CITY OF RIVERSIDE
LOCAL ROADWAY SAFETY PLAN

PREPARED FOR:

CITY OF RIVERSIDE

PREPARED BY:

Kimley»Horn

(Per Section 148 of Title 23, United States Code [23 U.S.C. §148(h) (4)] REPORTS

DISCOVERY AND ADMISSION INTO EVIDENCE OF CERTAIN REPORTS, SURVEYS,AND INFORMATION—Notwithstanding any other provision of law, reports, surveys, schedules, lists, or data compiled or collected for any purpose relating to this section, shall not be subject to discovery or admitted into evidence in a Federal or State court proceeding or considered for other purposes in any action for damages arising from any occurrence at a location identified or addressed in the reports, surveys, schedules, lists, or other data.)

TO BE SIGNED BY _____

Table of Contents

Executive Summary 6
1. Introduction 1
2. Vision and Goals 3
3. Process 5
3.1 Guiding Manuals 5
3.1.1 Local Roadway Safety Manual 6
3.1.2 Highway Safety Manual 6
3.2 Analysis Techniques 7
3.2.1 Collision and Network Screening Analysis 7
3.2.2 Statistical Performance Measures 8
3.3 Future Analysis 11
4. Safety Partners 12
4.1 Stakeholder Meeting #1 12
4.2 Field Tour Stakeholder Workshop 12
4.3 Stakeholder Meeting #2 12
5. Existing Efforts 12
6. Data Summary 18
6.1 Roadway Network 18
6.2 Collision Data 18
7. Crash Safety Trends 22
7.1 All Collisions 22
7.2 Fatalities & Severe Injuries 23
7.3 Injury Levels 24
7.4 Cause of Collision 24
7.5 Vulnerable Users 25
7.5.1 Pedestrian Collisions 25
7.5.2 Bicycle Collisions 25
7.6 Nighttime Collisions 27
7.7 Other Significant Trends 27
7.8 Statewide Comparison 27
7.9 Collision Network Screening Analysis Results 28

8. Best Practices Evaluation and Emphasis Areas 38
8.1 Best Practices Evaluation 38
8.2 Emphasis Areas 41
8.2.4 Emphasis Area #1: Vulnerable Road Users (Pedestrians & Bicyclists) 41
8.2.1 Emphasis Area #2: Impaired Driving 42
8.2.2 Emphasis Area #3: Intersection Improvements 43
8.2.3 Emphasis Area #4: Aggressive Driving 43
9. Countermeasure Toolbox 45
9.1 Infrastructure Improvements 45
9.1.1 Countermeasure Selection Process 45
9.1.2 Safety Project Case Studies 46
9.2 City-wide Countermeasure Toolbox 79
10. Funding Sources & Next Steps 83
10.1 Funding Sources 83
10.1.1 Highway Safety Improvement Program 83
10.1.2 Caltrans Active Transportation Program 83
10.1.3 California SB 1 84
10.1.4 California Office of Traffic Safety Grants 84
10.1.5 SCAG Sustainable Communities Program 85
10.1.6 Safe Streets and Roads for All (SS4A) Grant Program 85
10.1.7 Infrastructure Investment and Jobs Act 85
10.2 Implementation Plan 86
10.2.1 Monitoring 86
10.2.2 Analysis Update 86
10.2.3 Implementation Strategies 86
10.3 Next Steps 87
APPENDIX A 88

LIST OF FIGURES

Figure 1 - Riverside City Profile 1
Figure 2 – Critical Crash Rate Formula 8
Figure 3 – Probability of Specific Crash Types Exceeding Threshold Proportion 10
Figure 4 – Functional Classification & Signalized Intersections 19
Figure 5 – All Collisions (2017-2022) 20
Figure 6 – Fatal & Severe Injury Collisions (2017-2022) 21
Figure 7 – Collision Type by Year (2017-2022) 22
Figure 8 – Fatal & Severe Injury Collisions (2017-2022) 23
Figure 9 – Collisions by Injury Levels (2017-2022) 24
Figure 10 – Pedestrian & Bicycle Collisions (2017-2022) 26
Figure 11 – Collision Network Screening Analysis Results - Intersections 29
Figure 12 - Collision Network Screening Analysis Results – Mid-block Collisions 30

LIST OF TABLES

Table 1 – Review of Existing City Plans 13
Table 2 – Review of Existing City Projects 14
Table 3 – Fatal and Severe Injury Collisions Categorized by Modes Involved 23
Table 4: - Cause of Collisions (2017-2022) 24
Table 5: Comparison of Statewide and Riverside Fatal & Severe Injury Crashes 27
Table 6– Analysis Results: Intersections (Top 20 Per Type) 28
Table 7 – Analysis Results: Segments (Top 20 Per Type) 31
Table 8 – Summary of Program, Policies, and Practices 38
Table 9 - Citywide Safety Countermeasure Toolbox 80

Executive Summary

Riverside has created a Local Roadway Safety Plan (LRSP), which identifies a framework to identify, analyze, and develop traffic safety enhancements on the City's roadway network. The LRSP was developed in response to local issues and needs. Through the analysis, this report has identified emphasis areas to inform and further guide safety evaluation and planning for the City's transportation network. The LRSP also analyzes collision data on an aggregate basis as well as at specific locations to identify high-crash locations, high-risk locations, and citywide trends and patterns. The analysis of collision history on the City's transportation network allows for opportunities to:

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

With this LRSP, the City continues its safety efforts by identifying areas of emphasis and systemic recommendations to enhance safety.

The City's vision is to enhance the transportation network and reduce traffic fatalities and serious injury related crashes, and the goals for the City of Riverside include the following:

Goal #1: Identify areas with a high risk for crashes.

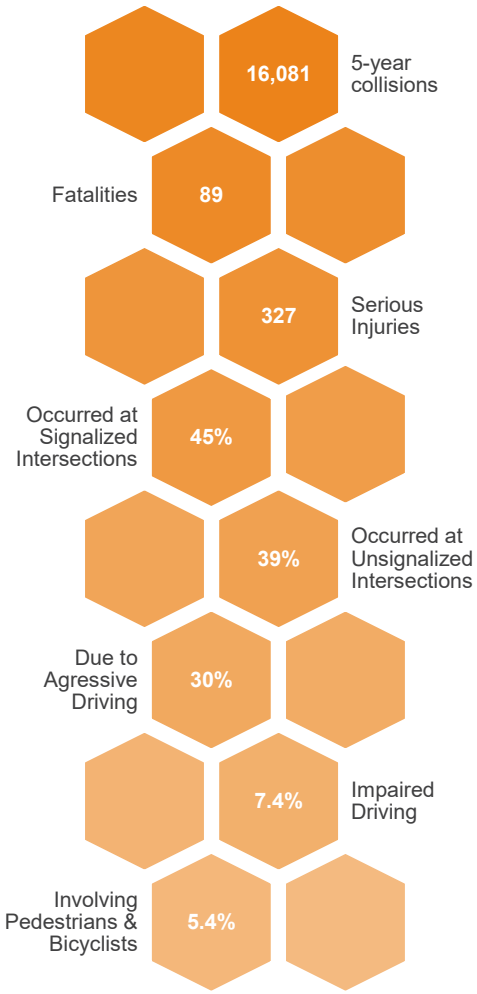
Goal #2: Illustrate the value of a comprehensive safety program and the systemic process.

Goal #3: Plan future safety improvements for near-, mid- and long-term.

Goal #4: Define safety projects for HSIP and other program funding consideration.

This LRSP analyzes the most recent range of crash data (July 1, 2017 – June 30, 2022) and roadway improvements to assess historic trends, patterns, and areas of increasing concern.

Further, the collision history was analyzed to identify locations with elevated risk of collisions either through their collision histories or their similarities to other locations with more



Source: Riverside Collision Database (2017- 2022)

active collision patterns. Using a network screening process, locations were identified within the City that will most likely benefit from safety enhancements. Using historic collision data, collision risk factors for the entire network were derived. The outcomes informed the identification and prioritization of engineering and non-infrastructure safety measures to address certain roadway characteristics and related behaviors that contribute to motor vehicle collisions with active transportation users.

Emphasis areas were developed by revisiting the vision and goals developed at the onset of the planning process and comparing them with the trends and patterns identified in the crash analysis.

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

Emphasis Area #2: Impaired Drivers

Emphasis Area #3: Intersection Improvements

Emphasis Area #4: Aggressive Driving

The following 12 case study locations were chosen to be representative of the corridor and intersection configurations throughout the City.

1. Signalized Intersection: Market St & 6th St
2. Roadway Segment: Mission Inn Ave – Redwood Dr to Scout Ln
3. Roadway Segment: Main St – Spruce St to Poplar St
4. Signalized Intersection: 14th St & Olivewood Ave
5. Unsignalized Intersection: Victoria Ave & Lincoln Ave
6. Unsignalized Intersection: Washington St & Lincoln Ave
7. Signalized Intersection: Van Buren Boulevard & Wood Rd
8. Unsignalized Intersection: Tyler St & Hemet St
9. Signalized Intersection: Tyler St & Magnolia Ave
10. Signalized Intersection: Van Buren Blvd & Arlington Ave
11. Signalized Intersection: Van Buren Blvd & Jurupa Ave
12. Roadway Segment: Central Ave – Fremont St to Wilderness Ave

These locations were identified through the analysis process based on their crash histories, stakeholder engagement, the observed crash patterns, and their different characteristics to provide the most insight into potential systemic safety countermeasures that the City can employ to achieve the most cost-effective safety benefits. Countermeasures were subjected to a benefit/cost assessment and scored according to their potential return on investment. These case studies can be used to select the most appropriate countermeasure, and to potentially phase improvements over the longer-term. The potential benefit of these countermeasures at locations

with similar design characteristics can then be extrapolated regardless of crash history, allowing for proactive safety enhancements that can prevent future safety challenges from developing. Additionally, this information can be used to help the City apply for grants and other funding opportunities to implement these safety improvements. These opportunities were assembled into the “countermeasure toolbox” shown below. The toolbox shows the crash reduction factor, which is the factor used to estimate the expected reduction in number of crashes after implementing a given countermeasure at a specific site (the higher the CRF, the greater the expected reduction in crashes). The toolbox also shows the countermeasure ID number from the California Local Roadway Safety Manual.

Citywide Countermeasure Toolbox

ID	Potential Countermeasures	Where to apply?	Crash Reduction Factor	Per Unit Cost	Unit
S02	Improve signal hardware; lenses, back-plates with retroreflective borders, mounting, size, and number	Signalized intersections with significant broadside and rear-end collisions due to signal visibility	15%	$26,400	per intersection
S04	Provide Advanced Dilemma Zone Detection system	Signalized intersections with significant right-angle and rear-end collisions due to unsafe stopping during yellow phases	40%	$76,800	per intersection
S10	Install flashing beacons as advance warning for signalized intersections	Locations with sight distance issues	30%	$10,200	per beacon
S17PB[1]	Install audible pedestrian push button systems	Signalized intersections with crosswalks	25%	$11,000	Per intersection
S18PB	Install high visibility crosswalk for signalized intersections	Signalized intersections with no marked crossing and pedestrian heads, with significant turning movements	25%	$74,400	per intersection
S21PB	Modify signal phasing to implement a Leading Pedestrian Interval (LPI)	Signalized Intersections – especially those with high pedestrian activity	60%	$45,600	per intersection
NS03	Install signals	Unsignalized intersections with significant collision activity where warrants are met	30%	$378,000	per intersection
NS05mr	Convert intersection to mini-roundabout	Intersections with lower vehicle speeds, with posted speed limits of 30 mph or less	30%	$100,000	per location
NS06	Install/upgrade larger or additional stop signs or other intersection warning/regulatory signs	Unsignalized intersections with crash history showing running stop signs	15%	$8,400	per sign
NS08	Install Flashing Beacons at Stop-Controlled Intersections	Unsignalized intersections with crash history showing running stop signs	15%	$12,000	per beacon

[1] This countermeasure typically covers pedestrian countdown signal heads, but can be also used for audible pedestrian push buttons

ID	Potential Countermeasures	Where to apply?	Crash Reduction Factor	Per Unit Cost	Unit
NS14	Install raised median on approaches for unsignalized intersections	Unsignalized intersections where related or nearby turning movements affect the safety and operation of an intersection	25%	$1,068	per LF
NS20PB	Install pedestrian crossing at uncontrolled locations (new signs and markings only)	Unsignalized intersections with high pedestrian activity where sufficient sight distance is available	25%	$34,800	per intersection
NS22PB	Install Rectangular Rapid Flashing Beacon (RRFB)	Unsignalized intersections and mid-block pedestrian crossings	35%	$30,000	Per location
R08	Install raised median	Locations with a high number of head-on collisions	25%	$1,068	per LF
R14	Road Diet (Reduce travel lanes and add a two-way left-turn and bike lanes)	Roadway segments with high number of sideswipe collisions	30%	$79,200	per mile
R23	Install chevron signs on horizontal curves	Roadway segments that have a significant amount of collision activity at sharp curves.	40%	$2,400	per sign
R24	Install curve advance warning signs	Roadway segments that have a significant amount of collision activity at sharp curves.	25%	$2,400	per sign
R25	Install curve advance warning signs (flashing beacon)	Roadway segments that have a significant amount of collision activity at sharp curves.	30%	$12,000	per beacon
R26	Install dynamic/variable speed warning signs	Roadway segments with a significant number of collisions due to unsafe speeds.	30%	$22,800	per sign
R28	Install edge-lines and centerlines	Roadway segments with collisions that resulted in run-off-road right/left, head-on, or opposite-direction-sideswipe.	25%	$100,800	per mile
R32PB	Install bike lanes	Locations with a high number of bicycle collisions	35%	$76,800	per mile

ID	Potential Countermeasures	Where to apply?	Crash Reduction Factor	Per Unit Cost	Unit
R33PB	Install Separated Bike Lanes	Locations with a high number of bicycle collisions and/or high bicycle traffic volumes, where sufficient space is available for the selected separation measure	45%	$120,000	per mile
R21	Improve Pavement Friction (High Friction Surface Treatments)	Areas where there are significant crashes or skidding, and areas near curves, loop rams, intersections, and areas with short stopping or weaving distances	55%	$33	Per square yard
-*	Refresh lane guidance markings	Locations with faded lane guidance markings/striping	5%	$6,000	per location
-*	Install curb extensions	Intersections with high pedestrian activity	5%	$20,000	per extension

**The City is not limited to the countermeasures in this toolbox and can utilize other approved countermeasures in its roadway safety planning.*

Near-term action items were identified to accelerate the City's achievement of the goals and vision of this LRSP. The City can:

- Actively seek other funding opportunities to improve safety for all modal users,
- Collaborate with established safety partners & neighboring municipalities as improvements are made to create a cohesive transportation network, and
- Iteratively evaluate existing and proposed transportation safety programs and capital improvements to design a safer transportation network in Riverside.

The City will be regularly monitored and update the analysis performed in this plan. A full plan update will completed five years from the City Council's adoption of this plan which will maintain eligibility for HSIP funding.

1. Introduction

Located in Riverside County about 50 miles southeast of Downtown Los Angeles, the City of Riverside is a city with a population of 314,998 according to the 2020 census. **Figure 1** shows vital statistics for the City of Riverside.

Figure 1 - Riverside City Profile

Source: City of Riverside

Riverside is a medium-sized city with shopping, food, entertainment, and outdoor recreation. Based on University of California Berkeley's Transportation Injury Mapping System (TIMS) and California Department of Transportation (Caltrans) Vehicle Operation Cost Parameters, Riverside's economic losses due to traffic injuries amounted to approximately $1.3B from 2017 to 2021. This report identifies factors associated with the most vehicle crashes particular to the City and proposes matching countermeasures to reduce or eliminate those crashes.

This Local Road Safety Plan (LRSP) identifies emphasis areas to inform and guide further safety evaluation of the City's transportation network. The emphasis areas include the type of crash, certain locations, and notable relationships between current efforts and crash history. The LRSP analyzes crash data on an aggregate basis as well as at specific locations to identify high-crash locations, high-risk locations, and city-wide trends and patterns. The analysis of crash history throughout the City's transportation network allows for the following opportunities:

1. Identify factors in the transportation network that inhibit safety for all roadway users,
2. Improve safety at specific high-crash locations, and

3. Develop safety measures using the four E's of safety (Engineering, Enforcement, Education, and Emergency Response) to encourage safer driver behavior and better severity outcomes.

Riverside has taken steps to enhance all modal safety throughout the City and with this LRSP, Riverside is continuing to prioritize safety in its planning processes. The Office of Traffic Safety (OTS) most recently ranked Riverside 8 out of 15 peer cities for traffic injuries after normalizing for population and VMT in 2019. With number one (1) in the OTS crash rankings considered the highest, or "worst," this positions the City at slightly below average for roadway safety performance. This LRSP analyzes the most recent range of Crossroads crash data from July 1, 2017 – June 30, 2022 and roadway improvements to assess historic trends, patterns, and areas of increasing concern.

The intent of the LRSP is to:

- Create a greater awareness of road safety and risks
- Reduce the number of fatal and severe-injury crashes
- Develop lasting partnerships
- Support for grant/funding applications, and
- Prioritize investments in traffic safety.

2. Vision and Goals

The Riverside LRSP evaluates the transportation network as well as non-infrastructure programs and policies within the City. Mitigation measures are evaluated using criteria to analyze the safety of road users (drivers, bicyclists, and pedestrians), the interaction of modes, the influences on the roadway network from adjacent municipalities, and the potential benefits of safety countermeasures. Through historical data and trends, proactive identification and safety opportunities can be identified and implemented without relying solely on a reaction and response to crashes as they occur.

As cities across the country have implemented LRSPs and systemically addressed the conditions leading to fatal and severe-injury crashes, the Federal Highway Administration (FHWA) has found that LRSPs effectively improve safety. LRSPs provide a locally developed and customized roadmap to directly address the most common safety challenges in the given jurisdiction. This project's vision, goals, and objectives have been established to reflect discussions with Riverside staff, various stakeholders identified by City staff, and a review of existing plans/policies in the area.

VISION:	*To enhance the transportation network for all users to move towards zero traffic fatalities and serious injuries*

Goal #1: Identify areas with a high risk for crashes.

Objectives:

- Identify intersections and segments that would most benefit from mitigation.
- Identify areas of interest with respect to safety concerns for vulnerable users (pedestrians and bicyclists).

Goal #2: Illustrate the value of a comprehensive safety program and the systemic process.

Objectives:

- Demonstrate the systemic process' ability to identify locations with higher risk for crashes based on present characteristics closely associated with severe crashes.
- Demonstrate, through the systemic process, the gaps and data collection activities that can be improved upon.

Goal #3: Plan future safety improvements for near-, mid- and long-term.

Objectives:

- Identify safety countermeasures for specific locations (case studies).
- Identify safety countermeasures that can be applied city-wide.

Goal #4: Define safety projects for future Highway Safety Improvement Plan (HSIP) and other program funding consideration.

Objectives:

- Create the outline for a prioritization process that can be used in this and forth-coming cycles to apply for funding.
- Use the systemic process to create Project Case Studies.
- Use Case Studies to apply for HSIP and other funding consideration.
- Demonstrate the correlation between the proposed safety countermeasures with the Vision Zero Initiative and the California State Highway Safety Plan.

3. Process

The primary goal for the City of Riverside and their safety partners is to provide safe, sustainable, and efficient mobility choices for their residents and visitors. Through the development and implementation of this LRSP, the City will continue its collaboration with safety partners to identify and discuss safety issues within the community.

Guidance on the LRSP process is provided at both the national (FHWA) and state (Caltrans) level, and both agencies have developed a general framework of data and recommendations for a LRSP.

FHWA encourages the following:

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

Caltrans guidance follows a similar outline with the following steps:

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

This LRSP documents the results of data and information obtained, including the preliminary vision and goals for the LRSP, existing safety efforts, initial crash analysis, and developed emphasis areas. The LRSP recommendations consider the four E's of traffic safety defined by the California Strategic Highway Safety Plan (SHSP): Engineering, Enforcement, Education, and Emergency Response.

3.1 Guiding Manuals

This section describes the analysis process undertaken to evaluate safety within Riverside at a systemic level. This report identifies specific locations within the City that will benefit from safety enhancements and derives crash risk factors based on historic crash data using a network screening process. The outcome will inform the identification and prioritization of engineering and non-infrastructure safety measures by addressing certain roadway characteristics and related driving behaviors contributing to crashes. This process uses the latest national and state best practices for statistical roadway analysis described.

3.1.1 Local Roadway Safety Manual

The *Local Roadway Safety Manual: A Manual for California's Local Road Owners* (Version 1.5, April 2020) encourages local agencies to pursue a proactive approach when identifying and analyzing safety issues and preparing to compete for project funding opportunities. A proactive approach is the analyzation of safety in an entire roadway network through either a one-time network wide analysis or a routine analysis of the roadway network.[2]

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

To provide the most beneficial and competitive funding approach, the analysis leading to countermeasure selection should focus on both intersections and roadway segments and maintain consideration of roadway characteristics and traffic volumes. The result should reflect a list of locations that are most likely to benefit from cost-effective countermeasures, preferably prioritized by benefit/cost ratio. The manual suggests using a mixture of quantitative and qualitative measures to identify and rank locations using both crash frequency and crash rates. These findings should then be screened for crash type and severity patterns to determine the cause of crashes and the potential effective countermeasures. Qualitative analysis should include field visits and a review of existing roadway characteristics and devices. The specific roadway context can then be used to assess conditions that may decrease safety at the site and at systematic levels.

Countermeasure selection should be supported using Crash Modification Factors (CMFs). These factors are a peer reviewed product of research quantifying the expected rate of crash reduction expected from a given countermeasure. If more than one countermeasure is under consideration, the LRSM provides guidance on appropriate application of CMFs.

3.1.2 Highway Safety Manual

The American Association of State Highway and Transportation Officials (AASHTO) *Highway Safety Manual* (HSM), published in 2010, presents a variety of methods for quantitatively estimating crash frequency or severity at a variety of locations.[3] This four-part manual is divided into the following parts: A) Introduction, Human Factors, and Fundamentals, B) Roadway Safety Management Process, C) Predictive Method, D) Crash Modification Factors.

In Chapter 4 of Part B in the HSM, the "Network Screening Process" is a tool for an agency to analyze the entire network and identify/rank locations that are most likely or least likely to realize a reduction in the frequency of crashes.

[2] Local Roadway Safety Manual (Version 1.5) 2020. Page 5.

[3] AASHTO, Highway Safety Manual, 2010, Washington D.C., http://www.highwaysafetymanual.org/Pages/About.aspx

The HSM identifies five steps in this process:[4]

1. **Establish Focus:** Identify the purpose or intended outcome of the network screening analysis. This decision will influence data needs, the selection of performance measures and the screening method that can be applied.
2. **Identify Network and Establish Reference Populations:** Specify the types of sites or facilities being screened (i.e., segments, intersections, geometrics) and identify groupings of similar sites or facilities.
3. **Select Performance Measures:** There are a variety of performance measures available to evaluate the potential to reduce crash frequency at a site. In this step, the performance measure is selected as a function of the screening focus and the data and analytical tools available.
4. **Select Screening Method:** There are three principal screening methods described in this chapter (i.e., ranking, sliding window, peak searching). Each method has advantages and disadvantages; the most appropriate method for a given situation should be selected.
5. **Screen and Evaluate Results:** The final step in the process is to conduct the screening and analysis and evaluate the results.

The HSM provides several statistical methods for screening roadway networks and identifying high risk locations based on overall crash histories.

3.2 Analysis Techniques

3.2.1 Collision and Network Screening Analysis

Intersections and roadways were analyzed using four collision metrics:

- Number of Collisions
- Critical Crash Rate (HSM Ch. 4)
- Probability of Specific Crash Types Exceeding Threshold Proportion (HSM Ch. 4)
- Equivalent Property Damage Only (HSM Ch. 4)

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

The network screening process ranks intersections and roadway segments by the number of crashes that occurred at each one over the analysis period, and then identifies areas that had more of a given type of crash than would be expected for that type of location. These crash type factors were 1) collision injury

[4] AASHTO. *Highway Safety Manual.* 2010. Washington, DC. Page 4-2.

(fatal, serious injury, other visible injury, complaint of pain, property damage only), 2) collision type (broadside, rear-end, sideswipe, head-on, hit object, overturned, bicycle, pedestrian, other), 3) environmental factors (lighting, wet roads), 4) driver behavior (aggressive), and 5) driver impairment. With these additional factors, the locations were further analyzed and assigned a new rank.

From the results of the network screening analyses, a short-list of locations was chosen based on crash activity, crash severity, crash patterns, location type, and area of the City of Riverside to provide the greatest variety of locations covering the widest range of safety opportunities for safety toolbox development. The intent is to populate the safety toolbox with mitigation measures that will be applicable to most of the crash activity in the city. Ten locations will ultimately be selected for mitigation analysis.

3.2.2 Statistical Performance Measures

Critical Crash Rate (CCR)

Reviewing the number of collisions at a location is a method used to understand the cost to society incurred at the local level; however, it does not give a complete indication of the level of risk for those who use that intersection or roadway segment daily. The Highway Safety Manual describes the Critical Crash Rate method which provides a statistical review of locations to determine where risk is higher than that experienced by other similar locations. It is also the first step in analyzing for patterns that may suggest systemic issues that can be addressed at that location, and proactively at others to prevent new safety challenges from emerging.

The Critical Crash Rate compares the observed crash rate to the expected crash rate at a location based on facility type and volume using a locally calculated average crash rate for the specific type of intersection or roadway segment being analyzed. Based on traffic volumes and a weighted citywide crash rate for each facility type, a critical crash rate threshold is established at the 95% confidence level to determine locations with higher crash rates that are unlikely to be random. The threshold is calculated for each location individually based on its traffic volume and the crash profile of similar facilities.

Figure 2 – Critical Crash Rate Formula

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

Where,

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

R_a = Weighted average crash rate for reference population

P = P-value for corresponding confidence level

MEV_i = Million entering vehicles for intersection i

SOURCE: HIGHWAY SAFETY MANUAL

DATA NEEDS

CCR can be calculated using:

- Daily entering volume for intersections, or VMT for roadway segments;
- Intersection control types to separate them into like populations;
- Roadway functional classification to separate them into like populations;
- Collision records in GIS or tabular form including coordinates or linear measures.

STRENGTHS

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

CCR Methodology

The Process of analyzing the CCR and comparing locations (separately by intersections and segments) is a multi-step process. The following is a high-level description of the process undertaken to develop the initial ranking of locations.

The first step in the process was to establish a city-wide crash rate for each facility population. These populations are broken into two categories with sub-categories:

- Intersection:
  - Signalized
  - Unsignalized
- Roadway Classification:
  - Major Arterial
  - Minor Arterial
  - Collector
  - Local

The individual crash rate for each location was then calculated based on the associated traffic volume. This volume was either collected through data count resources or calculated based on the roadway classification. The next step was to establish a Significance Threshold. This Threshold was used to determine what level of exceedance (how much the crash rate exceeded the critical crash rate) a location must have based on traffic volume to provide a high level of confidence that the collision occurring at the location is not random. For this study, a confidence level of 95% was used. The local crash rates were then compared to Significance Threshold to see if each location exceeded the expected CCR and if so, by how much. After this analysis was completed, the locations were ranked by their categories according to that level of exceedance.

Equivalent Property Damage Only (EPDO)

The equivalent property damage only (EPDO) method is described in the Highway Safety Manual. This method assigns weighting factors to crashes based on injury level (severe, injury, property damage only) to develop a property damage only score. In this analysis, the injury crash costs were calculated for each location (based on the latest Caltrans injury costs). This figure is then divided by the injury cost for a property damage only crash. The resulting number is the equivalent number of property damage only

crashes at each site. This figure allows all locations to be compared based on injury crash costs. (Highway Safety Manual, Chapter 4).

Probability

The Highway Safety Manual describes the methodology for determining the probability that crash type is greater than an identified threshold proportion. This helps to identify locations where a crash type is more likely to occur.

DATA NEEDS

The probability of a specific crash type can be determined using collisions records with location data, and classifications of the locations (intersections or segments) studied.

STRENGTHS

- Can be used as a diagnostic tool
- Considers variance in data
- Not affected by selection bias

The HSM methodology first determines the frequency of a specific collision type at an individual location, then determines the observed proportion of that collision type relative to all collision types at that location. A threshold proportion is then determined for the specific collision type; HSM suggests utilizing the proportion of the collision type observed in the entire reference population (e.g. throughout the entire City of Riverside).

These proportions are then utilized to determine the probability that the proportion of a specific crash type is greater than the long-term expected proportion of that crash type.

Figure 3 – Probability of Specific Crash Types Exceeding Threshold Proportion

$$P\left(p_i > \overline{p^*_i} \,/\, N_{observed\,j}, N_{observed\,j(TOTAL)}\right) = 1 - betadist\left(\overline{p^*_i}, a + N_{observed\,j}, \beta + N_{observed\,j(TOTAL)} - N_{observed\,j}\right)$$

Where:

$\overline{p^*_i}$ = Threshold proportion

p_i = Observed proportion

$N_{observed,i}$ = Observed target crashes for a site i

$N_{observed,i(TOTAL)}$ = Total number of crashes for a site i

SOURCE: HIGHWAY SAFETY MANUAL

3.3 Future Analysis

The City will conduct regular collision monitoring as described in **Section 10.2**. The City will then refresh the analysis and update the LRSP every 5 years to maintain eligibility for HSIP funding, as described in **Section 10.2**.

4. Safety Partners

Local stakeholders were included in the development of this report to ensure the local perspective was maintained at the forefront of planning efforts. A stakeholder group of City staff and external partners consisted of representatives from the Riverside Police Department, Fire Department, Public Works, Riverside School District, University of California, Riverside, and Riverside Bicycle Club.

The local stakeholders were called together to offer insight on the safety issues present in the City's transportation network. After the initial network screening and safety analysis, the stakeholder group met to discuss potential countermeasures and challenge areas through a field visit. The summary of the field visit meeting are outlined below.

4.1 Stakeholder Meeting #1

The first stakeholder meeting was conducted virtually on August 4, 2022. At the meeting, stakeholders were introduced to the project and provided an overview of the data used, the required outputs, and the potential outcomes of the study.

In addition to the overview, stakeholders were asked to provide local insight and knowledge at ten "case study" locations that were identified after the initial network screening and crash analysis process.

4.2 Field Tour Stakeholder Workshop

On August 8, 2022, the project team visited each of the 12 "case study" locations to identify potential issues that are contributing to the collision patterns. Potential countermeasures were identified and discussed.

4.3 Stakeholder Meeting #2

The second stakeholder meeting was conducted virtually on September 1, 2022. During this meeting case study locations were presented to the stakeholders with a list of observations and potential countermeasures. Emphasis/challenge areas were discussed, specifically aggressive driving and impaired driving as a major factor in collisions throughout the City. Stakeholder feedback was reviewed and incorporated into the study process for the development of the LRSP.

5. Existing Efforts

Existing plans, policies, and projects that were recently completed, planned, or on-going were compiled at the start of the LRSP process to gain perspective on the existing efforts for transportation-related improvements within the City. High-level key points regarding transportation improvements and safety-related topics were identified to inform decision making in this LRSP.

Table 1 outlines the relevant existing City plans and their improvements and funding sources. **Table 2** outlines the relevant existing City projects and their timelines.

Table 1 – Review of Existing City Plans

Document Name	Transportation Policies/Improvements
General Plan 2025 (Circulation and Community Mobility Element)	• Outlines citywide improvements pertaining to housing, public safety, land use and urban design, circulation and community mobility, education, and more • Highlights the community's involvement in implementing changes for the City
Pedestrian Target Safeguarding Plan (PTS) **(part of PACT document)**	• Outlines design recommendations for six high priority zones in the City, such as Main Street Pedestrian Mall, University Village, and Ryan Bonaminio Park • Provides building perimeter and public space security recommendations to protect pedestrians from unauthorized vehicles entering public spaces • Aims to promote safe walkability in the City
Active Transportation Plan (AT Plan) **(part of PACT document)**	• Establishes policies, infrastructure recommendations, and supporting programs for walking, bicycling, and other transportation modes • Outlines funding sources, infrastructure projects, and implementation strategies • Identifies and prioritizes bicycle and pedestrian projects • Appendices A & B contain intersections with pedestrian/bicycle involved collisions
Complete Streets Ordinance (CS) **(part of PACT document)**	• Outlines improvements for the development of pedestrian paths, street connectivity for all users, and the integration of public gathering spaces placed in the City of Riverside • Identifies design guidelines for Complete Streets implementations
Trails Master Plan (TMP) **(part of PACT document)**	• Provides the City of Riverside's most updated version of its trail network, design, maintenance, and funding to its residents, advocates, and developers • Recommends new trail and gap closures, including trails along Main Street, Hole Ave, Mitchell Ave, and Wood St • Integrates the City's transportation network with trail facilities

Table 2 – Review of Existing City Projects

Project Name	Timeline	Transportation Policies/Improvements
Current		
La Sierra Neighborhood Sidewalk Improvements	Estimated Completion in Winter 2022	Improvements to sidewalks in La Sierra Neighborhoods
FY 20-21 Arterial and Minors Maintenance, Phase 2	Estimated Completion in Late Summer 2022	Asphalt concrete pavement restoration for various streets
FY 20-21 SB-1 Traffic Improvements	Estimated Completion in Late Summer 2022	Various traffic improvements from SB-1 funding
FY 19-20 SB-1 Maintenance Improvements, Phase 2	Estimated Completion in Late Summer 2022	Various maintenance improvements from SB-1 funding
Van Buren Blvd. widening from Jurupa Ave. to the Northerly City Limits	Estimated Completion in Spring 2023	Widening the east side of Van Buren Blvd along with installing new UT and streetlights
SR-91/Adams Street Interchange Reconfiguration	Estimated Completion in Spring 2023	Rehabilitating the SR-91 and Adams St interchange
Adair Sidewalk – Jo Jo Way to Randolph Street	TBD	New concrete sidewalks and American Disability Act-compliant truncated domes along Adair Avenue
Market Street Bridge Replacement Over the Santa Ana River	Estimated Completion in 2024	Replacing and Improving the Market Street Bridge
Berry Road Widening – Selina Street to Bush Avenue	Summer 2022	Widening Berry Road from 20 ft to 34 ft to match rest of road
Third St Grade Sep Project	TBD	Grade separation projects along Third Street
Mission Boulevard Bridge Replacement at Santa Ana River	Estimated Completion in Winter 2023	Replacing and Improving Mission Boulevard Bridge
Orange Street Widening Improvement Project	TBD	Construction of new gutter and curb to go along with concrete pavement rehabilitation

Project Name	Timeline	Transportation Policies/Improvements
HSIP Cycle 7	TBD	Install High Friction Surface Treatment at Five Locations, Construct 2 HAWK Signals, Deploy new signal timing plans for 35 Traffic Signals in the Downtown Area
HSIP Cycle 8	TBD	Install new model 2070 controllers, with an upgraded controller software and central system.
Completed		
Bicycle Improvements State-Aid Project No. ATPL-5058(96)	Completed	Downtown Pedestrian and Bicycle Improvements
Central/Canyon Crest/Watkins Bike Lanes	Completed	Install cycle tracks, bike lanes, pedestrian arrows
Indiana Widening at Pierce Street	Completed Spring 2021	Constructing new utilities and new traffic signals in preparation for a new high school on the intersection
Magnolia Ave. Improvements from Buchanan to Banburry Federal Aid Project: STPL-5058(102)	Completed 01/13/21	Widening the street to provide a third lane and to provide on- and off-ramps to SR-91
2018-2019 SB-1 Maintenance and Traffic Improvements	Completed 01/29/21	Allocating SB-1 funding for various improvements and maintenance
Iowa Avenue Improvements from Martin Luther King to University	Completed 02/26/21	Providing new UT and two travel lanes in each direction
City-Wide Bicycle and Pedestrian Improvements	Completed 03/11/21	Various improvements for bicycle lanes and pedestrian walkways
Adair Ave and Bonita Sidewalk Improvements	Completed Spring 2022	Improvements to Adair Avenue and Bonita Sidewalk including new concrete
Wells-Arlanza Sidewalk Improvements Federal-Aid Project No. ATPL-5058(101)	Completed 01/08/19	Improving the sidewalk for safe walking routes to nearby schools
2016-2017 Arterial and Minor Streets Maintenance	Completed 09/27/18	Asphalt concrete pavement restoration for various streets

Project Name	Timeline	Transportation Policies/Improvements
2015-2016 CDBG Street Improvements for Holding Street, Lime Street and Evans Street	Completed 12/15/17	Utilizing CDBG to add truncated domes and other various sidewalk improvements
Street Widening at Quiet Lane and Blehms St	Completed 06/19/18	Widening Quiet Lane and Blehms St
2016-2017 CDBG Street Improvements Project	Completed 08/03/19	Utilizing CDBG to add truncated domes and other various sidewalk improvements
2017-2018 Arterial & Minor Streets Maintenance Phase I	Completed 04/26/19	Asphalt concrete pavement restoration for various streets
2017-2018 SB-1 Maintenance & Traffic Improvements	Completed 10/18/19	Utilizing SB-1 funding for various traffic improvements and maintenance
2016-2017 CDBG ADA Footpath Improvements for Redwood Drive, Locust Street and Fairmount Park	Completed 11/09/19	Creating ADA improvements to sidewalks such as truncated domes
2017-2018 Arterial & Minor Streets Maintenance Ph 2	Completed 09/20/18	Asphalt concrete pavement restoration for various streets
Citywide Dynamic Speed Feedback Sign Installation	Completed 10/26/18	Dynamic Speed Feedback Sign Installation
Selkirk Avenue Street Improvements	Completed 03/21/19	Various improvements along Selkirk Avenue
2017-2018 CDBG ADA Footpath and Street Improvement	Completed 05/01/19	Utilizing Community Development Block Grants (CDBG) to add truncated domes and other various sidewalk improvements
2017-2018 CDBG Street Improvements for Wilbur Street and Sidewalk Improvements for Cook Avenue	Completed 12/19/19	Utilizing CDBG to add truncated domes and other various sidewalk improvements
Indian Hill Road Slope	Completed 11/01/19	Installation of a 100 ft retaining wall to support street right of way

Project Name	Timeline	Transportation Policies/Improvements
Alessandro Boulevard at Royal Hill Drive Pedestrian Ramp Repairs	Completed 09/06/17	Pedestrian ramp repairs at Alessandro Bl and Royal Hill Dr
2018-2019 CDBG ADA Footpath and Street Improvements	Completed 04/21/20	Utilizing CDBG to add truncated domes and other various sidewalk improvements
Norte Vista Sidewalk Improvements	Completed	Improving sidewalks to accommodate foot traffic for local schools
Victoria at Washington Southbound Merge Lane	Completed	Installation of Southbound Merge Lane to reduce intersection delay
Tyler Widening – Wells Avenue to Hole Avenue	Completed Winter 2021	Widening four travel lanes with raised center median

6. Data Summary

This section describes the data sources used for the analysis process of this LRSP.

6.1 Roadway Network

The California Department of Transportation (Caltrans) California Road System (CRS) GIS database was used to build the base roadway network used for this analysis. Intersections and roadway segments were divided into control and classification categories so that each set could have its own crash rates and be compared with similar facilities or control type. Functional Classifications were imported from the city's General Plan and confirmed by city staff. Information on intersection traffic control was provided by the city and included in the analysis network. The collision analysis requires each intersection to be classified by type: Signalized or Unsignalized. **Figure 4** illustrates the City of Riverside's roadway functional classification and intersection control type, respectively, as used for this study.

6.2 Collision Data

Collision data was collected from Crossroads software for the period from July 1, 2017 through June 30, 2022, displayed in **Figure 5**. This figure zoomed into each City ward is provided in Appendix A. Five years of data are utilized instead of the standard three years to provide more history to evaluate trends or patterns. Analysis of the raw collision data is the first step in understanding the specific and systemic challenges faced throughout the city. Analyzing the five years of data provided insight on the collision trends and patterns detailed in **Section 7.** The locations of fatal and severe injury collisions are displayed in **Figure 4.** This figure zoomed into each City ward is provided in Appendix A.

