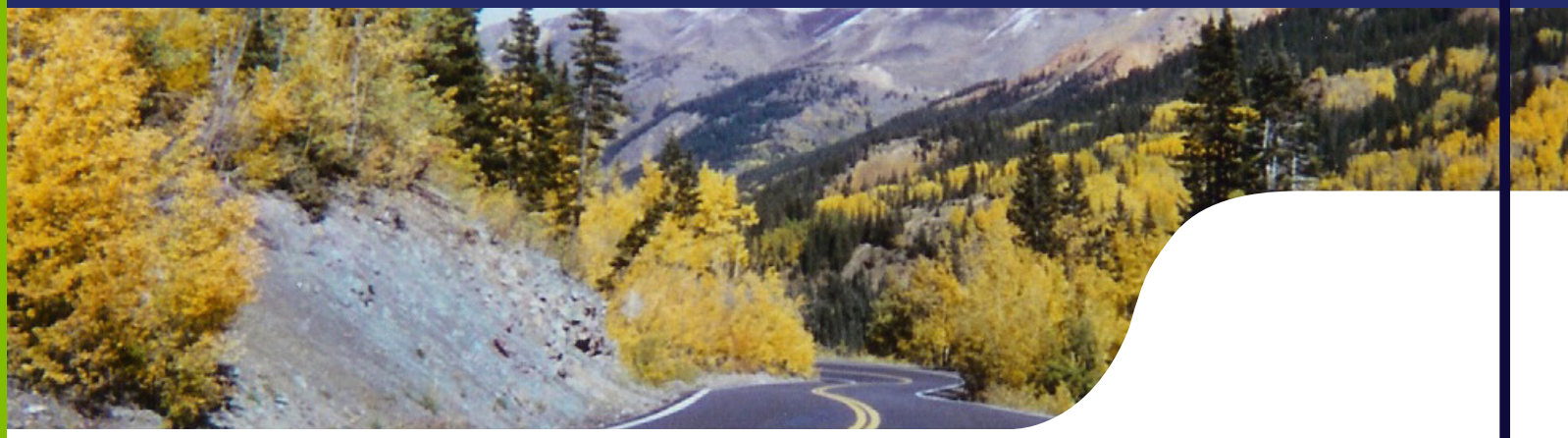
2020-2023 COLORADO STRATEGIC TRANSPORTATION SAFETY PLAN

APRIL 2020



COLORADO
Department of Revenue

COLORADO
Department of Public Health & Environment

COLORADO
Department of Transportation

STATE PATROL
COLORADO

LETTER FROM EXECUTIVE DIRECTOR

Dear Fellow Coloradans and Visitors,

No matter your journey or travel method, Colorado is committed to providing you a safe and efficient transportation network so you arrive at your destination safely.

I am pleased to present the 2020-2023 Colorado Strategic Transportation Safety Plan, or STSP. This plan reflects an extensive and cooperative planning effort by a multidisciplinary partnership of public agencies, private sector organizations, and advocacy groups representing transportation and safety interests statewide. Through collaborative discussion, data-driven analysis, and contribution of time and expertise, the STSP identifies unique, yet achievable strategies and goals to minimize fatalities and serious injuries statewide in Colorado's current transportation system.

The STSP embodies the state's new safety targets for 2023 - a reduction in fatalities and serious injury crashes by 15%. It relies on the premise that every agency and jurisdiction has a role in enhancing transportation safety to the benefit of our citizens and travelers for any transportation mode and facility in Colorado through policy, planning, funding, design and construction, operations, and maintenance.

The STSP focuses on promoting proven safety countermeasures; defining targeted and effective strategy deployment; incorporating local agency safety planning and implementation (39% of Colorado's fatalities occur on local facilities); and considering or using current innovative technologies that are proven to reduce fatalities effectively.

Thank you to the hundreds of stakeholders across Colorado who participated in developing this STSP. To achieve the STSP vision of zero deaths and serious injuries, Colorado need everyone's commitment to work together, including you as a user of the transportation system. Please join CDOT and our safety partners to support and implement the STSP to reduce motor vehicle, pedestrian, and bicycle-involved crashes and to save lives on our roadways.

Sincerely,

Shoshana Lew
Executive Director
Colorado Department of Transportation

PARTNER PLEDGE

The 2020-2023 Colorado Strategic Transportation Safety Plan (STSP) represents a shared vision to achieve zero fatalities and serious injuries so people using any transportation mode in the state of Colorado arrive at their destination safely. The emphasis areas, strategies, and action steps outlined in this plan are the product of a data-driven, collaborative effort by numerous transportation safety professionals and stakeholders statewide.

As safety partners determined to keep Colorado's transportation network as safe as possible, we are stating our support of the STSP and Colorado's other safety initiatives. We are confident zero fatalities can be achieved because it is already the personal goal for everyone who wants to get to and from their destination safely. Implementation of the STSP will help these road users keep that personal goal of staying safe while driving, walking, or riding in our state.

We recognize it takes more than words to improve safety – it takes partnerships and collaboration. We will do our part to make our roads safer for all modes of transportation and achieve the plan goal of a 15% reduction in fatalities and serious injuries by 2023. We pledge to do the following:

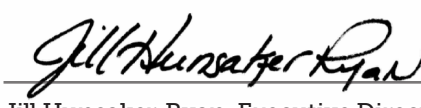
- **Lead strategies and action steps that relate to our agency or organization;**
- **Participate in events, meetings, and campaigns relevant to the STSP;**
- **Provide support and resources to implement the STSP; and**
- **Function as safety champions by promoting the STSP whenever possible.**

Signed by

Shoshana Lew, Executive Director,
Colorado Department of Transportation

Colonel Matthew Packard, Chief,
Colorado State Patrol

Lu Cordova, Executive Director,
Colorado Department of Revenue



Jill Hunsaker-Ryan, Executive Director,
Colorado Department of Public
Health and Environment

Administrator, Federal Highway
Administration

Gina Mia Espinosa-Salcedo,
Regional Administrator, National
Highway Transportation Safety
Administration, Region 8

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KEY DEFINITIONS

Crash	*An unintended event that causes death, injury, or property damage, and involves at least one motor vehicle on a roadway.*
Crash Severity: No Injury	*No one involved in the crash has any apparent injury. If a party is transported and is subsequently examined and found to have no injuries, that party would be classified as No Injury.*
Crash Severity: Complaint Of Injury	*A complaint of injury is any injury reported or claimed which is not a fatal, incapacitating, or non-incapacitating evident injury. Examples include a claim of injury, complaint of pain, limping, and nausea or hysteria.*
Crash Severity: Evident Non-Incapacitating Injury	*This type of injury is evident to observers at the scene, but is not a fatal or incapacitating injury. Examples include bruises, lumps, and lacerations. Injuries that cannot be seen, such as limping or complaints of pain, are classified as possible injury.*
Crash Severity: Evident Incapacitating Injury	*Any injury (other than a fatal injury) that prevents the injured person from walking, driving, or normally continuing the activities the person was capable of performing before the injury is an incapacitating injury. Examples include severe lacerations, broken limbs, and skull, chest, or abdominal injuries. Momentary unconsciousness is not included.*
Crash Severity: Fatal	*For the purposes of the crash report, a fatal injury is any injury that results in death within 30 days of the crash.*
High-Risk Behaviors	*Behaviors exhibited while traveling on a roadway that increase the risk of crashes or reduces the survivability of crashes such as: aggressive driving, distracted driving, impaired driving, driving without a seatbelt, or operating a motorcycle or riding on a motorcycle without wearing a helmet.*
Minor Crash	*A crash that resulted in one of the following three outcomes: no injury, possible injury, or evident, non-incapacitating injury.*
Programmatic	*Activities related to the administration and governance of safety programs involving public agencies, nonprofit organizations, and other safety stakeholders.*
Serious Injury	*Identical to "Crash Severity: Evident Incapacitating Injury" defined above.*
Severe Crash	*A crash resulting in an evident incapacitating injury or fatality.*
Transportation	*Multimodal travel that occurs on roadways. Specifically: rail, water, and air travel are excluded from the STSP unless they involve a roadway (i.e., an at-grade rail crossing).*
Vulnerable Roadway Users	*Young and older drivers; non-motorized road users such as pedestrians and cyclists; motorcyclists; persons with disabilities or reduced mobility and orientation; and work zone staff.*

EXECUTIVE SUMMARY

OVERVIEW

The State of Colorado is committed to the well-being of its citizens and visitors, and wants to be ever more effective in improving roadway safety around our state. The 2020-2023 Colorado Strategic Transportation Safety Plan (STSP) establishes a collaborative and shared vision and mission for transportation safety in Colorado. It relies on the premise that every agency and jurisdiction has a role in enhancing transportation safety for any transportation mode in Colorado through policy, planning, funding, design and construction, operations, and maintenance. The STSP, an update of the 2014 State Highway Safety Plan, identifies the key safety needs in Colorado for guiding investment decisions towards strategies and countermeasures with the highest potential to save lives and prevent injuries.

The future of Colorado is zero deaths and serious injuries so all people using any transportation mode arrive at their destination safely.

VISION

MISSION

Colorado agencies and partners will cooperatively implement strategies that eliminate transportation system fatalities and serious injuries.

PLAN DEVELOPMENT

Colorado Department of Transportation (CDOT), Colorado Department of Health and Environment (CDPHE), Colorado State Patrol (CSP), and Colorado Department of Revenue (CDOR) are the lead agencies that directed the development of the STSP. The process focused on the analysis of recent crash patterns with expertise from safety stakeholders around Colorado. Development of the STSP came together through collaboration among Regional Stakeholders and a Steering Committee, with overall policy direction from an Executive Committee. Teams of stakeholders created strategies for the four Emphasis Areas shown.

High-risk Behavior

- Aggressive Driving
- Distracted Driving
- Occupant Protection
- Impaired Driving

Vulnerable Roadway Users

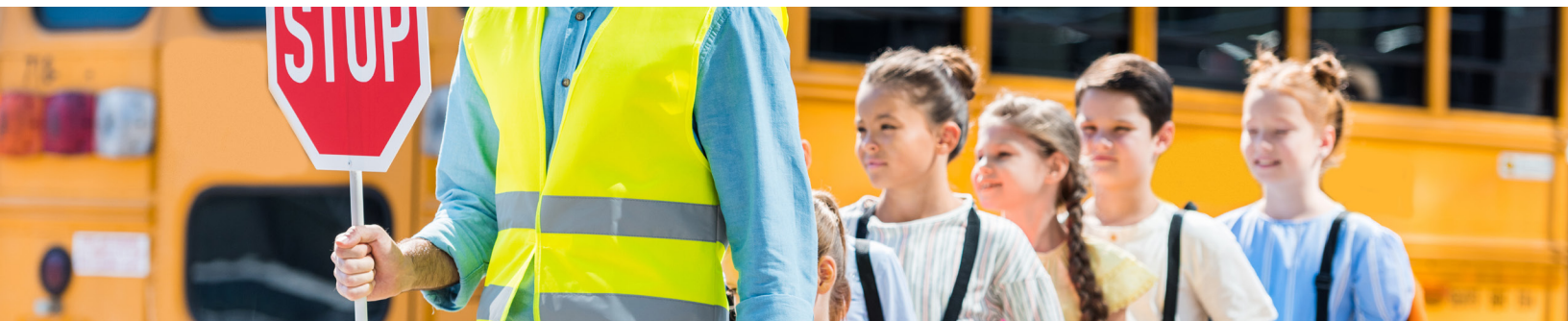
- Motorcyclists
- Bicyclists and Pedestrians
- Older Drivers
- Young Drivers
- Work Zones
- First Responders

Severe Crash Mitigation

- Infrastructure (Rural and Urban)
- Crash Reduction Locations
- Intersections
- Roadway Departures

Programmatic

- Data
- Safety Program Coordination and Cooperation
- Emergency Medical Services/Law Enforcement
- Legislation



TIER I STRATEGIES

Based on the Emphasis Areas, stakeholders identified 15 Tier I (highest priority) Strategies that focus on proven countermeasures and targeted deployment, utilize current technologies, and identify roles and responsibilities for implementation. Tier II and Tier III supporting strategies are also included in the STSP. A concise presentation of the Tier I Strategies information is provided in an Implementation Plan table located in the Resource Guide of this STSP.

A. Name a safety champion to lead a proactive safety program

Name a safety champion to lead an inclusive safety program with the responsibility, resources, and authority to advance safety strategies and monitor effectiveness. This strategy will provide a focused approach to championing, coordinating, and implementing safety programming. *CDOT will lead implementation with support from CSP, CDPHE, and CDOR.*

B. Build a safety advocacy coalition

Build a safety coalition of advocacy groups and state and local agencies to function as a lobbying and advocacy group. This group will work toward revisions to laws and policies at all phases of development and enforcement. This strategy will increase the visibility of key safety issues in policy discussions and create a central forum for strengthening relationships among participants and decision-makers in safety initiatives. *CDOT will lead implementation with support from CSP and CDPHE.*

C. Institutionalize safety roles and responsibilities

Establish agreements that define the ways agencies and organizations work together to deliver safety programs, including roles and responsibilities. These will be formal mechanisms such as a memorandum of understanding. Less formal arrangements may be appropriate at local levels. *CSP and CDOT will lead implementation with support from CDPHE and CDOR.*

D. Coordinate with existing safety programs

Coordinate the development and implementation of safety programs, incorporating strategies among agencies at the state and local level (example existing programs include CDOT's Whole System Whole Safety, and regional and local Vision Zero programs). This strategy will improve the reach and impact of the state's safety programs and avoid duplication of safety program development efforts. *CDOT will lead implementation with support from CSP.*

E. Promote consistent safety messaging

Coordinate the efforts of safety agencies and advocacy groups to develop consistent public-facing safety messaging to be distributed to audiences across the state. This strategy will create greater public safety awareness through consistent messaging. *CDOT Highway Safety Office and CDOT Office of Communications will lead implementation with support from CSP, CDPHE, and CDOR.*

F. Develop education campaigns for high-risk behaviors

Develop outreach campaigns aimed at high-risk groups, such as aggressive, distracted, and impaired drivers, with the goal to enhance and coordinate efforts among statewide education platforms. Occupant protection education campaigns will also be included within this strategy. *CDOT Highway Safety Office and CDOT Office of Communications will lead implementation with support from CSP, CDPHE, and CDOR.*

G. Provide transportation safety education to students and families

Establish a culture of safety among young people by expanding existing and developing new transportation safety education programs that engage them over many years. One aim of this strategy is to develop a comprehensive curriculum that can be used for education statewide, including education on how to be a safe pedestrian and bicyclist. *CSP and CDOT will lead implementation with support from CDPHE.*

H. Prioritize transportation safety funding

Increase the importance of safe infrastructure and transportation in transportation funding decisions. Educate funding decision-makers on the importance of safety and how funds could be used to make improvements. *Colorado Transportation Commission will lead implementation with support from CDOT, CSP, CDPHE, and CDOR.*

I. Prioritize safety in transportation planning, facility design, and project selection

Review policies and processes of roadway planning, design, and project selection to determine what role safety plays in decision-making. This includes updating existing planning and design guidelines and standards to integrate enhanced safety measures. *CDOT and CSP will lead implementation with support from CDPHE.*

CDOR: Colorado Department of Revenue
CDPHE: Colorado Department of Public Health and Environment
CSP: Colorado State Patrol
STRAC: Statewide Traffic Records Advisory Committee

J. Educate decision-makers on the effectiveness of occupant protection laws

Research and document the benefits of occupant protection laws, such as seatbelt use, helmet use, and restrictions on personal device use. Using available data, this strategy aims to educate legislators, commissioners, and other decision-makers on the benefits of such laws to aid in the development of new policies. *CDOT will lead implementation with support from CDPHE, CSP, and CDOR.*

K. Increase requirements for new and renewal driver licensing

Expand the graduated driver licensing (GDL) system to increase education and practice requirements for new drivers to obtain a license, and develop appropriate testing requirements to verify driver competency with increased age. *CDOR will lead implementation with support from CSP and CDPHE.*

L. Establish a framework for streamlining data management

Improve data gathering, reporting, storage, linkage, processing, analyses, and dissemination throughout the state for traffic records databases following the FHWA measures of quality: timeliness, accuracy, completeness, uniformity, integration, and accessibility. The databases will provide more uniform confidence in crash mitigation for agencies at both the state and local level. *CDOT will lead the implementation with support from STRAC, CSP, CDOT, and CDPHE, as directed by the newly formed leadership group that will be a liaison between the Executive Directors of the partner agencies and STRAC.*

M. Prioritize and promote proven safety toolbox strategies

Educate state and local traffic engineers on existing, known, and, effective safety toolbox strategies in transportation facility design, construction, and operation. This strategy will promote inclusion of proven strategies in design practices and development of Local Road Safety Plans by local agencies. *CDOT will lead implementation with support from CSP.*

N. Implement systemic infrastructure safety improvement strategies

Build on existing safety implementation projects and programs. Identify and implement the most effective wide-scale systemic safety mitigation strategies in conjunction with implementing hot-spot improvement projects. Examples of these strategies include, but are not limited to, rumble strips, median barriers, and fully protected left-turn phasing. *CDOT will lead implementation with support from local city and county transportation departments as well as CDOT Region Traffic Engineers.*

O. Increase education on and implementation of data-driven and automated enforcement

Increase implementation of data-driven enforcement for speeding and red-light running at high-crash locations. Educate decision-makers on the effectiveness of automated enforcement as a safety enhancement rather than as a revenue generator. *CDOT will lead implementation with support CSP.*

PERFORMANCE TARGETS

Implementation of the STSP strategies is anticipated to reduce the number and rate of fatalities and serious injuries in Colorado. The STSP identifies performance targets for these measures to be achieved over the 2020 to 2023 period of the plan. Achieving the performance targets is dependent upon the lead agencies' attention and devotion of resources to implement the strategies.

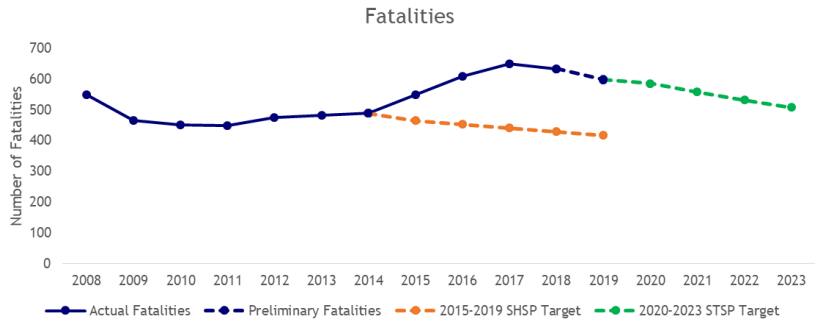
Recognizing that the STSP vision will be realized over a long term, the Executive Committee established a 15% reduction in fatalities and serious injuries as the performance target for the 2020 to 2023 time frame. This target is both plausible and aggressive given the estimated effectiveness of the STSP strategies. Note: If vehicle miles traveled (VMT) increases as expected, a commensurate decease in crash rates will be required to achieve the targeted reduction in serious injuries and fatalities.

The same performance targets apply for all serious injuries and fatalities, as well as serious injuries and fatalities of non-motorized roadway users. These performance targets should influence, and be influenced by, Office of Transportation Safety (OTS) and National Highway Traffic Safety Administration (NHTSA) targets.

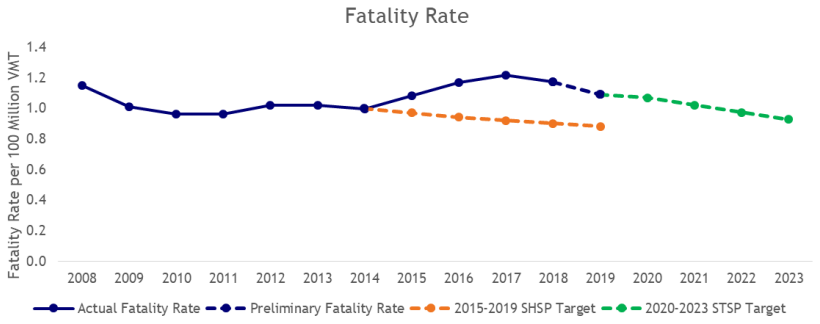
IMPLEMENTABLE ACTIONS

The performance targets can be achieved by successful implementation of the Tier I Strategies. To chart a course of immediate implementation steps, a set of initial action items is provided for each Tier I Strategy. These are presented in Chapter 2 Implementation Plan of the STSP. To foster implementation, each strategy has designated champions assisted by key partners. Implementers have been tasked with providing a yearly status of action items, new or found in the plan, as well as a biennial review and update of action items for each Tier I Strategy.

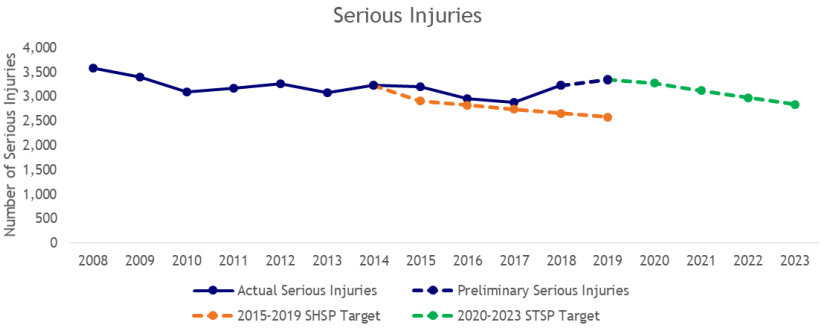
Actual, Estimated, and Targets for Fatalities*



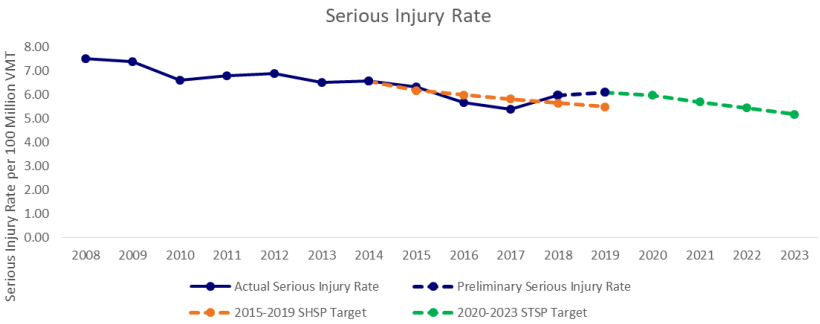
Actual, Estimated, and Targets for the Fatality Rate*



Actual, Estimated, and Targets for Serious Injuries*



Actual, Estimated, and Targets for the Serious Injury Rate*



**Crash data from 2019 was still preliminary and undergoing review at the time this plan was finalized in April 2020. To maintain integrity of the analysis, the remainder of this plan utilizes data through 2018, which is complete per CDOT and FHWA procedures.*

The future of Colorado is zero deaths and serious injuries so all people using any transportation mode arrive at their destination safely.

VISION

MISSION

Colorado agencies and partners will cooperatively implement strategies that eliminate transportation system fatalities and serious injuries.

CHAPTER 1
Background and Overview

Background and Overview

A snapshot of the roadway safety climate in Colorado reveals the following trends:

- Colorado's population has grown rapidly, adding several hundred thousand people
- Vehicle miles traveled has increased
- Travel modes are diversifying
- Legalization of recreational cannabis
- Distraction while driving continues

These challenges (among others) negatively affect the safety of users on Colorado's highway (or transportation) system. Organizations, such as the United Nations World Health Organization, Federal Highway Administration (FHWA), National Highway Transportation Safety Administration (NHTSA), American Association of State Highway Transportation Officials (AASHTO), Toward Zero Deaths Coalition, and Vision Zero Network, recognized the worldwide and national crisis of increasing numbers of deaths related to transportation and organized to support the reduction and prevention of fatalities. Many have provided guiding principles to states and agencies for consideration to implement.

The State of Colorado is committed to the well-being of its citizens and visitors, and wants to be ever more effective in improving roadway safety around our state. This updated plan, now known as the 2020-2023 Colorado Strategic Transportation Safety Plan (STSP), identifies unique strategies to minimize death and serious injuries statewide in the current safety climate. It is an implementation roadmap on how transportation stakeholders in Colorado will work together to create safer transportation facilities throughout Colorado.

? WHAT IS A STRATEGIC TRANSPORTATION SAFETY PLAN?

The FHWA defines a Strategic Transportation Safety Plan as a statewide-coordinated safety plan that provides a comprehensive framework for reducing fatalities and serious injuries on public roads. FHWA requires that a State identify its key safety needs and then guide investment decisions towards strategies and countermeasures with the highest potential to save lives and prevent injuries.

The STSP establishes a collaborative and shared vision and mission for transportation safety in Colorado. It relies on the premise that every agency and jurisdiction has a role in enhancing transportation safety to the benefit of our citizens and travelers for every transportation mode and facility in Colorado through policy, planning, funding, design and construction, operations, and maintenance.

The plan defines the most effective target areas and strategies. This strategic approach resulted in the identification of 15 high-priority strategies and accompanying actions that have the potential to actually reduce crashes and reverse Colorado's trend of increasing fatalities—with the vision of zero deaths on the Colorado transportation system. The STSP focuses on proven countermeasures and more targeted and effective deployment, incorporates local agency safety planning and implementation (where 39% of Colorado's fatalities occur), and reflects current innovations and technologies that are proven to reduce fatalities.

RELATION TO OTHER SAFETY PLANS AND INITIATIVES

Colorado Department of Transportation (CDOT), Colorado Department of Health and Environment (CDPHE), Colorado State Patrol (CSP), and Colorado Department of Revenue (CDOR) are the lead agencies that direct the development of the STSP. The STSP development process is an opportunity to update statewide direction on transportation safety based upon data driven and statewide needs. The STSP is the State of Colorado's overall strategic safety plan for state agencies, cities, counties, and other organizations and advocacy groups.

The STSP is the latest in a series of evolving plans. It updates the 2014 Colorado Strategic Highway Safety Plan (SHSP) which built on Colorado's original SPIRS (Strategic Highway Plan for Improving Roadway Safety) that was required under the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) Legislation of 2005. Colorado wants to ensure this is not just a "highway" safety plan given that every surface mode has a role in transportation safety. This must be a strategic safety plan for transportation.

Essential to the STSP plan development process is the coordination with numerous national, international, state, and local strategic safety plans, programs, initiatives, projects, and tasks for various transportation modes. These efforts inform and support the STSP. The graphic below illustrates the interconnectedness of some of the involved agencies, initiatives, organizations, and stakeholders.

Within CDOT, the STSP has been extensively coordinated with the Your Transportation Plan. Your Transportation Plan is a vision document that outlines what Colorado transportation options will look like over the next 10 and 25 years. The plan describes what needs to be done to so that all users of the transportation system — no matter how they travel — reach their destinations safely. Specifically relevant to the STSP, Your Transportation Plan includes a 10-year Strategic Project Pipeline to address the critical multimodal transportation needs of Colorado residents and businesses that includes safety improvement projects. Some stakeholder meetings for Your Transportation Plan and the STSP were held concurrently with presentations given at each to connect the purposes and visions of both plans. Participants in Your Transportation Plan meetings were provided with the vision and mission of the STSP along with crash data to consider when identifying candidate projects. Findings from these meetings are incorporated in the STSP, specifically public and stakeholder feedback related to safety.

The following three safety initiatives are mutually supportive and often interconnected with the STSP vision and mission

Whole System Whole Safety

Whole System Whole Safety is a CDOT initiative to fully integrate safety into everything that CDOT does in carrying out its mission. It encapsulates behavior, organizational, and built environments by focusing on human factors, organizational culture, and physical assets. It is the branded "face" of all aspects of safety throughout CDOT. The STSP embodies the vision and strategies of Whole System Whole Safety.

Vision Zero

Vision Zero is a multinational program that aims to eliminate all fatalities and serious injuries involving road traffic. It is a multidisciplinary approach to improve policies and roadway designs to lessen the severity of crashes. Several cities in Colorado have implemented Vision Zero programs, and the Denver Regional Council of Governments (DRCOG) is developing a Regional Vision Zero (RVZ) Action Plan. The RVZ will support DRCOG's various safety performance measures and targets and will increase awareness of Vision Zero to influence safer behaviors on roadways. It also will provide existing conditions analysis, identify countermeasures and actionable strategies to prioritize safety regionally. Additionally, RVZ will encourage local jurisdictions to prioritize safety in their communities. STSP strategies encompass Vision Zero programs that focus resources at the local level.

Toward Zero Deaths

Toward Zero Deaths (TZD) is a national strategy on highway safety to advocate for eliminating serious injuries and deaths on our nation's roadways. It provides a platform for state agencies, private industry, national organizations and others to develop safety plans that prioritize traffic safety culture and promote the national TZD vision. CDOT has committed to this strategy for every individual, family, and community using Colorado's transportation network. The campaign includes a new partners program that certifies safety initiatives administered by community allies to reach zero deaths.

The following list of relevant plans, programs, and reports were reviewed and coordination was conducted between agencies to develop this STSP. Representatives of the listed plans, programs, and reports attended several STSP outreach and plan development meetings and contributed specific plan knowledge to the STSP.

- 2014 Colorado Strategic Highway Safety Plan (CDOT, 2015)*
- AASHTO Strategic Highway Safety Plan (AASHTO, 2015)
- Colorado Highway Safety Improvement Program – 2018 Annual Report (HSIP) (FHWA, 2018)*
- Colorado 2018 Integrated Safety Plan (ISP) (Combines HSP and HSIP) (CDOT, 2018)
- Colorado Commercial Vehicle Safety Plan (CVSP) for the Federal Motor Carrier Safety Administration's Motor Carrier Safety Assistance Program (2018-2020) (Colorado Motor Carrier Safety Assistance Program, 2018)*
- 2019 Highway Safety Plan (HSP) (CDOT, 2019)
- Colorado Freight Plan (CDOT, 2019)
- Colorado State Patrol 2019-2023 Strategic Plan (Colorado State Patrol, 2019)*
- Statewide Bicycle and Pedestrian Plan (CDOT, Amended June, 2015)*
- Colorado Task Force on Drunk and Impaired Driving – 2018 Annual Report*
- Colorado Teen Driving Alliance Improving Motor Vehicle Safety – Action Plan 2013 Report Card*
- Your Transportation Plan 2040 (CDOT, 2015)*
- Standing Committee on Highway Traffic Safety – Strategic Plan (AASHTO, 2011)
- State of Colorado Traffic Records Advisory Committee – Strategic Plan (2016-2019)*

- Motorcycle Operator Safety Training Annual Report (CDOT, 2017)
- 2019 Colorado Motor Vehicle Problem Identification Dashboard (CDOT, 2019)
- Traffic Safety Facts 2017 State Traffic Data (NHTSA, 2019)
- DRCOG Regional Vision Zero (DRCOG, 2020 Draft)
- Colorado Department of Transportation Railroad Program
- Colorado's Funding Advancements for Surface Transportation and Economic Recovery Act of 2009 (FASTER) Safety Program

*Extensive agency coordination

The STSP incorporates discoveries from these Colorado and national safety initiatives that identify best practices, develop innovative strategies, and recognize opportunities to collaborate with other organizations.

- FHWA Every Day Counts Initiative
- FHWA list of Proven Safety Countermeasures
- UN Road Safety Collaboration – Global Plan for the Decade of Action for Road Safety 2011-2020
- National Highway Traffic Safety Administration – Countermeasures That Work: A Highway Safety Countermeasure Guide For State Highway Safety Offices
- Towards Zero Deaths: A National Strategy on Highway Safety

DEVELOPMENT PROCESS

This STSP is a plan for Colorado transportation agencies and stakeholders to implement by working cooperatively and collaboratively toward safer roads. It was critical that the plan development process not only focus on the data, but also include the feedback and expertise from the safety advocates around Colorado. Their hard work, dedication, and ideas are the basis for this plan. A special thank you to those who were involved:

- Cities and Counties
- Emergency Medical Services
- Local Law Enforcement
- State and Federal Agencies
- Metropolitan Planning Organizations (MPO)
- Non-profit Organizations
- Public Health Agencies
- Safety Advocacy Groups
- Transportation Planning Regions (TPR)

Representatives of organizations across the state participated in meetings and workshops to develop the STSP within the following framework:

Executive Committee

Representatives of the lead state agencies acknowledged and agreed with the overall STSP development and made decisions regarding policies.

Steering Committee

Representatives of the lead partner agencies and supporting organizations provided overall guidance for development of the STSP.

Regional Stakeholders

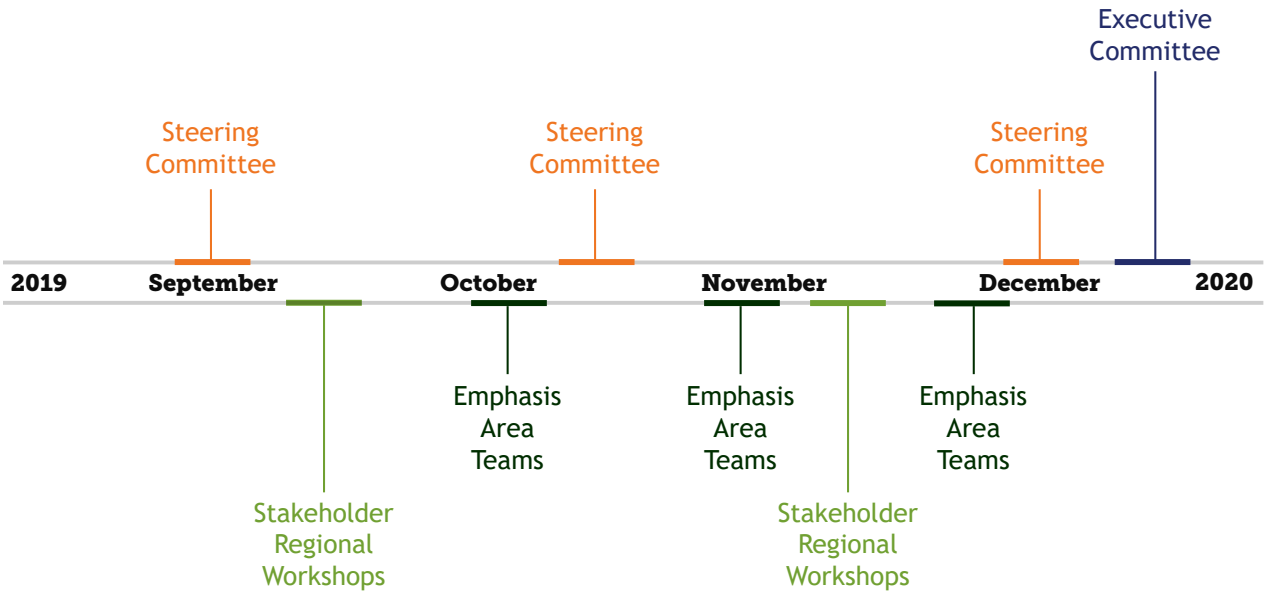
Representatives of local agencies, organizations, and safety officials provided feedback from different geographical, professional, and discipline perspectives on safety needs and strategies.

Emphasis Area Teams

Regional stakeholders focused on prioritized Emphasis Areas and developed recommendations for the STSP strategies and actions.

Development Process Timeline

Development of the STSP came together through a collaborative interplay between the Steering Committee, Regional Stakeholders, Emphasis Area Teams, and Executive Committee during the fall of 2019.



Steering Committee

Senior representatives from agencies and organizations around Colorado formed the Steering Committee. They attended three meetings throughout the plan development process.

> Colorado Department of Public Health and Environment

> Colorado Department of Revenue
  - Colorado Division of Motor Vehicles

> Colorado Transportation Commission

> Colorado Department of Transportation
  - Office of Transportation Safety
  - Highway Safety Office
  - Division of Transportation Development
  - Division of Maintenance and Operations
  - Office of Innovation Mobility
  - Region Directors
  - Media / Office of Communications
  - Division of Engineering
  - Office of Policy and Government Relations

> Colorado State Patrol

> Denver Regional Council of Governments

> Federal Highway Administration - Colorado Division

> Grand Valley Bikes

> National Highway Traffic Safety Administration

> North Front Range Metropolitan Planning Organization

> Pikes Peak Area Council of Governments

> Pueblo Area Council of Governments

Regional Stakeholder Workshops

Two rounds of Regional Stakeholder Workshops were held around the state with local agencies, organizations, and safety officials.

Region	Location
North Central	Silverthorne
Northwest	Grand Junction
Southwest	Durango
South Central	Poncha Springs
Northeast	Greeley and Evans
Denver Metro	Denver
Southeast	Pueblo

Emphasis Area Teams

Emphasis Area Teams were formed from the regional stakeholders to dive into the details of each Emphasis Area's goals, strategies, and implementation. The numbers of participants for each Emphasis Area for three rounds of meetings were within the following ranges:

> High-Risk Behavior: 10 to 16 participants
> Vulnerable Roadway Users: 14 to 20 participants
> Severe Crash Mitigation: 8 to 14 participants
> Programmatic: 10 to 17 participants

Executive Committee

The Executive Committee met to review, finalize, and adopt the STSP vision and mission statements. The committee reviewed, confirmed, and accepted the lead agency responsibilities for implementation of the Tier I Strategies. The committee also endorsed the recommended performance targets for the STSP. There was also initial discussion on how to successfully launch the final adopted plan in spring of 2020.

Phases for Stakeholder Feedback

Meetings with the Steering Committee, Regional Stakeholders, Emphasis Area Teams and Executive Committee were held within three phases of project development to align feedback with project milestones.

Phase 1: Project Inception

> Steering Committee Meeting 1 – September 20, 2019
> Regional Stakeholder Workshops Round 1 – September 23 – October 2, 2019
> Emphasis Area Team Meeting 1 – October 21 and 23, 2019

The first phase of meetings informed the participants of the project background, gave an overview of the crash data analysis of recent trends in Colorado, developed draft vision and mission statements for the plan, and identified and prioritized Emphasis Areas. Two activities provided input:

Vision and Mission Statements

Participants reviewed and commented on the vision and mission statements of the 2014 Colorado Strategic Highway Safety Plan and other state plans and then highlighted the areas they liked and disliked. Finally, draft vision and mission statements were crafted for this STSP for review and comment in upcoming plan development meetings.

Emphasis Areas

Participants reviewed Emphasis Areas from the 2014 Colorado Strategic Highway Safety Plan and other state plans with supporting data and an example strategy for each. They prioritized the top nine Emphasis Areas they considered most critical using 3 green dots (first priority), 3 yellow dots (second priority), and 3 red dots (third priority). The group agreed on and defined four Emphasis Areas:

> High-risk Behavior
> Vulnerable Roadway Users
> Severe Crash Mitigation
> Programmatic

Participants at the Regional Stakeholder Workshops also shared their expectations and concerns for the plan, which informed the development of the STSP strategies. Feedback at the seven workshops was very similar, and is summarized here:

Expectations

- Create a plan that is implementable
- Identify partnerships between local, state, and federal agencies/organizations
- Address the change in safety culture
- Include all modes of roadway transportation
- Address the safety needs of urban vs. rural areas
- Develop data-driven strategies
- Develop educational campaigns for the public
- Identify legislative representation
- Identify funding solutions
- Include FHWA's Strategic Highway Safety Plan four E's of Highway Safety: Engineering, Education, Enforcement, and Emergency Medical Services

Concerns

- Lack of funding
- Lack of plan implementation and ownership
- Lack of political will and acceptance
- Lack of resources/staff
- Lack of qualitative data to support safety issues
- Lack of data access and sharing
- Lack of communication and partnerships
- Lack of public will to shift behavior and culture
- Lack of education and outreach campaigns
- Emerging technologies

Phase 2: Strategy Refinement and Prioritization

- Steering Committee Meeting 2 – October 31, 2019
- Emphasis Area Team Meeting 2 – November 5 and 6, 2019
- Regional Stakeholder Workshops Final Round – November 18 – 21, 2019

The second phase of meetings focused on refining the vision and mission statements and Emphasis Areas, and on developing STSP goals and related strategies. Participants prioritized the strategies into Tiers I, II, and III. Participants were provided an example template for a strategy "Implementation Plan" that would present a list of strategies identifying the responsible agency, responsible party, benefit, expected outcome, time frame, implementation costs, and impediments to success for each.

Phase 3: Finalize Tier 1 Strategies and Overall Plan Modifications

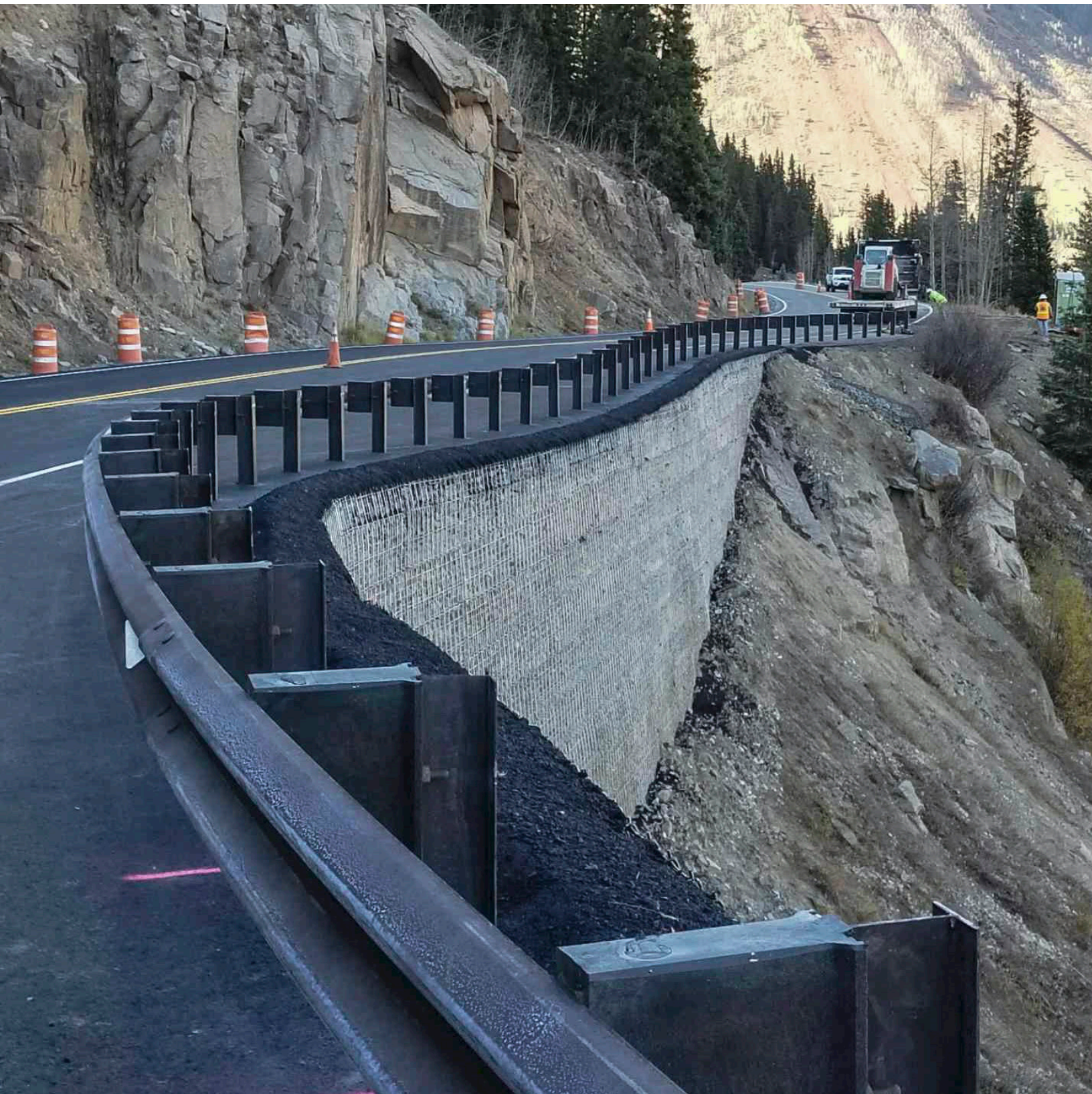
- Emphasis Area Team Meeting 3 – December 3 and 4, 2019
- Steering Committee Meeting 3 – December 12, 2019
- Executive Committee Meeting – December 19, 2019

The third phase of meetings focused on confirming the final recommended vision and mission statements, reviewed the Tier I Strategies and assigned lead and partner agency responsibilities to the strategies, and discussed effectiveness of the strategies and recommended performance targets for them. There were discussions on the review process for the draft report and that the final adopted plan would be launched in spring of 2020.

