# Regional Crash Data Inventory

Denver Regional Council of Governments

Regional Crash Data Consortium – March 27, 2024

## Introduction

Staff of local governments, the State of Colorado, federal agencies and other stakeholders find crash data valuable to improving traffic safety and saving lives in the Denver region. The Denver Regional Council of Governments staff is committed to improving the accuracy, use and coordination of regional crash data. DRCOG received a 405c traffic records improvement grant from the National Highway Traffic Safety Administration for federal fiscal year 2023 to investigate and demonstrate the value of a regional crash data consortium to inventory the needs of the region, and to work to identify and address common issues with crash data collection, processing, and analysis. This technical report and the accompanying needs assessment have been developed to inform and guide the work of the consortium throughout federal fiscal year 2024 and beyond.

DRCOG staff proposed the creation of a regional crash data consortium to leverage the interest and collective capacity of organizations in the Denver region, along with state and federal partners working with crash data. This report and the accompanying needs assessment are the culmination of two components of this effort. DRCOG staff have solicited information about data sources, analysis goals and tools, and challenges experienced relating to crash data, and this report outlines the broad themes that have been shared.

DRCOG has received a 405c grant for federal fiscal year 2024, and its staff will use this report and accompanying needs assessment to guide the regional crash data consortium's efforts as the planning process moves into the development and implementation of solutions and addressing the following topics:

- The feasibility of the regional crash data consortium concept.
- The continuation of the crash data consortium beyond September 30, 2024.
- Strategies for sustaining the crash data consortium (such as through participant funding or other means).
- Strategies for improving crash data records accuracy, processing and timeliness.
- Other relevant issues identified through the planning process.

## Key findings

DRCOG staff engaged with over 100 regional stakeholders representing more than 60 organizations to learn about the ways crash data is collected, processed and analyzed in the Denver region. Consortium stakeholders are using crash data to mitigate fatal and serious injury crashes mainly through engineering and planning efforts, educational campaigns, and law enforcement activities.

Stakeholders shared with DRCOG staff the data sources used in their work, data sources they desire to incorporate, the types of analysis they perform and various challenges they experience while working with crash data. Their main challenges include the quality and availability of geospatial data, the timeliness of data, the completeness of data, inconsistencies and errors in crash reports, the accessibility of data, discrepancies between datasets, and the challenges of integrating different datasets and types

of data. Though these challenges exist, there are many opportunities for stakeholders ranging from engineers and planners, law enforcement, geospatial information systems professionals, public health officials, crash data managers and others to collaborate to improve the crash data to move the Denver region and state closer to their traffic safety goals.

If you have difficulty using this document's content or you need an accommodation, please email access@drcog.org or call 303-455-1000.

# Contents

# 1. Stakeholder engagement process

## 1.1 Breakdown

This report contains information gathered by DRCOG staff, primarily through surveys and interviews conducted from November 2022 through September 2023 and reflects stakeholder feedback received through November 2023. DRCOG staff received substantive feedback about crash data collection, processing, and analysis from 135 individuals from 65 organizations in the Denver region and Colorado regarding crash data collection, processing and analysis. A breakdown of the types and number of organizations and contacts from each type of organization involved in this project follows below.

| Type of organization | Number of organizations | Number of contacts from each type of organization |
|---|---|---|
| Advocacy | 4 | 4 |
| City and county | 2 | 8 |
| Consultant | 8 | 8 |
| County | 6 | 17 |
| Federal agency | 3 | 6 |
| Fire district | 2 | 6 |
| Higher education | 2 | 2 |
| Metropolitan planning organization | 3 | 3 |
| Municipality | 27 | 52 |
| State agency | 4 | 24 |
| Tollway | 1 | 1 |
| Transit agency | 1 | 1 |
| Vendor | 2 | 3 |
| Total | 65 | 135 |

DRCOG staff developed an interactive jurisdictions engagement dashboard detailing engagement information for jurisdictions, districts, and state agencies. Appendices A and B of this report list all stakeholders which provided responses to survey prompts and participated in crash data conversations.

## 1.2 Methodology

### 1.2.1 Denver Regional Data Consortium Survey

Prior to the initiation of the Regional Crash Data Inventory project, staff solicited feedback from members of the Denver Regional Data Consortium related to their usage of crash data. Staff asked questions including what benefits and drawbacks members foresaw related to a crash data consortium, the data they were using and their likelihood to participate in a consortium. Staff used the information they received to better understand crash data in the Denver region and to support their decision to apply for the 405c grant.

### 1.2.2 Survey123 survey

DRCOG staff created a brief survey with ArcGIS Survey123 and invited potential stakeholders to take it via email to participants in DRCOG's Active Transportation Stakeholder Committee, Transportation Advisory Committee, Transportation Improvement Program contacts, Regional Vision Zero Working Group and local government staff contacts such as planners and engineers.

### 1.2.3 SurveyMonkey survey

DRCOG staff invited those who had responded to the previous surveys or had joined the Nov. 10, 2022, consortium kick-off meeting to participate in a more detailed survey.

To ensure representatives from all the Denver region's cities, counties and towns had an opportunity to provide insight, DRCOG staff sent the invitation to all DRCOG member governments — primarily to public works and planning departments — which had not responded to previous surveys or attended the Nov. 10 Kick-off.

The survey included scaled and open-ended questions, and an invitation to participate in one-on-one conversations with DRCOG staff.

### 1.2.4 Crash data conversations

DRCOG staff had over 40 semi-structured conversations with more than 50 stakeholders about crash data sources, uses and challenges, and to learn anything else related to crash data that stakeholders wanted to share.

Staff invited participants to attend the conversations through the previously mentioned SurveyMonkey survey, a call for participation in the February 2023 edition of the Crash Data Consortium Newsletter, referrals made by other stakeholders and DRCOG staff outreach to individuals.

### 1.2.5 Consortium meetings

- Kick-off meeting, November 10, 2022
    - DRCOG staff shared information about the purpose of the regional crash data consortium initiative and the 405c grant funding the project.
    - DRCOG staff conducted a workshop at which participants were invited to share the data sources they currently used, the challenges they faced and how the consortium might work together. Their responses helped shape the SurveyMonkey survey, content of crash data conversations and this report.
- First meeting, May 11, 2023
    - DRCOG staff shared a high-level summary of the regional crash data inventory.
    - DRCOG staff solicited feedback from stakeholders on a draft vision statement, mission statement and goals for the consortium.

    - Representatives from Colorado Department of Revenue, Colorado Department of Transportation and DRCOG presented their data processes for crash data.
- Second meeting, September 28, 2023
    - DRCOG staff shared a summary of the regional crash data inventory and presented a draft needs assessment. DRCOG staff had provided stakeholders with an earlier version of this report for review and has integrated their comments into the updated final version.
    - DRCOG staff shared a draft of the regional needs assessment and held a workshop to solicit stakeholder feedback on it.

### 1.2.6 Participation in other groups

- Regional Vision Zero Working Group
    - DRCOG's safety planner hosts a monthly working group that collaboratively furthers the goals of DRCOG's *Taking Action on Regional Vision Zero* plan. Among participants, there is considerable overlap in attendance at the Regional Vision Zero Working Group and participation in consortium meetings.
- Statewide Traffic Records Advisory Committee
    - DRCOG staff works with the Statewide Traffic Records Advisory Committee, a State of Colorado advisory group which represents "the data records interests of motor vehicle traffic and safety agencies and organizations" (Statewide Traffic Records Advisory Committee). The Statewide Traffic Records Advisory Committee manages the application process for the 405c program from the National Highway Traffic Safety Administration in Colorado, and the 405c program is administered by the Colorado Department of Transportation.
    - The Statewide Traffic Records Advisory Committee meets bimonthly to review the most up-to-date Colorado crash analytics, discuss current and proposed 405c projects, and explore other matters related to traffic records and systems.
    - DRCOG is a 405c grantee and participates in its conversations and task forces but is not a voting member of the committee.
- Statewide Traffic Records Advisory Committee Crash Manual Task Force
    - The Statewide Traffic Records Advisory Committee Crash Manual Task Force meets bi-monthly and is working to improve the *Investigating Officer's Crash Reporting Manual* to help law enforcement complete crash reports accurately and completely. Law enforcement, including representatives from the Colorado State Patrol, the City and County of Denver, and Douglas County Sheriff's Office often participate in the task force meetings.
    - DRCOG staff participates in task force meetings and helped create a survey of Colorado law enforcement in early 2023. The task force distributed the survey and conducted interviews to gain law enforcement insight into how they complete the crash report, and how often and how extensively agencies train responders on crash reporting.

## 2. Data sources

Nearly all consortium stakeholders reported using more than one crash data source in their work, as different data sources provide various levels of detail and utility. The tables that follow demonstrate the crash data sources that stakeholders in different types of organizations have reported using.

| Classification of data source | Data source |
|---|---|
| Main | Colorado Department of Transportation |
| Main | Denver Regional Council of Governments |
| Main | Law enforcement agency |
| Main | County-processed data |
| Main | Vendor data |
| Additional | Fire district or department |
| Additional | Emergency medical Services |
| Additional | Fatality Analysis Reporting System |
| Additional | Associated Data |
| Additional | Other |

| Type of organization | Number of each type of organization | Uses CDOT data | Uses DRCOG data | Uses law enforcement data | Uses county data | Uses vendor data | Uses Fatality Analysis Reporting System data | Uses fire data | Uses emergency medical services data | Uses other data |
|---|---|---|---|---|---|---|---|---|---|---|
| Advocacy | 4 | 2 | 2 | 1 | 1 | 1 | | | | |
| City and County | 2 | 2 | 1 | 2 | 1 | 1 | | | | |
| Consultant | 8 | 4 | 2 | 4 | | | | | | 1 |
| County | 6 | 6 | 2 | 2 | | 5 | 1 | | | |
| Federal agency | 3 | 3 | 1 | 2 | | | 1 | | | 1 |
| Fire district | 2 | 1 | 1 | | | | | 2 | | |
| Higher education | 2 | 1 | 1 | 1 | | | 1 | | | |
| Metropolitan planning organization | 3 | 3 | | | | | | | | |
| Municipality | 27 | 18 | 8 | 23 | 8 | 14 | 3 | 1 | | 1 |
| State agency | 4 | 3 | 2 | 4 | 2 | 2 | 4 | | 1 | |
| Tollway | 1 | 1 | | 1 | | | | | | |
| Transit Agency | 1 | 1 | 1 | 1 | | | | | | |
| Vendor | 2 | 2 | | 2 | | | 1 | | | |
| Total | 65 | 47 | 21 | 43 | 12 | 23 | 11 | 3 | 1 | 3 |

"Uses other data" includes data from the National Highway Traffic Safety Administration and North Front Range Metropolitan Planning Organization. One respondent chose 'Other' but did not tell DRCOG what the source was.

A chart detailing consortium stakeholder organization and the sources reportedly used by each can be found in Appendix A.

Various datasets have pros and cons, which crash consortium stakeholders consider in their analyses. For example, several large municipalities have similar practices where they may use DRCOG regional data, CDOT data for their municipality, or vendor-provided data to identify crash trends within their borders. Once they identify particular areas for further analysis, they dig into the crash reports maintained by their jurisdiction's law enforcement agencies, if they have access to the data, as they hone in on the details of individual crashes contributing to the trends. Such trends may be difficult to discern through the law enforcement data alone, especially if records lack geospatial coordinates or the quality of coordinates are poor and unreliable. Some data users told DRCOG that they sometimes have access to information about crashes beyond the information in a crash report, such as data from camera feeds which may have captured a crash, or the movements of vehicles or other roadway users prior to a crash. The resulting information can be essential in developing appropriate countermeasures and would not be available using the datasets provided by CDOT and DRCOG alone.

