



LARIMER COUNTY
COMMITTED TO EXCELLENCE

# Low Cost Roadway Safety Program

## 2011 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. The intent was 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.

*2011 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:

- In the past five years, overall numbers of crashes are down 25%, although the percentage of severe crashes (injury and fatals) has increased.
- After several years of decreases, the percent of severe crashes (either injury or fatal) compared to total crashes has increased to 23%.
- More than one-half of all crashes on unincorporated Larimer County roads are single vehicle crashes.
- 46% of all crashes take place on dry, paved roads during daylight hours.
- Drivers less than 20 years old drive only 5% 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; and motorcyclists not wearing helmets are 3 times more likely to die in a crash than those wearing helmets.
- Driving under the influence or distracted driving are a contributing factor in 24% of all crashes.
- 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 societal cost of crashes on the Larimer County road system is $ 12 million.

*2011 Safety Program*

The program is funded with $65,000 per year. The 2011 Safety Program included ten locations for roadway safety audits to identify engineering improvements. Two radar speed display signs were purchased to support the education portion, and information on the program was shared on a regional and national level. An interdisciplinary team of engineering, sheriff and state patrol staff has been created for coordination and collaboration on traffic related safety issues.

*Program Evaluation*

There has been an annual crash reduction of eight (8) injury or fatal crashes at locations improved through the Low Cost Safety Program. The societal savings of this $307,000 annually. This results in a benefit to cost ratio of more than 4.

Other locations that were analyzed through the program and higher cost improvements made resulted in 5 fewer severe crashes and 10 fewer minor crashes each year. This is an annual societal savings of about $300,000.

Two guardrail projects were recently completed and monitoring of those locations has begun. The need for the improvements was identified through the program, and successful funding was obtained through the federal hazard elimination and safety (HES) fund. In the four years prior to improvements, the locations saw a combined crash history of 22 crashes, including 2 fatalities. Since the installation (about 18 months ago), there have been 2 minor, non-injury crashes.

Roundabouts continue to show a safety benefit. There has been a 90% reduction in injury crashes at locations where roundabouts have been built in Larimer County.

*Summary*

Roadway crashes remain an everyday occurrence on Larimer County roads, and their impacts are significant. The Low Cost Safety Program is key in understanding, identifying, implementing and evaluating improvements.

The program has a substantial, quantifiable decrease in crashes at locations improved through the program, or identified through the program and improved through other funding sources. Ultimately, this results in a lasting positive impact on the citizens of Larimer County.

# Introduction

Program Purpose and Goal

The Larimer County Low Cost Roadway Safety Program, established in 2009 provides the policy, process, funding, and tools to systematically identify, prioritize, mitigate and evaluate the performance of transportation safety investments.

Traffic crashes cause loss of life, injuries, and property damage. Costs associated with crashes (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.

The goal is to 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. The benefit of a safety program is to save lives, reduce injuries, increase awareness, and better understand safe design practices and their payback.

Program Organization and Process

The toolbox of potential solutions is quite varied, and the program is organized to allow for flexibility and innovation. The program allows consideration of the roadway, vehicles, and drivers; engineering solutions are intended to be implemented 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 | February |
| 3. Data Analysis | Identify top locations of concern (intersections and segments)<br>o Use report card, maps, hot spot analysis and crash rate calculations | March - May |
| 4. Roadside Safety Audits | Road Safety audits<br>o Statistics analysis, field review<br>o ID contributing factors and countermeasures<br>Identify improvements and potential funding sources | June - August |
| 5. Prioritization and planning | Project Prioritization<br>Determine which will be constructed<br>Identify specific funding source for project. | July - August |

| | | | |
|---|---|---|---|
| 6. | Implementation | Implement improvements | August – November |
| 7. | Monitor / Review | Review projects from previous years<br>Re-run crash analysis<br>Evaluate effectiveness | December - January |
| 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. | The spring of the following year. |

## 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 works with the state patrol office to get copies of the crash reports in unincorporated Larimer County. The reports are reviewed, annotated, the data is input into the County's accident database, and then further refined as it is transferred to the Geographic Information System (GIS).

The analysis provided in this section is garnered from both the County's accident database, and GIS system. Many of the graphs reflect a 5-year crash history from 2007 – 2011.

## Overall Crashes

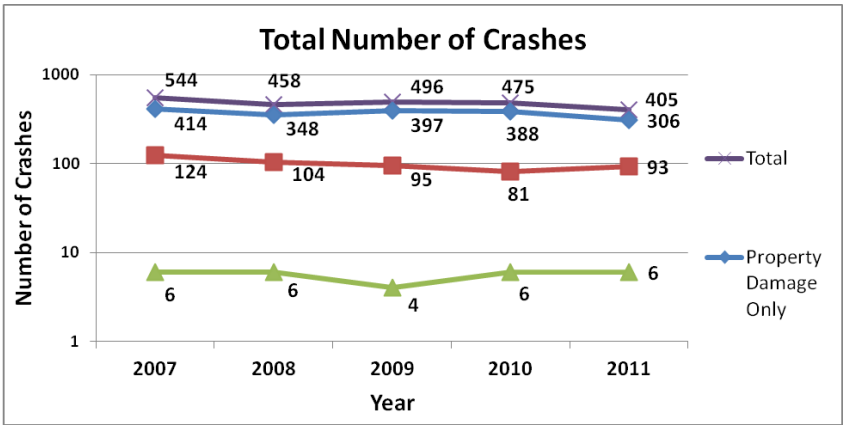



*Figure 1 – Total Number of Crashes*

The overall trend in numbers of crashes continues to be downward – overall 25% fewer crashes in 2011 than in 2007.

Injury crashes are down over the 5-year period, although up a little from 2010.

**25%**
Fewer
Crashes
In last five years

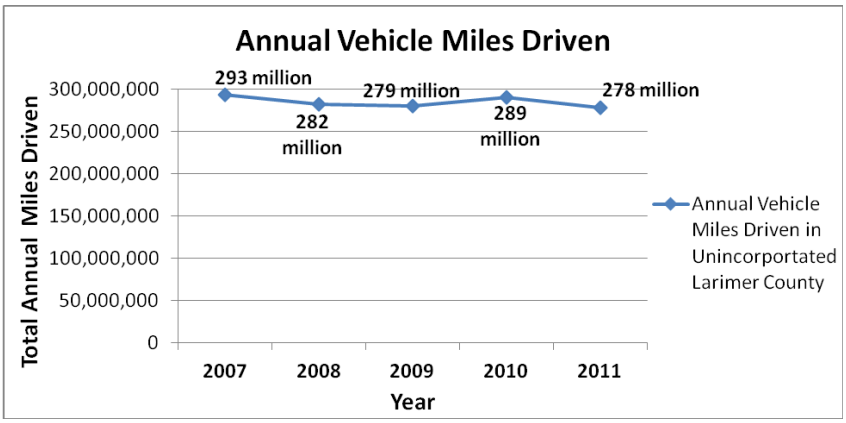



*Figure 2 – Total Annual Vehicle Miles Traveled*

The crash numbers reflect events on roads in unincorporated Larimer County only. As road segments are annexed into municipalities, the total number of road miles decreases by a small amount. The economy and fuel prices also impact vehicle miles traveled. The overall number of vehicle miles traveled on the county road system is about 5% lower in 2011 than in 2007.

