LARIMER COUNTY
COMMITTED TO EXCELLENCE

Low Cost Roadway Safety Program

2010 Annual Report

Public Works Division
Engineering Department
Road and Bridge Department

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Executive Summary

In 2009 Larimer County started the Low Cost Safety Program to better understand vehicular crashes on Larimer County roads and to identify, complete, and evaluate roadway improvements using minimal funding with the intent to reduce the severity and the number of crashes in locations with crash rates.

Program Purpose and Organization

The program is organized so that on an annual basis, data collection and analysis is followed by roadside safety audits, improvement plans and implementation, and an annual safety report that summarizes the information. The 'toolbox' for the program includes items in all five "Es" of traffic safety: engineering, education/encouragement, enforcement, and evaluation.

Traffic Safety Assessment

Roadway crashes that occur in unincorporated Larimer County along mainline county roads (not state highways) were analyzed and are detailed in the traffic safety assessment beginning on page 3. A few of the summary statistics include:

- Between 2007 and 2010, overall numbers of crashes are down 35%
- Between 2007 and 2010, severe crashes (injury or fatal crashes) are down 5.6%.
- 46% of all crashes take place on dry, paved roads during daylight hours.
- Distracted driving is noted as the *primary* cause of a crash in 12% of all crashes.
- Drivers less than 20 years old drive only 3% of total miles driven, but account for 22% of all crashes.
- Drivers not wearing seatbelts are 10 times more likely to be killed and 2 times more likely to be injured than drivers wearing seatbelts.
- Motorcyclists are 3.7 times more likely to be involved in a severe crash than drivers in vehicles.
- Rural, two lane roads remain the most dangerous part of the road system. Larimer County's fatality rate is almost 2 times the national average.
- Annual cost of crashes on the Larimer County road system is $ 11 million.

2010 Safety Program

The 2010 Safety Program included eight locations for engineering improvements, and a start to the establishment of education, encouragement and enforcement components of the program. The program is funded with $65,000 per year.

Engineering improvements generally consist of signing improvements such as warning signs, chevrons, sign size or upgrade of sign material. In addition, pre-formed thermoplastic pavement markings are also often utilized, and on occasion flashing beacons, vegetation removal (to improve sight distance) etc has been utilized.

Program Evaluation

The Low Cost Roadway Safety Program is now in its second year, and before- and after- comparisons of crash frequency and severity is possible at locations improved in the first year of the program.

- Of seven intersections improved, crashes per year have been reduced by almost 3 injury crashes per year.
- There are several intersections where the low cost improvements have not resulted in a significant safety benefit, and those intersections (such as CR 30 / CR 11) are now being programmed for more comprehensive capital improvements.
- Four road segments were improved in the first year of the program, resulting in an annual reduction of more than 5 injury crashes.
- After discounting for the general trend in reduction in crash numbers, the Low Cost Safety Program can be credited with reducing injury crashes by 8 injury crashes per year. This results in an annual societal cost savings of $320,000.
- The return on investment for the program's $65,000 annual cost is a factor of 5.
- Roundabout safety in Larimer County follows the national trend, with a reduction of 20% in minor crashes and 100% in severe crashes at locations where roundabouts have been built.

Summary

Roadway crashes remain an almost everyday occurrence on Larimer County roads, and their impacts are significant to citizens. The Low Cost Safety Program is key in understanding, identifying, implementing and evaluating improvements. Initial results of the first year of the program show a tangible, significant improvement in safety by the program, resulting in eight fewer injury crashes and societal savings of $320,000 per year. The return on investment of the $65,000 annual program funding is a factor of 5.

In coming years, additional improvements will be made, and further development and implementation of the education, encouragement and enforcement components will be undertaken.

Roadway safety is a vital component of local government. The Low Cost Safety program is expected to continue to have a substantial, quantifiable and lasting positive impact on the citizens of Larimer County.

Introduction

Program Purpose and Goal

The Larimer County Low Cost Roadway Safety Program is a relatively new program in just its second year that provides the policy, process, funding, and tools to systematically identify, prioritize, mitigate and evaluate the performance of transportation safety investments.

The goal is to consistently and effectively reduce numbers and severity of crashes. This includes the ability to identify high crash locations and respond in a timely manner with a systematic process, including education, to address safety concerns on Larimer County's roadways.

Collisions cause loss of life, injuries, and property damage. The primary benefit of a safety program is to save lives and reduce injuries. Costs associated with collisions (and savings realized by their avoidance) include wage loss from injuries, medical expenses, insurance administration costs, property damage, and claims for personal and property damage.

Other benefits include increased awareness and understanding of safe design practices and their payback by staff in Larimer County departments, administration, and the pubic.

Program Organization and Process

The toolbox of potential solutions is quite varied, and the program is organized to allow for innovation in their implementation. The program is flexible and includes consideration of the roadway, vehicles, and drivers; engineering solutions are intended to be considered in conjunction with education, enforcement, and emergency services concepts.

The program is operated on an annual basis and includes the general components and tasks shown below. The timeline provides an overview of the yearly process. Some projects have different implementation processes depending on the mitigation selected.

Table 1 – Low Cost Safety Annual Work Tasks and Timeline

Item	Tasks	Timeline
1. Program Planning	In conjunction with County budget planning, identify program budget for the year.	July / August
2. Data Collection	Update and retrieve crash history through end of calendar year	Jan / Feb
3. Data Analysis	Identify top locations of concern (intersections and segments) o Use report card, maps, hot spot analysis and crash rate calculations	March / April
4. Roadside Safety Audits	Road Safety audits o Statistics analysis, field review o ID contributing factors and countermeasures Identify improvements and potential funding sources	May - June

5.	Prioritization and planning	Project Prioritization Determine which will be constructed Identify specific funding source for project.	June - August
6.	Implementation	Implement improvements	August – November
7.	Monitor / Review	Review projects from previous years Re-run crash analysis Evaluate effectiveness	November
8.	Annual Safety Report	Ongoing annual reporting that documents the process, the projects, and the monitoring / review. The report also highlights the overall effectiveness and cost / benefit of the program.	January-March

Roadway Safety Toolbox

There is a long list of available mitigation measures for the Low Cost Safety Program (LCSP). The potential solutions are derived from staff experience, current practices for other agencies, and state of the art research.

The toolbox evolves each year, and the program is intended to encompass a wider range of solutions as time allows and the program becomes better established. Traffic safety solutions typically fall into one of several categories, known as the "Five E's" of traffic safety: Engineering, Education/Encouragement, Enforcement, and Evaluation. Elements of each category are shown below:

Some locations may have needs in excess of low-cost solutions. This program allows for their identification, and the analysis is useful in pursuing additional funding options and/or determining safety related components to add to capital improvement projects.

Table 2 – Typical Toolbox Items Within The Low Cost Safety Program

Category	Typical Applications and Solutions
Engineering	Signing, striping, pavement markings, guardrail, intersection traffic control, medians, rumble strips, sight distance improvements, lighting, delineators, speed limits, roadside hazards removal, minor widening, pedestrian considerations, etc.
Education / Encouragement	Education outreach program for schools and general public, speed display on roadway, traffic calming program, memorial signing, etc.
Enforcement	Partnership with Sheriff's Department, speed limits, and intersection control
Evaluation	Annual Safety Report

Traffic Safety Assessment (Crash Information)

Crash Data

Roadway crashes that occur in unincorporated Larimer County are reported to the Colorado State Patrol (CSP). Unlike local cities, the Larimer County Sheriff's Department does not complete traffic crash reports, even though they may respond to the scene of an accident. The CSP fills out the accident report and files the report at their office. Every month, Larimer County Engineering Department staff visits the state patrol office and makes photo copies of all the crash reports in unincorporated Larimer County. The raw data is input into the County's accident database, and then further refined as it is transferred to the GIS system.

The analysis provided in this section is garnered from both the County's accident database, and GIS system. Because the process involved with recording crash data changed in 2006, the analysis has been completed for the crashes in the past four calendar years – 2007, 2008, 2009, and 2010.

Overall Crashes

The number of crashes in the past four years is shown in Figure 1. The overall trend in numbers of crashes is downward – overall 13% fewer crashes in 2010 than in 2007. The largest decline is in the number of injury crashes, which are down by about 35% over four years (from 124 to 81).

35%
Fewer
Injury Crashes
from 2007 - 2010

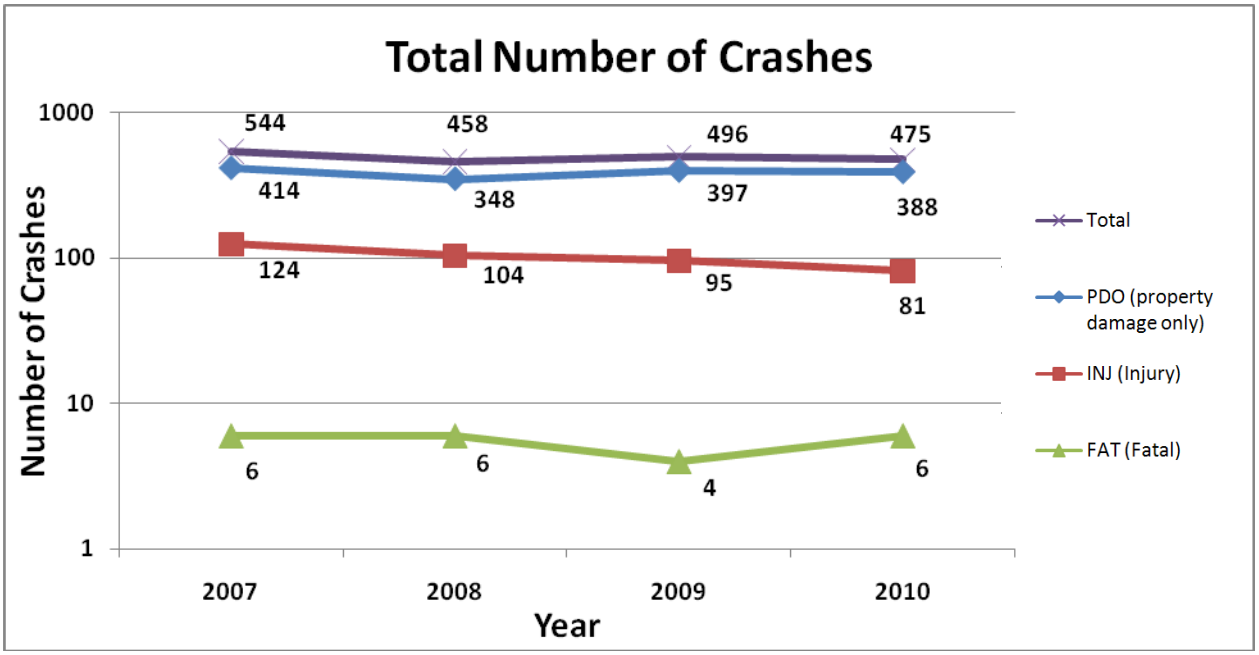

Figure 1 – Total Number of Crashes

It is important to note that these numbers reflect crashes on roads in unincorporated Larimer County, and as road segments are annexed into municipalities each year, the total number of road miles decreases by a small amount each year. However, the total number of vehicle miles travelled on the county road system is very similar in 2010 as in 2007 (about 290 million miles / year).

Figure 2 shows the historical trend of crash severity over the past four years. The most notable trend is that the overall crash severity has decreased. The percent injury crashes has declined from over 22% to less than 17%, while the prevalence of property damage only crashes has increased from almost 77% to almost 82%.