Implementation

Through the plan development process and the stakeholders' involvement in the Emphasis Area Teams (described in Chapter 4), the stakeholders created and agreed upon the Implementation Plan with the strategies and performance targets described in Chapter 2.

CHAPTER 2
Implementation Plan



Implementation Plan

PERFORMANCE TARGETS

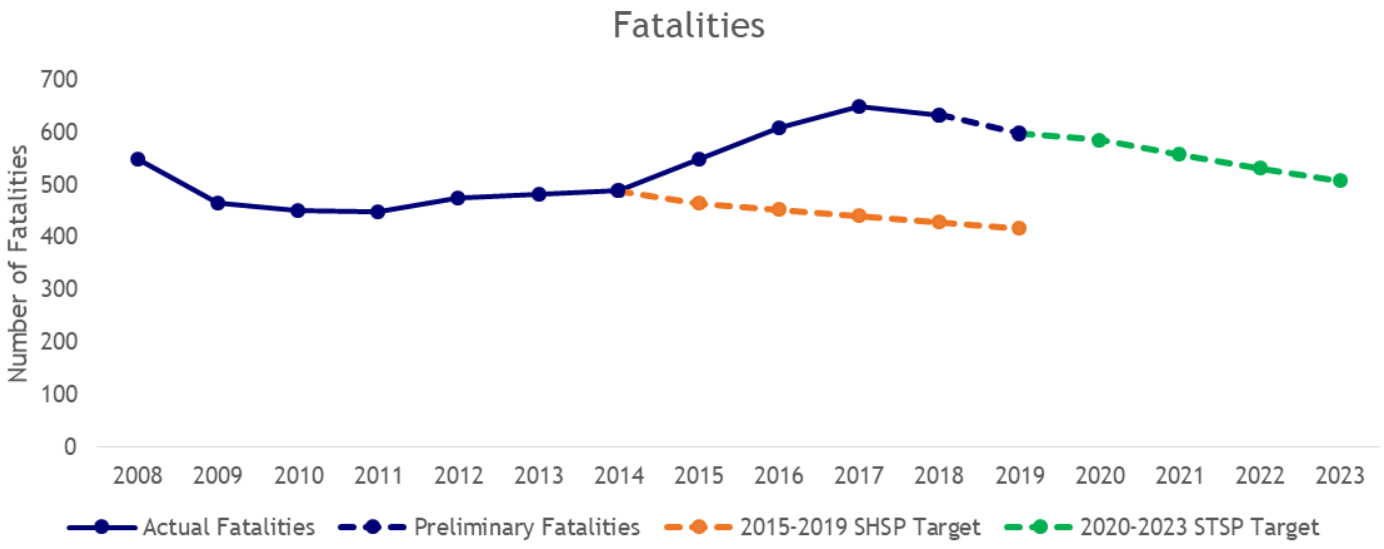
The Executive Committee and the Steering Committee provided direction on setting the 2020-2023 Colorado Strategic Transportation Safety Plan (STSP) performance targets for rates of fatalities and serious injuries for the STSP 2020 to 2023 time frame. The targets were set after review of how well prior plan targets have been met.

The performance targets set in the 2014 Colorado Strategic Highway Safety Plan were based on review of actual observed data over the 2008 to 2013 five-year performance period. The performance target years for the 2014 Colorado Strategic Highway Safety Plan were 2015 to 2019 including estimated data for 2014. To provide context in setting the targets for this STSP, the performance targets set in the 2014 Colorado Strategic Highway Safety Plan were compared to actual observed data for the 2014 to 2018 time frame. The data indicates that fatalities and the fatality rate increased beyond the set targets. It was also noted with concern that non-motorized fatalities increased during this time frame. While serious injuries were above the target set in 2014, the target for the rate of serious injuries has largely been achieved.

Moving forward, the committees realized that achieving performance targets is dependent upon the lead agencies' attention and devotion of resources to the implementation of STSP strategies. It was important to the committees that the current STSP performance targets reflect a serious intent toward achieving the vision. Recognizing that the STSP vision will be realized over a longer term than what is presented in this current STSP, it was agreed that **setting a 15% reduction in fatalities and serious injuries as the performance target for the 2020 to 2023 time frame was both plausible and aggressive.** Note: If vehicle miles traveled (VMT) increases as expected, a commensurate decrease in crash rates will be required to achieve the targeted reduction in serious injuries and fatalities.

The STSP acts as an overarching strategic plan. CDOT OTS and NHTSA, which have topic-specific annual targets per the FAST Act, should consider the STSP targets when setting their targets. *Figure 1* through *Figure 4* display the targets set in the 2014 Colorado Strategic Highway Safety Plan, the observed occurrences and rates from 2008 to 2018, and the new performance targets for the 2020 to 2023 time frame. *Figure 5* presents these trends for non-motorized serious injuries and fatalities.

Figure 1: Actual, Estimated, and Targets for Fatalities



Note: Crash data from 2019, while used in the figure above, was still preliminary and undergoing review at the time this plan was finalized in April 2020. To maintain integrity of the analysis, the remainder of this plan utilizes a dataset through 2018, which is complete and finalized per CDOT and FHWA procedures.

Figure 2: Actual, Estimated, and Targets for the Fatality Rate

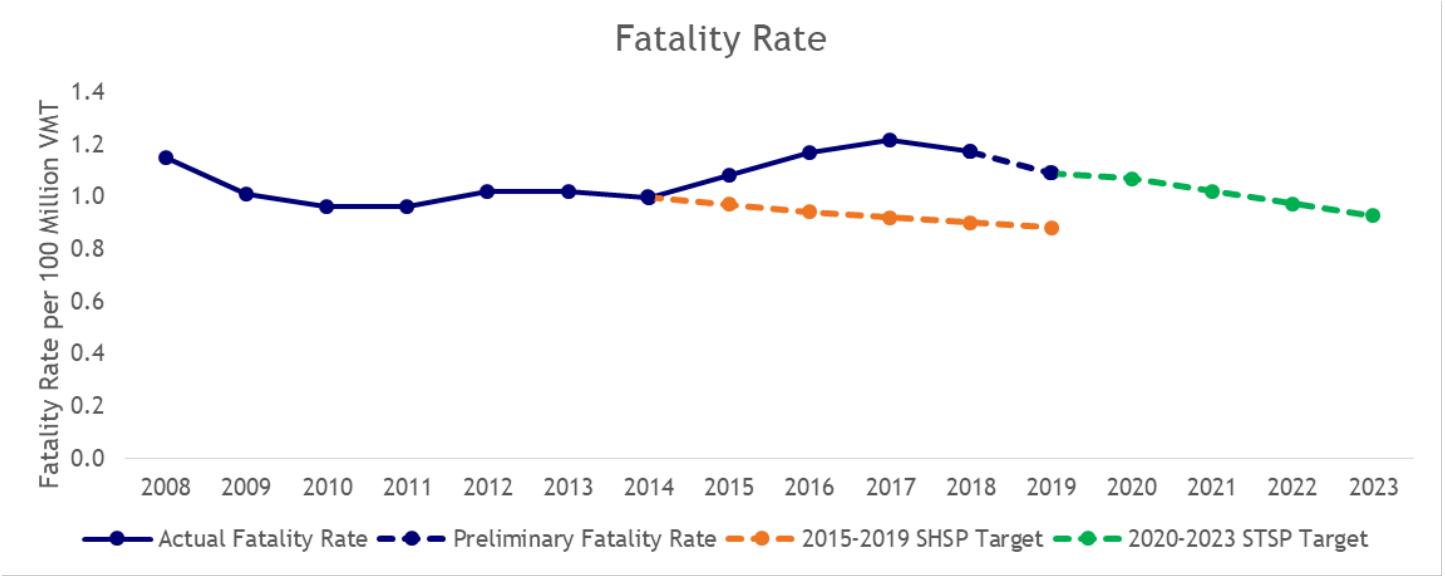
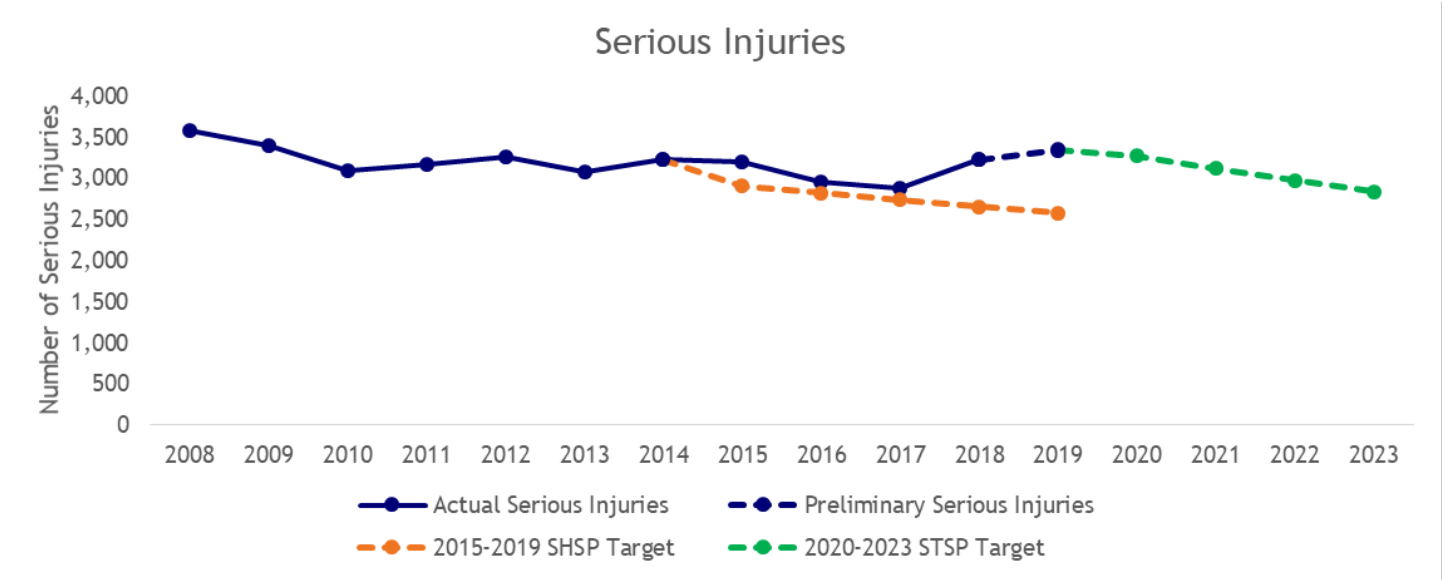


Figure 3: Actual, Estimated, and Targets for Serious Injuries



Note: Crash data from 2019, while used in the figures above, was still preliminary and undergoing review at the time this plan was finalized in April 2020. To maintain integrity of the analysis, the remainder of this plan utilizes a dataset through 2018, which is complete and finalized per CDOT and FHWA procedures.

Figure 4: Actual, Estimated, and Targets for the Serious Injury Rate

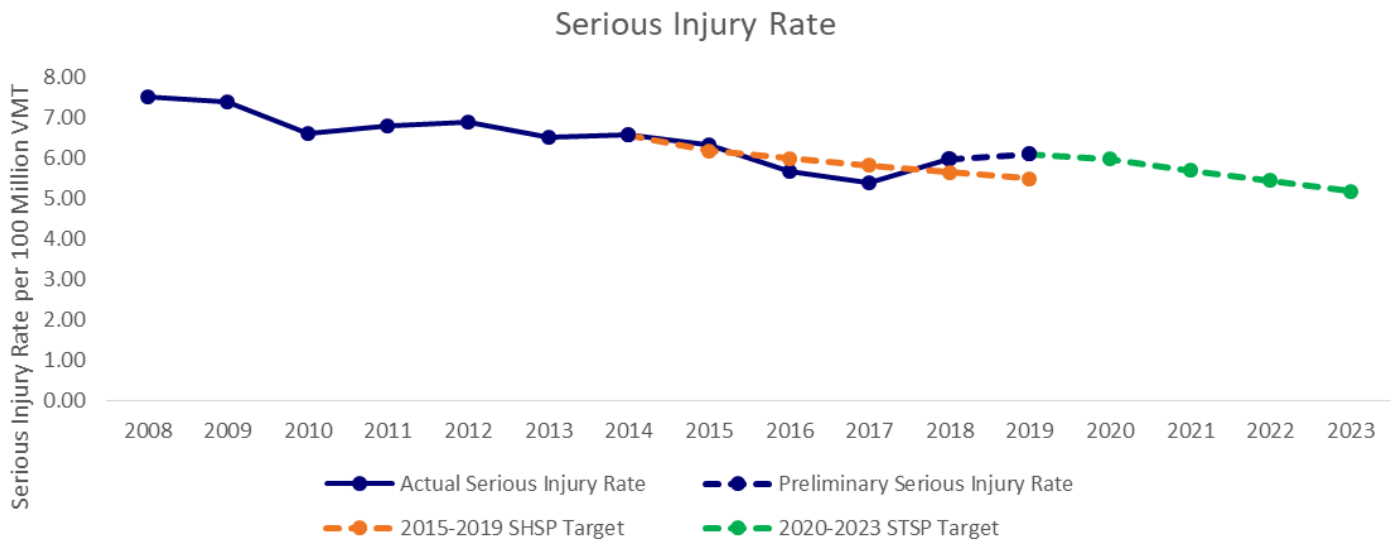
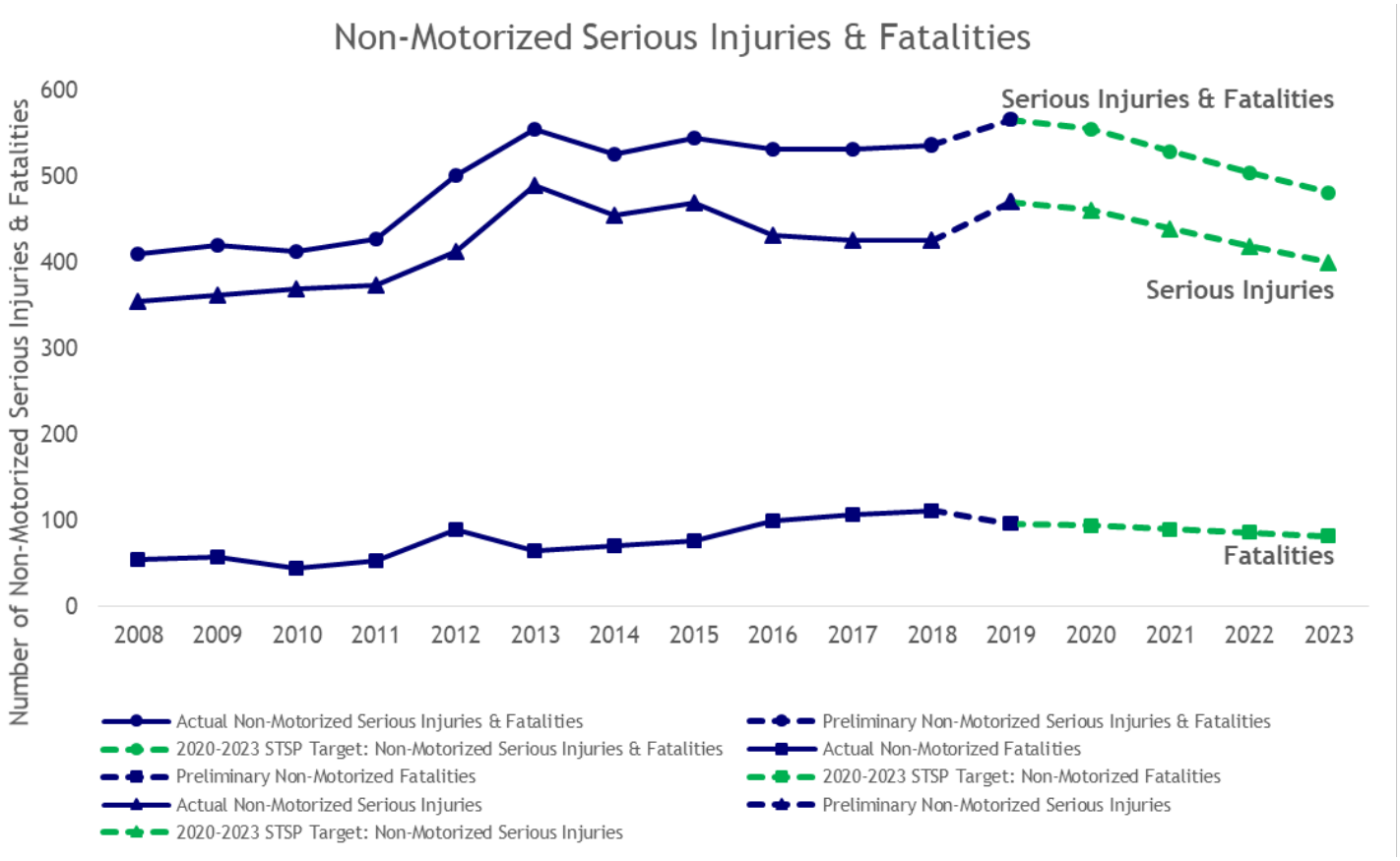


Figure 5: Actual, Estimated, and Targets for Non-Motorized Serious Injuries and Fatalities



Note: Crash data from 2019, while used in the figures above, was still preliminary and undergoing review at the time this plan was finalized in April 2020. To maintain integrity of the analysis, the remainder of this plan utilizes a dataset through 2018, which is complete and finalized per CDOT and FHWA procedures.

TIER I STRATEGY IMPLEMENTATION BY USER TYPE

Tier I Strategies are high-priority strategies intended to form the core of the STSP Implementation Plan. The Tier I Strategies are described in detail on the following pages. Implementation of the STSP strategies is the responsibility of a wide range of staff within the involved agencies and organizations. Each of these distinct users of the plan can play a crucial role in maximizing the safety improvements associated with the Tier I Strategies. The key user types responsible for improving the safety of surface transportation in Colorado are identified in *Table 1*, along with the strategies of particular interest to each group.

TABLE 1: STSP TIER I STRATEGIES — IMPLEMENTATION BY USER TYPE

ID	Tier I Strategies	STSP User Types						
		Traffic Engineer	Law Enforcement	Emergency Services	Communications/ Education	Advocacy Groups	Agency Safety Program Officials	Legislative Liaisons
A	Name a safety champion to lead a proactive safety program	◆				◆	◆	
B	Build a safety advocacy coalition				◆	◆	◆	◆
C	Institutionalize safety roles and responsibilities	◆	◆	◆	◆		◆	
D	Coordinate with existing safety programs	◆	◆	◆	◆	◆	◆	◆
E	Promote consistent safety messaging		◆		◆	◆	◆	
F	Develop education campaigns for high-risk behaviors	◆	◆	◆	◆	◆	◆	
G	Provide transportation safety education to students and families		◆		◆	◆	◆	
H	Prioritize transportation safety funding	◆				◆	◆	◆
I	Prioritize safety in transportation planning, facility design, and project selection	◆					◆	◆
J	Educate decision-makers on the effectiveness of occupant protection laws				◆	◆	◆	◆
K	Increase requirements for new and renewal driver licensing					◆	◆	◆
L	Establish a framework for streamlining data management	◆	◆	◆	◆		◆	
M	Prioritize and promote proven safety toolbox strategies	◆	◆	◆			◆	
N	Implement systemic infrastructure safety improvement strategies	◆	◆		◆		◆	
O	Increase education on and implementation of data-driven and automated enforcement	◆	◆				◆	

ESTIMATED EFFECTIVENESS OF TIER I STRATEGIES

Meeting the performance targets for this STSP is considered feasible if the lead agencies earnestly apply the required resources to implement the plan's Tier I Strategies. The estimated effectiveness of each of the Tier I Strategies is illustrated in *Table 2*. They are based on subject matter expert opinions discussed during Emphasis Area team meetings

Most strategies will achieve effectiveness at some point after year 1; in fact, the effectiveness of some long-term strategies is not expected to be realized until well beyond the 2020 to 2023 time frame of this STSP. This is not to say that the long-term strategies will not be implemented immediately. Many of these strategies require a year of research and/or preparation before implementation. Several strategies may not have a quantifiable effect on safety within the first year, but the efforts made internally to prepare for implementation will be an improvement to the status quo.

TABLE 2: Estimated Effectiveness of Tier I Strategies

ID	TIER I STRATEGIES	Potential Reduction in Severe Crashes by Year Little to No Change / Minor Change / Moderate Change / Substantial Change / Large Change			
		End of year 1	End of year 4*	End of year 10	Beyond 10
A	Name a safety champion to lead a proactive safety program				
B	Build a safety advocacy coalition				
C	Institutionalize safety roles and responsibilities				
D	Coordinate with existing safety programs				
E	Promote consistent safety messaging				
F	Develop education campaigns for high-risk behaviors				
G	Provide transportation safety education to students and families				
H	Prioritize transportation safety funding				
I	Prioritize safety in transportation planning, facility design, and project selection				
J	Educate decision-makers on the effectiveness of occupant protection laws				
K	Increase requirements for new and renewal driver licensing				
L	Establish a framework for streamlining data management				
M	Prioritize and promote proven safety toolbox strategies				
N	Implement systemic infrastructure safety improvement strategies				
O	Increase education on and implementation of data-driven and automated enforcement				
ESTIMATED COMBINED STRATEGY TARGET EFFECTIVENESS		2%	15%*	40%	50%

STSP Target

TIER I STRATEGIES

Each Tier I Strategy is presented in the form of an information sheet. The content contained on each of the information sheets was discussed extensively with each Emphasis Area Team during strategy development. The information identified for each strategy includes, but is not limited to, the safety issue the strategy will address, the proposed strategy champion and partners, a description of the strategy, data that supports the strategy, specific action items, the relative cost of implementation, and matrices for tracking implementation progress. The general magnitude of cost of implementation for each strategy was discussed with the subject matter experts within each Emphasis Area Team. Given the high degree of variability in implementation methods, specific implementation costs are not estimated. A concise presentation of the Tier I Strategies information is provided in an Implementation Plan table located in the Resource Guide of this STSP.

General Action Items

In addition to specific action items, the following general action items have been identified for the Tier I Strategies.

- Identify ongoing efforts within the state related to STSP strategies.
- Research implications of Colorado's challenges (population growth, VMT growth, travel mode diversity, cannabis legalization, distracted driving).
- Review related STSP strategies as they evolve during implementation.
- Establish a tracking and evaluation program of implementation independent from overall safety champion.
- Confirm and/or develop strategy effectiveness metrics.
- Provide a yearly status of action items, new or found in the STSP.
- Biennially review and update action items.
- Identify likely partners during implementation of strategies.
- Continue the on-going process of data collection, processing, sharing, and integration to improve data analysis and intelligence for all emphasis areas.

A

Cutsheets to come

NAME A SAFETY CHAMPION TO LEAD A PROACTIVE SAFETY PROGRAM

STRATEGY DESCRIPTION

Name a safety champion to lead an inclusive safety program with the responsibility, resources, and authority to advance safety strategies and monitor effectiveness.

SAFETY ISSUE

There is not currently a job position within the state government tasked with the sole responsibility to implement a cohesive, statewide approach to transportation safety. The result is that many strategies are not effectively implemented or carried forward.

BENEFITS

- Streamlines and improves the administration of safety-related activities.
- Provides a focused approach to championing, coordinating, and implementing safety programming.
- Supports more effective implementation of other strategies.
- Reduces the chance that useful strategies would be overlooked for implementation.

Action Items

- Hire and empower a leader of safety program who is credible, accountable, and has excellent interpersonal and organizational skills.
- Develop a dedicated staff to support implementation of the Safety Program.
- Identify responsibility for safety oversight within CDOT (either as a new division or within an existing division).
- Regularly brief leaders on the status of the STSP's implementation and how they can support it.
- Spearhead the development of an annual statewide transportation safety conference.
- Facilitate coordination and cooperation between the CDOT Office of Transportation Safety and the Traffic & Safety Engineering Branch.

Data/Supporting Information

- Minnesota has a **49%** lower fatality rate per vehicle miles traveled (VMT) than Colorado (in 2017). The state's focused safety culture is typified by Minnesota's Office of Traffic Safety, which is led by a strong director.[A1]

EXAMPLE

Strong Leadership

In New Mexico, a Highway Safety Improvement Program Manager oversees the state's safety program. This organizational structure has improved collaboration among both internal and external planning partners allowing for improved integration of safety priorities in project planning. The internal safety committee meets on a regular basis and includes members such as the New Mexico DOT chief engineer, office of safety programs director, traffic safety division, and several others. External collaboration with Highway Safety Improvement Program planning partners includes Metropolitan Planning Organizations, Governor's Office, and Regional Transportation Planning Organizations. The manager also interacts with local planning entities to gain more knowledge of local planning capabilities and technical assistance needs.

Source: FHWA Transportation Safety Planning, Module 3 (https://safety.fhwa.dot.gov/tsp/fhwasa16116/mod3.cfm#sec5)

EXAMPLE

Legislative Symposium

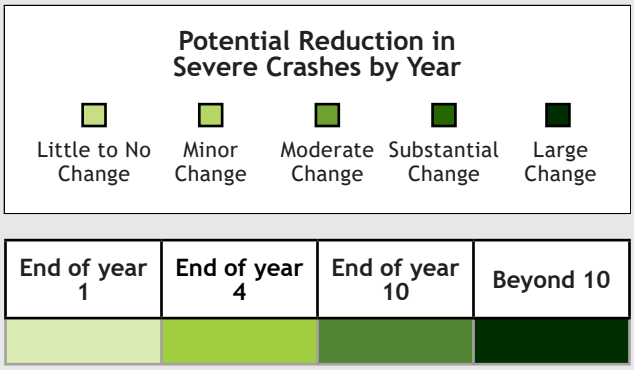
To enlist the support of New Jersey legislators for safety initiatives, the State's metropolitan planning organizations, with support of state and local agencies, organized and facilitated a statewide legislative symposium. The half-day event was designed to educate legislators about New Jersey's safety needs and market the State Highway Safety Plan.

The symposium agenda included presentations by agencies and advocacy groups. Legislators also were asked to discuss pending legislation relevant to transportation safety. To encourage participation in advance of the symposium, legislators were sent information about New Jersey's State Highway Safety Plan and initiatives being pursued through the State's Transportation Safety Policy Advisory Council.

Source: https://rspcb.safety.fhwa.dot.gov/noteworthy/html/ipm_legsymp.aspx?id=19

ESTIMATED STRATEGY EFFECTIVENESS

Initially, this strategy relies on identifying the staffing needs associated with a new safety program. Additional work will be required to clarify the role of this program and integrate it with existing programs and agencies. However, once the safety program and champion are established within the next decade, they will have significant impacts to the safety culture around the state of Colorado.



Strategy success will be achieved through partnerships and collaboration.

Strategy Champion(s)

CDOT Traffic and Safety Engineering Branch Manager with support from Colorado State Patrol, Colorado Department of Public Health and Environment, and Colorado Department of Revenue.

Strategy Partners

Key partners include advocacy groups.

Local Partner(s)

Not applicable to local implementation.

Implementation Costs

$$$

Barriers to Implementation

Political will, funding, internal institutional resistance, no existing state position.

Related Strategies

- Build a safety advocacy coalition.
- Institutionalize safety roles and responsibilities.
- Coordinate with existing safety programs.
- Promote consistent safety messaging.

Emphasis Areas Goals Supported

- Establish a sustainable and unified safety culture and vision among all agencies in the state.
- Achieve a high level of safety administration effectiveness.

Progress Metrics

- Create and hire a 100% safety-focused program lead.
- Create a safety program.

Cutsheets to come

B BUILD A SAFETY ADVOCACY COALITION

STRATEGY DESCRIPTION

Build a safety coalition of advocacy groups and state and local agencies to function as a lobbying and advocacy group. To create a forum for relationship-building and maintain coordination over time, emphasize specific information-sharing tactics, such as regular newsletters or an annual conference. This group would monitor and work toward revisions to laws and policies at all phases of development and enforcement.

SAFETY ISSUE

Many advocacy groups and state and local agencies do not coordinate and combine efforts with other groups. In addition, state agencies can't lobby—they can only inform. A coalition can be an independent forum with a more proactive voice. While a safety program can focus on implementing actions, a safety coalition can work toward changing the legislative and policy environment in Colorado.

BENEFITS

- Increases the visibility of key safety issues in policy discussions.
- Creates a central forum for strengthening relationships among participants and decision-makers in promoting safety.

Action Items

> Identify key partner agencies and advocacy groups that will become the coalition.

> Develop a coalition charter with its own vision and mission statements, and goals and strategies.

> Identify statewide safety needs that can be voiced by the coalition.

> Coordinate with existing coalitions and advocacy groups.

> Support the safety champion in developing an annual statewide transportation safety conference.

> Develop a logo and brand for the STSP vision.

EXAMPLE

Regional Safety Coalitions

To assist in implementation of the strategies and actions, the Louisiana Department of Transportation and Development uses nine regional safety coalitions at the local and regional level. The department designates regional safety coordinators who establish and manage coalitions, as well as develop regional safety plans reflecting state plan goals, objectives, and proven effective strategies. These coalitions compete for funding to implement statewide or regional strategies found in the plan.

Source: FHWA Transportation Safety Planning, Module 3 (https://safety.fhwa.dot.gov/tsp/fhwasa16116/mod3.cfm#sec5)

EXAMPLE

Statewide and Regional SHSP Coalitions

Missouri's 2004 Blueprint for Safer Roadways outlined the organization of ten regional safety coalitions designed to work in concert with the Missouri Coalition for Roadway Safety (MCRS). Safety champions helped establish the regional coalitions and provided the coalitions with safety resources to assist in planning efforts. Any national, state, regional, local organizations, or individuals are able to participate in any of the coalitions. The coalitions were tasked with:

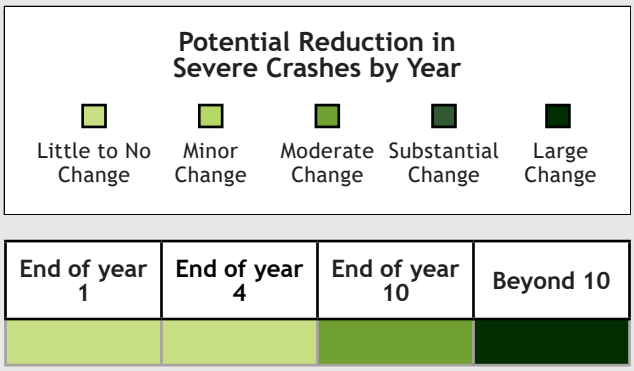
> Assisting in the implementation of the SHSP;
> Conducting regional data analysis to guide highway safety activities;
> Expanding regional safety network and partnerships;
> Actively participating in MCRS meetings, campaigns, and promotions;
> Developing a localized safety plan for the region; and
> Facilitating the expenditure of allocated funds.

Since 2004, the regional coalitions have expanded their number of partners and are now organized into three parts: executive committee, eleven state-level subcommittees and seven regional coalitions. Their continued progress and implementation efforts are outlined in the 2016 Blueprint.

Source: https://rspcb.safety.fhwa.dot.gov/noteworthy/html/stakeinvolve_mo.aspx

ESTIMATED STRATEGY EFFECTIVENESS

This strategy will take time to realize its potential. Initial benefits of coordination will be limited to information exchange, whereas true policy and legislative shifts will involve more planning and patience.



Strategy success will be achieved through partnerships and collaboration.

Strategy Champion(s)

Director of the CDOT Division of Public Relations/Government Relations with support from Colorado State Patrol and Colorado Department of Public Health and Environment.

Strategy Partners

Key partners include American Automobile Association, American Association of Retired Persons, and advocacy groups.

Local Partner(s)

Local advocacy groups, as well as cities and counties.

Implementation Costs

$$-$$$

Barriers to Implementation

Time commitment, institutional resistance, need for funding for an advocacy group or other leadership.

Related Strategies

- Name a safety champion to lead a proactive safety program.
- Institutionalize safety roles and responsibilities.
- Promote consistent safety messaging.
- Educate decision-makers on the effectiveness of occupant protection laws.
- Increase requirements for new and renewal driver licensing.
- Increase education on and implementation of data-driven and automated enforcement.

Emphasis Areas Goals Supported

- Have laws that effectively support transportation safety.
- Establish a sustainable and unified safety culture and vision among all agencies in the state.

Progress Metrics

- Safety coalition created.
- Number of safety coalition meetings.
- Percent of stakeholders who are coalition members.

C

Cutsheets to come

INSTITUTIONALIZE SAFETY ROLES AND RESPONSIBILITIES

STRATEGY DESCRIPTION

Establish agreements that define the ways agencies and organizations work together to deliver safety programs, including roles and responsibilities. These should focus on formal mechanisms, such as a Memorandum of Understanding. Less formal arrangements may be appropriate at local levels.

SAFETY ISSUE

State and local agencies and organizations are not always empowered to implement safety programs and projects through a consistent, agreed upon process. This can create confusion as to roles and responsibilities, leaving gaps in implementation in some areas and duplicated efforts in others. It can also hinder efforts to build a successful statewide safety culture over time, especially as key personnel change roles.

BENEFITS

- Removes barriers facing agencies and organizations resulting from unclear division of responsibility.
- Creates a more complete safety program and culture statewide, closing gaps in implementation and avoiding redundancy.
- Fosters continued cooperation and reduces redundant efforts.

Action Items

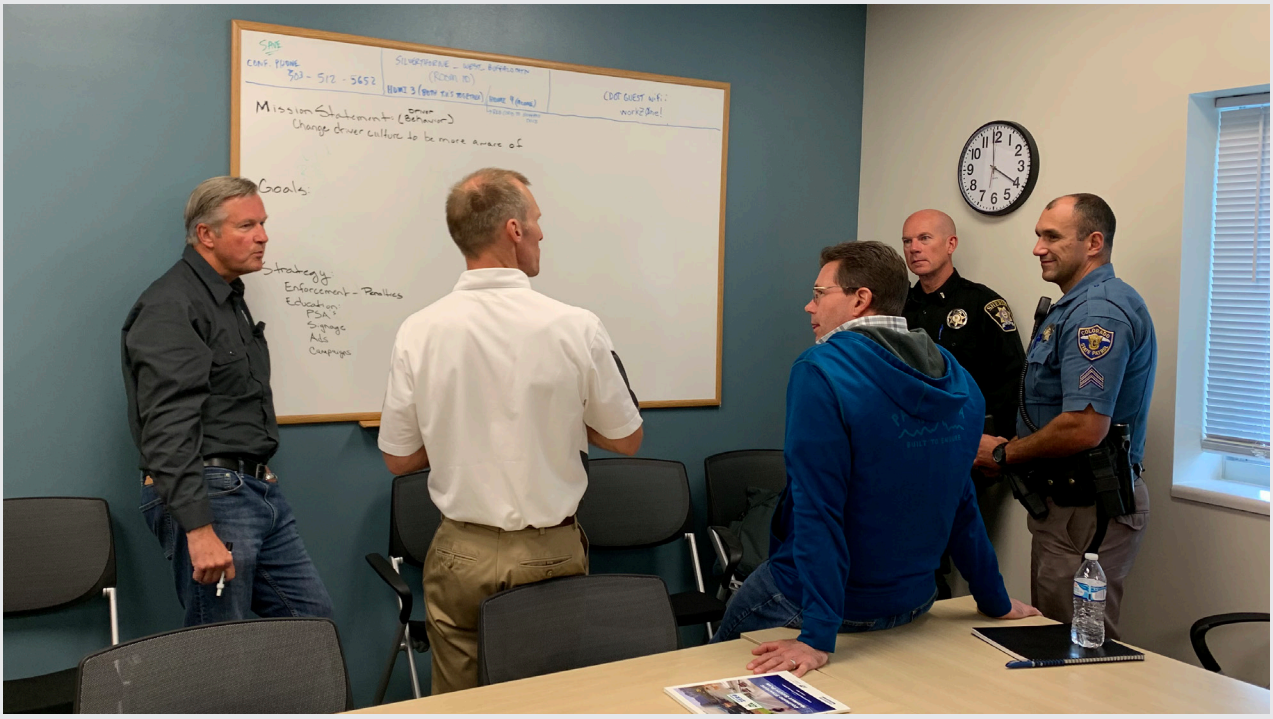
> Identify key relationships among agencies.

> Agree upon and formalize safety-related roles among state agencies as an initial step. This will eventually be expanded to other agencies.

> Establish formal agreements (e.g., Memorandum of Agreement) that define safety-related roles.

> Incorporate safety collaboration performance objectives into the position descriptions of those involved in STSP implementation.

> Incorporate safety criteria in agency performance reviews.



By formalizing agreements between law enforcement, educational institutions, and other concerned agencies, safety programs can be implemented more efficiently.

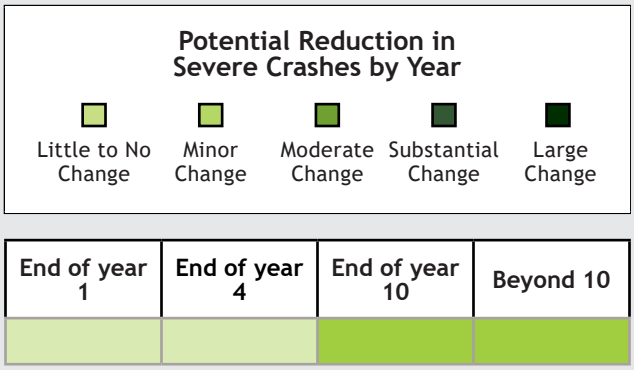
EXAMPLE

Formalizing a Framework

Currently, both CDOT and Colorado State Patrol develop and disseminate educational materials to communicate important safety messages to a wide variety of audiences across the state. These activities could be carried out jointly, with specific roles and coordination procedures articulated in a formal agreement.

ESTIMATED STRATEGY EFFECTIVENESS

This strategy will take time to achieve the full potential of its effectiveness as organizations work together to identify appropriate safety roles and responsibilities. Establishing the necessary formal agreements could also require a lengthy timeline.



Strategy success will be achieved through partnerships and collaboration.

Strategy Champion(s)

Lieutenant Colonel of Colorado State Patrol and the Executive Director at CDOT with support from Colorado Department of Public Health and Environment and Colorado Department of Revenue.

Strategy Partners

Key partners include cities and counties.

Local Partner(s)

Local law enforcement and city and county agencies.

Implementation Costs

$

Barriers to Implementation

Institutional resistance, political will, personnel turnover, funding.

Related Strategies

- Name a safety champion to lead a proactive safety program.
- Build a safety advocacy coalition.
- Promote consistent safety messaging.

Emphasis Areas Goals Supported

- Establish a sustainable and unified safety culture and vision among all agencies in the state.
- Achieve a high level of safety administration efficiency.
- Achieve a high level of safety administration effectiveness.

Progress Metrics

- Need for formal agreements is quantified.
- Number of agreements executed.

D COORDINATE WITH EXISTING SAFETY PROGRAMS

Cutsheets to come

STRATEGY DESCRIPTION

Coordinate the development and implementation of safety programs, incorporating strategies among agencies at the federal, state and local level. Existing example programs include CDOT's Whole System Whole Safety and regional and local Vision Zero programs. This would be part of a broader effort to coordinate roles and responsibilities to maximize the efficiency and effectiveness of safety strategies.

SAFETY ISSUE

Agencies and organizations at the state and local level do not always have a clear sense of how their safety programs fit within the context of other programs across the state. This duplicated efforts and missed opportunities, and it limits the effectiveness of any single program.

BENEFITS

- Improves the reach and impact of the state's safety programs.
- Recognizes the contributions of a wide range of agencies and organizations.
- Avoids duplication of safety program development efforts.

Action Items

> Facilitate communication among safety program leaders.

> Meet with planning and programming officials at relevant agencies to discuss how to incorporate safety considerations into project selection and prioritization activities.

> Identify gaps and overlaps in roles and responsibilities.

> Build a matrix to document major program strategies.

> Incorporate safety criteria in agency performance reviews.

> Coordinate annual performance target setting with OTS and NHTSA.

EXAMPLE

Regional Representation, Statewide Action

As part of its 2017 statewide safety plan, partner agencies in Alabama established a series of regional safety coalitions in order to maximize the safety efforts of a wide range of organizations throughout the state. This produced an approach to improving behavioral safety outcomes recognized as a best practice by the Federal Highway Administration.

Source: *https://safety.fhwa.dot.gov/tsp/fhwasa19016/*

EXAMPLE

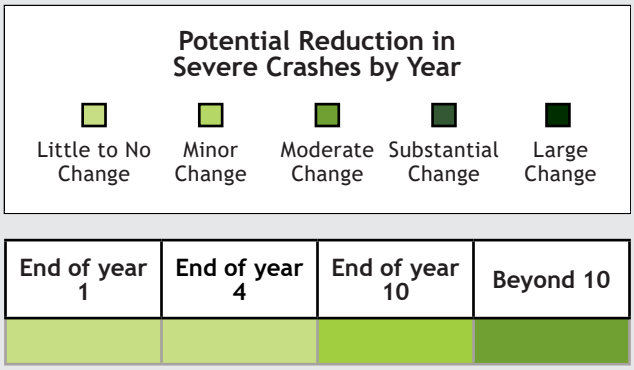
North Dakota Vision Zero Plan

Through the SHSP, the North Dakota DOT promotes coordination with safety partners and initiatives throughout the state. NDDOT has increased the number of stakeholders involved in the SHSP process and has had continued coordination among safety agencies with each update. The 2018 SHSP Vision Zero Plan serves as North Dakota's overarching transportation safety plan. It provides strategic direction for the state's Highway Safety Improvement Program (HSIP), Highway Safety Plan (HSP), and the Commercial Vehicle Safety Plan (CVSP). The Vision Zero Plan will be coordinated for alignment during the revisions and updates of these state safety plans as well as with the state's long-range statewide strategic transportation plan, Transaction III; 7 active and public transportation plan ND Moves; North Dakota's Statewide Transportation Improvement Program; and the MPO Transportation Improvement Program.

Source: *http://www.dot.nd.gov/divisions/safety/docs/FINAL_NDDOT_SHSP.pdf*

ESTIMATED STRATEGY EFFECTIVENESS

This strategy will evolve over time as new safety programs are developed and implemented across the state. Eventually, the potential effectiveness of coordinated programs could be substantial.



Strategy success will be achieved through partnerships and collaboration.

Strategy Champion(s)

CDOT Traffic and Safety Engineering Branch Manager with support from Colorado State Patrol.

Strategy Partners

Key partners include regional and local, state, federal planning agencies, American Automobile Association, and CDOT task forces.

Local Partner(s)

Plan/program owners (local, regional, state, federal advocacy groups.

Implementation Costs

$$

Barriers to Implementation

Institutional resistance, political will, personnel turnover.

Related Strategies

> Name a safety champion to lead a proactive safety program.

> Promote consistent safety messaging.

Emphasis Areas Goals Supported

> Achieve a high level of safety administration efficiency.

> Achieve a high level of safety administration effectiveness.

> Establish a sustainable and unified safety culture and vision among all agencies in the state.

Progress Metrics

> A matrix of existing programs is established.

> Percent matrix is complete.

E PROMOTE CONSISTENT SAFETY MESSAGING

STRATEGY DESCRIPTION

Coordinate the efforts of safety agencies and advocacy groups to develop consistent public-facing safety messaging. Coordinate the dissemination of these messages so they are visible to audiences across the state.

SAFETY ISSUE

Currently, many different safety messages come from a wide variety of organizations across many sectors. Many of these efforts have overlapping intention, but the variation in messaging can create confusion and reduce their effectiveness.

BENEFITS

- Create greater public safety awareness through consistent messaging.
- Minimize duplicate efforts associated with multiple agencies developing separate safety messages.

Action Items

> Create a matrix of existing messaging campaigns.

> Develop a process to consider common messages and combine accordingly.

> Establish a message-setting function of any new or existing statewide safety program.

> Generate template materials for local agencies and partner agencies to use in signage, media relations, and education efforts.

> Coordinate and educate media on appropriate and consistent safety messaging.