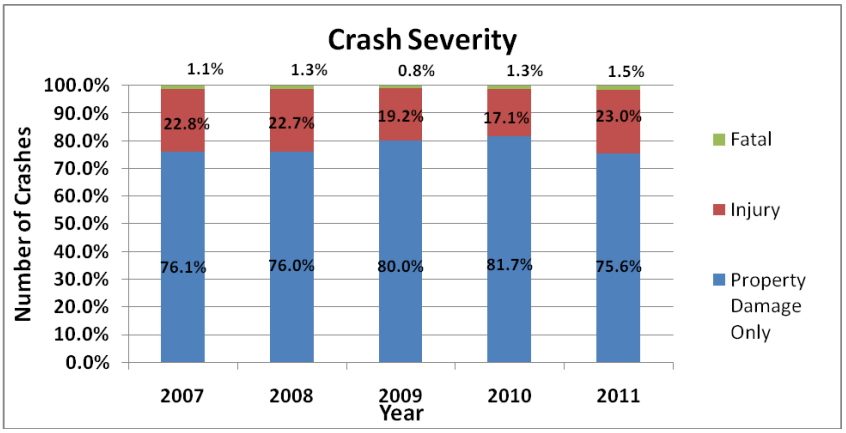



*Figure 3 – Crash Severity*

Percent of Severe Crashes Have Increased and Account for **20 - 25%** Of All Crashes

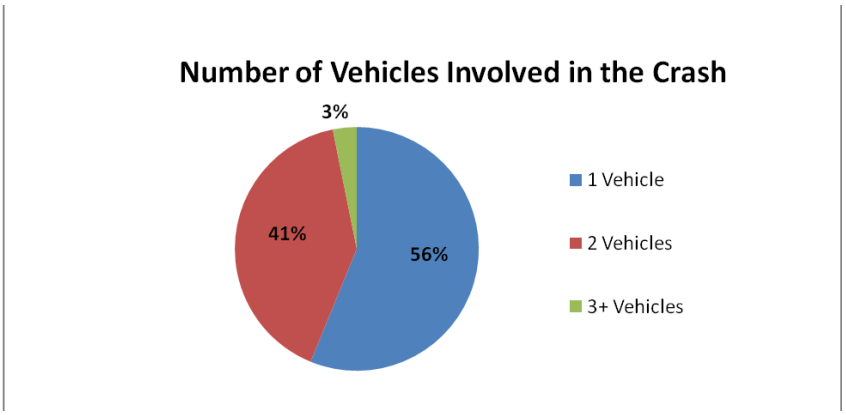



*Figure 4 – Number of Vehicles per Crash (5 year period: 2007-2011)*

More than **½** Of All Crashes Are Single Vehicle Crashes

<u>Crash Timeframe</u>

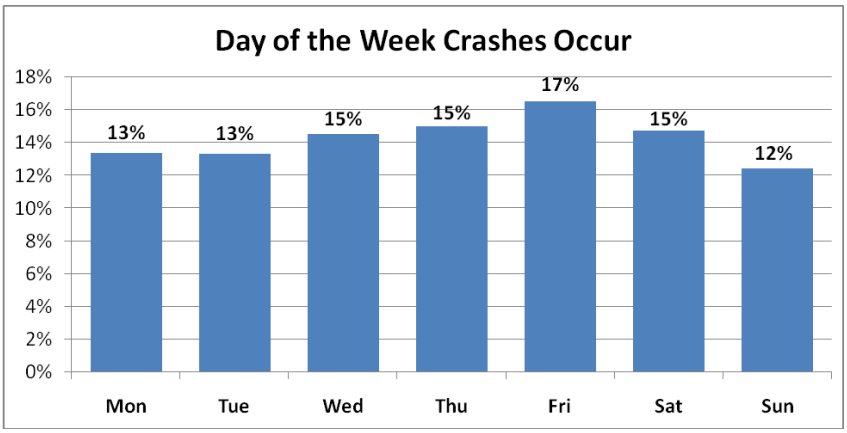



*Figure 5 – Crashes on a Given Day of the Week (5 year period: 2007-2011)*

**Fridays** see the most reported crashes

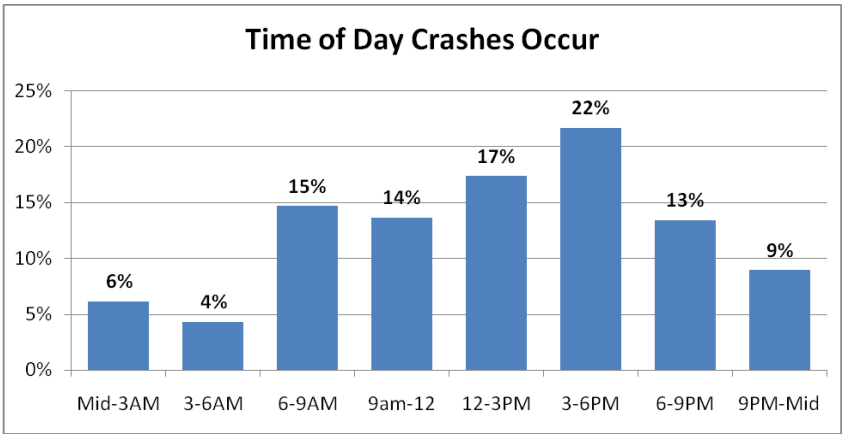



*Figure 6 – Crashes at a Given Time of Day (5 year period: 2007-2011)*

Nearly
**1/4 (22%)**
Of Crashes Occur During The Afternoon Peak (3-6 p.m.)

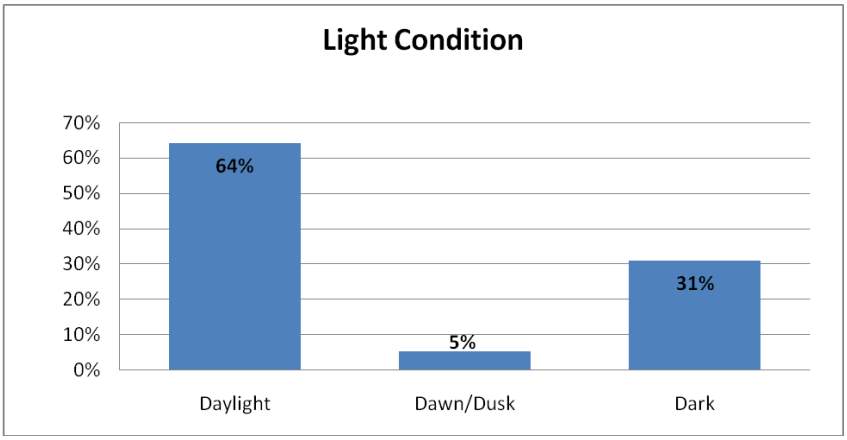



*Figure 7 – Light Conditions During Crashes (5 year period: 2007-2011)*

**2/3**
Of Crashes Occur in the Daytime

Road Conditions

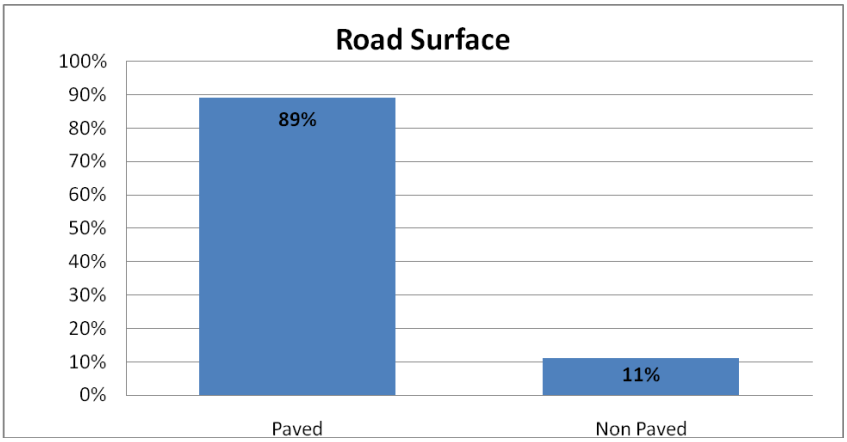



*Figure 8 – Road Surface at Crash Location (5 year period: 2007 – 2011)*

Almost
**90%**
Of All Crashes Occur on the Paved Road System

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 traveled on Larimer County roads occurs on paved roads.