5.6%
Decrease in Crashes that are Severe from 2007 - 2010

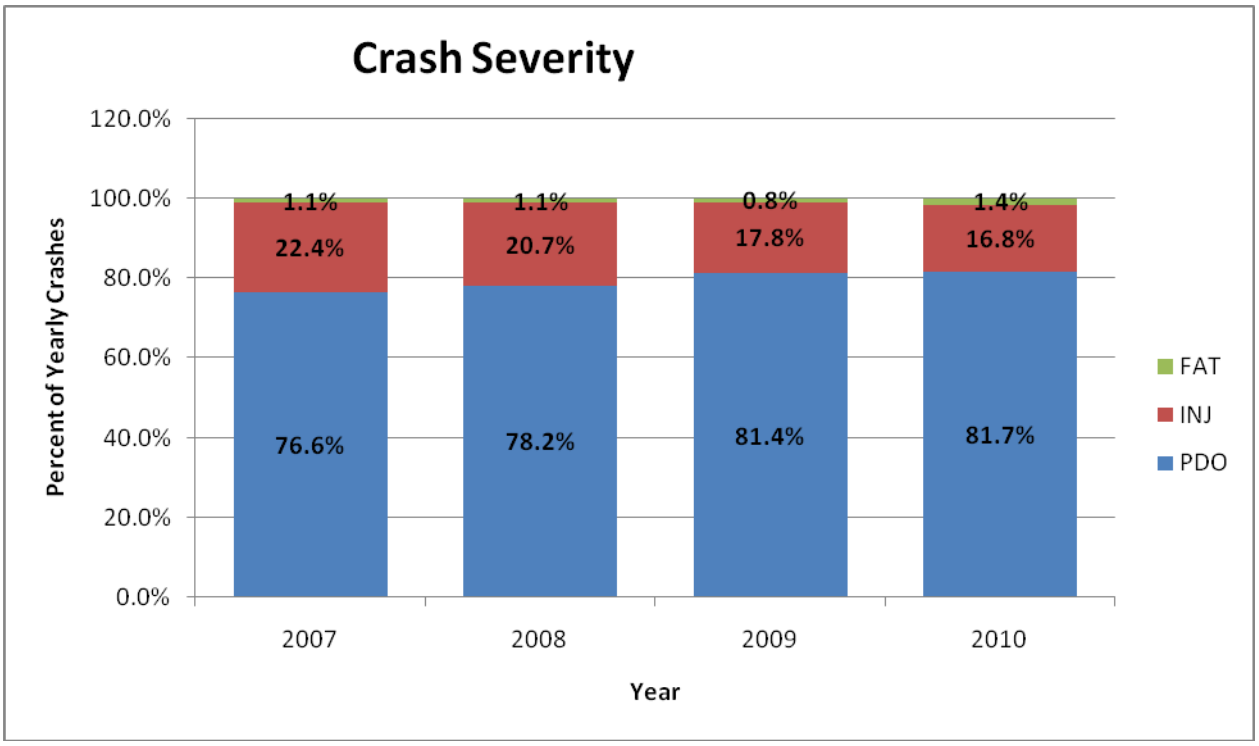

Figure 2 – Crash Severity

Figure 3 shows the number of vehicles involved in each crash. More than ½ of all crashes on roadways in unincorporated Larimer County are single vehicle crashes.

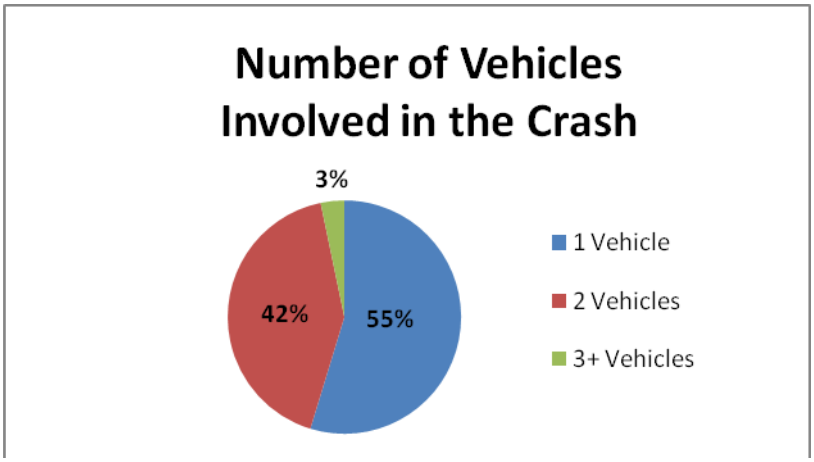

Figure 3 – Number of Vehicles per Crash (2007-2010)

Crash Timeframe

Figure 4 represents the allocation of crashes to days of the week. Sundays see the fewest reported crashes.

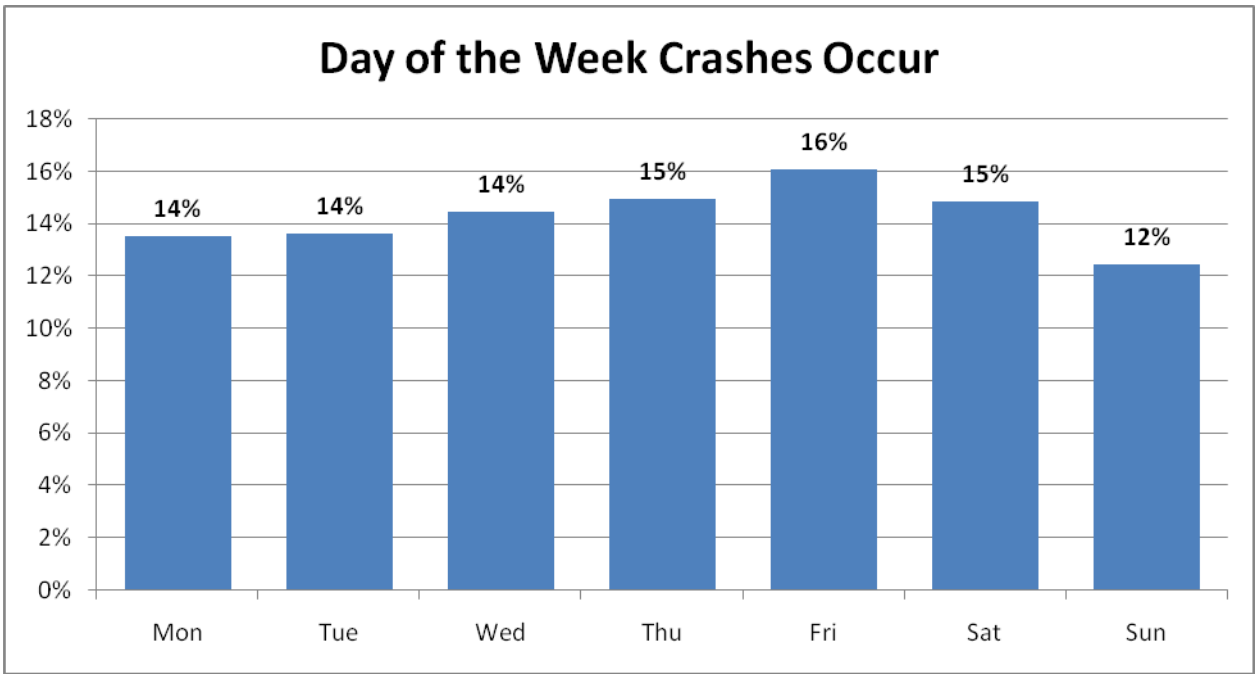

Figure 4 – Crashes on a Given Day of the Week (2007-2010)

Figure 5 shows the light conditions at the time of crash. About two-thirds of crashes occur during daylight hours.

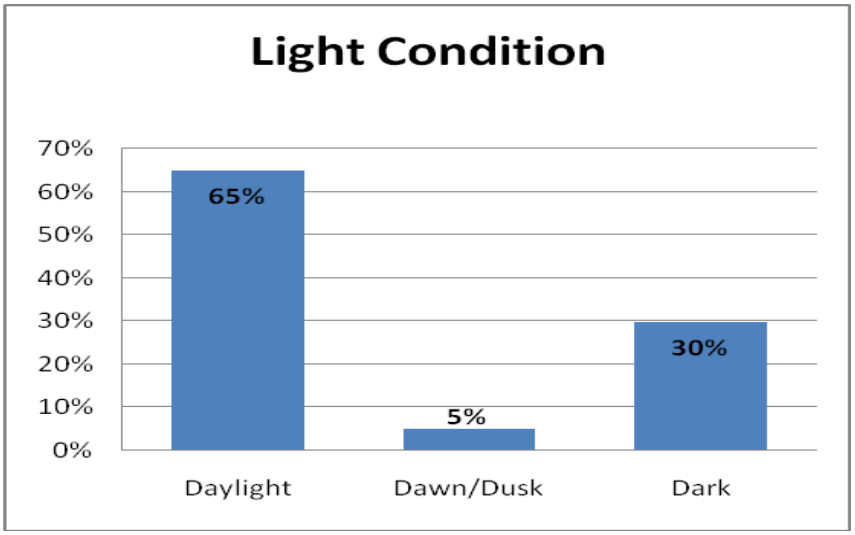

Figure 5 – Light Conditions During Crashes (2007-2010)

Road Conditions

Figure 6 represents the road surface at the crash location. Almost 90% of crashes occur on a paved road. This can be viewed in two ways – the Larimer County mainline road system includes about 60% paved roads and 40% non-paved roads –meaning about 90% of crashes occur on 60% of the roads. However, the paved roads see significantly more traffic than the non-paved roads. In fact, about 90% of the vehicle miles travelled on Larimer County roads occurs on paved roads.

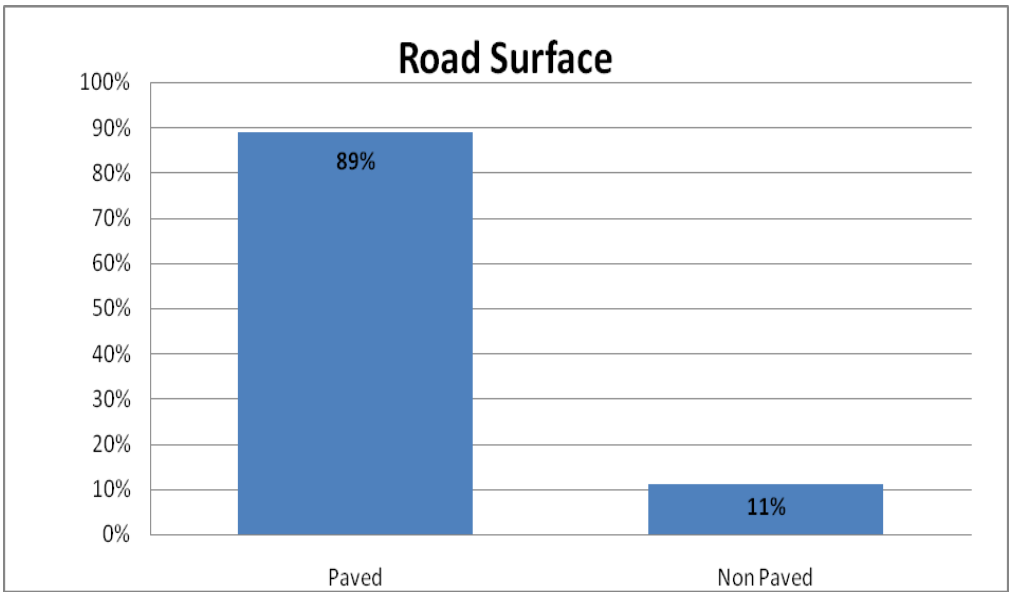

Figure 6 – Road Surface at Crash Location (2007 – 2010)

Figure 7 shows the condition of the road at the time of crash. 79% of all crashes occur on dry roads.

