatments, as shown in Figure 44:

Install retroreflective backplates on all signal heads, all approaches.

This treatment is intended to address right-angle and rear-end collisions by improving visibility of the signal indications. Twenty-three of the 35 collisions were either rear-end or broadside collisions. This treatment aligns with the LRSM countermeasure ID S02.

Install additional signal heads for westbound Alicia Parkway through movement.

This treatment is intended to address right-angle and rear-end collisions by improving visibility of the current signal indication. The westbound Alicia Parkway approach at this intersection currently has one overhead signal head and one pole-mounted signal head for three through lanes of traffic. An additional signal head on the mast arm would allow placement of signal heads to be more visible for each of the through lanes. As part of the recent widening for the eastbound approach of Alicia Parkway, two signal heads were provided on the mast arm. Twenty-three of the 35 collisions were either rear-end or broadside collisions. This treatment aligns with LRSM countermeasure ID S02.

Install “SIGNAL AHEAD” pavement markings on all approaches.

This treatment provides additional warning that the driver is approaching a traffic signal to address right-angle and rear-end collisions. The intersection visibility is limited on all approaches with the curves and grades of the roadway. Four of the 35 collisions were sideswipe collisions.

Install advanced stop bar on each approach.

This treatment further separates vehicles from crossing pedestrians. One of the 35 collisions involved a pedestrian. This treatment aligns with LRSM countermeasure ID S20PB.

Restripe pedestrian crossings with high visibility continental pattern or similar.

This treatment improves driver awareness when approaching a crosswalk and encourages pedestrians to cross at the designated locations. One of the 35 collisions involved a pedestrian.

Install bicyclist push buttons at all corners of the intersection.

This treatment provides an opportunity for bicyclists to provide the signal indication that they are present and ready to cross. Installation of bicyclist push buttons throughout the city was identified as a priority treatment to better accommodate bicyclists at the signalized intersections.

Install bicycle lane markings through the intersection.
This treatment directs bicyclists through the intersection to the bike lane on the opposite side of the intersection with dedicated space. While none of the reported collisions involved a bicyclist, this treatment is an industry best practice for helping to reduce the risk of bicyclists being struck by vehicles.

Install two-stage left-turn bike queue boxes on all approaches.
This treatment provides space for a bicyclist to stage and provides an opportunity to make a left turn from one major roadway to another without having to cross several lanes of traffic. While none of the reported collisions involved a bicyclist, this treatment is an industry best practice for helping to reduce the risk of bicyclists being struck by vehicles.

Install green conflict zone markings for the bike lanes on Alicia Parkway as they approach the intersection.
This treatment provides visual indication that the bicycle lane is sharing space with right-turning vehicles as they approach the intersection. While none of the reported collisions involved a bicyclist, this treatment is an industry best practice for helping to reduce the risk of bicyclists being struck by vehicles.

Install conflict zone markings for the bike lane to right-turn lane transition and pavement markings indicating a shared space for bicyclists within the right-turn lanes on Marguerite Parkway.
This treatment provides bicyclists guidance as they approach the intersection and visually alerts drivers as to where to look for/expect bicyclists. This treatment provides information to bicyclists and drivers to help both road users better manage potential conflicts. The existing configuration terminates the bicycle lanes prior to the right-turn lane without further indication of where a bicyclist should be within the roadway. While none of the reported collisions involved a bicyclist, this treatment is an industry best practice for helping to reduce the risk of bicyclists being struck by vehicles.

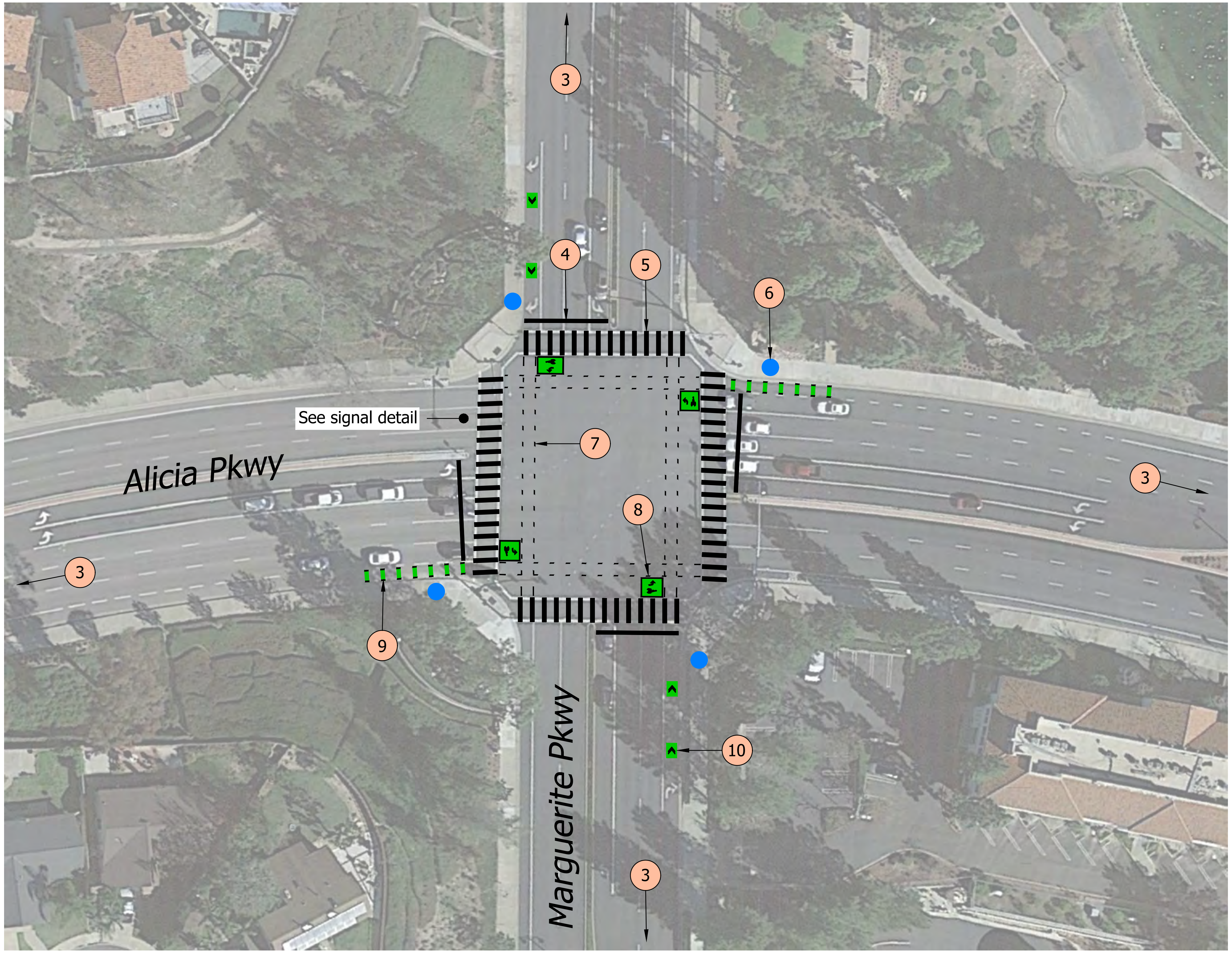
COST ESTIMATE

The total estimated cost for construction of the recommended improvements is shown below. An estimate of the eligible project costs for HSIP funding reimbursement is provided below as well. The estimate is based on the HSIP Cycle 10 guidelines and current funding eligibility percentages. A local match is often required for grant applications, which would be the difference between the two values below or as required by the specific grant.

COST

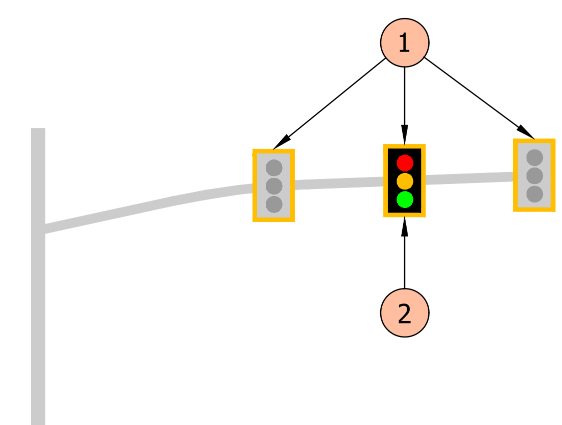
Total Estimated Cost:
$98,980

Estimated Eligible for HSIP Funding:
$88,600



Summary of Treatments

1. Install retroreflective backplates on all signal heads, all approaches (LRSM ID: S02)
2. Add additional signal head for westbound Alicia Pkwy through movement (LRSM ID: S02)
3. Add SIGNAL AHEAD pavement markings, all approaches
4. Install advanced stop bar before crosswalk (LRSM ID: S20PB)
5. Install High Visibility Crosswalk
6. Install bike push buttons, all intersection corners
7. Add bike crossing markings through intersection
8. Install two-stage left turn bike queue boxes
9. Install green conflict zone marking
10. Add conflict zone markings and convert right turn lane to a combined bike/right turn lane with shared lane markings



N

Scale: 1" = 60'

60 30 0 60

Note

Proposed white pavement markings are shown in black for clarity.

Intersection Treatments
Alicia Parkway / Marguerite Parkway
Mission Viejo, CA

Figure
44

KITTELSON & ASSOCIATES

OLYMPIAD ROAD/MARGUERITE PARKWAY

EXISTING CONDITIONS

Olympiad Road is a four-lane arterial with a striped median, and Marguerite Parkway is a four-lane arterial divided by a raised median. This is a T-intersection, with Olympiad Road terminating at Marguerite Parkway. Marguerite Parkway has a southbound left-turn lane and northbound right-turn lane at the intersection in addition to the through lanes. Olympiad Parkway has two left-turn lanes and one right-turn lane.

This intersection has marked crosswalks across the north leg (crossing Marguerite Parkway) and the east leg (crossing Olympiad Road). There is no marked crosswalk and no pedestrian ramp for the south leg, and a continuous sidewalk is provided for the west side of the T-intersection. Class II bicycle lanes are provided on both Marguerite Parkway and Olympiad Road, with the bicycle lanes terminating prior to the intersection to make room for the right-turn lanes. Bus stops are located along Marguerite Parkway on the northeast and southwest corners of the intersection.

The land use around the intersection is residential dwellings and parks. There is no driveway access located near the intersection.

COLLISION HISTORY

Table 13 provides an overview of this intersection's reported collision history data from January 2016 through December 2020. Collision data show a mix of broadside, rear-end, and hit object collision types at this intersection.

TABLE 13: COLLISION HISTORY (2016 THROUGH 2020), OLYMPIAD ROAD/MARGUERITE PARKWAY

	Total Collisions	Fatal	Severe Injury	Moderate Injury	Minor Injury	Property Damage Only
Olympiad/Marguerite by Severity	16	0	2	4	1	9
	2016	**2017**	**2018**	**2019**	**2020**	
Olympiad/Marguerite by Year	6	4	2	2	2	
	Pedestrian-Involved	**Bicycle-Involved**				
Olympiad/Marguerite by User	0	0				

Source: Kittelson, 2021

RECOMMENDATIONS

Proposed countermeasures are primarily focused on increasing visibility of the traffic signal and lane assignments and improving accommodations for vulnerable roadway users. A design concept for the intersection of Olympiad Road/Marguerite Parkway includes the following safety treatments, as shown in Figure 45:

Install retroreflective backplates on all signal heads, all approaches.

This treatment is intended to address right-angle and rear-end collisions by improving visibility of the signal indications. Eleven of the 16 collisions were either rear-end or broadside collisions. This treatment aligns with the LRSM countermeasure ID S02.

Evaluate extending red clearance intervals for all approaches.

This treatment is intended to provide additional time for vehicles to clear the intersection before the next green indication to address right-angle and rear-end collisions. Eleven of the 16 collisions were either rear-end or broadside collisions. This treatment aligns with the LRSM countermeasure ID S03.

Install advanced stop bar on each approach.

This treatment further separates vehicles from crossing pedestrians. While none of the reported collisions involved a pedestrian, this treatment is an industry best practice for helping to reduce the risk of pedestrians being struck by vehicles. This treatment aligns with LRSM countermeasure ID S20PB.

Restripe pedestrian crossings with high visibility continental pattern or similar.

This treatment improves driver awareness when approaching a crosswalk and encourages pedestrians to cross at the designated locations. While none of the reported collisions involved a pedestrian, this treatment is an industry best practice for helping to reduce the risk of pedestrians being struck by vehicles.

Install bicyclist push buttons at the east side corners of the intersection.

This treatment provides an opportunity for bicyclists to provide the signal indication that they are present and ready to cross. Installation of bicyclist push buttons throughout the city was identified as a priority treatment to better accommodate bicyclists at the signalized intersections.

Install conflict zone markings for the bike lane to right-turn lane transition and pavement markings indicating a shared space for bicyclists within the right-turn lanes.

This treatment provides bicyclists guidance as they approach the intersection and visually alerts drivers as to where to look for/expect bicyclists. This treatment provides information to bicyclists and drivers to help both road users better manage potential conflicts. The existing configuration terminates the bicycle lanes prior to the right-turn lane without further indication of where a bicyclist should be within the roadway. While none of the reported collisions involved a bicyclist, this treatment is an industry best practice for helping to reduce the risk of bicyclists being struck by vehicles.

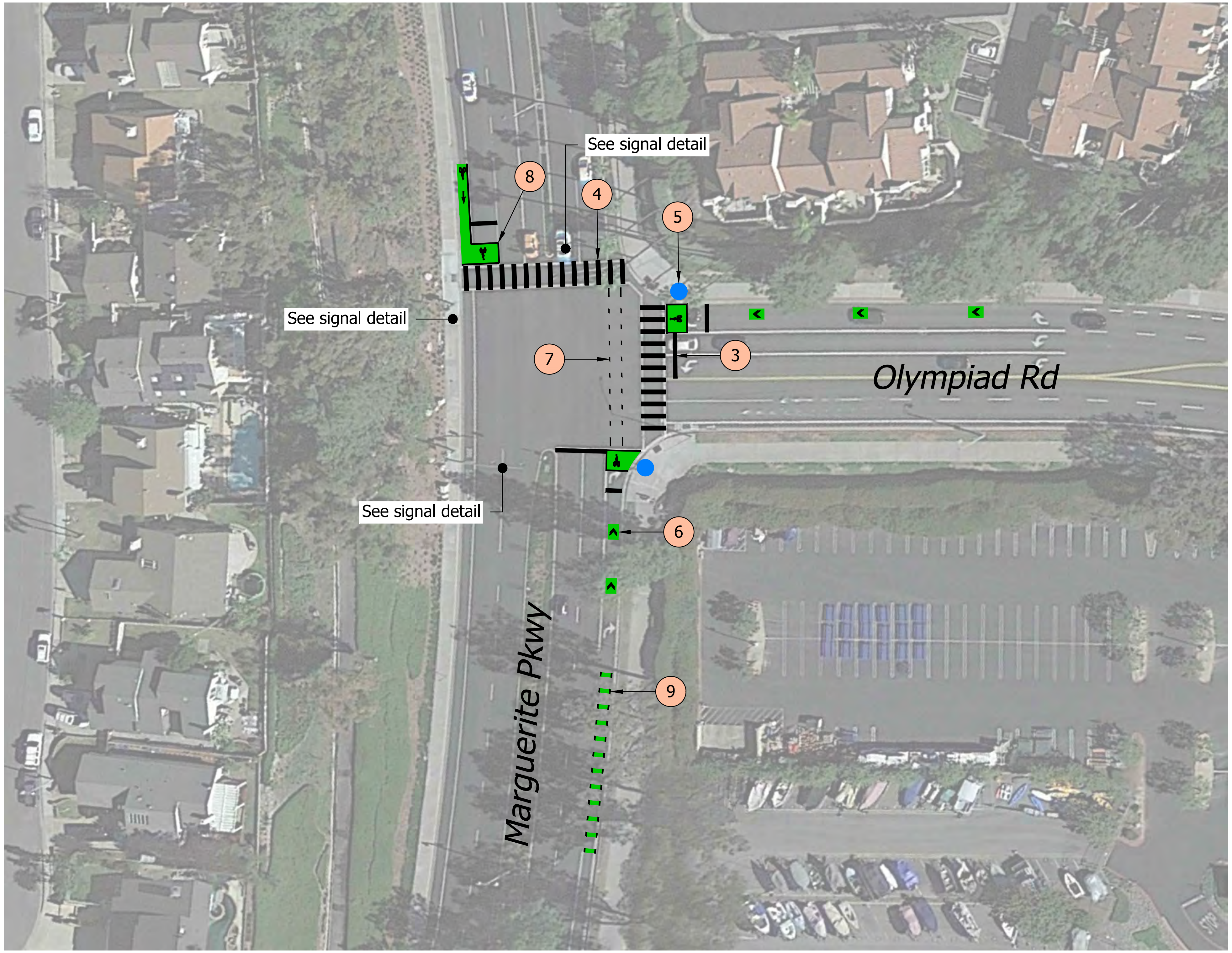
COST ESTIMATE

The total estimated cost for construction of the recommended improvements is shown below. An estimate of the eligible project costs for HSIP funding reimbursement is provided below as well. The estimate is based on the HSIP Cycle 10 guidelines and current funding eligibility percentages. A local match is often required for grant applications, which would be the difference between the two values below or as required by the specific grant.

COST

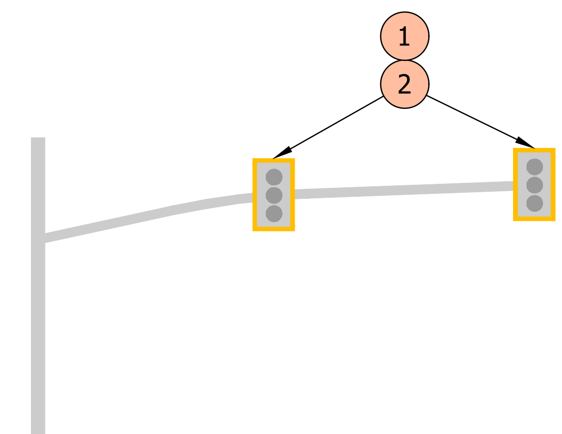
Total Estimated Cost:
$61,600

Estimated Eligible for HSIP Funding:
$48,930



Summary of Treatments

1. Install retroreflective backplates on all signal heads, all approaches (LRSM ID: S02)
2. Evaluate extending red clearance intervals, all approaches (LRSM ID: S03)
3. Install advanced stop bar before crosswalk (LRSM ID: S20PB)
4. Install high visibility crosswalks
5. Install bike push buttons
6. Add conflict zone markings and convert right turn lane to a combined bike/right turn lane with shared lane markings
7. Add bike crossing markings through intersection
8. Install bike boxes
9. Install green conflict zone marking



N

Scale: 1" = 60'

60 30 0 60

Note

Proposed white pavement markings are shown in black for clarity.

Intersection Treatments
Olympiad Road / Marguerite Parkway
Mission Viejo, CA

Figure
45

CROWN VALLEY PARKWAY/DR GUEVARA WAY/ MEDICAL CENTER ROAD

EXISTING CONDITIONS

Crown Valley Parkway is an eight-lane arterial divided by a raised median. Dr Guevara Way is the north leg of the intersection and is a 300-foot long four-lane roadway divided by a raised median before ending at an all-way stop control with La Alameda and access to the Camden Crown Valley apartment complex. Medical Center Road is the south leg of the intersection and is a four-lane arterial divided by a striped median. The intersection has one left-turn lane eastbound and two left-turn lanes westbound on Crown Valley Parkway with shared through-right lanes in each direction. The Dr Guevara Way/Medical Center Road approaches are split-phased.

This intersection has marked crosswalks on three of the four legs. There is no crosswalk on the west leg (crossing Crown Valley Parkway) to accommodate the split phase needed for the lane assignments to meet vehicle demand. There is a curb extension on the northwest corner. Class II bicycle lanes are provided on Crown Valley Parkway. There are no bicycle routes or facilities designated on Dr Guevara Way/Medical Center Road. A bus stop is located along Medical Center Road near the southwest corner of the intersection.

The intersection is surrounded by office and retail buildings to the north and west, and adjacent to a hospital and medical offices to the southeast. There is also primary access to a large retail center – The Shops at Mission Viejo – located at the signalized intersection 600 feet west of this intersection.

COLLISION HISTORY

Table 14 provides an overview of this intersection’s reported collision history data from January 2016 through December 2020. Collision data show improper turning and lane changes as common primary collision factor at this intersection. This indicates that there is potential confusion on lane assignments or vehicles are maneuvering to get to their destination without time to adequately complete the movement.

TABLE 14: COLLISION HISTORY (2016 THROUGH 2020), CROWN VALLEY PARKWAY/DR GUEVARA WAY/MEDICAL CENTER ROAD

	Total Collisions	Fatal	Severe Injury	Moderate Injury	Minor Injury	Property Damage Only
Crown Valley/Dr Guevara/Medical Center by Severity	19	1	1	1	5	11
	2016	**2017**	**2018**	**2019**	**2020**	
Crown Valley/Dr Guevara/Medical Center by Year	4	4	3	5	3	
	Pedestrian-Involved	**Bicycle-Involved**				
Crown Valley/Dr Guevara/Medical Center by User	1	0				

Source: Kittelson, 2021

RECOMMENDATIONS

Proposed countermeasures are primarily focused on increasing visibility of the traffic signal and lane assignments and improving accommodations for vulnerable roadway users.

A design concept for the intersection of Crown Valley Parkway/Dr Guevara Way/Medical Center Road includes the following safety treatments, as shown in Figure 46:

Install retroreflective backplates on all signal heads, all approaches.

This treatment is intended to address right-angle and rear-end collisions by improving visibility of the signal indications. Nine of the 19 collisions were either rear-end or broadside collisions. This treatment aligns with the LRSM countermeasure ID S02.

Evaluate extending red clearance intervals for all approaches.

This treatment is intended to provide additional time for vehicles to clear the intersection before the next green indication to address right-angle and rear-end collisions. Nine of the 19 collisions were either rear-end or broadside collisions. This treatment aligns with the LRSM countermeasure ID S03.

Install advanced stop bar on each approach.

This treatment further separates vehicles from crossing pedestrians. One of the 19 collisions involved a pedestrian. This treatment aligns with LRSM countermeasure ID S20PB.

Restripe pedestrian crossings with high visibility continental pattern or similar.
This treatment improves driver awareness when approaching a crosswalk and encourages pedestrians to cross at the designated locations. One of the 19 collisions involved a pedestrian.

Install bicyclist push buttons at all corners of the intersection.
This treatment provides an opportunity for bicyclists to provide the signal indication that they are present and ready to cross. Installation of bicyclist push buttons throughout the city was identified as a priority treatment to better accommodate bicyclists at the signalized intersections.

Install bicycle lane markings through the intersection.
This treatment directs bicyclists through the intersection to the bike lane on the opposite side of the intersection with dedicated space. While none of the reported collisions involved a bicyclist, this treatment is an industry best practice for helping to reduce the risk of bicyclists being struck by vehicles.

Install green conflict zone markings for the bike lanes as they approach the intersection.
This treatment provides visual indication that the bicycle lane is sharing space with right-turning vehicles as they approach the intersection and visually alerts drivers as to where to look for/expect bicyclists. This treatment provides information to bicyclists and drivers to help both road users better manage potential conflicts. While none of the reported collisions involved a bicyclist, this treatment is an industry best practice for helping to reduce the risk of bicyclists being struck by vehicles.

Install advanced pavement marking arrows on Medical Center Road.
This treatment provides advanced warning of lane assignments to allow vehicles to position in the appropriate lane for their movement prior to reaching the intersection. Six of the 19 collisions were sideswipes.

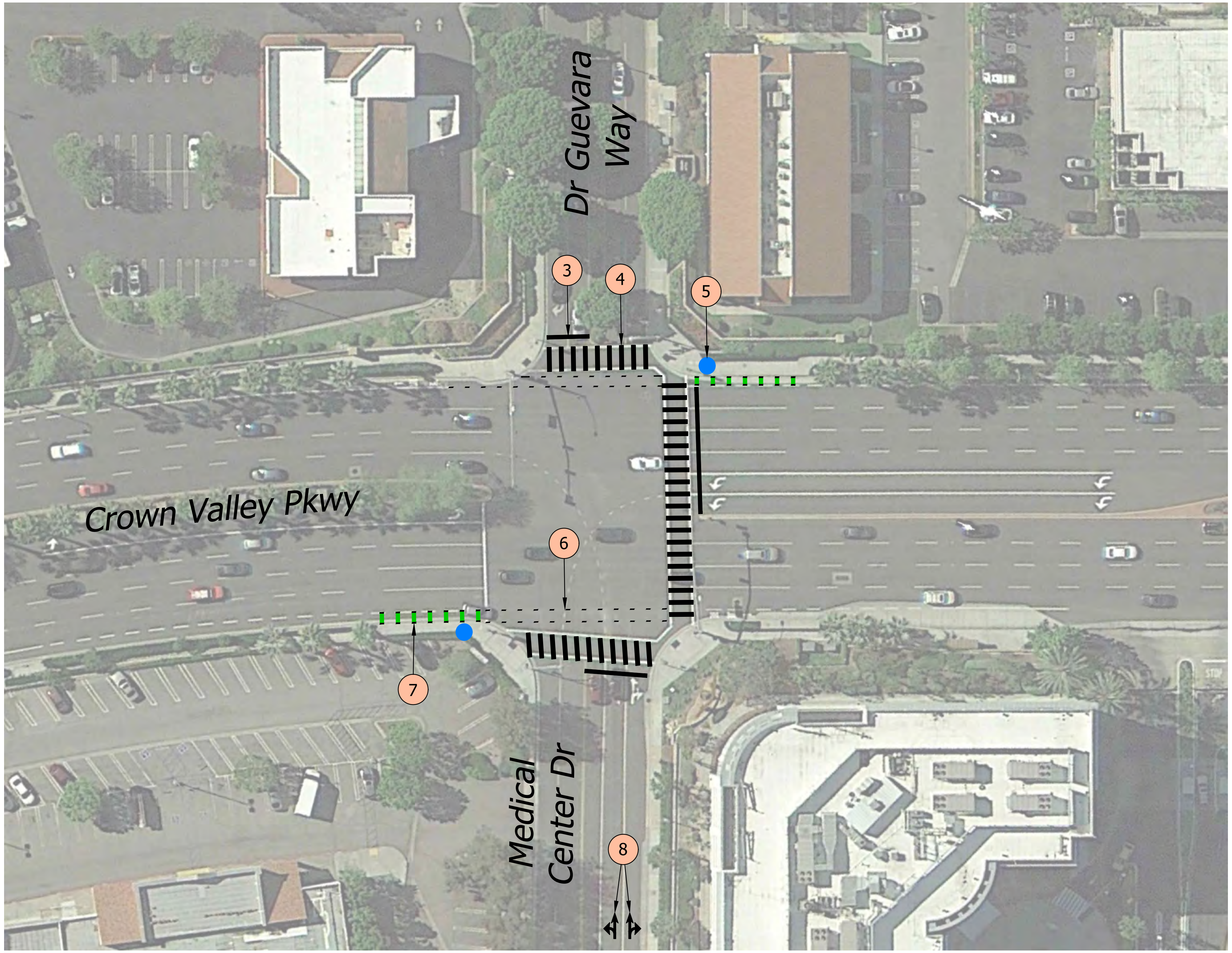
COST ESTIMATE

The total estimated cost for construction of the recommended improvements is shown below. An estimate of the eligible project costs for HSIP funding reimbursement is provided below as well. The estimate is based on the HSIP Cycle 10 guidelines and current funding eligibility percentages. A local match is often required for grant applications, which would be the difference between the two values below or as required by the specific grant.

COST

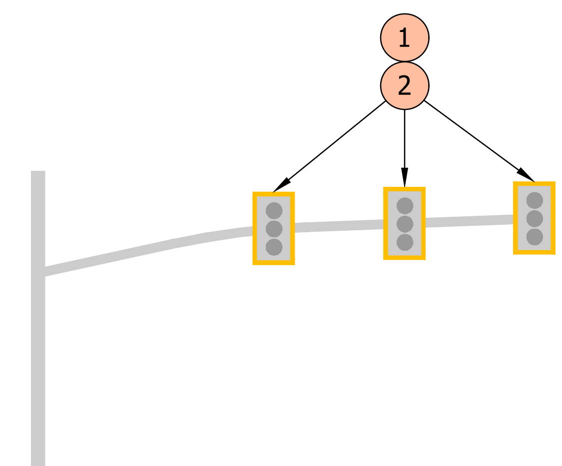
Total Estimated Cost:
$51,530

Estimated Eligible for HSIP Funding:
$49,180



Summary of Treatments

1. Install retroreflective backplates on all signal heads, all approaches (LRSM ID: S02)
2. Evaluate extending yellow and red clearance intervals, all approaches (LRSM ID: S03)
3. Install advanced stop bar before crosswalk (LRSM ID: S20PB)
4. Install High Visibility Crosswalk
5. Install bike push buttons
6. Add bike crossing markings through intersection
7. Install green conflict zone marking
8. Install advanced arrows for northbound approach



Scale: 1" = 60'

60 30 0 60

Note

Proposed white pavement markings are shown in black for clarity.

Intersection Treatments
Crown Valley Parkway / Dr Guevara Way / Medical Center Drive
Mission Viejo, CA

Figure 46

Citywide Systemic Treatments

Based on citywide collision patterns, Kittelson identified the systemic treatments recommended in this section to reduce collision frequency and severity. For each measure, an engineering cost estimate and preliminary design concepts are included for a typical application, as well as locations in the city where the systemic treatment would be most beneficial.

Citywide collision patterns and factors were considered when developing the systemic measures.

KEY COLLISION PATTERNS AND FACTORS

Seventy-eight percent of collisions occurred at intersections, and 22 percent occurred on roadways between intersections.

The top primary collision factors were unsafe speed (20 percent), improper turning (19 percent), traffic signals and signs (13 percent), and driving or bicycling under the influence of alcohol or drugs (13 percent).

The top collision types were broadside (28 percent), rear-end (28 percent), and hit-object (21 percent).

Fourteen percent of fatal and severe injury collisions involved a pedestrian. Eighteen percent of fatal collisions had a primary collision factor of pedestrian violation. This is reported when a pedestrian fails to yield the right-of-way to vehicles.

Fourteen percent of fatal and severe injury collisions had a primary collision factor of automobile right-of-way. This is reported when a driver turning fails to yield the right-of-way to oncoming traffic.

Thirty-five percent of collisions occurred in dark conditions.

Based on citywide collision patterns and contributing factors, the systemic treatments recommended are grouped into the following general categories:

- Speed management
- Intersections
- Intersection approaches
- Roadside conditions

SPEED MANAGEMENT TREATMENTS

Speed management would address several of the collision patterns and factors identified. Lower speeds have been found to reduce the severity of a collision and also provide more time for road users to react to avoid a collision. Measures to reduce speeds would be most applicable to arterial roadways in the city where speeds and volumes are highest. Mitigation measures to help lower vehicle speeds include:

REDUCING THE NUMBER OF VEHICLE LANES

These projects are sometimes referred to as “road diet” or “roadway reconfiguration” projects. They remove vehicle through lanes and reallocate that space for enhanced pedestrian and/or bicycle facilities. This is a potential systemic measure the City could consider for large multilane arterials, such as Crown Valley Parkway, Felipe Road, Jeronimo Road, Los Alisos Boulevard, Melinda Road, Muirlands Boulevard, Olympiad Road, Santa Margarita Parkway, and Trabuco Road. Removing vehicle lanes can increase travel time for motorists during peak travel periods of the day; however, they have been found to consistently reduce the occurrence of collisions by approximately 30 percent (HSM, 2010). Slowing vehicle speeds also helps reduce the severity of collisions that do occur.

They are particularly effective where, for the majority of the hours of the day, the multiple vehicle lanes are not needed to accommodate the traffic volume. Reducing the number of vehicle through lanes would help reduce vehicle speeds in peak and off-peak travel periods, thereby helping to reduce collisions associated with “unsafe speed.” It would also help deter and reduce the occurrence of “road shows” and “street racing” which has been consistently brought up by city stakeholders and local law enforcement as a concern and challenge. Preliminary discussion on feasibility of removing travel lanes is provided in Appendix E. An engineering study is needed to assess the trade-offs associated with reducing the number of vehicle lanes on a roadway as well as to inform the preferred design features of such a project.

NARROWING THE WIDTH OF VEHICLE LANES

Where it is necessary to maintain the number of vehicle lanes on a roadway, reducing the painted width of those vehicle lanes can help manage vehicle speeds. The paved width of the street would remain the same. The painted width of lane would narrow to approximately 11 feet. This visually narrows the lane for motorists and naturally causes drivers to slow their speed. The resulting remaining roadway width can be used to paint a buffer adjacent to bicycle lanes or, if on-street parking is present, a buffer adjacent to the parking lane; in both instances, the painted buffer provides visual separation between moving vehicles and either bicyclists or parked vehicles.

REMOVING ACCELERATION LANES FOR TURN MOVEMENTS ONTO ARTERIAL STREETS

Several of the larger, multilane streets within the city include painted acceleration lanes for left-turn movements from minor streets onto the major street at unsignalized intersections. Figure 47 is an example of such an acceleration lane on Jeronimo Road. They are also frequently seen on Felipe Road. These acceleration lanes set an expectation of higher speeds on the multilane streets and may work against efforts to slow vehicle speeds to reduce collision risk. In conjunction with other speed management treatments, it may benefit the city to remove those acceleration lanes and replace them with two-way left-turn lanes or raised medians.

ADDING RAISED MEDIANS WITH LANDSCAPING

Raised medians with landscaping separating opposing directions of traffic can help manage vehicle speeds by visually narrowing the roadway for motorists and also add visual cues that naturally cause the human eye to detect travel speed and therefore, slow down. Humans use peripheral vision to judge speed (HSM, 2010). By placing vertical elements in the peripheral vision of motorists, it naturally slows motorists' speeds.

FIGURE 47: EXAMPLE ACCELERATION LANE: JERONIMO ROAD/ARBOLITOS

SOURCE: GOOGLE EARTH

AT PEDESTRIAN CROSSINGS, IMPLEMENTING PEDESTRIAN CROSSING REFUGE ISLANDS AND FLASHING BEACONS

Where there are marked pedestrian crossings across more than two vehicle lanes, use raised pedestrian crossing refuge islands and flashing beacons to increase the visibility of the crossing, slow vehicle speeds, and help increase the likelihood of motorists yielding to pedestrians waiting to cross or those in the crosswalk.

USING SPEED TRAILERS AND OTHER ENFORCEMENT STRATEGIES

Use portable speed trailers (or permanent speed feedback signs) to inform motorists of their speeds relative to the posted speed limit. This can be supplemented with enforcement and/or education efforts to then give warnings or citations to motorists exceeding the speed limit. Such treatments tend to have limited lasting effect on speeds as motorists tend to trend back to higher speeds when the trailers or enforcement is not evident.

REDUCE SPEED LIMITS

The severity of a collision has a direct correlation with the speed of the motor vehicle(s) involved. Reducing vehicle speeds through speed limit changes can be effective with corresponding enforcement. Currently, speed limits are set based on the 85th percentile speed of vehicles traveling on the roadway. With some of the other strategies recommended in this report, vehicle travel speeds on some corridors may be reduced, and the 85th percentile speed could drop to allow for reduced speed limits. Future legislation changes are being considered to modify the approach to setting speed limits to allow flexibility away from basing speed limits on the 85th percentile speed. Opportunities to post lower speed limits when feasible and applicable should be considered.

The following further discusses the use of speed trailers to potentially manage vehicle speeds. Speed trailer use is of particular interest to the city. Additional potential enforcement strategies are discussed later in this report under “Non-Engineering Mitigation Measures” section.

As noted above, portable speed trailers are another type of enforcement tool that visually display a driver’s real-time speed compared to the speed limit and may be effective at reducing speeds and increasing awareness of local speed limits. Portable speed trailers are most effective when the trailer flashes “SLOW DOWN” or flashes a bright white light that mimics a photo speed camera or a blue and red light that mimics a police car when drivers are moving too fast. In some cases, back-up speed enforcement by officers may be needed when radar speed trailers are used. If a driver fails to slow when the sign tells them that they are violating the law, an officer may stop the driver.

Figure 48 and Figure 49 illustrate recommended locations for implementing systemic speed management measures. These locations were selected by reviewing roadway segments that have multiple lanes and longer signal spacing. The locations where these measures are implemented should be rotated regularly to avoid driver complacency of adhering to the speed indicators.

TABLE 15: SPEED MANAGEMENT MEASURES

Measure	Potential Locations	Typical Cost	Implementation Strategy
Install dynamic regulatory speed warning signs	Alicia Parkway, Felipe Road/Olympiad Road, and Marguerite Parkway. See Figure 48 and Figure 49 for recommended locations.	$2,000 - $11,000 per sign	Utilize at least 6 signs to cover both directions on each of the 3 corridors. Relocate the sign along the arterial corridor via street light poles or movable pole to pre-constructed foundations.
Install speed radar trailers	El Toro Road, Jeronimo Road, La Paz Road, Los Alisos Boulevard, Melinda Road, and Trabuco Road. See Figure 48 and Figure 49 for recommended locations.	$8,000 - $14,000 per trailer	12 total locations identified. Utilize at least 4 trailers and rotate location every 3-4 months.
Reducing the number of vehicle lanes (Road Diet)	Large multilane arterials such as Jeronimo Road, Marguerite Parkway, Alicia Parkway, and Oso Parkway.	Varies	Evaluate daily traffic volume patterns to identify opportunities and assess trade-offs of reducing the travel lanes
Narrowing the width of vehicle lanes	Arterials and collectors	Varies	Consider restriping during regular pavement maintenance
Removing acceleration lanes for turn movements	Arterials	$15 - $40 per square foot	Replace existing acceleration lanes with raised median or two-way left-turn lanes
Add raised medians with landscaping	Arterials and collectors	$20 - $40 per square foot	Inventory roadways with striped median and evaluate potential for raised median
Reducing speed limits	Residential and arterial, could apply to all streets	$500 per sign	Requires policy and City code changes

Figure 48: Systemic Speed Management Approach (North Area)

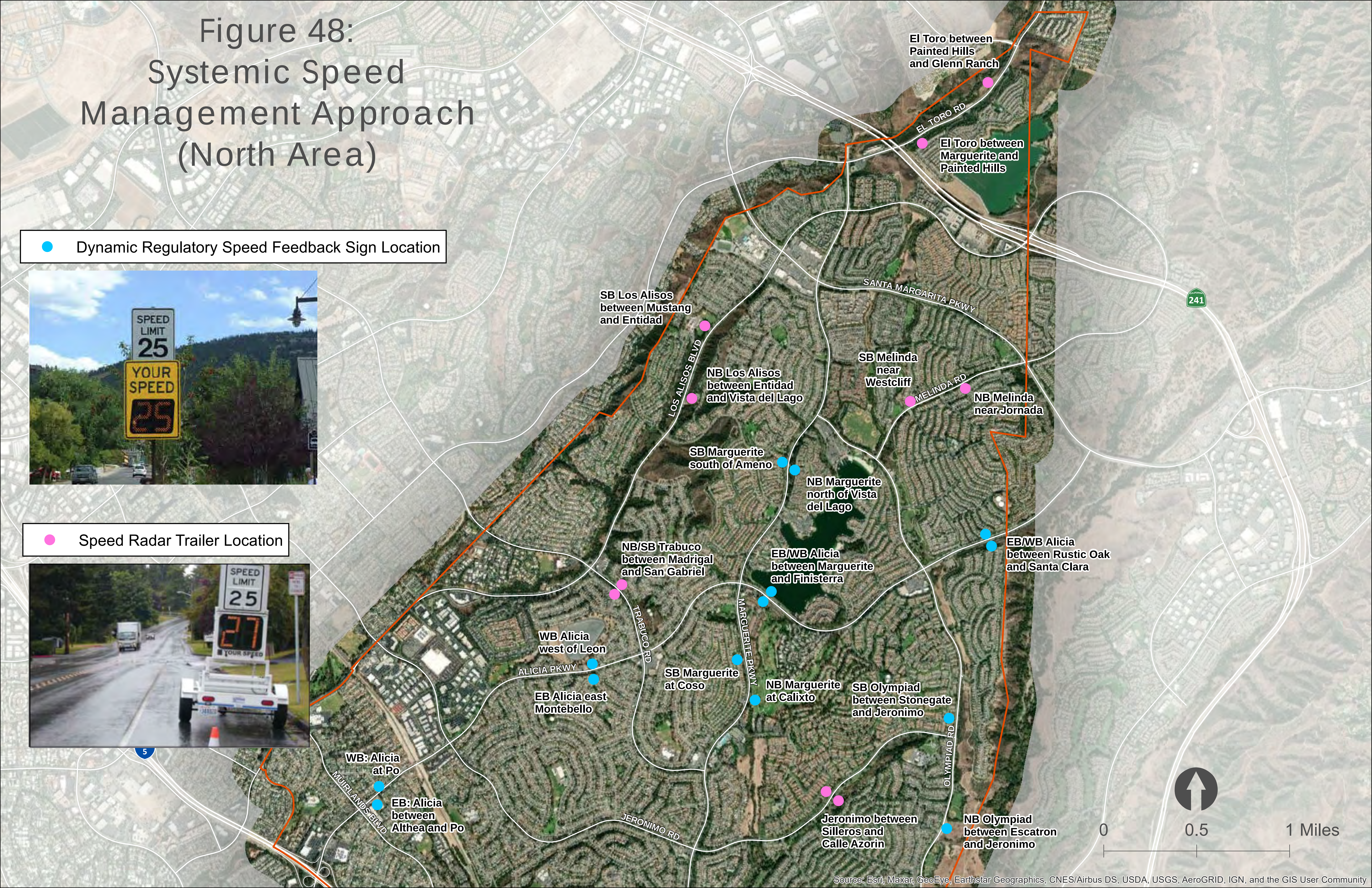
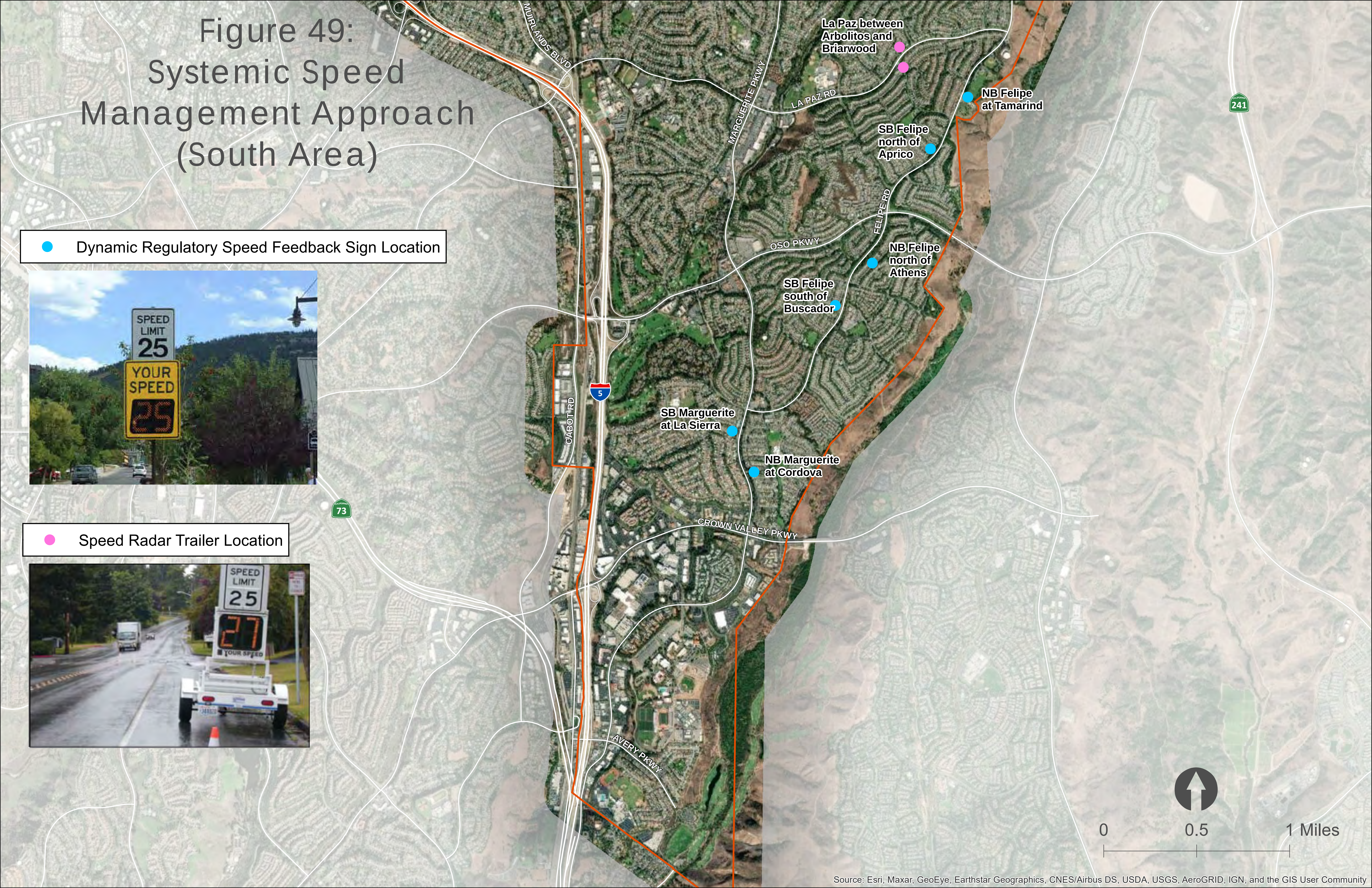


Figure 49: Systemic Speed Management Approach (South Area)



INTERSECTION TREATMENTS

Intersections are the primary location of collisions in the city because of Mission Viejo's urban setting. It is estimated that there are over 110 signalized intersections and over 1,600 unsignalized intersections in the city's roadway network. Measures to modify existing intersections with low-cost solutions can help reduce potential future collisions at all locations, even where there may not be collision history.

TABLE 16: INTERSECTION MODIFICATIONS

Measure	Potential Locations	Typical Cost	Implementation Strategy
Install retroreflective backplates	All signalized intersections	$6,000 - $12,000 per intersection	Update design policies so that retroreflective backplates are recommended or required for new construction. Add retroreflective traffic signal heads to existing locations.
Add signal heads to roadways with multiple lanes	Arterial corridors	$1,000 - $2,000 per head* *Mast arm upgrades would affect cost	Update design policies so that new signals have additional heads. Add additional traffic signal heads to existing locations.
Install/Upgrade signs with fluorescent sheeting	All Regulatory, Warning, and Guide Signs	$500 per sign	Utilize roadway maintenance programs to inventory and replace signs as needed.
Provide advanced dilemma-zone detection for high speed approaches	Signalized intersections along arterial corridors	$5,000 - $25,000 per approach	Review signal coordination plans and identify opportunities for phased integration
Restrict right turns on red	Areas with high pedestrian volumes, where children are present (near schools, parks), or where collision history or cross-street queues indicate benefit	$500 - $5,000 per approach	Identify areas with high pedestrian volumes. Consider pairing with a dynamic blank-out sign that is only activated when a pedestrian push button is activated.

Measure	Potential Locations	Typical Cost	Implementation Strategy
Install pedestrian refuge islands to provide slower pedestrians a place to stop on longer crossings	Signalized intersections with a raised median	Varies	Identify signalized intersections with raised medians and high pedestrian activity near senior centers, schools, parks, and community centers.
Convert control type to roundabout	Intersections	Varies (high cost improvement)	Further study to identify locations with highest probability of benefiting from a roundabout

INTERSECTION APPROACH TREATMENTS

Intersection approaches should limit distractions and additional movements to keep driver attention on the upcoming intersection. Measures to modify conflicts near intersections would be most applicable to signalized intersections and roadways near retail centers.

TABLE 17: INTERSECTION APPROACH MODIFICATIONS

Measure	Potential Locations	Typical Cost	Implementation Strategy
Restrict cross-median access	Approaches to signalized intersections with driveways within 250 feet or high risk for potential conflicts	Varies	Guide new development to restrict cross-median access on intersection approaches. Identify potential existing locations with high collision history that may be resolved with a raised median or median restrictions.
Eliminate parking adjacent to intersection	All intersections	$2,000 - $4,000 per approach	Inventory parking within 250 feet of intersection limit lines and evaluate sight distance and collision history. Coordinate with adjacent landowners on need for on-street parking.

ROADSIDE CONDITIONS TREATMENTS

Roadside conditions can create potential hazards for errant vehicles leaving the roadway. Measures to improve roadside conditions would be most applicable on roadways with a speed limit of 30 miles per hour or greater.

TABLE 18: ROADSIDE MODIFICATIONS

Measure	Potential Locations	Typical Cost	Implementation Strategy
Relocate fixed objects within clear zone	Roadways with a speed limit of 30 mph or greater	$200 - $10,000 per object	Start with locations where hit-object collisions have occurred in the past and extend to similar roadside condition locations.
Roadway street lighting	Approaches to signalized intersections with driveways within 250 feet or high risk for potential conflicts	$7,000 - $10,000 per light* *Maintenance and electrical costs are needed after installation	Inventory existing streetlights and compare against collision history to determine areas with missing or poor lighting conditions.

Citywide Signalized Pedestrian Mitigation Measures

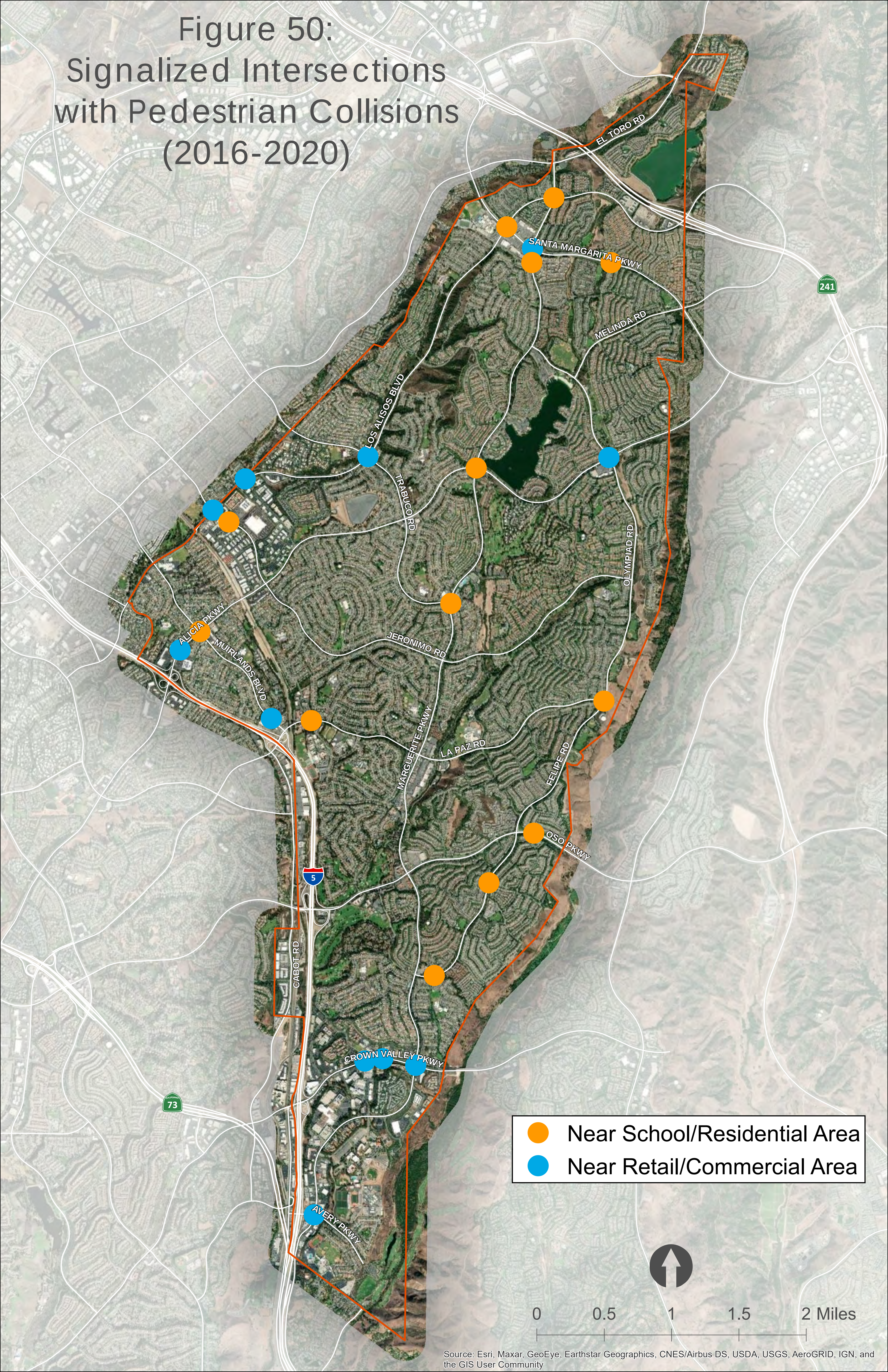
Based on a review of signalized intersections with pedestrian collisions, Kittelson identified signalized pedestrian countermeasures and preliminary design concepts for two types of intersections:

Type 1: Three- or four-legged intersections on an arterial roadway near a retail/commercial area

Type 2: Three- or four-legged intersections on an arterial roadway near a school or residential area

For each intersection type, a set of recommended improvements and a preliminary design concept for the typical application of these measures were developed for one example intersection. The typical application could then be translated and applied to similar intersections in that category. Signalized intersections that experienced at least one or more pedestrian collisions are shown in Figure 50, which also includes the corresponding treatment set type and design concept.

Figure 50: Signalized Intersections with Pedestrian Collisions (2016-2020)



TYPE 1: SIGNALIZED INTERSECTIONS ON ARTERIAL ROADWAY NEAR RETAIL/COMMERCIAL AREA

EXAMPLE LOCATION: ALICIA PARKWAY/CHARLINDA DRIVE

Alicia Parkway/Charlinda Drive is a four-legged signalized intersection in the city that experienced four pedestrian collisions between 2016 and 2020. Alicia Parkway is a seven-lane roadway with four lanes southbound and three lanes in the northbound direction divided by a raised median. Charlinda Drive is a minor roadway with one lane in each direction. Dedicated left turns are provided on all intersection approaches, and dedicated right turns are provided on both minor street intersection approaches.

Marked crosswalks are provided on all four legs, and sidewalk is provided on all four corners as well. Two bus stops are located on the north leg of Alicia Parkway, one in each direction. This intersection is upstream of the entrance and exit ramps to Interstate 5. The land uses surrounding this intersection are retail and commercial on the south side of the intersection and residential on the immediate north side of the intersection.

Four pedestrian collisions took place at this intersection during the study period – two of them resulted in other visible injury and the other two resulted in complaint of pain injury. Two of the four pedestrian collisions occurred at night.

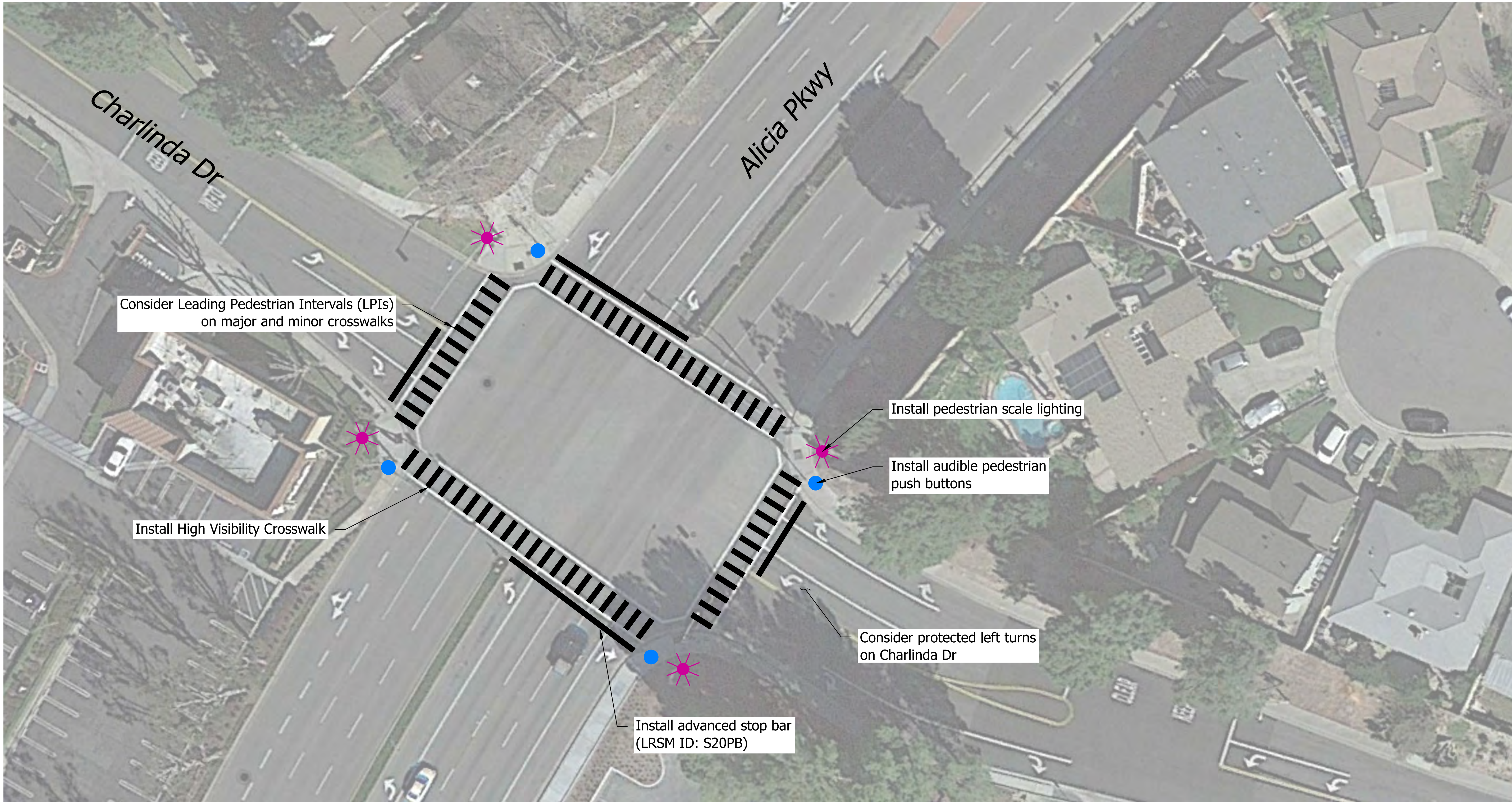
RECOMMENDATIONS

A design concept for the intersection of Alicia Parkway/Charlinda Drive includes the following treatments, as shown in Figure 51:

- Install audible pedestrian push buttons at all corners of the intersection.
- Install advanced stop bar on each approach.
- Install pedestrian scale lighting.
- Install/upgrade existing crosswalk to high visibility crosswalk.
- Consider changing signal timing to provide protected left turns on Charlinda Drive.
- Consider LPIs on major and minor crosswalk approaches.

COST

Cost Estimate: $205,400



N

Scale: 1" = 40'

40 20 0 40

Note

Proposed white pavement markings are shown in black for clarity.

Pedestrian Treatments
Signalized Intersection Near Commercial
Mission Viejo, CA

Figure
51

APPLICABLE SIGNALIZED INTERSECTIONS

Proposed pedestrian countermeasures at a signalized intersection near commercial/retail areas include: upgrading the existing crosswalk to high visibility crosswalk; installing pedestrian scale lighting to increase driver awareness of the crosswalk and pedestrian presence; installing advanced stop bar before crosswalk; installing audible pedestrian push buttons (if not already present); considering changing signal timing to providing protected left-turns on the minor street; and considering leading pedestrian intervals (LPIs) on both major and minor crosswalks. Collectively these countermeasures are focused on reducing the risk or likelihood of collisions between vehicles and pedestrian occurring.

These recommendations as applied in the design concept are applicable for three-legged or four-legged signalized intersections near commercial or retail areas. The following are applicable locations which experienced pedestrian collisions during the 2016-2020 period.

TABLE 19: SIGNALIZED INTERSECTIONS ON ARTERIAL ROADWAY NEAR COMMERCIAL AREAS WITH PEDESTRIAN COLLISIONS (2016– 2020)

Intersection	Ped Collision Severity	Primary Collision Factor	Collision Type/ Pedestrian Action	Lighting Condition	Additional Considerations
Marguerite Pkwy/Santa Margarita Pkwy	Complaint of Pain	Other Hazardous Violation	Vehicle-Pedestrian/Crossing in Crosswalk at Intersection	Daylight	
Los Alisos Blvd/Trabuco Rd	Property Damage Only	Pedestrian Right-of-Way	Vehicle-Pedestrian/Not Stated	Daylight	
Los Alisos Blvd /Jeronimo Rd	Complaint of Pain	Unknown	Vehicle-Pedestrian/Crossing in Crosswalk at Intersection	Daylight	
Alicia Pkwy/ Charlinda Dr	Other Visible Injury (2), Complaint of Pain (2)	Pedestrian Right-of-Way (3), Unknown (1)	Vehicle-Pedestrian/Crossing in Crosswalk at Intersection	Daylight (2), Dark-Street Lights (2)	

Intersection	Ped Collision Severity	Primary Collision Factor	Collision Type/ Pedestrian Action	Lighting Condition	Additional Considerations
Muirlands Blvd/Robin Cir	Other Visible Injury	Unknown	Vehicle-Pedestrian/Crossing in Crosswalk at Intersection	Daylight	Install high visibility crosswalk on the South-eastern intersection approach where there is none currently
Crown Valley Pkwy/ Bellogente	Severe Injury	Pedestrian Right-of-Way	Vehicle-Pedestrian/Crossing in Crosswalk at Intersection	Dark-Street Lights	
Crown Valley Pkwy/ Marguerite Pkwy	Other Visible Injury	Pedestrian Violation	Vehicle-Pedestrian/Crossing Not in Crosswalk	Dark-Street Lights	
Alicia Pkwy/ Olympiad Rd	Complaint of Pain	Unknown	Vehicle-Pedestrian/Crossing in Crosswalk at Intersection	Daylight	
Los Alisos Blvd /Madero	Severe Injury	Pedestrian Right-of-Way	Vehicle-Pedestrian/Crossing in Crosswalk at Intersection	Dark-Street Lights	Install high visibility crosswalk on the western intersection approach where there is none currently
Crown Valley Pkwy/Los Altos	Severe Injury	Other Improper Driving	Vehicle-Pedestrian/Not in Road	Daylight	Install high visibility crosswalk on the western intersection approach where there is none currently
Marguerite Pkwy/Avery Pkwy	Property Damage Only	Unknown	Vehicle-Pedestrian/Crossing Not in Crosswalk	Dark-Street Lights	

TYPE 2: SIGNALIZED INTERSECTIONS ON ARTERIAL ROADWAY NEAR SCHOOL/RESIDENTIAL AREA

EXAMPLE LOCATION: FELIPE ROAD/BUSCADOR

Felipe Road/Buscador is a signalized intersection in the city that experienced one pedestrian collision between 2016 and 2020. Felipe Road is a four-lane divided roadway and Buscador is a minor roadway with one lane in each direction. Dedicated left turns are provided for northbound and southbound traffic on Felipe Road and exclusive right-turn lanes are provided for east and westbound traffic on Buscador.

Marked crosswalks are provided on all four legs, and sidewalk is provided on all four corners of the intersection as well. The land use surrounding this intersection is residential, and Bathgate Elementary School is located approximately 700 feet south of the intersection. During the study period, one pedestrian collision took place at this intersection, resulting in a severe injury.

