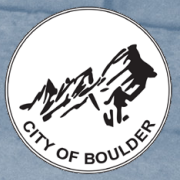


MAY 2023

BOULDER VISION ZERO ACTION PLAN



Glossary

Backplate (retroreflective) – shields a traffic signal from background obstructions. Retroreflective backplates introduce contrast and reflect light at nighttime.

Benefit-cost ratio (BCR) – the outcome of a benefit-cost analysis, which is a systematic process for identifying, quantifying, and comparing expected benefits and costs of an investment.

Big Data – large, datasets, often collected perpetually from mobile or other connected devices.

CAN – Boulder’s Core Arterial Network, a proposed connected system of protected bike lanes, intersection enhancements, pedestrian facilities, and transit facility upgrades.

CDOT – the Colorado Department of Transportation.

Contextual factor – a factor possibly related to crashes, such as roadway data (e.g., number of lanes), intersection data (e.g., presence of a traffic signal), land use data (e.g., commercial areas), operations data (e.g., traffic volumes), or Big Data (e.g., operating speeds from connected vehicles).

Countermeasure – an engineering solution that can be implemented to correct a crash problem or mitigate the likelihood of a crash occurring.

Crash modification factor (CMF) – used to compute the expected number of crashes after implementing a countermeasure on a street or at an intersection.

Cycle length – the time required for a complete sequence of traffic signal phases. Cycle lengths typically range between 80 and 150 seconds.

DRCOG – the Denver Regional Council of Governments.

Fatal crash – a crash where one or more people is killed.

High Injury Network (HIN) – defined by DRCOG, the Regional High Injury Network identifies the roadways with the highest number of fatal and severe injury crashes (also known as killed and severely injured crashes, or “KSI” crashes).

High Risk Network (HRN) – defined by the City of Boulder, the network of Boulder streets that features the most contextual factors associated with fatal and serious injury crashes.

Highway Safety Improvement Program (HSIP) – a federal grant program with the purpose to achieve a significant reduction in traffic fatalities and serious injuries on all public roads.

KSI crash - a crash resulting in a fatality (killed) or serious injury.

Leading Pedestrian Interval – a three to seven second head start for pedestrians when entering an intersection with a corresponding green signal in the same direction of travel.

Level of Service of Safety – a qualitative measure that reflects how a roadway segment or intersection is performing compared to other similar segments or intersections in terms of crash frequency and severity.

Major intersection – an intersection where the major street has multiple lanes in each direction.

Protected bike lane - an exclusive facility for bicyclists that is located within or directly adjacent to the roadway and that is physically separated from motor vehicle traffic with a vertical element

Protected intersection – an at-grade intersection in which bicyclists and pedestrians are separated from cars. Vehicles turning right are separated from crossing bicyclists and pedestrians by a buffer, providing increased reaction times and visibility.

Protected left-turn (or right-turn) – consists of providing a separate phase for left-turning (or right-turning) traffic and allowing left-turns (or right-turns) to be made only on a green left arrow (or right arrow) signal indication, with no pedestrian movement or vehicular traffic conflicting with the turn.

Rectangular Rapid Flashing Beacon (RRFB) – rectangular-shaped yellow lights with light-emitting diode (LED) arrays that flash a rapid sequence when activated by a pedestrian; RRFBs are not able to be integrated into nearby traffic signals.

Regional Transportation District (RTD) – the regional agency operating public transit services in the Boulder area.

Right-turn slip lane – at signalized intersections, right turn lanes that bypass the traffic signal with a triangular shaped island.

Risk Factor – a contextual factor shown through statistical and spatial analysis to relate to crashes.

Safe Streets and Roads for All (SSRA) – a federal, discretionary grant program providing \$5 billion in grants from 2022 through 2026 to prevent roadway deaths and serious injuries.

Serious injury crash – a crash that results in an incapacitating (life altering) injury.

Severe crash – a general term encompassing both fatal and serious injury crashes.

Signal head – the portion of a traffic signal containing the red, yellow, and green lights.

Systemic Safety – an approach to safety involving widely implementing improvements based on high-risk roadway features correlated with specific severe crash types.

Traffic signal – also known as a traffic light or stop light.

Transportation Improvement Program (TIP) – the DRCOG program that identifies all current federal- and state-funded transportation projects to be completed in the Denver region over a four-year period.

Vertical separation (bikeway) - a bikeway type defined by the Low-Stress Walk and Bike Network Plan as either a protected bike lane or a multi-use path.

Executive Summary

Vision Zero is Boulder's goal to eliminate all severe crashes resulting in a serious injury or fatality.

The City of Boulder is developing an updated action plan to address areas of concern identified in the city's *Vision Zero Boulder: Safe Streets Report, 4th Edition, 2022*.

For this update, staff are creating a five-year 2023-27 *Vision Zero Action Plan*. The updated plan incorporates community engagement, improves on the prior 2019-21 *Vision Zero Action Plan*, develops a five-year list of implementation strategies and projects, and identifies opportunities for federal, state, regional, and local funding.

The city completed two rounds of community engagement: the first in summer 2022 to better understand community members' attitudes and concerns regarding traffic safety in Boulder, and another in winter 2023 to receive initial feedback on the 2023-27 *Vision Zero Action Plan* proposals.

The project team completed technical analysis to define a High Risk Network that informs the *Vision Zero Action Plan's* priority actions.

A summary of the findings regarding the High Risk Network (HRN) is:

THE HRN REPRESENTS JUST
7% OF CITY STREETS
BUT ACCOUNTS FOR:

48% of fatal and serious injury crashes

56% of bike crashes

57% of pedestrian crashes (2016-2020 crash data)








MEASURED BY CRASHES PER VEHICLE MILES TRAVELED, THE HRN HAS ROUGHLY

FIVE TIMES

MORE RISK THAN ALL BOULDER ARTERIAL STREETS COMBINED

SEVEN COMMON CRASH TYPES ACCOUNT FOR OF

62% FATAL AND SERIOUS INJURY CRASHES ON THE HRN:

-  Red light running crashes
-  Left-turn crashes
-  Right-turn slip-lane crashes
-  Right-turn on red crashes
-  Right-turn crashes
-  Multi-use path crossing crashes
-  Pedestrian crashes while crossing the street

The *Vision Zero Action Plan* is oriented towards the implementation of improvements across Boulder's transportation system, starting with the HRN and expanding to other streets, that will reduce the seven common crash types, as well as address other location-specific safety issues. The *Vision Zero Action Plan* includes four categories of actions to achieve Vision Zero through 20 specific actions.

Where possible, the city will advance actions ahead of the proposed time frame.

| Implement and improve engineering solutions to reduce fatal and serious injury crashes. | | |
|---|---------------------------------|-------------------|
| Action | Responsibility (Partner) | Time Frame |
| 1. Broadly implement low-cost projects on the High Risk Network to address top crash patterns | Transportation & Mobility | Ongoing |
| A. Leading Pedestrian Interval | | |
| i. Implement new LPI at Arapahoe Avenue & 17th Street | | 2023 |
| ii. Proactively implement the LPI Traffic Operations Practice across the High Risk Network, including accessible pedestrian signals where possible | | 2024 |
| iii. Proactively implement the LPI Traffic Operations Practice at remaining traffic signals, including accessible pedestrian signals where possible | | 2025 |
| B. No Right-Turn on Red (RTOR) | | |
| i. Implement no RTOR prohibitions at the following locations: <ul style="list-style-type: none"> Broadway & Arapahoe Avenue (westbound right-turn) Broadway & University Avenue (eastbound right-turn) Broadway & Table Mesa Drive (northbound right-turn) 30th Street & Valmont Street (northbound right-turn and westbound right-turn) Arapahoe Avenue & Folsom Street (westbound right-turn) Canyon Boulevard & Folsom Street (eastbound right-turn) | | 2023 |
| ii. Update Boulder's no RTOR Traffic Operations Practice | | 2024 |
| iii. Proactively implement the new no RTOR Traffic Operations Practice across the High Risk Network | | 2025 |
| iv. Proactively implement the new no RTOR Traffic Operations Practice at remaining traffic signals | | 2026 |
| C. Left-Turn Operation Change | | |
| i. Update Boulder's Left-Turn Operation Traffic Operations Practice | | 2024 |
| ii. Proactively implement the Left-Turn Operation Traffic Operations Practice across the High Risk Network; document relevant HSIP information for locations that lack adequate signal equipment | | 2025 |
| iii. Proactively implement the Left-Turn Operation Traffic Operations Practice at remaining traffic signals; document relevant HSIP information for locations that lack adequate signal equipment | | 2026 |
| D. Green Pavement Markings in Conflict Zones | | |
| i. Add green pavement markings at major intersections, minor intersections, and driveways on CAN corridors that overlap at least in part with the High Risk Network | | 2024 |
| E. Right-Turn Slip Lanes | | |
| i. Update right-turn slip lanes on the HRN to feature consistent signing for drivers and pedestrians (See Figure 14) | | 2024 |
| ii. Update right-turn slip lanes on remaining streets to feature consistent signing for drivers and pedestrians | | 2025 |
| F. Additional Low-Cost Solutions | | |
| i. Implement additional, high-priority, low-cost solutions (See Table 5) | | By 2025 |
| 2. Strategically implement higher cost solutions on the High Risk Network to address top crash patterns; document relevant HSIP information for these locations (See Table 6) | Transportation & Mobility | Ongoing |

| | | |
|---|---------------------------|---|
| <p>3. Implement capital projects to improve safety and comfort including protected bike lanes, protected intersections, and setback multi-use path crossings on high priority High Risk Network and Core Arterial Network corridors:</p> <ul style="list-style-type: none"> • Arapahoe Avenue • Baseline Road • Folsom Street • Iris Avenue | Transportation & Mobility | By 2027 |
| <p>4. Upgrade Boulder’s traffic signal system by replacing traffic signal equipment not built to current standards to enable expanded use 12-inch yellow and green lenses, retroreflective backplates, and conduct engineering countermeasures evaluations in accordance with FHWA Red Light Camera Systems Operational Guidelines to reduce red light running</p> | Transportation & Mobility | Ongoing |
| <p>5. Update Boulder’s Traffic Operations Practices for right-turn on red (1.B.ii) and left-turn phases (1.C.ii); develop a practice for protected right-turn phases</p> | Transportation & Mobility | 2024 |
| <p>6. Update the <i>Pedestrian Crossing Treatment Installation Guidelines</i>; document relevant HSIP information for existing marked crosswalk locations that no longer meet the guidelines</p> | Transportation & Mobility | 2024 |
| <p>7. Update and implement Boulder’s policies and practices regarding speed limit setting to better align target and actual operating speeds</p> | Transportation & Mobility | New policy/ practice by 2024; otherwise ongoing |
| <p>8. Pursue and attract state and federal funding for high cost projects, with a focus on federal Highway Safety Improvement Program, federal Safe Streets for All, and DROCG Transportation Improvement Program funding ; grant funding priorities include:</p> <ul style="list-style-type: none"> • Traffic signals on the HRN where left-turn operation changes are needed but signal equipment upgrades are necessary (Action 1.C.ii) <i>Candidate funding source(s): HSIP, SS4A</i> • Traffic signals at remaining traffic signals where left-turn operation changes are needed but signal equipment upgrades are necessary (Action 1.C.iii) <i>Candidate funding source(s): HSIP, SS4A</i> • Other higher cost solutions (Action 2) <i>Candidate funding source(s): HSIP</i> • CAN corridors (Action 3) <i>Candidate funding source(s): SS4A, DRCOG TIP</i> • Other signals where 12-inch yellow and green lenses and backplates are necessary (Action 4) <i>Candidate funding source(s): HSIP</i> • Pedestrian crossing upgrades on the HRN where new RRFBs or signals are necessary (Action 6) <i>Candidate funding source(s): HSIP, SS4A</i> • (See Figure 15) Pedestrian crossing upgrades at remaining pedestrian crossings where new RRFBs or signals are necessary (Action 6) <i>Candidate funding source(s): HSIP, SS4A</i> | Transportation & Mobility | Ongoing |

| | | |
|---|---------------------------|---|
| 9. Design and conduct a robust study or experiment of right-turn slip lane design, addressing locations with no right-turn lane, locations with a right-turn lane and no slip lane, locations with a yield-controlled slip lane, and locations with a signal-controlled slip lane. Based on the findings, develop a strategy for improving right-turn slip lanes across the city, including communication to other city departments regarding updates to design standards or development review procedures. | Transportation & Mobility | Begin study/experiment in 2025; evaluation complete by 2027 |
|---|---------------------------|---|

Pair engineering solutions with education and enforcement

| Action | Responsibility (Partner) | Time Frame |
|---|---|------------|
| 10. Facilitate regular collaboration between the Boulder Police Department and Transportation & Mobility Department to identify and enforce unsafe travel behaviors at problem locations or locations with recently installed solutions | Police Department (Transportation & Mobility) | Ongoing |
| 11. Strategically deploy photo radar van along high-speed corridors where allowed by state law | Police Department | Ongoing |
| 12. Expand the use of red light camera locations at eligible locations | Police Department (Transportation & Mobility) | Ongoing |
| 13. Support legislation to enable expanded use of photo radar van (commercial settings, higher speed streets) and red light cameras | Transportation & Mobility | Ongoing |
| 14. Collaborate with CDOT and DRCOG to implement Vision Zero campaigns, focusing on behaviors of concern such as distracted driving, driving under the influence, drivers/bicyclist/pedestrians sharing the road, and unsafe behaviors by youth drivers | Transportation & Mobility (Police Department) | Ongoing |
| 15. Combine countermeasure deployment with accompanying events and announcements, such as press releases, news interviews, ribbon cuttings, or project signage | Transportation & Mobility | Ongoing |

Improve the city's internal Vision Zero practices

| Action | Responsibility (Partner) | Time Frame |
|--|---------------------------|------------|
| 16. For all capital projects, designate a Transportation & Mobility representative to champion Vision Zero goals and strategies; coordinate with Community Vitality and Planning & Development Services staff to elevate Vision Zero within their work | Transportation & Mobility | Ongoing |
| 17. Continue participation in the national Vision Zero Cities Network to learn and share new ideas and approaches with community leaders | Transportation & Mobility | Ongoing |

Improve Vision Zero data and transparency

| Action | Responsibility (Partner) | Time Frame |
|---|---|------------|
| 18. Maintain and update the crash data dashboard | Transportation & Mobility (Police Department) | Ongoing |
| 19. Continue to refine and improve accuracy in and utility of crash documentation | Transportation & Mobility (Police Department) | Ongoing |
| 20. Annually summarize progress in delivering the Vision Zero Action Plan | Transportation & Mobility | Ongoing |



CHAPTER 1.

08

The Vision Zero Goal



CHAPTER 2.

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Status of Vision Zero



CHAPTER 3.

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CHAPTER 4.

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Engineering Solution Prioritization



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CHAPTER 6.

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Monitoring & Next Steps



CHAPTER 1.

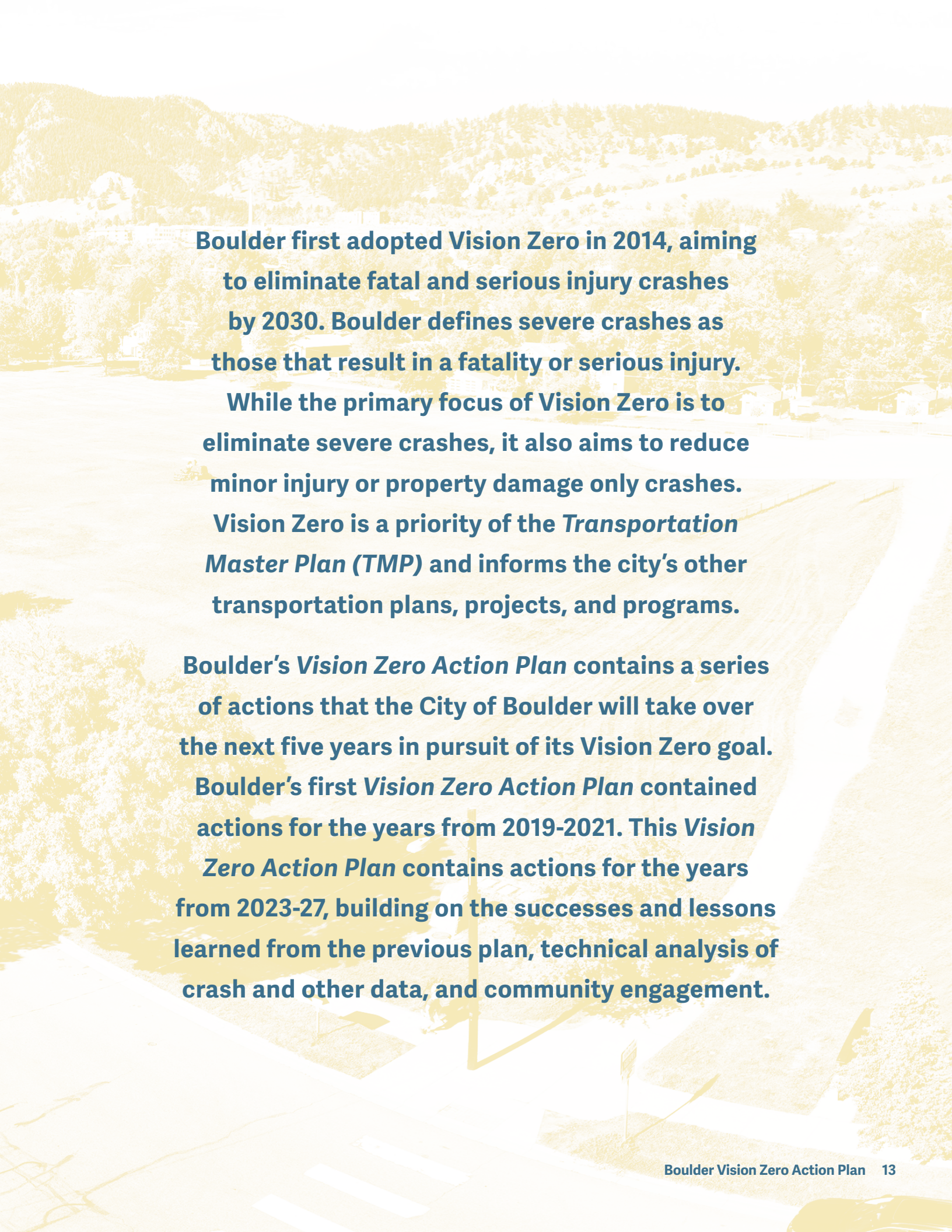
THE VISION ZERO GOAL





The Vision Zero Goal

Vision Zero is Boulder's goal to reduce the number of traffic-related fatalities and serious injuries to zero.