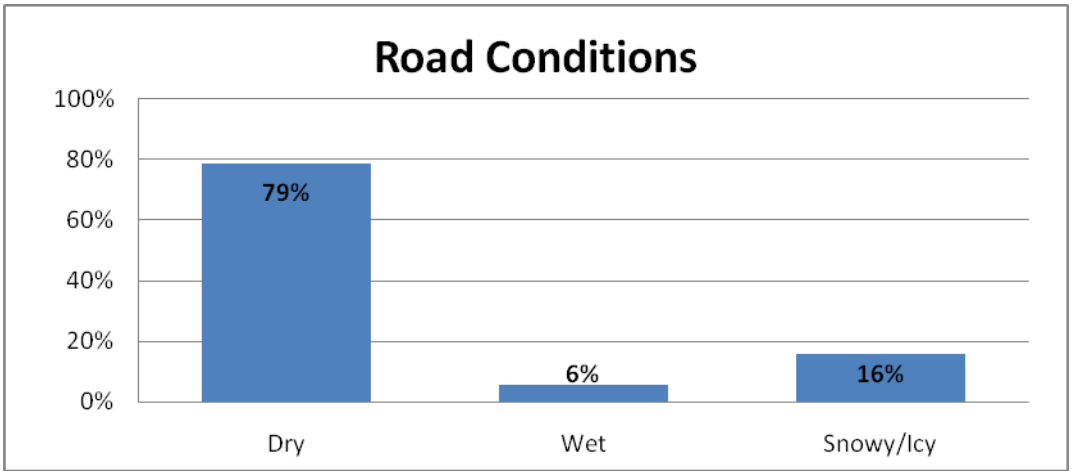

Figure 7 – Road Condition at Crash Location

When considered in combination, 46% of all crashes on unincorporated Larimer County roads between 2007 and 2010 occurred on dry, paved roads during daylight hours.

46%
of all crashes take place on dry, paved roads during daylight hours.

Crash 'Causes'

It is frequently difficult to identify what "caused' a crash; there may be no easily apparent reason, or alternatively, there may well be more than one contributing factor. So the information provided in this section is simply a reflection of information provided on the crash report. It may help to identify general trends, or areas of concern through further investigation.

Figure 8 shows the primary contributing factor to crashes in 2009 in the opinion of the responding officer. The form only allows one choice to be selected, so multiple factors are not identified.

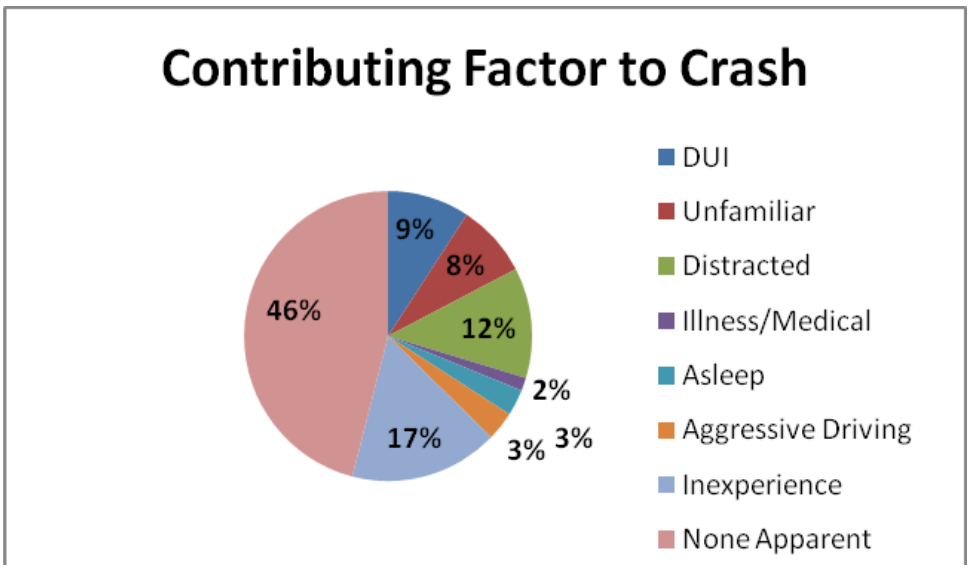

Figure 8 – Primary Contributing Factors (2007-2010)

Distracted Drivers

The percentage of drivers that were indicated to be 'distracted' as the ***primary*** contributing factor to the crash includes those distracted by passengers, cell phone, radio, etc. While the crash reports for Larimer County from 2007 to 2010 indicate this percentage to be 12%, the National Safety Council estimates at least 28% of all traffic crashes are initially a result of drivers using cell phones and texting. The Insurance Institute for Highway Safety indicates that drivers who use hand-held devices are four times as likely to get into crashes serious enough to injure themselves.

Figure 9 is a compilation of the driver action that resulted in the crash. As with the contributing factors discussed above, the crash report form only allows the responding officer to select one action that most closely identifies the action that resulted in the crash. Exceeding the safe speed and careless driving together accounted for almost 40% of all crashes from 2007 to 2010.

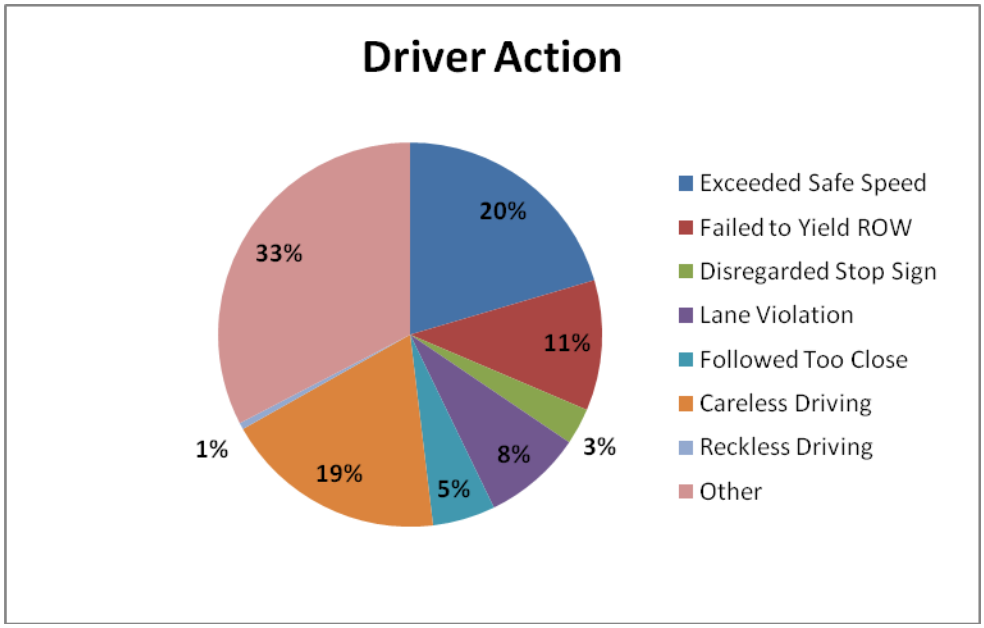

Figure 9 – Driver Action That Resulted in Crash (2007-2010)

During the field study of the chosen locations, Larimer County Engineering deciphers many different features in the road that might cause an increased safety concern as compared to some other areas.

Figure 10 shows the percentage of vehicles that collide with different objects while the crash occurs, which is classified in the crash reports as "Harmful Event".

The majority of crashes from 2007 to 2010 involved cars colliding with a moving vehicle. Although not the majority, cars colliding with "objects" during crashes was second most common at 35.6% of the crashes occurring from 2007 to 2010. While "object" could mean guardrail, traffic signs, and embankments, it also includes rocks and other off roadway items. Taking this into account during safety reviews, off road objects are considered as well as road characteristics while determining safety improvements for given locations.

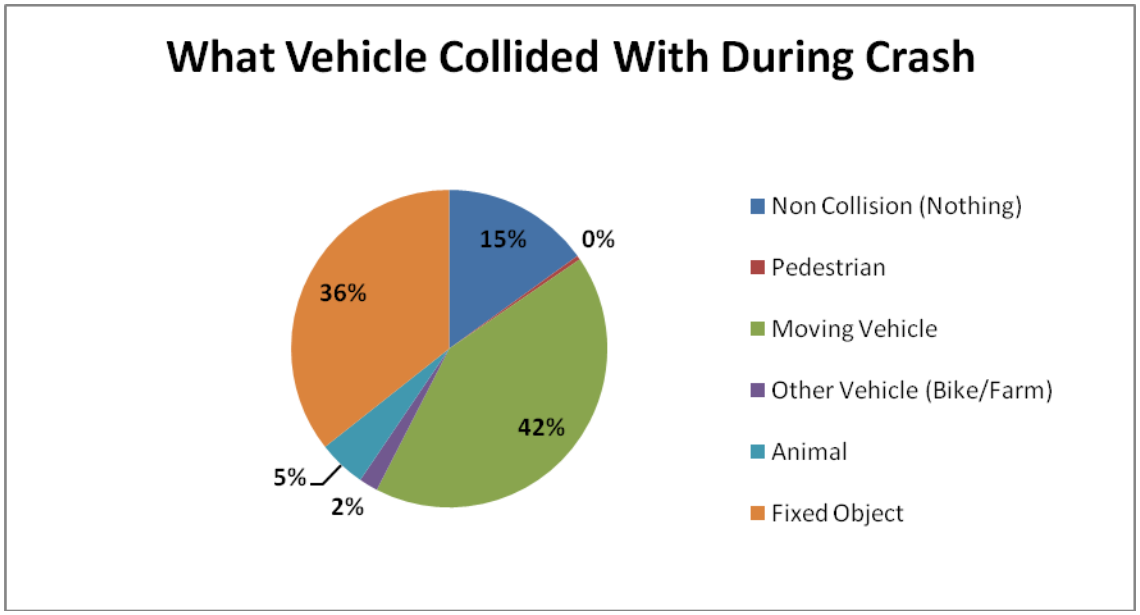

Figure 10 – Harmful Event (What Vehicle Collided with during Crash) (2007-2010)

Figure 11 shows the severity of crashes that occurred between 2007 and 2010 compared to the speed the cars were going when being involved in the crash. As can be seen by the data trends within Figure 11, as the speed of vehicles increases from the speed limit to more than 20 miles per hour over the speed limit, the severity of the crashes also rises significantly.

Likelihood of Injury in a crash more than **Doubles** for vehicles driving at least 20 mph over speed limit

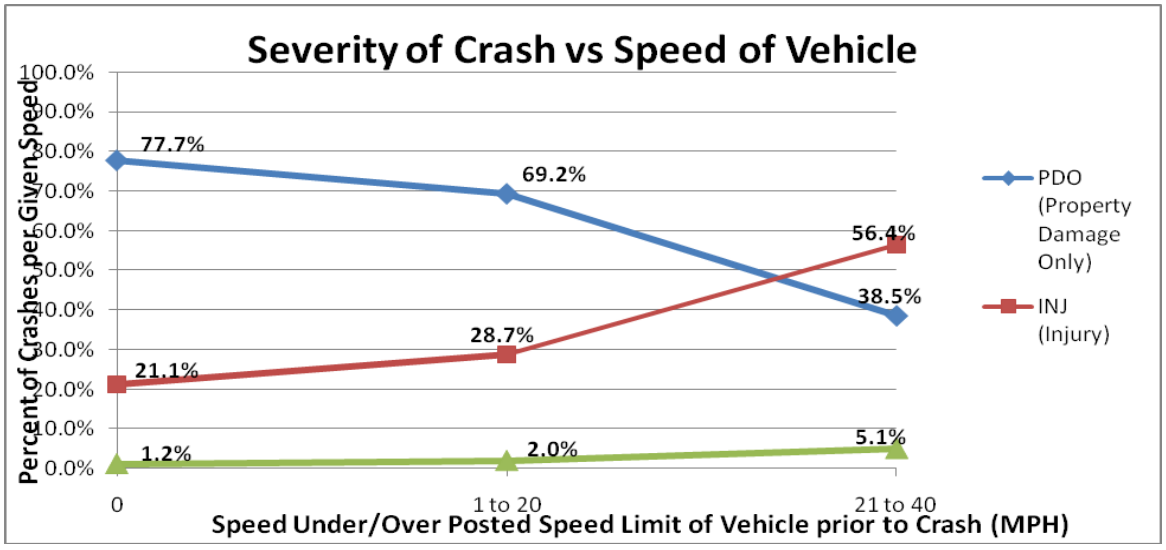

Figure 11 – Severity of Crash vs. Speed of Vehicle over Speed Limit

Driver information

Information about the driver of the vehicle responsible for the crash can be helpful in identifying appropriate target audiences for education programs. The information is more meaningful when it is compared to amount that a particular driver sub-set drives. Figures 12 and 13 are a compilation of crash statistics from 2007 to 2010 Larimer County (blue bars) and nationwide averages (red bars) for the amount those drivers drive (Federal Highway Administration - Office of Highway Policy Information data from 2000).