Figure 4 – Functional Classification & Signalized Intersections

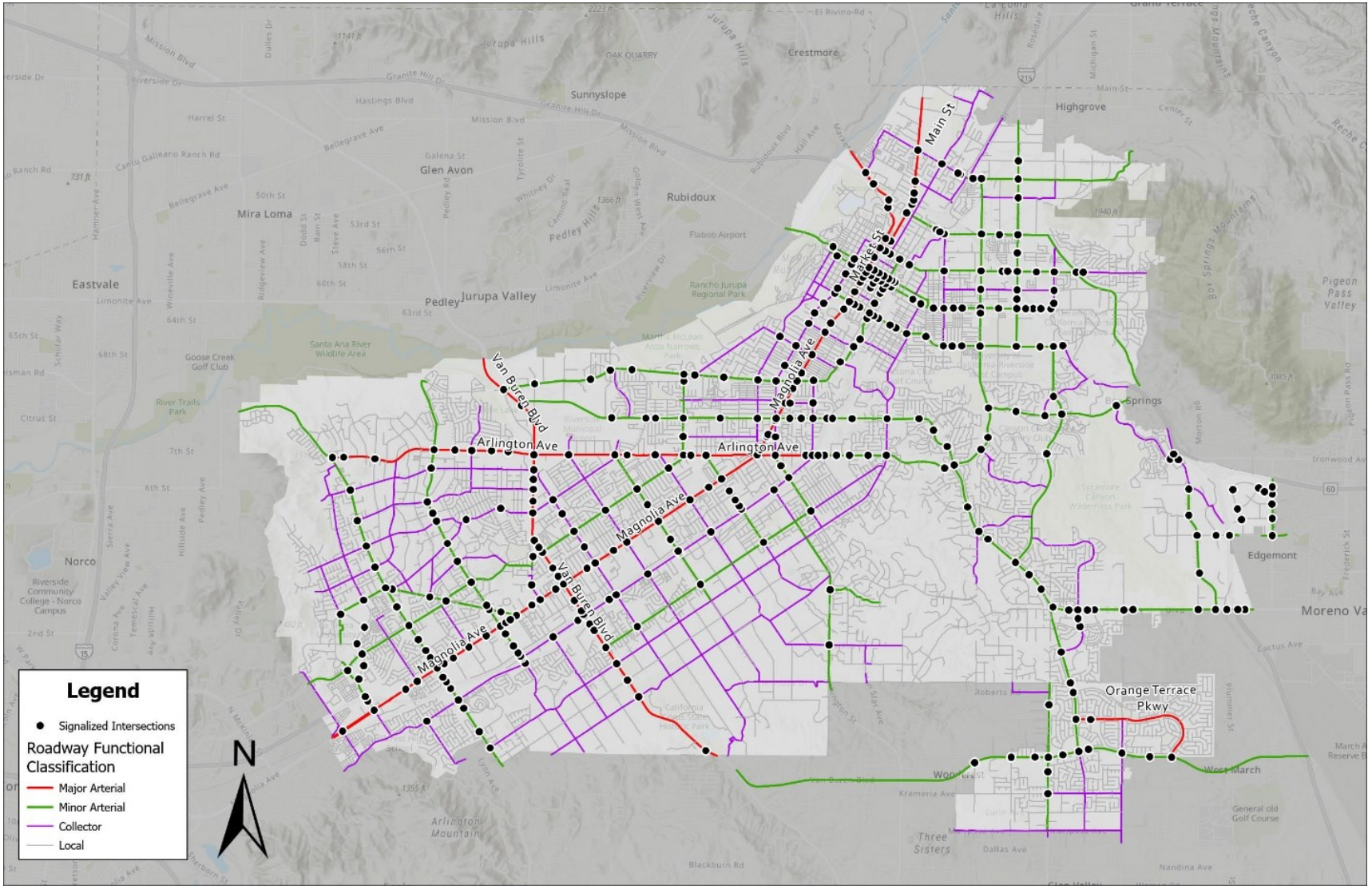


Figure 5 – All Collisions (2017-2022)

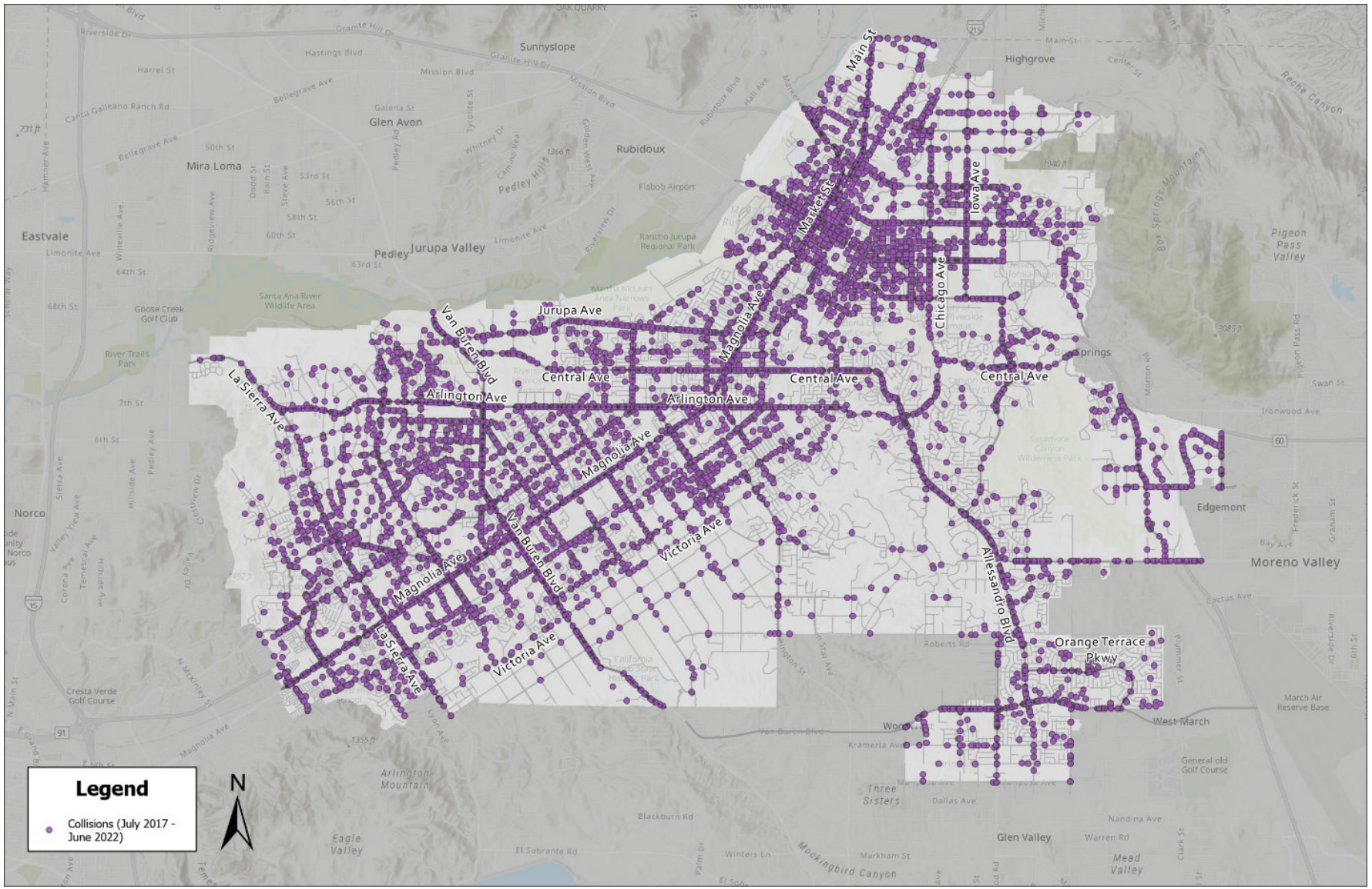
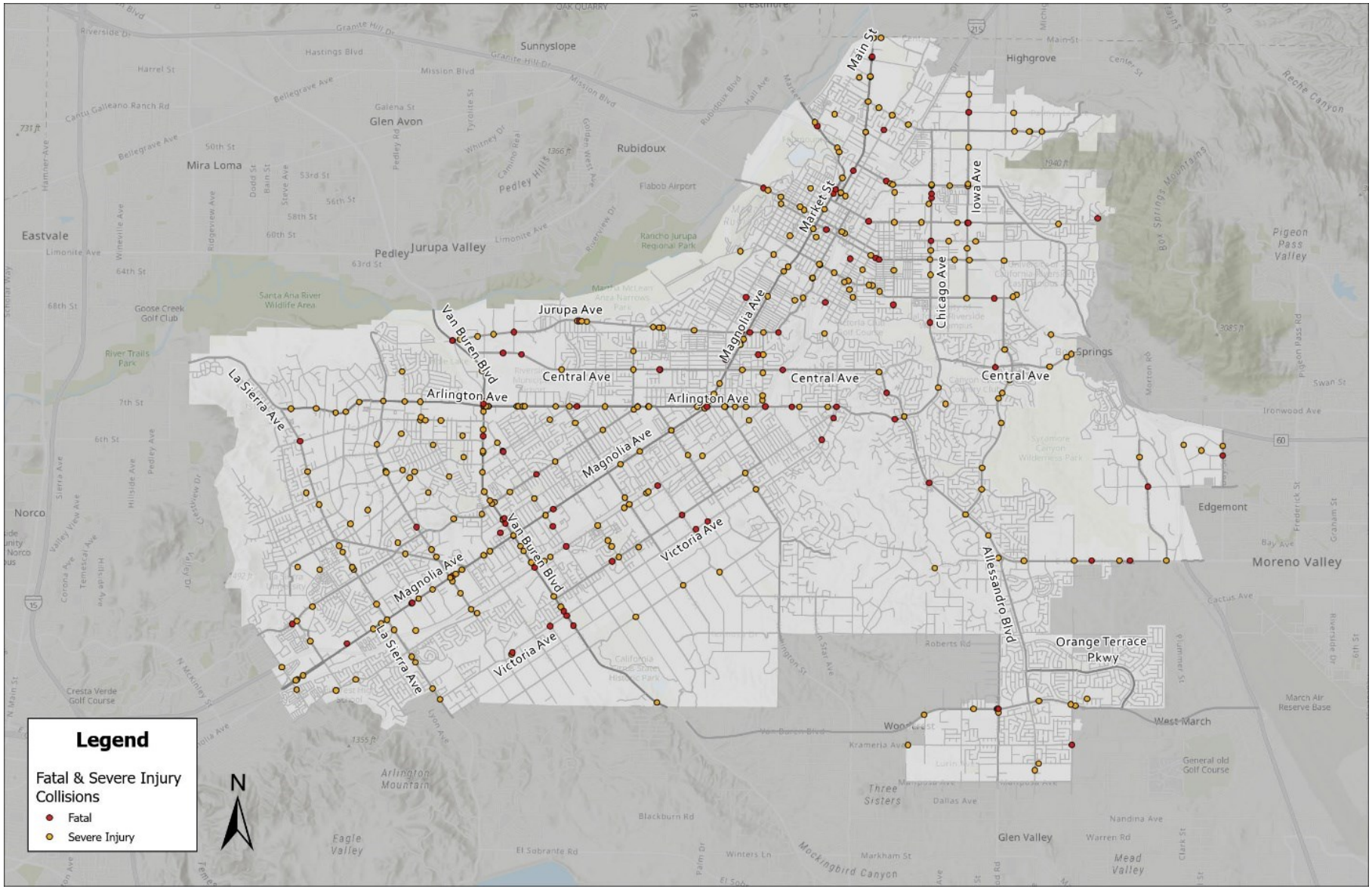


Figure 6 – Fatal & Severe Injury Collisions (2017-2022)



7. Crash Safety Trends

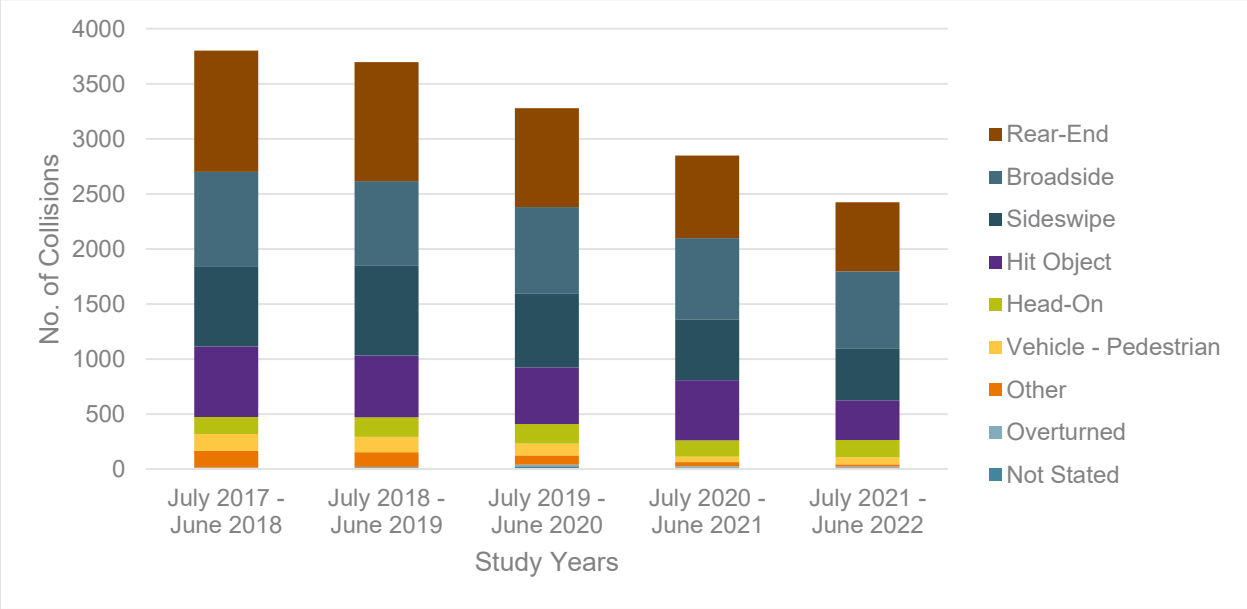
The analysis was conducted using a network screening process for the City-maintained roadway system based on collision records spanning from July 1, 2017 through June 30, 2022. This section contains the results of the analysis, which included the evaluation of Riverside's fatal and serious injury (generally denoted as K+SI) collisions, statewide K+SI collisions, pedestrian collisions, bicycle collisions, collision severity levels, and collision causes.

7.1 All Collisions

This report utilized collision data for a five-year period to provide a better understanding of trends and to reflect the patterns in crashes that have occurred on city streets. Data used for this report was extracted from Crossroads Software on July 5, 2022 and was current as of that date. Collision data from July 1, 2017, through June 30, 2022 as reported to Crossroads from the local enforcement indicated that during this time there were 16,081 collisions recorded within Riverside.

During this time, the most common occurring collision types were Rear-Ends (28%) and Broadsides (24%). The total number of collisions declined throughout the study period, with a decline in collisions with each ensuing year, as shown in **Figure 7.**

Figure 7 – Collision Type by Year (2017-2022)



Source: Riverside Crossroads Database (2017-2022)

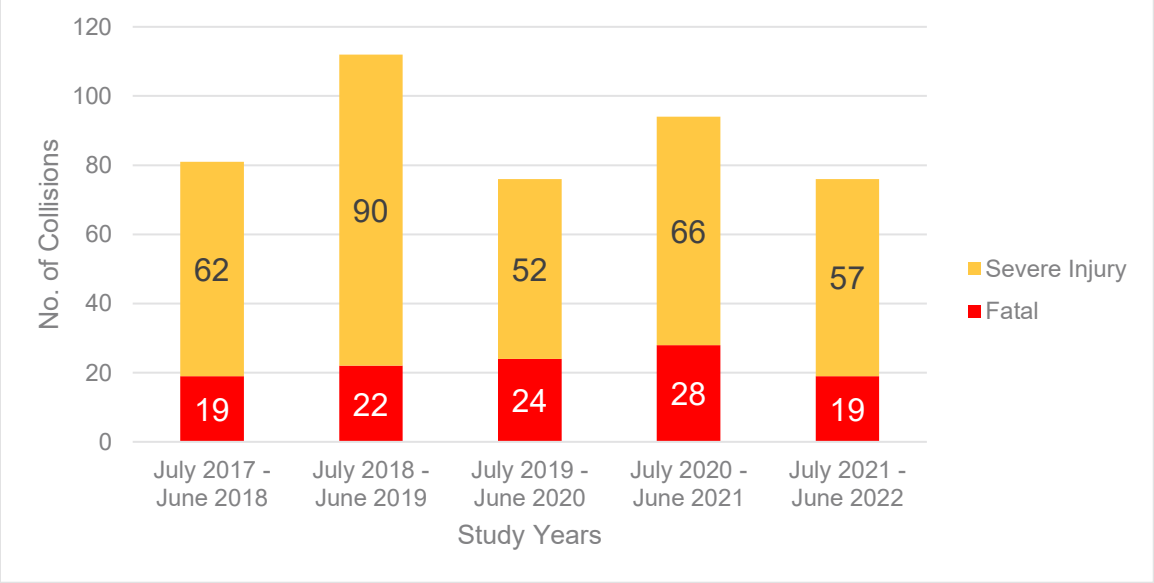
7.2 Fatalities & Severe Injuries

During the study period, 89 fatal collisions and 327 severe injury collisions occurred during the study period, as seen in **Figure 6.** This figure zoomed into each City ward is provided in Appendix A. **Table 3** outlines the fatal and severe injury collisions categorized by modes involved.

Table 3 – Fatal and Severe Injury Collisions Categorized by Modes Involved (2017-2022)

Involved With	# of Fatal Injury Collisions	# of Severe Collisions
Other Motor Vehicle	36	144
Fixed Object	23	62
Pedestrian	21	62
Bicycle	4	25
Parked Motor Vehicle	1	13
Other Object	3	8
Non - Collision	-	8
Motor Vehicles on Other Roadway	1	5

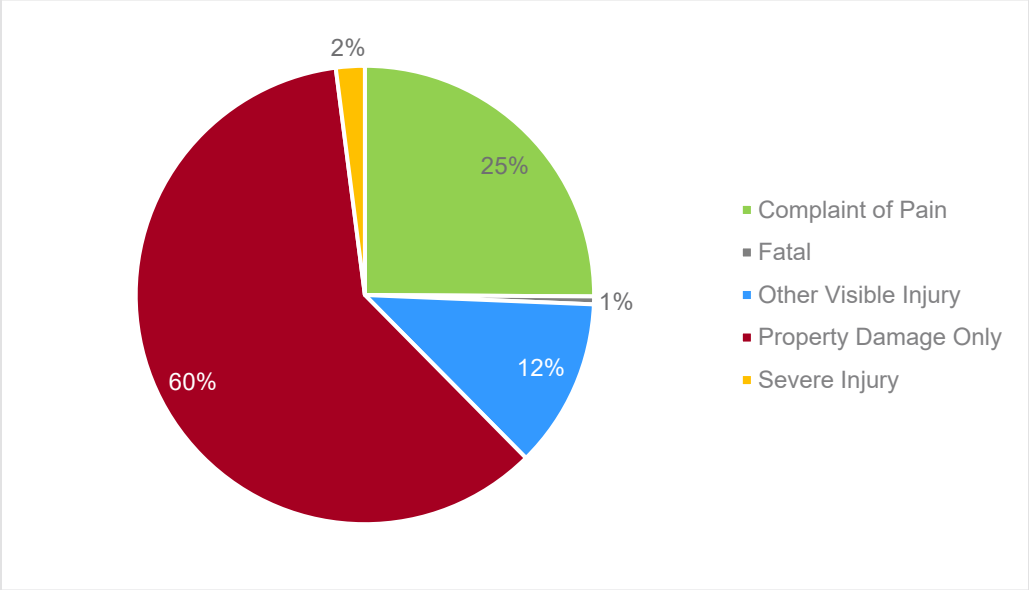
Figure 8 – Fatal & Severe Injury Collisions (2017-2022)



7.3 Injury Levels

As shown in **Figure 9**, 60% of the collisions reported during the time-period resulted in property damage only. Fatalities and severe injuries totaled 3% of all collisions.

Figure 9 – Collisions by Injury Levels (2017-2022)



Source: Riverside Crossroads Database (2017 – 2022)

7.4 Cause of Collision

The highest recorded cause of collisions in Riverside during this time period is Improper Turning at 28.3%, followed by Unsafe Speed at 19.2% and Other Improper Driving at 11.2%. Issues with Drivers Ignoring Traffic Signals and Signs also had a substantial impact on the City, comprising 10.4% of the collisions.

Table 4: - Cause of Collisions (2017-2022)

Primary Collision Factor	No. of Collisions	%
Improper Turning	4500	28.32%
Unsafe Speed	3050	19.20%
Other Improper Driving	1777	11.19%
Traffic Signals and Signs	1656	10.42%
Auto R/W Violation	1591	10.02%
Driving Under Influence	1176	7.40%
Unsafe Starting or Backing	542	3.41%
Unknown	385	2.42%
Wrong Side of Road	219	1.38%

Primary Collision Factor	No. of Collisions	%
Pedestrian Violation	187	1.18%
Not Stated	169	1.06%
Other Than Driver	152	0.96%
Unsafe Lane Change	138	0.87%
Ped R/W Violation	130	0.82%
Improper Passing	79	0.50%
Other Hazardous Movement	62	0.39%
Hazardous Parking	25	0.16%
Following Too Closely	21	0.13%
Impeding Traffic	8	0.05%
Other Equipment	8	0.05%
Other	5	0.03%
Lights	3	0.02%
Other Than Driver or PED	1	0.01%
Brakes	1	0.01%

Source: Riverside Crossroads Database (2017 – 2022)

7.5 Vulnerable Users

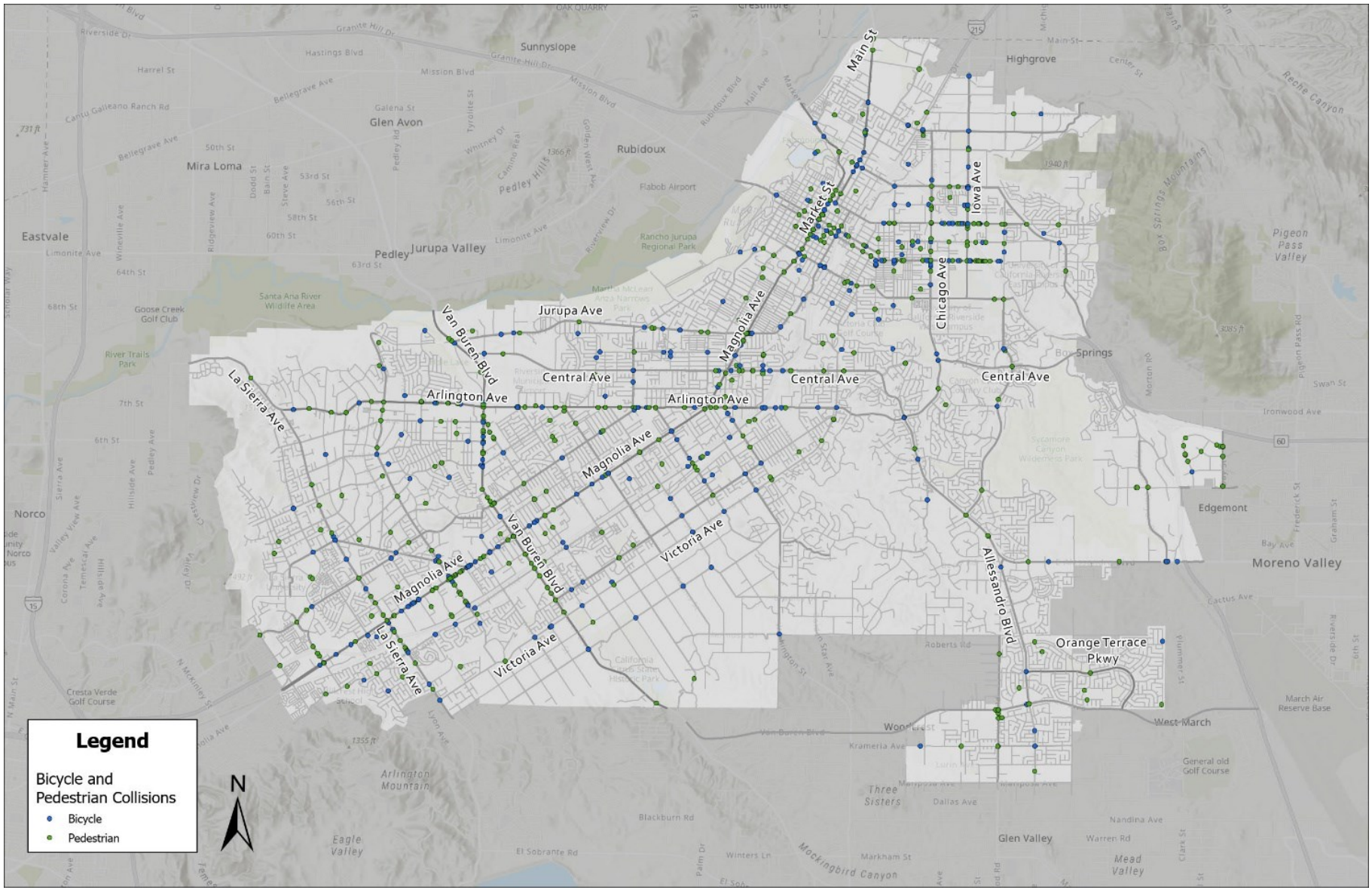
7.5.1 Pedestrian Collisions

509 pedestrian involved collisions occurred during the study period, resulting in 21 fatal collisions, 62 severe injuries, and 369 collisions with some form of reported injury or pain. **Figure 10** shows the locations of pedestrian collisions during the study period. This figure zoomed into each City ward is provided in Appendix A. The top 3 primary collision factors for these collisions were pedestrian violation (36.6%), pedestrian right-of-way violation (25.5%), and other improper driving (16.9%).

7.5.2 Bicycle Collisions

During the study period, 354 collisions involving bicycles were reported. Of these, 4 were fatal, 25 were severe injuries, and 277 were some forms of reported injury or pain. **Figure 10** shows the location of bicycle collisions during the study period. This figure zoomed into each City ward is provided in Appendix A. The top 3 primary collision factors for bicycle collisions were drivers/bicyclists on the wrong side of the road (29.7%), drivers/bicyclists ignoring traffic signals and signs (17.4%), and automobile right-of-way violations (14.7%).

Figure 10 – Pedestrian & Bicycle Collisions (2017-2022)



7.6 Nighttime Collisions

The following nighttime trends were observed:

- 38% of collisions occurred at night or during dusk/dawn hours.
- 4% of nighttime collisions involved pedestrians.
- 2% of nighttime collisions involved bicycles.

7.7 Other Significant Trends

In addition, the following trends were observed:

- 27% of collisions occurred at night or during the dusk/dawn hours.
- Drivers aged 16-20 were at fault in 15.7% of all collisions.
- Drivers aged 65+ were at fault in 12.8% of all collisions.

7.8 Statewide Comparison

A comparison of fatal & severe injury collision data to the State averages were conducted for data from 2016-2018 (the most recent statewide data available). These numbers may vary slightly from those mentioned previously, due to the differences in the years of the study period. The following are areas where Riverside's collision rates are higher or lower than those of the State. These numbers specifically compare the proportion of fatal and serious injury crashes that have the characteristics listed in **Table 5.**

Table 5: Comparison of Statewide and Riverside Fatal & Severe Injury Crashes (2016-2018)

Challenge Areas	Statewide		Riverside		
	F+SI Collisions (2016-2018)	% of F+SI Collisions (2016-2018)	F+SI Collisions (2016-2018)	% of F+SI Collisions (2016-2018)	% Point Difference
Total	**48,182**	**100.0%**	**383**	**100.0%**	**-**
Impaired Driving	11,318	23.5%	121	31.6%	8.1%
Young Drivers	5,873	12.2%	73	19.1%	6.9%
Aggressive Driving	15,997	33.2%	144	37.6%	4.4%
Improper Use of Occupant Protection	6,635	13.8%	54	14.1%	0.3%

Challenge Areas	Statewide		Riverside		
	F+SI Collisions (2016-2018)	% of F+SI Collisions (2016-2018)	F+SI Collisions (2016-2018)	% of F+SI Collisions (2016-2018)	% Point Difference
Lane Departure	20,232	42.0%	161	42.0%	0.0%
Bicyclists	3,491	7.2%	27	7.0%	-0.2%
Distracted Driving	2,253	4.7%	17	4.4%	-0.2%
Commercial Vehicles	3,153	6.5%	21	5.5%	-1.1%
Work Zones	623	1.3%	0	0.0%	-1.3%
Aging Drivers (65+)	6,337	13.2%	34	8.9%	-4.3%
Intersections	11,471	23.8%	45	11.7%	-12.1%
Pedestrians	9,303	19.3%	12	3.1%	-16.2%
Motorcyclists	10,446	21.7%	3	0.8%	-20.9%

7.9 Collision Network Screening Analysis Results

Figure 11 and **Figure 12** below show the results of the collision network screening analysis, with the number of collisions at both intersections and mid-block roadway segments. These figures zoomed into each City ward are provided in Appendix A.

Figure 11 – Collision Network Screening Analysis Results - Intersections (2017-2022)

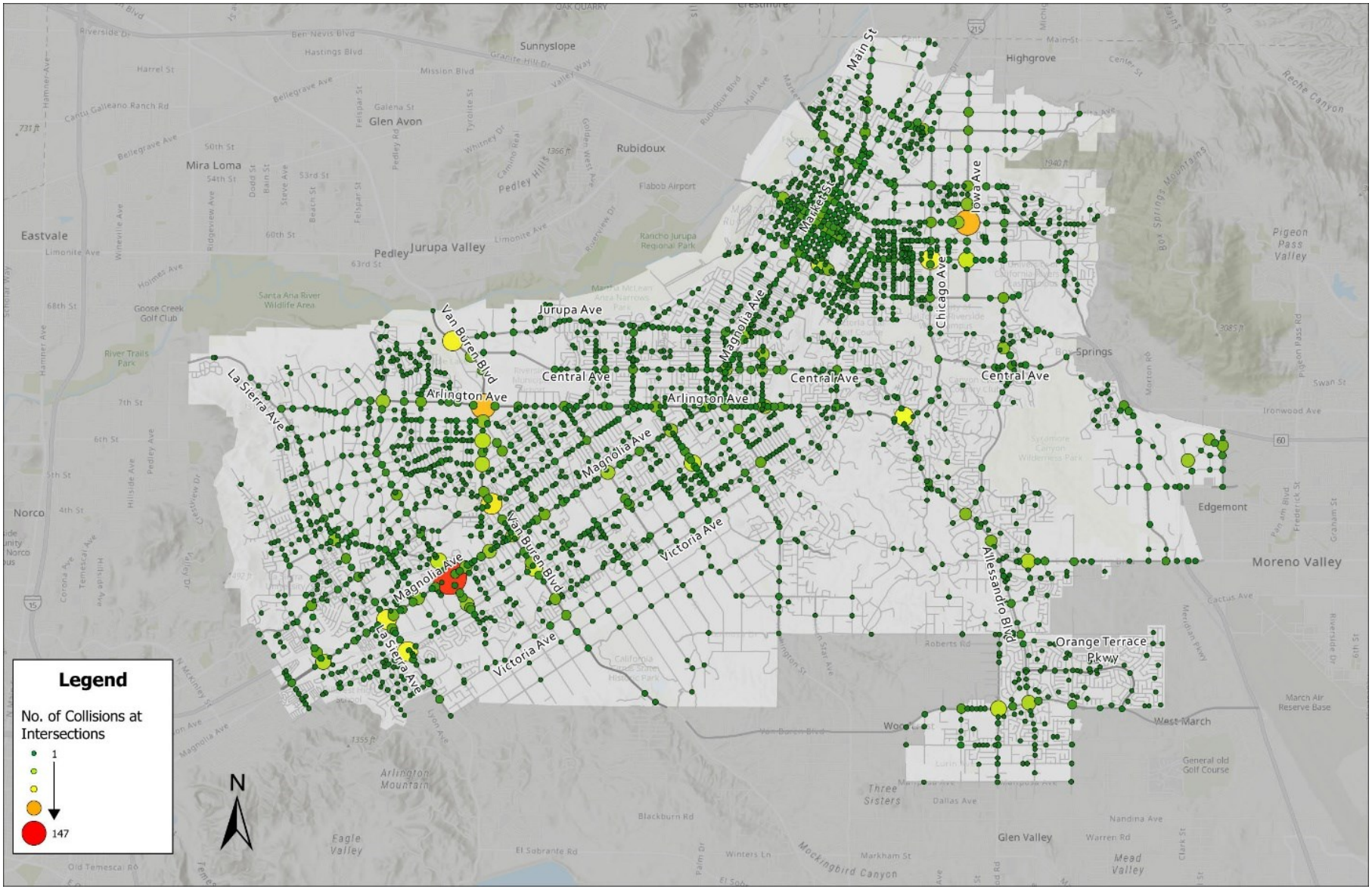


Figure 12 - Collision Network Screening Analysis Results – Mid-block Collisions (2017-2022)

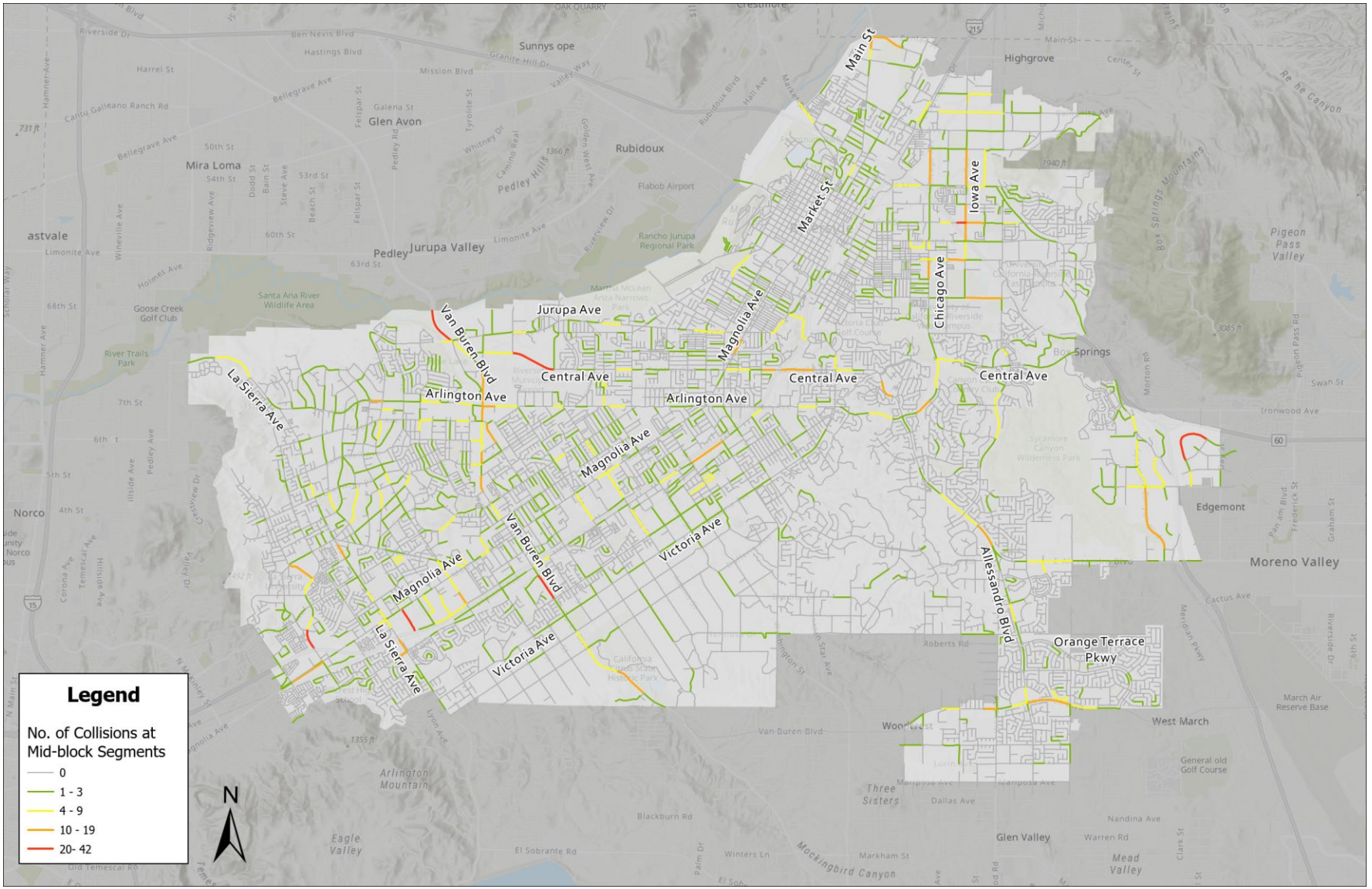


Table 6 and 7 show the number of crashes occurring at the top 20 locations in Riverside by crash type for the locations that will be studied further in the Report, and highlights locations in which the probability of those crash types exceeding the threshold proportion is greater than 33%.

The tables are ordered by the number of collisions that occurred at that segment or intersection. To be statistically significant, only locations where more than two collisions occurred are represented. At locations with two or less collisions, random chance can account for crash history as much or more than specific roadway characteristics.

The tables are separated into sub-sections visible by the blue gradient. The first two columns, Collisions and CCR, represent the level of crash activity in absolute terms, and as relative to other similar locations, respectively.

Per guidance from the Local Roadway Safety Manual (LRSM) each sub-population of locations was ranked according to the number of collisions. The second column shows the CCR, which highlights whether or not the collision activity was higher or lower than the average for the sub-population based on the individual segment or intersection volume. This volume was either collected through data count resources or calculated based on the roadway classification. All averages used in the CCR calculation were established based on City of Riverside crash data to determine what locations might be best to prioritize at the local level. This process highlights locations of collisions that are unusual for the City to determine Riverside's challenge areas, and not problems faced by peer cities that do not apply in Riverside. The remaining columns total collisions by type, to evaluate each sub-population and understand what proportion of crashes in the City are of a particular type. The citywide proportion was compared with the local intersection or segment specific proportion to determine which locations have more of a given crash type than would be expected when considering the City average. A confidence level of 95% was used for the CCR Calculations. For this study, two categories of ranges were highlighted:

- **Light Gray:** >50% probability that this crash type is over-represented on this segment/intersection as compared to other characteristically similar locations within the City of Riverside. Although these locations have a slightly higher probability of this crash type than their counterparts, they are not necessarily highly significant.
- **Dark Gray:** >75% probability that this crash type is over-represented on this segment/intersection as compared to other characteristically similar locations within the City of Riverside. These locations are highly significant in regard to the number of collisions occurring here and should be further investigated.

After this analysis was completed, the locations were ranked against other similar locations within the City by their categories according to the expected proportion of that crash type within Riverside. Locations with higher-than-expected crashes of that type were identified by the probability that random chance would not account for exceedances.

Additionally, it should be noted that the columns for Collision Severity, Type, Involved With, and Behavior are additional characteristics of the collisions and should not be counted as a separate collision.

The following provides an example of how to read **Tables 6 and 7.**

Table Definitions:

- Total Collisions: Number of collisions observed at the intersection or segment from July of 2017 through June of 2022.
- Severity: The number of severe injury and fatal collisions that occurred at this location in the study period.
- Fatality: The number of fatal collisions that occurred at this location in the study period.
- Broadside, Sideswipe, Rear-End, Head-On, Hit Object, Overturned, Other, Pedestrian, Bicycle: The number of these types of collisions that occurred at this location in the study period.
- Other: The number of miscellaneous collision types (mostly single vehicle) that occurred at this location in the study period.
- Aggressive, Dark, Wet: The number of the collisions with this factor identified as the cause of collision.

Table 6– Analysis Results: Intersections (Top 20 Per Type)

No.	Intersection	Ward	Crashes	Local CCR Differential[1]	EPDO[2]	Fatal	Serious Injury	Other Visible Injury	Complaint of Pain	PDO	Broadside	Sideswipe	Rear End	Head On	Hit Object	Overturned	Other	Pedestrian	Bicycle	Aggressive	Distracted	Impaired	Dark	Wet
Signalized Intersections																								
1	Tyler St & Magnolia Ave	6	147	0.76	1046	2	2	10	29	104	26	39	50	4	9	0	8	10	2	24	4	6	1	4
2	Iowa Ave & W Blaine St	1	105	0.74	776	1	2	7	22	73	21	25	34	7	11	0	2	4	2	22	2	6	3	2
3	Van Buren Blvd & Arlington Ave	3/6	103	0.29	1142	3	2	6	32	60	17	20	43	4	10	0	5	4	2	42	2	7	1	6
4	Van Buren Blvd & California Ave	5	84	0.33	592	0	2	6	24	52	24	19	27	2	6	0	2	4	2	32	1	8	0	2
5	Van Buren Blvd & Jurupa Ave	3	80	7.18	779	3	0	11	20	46	18	8	37	5	8	0	3	1	1	46	1	5	2	3
6	La Sierra Ave & Magnolia Ave	6	79	0.23	437	0	1	8	23	47	20	17	31	5	3	0	1	2	2	32	3	4	0	1
7	Chicago Ave & University Ave	2	79	0.29	367	0	1	5	15	58	16	14	31	3	6	0	2	5	1	22	0	4	1	2
8	La Sierra Ave & Indiana Ave	6	78	0.22	187	0	0	5	12	61	13	19	34	3	6	0	0	4	2	25	0	3	0	3
9	Alessandro Blvd & Chicago Ave	2	74	-0.03	870	0	4	3	22	45	11	22	29	2	8	0	2	0	2	33	2	8	0	5
10	Van Buren Blvd & Indiana Ave	5	66	0.21	365	1	0	3	21	41	13	13	34	1	3	0	0	1	0	32	1	2	0	2
11	Olivewood Ave & 14th St	1	64	2.72	515	0	2	8	9	45	17	18	18	2	5	0	2	2	2	21	3	5	0	5
12	Madison St & Indiana Ave	4	62	0.83	172	0	0	3	16	43	15	14	24	2	3	0	1	1	0	20	1	1	2	3
13	Iowa Ave & University Ave	2	62	0.19	301	0	1	2	11	48	12	15	21	0	5	1	4	3	1	12	2	3	0	0
14	Tyler St & Hole Ave	6	61	0.20	234	0	0	10	15	36	26	12	14	2	3	0	1	2	1	25	1	0	0	1
15	Wood Rd & Van Buren Blvd	4	59	0.02	694	1	2	8	13	35	5	18	17	5	3	2	3	5	1	19	1	3	0	5
16	Van Buren Blvd & Philbin Ave	6	58	0.23	183	0	0	5	15	38	19	12	16	3	1	0	1	5	1	21	1	3	1	3

No.	Intersection	Ward	Crashes	Local CCR Differential[1]	EPDO[2]	Fatal	Serious Injury	Other Visible Injury	Complaint of Pain	PDO	Broadside	Sideswipe	Rear End	Head On	Hit Object	Overturned	Other	Pedestrian	Bicycle	Aggressive	Distracted	Impaired	Dark	Wet
17	Pierce St & Magnolia Ave	7	56	4.75	229	0	0	10	15	31	15	6	22	2	9	0	1	1	3	23	4	6	0	3
18	Van Buren Blvd & Colorado Ave	6	55	4.65	214	0	0	7	18	30	16	9	20	3	5	0	1	1	3	25	0	5	1	3
19	Mission Grove Pkwy S & Alessandro Blvd	2/4	54	0.21	150	0	0	2	15	37	8	16	22	0	3	0	5	1	0	16	0	4	3	5
20	Cole Ave & Van Buren Blvd	4	53	0.17	216	0	0	11	11	31	11	14	15	5	4	0	2	2	1	19	1	6	1	5
Unsignalized Intersections																								
1	Shopping Center Driveway & Arlington Ave	3	49	0.55	317	1	0	6	9	33	3	10	27	1	7	0	1	0	2	21	0	3	0	3
2	Market St & 6th St	1	30	0.45	119	0	0	5	8	17	12	7	7	0	0	0	1	3	1	5	1	0	0	2
3	Adams St & Diana Ave	5	26	0.97	240	0	1	1	8	16	6	6	6	3	5	0	0	0	0	7	0	1	0	2
4	Jackson St & Audrey Ave	6	23	1.52	212	0	1	1	3	18	7	9	5	1	1	0	0	0	0	1	1	2	0	1
5	McMahon St & Arlington Ave	3	23	0.20	113	0	0	4	10	9	10	4	2	1	2	1	2	0	1	2	1	0	0	0
6	Jones Ave & Magnolia Ave	6	21	0.23	383	1	1	1	5	13	2	5	8	0	3	0	1	2	2	3	1	2	0	1
7	Pegasus Dr & Arlington Ave	3	21	0.25	111	0	0	4	10	7	12	3	1	2	2	1	0	0	0	2	0	1	0	0
8	Tyler St & Hemet St	6	20	0.09	214	0	1	1	4	14	4	6	7	0	1	0	0	2	1	3	0	1	0	0
9	Harold St & Arlington Ave	6	19	0.21	93	0	0	5	5	9	5	0	5	1	8	0	0	0	0	4	1	5	0	0
10	La Cadena Dr W & Primer St	1	18	0.19	58	0	0	2	4	12	4	6	2	0	4	0	1	1	0	3	0	1	0	2
11	Polk St & Collett Ave	6	17	0.18	77	0	0	2	8	7	9	1	5	1	0	0	0	1	1	10	1	0	1	1
12	Washington St & Lincoln Ave	4	17	0.24	211	0	1	0	6	10	11	3	1	1	0	0	0	1	1	7	1	1	0	0
13	Tyler St & Gould St	7	17	0.38	37	0	0	1	2	14	6	3	4	0	3	0	0	1	0	2	0	1	1	3
14	Lake St & Arlington Ave	7	17	0.16	72	0	0	3	5	9	5	4	3	2	0	0	2	1	1	1	1	0	0	0
15	Locust St & Mission Inn Ave	1	17	0.23	231	0	1	2	6	8	6	5	4	2	0	0	0	0	0	2	0	3	0	1
16	Mitchell Ave & Wells Ave	6	16	0.54	51	0	0	1	5	10	6	2	4	1	2	0	1	0	0	9	1	0	1	1

No.	Intersection	Ward	Crashes	Local CCR Differential[1]	EPDO[2]	Fatal	Serious Injury	Other Visible Injury	Complaint of Pain	PDO	Broadside	Sideswipe	Rear End	Head On	Hit Object	Overturned	Other	Pedestrian	Bicycle	Aggressive	Distracted	Impaired	Dark	Wet
17	Jones Ave & Arlington Ave	7	16	0.23	46	0	0	1	4	11	10	0	2	1	2	0	0	1	0	0	0	0	0	2
18	Washington St & Victoria Ave	3	15	0.22	208	0	1	2	2	10	5	2	4	0	4	0	0	0	1	7	0	1	0	0
19	Crowell Ave & Magnolia Ave	5	15	0.20	204	0	1	1	3	10	5	2	2	0	6	0	0	0	0	1	0	0	0	1
20	Palm Ave & Dewey Ave	3	15	0.49	70	0	0	3	5	7	10	3	2	0	0	0	0	0	1	4	1	0	0	1

1. Local Critical Crash Rate Differential

2. Equivalent Property Damage Only Crashes

= Local CCR Differential > 1.0

= Local CCR Differential 0.33-1.0

= Local CCR Differential < 0.33

= 90-100% probability that crash type if over-represented

= 80-90% probability that crash type is over-represented

= 70-80% probability that crash type is over-represented

Table 7 – Analysis Results: Segments (Top 20 Per Type)