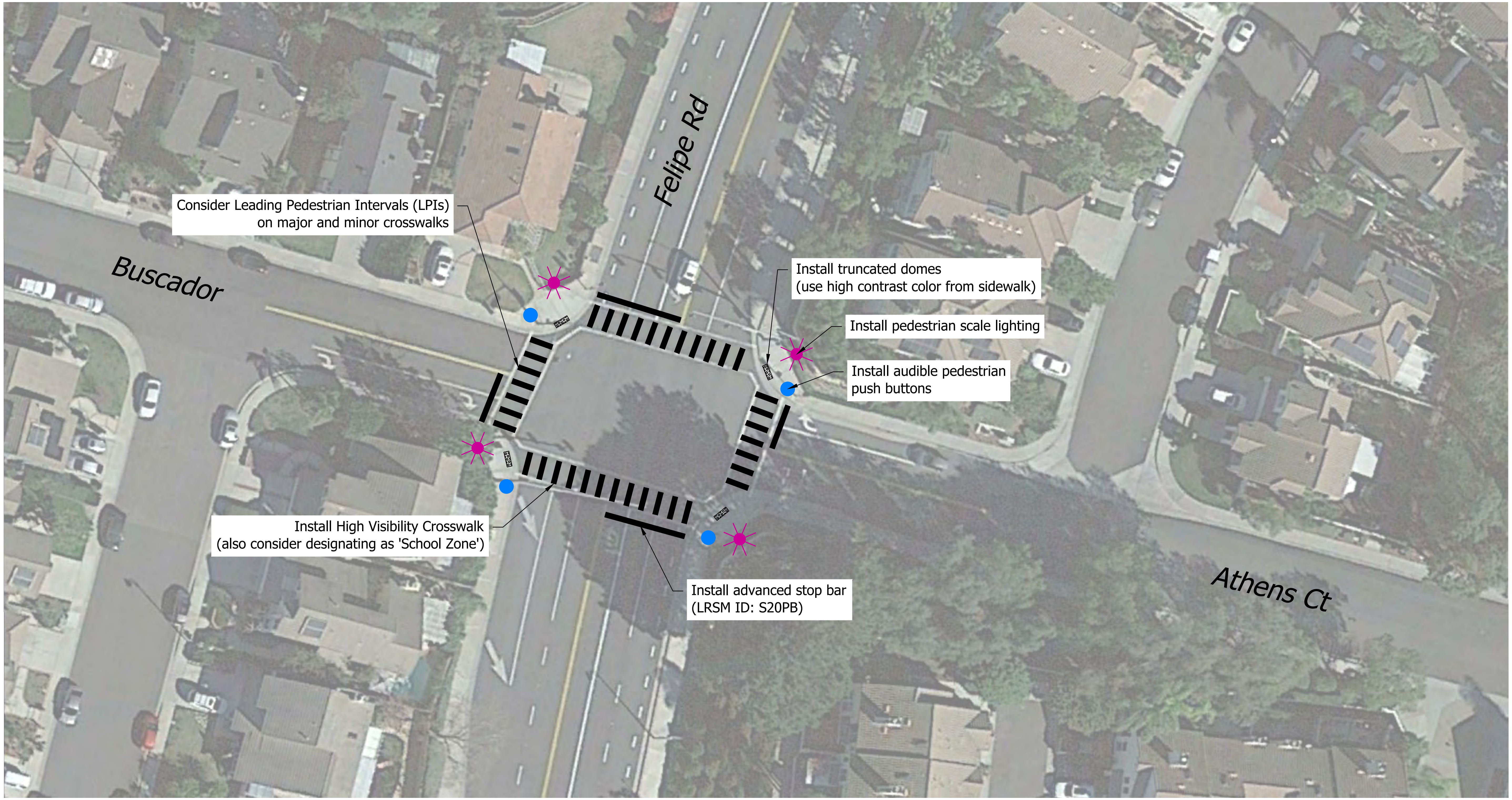
RECOMMENDATIONS

A design concept for the intersection of Felipe Road/Buscador includes the following treatments, as shown in Figure 52:

- Install audible pedestrian push buttons at all corners of the intersection.
- Install advanced stop bar on each approach.
- Install pedestrian scale lighting.
- Install/upgrade existing crosswalk to high visibility crosswalk. (Also, consider marking it as 'School Zone' where necessary.)
- Install truncated domes at all corners of the intersection (using a high contrast color from sidewalk).
- Consider LPIs on major and minor crosswalk approaches.

COST

Cost Estimate: $195,000



Note

Proposed white pavement markings are shown in black for clarity.

Pedestrian Treatments
Signalized Intersection Near Residential / School
Mission Viejo, CA

Figure 52

APPLICABLE SIGNALIZED INTERSECTIONS

Proposed countermeasures at a signalized intersection near a school or residential areas include upgrading the existing crosswalk to high visibility crosswalk and consider marking this crosswalk as ‘School Zone’; installing pedestrian scale lighting to increase driver awareness of the crosswalk and pedestrian presence; installing advanced stop bar before crosswalk; installing audible pedestrian push buttons (if not already present); installing truncated domes on all intersection corners using a high contrast color from sidewalk; and considering leading pedestrian intervals (LPIs) on both major and minor crosswalks to reduce the risk or likelihood of collisions between vehicles and pedestrians from occurring.

These recommendations as applied in the design concept are applicable for three-legged or four-legged signalized intersections near school and/or residential areas. The following are applicable locations which experienced pedestrian collisions during the 2016-2020 period.

TABLE 20: SIGNALIZED INTERSECTIONS ON ARTERIAL ROADWAY NEAR SCHOOL OR RESIDENTIAL AREAS WITH PEDESTRIAN COLLISIONS (2016 - 2020)

Intersection	Ped Collision Severity	Primary Collision Factor	Collision Type/ Pedestrian Action	Lighting Condition	Additional Considerations
Marguerite Pkwy/Los Alisos Blvd	Other Visible Injury	Pedestrian Right-of-Way	Vehicle-Pedestrian/Crossing in Crosswalk at Intersection	Daylight	
Marguerite Pkwy/Mustang Run	Complaint of Pain	Pedestrian Right-of-Way	Vehicle-Pedestrian/Crossing in Crosswalk at Intersection	Daylight	Install high visibility crosswalk on the northern intersection approach where there is none currently
Santa Margarita Pkwy/ Monterey	Severe Injury	Unsafe Speed	Vehicle-Pedestrian/Crossing in Crosswalk at Intersection	Daylight	Install high visibility crosswalk on the eastern intersection approach where there is none currently
Marguerite Pkwy/Alicia Pkwy	Other Visible Injury	Pedestrian Violation	Vehicle-Pedestrian/Crossing in Crosswalk at Intersection	Dark-Street Lights	

Intersection	Ped Collision Severity	Primary Collision Factor	Collision Type/ Pedestrian Action	Lighting Condition	Additional Considerations
Jeronimo Rd/ Peter A Hartman Way	Other Visible Injury, Complaint of Pain	Traffic Signals and Signs, Pedestrian Violation	Vehicle-Pedestrian/Crossing in Crosswalk at Intersection	Daylight	
Alicia Pkwy/ Muirlands Blvd	Complaint of Pain	Unknown	Vehicle-Pedestrian/Crossing in Crosswalk at Intersection	Daylight	
Oso Pkwy /San Rafael	Severe Injury	Unknown	Vehicle-Pedestrian/In Road, including shoulder	Dark-Street Lights	
Felipe Rd/ Buscador	Severe Injury	Pedestrian Right-of-Way	Vehicle-Pedestrian/Crossing in Crosswalk at Intersection	Daylight	
Felipe Rd/El Retiro	Severe Injury	Pedestrian Right-of-Way	Vehicle-Pedestrian/Crossing in Crosswalk at Intersection	Daylight	
Los Alisos Blvd /Santa Margarita Pkwy	Complaint of Pain	Improper Turning	Hit Object/Not in Road	Daylight	
Marguerite Pkwy/ Trabuco Rd	Complaint of Pain	Unknown	Vehicle-Pedestrian/Crossing in Crosswalk at Intersection	Dark-Street Lights	
Felipe Rd/La Paz Rd	Complaint of Pain	Pedestrian Right-of-Way	Vehicle-Pedestrian/Crossing in Crosswalk at Intersection	Daylight	
La Paz Rd/ Chrisanta Dr	Other Visible Injury	Pedestrian Right-of-Way	Vehicle-Pedestrian/Crossing Not in Crosswalk	Daylight	

Citywide Signalized Bicycle Mitigation Measures

Based on a review of signalized intersections in Mission Viejo that experienced at least one bicycle collision, Kittelson developed intersection measures and preliminary design concepts for three types of intersections:

Type 1: Four-legged intersections

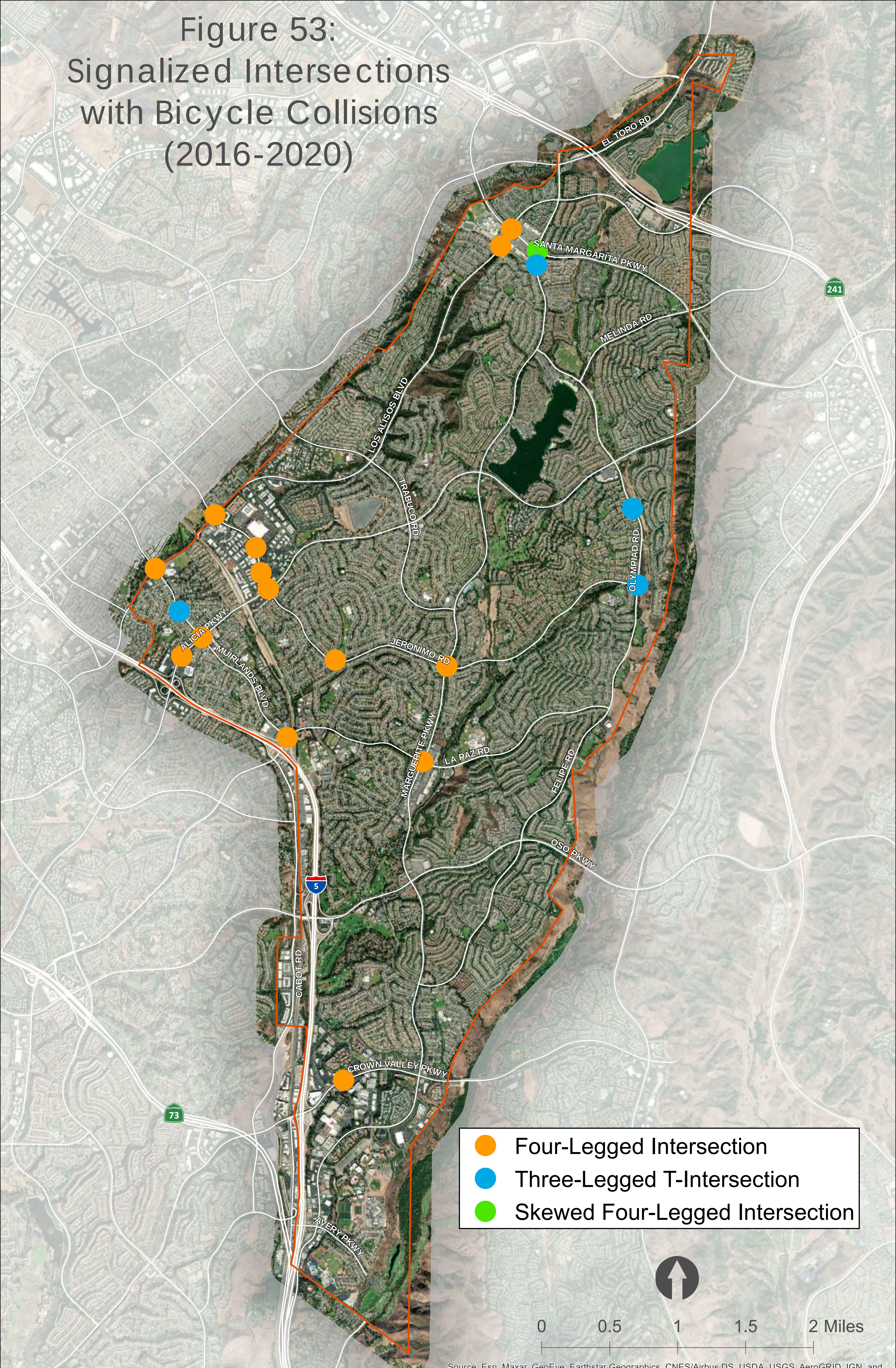
Type 2: Three-legged T-intersections

Type 3: Skewed four-legged intersections

For each intersection type, a set of recommended improvements and a preliminary design concept for the typical application of these measures were developed for one example intersection. The typical application could then be translated and applied to similar intersections in that category.

Signalized intersections which experienced at least one bicycle collision are shown in Figure 53, which also includes the corresponding treatment set type and design concept.

Figure 53: Signalized Intersections with Bicycle Collisions (2016-2020)



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

TYPE 1: FOUR-LEGGED SIGNALIZED INTERSECTION

EXAMPLE LOCATION: MARGUERITE PARKWAY/LA PAZ ROAD

Marguerite Parkway/La Paz Road is one of the typical four-legged signalized intersections in the city that experienced a bicycle collision between 2016 and 2020. Marguerite Parkway and La Paz Road are four-lane arterial roads divided by raised medians. Two left-turn lanes are provided at all four approaches. Dedicated right-turn lanes are provided at Marguerite Parkway's southbound approach and La Paz Road's eastbound approach.

Marked crosswalks are provided on all four legs, and Class II bicycle lanes are provided in all four directions. However, bike lanes are not provided on Marguerite Parkway at the intersection departures. Where dedicated right-turn lanes are provided, pocket bike lanes are not provided and bicyclists must share the right turn lane with vehicles. In addition, the bike lanes at this intersection are dashed at several locations (e.g., intersection and driveway approaches). There is a bus stop with a bus pad on Marguerite Parkway immediately south of the intersection.

The land uses around this intersection are primarily retail and commercial. The Mission Viejo library is located in the southwestern quadrant, next to the bus stop on Marguerite Parkway.

One bicycle collision took place at this intersection during the study period; the collision took place in 2018 and resulted in a severe injury. The bicyclist was traveling the wrong way and collided with a vehicle that was proceeding straight.

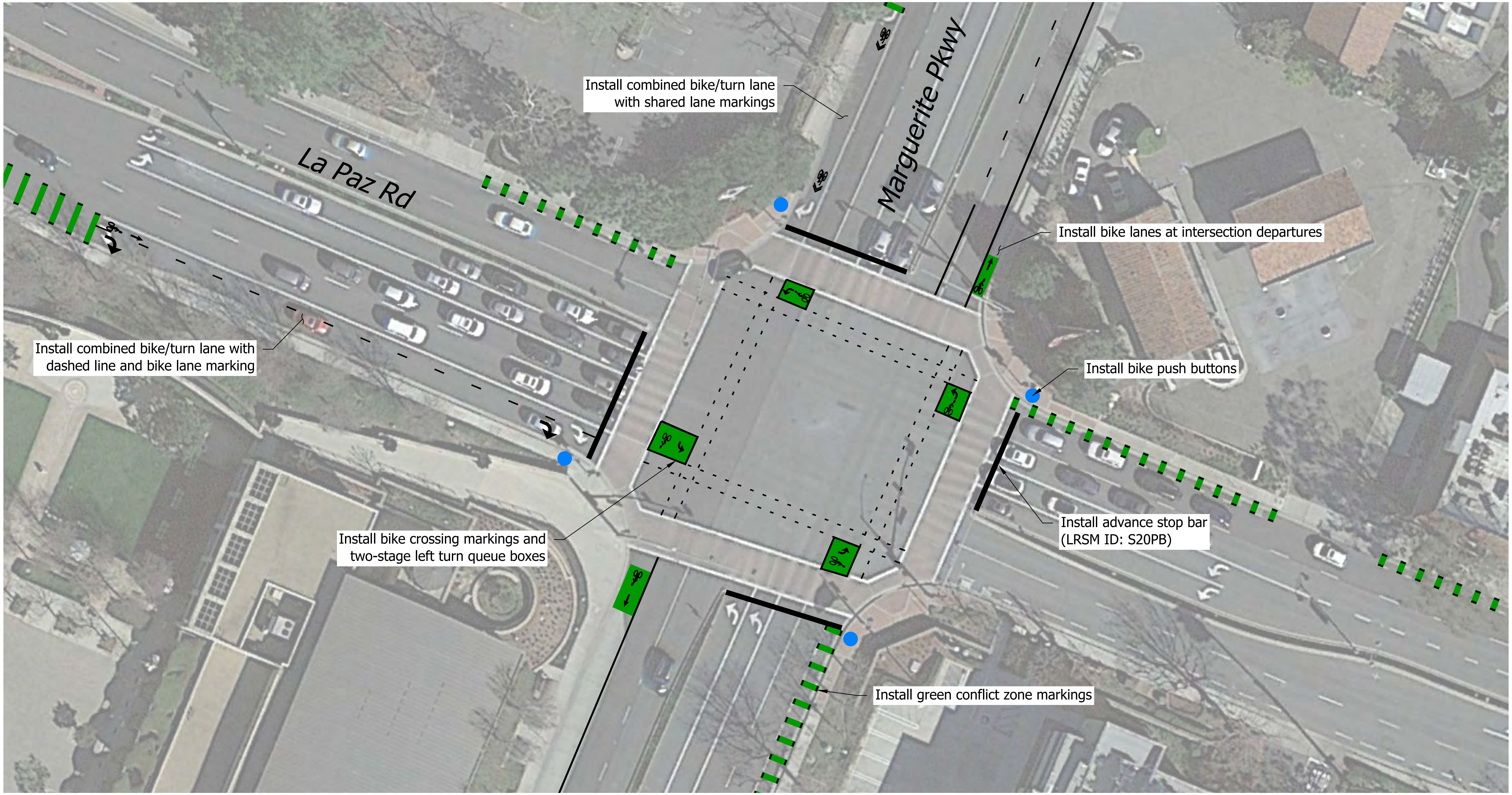
RECOMMENDATIONS

A design concept for the intersection of Marguerite Parkway/La Paz Road includes the following treatments, as shown in Figure 54:

- Install bicyclist push buttons at all corners of the intersection.
- Install advanced stop bar on each approach.
- Install bicycle scale lighting.
- Install green conflict zone markings at conflict zones. This includes the bike lane to right-turn lane transition as well as locations with dashed bike lanes.
- In place of dedicated right turn lanes, add pavement markings to indicate that bicyclists can also use the lane to proceed straight (combined bike/turn lane). Where right-turn lane width allows, include a dashed line to delineate the bicycle path of travel.
- Install bicycle lane markings through the intersection.
- Install two-stage left-turn bike queue boxes on all approaches.
- Install bike lanes at intersection departures.

COST

Cost Estimate: $85,650



Scale: 1" = 40'

40 20 0 40

Note

Proposed white pavement markings are shown in black for clarity.

Bicycle Treatments
Signalized Four-Legged Intersection
Mission Viejo, CA

Figure 54

APPLICABLE SIGNALIZED INTERSECTIONS

Proposed bicyclist countermeasures at a typical four-legged signalized intersection are primarily focused on delineating the bicycle path of travel, providing separation for bicyclists, and highlighting potential conflict zones to increase both driver and bicyclist awareness. In addition, bike push buttons can reduce delay for bicyclist and may reduce instances of risky bicyclist behavior (e.g., proceeding through an intersection against the signal indications).

These recommendations as applied in the design concept are applicable for four-legged signalized intersections. The following are applicable locations which experienced bicycle collisions during the 2016-2020 period.

TABLE 21: FOUR-LEGGED SIGNALIZED INTERSECTIONS WITH BICYCLE COLLISIONS (2016 - 2020)

Intersection	Ped Collision Severity	Primary Collision Factor	Collision Type/ Pedestrian Action	Lighting Condition	Additional Considerations
Alicia Pkwy/ Charlinda Dr	Other Visible Injury	Other Hazardous Violation	Broadside	Daylight	Accommodate bike lanes on Alicia Parkway within the existing curb-to-curb.
Alicia Pkwy/ Jeronimo Rd	Complaint of Pain (2 collisions); Other Visible Injury	Improper Turning; Wrong Side of Road; Unknown	Rear-End; Vehicle/ Pedestrian; Overturned	Dark w/ Street Lights; Daylight (2 collisions)	
Alicia Pkwy/ Muirlands Blvd	Severe Injury; Other Visible Injury	Other Improper Driving; Improper Turning	Broadside; Other	Daylight	Install bike lanes at Alicia Parkway departure
Crown Valley Pkwy/Dr Guevara Way /Medical Center Rd	Severe Injury	Improper Turning	Overturned	Daylight	
Jeronimo Rd/ Acero	Other Visible Injury	Wrong Side of Road	Broadside	Daylight	Convert northbound shared through/right turn lane to through-only lane. Straighten transition from northbound bike lane to right turn lane to reduce angle of transition for bikes. Incorporate bus stop conflict treatments.

Intersection	Ped Collision Severity	Primary Collision Factor	Collision Type/ Pedestrian Action	Lighting Condition	Additional Considerations
Jeronimo Rd/ Montilla	Other Visible Injury	Improper Turning	Hit Object	Daylight	Incorporate bus stop conflict treatments
Jeronimo Rd/ Obrero Dr	Other Visible Injury	Traffic Signals and Signs	Broadside	Daylight	
Los Alisos Blvd /Jeronimo Rd	Other Visible Injury	Automobile Right-of-Way	Other	Daylight	Incorporate bus stop conflict treatments
Marguerite Pkwy/ Jeronimo Rd	Other Visible Injury	Traffic Signals and Signs	Other	Daylight	Incorporate bus stop conflict treatments
Marguerite Pkwy/La Paz Rd	Severe Injury	Other Improper Driving	Other	Daylight	Install bike lanes at Marguerite Parkway departures. Install bus stop/pad treatments.
Muirlands Blvd /La Paz Rd	Other Visible Injury	Wrong Side of Road	Broadside	Daylight	Install transition and conflict markings through free on-ramps.
Muirlands Blvd /Los Alisos Blvd	Complaint of Pain	Other Improper Driving	Broadside	Dark w/ Street Lights	
Mustang Run/ Los Alisos Blvd	Property Damage Only	Improper Passing	Sideswipe	Daylight	Incorporate bus stop conflict treatments
Santa Margarita Pkwy/Los Alisos Blvd	Property Damage Only	Improper Turning	Sideswipe	Daylight	Incorporate bus bay/turnout treatments

TYPE 2: THREE-LEGGED SIGNALIZED INTERSECTION

EXAMPLE LOCATION: OLYMPIAD ROAD/STONERIDGE

Olympiad Road/Stoneridge is a three-legged signalized T-intersection in the city that experienced a bicycle collision between 2016 and 2020. Olympiad Road is a four-lane arterial divided by a two-way left-turn lane. Stoneridge is a two-lane residential street. One southbound left-turn lane is provided on Olympiad Road. Marked crosswalks are provided on all three legs, and northbound and southbound Class II bicycle lanes are provided along Olympiad Road; there are no bicycle lanes along Stoneridge. The northbound bike lane is dashed at the intersection approach.

The land uses around this intersection are entirely residential. However, there is no direct access from this intersection to the residences to the west.

One bicycle collision took place at this intersection during the study period; the collision took place in 2018 and was categorized as a “complaint of pain” severity collision. The bicyclist was traveling the wrong way and collided with a vehicle that was making a right turn.

RECOMMENDATIONS

A three-legged intersection design concept for the intersection of Olympiad Road/Stoneridge includes the following treatments, as shown in Figure 55.

- Install bicyclist push buttons.
- Install advanced stop bars.
- Install bicycle scale lighting.
- Install green conflict zone markings at locations with dashed bike lanes.
- To facilitate left-turning bicycles, install a bike ramp and convert the sidewalk on the west side of the T-intersection to a shared-use path for both bicycles and pedestrians. Then, convert the existing crosswalk on the southern leg to a high visibility crosswalk and install parallel bike crossing markings.

COST

Cost Estimate: $41,785

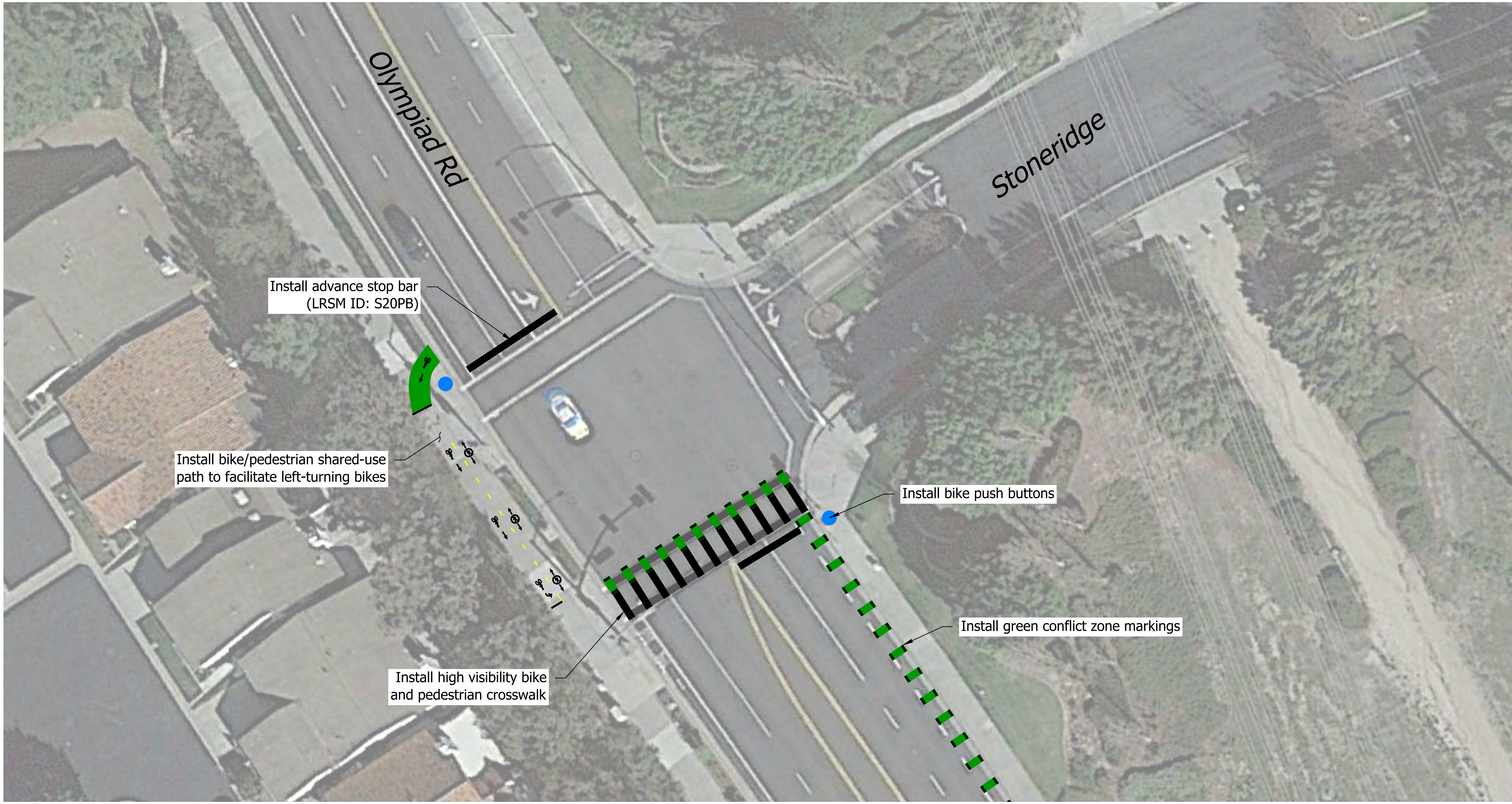
APPLICABLE SIGNALIZED INTERSECTIONS

Proposed countermeasures at a three-legged signalized intersection are primarily focused on delineating the bicycle path of travel and providing a separated path for bicyclists making a left turn into the neighborhood. It also includes highlighting potential conflict zones to increase driver, pedestrian, and bicyclist awareness. In addition, bike push buttons can reduce delay for bicyclist and may reduce instances of risky bicyclist behavior.

These recommendations as applied in the design concept are applicable for three-legged signalized intersections. The following are applicable locations which experienced bicycle collisions during the 2016-2020 period.

TABLE 22: THREE-LEGGED SIGNALIZED INTERSECTIONS WITH BICYCLE COLLISIONS (2016 - 2020)

Intersection	Ped Collision Severity	Primary Collision Factor	Collision Type/ Pedestrian Action	Lighting Condition	Additional Considerations
Jeronimo Rd/ Olympiad Rd	Complaint of Pain	Unknown	Sideswipe	Daylight	Transition eastbound left-turning bikes along Jeronimo Road left of the right-turn-only lane
Marguerite Pkwy/ Mustang Run	Severe Injury	Improper Turning	Broadside	Dark - Street Lights	
Muirlands Blvd /Marathon St	Severe Injury	Other Improper Driving	Broadside	Daylight	Install striping on Marathon Street
Olympiad Rd/ Stoneridge	Complaint of Pain	Wrong Side of Road	Other	Daylight	



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Scale: 1" = 30'

30 15 0 30

Note

Proposed white pavement markings are shown in black for clarity.

Bicycle Treatments
Signalized Three-Legged Intersection
Mission Viejo, CA

Figure 55

TYPE 3: SKEWED FOUR-LEGGED SIGNALIZED INTERSECTION

LOCATION: MARGUERITE PARKWAY/SANTA MARGARITA PARKWAY

Marguerite Parkway/Santa Margarita Parkway is a skewed four-legged signalized intersection which experienced bicycle collisions between 2016 and 2020. It is the only intersection among the signalized intersections with bicycle collisions that is a skewed intersection. Therefore, its design concept would not apply to other intersections in this section and additional detail is provided given the intersection's unique layout and needs.

Santa Margarita Parkway is a six-lane arterial divided by a raised median and Marguerite Parkway is a four-lane arterial divided by a raised median. The intersection has a left-turn lane on each Santa Margarita Parkway approach and a right-turn lane for westbound Santa Margarita Parkway. It also has two left-turn lanes with U-turns prohibited and a shared through-right lanes on the Marguerite Parkway approaches. The intersection's skewed layout can factor into visibility and can affect some of the design recommendations.

This intersection has marked crosswalks across all approaches. Class II bicycle lanes are provided on both Santa Margarita Parkway and Marguerite Parkway. The bicycle lane on eastbound Santa Margarita Parkway terminates prior to the intersection to make room for the right-turn lane. Bus stops are located on the northwest, southwest, and southeast corners of the intersection.

There are large retail centers on both sides of Santa Margarita west of the intersection which take access from both Santa Margarita Parkway and Marguerite Parkway Driveways for the retail centers are located within 200 feet of the intersection north, west, and south of the intersection. The land use east of the intersection is residential dwellings that have access points farther from the intersection.

Two bicycle collisions took place at this intersection during the study period. A "complaint of pain" collision took place in 2016; a vehicle making a right turn collided with a bicycle that was proceeding straight. A severe injury collision took place in 2020; a bicyclist traveling the wrong way collided with a vehicle making a right turn.

Collision data for this intersection shows improper turning and lane changes as common primary collision factors. This indicates that there is potential confusion on lane assignments or vehicles are maneuvering to get to their destination without time to adequately complete the movement.

Proposed countermeasures are primarily focused on increasing visibility of the traffic signal and lane assignments and improving accommodations for vulnerable roadway users.

RECOMMENDATIONS

A design concept for the intersection of Santa Margarita Parkway/Marguerite Parkway includes the following safety treatments, as shown in Figure 56. Given the intersection's skew, detailed countermeasure information is provided for multiple modes.

Install retroreflective backplates on all signal heads, all approaches.

This treatment is intended to address right-angle and rear-end collisions by improving visibility of the signal indications. This treatment aligns with the LRSM countermeasure ID S02.

Evaluate extending red clearance intervals for all approaches.

This treatment is intended to provide additional time for vehicles to clear the intersection before the next green indication to address right-angle and rear-end collisions. This treatment aligns with the LRSM countermeasure ID S03.

Install additional signal heads for Santa Margarita Parkway through movement approaches.

This treatment is intended to address right-angle and rear-end collisions by improving visibility of the current signal indication. The Santa Margarita Parkway approaches at this intersection currently have one overhead signal head and one pole-mounted signal head for three through lanes of traffic. An additional signal head on the mast arm would allow placement of signal heads to be more visible for each of the through lanes. This treatment aligns with LRSM countermeasure ID S02. This treatment may require pole upgrades if case load requirements are not met.

Install advanced stop bar on each approach.

This treatment further separates vehicles from crossing pedestrians. This treatment aligns with LRSM countermeasure ID S20PB.

Restripe pedestrian crossings with high visibility continental pattern or similar.

This treatment improves driver awareness when approaching a crosswalk and encourages pedestrians to cross at the designated locations.

Install bicyclist push buttons at all corners of the intersection.

This treatment provides an opportunity for bicyclists to provide the signal indication that they are present and ready to cross. Installation of bicyclist push buttons throughout the city was identified as a priority treatment to better accommodate bicyclists at the signalized intersections.

Install conflict zone markings for the bike lane to right-turn lane transition and pavement markings indicating a shared space for bicyclists within the right-turn lane on Santa Margarita Parkway.

This treatment provides bicyclists guidance as they approach the intersection and visually alerts drivers as to where to look for/expect bicyclists. This treatment provides information to bicyclists and drivers to help both road users better manage potential conflicts. The existing configuration terminates the bicycle lanes prior to the right-turn lane without further indication of where a bicyclist should be within the roadway.

Install bicycle lane markings through the intersection.

This treatment directs bicyclists through the intersection to the bike lane on the opposite side of the intersection with dedicated space.

Install bike boxes on all approaches.

This treatment provides space for a bicyclist to stop at the intersection and places them in front of stopped vehicles for increased visibility. In addition, in at skewed intersections bike boxes can provide a staging area for left-turning bicycles without having to cross several lanes of traffic.

Install green conflict zone markings for the bike lanes as they approach the intersection.

This treatment provides visual indication that the bicycle lane is sharing space with right-turning vehicles as they approach the intersection.

Install truncated domes on all pedestrian ramps.

This treatment provides physical indication for visually impaired persons to identify they are entering a roadway. The domes should be a color different than the color of the pavement and meet required accessibility design standards.

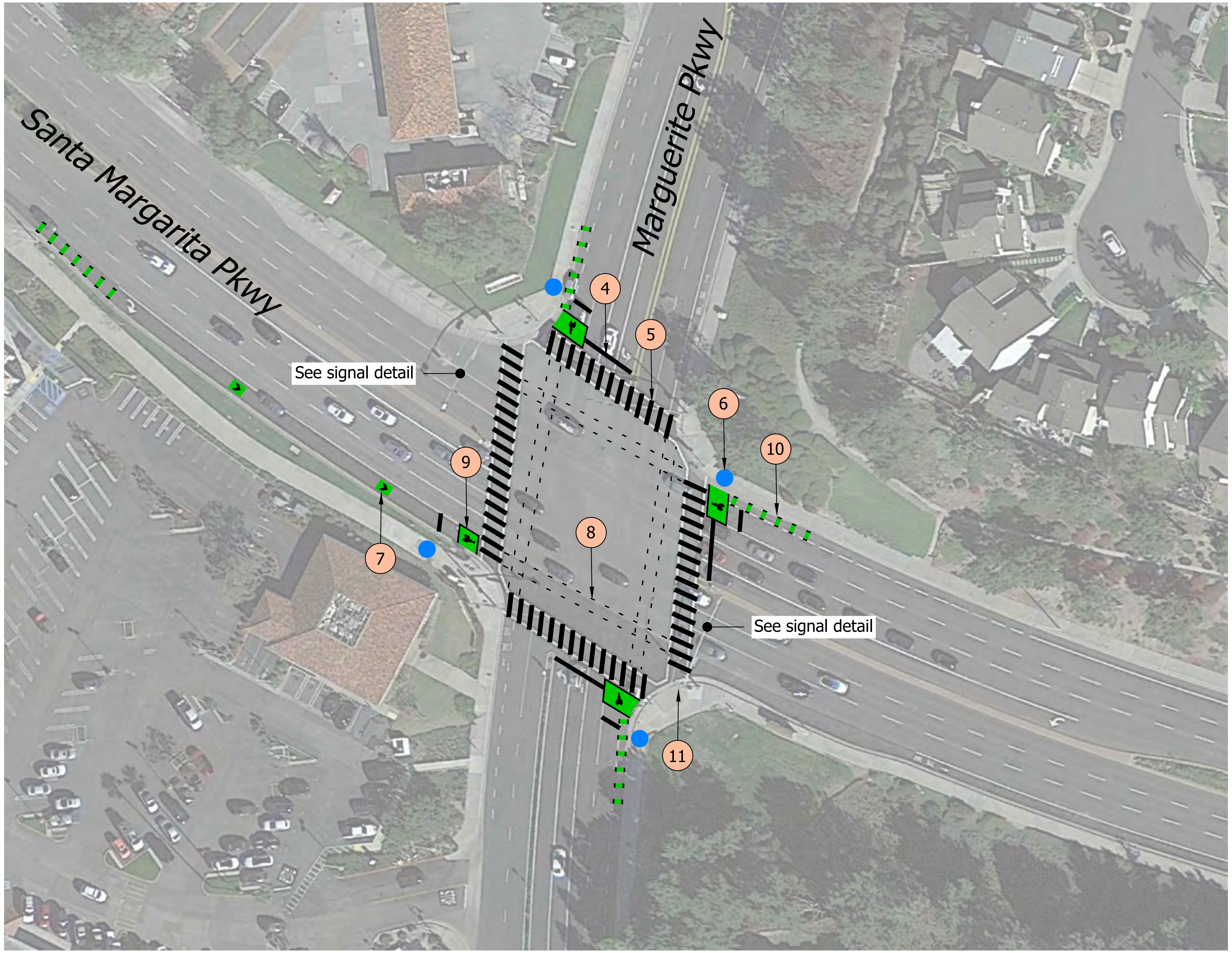
COST ESTIMATE

The total estimated cost for construction of the recommended improvements is shown below. An estimate of the eligible project costs for HSIP funding reimbursement is provided below. The estimate is based on the HSIP Cycle 10 guidelines and current funding eligibility percentages. A local match is often required for grant applications, which would be the difference between the two values below or as required by the specific grant.

COST

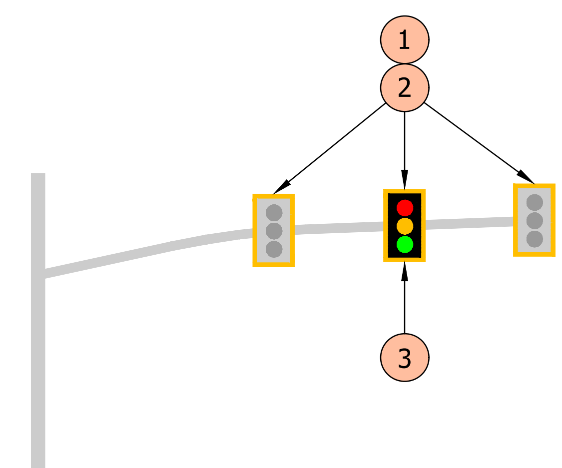
Total Estimated Cost:
$101,930

Estimated Eligible for HSIP Funding:
$89,960



Summary of Treatments

1. Install retroreflective backplates on all signal heads, all approaches (LRSM ID: S02)
2. Evaluate extending red clearance intervals, all approaches (LRSM ID: S03)
3. Install additional signal head on Santa Margarita (E/W) through approaches (LRSM ID: S02)
4. Install advanced stop bar before crosswalk (LRSM ID: S20PB)
5. Install high visibility crosswalks
6. Install bike push buttons, all intersection corners
7. Add conflict zone markings and convert right turn lane to a combined bike/right turn lane with shared lane markings
8. Add bike crossing markings through intersection
9. Install bike boxes
10. Install green conflict zone marking
11. Install truncated domes, all ramps on all corners



N

Scale: 1" = 60'

60 30 0 60

Note

Proposed white pavement markings are shown in black for clarity.

Bicycle Treatments
Skewed Signalized Four-Legged Intersection
Mission Viejo, CA

Figure 56

KITTELSON & ASSOCIATES

Crosswalk Enhancement Mitigation Measures

Based on an inventory of crosswalks in Mission Viejo and the analysis of collision locations and patterns, Kittelson developed pedestrian improvement measures and preliminary design concepts for four unsignalized locations. These locations experienced at least one pedestrian collision and/or contain roadway characteristics conducive to pedestrian improvements:

- Via Linda/Medero
- Pradera Drive/Pericia Drive
- Herencia/Anaya
- Mustang Run/Portola Plaza

This section provides improvement measures for each of these four intersections including a summary of existing conditions at the intersection, collision history, applicable countermeasures, preliminary design concepts, and engineering cost estimates.

While these locations represent the typical application of relevant pedestrian measures, these measures are also applicable to other unsignalized locations in Mission Viejo that have experienced pedestrian collisions. Unsignalized locations that experienced at least one pedestrian collision between 2016 and 2020 are shown in Figure 57 and detailed in Table 23. The figure also highlights unsignalized intersections in the vicinity of schools, which can be candidates for the improvements described in this section as a means for proactively reducing collision risk at those locations.

Figure 57:
Unsignalized Intersections
with Pedestrian Collisions
(2016-2020)

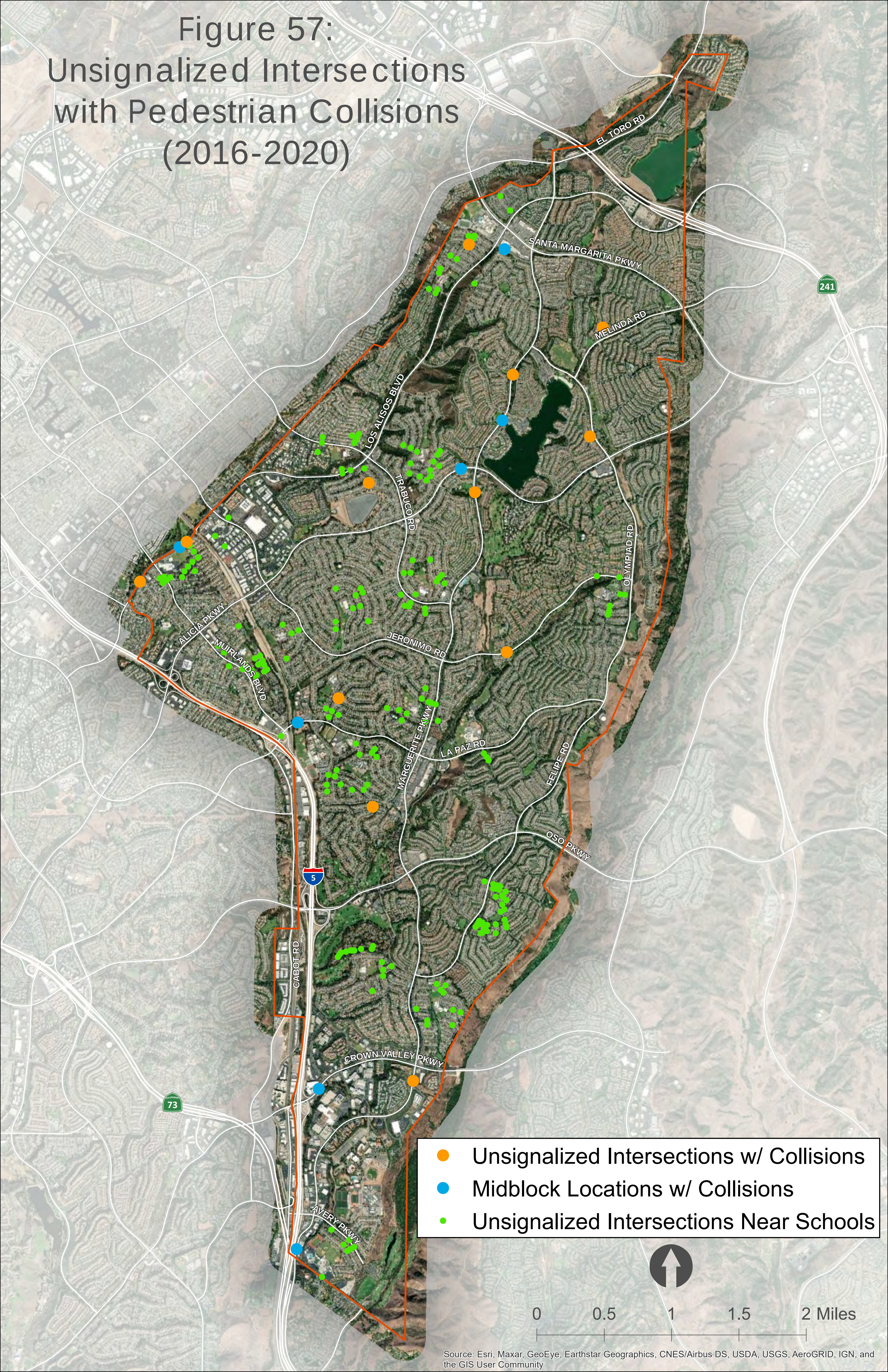


TABLE 23: UNSIGNALIZED INTERSECTIONS WITH PEDESTRIAN COLLISIONS (2016 - 2020)

Location Type	Location	Pedestrian Collision(s) Severity
Intersection	Anaya/Herencia	Severe Injury
	Brussels Ave/Los Alisos Blvd	Complaint of Pain
	Calle Alcala/Via Cuervo	Complaint of Pain
	Jeronimo Rd/Arbolitos	Severe Injury Complaint of Pain
	Los Alisos Blvd/Bough Av	Other Visible Injury
	Marguerite Pkwy/Alarcon	Severe Injury
	Marguerite Pkwy/Alerzal	Fatal
	Marguerite Pkwy/Highland	Other Visible Injury
	Osuna/Aguilar	Complaint of Pain
	Pariso Dr/Santo Dr	Complaint of Pain
	Saddleback Dr/Mosquero Ln	Property Damage Only
	San Marcos/Barlovento	Other Visible Injury
Midblock	Alicia Pkwy (565 feet west of Marguerite Pkwy)	Severe Injury
	Crown Valley Pkwy (398 feet south of Puerta Real)	Severe Injury
	La Paz Rd (473 feet west of Chrisanta Dr)	Other Visible Injury
	Los Alisos Blvd (330 feet west of Brussels Ave)	Other Visible Injury
	Marguerite Pkwy (306 feet south of Visa del Lago)	Other Visible Injury
	Marguerite Pkwy (369 feet north of Via Escolar)	Complaint of Pain
	Mustang Run (415 feet east of Los Alisos Blvd)	Severe Injury

TYPICAL APPLICATION EXAMPLE: VIA LINDA/MADERO

Via Linda is a three-lane local roadway south of this T-intersection and a two-lane roadway north of this intersection, divided by a yellow centerline. Madero is a two-lane local roadway also divided by a yellow centerline. The intersection's southern leg has a high visibility continental crosswalk, and its western leg has a standard crosswalk; no marked crosswalk is provided across the northern leg. The eastbound approach has a stop sign while the northbound and southbound approaches have advance yield markings with "Yield Here to Pedestrians" signs. The speed limit along Via Linda is 30 mph, and the speed limit along Madero is 35 mph. This intersection is surrounded by industrial uses, a religious center, William S. Craycraft Park, and a park & ride lot.

Reviewing the collision data locations, this intersection's roadway characteristics and land use context make it a viable candidate for illustrating crosswalk enhancements and other pedestrian measures at unsignalized locations. While no pedestrian collisions took place at this intersection during the study period, two automobile-only collisions took place.

Proposed countermeasures at this intersection are primarily focused on delineating the pedestrian crossing path, reducing crossing distances, increasing pedestrian visibility, and increasing driver awareness.

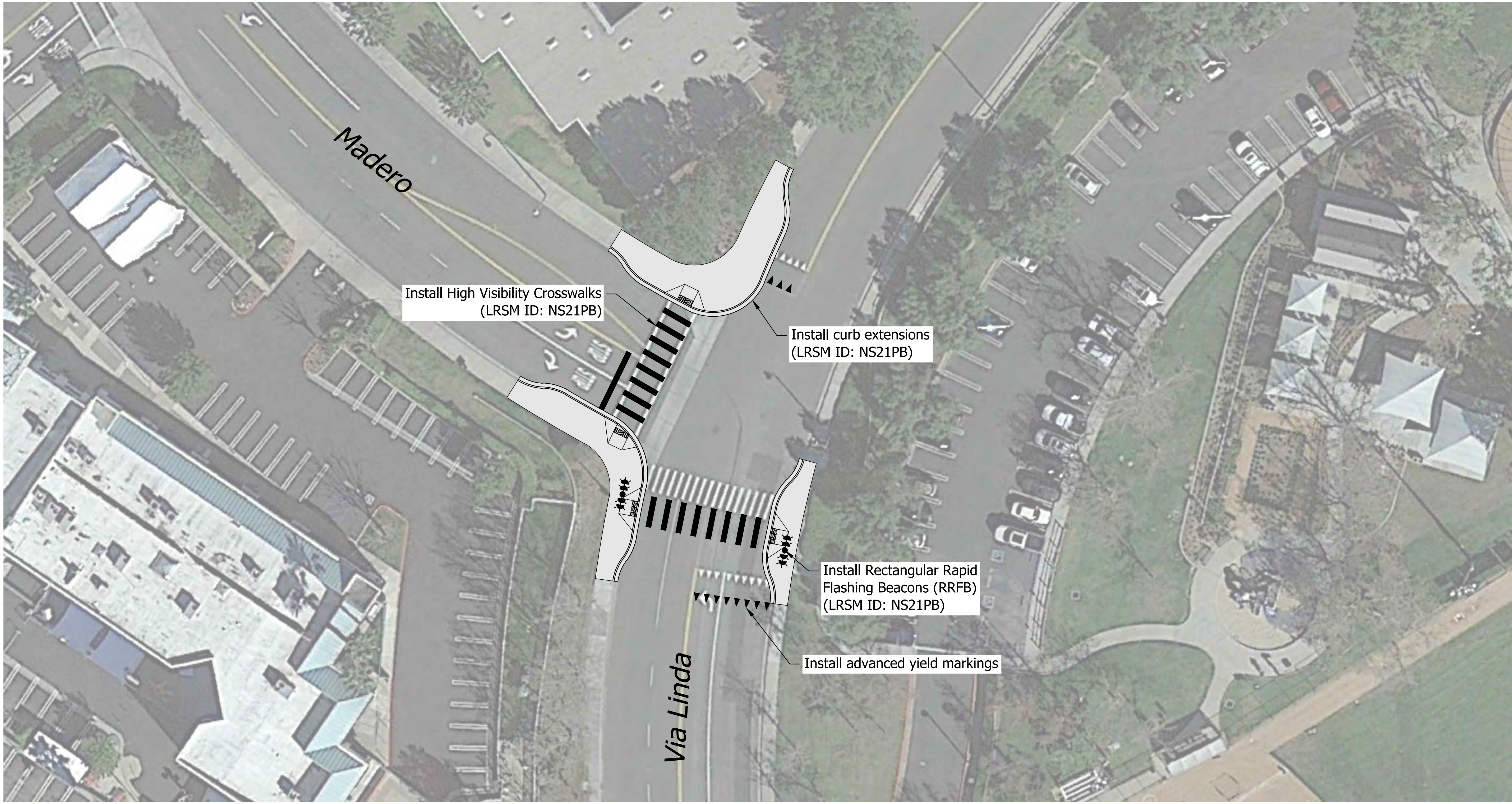
RECOMMENDATIONS

A design concept for the intersection of Via Linda/Madero includes the following treatments, as shown in Figure 58:

- Install curb extensions to reduce crossing distances and increase pedestrian visibility when preparing to cross.
- Install a high visibility crosswalk on the western leg to increase pedestrian visibility and driver awareness.
- Install Rectangular Rapid-Flashing Beacons across Via Linda to increase the visibility of the crossing location and increase driver awareness of crossing pedestrians.

COST

Cost Estimate: $176,845



N

Scale: 1" = 40'

40 20 0 40

Note

Proposed white pavement markings are shown in black for clarity.

Unsignalized Crosswalk Enhancements
Via Linda / Madero
Mission Viejo, CA

Figure
58

TYPICAL APPLICATION EXAMPLE: PRADERA DRIVE/PERICIA DRIVE

Pradera Drive and Pericia Drive are both two-lane local streets divided by a yellow centerline. This T-intersection's southern and eastern legs have yellow school crosswalks; no marked crosswalk is provided across the northern leg. The westbound approach is stop-controlled while the northbound and southbound approaches are uncontrolled; the northbound approach has a yellow high visibility pedestrian crossing warning sign. The intersection is surrounded by residential uses to the east and K-12 schools to the west.

A review of the collision data locations indicates that this intersection's roadway characteristics and proximity to schools make it a viable candidate for illustrating crosswalk enhancements and other pedestrian measures at unsignalized locations. While no pedestrian collisions took place at this intersection during the study period, one automobile-only collision took place.

Proposed countermeasures at this intersection are primarily focused on delineating the pedestrian crossing path and increasing driver awareness.

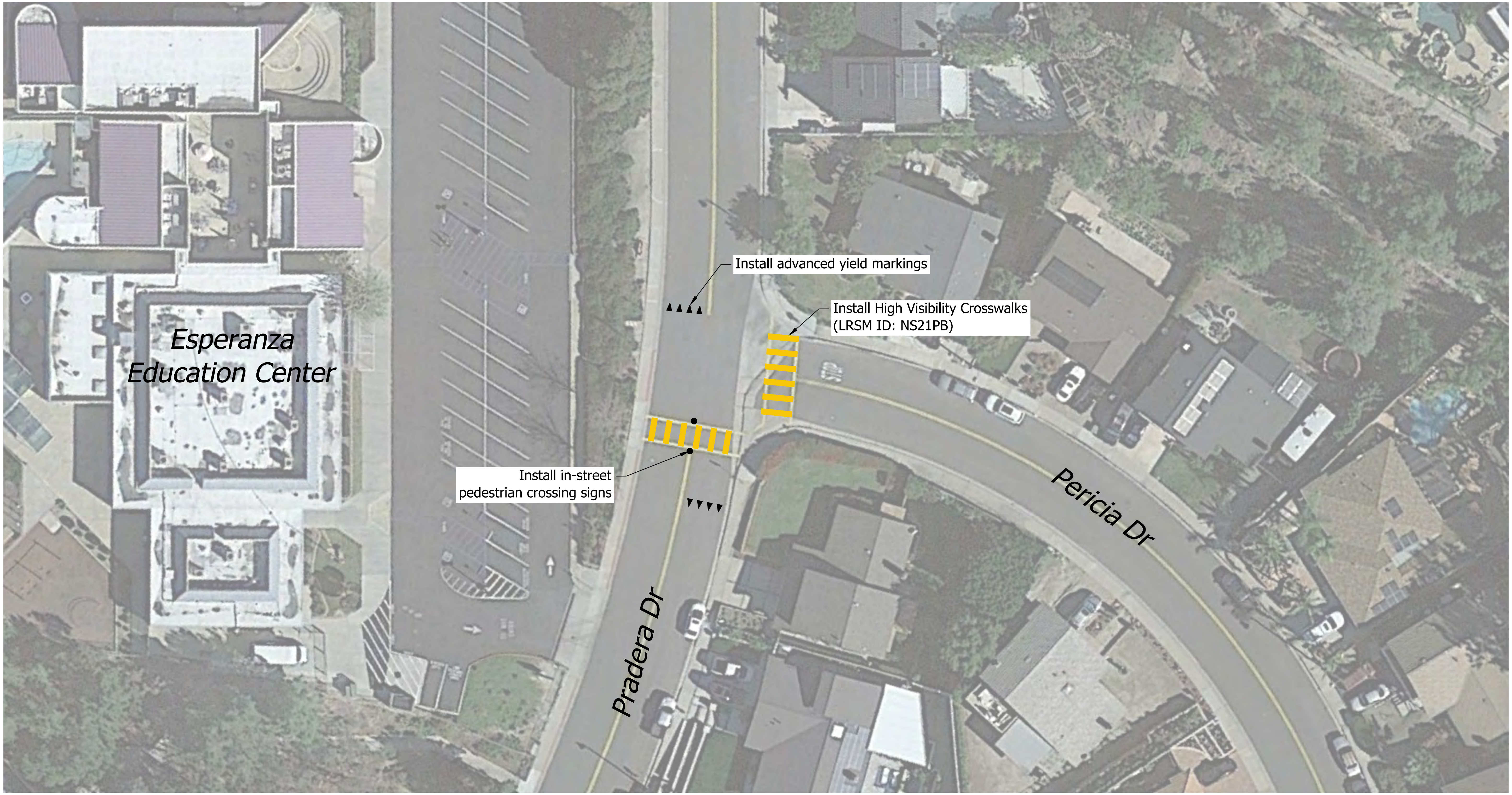
RECOMMENDATIONS

A design concept for the intersection of Pradera Drive/Pericia Drive includes the following treatments, as shown in Figure 59:

- Install high visibility crosswalks to increase pedestrian visibility and driver awareness.
- Install in-street pedestrian crossing signs at the Pradera Drive crosswalk as well as advance yield markings along Pradera Drive to increase driver awareness of the crossing location.

COST

Cost Estimate: $9,500



N

Scale: 1" = 40'

40 20 0 40

Note

Proposed white pavement markings are shown in black for clarity.

Unsignalized Crosswalk Enhancements
Pradera Drive / Pericia Drive
Mission Viejo, CA

Figure
59

TYPICAL APPLICATION EXAMPLE: HERENCIA/ANAYA

Herencia and Anaya are both two-lane residential streets with no centerline. No marked crosswalks are provided here nor at adjacent intersections. All three approaches at this T-intersection are uncontrolled. The intersection is surrounded on all sides by residential; Birchwood Park and Castlewood Park are both southwest of this intersection.

During the study period, one pedestrian collision took place at this intersection in 2020 and resulted in a severe injury. The collision occurred in the morning at approximately 7:45 AM.

Proposed countermeasures at this intersection are primarily focused on delineating the pedestrian crossing path, increasing driver awareness, and lowering vehicle speeds.

RECOMMENDATIONS

A design concept for the intersection of Herencia/Anaya includes the following treatments, as shown in Figure 60:

- Install high visibility crosswalks across Herencia to increase pedestrian visibility and driver awareness.
- Install a high-visibility crosswalk, curb extensions, and in-street pedestrian crossing signs on Anaya to both increase driver awareness as well as lower vehicle speeds.

COST

Cost Estimate: $32,630

N

Scale: 1" = 40'

40 20 0 40

Note

Proposed white pavement markings are shown in black for clarity.

Unsignalized Crosswalk Enhancements
Anaya / Herencia
Mission Viejo, CA

Figure
60

KITTELSON & ASSOCIATES

TYPICAL APPLICATION EXAMPLE: MUSTANG RUN/CRUCERO

Mustang Run is a two-lane roadway divided by a striped median; the speed limit is 35 mph. Near Portola Plaza and Crucero, Mustang Run has a shopping center to the north and residences to the south.

Portola Plaza provides access to a shopping center and has one lane in each direction divided by a centerline. No marked crosswalks are provided. The Portola Plaza approach is stop-controlled while the Mustang Run approaches are uncontrolled.

Crucero provides access to residential areas to the south and has one lane in each direction divided by a centerline. No marked crosswalks are provided. The Crucero approach is stop-controlled while the Mustang Run approaches are uncontrolled.

One pedestrian collision took place at the intersection of Mustang Run/Portola Plaza during the study period; the collision took place in 2018 and resulted in a severe injury. While the collision occurred near the intersection of Mustang Run/Portola Plaza, recommendations have been made to accommodate pedestrians crossing to the east, at the adjacent uncontrolled intersection of Mustang Run/Crucero. This is due to the proximity to a bus stop and sidewalk connections from the residential area.

Proposed countermeasures at this intersection are primarily focused on delineating the pedestrian crossing path, providing separation for crossing pedestrians, increasing pedestrian visibility and driver awareness, and lowering vehicle speeds.

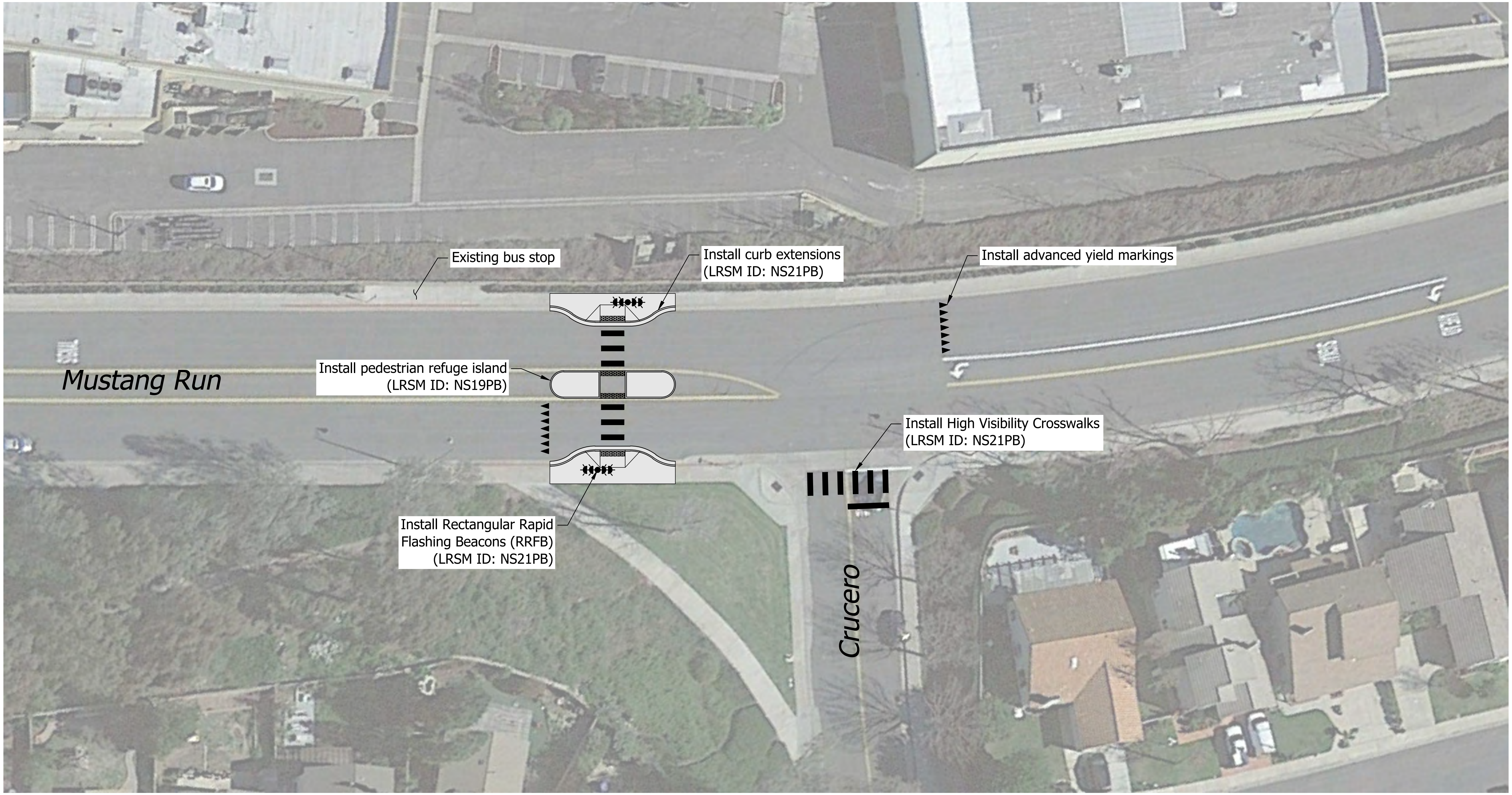
RECOMMENDATIONS

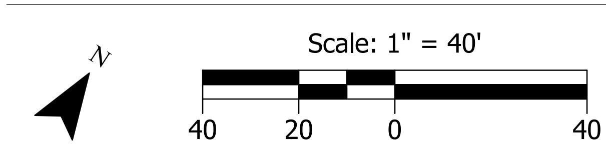
A design concept for the intersection of Mustang Run/Crucero includes the following treatments, as shown in Figure 61:

- Install high visibility crosswalks across Mustang Run and Crucero to increase pedestrian visibility and driver awareness.
- Install curb extensions to reduce crossing distances and increase pedestrian visibility when preparing to cross.
- Install a pedestrian refuge island on Mustang Run to provide additional separation from vehicles for crossing pedestrians.
- Install Rectangular Rapid-Flashing Beacons with advance yield markings across Mustang Run to increase the visibility of the crossing location and increase driver awareness of crossing pedestrians.