Figure 12 shows the statistics related to the gender of the driver. Figure 13 is a breakdown of the age of driver responsible for crashes. Because the data comes from two separate sources, a precise comparison should not be made, but rather the graph should be used to identify an overall trend.

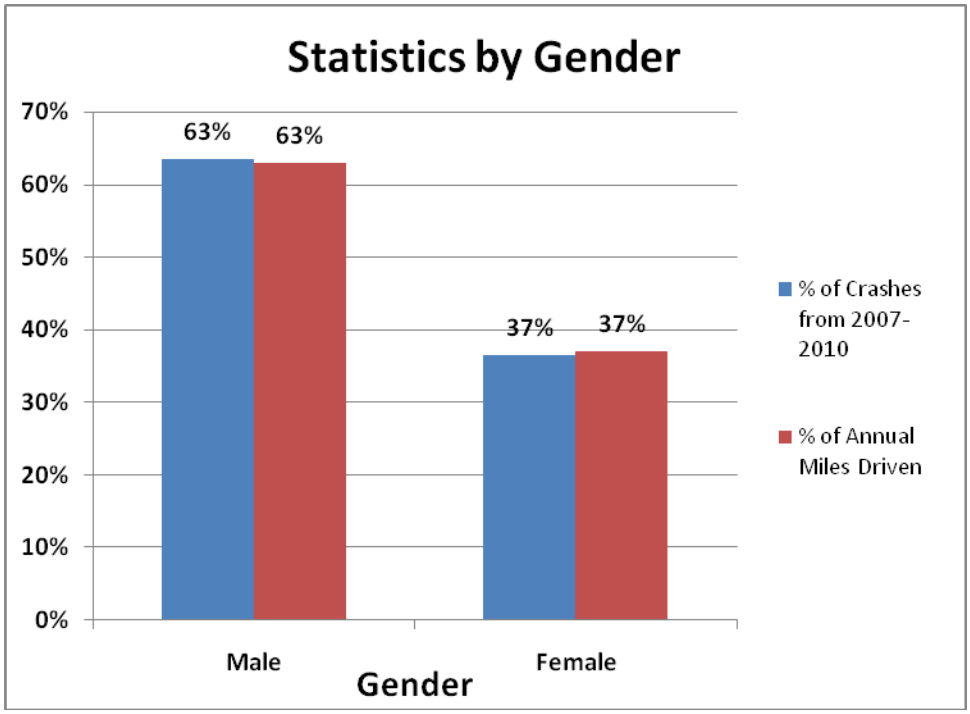

Figure 12 – Crash Statistics by Gender

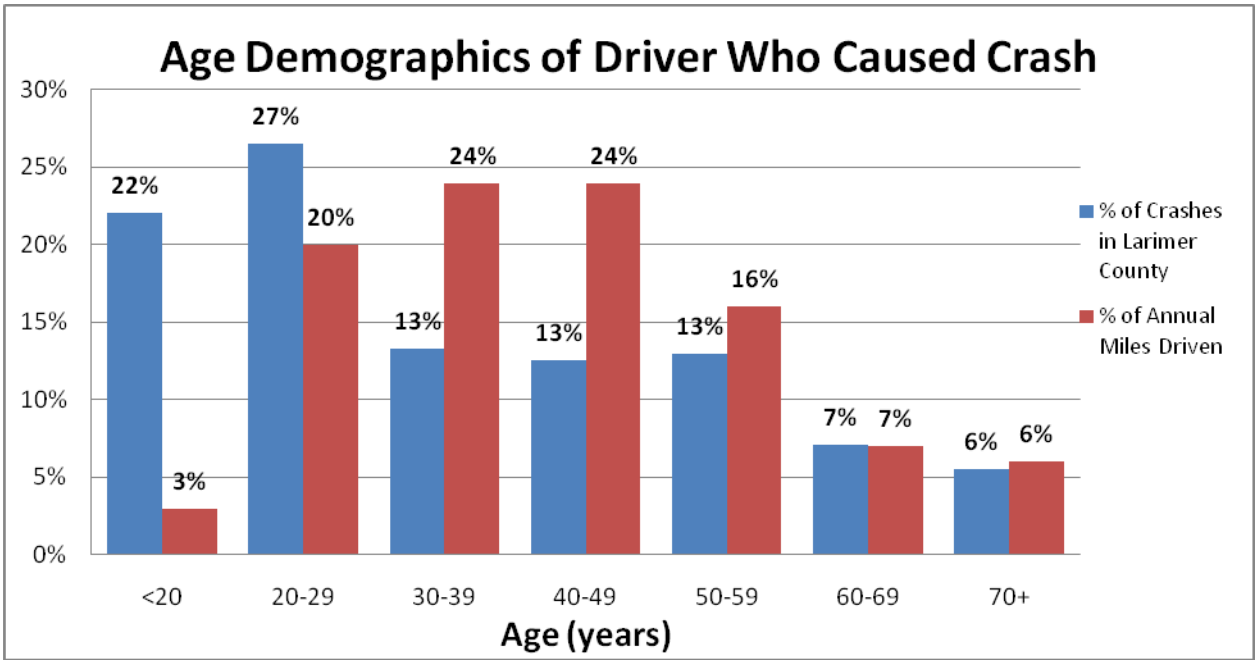

Figure 13 – Crash Statistics by Age Group

The item of note is that drivers under the age of 20 years drive only 3% of the total miles driven on the road system, but are involved in 22% of crashes. In general, drivers under 30 are significantly overrepresented in crashes.

As education programs are developed and marketed, this type of statistic is useful in identifying audiences that would most benefit from the programs.

Drivers less than 20 years old drive **3%** of total miles driven, but account for **22%** of crashes.

Vehicle Safety

In Figure 14 the severity of crashes was compared to whether or not the motorist was wearing a seatbelt at the time of the crash. The data contained no motorcycles, as the unavailability of a seatbelt on these vehicles would skew the data.

It was found that during a crash, drivers who used their seatbelts were significantly less likely to be injured or killed. In fact, drivers that did not use their seatbelts and were involved in a crash were 10 times more likely to be killed, 2 times more likely to be injured, and 1.25 times less likely to walk away with no injuries.

Law enforcement and public awareness/education is a large part in helping increase the number of people who wear seatbelts. Currently, driving without a seatbelt on is a secondary offense, making enforcement of wearing a seatbelt while driving a challenge.

Drivers not wearing seatbelts are **10** times more likely to be killed and **2** times more likely to be injured than drivers wearing seatbelts.

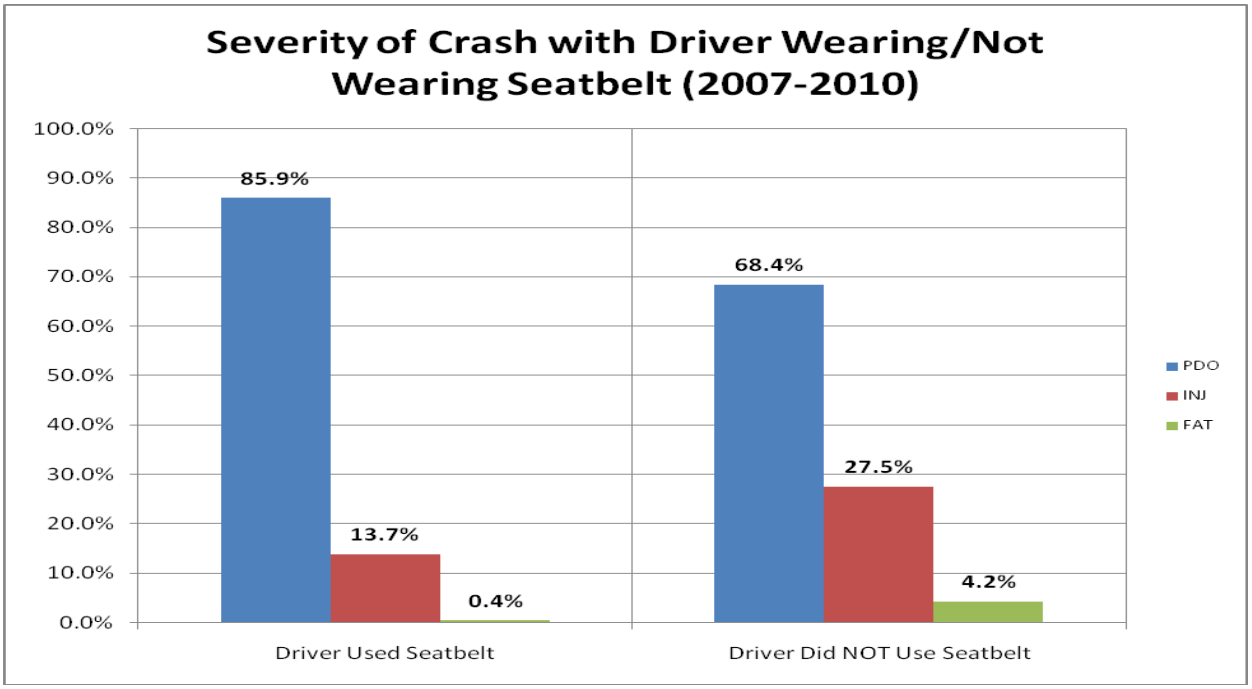

Figure 14 – Severity Compared with Seatbelt Use *(no motorcycles included)*

Motorcycles

The information gathered from the crash reports can be used for more specialized analysis each year. For instance, motorcycle crashes can be evaluated separately. Figure 15 shows the comparison of crash severity between the overall data and only motorcycle data. Overall, only 21% of crashes (in the past four years) have been severe crashes (injury or fatalities). However, 78% of motorcycle crashes that occurred during this time frame are severe.