No.	Facility	Limits	Ward	Crashes	Local CCR Differential[1]	EPDO[2]	*Fatal*	*Serious Injury*	*Other Visible Injury*	*Complaint of Pain*	*PDO*	Broadside	Sideswipe	Rear End	Head On	Hit Object	Overturned	Other	Pedestrian	Bicycle	Aggressive	Distracted	Impaired	Dark	Wet
Major Arterial																									
1	Van Buren Blvd	Jurupa Ave - Bradford St	7	**25**	0.69	80	0	0	1	9	15	0	7	13	0	4	0	0	1	0	12	0	1	0	1
2	Van Buren Blvd	Lincoln Ave - Indiana Ave	5	**24**	0.57	89	0	0	2	9	13	12	1	5	0	3	0	1	2	0	1	0	2	0	0
3	Mission Inn Ave	Redwood Dr to Scout Ln	1	**22**	0.03	598	1	2	2	11	16	1	3	11	5	11	1	0	0	1	8	0	3	11	3
4	Van Buren Blvd	Arlington Ave - Morris St	7	**14**	-0.07	217	0	1	3	2	8	1	3	3	1	5	0	1	0	1	3	0	1	0	1
5	Van Buren Blvd	Challen Ave - Duncan Ave	6	**14**	0.68	54	0	0	2	4	8	4	0	1	0	8	0	0	1	0	2	0	3	0	0
6	Van Buren Blvd	Wells Ave - Audrey Ave	6	**13**	0.81	58	0	0	2	5	6	2	4	4	0	2	0	1	0	1	5	0	1	0	0
7	Arlington Ave	Tyler St - Jones Ave	7	**11**	1.14	26	0	0	0	3	8	7	0	1	2	0	0	1	0	0	3	0	1	0	1
8	Arlington Ave	Pegasus Dr - Van Buren Blvd	7	**11**	0.85	358	0	2	1	2	6	2	2	6	1	0	0	0	0	0	3	0	1	0	1
9	Van Buren Blvd	Jackson St - Arlington Ave	7	**11**	0.46	205	0	1	1	4	5	3	1	2	2	2	0	0	1	0	3	1	1	0	1
10	Magnolia Ave	Buchanan St - Pierce St	7	**11**	0.04	537	0	3	2	3	3	2	1	4	1	3	0	0	0	0	4	0	0	0	0
11	Magnolia Ave	Elizabeth St - Merrill Ave	3	**10**	0.47	377	0	2	3	2	3	2	0	2	1	3	0	2	0	1	3	1	2	0	1
12	Arlington Ave	Decamp Ct - Jefferson St	5	**9**	0.28	39	0	0	1	4	4	2	0	2	0	4	0	0	1	0	2	0	0	0	0

No.	Facility	Limits	Ward	Crashes	Local CCR Differential[1]	EPDO[2]	*Fatal*	*Serious Injury*	*Other Visible Injury*	*Complaint of Pain*	*PDO*	Broadside	Sideswipe	Rear End	Head On	Hit Object	Overturned	Other	Pedestrian	Bicycle	Aggressive	Distracted	Impaired	Dark	Wet
13	Arlington Ave	Ben Lomand Way - Rutland Ave	7	**9**	0.17	33	0	0	2	1	6	0	4	3	0	0	0	1	1	1	1	0	1	0	0
14	Van Buren Blvd	Garfield St - California Ave	6	**9**	0.14	58	0	0	3	4	2	3	2	4	0	0	0	0	0	1	3	2	0	1	1
15	Van Buren Blvd	Ccshp Rd - Van Buren Blvd	5	**9**	-0.07	58	0	0	4	2	3	0	0	3	0	6	0	0	0	0	4	0	0	0	0
16	Market St	Rivera St - Santa Ana River Trail	1	**7**	-0.04	27	0	0	1	2	4	1	1	1	1	2	1	0	0	0	2	0	1	1	0
17	Magnolia Ave	La Sierra Ave - Castle Oak Dr	6	**7**	0.54	22	0	0	0	3	4	0	1	4	0	1	0	1	0	0	3	0	0	0	0
18	Van Buren Blvd	Van Buren Blvd - Cleveland Ave	5	**7**	0.05	7	0	0	0	0	7	0	0	1	0	6	0	0	0	0	0	0	1	0	1
19	Main St	Spruce St - Poplar St	1	**6**	0.57	180	1	0	0	2	3	1	3	1	0	0	0	1	0	1	0	0	0	0	0
20	Arlington Ave	Harold Ave - Copperlantern Dr	7	**6**	0.01	16	0	0	0	2	4	0	1	4	0	1	0	0	0	0	3	0	2	0	0
Minor Arterial																									
1	W Blaine St	Iowa Ave - I-215 NB Off-Ramp	1	**27**	5.12	96	0	0	4	6	17	10	3	4	4	4	0	0	2	1	3	1	0	0	2
2	Pierce St	Sh-91 - Pierce St	7	**25**	1.61	234	0	1	1	7	16	10	2	8	0	4	1	0	0	0	10	0	2	0	1
3	Central Ave	Fremont St - Wilderness Ave	3	**21**	1.29	298	1	0	8	7	5	2	2	4	0	12	0	1	0	0	6	0	2	1	0
4	University Ave	Iowa Ave - Cranford Ave	2	**18**	1.37	241	0	1	3	6	8	7	3	2	0	3	0	1	2	1	1	0	0	0	0

No.	Facility	Limits	Ward	Crashes	Local CCR Differential[1]	EPDO[2]	*Fatal*	*Serious Injury*	*Other Visible Injury*	*Complaint of Pain*	*PDO*	Broadside	Sideswipe	Rear End	Head On	Hit Object	Overturned	Other	Pedestrian	Bicycle	Aggressive	Distracted	Impaired	Dark	Wet
5	Central Ave	SR-91 EB Off-Ramp - Alleyway West of Rumsey Dr	3	**17**	0.31	53	0	0	0	7	10	3	5	3	1	3	0	0	2	0	4	1	1	0	0
6	Alessandro Blvd	Gloucester Way - Alessandro Blvd	3	**16**	0.62	229	1	0	4	2	9	1	3	3	0	9	0	0	0	0	5	0	3	0	5
7	Alessandro Blvd	Cannon Rd – Trautwein Dr (including Communications Center Dr)	4	**15**	0.02	233	0	1	3	5	6	1	0	5	0	7	0	0	2	0	4	0	3	0	1
8	Iowa Ave	Marlborough Ave - Spruce St	1	**13**	0.10	47	0	0	3	1	9	3	3	0	0	6	0	1	0	1	0	1	1	0	0
9	W Blaine St	Rustin Ave - Iowa Ave	1	**13**	0.86	58	0	0	2	5	6	2	3	3	0	1	0	1	3	1	3	0	1	0	0
10	Chicago Ave	University Ave - 12th St	2	**13**	0.96	206	0	1	2	2	8	4	3	1	2	1	0	1	1	0	1	0	0	0	1
11	Tyler St	SR-91 WB Off-Ramp - Hemet St	6	**13**	0.53	18	0	0	0	1	12	2	4	6	0	0	0	0	2	0	3	0	0	0	0
12	Chicago Ave	Marlborough Ave - Spruce St	1	**12**	0.60	47	0	0	1	5	6	4	4	2	0	2	0	0	0	1	3	0	0	0	0
13	Iowa Ave	Massachusetts Ave - W Blaine St	1	**12**	0.63	37	0	0	1	3	8	4	3	3	0	1	0	0	1	0	2	0	1	0	0
14	Central Ave	SR-91 WB Off-Ramp - Riverside Ave	3	**12**	1.15	61	0	0	3	4	5	5	4	2	0	1	0	0	0	1	1	0	0	0	0
15	Iowa Ave	W Blaine St - W Linden St	1/2	**11**	0.66	56	0	0	2	5	4	5	2	2	0	1	0	0	1	0	1	0	2	0	0
16	La Sierra Ave	Schuyler Ave - Whitford Ave	7	**11**	0.91	209	0	1	2	3	5	4	1	3	2	1	0	0	0	0	2	0	0	1	0

No.	Facility	Limits	Ward	Crashes	Local CCR Differential[1]	EPDO[2]	*Fatal*	*Serious Injury*	*Other Visible Injury*	*Complaint of Pain*	*PDO*	Broadside	Sideswipe	Rear End	Head On	Hit Object	Overturned	Other	Pedestrian	Bicycle	Aggressive	Distracted	Impaired	Dark	Wet
17	Van Buren Blvd	Prairie Way - Wood Rd	4	**11**	0.34	21	0	0	0	2	9	1	3	6	0	0	0	0	0	0	8	0	0	0	0
18	Martin Luther King B	Canyon Crest Dr - Iowa Ave	2	**10**	0.00	199	1	0	1	3	5	1	2	5	0	1	0	0	1	0	6	1	0	0	0
19	Chicago Ave	Chicago Ave - Keswick Ave	3	**10**	0.40	74	0	0	4	5	1	0	2	5	1	2	0	0	0	0	3	2	0	0	1
20	Sycamore Canyon Blvd	Motorfair Dr - Eastridge Ave	2	**10**	-0.06	40	0	0	2	2	6	0	0	3	0	6	1	0	0	0	3	1	1	0	2
Collector																									
1	Indiana Ave	La Sierra Ave - Wickham Dr	6	**15**	4.94	70	0	0	2	7	6	9	4	2	0	0	0	0	0	0	1	0	0	0	0
2	Indiana Ave	Washington St - Madison St	4	**13**	0.29	226	0	1	3	4	5	5	2	2	1	1	0	1	1	2	1	2	0	0	0
3	Jackson St	Audrey Ave - Colony Pl	6	**11**	2.27	26	0	0	1	1	9	2	3	2	2	0	0	1	3	0	0	0	0	0	0
4	Cypress Ave	Montgomery St - Warren St	6	**9**	2.02	19	0	0	1	0	8	3	4	1	1	0	0	0	0	0	1	0	1	0	0
5	Panorama Rd	Rockhill Way - Olivewood Ave	2/3	**7**	0.56	22	0	0	1	1	5	3	1	1	1	1	0	0	0	0	0	0	1	1	0
6	Cypress Ave	Challen Ave - Rutland Ave	6	**7**	2.32	185	0	1	1	1	4	1	2	2	0	2	0	0	0	0	1	0	1	0	0
7	Palm Ave	Pine St - Beechwood Pl	1	**6**	0.33	25	0	0	2	0	4	0	0	1	0	5	0	0	0	0	0	2	1	0	1
8	Indiana Ave	Verde St - Jefferson St	4	**6**	0.20	45	0	0	4	0	2	0	3	0	2	1	0	0	0	0	1	0	0	0	0
9	Indiana Ave	Gibson St - Van Buren Blvd	5	**6**	1.04	184	0	1	1	1	3	0	1	3	0	1	0	0	1	0	1	0	1	0	0

No.	Facility	Limits	Ward	Crashes	Local CCR Differential[1]	EPDO[2]	*Fatal*	*Serious Injury*	*Other Visible Injury*	*Complaint of Pain*	*PDO*	Broadside	Sideswipe	Rear End	Head On	Hit Object	Overturned	Other	Pedestrian	Bicycle	Aggressive	Distracted	Impaired	Dark	Wet
10	Box Springs Blvd	Lochmoor Dr - Box Springs Blvd	2	**5**	0.86	20	0	0	1	1	3	0	0	3	0	2	0	0	0	0	2	0	0	0	0
11	Rutland Ave	Trey Ave - Cypress Ave	6	**5**	1.48	20	0	0	1	1	3	0	1	1	1	2	0	0	0	0	1	0	0	1	0
12	Philbin Ave	Van Buren Blvd - Harold St	6	**5**	1.58	20	0	0	1	1	3	0	3	1	0	0	0	0	0	0	1	0	0	0	0
13	Harrison St	Magnolia Ave - County Farm Rd	6	**5**	0.84	25	0	0	0	4	1	3	0	0	0	2	0	0	0	0	2	0	0	0	1
14	Victoria Ave	Rumsey Dr - Central Ave	3	**4**	0.42	14	0	0	0	2	2	0	1	1	0	2	0	0	0	0	0	0	1	0	0
15	Indiana Ave	Alleyway South of Arlington Ave - Jane St	3	**4**	0.91	28	0	0	2	1	1	1	0	2	0	1	0	0	0	0	2	1	0	0	0
16	Wells Ave	Van Buren Blvd - Harold St	6	**4**	0.57	9	0	0	0	1	3	1	1	2	0	0	0	0	0	0	0	1	0	0	1
17	Wells Ave	Crest Ave - Halsey Pl	6	**4**	0.85	168	0	1	0	0	3	0	1	0	0	2	0	1	0	1	0	0	0	0	0
18	Monroe St	Diana Ave - Magnolia Ave	5	**4**	-0.12	19	0	0	1	1	2	0	0	3	0	1	0	0	0	0	1	0	2	0	0
19	Orange St	Hiawatha Pl - 1st St	1	**3**	0.28	3	0	0	0	0	3	1	2	0	0	0	0	0	0	0	0	0	0	0	0
20	Jefferson St	Willow Ave - California Ave	5	**3**	0.18	3	0	0	0	0	3	0	0	1	0	2	0	0	0	0	1	0	0	0	1
Local																									
1	Canyon Springs Pkwy W	Corporate Centre Pl - Canyon Springs Pkwy E	2	**42**	63.98	345	0	1	6	16	19	20	7	2	0	4	0	4	5	0	0	2	0	1	1
2	Park Sierra Dr	Diana Ave - Magnolia Ave	6	**21**	18.92	250	0	1	2	9	9	14	1	2	1	2	0	1	0	0	1	0	1	0	2

No.	Facility	Limits	Ward	Crashes	Local CCR Differential[1]	EPDO[2]	*Fatal*	*Serious Injury*	*Other Visible Injury*	*Complaint of Pain*	*PDO*	Broadside	Sideswipe	Rear End	Head On	Hit Object	Overturned	Other	Pedestrian	Bicycle	Aggressive	Distracted	Impaired	Dark	Wet
3	Placentia Ln	Leland Pl - N Main St	1	**19**	8.44	569	0	3	4	4	8	6	3	3	3	3	0	0	1	0	4	0	1	2	2
4	Sierra Vista Ave	Pierce St - Riverwalk Pkwy	7	**15**	2.76	204	0	1	1	3	10	1	6	1	1	4	1	0	1	0	2	1	1	1	1
5	Loma Vista St	West Linden St W - West Linden St E	2	**9**	6.31	24	0	0	1	1	7	1	4	0	0	1	0	2	1	1	0	0	0	0	0
6	Eastridge Ave	Sycamore Canyon Blvd - Box Springs Blvd	2	**9**	0.56	43	0	0	3	1	5	3	0	2	0	4	0	0	0	0	2	0	2	0	0
7	La Cadena Dr W	Bowman St - Interchange Dr	1	**8**	5.68	28	0	0	1	2	5	5	0	1	1	1	0	0	0	0	0	0	0	1	0
8	Palmyrita Ave	Iowa Ave - Ardmore St	1	**7**	3.17	26	0	0	2	0	5	2	1	1	0	2	0	1	0	0	1	0	1	1	0
9	Banbury Dr	Allenby St - Diana Ave	6	**7**	2.73	22	0	0	1	1	5	0	1	3	2	0	0	1	0	0	0	0	0	0	0
10	Valley Springs Pkwy	Eucalyptus Ave - Gateway Dr	2	**6**	6.83	16	0	0	0	2	4	1	1	3	0	1	0	0	0	0	3	0	0	0	0
11	Riverwalk Pkwy	Sierra Vista Ave - Raley Dr	7	**6**	-0.10	45	0	0	3	2	1	0	1	1	1	3	0	0	0	0	2	0	2	0	0
12	Citrus St	Iowa Ave - Building Driveway	1	**5**	2.13	5	0	0	0	0	5	0	0	0	0	5	0	0	0	0	1	0	1	0	0
13	Palmyrita Ave	Prospect Ave - Iowa Ave	1	**5**	1.85	25	0	0	1	2	2	2	0	0	0	3	0	0	0	0	1	0	0	0	0
14	Box Springs Blvd	River Crest Dr - Eastridge Ave	2	**5**	2.05	20	0	0	1	1	3	1	2	1	0	1	0	0	0	0	0	0	0	0	1
15	Emerald St	Madison St - Grace St	4	**5**	23.30	5	0	0	0	0	5	0	5	0	0	0	0	0	0	0	0	0	0	0	0
16	Bushnell Ave	Mitchell Ave - Cameo Ct	7	**5**	3.86	20	0	0	1	1	3	2	0	0	0	3	0	0	0	0	1	0	1	0	1

No.	Facility	Limits	Ward	Crashes	Local CCR Differential[1]	EPDO[2]	*Fatal*	*Serious Injury*	*Other Visible Injury*	*Complaint of Pain*	*PDO*	Broadside	Sideswipe	Rear End	Head On	Hit Object	Overturned	Other	Pedestrian	Bicycle	Aggressive	Distracted	Impaired	Dark	Wet
17	Jones Ave	Wells Ave - Hedrick Ave	7	**5**	3.77	25	0	0	1	2	2	3	0	1	0	1	0	0	0	0	0	0	1	0	0
18	Northrop Dr	Mission Village Dr - E Alessandro Blvd	2/4	**5**	2.37	5	0	0	0	0	5	1	2	1	1	0	0	0	0	0	0	0	0	1	0
19	Lively St	Hines Ave - Hines Ave	6	**5**	3.76	5	0	0	0	0	5	3	2	0	0	0	0	0	0	0	1	0	0	0	1
20	Diana Ave	Tyler St - Banbury Dr	6	**5**	4.12	20	0	0	1	1	3	2	0	2	1	0	0	0	0	0	1	0	0	0	0

1. Local Critical Crash Rate Differential
2. Equivalent Property Damage Only Crashes

= Local CCR Differential > 1.0

= Local CCR Differential 0.33-1.0

= Local CCR Differential < 0.33

= 90-100% probability that crash type if over-represented

= 80-90% probability that crash type is over-represented

= 70-80% probability that crash type is over-represented

8. Best Practices Evaluation and Emphasis Areas

8.1 Best Practices Evaluation

Table 8 identifies existing plans and policies that were recently completed, or are planned, or on-going within the City of Riverside. The intent of this review is to provide an idea of the types of strategies in place or encouraged by the City that may impact the safety analysis process. It will also identify opportunity areas where the City could adopt non-infrastructure countermeasures. This table also ties each topic and enhancement to the emphasis areas that are laid out in **Section 8.2.**

Table 8 – Summary of Program, Policies, and Practices

Topic	Initiatives/ Current Status	Opportunities for Implementation or Enhancement
COMMITTEES / ROLES		
Does the City have an Active Transportation Coordinator?	Yes, role is outlined in the Active Transportation Plan (part of the PACT)	Continue Active Transportation Coordinator role; Plan to maintain the role through personnel changes
Does the City have a Safety or Active Transportation Advisory Committee?	City has a Transportation Board Committee	Continue to have board committee meeting to discuss roadway and transportation safety issues and efforts
Does the City have an Active Transportation Safety Education Program?	Yes, the Riverside Police Department (RPD) conducts a monthly Bicycle and Pedestrian Safety Operations training program funded by California Office of Traffic Safety.	Continue education efforts led by RPD
POLICY / PLANS		
Does the City have a Complete Streets Plan?	Yes, the City of Riverside PACT includes a Complete Streets Ordinance	Regularly update Complete Streets Ordinance; Continue to plan for complete streets improvements as part of regular planning process
Does the City assess Traffic Impact Fees?	City currently assesses impact fees	Continue to assess Traffic Impact Fees and apply funding to transportation improvements
Does the City have a Safe Routes to School program?	No, however the City did apply and implement SRTS grants, most recently ATP Cycle VI	Implement a Safe Routes to School program with funding, utilize collision analyses to refocus efforts
Does the City implement Traffic Calming Policies?	The City installs mini roundabouts, bulbs, road diets, changes in road texture	Continue to implement traffic calming policies where necessary

Does the City regularly conduct Speed Surveys?	Yes, updated once every seven years.	Continue to update as required by California Vehicle Code; review
Does the City utilized Warrants for Stop Signs and Signals?	Yes	Continue to utilize warrants for stop signs and signals
Is the City planning for Density and Walkable Areas?	Planned as part of Active Transportation Plan (ATP). The City has also recently adopted a Housing Element.	Continue to plan for walkable areas; utilize collision analysis to refocus efforts
Does the City have Transportation Demand Management (TDM) or Vehicle Miles Travelled (VMT) Reduction policies?	The City is working on a VMT Mitigation program. However, there are existing programs – RTA Bus Pass Option, County of Riverside VMT Mitigation options, and CAPCOA 2021 Handbook. The City requires developers to meet VMT requirements outlined in the TIA guidelines.	Continue to expand efforts to align TDM and VMT reduction policies with state guidelines
Does the City perform Traffic Crash Monitoring?	Yes, the City has the CrossRoads software and conducts Traffic Crash Monitoring to address traffic safety concerns from the public. Spot monitoring is not a citywide evaluation.	Continue to utilize Crossroads database for spot monitoring; complete citywide monitor on regular basis
Does the City have an Active Transportation Master Plan?	Yes, the City of Riverside PACT includes an Active Transportation Plan.	Continue to implement Active Transportation Plan
Does the City have CAMUTCD-compliant Pedestrian Signal Timing?	Yes, all City traffic signals have CAMUTCD-compliant pedestrian signal timing.	Continue to update pedestrian signal timing as new standards are developed. Explore the implementation of bicycle signal timing and bicycle detection at key locations.
Does the City implement Crosswalks at high pedestrian locations?	Yes	Continue to implement these improvements where feasible; keep updated with best practices regarding pedestrian improvements
What type of traffic enforcement does the City conduct?	Speeding, stop violations, parking violations, red light, failure to yield to pedestrians, commercial vehicle weight limit and axle restriction violations, and other routine traffic enforcement.	Continue to enforce traffic laws at key locations; Apply for OTS funding to expand enforcement activities
What is the City's Bicycle Policy?	City has a Bicycle Master Plan and Bicycle Program	Continue to implement and update Bicycle Master Plan and Program; Utilize collision analysis to refocus efforts if needed
What types of transit does the City have?	Riverside Transit Authority (bus), Metrolink (rail)	Identify areas of high transit usage and focus collision analysis efforts at these locations

What types of wayfinding does the City have?	City has traditional wayfinding signs	Identify areas where wayfinding can be expanded, including pedestrian and destination wayfinding
DATA COLLECTION / INVENTORY		
Does the City have an Inventory of Pedestrian Signs and Signals?	The City has an inventory of signals, flashing beacons, and HAWK signals. We have an inventory of pedestrian signs.	Continue to take inventory of these signals as they are updated/installed; Incorporate inventory into GIS database
Does the City have an Inventory/Mapping of Active Transportation Routes?	Yes, we have a trail master plan in the PACT document.	Continue to update inventory as active transportation routes are expanded; Incorporate into GIS database
Does the City utilize Crossroads Database for collisions?	City utilizes Crossroads database	Continue to utilize Crossroads database and regularly update
Does the City have Active Transportation Volume Counting?	We have traffic count data for spot intersections that have been counted and from traffic studies.	Continue to update database of volumes; Incorporate into GIS database
COORDINATION / FEEDBACK		
What ways can citizens give feedback about roadway safety?	Citizens can make requests online or by calling 311. Citizens give feedback via surveys, emails, meetings, etc.	Continue to expand ways that citizens can give feedback. Incorporate requests into GIS maps to show hotspots for requests.
What types of Coordination with other City organization does your department perform?	Riverside Police Department, Riverside Unified School District, Riverside Public Utilities, Riverside Fire Department, Riverside Parks & Rec, Riverside Public Health, Transportation Board	Continue to engage across departments and organizations; continue to involve these organizations in collision analysis and countermeasure development process
What types of School Engagement does the City perform?	City has quarterly meetings with the school districts and UCR. City has used OTS grant funding for Safety Education events at elementary schools.	Continue school engagement processes
What types of Law Enforcement/Emergency Service Engagement does the City perform?	The City has its own Police & Fire Departments. Staff member from RPD coordinates safety outreach programs	Continue to engage law enforcement and fire department in roadway safety planning

8.2 Emphasis Areas

Emphasis areas represent crash factors that are common in the City and provide the opportunity to reduce the largest number of traffic injuries with strategic investment. Emphasis areas were developed by revisiting the vision and goals of this planning process and comparing them with the trends and patterns identified in the crash analysis.

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

Description: Pedestrians and bicyclists are classified by Caltrans as vulnerable users, meaning they possess the highest potential for severe harm during a crash. This emphasis area is inclusive of wheelchairs and those on scooters and skateboards. These groups need appropriate infrastructure to travel to key destinations such as schools, workplaces, and core commercial areas. Of the 863 crashes involving vulnerable road users, 25 resulted in a fatal injury and 87 resulted in a severe injury. The City should aim to implement countermeasures to further protect these users from injury.

Goals for Emphasis Area #1:

- Improve active transportation infrastructure by adding pedestrian facilities, bike lanes, and other amenities to make it safer for employees and community members to get to key destinations such as school, commercial centers, transit centers, and recreation areas
- Encourage healthier lifestyles through active transportation infrastructure
- Apply for HSIP, ATP, SS4A, and other funding to implement countermeasures to address vulnerable road user crashes

Strategies for Emphasis Area #1:

- Provide outreach, education, and enforcement to encourage more separation between vehicular and pedestrian traffic
- Install high-visibility crosswalk markings at the intersection of key destinations
- Ensure all signalized intersections have completed crosswalks
- Provide dedicated pedestrian and bicycle infrastructure to and from bus stops
- Install adequate street lighting and increase lighting levels in conflict areas
- Widen street shoulders
- Provide signage (e.g., pedestrian crossing ahead) to help drivers expect to slow down for pedestrians and bikes
- Install bicycle lanes along key corridors
- Install bicycle storage facilities in public areas, such as parks and schools, to encourage bicycle use
- Install bicycle markings (including green paint in conflict zones)
- Install bicycle detection with discrimination capability on key corridors

- Install curb extensions
- Install ADA ramps
- Modify signal phasing to implement a Leading Pedestrian Interval (LPI)
- Install/upgrade pedestrian crossing at uncontrolled locations
- Install audible pedestrian push button systems at signalized intersections
- Establish rotating enforcement targets for high visibility campaigns
- Work closer with local advocacy groups and bicycle clubs (such as the Inland Empire Biking Alliance and Riverside Bicycle Club) to assist in prioritizing bicycle improvements
- Work with rail operators to improve safety at rail crossings

These strategies will be implemented by the City, law enforcement, and community organizations. Funding sources for these strategies may include OTS, NHTSA, and SB1 grant programs.

8.2.1 Emphasis Area #2: Impaired Driving

Description: Impaired driving crashes are a high priority challenge area within the Caltrans SHSP. Caltrans defines these as crashes where any evidence of drug or alcohol use by the driver is present, even if the driver was not over the legal limit. 7.4% were reported as the driver being under the influence of alcohol or drugs. 6.74% of all fatalities and 14.07% of all severe injuries were attributable to impaired driving.

Goal for Emphasis Area #2:

- Reduce the number of crashes attributed to impaired driving
- Identify hot spots and priority corridors for countermeasures to reduce impaired driving
- Apply for funding to implement countermeasures to reduce impaired driving crashes

Strategies for Emphasis Area #2:

- Authorize, publicize, and conduct sobriety checkpoints programs
- Implement an impaired driving education campaign
- Develop educational programs targeting specific audiences based on age group
- Additional enforcement presence
- Create effective media campaigns in both visual and print media

These strategies will be implemented by the City, law enforcement, and community organizations. Funding sources for these strategies may include OTS, NHTSA, and SB1 grant programs.

8.2.2 Emphasis Area #3: Intersection Improvements

Description: Collisions involved at intersections, interchanges, and other roadway access. About 82% of total of collisions took place at or near intersections. 12.1% of the fatal and severe injury collisions in Riverside took place at or near intersections, compared to 23.8% statewide.

Goal for Emphasis Area #3:

- Reduce the number of crashes at intersections, interchanges, and other roadway access.
- Identify hot spots and prioritize locations for intersection improvements.
- Apply for funding and implement countermeasures to address collisions at intersections for improvement.

Strategies for Emphasis Area #3:

- Engineering improvements are not limited but could include:
    - backplates with reflective borders
    - left-and right turn lanes at two-way controlled intersections
    - protected left-turn movements
    - battery back-up systems
    - intersection safety lighting
    - high visibility crosswalks
- Collaborate with Caltrans to prioritize safety at interchanges and promote walking and bicycling

These strategies can be implemented by the City with assistance from emergency services and community organizations. Funding sources for these strategies may include HSIP, OTS, and SB1 grant programs.

8.2.3 Emphasis Area #4: Aggressive Driving

Description: Aggressive driving, as defined by the Caltrans SHSP, includes several behaviors including speeding, tailgating, and ignoring traffic signals and signs. Aggressive driving behaviors (unsafe speed or following too closely) accounted for 30 percent of collisions. 16 percent of these collisions resulted in a fatality, 28 percent of these collisions resulted in a severe injury, and 9 percent of these collisions resulted in some other form of injury.

Goal for Emphasis Area #4:

- Reduce the number of crashes due to aggressive driving in the City
- Identify hot spots and priority corridors for aggressive driving
- Apply for funding and implement countermeasures to address aggressive driving

Strategies for Emphasis Area #4:

- Educational campaign to target aggressive drivers

- Increased law enforcement presence near aggressive driving hotspots
- Increased coordination with law enforcement and other community organizations
- Engineering strategies such as:
    - Dynamic speed feedback signs
    - Temporary speed radar trailers

These strategies will be implemented by the City, while partnering with Caltrans, Southern California Association of Governments (SCAG), California Highway Patrol (CHP), and other community partners. Funding sources for these strategies may include HSIP, Active Transportation Program (ATP), OTS, SB 1, and SS4A grant programs.

9. Countermeasure Toolbox

This section provides information on general identified issues, crash reduction factors, improvements, and countermeasures identified for the City of Riverside, as well as for specific project locations identified as part of this analysis. Countermeasures for each of the Safety Project Case Studies are based on data analysis, stakeholder input, and site visits.

9.1 Infrastructure Improvements

9.1.1 Countermeasure Selection Process

Part D of the HSM provides information on Crash Modification Factors (CMF) for roadway segments, intersections, interchanges, special facilities, and road networks. CMFs are used to estimate the safety effects of highway improvements, specifically to compare and select highway safety improvements. A CMF less than 1.0 indicates that a treatment has the potential to reduce crashes. A CMF greater than 1.0 indicates that a treatment has the potential to increase crashes. A Crash Reduction Factor (CRF) is directly connected to the CMF and is "mathematically defined as (1 – CMF) (the higher the CRF, the greater the expected reduction in crashes)[5]." CMFs can help decision makers weigh potential alternative projects, but are only one measure of a project's value and should be considered part of a larger decision making process. Furthermore, it is important to note that not all CMFs are as reliable as others. The FHWA maintains a federal depository of CMFs and includes a star rating system to help users determine which CMFs are bolstered by the best and most thorough research. Key factors to consider when applying CMFs include:

1. Selection of an appropriate CMF;
2. Estimation of crashes without treatment;
3. Application of CMFs by type and severity; and,
4. Estimation of the combined effect for multiple treatments.

Examples of Safety Countermeasures can be found through several sources. This Report utilizes the countermeasures found in the California LRSM and the CMF Clearinghouse (CMF CH) website. Countermeasures for each of the Safety Project Case Studies are based on the data analysis and site visits. Additional countermeasures were identified for the high-level issues on a city-wide level and are discussed in **Section 9.2.**

[5] Local Roadway Safety Manual (Version 1.6) 2022. Page 27.

9.1.2 Safety Project Case Studies

From the city-wide analysis, twelve (12) project case study locations were selected for further evaluation and countermeasure development. For each of these locations, Safety Project Case Studies were developed to provide a balanced understanding of common safety patterns at a variety of location types that can be used to associate countermeasures with specific roadway configurations and conditions. These locations were identified through the analysis process based on their crash histories, stakeholder engagement, the observed crash patterns, and their different characteristics to provide the most insight into potential systemic safety countermeasures that the City can employ to achieve the most cost-effective safety benefits.

A Safety Project Case Study was developed for each of the following locations:

1. Signalized Intersection: Market St & 6th St
2. Roadway Segment: Mission Inn Ave – Redwood Dr to Bridge
3. Roadway Segment: Main St – Spruce St to Poplar St
4. Signalized Intersection: 14th St & Olivewood Ave
5. Unsignalized Intersection: Victoria Ave & Lincoln Ave
6. Unsignalized Intersection: Washington St & Lincoln Ave
7. Signalized Intersection: Van Buren Boulevard & Wood Rd
8. Unsignalized Intersection: Tyler St & Hemet St
9. Signalized Intersection: Tyler St & Magnolia Ave
10. Signalized Intersection: Van Buren Blvd & Arlington Ave
11. Signalized Intersection: Van Buren Blvd & Jurupa Ave
12. Roadway Segment: Central Ave – Fremont St to Wilderness Ave

The following pages summarize conditions at each location, and potentially beneficial countermeasures. Countermeasures were subjected to a benefit/cost assessment and scored according to their potential return on investment. These case studies can be used to select the most appropriate countermeasure, and to potentially phase improvements over the longer-term. The potential benefit of these countermeasures at locations with similar design characteristics can then be extrapolated regardless of crash history, allowing for proactive safety enhancements that can prevent future safety challenges from developing. These case study sheets can also be used to position the City for future grant funding opportunities. The monetary benefits are calculated from the latest Caltrans injury level cost data[6]. Fatal and severe injury collisions are estimated at $2.46 million, Other Visible Injury collisions at $159,900, Complaint of Pain collision at $90,900, and Property Damage Only collisions at $14,900.

[6] Local Roadway Safety Manual (Version 1.6) 2022. Page 97.

Case Study Sheet: Location #1

Project Name: Riverside LRSP
Agency Name: City of Riverside
Contact Name: Brett Craig, PE, TE, Senior Traffic Engineer
Email: bcraig@riversideca.gov

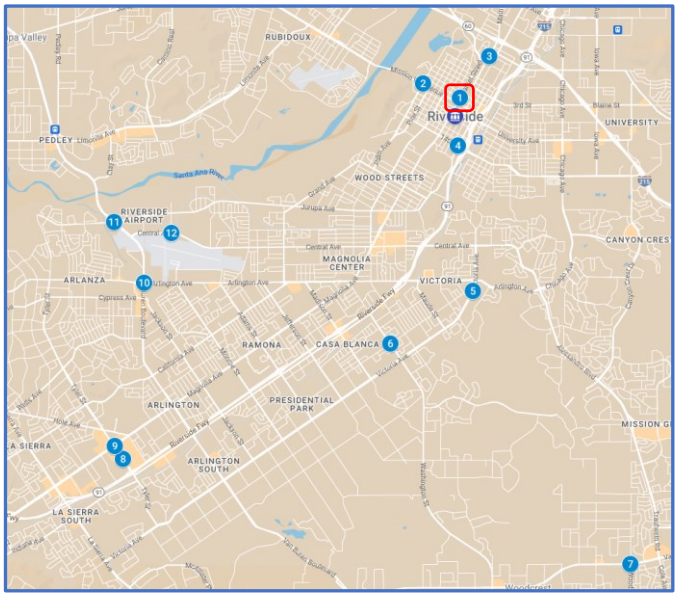
Prepared by: Kimley-Horn
Checked by: Jason Melchor, PE
Date: October 2022

HAWK SIGNAL INTERSECTION

Project Location, Description & Maps

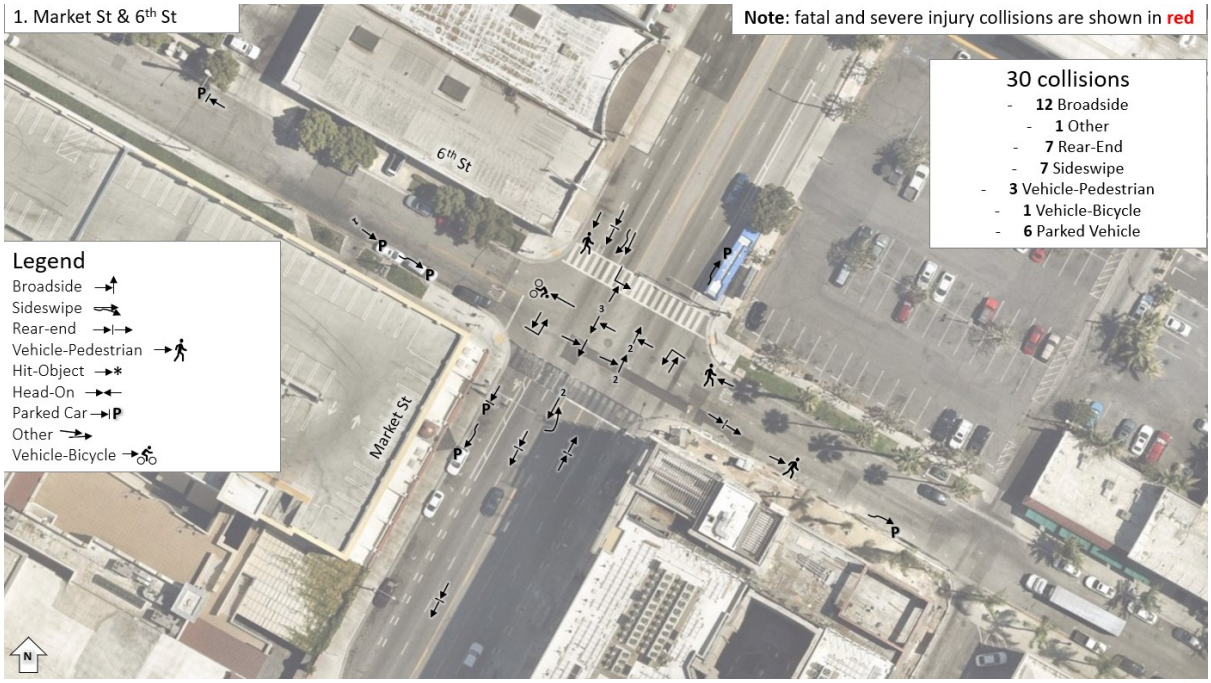
Intersection: Market St & 6th St

Example of Similar Intersections: Market St & 11th St, Brockton Ave & 12th St



1. Market St & 6th St

Note: fatal and severe injury collisions are shown in **red**



Kimley»Horn

Case Study Sheet: Location #1

Project Location, Description & Maps

Collision Data	
Total Collisions	30
Fatal and Severe Injury Collisions	0
Top 3 Collision Types (%)	Broadside (40%) Sideswipe (23%) Rear-End (23%)
Dark Collisions	11
Impaired Collisions	0

Collision Data	
Number of Approaches	4
Total Entering Vehicles	25,524
Crosswalk Condition	Good
Control Type	Hawk Signal
Lighting	Well Lit
Highest Posted Speed Limit	35

Collisions Involved With		
Vehicular	**Pedestrian**	**Bicycle**
26	3	1

Field Visit Notes

- HAWK signal present
- Lots of construction going on nearby
- Several pedestrian collisions here

Countermeasure Evaluation

Potential Countermeasures	Crash Reduction Factor (LRSM/CMF ID)	20 Year Safety Benefit	Total 20-Year Costs	Safety Related B/C Ratio
Install signals	30% (NS03)	$475,440	$378,000	1.26
Install high visibility crosswalks on N/S crosswalks	25% (NS20PB)	$111,600	$34,800	3.21
Install green bicycle paint in conflict zones	35% (R32PB)	$156,240	$29,184	5.35

Countermeasure Evaluation (continued)

Potential Countermeasures	Crash Reduction Factor (LRSM/CMF ID)	20 Year Safety Benefit	Total 20-Year Costs	Safety Related B/C Ratio
Improve signal hardware; lenses, back plate with retroreflective borders, mounting, size, and number	15% (S02)	$237,720	$26,400	9.00
Install dynamic speed feedback signs	30% (R26)	$475,440	$45,600	10.43
Install audible pedestrian push button systems	25% (S17PB)	$111,600	$11,000	10.15

Case Study Sheet: Location #2

Project Name: Riverside LRSP
Agency Name: City of Riverside
Contact Name: Brett Craig, PE, TE, Senior Traffic Engineer
Email: bcraig@riversideca.gov

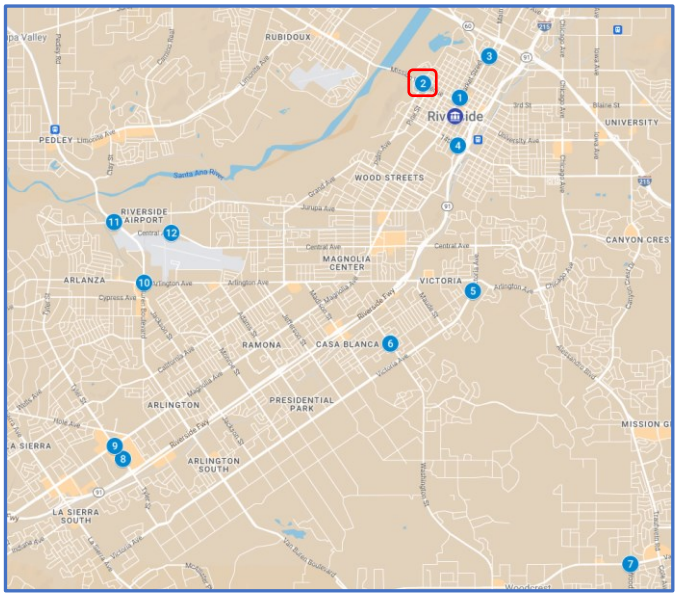
Prepared by: Kimley-Horn
Checked by: Jason Melchor, PE
Date: October 2022

ROADWAY SEGMENT

Project Location, Description & Maps

Segment: Mission Inn Ave: Redwood Dr to Scout Lane

Example of Similar Segments: Van Buren Bl: Arlington Ave to Morris Ave; Market St: Rivera St – Santa Ana River Trail



2. Mission Inn Ave: Redwood Dr to Scout Ln

Note: fatal and severe injury collisions are shown in **red**

Kimley»Horn

Case Study Sheet: Location #2

Project Location, Description & Maps

Collision Data	
Total Collisions	66
Fatal and Severe Injury Collisions	3
Top 3 Collision Types (%)	Rear-end (30%) Broadside (26%) Hit Object (20%)
Dark Collisions	22
Impaired Collisions	4

Collision Data	
Average Daily Traffic (ADT)	18,836
Lighting	Well-lit
Median	Double yellow
Highest Posted Speed Limit	35

Collisions Involved With		
Vehicular	**Pedestrian**	**Bicycle**
51	0	1

Field Visit Notes

- County bridge project will straighten curve near bridge (look at cross-section)
- Roadway near park is constrained by retaining walls and path
- Several head on and run-off collisions along Mission Inn Ave

Countermeasure Evaluation

Potential Countermeasures	Crash Reduction Factor (LRSM/CMF ID)	20 Year Safety Benefit	Total 20-Year Costs	Safety Related B/C Ratio
Install raised median	25% (R08)	$8,941,100	$2,883,600	0.91
Install dynamic/variable speed warning signs	30% (R26)	$3,136,650	$45,600	68.79
Install high-visibility crosswalks at Redwood Dr	25% (S18PB)	$20,225	$74,400	0.27
Install High Friction Surface Treatment	55% (S11)	$5,750,525	$462,000	12.45

Countermeasure Evaluation (continued)

Potential Countermeasures	Crash Reduction Factor (LRSM/CMF ID)	20 Year Safety Benefit	Total 20-Year Costs	Safety Related B/C Ratio
Install LED edge-lit Chevron signs	15% (NS08)	$1,568,325	$12,000	130.69

Case Study Sheet: Location #3

Project Name: Riverside LRSP
Agency Name: City of Riverside
Contact Name: Brett Craig, PE, TE, Senior Traffic Engineer
Email: bcraig@riversideca.gov

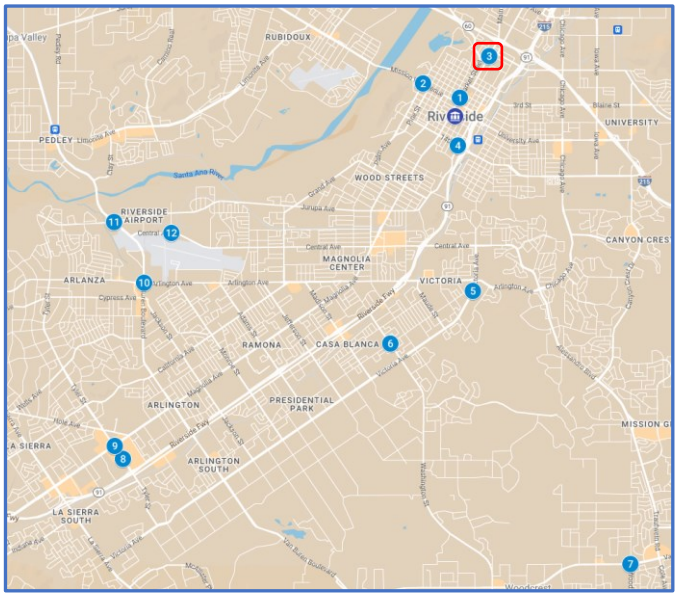
Prepared by: Kimley-Horn
Checked by: Jason Melchor, PE
Date: October 2022

ROADWAY SEGMENT

Project Location, Description & Maps

Segment: Main St: Spruce St to Poplar St

Example of Similar Segments: Brockton Ave from 12th St to 13th St, Main St from 1st St to 2nd St



