GFS-S121

Improving Road Safety in the Santa Fe Metropolitan Planning Area

An Interdisciplinary Qualifying Project Submitted to the faculty of Worcester Polytechnic Institute in partial fulfillment of the requirements for the Degree of Bachelor of Science

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Abstract

The Santa Fe region has experienced automobile crash rates consistently higher than state and national averages. To alleviate this problem, traffic data from the last six years was organized and then analyzed to produce a list of the top twenty-five most hazardous intersections in the Santa Fe metropolitan planning area. Each of these intersections was further analyzed to identify crash patterns, and then a final list of safety countermeasures was recommended to the city to improve traffic safety.

Executive Summary

The Santa Fe region has been experiencing vehicle crash rates consistently higher than those of the state of New Mexico and the nation as a whole. While human injury and loss of life are tragic occurrences, the monetary costs associated with these crashes also take their toll on the area. Vehicle crashes cost the Santa Fe County over 189 million dollars in economic losses in 2009 alone. These trends indicate the existence of local factors that make Santa Fe a hazardous environment for drivers.

It is the job of the Santa Fe Metropolitan Planning Organization (SFMPO) to alleviate this problem. The SFMPO was formed to organize transportation decision-making in the metropolitan planning area, and has worked over the years to improve the safety and efficiency of the transportation system in Santa Fe. Every two years the SFMPO produces a Unified Planning Work Program, which outlines budgets and projects for the next two years. The most current plan addresses the need to identify and utilize available crash data to determine hazardous locations within the Santa Fe metropolitan planning area in order to determine future planning initiatives. Solid results taken from a data-driven analysis such as this one will also be used by the SFMPO to apply for funding from the Highway Safety Improvement Program which can be used to increase traffic safety.

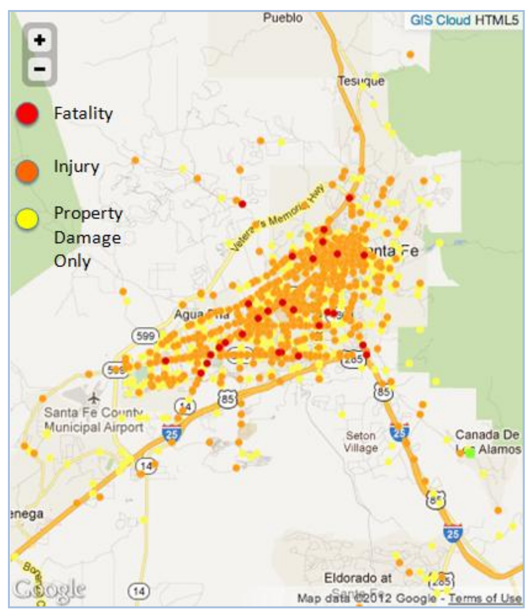

Figure 1— All crashes, separated by severity

The main goal of this project was to assist the SFMPO in its efforts and obligations to improve roadway safety in Santa Fe. To accomplish this goal, the following objectives were completed:

1. Organized traffic safety data
2. Identified the most hazardous locations
3. Identified crash patterns
4. Determined appropriate safety improvements

The first step was to organize crash data, which was obtained through the New Mexico Department of Transportation and the University of New Mexico. To supplement the available data and fill in missing gaps, the team performed its own data collection activities, including selective peak-hour traffic volume counts and traffic flow observations.

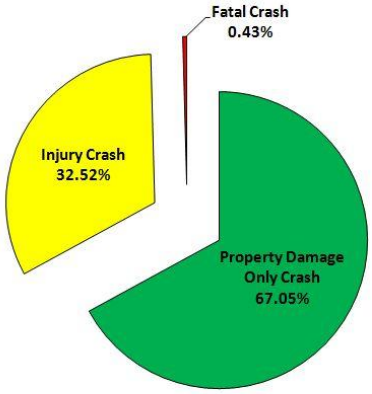

Figure 2—Crash severity by percentages

The crash data showed that there were 12,542 crashes for the six year period. Figure 1 displays the location of each crash in the dataset, while Figure 2 displays the crash severity by percentage for each type. The severity of crashes is important, because fatal crashes are more significant than injury crashes, which are in turn more significant that crashes that result in property damage only.

To identify the most hazardous intersections, the crashes were consolidated into intersections, which were then ranked according to the highest number of crashes. However, it is expected that a heavily-used intersection will have more crashes than an infrequently-used one. To account for this factor, the number of crashes at each intersection was normalized by considering the volume of traffic at each intersection. In order to better reflect the social and economic impact of these crashes, the crash severity was also taken into account. After taking the number of crashes, the traffic volumes, and the severities into account, the final list of the top twenty-five most dangerous intersections in Santa Fe was completed. Figure 3 shows how the rank of each intersection changed after taking the volume and then the severities into account. The location of each of the most hazardous intersections can be seen in Figure 4.

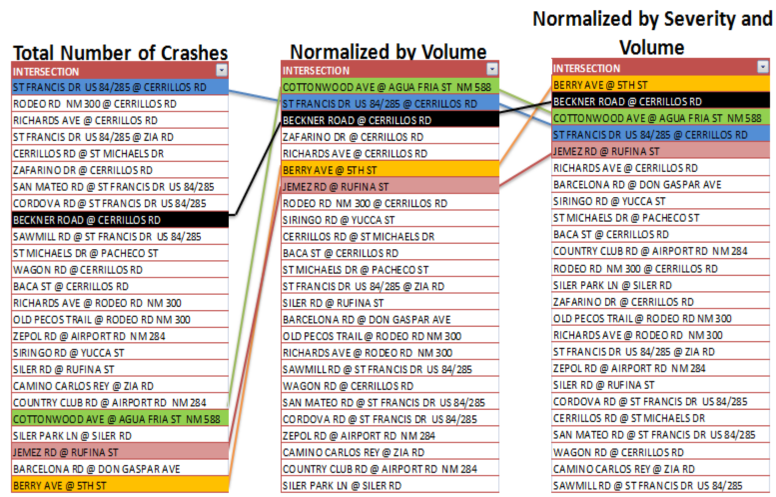

Figure 3—Final top twenty-five intersections change in ranking throughout analysis

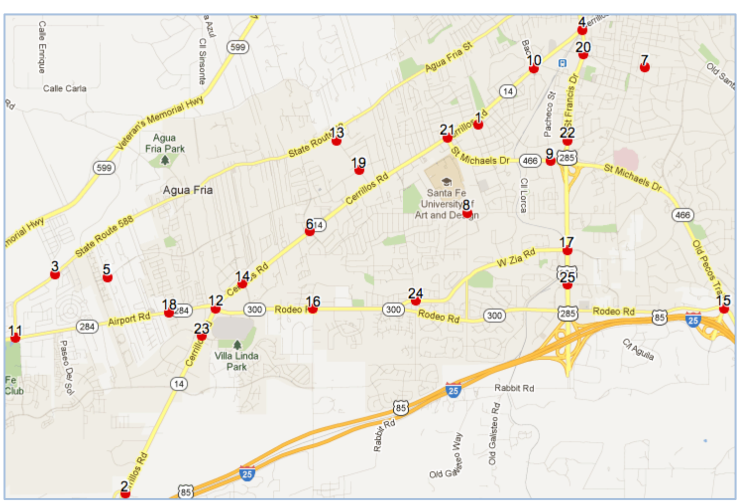

Figure 4—Top twenty-five most hazardous intersections in the Santa Fe metropolitan planning area

The next objective was to identify crash patterns at the most hazardous intersections. To do so, police crash reports were obtained from the Santa Fe Police Department. These police reports are filled out by the responding officer at the scene of a crash, and thus they provide a wealth of valuable information, such as weather and road and lighting conditions, alcohol involvement, and a narrative of the crash. Figure 5 displays how these crash reports were then translated into collision diagrams, which were used to identify the crash patterns at each intersection.

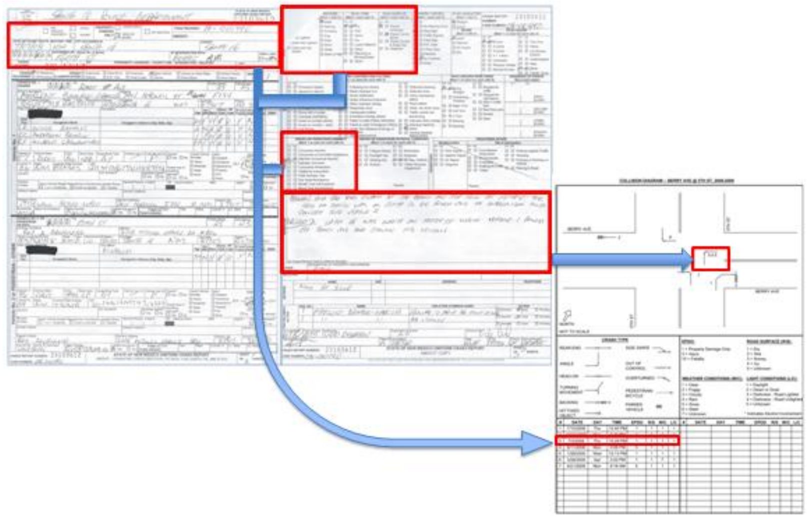

Figure 5—Transferring information from police report to collision diagram

Once the crash patterns had been identified for an intersection, the next step was to determine safety improvements. The Federal Highway Administration (FHWA) maintains a database of safety countermeasures, each with its own application. Using this database, as well as the help of the SFMPO and Santa Fe's Traffic Engineering department, the appropriate countermeasures were selected to address each identified crash pattern. Figure 6 displays a list of the final recommended countermeasures for each intersection that underwent a detailed analysis.

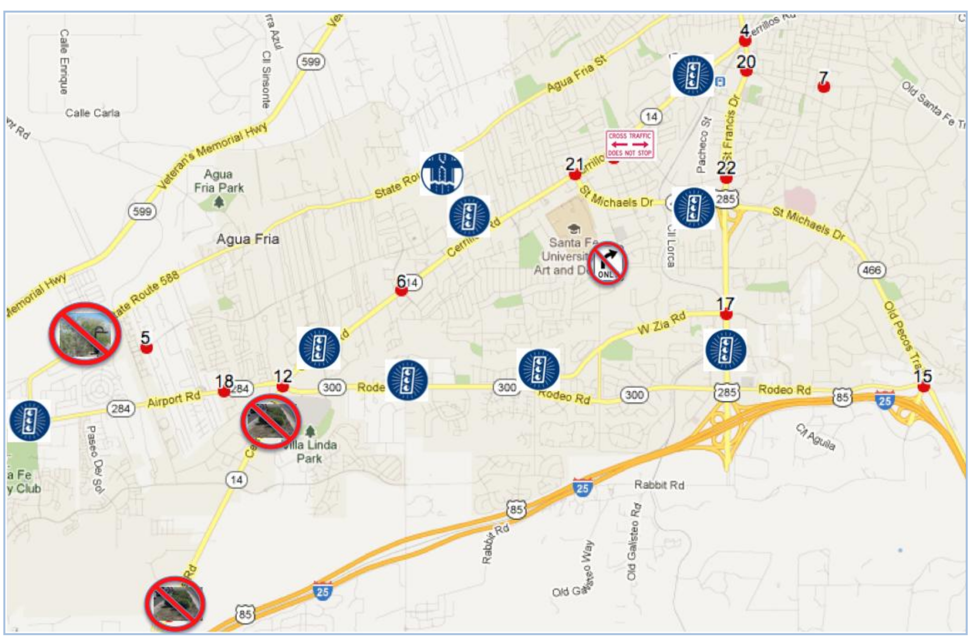

Figure 6—Recommended countermeasures for each intersection that underwent a detailed analysis

The safety improvements recommended in this project are intended to increase the traffic safety in the Santa Fe metropolitan planning area. The systematic organization and analysis of this crash data, as shown in this study, will be of great use to the SFMPO and the city of Santa Fe to conduct future data-driven research as they work to improve the traffic safety in the area and apply for federal funding. The team recommends that the SFMPO implement this project as part of its regular planning activities, to be completed every few years. This will allow for a comparison between intersections before and after countermeasures are implemented, and it will ensure that the Santa Fe region becomes a safer place for all forms of transportation.

Authorship

Raymond Casola – Introduction, Background (2.2 – 2.2.9), Methodology (3.1.2 – 3.1.3), Analysis, Editing, GIS mapping of intersections and road segments

Richard Downey – Abstract, Executive Summary, Introduction, Background (2.1 – 2.1.1.6, 2.1.3 – 2.1.3.2, 2.1.3.4 – 2.1.3.5, 2.3.1), Methodology (3.1.1 – 3.1.1.1, 3.3.1 – 3.3.2), Results, Analysis, Conclusions/Recommendations, Editing, Collision Diagrams

Nicholas Nava– Acknowledgements, Introduction, Background (2.1.3.3), Methodology (3.2.1 – 3.2.5), Results, Analysis, Editing, Data input and analysis spreadsheets

Jesse Taylor – Introduction, Background (2.1.2, 2.3.2), Methodology (3.1.1.2, 3.4.1 – 3.4.2), Analysis, Conclusions/Recommendations, Editing, Santafedia intersection pages

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- Miquela Gonzalez from the Santa Fe Police Department and Lavina Maestas from the City Records Division for compiling police reports

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1. Introduction

Vehicle crashes are a widespread problem on the nation's roads, resulting in injury, death, and billions of dollars in economic losses each year. The number of registered vehicles on U.S. roadways has reached nearly 260 million[1]. In 2009, the National Household Travel Survey reported that there were 1.86 vehicles registered to each household[2]. On average, there are over 30,000 fatal crashes each year in the United States[3]. In fact, vehicle crashes are the leading cause of death for people between the ages of 3 and 33[4]. An additional consequence of these crashes is congestion, which results in approximately 4.2 billion person-hours of delay nationwide every year[5]. Comparing this to an average minimum wage of $8 per hour, congestion alone wastes an estimated $33.6 billion per year.

Similar to the country as a whole, the Santa Fe region is suffering from the impacts of vehicle crashes. During 2009 there were over 3,500 documented crashes in Santa Fe County, with 20 of those crashes resulting in fatalities[6]. While human injury and loss of life are tragic occurrences, the monetary costs associated with these crashes also take their toll on the city. Vehicle crashes cost the Santa Fe County over 189 million dollars in economic losses in 2009 alone[7]. In the same year, the Santa Fe County was rated at 189 crashes per 100 million vehicle miles (MVM), higher than the New Mexico state average of 176[8]. This trend indicates the existence of local factors that contribute to a more hazardous environment in Santa Fe County than in the rest of the state.

The Santa Fe Metropolitan Planning Organization (SFMPO) was formed to organize transportation decision-making in the metropolitan planning area[9]. The SFMPO has worked over the years to improve the safety and efficiency of the transportation system in Santa Fe and is

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[1] Number of U.S. Aircraft, Vehicles, Vessels, and Other Conveyances. in U.S. Department of Transportation Research and Innovative Technology Administration [database online]. 2009 [cited 1/24 2011]. Available from http://www.bts.gov/publications/national_transportation_statistics/html/table_01_11.html.

[2] *2009 National Household Travel Survey* Federal Highway Administration,[2009a]).

[3] "FARS Data Tables." National Highway Traffic Safety Administration, http://www-fars.nhtsa.dot.gov/Main/index.aspx (accessed 2/6, 2012).

[4] Road traffic crashes leading cause of death among young people. in World Health Organization [database online]. 2007 [cited 2/6 2012]. Available from http://www.who.int/mediacentre/news/releases/2007/pr17/en/index.html.

[5] Traffic congestion factoids. in U.S. Department of Transportation Federal Highway Administration [database online]. 2009 [cited 1/24 2011]. Available from http://www.fhwa.dot.gov/congestion/factoids.htm.

[6] *New Mexico Traffic Crash Information*. New Mexico Department of Transportation,[2009c]).

[7] Ibid.

[8] Ibid.

[9] Santa Fe Metropolitan Planning Organization. 2011 [cited 1/28 Available from http://santafempo.org/.

responsible for producing a report regarding safety initiatives[10]. These sorts of studies are common when analyzing traffic safety in a certain transportation system. One such study was recently conducted in Franklin County, Massachusetts, and improvements were suggested to increase safety. Examples of improvements used in Franklin County include added signage, additional lanes and lane markings, and directional pavement markings[11].

Currently, the Santa Fe Metropolitan Transportation Plan 2010-2035 (MTP) indicates the need for the SFMPO to assess transportation safety. More specifically, the MTP addresses the SAFETEA-LU legislation, which allocates money and supports innovative approaches to reducing highway fatalities and injuries[12]. Every other year the Santa Fe MPO creates the Unified Planning Work Program (UPWP), which outlines budgets and projects for the next two years. In the UPWP for 2010-2012, Section 3.6 addresses the need to identify and utilize available crash data to determine hazardous locations within the Santa Fe Metropolitan Planning Area in order to determine future planning safety initiatives[13]. The New Mexico Department of Transportation (NMDOT) tasked the SFMPO to complete this initiative by the end of this year.

The goal of this project was to assist the SFMPO in its efforts and obligations to improve roadway safety in the Santa Fe metropolitan area by identifying hazardous locations and then analyzing and proposing possible solutions. After consolidating crash data into an organized database, the team was able to employ standard analysis techniques to rank each location in Santa Fe according to its hazard level. Once a list of the most hazardous locations was created, the team worked with the SFMPO to determine the crash patterns at each location and then propose appropriate countermeasures to improve traffic safety. After identifying viable solutions, all findings were shared through a report for the MPO to make other organizations aware of the team's recommended improvements.

[10] *Santa Fe Metropolitian Planning Organization Unified Planning Work Program 2010-2012* (Santa Fe: Transportation Policy Board,[2010]).
[11] *Identification of the most Hazardous Intersections in Franklin County 2004-2006* Franklin Regional Council of Governments,[2009b]).
[12] *Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users,* (2005): Improving Safety.
[13] Ibid.

2. Background

Establishing a strong foundation of background knowledge was essential to the completion and success of this project. The team utilized elements of transportation safety and traffic engineering, as well as proven safety countermeasures, in order to improve the transportation network in the Santa Fe metropolitan planning area. Each of these topics will be explained in further detail in the following sections.

2.1 Transportation Safety

Transportation planning is a process that constantly repeats itself, as traffic engineering principles are applied to construct, monitor, evaluate, and improve methods for moving people and goods. Safety is often the most important goal in planning or improving a transportation network. In order to determine proper safety initiatives, one must first understand the current safety issues. Studying annual crash data is an effective way to quantify and compare hazardous areas of a transportation system.

2.1.1 Recording and Classifying Crashes

In order to compare and analyze crash data, crashes must be recorded and classified using a standard method. When a crash occurs, the proper authority at the scene records a variety of information: the date, time, and location of the crash; the type and severity of the crash; and the current lighting, weather, and road conditions. An example of crash data, taken from Santa Fe County in 2010, is shown in Figure 7.

Crash Number Date Time	Pstd Rte Milepost Milelog Milepoint	Dir	City Street Intersect	Severity Lighting Weather Alcohol	Vehicles Involved Classification Analysis
20100710038502 05-JAN-10 04:07	 000.000 000.000 000.000		Santa Fe AGUA FRIA ST NM 588 SILER RD	PROPERTY DAMAGE ONLY ACCIDENT DAYLIGHT CLEAR	2 OTHER VEHICLE SIDESWIPE COLL/SAME DIR
Vehicle 1		EAST	Bus	HAD NOT CONSUMED ALCOHOL	
Contributing Factor 1			None		
Vehicle 2			Passenger Vehicle	HAD NOT CONSUMED ALCOHOL	
Contributing Factor 2			Improper overtaking		

Figure 7—Crash data from Santa Fe County, 2010

2.1.1.1 Location

Location is an essential piece of information in a crash report. In fact, a very crude analysis on transportation safety can be performed using the number of crashes and locations alone. Unfortunately, problems often occur in the recording of crash locations, particularly those that occur at intersections. Specific jurisdictions use inconsistent traffic jargon and varying criteria relating to crash location and road geometry.[14] There is no standard way of reporting intersection names, which makes it difficult to organize data. Intersections are, by definition, the location where multiple streets intersect, and this leads to discrepancies in naming them. An intersection may be referred to in a number of ways, depending on which intersecting street one refers to.

2.1.1.2 Types of Crashes

There are many ways a vehicle can be involved in a crash. Thus, it is important to categorize crash types. Examples of common crash types include Rear-End, Angle, Head-On, Turning Movement, Backing, Side Swipe, Out of Control, as well as crashes involving pedestrians or cyclists.[15] These broad types allow crashes to be more easily compared and analyzed.

2.1.1.3 Crash Severity

Crash severity is often defined using the Estimated Property Damage Only (EPDO) system, in which the severity of a crash is represented as one of three values. When a crash results in property damage only, it receives a value of one. A crash in which someone is injured will receive a value of five. The most severe crash, one which results in a fatality, is represented with a ten.[16] If the crash involves multiple levels of severity, the highest value is chosen. These three classifications—property damage only, injury, and fatality—represent the standard method of classifying crash severity.

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[14] *Highway Safety Manual.* American Association of State Highway and Transportation Officials (AASHTO), http://www.knovel.com/web/portal/browse/display?_EXT_KNOVEL_DISPLAY_bookid=3419.

[15] *Identification of the Most Hazardous Intersections in Franklin County 2004-2006* Franklin Regional Council of Governments,[2009b]).

[16] *Highway Safety Manual.* American Association of State Highway and Transportation Officials (AASHTO), http://www.knovel.com/web/portal/browse/display?_EXT_KNOVEL_DISPLAY_bookid=3419.

2.1.1.4 Lighting Conditions

It is important to record lighting conditions at the scene of a crash, as lighting can be one of the contributing factors. For example, if a large number of crashes occur in a particular location when it is dark out, then improving the lighting may increase the safety. Examples of different lighting conditions include Daylight, Dawn, Dusk, Darkness-Road Lighted, and Darkness-Road Unlighted.[17]

2.1.1.5 Weather Conditions

It is important to record weather conditions at the scene of a crash, as the weather can also be one of the contributing factors. Driving in the rain, snow, or fog is often more difficult than driving in mild weather due to decreased visibility and vehicle traction. Examples of weather conditions include Clear, Foggy, Cloudy, Rain, Snow, and Sleet.[18]

2.1.1.6 Road Surface Conditions

Road surface conditions often correlate with weather conditions. For example, if it is raining the road is going to be wet. However, the road surface conditions do not always match the weather conditions. It is possible that the road could be wet even though it is a clear day; perhaps the city is performing a flow test on a nearby hydrant, covering the street in water. Thus it is important to record road surface conditions along with weather conditions. Examples of different road surface conditions include Dry, Wet, Snowy, and Icy.[19]

2.1.2 Recording and Classifying Traffic Volumes

Traffic volume counts are the number of vehicles that travel through an intersection or on a roadway over a certain period of time. This data is vital to the analysis of any transportation system. Traffic counts can be done and studied over different times of the day, days of the week, and even

[17] *Identification of the Most Hazardous Intersections in Franklin County 2004-2006* Franklin Regional Council of Governments,[2009b]).
[18] Ibid.
[19] Ibid.

months of the year. One standard method of defining traffic volume is the Average Annual Daily Traffic (AADT), which is the average of 24-hour counts collected every day of the year.[20]

Volume counts are done both manually and automatically. Automated methods have an advantage in their ability to record large amounts of data over long periods of time. Manual counts, however, have an advantage in their ability to collect very specific data, such as the types of vehicles traveling on a specific road or the percentage of vehicles turning at an intersection. The drawbacks of manual data recording lie in their need for someone to observe the intersection and physically take the measurements. According to MPO Senior Planner Keith Wilson, the SFMPO has access to the TDC Ultra hand-held Traffic Data Collector from Jamar Technologies, Inc for traffic counting. This hand held unit allows the user to record movements in the field and later download the data onto a computer and produce a report.[21]

2.1.3 Transportation Safety Tools

Traffic engineers have a variety of tools at their disposal to analyze transportation systems. These tools are essential to identifying crash patterns and crash-contributing factors in the hopes of determining possibly safety changes.