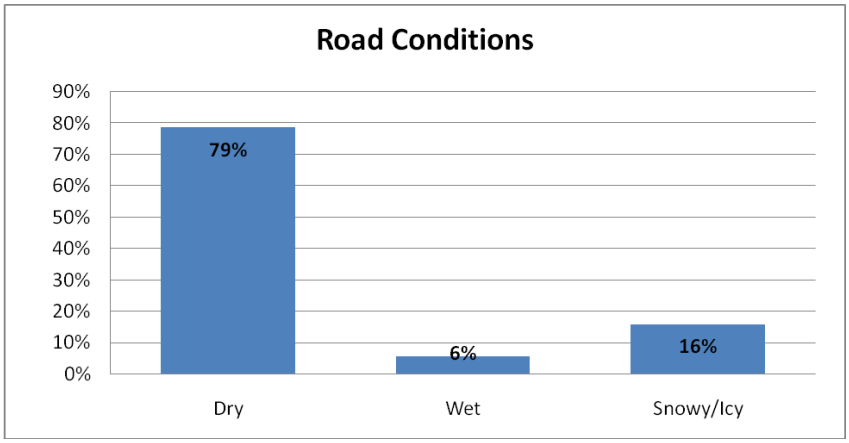



*Figure 9 – Road Condition at Crash Location (5 year period: 2007 – 2011)*

**80%**
of all crashes take place on dry roads.

When considered in combination, 46% of all crashes on unincorporated Larimer County roads between 2007 and 2011 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.

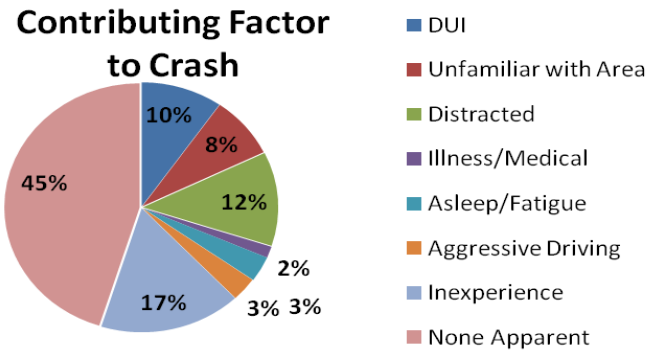


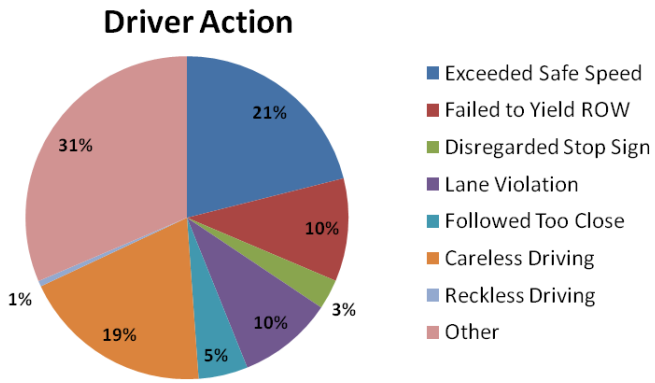

Figure 10 shows the primary contributing factor to crashes in the opinion of the responding officer. The form only allows one choice to be selected, so multiple factors are not identified.

*Figure 10 – Primary Contributing Factors (5 year period: 2007-2011)*

*Distracted Drivers*

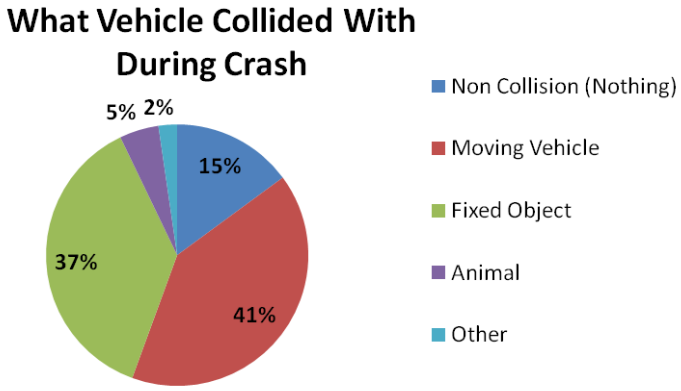
The percentage of drivers that were indicated to be 'distracted' as the ***primary*** contributing factor to the crash includes those distracted by passengers, cell phone, radio, etc. While the crash reports for Larimer County from 2007 to 2011 indicate this percentage to be 12%, the US DOT National Highway Traffic Safety Administration Traffic Safety Fact September 2010 indicated that nationwide 17% of all traffic crashes are identified by responding officers as caused by distracted driving.

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 account for **21%** of all crashes.

*Figure 11 – Driver Action That Resulted in Crash (5 year period:- 2007-2011)*




**37%** of all crashes involve leaving the road and hitting a fixed object such as guardrail, signs and/or rocks.

*Figure 12 – Harmful Event (What Vehicle Collided with during Crash) (5 year period: 2007-2011)*

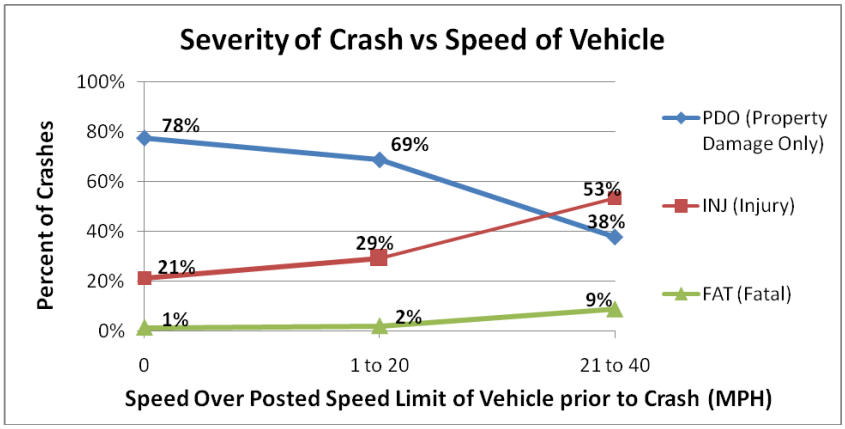



*Figure 13 – Severity of Crash vs. Speed of Vehicle over Speed Limit*

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

## Driver information

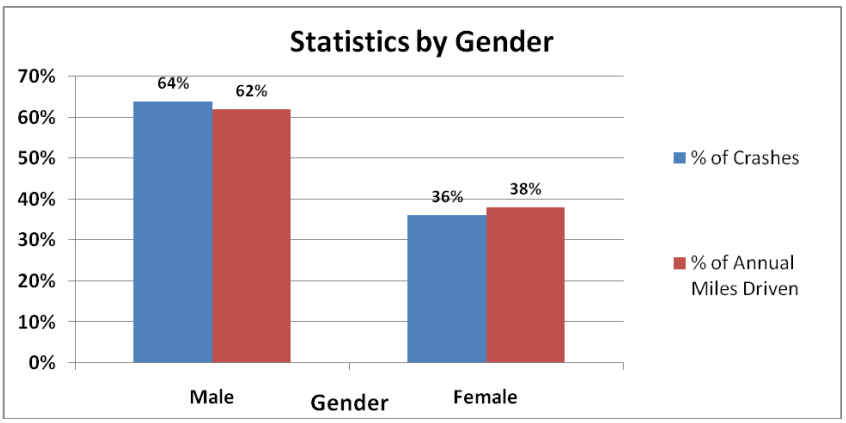



*Figure 14 – Crash Statistics by Gender*

Note: miles driven from Federal Highway Administration - Office of Highway Policy Information