3. Main St: Spruce St to Poplar St

Note: fatal and severe injury collisions are shown in **red**

Kimley»Horn

Case Study Sheet: Location #3

Project Location, Description & Maps

Collision Data	
Total Collisions	6
Fatal and Severe Injury Collisions	1
Top 4 Collision Types (%)	Sideswipe (50%) Broadside (17%) Other (17%) Rear-End (17%)
Dark Collisions	2
Impaired Collisions	0

Collision Data	
Average Daily Traffic (ADT)	13,132
Lighting	Well-lit
Median	Double yellow
Highest Posted Speed Limit	35

Collisions Involved With		
Vehicular	**Pedestrian**	**Bicycle**
5	0	1

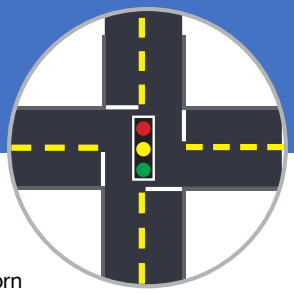
Field Visit Notes

- ADT: 10,408 (March 2011)
- 35 mph speed limits

Countermeasure Evaluation

Potential Countermeasures	Crash Reduction Factor (LRSM/CMF ID)	20 Year Safety Benefit	Total 20-Year Costs	Safety Related B/C Ratio
Implement a Road Diet (including zipper parking in median; consistent with the Northside Specific Plan)	30% (R14)	$717,510	$15,048	47.68
Install dynamic/variable speed warning signs	30% (R26)	$717,510	$45,600	15.73
Install edge-lines and centerlines	25% (R28)	$597,925	$19,152	31.22
Install bicycle lanes and signage	45% (R33PB)	$985,500	$16,800	58.66
Install bicycle sharrows	35% (R32PB)	$766,500	$7,680	99.80

Case Study Sheet: Location #4



SIGNALIZED INTERSECTION

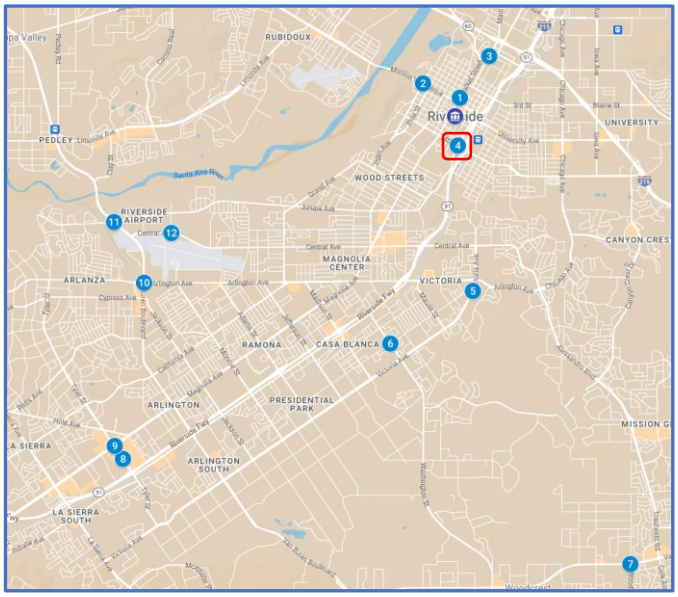
Project Name: Riverside LRSP
Agency Name: City of Riverside
Contact Name: Brett Craig, PE, TE, Senior Traffic Engineer
Email: bcraig@riversideca.gov

Prepared by: Kimley-Horn
Checked by: Jason Melchor, PE
Date: October 2022

Project Location, Description & Maps

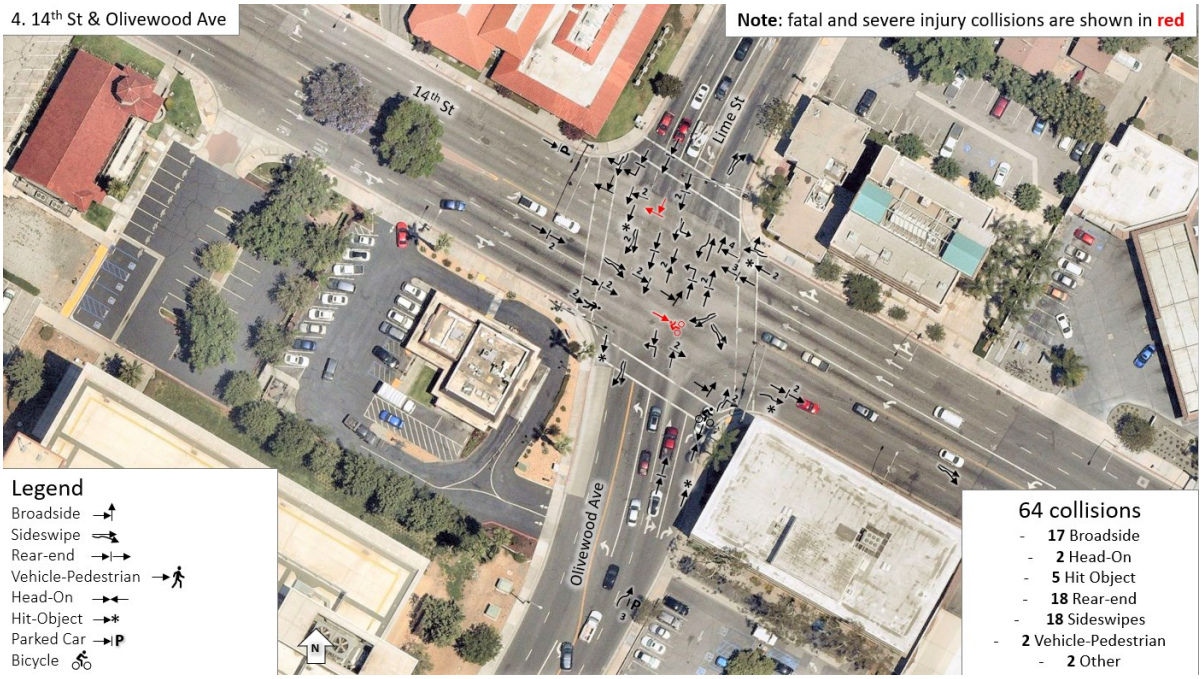
Intersection: 14th St & Olivewood Ave

Example of Similar Intersections: Van Buren Blvd & Cypress Ave, La Sierra Ave & Collett Ave



4. 14th St & Olivewood Ave

Note: fatal and severe injury collisions are shown in **red**



Legend
- Broadside
- Sideswipe
- Rear-end
- Vehicle-Pedestrian
- Head-On
- Hit-Object
- Parked Car
- Bicycle

64 collisions
- **17** Broadside
- **2** Head-On
- **5** Hit Object
- **18** Rear-end
- **18** Sideswipes
- **2** Vehicle-Pedestrian
- **2** Other

Kimley»Horn

Case Study Sheet: Location #4

Project Location, Description & Maps

Collision Data	
Total Collisions	64
Fatal and Severe Injury Collisions	2
Top 3 Collision Types (%)	Rear-end (28%) Sideswipe (28%) Broadside (27%)
Dark Collisions	22
Impaired Collisions	5

Collision Data	
Number of Approaches	4
Total Entering Vehicles	9,972
Crosswalk Condition	Fair
Control Type	Signal
Lighting	Well-lit
Highest Posted Speed Limit	35

Collisions Involved With		
Vehicular	**Pedestrian**	**Bicycle**
54	2	2

Field Visit Notes

- Lane guidance signs for 91 freeway are not consistent with direction (sign on intersection says 91 South, but signs further down say 91 West)
- Lane guidance markings are faded

Countermeasure Evaluation

Potential Countermeasures	Crash Reduction Factor (LRSM/CMF ID)	20 Year Safety Benefit	Total 20-Year Costs	Safety Related B/C Ratio
Improve signal hardware; lenses, back plate with retroreflective borders, mounting, size and number	15% (S02)	$1,026,750	$26,400	38.89
Install high visibility crosswalks	25% (S18PB)	$606,625	$74,400	8.15
Install audible pedestrian push buttons	25% (S17PB)	$606,625	$11,000	55.15

Countermeasure Evaluation (continued)

Potential Countermeasures	Crash Reduction Factor (LRSM/CMF ID)	20 Year Safety Benefit	Total 20-Year Costs	Safety Related B/C Ratio
Modify signal phasing to implement a Leading Pedestrian Interval (LPI)	60% (S21PB)	$1,455,900	$5,000	291.18
Refresh lane guidance markings	5%	$342,250	$6,000	57.04
Review lane guidance signs for SR-91	5%	$342,250	Varies	Varies

Case Study Sheet: Location #5

Project Name: Riverside LRSP
Agency Name: City of Riverside
Contact Name: Brett Craig, PE, TE, Senior Traffic Engineer
Email: bcraig@riversideca.gov

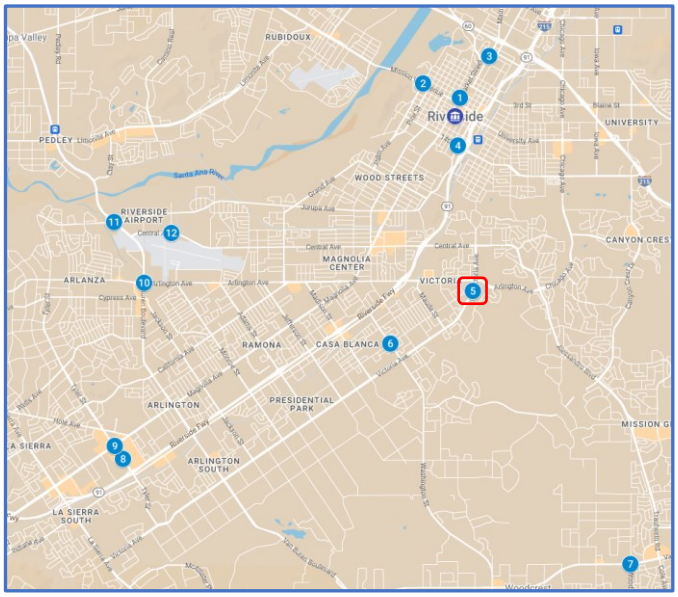
Prepared by: Kimley-Horn
Checked by: Jason Melchor, PE
Date: October 2022

FOUR-WAY-STOP INTERSECTION

Project Location, Description & Maps

Intersection: Victoria Ave & Lincoln Ave

Example of Similar Intersections: Victoria Ave & Maude St, 14th St & Pine St



Kimley»Horn

Case Study Sheet: Location #5

Project Location, Description & Maps

Collision Data	
Total Collisions	3
Fatal and Severe Injury Collisions	1
Top 2 Collision Types (%)	Broadside (33%) Vehicle-Pedestrian (33%)
Dark Collisions	3
Impaired Collisions	0

Collision Data	
Number of Approaches	4
Total Entering Vehicles	25,524
Crosswalk Condition	Fair
Control Type	Stop sign
Lighting	Sufficient Lighting
Highest Posted Speed Limit	25

Collisions Involved With		
Vehicular	**Pedestrian**	**Bicycle**
0	1	1

Field Visit Notes

- Free right turn SB
- Pedestrians cross diagonally
- Victoria Ave (Frontage Rd) is underutilized

Countermeasure Evaluation

Potential Countermeasures	Crash Reduction Factor (LRSM/CMF ID)	20 Year Safety Benefit	Total 20-Year Costs	Safety Related B/C Ratio
Install pedestrian crossing at uncontrolled locations	25% (NS20PB)	$567,725	$34,800	16.31
Close free right turn and reconfigure	5%	$114,210	$30,000	3.81
Close access to Victoria Ave frontage road to allow for simpler intersection reconfiguration	5%	$114,210	$25,000	4.57

Countermeasure Evaluation (continued)

Potential Countermeasures	Crash Reduction Factor (LRSM/CMF ID)	20 Year Safety Benefit	Total 20-Year Costs	Safety Related B/C Ratio
Install intersection safety lights	40% (NS01)	$913,680	$25,000	36.55
Install stop signs to free right turns	15% (NS06)	$342,630	$8,400	40.79
Install LED stop signs	15% (NS08)	$342,630	$12,000	28.55
Install curb extensions	35% (NS21PB)	$794,815	$80,000	9.93

Case Study Sheet: Location #6

Project Name: Riverside LRSP
Agency Name: City of Riverside
Contact Name: Brett Craig, PE, TE, Senior Traffic Engineer
Email: bcraig@riversideca.gov

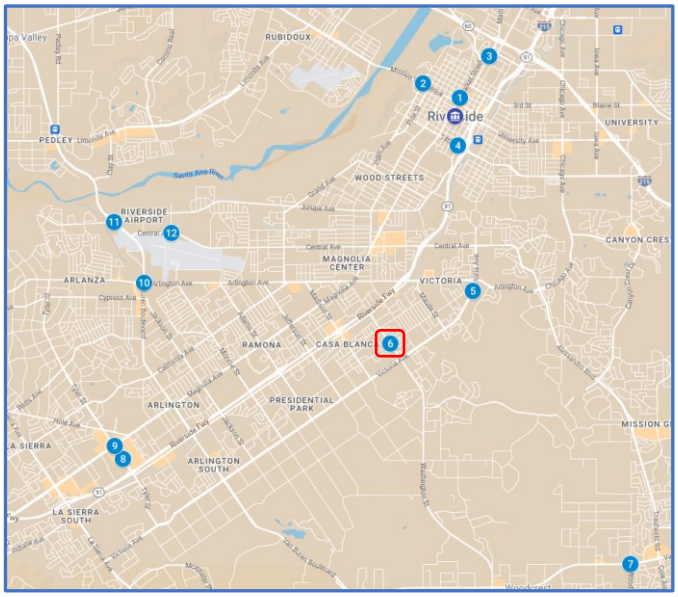
Prepared by: Kimley-Horn
Checked by: Jason Melchor, PE
Date: October 2022

FOUR-WAY-STOP INTERSECTION

Project Location, Description & Maps

Intersection: Washington St & Lincoln Ave

Example of Similar Intersections: Kansas Ave & 12th St, Pennsylvania Ave & Sedgwick Ave



6. Washington St and Lincoln Ave

Note: fatal and severe injury collisions are shown in **red**

Legend
- Broadside
- Sideswipe
- Rear-end
- Vehicle-Pedestrian
- Head-On
- Parked Car
- Bicycle

17 collisions
- **11** Broadside
- **1** Head-On
- **1** Rear-end
- **3** Sideswipes
- **1** Vehicle-Pedestrian

Kimley»Horn

Case Study Sheet: Location #6

Project Location, Description & Maps

Collision Data	
Total Collisions	17
Fatal and Severe Injury Collisions	1
Top 5 Collision Types (%)	Broadside (65%) Sideswipe (18%) Vehicle-Pedestrian (6%) Head-On (6%) Rear-End (6%)
Dark Collisions	6
Impaired Collisions	1

Collision Data	
Number of Approaches	4
Total Entering Vehicles	21,160
Crosswalk Condition	Fair
Control Type	Stop sign
Lighting	Sufficient Lighting
Highest Posted Speed Limit	40

Collisions Involved With		
Vehicular	**Pedestrian**	**Bicycle**
15	1	1

Field Visit Notes

- Majority of collisions are broadsides

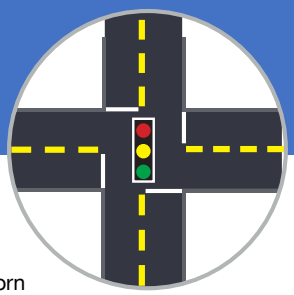
Countermeasure Evaluation

Potential Countermeasures	Crash Reduction Factor (LRSM/CMF ID)	20 Year Safety Benefit	Total 20-Year Costs	Safety Related B/C Ratio
Convert intersection to mini-roundabout	30% (NS05mr)	$842,520	$100,000	8.43
Install/upgrade larger or additional stop signs or other intersection warning/regulatory signs	15% (NS06)	$421,260	$33,600	12.54
Install Flashing Beacons at Stop-Controlled Intersections	15% (NS08)	$421,260	$48,000	8.78

Countermeasure Evaluation (continued)

Potential Countermeasures	Crash Reduction Factor (LRSM/CMF ID)	20 Year Safety Benefit	Total 20-Year Costs	Safety Related B/C Ratio
Install high visibility crosswalks	25% (NS20PB)	$567,725	$34,800	16.31
Install curb extensions	5%	$140,420	$80,000	1.76
Install traffic signal	30% (NS03)	$842,520	$378,000	2.23
Install LED edge-lit stop signs	15% (NS08)	$421,260	$12,000	35.11

Case Study Sheet: Location #7



SIGNALIZED INTERSECTION

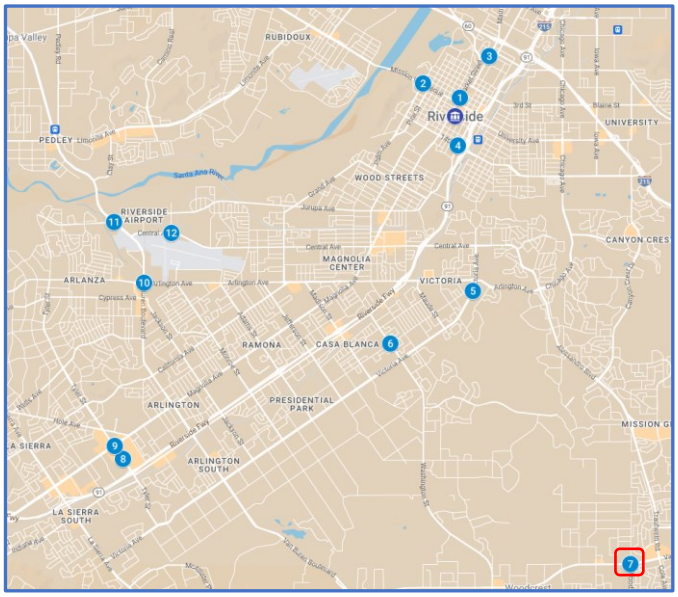
Project Name: Riverside LRSP
Agency Name: City of Riverside
Contact Name: Brett Craig, PE, TE, Senior Traffic Engineer
Email: bcraig@riversideca.gov

Prepared by: Kimley-Horn
Checked by: Jason Melchor, PE
Date: October 2022

Project Location, Description & Maps

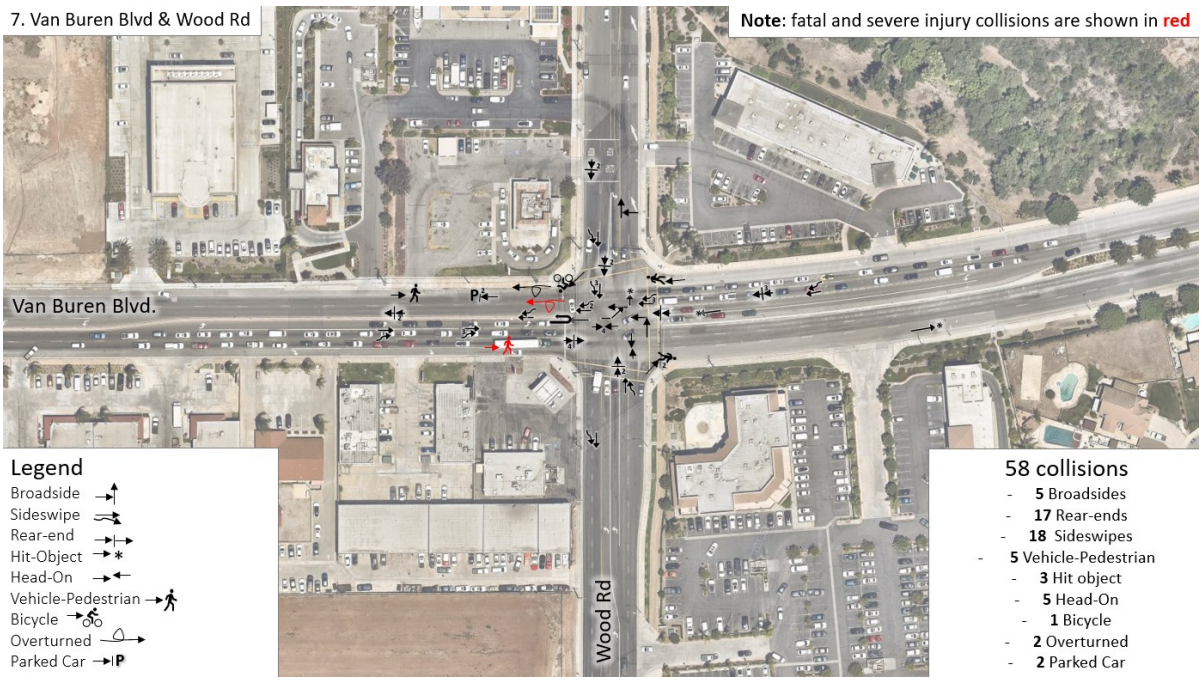
Intersection: Van Buren Blvd & Wood Rd

Example of Similar Intersections: Magnolia Ave & Jackson St, Van Buren Blvd & California Ave



7. Van Buren Blvd & Wood Rd

Note: fatal and severe injury collisions are shown in **red**



Legend

- Broadside
- Sideswipe
- Rear-end
- Hit-Object
- Head-On
- Vehicle-Pedestrian
- Bicycle
- Overturned
- Parked Car

58 collisions

- **5** Broadsides
- **17** Rear-ends
- **18** Sideswipes
- **5** Vehicle-Pedestrian
- **3** Hit object
- **5** Head-On
- **1** Bicycle
- **2** Overturned
- **2** Parked Car

Kimley»Horn

Case Study Sheet: Location #7

Project Location, Description & Maps

Collision Data	
Total Collisions	59
Fatal and Severe Injury Collisions	3
Top 5 Collision Types (%)	Rear-end (29%) Sideswipe (31%) Broadside (9%) Head-On (9%) Vehicle-Pedestrian (9%)
Dark Collisions	21
Impaired Collisions	3

Collision Data	
Number of Approaches	4
Total Entering Vehicles	50,944
Crosswalk Condition	Fair
Control Type	Signal
Lighting	Well-lit
Highest Posted Speed Limit	50

Collisions Involved With		
Vehicular	**Pedestrian**	**Bicycle**
46	5	1

Field Visit Notes

- Rear-ends and sideswipes were most common collision types
- WB crosswalk is not present – crosswalk was removed after 2011
- MLK Jr High School to the south

Countermeasure Evaluation

Potential Countermeasures	Crash Reduction Factor (LRSM/CMF ID)	20 Year Safety Benefit	Total 20-Year Costs	Safety Related B/C Ratio
Improve signal hardware; lenses, back plate with retroreflective borders, mounting, size, and number	15% (S02)	$1,383,840	$26,400	52.42
Provide Advanced Dilemma Zone Detection system	40% (S04)	$3,690,240	$76,800	48.05

Countermeasure Evaluation (continued)

Potential Countermeasures	Crash Reduction Factor (LRSM/CMF ID)	20 Year Safety Benefit	Total 20-Year Costs	Safety Related B/C Ratio
Install high visibility crosswalks	25% (S18PB)	$1,205,050	$74,400	16.20
Modify signal phasing to implement a Leading Pedestrian Interval (LPI)	60% (S21PB)	$2,892,120	$45,600	63.42
Install audible pedestrian push button systems	25% (S17PB)	$2,306,400	$11,000	209.67
Install bicycle lanes with green conflict zone paint	25% (R32PB)	$1,687,070	$19,200	87.87

Case Study Sheet: Location #8

Project Name: Riverside LRSP
Agency Name: City of Riverside
Contact Name: Brett Craig, PE, TE, Senior Traffic Engineer
Email: bcraig@riversideca.gov

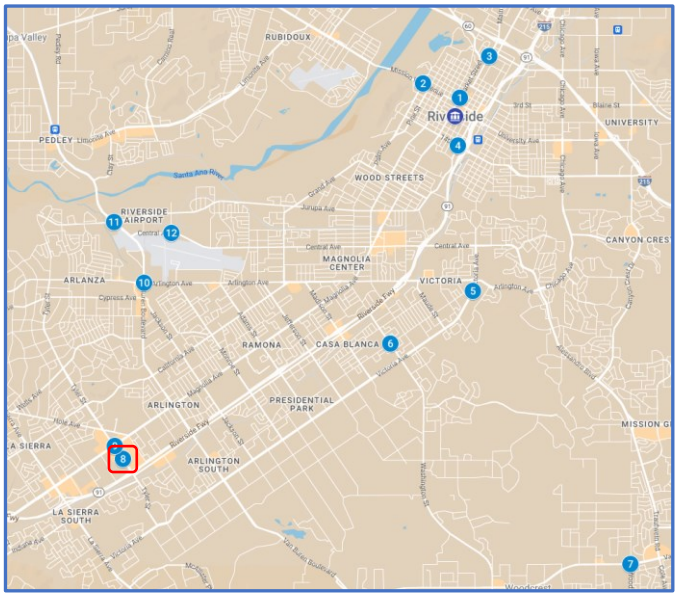
Prepared by: Kimley-Horn
Checked by: Jason Melchor, PE
Date: October 2022

ONE-WAY STOP INTERSECTION

Project Location, Description & Maps

Intersection: Tyler St & Hemet St

Example of Similar Intersections: Market St & Northbend St, Peck Ave & 3rd St



8. Tyler St & Hemet St

Note: fatal and severe injury collisions are shown in **red**

Legend
- Broadside
- Sideswipe
- Rear-end
- Vehicle-Pedestrian
- Vehicle-Bicyclist
- Hit-Object
- Parked Car

20 collisions
- **3** Broadsides
- **8** Rear-Ends
- **6** Sideswipes
- **2** Vehicle-Pedestrian
- **1** Hit Object

Case Study Sheet: Location #8

Project Location, Description & Maps

Collision Data	
Total Collisions	20
Fatal and Severe Injury Collisions	1
Top 3 Collision Types (%)	Rear-End (40%) Sideswipe (30%) Broadside (15%)
Dark Collisions	10
Impaired Collisions	1

Collision Data		
Number of Approaches	4	
Total Entering Vehicles	41,594	
Crosswalk Condition	Fair	
Control Type	Stop controlled on Hemet St	
Lighting	Well Lit	
Highest Posted Speed Limit	35	
Collisions Involved With		
Vehicular	**Pedestrian**	**Bicycle**
16	2	1

Field Visit Notes

- Currently no left-turns from Hemet St onto Tyler St, but several drivers observed making the illegal left turn
- Crosswalk striping is faded

Countermeasure Evaluation

Potential Countermeasures	Crash Reduction Factor (LRSM/CMF ID)	20 Year Safety Benefit	Total 20-Year Costs	Safety Related B/C Ratio
Extend median to prevent left-turn collisions	25% (NS14)	$727,425	$53,400	13.62
Install crosswalks on SB Tyler St across Hemet St	25% (NS20PB)	$603,300	$34,800	17.34

Case Study Sheet: Location #9

Project Name: Riverside LRSP
Agency Name: City of Riverside
Contact Name: Brett Craig, PE, TE, Senior Traffic Engineer
Email: bcraig@riversideca.gov

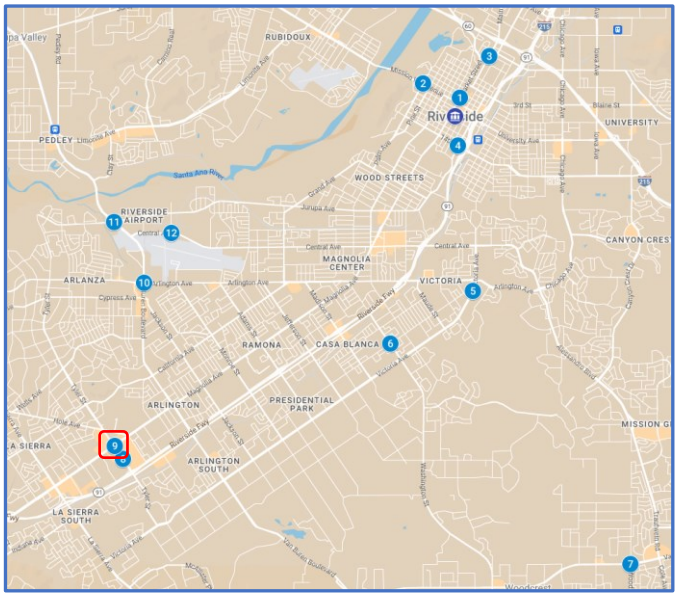
Prepared by: Kimley-Horn
Checked by: Jason Melchor, PE
Date: October 2022

SIGNALIZED INTERSECTION

Project Location, Description & Maps

Intersection: Tyler St & Magnolia Ave

Example of Similar Intersections: La Sierra Ave & Magnolia Ave, Alessandro Blvd & Chicago Ave



Case Study Sheet: Location #9

Project Location, Description & Maps

Collision Data	
Total Collisions	147
Fatal and Severe Injury Collisions	4
Top 3 Collision Types (%)	Sideswipe (27%) Rear-end (34%) Broadside (18%)
Dark Collisions	43
Impaired Collisions	6

Collision Data	
Number of Approaches	4
Total Entering Vehicles	58,714
Crosswalk Condition	Fair
Control Type	Signal
Lighting	Well-lit
Highest Posted Speed Limit	40 MPH

Collisions Involved With		
Vehicular	**Pedestrian**	**Bicycle**
123	10	2

Countermeasure Evaluation

Potential Countermeasures	Crash Reduction Factor (LRSM/CMF ID)	20 Year Safety Benefit	Total 20-Year Costs	Safety Related B/C Ratio
Install bicycle striping and green conflict zone paint	35% (R32PB)	$1,854,790	$19,200	96.60
Improve signal hardware; lenses, back plate with retroreflective borders, mounting, size, and number	15% (S02)	$2,086,845	$26,400	79.05

Countermeasure Evaluation (continued)

Potential Countermeasures	Crash Reduction Factor (LRSM/CMF ID)	20 Year Safety Benefit	Total 20-Year Costs	Safety Related B/C Ratio
Provide Advanced Dilemma Zone Detection system	40% (S04)	$5,564,920	$76,800	72.46
Modify signal phasing to implement a Leading Pedestrian Interval (LPI)	60% (S21PB)	$3,179,640	$45,600	69.73
Install audible pedestrian push button system	25% (S17PB)	$1,324,850	$11,000	120.44

Case Study Sheet: Location #10

Project Name: Riverside LRSP
Agency Name: City of Riverside
Contact Name: Brett Craig, PE, TE, Senior Traffic Engineer
Email: bcraig@riversideca.gov

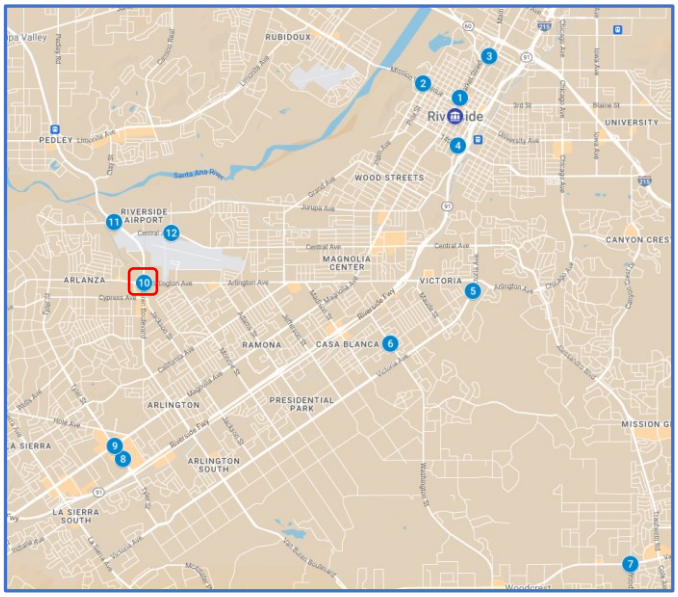
Prepared by: Kimley-Horn
Checked by: Jason Melchor, PE
Date: October 2022

SIGNALIZED INTERSECTION

Project Location, Description & Maps

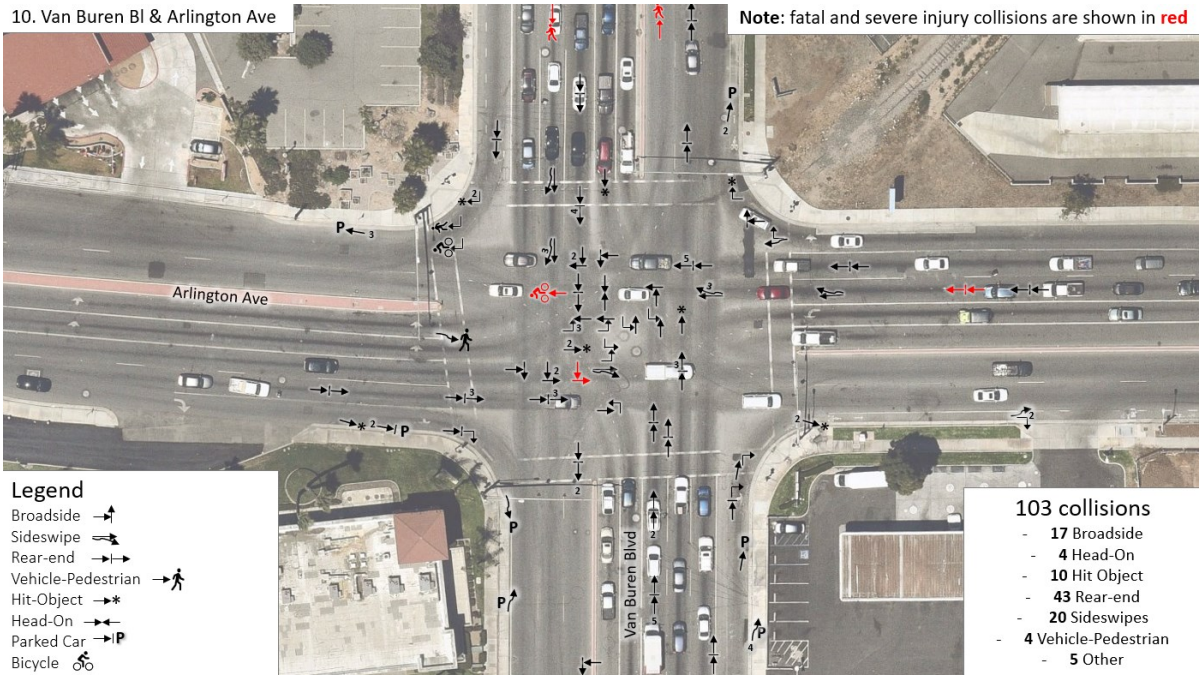
Intersection: Van Buren Blvd & Arlington Ave

Example of Similar Intersections: Van Buren Blvd & Magnolia Ave, La Sierra Ave & Pierce St



10. Van Buren Bl & Arlington Ave

Note: fatal and severe injury collisions are shown in **red**



Legend
- Broadside
- Sideswipe
- Rear-end
- Vehicle-Pedestrian
- Hit-Object
- Head-On
- Parked Car
- Bicycle

103 collisions
- **17** Broadside
- **4** Head-On
- **10** Hit Object
- **43** Rear-end
- **20** Sideswipes
- **4** Vehicle-Pedestrian
- **5** Other

Kimley»Horn

Case Study Sheet: Location #10

Project Location, Description & Maps

Collision Data	
Total Collisions	103
Fatal and Severe Injury Collisions	5
Top 3 Collision Types (%)	Rear-end (42%) Sideswipe (20%) Broadside (17%)
Dark Collisions	47
Impaired Collisions	7

Collision Data	
Number of Approaches	4
Total Entering Vehicles	63,320
Crosswalk Condition	Fair
Control Type	Signal
Lighting	Well-lit
Highest Posted Speed Limit	45

Collisions Involved With		
Vehicular	**Pedestrian**	**Bicycle**
86	4	2

Field Visit Notes

- Controller replacement and fiber project here
- Video detection present

Countermeasure Evaluation

Potential Countermeasures	Crash Reduction Factor (LRSM/CMF ID)	20 Year Safety Benefit	Total 20-Year Costs	Safety Related B/C Ratio
Install dynamic/variable speed warning signs on approaches	30% (R26)	$4,557,180	$91,200	49.97
Install bike lanes with green conflict zone paint	35% (R32PB)	$2,384,445	$29,184	81.70

Countermeasure Evaluation (continued)

Potential Countermeasures	Crash Reduction Factor (LRSM/CMF ID)	20 Year Safety Benefit	Total 20-Year Costs	Safety Related B/C Ratio
Install high visibility crosswalks	25% (S18PB)	$1,703,175	$74,400	22.89
Refresh lane guidance striping	5%	$759,530	$6,000	126.59
Install audible pedestrian push buttons	25% (S17PB)	$1,703,175	$11,000	154.83

Case Study Sheet: Location #11

Project Name: Riverside LRSP
Agency Name: City of Riverside
Contact Name: Brett Craig, PE, TE, Senior Traffic Engineer
Email: bcraig@riversideca.gov

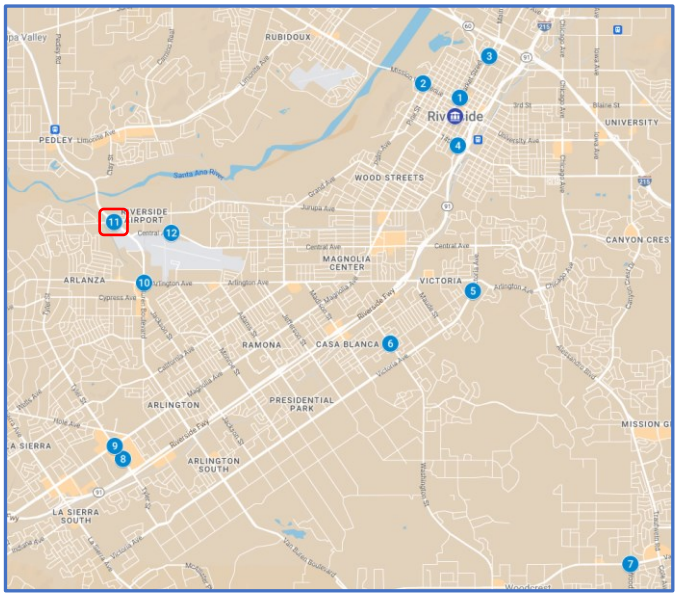
Prepared by: Kimley-Horn
Checked by: Jason Melchor, PE
Date: October 2022

SIGNALIZED INTERSECTION

Project Location, Description & Maps

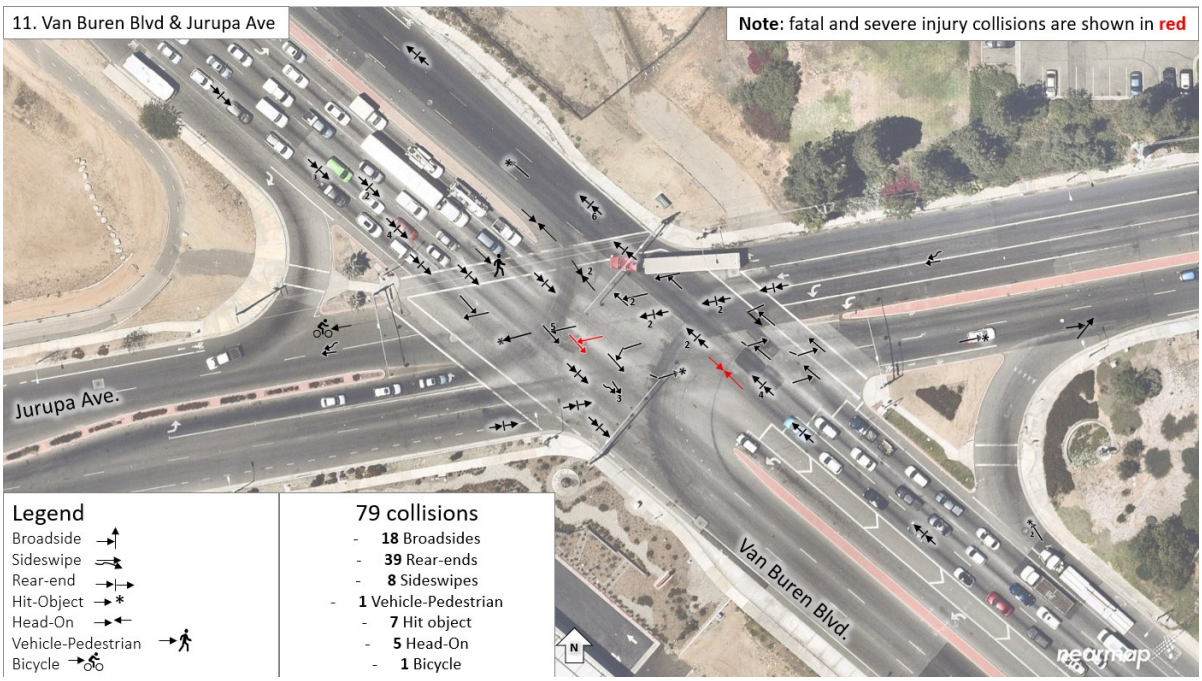
Intersection: Van Buren Blvd & Jurupa Ave

Example of Similar Intersections: Victoria Ave & Arlington Ave, Central Ave & Canyon Crest Dr



11. Van Buren Blvd & Jurupa Ave

Note: fatal and severe injury collisions are shown in **red**



Legend
- Broadside
- Sideswipe
- Rear-end
- Hit-Object
- Head-On
- Vehicle-Pedestrian
- Bicycle

79 collisions
- **18** Broadsides
- **39** Rear-ends
- **8** Sideswipes
- **1** Vehicle-Pedestrian
- **7** Hit object
- **5** Head-On
- **1** Bicycle

Kimley»Horn

Case Study Sheet: Location #11

Project Location, Description & Maps

Collision Data	
Total Collisions	80
Fatal and Severe Injury Collisions	3
Top 3 Collision Types (%)	Rear-end (%) Sideswipe (%) Broadside (%)
Dark Collisions	38
Impaired Collisions	5

Collision Data	
Number of Approaches	4
Total Entering Vehicles	5,415
Crosswalk Condition	Fair
Control Type	Signal
Lighting	Well-lit
Highest Posted Speed Limit	55

Collisions Involved With		
Vehicular	**Pedestrian**	**Bicycle**
70	1	1

Field Visit Notes

- Skewed intersection with free right turn lanes
- EB crosswalk not present
- High speeds on SB Van Buren Bl approach
- Bike lanes on all approaches

Countermeasure Evaluation

Potential Countermeasures	Crash Reduction Factor (LRSM/CMF ID)	20 Year Safety Benefit	Total 20-Year Costs	Safety Related B/C Ratio
Install green bicycle paint in conflict zones	35% (R32PB)	$78,120	$29,184	2.68
Install flashing beacons as advance warning (S.I.)	30% (S10)	$3,129,810	$20,400	153.42

Countermeasure Evaluation (continued)

Potential Countermeasures	Crash Reduction Factor (LRSM/CMF ID)	20 Year Safety Benefit	Total 20-Year Costs	Safety Related B/C Ratio
Install pedestrian crossing on missing leg	25% (S18PB)	$55,800	$74,400	0.75
Install audible pedestrian push button	25% (S17PB)	$55,800	$11,000	5.07
Install EB dual left turns (convert #1 EB thru to EB-thru and left-turn lanes)	5%	$13,410	$15,000	0.89

Case Study Sheet: Location #12

Project Name: Riverside LRSP
Agency Name: City of Riverside
Contact Name: Brett Craig, PE, TE, Senior Traffic Engineer
Email: bcraig@riversideca.gov

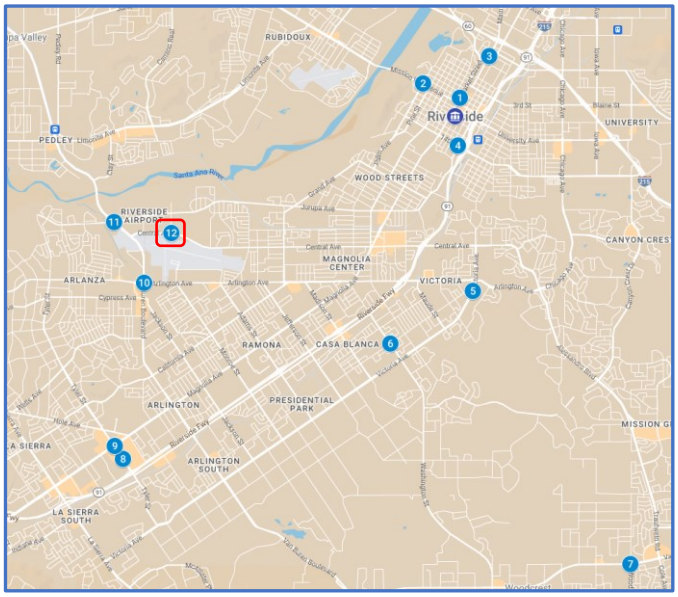
Prepared by: Kimley-Horn
Checked by: Jason Melchor, PE
Date: September 2022

ROADWAY SEGMENT

Project Location, Description & Maps

Segment: Central Ave: Fremont Ave to Wilderness Ave

Example of Similar Segments: Jurupa Ave from Columbus St to Ordway St, Central Ave from Acorn St to Wilderness Ave



12. Central Ave: Fremont St to Wilderness Ave

Note: fatal and severe injury collisions are shown in **red**

Kimley»Horn

Case Study Sheet: Location #12

Project Location, Description & Maps

Collision Data	
Total Collisions	21
Fatal and Severe Injury Collisions	1
Top 4 Collision Types (%)	Hit Object (57%) Rear-End (19%) Sideswipe (10%) Broadside (10%)
Dark Collisions	8
Impaired Collisions	0

Collision Data	
Average Daily Traffic (ADT)	10,632
Lighting	Well-lit
Median	Raised & Painted
Highest Posted Speed Limit	50

Collisions Involved With		
Vehicular	**Pedestrian**	**Bicycle**
8	0	0

Field Visit Notes

- High number of hit object/run off road collisions
- High speeds along Central Ave, especially straight section

Countermeasure Evaluation

Potential Countermeasures	Crash Reduction Factor (LRSM/CMF ID)	20 Year Safety Benefit	Total 20-Year Costs	Safety Related B/C Ratio
Install raised median	25% (R08)	$597,925	$2,563,200	0.23
Install chevron signs on horizontal curves	40% (R23)	$956,680	$14,400	66.44
Install curve advance warning signs	25% (R24)	$597,925	$4,800	124.57

Countermeasure Evaluation (continued)

Potential Countermeasures	Crash Reduction Factor (LRSM/CMF ID)	20 Year Safety Benefit	Total 20-Year Costs	Safety Related B/C Ratio
Install curve advance warning signs (flashing beacon)	30% (R25)	$717,510	$24,000	29.90
Install dynamic/variable speed warning signs	30% (R26)	$717,510	$45,600	15.73
Install Separated Bike Lanes along Central Ave corridor	45% (R33PB)	$985,500	$51,240	19.23
Install High Friction Surface Treatment	55% (R21)	$1,315,435	$733,326	1.79

9.2 City-wide Countermeasure Toolbox

This evaluation considered citywide trends to identify countermeasures that would likely provide the most benefit with widespread implementation. **Table 9** outlines the citywide safety project opportunities, which is also referred to as the "Countermeasure Toolbox". Within the toolbox, the description of the countermeasure along with its Local Roadway Safety Manual (LRSM) ID number is listed. The next column, Crash Reduction Factor (CRF), are "multiplicative factors used to estimate the expected reduction in number of crashes after implementing a given countermeasure at a specific site (the higher the CRF, the greater the expected reduction in crashes)." For each of these countermeasures, a planning level benefit/cost analysis was completed.