COST

Cost Estimate: $121,700





Note

Proposed white pavement markings are shown in black for clarity.

Unsignalized Crosswalk Enhancements
Mustang Run / Crucero
Mission Viejo, CA

Figure
61

INTEGRATE NON-ENGINEERING STRATEGIES

This section presents non-engineering transportation safety countermeasures identified to address the systemic collision trends documented in Section 6. These countermeasures are intended to complement the engineering countermeasures described above and generally are intended to address behavioral factors contributing to collision risk. Countermeasures are grouped into law enforcement approaches, community enforcement approaches, and education approaches. While non-engineering countermeasures are not eligible for HSIP funding, they can be funded through various other grant programs, including:

- **Active Transportation Program (ATP):** The California ATP provides funding for projects that improve walking and bicycling around the state, including both infrastructure and non-infrastructure projects. The Cycle 5 Call for Projects was released in Spring 2020 with $400 million of funding allocated.[15]
- **Office of Traffic Safety (OTS):** The California OTS offers grant funding for a wide variety of non-infrastructure traffic safety countermeasures. The next grant application period will open in December 2021.[16]

The strategies discussed in this section would be best implemented in coordination with transportation safety partners listed in Section 4.

If available, effectiveness ratings from NHTSA are also included. Effectiveness is graded from 1 to 5 (low to high). Strategies that are rated 1 or 2 should be used in combination with other strategies rather than standalone, since evidence of effectiveness may be limited.

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

Enforcement

LAW ENFORCEMENT APPROACH

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

COORDINATION AND COLLABORATION

Enforcement is often outside of the immediate control of the agency leading roadway safety planning or implementation efforts because the primary actions are taken by external departments. Coordination across agencies can help address this challenge. Working together, the departments can agree upon strategies and priorities. The departments can also work together to identify additional funding to support different enforcement related programs and trainings. Ultimately, the allocation of resources (toward roadway safety in general and spatially within the City) are not at the discretion of the City; the coordination and collective agreement on the role of enforcement to help educate and encourage safe roadway behavior can be helpful in establishing and furthering a roadway safety culture.

EMPLOYING STRATEGIES LESS SUSCEPTIBLE TO RACIAL BIASES

Based on 2019 ACS data, 26 percent of Mission Viejo's population identify as a person of color or identify as more than one race. Recent national dialogue as well as supporting studies have renewed and broadened awareness of the potential for traffic stops and police enforcement to reinforce or exacerbate existing racial inequities. Studies of police traffic stops have shown racial biases nationwide in who gets stopped and subsequently searched, with Black and Hispanic drivers more likely to be searched than people of other races and ethnicities. Given these considerations, enforcement activities undertaken in Mission Viejo to further roadway safety should be pursued in an equitable and unbiased manner. Some of the strategies presented below do not require the presence of officers and therefore reduces the risk of bias. Others do require officers and police resources and should be carefully weighed for the risk that they could erode community relations and undercut broader efforts for community health and safety. Even among the strategies that lessen the risks of enforcement bias like automated camera enforcement, other factors can result in inequities. For example, flat-rate ticket or court fees place a larger burden on low-income residents as a relative share of their income.

The following complementary solutions are recommended to accompany enforcement strategies:

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

Collision data can help identify priority intersections and/or road segments and the times of the day when the collisions have occurred. This information can inform and guide the type of enforcement strategy to be selected at the most appropriate locations and time periods. City staff can also help monitor the impact of the enforcement strategy by coordinating with the Orange County Sheriff's Department (OCSD) to obtain and analyze enforcement records to help evaluate effectiveness and equity considerations.

Table 24 provides a summary of law enforcement strategies. Following the table are further descriptions of each strategy including benefits, considerations, and resource links.

TABLE 24: SUMMARY OF LAW ENFORCEMENT STRATEGIES

Enforcement Strategy	Campaign Type	Conditions Addressed	Relative Cost	Effectiveness (out of 5)
Publicized Sobriety Chokepoints	Vehicle	DUI	High	5
High Visibility Saturation Patrols	Vehicle	DUI	Medium	4
Speed Limits	Vehicle	Unsafe Speed	High	5
High Visibility Enforcement	Vehicle	Unsafe Speed	Low	N/A
Speed Enforcement in School Zones	Vehicle	Unsafe Speed and Pedestrians	Low to Medium	N/A
Active Speed Monitors	Vehicle	Unsafe Speed	Low	N/A
Progressive Ticketing	All modes	Multiple driver, bicyclist, and pedestrian actions	Varies	N/A

PUBLICIZED SOBRIETY CHECKPOINTS

At a sobriety checkpoint, law enforcement officers stop vehicles at a predetermined location to check whether the driver is impaired. They either stop every vehicle or stop vehicles at some regular interval, such as every third or tenth vehicle. The purpose of checkpoints is to deter driving after drinking by increasing the perceived risk of arrest. To do this, checkpoints should be highly visible, publicized extensively, and conducted regularly, as part of an ongoing sobriety checkpoint program.

BENEFITS

- Effective in reducing alcohol-related collisions among high-risk populations including males and drivers ages 21 to 34.
- Can be implemented quickly once officers are trained.

CONSIDERATIONS

- Requires substantial staffing and funding resources, and potential pooling of resources among agencies.
- Effectiveness is tied to levels of enforcement and publicity; checkpoints must be highly visible and publicized extensively.

RESOURCE LINKS

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

HIGH VISIBILITY SATURATION PATROLS

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

BENEFITS

- Can be effective in reducing DUI-related fatalities when accompanied by extensive publicity.
- Flexible in terms of number of officers and time.

CONSIDERATIONS

- Should be publicized extensively, conducted regularly, and highly visible.
- Paid media publicity can increase costs.

RESOURCE LINKS

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

SPEED LIMITS

Speed limits are only one part of the system that attempts to control driving speeds. Well-established speed limits based on the use of appropriate engineering practices form the basis for roadway design and operations. Active enforcement and supportive adjudication are also essential to support established limits.

BENEFITS

- Speeds can decrease significantly when limits are lowered (and paired with enforcement or other measures).
- When lower limits result in lower speeds, collisions and casualties are reduced.

CONSIDERATIONS

- Speeds may decrease by a lower degree than the reduction in limits.
- The roadway design should reflect the desired speed limit and operating speeds.

RESOURCE LINKS

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

HIGH VISIBILITY ENFORCEMENT

High visibility enforcement campaigns have been used to deter speeding and aggressive driving through specific and general deterrence. In the high visibility enforcement model, law enforcement targets certain high collision or high violation geographical areas using either expanded regular patrols or designated aggressive driving patrols. The objective is to convince the public that speeding and aggressive driving actions are likely to be detected and that offenders will be arrested and punished.

BENEFITS

- Allow officers to focus on speeding and aggressive driving, which are moving violations and cannot be observed at checkpoints.

CONSIDERATIONS

- Publicity should be included in high visibility enforcement efforts.

RESOURCE LINKS

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

SPEED ENFORCEMENT IN SCHOOL ZONES

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

BENEFITS

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

CONSIDERATIONS

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

RESOURCE LINKS

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

ACTIVE SPEED MONITORS

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

BENEFITS

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

CONSIDERATIONS

- Cannot be moved around easily.

RESOURCE LINKS

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

PROGRESSIVE TICKETING

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

EDUCATING

Establish community awareness of the problem. The public needs to understand that drivers are speeding and the consequences of this speeding for road safety. Raising awareness about the problem will change some behaviors and create public support for the enforcement efforts to follow.

WARNING

Announce what action will be taken and why. Give the public time to change behaviors before ticketing starts. Fliers, signs, newspaper stories, and official warnings from officers can all serve as reminders.

TICKETING

After the “warning” period, hold a press conference announcing when and where the police operations will occur. If offenders continue their unsafe behaviors, officers issue tickets.

BENEFITS

- Allows support to build for the program.
- Warnings allow officers to contact up to 20 times as many non-compliant motorists than writing citations.

CONSIDERATIONS

- Program should begin with education and warnings.

RESOURCE LINKS

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

COMMUNITY ENFORCEMENT APPROACH

Table 25 provides a summary of community enforcement strategies. Following the table are further descriptions of each strategy including benefits, considerations, and resource links.

TABLE 25: SUMMARY OF COMMUNITY ENFORCEMENT STRATEGIES

Enforcement Strategy	Campaign Type	Conditions Addressed	Relative Cost	Effectiveness (out of 5)
Neighborhood Speed Watch Programs	Vehicle	Unsafe Speed	Low to Medium	N/A
Adult School Crossing Guards	Pedestrian	Unsafe Speed; Pedestrians	Low to Medium	N/A

NEIGHBORHOOD SPEED WATCH PROGRAMS

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

BENEFITS

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

CONSIDERATIONS

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

RESOURCE LINKS

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

ADULT SCHOOL CROSSING GUARDS

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

BENEFITS

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

CONSIDERATIONS

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

RESOURCE LINKS

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

Education

Bicyclists, pedestrians, and/or drivers can be misinformed regarding traffic laws, which may lead to risky or reckless behavior. Education can provide information to roadway users and help motivate a change in specific behaviors to reduce the risk of injuries. These strategies can be developed to include interactive activities, comprehensive teaching notes, and information on road safety messages and concepts that can be taught to various roadway user groups.

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

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

There are three specific types of educational campaigns:

PUBLIC AWARENESS

Public awareness campaigns are a great example of a method for garnering public support. An effective campaign can lay the groundwork for subsequent transportation safety initiatives and can increase the likelihood of their success. Campaigns to target groups are usually aimed at changing behavior patterns in specific groups of people (e.g., drivers, schoolchildren).

TARGETED CAMPAIGNS

Since changing behavior in these groups can be a long and arduous task, these campaigns tend to be ongoing efforts aimed at long-term results. Individual campaigns differ from campaigns at target groups because the audience is reached through an intermediary.

INDIVIDUAL CAMPAIGNS

Intervention occurs at an individual level through public safety officers, crossing guards, doctors, and other authority figures. Using these different approaches in concert reaches a broader audience and increases the likelihood of long-term success in changing attitudes and behaviors.

CONSIDERATIONS

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

RESOURCE LINKS

- Countermeasures That Work: A Highway Safety Countermeasure Guide for State Highway Safety Offices (https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/documents/812478_countermeasures-that-work-a-highway-safety-countermeasures-guide-.pdf)
- Safe Routes to School Guide (http://guide.saferoutesinfo.org/)

Table 26 provides a summary of education strategies. Following the table are further descriptions of each strategy including benefits, considerations, and resource links.

TABLE 26: SUMMARY OF EDUCATION STRATEGIES

Enforcement Strategy	Campaign Type	Conditions Addressed	Relative Cost	Effectiveness (out of 5)
Mass Media Campaigns	Vehicle	DUI	High	3
Communications and Outreach Supporting Enforcement	Vehicle	Unsafe Speed	Varies	3
High Visibility Cell Phone and Text Messaging Media Campaign	Vehicle	Distracted Driving	High	4
Formal Courses for Older Drivers	Vehicle	Older Drivers	Low	2
Referring Older Drivers to Licensing Agencies	Vehicle	Older Drivers	Medium	4
Elementary-Age Children Pedestrian Training	Pedestrian	Pedestrian	Low	3
Safe Routes to School	All modes	Pedestrian	Low	3
Active Lighting and Rider Conspicuity	Bicycle	Lighting	Low	3

MASS MEDIA CAMPAIGNS

A mass media campaign consists of intensive communications and outreach activities regarding alcohol-impaired driving that use radio, television, print, and other mass media, both paid and/or earned. Mass media campaigns are a standard part of every state's effort to reduce alcohol-impaired driving. Some campaigns publicize a deterrence or prevention measure such as a change in a state's DWI laws or a checkpoint or other highly visible enforcement program. Others promote specific behaviors such as the use of designated drivers, illustrate how impaired driving can injure and kill, or simply urge the public not to drink and drive. Campaigns vary enormously in quality, size, duration, funding, and many other ways. Effective campaigns identify a specific target audience and communications goal and develop messages and delivery methods that are appropriate to – and effective for – the audience and goal.

BENEFITS

- Effective campaigns have been tied to a notable reduction in alcohol-related collisions.

CONSIDERATIONS

- Effective campaigns are carefully planned, well-funded, and conducted in conjunction with other impaired-driving activities.

RESOURCE LINKS

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

COMMUNICATIONS AND OUTREACH SUPPORTING ENFORCEMENT

Effective, high visibility communications and outreach are an essential part of successful speed and aggressive-driving enforcement programs. The objective should be to provide information about the program, including expected safety benefits, and to persuade motorists that detection and punishment for violations is likely. Campaign messages that are pre-tested to ensure they are relevant to the target audience and that reach the audience with sufficient intensity and duration to be perceived and noticed are most likely to be effective.

BENEFITS

- Messages that are pre-tested for relevancy can be effective.

CONSIDERATIONS

- Programs are unlikely to be effective unless tied to enforcement.
- Speed-based campaigns are generally less effective than alcohol-themed ones.

RESOURCE LINKS

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

HIGH VISIBILITY CELL PHONE AND TEXT MESSAGING MEDIA CAMPAIGN

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

BENEFITS

- Can reduce collisions involving drivers using handheld cell phones.

CONSIDERATIONS

- Requires four to six months to plan and implement.

RESOURCE LINKS

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

FORMAL COURSES FOR OLDER DRIVERS

This countermeasure involves formal courses specifically developed for older drivers. These courses are typically offered by organizations such as AAA, AARP, and the National Safety Council, either independently or under accreditation by States. The courses typically involve six to ten hours of classroom training in basic safe driving practices and in how to adjust driving to accommodate age-related cognitive and physical changes.

BENEFITS

- Can be offered by existing local organizations.
- Can combine classroom and on-the-road instruction.

CONSIDERATIONS

- Courses may only reach a fraction of older drivers.

RESOURCE LINKS

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

REFERRING OLDER DRIVERS TO LICENSING AGENCIES

Older drivers come to the attention of licensing agencies at regular license renewals, or when they are referred to the licensing agency for reevaluation of their driving skills. Licensing agencies in all States accept reevaluation referrals for drivers of any age. A survey of all state licensing agencies found that three sources accounted for 85 percent of referrals: law enforcement (37 percent), physicians and other medical professionals (35 percent), and family and friends (13 percent). The remaining 15 percent came from collision and violation record checks, courts, self-reports, and other sources. Law enforcement officers have the opportunity to observe drivers directly at traffic stops or collisions. With appropriate training, they can identify many drivers who should be referred to the licensing agency for assessment.

BENEFITS

- Physicians are in an excellent position to assess if changes in their patients' physical or cognitive abilities may increase their collision risk.

CONSIDERATIONS

- Guidelines should define "unsafe" drivers, and procedures should be established for family members and friends to report drivers whose abilities may be impaired.

RESOURCE LINKS

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

ELEMENTARY-AGE CHILD PEDESTRIAN TRAINING

The purpose of elementary school pedestrian training is to equip school-age children with knowledge and practice to enable them to walk safely in environments with traffic and other safety hazards. School-based programs are useful to teach basic pedestrian concepts and safe behaviors at schools, faith-based settings, and other institutions with groups of elementary-aged children. Pedestrian safety programs are especially important for children such as those from lower-income families and neighborhoods, or those who may be more likely to make risky decisions and are less able to control their behavior.

BENEFITS

- NHTSA and other organizations have developed free resources and curriculum that can be used in schools and other settings.
- Can improve children's behavior during activities such as crossing a street.

CONSIDERATIONS

- Lessons should be developmentally appropriate for the target age group(s).
- Schools would need to find time to implement programs along existing services and teaching.

RESOURCE LINKS

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

SAFE ROUTES TO SCHOOL

The goal of Safe Routes to School (SRTS) programs is to increase the amount of walking and bicycling trips to and from school while simultaneously improving safety for children walking or bicycling to school. SRTS programs are community-based and are intended to be comprehensive in nature. Programs include education of children, school personnel, parents, community members, and law enforcement officers about safe walking and bicycling behavior and safe driving behavior around pedestrians and bicyclists. In addition, programs include enforcement and engineering activities to improve traffic safety and reduce or eliminate risky elements of the traffic environment around primary and secondary schools so children can safely walk or bicycle to school.

BENEFITS

- Increased walking and biking to school have health benefits for children.
- Programs can educate both students and parents on safe routes and behaviors.

CONSIDERATIONS

- At a minimum, must include a 3E approach to pedestrian and bike safety, addressing engineering, education, and enforcement programs.

RESOURCE LINKS

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

ACTIVE LIGHTING AND RIDER CONSPICUITY

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

BENEFITS

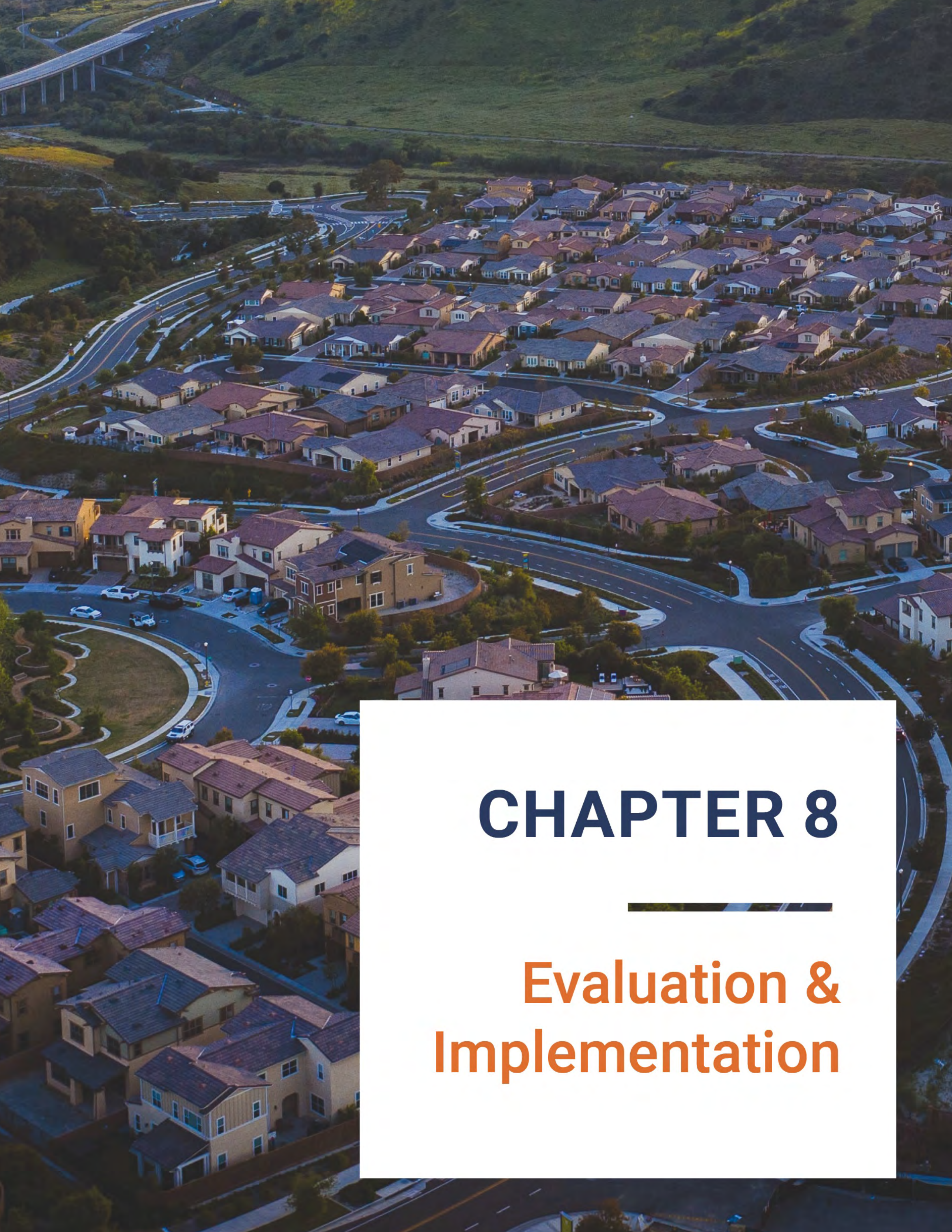
- Can improve driver detection of bicyclists during the day and at night.
- Can reduce vehicle-bicycle collisions and injuries.

CONSIDERATIONS

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

RESOURCE LINKS

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



CHAPTER 8

Evaluation & Implementation

EVALUATION & IMPLEMENTATION

ABOUT

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

PERFORMANCE MEASURES

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

- Total number of annual fatal and severe injury collisions on City roads
- Number of annual fatal and severe injury collisions with the following collision types:
  - Broadside collisions
  - Hit-object collisions
  - Pedestrian-involved collisions
- Number of annual fatal and severe injury collisions with one of the following primary collision factors:
  - Traffic signals and signs
  - Improper turning
  - Automobile right-of-way
  - Pedestrian violation
  - Unsafe speed
- Number of collisions at the priority intersection locations listed in the emphasis area discussions of this plan
- Change in number of collisions at intersections and roadways after modifications are made

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

Many of the non-engineering solutions discussed above require collaboration across multiple agencies going beyond the City's Department of Public Works. The City can coordinate with their traffic safety partners to develop an approach for when and how some of these could be implemented.

UPDATING THE PLAN

The City should continue to review collision data annually for key findings and to track progress against performance measures. This plan relies on collision data from 2016 through 2020 and can be built upon with future year data. As part of an annual review of the data, the City, in conjunction with its safety partners, can assess the plan, consider new trends and technologies, and determine if an update to the plan is needed. As new strategies are identified, the group of safety partners may update goals, emphasis areas, or priority locations and should assign champions for specific strategies and action items. More substantial updates to the safety plan can occur at longer intervals (approximately every five years).

Mission Viejo

SYSTEMIC SAFETY ANALYSIS REPORT & LOCAL ROAD SAFETY PLAN

December 2021

APPENDIX A

Citywide Pin Maps

Figure 1: Citywide Collision Locations Pin Map 2017

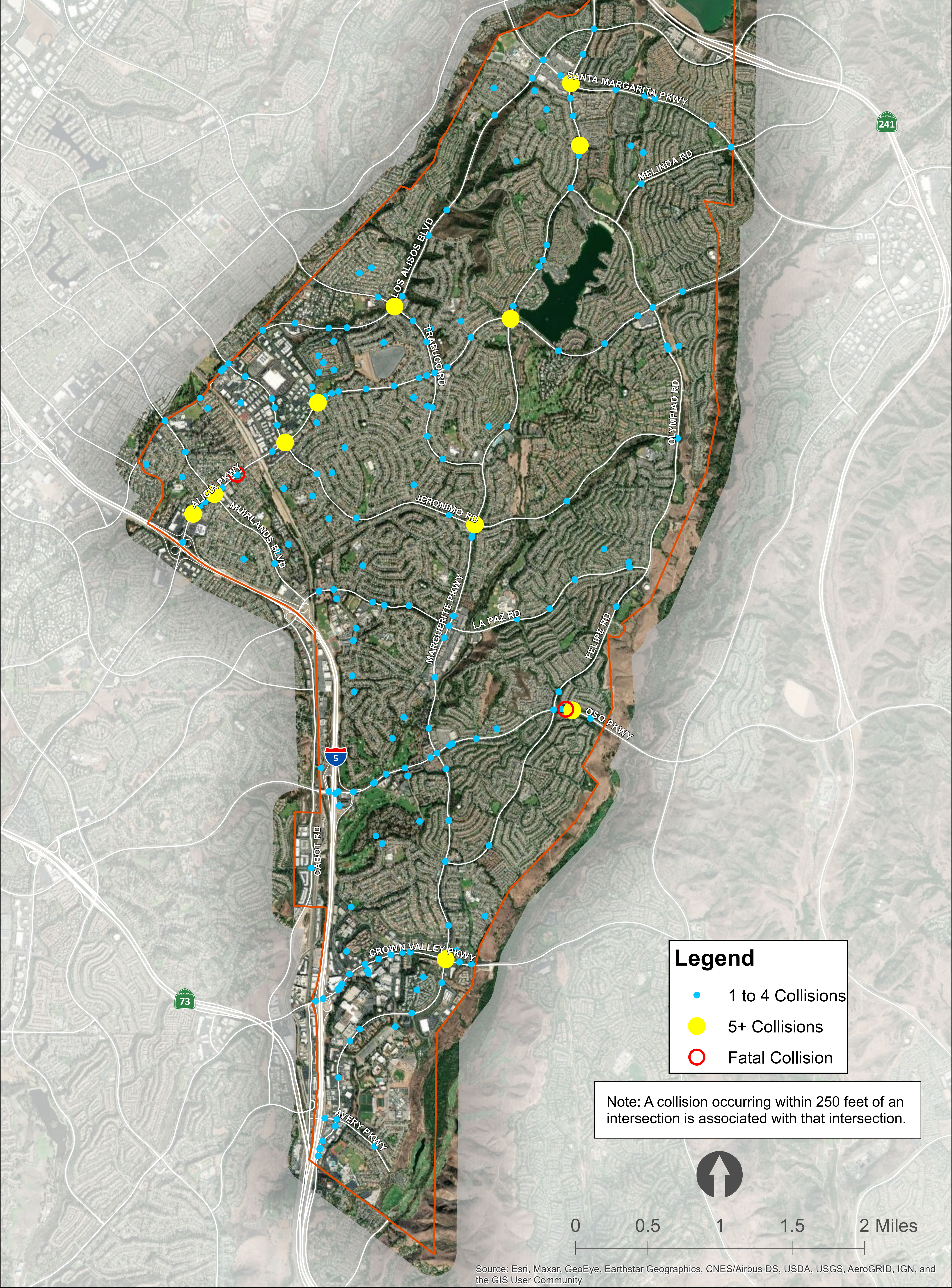
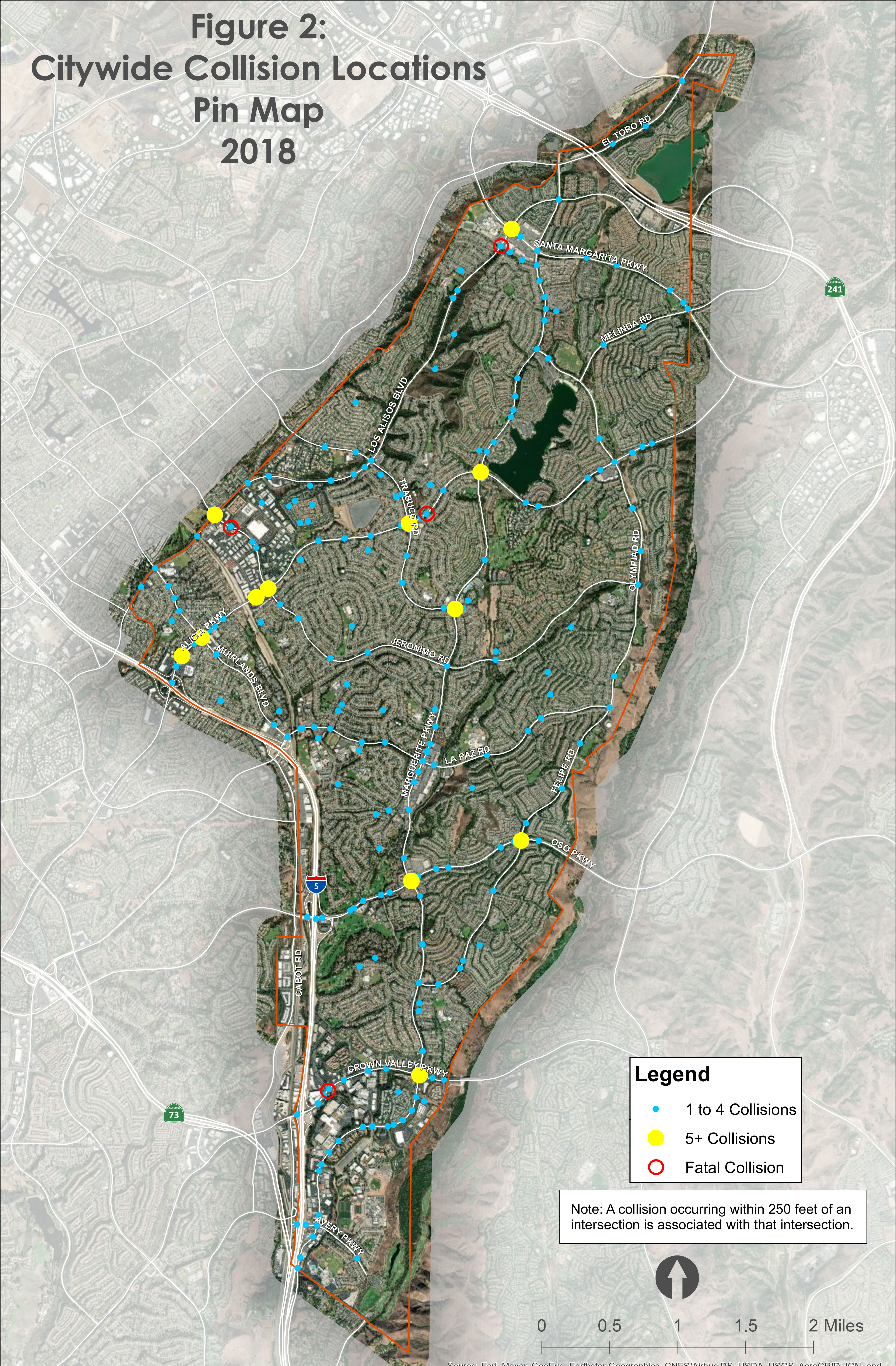
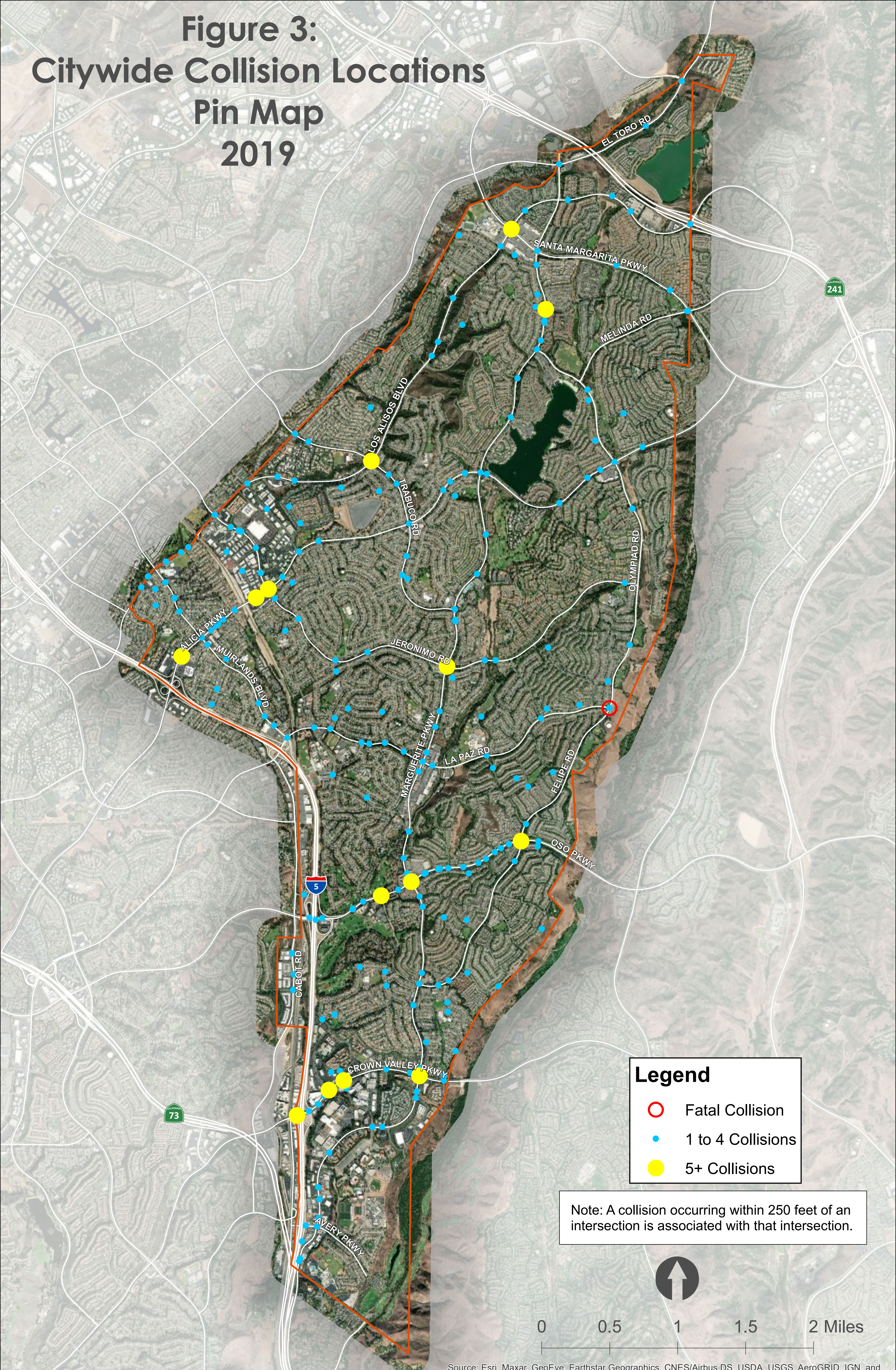


Figure 2: Citywide Collision Locations Pin Map 2018



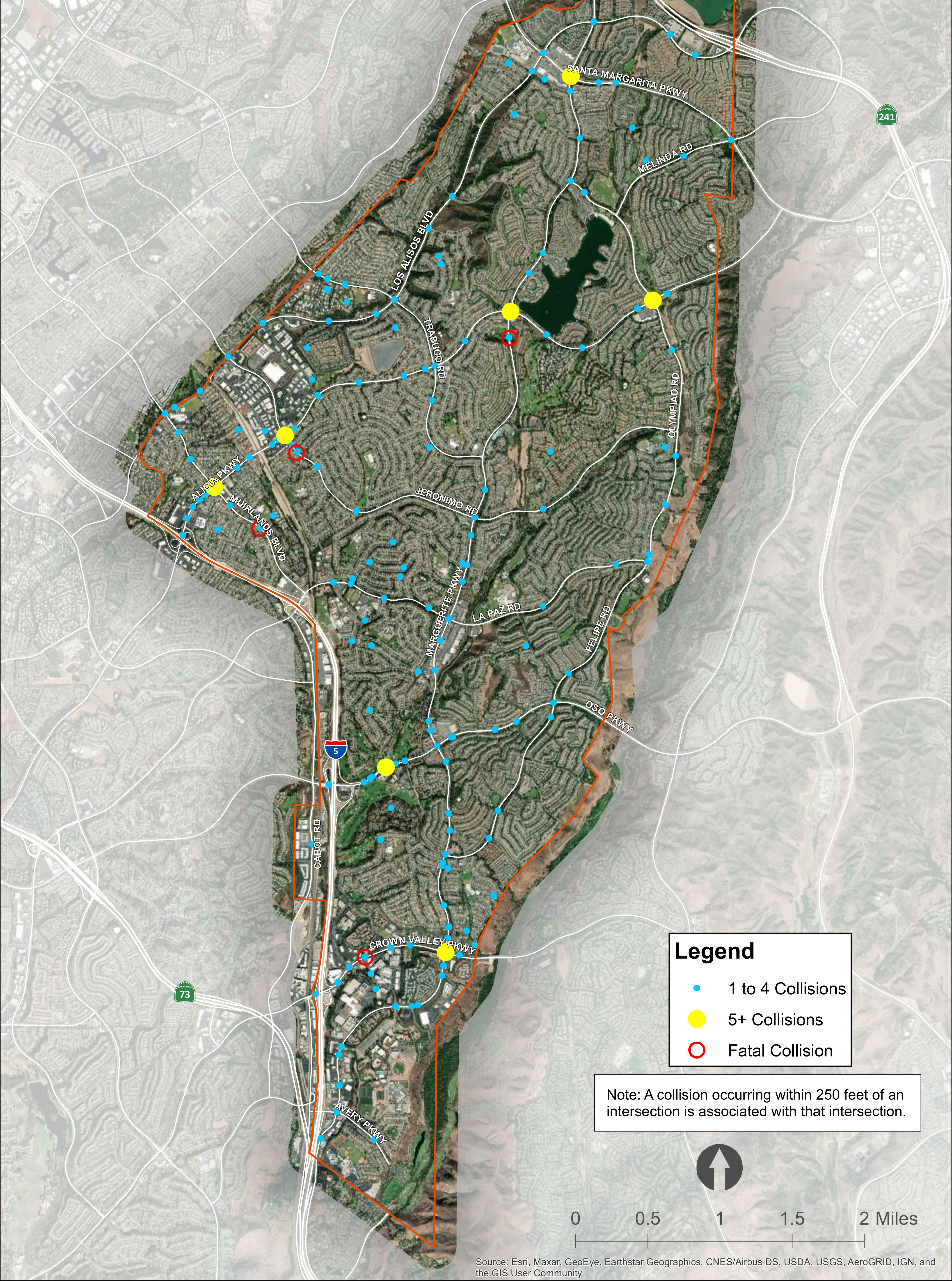
Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

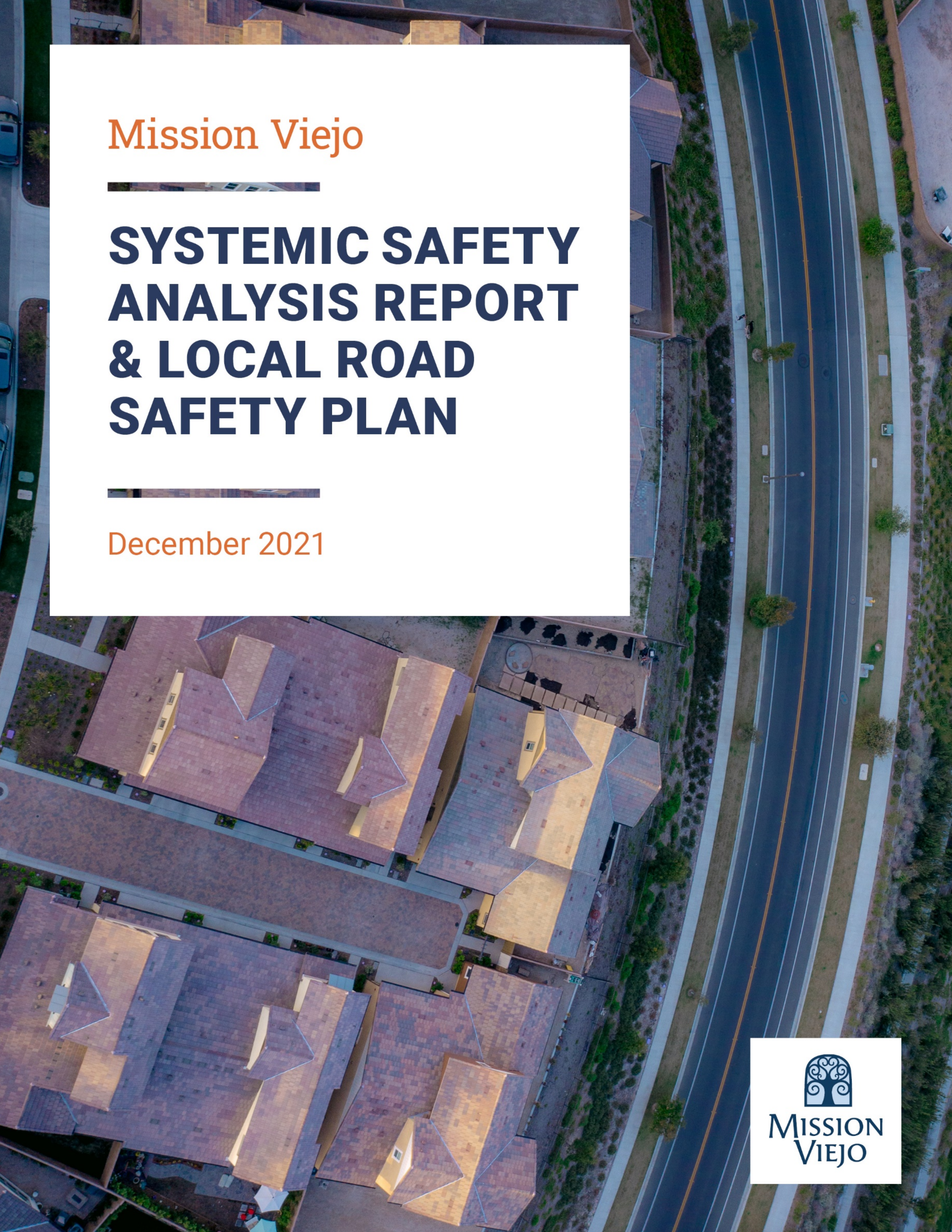
Figure 3:
Citywide Collision Locations
Pin Map
2019



Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Figure 4: Citywide Collision Locations Pin Map 2020





Mission Viejo

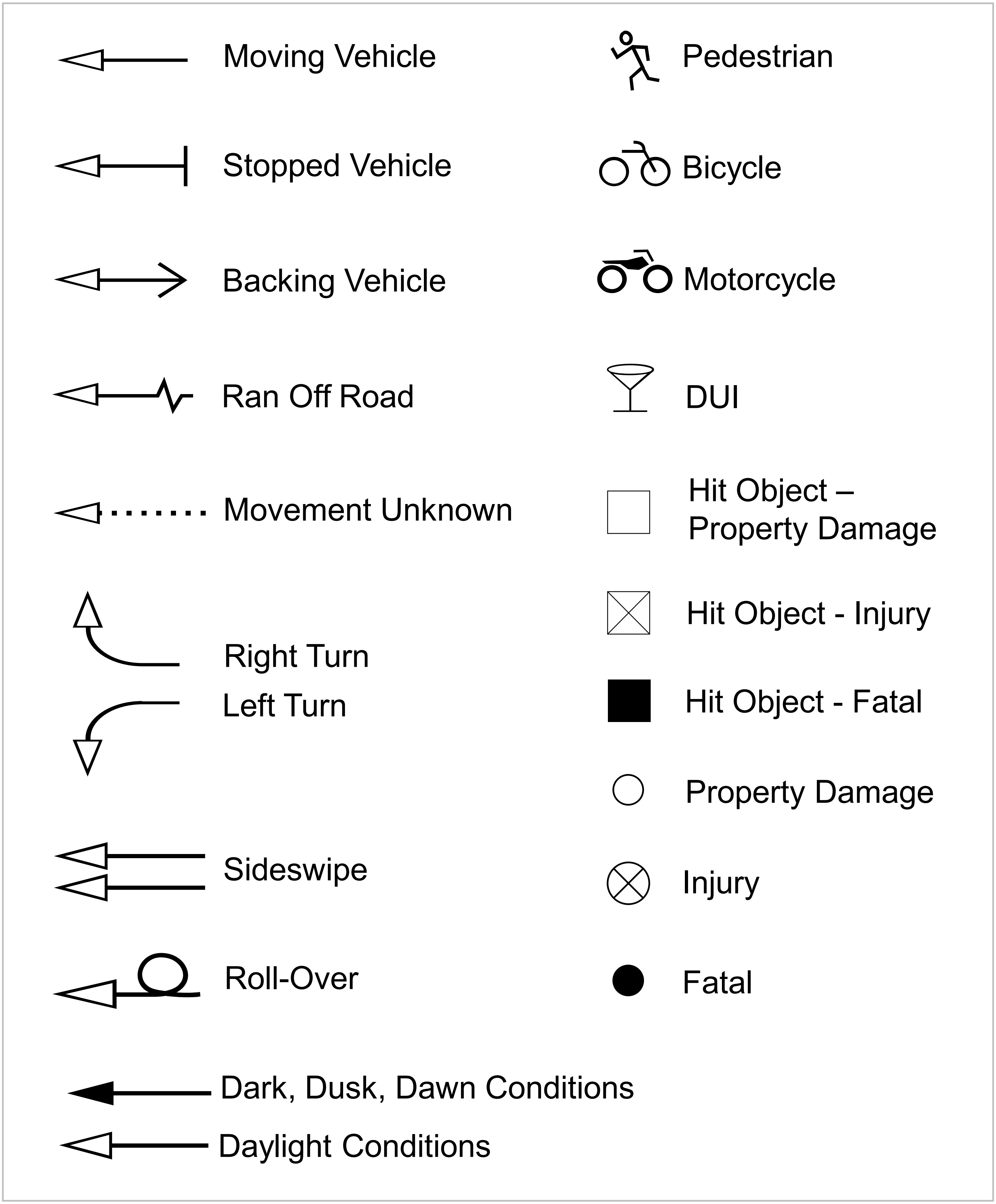
SYSTEMIC SAFETY ANALYSIS REPORT & LOCAL ROAD SAFETY PLAN

December 2021

MISSION VIEJO

APPENDIX B

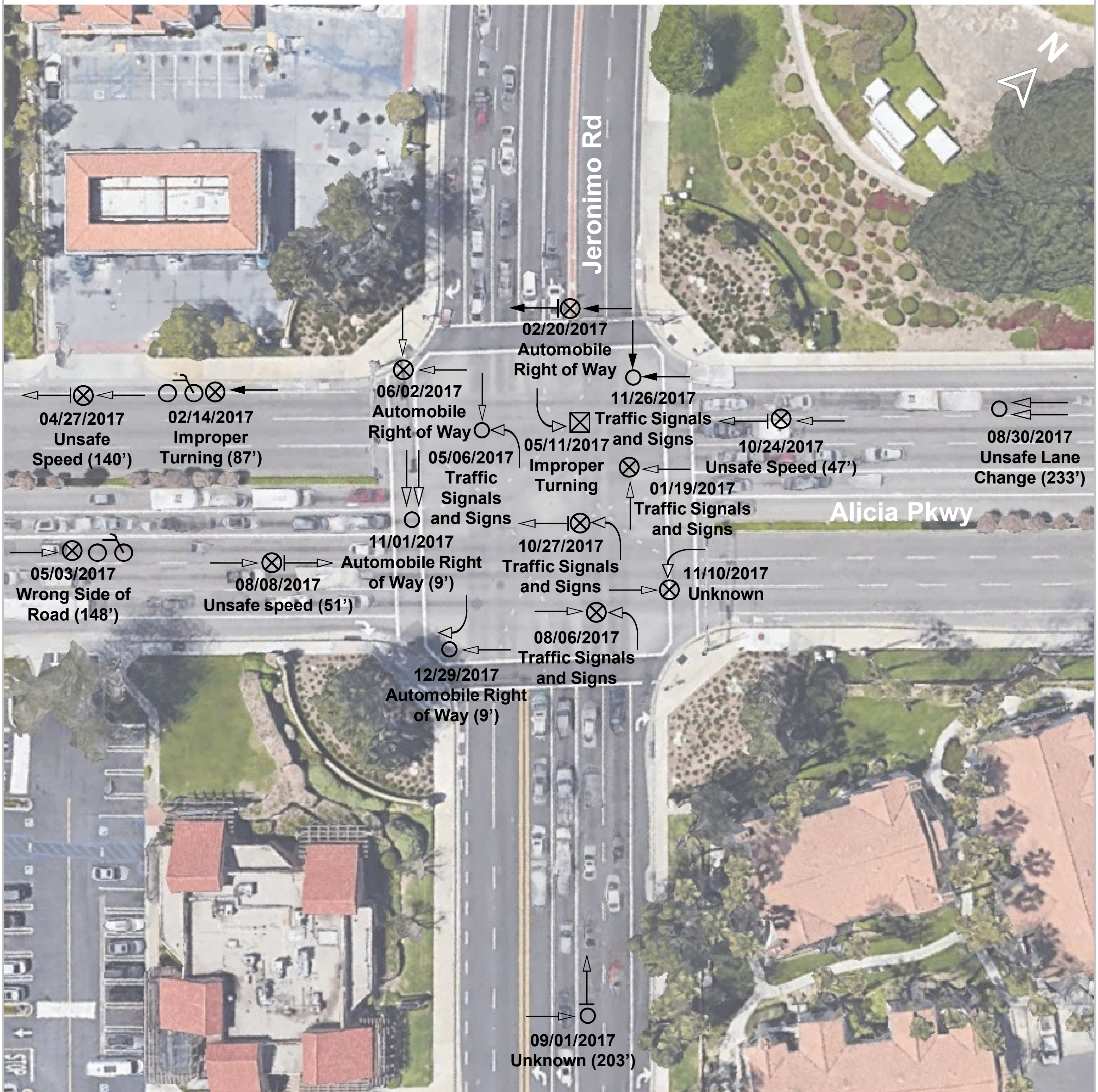
Collision Diagrams


Moving Vehicle
Stopped Vehicle
Backing Vehicle
Ran Off Road
Movement Unknown
Right Turn
Left Turn
Sideswipe
Roll-Over
Dark, Dusk, Dawn Conditions
Daylight Conditions
Pedestrian
Bicycle
Motorcycle
DUI
Hit Object –
Property Damage
Hit Object - Injury
Hit Object - Fatal
Property Damage
Injury
Fatal

Legend

East-West Street: **Alicia Pkwy** | From: **January 2017** To: **December 2017**

North-South Street: **Jeronimo Rd** | Date Prepared: **2021**



Number of Collisions

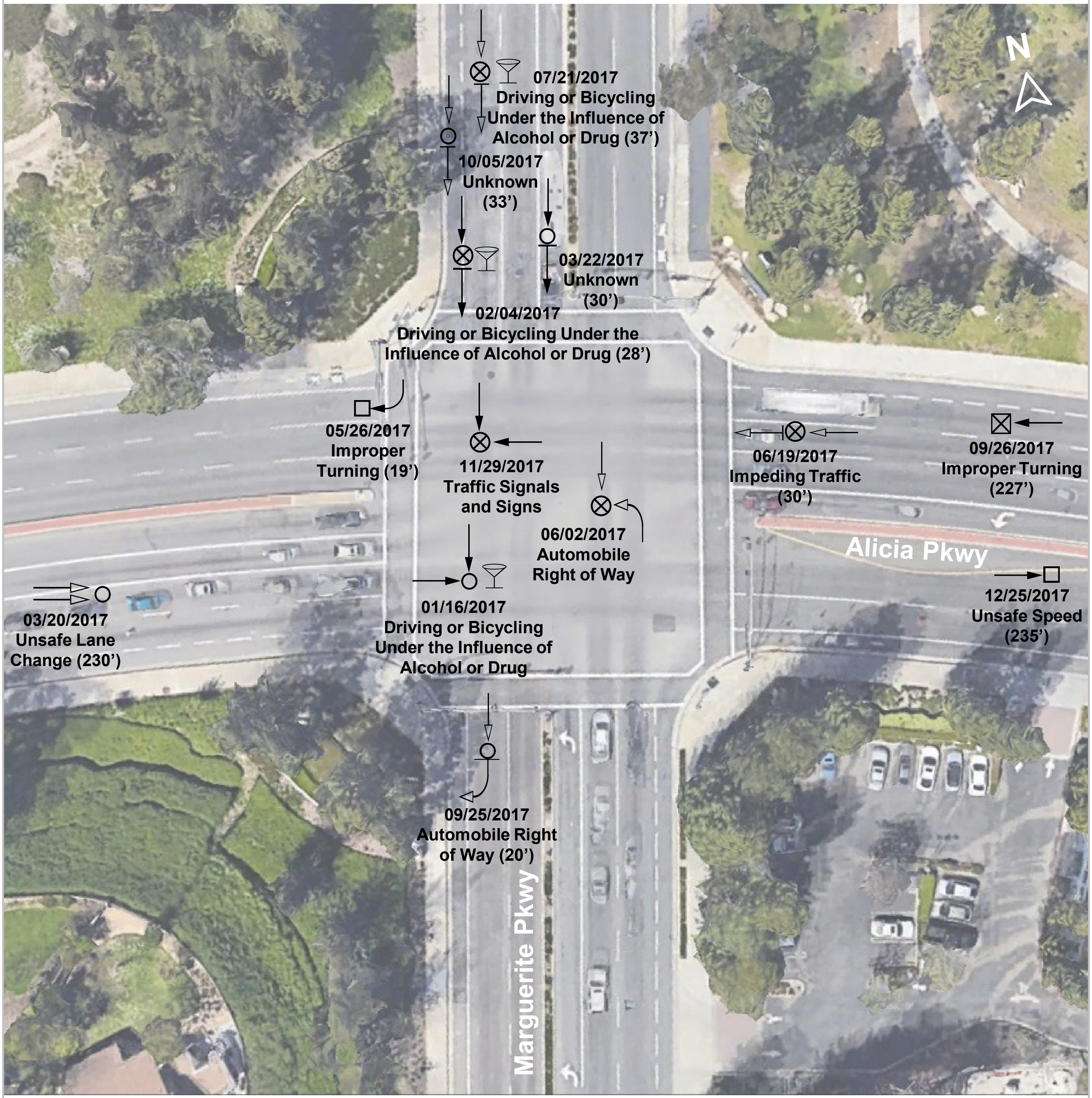
6 Property Damage Only	12 Injury Collisions	0 Fatal Collisions	18 Total Collisions

City of Mission Viejo, California

Figure 2017.1
Collision Diagram

East-West Street: **Alicia Pkwy** From: **January 2017** To: **December 2017**

North-South Street: **Marguerite Pkwy** Date Prepared: **2021**



Number of Collisions

7 Property Damage Only	6 Injury Collisions	0 Fatal Collisions	13 Total Collisions

City of Mission Viejo, California

Figure 2017.2
Collision Diagram

East-West Street: **Alicia Pkwy**

From: **January 2017** To: **December 2017**

North-South Street: **Muirlands Blvd**

Date Prepared: **2021**

Number of Collisions

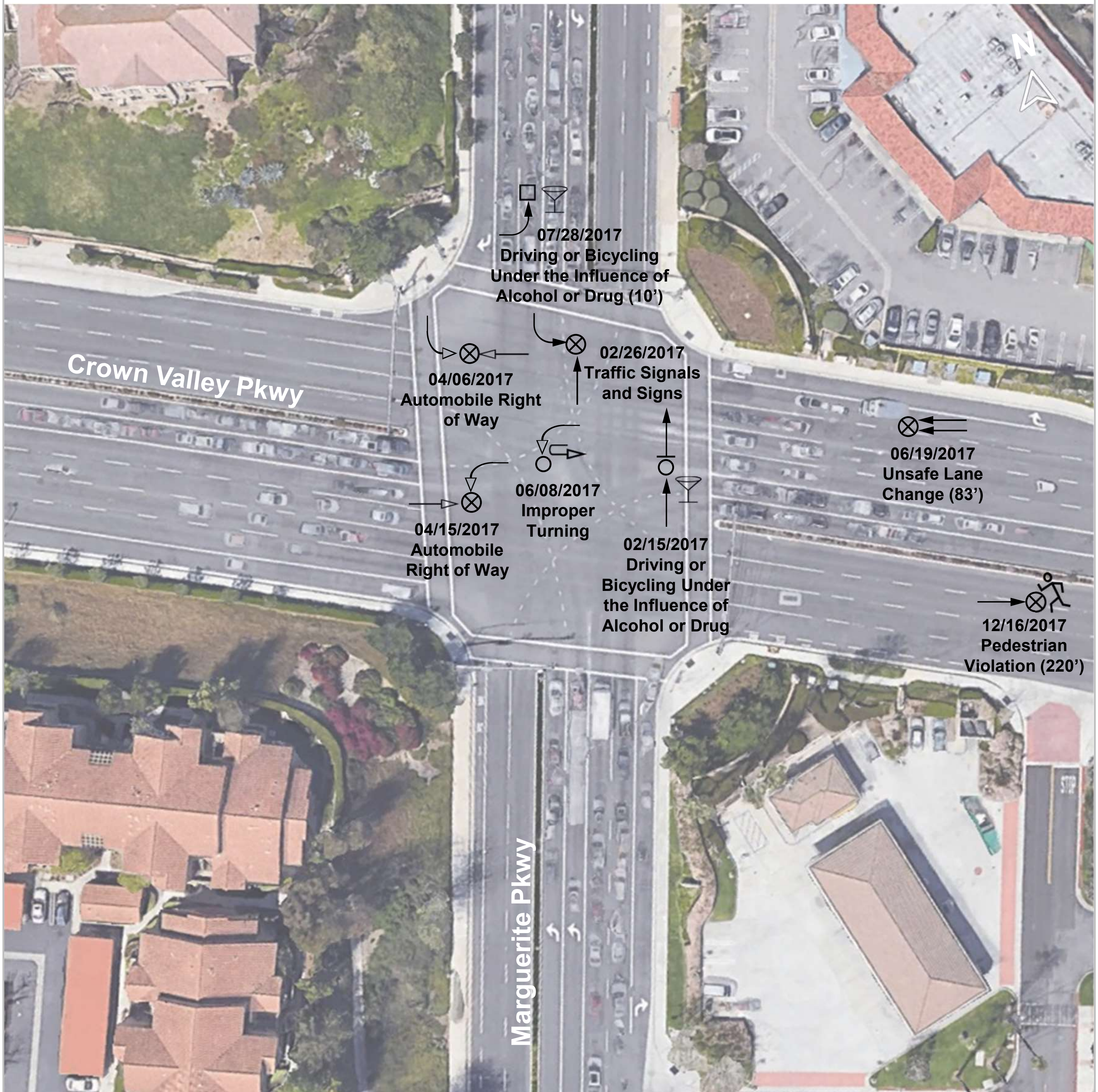
5	Property Damage Only	5	Injury Collisions	0	Fatal Collisions	10	Total Collisions

City of Mission Viejo, California

Figure 2017.3
Collision Diagram

East-West Street: **Crown Valley Pkwy** | From: **January 2017** To: **December 2017**

North-South Street: **Marguerite Pkwy** | Date Prepared: **2021**



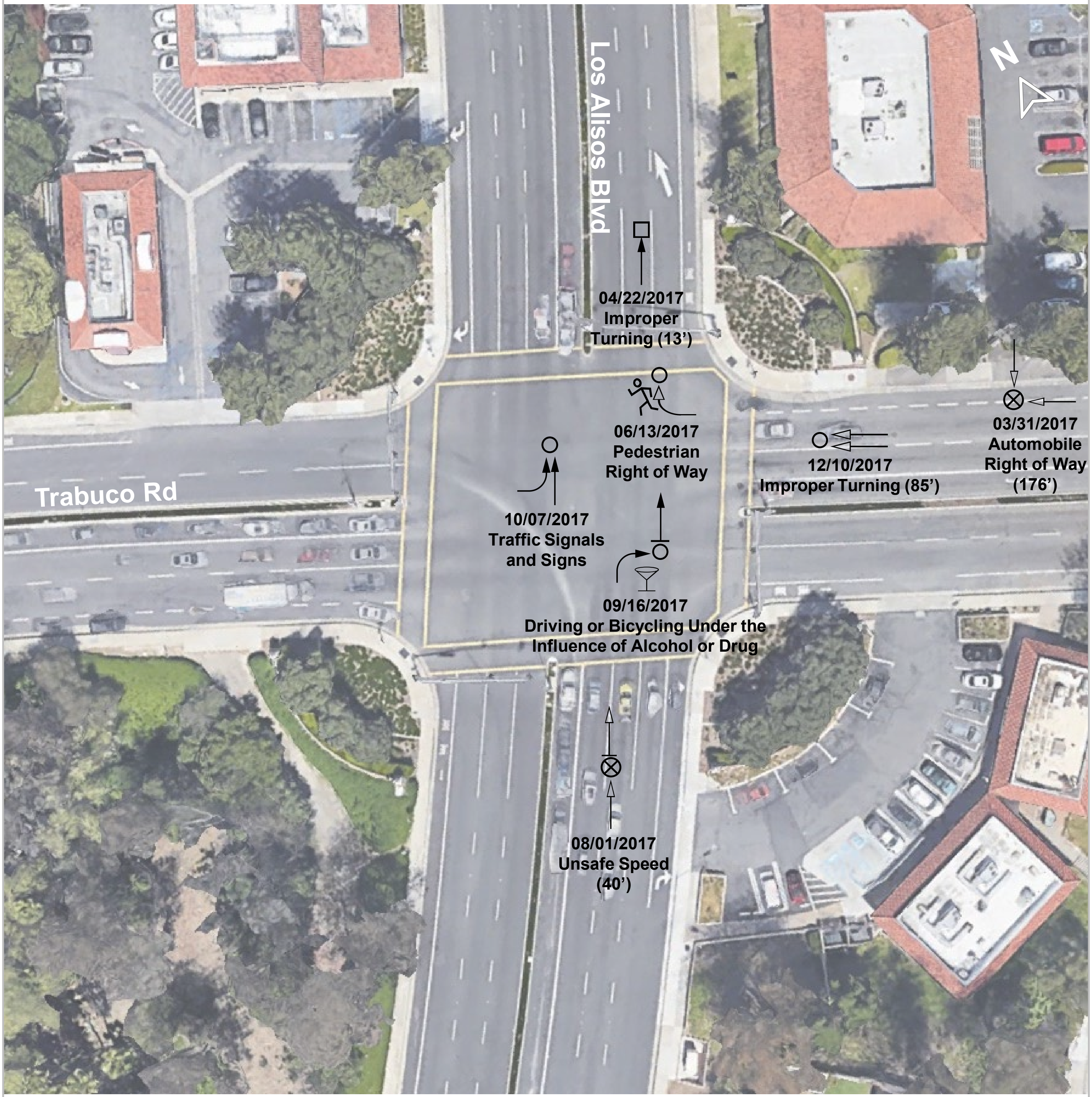
Number of Collisions

3 **Property Damage Only** 5 **Injury Collisions** 0 **Fatal Collisions** 8 **Total Collisions**

Figure 2017.4
Collision Diagram

East-West Street: **Trabuco Rd** | From: **January 2017** To: **December 2017**

North-South Street: **Los Alisos Blvd** | Date Prepared: **2021**



Number of Collisions

5 Property Damage Only | 2 Injury Collisions | 0 Fatal Collisions | 7 Total Collisions

City of Mission Viejo, California

Figure 2017.5
Collision Diagram

East-West Street: **Alicia Pkwy**

From: **January 2017** To: **December 2017**

North-South Street: **Charlinda Dr**

Date Prepared: **2021**

Number of Collisions

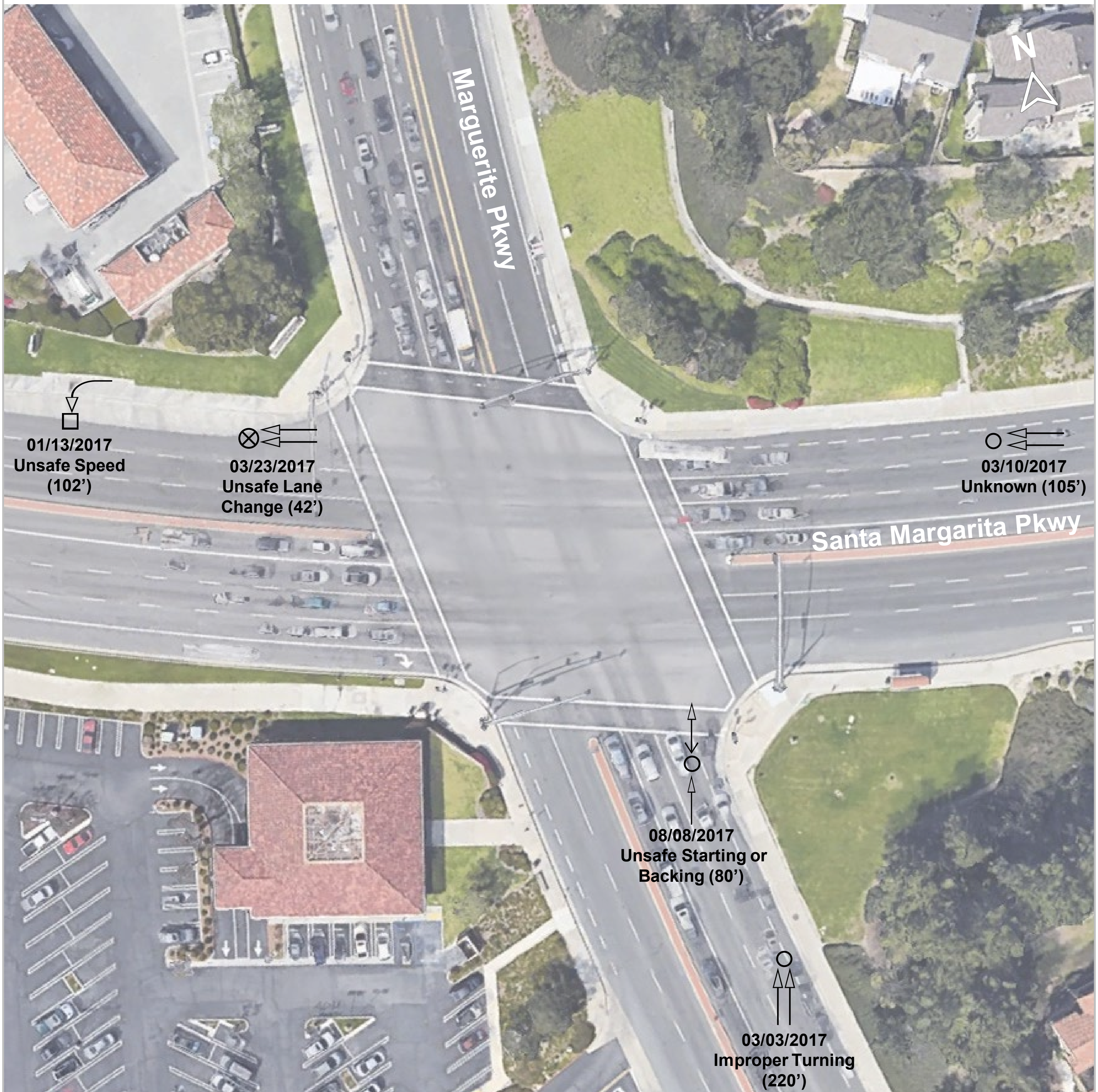
2 Property Damage Only 4 Injury Collisions 0 Fatal Collisions 6 Total Collisions