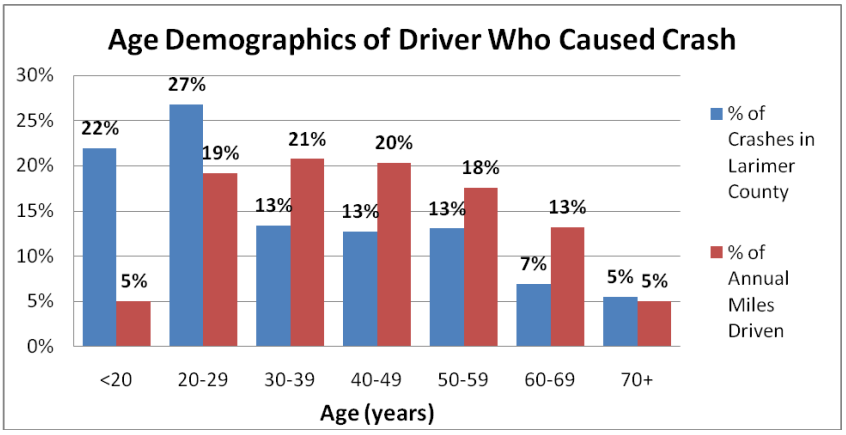



*Figure 15 – Crash Statistics by Age Group (2007 – 2011)*

Drivers less than 20 years old drive **5%** of total miles driven, but account for **22%** of crashes. Drivers younger than 30 are significantly overrepresented in crashes.

Vehicle Safety

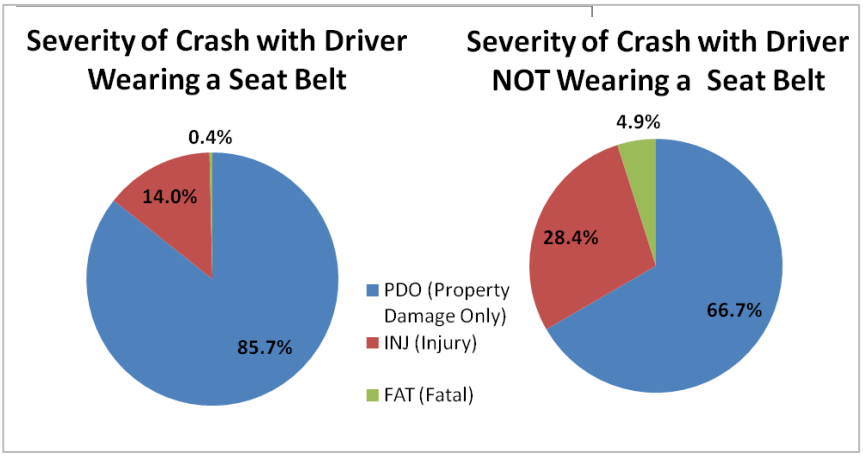



*Figure 16 – Severity of Vehicle Crashes Compared with Seatbelt Use*
Note: no motorcycles included

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

Motorcycles

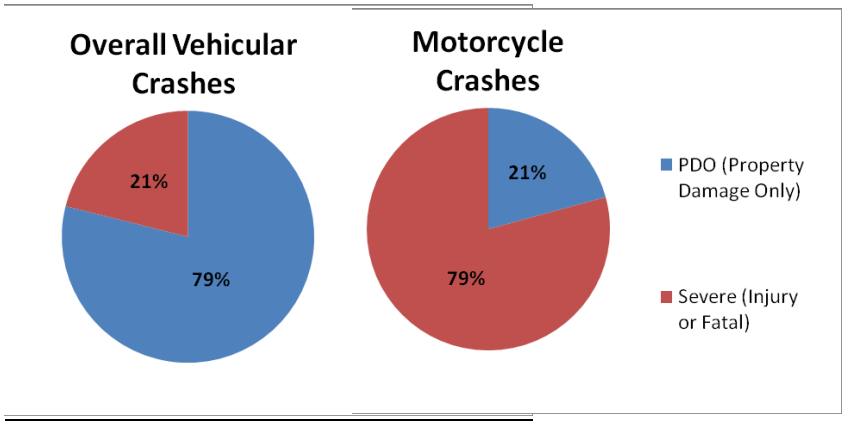



*Figure 17 – Crash Severity Comparison between Vehicles and Motorcycles*

Motorcyclists are almost **4** times more likely to be involved in a severe crash than drivers in vehicles

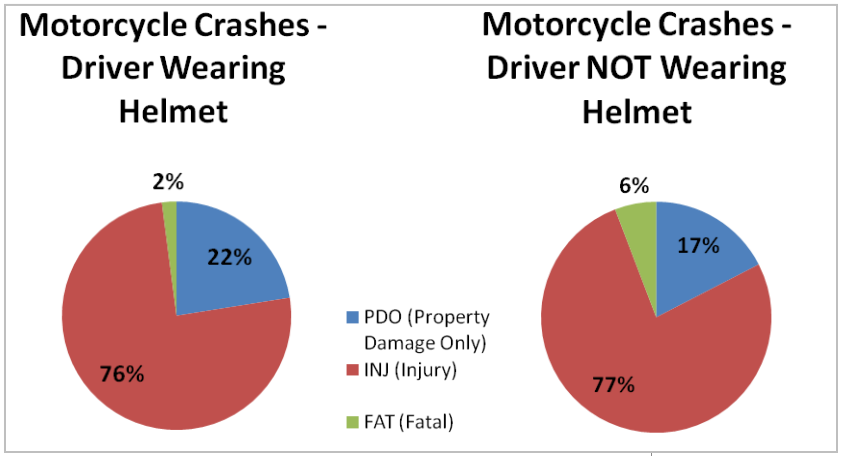



*Figure 18 – Crash Severity Comparison for Helmet Use in Motorcycle Crashes (2007 – 2011)*

Motorcyclists not wearing a helmet are **3** times more likely to die in a crash than motorcyclists wearing helmets.

## DUI Crashes

DUI (Driving Under the Influence) is a contributing factor in 12% of the crashes in Larimer County during 2011, up from 8% in 2007. In the last five years, 261 crashes were due to driving under the influence.

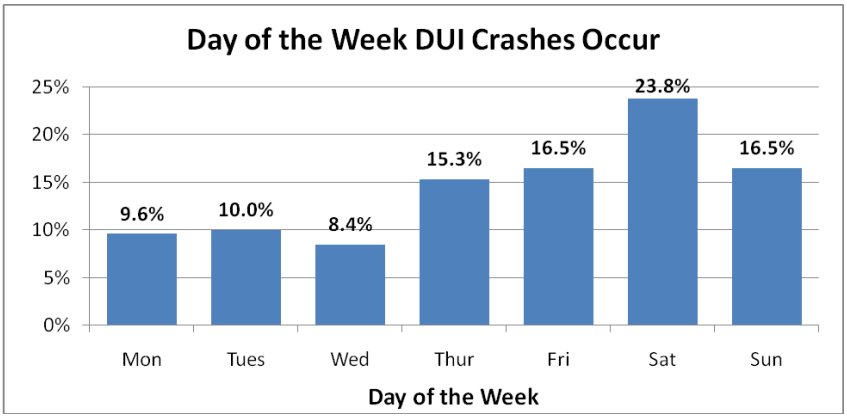



*Figure 19 – Day of the Week DUI Crashes Occur (2007 – 2011)*

Driving Under the Influence accounts for **12%** of crashes – up from **8%** 5 years ago.