> Collect relevant data related to messaging campaign dissemination and effectiveness and produce an annual public-facing report.

EXAMPLE

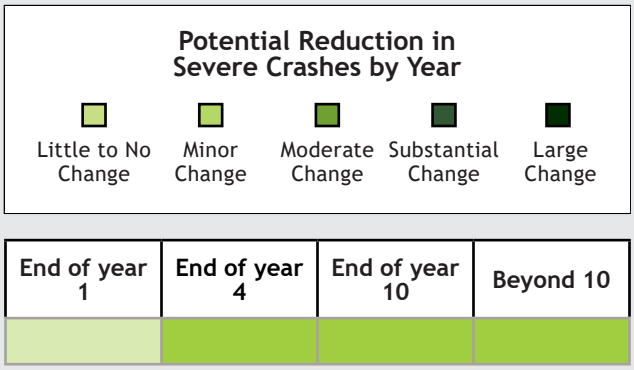
Click it or Ticket

The Click it or Ticket campaign, which includes a coordinated messaging and enforcement campaign originating at the National Highway Traffic Safety Administration, demonstrates the potential of focusing on consistent messaging. According to a 2009 National Highway Traffic Safety Administration report, public awareness of police efforts to ticket drivers for not using their seat belts increased significantly from pre- to post-Click it or Ticket mobilizations (from 17% to 42% in 2008 and from 19% to 34% in 2009).

Source: https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/811536.pdf

ESTIMATED STRATEGY EFFECTIVENESS

This strategy requires some initial effort to understand existing safety messaging development efforts across the state. Therefore, its primary effectiveness will be realized in later horizon years, once new programs and roles are established.



Strategy success will be achieved through partnerships and collaboration.

Strategy Champion(s)

CDOT Highway Safety Office and CDOT Office of Communications with support from Colorado State Patrol, Colorado Department of Public Health and Environment, and Colorado Department of Revenue.

Strategy Partners

Key partners include cities and counties, Metropolitan Planning Organizations, and regional councils.

Local Partner(s)

Cities, counties, local law enforcement.

Implementation Costs

$$

Barriers to Implementation

Funding, institutional resistance, regional agency support.

Related Strategies

- Name a safety champion to lead a proactive safety program.
- Build a safety advocacy coalition.
- Institutionalize safety roles and responsibilities.
- Coordinate with existing safety programs.
- Develop education campaigns for high-risk behaviors.
- Provide transportation safety education to students and families.

Emphasis Areas Goals Supported

- Establish a sustainable and unified safety culture and vision among all agencies in the state.
- Establish a safe transportation culture in Colorado (general population).

Progress Metrics

- Message templates are created.
- Percent of safety entities using message templates.
- Message matrix is created.

Cutsheets to come

DEVELOP EDUCATION CAMPAIGNS FOR HIGH-RISK BEHAVIORS

STRATEGY DESCRIPTION

Develop outreach campaigns aimed at high-risk groups, such as aggressive, distracted, and impaired drivers, with the goal to enhance and coordinate efforts among statewide education platforms. Develop outreach campaigns aimed at occupant protection education, including seat belt and helmet usage, to be included in statewide education platforms.

SAFETY ISSUE

High-risk behaviors have two common outcomes: some cause severe crashes while others decrease the likelihood of surviving a severe crash.

BENEFITS

- Reduces high-risk behaviors with continuous, but not over-saturated, messaging.
- Brings awareness of high-risk behaviors to the driving population, including younger and older drivers.
- Educates on the impacts of high-risk behaviors.
- Brings awareness to roadside worker safety, e.g., work zones and first responders.

Action Items

- Develop a contact list of local partner agencies, e.g., law enforcement, task forces, advocacy groups.
- Identify and coordinate with key partner agencies and hold a kick-off meeting.
- Develop communications team with the supporting agencies.
- Identify existing statewide and local education campaigns aimed at high-risk behaviors including impaired, aggressive, and distracted driving as well as lack of seatbelt and helmet use.
- Develop and launch high-risk education campaign for micro-mobility users.
- Develop and launch high-risk education campaign for the general public to be more aware of roadside workers and first responders.

Data/Supporting Information

Crash Statistics

- **96%** of fatalities in Colorado in 2018 could be attributed to human error, according to an analysis of the preliminary fatal crash dataset.[F1]
- **75%** of severe impaired driving crashes occur between the hours of 6 pm and 6 am.[F2]
- An average of **84%** of people statewide wore seatbelts according to 2014-2018 seatbelt surveys, but only **45%** of people killed in traffic crashes in Colorado in the same time frame were wearing seatbelts at the time of impact.[F2, F4]
- **309** potential lives saved with 100% seatbelt use over the 2013-2017 period, according to NHTSA.[F3]
- Crashes involving alcohol/drugs are more than **3x** more likely to be severe.[F2]
- **33%** of fatal crashes on county roads are linked to driver impairment.[F2]
- **41%** of all impairment-related fatalities occur on state highways.[F2]
- The National Highway Traffic Safety Administration has estimated an additional **126** lives could have been saved in Colorado between 2013 and 2017 with 100% helmet usage among motorcyclists.[F3]

EXAMPLE

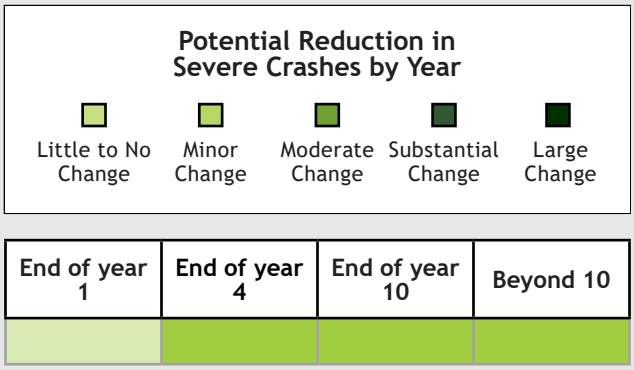
The Heat is On

The Heat is On is Colorado's high-visibility enforcement campaign, combined with strong public awareness, aimed at impaired drivers. This campaign is active during the twelve enforcement periods throughout the year by CDOT and Colorado State Patrol. The campaign encourages Colorado residents and visiting drivers to plan ahead and arrange a sober ride home if they choose to drink. The Thanksgiving enforcement period and Driving Under the Influence-prevention campaign support CDOT's Whole System Whole Safety initiative to reduce traffic injuries and deaths.

Source: *https://www.colorado.gov/pacific/csp/heat*

ESTIMATED STRATEGY EFFECTIVENESS

Initially, this strategy will have very limited deployment as the first few years of implementation will include campaign development and coordination among agencies. The impact over the next decade will be modest due to the extensiveness of the campaign roll outs. These immediate impacts, however, are not as important as the long term effort to shift the cultural norms of high-risk behaviors within the state of Colorado.



Strategy success will be achieved through partnerships and collaboration.

Strategy Champion(s)

CDOT Highway Safety Office and CDOT Office of Communications with support from Colorado State Patrol, Colorado Department of Public Health and Environment, and Colorado Department of Revenue.

Strategy Partners

Key partners include advocacy groups and CDOT task forces.

Local Partner(s)

Local law enforcement.

Implementation Costs

$$$$

Barriers to Implementation

Funding, available data, cultural and local resistance, available resources.

Related Strategies

> Promote consistent safety messaging.

> Provide transportation safety education to students and families.

Emphasis Areas Goals Supported

> Reduce all crashes caused by aggressive, impaired, distracted driving.

> Achieve a nationwide leading level of safe driver behavior and occupant protection.

> Make the occupation of roadway workers and responders as safe as any other occupation.

Progress Metrics

> Number of campaigns created.

> Percent of safety entities promoting campaigns.

> Various behavioral metrics e.g., drivers wearing seat belts, motorcyclists wearing helmets, etc.

Cutsheets to come

G PROVIDE TRANSPORTATION SAFETY EDUCATION TO STUDENTS AND FAMILIES

STRATEGY DESCRIPTION

Establish a culture of safety among young people by expanding existing and developing new transportation safety education programs, including education on how to be a safe pedestrian and bicyclist, that engage them over many years.

SAFETY ISSUE

Young people are the next generation of drivers, but roadway safety programs for K-12 students are lacking. There is currently no comprehensive roadway, pedestrian, and bicyclist safety curriculum available for teachers and students.

BENEFITS

- Reduces vulnerable roadway user fatalities and serious injuries.
- Enhances safety culture among young people.
- Enacts transportation safety programs that have a positive, multi generational impact.
- Encourages safe active travel behaviors and ingrains a comprehensive understanding of transportation safety for roadway users.

Action Items

- Establish strategic partnership between CDOT and Colorado Department of Public Health and Environment to align and elevate existing transportation safety programs.
- Research successful education campaigns in local municipalities and partner states.
- Develop a comprehensive curriculum that can be used by partners of various entities.
- Provide pedestrian and bicycle education for children at elementary and middle schools.
- Incorporate interactive training into education programs.
- Educate youth regarding current laws and regulations to increase effectiveness.
- Promote child safety clubs and other organized activities to promote changes in group culture and behavior.
- Increase use of child bicycle helmet and booster seats through promotions/events.

Data/Supporting Information

- A study in New York City measured **33-44%** reductions in pedestrian injury among school-aged children in areas with Safe Routes to School projects, compared to no change in locations without similar projects.[G1]
- Numerous studies indicate that pedestrian-oriented education and training programs increase knowledge and behaviors of young children, but real-world traffic behavior changes are more likely to occur when education programs incorporate interactive training.[G2]
- A study of 801 schools found that education and encouragement programs were associated with an annual **5%** increase in the percentage of students walking and bicycling to school, which cumulatively could result in a **25%** increase over five years for sustained education and encouragement efforts.[G3]

EXAMPLE

Fort Collins Safe Routes to School

The City of Fort Collins FC Moves (Transportation Planning) Department operates a Safe Routes to School program that annually offers Safe Routes to School Bicycle and Pedestrian Safety education in the city's K-12 public schools. The goal of the program is to encourage at least 50% of K-12 students to regularly walk or bicycle to school. The city complements education efforts with engineering and enforcement strategies to increase safety for students actively commuting to and from school.

Source: *https://www.fcgov.com/saferoutes/files/18-19271-annual-summary-update.pdf?1548189879*

EXAMPLE

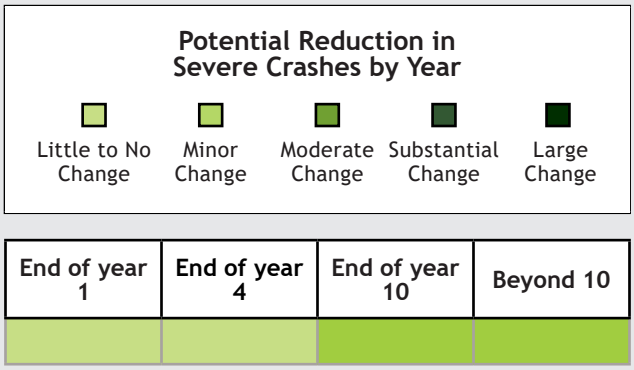
Colorado Safe Routes to School

CDOT administers Colorado's Safe Routes to School funding to support local infrastructure and programmatic projects. Between 2005 and 2018, CDOT funded 255 Safe Routes to School projects throughout the state, including 114 infrastructure and 141 non-infrastructure projects. CDOT makes many resources available to support local Safe Routes to School initiatives, including a full online curriculum. While the program is effective, it has room for improvement and expansion.

Source: *https://www.codot.gov/programs/bikeped/safe-routes*

ESTIMATED STRATEGY EFFECTIVENESS

The direct impact of this strategy on reducing serious or fatal crashes will be minimal, although it will improve the safety culture in Colorado. Initially, this strategy will have very limited deployment as the first actions will include research, curriculum development, and coordination among agencies. As programs develop and are increasingly deployed, the effectiveness of this strategy is expected to increase and offer minor reductions in crash rates, particularly near schools.



Strategy success will be achieved through partnerships and collaboration.

Strategy Champion(s)

Colorado State Patrol and CDOT with support from Colorado Department of Public Health and Environment.

Strategy Partners

Key partners include Safe Routes to School programs, CDOT Highway Safety Office federal grantees, local planning agencies, and advocacy groups.

Local Partner(s)

Local law enforcement.

Implementation Costs

$$$

Barriers to Implementation

Institutional resistance, available resources, funding, training.

Related Strategies

- Promote consistent safety messaging.
- Develop education campaigns for high-risk behaviors.

Emphasis Areas Goals Supported

- Establish a safe transportation culture in Colorado (general population).
- Minimize the over representation of vulnerable users in severe crashes.

Progress Metrics

- Curriculum templates are created.
- Number of schools where curriculum is presented.
- Number of schools where safety information is incorporated into curriculum.

Cutsheets to come

PRIORITIZE TRANSPORTATION SAFETY FUNDING

STRATEGY DESCRIPTION

Increase the importance of safe infrastructure and transportation in transportation funding decisions. Educate funding decision-makers on the importance of safety and how funds could be used to make improvements.

SAFETY ISSUE

More funds dedicated to safety programs and infrastructure are needed to make a larger impact on safety. Safety is a critical priority for the Colorado transportation system, but there is a lack of awareness of how few resources are specifically devoted to safety issues. The CDOT Vision Statement includes the phrase, "safely moving people and goods," but the statewide wish-list of safety projects is woefully underfunded due to a shortage of funding for transportation overall and lack of adequate safety prioritzation.

BENEFITS

- Increases ability to fund safety improvements, including infrastructure, enforcement, and education.
- Elevates the importance of safety by "putting your money where your mouth is."
- Results in fewer crashes, injuries, and deaths.

Action Items

> Reinstate the Colorado Transportation Commission Safety Subcommittee.

> In coordination with Your Transportation Plan, research and quantify overall state safety improvement needs through a safety conditions assessment.

> Identify corridor multimodal safety gaps statewide.

> Conduct an analysis to determine the level of underfunding.

Data/Supporting Information

> Minnesota, Utah, and Washington are states with similarly-sized populations and annual vehicle miles traveled (VMT), but their annual roadway deaths are significantly lower than Colorado's due in part to a culture of safety that has been developed through continued efforts and dedicated funding for safety programs and grants. In 2018 Minnesota had a death per 100,000 population rate **39%** lower than Colorado, Washington was **35%** lower, and Utah was **26%** lower.[H1]

State	Population	Roadway Deaths	Deaths per 100,000 Population	State Rank	VMT (Millions)	Deaths per 100 Million VMT	State Rank
Minnesota	5,611,179	381	6.8	6th	60,438	0.63	2nd
Washington	7,535,591	546	7.2	7th	62,367	0.88	9th
Utah	3,161,105	260	8.2	11th	32,069	0.81	6th
Colorado	5,695,564	632	11.1	25th	53,954	1.17	31st

Source: Insurance Institute for Highway Safety

EXAMPLE

PennDOT Improvement Program

Each year, PennDOT receives approximately $97 million in federal funding for its Improvement Program. PennDOT distributes funding to planning regions based on fatalities, major injuries and reportable crashes, approximately $45.5 million. For larger projects in the smaller planning organizations, each organization receives $500,000. The remaining $35 million is awarded annually to implement low- to moderate-cost systemic infrastructure safety improvements.

Source: https://www.penndot.gov/TravelInPA/Safety/Pages/Safety-Infrastructure-Improvement-Programs.aspx

EXAMPLE

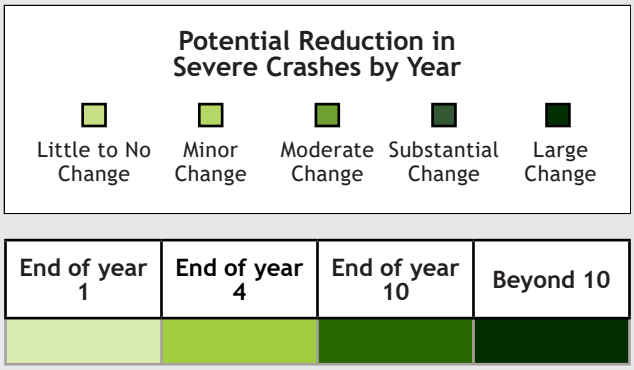
Virginia DOT SMART SCALE

To ensure the best use of limited transportation funds, the Virginia DOT uses the SMART SCALE prioritization process to evaluate the safety benefits of projects proposed for the State's long-range transportation plan. SMART SCALE is a data-driven prioritization process that develops planning-level metrics and weighted crash modification factors for different countermeasures, including innovative intersection approaches. As a result of this transportation funding prioritization process, Virginia DOT has seen a significant increase in quality safety projects.

Source: https://safety.fhwa.dot.gov/tsp/fhwasa19013/

ESTIMATED STRATEGY EFFECTIVENESS

This strategy will have limited effectiveness in the first year as initial actions do not immediately lead to an increase in safety funding. The strategy effectiveness will increase gradually as more funds are dedicated to safety, and state and local transportation budgets begin to make safety an ongoing priority in their annual and strategic budgeting processes.



Strategy success will be achieved through partnerships and collaboration.

Strategy Champion(s)

Colorado Transportation Commission with support from CDOT, Colorado State Patrol, Colorado Department of Public Health and Environment, and Colorado Department of Revenue.

Strategy Partners

Key partners include directors of regional and local planning agencies, as well as city councils and county commissions.

Local Partner(s)

Municipal agencies.

Implementation Costs

$$-$$$$$

Barriers to Implementation

Institutional resistance, cultural resistance, funding criteria.

Related Strategies

- Prioritize safety in transportation planning, facility design, and project selections.
- Prioritize and promote proven safety toolbox strategies.
- Implement systemic infrastructure safety improvement strategies.

Emphasis Areas Goals Supported

- Build, maintain, and operate a complete and connected transportation network safe for all users.
- Achieve equitable safety improvements to address the safety needs of all agencies in the state.

Progress Metrics

- Percent of funding dedicated to safety by agency (trend analysis).
- Amount of funding dedicated to safety by agency (trend analysis).
- Transportation Commission Safety Subcommittee reinstated.
- Statewide Transportation Improvement Program (STIP) and Transportation Improvement Program (TIP) processes are amended.

Cutsheets to come

PRIORITIZE SAFETY IN TRANSPORTATION PLANNING, FACILITY DESIGN, AND PROJECT SELECTION

STRATEGY DESCRIPTION

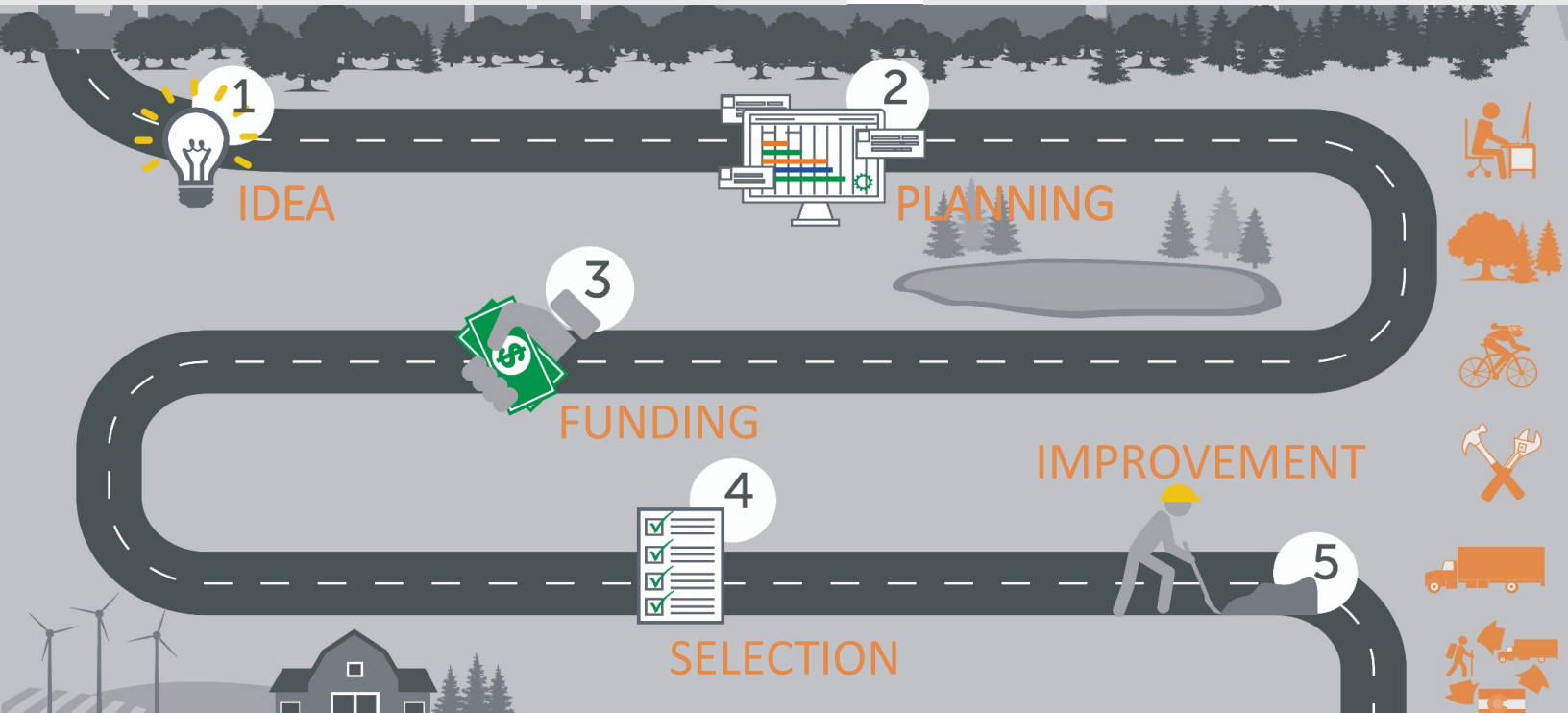
Review policies and processes of roadway planning, design, and project selection to determine what role safety plays in decision-making. Advocate for increasing the relevance of safety in processes of roadway planning, design, and project selection.

SAFETY ISSUE

Often safety is not prominent in project selection processes. Although purpose and need type project statements usually includes safety, its importance typically lags well behind traffic operations and environmental concerns, so safer alternatives may not be preferred. Transportation design manuals may not include newer best safety practices that can decrease crash frequency and severity. Existing design guidelines and policies may not be up to date, which results in the selection and design of less safe facilities.

BENEFITS

- Improves safety of new facilities and infrastructure.
- Improves roadway design standards to better serve all travelers.
- Promotes consistency in safe design standards between communities.
- Quantifies and weighs safety opportunities in all transportation projects.



Action Items

- Investigate the feasibility and suitability of a statewide "roundabouts first" policy.
- Investigate an intersection control evaluation policy.
- Amend Statewide Transportation Improvement Program and Metropolitan Planning Organization Transportation Improvement Programs to more highly prioritize projects that address identified safety issues.
- Update CDOT design manual and local design guidelines to place a greater emphasis on safety and consideration for vulnerable roadway users (e.g., adequate pedestrian crossings, bike lanes, micro transit, such as near transit stations).
- Develop a road design manual for non-highway (local) facilities and rural communities.
- Develop model traffic calming design criteria and standards to be used by local jurisdictions for new development and retrofits for existing streets.
- Facilitate agency and community infrastructure and roadway design decisions with context sensitive considerations of the community and surrounding land use.
- Develop a road design manual for highways in urban settings.

Data/Supporting Information

- According to the CDOT 2019 Problem Identification Report, speeding was a factor in **35%** of all fatalities in 2017. There were **230** speeding-related motor vehicle fatalities, a **9%** increase from the previous year.[11]
- More safety-oriented design decisions could reduce speeding-related fatalities.
- Highway improvement projects indirectly improve safety, but CDOT has only two funding sources dedicated to safety improvements--the federal Highway Safety Improvement Program and Colorado's Funding Advancements for Surface Transportation and Economic Recovery Act of 2009 (FASTER) Safety Program--that amount to approximately **6%** of CDOT's overall annual budget.[12]

EXAMPLE

Safety Considerations in Design Manuals

Many states have taken action to greater prioritize safety in transportation policies. The New York Highway Design Manual requires an evaluation of roundabout feasibility during intersection design and, when feasible, dictates that a single-lane roundabout be the preferred alternative due to the proven safety benefits.

Similarly, the Washington State Department of Transportation Design Manual embraces context-based roadway design that considers the area's modal needs instead of predetermined design criteria.

Source: *https://www.dot.ny.gov/divisions/engineering/design/dqab/hdm/hdm-repository/chapt_05.pdf*
Source: *http://wtsc.wa.gov/wp-content/uploads/dlm_uploads/2016/09/Target-Zero-2016-low-res.pdf*

EXAMPLE

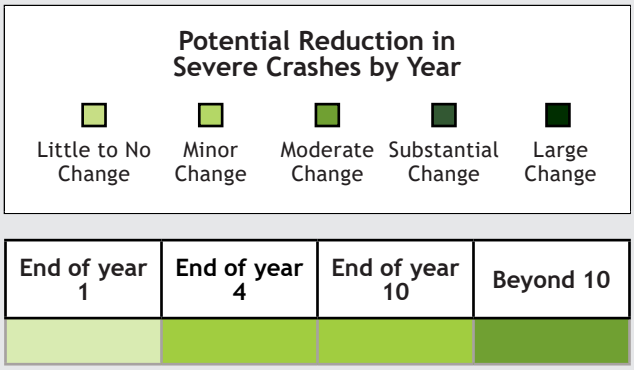
International Efforts: Sweden

Sweden's Vision Zero design strategy centers on setting speed limits in concert with roadway design to promote survivability in the case of a crash. For example, vehicle traffic is limited to 30 km/h, or 18.75 mi/h, in settings where pedestrians may cross a roadway. Similar limits exist when vehicles may cross paths at right angles or be exposed to head-on collisions. Because of this program, between 2000 and 2016, the number of traffic fatalities in Sweden decreased from 565 to 270.

Source: DiExSys (Diagnostic Expert Systems) White Paper for CDOT, February 2019

ESTIMATED STRATEGY EFFECTIVENESS

This strategy will have limited effectiveness in the first year as initial actions will include researching and amending policy and processes to greater prioritize safety. The strategy effectiveness will increase gradually as changes are deployed and begin to influence decision-making. The impact within five to ten years will be moderate as changes to design manuals and project selection processes begin to influence project design and construction.



Strategy success will be achieved through partnerships and collaboration.

Strategy Champion(s)

CDOT Division of Transportation Development with support from Colorado State Patrol and Colorado Department of Public Health and Environment.

Strategy Partners

Key partners include directors of regional and local planning agencies, public works departments, and local city engineers.

Local Partner(s)

City and county engineering and planning departments.

Implementation Costs

$$-$$$$

Barriers to Implementation

Institutional resistance, potential increase in construction costs, environmental and/or right-of-way impacts, developers, elected officials.

Related Strategies

- Prioritize transportation safety funding.
- Prioritize and promote proven safety toolbox strategies.
- Implement systemic infrastructure safety improvement strategies.

Emphasis Areas Goals Supported

- Minimize the over representation of vulnerable users in severe crashes.
- All roadway segments' safety performance should achieve a LOSS I or II given the conditions at each location.
- All intersections' safety performance should achieve a LOSS I or II given the conditions at each location.

Progress Metrics

- CDOT design manual and local design guidelines are updated.
- Intersection Control Evaluation policy is in place.
- Statewide Transportation Improvement Program (STIP) and Transportation Improvement Program (TIP) processes are amended.

Cutsheets to come

J EDUCATE DECISION-MAKERS ON THE EFFECTIVENESS OF OCCUPANT PROTECTION LAWS

STRATEGY DESCRIPTION

Research and document the benefits of occupant protection laws, such as seatbelt use, helmet use, and restrictions on personal device use. Educate legislators, commissioners, and other decision-makers on the benefits of such laws.

SAFETY ISSUE

Occupant protection measures have a significant and direct impact on saving lives. Lack of seatbelt protection, helmet use, and other measures cost lives and contribute to serious crashes. Distracted driving is a major contributing factor to serious and deadly crashes throughout the state. Inattentive driving is more prevalent among younger drivers, but remains an issue for all drivers. Currently, Colorado does not have a hand-held cell phone ban.

BENEFITS

> Improves immediate and long-term survivability of vehicular crashes.

> Prevents crashes, injuries, and fatalities related to personal device use while driving.

Action Items

- Identify champions to coordinate agency action.
- Engage advocacy groups to promote legislative changes.
- Develop education materials for decision-makers and the general public.
- Create a safety awareness test for decision-makers.

Data/Supporting Information

- Colorado ranks **40th** in seatbelt use nationwide.[J1]
- The National Highway Traffic Safety Administration estimates **309** Colorado lives could have been saved from 2013 to 2017 with 100% seatbelt usage.[J2]
- Universal helmet use is associated with a decrease in motorcycle serious injury and fatality rates. States that enact universal helmet laws observe relatively high compliance, nearly **90%**.[J3]
- The National Highway Traffic Safety Administration estimates that **126** Colorado lives could have been saved from 2013 to 2017 with 100% helmet usage among motorcyclists.[J2]
- According to the Strategic Opportunities to Improve Highway Safety in Colorado white paper (2019), reliable studies consistently show that seat belt usage increases about **10%**, and vehicle occupant fatalities decrease **7-8%** when a primary seat belt enforcement law replaces a secondary seat belt enforcement law.[J4]
- When the state of Louisiana repealed its universal helmet law in 1999, helmet usage dropped from near universal compliance to approximately **50%** and the number of motorcyclist fatalities sharply increased. After reinstating the law in 2004, observed helmet use doubled and fatal and serious crashes decreased.[J5]
- All but three states in the United States have enacted some form of helmet law. Of these laws, 19 states and the District of Columbia have enacted universal helmet laws. Research and case studies indicate that universal helmet laws increase helmet use and decrease fatalities and serious injuries among motorcyclists.[J6]

EXAMPLE

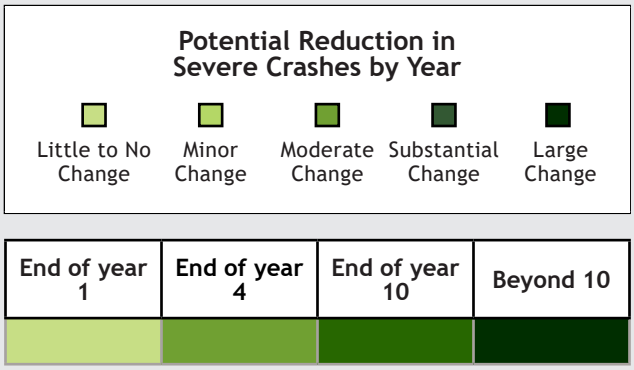
Cell Phone Restrictions

Legislative approaches exist to restrict cell phone use while driving. Texting bans are the most common approach and exist in 46 states. Results from a high-visibility enforcement demonstration project conducted by the National Highway Traffic Safety Administration suggest that a strong set of distracted driving laws help enforce texting law compliance.

Source: Richard, C. M., Magee, K., Bacon-Abdelmoteleb, P., Brown, J. L. (2018, April). Countermeasures that work: A countermeasure guide for State Offices, Ninth edition (Report No. DOT HS 812 478). Washington, DC: National Highway Traffic Safety Administration) Source: Richard et al, 2018

ESTIMATED STRATEGY EFFECTIVENESS

The effectiveness of this strategy will increase quickly over time. The first year of implementation will include materials development and coordination among agencies. As coordination strengthens in the subsequent years, strategy partners will engage and educate policy decision-makers to promote legislative changes that protect vehicle occupants. The adoption of these legislative changes will produce large-scale systemic changes that will greatly increase roadway safety over time.



Strategy success will be achieved through partnerships and collaboration.

Strategy Champion(s)

Safety leaders within CDOT, Colorado Department of Public Health and Environment, Colorado State Patrol, and Colorado Department of Revenue.

Strategy Partners

Key partners include Colorado Department of Human Services, local law enforcement, American Automobile Association, emergency medical responders, Rocky Mountain Insurance Advisors, the Governor's Office, and advocacy groups, including the Occupant Protection Task Force and Colorado Young Driver Alliance.

Local Partner(s)

Local governments.

Implementation Costs

$$-$$$

Barriers to Implementation

Political resistance, public acceptance.

Related Strategies

> Build a safety advocacy coalition.

> Increase requirements for new and renewal driver licensing .

Emphasis Areas Goals Supported

> Achieve a nationwide leading level of safe driver behavior and occupant protection.

> Have laws that effectively support transportation safety.

> Reduce crashes caused by aggressive, impaired, distracted driving.

> Reduce crashes and injuries prevalent at severe crash locations.

Progress Metrics

> Decision-maker safety awareness test scores.

> Number of education materials produced for decision-makers.

Cutsheets to come

K INCREASE REQUIREMENTS FOR NEW AND RENEWAL DRIVER LICENSING

STRATEGY DESCRIPTION

Expand the graduated driver licensing (GDL) system to increase education and practice requirements for new drivers to obtain a license. Develop appropriate testing requirements to verify driver competency with increased age.

SAFETY ISSUE

Motor vehicle crashes are the leading cause of death for teenagers in the United States, and young drivers are overrepresented in vehicle crashes in comparison to adult drivers. Requirements for obtaining and renewing a driver's license in Colorado are not rigorous compared to other states, with looser restrictions on learner's permits and road tests. While age does not determine driving performance, drivers may experience physical, cognitive, or behavioral changes as they age, which may impact driving abilities over time.

BENEFITS

- Reduces severe crashes caused by new and older drivers.
- Improves transportation safety culture.
- Verifies driving competency among new and older drivers.

Action Items

- Research steps that Colorado can take toward increasing GDL and formal driver education requirements to align with recommended best practices.
- Strengthen relationships between partner agencies to establish a shared understanding and approach to improving safety for new and older drivers.
- Define the issue further through additional, targeted data analysis.
- Compare Colorado requirements and crash data for new and older drivers with those of peer states.
- Educate decision-makers via legislative liaisons.
- Educate law enforcement and medical professionals on how to evaluate driving competency and the referral system.

Data/Supporting Information

- Colorado ranks **46 out of 50** (5th easiest) states in relative difficulty to obtain a driver's license.[K1]
- Inexperience was the leading contributing factor (**51%**) of fatal or serious injury crashes among young drivers ages 15 to 20 in Colorado from 2014 to 2018.[K2]
- Older drivers are more likely to be killed or seriously injured in a crash than drivers in other age groups due to the greater fragility of their bodies. In 2018, **131** Colorado drivers over 65 years old were involved in fatal crashes, and **72** older drivers died in car crashes.[K2]

EXAMPLE

Graduated Driver License Systems

Research demonstrates that comprehensive GDL systems have the greatest impact on crash reductions. A study conducted by AAA (American Automobile Association) indicates that GDL systems with at least a 6-month permit stage, a night restriction beginning no later than 10 pm, and restrictions allowing no more than one teen passenger are associated with a 38% reduction in fatal crashes and a 40% reduction in injury crashes among 16-year-old drivers.

Source: Baker, S. P., Chen, L-H., & Li, G. (2007). Nationwide review of Graduated Driver Licensing. Retrieved from the AAA Foundation website: https://aaafoundation.org/nationwide-review-graduated-driver-licensing/

EXAMPLE

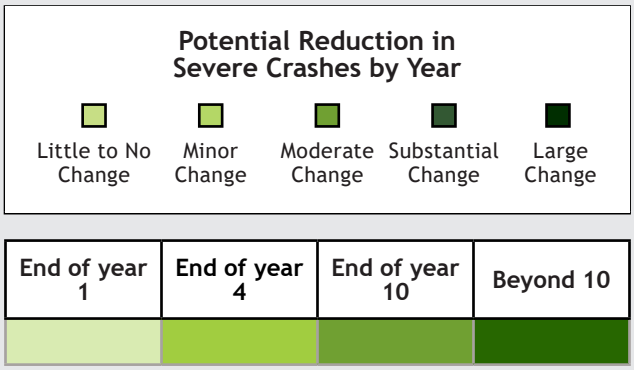
Graduated De-Licensing

Graduated de-licensing models increase roadway safety and allow aging adults to maintain independence and mobility. Graduated de-licensing refers to license restrictions for drivers whose driving behavior only poses risk in certain situations. For example, a driver with poor night vision may receive a license that is restricted to daylight hours. The state of Kansas offers a "Local Drive" road test program that allows qualified drivers to continue driving specific routes close to home.

Source: Richard, C. M., Magee, K., Bacon-Abdelmoteleb, P., & Brown, J. L. (2018, April). Countermeasures that work: A Highway Safety countermeasure guide for State Highway Safety Offices, Ninth edition (Report No. DOT HS 812 478). Washington, DC: National Highway Traffic Safety Administration)

ESTIMATED STRATEGY EFFECTIVENESS

Initially, this strategy will have very limited impact as the first actions will include research, system development, and coordination among agencies. The impact within five to ten years will be moderate as the new licensing requirements are implemented and new and renewal driver behavior is more strictly monitored. Research suggests that the long-term impact of increased licensing requirements will be substantial.



Strategy success will be achieved through partnerships and collaboration.

Strategy Champion(s)

Colorado Department of Revenue-Division of Motor Vehicles Driver License Section with support from CDOT, Colorado State Patrol and Colorado Department of Public Health and Environment.

Strategy Partners

Key partners include CDOT's Occupant Protection Task Force, Colorado Young Driver Alliance, Colorado Public Utilities Commission, American Association of Retired Persons, American Automobile Association, and Drive Smart Colorado.

Local Partner(s)

Local law enforcement, medical community.

Implementation Costs

$$-$$$

Barriers to Implementation

Political resistance, funding and staffing limitations.

Related Strategies

- Build a safety advocacy coalition.
- Educate decision-makers on the effectiveness of occupant protection laws.

Emphasis Areas Goals Supported

- Achieve a nationwide leading level of safe driver behavior and occupant protection.
- Have laws that effectively support transportation safety.
- Minimize the over representation of vulnerable users in severe crashes.

Progress Metrics

- Change in driver licensing requirements.
- Percent of crashes and severe crashes of younger and older drivers.

Cutsheets to come

L ESTABLISH A FRAMEWORK FOR STREAMLINING DATA MANAGEMENT

STRATEGY DESCRIPTION

Improve data gathering, reporting, storage, linkage, processing, analysis, and dissemination throughout the state by creating traffic records databases following the FHWA measures of quality: timeliness, accuracy, completeness, uniformity, integration, and accessibility.

SAFETY ISSUE

Both local and state agencies have identified a need for a comprehensive statewide crash database, comprised of files for Crash, Vehicle, Driver, Roadway, Citation/Adjudication, and Emergency Medical Services/Injury Surveillance. Many jurisdictions do not have easy access to statewide or local crash statistics, which creates a concern for data timeliness and reliability. Many agencies have turned to local law enforcement as a resource for crash data. Law enforcement officials across the state do not have a consistent data collection method as there is a lack of a digital reporting system. This disconnect creatves an environment in which different data sources and collection methods are being used to analyze data, causing inconsistency in problem identification, use of multiple databases, and data incompleteness.

BENEFITS

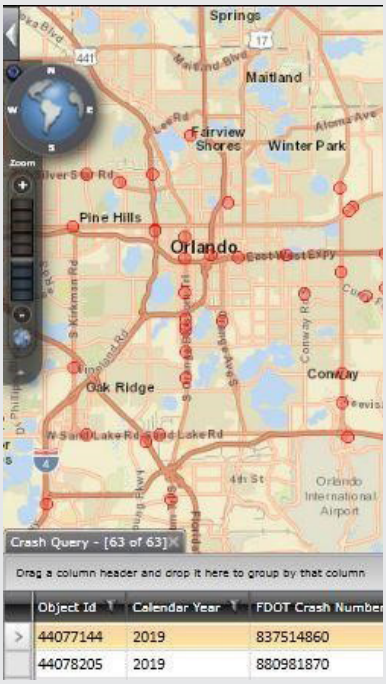
- Allows for a more immediate response to emerging crash patterns.
- Provides more uniform confidence in crash mitigation strategies at the state and local level.
- Provides consistent, complete, and more uniform crash data.
- Provides a uniform source for data that has been properly vetted by standardized quality assurance/ quality control protocols.

Action Items

- Create a statewide web-based crash data entry form for consistent data entry by law enforcement for direct submission to a statewide crash database.
- Coordinate and communicate with agencies at the state and local level that collect, process, or analyze crash data.
- Coordinate with partner agencies to determine non-crash data needs.
- Pursue implementation of Traffic Records Assessment recommendations for improvements to the statewide crash data.
- Create a leadership group to be a liaison between the Executive Directors of the partner agencies and the Statewide Traffic Records Advisory Committee.
- Implement Unified Street Naming Convention standards in the electronic crash data entry form.
- Develop a public-facing data analysis, reporting. and visualization tool to provide data in a more usable format to partner agencies.
- Combine other safety-related databases to do more comprehensive analysis (roadway, assets, weather, traffic, citations, health, etc.).

Data/Supporting Information

- Consensus from statewide safety stakeholders was that traffic records data need to be improved at both the state and local level.
- Current data is not easily analyzed for seatbelt usage because data collection efforts are inconsistent throughout the state.
- Law enforcement officials currently do not report off-system crash locations with sufficient accuracy, i.e., lack of geo-location.
- Currently, the state does not have a consistent crash data collection method for law enforcement. About half of the crash data is submitted on paper, creating data consistency issues and a lack of quality control in data reporting. A consistent submittal method, preferably electronic, would benefit law enforcement, as well as state and local agencies.
- Law enforcement has 5 days from the completion of the investigation to submit the record to Colorado Department of Revenue. CDOT manually enters paper records and sends approximately 90% of the crash records in 90 days to CDOT. CDOT compiles the crash data and releases it for local agencies and other partners typically 5-6 months after the end of the calendar year. These delays may prevent agencies from immediately responding to emerging crash patterns within their respective jurisdictions.



EXAMPLE

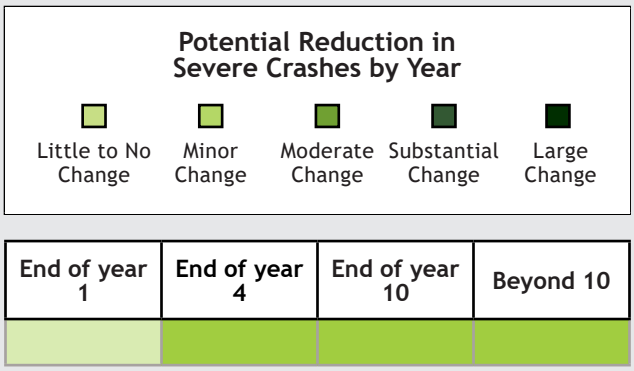
Florida DOT Traffic Safety Portal

The Florida DOT has a Traffic Safety Portal on its website. The site offers access to various safety resources, news articles, and analysis tools. The home page houses a statewide crash database named the State Safety Office Map Based Query Tool (SSOGis). This tool allows the user to filter the data by year, location, harmful event, intersection type, etc., and then locates the crashes on a map. Each data point on the map correlates to a crash in the crash query. The crash query provides additional information pertaining to the crash selected.

Source: *https://fdotewp1.dot.state.fl.us/SSOGis/Home.aspx*

ESTIMATED STRATEGY EFFECTIVENESS

Initially, impacts to safety will be minor as implementation requires coordinating with all agencies throughout the state. To build and maintain a statewide crash database improving data gathering, reporting, storage, linkage, processing, analysis, and dissemination will be an immense undertaking. The effectiveness of this strategy will increase over time and full implementation may take several years.



Strategy success will be achieved through partnerships and collaboration.

Strategy Champion(s)

CDOT Traffic and Safety Engineering Branch Manager with support from the Statewide Traffic Records Advisory Committee, Colorado State Patrol, Colorado Department of Revenue, and Colorado Department of Public Health and Environment, as directed by the newly formed leadership group (defined under Action Items).

Strategy Partners

Key partners include any stakeholders who attend or participate in the Statewide Traffic Records Advisory Committee.

Local Partner(s)

Cities, counties, local law enforcement.

Implementation Costs

$$$$

Barriers to Implementation

Data privacy requirements, legislation, institutional resistance, reporting methods (electronic v paper), available resources (especially at the local level), timeliness of data.

Related Strategies

- Prioritize and promote proven safety toolbox strategies.
- Implement systemic infrastructure safety improvement strategies.
- Increase education on and implementation of data-driven and automated enforcement.