City of Mission Viejo, California

Figure 2017.6
Collision Diagram

East-West Street: **Santa Margarita Pkwy** From: **January 2017** To: **December 2017**

North-South Street: **Marguerite Pkwy** Date Prepared: **2021**



Number of Collisions

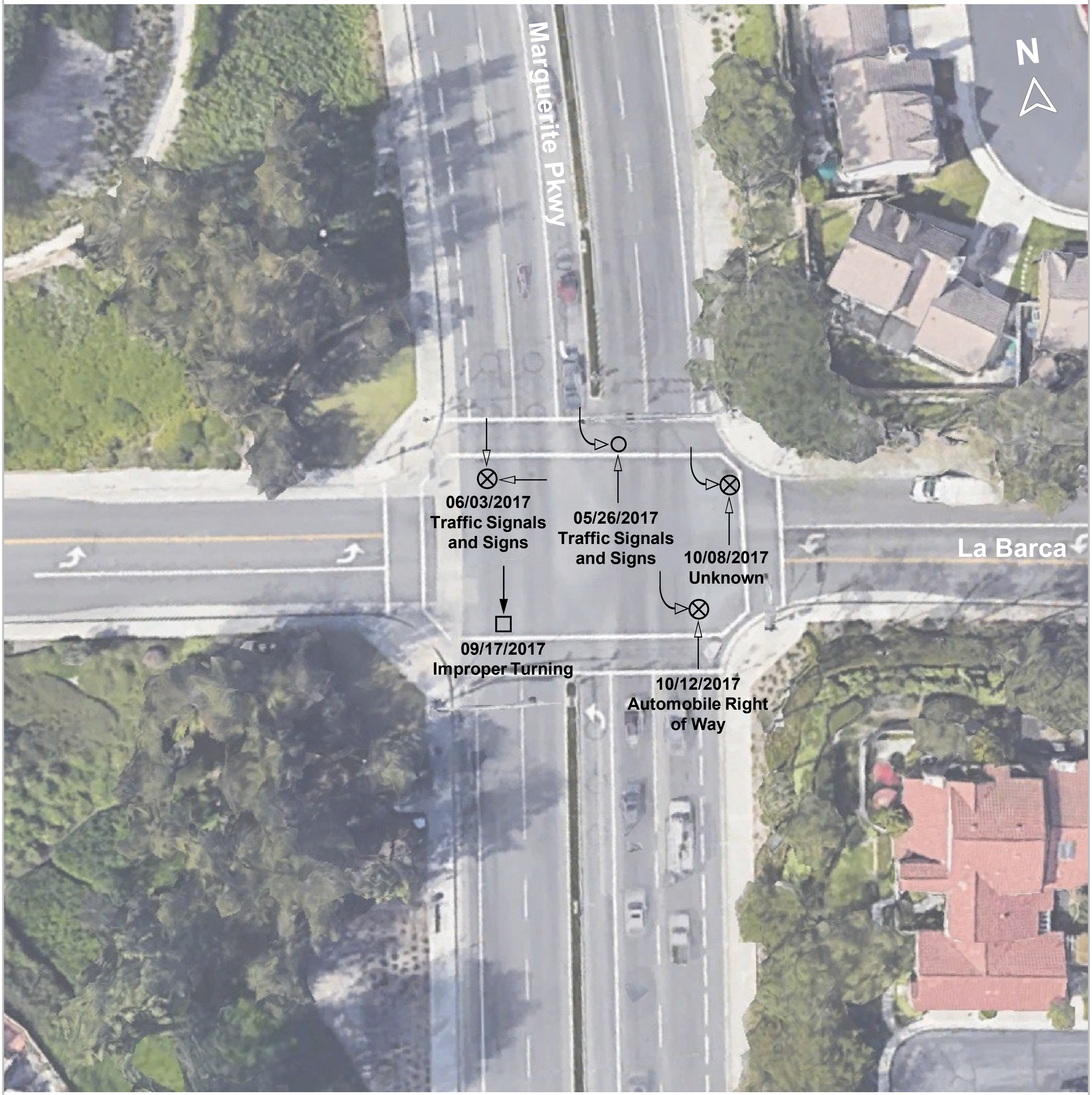
4 **Property Damage Only** 1 **Injury Collisions** 0 **Fatal Collisions** 5 **Total Collisions**

City of Mission Viejo, California

Figure 2017.7
Collision Diagram

East-West Street: **Marguerite Pkwy** | From: **January 2017** To: **December 2017**

North-South Street: **La Barca** | Date Prepared: **2021**



Number of Collisions

2 Property Damage Only | 3 Injury Collisions | 0 Fatal Collisions | 5 Total Collisions

City of Mission Viejo, California

Figure 2017.8
Collision Diagram

East-West Street: **Alicia Pkwy** From: **January 2017** To: **December 2017**

North-South Street: **Via Linda** Date Prepared: **2021**

Number of Collisions

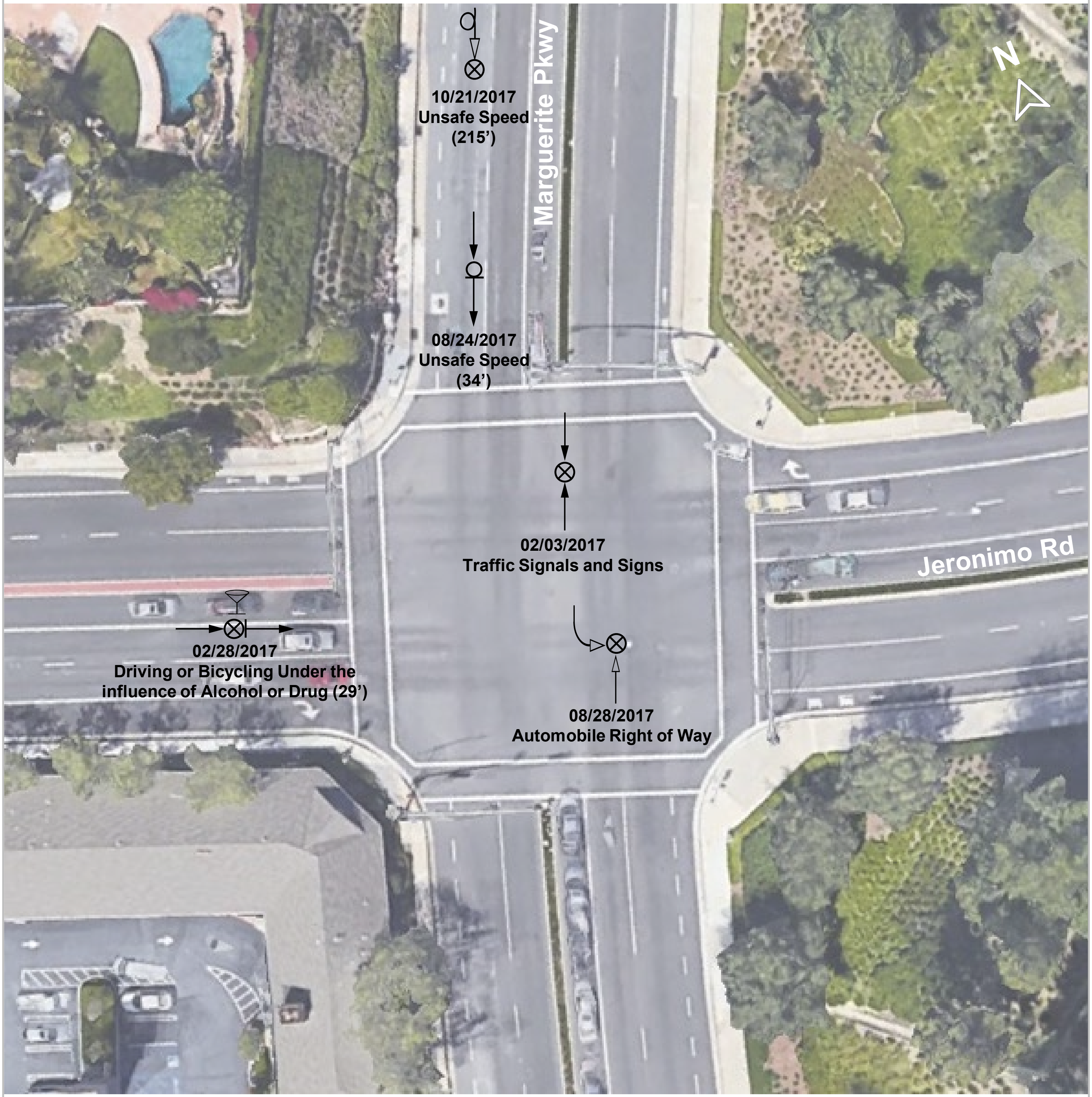
3	Property Damage Only	2	Injury Collisions	0	Fatal Collisions	5	Total Collisions

City of Mission Viejo, California

Figure 2017.9
Collision Diagram

East-West Street: **Jeronimo Rd** From: **January 2017** To: **December 2017**

North-South Street: **Marguerite Pkwy** Date Prepared: **2021**



Number of Collisions

1	Property Damage Only	4	Injury Collisions	0	Fatal Collisions	5	Total Collisions

City of Mission Viejo, California

Figure 2017.10
Collision Diagram

East-West Street: **Oso Pkwy** From: **January 2017** To: **December 2017**

North-South Street: **San Rafael** Date Prepared: **2021**

Number of Collisions

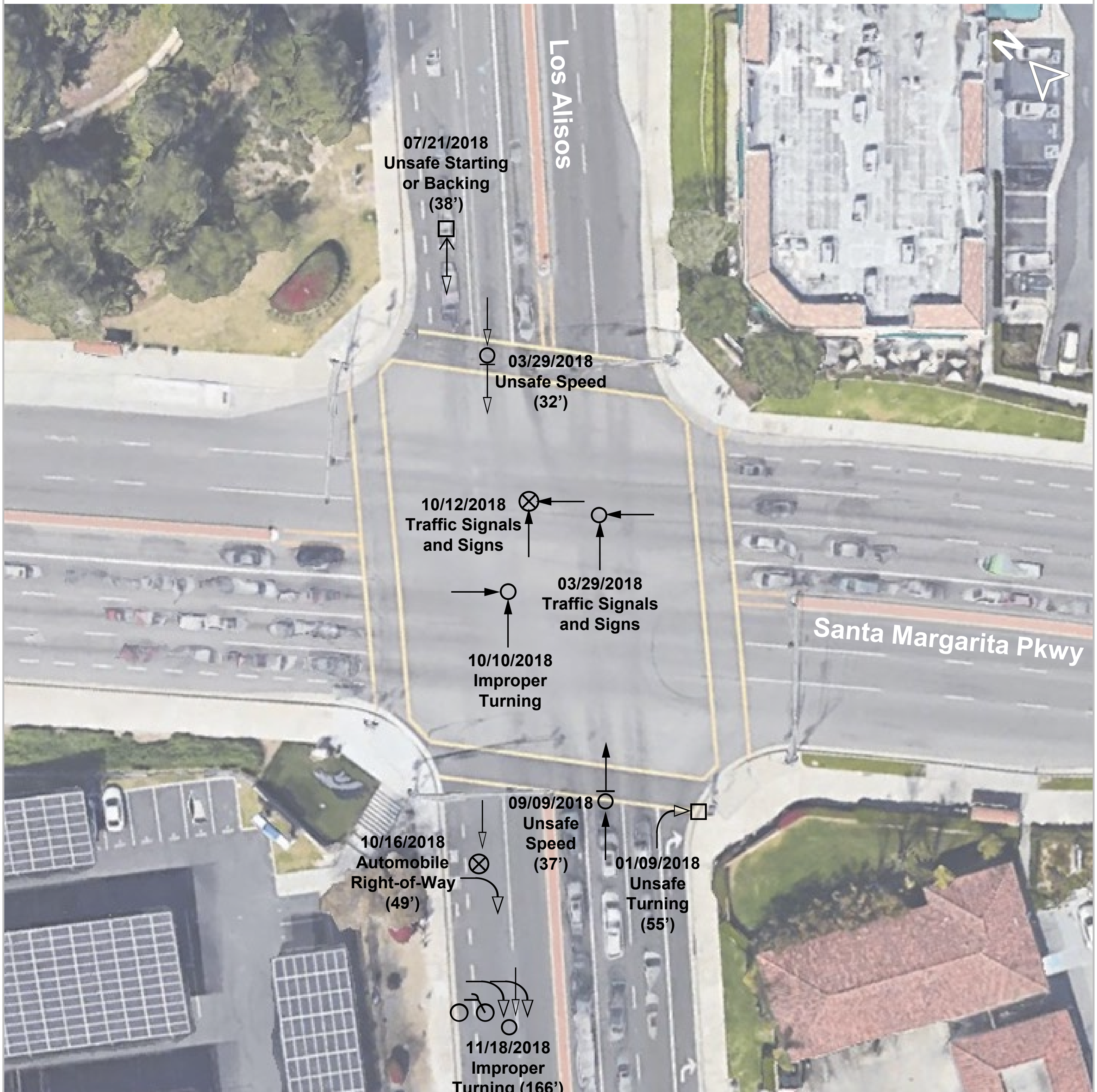
2	Property Damage Only	2	Injury Collisions	1	Fatal Collisions	5	Total Collisions

City of Mission Viejo, California

Figure 2017.11
Collision Diagram

East-West Street: **Santa Margarita Pkwy** From: **January 2018** To: **December 2018**

North-South Street: **Los Alisos** Date Prepared: **2021**



Number of Collisions

7 **Property Damage Only** 2 **Injury Collisions** 0 **Fatal Collisions** 9 **Total Collisions**

City of Mission Viejo, California

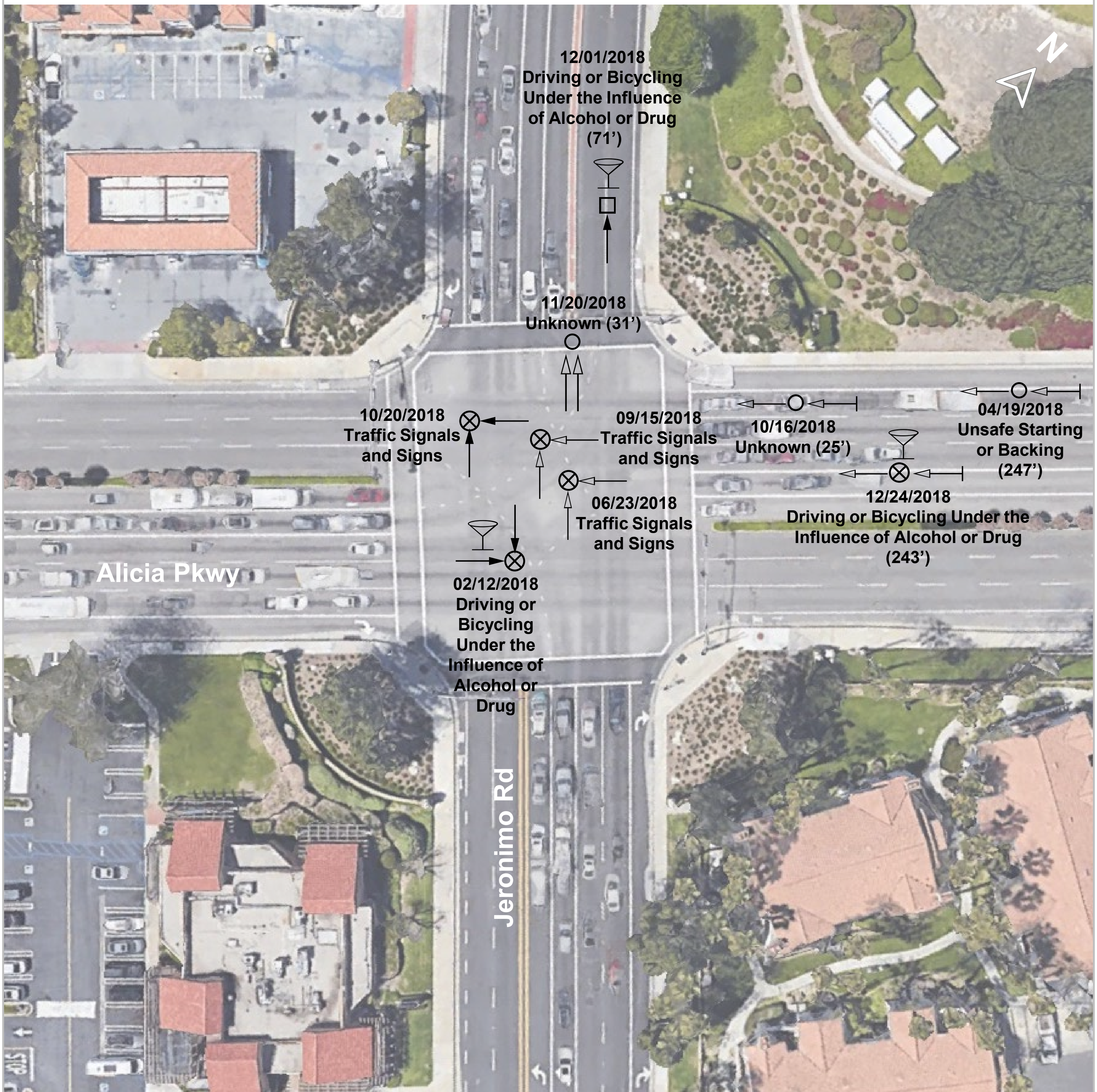
Figure 2018.1
Collision Diagram

East-West Street: **Alicia Pkwy**

North-South Street: **Jeronimo Rd**

From: **January 2018** To: **December 2018**

Date Prepared: **2021**



Number of Collisions

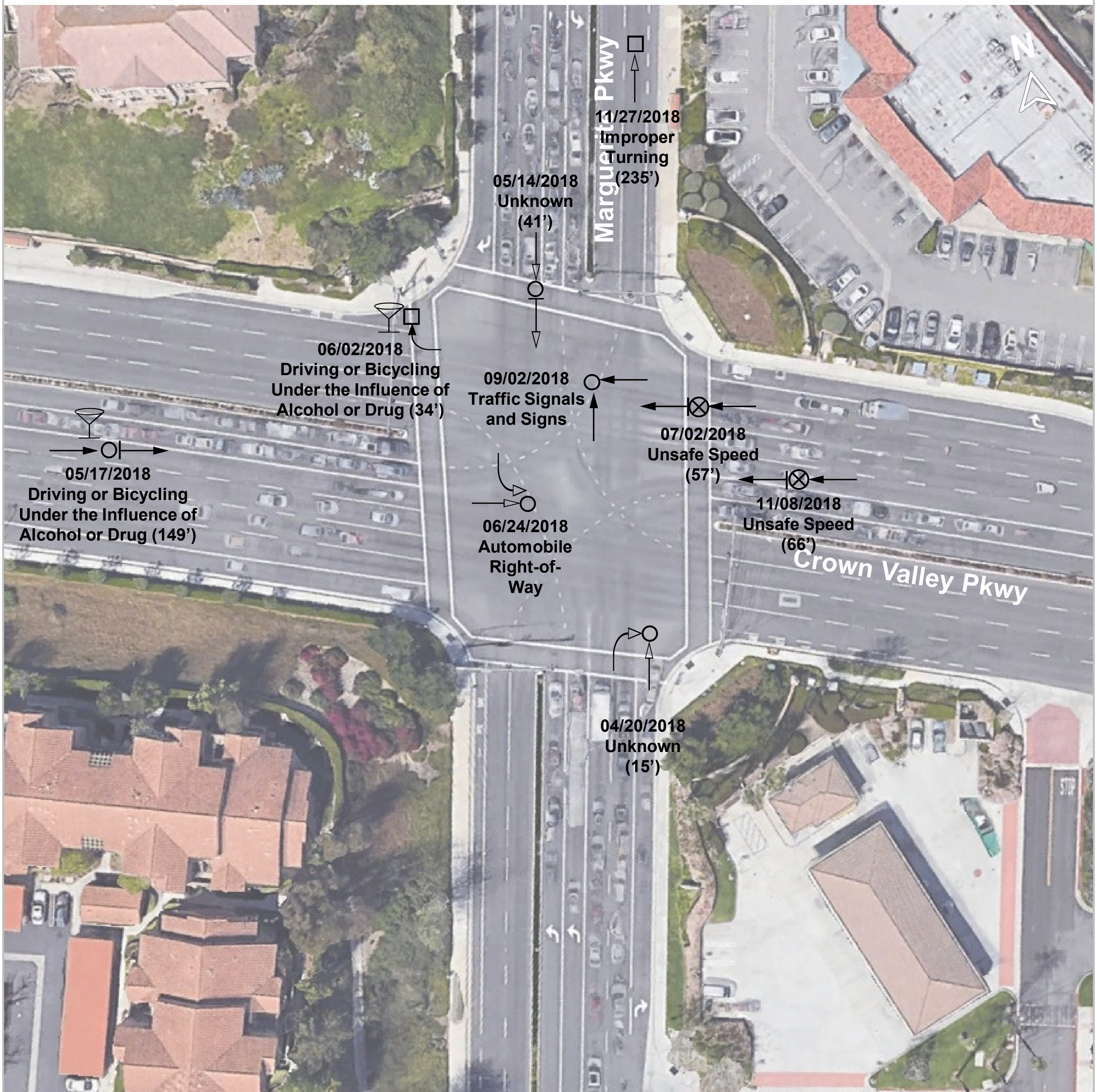
4 Property Damage Only	5 Injury Collisions	0 Fatal Collisions	9 Total Collisions

City of Mission Viejo, California

Figure 2018.2
Collision Diagram

East-West Street: **Crown Valley Pkwy** From: **January 2018** To: **December 2018**

North-South Street: **Marguerite Pkwy** Date Prepared: **2021**



Number of Collisions

7 Property Damage Only   2 Injury Collisions   0 Fatal Collisions   9 Total Collisions

City of Mission Viejo, California

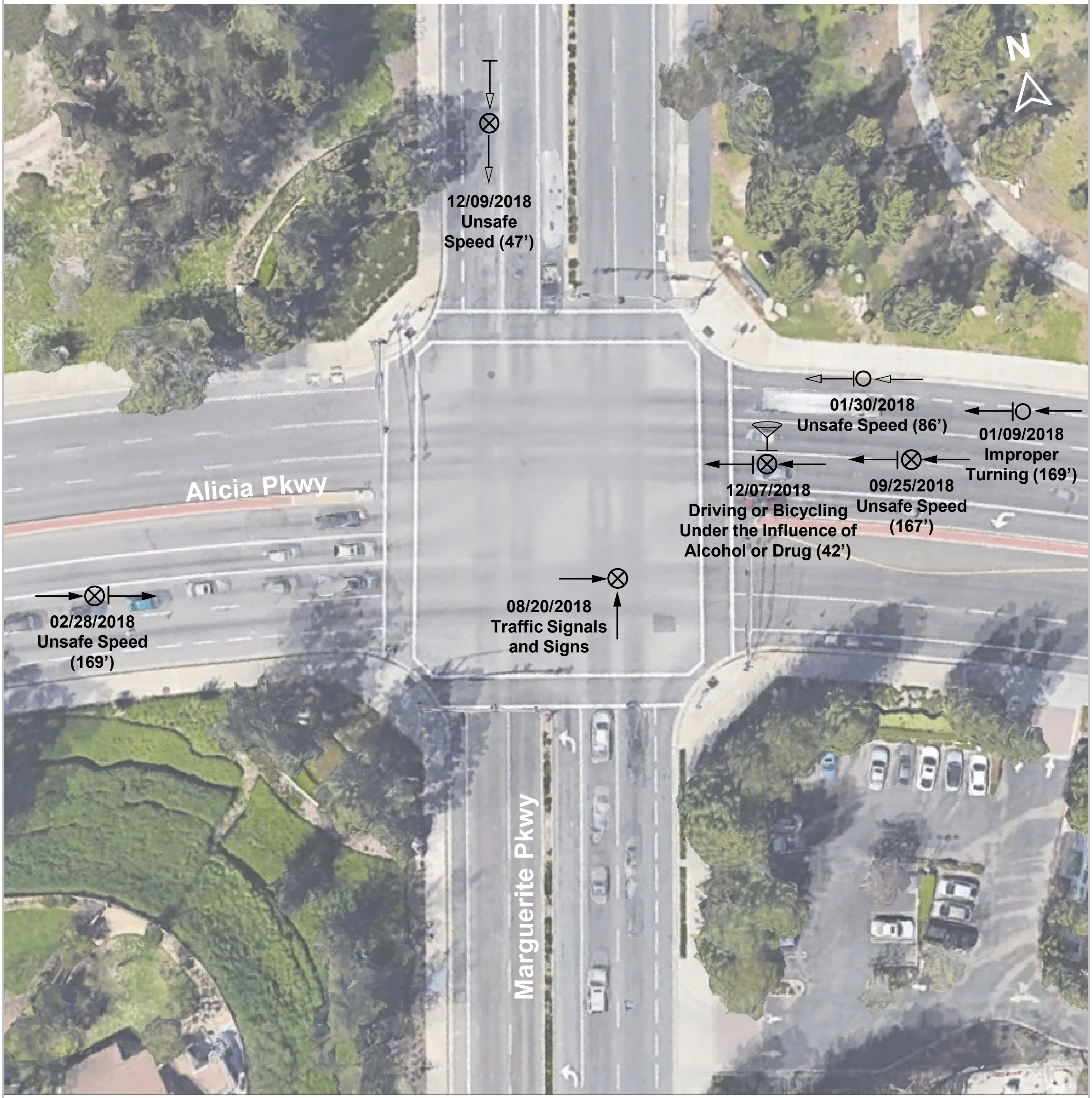
Figure 2018.3
Collision Diagram

East-West Street: **Alicia Pkwy**

From: **January 2018** To: **December 2018**

North-South Street: **Marguerite Pkwy**

Date Prepared: **2021**



Number of Collisions

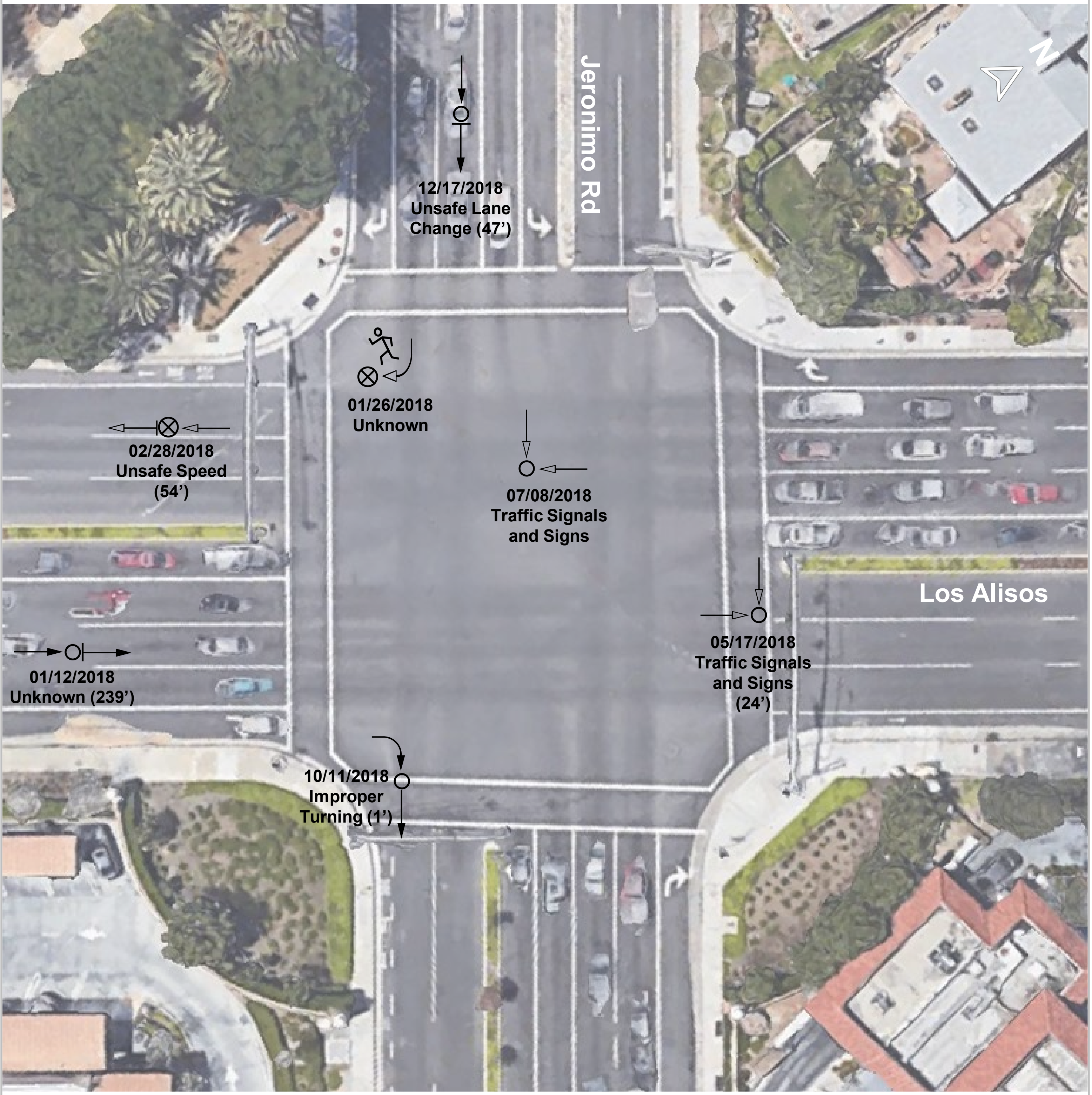
2	**Property Damage Only**	5	**Injury Collisions**	0	**Fatal Collisions**	7	**Total Collisions**

City of Mission Viejo, California

Figure 2018.4
Collision Diagram

East-West Street: **Los Alisos** From: **January 2018** To: **December 2018**

North-South Street: **Jeronimo Rd** Date Prepared: **2021**



Number of Collisions

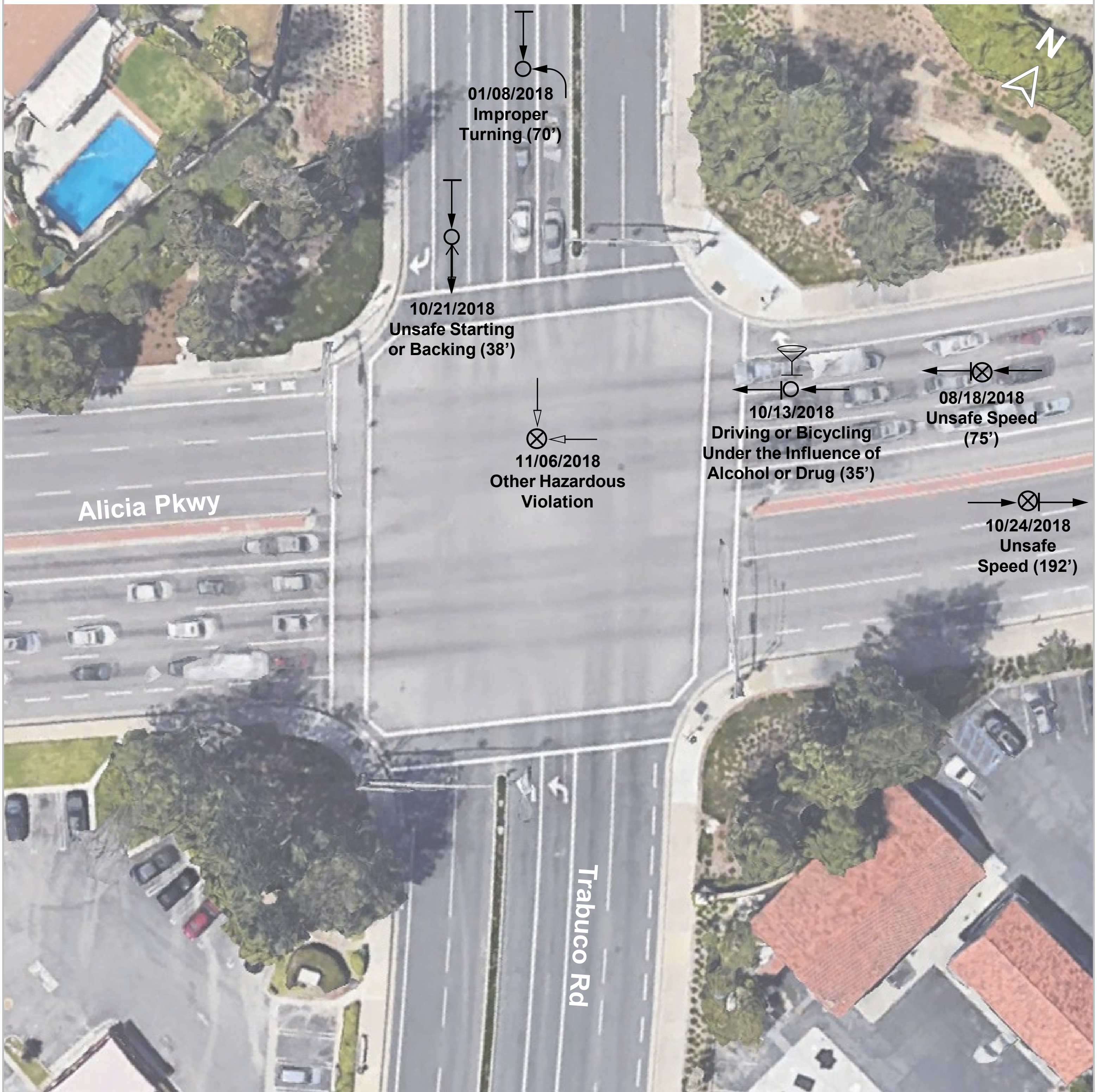
5 Property Damage Only	2 Injury Collisions	0 Fatal Collisions	7 Total Collisions

City of Mission Viejo, California

Figure 2018.5
Collision Diagram

East-West Street: **Alicia Pkwy** | From: **January 2018** To: **December 2018**

North-South Street: **Trabuco Rd** | Date Prepared: **2021**



Number of Collisions

3 Property Damage Only | 3 Injury Collisions | 0 Fatal Collisions | 6 Total Collisions

City of Mission Viejo, California

Figure 2018.6
Collision Diagram

East-West Street: **Alicia Pkwy** From: **January 2018** To: **December 2018**

North-South Street: **Via Fabricante** Date Prepared: **2021**

Number of Collisions

3 Property Damage Only 3 Injury Collisions 0 Fatal Collisions 6 Total Collisions

City of Mission Viejo, California

Figure 2018.7
Collision Diagram

East-West Street: **Alicia Pkwy** From: **January 2018** To: **December 2018**

North-South Street: **Muirlands Blvd** Date Prepared: **2021**

Number of Collisions

4 Property Damage Only	2 Injury Collisions	0 Fatal Collisions	6 Total Collisions

City of Mission Viejo, California

Figure 2018.8
Collision Diagram

East-West Street: **Trabuco Rd**

From: **January 2018** To: **December 2018**

North-South Street: **Marguerite Pkwy**

Date Prepared: **2021**

Number of Collisions

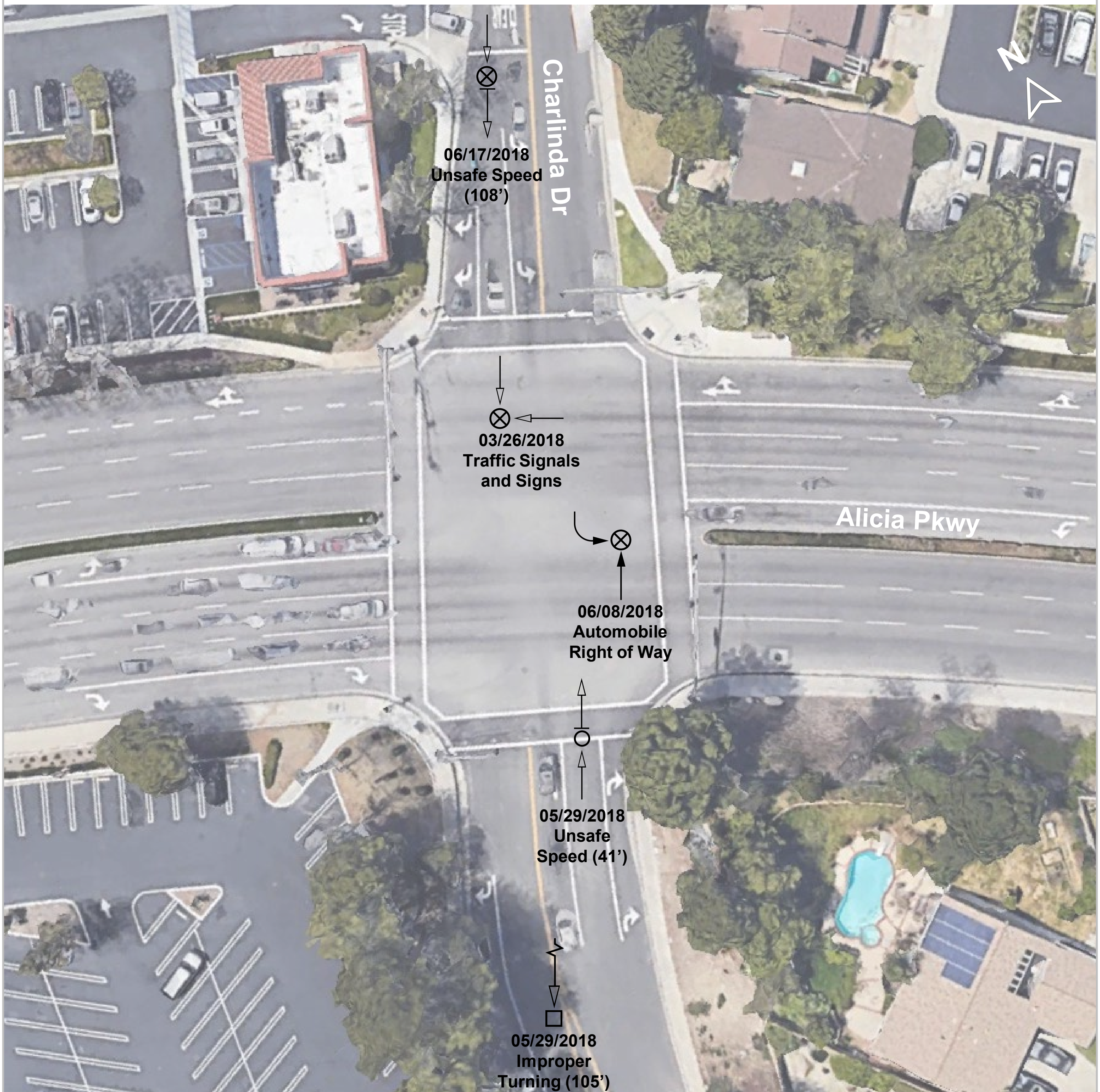
2 Property Damage Only **3** Injury Collisions **0** Fatal Collisions **5** Total Collisions

City of Mission Viejo, California

Figure 2018.9
Collision Diagram

East-West Street: **Alicia Pkwy** From: **January 2018** To: **December 2018**

North-South Street: **Charlinda Dr** Date Prepared: **2021**



Number of Collisions

2	Property Damage Only	3	Injury Collisions	0	Fatal Collisions	5	Total Collisions

City of Mission Viejo, California

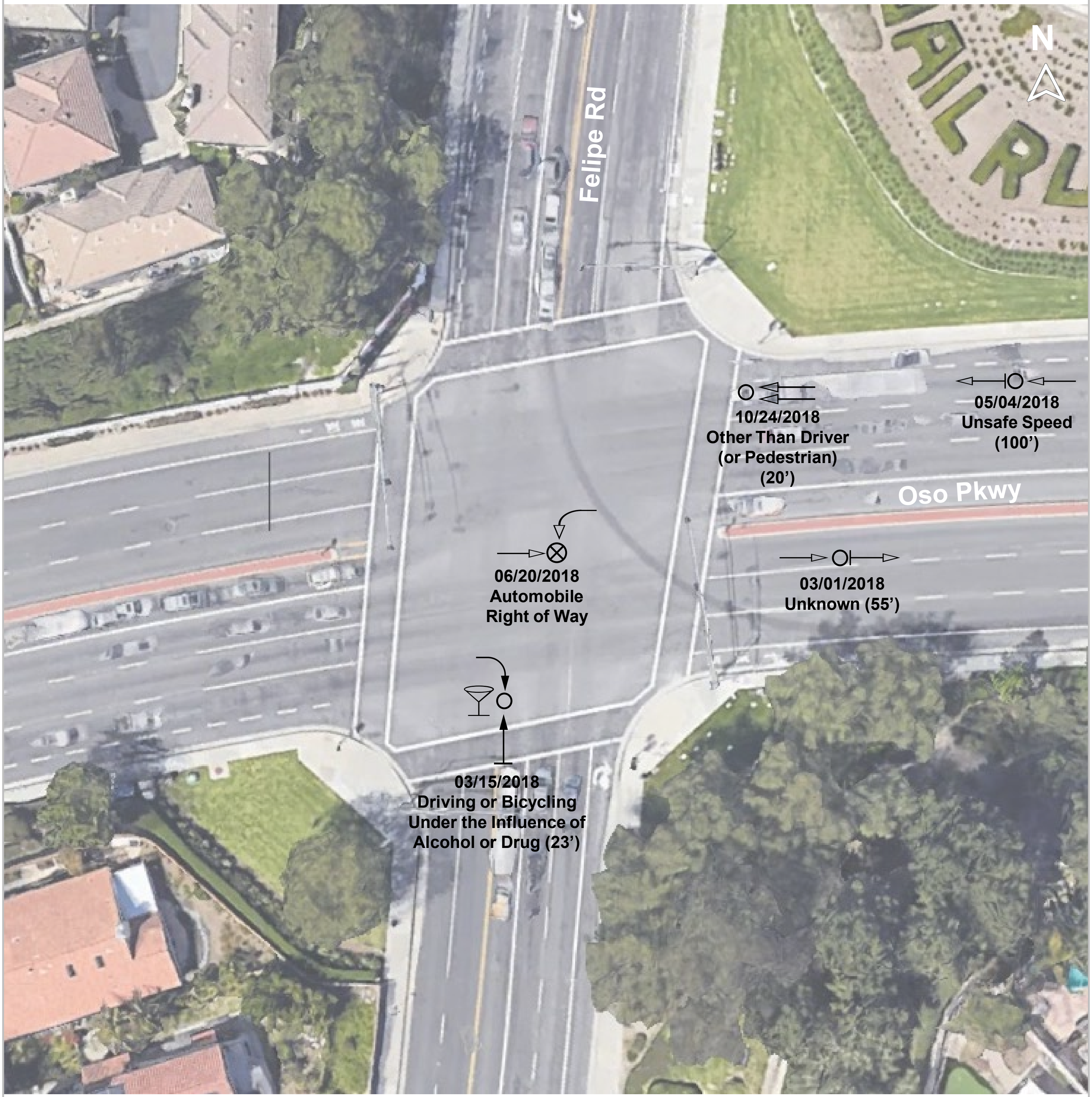
Figure 2018.10
Collision Diagram

East-West Street: **Oso Pkwy**

From: **January 2018** To: **December 2018**

North-South Street: **Felipe Rd**

Date Prepared: **2021**



Number of Collisions

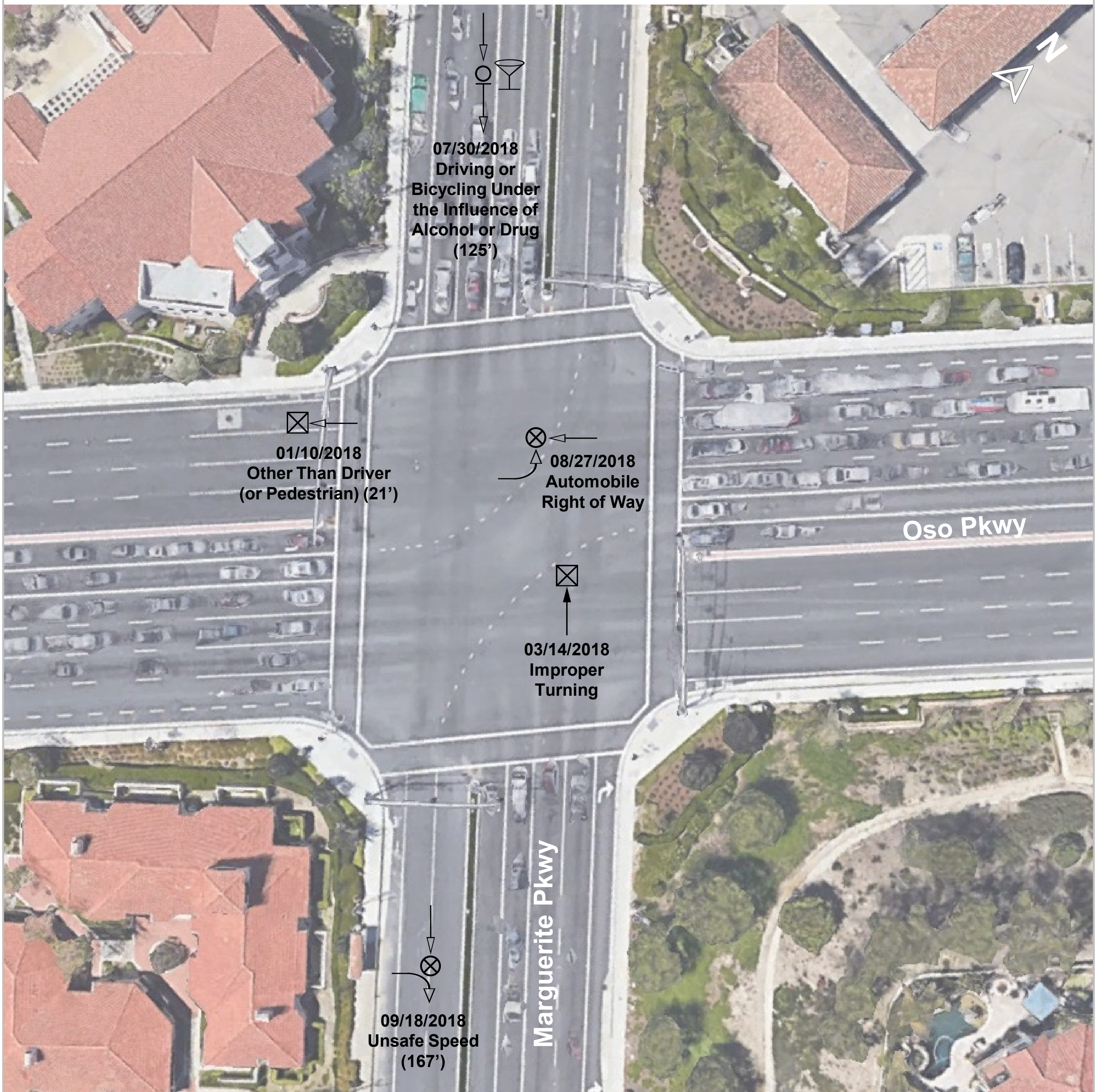
4 Property Damage Only | **1** Injury Collisions | **0** Fatal Collisions | **5** Total Collisions

City of Mission Viejo, California

Figure 2018.11
Collision Diagram

East-West Street: **Oso Pkwy** From: **January 2018** To: **December 2018**

North-South Street: **Marguerite Pkwy** Date Prepared: **2021**



Number of Collisions

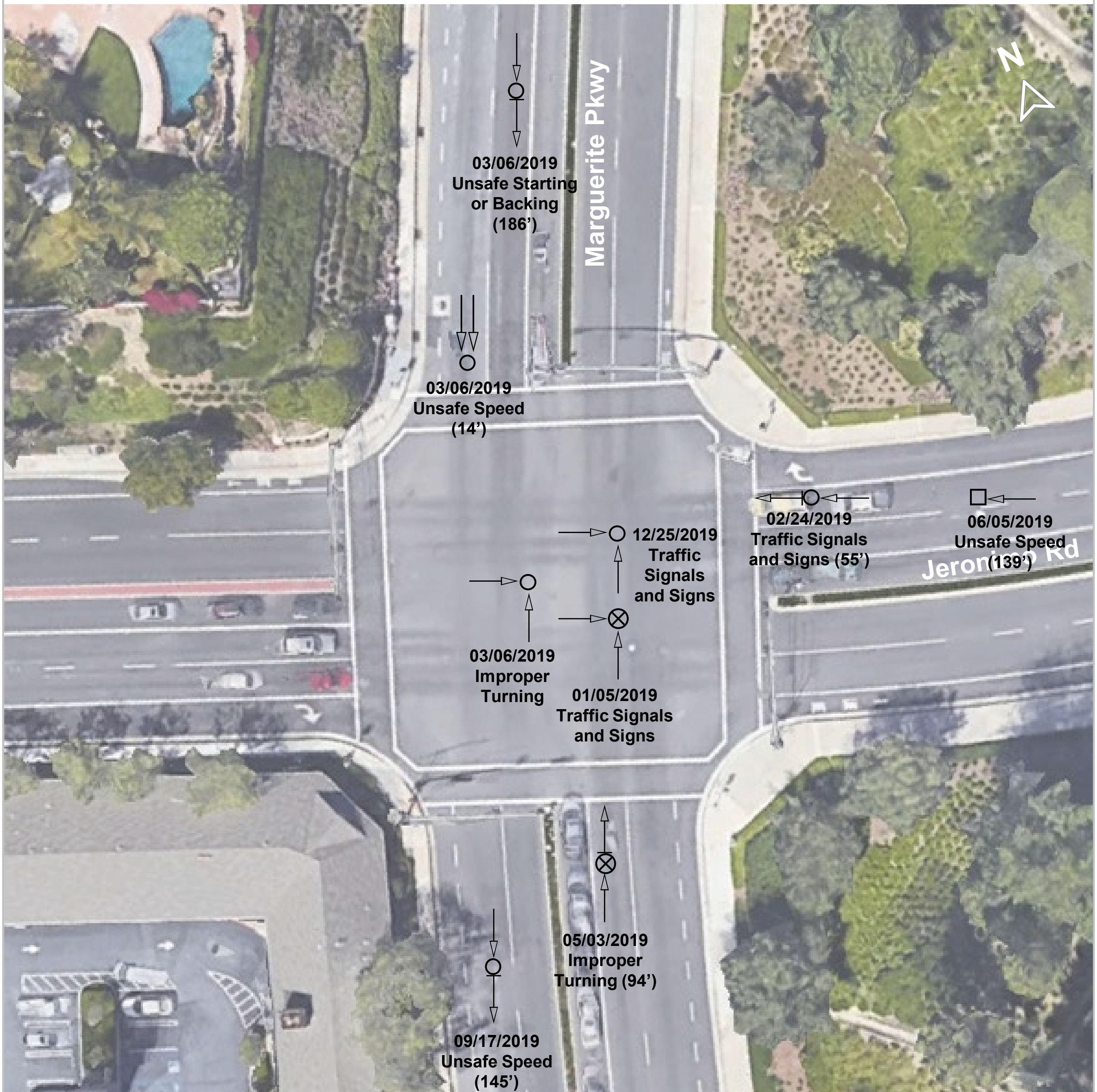
1	Property Damage Only	4	Injury Collisions	0	Fatal Collisions	5	Total Collisions

City of Mission Viejo, California

Figure 2018.12
Collision Diagram

East-West Street: **Jeronimo Rd** From: **January 2019** To: **December 2019**

North-South Street: **Marguerite Pkwy** Date Prepared: **2021**



Number of Collisions

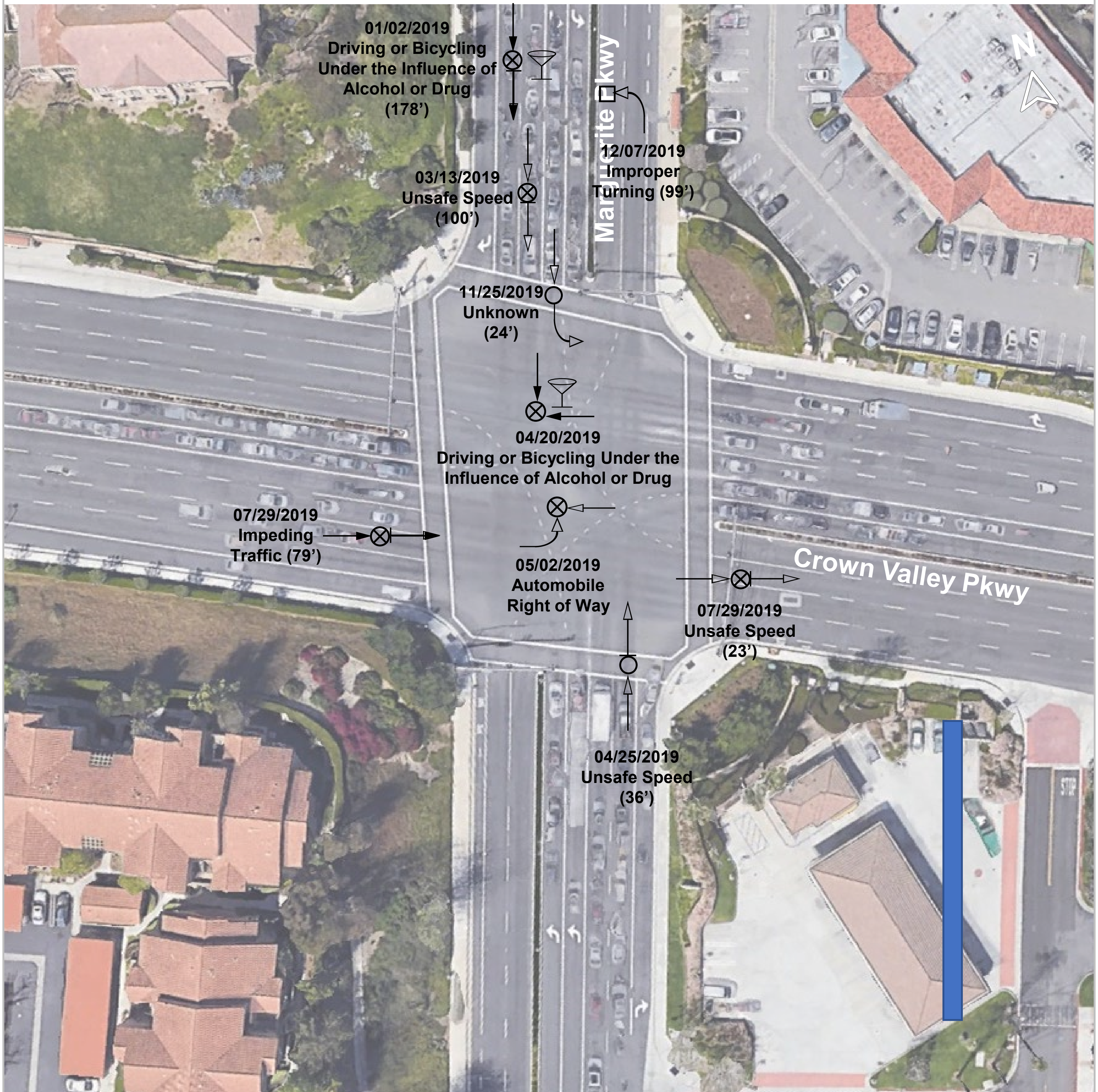
7 Property Damage Only **2** Injury Collisions **0** Fatal Collisions **9** Total Collisions

City of Mission Viejo, California

Figure 2019.1
Collision Diagram

East-West Street: **Crown Valley Pkwy** From: **January 2019** To: **December 2019**

North-South Street: **Marguerite Pkwy** Date Prepared: **2021**



Number of Collisions

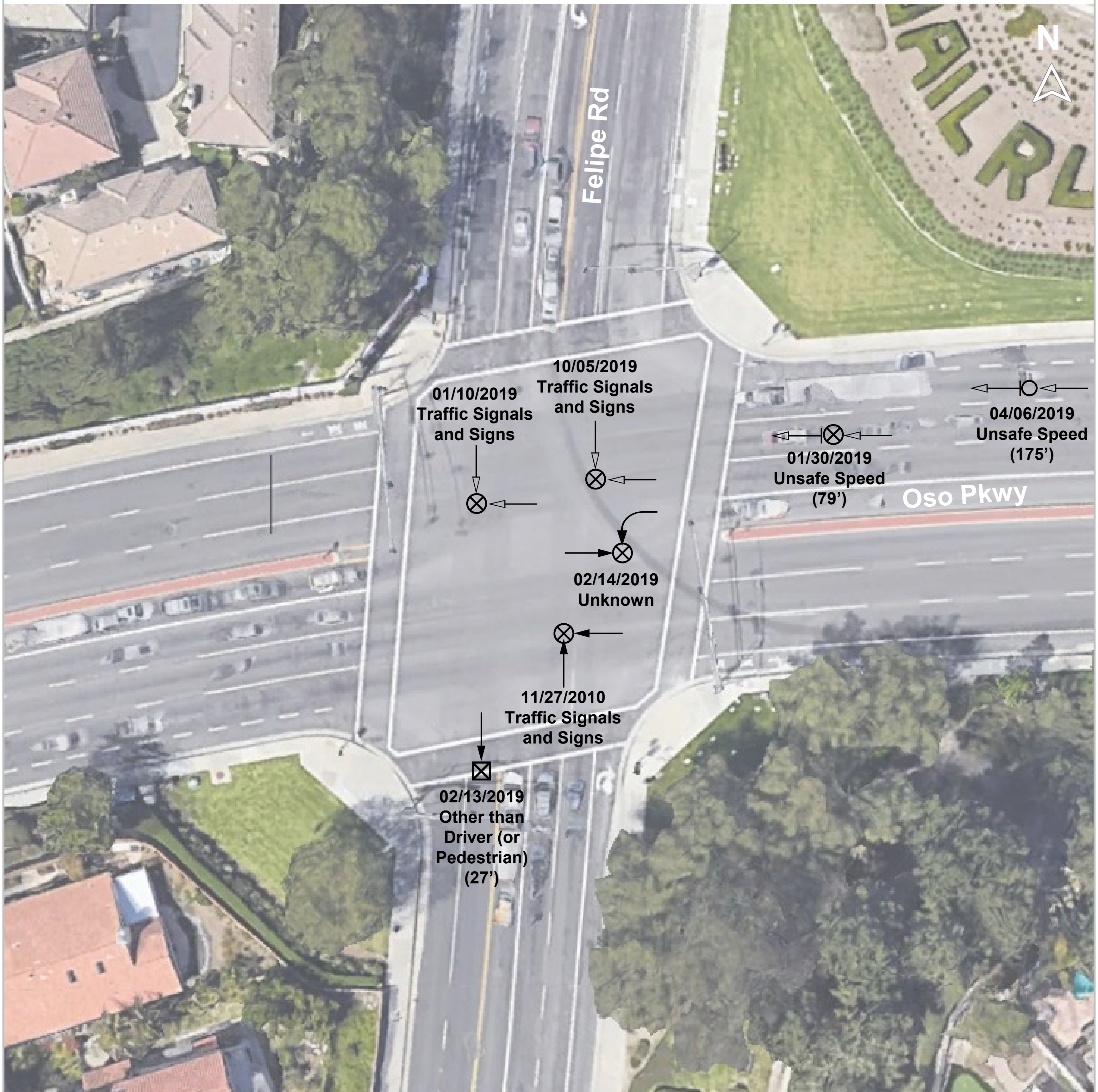
3 Property Damage Only 6 Injury Collisions 0 Fatal Collisions 9 Total Collisions