Motorcyclists are **3.7** times more likely to be involved in a severe crash than drivers in vehicles

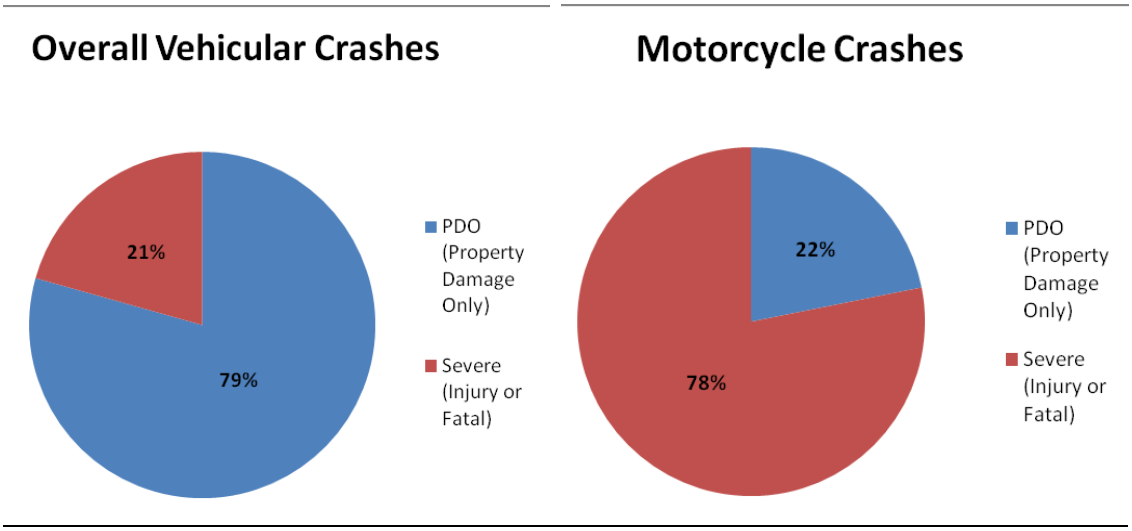

Figure 15 – Crash Severity Comparison for Motorcycles

Helmet information on crash reports began to be coded in 2007, and the data from the last four years is used below. Figure 16 visually shows that motorcyclists involved in crashes and NOT wearing helmets are 66% more likely to be killed. Cyclists wearing helmets are about 17% more likely to have no injuries in a crash.

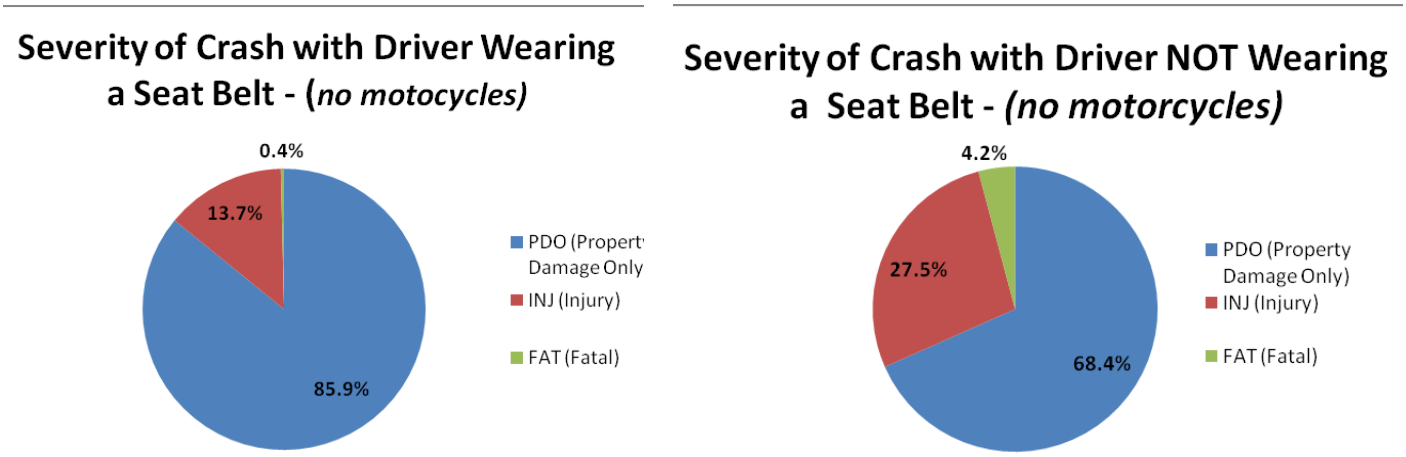

Figure 16 – Crash Severity Comparison for Helmet Use (2007 – 2010)

Motorcyclist Driving on CR 8E near Carter Lake

DUI Crashes

Contributing to almost 10% of the yearly crashes between 2007 and 2010, DUI (Driving Under the Influence) crashes are the third largest cause of crashes, when the classification of "other" is disregarded. This means that out of the number of crashes that occurred on Larimer County roads between 2007 and 2010 about 210 of them were due to a driver under the influence.

By analyzing the data presented in Figure 17 shown below, it can be seen that most DUI accidents occur on Saturday. Although the most crashes occur on Saturday, the number of DUI related crashes increases towards the end of the week and into the weekend.

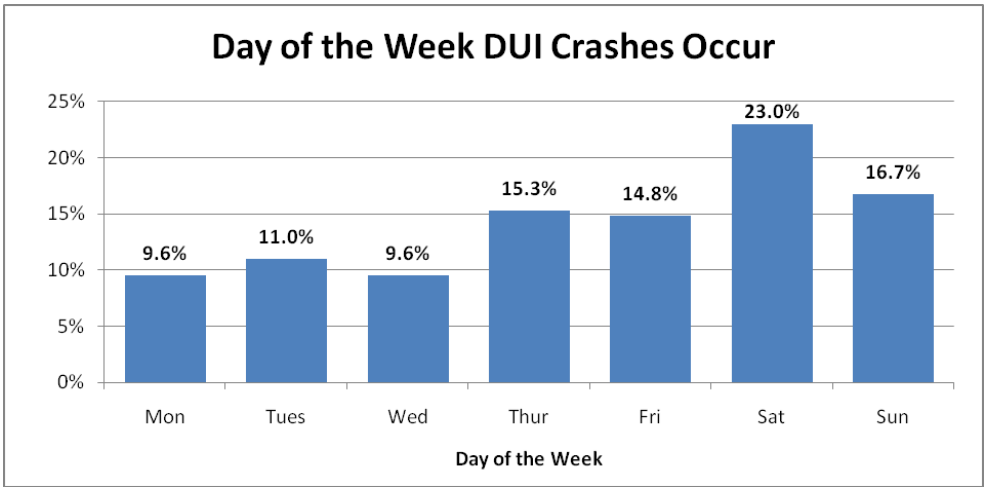

Figure 17 – Day of the Week DUI Crashes Occur

Figure 18 shows that the majority of DUI crashes occur between 6pm and 9pm, closely followed by the hours between 12am and 3am. Although the majority of DUI crashes occur late in the day and very early in the morning, the data shows that DUI crashes occur throughout all hours of the day.

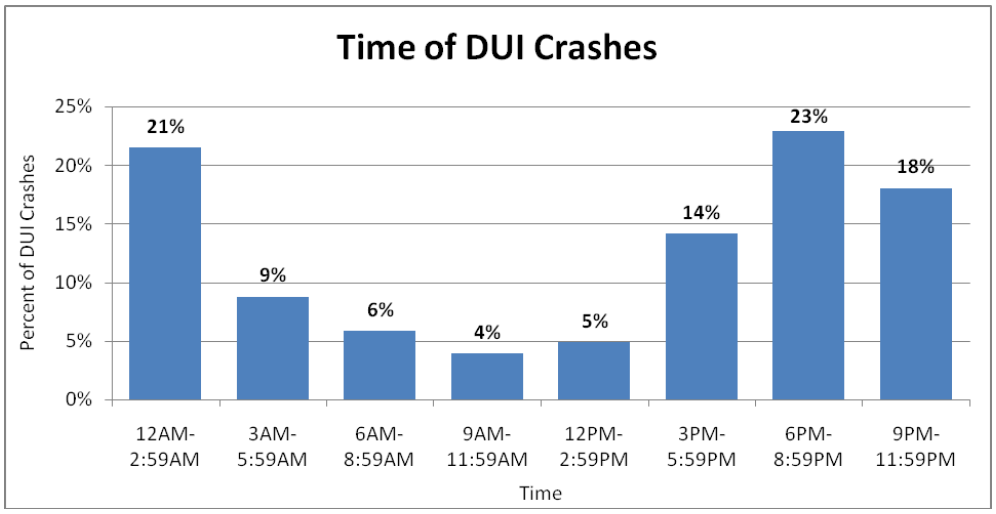

Figure 18 – Time of DUI Crashes (2007-2010)

Traffic Safety Assessment (Crash Rates)

The number of crashes is influenced by a lot of factors, including the volume of traffic using the road system. The crash statistics on different types of roads may not represent an unbiased comparison as the traffic volumes can vary dramatically. In order to account for varying amounts of traffic, a measure of crash ***RATE*** is used in addition to crash ***NUMBERS***. A crash rate is expressed in the number of crashes per 100 million vehicles miles traveled.

Figure 19 shows the 4-year historic crash rates. The PDO crashes are Property Damage Only, while the severe crashes are a combination of injury and fatal crashes. Similar to the trends shown in the crash volumes represented on page 3, crash rates have decreased. Specifically, the severe crash rate is 32% less than 4 years ago.

32%
Decrease in crash rate of severe crashes from 2007 - 2010

The increase in crash rate in 2009 for property damage only crashes may be attributed to the decrease in total vehicle miles travelled. That year, due to the economy and the price of gas, vehicle miles driven were 5% less than in 2007. With similar number of crashes but less miles driven, the crash rate goes up. The vehicle miles driven in 2010 returned to similar levels as 2007.

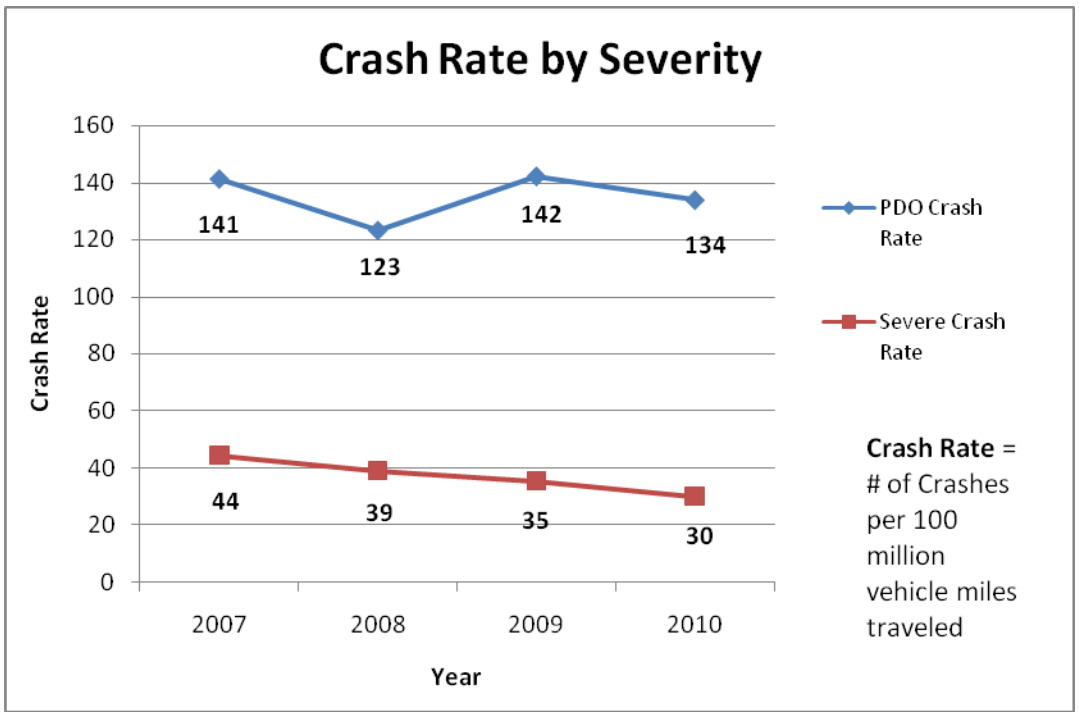

Figure 19 – Crash Rate by Severity

The crash rates can be further analyzed in more granular detail such as functional classification, pavement type and terrain type. Those graphs are in shown in Figures 20, 21, and 22 respectively on the following pages.