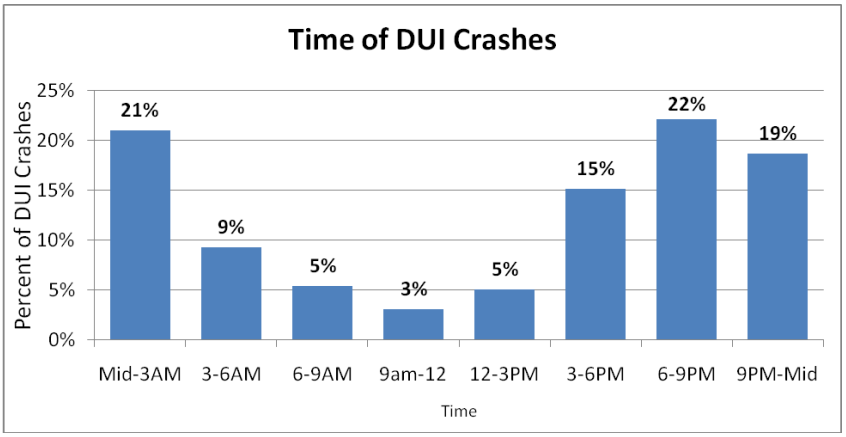



*Figure 20 – Time of DUI Crashes (2007-2011)*

# Traffic Safety Assessment (Crash Rates)

The number of crashes at a given location 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.

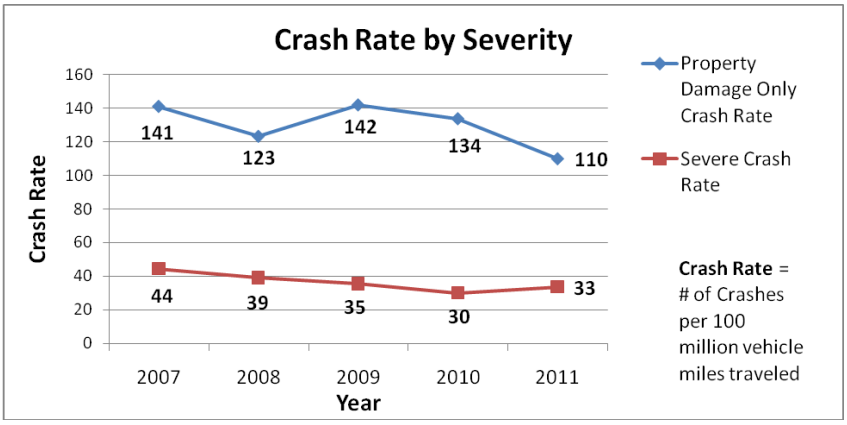



*Figure 21 – Crash Rate by Severity (2007 – 2011)*

**25%**
Decrease in crash rate of severe crashes from 2007 - 2011

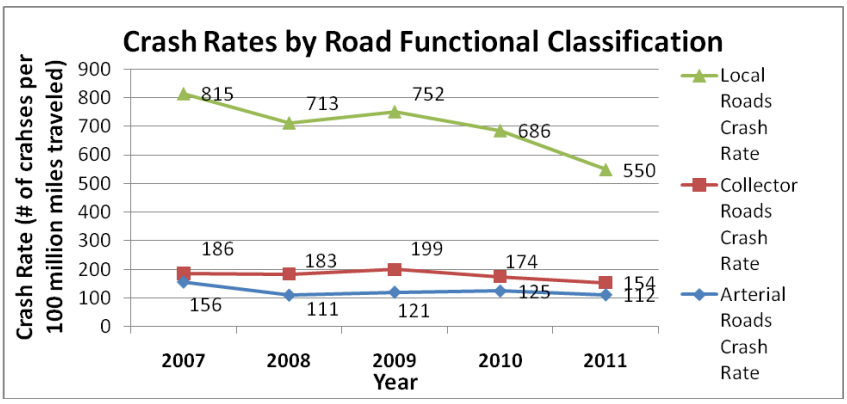


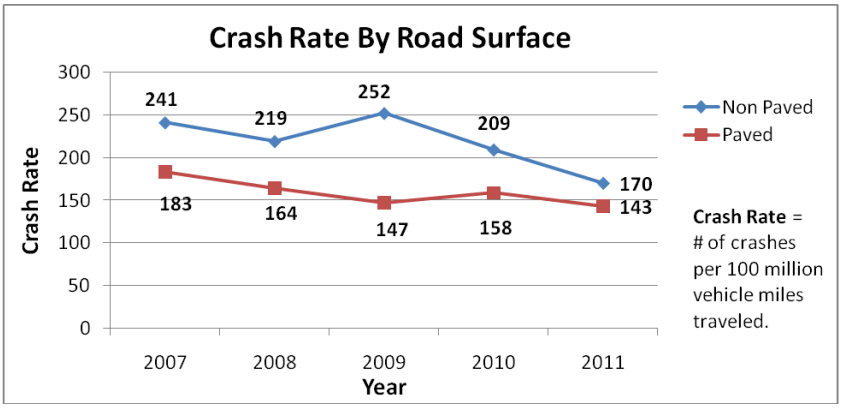

*Figure 22 – Crash Rate by Road Functional Classification*

**Arterials**
are statistically the 'safest' roads to drive on. But the limited numbers of crashes on local roads can skew the results.

Table 3 shows the comparative crash information for 2011 for the different functional classifications of the County's roadway system.

*Table 3 – 2011 Statistics by Major Functional Classification*

| | Arterials | Collectors | Local Roads |
|---|---|---|---|
| 2011 Number of Crashes | 126 | 245 | 34 |
| Vehicle Miles Traveled (in millions) | 112.6 | 159.4 | 6.2 |
| Crash Rate /100 million miles | 112 | 154 | 550 |




Crash rate for non-paved roads has decreased by **30 %** in the past 5 years.

*Figure 23 – Crash Rate by Road Surface*

*Table 4 – 2011 Statistics by Pavement Type*

| | Paved | Non-Paved |
|---|---|---|
| 2011 Numbers of Crashes | 356 | 49 |
| Vehicle Miles Traveled (in millions) | 49.4 | 28.8 |
| Crash Rate /100 million miles | 143 | 170 |
| Percent of Severe Crashes | 89.9% | 10.1% |

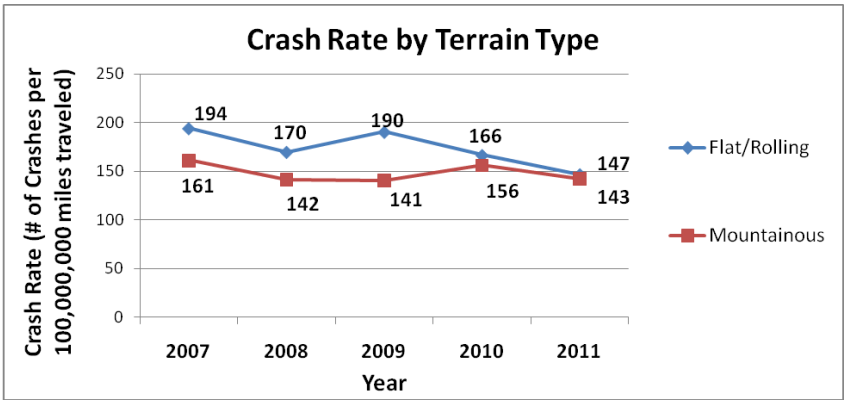
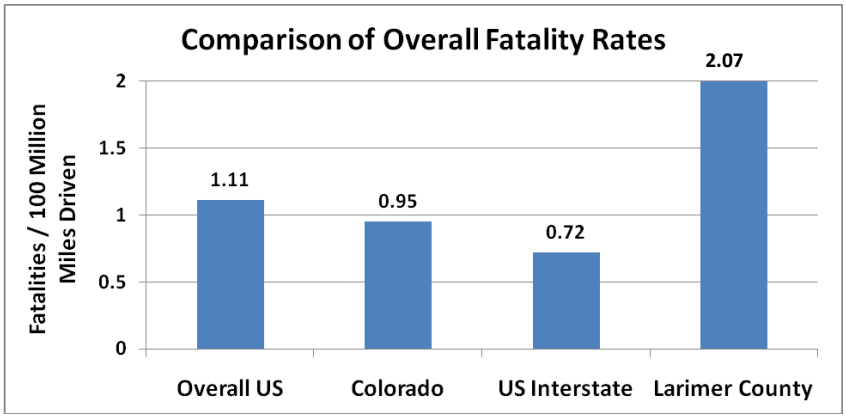