City of Mission Viejo, California

Figure 2019.2
Collision Diagram

East-West Street: **Oso Pkwy** | From: **January 2019** To: **December 2019**

North-South Street: **Felipe Rd** | Date Prepared: **2021**



Number of Collisions

1 Property Damage Only | **6** Injury Collisions | **0** Fatal Collisions | **7** Total Collisions

City of Mission Viejo, California

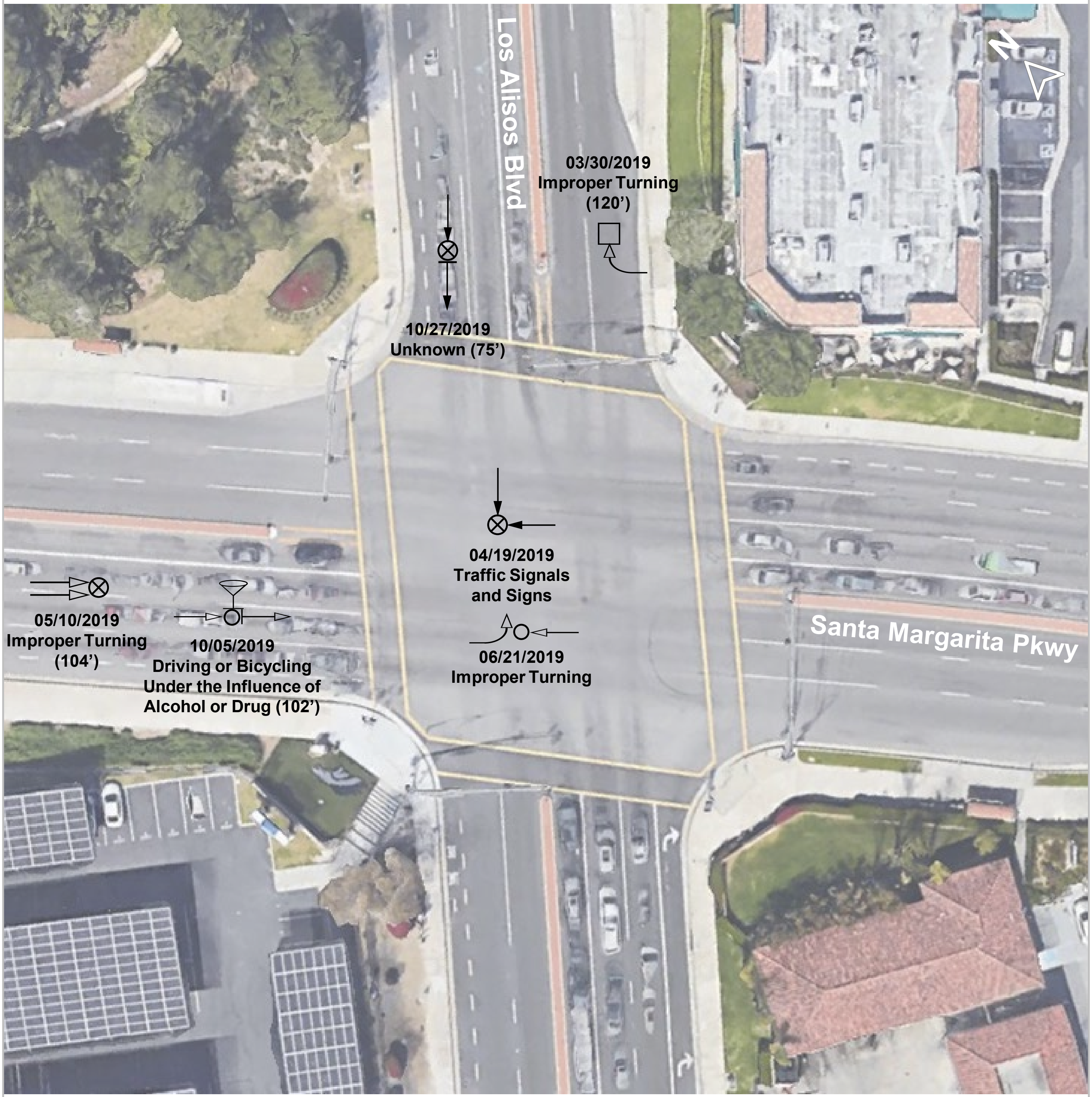
Figure 2019.3
Collision Diagram

East-West Street: **Santa Margarita Pkwy**

From: **January 2019** To: **December 2019**

North-South Street: **Los Alisos Blvd**

Date Prepared: **2021**



Number of Collisions

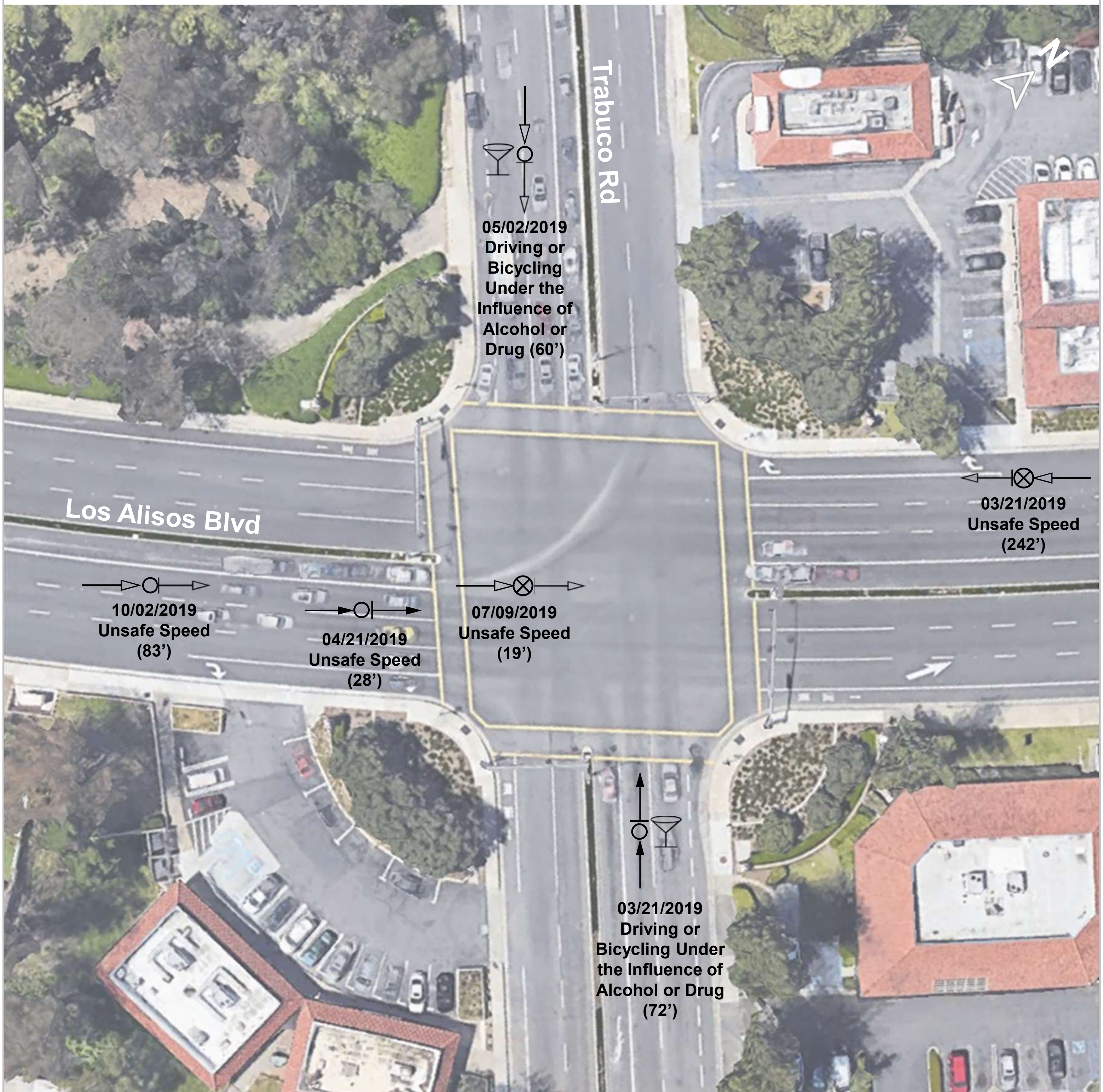
3 Property Damage Only **3** Injury Collisions **0** Fatal Collisions **6** Total Collisions

City of Mission Viejo, California

Figure 2019.4
Collision Diagram

East-West Street: **Los Alisos Blvd** From: **January 2019** To: **December 2019**

North-South Street: **Trabuco Rd** Date Prepared: **2021**



Number of Collisions

4 **Property Damage Only** 2 **Injury Collisions** 0 **Fatal Collisions** 6 **Total Collisions**

City of Mission Viejo, California

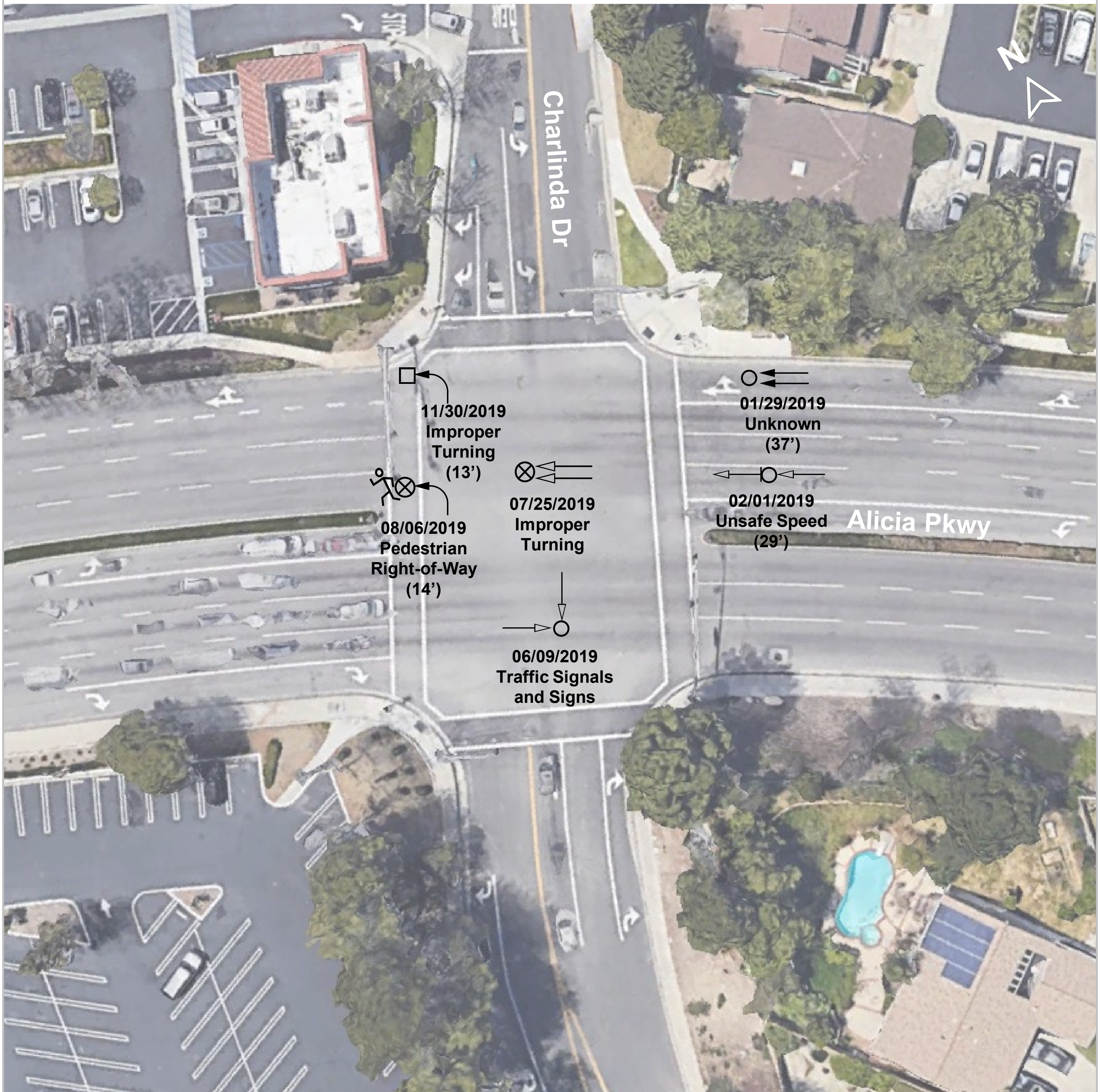
Figure 2019.5
Collision Diagram

East-West Street: **Alicia Pkwy**

From: **January 2019** To: **December 2019**

North-South Street: **Charlinda Dr**

Date Prepared: **2021**



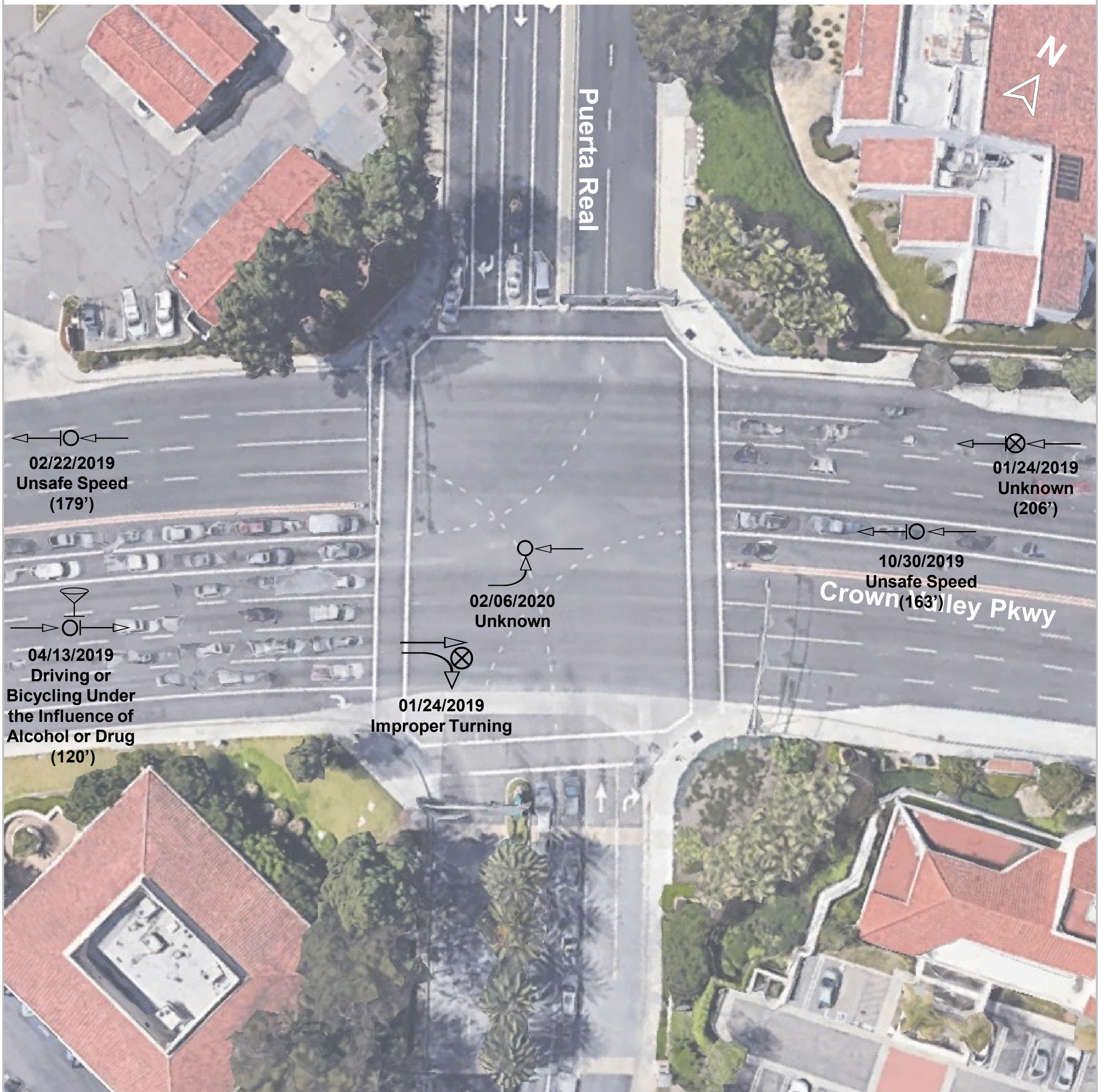
Number of Collisions

4	Property Damage Only	2	Injury Collisions	0	Fatal Collisions	6	Total Collisions

City of Mission Viejo, California

Figure 2019.6
Collision Diagram

East-West Street: **Crown Valley Pkwy**		From: **January 2019**	To: **December 2019**
North-South Street: **Puerta Real**		Date Prepared: **2021**	



Number of Collisions

4 **Property Damage Only** 2 **Injury Collisions** 0 **Fatal Collisions** 6 **Total Collisions**

City of Mission Viejo, California

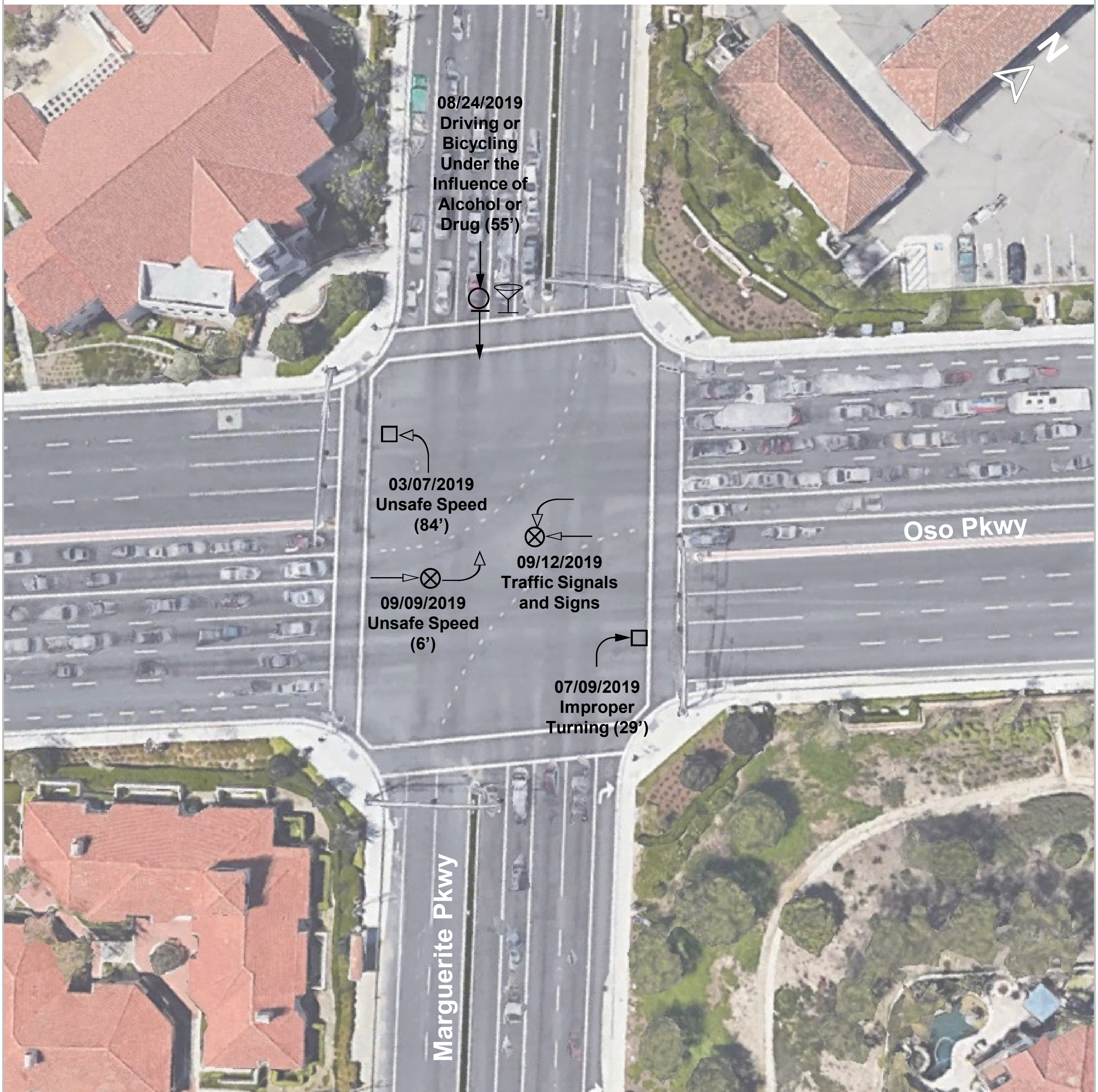
Figure 2019.7
Collision Diagram

East-West Street: **Oso Pkwy**

From: **January 2019** To: **December 2019**

North-South Street: **Marguerite Pkwy**

Date Prepared: **2021**



Number of Collisions

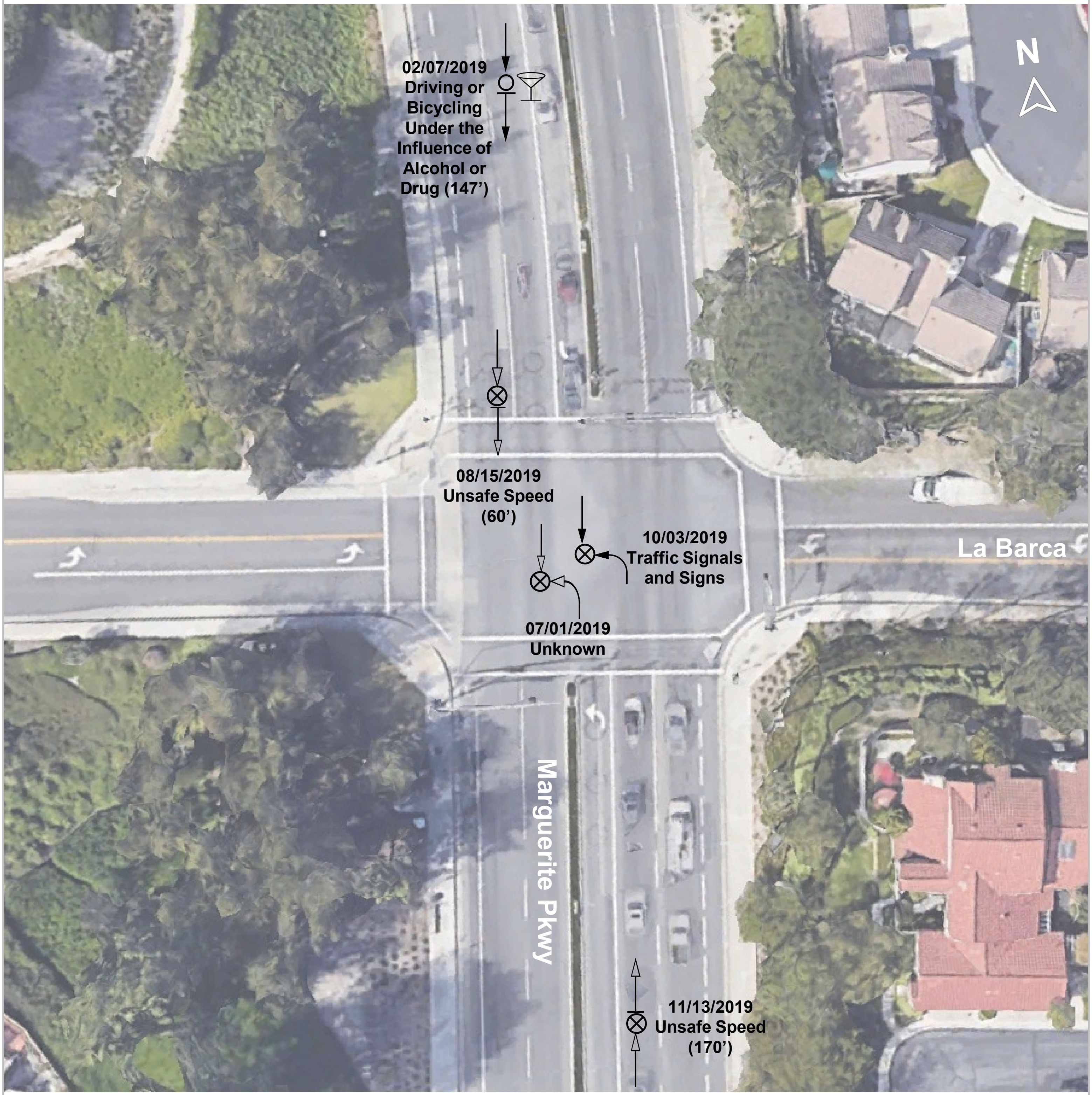
3	Property Damage Only	2	Injury Collisions	0	Fatal Collisions	5	Total Collisions

City of Mission Viejo, California

Figure 2019.8
Collision Diagram

East-West Street: **La Barca** | From: **January 2019** To: **December 2019**

North-South Street: **Marguerite Pkwy** | Date Prepared: **2021**



Number of Collisions

1	**Property Damage Only**	4	**Injury Collisions**	0	**Fatal Collisions**	5	**Total Collisions**

City of Mission Viejo, California

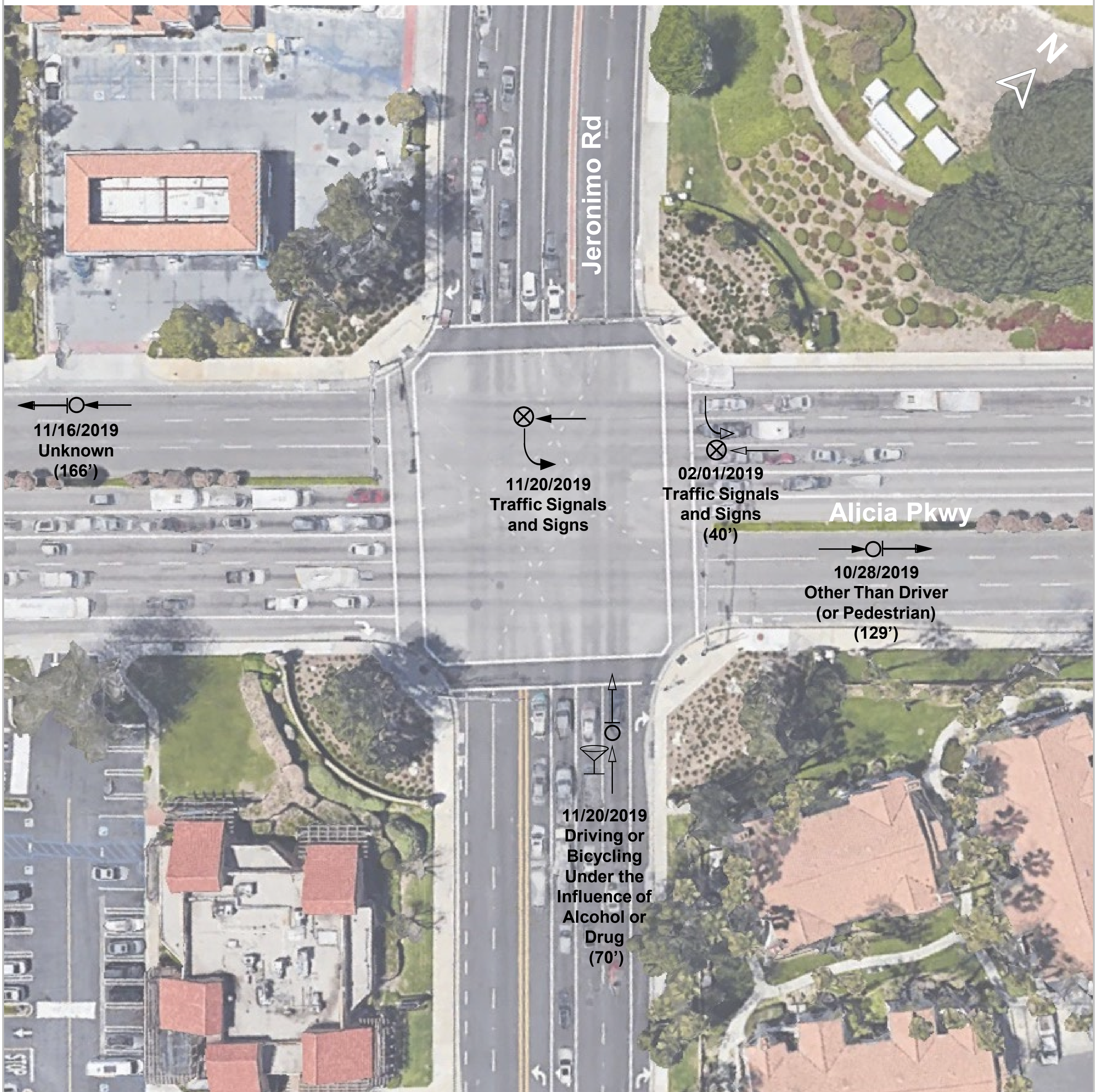
Figure 2019.9
Collision Diagram

East-West Street: **Alicia Pkwy**

From: **January 2019** To: **December 2019**

North-South Street: **Jeronimo Rd**

Date Prepared: **2021**



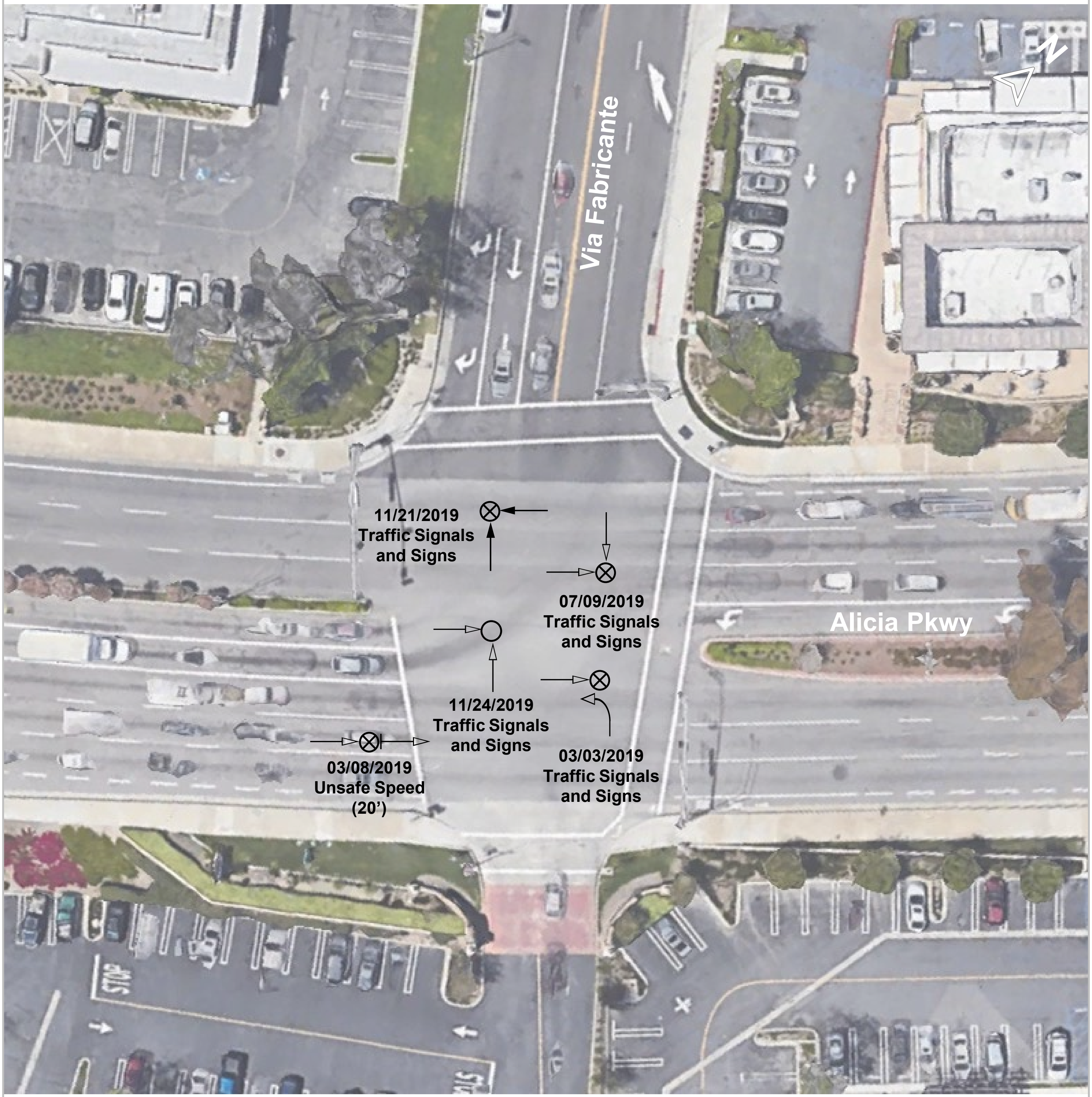
Number of Collisions

3 Property Damage Only **2** Injury Collisions **0** Fatal Collisions **5** Total Collisions

Figure 2019.10
Collision Diagram

East-West Street: **Alicia Pkwy** | From: **January 2019** To: **December 2019**

North-South Street: **Via Fabricante** | Date Prepared: **2021**



Number of Collisions

1 **Property Damage Only** 4 **Injury Collisions** 0 **Fatal Collisions** 5 **Total Collisions**

City of Mission Viejo, California

Figure 2019.11
Collision Diagram

East-West Street: **Oso Pkwy**

From: **January 2019** To: **December 2019**

North-South Street: **Country Club Dr**

Date Prepared: **2021**

Number of Collisions

4	Property Damage Only	1	Injury Collisions	0	Fatal Collisions	5	Total Collisions

City of Mission Viejo, California

Figure 2019.12
Collision Diagram

East-West Street: **Crown Valley Pkwy** | From: **January 2019** To: **December 2019**

North-South Street: **Dr Guevara Wy - Medical Center Rd** | Date Prepared: **2021**

Number of Collisions

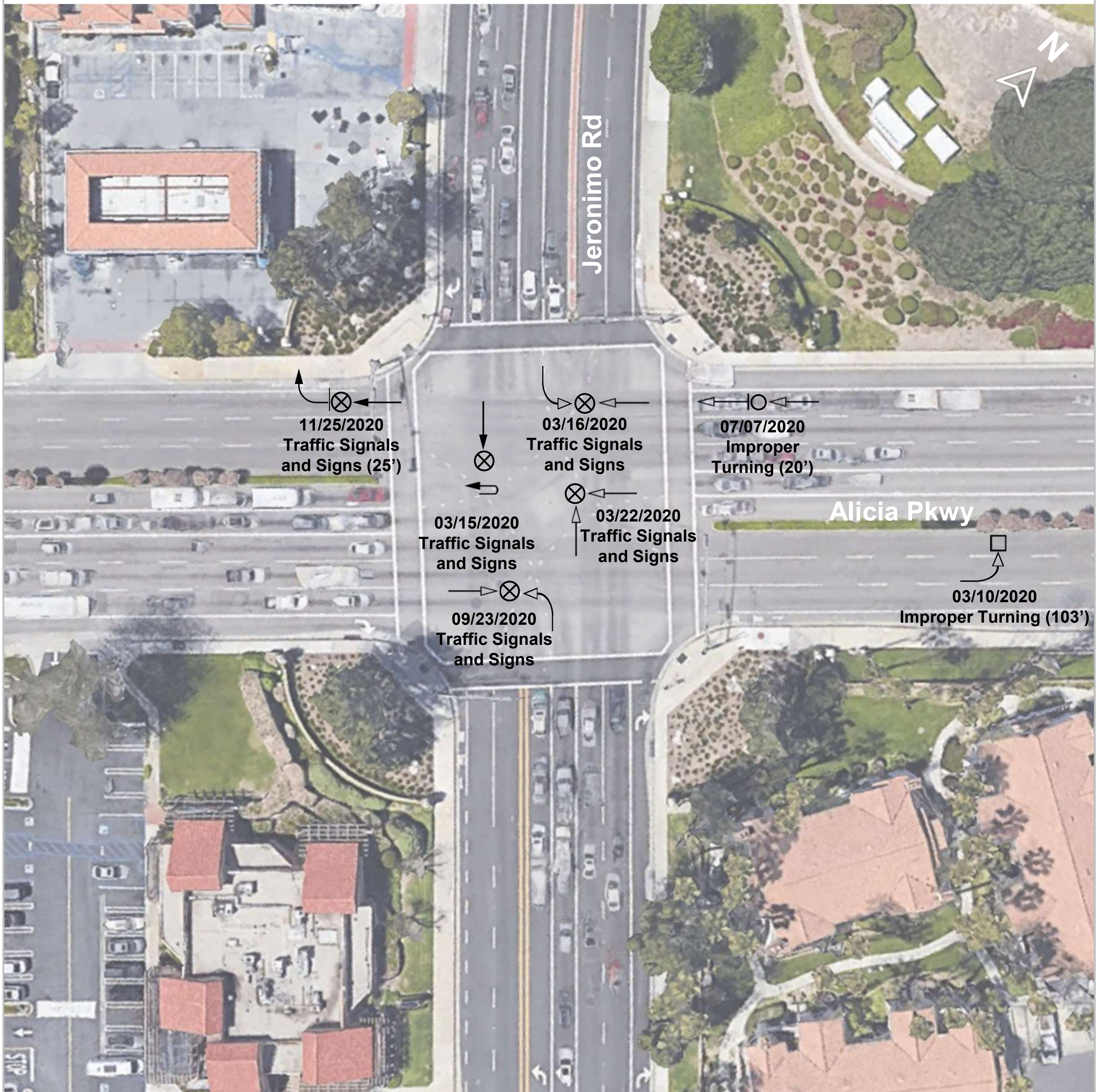
4 Property Damage Only	1 Injury Collisions	0 Fatal Collisions	5 Total Collisions

City of Mission Viejo, California

Figure 2019.13
Collision Diagram

East-West Street: **Alicia Pkwy** | From: **January 2020** To: **December 2020**

North-South Street: **Jeronimo Rd** | Date Prepared: **2021**



Number of Collisions

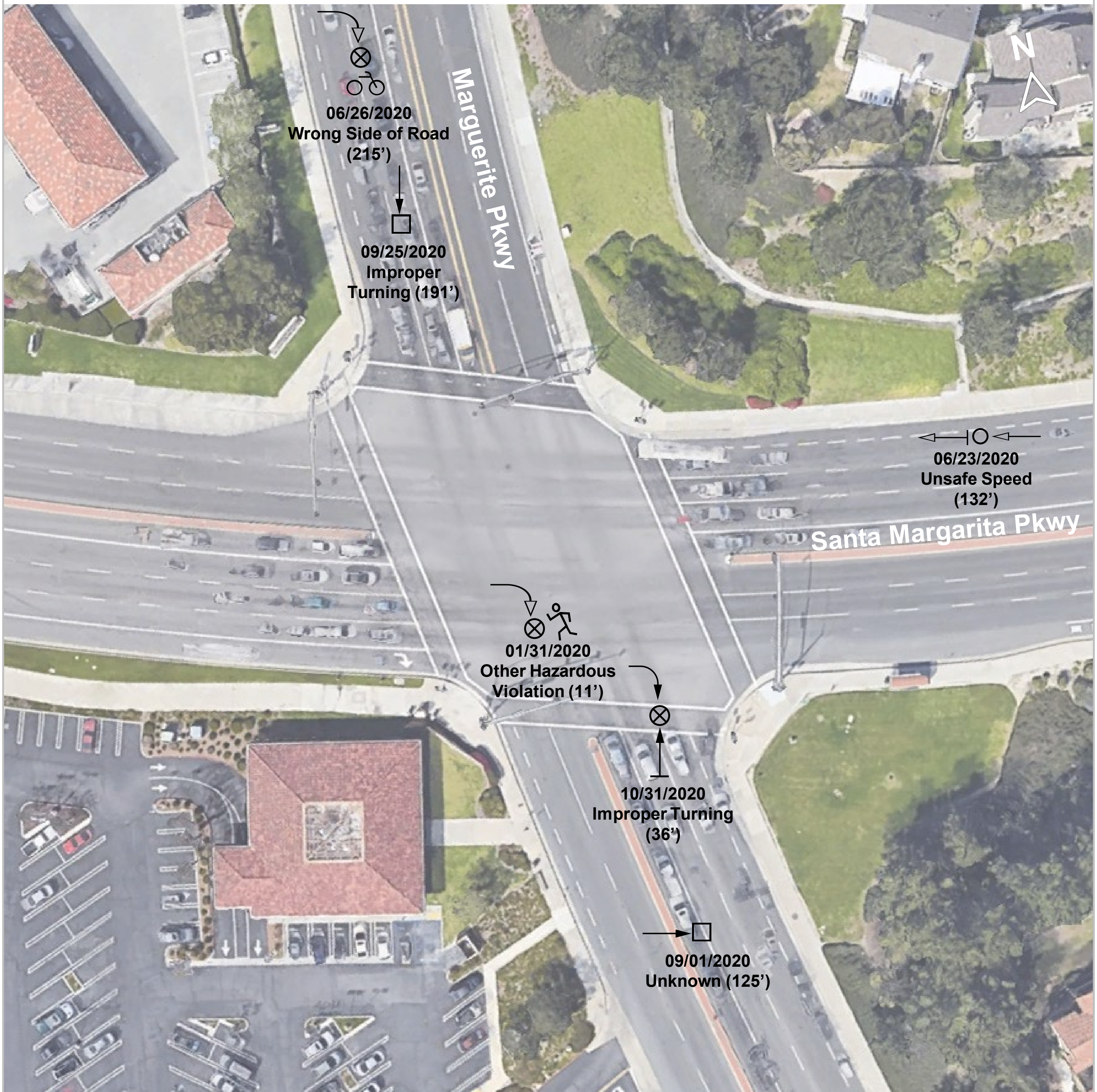
2 Property Damage Only	5 Injury Collisions	0 Fatal Collisions	7 Total Collisions

City of Mission Viejo, California

Figure 2020.1
Collision Diagram

East-West Street: **Santa Margarita Pkwy** From: **January 2020** To: **December 2020**

North-South Street: **Marguerite Pkwy** Date Prepared: **2021**



Number of Collisions

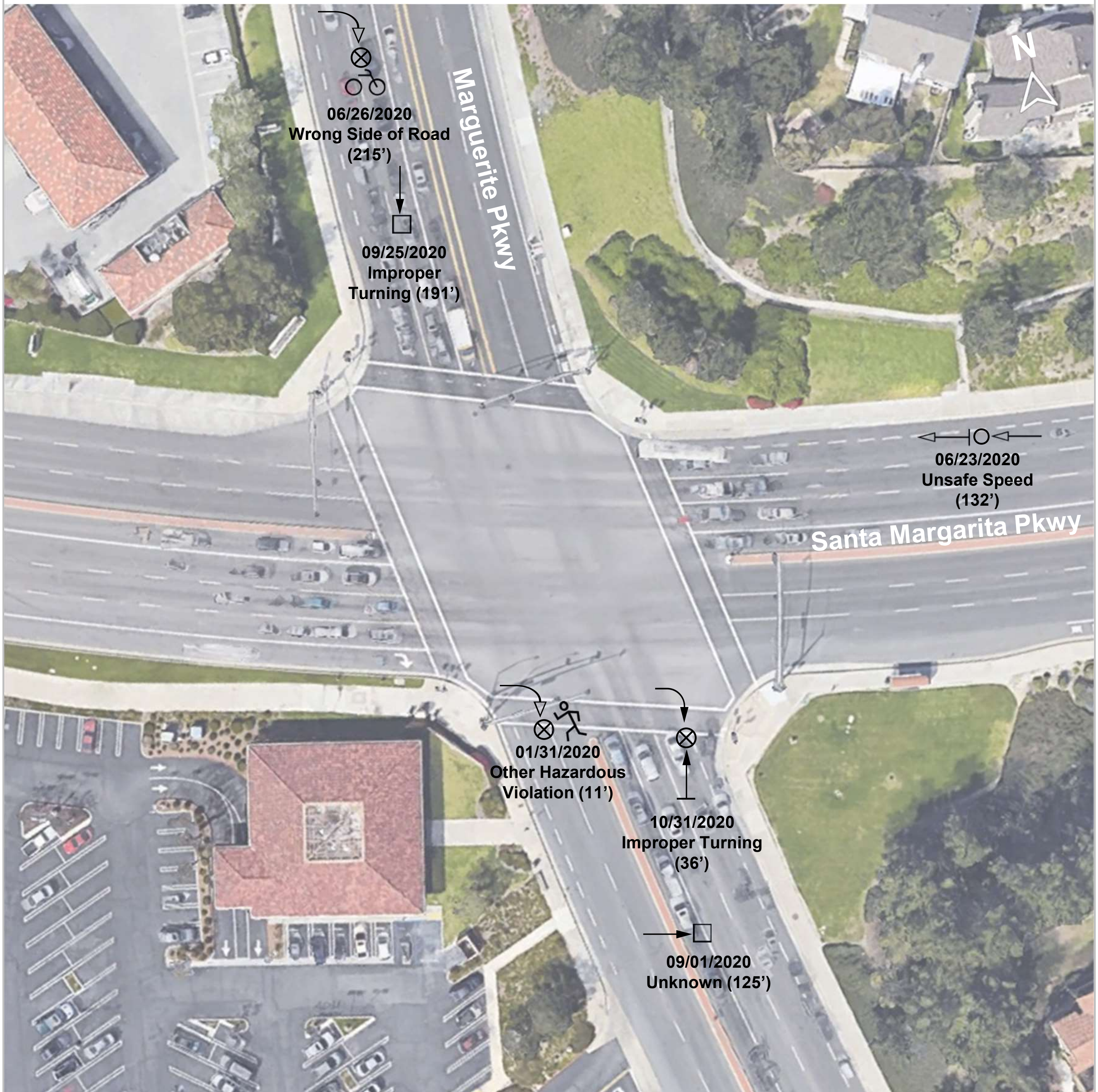
3	Property Damage Only	3	Injury Collisions	0	Fatal Collisions	6	Total Collisions

City of Mission Viejo, California

Figure 2020.2
Collision Diagram

East-West Street: **Santa Margarita Pkwy** From: **January 2020** To: **December 2020**

North-South Street: **Marguerite Pkwy** Date Prepared: **2021**



Number of Collisions

3	**Property Damage Only**	3	**Injury Collisions**	0	**Fatal Collisions**	6	**Total Collisions**

City of Mission Viejo, California

Figure 2020.2
Collision Diagram

East-West Street: **Oso Pkwy** | From: **January 2020** | To: **December 2020**

North-South Street: **Montanoso Dr** | Date Prepared: **2021**

Number of Collisions

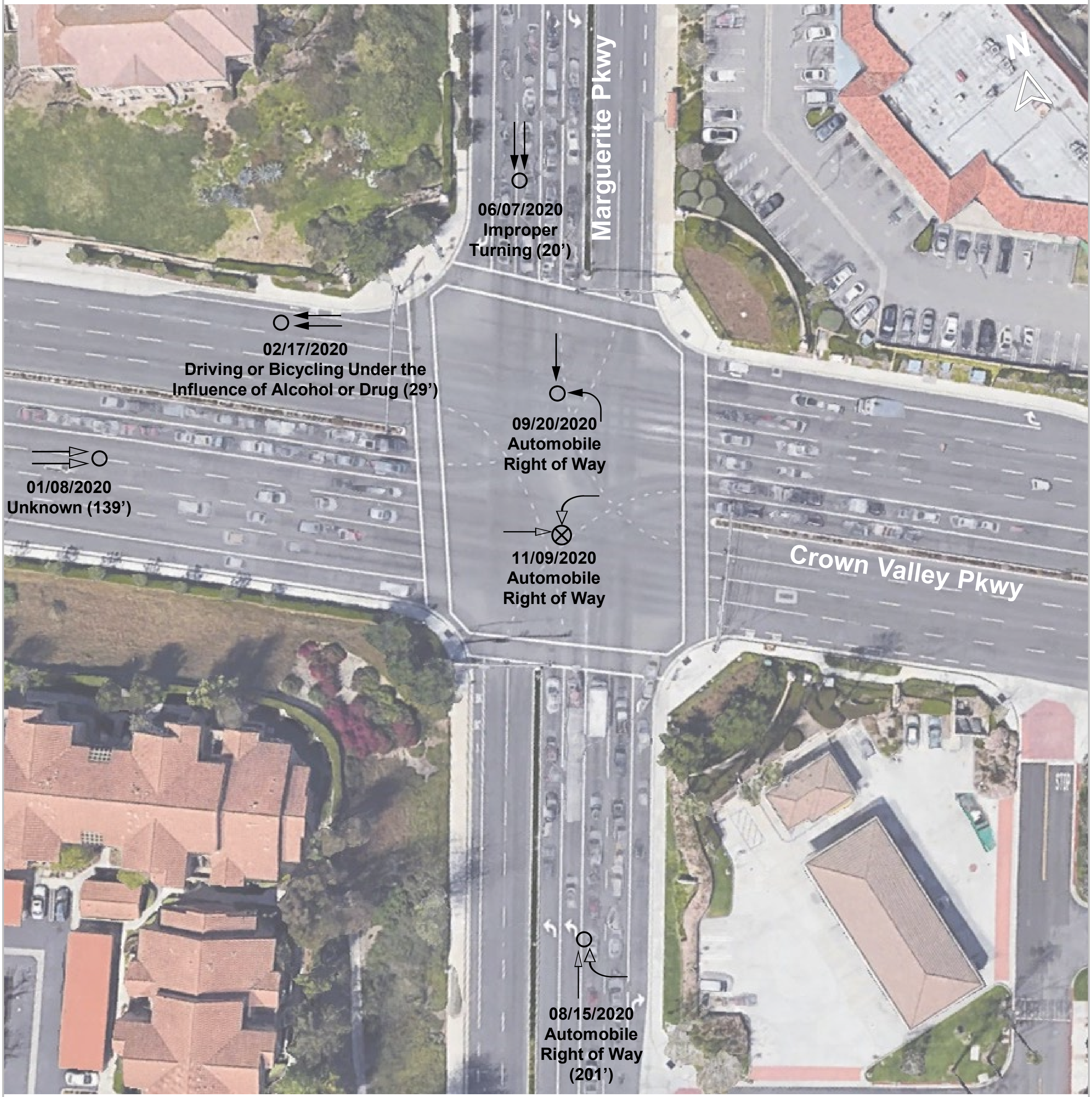
1 Property Damage Only **4** Injury Collisions **0** Fatal Collisions **5** Total Collisions

City of Mission Viejo, California

Figure 2020.4
Collision Diagram

East-West Street: **Crown Valley Pkwy** From: **January 2020** To: **December 2020**

North-South Street: **Marguerite Pkwy** Date Prepared: **2021**



Number of Collisions

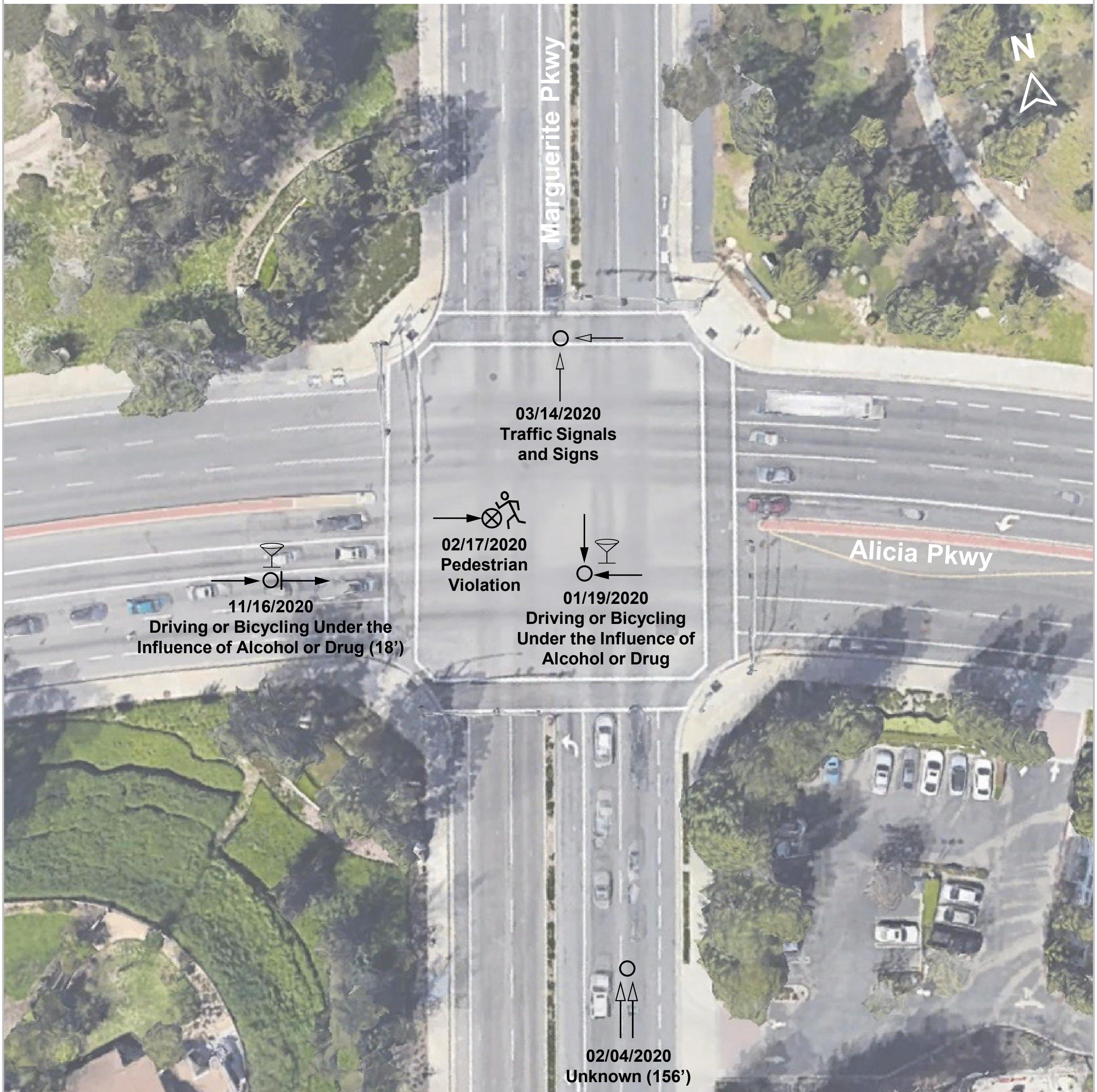
5	**Property Damage Only**	1	**Injury Collisions**	0	**Fatal Collisions**	6	**Total Collisions**

City of Mission Viejo, California

Figure 2020.5
Collision Diagram

East-West Street: **Alicia Pkwy** From: **January 2020** To: **December 2020**

North-South Street: **Marguerite Pkwy** Date Prepared: **2021**



Number of Collisions

4 **Property Damage Only** 1 **Injury Collisions** 0 **Fatal Collisions** 5 **Total Collisions**

City of Mission Viejo, California

Figure 2020.6
Collision Diagram

East-West Street: **Alicia Pkwy** From: **January 2020** To: **December 2020**

North-South Street: **Muirlands Blvd** Date Prepared: **2021**

Number of Collisions

4 **Property Damage Only** **1** **Injury Collisions** **0** **Fatal Collisions** **5** **Total Collisions**

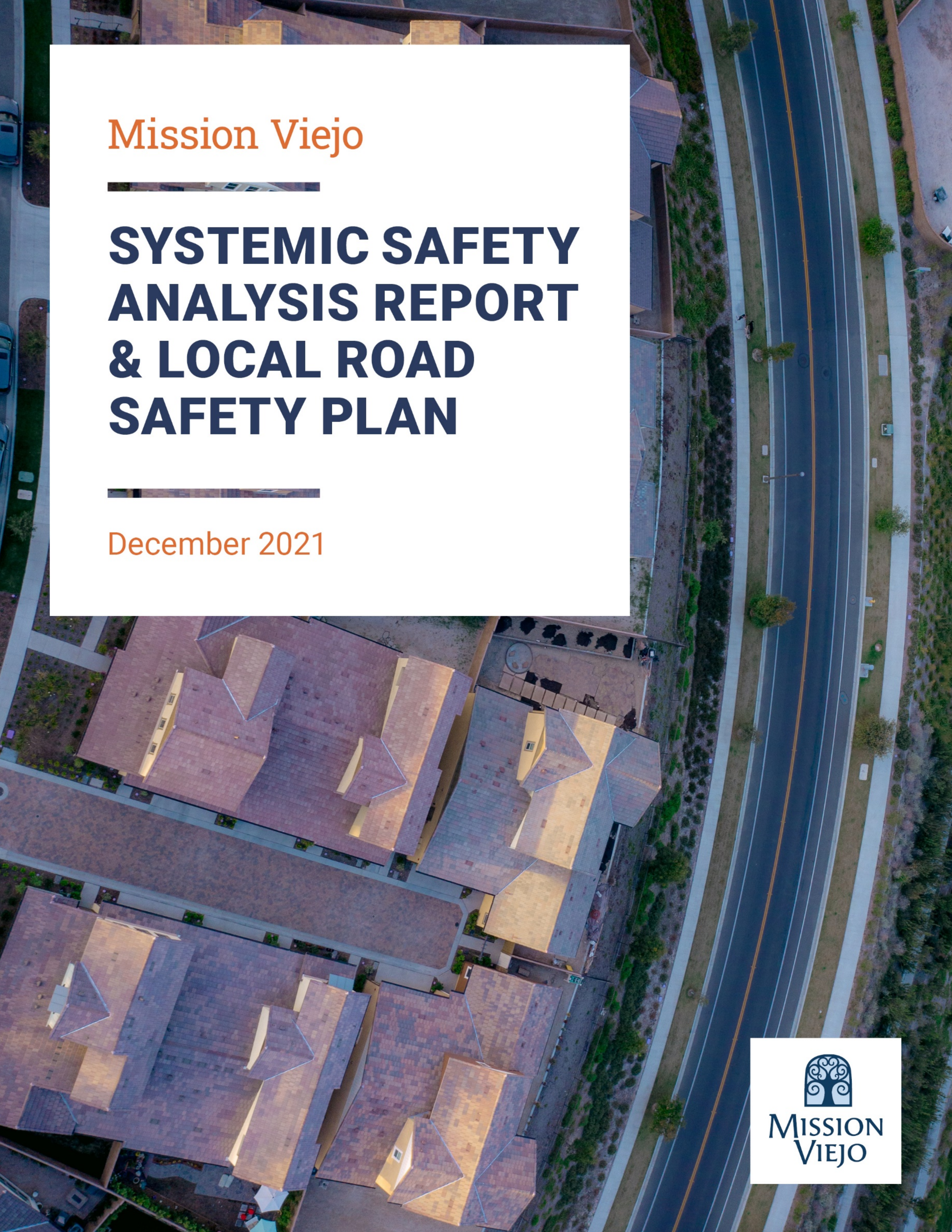
City of Mission Viejo, California

Figure 2020.7
Collision Diagram

Mission Viejo

SYSTEMIC SAFETY ANALYSIS REPORT & LOCAL ROAD SAFETY PLAN

December 2021



APPENDIX C

Intersection Watch List

Mission Viejo
Make Living Your Mission

CITY OF MISSION VIEJO
2021 INTERSECTION WATCH LIST

				Approach Volumes (May 2021)		Evaluation Criteria											
																CA MUTCD Warrant #1	
Total Points	**Intersection**	***2020 Rank*** [1]	***Rank Change*** [2]	**Total Major Street**	**Minor Street(s)**	**Total Vehicular Volume**	**Interruption of Continuous Traffic**	**Pedestrian Volume**	**Coordination**	**Accident Hazard**	**Special Conditions**	**Funding Sources**	**Environmental**	**Highway Geometrics**	**Signal Warrant**	**Condition A**	**Condition B**
23	Marguerite @ Claro	*1*	*0*	27,770	1,836	10	10	0	0	1	2	0	-2	1	1	-	100%
22	Felipe @ Aprico	*2*	*0*	14,866	1,535	10	10	0	0	0	2	0	-2	1	1	-	100%
21	Alicia @ Po	*3*	*0*	55,733	306	2	10	0	3	0	4	0	-1	3	0	-	-
21	Alicia @ Althea	*8*	*+4*	55,758	511	3	10	0	1	3	3	0	-2	3	0	-	-
20	Alicia @ Lanzarote	*4*	*-1*	27,034	690	4	10	0	1	1	4	0	-1	1	0	-	-
20	Marguerite @ La Sierra	*5*	*-1*	28,005	848	5	10	0	0	3	4	0	-3	1	0	-	-
19	Muirlands @ Heath/Moor	*9*	*+2*	17,366	1,018	5	10	0	0	0	3	0	-2	3	0	-	-
18	Muirlands @ Turf	*6*	*-2*	17,366	875	4	10	0	1	1	2	0	-1	1	0	-	-
17	Los Alisos @ Calle Alcala	*7*	*-2*	21,211	836	5	10	0	0	0	2	0	-1	1	0	-	-
16	Jeronimo @ Carranza	*17*	*+7*	11,726	1,378	7	8	0	1	0	1	0	-2	1	0	-	80%
15	Marguerite @ Aldeano	*13*	*+2*	30,360	741	5	10	0	0	0	2	0	-3	1	0	-	-
15	Marguerite @ Venado	*15*	*+3*	28,005	554	3	10	0	0	0	4	0	-3	1	0	-	-
15	Olympiad @ Lake/Youth Park	*16*	*+3*	9,634	596	2	5	0	0	0	6	0	-1	3	0	-	-
15	La Paz @ Arbolitos	*18*	*+4*	8,099	1,531	3	4	0	1	1	4	0	1	1	0	-	-
15	Santa Margarita @ Pinecrest	*19*	*+4*	27,740	582	3	10	0	1	0	3	0	-3	1	0	-	-
14	Olympiad @ Stonegate	*10*	*-6*	15,903	884	5	10	0	0	0	0	0	-2	1	0	-	80%
14	Felipe @ Quail Run	*11*	*-6*	14,866	672	4	10	0	0	0	2	0	-3	1	0	-	-
13	Marguerite @ Alarcon	*21*	*+3*	21,335	588	3	10	0	0	0	2	0	-3	1	0	-	-
13	Muirlands @ Troy	*22*	*+3*	12,568	451	2	8	0	0	0	2	0	-2	3	0	-	-
13	Alicia @ Montebello	*24*	*+4*	38,069	393	2	10	0	0	0	3	0	-3	1	0	-	-
13	Olympiad @ Fonda	*26*	*+5*	14,690	386	2	10	0	0	0	2	0	-2	1	0	-	-
12	Jeronimo @ Quintana	*20*	*-2*	11,726	553	3	8	0	1	0	1	0	-2	1	0	-	-
12	Jeronimo @ Via Albeniz	*23*	*0*	9,273	571	1	5	0	1	0	6	0	-2	1	0	-	-
12	Los Alisos @ Bough	*25*	*+1*	24,772	504	2	10	0	0	0	2	0	-3	1	0	-	-
11	Jeronimo @ Arbolitos	*12*	*-13*	9,273	1,378	4	5	0	1	0	1	0	-1	1	0	-	-
11	La Paz @ Floresta	*27*	*+1*	22,095	299	1	10	0	0	0	2	0	-3	1	0	-	-
11	Oso @ Lalin	*30*	*+3*	41,338	193	1	10	0	0	0	2	0	-3	1	0	-	-
10	Marguerite @ Cordova Canyon	*31*	*+3*	28,005	420	2	10	0	0	0	0	0	-3	1	0	-	-
9	Puerta Real @ La Alameda	*14*	*-15*	4,569	812	0	0	0	1	0	6	0	1	1	0	-	-
9	Marguerite @ Tres Vistas	*33*	*+3*	22,785	271	1	10	0	0	0	0	0	-3	1	0	-	-
7	Los Alisos @ California Terrace	*28*	*-3*	10,505	378	1	6	0	0	0	2	0	-3	1	0	-	-
6	La Paz @ Los Caballos	*29*	*-3*	9,080	771	2	5	0	0	0	0	0	-2	1	0	-	-
6	El Toro @ Cielo Entrada	*32*	*-1*	11,656	368	1	7	0	0	0	0	0	-3	1	0	-	-
5	Jeronimo @ Calle Azorin	*34*	*0*	6,157	1,032	0	2	0	1	0	2	0	-1	1	0	-	-
3	Puerta Real @ Las Ramblas	*35*	*0*	4,569	829	0	0	0	0	0	4	0	-2	1	0	-	-
3	Via Linda @ Madero	*36*	*0*	5,701	1,895	0	1	0	0	0	4	0	-3	1	0	-	-

Notes

1. This column shows the previous rank that the intersection held in the 2020 Watch List.

2. This column shows how much the intersection's ranking changed between the 2020 Watch List and the current version. Those intersections with the greatest change (i.e. top and bottom 10%) are highlighted.

KITTELSON & ASSOCIATES
750 The City Drive, Suite 410
Orange, CA 92868
P 714.468.1997

August 2, 2021 Project# 26111

To: Brett Canedy – City of Mission Viejo, CA

From: Fernando Sotelo, TE PTP; Zachri Jensen, PE – Kittelson & Associates, Inc.

RE: Mission Viejo Systemic Safety Analysis Report (SSAR)/Local Road Safety Plan (LRSP)

SIGNAL WARRANT & WATCH LIST UPDATE METHODOLOGY

Kittelson & Associates ("Kittelson") is assisting the City of Mission Viejo ("City") in preparing a Systemic Safety Analysis Report (SSAR) and Local Road Safety Plan (LRSP). As part of this effort, Kittelson has prepared this memorandum documenting the methodology for conducting intersection signal warrant analyses and updating the City's Intersection Watch List. This memorandum is organized into the following sections:

- Signal Warrant Analysis
- Intersection Watch List Update
- Appendix A: Signal Warrant Summary
- Appendix B: Updated Intersection Watch List
- Appendix C: Intersection Crash History
- Appendix D: Prioritization Category 2 Documentation
- Appendix E: Traffic Signal Prioritization Methodology
- Appendix F: Signal Warrants 1-3 Detailed Analysis Results

SIGNAL WARRANT ANALYSIS

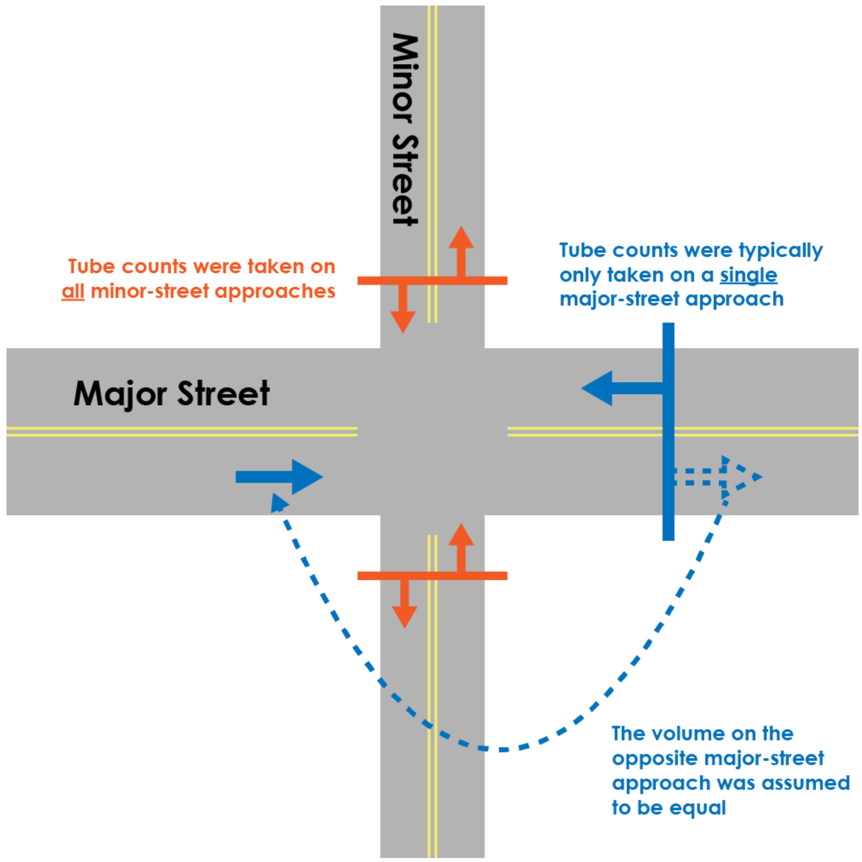
The assignment of points to each category within the City's traffic signal prioritization methodology partially depends on the results of signal warrant analyses conducted per the current version of the *California Manual on Uniform Traffic Control Devices* ("CA MUTCD"), which at the time of writing is version 2014, Revision 6. Following is a discussion of the approach used to conduct signal warrants for each of the 36 intersections on the City's Intersection Watch List ("Watch List").