Other stakeholders report that they contract with vendors to geocode and process their jurisdiction's law enforcement data, identify trends, review crash details, and highlight problematic intersections and corridors. Some jurisdictions that typically use vendor processed data for their day-to-day work report using CDOT data, when required, for grant purposes.

Stakeholders also reported using different datasets as a check against one another, and discrepancies are common between datasets. For some jurisdictions, the difference between total number of crashes recorded in a jurisdiction's dataset may be up to 30% greater than what is represented in CDOT's dataset for the jurisdiction over the same period.

## 2.1 Main data sources

Participants and survey respondents throughout the region cited that they most frequently and consistently used crash data originally generated by law enforcement as their source for crash data. Planners, engineers, and other data users access data originally collected by law enforcement in different ways. After law enforcement responds to a crash that fits the state's definition, the law enforcement agency is required to submit a report to the Colorado Department of Revenue using the DR3447 state crash report form. Per state statute, the Colorado Department of Revenue is the official custodian of the data. The Colorado Department of Revenue checks the completeness of a series of required fields, and integrates the crash records into the Colorado Driver License, Record, Identification and Vehicle Enterprise Solution system, where the legal record is maintained. After going through processing at the Colorado Department of Revenue, the crash data goes on to CDOT. CDOT produces a dataset from the

Department of Revenue data and provides limited data to local governments and partners, including DRCOG upon request. DRCOG annually requests crash data from CDOT for the 10-county area of DRCOG and Elbert County, which falls within DRCOG's data modeling boundary. DRCOG staff process and geocode the data to create an annual regional crash dataset which informs internal analysis and is made available for the public to download as a shapefile, a file type which can be imported into many geographic information systems applications to view crashes geospatially and perform geospatial analysis.

The crash data which forms the basis of both CDOT and DRCOG datasets is derived from DR3447 crash reports which law enforcement submit to the Colorado Department of Revenue. Some local governments access crash data directly from their police departments and use the data as preserved by the agency which has not gone through data cleaning at the Colorado Department of Revenue and CDOT. Some local governments and state agencies use private software vendors to process crash data and perform geospatial analysis. Two prominent vendors in the Denver region, DiExSys and Pd' Programming use different types of crash data, but both are derived from the crash report. DiExSys operates using CDOT data, and Pd' Programming uses law enforcement agency data. Beyond law enforcement, crash data exists in the form of records generated by fire departments and fire districts and other emergency response entities including emergency medical services. This report focuses on the data collected by law enforcement and its various iterations and uses.

### 2.1.1 Colorado Department of Transportation

#### *2.1.1.1 Yearly crash data*

- CDOT processes crash data from the Colorado Department of Revenue on an ongoing basis and manages data it makes available upon request to local governments, agencies and consultants working on highway improvement projects in the state. Since CDOT relies on the data provided by the Colorado Department of Revenue, it depends on Colorado Department of Revenue timelines for processing crash data it receives from law enforcement.
- CDOT has a team that conducts quality control on the crash data from the Colorado Department of Revenue. They check for duplicate records, apply uniform naming standards, check for missing data and geolocate all crashes on the CDOT highway system or interstate system, and all fatal and serious injury crashes on non-CDOT maintained roadways in Colorado.
- CDOT uses a combination of fields from the crash report to determine a field for the "crash type."
- In 2023, DRCOG collaborated with CDOT to conduct quality control checks of CDOT's 2021 data for the Denver region, which was released to DRCOG in May 2023. DRCOG staff checked various fields DRCOG staff considered important, including the number of those injured or killed, crash type, law enforcement narrative about the crash mechanics, and crashes involving vulnerable road users, such as bicyclists or pedestrians. CDOT staff were responsive to DRCOG staff feedback and addressed some of the records with issues that DRCOG staff identified.
- CDOT's process for reviewing crash data requires manual attention for each record, and many records go through multiple corrections based on data found in the report. Many crash reports

contain a narrative which CDOT can make available in many cases for analysts. Some law enforcement personnel are incorrectly including personal identifiable information in narratives, so narratives are not made publicly available by CDOT.

- CDOT data does not include diagrams for any crash. In many cases, law enforcement officers completing a crash report will create a diagram of each crash. All CDOT's crash data use text and number values, and as diagrams are not text-based they are not included in CDOT data.
- As provided, CDOT data uses coded values for many fields which are difficult to discern without a detailed data dictionary. CDOT does not currently make available a complete data dictionary relating human readable values for fields.

#### *2.1.1.2 Colorado Crash Data Dashboard*

- CDOT hosts the Colorado Crash Data Dashboard which is updated more frequently than the yearly datasets CDOT creates.
- The Colorado Crash Data Dashboard provides data at the county level and contains tools which can be used to sort various attributes, including level of injury, weather-related conditions, date range and more.
- CDOT staff are currently undertaking a project to update the dashboard.

#### *2.1.1.3 Stakeholders shared:*

- Stakeholders generally gave positive feedback about the quality of CDOT data, though they mentioned it can often require some cleaning on the back end by analysts.
- Stakeholders often consider CDOT data significantly delayed. Within current state processes, it can take more than a year for crash data to be released to stakeholders. For example, DRCOG received crash data from CDOT for 2021 in May 2023. Nearly half of all organizations which have shared information with DRCOG about crash data expressed that their staff considers the data delay from CDOT to be too long. Throughout the region, stakeholders consider the dataset to be valuable but express a desire for a quicker turnaround.
- Stakeholders indicated CDOT data can be challenging to work with when geospatial coordinates associated with the crash data are missing. They indicated many off-CDOT system records do not have geospatial coordinates.

### 2.1.2 Denver Regional Council of Governments

#### *2.1.2.1 Yearly crash data*

- DRCOG publishes yearly regional crash data on the Denver Regional Data Catalog. 2021 Crash Data for the Denver region is publicly available for download.
- DRCOG annually requests crash data from CDOT for the 10-county area of the Denver region and Elbert County, which falls within DRCOG's data modeling boundary.
- DRCOG processes and geocodes regional data from CDOT to create an annual regional crash dataset. The dataset informs internal analysis and DRCOG staff makes it available for the public

to download in formats which can be imported into commonly used geographic information systems applications to view crashes geospatially and perform geospatial analysis.

- DRCOG staff have created data dictionaries to translate the coded values of various fields into a more human-readable format.
- DRCOG staff have created several variables that they consider in analysis, including high-priority crashes (all records with a fatality, a serious injury, or involving a bicyclist, pedestrian or motorcyclist).
- DRCOG's data has not historically been linked to a linear referencing system, which is a geographic information systems methodology that takes and stores roadway data and unique events along relative positions of a line dataset, but DRCOG is working to link 2021 crash data to a linear referencing system as part of its 405c grant.

#### *2.1.2.2 DRCOG Data Tool*

- The DRCOG Data Tool can be used by the public to immediately conduct a high-level analysis of crashes and other data in the Denver region. Users can import a project location in various data formats or use the tool to draw an area on the map to conduct their analysis.

#### *2.1.2.3 Regional Vision Zero StoryMap*

- DRCOG's Regional Vision Zero StoryMap is a virtual tool complementing DRCOG's *Taking Action on Regional Vision Zero* plan. The StoryMap explores the fatal and serious injury crash trends in the Denver region, breaking down where these crashes are occurring on the regional roadway system and the top contributing factors. Analyzing the patterns in the data shows where crashes occur, reveals how they happen and helps determine which countermeasures will have the largest positive effect.

#### *2.1.2.4 Stakeholders shared:*

- DRCOG's dataset is useful for trends and big-picture analysis, including determining whether crashes involving impairment are increasing, or identifying high-injury corridors, but it is not always great for location-specific analyses.
- Somes stakeholders rely on DRCOG data for mapping and understanding the context of crashes outside of their jurisdiction borders.
- The DRCOG Data Tool is useful to determine the potential effect of proposed projects by analyzing the number and types of crashes recorded in the project area in the past.
- Stakeholders suggested DRCOG data could be improved by mapping crashes to a street centerline as opposed to using the coordinates the geocoding process creates.
- DRCOG data could be improved by being updated more frequently and having more accurate geolocated data points.
- Stakeholders offered some criticism of DRCOG's approach regarding the presentation and analysis of crash data. Stakeholders shared that context is missing with the tabular data provided by DRCOG, and that DRCOG staff seem over-focused on some crash types.

### 2.1.3 Law enforcement

#### *2.1.3.1 Municipal police departments, county sheriff's offices and Colorado State Patrol*

Law enforcement agencies collect two types of crash reports, 1) through the DR3447 crash report for crashes investigated on-scene and 2) reports submitted by the public online known as counter reports. Crash reports are completed by law enforcement and must be submitted to the Department of Revenue within five days of concluding a crash investigation. Law enforcement personnel submit crash reports to the state through a variety of records management systems and other software or by sending an electronic version of the document or scanned paper form.

Most municipalities in the Denver region have police departments that respond to crashes and complete crash reports, while a handful contract out law enforcement to their county sheriff's office. Colorado State Patrol typically responds to and reports crashes in unincorporated parts of counties and on highway and interstate facilities.

In times of inclement weather when it is unsafe or unfeasible for law enforcement to respond to a large volume of crashes, or in instances where agencies are understaffed and cannot respond, law enforcement agencies enact accident alerts, which instruct individuals involved in crashes to complete a counter report. Under accident alert conditions, law enforcement agencies typically only respond if certain requirements are met, such as if alcohol or drugs are involved, vehicles are disabled, or there is a fatality or serious injury requiring emergency attention (Colorado State Patrol).

#### *2.1.3.2 Stakeholders shared:*

- Some local government data users have strong relationships with their respective law enforcement agencies and can request crash data directly from the agency.
- Some local government data users reported that their respective law enforcement agency is unwilling to share crash data or may take a long time to deliver requested data.
- Law enforcement agencies use a variety of software solutions to visualize and understand their data including Crystal Reports.
- Crash data held by law enforcement agencies does not go through the data cleaning processes at the Colorado Department of Revenue and CDOT, and as such the number and quality of records that an agency maintains may vary compared to the records maintained by the Colorado Department of Revenue and CDOT. Law enforcement agencies may have staff who enter, clean and maintain enhanced data which they may or may not provide to the Colorado Department of Revenue and CDOT via amended reports.
- Changes and enhancements made to data by CDOT will not be reflected in the data maintained by law enforcement agencies.
- Some local government data users reported having access to additional information uncovered later in criminal justice system and adjudication processes to which users of CDOT or DRCOG data later do not have access.
- Some local governments use civilian response teams that work with law enforcement to respond to crashes. These teams still use the DR3447 crash report form to report the crash data. Municipalities use their civilian response teams differently. Some civilian response teams focus

on non-serious injury and non-fatal crashes, managing less serious crashes such as property damage only crashes. Other municipalities take the opposite approach, specializing in responding to serious injury crashes.

### 2.1.4 County-processed data

Some counties process data from CDOT or local law enforcement agencies. For example, Boulder County processes crash data from CDOT, geocodes the records missing geospatial coordinates and ties the geocoded records to a linear referencing system for the county's roads. Boulder County makes this data available to local governments.

### 2.1.5 Vendor data

Several vendors provide specialized crash data processing and geocoding services to jurisdictions in the Denver region. In addition to these companies, several of the records management systems used by law enforcement agencies have some crash data analysis capabilities. Representatives from both DiExSys and Pd' Programming spoke with DRCOG staff and are considered stakeholders in this project.