*Figure 24 – Crash Rate by Terrain Type*

Comparing Larimer County Crash Rates to Others

It is difficult to compare similar crash information among entities and different types of roads as calculations are completed in a number of different ways. However, fatality crash rates can be used to gain a general understanding of how the County's road system compares to the state and national averages.

Transportation professionals often note that rural two lane roads are the most dangerous part of the nation's road system. Travel on local urban roads and the interstate system is, comparatively, safer than travel on rural county roads.




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.

*Figure 25 – Fatality Crash Rate Comparison*

*Note: US value: National Highway Traffic Safety Administration (2010)*
*Colorado value: National Highway Traffic Safety Administration (2010)*
*US Interstate value from:* International Traffic Safety Data and Analysis Group (date unknown)
*Larimer County value from: County records (2011)*

## Cost Impacts of Crashes

In 2010 the National Safety Council estimated that the societal cost for each traffic death is $1,400,000, while an injury ranges between $12,600 and $70,200. A Property Damage Only (or very minor injury) crash has an average economic cost of $8,900. 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 (injuries and fatals) in unincorporated Larimer County is more than $ 12 million dollars.

**$ 12 Million**
Annual cost of severe crashes on the Larimer County road system.

# 2011 Safety Program

The Low Cost Roadway Safety Program just finished its third year, and it is expected that the program will continue to develop and mature 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 the traffic safety program continues to be the area of emphasis. Traffic engineering staff evaluates the safety of the road system in several ways to identify a 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 26). This map was visually reviewed for areas of concern

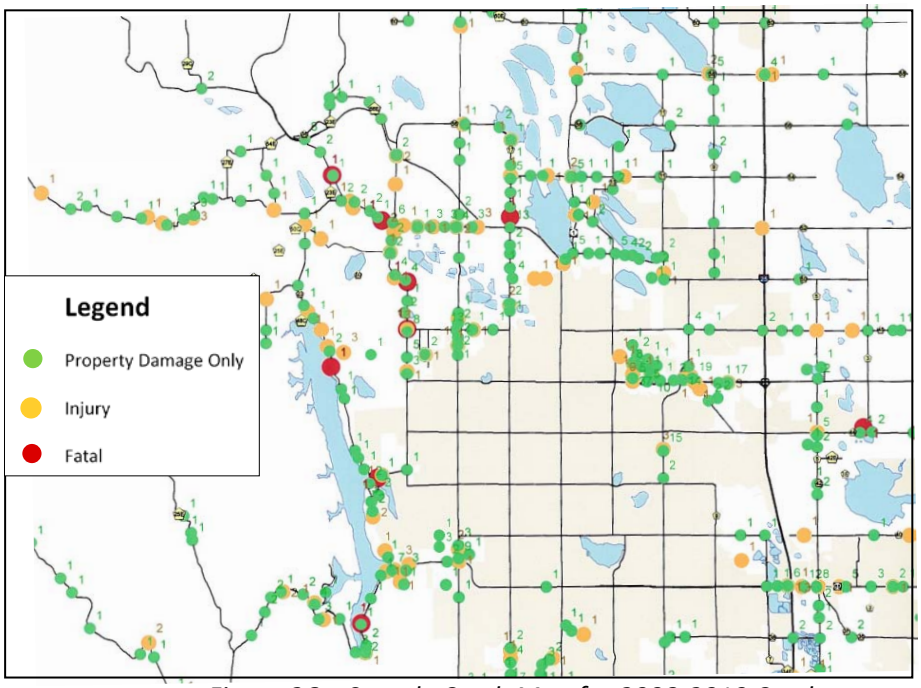



*Figure 26 – Sample Crash Map for 2008-2010 Crashes*

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 two years of the program, a number of intersections and short road segments or corridors with clear safety concerns were audited for safety and a plan of improvement developed. Many of the audit results recommended improved signing, striping, using thermoplastic pavement markings,

upgrades 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.

These areas are then monitored for safety (see page 19). In locations where the improvements are not proving to be adequate, further options are identified and funding sought for additional changes. This may include safety funding, other federal funding, or capital improvement projects.

A list of the Engineering improvements is shown in Table 6. Figure 27 shows the locations of the improvements throughout the County.

Education/Encouragement


Initial efforts in this area included public information brochures on 'how to drive a roundabout' and options for neighborhood traffic calming.

To further support education efforts, the low cost safety program purchased two radar speed display signs that can be used in various locations where citizens are concerned about speed. These are popular with the public and in high demand. A before and after speed monitoring program to be implemented in coming years will help identify impact of the signs.

On a more regional, and in fact national basis, Larimer County's program was highlighted at a statewide conference for Colorado Counties, and the Federal Highway Administration (FHWA) asked Larimer County staff to teach an educational 'webinar' on the low cost safety program and how it can be utilized in other agencies across the country.

Enforcement

The enforcement of traffic safety rests within the jurisdiction of the Sheriff's Department, or in some cases the State Patrol. As a part of the safety program, staff initiated contact with law enforcement which was positive.

An inter-disciplinary team of Engineering, Sheriff and State Patrol staff have begun meeting to coordinate and collaborate on roadway safety.

These initial efforts have resulted in the development of a small inter-disciplinary team of Engineering, Sheriff, and State Patrol staff that have committed to meeting on a regular basis for coordination, collaboration, and discussion. For instance, the traffic crash map was provided to both State Patrol and Sheriff's office, and the annual safety report was shared as well. Law enforcement personnel were very interested in some of the crash analysis and trends which can help them better understand areas of concern. An additional benefit of the meetings is to discuss various citizen concerns and coordinate responses.

Evaluation

Evaluation and monitoring is an important component of a safety program, and is discussed in detail in the following section on page 19.

Program Costs

The program was funded in 2011 with an allocation of $65,000. Table 5 summarizes the programs expenditures for 2011.

*Table 5 – 2011 Safety Program Expenditures*

| Type Of Work | Cost |
|---|---|
| Thermoplastic striping | $ 31,100 |
| Material for thermoplastic stencils | $ 980 |
| Reserve funding for larger project in 2012 | $ 32,920 |
| **Total** | **~$65,000** |

In past years, all the funding was utilized on a yearly basis. This year, because many of the initial areas of concern that can be addressed with signing and striping have been completed, the next-most urgent areas of concern may require somewhat higher cost solutions. Therefore, some of the funding in 2011 was requested to be rolled in 2012 so more robust projects could be completed – this may include rumble strips or guardrail.

