Safe Streets Boulder Report

Toward Vision Zero

preventing fatal and serious injury crashes and improving safety for all modes of travel

Prepared by the City of Boulder
Transportation Division

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EXECUTIVE SUMMARY

The City of Boulder seeks to provide a safe and efficient transportation system for people using all modes of travel. Transportation safety is a priority for the city. The 2014 Transportation Master Plan (TMP) affirmed the city's commitment to safety by establishing a new objective: "Toward Vision Zero"[1] to eliminate fatalities and serious injuries from future traffic collisions. This objective reflects a national and worldwide movement to innovate and use a data-driven, interdisciplinary approach to improving safety across the city's transportation systems. It is now one of the TMP's nine measurable objectives.

The Safe Streets Boulder report is an important step in meeting that objective. This report expands on the 2016 Transportation Report on Progress, which evaluates the Transportation Division's work to implement the TMP and meet the nine objectives. The Report on Progress provides an overview of the Toward Vision Zero strategy, and the Safe Streets Boulder report is a detailed look at Boulder's traffic safety data and strategies for improving safety. A previous Safe Streets Boulder report, published in 2012, provided an analysis of motor vehicle collisions involving a bicyclist or pedestrian and was used to identify and implement safety improvements.

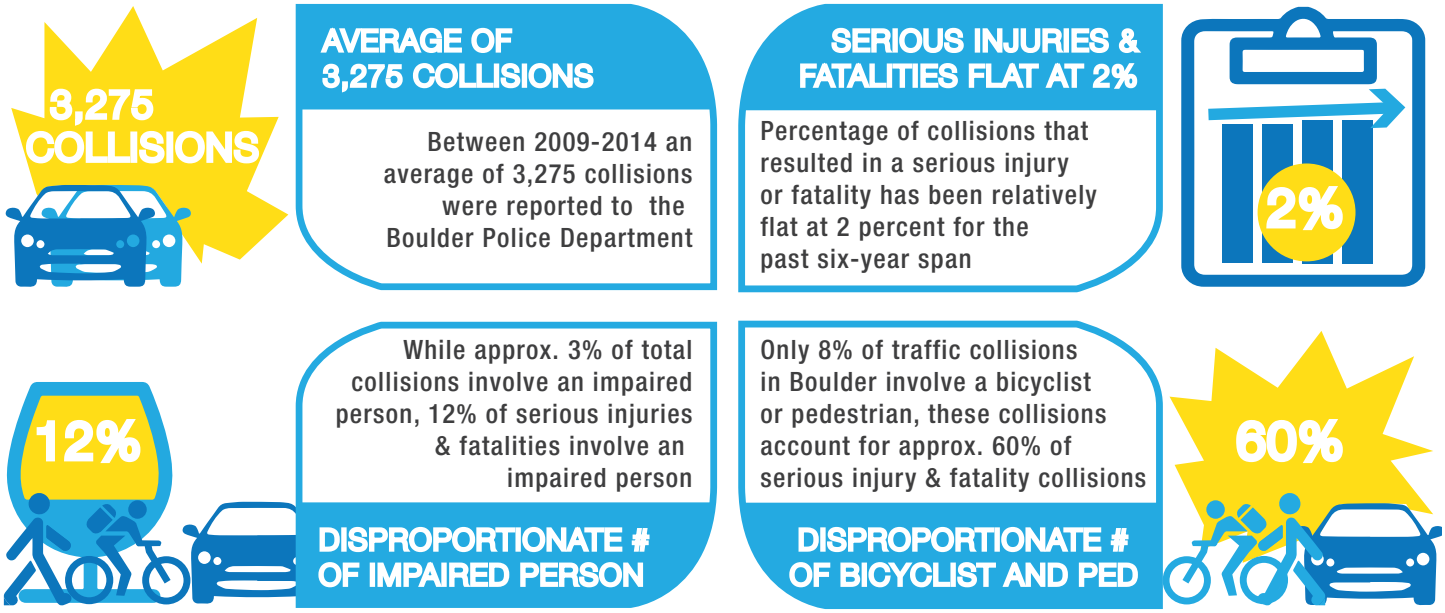
The 2016 Safe Streets Boulder report has expanded the scope of the original report to include all collisions, not just those involving bicyclists and pedestrians, and establishes a baseline for tracking progress and a plan for future action to achieve traffic collision reduction goals.

The data presented in this Safe Streets Boulder report shows that the city's fatal collision rate is well below the national average and the lowest among Colorado cities with comparable populations. However, during the six years between 2009 and 2014, an average of three people lost their lives and more than 60 people sustained serious injuries each year as a result of traffic collisions. Policy makers, city staff and the community must collectively do more to attain the ambitious and important TMP objective of Toward Vision Zero.

This report reviews recent trends and provides a comprehensive analysis of collision data. A primary purpose of the evaluation is to identify overall trends and guide strategies for mitigating future collisions, particularly those that result in serious injuries and fatalities.

[1] An overview of the Toward Vision Zero strategy is part of the recently released 2016 Transportation Report on Progress. That report, available online at www.bouldercolorado.gov/transportation, outlines the City of Boulder Transportation Division's work to implement the TMP.

Key findings from the city's data analysis includes:



Improving the safety and efficiency of transportation facilities for all modes of travel has been a primary focus of many city efforts, including:

- 2012 Safe Streets Boulder Report
- Safety enhancement projects
- Safe Routes to School Program
- Pedestrian crossing treatments
- Education and outreach campaigns

While previous efforts have contributed to the relatively flat number of collisions over time, more focused efforts are needed to make progress toward the Vision Zero goal of eliminating serious injuries and fatalities from future traffic collisions. The following elements comprise the Transportation Division's approach to reaching the goal:

- Understand collision trends to inform mitigation strategies as well as street design, corridor projects and city policies.
- Analyze high crash locations and identify trends to address.
- Focus on specific collision types and behaviors more likely to result in serious injuries and fatalities.

This report identifies a plan of action for reducing the number and severity of collisions. The action plan outlines a comprehensive approach that includes engineering, education, enforcement and evaluation strategies. Action items are grouped by strategy area and include the following:

Engineering

- Implement changes to traffic signal operations, including signal timing and traffic signal displays, to reduce conflicts between drivers turning left and other vehicles, bicyclists and pedestrians at signalized intersections identified as high crash locations.
- Install signs and pavement markings to highlight potential conflict points and to reduce conflicts between turning vehicles and bicycles and pedestrians at high crash locations. For example, the city is installing green pavement markings to highlight bicycle lanes at intersections.
- Install enhanced pedestrian crossing treatments, including construction of grade-separated crossings (overpasses and underpasses) according to the City of Boulder Pedestrian Crossing Treatment Installation Guidelines.

Education

- Continue the Heads Up Boulder campaign to increase safety and awareness of crosswalk-related ordinances, common collision types, and user rights and responsibilities. Focus work on top locations for motor vehicle collisions involving bicyclists and pedestrians. Create messages targeting key age and demographic groups, and prioritize messaging in support of bicyclists knowing and complying with 8 mile per hour speed limit in crosswalks.
- Continue the Lighten Up Boulder program to remind bicyclists that riding at night without a light is illegal and unsafe, as well as offer reflective lights to pedestrians walking at night.
- Continue support for Bicycle Accessories and Safety Education (BASE) program, which was created by Community Cycles, with funding from the City of Boulder, to familiarize Earn a Bike program participants with Boulder's rules of the road and path.
- Introduce new messaging to raise awareness about the increased potential for motor vehicle collisions with bicyclists traveling against traffic on sidewalks and multi-use paths.

- Introduce new messaging to raise awareness of the dangers of traveling while impaired, whether driving, walking or biking.
- Introduce new messaging to raise awareness of common preventable motor vehicle driver collisions, such as rear ends in right-turn bypass lanes.

Enforcement

- As part of the Heads Up Boulder program, continue the partnership with the City of Boulder, CU-Boulder Police departments and the cycling community to conduct education and enforcement activities at high collision locations.
- Investigate creating a restorative justice curriculum for offenders of crosswalk-related ordinances to offer opportunity to further educate transportation users on the importance of traffic safety.
- Work with Boulder Police Department and the Municipal Court to monitor effectiveness of enforcement, including the application of alternative sentencing such as restorative justice.
- Work with the Boulder Police Department to address impaired person and red-light running collision trends and consider options including targeted enforcement and possible new red-light camera locations.

Evaluation

- Continue monitoring and evaluating collision types, locations and other trends to further refine and enhance safety improvements to achieve goal of Toward Vision Zero.
- Conduct further evaluation of motorcycle collision and serious injury trends, as well as causal factors related to bicycle and pedestrian collisions such as bike light use, distraction and adherence to the crosswalk speed limit.

INTRODUCTION

The Safe Streets Boulder report provides an overview of the city's efforts to continuously improve safety for all modes of travel. Transportation safety is always a priority for the city, and the addition of a new safety objective in the 2014 Transportation Master Plan (TMP) affirmed the city's commitment to safety by establishing a new goal of "Toward Vision Zero" to eliminate fatal and serious injury collisions. This report is intended to establish a baseline for tracking progress and a plan for future action to achieve traffic collision reduction goals.

The first Safe Streets Boulder report was published in 2012, prior to the 2014 TMP update, and focused on motor vehicle collisions involving a bicyclist or pedestrian for a period between January 2008 and April 2011. The 2012 report updated and expanded upon previous analysis to improve safety for bicyclists and pedestrians. The report identified the most common types of collisions, the behaviors that caused them and the locations where they occurred most frequently. It also included mitigation strategies to reduce the number and severity of these collisions.

The 2016 edition of the Safe Streets Boulder report has expanded the scope of the original report. In order to provide a more comprehensive approach to understanding traffic safety and reducing collisions, this analysis includes all motor vehicle collisions, not just those involving bicyclists and pedestrians.

What is a Serious Injury?

A serious injury is one that is evidently incapacitating. Such injuries may include severe lacerations, broken bones, internal injuries or any injury that requires transportation to a hospital for treatment.

Moving Toward Vision Zero

As part of the 2014 TMP update, the city embraced the federal government's goal of eliminating fatalities on the highway system and adopted a "Toward Vision Zero" approach. Vision Zero is a traffic safety initiative aimed at eliminating fatalities and serious injuries in traffic collisions and has been adopted by a number of cities worldwide. The city's ultimate goal is to strive toward zero serious injuries and fatalities for all modes of travel.

Measuring Progress

Progress toward the TMP "Toward Vision Zero" safety objective will be measured using the following metrics:

- Total collisions, fatalities and serious injuries
- Total bicycle collisions, fatalities and serious injuries
- Total pedestrian collisions, fatalities and serious injuries

The collision data for these metrics and for this report is obtained from the City of Boulder's Police Department traffic accident records database. This data is primarily collected by the Police Department's accident investigation team when a member of that team completes a Colorado Traffic Accident Report form at the time of a collision. Much of the analysis for this report was conducted in 2015 before a full set of 2015 collision data was available. Therefore, this report only includes collision data through December 2014. More detailed information about the collision data is included in the appendix.

NAVIGATING THIS REPORT

The 2016 Safe Streets Boulder report contains the following sections:

How Safe Are Boulder's Streets? - Page 9

This section describes the state of traffic safety in Boulder, discussing overall trends in traffic collisions from 2009 to 2014 and providing the first set of data points to begin measuring progress toward the TMP safety objective.

Making Boulder's Streets Safer - Page 15

This section describes prior and ongoing efforts to provide safe transportation facilities for all modes of travel within the city.

What We've Learned: 2012 to 2014 - Page 21

This section describes the Transportation Division's new approach to reducing the number and severity of traffic collisions and includes a detailed analysis of collision data from 2012 through 2014. The findings from this analysis are used to determine mitigation strategies to address collision trends and high collision locations.

Moving Toward Vision Zero - Page 34

The actions in this section represent how the city will reduce the number and severity of traffic collisions, working toward the Vision Zero goal. The actions are organized in terms of engineering, education, enforcement and evaluation strategies.

These symbols indicate specific projects where a comprehensive approach that includes engineering, education, enforcement, and evaluation strategies were identified as an action plan for reducing the number of severity of collisions within the City of Boulder.

HOW SAFE ARE BOULDER'S STREETS?

Historically, the City of Boulder's fatality rate (defined as fatalities per 100,000 people) has been well below the national average. Similarly, the city's fatal collision rate is the lowest among many other Colorado cities with similar populations (see Table 1). Nevertheless, an average of three people lost their lives and more than 60 people sustained serious injuries each year as a result of traffic collisions during the six years studied in this report (2009 through 2014). In order to reduce these deaths and injuries, future efforts must target circumstances and behaviors more likely to result in collisions, especially fatal and serious injury collisions.

Table 1: Fatal Collision Rates for Colorado Cities

City	Population	Fatal Collisions				Average	Fatality Rate
		2010	2011	2012	2013		
Pueblo	108,249	9	9	11	6	8.8	8.1
Lakewood	147,214	13	10	9	6	9.5	6.5
Greeley	96,539	5	3	7	5	5.0	5.2
Thornton	127,359	5	3	5	4	4.3	3.3
Fort Collins	152,205	3	4	4	3	2.5	2.2
Arvada	111,701	0	3	3	4	2.5	2.2
Longmont	89,919	2	2	2	2	2.0	2.2
Boulder	103,166	1	4	3	0	2.0	1.9
Total all cities	936,352	38	38	44	30	37.5	4.0

Source: City of Fort Collins 2014 Traffic Safety Report, April 2015. The national fatality rate was derived from online Fatality Analysis Reporting System (FARS) data. Note that FARS data only contains collisions involving a motor vehicle traveling on a public roadway that result in the death of a person within 30 days of the collision.

Total Collisions

Between 2009 and 2014, an average of 3,275 traffic collisions were reported within the City of Boulder each year. An average of 183 (6 percent) of these collisions involved bicyclists and 57 (2 percent) involved pedestrians. These collision totals remained relatively flat during the last six years.

What are total collisions?

Total collisions includes all collisions investigated by the Boulder Police Department (officer reports) and all collisions reported to the Boulder Police Department in the form of counter reports. Counter reports are completed either online or in-person by people involved in traffic collisions within the city under circumstances where there was no on-scene investigation, no injuries and no major damage to vehicles. Many collisions reported by counter reports occur during snow emergencies when the city is on accident alert, which means police only respond to collisions involving injuries. More information about counter reports is included in Appendix A.

Total Collisions

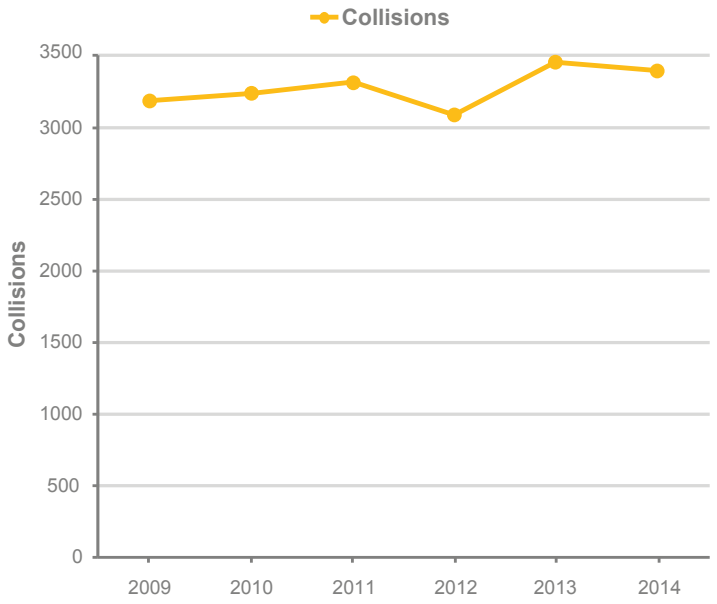


Figure 1. Total collisions (2009-2014). These totals include both officer and counter reported collisions, public and private property collisions, and motor vehicle and non-motor vehicle collisions. More details about collision data are included in the appendix.

Bicycle and Pedestrian Collisions

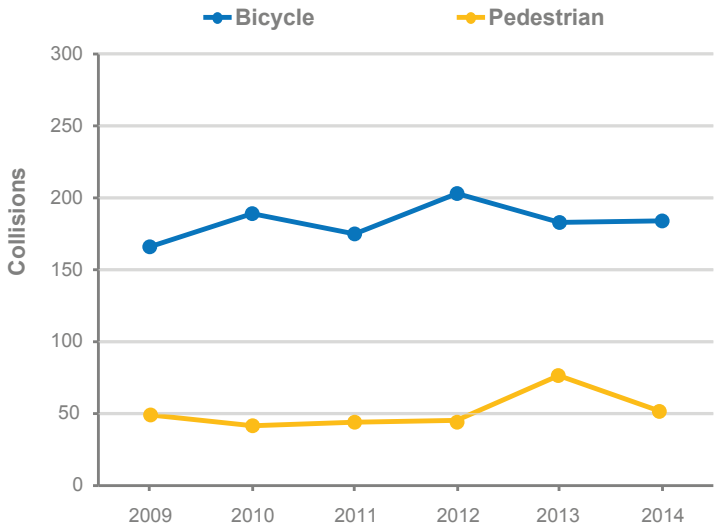


Figure 2. Bicycle and pedestrian collisions (2009-2014). Collisions occurring between bicyclists and pedestrians are included in the pedestrian collision totals.

Serious Injuries and Fatalities

Between 2009 and 2014, an average of 63 serious injuries occurred each year as the result of traffic collisions within the City of Boulder. On average, approximately 25 (39 percent) of these serious injuries were sustained by bicyclists and 13 (21 percent) were sustained by pedestrians. A total of 16 people were killed as a result of traffic collisions during these six years. Details about these fatal crashes can be found in Appendix B. Of the 16 people killed, two were bicyclists and five were pedestrians. These trends indicate that bicyclists and pedestrians are overrepresented in collisions that result in a serious injury or fatality and a need for mitigation strategies targeting bicycle and pedestrian collisions.

Based on the limited number of data points and variance in this baseline data, the presence of an overall upward or downward trend in serious injuries and fatalities cannot be concluded. However, the number of serious injuries and fatalities sustained by bicyclists in 2014 represents a significant increase compared to 2013. The total number of bicycle collisions in 2014 did not exhibit a similar increase. Future safety efforts will target collisions resulting in serious injuries and fatalities in order to establish a downward trend and move these totals Toward Vision Zero.