Applying the benefit/cost at the citywide level was estimated assuming some randomness in crash distribution. The location characteristics, such as whether there is a traffic signal, and the type of crashes, were used at the citywide level to calculate an average cost of crashes that the countermeasure might reduce. The benefit per location was then factored out to a 20-year lifecycle savings, with an Opinion of Project Probable Cost (OPCC) for the initial installation costs and a per-year maintenance cost estimate. The cost shown in **Table 9** should be considered initial planning costs using 2022 dollars and not assumed final.

Table 9 - Citywide Safety Countermeasure Toolbox

ID	Potential Countermeasures	Where to apply?	Crash Reduction Factor	Per Unit Cost	Unit
S02	Improve signal hardware; lenses, back-plates with retroreflective borders, mounting, size, and number	Signalized intersections with significant broadside and rear-end collisions due to signal visibility	15%	$26,400	per intersection
S04	Provide Advanced Dilemma Zone Detection system	Signalized intersections with significant right-angle and rear-end collisions due to unsafe stopping during yellow phases	40%	$76,800	per intersection
S10	Install flashing beacons as advance warning for signalized intersections	Locations with sight distance issues	30%	$10,200	per beacon
S17PB[7]	Install audible pedestrian push button systems	Signalized intersections with crosswalks	25%	$11,000	Per intersection
S18PB	Install high visibility crosswalk for signalized intersections	Signalized intersections with no marked crossing and pedestrian heads, with significant turning movements	25%	$74,400	per intersection
S21PB	Modify signal phasing to implement a Leading Pedestrian Interval (LPI)	Signalized Intersections – especially those with high pedestrian activity	60%	$45,600	per intersection
NS03	Install signals	Unsignalized intersections with significant collision activity where warrants are met	30%	$378,000	per intersection
NS05mr	Convert intersection to mini-roundabout	Intersections with lower vehicle speeds, with posted speed limits of 30 mph or less	30%	$100,000	per location
NS06	Install/upgrade larger or additional stop signs or other intersection warning/regulatory signs	Unsignalized intersections with crash history showing running stop signs	15%	$8,400	per sign
NS08	Install Flashing Beacons at Stop-Controlled Intersections (LED edge lit)	Unsignalized intersections with crash history showing running stop signs	15%	$12,000	per beacon

[7] This countermeasure typically covers pedestrian countdown signal heads, but can be also used for audible pedestrian push buttons

ID	Potential Countermeasures	Where to apply?	Crash Reduction Factor	Per Unit Cost	Unit
NS14	Install raised median on approaches for unsignalized intersections	Unsignalized intersections where related or nearby turning movements affect the safety and operation of an intersection	25%	$1,068	per LF
NS20PB	Install pedestrian crossing at uncontrolled locations (new signs and markings only)	Unsignalized intersections with high pedestrian activity where sufficient sight distance is available	25%	$34,800	per intersection
NS22PB	Install Rectangular Rapid Flashing Beacon (RRFB)	Unsignalized intersections and mid-block pedestrian crossings	35%	$30,000	Per location
R08	Install raised median	Locations with a high number of head-on collisions	25%	$1,068	per LF
R14	Road Diet (Reduce travel lanes from 4 to 4 and add a two-way left-turn and bike lanes)	Roadway segments with high number of sideswipe collisions	30%	$79,200	per mile
R23	Install chevron signs on horizontal curves	Roadway segments that have a significant amount of collision activity at sharp curves.	40%	$2,400	per sign
R24	Install curve advance warning signs	Roadway segments that have a significant amount of collision activity at sharp curves.	25%	$2,400	per sign
R25	Install curve advance warning signs (flashing beacon)	Roadway segments that have a significant amount of collision activity at sharp curves.	30%	$12,000	per beacon
R26	Install dynamic/variable speed warning signs	Roadway segments with a significant number of collisions due to unsafe speeds.	30%	$22,800	per sign
R28	Install edge-lines and centerlines	Roadway segments with collisions that resulted in run-off-road right/left, head-on, or opposite-direction-sideswipe.	25%	$100,800	per mile
R32PB	Install bike lanes	Locations with a high number of bicycle collisions	35%	$76,800	per mile
R33PB	Install Separated Bike Lanes	Locations with a high number of bicycle collisions and/or high bicycle traffic volumes, where sufficient space is available for the selected separation measure	45%	$120,000	per mile

ID	Potential Countermeasures	Where to apply?	Crash Reduction Factor	Per Unit Cost	Unit
R21	Improve Pavement Friction (High Friction Surface Treatments)	Areas where there are significant crashes or skidding, and areas near curves, loop rams, intersections, and areas with short stopping or weaving distances	55%	$33	Per square yard
-*	Refresh lane guidance markings	Locations with faded lane guidance markings/striping	5%	$6,000	per location
-*	Install curb extensions	Intersections with high pedestrian activity	5%	$20,000	per extension

**The City is not limited to the countermeasures in this toolbox and can utilize other approved countermeasures in its roadway safety planning.*

10. Funding Sources & Next Steps

10.1 Funding Sources

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

10.1.1 Highway Safety Improvement Program

The Highway Safety Improvement Program (HSIP) is a Federal program that apportions funding as a lump sum for each state, which is then divided among apportioned programs. These flexible funds can be used for projects to preserve or improve safety conditions and performance on any Federal-aid highway, bridge projects on any public road, facilities for non-motorized transportation, and other project types. Safety improvement projects eligible for this funding include:

- New or upgraded traffic signals
- Upgraded guard rails
- Pedestrian warning flashing beacons
- Marked crosswalks
- Other projects listed in the Caltrans Local Road Safety Manual

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

Additional information regarding this program at the Federal level can be found online at: https://safety.fhwa.dot.gov/hsip/. California specific HSIP information – including dates for upcoming call for projects - can be found at: http://www.dot.ca.gov/hq/LocalPrograms/hsip.html. HSIP Cycle 11 applications are due in September 2022.

10.1.2 Caltrans Active Transportation Program

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

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

This program funding is provided annually. The ATP call for projects typically comes out in the spring. Information on this program and cycles can be found online at: http://www.dot.ca.gov/hq/LocalPrograms/atp/.

10.1.3 California SB 1

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

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

- Local Street and Road Maintenance and Rehabilitation: $1.5 billion
  - This funding is dedicated to improve local road maintenance, rehabilitation, and/or safety through projects such as restriping and repaving.
- Bike and Pedestrian Projects: $100 million
  - This will go to cities, counties, and regional transportation agencies to build or convert more bike paths, crosswalks, and sidewalks. It is a significant increase in funding for these projects through the ATP.
- Local Planning Grants: $25 million

10.1.4 California Office of Traffic Safety Grants

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

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

10.1.5 SCAG Sustainable Communities Program

This program is an innovative vehicle for promoting local jurisdictional efforts to test local planning tools. The Sustainable Communities Program (SCP) provides direct technical assistance to SCAG member jurisdictions to complete planning and policy efforts to implement the regional Sustainable Communities Strategies (SCS). Grants are available in the following three categories:

- Integrated Land Use
  - Sustainable Land Use Planning
  - Transit Oriented Development (TOD)
  - Land Use & Transportation Integration
- Active Transportation
  - Bicycle Planning
  - Pedestrian Planning
  - Safe Routes to School Plans
- Green Region
  - Natural Resource Plans
  - Climate Action Plans (CAPs)
  - Green House Gas (GHG) Reduction programs

10.1.6 Safe Streets and Roads for All (SS4A) Grant Program

This program has allocated $1B annually for the next 5 years for local cities, counties, MPOs, and other roadway owners (excepting state DOTs) for safety improvement grants for safety planning, education, enforcement, and roadway improvements. This program is not benefit / cost based. Evaluation criteria are oriented to the project's alignment with the Safe Systems approach. There is a 20% local match requirement (can be in-kind contribution via staff billable hours). Planning grants are open to any eligible agency and Implementation grants are open to agencies with a completed safety plan such as a Local Roadway Safety Plan. Planning grants are expected to range from $100K to $1M and Implementation grants are expected to range from $1M to $20M. Grant applications are due in September 2022.

10.1.7 Infrastructure Investment and Jobs Act

In November 2021, the President signed into law the $1.2 trillion Infrastructure Investment and Jobs Act. In addition to the SS4A grant program described above, this law provides billions of dollars in additional funding for improvements and investment in the transportation sector nationwide. The law provides $30 billion in funding over 5 years for competitive RAISE grants for transportation projects, as well as additional funding for repair and environmental mitigation projects. As these grant programs continue to be developed, City can position itself by identifying potential projects and programs to pursue.

10.2 Implementation Plan

Once the Local Roadway Safety Plan has been completed, the City can plan to regularly review and monitor collision data for trends and changes. The City can also plan to prioritize and implement certain improvements that were identified in this plan.

10.2.1 Monitoring

The City can plan to regularly monitor the success of the LRSP and its related implementations by performing the following steps. This before and after analysis can be performed every second year. The City can also meet with the Sheriff department quarterly to discuss roadway safety issues and compare to the latest collision analysis.

- Pull yearly collision data from Crossroads database to determine year-over-year trend
- Utilize Crossroads or GIS software to review the number of collisions occurring at specific locations. Locations where improvements have been made should receive priority for monitoring.
- Based upon changes in collision activity, determine efficacy of improvements and adjust strategies going forward

10.2.2 Analysis Update

The City can plan to update the analysis every two years as part of a monitoring program, as described in **Section 10.2.1**. Every 4 years the City will perform a major update to the analysis and the Local Roadway Safety Plan by performing the following steps. This update will maintain eligibility for the HSIP grant funding for the City. This analysis should continue to focus on both systemic and location-specific safety needs.

1. Obtain updated Statewide Integrated Traffic Records System (SWITRS) collision data from the Crossroads database
2. Use Excel software to update the collision trend analysis completed in Section 7, continue to compare new collision to historic trends
3. Update the roadway shapefile with any new or upgraded roadways
4. Update the intersection shapefile with any new or upgraded intersections
5. Re-run the GIS collision tool to determine the number of collisions at intersections and roadways within the updated study period. The City can plan to run the collision tool for all collisions, as well as the collision types identified in **Section 3.2.2.**
6. Update the collision analysis performed in this report, including the collision analysis tables shown in **Section 7.7.**
7. Review the Collision Toolbox to determine if any additional countermeasures should be considered for implementation in the City

10.2.3 Implementation Strategies

The opportunities identified in this report provide systemic and location-specific countermeasures that can be implemented within the City. Implementation will be dictated by funding and available resources, this

guidance is preliminary and subject to change. Over the near-term and mid-term, the City can concentrate its efforts on the following emphasis areas.

- Vulnerable Road Users (Pedestrians and Bicyclists)
- Aggressive Driving
- Impaired Driving
- Intersection Improvements

Analysis conducted at the citywide level indicated that these factors were some of the most frequent influences contributing to collisions within the City. The countermeasure opportunities previously discussed in this report for both systemic and project-specific improvements can be used as a basis for developing projects at locations where addressing these focus areas would be of the most benefit. Projects that address these focused areas citywide can be developed with a high benefit-to-cost ratio (by applying City-wide collision rates), allowing competitive projects to be developed even at sites with little to no direct collision history, but with conditions that might contribute to future collisions. For location-specific improvements, the City can utilize benefit-cost ratio calculations to help prioritize projects as funding and resources become available. The countermeasure toolbox in **Table 8** also identified a potential prioritization timeline for each improvement, based on cost, effectiveness and feasibility.

This project prioritization process will help the City be ready for the funding opportunities identified in **Section 10.1**. Project prioritization will also help to guide the projects as they are taking into the design and construction project. Coordination with City departments will be key in the completion of these implementations.

The City can also plan to implement the non-engineering improvements identified throughout this report, including actions related to Enforcement, Education, and Emergency Services. These actions will require coordination with internal and external stakeholders, such as City departments, law enforcement, local government organizations, and local community organizations. Early buy-in and engagement from these stakeholders will be key to the success of these actions.

To aid in these actions, the City can assemble a ‘Task Force’ of representatives from different City departments, such as Public Works, Development Services, and Public Safety. This task force will be instrumental in the monitoring, analysis update, project development and project implementation outlined in this plan.

10.3 Next Steps

The City has completed this LRSP to guide the process of future transportation safety improvements for years to come. In addition to the actions identified in the Implementation Plan, the City can perform the following to guide the success of this LRSP and the safety efforts overall.

- Develop investment program to help achieve the City’s Vision Zero goals
- Work with state and partner agencies on implementation of large-scale programs and policies
- Incorporate safety analysis findings in future updates of safety programs
- Monitor statewide safety priorities, guidance, and funding opportunities

APPENDIX A – LRSP MAPS BY RIVERSIDE CITY WARD

WARD 1

Figure 1- Roadway Functional Classification and Signals

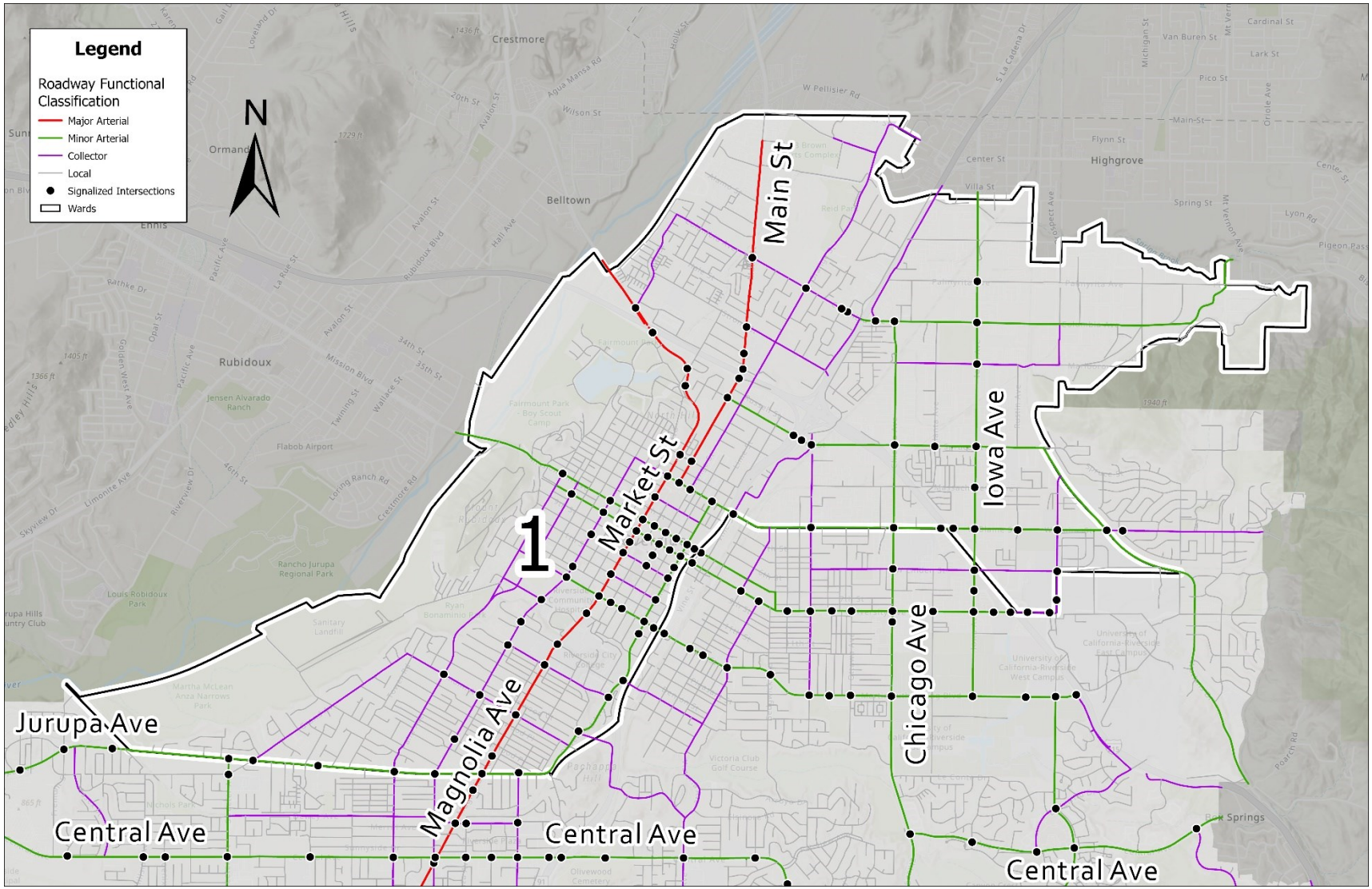


Figure 2- All Collisions (July 2017 – July 2022)

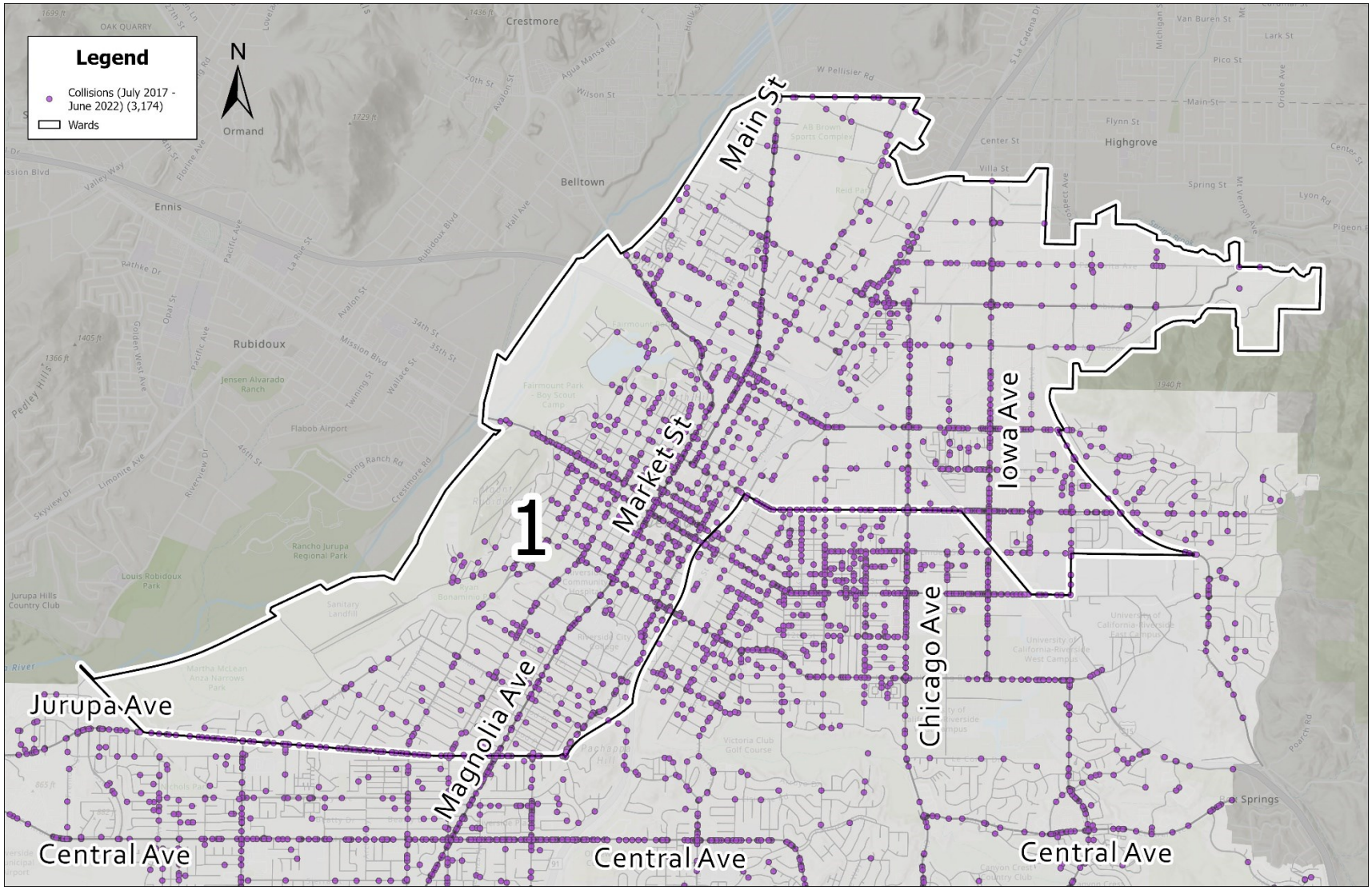


Figure 3- Fatal and Severe Injury Collisions (July 2017 – June 2022)

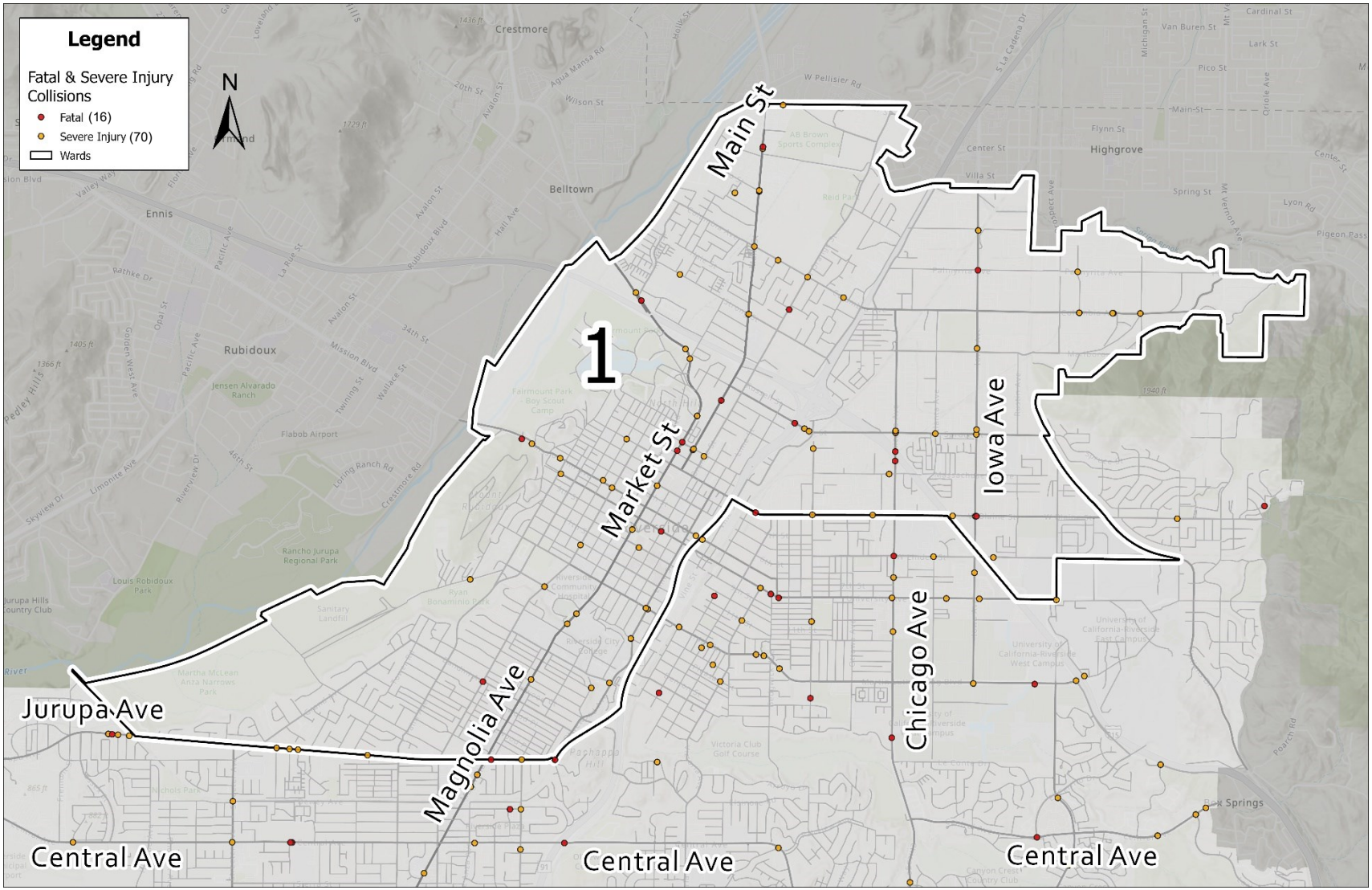


Figure 4- Bicycle and Pedestrian Collisions (July 2017 – June 2022)

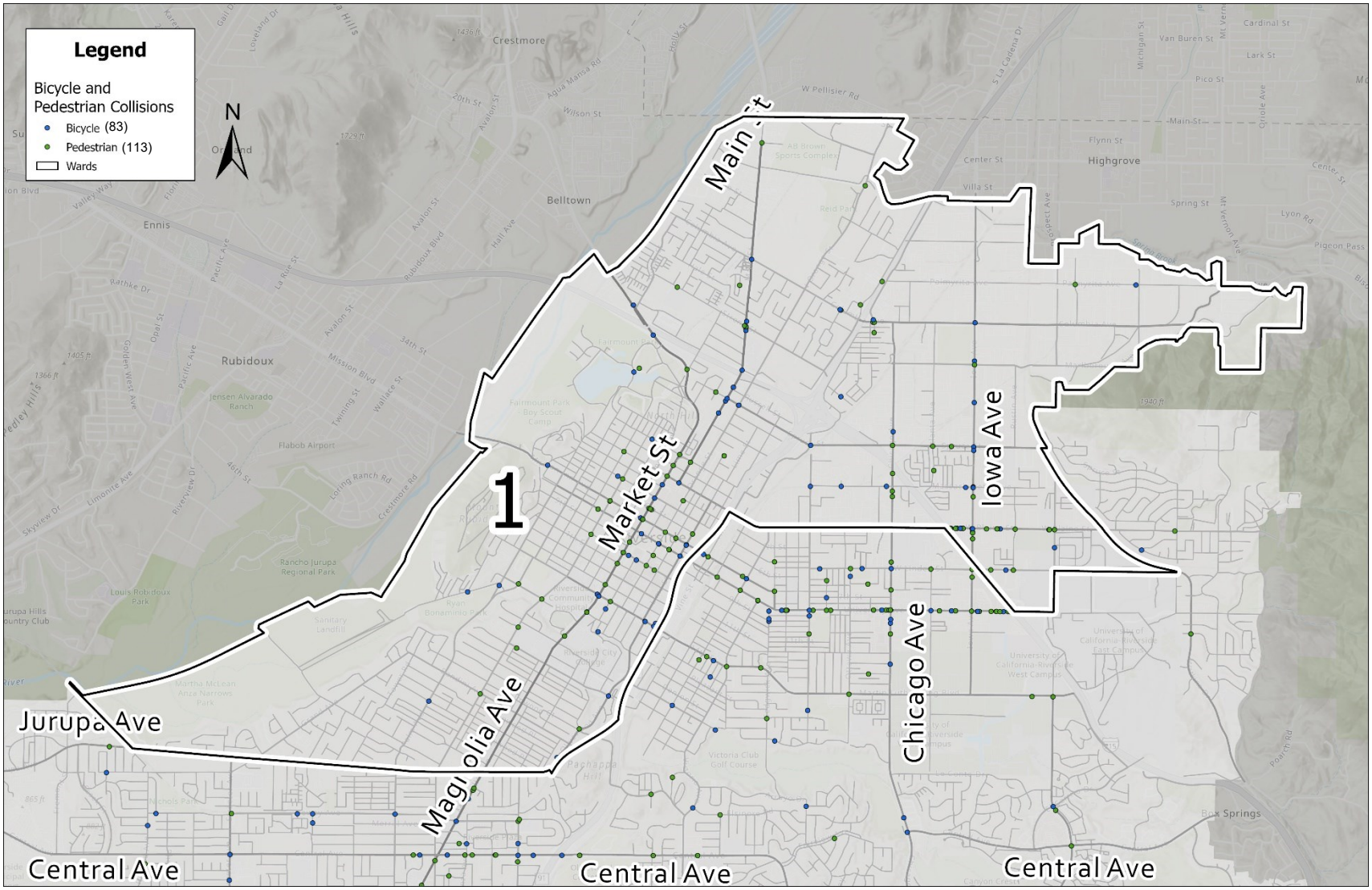


Figure 5- Collisions Analysis Results – Intersections (July 2017 – June 2022)

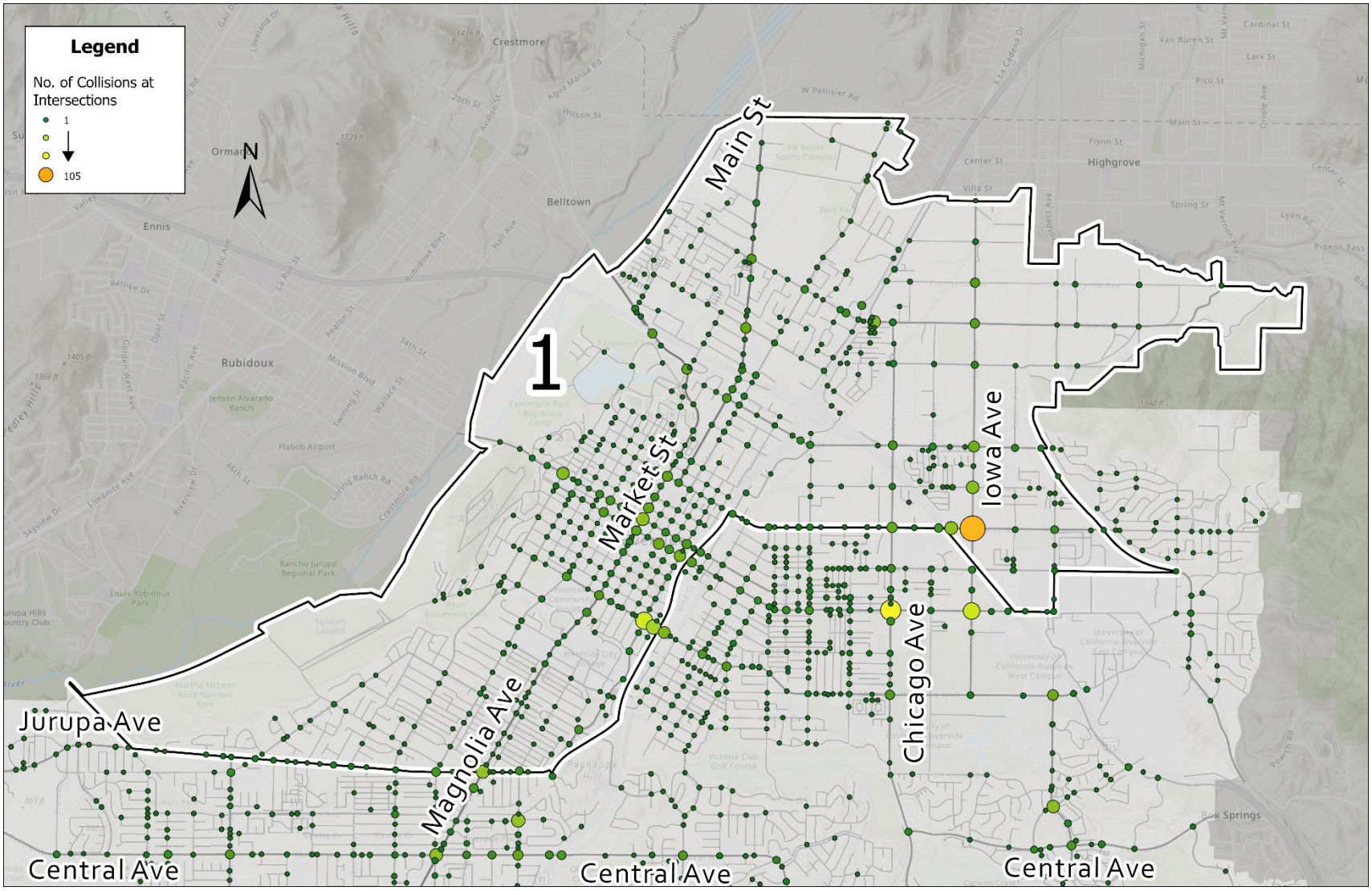
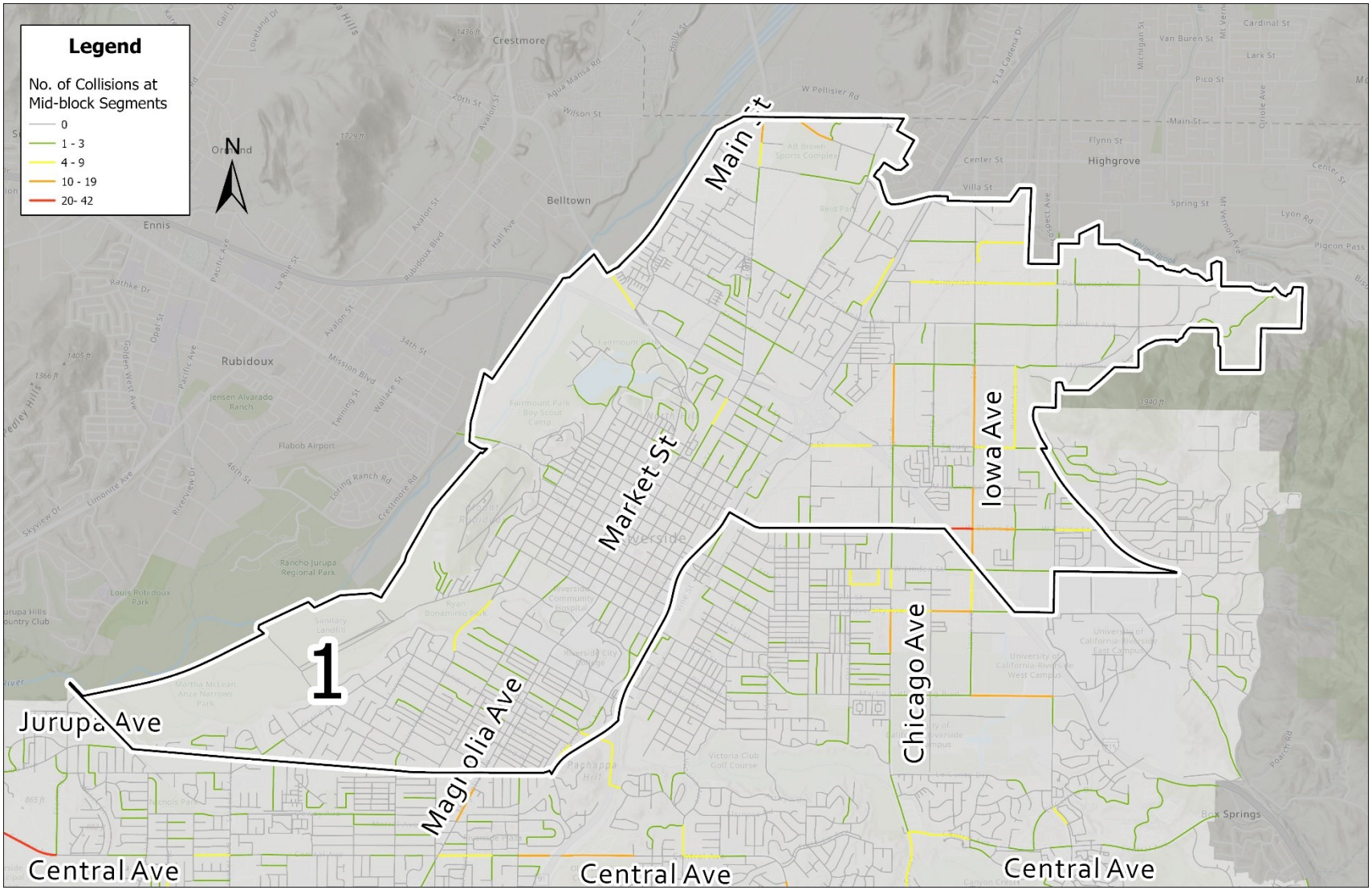


Figure 6- Collisions Analysis Results – Mid-block (July 2017 – June 2022)



WARD 2

Figure 1- Roadway Functional Classification and Signals

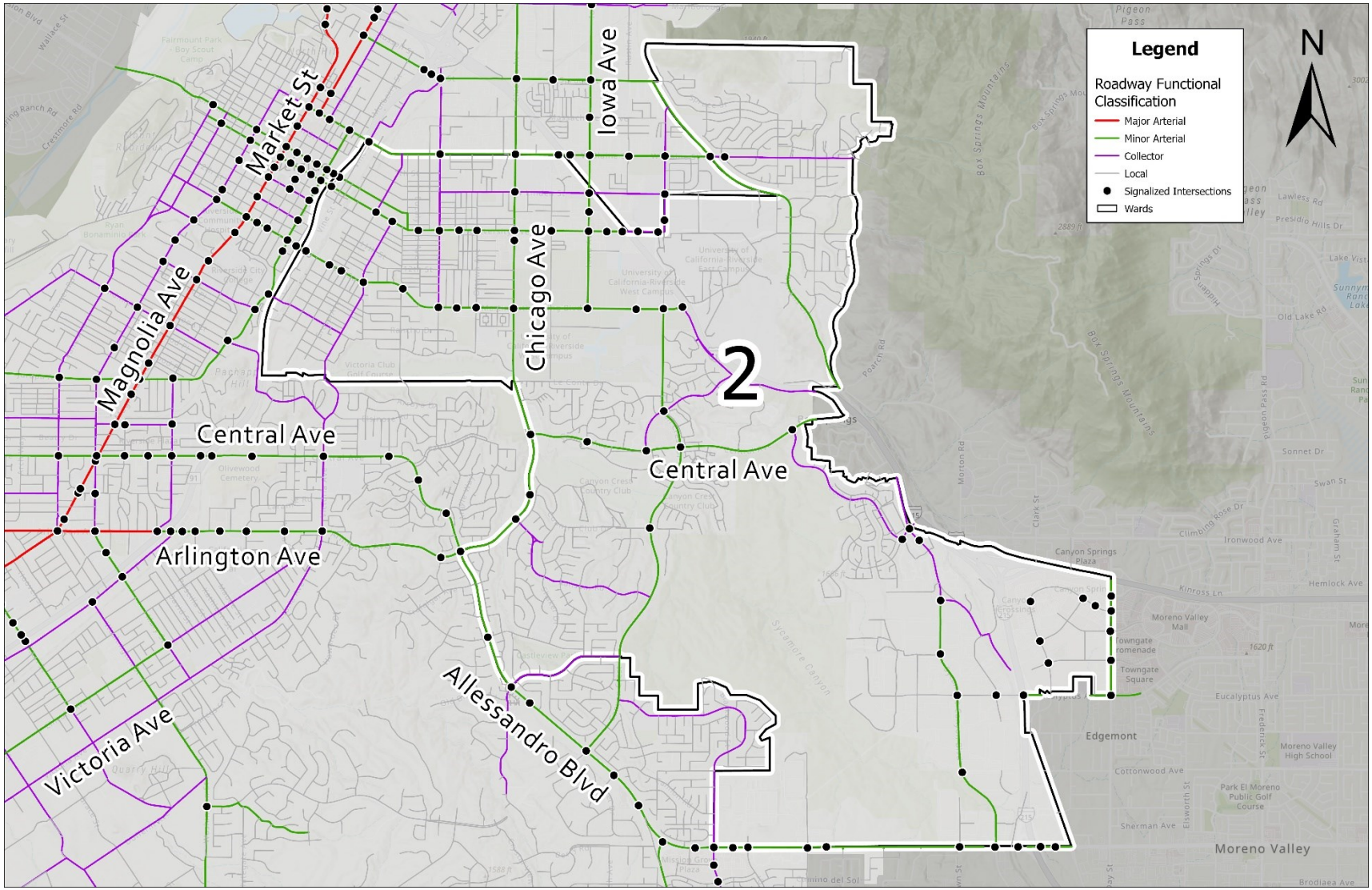


Figure 2- All Collisions (July 2017 – July 2022)

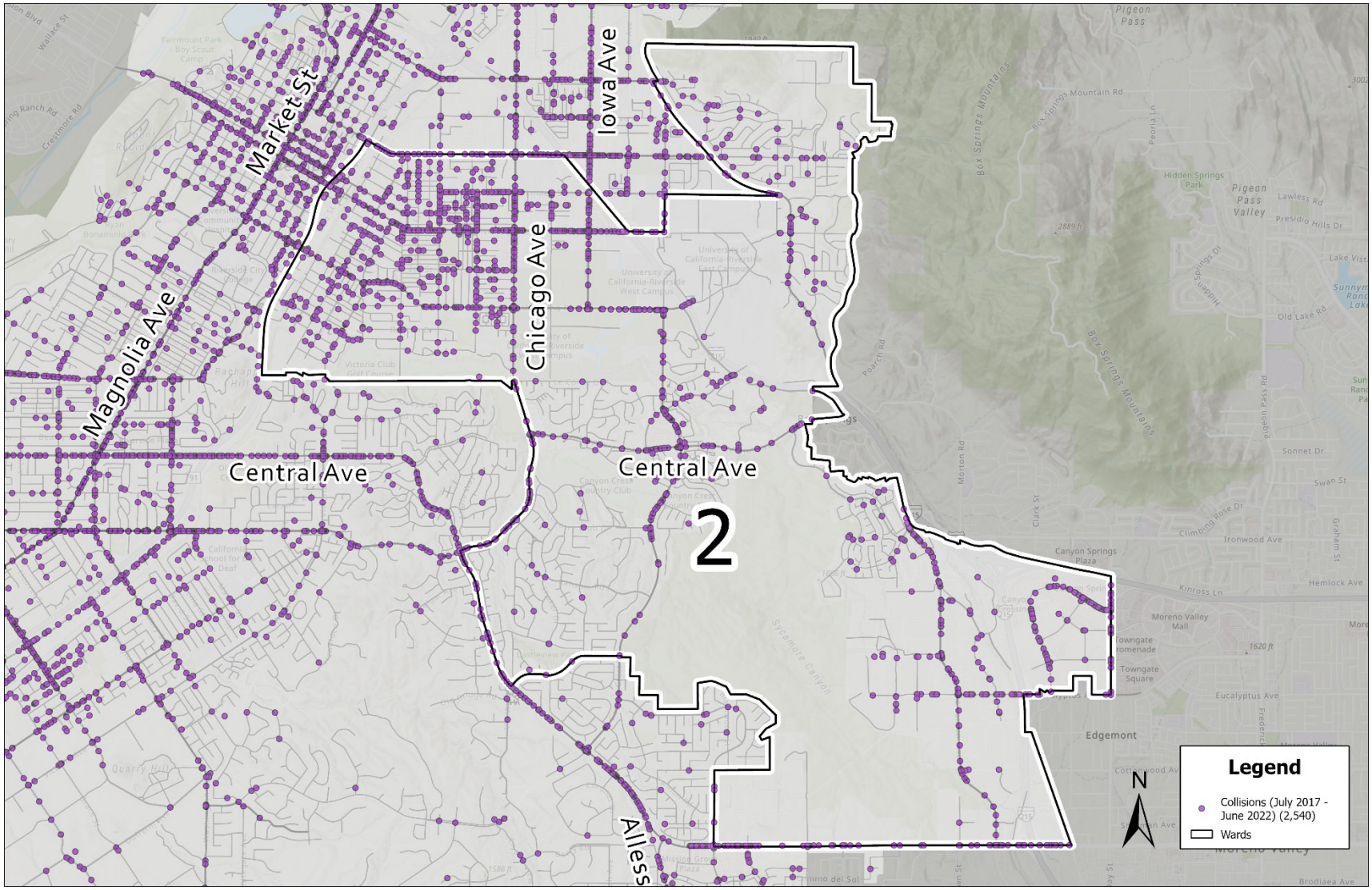


Figure 3- Fatal and Severe Injury Collisions (July 2017 – June 2022)

