Denver Regional Council of Governments

Report on Traffic Safety in the Denver Region

October 2011

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Visit these agency websites for more information:

Colorado Department of Transportation: www.dot.state.co.us

National Highway Traffic Safety Administration: www.nhtsa.gov

Fatality Analysis Reporting System: http://www-fars.nhtsa.dot.gov

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1. INTRODUCTION

A. Background and Purpose

Traffic crashes represent a major safety problem worldwide. In the United States, traffic crashes are the leading cause of death for those ages eight to 34 (NHTSA, 2007). In the Denver region, there are about 220 **reported** traffic crashes per day. Tragically, these crashes result in about 70 injured persons per day and four traffic fatalities per week. These crashes incur a large cost in terms of property damage, medical costs, lost productivity, and the pain and suffering associated with an injury or fatal crash. According to the National Safety Council (2009), the average cost per crash is:

- $1,290,000 per fatality,
- $68,100 per disabling injury, and
- $8,200 per property damage crash.

The purpose of this report is to describe traffic safety issues and conditions within the Denver region and to provide information on crash mitigation strategies.

This report is a follow-up to the 2003 Denver Regional Council of Governments (DRCOG) report, *Overview of Traffic Safety in the Denver Region*. The 2003 report should be used as a resource for information on general traffic safety issues, regional traffic safety programs, and basic techniques for measuring and improving roadway safety. It can be found on the publications page of DRCOG's website at http://www.drcog.org/index.cfm?page=PublicationsForTransportation.

B. Report Structure

This report is divided into eight sections following the introduction, including:

- Regional traffic crash trends,
- Crash demographics,
- Crash characteristics (e.g., crash causes and time of day),
- Specific crash types (e.g., bicycle and pedestrian crashes),
- High-risk behavior crashes,
- Identification of crash hot spots within the region,
- Other safety efforts, and
- Summary of findings.

Beyond this report, additional crash data can be accessed on the DRCOG Traffic Safety website (www.drcog.org/TrafficSafety). The Traffic Safety website is a dynamic resource for regional crash data, updated as new data becomes available.

C. Notes on Crash Data

Crash data is dynamic in nature, as reporting procedures change and errors are found. The crash data used in this report is the latest available from the Colorado Department of Transportation (CDOT), and dates from 2006. The majority of the charts and figures presented in this report only reflect crash data through 2006. Information on the causes and nature of fatal crashes occurring through 2009 was obtained from the National Highway Traffic Safety Administration's Fatality Analysis Reporting System.

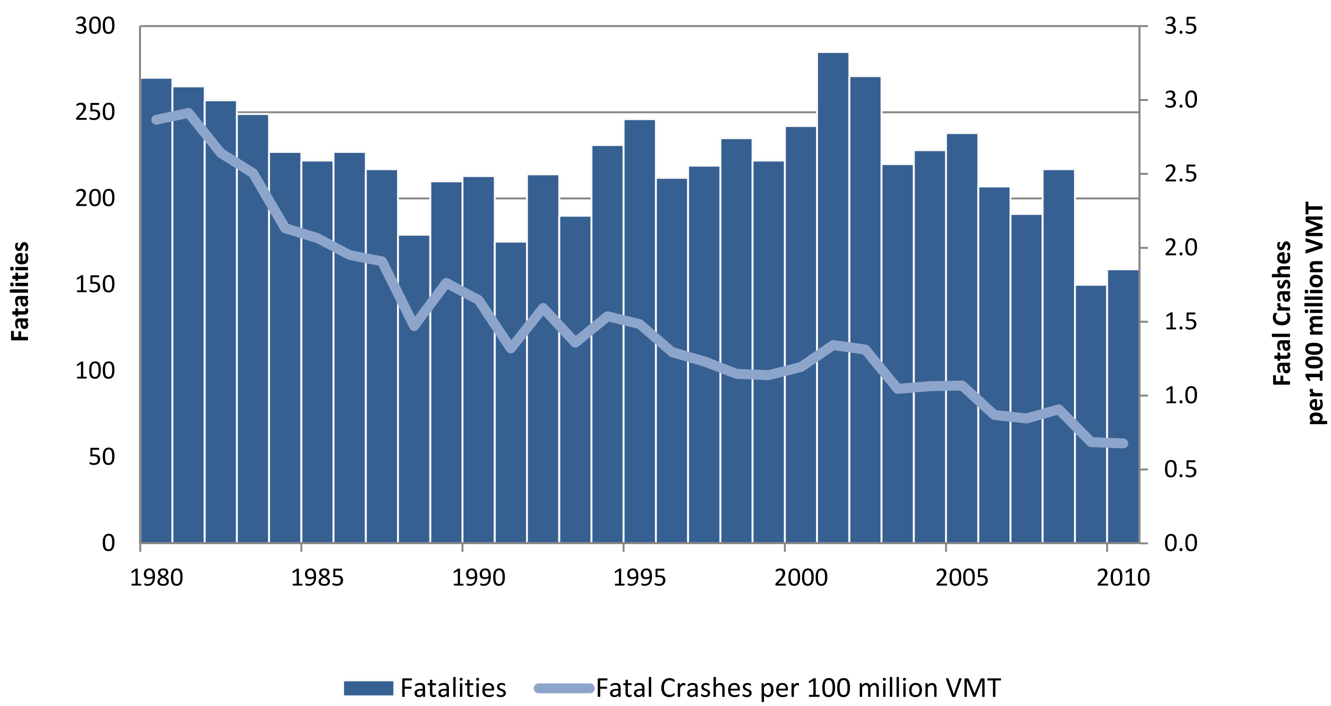
2. DENVER REGION CRASH DATA

A. Traffic Fatality Trends

The region's safety goal is to reduce the fatal crash rate to 0.60 per 100 million VMT by 2035.

The number of traffic fatalities in the Denver region reached a three-decade low in 2009. Between 2001 and 2010, the number of traffic fatalities decreased by 34 percent. Regardless, even one traffic fatality is too many. DRCOG has set a goal of reducing the fatal crash rate to 0.60 per 100 million vehicle miles traveled (VMT) by 2035 (0.68 in 2010). The chart below shows regional traffic fatalities and the fatal crash rate per 100 million VMT from 1980 to 2010. The fatal crash rate has decreased from 2.87 to 0.68 in the last 30 years.

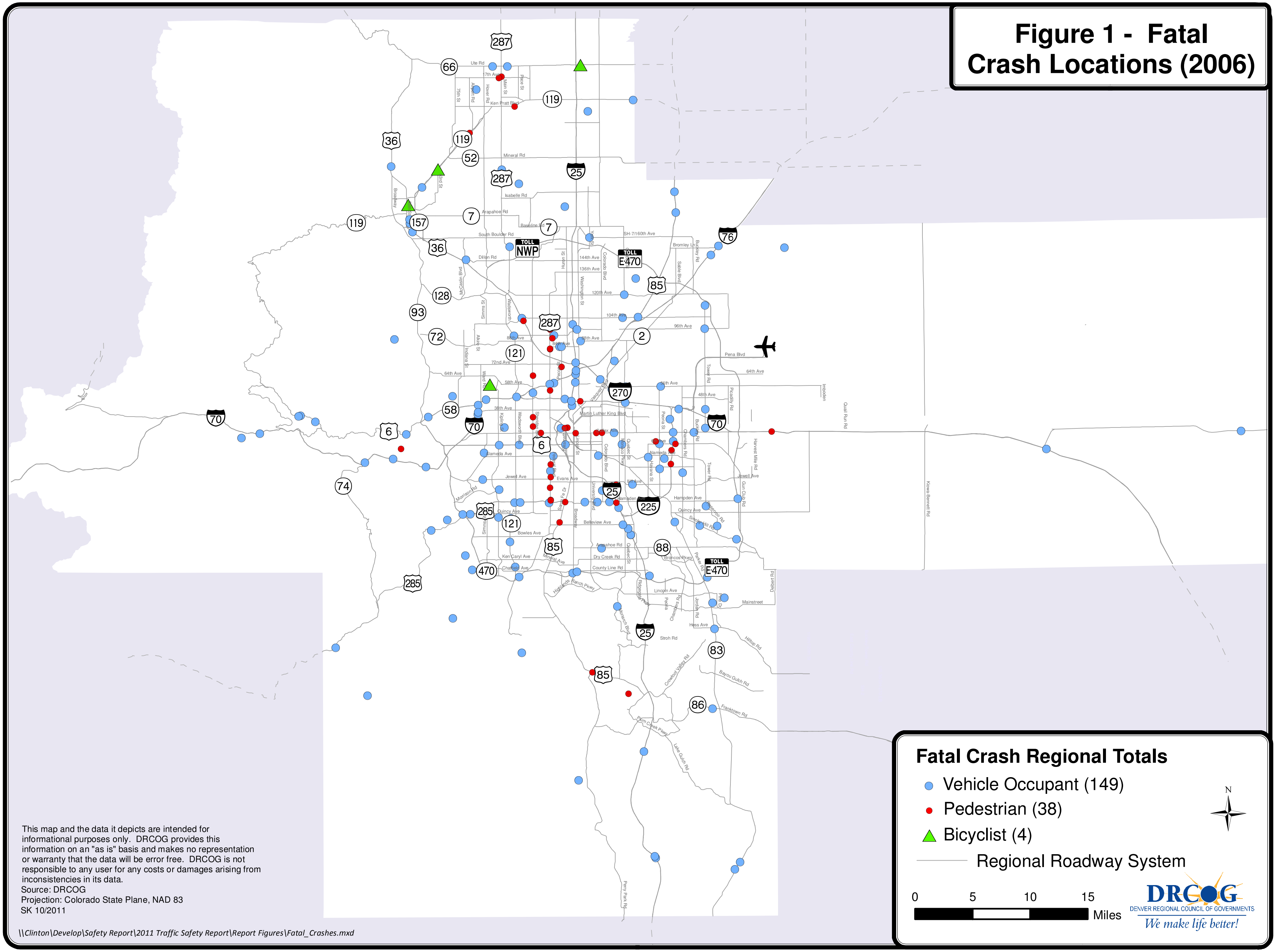
Traffic Fatalities and Fatal Crash Rate in the Denver Region (1980-2010)



Several factors have contributed to the reduction in traffic fatalities. Improvements in vehicle safety design (e.g., increased prevalence of front and side airbags) and phasing out older vehicles from the motor vehicle fleet have played a critical role, as has increased seat belt use. According to CDOT, overall seat belt use in Colorado rose from 50 percent to 83 percent between 1990 and 2010. Education and enforcement efforts have drastically reduced the occurrence of impaired driving fatal crashes. In the Denver region, impaired-driving fatal crashes dropped by 71 percent between 2004 and 2010 (from 103 to 30 fatal crashes per year). Improvements in emergency response and medical care technology have also helped to reduce traffic fatalities. Finally, better roads and traffic safety projects have improved roadway safety over the last 30 years.

Figure 1 shows a map of fatal crash locations in 2006. The figure shows that traffic fatalities are scattered throughout the region and occur on all types of roadway facilities. In 2005 and 2006, 23 percent of fatal crashes occurred on freeways.

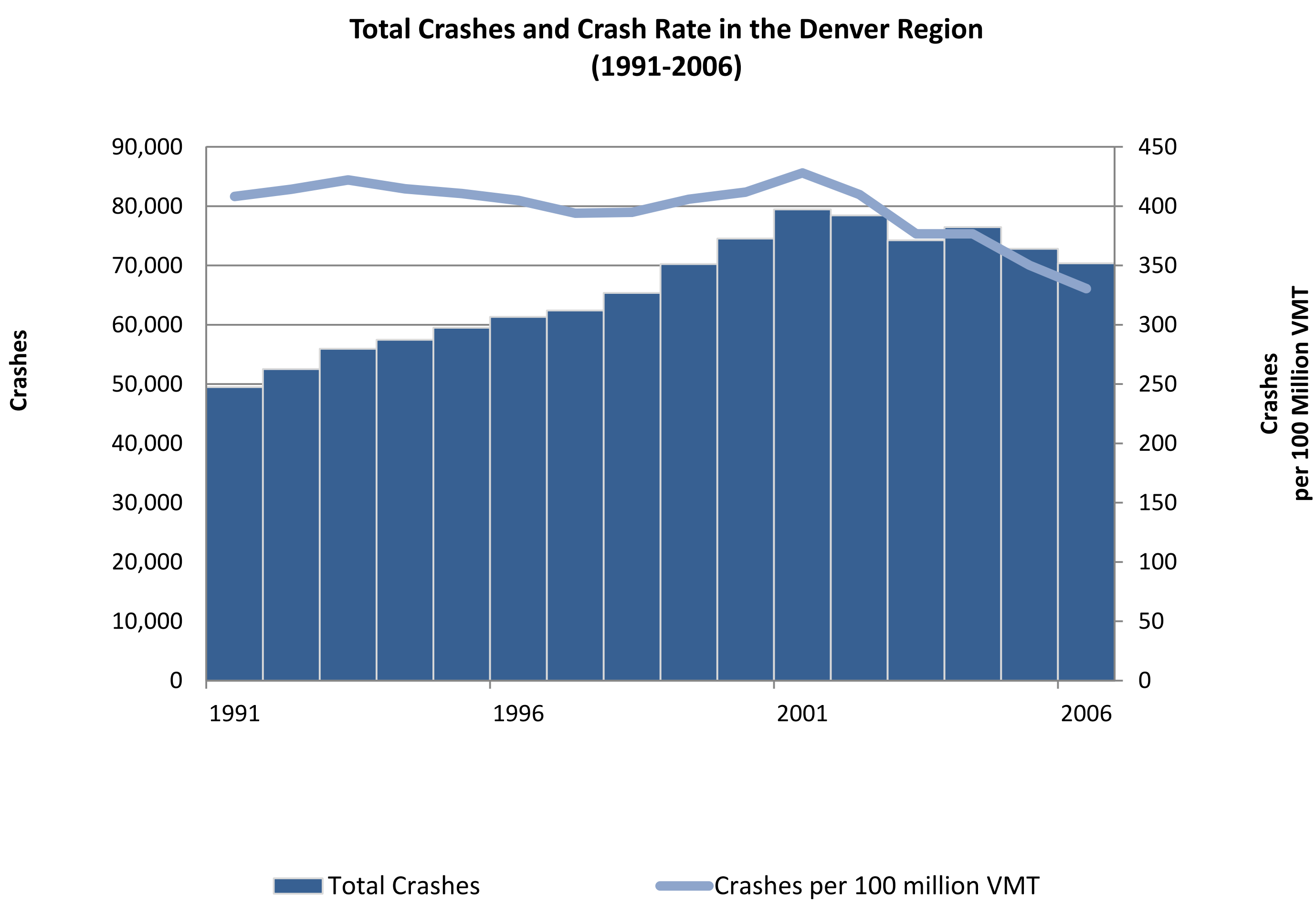
Figure 1 - Fatal Crash Locations (2006)



B. Total Traffic Crash Trends

The number of reported crashes in the region increased from about 50,000 to 70,000 crashes per year between 1991 and 2006. The increase in crashes is primarily due to growth in VMT and partly due to increased congestion. As shown in the chart below, the crash rate per 100 million VMT remained about the same between 1991 and 2001, but steadily declined between 2001 and 2006. The overall crash data shown in this report does not include unreported traffic crashes. The National Highway Traffic Safety Administration (NHTSA) estimates that only half of all crashes are reported to the police.