Emphasis Areas Goals Supported

- Achieve a high level of safety administration efficiency.
- Achieve a high level of safety administration effectiveness.

Progress Metrics

- Percent of law enforcement agencies that adopt the web-based crash data entry form.
- Number of meetings for Statewide Traffic Records Advisory Committee.
- Number of meetings for leadership liaison group.

M PRIORITIZE AND PROMOTE PROVEN SAFETY TOOLBOX STRATEGIES

Cutsheets to come

STRATEGY DESCRIPTION

Educate state and local traffic engineers on existing, known, and effective safety toolbox strategies in transportation facility design, construction, and operation. Promote inclusion of proven strategies in design practices and development of Local Road Safety Plans. Promote funding for implementation of proven strategies, and elevate safety as a priority in transportation facility design.

SAFETY ISSUE

Known effective mitigation measures are often not being implemented due to a lack of funding, awareness, safety planning, and safety prioritization.

BENEFIT

Reduces serious injury and fatal crashes through greater use of known safety mitigation measures.

Action Items

- Identify cities and counties with the highest serious injury and fatal crash rates.
- Collect data related to the safety performance of transportation facilities statewide.
- Collect data related to proven countermeasures and their crash reduction potential.
- Prioritize proven countermeasures in the design of transportation facilities and Local Roadway Safety Plans.
- Educate state and local traffic engineers on the benefits, efficacy, and implementation of proven safety countermeasures.
- Develop a technology toolbox of proven safety countermeasures.
- Develop a transportation safety self assessment tool for local and regional jurisdictions.

Data/Supporting Information

Crash Statistics

- County roads account for **7%** of total statewide crashes but **12%** of severe crashes and **15%** of fatalities.[M1]
- Rural roads account for **21%** of total statewide crashes but **34%** of serious injury crashes and **54%** of fatal crashes.[M1]
- Centerline rumble strips have been found to reduce severe injury and fatal head-on and opposite direction sideswipe crashes by **44 to 64%**.[M2]
- When installed on rural four-lane freeways median barriers have been found to reduce cross-median crashes by **97%**.[M3]
- Local roads experience **3x** the fatality rate of the Interstate Highway System.[M4]
- The top ten counties measured by total number of 2018 fatalities in Colorado had a total of **453** roadway fatalities in 2018, out of a statewide total of **632 (72%)** [see table below].[M5]

2018 Ranking	Colorado Counties	Fatalities				
		2014	2015	2016	2017	2018
1	El Paso County	53	48	48	77	81
2	Weld County	55	55	55	66	63
3	Denver County	42	52	54	49	60
4	Adams County	32	44	60	64	51
5	Arapahoe County	30	37	46	45	47
6	Jefferson County	42	55	48	41	38
7	Larimer County	24	33	44	36	36
8	Pueblo County	19	12	20	34	36
9	Boulder County	16	19	24	31	21
10	Mesa County	13	20	17	16	20
Top Ten Counties Total		330	376	423	464	453
Al Other Counties Total		158	171	185	184	179
All Counties Total		488	547	608	648	632

Source: National Highway Traffic Safety Administration Traffic Safety Facts, Colorado (2014-2018)

FHWA Additional Resources:
Local Road Safety Plans[M6]
Local and Rural Road Safety Briefing Sheets[M7]
Developing Safety Plans - A Manual for Local Rural Road Owners[M8]

EXAMPLE

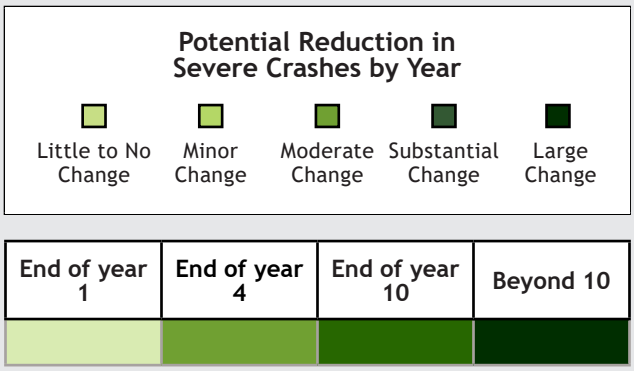
Local Road Safety Plan

In support of the Oregon DOT's Transportation Safety Action Plan, Clackamas County developed a standalone Local Road Safety Plan that established a safety goal of achieving a 50% reduction in serious injury and fatal crashes in the County over a 10-year period. The Local Road Safety Plan also identified countermeasures and short-, mid-, and long-term action items to achieve this goal.

Source: *https://safety.fhwa.dot.gov/local_rural/training/fhwasa14088*

ESTIMATED STRATEGY EFFECTIVENESS

Initially, this strategy will have very limited deployment as the first year of implementation will include education campaigns and identification of funding sources. The impacts of this strategy will rapidly grow in scale over the next decade as city and county transportation departments develop Local Road Safety Plans, countermeasures are increasingly deployed, and safety is increasingly prioritized in transportation facility design. Beyond the next decade, the prioritization of safety will continue to become the "status quo" for city and county engineers, and significant benefits will be seen statewide.



Strategy success will be achieved through partnerships and collaboration.

Strategy Champion(s)

CDOT Traffic and Safety Engineering Branch Manager with support from Colorado State Patrol.

Strategy Partners

Key partners include local city and county transportation departments and the CDOT Safety Circuit Rider.

Local Partner(s)

City and county engineers.

Implementation Costs

$$$$

Barriers to Implementation

Political will, funding, design standards, design culture, lack of local expertise.

Related Strategies

- Prioritize transportation safety funding.
- Prioritize safety in transportation planning, facility design, and project selection.
- Establish a framework for streamlining data management.
- Implement systemic infrastructure safety improvement strategies.

Emphasis Areas Goals Supported

- Build, maintain, and operate a complete and connected transportation network safe for all users.
- Reduce crashes and injuries prevalent at severe crash locations.
- All intersections' safety performance should achieve a LOSS I or II given the conditions at each location.
- All roadway segments' safety performance should achieve a LOSS I or II given the conditions at each location.

Progress Metrics

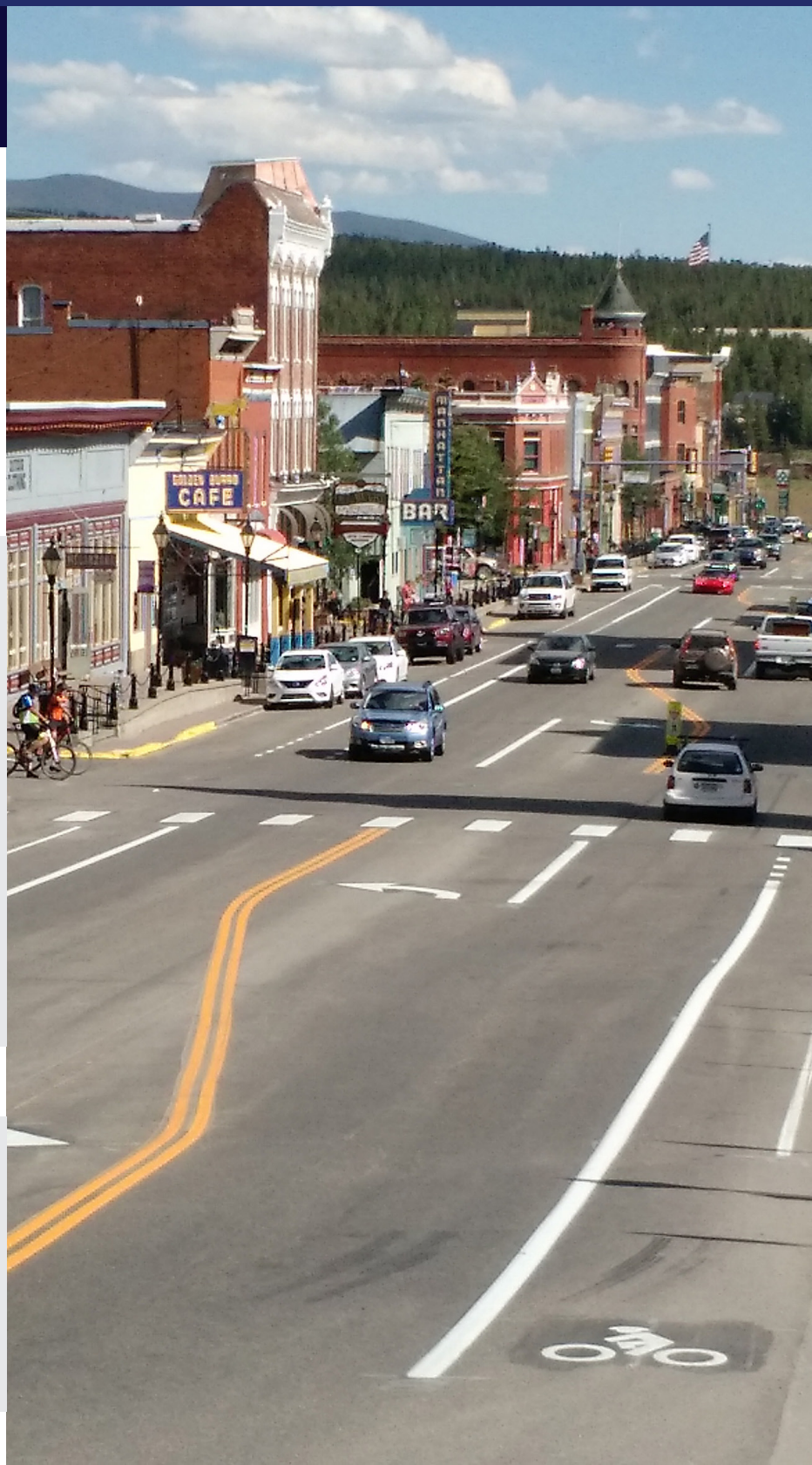
- Number and crash rates of fatal crashes, serious injury crashes, bicycle and pedestrian crashes.
- Number and% increase of safety infrastructure features, e.g., miles of median barrier, miles of rumble strips, and others.

N Cutsheets to come

IMPLEMENT SYSTEMIC INFRASTRUCTURE SAFETY IMPROVEMENT STRATEGIES

STRATEGY DESCRIPTION

Build on existing safety implementation projects and programs. Identify and implement the most effective wide-scale systemic safety mitigation strategies in conjunction with implementing hot-spot improvement projects.



SAFETY ISSUE

Many existing transportation facilities were built using inadequate or substandard safety design features. Even some recently constructed facilities could improve their safety performance. Proven countermeasures to address these issues have been developed but not incorporated in a statewide safety toolbox that is easily accessible and implementable. Simply put, Colorado's transportation infrastructure is less safe than it should be.

BENEFITS

Reduces serious injury and fatal crashes through greater use of known safety mitigation measures.

Action Items

> Establish a dedicated CDOT Safety Program champion to manage and measure progress on implementation of safety countermeasures and achievement of related safety benefits.

> Identify, research, and implement proven safety countermeasures to address overrepresented groups. These may include, but are not limited to, the example strategies provided below.

> Continue CDOT's edgeline striping and median cable barrier installation programs on rural highways.

> Continue and expand the CDOT Safety Circuit Rider program. Promote funding for implementation of proven strategies.

Data/Supporting Information

Crash Statistics

> There were **9,845** head-on/sideswipe (opposite direction) crashes on Colorado roads between 2014 and 2018, of which **642 (6.5%)** resulted in serious injury or death.[N1]

> There were **35,673** approach turn (left turn) crashes on Colorado roads between 2014 and 2018, of which **1,094 (3.1%)** resulted in serious injury or death.[N1]

> There were **12,303** crashes related to fatigued driving on Colorado roads between 2014 and 2018, of which **661 (5.4%)** resulted in serious injury or death.[N1]

> There were **75,929** crashes related to distracted driving on Colorado roads between 2014 and 2018, of which **1,591 (2.1%)** resulted in serious injury or death.[N1]

> There were **7,713** pedestrian-related crashes on Colorado roads between 2014 and 2018, of which **91%** were in urban areas. Of these urban pedestrian crashes, **22%** resulted in serious injury or death.[N1]

> **32%** of severe crashes are single-vehicle crashes, **56%** are two-vehicle crashes, and **12%** are three or more.[N1]

Potential Available Funding

> FASTER, HSIP, and CDOT Strategic Safety Funding

EXAMPLES

Immediately Implementable Safety Countermeasures

Fully Protected Left Turn Movements at Signals

Left-turn collisions are a significant safety concern at intersections, occurring when a left-turning driver misjudges a gap in opposing (and often high-speed) traffic. Left-turn phasing can be permissive, protected-permissive, or fully protected; per the Strategic Opportunities to Improve Highway Safety in Colorado white paper, conversion to fully protected left-turn phasing can reduce these crashes by up to 90%.[N2]

Median Cable Rail Barrier

Median barriers, made of either cable, concrete, or beams, separate opposite traffic on a divided highway. Cable barriers in particular are less rigid, more adaptable to slopes, less intrusive to install, and more cost-effective than other types of median barriers. Per NCHRP Report 794, when installed on rural four-lane freeways, median barriers such as these have been found to reduce cross-median crashes by 97%.

Centerline Rumble Strips

Centerline rumble strips are milled or raised elements on the pavement designed to vibrate when drivers drift from their lane, aimed at addressing head-on and sideswipe (opposite direction) crashes caused by distracted, drowsy, or inattentive drivers. Per NCHRP Report 641, centerline rumble strips have been found to reduce severe injury and fatal head-on and opposite direction sideswipe crashes by 44 to 64%.

Roundabouts

The design of a modern roundabout inherently results in reduced speeds and fewer conflict points, including the removal of all left-turn "crossing" conflict points where severe angle and broadside crashes occur. Per the Highway Safety Manual, conversion of a two-way stop-controlled intersection to a roundabout design can reduce severe crashes by 82%. Similarly, conversion of a signalized intersection to a roundabout design can reduce severe crashes by 78%.

At-Grade Highway-Rail Crossing Treatments

When driving in Colorado, drivers may encounter an at-grade highway-rail crossing that is unprotected or provides little to no advance warning that they are about to cross an active rail line. Treatments to improve safety at these crossings may include passive devices, such as signs and pavement markings, and/or active devices, such as flashing lights, automatic gates, and warning bells. The CMF Clearinghouse database provides CMFs for some of these countermeasures; for example, installation of a stop sign at an at-grade highway-rail crossing can reduce crashes by 32%, installation of flashing lights and sound signals can reduce crashes by 50%, and installation of automatic gates can reduce crashes by 67%.

Enhanced Delineation and Friction for Horizontal Curves

Enhanced delineation treatments, including enhanced pavement markings, signage with enhanced retroreflectivity, and dynamic advance warning signs, can be used to alert drivers in advance of a curve. Based on crash modification factors (CMF) from the CMF Clearinghouse database, these measures can reduce nighttime crashes by 25% and fatal and injury crashes by 16%. High-friction surface treatments are also a cost-effective way to improve safety at curves, with associated CMFs showing a 52% reduction in wet road crashes and a 24% reduction in total curve crashes.

Passing Lanes and Protected Passing Zones

Many European countries, most notably Sweden and Germany, have converted hundreds of miles of two-lane, two-way highways to a "2+1" design, in which the road is widened to a three-lane cross-section that provides alternating passing lanes. The National Cooperative highway Research Program Report 275 reviewed the 2+1 design in these countries, finding that the reconfigured roadways in Germany operated with a 36% reduction in crashes and in Sweden with a 55% reduction. The primary difference between the two countries' roadway treatments were found to be the separation between opposing traffic; while the Swedish treatment utilizes cable median barriers, Germany often provides pavement markings only.

Reduced Left-Turn Conflict Intersections

Reduced left-turn conflict intersections offer alternative designs to the "traditional" four-legged intersection, improving safety by reducing or removing conflicts between left-turning vehicles and opposing traffic flows. Examples of these designs include Restricted Crossing U-Turn and Median U-Turn intersections. These alternative designs reduce the total number of conflict points at an intersection from 32 under the "traditional" design to 14 and 16, respectively, including "crossing" conflict points where severe angle and broadside crashes occur. Based on the FHWA Proven Safety Countermeasures briefing, these two designs can reduce severe crashes by 54% and 30%, respectively.

Road Diets

Road diets typically convert an existing four-lane undivided roadway to a three-lane cross-section with one through lane per direction and a center two-way left-turn lane. Benefits of implementing a road diet include traffic calming, shorter crossing distances for pedestrians, and often the opportunity to provide painted bike lanes on each shoulder. Based on research conducted by the Federal Highway Administration, this strategy can reduce total crashes (particularly rear-end and left-turn crashes) through provision of the dedicated left-turn lane rather than a shared through/left-turn lane by 19% to 47%.

Six-Inch Edgeline Striping on Rural Highways

While the Manual on Uniform Traffic Control Devices considers a "normal" longitudinal pavement marking to have a width of 4 to 6 inches, research on longitudinal pavement striping generally considers 4-inch markings "normal" and 6-inch markings "wide." Based on research conducted in 2012, these "wide" edgelines can reduce injury and fatal crashes by as much as 38% on two-lane, two-way rural highways. A follow-up to the 2012 study estimated a benefit-cost ratio up to $55 per $1 spent on wider markings for these roadways.

Urban Pedestrian and Bicycle Safety Improvements

Urban pedestrian and bicycle safety improvements may include striping, signalization, and/or geometric changes, such as near transit stations. For example, installation of raised medians, raised crossings, or refuge islands can reduce pedestrian crashes by 25%, 30%, and 56%, respectively per FHWA's Toolbox of Countermeasures and Their Potential Effectiveness for Pedestrian Crashes. Research on the safety benefits of bicycle facilities is relatively limited; however, per NTSB's 2019 publication Bicyclist Safety on US Roadways: Crash Risks and Countermeasures, installation of separated bike lanes can result in a 23 to 28% reduction in injury crashes involving a cyclist.

EXAMPLE

Examples of Past Expenditures of HSIP Funding

The types of strategies, activities or projects funded by the federal Highway Safety Improvement Program include, but are not limited to, the following (as allowed per 23 USC 148 and 23 CFR 924):

- Roadway or Lane Departure Mitigation
- Intersection, Interchange, and Roadway Segment Safety Improvements
- Safety Improvements for Vulnerable Roadway Users
- Corridor Access Management
- Signing, Pavement Marking, and Guardrail Upgrades
- Wildlife Collision Mitigation
- Advanced Technologies and Intelligent Transportation System Devices that Mitigate Crashes (Variable Speed Limits, Ramp Meters)
- Transportation Safety Planning (Strategic Safety Plan, Safety Prioritization Studies)
- Transportation Safety Local Agency Support (Safety Circuit Rider, Local Road Safety Plans)
- Project or Corridor Level Safety Analysis Support (Safety Assessments, Road Safety Audits)
- Improvement of Safety Data and Safety Analysis Tools for Network Screening and Diagnosis (Colorado Specific Safety Performance Function Development)
- Safety Effectiveness Evaluation (Before and After Studies)

EXAMPLES

Existing Safety Strategy Toolboxes

FHWA Proven Safety Countermeasures

FHWA established the Proven Safety Countermeasures initiative in 2008 to promote proven infrastructure-related countermeasures and encourage widespread implementation of these measures by transportation agencies at all levels to reduce serious injury and fatal crashes on American highways. The list of countermeasures was most recently updated in 2017 and now includes these 20 strategies:

<u>Roadway Departure</u>

- **Enhanced Delineation and Friction for Horizontal Curves**
- **Longitudinal Rumble Strips and Stripes**
- **SafetyEdgeSM**
- **Roadside Design Improvements at Curves**
- **Median Barriers**

<u>Intersections</u>

- **Backplates with Retroreflective Borders**
- **Corridor Access Management**
- **Left- and Right-Turn Lanes at Two-Way Stop-Controlled Intersections**
- **Reduced Left-Turn Conflict Intersections**
- **Roundabouts**
- **Systemic Application of Multiple Low-Cost Countermeasures at Stop-Controlled Intersections**
- **Yellow Change Intervals**

<u>Pedestrians/Bicycles</u>

- **Leading Pedestrian Intervals**
- **Medians and Pedestrian Crossing Islands in Urban and Suburban Areas**
- **Pedestrian Hybrid Beacons**
- **Road Diets/Reconfigurations**
- **Walkways**

<u>Crosscutting</u>

- **Local Road Safety Plans**
- **Road Safety Audits**
- **USLIMITS2**

Source: https://safety.fhwa.dot.gov/provencountermeasures

MnDOT Traffic Safety Fundamentals Handbook

The Minnesota DOT updated its Traffic Safety Fundamentals Handbook in 2015, including a safety toolbox with "proven," "tried," and "experimental" strategies. The toolbox identified these 22 infrastructure-related strategies:

Urban

- Conversions (Road Diets)
- Access Management
- Confirmation Lights
- Advanced Walk
- Countdown Timers
- Curb Extensions
- Median Refuge Island

Rural Segments

- 6-Inch Latex Edge Line
- Rumble Strip/Stripe
- 2-Foot Paved Shoulder and Rumble Strip
- Centerline Rumble Strip
- 4-Foot Buffer
- 12-Foot Buffer with Left Turn Lanes

Rural Curves

- Chevrons
- Edgeline Rumble Strip
- 2-Foot Paved Shoulder and Rumble Strip

Rural Intersections

- Roundabout
- RCI (J-Turn)
- Mainline Dynamic Warning Sign
- Intersection Lighting
- Upgrade Signs and Markings
- Clear Sight Triangle

Source: http://www.dot.state.mn.us/stateaid/trafficsafety.html

Governors Highway Safety Association Speeding Away from Zero

The Governors Highway Safety Association released a report in January 2019 spotlighting the prevalence of speeding in driving culture and identifying countermeasures to reduce the rate and severity of speed-related crashes. Infrastructure-related countermeasures include:

- Flashing Beacons
- Profile Thermoplastic Markings
- Raised Pavement Markers, Reflectors, or Panels of Retroreflective Sheeting
- Curb Bump-Outs
- Speed Humps
- Refuge Islands
- Roundabouts

Source: https://www.ghsa.org/resources/Speeding19

FHWA Toolbox of Countermeasures and Their Potential Effectiveness for Pedestrian Crashes

In May 2008 FHWA developed a brief to estimate the pedestrian crash reduction associated with implementation of one or more countermeasures The brief identifies a number of countermeasures, including:

Signalization

- Add Exclusive Pedestrian Phasing
- Replace Existing WALK/DON'T WALK Signals with Pedestrian Countdown Signal Heads
- Implement a Leading Pedestrian Interval
- Convert Permissive to Protected-Only Left-Turn Phasing

Geometric

- Convert Intersection to Roundabout
- Install Raised Median
- Install Raised Pedestrian Crossing
- Install Refuge Islands
- Install Sidewalk
- Provide Paved Shoulder
- Narrow Roadway Cross-Section

Signs/Markings/Operational

- Add Intersection/Segment Lighting
- Improve Pavement Friction
- Prohibit Right-Turn-On-Red
- Prohibit Left Turns
- Restrict Parking Near Intersections

Source: https://safety.fhwa.dot.gov/ped_bike/tools_solve/ped_tctpepc

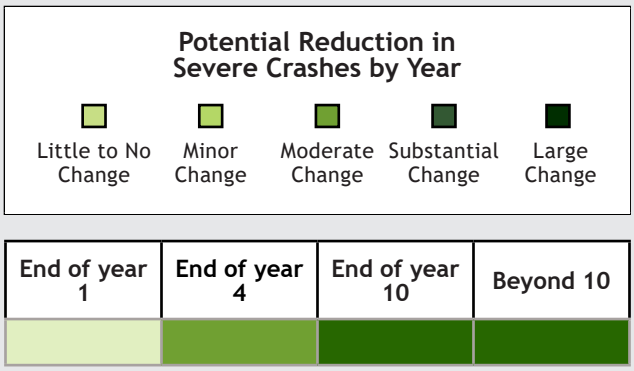
CDOT Key Transportation Safety Improving Strategies

CDOT has compiled a list of key strategies to prioritize to reduce crash rates and severities on transportation facilities, based on the guidance provided by FHWA, CDOT, NHTSA, and NCHRP. Infrastructure-related strategies identified include:

- Median Cable Rail
- Centerline and Shoulder Rumble Strips
- 6-Inch Edgeline Striping on Rural Highways
- Standard Shoulders
- Passing Lanes and Protected Passing Zones
- Striping, Signing, and Curve Warning on Local Roads
- Signal Timing and Left-Turn Protection at Signalized Intersections
- Conversion to Roundabouts
- Variable Speed Limits on Freeways
- New and Upgraded Guardrails
- Centerline Rumble Strip
- 4-Foot Buffer
- 12-Foot Buffer with Left-Turn Lanes

ESTIMATED STRATEGY EFFECTIVENESS

Initially, this strategy may have somewhat limited deployment as the first year of implementation will include identification of appropriate and implementable strategies. The impacts of this strategy will rapidly grow in scale over the next decade as funding increases and priority changes allow for greater implementation. Significant benefits will continue to be seen beyond this first decade as safety strategies continue to be implemented and new strategies are developed and added to the toolbox.



Strategy success will be achieved through partnerships and collaboration.

Strategy Champion(s)

CDOT Traffic and Safety Engineering Branch Manager.

Strategy Partners

Key partners include local city and county transportation departments and CDOT Region Traffic Engineers.

Local Partner(s)

City and county engineers.

Implementation Costs

$$$$$

Barriers to Implementation

Political will, funding, lack of local expertise.

Related Strategies

> Prioritize transportation safety funding.

> Prioritize safety in transportation planning, facility design, and project selection.

> Establish a framework for streamlining data management.

> Prioritize and promote proven safety toolbox strategies.

Emphasis Areas Goals Supported

> Build, maintain, and operate a complete and connected transportation network safe for all users.

> Reduce crashes and injuries prevalent at severe crash locations.

> All intersections' safety performance should achieve a LOSS I or II given the conditions at each location.

> All roadway segments' safety performance should achieve a LOSS I or II given the conditions at each location.

Progress Metrics

> Number and crash rates of fatal crashes, serious injury crashes, bicycle and pedestrian crashes.

> Number and percent increase of safety infrastructure features, e.g., miles of median barrier, miles of rumble strips, etc.

Cutsheets to come

INCREASE EDUCATION ON AND IMPLEMENTATION OF DATA-DRIVEN AND AUTOMATED ENFORCEMENT

STRATEGY DESCRIPTION

Increase implementation of data-driven enforcement for speeding and red-light running at high-crash locations. Educate decision-makers on the effectiveness of automated enforcement as a safety enhancement rather than as a revenue generator.

SAFETY ISSUE

A disproportionately high number of severe crashes occur on a relatively small proportion of roadways and intersections. Limited enforcement resources may not be deployed in the most efficient way to cover these locations. Automated enforcement is significantly underutilized as a tool to affect driver behavior.

BENEFITS

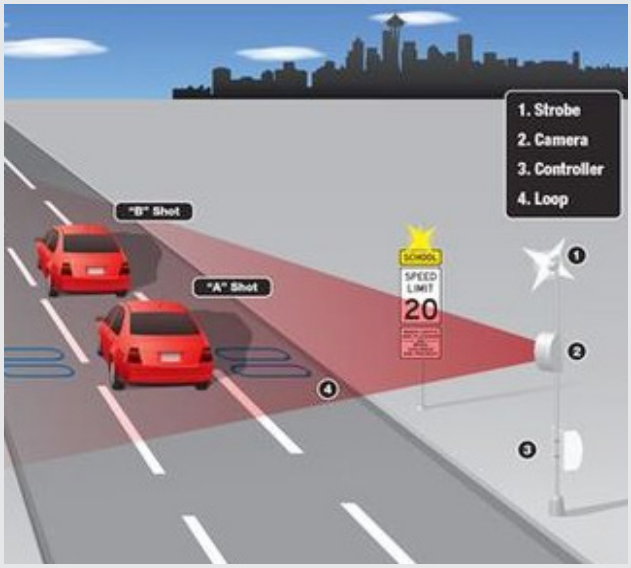
- Reduces the number of severe crashes at high crash locations and improves safety culture.
- Allows for more efficient use of limited resources.

Action Items

- Create a step-by-step guide for local agencies on how to implement automated or data-driven enforcement, including how to tie revenue generated through enforcement in school zones to Safe Routes to School funding.
- Research and develop a white paper that demonstrates the effectiveness of data-driven and automated enforcement at increasing safety.
- Conduct education before enforcement first in communities that are historically marginalized.
- Partner with Safety Circuit Rider program.

Data/Supporting Information

- In 2018, **23%** of fatalities in Colorado resulted from issues related to speeding [16%] and disregarding a traffic device [7%]).
- In Denver, **50%** of traffic fatalities occurred on **5%** of the city's streets from 2013 to 2016.[02]
- A study conducted in Spain showed that fixed speed cameras reduced crash rates by **30%** on urban arterials and highways.[03]
- In a study of 253 signalized intersections in Belgium, red light and speed cameras resulted in a **14%** reduction in severe crashes.[04]



EXAMPLE

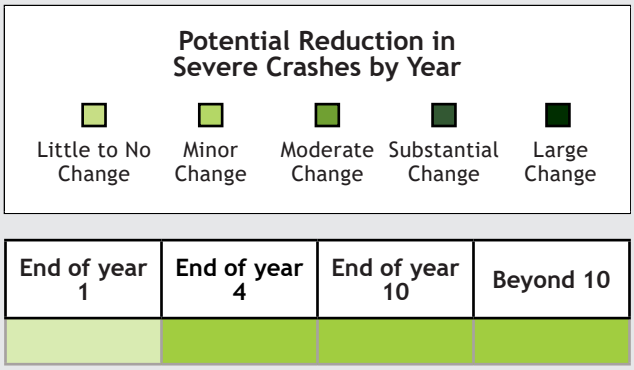
Seattle DOT School Zone Speed Cameras

The City of Seattle uses fixed cameras to enforce school zone speed limits at 14 schools. One of the many aspects of the program worth modeling is the use of revenue generated to invest in Safe Routes to Schools improvements, such as enhanced crosswalks, sidewalks, and traffic calming around schools.

Source: *https://www.seattle.gov/police/community-policing/school-zone-enforcement*

ESTIMATED STRATEGY EFFECTIVENESS

This strategy will initially have very limited deployment as the first few years of implementation will involve research and reporting the data-driven effectiveness of automated enforcement to decision-makers. The impact over the next decade will be relatively moderate as automated enforcement is a location-based, data-driven strategy. This strategy will impact driver behavior at the locations where it is implemented.



Strategy success will be achieved through partnerships and collaboration.

Strategy Champion(s)

CDOT Traffic and Safety Engineering Branch Manager alongside Colorado State Patrol.

Strategy Partners

Key partners include the Office of Transportation Safety at CDOT and local agencies.

Local Partner(s)

Local law enforcement.

Implementation Costs

$$$

Barriers to Implementation

Funding, available data, cultural, judicial, and local resistance, available resources.

Related Strategies

> Build a safety advocacy coalition.

> Establish a framework for streamlining data management.

Emphasis Areas Goals Supported

> Have laws that effectively support transportation safety.

> Reduce crashes and injuries prevalent at severe crash locations.

Progress Metrics

> Number and percentage of communities with policies favorable for automated/data-driven enforcement.

> Number of locations that have demonstrated improvements in safety performance due to automated/data driven enforcement.

TIER II AND TIER III STRATEGIES

During the strategy development process, stakeholders found additional strategies to be important, however, they were not selected as their top priority. Tier II Strategies were identified by the stakeholders or the FHWA and are categorized as supporting strategies, as shown in *Table 3*. Tier III Strategies are categorized as the lower priority strategies and can be found in *Table 4*. Each table provides a description and identifies the related Emphasis Area(s) for each of the lower tiered strategies.

TABLE 3: Tier II Strategies

ID	Strategy	Description	Emphasis Area			
			Programmatic	High-Risk Behavior	Vulnerable Roadway User	Severe Crash Mitigation
Tier II						
AA	Explore and adopt context-sensitive speed limit setting protocols	> Research context-sensitive speed limit setting protocols > Coordinate with state and local agencies to establish standards for speed limit setting	◆	◆	◆	◆
BB	Advocate for more impactful fees and sentencing guidelines (e.g., repeat offender increases)	> Coordinate with the safety coalition Tier I strategy > Educate decision-makers on the need for more impactful fees and sentencing for repeat offenders > Support local level law enforcement for addressing the non-licensed drivers / repeat offenders	◆	◆	◆	
CC	Optimize incident management response practices	> Institutionalize standards for incident management response statewide			◆	◆
DD	Implementation of correct work zone traffic control practices for vulnerable roadway users especially on city and county roads	> Consider the development of a local level roadside safety task force > Institutionalize best practices for roadside workers			◆	◆
EE	Educate workers on safe roadside practices (e.g., the importance of wearing personal protective equipment)	> Develop education campaigns targeted at roadside safety > Deploy the campaigns statewide at both the state and local levels			◆	◆
FF	Develop a comprehensive education campaign around vulnerable roadway users	> Perform outreach aimed at vulnerable roadway users > Target high-risk behaviors of vulnerable roadway users > Target bicyclists - rules for biking on roads and multi use paths > Conduct campaigns to educate the driving population about the safety of roadside workers, e.g., first responders and work zones			◆	◆

ID	Strategy	Description	Emphasis Area			
			Programmatic	High-Risk Behavior	Vulnerable Roadway User	Severe Crash Mitigation
GG	Educate the public on how to navigate new infrastructure (e.g., roundabouts and diverging diamonds)	> Develop campaigns on navigating new infrastructure for driving population > Engage student driving classes and include the education of new infrastructure as part of driver licensing class requirements	◆			◆
HH	Engage with vulnerable roadway users during the project planning and design processes	> Consider vulnerable roadway user needs in both the planning and design process > Engage advocacy groups, task forces, and local agencies > Establish standards/guidelines for consistency between communities, state and local infrastructure			◆	◆
II	Emphasize effects on driver behavior of roadway design during project planning and design	> Engage behavior experts, task forces, and advocacy groups during project planning and design processes	◆	◆	◆	◆
JJ	Research high-risk behaviors	> Coordinate with existing high-risk task forces and develop research program > Identify trends that will require additional resources to research	◆	◆		
KK	Ensure new vehicle licensing and registration for vehicles with advance technologies exceed existing vehicle safety levels	> Evaluate the possibly of an incentive program for drivers who register a vehicle with advance technologies > Engage insurance companies and in-vehicle technology companies	◆	◆		
LL	Implement technological advances as they become available	> Develop a technology task force to lead the implementation of new technology for safety measures > Utilize the technology toolbox in the STSP	◆	◆	◆	◆
MM	Implement automated enforcement	> Coordinate with local agencies to incorporate automated enforcement at data-driven high-crash locations			◆	◆
NN	Implement railroad crossing outreach programs	> Continue to fund CDOT's Railroad Program to analyze railroad crossings using a risk-based analysis system to identify high-risk crossings and appropriate countermeasures		◆		

TABLE 4: Tier III Strategies

ID	Strategy	Description	Emphasis Area			
			Programmatic	High-Risk Behavior	Vulnerable Roadway User	Severe Crash Mitigation
Tier III						
AAA	Increase amount of passing lanes and signage to reduce driver aggression and frustration	> Use crash data / crash statistics to determine locations where passing lanes could be considered > Develop a standard for passing lane signing and striping for statewide consistency	◆			◆
BBB	Provide additional information and advance warnings about work zones and other roadway activities	> Evaluate the need for public awareness campaigns about work zones and construction projects especially in the local communities			◆	◆
CCC	Provide ride home programs for impaired drivers, including rural areas	> Engage ride share companies during program development > Coordinate with local / rural law enforcement and establishments that serve alcohol > Incentivize impaired drivers to use ride home programs instead of getting behind the wheel		◆		
DDD	Develop education campaigns around severe crash locations	> Use data/ crash statistics to determine which locations need additional education > Develop campaigns to educate the driving population and vulnerable roadway users about target locations			◆	◆
EEE	Educate the public on how smart cars don't solve all safety problems	> Develop an education campaign regarding the capabilities of smart car technology	◆	◆	◆	◆
FFF	Advocate and educate decision-makers on the effectiveness of required motor vehicle safety inspections	> Research states that have mandatory motor vehicle safety inspections > Develop a coalition to advocate for safety inspections – could be included in Tier I Safety Coalition strategy > Provide ride home programs for impaired drivers, including in rural areas > Engage ride share companies during program development > Coordinate with local / rural law enforcement and establishments that serve alcohol > Incentivize impaired drivers to use ride home programs instead of getting behind the wheel	◆	◆		◆
GGG	Include vulnerable roadway user needs in transportation engineering curriculum	> Engage college administration and professors with transportation engineering curriculums > Develop curriculum with experts and advocacy groups for vulnerable roadway users			◆	
HHH	Address multicultural challenges (e.g., language barriers)	> Engage multicultural advocacy groups and communities during the planning and design processes	◆	◆	◆	◆

TECHNOLOGY

The STSP would be remiss if it did not recognize the role new technologies are increasingly playing in the operation of transportation systems globally. Several recent studies have been conducted by regional and state agencies that are collaborating to specifically establish programs and policies to effectively incorporate technology into transportation improvements. Because many of these emerging technologies are proven to support and improve safety measures, this STSP includes a "Toolbox of Technologies" tied to the strategies. Additional technology countermeasures, as well as detailed descriptions of the top 22, are contained in the Technology Toolbox in the Resource Guide of this STSP. The top 22 technologies assumed to have the lowest cost with the highest benefit (related to the Tier I Strategies for rural and urban environments) are identified in *Table 5*.

TABLE 5: Technologies that Support Tier I Strategies

Existing Technology	Urban Deployment	Rural Deployment	Tier I Strategy Correlation
Automatic Crash Notification Systems		◆	• Prioritize and promote proven safety toolbox strategies
Breathalyzer Vehicle Interlock	◆	◆	• Build a safety advocacy coalition • Prioritize and promote proven safety toolbox strategies • Increase education on and implementation of data-driven and automated enforcement.
Adaptive Control Decision Support System (ACDSS)	◆		• Establish a framework for streamlining data management • Prioritize and promote proven safety toolbox strategies
Curve Warning Systems		◆	• Prioritize and promote proven safety toolbox strategies • Prioritize safety in transportation planning, facility design, and project selection
Do Not Disturb While Driving	◆	◆	• Prioritize and promote proven safety toolbox strategies
Dynamic Queue Ahead Warning Systems		◆	• Prioritize and promote proven safety toolbox strategies • Prioritize safety in transportation planning, facility design, and project selection
Emergency Truck Parking		◆	• Prioritize and promote proven safety toolbox strategies
Freight Signal Priority	◆	◆	• Prioritize and promote proven safety toolbox strategies
Green Wave Systems (Coordinated Signals)	◆		• Prioritize and promote proven safety toolbox strategies • Prioritize safety in transportation planning, facility design, and project selection
Highway-Rail Grade Crossing Systems	◆	◆	• Prioritize and promote proven safety toolbox strategies • Prioritize safety in transportation planning, facility design, and project selection
In-Road Pedestrian Crossing LEDs	◆	◆	• Prioritize and promote proven safety toolbox strategies • Prioritize safety in transportation planning, facility design, and project selection

Existing Technology	Urban Deployment	Rural Deployment	Tier I Strategy Correlation
Intersection Collision Warning Systems		◆	• Prioritize and promote proven safety toolbox strategies • Prioritize safety in transportation planning, facility design, and project selection
Limited Sight Distance Warning Systems		◆	• Prioritize and promote proven safety toolbox strategies • Prioritize safety in transportation planning, facility design, and project selection
Local Road Safety Plans	◆	◆	• Establish a framework for streamlining data management • Prioritize and promote proven safety toolbox strategies • Prioritize safety in transportation planning, facility design, and project selection
Optical Cameras with Machine Learning Algorithms	◆		• Prioritize safety in transportation planning, facility design, and project selection • Establish a framework for streamlining data management
Passive Pedestrian and/or Bike Detection	◆		• Prioritize and promote proven safety toolbox strategies • Prioritize safety in transportation planning, facility design, and project selection
Photo Radar Enforcement Vans	◆		• Prioritize and promote proven safety toolbox strategies • Increase education on and implementation of data-driven and automated enforcement.
Protected Yet Concurrent Phasing Scheme	◆		• Prioritize and promote proven safety toolbox strategies • Prioritize safety in transportation planning, facility design, and project selection
Road Geometry Warning Systems		◆	• Prioritize and promote proven safety toolbox strategies • Prioritize safety in transportation planning, facility design, and project selection
Road Safety Audits (RSA)	◆	◆	• Establish a framework for streamlining data management • Prioritize and promote proven safety toolbox strategies • Prioritize safety in transportation planning, facility design, and project selection
Work Zone Intrusion Alarms	◆	◆	• Prioritize and promote proven safety toolbox strategies
Wrong Way Detection Systems	◆		• Prioritize and promote proven safety toolbox strategies • Increase education on and implementation of data-driven and automated enforcement. • Prioritize safety in transportation planning, facility design, and project selection

PERFORMANCE TRACKING

CDOT is proposing that the next update to the STSP occur in four years (2023), concurrent with the next update to Your Transportation Plan. In the interim, the Emphasis Area Teams have agreed to develop a methodology to track the implementation of the plan strategies and to evaluate their effectiveness in meeting the plan performance measures. The statewide safety champion will check in annually with the Emphasis Area Teams to monitor progress. In addition, two years into plan implementation, it is suggested that the stakeholders hold a workshop to evaluate the progress of the plan so that interim adjustments to strategies, action items, or performance measures can be made prior to the end of the four-year cycle. The ongoing monitoring and the mid-point performance review allow Colorado to take advantage of the most current safety program measures and maintain a focus on the strategies that are the most effective in keeping everyone safe on Colorado's roads.

Tier I Strategies Sources for Data/Supporting Information

Strategy A: Name a safety champion to lead a proactive safety program

A1. Insurance Institute for Highway Safety (IIHS). 2017. State by State Fatality Facts https://www.iihs.org/topics/fatality-statistics/detail/state-by-state.

Strategy F: Education campaign for high-risk behaviors

F1. CDOT Crash Data Intelligence Unit.
F2. CDOT Crash Database for Colorado.
F3. National Highway Traffic Safety Administration (NHTSA) database. https://cdan.nhtsa.gov/SASStoredProcess/guest.
F4. Annual CDOT Statewide Seatbelt Survey (2014-2018).

Strategy G: Provide transportation safety education to students and families

G1. C DiMaggio and G Li, "Effectiveness of a Safe Routes To School Program In Preventing School-Aged Pedestrian Injury." Pediatrics 131, iss 2 (2013): 290-296.
G2. Percer, J. 2009. Child pedestrian safety education: Applying learning and developmental theories to develop safe street crossing behaviors (Report No. DOT HS 811 190). Washington, DC: National Highway Traffic Safety Administration. Retrieved from www.nhtsa.gov/DOT/NHTSA/Traffic%20Injury%20Control/Articles/Associated%20Files/811190.pdf.
G3. McDonald, N. C., Steiner, R. L., Lee, C., Rhoulac Smith, T., Zhu, X., & Yang, Y. 2014. Impact of the safe routes to school program on walking and bicycling. Journal of the American Planning Association, 80(2), 153-167. doi: 10.1080.

Strategy H: Prioritize transportation safety funding

H1. Insurance Institute for Highway Safety (IIHS). Fatality Facts. 2018. https://www.iihs.org/topics/fatality-statistics/detail/state-by-state. McDonald, N. C., Steiner, R. L., Lee, C., Rhoulac Smith, T., Zhu, X., & Yang, Y. (2014). Impact of the safe routes to school program on walking and bicycling. Journal of the American Planning Association, 80(2), 153-167. doi: 10.1080

Strategy I: Prioritize safety in transportation planning, facility design, and project selection

I1. https://www.codot.gov/safety/safety-data-sources-information/colorado-problem-identification-id-reports/2019-problem-id-report.
I2. CDOT Traffic and Safety Engineering Branch.