TRAFFIC VOLUMES

At each Watch List intersection, roadway segment volume data was collected on each minor street approach. On the major street, volume data was typically collected on a single approach only. Kittelson took the bi-directional volumes collected on the major street and assigned them to their corresponding intersection approach, as illustrated in Figure 1 below.

Traffic volume data was collected by AimTD, LLC on May 11, 2021. Vehicle turning movement, pedestrian, and bicycle volume data was collected at each Watch List intersection during the peak periods of 7-9am and 4-6pm. Roadway segment vehicular volume data was collected via bi-directional tube counts over a 24-hour period. The roadway segments were chosen by Kittelson and confirmed by the City prior to commencing data collection.

Figure 1 Typical intersection approach volume assumptions



WARRANT 1, EIGHT-HOUR VEHICULAR VOLUME

Compared with the other warrants, Warrant 1 is generally considered to carry the most weight when trying to decide whether a traffic signal is necessary or not. It contains two parts, Condition A and Condition B, but is intended to be treated as a single warrant. Condition A (Minimum Vehicular Volume) is intended for application at locations where a large volume of intersecting traffic is the principal reason to consider installing a traffic control signal. Condition B (Interruption of Continuous Traffic) 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. **The following intersections satisfy the conditions of Warrant 1:**

- **Felipe Road @ Aprico Drive**
- **Jeronimo Road @ Arbolitos**
- **Jeronimo Road @ Carranza Drive**
- **Marguerite Parkway @ Claro**
- **Marguerite Parkway @ La Sierra Drive**
- **Olympiad Road @ Stonegate**

Detailed analysis results and documentation related to Warrant 1 can be found in Appendix F.

WARRANT 2, FOUR-HOUR VEHICULAR VOLUME

The conditions of Warrant 2 are intended to be applied where the volume of intersecting traffic is the principal reason to consider installing a traffic control signal. The analysis procedure involves plotting the highest minor street approach volume against the combined major street approach volumes and comparing against the appropriate curves provided in CA MUTCD Figures 4C-1 and 4C-2. **The following intersections satisfy the conditions of Warrant 2:**

- **Felipe Road @ Aprico Drive**
- **Jeronimo Road @ Arbolitos**
- **Jeronimo Road @ Carranza Drive**
- **La Paz Road @ Arbolitos**
- **Los Alisos Boulevard @ Calle Alcala**
- **Marguerite Parkway @ Aldeano Drive**
- **Marguerite Parkway @ Claro**
- **Marguerite Parkway @ La Sierra Drive**
- **Olympiad Road @ Stonegate**

Detailed analysis results and documentation related to Warrant 2 can be found in Appendix F.

WARRANT 3, PEAK HOUR

Warrant 3 is intended for use at a location where traffic conditions are such that for a minimum of one hour of an average day, the minor-street traffic suffers undue delay when entering or crossing the major street. The CA MUTCD states that this warrant should 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. **The following intersections satisfy Warrant 3:**

- **Felipe Road @ Aprico Drive**
- **Jeronimo Road @ Carranza Drive**
- **Los Alisos Boulevard @ Calle Alcala**
- **Marguerite Parkway @ Aldeano Drive**
- **Marguerite Parkway @ Claro**
- **Marguerite Parkway @ La Sierra Drive**

Detailed analysis results and documentation related to Warrant 3 can be found in Appendix F.

WARRANT 4, PEDESTRIAN VOLUME

Warrant 4 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. The minimum pedestrian volume needed to satisfy the warrant is 75 pedestrians per hour, as shown in CA MUTCD Figure 4C-6. Therefore, 75 pedestrians per hour can be treated as the threshold condition.

Warrant 4 is not satisfied for any of the Watch List intersections because the volume of pedestrians crossing the major street at each intersection is below the threshold value of 75 pedestrians per hour.

WARRANT 5, SCHOOL CROSSING

Warrant 5 is intended for application where schoolchildren crossing the major street is the principal reason to consider installing a traffic control signal. The language in the CA MUTCD states that the warrant shall only be considered "at an established school crossing across the major street" and that there must be a minimum of 20 crossing schoolchildren during the highest crossing hour. A review of the City's Safe Routes to School maps along with aerial imagery indicated that the intersections shown in Table 1 below are located along a designated Safe Route.

Table 1 Watch List intersections located along designated Safe Routes to School

Intersection	Nearby School(s)	Pedestrian Volume Crossing Major Street (AM Peak Period)
Alicia Parkway @ Althea Avenue	Los Alisos Intermediate	0
Alicia Parkway @ Po Avenue	Los Alisos Intermediate	0
La Paz Road @ Floresta Lane	Esperanza Special Education School, La Paz Intermediate, and Linda Vista Elementary	1
La Paz Road @ Arbolitos	Fred Newhart Middle School	1
La Paz Road @ Los Caballos Court	Fred Newhart Middle School	1
Marguerite Parkway @ Alarcon	De Portola Elementary School	2
Muirlands Boulevard @ Heath Avenue/Moor Avenue	Los Alisos Intermediate	0
Muirlands Boulevard @ Troy Street	Del Cerro Elementary School	0
Muirlands Boulevard @ Turf Avenue	Los Alisos Intermediae	0

As shown in Table 1, none of the intersections experience a peak pedestrian volume (schoolchildren or otherwise) crossing the major street of 20 pedestrians per hour, and therefore Warrant 5 is not satisfied.

WARRANT 6, COORDINATED SIGNAL SYSTEM

Warrant 6 is intended to account for the situation where installing traffic control signals may be necessitated at intersections where they would not otherwise be needed to maintain proper platooning of vehicles. The CA MUTCD is relatively less thorough in prescribing the conditions that would satisfy this warrant and essentially implies that the analyst should exhibit sound engineering judgement when evaluating each location. Guidance is provided that this warrant should not be applied when the resultant spacing of signals would be less than 1,000 feet.

Kittelson reviewed each location and concluded that, in most cases, Warrant 6 would not be satisfied for one or more of the following reasons:

- **The intersection is close to a nearby intersection**
- **Improper platooning of vehicles in likely not an existing issue**

- **The intersection previously scored very low in the corresponding "Coordination" evaluation criteria for the City's priority list**

However, the Alicia Parkway corridor between Muirlands Boulevard and Jeronimo Road could be an area of further review. Figure 2 shows the area in question.

Figure 2 Alicia Parkway signalized corridor

A coordinated traffic signal at either Althea Avenue or Po Avenue could provide benefits for the corridor coordinated system, but a signal at either location should be further evaluated for platooning because of the close spacing. The previous Watch List update (2020) included a high point value for the Po Avenue intersection, which indicates that this location has been carefully considered in the past. Neither intersection satisfies the conditions of the vehicular volume warrants (i.e. Warrants 1-3), however if a signal is considered at either location solely based on Warrant 6, then the Althea intersection would likely be a superior choice because of slightly higher overall minor-street volumes. **Warrant 6 was considered to be met for the intersection of Alicia @ Po, but Alicia @ Althea could be considered instead.**

WARRANT 7, CRASH EXPERIENCE

The conditions of Warrant 7 are intended for application where the severity and frequency of crashes are the principal reasons to consider installing a traffic control signal. The analysis procedure contains three criteria, all of which must be met to satisfy the warrant. The second criteria states that a minimum or five crashes must have been reported at the intersection within a 12-month period. This can be treated as a threshold condition, where no further analysis of the other criteria is necessary if the intersection has less than five reported crashes over a 12-month period.

Kittelson analyzed historical crash data as part of a separate task in the SSAR/LRSP process. **In summary, none of the Watch List intersection had five or more reported crashes over a 12-month period, meaning that Warrant 7 is not satisfied at any location.** *A full summary of crash history at each intersection can be found in Appendix C.*

WARRANT 8, ROADWAY NETWORK

Warrant 8 is intended to account for the situation where a traffic signal may be needed to encourage concentration and organization of traffic flow on a roadway network. The language in the CA MUTCD states that this warrant would only apply at the intersection of two or more major routes, where a "major route" must possess at least one of the following characteristics:

- It is part of the street or highway system that serves as the principal roadway network for through traffic flow
- It includes rural or suburban highways outside, entering, or traversing a city
- It appears as a major route on an official plan, such as a major street plan in an urban area traffic and transportation study

Kittelson determined by inspection that none of the Watch List intersections included the intersection of two roadways meeting the criteria mentioned above.

WARRANT 9, INTERSECTION NEAR A GRADE CROSSING

Warrant 9 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 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.

Kittelson reviewed aerial imagery and determined that Warrant 9 is not satisfied because none of the Watch List intersections are near a grade crossing.

SIGNAL WARRANT ANALYSIS FINDINGS

A full warrant summary for each intersection can be found in Appendix A. The results described in this section and shown in the summary table indicate that 10 of the 36 intersections on the City's Watch List met at least one of the signal warrants.

INTERSECTION WATCH LIST UPDATE

The City's Intersection Watch List contains a list of unsignalized intersections throughout Mission Viejo that are ranked based on a priority rating system. This rating is used to make recommendations for the installation of signals under various City improvement programs and to evaluate various intersections that have been identified by residents as needing a traffic signal. The list also provides a running inventory of intersections to be resurveyed periodically for significant changes in operating conditions. The current Watch List contains 36 intersections.

TRAFFIC SIGNAL PRIORITIZATION METHODOLOGY

The City's traffic signal prioritization methodology was initially developed by BSI Consultants in September 1990 and was updated in January 2001. The priority system includes 10 categories that are given a point value for each intersection. The intersections are sorted by descending number of points to form a priority list. The point categories are as follows:

1. Total vehicular volume
2. Interruption of continuous traffic
3. Pedestrian volume
4. Coordination
5. Accident hazard
6. Special conditions
7. Funding sources

8. Environmental
9. Highway geometrics
10. Signal Warrants 1 and 2

When the prioritization methodology was originally developed, the written standards for traffic signals (including signal warrants) were contained within Section 9-01 of the Caltrans Traffic Manual ("Traffic Manual"). However, that changed in 2006 with the adoption of the CA MUTCD. The standards for signal warrants were removed from Chapter 9 of the Traffic Manual and replaced by Part 4 of the CA MUTCD. The naming and numbering of the signal warrants was also updated to be what it is today, with the consolidation of 11 warrants to a total of nine. Table 2 below compares the terminology used in the Traffic Manual (and consequently what is used in the City's prioritization methodology) versus the terminology used in the current version of the CA MUTCD.

Table 2 Comparison of signal warrant naming and numbering between Traffic Manual and CA MUTCD

Current CA MUTCD Warrant	Corresponding Traffic Manual Warrant(s)
Warrant 1, Eight-Hour Vehicular Volume	Warrant 1, Minimum Vehicular Volume Warrant 2, Interruption of Continuous Traffic Warrant 8, Combination of Warrants
Warrant 2, Four-Hour Vehicular Volume	Warrant 9, Four Hour Volume
Warrant 3, Peak Hour	Warrant 10, Peak Hour Delay Warrant 11, Peak Hour Volume
Warrant 4, Pedestrian Volume	Warrant 3, Minimum Pedestrian Volume
Warrant 5, School Crossing	Warrant 4, School Areas
Warrant 6, Coordinated Signal System	Warrant 5, Progressive Movement
Warrant 7, Crash Experience	Warrant 6, Accident Experience
Warrant 8, Roadway Network	Warrant 7, Systems Warrant
Warrant 9, Intersection Near a Grade Crossing	Did not exist in Traffic Manual

A copy of the City's traffic signal prioritization methodology can be found in Appendix E. Following is a breakdown of the approach that Kittelson used for assigning points to each prioritization category.

CATEGORY 1, TOTAL VEHICULAR VOLUME

Kittelson followed the approach outlined in the prioritization methodology and used the 2pm – 6pm portion of the 24-hour volume data collected by AimTD.

Note that although the name of Category 1 implies a connection with Warrant 1 Condition A, the assignment of points is completely independent of the results of Warrant 1. Rather, the assignment of points is based entirely on plotting traffic volumes on Figure 4 found in the prioritization methodology.

CATEGORY 2, INTERRUPTION OF CONTINUOUS TRAFFIC

Kittelson assigned points to Category 2 according to Table 4-A in the prioritization methodology. The same 2pm – 6pm volumes that were used when evaluating Category 1 were used for Category 2.

Note that although the name of Category 2 implies a connection with Warrant 1 Condition B, the assignment of points is completely independent of the results of Warrant 1. Rather, the assignment of points is based entirely on Table 4-A in the prioritization methodology. *A full breakdown of point assignments for Category 2 can be found in Appendix D.*

CATEGORY 3, PEDESTRIAN VOLUME

Kittelson assigned points to Category 3 according to Table 4-B in the prioritization methodology, which depends on the results of Warrant 4. Kittelson was also directed by City staff to consider the points assigned to this category in the previous Watch List and default to maintaining those point assignments should discrepancies arise.

CATEGORY 4, COORDINATION

The definition for Category 4 references Traffic Manual Warrants 5 and 7, which would correspond to CA MUTCD Warrants 6 and 8 as shown in Table 2 above. Kittelson was directed by City staff to maintain the points assigned to this category from the previous Watch List, with the justification being that conditions likely have not significantly changed since the 2020 update.

CATEGORY 5, ACCIDENT HAZARD

Kittelson assigned points to Category 5 according to Table 4-C in the prioritization methodology. Note that points can be assigned to this category even if the number of correctable accidents is less than five, which is in contrast with the minimum threshold for consideration in Warrant 4. In other words, an intersection could receive points in Category 5 even if Warrant 4 is not satisfied for that same intersection.

When defining the acceptable time period for crash data to be considered, the note below Table 4-C mentions that the annual average of the last two years or any 12-month period may be used. Kittelson tallied the total crashes per year at each intersection for the four years between 2017 and 2020 and then computed both the maximum number of crashes in a 12-month period and the average of the last two years (2019 and 2020). Then the maximum of those two values was used to assign points per Table 4-C in the prioritization methodology. *A full breakdown of point assignments for Category 5 can be found in Appendix C.*

CATEGORY 6, SPECIAL CONDITIONS

Kittelson was directed by City staff to maintain the points assigned to this category from the previous Watch List, with the justification being that conditions likely have not significantly changed since the 2020 update.

CATEGORY 7, FUNDING SOURCES

Kittelson was directed by City staff to maintain the points assigned to this category from the previous Watch List, with the justification being that conditions likely have not significantly changed since the 2020 update.

CATEGORY 8, ENVIRONMENTAL

Kittelson was directed by City staff to maintain the points assigned to this category from the previous Watch List, with the justification being that conditions likely have not significantly changed since the 2020 update.

CATEGORY 9, HIGHWAY GEOMETRICS

Kittelson was directed by City staff to maintain the points assigned to this category from the previous Watch List, with the justification being that conditions likely have not significantly changed since the 2020 update.

CATEGORY 10, SIGNAL WARRANTS 1 AND 2

As shown in Table 2 above, Warrants 1, 2, and 8 in the Traffic Manual were consolidated into Warrant 1 in the CA MUTCD. This creates inconsistencies in the terminology used in the City's prioritization category 10, which is defined as:

> *"A verification that the Caltrans traffic signal Warrants 1 and 2 were met 100 percent. While all of the warrants are important, the total volume and interruption of traffic on the major street are very important considerations for determining the location of any traffic signal. Those intersections meeting these warrants 100 percent are given one point. The range of points is zero (0) to two (2)."*

The "Caltrans signal Warrants 1 and 2" mentioned in the definition refer to Conditions A and B in CA MUTCD Warrant 1, and Kittelson's update of the City's Watch List follows the updated terminology. In other words, the first part of the definition for Category 10 could be rewritten as:

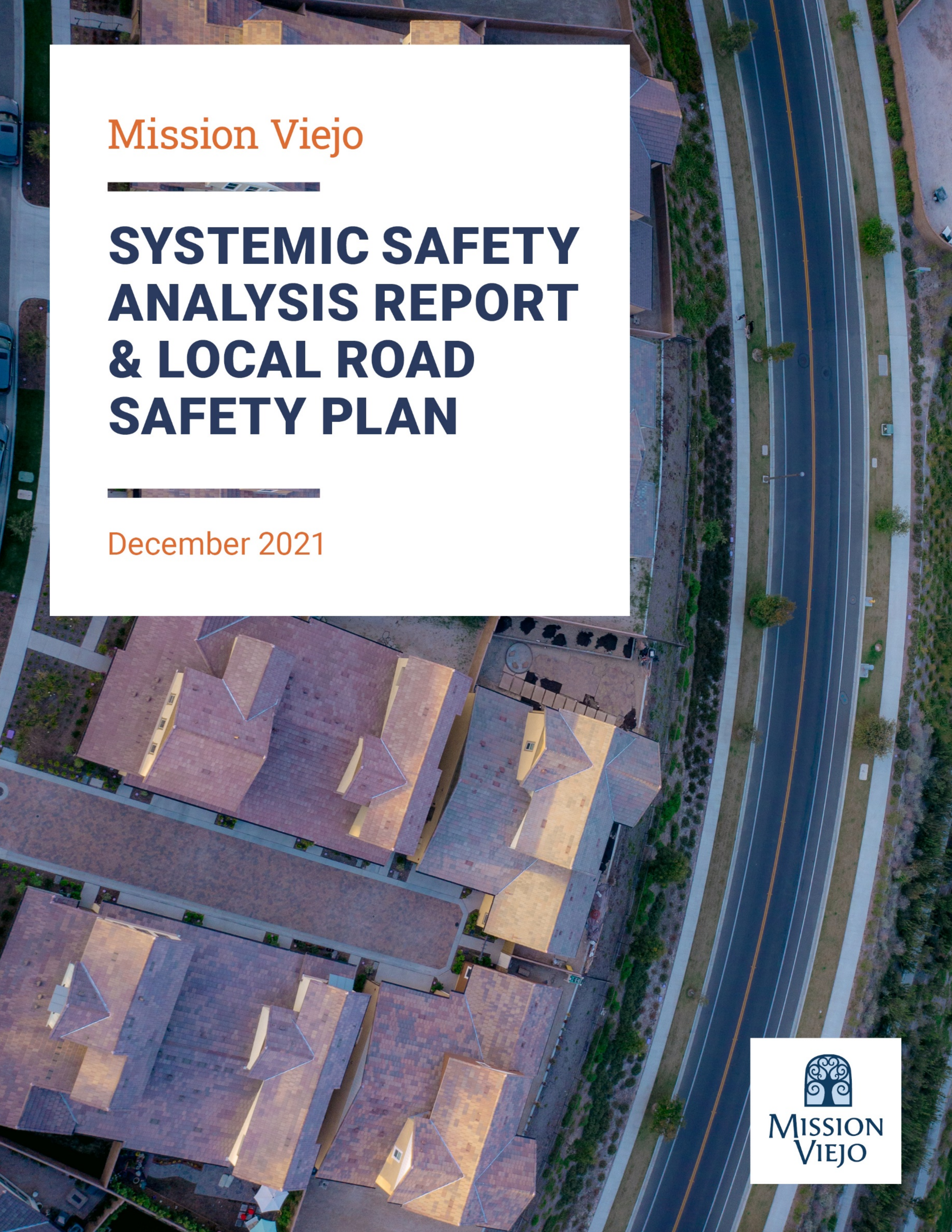
> *"A verification that CA MUTCD Warrant 1, Parts A and B were met 100 percent."*

INTERSECTION WATCH LIST UPDATE FINDINGS

The updated 2021 Intersection Watch List can be found in Appendix B. The 2021 Intersection Watch List provides the scoring for each Category, the resulting total points per location, and the change in rank from the 2020 Watch List.

REFERENCES

1. Caltrans. *California Manual on Uniform Traffic Control Devices, Part 4: Highway Traffic Signals.* 2014 Edition, Revision 6 (March 30, 2021).
2. Caltrans. *Traffic Manual: Chapter 9.* https://dot.ca.gov/programs/safety-programs/camutcd/traffic-manual-ch9.
3. City of Mission Viejo. *Safe Routes to School Maps*. https://cityofmissionviejo.org/departments/public-works/traffic-and-transportation/safe-routes-school.
4. City of Mission Viejo Department of Public Works. *Traffic Signal Prioritization Methodology*. Originally prepared by BSI Consultants, September 1990. Updated January 2001.



Mission Viejo

SYSTEMIC SAFETY ANALYSIS REPORT & LOCAL ROAD SAFETY PLAN

December 2021

APPENDIX D

2016 Citywide Collision Report

CITY OF MISSION VIEJO

CITYWIDE COLLISION ANALYSIS

2016

City of Mission Viejo Citywide Collision Analysis 2016

Overview

The goal of this report is to review the City of Mission Viejo's collision data to determine if there are any patterns or conditions at locations where the application of the tools of traffic safety – **Engineering, Enforcement, and Education** – might be applied to improve traffic flow and traffic safety within our community. In preparing this report, we used the City's Accident Inventory System (AIS), which is a database supported by updates from the Sheriff's Traffic Division and the Department of California Highway Patrol's Statewide Integrated Traffic Records System (SWITRS). While the focus of this analysis is on the collisions occurring in 2016, information from two previous years is included for reference and comparison.

The City of Mission Viejo, incorporated in 1988, has always considered traffic safety and operation a priority. The City Councils have been very supportive in completing the planned arterial roadway systems, constructing capacity improvements as needed, and authorizing regular maintenance of the streets. They had an early interest in implementing an integrated traffic signal system with a central master controller and have restricted parking along most arterials to eliminate conflicts between vehicles and bicycles.

The Transportation Division of the Public Works Department manages the transportation planning, operation, safety, signal maintenance and crossing guard programs. Public Works also coordinates with Public Services to provide the appropriate signing and striping. The City of Mission Viejo works in cooperation with the County of Orange Sheriff's Department deputies assigned to traffic safety/enforcement. We currently have six (6) motorcycle units, and one (1) full-time traffic sergeant. These deputies have high mobility in responding to traffic situations and have been very active in providing traffic speed enforcement and assistance in monitoring school traffic. Their efforts are supported by six (6) civilian Community Service Officers whose primary responsibilities include traffic collision investigation and parking enforcement. A full-time deputy is also assigned to commercial truck enforcement.

Mission Viejo occupies approximately 17 square miles with an estimated 44 miles of arterial streets (see Exhibit 1). These arterial streets carry a higher volume of traffic with commercial or major collector accesses. Traffic counts are conducted to help us track increased traffic demands – especially the high traffic demands on our east-west arterial streets, which connect to Interstate 5 (I-5). Annual traffic counts for 2016 are summarized on Exhibit 2. Almost all of the streets have been constructed to their ultimate width per the City's General Plan and the Orange County Master Plan of Arterial Highways. This traffic volume information is used to identify locations that may need additional capacity improvements and update our intersection WATCH list, which is prepared every two years as a planning tool for evaluating the operations at un-signalized locations at various intersections along the arterial corridors.

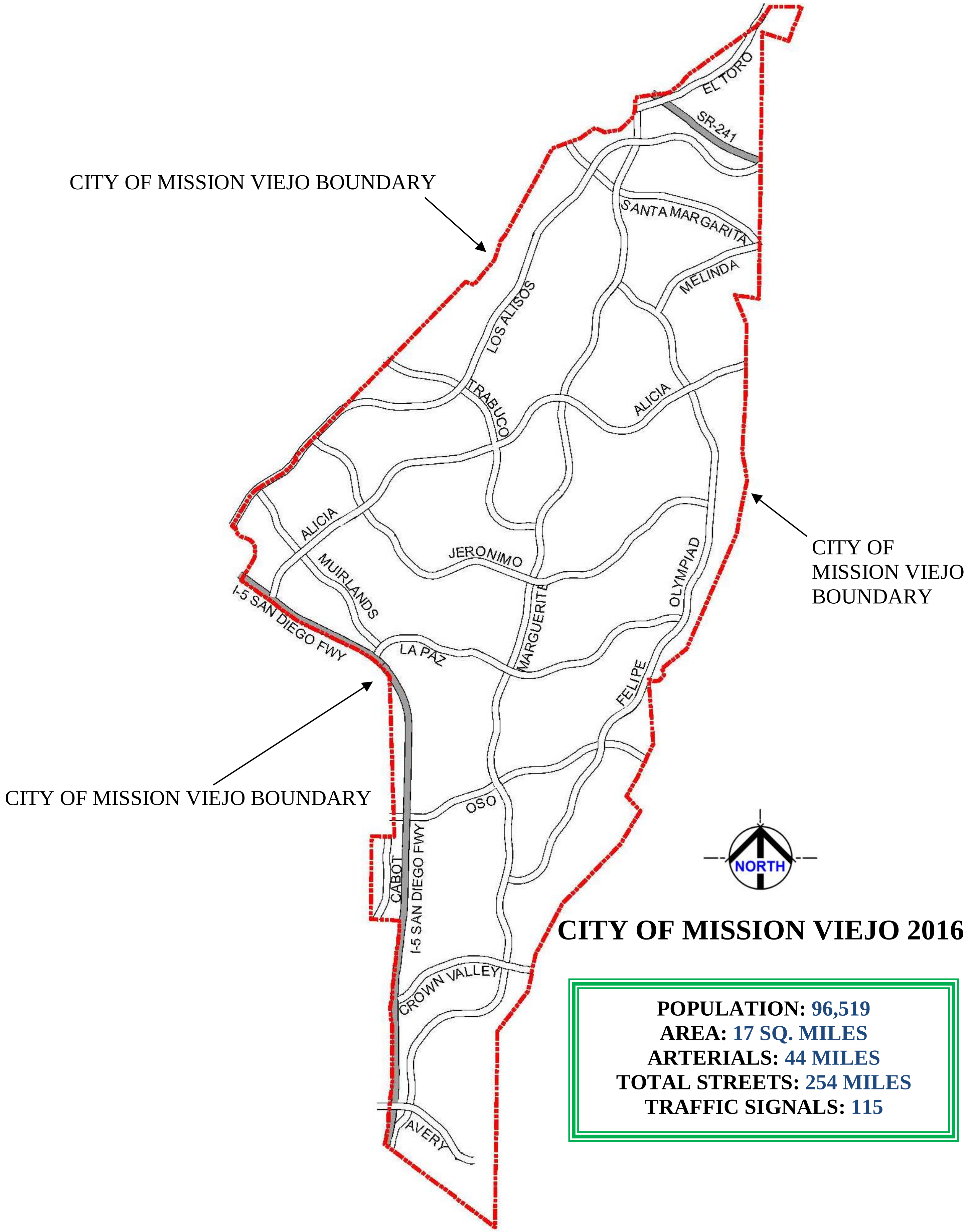
These traffic counts also provide background data in reviewing the collision locations and contribute to our understanding and expectations for traffic safety. For 2016:

- Design of the La Paz Road widening between Chrisanta and Muirlands has been completed and construction is planned to start in 2020.
- Final Design for the intersection improvements at Oso Pkwy & Felipe Rd is expected to be complete in 2019 and construction is anticipated to start in 2020.
- Designs for the intersection improvements at Los Alisos Blvd & Santa Margarita Pkwy is complete and construction is scheduled for 2019.
- Design plans of the intersection improvements at Marguerite Pkwy & Jeronimo Rd and Marguerite Pkwy & Los Alisos Blvd are anticipated to be completed in 2020.

Our speed limits contained in Exhibit 3 are established per the requirements of the California Vehicle Code (CVC) and the Caltrans Manual of Uniform Traffic Control Devices (MUTCD). The *Speed Trap* provisions of the CVC require that the speed limits be established per "reasonable" speed or based on the 85^{th} percentile of the measured or survey speeds. We are required to reevaluate the actual roadway conditions every five years (seven with special conditions) by conducting speed surveys, review of collisions, and the gathering of other information. The required Engineering and Traffic Surveys were released in 2017 with the next city-wide update is planned for 2022.

The balance of the 254 miles of city streets (less the 44 miles of the arterial streets) is collector and residential streets. These are lower volume streets located in the neighborhoods where residents typically have concerns relating to speeds on the 25 mph streets, neighborhood school activities, and general traffic safety of children playing in the area. The City has provided an ongoing program of using speed radar trailers in residential areas to remind motorists to observe the 25 mph speed limit and also adopted speed hump policies and procedures to respond to residents' requests. Enforcement is provided as needed; however, there are a lower number of reported collisions in these areas.

EXHIBIT 1



CITY OF MISSION VIEJO 2016

POPULATION: **96,519**
AREA: **17 SQ. MILES**
ARTERIALS: **44 MILES**
TOTAL STREETS: **254 MILES**
TRAFFIC SIGNALS: **115**

EXHIBIT 2

CITY OF MISSION VIEJO
TRAFFIC FLOW MAP
2016

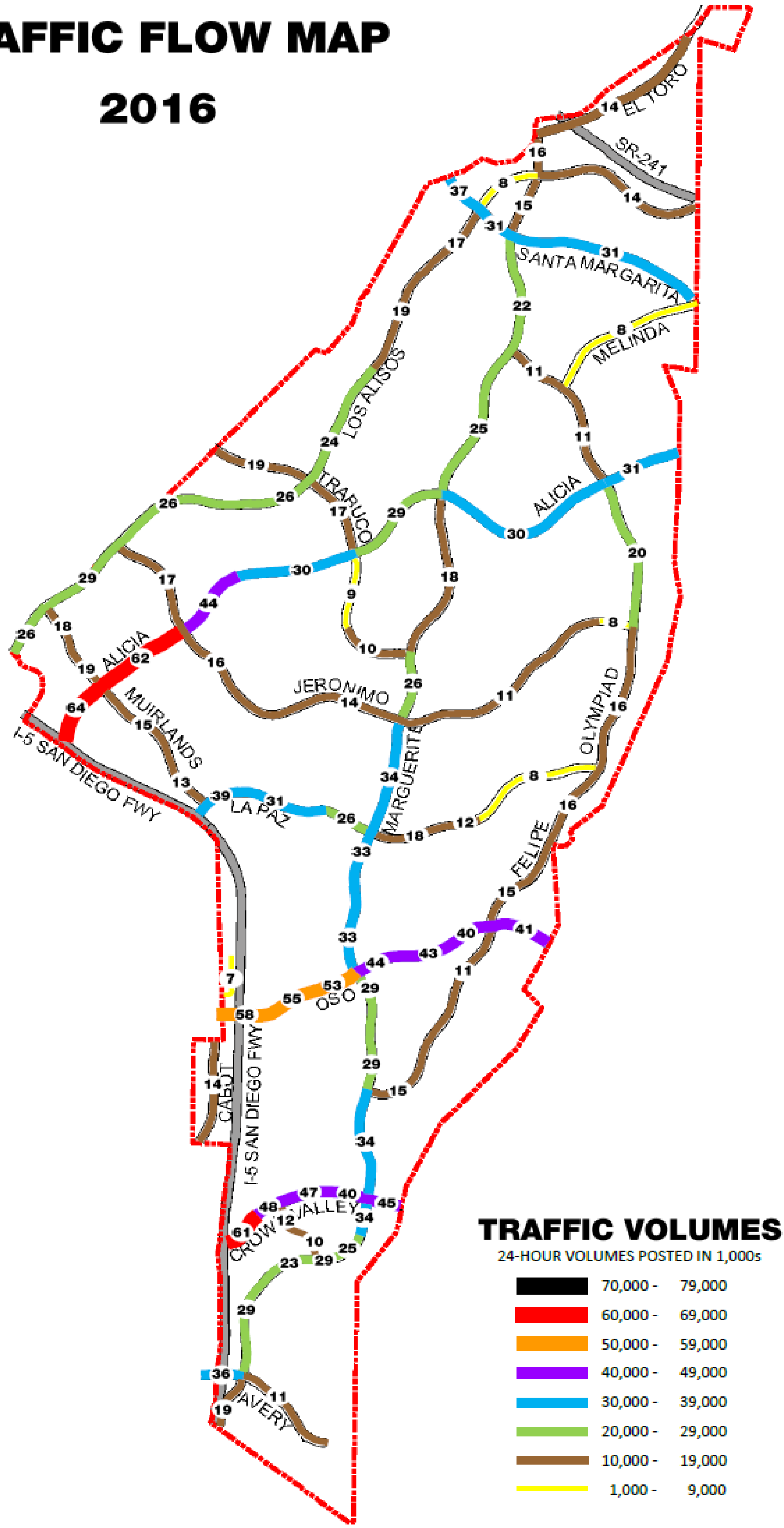
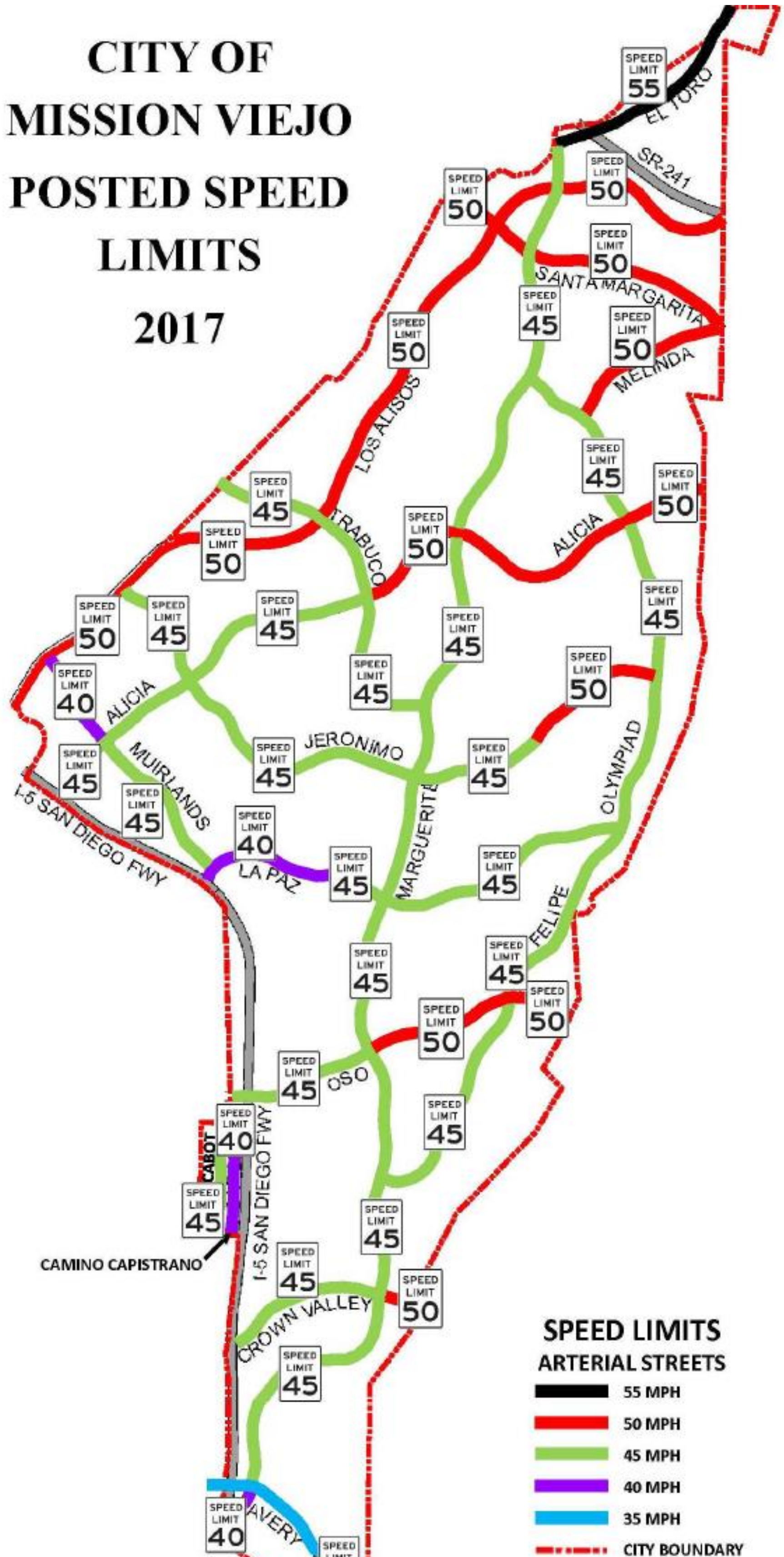


EXHIBIT 3

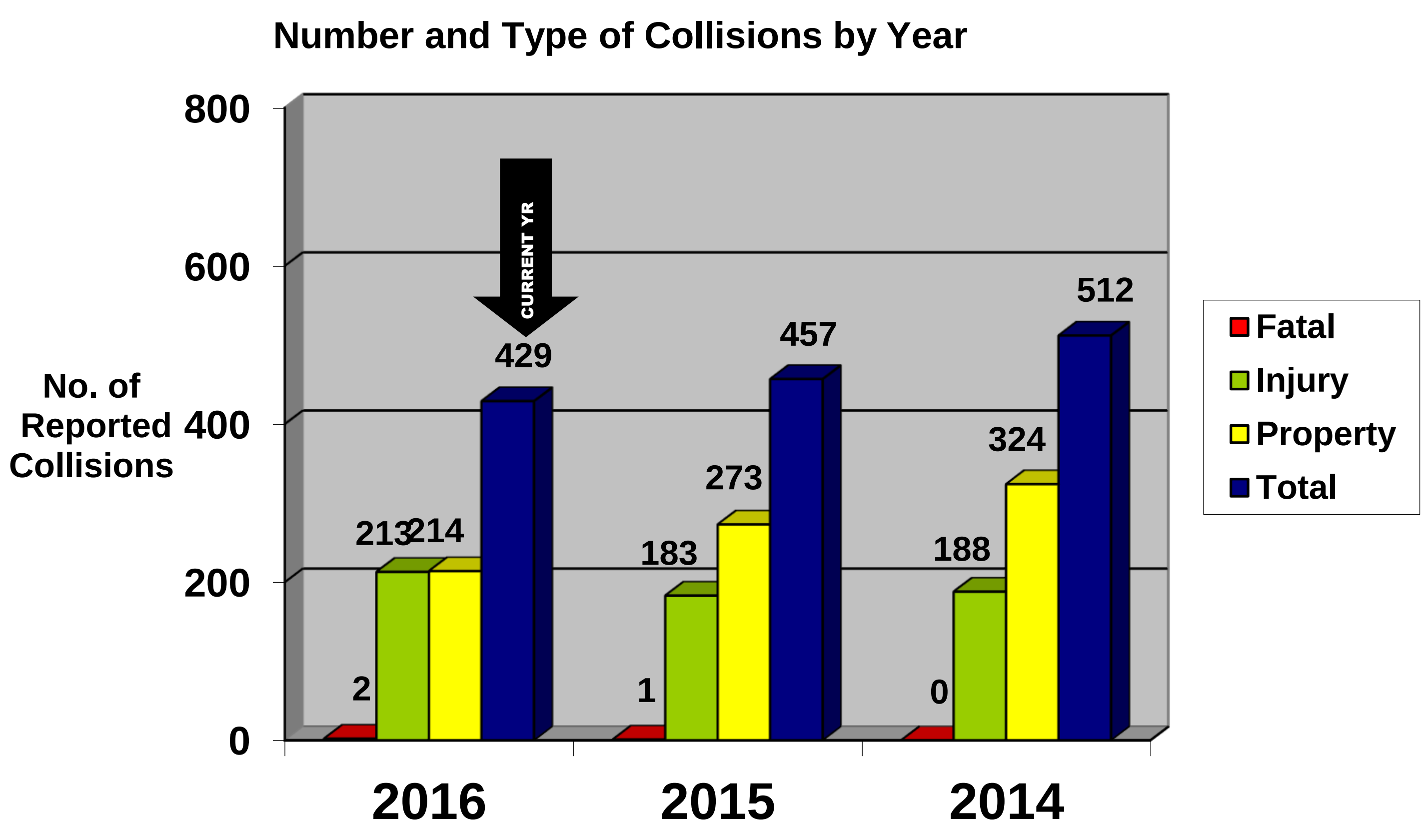

CITY OF
MISSION VIEJO
POSTED SPEED
LIMITS
2017
EL TORO
SR-241
SANTA MARGARITA
MELINDA
LOS ALISOS
TRABUCO
ALICIA
JERONIMO
MUIRLANDS
MARGUERITE
OLYMPIAD
LA PAZ
FELIPE
I-5 SAN DIEGO FWY
OSO
CABOT
CAMINO CAPISTRANO
CROWN VALLEY
AVERY
SPEED LIMIT 55
SPEED LIMIT 50
SPEED LIMIT 45
SPEED LIMIT 40
SPEED LIMIT 35
SPEED LIMITS
ARTERIAL STREETS
55 MPH
50 MPH
45 MPH
40 MPH
35 MPH
CITY BOUNDARY

Citywide Collisions 2016

As previously discussed, we use the City's Accident Inventory System (AIS), which is a database supported by updates from the Sheriff's Traffic Division and the Department of California Highway Patrol as reported in their Statewide Integrated Traffic Records System (SWITRS). The focus of this analysis is on the collisions occurring in 2016; however, a comparison of data for two (2) years is included to provide a basis of analysis, looking for the changes or patterns that occur over time.

During 2016, the traffic in the City of Mission Viejo has slightly decreased, especially on the east-west corridors as reported in recent years, while the rate of collisions has similarly been declining. The total number of collisions in 2016 is less than any of the last three years (2013 to 2015). Unfortunately, the occurrence of two (2) fatal collisions raised traffic safety concerns this year. Consistent with the overall total, there has been an overall decrease in the number of property damage only collisions. However, the number of injury collisions has inversely increased this year compared to the prior three years. The following is a summary of the reported collisions for the year 2016 in comparison to the past 3 years:

Year	Total	% chg	Fatal	% chg	Injury	% chg	Property	% chg
2016	429	-6.13%	2	100.0%	213	16.39%	214	-21.61%
2015	457	-10.74%	1	100.0%	183	-2.66%	273	-15.74%
2014	512	-10.96%	0	-100.0%	188	-12.15%	324	-9.24%
2013	575	--	4	--	214	--	357	--



The total number of collisions per this analysis represents the reported collisions on public streets in Mission Viejo. These figures are consistent with the number of collisions reported to the Department of California Highway Patrol's Statewide Integrated Traffic Records System (SWITRS). The Orange County Sheriff's Traffic Bureau statistics will indicate a higher number of reported collisions for the City of Mission Viejo because their statistics include both public streets and private property collision reports taken every year. They respond to private property collisions, which include parking lots or private streets. For our purposes, these have been excluded since the City has no direct authority over the operation of the private property. Our review of traffic safety focuses on the public streets.

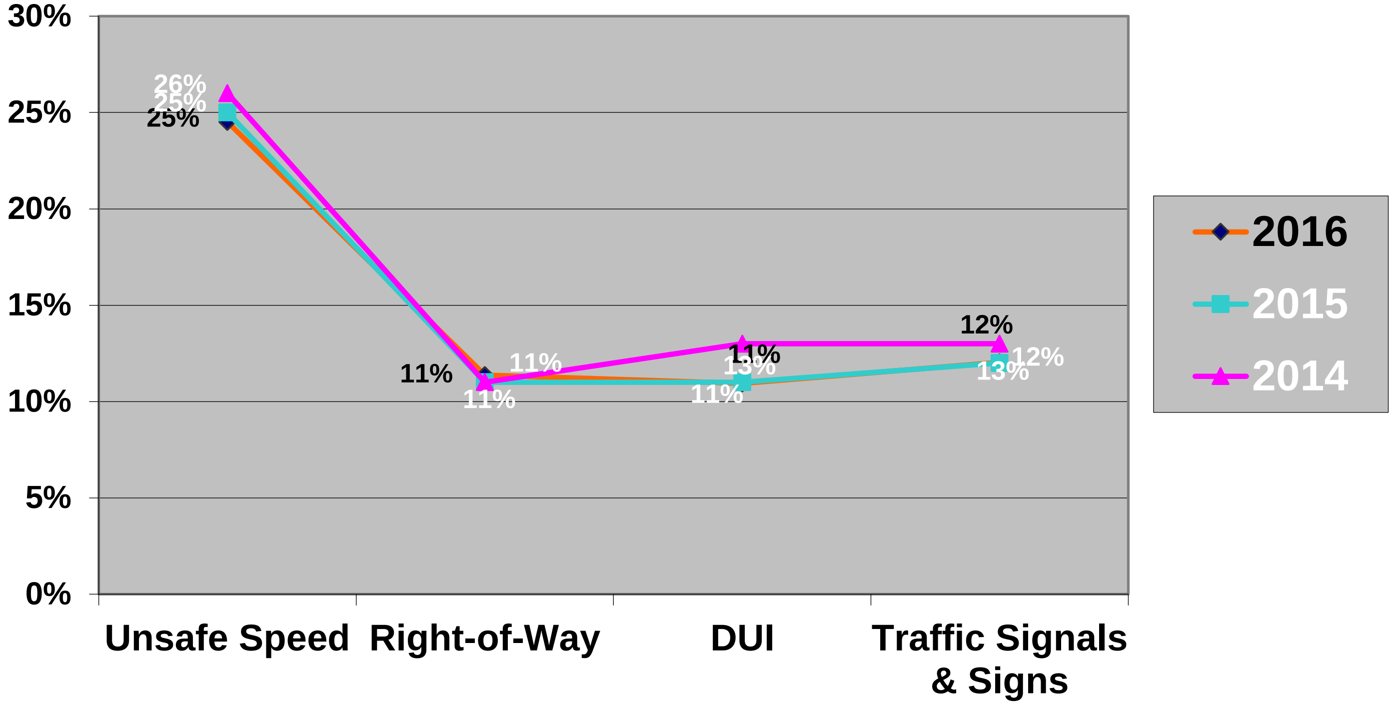
Year	Sheriff	SWITRS	Private Property Collisions
2016	499	429	70
2015	540	457	83
2014	624	512	112
2013	691	575	116

Primary Collision Factors

Collision reports try to identify the cause or *Primary Collision Factors*. These are identified as violations of the California Vehicle Code (CVC). Unsafe Speed (§22350), Failure to Obey Traffic Signals (§21453), Improper Turning (§22100-22113), Driving Under the Influence - DUI (§21352a) and Right-of-Way (§21800-21804) contributed to 75.52% of our collisions.

Primary Collision	Total City	% of Collision	Fatal	Injury	Property
Unsafe Speed	97	22.61%	0	52	45
Traffic Signals & Signs	71	16.55%	0	47	24
Improper Turn	62	14.45%	0	26	36
Driving or Bicycling Under the Influence (DUI)	48	11.19%	0	16	32
Automobile Right-of-Way	46	10.72%	1	30	15
Subtotals	324	75.52%	1	171	152
Unsafe Starting or Backing	7	1.63%	0	2	5
Unsafe Lane Change	15	3.50%	0	3	12
Unknown	44	10.26%	0	13	31
Wrong Side of Road	2	0.47%	0	2	0
All Others	37	8.62%	1	22	14
Total	429	100%	2	213	214

A comparison of primary collision factors in 2016 with those reported in 2015 and 2014 indicates that the primary collision factors have remained within the same ranges. The “*Traffic Signal & Signs Violations*” in 2016 contributed to 12% (2015–12%; 2014–13 %) of the collisions; “*Driving Under the Influence”* violations were at 11%, which is the same range or slightly lower than the 11% in 2015 and 13% reported in 2014, respectively. “*Right-of-Way”* violations” remained consistent at 11% from 11% in 2015 and 11% in 2014. One of the two fatal collisions in 2016 involved one (1) “*Driving Under the Influence*” violation.



These primary collision factors represent “technical” or legal contributing causes. In many of the reports “inattention” is a major contributing factor but not a violation. Factors such as “unsafe speed” do not always mean extreme or high speed, rather unsafe for the conditions. This could be applied to situations where a motorist might be traveling at or below the speed limit and should be slowing or stopping due to the traffic in front of them. Fault or primary collision factors cannot always be determined due to lack of witnesses, late reports, and conflicting statements. In looking for solutions or prevention of collisions, it is important to review the statements by the motorists and witnesses contained in the report in addition to the primary collision factors.

Fatal Collisions

Two (2) fatal collision occurred on the public streets in Mission Viejo during 2016. This is twice the amount as the one (1) fatal collision for 2015 and an increase from the zero (0) fatal collisions reported for 2014. These collisions are investigated and documented by M.A.R.T. (Major Accident Reconstruction Team), the Orange County Sheriff's special team for fatal, high profile, or complex incidents.

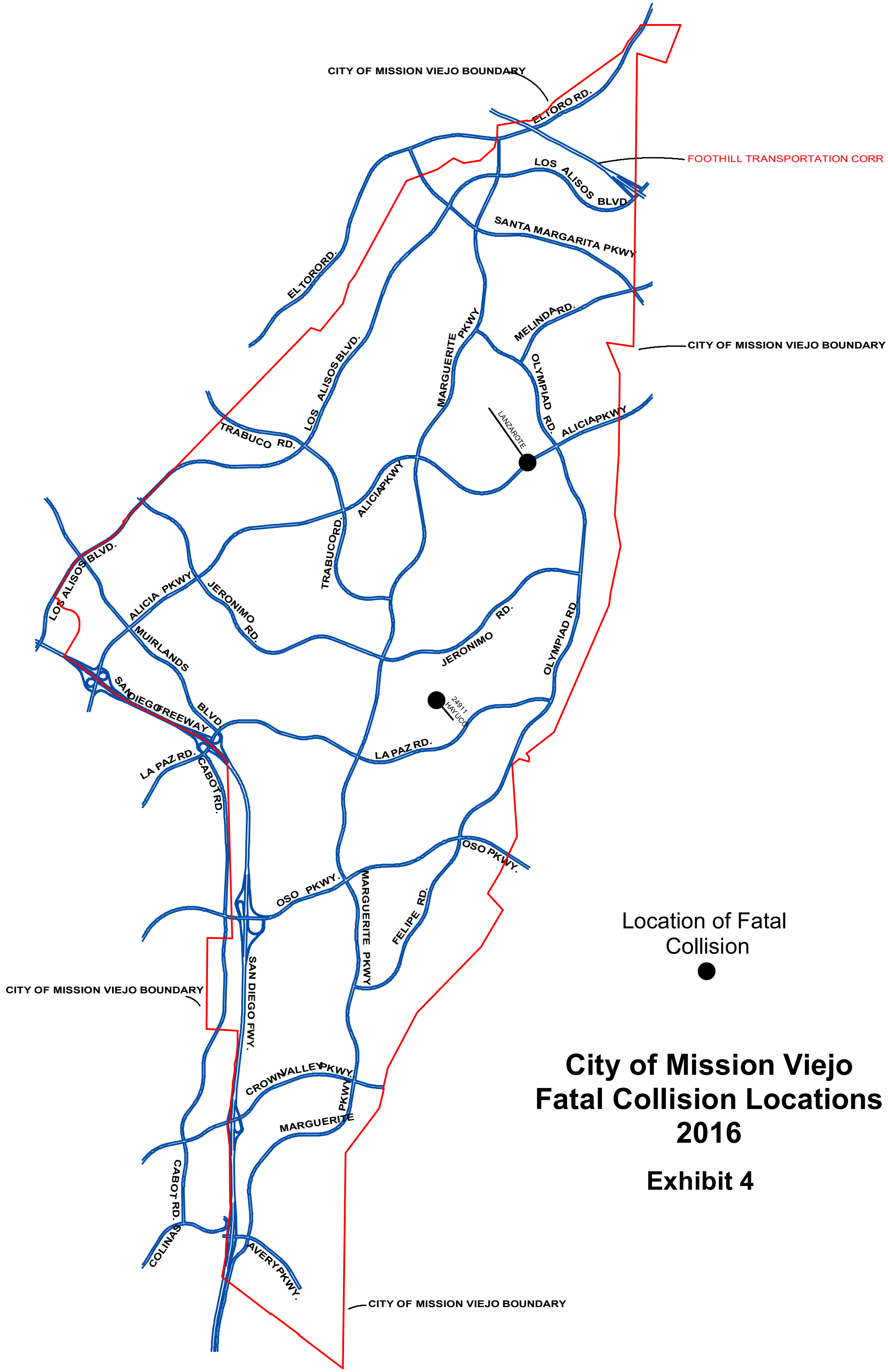
The following is a summary of the two (2) fatal collisions for 2016 on public streets (see Exhibit 4 for map location):

Street	Factors	Type of Collision
Alicia Pkwy & Lanzarote	**DUI (Driving Under the Influence) & Failure to yield the right-of-way until safe to proceed**	**Broadside**
24911 Hayuco	**Out of control van rolled downhill over its driver**	**Unknown**

Pedestrian and Bicycle Collisions

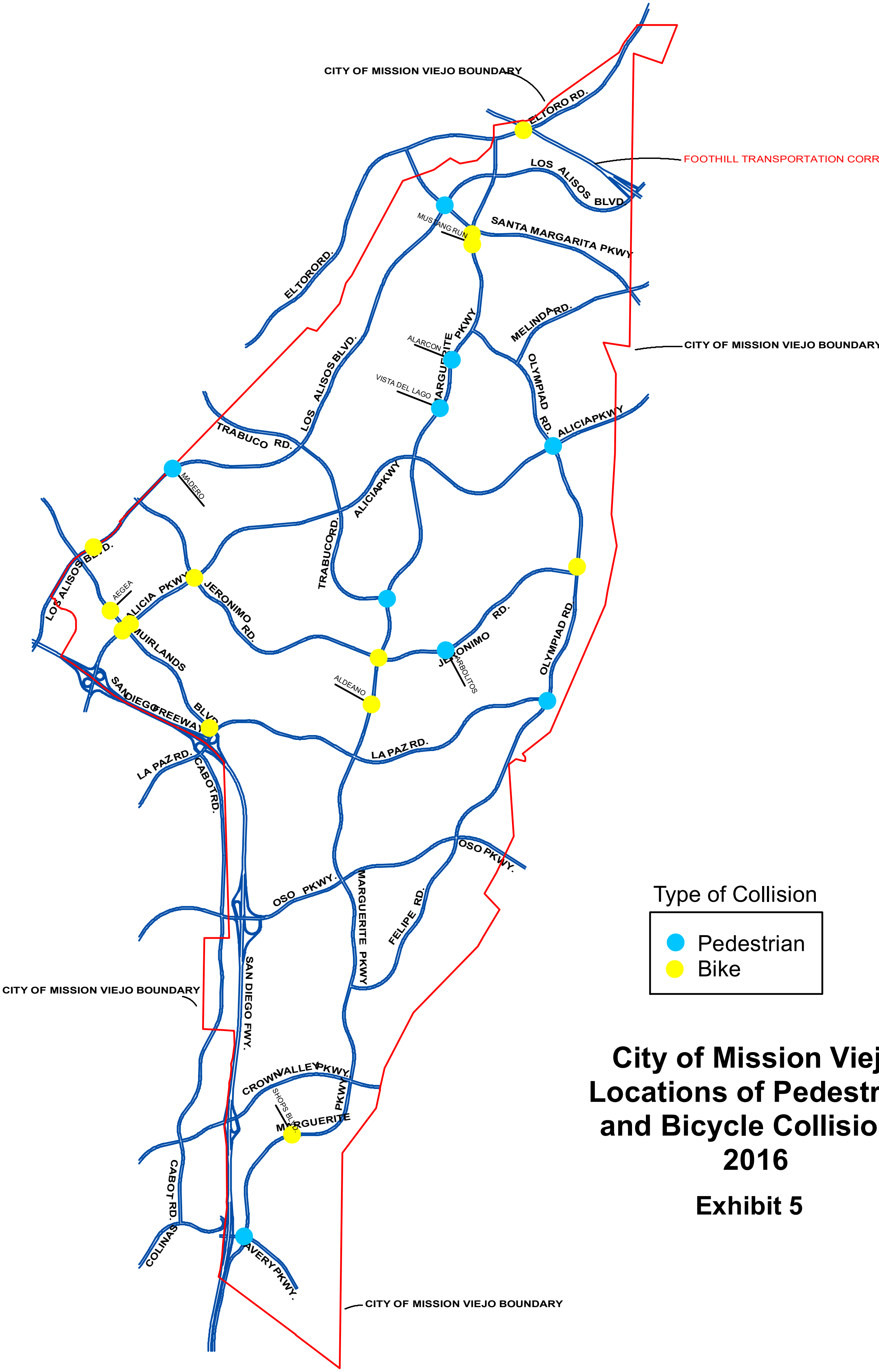
The City of Mission Viejo reported a total of 9 pedestrian and 14 bicycle collisions on public streets during 2016. All were random locations with no reoccurring trends or high collision locations for these types of collisions (see Exhibit 5). There was a total of 23 injuries out of the total 23 pedestrian and bicycle collisions. The trend of a higher rate of injury is one of the reasons we specifically look at these collisions. The total number of pedestrian collisions is increased from 2015 but decreased from 2014; similarly, the total number of bicycle collisions also slightly increased from 2015 and 2014.

In 2016, there were a total of nine (9) collisions involving pedestrians. The primary cause for three (3) of the pedestrian collisions were attributed to vehicles failing to yield to a pedestrian at an intersection. One (1) collision was caused by a pedestrian crossing unsafely in front of a vehicle so as to constitute an immediate hazard. A motorist driving under the influence of drugs caused one (1) collision. A driver caused one (1) collision due to an unsafe turn at an intersection. The remaining three (3) collisions have unknown causes. Pedestrian ages ranged from 17 to 63 years with the involved drivers ranging from 16 to 68.



City of Mission Viejo
Fatal Collision Locations
2016

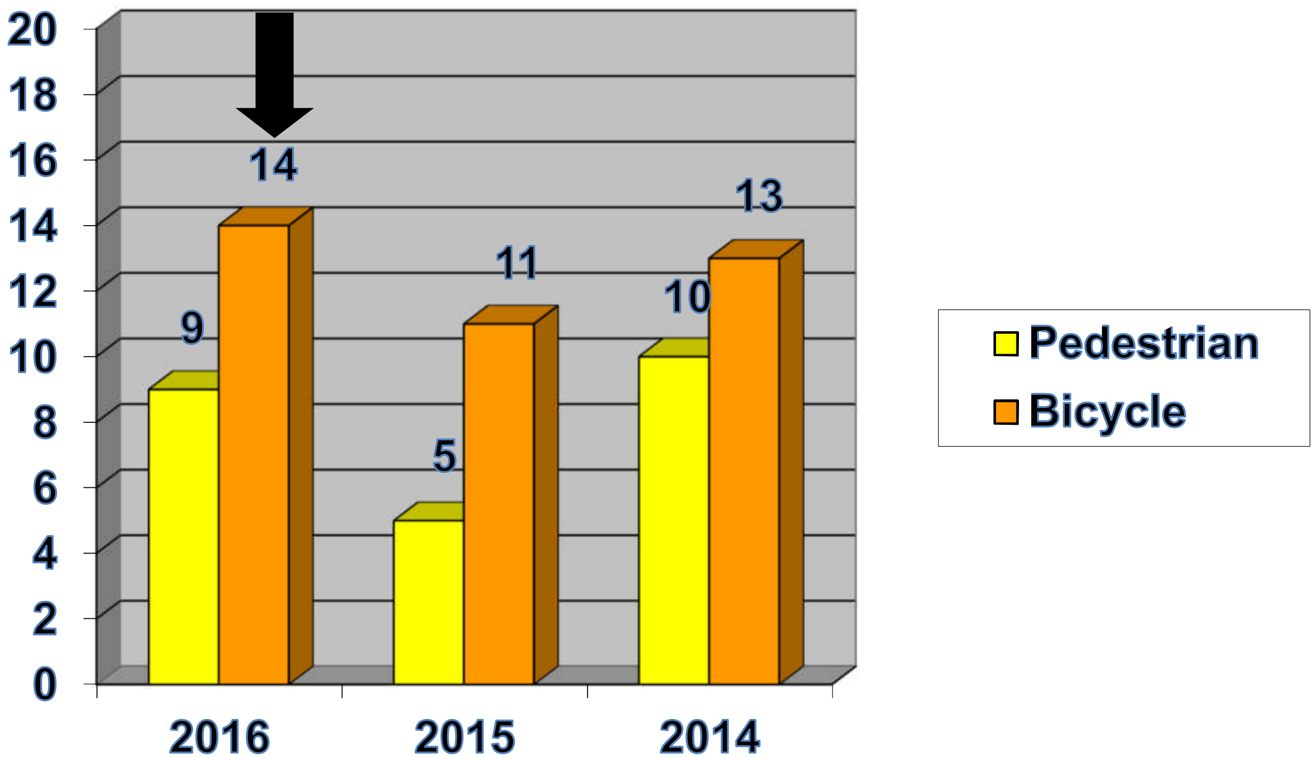
Exhibit 4



City of Mission Viejo Locations of Pedestrian and Bicycle Collisions 2016

Exhibit 5

There was a total of fourteen (14) collisions involving bicycles. The collisions involved bicyclists over a range of ages from 13 through 77 and involved vehicle drivers ranging from 17 to 86. Drivers failed to yield to bicycles in two (2) of the collisions which occurred at an intersection. A motorist driving at an unsafe speed caused one (1) collision. A bicyclist failed to stop at a marked limit line facing a steady circular red indication was the root of one (1) collision. One (1) collision was due to a bicyclist who made an unsafe turning movement and one (1) collision was due to a driver who made an unsafe turning movement. One (1) violation was caused by a driver who failed to yield to approaching traffic that constituted an immediate hazard. Three (3) collisions were due to bicyclists who failed to yield the right of way to all traffic while entering a driveway. The remaining four (4) collisions have an unknown primary collision factor.



Intersection versus Mid-block Collisions

All collisions are reported by a location or intersection of two streets; however, for traffic engineering these are separated into two types of collisions: intersection and mid-block collisions. Intersection collisions in our analysis are defined as collisions which occur either "AT' or within the first 200 feet on any leg of the intersection. Separating between mid-block and intersection help determine what type of corrective measures may be needed. Intersection collisions are usually *broadsides* and *rear-end* depending on the type of controls and operation of the intersection. We may need to change the operation of the intersection in some manner or provide a specific type of enforcement. Mid-block collisions are those that occur beyond the first 200 feet of the intersection and are typically associated with speeding or unexpected moves by a motorist to access driveways. *Sideswipe, hit object,* and *rear-end* collisions are the normal types of mid-block collisions. Some *broadside* collisions may occur at driveways. Using these definitions, the collisions for 2016 (along with similar information from 2015 and 2014 for comparison purposes) can be broken down in a three-year summary of collisions by intersection and mid-block.

Three-Year Summary of Collisions
Intersection versus Mid-block

Year	Intersection	Mid-block	Total Collisions
2016	321	108	429
2015	320	137	457
2014	365	147	512

The intersection collisions ("AT" or within the first 200 feet) represent approximately 75% of the total number of collisions with 25% occurring mid-block. This has not significantly changed over the years (compared to previous 70%-30% splits). The City's median islands on arterial streets limit mid-block access and probably contribute to fewer incidents of mid-block collisions. The following table is a further breakdown of the "type of collision" for each category.

	Intersection	%	Mid-block	%	Total Collisions	%
A Head-On	19	6%	2	2%	21	5%
B Sideswipe	47	15%	15	14%	62	14%
C Rear-end	94	29%	34	31%	128	29%
D Broadside	97	30%	21	19%	118	28%
E Hit Object	44	14%	29	27%	73	17%
F Overturned	6	2%	3	3%	9	2%
G Veh/Pedestrian	7	2%	0	0%	7	2%
H Other	7	2%	4	4%	11	3%
Total	321	100%	108	100%	429	100%

While there are definitely more collisions reported at intersections, the overall "mix" or types of collisions at mid-block appears to be quite similar to the types of collisions at the intersection. There are almost twice the amount percentages of collisions for mid-block "Hit Objects" with an expected reduction in percentage for "Broadside" collisions. No special conditions or concerns were identified based on this general information.