2.1.3.1 Haddon Matrix

A Haddon Matrix can be used to break down and analyze different potential crash-contributing factors. An example of a generic Haddon Matrix is shown in Figure 8. The chart is broken down into four categories: the time period in relation to the accident, and the human, vehicle, and roadway/environmental factors that could potentially contribute to an accident in that time period.

[20] Garber, Nicholas J., and Lester Hoel. 2000. Traffic and Highway Engineering. Toronto ON: Cengage Learning.
[21] Jamar Technologies, Inc. Traffic Data Collector. in Jamar Technologies, Inc. [database online]. 2010 [cited 2/15 2012]. Available from http://www.jamartech.com/files/TDC_Ultra_Brochure.pdf.

Period	Human Factors	Vehicle Factors	Roadway/Environment Factors
Before Crash Factors contributing to increased risk of crash	distraction, fatigue, inattention, poor judgment, age, cell phone use, deficient driving habits	worn tires, worn brakes	wet pavement, polished aggregate, steep downgrade, poorly coordinated signal system
During Crash Factors contributing to crash severity	vulnerability to injury, age, failure to wear a seat belt, driving speed, sobriety	bumper heights and energy adsorption, headrest design, airbag operations	pavement friction, grade, roadside environment
After Crash Factors contributing to crash outcome	age, gender	ease of removal of injured passengers	the time and quality of the emergency response, subsequent medical treatment

Figure 8—Haddon Matrix

Once these factors are identified, the team can consult the Federal Highway Administration's list of recommended countermeasures to determine what actions can be taken to address these problems.

2.1.3.2 Collision Diagrams

A collision diagram is another tool that aids in the identification of crash-contributing factors. A sample is shown in Figure 9. A collision diagram is a schematic, not-to-scale drawing of an intersection or section of roadway that visually displays all the standard information about each crash that occurred in that particular area. A typical collision diagram will display: the type of crash; the EPDO rate; the weather, road and light conditions; and the date and time of the crash. This diagram is useful because it provides a spatial representation of a set of crash data, which allows for a better interpretation of potential contributing factors.

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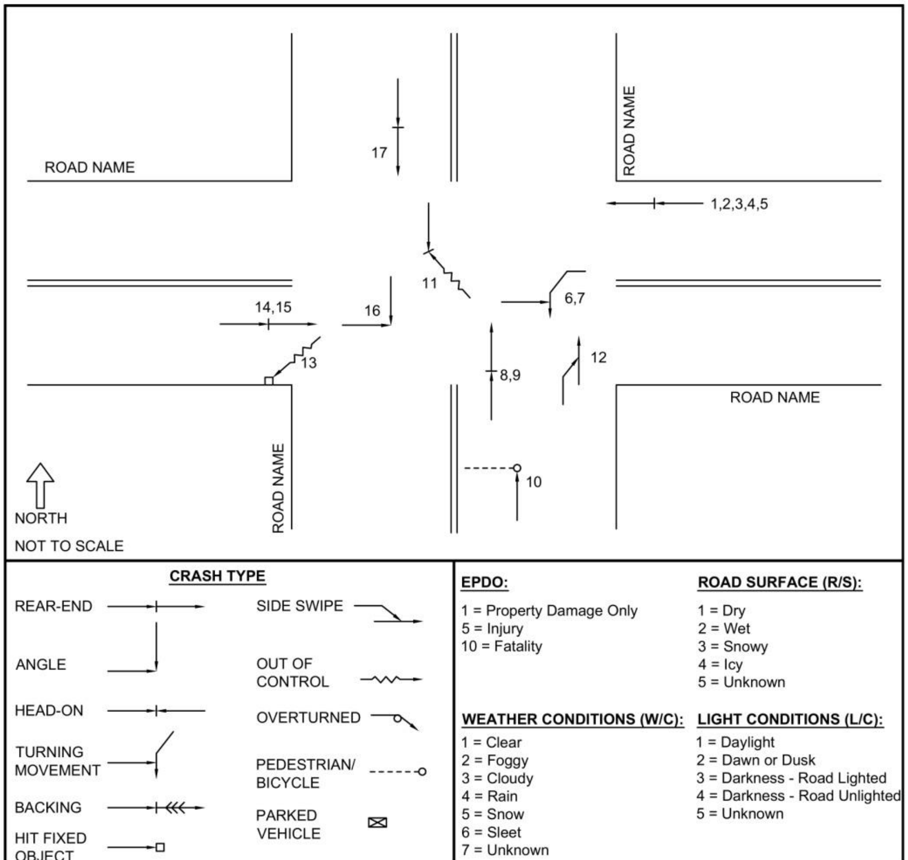
COLLISION DIAGRAM --SAMPLE INTERSECTION



#	DATE	DAY	TIME	EPDO	R/S	W/C	L/C	#	DATE	DAY	TIME	EPOD	R/S	W/C	L/C
1	1/12/1991	Thur	2:57 PM	1	1	1	1	15	11/4/1993	Thur	5:30 PM	1	2	2	1
2	5/2/1991	Tue	12:13 PM	1	1	4	1	16	11/25/1993	Fri	1:47 AM	1	1	4	1
3	6/14/1991	Mon	5:32 AM	5	4	5	1	17	12/14/1993	Tue	2:57 PM	5	1	1	2
4	6/16/1991	Tue	2:57 PM	5	1	2	3								
5	6/29/1991	Fri	8:01 AM	1	3	1	1								
6	9/25/1992	Sun	8:30 PM	1	3	1	1								
7	9/27/1992	Tue	5:42 PM	10	1	4	1								
8	1/8/1992	Thur	3:12 AM	1	1	1	1								
9	3/2/1992	Sun	2:57 PM	1	2	1	2								
10	7/4/1992	Tue	6:44 PM	1	1	5	1								
11	8/29/1992	Tue	3:37 AM	5	1	2	1								
12	2/17/1993	Thur	11:23 AM	1	4	1	2								
13	2/31/1993	Mon	2:19 PM	1	1	1	1								
14	8/25/1993	Sat	2:57 PM	5	1	1	1								

Figure 9—Collision diagram example

2.1.3.3 Crash Rate Equations

A number of equations exist for calculating crash rates and hazard levels of intersections and sections of roadway. One of the most useful is the Equivalent Property Damage Only per Million Entering Vehicles (MEV_{EPDO}) equation. This equation utilizes the same EPDO system as described earlier, which categorizes the severity of a crash as a one, a five, or a ten. The equation used to solve for the MEV_{EPDO} of an intersection is as follows:[22]

$$MEV_{EPDO} = \frac{1{,}000{,}000 \times EPDO}{365 \times T \times AADT}$$

Where: EPDO=Equivalent Property Damage Only rating
T=Time Frame of Analysis (years)
AADT= Average Annual Daily Traffic

This equation is useful because it takes into account the severity per million vehicles instead of just the number of crashes. A simpler form of this equation is the Crash Rate per Million Entering Vehicles (MEV_{CRASH}) equation, which does not take the severity of each crash into account. This equation is shown below: [23]

$$MEV_{CRASH} = \frac{1{,}000{,}000 \times C}{365 \times T \times AADT}$$

Where: C=Total Number of Crashes in the Intersection of Study
T=Time Frame of Analysis (years)
AADT= Average Annual Daily Traffic

This equation does not involve the severity, but it is useful for comparative purposes because much of the national crash data is expressed in terms of the MEV_{CRASH} rate.[24] However, this equation is only applicable for intersections. For sections of roadway, the Crash Rate per Million Vehicle Miles of Travel ($MVMT_{CRASH}$) equation must be used, which is also a frequently used rate. This equation is shown below:[25]

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[22] *Identification of the Most Hazardous Intersections in Franklin County 2004-2006*Franklin Regional Council of Governments,[2009b]).
[23] Ibid.
[24] New Mexico Department of Transportation. 2011. NEW MEXICO TRAFFIC CRASH INFORMATION 2009. University of New Mexico: Division of Government Research.
[25] *Identification of the Most Hazardous Intersections in Franklin County 2004-2006* Franklin Regional Council of Governments,[2009b]).

$$MVMT_{CRASH} = \frac{1,000,000 \times A}{365 \times L \times AADT}$$

Where: A=Average Number of Crashes per Year

L=Segment Length (miles)

AADT= Average Annual Daily Traffic

Likewise, the Equivalent Property Damage Only per Million Vehicle Miles of Travel ($MVMT_{EPDO}$) equation can be used to calculate a crash rate that also severity into account. This rate is similar to the MEV_{EPDO}, except that it applies to sections of roadway instead of intersections. This equation is shown below:

$$MVMT_{EPDO} = \frac{1,000,000 \times EPDO}{365 \times L \times AADT}$$

Where: EPDO=Equivalent Property Damage Only rating

L=Segment Length (miles)

AADT= Average Annual Daily Traffic

2.1.3.4 Geographic Information Systems

A Geographic Information System (GIS) is a powerful tool used to display transportation information. Traffic data can be organized spatially in GIS to better visualize, interpret, and manage important information. In the case of transportation planning, GIS is often used to compile and view multiple sets of data that are associated with particular locations.[26] Sets of information can be sorted into different layers, enabling a large amount of information to be stored in a single GIS system. This arrangement allows for better interpretation of important data, leading to more informed decision making. Figure 10 displays how GIS can be used to integrate multiple sets of data into a single inclusive system. GIS can be utilized to display traffic information that enables its user to make better transportation planning decisions.

[26] The Transportation Planning Process: Key Issues 2007. Transportation Planning Capacity Building

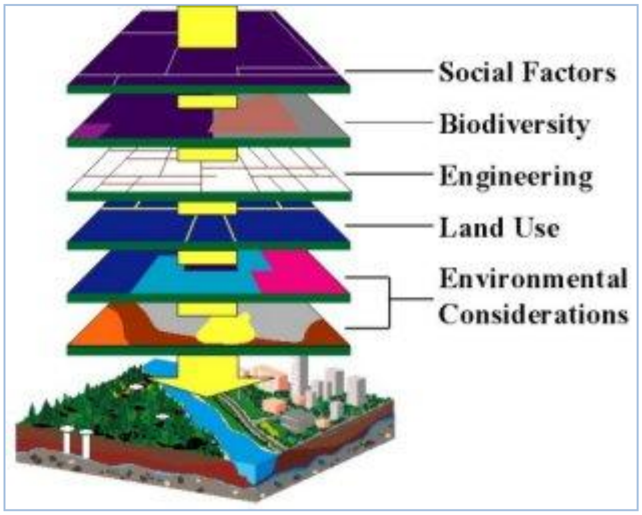

Figure 10—Example of GIS layering

2.1.3.5 Traffic Modeling

Traffic models are dynamic tools that can simulate the characteristics of traffic, specifically traffic volumes. These models are composed of two primary components: current-year data that describes the characteristics of the transportation system in terms of quantifiable variables, and mathematical relationships between these variables.[27]

Traffic models can be extremely complex, but most models operate using the same basic four-step approach. This approach starts with trip generation, which estimates the number of trips that will be generated in a small geographic location called a zone, as well as the attractions of each zone in relation to one another. The model then estimates how many trips will originate from and end in each zone to create a trip table. This trip table is then split into different categories depending on estimates of which mode of transportation will be taken for each trip. Finally, the model will estimate the specific paths through the road network that each trip will take, which allows transportation planners to forecast traffic densities and congestion across the entire system.[28] Figure 11 shows an example of a traffic model. Traffic modeling is a powerful tool that can be used to extrapolate volume counts at varying locations.

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[27] The Transportation Planning Process: Key Issues 2007. Transportation Planning Capacity Building
[28] Ibid.

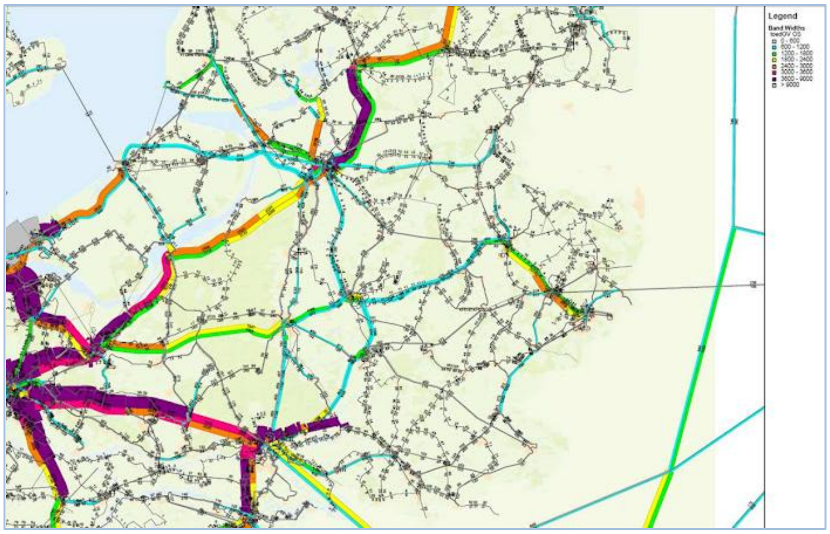

Figure 11—Sample traffic model output during morning rush hour

2.2 Road Safety Improvements

When it comes to road safety, the Federal Highway Administration (FHWA) is the authority on proven countermeasures. As a result of studies performed throughout the country, the FHWA has recommended nine countermeasures that have been tested and proven to reduce crashes and fatalities.[29] These findings are based on both economic feasibility and the ability to improve safety. Since no studies of similar breadth were performed on other countermeasures during the course of this project, any recommendations made by the team are based in part on the FHWA's guidelines. A list of the expected benefits of each of these countermeasures can be found in Appendix G.

2.2.1 Roundabouts

A roundabout is a circular type of intersection in which all vehicles enter a one-way circular path and proceed around an island until exiting onto whichever road they are headed. Roundabouts are useful for reducing crashes and fatalities because they reduce the speed of traffic. Conflict points are also reduced because all traffic in the intersection flows steadily in the same direction, while vehicles entering must yield to those already in the roundabout. When a signalized intersection is

[29] "Proven Safety Countermeasures." Federal Highway Administration, http://safety.fhwa.dot.gov/provencountermeasures/ (accessed 2/9, 2012).

replaced with a roundabout, serious injuries can be reduced by 78% and overall crashes lowered by 48%.[30] Although four way stop intersections attain similar reductions, they are not as efficient for large traffic volumes because each vehicle must come to a complete stop before proceeding.[31]

2.2.2 Corridor Access Management

Corridor access management is the systematic control of entrances and exits to roadways in order to reduce the number of conflict points. This technique is particularly useful for main arteries where traditional intersections, which allow cars to enter in either direction, would be unsafe. Tools such as on-ramps and off-ramps allow engineers to restrict the number of ways in which vehicles can enter, reducing confusion and the potential for crashes. Other options include medians and limited turning options. Corridor access management is proven to reduce the number of fatal crashes by 25-31% in urban and suburban areas.[32] When all the elements of corridor access management are correctly placed, they help prevent conflict points and assist traffic in moving smoothly.

2.2.3 Backplates with Retroreflective Borders

Backplates with retroreflective borders can improve the safety of signalized intersections. The installation of metal plates behind traffic signals increases contrast, making them more visible during the day and a retroreflective border illuminates them at night.[33] On average, intersections fitted with these special plates have enjoyed a 28.6% reduction in total crashes and a 49.6% drop in nighttime accidents.[34] The economical price and high success rate of these retroreflective plates has encouraged state and local highway agencies to retrofit known dangerous intersections and to incorporate this modification into all future constructions.

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30 "Proven Safety Countermeasures." Federal Highway Administration, http://safety.fhwa.dot.gov/provencountermeasures/ (accessed 2/9, 2012).
31 Ibid.
32 Ibid.
33 Ibid.
34 Federal Highway Administration, *Retroreflective Borders on Traffic Signal Backplates - A South Carolina Success Story* FHWA,[2009]).

2.2.4 Longitudinal Rumble Strips and Stripes

A rumble strip is a line of divots running down the edge of a lane that causes vibration and noise to warn drivers when they are leaving their lane due to drowsiness or distraction.[35] On urban two-lane roads, the installation of rumble strips can reduce the number of head on collisions by up to 64%, a respectable figure. With greater employment of rumble strips, the number of fatalities caused by vehicles leaving the roadway, which is currently 58%, can perhaps be lessened.[36]

2.2.5 Enhanced Delineation and Friction for Horizontal Curves

Horizontal curves often become conflict points during inclement weather or when vehicles are simply driving too fast. Curves on roadways are responsible for 28% of all fatal crashes. To combat this problem, enhanced delineation and friction treatments for road surfaces have been employed.[37] New fluorescent chevron signs and warning lights have been shown to reduce crashes by up to 43%.[38] There are also special coatings available to increase friction between a vehicles tires and the road surface, decreasing serious and fatal injuries by 43% on horizontal curves.[39] The FHWA recommends that all states having issues with crashes on curves begin incorporating these modern countermeasures into their construction policies.

2.2.6 Safety Edges

A common hazard on roadways without curbs is the vertical drop-off at the edge of the road. Studies have shown that crashes involving drop-offs are three to four times more likely to involve a fatality.[40] To combat this problem, a new countermeasure has been developed called Safety Edge, which involves angling the edge of the pavement at thirty degrees and bringing graded material up to the edge of the road, flush with the paved surface. Safety Edge has been incorporated into new road construction because of its low cost and improved safety.

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35 "Proven Safety Countermeasures." Federal Highway Administration, http://safety.fhwa.dot.gov/provencountermeasures/ (accessed 2/9, 2012).
36 Ibid.
37 Ibid.
38 Ibid.
39 Ibid.
40 Ibid.

2.2.7 Medians and Pedestrian Crossing Islands

Medians and crossing islands are designed to reduce the number of crashes involving pedestrians. People hit by vehicles traveling at 40 mph or faster are killed 80% of the time, but when hit at 20 mph or slower, only 10% of incidents are fatalities.[41] This is where raised crossing islands can be advantageous because they make pedestrians more visible and encourage vehicles to reduce their speed. Traffic islands offer another protection for pedestrians; they provide a safe zone in the center of the road, allowing people to cross one lane at a time. Medians and islands are recommended for all crossings of multi-lane roadways.[42]

2.2.8 Pedestrian Hybrid Beacon

Pedestrian hybrid beacons are similar to traffic lights but they have only flashing red lights. These lights can be activated by pedestrians, stopping the flow of traffic so that they may safely cross the roadway. In urban areas, these crossing signals have been shown to reduce pedestrian crashes by as much as 69%, a respectable figure.[43] These beacons are recommended for areas where vehicle speeds are too high for standard pedestrian crossings or if there are insufficient gaps between vehicles to allow crossing. The FHWA also recommends programs to inform drivers about hybrid beacons because they are relatively new and may cause confusion at first.

2.2.9 Road Diet

Road diet is the policy of reducing the number of travel lanes on roadways to reduce speeds and make crossing safer for both vehicles and pedestrians. Four lane roads are often converted into three lane roads, with the center lane being reserved for left turns only.[44] Reducing the number of travel lanes in each direction down to a single lane eliminates the problem of drivers not seeing pedestrians due to a stopped car in a different lane blocking their view. Another advantage to having a neutral middle lane is that it provides space for a pedestrian island, further increasing safety.

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41 "Proven Safety Countermeasures." Federal Highway Administration, http://safety.fhwa.dot.gov/provencountermeasures/ (accessed 2/9, 2012).
42 Ibid.
43 Ibid.
44 Ibid.

Three lane roads with a neutral middle lane have shown a 29% reduction in crashes and provide a safer environment for pedestrians.[45]

2.3 Transportation Safety in Santa Fe

2.3.1 Santa Fe Metropolitan Planning Organization

Figure 12— Santa Fe Metropolitan Planning Organization logo

The Santa Fe Metropolitan Planning Organization (SFMPO) is a federally funded and mandated organization whose purpose is to create a forum for transportation decision making in Santa Fe's metropolitan planning area. The Federal-Aid Highway Act of 1962 established that an urbanized area must be designated an MPO once its population surpasses 50,000.[46] For the city of Santa Fe, this requirement was met in 1982. The SFMPO works with the New Mexico Department of Transportation (NMDOT), the city of Santa Fe, and the Santa Fe County to improve and maintain the transportation system in the metropolitan planning area. There are several factors the organization must consider when making changes to the transportation system including the safety, security, economic vitality, accessibility, mobility, efficiency, preservation, integration, and environmental impacts of a this system.[47] The SFMPO is responsible for the entire metropolitan planning area, a map of which can be found in Appendix A. The logo of the SFMPO can be seen in Figure 12.

[45] "Proven Safety Countermeasures." Federal Highway Administration, http://safety.fhwa.dot.gov/provencountermeasures/ (accessed 2/9, 2012).
[46] Association of Metropolitan Planning Organizations. About MPOs: A brief history. 2012 [cited 2/13 2012]. Available from http://www.ampo.org/what/index.php.
[47] Santa Fe Metropolitan Planning Organization. 2010. *Santa Fe Metropolitan Transportation Plan 2010-2035*. Santa Fe: .