Strategy J: Educate decision-makers on the effectiveness of occupant protection laws

J1. http://www.teendrivingallianceco.com/2018/12/new-motor-vehicle-safety-fact-sheet.html (Use Rates in the States and Territories. Traffic Safety Fact, NHTSA, 2017)
J2. National Highway Traffic Safety Administration (NHTSA) database. https://cdan.nhtsa.gov/SASStoredProcess/guest.
J3. Richard, C. M., Magee, K., Bacon-Abdelmoteleb, P., & Brown, J. L. 2018, April. Countermeasures that work: A highway safety countermeasure guide for State Highway Safety Offices, Ninth edition (Report No. DOT HS 812 478). Washington, DC: National Highway Traffic Safety Administration.
J4. DiExSys. 2019. Strategic Opportunities to Improve Highway Safety in Colorado white paper.
J5. https://www.ems.gov/pdf/810956.pdf.
J6. https://www.transportation.gov/mission/health/strengthen-helmet-laws.

Strategy K: Increase requirements for new and renewal driver licensing

K1. https://www.siegfriedandjensen.com/passing-the-test/.
K2. CDOT Crash Database for Colorado.

Strategy M: Prioritize and promote proven safety toolbox strategies

M1. CDOT Crash Database for Colorado.
M2. National Cooperative Highway Research Program. 2009. Report 641. Guidance for the Design and Application of Shoulder and Centerline Rumble Strips. http://www.cmfclearinghouse.org/studydocs/nchrp_rpt_641-GuidanceRumbleStrips.pdf.
M3. National Cooperative Highway Research Program (NCHRP). 2014. Report 794. Median Cross-Section design for Rural Divided Highways.
M4. Fatality Analysis Reporting System (FARS) and Federal Highway Administration (FHWA) Statistics Series. 2014.
M5. National Highway Traffic Safety Administration (NHTSA). Traffic Safety Facts, Colorado (2014-2018).
M6. https://safety.fhwa.dot.gov/provencountermeasures/local_road/
M7. https://safety.fhwa.dot.gov/local_rural/training/fhwasa14088
M8. https://safety.fhwa.dot.gov/local_rural/training/fhwasa12017.

Strategy N: Implement infrastructure safety improvement strategies

N1. CDOT Crash Database for Colorado.

N2. DiExSys. 2019. Strategic Opportunities to Improve Highway Safety in Colorado white paper.

Strategy O: Increase education on and implementation of data-driven and automated enforcement

O1. Fatality Analysis Reporting System (FARS) Data.
O2. City and County of Denver. 2016. Denver Vision Zero Action Plan. https://www.denvergov.org/content/dam/denvergov/Portals/705/documents/visionzero/Denver-Vision-Zero-Action-Plan.pdf.
O3. Novoa, A., Pérez,K., Santamariña-Rubio,E., Marí-Dell'Olmo,M., and Tobías,A. 2009. "Effectiveness of speed enforcement through fixed speed cameras: a time series study." Injury Prevention, Vol. 16, Issue 1, pp. 12-16.
O4. De Pauw, E, S. Daniels, T. Brijs, E. Hermans, and G. Wets. "To brake or to accelerate? Safety effects of combined speed and red light cameras". Journal of Safety Research, Vol. 50, (2014) pp.59-65.

CHAPTER 3

Data Analysis

Data Analysis

An analysis of statewide and national crash data provided insight to the trends that have occurred in Colorado from 2014 to 2018. Preliminary data for the number of fatalities in 2019 demonstrates similar trends exhibited from 2014 to 2018. The results of the 2014 to 2018 data analysis were presented to the 2020-2023 Colorado Strategic Transportation Safety Plan (STSP) Executive and Steering Committee members, Regional Stakeholder Workshop participants, and Emphasis Area Teams. The goals and strategies developed for the STSP to reduce severe crashes around the state were driven by the findings presented in this crash data analysis.

METHODOLOGY

The industry standard practice is to analyze at least five years of crash data to provide a statistically significant dataset and analysis. The data used in this analysis reflects all crashes included in CDOT's crash database in the five-year period from 2014 through 2018. This database includes all roads across Colorado, encompassing state, local, and tribal jurisdictions. Additional national databases were used to supplement the CDOT database. These national sources were primarily used to make comparisons between Colorado and national averages, and to analyze the effectiveness and potential utility of proven countermeasures.

Even with the robust database that CDOT currently maintains, there were pieces of data that were either incomplete or absent that would have provided additional insight to the data analysis—for example, seatbelt use, distracted driving, and the assumed unreported crashes when law enforcement was not contacted. Regardless of its limitations, the available crash data played an important role in the safety strategy decisions of this plan.

Data Sources

CDOT

As required by 23 U.S.C. 148, 23 U.S.C. Section 405, the Fatality Analysis Reporting System (FARS), and other federal and state rules and guidance, CDOT maintains a database of crash data that informs its programs and strategies to improve traffic and highway safety statewide. CDOT obtains crash data according to an established process.

When a crash occurs, an officer investigates and fills out a crash form that is sent to the Colorado Department of Revenue (CDOR). Since 2006, CDOR has used crash form DR 2447, but is in the process of transitioning to crash form DR 3447 to address the evolving transportation landscape in Colorado. This data analysis uses reports from the DR 2447 form.

CDOR processes the crash record and enters it into a database called DRIVES where the official, legal record is maintained. CDOT downloads data from the DRIVES system for crashes, excluding private property and counter reports. (Counter reports are crash reports that are self-reported by drivers and are not investigated by an officer.)

To process or "code" the crash data received from CDOR, CDOT adds a field for crash type, corrects detectable errors, updates location information where available, and normalizes the data. This process creates a working database that CDOT uses for analyses related to its safety programs and projects. For example, this data is used to identify crash patterns, over-representation of crashes for a specific roadway type or volume, inform statewide planning, develop crash mitigation projects, and identify behavioral patterns for the development of programs, such as "click it or ticket" and holiday impaired driving campaigns.

CDOT typically compiles the data every six months, with an approximately three-month delay before the data is released. CDOT may delay the release of data to address known deficiencies, correct data, or download data that is delayed through the CDOR process.

Colorado has two federally recognized tribes, the Southern Ute Indian Tribe and the Ute Mountain Ute Tribe. Crashes that occur on these Indian reservations are recorded by tribal police and some of the records are shared with CDOT. CDOT then incorporates these crashes into the statewide database. When provided to CDOT, crashes on federal lands such as national parks, national forest, and Bureau of Land Management lands are included in the database. However, these crashes may not always be provided to the state.

Other Sources

The National Highway Traffic Safety Administration (NHTSA) is a federal agency whose mission is to save lives, prevent injuries, and reduce economic costs due to road traffic crashes, through education, research, safety standards, and enforcement. NHTSA maintains FARS, which is a separate database containing only records of fatal crashes that contains more detailed data than CDOT's data on fatal injuries suffered in motor vehicle traffic crashes. The information in the FARS database is collected through a variety of nationwide sources, including coroner toxicology results, death certificates, initial fatal blotter notifications, and supplemental information. Fatal crashes included in the database meet the NHTSA definition of a fatal crash, which may not include all crashes involving a death. Examples of crashes that are not in the FARS database include deaths not resulting from the injuries sustained in the crash, such as suicides or existing medical conditions. FARS data is published annually on December 31 of the following year of the reported data. For example, 2015 data was published on December 31, 2016.

Other sources included data from the Insurance Institute for Highway Safety (IIHS). IIHS is an independent, nonprofit scientific and educational organization dedicated to reducing the losses - deaths, injuries, and property damage - from motor vehicle crashes. IIHS obtains data from a variety of sources, including NHTSA's FARS database, FHWA, and scientific research papers. Their published reports are a resource for transportation safety professionals across the country.

Severity Definitions

The crash form (DR 2447) used for CDOR's DRIVES database from 2014 to 2018 categorizes crashes into five severity levels shown in *Figure 6*.

- Level 1 is no injury.
- Level 2 is possible injury. A possible injury is any injury reported or claimed which is not a fatal, incapacitating, or non-incapacitating evident injury.
- Level 3 is evident, non-incapacitating injury. This type of injury is evident to observers at the scene, but is not a fatal or incapacitating injury. Examples include bruises, lumps, and lacerations. Injuries that cannot be seen, such as limping or complaints of pain, are classified as possible injury.
- Level 4 is evident, incapacitating injury. Any injury (other than a fatal injury) that prevents the injured person from walking, driving, or normally continuing the activities the person was capable of performing before the injury is an incapacitating injury. Examples include severe lacerations, broken limbs, and skull, chest, or abdominal injuries. Momentary unconsciousness is not included.
- Level 5 is fatal injury. For the purposes of the accident report, a fatal injury is any injury that results in death within thirty days of the accident.

Figure 6: Crash Severity Definitions

Analysis

The crash analysis for the STSP was based on five years of CDOT crash data from 2014 to 2018, which reflects crashes on all roadway facilities in Colorado, including state-, local-, and tribal-owned roads. Crashes on federal lands are not always provided to CDOT. Any crashes CDOT receives are included in the database. Based on the severity categories of Level 1 through Level 5, each crash record was designated as a minor crash, serious injury crash, or fatal crash. Collectively, serious injury crashes and fatal crashes are referred to as the severe crashes shown in *Figure 7*.

The data was analyzed by time, age of driver, roadway facility, road condition, weather condition, land use, crash type, most harmful event, vehicle type, driver impairment, primary factor, and other key fields within the crash database. Each of these data sets was summarized by year, crash severity, and CDOT region to identify trends.

Throughout the analysis process, data was scrubbed as needed. For example, most data fields have an option for an "unknown" input. Crash reports with "unknown" in the data fields were generally excluded from a particular analysis, so the results only reflect those inputs that are "known." In these cases, the total number of crashes used for a particular analysis would be lower than the total number of crashes reflected within the five-year database.

Further, some input terminology changed across years. For example, under the most harmful event field, inputs included both "Sideswipe (Opposite Direction)" and "Sideswipe Opposite Direction," where the only difference is in use of parentheses. These inputs were combined, and the numbers of crashes in both were summed to reflect a single most harmful event of sideswiping when vehicles were traveling in opposite directions. These discrepancies were also scrubbed in the crash type, vehicle type, driver impairment, and primary factor fields, in addition to the most harmful event field.

When the CDOT database was insufficient for analysis, supplemental data was used. In particular, NHTSA data was used to estimate the number of lives saved based on various countermeasures, and the IIHS data was used to draw a crash rate comparison between Colorado and other states.

Finally, unless stated otherwise, the data used in the analysis is presented at the crash level instead of the person level. For example, in the five-year analysis period (2014-2018), 183 fatal crashes (crash level) had more than one fatality per crash (person level), so the numbers of fatal crashes would not equal the numbers of fatalities. The same distinction would apply to the numbers of serious injuries (person level) and numbers of serious injury crashes (crash level).

CRASH ANALYSIS RESULTS

Crash data analysis in Colorado from 2014 through 2018 are presented according to crash severity trends, crash characteristics, driver and vehicle characteristics, and roadway and land use characteristics.

Crash Severity Trends

Table 6 shows the number of crashes by severity by year. Between 2014 and 2018, the number of total crashes in Colorado increased from 115,566 to 122,192, an increase of 6%; and the number of fatal crashes increased from 451 to 588, an increase of 30%. Serious injury crashes remained consistent with 2,625 in 2014 and 2,637 in 2018. Serious injury crashes are less susceptible to randomness as opposed to fatal crashes and therefore are generally considered a better statistic to measure safety. Despite the increase in total number of crashes, the crash rate per 10,000 population has decreased since 2014 because during the same time the population across the state was growing rapidly.

TABLE 6: Crash Severity by Year

Statewide Statistics	2014	2015	2016	2017	2018
Minor Crashes	112,490	117,802	118,067	116,320	118,967
Serious Injury Crashes	2,625	2,624	2,431	2,347	2,637
Fatal Crashes	451	507	558	600	588
Total Crashes	115,566	120,933	121,056	119,267	122,192
Statewide Population	5,351,218	5,452,107	5,540,921	5,615,902	5,695,564
Crashes per 10,000 Population	216.0	221.8	218.5	212.4	214.5

Source: ACS 1-Year Estimates

Table 7 shows the serious injury and fatal crash rates per vehicle miles traveled (VMT) and population. Although the number of serious injury crashes remained consistent from 2014 to 2018, the serious injury crash rates decreased 9% per 100 million VMT because of population growth during the same time. The fatal crash rate per 100 million VMT increased 18% between 2014 and 2018.

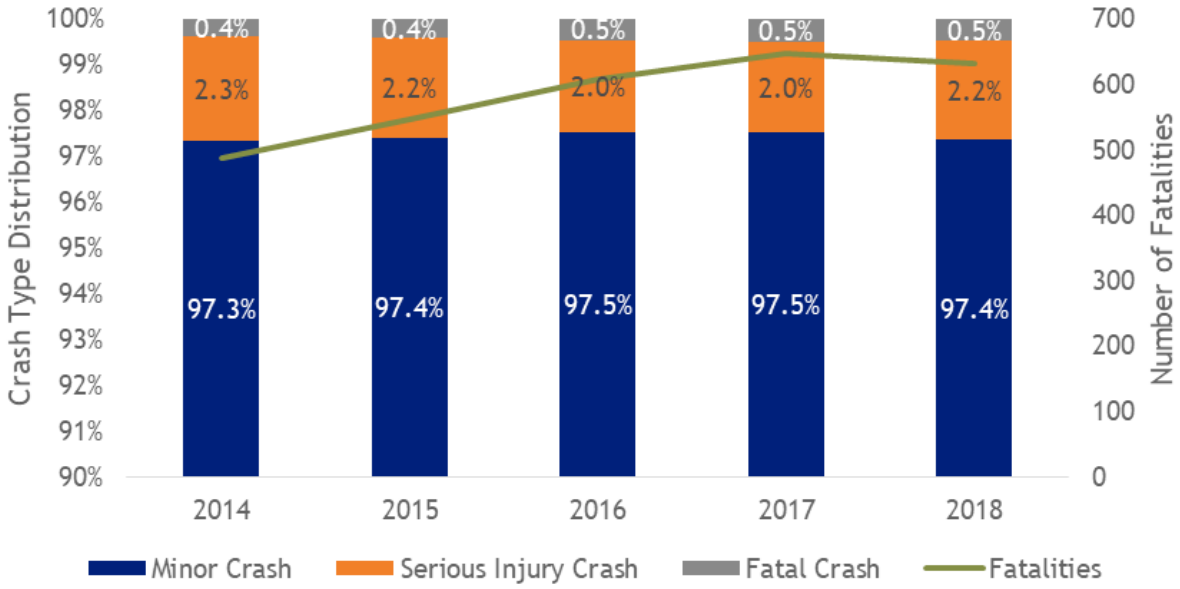
TABLE 7: Crash Rate by Year

Crash Rate	2014	2015	2016	2017	2018
Serious Injury Crash Rate per 100 million VMT	5.36	5.19	4.66	4.40	4.89
Serious Injury Crash Rate per 10,000 Population	4.91	4.81	4.39	4.18	4.63
Fatal Crash Rate per 100 million VMT	0.92	1.00	1.07	1.12	1.09
Fatal Crash Rate per 10,000 Population	0.84	0.93	1.01	1.07	1.03

Source: ACS 1-Year Estimates

Figure 7 shows that while the distribution of crash severity remained relatively stable between 2014 and 2018, the total number of person-level fatalities increased from 488 in 2014 to a peak of 648 in 2017, before decreasing to 632 in 2018. Serious injury crashes as a percentage of all crashes remained consistent in the 2.0% to 2.3% range from 2014 to 2018.

Figure 7: Crash Severity by Year

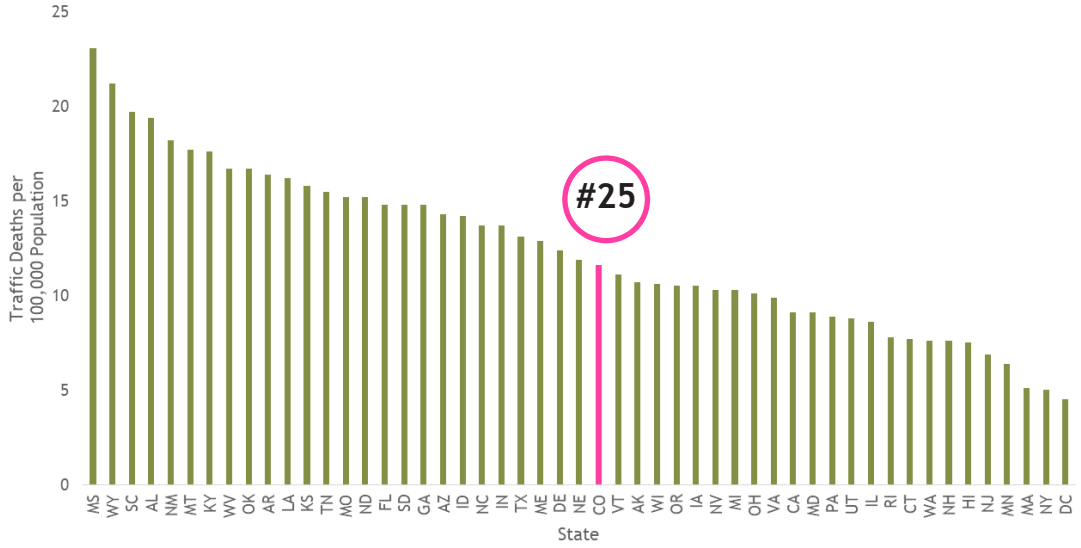


In 2017, Colorado had 11.6 deaths per 100,000 population and 1.21 deaths per 100 million vehicle miles traveled (VMT). Based on this one-year snapshot across all states, Colorado ranks 25th in traffic deaths per population and 30th in traffic deaths per VMT, as shown in *Figure 8* and *Figure 9*, respectively. Note that this particular data is presented at the person level, whereas the majority of the data in this analysis is presented at the crash level.

Two states that have similar population, terrain, and weather to Colorado are Minnesota and Utah. Both states are performing significantly above Colorado in terms of safety, as shown in *Figure 8* and *Figure 9*. Both states have prominent safety cultures and have served as examples for many of the programmatic strategies found in this plan. In addition to culture, legislatively these states have taken additional measures to improve safety on their roads. According to a 2019 study, Minnesota has the toughest culture against driving under the influence in the country with Utah ranked at number 2 while Colorado ranks 42nd in the country. Colorado has a driving under the influence (DUI) fatality rate of 3.1 per 100,000 population compared to Minnesota with a DUI fatality rate of 1.5 per 100,000 population.

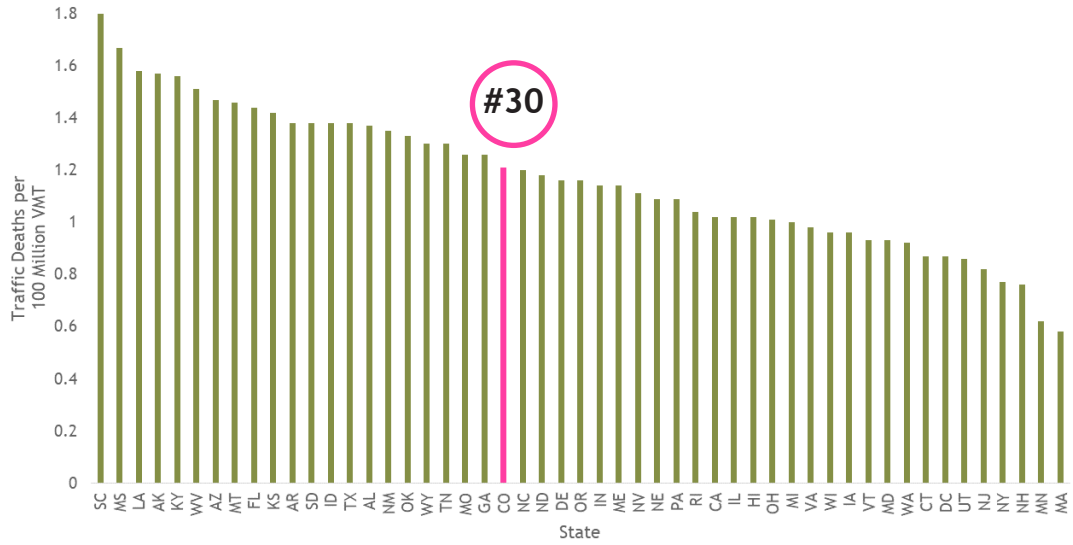
Source: ***https://www.siegfriedandjensen.com/dui-laws-by-state/***

Figure 8: Traffic Death per Population Comparison Across States (2017)



Source: IIHS

Figure 9: Traffic Death Comparison per Vehicle Miles Traveled Across States (2017)



Source: IIHS

Crash Characteristics

In preparation for a meeting with the Transportation Commission, an analysis was conducted of the 2018 preliminary fatal crash dataset. This indicated that 96% of all fatal crashes in 2018 were a result of human error, including impaired driving, speeding, disregarding a traffic device, and failing to yield the right-of-way, among others. This 2018 dataset reinforces the notion that almost all fatal crashes are preventable.

Figure 10 shows all crashes and severe crashes by contributing factor. Nearly 60% of all crashes in Colorado are reported as having no apparent contributing factor (note this is different from "unknown"), which is consistent with data collection limitations across the country. Many law enforcement stakeholders expressed concerns with the high%age of no apparent contributing factor crashes, as distracted driving can be assumed to account for a%age of those crashes. However, there is no way to report a driver was preoccupied in Colorado unless the driver admits that they were distracted to law enforcement. Therefore, the statistics for "no apparent contributing factor" may be misrepresented in the data.

Outside of "no apparent contributing factor," the most common contributing factor is a preoccupied driver, followed by driver inexperience. Falling asleep at the wheel results in a disproportionate number of severe crashes compared to other contributing factors.

Figure 10: Crash Distribution by Contributing Factor in All Crashes and Severe Crashes (2014-2018)

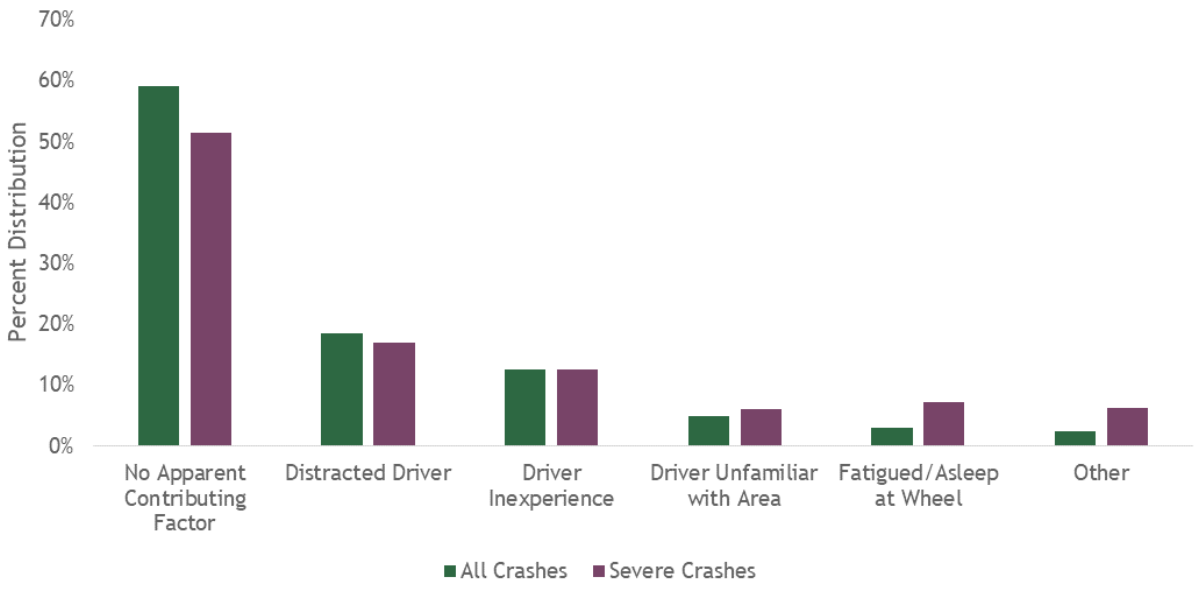
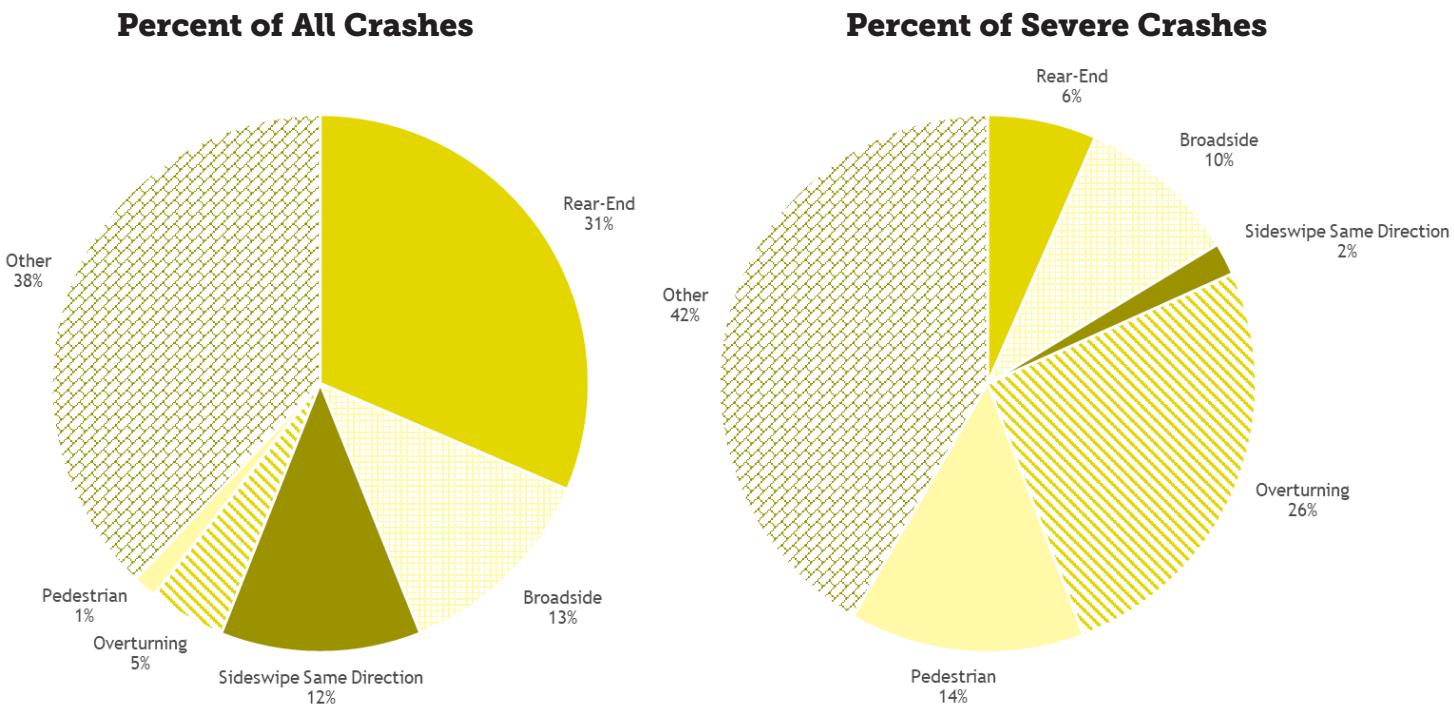


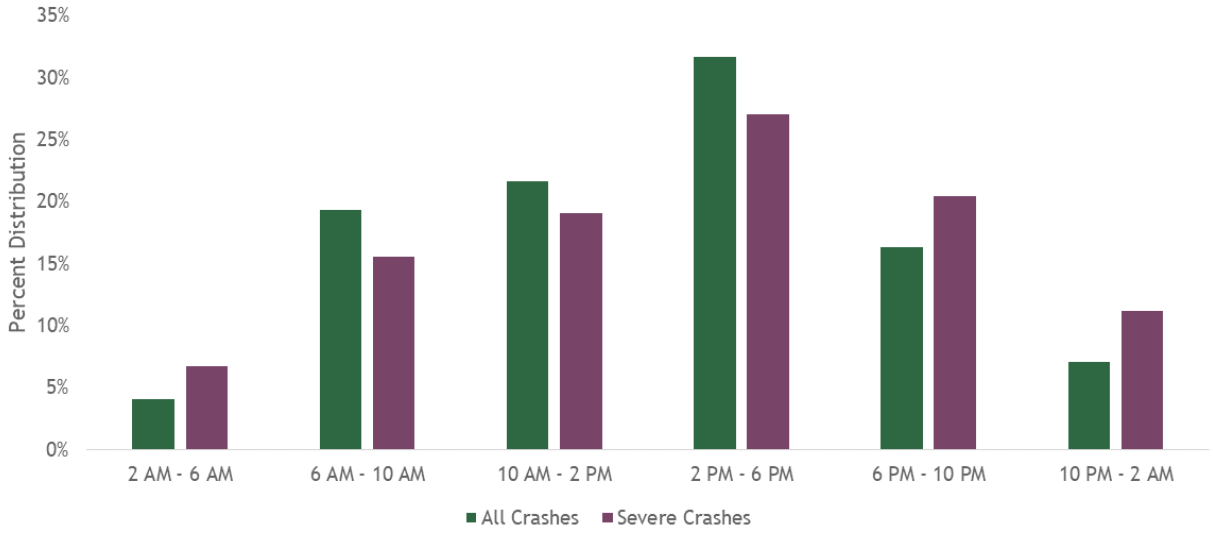
Figure 11 summarizes the most harmful event in all crashes in Colorado from 2014 to 2018 and severe crashes in the same time period. The comparison shows that while rear-end crashes account for 31% of all crashes, they are underrepresented in severe crashes at only 6% because rear-end crashes tend to be less severe. Broadside crashes account for 13% of all crashes, and 10% of severe crashes. Conversely, overturning and pedestrian crashes account for only 5% and 1% of all crashes, but account for 26% and 14% of severe crashes, respectively. Pedestrians are the most vulnerable roadway user, with bicyclists as a close second.

Figure 11: Crash Distribution by Most Harmful Event in All Crashes and Severe Crashes (2014-2018)



Crashes are most likely to occur during the evening commute (2:00 pm to 6:00 pm), accounting for 32% of all crashes and 27% of severe crashes in Colorado from 2014 to 2018 (*Figure 12*). These numbers are expected as the majority of traffic is on the roads during the day and/or during commutes. Crashes that occur at night (6:00 pm to 6:00 am) are more likely to be severe compared to crashes that occur during daytime. The over-representation of severe crashes from 6:00 pm to 6:00 am could be attributed to the time of day in which drivers exhibit more high-risk behaviors, such as driving under the influence or speeding.

Figure 12: Crash Distribution by Time for All Crashes and Severe Crashes (2014-2018)



Driver and Vehicle Characteristics

Figure 13 shows how the distribution of licensed drivers compares to the distribution of drivers involved in severe crashes by age. People within the 20 to 24 age range account for 8% of licensed drivers, but are overrepresented at 15% of drivers involved in severe crashes. People within the 60 to 64 age range account for 8% of licensed drivers, but are drivers in just 5% of severe crashes.

There is an inflection point near the 30 to 34 age range, when drivers transition from being over-represented in severe crashes to being under-represented in severe crashes. More specifically, this is the point at which drivers become safer, possibly due to partaking in fewer risky behaviors.

Figure 13: Severe Crashes by Driver Age (2014-2018)

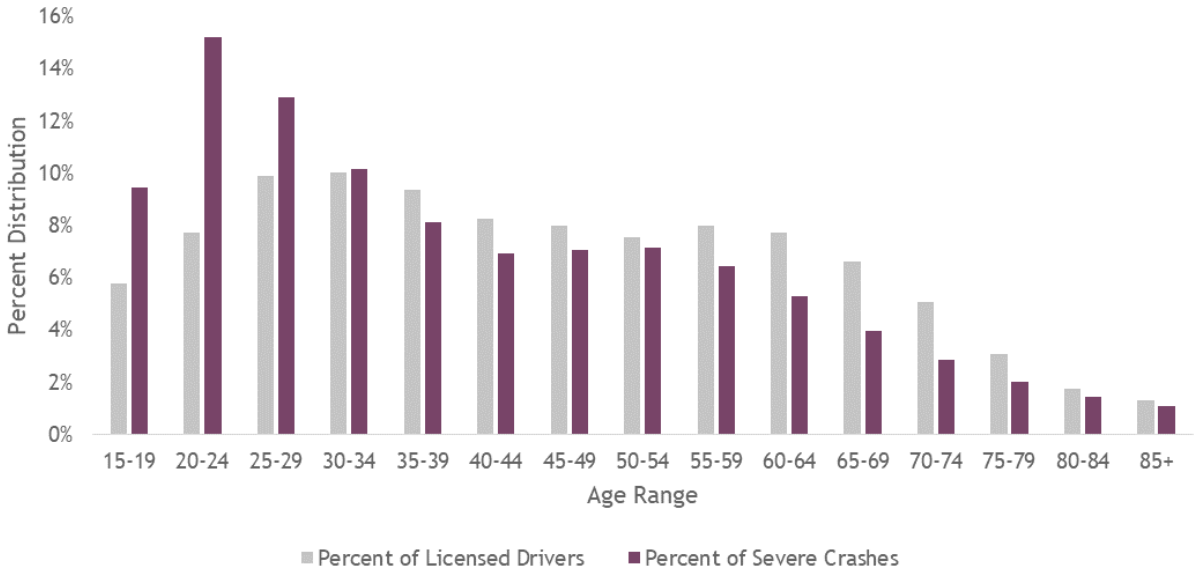


Figure 14: Crash Severity Distribution by Driver Impairment (2014-2018)

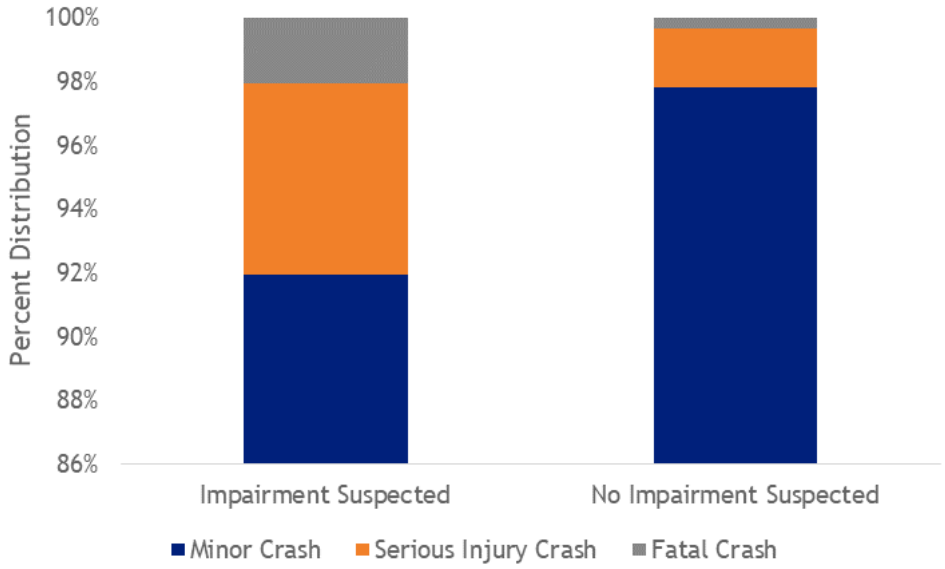


Figure 14 shows crashes by suspected driver impairment in Colorado. 94% of crashes have no suspected impairment. Of those crashes, only 2% result in a serious injury and 0.3% result in a fatality. For comparison, 6% of crashes involve suspected impairment, but these crashes tend to be much more severe; 6% result in a serious injury and 2% result in a fatality. In other words, crashes with suspected alcohol and/or drug impairment are more than 3 times more likely to result in a serious injury or fatality as crashes with no impairment suspected. 26% of all fatal crashes occur when the driver is suspected to be under the influence.

More specifically, *Figure 15* shows the distribution of tetrahydrocannabinol (THC) impaired driving among fatal crashes from 2016 to 2018. Prior to 2016, data collection of THC-impaired driving was new and unreliable, and therefore, *Figure 15* reflects three years of data rather than five.

Because THC is traceable in blood for multiple weeks after use, Colorado has adopted a level of 5 nanograms per milliliter (ng/mL) of Delta-9 THC in whole blood as a "permissible inference of impairment" in a driver. In other words, only a driver that tests above the 5 ng/mL limit is considered impaired. Based on this definition, 8% of at-fault drivers in fatal crashes between 2016 and 2018 were THC-impaired. Another 8% of at-fault drivers in fatal crashes tested positive for THC, but were below the permissible limit.

Figure 15: THC Levels in At-Fault Drivers of Fatal Crashes (2016-2018)

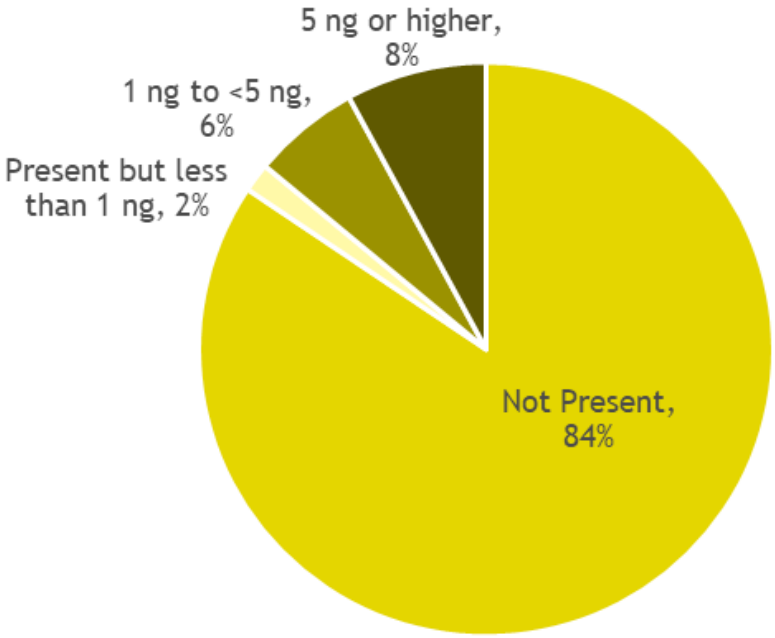


Figure 16 shows a comparison of motorcycle involvement in all crashes and severe crashes across Colorado from 2014 to 2018. This reflects all crash records in which Vehicle 1, Vehicle 2, and/or Vehicle 3 was a motorcycle. In other words, *Figure 16* does not distinguish which vehicle was identified by the responding officer to be at fault. As shown in the figure, motorcycles are involved in just 2% of all crashes, but 19% of severe crashes. This disparity reflects the vulnerability of motorcyclists on the road.

Figure 16: Crash Distribution by Vehicle Type in All Crashes and Severe Crashes (2014-2018)

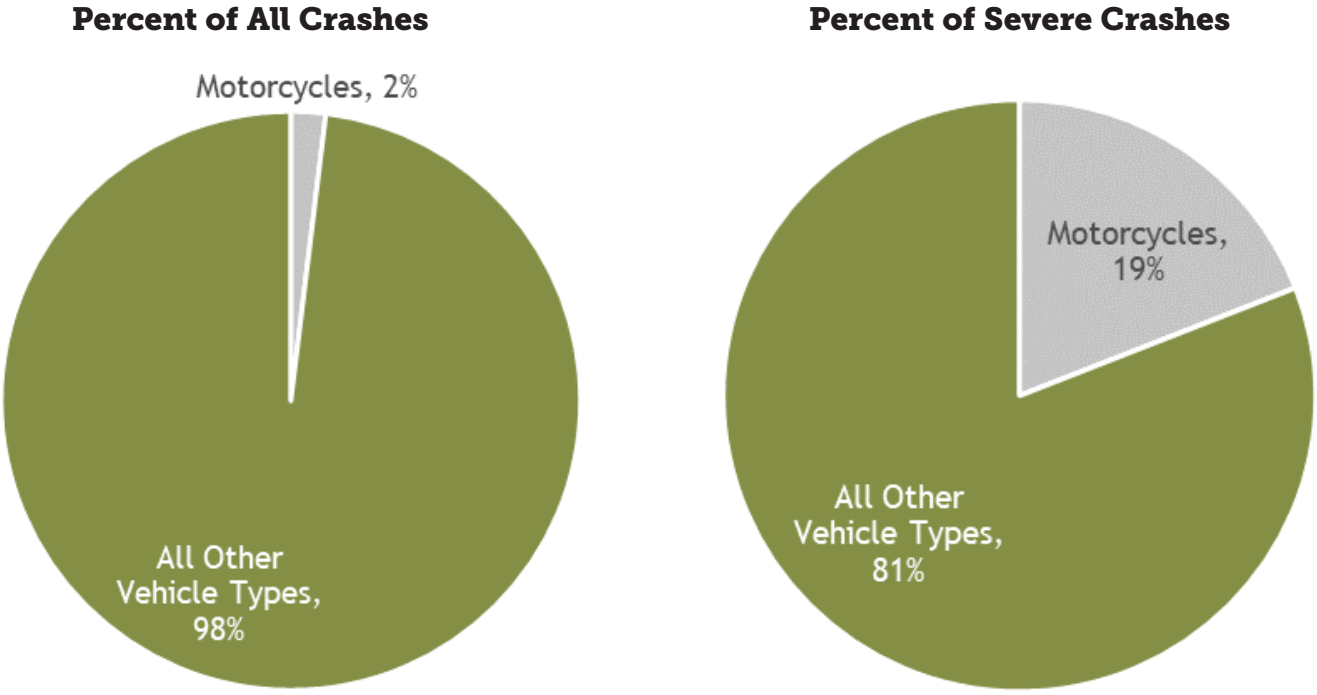


Figure 17 shows that 62% of motorcyclists that died in traffic crashes in Colorado between 2014 and 2018 were not wearing helmets. Statewide helmet usage among all motorcyclists is not known.

Table 8 shows helmet use among fatal crashes from 2013 to 2017 in Colorado. Note that NHTSA's crash database includes only a subset of crashes, and therefore may show different results than CDOT's crash database. Based on this dataset, 63 to 70% of fatal motorcycle crashes in any given year involve a rider without a helmet. NHTSA estimates that 126 lives in Colorado could have been saved within that time frame with 100% helmet usage.

Figure 17: Motorcyclist Helmet Use in Fatal Crashes (2014-2018)

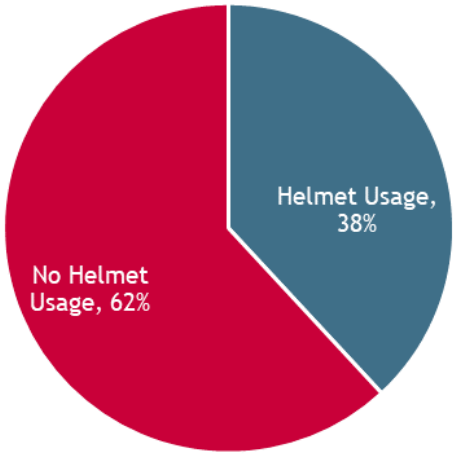


TABLE 8: Colorado Motorcyclist Fatalities by Helmet Use and Lives Saved Estimates (2013-2017)

Year	Fatalities					Lives Saved Estimates**	
	Total	Helmeted	Un-helmeted	Unknown Helmet Use	Percent Known Helmeted*	Lives Saved at Current Helmet Use	Additional Lives Savable at 100% Helmet Usage
2013	87	31	55	1	36%	19	21
2014	94	33	61	0	35%	19	22
2015	106	39	67	0	37%	23	25
2016	125	42	82	1	34%	25	31
2017	103	31	72	0	30%	18	27

Source: NHSTA Traffic Safety Facts - Colorado https://cdan.nhtsa.gov/SASStoredProcess/guest.
Notes:
**Percent based only where helmet use was known.*
***Lives saved estimates (sum of columns may not equal other published numbers due to rounding).*

As seen in *Figure 18*, seatbelt use is markedly higher among a statewide sample of vehicles compared to individuals killed in traffic crashes. The statewide data reflects CDOT's annual Statewide Seatbelt Survey from 2014 to 2018 and indicates that 84% of drivers and front-seat passengers used seatbelts within the sample, ranging from 82% in 2014 to 86% in 2018. Among traffic fatalities, only 45% were wearing seatbelts at the time of impact.