*Table 6 – 2011 Safety Program Engineering Improvements*

| No. | Location | Type of Work | Comments |
|---|---|---|---|
| 1 | CR 11 and 30 | Signage and thermoplastic | Interim improvements in advance of complete intersection reconstruction |
| 2 | CR 70 from CR 15 to I-25 | Signing, guardrail etc review of corridor | Review in advance of road realignment and improvements at west end of corridor |
| 3 | CR 14 and 17 | Review of supplemental signs at signal | |
| 4 | CR 74E from CR 37 to 287 | Signing upgrade | |
| 5 | CR 13 at CR 30 (Donath Lake) | Advance warning signs, chevrons | |
| 6 | CR 43 in Glen Haven | Signing and thermoplastic upgrades | In response to citizen complaints – pedestrian issues |
| 7 | CR 52E in Bellvue | Signing and thermoplastic upgrades (including crosswalk) | In response to citizen complaints – pedestrian issues |
| 8 | CR 3F south of Harmony | Sign review | In response to citizen complaints – speeding issues |
| 9 | CR 19 / CR 48 (roundabout) | Re-review of signs | Slight uptick in minor crashes and new standards for signing in roundabouts |
| 10 | CR38E at horseshoe turn just south of Shoreline Drive | Advance warning signs and chevrons | In response to citizen complaint |
| 11 | Preformed thermoplastic work at various locations (turn lanes, intersection approaches and railroad crossings) throughout the County | | Work Completed |

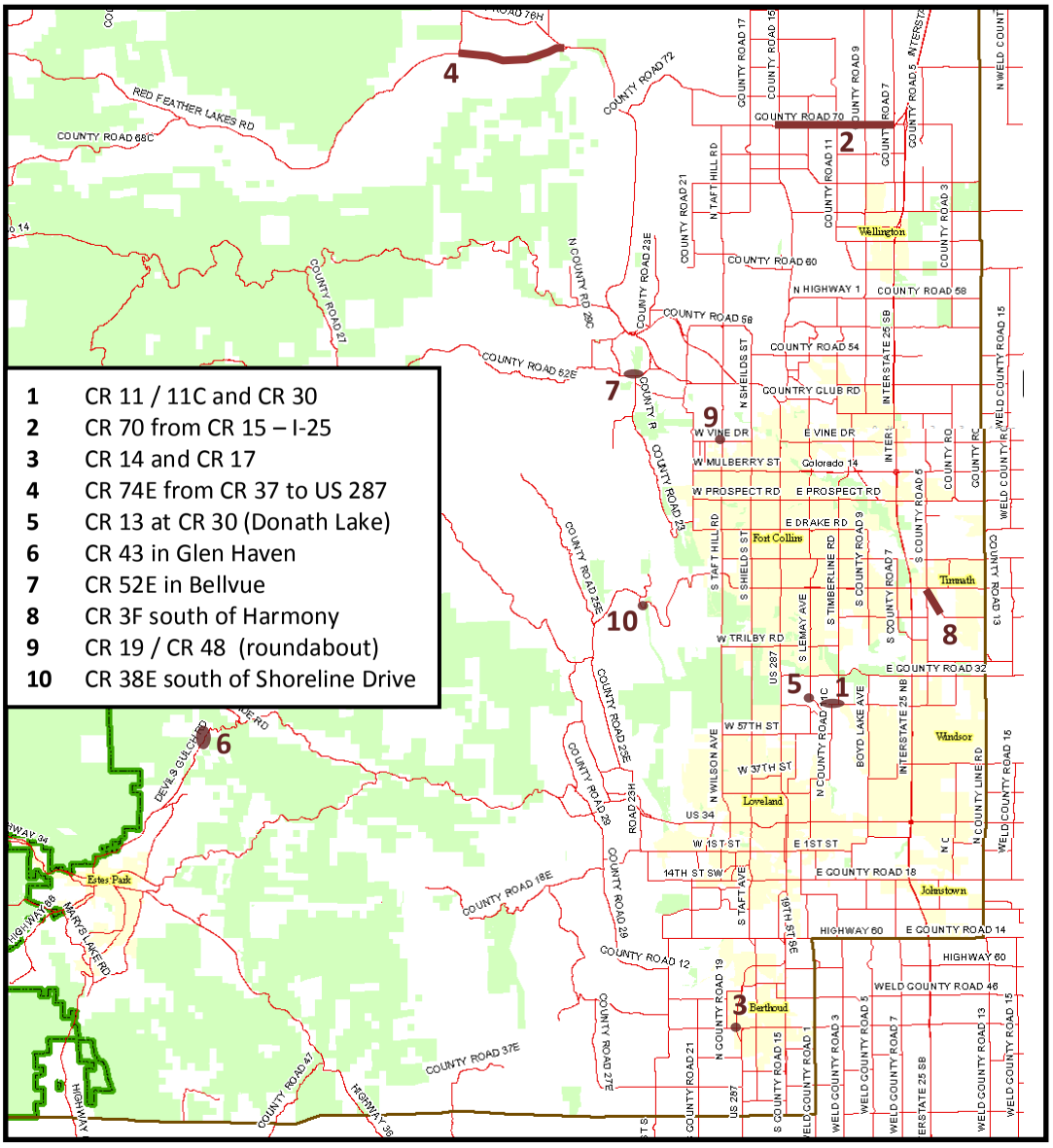



*Figure 27 – 2011 Low Cost Safety Program Safety Audit Locations*

A few examples of the types of improvements from 2010 and 2011 are shown below:

**Before**

**After**


## CR 13 / CR 30

Advance warning signs and upgraded chevrons.

**Before**

**After**


## CR 28/CR 11C

Thermoplastic advance warning.

**Before**

**After**

## CR 27 / SH 14

Cattleguard warning sign for motorcycle safety.

# Monitoring and Evaluation

The monitoring and evaluation portion of the safety program is becoming more robust as post-improvement data becomes available and full years of data allow for a more thorough review. Tables 7 and 8 show a before and after comparison of crash frequency of various intersections and roadway corridors that were improved in the first two years (2009 and 2010) of the program.

*Table 7 –Low Cost Safety Location Crash Review (Intersections improved in previous years)*

| Intersection | Time Frame | Number Crashes Per Year PDO | INJ | FAT | Total Avg | Minor | Severe | Date Improved | Notes |
|---|---|---|---|---|---|---|---|---|---|
| **Intersection of CR 52E (Rist Canyon) and CR** | Before Improvements | 0.75 | 0.25 | 0 | 1 | 0.75 | 0.25 | 12/7/2009 | Average 4 years before improvements and 2 years after |
| | After Improvements | 0 | 0 | 0 | 0 | 0 | 0 | | |
| | Change | 100% | 100% | 0% | 100% | 100% | 100% | | |
| | Type of Improvement | Additional warning signs and upgraded sign material | | | | | | | |
| **Intersection of CR 17 (Shields) and CR 54** | Before Improvements | 1.5 | 0.25 | 0 | 1.75 | 1.5 | 0.25 | 11/1/2009 | Average of 4 years before improvements and 2 years after |
| | After Improvements | 1 | 0 | 0 | 1 | 1 | 0 | | |
| | Change | 33% | 100% | 0% | 43% | 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 | 11/18/200 | Av... to ... |
| | After Improvements | 4 | 0 | 0 | 4 | 4 | 0 | | |
| | Change | -45% | 100% | 0% | -33% | -45% | 100% | | |
| | 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 2 years 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 2 years after |
| | After Improvements | 0.5 | 0 | 0 | 0.5 | 0.5 | 0 | | |
| | Change | 86% | 100% | 0% | 87% | 86% | 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 ... and ... |
| | After Improvements | 5 | 0 | 0 | 5 | 5 | 0 | | |
| | Change | -186% | 100% | 0% | -82% | -186% | 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 2 years 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 | | | | | | | |