2.3.2 Transportation Network in Santa Fe

The city of Santa Fe, originally formed as a collection of Pueblo Indian villages along the Santa Fe River, is one of the oldest cities in the United States.[48] Don Pedro de Peralta founded modern Santa Fe in 1610 and made it the capital of the province of New Mexico.[49] Santa Fe, as part of New Mexico, was official claimed by the United States through the Treaty of Guadalupe Hidalgo in 1848.[50] The Santa Fe Trail was the first major transportation network in Santa Fe.[51] Predating the railroad, it served as the first major artery to the southwest, running from Franklin, Missouri to Santa Fe, New Mexico. With the dawn of the railroad, the Santa Fe Trail lost favor to the speed and convenience of the Atchison, Topeka and Santa Fe Railway (ATSF).[52] The main line never actually ran directly to Santa Fe because of difficulties encountered laying track; instead a branch line ran up from Lamy, New Mexico, completed in 1880.[53] A branch of the Denver and Rio Grande Western Railroad was run to Santa Fe in 1886.[54]

Santa Fe continued to grow as an arts community, and in 1912 New Mexico became the 47th state of the United States of America; Santa Fe was designated as the capital.[55] This led to the first city plan in 1912, which set forth a plan to maintain historic roads and required new roads to fit in with the established city.[56] The character of the city lends itself to tourism, facilitated by the growing popularity of the automobile and roads such as Route 66.[57] The transportation network continued to grow, with new roads following the old routes established by the Santa Fe Trail and the railroads. Recently, a commuter line called the New Mexico Rail Runner Express has been established to serve

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48 Official Santa Fe Trail Association. in Santa Fe Trail Association [database online]. 2012 [cited 02/13 2012]. Available from http://www.santafetrail.org/.
49 Official Travel Site Santa Fe, New Mexico. in Santa Fe Convention Center [database online]. 2012 [cited 02/14 2012]. Available from www.santafe.org.
50 Santa Fe. in Encyclopedia Britannica Online [database online]. 2012 [cited 02/13 2012]. Available from http://www.britannica.com/EBchecked/topic/522867/Santa-Fe.
51 Santa Fe Trail. in Encyclopedia Britannica Online [database online]. 2012 [cited 02/13 2012]. Available from http://www.britannica.com/EBchecked/topic/522881/Santa-Fe-Trail.
52 Santa Fe, NM - Official Website. in City of Santa Fe, NM [database online]. 2012 [cited 02/14 2012]. Available from www.santafenm.gov.
53 Santa Fe, NM. in Denver and Rio Grande [database online]. 2005 [cited 02/13 2012]. Available from http://www.ghostdepot.com/rg/mainline/san%20juan%20branch/santa%20fe.htm.
54 About SFSR. in Santa Fe Southern Railway [database online]. [cited 02/13 2012]. Available from http://www.sfsr.com/about.html.
55 Santa Fe. in Encyclopedia Britannica Online [database online]. 2012 [cited 02/13 2012]. Available from http://www.britannica.com/EBchecked/topic/522867/Santa-Fe.
56 Wallis, Michael. 1992. *Route 66: The Mother Road*. New York: St. Martin's Griffin.
57 Wilson, Chris. 1997. *The Myth of Santa Fe: Creating a Modern Regional Tradition*. University of New Mexico Press.

downtown Santa Fe to Albuquerque. Still, the road system plays a major role in Santa Fe's transportation network.

Santa Fe, like any major city, suffers from vehicle crashes. Figure 13 shows the crashes per 1,000 people in Santa Fe compared to the nation as a whole.[58]

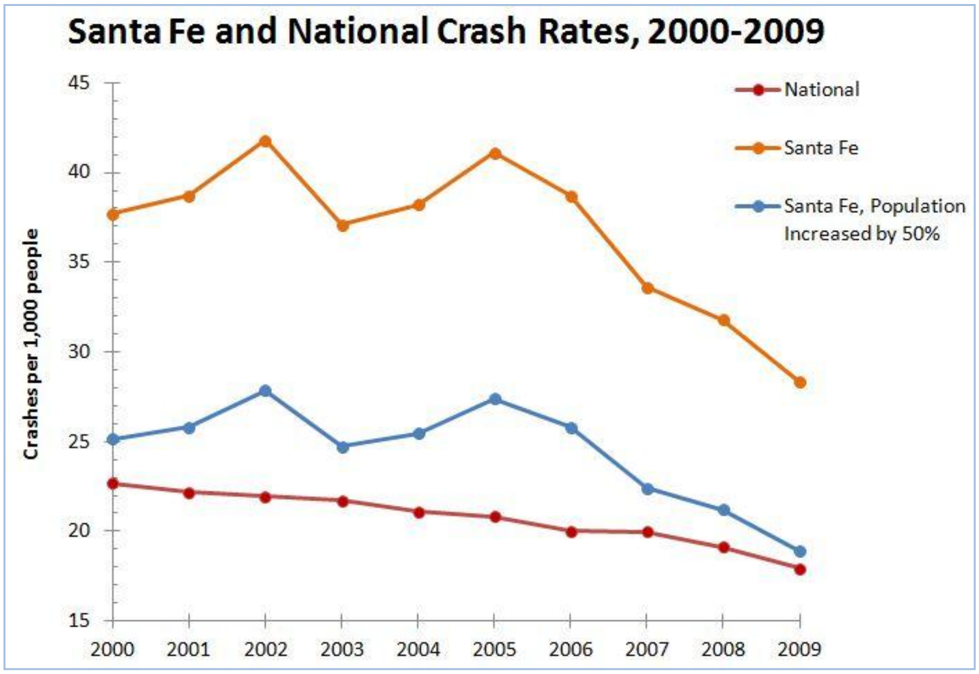

Figure 13—Santa Fe and nation crash rates

This information shows that the city of Santa Fe has a higher crash rate, per 1,000 people, than the nation as a whole. However, it is important to take into account Santa Fe's fluctuating population. Because it is the capital of New Mexico, Santa Fe is the headquarters for many government agencies. This brings in many government employees who may not live in Santa Fe. The city also draws in many tourists from the surround area, further increasing the amount of people in Santa Fe. Estimating a population increase of 50% due to these factors, Santa Fe is still slightly more hazardous than the nation as a whole. While there has been a decrease in crashes over the last few years, there is still ample room for improvement.

58 New Mexico Department of Transportation. 2011. NEW MEXICO TRAFFIC CRASH INFORMATION 2009. University of New Mexico: Division of Government Research. New Mexico Traffic Crash Information. 2009. New Mexico Department of Transportation.

3. Methodology

The purpose of this project is to improve roadway safety in the Santa Fe metropolitan planning area by identifying hazardous locations and then evaluating and proposing possible improvements. To complete this mission, the team accomplished these four goals:

1. Organized traffic safety data
2. Identified the most hazardous locations
3. Identified crash patterns
4. Determined appropriate safety improvements

The team used existing crash data from 2006 to 2011, provided by the New Mexico Department of Transportation and the University of New Mexico (UNM). The major data collection and analysis portion of this project took place between March 18th, 2012, and May 5th, 2012, and covered the extent of the Santa Fe metropolitan planning area, shown in Figure 14.

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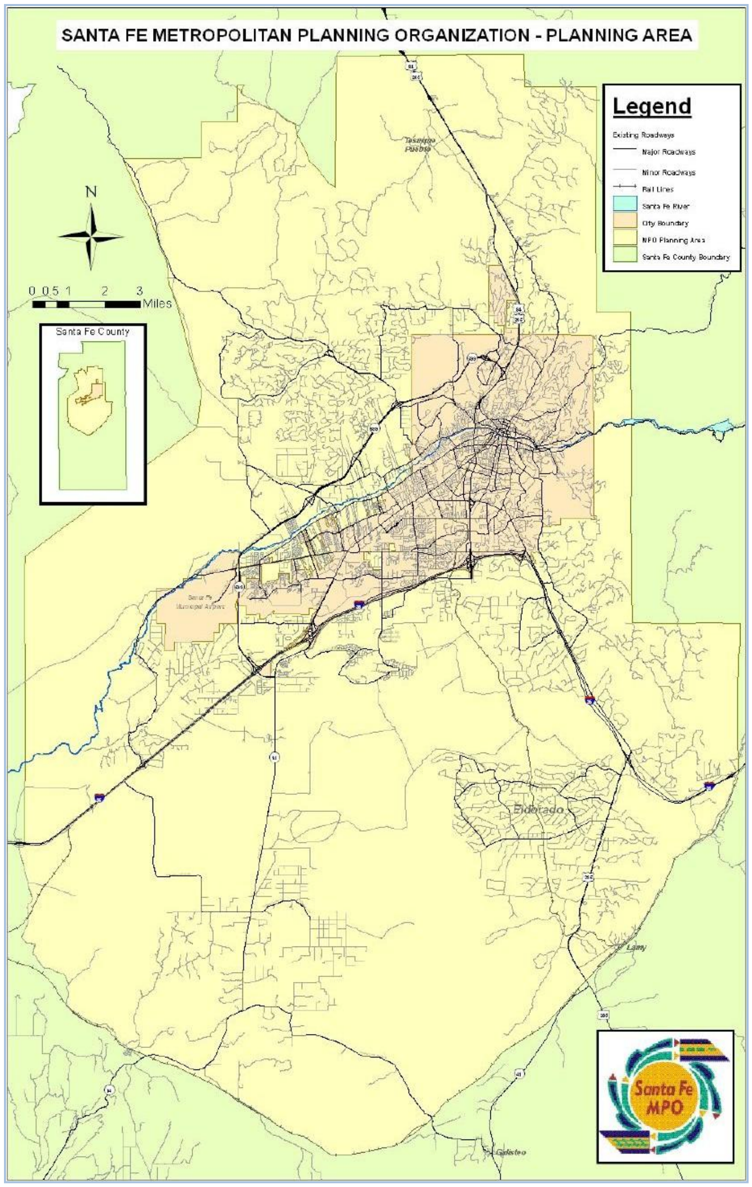

Figure 14—Santa Fe Metropolitan Planning Area

The American Association of State Highway and Transportation Officials' (AASHTO) Highway Safety Manual (HSM), the standard text for traffic engineering, defines a crash as a "set of events that result in injury or property damage due to the collision of at least one motorized vehicle and may involve collision with another motorized vehicle, a bicyclist, a pedestrian, or an object."[59] This definition does not include crashes between cyclists and pedestrians that do not involve an automobile, or vehicles on rails. The HSM also defines an intersection as "the general

[59] Highway Safety Manual American Association of State Highway and Transportation Officials (AASHTO). http://www.knovel.com/web/portal/browse/display?_EXT_KNOVEL_DISPLAY_bookid=3419.

area where two or more roadways join or cross, including the roadway and roadside facilities for traffic movements within the area."[60]

3.1 Organizing Traffic Safety Data

3.1.1 Crash Data

It was crucial to organize the crash data for an efficient strategy for analysis. To accomplish this, the team created an Excel sheet to organize the crash data, an excerpt of which is shown in Figure 15.

DATE	TIME	INTERSECTION	X_LAT	Y_LONG	Sort ID	REPORT
1/2/2006	1652	ST FRANCIS DR US 84/285 @ CERRILLOS RD	413683.5617	3948604.249	413683.5617,3948604.249	0022037235
1/5/2006	0940	ST FRANCIS DR US 84/285 @ CERRILLOS RD	413683.5617	3948604.249	413683.5617,3948604.249	0022037238
1/7/2006	1950	ZEPOL RD @ AIRPORT RD NM 284	407164.3758	3944325.25	407164.3758,3944325.25	0022104427
1/9/2006	0919	CORDOVA RD @ ST FRANCIS DR US 84/285	413694.2812	3948224.249	413694.2812,3948224.249	0022037240
1/10/2006	0850	SAN MATEO RD @ ST FRANCIS DR US 84/285	413433.7497	3946903.5	413433.7497,3946903.5	0022031544
1/11/2006	1407	ST FRANCIS DR US 84/285 @ ZIA RD	413413.8114	3945221.749	413413.8114,3945221.749	0022037248
1/13/2006	1429	BECKNER ROAD @ CERRILLOS RD	406440.5943	3941536.999	406440.5943,3941536.999	0022095619
1/13/2006	1503	RICHARDS AVE @ RODEO RD NM 300	409414.0628	3944351.749	409414.0628,3944351.749	0022033157
1/13/2006	1605	CERRILLOS RD @ OSAGE AVE	411552.0322	3946972.499	411552.0322,3946972.499	0022037291
1/14/2006	1230	BARCELONA RD @ DON GASPAR AVE	414660.468	3948017.249	414660.468,3948017.249	0022031545

Figure 15—Intersection crash data spreadsheet excerpt

This sheet organized all of the crash data in a way that allowed the team to later perform analysis. Each crash report contained a variety of data taken from the crash. It was important that this spreadsheet included all available data to ensure the analysis was as accurate as possible.

The crash data contained a large amount of information about each crash, including identification number, crash report reference number, street names, GPS coordinates, date and time, number of occupants involved, alcohol and drug involvement, pedestrian and cyclist involvement, crash severity, crash analysis, contributing factors, a code indicating the type of accident, and the light, road, and weather conditions. Each of these categories had its own column in Excel, which allowed for ease of organization and sorting. Several columns were added to assist calculations by converting the information into numbers. For example, the severity was listed as either "Property Damage Only Crash," "Injury Crash," or "Fatal Crash" in the master data list. These values had to

[60] Highway Safety Manual American Association of State Highway and Transportation Officials (AASHTO). http://www.knovel.com/web/portal/browse/display?_EXT_KNOVEL_DISPLAY_bookid=3419.

be converted to numbers for use in the MEV_{EPDO} and $MVMT_{EPDO}$ equations. This was accomplished using functions built into Excel.

Vehicle crashes were sorted by location using street names and GPS coordinates. If the crash took place on a stretch of road, the length of that segment of roadway was recorded via Google Earth for use in the crash rate equations. The team also created a similar Excel spreadsheet to deal with road segment crash data, which can be found in Appendix D.

The final step in categorizing the crash data was to sum the EPDO ratings for each location. Once the data was categorized, the team had the ability to sort it by different parameters, such as type of crash or environmental factors. The ability to easily sort and order data was crucial for analysis.

3.1.2 Volume Data

Volume data needed to be organized and paired with crash data by location. The unit of measurement desired for volume counts is the AADT, or Average Annual Daily Traffic. If the data was not already in this format, it was converted using simple conversion factors. Once all volume counts had been expressed as an AADT, each crash in the database was linked to one of these volume measurements. If there was an existing volume measurement for the precise location of a crash, they were paired together. If a volume measurement was not available for the precise location of a crash, the closest possible AADT was used. Accurate volume data had to be paired with each location to normalize crash rates. The team created an Excel spreadsheet to organize the volume, an excerpt of which is shown in Figure 16. A similar spreadsheet that deals with road segment volume can be found in Appendix E.

INTERSECTION	LATITUDE	LONGITUDE	AADT
GUADALUPE ST @ PASEO DE PERALTA	414170.6868	3949067.9990	26530
5TH ST @ ST MICHAELS DR	412240.3738	3946597.7500	30865
GALISTEO ST @ ST MICHAELS DR	413849.4994	3946507.7490	32158
SILER RD @ RUFINA ST	410157.0001	3946482.4990	23158
ALAMO DR @ ST FRANCIS DR US 84/285	413714.1866	3950698.9990	35398
JEMEZ RD @ AIRPORT RD NM 284	406433.4389	3944211.2490	24575
AVENIDA DE LAS AMERICAS @ CERRILLOS RD	409190.6263	3945404.9990	44470

Figure 16—Intersection volume data spreadsheet

3.1.2.1 Obtaining Traffic Volume Data

While the NMDOT provided the existing crash data for 2006-2011, the SFMPO was able to provide traffic volume data. However, this data contained a limited number of traffic count locations. Instead of using these physical counts, the group made use of the SFMPO's VISUM traffic modeling software to obtain all volume data. This method ensured that the volume data was consistent. The VISUM program provided the team with the necessary traffic volume information needed to complete this project.

The traffic model in question is regularly updated and recalibrated by the SFMPO. The majority of the volume data that was used for this project was from the model's last calibrated in 2010. According to MPO Senior Planner Keith Wilson, the traffic volumes are relatively constant from year to year in Santa Fe, so there was no issue with using volume data from 2010 to analyze crashes from 2006-2011.

To get more detail than the traffic model could provide, and to fill in missing gaps, the team had to go out in Santa Fe and manually collect vehicle turning counts on the most dangerous locations. The best method for the manual collection of data was the TDC hand held data collector discussed earlier, which was an efficient and reliable method for recording traffic movements in intersections. All manual counts were done at the peak-hour for traffic volumes. This value could be converted to an AADT by simple multiplication constants. Since the team was able to acquire two TDC counting boards, two intersections were able to be monitored at any given time. This valuable manpower along with an efficient collection system made data collection quite feasible.

3.2 Identifying the Most Hazardous Locations

After the traffic data was obtained and organized within its respective spreadsheets, it had to be analyzed. The team used additional spreadsheets to perform necessary analysis calculations and to create a map to show hazardous intersection locations. All of the spreadsheets can be found in Appendices D-F.

3.2.1 Calculating Crash Rates

The crash rates, per million vehicles, differ in computation for intersections and road segments. Intersections refer to a specific location, while road segments refer to a length of road, which affects the crash rates. These rates were used to compare the crash rates for intersections and road segments in Santa Fe with the average crash rate of New Mexico.

3.2.1.1 Intersections

The crash rates for intersections were found using the MEV_{CRASH} equation described earlier. A spreadsheet with a column for the MEV_{CRASH} formula was used to perform these calculations. The formula references cells from the sheets used to organize the data. These cells include:

- Total Number of Crashes for the specific intersection
- The AADT for the specific intersection

The MEV_{CRASH} was found for each intersection and is available for viewing in a results Excel sheet, which can be found in Appendix F.

3.2.1.2 Road Segments

The crash rate for road segments was found using the $MVMT_{CRASH}$ equation which can be seen in the Background. A spreadsheet with a column with this formula for $MVMT_{CRASH}$ was used to perform these calculations. The formula references cells from the sheets used to organize the data. These cells include:

- Total Number of Crashes for the specific road segment
- The AADT for the specific road segment
- The length of each road segment

The $MVMT_{CRASH}$ rate was found for each road segment and is available for viewing in a results Excel sheet, which can be found in Appendix F.

It was decided that the analysis that would be performed on the road segment crash data would lack the depth found in the intersection analysis. This decision was made for several reasons, the first being that the $MVMT_{CRASH}$ rate equation is designed for use in rural areas, or on long segments of highway. When it is applied to the short road segments typically found in cities, the equation tends to produce unreliable results. For example, a road in downtown Santa Fe may only be a tenth of a mile in length. Because the $MVMT_{CRASH}$ rate equation accounts for length, this miniscule length would heavily skew the results, indicating that this particular segment is extremely hazardous.

Project deadlines also limit the level of detail the team can pursue for road segment analysis. To perform an in-depth analysis on both the most hazardous intersections and the most hazardous road segments in only seven weeks would be nearly impossible. In the interest of time, our sponsor Keith Wilson of the SFMPO advised that the team focus on intersection analysis and only carry out a simply analysis of road segments.

3.2.2 Ranking Locations Based on Crash Rates

The team was able to separately rank both the intersection data and road segment data based on MEV_{CRASH} and $MVMT_{CRASH}$ values, respectively. This data was then compared with the average crash rate for New Mexico, provided by the New Mexico Department of Transportation. This helped determine which intersections have a higher crash rate than the rest of New Mexico and proved to be an interesting data point.

3.2.3 Calculating the Equivalent Property Damage Only Rate

The Equivalent Property Damage per Million Entering Vehicles (MEV_{EPDO}) is used to rank the hazardousness of intersections and road segments. This value was calculated using Excel's ability to solve formulas. To use this tool, the equation for MEV_{EPDO} was input into the cells of a specific column where the results of the formula were displayed. Then the equation displayed the results using references to cells from the sheets used to organize the crash and volume data. These cells include:

- Total of EPDO value for each intersection and road segment
- The AADT for each intersection and road segment

This MEV_{EPDO} rate was found for each intersection and road segment and is available for viewing in Appendix F.

3.2.4 Ranking Locations Based on Equivalent Property Damage Only Rate

Each intersection and road segment was ranked collectively using the MEV_{EPDO} and $MVMT_{EPDO}$ rates, respectively. The team combined all available data from both the intersections and road segments into an additional sheet, which served as a database to rank both based on hazardousness. These values were then sorted by the MEV_{EPDO} and $MVMT_{EPDO}$ rates from highest value to lowest. An intersection or road segment with a higher MEV_{EPDO} or $MVMT_{EPDO}$ value was deemed more hazardous.

The top twenty-five most hazardous intersections were then highlighted and chosen as locations that the team evaluated and proposed safety improvements for. Figure 17 is an example of what this spreadsheet looked like.

Rank	INTERSECTION	SORT ID	AADT	STUDY LENGTH	TOTAL # OF CRASHES	TOTAL EPDO	MEVcrash	MEVepdo
1	BERRY AVE @ 5TH ST	412036.2187,3947157.749	2760	6	7	27	1.158096751	4.46694461
2	BECKNER ROAD @ CERRILLOS RD	406440.5943,3941536.999	31133.5	6	80	256	1.173323923	3.754636554
3	COTTONWOOD AVE @ AGUA FRIA ST NM 588	405381.97,3944930.25	7460	6	24	52	1.469021999	3.182880997
4	ST FRANCIS DR US 84/285 @ CERRILLOS RD	413683.5617,3948604.249	72208.5	6	215	463	1.359583927	2.927848177
5	JEMEZ RD @ RUFINA ST	406198.3447,3944873.249	4394.5	6	11	27	1.142981238	2.805499402
6	RICHARDS AVE @ CERRILLOS RD	409381.72,3945543.999	52210	6	133	309	1.163198499	2.702468692
7	BARCELONA RD @ DON GASPAR AVE	414660.468,3948017.249	5180	6	10	30	0.881507731	2.644523192

Figure 17— Spreadsheet for intersection data excerpt

3.2.5 Comparing Hazardous Intersections with Expected Number of Crashes

The team compared the list of the top twenty-five of most hazardous intersections based on crash severity rate with the expected number of crashes for each location. This expected rate was calculated using the HSM's "Predictive Method for Urban and Suburban Arterials" spreadsheet, which takes into account physical characteristics of an intersection and crash modification factors, and then outputs a total number of expected crashes per year for that intersection. This sheet can be found in Appendix H. The team then multiplied this result by six to get the total number of expected crashes for the study period. This number was then compared with the total number of crashes for each intersection to ensure that they were all considered hazardous according to the HSM's standards. The difference in number of crashes was then shown in the table as a percentage. A sample of the output section of the HSM's spreadsheet is shown in Figure 18.

Worksheet 2L -- Summary Results for Urban and Suburban Arterial Intersections	
(1)	(2)
Crash severity level	Predicted average crash frequency, $N_{predicted\ int}$ (crashes/year)
	(Total) from Worksheet 2K
Total	1.6
Fatal and injury (FI)	0.5
Property damage only (PDO)	1.0

Figure 18—Sample output section from expected crash rate sheet

3.2.6 Creating Geographic Display of Top Locations

After the data was analyzed and the MEV_{CRASH}, $MVMT_{CRASH}$, MEV_{EPDO}, and $MVMT_{EPDO}$ values were calculated for each intersection and road segment, the data was shown using GIS data layers. Since the data was already geo-coded, mapping the information with GIS Cloud was automatic. The coordinates for data that was not geo-coded was found manually. Coordinates for intersections were taken at the center of the intersection, and coordinates for road segments were taken in the middle of the physical segment. All the information was located in a single GIS map, and separate layers could be turned on and off. The basic foundation layer—which displays the city boundaries, the MPO boundaries, and the major roads— is shown in Figure 19.