The data suggests that seatbelt use increases the likelihood of surviving a crash. The direction of causality is difficult to discern, but it is clear that fatal crashes have lower rates of seatbelt usage. In other words, it is possible that those occupants who do not wear seatbelts are more likely to engage in other risky behaviors, leading to more fatal crashes, or it is also possible that crashes that would have otherwise been less severe become fatal because vehicle occupants were not wearing seatbelts.

Figure 18: Seatbelt Use Statewide and Among Fatal Crashes (2014-2018)

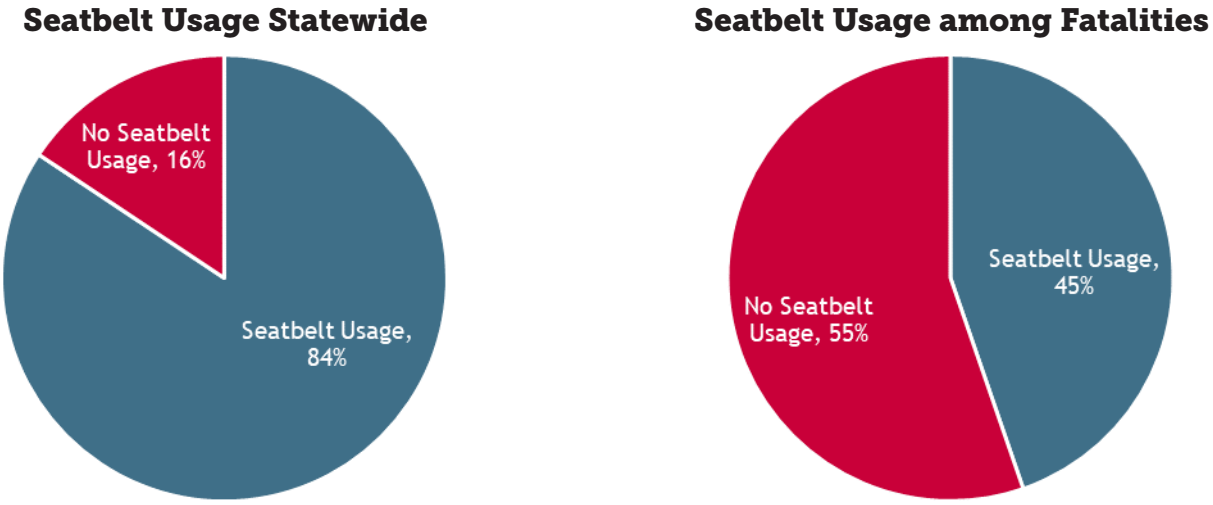


Table 9 shows seatbelt use among fatal crashes from 2013 to 2017 in Colorado. Note that NHTSA's crash database includes only passenger vehicle crashes, and therefore may show different results than CDOT's crash database. Based on this dataset, 53 to 60% of fatal crashes in any given year involve an unrestrained occupant. NHTSA estimates that 309 lives in Colorado could have been saved within that time frame with 100% seatbelt usage.

TABLE 9: Colorado Passenger Vehicle Occupant Fatalities Age 5 and Above by Restraint Use and Lives Saved Estimates (2013-2017)

Year	Fatalities Age 5 and Above					Lives Saved Estimates**	
	Total	Restrained	Unrestrained	Unknown Restraint Use	Percent Known Restrained*	Lives Saved at Current Belt Use	Additional Lives Savable at 100% Belt Usage
2013	309	118	175	16	40%	160	61
2014	307	139	156	12	47%	170	63
2015	346	147	188	11	44%	200	57
2016	359	164	185	10	47%	209	58
2017	408	173	222	13	44%	226	70

Source: NHSTA Traffic Safety Facts - Colorado https://cdan.nhtsa.gov/SASStoredProcess/guest.
Notes:
**Percent based only where restraint use was known.*
***Lives saved estimates (sum of columns may not equal other published numbers due to rounding).*

Figure 19: Crash Rates of Trucks and All Vehicles on CDOT Facilities (2018)

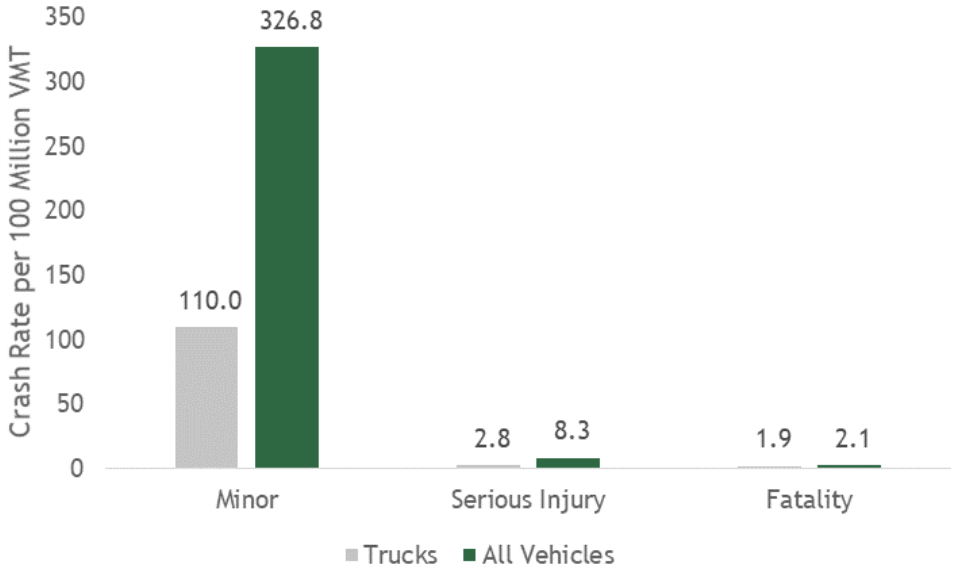


Figure 19 compares the crash rates of trucks and all vehicles by severity. The data reflects all crashes in 2018 on CDOT facilities, namely state highways and interstates. The crash rates are reflective of the VMT of that vehicle type; in other words, the truck crash rate is per 100 million truck VMT, and the all vehicles crash rate is per 100 million VMT of all vehicle types. The chart shows that trucks have a minor and serious injury crash rate per VMT that is two thirds lower than all vehicle types. However, while still ten percent lower than the general vehicle population, trucks are much closer to all vehicles when it comes to fatal crashes. Overall trucks have a superior safety record compared to all vehicles.

Figure 20 shows pedestrian and bicyclist fatalities, and *Figure 21* shows pedestrian and bicyclist serious injuries. Since 2014, fatalities have increased and serious injuries have decreased or remained relatively flat for both pedestrians and bicyclists in Colorado. Pedestrian fatalities have experienced a dramatic increase from 60 in 2014 to 90 in 2018, or a 50% increase in five years. Bicyclist fatalities have more than doubled from 10 in 2014 to 21 in 2018. Pedestrian serious injuries have remained nearly flat at about 290 per year, while bicyclist serious injuries have decreased from 162 in 2014 to 134 in 2018.

Figure 20: Pedestrian and Bicyclist Fatalities (2014-2018)

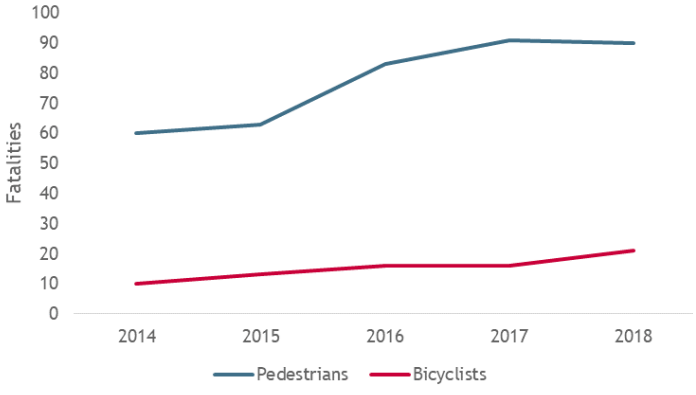
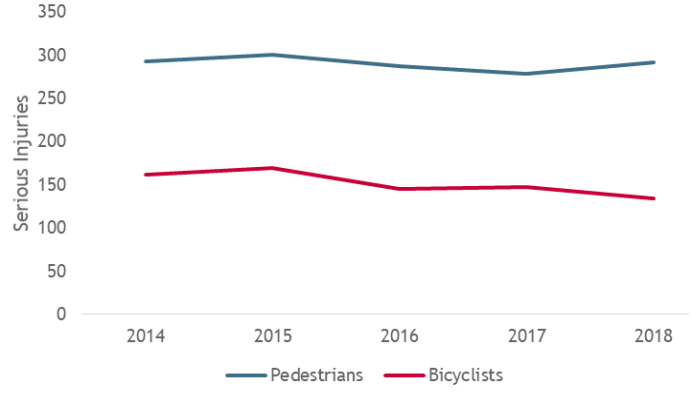


Figure 21: Pedestrian and Bicyclist Serious Injuries (2014-2018)

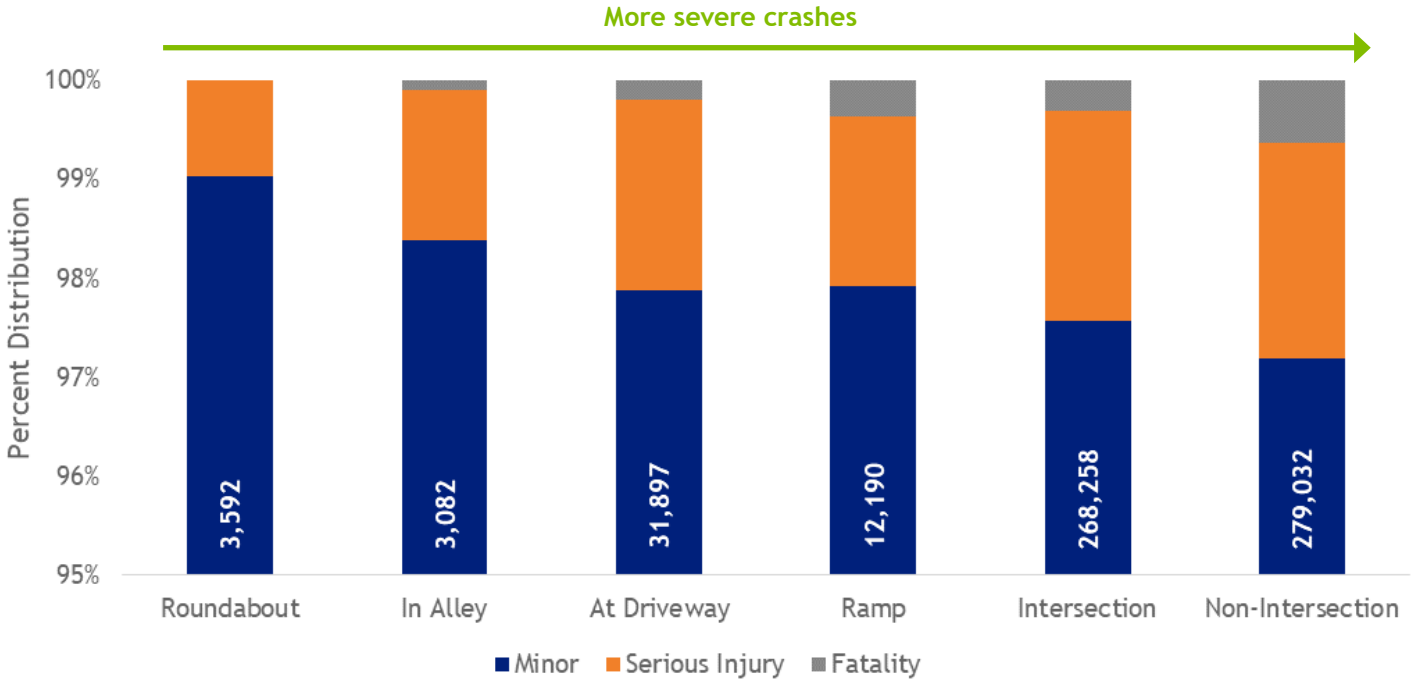


Roadway and Land Use Characteristics

Figure 22 shows crash severity and the total number of crashes by roadway location. Non-intersection crashes occur most frequently and are also among the most severe; there were 279,032 non-intersection crashes from 2014 to 2018 in Colorado that resulted in 7,622 serious injuries and 1,910 fatalities.

While roundabouts are intersection control devices, they are reported separately from stop-controlled or signal-controlled intersections. Crashes are more likely to be minor at roundabouts (99.0%) compared to crashes at other intersection types (97.6%). Crashes at roundabouts in the five-year period resulted in zero reported fatalities. The data shows that roundabouts are significantly safer than other intersection controls.

Figure 22: Crash Severity by Roadway Location (2014-2018)



Speed at the time of impact can be a big indicator of crash severity. Intuitively, crashes that occur on congested city streets are, therefore, more likely to be more minor crashes than crashes that occur on facilities with higher speeds and less congestion.

Between 2014 and 2018, 46% of all crashes in Colorado occurred on city streets, 33% on state highways, 14% on interstates, and 7% on county roads (*Figure 23*). Among the same facility types, crashes on county roads tend to have the most severe outcomes (*Figure 24*). Across all types of roadway facilities, 2.6% of crashes result in a serious injury or fatality. On county roads, that number increases to 4.4%.

Figure 23: Crashes by Roadway Facility in All Crashes and Severe Crashes (2014-2018)

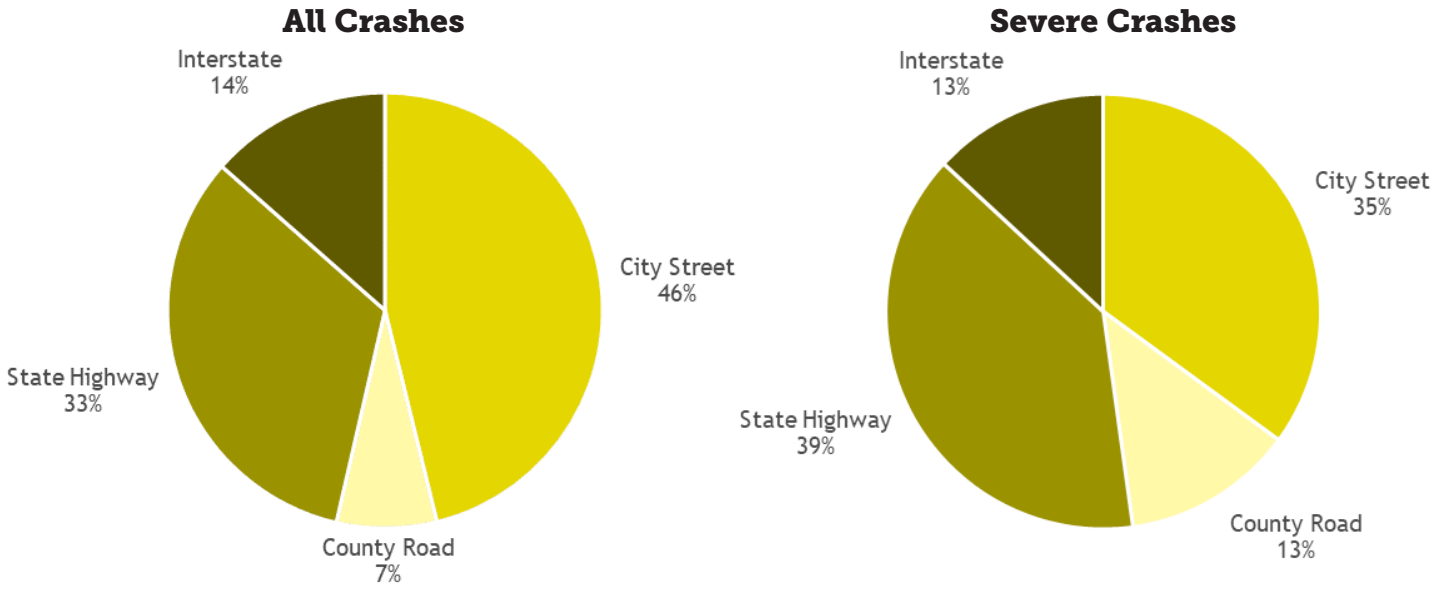
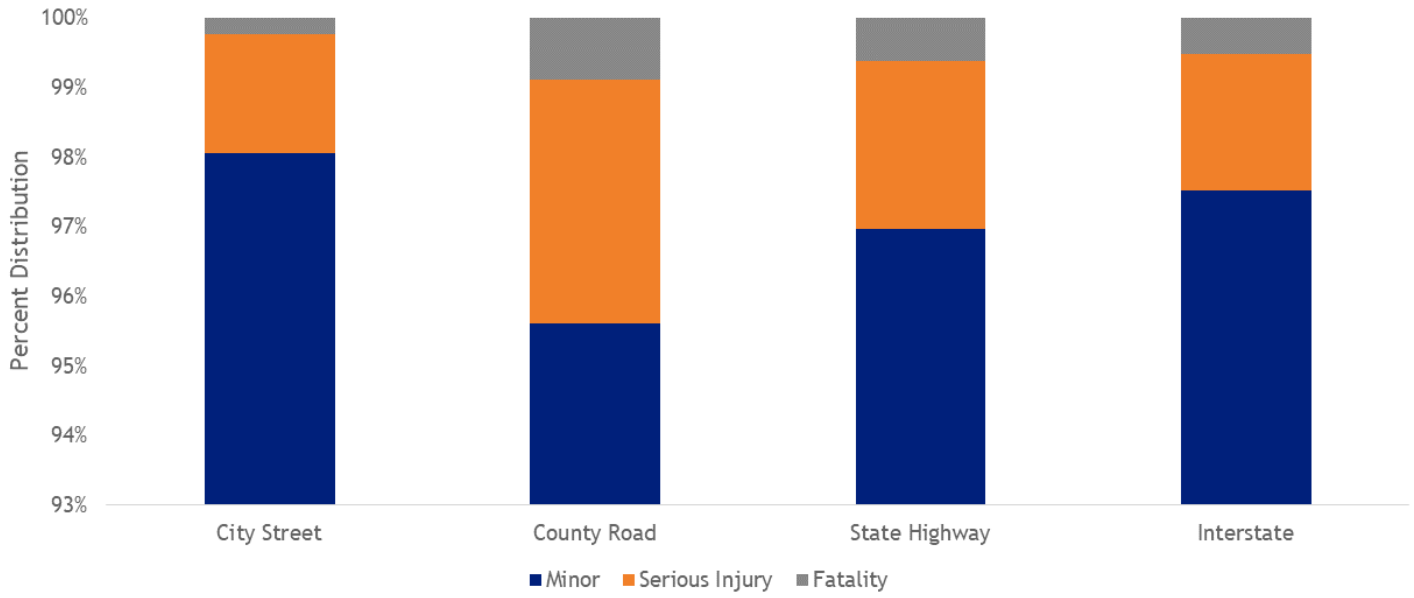
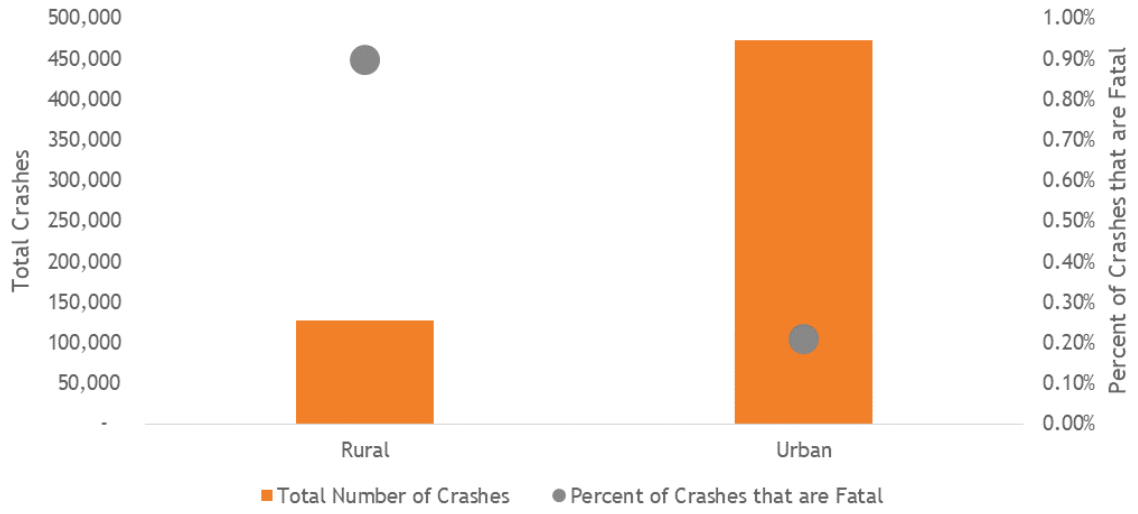


Figure 24: Crash Severity by Roadway Facility Type (2014-2018)



Similar to trends shown in *Figure 24*, *Figure 24* shows that crashes are far more common in urban areas (because of the population density and corresponding higher VMT), but crashes in rural areas are four times more likely to be fatal than crashes in urban areas (0.9% and 0.2%, respectively). Between 2014 and 2018 in Colorado, 79% of all crashes occurred in urban areas, but more fatal crashes occurred in rural areas than urban areas (1,135 and 981 fatal crashes, respectively).

Figure 25: Total Number of Crashes and Fatal Crash Percentage by Land Use (2014-2018)



The need to focus on improving safety in the rural parts of the state is apparent. The ten rural counties with the highest fatality counts in Colorado for the period 2014 to 2018 are presented in *Table 10*.

TABLE 10: Highest Fatality Counts for Rural Colorado Counties

County	Fatalities					Fatalities per 100,000 Population				
	2014	2015	2016	2017	2018	2014	2015	2016	2017	2018
Logan County	5	6	8	4	10	23.0	27.6	36.8	18.5	46.5
Fremont County	7	9	10	9	9	15.2	19.5	21.3	18.9	18.7
La Plata County	5	7	10	11	8	9.3	12.8	18.1	19.8	14.2
Montrose County	6	7	3	9	7	14.8	17.3	7.3	21.5	16.6
Chaffee County	2	3	4	4	6	10.8	16.1	21.0	20.4	30.0
Garfield County	8	8	10	21	6	14.0	13.9	17.0	35.5	10.0
Delta County	3	0	3	6	5	10.0	0.0	9.9	19.7	16.2
Gunnison County	3	9	2	2	5	18.9	55.6	12.1	11.8	29.0
Otero County	2	8	3	0	5	10.9	43.9	16.5	0.0	27.1
Ouray County	2	3	2	1	5	43.7	65.1	41.8	20.8	103.5

Source: NHTSA.

Table 11 shows at-grade highway-rail crossing crashes in Colorado from 2014 to 2018. Colorado had 147 crashes at at-grade highway-rail crossings from 2014 to 2018. Of the 147 crashes, 6% were fatal, resulting in 14 fatalities. From 2017 to 2018, the number of at-grade highway-rail crossing crashes increased by 39% with a total of three fatalities per year. This analysis indicates that at-grade highway-rail crossing crashes may not be a top priority in Colorado. The State continually monitors highway-railroad crashes under CDOT's Railroad Program.

TABLE 11: At-Grade Highway-Rail Crossing Crashes

	2014	2015	2016	2017	2018	Total
Crash Level						
Minor Crashes	36	24	25	20	30	135
Serious Injury Crashes	2	1	0	0	0	3
Fatal Crashes	0	2	2	3	2	9
Total	38	27	27	23	32	147
Personal Level						
Serious Injuries	2	1	0	0	0	3
Fatalities	0	2	6	3	3	14
Total	**2**	**3**	**6**	**3**	**3**	**17**

SPECIAL RULES

The 2015 Fixing America's Surface Transportation (FAST) Act (Pub. L. No. 114-94) established two special rules for state safety plans.

Older Drivers and Pedestrians

According to the FAST Act, if fatalities and serious injuries per capita for drivers and pedestrians who are 65 years of age or older increase during the most recent 2-year period for which data is available, older driver strategies must be identified and included in the STSP. In Colorado, traffic fatalities and serious injuries per capita for drivers and pedestrians over the age of 65 have decreased from an average of 57.4 in the 2012-2016 period to 52.6 in the 2014-2018 period. Because of this decrease, the Older Drivers and Pedestrian Special Rule does not apply. Regardless, the STSP includes strategies aimed at Older Driver licensing requirements to ensure continued driver competency as drivers age.

High-Risk Rural Roads

Under the FAST Act, if fatality rates on rural major or minor collectors or on rural local roads with significant safety risks (as identified in the STSP) increase over a 2-year period, the state must obligate at least 200% of their fiscal year 2009 set-aside for projects on the high-risk rural road (HRRR) system.

Specific in Colorado, HRRRs are defined as rural local and rural major/minor collectors which have a significant safety risk defined as 1) roadways with a higher total or severe (injury and fatal) crash frequency than expected as compared to other similar rural undivided roadways statewide, and 2) roadways with an overrepresented crash pattern as determined through a diagnostic or systemic analysis. These patterns may relate to crash type, severity, roadway or environmental conditions, weather conditions or driver behavior. Review of the crash data in Colorado shows the fatality rate on rural roads has increased from 1.9 fatalities per 100 million VMT in the 2012-2016 period to 2.0 fatalities per 100 million VMT in the 2014-2018 period. Therefore, the HRRR Special Rule applies, and Colorado will obligate in the next fiscal year for high risk rural roads an amount at least equal to 200 percent of its Fiscal Year 2009 HRRR set-aside.

DATA ANALYSIS CONCLUSIONS

In summary, the number of fatal crashes in Colorado increased 30% over the 2014 to 2018 five-year period. The fatal crash rates per 100 million VMT and 100,000 population also increased by 18% and 22%, respectively. Serious injury crash rates, which tend to be a better indicator of safety because they are less susceptible to randomness, decreased 9% per 100 million VMT and 6% per 100,000 population. The STSP serves to improve these and other safety statistics in Colorado over the next four years. Specifically, the results of this detailed crash analysis served as a catalyst to the generation of the STSP Emphasis Areas and subsequently the development of goals, strategies, and action items.

CHAPTER 4
Emphasis Areas

Emphasis Areas

EMPHASIS AREA IDENTIFICATION

Emphasis Areas are a required element of strategic highway safety plans and are based on traffic crash data analysis and broad stakeholder input. The Emphasis Areas for this 2020-2023 Colorado Strategic Transportation Safety Plan (STSP) were identified by the Steering Committee and participants at the Regional Stakeholder Workshops and were then further defined by the Emphasis Area Teams.

At the first Steering Committee meeting, the current trends of crash statistics in Colorado during the past five years were presented (Chapter 3). The Steering Committee members reviewed the Emphasis Areas of the 2014 SHSP, the findings of the FHWA 2014 SHSP Evaluation Workshop, and the 2014 SHSP participant survey, as well as emphasis areas from other state safety plans (the appendix contains a technical memorandum regarding the evaluation of the 2014 SHSP). Based on their review, it was agreed that the nine Emphasis Areas in the prior plan were too many to effectively implement, and the number would be reduced for this STSP.

A long list of potential Emphasis Areas from the 2014 Colorado SHSP and other state plans was presented for consideration at the first Steering Committee meeting and the first round of Regional Stakeholder Workshops. Each participant prioritized the top nine Emphasis Areas they considered most critical using 3 green dots (first priority), 3 yellow dots (second priority), and 3 red dots (third priority). A combined total of 3,360 votes were cast at the first Steering Committee meeting and the first round of seven Regional Stakeholder Workshops. Each priority category was given a weight for scoring (green 3 points, yellow 2 points, red 1 point). Based on the weighted scoring, the following five Emphasis Areas were identified (in ranked order):

- Distracted Driving
- Occupant Protection
- Bicycle and Pedestrians
- Impaired Driving
- Infrastructure (Rural and Urban)

These topics were broadened to three Emphasis Areas: High-Risk Behavior, Vulnerable Roadway Users, and Severe Crash Mitigation. Based on best practices from other states, a Programmatic Emphasis Area was added to address policy and program issues. Each Emphasis Area was further defined in terms of focus topics.

HIGH-RISK BEHAVIOR

- Aggressive Driving
- Distracted Driving
- Occupant Protection
- Impaired Driving

VULNERABLE ROADWAY USERS

- Motorcyclists
- Bicyclists and Pedestrians
- Older Drivers
- Young Drivers
- Work Zones
- First Responders

SEVERE CRASH MITIGATION

- Infrastructure (Rural and Urban)
- Crash Reduction Locations
- Intersections
- Roadway Departures

PROGRAMMATIC

- Data
- Safety Program Coordination and Cooperation
- Emergency Medical Services/Law Enforcement
- Legislation

DEVELOPMENT AND PRIORITIZATION OF STRATEGIES

Volunteers from the Regional Stakeholder Workshops formed four teams to focus on each Emphasis Area. Each Emphasis Area Team met three times to develop and refine strategies and goals for their respective Emphasis Areas.

At the second round of meetings, each Emphasis Area Team prioritized its set of preliminary strategies through an informal discussion and voting process.

> Tier I Strategies are high-priority strategies and are intended to form the core of the STSP implementation plan. The Tier I Strategies are fully defined and described in Chapter 2 Implementation Plan.
> Tier II Strategies are supporting strategies.
> Tier III Strategies are lower priority strategies.

The Tier I, Tier II, and Tier III Strategies are presented in *Table 12*. As shown, many strategies were common to more than one Emphasis Area.

TABLE 12: Strategies Across Emphasis Areas

ID	Strategy	Emphasis Area			
		Programmatic	High-Risk Behavior	Vulnerable Roadway User	Severe Crash Mitigation
Tier I					
A	Name a safety champion to lead a proactive safety program	◆			
B	Build a safety advocacy coalition	◆	◆		
C	Institutionalize safety roles and responsibilities	◆			
D	Coordinate with existing safety programs	◆			
E	Promote consistent safety messaging	◆			
F	Develop education campaigns for high-risk behaviors		◆		
G	Provide transportation safety education to students and families		◆	◆	◆
H	Prioritize transportation safety funding	◆	◆	◆	◆
I	Prioritize safety in transportation planning, facility design, and project selection			◆	◆
J	Educate decision-makers on the effectiveness of occupant protection laws	◆	◆	◆	
K	Increase requirements for new and renewal driver licensing		◆	◆	◆
L	Establish a framework for streamlining data management	◆	◆	◆	◆
M	Prioritize and promote proven safety toolbox strategies			◆	◆
N	Implement systemic infrastructure safety improvement strategies			◆	◆
O	Increase education on and implementation of data-driven and automated enforcement			◆	◆

ID	Strategy	Emphasis Area			
		Programmatic	High-Risk Behavior	Vulnerable Roadway User	Severe Crash Mitigation
Tier II					
AA	Explore and adopt context-sensitive speed limit setting protocols	◆	◆	◆	◆
BB	Advocate for more impactful fees and sentencing guidelines (e.g., repeat offender increases)	◆	◆	◆	
CC	Optimize incident management response practices			◆	◆
DD	Implementation of correct work zone traffic control practices for vulnerable roadway users especially on city and county roads			◆	◆
EE	Educate workers on safe roadside practices (e.g., the importance of wearing personal protective equipment)			◆	◆
FF	Develop a comprehensive education campaign around vulnerable roadway users			◆	◆
GG	Educate the public on how to navigate new infrastructure (e.g., roundabouts and diverging diamonds)	◆			◆
HH	Engage with vulnerable roadway users during the project planning and design processes			◆	◆
II	Emphasize effects on driver behavior of roadway design during project planning and design	◆	◆	◆	◆
JJ	Research high-risk behaviors	◆	◆		
KK	Ensure new vehicle licensing and registration for vehicles with advance technologies exceed existing vehicle safety levels	◆	◆		
LL	Implement technological advances as they become available	◆	◆	◆	◆
MM	Implement automated enforcement			◆	◆
NN	Implement railroad crossing outreach programs		◆		
Tier III					
AAA	Increase amount of passing lanes and signage to reduce driver aggression and frustration		◆		◆
BBB	Provide additional information and advance warnings about work zones and other roadway activities		◆	◆	◆
CCC	Provide ride home programs for impaired drivers, including rural areas		◆		
DDD	Develop education campaigns around severe crash locations			◆	◆
EEE	Educate the public on how smart cars don't solve all safety problems	◆	◆	◆	◆
FFF	Advocate and educate decision-makers on the effectiveness of required motor vehicle safety inspections	◆	◆		◆
GGG	Include vulnerable roadway user needs in transportation engineering curriculum			◆	
HHH	Address multicultural challenges (e.g., language barriers)	◆	◆	◆	◆

GOALS

Many goals were developed during workshops and Emphasis Area Team meetings throughout plan process and were intended to provide broad direction to achieve the STSP vision and mission. The Emphasis Area Teams consolidated the longer list of goals to the ones listed below. The goals were then aligned with individual Tier I Strategies and are shown on the information sheets in Chapter 2.

> Achieve a high level of safety administration efficiency
> Achieve a high level of safety administration effectiveness
> Have laws that effectively support transportation safety

> Build, maintain, and operate a complete and connected transportation network safe for all users
> All intersections' safety performance should achieve a LOSS I or II given the conditions at each location
> All roadway segments' safety performance should achieve a LOSS I or II given the conditions at each location
> Reduce crashes and injuries prevalent at severe crash locations

> Establish a safe transportation culture in Colorado (general population)
> Establish a sustainable and unified safety culture and vision among all agencies in the state
> Achieve a nationwide leading level of safe driver behavior and occupant protection
> Reduce crashes caused by aggressive, impaired, distracted driving

> Achieve equitable safety improvements to address the safety needs of all agencies in the state
> Minimize the overrepresentation of vulnerable users in severe crashes
> Make the occupation of roadway workers and responders as safe as any other occupation

In the future (suggested for the next update) these goals can be developed in greater detail, by supplementing them with objectives that are specific, measureable, actionable, relevant, and time specific.

ACTION ITEMS

At the third round of Emphasis Area Team meetings, participants developed action items for each strategy. The action items for each of the Tier I Strategies can be found in Chapter 2.

The goals, strategies, and action items identified within each Emphasis Area form the draft "Implementation Plan" that supports the STSP vision and mission.

RESOURCE GUIDE

Glossary of Terms and Acronyms

Automated Enforcement	*An enforcement technique that uses technology to enforce laws in the absence of law enforcement officials.*
Countermeasure	*An action or device designed to prevent an undesirable outcome.*
Crash	*An unintended event that causes death, injury, or property damage, and involves at least one motor vehicle on a roadway.*
Crash Severity: No Injury	*No one involved in the crash has any apparent injury. If a party is transported and is subsequently examined and found to have no injuries, that party would be classified as No Injury.*
Crash Severity: Complaint of Injury	*A complaint of injury is any injury reported or claimed which is not a fatal, incapacitating, or non-incapacitating evident injury. Examples include a claim of injury, complaint of pain, limping, and nausea or hysteria.*
Crash Severity: Evident Non-Incapacitating Injury	*This type of injury is evident to observers at the scene, but is not a fatal or incapacitating injury. Examples include bruises, lumps, and lacerations. Injuries that cannot be seen, such as limping or complaints of pain, are classified as possible injury.*
Crash Severity: Evident Incapacitating Injury	*Any injury (other than a fatal injury) that prevents the injured person from walking, driving, or normally continuing the activities the person was capable of performing before the injury is an incapacitating injury. Examples include severe lacerations, broken limbs, and skull, chest, or abdominal injuries. Momentary unconsciousness is not included.*
Crash Severity: Fatal	*For the purposes of the crash report, a fatal injury is any injury that results in death within thirty days of the crash.*
Data-Driven	*Informed by a systematic review and analysis of quality data sources when making decisions related to planning, target establishment, resource allocation and implementation.*
Distracted Driving	*Any activity that could divert a person's attention away from the primary task of driving. Includes activities such as texting or talking on a cell phone while driving.*
Emphasis Area	*A focused topic category determined through crash data analysis and input from safety stakeholders.*
Goal	*A goal is the more specific aim that organizations pursue to reach their visions and missions. Goals are typically supported by one or more objectives.*
High Crash Location	*Highway or road segments that are susceptible to an inordinate number of crashes, often the result of poor road design, absence of appropriate traffic signing or signals, or lack of enforcement. Identification of high crash locations are a desirable part of the problem identification process.*

High-Risk Behaviors *Behaviors exhibited while traveling on a roadway that increase the risk of crashes or reduces the survivability of crashes such as: aggressive driving, distracted driving, impaired driving, driving without a seatbelt, or operating a motorcycle or riding on a motorcycle without wearing a helmet.*

High-Risk Rural Roads *Colorado defines high-risk rural roads as any roadway functionally classified as a rural major or minor collector or a rural road with significant safety risk. Significant safety risk is defined by two metrics: 1) Roadways with a higher total or severe (injury and fatal) crash frequency than expected as compared to other similar rural undivided roadways statewide and 2) Roadways with an overrepresented crash pattern as determined through a diagnostic or systemic analysis. These patterns may relate to crash type, severity, roadway or environmental conditions, weather conditions or driver behavior.*

Micro-Mobility *A category of modes of transport that includes light vehicles such as bicycles, electric scooters, electric pedal-assist bicycles and electric skateboards among other vehicles*

Minor Crash *A crash that resulted in one of the following three outcomes: no injury, possible injury, or evident, non-incapacitating injury.*

Mission *A mission statement conveys the purpose of a plan and what an entity does to achieve its' vision. It is typically supported by one or more goals.*

Mode *The means by which passengers achieve mobility within a transportation system.*

Motorcycle *A motor vehicle with motive power having a seat or saddle for the use of the rider and designed to travel on not more than three wheels in contact with the ground.*

Objective *Objectives are the smaller supporting elements that lead to the accomplishment of the goals.*

Occupant Protection *A category of traffic injury control tools for occupants of vehicles that includes seat belts, child seats and automatic occupant protection systems (e.g. air bags).*

Older Driver *A driver aged 70 and older.*

Passenger *Any occupant of a motor vehicle who is not a driver.*

Pedestrian *Any person not in or upon a motor vehicle, motorcycle, or bicycle, but includes persons on personal conveyance devices, such as skateboards or wheelchairs.*

Programmatic *Activities related to the administration and governance of safety programs involving public agencies, nonprofit organizations, and other safety stakeholders.*

Restraint *A device such as a seatbelt, shoulder belt, booster seat, or child seat used to hold the occupant of a motor vehicle in the seat at all times while the vehicle is in motion.*

Rural *All areas of the state not falling within an urbanized area (of 50,000 or more people) or an urban cluster (at least 2,500 and less than 50,000 people) as defined by the U.S. Census.*

Safe Routes to School *A program that promotes walking and bicycling to school through infrastructure improvements, enforcement, tools, safety education, and incentives to encourage walking and bicycling to school.*

Safety Circuit Rider *A CDOT initiative that provides specific safety related training and works hand in hand (boots on the ground) with counties to identify, diagnose and treat safety deficiencies on the local road system.*

Serious Injury *Identical to "Crash severity: Evident incapacitating injury" defined above.*

Severe Crash *A crash resulting in an evident incapacitating injury or fatality.*

Severe Crash Mitigation *Infrastructure improvements intended to lessen the severity of crashes or the number of severe crashes at targeted locations with an identified safety issue.*

Speeding *When a driver travels above the posted speed limit or too fast for the prevailing conditions which may include poor weather or poor visibility.*

Strategy *The activities, actions, projects, etc., that are implemented to achieve goals and objectives.*

Transportation *Multimodal travel that occurs on roadways. Specifically: rail, water, and air travel are excluded from the STSP unless they involve a roadway (i.e., an at-grade rail crossing).*

Urban *All areas of the state that fall within an urbanized area (of 50,000 or more people) or an urban cluster (at least 2,500 and less than 50,000 people) as defined by the U.S. Census.*

Vision *A vision statement conveys the hopes for an ideal future. It focuses on tomorrow and what an entity wants to ultimately become or achieve.*

Vision Zero *A global initiative started in Sweden with a goal to eliminate all traffic fatalities and serious injuries, while increasing safe, healthy, equitable mobility for all. Integral to the strategy is the recognition that people make mistakes, so the road system and related policies should be designed to ensure those inevitable mistakes do not result in serious injuries or fatalities.*

Vulnerable Roadway Users *Young and older drivers; Non-motorized road users such as pedestrians and cyclists; motorcyclists; persons with disabilities or reduced mobility and orientation; and work zone staff.*

Whole System Whole Safety *A CDOT initiative that heightens safety awareness by taking a systematic statewide approach to safety — combining the benefits of CDOT programs that address driving behaviors, the CDOT built environment and CDOT operations. The goal: Improve the safety of Colorado's transportation network by reducing the rate and severity of crashes, and improving safety conditions for those traveling by all modes. The program has one simple mission — to get everyone home safely.*

Work Zone *Any activity involving construction, maintenance, or utility work on or in the immediate vicinity of a public roadway. A work zone may be active (workers present) or inactive.*

Young Driver *A driver aged 15-25.*

AASHTO *American Association of State Highway and Transportation Officials*

CDOR *Colorado Department of Revenue*

CDOT *Colorado Department of Transportation*

CDPHE *Colorado Department of Public Health and Environment*

CMF *Crash Modification Factor*

CSP *Colorado State Patrol*

DRCOG *Denver Regional Council of Governments*

DUI *Driving Under the Influence*

FARS *Fatality Analysis Reporting System — The nationwide census providing public yearly data regarding fatal injuries suffered in motor vehicle traffic crashes, as published by NHTSA*

FAST *Fixing America's Surface Transportation Act of 2015*

FHWA *Federal Highway Administration*

GDL *Graduated Driver Licensing*

HSIP *Highway Safety Improvement Program*

IIHS *Insurance Institute for Highway Safety*

ITS *Intelligent Transportation System*

MPO *Metropolitan Planning Organization*

NHTSA *National Highway Traffic Safety Administration*

OTS *Office of Transportation Safety*

PDO *Property Damage Only*

RVZ *Regional Vision Zero*

SHSP *Strategic Highway Safety Plan*

STIP *Statewide Transportation Improvement Program*

STRAC *Statewide Traffic Records Advisory Committee*

STSP *2020-2023 Colorado Strategic Transportation Safety Plan*

THC *Tetrahydrocannabinol, the active mood altering chemical found in marijuana.*

TIP *Transportation Improvement Program(s) - developed at the Transportation Planning Region and Metropolitan Planning Organization level*