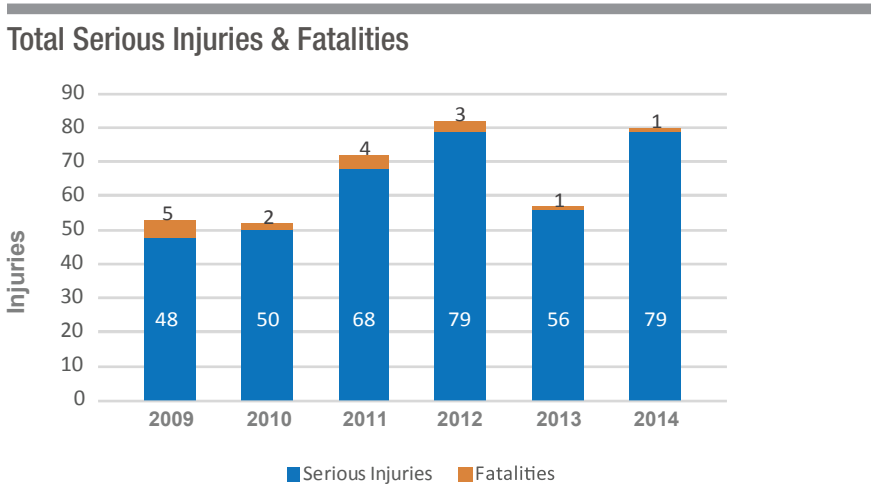


Figure 3. Total serious injuries and fatalities (2009-2014). A summary of fatal collisions is included in the appendix.

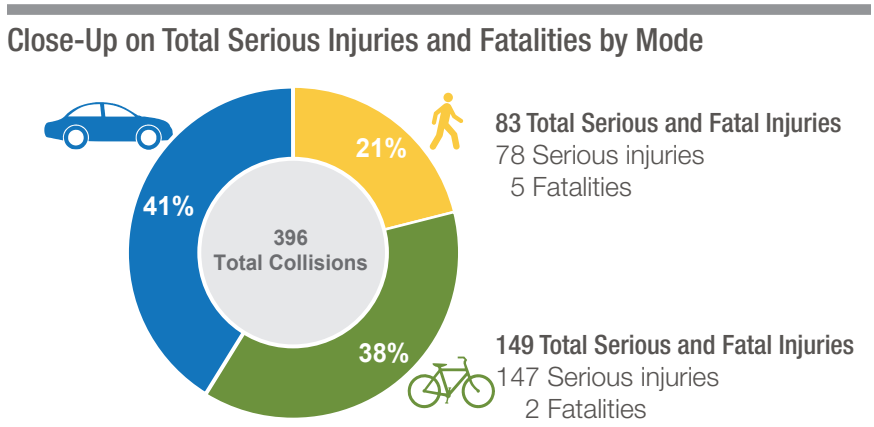
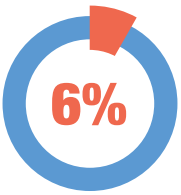
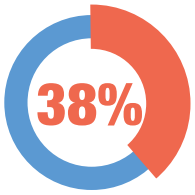


Figure 4. Break down of total serious injuries and fatalities by mode (2009-2014).

Figure 4. Bicyclist serious injuries and fatalities (2009-2014).



6% of total collisions
Bike collisions 1,102
Total collisions 19,665



38% of total Serious injuries and fatalities
Bike serious injury and fatal collisions 151
Total serious injury collisions 396

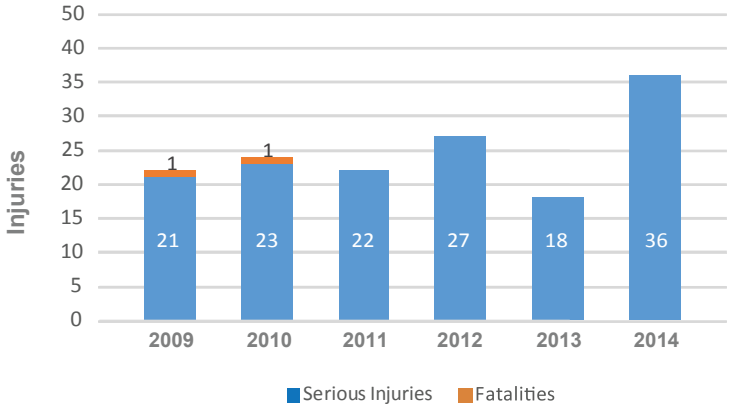
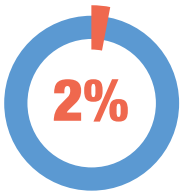
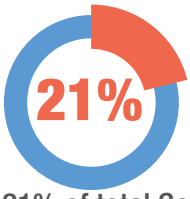


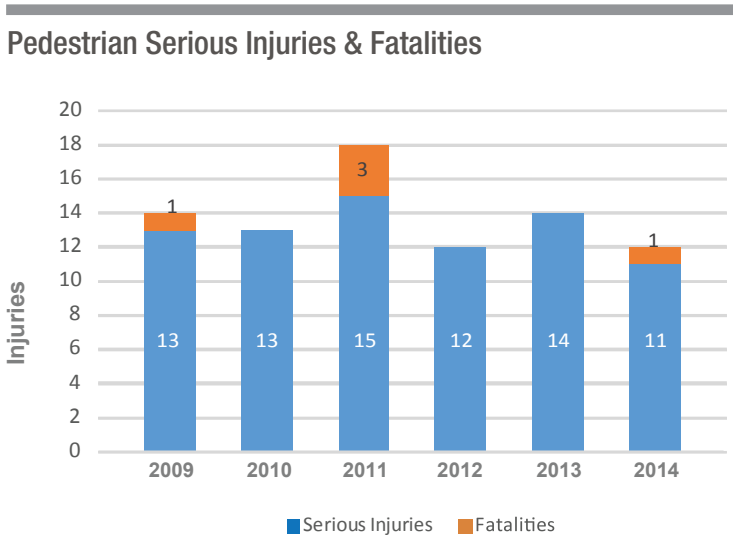
Figure 5. Pedestrian serious injuries and fatalities (2009-2014).



2% of total collisions
Ped collisions 332
Total collisions 19,665



21% of total Serious injuries and fatalities
Ped serious injury and fatal collisions 83
Total serious injury collisions 396



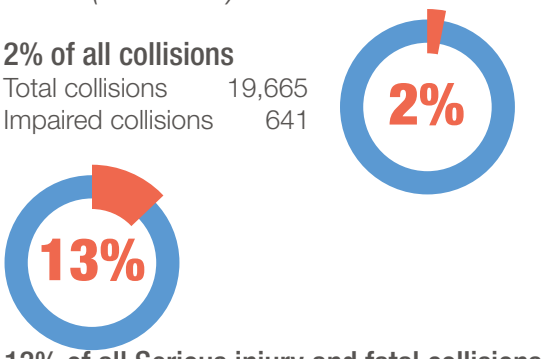
On average, 112 collisions occur each year that involve a driver, pedestrian or bicyclist suspected to be under the influence of drugs and/or alcohol. Impaired person collisions represent about 2 percent of total collisions within the City of Boulder. However, impaired person collisions result in 38 percent of all traffic fatalities and 13 percent of all serious injuries.

Problem: Bicycling or walking under the influence.

Strategy: Education and enforcement efforts targeting impaired walking, bicycling and driving.

Approximately 11 percent of impaired person collisions involve a bicyclist or pedestrian. But, nearly half of all impaired person related serious injuries involved a bicyclist or pedestrian, and 67 percent of impaired person related fatalities involved a bicyclist or pedestrian. In bicycle or pedestrian collisions involving motor vehicles and resulting in serious injuries or fatalities, the bicyclist or pedestrian was more likely to be impaired than the motor vehicle driver. These trends indicate a need for education and enforcement strategies targeting impaired persons, especially among bicyclists and pedestrians.

Figure 6. Impaired person collision fatalities and serious injuries for all modes (2009-2014).



2% of all collisions

Total collisions	19,665
Impaired collisions	641

13% of all Serious injury and fatal collisions

Impaired collisions	52
All collisions	396

Impaired Person: Serious Injuries & Fatalities

Figure 7. Impaired person collision fatalities and serious injuries involving bicyclists or pedestrians (2009-2014).

Impaired Person: Bicycle & Pedestrian

Enforcement: Marijuana Impairment

Colorado voters in 2012 approved an amendment to the state constitution that legalized the use and sale of recreational marijuana, and retail marijuana sales began on Jan. 1, 2014. Because marijuana is an intoxicant that can impair driving, the Colorado Legislature established a legal limit for marijuana impairment while operating a vehicle. Drivers with five nanograms of tetrahydrocannabinol (THC) or more in their blood can be prosecuted for driving under the influence (DUI). This applies to both recreational and medicinal marijuana use. Law enforcement officers, including the Boulder Police, base arrests on observed impairment and are trained to detect impairment caused by marijuana. More data will need to be collected before conclusions can be drawn about the effect legalized marijuana might or might not have on the number of traffic collisions.

Human and Economic Impact

Traffic collisions impact not only the people involved in the collisions, but also their families, employers and society as a whole. Victims of traffic collisions suffer economic consequences in the form of medical expenses, property damage and loss of productivity, as well as physical pain, disability and emotional impacts. However, this only accounts for a portion of total costs associated with collisions. A study by the National Highway Traffic Safety Administration found that more than 75 percent of collision costs are borne by society in the form of insurance premiums, taxes and congestion-related costs such as travel delay, excess fuel consumption and environmental impacts.

The societal costs of the 3,392 collisions that occurred in Boulder in 2014 is estimated at more than $99 million. This was calculated using cost estimates by crash severity developed by the Federal Highway Administration (FHWA) and published in the Highway Safety Manual. These cost estimates incorporate both monetary losses associated with medical care, emergency services, property damage and lost productivity, as well as costs related to reduction in quality of life.

Table 2: 2014 Collision Cost Estimates by Severity for the City of Boulder

Collision Severity	Number of Collisions	Cost per Collision	Cost
Fatal	1	$5,487,900	$5,487,900
Incapacitating Injury	75	$291,200	$21,840,000
Non-Incapacitating Injury	211	$106,400	$22,450,400
Possible Injury	393	$60,000	$23,580,000
Property Damage	2712	$9,700	$26,306,400
Total	3392		$99,664,700

Source: Crash Cost Estimates by Maximum Police-Reported Injury Severity within Selected Crash Geometries, FHWA-HRT-05-051, October 2005 (adjusted to reflect 2014 values)

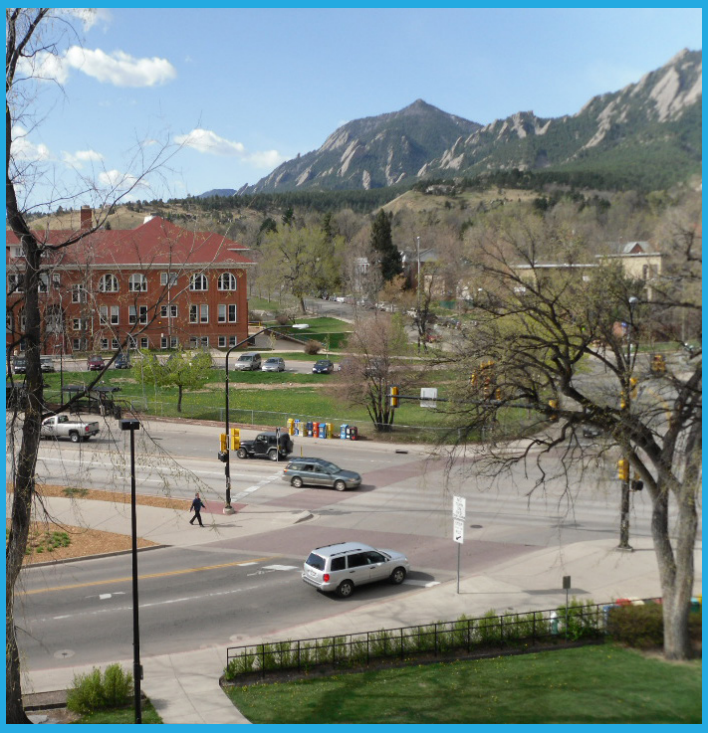
MAKING BOULDER'S STREETS SAFER

Transportation safety has always been a priority for the city. Improving the safety and efficiency of transportation facilities for all modes of travel has been a primary focus of many prior and ongoing efforts that have helped to keep Boulder's serious injury and fatal collision rates relatively low.

2012 Safe Streets Boulder Report

The first Safe Streets Boulder report provided an analysis of the motor vehicle collisions involving bicyclists or pedestrians that occurred in the City of Boulder from January 2008 through April 2011. The report identified when and where collisions happened, who was involved, and the most common collision types and locations. Findings of the report guided mitigation measures including engineering, education and enforcement strategies. Safety improvements were identified and implemented for the top 15 most common locations for bicycle and pedestrian collisions based on collision trends at those locations.

Highlights of Implemented Strategies Include:



Broadway and Euclid intersection before construction of bicycle/pedestrian underpass.

Broadway and Euclid intersection after construction of bicycle/pedestrian underpass.

Broadway and Euclid intersection reconfiguration: In 2011, the city began a major reconstruction project at this intersection that included a bicycle/pedestrian underpass under Broadway to replace the former at-grade signalized intersection crossing. A total of eight collisions involving a bicyclist or pedestrian occurred at this intersection during the 2008 to 2011 reporting period. Only one collision involving a bicycle and none involving a pedestrian occurred at this location during the 2012 to 2014 reporting period.

Current mid-block pedestrian signal at Baseline.

Bicycle/pedestrian underpass construction begins summer 2016 replacing the current mid-block pedestrian signal.

Pedestrian signal installation on Baseline east of Broadway: Between 2008 and 2011, there were nine motor vehicle collisions involving a bicyclist or pedestrian within the flashing crosswalk making this location one of the top 15 locations for these collisions. As a result, the crossing treatment was replaced with a pedestrian signal. This modification was authorized by the Colorado Department of Transportation as an interim treatment until a pedestrian underpass could be constructed. As expected, the mid-block pedestrian crossing is no longer ranked within the top 15 locations across the city for of motor vehicle collisions with bicyclists and pedestrians. However, both the intersections of Broadway and Baseline and Baseline and 27th Way are identified as top 15 bicycle/pedestrian high crash locations, with numbers of people being hit crossing Baseline Road at these two signals. Overall the underpass will balance the efficiency and safety of all modes of travel along and across Baseline Road. The underpass also will remove the need for the pedestrian signal which currently stops motor vehicle traffic on Baseline Road.

Green pavement markings: Green bike lanes were installed on Folsom Street on the northbound approaches at Canyon Boulevard and Pearl Street in September 2012. After the installation, the number of northbound right-hook collisions decreased at both locations. These markings were recently reconfigured as part of the Folsom Street Living Laboratory project. The effectiveness of green markings installed in other locations will continue to be evaluated.

Education and enforcement: The city promoted new crosswalk-related ordinances adopted in 2012 with consistent messaging and graphics as part of the Heads Up crosswalk safety campaign. The information is reinforced through increased enforcement at the top locations for motor vehicle collisions involving a bicyclist or pedestrian.

Safety Enhancement Projects

Since 2000, the City of Boulder's Transportation Division has been awarded more than $4 million in FHWA Highway Safety Improvement Program (formerly Hazard Elimination Program) funding to carry out safety improvement projects to reduce the number and severity of collisions at high collision locations. Completed and current projects include:

South Broadway: Median improvements at the intersections of Darley Avenue and Grinnell Avenue to address right angle collisions.

Foothills Parkway and Arapahoe Avenue: Intersection improvements to address congestion related rear-end collisions for through movements and right turn movements.

28th and Iris streets: Intersection improvements including additional through lanes, left-turn lanes and raised pedestrian crossings to address congestion-related collisions and improve bicycle and pedestrian safety.

29th Street and Valmont Road (underway): Traffic signal installation and intersection improvements to address bicycle, pedestrian and vehicle collisions including rear-end, left-turn and sideswipe collisions.

Engineering: Valmont Road and 29th Street Safety and Multimodal Enhancements Project

The city was awarded federal Hazard Elimination funding to construct safety improvements at the intersection of Valmont Road and 29th Street. This intersection was previously identified as a high collision location with trends including rear end, right angle, and bicycle and pedestrian collisions that could be corrected by intersection improvements. One of these rear-end collisions resulted in a bicyclist fatality in 2006. This project will begin in fall 2016 and will install a new traffic signal at the intersection of Valmont Road and 29th Street, enhance existing bicycle and pedestrian facilities, and widen Valmont Road for center left turn lanes.

Safe Routes to School Program

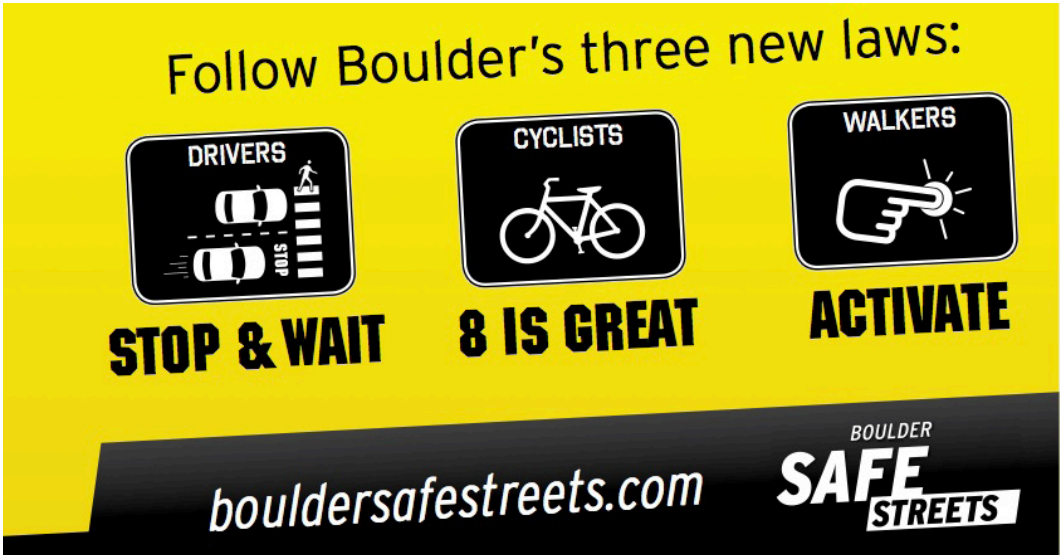
Since 2005, the City of Boulder's Transportation Division has been awarded more than $1.1 million in Safe Routes to School (SRTS) funding for infrastructure improvement projects and the Heads Up Boulder campaign. Concurrently, the Boulder Valley School District (BVSD) has received approximately $226,000 for education and outreach projects.

The city has completed a total of seven infrastructure projects that have benefited students at six elementary schools, five middle schools and two private schools. These projects are directly benefiting an estimated 1,300 students. Students at all 22 public elementary and middle schools also have benefited from Heads Up education and outreach activities and informational materials.