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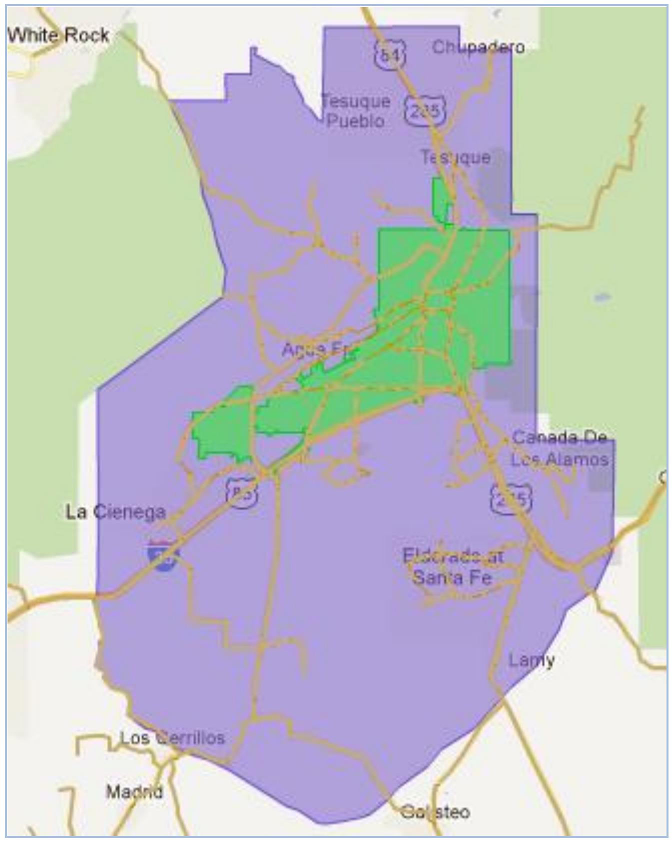

Figure 19—Foundation layer showing MPO and city (purple and green), and major roads (gold)

GIS Cloud was then used to map a variety of interesting datasets, such as pedestrian crashes, bicycle crashes, crashes by severity, crash rate comparison verses the state average, and many more.

The team also produced a GIS map displaying the top twenty-five most hazardous intersections, as well as their rank and EPDO, MEV_{CRASH} or $MVMT_{CRASH}$, and MEV_{EPDO} or $MVMT_{EPDO}$ rates in info boxes. Crash and volume data for these intersections were also displayed in these information boxes, which pop up when a "pin" is clicked with a mouse.

3.3 Identifying Crash Patterns

Once the group identified the most hazardous locations in the Santa Fe metropolitan planning area, the next task was to identify and analyze the crash patterns at these locations. Identifying these patterns was essential in determining the main factors that contribute to these crashes and to applying the correct countermeasures to increase safety.

3.3.1 Identifying Crash Patterns

One tool that was used to identify crash patterns were collision diagrams, discussed earlier. Displaying crash information spatially allows for a better interpretation of potential contributing factors. For example, if a collision diagram shows that the majority of crashes happened while entering an intersection from a particular direction, perhaps there is a problem with that street or that side of the intersection. The signage could be obscured, or maybe recent foliage growth has blocked an important sightline. Displaying information visually in a collision diagram allowed the team to better identify characteristics and patterns in crash data.

Once the team had identified the most hazardous locations in Santa Fe, collision diagrams were created for the top twenty-five most hazardous intersections. These collision diagrams helped to identify crash patterns in order to select the appropriate countermeasures to address the specific safety issues at each location. In order to accomplish this task, the team needed to obtain the original crash reports from the Santa Fe Police Department. These crash reports, described in an earlier section, contained a far more detailed account of the crash than is available in the crash data compiled by the NMDOT, ensuring accurate collision diagrams.

3.3.2 Displaying Crash Patterns

Once collision diagrams were completed for each of the most hazardous intersections, the most prominent and commonly-occurring crash types were lifted from each diagram. These specific crashes were then overlaid onto an aerial image of that intersection. Descriptions of each intersection followed, with special emphasis centered on the part of the intersection that relates to the most commonly occurring crash at that intersection. For example, most of the crashes in a certain intersection occur when automobiles are making left turns. The symbol for left turns was overlaid onto the to-scale image of that intersection, and then the written description of that intersection was centered on information related to left turns. This description included the number of lanes an automobile must cross to complete a left turn, the signage and lights related to turning left, the number of lanes entering the intersection from the approaching direction, sightlines while turning left, and more. Each description was also supported by photographs of the intersection taken from the field.

Once all of this information had been processed, formatted, and displayed together, it gave an in-depth representation of the crash patterns that occur at each intersection.

3.4 Determining Appropriate Safety Improvements

Once the group identified the most common crash patterns at the most hazardous locations in the Santa Fe metropolitan planning area, the next task was to develop appropriate safety countermeasures that would make those locations safer. A countermeasure is defined by the HSM as a "roadway strategy that is intended to decrease crash frequency or severity, or both, at a site.[61]" In order to improve traffic safety, these countermeasures had to be carefully chosen for each situation. For this task, the team utilized the determined crash patterns for each individual location in order to determine the correct countermeasures to employ.

It is important to note that all safety improvements made by the team need to be further analyzed and approved by traffic engineering professionals before any action is taken.

3.4.1 Selecting Appropriate Countermeasures

As previously discussed, the FHWA has a list of recommended countermeasures that are proven to reduce accidents and fatalities. Selecting the appropriate safety countermeasures can decrease the crash frequency at a site. However, choosing a countermeasure that does not address the corresponding problem will result in modifications that do nothing to improve traffic safety. The correct countermeasures must be chosen to address the specific crash characteristics and patterns at each location.

Once the crash trends were identified, the team needed to determine which countermeasures to employ to address these safety issues. The FHWA provides funding for a website known as Crash Modification Factors Clearinghouse, which contains a more detailed list of known safety countermeasures as well as information on what issues each improvement should alleviate.[62] The group sorted through this list and selected improvements that will address each of the issues identified from the crash patterns. This provided a final list of all the possible countermeasures that can improve safety at each of the most hazardous intersections in the Santa Fe metropolitan planning area.

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[61] Highway Safety Manual. American Association of State Highway and Transportation Officials (AASHTO), http://www.knovel.com/web/portal/browse/display?_EXT_KNOVEL_DISPLAY_bookid=3419.

[62] University of North Carolina Highway Research Safety Center. Crash Modification Factors Clearinghouse. in U.S. Department of Transportation Federal Highway Administration [database online]. 2012 [cited 2/23 2012]. Available from http://www.cmfclearinghouse.org/.

4. Results

The following results were compiled using information taken entirely from the crash data provided by the NMDOT and volume data obtained from the SFMPO and manual volume counts.

4.1 Crash Data Overview

4.1.1 Crashes by Severity

The data received consisted of 12,542 crashes in total, 8,409 of which were property damage only crashes, 4,079 were injury crashes, and 54 were fatal crashes. Figure 20 displays the crash severity by percentage for the entire set of crash data.

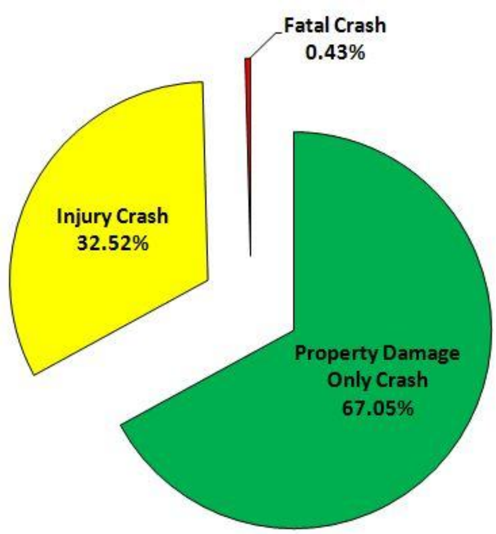


Figure 20—Crash severity by percentage for all crash data

While property damage only crashes made up a significant percent of the total crashes, the crashes that resulted in injuries and fatalities will carry more weight when ranking by hazardousness because of their increased severity. Figure 21 displays each crash in the metropolitan planning area in the entire dataset, with the colors corresponding to the severity.

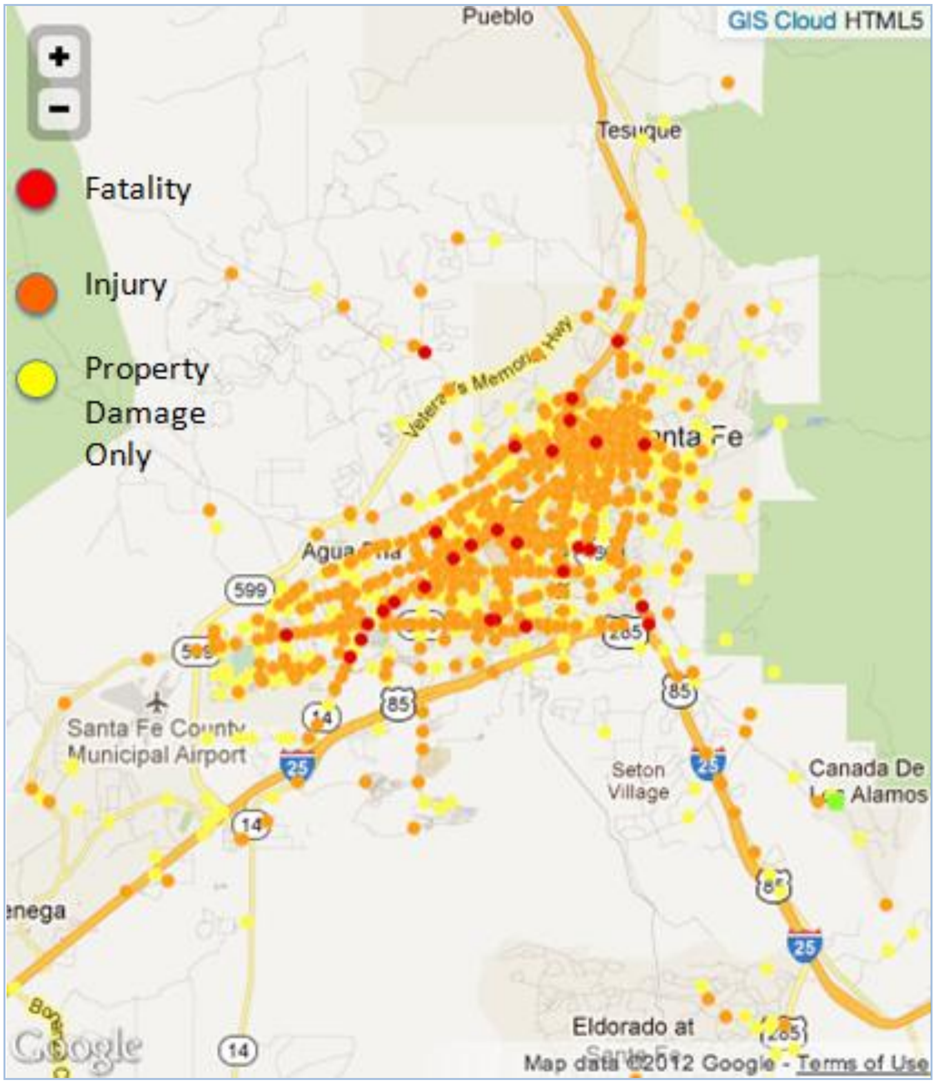


Figure 21—All crashes in the metropolitan planning area by severity

4.1.2 Types of Crashes

The crash data indicated whether a crash involved a bicycle, pedestrian, motorcycle, or another vehicle. A breakdown of this data is shown in Figure 22.

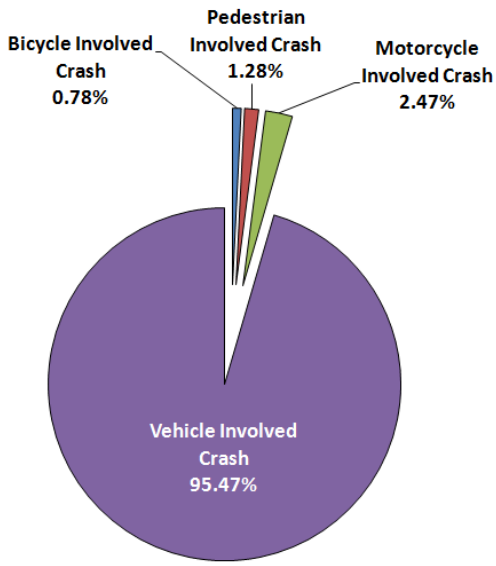
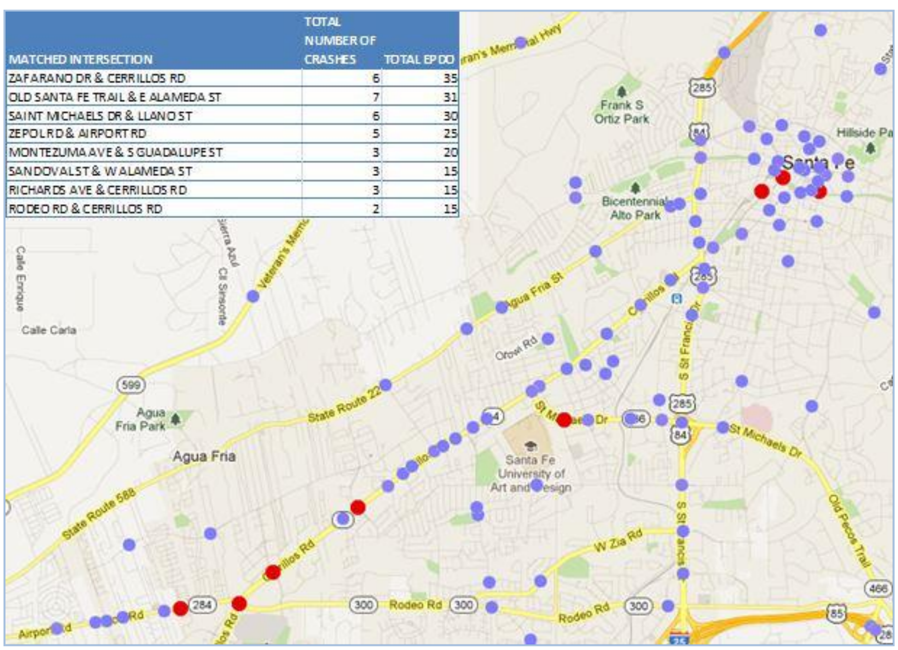


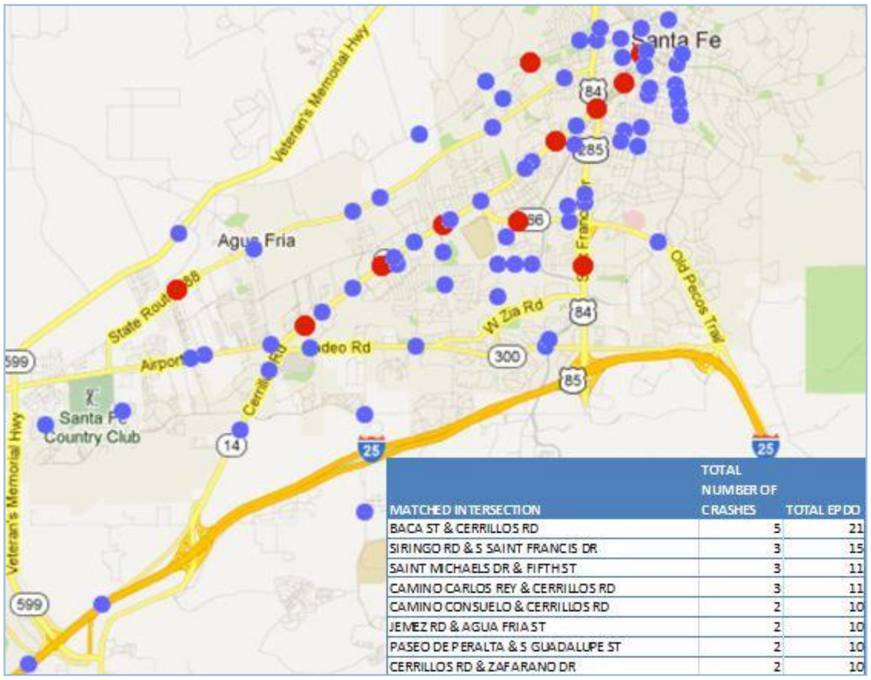
Figure 22— Crash involvement by percentage for all crash data

More than 95% of the total crashes involved vehicles colliding with other vehicles or stationary objects, while crashes involving cyclists, pedestrians, and motorcyclists only make up a small percent of the total data. Breaking down the data further, it was possible to identify the most hazardous locations for pedestrians and cyclists, shown in Figure 23 and Figure 24 respectively. Each location where a crash involving a pedestrian or cyclist took place is displayed, with the most hazardous locations displayed in red.



MATCHED INTERSECTION	TOTAL NUMBER OF CRASHES	TOTAL EPDO
ZAFARANO DR & CERRILLOS RD	6	35
OLD SANTA FE TRAIL & E ALAMEDA ST	7	31
SAINT MICHAELS DR & LLANO ST	6	30
ZEPOL RD & AIRPORT RD	5	25
MONTEZUMA AVE & S GUADALUPE ST	3	20
SANDOVAL ST & W ALAMEDA ST	3	15
RICHARDS AVE & CERRILLOS RD	3	15
RODEO RD & CERRILLOS RD	2	15

Figure 23—All pedestrian crash locations, including most hazardous



MATCHED INTERSECTION	TOTAL NUMBER OF CRASHES	TOTAL EPDO
BACA ST & CERRILLOS RD	5	21
SIRINGO RD & S SAINT FRANCIS DR	3	15
SAINT MICHAELS DR & FIFTH ST	3	11
CAMINO CARLOS REY & CERRILLOS RD	3	11
CAMINO CONSUELO & CERRILLOS RD	2	10
JEMEZ RD & AGUA FRIA ST	2	10
PASEO DE PERALTA & S GUADALUPE ST	2	10
CERRILLOS RD & ZAFARANO DR	2	10

Figure 24— All cyclist crash locations, including most hazardous

It is interesting to note that the majority of these pedestrian and cyclist crash locations—including the most hazardous ones—occurring on Cerrillos Rd. and in the downtown area.

4.1.3 Alcohol Involvement

The crash data also noted whether or not alcohol was involved in each crash, and it was determined that alcohol was listed as a contributing factor in 5.16% of all crashes. Figure 25 illustrates the trend of alcohol related crashes from 2006 to 2011, with the trend line displayed in black.

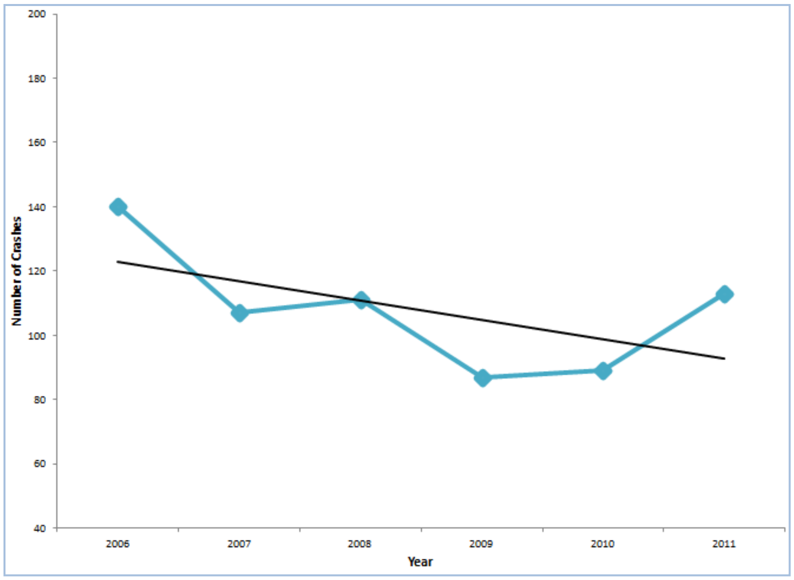


Figure 25—Alcohol related crashes by year

While the data does fluctuate by year, there has been an overall decreasing trend in alcohol related crashes in the last six years. However, it is also interesting to note that there has been a decreasing trend in the total number of crash as well. This information is displayed in Figure 26, with the trend line shown in black.

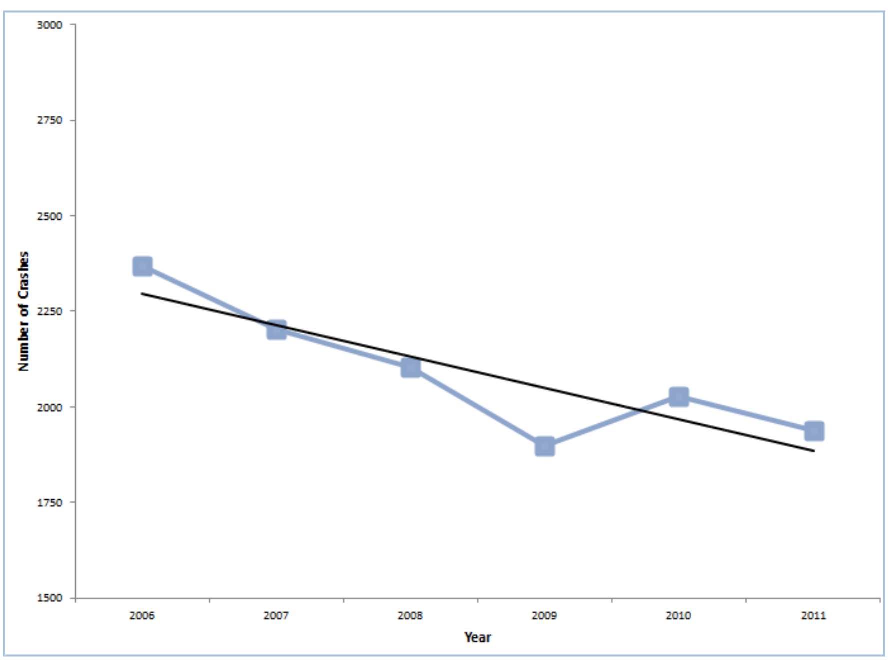


Figure 26—Total number of crashes by year

4.1.4 Crashes by Time

Examining the data for other possible correlations, the crashes were further broken down by day of the week. Figure 27 shows the percentage of crashes that occur on each specific day of the week.

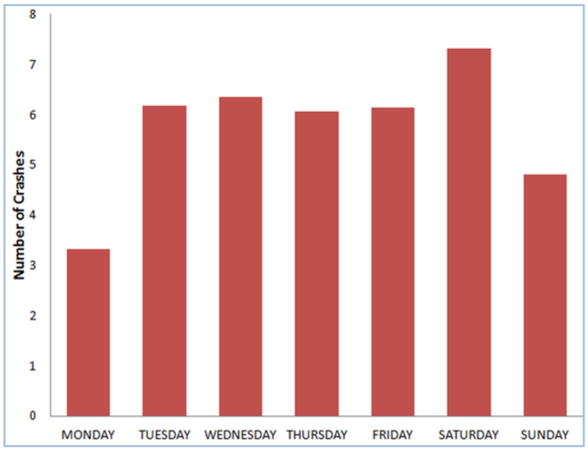


Figure 27—Average number of crashes by day of the week

The data shows that the least number of crashes take place on Monday, while the most number of crashes take place on Saturday. Interestingly, Monday falls far below the standard deviation of $\pm$ 3% from the average of 15% that occurs on almost every other day. There are many possible reasons for this, but for the purposes of this report, the data is simply provided to inform the reader of trends.

The data was also organized and examined by time of day, with both the severity and the total number of crashes taken into account. Figure 28 displays the number of crashes by time of day, while Figure 29 displays the crash severity by time of day.