TPR *Transportation Planning Region*

TZD *Toward Zero Deaths*

VMT *Vehicle Miles Traveled*

Implementation Plan Details

IMPLEMENTATION PLAN DETAILS FOR TIER I STRATEGIES

ID	Strategy Name	Strategy Champion(s)	Strategy Partners	Other Partners	Local Implementation Partners	Strategy Description	Safety Issue	Strategy Action Items	Benefits	Progress Metrics	Complementary Strategies	Goal(s) Supported	Data/Supporting Information	Potential Reduction (rate) in Serious Injury Crashes by years				Implementation Costs ($)	Barriers to Implementation	Corresponding Emphasis Area			
														End of Year 1	End of Year 4	End of Year 10	Beyond 10			Programmatic	High Risk Behavior	Vulnerable Roadway Users	Severe Crash Mitigation
A	Name a safety champion to lead a proactive safety program	CDOT	CSP, CDPHE, CDOR	Advocacy groups	Not applicable	Name a safety champion to lead an inclusive safety program with the responsibility, resources, and authority to advance safety strategies and monitor effectiveness.	There is not currently a job position within the state government tasked with the sole responsibility to implement a cohesive, statewide approach to transportation safety. The result is that many strategies are not effectively implemented or carried forward.	> Hire and empower a leader of safety program who is credible, accountable, and has excellent interpersonal and organizational skills. > Develop a dedicated staff to support implementation of the Safety Program. > Identify responsibility for safety oversight within CDOT (either as a new division or within an existing division). ›Regularly brief leaders on the status of the STSP's implementation and how they can support it. > Spearhead the development of an annual statewide transportation safety conference. ›Facilitate coordination and cooperation between the CDOT Office of Transportation Safety and the Traffic & Safety Engineering Branch.	> Streamlines and improves the administration of safety-related activities. > Provides a focused approach to championing, coordinating, and implementing safety programming. > Supports more effective implementation of other strategies. > Reduces the chance that useful strategies would be overlooked for implementation.	> Create and hire a 100% safety-focused program lead. > Create a safety program.	B, C, D, E	›Establish a sustainable and unified safety culture and vision amongst all agencies in the state. ›Achieve a high level of safety administration effectiveness.	> Minnesota has a 49% lower fatality rate per VMT than Colorado (in 2017). > See Chapter 2 for Data Sources.	Little to No Change	Minor Change	Substantial Change	Large Change	$$$	Political will, funding, internal institutional resistance, no existing state position	x			
B	Build a safety advocacy coalition	CDOT	CSP, CDPHE	AAA, AARP, Advocacy groups	Local advocacy groups as well as cities and counties	Build a safety coalition of advocacy groups and state and local agencies to function as a lobbying and advocacy group. To create a forum for relationship-building and maintain coordination over time, emphasize specific information-sharing tactics, such as regular newsletters or an annual conference. This group would monitor and work toward revisions to laws and policies at all phases of development and enforcement.	Many advocacy groups and state and local agencies do not coordinate and combine efforts with other groups. In addition, state agencies can't lobby—they can only inform. A coalition can be an independent forum with a more proactive voice. While a safety program can focus on implementing actions, a safety coalition can work toward changing the legislative and policy environment in Colorado.	> Identify key partner agencies and advocacy groups that will become the coalition. > Develop a coalition charter with its own vision and mission statements, and goals and strategies. > Identify statewide safety needs that can be voiced by the coalition. > Coordinate with existing coalitions and advocacy groups. > Support the safety champion in developing an annual statewide transportation safety conference. > Develop a logo and brand for the STSP vision.	> Increases the visibility of key safety issues in policy discussions. > Creates a central forum for strengthening relationships among participants and decision-makers in promoting safety.	> Safety coalition created. > Number of safety coalition meetings. > Percent of stakeholders who are coalition members.	A, C, E, J, K, O	›Have laws that effectively support transportation safety. ›Establish a sustainable and unified safety culture and vision amongst all agencies in the state.	Not Applicable	Little to No Change	Little to No Change	Moderate Change	Large Change	$$	Time commitment, institutional resistance, need for funding for an advocacy group or other leadership	x	x		
C	Institutionalize safety roles and responsibilities	CSP, CDOT	CDPHE, CDOR	Cities and counties	Local law enforcement, city and county agencies	Establish agreements that define the ways agencies and organizations work together to deliver safety programs including roles and responsibilities. These should focus on formal mechanisms such as memorandums of understanding (MOU). Less formal arrangements may be appropriate at local levels.	State and local agencies and organizations are not always empowered to implement safety programs and projects through a consistent, agreed upon process. This can create confusion as to roles and responsibilities, leaving gaps in implementation in some areas and duplicated efforts in others. It can also hinder efforts to build a successful statewide safety culture over time, especially as key personnel change roles.	> Identify key relationships among agencies. > Agree upon and formalize safety-related roles among state agencies as an initial step. This will eventually be expanded to other agencies. > Establish formal agreements (e.g., Memorandum of Agreement) that define safety-related roles. > Incorporate safety collaboration performance objectives into the position descriptions of those involved in STSP implementation. > Incorporate safety criteria in agency performance reviews.	> Removes barriers facing agencies and organizations resulting from unclear division of responsibility. > Creates a more complete safety program and culture statewide, closing gaps in implementation and avoiding redundancy. > Fosters continued cooperation and reduces redundant efforts.	> Need for formal agreements is quantified. > Number of agreements executed.	A, B, E	›Establish a sustainable and unified safety culture and vision amongst all agencies in the state. › Achieve a high level of safety administration efficiency. › Achieve a high level of safety administration effectiveness.	Not Applicable	Little to No Change	Little to No Change	Minor Change	Minor Change	$	Institutional resistance, political will, personnel turnover, funding	x			
D	Coordinate with existing safety programs	CDOT	CSP	Regional and local planning agencies, AAA, CDOT task forces	Cities and counties	Coordinate the development and implementation of safety programs, incorporating strategies among agencies at the state and local level. Existing example programs include CDOT's Whole System Whole Safety and regional and local Vision Zero programs. This would be part of a broader effort to coordinate roles and responsibilities to maximize the efficiency and effectiveness of safety strategies.	Agencies and organizations at the state and local level do not always have a clear sense of how their safety programs fit within the context of other programs across the state. This duplicated efforts and missed opportunities, and it limits the effectiveness of any single program.	> Facilitate communication among safety program leaders. › Meet with planning and programming officials at relevant agencies to discuss how to incorporate safety considerations into project selection and prioritization activities. › Identify gaps and overlaps in roles and responsibilities. › Build a matrix to document major program strategies. › Incorporate safety criteria in agency performance reviews. › Coordinate annual performance target setting with OTS and NHTSA.	> Improves the reach and impact of the state's safety programs. > Recognizes the contributions of a wide range of agencies and organizations. › Avoids duplication of safety program development efforts.	> A matrix of existing programs is established. › Percent matrix is complete.	A, E	›Achieve a high level of safety administration efficiency. › Achieve a high level of safety administration effectiveness. › Establish a sustainable and unified safety culture and vision among all agencies in the state.	Not Applicable	Little to No Change	Little to No Change	Minor Change	Moderate Change	$$	Institutional resistance, political will, personnel turnover	x			
E	Promote consistent safety messaging	CDOT	CSP, CDPHE, CDOR	Cities, counties, MPOs, regional councils	Cities, counties, local law enforcement	Coordinate the efforts of safety agencies and advocacy groups to develop consistent public-facing safety messaging. Coordinate the dissemination of these messages so they are visible to audiences across the state.	Currently, many different safety messages come from a wide variety of organizations across many sectors. Many of these efforts have overlapping intention, but the variation in messaging can create confusion and reduce their effectiveness	> Create a matrix of existing messaging campaigns. › Develop a process to consider common messages and combine accordingly. › Establish a message-setting function of any new or existing statewide safety program. › Generate template materials for local agencies and partner agencies to use in signage, media relations, and education efforts. › Coordinate and educate media on appropriate and consistent safety messaging. › Collect relevant data related to messaging campaign dissemination and effectiveness and produce an annual public-facing report.	> Create greater public safety awareness through consistent messaging. › Minimize duplicate efforts associated with multiple agencies developing separate safety messages.	> Message templates are created. › Percent of safety entities using message templates. › Message matrix is created.	A, B, C, D, F, G	›Establish a sustainable and unified safety culture and vision amongst all agencies in the state. ›Establish a safe transportation culture in Colorado (general population).	Not Applicable	Little to No Change	Minor Change	Minor Change	Minor Change	$$	Funding, institutional resistance, regional agency support	x			
F	Develop education campaigns for high-risk behaviors	CDOT	CSP, CDPHE, CDOR	Advocacy groups, CDOT task forces	Local law enforcement	Develop outreach campaigns aimed at high-risk groups, such as aggressive, distracted, and impaired drivers, with the goal to enhance and coordinate efforts among statewide education platforms.	High-risk behaviors have two common outcomes: some cause severe crashes while others decrease the likelihood of surviving a severe crash.	› Develop a contact list of local partner agencies, e.g., law enforcement, task forces, advocacy groups. › Identify and coordinate with key partner agencies and hold a kick-of meeting. › Develop communications team with the supporting agencies. › Identify existing statewide and local education campaigns aimed at high-risk behaviors including impaired, aggressive, and distracted driving as well as lack of seatbelt and helmet use. › Develop and launch high-risk education campaign for micro-mobility users. › Develop and launch high-risk education campaign for the general public to be more aware of roadside workers and first responders.	› Reduces high-risk behaviors with continuous, but not over-saturated, messaging. › Brings awareness of high-risk behaviors to the driving population, including younger and older drivers. › Educates on the impacts of high-risk behaviors. › Brings awareness to roadside worker safety, e.g., work zones and first responders.	> Number of campaigns created. › Percent of safety entities promoting campaigns. › Various behavioral metrics e.g. drivers wearing seatbelts, motorcyclists wearing helmets, etc.	E, G	› Reduce all crashes caused by aggressive, impaired, distracted driving. › Achieve a nationwide leading level of safe driver behavior and occupant protection. › Make the occupation of roadway workers and responders as safe as any other occupation.	› 96% of fatalities in Colorado in 2018 could be attributed to human error, according to an analysis of the preliminary fatal crash dataset. › 75% of severe impaired driving crashes occur between the hours of 6 pm and 6 am. › An average of 84% of people statewide wore seatbelts according to 2014-2018 seatbelt surveys, but only 45% of people killed in traffic crashes in Colorado in the same time frame were wearing seatbelts at the time of impact. › 309 potential lives saved with 100% seatbelt use over the 2013-2017 period, according to NHTSA. › Crashes involving alcohol/drugs are more than 3x more likely to be severe. › 33% of fatal crashes on county roads are linked to driver impairment. › 41% of all impairment-related fatalities occur on state highways. › The National Highway Traffic Safety Administration has estimated an additional 126 lives could have been saved in Colorado between 2013 and 2017 with 100% helmet usage among motorcyclists. › See Chapter 2 for Data Sources.	Little to No Change	Minor Change	Minor Change	Minor Change	$$$$	Funding, available data, cultural and local resistance, available resources		x		x
G	Provide transportation safety education to students and families	CSP, CDOT	CDPHE	Safe Routes to School, CDOT HSO federal grantees, local planning agencies, advocacy groups	Local law enforcement	Establish a culture of safety among young people by expanding existing and developing new transportation safety education programs, including education on how to be a safe pedestrian and bicyclist, that engage them over many years.	Young people are the next generation of drivers, but roadway safety programs for K-12 students are lacking. There is currently no comprehensive roadway, pedestrian, and bicyclist safety curriculum available for teachers and students.	› Establish strategic partnership between CDOT and Colorado Department of Public Health and Environment to align and elevate existing transportation safety programs. › Research successful education campaigns in local municipalities and partner states. › Develop a comprehensive curriculum that can be used by partners of various entities. › Provide pedestrian and bicycle education for children at elementary and middle schools. › Incorporate interactive training into education programs. › Educate youth regarding current laws and regulations to increase effectiveness. › Promote child safety clubs and other organized activities to promote changes in group culture and behavior. › Increase use of child bicycle helmet and booster seats through promotions/events.	› Reduces vulnerable roadway user fatalities and serious injuries. › Enhances safety culture among young people. › Enacts transportation safety programs that have a positive, multi generational impact › Encourages safe active travel behaviors and ingrains a comprehensive understanding of transportation safety for roadway users.	> Curriculum templates are created. › Number of schools where curriculum is presented. › Number of schools where safety information is incorporated into curriculum.	E ,F	› Establish a safe transportation culture in Colorado (general population). › Minimize the over representation of vulnerable users in severe crashes.	› A study in New York City measured reductions in pedestrian injury between 33 to 44 percent among school-aged children in areas with Safe Routes to School projects › Numerous studies indicate that pedestrian-oriented education and training programs increase knowledge and behaviors of young children, but real-world traffic behavior changes are more likely to occur when education programs incorporate interactive training › A study of 801 schools found that education and encouragement programs were associated with an annual 5 percent increase per year in the percentage of students walking and bicycling to school, which cumulatively could result in a 25 percent increase over five years for sustained education and encouragement efforts. › See Chapter 2 for Data Sources.	Little to No Change	Little to No Change	Minor Change	Minor Change	$$$	Institutional resistance, available resources, funding, training	x	x	x	
H	Prioritize transportation safety funding	Transportation Commission	CDOT, CSP, CDPHE, CDOR	Regional and local planning agencies, city councils, county commissions	Municipal agencies	Increase the importance of safe infrastructure and transportation in transportation funding decisions. Educate funding decision-makers on the importance of safety and how funds could be used to make improvements.	More funds dedicated to safety programs and infrastructure are needed to make a larger impact on safety. Safety is a critical priority for the Colorado transportation system, but there is a lack of awareness of how few resources are specifically devoted to safety issues. The CDOT Vision Statement includes the phrase, "safely moving people and goods," but the statewide wish-list of safety projects is woefully underfunded due to a shortage of funding for transportation overall and lack of adequate safety prioritization.	> Reinstate the Colorado Transportation Commission Safety Subcommittee. › In coordination with Your Transportation Plan, research and quantify overall state safety improvement needs through a safety conditions assessment. › Identify corridor multimodal safety gaps statewide. › Conduct an analysis to determine level of understanding.	> Increases ability to fund safety improvements, including infrastructure, enforcement, and education. › Elevates the importance of safety by "putting your money where your mouth is." › Results in fewer crashes, injuries, and deaths.	> Percent of funding dedicated to safety by agency (trend analysis). > Amount of funding dedicated to safety by agency (trend analysis). ›Transportation Commission Safety Subcommittee reinstated. › Statewide Transportation Improvement Program (STIP) and Transportation Improvement Program (TIP) processes are amended.›	I, M, N	›Build, maintain, and operate a complete and connected transportation network safe for all users. ›Achieve equitable safety improvements to address the safety needs of all agencies in the state.	> Minnesota, Utah, and Washington are states with similarly-sized populations and annual vehicle miles traveled (VMT), but their annual roadway deaths are significantly lower than Colorado's due in part to a culture of safety that has been developed through continued efforts and dedicated funding for safety programs and grants. In 2018 Minnesota had a death per 100,000 population rate 39% lower than Colorado, Washington was 35% lower, and Utah was 26% lower. › See Chapter 2 for Data Sources.	Little to No Change	Minor Change	Substantial Change	Large Change	$$-$$$$$	Institutional resistance, cultural resistance, funding criteria	x	x	x	x
I	Prioritize safety in transportation planning, facility design, and project selection	DTD	CSP, CDPHE	Regional and local planning agencies, public works departments, and local city engineers	City and county engineering and planning departments	Review policies and processes of roadway planning, design, and project selection to determine what role safety plays in decision-making. Advocate for increasing the relevance of safety in processes of roadway planning, design, and project selection.	Often safety is not prominent in project selection processes. Although purpose and need type project statements usually includes safety, its importance typically lags well behind traffic operations and environmental concerns, so safer alternatives may not be preferred. Transportation design manuals may not include newer best safety practices that can decrease crash frequency and severity. Existing design guidelines and policies may not be up to date, which results in the selection and design of less safe facilities.	> Investigate the feasibility and suitability of a statewide "roundabouts first" policy. › Investigate an intersection control evaluation policy. › Amend Statewide Transportation Improvement Program and Metropolitan Planning Organization Transportation Improvement Programs to more highly prioritize projects that address identified safety issues. › Update CDOT design manual and local design guidelines to place a greater emphasis on safety and consideration for vulnerable roadway users (e.g., adequate pedestrian crossings, bike lanes, micro transit, such as near transit stations). › Develop a road design manual for non-highway (local) facilities and rural communities. › Develop model traffic calming design criteria and standards to be used by local jurisdictions for new development and retrofits for existing streets. › Facilitate agency and community infrastructure and roadway design decisions with context sensitive considerations of the community and surrounding land use.	> Improves safety of new facilities and infrastructure. › Improves roadway design standards to better serve all travelers. › Promotes consistency in safe design standards between communities. › Quantifies and weighs safety opportunities in all transportation projects.	> CDOT design manual and local design guidelines are updated. › Intersection Control Evaluation policy is in place. › Statewide Transportation Improvement Program (STIP) and Transportation Improvement Program (TIP) processes are amended.	H, M, N	› Minimize the over representation of vulnerable users in severe crashes. › All roadway segments' safety performance should achieve a LOSS I or II given the conditions at each location. › All intersections' safety performance should achieve a LOSS I or II given the conditions at each location.	› According to the CDOT 2019 Problem Identification Report, speeding was a factor in 35% of all fatalities in 2017. There were 230 speeding-related motor vehicle fatalities, a 9% increase from the previous year. › More safety-oriented design decisions could reduce speeding-related fatalities. › Highway improvement projects indirectly improve safety, but CDOT has only two funding sources dedicated to safety improvements—the federal Highway Safety Improvement Program and Colorado's Funding Advancements for Surface Transportation and Economic Recovery Act of 2009 (FASTER) Safety Program—that amount to approximately 6% of CDOT's overall annual budget. › See Chapter 2 for Data Sources.	Little to No Change	Minor Change	Minor Change	Moderate Change	$$-$$$$$	Institutional resistance, potential increase in construction costs, environmental and/or right of way impacts, developers, elected officials			x	x

IMPLEMENTATION PLAN DETAILS FOR TIER I STRATEGIES

ID	Strategy Name	Strategy Champion(s)	Strategy Partners	Other Partners	Local Implementation Partners	Strategy Description	Safety Issue	Strategy Action Items	Benefits	Progress Metrics	Complementary Strategies	Goal(s) Supported	Data/Supporting Information	Potential Reduction (rate) in Serious Injury Crashes by years				Implementation Costs ($)	Barriers to Implementation	Corresponding Emphasis Area			
														End of Year 1	End of Year 4	End of Year 10	Beyond 10			Programmatic	High Risk Behavior	Vulnerable Roadway Users	Severe Crash Mitigation
J	Educate decision makers on the effectiveness of occupant protection laws	CDOT, CSP, CDPHE, CDOR	-	CDHS, local law enforcement, AAA, emergency medical responders, RMIA, governor's office, advocacy groups including Occupant Protection Task Force and Colorado Young Driver Alliance	Local governments	Research and document the benefits of occupant protection laws, such as seatbelt use, helmet use, and restrictions on personal device use. Educate legislators, commissioners, and other decision-makers on the benefits of such laws.	Occupant protection measures have a significant and direct impact on saving lives. Lack of seatbelt protection, helmet use, and other measures cost lives and contribute to serious crashes. Distracted driving is a major contributing factor to serious and deadly crashes throughout the state. Inattentive driving is more prevalent among younger drivers, but remains an issue for all drivers. Currently, Colorado does not have a hand-held cell phone ban.	> Identify champions to coordinate agency action. > Engage advocacy groups to promote legislative changes. > Develop education materials for decision-makers and the general public. > Create a safety awareness test for decision-makers.	> Improves immediate and long-term survivability of vehicular crashes. > Prevents crashes, injuries, and fatalities related to personal device use while driving.	> Decision-maker safety awareness test scores. > Number of education materials produced for decision-makers.	B, K	> Achieve a nationwide leading level of safe driver behavior and occupant protection. > Reduce crashes and injuries prevalent at severe crash locations.	> Colorado ranks 40th in seatbelt use nationwide. > NHTSA estimates 309 Colorado lives could have been saved from 2013-2017 with 100% seatbelt usage. > States that enact universal helmet laws observe relatively high compliance, nearly 90%. > NHTSA estimates that 126 Colorado lives could have been saved from 2013-2017 with 100% helmet usage among motorcyclists. > Reliable studies consistently show that seat belt usage increases about 10%, and vehicle occupant fatalities decrease 7-8% when a primary seat belt enforcement law replaces a secondary seat belt enforcement law. > When the state of Louisiana repealed its universal helmet law in 1999, helmet usage dropped from near universal compliance to approximately 50% and the number of motorcyclist fatalities sharply increased. > All but three states in the United States have enacted some form of helmet law. > See Chapter 2 for Data Sources.	Little to No Change	Moderate Change	Substantial Change	Large Change	$$-$$$	Political resistance, public acceptance	x	x	x	
K	Increase requirements for new and renewal driver licensing	CDOR	CDOT, CSP, CDPHE	Occupant Protection Task Force, Colorado Young Driver Alliance, Colorado PUC, AARP, AAA, Drive Smart Colorado	Local law enforcement, medical community	Expand the graduated driver licensing (GDL) system to increase education and practice requirements for new drivers to obtain a license. Develop appropriate testing requirements to verify driver competency with increased age.	Motor vehicle crashes are the leading cause of death for teenagers in the United States, and young drivers are overrepresented in vehicle crashes in comparison to adult drivers. Requirements for obtaining and renewing a driver's license in Colorado are not rigorous compared to other states, with looser restrictions on learner's permits and road tests. While age does not determine driving performance, drivers may experience physical, cognitive, or behavioral changes as they age, which may impact driving abilities over time.	> Research steps that Colorado can take toward increasing GDL and formal driver education requirements to align with recommended best practices. > Strengthen relationships between partner agencies to establish a shared understanding and approach to improving safety for new and older drivers. > Define the issue further through additional, targeted data analysis. > Compare Colorado requirements and crash data for new and older drivers with those of peer states. > Educate decision-makers via legislative liaisons. > Educate law enforcement and medical professionals on how to evaluate driving competency and the referral system.	> Reduces severe crashes caused by new and older drivers. > Improves transportation safety culture. > Verifies driving competency among new and older drivers.	> Change in driver licensing requirements. > Percent of crashes and severe crashes of younger and older drivers.	B, J	> Achieve a nation-wide leading level of safe driver behavior and occupant protection. > Have laws that effectively support transportation safety. > Minimize the over representation of vulnerable users in severe crashes.	> Colorado ranks 46 out of 50 (5th easiest) states in relative difficulty to obtaining a driver's license. > Inexperience was the leading contributing factor (51%) of fatal or serious injury crashes among young drivers ages 15 to 20 in Colorado from 2014 to 2018. > Older drivers are more likely to be killed or seriously injured in a crash than drivers in other age groups. In 2018, 131 Colorado drivers over 65 years old were involved in fatal crashes and 72 older drivers died in car crashes. > See Chapter 2 for Data Sources.	Little to No Change	Minor Change	Moderate Change	Substantial Change	$$-$$$	Political resistance, funding and staffing limitations		x	x	x
L	Establish a framework for streamlining data management	CDOT	STRAC, CSP, CDOR, CDPHE (directed by leadership group)	STRAC (Statewide Traffic Records Advisory Committee)	Cities, counties, local law enforcement	Improve data gathering, reporting, storage, linkage, processing, analysis, and dissemination throughout the state by creating traffic records databases following the FHWA measures of quality: timeliness, accuracy, completeness, uniformity, integration, and accessibility.	Both local and state agencies have identified a need for a comprehensive statewide crash database, comprised of files for Crash, Vehicle, Driver, Roadway, Citation/Adjudication, and Emergency Medical Services/Injury Surveillance. Many jurisdictions do not have easy access to statewide or local crash statistics, which creates a concern for data timeliness and reliability. Many agencies have turned to local law enforcement as a resource for crash data. Law enforcement officials across the state do not have a consistent data collection method as there is a lack of a digital reporting system. This disconnect creates an environment in which different data sources and collection methods are being used to analyze data, causing inconsistency in problem identification, use of multiple databases, and data incompleteness.	> Create a statewide web-based crash data entry form for consistent data entry by law enforcement for direct submission to a statewide crash database. > Coordinate and communicate with agencies at the state and local level that collect, process, or analyze crash data. > Coordinate with partner agencies to determine non-crash data needs. > Pursue implementation of Traffic Records Assessment recommendations for improvements to the statewide crash data. > Create a leadership group to be a liaison between the Executive Directors of the partner agencies and the Statewide Traffic Records Advisory Committee. > Implement Unified Street Naming Convention standards in the electronic crash data entry form. > Develop a public-facing data analysis, reporting, and visualization tool to provide data in a more usable format to partner agencies. > Combine other safety-related databases to do more comprehensive analysis (roadway assets, weather, traffic, citation, health, etc.)	> Allows for a more immediate response to emerging crash patterns. > Provides more uniform confidence in crash mitigation strategies at the state and local level. > Provides consistent, complete, and more uniform crash data. > Provides a uniform source for data that has been properly vetted by standardized quality assurance/quality control protocols.	> Percent of law enforcement agencies that adopt the web-based crash data entry form. > Number of meetings for Statewide Traffic Records Advisory Committee. > Number of meetings for leadership liaison group	M, N, O	> Achieve a high level of safety administration efficiency. > Achieve a high level of safety administration effectiveness.	> Consensus from statewide safety stakeholders was that traffic records data need to be improved at both the state and local level. > Current data is not easily analyzed for seatbelt usage because data collection efforts are inconsistent throughout the state. > Law enforcement officials currently do not report of-system crash locations with sufficient accuracy, i.e., lack of geo-location. > Currently, the state does not have a consistent crash data collection method for law enforcement. About half of the crash data is submitted on paper, creating data consistency issues and a lack of quality control in data reporting. > Law enforcement has 5 days from the completion of the investigation to submit the record to Colorado Department of Revenue. CDOT manually enters paper records and sends approximately 90% of the crash records in 90 days to CDOT. These delays may prevent agencies from immediately responding to emerging crash patterns within their respective jurisdictions. > See Chapter 2 for Data Sources.	Little to No Change	Minor Change	Minor Change	Minor Change	$$$$	Data privacy requirements, legislation, institutional resistance, reporting methods (electronic v paper), available resources (especially at the local level), timeliness of data	x	x	x	x
M	Prioritize and promote proven safety toolbox strategies	CDOT	CSP	City and county transportation departments, CDOT Safety Circuit Rider	City and County Engineers	Educate state and local traffic engineers on existing, known, and effective safety toolbox strategies in transportation facility design, construction, and operation. Promote inclusion of proven strategies in design practices and development of Local Road Safety Plans. Promote funding for implementation of proven strategies, and elevate safety as a priority in transportation facility design.	Known effective mitigation measures are often not being implemented due to a lack of funding, awareness, safety planning, and safety prioritization.	> Identify cities and counties with the highest serious injury and fatal crash rates. > Collect data related to the safety performance of transportation facilities statewide. > Collect data related to proven countermeasures and their crash reduction potential. > Prioritize proven countermeasures in the design of transportation facilities and Local Roadway Safety Plans. > Educate state and local traffic engineers on the benefits, efficacy, and implementation of proven safety countermeasures. > Develop a technology toolbox of proven safety countermeasures. > Develop a transportation safety self assessment tool for local and regional jurisdictions.	> Reduces serious injury and fatal crashes through greater use of known safety mitigation measures.	> Number and crash rates of fatal crashes, serious injury crashes, bicycle and pedestrian crashes. > Number and% increase of safety infrastructure features, e.g., miles of median barrier, miles of rumble strips, and others.	H, I, L, N	> Build, maintain, and operate a complete and connected transportation network safe for all users. > Reduce crashes and injuries prevalent at severe crash locations. > All intersections' safety performance should achieve a LOSS I or II given the conditions at each location. > All roadway segments' safety performance should achieve a LOSS I or II given the conditions at each location.	> County roads account for 7% of total statewide crashes but 12% of severe crashes and 15% of fatalities. > Rural roads account for 21% of total statewide crashes but 34% of severe crashes and 54% of fatalities. > Centerline rumble strips have been found to reduce severe injury and fatal head-on and opposite-direction sideswipe crashes by 44 to 64% . > When installed on rural four-lane freeways median barriers such as these have been found to reduce cross-median crashes by 97% . > Local roads experience 3x the fatality rate of the Interstate Highway System. > The top ten counties in Colorado saw 453 roadway fatalities in 2018, out of a statewide total of 632 (72%). > See Chapter 2 for Data Sources.	Little to No Change	Moderate Change	Substantial Change	Large Change	$$$$	Political will, funding, design standards, design culture, lack of local expertise			x	x
N	Implement systemic infrastructure safety improvement strategies	CDOT	-	Local city and county transportation departments, CDOT Region Traffic Engineers	City and county engineers	Build on existing safety implementation projects and programs. Identify and implement the most effective wide-scale safety mitigation strategies in conjunction with implementing hot-spot improvement projects.	Many existing transportation facilities were built using inadequate or substandard safety design features. Even some recently constructed facilities could improve their safety performance. Proven countermeasures to address these issues have been developed but not incorporated in a statewide safety toolbox that is easily accessible and implementable. Simply put, Colorado's transportation infrastructure is less safe than it should be.	> Establish a dedicated CDOT Safety Program champion to manage and measure progress on implementation of safety countermeasures and achievement of related safety benefits. > Identify, research, and implement proven safety countermeasures to address overrepresented groups. These may include, but are not limited to, the example strategies provided below. > Continue CDOT's edgeline striping and median cable barrier installation programs on rural highways. > Continue and expand the CDOT Safety Circuit Rider program. Promote funding for implementation of proven strategies.	> Reduce severe injury and fatal crashes through greater use of know safety mitigation measures.	> Number and crash rates of fatal crashes, serious injury crashes, bicycle and pedestrian crashes. > Number and percent increase of safety infrastructure features, e.g., miles of median barrier, miles of rumble strips, etc.	H, I, L, M	> Build, maintain, and operate a complete and connected transportation network safe for all users. > Reduce crashes and injuries prevalent at severe crash locations. > All intersections' safety performance should achieve a LOSS I or II given the conditions at each location. > All roadway segments' safety performance should achieve a LOSS I or II given the conditions at each location.	> There were 9,845 head-on/sideswipe (opposite direction) crashes on Colorado roads between 2014 and 2018, of which 642 (6.5%) resulted in serious injury or death. > There were 35,673 approach turn (left turn) crashes on Colorado roads between 2014 and 2018, of which 1,094 (3.1%) resulted in serious injury or death. > There were 12,303 crashes related to fatigued driving on Colorado roads between 2014 and 2018, of which 661 (5.4%) resulted in serious injury or death. > There were 75,929 crashes related to distracted driving on Colorado roads between 2014 and 2018, of which 1,591 (2.1%) resulted in serious injury or death. > There were 7,713 pedestrian-related crashes on Colorado roads between 2014 and 2018, of which 9% were in urban areas. Of these urban pedestrian crashes, 22% resulted in serious injury or death. > 32% of severe crashes are single-vehicle crashes, 56% are two-vehicle crashes, and 12% are three or more. > See Chapter 2 for Data Sources.	Little to No Change	Moderate Change	Substantial Change	Substantial Change	$$$$$	Political will, funding, lack of local expertise			x	x
O	Increase education on and implementation of data-driven and automated enforcement	CDOT, CSP	-	CDOT HSO, local agencies	Local law enforcement	Increase implementation of data-driven enforcement for speeding and red-light running at high-crash locations. Educate decision-makers on the effectiveness of automated enforcement as a safety enhancement rather than as a revenue generator.	A disproportionately high number of severe crashes occur on a relatively small proportion of roadways and intersections. Limited enforcement resources may not be deployed in the most efficient way to cover these locations. Automated enforcement is significantly underutilized as a tool to affect driver behavior.	> Create a step-by-step guide for local agencies on how to implement automated or data-driven enforcement, including how to tie revenue generated through enforcement in school zones to Safe Routes to School funding. > Research and develop a white paper that demonstrates the effectiveness of data-driven and automated enforcement at increasing safety. > Conduct education before enforcement first in communities that are historically marginalized. > Partner with Safety Circuit Rider program.	> Reduces the number of severe crashes at high crash locations and improves safety culture. > Allows for more efficient use of limited resources.	> Number and percentage of communities with policies favorable for automated/data-driven enforcement. > Number of locations that have demonstrated improvements in safety performance due to automated/data driven enforcement.	B, L	> Have laws that effectively support transportation safety. > Reduce crashes and injuries prevalent at severe crash locations.	> In 2018, 22% of fatal crashes in Colorado resulted from issues related to speeding [16%] and disregarding a traffic device [7%]). > In Denver, 50% of traffic fatalities occurred on 5% of the city's streets from 2013 to 2016. > A study conducted in Spain showed that fixed speed cameras reduced crash rates by 30% on urban arterials and highways. > In a study of 253 signalized intersections in Belgium, red light and speed cameras resulted in a 14% reduction in severe crashes. > See Chapter 2 for Data Sources.	Little to No Change	Minor Change	Minor Change	Minor Change	$$$	Funding, available data, cultural, judicial, and local resistance, available resources			x	x

Technology Toolbox

Appendix A: Intelligent Transportation Systems & Technology-Based Crash Countermeasures Toolbox

Capital Costs are ranked Low (L), Medium (M), or High (H) on the following scale: Low: $0 - $100,000, Medium: $100,000 to $1,000,000, High: > $1,000,000 for single site deployments.
Impacts are ranked Low (L), Medium (M), or High (H) based on their measured reduction in crashes and deployment performance.

Table 1: Deployed SolutionsW

High Risk Behavior								
Applicable Strategies	**Countermeasure Type**	**Technology**	**Description**	**Deployed**	**Crash Types Mitigated**	**Evaluation, Deployment, and Guideline References**	**Capital Costs**	**Impact**
Tier II: LL Tier III: EEE	In-Vehicle	Adaptive Cruise Control	An in-vehicle system of sensors and software that measures the speed and distance from surrounding vehicles to match speed and maintain a pre-programmed following distance.	Global	Rear End	NHTSA Behavior Study NHTSA Old/Young Driver Study FHWA Study Virginia Tech Transportation Institute Study FHWA Study	L	M
Tier I: M, O Tier II: LL, MM	On-Road, Site Specific or Systematic	Automated Speed Enforcement Cameras	A system of license plate reading optical speed cameras paired with radar, microwave, Bluetooth, or laser technology that measures the speed of oncoming vehicles and issues automated citations for speeding vehicles.	Global	All Types	CDC Study USDOT Congressional Testimony USDOT Guidelines NCHRP Study NHTSA Literature Review PBIC Review Study VisionZero Planning Network Resource Center NHTSA System Analysis FHWA CMF Clearing House 2009	L	H
Tier II: LL Tier III: EEE	In-Vehicle, Pedestrian and Bicycle	Automatic Emergency Braking/Forward Collision Warning	An in-vehicle system designed to increase warning and reaction time for incidents. One second of additional warning time reduces likelihood of a crash by 60%; five seconds reduces likelihood by 95%.	Global	All Types	IIHS Study NHTSA Study NHTSA Ped Study NHTSA UK Study IIHS and General Motors Study SafeCar.gov Study FMCSA CMV Study Consumer Reports Survey FHWA Study FHWA Study and Guide FHWA Graphic FMSCA Rule Making FHWA Large Scale Study NTSB Study	L	H
Tier II: LL Tier III: EEE	In-Vehicle	Blind Spot Warning Systems	An in-vehicle system of sensors that detects when another vehicle, motorcycle, or a bicycle is in the vehicle's blind spot and sounds an alarm or illuminates a warning light.	Global	All Types	Freight Blind Spot Study NIH Sensor Study NHTSA Study USDOT Studies NHTSA Performance Evaluation	L	M

High Risk Behavior

Applicable Strategies	Countermeasure Type	Technology	Description	Deployed	Crash Types Mitigated	Evaluation, Deployment, and Guideline References	Capital Costs	Impact
Tier I: B, M, O Tier II: BB, LL Tier III: EEE	In-Vehicle	Breathalyzer Vehicle Interlock	A vehicle interlock attached to a breathalyzer on vehicle dashboards currently used to ensure compliance for DUI offenders. Legislators are evaluating whether to make this or similar equipment standard on all new vehicles.	Global	All Types	NHTSA 2014 Guide NCSL Law Code Review Arizona DOT Guide Wyoming DOT Guide Colorado Dept. of Revenue DUI Homepage NHTSA Case Studies NHTSA Countermeasures That Work CDC Report American Journal of Public Health Research Report	L	H
Tier I: M Tier II: LL Tier III: EEE	In-Vehicle, On-Road Systematic	Do Not Disturb While Driving	A function of the latest mobile device operating systems that activates when device speed exceeds 15 MPH and prohibits notifications and use while driving. Alternatively, the user may manually activate the feature.	Global	All Types	FHWA Abstract Colorado DOT “Get Turned On” FMSCA Rule NHTSA Crash Statistics NHTSA Investigation and Prosecution Apple How-To CDC Report EverDrive Study IIHS Report	L	M
Tier II: LL Tier III: EEE	In-Vehicle	Drowsy Driver Detection Systems	An in-vehicle system of sensors that monitors the driver for physiological signs of fatigue and provides direct feedback to the driver in the form of an alarm.	Global	All Types	NHTSA Drowsy Driving Study FMCSA Stage I FMCSA Stage II NHTSA Research Program NSC Research FHWA Project Reports	L	L
Tier I: I, M Tier II: LL Tier III: BBB	On-Road Site Specific	Dynamic Speed Feedback Systems	VMS signs equipped with radar to measure vehicle speed. Speed measurements are displayed for the driver and may include ‘Slow Down’ messages.	Global	All Types	FHWA Evaluation Report FHWA Spatial Report Midwest Transportation Consortium Tech Brief University of Wisconsin – Madison Study FHWA Deployment Guide	L	L
Tier I: M Tier II: LL	On-Road Systematic, Organizational, Driver Behavior	Emergency Truck Parking	A mobile application designed for freight truckers to locate the nearest emergency truck parking in the event of severe weather to avoid stranding.	United States	All Types	Maryland DOT Project Report Colorado DOT Study Virginia DOT Study FHWA Working Group Report FHWA Jason’s Law	L	M
Tier II: LL Tier III: EEE	In-Vehicle	Lane Departure/Lane Keeping Assist	An in-vehicle system of optical cameras and algorithms designed to watch roadway striping and center the vehicle in lane by steering the vehicle for the driver.	Global	Roadway Departure, Angle	FHWA Study IIHS Studies Minnesota DOT Study Brief NCBI Field Effectiveness Evaluation NHTSA Effectiveness Study FHWA Performance Evaluation NHTSA Heavy Vehicle Evaluation Report FHWA Infrastructure Initiatives Report AAA Large Vehicle Research Report	L	M

High Risk Behavior

Applicable Strategies	Countermeasure Type	Technology	Description	Deployed	Crash Types Mitigated	Evaluation, Deployment, and Guideline References	Capital Costs	Impact
Tier I: O Tier II: CC, LL, MM	On-Road Systematic	Optical Cameras with Machine Learning to Detect Impaired Drivers	An optical camera with an algorithm trained to detect impaired drivers that can alert law enforcement and TMC operators; ideally, before an incident.	Global	All Types	FHWA Study FHWA Research FHWA Video Analytics FHWA Rural Application FHWA TMC Guidelines Iowa State University of Research Report Cornell University Anomaly Detection Research NCBI Research	L	H
Tier I: O Tier II: LL, MM	On-Road Systematic	Optical Cameras with Machine Learning to Detect Unrestrained Occupants	An optical camera with an algorithm trained to detect unrestrained occupants and alert law enforcement and TMC operators to asses compliance or enable enforcement.	Global	All Types	FHWA Study FHWA Research FHWA Video Analytics FHWA Rural Application FHWA TMC Guidelines Iowa State University Research Report Cornell University Anomaly Detection Research NCBI Research	L	H
Tier I: M, O Tier II: HH, LL, MM	On-Road Site Specific	Photo Radar Enforcement Vans	A mobile van equipped with automated speed enforcement cameras that issues citations, especially effective in work zones and school zones.	United States	All Types	USDOT Study NHTSA Operations Guidelines City of Portland, OR Police Department Report	L	H
Tier I: E, F, G Tier II: FF, GG, HH Tier III: DDD	Public Outreach, Organizational	Public Awareness Campaigns	A campaign of traditional and non-traditional marketing tactics about roadway changes and legislative changes.	Global	All Types	Colorado DOT Get Turned On Colorado DOT Cannabis Campaign Colorado DOT Alcohol Campaign NHTSA Impaired Driving Campaigns NHTSA Marketing Index	M	M
Tier I: M, O Tier II: LL, MM	On-Road Site Specific	Red Light Enforcement Cameras	Optical cameras at signalized intersections that detect when a vehicle runs a red light and issues an automated citation.	Global	All Types	Vermont DOT Countermeasures That Work Illinois DOT Work Zone FAQ PedBikeInfo White Paper FHWA Guidelines City of Chicago, IL Report CDC Research IIHS Law Review GHSA Report FHWA Data FHWA Safety Brief Alabama DOT Guidelines	L	L
Tier I: I, M, O Tier II: HH, LL	On-Road Site Specific, Driver Behavior	Wrong Way Detection Systems	A system of optical, infrared, radar, or Bluetooth sensors that detect when a vehicle is engaged in a wrong way movement; integrated systems can automatically send alerts to law enforcement and TMC operators.	Global	All Types	Concept Link Texas DOT and FHWA Study FHWA Data Nevada DOT Deployment Arizona DOT Deployment CALTRANS Guidelines Arizona DOT Evaluation	L	H

Vulnerable Road Users

Applicable Strategies	Countermeasure Type	Technology	Description	Deployed	Crash Types Mitigated	Evaluation, Deployment, and Guideline References	Capital Costs	Impact
Tier I: L, M Tier II: CC, LL	On-Road Systematic, Organizational	Active Traffic Management (ATM) Signs	A system of VMS signs controlled by algorithms and TMC operators to display warnings, advisories, closure notices, speed notices, accident notices, and HOV notices in advance to reduce conflicts and control speed reduction. These can be deployed to manage individual lanes to help mitigate congestion impacts from roadside or on road incidents or enable lane switching.	Global	All Types	FHWA Approaches FHWA Implementation Guide Texas A&M University Research Report Wisconsin DOT ATM Public Outreach ITS International Literature Review FHWA Screening and Feasibility Guide FHWA Resource Center FHWA ATM Brief CALTRANS Safety Guidebook	H	M
Tier II: LL Tier III: EEE	In-Vehicle	Adaptive Cruise Control	An in-vehicle system of sensors and software that measures the speed and distance from surrounding vehicles to match speed and maintain a pre-programmed following distance.	Global	Rear End	NHTSA Behavior Study NHTSA Old/Young Driver Study FHWA Study Virginia Tech Study	L	M
Tier I: M, O Tier II: LL, MM	On-Road Site Specific or Systematic	Automated Speed Enforcement Cameras	A system of license plate reading optical speed cameras paired with radar, microwave, Bluetooth, or laser technology that measures the speed of oncoming vehicles and issues automated citations for speeding vehicles.	Global	All Types	CDC Study USDOT Congressional Testimony USDOT Guidelines NCHRP Study NHTSA Literature Review PBIC Review Study VisionZero Planning Network NHTSA System Analysis FHWA CMF Clearing House 2009 CALTRANS Safety Guidebook CALTRANS Report for Work Zones	L	H
Tier I: M Tier II: HH, LL Tier III: EEE	In-Vehicle, Pedestrian and Bicycle	Automated Stop Announcement Systems	A stop announcement on transit systems that audibly communicates the upcoming and active stop locations. These systems typically include exterior speaker warnings for nearby pedestrians and bicyclists.	Global	Pedestrian/ Bicycles	Halifax, Canada Transit Agency Report NADTC Research USAB Capital Cost Estimates FHWA Transit Design Guidelines FHWA Transit Management Guidelines	L	L
Tier I: M Tier II: CC, LL Tier III: EEE	In-Vehicle, Organizational	Automatic Crash Notification Systems	An in-vehicle system of sensors that detect when a crash has happened and automatically alerts law enforcement and/or TMC operators.	Global	All Types	SaferCar.gov Brief Rural ITS Safety Toolbox NCBI Research USDOT Brief American College of Emergency Physicians Report American College of Emergency Physicians Brief Montana DOT Project Report State of Washington and FHWA Study	L	M
Tier I: H, I, M Tier II: HH, LL Tier III: GGG	On-Road Site Specific or Systematic, Bicycle	Bicycle Loop Detection	Inductive loops on bike paths and at signalized intersections. Bicycle loops can also be integrated with bike detection warning systems to illuminate flashing signs at trail or other unsignalized crossings.	United States	Bicycle/ Vehicle	NACTO Design Guide City of Portland, OR Use Guide FHWA Inductive Loop Guidance NHTSA Safety Page FHWA Literature Review City of Berkeley, CA Planning Guide	M	M