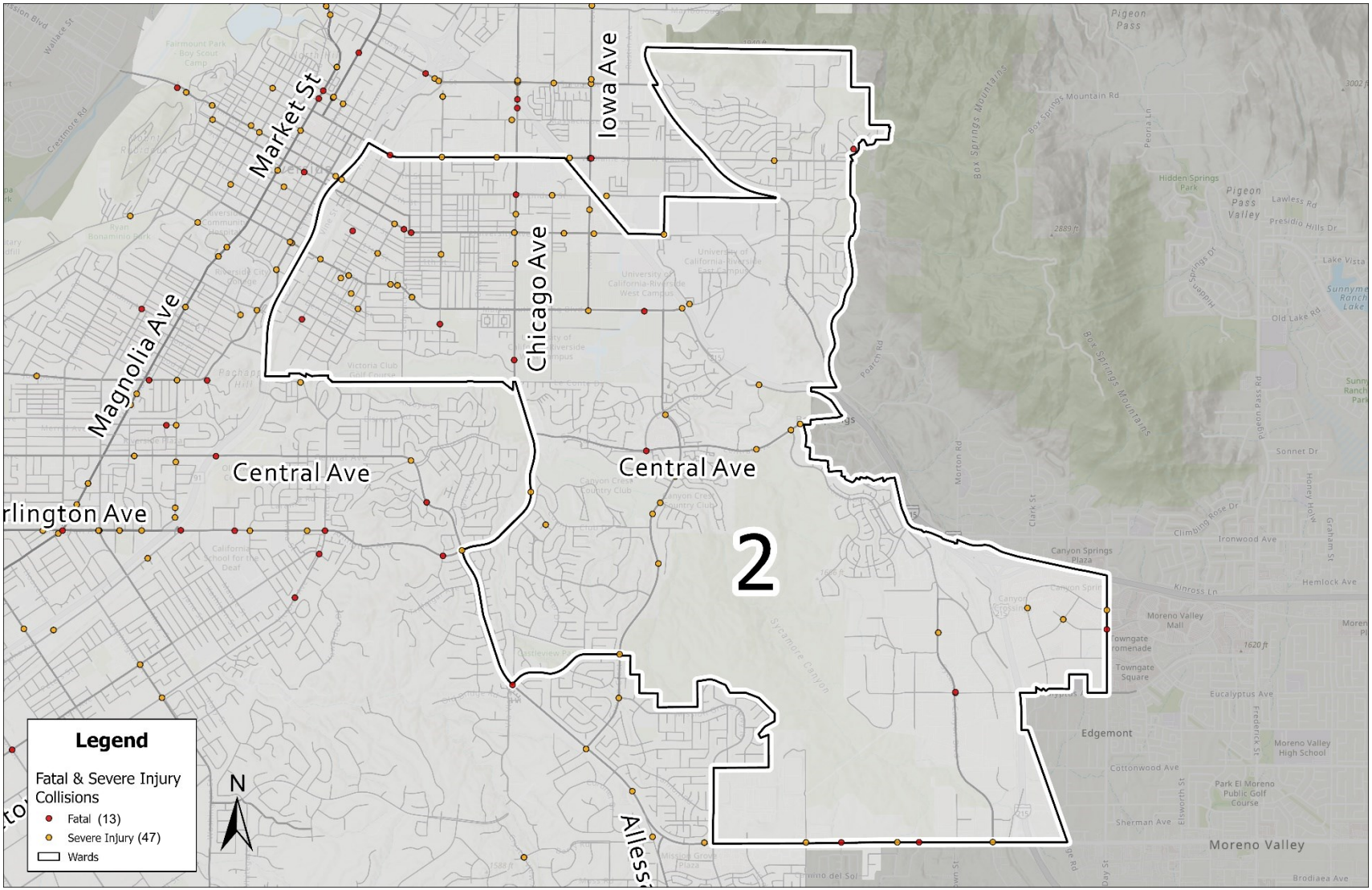


Figure 4- Bicycle and Pedestrian Collisions (July 2017 – June 2022)

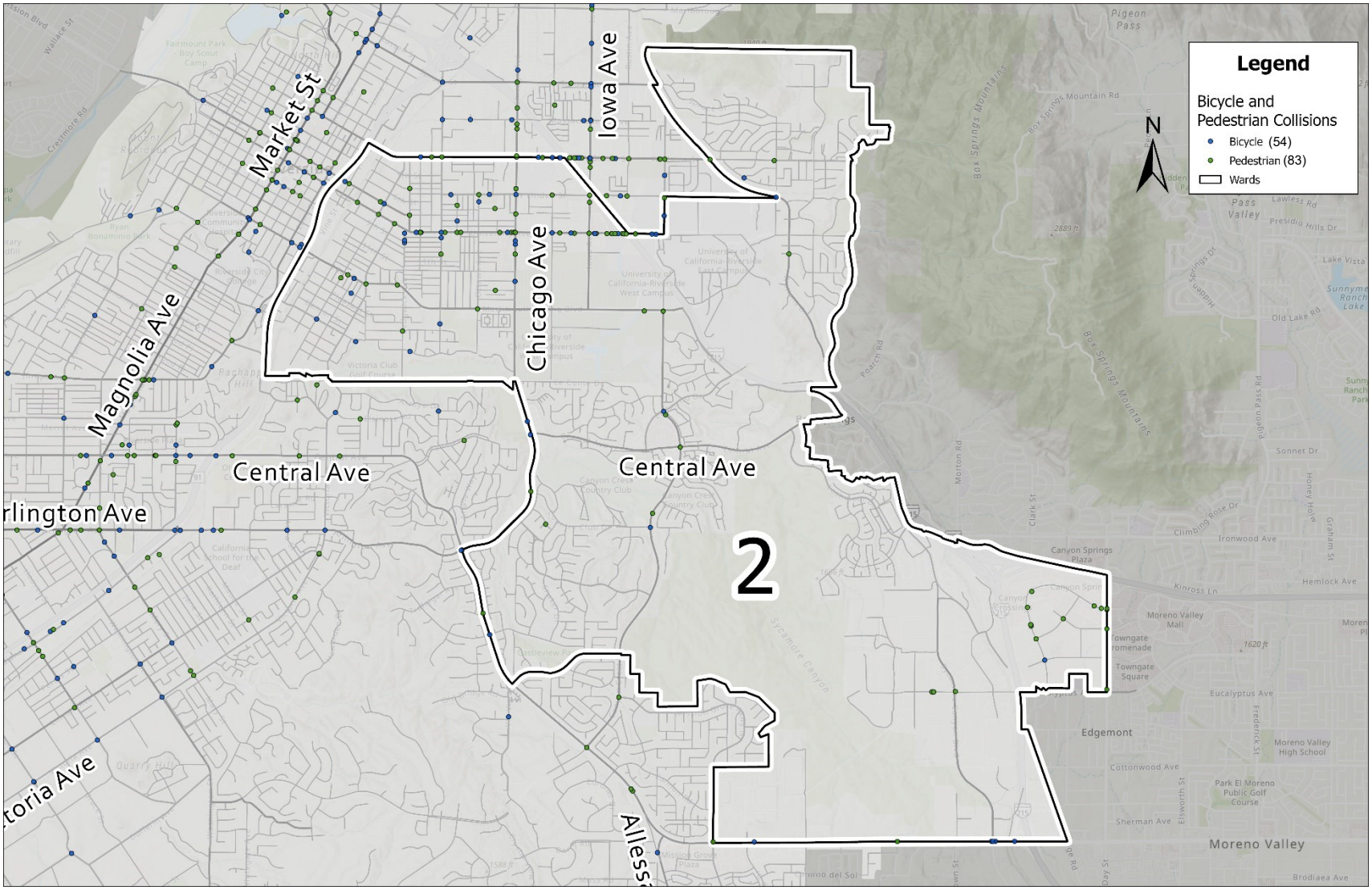


Figure 5- Collisions Analysis Results – Intersections (July 2017 – June 2022)

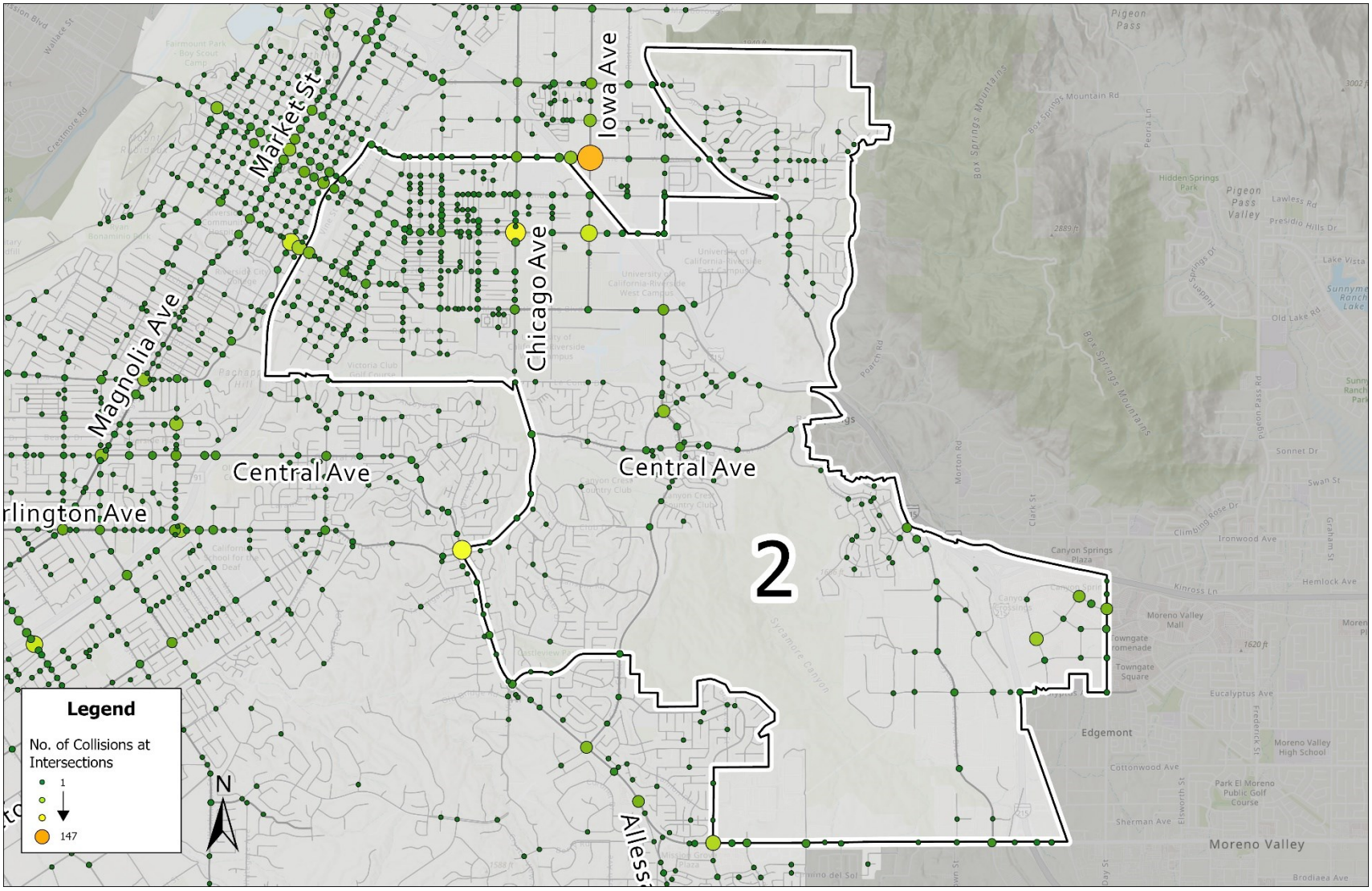
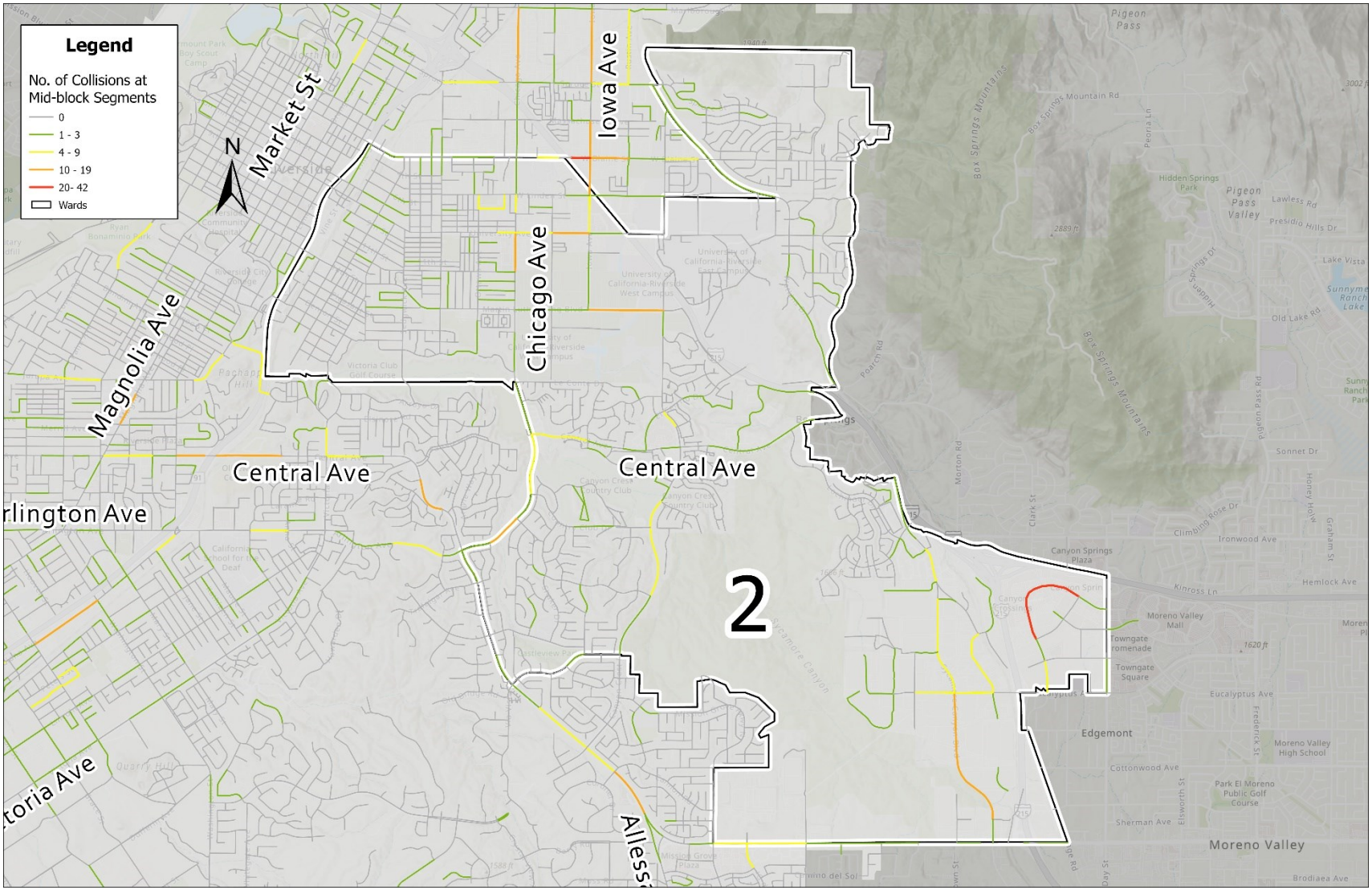


Figure 6- Collisions Analysis Results – Mid-block (July 2017 – June 2022)



WARD 3

Figure 1- Roadway Functional Classification and Signals

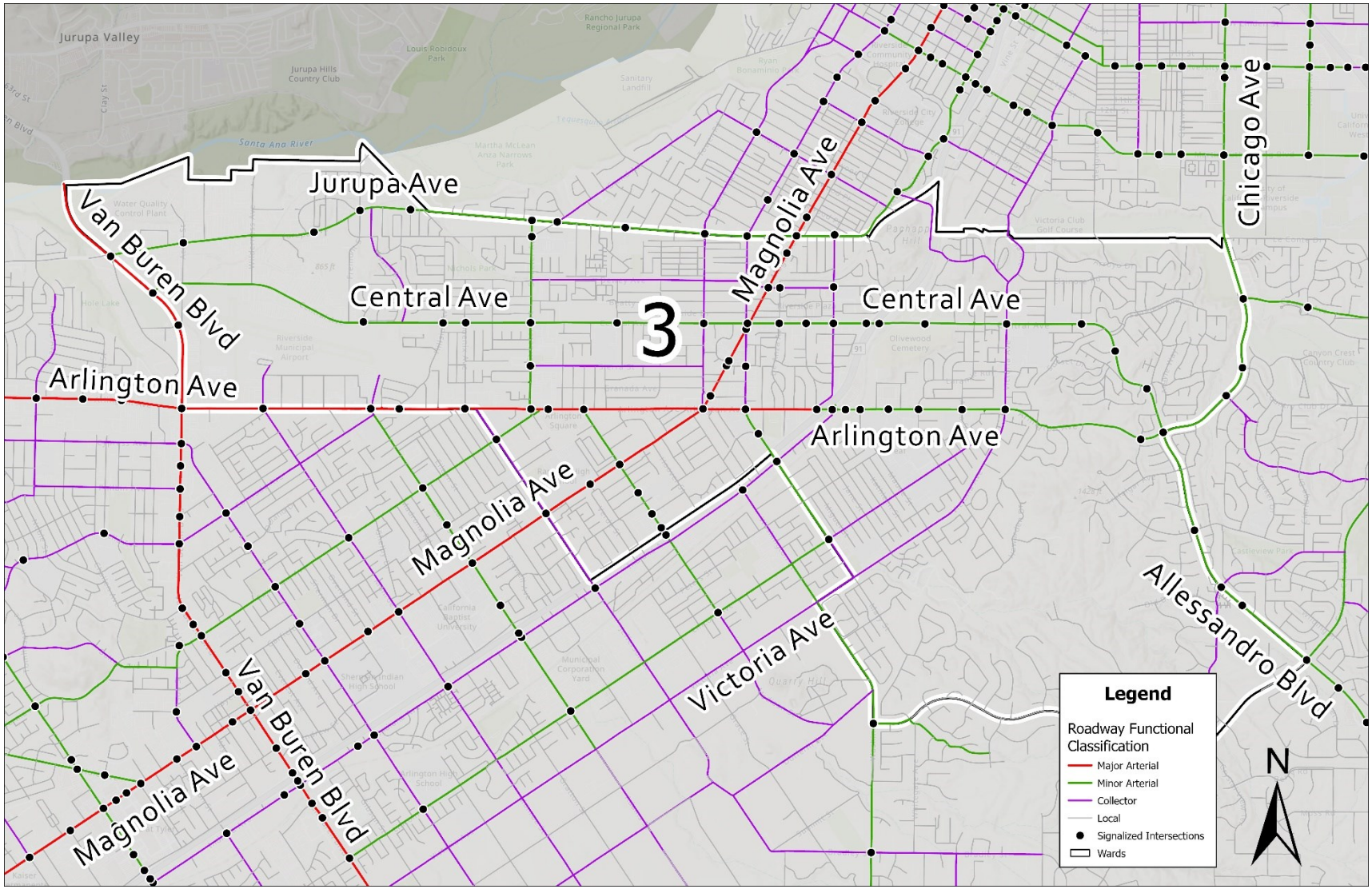


Figure 2- All Collisions (July 2017 – July 2022)

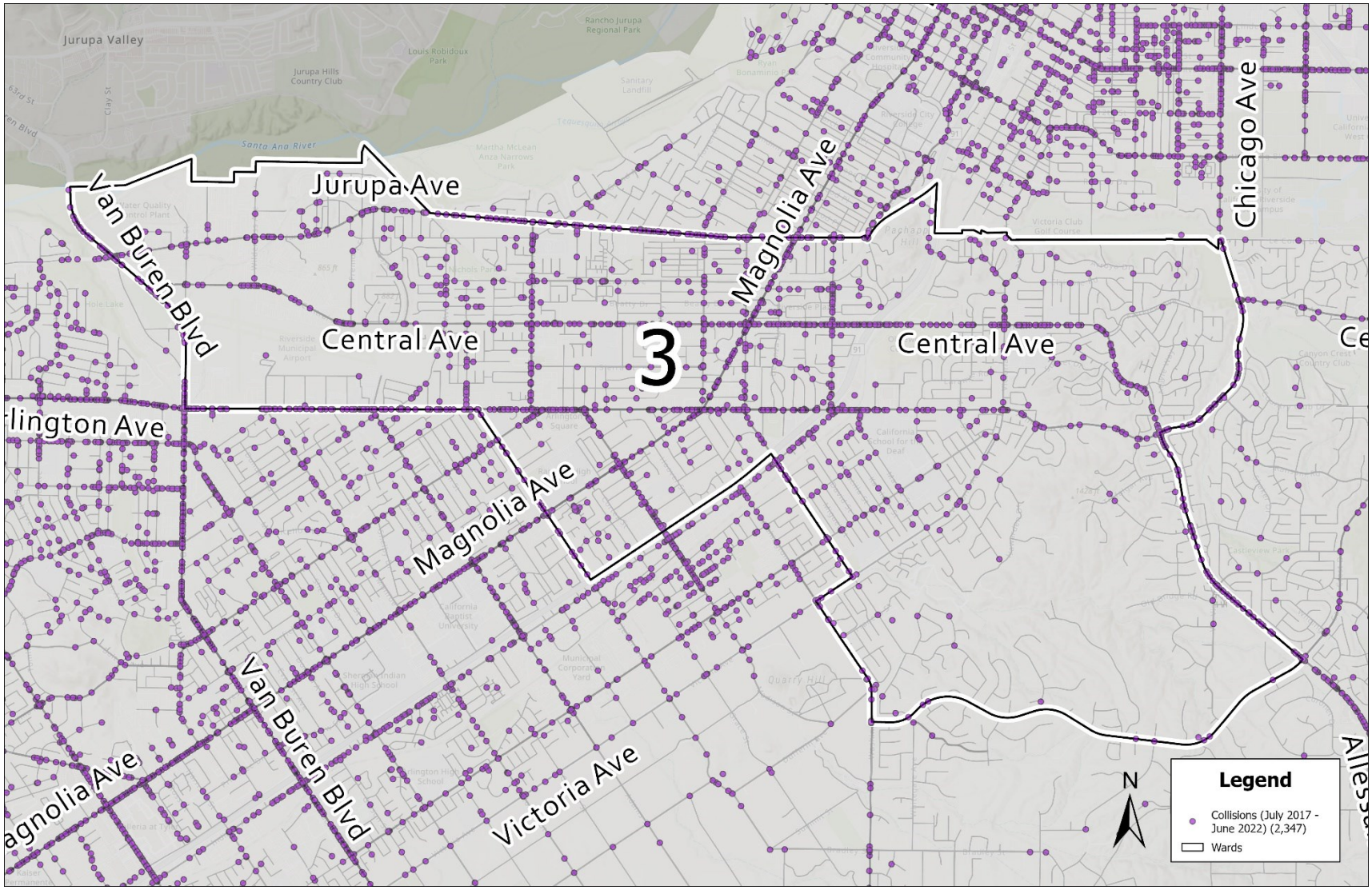


Figure 3- Fatal and Severe Injury Collisions (July 2017 – June 2022)

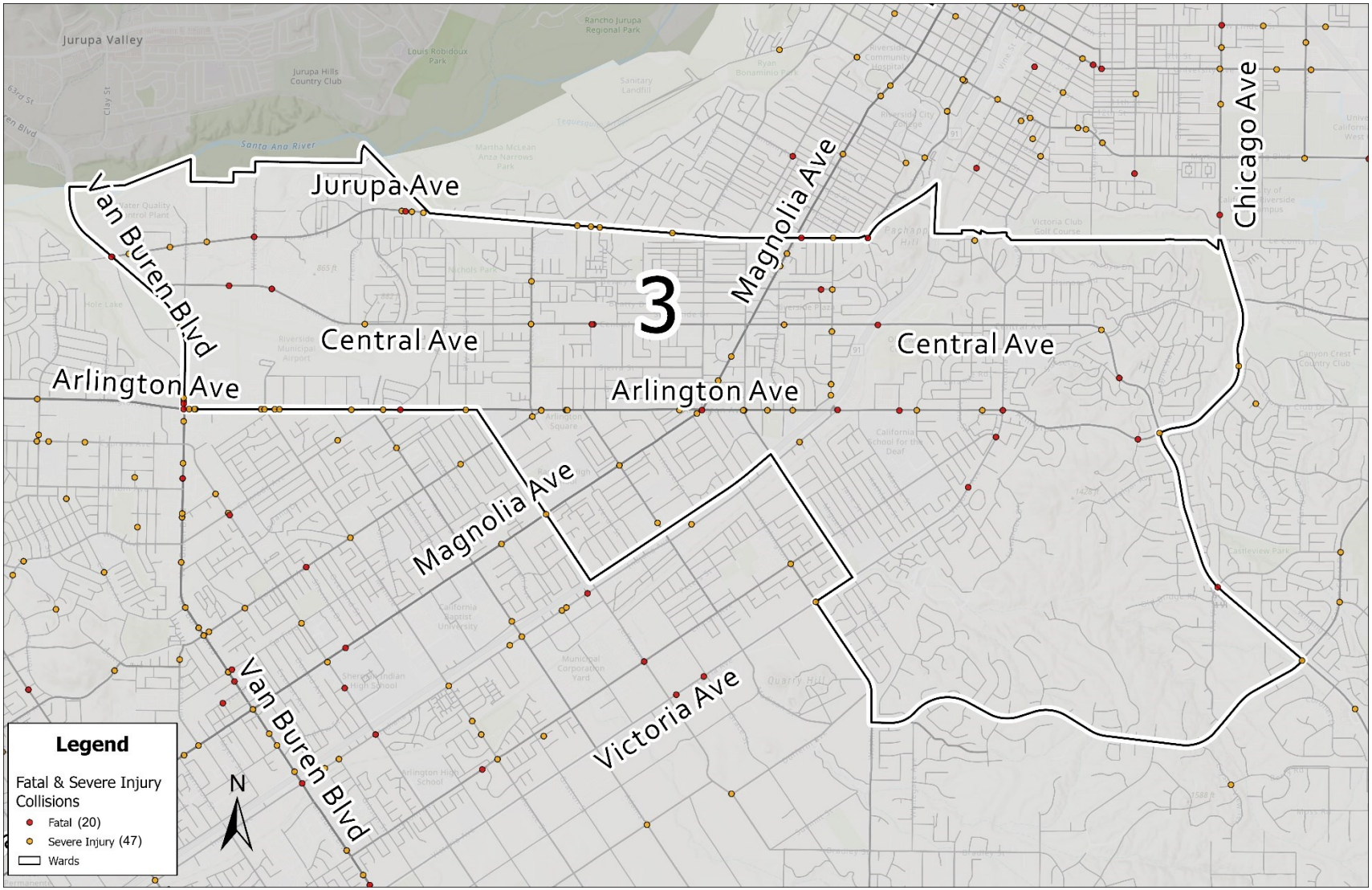


Figure 4- Bicycle and Pedestrian Collisions (July 2017 – June 2022)

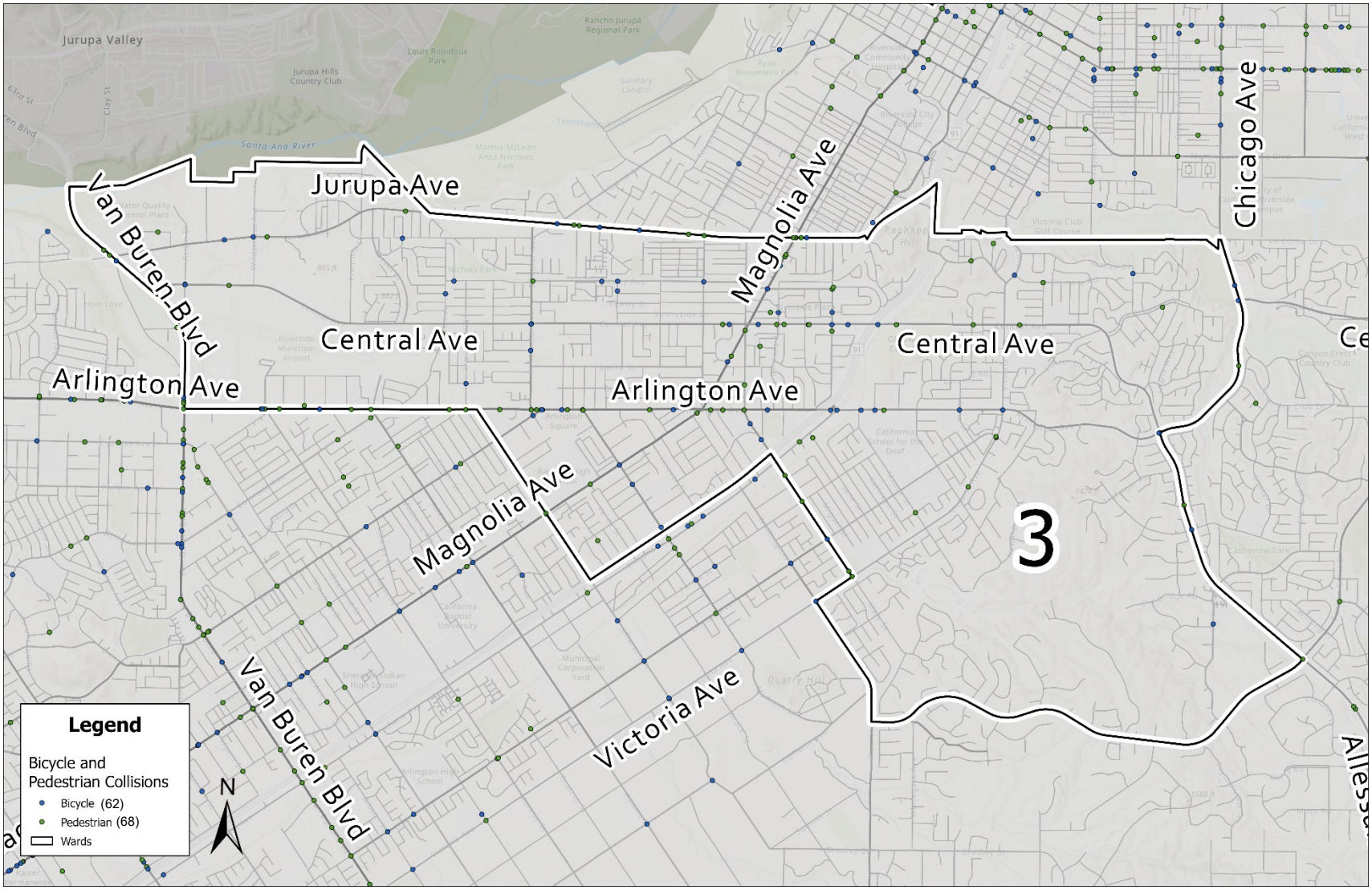


Figure 5- Collisions Analysis Results – Intersections (July 2017 – June 2022)

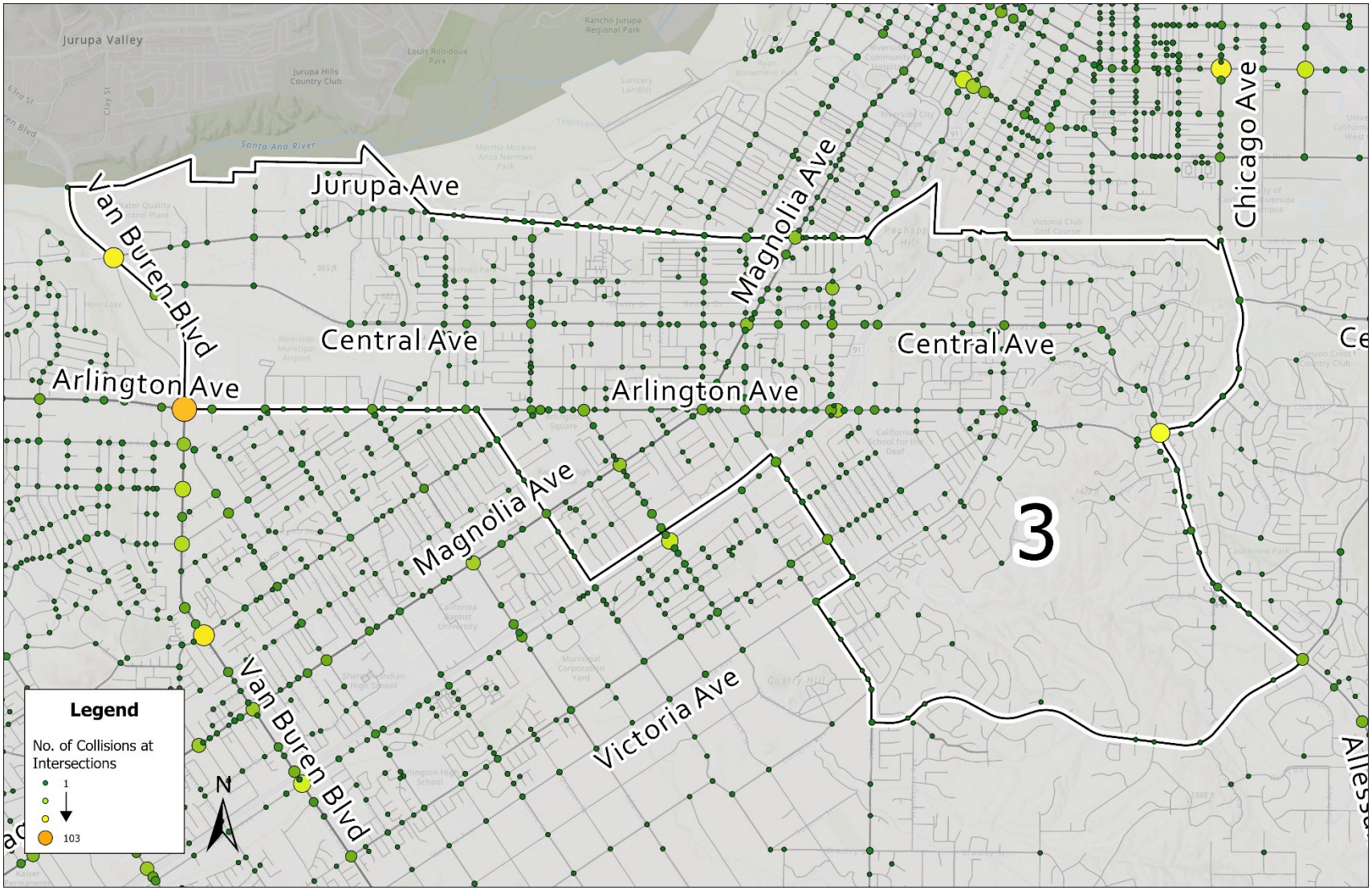
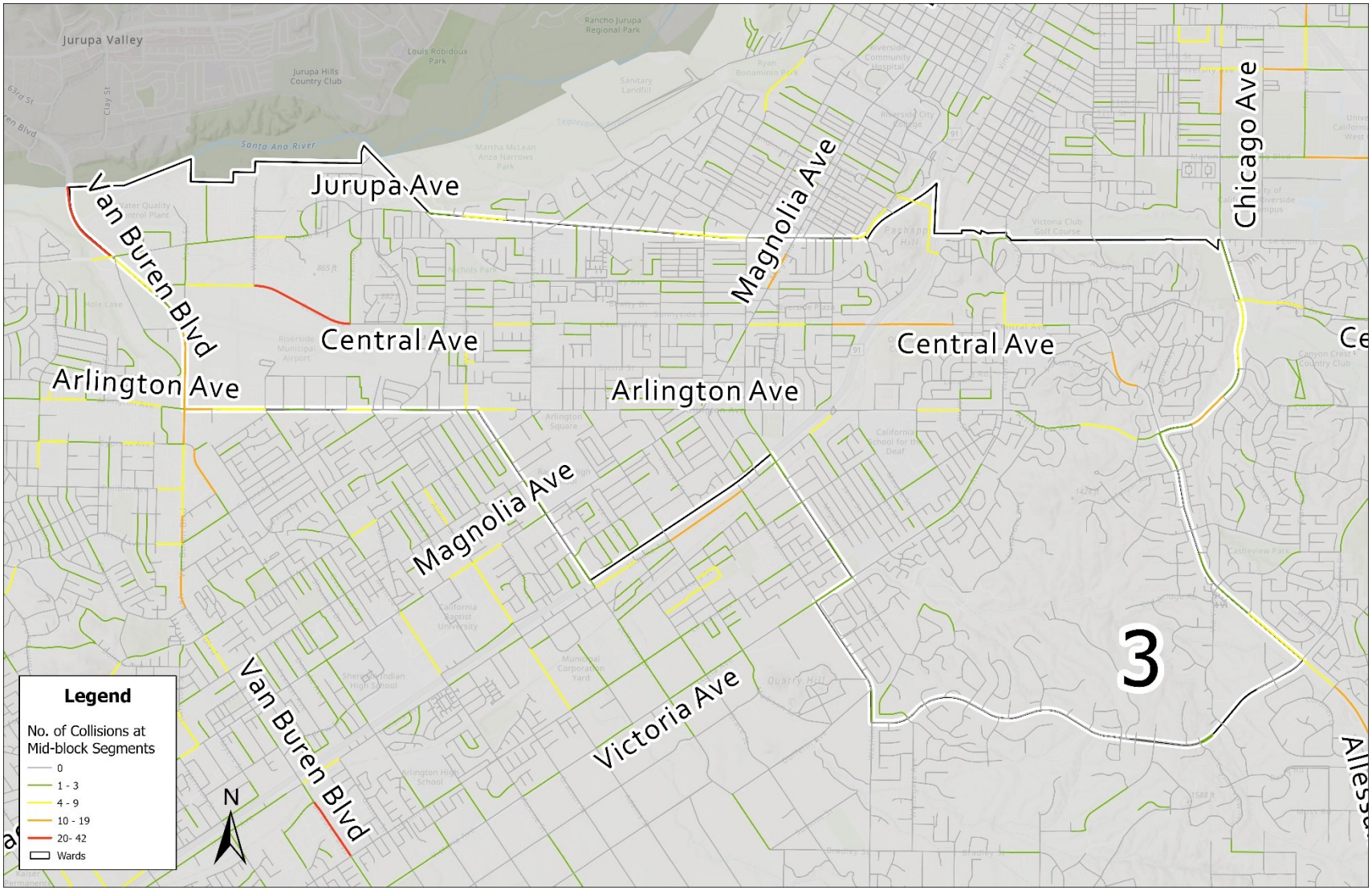


Figure 6- Collisions Analysis Results – Mid-block (July 2017 – June 2022)



WARD 4

Figure 1- Roadway Functional Classification and Signals

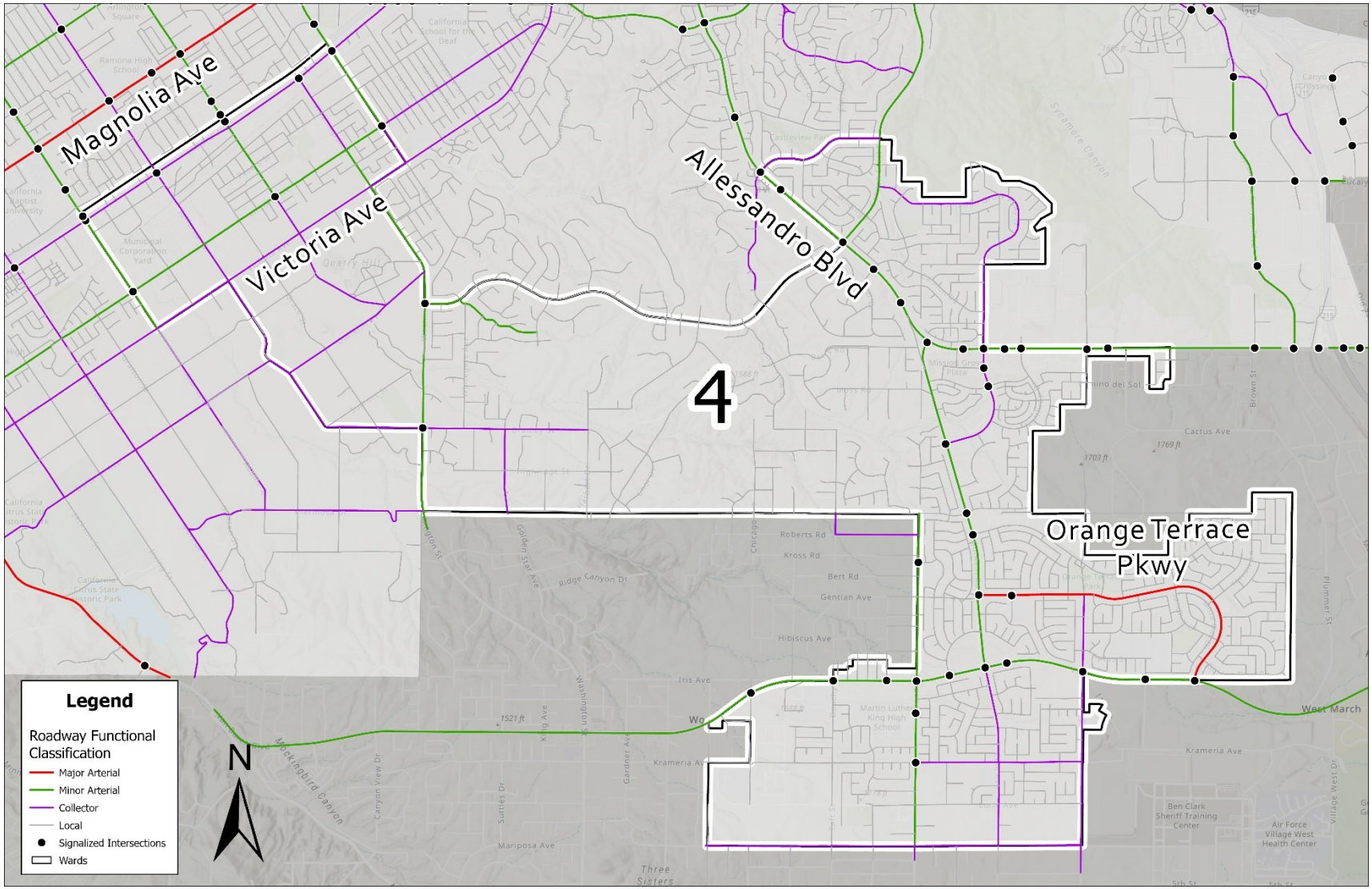


Figure 2- All Collisions (July 2017 – July 2022)