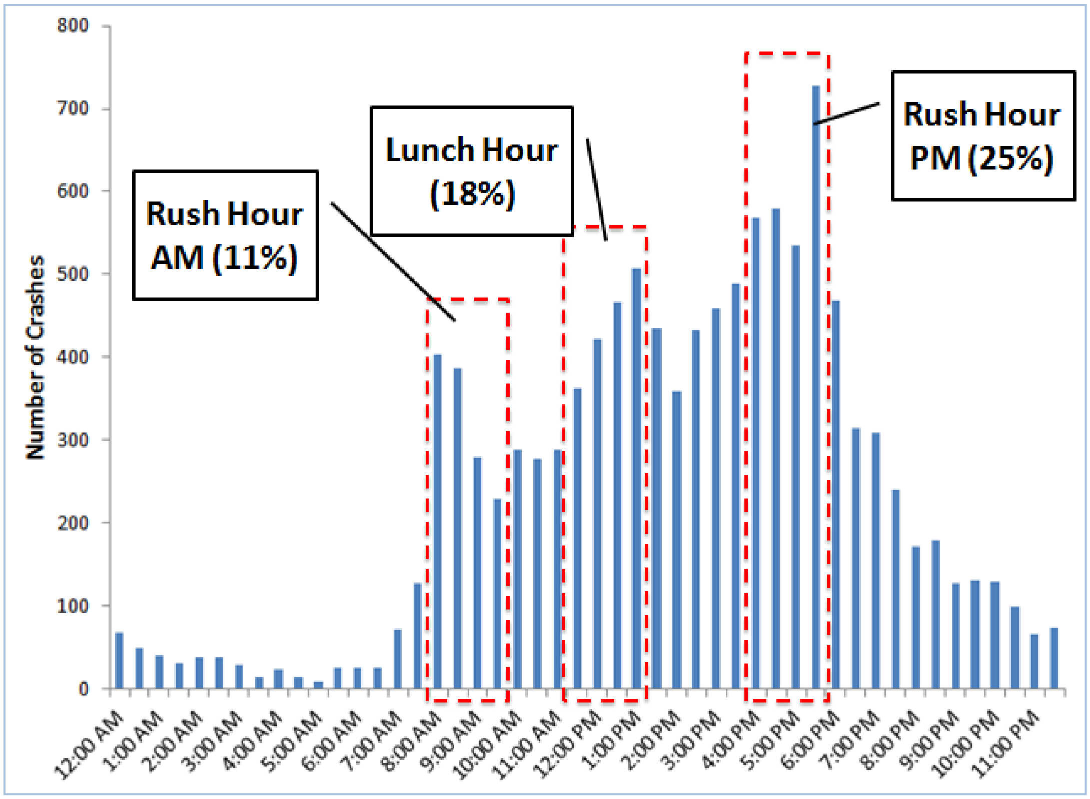


Figure 28—Number of crashes by time of day

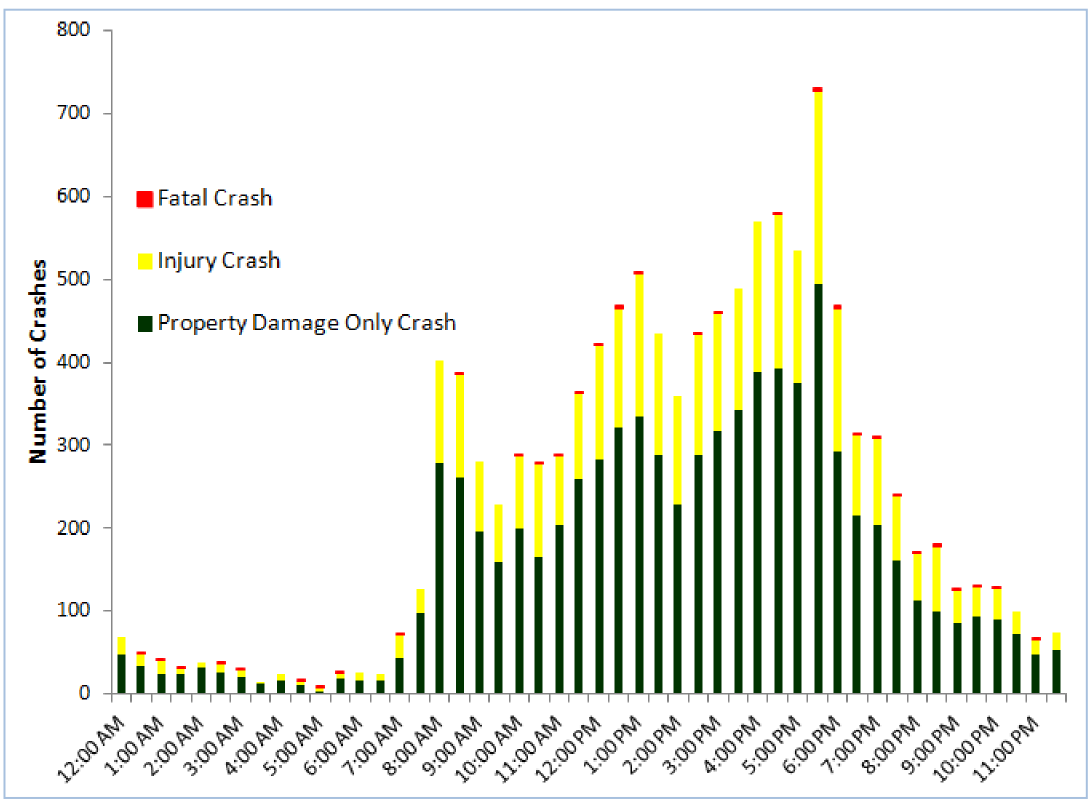


Figure 29—Crash severity by time of day

The comparison between Figure 28 and Figure 29 reveals intersecting trends. It can be seen that there are spikes in crashes during morning rush hour, lunch hour, and evening rush hour. Specifically, assuming a morning rush hour of 8:00 AM to 10:00 AM, lunch hour of 11:00 AM to 1:00 PM, and evening rush hour of 4:00 PM to 6:00 PM, these times hosts 54% of the total crashes but only makes up 25% of the day. Figure 29 also shows the fact that every 30 minute time block consists of more property damage only crashes than injury crashes, and has very few fatal crashes. Because it is difficult to see fatal crashes in Figure 29, Figure 30 shows only the fatal crashes for clarity. The most fatal crashes occurred between 12:30 PM and 1:00 PM, 2:30 PM and 3:00 PM, 5:30 PM and 6:30 PM, 7:30 PM and 8:00 PM, 8:30 PM and 9:00 PM, and 9:30 PM and 10:00 PM.

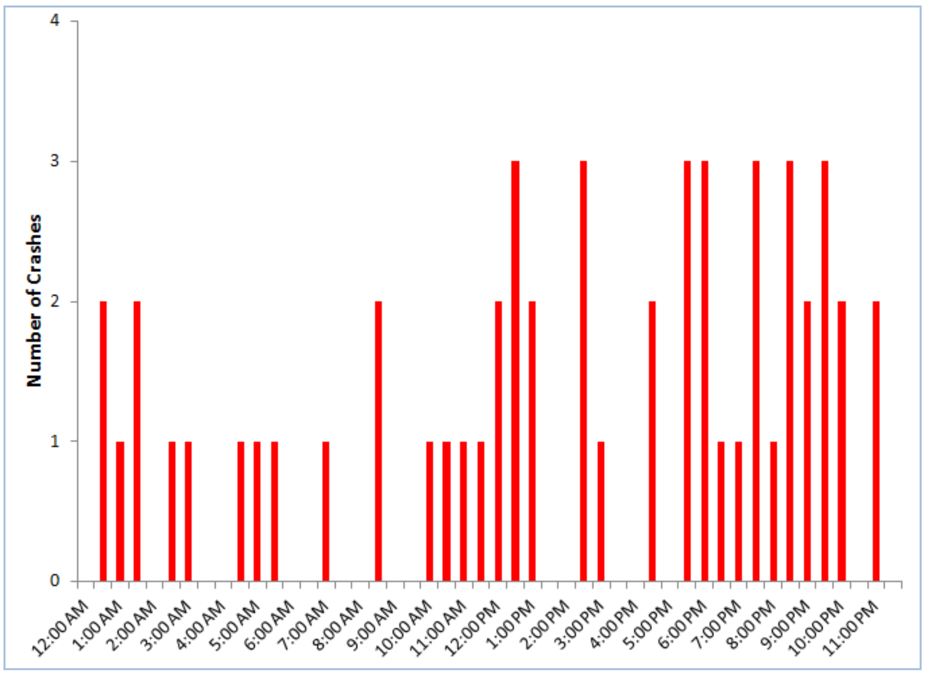


Figure 30— Fatal crashes by time of day

4.2 Most Hazardous Intersections

The data was first organized by Total EPDO, which was the summation of the EPDO values for all crashes that occurred at the same intersection. In order to obtain a reasonable number of intersections for analysis, it was decided to only include intersections with a Total EPDO of twenty or more.

4.2.1 Rank by Totally Number of Crashes

The data was then organized by the total number of crashes that occurred at that intersection for the six year time period. Figure 31 below shows the top twenty-five intersections sorted by total number of crashes.

INTERSECTION	COORDINATES	TOTAL NUMBER OF CRASHES
ST FRANCIS DR US 84/285 @ CERRILLOS RD	413683.5617,3948604.249	215
RODEO RD NM 300 @ CERRILLOS RD	407891.7501,3944377.25	152
ST FRANCIS DR US 84/285 @ ZIA RD	413413.8114,3945221.749	133
RICHARDS AVE @ CERRILLOS RD	409381.72,3945543.999	133
CERRILLOS RD @ ST MICHAELS DR	411552.0322,3946972.499	131
ZAFARINO DR @ CERRILLOS RD	408316.907,3944748.749	123
SAN MATEO RD @ ST FRANCIS DR US 84/285	413433.7497,3946903.5	104
SIRINGO RD @ ST FRANCIS DR US 84/285	413410.9056,3945785.499	100
CORDOVA RD @ ST FRANCIS DR US 84/285	413694.2812,3948224.249	100
ST MICHAELS DR @ ST FRANCIS DR US 84/285	413409.499,3946559.999	92
BECKNER ROAD @ CERRILLOS RD	406440.5943,3941536.999	80
SAWMILL RD @ ST FRANCIS DR US 84/285	413413.343,3944683	80
SILER RD @ CERRILLOS RD	410337.6256,3946235.249	79
ST MICHAELS DR @ PACHECO ST	413162.4059,3946589.249	75
VEGAS VERDES DR @ CERRILLOS RD	408626.1255,3944975	74
WAGON RD @ CERRILLOS RD	407668.4692,3943954.749	73
BACA ST @ CERRILLOS RD	412919.3124,3948021.749	70
ALAMEDA @ ST FRANCIS DR US 84/285	413680.4059,3949840.249	70
CAMINO CONSUELO @ CERRILLOS RD	409748.0945,3945816.249	67
CALLE DEL CIELO @ CERRILLOS RD	409941.5943,3945959.249	67
RICHARDS AVE @ RODEO RD NM 300	409414.0628,3944351.749	63
SAN MATEO RD @ CERRILLOS RD	412237.9677,3947445.499	62
GUADALUPE ST @ CERRILLOS RD	414175.1863,3948895.749	60
CAMINO CARLOS REY @ CERRILLOS RD	410851.1263,3946543.999	59
OLD PECOS TRAIL @ RODEO RD NM 300	415858.499,3944295.249	58

Figure 31—Top twenty-five intersections ranked by total number of crashes

4.2.2 Rank by MEV_{CRASH}

This spreadsheet simply shows intersections with the largest number of crashes. The data needed to be normalized by traffic volume to account for the number of automobiles that travel through each intersection daily. Traffic volumes were then taken into consideration, and a new top twenty-five list was created according to the MEV_{CRASH} value for each intersection. Figure 32 displays the resulting list.

INTERSECTION	COORDINATES	AADT	MEVcrash
COTTONWOOD AVE @ AGUA FRIA ST NM 588	405381.97,3944930.25	7460	1.47
ST FRANCIS DR US 84/285 @ CERRILLOS RD	413683.5617,3948604.249	72209	1.36
BECKNER ROAD @ CERRILLOS RD	406440.5943,3941536.999	31134	1.17
ZAFARINO DR @ CERRILLOS RD	408316.907,3944748.749	48187	1.17
RICHARDS AVE @ CERRILLOS RD	409381.72,3945543.999	52210	1.16
BERRY AVE @ 5TH ST	412036.2187,3947157.749	2760	1.16
JEMEZ RD @ RUFINA ST	406198.3447,3944873.249	4395	1.14
RODEO RD NM 300 @ CERRILLOS RD	407891.7501,3944377.25	67636	1.03
SIRINGO RD @ YUCCA ST	411846.4986,3945803.249	21300	0.96
CERRILLOS RD @ ST MICHAELS DR	411552.0322,3946972.499	62619	0.96
BACA ST @ CERRILLOS RD	412919.3124,3948021.749	34320	0.93
ST MICHAELS DR @ PACHECO ST	413162.4059,3946589.249	36805	0.93
GUADALUPE ST @ PASEO DE PERALTA	414170.6868,3949067.999	26530	0.93
ST FRANCIS DR US 84/285 @ ZIA RD	413413.8114,3945221.749	66400	0.91
SILER RD @ RUFINA ST	410157.0001,3946482.499	23158	0.89
BARCELONA RD @ DON GASPAR AVE	414660.468,3948017.249	5180	0.88
OLD PECOS TRAIL @ RODEO RD NM 300	415858.499,3944295.249	30584	0.87
RICHARDS AVE @ RODEO RD NM 300	409414.0628,3944351.749	34260	0.84
SAWMILL RD @ ST FRANCIS DR US 84/285	413413.343,3944683	43576	0.84
WAGON RD @ CERRILLOS RD	407668.4692,3943954.749	40458	0.82
SAN MATEO RD @ ST FRANCIS DR US 84/285	413433.7497,3946903.5	58120	0.82
SAWMILL RD @ RODEO RD NM 300	413211.4998,3944287.499	15501	0.80
CORDOVA RD @ ST FRANCIS DR US 84/285	413694.2812,3948224.249	57714	0.79
SAN MATEO RD @ CERRILLOS RD	412237.9677,3947445.499	36304	0.78
CONSTELLATION DR @ AIRPORT RD NM 284	403555.9692,3943766.749	11738	0.78

Figure 32—Top twenty-five intersections ranked by MEV_{CRASH} rate

4.2.3 Rank by MEV_{EPDO}

To ensure that the severity of the crashes was also taken into consideration, the Total EPDO had to be taken into account for each intersection. These values were added to the spreadsheet and a new top twenty-five list was created, which was ranked by the MEV_{EPDO} rate. This list was the best representation of hazardousness because it took into account both traffic volumes and crash severity. Figure 33 displays this final list, while Figure 34 shows where each of these top twenty-five intersections is located in Santa Fe.

INTERSECTION	COORDINATES	AADT	TOTAL EPDO	MEVepdo
BERRY AVE @ 5TH ST	412036.2187,3947157.749	2760	27	4.47
BECKNER ROAD @ CERRILLOS RD	406440.5943,3941536.999	31134	256	3.75
COTTONWOOD AVE @ AGUA FRIA ST NM 588	405381.97,3944930.25	7460	52	3.18
ST FRANCIS DR US 84/285 @ CERRILLOS RD	413683.5617,3948604.249	72209	463	2.93
JEMEZ RD @ RUFINA ST	406198.3447,3944873.249	4395	27	2.81
RICHARDS AVE @ CERRILLOS RD	409381.72,3945543.999	52210	309	2.70
BARCELONA RD @ DON GASPAR AVE	414660.468,3948017.249	5180	30	2.64
SIRINGO RD @ YUCCA ST	411846.4986,3945803.249	21300	121	2.59
ST MICHAELS DR @ PACHECO ST	413162.4059,3946589.249	36805	207	2.57
BACA ST @ CERRILLOS RD	412919.3124,3948021.749	34320	182	2.42
COUNTRY CLUB RD @ AIRPORT RD NM 284	404745.9381,3943949.749	21191	110	2.37
RODEO RD NM 300 @ CERRILLOS RD	407891.7501,3944377.25	67636	337	2.28
SILER PARK LN @ SILER RD	409817.5637,3946942	12060	60	2.27
ZAFARINO DR @ CERRILLOS RD	408316.907,3944748.749	48187	239	2.26
OLD PECOS TRAIL @ RODEO RD	415858.499,3944295.249	30584	150	2.24
RICHARDS AVE @ RODEO RD NM 300	409414.0628,3944351.749	34260	167	2.23
ST FRANCIS DR US 84/285 @ ZIA RD	413413.8114,3945221.749	66400	313	2.15
ZEPOL RD @ AIRPORT RD NM 284	407164.3758,3944325.25	29548	134	2.07
SILER RD @ RUFINA ST	410157.0001,3946482.499	23158	105	2.07
CORDOVA RD @ ST FRANCIS DR US 84/285	413694.2812,3948224.249	57714	260	2.06
CERRILLOS RD @ ST MICHAELS DR	411552.0322,3946972.499	62619	279	2.03
SAN MATEO RD @ ST FRANCIS DR US 84/285	413433.7497,3946903.5	58120	256	2.01
WAGON RD @ CERRILLOS RD	407668.4692,3943954.749	40458	177	2.00
CAMINO CARLOS REY @ ZIA RD	411029.0944,3944457.75	25546	111	1.98
SAWMILL RD @ ST FRANCIS DR US 84/285	413413.343,3944683	43576	188	1.97

Figure 33—Top twenty-five intersections ranked by MEV_{EPDO} rate

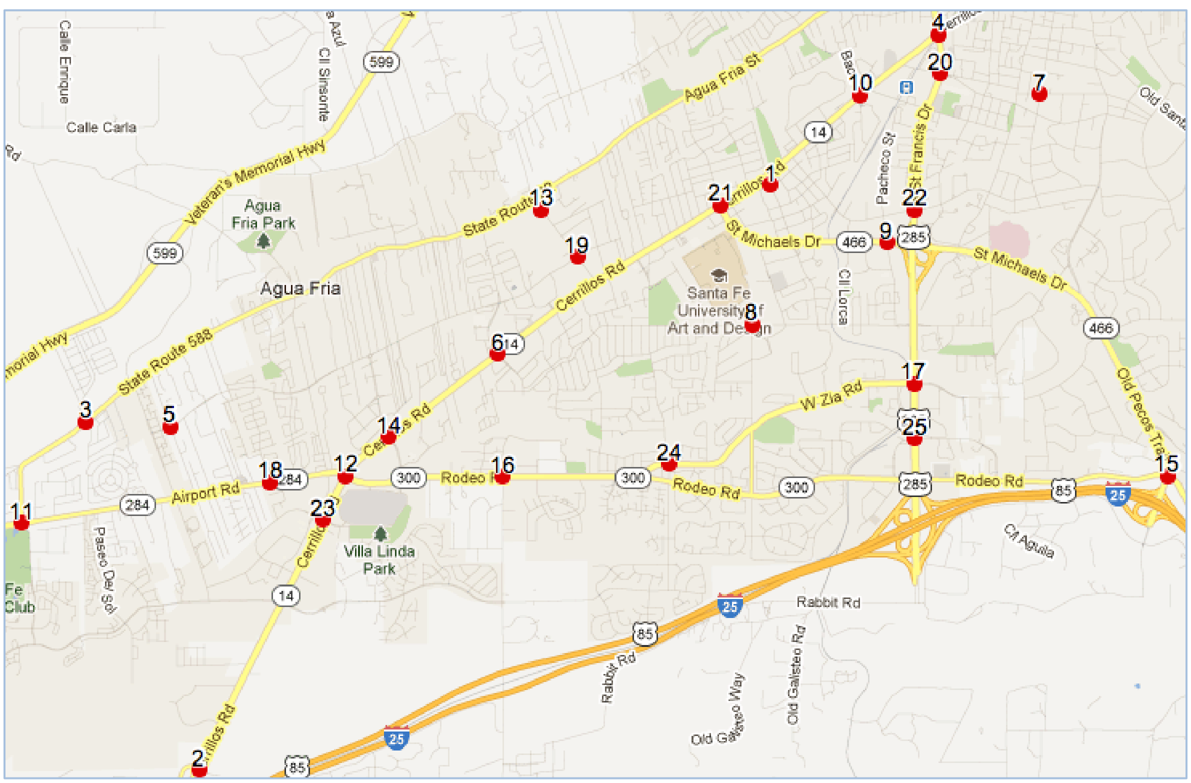


Figure 34—Top twenty-five most hazardous intersections by rank

4.2.4 Comparing Expected Total Crashes vs. Actual Total Crashes

To ensure that these intersections were deemed hazardous by established standards, the number of crashes for each intersection was compared with the expected number of crashes, which was determined using the HSM. The resulting list can be seen in Figure 35. This method of comparison turned out to be of greater use than comparing crash rates with the state average.

RANK	INTERSECTION	TOTAL NUMBER OF CRASHES	HSM EXPECTED CRASHES 6 YEARS	% DIFFERENCE FROM HSM EXPECTED AMOUNT OF CRASHES
1	BERRY AVE @ 5TH ST	7	4.8	146%
2	BECKNER ROAD @ CERRILLOS RD	80	23.4	342%
3	COTTONWOOD AVE @ AGUA FRIA ST NM 588	24	1.2	2000%
4	ST FRANCIS DR US 84/285 @ CERRILLOS RD	215	63.0	341%
5	JEMEZ RD @ RUFINA ST	11	4.2	262%
6	RICHARDS AVE @ CERRILLOS RD	133	37.8	352%
7	BARCELONA RD @ DON GASPAR AVE	10	4.8	208%
8	SIRINGO RD @ YUCCA ST	45	13.8	326%
9	ST MICHAELS DR @ PACHECO ST	75	37.8	198%
10	BACA ST @ CERRILLOS RD	70	33.6	208%
11	COUNTRY CLUB RD @ AIRPORT RD NM 284	34	13.2	258%
12	RODEO RD NM 300 @ CERRILLOS RD	152	38.4	396%
13	SILER PARK LN @ SILER RD	19	5.4	352%
14	ZAFARINO DR @ CERRILLOS RD	123	30.0	410%
15	OLD PECOS TRAIL @ RODEO RD	58	21.6	269%
16	RICHARDS AVE @ RODEO RD NM 300	63	25.8	244%
17	ST FRANCIS DR US 84/285 @ ZIA RD	133	44.4	300%
18	ZEPOL RD @ AIRPORT RD NM 284	50	25.8	194%
19	SILER RD @ RUFINA ST	45	16.2	278%
20	CORDOVA RD @ ST FRANCIS DR US 84/285	100	34.8	287%
21	CERRILLOS RD @ ST MICHAELS DR	131	50.4	260%
22	SAN MATEO RD @ ST FRANCIS DR US 84/285	104	55.8	186%
23	WAGON RD @ CERRILLOS RD	73	33.0	221%
24	CAMINO CARLOS REY @ ZIA RD	43	21.0	205%
25	SAWMILL RD @ ST FRANCIS DR US 84/285	80	24.0	333%

Figure 35—Actual vs. expected crash totals

After completing this comparison, it was confirmed that all twenty-five intersections were more hazardous than expected. Checking these intersections against an established standard such as the HSM gives this list an added level of creditability.

4.3 Most Hazardous Road Segments

As previously stated, the focus of this project was on intersections; however, a very simple analysis of road segments was also performed. A top twenty-five list was created using the same principles used for intersections, but with a few minor adjustments to account for the length of the segments. Figure 36 displays the resulting list, ranked by $MVMT_{EPDO}$.