#### 2.1.5.1 DiExSys Road Safety Analytics - Vision Zero Suite

DiExSys Road Safety Analytics is a Colorado-based vendor of crash data software that primarily uses CDOT's yearly data to provide safety analysis to many local governments in Colorado and CDOT. DiExSys' software tool Vision Zero Suite can help decision-makers understand which roadway segments or intersections are showing a higher-than-expected rate of serious crashes given traffic volumes and roadway characteristics. DiExSys geocodes thousands of records in the Denver region by contracting directly with local governments or through using 405c traffic records improvement grants.

#### *2.1.5.2 Pd' Programming - Crash Magic*

Pd' Programming is a Colorado-based vendor of the crash data software Crash Magic that primarily works with data coming from DR3447 crash reports produced by law enforcement, before or as data is being submitted to the Department of Revenue. The data transfer can take several forms, but for Pd' Programming and its clients the data is available much more quickly than the data coming from CDOT. Crash Magic has customizable fields and calculations for local governments and is capable of geolocating law enforcement records for use in the software or export for use in other programs.

#### *2.1.5.3 Stakeholders shared:*

- Many local governments use either Vision Zero Suite or Crash Magic for analysis of their crash data and geolocating data.
- Generally, users provided positive feedback about both Vision Zero Suite and Crash Magic.
- In the past, some local government stakeholders had used vendor solutions but no longer have licenses due to the expense of maintaining licenses.

- Several stakeholders expressed interest in sharing costs if a regional license for a vendor's product would be a viable solution to regional needs.
- At least one stakeholder expressed a desire that consortium activities would improve existing software options available instead of attempting to create something new.

## 2.2 Additional data sources

### 2.2.1 Non-law enforcement emergency response

#### *2.2.1.1 Fire districts and departments*

- Fire districts and departments may maintain their own records for crash responses.
- Fire districts and departments may share a computer-aided dispatch with other emergency responders in a municipality, county or district.
- Fire records do not capture the same information as the DR3447 crash report. Fire records may provide an opportunity for analysts to compare records for accuracy or serve as a supplemental data source for analyzing geographies for high crash rates, even if the crashes did not generate a comparable crash report in a law enforcement system.
- Fire records may contain data about the emergency response including whether vehicles were used as lane blockers for post-crash care.

#### *2.2.1.2 Emergency medical services*

- Emergency medical services entities respond to a variety of crash incidents from dispatch centers and may maintain records which could correlate with other emergency response records including law enforcement and fire. Emergency medical services entities may include records of crashes not captured by other responders or generated through their own systems independent of the records created by law enforcement.

#### *2.2.1.3 Stakeholders shared:*

- Fire district and department data can help analysts explore details of the types of calls that required a firetruck to block traffic for safety.
- Only a handful of stakeholders mentioned emergency medical services in surveys or interviews, but when they did they described the data as robust. Such data may present an opportunity to augment the crash data details captured by law enforcement if regional partners can develop data-sharing agreements.

### 2.2.2 Fatality Analysis Reporting System

Since 1975, the National Highway Traffic Safety Administration has used the Fatality Analysis Reporting System to compile nationwide fatal motor vehicle crash data from the 50 states, Puerto Rico and the District of Columbia. CDOT is responsible for reporting data to the Fatality Analysis Reporting System for crashes that involve a motor vehicle on a public roadway in which there is a fatality of an occupant or nonoccupant of a vehicle within 30 days of a crash. National Highway Traffic Safety Administration

analysts calculate data elements for fatal crashes in each state and do not collect personal identifiable information, so the data can be freely shared. Fatality Analysis Reporting System data can be a helpful tool for analysts to compare fatal crash statistics between states. Due to the requirements of what kind of fatal crash counts in FARS, there can be discrepancies in state or local data as to the number of fatalities and FARS, when for example a fatality is a result of a  crash but an individual passes away more than 30 days past the date of the crash.

### 2.2.3 Associated data

Several stakeholders expressed a desire to have more access to information about crashes beyond what is provided by law enforcement and on-scene emergency response personnel.

#### *2.2.3.1 Toxicology, medical examiner, coroner and Colorado Bureau of Investigation*

Stakeholders expressed concern that impairment is underreported in crash data and would prefer greater access to incident information which is generated in the criminal justice system after crashes are reported through the DR3447 crash report. Stakeholders suggested that, if appropriate data-sharing agreements can be negotiated, information from toxicology specialists, the Colorado Bureau of Investigation, medical examiners and coroner's offices may provide useful data to augment stakeholders' understanding of which crashes involved drugs and alcohol and to inform appropriate countermeasures.

#### *2.2.3.2 Hospitals and emergency departments*

Some stakeholders indicated an interest in access to data from emergency departments and the hospital system to better understand the nature of crashes and their effects in the Denver region and state, especially regarding underreported crashes. There are incidents where crashes occur, but the crash is never reported to law enforcement. Those involved in an unreported crash may seek medical attention and records of injuries are created by the medical entities including hospitals and emergency departments. The Colorado Department of Public Health and Environment maintains Colorado's Injury Indicators Dashboard which documents deaths resulting from injuries, hospital discharges and emergency department visit data by county and health statistics region.

# 3. Analysis

Stakeholders across the region use crash data to mitigate fatal and serious injury crashes and improve the capacity of transportation systems while working to provide safe operations. Crash data helps stakeholders understand where crashes occur, the causes of crashes, and the type of road users affected. Organization staff mitigate crashes through the non-mutually exclusive approaches of engineering, education and enforcement.

| Approaches | Examples |
|---|---|
| Engineering | • Roadway design.<br>• Signage.<br>• Lighting.<br>• Signal timing. |
| Education | • Educational campaigns about behavior including seatbelt and car seat use.<br>• Messaging around dangerous areas and intersections. |
| Enforcement | • Law enforcement uses crash data to direct patrols.<br>• Some law enforcement agencies coordinate with engineers based on their crash data and first responders' expertise and knowledge of where crashes occur.<br>• Fire districts use crash data to help them identify community risks. |

## 3.1 Safety reviews and screening for correctable patterns

The broadest goals of stakeholders involved in the consortium involve engineering and planning solutions to mitigating fatal and serious injury crashes. Stakeholders from municipalities of all sizes, counties, CDOT, consulting firms, vendors, and law enforcement agencies shared examples of how they conduct safety reviews and screen for correctable patterns. Stakeholders conduct different types of reviews when high crash numbers are observed through normal work, as requested by local officials or concerned constituents, perform analyses at regular intervals, and often when a roadway or area has planned improvements. Stakeholders also use crash data to identify problematic trends. Stakeholders use crash data to show areas with high incidents of crashes and top crash intersections or roadways often as a first step in their analysis. Analysts can use these different datasets and tools to determine when to further investigate the individual crashes that make up trends. Local law enforcement records are often used to inform appropriate countermeasures or to support or refute community or elected officials' concerns about safety and where to allocate resources.

Some municipal governments have greater access to law enforcement data than others. Law enforcement data can go beyond the information found on the DR3447 crash report form. At times, crash investigators create supplemental reports that cover details and crash scene reconstruction. Some local government staff have indicated they have access to more in-depth law enforcement records

including information related to toxicology, aspects of the criminal justice system process, and networks of recorded footage which can help analysts understand the circumstances of individual crashes. Sometimes law enforcement personnel learn information after they have submitted the DR3447 crash report to the Colorado Department of Revenue. New information (for example an update regarding a crash party's impairment) can be provided to the Colorado Department of Revenue through an amended report. Stakeholders have informed DRCOG staff that not all law enforcement personnel submit amended reports for all crashes where it may be appropriate, and therefore some updated information is not provided to the Colorado Department of Transportation or DRCOG, which can lead to data discrepancies.

## 3.2 Key topics stakeholders want to understand

Stakeholders expressed an interest in several topics, but five consistently came to the fore:

- Crash locations.
- Behavior and contributing factors.
- Movements, harmful event sequences and crash type.
- Road user analysis and vulnerable road user emphasis.
- Specific countermeasures to mitigate fatal and serious injury crashes.

### 3.2.1 Crash locations

Knowing where crashes occur on roadways is vital to stakeholders' approaches to mitigate serious injury and fatal crashes. Knowing where crashes happen in a timely manner can allow local jurisdictions to respond to serious crashes and attempt quick fixes, if feasible, in that location to prevent future crashes. Stakeholders use historical crash data to identify locations which share similar features to where crashes have been reported that can be modified to prevent similar crashes and respond to constituent and leadership inquiries about high-profile crashes.

Consortium stakeholders use location data for a variety of approaches. Some examples of how stakeholders use location data are:

- Top five or 10 highest number of crash intersections or roadways in a jurisdiction.
- Crash rate at specific locations or across corridors.
- Trends and patterns beyond raw numbers, for example, where crashes happen either with more frequency than would be expected or are more severe than would be expected based on volume and type of roadway or intersection.
- Taking a systemic approach to crash data, where the characteristics of locations of prior crashes are used to identify locations which share similar characteristics to proactively mitigate potentially dangerous circumstances to prevent crashes.

Sometimes just knowing the locations and numbers of fatal or serious injury crashes is not by itself enough to direct the limited resources of stakeholders to prevent crashes. For example, a large municipality in the Denver region indicated that if its engineers and planners were to plot all crashes and

look for hot spots purely based on the number of crashes and severity, without taking into account traffic volumes or roadway geometries, then all the main arterials would be considered among the most problematic areas. Considering a factor like annual average daily traffic in combination with the number of crashes or Highway Safety Manual style analyses can help provide a more complete understanding of where severe crashes happen disproportionately to the aggregate and help guide decision-making to target mitigations where they may have the greatest traffic safety improvements.

| Tools for analysis | Description |
|---|---|
| Traffic volume and annual average daily traffic | • Stakeholders shared that bringing together traffic volume data with crash data can help identify issues on roadways to avoid overfocusing on places with a large number of crashes at the expense of where there may be more severe crashes or a disproportionate number of crashes.<br>• Engineers expressed it is important to know how many lanes are on a roadway, the traffic volume and whether intersections have traffic signals.<br>• Some stakeholders report limited access to roadway volume data.<br>• CDOT's Online Transportation Information System has tools including volume for on-CDOT system roadways. |
| Highway Safety Manual and Level of Service of Safety | • Contains methodologies to analyze roadway segments and intersections for statistically high crash frequency.<br>• DiExSys created diagnostic norms used by CDOT that determine the normal or expected number of various crash types by roadway facility to determine outliers.<br>• "Level of Service of Safety reflects how a roadway segment or an intersection is performing in reference to the expected frequency and severity of crashes predicted by its safety performance function" (Kononov et al., 2019).<br>• Analysts using a highway safety manual approach need to have data from a several year timeframe to perform their analysis. |

### 3.2.2 Behavioral and other contributing factors

Stakeholders consider behavioral and other contributing factors to be important and use such data, when it is available, to analyze crashes and identify patterns. Knowing more about the conditions experienced by those in crashes can help stakeholders identify the approach to mitigation that would be most effective. The elements most cited by stakeholders include:

- Impairment (drugs or alcohol).
- Distracted driving.
- Speeding.
- Seat belt usage.
- Weather and time of day.
- Roadway conditions at the time of crash.

### 3.2.3 Movements: harmful event sequences and crash type

Data users indicated they're interested in knowing crash circumstances. Understanding the harmful events leading to individual crashes can help analysts understand the movements that cause the crashes they hope to mitigate. A segment of the DR3447 crash report form lists the variety of options law enforcement has available to describe what happened in a crash, in which order and which event is considered the most harmful event, defined as "the event that caused the most severe injury or, if not injury, the greatest property damage involving this motor vehicle" (Investigating Officer's Crash Reporting Manual, 2019). CDOT coders assign a new value to crashes in its system called a crash type, after review of the individual circumstances of crashes.