Boulder first adopted Vision Zero in 2014, aiming to eliminate fatal and serious injury crashes by 2030. Boulder defines severe crashes as those that result in a fatality or serious injury.

While the primary focus of Vision Zero is to eliminate severe crashes, it also aims to reduce minor injury or property damage only crashes. Vision Zero is a priority of the *Transportation Master Plan (TMP)* and informs the city's other transportation plans, projects, and programs.

Boulder's *Vision Zero Action Plan* contains a series of actions that the City of Boulder will take over the next five years in pursuit of its Vision Zero goal. Boulder's first *Vision Zero Action Plan* contained actions for the years from 2019-2021. This *Vision Zero Action Plan* contains actions for the years from 2023-27, building on the successes and lessons learned from the previous plan, technical analysis of crash and other data, and community engagement.



CHAPTER 2.

STATUS OF VISION ZERO



The crash data reported in this document comes from the City of Boulder's Transportation & Mobility Department database, which is derived from the Police Department's Record Management System. The information contained in these databases is updated periodically and may change over time

Status of Vision Zero

The City of Boulder regularly prepares a *Safe Streets Report* that reports on the progress of crash reduction efforts, summarizes analysis of crash data, and identifies crash trends and other areas of concern.

A summary of the 2022 Vision Zero: *Safe Streets Report* is:

Total crashes per year in Boulder have been trending down since 2001; however, severe crashes per year have remained steady.

Areas of concern include:



BETWEEN 2018 AND 2020, APPROXIMATELY

14,500
people were
involved in a
crash in
Boulder.

NINE PEOPLE WERE KILLED

 **2 walking**

 **1 on a bike**

 **6 in a car**

150 PEOPLE WERE SERIOUSLY INJURED

 **25 walking**

 **55 on a bike**

 **70 in a car**

Boulder has five Vision Zero objectives:

- 1. ELIMINATE CRASHES RESULTING IN SERIOUS INJURIES AND FATALITIES**
- 2. REDUCE OTHER TYPES OF CRASHES**
- 3. IMPROVE TRAVEL COMFORT AND SAFETY**
- 4. ENHANCE AWARENESS OF AND COMMUNITY ENGAGEMENT WITH VISION ZERO**
- 5. IMPROVE DATA AND BE TRANSPARENT**

Whereas the *Safe Streets Report* summarizes the most recent three years of crash data (2018 through 2020), this *Vision Zero Action Plan* used five years of crash data, from 2016 through 2020, to more broadly inform crash patterns and the application of location-specific engineering solutions.

Figure 1 shows the locations of all crashes, **Figure 2** shows the locations of fatal and serious injury

crashes, **Figure 3** shows the locations of pedestrian crashes, **Figure 4** shows the locations of fatal and serious injury pedestrian crashes, **Figure 5** shows the locations of bicyclist crashes, and **Figure 6** shows the locations of fatal and serious injury bicyclist crashes between 2016 and 2020.

Note: not all crashes were displayed on the maps due to insufficient location data.

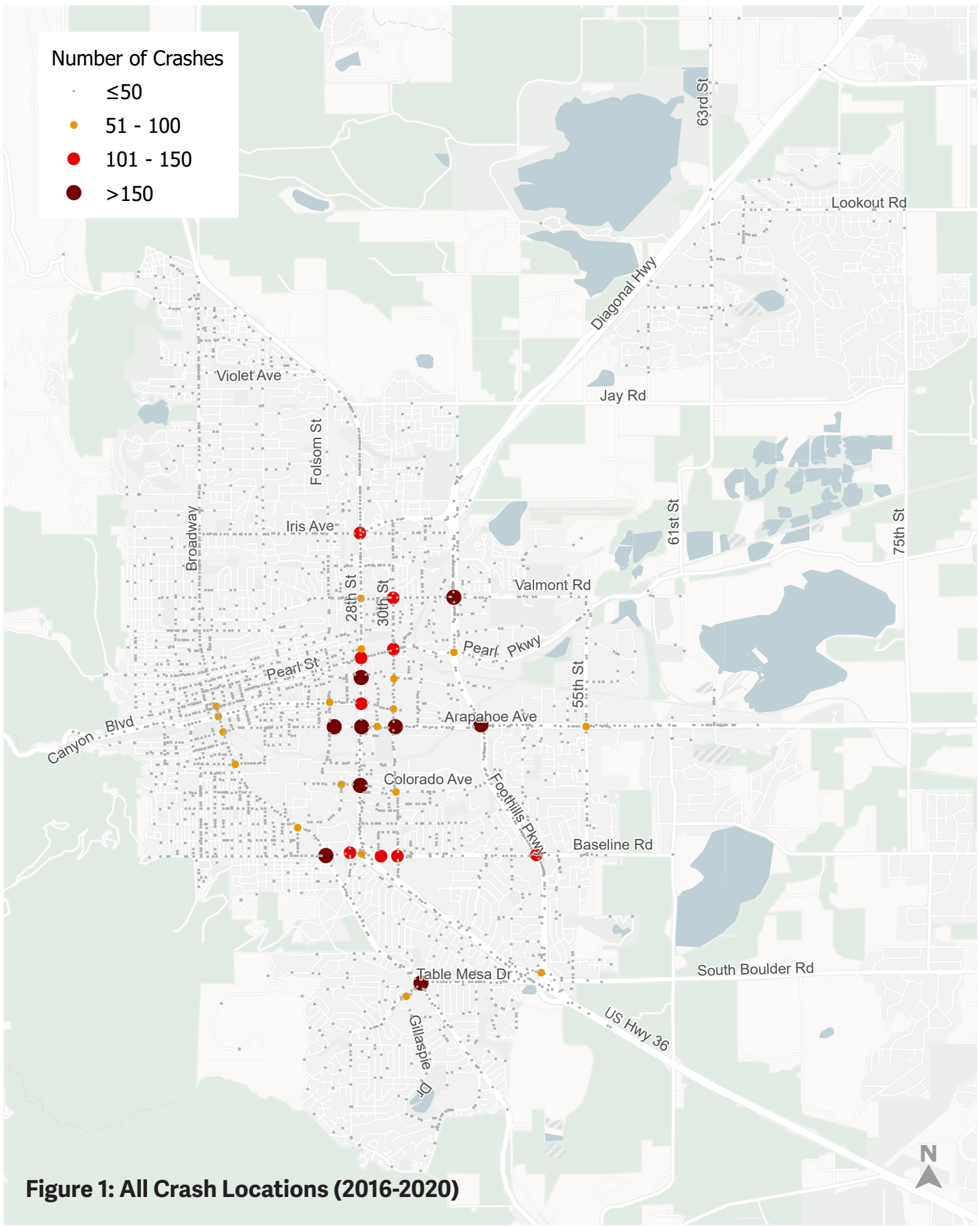
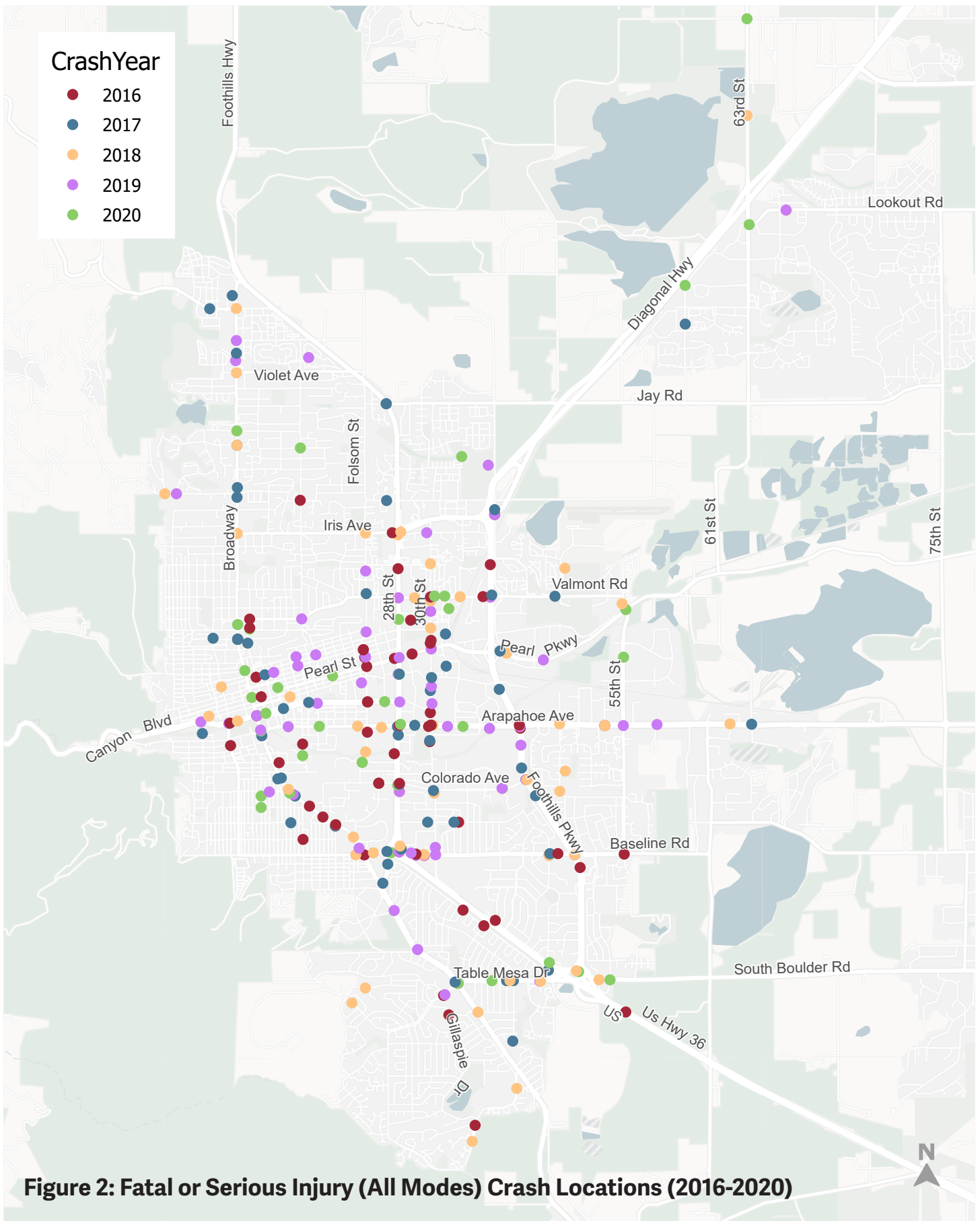


Figure 1: All Crash Locations (2016-2020)



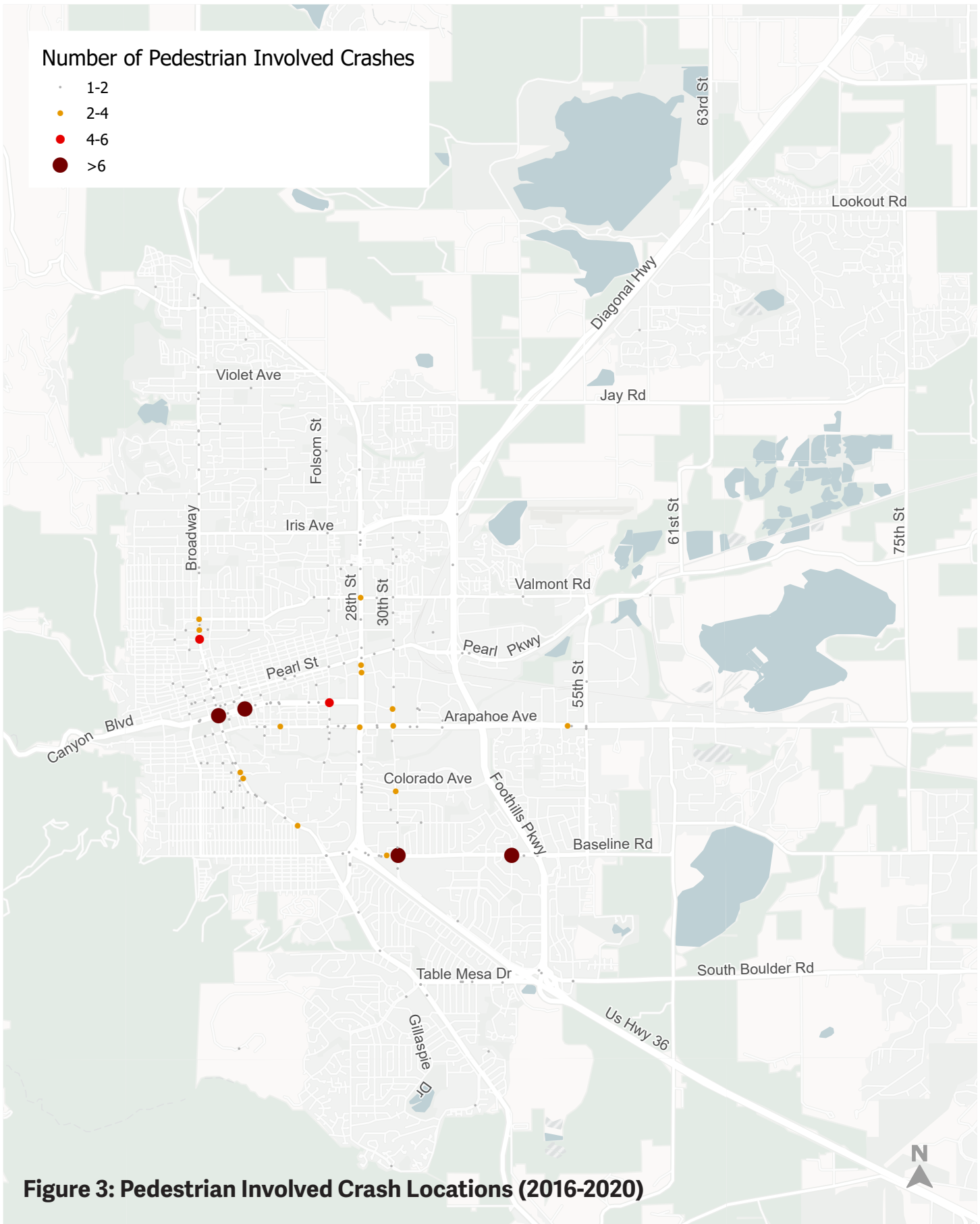


Figure 3: Pedestrian Involved Crash Locations (2016-2020)