Pedestrian Crossing Treatments

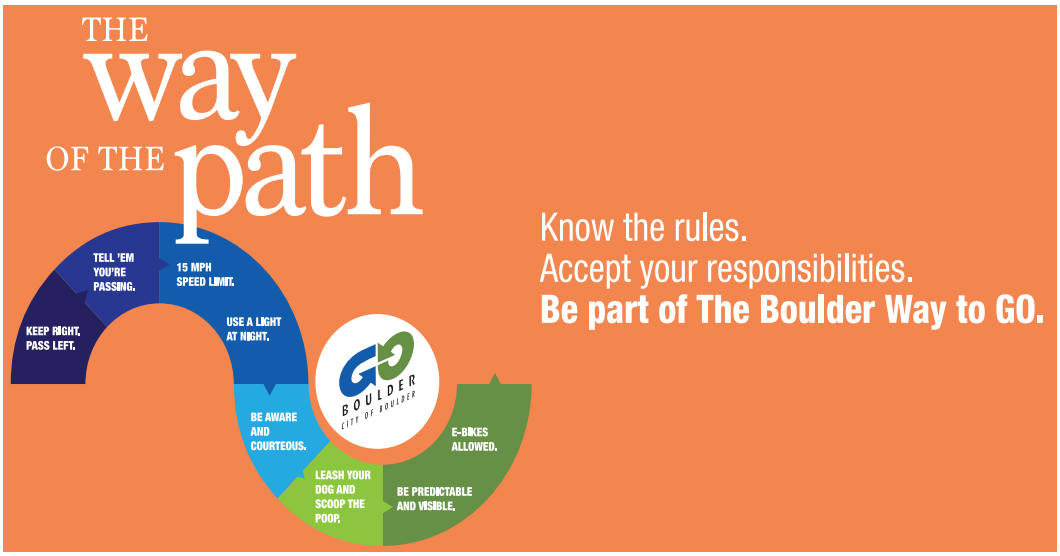
Pedestrian crossing treatments are installed in accordance with the city's Pedestrian Crossing Treatment Installation Guidelines (PCTIG) to facilitate safe and efficient pedestrian crossings. These guidelines are used by the Transportation Division to determine where to install crossing treatments and which types of crossing treatments are appropriate for different situations. Considerations include the volume of pedestrians, number of lanes and traffic speed and volume. The city first adopted a policy for the installation of pedestrian crossing treatments in 1996 and most recently updated the PCTIG in 2011 based on evaluations of several flashing crosswalk locations.

Education and Outreach Campaigns



Heads Up Boulder Campaign: In 2012, the city launched the Heads Up crosswalk safety campaign to inform community members about their rights and responsibilities as users of the transportation system, particularly at crosswalks. A citywide outreach campaign also includes focused messages to engage the K- 8 student population through events at schools and citywide engagement activities. The campaign has grown to include Crosswalk Safety Weeks in an effort to raise public awareness of high collision locations and increase enforcement at these select intersections.

Lighten Up Boulder: Each fall, the city teams up with CU-Boulder and local businesses to encourage bike light use for nighttime riding by providing discounts on bike light accessories at participating businesses.



The Way of the Path: This eight-week campaign seeks to increase safety on Boulder's multi-use paths by encouraging people to take personal responsibility for reducing conflicts between users, which ensures that everyone can safely share and enjoy Boulder's paths. With a focus on eight key messages, the campaign highlights a new topic each week, from appropriate ways to pass fellow path users (giving an audible alert before passing) to raising awareness of the 15 m.p.h. speed limit on the paths to the need to pick up after dogs.

Bicycle Accessories and Safety Education Program: Funding from the City of Boulder is used to support a safety education presentation by Community Cycles for participants of the Earn a Bike program. The class aims to familiarize students with Boulder's rules of the road and path and provides lights, locks and bells.

Bicycle Ambassadors: In partnership with the cycling community, the city supports a team of ambassadors that make appearances at top collision locations, select locations along multi-use paths and community-based events to engage community members. Ambassadors share information about rules of the road and path and tips to encourage safe use of the transportation system.

WHAT WE'VE LEARNED: 2012 TO 2014

The Toward Vision Zero approach to traffic safety reflects a new way the city will aim to improve the safety of Boulder's streets. To make progress toward the new TMP safety objective, the Transportation Division will seek to reduce the number and severity of traffic collisions by:

- Understanding collision trends to inform mitigation strategies as well as street design, corridor projects and city policies.
- Analyzing high crash locations and identifying mitigation trends.
- Focusing on specific collisions types and behaviors more likely to result in serious injuries and fatalities.

A detailed evaluation of collision data from the last three years, between 2012 and 2014, was conducted to identify these trends, behaviors and locations. The findings from this analysis were used to determine mitigation strategies to address collision trends and high collision locations. The significant findings from this evaluation are presented in the following section.

2012-2014 Collision Analysis

This analysis continues from the first Safe Streets Boulder Report and analyzes collisions within the city from January 2012 through 2014. In order to provide a more comprehensive approach to understanding traffic safety and reducing collisions, this analysis includes all police officer-reported motor vehicle collisions, not just those involving bicyclists and pedestrians. However, because bicycle and pedestrian collisions are more likely to result in serious injuries or fatalities, additional analysis was conducted for collisions involving these modes.

Problem: Most collisions occur at intersections.

Strategy: Identify high collision intersections and site specific safety improvements.

Where are Collisions Happening?

Intersections, particularly signalized intersections, are the most common location for all collisions. Nearly half of all collisions within the City of Boulder occur at intersections, and about 70 percent of intersection collisions occur at signalized intersections. This finding illustrates the importance of focusing traffic safety efforts on intersections.

Location of Collisions

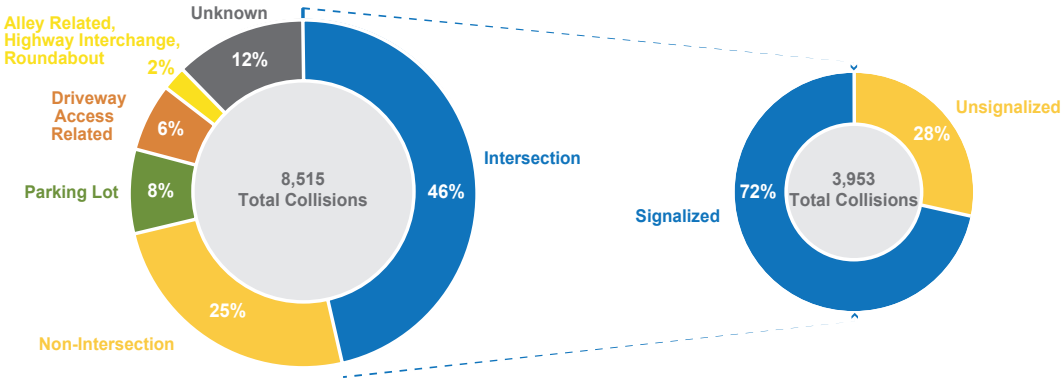


Figure 8. Location of collisions (2012-2014).

Problem: Most bicycle and pedestrian collisions occur at crosswalks.

Strategy: Continue education and outreach efforts focused on crosswalks. Implement safe pedestrian crossing treatments per the PCTIG.

Crosswalks are the most common location for motor vehicle collisions involving a bicyclist (58 percent) or pedestrian (68 percent). This includes marked and unmarked crosswalks at intersections, driveways and signed or flashing mid-block crossings. A more detailed analysis of crosswalk collisions (included in Appendix D) found that the majority occur within crosswalks at intersections for both bicyclists and pedestrians. This finding supports the continued use of education and outreach efforts that focus on crosswalk safety such as the Heads Up Boulder campaign.

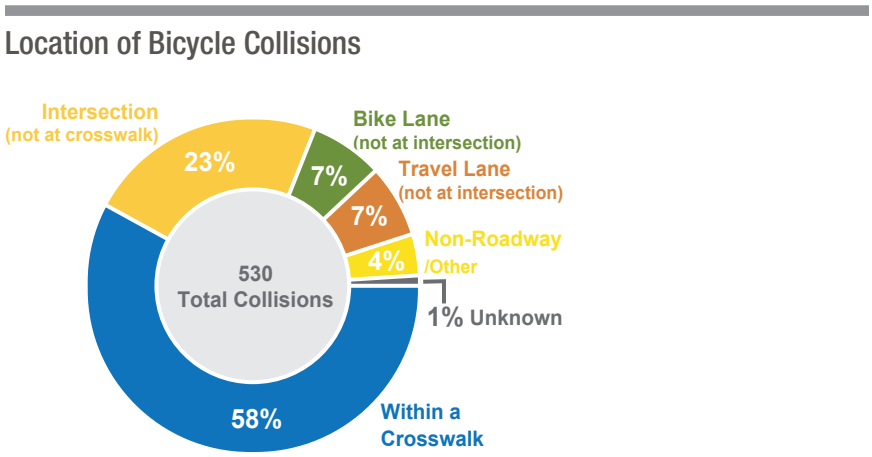


Figure 9. Location of vehicle collisions involving a bicyclist (2012-2014).

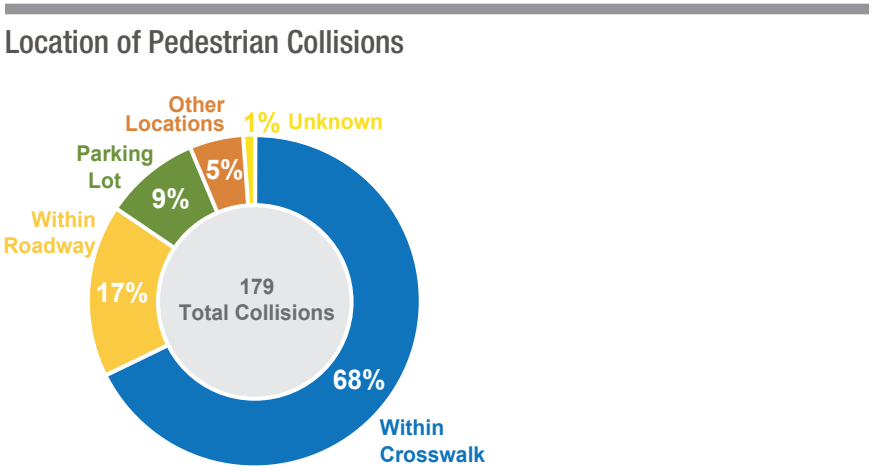


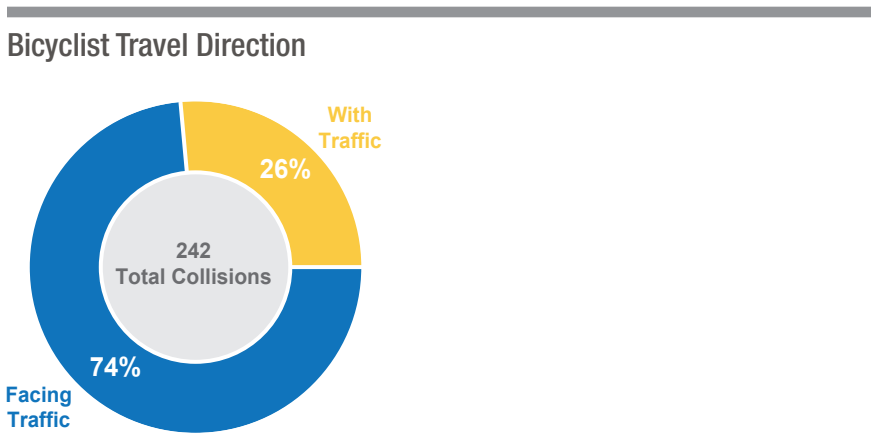
Figure 10. Location of vehicle collisions involving a pedestrian (2012-2014).

Problem: Bicyclists traveling against traffic on multi-use paths are more likely to be involved in collisions with vehicles.

Strategy: Develop new messaging to raise awareness of this risk.

Of collisions involving a vehicle crossing paths with a bicyclist traveling on a sidewalk or multi-use path, collisions involving bicyclists going against the flow of traffic (74 percent) were nearly three times as common as those traveling with traffic (26 percent).

Figure 11. Direction of bicyclists' travel on a sidewalk or multi-use path when involved in a collision with a motor vehicle (2012-2014).



About 85 percent of these collisions involve a driver and a bicyclist approaching an intersection and traveling perpendicular to each other. These collisions likely involve drivers who look over their left shoulder for a gap in traffic, but who fail to check for bicyclists traveling in the opposite direction. This finding illustrates the importance of minimizing access points, especially along multi-use paths, and indicates the need for new messaging to increase awareness of this trend among bicyclists and motorists.

Education: Bicycling on Sidewalks

Within the City of Boulder, bicycling is only permitted on sidewalks in residential and park zones or on sidewalks designated as multi-use paths. Bicycling is not permitted on the Pearl Street Mall. Visit https://bouldercolorado.gov/goboulder/bike-safety for a map of areas where bicycling on sidewalks is allowed and for tips on safe bicycling behavior. Bicyclists riding on sidewalks or multi-use paths should remember to enter crosswalks at 8 M.P.H. or less.

Problem: : People ages 20 to 24 are most likely to be involved in collisions.

Strategy: Focus education and outreach efforts on these age groups.

Who is Involved?

People who are 20 to 24 years old make up a significant portion of Boulder's population and are the most likely to be involved in a collision as a bicyclist, pedestrian or driver. While not overrepresented in collisions as drivers, this age group is disproportionately involved in collisions as pedestrians and bicyclists. Pedestrians and bicyclists, ages 25 to 34, are also overrepresented in collisions. These findings help inform the city's education and outreach efforts to ensure messaging and programs target these subsets of Boulder's population.

Age of at-Fault Drivers

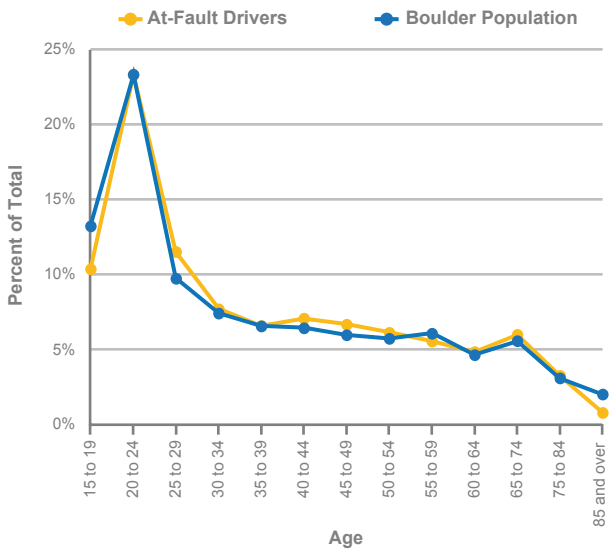


Figure 12. Ages of at-fault drivers involved in collisions compared to ages of Boulder population (2012-2014).

Age of Pedestrians

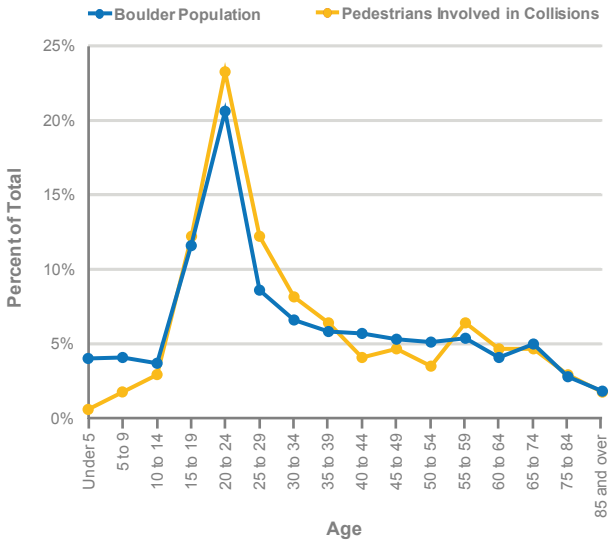
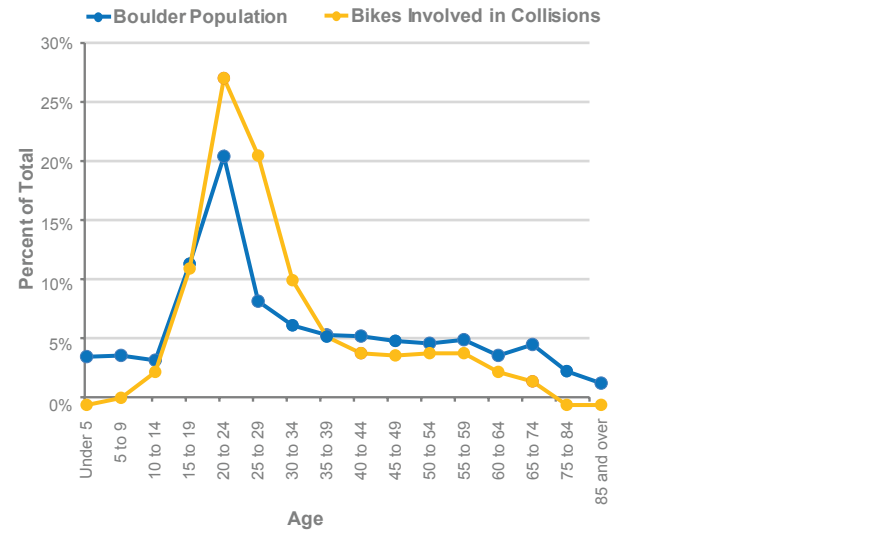


Figure 13. Ages of pedestrians involved in collisions compared to ages of Boulder population (2012-2014).

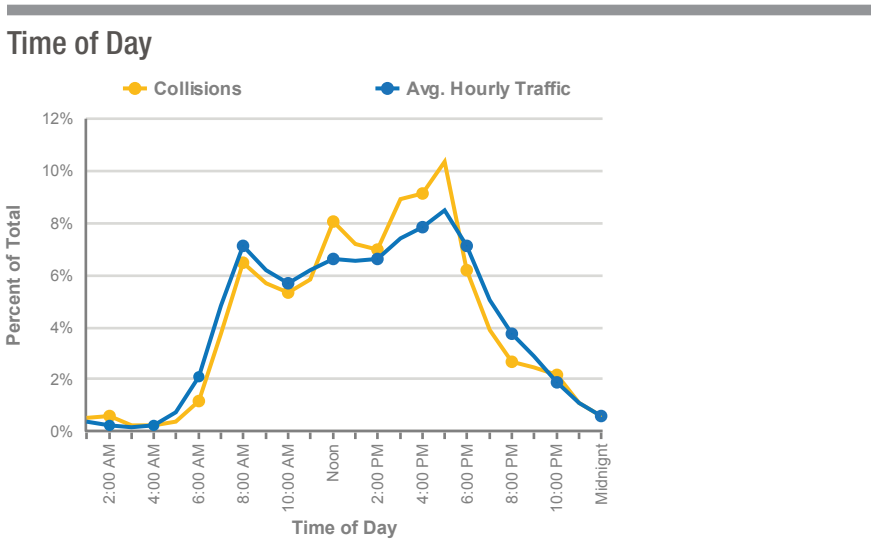
Figure 14. Ages of bicyclists involved in collisions compared to ages of Boulder population (2012-2014).



When are Collisions Happening?

Overall, collisions tend to occur more often during the late afternoon and early evening hours (3 to 6 p.m.). This corresponds to the time of day during which vehicle volumes are at their peak. However, collisions tend to be overrepresented during these hours as well as during the mid-day peak hour (12 p.m. to 1 p.m.). These findings indicate the time periods during which targeted enforcement efforts would be most effective.