Vulnerable Road Users

Applicable Strategies	Countermeasure Type	Technology	Description	Deployed	Crash Types Mitigated	Evaluation, Deployment, and Guideline References	Capital Costs	Impact
Tier I: I, M Tier II: HH, LL Tier III: GGG	On-Road Site Specific, Bicycle	Bicycle Warning Systems	A system of optical, radar, microwave, Bluetooth, or infrared sensors that alerts drivers of an approaching bicycle. It can also be deployed on bicycles to detect when a vehicle is approaching and adjust flashing lights and issue audible warnings. Similarly, they can be deployed to warn cyclists of upcoming obstacles such as low bridges or blind curves.	Global	Bicycle	DC Rainmaker Rural ITS Safety Toolkit NACTO Toolkit FHWA Bike Safety RSA FHWA Ped/Bike Safety Index FHWA Bike Database FHWA How to Develop Bike a RSA	L	L
Tier I: I, M Tier II: HH, LL Tier III: GGG	On-Road Site or Systematic, Bicycle	Bike Scouting/ Counting	A system of radar sensors that detect an approaching bicycle. It is connected to VMS, embedded LEDs, or pedestrian hybrid beacons, that illuminate/flash at unsignalized or poorly lit crossings ahead of vehicles.	Global	Bicycle	BikeScout Project Report News Report News Report New Zealand News Report FHWA Evaluation Report	L	M
Tier II: LL Tier III: EEE	In-Vehicle	Blind Spot Warning Systems	An in-vehicle system of sensors that detects when another vehicle, motorcycle, or a bicycle is in the vehicle's blind spot and sounds an alarm or illuminates a warning light.	Global	All Types	Freight Blind Spot Study NIH Sensor Study NHTSA Study USDOT Studies NHTSA Performance Evaluation	L	L
Tier I: M Tier II: HH, LL Tier III: EEE	In-Vehicle, Pedestrian and Bicycle	Bus Based Transit Warning Systems	A system of sensors actuated mechanically or using detection that sounds an exterior audible alarm that the bus is turning.	Global	Pedestrian/ Bicycle	FHWA Transit Design Guidelines FHWA and Portland State University Evaluation Report	L	L
Tier I: I, M Tier II: LL Tier III: BBB	On-Road Site Specific	Curve Warning Systems	A system of optical, radar, microwave, Bluetooth, or infrared sensors that detects when a vehicle is approaching a sharp turn and illuminates VMS signs to warn the driver. (Also see Road Geometry Warning Systems.)	Global	Roadway Departure, Head On, Angle	Michigan DOT Review FHWA Horizontal Curve Safety Brief Minnesota DOT In-Vehicle Warning System Report FHWA Low Cost Guidebook FHWA Evaluation Report CALTRANS Ice Curve Warning System	M	H
Tier I: I, M Tier II: LL Tier III: BBB	On-Road Site Specific	Dynamic Advance Intersection Warning Systems	A system of optical, radar, microwave, Bluetooth, or infrared sensors that detect approaching vehicles and illuminate VMS signs to warn the driver of an impending intersection and/or stop maneuver. (Also see Road Geometry Warning Systems.)	Global	All Types	FHWA Report Minnesota DOT Report Minnesota DOT Rural Report ENTERPRISE Group Report FHWA Selection Criteria Database Purdue University High Speed Rural Report NCHRP Report NHTSA Research Report FHWA Local and Rural Safety Sheets	L	H

Vulnerable Road Users

Applicable Strategies	Countermeasure Type	Technology	Description	Deployed	Crash Types Mitigated	Evaluation, Deployment, and Guideline References	Capital Costs	Impact
Tier I: L, M Tier II: HH Tier III: DDD	Organizational Data Sharing	FHWA PBCAT Crash Typing Tool	A program developed by FHWA to isolate specific high conflict areas for pedestrians and bicyclists.	United States	Pedestrian/ Bicycle	PedBikeInfo Download Resource North Carolina DOT Ped/Bike Crash GIS Map Wisconsin DOT Analysis FHWA Forward FHWA Brief FHWA Manual NHTSA PBCAT Database Construction Manual PedBikeInfo Webinar Arizona Bike Law Brief on Deployment HSIS Brief Miami-Dade County, FL Deployment Report PBCAT and HSIS Hybrid Use NHTSA Compendium	M	H
Tier I: I, M Tier II: HH, LL Tier III: GGG	On-Road Systematic, Organizational Data Sharing	Green Wave Systems (Coordinated Signals)	A signal coordination model that creates a continuous bicycle wave along a corridor to reduce conflicts and encourage cyclists to avoid dangerous lane switching, sidewalk to roadway switching, or red light running.	United States	Bicycle	Technical University of Denmark Report FHWA Signal Timing Guidelines Polytechnic University of Bucharest Research Report	H	M
Tier I: I, M Tier II: HH, LL Tier III: GGG	On-Road Site Specific, Pedestrian and Bicycle	In-Road Bike Crossing LEDs	A system of roadway or walkway embedded LEDs that illuminate when a bicycle is detected by sensors or when a crossing button is pushed.	United States	Bicycle	TAPCO Product Lightguard Product North Carolina DOT Design Toolbox CDOT Deployment NCHRP Synthesis Report University of Massachusetts - Amherst Analysis Report Virginia DOT Analysis Report FHWA Guidelines FHWA Resource FHWA Study Report FHWA Infrastructure Guidelines FHWA Countermeasures Methods FHWA Statewide Bike/Ped Planning Guidebook Consulting Study CALTRANS and FHWA	L	H
Tier I: I, M Tier II: HH, LL Tier III: GGG	On-Road Site Specific, Pedestrian and Bicycle	In-Road Pedestrian Crossing LEDs	A system of roadway or walkway embedded LEDs that illuminate when a pedestrian is detected by sensors or when a crossing button is pushed.	Global	Pedestrian	TAPCO Product Lightguard Product North Carolina DOT Design Toolbox Colorado DOT Deployment NCHRP Synthesis Report University of Massachusetts - Amherst Analysis Report Virginia DOT Analysis Report FHWA Guidelines FHWA Resource FHWA Study Report FHWA Study - Virginia FHWA Infrastructure Guidelines FHWA Countermeasures Methods	L	H

Vulnerable Road Users

Applicable Strategies	Countermeasure Type	Technology	Description	Deployed	Crash Types Mitigated	Evaluation, Deployment, and Guideline References	Capital Costs	Impact
Tier I: L Tier II: LL	In-Vehicle, Programmatic	In-Vehicle Warning Systems	Vehicles equipped to receive messages from infrastructure (V2I) about upcoming road geometry, queueing, and other adverse conditions.	Global	All Types	CALTRANS Study University of Minnesota - Duluth Evaluation Report	M	M
Tier I: I, M Tier II: LL Tier III: GGG	On-Road Site Specific	Limited Sight Distance Warning Systems	A system of radar, microwave, Bluetooth, or infrared sensors that detect when a vehicle is approaching a limited sight distance conflict and illuminates a VMS sign to warn the driver. (Also see Road Geometry Warning Systems.)	Global	All Types	FHWA and Texas DOT Report on Advance Warning Systems Virginia DOT Report Minnesota DOT Phase II Report FHWA Brief FHWA Literature Review Texas DOT Research Report	L	H
Tier I: I, M Tier II: HH, LL Tier III: GGG	On-Road Site Specific, Pedestrian	Passive Pedestrian Detection	Radar, optical, infrared, Bluetooth, or LiDAR sensors that detect approaching pedestrians and alter signal timing to efficiently and safely cross the intersection.	Global	Pedestrian, Bicycle	Blaxtair Workzone Detection 2001 FHWA Report 1997 Transportation Research Institute Report National Cooperative Highway Research Program APS Guidebook	L	H
Tier I: M, O Tier II: HH, LL, MM	On-Road Site Specific	Photo Radar Enforcement Vans	A mobile van equipped with automated speed enforcement cameras that issues citations, especially effective in work zones and school zones.	United States	All Types	USDOT Study NHTSA Operations Guidelines City of Portland. OR Police	L	H
Tier I: I, M Tier II: HH, LL Tier III: GGG	On-Road Site Specific and Systematic, Bicycle	Protected Yet Concurrent Phasing Scheme	A signal phasing scheme that illuminates a blank out “No Right Turn on Red” sign when a pedestrian or bicycle activation is detected.	Global	Pedestrian/ Bicycle	Alta Planning Guidelines Boston Metropolitan Planning Organization Study Report Northeastern University Study and Literature Review New York City DOT Vision Zero Phasing Review Pennsylvania State University Research Report	M	H
Tier I: I Tier II: HH, LL	On-Road Site Specific and Pedestrian	Turning Bus Blank Out Warning Signs	A blank out warning sign that illuminates on a pedestrian or bicycle crossing to advise a turning bus has been detected.	United States	Pedestrian, Bicycle	FHWA Transit Design Guidelines FHWA and Portland State University Evaluation Report	L	L
Tier I: I, M, O Tier II: HH, LL	On-Road Site Specific, Driver Behavior	Wrong Way Detection Systems	A system of optical, infrared, radar, or Bluetooth sensors that detect when a vehicle is engaged in a wrong way movement; integrated systems can automatically send alerts to law enforcement and TMC operators.	Global	All Types	Concept Link Texas DOT and FHWA Study FHWA Data Nevada DOT Deployment Arizona DOT Deployment CALTRANS Guidelines Arizona DOT Evaluation	L	H

Severe Crash Mitigation

Applicable Strategies	Countermeasure Type	Technology	Description	Deployed	Crash Types Mitigated	Evaluation, Deployment, and Guideline References	Capital Costs	Impact
Tier I: L, M Tier II: CC, LL	On-Road Site Specific and Systematic, Organizational, Data Sharing	Active Traffic Management (ATM) Signs	A system of VMS signs controlled by algorithms and TMC operators to display warnings, advisories, closure notices, speed notices, accident notices, and HOV notices in advance to reduce conflicts and control speed reduction. These can be deployed to manage individual lanes to help mitigate congestion impacts from roadside or on road incidents or enable lane switching.	Global	All Types	FHWA Approaches FHWA Implementation Guide Texas A&M University Research Report Wisconsin DOT ATM Public Outreach ITS International Literature Review FHWA Screening and Feasibility Guide FHWA Resource Center FHWA ATM Brief CALTRANS Safety Guidebook	H	M
Tier II: LL Tier III: EEE	In-Vehicle	Adaptive Cruise Control	An in-vehicle system of sensors and software that measures the speed and distance from surrounding vehicles to match speed and maintain a pre-programmed following distance.	Global	Rear End	NHTSA Behavior Study NHTSA Old/Young Driver Study FHWA Study Virginia Tech Transportation Institute Study Report	L	M
Tier I: I, M Tier II: LL	On-Road Site Specific or Systematic	Animal Warning Systems	A system of networked infrared, laser, or radar sensors communicating with each other to create a detection 'line' which activates VMS 'Animal Warning' signs on roadways with high animal conflicts.	Global	Head On, Angle, Roadway Departure	Minnesota DOT Final Report Colorado DOT Final Evaluation Report FHWA Report to Congress 2008 CALTRANS Evaluation Report CALTRANS Testing Report Virginia DOT Evaluation Report Utah DOT Animal Warning App California PATH Program Research Report Oregon DOT Phase I Deployment Report Nevada DOT Evaluation Report	M	L
Tier II: CC, LL	On-Road Systematic	Automated Incident Detection	An optical camera with an algorithm trained to detect incident and at-risk vehicles that can alert law enforcement and traffic managers ideally, before an incident.	Global	All Types	PIARC Literature CALTRANS Evaluation Report FHWA Abstract	L	H

Severe Crash Mitigation

Applicable Strategies	Countermeasure Type	Technology	Description	Deployed	Crash Types Mitigated	Evaluation, Deployment, and Guideline References	Capital Costs	Impact
Tier I: I, L ,M Tier II: LL, MM	On-Road Systematic, Organizational, Data Sharing	All-Electronic Tolling	A system using high speed optical license plate cameras and/or RFID tag readers automate tolling and create fast cashless transactions	Global	All Types	FHWA Primer Colorado E-470 Toll Road FHWA Brief California Foothill/Eastern San Joaquin Hills Toll Roads FHWA Brief FHWA HOV Lanes Deployment Guide Wisconsin DOT Tolling Policy and Literature Review Minnesota DOT Tolling Study Report Oregon DOT Research Report Connecticut Evaluation Study Minnesota DOT Tolling Study CALTRANS Investigative Report Tennessee DOT Feasibility Study Wisconsin DOT Tolling Summary Center for Transportation Research, University of Texas – Austin Best Practices and Summary Texas A&M Overview Brief KPMG International Brief European Union State of the Art of Electronic Tolling Report National Institutes of Health Safety Assessment New Hampshire DOT Feasibility and Comparative Assessment University of South Florida Study	L	H
Tier I: M Tier II: CC, LL	On-Road Site Specific	Automated Truck Ramp Detection	A system of radar, microwave, Bluetooth, infrared, or optical sensors with machine learning that detect when a runaway truck has entered a runaway truck ramp and alert EMS, law enforcement, and traffic managers. This feature is often useable with automated incident detection systems.	United States	Rear End, Overturn	PIARC Literature California DOT Evaluation Report FHWA Abstract	L	L
Tier II: LL Tier III: EEE	In-Vehicle, Pedestrian and Bicycle	Automatic Emergency Braking/Forward Collision Warning	An in-vehicle system designed to increase warning time for incidents. One second of additional warning time reduces likelihood of a crash by 60%; five seconds reduces likelihood by 95%.	Global	All Types	IIHS Study NHTSA Study NHTSA Ped Study NHTSA UK Study IIHS GM Study SafeCar.gov Study FMCSA CMV Study Consumer Reports Survey FHWA Study FHWA Study and Guide FHWA Graphic FMSCA Rule Making FHWA Large Scale Study NTSB Study	L	H
Tier II: LL Tier III: EEE	In-Vehicle	Blind Spot Warning Systems	An in-vehicle system of sensors that detects when another vehicle, motorcycle, or a bicycle is in the vehicle's blind spot and sounds an alarm or illuminates a warning light.	Global	All Types	Freight Blind Spot Study NIH Sensor Study NHTSA Study USDOT Studies NHTSA Performance Evaluation	L	L

Severe Crash Mitigation

Applicable Strategies	Countermeasure Type	Technology	Description	Deployed	Crash Types Mitigated	Evaluation, Deployment, and Guideline References	Capital Costs	Impact
Tier I: I, M Tier II: LL Tier III: BBB	On-Road Site Specific	Curve Warning Systems	A system of optical, radar, microwave, Bluetooth, or infrared sensors that detects when a vehicle is approaching a sharp turn and illuminates VMS signs to warn the driver. (Also see Road Geometry Warning Systems.)	United States	All Types	Michigan DOT Review FHWA Horizontal Curve Safety Brief Minnesota DOT In-Vehicle Warning Report FHWA Low Cost Guidebook FHWA Evaluation Report CALTRANS Ice Curve Warning System	M	H
Tier I: M Tier II: LL Tier III: EEE	In-Vehicle, Organizational, Driver Behavior	Do Not Disturb While Driving	A function of the latest mobile device operating systems that activates when device speed exceeds 15 MPH and prohibits notifications and use while driving. Alternatively, the user may manually activate the feature.	Global	All Types	FHWA Abstract Colorado DOT Get Turned On FMSCA Rule NHTSA Crash Statistics NHTSA Investigation and Prosecution Apple How-To CDC Report EverDrive Study 2018 2019 IIHS Report	L	M
Tier II: LL Tier III: EEE	In-Vehicle, Driver Behavior	Drowsy Driver Detection Systems	An in-vehicle system of sensors that monitors the driver for physiological signs of fatigue and provides direct feedback to the driver in the form of an alarm.	Global	All Types	NHTSA Drowsy Driving Study FMCSA Stage I FMCSA Stage II NHTSA Research Program NSC Research FHWA Project Reports	L	L
Tier I: M Tier II: LL Tier III: BBB	On-Road Site Specific or Systematic, Driver Behavior	Dynamic Queue Ahead Warning Systems	A system of optical, radar, microwave, Bluetooth, or infrared sensors located at an intersection or along a busy roadway that illuminate VMS signs upstream to alert drivers of a queue ahead.	Global	Rear End, Head On, Roadway Departure	Minnesota DOT Research Report Minnesota DOT Implementation Report FHWA Dynamic Harmonization FHWA Harmonization Research University of Virginia Letter of Intent FHWA Overview Presentation Texas A&M University Queue Ahead Brief Minnesota DOT End of Queue Research Report ENTERPRISE Program Queue Ahead Summary Report FHWA ATM (Queue Ahead) Approaches Report	L	H
Tier I: I, M Tier II: LL Tier III: BBB	On-Road Site Specific, Driver Behavior	Dynamic Speed Feedback Systems	VMS signs equipped with radar to measure vehicle speed. Speed measurements are displayed for the driver and may include 'Slow Down' messages.	Global	All Types	FHWA Evaluation Report FHWA Spatial Report Midwest Transportation Consortium Tech Brief University of Wisconsin – Madison Study FHWA Deployment Guide	L	L
Tier I: M Tier II: LL	On-Road Systematic, Organizational, Driver Behavior	Emergency Truck Parking	A mobile application designed for freight truckers to locate the nearest emergency truck parking in the event of severe weather to avoid stranding.	United States	All Types	Maryland DOT Colorado DOT Study Virginia DOT Study FHWA Working Group FHWA Jason's Law	L	M

Severe Crash Mitigation

Applicable Strategies	Countermeasure Type	Technology	Description	Deployed	Crash Types Mitigated	Evaluation, Deployment, and Guideline References	Capital Costs	Impact
Tier I: L, M Tier II: HH Tier III: DDD	Organizational Data Sharing	FHWA PBCAT Crash Typing Tool	A program developed by FHWA to isolate specific high conflict areas for pedestrians and bicyclists.	United States	Pedestrian/ Bicycle	PedBikeInfo Download Resource North Carolina DOT Ped/Bike Crash GIS Map Wisconsin DOT Analysis FHWA Forward FHWA Brief FHWA Manual NHTSA PBCAT Database Construction Manual PedBikeInfo Webinar Arizona Bike Law Brief on Deployment HSIS Brief Miami-Dade County, FL Deployment PBCAT and HSIS Hybrid Use NHTSA Compendium	M	L
Tier I: M Tier II: LL	Road Conditioning	Fixed Automated Spray Technology (FAST)	A series of roadway embedded RWIS sensors connected to a system of pumps that spray deicing liquids onto roadways via embedded nozzles under the appropriate low temperature conditions.	Global	All Types	Colorado DOT Benefit/Cost Analysis 2014 Upper Great Plains Transportation Institute, North Dakota Evaluation Report Pennsylvania DOT Final Research Report FHWA Synthesis Report Maryland DOT Report	H	H
Tier I: M Tier II: LL	On-Road Systematic, Driver Behavior, Organizational	Freight Signal Priority	A system like Transit Signal Priority wherein freight vehicles are equipped with a device to communicate with traffic signals and extend green time to expedite freight movement and reduce stop/go conflicts in dense urban environments. Alternatively, traditional inductive loop detection can be used to measure truck length and speed and calculate changes to the upcoming signal timing to maximize efficiency and minimize stopping.	Global	All Types	University of Arizona ConOps Final Report Washington DOT TSMO Brief USDOT Knowledge Database USDOT Preliminary Results Report Florida Atlantic University Evaluation Report Portland State University Evaluation Report Texas DOT Homepage and Proposal Report	M	M
Tier I: I, M Tier II: LL, NN	On-Road Site Specific	Highway-Rail Grade Crossing Systems	A system of radar, optical cameras, Bluetooth, microwave, or infrared sensors designed to detect vehicles approaching an activated rail crossing to alert drivers of an upcoming stop or at unsignalized crossings to indicate a train is approaching. (Also see Road Geometry Warning Systems.)	Global	All Types	FHWA Research Association of American Railroads FHWA Handbook APTA Guidelines Minnesota DOT and FHWA Seminar and Best Practices Guidelines Texas Transportation Institute, Texas A&M University and NCHRP Analysis Indiana DOT Rail Grade Crossing Guidelines FHWA Guidance Wisconsin DOT Guidelines Illinois DOT Guidelines Manual	M	H
Tier I: I, M Tier II: LL Tier III: BBB	On-Road Site Specific, Road Conditioning, Driver Behavior	Ice Curve Warning Systems	A system of RWIS sensors embedded in the roadway or on poles that detect when temperatures are low enough for ice to form. They are linked to VMS signs to notify motorists of icy conditions. (Also see Road Geometry Warning Systems.)	United States	All Types	Michigan DOT Review FHWA Horizontal Curve Safety Brief Minnesota DOT In-Vehicle Warning Report FHWA Low Cost Guidebook FHWA Evaluation Report CALTRANS Ice Curve Warning System	M	H

Severe Crash Mitigation

Applicable Strategies	Countermeasure Type	Technology	Description	Deployed	Crash Types Mitigated	Evaluation, Deployment, and Guideline References	Capital Costs	Impact
Tier I: I, M Tier II: HH, LL	On-Road Site Specific or Systematic, Driver Behavior	Intersection Collision Warning Systems	A system of radar, infrared, microwave, Bluetooth, or optical sensors designed to detect vehicles approaching an intersection in high speed or high conflict areas to provide advance warning of upcoming conflict zones. (Also see Road Geometry Warning Systems.)	Global	All Types	FHWA Planning Brief FHWA ITS Compendium University of Utah Advance Warning Signals Evaluation Western Transportation Institute Synthesis Survey FHWA Safety Evaluation Rural Safety Center ITS Toolbox	M	H
Tier II: LL Tier III: EEE	In-Vehicle	Lane Departure/Lane Keeping Assist	An in-vehicle system of optical cameras and algorithms designed to watch roadway striping and center the vehicle in lane by steering the vehicle for the driver.	Global	Roadway Departure, Angle	FHWA Study IIHS Studies Minnesota DOT Study Brief NCBI Field Effectiveness Evaluation NHTSA Effectiveness Study FHWA Performance Evaluation NHTSA Heavy Vehicle Evaluation Report FHWA Infrastructure Initiatives Report AAA Large Vehicle Research Report	L	M
Tier I: I, M Tier II: LL Tier III: GGG	On-Road Site Specific, Driver Behavior	Limited Sight Distance Warning Systems	A system of radar, microwave, Bluetooth, or infrared that detect when a vehicle is approaching a limited sight distance conflict and illuminates a VMS sign to warn the driver. (Also see Road Geometry Warning Systems.)	Global	All Types	FHWA and Texas DOT Report on Advance Warning Systems Virginia DOT Report Minnesota DOT Report FHWA Brief FHWA Literature Review	L	H
Tier I: L, M Tier II: CC, LL Tier III: BBB	On-Road Site Specific and Systematic, Organizational Driver Behavior	Mass Evacuation (Active Traffic Management)	A regional planning initiative supported by lane switching Active Traffic Management signs to reverse traffic on multilane roadways and evacuate population centers more quickly and efficiently.	Global	All Types	FHWA Approaches FHWA Implementation Guide Texas A&M University Research Wisconsin DOT ATM Public Outreach ITS International Literature Review FHWA Screening and Feasibility Guide FHWA Resource Center FHWA ATM Brief CALTRANS Safety Guidebook	H	L
Tier I: I, M Tier II: LL	On-Road Systematic	Ramp Meters	Signal heads at on-ramps to freeways and interstates that meter traffic merging to reduce conflicts and prevent backups.	Global	All Types	FHWA Primer Guide FHWA Freeway Management Program Synthesis Minnesota DOT Study and Website Kentucky DOT Consultant Study North Carolina DOT Feasibility Study Texas DOT Design Guidelines Oregon DOT Design Guidelines University of Alabama Synthesis and Evaluation NOACA Safety Operations Council Presentation University of Minnesota Metering Holiday Analysis Louisiana DOT Report and Data Repository Pennsylvania DOT Feasibility Study Louisiana State University and FHWA Effectiveness Study Indiana DOT and FHWA Synthesis	L	H

Severe Crash Mitigation

Applicable Strategies	Countermeasure Type	Technology	Description	Deployed	Crash Types Mitigated	Evaluation, Deployment, and Guideline References	Capital Costs	Impact
Tier I: I, M Tier II: LL Tier III: BBB	On-Road Site Specific, Driver Behavior	Road Geometry Warning Systems	A system of radar, microwave, or Bluetooth sensors that detect approaching vehicles and activate VMS, blank out, or flashing signs about upcoming road geometry. These systems are most effective when deployed as part of a Road Safety Audit (RSA) and/or Local Road Safety Plan (LSRP).	Global	All Types	Rural Safety Center ITS Toolbox FHWA Brief FHWA Brief on Colorado DOT Deployment Oregon DOT Curve Warning Evaluation Utah DOT Research Report University of Florida Curve Warning Evaluation Texas DOT TM&W Evaluation Report FHWA ITS Compendium University of Michigan and FHWA Road Departure Warning Evaluation University of Utah Advance Warning Signals Evaluation Minnesota DOT Final Evaluation Report Western Transportation Institute Synthesis Survey FHWA Safety Evaluation FHWA Human Factors Evaluations University of Minnesota Evaluation and Design Investigation Minnesota DOT Traffic Engineering Manual Chapter 5	L	M
Tier I: L Tier II: LL	In-Vehicle Systematic and Programmatic	Salt Use Dashboard	A system of sensors deployed on snowplows that measure dispensing rates and reports the data back to a central controller which logs the amount dispensed and sends feedback to the driver to accelerate or decelerate dispensing based on existing road and weather conditions.	Iowa	All Types	FHWA Synthesis Iowa DOT Dashboard	H	L
Tier I: M Tier II: LL Tier III: BBB	On-Road Site Specific, Road Conditioning, Driver Behavior	Visibility/Fog Detection Systems	A networked system of RWIS and visibility sensors that detect when visibility is low enough to indicate fog or other atmospheric phenomena is present and activate VMS signs to warn approaching vehicles to reduce speed.	United States	All Types	AAA Foundation Crash Analysis West Virginia University Analysis Report FHWA Best Practices Guidelines FHWA Report I-68 Maryland Deployment Florida DOT Deployment Brief AAA Foundation Crash Analysis FHWA Best Practices Guidelines FHWA Report I-68 Maryland Deployment Florida DOT Deployment Brief Utah DOT and FHWA I-215 Report Fog Warning System Evaluation from King Saud University (Saudi Arabia) Pennsylvania DOT and FHWA Study on Pennsylvania Turnpike Tennessee DOT and FHWA Study on I-75 Virginia DOT and FHWA Study on I-64 and I-77 FHWA Brief on Alabama DOT System CALTRANS System Evaluation	H	H

Severe Crash Mitigation

Applicable Strategies	Countermeasure Type	Technology	Description	Deployed	Crash Types Mitigated	Evaluation, Deployment, and Guideline References	Capital Costs	Impact
Tier I: I, M Tier II: LL	On-Road Systematic	Weigh in Motion	A system of sensors that weigh freight trucks on roadways while they are moving to asses compliance with Federal roadway weight restrictions. The system helps mitigate stop/go conflicts.	Global	Sideswipe, Angle, Rear End	Kentucky Transportation Center Study FHWA Guidelines FHWA and Consulting Firm Literature Review FHWA Review Maryland and New York Deployments FHWA Primer Arizona DOT Successful Policies Guidebook Volumes 1 and 2 Montana DOT WIM Strategy Guidebook Minnesota DOT Statewide Strategic Plan Wisconsin DOT Implementation Plan Minnesota DOT Technical Summary Minnesota DOT Implementation Evaluation Virginia Tech Transportation Institute Evaluation Study Texas DOT and FHWA Deployment Plan/Study University of Zagreb, Croatia, and Slovenian National Building and Civil Engineering Institute Report Western Michigan University and Michigan DOT Report University of California Berkeley Analysis University of Manitoba WIM Evaluation Queen's University of Belfast Study Report Virginia DOT Research Report Washington State Efficiency and Effectiveness Report	L	L
Tier I: M Tier II: CC, DD, HH, LL	On-Road Site Specific, Driver Behavior	Work Zone Intrusion Alarms	A roadside mounted system or cone mounted micro-mobile sensor that detects and alerts when an unauthorized vehicle enters the work zone.	Global	All Types	CALTRANS DRSI Report University of Texas - San Antonio and Georgia Institute of Technology Research Report Transpo Industries Lund University Literature Review Oregon State University Review of WZI Alarms ResearchGate Peer Reviewed Publication on Technology Review TRID Research Report National Academies of Science Oregon DOT Practical Guidance BBC News Report FHWA Work Zone Resource Center Michigan DOT IWZ Toolbox NCHRP Synthesis New Hampshire DOT Work Zone Safety Guide Minnesota DOT Screaming Cones Final Report American Road and Transportation Builders Association Guidebook	L	H
Tier I: I, M, O Tier II: HH, LL	On-Road Site Specific, Driver Behavior	Wrong Way Detection Systems	A system of optical, infrared, radar, or Bluetooth sensors that detect when a vehicle is engaged in a wrong way movement; integrated systems can automatically send alerts to law enforcement and TMC operators.	Global	All Types	Concept Link Texas DOT and FHWA Study FHWA Data Nevada DOT Deployment Arizona DOT Deployment CALTRANS Guidelines Arizona DOT Evaluation	L	H
Tier I: L Tier II: HH	Coordination, Data Sharing, Organizational	Action Intent of Measure (AIM)	A methodology for identifying key areas for improvement in transportation networks. Data driven and focused, it enables action.	Michigan	All Types	Michigan DOT AIM Evaluation Report Michigan DOT Performance Measures Report	L	M

Programmatic

Applicable Strategies	Countermeasure Type	Technology	Description	Deployed	Crash Types Mitigated	Evaluation, Deployment, and Guideline References	Capital Costs	Impact
Tier II: LL	On-Road Systematic, Organizational	Active Guard Rail Sensing	Guard rails that have incident or destruction sensors to communicate when a destructive event occurred and immediate repair is needed.	Global	N/A	Lindsay Corporations FHWA Guidelines	M	L
Tier I: L, M Tier II: CC, LL	On-Road Systematic, Data Sharing, Organizational	Adaptive Control Decision Support System (ACDSS)	A network of all roadway sensors and cameras that feed data into central controllers at Traffic Management Centers to provide holistic real time roadway information.	New York City	All Types	University Transportation Research Center, The College of New York Comprehensive Guide New York City DOT Strategic Plan Progress Report Roads and Bridges Press Report FHWA Overview BusinessWire Press Report ITS International Report New York City DOT Press Release New York City Mobility Report FHWA ITS Lesson Learned Webinar KLS and NYSERDA Final Report NYSERDA Decision Making Tool for Applying Adaptive Traffic Control Systems NACTO Initial Application Report Oregon DOT Application Criteria	H	H
Tier II: CC, LL	On-Road Site Specific or Systematic, Organizational	Automated Incident Detection	An optical camera with an algorithm trained to detect incidents and at-risk vehicles that can alert law enforcement and traffic managers in real time to help optimize response times.	Global	All Types	PIARC Literature CALTRANS Evaluation Report FHWA Abstract	L	H
Tier I: M Tier II: LL	On-Road Systematic, Organizational, Driver Behavior	Emergency Truck Parking	A mobile application designed for freight truckers to locate the nearest emergency truck parking in the event of severe weather to avoid stranding.	United States	All Types	Maryland DOT Colorado Study Virginia DOT Study FHWA Working Group FHWA Jason's Law	L	M

Programmatic

Applicable Strategies	Countermeasure Type	Technology	Description	Deployed	Crash Types Mitigated	Evaluation, Deployment, and Guideline References	Capital Costs	Impact
Tier I: L, M Tier II: LL	On-Road Systematic, Data Sharing	Fully Networked Adaptive Signal Systems	A system of fully actuated signals that coordinate with each other to maximize traffic flows and minimize congestion during off peak and peak hours by responding in real-time to volume fluctuations.	Global	All Types	FHWA Evaluation Final Report FHWA Research and Technology Evaluation FHWA Model Systems Engineering FHWA and Pennsylvania DOT Report FHWA Model Systems Engineering Report FHWA Safety and efficiency Study FHWA FAQ Brief FHWA FAQ Site MDOT and FHWA Report West Virginia DOT and Rahall Transportation Institute Presentation Illinois Center for Transportation Evaluation Louisiana Transportation Conference ITS Presentation New Jersey DOT Project Implementation Guidelines and Report Nevada DOT Research Report Texas DOT and Texas A&M Synthesis Colorado DOT Research Report Virginia DOT Feasibility Report Texas DOT Research Library Florida DOT Technical Memorandum University of Nevada - Reno Webinar City of Federal Way, WA Validation Plan Connecticut DOT Guidelines FHWA Performance Measures and Deployment Reports Metropolitan Transportation Commission (California) Consultant Presentation Virginia DOT Analysis Beijing Jiaotong University and University of Nevada Reno Overview	M	M
Tier I: I, L, M Tier II: AA, HH, II, LL Tier III: DDD	Organizational, On-Road Site Specific or Systematic	Local Road Safety Plans	A local road safety plan (LRSP) provides a framework for identifying, analyzing, and prioritizing roadway safety improvements on local roads. The LRSP development process and content are tailored to local issues and needs. The process results in a prioritized list of issues, risks, actions, and improvements that can be used to reduce fatalities and serious injuries on the local road network.	United States	All Types	FHWA RSP Planning Guide FHWA Brief FHWA Webinar Presentation National Center for Rural Road Safety Development Presentation National Association of Counties Report Iowa DOT Local Road Safety Plan Nevada DOT Local Road Safety Plan National Association of County Engineers Report Michigan DOT Local Road Safety Initiative National Center for Rural Road Safety Development Guide CALTRANS Webinar and Planning Sessions American Traffic Safety Services Association and National Association of County Engineers Cost Effective Planning Guide	L	H
Tier I: I, L Tier II: LL	On-Road Site Specific, Data Sharing, Organizational	Optical Cameras with Machine Learning	Optical cameras equipped with machine learning algorithms that are trained for a variety of purposes.	Global	All Types	FHWA Study FHWA Research FHWA Video Analytics FHWA Rural Application FHWA TMC Guidelines Iowa State University Research Report Cornell University Anomaly Detection Research NCBI Research	L	H

Programmatic

Applicable Strategies	Countermeasure Type	Technology	Description	Deployed	Crash Types Mitigated	Evaluation, Deployment, and Guideline References	Capital Costs	Impact
Tier I: I, L, M Tier II: AA, HH, II, LL Tier III: DDD	Organizational Data Sharing, Site Specific or Systematic	Road Safety Audits (RSA)	RSAs are performed by a multidisciplinary team independent of the project managers. RSAs consider all road users, work to account for human factors and road user capabilities, are documented in a formal report, and require a formal response from the road owner.	Global	All Types	FHWA RSA Planning Guide Massachusetts DOT RSA Guidelines New Zealand DOT RSA Guidelines Minnesota DOT RSA 2006 Northern Territory, Australia RSA Guidelines European Transport Safety Council RSA Western Australia, Australia RSA Guidelines New South Wales, Australia Report Washington State and Lummi Nation RSA National Academies of Science Review FHWA and ITE Overview Montgomery County, MD RSA Archive Transport for the City of London RSA Procedure NOACA RSA Overview and Completed Reports Ohio DOT RSA Guidelines SWOV Institute for Road Safety Research, Netherlands, Report Warwick County, United Kingdom, Guidelines Minnesota DOT RSA Archive The University of North Carolina Highway Safety Research Center Assessment Guide Wisconsin DOT RSA Report University of Wisconsin – Madison RSA Archive and Guidelines Massachusetts DOT Final RSA Reports University of Wisconsin - Madison VRSA Report New York State RSA Fundamentals Alabama DOT RSA Guidelines Oregon DOT RSA Example Idaho DOT RSA Guidelines	L	H
Tier I: I, L ,M Tier II: HH, LL Tier III: BBB, HHH	On-Road Systematic, Organizational, Data Sharing, Driver Behavior, Pedestrian and Bicycle	Smart City/Mobility Hubs	A system of systems designed to coordinate travel use in multimodal transit corridors using mobile applications, API's, and physical interactive screens in areas that are underserved, high volume, or at transit hubs. Smart Cities can form the backbone of a multimodal transport and work to achieve a transportation vision of Mobility as a Service (MAAS) instead of a commodity.	Global	All Types	Smart Columbus, OH Project Homepage FHWA Integrated Corridor Management and Smart Cities Revolution National Science and Technology Council Federal Smart Cities Strategic Plan University of Texas - El Paso, Rutgers Center for Advanced Infrastructure and Transportation, and FHWA Research Report University of Texas - Austin Mobility Plan FHWA International Deployment Review FHWA Mobility Hubs Primer FHWA Shared Mobility and Transportation Equity Report Riverside, CA Transit Agency and CALTRANS Mobility Plan Kansas City, KS Mobility Plan City of Austin, TX Strategic Mobility Plan Rocky Mountain Institute Report City of Oakland, CA Suitability Analysis Metrolinx, Government of Ontario, Canada Mobility Hubs Guidelines City of Burlington, CA Mobility Hub Area Specific Plans TriMet, Portland, OR New Mobility Study City of Rochester, MN Study Report A Better City Guide to Placemaking, Boston, MA City of Santa Monica, CA Shared Mobility Pilot Program City of Portland, OR Smart Cities Challenge Proposal	H	M

Programmatic								
Applicable Strategies	Countermeasure Type	Technology	Description	Deployed	Crash Types Mitigated	Evaluation, Deployment, and Guideline References	Capital Costs	Impact
Tier I: L, M Tier II: LL	Systematic Data Sharing, Organizational	TRIP, USDOT Massive Informatics and Visualization of Urban Mobility Data from Intelligent Transportation Systems	A massive informatics program designed by USDOT to process massive data sets from SHRP2, CLARUS, HSIS, and RID. Its modern architecture can be adapted to create a real-time processing program for traffic sensors. Using methodologies for visualizing ITS data, the two can be used to enhance understanding and enable action.	United States	N/A	Visualization Report FHWA TRIP Development Report	H	H
Tier I: I, M Tier II: AA, HH	On-Road Systematic, Organizational	USLIMITS2	A free, web-based tool designed to help practitioners assess and establish safe, reasonable, and consistent speed limits for specific segments of roadway. It is applicable to all types of facilities, from rural and local roads to residential streets and urban freeways.	United States	All Types	FHWA USLIMITS2 Guide	L	H

List 1: Top 15 Existing Technologies for Rural Deployment

- Automatic Crash Notification Systems
- Breathalyzer Vehicle Interlock
- Curve Warning Systems
- Do Not Disturb While Driving
- Dynamic Queue Ahead Warning Systems
- Emergency Truck Parking
- Freight Signal Priority
- Highway-Rail Grade Crossing Systems
- In-Road Bike and Pedestrian Crossing LEDs
- Intersection Collision Warning Systems
- Limited Sight Distance Warning Systems
- Local Road Safety Plans (LRSP)
- Road Geometry Warning Systems
- Road Safety Audits (RSA)
- Work Zone Intrusion Alarms

List 2: Top 15 Existing Technologies for Urban Deployment

- Adaptive Control Decision Support System (ACDSS)
- Breathalyzer Vehicle Interlock
- Do Not Disturb While Driving
- Freight Signal Priority
- Green Wave Systems (Coordinated Signals)
- Highway-Rail Grade Crossing Systems
- In-Road Bike and Pedestrian Crossing LEDs
- Local Road Safety Plans (LRSP)
- Optical Cameras with Machine Learning Algorithms
- Passive Pedestrian and/or Bike Detection
- Photo Radar Enforcement Vans
- Protected Yet Concurrent Phasing Scheme
- Road Safety Audits (RSA)
- Work Zone Intrusion Alarms
- Wrong Way Detection Systems

Table 2: Emerging Technologies

Technology	Description	Countermeasure Type
Binocular Vision in Cars, Accident Warning	A system of two optical cameras on-vehicle that are used like human eyes to detect impending crashes, incidents, pedestrians, bicycles, and read roadway signs designed for both machine and human interfacing.	In-Vehicle, Driver Behavior
Dynamic Mobility Applications	A system of systems designed to communicate real-time traffic information vehicle to vehicle (V2V), vehicle to infrastructure (V2I), and vehicle to pedestrian (V2P). The goal of the system is to reduce congestion by equipping autonomous and semi-autonomous vehicles with more real time data so they can adjust and compensate in real time more safely and more efficiently.	Organizational, On-Road Systematic
MAPS, ADA Pedestrian Access Software	A system in testing at the University of Michigan consisting of a controller at signalized intersections that communicates with a mobile application used by impaired/disabled pedestrians to communicate crossing length, position, and time remaining to cross from the signal controller to enhance safety and prevent stranding.	On-Site Systematic, Pedestrian
Mobile Applications for Enhanced Real-Time Crash Reporting (360°, picture, Video, Custom Fields)	A mobile device-based application for reporting crashes. Responding personnel can upload photos, videos, license information, exact location, make/model, VIN, person information, injury information, and personal statements to a central database for validation. To be used by Department of Revenue for reporting, and traffic managers for crash mitigation and planning where applicable.	On-Site Systematic, Organizational, Data Sharing
Semi-Autonomous Vehicles	Vehicles that have limited autonomy, require human validation, and are typically limited to interstate use. The technology is proving to be effective in some cases and ineffective in others. The City of Tampa, FL and the USDOT are currently piloting semi-autonomous vehicles in a dense urban environment.	In-Vehicle, On-Site Systematic, Organizational, Data Sharing
Vehicle to Infrastructure (V2I)	Vehicles will be able to communicate directly with ITS infrastructure about their speed, position, the vehicles around them, and highly localized weather and road weather information. Similarly, ITS infrastructure will be able to communicate back high-level systematic information to allow the vehicles to create a complete picture of their surroundings and react safely and efficiently.	Organizational, Data Sharing, On-Road Systematic, Driver Behavior
Vehicle to Pedestrian (V2P)	A system wherein the pedestrian has a mobile application or device that alerts drivers of their presence at a crossing. Similarly, the vehicle can warn pedestrians.	Organizational, On-Road Systematic, Pedestrian, and Bicycle, Driver Behavior
Vehicle to Vehicle (V2V)	A system wherein vehicles communicate with one another about speed, location, and direction. The system can also communicate highly localized data about roadway conditions and slowing traffic.	Data Sharing, In-Vehicle, Driver Behavior
Wireless Embedded Roadway Charging (EV)	For electric vehicles, embedding wireless charging modules in the roadway will enhance the vehicle's ability to keep moving. This mitigates risks associated with battery charging and EV stranding on roadways. These chargers can also be used for data collection on traffic volumes, speed, and congestion to serve multiple purposes. A unified charging standard would likely be required to take advantage of these systems.	On-Road Systematic, Organizational, Data Sharing

Table 3: Conceptual Technologies

Technology	Description	Countermeasure Type
Cooperative Adaptive Cruise Control	Leveraging the features of adaptive cruise control and V2V communication, a group of vehicles on the roadway can coordinate with each other to reduce or eliminate conflicts. This would include consistent spacing, speed, and merging.	Driver Behavior, Data Sharing
Fully Autonomous Public Transit	A system wherein public transit systems are fully automated.	Data Sharing, Organizational, On-Road Systematic
Fully Autonomous Vehicles	Like the name suggests, these vehicles will drive themselves using a combination of vehicle to vehicle, vehicle to infrastructure, vehicle to pedestrian, and on-board sensors to complete entire trips without human interaction.	Data Sharing, Organizational, In-Vehicle, On-Road Systematic
Fully Networked Sensor Grids	A grid of sensors networked to produce real time full system analytics and enable advanced real time traffic management. These sensor grids will be the backbone of vehicle to infrastructure communications.	Data Sharing, Organizational, On-Road Systematic
Human/Machine Readable LED Displays/ Signs	VMS signs that communicate machine readable and human readable roadway information.	On-Road Site Specific and Systematic
LiDAR/Bluetooth Integration, Vehicle Sensing	Vehicle sensing using LiDAR instead of traditional methods like microwave and radar. The system is low energy, high data capacity.	On-Road Site Specific and Systematic, Data Sharing
LSTM-Based SQL Injection Detection Method	A proposed method of network security that leverages an ultrafast detection neural network algorithm that is adaptive to the rapidly changing methods of breach employed by State actors and/or hacker groups.	Data Sharing, Organizational
Pheromone Based Green Vehicle Routing	An algorithm within networked signal systems used to efficiently reroute traffic from blocked roadways to reduce emissions from idling and minimize travel time delays.	Data Sharing, Organizational, On-Road Systematic
Public Vehicle Coordination in Smart Cities	A system of autonomous public vehicles coordinating with each other to maintain schedule adherence and transport at risk and underserved communities.	Data Sharing, Organizational
Sink Nodes	Clusters of sensors and cameras oriented towards vehicle to infrastructure communications to gather and disseminate mass data to traffic operators and vehicles/ drivers.	Data Sharing, Organizational, On-Road Systematic
Vehicular Ad Hoc Networks	A system of vehicle to vehicle communication wherein edge processing in each vehicle enables them to communicate highly localized data such as weather, traffic conditions, and speed. A key component will be to communicate about nearby human controlled vehicles in hybrid transportation environments.	Driver Behavior, Data Sharing
Wireless Information Transmission Encryption	A method of encrypting over the air sensor transmissions to and from traffic operations centers and controllers to prevent interference and/or data spoofing.	Data Sharing, Organizational, On-Site Systematic