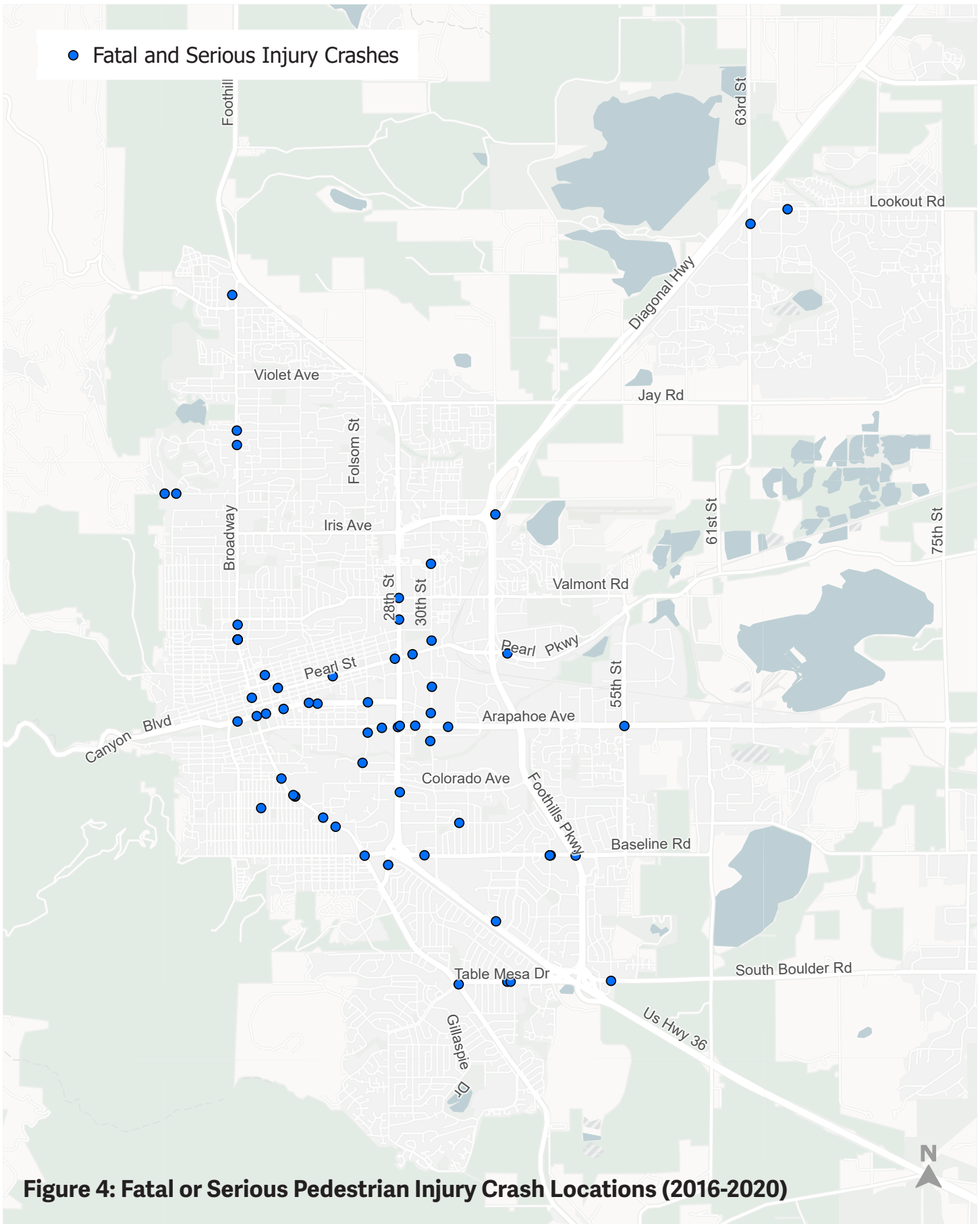
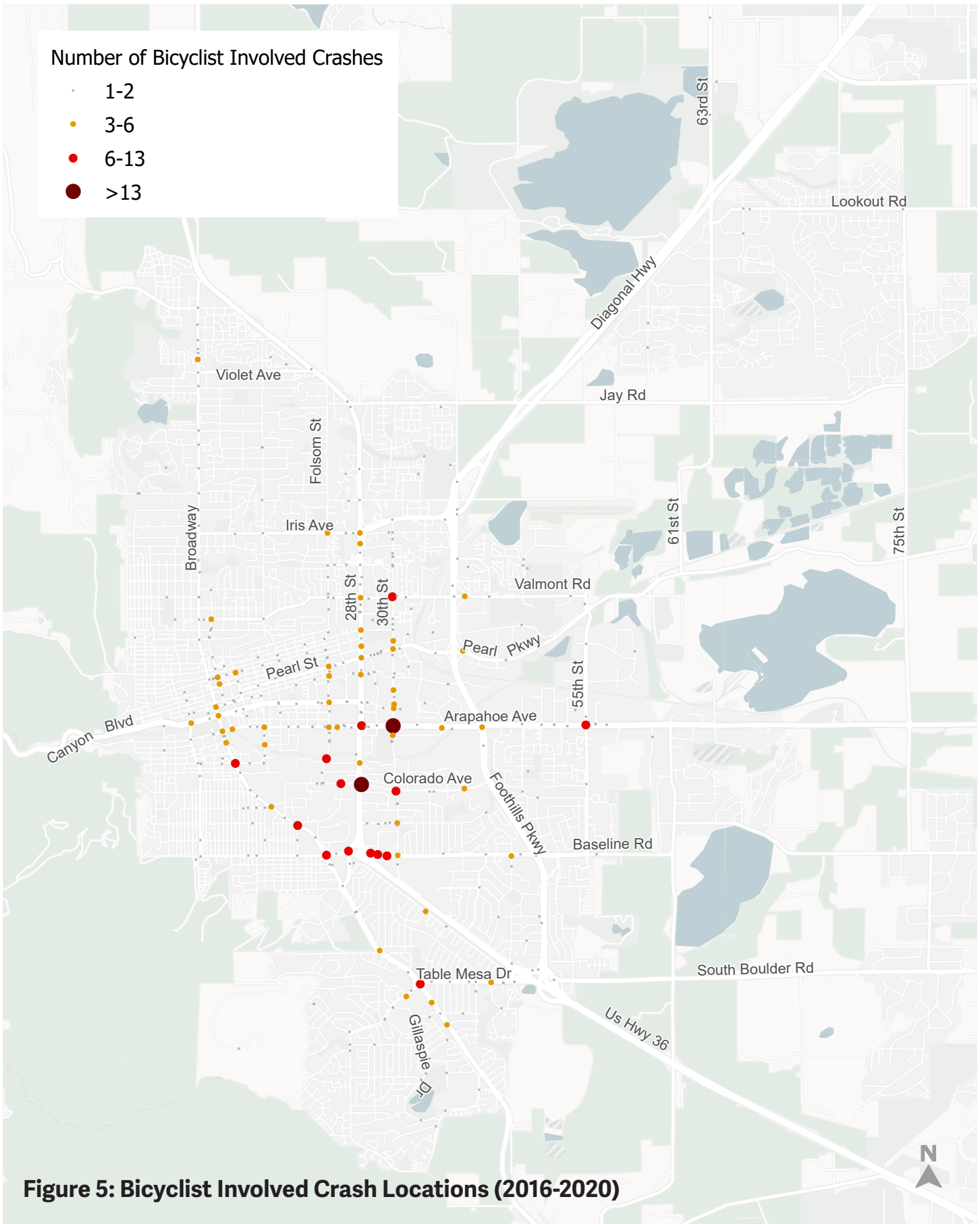


Figure 4: Fatal or Serious Pedestrian Injury Crash Locations (2016-2020)



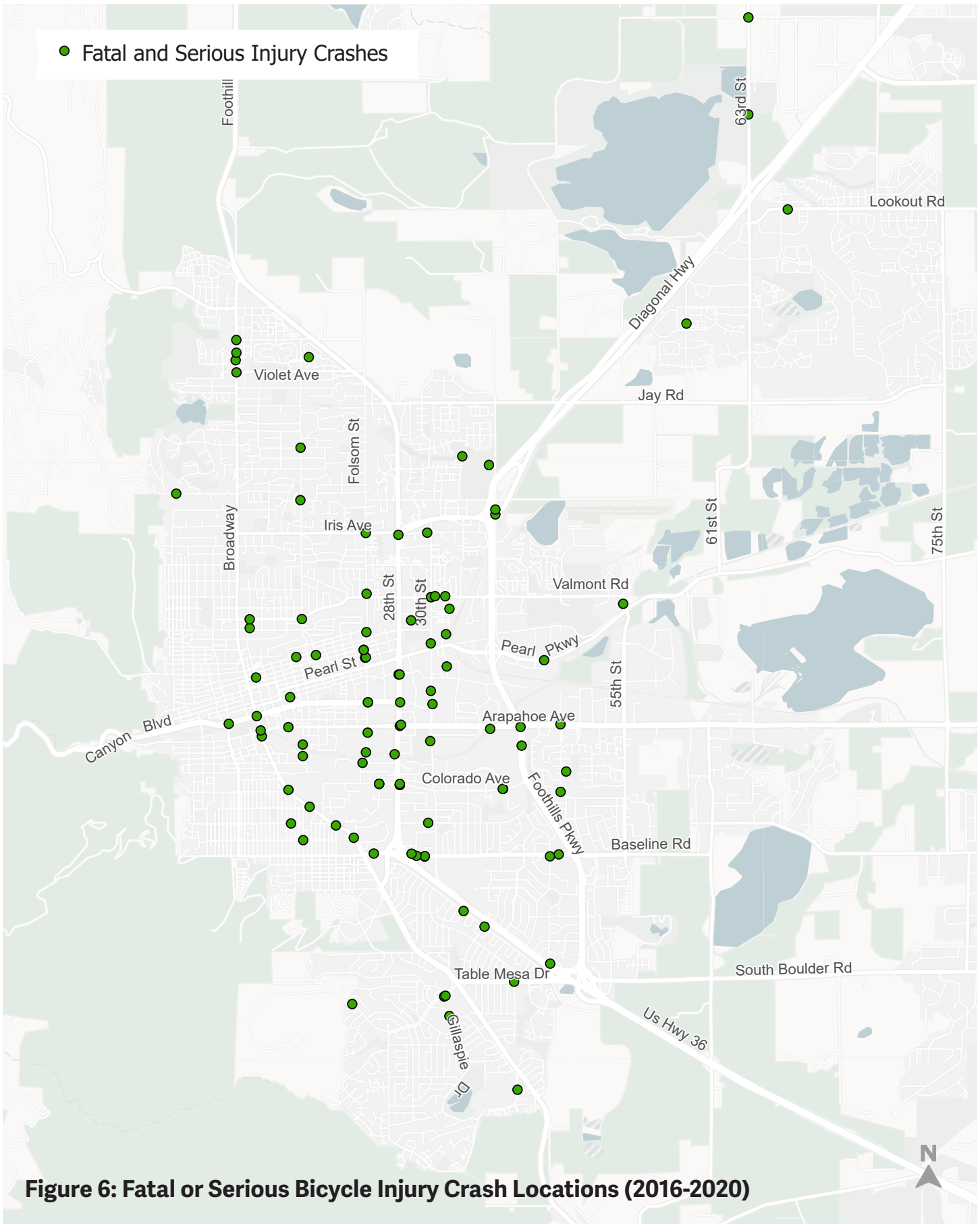


Figure 6: Fatal or Serious Bicycle Injury Crash Locations (2016-2020)



CHAPTER 3.

HOW WE DEVELOPED THE ACTION PLAN



VISION ZERO SPEED LIMIT

How We Developed the Action Plan

This *Vision Zero Action Plan* represents a significant shift from the 2019-21 Action Plan. This *Vision Zero Action Plan* outlines a prioritized set of fundable and actionable projects and programs that can be implemented over the next five years in areas that have the greatest potential to reduce the number and severity of crashes.

Staff were successful in implementing many elements of the 2019-21 Action Plan (see **Appendix A**), including:

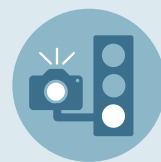
Made changes at 49 intersections to add:



**Leading
Pedestrian
Intervals**



**Protected
Left-Turns**



**Red Light
Cameras**

and other signing/markings to improve safety.

Advanced Vision Zero improvements like bike lane and/or green pavement marking enhancements with the pavement management mobility enhancements program, including on:

- Table Mesa Drive
- Lehigh Street
- Pine Street
- Folsom Street
- 17th Street



In 2020, implemented 20 Is Plenty, the 20 mile per hour residential street speed limit.

Received \$4.8 million in grant funding through the Highway Safety Improvement Program and other regional, state, and federal sources for:

- Mesa Elementary Safe Routes to School improvements
- Pedestrian crossings
- 47th Street sidewalks
- New traffic signals
- Speed limit setting and signing framework development
- Other street design, traffic signal, and pedestrian crossing treatment upgrades

The 2023-27 Vision Zero Action Plan was developed using community engagement, Systemic Safety analysis, and corridor analysis on the High Risk Network. The Systemic Safety analysis reflects both crash history as well as contextual factors to proactively mitigate risk and to reduce crashes before they occur, by pairing solutions to the crash types most associated with the risk factors. The resulting project list provides more specific actions that can be undertaken to address transportation safety and achieve Vision Zero.

Community Engagement

The project team completed two phases of community engagement to develop the Vision Zero Action Plan: in the first phase, the public was consulted to understand their transportation safety concerns, and in the second phase we informed the public of the draft plan.

PHASE 1 COMMUNITY ENGAGEMENT

From summer to fall 2022, the community was asked to share their traffic safety concerns when travelling in Boulder. The City of Boulder hosted a virtual open house for community members, facilitated stakeholder meetings with Community Cycles and the Center for People with Disabilities, a hosted a survey and web map hosted through the city's engagement platform, Be Heard Boulder, and hosted an in-person event at the San Lazaro Mobile Home Park. Community members shared over 700 comments on specific locations where they felt unsafe traveling by foot, bike, and/or vehicle. **Appendix B** includes a summary of Phase 1 engagement activities. This is what the city learned through the online survey and web map:

- 37% of survey respondents have had personal experience with a severe traffic crash, either being seriously injured themselves or knowing someone who had been seriously injured or killed
- The top four traffic safety concerns of survey respondents were:
 1. Distracted driving
 2. Drivers not yielding to pedestrians or bicyclists
 3. Speeding
 4. Drivers and bicyclists sharing the road

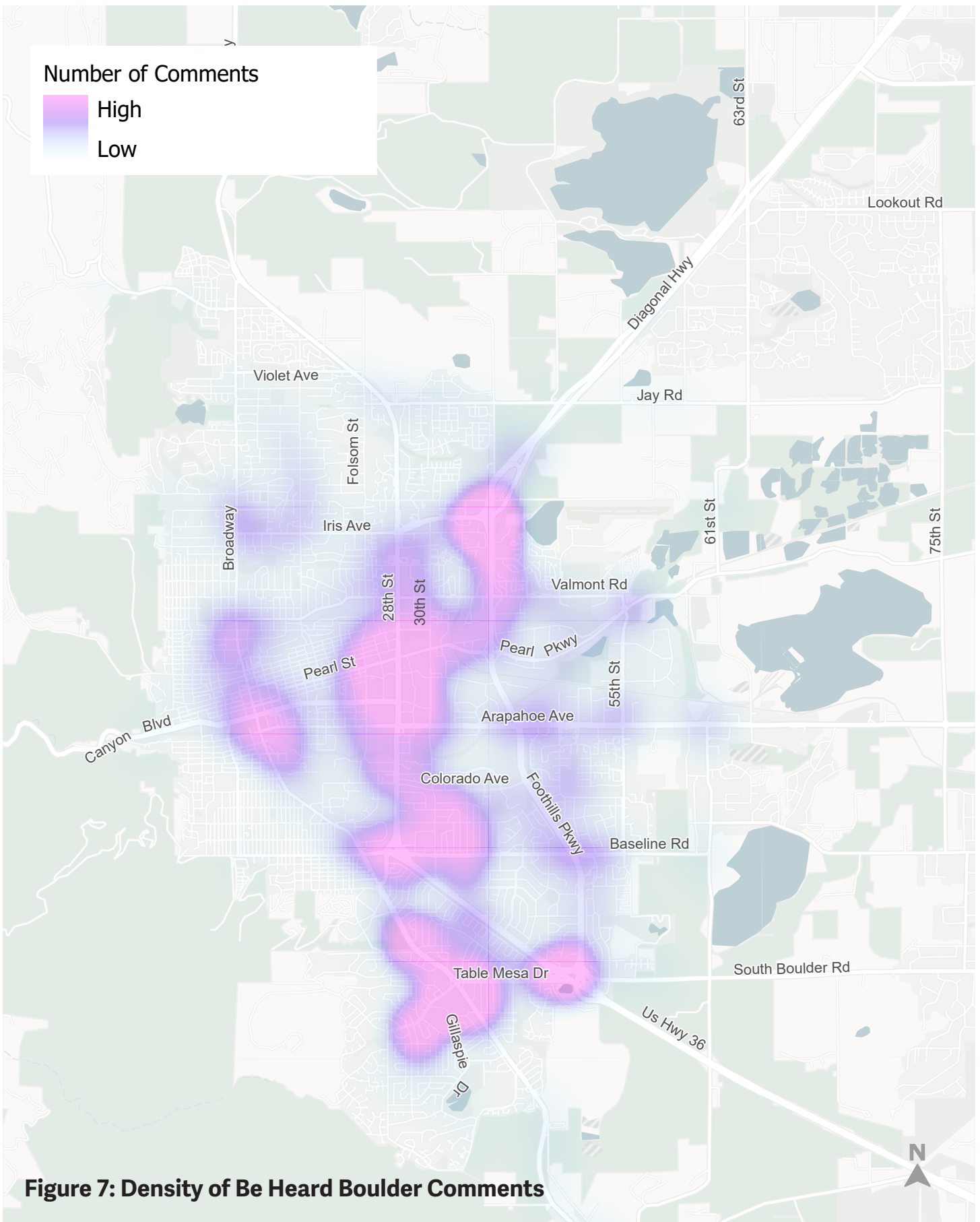
- 66% of survey respondents choose whether to walk, bike, or drive based on traffic safety concerns for their trip route
- The top four traffic safety corridors are:
 1. Broadway/South Broadway in the vicinity of Iris Avenue, intersections adjacent to the University of Colorado, Baseline Road, Rayleigh Road, Dartmouth Avenue, and Table Mesa Drive
 2. Table Mesa Drive/South Boulder Road from Hartford Drive to Foothills Parkway
 3. Arapahoe Avenue between 28th Street and 55th Street
 4. 28th Street, primarily from Colorado Avenue to Mapleton Avenue

PHASE 2 COMMUNITY ENGAGEMENT

In winter 2023, the city hosted a virtual open house, office hours with community members for more detailed discussions, stakeholder meetings with Community Cycles and the Center for People with Disabilities, and a questionnaire hosted through Be Heard Boulder. People were generally supportive of the direction of the plan and identified specific areas for enhancement prior to finalization. **Appendix C** includes a summary of Phase 2 engagement activities.