RANK	ROUTE NAME	A Street	B Street	TOTAL NUMBER OF CRASHES	TOTAL EPDO	AADT	LENGTH	MVMTcrash	MVMTepdo
1	NM 599S	I 25 NM 85	Airport Rd NM 284	23	84	9320	2.6	0.43	1.58
2	NM 599N	I 25 NM 85	Airport Rd NM 284	20	73	8443	2.6	0.42	1.52
3	NM 599S	Airport Rd NM 284	S Meadows Rd	27	88	9902	2.8	0.44	1.44
4	NM 599N	Airport Rd NM 284	S Meadows Rd	21	73	8678	2.8	0.39	1.37
5	NM 599S	S Meadows Rd	Via Veteranos	8	37	8387	1.9	0.23	1.07
6	NM 599N	S Meadows Rd	Via Veteranos	7	31	7437	1.9	0.23	1.01
7	NM 592	Pueblo De Cielo	Co Rd 74	1	10	3650	1.9	0.07	0.68
8	I 25N	Old Pecos Tr NM 466	St Francis Dr NM 84	9	34	16690	1.5	0.16	0.62
9	NM 14	Santa Fe Studio Rd	Veteran's Mem Hwy NM 599	14	34	18038	1.4	0.25	0.60
10	I 25N	Veteran's Mem Hwy NM 599	Cerrillos Rd NM 14	11	35	14592	1.9	0.19	0.59
11	NM 300	NM 285	Old Pecos Tr NM 466	8	33	4132	6.3	0.14	0.58
12	I 25S	Veteran's Mem Hwy NM 599	Ent La Cienega	26	89	17599	4.1	0.16	0.56
13	US 285S	NM 41	Ave Vista Grande	6	27	4106	5.5	0.12	0.55
14	I 25S	NM 285	Sleeping Dog Rd	5	26	6717	3.5	0.10	0.50
15	US 84N	Veteran's Mem Hwy NM 599	Avenida Monte Sereno	21	70	29028	2.3	0.14	0.47
16	I 25N	Cerrillos Rd NM 14	St Francis Dr NM 84	21	77	15359	4.9	0.13	0.47
17	I 25S	Old Pecos Tr NM 466	St Francis Dr NM 84	3	20	13061	1.5	0.07	0.47
18	I 25S	Veteran's Mem Hwy NM 599	Cerrillos Rd NM 14	6	23	14542	1.9	0.10	0.39
19	NM 599N	St Francis Dr NM 84	Camino La Tierra	6	22	9008	2.9	0.11	0.39
20	I 25S	NM 285	Old Pecos Tr NM 466	16	59	11139	6.4	0.10	0.38
21	I 25N	NM 285	Old Pecos Tr NM 466	21	86	16977	6.4	0.09	0.36
22	US 285N	Ave Vista Grande	I 25 NM 85	3	11	12433	1.3	0.08	0.31
23	I 25N	Veteran's Mem Hwy NM 599	Ent La Cienega	17	42	15628	4.1	0.12	0.30
24	NM 14	Veteran's Mem Hwy NM 599	I 25 NM 85	3	20	17540	1.8	0.04	0.30
25	US 84S	Avenida Monte Sereno	Tesuque Village Rd	16	40	25724	2.9	0.10	0.25

Figure 36—Top twenty-five most hazardous road segments ranked by $MVMT_{EPDO}$

Road segment crash contributing factors were examined to find possible correlations in data, which can be seen in Figure 37.

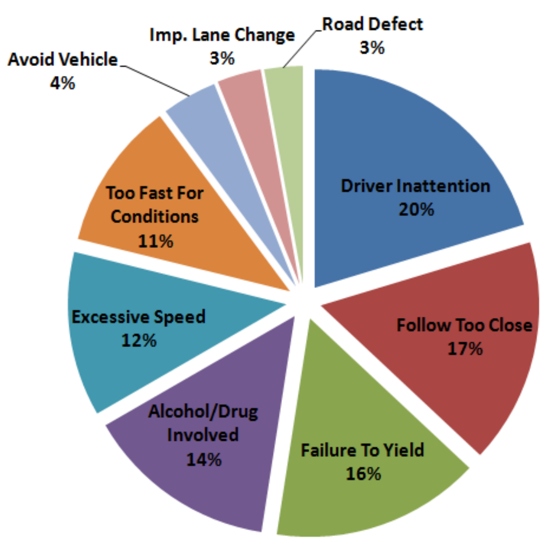


Figure 37—Road segment crash contributing factors for all road segment crashes

Because it was not deemed a priority, the team was unable to further analyze road segment crashes. However, it is possible to perform a detailed analysis of road segment crash data, and hopefully the success of the intersection analysis will entice the SFMPO to perform a similar study in the future.

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5. Analysis

Having completed the basic organization and examination of the crash data, each of the top twenty-five most hazardous intersections was studied in further detail in order to determine crash patterns and then suggest countermeasures to address these reoccurring characteristics. It is important to note that all safety improvements made by the team need to be further analyzed and approved by traffic engineering professionals before any action is taken.

Because of the inherently slow process of obtaining police reports from the Santa Fe Police Department, the team was only able to perform a detailed analysis on fourteen of the top twenty-five most hazardous intersections. With the exception of the missing police reports, the team has compiled all other information necessary for analysis, so the SFMPO will have the ability to complete the analysis of each of the top twenty-five intersections, if they choose to do so.

5.1 Weather Conditions, Lighting, and Alcohol Involvement

The team was especially interested to learn whether or not the weather conditions, lighting, or alcohol involvement played a significant role in the crashes occurring at the top twenty-five intersections. From a brief glance at the resulting information in Figure 38, it is obvious that none of these factors contribute significantly to the crashes that occur at these intersections. Alcohol was only involved in 3% of all crashes, 92% of all crashes occurred in clear weather, and 95% of all crashes occurred in well-lit areas. While it may be true that several crashes could have happened as a result of snow or darkness or drunk driving, the vast majority of crashes were unaffected by weather conditions, lighting, and alcohol involvement. This information helped to simplify the number of factors that would be taken into account during the analysis.

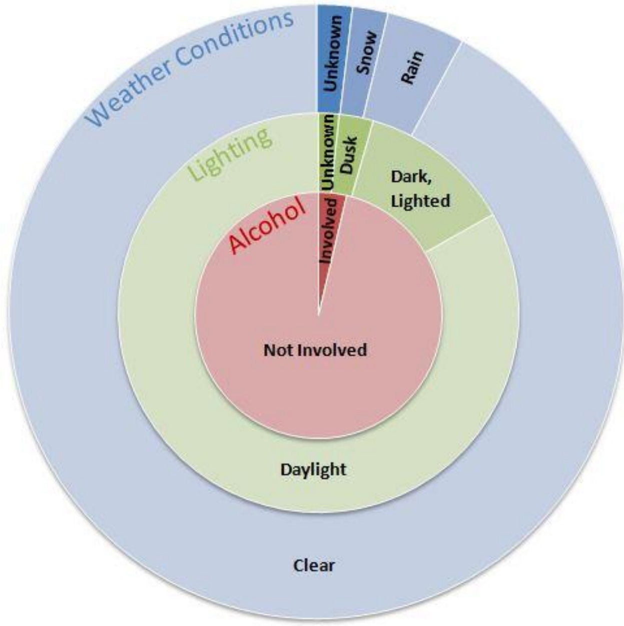


Figure 38—Weather conditions, lighting, and alcohol involvement for crashes at top twenty-five intersections

5.2 Crash Patterns and Appropriate Safety Improvements

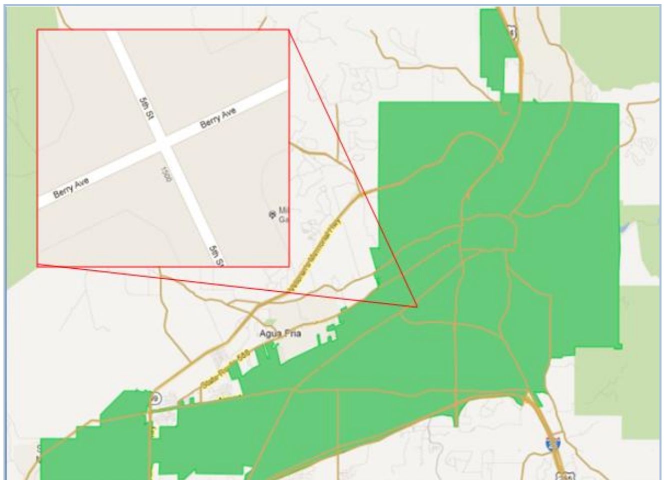
Utilizing the crash reports, collision diagrams, and crash data, fourteen of the top twenty-five intersections were analyzed in great detail to identify crash patterns. Once an understanding of the causes of crashes was achieved, it was then possible to come up with recommended safety improvements to address the situation. It is important to note that all safety improvements made by the team need to be further analyzed and approved by traffic engineering professionals before any action is taken.

All of the information the team collected for each intersection has been stored online at Santafedia.org, the wiki-based encyclopedia for all things related to the city of Santa Fe. Each of the top twenty-five most hazardous intersections has its own page detailing everything from basic information to interactive maps to collision diagrams. For further information regarding each of the following intersections, feel free to visit www.Santafedia.org.

5.2.1 5th St. & Berry Ave. Intersection Analysis

The following intersection analysis is presented as an example of the process by which each intersection was analyzed, displaying the intersection description, identification of crash patterns, and then suggestion of safety improvements. For the complete analysis of each intersection, refer to Appendix L.

5.2.1.1 Intersection Description and Crash Characteristics



Rank	AADT	Total Crashes	Expected Crashes	Total EPDO	MEV_{CRASH}	MEV_{EPDO}
1	2760	7	>5	27	1.16	4.47

Figure 39—5th St. & Berry Ave.

The intersection between 5th St. and Berry Ave.—shown in Figure 39—is a four-way, two-way stop, unsignalized intersection. Each approaching road has a single lane of travel in each direction. Both westbound and eastbound segments of Berry Ave. have stop signs and must yield to traffic on 5th St. Figure 40 displays the contributing factors obtained from the crash data for this intersection.

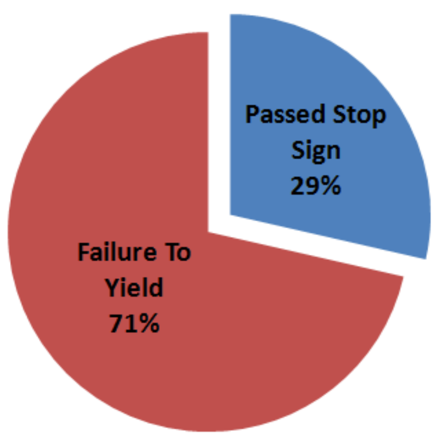


Figure 40—5th St. & Berry Ave. contributing factors

5.2.1.2 Crash Patterns and Observations

A collision diagram was created for this intersection, which can be found in Appendix I. This diagram was created using crash reports from 2008-2009, provided by the Santa Fe Police Department. Over 70% of the crashes were angle crashes, with the majority of those occurring between automobiles travelling northbound on 5th St. and westbound on Berry Ave. Figure 41 displays the most commonly occurring crash type on an aerial image of the actual intersection, while Figure 42 displays the westbound and northbound approaches to the intersection.

Figure 41—5th St. & Berry Ave. with most commonly occurring crash type

Figure 42—Views from approaching roads on 5th St. & Berry Ave.

5.2.1.3 Intersection Conclusions and Recommendations

The combination of this data has led to the conclusion that these crashes are occurring because the drivers on Berry Ave. do not realize that the intersection is only a two-way stop. Both the collision diagram and the contributing factors support this theory. The drivers on Berry Ave. fail to yield to the drivers on 5th St., most likely because they expect the drivers on 5th St. to slow down for the stop sign that isn't really there. This error results in a crash as the drivers on Berry Ave. attempt to pull into the intersection and are hit by the drivers on 5th St., who have the right of way.

Pending further engineering analysis, it is recommended that additional signage be posted that alerts drivers on Berry Ave. that cross traffic on 5th St. does not stop. The possible addition of these signs to the pre-existing stop signs has the potential to decrease the number of crashes at this intersection.

5.3 Overview of Countermeasures

The team analyzed the remainder of the hazardous intersections in the same manner as 5th St. and Berry Ave. However, as previously stated, due to complications in obtaining the police reports, only fourteen of the top twenty-five most hazardous intersections were able to be examined in detail. Figure 43 displays the recommended countermeasures for each of these intersections, while Figure 44 displays the location of each suggested countermeasure.

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Intersection	Crash Pattern	Countermeasure
5th St. & Berry Ave.	Angle crashes, failure to yield	Improve signage by adding "Cross Traffic Does Not Stop" sign
Cerrillos Rd. & Beckner Rd.	Rear-ends going southbound	Improve sightlines by trimming shrubbery, remove raised median
Agua Fria St. & Cottonwood Dr.	Angle crashes between southbound and left turn	Remove bus stop and shrubbery, road diet, signalize intersection
Siringo Rd. & Yucca St.	Rear-ends going northbound	Remove right turn lane
Saint Michaels Rd. & Pacheco St.	Rear-ends	Backplates with retroreflective boarders, increase yellow signal timing
Baca St. & Cerrillos Rd.	Rear-ends going west	Backplates with retroreflective boarders, increase yellow signal timing
Airport Rd. & Country Club Rd	Rear-ends	Backplates with retroreflective boarders, increase yellow signal timing
Siler Park Ln. & Siler Rd.	Angle crashes	Road diet
Cerrillos Rd. & Zafarano Dr.	Rear-ends	Backplates with retroreflective boarders, increase yellow signal timing
Rodeo Rd. & Richards Ave.	Rear-ends	Backplates with retroreflective boarders, increase yellow signal timing
Rufina St. & Siler Rd.	Rear-ends	Backplates with retroreflective boarders, increase yellow signal timing
Camino Carlos Rey & Zia Rd.	Rear-ends, angle crashes	Backplates with retroreflective boarders, increase yellow signal timing, changed left turn from Protected/Permissive to Protected
Cerrillos Rd. & Wagon Rd.	Angle crashes between northbound and left turn	Improve sightlines by trimming shrubbery, remove raised median
Sawmill Rd. & Saint Francis Dr.	Rear-ends	Backplates with retroreflective boarders, increase yellow signal timing

Figure 43—List of suggested countermeasures

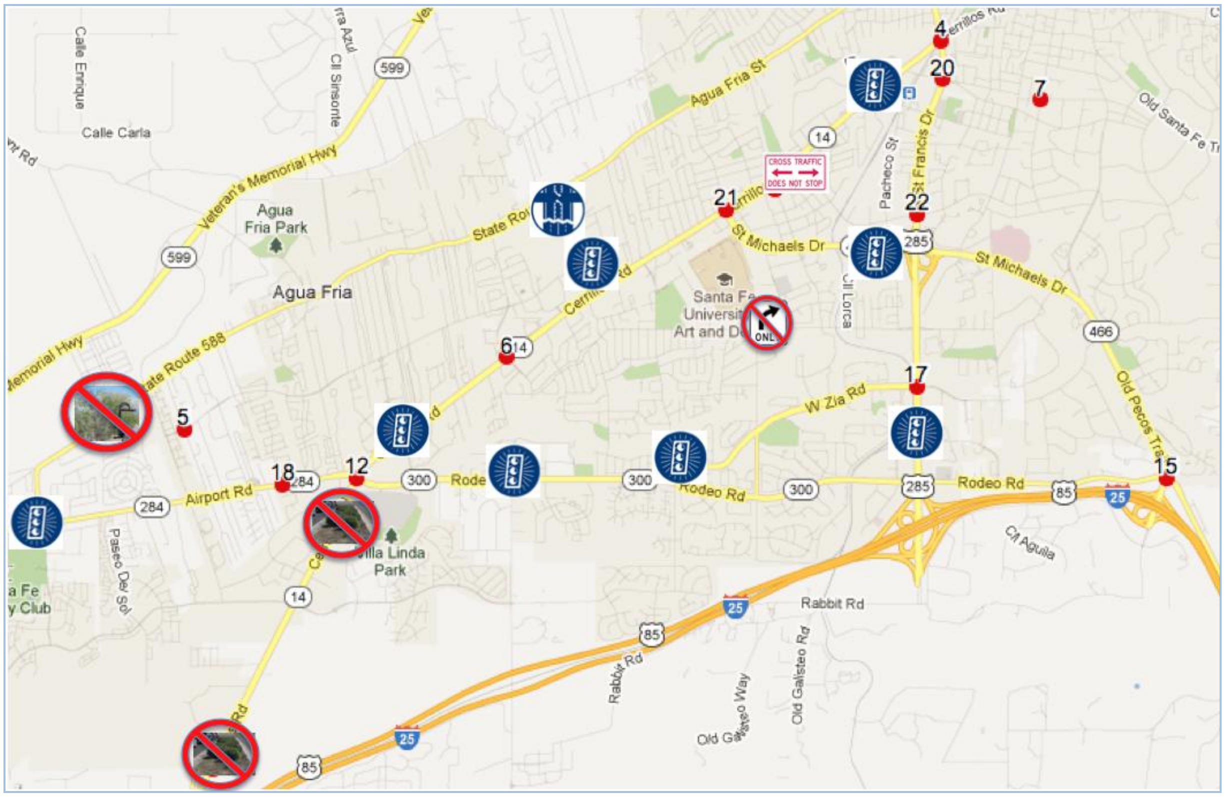

Figure 44—Locations of suggested countermeasures

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6. Conclusions and Recommendations

The safety improvements recommended in this project are intended to increase the traffic safety in the Santa Fe metropolitan planning area. The systematic organization and analysis of this crash data, as shown in this study, will be of great use to the SFMPO and the city of Santa Fe to conduct future data-driven research as they work to improve the traffic safety in the area and apply for federal funding from the Highway Safety Improvement Program. The team recommends that the SFMPO implement this project as part of its regular planning activities, to be completed every few years. This will allow for a comparison between intersections before and after countermeasures are implemented, and it will ensure that the Santa Fe region becomes a safer place for all forms of transportation.

This project was completed successfully, as all of the objectives were accomplished with only a few setbacks. While the limitations of time ruled out the possibility of an in-depth road segment study, the team organized the existing data well and laid the groundwork for the SFMPO to conduct this study, if they so choose. Likewise, time was the limiting factor regarding the number of intersections the team could study, as this study was dependant on obtaining the crash reports from the Santa Fe Police Department. While the team was only able to study and provide safety improvements for fourteen of the top twenty-five most hazardous intersections, the crash reports for the remaining intersections will be processed and delivered to the SFMPO. Using these crash reports, the available crash data, and the team's previous intersection analysis as a guide, the SFMPO will have the ability to complete in-depth studies at each of the remaining intersections.

The following recommendations will build off this project, taking advantage of the data gathered and work already completed, and also aid in repeating this study in the future.

First, it must be reiterated that any and all recommendations for safety improvements discussed in this report are simply suggestions derived from the study conducted in this project and must be first reviewed and approved by traffic engineers. All the data regarding contributing factors and crash patterns should be taken into consideration to improve the hazardous intersections, but the traffic engineers should make official recommendations.

It is recommended that an in-depth road segment analysis be performed in the same manner as the intersection analysis. The list of most hazardous road segments found in the Results section was compiled accounting for both traffic volume and crash severity, but this report does not look at the contributing factors and crash patterns at these road segments. Police reports should be obtained for these hazardous road segments and a traffic engineer should study the locations to determine appropriate safety improvements.

The Santa Fe Police Department needs to update their manually-based management information system. Currently crash reports are filled out by hand by the reporting officer and the papers are filed in the City Records Division. When a crash report is requested, someone must find the case number in the filing cabinets, copy it by hand, and return the record to the filing cabinet. The reporting officer should fill out an electronic form and submit it electronically to a database of crash records. Some efforts have been made in the past to switch over to this type of system, but the police department never adopted it.

Another project that could be completed with the data compiled in this report is to add a "safest route" option to online driving directions services such as Google Maps or handheld GPS devices. Google Maps currently provides options to avoid highways and avoid tolls. With the ranked list of most hazardous locations in Santa Fe, the hazardousness of each possible route could be determined and the safest route picked for the user. The success of such an option relies on this study being repeated periodically to keep the hazardousness of each location up to date as roadway changes are made. The database of crash data, which could be SantaFedia, would also have to be updated as previously suggested.