CDOT provided an example to DRCOG staff about a hypothetical harmful event sequence and how the fields should be reported. In the hypothetical example, a motor vehicle stopped for a deer in the middle of a roadway. The motor vehicle did not strike the deer, but then another motor vehicle rear-ended the stopped vehicle. CDOT staff would recommend the first harmful event be recorded as "other non-collision," the second harmful event as "front to rear," and the most harmful events "front to rear." CDOT staff recommend that the crash type in the hypothetical scenario be considered "wild animal." Many crashes are more complicated than the hypothetical example, necessitating CDOT coders to spend time correcting details for crashes compiled in CDOT's yearly data. CDOT does not expect 100% accuracy in coding from law enforcement and relies on provided narratives to help make crash type determinations.

### 3.2.4 Road user analysis and vulnerable road user emphasis

To prevent fatal and serious injury crashes, several stakeholders expressed interest in tracking and learning more about crashes involving various types of roadway users, including bicyclists, pedestrians and motorcyclists. Between 2013 and 2017, while people walking, biking and riding a motorcycle made up 2%, 1% and 2% of all crashes by travel mode, the percent of fatal crashes by travel mode was 19%, 4% and 21% respectively, demonstrating the highly disproportionate rate of fatal crashes by mode share in the Denver region (*Taking Action on Regional Vision Zero*, 2020).

A handful of stakeholders have used the free Pedestrian and Bicycle Crash Analysis Tool from the Federal Highway Administration to analyze bicycle and pedestrian crash data.

Stakeholders have also suggested that there is an underreporting of bicyclist and pedestrian crashes, especially if a motor vehicle is not involved. Local government stakeholders have noted that some bicycle-on-bicycle or bicycle-on-pedestrian crashes are not reported in the same way that a crash involving a motor vehicle would be by their law enforcement agencies. While the severity of such crashes may be less than a crash involving a motor vehicle, stakeholders expressed that they would like details about such occurrences to better help prevent bicycle-on-bicycle or bicycle-on-pedestrian crashes.

### 3.2.5 Specific countermeasures to mitigate fatal and serious injury crashes

Stakeholders use location, behavior and contributing factors, movements, and road user analysis to determine specific countermeasures to mitigate fatal and serious injury crashes in the Denver region.

| Countermeasure | Description |
|---|---|
| Redesign roadways and intersections | Stakeholders consider changing the geometry and configuration of roadways and intersections one of the best ways to mitigate fatal and serious injury crashes if the inherent designs are unsafe for roadway users. |
| Traffic signal timing | Traffic signal timing can affect crash rates and changing timing may influence user behavior to make intersections safer. |
| Flashing yellow arrows | Stakeholders have used crash data to determine at what times of day some flashing yellow left turn arrows should be eliminated in favor of solid red and solid green arrows at intersections in the Denver region. |
| Signage changes | Unclear, misleading, incomplete or outdated signage can be crash factors when users are unsure of or misinformed about how to safely navigate a space. |
| Quick fixes/rapid response | Some local governments use crash data to rapidly respond to crash events and investigate crash locations for potential (and sometimes simple) safety enhancements such as clearing foliage obstructing signs or lights or installing low-cost infrastructure such as bollards at intersections or along roadways to separate modes of traffic or slow vehicles. |
| Educational campaigns | Some local governments and agencies employ educational campaigns to warn users of dangerous |

| Countermeasure | Description |
|---|---|
| | roadway stretches or intersections and encourage safer driving and roadway behaviors. |
| Pedestrian leading intervals | Pedestrian leading intervals provide pedestrians a head start on crossing an intersection. |
| Direct patrols and other resources | Colorado State Patrol staff have noted that an increased presence of troopers on Colorado highways positively correlates to better driving behavior and fewer serious injury crashes. |

## 3.3 Stakeholder desires

Stakeholders expressed the desire for more access to information and the streamlining of processes to improve their analysis objectives.

- Integration of other data sources.
- Single, standardized and geolocated data source.
- Increased use of linear referencing systems.
- Learn and collaborate with peers.

### *3.3.1 Integration of other data sources*

Stakeholders indicated that they find the information in the DR3447 crash report to be valuable information, and expressed that additional information, if it could be linked with more data sources, could help inform better countermeasures.

| Data sources | Description |
|---|---|
| Emergency medical services | Robust statewide emergency medical services data could supplement the number and details of crashes reported by law enforcement. |
| Toxicology/medical examiner/coroner | Discrepancies exist between state and local data as to the number of crashes involving drug and alcohol impairment. Stakeholders expressed an interest in linking toxicology and other medical data to crash records to have a more accurate accounting of which crashes are related to drugs or alcohol by any party involved. |

| Data sources | Description |
|---|---|
| Hospital | Stakeholders noted that hospital data could augment the counts of crash reports to help account for underreported bicycle and pedestrian crashes. Cyclists or pedestrians injured in a crash sometimes go to an emergency department following a crash without having contacted law enforcement, so there may be a record of an emergency department visit or hospitalization resulting from a crash that has no corresponding crash in law enforcement data. |
| Supplemental police investigation | Several local government stakeholders have suggested there may be information that can be made available to engineers and planners discovered after the submission of a completed crash report or that exists in a way that does not connect easily with an official crash report. An example of this kind of information includes surveillance camera or other video footage, which informs a law enforcement investigation and could add context to a crash for designing countermeasures, but this data does not accompany the crash data going to CDOR, CDOT and DRCOG. |
| Citation | Staff from several local governments are interested in being able to link citation data to crash data if possible, for a more robust understanding of crash causes. |
| Law enforcement contacts | Stakeholders noted that contact data collected by law enforcement often has more detailed information, including demographics, which is not included on to the DR3447 crash form and is thus not forwarded to the Colorado Department of Revenue, CDOT and DRCOG. |

### *3.3.2 Single, standardized, geolocated data source*

Stakeholders expressed that a single geocoded data source would be desirable. Stakeholders at all levels use multiple data sources, and at times various data sources conflict with one another. While it's unrealistic to expect a centralized, comprehensive data source for all stakeholder needs, stakeholders indicated a data source with latitude and longitude for all crash records in the state of Colorado, on-CDOT system and off-system, could help eliminate some doubts and confusion with the data. Stakeholders expressed that getting data users to use the same dataset could be a benefit of working

together as a data consortium. Some stakeholders would like CDOT to maintain a centralized data source available to all users as a standardized reference for the Denver region and state.

### *3.3.3 Increased use of linear referencing systems*

#### 3.3.3.1 Linear referencing primer

Linear referencing is a geographic information systems methodology that takes roadway data and unique events and stores these data along relative positions of a polyline dataset. Esri, a large geographic information systems software producer describes linear referencing as:

"Linear referencing is the method to store and geographically locate data using relative positions along a measured line feature without the need to explicitly use x,y coordinates or an address. When data is linearly referenced, measure values are used to measure the distance along a line feature, allowing multiple sets of dynamically changing attribute data to be associated with any portion of an existing linear feature, independent of its beginning and end. Measurements along features are used to locate point events and line events using several conventions (Esri)."

CDOT maintains two statewide linear referencing systems: a legacy system which only contains state roads, and a second system called the All Roads Network of Linear Reference Data containing all public roads in Colorado. DRCOG is working with CDOT to trial connecting 2021 crash data to the All Roads Network of Linear Reference Data system for the Denver region. Stakeholders indicated that linear referencing can be a powerful tool when combined with crash data. With a linear referencing system, roadway attributes such as the speed limit, type of surfacing or volume class can be maintained as separate attributes along the roadway without requiring separate features. Geolocated crash data tied to the centerline of a linear referencing system allow for various kinds of analysis to be performed. Using a linear referencing system can help geolocate crashes as well, especially as it relates to siting crash locations with mile markers or intersections and offsets. If a crash report has a mile marker and offset distance, then the linear referencing system can be used to place the crash location at the value indicated in the report accounting for the offset distance. Similarly, a linear referencing system combined with an up-to-date intersection dataset can be used to connect crashes with intersection location information, including offsets, along the roadway network.

#### 3.3.3.2 What stakeholders said:

- Some stakeholders indicated that they believe the focus of data managers and users should be on data quality, linear referencing and geocoding, rather than having the most up-to-date data possible.
- Many local governments do not have linear referencing systems and the lack of linear referencing contributes to the time it takes CDOT to review crash data. Stakeholders indicated that a unified linear referencing system that could be used by CDOT and local governments would make local geocoding records easier and better align with the state's methodology.

- It can be time consuming to work with raw crash data that is not tied to a linear referencing system, and a good liner referencing system can provide confidence that crash locations are accurate.
- Not all stakeholders have access to linear referencing system technology through their geographic information systems software, or have access to or know how to use the State of Colorado's linear referencing systems.

#### *3.3.4 Learn and collaborate with peers*

The Denver region has a long history of collaboration and working as a region to address challenges.

- Stakeholders shared an interest in learning from one another and making sure best practices are communicated among one another.
- Several stakeholders indicated an interest in standardizing crash data schemas with DRCOG and other data users, so data can be shared and integrated in the same format.
- Stakeholders indicated it's useful to know how they compare with other jurisdictions both to support regional projects and to identify grant opportunities.
- Stakeholders indicated that understanding what other local governments are doing to reduce crashes in their jurisdictions can help inform a systemic approach and identify whether similar conditions exist in other jurisdictions.
- Stakeholders indicated an interest in developing policies and best practices to address commonly identified problems and patterns.

## 3.4 Valuable components of the DR3447 crash report

Consortium stakeholders often cited two components of the DR3447 crash report as valuable: the crash narrative and diagram.

### 3.4.1 Crash narrative

Law enforcement personnel can use the crash narrative field on the DR3447 crash report form to provide a brief written account of what happened in a crash. Several data users cited narratives as valuable to understanding what happened in individual crashes as well as in checking data quality against data recorded in other fields of the DR3447 crash report form.

#### *3.4.1.1* Narrative information from the *Investigating Officer's Crash Reporting Manual*

- "The narrative provides a description of the crash as a chronological narrative of what occurred, involving three steps:

  a. Set the Stage – describe what was happening just before the crash event occurred; what was each vehicle/non-motorist doing prior to the crash.

  b. Crash the involved parties – describe what happened as the crash event occurred; which vehicle did what that led it to collide with which other vehicle (or non-motorist).

c. Bring the parties to rest – described what happened after the crash event occurred; how/where did the parties wind up" (Investigating Officer's Crash Reporting Manual, 2019, 79).

- Guidance from the *Investigating Officer's Crash Reporting Manual*
  - "The only other information that should be included in the narrative are the details for specific field when specified elsewhere in this manual. For example, if a harmful event in the sequence was a vehicle hitting a fixed object not provided in the list, and 39. Other Fixed Object was selected, then the description of the fixed object should be included in the narrative" (Investigating Officer's Crash Reporting Manual, 2019, 79).
  - "The DR3447 narrative should NOT include other case-related information such as witness statements" (Investigating Officer's Crash Reporting Manual, 2019, 80).
  - "Note: Do Not Include Personal Identifiers (names, addresses, phone numbers, etc.) in the narrative, as they would have to be redacted in many cases for release" (Investigating Officer's Crash Reporting Manual, 2019, 80).