Systemic Safety Analysis

This plan uses a national best practice¹ Systemic Safety analysis to evaluate risk across the city's entire roadway system. This approach can identify patterns that may not be reflected in standard crash data sources by pairing the data with contextual factors, such as the number of travel lanes and roadway speeds, the type of on-street bicycle facility, the types and timing of signals at an intersection, if there are schools, businesses, parks, and other land uses along the road, and Big Data² from connected vehicles on speeds and braking. **Appendix D** includes a technical memorandum summarizing the Systemic Safety Analysis. From the 61 contextual factors used for the analysis, six Risk Factors were found to account for the most frequent and most severe crashes (**Table 1**):

- **Multi-use path present**
- **Daily vehicle traffic between 5,000-10,000 vehicles per travel lane**
- **Signalized intersections**
- **A major intersection with no traffic signal**
- **Businesses and a mix of land uses present**
- **85% of vehicle speeds at 30 miles per hour or faster**

¹Highway Safety Manual and National Cooperative Highway Research Program (NCHRP) Research Report 893: Systemic Pedestrian Safety Analysis

²Wejo sourced connected vehicle data

Table 1: Systemic Safety Analysis Contextual Factors

| Roadway Data | Intersection Data | Land Use/Zoning Data | Big Data |
|------------------------------------|---------------------------------|----------------------------------|---------------------------|
| 3 lanes or less, ≤30 mph | Signal | Near school | 85th %tile speed ≤30 mph |
| 3 lanes or less, ≥35 mph | Major unsignalized intersection | Near OSMP trailhead | 85th %tile speed >30 mph |
| 4-5 lanes, ≤30 mph | Minor unsignalized intersection | Near bus stop | Quick acceleration high |
| 4-5 lanes, ≥35 mph | Midblock | Near community/ senior center | Quick acceleration medium |
| 6+ lanes, ≤30 mph | Signal cycle length ≤100s | Near alcohol serving business | Quick acceleration low |
| 6+ lanes, ≥35 mph | Signal cycle length >100s | Business zoning | Hard braking high |
| Classification: Freeway | Signalized/HAWK crosswalk | Downtown zoning | Hard braking medium |
| Classification: Expressway | RRFB crosswalk | Mixed-use zoning | Hard braking low |
| Classification: Ramp | Signing/markings crosswalk | Industrial zoning | |
| Classification: Principal Arterial | Unmarked crosswalk | Public zoning | |
| Classification: Minor Arterial | | Single-family residential zoning | |
| Classification: Collector | | Agricultural zoning | |
| Classification: Residential | | | |
| Classification: Private | | | |
| Classification: Pedestrian Mall | | | |
| Classification: Alley | | | |
| Protected bike lane | | | |
| On-street bike lane | | | |
| Multi-use path | | | |
| No bike facility/shared lane | | | |
| Sidewalks present | | | |
| Sidewalks missing | | | |
| On-street parking present | | | |
| No on-street parking | | | |
| Streetlight present | | | |
| Streetlight not present | | | |
| Daily traffic <5,000 vpl | | | |
| Daily traffic 5,000-10,000 vpl | | | |
| Daily traffic >10,000 vpl | | | |
| No on-street parking | | | |

The six Risk Factors are correlated with past locations of frequent and severe crashes. The cause of crashes is not always directly related to a Risk Factor. For example, multi-use paths and business or mixed use zoning are correlated with crashes, but do not cause crashes themselves. Crash analysis presented later in this plan identifies the causes of crashes at locations with a high number of Risk Factors.

Figure 8 shows Boulder's street segments with one to six of the Risk Factors that were found to account for the most frequent and most severe crashes.

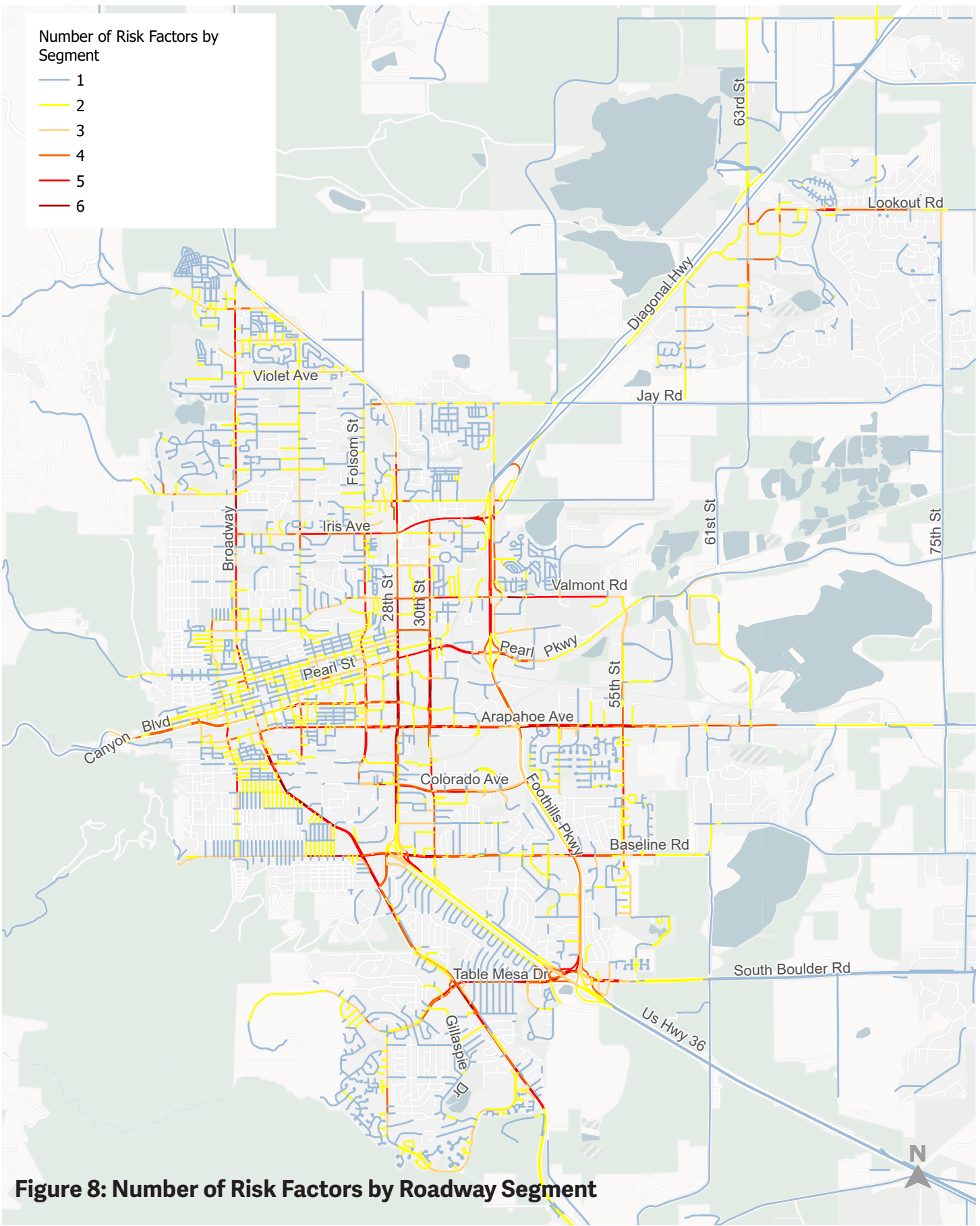


Figure 8: Number of Risk Factors by Roadway Segment

High Risk Network

Boulder’s High Risk Network (HRN) consists of locations with five or six Risk Factors.

Figure 9 shows the High Risk Network, **Figure 10** shows the High Risk Network where it overlaps with Boulder’s Core Arterial Network (CAN). The Core Arterial Network is a connected system of corridors in Boulder where the city is elevating work to meet Boulder’s transportation goals. These corridors will feature protected bike lanes, intersection enhancements, pedestrian facilities, and transit facility upgrades. In addition to reducing the potential for severe injury crashes, another purpose of this work is to make travel by all modes more comfortable and convenient.

Figure 11 shows the High Risk Network where it overlaps with the High Injury Network (HIN) and Critical Corridors from DRCOG’s *Taking Action on Regional Vision Zero*. DRCOG developed this High Injury Network based on crash history and uses it to inform regional funding priorities.

Table 2: High Risk Network Corridors

| High Risk Network Street | Extents |
|--------------------------|--|
| 28th Street | Winding Trail Drive to Baseline Road/US 36 |
| 30th Street | Valmont Road to Colorado Avenue |
| Arapahoe Avenue | 14th Street to Foothills Parkway |
| Arapahoe Avenue | Foothills Parkway to 56th Street |
| Baseline Road | 16th Street to Manhattan Drive |
| Broadway | Lee Hill Drive to Mapleton Avenue |
| Broadway | Marine Street to Rayleigh Road |
| South Broadway | Table Mesa Drive to Darley Avenue |
| Canyon Boulevard | 15th Street to 28th Street |
| Colorado Avenue | Regent Drive to 35th Street |
| Folsom Street | Fremont Street to Taft Drive |
| Foothills Parkway | Iris Avenue to Pearl Parkway |
| Iris Avenue | 19th Street to 28th Street |
| Iris Avenue | 29th Street to Foothills Parkway |
| Lookout Road | Gunpark Drive to 71st Street |
| Pearl Street/Parkway | 28th Street to Foothills Parkway |
| Table Mesa Drive | Stanford Avenue to 55th Street |
| Valmont Road | 30th Street to Marshall Road |

The High Risk Network accounts for just 7% (26 centerline miles) of City of Boulder streets. Nearly all of the High Risk Network occurs on principal or minor arterial streets; however, the High Risk Network includes only 35% of Boulder’s arterial streets. Measured by crashes per vehicle miles traveled, the High Risk Network has roughly five times more risk than all Boulder arterial streets.

Managing risk and mitigating crashes on this small percentage of streets can have an outsized impact on reducing fatal and serious injury crashes.

Between 2016 and 2020,

- **48% of severe crashes**
- **56% of bike crashes**
- **57% of pedestrian crashes**

occurred on the High Risk Network.

Beyond these streets, severe crashes are much more dispersed.

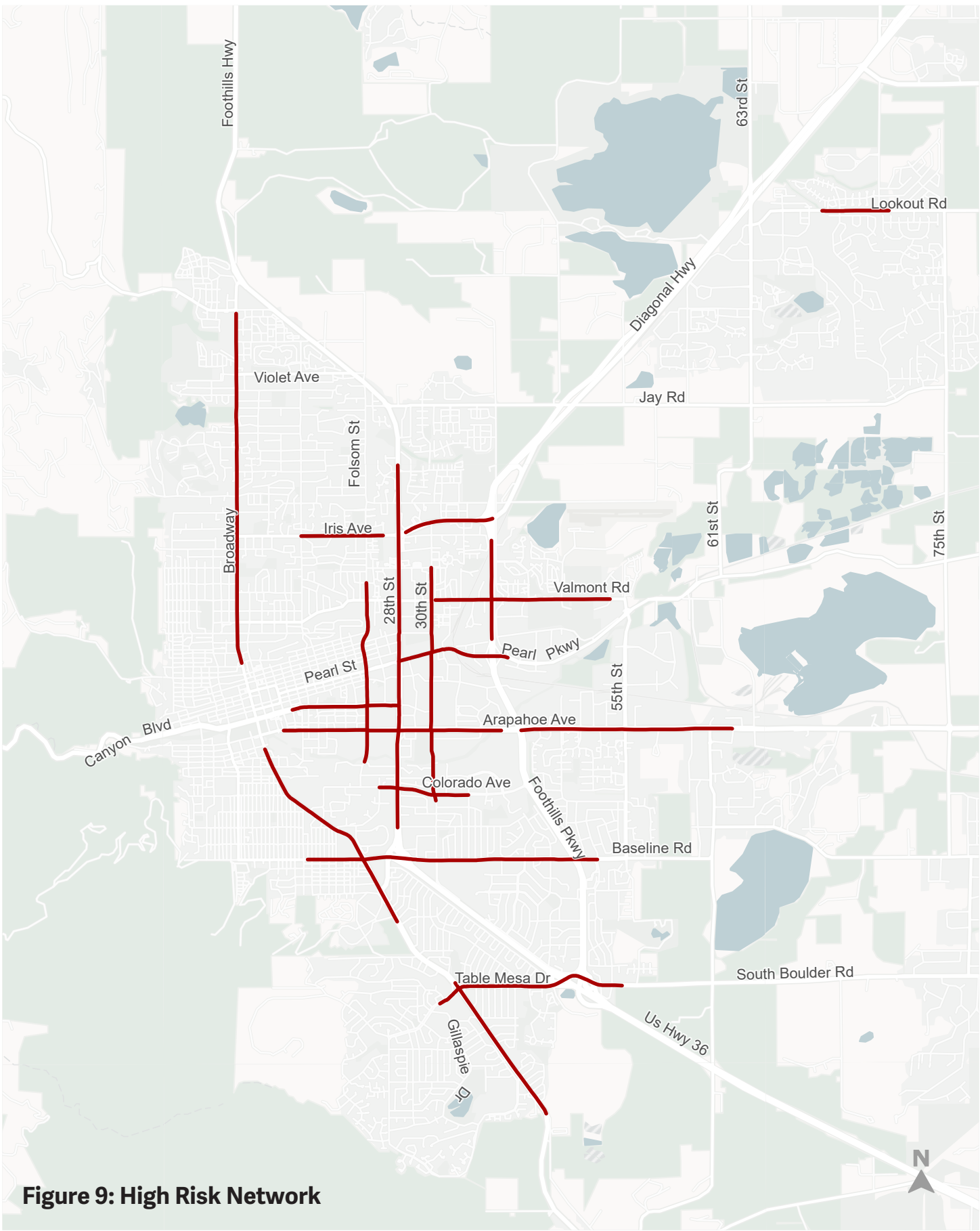
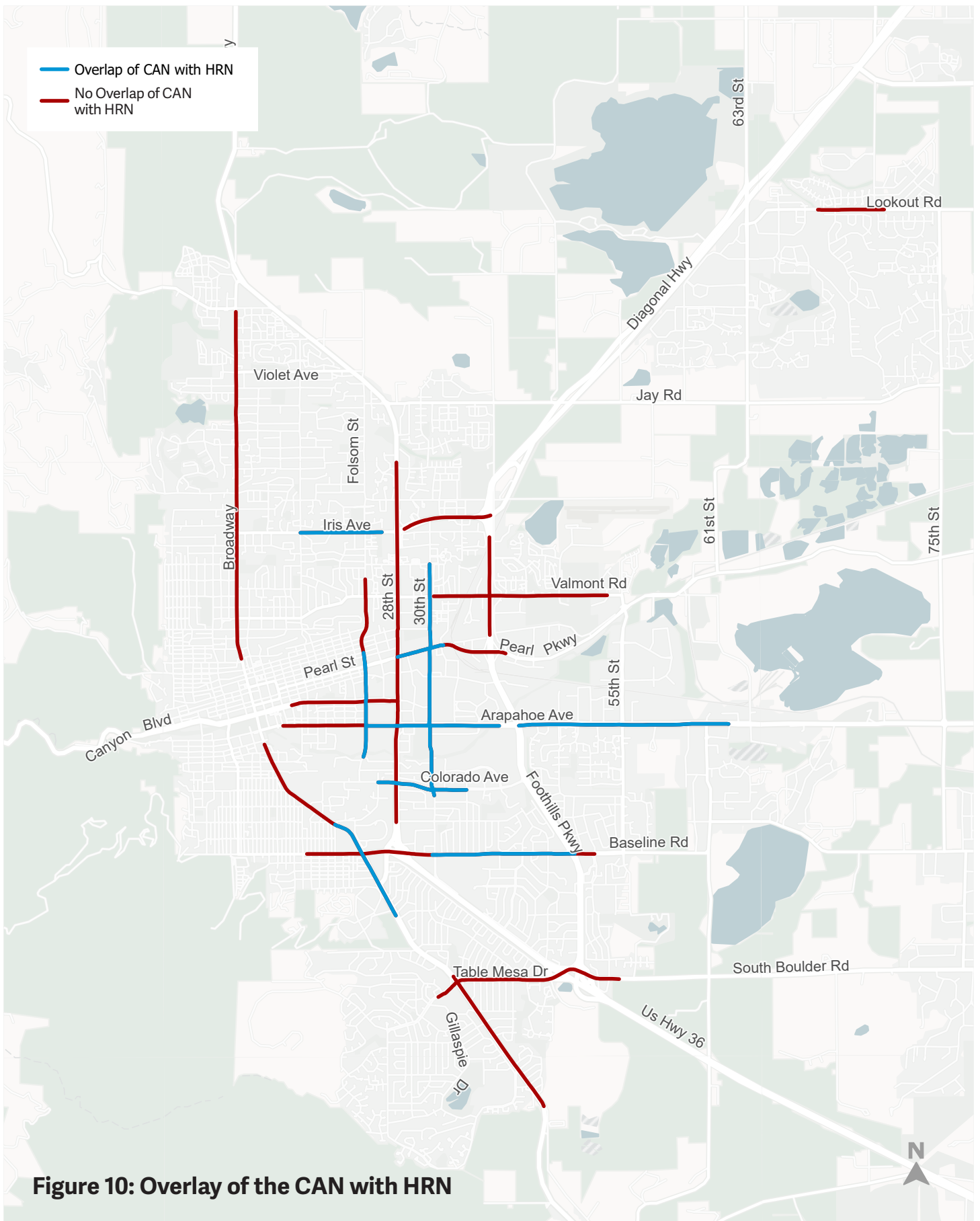