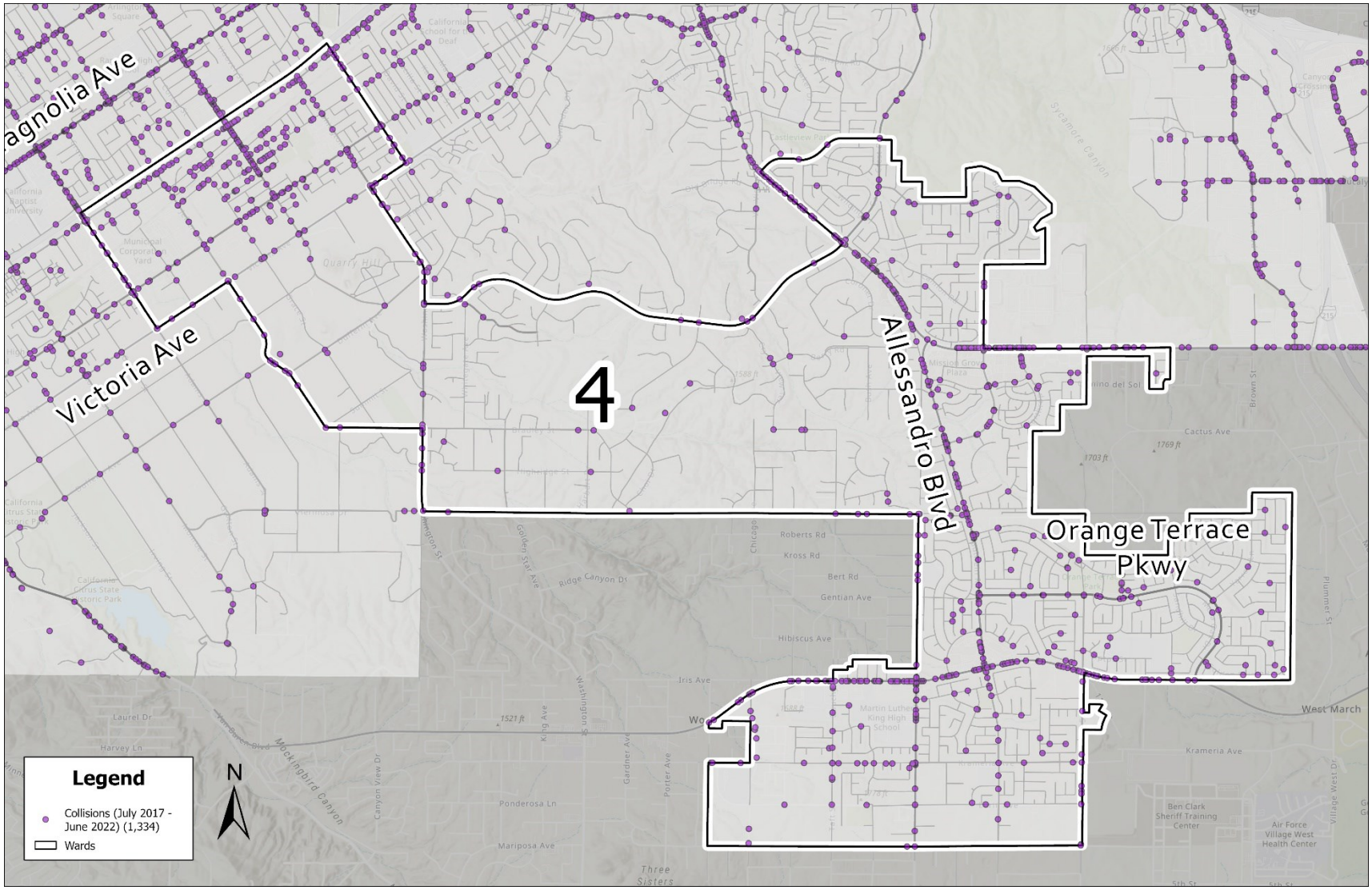


Figure 3- Fatal and Severe Injury Collisions (July 2017 – June 2022)

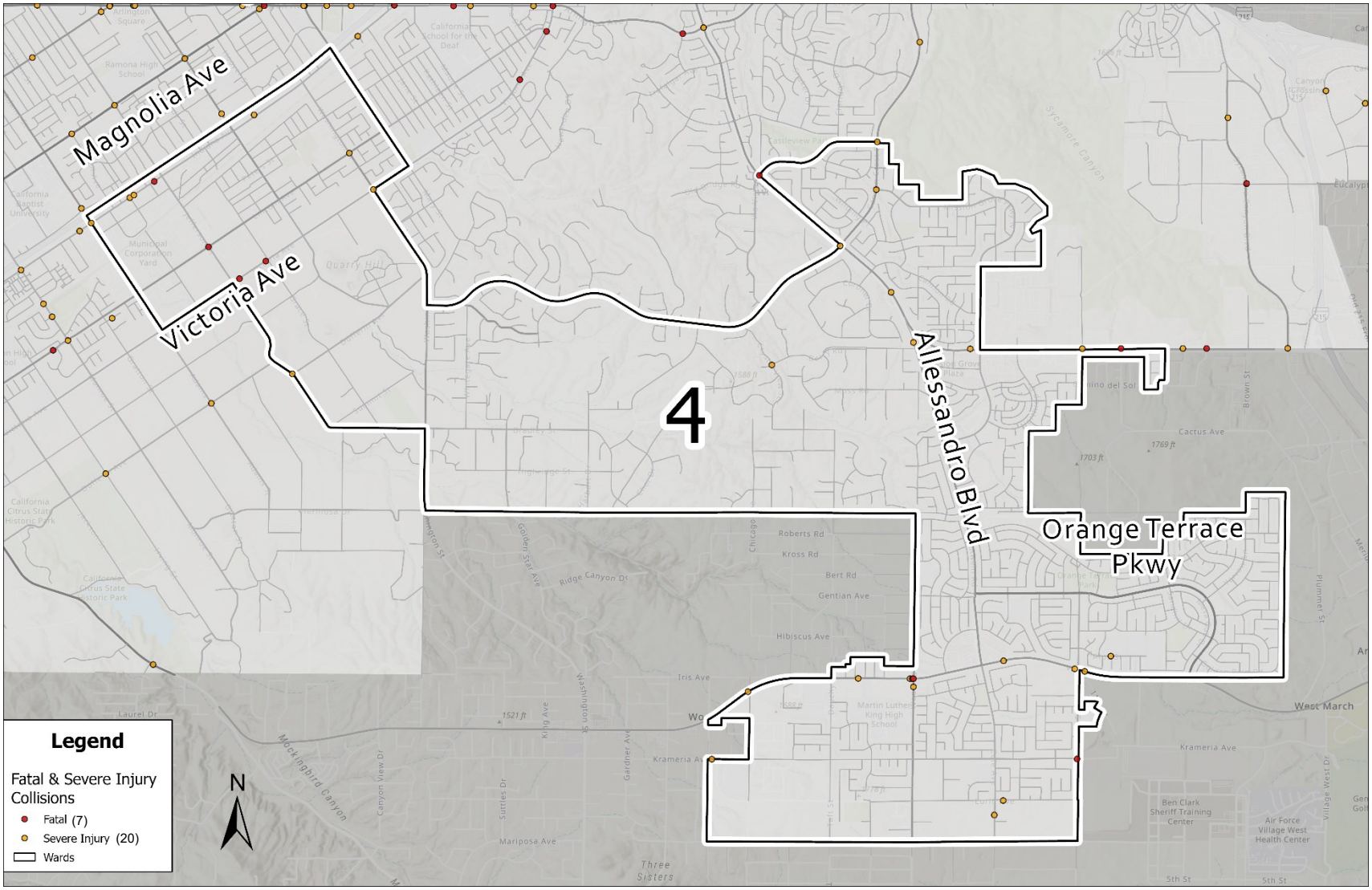


Figure 4- Bicycle and Pedestrian Collisions (July 2017 – June 2022)

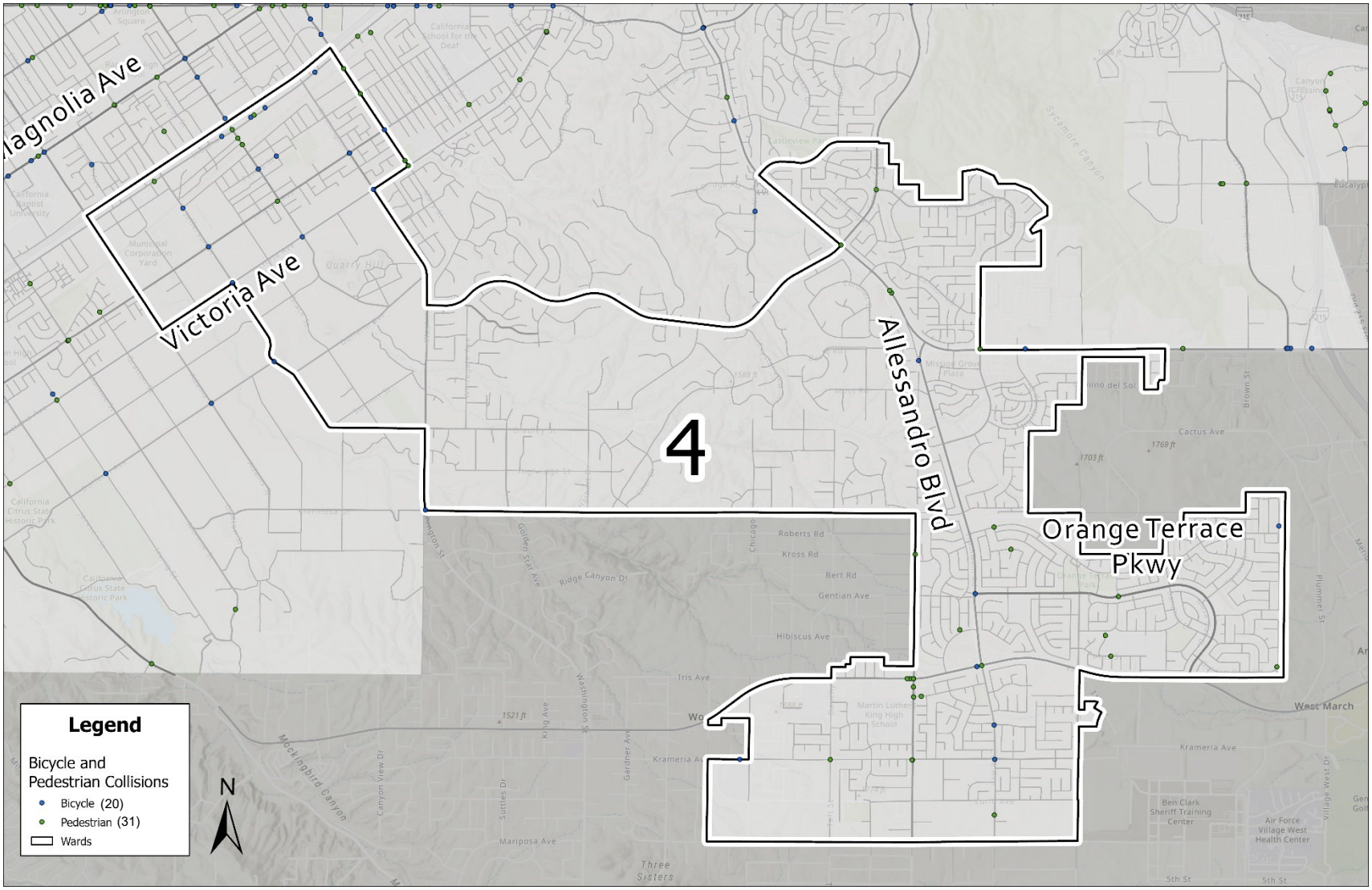


Figure 5- Collisions Analysis Results – Intersections (July 2017 – June 2022)

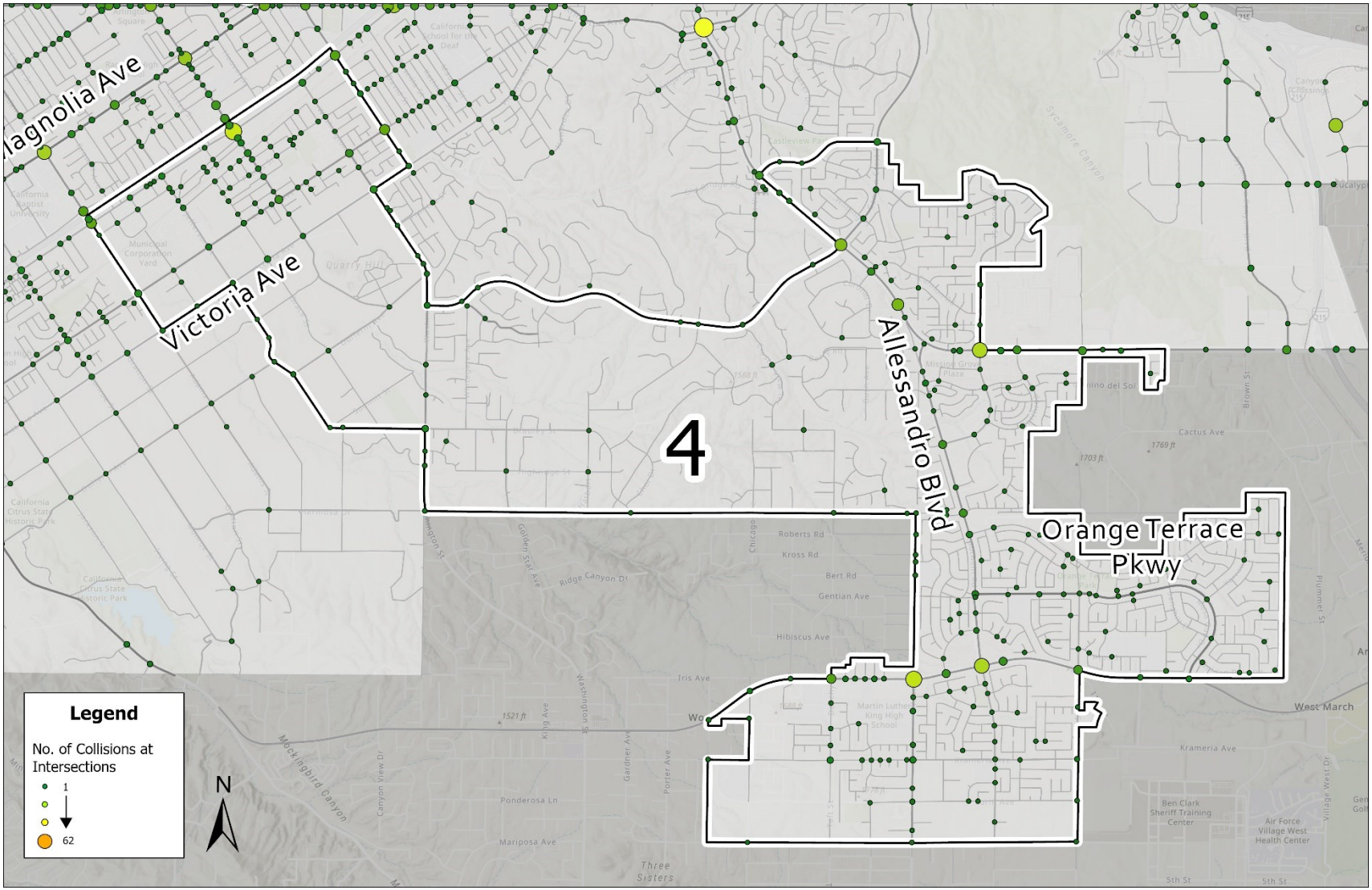
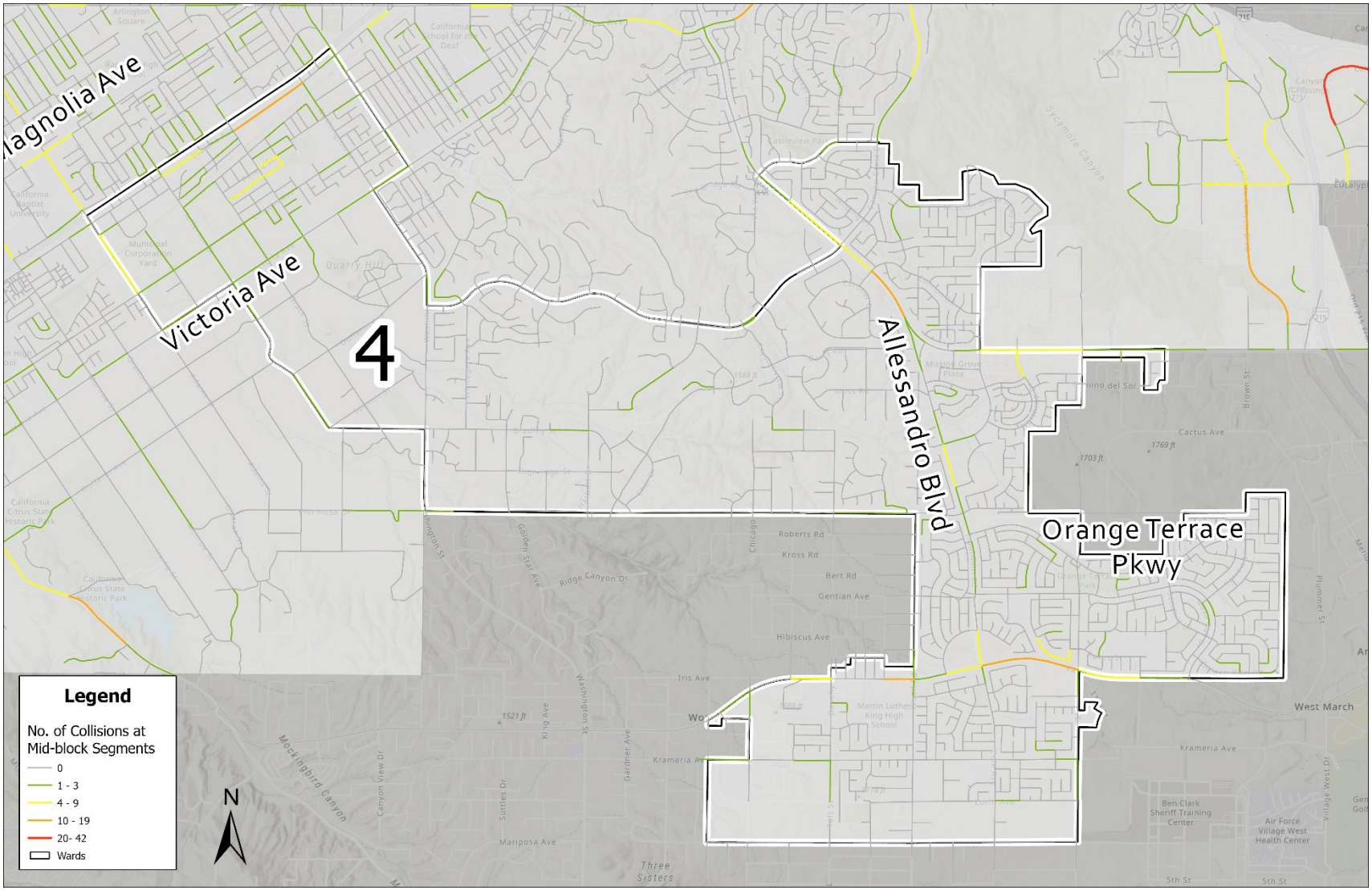


Figure 6- Collisions Analysis Results – Mid-block (July 2017 – June 2022)



WARD 5

Figure 1- Roadway Functional Classification and Signals

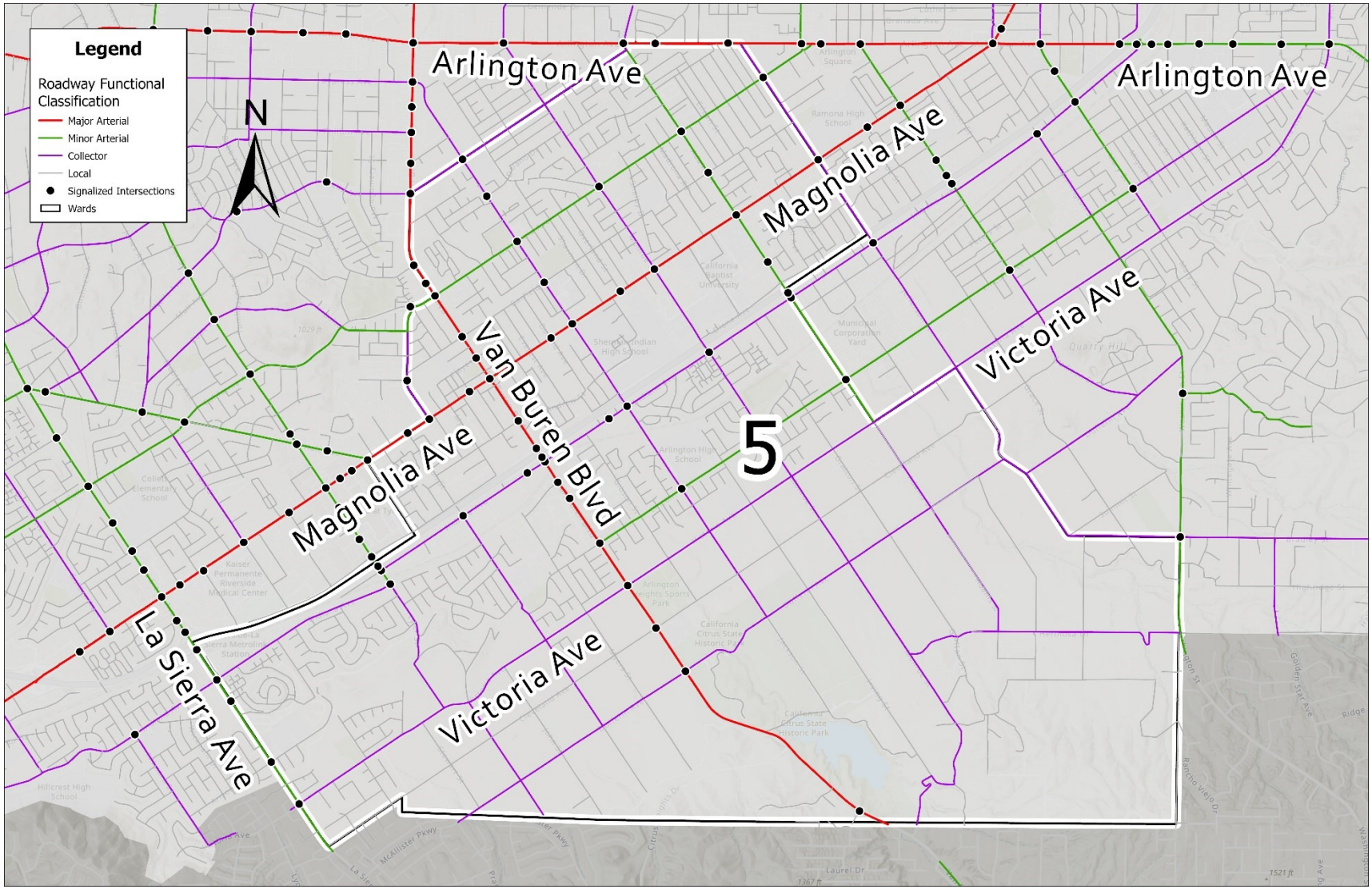


Figure 2- All Collisions (July 2017 – July 2022)

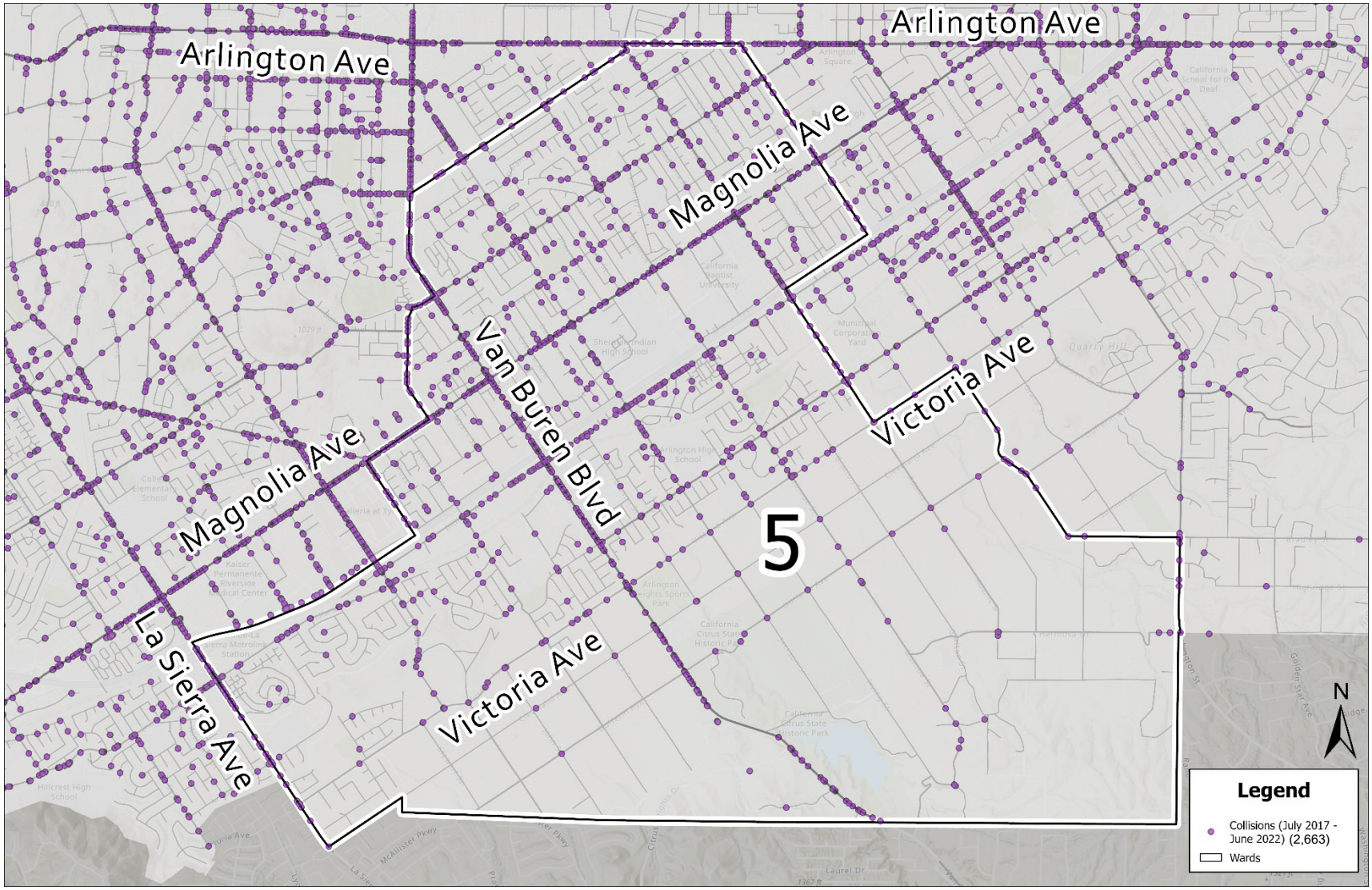


Figure 3- Fatal and Severe Injury Collisions (July 2017 – June 2022)

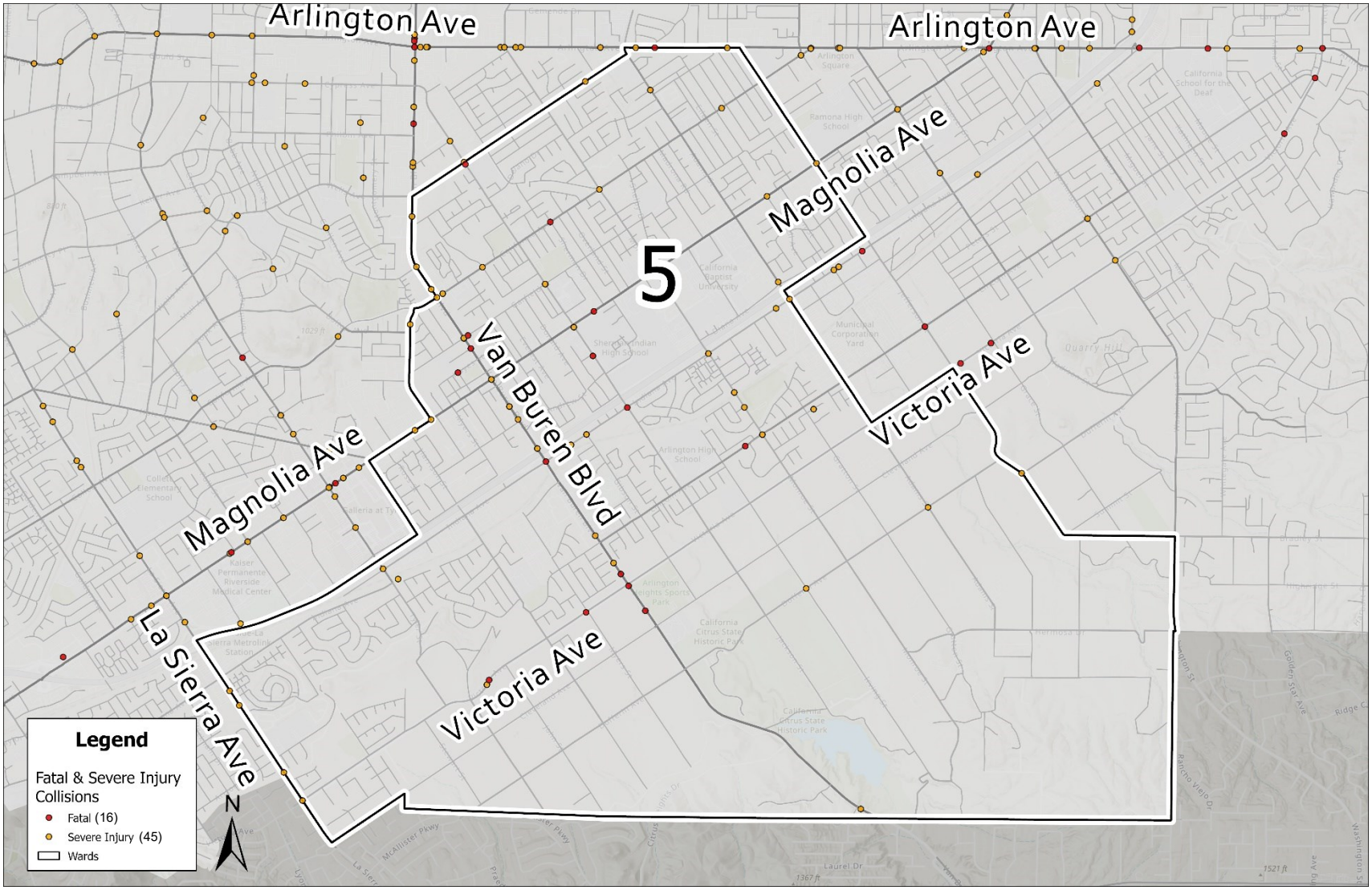


Figure 4- Bicycle and Pedestrian Collisions (July 2017 – June 2022)

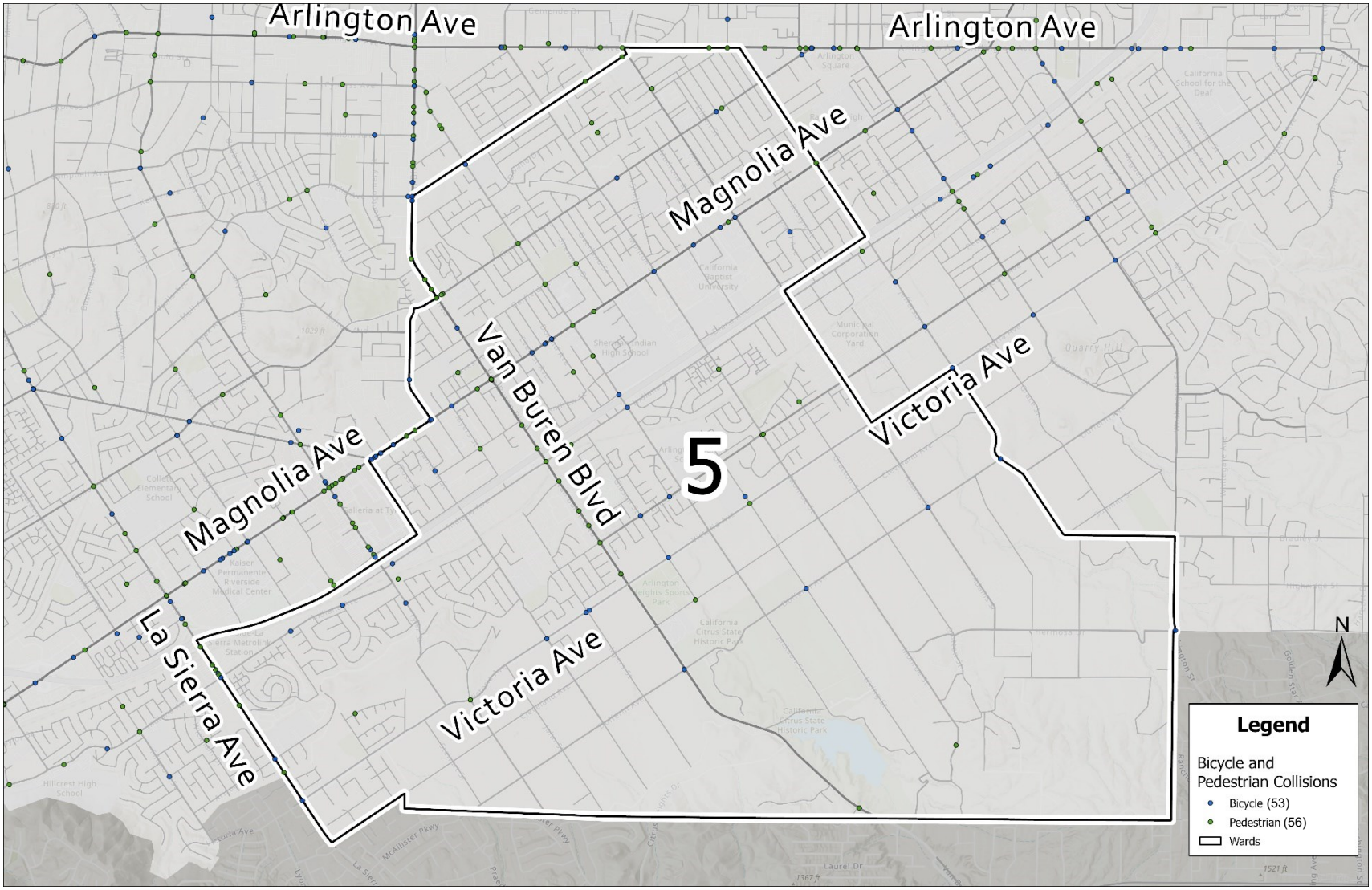


Figure 5- Collisions Analysis Results – Intersections (July 2017 – June 2022)

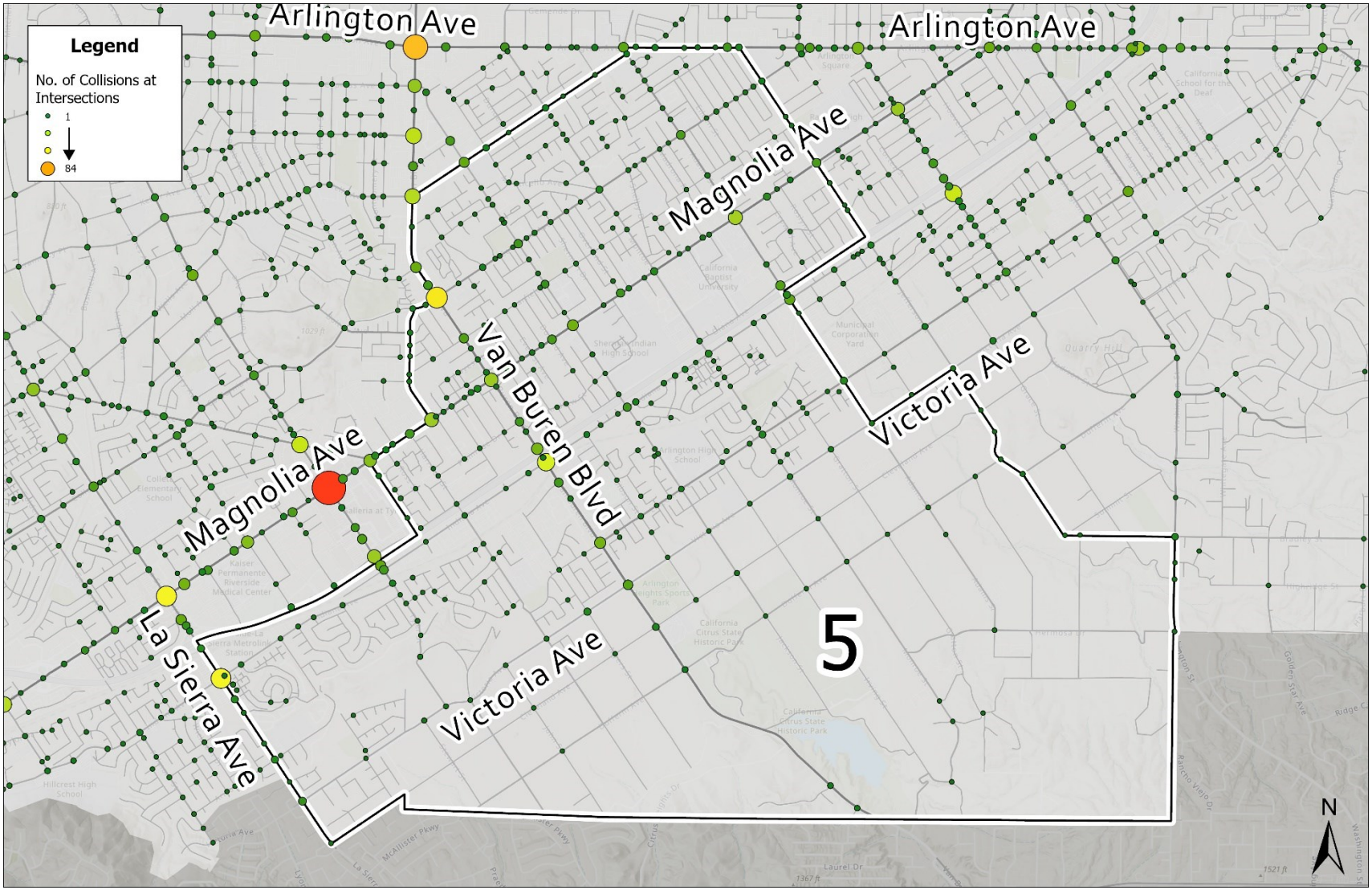
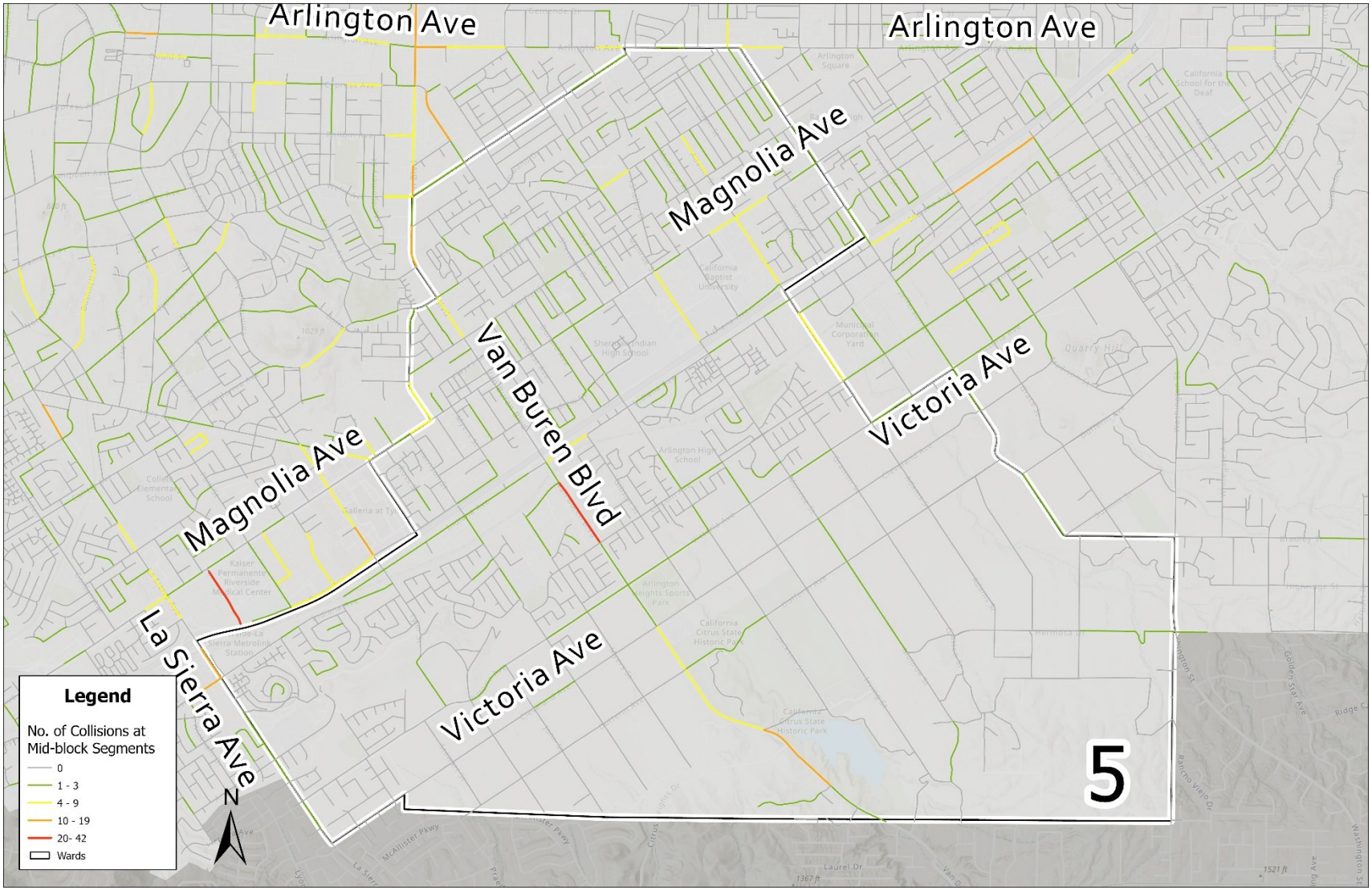


Figure 6- Collisions Analysis Results – Mid-block (July 2017 – June 2022)



WARD 6

Figure 1- Roadway Functional Classification and Signals

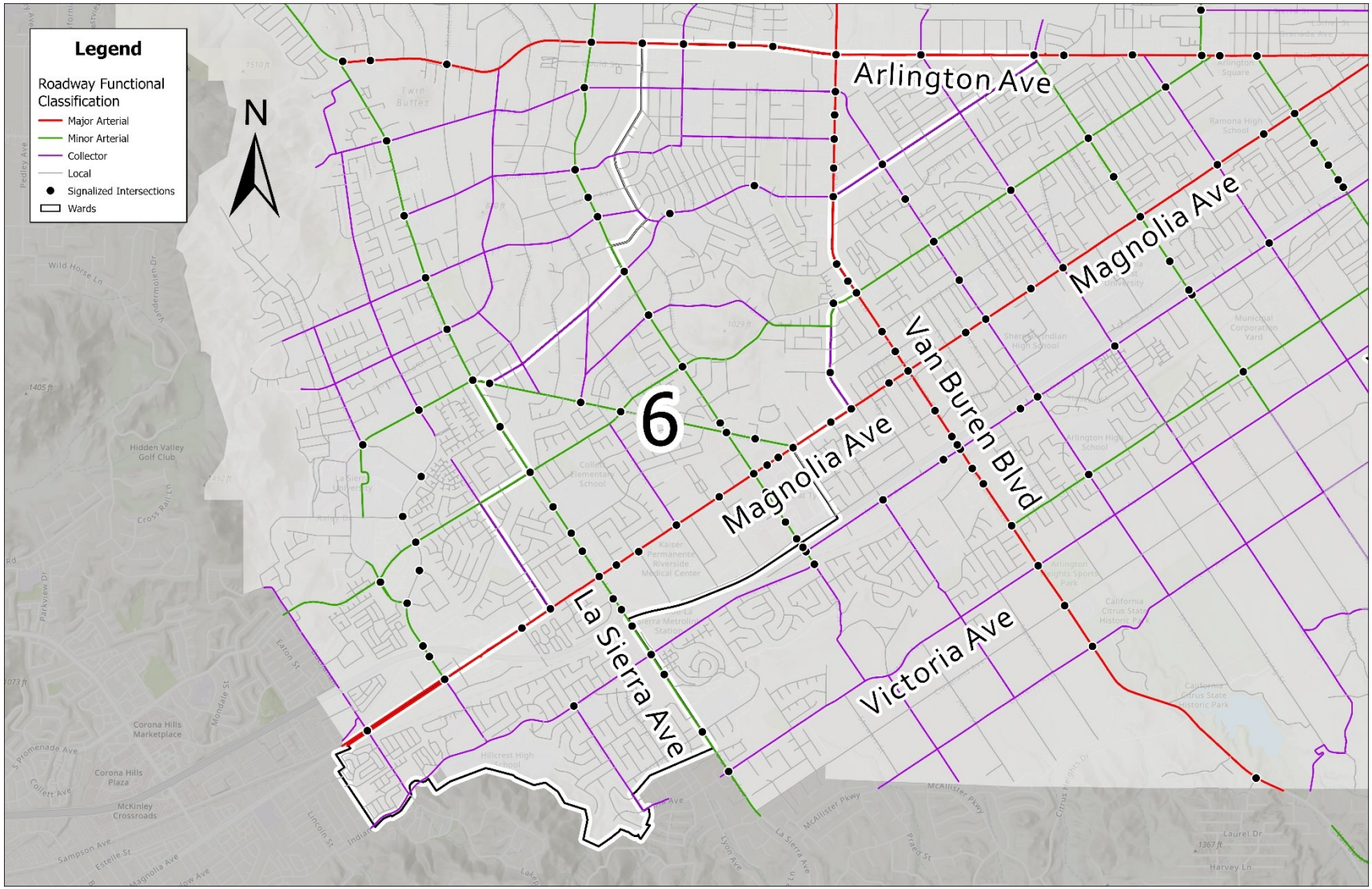


Figure 2- All Collisions (July 2017 – July 2022)