#### *3.4.1.2 What stakeholders said:*

- Many stakeholders highlighted the usefulness of narratives, further sharing that narratives can help provide important context to the other data fields of a report or suggest that other fields in a report are incorrect. A local jurisdiction engineer shared that reviewing narratives revealed that many records reporting crashes as involving pedestrians in fact involved bicyclists.
- Staff of both major crash data vendors used by stakeholders in the region consider narratives important in their analysis and shared that narratives can help validate or interpret officer codes.
- While many stakeholders noted the usefulness of narratives, not all stakeholders use them consistently. Some stakeholders reported that, for their analyses, they find other data fields in the crash report more useful than the narrative.
- Some stakeholders reported that their access to narratives from CDOT in years past has been limited.
- Narratives coming from law enforcement can contain personally identifiable information, which can at times need to be removed before data is made available to users.

### 3.4.2 Crash diagram

The crash diagram is a visualization of what is reported to have happened in a crash event. Depending on the severity or type of crash, a diagram may be required. Some law enforcement agencies require a diagram if certain conditions beyond the requirements of the *Investigating Officer's Crash Reporting Manual* are met, such as if a person is charged with a felony in relation to a crash. Severity or possible felony charges may also precipitate the need for an at-scale diagram, whereas less serious crashes may not require such a detailed depiction of the crash. Diagrams make it through from law enforcement to the Colorado Department of Revenue and to CDOT, but they are not considered a report field and can be difficult to share beyond State of Colorado entities. If capacity permits, law enforcement may make

diagrams available to users with whom they are in data sharing agreements.

#### *3.4.2.1 Diagram information from the Investigating Officer's Crash Reporting Manual*

- "The diagram area is provided for the officer to draw a diagram of the crash scene" (Investigating Officer's Crash Reporting Manual, 2019, 81).
- "Diagrams are required for:
  - All crashes involving trains
  - All crash reports involving injury classifications 03. Suspected Serious Injury and 04. Fatal" (Investigating Officer's Crash Reporting Manual, 2019, 81).

- Guidance from the Crash Reporting Manual
  - "NOTE: Diagrams are strongly encouraged for any crash" (Investigating Officer's Crash Reporting Manual, 2019, p 81).
  - "NOTE: Even when a diagram is not required on the DR3447, it is strongly encouraged that officers do a field diagram of the crash scene, even though this diagram may not be required with the DR3447" (Investigating Officer's Crash Reporting Manual, 2019, 81).
  - "Diagrams should include:
    - Road
    - Vehicles
    - Measurements" (Investigating Officer's Crash Reporting Manual, 2019, 82).

#### *3.4.2.2 What stakeholders said:*

- Many stakeholders highlighted the usefulness of diagrams when available.
- Stakeholders indicated that police reports do not always have diagrams.
- Various records management systems capture diagrams in different ways or may not have the capacity to complete a diagram within the system and require additional programs.
- Law enforcement can use automated or computer systems to draw diagrams, but sometimes officers will hand-draw diagrams, and hand-drawn sketches can be difficult to decipher.

# 4. Issues and challenges

Several trends in issues and challenges came up in DRCOG staff conversations with stakeholders. Trends included six main topics: location, timeliness, reporting issues, accessibility, discrepancies between datasets and the challenge of integrating crash data with other data.

- Location
    - Availability of geospatial data.
    - Accuracy of geospatial data.
- Timeliness.
- Reporting issues.
    - Inconsistency.
    - Errors.
- Accessibility of data.
- Discrepancies between datasets.
- Integration of data.

## 4.1 Location

Nearly all stakeholders consider the ability to identify accurate crash locations of crashes to be a key component to addressing traffic safety. Many challenges currently exist with the geolocation of crash data in the Denver region and Colorado. Many stakeholders report wanting to have latitude and longitude location data for crash records to use the data in geographic information system software and map crash locations. Consortium stakeholders identified three main problems related to crash data location: the availability of geospatial data and lack of consistent latitude and longitude; the accuracy of geospatial data when it is present; and the difficulty in using and interpreting crash data without geospatial coordinates.

### 4.1.1 Lack of geospatial data (latitude and longitude)

#### *4.1.1.1 Missing geospatial data*

Many records produced by law enforcement agencies do not have geospatial data captured either at the scene of a crash, generated through a records management system or otherwise geolocated before the DR3447 report is submitted to Colorado Department of Revenue. DiExSys, which has conducted geocoding for crash reports for multiple jurisdictions in the Denver region, relayed to DRCOG staff that more than 95% of off-CDOT system records do not have latitude and longitude coordinates.

According to the *Investigating Officer's Crash Reporting Manual* the location of a crash is supposed to be recorded on the DR3447, but there is currently no requirement from the state that latitude and longitude must be recorded for each crash. The *Investigating Officer's Crash Reporting Manual* provides guidance for how coordinates should be recorded if they are captured, but the Colorado Department of Revenue does not require coordinates to be recorded for a report to be accepted. Law enforcement agencies have varying polices as to the collection of latitude and longitude, and some agencies record

geospatial coordinates on a regular basis. Other law enforcement agencies do not collect many or any coordinates for crashes.

Some departments capture geospatial data regularly, but there may still be instances in which a coordinate is not collected. For example, some computer-aided dispatch systems used by law enforcement in the Denver region record the geospatial coordinates for crashes as the address for which dispatch receives information about the crash. If coordinates are autocompleted by computer-aided dispatch in the crash report, two errors are possible. First, if the address provided does not correspond with information in the system, no coordinates are assigned, and the latitude and longitude are left as a null value. Second, if the address reported through the dispatch system is not where the actual crash occurred, the geospatial location of the crash will be incorrect if not later modified by law enforcement personnel.

#### *4.1.1.2 What stakeholders said:*

- Several local government staff reported that missing geospatial data can require extra work to geolocate the data themselves, or cause delays in performing desired analysis while waiting for geolocated data from CDOT, DRCOG or a vendor.
- A wide range of stakeholders expressed the desire that CDOT should move from geolocating all on-CDOT system and off-CDOT system fatal and serious injury crashes to geolocating all crashes in the state, regardless of injury level or where the crash occurred.
- Stakeholders indicated that how crash data is often captured is up to how individual officers and the supervisors who review crash reports want to see the reports. Law enforcement stakeholders have shared that oftentimes latitude and longitude does not mean much to an officer or supervisor, whereas a mile marker on a known roadway or the offset distance from an intersection can be easily matched to a real-world location, which is easier to understand. Within departments there may be discrepancies among what individual officers do as they complete crash reports, especially if there is no departmentwide policy requiring the collection of latitude and longitude.
- While most stakeholders who talked to DRCOG about geospatial data expressed a desire for more latitudes and longitudes to be recorded in the crash report itself, others told DRCOG staff that the officer's description of a crash location can sometimes be more reliable than geospatial coordinates as currently captured.
- There is a strong desire by many stakeholders that law enforcement personnel submit reports with accurate geospatial information, or at least in a way that can be geocoded by the state or other partners. Location information like an address, intersection and offset, or mile marker can be difficult for analysts to interpret.
- Stakeholders indicated that crash locations in the middle of blocks, or at intersections of streets that deviate from cardinal directions are difficult to work with without accurate latitude and longitude.
- Some stakeholders noted that technological solutions might help law enforcement capture geospatial coordinates. Stakeholders have suggested that if jurisdictions invested in training

responders to use widely available GPS technology, they might be more likely to capture latitude and longitude for crash locations. Examples of stakeholder-proposed solutions include having a device in each patrol vehicle that an officer or trooper can use to record their vehicle's location with the push of a button, or a screen-based interactive software solution that allows law enforcement to capture their location and adjust the coordinates to where the crash occurred. Stakeholders acknowledged it may be a challenge to integrate such solutions into various records management systems used by law enforcement agencies or ensure consistency in using the same system among the region's law enforcement agencies. Stakeholders indicated such tools warrant proper consideration as solutions to missing geospatial data.

- Stakeholders from some law enforcement agencies noted some of their officers find using coordinates to be difficult and prefer recording location by other means.

#### *4.1.1.3 Law enforcement location practices shared by law enforcement agencies*

| Agency | How are coordinates captured, if at all? | Preferred method of recording location | Notes |
|---|---|---|---|
| Aurora Police Department | Coordinates auto filled by computer-aided dispatch at intersection centerlines. | Nearest intersection. | No way for officers to put the exact coordinates for a crash. |
| Denver Police Department | Coordinates auto filled by records management system based on preprogrammed locations. | Intersection and offset. | If there is no location match, the coordinates will be left blank. |
| Douglas County Sheriff's Office | Coordinates auto filled by computer-aided dispatch. | Intersection and offset. | Public Works geocodes records based on the intersection and offset. |
| Lakewood Police Department | Coordinates only recorded when there is no better option. | Intersection and offset. | Captured coordinates need to be hand-keyed into a report when recorded. |

| Agency | How are coordinates captured, if at all? | Preferred method of recording location | Notes |
|---|---|---|---|
| Mead Police Department | Coordinates only recorded when there is no better option. | Mile marker to nearest 0.1-mile, address. | Coordinates do not mean much to those reviewing reports, so using them makes the review process more difficult compared to other locating methods. |
| Northglenn Police Department | Analyst-reported coordinates seem to be auto geocoded from address recorded by officers. | Intersection and offset, address. | Some coordinates are missing despite auto geocoding. |
| Thornton Police Department | | Intersection and offset. | Sometimes locations do not verify correctly, especially with block information.<br><br>Generally available, but quality suspect. |
| Westminster Police Department | Coordinates auto filled by computer-aided dispatch. | Intersection and offset. | |

Additional data gathered through conversations with non-law enforcement contacts at jurisdictions describing data collection can be found in Appendix B of this report.

### 4.1.2 Geospatial data accuracy

Even when geospatial data is available for crash data in the Denver region, some stakeholders maintain a high level of skepticism regarding the accuracy of latitudes and longitudes. There is no standard way that geospatial location data is collected, resulting in an assortment of methods used to capture it, with some methods likely being more accurate than others. Data that is geocoded after the fact from the location fields of the report is also subject to potential accuracy issues depending on the process by which records are geolocated.

#### *4.1.2.1 Stakeholder concerns for law enforcement coordinate accuracy*

Stakeholders described that the geospatial accuracy of records coming from many law enforcement agencies is inconsistent, and that many off-system coordinates are inaccurate. Due to the suspect nature

of many coordinates, stakeholders said they often need to review additional location fields of many reports and spend time and effort to ensure coordinates are accurate for use in geospatial analysis.

Examples of inaccurately reported geospatial locations include:

- Coordinates on a mountainside or field, far from a roadway, potentially because of missing a digit in latitude or longitude, transposing digits, or other data entry error.
- Coordinates outside of Colorado, potentially because of missing a digit in latitude or longitude, transposing digits, or other data entry error.
- Stacked coordinates in residential neighborhoods, which stakeholders indicate are often due to an officer completing reports at home. Similarly, parking lots adjacent to roadways, cafes and restaurants appear in some datasets as incorrect crash locations due to law enforcement officers completing their reports in parked vehicles at such locations.
- Coordinates which fall upon structures or geographic features that align with an address, and not the roadway adjacent to the address.
- Stacked coordinates on mile markers and highway ramps.
- Some records management systems and computer-aided dispatch systems used by law enforcement agencies in the region assign coordinates to the initial reported location of a crash. If the actual location of the crash differs, law enforcement personnel may not change assigned coordinates to reflect the actual crash location.

#### *4.1.2.2 Stakeholder concerns for geocoded location field accuracy*

Latitude and longitude data geocoded by analysts is not immune to error. Despite attentive quality control, with tens of thousands of crashes recorded annually in Colorado, at times records are geocoded incorrectly in CDOT data, DRCOG data and other datasets. Municipal stakeholders pointed to errors in CDOT and DRCOG datasets, and DRCOG analysis found in CDOT data multiple instances of stacked points for crashes that share the exact same latitude and longitude. No geocoding system or process is perfect and can prevent all errors, but stakeholders expressed that the data still contains too many errors.