Figure 9: High Risk Network



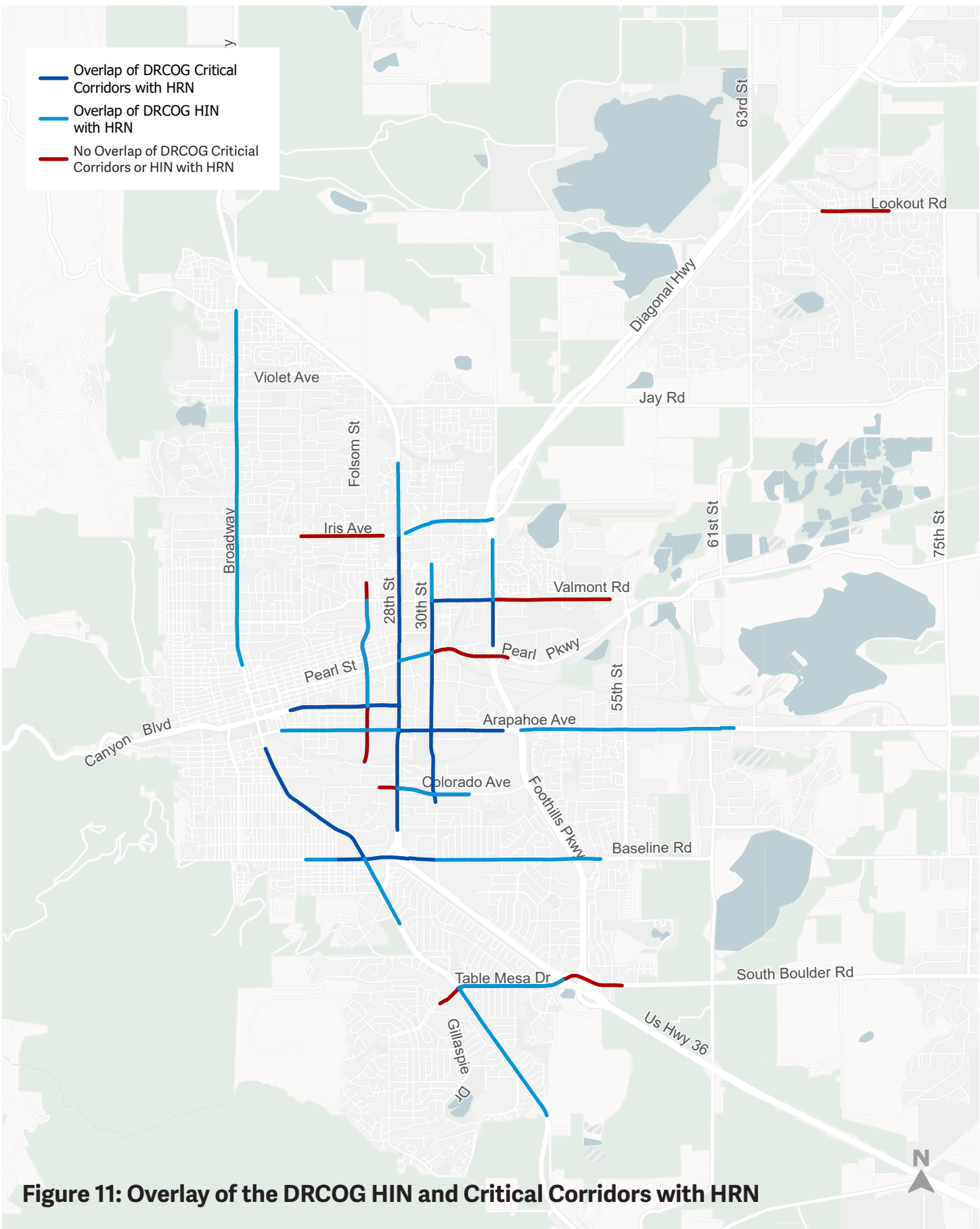


Figure 11: Overlay of the DRCOG HIN and Critical Corridors with HRN

Corridor Analysis

Each of the High Risk Network corridors was evaluated to identify proven safety treatments, or countermeasures, that can reduce the common crashes identified by the Systemic Safety analysis. At locations that had a high number of crashes, the team completed two additional analyses: 1) a review of five years of crash data (2016-2020) to identify contributing patterns, and 2) *Highway Safety Manual* analysis to identify a location's Level of Service of Safety, which quantifies a location's potential for crash reduction. **Appendix E** includes a summary of the crash data review and **Appendices F and G** include summaries of the *Highway Safety Manual* analysis. **Figure 12** shows the locations where the project team completed *Highway Safety Manual* analysis.

Table 3: Highway Safety Manual Analysis Intersections

| Intersection | Total Crashes (2016-2020) | Fatal Crashes (2016-2020) | Injury Crashes (2016-2020) *Includes all injury crashes: incapacitating, non-incapacitating, and possible |
|---|---------------------------|---------------------------|--|
| 28th Street & Jay Road | 46 | 0 | 21 |
| 28th Street & Iris Avenue | 69 | 0 | 15 |
| 28th Street & Valmont Road | 94 | 0 | 26 |
| 28th Street & Pearl Street | 64 | 0 | 19 |
| 28th Street & Walnut Street | 32 | 0 | 7 |
| 28th Street & Canyon Boulevard | 57 | 0 | 11 |
| 28th Street & Arapahoe Avenue | 169 | 1 | 32 |
| 30th Street & Valmont Road | 80 | 0 | 26 |
| 30th Street & Pearl Street/Parkway | 94 | 0 | 24 |
| 30th Street & Walnut Street | 46 | 0 | 10 |
| 30th Street & Canyon Boulevard | 33 | 0 | 12 |
| 30th Street & Arapahoe Avenue | 129 | 0 | 31 |
| 30th Street & Aurora Avenue | 27 | 0 | 10 |
| 30th Street & Baseline Road | 84 | 0 | 28 |
| Arapahoe Avenue & Broadway | 42 | 0 | 13 |
| Arapahoe Avenue & Folsom Street | 59 | 0 | 14 |
| Arapahoe Avenue & Foothills Parkway | 231 | 1 | 61 |
| Arapahoe Avenue & Conestoga Street | 29 | 0 | 10 |
| Arapahoe Avenue & 55th Street | 64 | 0 | 21 |
| Baseline Road & Broadway | 156 | 0 | 42 |
| Baseline Road & Foothills Parkway | 102 | 0 | 16 |
| Broadway & Iris Avenue | 25 | 0 | 10 |
| Broadway & Balsam Avenue | 30 | 0 | 6 |
| Broadway & Alpine Avenue | 20 | 0 | 3 |
| Broadway & Canyon Boulevard | 59 | 0 | 15 |
| Broadway & University Avenue | 77 | 0 | 26 |
| Broadway & College Avenue | 18 | 1 | 0 |
| Broadway/South Broadway & Dartmouth Avenue | 26 | 0 | 9 |
| South Broadway & Table Mesa Drive | 139 | 0 | 42 |
| Folsom Street & Canyon Boulevard | 92 | 1 | 27 |
| Folsom Street & Iris Avenue | 26 | 0 | 8 |
| Folsom Street & Valmont Road | 17 | 0 | 8 |
| Folsom Street & Pearl Street | 38 | 0 | 11 |
| Foothills Parkway & Valmont Road | 173 | 0 | 45 |
| Foothills Parkway & Table Mesa Drive/South Boulder Road | 66 | 0 | 25 |

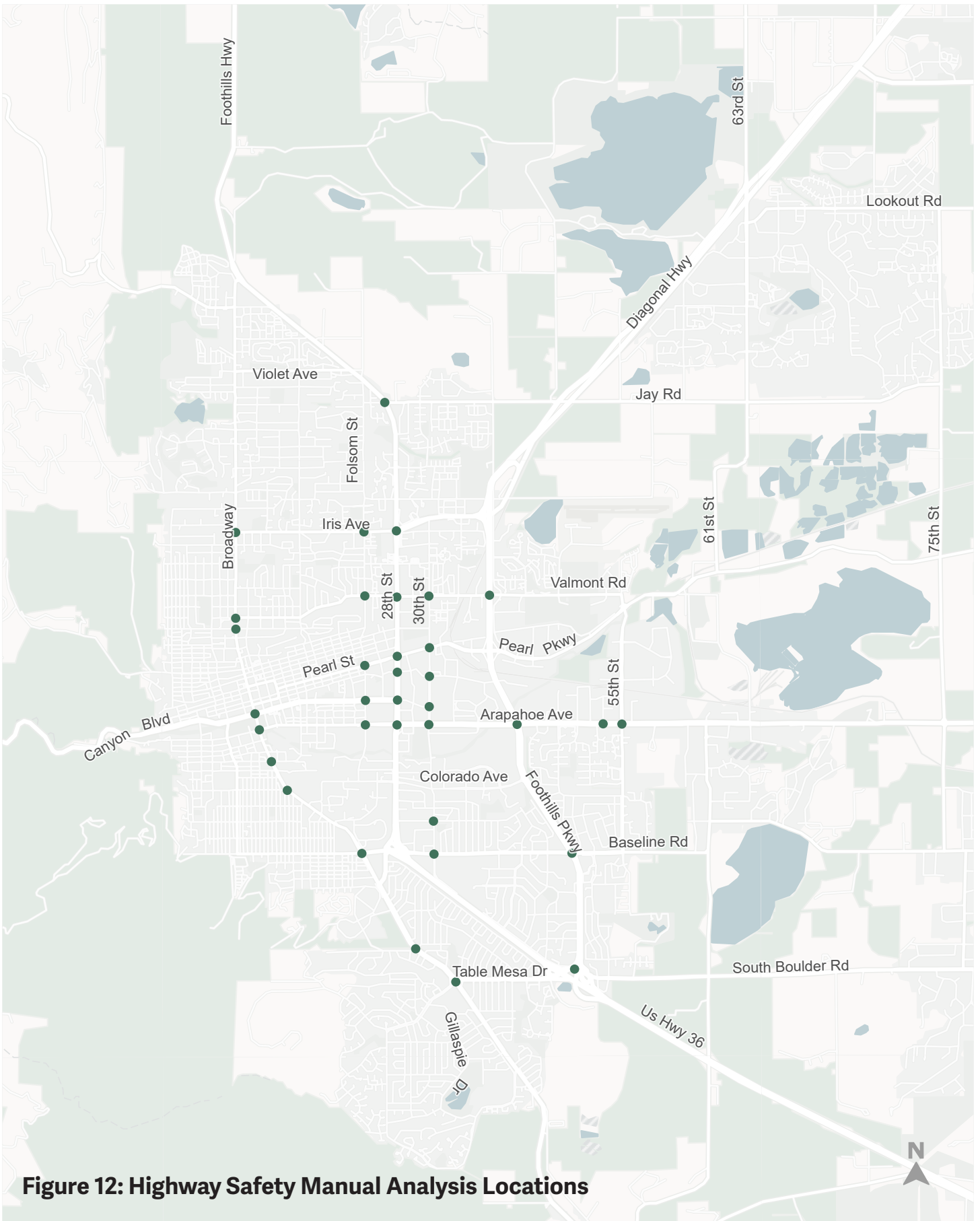


Figure 12: Highway Safety Manual Analysis Locations

Systemic Approach to Crash Reduction

Focus on common crash types and typical solutions.

- » Running red lights
- » Left-turn crashes
- » Right-turn slip lanes
- » Right-turn on red crashes
- » Right-turn crashes
- » Multi-use path crossings
- » Pedestrian crashes while crossing the street

Developed using the *Safe Streets Report*, an engineer's review of crash data, and *Highway Safety Manual* analysis across the High Risk Network.

THESE SEVEN CRASH TYPES ACCOUNT FOR 62% OF FATAL AND SERIOUS INJURY CRASHES ON THE HIGH RISK NETWORK.

Prioritize locations with the most risk.

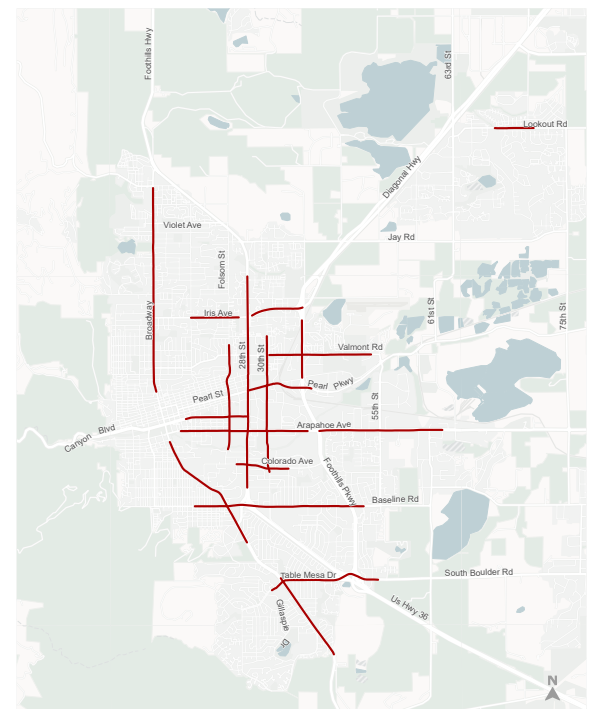
Generally, first the High Risk Network, then other streets.

Developed by analyzing contextual factors and crash data so we can manage all locations where risk exists, not just locations where crashes have occurred.

- » 7% of Boulder streets, 26% of Boulder arterials, five times more risk than all Boulder arterial streets
- » 48% of fatal and serious injury crashes (2016-2020)
- » 57% of crashes involving a pedestrian and 56% of crashes involving a bicyclist (2016-2020)

Boulder Vision Zero Action Plan

Figure 6: High Risk Network



Implement solutions across the system where possible, and at specific locations where systemic implementation is not feasible.

Common Crash Types & Potential Solutions

Analysis of the High Risk Network revealed some common crash types: running red lights, left-turns, right-turn slip lanes, right-turn on red, right-hooks, multi-use path crossings, marked crosswalks, unmarked and midblock pedestrian crossings, and pedestrians in crosswalks against the signal.