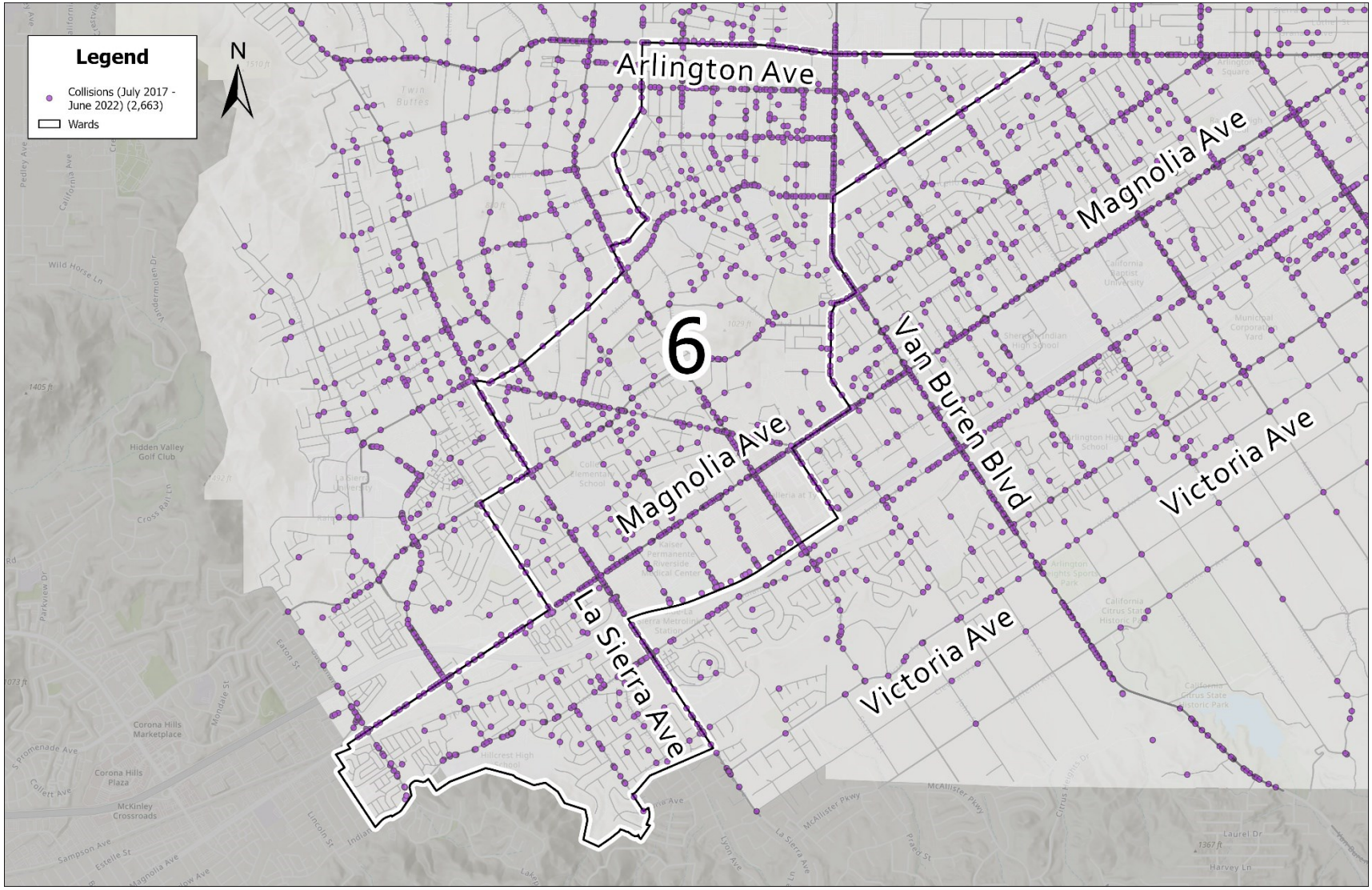


Figure 3- Fatal and Severe Injury Collisions (July 2017 – June 2022)

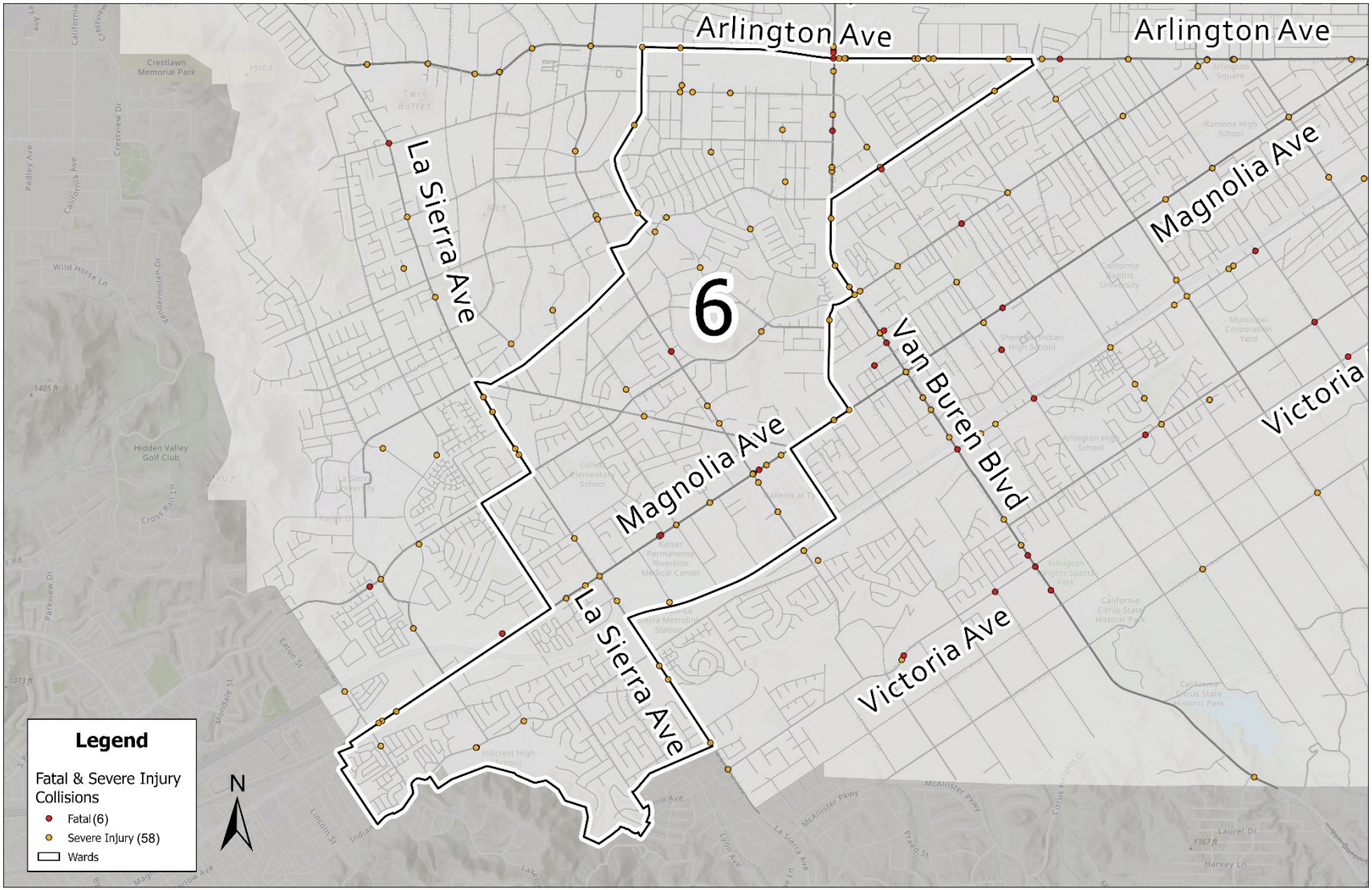


Figure 4- Bicycle and Pedestrian Collisions (July 2017 – June 2022)

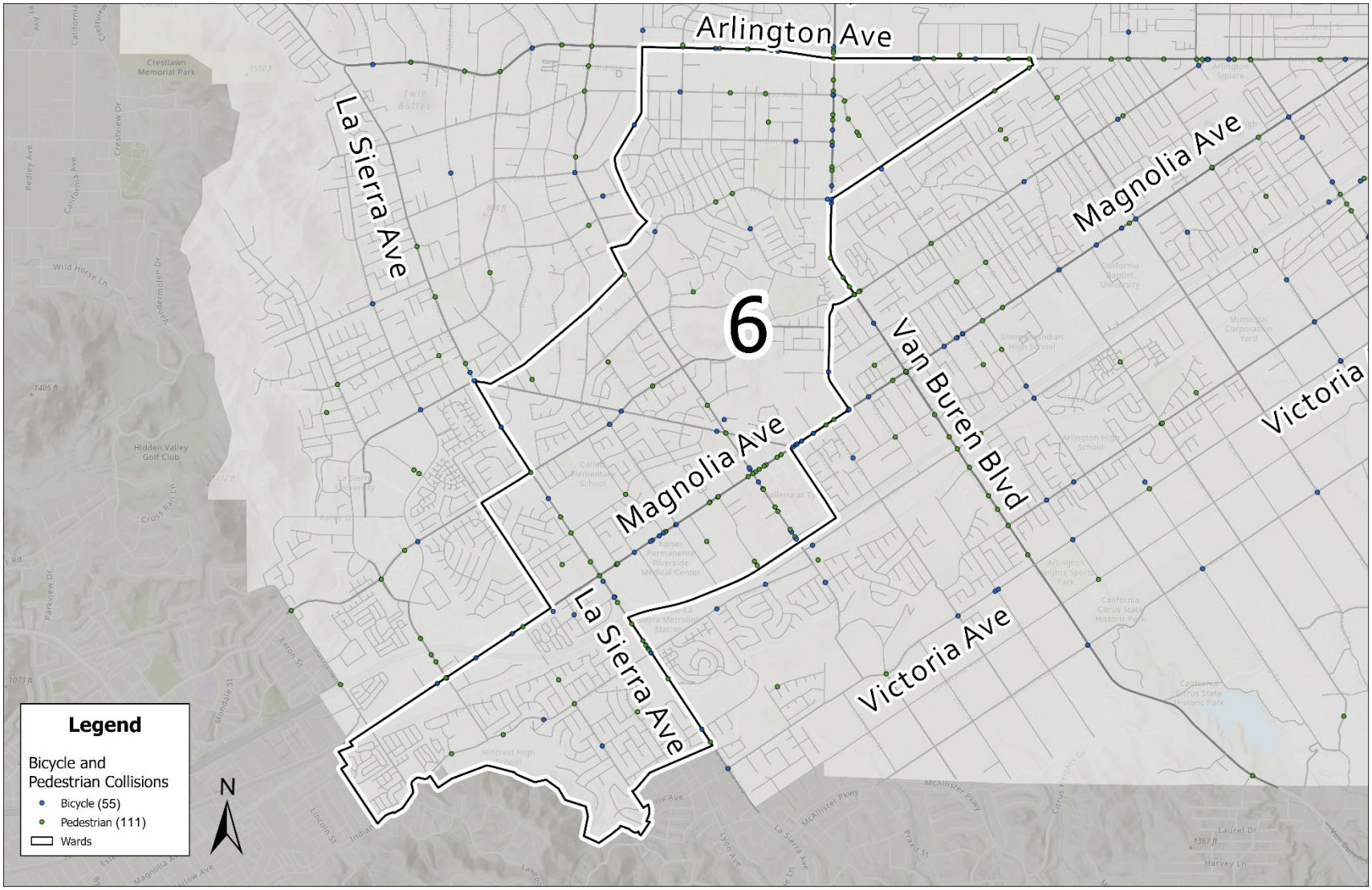


Figure 5- Collisions Analysis Results – Intersections (July 2017 – June 2022)

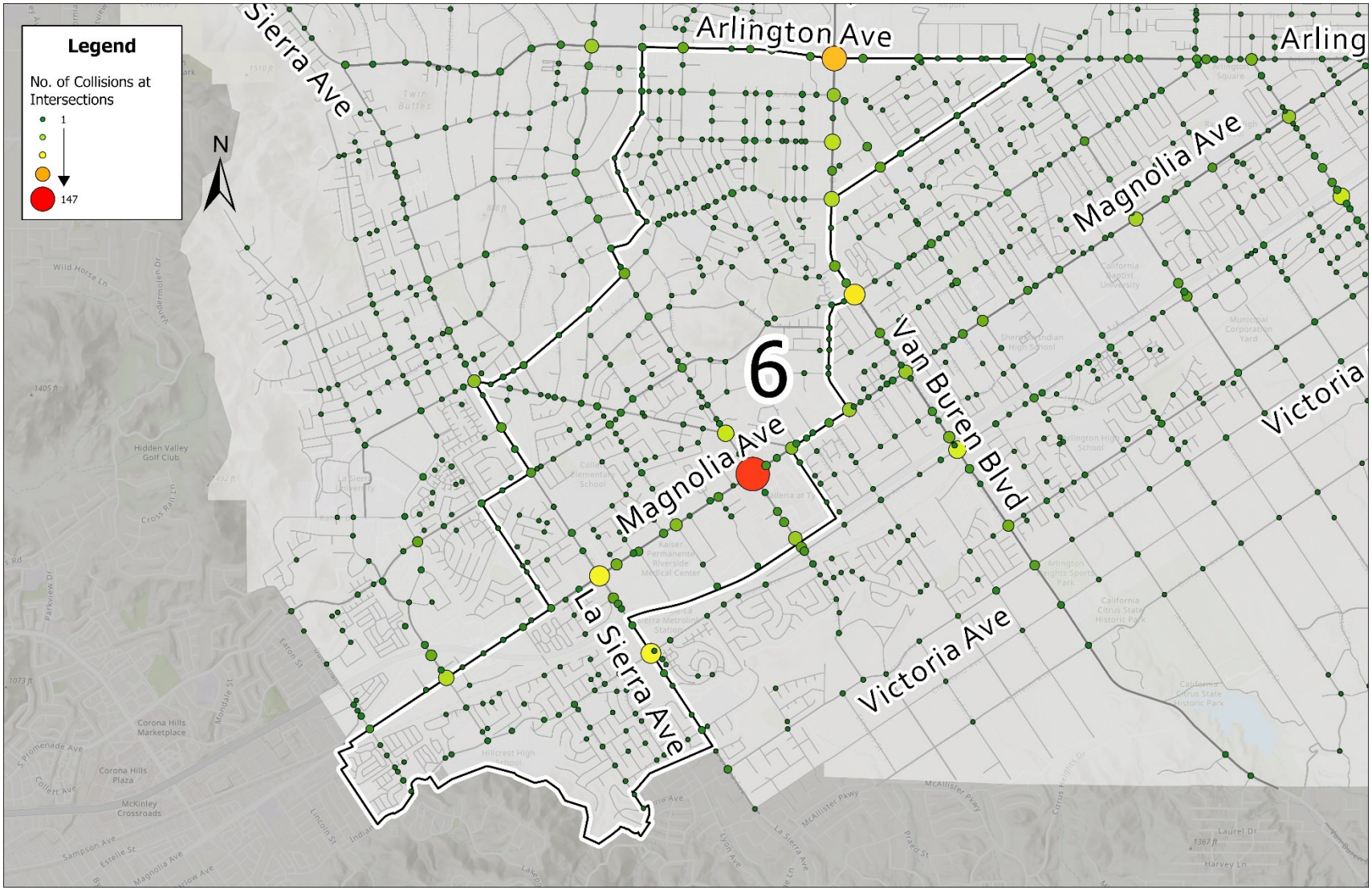
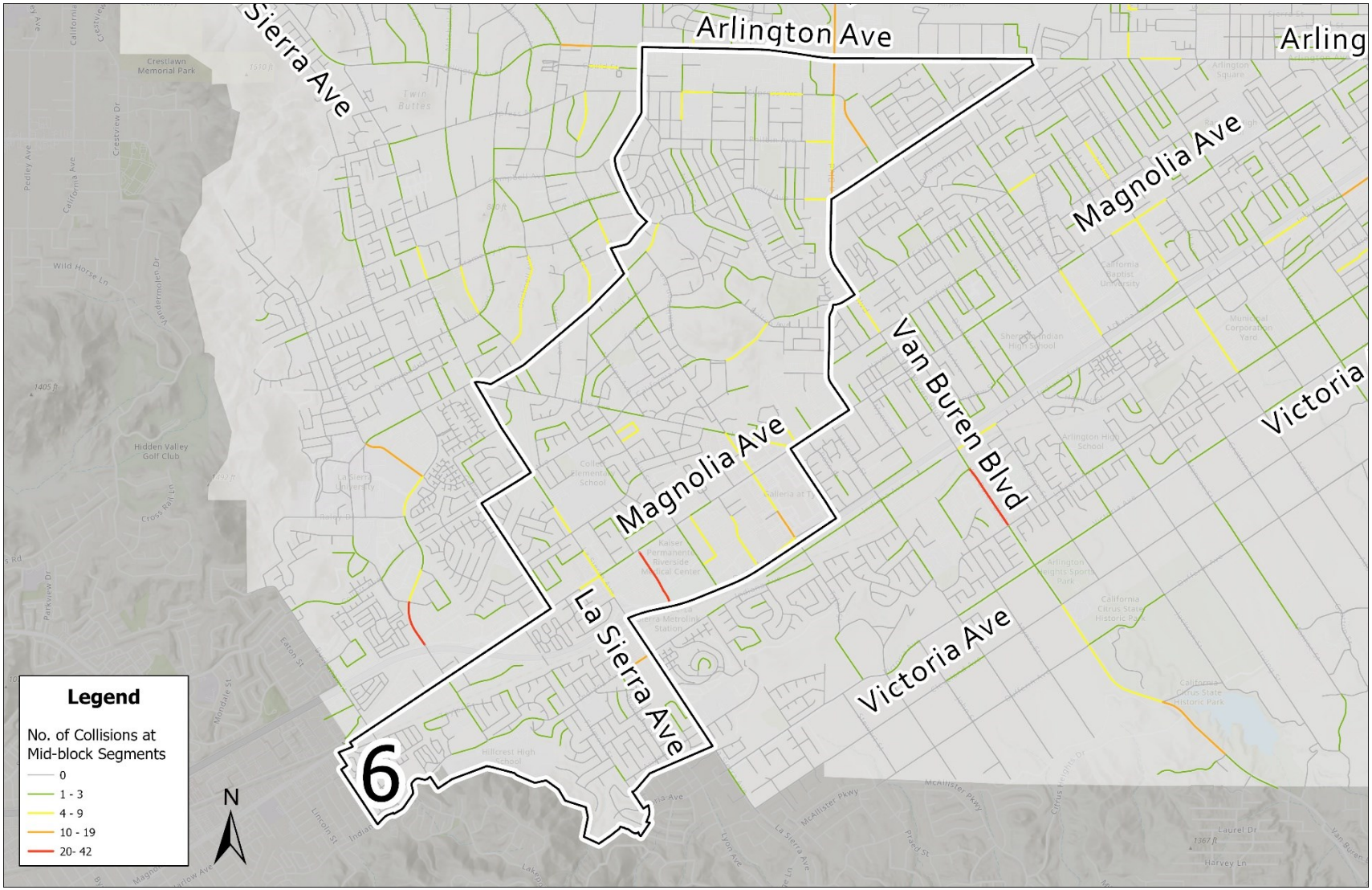


Figure 6- Collisions Analysis Results – Mid-block (July 2017 – June 2022)



WARD 7

Figure 1- Roadway Functional Classification and Signals

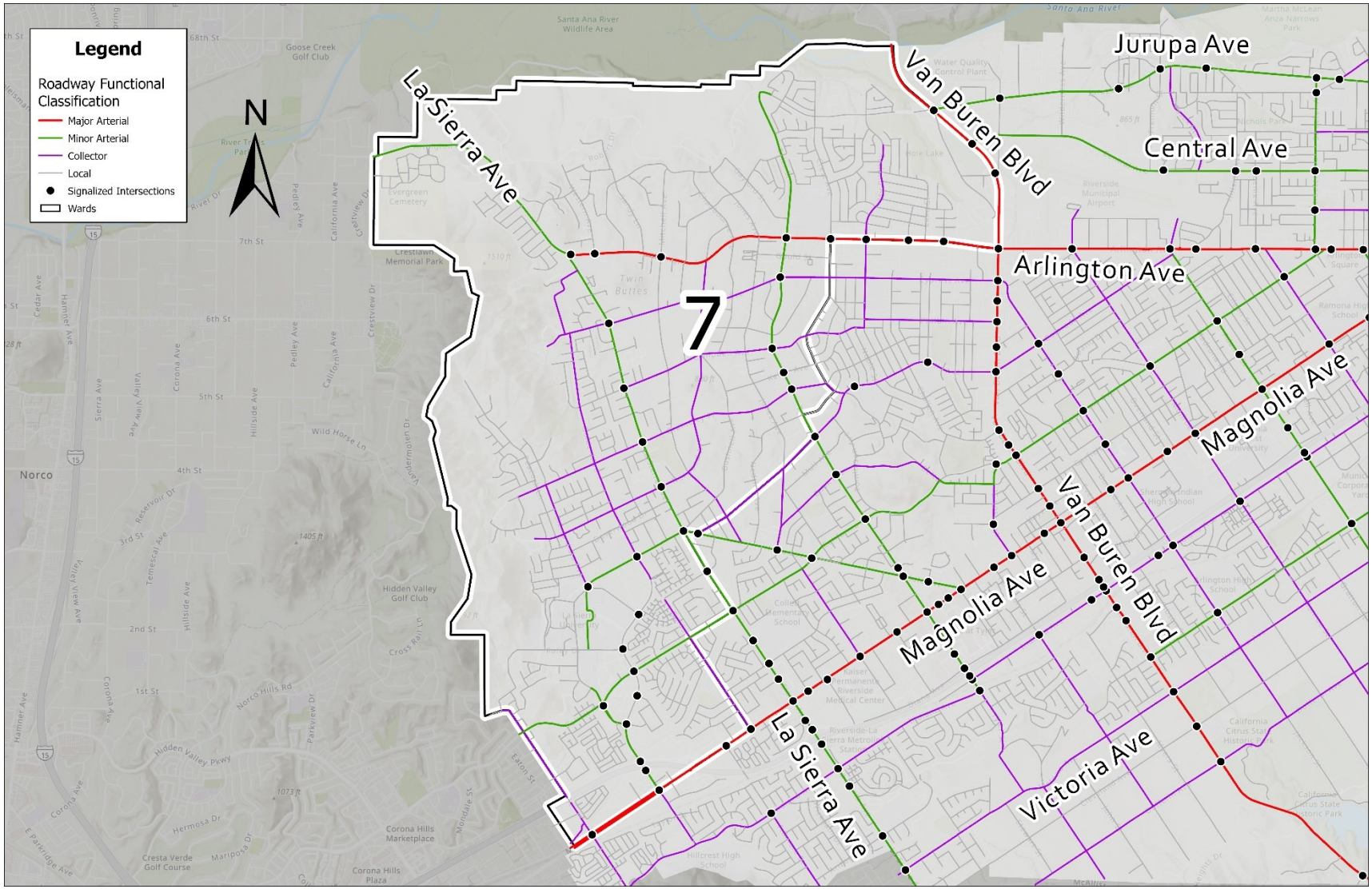


Figure 2- All Collisions (July 2017 – July 2022)

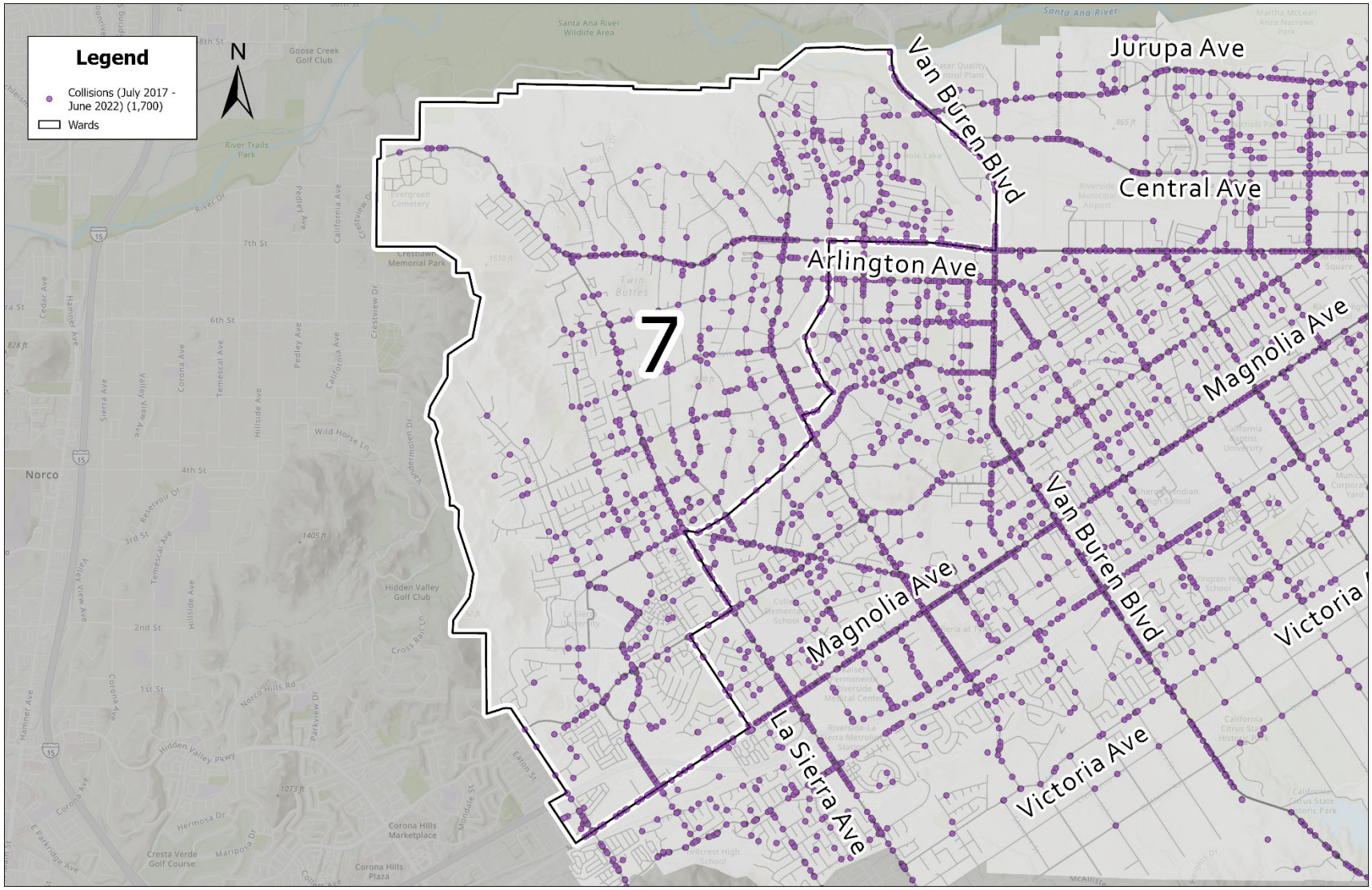


Figure 3- Fatal and Severe Injury Collisions (July 2017 – June 2022)

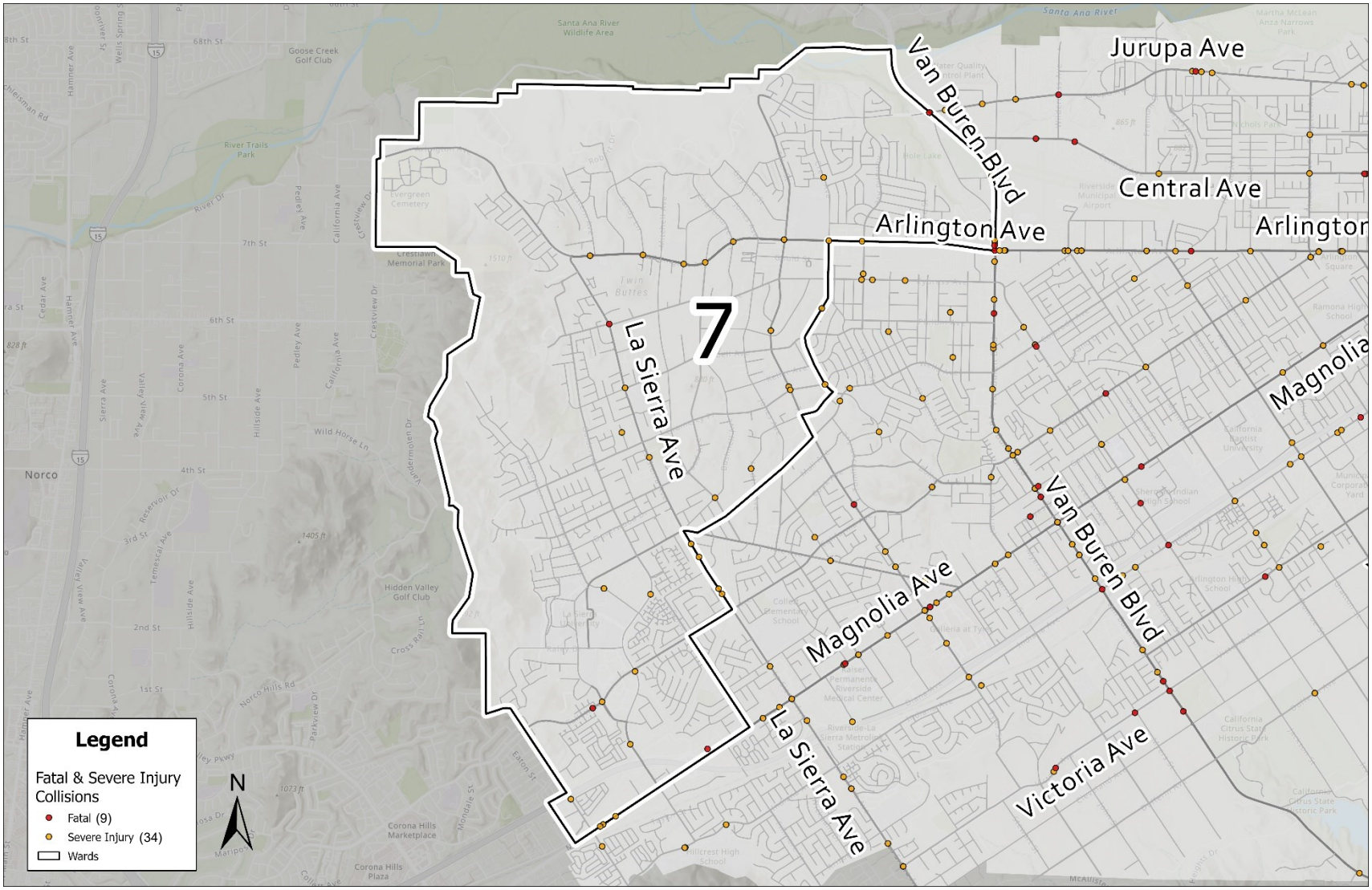


Figure 4- Bicycle and Pedestrian Collisions (July 2017 – June 2022)

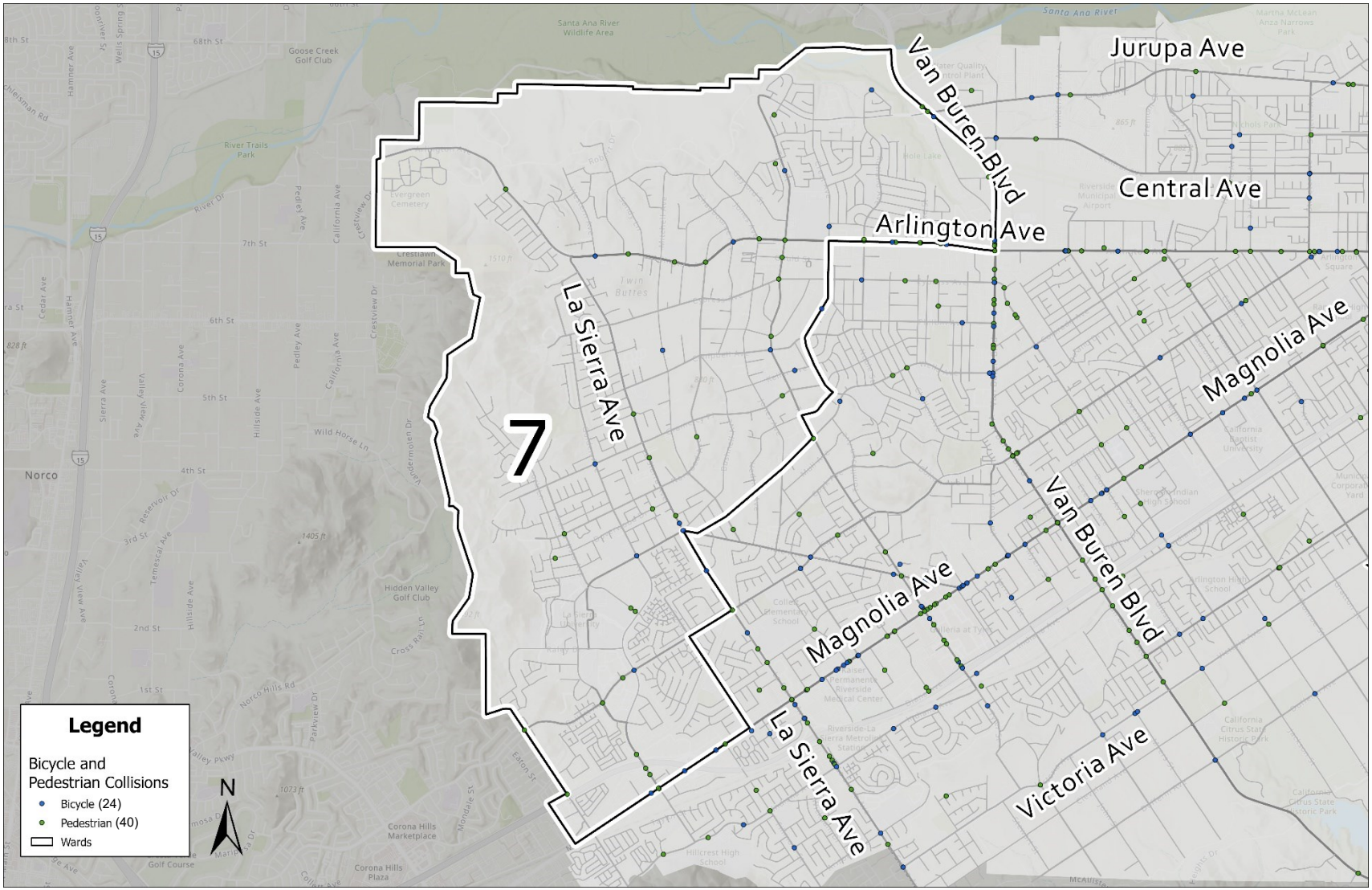


Figure 5- Collisions Analysis Results – Intersections (July 2017 – June 2022)

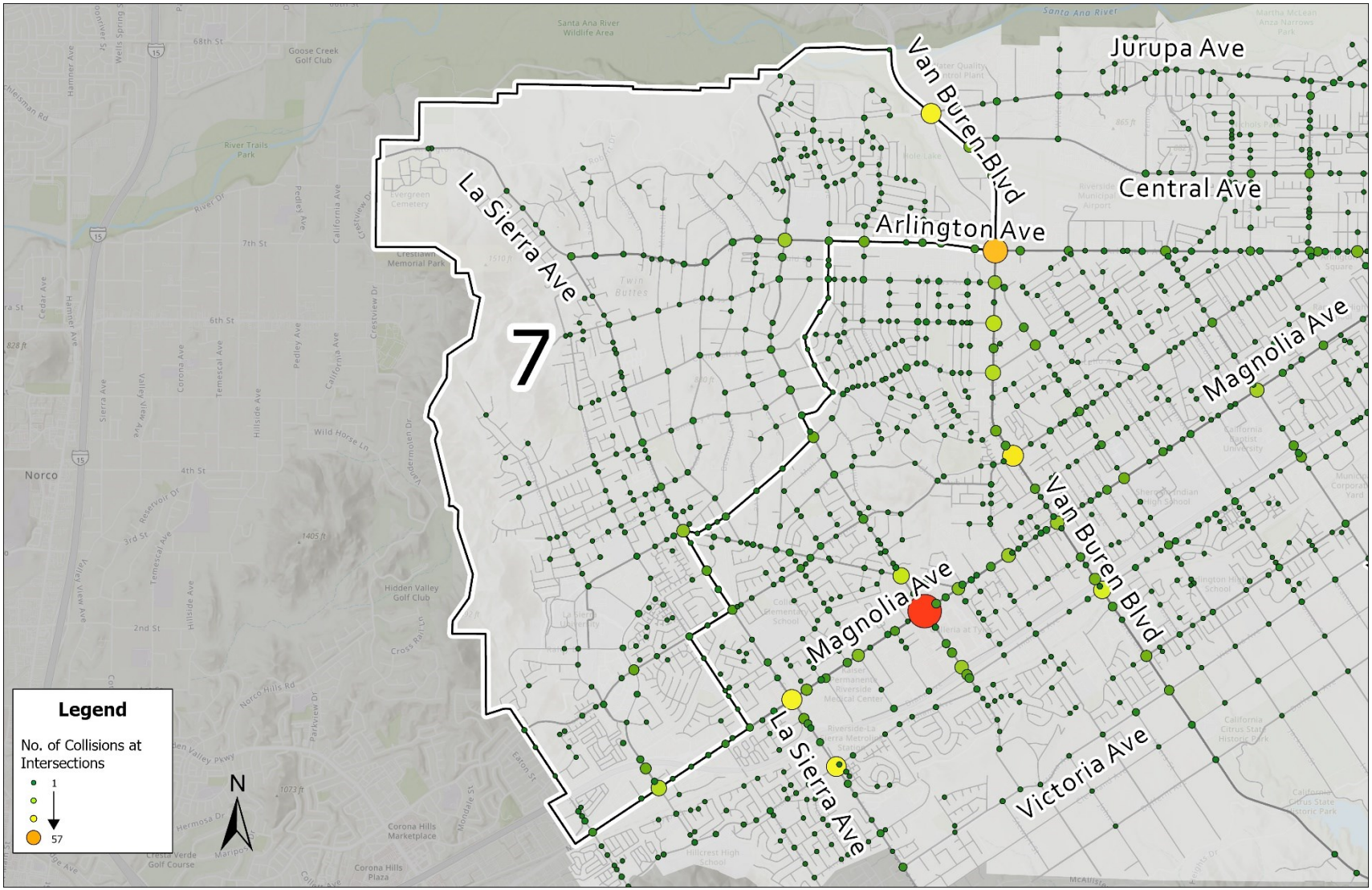
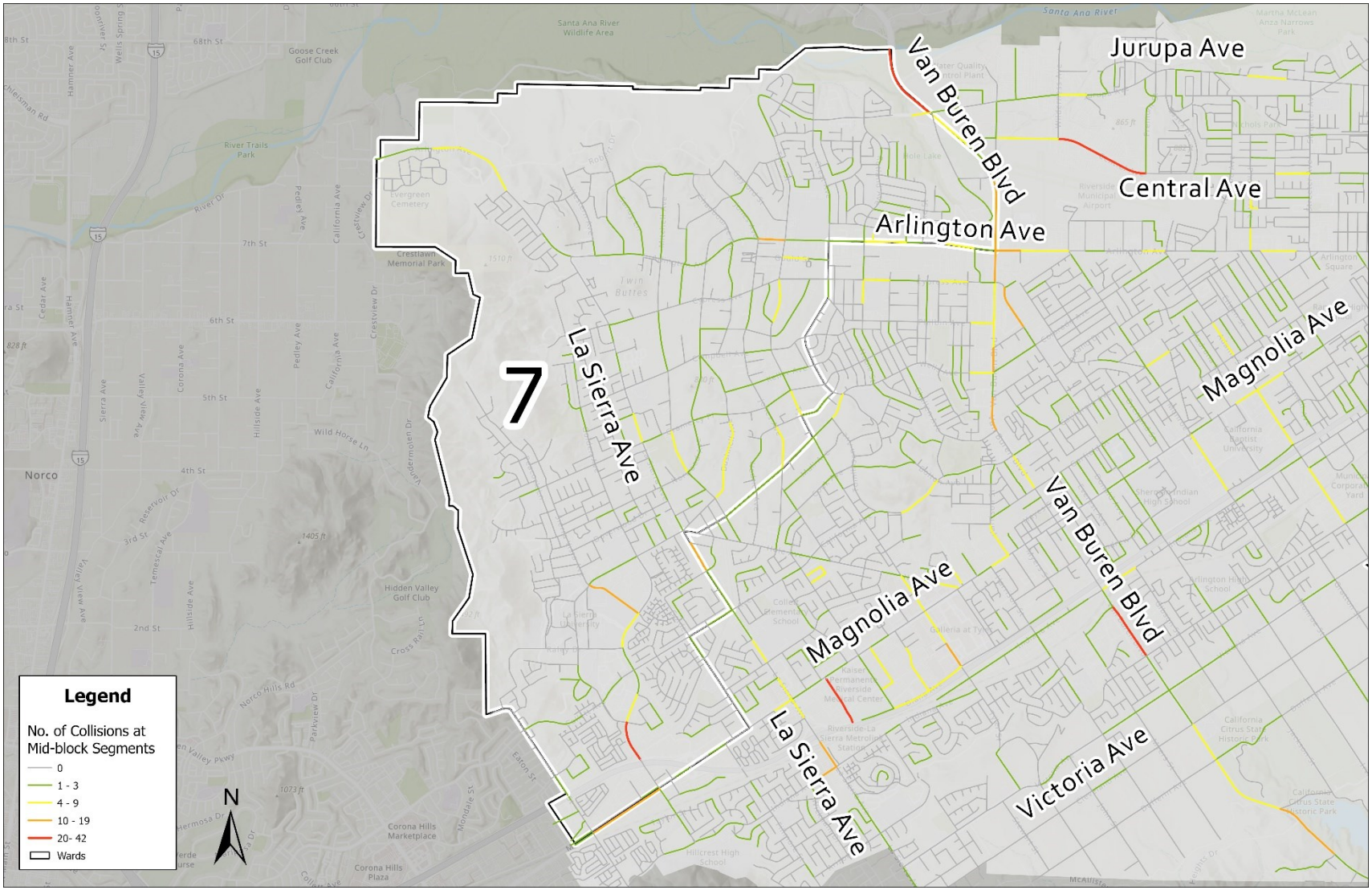



Figure 6- Collisions Analysis Results – Mid-block (July 2017 – June 2022)