## 4.2 Timeliness

Many stakeholders consider the timeliness of data to be critically important. In general, stakeholders would like to get access to CDOT data more quickly.

### 4.2.1 Timeliness of Colorado Department of Transportation and DRCOG data

The timeliness of crash data from CDOT and DRCOG is a major concern for many consortium stakeholders, ranging from municipalities of all sizes, counties, state and federal agencies, advocates, vendors, consultants and fire districts, especially as it relates to the yearly crash dataset produced by CDOT, and later processed by DRCOG for the Regional Data Catalog. DRCOG staff heard from stakeholders that they consider the data to be highly delayed and there is a strong appetite for state data to be released to users much sooner than has historically been the case. Data from CDOT is usually made

available to local governments and contractors between 12 and 18 months after the calendar year for the data; for example, DRCOG received the first version of crash data for the Denver region from CDOT for calendar year 2021 in May of 2023. Some stakeholders reported receiving data for their jurisdictions from CDOT in a similar timeframe.

The Colorado Department of Revenue receives DR3447 crash reports submitted by law enforcement and citizen-submitted reports, called counter reports. It has a team that checks for completeness of records and processes the reports received. The Colorado Department of Revenue may send crash reports back to law enforcement if required fields are incomplete and its staff conducts an error-correcting process to check for common errors. For example, staff ensure that the time a scene is reported as cleared on a report is later than the time law enforcement arrived on-scene. Some stakeholders indicated the process takes too long and unnecessarily delays their receipt of useful data.

DR3447 crash report mandatory fields

| DR3447 field name | Additional information |
|---|---|
| Case number | N/A |
| Agency name | N/A |
| Date of crash | N/A |
| Investigated at scene | N/A |
| Number killed | N/A |
| Number injured | Only for injury levels 2 or 3 |
| Total vehicles | N/A |
| Total non-motorist | N/A |
| First and last name | Requirement removed if hit and run |
| Date of birth | Requirement removed if hit and run |
| Address | Requirement removed if hit and run |
| Insurance information | N/A |
| Vehicle type | Examples include passenger car, transit bus and motorcycle.<br>If the vehicle type is a commercial vehicle, the gross vehicle weight rating is required. |

After data clears the Colorado Department of Revenue's requirements, it provides the data to CDOT, which can be up to 90 days from when the Colorado Department of Revenue receives a crash report from law enforcement. CDOT has a team of dedicated contractors who conduct a lengthy, largely manual process to prepare crash data into a single record for analysis in CDOT's system, including combining multiple data items from the Colorado Department of Revenue. CDOT's contractors determine the crash type, correct crash data that can be determined through context, and assign geospatial coordinates to all crashes on the state system and all fatal and serious injury crashes off-system. CDOT packages the crash data for each calendar year and provides DRCOG with the data for the Denver region. DRCOG staff works

with CDOT to conduct quality control checks on the data for the Denver region and share feedback which has been received positively and collaboratively.

### 4.2.2 Timeliness of law enforcement data

The timeliness of crash data from law enforcement varies considerably and there is no standard for when data is made available to partner agencies, nor any state requirement that agencies must share their data with analysts within their jurisdiction or beyond. The relationships between law enforcement and data users greatly affects the availability and timeliness of records from law enforcement agencies. Some local government staff can access police crash reports and records directly and nearly immediately, others may need to request access to records for specific time periods, if they have access at all.

### 4.2.3 What stakeholders said:

- Consortium stakeholders would like crash data to be made available from the state, DRCOG and law enforcement agencies much sooner.
- Some law enforcement agencies can share information nearly immediately with staff of other departments within their jurisdictions, and practices vary within each local government.
- In general, stakeholders would like crash data from CDOT within about six months as opposed to the current year to year-and-a-half timeline.
- Some stakeholders indicated that data should be made available from CDOT as soon as a month following submission of the report to the state.
- Not all stakeholders have a problem with the current timeline from CDOT. Some stakeholders indicated that long-term data is necessary to make informed decisions and to perform the types of analysis laid out in the Highway Safety Manual. These stakeholders maintain that quality of the data being released by CDOT is more important than the expediency of the data releases.
- A timing concern for many stakeholders is that data needs to be current to relate to policymaker and constituent concerns. Policymakers and constituents are generally interested in crashes and trends that happened within the past few weeks, rather than from a year or two ago.
- Some stakeholders expressed that there are opportunities for the Colorado Department of Revenue to improve its process which could speed up the overall timeliness of data.
- The Colorado Department of Revenue and CDOT are often slowed down in their processes by missing fields in the data on crash reports coming from law enforcement.

## 4.3 Reporting issues

How law enforcement personnel initially input data is crucial to downstream data users who rely on the information in crash report fields to understand what is happening in their communities and mitigate serious crashes. Law enforcement agencies expect their officers to collect numerous data points in response to a crash, and data users expressed appreciation for their work, especially as responding to crashes can be difficult and life-threatening, depending on crash and roadway circumstances. Issues in reports that were identified by stakeholders typically involved inconsistency in reporting and errors in

reporting. Some of these inconsistencies and errors may be related to the way records management systems and data entry applications available to law enforcement guide officers through the reporting process.

### 4.3.1 Inconsistency

Inconsistency is a general concern among stakeholders, including those from small to large municipalities, counties, consultants and the State of Colorado. CDOT staff have stated that data quality can vary greatly among law enforcement agencies. Stakeholders identified three main themes related to inconsistencies in reporting among officers and agencies: non-geospatial locations, impairment, and reporting of bicycle and pedestrian crashes.

#### *4.3.1.1 Non-geospatial location fields*

- Stakeholders indicated they consider it important for street name conventions to be consistent. For example, even a small discrepancy can affect how useful data is to users (such as recording "38th Avenue" versus "West 38th Avenue").
- Roadway spellings are inconsistent and database systems can cause similar frustrations as the prior "38th Avenue" versus "West 38th Avenue" issue. "Mississippi Ave" and" Misissippi Ave," while different by just one letter, will not be considered the same street in certain database queries and may require special queries or data cleaning on the back end, which can slow processes down.
- Law enforcement personnel sometimes provide addresses or block information as a location method, which can be inconsistent applied. For example, if a crash happens on Federal Boulevard between West 49th Avenue and West 50th Avenue near the intersection of West 49th Avenue and Federal Boulevard, the reporting officer may understand "4900 block of Federal Boulevard" to be the same as saying "49th and Federal Boulevard." While these values are attempting to describe the same location, a query for one or the other might not capture all crashes at that location. Analysts may need to do additional queries to capture all crashes for the same block or intersection or important data could be missed in analyses due to the inconsistency in the location assignment.
- One local government shared an example of law enforcement simply recording "I-25 ramp" as a location for some crashes, which is not specific enough to adequately inform a crash analysis. A location like "I-25 ramp" could apply to multiple I-25 on- or off-ramps within a jurisdiction's boundaries.

#### *4.3.1.2 Impairment*

- Stakeholders indicated law enforcement officers may be reluctant to check boxes for "suspected impairment' if they are not confident charges can be brought or won, which leads to an underreporting of impairment data.
- Comparisons of CDOT data to local jurisdictions with access to information from their criminal justice systems has shown an underreporting of impairment in CDOT data.

- Underreporting of impairment may affect the type of mitigation solutions used by engineers and the wrong countermeasures may be employed.

#### *4.3.1.3 Bicycle and pedestrian*

- According to stakeholders, police reports are not being completed for all bicycle and pedestrian crashes in the region.
- Crashes may not appear to rise to the level of injury for non-motorists, who may later go to an emergency department or other health care facility but not report the crash to law enforcement.

### 4.3.2 Errors

Some errors are inevitable in data, but stakeholders expressed a concern about the amount of data entered in error and coded incorrectly. Sometimes analysts can identify errors by reviewing a narrative diagram, or other contextual information. Errors are not always identified and corrected and may cause further errors in analysis.

Common errors reported by stakeholders:

- Crashes being incorrectly coded to the nearest intersection, not the actual location of a crash, if a crash is not intersection related.
- Locations being coded incorrectly, for example citing physical objects such as light poles, electrical boxes or plants, instead of specific locations like an address or offset distance from an intersection or mile marker.
- Inaccurate reporting of the direction of vehicle travel.
- Harmful event sequences reported incorrectly.
- Law enforcement is under assuming incapacitating injury at times, and assuming data will be cleaned up later.
- Bicycle and pedestrian crashes are not being coded correctly by some local law enforcement agencies. A local government engineer shared with DRCOG staff that dozens of crash reports for pedestrians turned out to be bicycle crashes upon examining the narratives. The incorrect reports required local government staff to make changes to the back end of its data, and these changes are not reflected in CDOT data for the same crashes.
- Some law enforcement agencies are not completing the non-motorist page of the DR3447 for bicyclist crashes and thus introduce errors into the datasets.

### 4.3.3 Records management systems and data entry

#### *4.3.3.1 Records management system primer*

Each law enforcement agency in the Denver region and the Colorado State Patrol uses a records management system . Some agencies have records management systems with tools law enforcement personnel use to collect data. Others may employ a suite of applications to collect data that is integrated with the records management system. The U.S. Department of Justice provides a definition for records management systems stating:

> "RMS is an agency-wide system that provides for the storage, retrieval, retention, manipulation, archiving, and viewing of information, records, documents, or files pertaining to law enforcement operations.
>
> RMS covers the entire life span of records development— from the initial generation to its completion. An effective RMS allows single entry of data while supporting multiple reporting mechanisms" (Standard Functional Specifications for Law Enforcement Records Management Systems Version II, 2008, ix).

Consortium stakeholders indicated that several records management systems are used across the region including, but not limited to:

- Carfax for Police.
- CentralSquare Records.
- LexisNexis.
- Tyler Technologies New World.
- Niche.
- Versadex.

Records management systems with crash reporting capabilities and other software used by law enforcement agencies guide officers and troopers through the crash reporting process differently from one another. While there is a standard crash report form recognized by the state, the way it is completed using records management applications varies greatly. Some systems display a representation of the crash form itself with fillable boxes for law enforcement to complete, while others guide law enforcement through series of screens and questions to provide crash data. CDOT staff reported that the way various records management and reporting systems guide law enforcement personnel through the process of completing crash reports greatly affects the quality of the data collected. CDOT staff are in the process of developing an electronic reporting system for law enforcement agencies to use to submit crash reports.

#### *4.3.3.2 What stakeholders said:*

- Having everyone in the region using the same records management system would improve data collection consistency.
- Records management systems are often integrated with other systems and law enforcement agencies often have multiyear contracts with their records management system provider. For large agencies it may be incredibly difficult to change their records management system unless the provider were to go out of business.
- The interest of some records management system providers and the way they handle data does not prioritize the elements relevant to traffic safety, engineering and the public interest, but that of data collection that can be sold to the insurance industry.
- Several law enforcement stakeholders reported that their current records management system is not user-friendly on the front end for data input and expressed frustration with the processes and steps required to complete crash reports using their systems.

- Law enforcement stakeholders reported a desire for conditional logic formatting in crash reporting. For example, if a crash involves a motorcycle, conditional logic built into a system could skip asking whether the motorcyclist was wearing a seatbelt. Similarly, officers and users expressed frustration about being asked questions to the effect of whether infants in a vehicle were under the influence of drugs or alcohol.
- Some records management systems have tools that law enforcement analysts can use to analyze trends and map crashes geospatially when coordinates are available.

## 4.4 Data accessibility

Stakeholders indicated several concerns related to the crash data accessibility including questions about where and how to access data, the cost of current tools, and a lack of access to data on shared borders.