Figure 20 shows that the highest crash rates are on local roads, while the lowest crash rates are on arterials. This is partially a function of overall volume, since volumes on local roads are far less than volumes on arterials. In fact, volumes on local roads are often so low, that crash rates can become skewed by even a small number of crashes. Table 3 shows the comparative crash information for 2010 for the different functional classifications.

Table 3 – 2010 Statistics by Major Functional Classification

	Arterials	Collectors	Local Roads
2010 Number of Crashes	155	278	42
Vehicle Miles Traveled (in millions)	124.3	159.6	6.1
Crash Rate /100 million miles	125	174	686

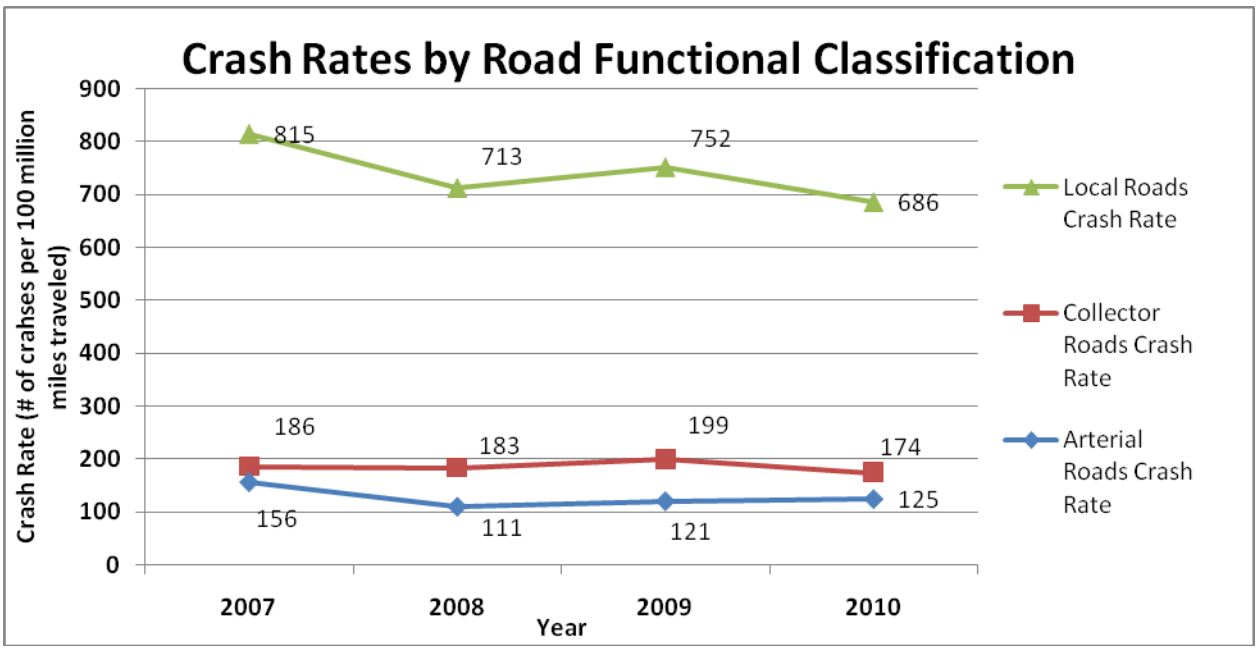

Figure 20 – Crash Rate by Road Functional Classification

Figure 21 shows the crash rates by pavement type – paved or non-paved roads and Table 4 provides some comparative context for the 2010 numbers.

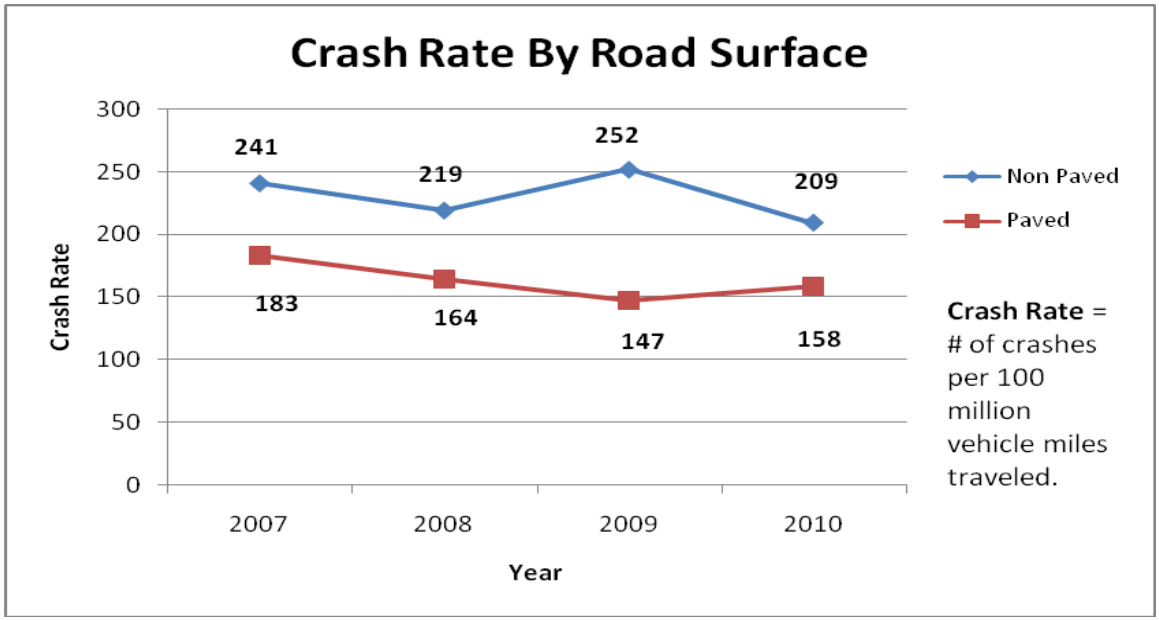

Figure 21 – Crash Rate by Road Surface

Table 4 – 2010 Statistics by Pavement Type

	Paved	Non-Paved
2010 Numbers of Crashes	411	64
Vehicle Miles Traveled (in millions)	259.3	30.6
Crash Rate /100 million miles	158	209
Percent of Severe Crashes	91.1%	8.9%

Figure 22 correlates the crash rate when compared to the distinctive terrain types in Larimer County. The mountainous (western portions of the county) crash rate been averaging around 150 crashes per 100 million miles driven over the past four years. Crash rates on flat/rolling sections of the county have been averaging about 180 crashes per 100,000,000 miles driven over the past four years.

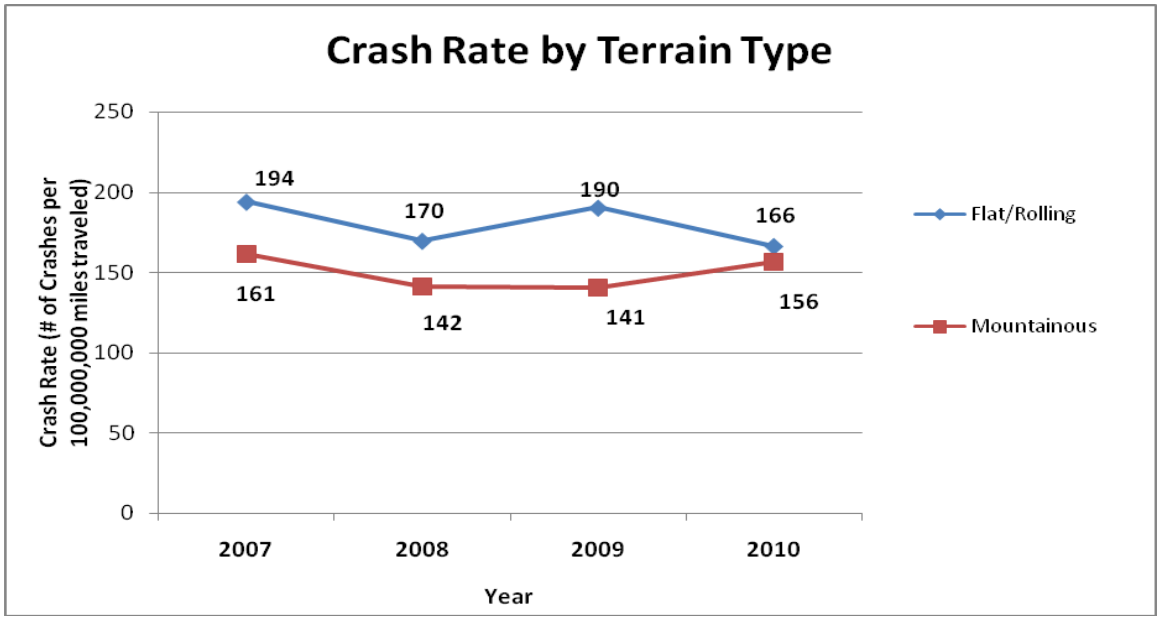

Figure 22 – Crash Rate by Terrain Type

Comparing Larimer County Crash Rates to Others

It is difficult to compare similar crash information between entities as calculations are completed in a number of different ways. However, it is important to gain a general understanding of how the County's road system compares to the state and national averages. Table 5 shows a similar comparison among local, state, and national values.

Table 5 – Fatality Crash Rate (per 100,000,000 miles driven) Comparison among Entities

	2007	2008	2009	2010
United States	1.36	1.27	1.13	-
Colorado	1.14	1.15	-	-
Larimer County	2.05	2.13	1.43	2.07

**US and Colorado numbers are the most current available at the time of this report.*

Transportation professionals often noted that rural two lane roads are the most dangerous part of the nation's road system. Travel on local urban road and the interstate system is, comparatively, safer than travel on rural county roads. Table 5 indicates that in 2008 (last comparable year) the Larimer County road system, the majority of which encompasses rural roads, had a fatality rate of about twice that of the state of Colorado.

Rural two-lane roads remain the most dangerous part of the road system. Larimer County's fatality rate is almost **2 Times** that of the national average.

Cost Impacts of Crashes

In 2009 the National Safety Council estimated that the cost for each traffic death is $1,300,000, while an injury ranges between $12,000 and $68,000. These costs represent loss of wages, productivity, medical expenses, administrative expenses, motor vehicle damage and employers' uninsured costs.

Using 2010 crash numbers with 2009 monetary values, the cost to society of severe traffic crashes in unincorporated Larimer County is about $11 million dollars per year.

$ 11 Million
Annual cost of crashes on the Larimer county road system.

Chevron Signs on CR 19 S-Curves north of CR 60E

Rumble strips and flashing beacons at CR 70 and CR 15

2010 Safety Program

The Low Cost Roadway Safety Program just finished its second year, and it is expected that the program will continue to develop over the course of the next few years. As noted in the introduction, there are five 'Es' of traffic safety. In time, this program is intended to, at some level, address each area of importance.