Figure 15. Weekday collisions by time of day compared to average weekday hourly traffic (2012-2014).



Collisions are most common in August and October, perhaps coinciding with the start of school and the first winter weather events. The number of collisions is lowest during the month of March. While average daily traffic volumes vary by time of year, the fluctuations are more pronounced in the number of collisions and do not necessarily correspond to the changing traffic volumes.

Time of Year

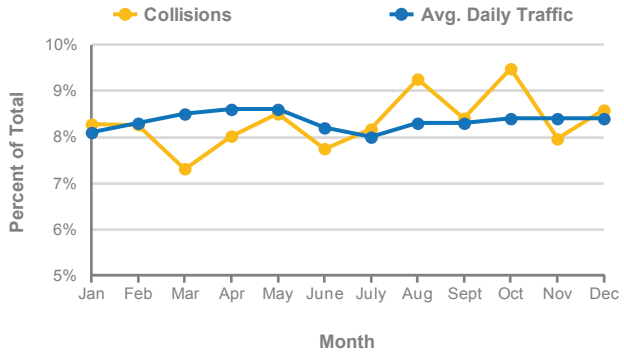


Figure 16. Collisions by time of year compared to average daily traffic (2012-2014).

Problem: : Bicycle and pedestrian collisions peak in the late summer and fall.

Strategy: Conduct education and enforcement efforts related to bicycle and pedestrian safety in the early fall.

Collisions involving bicyclists increase in warmer months as ridership increases. However, the peak of bicycle collisions does not correspond to the peak of bicycle usage. Bicycle collisions occur most often in August and September, perhaps coinciding with the start of school. Pedestrian collisions also are most common in the fall and winter months , and they are lower during summer months when the majority of college students are gone. These findings may be used to select the time of year most appropriate for education and enforcement efforts related to bicycle and pedestrian safety, such as the Heads Up Boulder campaign.

Time of Year: Bicycle and Pedestrian Collisions

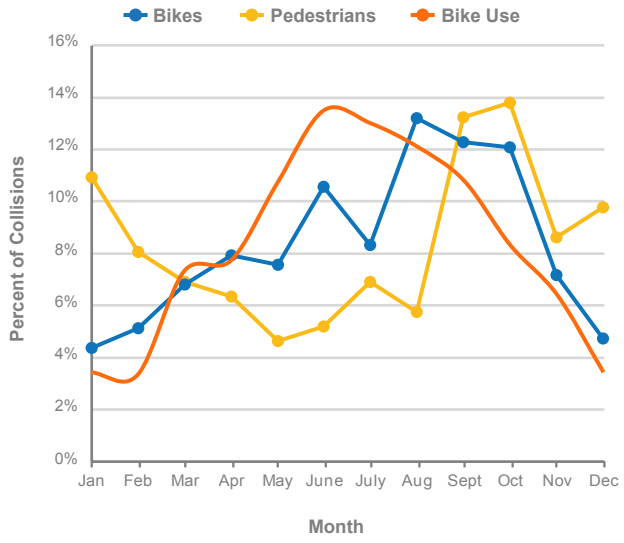


Figure 17. Bicycle and pedestrian collisions by time of year compared to bicycle use (2012-2014). The bicycle use data is a monthly average of daily bicycle volumes from 2012 to 2014 at one count station on the Boulder Creek Path.

Most Common Collision Types

Rear end collisions were by far the most common type of collision during the reporting period, accounting for 35 percent of total collisions, followed by right angle (broadside) collisions (9 percent). Bicycle and pedestrian related collisions represented the highest percentage of serious injury and fatal collisions, followed by approach turn (left-turn) collisions. Thus, mitigating these crash types offers the greatest potential for reducing the number of serious injury and fatal collisions. A description of crash types is provided in Appendix C.

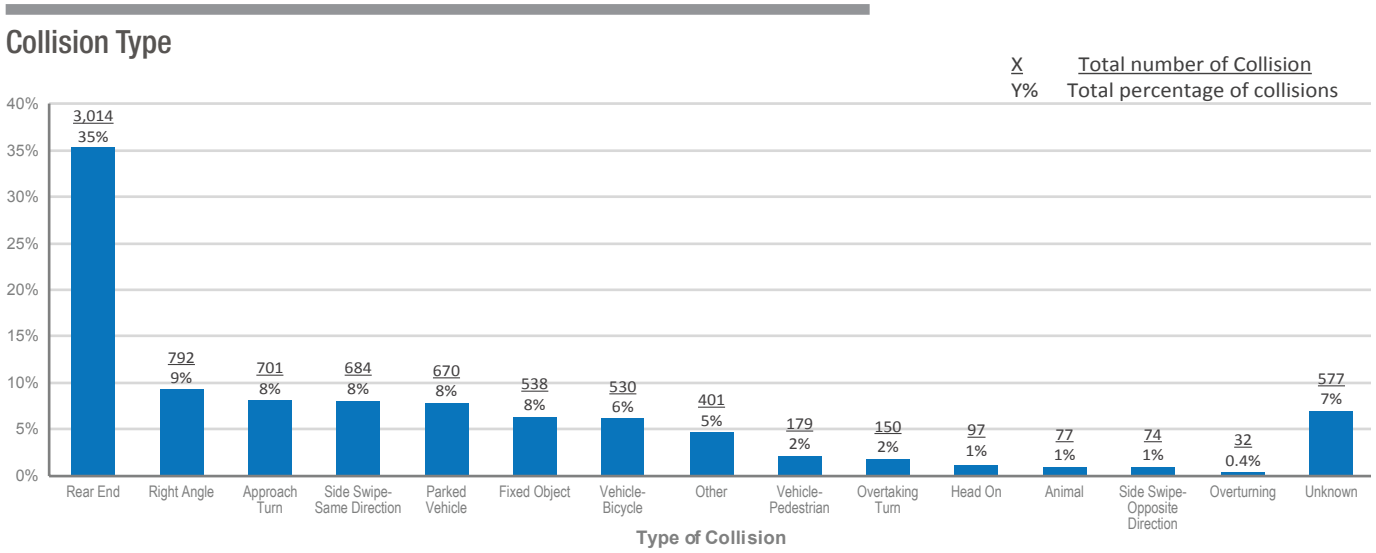


Figure 18. Motor vehicle collisions by type (2012-2014).

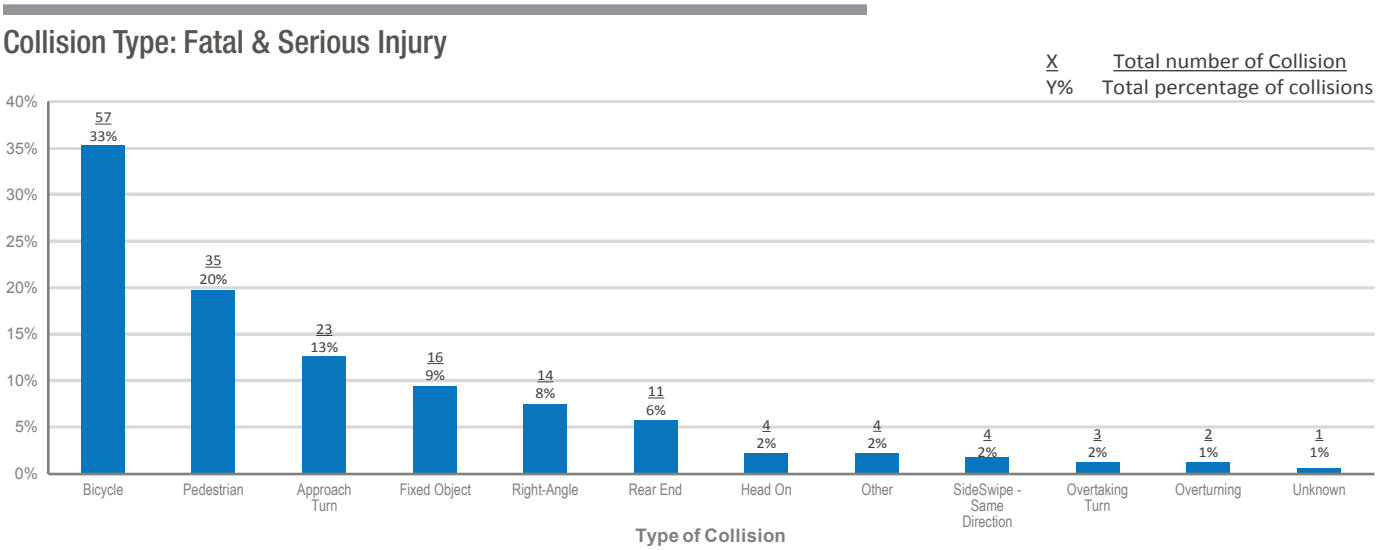


Figure 19. Serious injury and fatal motor vehicle collision types (2012-2014).

While motor vehicle collisions involving bicycles and pedestrians represent only 8 percent of total collisions, they account for 53 percent of collisions resulting in serious injuries or fatalities. The most common types of collisions between motor vehicles and bicycles or pedestrians that result in serious injuries are detailed below. These collision types do not always assign fault, but rather seek to increase the understanding of the behaviors that lead to collisions, which then informs education and enforcement efforts.

Problem: : Bicycle, pedestrian, and approach turn collisions are most likely to result in serious injuries and fatalities.

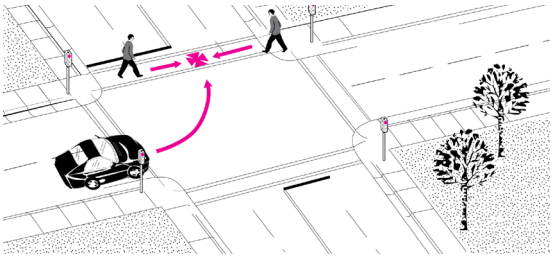
Strategy: Identify top locations for these collision types and site specific safety improvements.

Most common types of collisions resulting in serious injury between drivers and pedestrians

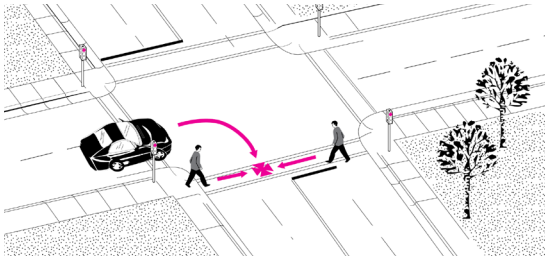
Approximately 29 percent of pedestrian collisions resulting in a serious injury occur within a crosswalk and involve a motorist executing a turn. Most of these involve a motorist turning left. Another 13 percent involve a motorist failing to yield the right of way to a pedestrian.

Pedestrians dashing into the roadway account for almost another quarter of serious injury collisions. Another 16 percent of serious injury pedestrian collisions occur in parking lots, with 6 percent of these involving a backing vehicle.

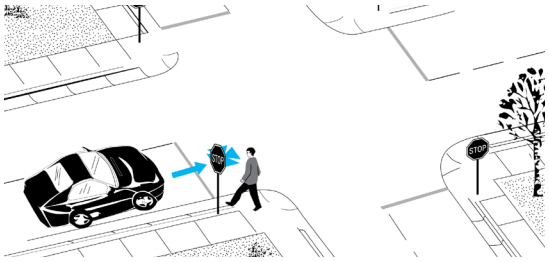
Driver left turn – parallel pedestrian travel
23 percent



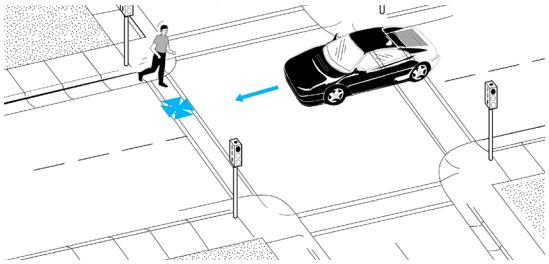
Driver right turn – pedestrian traveling parallel
6 percent



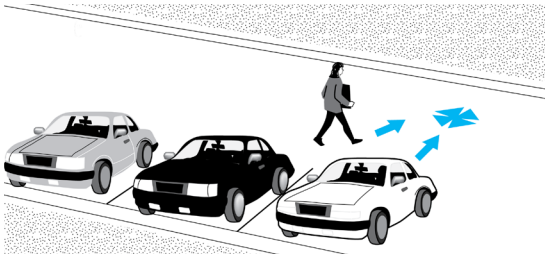
Motorist failed to yield
13 percent



Pedestrian Dash – jaywalking or crossing against the light
23 percent



Parking lot - (often backing vehicle)
16 percent

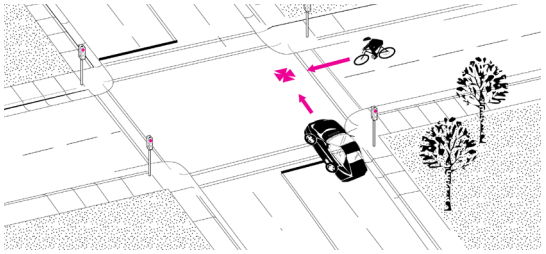


Most common types of collisions resulting in serious injury between drivers and bicyclists

About 34 percent of bicycle collisions resulting in a serious injury involve a motorist driving out into the path of the bicyclist. Another 30 percent involve a motorist turning at an intersection.

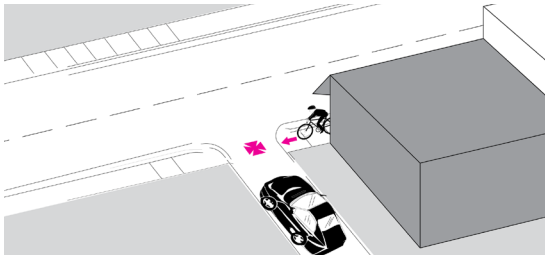
Motorist Drive Out

Sign controlled intersection -
15 percent



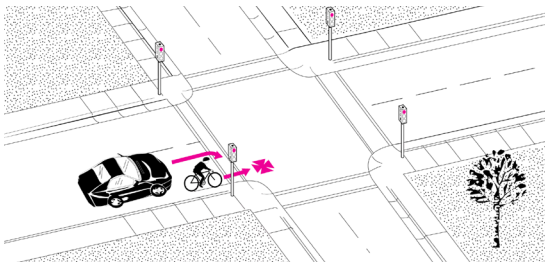
Driver turning right on red
15 percent

Driveway or Alley
4 percent

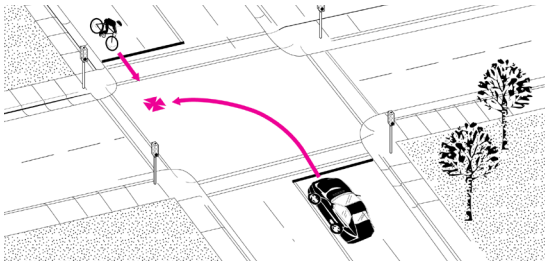


Motorist Turning

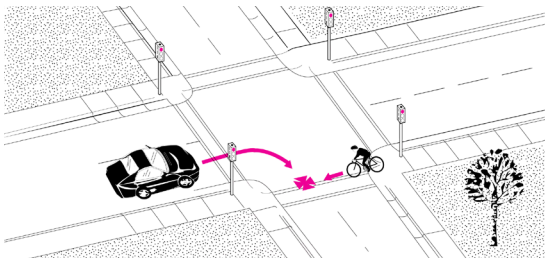
Driver right turn – bicyclist traveling in the same direction
13 percent



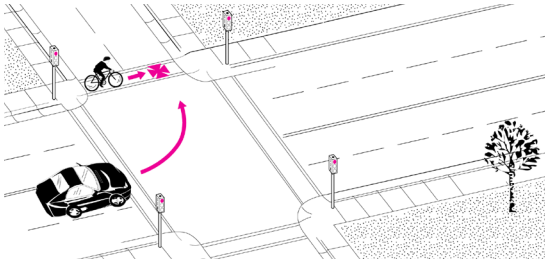
Driver left turn – bicyclist traveling in opposite direction
11 percent



Driver right turn – bicyclist traveling in opposite direction
4 percent



Driver left turn – bicyclist traveling in same direction
2 percent



Most Common Locations for Collisions

In order to target high collision locations and identify mitigation trends, the top locations for overall collisions were determined using intersection collision rates. Collision rates are a ratio of collision frequency to vehicle exposure, expressed as the number of collisions per million entering vehicles (MEV). The top 12 locations for motor vehicle collisions are detailed in the map on page 32. City staff examined each of the top intersections and analyzed collision trends in order to identify possible mitigation measures. Details about this analysis and the proposed safety improvements are included in Appendix E.

In addition to identifying the top collision locations based on collision rate, the findings from the most common collision types for serious injury and fatal collisions guided the selection of additional top locations based on specific crash types, including bicycle and pedestrian collisions, as well as left-turn and right angle collisions. The specific findings and recommendations for each location are included in Appendix E. Note that some locations were identified as top locations under multiple categories.

A map of the top locations for motor vehicle collisions involving a bicyclist or pedestrian is detailed on page 33. The 2012 Safe Streets Boulder report identified the top 15 most common locations for bicycle and pedestrian collisions based on 2008-2011 data. The 2016 report identifies the top 16 locations for these collisions based on 2012-2014 data. Seven of the top locations in the 2012 report remain on the list. These have been included on the map to show the change in top locations between the 2012 and 2016 reports. Safety improvements were identified and implemented based on collision trends identified in the 2012 report at the top locations. Of the 2012 top locations, eight are no longer on the list for this report. Additional mitigation strategies have been identified for these seven locations, which are still considered high-collision locations.