RED LIGHT RUNNING CRASHES

CRASH TYPE DESCRIPTION

There are three common factors associated with vehicles running red lights:

1. POOR SIGNAL VISIBILITY

Signal size, the number of signal heads per lane, and missing signal backplates can contribute to these crashes

2. SIGNAL TIMING OUT OF SYNC

Some High Risk Network corridors coordinate traffic signal timing; however, some signals may be out of sync which can contribute to these crashes

3. CONGESTION

Traffic congestion can create driver frustration which can contribute to these crashes

Potential Solutions

1. SIGNAL VISIBILITY

Upgrading traffic signals with retroreflective backplates, additional signal heads, or signal heads in more visible locations can provide lower-cost, high impact crash reduction benefits. However, sometimes additional signal equipment can exceed the structural capacity of signal poles and mast arms. In these cases, the costs of these solutions are higher.

2. SIGNAL TIMING OUT OF SYNC

Where signal coordination is out of sync along a corridor, timing adjustments can be made.

3. CONGESTION

Where running red lights is a result of congestion and associated driver frustration, increased enforcement during peak travel periods, including with red light cameras, is an appropriate solution.

Systemic Approach to Crash Reduction

| | |
|--|--|
| SYSTEMIC SOLUTION | STRATEGY FOR MANAGING RISK |
| Red light cameras | Implement red light cameras based on the number of red light crashes in the past three years |
| WHERE TO DEPLOY RISK MANAGEMENT STRATEGIES | ASSOCIATED VISION ZERO ACTION PLAN ACTIONS |
| At suitable locations with the greatest history of red light running crashes | 12. Expand the use of red light camera locations at effective locations (Ongoing) |

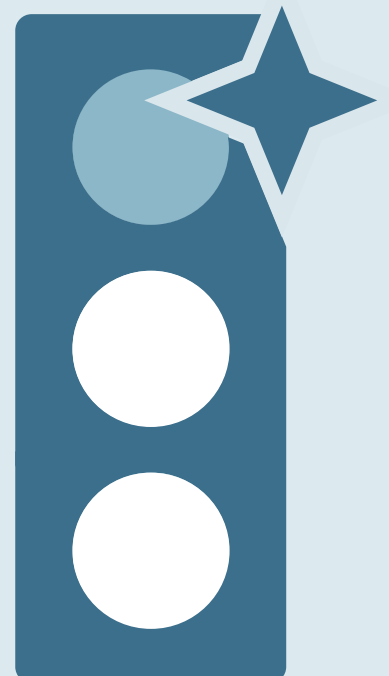
Other Strategies for Crash Reduction

LOCATION-SPECIFIC SOLUTIONS

- » Signal visibility upgrades
- » Signal timing adjustments through regular re-timing

Related areas of concern from 2022 Safe Streets Report:

- Bicycle, pedestrian, and motorcycle crashes
- People ages 15-29 and older adults ages 65 and older
- People speeding, people impaired, and people making left-turns





LEFT-TURN CRASHES

CRASH TYPE DESCRIPTION

There are three common types of left-turn crashes:

1. VEHICLE-VEHICLE LEFT-TURN CRASHES

A driver turns left and does not yield to an oncoming through vehicle

2. VEHICLE-PEDESTRIAN/BICYCLIST

A driver turns left and does not yield to a pedestrian or bicyclist traveling in the crosswalk

3. VEHICLE-BICYCLIST

A driver turns left and does not yield to an oncoming through bicyclist traveling in the bike lane

Potential Solutions

All Types

Continued implementation of the city's Left-Turn Phase Operation Practice, which guides changes to left-turn operation at signalized intersections. And updating the guidance with consideration of:

- Lower pedestrian and bicyclist (in crosswalk) volume thresholds
- A threshold for oncoming bicyclists in bike lane volume
- A threshold for people with disabilities (in crosswalk)
- Providing protected left-turn signal phasing when a pedestrian or bicyclist pushes the pedestrian push button

Systemic Approach to Crash Reduction

SYSTEMIC SOLUTION

Protect left-turns

STRATEGY FOR MANAGING RISK

Protect left-turns based on conflicting volumes of left-turning vehicles and pedestrians or bicyclists in the crosswalk or oncoming bicyclists

-or-

Protect left-turns when pedestrians push the pedestrian push button

WHERE TO DEPLOY RISK MANAGEMENT STRATEGIES

High Risk Network first, other signalized intersections later

ASSOCIATED VISION ZERO ACTION PLAN ACTIONS

- » 1.C.i – Update Boulder’s Left-Turn Operation Traffic Operations Practice (2024)
- » 1.C.ii – Proactively implement the new left-turn operation practice across the HRN (2025)
- » 1.C.iii – Proactively implement the new left-turn operation practice at remaining traffic signals (2026)

Related areas of concern from 2022 Safe Streets Report:

- ✓ Bicycle, pedestrian, and motorcycle crashes
 - ✓ People ages 15-29 and older adults ages 65 and older
 - ✓ People speeding, people impaired, and people making left-turns
-





RIGHT-TURN SLIP LANE CRASHES

Right-turn slip lanes exist at many signalized intersections in Boulder, with most including raised crosswalks for people walking or biking to more safely navigate to a pedestrian crossing island near the intersection. A right-turn slip lane allows right-turning traffic to “slip past” an intersection and avoid a red light which can reduce intersection delay.

CRASH TYPE DESCRIPTION

There are generally two types of crashes that occur at right-turn slip lanes:

1. VEHICLE-PEDESTRIAN/ BICYCLIST

A driver turns right and does not yield to a pedestrian or bicyclist in the crosswalk or a driver is stopped in the crosswalk creating collision potential with a bicyclist; the free movement of vehicles at slip lanes is also difficult to navigate for people who are visually impaired

2. VEHICLE-VEHICLE REAR-END

A driver turns right and stops to wait to enter the intersecting street and a second right-turning vehicle driver does not stop; inconsistency in design of right-turn slip lanes can contribute to this crash type by creating confusion and hard braking

Potential Solutions

All Types

Consistent signing and markings are a low-cost solution that can clarify expected behaviors and reduce the potential for crashes. For example, adding “STATE LAW YIELD,” “2-WAY CROSSING” warning, “LOOK,” and/or “YIELD” signage and painting high-visibility crosswalk markings.

At locations where there are many pedestrians and/or bicyclists, right-turn traffic signals should be added or the right-turn slip lane should be removed, when supported by delay and queuing analysis to ensure that other safety issues are not created.

Where it is necessary to retain a right-turn slip lane, the slip lane itself can be modified in a number of ways. The slip lane can be changed to lower speeds with tighter angles at corners. Adequate storage can be provided at the crosswalk for drivers waiting to merge. And, increased or consistent yield signage can be provided at the crosswalk and at the merge point.

Systemic Approach to Crash Reduction

SYSTEMIC SOLUTION

- » Implement consistent pedestrian crossing and yield signage
- » Evaluate and decide on a preferred geometric/ signalization solution

STRATEGY FOR MANAGING RISK

- » Implement new signage at all right-turn slip lanes
- » Upgrade right-turn slip lanes based on conflicting volumes of right-turning vehicles and pedestrians or bicyclists in the crosswalk

WHERE TO DEPLOY RISK MANAGEMENT STRATEGIES:

- » High Risk Network first, other signalized intersections later
- » High Risk Network first, other signalized intersections later

ASSOCIATED VISION ZERO ACTION PLAN ACTIONS:

- » 1.E.i Update right-turn slip lane signage on the HRN (2024)
- » 1.E.ii Update right-turn slip lane signage on remaining streets (2025)
- » 9 Evaluate right-turn slip lane designs (by 2027)

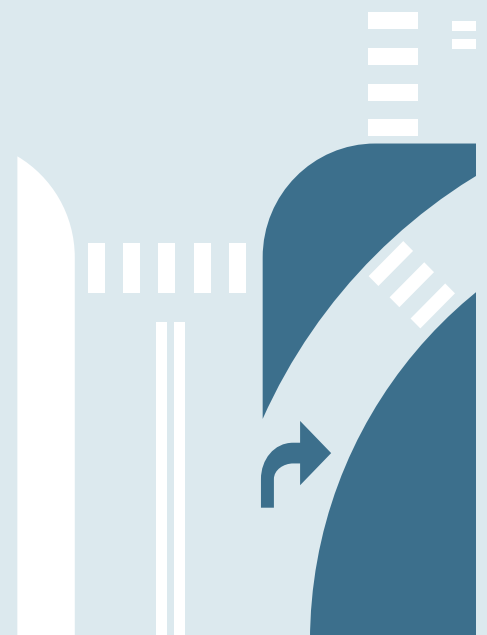
Other Strategies for Crash Reduction

LOCATION-SPECIFIC SOLUTIONS

Signals or other upgrades at locations with crash history

Related areas of concern from 2022 Safe Streets Report:

- Bicycle, pedestrian, and motorcycle crashes
- People ages 15-29 and older adults ages 65 and older
- People speeding, people impaired, and people making left-turns





RIGHT-TURN ON RED CRASHES

CRASH TYPE DESCRIPTION

Turning right on a red light is legal in Boulder unless a sign prohibits the movement or if the movement is controlled by a red arrow.

1. VEHICLE-PEDESTRIAN/ BICYCLIST

Vehicle drivers fail to yield and enter the crosswalk where a pedestrian or bicyclist is present while looking in the opposite direction of the pedestrian or bicyclist for oncoming traffic

2. VEHICLE-BICYCLIST

Vehicle drivers turn across an intersecting bike lane where a bicyclist is present

Potential Solutions

All Types

Prohibiting right-turn on red, either with signs or traffic signals, can reduce this crash type. Greater compliance can be achieved by prohibiting right-turns at priority locations, such as intersections with high volumes of people walking or biking, while also considering impacts to delay, which can cause driver frustration and non-compliance. Targeted enforcement and red light cameras can also increase compliance.

Systemic Approach to Crash Reduction

SYSTEMIC SOLUTION

- » Prohibit right-turn on red (RTOR)

STRATEGY FOR MANAGING RISK

- » Prohibit RTOR based on conflicting volumes of right-turning vehicles and pedestrians or bicyclists in the crosswalk

WHERE TO DEPLOY RISK MANAGEMENT STRATEGIES

- » High Risk Network first, other signalized intersections later

ASSOCIATED VISION ZERO ACTION PLAN ACTIONS

- » 1.B.i – Implement no RTOR prohibitions (2023)
- » 1.B.ii – Update Boulder’s no RTOR Traffic Operations Practice (2024)
- » 1.B.iii – Proactively implement the new no RTOR practice across the HRN (2025)
- » 1.B.iv – Proactively implement the new no RTOR practice at remaining traffic signals (2026)

Related areas of concern from 2022 Safe Streets Report:

- Bicycle, pedestrian, and motorcycle crashes
 - People ages 15-29 and older adults ages 65 and older
 - People speeding, people impaired, and people making left-turns
-





RIGHT-TURN CRASHES

CRASH TYPE DESCRIPTION

There are two common types of right-turn crashes:

1. VEHICLE-BICYCLIST

A driver turns right in front of a bicyclist traveling parallel to the vehicle in the on-street bike lane; this is commonly known as a right-hook crash

2. VEHICLE-PEDESTRIAN/BICYCLIST (IN THE CROSSWALK)

A driver turns right when a pedestrian or bicyclist is in the crosswalk

Potential Solutions

Vehicle-Bicyclist or Vehicle-Pedestrian/Bicyclist (in the Crosswalk)

Providing a dedicated right-turn lane with adequate queue storage and protected right-turns with a red arrow traffic signal phase, where the number of right-turning vehicles reaches a threshold, can mitigate these crashes. Protected intersection elements can also mitigate these crashes. Implementation of these solutions on *Low-Stress Walk and Bike Network Plan* vertical separation corridors should be prioritized.

Vehicle-Pedestrian/Bicyclist (in the Crosswalk)

Leading Pedestrian Intervals give pedestrians or bicyclists in the crosswalk a three to seven second head start when entering an intersection with a corresponding green signal in the same direction.

Systemic Approach to Crash Reduction

SYSTEMIC SOLUTION

- » Green pavement markings in conflict zones
- » Leading Pedestrian Interval (LPI)
- » Protected right-turns

STRATEGY FOR MANAGING RISK

- » Add green pavement markings at major intersections, minor intersections, and driveways
- » Implement LPI based on conflicting volumes of right-turning vehicles and pedestrians or bicyclists in the crosswalk
- » Protect right-turns based on conflicting volumes of right-turning vehicles and pedestrians or bicyclists in the crosswalk or right-hook bicyclists

WHERE TO DEPLOY RISK MANAGEMENT STRATEGIES

- » CAN corridors that overlap at least in part with the High Risk Network
- » High Risk Network first, other signalized intersections later
- » Priority CAN corridors

ASSOCIATED VISION ZERO ACTION PLAN ACTIONS

- » 1.D.i – Add green pavement markings at major intersections, minor intersections, and driveways on CAN corridors that overlap at least in part with the High Risk Network (2024)
- » 1.A.i – Implement LPI at 17th & Arapahoe (2023)
- » 1.A.ii – Proactively implement LPI Traffic Operations Practice across the HRN (2024)
- » 1.A.iii – Proactively implement LPI Traffic Operations Practice at remaining traffic signals (2025)
- » 3. Implement capital projects to improve safety and comfort including protected bike lanes, protected intersections, and setback multi-use path crossings on high priority Vision Zero and CAN corridors (by 2027)

Related areas of concern from 2022 Safe Streets Report:

- Bicycle, pedestrian, and motorcycle crashes
- People ages 15-29 and older adults ages 65 and older
- People speeding, people impaired, and people making left-turns





MULTI-USE PATH CROSSING CRASHES

CRASH TYPE DESCRIPTION

There are two types of multi-use path crossing crashes:

1. OUTBOUND RIGHT-TURN VEHICLE-PEDESTRIAN/BICYCLIST

A driver on a minor street or at a driveway crosses a multi-use path to make a right-turn onto the major street collides with a pedestrian or bicyclist traveling from the opposite direction than a driver is looking.

2. INBOUND VEHICLE PEDESTRIAN/BICYCLIST

A driver on the major street makes a right-turn or left-turn across the multi-use path and collides with a pedestrian or bicyclist.

Potential Solutions

Outbound right-turn vehicle-pedestrian/bicyclist

Creating setbacks at multi-use path crossings at minor streets and driveways to provide storage for one vehicle past the crosswalk can reduce this crash type by separating drivers' turning from the multi-use path crossing. Raised crosswalks can also help reduce this crash type. This solution is particularly challenging to implement because of the number of multi-use path crossing locations and the amount of right-of-way needed to create the setback, so this solution should be implemented at select locations, in particular with corridor reconstruction projects.

Inbound vehicle pedestrian/bicyclist

Access management to restrict inbound left-turns will eliminate the conflict for inbound, left-turning vehicles. Where access remains, and where inbound right-turning vehicles cross a multi-use path, these crashes can be mitigated with appropriate sight distance and high-visibility markings or signage.

Systemic Approach to Crash Reduction

SYSTEMIC SOLUTION

Setback multi-use path crossings with raised crosswalks

STRATEGY FOR MANAGING RISK:

Upgrade multi-use path crossings at minor intersections and driveways based on conflicting volumes of turning vehicles and pedestrians or bicyclists in the crosswalk

WHERE TO DEPLOY RISK MANAGEMENT STRATEGIES:

Priority CAN corridors

ASSOCIATED VISION ZERO ACTION PLAN ACTIONS:

3. Implement capital projects to improve safety and comfort including protected bike lanes, protected intersections, and setback multi-use path crossings on high priority Vision Zero and CAN corridors (by 2027)

Related areas of concern from 2022 Safe Streets Report:

- Bicycle, pedestrian, and motorcycle crashes
- People ages 15-29 and older adults ages 65 and older
- People speeding, people impaired, and people making left-turns





PEDESTRIAN CRASHES WHILE CROSSING THE STREET

CRASH TYPE DESCRIPTION

There are three types of crashes that involve pedestrians (or bicyclists in the crosswalk) crossing the street:

1. VEHICLE-PEDESTRIAN/ BICYCLIST AT A MARKED CROSSWALK (WITH NO PEDESTRIAN SIGNAL)

A driver on the major street does not yield at a marked crosswalk (with no pedestrian signal) when a pedestrian or bicyclist is present despite the crossing featuring markings, signs, or flashing beacons.

2. VEHICLE-PEDESTRIAN OUTSIDE OF A MARKED CROSSWALK

This crash occurs when a pedestrian is struck by a vehicle outside of a marked crosswalk. In some cases, these locations are legal, unmarked crosswalks; however, the rights and duties of pedestrians and drivers are not well-understood by most people in these settings.

3. PEDESTRIANS IN CROSSWALKS AGAINST THE SIGNAL

This crash most commonly occurs at a signalized intersection between a vehicle and a pedestrian or a bicyclist in the crosswalk. For these crashes the crash reports and crash data indicate that the pedestrian or bicyclist was unlawfully in the crosswalk, usually because the pedestrian signal had a "Don't Walk" signal. A pedestrian or bicyclist may enter a crosswalk unlawfully for a variety of reasons. In some cases, this behavior may be encouraged by high pedestrian delay; however, further evaluation is needed to better understand the role that delay plays in this behavior in Boulder.