Engineering

The engineering aspect of traffic safety was the area of most effort during the first and second year. The Engineering Department staff evaluated the safety of the road system in several ways to identify an initial list of potential candidates for improvements:

- The crash database was mined for locations with high accident counts.
- All locations of fatalities and associated accident reports in the past five years were reviewed.
- A map of crash locations and severities for the past three years was developed with the GIS system (see sample in Figure 23). This map was visually reviewed for areas of concern

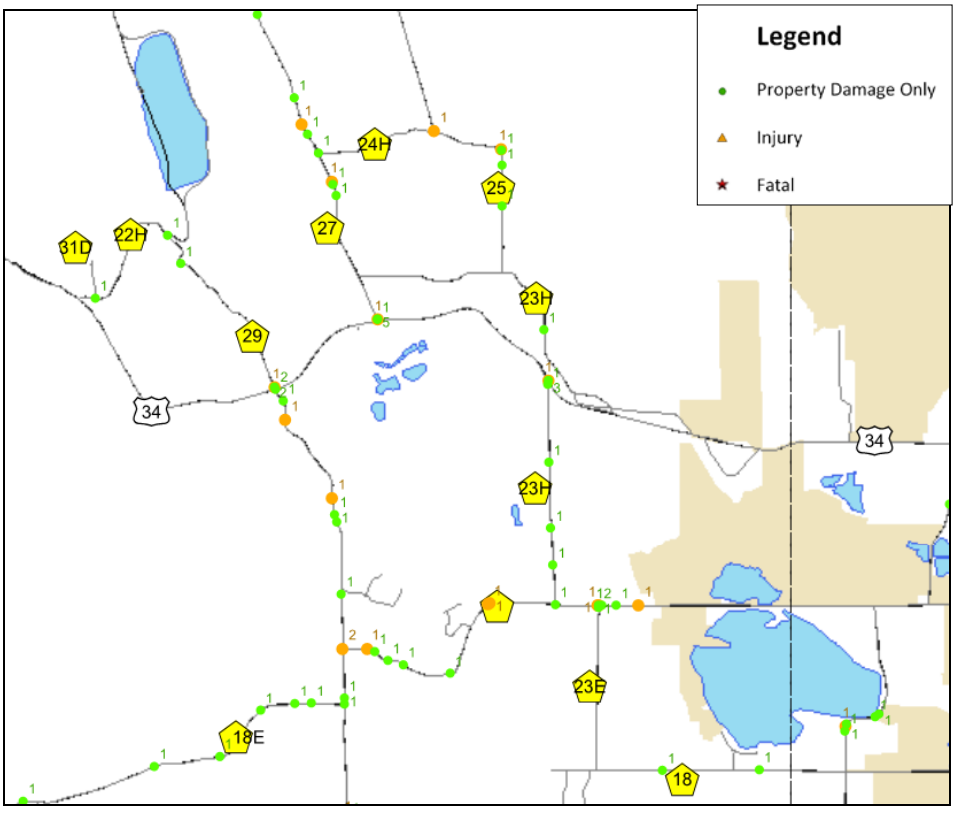

Figure 23 – Sample Crash Map for 2007-2009 Crashes

With an initial list of potential locations, specific crash data for those hot spots was compiled. Areas of single crashes on low volume roads were eliminated, and crash rates that adjust for traffic volumes

were calculated. The crash rate in a specific location was then used to finalize the locations that would undergo the review process done by the Larimer County Engineering Department.

In the first year of the program, a number of intersections and short roadway segments were audited for safety and targeted for low cost upgrades. Those locations are now in the monitoring portion of the program to determine the level of improvement, or if additional work may be needed. In the meantime, in 2010, a list of seven (7) longer roadway corridors became the list of candidates for a road safety audit.

Each location was field reviewed and a plan of improvement was developed. Many of the audit results recommended improvements that were appropriate for the Low Cost Safety Program – this included improved signing, striping, using thermoplastic pavement markings, changes to high intensity sheeting on signing, and sight distance review. Work orders for these areas are then written, and Road and Bridge Department staff completes much of the work.

A list of the Engineering improvements is shown in Table 7. Figure 24 shows the locations of the improvements throughout the County.

Education/Encouragement

The education and encouragement portion of the program will be further developed over the course of the next several years. The intent is to utilize the analysis of the data to specifically target potential audiences (such as young drivers). Education programs such as a presentation on 'how to drive a roundabout' have been undertaken at a local high school, and a brochure is available on the website.

Enforcement

The enforcement of traffic safety rests within the jurisdiction of the Sheriff's Department. The information compiled in the safety report on an annual basis can be used by the Sheriff's Department to identify additional enforcement zones.

Initial contact with law enforcement has been positive, and a continued partnership will be pursued. For example the identification of day of the week and time of day crashes in specific areas during the summer season can be used to better understand problematic areas.

Evaluation

Evaluation and monitoring is a very important component of a safety program, and is discussed in detail in the following section on page 25.

Program Costs

The program was funded in 2010 with an allocation of $65,000. Table 6 summarizes the programs expenditures for 2010.

Table 6 – 2010 Safety Program Expenditures

Type Of Work	Cost
Thermoplastic striping	$32,800
Sign materials	$5,917
Speed limit radar signs	$6,750
Bike path upgrade in LaPorte	$11,492
Tether wire on span wire signal at Overland Trail	$1,338
Add short distance of shoulder to create bike lane along CR 54G east of Overland	$5,690
Total	**~$64,000**

Table 7 – 2010 Safety Program Engineering Improvements

No.	Location	Crashes		Field Review	Type of Work	Comments
		PDO	Severe			
Segments						
1	CR 8E - from CR 31 to 1.0 mile west of CR 23	16	13	Summer 2010	Signage	Signs installed
2	CR 52E – Rist Canyon from Davis Ranch Rd to CR 27E	13	5	Summer 2010	Upgrade Signaling, Signing, Advisory Speed Plaques	Work order in progress.
3	CR 54G – from CR 52E east to US 287	34	9	Summer 2010	Relocate Crosswalk, Signage, Additional Shoulder Paving	Signage work in progress. Shoulder widened to ~4'.
4	CR 27 – from US 34 north to CR 29	8	3	Summer 2010	Deer Xing Warning Signs	Work not yet completed.
5	CR 9 – from CR 52 to CR 54	4	2	Summer 2010	Delineator Installation, 2 Warning Signs	Signage work in progress.
6	CR 9 – from CR 56 to CR 58	8	0	Summer 2010	None identified	No Recommendations Made
7	CR 18 – east of I-25	15	5	Summer 2010	Under review	
Miscellaneous Improvements						
8	Preformed Thermoplastic Work at turn lane and railroad crossing locations throughout the County				Work Completed	

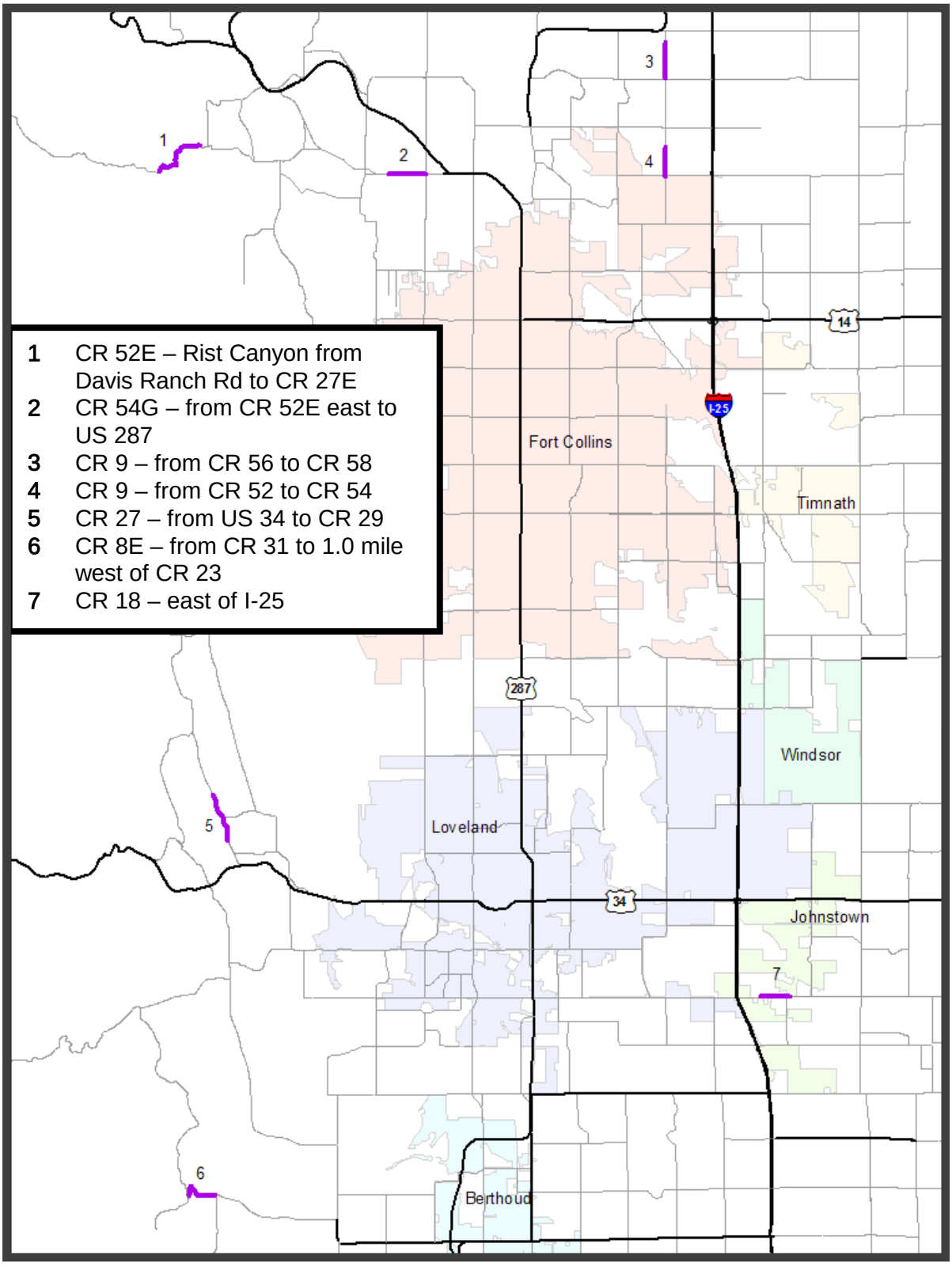

Figure 24 –2010 Low Cost Safety Program Improvement Corridor Review Locations

Monitoring and Evaluation

With the program now in its second year, the monitoring and evaluation of improvements has begun. It should be noted that not a lot of data is yet available for post-improvement comparison, and additional years of data will provide a more thorough review.

Table 8 show a before and after comparison of crash frequency at intersections that were improved in the first year of the program, and have had at least one year of time since improvements were made.

Table 8 – 2009 Low Cost Safety Location Crash Review (Intersections)

Intersection	Time Frame	PDO	INJ	FAT	Total Avg	Minor	Severe	Date Improved	Notes
Intersection of CR 52E (Rist Canyon) and CR 25E	Before Improvements	0.75	0.25	0	1	0.75	0.25	12/7/2009	Average 4 years before improvements and 1 year after
	After Improvements	0	0	0	0	0	0		
	Change	100%	100%	0%	100%	75%	25%		
	Type of Improvement	Additional warning signs and upgraded sign material							
Intersection of CR 17 (Shields) and CR 54 (Douglas)	Before Improvements	1.5	0.25	0	1.75	1.5	0.25	11/1/2009	Average of 4 years before improvements and 1 after
	After Improvements	2	0	0	2	2	0		
	Change	-33%	100%	0%	-14%	-33%	100%		
	Type of Improvement	Upgrade sign materials, added pavement markings							
Intersection of CR 28 and CR 11C	Before Improvements	2.75	0.25	0	3	2.75	0.25	11/18/2009	Average of 4 years prior to improvements and 1 year after
	After Improvements	7	0	0	7	7	0		
	Change	-155%	100%	0%	-133%	-155%	25%		
	Type of Improvement	Additional pavement markings							
Intersection of CR 23E and CR 4	Before Improvements	1	0.4	0	1.4	1	0.4	2/5/2010	Average of 5 years before improvements and 1 year after
	After Improvements	0	0	0	0	0	0		
	Change	100%	100%	0%	100%	100%	100%		
	Type of Improvement	Added pavement markings, cross street warning signs, and speed limit signs							
Intersection of CR 11C and CR 46E	Before Improvements	3.5	0.25	0	3.75	3.5	0.25	11/19/2010	Average of 4 years before improvements and 1 after
	After Improvements	0	0	0	0	0	0		
	Change	100%	100%	0%	100%	100%	100%		
	Type of Improvement	Relocated signs, upgraded material, added cross street warning signs, pavement markings, painted minor street centerline							
Intersection of CR 11 and CR 30	Before Improvements	1.75	1	0	2.75	1.75	1	11/10/2009	Average of 4 years before improvements and 1 year after
	After Improvements	6	0	0	6	6	0		
	Change	-243%	100%	0%	-118%	-243%	100%		
	Type of Improvement	Upgraded sign materals, added pavement markings. *(Now slated for capital project improvement)*							
Intersection of CR 5 and CR 48 (Vine)	Before Improvements	0.25	0.5	0	0.75	0.25	0.5	10/25/2009	Average of 4 years before improvements and 1 after
	After Improvements	0	0	0	0	0	0		
	Change	100%	100%	0%	100%	100%	100%		
	Type of Improvement	Upgraded sign materials, added stop ahead pavement markings							

Of the seven intersections where improvements were made and enough time has elapsed to allow at least one year of review, the reduction in severe crashes is almost 3 injury crashes per year.