Focus Areas for Street Safety

The analysis of recent trends and the evaluation of 2012-2014 collision data reveals the need for focused efforts in the following areas in order to reduce the number of serious injury and fatal collisions:

- Bicycle and Pedestrian Collisions
- Impaired Person Collisions
- Right Angle Collisions
- Left-Turn Collisions
- Motorcycle Fatalities

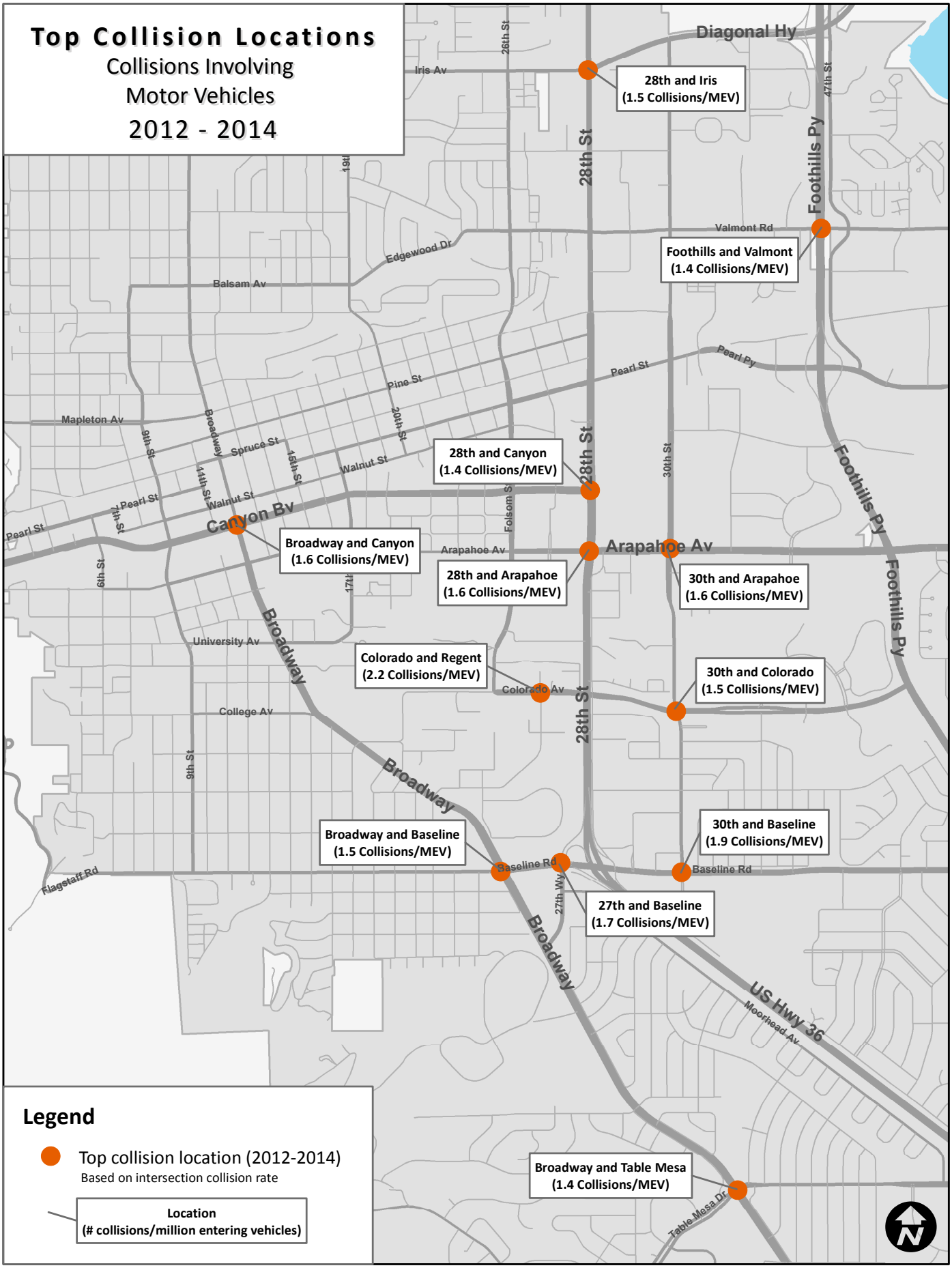


Figure 20. Map of most common locations for all collisions involving motor vehicles based on intersection collision rate (2012-2014).

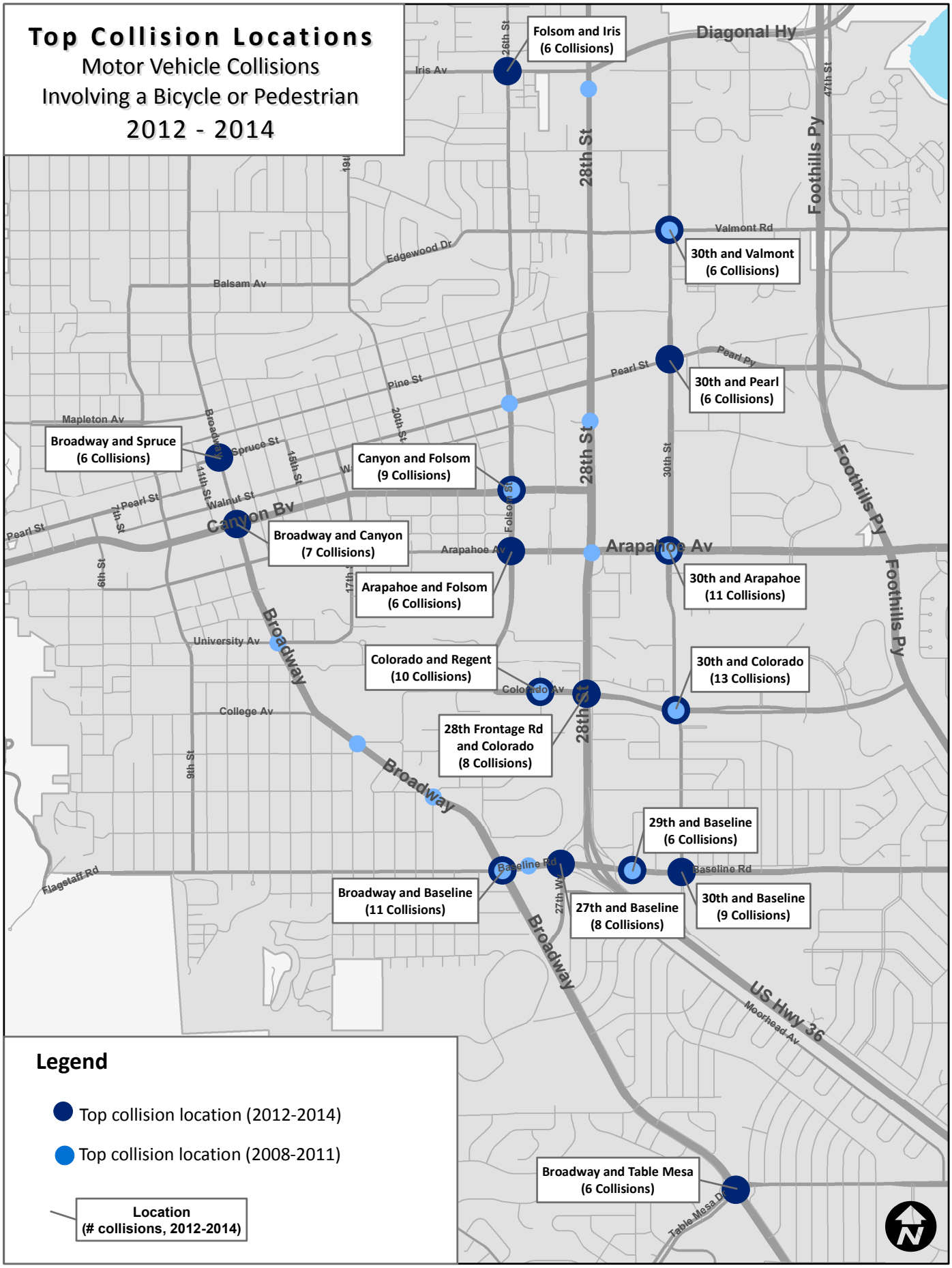
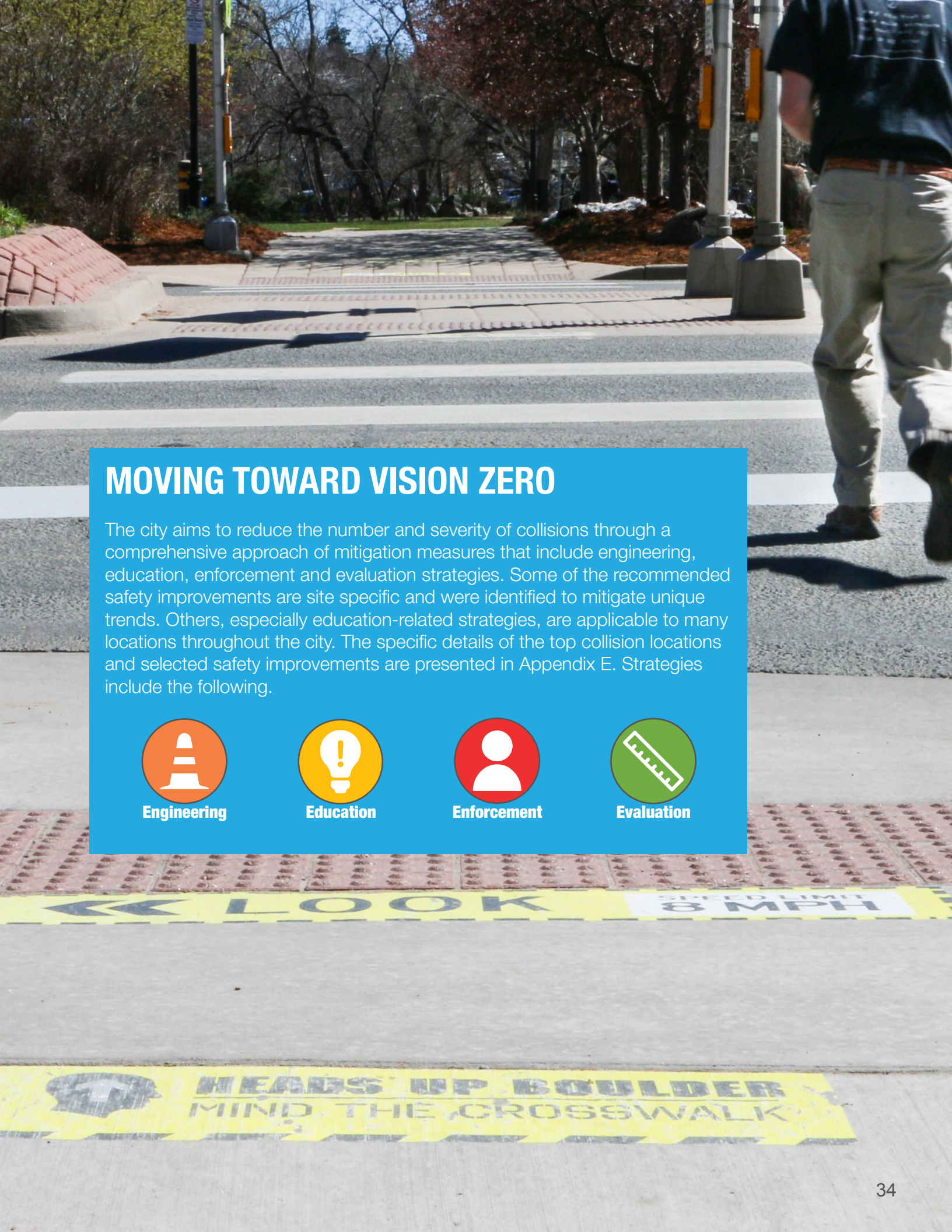


Figure 21. Map of most common locations for motor vehicle collisions involving a bicycle or pedestrian based on collision frequency for 2008 to 2011 and 2012 to 2014



MOVING TOWARD VISION ZERO

The city aims to reduce the number and severity of collisions through a comprehensive approach of mitigation measures that include engineering, education, enforcement and evaluation strategies. Some of the recommended safety improvements are site specific and were identified to mitigate unique trends. Others, especially education-related strategies, are applicable to many locations throughout the city. The specific details of the top collision locations and selected safety improvements are presented in Appendix E. Strategies include the following.

Engineering **Education** **Enforcement** **Evaluation**

ENGINEERING

Engineering strategies are intended to improve the physical transportation infrastructure through enhancements to the roadway, traffic signals, signs or markings. Many of the safety improvements selected in this report fall into one of the following categories.

Traffic signal operations: At key locations, converting left-turn signal phasing to protected-only phasing (left turns on green arrow only) during certain periods of the day or providing additional green time during certain portions of the left-turn phasing may be recommended when appropriate to decrease the number of approach turn collisions at certain locations. These changes may also provide an additional benefit of reducing conflicts between left-turning vehicles and bicycles or pedestrians.

Traffic signal display modifications: The city is in the process of converting some left-turn signal heads to the flashing yellow arrow displays, where appropriate. These displays offer more versatility in signal phasing plans and may provide additional clarity on when to yield to opposing traffic compared to a traditional solid green ball left-turn display. Some of the top motor vehicle collision locations with approach turn collision trends will be prioritized for conversion to the flashing yellow arrow display.

Lane modifications: Some of the safety improvements that were identified or have recently been completed involve changes to the roadway geometry, such as the addition or conversion of general purpose through lanes or turn lanes. These modifications may be used to address congestion-related collisions trends, such as rear ends or conflicts between turning vehicles and other vehicles, bicycles or pedestrians.

Signs and pavement markings: Other engineering improvements may include the installation of signs, striping and other pavement markings to provide additional warning or clarification about lanes ending, merging lanes or yield conditions in order to address rear end or sideswipe collisions. Regulatory signs that remind turning vehicle drivers to yield to pedestrians and/or bicycles may be installed at locations with a high number of bicycle and pedestrian collisions involving turning vehicles. The city has also been installing green pavement markings to highlight bicycle lanes at intersections. A preliminary analysis of their effectiveness supports their continued use and evaluation as a treatment to improve safety.

Enhanced pedestrian crossing treatments: The installation of enhanced pedestrian crossing treatments such as flashing crosswalks, pedestrian signals or underpasses may be recommended in accordance with the city's Pedestrian Crossing Treatment Installation Guidelines (PCTIG).

Engineering: Baseline Road Underpass Project

The Baseline Road Underpass project will begin construction in spring 2016 and will improve safety and efficiency for bicyclists, pedestrians and drivers by providing a grade separated bicycle/pedestrian crossing under Baseline Road. This underpass is part of the city's Transportation Master Plan and will replace an interim pedestrian signal east of Broadway. The project will also construct a multi-use path on the east side of Broadway and install bicycle parking, a B-Cycle station, landscaping and public art. A federal Transportation Improvements Program (TIP) grant, the Colorado Department of Transportation (CDOT) and the City of Boulder are providing funds for the project.

EDUCATION

Education-related strategies involve improving awareness and understanding of people's behaviors or situations that are more likely to result in traffic collisions. This may be achieved through the use of signage and advertising, media safety campaigns, classes, and community outreach. Current educational programs include:

- Heads Up Boulder Campaign: Continue education and enforcement efforts to increase crosswalk safety at top locations for motor vehicle collisions involving bicyclists or pedestrians. Develop messaging to increase bicyclists' knowledge and compliance with the 8 mile per hour speed limit in crosswalks.

- Lighten Up Boulder: Continue partnerships with CU-Boulder and local businesses to encourage bike light use for nighttime riding. Future efforts will expand this program to offer reflective lights to pedestrians walking at night and partner with Boulder Valley School District to provide lights to children riding bikes at night.

- The Way of the Path: Continue the annual campaign each fall to coincide with back to school in an effort to reduce conflicts between users, ensuring that everyone can safely share and enjoy Boulder's paths.

- Bicycle Accessories and Safety Education (BASE) Program: Continue partnership with Community Cycles to engage participants of the Earn a Bike program. Introduce new messaging developed as part of the other educational campaign efforts.

New messaging will also be introduced to address collision trends such as:

- Impaired bicyclists and pedestrians: Bicyclists and pedestrians were found to be overrepresented in impaired person related collisions that resulted in serious injuries or fatalities. New messaging will seek to raise awareness of the dangers of traveling while impaired, whether driving, walking or biking.

Bicyclists traveling against traffic on sidewalks/multi-use paths: A trend identified at many of the top collision locations, as well as citywide, involves an increased potential for motor vehicle collisions with bicyclists traveling against traffic on sidewalks and multi-use paths. While this behavior is not illegal, increased awareness of this trend among bicyclists and motorists will aim to reduce these conflicts.

Rear ends in right-turn bypass lanes: One common collision trend identified across several of the top motor vehicle collision locations was a high number of motorists rear-ending the vehicle in front of them while waiting to turn right within a right-turn bypass lane. Many of the drivers involved in this type of collision admitted that they were looking left for a gap in traffic, assumed the vehicle in front of them had already pulled out, and then began to pull forward without looking ahead. An educational campaign that raises awareness of this common collision trend will aim to decrease the number of these preventable collisions.

Flashing yellow arrow: Another opportunity to educate drivers will center on the flashing yellow arrow traffic signal display to increase awareness of its meaning and uses. One type of collision identified at several of the top locations for approach turns occurs when left-turning vehicles assume the opposing through vehicles will stop as the adjacent through movement turns to yellow, when in fact their left-turn signal is still a flashing yellow arrow and the left-turning vehicle must continue to yield.

Collisions involving motorcycles: More than 30 percent of fatal collisions within the city during the last six years involved motorcyclists. Motorcyclist safety has been identified as an emphasis area by the Colorado Department of Transportation (CDOT) Strategic Highway Safety Plan. The Transportation Division will explore opportunities to work with CDOT to promote motorcycle safety.

Education: Heads Up Boulder

In spring 2012, the city introduced a larger than life mascot, CW, to help remind everyone to keep their Heads Up when crossing the street. In partnership with Boulder Valley School District, the Heads Up campaign includes age-appropriate messaging for K-8 students to encourage safe travel behavior and smart choices when crossing streets. Between 2012 and 2014, 24 in-school assemblies were conducted at elementary and middle schools, and CW has appeared at more than 95 family focused public and school-based events.

In 2015, the campaign expanded to include crosswalk safety education and enforcement at the top locations for collisions between motorists, pedestrians and bicyclists as identified by the 2012 Safe Streets Boulder report. Many of these locations were located on or near the University of Colorado-Boulder campus. This campaign includes partnerships with the City of Boulder and CU-Boulder Police Departments and Community Cycles. City of Boulder and CU-Boulder Police conducted more than 50 hours of enforcement activities at five top crosswalk collision locations in July and September 2015. Seventy warnings and five summons were issued. Concurrently, bike ambassadors made 47 appearances at high collision crosswalk locations to inform transportation users of their rights and responsibilities at crosswalks.

ENFORCEMENT

Enforcement techniques include targeted enforcement in coordination with the Boulder and CU-Boulder Police departments to address specific illegal behaviors, as well as automated enforcement such as photo red-light and photo radar to reduce red-light running or speed-related collisions. Collision trends identified that may be mitigated through enforcement techniques include:

- Crosswalk-related offenses: As part of the Heads Up Boulder program, the city will continue to partner with Boulder and CU-Boulder Police departments and the cycling community to conduct education and enforcement activities at high collision locations. Restorative justice curriculum will be explored for offenders of crosswalk-related ordinances.
- Impaired driving, walking and biking: The Transportation Division will coordinate with the Police Department on enforcement strategies at the top locations for impaired person collisions.
- Red-light running: When red-light running collision trends cannot be successfully mitigated through engineering improvements, targeted enforcement or the installation of photo red-light may be appropriate.
- No turn on red restriction: There are a number of intersections with a restriction prohibiting right turn on a red signal. These are usually because of potential or identified conflict with bicycles and pedestrians in a busy crosswalk that the right turn movement would need to cross. Transportation Division staff will coordinate with the Police Department on enforcement at locations where a lack of adherence to this restriction has resulted in a collision trend.