Potential Solutions

Vehicle-Pedestrian/Bicyclist at a Marked Crosswalk

At locations where the city's *Pedestrian Crossing Treatment Installation Guidelines* guide staff to install a marked crosswalk, installing pedestrian signals or Rectangular Rapid Flashing Beacons (RRFBs) at locations with a lower number of vehicles and lower speed limit streets can reduce this crash type. This would require an update to the city's *Pedestrian Crossing Treatment Installation Guidelines*, and specifically the criteria for crossing treatments in Table 1, Figure 2a, and Figure 2b. The update to the *Pedestrian Crossing Treatment Installation Guidelines* should also address raised crosswalks. Subsequent to updating the *Guidelines*, existing pedestrian crossings should also be updated incrementally over time as funding and staff resources allow.

Vehicle-Pedestrian Outside of a Marked Crosswalk

The city can implement new pedestrian crossings at unmarked or midblock locations consistent with Boulder's *Pedestrian Crossing Treatment Installation Guidelines*.

Systemic Approach to Crash Reduction

SYSTEMIC SOLUTION

Upgraded and new pedestrian crossings

STRATEGY FOR MANAGING RISK

Upgrade and install new pedestrian crossings based on conflicting volumes of vehicles and pedestrians or bicyclists in the crosswalk.

WHERE TO DEPLOY RISK MANAGEMENT STRATEGIES

High Risk Network first, other streets later

ASSOCIATED VISION ZERO ACTION PLAN ACTIONS

» 6. Update the *Pedestrian Crossing Treatment Installation Guideline*

Related areas of concern from 2022 *Safe Streets Report*:

- Bicycle, pedestrian, and motorcycle crashes
 - People ages 15-29 and older adults ages 65 and older
 - People speeding, people impaired, and people making left-turns
-



PROTECTING BIKE LANES BEFORE PHYSICAL SEPARATION

In addition to physical separation, protected bike lanes feature treatments to reduce risk associated with conflicting turning movements:

- Protected left-turns
- Prohibiting right-turn on red
- Protected right-turns
- Protected intersections
- Green pavement markings in conflict zones

Several Vision Zero Action Plan actions will result in more protection for bicyclists before physical separation can be installed:

- Actions 1.C.i through 1.C.iii which will result in more protected left-turns across bikeways
- Actions 1.B.i through 1.B.iv which will result in more right-turn on red prohibitions across multi-use paths
- Action 3 which will implement protected right-turns and protected intersections on high priority High Risk Network and CAN corridors
- Action 1.D.i which will add green pavement markings in conflict zones on CAN corridors that overlap at least in part with the High Risk Network





CHAPTER 4.

ENGINEERING SOLUTION PRIORITIZATION





Engineering Solutions Prioritization

The project team used three criteria to prioritize engineering solutions at specific locations, or projects, that emerged from the Systemic Safety and corridor analysis. This prioritization method applied to higher cost projects and stand-alone, low-cost projects and not the improvements that will apply to broad portions of the street system as described in the previous section:

- Benefit-cost ratio (BCR) – for each project, the team produced an order of magnitude cost estimate. The team estimated the project's benefit according to the crash history at the intersection, relevant Crash Modification Factors (CMFs) for all intersection crashes, and cost data from the National Safety Council's (NSC) *Estimating the Costs of Unintentional Injuries, 2013* per CDOT's procedures for [Highway Safety Improvement Program](#) funding. The project team prioritized projects where the estimated benefits exceeded the estimated costs.
- Boulder's Racial Equity Index – Boulder's Draft Racial Equity Index evaluates city census block groups for level of need using five variables:
 1. Proportion of the population that are people of color
 2. Proportion of the population that is Hispanic/Latino
 3. Household median income
 4. Proportion of households living below the Federal poverty line
 5. The proportion of residents that are Housing and Human Services aid recipients

Figure 13 shows Boulder's Racial Equity Index. The team prioritized projects in or adjacent to Equity Index Numbers 4 or 5.

- Community engagement feedback – During Phase 1 of community engagement for the Vision Zero Action Plan's development, the city hosted a web map for community members to identify specific locations of concern. The team prioritized projects that had high levels of BeHeardBoulder feedback. **Figure 7** shows a heat map of BeHeardBoulder Web map pin drops.

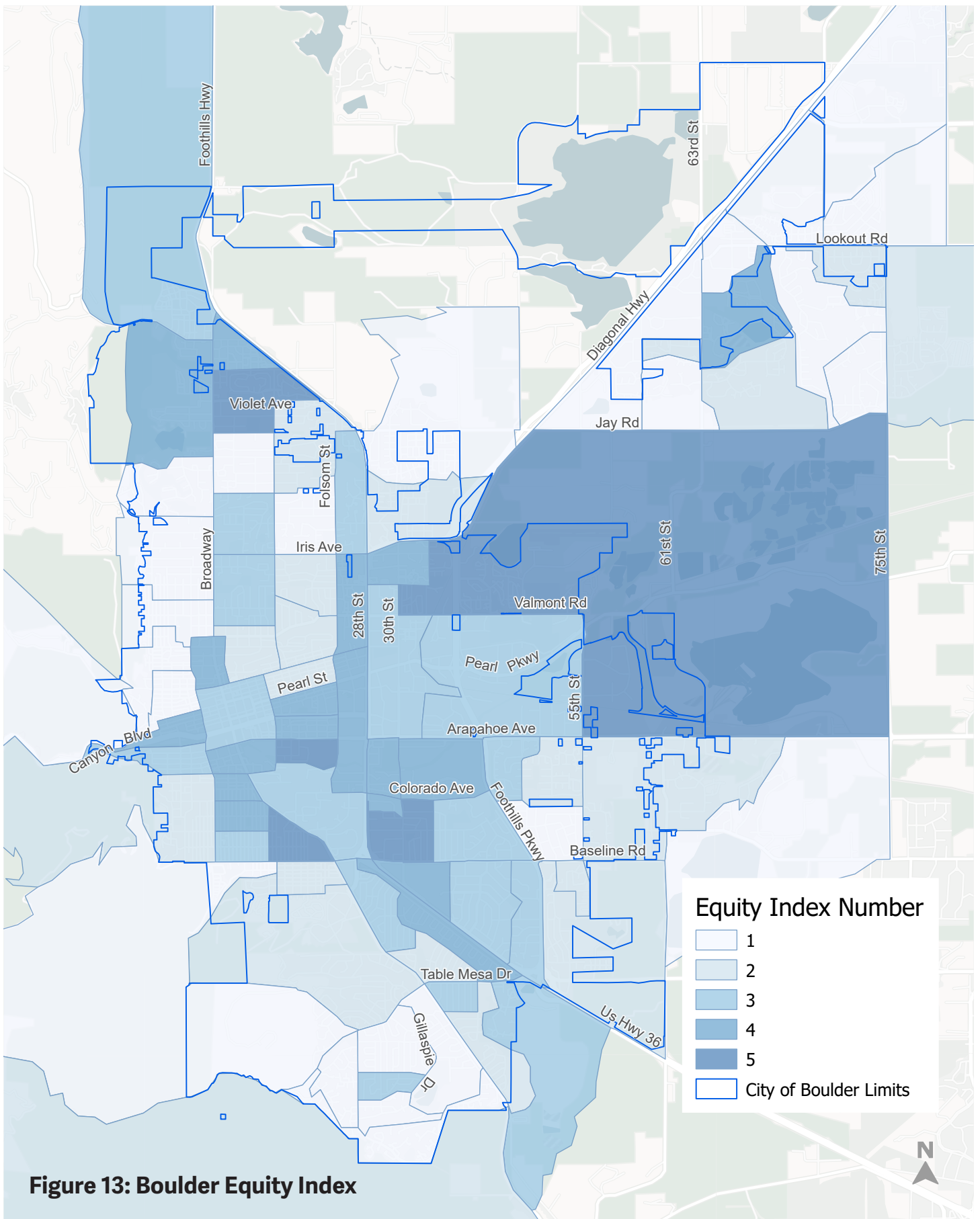


Figure 13: Boulder Equity Index

CHAPTER 5.

ACTION PLAN

NCTC
970-356-6881
303-659-1729





Action Plan

The *Vision Zero Action Plan* identifies four categories of actions to achieve Vision Zero:



1. Implement and improve engineering solutions to reduce fatal and serious injury crashes.



3. Improve the city's internal Vision Zero practices.



2. Pair engineering solutions with education and enforcement.



4. Improve Vision Zero data and transparency.

Where possible, the city will advance actions ahead of the proposed time frame.

| Implement and improve engineering solutions to reduce fatal and serious injury crashes. | | |
|---|---------------------------|------------|
| Action | Responsibility (Partner) | Time Frame |
| 1. Broadly implement low-cost projects on the High Risk Network to address top crash patterns | Transportation & Mobility | Ongoing |
| A. Leading Pedestrian Interval | | |
| i. Implement new LPI at Arapahoe Avenue & 17th Street | | 2023 |
| ii. Proactively implement the LPI Traffic Operations Practice across the High Risk Network, including accessible pedestrian signals where possible | | 2024 |
| iii. Proactively implement the LPI Traffic Operations Practice at remaining traffic signals, including accessible pedestrian signals where possible | | 2025 |
| B. No Right-Turn on Red (RTOR) | | |
| i. Implement no RTOR prohibitions at the following locations: <ul style="list-style-type: none"> Broadway & Arapahoe Avenue (westbound right-turn) Broadway & University Avenue (eastbound right-turn) Broadway & Table Mesa Drive (northbound right-turn) 30th Street & Valmont Street (northbound right-turn and westbound right-turn) Arapahoe Avenue & Folsom Street (westbound right-turn) Canyon Boulevard & Folsom Street (eastbound right-turn) | | 2023 |
| ii. Update Boulder's no RTOR Traffic Operations Practice | | 2024 |
| iii. Proactively implement the new no RTOR Traffic Operations Practice across the High Risk Network | | 2025 |
| iv. Proactively implement the new no RTOR Traffic Operations Practice at remaining traffic signals | | 2026 |

| C. Left-Turn Operation Change | | |
|---|---|--------------------------------------|
| i. | Update Boulder’s Left-Turn Operation Traffic Operations Practice | 2024 |
| ii. | Proactively implement the Left-Turn Operation Traffic Operations Practice across the High Risk Network; document relevant HSIP information for locations that lack adequate signal equipment | 2025 |
| iii. | Proactively implement the Left-Turn Operation Traffic Operations Practice at remaining traffic signals; document relevant HSIP information for locations that lack adequate signal equipment | 2026 |
| D. Green Pavement Markings in Conflict Zones | | |
| i. | Add green pavement markings at major intersections, minor intersections, and driveways on CAN corridors that overlap at least in part with the High Risk Network | 2024 |
| E. Right-Turn Slip Lanes | | |
| i. | Update right-turn slip lanes on the HRN to feature consistent signing for drivers and pedestrians (<i>See Figure 14</i>) | 2024 |
| ii. | Update right-turn slip lanes on remaining streets to feature consistent signing for drivers and pedestrians | 2025 |
| F. Additional Low-Cost Solutions | | |
| i. | Implement additional, high-priority, low-cost solutions (<i>See Table 5</i>) | By 2025 |
| 2. | Strategically implement higher cost solutions on the High Risk Network to address top crash patterns; document relevant HSIP information for these locations (<i>See Table 6</i>) | Transportation & Mobility Ongoing |
| 3. | Implement capital projects to improve safety and comfort including protected bike lanes, protected intersections, and setback multi-use path crossings on high priority High Risk Network and Core Arterial Network corridors: <ul style="list-style-type: none"> • Arapahoe Avenue • Baseline Road • Folsom Street • Iris Avenue | Transportation & Mobility By 2027 |
| 4. | Upgrade Boulder’s traffic signal system by replacing traffic signal equipment not built to current standards to enable expanded use 12-inch yellow and green lenses, retroreflective backplates, and conduct engineering countermeasures evaluations in accordance with FHWA Red Light Camera Systems Operational Guidelines to reduce red light running | Transportation & Mobility Ongoing |
| 5. | Update Boulder’s Traffic Operations Practices for right-turn on red (1.B.ii) and left-turn phases (1.C.ii); develop a practice for protected right-turn phases | Transportation & Mobility 2024 |

| | | |
|---|--------------------------------------|---|
| <p>6. Update the <i>Pedestrian Crossing Treatment Installation Guidelines</i>; document relevant HSIP information for existing marked crosswalk locations that no longer meet the guidelines</p> | <p>Transportation & Mobility</p> | <p>2024</p> |
| <p>7. Update and implement Boulder’s policies and practices regarding speed limit setting to better align target and actual operating speeds</p> | <p>Transportation & Mobility</p> | <p>New policy/ practice by 2024; otherwise ongoing</p> |
| <p>8. Pursue and attract state and federal funding for high cost projects, with a focus on federal Highway Safety Improvement Program, federal Safe Streets for All, and DROCG Transportation Improvement Program funding ; grant funding priorities include:</p> <ul style="list-style-type: none"> • Traffic signals on the HRN where left-turn operation changes are needed but signal equipment upgrades are necessary (Action 1.C.ii) <i>Candidate funding source(s): HSIP, SS4A</i> • Traffic signals at remaining traffic signals where left-turn operation changes are needed but signal equipment upgrades are necessary (Action 1.C.iii) <i>Candidate funding source(s): HSIP, SS4A</i> • Other higher cost solutions (Action 2) <i>Candidate funding source(s): HSIP</i> • CAN corridors (Action 3) <i>Candidate funding source(s): SS4A, DRCOG TIP</i> • Other signals where 12-inch yellow and green lenses and backplates are necessary (Action 4) <i>Candidate funding source(s): HSIP</i> • Pedestrian crossing upgrades on the HRN where new RRFBs or signals are necessary (Action 6) <i>Candidate funding source(s): HSIP, SS4A</i> • (See Figure 15) Pedestrian crossing upgrades at remaining pedestrian crossings where new RRFBs or signals are necessary (Action 6) <i>Candidate funding source(s): HSIP, SS4A</i> | <p>Transportation & Mobility</p> | <p>Ongoing</p> |
| <p>9. Design and conduct a robust study or experiment of right-turn slip lane design, addressing locations with no right-turn lane, locations with a right-turn lane and no slip lane, locations with a yield-controlled slip lane, and locations with a signal-controlled slip lane. Based on the findings, develop a strategy for improving right-turn slip lanes across the city, including communication to other city departments regarding updates to design standards or development review procedures.</p> | <p>Transportation & Mobility</p> | <p>Begin study/ experiment in 2025; evaluation complete by 2027</p> |

Pair engineering solutions with education and enforcement

| Action | Responsibility (Partner) | Time Frame |
|---|---|------------|
| 10. Facilitate regular collaboration between the Boulder Police Department and Transportation & Mobility Department to identify and enforce unsafe travel behaviors at problem locations or locations with recently installed solutions | Police Department (Transportation & Mobility) | Ongoing |
| 11. Strategically deploy photo radar van along high-speed corridors where allowed by state law | Police Department | Ongoing |
| 12. Expand the use of red light camera locations at eligible locations | Police Department (Transportation & Mobility) | Ongoing |
| 13. Support legislation to enable expanded use of photo radar van (commercial settings, higher speed streets) and red light cameras | Transportation & Mobility | Ongoing |
| 14. Collaborate with CDOT and DRCOG to implement Vision Zero campaigns, focusing on behaviors of concern such as distracted driving, driving under the influence, drivers/bicyclist/pedestrians sharing the road, and unsafe behaviors by youth drivers | Transportation & Mobility (Police Department) | Ongoing |
| 15. Combine countermeasure deployment with accompanying events and announcements, such as press releases, news interviews, ribbon cuttings, or project signage | Transportation & Mobility | Ongoing |

Improve the city's internal Vision Zero practices

| Action | Responsibility (Partner) | Time Frame |
|--|---------------------------|------------|
| 16. For all capital projects, designate a Transportation & Mobility representative to champion Vision Zero goals and strategies; coordinate with Community Vitality and Planning & Development Services staff to elevate Vision Zero within their work | Transportation & Mobility | Ongoing |
| 17. Continue participation in the national Vision Zero Cities Network to learn and share new ideas and approaches with community leaders | Transportation & Mobility | Ongoing |

Improve Vision Zero data and transparency

| Action | Responsibility (Partner) | Time Frame |
|---|---|------------|
| 18. Maintain and update the crash data dashboard | Transportation & Mobility (Police Department) | Ongoing |
| 19. Continue to refine and improve accuracy in and utility of crash documentation | Transportation & Mobility (Police Department) | Ongoing |
| 20. Annually summarize progress in delivering the Vision Zero Action Plan | Transportation & Mobility | Ongoing |