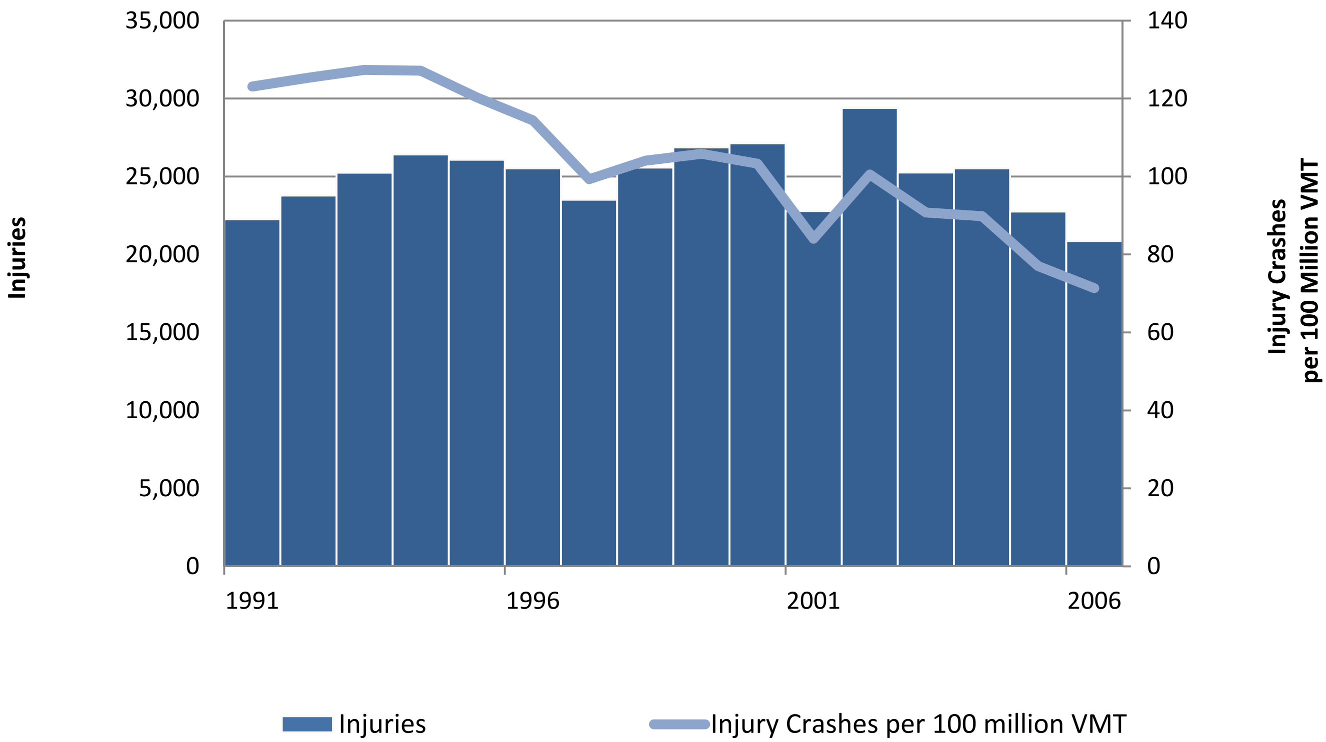
The overall crash data shown in this report does not include unreported crashes.



C. Injury Trends

The number of people injured in traffic crashes has fluctuated, ranging between 20,000 and 30,000 injuries per year between 1991 and 2006. Between 2004 and 2006, about one in every five crashes resulted in an injured person. As shown in the chart below, the number of injuries per 100 million VMT is trending downward. DRCOG has set a goal of reducing the injury crash rate to 55 per 100 million VMT by 2035 (71 in 2006). It should be noted that “possible injury” and “complaint of injury” is included in the total number of injuries. An average of 1,800 severe, incapacitating injures occurred per year between 2004 and 2006.

Injuries and Injury Crash Rate in the Denver Region (1991-2006)



D. Crash Data by Jurisdiction

Table 1 and Figure 2 show 2006 crash data by jurisdiction in the Denver region.

Table 1. Crashes by Jurisdiction in the Denver Region (2006)

	Population	Total Crashes	Injuries	Fatalities	Pedestrian Crashes	Bicycle Crashes
Arvada	104,906	1,813	457	3	25	25
Aurora	307,623	7,108	2,589	20	142	89
Bennett	2,347	14	1	0	0	0
Black Hawk	110	40	14	0	0	0
Boulder	98,396	2,428	773	4	30	99
Bow Mar	817	7	0	0	0	0
Brighton	30,167	672	139	2	12	5
Broomfield – City & County	51,454	1,188	334	0	6	12
Castle Rock	40,610	615	126	1	1	4
Centennial	100,073	1,248	392	3	12	11
Central City	521	68	13	0	0	0
Cherry Hills Village	6,131	270	47	0	0	2
Columbine Valley	1,250	22	10	0	0	1
Commerce City	35,432	930	245	5	8	4
Dacono	3,751	31	7	0	0	0
Deer Trail	572	5	1	0	0	0
Denver – City & County	585,026	22,987	6,027	35	408	209
Edgewater	5,260	66	21	1	3	1
Empire	391	0	0	0	0	0
Englewood	32,199	907	183	2	21	14
Erie	13,478	82	40	1	0	0
Federal Heights	11,787	226	55	6	7	1
Firestone	7,117	51	21	1	2	0
Foxfield	778	11	4	0	0	0
Frederick	7,354	90	17	0	0	0
Georgetown	1,101	5	4	0	0	0
Glendale	4,743	226	54	0	8	3
Golden	17,664	464	108	1	6	7
Greenwood Village	13,482	1,007	335	4	7	7
Idaho Springs	1,811	127	34	4	1	1
Lafayette	24,498	433	118	1	2	8
Lakeside	20	40	19	0	1	0
Lakewood	142,432	3,620	912	8	64	56
Larkspur	258	6	1	0	0	0
Littleton	40,226	925	209	1	23	9
Lonetree	9,218	865	146	0	0	2
Longmont	83,520	1,998	601	4	21	33
Louisville	18,715	313	87	1	1	3
Lyons	1,760	18	17	0	0	0
Mead	2,875	30	10	0	1	0
Morrison	416	43	9	0	0	1
Mountain View	540	5	2	0	0	0
Nederland	1,462	0	0	0	0	0
Northglenn	35,636	947	175	1	10	4
Parker	41,066	764	123	1	7	3
Sheridan	5,398	445	83	5	5	2
Silver Plume	199	1	0	0	0	0
Superior	10,248	125	30	0	0	1
Thornton	109,468	2,198	473	3	14	13
Westminster	106,680	2,163	689	6	27	14
Wheat Ridge	31,550	1,281	476	5	21	7
Unincorp. Adams County	84,184	2,840	1,115	15	29	12
Unincorp. Arapahoe	72,051	1,270	598	9	16	12
Unincorp. Boulder County	45,183	1,232	599	7	4	20
Unincorp. Clear Creek	5,876	676	245	3	1	2
Unincorp. Douglas County	171,936	2,612	1,046	19	10	12
Unincorp. Gilpin County	4,478	117	77	3	0	0
Unincorp. Jefferson	186,741	2,960	1,049	23	14	26
Unincorp. SW Weld County	21,959	653	281	5	3	1
DRCOG REGION TOTAL	**2,744,944**	**71,288**	**21,241**	**213**	**973**	**736**

Note: Population obtained from State Demography Office (2006); population for Unincorporated SW Weld is an estimate.

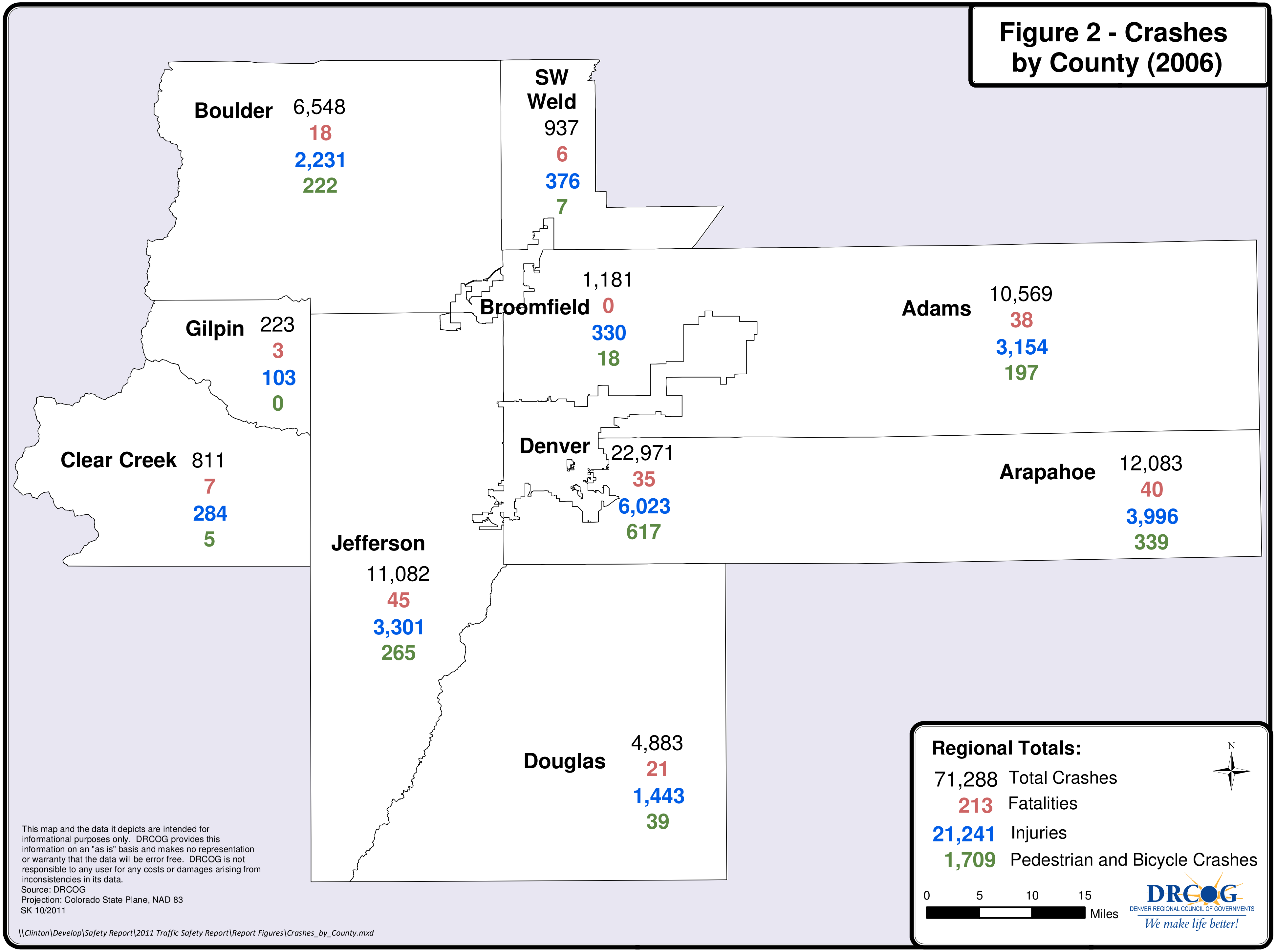


Figure 2 - Crashes by County (2006)
Boulder 6,548 18 2,231 222
SW Weld 937 6 376 7
Gilpin 223 3 103 0
Clear Creek 811 7 284 5
Broomfield 1,181 0 330 18
Adams 10,569 38 3,154 197
Denver 22,971 35 6,023 617
Arapahoe 12,083 40 3,996 339
Jefferson 11,082 45 3,301 265
Douglas 4,883 21 1,443 39
Regional Totals:
71,288 Total Crashes
213 Fatalities
21,241 Injuries
1,709 Pedestrian and Bicycle Crashes
0 5 10 15 Miles
N
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Source: DRCOG
Projection: Colorado State Plane, NAD 83
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E. Comparison of Crash Data to Other Regions

Table 2 compares Denver region crash data to peer metropolitan areas in the United States. The overall crash rate depends somewhat on the area's crash record-keeping procedures. Some areas will keep all reported crash records, where as others will only keep those which incur a minimum amount of property damage or injury/death. The Denver region had the second lowest injury rate compared to the 10 peer metropolitan areas. The Denver region ranks in the middle for fatality rate. The fatality rate is the most reliable metric for crash comparison across metropolitan areas.

Table 2. Traffic Crash Comparison to Peer Metropolitan Areas (2006)

Metropolitan Area	Population	Crashes* per 100,000 population	Injuries per 100,000 population	Fatalities per 100,000 population
Minneapolis	2,766,951	1,640	698	5.1
Portland	1,569,953	1,365	854	6.8
Cleveland	2,114,155	2,534	964	7.0
Salt Lake City	1,529,673	2,307	1,126	7.3
Seattle	3,504,101	2,322	1,092	7.6
Denver	2,744,944	2,597	774	7.8
Baltimore	2,612,164	2,000	n/a	9.4
Miami	2,402,208	1,773	1,292	14.3
Phoenix	3,768,123	2,499	1,204	15.0
Tampa	2,845,620	1,690	1,488	16.3
Orlando	1,694,420	1,382	1,210	16.9

***Note the overall crash rate should not be compared across metropolitan areas, due to differences in crash reporting procedures.** Sources: Total crash and injury data obtained from Colorado DOT, Ohio Dept. of Public Safety, Arizona DOT, Washington State DOT, Maryland DOT, Utah Dept. of Public Safety, Florida Dept. of Highway Safety and Motor Vehicles, Oregon DOT, Minnesota Dept. of Public Safety. Fatality data obtained from FARS. Population data from 2006 American Community Survey.

3. DEMOGRAPHICS OF PERSONS INVOLVED IN CRASHES

Crashes were analyzed by the age and gender of the drivers, pedestrians, and bicyclists involved. The term "involvement in a crash" does not imply the person was at fault. Table 3 shows crash involvement statistics by age and gender based on data from 2004 to 2006.

Table 3. Crash Involvement Demographics (2004-2006)

Age Group	Gender	Portion of Involvement in All Crashes	Portion of Involvement in Fatal Crashes	Portion of Regional Vehicle Miles Driven*	Portion of Regional Population
0-14	M	0%	1%	0%	11%
	F	0%	0%	0%	10%
15-24	M	15%	19%	7%	7%
	F	11%	7%	6%	7%
25-34	M	14%	17%	11%	7%
	F	9%	6%	9%	7%
35-44	M	12%	14%	13%	8%
	F	8%	4%	12%	8%
45-54	M	10%	12%	12%	8%
	F	7%	4%	11%	8%
55-64	M	5%	7%	6%	5%
	F	4%	3%	5%	5%
65-74	M	2%	3%	3%	2%
	F	1%	1%	3%	3%
75+	M	1%	2%	1%	2%
	F	1%	1%	2%	3%
Total	M	58%	74%	52%	50%
	F	42%	26%	48%	50%

***Notes: Vehicle miles driven is for an average weekday (Source: DRCOG Travel Model, 2010). Excludes commercial vehicle travel, trips leaving the region, and trips passing through the region.**

74% of the drivers involved in fatal crashes were male.

Table 3 shows that 74 percent of persons involved in fatal crashes were male. Young male drivers, in particular, made up a large portion of involvement in fatal crashes. Males age 15 to 44 made up 50 percent of all persons involved in fatal crashes, but only 31 percent of all vehicle miles driven. This same demographic also had the highest involvement in all crashes.

In 2010, CDOT found that one in every five licensed 16-year-olds was involved in a crash. Teen drivers are a high-risk crash demographic primarily because they lack driving experience.

Teen Driver Education and Enforcement Efforts

Several efforts have been made in Colorado to reduce teen involvement in crashes. The Graduated Drivers License (GDL) laws were initiated in 1999. The laws aim to reduce teen crashes by limiting the number of distractions present during the first years of learning to drive. Under the GDL laws, teens are given a Restricted Drivers License until age 18. The restricted license prohibits passengers under age 21 for the first six months, and then allows only one passenger under 21 until the end of the first year. The laws also prohibit cell phone use by drivers under age 18. For full information on GDL laws, visit www.coteendriver.com.

4. CRASH CHARACTERISTICS

A. Crash Types

Table 4 shows the distribution of crash types. The majority of crashes (70 percent) occur between two or more moving motor vehicles. About 16 percent of crashes occur with a fixed object. Among crashes occurring between moving motor vehicles, half are rear-end collisions and 28 percent are broadside collisions (i.e., a front to side impact).

Table 4. Crash Types (2004-2006)

Crash Type (2004-2006)	
Moving motor vehicle	70%
Fixed object (e.g., light pole)	16%
Parked vehicle, train, or bicycle	8%
Rollover or non-collision	4%
Pedestrian	1%
Animal	1%
Total	100%

Collisions between Moving Vehicles (2006)	
Front to rear	50%
Front to side	28%
Sideswipe - same direction	16%
Front to front	4%
Sideswipe - opposite direction	2%
Rear to side or Rear to rear	0.5%
Total	100%

Half of all crashes between moving vehicles are rear-end collisions.

B. Crash Conditions

Table 5 shows the prevailing light and weather conditions during the crash. The majority of crashes occur during daylight, as 75 percent of driving occurs during this time. Crashes occurring during snowy weather make up 6 percent of all reported crashes. For snowy weather crashes in particular, many crashes are unreported.