Enforcement: Photo Red Light

The city utilizes photo red light enforcement at a limited number of high-traffic intersections to address collision trends related to running red lights. Collisions caused by a vehicle running a red light are often right-angle (broadside) collisions, which are more likely to result in serious injuries or fatalities. Photo red light captures images of any vehicles that run red lights, records the time elapsed since the light turned red and the vehicle entered the intersection, and issues tickets. The goal of photo red light enforcement is not to generate revenue—the goal is to improve safety at busy intersections. Over the 16 year history of the program, red light running collisions have been reduced by 68 percent.

EVALUATION

The city will continue to monitor and evaluate collision types, locations and other trends to further refine and enhance safety improvements to continue to work Toward Vision Zero and display ongoing data on the new citywide metrics dashboard. The next Safe Streets Boulder Report covering data from 2015-2017 will be published in the spring of 2019. In addition, action items include:

- Improve Collision Data: The Transportation Division will seek to improve the quality and completeness of collision data in conjunction with the Police Department's procurement of a new record management system.

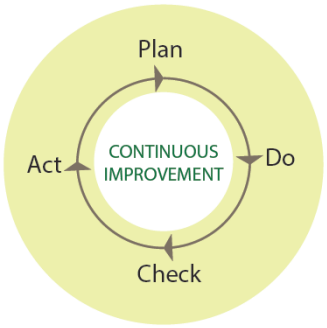
- Further Analysis: Conduct additional analysis to better understand trends in motorcycle related collisions and serious injuries and refine mitigation strategies. In addition, further evaluate in more detail the causal factors related to bicycle and pedestrian collisions such as bike light use, distraction and adherence to the crosswalk speed limit.

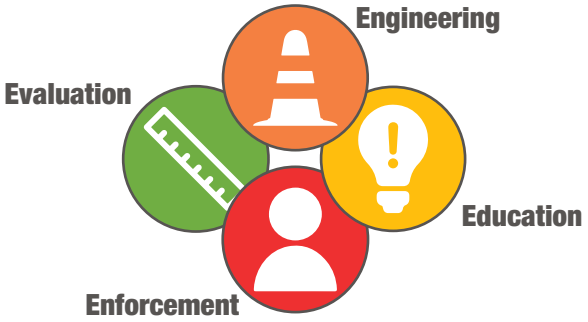
NEXT STEPS

Moving Toward Vision Zero is a challenging and important goal to achieve a safe transportation system for all modes of travel within the City of Boulder. Improving the safety of city streets requires everyone—the city, community and individuals—to share the responsibility of ensuring the safety of people in the community and reaching Boulder's Vision Zero safety goal by working together.

Traffic safety is the city's first priority. A comprehensive approach to improving the safety of Boulder's transportation system that uses the latest available data is necessary, with efforts targeted at reducing serious injuries and fatalities in traffic collisions. The 2012 Safe Streets Boulder report was an important step toward improving traffic safety for bicyclists and pedestrians, providing insight into the causes of collisions and identifying strategies to reduce them.

This 2016 report builds upon the work of the first report, with a new approach, Toward Vision Zero. The city's findings will continue to be used for broad, community-wide campaigns to inform drivers, bicyclists and pedestrians, and also for site-specific solutions.





Engineering: Violet Avenue and U.S. 36 Intersection Re-alignment

Completed in 2015, this capital improvement project was jointly funded by Boulder County and the City of Boulder to improve safety at the intersection of Violet Avenue and U.S. 36. Two fatal collisions involving bicyclists occurred at this intersection within the last few years, one in 2009 and one in 2012. The city worked in partnership with Boulder County to make this intersection safer by realigning the intersection to improve sightlines and visibility for both drivers and bicyclists. The project also built a section of missing sidewalk on the south side of Violet Avenue and a pedestrian island at U.S. 36.

KEY FINDINGS SUMMARY

Progress towards the TMP safety objectives is measured using the following metrics:

- Total collisions, fatalities and serious injuries
- Total bicycle collisions, fatalities and serious injuries
- Total pedestrian collisions, fatalities and serious injuries

From 2009-2014, approximately **3,275 COLLISIONS** were reported to the Boulder Police Department each year

Collisions that resulted in a **SERIOUS INJURY** or **FATALITY** have been relatively flat at **2%** of total collisions in the past six years

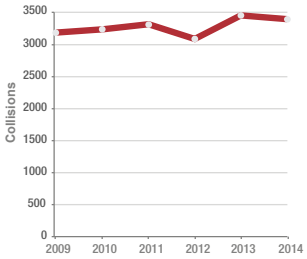
BICYCLISTS & PEDESTRIANS are overrepresented in collisions that result in serious injuries or fatalities, **ONLY 8%** of all traffic collisions in the City of Boulder involve bicyclists or pedestrians. They account for approximately **60%** of serious injuries and fatalities

IMPAIRED PERSONS are overrepresented, especially those involving bicyclists and pedestrians resulting in serious injuries or fatalities

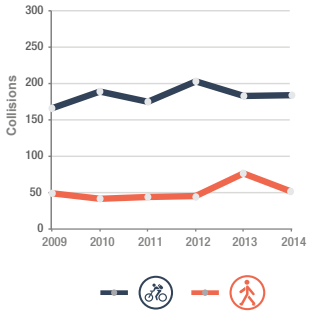
Approximately **3%** of total collisions involve an impaired person

12% of serious injuries and **38%** of fatalities involve an impaired person

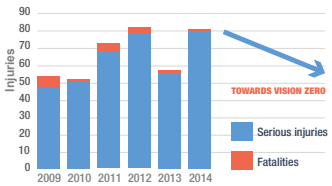
Total Collisions



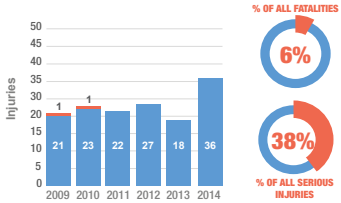
Bicycle & Ped Collisions



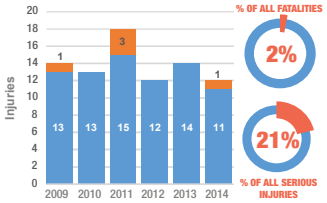
Serious Injuries & Fatalities



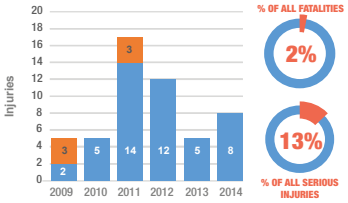
Bicycle Serious Injuries & Fatalities



Pedestrian Serious Injuries & Fatalities



Impaired Person: Serious Injuries & Fatalities



ENGINEERING

Engineering strategies are intended to improve the physical transportation infrastructure through enhancements to the roadway, traffic signals, signs or markings. Many of the safety improvements selected in this report fall into one of the following categories.

- Traffic signal operations
- Traffic signal display modifications
- Lane modification
- Sign and pavement markings
- Enhanced pedestrian crossing treatments

EDUCATION

Education-related strategies involve improving awareness and understanding of people's behaviors or situations that are more likely to result in traffic collisions. This may be achieved through the use of signage and advertising, media safety campaigns, classes, and community outreach.

- Heads Up Boulder campaign
- Litghten Up Boulder
- The Way of the Path
- Bicycle Accessories and Safety Education Program
- Impaired bicyclists and pedestrians
- Bicyclists traveling against traffic on sidewalks/multiuse path
- Rear ends in right-turn bypass lanes
- Flashing yellow arrows
- Collisions involving motorcycles

ENFORCEMENT

Enforcement techniques include targeted enforcement in coordination with the Boulder and CU-Boulder Police departments to address specific illegal behaviors, as well as automated enforcement such as photo red-light and photo radar to reduce red-light running or speed-related collisions.

- Crosswalk-related offenses
- Impaired driving, walking and driving
- Red-light running
- No turn on red restriction

EVALUATION

The city will continue to monitor and evaluate collision types, locations and other trends to further refine and enhance safety improvements to continue to work Toward Vision Zero and display ongoing data on the new citywide metrics dashboard. The next Safe Streets Boulder Report covering data from 2015-2017 will be published in the spring of 2019.

- Improve Collision Data
- Further Collision Analysis

APPENDIX A. ABOUT COLLISION DATA

Sources of Data

The collision data used for the analysis in this report was obtained from the City of Boulder's Police Department traffic accident records database and was imported into the Transportation Division's GIS-based program. This data is primarily collected by the Police Department's accident investigation team when they complete a Colorado Traffic Accident Report form at the time of a collision. This form captures information about the location of the collision, people involved in the collision, a description of the collision and various causal factors. Sometimes information is not provided for all data fields, especially in the case of bicycle and pedestrian collisions, private property collisions or hit-and-run collisions. The data from the reports is then entered into the Police Department's traffic accident records database by the records department. Any data not entered into the database is not available to the Transportation Division without reading the original report.

Counter Reports

The database also contains another type of collision record known as a counter report. These reports are completed either online or in-person by citizens involved in traffic collisions in the City of Boulder in which there was no on-scene investigation, no injuries and no major damage to vehicles. Many collisions reported by counter reports occur during snow emergencies when the city is on accident alert, which means police only respond to collisions involving injuries. Counter reports do not follow the same format, nor do they contain all of the same information as the Colorado Traffic Accident Report. On average, about 12 percent to 17 percent of reported collisions are in the form of counter reports, and the remaining 83 percent to 88 percent are officer reports. Because counter reports are not completed by accident investigation officers, they often lack accurate information such as collision location and collision type, which are needed for an accurate analysis of collision data. Collisions reported through counter reports were included in the totals for number of collisions each year, but were excluded from the detailed analysis of 2012-2014 collision data.

Private Property Collisions

City of Boulder Police Department accident scene investigators respond to and complete traffic accident reports for collisions occurring on both public and private property. Public property collisions include any collisions occurring within or originating from city-maintained roadways, right-of-way, or bicycle and pedestrian facilities. Examples of private property collisions include those occurring in parking lots, driveways, etc. Approximately 13 to 15 percent of collisions per year occur on private property. While the accident reports for police-reported collisions indicate whether or not the collision occurred on private property, inconsistencies in this data often occur for collisions on

sidewalks, multi-use paths or private roadways such as those within the 29th Street Mall. For the collision totals and analysis presented in this report, both public and private property collisions were included.

Data Scrubbing

Prior to summarizing or analyzing the collision data, the Transportation Division conducts some data cleaning in an effort to amend incorrect, incomplete or duplicated data related to collision location, injury severity, and bicycle and pedestrian demographics. However, limitations still exist in terms of data completeness and accuracy.

PBCAT Data

Bicycle and pedestrian-related collision information from the accident records database was supplemented with additional data fields identified by the Pedestrian and Bicycle Crash Analysis Tool (PBCAT). PBCAT is a crash typing software developed by the Federal Highway Administration to identify details associated with collisions between motor vehicles and pedestrians or bicyclists. PBCAT uses pre-collision actions of the persons involved in a collision to better understand the types of collisions occurring and to identify potential strategies to mitigate them. The information in the PBCAT fields was filled in by the research team based on a review of the narrative of each individual report.

APPENDIX B. SUMMARY OF FATAL COLLISIONS (2009-2014)

Year	Description
2009	On 1/18/09 at 6:31 pm, an impaired 30-year old male bicycling southbound on 30th St north of Colorado crossed to the center of the roadway and was hit by a southbound motorist.
2009	On 3/30/09 at 1:39 am, an impaired 23-year old male driving northbound on 28th St ran a red light at Jay Rd and hit a westbound motorist.
2009	On 10/12/19 at 4:21 pm, a 46-year old male traveling southbound Broadway on a scooter turned left in front of a northbound motorist to enter the Basemar Shopping Center.
2009	On 12/3/09 at 8:13 pm, a motorist traveling eastbound on US-36 approaching the Table Mesa overpass hit an impaired 22-year old male lying in the roadway.
2009	On 12/16/19 at 5:27 am, a 54-year old male exiting westbound US-36 to South Boulder Rd lost control of his motorcycle and struck the concrete center median.
2010	On 5/1/10 at 11:35 am, a 56-year old female bicycling eastbound on Lee Hill Rd hit a pedestrian crossing at 5th St, lost control and crashed her bicycle.
2010	On 7/3/10 at 11:53 pm, a 20-year old male riding a motorcycle westbound on Diagonal Hwy approaching 28th St was hit by a 19-year old eastbound motorist turning left onto northbound 28th St.
2011	On 3/8/11 at 6:34 pm, an impaired 54-year old male lying in the northbound lane of Broadway north of Baseline was hit by an unknown motorist (hit and run).
2011	On 7/2/11 at 3:00 am, an impaired 21-year old male speeding westbound on Hwy 52 crossed Diagonal Hwy onto IBM Drive, veered off the roadway and hit several trees.
2011	On 9/15/11 at 7:23 pm, a 57-year old female crossing Broadway at Greenbriar was hit by a northbound motorist.
2011	On 10/18/11 at 7:25 pm, an impaired 35-year old male crossing 28th St north of Valmont Rd was hit by a northbound motorist.
2012	On 4/23/12 at 8:26 am, a 44-year old male traveling westbound on Table Mesa Dr attempted to brake for traffic backed up from Broadway and crashed his motorcycle.
2012	On 5/9/12 at 11:16 am, a 92-year old female traveling eastbound on South Boulder Rd hit a northbound RTD bus that pulled out in front of her from Manhattan Cir.
2012	On 8/21/12 at 4:53 pm, a 40-year old male traveling southbound on 30th St. crashed his motorcycle while trying to avoid an eastbound motorist pulling out from a driveway access across from O'Neal Pkwy.
2013	On 10/29/13 at 4:09 pm, a 60-year old male was found unresponsive in his vehicle after traveling northbound on Foothills Pkwy north of Pearl Pkwy in the wrong direction and hitting a southbound motorist.
2014	On 11/6/14 at 8:55 pm, a 62-year old male walking either along or across Canyon Blvd was hit by a southbound bus exiting the RTD station onto Canyon Blvd.

APPENDIX C. COLLISION TYPE DESCRIPTIONS

Animal – A vehicle collides with a domestic or wild animal.

Approach turn – One vehicle turns left in front of another vehicle traveling in the opposite direction.

Bicycle – Any collision involving bicyclist.

Fixed Object – A single vehicle collides with a fixed object. (Example: curb, tree, sign, boulder).

Head on – A vehicle collides with the front of another vehicle traveling in the opposite direction.

Overtaking turn - One vehicle turns in front of another vehicle traveling in the same direction. (Example: right-turn from left lane).

Overturning – A single vehicle tips over onto its side or roof.

Parked vehicle – A vehicle collides with a parked vehicle while traveling on the roadway or maneuvering into or out of a parking space.

Pedestrian – Any collision involving a pedestrian.

Rear end – A vehicle collides with the rear end of another vehicle traveling ahead in the same direction.

Right angle – Two vehicles traveling in perpendicular directions collide at approximately a right angle, often referred to as broadside or T-bone collisions. This collision type can occur at uncontrolled intersections or as a result of one vehicle running a red light.

Side swipe-same direction – A vehicle collides with the side of another vehicle traveling in the same direction, often due to improper lane changes.

Side swipe-opposite direction – A vehicle collides with the side of another vehicle traveling in the opposite direction.

APPENDIX D. SUPPLEMENTAL INFORMATION FOR 2012-2014 COLLISION DATA ANALYSIS

Where are Collisions Happening?

Focusing on collisions occurring in a crosswalk, the majority occur within a crosswalk at an intersection for both pedestrians (81 percent) and bicyclists (73 percent). Collisions with vehicles in driveway crossings are twice as common for bicyclists (22 percent) than for pedestrians (8 percent) – possibly due to the speed of bicyclists traveling on a multi-use path or sidewalk.

Close-Up on Ped Collisions in Crosswalks

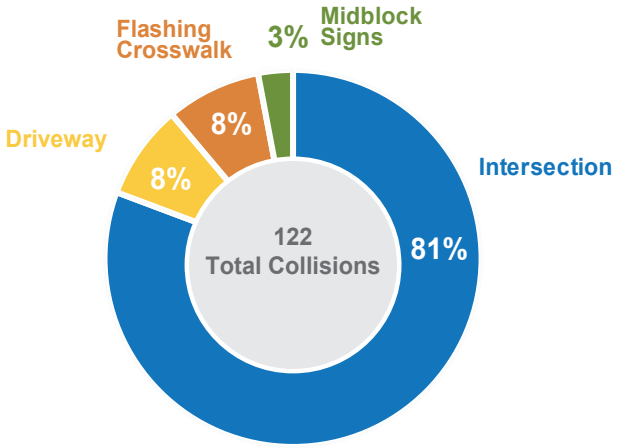


Figure 1. Breakdown of pedestrian collisions in crosswalks (2012-2014).

Close-Up on Bike Collisions in Crosswalks

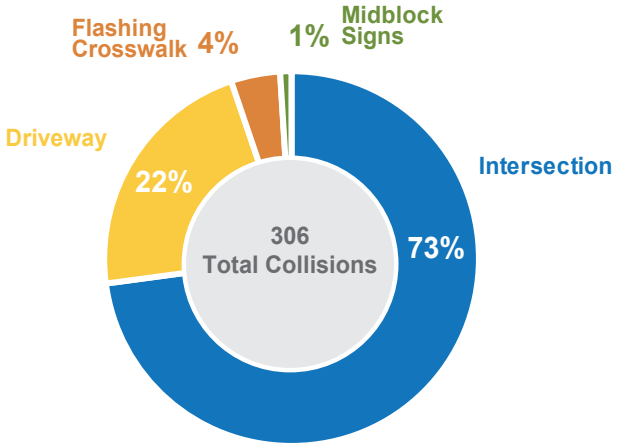


Figure 2. Breakdown of bicycle collisions in crosswalks (2012-2014).

Traffic Violations

The top traffic violations cited in collisions are associated with motor vehicles failing to avoid interfering with a vehicle ahead, careless driving and failing to yield when turning left. These trends agree with the most common types of collisions (rear end, right angle and approach turn) and the number of tickets filed with the Municipal Court. Overall traffic violation data from the Municipal Court reveals that tickets are most frequently issued for failing to avoid interfering with a vehicle ahead, failing to stop at a stop sign, disobeying a red signal light and making illegal U-turns. Data from the Municipal Court also suggests that citations may not often be issued for a few types of violations associated with traffic collisions. The Transportation Division will coordinate with the Police Department and Municipal Court to better understand these trends.

Who is at Fault in Bicycle and Pedestrian Collisions?

Drivers were more likely to be cited than bicyclists or pedestrians in the collisions that were analyzed. In collisions involving pedestrians, drivers were cited 3.7 times more often than pedestrians. Similarly, drivers were cited 3.6 times more often than bicyclists in vehicle collisions involving a bicyclist.
About 10 percent of pedestrian collisions resulted in neither party receiving a citation. No one was cited in almost 40 percent of motor vehicle collisions involving a bicyclist. This is due to a variety of factors. In many instances, officers find it difficult to ascertain fault with enough certainty to write tickets. In some instances, vehicles and persons involved were moved, or statements from witnesses and persons involved were not consistent. In some instances, officers may refrain from citing pedestrians and bicyclists who have been injured.