### 4.4.1 Where to access crash data

- Stakeholders reported not knowing where to look for data and that data produced outside their organizations can be difficult to find.
- Several local government stakeholders did not know they could access CDOT or DRCOG crash data for their jurisdictions.

### 4.4.2 How to use crash data

- Local government planners said that the CDOT data is not accessible for their use cases.
- Stakeholders suggested raw crash data in database rows and columns is not always useful or insightful to inform user decision-making.
- Stakeholders expressed interest in workshops on ways to use publicly available data like data in DRCOG's Regional Data Catalog.

### 4.4.3 Cost of crash data analysis tools

- Several stakeholders that do not use crash data vendors indicated that they might like to use the vendor's products, but they're prohibitively expensive for them to purchase.
- Some stakeholders are open to cost-sharing for a regional license if it were available for software like Vision Zero Suite or Crash Magic.
- Some stakeholders desire freeware for mapping and analysis.
- Some stakeholders desire a regional tool that can be used for initial analysis for free or at a lower price than software currently offered by vendors.
- One stakeholder shared they would prefer improvements to current software solutions versus purchasing or developing a new product.

### 4.4.4 Borders and cross-jurisdiction challenges

- Crashes may have causes, contributing factors or conditions similar to crashes on the other side of jurisdiction borders, but it can be difficult for local government staff to know what occurs

beyond their own borders because jurisdictions cannot request adjacent county or municipal data from CDOT.

- To help direct patrols around borders, several local law enforcement agencies indicated they desired the integration of data from surrounding jurisdictions.

## 4.5 Discrepancies between datasets

Stakeholders reported that various datasets contain different information.

### 4.5.1 Colorado Department of Transportation fatal records data versus Fatality Analysis Reporting System data

There are inconsistencies reported between CDOT's fatal records and the Fatality Analysis Reporting System. CDOT has several staff who capture information about all fatal crashes in Colorado, but due to the requirement that a fatality must occur within 30 days to be considered for the Fatality Analysis Reporting System, there are instances where the state's numbers will differ from the Fatality Analysis Reporting System. For example, if someone involved in a crash dies because of a crash after 30 days have passed and is not recorded in the Fatality Analysis Reporting System.

Stakeholders also reported discrepancies between the geospatial coordinates in the Fatality Analysis Reporting System for a crash and those reported by the county where the fatality occurred.

### 4.5.2 Local data versus Colorado Department of Transportation data

Some local governments and districts report inconsistencies related to the number of crashes and information about crashes between local records and CDOT. Staff from one local government indicated that their law enforcement had 30% more crashes on record than was documented in CDOT data for a given period.

CDOT has reported that its team of contractors is making updates and corrections to crash data. However, such changes are only made within the CDOT database and does not affect records maintained by the local governments, which can result in different information being available to users depending on which data source they choose. An example of information that may change in CDOT's dataset is the direction of travel of one or more traffic units involved in a crash.

### 4.5.3 Updates don't always happen among datasets

Changes to data which are related to other datasets occur frequently, but the related data is not always updated to reflect changes. Such discrepancies largely occur between law enforcement agency-owned data and the data that has been delivered to the Colorado Department of Revenue and CDOT; and between data from CDOT or law enforcement that has been modified by a crash data vendor.

- Law enforcement agencies may receive information related to a crash after the submission of a crash report to Colorado Department of Revenue. Such information may come from

toxicologists, medical examiners or coroners, and may be discovered during the criminal justice and adjudication process. An example of information that may be discovered after a crash report has been submitted is impairment. If law enforcement personnel submit a crash report without having indicated suspected impairment, but later in the criminal justice process it is determined that drugs or alcohol were a factor, there is no guarantee that the law enforcement agency will file an amended report with this new information. If no amended report is filed with this new information, the official record maintained by the Colorado Department of Revenue, and the records processed by CDOT will be different from the record maintained by the law enforcement agency for the same crash. There will be a discrepancy regarding the suspected impairment between state data and the law enforcement agency's data which could lead to an incomplete understanding of the crash by analysts using CDOT or CDOT derived data.

- According to stakeholders, law enforcement's focus is on the criminal justice element of impairment, not necessarily the traffic safety element caused by potential impairment.
- Some crash data vendors geocode or otherwise geolocate crashes from law enforcement or CDOT data for their clients. Vendors maintain data and one has told DRCOG staff that they make any records that have been geocoded for CDOT data available back to CDOT to integrate into its yearly crash data. CDOT has not fully integrated vendor-geolocated records back into its records. As a result, multiple records representing the same crash in different systems have different values for the coordinates of the crash, so users accessing different datasets derived from a CDOT dataset may be working with different data.

## 4.6 Challenges with data integration

Stakeholders are interested in integrating many types of data to inform engineering, education and enforcement decisions in the Denver region, but it can be challenging to connect crash records with other data sources.

### 4.6.1 Unique identifier

A principal challenge to integrating data is the lack of a clear, unique crash identifier agreed-upon by crash data collectors, managers and analysts. Each law enforcement agency has its own system for assigning an identifier to crash records, and systems can overlap with one another. When such data is aggregated into a centralized system, multiple records might have the same identifier. Some law enforcement agencies begin their records with the year the crash occurred followed by a string representing the order of crashes reported for the year. For example, 202300001, 202300002, 20230003 and so on. If multiple law enforcement agencies use the same method and submit crash reports to a central repository, identifiers may not be unique and can cause analysis problems. CDOT has a system for creating a unique identifier for crashes, but it only occurs on the back end of its system.

### 4.6.2 Direct ways to connect and compare data may not exist

It is likely that many of the additional data sources used or desired by stakeholders such as toxicology, citation, emergency medical services or hospital information will not have a clear way to link to crash

data, even with unique, official identifiers for each crash. Approximations and correlations may be appropriate and the best option in instances where direct connections cannot be made. Data-sharing agreements likely will need to be established among data users and organizations with outside data, and issues of personally identifiable information will likely arise that would require navigation to come to mutually agreeable and legal data sharing.

### 4.6.3 Colorado Department of Public Health and Environment Data linkage projects

The Colorado Department of Public Health and Environment conducted a pilot project attempting to relate injury severity among people involved in crashes and related crash characteristics by linking crash report data from the Colorado Department of Revenue to trauma registry data from the Colorado Trauma Registry. In a study conducted in 2020, the Colorado Department of Public Health and Environment relayed that of the records used in the analysis, "only about a third of the billing records for persons hospitalized after a motor vehicle crash linked to a Crash Report" (Colorado Department of Public Health and Environment, 2020). Colorado Department of Public Health and Environment also related substance use codes in hospital discharge data to motor vehicle crash records, however, due to low linking rates and other concerns, results were released with caveats to drawing strong conclusions from them. The two linkage briefs can be accessed at the Colorado Department of Public Health and Environment website.

# 5. Other relevant information

## 5.1 Law enforcement relationship with other data users

The data used by most stakeholders primarily originates from the data collected by law enforcement. Data users expressed the importance of law enforcement's work and the relationships between law enforcement and other data users and managers, and there are several examples in the Denver region of strong collaboration between engineers and planners and law enforcement worth highlighting. Data users recognized the often dangerous and challenging nature of the work being done by law enforcement to collect the data.

### 5.1.1 Importance of relationships

Data analysis can only be as good as the source data, so high-quality data collection is a critical element of the process. Data users indicated that improving the data must start with law enforcement, and that they would prefer to coordinate more consistently with law enforcement from the start, as data is collected. Some law enforcement agencies and local government data users shared examples of strong working relationships and collaboration. Multiple stakeholders described processes in which engineers and planners work cooperatively with law enforcement or have regular meetings to review crash data and how it applies to both groups' collective work for their jurisdictions. CDOT reported that law enforcement has generally been receptive to feedback from analysts about how to improve the quality of submitted data. Stakeholders also provided examples of less ideal relationships, however, with some jurisdiction staff stating that data from law enforcement is difficult to access, and that some law enforcement agencies are not willing to provide data to other departments within the same jurisdiction.

### 5.1.2 Ensuring law enforcement knows how analysts use crash data

To collaborate effectively and ensure that all parties get what they need from crash data, it is important that all parties know how data is used and why it is collected. Law enforcement stakeholders expressed that officers collect a lot of information that doesn't necessarily mean anything to them, and while they recognize that it's useful to others, officers and troopers may not recognize the importance of capturing all information asked of them. Filling out crash reports can take troopers and officers hours, depending on the level of experience of law enforcement and their specialty within their respective departments. Law enforcement personnel expressed that ever-lengthening police reports present them with challenges, so they recommend contextual consideration of future form changes or ways of making the form easier to complete and more connected to their responsibilities. Some stakeholders suggested that engagement and training opportunities between law enforcement and data users could help both parties better understand each other, the importance of the data to traffic safety and the common problems in crash reporting.

## 5.2 Understaffing and resources of law enforcement agencies

Several law enforcement agencies expressed a lack of capacity and resources to respond effectively to crashes. Some agencies are operating with crash response teams at a third of the capacity necessary, and report that hiring and retaining officers is a challenge as hiring isn't keeping pace with the number of officers leaving for other jobs or retiring. Some agencies reported they also struggle with maintaining minimum required training standards and finding time to meet current state requirements.

# 6. Conclusion

Over the course of federal fiscal year 2023, DRCOG staff engaged with dozens of stakeholders throughout the Denver region and the State of Colorado as a part of its work of investigating and demonstrating the value of a regional crash data consortium to inventory the needs of the region and to identify and address common issues with crash data collection, processing and analysis. DRCOG staff identified multiple sources of crash data used by state and regional stakeholders, various analysis goals related to traffic safety and operations, and challenges with the state's current crash data system leading to issues around crash data accuracy, completeness, timeliness, and the ability to integrate with other data sources. Using the information gathered in this report, DRCOG staff created a Regional Needs Assessment as a companion to this report. The Regional Needs Assessment outlines needs, potential strategies and resources that stakeholders could use to remedy needs, and potential barriers to progress for each need. The potential strategies, resources and barriers are not exhaustive and represent DRCOG staff's current understanding of each need as of the publication of the assessment in early 2024. The needs assessment is intended to lay a foundation and guide consortium activities through federal fiscal year 2024 and beyond.