Table 5. Prevailing Conditions at Time of Crash (2004-2006)

Lighting	**% of Crashes**	**% of VMT**
Daylight	70%	75%
Dark	26%	16%
Dawn or dusk	4%	8%
Total	100%	100%

Weather	**% of Crashes**
No adverse weather	88%
Snow, sleet, or hail	6%
Rain	5%
Fog, dust, or wind	1%
Total	100%

Notes: Daylight hours defined as 7am-7pm, dawn and dusk defined as 6-7am and 7-8pm, based on annual average sunrise and sunset times.

C. Crash Causes

Table 6 shows the causes of traffic crashes, based on the responding police officer's opinion of the driver actions, which led to the crash. A causal factor was given in 72 percent of traffic crashes. Careless driving was the most common causal factor. Next were following too close and turning left into oncoming traffic.

CDOT estimates 85 percent of crashes occur due to improper driver behavior. The remaining 15 percent of crashes occur due to conditions out of the driver's control.

43% of traffic crashes are attributed to careless driving.

Table 6. Causes of Traffic Crashes (2004-2006)

Causal Factor	Persons At-Fault	
Careless driving	69,327	43%
Following too close	23,529	15%
Turn left into coming traffic	12,391	8%
Violation of red traffic signal	7,449	5%
Unsafe lane change	6,585	4%
Unsafe backing	4,277	3%
Fail to yield to ROW at stop sign	3,989	2%
Driving under the influence of alcohol	3,723	2%
Too fast for conditions or speeding	3,470	2%
All other causal factors	26,549	16%
Total persons at-fault	**161,289**	**100%**
Total Crashes	220,277	
Crashes with one or more person at-fault	158,360	72%

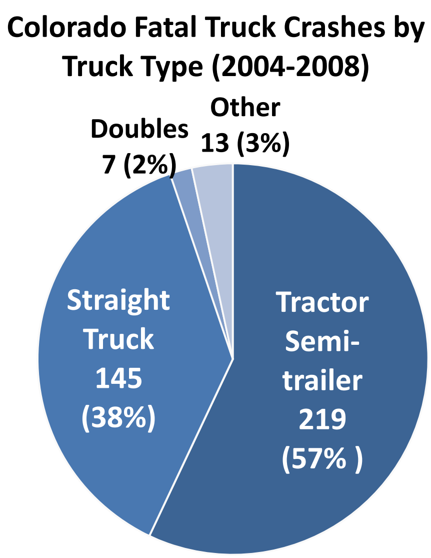
5. SPECIFIC CRASH TYPES

A. Truck Crashes

The truck driver was assigned a violation in 49% of truck crashes.

The crash database classifies a truck as a vehicle with a gross weight greater than 10,000 pounds. As a point of reference, a Ford F350 pickup marks the bottom end of the weight threshold. In 2006 there were 3,600 truck crashes in the Denver region, resulting in 900 injuries and 14 fatalities. Between 1991 and 2006, the number of annual truck crashes more than doubled (120 percent increase), while non-truck crashes increased by only 40 percent over the same period.

There were 384 fatal truck crashes in the state of Colorado between 2004 and 2008 (Center for National Truck and Bus Statistics). When analyzed by truck type, 219 of the fatal truck crashes in Colorado (57 percent) involved a tractor semi-trailer.



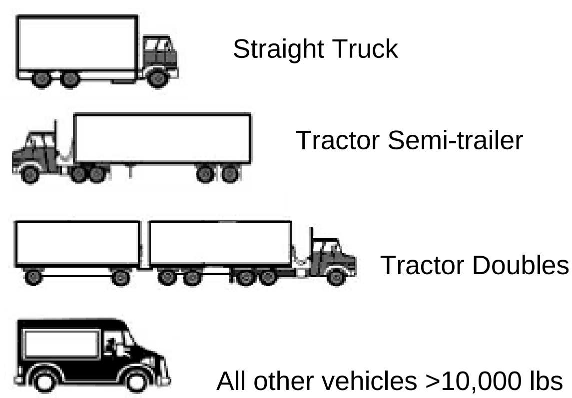


Table 7 shows the number of truck crashes by driver assigned a violation (based on the responding police officer's opinion of the driver actions, which led to the crash). No violations were specified in 24 percent of crashes. Truck drivers were the only violator in 49 percent of crashes. These results indicate that truck drivers are more often at fault than passenger-car drivers.

Table 7. Violations Assigned in Truck Crashes (2006)

At-Fault	Crashes	% of Total Crashes	% of At-Fault Crashes
Truck	1,756	49%	63%
Other vehicle	960	27%	35%
Both drivers	39	1%	1%
Pedestrian or bicyclist	12	0.3%	0.4%
No fault specified	851	24%	**100%**
Total crashes	**3,618**	**100%**	

Table 8 shows the causes of traffic crashes when the truck driver was assigned a violation. Similar to the causal factors in all crashes (see Table 6), careless driving was the most noted truck driver action. Unsafe lane changing was the second most common truck driver action, occurring more often in truck crashes compared to all crashes (11 percent of truck driver actions compared to 4 percent of all driver actions, see Table 6).

Table 8. Causes of Traffic Crashes when Truck Driver Assigned a Violation (2006)

Causal Factor	Crashes	
Careless driving	676	38%
Unsafe lane change	197	11%
Following too close	167	9%
Unsafe backing	149	8%
Fail to drive in designated lane	58	3%
Left turn into oncoming traffic	57	3%
Left turn from wrong lane	51	3%
Spill load on highway	45	3%
Right turn from wrong lane	33	2%
Defective or unsafe vehicle	27	2%
All other causes	340	19%
Total	***1,800***	***100%***

Figure 3 shows the location of truck crashes in 2006.

Truck Crash Mitigation

The Colorado State Patrol campaign, *Ticketing Aggressive Cars and Trucks (TACT)*, was launched in 2010 and aims to reduce crashes between passenger cars and trucks. The campaign raises awareness of truck blind spots and tickets motorists for driving aggressively around trucks (e.g., speeding, following too close, or improper lane changing). For more information on the TACT campaign visit: www.givetrucksmoreroom.com. The diagram below, featured in the campaign brochure, highlights truck blind spots.

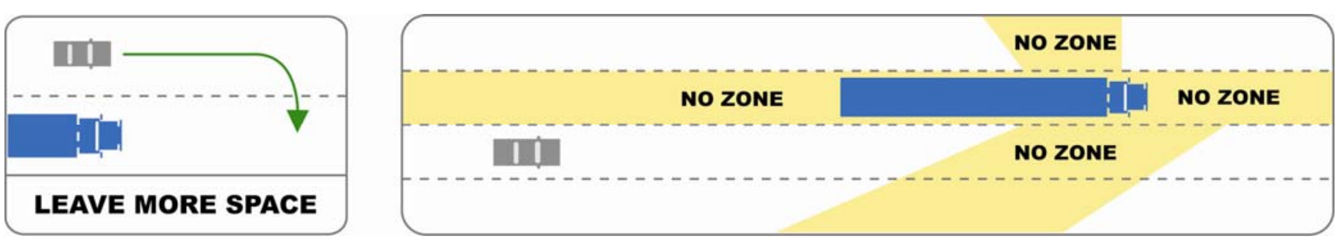
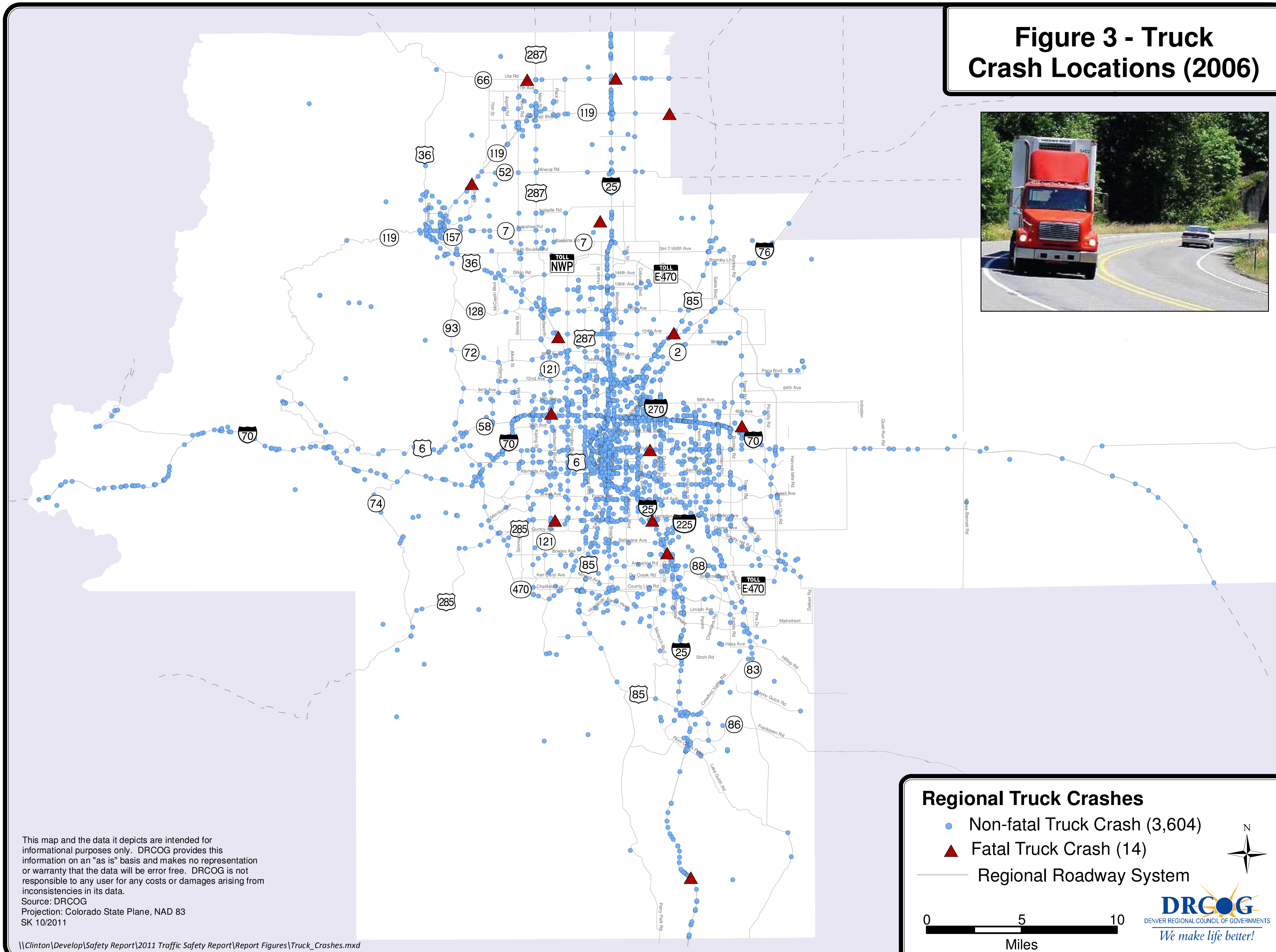


Figure 3 - Truck Crash Locations (2006)



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Projection: Colorado State Plane, NAD 83
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B. Interstate 70 Mountain Corridor Crashes

The I-70 mountain corridor is of particular concern because it experiences inclement weather and has steep grades (up to 7 percent). For this analysis, the corridor was defined as the stretch of I-70 between Vail and Morrison Road (mileposts 181 to 259). Crash data for the corridor was obtained from the I-70 Mountain Corridor Mobility and Operation Assessment (2011), which can be accessed at: www.coloradodot.info/library/studies.

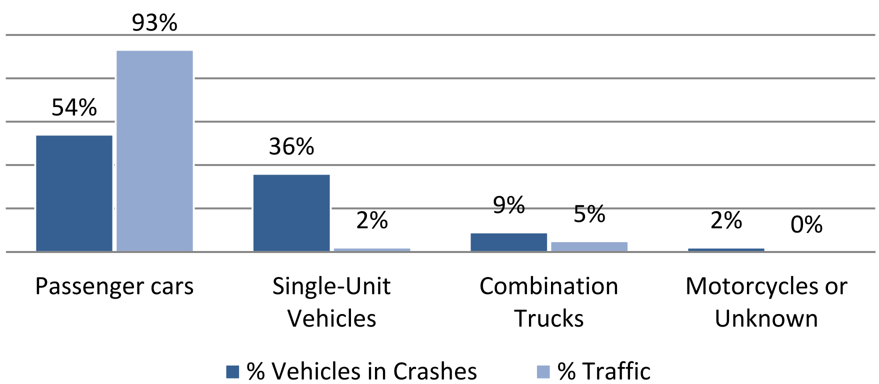
From 2004 to 2008, an average of 1,375 crashes occurred per year on the corridor. Over the same time period, there were five fatal crashes and 151 injury crashes per year on average. Fifty percent of crashes occurred on snowy pavement, 39 percent on dry pavement, and 11 percent on wet pavement.

50% of I-70 mountain corridor crashes occurred on snowy pavement.

When analyzed by driver action, 61 percent of crashes occurred due to exceeding the speed limit or unsafe speed. Careless driving and following too close were the next highest causes. Forty percent of crashes were fixed-object collisions, most commonly into the embankment or guardrail; 19 percent of crashes were rear-end collisions.

When analyzed by the type of vehicles involved in crashes, passenger cars made up the highest portion (54 percent); passenger cars make up 93 percent of traffic on the corridor. Single-unit vehicles (e.g., pickups, vans, SUVs, and ambulances) made up 36 percent of vehicles in crashes, but only 2 percent of all traffic. Single-unit vehicles are involved in more crashes due to their top-heavy design, which makes it easier to lose control of the vehicle and run off the road.

I-70 Mountain Corridor Traffic Composition vs. Crash Involvement (2004-2008)



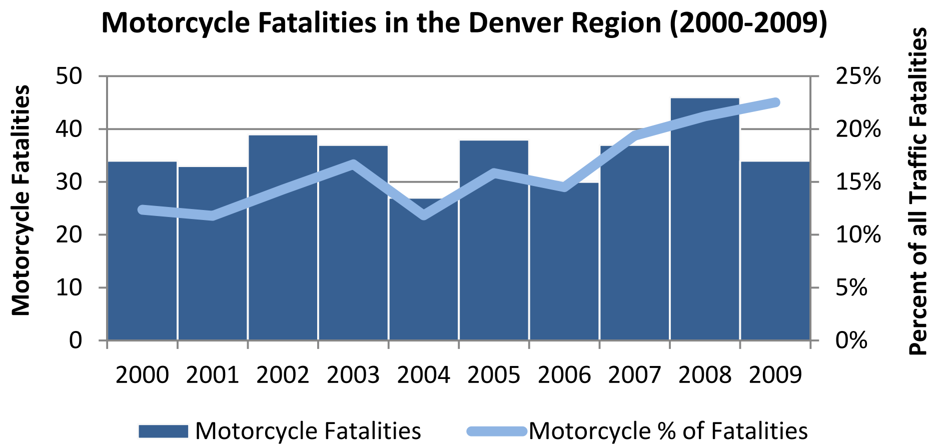
<u>I-70 Mountain Corridor Crash Mitigation Efforts</u>

Several efforts have been made to reduce crashes on the I-70 mountain corridor, in particular for heavy vehicles. Some of these safety efforts include:

- Speed and lane restrictions for heavy vehicles (e.g., due to steep downgrades heavy vehicles must slow to 30 mph when exiting the Eisenhower Tunnel on westbound I-70),
- Commercial vehicle chain requirements and Chain Assistance Stations (September through May),
- Brake check areas, and runaway truck ramps.

C. Motorcycle Crashes

Between 2004 and 2006, an average of 1,200 motorcycle crashes occurred per year in the Denver region. The chart below shows motorcycle fatalities from 2000 to 2009, averaging 36 fatalities per year. Annual motorcycle fatalities have remained about the same over the last decade. However, motorcycle fatalities make up an increasing proportion of all traffic fatalities (12 percent in 2000 and 23 percent in 2009).



The number of motorcycle registrations has increased substantially during the last decade. Because the number of motorcycle fatalities has remained constant, the fatality rate per number of motorcycle registrations has decreased (see Table 9), from 0.62 per 1,000 registrations in 2001 to 0.41 per 1,000 registrations in 2009. The overall motorcycle crash rate remained about the same between 2001 and 2005.