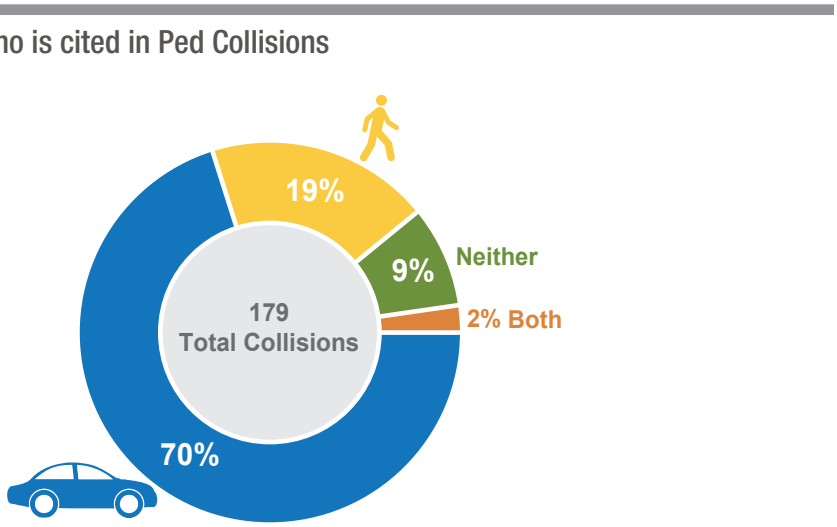


Figure 3. Citations issued in collisions with pedestrians (2012-2014).

Who is cited in Bike Collisions

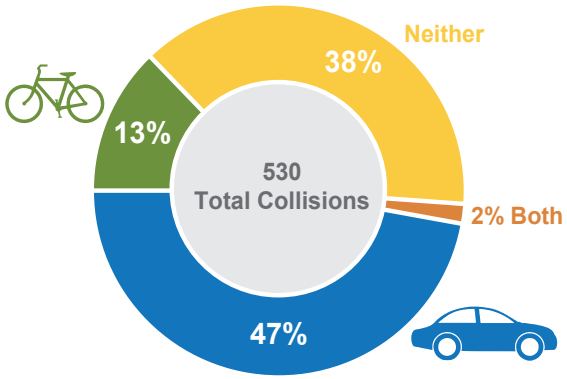


Figure 4. Citations issued in collisions with bicyclists (2012-2014).

Who is Involved in Bicycle and Pedestrian Collisions?

Demographic information such as city of residence, gender and age of persons involved in collisions can provide useful information for improving safety and reducing collisions by developing messages geared toward specific populations. It should be noted that while this information is almost always provided for bicyclists and pedestrians on accident reports (less than 4 percent incomplete), demographic data for the motor vehicle driver is unknown for 12 percent of collisions involving a bicyclist and 14 percent of collisions involving a pedestrian. This is attributed to hit and run collisions or cold reports where the bicyclist or pedestrian reported an accident later. Key highlights are described in greater detail in this section.

Residence

- Boulder residents comprise the majority for all involved in the collisions – with a City of Boulder address listed for at least 52 percent of motor vehicle operators, 70 percent of pedestrians and 85 percent of bicyclists.
- At least 82 percent of all motor vehicle operators and virtually all bicyclists and pedestrians are from Colorado.

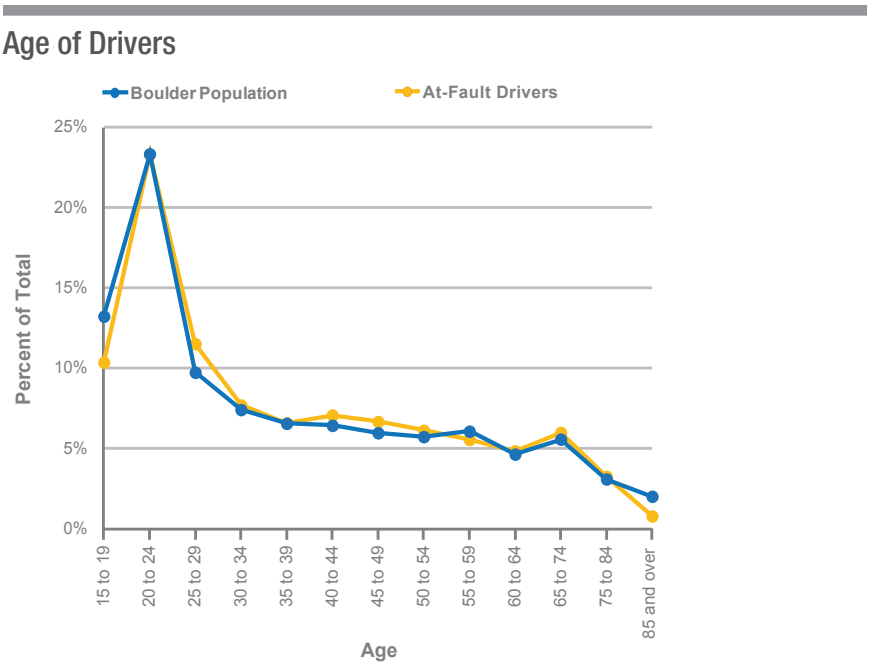
Gender

- Approximately three-quarters of all bicyclists involved in collisions are male.
- There were slightly more male (54 percent) than female (46 percent) pedestrians involved in collisions with vehicles.
- Of accident reports with known demographics, there were also slightly more male (56 to 59 percent) than female (41 to 44 percent) drivers involved in collisions with a pedestrian or bicyclist, respectively.

Table 1. Gender of Pedestrians and Bicyclists Involved in Motor Vehicle Collisions.

Gender	Pedestrian Collision		Bicycle Collisions	
	Driver	Pedestrian	Driver	Pedestrian
Total Known	162	174	500	521
Female	41 Percent	46 Percent	44 Percent	26 Percent
Male	59 Percent	54 Percent	56 Percent	74 Percent

Figure 5. Ages of drivers involved in bicycle and pedestrian collisions compared to ages of Boulder population (2012-2014).



When are Collisions Happening?

Time of Day

The peak time for bicycle and pedestrian collisions is in the late afternoon and early evening hours (2:00 pm to 6:00 pm). A higher percentage of pedestrian collisions compared to bicycle collisions tend to occur in the early morning hours (midnight to 2:00 am).

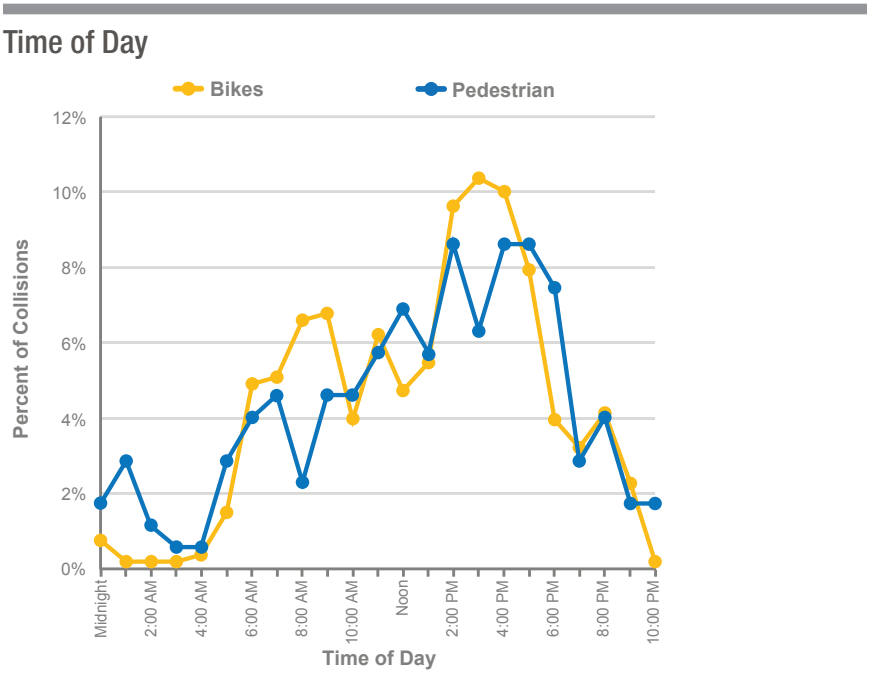


Figure 6. Bicycle and pedestrian collisions by time of day (2012-2014).

Day of Week

A higher number of motor vehicle collisions occur on Tuesdays, Wednesdays and Thursdays. Collisions on these days appear to be slightly over-represented compared to average daily traffic volumes, while Saturdays and Sundays are under-represented in the number of collisions. Average daily traffic volumes are generally highest on Fridays, but the number of motor vehicle collisions does not peak on Fridays.

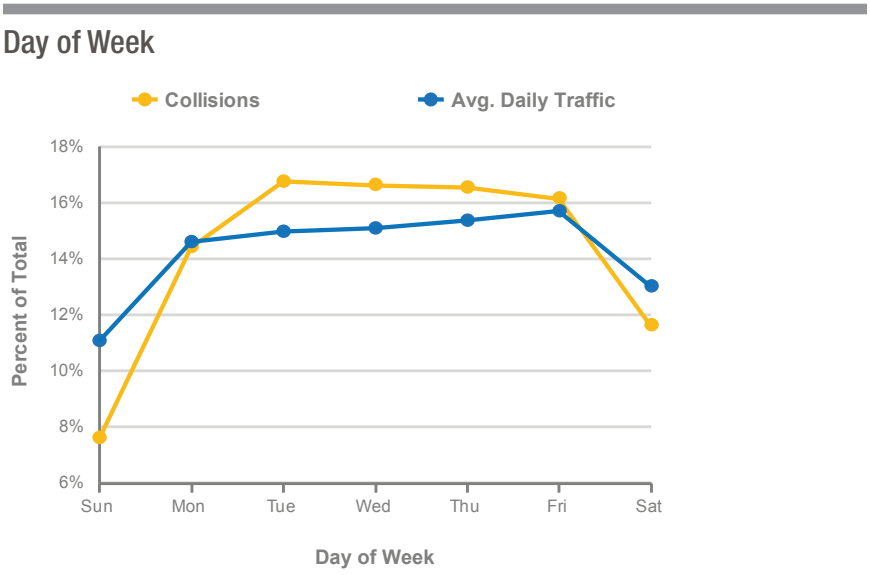


Figure 7. Collisions by day of week compared to average daily traffic (2012-2014).

Bicycle & Pedestrian Collisions Not Involving a Motor Vehicle

Between 2012 and 2014, there were a total of 47 bicyclist collisions that did not involve a motor vehicle. Twenty-three or 49 percent resulted in a serious injury to a bicyclist. Seven involved a bicyclist colliding with another bicyclist, one involved a skateboard and a bicyclist and 15 were single bicycle crashes. While seven of the non-motor vehicle bicyclist collisions involved a pedestrian, only two resulted in serious injury to the pedestrian.

APPENDIX E. SAFETY IMPROVEMENTS FOR TOP LOCATIONS

The top 12 intersections with the highest rate of collisions (collisions per million entering vehicles) involving motor vehicles were identified by the 2016 Boulder Safe Streets Report. The top 16 locations with the highest frequency of bicycle and pedestrian collisions were also identified. A summary of collisions at each of these locations and recommended mitigation measures is discussed below. Additionally, the top intersections with the highest frequency of approach turn and right angle collisions were identified, as these collision types are more likely to result in serious injuries and fatalities. Safety improvements were also selected for any of these locations that were not identified as a top location by collision rate or bicycle and pedestrian collision frequency. Note that any modifications on state highways will require coordination with CDOT.

Collision Rate

1. **Colorado and Regent** (2.2 collisions/MEV): This intersection of a minor arterial and collector roadway was also identified as a top location for bicycle and pedestrian and approach turn collisions. Colorado Avenue currently has one through lane and two left-turn lanes in the westbound direction and two through lanes and one left-turn lane in the eastbound direction. A right-turn bypass lane and a shared through/left-turn lane serve vehicles on the northbound approach. Collision trends include rear ends in the northbound right-turn bypass lane and approach turn collisions involving the westbound left-turn movement. This intersection was recently evaluated to identify potential improvements to increase safety and provide efficient traffic operations. The recommendations offer mitigation measures that would address both the above motor vehicle collisions trends as well as the bicycle and pedestrian collision trends. The implementation of these recommendations would require additional public process.

Mitigation:

Engineering – Possible conversion of outside eastbound lane to a right-turn lane with the bike lane transitioned to the left of the right-turn lane and conversion of left-turn signal heads to flashing yellow arrow displays.

2. **30th and Baseline** (1.9 collisions/MEV): This intersection of an arterial and minor arterial roadway was also identified as a top location for bicycle and pedestrian related collisions and approach turn collisions. Both the eastbound and southbound approaches have double left-turn lanes, while the westbound and northbound approaches have single left-turn lanes. The most common collisions involving motor vehicles were approach turn crashes in the eastbound and southbound double left-turn directions.

Mitigation:
Engineering – Conversion of southbound and eastbound left-turn signal phasing to protected-only operations during the weekday evening peak period and consideration of installing an additional southbound left-turn signal head.

3.**Baseline and 28th Street Frontage Road/US-36 East Ramp** (1.7 collisions/MEV): This is the intersection of a state highway with the US-36 westbound ramps. In the vicinity of this intersection, Baseline road has two through lanes and two eastbound left-turn lanes for the US-36 westbound on-ramp. The westbound off-ramp terminates at Baseline with a northbound right-turn bypass lane and a left-turn and shared through/left-turn lane. Most of the collisions at this intersection were northbound rear ends in the right-turn bypass lane. Drivers involved in this type of collision often admitted that they were looking to their left to find a gap in eastbound traffic, assumed the vehicle in front of them had already proceeded and then began to pull forward.

Mitigation:
Engineering – Installation of dashed line and yield line pavement markings for northbound right-turn bypass lane to reinforce yield condition.
Education – Rear ends in right-turn bypass lanes.

4.**Arapahoe and 30th** (1.6 collisions/MEV): This intersection of a state highway and an arterial roadway was also identified as a top location for bicycle and pedestrian collisions as well as approach turn collisions. Double left-turn lanes are present on all approaches and these left-turn movements currently run protected-only phasing during most of the day. The most prevalent collision type was approach turn collisions, especially in the northbound and westbound left-turn directions. Another trend was impaired driving collisions, as four collisions involved suspicion of alcohol and one involved suspicion of drugs.

Mitigation:
Engineering – Conversion of left-turn signal heads to flashing yellow arrow displays.
Enforcement – Impaired driving.

5.**28th and Arapahoe** (1.6 collisions/MEV): This is the intersection of two state highways. Both the eastbound and westbound approaches have right-turn bypass lanes while northbound and southbound right-turns share a lane with through vehicles. The majority of collisions at this intersection were rear ends, with the highest number in the northbound direction. Rear ends were also prevalent in the southbound direction and in the westbound right-turn bypass lane. Photo red-light cameras are present in the southbound and westbound directions, though this doesn't correlate to the movements with the highest number of rear ends.

Mitigation:
Engineering – Installation of dashed line and yield line pavement markings for westbound right-turn bypass lane to reinforce yield condition.
Education – Rear ends in right-turn bypass lanes.

6.**Broadway and Canyon** (1.6 collisions/MEV): This intersection of two state highways was also identified as a top location for bicycle and pedestrian and approach turn collisions. This intersection is also heavily traveled by transit vehicles due to its proximity to the Downtown Boulder Transit Center and location along multiple transit routes. Currently, none of the approaches have dedicated right turn lanes. About half of the collisions at this intersection were rear ends, though they were distributed fairly evenly between all the through lane approaches. Another trend was sideswipes between vehicles traveling in the same direction. Several of these collisions appear to be the result of one large vehicle passing by another large vehicle (moving trucks, transit vehicles, trash trucks, etc.), but the majority were associated with vehicles entering or exiting the left-turn lanes. No immediate mitigation measures were identified for this location, but more consideration will be given to this intersection as part of the Canyon Boulevard Complete Streets project.

7.**Broadway and Baseline** (1.5 collisions/MEV): This intersection of two state highways and a collector roadway on the west side and was also identified as a top location for bicycle and pedestrian collisions. This intersection serves a large number of students, faculty and visitors accessing the University of Colorado as well as commuters and transit users along State Highway 93. Collision trends include rear end collisions, serious injury collisions and impaired driving collisions. The highest number of rear end collisions occurred in the westbound right-turn direction, the only approach with a right-turn bypass lane. The majority of serious injury collisions involving motor vehicles were bicycle or pedestrian related.

Mitigation:
Engineering – Installation of a Lane Ends Merge Left Sign for the westbound right-turn acceleration lane.
Education – Rear ends in right-turn bypass lanes.
Enforcement – Impaired driving.

8.**30th and Colorado** (1.5 collisions/MEV): This intersection of an arterial and a minor arterial roadways was identified as the top location for bicycle and pedestrian collisions. Other than bicycle and pedestrian related collisions, the only other trend in motor vehicle collisions was rear ends, though not in any one particular direction. As discussed in the bicycle and pedestrian collision safety improvements, the construction of an underpass is planned for this intersection, which should reduce some of the conflicts between motor vehicles and bicyclists and pedestrians. No immediate mitigation measures were identified for this location, but more consideration will be given to this intersection as part of the upcoming 2016 corridor plans for 30th Street and Colorado Avenue.

9. **28th and Iris** (1.5 collisions/MEV): This intersection of two state highways and an arterial roadway on the west side was also identified as a top location for approach turn collisions. Intersection improvements to better facilitate bicycle and pedestrian movement and improve intersection operations were completed at this location in 2007. Modifications to signal heads and phasing were made in 2012, which appear to have decreased approach turn crashes in 2013 and 2014. Over half of the collisions involving motor vehicles were rear ends, with the most occurring for the westbound and northbound right turn movements.

Mitigation:
Engineering – Lane line marking modifications for the northbound right-turn acceleration lane to clarify that it is a continuous lane.

10. **Valmont and Foothills** (1.4 collisions/MEV): This is the intersection of a state highway and a minor arterial roadway that serves a large volume of north-south traffic on Foothills Parkway. Right-turn bypass lanes, double left-turn lanes and two through lanes are present on all approaches of this intersection. The majority of collisions at this intersection over the last three years were rear ends, with the highest number in the southbound direction. Recently, a third southbound lane was constructed on Foothills Parkway from the Diagonal highway on-ramp to Valmont Road to reduce congestion and improve safety. This improvement is expected to reduce the number of southbound rear end collisions. No additional mitigation measures are recommended at this time.

11. **28th and Canyon** (1.4 collisions/MEV): This is the intersection of two state highways and the private portion of Canyon Boulevard that runs through the 29th Street Mall. Right turn bypass lanes and double left-turn lanes are provided on all approaches. The majority of collisions at this intersection were rear end collisions, with the highest number in the eastbound right-turn direction. While most of the at-fault drivers involved in these collisions admitted that they were looking left when they began to merge onto southbound 28th Street and struck the vehicle in front of them, others expressed confusion over whether or not the southbound receiving lane was a continuous acceleration lane.