In some locations, the monitoring program has shown although the severity of crashes has decreased, the number of crashes remains high and is of concern. Those locations can then be re-evaluated for additional safety improvements. For example, the intersection of CR 11 and CR 30 has now been targeted for a capital improvement project and federal funding for its costs is being sought.

Table 9 shows the available information for road segments that were improved in the first year of the program. As with the intersections, several locations show considerable improvements, with an average of more than 5 fewer injury crashes per year.

At the CR 27 turn north of Rist Canyon, while the additional signage seems to have improved the severity of crashes, the total number of crashes continues to be a concern. That location was recently submitted for a Hazard Elimination Safety project (HES) and funding secured for re-alignment.

Table 9 – 2009 Low Cost Safety Location Crash Review (Road Segments)

Segment	Time Frame	PDO	INJ	FAT	Total Avg	Minor	Severe	Date Improved	Notes
CR 50E (Near top of the hill)	Before Improvements	0	1	0	1	0	1	12/15/2009	Average 4 years before improvements and 1 year after
	After Improvements	0	0	0	0	0	0		
	Change	0%	100%	0%	100%	0%	100%		
	Type of Improvement	Added turn and chevron warning signs, ugraded sign material							
CR 38E (West of CR 19 (Taft))	Before Improvements	1.2	1.4	0.2	2.8	1.2	1.6	11/1/2010	NOT ENOUGH DATA AFTER IMPROVEMENTS
	After Improvements	0	0	0	0	0	0		
	Change	NA	NA	NA	NA	NA	NA		
	Type of Improvement	Side slope reshaping, cleared vegetation to improve sight distance, upgraded sign material							
CR 16 (Between CR 21 (Overland) and CR 19 (Taft))	Before Improvements	2.75	0.75	0.25	3.75	2.75	1	6/1/2010	Average of 4 years before improvements and 1 after
	After Improvements	2	0	0	2	2	0		
	Change	38%	100%	100%	88%	27%	100%		
	Type of Improvement	Relocated signs, upgraded sign material, added large arrows and chevrons							
CR 27 (At turn north of CR 52E (Rist Canyon))	Before Improvements	0.25	2	0	2.25	0.25	2	10/20/2009	Average of 4 years before improvements and 1 year after
	After Improvements	2	0	0	2	2	0		
	Change	-800%	100%	0%	13%	-800%	100%		
	Type of Improvement	Relocated signs, upgraded sign material, added warning signs							

Damaged Guardrail on CR 27. A realignment project will further enhance safety.

Overall, the low cost safety program in just its first year saw an average annual reduction of more than 8 injury crashes.

There have been several locations where county staff completed various safety projects prior to the initiation of this program. A few of those improvements are listed in Table 10 and 11 and their safety statistics in the years prior and years after installation.

8
Annual reduction in injury crashes at locations improved through Low Cost Safety Program

Table 10 – Other Safety Improvement Monitoring (Intersections)

Intersection	Time Frame	PDO	INJ	FAT	Total Avg	Minor	Severe	Date Improved	Notes
Intersection of CR 70 (Owl Canyon) and CR 15	Before Improvements	1	1.67	0	2.67	1	1.67	March, 2008	Average of 3 years before improvements and 2 after
	After Improvements	0	0	0	0	0	0		
	Change	100%	100%	0%	100%	100%	100%		
	Type of Improvement	4-way stop with flashing beacons, added signing, rumble strips							
Intersection of CR 21C (Overland) and CR 50 (Michaud)	Before Improvements	0.67	0.33	0	1	0.67	0.33	6/9/2008	Average of 3 years before improvments and 2 years after
	After Improvements	0.5	0.5	0	1	0.5	0.5		
	Change	33%	-50%	0%	0%	25%	-50%		
	Type of Improvement	Added chevron warning signs, upgraded sign material							
Intersection of CR 19 (Taft) and CR 48 (Vine)	Before Improvements	3.5	1	0	4.5	3.5	1	8/1/2007	Average of 2 years before improvements and 3 after
	After Improvements	4	0	0	4	4	0		
	Change	-14%	100%	0%	13%	-14%	100%		
	Type of Improvement	Replaced 4-way stop with modern roundabout							
Intersection of CR 9 (Boyd Lake) and CR 30	Before Improvements	4	1.33	0	5.33	4	1.33	8/1/2009	Average of 3 years before improvements and 1.5 years after
	After Improvements	2	0	0	2	2	0		
	Change	50%	100%	0%	63%	50%	133%		
	Type of Improvement	Replaced 2-way stop with modern roundabout							

Table 11 – Other Safety Improvement Monitoring (Road Segments)

Segment	Time Frame	PDO	INJ	FAT	Total Avg	Minor	Severe	Date Improved	Notes
CR 19 (between CR 38 (Harmony) and CR 40 (Horsetooth))	Before Improvements	10	3	0	13	10	3	2006	Average of 1 year before improvements and 3 after
	After Improvements	4.67	1.33	0	6	4.67	1.33		
	Change	114%	125%	0%	117%	53%	56%		
	Type of Improvement	Added 2-way center turn lane							
CR 19 (S-Curve between CR 60E and CR 64)	Before Improvements	0	1	0	1	0	1	2006	Average of 1 year before improvements and 2 years after
	After Improvements	0	0.5	0.5	1	0	1		
	Change	0%	100%	-100%	0%	0%	0%		
	Type of Improvement	Added warning signs and chevrons, upgraded sign material							

** Severe crash refers to a combination of injury and fatal crashes.*

The change in the number of crashes at these locations is substantial. These various projects show an ANNUAL improvement of about 8 minor crashes and 6 injury crashes.

As additional data is gathered, each of the areas will be closely monitored to determine the impact of the improvements, and identify whether additional changes may be beneficial. While a reduction in crashes and/or their severity may be attributed to the program, an increase in crashes is not likely associated the improvements. Continued high crash numbers simply indicated a greater need at a particular location than what the low cost safety program may be able to offer. In those cases, the location may be referred to a capital improvements projects, or state/federal safety funding pursued.

The monitoring will also review the safety benefits among different improvement treatments and their costs. Classifying the most effective treatments (in terms of cost/benefit) in the safety toolbox will be helpful when considering solutions in future problem areas.

Cost Savings Due to Safety Improvements

Monitoring of the locations where improvements have been made through the Low Cost Safety Program in the first year indicates a total of 8.5 fewer injury crashes per year. This number should be discounted by 5% to reflect the overall decrease in crashes between 2009 and 2010 – resulting in an estimate of 8 fewer injury crashes due to the Low Cost Safety Program.

Using the cost figures from the National Safety Council (see page 19) and utilizing an average societal cost for in injury crash of $40,000, this represents a savings of about $320,000 per year to the community within Larimer County. Since the budget for the program is only $65,000 per year, the return on investment for the program is a factor of 5.

A review of crash statistics from locations where other safety related projects have been completed in the past few years shows an annual reduction of 6 fewer injury crashes. This represents a cost reduction of $240,000 per year to the overall community.

$ 320,000
Annual societal cost savings due to Low Cost Roadway Safety Program

As the Low Cost Roadway Safety Program continues in future years, it is expected that the minor investment will continue to have a considerable impact in lowering crash numbers, reducing severity, and realizing significant cost savings to society.

What About Roundabout Safety?

Two roundabouts have been built in unincorporated Larimer County. They were constructed to address both capacity / function issues as well as safety issues.

From a function and capacity level of service, the intersections are now performing at a much higher level than before construction. A safety review shows that on average, the intersections have 1.5 fewer minor crashes per year, and 2.3 fewer injury crashes per year. In terms of percentages, it is an overall 20% reduction in minor crashes and a 100% reduction in severe crashes. These types of safety enhancements are typical with the construction of modern roundabouts, and the County will continue to consider roundabouts as a potential intersection improvement type in coming .

Roundabout at CR 30 and CR 9

Roundabout at CR 19 (Taft) / CR 48 (Vine)

Looking Forward

The 2009 Low Cost Safety Program was a time for program planning, establishment, and initial implementation. The 2010 Low Cost Safety Program was a time for final implementation of the solutions from the 2009 program, analysis of more additional locations, and monitoring of completed implementations. Much of the groundwork has been laid, many implementations have been carried out, and monitoring of locations where solutions have been implemented has been conducted, thus allowing additional efforts to be undertaken in 2011.

In the education, encouragement, and enforcement arenas, 2011 will be a year of program and partnership development.

As the first data continues to be collected from the improvements made in 2009 and in 2010, the evaluation program will be refined.

Roadway safety is a vital component of local government. This low cost program is expected have a substantial, quantifiable, and lasting positive impact on the citizens of Larimer County.

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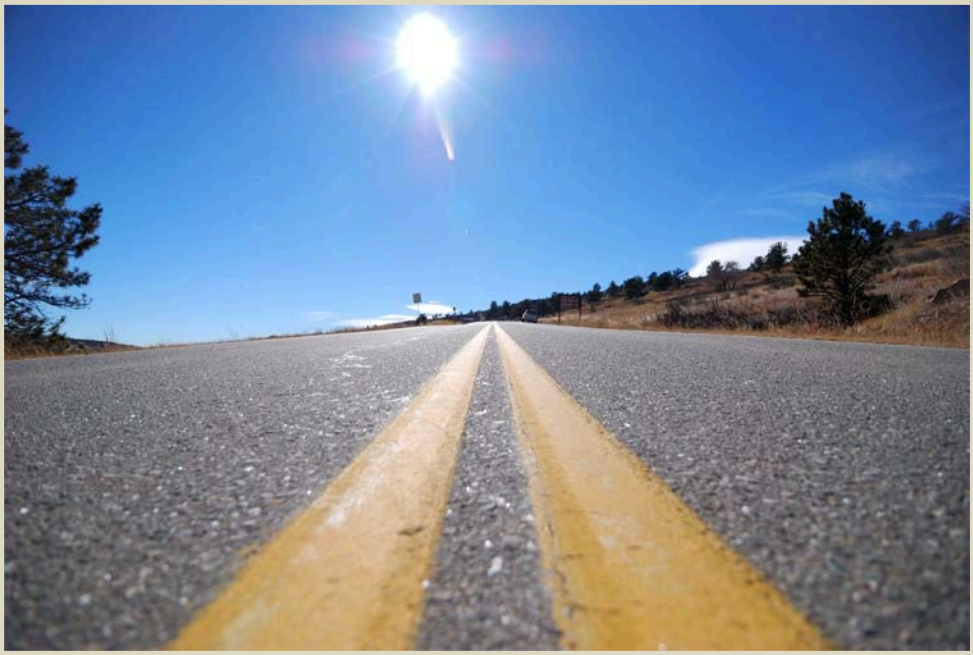

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