Table 9. Motorcycle Fatality and Crash Rate in the Denver Region (2001-2009)

Year	Motorcycle Registrations	Motorcycle Fatalities	Motorcycle Fatalities per 1,000 Registrations	Motorcycle Crashes	Motorcycle Crash Rate per 1,000 Registrations
2001	53,525	33	0.62	1,085	20
2003	60,843	37	0.61	1,036	17
2005	67,694	38	0.56	1,259	19
2007	74,670	37	0.50	n.a.	n.a.
2009	83,124	34	0.41	n.a.	n.a.

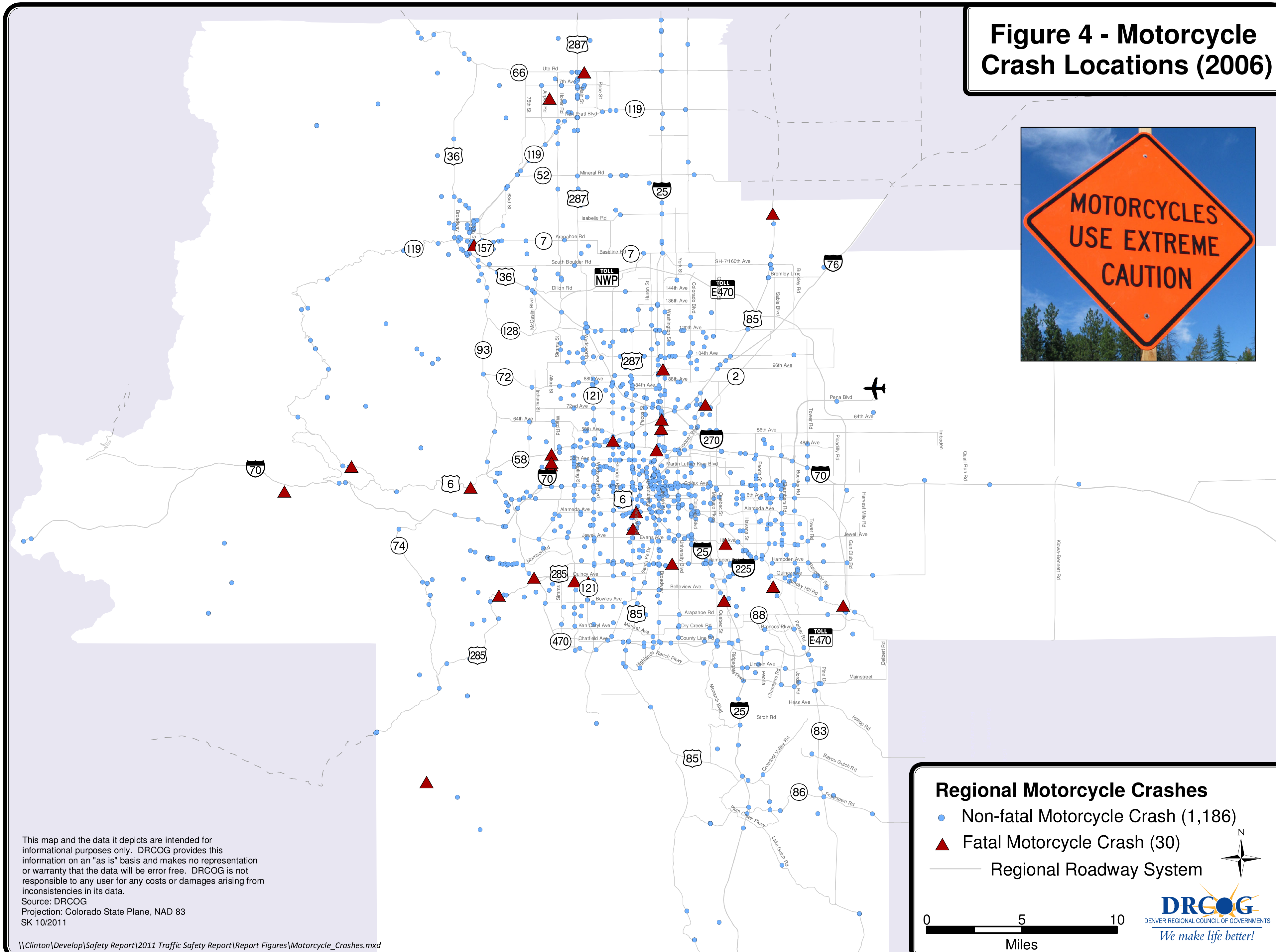
CDOT found that 40 percent of motorcyclist fatalities in 2009 were attributed to the rider being under the influence of alcohol. In addition, 67 percent of all motorcyclists killed in 2010 were not wearing a helmet. In Colorado, helmet use is not required for adults, but is required for operators and passengers under the age of 18.

Figure 4 shows a map of motorcycle crash locations from 2006. Motorcycle crashes are somewhat more prevalent on rural/mountain roads, given the amount of travel on those roads.

<u>Motorcycle Training Requirements in Colorado</u>

CDOT found motorcyclists were at fault in seven out of 10 fatal crashes in 2010. CDOT's Live to Ride campaign emphasizes the need for motorcycle training by requiring a motorcycle endorsement in order to ride in Colorado. An endorsement can be obtained by taking a Motorcycle Operator Safety Training (MOST) course or by taking a written exam and riding test. For additional information on CDOT motorcycle training, visit www.comotorcyclesafety.com.

Figure 4 - Motorcycle Crash Locations (2006)



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Projection: Colorado State Plane, NAD 83
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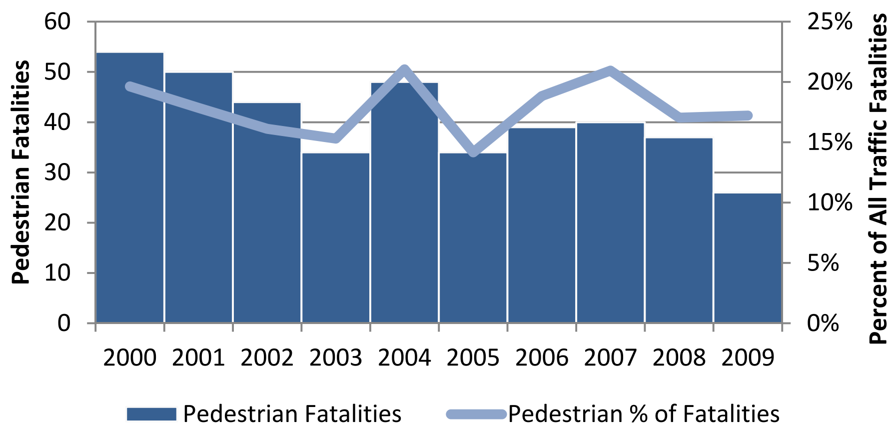
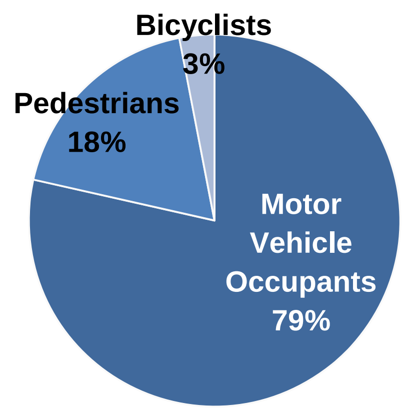
D. Pedestrian Crashes

Between 2004 and 2006, an average of 950 pedestrian crashes occurred per year in the Denver region, resulting in 40 fatalities and 770 injuries per year. The chart below, showing pedestrian fatalities in the region from 2000 to 2009, indicates pedestrian fatalities are trending downward. However, pedestrians account for a disproportionately high percentage of traffic fatalities, considering the length and time of travel by this mode. Between 2007 and 2009, pedestrians accounted for 18 percent of traffic fatalities. However, walking only makes up 1.1 percent of all person miles of travel in the region (DRCOG Travel Model, 2010). Pedestrians are more at risk than vehicle occupants in regard to injury severity in a traffic crash.

Pedestrian Fatalities in the Denver Region (2000-2009)



Traffic Fatalities (2007-2009)



DRCOG will be releasing a traffic safety study exclusively devoted to pedestrian and bicycle crashes in 2012. The study will include more detailed analyses on the nature and causes of pedestrian and bicycle crashes in the Denver region.

Table 10 shows the ages of pedestrians involved in crashes. Pedestrians age 0 to 24 had the highest involvement in pedestrian crashes. Pedestrians age 35 to 54 experienced the highest number of fatalities.

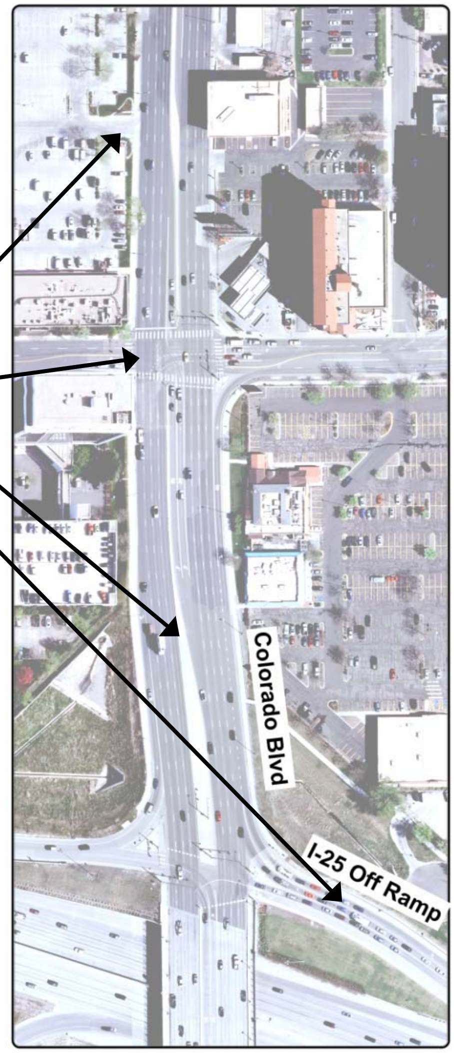
Table 10. Age of Pedestrians in Traffic Crashes (2004-2006)

Age Group	Pedestrians Involved in Crashes		Pedestrians Killed	
	Number	Percent	Number	Percent
0-14	395	20%	5	5%
15-24	458	23%	15	14%
25-34	301	15%	16	15%
35-44	288	14%	23	21%
45-54	318	16%	26	24%
55-64	156	8%	9	8%
65-74	51	3%	4	4%
75+	48	2%	9	8%
Total Reported	**2,015**	**100%**	**107**	**100%**
Age Unreported	*913*		*14*	
Total Pedestrians	2,928		121	

Table 11 shows pedestrian crash characteristics for 2004 to 2006. The table shows the majority of pedestrian crashes occurred on arterials (67 percent) and at intersections (55 percent). In addition, the most common vehicle path in a pedestrian crash is traveling straight; the second most common path is making a left turn. The driver is more often at fault than the pedestrian (based on the responding police officer's opinion of the actions which led to the crash). One-third of crashes occurred at night. The pedestrian was impaired by alcohol or drugs in 9 percent of pedestrian crashes.

Table 11. Pedestrian Crash Characteristics (2004-2006)

Facility Type	**Crashes**	**Percent**
Freeways	63	2%
Arterials	1,918	67%
Collector or local roads	883	31%
Total pedestrian crashes	**2,864**	**100%**
Crash Location		
At driveway access	207	7%
At intersection or intersection related	1,588	55%
Non-intersection	962	34%
Highway interchange	27	1%
In alley	40	1%
Unreported	40	1%
Total pedestrian crashes	**2,864**	**100%**
Vehicle Movement		
Going straight	1,444	50%
Making left-turn	530	19%
Making right-turn	407	14%
All other movements	483	17%
Total pedestrian crashes	**2,864**	**100%**
At-Fault in Crash		
Driver	1,085	38%
Pedestrian	453	16%
Both driver and pedestrian	40	1%
No fault specified	1,286	45%
Total pedestrian crashes	**2,864**	**100%**
Lighting		
Daylight	1,800	**63%**
Dark	943	33%
Dawn or dusk	121	4%
Total pedestrian crashes	**2,864**	**100%**
Impairment		
Pedestrian sober	2,616	91%
Pedestrian impaired	248	9%
Total pedestrian crashes	**2,864**	**100%**



When a causal factor was noted, the driver was at-fault in 69% of pedestrian crashes.

Table 12 shows the streets with the highest number of pedestrian crashes in the region between 2003 and 2006. Colfax Avenue, Federal Boulevard, and Broadway experienced the highest number of pedestrian crashes. The number of pedestrian crashes on a street is affected by the street length, level of pedestrian activity, and pedestrian amenities available. Colfax Avenue had the highest pedestrian crash rate per mile.

Table 12. Streets with Highest Number of Pedestrian Crashes (2003-2006)

Street	**Crashes**	**Length (mi)**	**Crashes per Mile**
Colfax Ave. *(Denver, Lakewood, Aurora)*	351	25.9	13.6
Federal Blvd. *(Denver, Broomfield, Westminster, Federal Heights, Englewood, Sheridan)*	196	26.0	7.5
Broadway *(Denver, Englewood, Littleton)*	185	16.8	11.0
Sheridan Blvd. *(Denver, Lakewood, Arvada, Westminster)*	112	22.7	4.9
Alameda Ave. *(Denver, Lakewood, Aurora)*	102	25.2	4.0
Wadsworth Blvd. *(Denver, Lakewood, Wheat Ridge, Arvada, Westminster)*	97	30.2	3.2
Colorado Blvd. *(Denver, Thornton, Glendale)*	95	26.8	3.5
Mississippi Ave. *(Denver, Aurora, Glendale, Lakewood)*	84	20.0	4.2
Peoria St. *(Denver, Aurora)*	80	19.1	4.2
Total	1,302	212.7	
Percent of all pedestrian crashes	34%		

Figure 5 shows a map of pedestrian crashes from 2006. Mid-block crashes are mapped to the nearest intersection. There may be more than one crash at each identified intersection.

<u>Pedestrian Crash Mitigation Strategies</u>
There are several safety treatments, which can reduce the occurrence of pedestrian crashes. See DRCOG's *Guidelines for Successful Pedestrian and Bicycle Facilities in the Denver Region* (2010) for a complete overview of pedestrian facility design considerations. The document can be accessed at:
http://www.drcog.org/documents/2010%20Ped%20Bike%20Guidelines%20booklet.pdf.

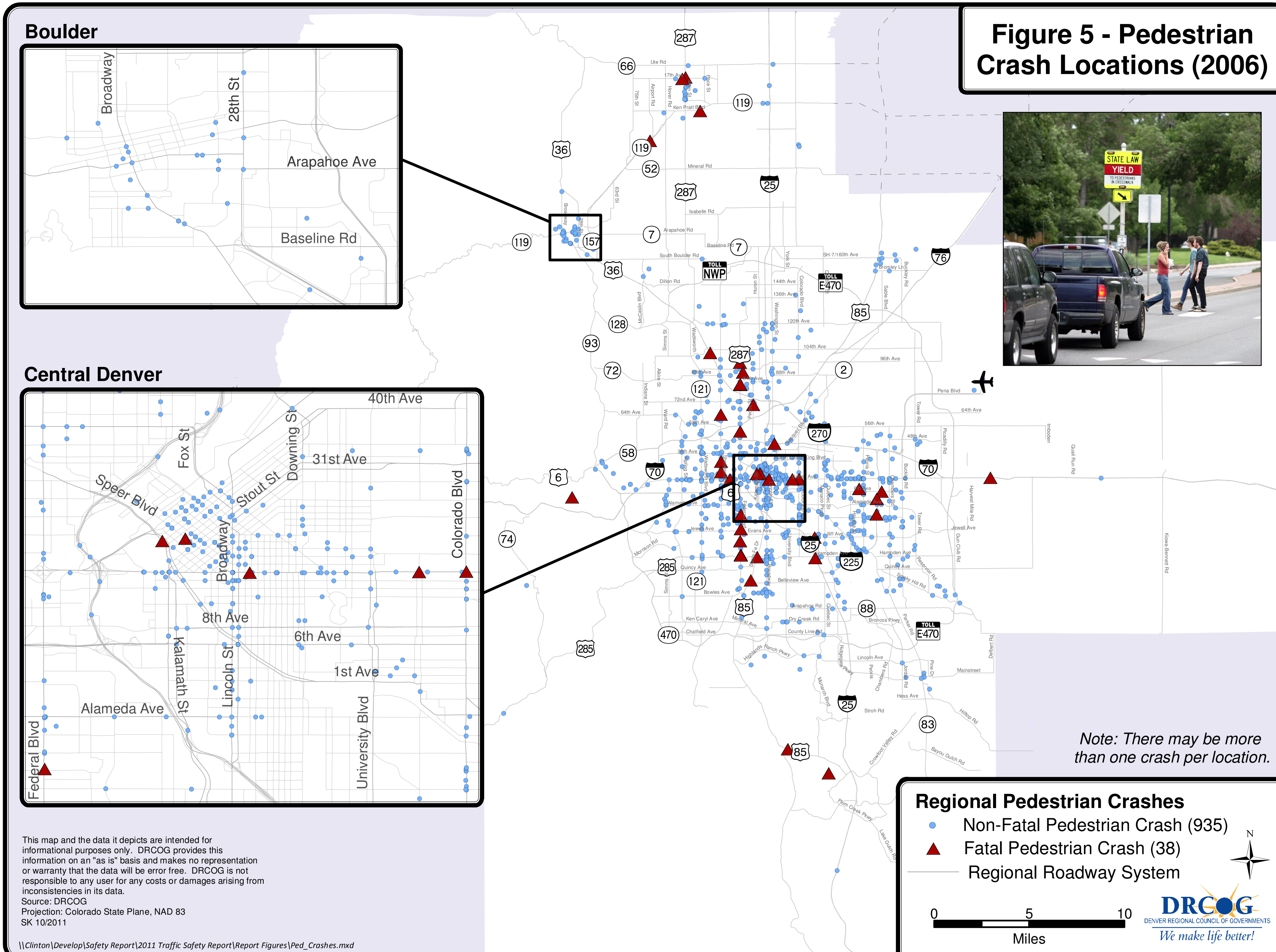
A few examples of pedestrian safety improvements include:

- Mid-block crossing treatments,
- Median refuge islands, and
- Giving the pedestrian signal phase a three-second start-up time, allowing the pedestrian to begin crossing before the through green phase is given to the motorist (e.g., implemented at 13th Avenue and Broadway in Denver).