Mitigation:
Engineering – Installation of dashed line and yield line pavement markings for eastbound right-turn bypass lane to reinforce yield condition.
Education – Rear ends in right-turn bypass lanes.

12. **Broadway and Table Mesa** (1.4 collisions/MEV): This intersection of a state highway with an arterial roadway and minor arterial roadway was also identified as a top location for bicycle and pedestrian collisions as well as approach turn collisions. The majority of approach turn collisions were in the southbound left-turn direction, though they occurred at various times throughout the day. An additional collision trend was rear ends in the southbound right-turn bypass lane.

Mitigation:
Engineering – Conversion of left-turn signal heads to flashing yellow arrow displays and installation of yield line pavement markings for southbound right-turn bypass lane to reinforce yield condition.
Education – Rear ends in right-turn bypass lanes.

Bicycle and Pedestrian Collision Frequency

1.**30th and Colorado** (13 collisions, 4.3 collisions/year): This intersection is located along the main route between the University of Colorado's Main and East Campuses and serves many bicyclists, pedestrians, transit riders and drivers. Bike lanes are present on both 30th Street and Colorado Avenue and a multi-use path begins at the northeast corner of the intersection and runs along the north side of Colorado Avenue through East Campus. Collision trends at this intersection include conflicts between eastbound motorists turning right and westbound bicyclists in the south crosswalk and northbound bicyclists in the west crosswalk. Two other collisions involved bicyclists riding in the crosswalks against the pedestrian signal. Funding has been secured for the design and construction of an underpass under 30th Street at this intersection, which should reduce conflicts between motor vehicles and bicycles and pedestrians.

Mitigation:
Engineering - Signing for turning vehicles to yield to bicycles and pedestrians to be installed for the eastbound right turn movement.
Enforcement - Bicyclists riding against signal and crosswalk speed limit for bicyclists.
Education - Increased awareness of bicyclists riding against traffic on sidewalks and the associated risks.

2.**30th and Arapahoe** (11 collisions, 3.7 collisions/year): This intersection of an arterial roadway and a state highway has served as an important north-south route for bicyclists since bike lanes were installed on 30th Street in 2011. Multi-use paths are located on the north side of Arapahoe, south side of Arapahoe west of 30th, and along 30th north of Arapahoe. This intersection has also been identified as a top location for motor vehicle collisions, especially collisions involving left-turning vehicles. The bicycle and pedestrian collisions trends noted were bicyclists and pedestrians crossing in the crosswalks against the signal as well as vehicles turning left and hitting bicyclists and pedestrians in west, north and south crosswalks.

Mitigation:
Engineering - Conversion of signals to flashing yellow arrow for permissive left turns, installation of Heads Up decals and "8 is Great" signing, and signing for turning vehicles to yield to bicycles and pedestrians.
Enforcement - Bicycles and pedestrians crossing against signal.
Education - Increased awareness of bicyclists riding against traffic on sidewalks and the associated risks.

3.**Broadway and Baseline** (11 collisions, 3.7 collisions/year): This intersection of two state highways and a collector roadway on the west side is located at the southwest corner of the University of Colorado Campus. The Broadway multi-use path runs along the west side of Broadway through this intersection, and multi-use paths are also located on the north and south sides of Baseline east of Broadway. Several collisions involved westbound vehicles turning left and hitting bicyclists or pedestrians in the south crosswalk. Two collisions occurred when eastbound vehicles turned right on red, which is prohibited for this movement, and struck northbound bicyclists in the west crosswalk.

Mitigation:
Enforcement - No right turn on red for eastbound motorists.
Education – Encouraging drivers to use 27th Way to travel between westbound Baseline and southbound Broadway, instead of making a westbound left turn at Broadway and Baseline.

4.**Colorado and Regent** (10 collisions, 3.3 collisions/year): This intersection serves bicycles, pedestrians, and motorists entering and exiting the main University of Colorado campus. Both the multi-use path on the south side of Colorado and the bike lanes on Colorado are heavily used by bicyclists. A common collision trend at this intersection is eastbound vehicles turning right in front of or into eastbound bicyclists in the bike lane. Green pavement markings were installed on the eastbound approach in August 2013, but two of the right hook collisions occurred after this. This intersection was also identified as the top location for motor vehicle collisions by rate. Recommendations for improvements to the intersection were developed by a consultant as part of an intersection improvement study.

Mitigation:
Engineering - Possible conversion of outside eastbound lane to a right-turn lane with the bike lane transitioned to the left of the right-turn lane and conversion of left-turn signal heads to flashing yellow arrow displays.
Education - Increased awareness of bicyclists riding against traffic on sidewalks and the associated risks.

5.**Canyon and Folsom** (9 collisions, 3 collisions/year): This is the intersection of a state highway and a minor arterial roadway. The bike lanes on Folsom Street are heavily used and serve as a major north-south route for bicyclists. Several of the collisions at this intersection involved vehicles turning left and hitting pedestrians in the crosswalk and bicyclists in the crosswalk or bike lane.

Mitigation:
Engineering - Installation of dismount decals on the sidewalk to reduce the number of bicyclists riding on sidewalks, signing for northbound and southbound left-turning vehicles to yield to bicycles and pedestrians.
Education & Enforcement -Riding bicycles on sidewalks in commercially zoned areas is prohibited.

6.**30th and Baseline** (9 collisions, 3 collisions/year): This intersection of an arterial roadway with a minor arterial roadway is located adjacent to Williams Village student housing area and other residential and commercial development. Bicycle and pedestrian facilities include bike lanes on Baseline and 30th north of Baseline as well as multi-use paths on the south side of Baseline and the north side of Baseline west of 30th. The most common collision trend was conflicts between left-turning vehicles and bicyclists or pedestrians crossing in the crosswalk. This intersection is also one of the top locations for motor vehicle collisions involving left-turns.

Mitigation:
Engineering - Adjustments to eastbound and southbound left-turn phasing due to corresponding motor vehicle approach turn collision trend should be effective in reducing both the vehicle/vehicle and vehicle/bicycle or vehicle/pedestrian collisions.

7.**28th Street Frontage Road and Colorado** (8 collisions, 2.7 collisions/year): This intersection is located immediately adjacent to the intersection of 28th Street and Colorado and has bike lanes on both Colorado and the frontage road. Half of the collisions at this intersection were caused when eastbound vehicles turned right onto 28th Street Frontage Road and collided with eastbound bicycles in the bike lane.

Mitigation:
Engineering - Installation of green pavement markings and signing for turning vehicles to yield to bicycles on the eastbound approach.

8.**Baseline and 27th Way** (8 collisions, 2.7 collisions/year): This is the intersection of a state highway with a minor arterial roadway and the US-36 eastbound off ramp. A high volume multi-use path runs along the north side of Baseline and crosses a right-turn bypass lane for the off-ramp. Most of the collisions at this intersection occurred in the raised crossing of the southbound right-turn bypass lane as vehicles exiting US-36 and turning right struck eastbound bicyclists in the raised crossing. Three other collisions involved bicyclists or pedestrians crossing against the signal.

Mitigation:
Engineering – Installation of “8 is Great” signing and possible conversion of southbound right turn yield to a stop condition.
Enforcement - Bicycles and pedestrians crossing against signal and crosswalk speed limit for bicyclists.

9.**Broadway and Canyon** (7 collisions, 2.3 collisions/year): This is the intersection of two state highways located downtown with heavy pedestrian usage. Many of the collisions at this location involved bicyclists in crosswalks, though riding on sidewalks in this commercial area is prohibited. Two collisions involved pedestrians being struck by right-turning vehicles. More consideration will be given to this intersection as part of the Canyon Boulevard Complete Streets project.

Mitigation:

Education and Enforcement - Bicycles riding on sidewalks and bicycles crossing against signal.

10. **30th and Pearl** (6 collisions, 2 collisions/year): This is the intersection of an arterial roadway with a minor arterial roadway. Bike lanes are located on 30th and on Pearl west of 30th and multi-use paths are located on all approaches to the intersection except the northeast corner. Most of the collisions at this intersection were fairly unique, and no mitigation measures are recommended at this time.

11. **Arapahoe and Folsom** (6 collisions, 2 collisions/year): This is the intersection of a minor arterial with a state highway. Heavily used bike lanes run along Folsom and multi-use paths run along Arapahoe, east of Folsom. The only collision trend was northbound vehicles turning right and colliding with northbound bicycles in the bike lane. Green pavement markings were installed on the northbound approach and a bike box was installed on the southbound approach as part of the Folsom Street Living Laboratory project in July 2015. These treatments will be evaluated as part of the Living Lab Phase II program in May 2016. No further mitigation is recommended at this time.

12. **Broadway and Table Mesa** (6 collisions, 2 collisions/year): This is the intersection of a state highway with an arterial roadway and a minor arterial roadway. Bike lanes are provided on Table Mesa, east of Broadway, and westbound Table Mesa, west of Broadway. The Broadway multi-use path runs along the west side of Broadway through this intersection and the Bear Creek multi-use path passes under Broadway just north of the intersection. Sidewalk and multi-use path connections on the east side of the intersection link the Lashley Lane bike route and Bear Creek Path. Most of the collisions at this intersection occurred in the east crosswalk between bicyclists or pedestrians and vehicles turning left or right. Another trend was conflicts between right-turning vehicles and bicyclists riding against traffic in the crosswalk.

Mitigation:

Engineering - Install Turning vehicles Yield to Bikes/Peds sign for northbound right turning vehicles.
Education - Increased awareness of bicyclists riding against traffic on sidewalks and the associated risks.

13. **Baseline and 29th** (6 collisions, 2 collisions/year): This is the T-intersection of a local roadway with an arterial roadway. The Baseline multi-use path runs along the north side and south side of Baseline through this intersection. All of the collisions at this location involved conflicts between southbound turning vehicles and eastbound bicyclists riding on the north side multi-use path. Nearly all of the vehicles involved in the collisions were turning right onto westbound Baseline.

Mitigation:
Engineering - Installation of additional southbound stop sign and two-way bike/pedestrian crossing sign in center median, 8 mph speed limit signing for bicyclists approaching crosswalk, and investigate removal or relocation of sight distance obstructions in northwest corner.
Enforcement – Crosswalk speed limit for bicyclists and vehicle stop sign compliance.
Education - Increased awareness of bicyclists riding against traffic on sidewalks and the associated risks.

14. **Broadway and Spruce** (6 collisions, 2 collisions/year): This intersection of an arterial and a minor arterial roadway is located downtown just north of the Pearl Street Mall. The most common collision at this intersection was westbound vehicles turning left and colliding with eastbound pedestrians or bicyclists in the south crosswalk.

Mitigation:
Engineering - Addition of a leading pedestrian interval in the signal phasing.

15. **30th and Valmont** (6 collisions, 2 collisions/year): This is the intersection of two minor arterial roadways. Bike lanes are present on both 30th and Valmont. Most of the collisions at this intersection resulted from conflicts between westbound vehicles turning right and bicyclists or pedestrians crossing in the north or east crosswalks.

Mitigation:
Engineering - Signing for westbound right-turning vehicles to yield to bicyclists.

16. **Folsom and Iris** (6 collisions, 2 collisions/year): This is the intersection of an arterial with a minor arterial roadway. Both Iris and Folsom have bike lanes. Most of the collisions at this intersection were fairly unique. Two of the collisions involved westbound vehicles turning left into eastbound bicycles in the bike lane. However, no corresponding left-turn collision trends between motor vehicles were found. No mitigation is recommended at this time.

Approach Turn Collision Frequency

30th and Pearl: This intersection of an arterial roadway and a minor arterial roadway was also identified as a top location for bicycle and pedestrian collisions. Flashing yellow arrow left-turn displays were implemented in 2010. The highest number of approach turn collisions occurred in the southbound left-turn direction. A portion of these collisions appear to be caused by southbound left-turning drivers assuming northbound traffic will stop when the adjacent southbound through signal indications change to yellow.

Mitigation:
Education – Flashing yellow arrow signal operations.

28th and Valmont: This is the intersection of a state highway and a minor arterial roadway with existing flashing yellow arrow left-turn signal displays. While approach turn collisions occurred on all approaches to the intersection, a slightly higher number occurred in the westbound left-turn direction. The majority of these collisions appear to be caused by westbound left-turning drivers assuming eastbound traffic will stop when the adjacent westbound through signal indications change to yellow.

Mitigation:
Education – Flashing yellow arrow signal operations.

28th and Pearl: This intersection of a state highway and an arterial roadway. The traffic signals currently run protected-only left-turn phasing during the majority of the day, so approach turn collisions are more likely to occur afterwards during the evening off-peak hours. These collisions have occurred on all approaches and are not associated with any one particular direction. The left-turn signal displays at this intersection have not yet been converted to flashing yellow arrow displays.

Mitigation:
Engineering – Conversion of left-turn signal heads to flashing yellow arrow displays.

28th and Walnut: This is the intersection of a state highway and two private collector roadways connecting the 29th Street Mall with other adjacent shopping centers and commercial development. The westbound approach has two left-turn lanes while all other approaches have one. A slightly higher number of approach turn collisions occurred in the westbound left-turn direction, though not enough to necessitate changes to left-turn signal phasing. This location will continue to be monitored, but no mitigation measures are recommended at this time.

28th and Colorado: This is the intersection of a state highway and a minor arterial entering the University of Colorado. All of the approach turn collisions at this intersection occurred in the eastbound and westbound directions, as the northbound and southbound directions run protected-only left-turn phasing. These collisions were split evenly between the eastbound left-turn and west-bound left-turn approaches and did not indicate a need for changes at this time.

Canyon and Folsom: This intersection of a state highway and a minor arterial roadway was also identified as a top location for bicycle and pedestrian collisions. Two left-turn lanes are provided in the northbound direction, while all other approaches have one left-turn lane. The left-turn signal heads were converted to flashing yellow arrow displays in 2013. A slightly higher number of approach turn collisions occurred in the northbound left-turn direction, though not enough to necessitate changes to left-turn signal phasing. This location will continue to be monitored, but no mitigation measures are recommended at this time.

30th and Diagonal: This is the T-intersection of a state highway and a minor arterial roadway. Flashing yellow arrow left-turn displays were installed at this intersection in 2012. All left-turn collisions occurred in the westbound direction. Currently, the signal runs protected-permitted left-turn phasing during the morning, mid-day and evening periods. The results of the most recent intersection level of service analysis indicate a possible benefit for providing additional green time for this movement during the PM peak hour.

Mitigation:
Engineering – Increase green time during protected portion of westbound left-turn phase during the PM peak period.

48th and Arapahoe: This intersection of a state highway and a local street is located adjacent to the Boulder Community Foothills Hospital. Approach turn collisions occur in both the eastbound and westbound direction, with a slightly higher number in the eastbound direction. This location may benefit from conversion to flashing yellow arrow displays, though the existing signal traffic signal infrastructure may limit its use to the eastbound direction.

Mitigation:
Engineering – Conversion of eastbound left-turn signal head to flashing yellow arrow and examination in field to determine whether westbound left-turn can also be converted using existing mast arm.

55th and Arapahoe: This is the intersection of a state highway with a minor arterial and collector roadway that experiences a high volume of southbound left-turns during the evening peak hour. Double left-turns are provided in the southbound direction to accommodate this movement, while single left-turn lanes are provided on all other approaches. The majority of approach turn collisions occurred in the eastbound left-turn direction, especially in the evening peak period. The left-turn signal heads at this intersection have not yet been converted to flashing yellow arrow but have been prioritized for installation.

Mitigation:
Engineering – Conversion of left-turn signal heads to flashing yellow arrow displays.

28th and Jay: This is the intersection of a state highway and a minor arterial roadway located on the north side of the city. This intersection has been monitored closely for approach turn collision trends in recent years and adjustments to signal timing and phasing have been made as necessary. The majority of approach turn collisions occur in the southbound direction. This location will continue to be monitored, but no mitigation measures are recommended at this time.

Right Angle Collision Frequency

47th and Diagonal: This is the intersection of a state highway and a collector roadway, located just to the east of the Foothills Parkway and Diagonal Highway interchange. Nearly all of the right angle collisions at this intersection occurred as the result of an eastbound vehicle disobeying a red traffic signal and colliding with a northbound or southbound vehicle on 47th Street. Three of these collisions involved a suspicion of alcohol. While this location may be a potential candidate for photo red-light, alternative improvements to reduce red-light running would first be explored.

Mitigation:
Engineering – Possible adjustments to signal visibility, conspicuity, or control parameters to reduce unintentional red-light running.
Enforcement – Consideration of photo red-light installation and impaired driving enforcement.

Arapahoe and Foothills: This is the intersection of two state highways, which carries large volumes of traffic in both directions. Right angle collisions occurred in the southbound, northbound and westbound directions, with the majority of them related to red-light running violations. Some of these collisions occurred during wet or snowy roadway conditions. This intersection has already been identified as a candidate location for photo red-light in the southbound direction. No additional mitigation measures are recommended at this time, but this intersection will be studied in more detail as part of the East Arapahoe Transportation Plan.

Baseline and 27th Way: This intersection of a state highway with a minor arterial roadway and the US-36 eastbound off ramp was also identified as a top location for bicycle and pedestrian collisions. Right angle collisions occur in the eastbound and southbound directions, with a higher number in the eastbound direction. About half of these eastbound right angle collisions were a result of red-light running. This location is already equipped with photo red-light in the eastbound direction. No additional mitigation measures are recommended at this time.

Stanford and Table Mesa: This is the unsignalized intersection of a minor arterial roadway and a local street located at the entrance to the King Soopers - Table Mesa grocery store. In this section of Table Mesa Drive, the eastbound and westbound lanes are separated by a median and Bear Canyon Creek, with storage space on Stanford Avenue in between. The southbound and northbound approaches of Stanford Avenue and the King Soopers entrance are stop-controlled. Right angle collision trends at this location include southbound vehicles getting struck by eastbound vehicles when continuing straight across the eastbound lanes into King Soopers. The number of collisions does not meet criteria for a change in traffic control (i.e. four way stop or traffic signal). These collisions all occurred in the winter months, so they were likely not due to vegetation-related sight obstructions in the median. This location will continue to be monitored, but no mitigation measures are recommended at this time.

Broadway and Mapleton: This is the unsignalized intersection of a state highway and a minor arterial roadway. Mapleton Avenue approaches Broadway from the west at a relatively steep grade. A right angle collision trend was identified involving eastbound vehicles who were unable to stop at Broadway during snowy roadway conditions, slid into the intersection and were broadsided by southbound or northbound vehicles on Broadway. This trend was previously identified, and warning signs were installed in advance of the eastbound approach.

Mitigation:

Engineering – Coordination with the Transportation Maintenance regarding snow removal operations on Mapleton Avenue to address collision trends.

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