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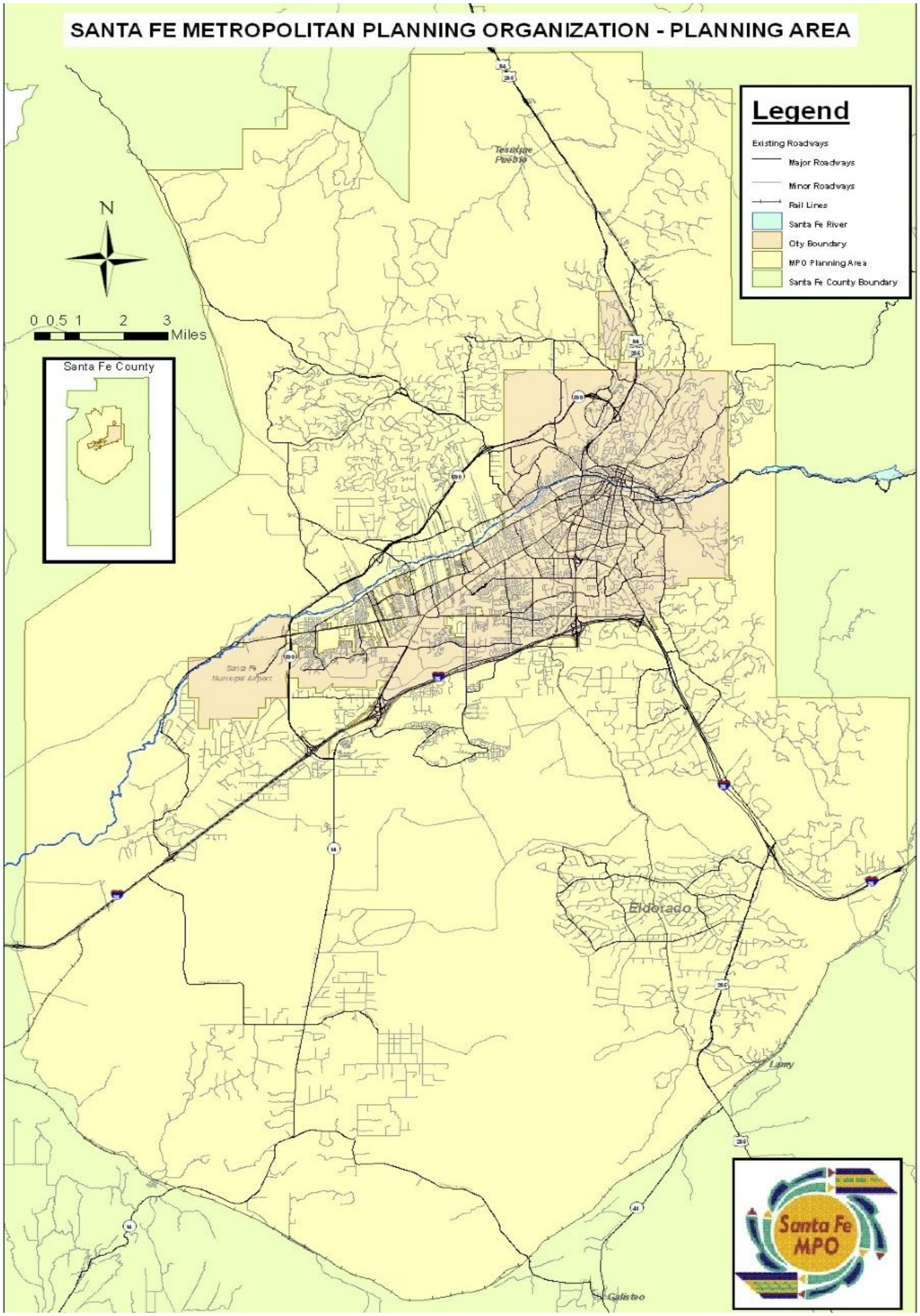
Appendix A: Santa Fe Metropolitan Planning Area



Appendix B: Team Calendar

sf12-mpo Calendar — **Mar 2012 (Eastern Time)**

Sun	Mon	Tue	Wed	Thu	Fri	Sat
26 1pm - Group meeting	27 6:30pm - ID 2050 8:30pm - Group	28 6pm - Group meeting	29 3:30pm - MPO: PQP 6pm - Group meeting	1 6:30pm - ID 2050 8:30pm - Group	2 6pm - Group meeting	3 1pm - Group meeting
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19 Finalize Background	20 Finalize Methodology	21	22	23 Field Work Methodology Testing	24
25	26 Objective 1 Start of Actual Field	27	28	29	30 Executive Summary	31

sf12-mpo Calendar

Apr 2012 (Eastern Time)

Sun	Mon	Tue	Wed	Thu	Fri	Sat
1	2 Objective 2	3	4	5	6	7
8	9 End of Field Work Objective 3	10	11	12	13 Objective 4	14
15	16	17	18	19	20 Analysis--Analytical Results	21
22	23	24	25	26	27	28
29	30 Abstract Conclusions/Recommen Executive Summary	1	2	3	4 Final Submissions	5

Appendix C: Acronyms

AADT – Average Annual Daily Traffic

AASHTO – American Association of State Highway and Transportation Officials

ATSF – Atchison, Topeka and SF Railway

EPDO – Estimated Property Damage Only

FHWA – Federal Highway Administration

GIS – Geographic Information System

HSM – Highway Safety Manual

MEV – Million Entering Vehicles

MTP – Metropolitan Transportation Plan

MVM – Million Vehicle Miles

MVMT – Million Vehicle Miles Traveled

NMDOT – New Mexico Department of Transportation

SAFETEA-LU – Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users

SFMPO – Santa Fe Metropolitan Planning Organization

UNM – University of New Mexico

UPWP – Unified Planning Work Program

Appendix D: Crash Data Excel Spreadsheets

OID	RID	INTERSECTION	X_LAT	Y_LONG	REPORT	DATE	YEAR	MONTH	DAY	WEEKDAY
1	23277533	SILER PARK LN @ SILER RD	409817.5637	3946942.0000	0023277533	18954	2011	November	23	THURSDAY
2	710031883	PEN RD @ ST FRANCIS DR US 84/285	413703.3115	3948455.4990	0710031883	18792	2011	June	14	WEDNESDAY
3	23271615	CAMINO DOS ANTONIOS @ AGUA FRIA	408831.4700	3946671.2500	0023271615	18647	2011	January	20	FRIDAY
5	23271891	COYOTE BRIDGE RD @ ALAMEDA	410010.8764	3948025.5000	0023271891	18815	2011	July	7	FRIDAY
6	23271838	HORTON RD @ FROST RD	389856.5325	3889442.7500	0023271838	18949	2011	November	18	SATURDAY
8	22744891	DON GASPAR AVE @ ALAMEDA	414928.6560	3949429.2500	0022744891	18109	2009	July	31	SATURDAY
9	710013234	HICKOX ST @ AGUA FRIA ST NM 588	412641.4686	3948882.5000	0710013234	18600	2010	December	4	SUNDAY
10	23271913	4951 AGUA FRIA ST NM 588 @ AGUA FRIA ST NM 588	405868.8073	3945328.2270	0023271913	18914	2011	October	14	SATURDAY
12	710013831	SILVA ST @ AGUA FRIA ST NM 588	412479.0307	3948786.2490	0710013831	18383	2010	May	1	SUNDAY
13	23271931	COTTONWOOD AVE @ AGUA FRIA ST NM 588	405381.9700	3944930.2500	0023271931	18767	2011	May	20	SATURDAY

Crash data, excerpt 1

HOUR	TIME	COUNTY	CITY	ACCDIR	IDIREC	TOTAL	CLASSA	CLASSB	CLASSC	KILLED	UNHURT	ALCINV	DRUGINV	MCINV	PECINV
13	1315	Santa Fe	Santa Fe	W		2	0	0	0	0	2	None Indicated	None Indicated	Motorcycle not involved	Pedalcyclist not involved
15	1513	Santa Fe	Santa Fe	S	U	2	0	0	0	0	2	None Indicated	None Indicated	Motorcycle not involved	Pedalcyclist not involved
0	0052	Santa Fe	Santa Fe	W	U	1	0	0	0	0	1	None Indicated	None Indicated	Motorcycle not involved	Pedalcyclist not involved
9	0929	Santa Fe	Santa Fe	W	W	2	0	0	0	0	2	None Indicated	None Indicated	Motorcycle not involved	Pedalcyclist not involved
12	1258	Santa Fe	Santa Fe	E	E	1	0	1	0	0	0	None Indicated	None Indicated	Motorcycle not involved	Pedalcyclist not involved
21	2122	Santa Fe	Santa Fe	W	U	4	0	0	0	0	4	None Indicated	None Indicated	Motorcycle involved	Pedalcyclist not involved
14	1444	Santa Fe	Santa Fe	W		5	3	0	1	0	1	None Indicated	None Indicated	Motorcycle not involved	Pedalcyclist not involved
21	2138	Santa Fe	Santa Fe	E	U	1	0	0	0	0	1	None Indicated	None Indicated	Motorcycle not involved	Pedalcyclist not involved
14	1448	Santa Fe	Santa Fe	E	E	1	0	1	0	0	0	None Indicated	None Indicated	Motorcycle not involved	Pedalcyclist not involved
13	1325	Santa Fe	Santa Fe	S		2	0	0	1	0	1	None Indicated	None Indicated	Motorcycle not involved	Pedalcyclist not involved

Crash data, excerpt 2

PEDINV	TRKINV	NVEH	HITRUN	CLASS	SEVERITY	TOPCFACC	ANALYSIS	LIGHT	WEATHER	MAXDAM
Pedestrian not involved	No	2		4	Property Damage Only Crash	Failure To Yield	Angle-1 Left	Daylight	Clear	1
Pedestrian not involved	No	2		4	Property Damage Only Crash	Failure To Yield	Sd-Sideswipe	Daylight	Clear	1
Pedestrian not involved	No	1		10	Property Damage Only Crash	Excessive Speed	Mailbox	Dark-Lighted	Clear	1
Pedestrian not involved	No	2		4	Property Damage Only Crash	Follow Too Close	Sd-Rear End	Daylight	Clear	2
Pedestrian not involved	No	1		10	Injury Crash	Excessive Speed	Fence	Daylight	Clear	1
Pedestrian not involved	No	2		4	Property Damage Only Crash	Follow Too Close	Sd-One Stopped	Dark-Lighted	Clear	2
Pedestrian not involved	No	2		4	Injury Crash	Failure To Yield	Od-1 Left Turn	Daylight	Clear	1
Pedestrian not involved	No	1		10	Property Damage Only Crash	Driver Inattention	Fence	Dark-Lighted	Clear	2
Pedestrian not involved	No	1		10	Injury Crash	Left Of Center	Barricade	Daylight	Clear	2
Pedestrian not involved	No	2		4	Injury Crash	Failure To Yield	Angle-1 Left	Daylight	Clear	0

Crash data, excerpt 3

MAXENF	AGENCY	ELEMENT	FUNCTCL	GRADE	CHARACT
C	Other City Police	1	16	1	1
C	Other City Police	2	15	1	1
	County Sheriff	2	16	3	2
C	County Sheriff	2	19	1	1
C	County Sheriff	2	19	1	1
C	Other City Police	3	19	1	1
C	Other City Police	1	16	1	1
	County Sheriff	2	16	1	1
	Other City Police	2	16	1	1
C	County Sheriff	1	16	1	1

Crash data, excerpt 4

Appendix E: Volume Data Excel Spreadsheets

INTERSECTION	LATITUDE	LONGITUDE	AADT
GUADALUPE ST @ PASEO DE PERALTA	414170.6868	3949067.9990	26530
5TH ST @ ST MICHAELS DR	412240.3738	3946597.7500	30865
GALISTEO ST @ ST MICHAELS DR	413849.4994	3946507.7490	32158
SILER RD @ RUFINA ST	410157.0001	3946482.4990	23158
ALAMO DR @ ST FRANCIS DR US 84/285	413714.1866	3950698.9990	35398
JEMEZ RD @ AIRPORT RD NM 284	406433.4389	3944211.2490	24575
AVENIDA DE LAS AMERICAS @ CERRILLOS RD	409190.6263	3945404.9990	44470

Intersection volume data excerpt

ROUTE NAME	A Street	B Street	AADT	LENGTH
NM 599S	I 25 NM 85	Airport Rd NM 284	9320	2.6
NM 599N	I 25 NM 85	Airport Rd NM 284	8443	2.6
NM 599S	Airport Rd NM 284	S Meadows Rd	9902	2.8
NM 599N	Airport Rd NM 284	S Meadows Rd	8678	2.8
NM 599S	S Meadows Rd	Via Veteranos	8387	1.9
NM 599N	S Meadows Rd	Via Veteranos	7437	1.9
NM 592	Pueblo De Cielo	Co Rd 74	3650	1.9
I 25N	Old Pecos Tr NM 466	St Francis Dr NM 84	16690	1.5

Road segment volume data excerpt

Appendix F: Computation Excel Spreadsheets

Rank	INTERSECTION	SORT ID	AADT	STUDY LENGTH	TOTAL # OF CRASHES	TOTAL EPDO	MEVcrash	MEVepdo
1	BERRY AVE @ 5TH ST	412036.2187,3947157.749	2760	6	7	27	1.158096751	4.46694461
2	BECKNER ROAD @ CERRILLOS RD	406440.5943,3941536.999	31133.5	6	80	256	1.173323923	3.754636554
3	COTTONWOOD AVE @ AGUA FRIA ST NM 588	405381.97,3944930.25	7460	6	24	52	1.469021999	3.182880997
4	ST FRANCIS DR US 84/285 @ CERRILLOS RD	413683.5617,3948604.249	72208.5	6	215	463	1.359583927	2.927848177
5	JEMEZ RD @ RUFINA ST	406198.3447,3944873.249	4394.5	6	11	27	1.142981238	2.805499402
6	RICHARDS AVE @ CERRILLOS RD	409381.72,3945543.999	52210	6	133	309	1.163198499	2.702468692
7	BARCELONA RD @ DON GASPAR AVE	414660.468,3948017.249	5180	6	10	30	0.881507731	2.644523192

Computations by intersection

ROUTE NA	A Street	B Street	TOTAL # OF CRASHES	TOTAL EPDO	AADT	LENGTH	MVMTcrash	MVMTepdo
NM 599S	I 25 NM 85	Airport Rd NM 284	23	84	9320	2.6	0.43	1.58
NM 599N	I 25 NM 85	Airport Rd NM 284	20	73	8443	2.6	0.42	1.52
NM 599S	Airport Rd NM 284	S Meadows Rd	27	88	9902	2.8	0.44	1.44
NM 599N	Airport Rd NM 284	S Meadows Rd	21	73	8678	2.8	0.39	1.37
NM 599S	S Meadows Rd	Via Veteranos	8	37	8387	1.9	0.23	1.07
NM 599N	S Meadows Rd	Via Veteranos	7	31	7437	1.9	0.23	1.01
NM 592	Pueblo De Cielo	Co Rd 74	1	10	3650	1.9	0.07	0.68
I 25N	Old Pecos Tr NM 466	St Francis Dr NM 84	9	34	16690	1.5	0.16	0.62
NM 14	Santa Fe Studio Rd	Veteran's Mem Hwy NM 599	14	34	18038	1.4	0.25	0.60
I 25N	Veteran's Mem Hwy NM 599	Cerrillos Rd NM 14	11	35	14592	1.9	0.19	0.59

Computations by road segment

Appendix G: Expected Benefits of FHWA Countermeasures

Countermeasure	Severe Crash Reduction	Total Crash Reduction	Cost
Roundabout	78%	48%	high
Corridor Access Management	25-31%	5-23%	high
Backplates with Retroreflective Borders	--	15%	low
Longitudal Rumble Strips and Stripes on Two-Lane Roads	36-64%	--	low
Enhanced Delineation and Friction for Horizontal Curves	38-43%	--	low
Safety Edge	--	6%	low
Medians and Pedestrian Crossing Islands	--	46%	high
Pedestrian Hybrid Beacon	69%	29%	high
Road Diet	--	29%	high

Appendix H: HSM's Expected Crash Rate Spreadsheet

Worksheet 2A -- General Information and Input Data for Urban and Suburban Arterial Intersections

General Information		Location Information	
Analyst	KKD	Roadway	SH 123
Agency or Company	OSU	Intersection	Main St at 4th Avenue
Date Performed	03/25/10	Jurisdiction	Anywhere, USA
		Analysis Year	2010

Input Data		Base Conditions	Site Conditions
Intersection type (3ST, 3SG, 4ST, 4SG)		--	3ST
AADT $_{major}$ (veh/day)	$AADT_{MAX}$ = 45,700 (veh/day)	--	14,000
AADT $_{minor}$ (veh/day)	$AADT_{MAX}$ = 9,300 (veh/day)	--	4,000
Intersection lighting (present/not present)		Not Present	Not Present
Calibration factor, C_i		1.00	1.00
Data for unsignalized intersections only:		--	--
Number of major-road approaches with left-turn lanes (0,1,2)		0	1
Number of major-road approaches with right-turn lanes (0,1,2)		0	0
Data for signalized intersections only:		--	--
Number of approaches with left-turn lanes (0,1,2,3,4) [for 3SG, use maximum value of 3]		0	0
Number of approaches with right-turn lanes (0,1,2,3,4) [for 3SG, use maximum value of 3		0	0
Number of approaches with left-turn signal phasing [for 3SG, use maximum value of 3]		--	0
Type of left-turn signal phasing for Leg #1		Permissive	Not Applicable
Type of left-turn signal phasing for Leg #2		--	Not Applicable
Type of left-turn signal phasing for Leg #3		--	Not Applicable
Type of left-turn signal phasing for Leg #4 (if applicable)		--	Not Applicable
Number of approaches with right-turn-on-red prohibited [for 3SG, use maximum value of		0	0
Intersection red light cameras (present/not present)		Not Present	Not Present
Sum of all pedestrian crossing volumes (PedVol) -- Signalized intersections only			
Maximum number of lanes crossed by a pedestrian (n_{lanesx})		--	0
Number of bus stops within 300 m (1,000 ft) of the intersection		0	0
Schools within 300 m (1,000 ft) of the intersection (present/not present)		Not Present	Not Present
Number of alcohol sales establishments within 300 m (1,000 ft) of the intersection		0	0

Input section

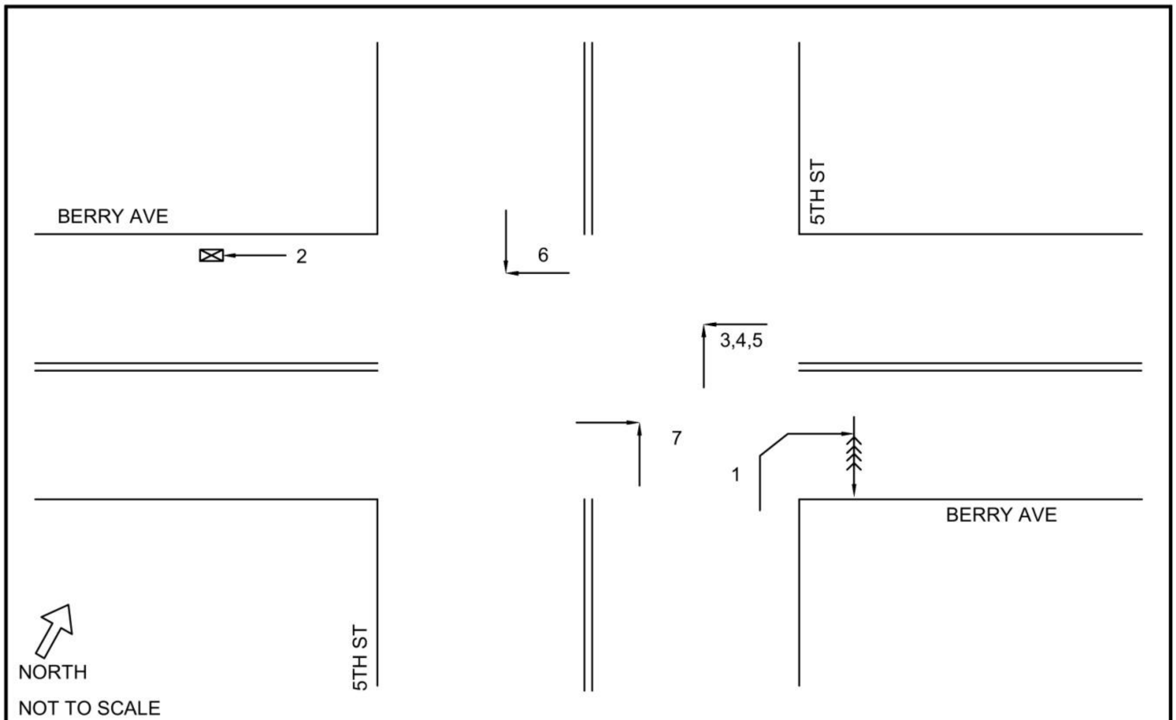
Worksheet 2L -- Summary Results for Urban and Suburban Arterial Intersections

(1)	(2)
Crash severity level	Predicted average crash frequency, $N_{predicted\ int}$ (crashes/year)
	(Total) from Worksheet 2K
Total	1.6
Fatal and injury (FI)	0.5
Property damage only (PDO)	1.0

Output section

Appendix I: Collision Diagrams

COLLISION DIAGRAM -- BERRY AVE @ 5TH ST, 2008-2009



CRASH TYPE

- REAR-END
- ANGLE
- HEAD-ON
- TURNING MOVEMENT
- BACKING
- HIT FIXED OBJECT
- SIDE SWIPE
- OUT OF CONTROL
- OVERTURNED
- PEDESTRIAN/ BICYCLE
- PARKED VEHICLE

EPDO:

1 = Property Damage Only
5 = Injury
10 = Fatality

ROAD SURFACE (R/S):

1 = Dry
2 = Wet
3 = Snowy
4 = Icy
5 = Unknown

WEATHER CONDITIONS (W/C):

1 = Clear
2 = Foggy
3 = Cloudy
4 = Rain
5 = Snow
6 = Sleet
7 = Unknown

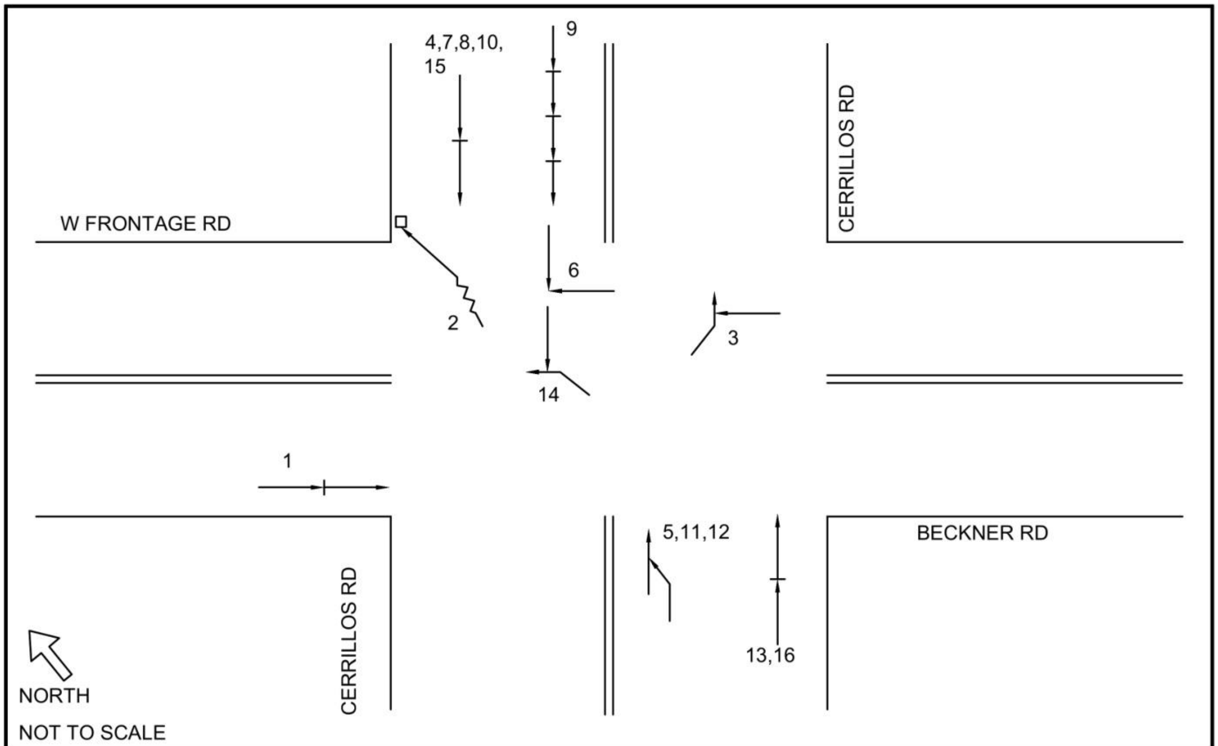
LIGHT CONDITIONS (L/C):

1 = Daylight
2 = Dawn or Dusk
3 = Darkness - Road Lighted
4 = Darkness - Road Unlighted
5 = Unknown

* Indicates Alcohol Involvement

#	DATE	DAY	TIME	EPDO	R/S	W/C	L/C	#	DATE	DAY	TIME	EPOD	R/S	W/C	L/C
1	7/10/2008	Thu	12:45 PM	1	1	1	1								
2	10/27/2008	Mon	5:30 PM	1	1	1	1								
3	7/3/2008	Thu	10:29 PM	1	1	1	1								
4	8/11/2008	Mon	9:56 PM	5	1	1	1								
5	1/28/2009	Wed	12:13 PM	1	1	1	1								
6	3/28/2009	Sat	2:02 PM	1	1	7	1								
7	9/21/2009	Mon	8:18 AM	5	1	1	1								

COLLISION DIAGRAM -- CERRILLOS RD @ BECKNER, 2010



CRASH TYPE

- REAR-END
- ANGLE
- HEAD-ON
- TURNING MOVEMENT
- BACKING
- HIT FIXED OBJECT
- SIDE SWIPE
- OUT OF CONTROL
- OVERTURNED
- PEDESTRIAN/ BICYCLE
- PARKED VEHICLE