Complementary Efforts

While not specifically called out as actions to deliver through the *Vision Zero Action Plan*, the city acknowledges and is committed to a variety of complementary programs and efforts:

- Buildout of the [Low-Stress Walk and Bike Network Plan](#)
- New sidewalk and curb ramp construction via the [Missing Sidewalk Links](#) program and associated maintenance
- [Snow and ice removal program](#)
- Ongoing maintenance of existing sidewalks and curb ramps through the [Annual Sidewalk Repair Program and Pavement Management Program](#)
- Building low-cost pedestrian, bicycle, and transit improvements along with planned paving through the [Pavement Management Program Mobility Enhancements program](#)
- Acquiring streetlights from Xcel Energy and upgrading streetlighting throughout the city
- [Safe Routes to School](#) infrastructure projects through partnership with the Boulder Valley School District
- Adoption and implementation of the city's [Americans with Disability Act Transition Plan](#)



Systemic Safety & Proactive Implementation

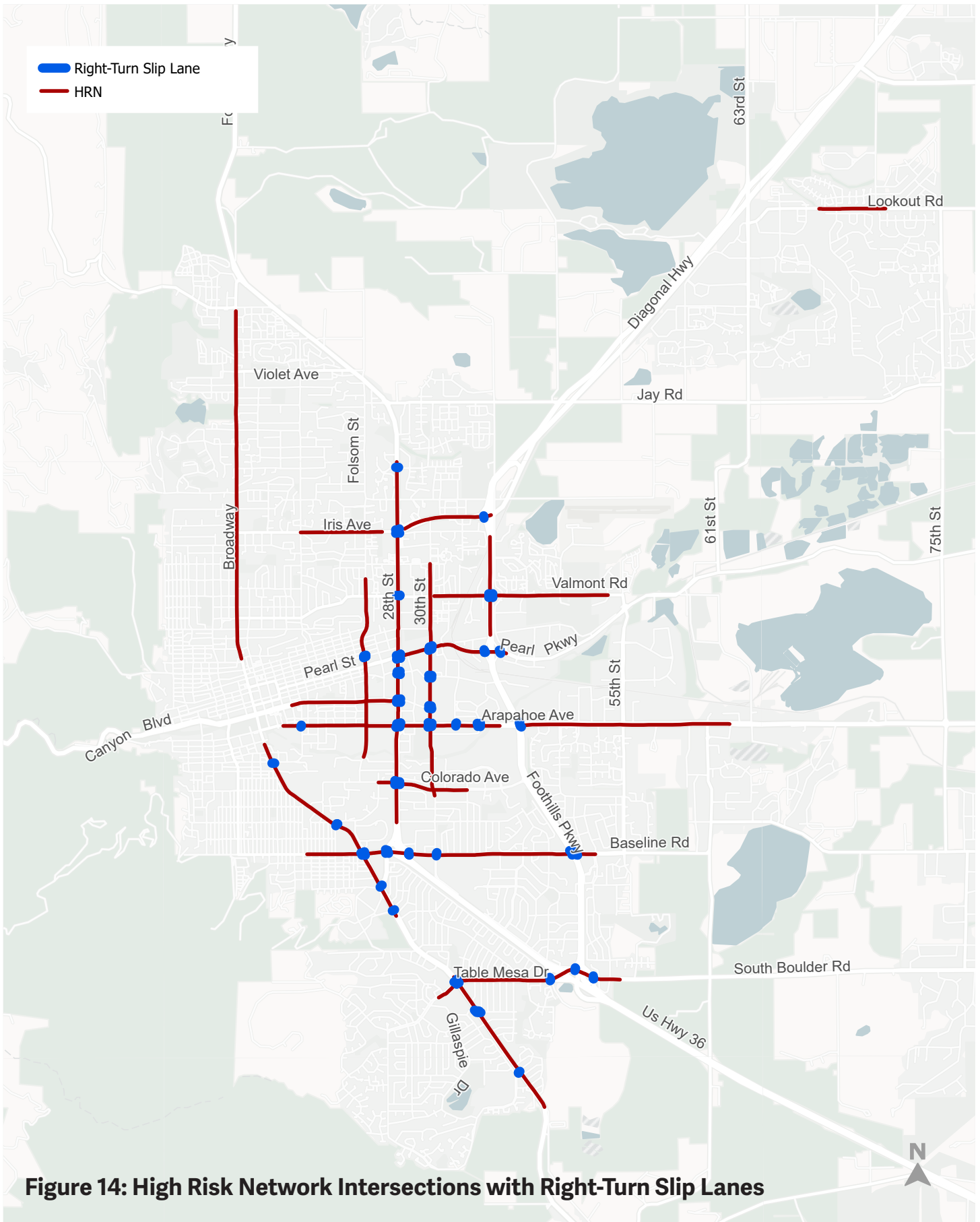
Table 4 shows how the *Vision Zero Action Plan* will implement solutions both reactively and proactively.

Table 4: Reactive and Proactive Approaches to Mitigating Common Crash Types

| Crash Type | Reactive Approach | Proactive Approach |
|--|---|---|
| Red light running, poor signal visibility | Signal upgrades (12-inch yellow and green lenses, additional signal heads, backplates) at locations where crashes have occurred | Action 4 includes locations with signal equipment not built to current standards that have not yet experienced crashes |
| Red light running, signal timing out of sync | N/A | The City of Boulder regularly updates signal timings, coordination, and offset to keep signal timings in sync |
| Red light running, congestion | Action 12 includes the expanded use of red light cameras at effective locations | N/A |
| Left-turn crashes | The City of Boulder’s Left-Turn Traffic Operations Practice includes crash history as a criterion for choosing left-turn operation type | Actions 1.C.ii and 1.C. include the proactive implementation of an updated Left-Turn Traffic Operations Practice |
| Right-turn slip lanes | N/A | Action 9.A includes the evaluation of different right-turn slip lanes for later systemic upgrades across the HRN and elsewhere in Boulder |
| Right-turn on red crashes | Action 1.B.i includes locations where the City of Boulder will prohibit right-turn on red based on crash history or pedestrian volumes | Actions 1.B.iii and 1.B.iv include the proactive implementation of an updated Right-Turn on Red Traffic Operations Practice |
| Right-turn crashes, Leading Pedestrian Interval | Action 1.A.i includes locations where the City of Boulder will install a Leading Pedestrian Interval based on crash history or pedestrian volumes | Actions 1.A.ii and 1.A.iii include the proactive implementation of the Leading Pedestrian Interval Traffic Operations Practice |
| Right-turn crashes, protected right-turns or protected intersections | Action 3 includes the implementation of protected right-turns and protected intersections on CAN corridors at locations with crash history | Action 3 includes the implementation of protected right-turns and protected intersections on CAN corridors at locations with high conflicting volumes of vehicles and pedestrians or bicyclists |
| Multi-use path crossings | Action 3 includes the implementation of setback multi-use path crossings on CAN corridors at locations with crash history | Action 3 includes the implementation of setback multi-use path crossings on CAN corridors at locations with high conflicting volumes of vehicles and pedestrians or bicyclists |
| Pedestrian crashes while crossing the street in marked crosswalks | Action 6 and 8 include upgrading pedestrian crossings at locations with crash history | Action 6 and 8 include upgrading pedestrian crossings at locations where crashes have not occurred but where RRFBs or signals are necessary |
| Pedestrian crashes outside of a marked crosswalk | The City of Boulder installs new crossings based on the <i>Pedestrian Crossing Treatment Installation Guidelines</i> | The City of Boulder installs new crossings based on the <i>Pedestrian Crossing Treatment Installation Guidelines</i> |

Figure 14 shows High Risk Network intersections with right-turn slip lanes and

Figure 15 shows marked crosswalks on the High Risk Network.



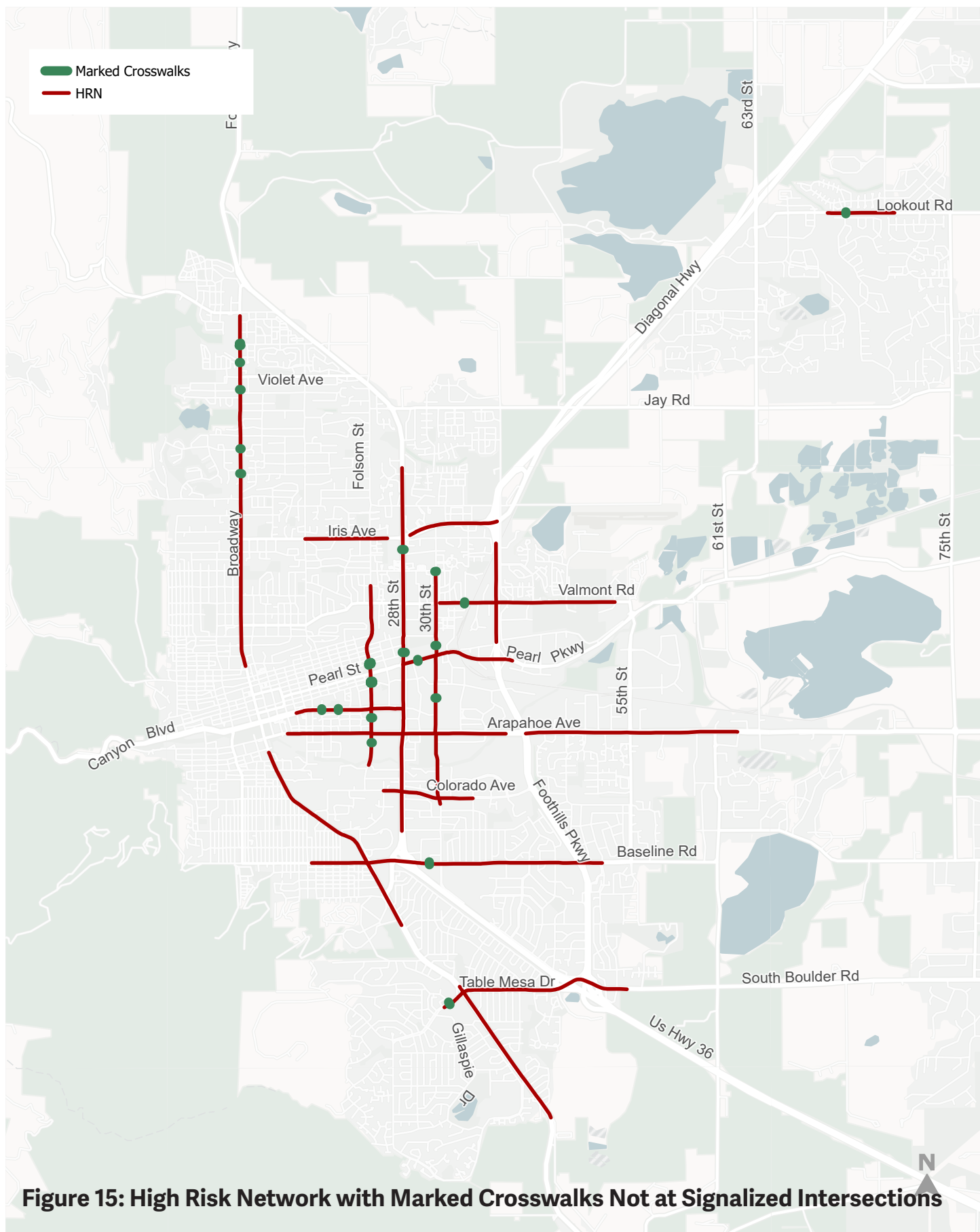


Figure 15: High Risk Network with Marked Crosswalks Not at Signalized Intersections

Note: each of the project recommendations requires further engineering study or design to verify that recommendations are appropriate.

Table 5: Additional Low-cost Solutions (Action 1.E)

| Corridor | Location | Solution | Cost |
|---|----------------------|--|-------------|
| Racial Equity Index and BeHeardBoulder Feedback High | | | |
| Arapahoe Ave | 17th St | Increase intersection sight distance on southeast corner for northbound right-turns (routine maintenance) | \$1.00 |
| Baseline Rd | Broadway to US 36 EB | At westbound left-turn into Basemar Center, remove trees to increase sight distance | \$3,000.00 |
| Baseline Rd | Broadway to US 36 EB | Re-stripe eastbound lanes to add lane at US 36 eastbound to left rather than to right to improve lane utilization for southbound left-turn at Broadway | \$29,040.00 |
| Racial Equity Index or BeHeardBoulder Feedback High | | | |
| 30th St | Pearl Pkwy | Add right-turn only signage to nearby frontage roads | \$10,000.00 |
| Broadway | Dartmouth Ave | Improve signal visibility for northbound/southbound directions | \$25,000.00 |
| Broadway | Iris Ave | Install advance warning signage with flashing beacon and object markers (westbound direction) | \$5,000.00 |
| Pearl St/Pkwy | 47th St | Install high-visibility crosswalk on north leg | \$900.00 |
| Table Mesa Dr | Broadway | Install oversized sign and pavement markings on westbound approach | \$10,000.00 |
| Racial Equity Index and BeHeardBoulder Feedback Low | | | |
| Broadway | Pleasant St | Improve lighting on west leg | \$2,000.00 |
| Pearl St/Pkwy | Foothills Pkwy SB | Install advance warning signage with flashing beacon and object markers (southbound direction) | \$5,000.00 |

Table 6: Higher Cost Solutions (Action 2)

| Corridor | Location | Solution | Cost |
|--|-------------------|---|--------------|
| Racial Equity Index and BeHeardBoulder Feedback High | | | |
| Baseline Rd | 27th Way/US 36 EB | Signalize southbound right-turn slip lane | \$100,000.00 |
| Racial Equity Index or BeHeardBoulder Feedback High | | | |
| Pearl St/Pkwy | 47th St | Reconstruct corners to reduce radii and slow turning vehicles | \$75,000.00 |
| Racial Equity Index and BeHeardBoulder Feedback Low | | | |
| Broadway | Marine St | Install raised median | \$105,600.00 |
| Broadway | Pleasant St | Signalize northbound left-turn | \$100,000.00 |
| Table Mesa Dr | Stanford Ave | Install traffic signal | \$500,000.00 |
| South Broadway | Darley St | Bend-out shared use path crossing on west side | \$20,000.00 |

Overall Costs & Funding

The updated action plan represents a more focused set of actions than what was included in the 2019-21 plan, and it is anticipated that it will more effectively reduce fatal and serious injury crashes due to the robust methodology and analyses supporting the actions. Although the original intent was to develop a fiscally constrained plan, the cost of countermeasures, especially higher cost projects, exceeds the amount of city funds available toward Vision Zero over the next five years. While an action of the plan focuses on the pursuit of competitive external grant funds, the reality is that, due to the nature of competitive grants and limitations on when funds are available, it is possible that some of the recommended projects would ultimately require local funds to be completed in the next five years. For this reason, the plan prioritizes actions so that they can be completed incrementally as resources become available, recognizing that Vision Zero remains a top department priority.



CHAPTER 6.

MONITORING & NEXT STEPS



Monitoring & Next Steps

Every year the city analyzes progress in achieving the actions outlined in the Vision Zero Action Plan.

The City of Boulder will begin its next *Vision Zero Action Plan* in 2027.



FEHR & PEERS



Prepared by Fehr & Peers
with support from FHU

A blue-tinted photograph of a street scene. In the foreground, a crosswalk with white stripes is visible on a dark asphalt road. To the right, a white SUV is parked or driving. The background is filled with lush green trees and a clear sky. The overall scene is bright and clear, with a consistent blue color cast.

APPENDICES

A. 2019-21 VISION ZERO ACTION PLAN PROGRESS SUMMARY

B. PHASE 1 COMMUNITY ENGAGEMENT SUMMARY

C. PHASE 2 COMMUNITY ENGAGEMENT SUMMARY

D. SYSTEMIC SAFETY ANALYSIS MEMORANDUM

E. HIGH RISK NETWORK CORRIDOR ANALYSES

F. HIGHWAY SAFETY MANUAL ANALYSIS MEMORANDUM (FHU)

**G. SUPPLEMENTARY HIGHWAY SAFETY MANUAL
ANALYSIS MEMORANDUM**



APPENDIX A

2019-21 VISION ZERO ACTION PLAN PROGRESS SUMMARY

APPENDIX B

PHASE 1 COMMUNITY ENGAGEMENT SUMMARY

APPENDIX C

PHASE 2 COMMUNITY ENGAGEMENT SUMMARY

APPENDIX D

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APPENDIX E

HIGH RISK NETWORK CORRIDOR ANALYSES

APPENDIX F

HIGHWAY SAFETY MANUAL ANALYSIS MEMORANDUM (FHU)

APPENDIX G

**SUPPLEMENTARY
HIGHWAY SAFETY
MANUAL
ANALYSIS
MEMORANDUM**