# Appendix A

The information provided below is based on conversations and survey results with individuals from local jurisdictions including engineers, planners, law enforcement, and geographic information systems managers describing their best understanding of the data sources used through September 27, 2023.

| Name of organization | Type of organization | Total respondents | Uses CDOT data | Uses DRCOG data | Uses law enforcement data | Uses county data | Uses vendor data (vendor or vendors noted) | Uses Fatality Analysis Reporting System data | Uses fire data | Uses emergency medical systems data | Uses other data (source noted) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Adams | County | 3 | Yes | Yes | | | DiExSys | Yes | | | |
| Arapahoe | County | 2 | Yes | Yes | | | DiExSys | | | | |
| Arvada | Municipality | 2 | Yes | Yes | Yes | | | | | | |
| Arvada Fire Protection District | Fire district | 3 | | | | | | | Yes | | |
| Aurora | Municipality | 4 | Yes | Yes | Yes | Yes | DiExSys | | | | |
| Bike Jeffco | Advocacy | 1 | Yes | Yes | | | | | | | |
| Boulder | Municipality | 2 | Yes | | Yes | Yes | Crash Magic | | | | |
| Boulder County | County | 5 | Yes | | | | | | | | |
| Brighton | Municipality | 2 | Yes | Yes | | | | | | | |
| Broomfield | City and County | 3 | Yes | | Yes | | | | | | |
| Castle Pines | Municipality | 1 | Yes | Do not know | | | DiExSys | | | | |
| Castle Rock | Municipality | 3 | Yes | | Yes | | DiExSys | | | | |
| Centennial | Municipality | 4 | Yes | Yes | Yes | Yes | Crash Magic and DiExSys | | | | |
| Colorado Department of Public Health and Environment | State | 7 | Yes | Yes | Yes | | | Yes | | Yes | |
| Colorado State Patrol | State | 3 | Yes | | Yes | | | Yes | | | |

| Name of organization | Type of organization | Total respondents | Uses CDOT data | Uses DRCOG data | Uses law enforcement data | Uses county data | Uses vendor data (vendor or vendors noted) | Uses Fatality Analysis Reporting System data | Uses fire data | Uses emergency medical systems data | Uses other data (source noted) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Colorado Department of Revenue | State | 2 | | | Yes | Yes | Work with multiple vendors | Yes | | | |
| Colorado Department of Transportation | State | 12 | Yes | Yes | Yes | Yes | DiExSys | Yes | | | |
| Commerce City | Municipality | 2 | | | Yes | | | | | | |
| CU Denver | Higher education | 1 | Yes | Yes | Yes | | | Yes | | | |
| Cyclists 4 Community | Advocacy | 1 | Yes | Yes | Yes | Yes | Undisclosed | | | | |
| Denver | City and County | 5 | Yes | Yes | Yes | Yes | DiExSys | | | | |
| DiExSys Road Safety Analytics | Vendor | 2 | Yes | | Yes | | N/A (produces DiExSys/Vision Zero Suite) | Yes | | | |
| Douglas | County | 3 | Yes | | Yes | | Crash Magic and DiExSys | | | | |
| Edgewater | Municipality | 1 | Yes | | | | DiExSys | | | | |
| E.E. (individual) | Consultant | 1 | | | Yes | | | | | | |
| Erie | Municipality | 1 | | | Yes | | | | | | |
| Federal Highway Administration | Federal | 2 | Yes | Yes | Yes | | | Yes | | | |
| Federal Motor Carrier Safety Administration | Federal | 3 | Yes | | | | | | | | National High Traffic Safety Administration |
| Fort Collins | Municipality | 1 | Yes | | Yes | | | | | | North Front Range |

| Name of organization | Type of organization | Total respondents | Uses CDOT data | Uses DRCOG data | Uses law enforcement data | Uses county data | Uses vendor data (vendor or vendors noted) | Uses Fatality Analysis Reporting System data | Uses fire data | Uses emergency medical systems data | Uses other data (source noted) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | Metropolitan Planning Organization |
| Fox Tuttle Transportation Group | Consultant | 1 | Yes | Yes | Yes | | | | | | |
| Foxfield | Municipality | 2 | | | Yes | Yes | | | | | |
| Greenwood Village | Municipality | 2 | Yes | | Yes | | DiExSys | | | | |
| Grand Valley Metropolitan Planning Organization | Metropolitan planning organization | 1 | Yes | | | | | | | | |
| Jefferson | County | 2 | Yes | | | | DiExSys | | | | |
| J.H. (individual) | Consultant | 1 | | | | | | | | | |
| Lafayette | Municipality | 1 | Yes | | Yes | | Crash Magic | | | | |
| Lakewood | Municipality | 4 | Yes | | Yes | | DiExSys | | | | |
| Lakewood Advisory Committee | Advocacy | 1 | | | | | | | | | |
| Littleton | Municipality | 1 | | | Yes | Yes | Crash Magic | | | | |
| Lone Tree | Municipality | 2 | Yes | | Yes | | | | | | |
| Longmont | Municipality | 3 | Yes | | Yes | | Crash Magic | | | | |
| Lyons | Municipality | 1 | Yes | | | Yes | | | | | |
| Mead | Municipality | 1 | | | Yes | Yes | Carfax for Police | | | | |
| Michael Baker International | Consultant | 1 | Yes | | Yes | | | | | | |

| Name of organization | Type of organization | Total respondents | Uses CDOT data | Uses DRCOG data | Uses law enforcement data | Uses county data | Uses vendor data (vendor or vendors noted) | Uses Fatality Analysis Reporting System data | Uses fire data | Uses emergency medical systems data | Uses other data (source noted) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Muller Engineering Company | Consultant | 1 | Yes | Yes | | | | | | | |
| National Highway Traffic Safety Administration | Federal | 1 | Yes | | Yes | | | | | | |
| North Front Range Metropolitan Planning Organization | Metropolitan planning organization | 1 | Yes | | | | | | | | |
| Northglenn | Municipality | 1 | | | Yes | | | | | | |
| Northwest Parkway LLC | Tollway | 1 | Yes | | Yes | | | | | | |
| Parker | Municipality | 1 | Yes | | Yes | | | Yes | | | |
| Pd' Programming | Vendor | 1 | Yes | | Yes | | N/A (producer of Crash Magic | | | | |
| Pikes Peak Area Council of Governments | Metropolitan planning organization | 1 | Yes | | | | | | | | |
| Populus | Consultant | 1 | | | | | | | | | |
| Rocky Mountain Collegiate Cycling Conference | Advocacy | 1 | | | | | | | | | |

| Name of organization | Type of organization | Total respondents | Uses CDOT data | Uses DRCOG data | Uses law enforcement data | Uses county data | Uses vendor data (vendor or vendors noted) | Uses Fatality Analysis Reporting System data | Uses fire data | Uses emergency medical systems data | Uses other data (source noted) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Regional Transportation District | Transit agency | 1 | Yes | Yes | Yes | | | | | | |
| Sheridan | Municipality | 3 | | Yes | Yes | | Carfax for Police | Yes | | | |
| South Metro Fire Rescue and South Metro Safety Foundation | Fire district | 3 | Yes | Yes | | | | | Yes | | |
| Stolfus and Associates | Consultant | 1 | Yes | | Yes | | | | | | |
| Superior | Municipality | 1 | | | Yes | Yes | | | | | |
| The Innova Group | Consultant | 1 | | | | | | | | | Undisclosed |
| Thornton | Municipality | 4 | Yes | Yes | Yes | | | Yes | Yes | | |
| University of Maryland Baltimore | Higher education | 1 | | | | | | | | | |
| Weld | County | 2 | Yes | | Yes | | DiExSys | | | | |
| Westminster | Municipality | 1 | Yes | Yes | Yes | | | | | | |
| Wheat Ridge | Municipality | 1 | | | Yes | | Crash Magic | | | | |

## Appendix B

The information provided below is based on conversations and survey results with individuals from local jurisdictions including engineers, planners, law enforcement, and geographic information systems managers describing their best understanding of how location is reported for their jurisdiction's crash reports through September 27, 2023.

| Jurisdiction or agency | At least one conversation with DRCOG staff | Police reports consistently have geospatial coordinates | Reported methods of location on reports | Records management system | Agency that provides law enforcement | Use law enforcement and CDOT data | Notes |
|---|---|---|---|---|---|---|---|
| Arvada | Yes | No | Intersection and offset, block | | Arvada Police Department | Yes | |
| Aurora | Yes | Sometimes | Nearest biggest intersection, latitude and longitude | Versadex | Aurora Police Department | Yes | Traffic engineers say reports are not great about having coordinates, and that the coordinates are not always exactly at the crash site |
| Boulder | Yes | Yes | Intersection and offset, latitude and longitude | | Boulder Police Department | Yes | Original latitude and longitude recorded from where dispatch picks up signal; engineers use geospatial data calculated from vendor |
| Brighton | No | | | | Brighton Police Department | | |
| Broomfield | No | Yes | | | Broomfield Police Department | Yes | Public Works reports there are issues with latitude and longitude |
| Castle Pines | No | Yes | Intersection and Offset | | Douglas County Sheriff's Office | No | Computer aided dispatch populates latitude and longitude |
| Castle Rock | No | | | | Castle Rock Police Department | Yes | |
| Centennial | No | | | | Arapahoe County Sheriff's Office | Yes | |
| Colorado State Patrol | Yes | Sometimes | Mile marker | Niche | | Yes | Troopers need to manually key in coordinates |

| Jurisdiction or agency | At least one conversation with DRCOG staff | Police reports consistently have geospatial coordinates | Reported methods of location on reports | Records management system | Agency that provides law enforcement | Use law enforcement and CDOT data | Notes |
|---|---|---|---|---|---|---|---|
| Commerce City | Yes | No | Intersection and offset | | Commerce City Police Department | No | Some coordinates calculated through records management system |
| Denver | Yes | Yes | | Versadex | Denver Police Department | Yes | Coordinates come from computer-aided dispatch based on preprogrammed addresses, not captured on scene; if unrecognized, left blank |
| Douglas County Sheriff's Office | Yes | Sometimes | Intersection and offset | Tyler Technologies' New World | Douglas County Sheriff's Office | No | Computer-aided dispatch populates latitude and longitude; Public Works geocodes the intersection and offset for their work |
| Edgewater | No | | | | Edgewater Police Department | No | |
| Erie | Yes | No | Intersection, address | | Erie Police Department | No | |
| Fort Collins (non-DRCOG) | No | | | | Fort Collins Police Services | Yes | |
| Foxfield | Yes | | | | Arapahoe County Sheriff's Office | No | |
| Greenwood Village | Yes | Sometimes | Intersection and offset | | Greenwood Village Police Department | Yes | Depends on the officer responding, no standard for location |
| Lafayette | Yes | No | Nearest intersection | | Lafayette Police Department | Yes | |
| Lakewood | Yes | Yes | Intersection and offset | Niche | Lakewood Police Department | Yes | Engineers would like more coordinates |

| Jurisdiction or agency | At least one conversation with DRCOG staff | Police reports consistently have geospatial coordinates | Reported methods of location on reports | Records management system | Agency that provides law enforcement | Use law enforcement and CDOT data | Notes |
|---|---|---|---|---|---|---|---|
| | | | | | | | captured; officers need to manually key in latitude and longitude |
| Littleton | Yes | Yes | | | Littleton Police Department | No | |
| Lone Tree | No | | | | Lone Tree Police Department | Yes | |
| Longmont | Yes | No | Intersection and offset | | Longmont Police Department | Yes | |
| Lyons | Yes | | | | Boulder County Sheriff's Office | No | |
| Mead | Yes | Sometimes | Address, mile marker | Carfax for Police | Mead Police Department | No | Latitude and longitude have not been established as requirements for the department, typically do a physical address or mile maker—but is collected in the records management system at times, likely from where the car is parked |
| Northglenn | Yes | Yes | Intersection and offset, address | TriTech | Northglenn Police Department | No | Analyst reports coordinates seem to be auto geocoded from address |
| Parker | Yes | Yes | | | Parker Police Department | Yes | |
| Sheridan | Yes | Yes | Intersection, block | Carfax for Police | Sheridan Police Department | No | |
| Superior | Yes | | | | Boulder County Sheriff's Office | No | Engineer reports relying on location in crash |

| Jurisdiction or agency | At least one conversation with DRCOG staff | Police reports consistently have geospatial coordinates | Reported methods of location on reports | Records management system | Agency that provides law enforcement | Use law enforcement and CDOT data | Notes |
|---|---|---|---|---|---|---|---|
| | | | | | | | description not latitude and longitude |
| Thornton | Yes | Yes | Intersection and offset, latitude and longitude | LexisNexis | Thornton Police Department | Yes | Reports generally have latitude and longitude, but the accuracy is considered suspect |
| Westminster | Yes | Yes | Intersection and offset, latitude and longitude | CentralSquare Records | Westminster Police Department | Yes | Records management system auto populates latitude and longitude |
| Wheat Ridge | Yes | Sometimes | Intersection and offset, address | | Wheat Ridge Police Department | No | Often just by street address |