The Manual on Uniform Traffic Control Devices (MUTCD) recently lowered the assumed pedestrian walk "design speed" to 3.5 feet per second (from 4.0 feet per second), therefore giving the pedestrian a longer time to cross the intersection.

CDOT's Safe Routes to School program funds traffic safety education and infrastructure, such as sidewalk and signage enhancements, which enable school age children to walk or bicycle to school safely. CDOT's Share the Road campaign aims to raise driver awareness of pedestrians and bicyclists. For more information on these CDOT programs visit: www.coloradodot.info/programs/bikeped.

Figure 5 - Pedestrian Crash Locations (2006)



Note: There may be more than one crash per location.

Regional Pedestrian Crashes

- Non-Fatal Pedestrian Crash (935)
- Fatal Pedestrian Crash (38)
- Regional Roadway System

0 5 10
Miles

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E. Bicycle Crashes

Between 2004 and 2006, an average of 690 bicycle crashes occurred per year, resulting in six fatalities and 540 injuries per year. The chart below shows bicyclist fatalities in the Denver region from 2000 to 2009. Bicyclist fatalities have remained about the same in the last nine years, and make up about 3 percent of all traffic fatalities. Person miles of travel (PMT) by bicycle constitutes only 0.5 percent of travel in the region (DRCOG Travel Model, 2010).

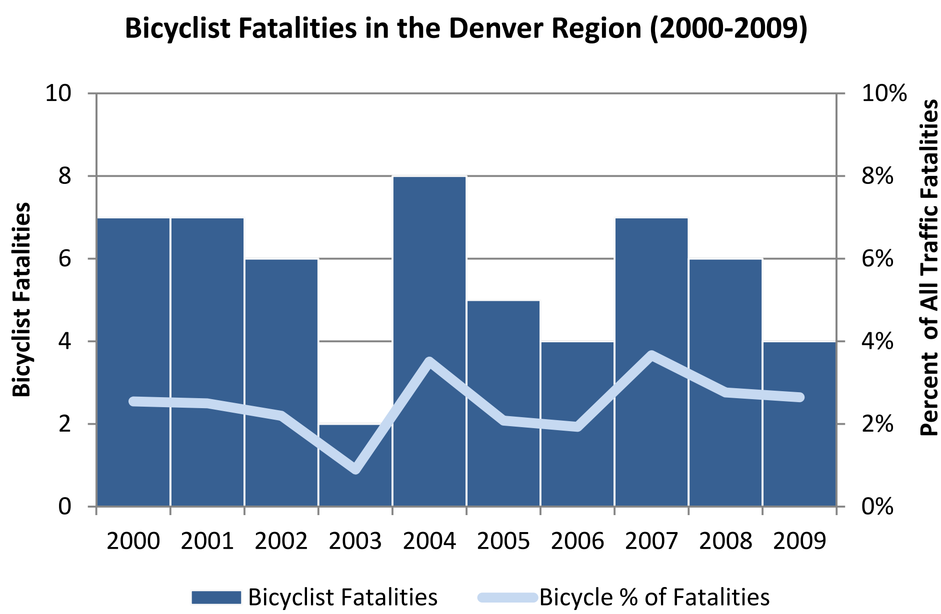


Table 13 shows the ages of bicyclists involved in traffic crashes. Similar to pedestrian crashes, bicyclists age 0 to 24 had the highest involvement in crashes. Bicyclists age 25 to 54 experienced the highest number of fatalities.

Table 13. Age of Bicyclists in Traffic Crashes (2004-2006)

Age Group	Bicyclists Involved in Crashes		Bicyclists Killed	
	Number	Percent	Number	Percent
0-14	339	20%	1	7%
15-24	435	26%	2	13%
25-34	274	17%	3	20%
35-44	268	16%	3	20%
45-54	233	14%	3	20%
55-64	78	5%	2	13%
65-74	27	2%	0	0%
75+	4	0%	1	7%
Total Reported	**1,658**	**100%**	**15**	**100%**
Age Unreported	*395*		*2*	
Total Bicyclists	2,053		17	

Table 14 shows bicycle crash characteristics for 2004 to 2006. The table shows more than two-thirds of bicycle crashes occur on arterials and the vast majority of bicycle crashes occur at intersections (70 percent). The most common vehicle movements in a bicycle crash are "driver going straight" and "driver turning right." The driver was more often at fault than the bicyclist (based on the responding police officer's opinion of the actions which led to the crash). Fourteen percent of bicycle crashes occurred at night.

70% of bicycle crashes occurred at an intersection.

Table 14. Bicycle Crash Characteristics (2004-2006)

Facility Type	Crashes	Percent
Freeways	24	1%
Arterials	1,404	68%
Collector or local roads	649	32%
Total Bicycle Crashes	**2,077**	**100%**
Location		
At intersection or intersection related	1,452	70%
At driveway access	328	16%
Non-intersection	261	13%
In alley	28	1%
Highway interchange	4	0%
Unreported	4	0%
Total Bicycle Crashes	**2,077**	**100%**
Vehicle Movement		
Going straight	776	37%
Making right-turn	689	33%
Making left-turn	325	16%
All other movements	287	14%
Total Bicycle Crashes	**2,077**	**100%**
At-Fault in Crash		
Driver	705	34%
Bicyclist	407	20%
Both driver and bicyclist	68	3%
No fault specified	897	43%
Total Bicycle Crashes	**2,077**	**100%**
Lighting		
Daylight	1,710	82%
Dark	290	14%
Dawn or dusk	77	4%
Total Bicycle Crashes	**2,077**	**100%**

Table 15 shows the streets with the highest number of bicycle crashes in the region between 2003 and 2006. Colfax Avenue, Broadway Street (Boulder) and Broadway (Denver, Englewood, and Littleton) experienced the highest number of bicycle crashes. The number of bicycle crashes on a street is affected by the street length, cross-section design, and level of bicycle activity. Broadway Street in Boulder had the highest bicycle crash rate per mile.

Table 15. Streets with Highest Number of Bicycle Crashes (2003-2006)

Street	Crashes	Length (mi)	Crashes per Mile
Colfax Ave. *(Denver, Lakewood, Aurora)*	131	25.9	5.1
Broadway St. *(Boulder)*	83	10.5	7.9
Broadway *(Denver, Englewood, Littleton)*	67	16.8	4.0
Mississippi Ave. *(Denver, Aurora, Glendale, Lakewood)*	64	20.0	3.2
Arapahoe Ave. *(Boulder)*	62	12.3	5.0
Alameda Ave. *(Denver, Lakewood, Aurora)*	53	22.3	2.4
Federal Blvd. *(Denver, Broomfield, Westminster, Federal Heights, Englewood, Sheridan)*	52	26.0	2.0
Wadsworth Blvd. *(Denver, Lakewood, Wheat Ridge, Arvada, Westminster)*	49	30.2	1.6
Colorado Blvd. *(Denver, Thornton, Glendale)*	48	26.8	1.8
Total	609	190.8	
Percent of all bicycle crashes	29%		

Figure 6 shows a map of bicycle crashes from 2006. Mid-block crashes are mapped to the nearest intersection. There may be more than one crash at each identified intersection.

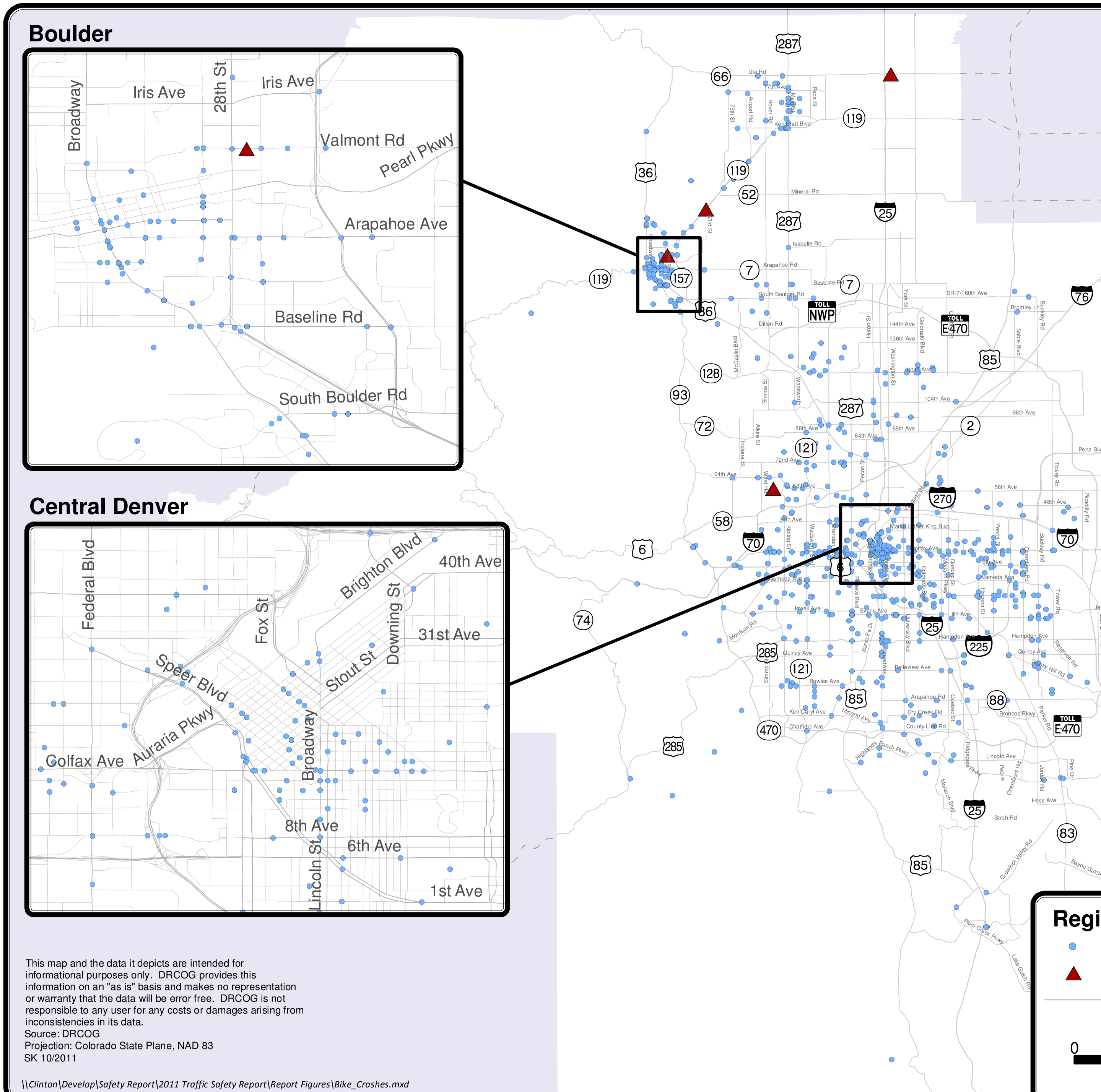
<u>Bicycle Crash Mitigation Strategies</u>

There are several bicycle facility treatments which can reduce the occurrence of bicycle crashes. As mentioned previously, DRCOG's *Guidelines for Successful Pedestrian and Bicycle Facilities in the Denver Region* (2010) can be used a resource for bicycle facility design considerations. Some examples of bicycle safety improvements include:

- Striped bike lanes,
- Bike routes designated by sharrows,
- Wide curb lanes and shoulders,
- Street maintenance,
- Increased law enforcement, and
- Education and awareness campaigns for motorists and bicyclists.

The National Association of City Transportation Officials (NACTO) publishes an Urban Bikeway Design Guide, which can also be used as a resource for bicycle facility design. The design guide is available at www.nacto.org.

Figure 6 - Bicycle Crash Locations (2006)



Note: There may be more than one crash per location.

Regional Bicycle Crashes

- Non-Fatal Bicycle Crash (732)
- Fatal Bicycle Crash (4)
- Regional Roadway System

0 5 10
Miles

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F. Wildlife-Vehicle Collisions

Wildlife-vehicle collisions (WVCs) increased from about 400 per year to 600 per year between 1991 and 2006. The increase is mainly attributed to expanding urban growth and increased traffic volumes in the Denver region. From 2004 to 2006 an average of 70 injuries occurred per year in the Denver region due to WVCs. Beyond the initial safety threat of a WVC, dead animals on the roadway also present a hazard due to drivers swerving to miss the carcass. The Rocky Mountain Insurance Information Association found that the average claim for a WVC is $3,100 (2011).

65% of wildlife-vehicle collisions occur within a quarter mile of open space.