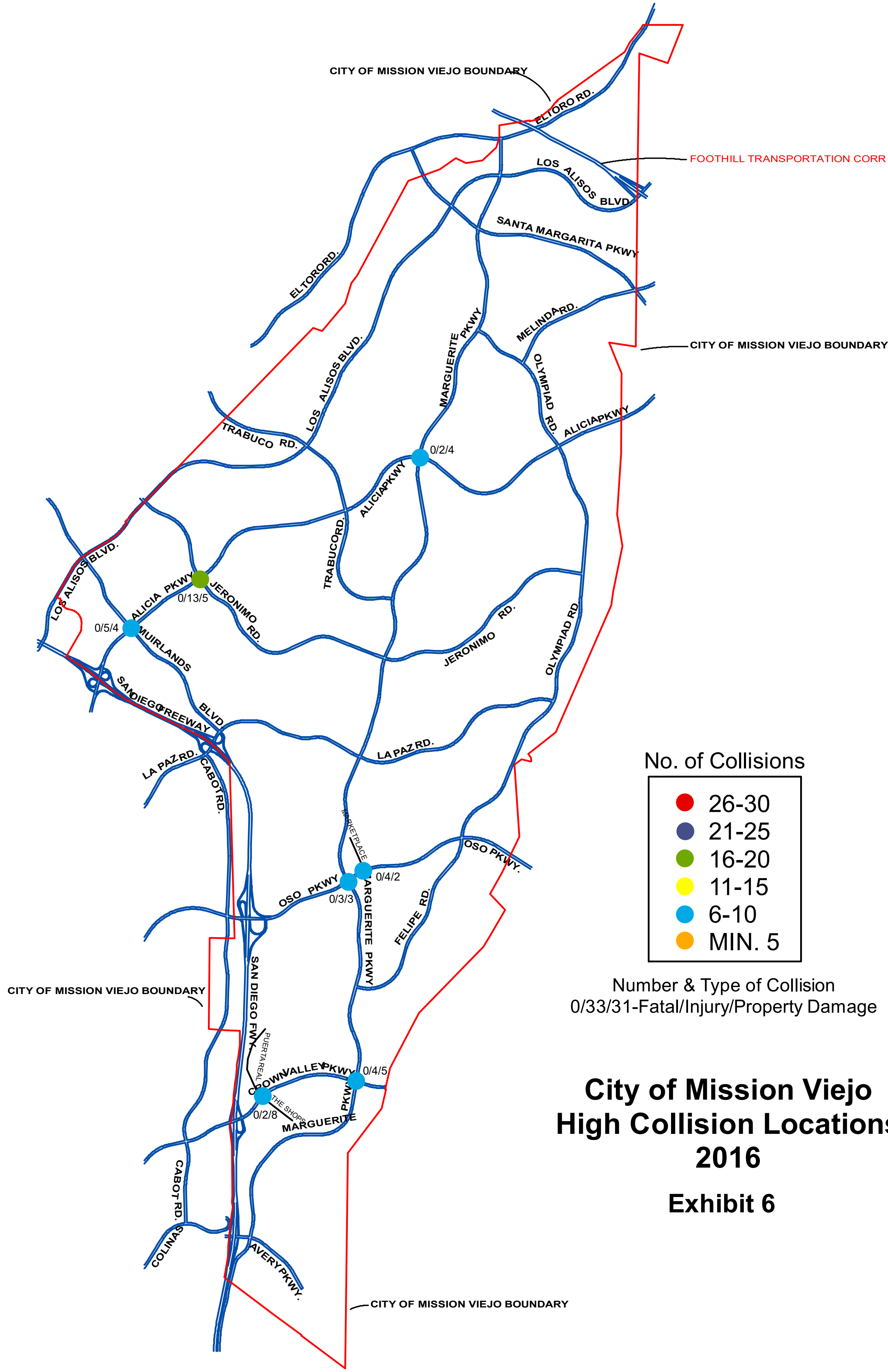
Locations with the Highest Number of Collisions

In review of the 2016 citywide collision data we found that there were 7 locations that ranged between 6 to 18 collisions per location. This is comparably less than the number of high collision intersections from previous years. In previous years, the City of Mission Viejo has averaged in the range of 10-20 intersections with a higher number of collisions usually ranging between 5 to 12 collisions per location. These intersections represent approximately 14.9% (64/429) of the total number of collisions reported in 2016. All of the subject intersections are signalized.

Overall the incident of injury collisions at these locations is 52% (33/64=52%) which is slightly higher than the citywide rate of 50% (213/429=49.7%). These high-collision locations are generally not more severe than other locations. In 2016, one (1) fatal collision occurred along an un-signalized intersection location and one (1) fatal collision occurred on a residential street. A summary of the locations, the number and type of collision is provided below with a map per Exhibit 6.

Locations with Highest Number of Collisions 2016

	LOCATION	Total	Fatal	Injury	Property Damage
1	ALICIA PKWY & JERONIMO RD	18	0	13	5
2	CROWN VALLEY PKWY & PUERTA REAL-THE SHOPS AT MISSION VIEJO	10	0	2	8
3	CROWN VALLEY PKWY & MARGUERITE PKWY	9	0	4	5
4	ALICIA PKWY & MUIRLANDS BLVD	9	0	5	4
5	ALICIA PKWY & MARGUERITE PKWY	6	0	2	4
6	MARGUERITE PKWY & OSO PKWY	6	0	3	3
7	OSO PKWY & MARKETPLACE	6	0	4	2
	TOTALS	**64**	**0**	**33**	**31**



City of Mission Viejo High Collision Locations 2016

Exhibit 6

Further Analysis

High-Collision Locations

A list of the 7 identified high-collision locations is provided on page 21. It includes the total number of collisions for 2016 with the totals for the two previous years. The comments/recommendations are based on the review and information summarized on the collision diagrams that follow. These collision diagrams provide schematic (not a precise) plotting of the collision locations and symbols indicating the type of collision. They visually display the collision information in a manner that helps to identify trends or patterns. Transportation Services prepared these collision diagrams for each location based on the review of the information provided in the individual collision reports submitted by the Orange County Sheriff's Department. Each year may be unique in the pattern of collisions, or there may be trends that need to be evaluated for corrections. The trends are identified by using the current and previous collision diagrams for 2015 and 2014, which provides a comparison to previous occurrences at each location. The goal is to evaluate the history and patterns, looking for suggested engineering (signs, signals, striping or other roadway modifications) and enforcement actions that could be applied to reduce collisions in future years.

Pin Maps

There are many locations that will end up with a higher number of collisions each year. One of the reasons for this is the correspondingly high traffic volumes which result in the increased opportunity for collisions as well as the "stop-and-go" or congestion associated with the arterial corridors (such as Alicia, Oso, and Crown Valley Parkways) especially near the freeways. To look for unexpected trends or local residential streets that might have problems, a citywide "pin" map was created plotting the 429 collisions at their reported locations. The **"City of Mission Viejo 2016 'Pin' Map"** and two closer images for the north and south parts of town are provided in the back of this report. Each dot (or pin) represents a collision with a change in color for locations where the number is high.

The maps generally validate that most of the collisions are occurring on the arterial streets with a random pattern within the residential communities. All of our information is based on "reported" collisions so some of the minor incidents may not be reported. The number of collisions seems to increase on the east-west arterial streets between Marguerite Parkway and the Interstate 5 (I-5) freeway interchanges. There are clusters of collisions along Crown Valley Parkway and Alicia Parkway corridor, which are the two highest traffic volume arterials in the city. There are also grouped collisions along Marguerite Parkway between Crown Valley Parkway and Avery Parkway where there are several closely spaced intersections and different land use traffic generators.

Collisions continue to be clustered on the collector street of Mustang Run by Trabuco Hills High School (northerly part of town) between Los Alisos and Marguerite. Near Alicia Parkway between Charlinda and the freeway there is a cluster of collision activity.

Some patterns on Alicia at Jeronimo near closely spaced traffic signals. Some of these areas will be monitored in the future to see if the patterns continue, and further reviews will be conducted to evaluate the need for engineering changes (i.e. signage, signal timing modifications, or striping), or additional enforcement.

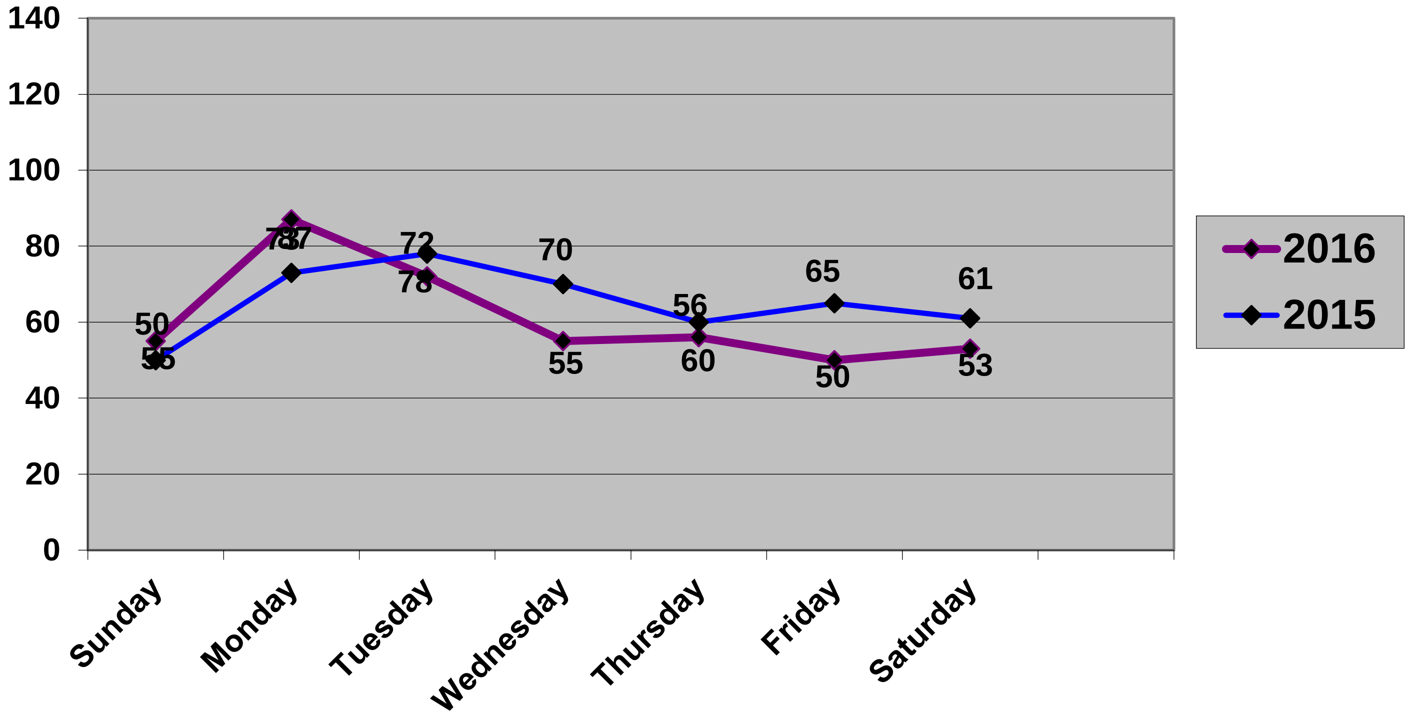
Other Data

As previously analyzed in the primary collision factors, the incidents of unsafe speed, signal violations, DUI, and improper turn violations have remained within consistent patterns over several years. Since the overall number of collisions has been declining, the currently applied engineering and enforcement appear to be effective. The practice of providing MART response to provide a professional and detail review of each serious collision, tracking all collisions, and an annual review/analysis of collisions are preventative measures that the City uses to help monitor and provide early identification of traffic issues.

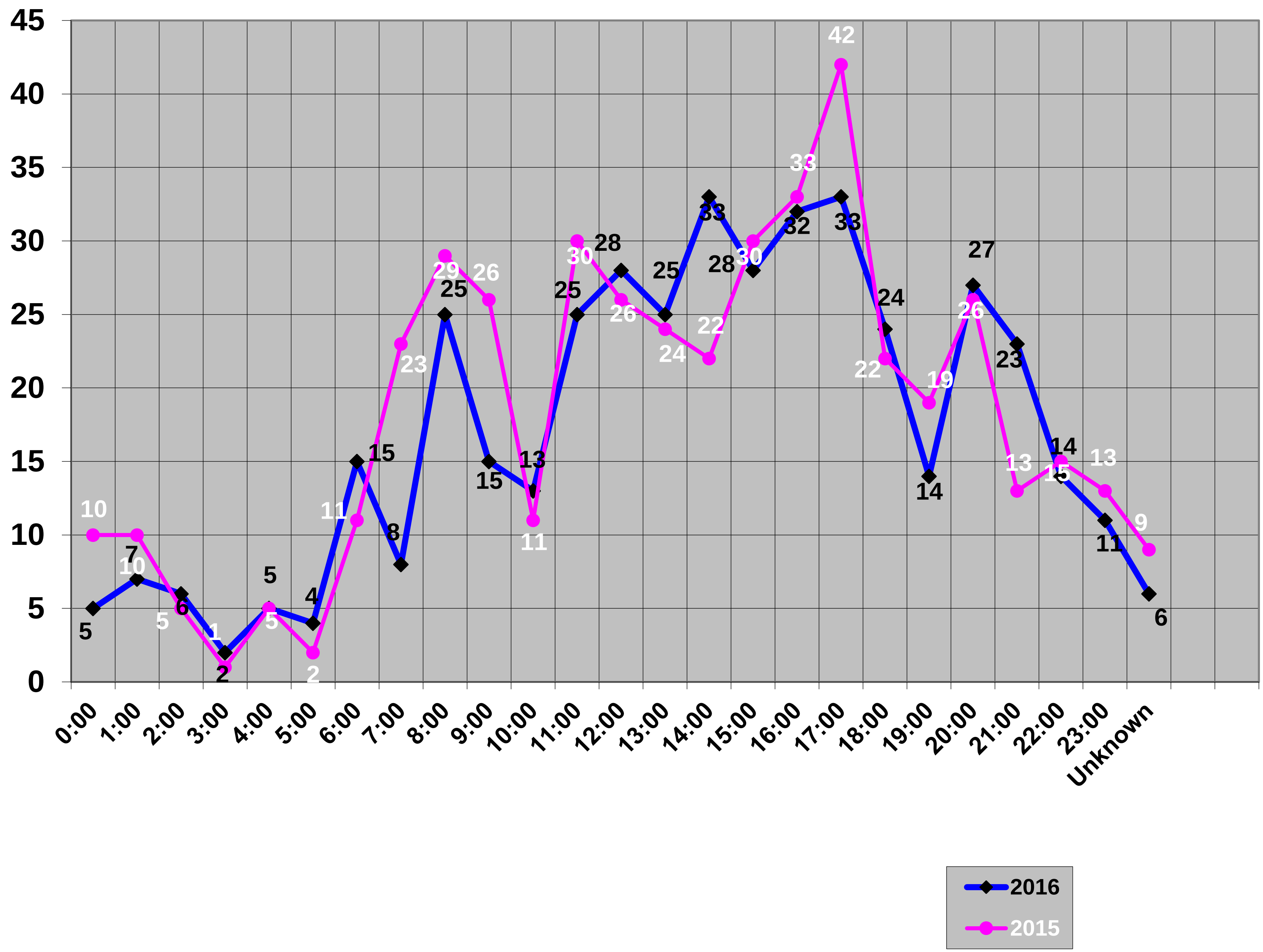
Enforcement programs such as the DUI or seat belt enforcement “checkpoints” appear to have had an impact since factors such as DUI collisions continue to remain consistent with the lower total numbers reported during the previous years. We would encourage these programs to be supported in the future. The lack of school-related pedestrian problems should recognize the City’s investment in the crossing guard programs.

Some additional information regarding other factors of traffic collisions in the City of Mission Viejo are provided in the following charts:

Collisions by the Day of the Week



Collisions by Hour of the Day

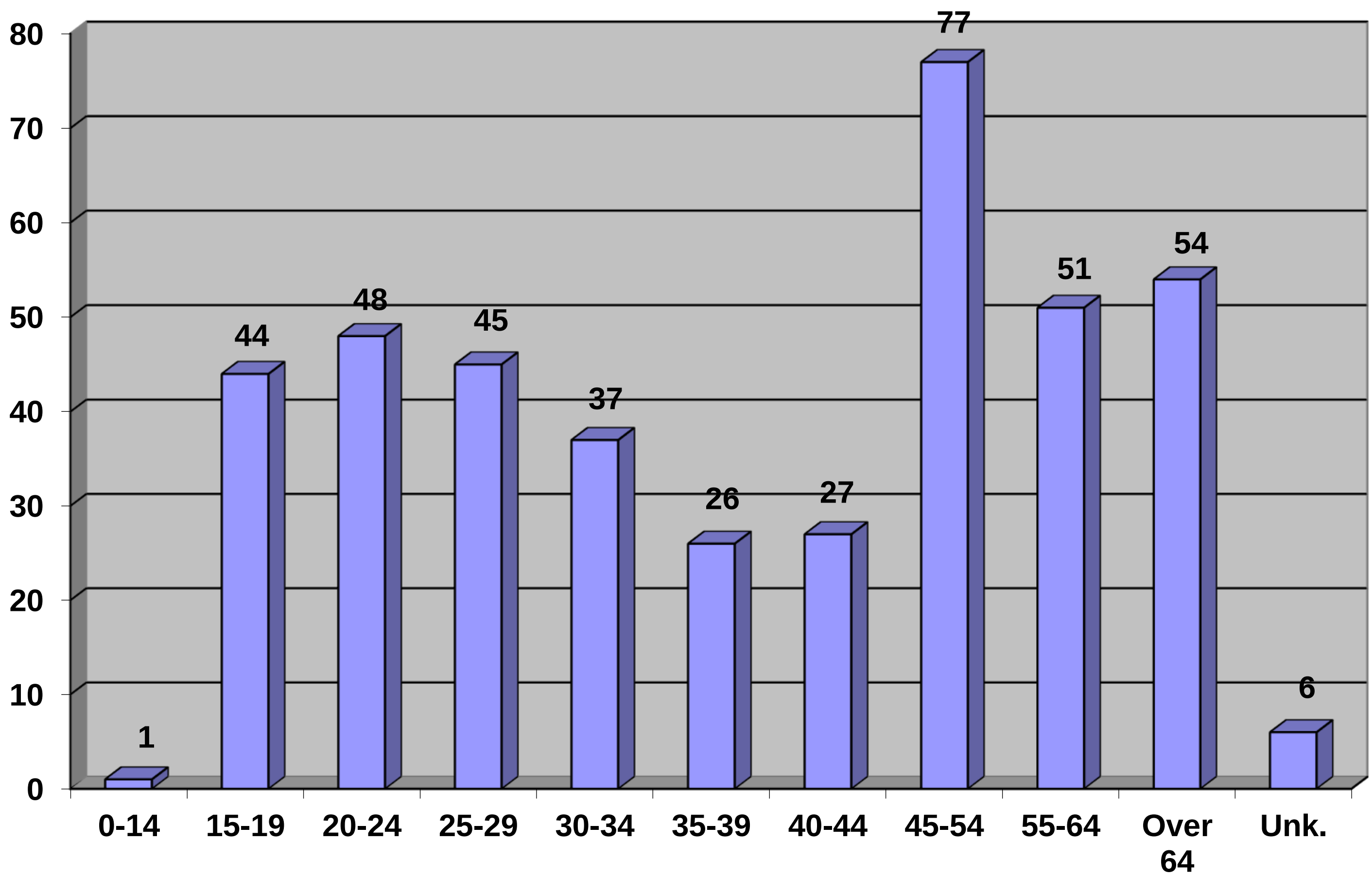


Age Profiles of All Involved Parties For
2016 Drivers in Fatal & Injury Collisions Only

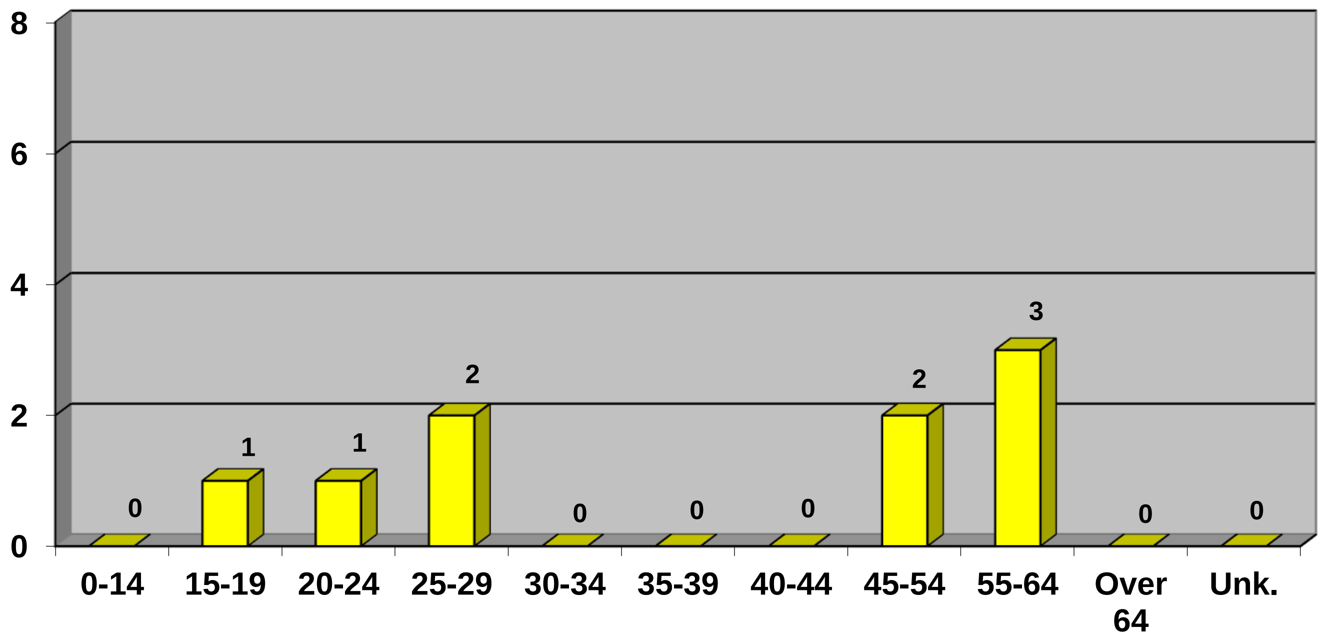
	Total	0-14	15-19	20-24	25-29	30-34	35-39	40-44	45-54	55-64	Over 64	Unk.
Driver	394	0	39	46	43	35	25	27	74	46	53	6
Pedestrian	9	0	1	1	2	0	0	0	2	3	0	0
Bicyclists	13	1	4	1	0	2	1	0	1	2	1	0
Total	416	1	44	48	45	37	26	27	77	51	54	6

Total Number of Fatal & Injury Collisions Only: 214 (2 Fatal, 212 Injury) The "involved parties" include all drivers, pedestrians, and bicyclists involved in the collision report.

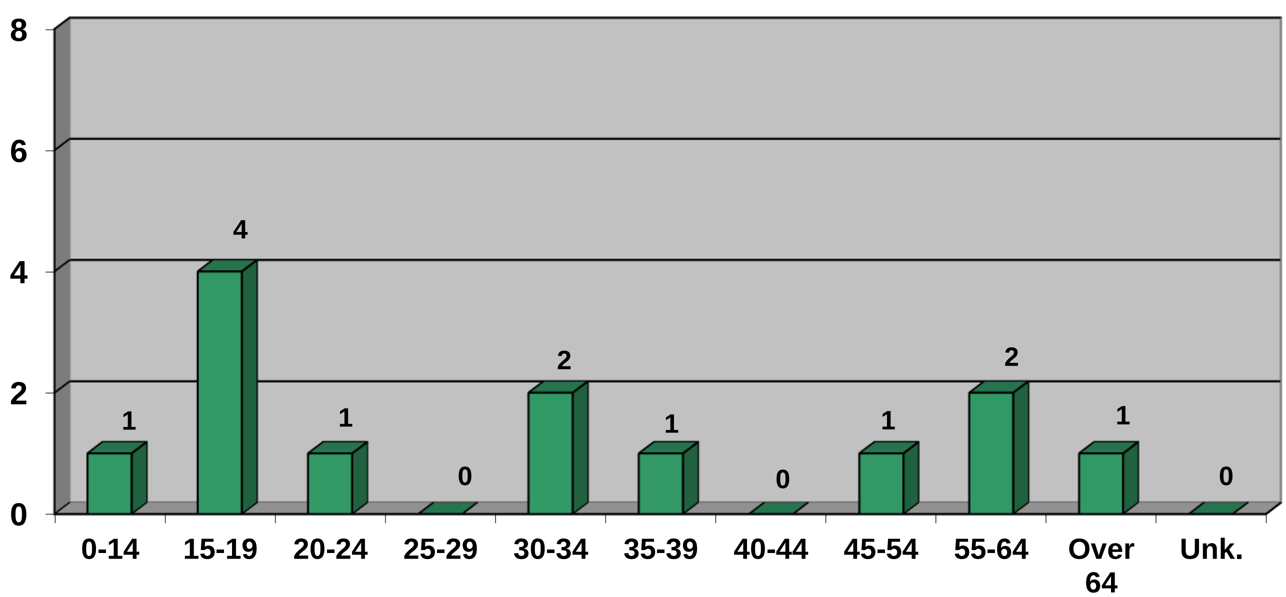
Fatal & Injury Collisions ONLY by Age Profiles of All Involved Parties (Driver, Pedestrian & Bicyclists)



Collisions by Age of Pedestrian Involved Collisions



Collisions by Age of Bicyclist Involved Collisions



City of Mission Viejo
Locations with High Number of Collisions – 2016
Comments and Recommendations

	LOCATION	2016 Total	2015 Total	2014 Total	Comments/ Recommendations
1	ALICIA PKWY & JERONIMO RD	18	12	14	An increase in collisions from the past 2 years which is consistent with increased traffic volumes. Pattern of red-light-running in all directions. Enforcement recommended. Monitor signal operations.
2	CROWN VALLEY PKWY & PUERTA REAL- THE SHOPS AT MISSION VIEJO	10	5	8	Increase in collisions from prior years past (2015 & 2014). Continuous red-light infractions due to high turning movement volumes and pattern of rear-end collisions in the westbound direction. Consider modifying signal timing intervals. Monitor.
3	CROWN VALLEY PKWY & MARGUERITE PKWY	9	8	8	Collision occurrences are very similar each year and consistent with identical traffic volume patterns. Four DUI related collisions. Potential location for a DUI Check Point. Monitor.
4	ALICIA PKWY & MUIRLANDS BLVD	8	11	4	Number of collisions has decreased from last year but increased from 2 prior years. Pattern of red-light running violation from eastbound direction and unsafe lane changes, turns & speeds. Recommend enforcement of speeds from eastbound direction. Monitor.
5	ALICIA PKWY & MARGUERITE PKWY	6	6	7	Similar level of collisions to previous years. Random collisions in all directions. Future Intersection Widening Project to add 3rd EB through lane & dual WB left turn lane. Continue to monitor after construction project.
6	MARGUERITE PKWY & OSO PKWY	6	8	8	Total number of collisions has slightly reduced from past 2 years. Multiple collisions from vehicles traveling in the eastbound direction. Recommend enforcement of speeds in eastbound direction. Monitor.
7	OSO PKWY & MARKETPLACE	6	1	2	An increase in collisions from prior years. Continuous red-light running violations in the westbound direction due to high traffic volumes. Consider increasing yellow & red timing intervals. Monitor.

Collision Legend

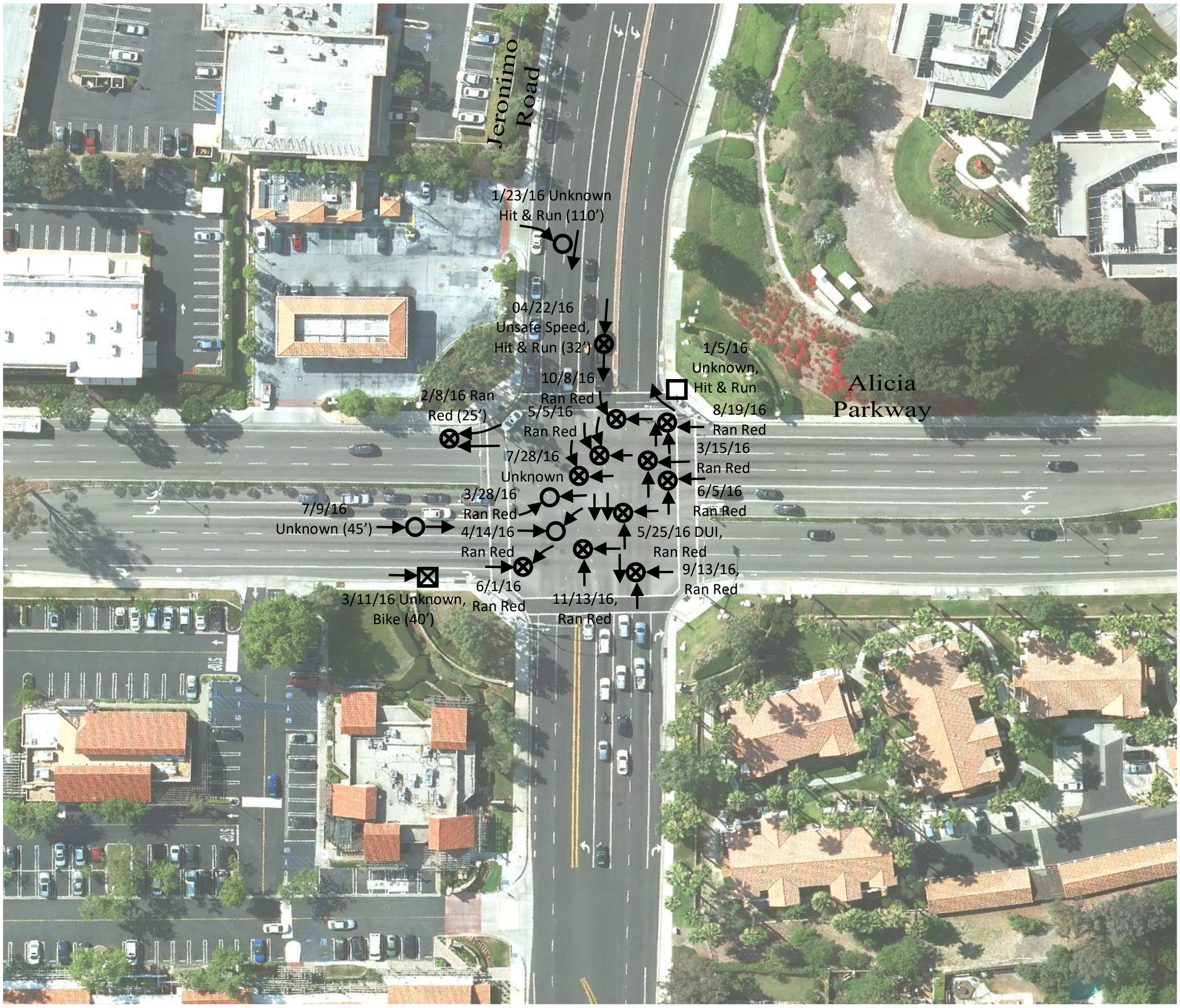
Vehicle Vs. Vehicle/Ped./Bike	Vehicle Vs. Fixed Object	
○	□	Property Damage
⊗	⊠	Injury
●	■	Fatal

∼∼→	Lost Control
	Roll Over
←≪≪→	Reverse
- - - - →	Pedestrian
- Bike →	Bike

2016 Collision Diagram

Intersection:

Street (1) Jeronimo Road (N-S)
Street (2) Alicia Parkway (E-W)



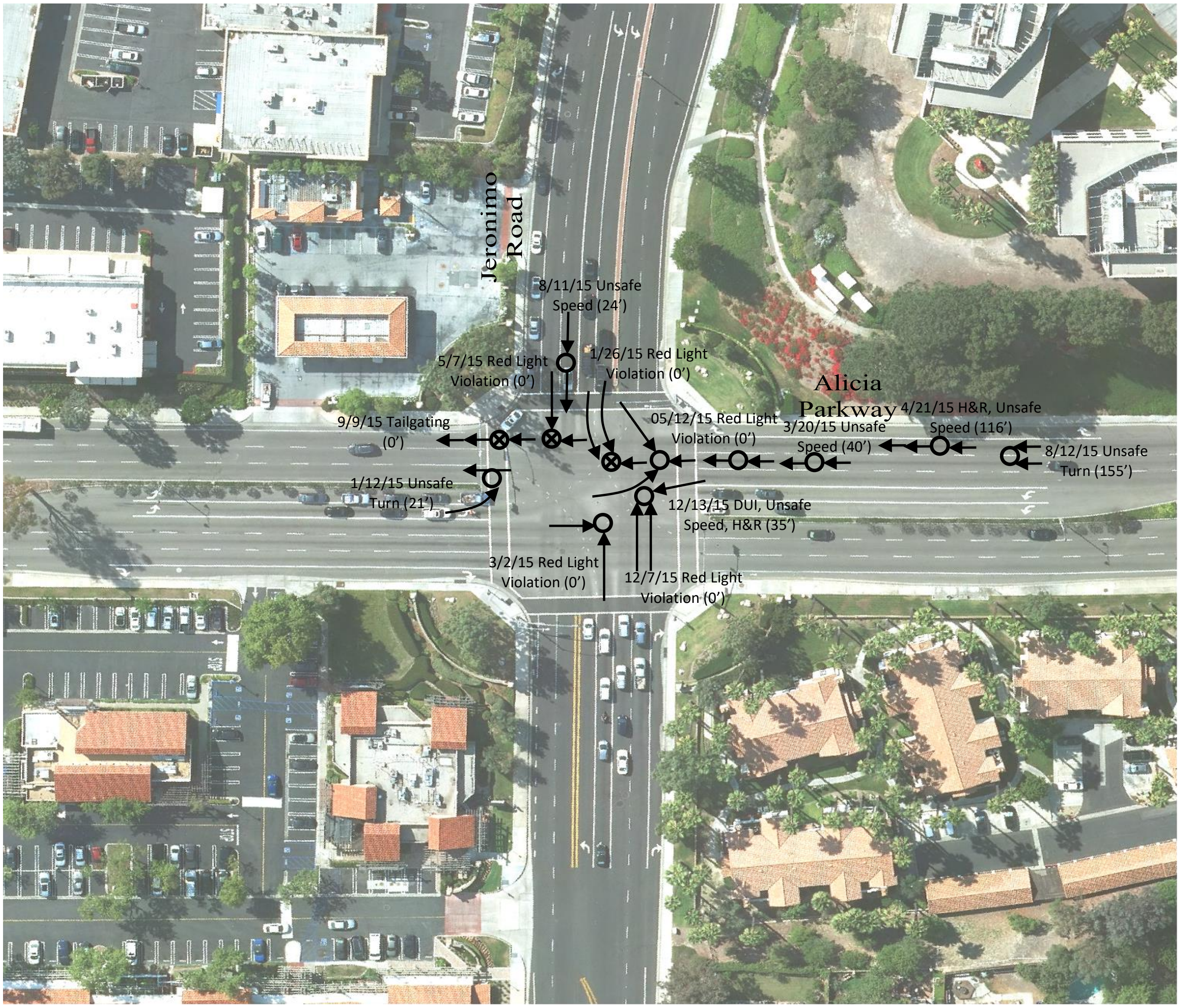
2016 Totals : 18 (0 Fatals – 13 Injury – 5 Property)

Comments:

This is a signalized intersection with traffic volumes ranging from 61,500 vehicles per day on the west leg and 43,900 vehicles on the east leg. The north leg of Jeronimo traffic averages 17,100 vehicles and the south leg averages 15,600 vehicles. There is a pattern of broadside collisions occurring at the intersection due to red light violations. Suggest enforcement. Monitor.

2015 Collision Diagram

Intersection:
Street (1) Jeronimo Road (N-S)
Street (2) Alicia Parkway (E-W)



2015 Totals : 12 (0 Fatals – 3 Injury – 9 Property)

Comments:

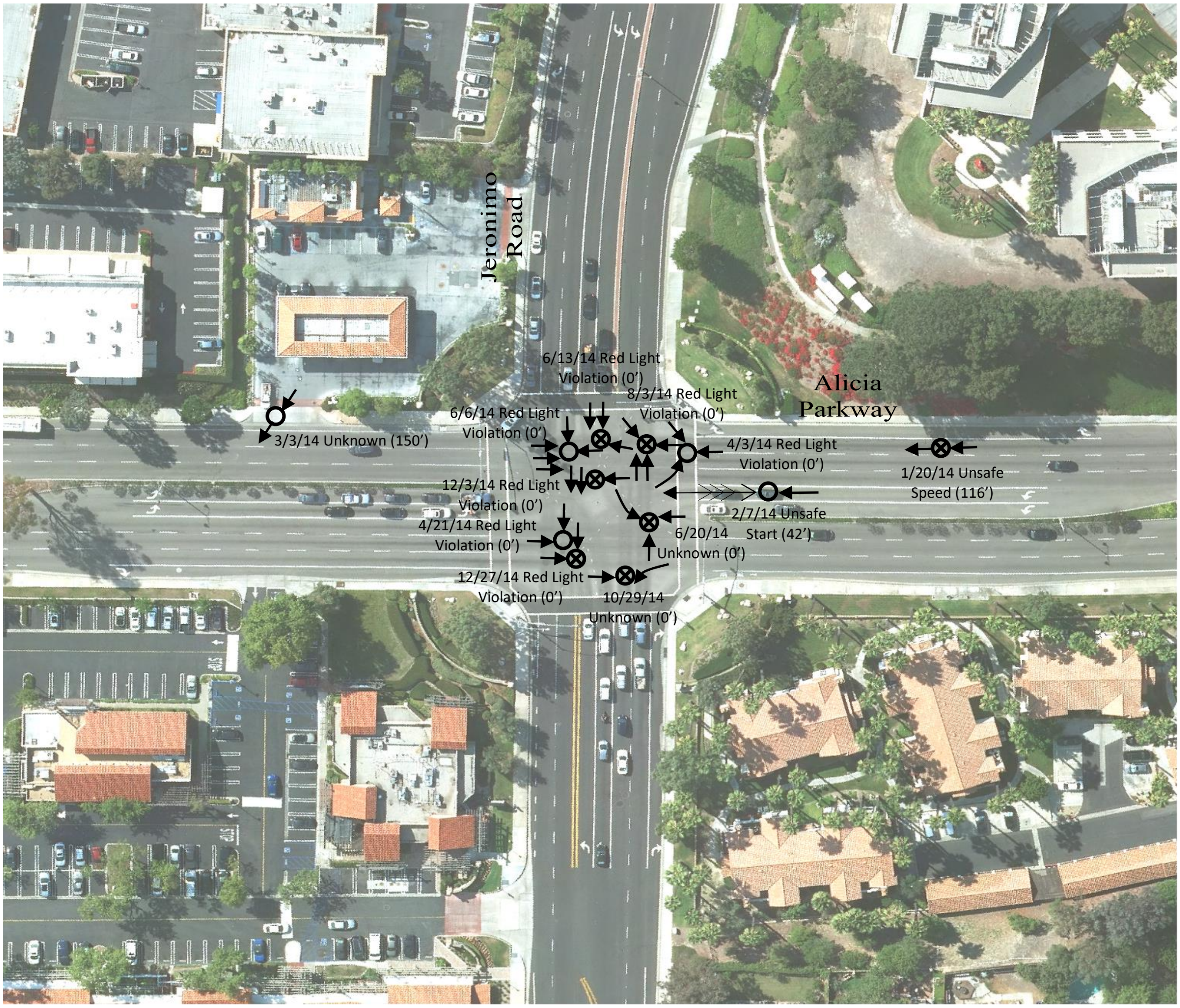
This is a signalized intersection with traffic volumes ranging from 60,300 vehicles per day on the west leg and 47,500 vehicles on the east leg. The north leg of Jeronimo traffic averages 22,900 vehicles and the south leg averages 15,000 vehicles. There is a pattern of broadside collisions occurring at the intersection due to red light violations and rear-end collisions due to speeding. Suggest enforcement. Monitor.

2014 Collision Diagram

Intersection:

Street (1) Jeronimo Road (N-S)

Street (2) Alicia Parkway (E-W)



2014 Totals : 12 (0 Fatals – 7 Injury – 5 Property)

2016 Collision Diagram

Intersection:

Street (1) Puerta Real-The Shops Blvd. (N-S)

Street (2) Crown Valley Parkway (E-W)

2016 Totals : 10 (0 Fatals – 2 Injury – 8 Property)

Comments:

This is a signalized intersection. Crown Valley has an average daily traffic volume of 47,500 vehicles per day on the east leg of and 60,700 vehicles per day on the west leg. Puerta Real is a local collector with about 8,600 vehicles per day on the north leg and the southerly leg is a private driveway to the Shops at Mission Viejo. The pattern of collisions at the intersection are continuous red-light infractions due to high turning movement volumes and a trend of rear-end collisions in the westbound direction. Enforcement recommended. Considering modifying signal timing intervals. Continue to monitor.

2015 Collision Diagram

Intersection:
Street (1) Puerta Real-The Shops Blvd. (N-S)
Street (2) Crown Valley Parkway (E-W)

2015 Totals : 5 (0 Fatals – 2 Injury – 3 Property)

Comments:

This is a signalized intersection. Crown Valley has an average daily traffic volume of 52,500 vehicles per day on the east leg of and 61,800 vehicles per day on the west leg. Puerta Real is a local collector with about 8,400 vehicles per day and the southerly leg is a private driveway to the Shops at Mission Viejo. The pattern of collisions at the intersection is random. Monitor.

2014 Collision Diagram

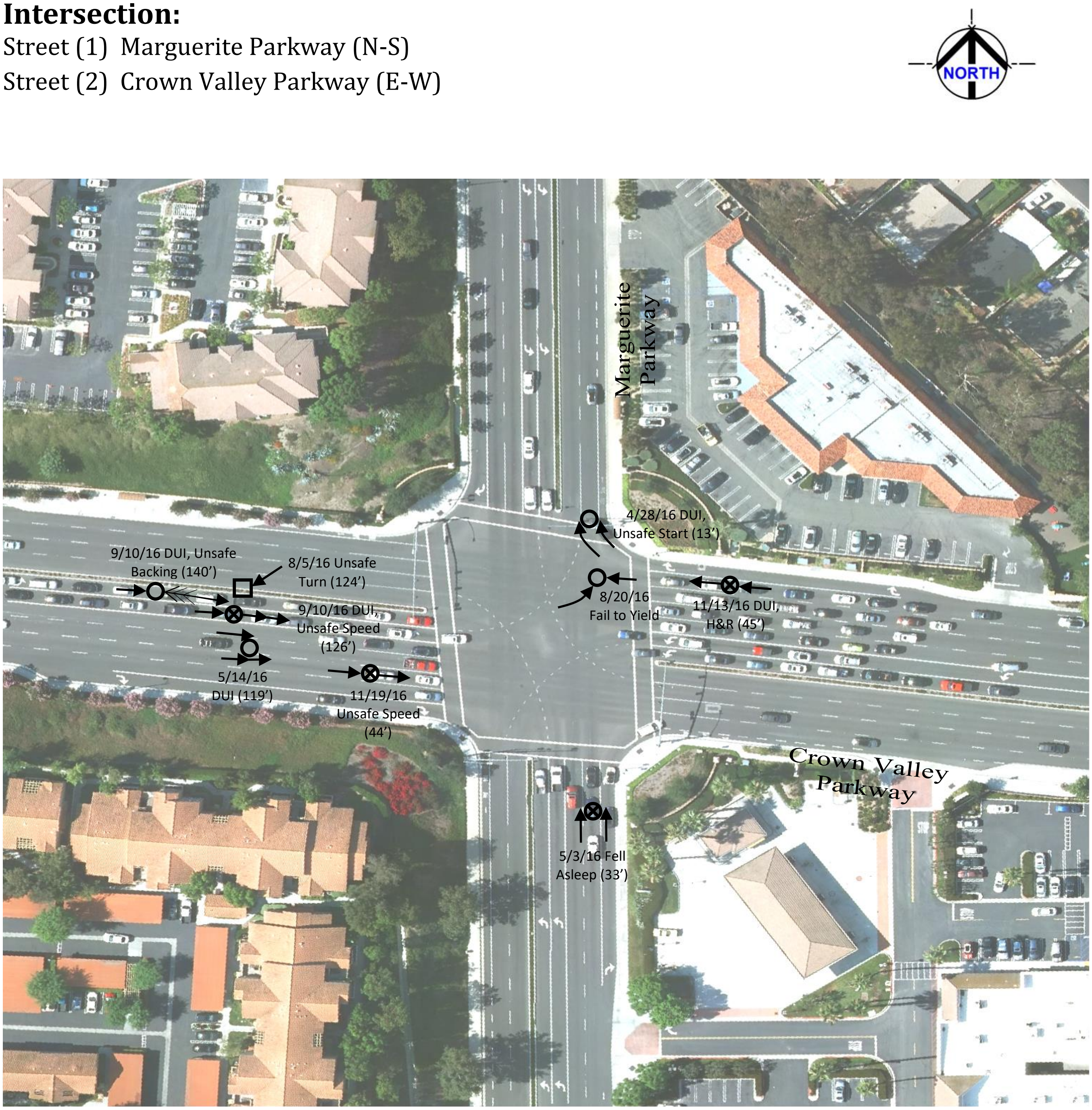
Intersection:
Street (1) Puerta Real-The Shops Blvd. (N-S)
Street (2) Crown Valley Parkway (E-W)

2014 Totals : 8 (0 Fatals – 4 Injury – 4 Property)

2016 Collision Diagram

Intersection:

Street (1) Marguerite Parkway (N-S)
Street (2) Crown Valley Parkway (E-W)



2016 Totals : 9 (0 Fatals – 4 Injury – 5 Property)

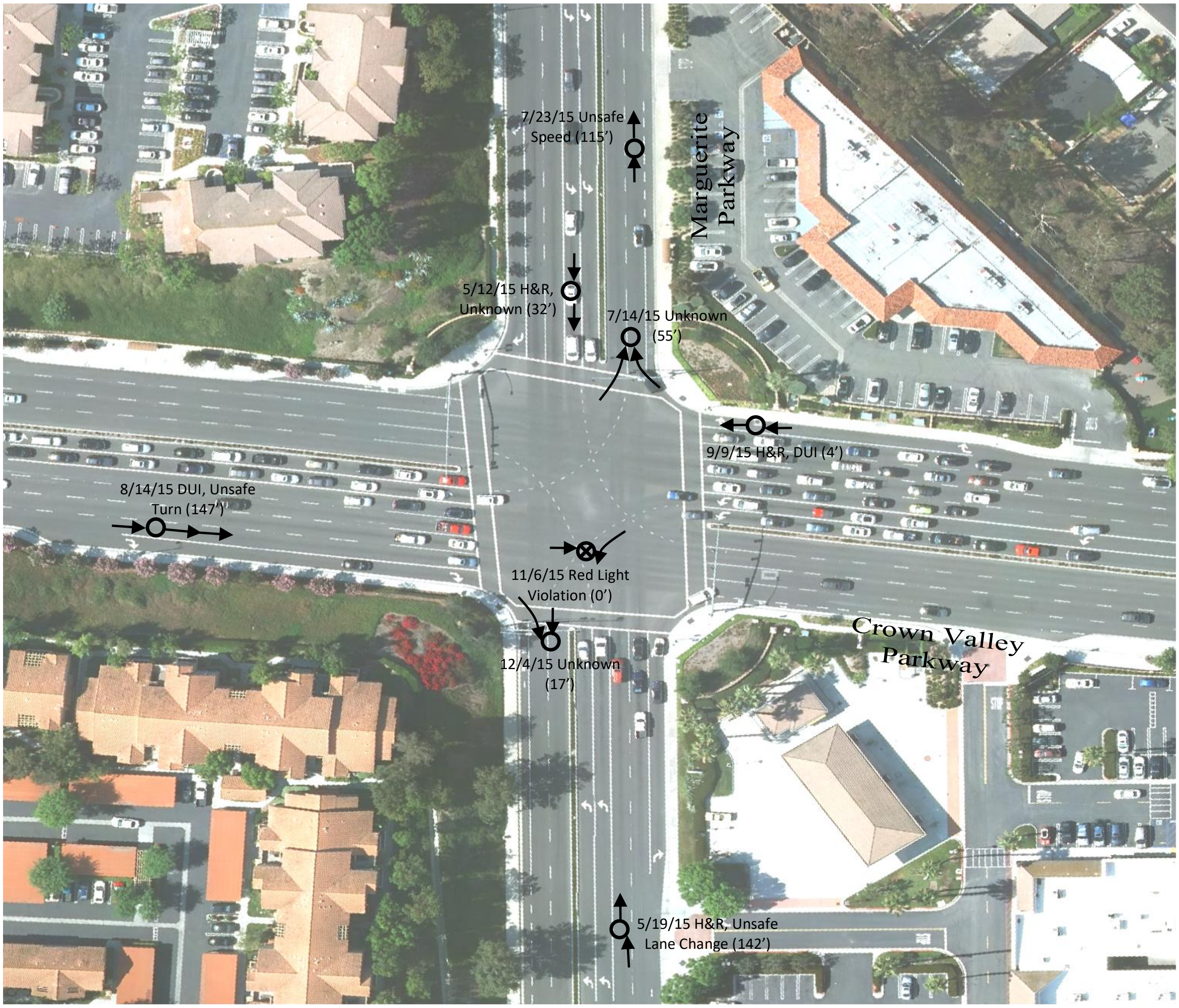
Comments:

This is a signalized intersection with high traffic volumes on all approaches. Crown Valley has recorded average traffic volumes of 39,500 vehicles per day on the west leg and 44,600 vehicles to the east leg. Marguerite operates with 33,900 vehicles on the north leg with a drop to 33,600 on the south leg of the intersection. A trend of four Driving Under the Influence (DUI) related collisions. Potential location for a DUI check point.

2015 Collision Diagram

Intersection:

Street (1) Marguerite Parkway (N-S)
Street (2) Crown Valley Parkway (E-W)



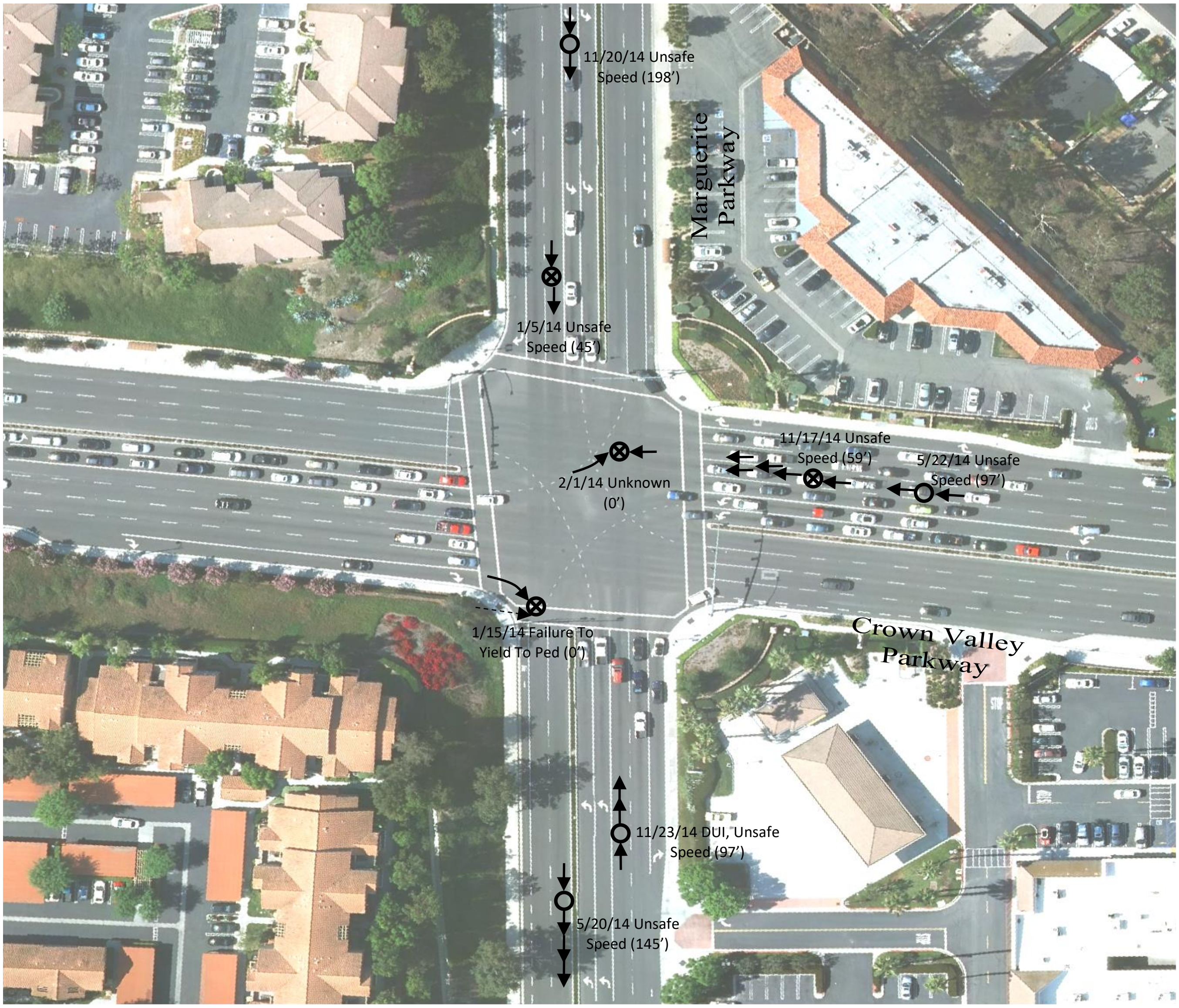
2015 Totals : 8 (0 Fatals – 1 Injury – 7 Property)

Comments:

This is a signalized intersection with high traffic volumes on all approaches. Crown Valley has recorded average traffic volumes of 36,800 vehicles per day on the west leg and 46,800 vehicles to the east leg. Marguerite operates with 32,300 vehicles on the north leg with a drop to 38,800 on the south leg of the intersection. A trend of rear-end collisions is associated with congestion. Crown Valley was widened one lane in each direction between Puerta Real and Jardines in 2009.

2014 Collision Diagram

Intersection:
Street (1) Marguerite Parkway (N-S)
Street (2) Crown Valley Parkway (E-W)



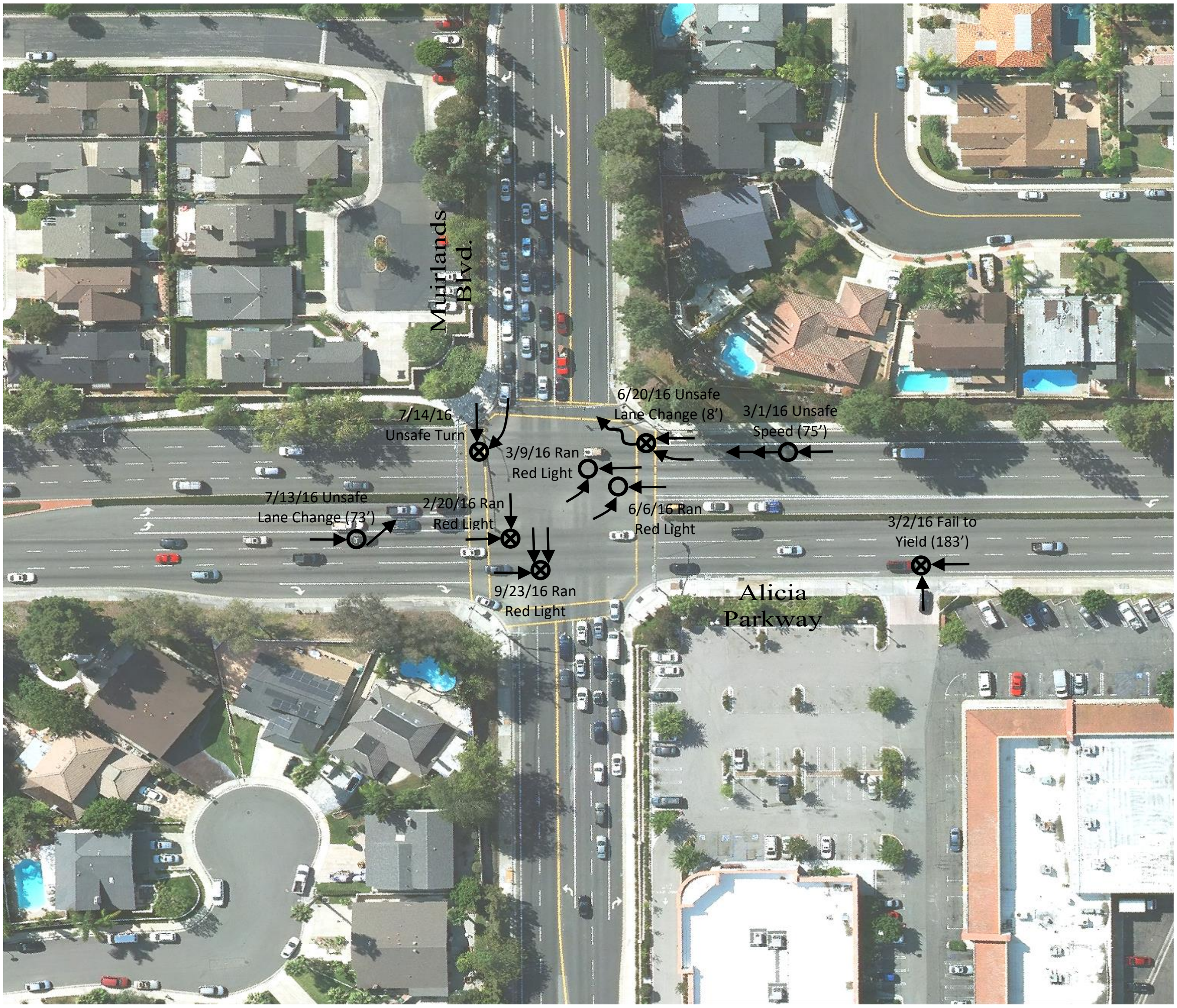
2014 Totals : 8 (0 Fatals – 4 Injury – 4 Property)

2016 Collision Diagram

Intersection:

Street (1) Muirlands Blvd. (N-S)

Street (2) Alicia Parkway (E-W)



2016 Totals : 9 (0 Fatals – 5 Injury – 4 Property)

Comments:

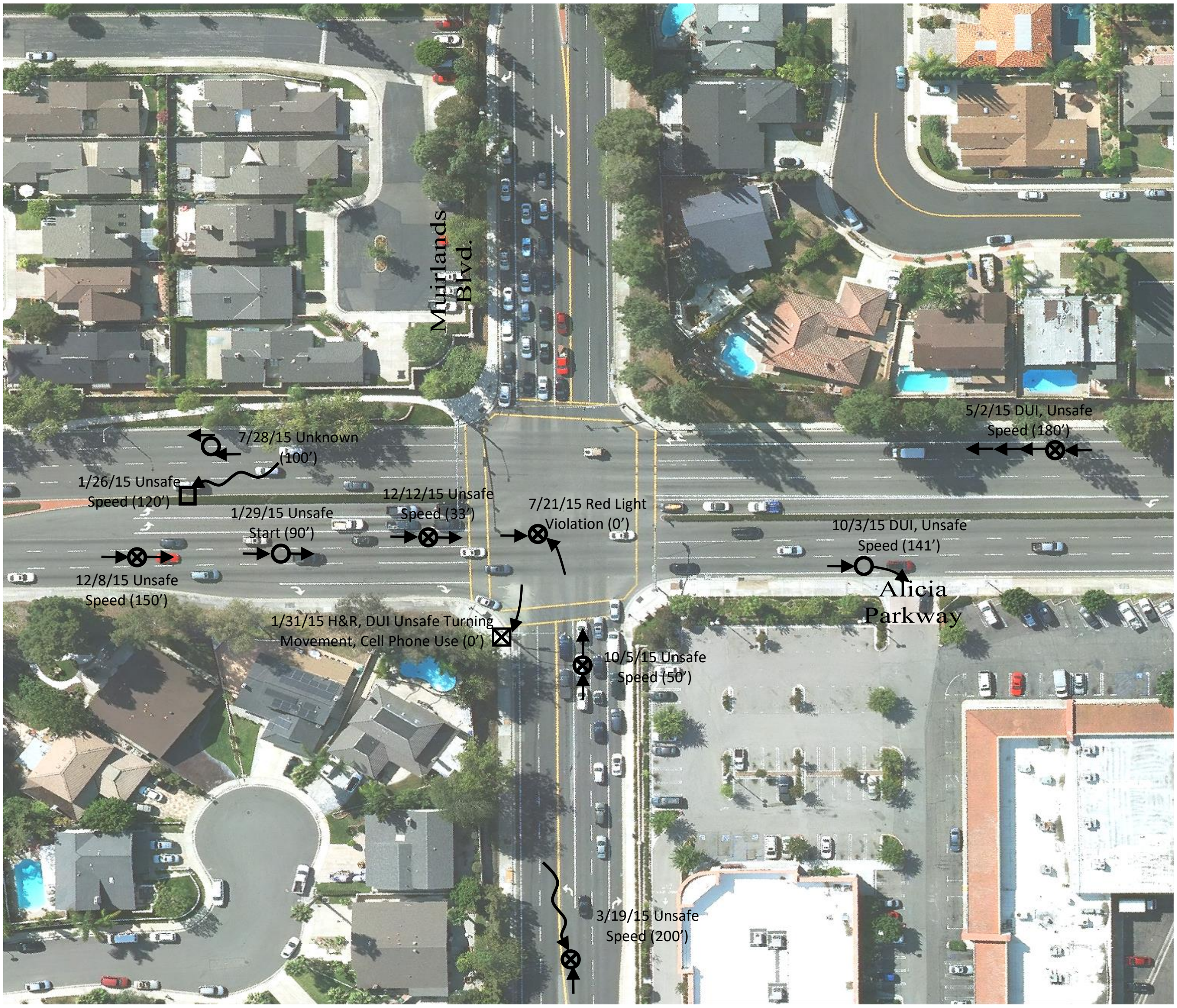
This is a signalized intersection with traffic volumes on Alicia ranging from 63,500 vehicles per day on the west leg and 61,500 vehicles on the east leg. The north leg of Muirlands averages 19,200 vehicles per day and the south leg averages 15,200 vehicles. There is a pattern of red-light running violations from eastbound direction along with unsafe lane changes, turns and speeds. Recommend enforcement of speed from eastbound approach. The collisions may be attributed to high-volume traffic congestion.