**Now under review for additional higher cost improvements**

**Federally funded capital project in design (roundabout)**

*Table 8 –Low Cost Safety Location Crash Review (Road segments improved in previous years)*

| Segment | Time Frame | Number Crashes Per Year 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 2 years 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 | Average of 4 years before improvements and 1 year after |
| | After Improvements | 2 | 0 | 0 | 2 | 2 | 0 | | |
| | Change | -67% | 100% | 100% | 29% | -67% | 100% | | |
| | Type of Improvement | Side slope reshaping, cleared vegetation to improve sight distance, upgraded sign material | | | | | | | |
| **CR 16 (Between CR 21 and CR 19 )** | Before Improvements | 2.75 | 0.75 | 0.25 | 3.75 | 2.75 | 1 | 6/1/2010 | Average of 4 years before improvements and 2 years after |
| | After Improvements | 1 | 0 | 0 | 1 | 1 | 0 | | |
| | Change | 64% | 100% | 100% | 73% | 64% | 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 | 10/20/2008 | **Received federal safety funding to re-align road and eliminate curve** |
| | After Improvements | 1 | 0.5 | 0 | 1.5 | 1 | 0.5 | | |
| | Change | -300% | 75% | 0% | 33% | -300% | 75% | | |
| | Type of Improvement | Relocated signs, upgraded sign material, added warning signs | | | | | | | |

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

Of all the intersections and corridors that are being monitored, the improvements made have resulted in an average one fewer minor crash, and 8 fewer severe crashes (injuries or fatals) each year.

**8**
Annual reduction in injury or fatal crashes at locations improved through Low Cost Safety Program.

In areas where low cost improvements have not effected significant changes, the locations are being targeted for further improvements through federal funding, safety funding, and/or capital improvement projects.

<u>Cost Savings Due to Low Cost Safety Improvements</u>

Monitoring of the locations where improvements have been made through the Low Cost Safety Program shows an average annual reduction of more than 9 crashes. Since the general trend in crashes is downward by 25% in five years, this number should be discounted by 5% annually to reflect the overall decrease in crashes between 2010 and 2011 – resulting in an estimate of about 8 fewer crashes due to the Low Cost Safety Program.

Using the cost figures from the National Safety Council (see page 13) and utilizing an average societal cost for in injury crash of $41,400, this represents a savings of about $307,000 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 more than 400%.

**$ 307,000**
Annual societal cost savings due to Low Cost Roadway Safety Program

Other Safety Improvements

There are also other locations, both intersections and road segments where county staff completed safety related projects prior to the official initiation of this program. The monitoring of those locations are listed in Table 9 and 10.

These locations result in an annual improvement of almost 10 minor crashes and more than 5 severe crashes. This results in an annual societal cost reduction of an additional $300,000 each year.

*Table 9 – Other Safety Improvement Monitoring (Intersections)*

| Intersection | Time Frame | Number Crashes Per Year 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 3 years 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** | Before Improvements | 0.67 | 0.33 | 0 | 1 | 0.67 | 0.33 | 6/9/2008 | Average of 3 years before improvments and 3 years after |
| | After Improvements | 0.33 | 0.33 | 0 | 0.66 | 0.33 | 0.33 | | |
| | Change | 51% | 1% | 0% | 34% | 51% | 1% | | |
| | 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 3 years before improvements and 3 years after |
| | After Improvements | 3.75 | 0.25 | 0 | 4 | 3.75 | 0.25 | | |
| | Change | -7% | 75% | 0% | 11% | -7% | 75% | | |
| | 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 2.5 years after |
| | After Improvements | 1.2 | 0 | 0 | 1.2 | 1.2 | 0 | | |
| | Change | 70% | 100% | 0% | 78% | 70% | 100% | | |
| | Type of Improvement | Replaced 2-way stop with modern roundabout | | | | | | | |

**Crashes are minor. Signage re-evaluated for additional changes**

*Table 10 – Other Safety Improvement Monitoring (Road Segments)*

| Segment | Time Frame | Number Crashes Per Year PDO | INJ | FAT | Total Avg | Minor | Severe | Date Improved | Notes |
|---|---|---|---|---|---|---|---|---|---|
| **CR 19 (between CR 38E (Harmony) and CR 40 (Horsetooth))** | Before Improvements | 10 | 3 | 0 | 13 | 10 | 3 | 2006 | Average of 1 year before improvements and 3 years after |
| | After Improvements | 4.00 | 1.50 | 0 | 6 | 4.00 | 1.50 | | |
| | Change | 60% | 50% | 0% | 58% | 60% | 50% | | |
| | 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 3 years after |
| | After Improvements | 0 | 0.33 | 0.33 | 0.66 | 0 | 0.66 | | |
| | Change | 0% | 67% | -33% | 34% | 0% | 34% | | |
| | Type of Improvement | Added warning signs and chevrons, upgraded sign material | | | | | | | |

**Received federal funding for capital improvement project**

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

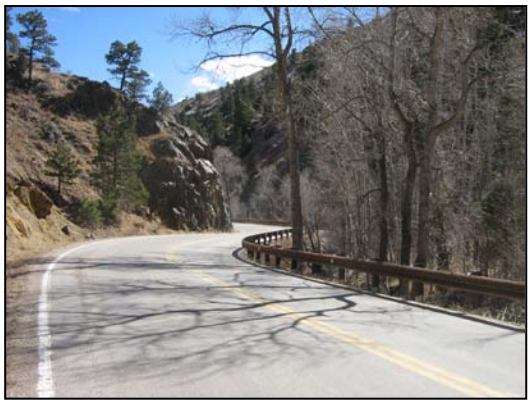
Recent Guardrail Projects

There were two mountainous locations where guardrail was installed in response to a high crash trend. Since this type of improvement is not necessarily low cost, the program was used to identify the area, finalize the analysis, and apply for federal hazard elimination funds. The grant of more than $120,000 was awarded, and in 2010 the guardrail was installed.

**CR 27 just south of CR 44H**

Before

After



CR 27

80% reduction in crashes

The four-year crash history before the project included 17 crashes, including ten injury crashes. Since the completion of guardrail installation (about 18 months ago), there has been only one minor reported crash.

**CR 74E near Axtell Mountain Road**

Before

After

CR 74E

50% reduction in crashes

The four-year crash history before the project included five crashes, two of the crashes resulting in fatalities. Since the guardrail was installed (about 18 months ago), there has been only one minor crash.

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 seen a 34% reduction in minor crashes and a 90% reduction in injury crashes. This equates to 2.5 fewer minor crashes each year, and about 2 fewer injury crashes each year. The societal savings is about $100,000 each year.

**34%** reduction in minor crashes and **90%** reduction in injury crashes at roundabouts in Larimer County.

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 years.

# Summary and Looking Forward

The first two years of the Low Cost Safety Program was a time for program planning, establishment, and initial implementation of basic improvements. This past year, the monitoring program became better established, and the education and enforcement piece began. The safety analysis of the road system also allowed for the successful receipt of hazard elimination funds to complete the guardrail projects.

The results of the monitoring and review continue to show the value of the program, both in return on investment, as well as quantifiable reduction in number and severity of crashes.

As the program moves forward in coming years, it will continue to evolve and mature. Specifically, the early years of the program were reactionary, and the easily identified and most significant areas of concern based on crash history were addressed. While it is important to continue to analyze, monitor and address areas with crash history, an added component should be to also add a proactive component, where analysis of geometrics and implementation of known safety countermeasures occurs before a crash history develops. This approach is supported by the new Highway Safety Manual published by AASHTO, and it is intended that the Larimer County Low Cost Roadway Safety Program find a balance between reactionary and proactive solutions to traffic safety.

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

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