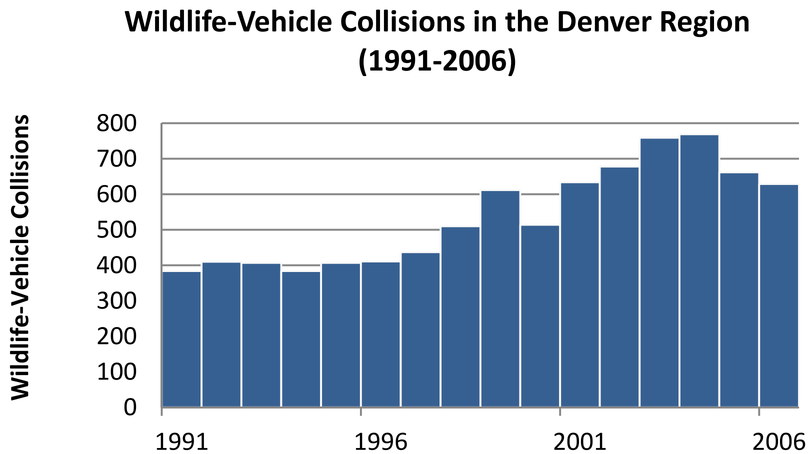


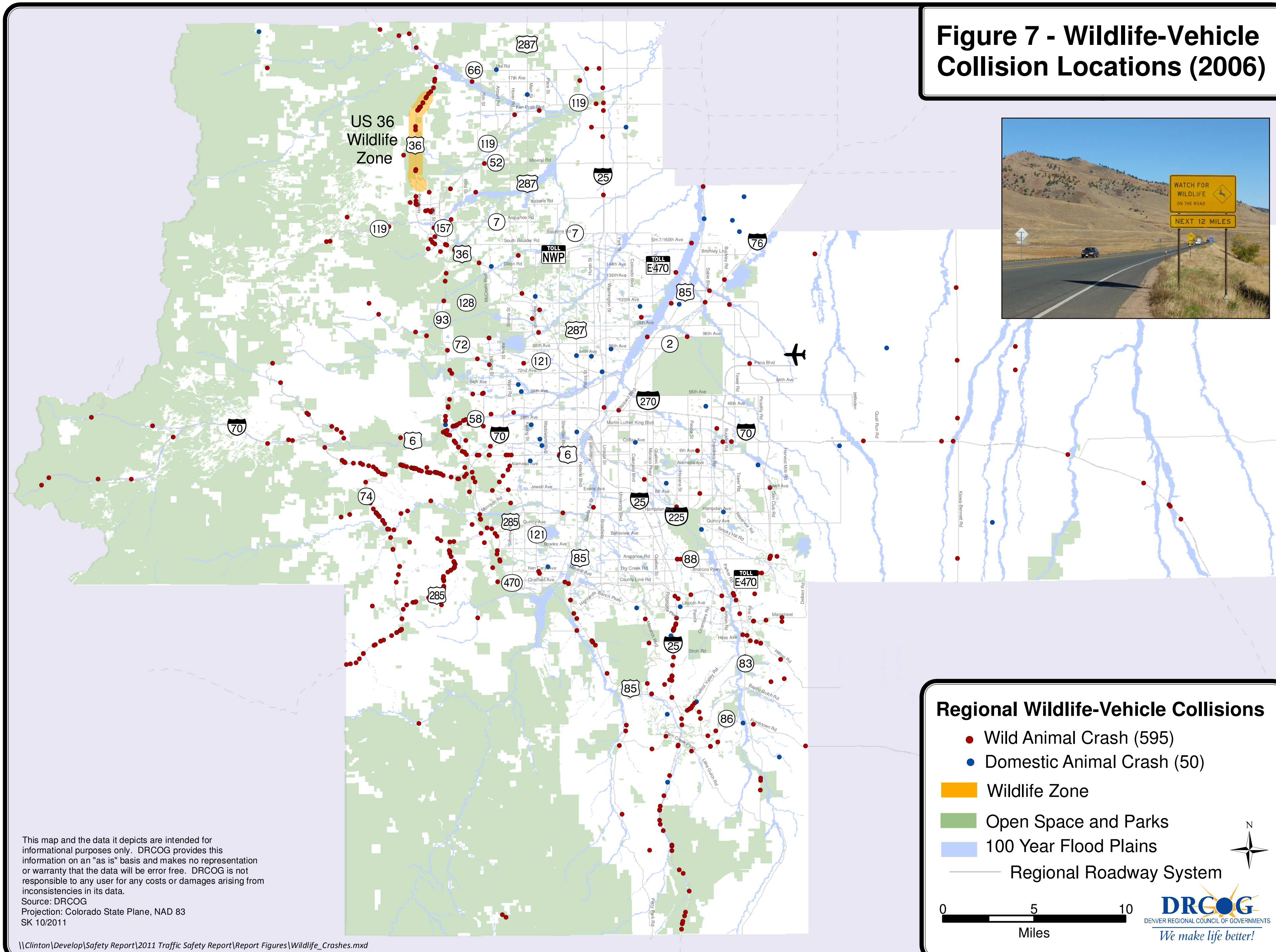
Figure 7 shows a map of WVCs during 2006. Figure 7 also shows the open space and flood plains within the region. When analyzed by crash location in 2006, 65 percent of WVCs occurred within a quarter-mile of open space.

<u>Animal-Vehicle Crash Mitigation Strategies</u>

CDOT's *Wildlife on the Move* campaign reminds drivers to drive with caution each fall, when WVCs are more common due to animal migration. The majority of WVCs occur at nighttime; therefore CDOT has designated certain at-risk corridors as Wildlife Zones, reducing the nighttime speed limit from September to April (enforced 5 p.m. to 7 a.m.). The US 36 corridor from Boulder to Lyons (milepost 25 to 33) is a designated Wildlife Zone with reduced night speeds. WVCs make up over 65 percent of nighttime crashes on this corridor. Figure 7 highlights the Wildlife Zone location on US 36.

In 2010, the CDOT Hazard Elimination Program funded the construction of a wildlife exclusion fence on 6th Avenue from 19th Street to Heritage Road in Golden. The eight-foot tall fence extends 2.5 miles and funnels animals to a single wildlife crossing. Flashing beacons and dynamic message signs at the crossing alert motorists when an animal is detected in the right of way. WVCs make up 40 percent of the crashes on this corridor. CDOT will be tracking the change in crashes and modifying the system as needed in the coming years. For more information on the project visit: www.coloradodot.info/programs/environmental/wildlife.

Figure 7 - Wildlife-Vehicle Collision Locations (2006)



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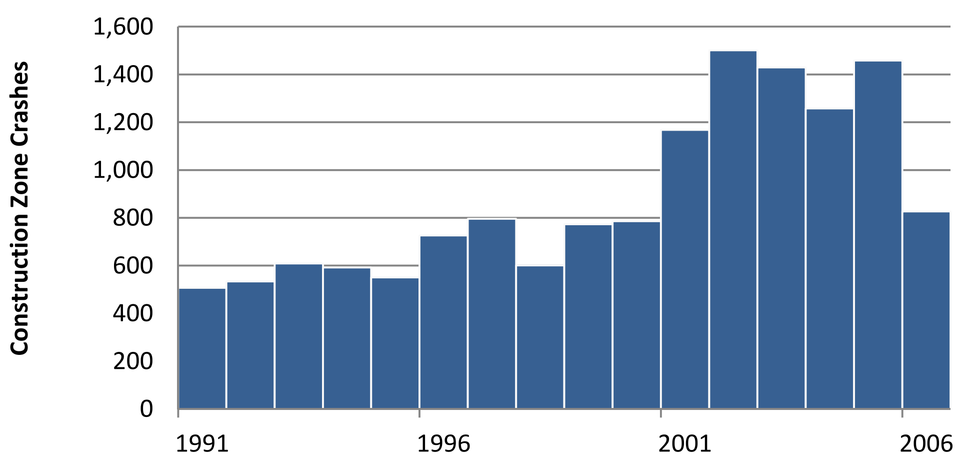
G. Construction Zone Crashes

Between 2004 and 2006, an average of 1,200 construction zone crashes occurred per year, resulting in 400 injuries and seven fatalities per year. As shown in the chart below, the number of construction zone crashes is highly variable, depending on the amount of construction occurring each year. The number of construction crashes per year was highest between 2001 and 2005.

Construction Zone Crashes in the Denver Region (1991-2006)



According to CDOT, motorists make up the vast majority of construction-zone fatalities (four out of five fatalities). Rear-end collisions are by far the most common crash type in a construction zone, representing 60 percent of all collisions between moving motor vehicles in 2006. When analyzed by the causal factors in the crash, careless driving and following too close were the most common driver actions (representing 45 and 26 percent of driver actions leading to the crash, respectively) between 2004 and 2006.

Construction Zone Crash Mitigation Strategies

CDOT's *Slow for the Cone Zone* campaign aims to reduce construction zone crashes by funding overtime enforcement at construction projects from June to September each year. For more information on this campaign visit: www.coloradodot.info/programs/cone-zone. Higher fines for violating traffic laws in a construction zone also help to reduce unsafe behavior. As of 2006, nearly all fines are doubled in work zones in Colorado (prior to 2006, only speeding violation fines were doubled).

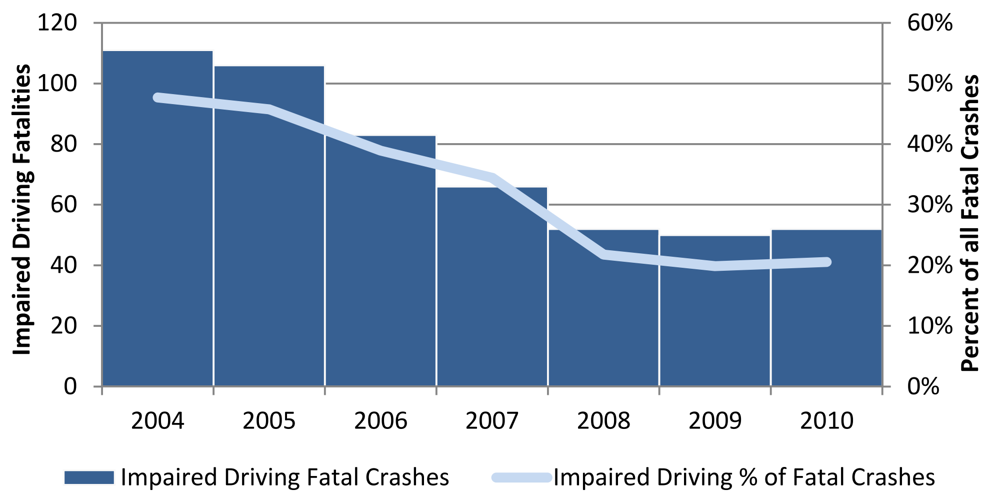
6. HIGH-RISK BEHAVIOR CRASHES

A. Impaired Driving

Impaired driving fatalities have dropped by 71% in the last six years.

Between 2004 and 2006, an average of 4,300 impaired driving crashes occurred per year in the Denver region. These crashes resulted in an average of 2,500 injuries and 85 fatalities per year. The chart below shows trends in impaired driving fatalities from 2004 to 2010. Impaired driving fatalities in the Denver region have experienced a downward trend over the last six years, from 111 fatalities in 2004 to 52 in 2010. In addition, the percentage of all fatal crashes related to impaired driving has decreased steadily over the same time period (from 48 percent to 21 percent).

Impaired Driving Fatalities in the Denver Region (2004-2010)



The chart below shows the demographics of drivers killed while driving under the influence of drugs or alcohol between 2004 and 2006. Younger drivers make up the vast majority of impaired driving fatalities.

Fatally Injured Impaired Drivers by Age Group (2004-2006)

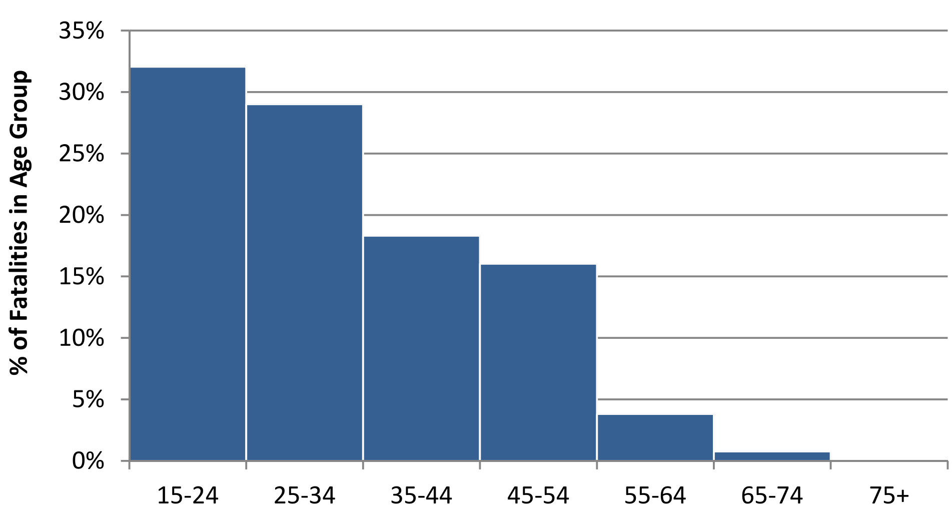


Table 16 shows impaired driving crashes by time of day. The highest hours are from 12 a.m. to 3 a.m., when 28 percent of impaired driving crashes occur, but only 2 percent of daily VMT.

28% of impaired driving crashes occur between 12 and 3 a.m.

Table 16. Impaired Driving Crashes by Time of Day (2004-2006)

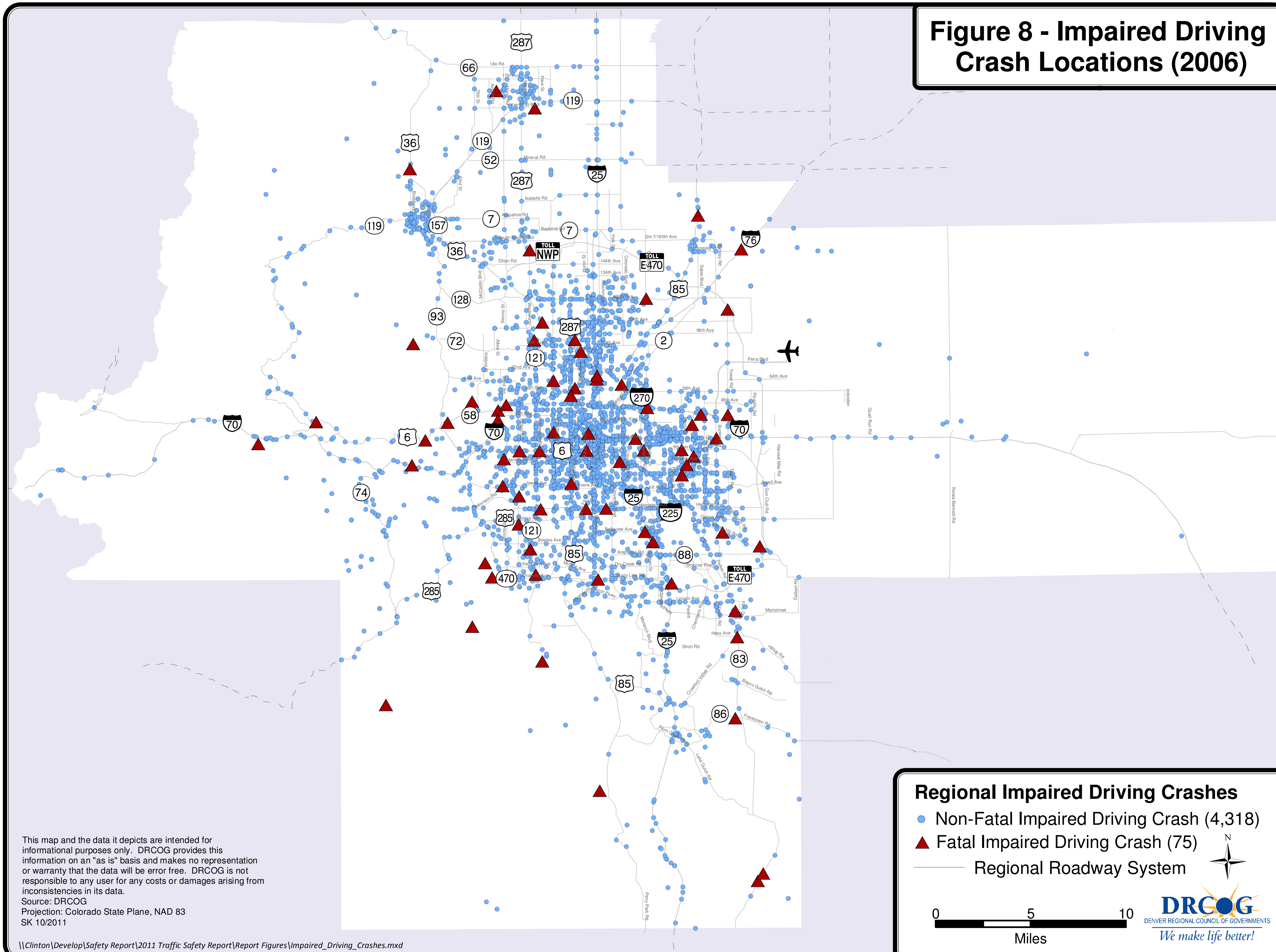
Time of Day	Crashes	% Crashes	% VMT
12-3am	3,587	28%	2%
3-6am	958	7%	2%
6-9am	391	3%	15%
9am-12pm	422	3%	17%
12-3pm	683	5%	17%
3-6pm	1,463	11%	21%
6-9pm	2,358	18%	18%
9pm-12am	2,970	23%	8%
Total	**12,832**	**100%**	**100%**

Figure 8 shows a map of impaired driving crash locations from 2006.

Impaired Driving Education and Enforcement Efforts

CDOT runs several campaigns and programs to reduce driving under the influence. *The Heat is On!* campaign raises public awareness of DUI through high visibility enforcement and sobriety check points during 12 key periods of the year (e.g., Labor Day, Fourth of July, Memorial Day, and New Years Eve). From Memorial Day to Labor Day, the *100 Days of Heat* campaign increases enforcement visibility by placing two large banners at the Eisenhower and Johnson tunnels on I-70 and a traveling dynamic message sign counts the number of DUI arrests made year to date. Visit www.HeatIsOnColorado.com for more information on CDOT enforcement activities and DUI arrest statistics.