2015 Collision Diagram

Intersection:

Street (1) Muirlands Blvd. (N-S)

Street (2) Alicia Parkway (E-W)



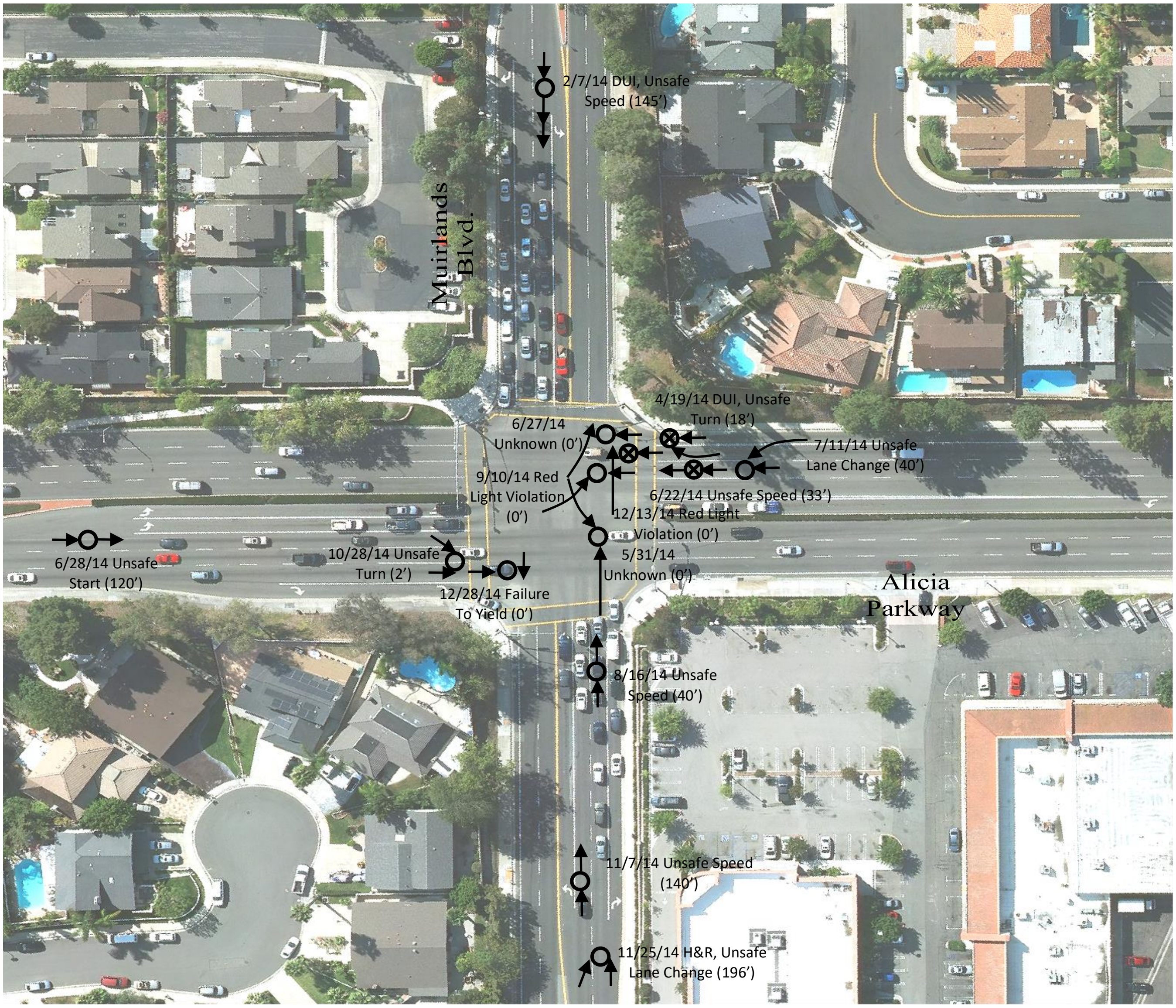
2015 Totals : 11 (0 Fatals – 7 Injury – 4 Property)

Comments:

This is a signalized intersection with traffic volumes on Alicia ranging from 62,100 vehicles per day on the west leg and 60,300 vehicles on the east leg. The north leg of Muirlands averages 18,400 vehicles per day and the south leg averages 12,000 vehicles. There is a pattern of read-end collisions caused by unsafe vehicle speeds. The collisions may be attributed to high-volume traffic congestion.

2014 Collision Diagram

Intersection:
Street (1) Muirlands Blvd. (N-S)
Street (2) Alicia Parkway (E-W)

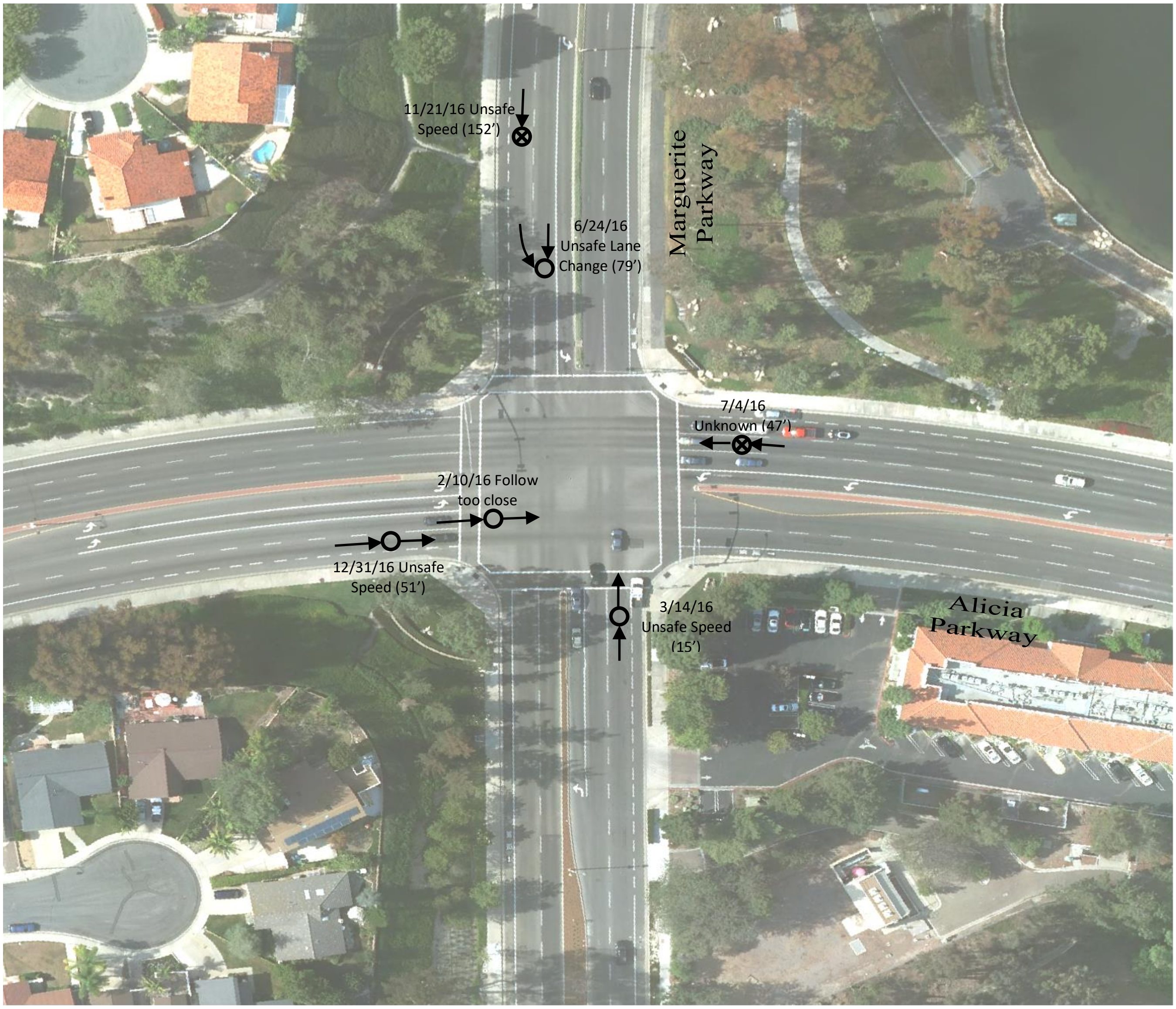


2014 Totals : 13 (0 Fatals – 3 Injury – 10 Property)

2016 Collision Diagram

Intersection:

Street (1) Marguerite Parkway (N-S)
Street (2) Alicia Parkway (E-W)



2016 Totals : 6 (0 Fatals – 2 Injury – 4 Property)

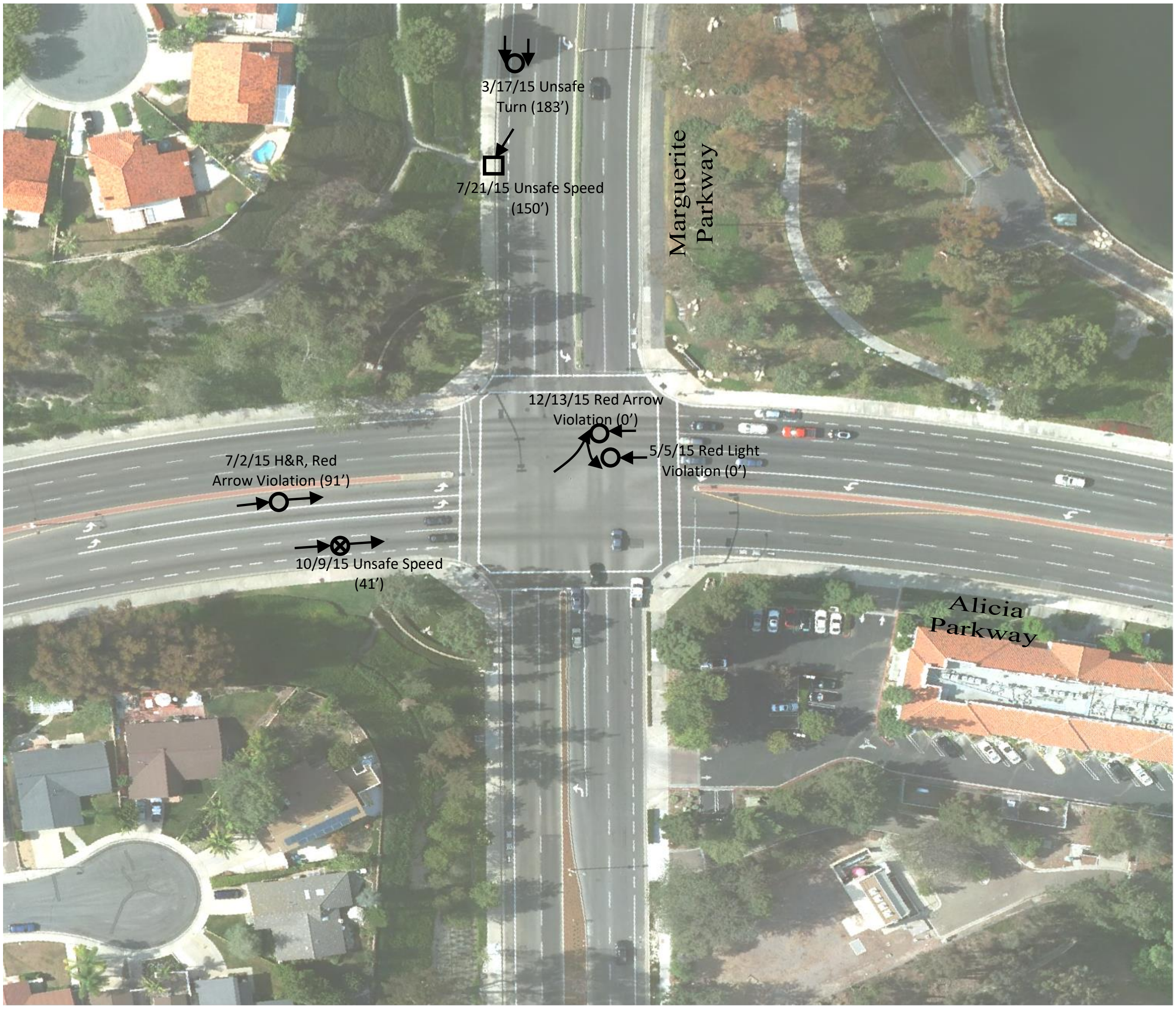
Comments:

This is a signalized intersection. Traffic volumes on Alicia range from an average of 28,500 vehicles per day on the west leg to 30,000 vehicles per day on the east leg. Marguerite averages 17,400 on the south leg to 24,300 vehicles per day on the north leg. There is a random pattern of collisions occurring from all directions at the intersection. Future Intersection widening project location that will add a 3rd eastbound through lane and a 2nd westbound left turn lane. Continue to monitor after construction of project.

2015 Collision Diagram

Intersection:

Street (1) Marguerite Parkway (N-S)
Street (2) Alicia Parkway (E-W)



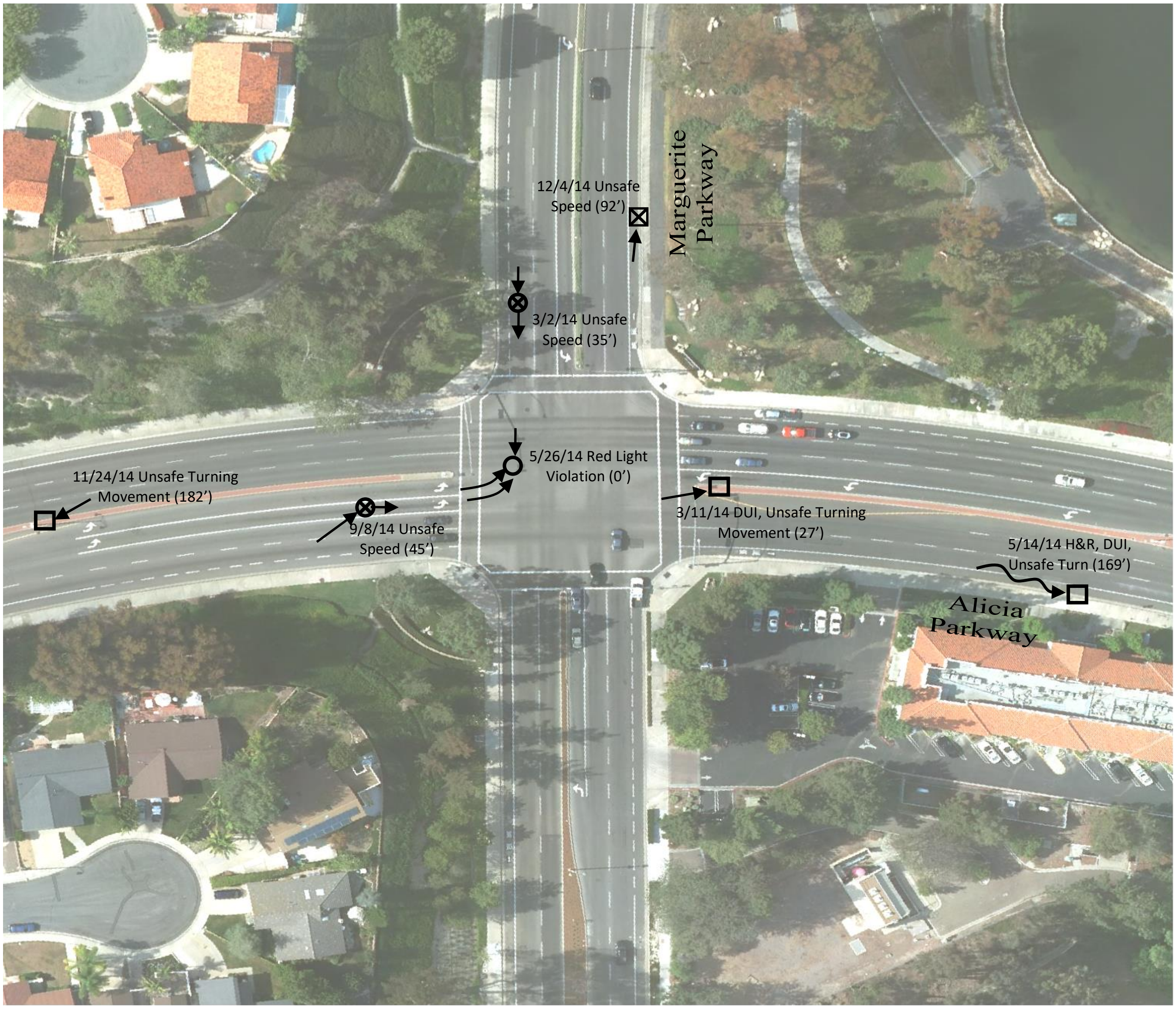
2015 Totals : 6 (0 Fatals – 1 Injury – 5 Property)

Comments:

This is a signalized intersection. Traffic volumes on Alicia range from an average of 32,400 vehicles per day on the west leg to 31,500 vehicles per day on the east leg. Marguerite averages 16,800 on the south leg to 23,600 vehicles per day on the north leg. There is a random pattern of collisions occurring at the intersection. Recommend enforcement. Review signal timing parameters and continue to monitor.

2014 Collision Diagram

Intersection:
Street (1) Marguerite Parkway (N-S)
Street (2) Alicia Parkway (E-W)



2014 Totals : 7 (0 Fatals – 3 Injury – 4 Property)

2016 Collision Diagram

Intersection:
Street (1) Marguerite Parkway (N-S)
Street (2) Oso Parkway (E-W)

2016 Totals : 6 (0 Fatals – 3 Injury – 3 Property)

Comments:

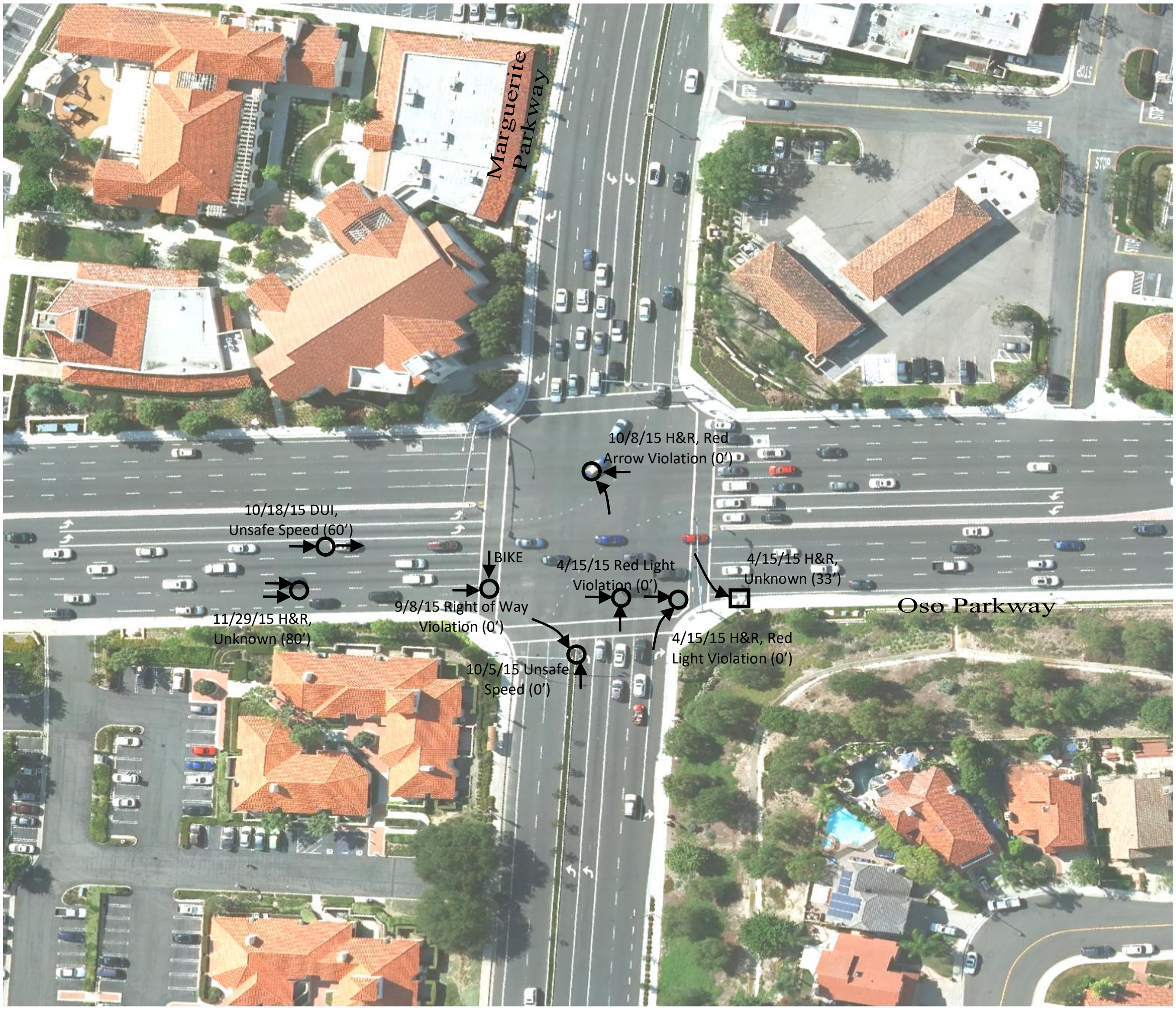
This is a signalized intersection. Traffic volumes on Oso range from an average of 43,400 vehicles per day on the east leg and 53,100 vehicles per day on the west leg. Marguerite averages 29,000 on the south leg to 33,000 vehicles per day on the north leg. Multiple collisions originate with vehicles traveling from the eastbound direction. Recommend speed enforcement from the eastbound approach. Continue to monitor.

2015 Collision Diagram

Intersection:

Street (1) Marguerite Parkway (N-S)

Street (2) Oso Parkway (E-W)



2015 Totals : 8 (0 Fatals – 0 Injury – 8 Property)

Comments:

This is a signalized intersection. Traffic volumes on Oso range from an average of 36,600 vehicles per day on the east leg (no traffic volume record on the west leg due to construction activities). Marguerite averages 30,600 on the south leg to 29,300 vehicles per day on the north leg. The majority of collisions are broadside accidents due to red-light running violations. Recommend enforcement. Review signal timing parameters and continue to monitor.

2014 Collision Diagram

Intersection:
Street (1) Marguerite Parkway (N-S)
Street (2) Oso Parkway (E-W)

2014 Totals : 8 (0 Fatals – 3 Injury – 5 Property)

2016 Collision Diagram

Intersection:

Street (1) Marketplace (N-S)
Street (2) Oso Parkway (E-W)

2016 Totals : 6 (0 Fatals – 4 Injury – 2 Property)

Comments:

This is a signalized intersection. Traffic volumes on Oso range from an average of 42,700 vehicles per day on the east leg and 43,400 vehicles per day on the west leg. There is no recorded average daily traffic from the commercial driveway at Marketplace on the north leg. The majority of collisions are broadside accidents due to red-light running violations and unsafe speeds in the westbound direction. Review signal timing parameters for all-red and yellow clearance intervals. Continue to monitor.

2015 Collision Diagram

Intersection:
Street (1) Marketplace (N-S)
Street (2) Oso Parkway (E-W)

2015 Totals : 1 (0 Fatals – 0 Injury – 1 Property)

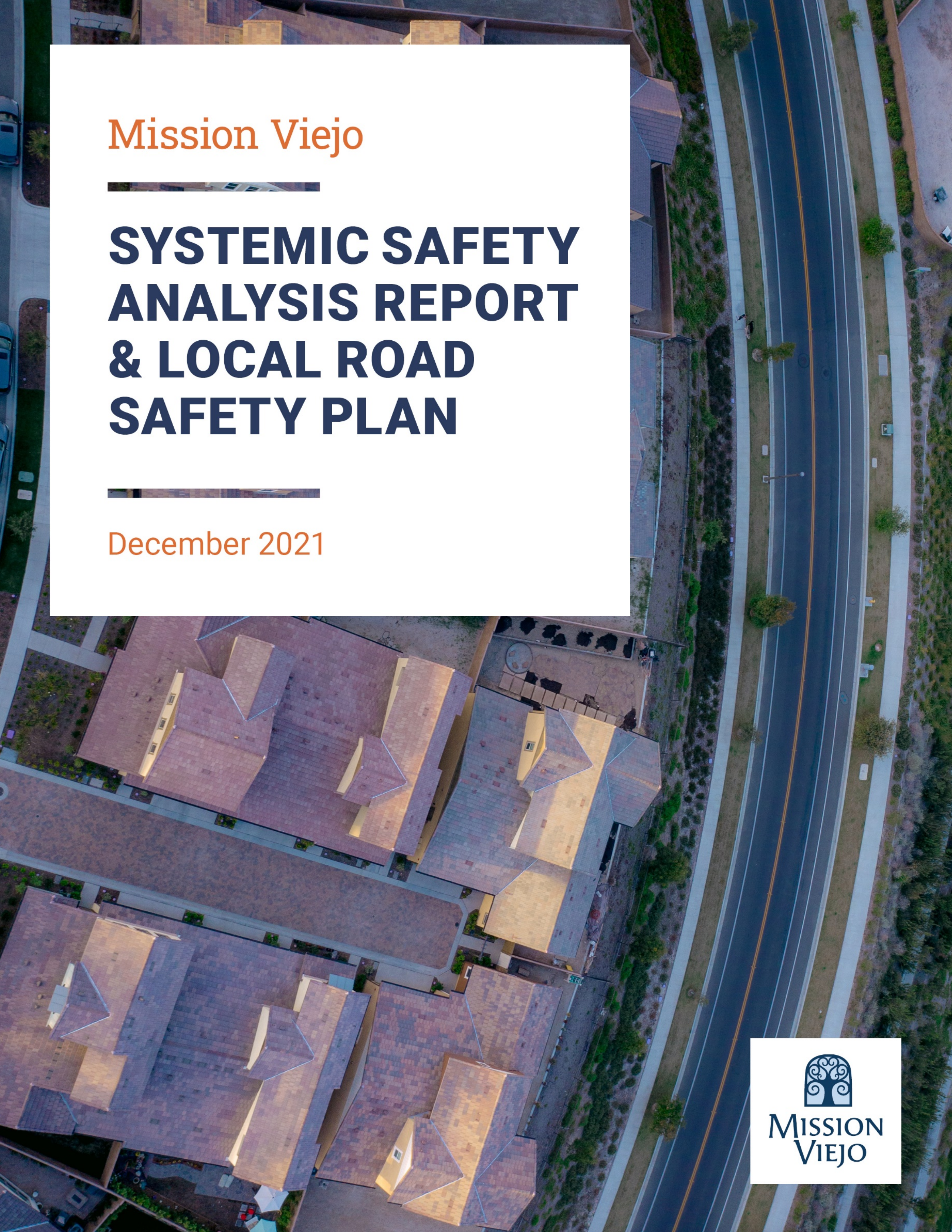
Comments:

2014 Collision Diagram

Intersection:
Street (1) Marketplace (N-S)
Street (2) Oso Parkway (E-W)

2014 Totals : 2 (0 Fatals – 2 Injury – 0 Property)

Comments:



Mission Viejo

SYSTEMIC SAFETY ANALYSIS REPORT & LOCAL ROAD SAFETY PLAN

December 2021

MISSION VIEJO

APPENDIX E

Vehicle Capacity Estimates

The following documents a planning-level methodology used to identify potential locations of a road diet which could lead to further feasibility studies. This effort was completed to understand potential application of the road diet countermeasure. A road diet removes vehicle travel lanes, typically reallocating the space for other modes and uses. Studies show that road diet projects have benefits such as: reducing traffic speed and volume; decreasing pedestrian crossing distance and exposure; increasing dedicated space for bicycles; and reducing the number and severity of crashes. The City of Mission Viejo's roadway network has several roadways with at least two and up to five lanes in each direction.

This discussion is intended to be an example methodology that could be updated or replicated in future efforts. It is a simplified method that only is considering average daily traffic and there are other considerations needed before implementing a road diet. The intent of the method is to be able to quickly assess potential for a road diet before investing further effort into a feasibility study.

Analysis Methodology: The average daily traffic analysis compares existing demand against capacity estimates for the existing and proposed configurations.

- Planning-level capacity estimates used are based on applications of the Highway Capacity Manual and Transit Capacity and Quality of Service Manual and reflect a level of service D capacity. Daily traffic volumes above this capacity would be at level of service E or F.
  - 8-Lane Arterial: 55,000 vpd
  - 6-Lane Arterial: 45,000 vpd
  - 4-Lane Arterial: 35,000 vpd
  - 4-Lane Collector with center lane: 25,000 vpd
  - 4-Lane Collector with no center lane: 13,000 vpd
  - 2-Lane Collector with center lane: 13,000 vpd
  - 2-Lane Collector with no center lane: 6,500 vpd

- Average daily traffic volumes were provided by the City for years 2015 through 2020. The highest volume between the six years was used in this preliminary evaluation.

The following table was used to compare traffic volumes to the estimated capacity of the street under existing conditions as well as under a potential road diet condition.

Road Diet Feasibility Evaluation Based on Volume-Capacity Comparison

Location	Street Type	LOS D Capacity	ADT (1)	Potential for Road Diet?	LOS D Capacity After Road Diet
Alicia Parkway *Olympiad Rd to Jeronimo Rd*	6-Lane Arterial	45,000	47,500	No	
Alicia Parkway *Jeronimo Rd to Muirlands Blvd*	6-Lane Arterial	45,000	61,500	No	
Alicia Parkway *Muirlands Blvd to West City Limit*	8-Lane Arterial	55,000	63,900	No	
Crown Valley Parkway *Marguerite Pkwy to Medical Center Dr/Dr Guevara Wy*	8-Lane Arterial	55,000	46,500	Yes*	45,000
Crown Valley Parkway *Medical Center Dr/Dr Guevara Wy to Puerta Real*	8-Lane Arterial	55,000	57,300	No	
Felipe Road *La Paz Rd to Oso Pkwy*	4-Lane Arterial	35,000	17,000	Yes*	13,000
Felipe Road *Oso Pkwy to Marguerite Pkwy*	4-Lane Arterial	35,000	15,100	Yes*	13,000
Jeronimo Road *Olympiad Rd to Marguerite Pkwy*	4-Lane Arterial	35,000	10,800	Yes	13,000
Jeronimo Road *Marguerite Pkwy to Los Alisos Blvd*	4-Lane Arterial	35,000	22,900	No	13,000
La Paz Road *Olympiad Rd to Pacific Hills Dr*	4-Lane Arterial	35,000	11,700	Yes	13,000
La Paz Road *Pacific Hills Dr to Marguerite Pkwy*	4-Lane Arterial	35,000	31,100	No	13,000
Los Alisos Boulevard *Marguerite Pkwy to Trabuco Rd*	4-Lane Arterial	35,000	24,600	No	13,000
Los Alisos Boulevard *Trabuco Rd to Muirlands Blvd*	6-Lane Arterial	45,000	29,200	Yes	35,000
Marguerite Parkway *El Toro Rd to Jeronimo Rd*	4-Lane Arterial	35,000	28,400	No	13,000
Marguerite Parkway *Jeronimo Rd to Center Dr*	4-Lane Arterial	35,000	33,900	No	13,000
Marguerite Parkway *Center Dr to Avery Pkwy*	4-Lane Arterial	35,000	28,800	No	13,000
Melinda Road *Santa Margarita Pkwy to Olympiad Rd*	4-Lane Arterial	35,000	11,500	Yes	13,000
Muirlands Boulevard *Los Alisos Blvd to Alicia Pkwy*	4-Lane Arterial	35,000	19,200	No	13,000
Muirlands Boulevard *Alicia Pkwy to La Paz Rd*	4-Lane Arterial	35,000	15,200	Yes*	13,000
Olympiad Road *Marguerite Pkwy to Alicia Pkwy*	4-Lane Arterial	35,000	10,700	Yes	13,000
Olympiad Road *Alicia Pkwy to La Paz Rd*	4-Lane Arterial	35,000	19,400	No	13,000
Oso Parkway *San Raphael to Marguerite Pkwy*	6-Lane Arterial	45,000	47,300	No	
Oso Parkway *Marguerite Pkwy to Montanoso Dr*	8-Lane Arterial	55,000	58,400	No	
Santa Margarita Parkway *Marguerite Pkwy to Los Alisos Blvd*	6-Lane Arterial	45,000	33,700	Yes	35,000
Trabuco Road *Los Alisos Blvd to Alicia Pkwy*	4-Lane Arterial	35,000	19,100	No	13,000
Trabuco Road *Alicia Pkwy to Marguerite Pkwy*	4-Lane Arterial	35,000	12,100	Yes	13,000

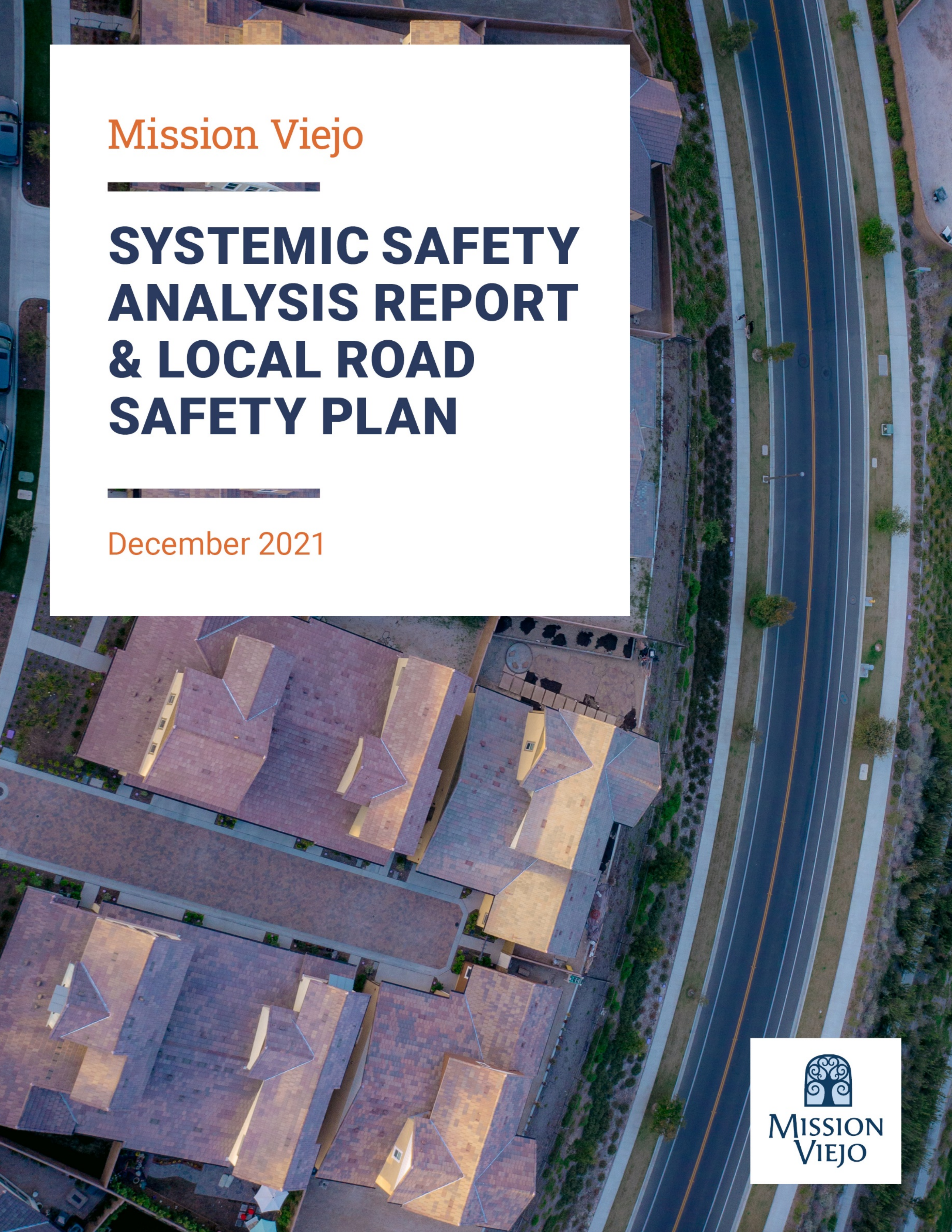
*These locations have historical counts that are more frequently under the available capacity although the highest count shown exceeds capacity.

(1) Average daily traffic volumes were provided by the City for years 2015 through 2020. The highest volume between the six years was used in this preliminary evaluation.

Mission Viejo

SYSTEMIC SAFETY ANALYSIS REPORT & LOCAL ROAD SAFETY PLAN

December 2021



MISSION VIEJO

APPENDIX F

Concept Level Cost Estimate Details

Mission Viejo SSAR/LRSP

Intersection Treatments

City of Mission Viejo

Engineer's Conceptual Estimate

Prepared By: Kittelson & Associates, Inc. — *Alicia Parkway/Jeronimo Road*

Reviewed By: Erin Ferguson — *Date: 9/9/2021*

NO.	ITEM	UNIT	TOTAL QUANTITY	UNIT PRICE	TOTAL COST
1	Mobilization (10%)	LS	1	$12,000.00	$12,000.00
2	Traffic Control (10%)	LS	1	$6,000.00	$6,000.00
3	Remove Traffic Stripe	LF	720	$1.00	$720.00
4	Thermoplastic Traffic Stripe	LF	1,070	$2.00	$2,140.00
5	Thermoplastic Crosswalk and Limit Lines	SF	990	$10.00	$9,900.00
6	Bike Lane Marking (Green)	SF	660	$10.00	$6,600.00
7	New Pavement Legend	EA	19	$250.00	$4,750.00
8	Push Button	EA	4	$5,000.00	$20,000.00
9	Traffic Signal Head	EA	2	$800.00	$1,600.00
10	Retroreflective Backplate	EA	16	$300.00	$4,800.00
11	New Pole and Mast Arm	EA	2	$30,000.00	$60,000.00
				TOTAL CONSTRUCTION COST $	**128,510**
	ENGINEERING SUPPORT				
	Engineering Design & Construction Management (20% of Construction)	LS	1	$26,000.00	$26,000.00
	ENGINEERING SUPPORT SUBTOTAL			**$**	**26,000**
				TOTAL PROJECT SUBTOTAL $	**154,510**
				25% Contingency $	**38,630**
				TOTAL ESTIMATED PROJECT COST $	**193,140**

Notes:

- Unit prices are based on adjusted costs found in the Caltrans Historical Contract Cost Database: https://sv08data.dot.ca.gov/contractcost/
- Quantities are taken from Figure 25 Intersection Treatments - Alicia Parkway/Jeronimo Road
-
-
-
-
-

Engineering Effort:

Level A: Preliminary engineering performed. Technical information is available, engineering calculations have been performed; clear understanding of the materials size and quantities needed to execute job. Schedule understood; staff and permitting is fairly clear, (however this element may still need refining). Project Development & Construction Contingencies ranges between 10%-20%.

Level B: Conceptual engineering performed. Technical information is available, rough engineering calculations may have been performed, or similar information from previous similar work is compared and used. Project Development Contingencies ranges between 15% to 25% and Construction Contingencies ranges between 20% to 30%.

Level C: No engineering performed. Educated guesstimating. Limited technical information available and/or analysis performed. Project Development and Construction Contingencies should be selected appropriately by Project Manager. Contingency may range up to 50%.

Mission Viejo SSAR/LRSP

Intersection Treatments

City of Mission Viejo

Engineer's Conceptual Estimate

Prepared By: Kittelson & Associates, Inc. *Oso Parkway/Marguerite Parkway*

Reviewed By: Erin Ferguson *Date: 9/9/2021*

NO.	ITEM	UNIT	TOTAL QUANTITY	UNIT PRICE	TOTAL COST
1	Mobilization (10%)	LS	1	$13,000.00	$13,000.00
2	Traffic Control (10%)	LS	1	$11,000.00	$11,000.00
3	Remove Traffic Stripe	LF	1,085	$1.00	$1,085.00
4	Thermoplastic Traffic Stripe	LF	460	$2.00	$920.00
5	Thermoplastic Crosswalk and Limit Lines	SF	1,680	$10.00	$16,800.00
6	Bike Lane Marking (Green)	SF	650	$10.00	$6,500.00
7	New Pavement Legend	EA	13	$250.00	$3,250.00
8	Pedestrian Lighting	LS	1	$56,000.00	$56,000.00
9	Push Button	EA	4	$5,000.00	$20,000.00
10	Retroreflective Backplate	EA	18	$300.00	$5,400.00
				TOTAL CONSTRUCTION COST $	**133,955**
	ENGINEERING SUPPORT				
	Engineering Design & Construction Management (20% of Construction)	LS	1	$27,000.00	$27,000.00
	ENGINEERING SUPPORT SUBTOTAL			**$**	**27,000**
				TOTAL PROJECT SUBTOTAL $	**160,955**
				25% Contingency $	**40,240**
				TOTAL ESTIMATED PROJECT COST $	**201,195**

Notes:

- Unit prices are based on adjusted costs found in the Caltrans Historical Contract Cost Database: https://sv08data.dot.ca.gov/contractcost/
- Quantities are taken from Figure 26 Intersection Treatments - Oso Parkway/Marguerite Parkway
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Engineering Effort:

Level A: Preliminary engineering performed. Technical information is available, engineering calculations have been performed; clear understanding of the materials size and quantities needed to execute job. Schedule understood; staff and permitting is fairly clear, (however this element may still need refining). Project Development & Construction Contingencies ranges between 10%-20%.

Level B: Conceptual engineering performed. Technical information is available, rough engineering calculations may have been performed, or similar information from previous similar work is compared and used. Project Development Contingencies ranges between 15% to 25% and Construction Contingencies ranges between 20% to 30%.

Level C: No engineering performed. Educated guesstimating. Limited technical information available and/or analysis performed. Project Development and Construction Contingencies should be selected appropriately by Project Manager. Contingency may range up to 50%.

Mission Viejo SSAR/LRSP

Intersection Treatments

City of Mission Viejo

Engineer's Conceptual Estimate

Prepared By: Kittelson & Associates, Inc. — *Alicia Parkway/Marguerite Parkway*

Reviewed By: Erin Ferguson — *Date: 9/9/2021*

NO.	ITEM	UNIT	TOTAL QUANTITY	UNIT PRICE	TOTAL COST
1	Mobilization (10%)	LS	1	$6,000.00	$6,000.00
2	Traffic Control (10%)	LS	1	$6,000.00	$6,000.00
3	Remove Traffic Stripe	LF	900	$1.00	$900.00
4	Thermoplastic Traffic Stripe	LF	440	$2.00	$880.00
5	Thermoplastic Crosswalk and Limit Lines	SF	1,450	$10.00	$14,500.00
6	Bike Lane Marking (Green)	SF	550	$10.00	$5,500.00
7	New Pavement Legend	EA	16	$250.00	$4,000.00
8	Push Button	EA	4	$5,000.00	$20,000.00
9	Traffic Signal Head	EA	1	$800.00	$800.00
10	Retroreflective Backplate	EA	22	$300.00	$6,600.00
				TOTAL CONSTRUCTION COST	**$ 65,180**
	ENGINEERING SUPPORT				
	Engineering Design & Construction Management (20% of Construction)	LS	1	$14,000.00	$14,000.00
	ENGINEERING SUPPORT SUBTOTAL				**$ 14,000**
				TOTAL PROJECT SUBTOTAL	**$ 79,180**
				25% Contingency	**$ 19,800**
				TOTAL ESTIMATED PROJECT COST	**$ 98,980**

Notes:

- Unit prices are based on adjusted costs found in the Caltrans Historical Contract Cost Database: https://sv08data.dot.ca.gov/contractcost/
- Quantities are taken from Figure 27 Intersection Treatments - Alicia Parkway/Marguerite Parkway
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Engineering Effort:

Level A: Preliminary engineering performed. Technical information is available, engineering calculations have been performed; clear understanding of the materials size and quantities needed to execute job. Schedule understood; staff and permitting is fairly clear, (however this element may still need refining). Project Development & Construction Contingencies ranges between 10%-20%.

Level B: Conceptual engineering performed. Technical information is available, rough engineering calculations may have been performed, or similar information from previous similar work is compared and used. Project Development Contingencies ranges between 15% to 25% and Construction Contingencies ranges between 20% to 30%.

Level C: No engineering performed. Educated guesstimating. Limited technical information available and/or analysis performed. Project Development and Construction Contingencies should be selected appropriately by Project Manager. Contingency may range up to 50%.

Mission Viejo SSAR/LRSP

Intersection Treatments

City of Mission Viejo

KITTELSON & ASSOCIATES

Engineer's Conceptual Estimate

Prepared By: Kittelson & Associates, Inc. — *Olympiad Road/Marguerite Parkway*

Reviewed By: Erin Ferguson — *Date: 9/9/2021*

NO.	ITEM	UNIT	TOTAL QUANTITY	UNIT PRICE	TOTAL COST
1	Mobilization (10%)	LS	1	$4,000.00	$4,000.00
2	Traffic Control (10%)	LS	1	$4,000.00	$4,000.00
3	Remove Traffic Stripe	LF	410	$1.00	$410.00
4	Thermoplastic Traffic Stripe	LF	210	$2.00	$420.00
5	Thermoplastic Crosswalk and Limit Lines	SF	590	$10.00	$5,900.00
6	Bike Lane Marking (Green)	SF	1,000	$10.00	$10,000.00
7	New Pavement Legend	EA	9	$250.00	$2,250.00
8	Push Button	EA	2	$5,000.00	$10,000.00
9	Retroreflective Backplate	EA	11	$300.00	$3,300.00
				TOTAL CONSTRUCTION COST $	**40,280**
	ENGINEERING SUPPORT				
	Engineering Design & Construction Management (20% of Construction)	LS	1	$9,000.00	$9,000.00
	ENGINEERING SUPPORT SUBTOTAL			**$**	**9,000**
				TOTAL PROJECT SUBTOTAL $	**49,280**
				25% Contingency $	**12,320**
				TOTAL ESTIMATED PROJECT COST $	**61,600**

Notes:

- Unit prices are based on adjusted costs found in the Caltrans Historical Contract Cost Database: https://sv08data.dot.ca.gov/contractcost/
- Quantities are taken from Figure 28 Intersection Treatments - Olympiad Road/Marguerite Parkway
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Engineering Effort:

Level A: Preliminary engineering performed. Technical information is available, engineering calculations have been performed; clear understanding of the materials size and quantities needed to execute job. Schedule understood; staff and permitting is fairly clear, (however this element may still need refining). Project Development & Construction Contingencies ranges between 10%-20%.

Level B: Conceptual engineering performed. Technical information is available, rough engineering calculations may have been performed, or similar information from previous similar work is compared and used. Project Development Contingencies ranges between 15% to 25% and Construction Contingencies ranges between 20% to 30%.

Level C: No engineering performed. Educated guesstimating. Limited technical information available and/or analysis performed. Project Development and Construction Contingencies should be selected appropriately by Project Manager. Contingency may range up to 50%.

Mission Viejo SSAR/LRSP

Intersection Treatments

City of Mission Viejo

Engineer's Conceptual Estimate

Prepared By: Kittelson & Associates, Inc. — *Crown Valley Parkway/Dr Guevara Way/Medical Center Road*

Reviewed By: Erin Ferguson — *Date: 9/9/2021*

NO.	ITEM	UNIT	TOTAL QUANTITY	UNIT PRICE	TOTAL COST
1	Mobilization (10%)	LS	1	$4,000.00	$4,000.00
2	Traffic Control (10%)	LS	1	$3,000.00	$3,000.00
3	Remove Traffic Stripe	LF	570	$1.00	$570.00
4	Thermoplastic Traffic Stripe	LF	150	$2.00	$300.00
5	Thermoplastic Crosswalk and Limit Lines	SF	920	$10.00	$9,200.00
6	Bike Lane Marking (Green)	SF	155	$10.00	$1,550.00
7	New Pavement Legend	EA	2	$250.00	$500.00
8	Push Button	EA	2	$5,000.00	$10,000.00
9	Retroreflective Backplate	EA	17	$300.00	$5,100.00
	TOTAL CONSTRUCTION COST			**$**	**34,220**
	ENGINEERING SUPPORT				
	Engineering Design & Construction Management (20% of Construction)	LS	1	$7,000.00	$7,000.00
	ENGINEERING SUPPORT SUBTOTAL			**$**	**7,000**
	TOTAL PROJECT SUBTOTAL			**$**	**41,220**
	25% Contingency			**$**	**10,310**
	TOTAL ESTIMATED PROJECT COST			**$**	**51,530**

Notes:

- Unit prices are based on adjusted costs found in the Caltrans Historical Contract Cost Database: https://sv08data.dot.ca.gov/contractcost/
- Quantities are taken from Figure 29 Intersection Treatments - Crown Valley Parkway/Dr Guevara Way/Medical Center Road
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Engineering Effort:

Level A: Preliminary engineering performed. Technical information is available, engineering calculations have been performed; clear understanding of the materials size and quantities needed to execute job. Schedule understood; staff and permitting is fairly clear, (however this element may still need refining). Project Development & Construction Contingencies ranges between 10%-20%.

Level B: Conceptual engineering performed. Technical information is available, rough engineering calculations may have been performed, or similar information from previous similar work is compared and used. Project Development Contingencies ranges between 15% to 25% and Construction Contingencies ranges between 20% to 30%.

Level C: No engineering performed. Educated guesstimating. Limited technical information available and/or analysis performed. Project Development and Construction Contingencies should be selected appropriately by Project Manager. Contingency may range up to 50%.

Mission Viejo SSAR/LRSP

Pedestrian Treatments

City of Mission Viejo

KITTELSON & ASSOCIATES

Engineer's Conceptual Estimate

Prepared By: Kittelson & Associates, Inc.

Reviewed By: Erin Ferguson

Alicia Parkway/Charlinda Drive

Date: 9/9/2021

NO.	ITEM	UNIT	TOTAL QUANTITY	UNIT PRICE	TOTAL COST
1	Mobilization (10%)	LS	1	$13,000.00	$13,000.00
2	Traffic Control (10%)	LS	1	$12,000.00	$12,000.00
3	Remove Traffic Stripe	LF	820	$1.00	$820.00
4	Thermoplastic Crosswalk and Limit Lines	SF	1,450	$10.00	$14,500.00
5	Pedestrian Lighting	LS	1	$56,000.00	$56,000.00
6	Audible Push Button	EA	8	$5,000.00	$40,000.00
				TOTAL CONSTRUCTION COST $	136,320
	ENGINEERING SUPPORT				
	Engineering Design & Construction Management (20% of Construction)	LS	1	$28,000.00	$28,000.00
	ENGINEERING SUPPORT SUBTOTAL			$	28,000
				TOTAL PROJECT SUBTOTAL $	164,320
				25% Contingency $	41,080
				TOTAL ESTIMATED PROJECT COST $	205,400

Notes:

- Unit prices are based on adjusted costs found in the Caltrans Historical Contract Cost Database: https://sv08data.dot.ca.gov/contractcost/
- Quantities are taken from Figure 34 Pedestrian Treatments - Alicia Parkway/Charlinda Drive
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Engineering Effort:

Level A: Preliminary engineering performed. Technical information is available, engineering calculations have been performed; clear understanding of the materials size and quantities needed to execute job. Schedule understood; staff and permitting is fairly clear, (however this element may still need refining). Project Development & Construction Contingencies ranges between 10%-20%.

Level B: Conceptual engineering performed. Technical information is available, rough engineering calculations may have been performed, or similar information from previous similar work is compared and used. Project Development Contingencies ranges between 15% to 25% and Construction Contingencies ranges between 20% to 30%.

Level C: No engineering performed. Educated guesstimating. Limited technical information available and/or analysis performed. Project Development and Construction Contingencies should be selected appropriately by Project Manager. Contingency may range up to 50%.

Mission Viejo SSAR/LRSP

Pedestrian Treatments

City of Mission Viejo

Engineer's Conceptual Estimate

Prepared By: Kittelson & Associates, Inc. — *Felipe Road/Buscador*

Reviewed By: Erin Ferguson — *Date: 9/9/2021*

NO.	ITEM	UNIT	TOTAL QUANTITY	UNIT PRICE	TOTAL COST
1	Mobilization (10%)	LS	1	$12,000.00	$12,000.00
2	Traffic Control (10%)	LS	1	$11,000.00	$11,000.00
3	Detectable Warning Surface	EA	4	$500.00	$2,000.00
4	Remove Traffic Stripe	LF	500	$1.00	$500.00
5	Thermoplastic Crosswalk and Limit Lines	SF	850	$10.00	$8,500.00
6	Pedestrian Lighting	LS	1	$56,000.00	$56,000.00
7	Push Button	EA	8	$5,000.00	$40,000.00
				TOTAL CONSTRUCTION COST $	**130,000**
	ENGINEERING SUPPORT				
	Engineering Design & Construction Management (20% of Construction)	LS	1	$26,000.00	$26,000.00
	ENGINEERING SUPPORT SUBTOTAL			**$**	**26,000**
				TOTAL PROJECT SUBTOTAL $	**156,000**
				25% Contingency $	**39,000**
				TOTAL ESTIMATED PROJECT COST $	**195,000**

Notes:

- Unit prices are based on adjusted costs found in the Caltrans Historical Contract Cost Database: https://sv08data.dot.ca.gov/contractcost/
- Quantities are taken from Figure 35 Pedestrian Treatments - Felipe Road/Buscador
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Engineering Effort:

Level A: Preliminary engineering performed. Technical information is available, engineering calculations have been performed; clear understanding of the materials size and quantities needed to execute job. Schedule understood; staff and permitting is fairly clear, (however this element may still need refining). Project Development & Construction Contingencies ranges between 10%-20%.

Level B: Conceptual engineering performed. Technical information is available, rough engineering calculations may have been performed, or similar information from previous similar work is compared and used. Project Development Contingencies ranges between 15% to 25% and Construction Contingencies ranges between 20% to 30%.

Level C: No engineering performed. Educated guesstimating. Limited technical information available and/or analysis performed. Project Development and Construction Contingencies should be selected appropriately by Project Manager. Contingency may range up to 50%.

Mission Viejo SSAR/LRSP

Bicycle Treatments

City of Mission Viejo

Engineer's Conceptual Estimate

Prepared By: Kittelson & Associates, Inc. — *La Paz Road/Marguerite Parkway*

Reviewed By: Erin Ferguson — *Date: 9/9/2021*

NO.	ITEM	UNIT	TOTAL QUANTITY	UNIT PRICE	TOTAL COST
1	Mobilization (10%)	LS	1	$6,000.00	$6,000.00
2	Traffic Control (10%)	LS	1	$5,000.00	$5,000.00
3	Remove Traffic Stripe	LF	150	$1.00	$150.00
4	Thermoplastic Traffic Stripe	LF	1,210	$2.00	$2,420.00
5	Thermoplastic Crosswalk and Limit Lines	SF	200	$10.00	$2,000.00
6	Bike Lane Marking (Green)	SF	1,720	$10.00	$17,200.00
7	New Pavement Legend	EA	15	$250.00	$3,750.00
8	Push Button	EA	4	$5,000.00	$20,000.00
				TOTAL CONSTRUCTION COST	**$ 56,520**
	ENGINEERING SUPPORT				
	Engineering Design & Construction Management (20% of Construction)	LS	1	$12,000.00	$12,000.00
	ENGINEERING SUPPORT SUBTOTAL				**$ 12,000**
				TOTAL PROJECT SUBTOTAL	**$ 68,520**
				25% Contingency	**$ 17,130**
				TOTAL ESTIMATED PROJECT COST	**$ 85,650**

Notes:

- Unit prices are based on adjusted costs found in the Caltrans Historical Contract Cost Database: https://sv08data.dot.ca.gov/contractcost/
- Quantities are taken from Figure 37 Bicycle Treatments - La Paz Road/Margeurite Parkway
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Engineering Effort:

Level A: Preliminary engineering performed. Technical information is available, engineering calculations have been performed; clear understanding of the materials size and quantities needed to execute job. Schedule understood; staff and permitting is fairly clear, (however this element may still need refining). Project Development & Construction Contingencies ranges between 10%-20%.

Level B: Conceptual engineering performed. Technical information is available, rough engineering calculations may have been performed, or similar information from previous similar work is compared and used. Project Development Contingencies ranges between 15% to 25% and Construction Contingencies ranges between 20% to 30%.

Level C: No engineering performed. Educated guesstimating. Limited technical information available and/or analysis performed. Project Development and Construction Contingencies should be selected appropriately by Project Manager. Contingency may range up to 50%.

Mission Viejo SSAR/LRSP

Bicycle Treatments

City of Mission Viejo

Engineer's Conceptual Estimate

Prepared By: Kittelson & Associates, Inc. — *Olympiad Road/Stoneridge*

Reviewed By: Erin Ferguson — *Date: 9/9/2021*

NO.	ITEM	UNIT	TOTAL QUANTITY	UNIT PRICE	TOTAL COST
1	Mobilization (10%)	LS	1	$3,000.00	$3,000.00
2	Traffic Control (10%)	LS	1	$3,000.00	$3,000.00
3	Remove Traffic Stripe	LF	155	$1.00	$155.00
4	Thermoplastic Traffic Stripe	LF	160	$2.00	$320.00
5	Thermoplastic Crosswalk and Limit Lines	SF	550	$10.00	$5,500.00
6	Bike Lane Marking (Green)	SF	370	$10.00	$3,700.00
7	New Pavement Legend	EA	7	$250.00	$1,750.00
8	Push Button	EA	2	$5,000.00	$10,000.00
				TOTAL CONSTRUCTION COST $	**27,425**
	ENGINEERING SUPPORT				
	Engineering Design & Construction Management (20% of Construction)	LS	1	$6,000.00	$6,000.00
	ENGINEERING SUPPORT SUBTOTAL			**$**	**6,000**
				TOTAL PROJECT SUBTOTAL $	**33,425**
				25% Contingency $	**8,360**
				TOTAL ESTIMATED PROJECT COST $	**41,785**

Notes:

- Unit prices are based on adjusted costs found in the Caltrans Historical Contract Cost Database: https://sv08data.dot.ca.gov/contractcost/
- Quantities are taken from Figure 38 Bicycle Treatments - Olympiad Road/Stoneridge
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Engineering Effort:

Level A: Preliminary engineering performed. Technical information is available, engineering calculations have been performed; clear understanding of the materials size and quantities needed to execute job. Schedule understood; staff and permitting is fairly clear, (however this element may still need refining). Project Development & Construction Contingencies ranges between 10%-20%.

Level B: Conceptual engineering performed. Technical information is available, rough engineering calculations may have been performed, or similar information from previous similar work is compared and used. Project Development Contingencies ranges between 15% to 25% and Construction Contingencies ranges between 20% to 30%.

Level C: No engineering performed. Educated guesstimating. Limited technical information available and/or analysis performed. Project Development and Construction Contingencies should be selected appropriately by Project Manager. Contingency may range up to 50%.

Mission Viejo SSAR/LRSP
Bicycle Treatments
City of Mission Viejo

Engineer's Conceptual Estimate
Prepared By: Kittelson & Associates, Inc. — *Santa Margarita Parkway/Marguerite Parkway*
Reviewed By: Erin Ferguson — *Date: 9/9/2021*

NO.	ITEM	UNIT	TOTAL QUANTITY	UNIT PRICE	TOTAL COST
1	Mobilization (10%)	LS	1	$7,000.00	$7,000.00
2	Traffic Control (10%)	LS	1	$6,000.00	$6,000.00
3	Remove Traffic Stripe	LF	870	$1.00	$870.00
4	Thermoplastic Traffic Stripe	LF	485	$2.00	$970.00
5	Thermoplastic Crosswalk and Limit Lines	SF	1,350	$10.00	$13,500.00
6	Bike Lane Marking (Green)	SF	950	$10.00	$9,500.00
7	New Pavement Legend	EA	6	$250.00	$1,500.00
8	Push Button	EA	4	$5,000.00	$20,000.00
9	Traffic Signal Head	EA	2	$800.00	$1,600.00
10	Retroreflective Backplate	EA	22	$300.00	$6,600.00
				TOTAL CONSTRUCTION COST	**$ 67,540**
	ENGINEERING SUPPORT				
	Engineering Design & Construction Management (20% of Construction)	LS	1	$14,000.00	$14,000.00
	ENGINEERING SUPPORT SUBTOTAL				**$ 14,000**
				TOTAL PROJECT SUBTOTAL	**$ 81,540**
				25% Contingency	**$ 20,390**
				TOTAL ESTIMATED PROJECT COST	**$ 101,930**

Notes:

- Unit prices are based on adjusted costs found in the Caltrans Historical Contract Cost Database: https://sv08data.dot.ca.gov/contractcost/
- Quantities are taken from Figure 39 Bicycle Treatments - Santa Margarita Parkway/Marguerite Parkway
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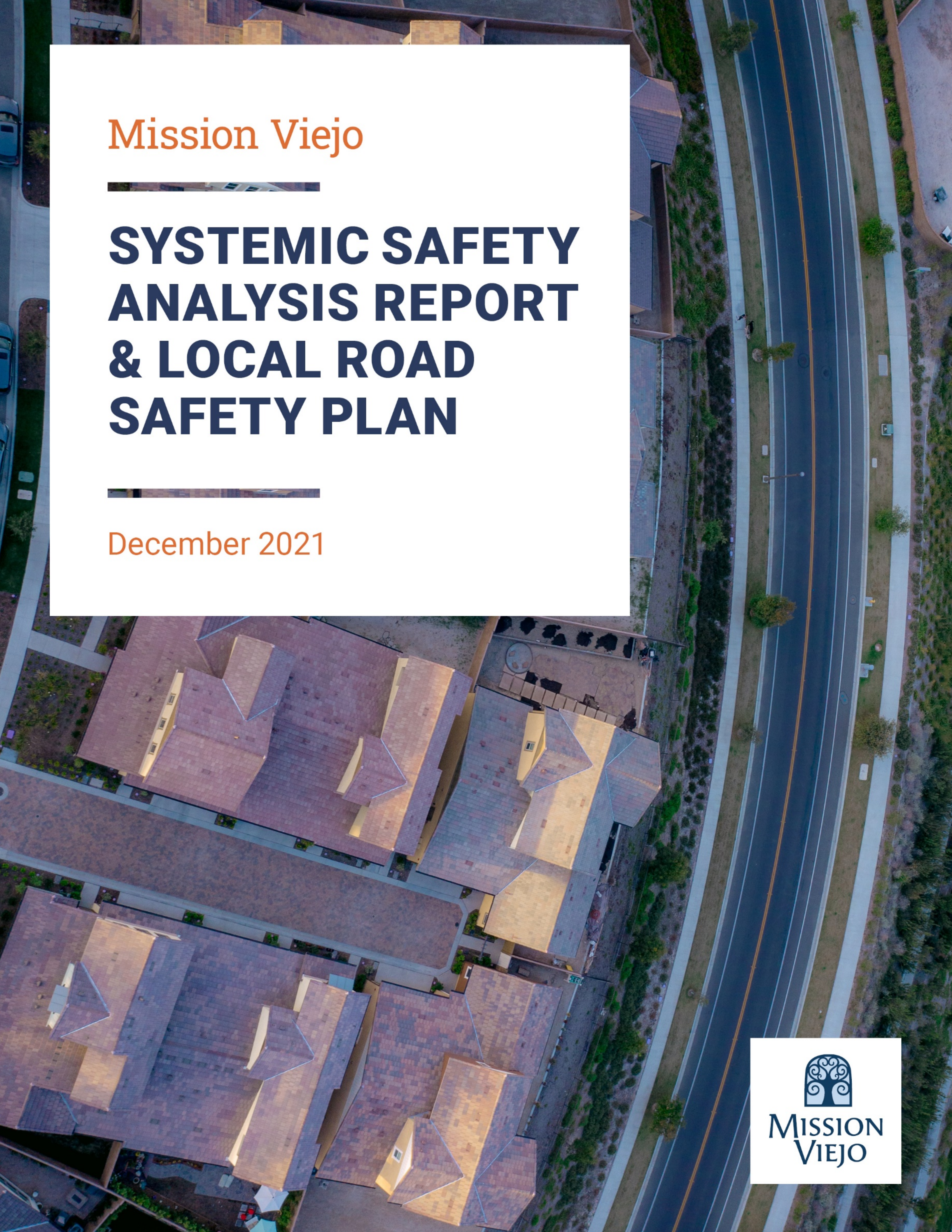
Engineering Effort:

Level A: Preliminary engineering performed. Technical information is available, engineering calculations have been performed; clear understanding of the materials size and quantities needed to execute job. Schedule understood; staff and permitting is fairly clear, (however this element may still need refining). Project Development & Construction Contingencies ranges between 10%-20%.

Level B: Conceptual engineering performed. Technical information is available, rough engineering calculations may have been performed, or similar information from previous similar work is compared and used. Project Development Contingencies ranges between 15% to 25% and Construction Contingencies ranges between 20% to 30%.

Level C: No engineering performed. Educated guesstimating. Limited technical information available and/or analysis performed. Project Development and Construction Contingencies should be selected appropriately by Project Manager. Contingency may range up to 50%.



Mission Viejo

SYSTEMIC SAFETY ANALYSIS REPORT & LOCAL ROAD SAFETY PLAN

December 2021

APPENDIX G

Olympiad Road Special Event Plan

Olympiad Rd/LMVA Driveway Special Event Control Concept

Posted speed limit = 45 mph
Special event speed limit = 25 mph

Note: This layout is conceptual only and further detail on temporary signage, advanced signage, cone spacing, flagger control, and other applicable measures are needed prior to implementation.

KITTELSON & ASSOCIATES