Figure 8 - Impaired Driving Crash Locations (2006)



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Source: DRCOG
Projection: Colorado State Plane, NAD 83
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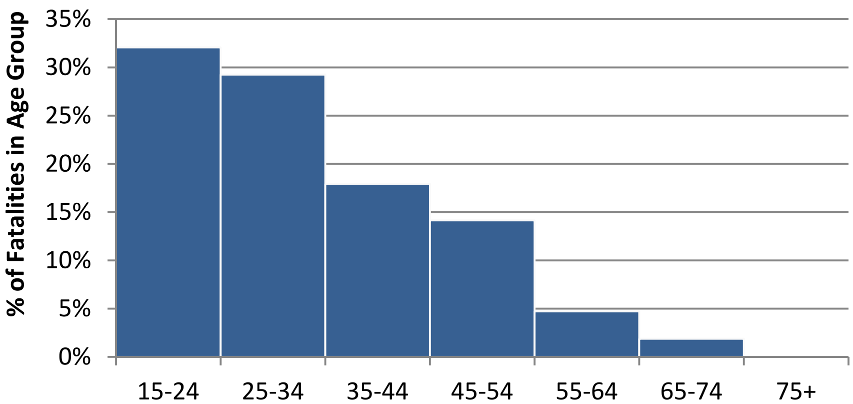
B. Speeding

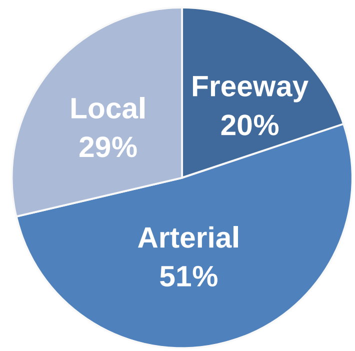
Speeding was involved in 27% of fatal crashes between 2004 and 2006.

Speeding generally involves exceeding the posted speed limit or driving too fast for conditions. For this analysis, speeding was defined as a driver traveling at 10 miles or more per hour above the speed limit. Between 2004 and 2006, an average of 4,500 speeding-related crashes occurred per year in the Denver region. These crashes resulted in an average of 64 fatalities and 2,100 injuries per year. Speeding was involved in about 27 percent of all fatal crashes between 2004 and 2006. The charts below show the age of fatally injured speeding drivers and the types of roadways where speeding-related fatal crashes occurred.

Fatally Injured Speeding Drivers by Age Group (2004 -2006)



Speeding Fatalities by Facility Type (2004-2006)



Young drivers make up the vast majority of fatalities occurring due to excessive speed. The age group of 15 to 34 makes up more than half of all fatalities. Speeding-related fatalities occur on all types of roadways. As shown in the pie chart, 51 percent of speeding-related fatal crashes occurred on arterials, 29 percent occurred on collector/local roads, and 20 percent occurred on freeways.

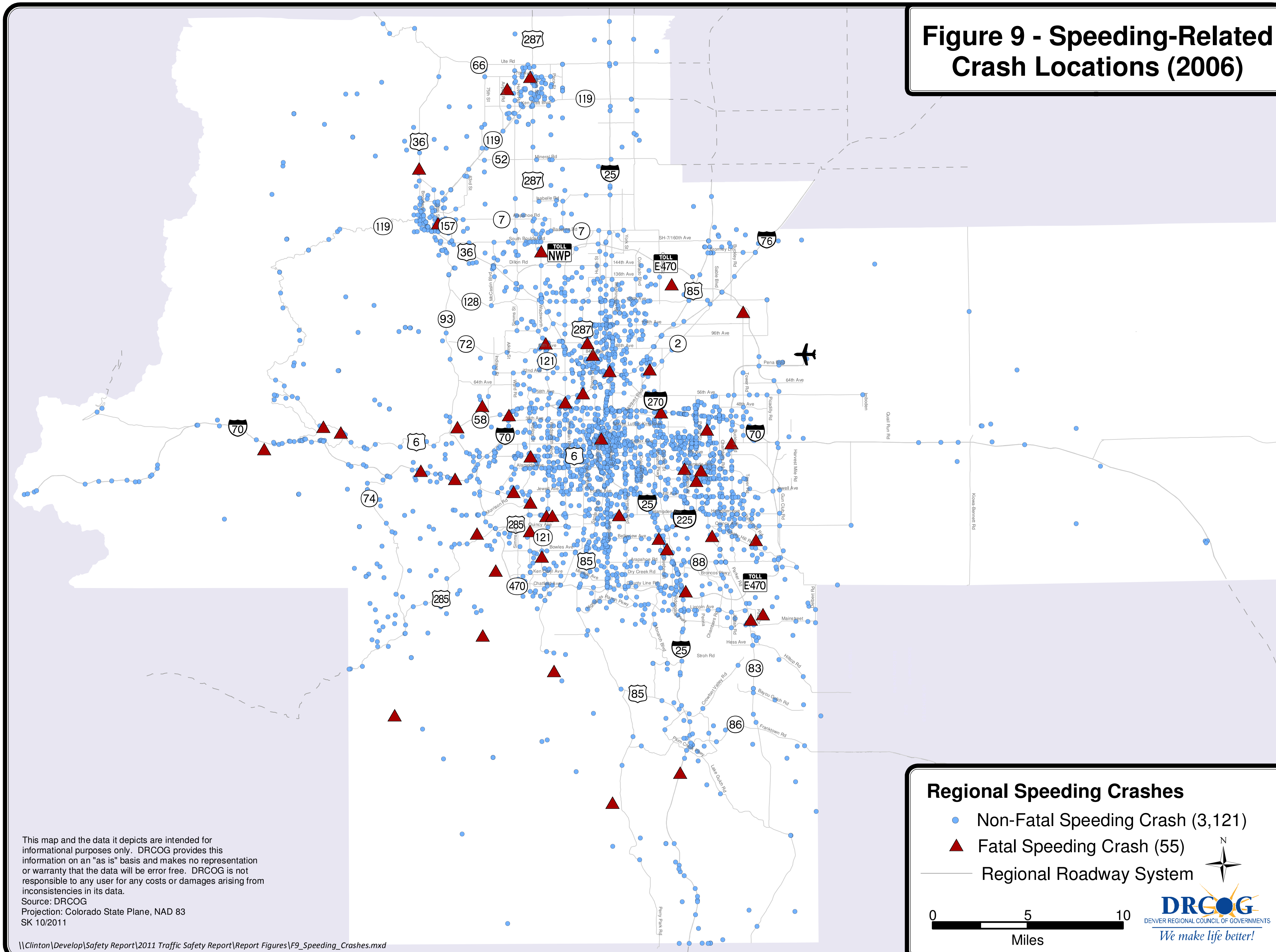
Figure 9 shows the locations of speeding-related crashes in 2006.

<u>Speeding Education and Enforcement Efforts</u>

CDOT's Speed Enforcement and Control Program aims to reduce speed-related crashes through "concentrated, repetitive, and high-visibility" speed enforcement. In 2009 and 2010, the program provided funds to the Denver Police Department to focus on speeding violations on the I-25 and I-70 corridors. For more information on CDOT Speed Enforcement program activities see the Annual Report for the CDOT Office of Transportation Safety and Traffic Engineering.

Many speeding-related crashes occur due to high speed differentials between vehicles on a roadway. Achieving speed harmonization (i.e., all vehicles traveling at roughly the same speed) greatly enhances roadway safety. In August 2011, CDOT began implementing 55 mph pacing vehicles on the I-70 Mountain corridor to reduce crashes and congestion during peak travel times. The pacing vehicle technique is in the initial testing phase at this time.

Figure 9 - Speeding-Related Crash Locations (2006)



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C. Red Light Running

From 2004 to 2006, an average of 2,500 red light running (RLR) crashes occurred per year in the Denver region. These crashes resulted in an average of four fatalities and 1,300 injuries per year. The Insurance Institute for Highway Safety found that, nationwide, two-thirds of RLR fatalities were persons other than the RLR driver, including passengers, other motorists, pedestrians, and bicyclists (2009).

The vast majority of RLR crashes occur on arterials (over 83 percent), as the majority of signals are located on arterial roads. Table 17 shows the intersections in the Denver region with the highest RLR crash frequency between 2004 and 2006. Of note, crashes at closely spaced intersections, such as freeway interchange on/off ramps, were grouped together.

Table 17. Intersections with Highest Number of RLR Crashes (2004-2006)

Intersection	Crashes
6th Ave. & Lincoln St. (Denver)	53
Mississippi Ave. & I-225 Ramps (Aurora)	50
Speer Blvd. & Colfax Ave. (Denver)	43
Kipling St. & I-70 Ramps (Wheat Ridge)	41
Speer Blvd. & 8th Ave. (Denver)	37
Colfax Ave. & I-225 (Aurora)	27
Speer Blvd. & Stout St. (Denver)	27
Colorado Blvd & I-25 (Denver)	26
Total	**304**
Total Number of RLR Crashes	7,378

Figure 10 shows the locations of red light running crash locations in 2006.

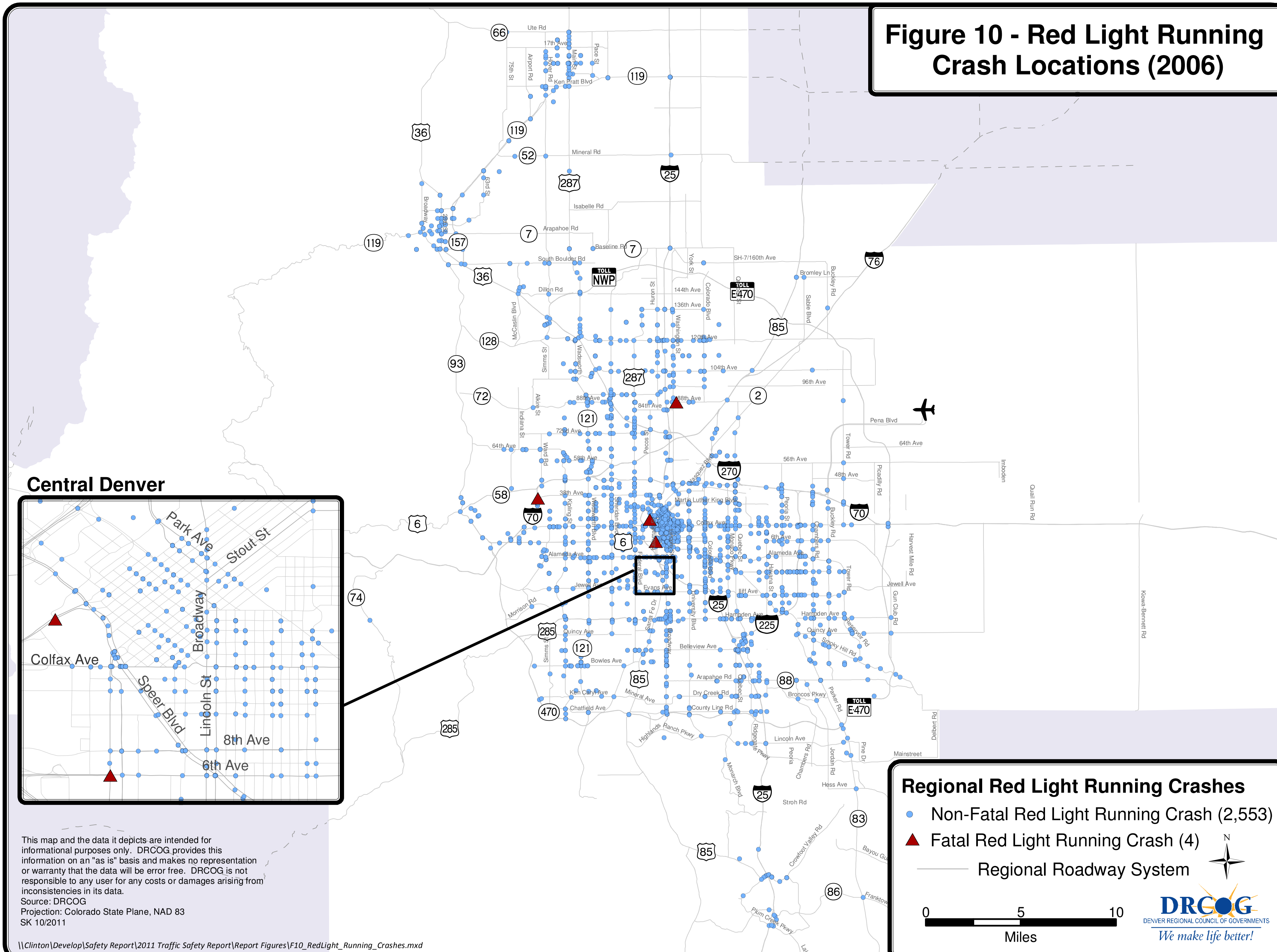
Red Light Running Crash Mitigation

RLR crash mitigation is divided into two categories; engineering treatments to reduce unintentional RLR and enforcement activity, which reduces intentional RLR. In regard to engineering countermeasures, some common treatments include:

- Improved signal visibility (e.g., placement of a signal head over each through lane),
- Installation of signal ahead warning signs,
- Adjustment of the yellow and all-red intervals, and
- Signal upgrades to allow for dilemma zone preemption (i.e., extending the green when a vehicle is detected in the dilemma zone).

Increased enforcement, via red light running cameras, is commonly used to reduce intentional RLR. There are about 50 intersections in the Denver region with RLR cameras (source: jurisdiction websites and www.photoenforced.com).

Figure 10 - Red Light Running Crash Locations (2006)



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7. IDENTIFICATION OF HIGH CRASH LOCATIONS

A. Arterial Crash Hot Spots

A 2007 study, done by Felsburg Holt & Ullevig (FHU) for DRCOG, analyzed crashes at arterial-arterial intersections and arterial segments in the region. The study grouped the intersections and segments based on the number of through lanes, then calculated a safety performance score based on:

- Total number of crashes
- Total number of injury and fatality crashes
- Crash exposure based on daily traffic volume
- Injury and fatality crash exposure based on daily traffic volume, and
- Weighted hazard index, which measures the severity of the crashes.

A total of 924 arterial segments and 398 arterial-arterial intersections were analyzed. Table 18 shows the results of the analysis, where a score of one is considered safest. The vast majority of intersections and segments score a two or three. There are 15 intersections and 29 segments with a score of four. These are locations where the crash histories exceed the average for similar facilities by more than 1.5 standard deviations.

Table 18. Safety Performance Score for Arterial Intersections and Segments

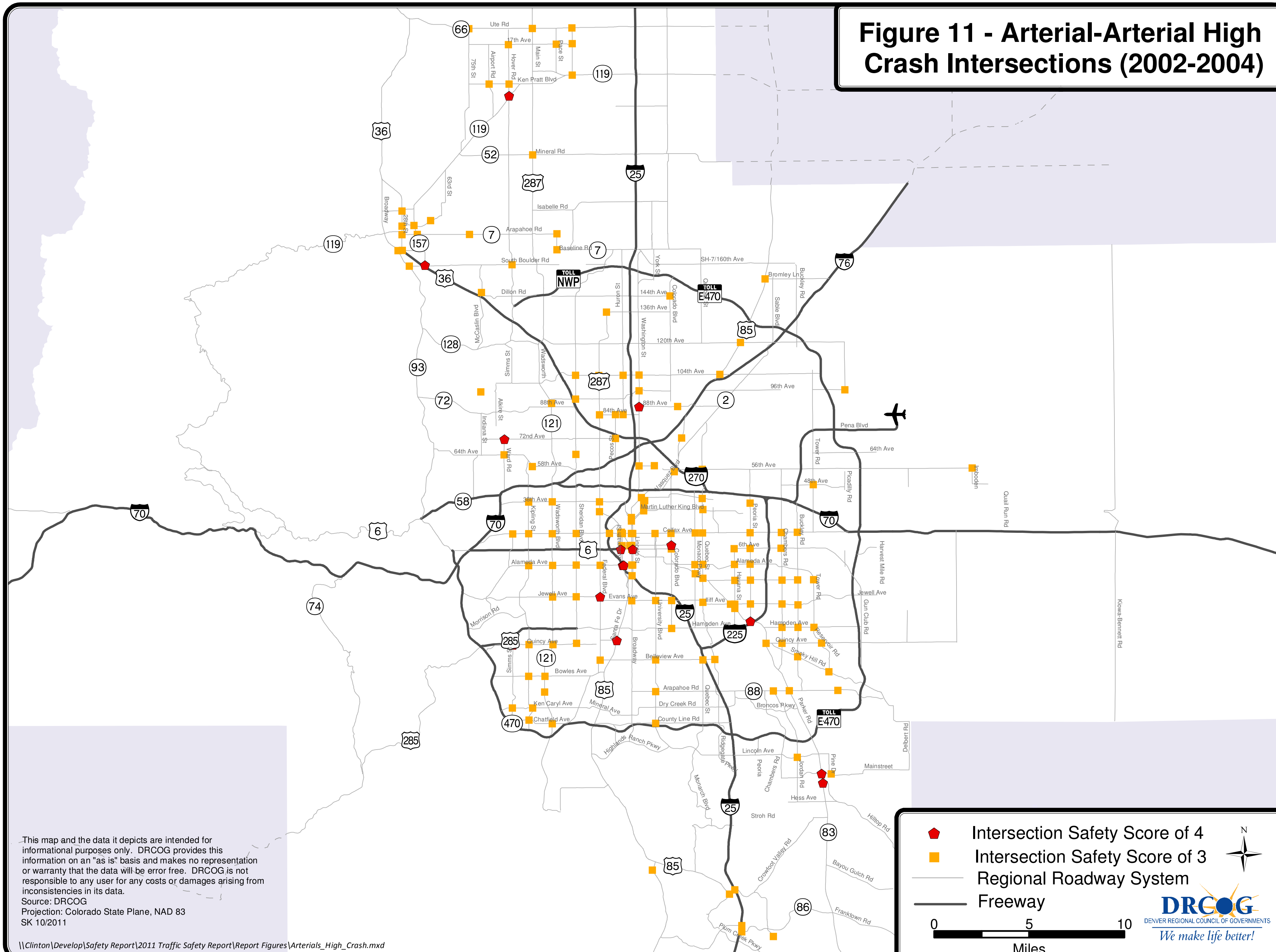
	Safety Performance Score			
	1 *(fewer crashes than expected)*	**2**	**3**	**4** *(more crashes than expected)*
Number of Arterial-Arterial Intersections	0	225	158	15
Number of Arterial Segments	0	660	235	29

Intersections with a score of three or four are shown in Figure 11. The arterial-arterial intersections with a score of four are listed in Table 19.

Table 19. Arterial-Arterial Intersections with Safety Score of Four (2002-2004)

Intersection	Total Crashes	Injury Crashes	Fatal Crashes
Alameda Ave. & Kalamath St. (Denver)	252	50	0
Foothills Pkwy. & S. Boulder Rd. (Boulder)	110	36	0
Federal Blvd. & Jewell Ave. (Denver)	124	40	0
6th Ave. & Lincoln St. (Denver)	289	52	0
Diagonal Hwy. & Hover Rd. (Longmont)	130	36	1
Parker Rd. & Main St. (Parker)	151	22	1
Ward Rd. & 72nd Ave. (Arvada)	75	29	0
Washington St. & 88th Ave. (Thornton)	106	33	2
Santa Fe Dr. & Alameda Ave. (Denver)	150	22	1
Colorado Blvd. & 8th Ave. (Denver)	137	31	0
Parker Rd. & Hilltop Rd. (Parker)	95	18	0
6th Ave. & Kalamath St. (Denver)	142	30	0
Parker Rd. & Peoria St. (Aurora)	118	41	0
Santa Fe Dr. & Oxford Ave. (Sheridan)	137	25	0
Quincy Ave. & Union St. (Jefferson County)	95	18	0

Figure 11 - Arterial-Arterial High Crash Intersections (2002-2004)



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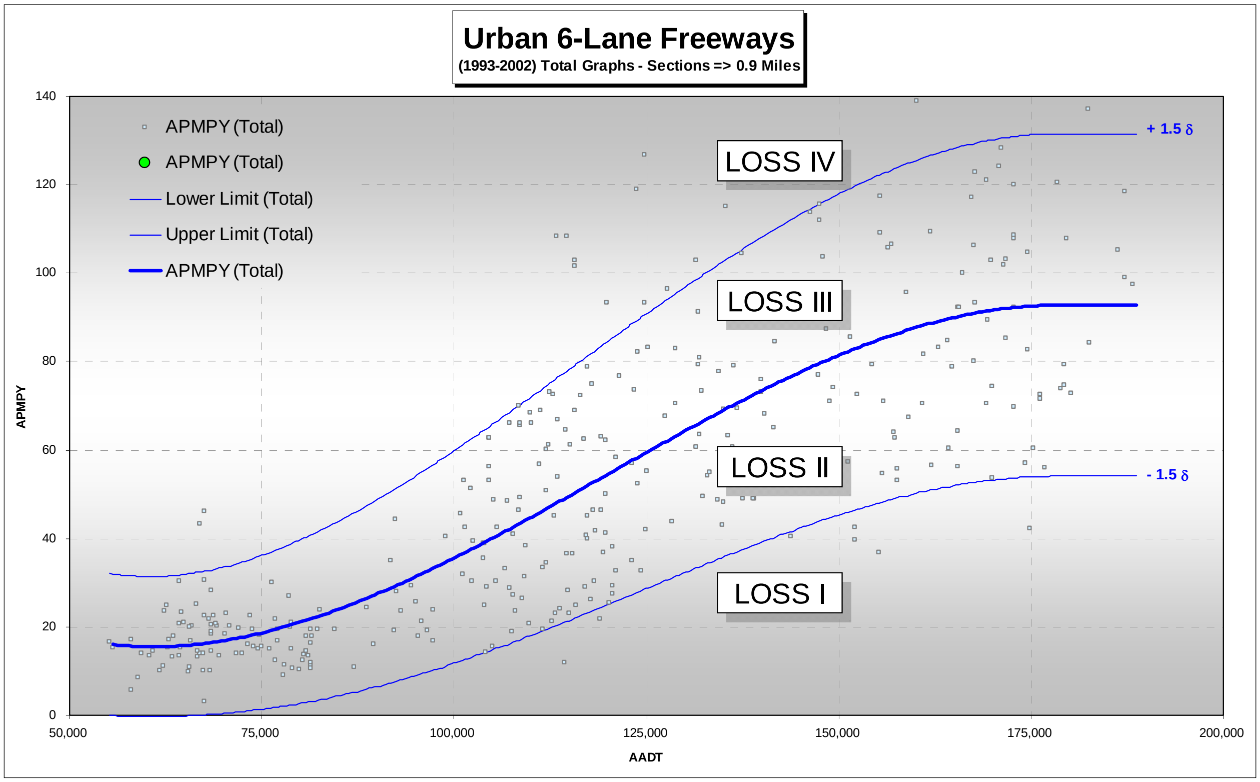
B. Freeway Crash Hot Spots

The 2007 FHU study also analyzed crashes on freeway segments in the region. The study used CDOT's Safety Performance Functions (SPFs), which plot the expected accidents per mile per year (APMPY) as a function of annual average daily traffic (AADT). A Level of Service of Safety (LOSS) is assigned based on a comparison of the expected safety performance to the actual safety performance. The LOSS ranges from I to IV, with a LOSS IV assigned to segments a crash history at least 1.5 standard deviations higher than the average for that facility type. The SPF for total crashes on a 6-lane urban freeway is shown in the chart below, as an example.

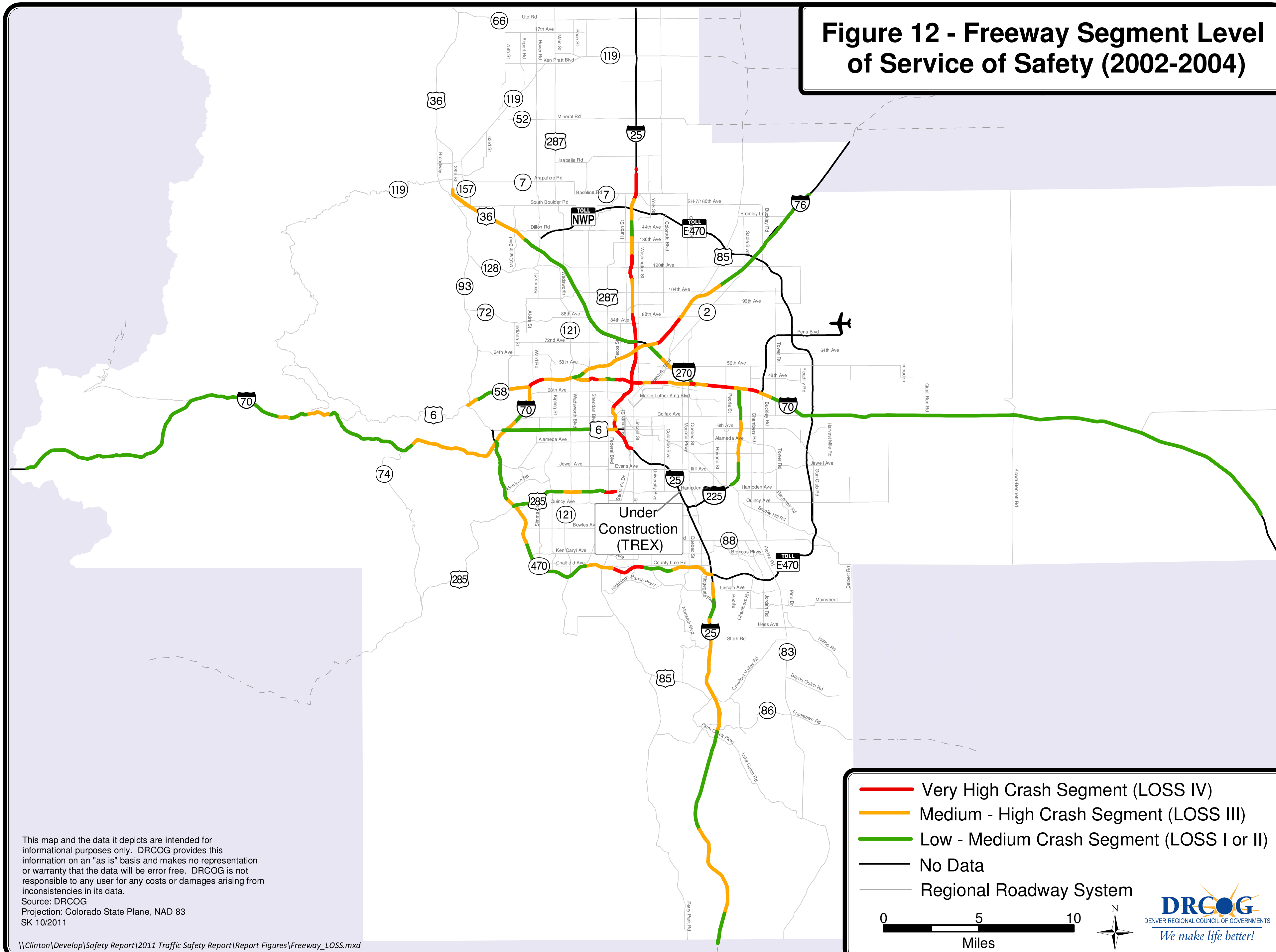


A total of 156 freeway segments were analyzed. The segments were divided such that each segment included only one interchange. All crashes on ramps and crossroads were removed from the freeway segment crash history. The results from the freeway segment analysis are shown in Table 20, showing that 28 segments have a LOSS of IV, or a high potential for crash reduction. Freeway segment LOSS scores are plotted in Figure 12. The highest crash segments mainly lie on I-25 and I-70.

Table 20. Level of Service of Safety on Freeway Segments

	Level of Service of Safety Score			
	I *(fewer crashes than expected)*	II	III	IV *(more crashes than expected)*
Number of Freeway Segments	2	66	60	28

Figure 12 - Freeway Segment Level of Service of Safety (2002-2004)



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8. OTHER SAFETY EFFORTS

A. Engineering Safer Roadways

A large part of roadway safety relies on proper signage, roadway design, maintenance, and vehicle design. The American Association for State and Highway Transportation Officials (AASHTO) publishes several manuals, which provide roadway and roadside design criteria based on the functional classification and traffic volume on the facility. In addition to appropriate design, regular maintenance, resurfacing, and restriping are needed to maintain roadway safety.

Proper communication with the driver, via signage and signals, is also critical to roadway safety. The MUTCD governs the design and placement of traffic signs, signals, and pavement markings nationwide. The purpose of the MUTCD is to ensure uniformity of traffic control devices, as driver understanding is greatly enhanced when messages are displayed in the same way at all times.

Also, advancements in vehicle technology, such as vehicle backing sensors and rear-vision cameras, can help prevent crashes. Vehicle technology is advancing quickly; several technologies in testing include traffic sign recognition (e.g., recognition of speed limit signs), automatic braking when a collision is sensed, and pedestrian protection systems, which lessen injuries to a pedestrian when hit by a vehicle.

B. Emergency Response and Crash Clearance

Crashes on freeways and major roads during peak hours have a major impact on traffic congestion. For this reason, emergency response time and removal of an incident from the traffic stream is very important. CDOT has several programs underway, which aid in faster clearance of the roadway following a traffic crash. These programs include:

- CDOT's *Mile High Courtesy Patrol* provides assistance for passenger cars and other small vehicles when stalled or involved in minor traffic crashes. The program has been in place since 1992 and patrols key areas of I-25, I-70, I-225, and US-6 during rush hours. The program provides services including flat tire repair, fueling, jump starts, short-distance towing, accident scene protection, and minor mechanical assistance. The *Courtesy Patrol* also serves the I-70 mountain corridor during weekends and holidays from November to March.

- CDOT's *Heavy Tow Quick Clearance* program clears stalled commercial vehicles from the travel lanes on I-70 between Floyd Hill and Vail Pass. The program operates on weekends and holidays between November and April. The average clearance time for the 2010/2011 winter season was 22 minutes. Before the program's implementation, in late 2008, the average clearance time was 50 minutes.

9. SUMMARY OF FINDINGS

This report provides benchmark crash statistics for the Denver region and aims to increase awareness among planners, engineers, and elected officials as they contemplate safety issues in their communities. Some of the key findings of safety conditions in the Denver region are as follows:

- The overall crash rate decreased slightly between 1991 and 2006. Although the number of reported crashes increased between 1991 and 2006, the crash rate per 100 million VMT decreased. A steady decline in the crash rate was seen between 2002 and 2006, following increases from 1998 to 2001.

- The fatal crash rate has decreased substantially over the last 30 years. The number of fatal crashes per 100 million VMT decreased from 2.87 to 0.68 between 1980 and 2010. The number of fatalities per year decreased from 270 to 159 over the same period.

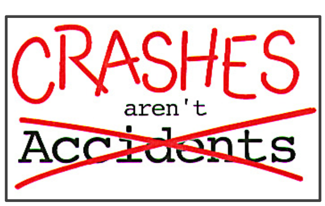
- Pedestrians and bicyclists are particularly vulnerable transportation system users. Pedestrian and bicyclist fatalities make up one in every five traffic fatalities. This is disproportionately high, considering that walking and biking make up only 1.6 percent of person miles of travel in the region.

- Motorcyclists make up one-fifth of all fatalities. Motorcycle crashes have inherently higher injury severity due to the high travel speeds associated with many crashes and lack of body protection. Motorcycling is also growing in popularity; the number of motorcycle registrations increased from 53,500 to 83,100 between 2001 and 2009.

- Motorists must drive cautiously around large trucks. Due to their significant weight and size, trucks have reduced visibility and maneuverability compared to passenger cars. Motorists must be aware of these limitations when approaching or passing a large truck.

- Many fatalities are preventable. About 21 percent of fatal crashes involved an impaired driver between 2008 and 2010. Fatalities attributed to high-risk behavior, such as speeding, impaired driving, and red-light running, point to the need for enhanced education and enforcement.

Fortunately, many crashes can be prevented. As mentioned earlier, CDOT estimates 85 percent of crashes are due to improper driver behavior, while only 15 percent of crashes occur due to conditions out of the driver's control. However, transportation safety is multidisciplinary in nature, and involves the effort of many entities, including drivers, educators, law enforcement, tow truck operations, emergency medical response professionals, and government agencies, to name a few.



Source: NHTSA

Report on Traffic Safety in the Denver Region

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