EPDO:

1 = Property Damage Only
5 = Injury
10 = Fatality

ROAD SURFACE (R/S):

1 = Dry
2 = Wet
3 = Snowy
4 = Icy
5 = Unknown

WEATHER CONDITIONS (W/C):

1 = Clear
2 = Foggy
3 = Cloudy
4 = Rain
5 = Snow
6 = Sleet
7 = Unknown

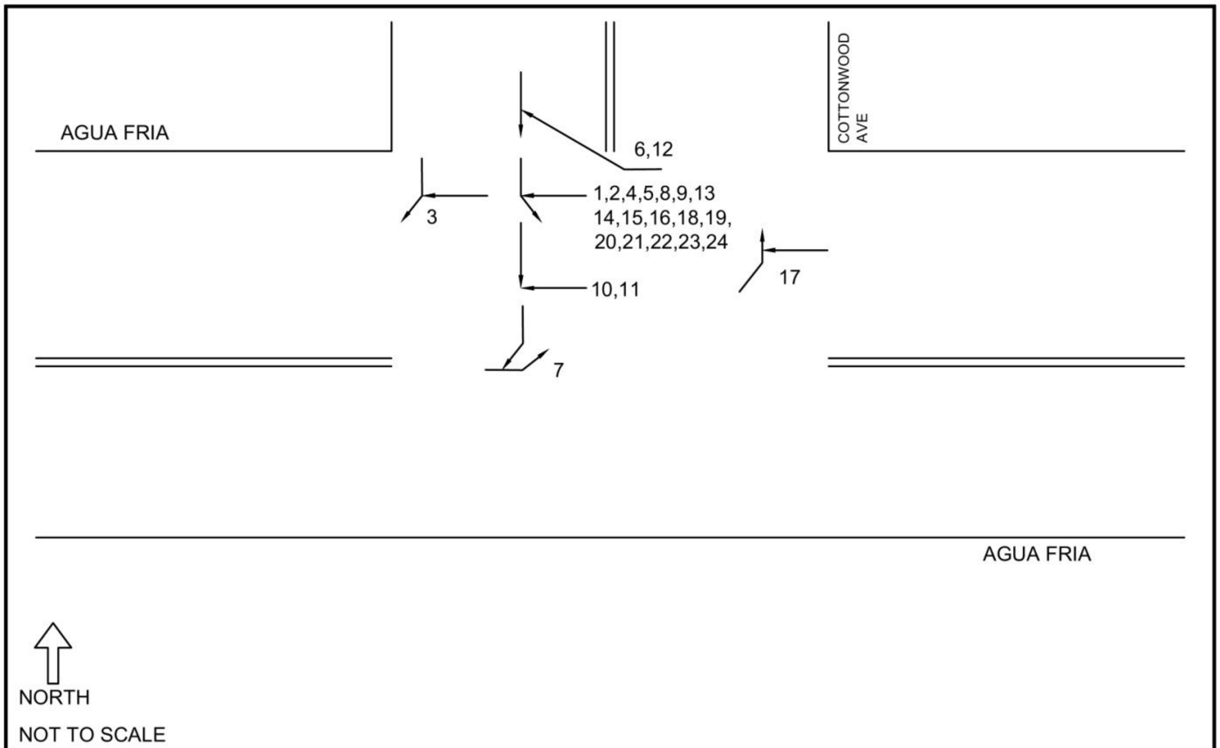
LIGHT CONDITIONS (L/C):

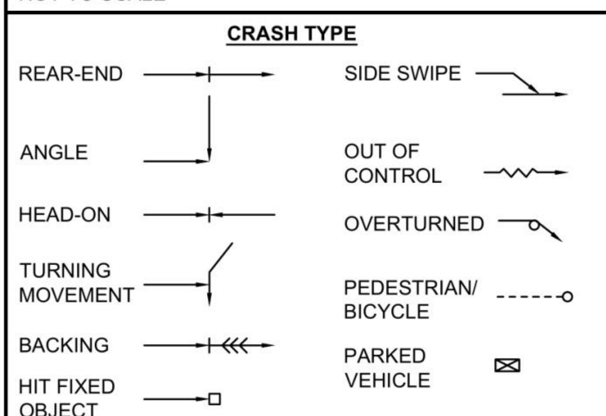
1 = Daylight
2 = Dawn or Dusk
3 = Darkness - Road Lighted
4 = Darkness - Road Unlighted
5 = Unknown

* Indicates Alcohol Involvement

#	DATE	DAY	TIME	EPDO	R/S	W/C	L/C	#	DATE	DAY	TIME	EPOD	R/S	W/C	L/C
1	1/4/2010	Mon	5:42 PM	5	1	1	3	15	11/24/2010	Wed	5:21 PM	1	1	1	3
2	2/3/2010	Wed	3:23 PM	1	3	5	1	16	11/29/2010	Mon	9:13 AM	1	1	1	1
3	2/13/2010	Sat	10:30 AM	1	1	1	1								
4	4/12/2010	Mon	3:55 PM	1	1	1	1								
5	5/22/2010	Sat	6:51 AM	1	1	1	1								
6	5/29/2010	Sat	5:36 PM	5*	1	1	1								
7	6/22/2010	Tues	2:57 PM	1	1	1	1								
8	6/25/2010	Fri	8:08 PM	1	2	4	3								
9	7/4/2010	Sun	2:46 PM	5	1	1	1								
10	7/11/2010	Sun	1:47 PM	5	1	1	1								
11	9/2/2010	Thu	12:17 PM	1	1	1	1								
12	9/17/2010	Fri	12:46 PM	1	1	1	1								
13	10/14/2010	Thu	8:33 AM	1	1	7	5								
14	10/14/2010	Thu	9:55 AM	5	1	1	1								

COLLISION DIAGRAM -- COTTONWOOD AVE @ AGUA FRIA ST NM 588, 2006-2011





EPDO:

1 = Property Damage Only
5 = Injury
10 = Fatality

ROAD SURFACE (R/S):

1 = Dry
2 = Wet
3 = Snowy
4 = Icy
5 = Unknown

WEATHER CONDITIONS (W/C):

1 = Clear
2 = Foggy
3 = Cloudy
4 = Rain
5 = Snow
6 = Sleet
7 = Unknown

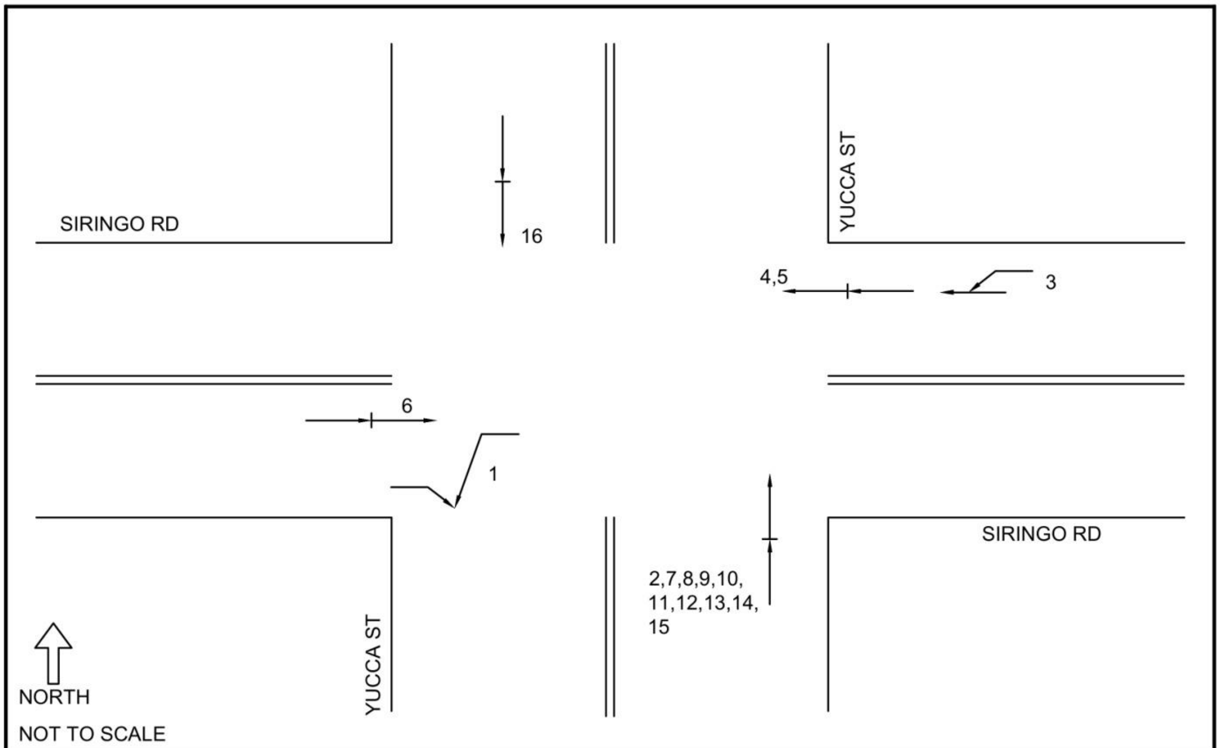
LIGHT CONDITIONS (L/C):

1 = Daylight
2 = Dawn or Dusk
3 = Darkness - Road Lighted
4 = Darkness - Road Unlighted
5 = Unknown

* Indicates Alcohol Involvement

#	DATE	DAY	TIME	EPDO	R/S	W/C	L/C	#	DATE	DAY	TIME	EPOD	R/S	W/C	L/C
1	3/17/2006	Fir	6:48 PM	5	1	1	3	15	10/9/2009	Fri	3:19 PM	5	1	1	1
2	5/31/2006	Wed	8:26 AM	1	1	1	1	16	10/14/2009	Wed	3:07 PM	1	1	1	1
3	7/26/2006	Wed	4:41 PM	1	1	1	1	17	1/15/2010	Fri	1:49 PM	1	1	1	1
4	8/25/2006	Fri	8:14 PM	1*	1	1	1	18	4/30/2010	Fri	3:01 PM	5	1	1	1
5	11/23/2006	Thu	7:39 AM	1	1	1	1	19	5/16/2010	Sun	3:08 PM	5	1	1	1
6	11/30/2006	Thu	7:42 AM	1	1	1	1	20	8/26/2010	Thu	6:46 AM	1	1	1	1
7	9/3/2007	Mon	2:16 PM	1	1	1	1	21	10/26/2010	Tues	5:55 PM	1	1	1	1
8	10/9/2007	Tues	10:11 AM	5	1	1	1	22	4/27/2011	Wed	2:51 PM	1	1	1	1
9	10/9/2007	Tues	7:05 PM	5	1	1	4	23	5/20/2011	Fri	1:25 PM	5	1	1	1
10	12/14/2007	Fri	12:54 PM	1	1	1	1	24	7/27/2011	Wed	2:46 PM	1	1	1	1
11	12/29/2007	Sat	4:42 PM	1	1	1	1								
12	4/12/2008	Sat	7:17 PM	1*	1	1	1								
13	9/3/2008	Wed	6:45 PM	1	1	1	1								
14	3/4/2009	Wed	6:59 PM	1	1	1	1								

COLLISION DIAGRAM -- SIRINGO RD @ YUCCA ST, 2010



CRASH TYPE

REAR-END
ANGLE
HEAD-ON
TURNING MOVEMENT
BACKING
HIT FIXED OBJECT
SIDE SWIPE
OUT OF CONTROL
OVERTURNED
PEDESTRIAN/ BICYCLE
PARKED VEHICLE

EPDO:

1 = Property Damage Only
5 = Injury
10 = Fatality

ROAD SURFACE (R/S):

1 = Dry
2 = Wet
3 = Snowy
4 = Icy
5 = Unknown

WEATHER CONDITIONS (W/C):

1 = Clear
2 = Foggy
3 = Cloudy
4 = Rain
5 = Snow
6 = Sleet
7 = Unknown

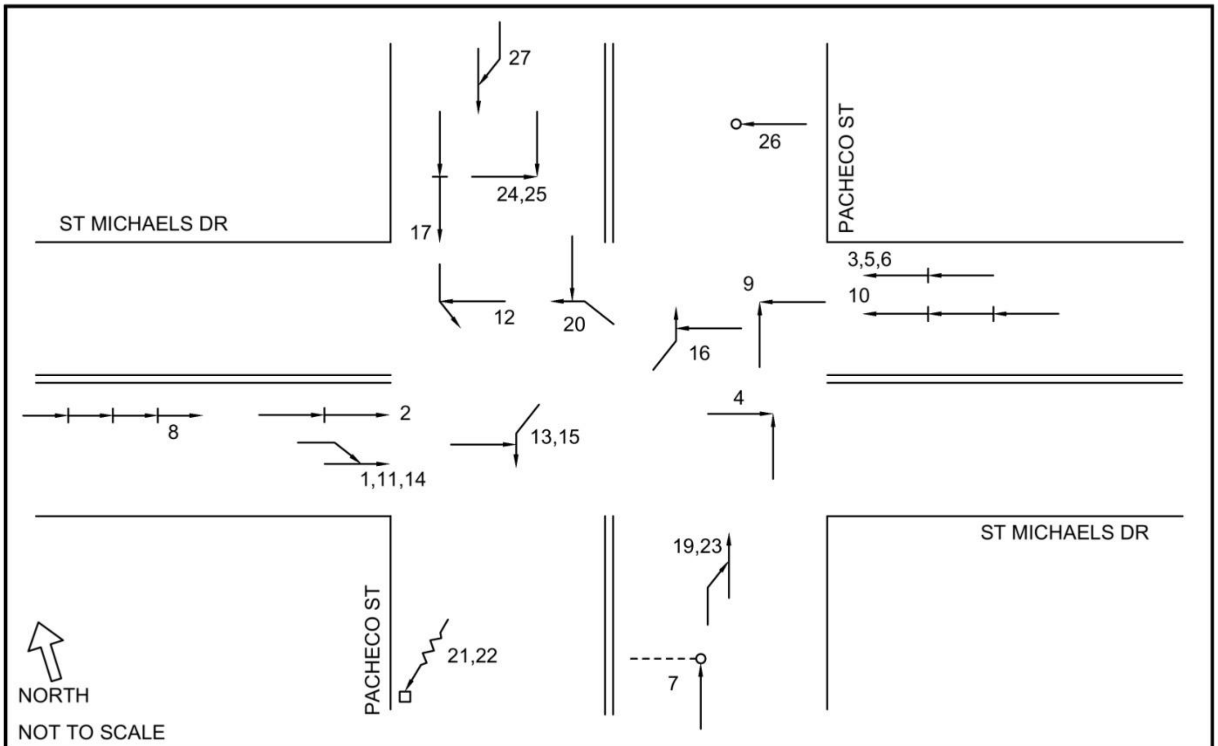
LIGHT CONDITIONS (L/C):

1 = Daylight
2 = Dawn or Dusk
3 = Darkness - Road Lighted
4 = Darkness - Road Unlighted
5 = Unknown

* Indicates Alcohol Involvement

#	DATE	DAY	TIME	EPDO	R/S	W/C	L/C	#	DATE	DAY	TIME	EPOD	R/S	W/C	L/C
1	1/27/2010	Wed	5:58 PM	1	1	1	2	15	10/29/2010	Fri	4:58 PM	1	1	1	1
2	3/28/2010	Sun	2:39 PM	1	1	1	1	16	12/6/2010	Mon	3:06 PM	1	1	1	1
3	4/14/2010	Wed	8:21 AM	1	1	1	1								
4	6/28/2010	Mon	6:06 PM	1	2	4	1								
5	6/29/2010	Tues	12:44 PM	1	1	1	1								
6	9/22/2010	Wed	3:50 PM	1	2	4	1								
7	10/31/2010	Sun	1:31 PM	1	1	1	1								
8	10/19/2010	Tues	9:16 AM	1	1	1	1								
9	1/16/2010	Sat	12:31 PM	1	1	1	1								
10	1/27/2010	Wed	3:41 PM	5	1	1	1								
11	2/5/2010	Fri	3:16 PM	1	1	1	1								
12	2/25/2010	Thu	3:12 PM	1	1	1	1								
13	6/14/2010	Mon	8:29 AM	1	1	1	1								
14	9/16/2010	Thu	2:37 PM	1	1	1	1								

COLLISION DIAGRAM -- SAINT MICHAELS DR @ PACHECO ST, 2010



CRASH TYPE

- REAR-END
- ANGLE
- HEAD-ON
- TURNING MOVEMENT
- BACKING
- HIT FIXED OBJECT
- SIDE SWIPE
- OUT OF CONTROL
- OVERTURNED
- PEDESTRIAN/ BICYCLE
- PARKED VEHICLE

EPDO:

1 = Property Damage Only
5 = Injury
10 = Fatality

ROAD SURFACE (R/S):

1 = Dry
2 = Wet
3 = Snowy
4 = Icy
5 = Unknown

WEATHER CONDITIONS (W/C):

1 = Clear
2 = Foggy
3 = Cloudy
4 = Rain
5 = Snow
6 = Sleet
7 = Unknown

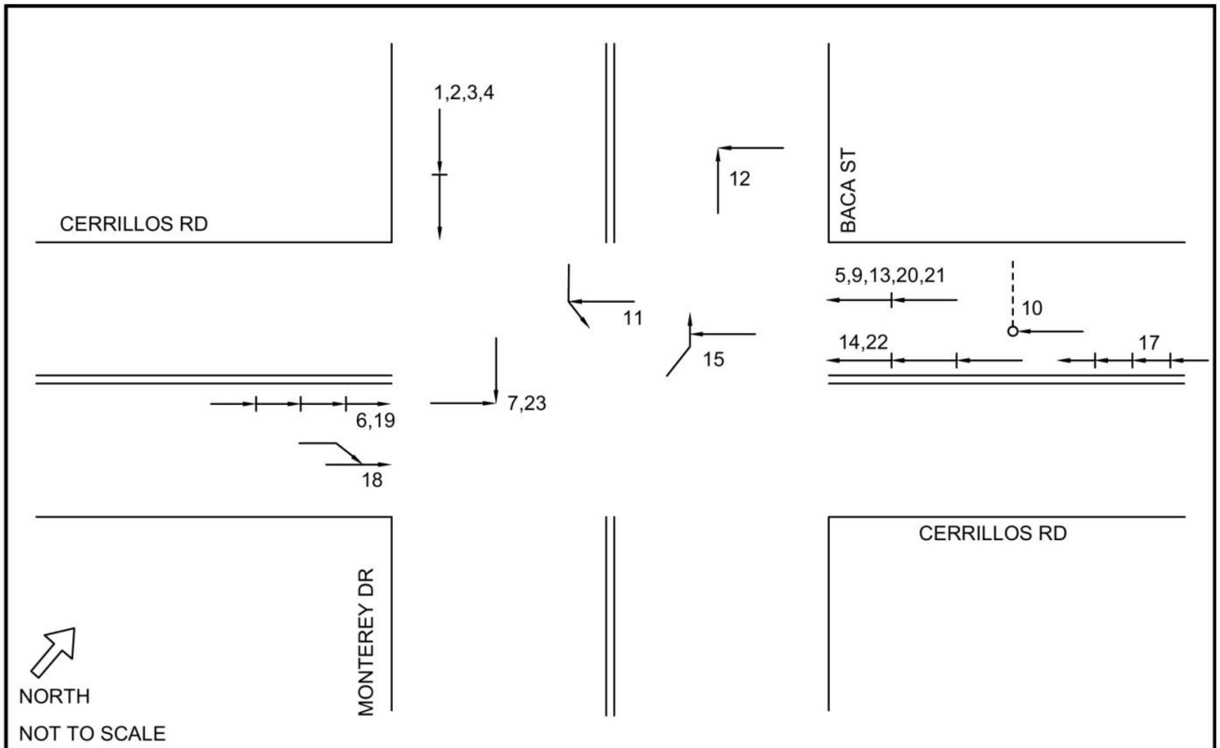
LIGHT CONDITIONS (L/C):

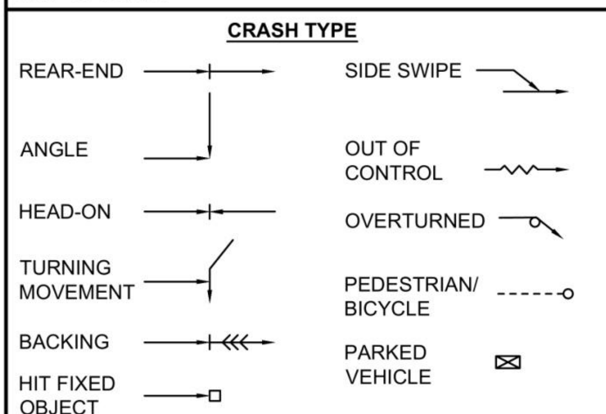
1 = Daylight
2 = Dawn or Dusk
3 = Darkness - Road Lighted
4 = Darkness - Road Unlighted
5 = Unknown

* Indicates Alcohol Involvement

#	DATE	DAY	TIME	EPDO	R/S	W/C	L/C	#	DATE	DAY	TIME	EPOD	R/S	W/C	L/C
1	2/2/2010	Tues	8:03 PM	1	1	1	3	15	12/12/2010	Sun	1:03 PM	1	1	1	1
2	2/6/2010	Sat	3:08 PM	1	1	1	1	16	12/20/2010	Mon	3:07 PM	5	1	1	1
3	2/25/2010	Thu	12:27 PM	5	1	1	1	17	8/12/2010	Thu	12:20 PM	1	1	1	1
4	4/14/2010	Wed	4:51 PM	1	1	1	1	18	8/30/2010	Mon	1:38 PM	5	1	1	1
5	4/14/2010	Wed	5:04 PM	1	1	1	1	19	1/3/2010	Sun	8:53 AM	1	1	1	1
6	6/22/2010	Tues	1:58 PM	1	1	1	1	20	2/20/2010	Sat	2:46 PM	5	1	1	1
7	7/14/2010	Wed	1:24 PM	5	1	1	1	21	4/9/2010	Fri	11:52 PM	5	1	1	3
8	8/6/2010	Fri	2:24 PM	1	1	1	1	22	4/10/2010	Sat	12:01 AM	1	1	1	3
9	8/21/2010	Sat	8:18 PM	5	1	1	3	23	8/7/2010	Sat	1:41 PM	5	1	1	1
10	9/29/2010	Wed	3:45 PM	1	1	1	1	24	8/12/2010	Thu	5:41 PM	1	1	1	1
11	10/11/2010	Mon	3:50 PM	1	1	1	1	25	8/25/2010	Wed	11:24 AM	1	1	1	1
12	10/15/2010	Fri	7:50 AM	1	1	1	1	26	929/2010	Wed	5:03 PM	5	1	1	1
13	10/16/2010	Sat	6:52 PM	1	1	1	3	27	12/2/2010	Thu	3:38 PM	5	1	1	1
14	11/6/2010	Sat	6:51 PM	1	1	1	3								

COLLISION DIAGRAM -- BACA ST @ CERRILLOS RD, 2010





EPDO:

1 = Property Damage Only
5 = Injury
10 = Fatality

ROAD SURFACE (R/S):

1 = Dry
2 = Wet
3 = Snowy
4 = Icy
5 = Unknown

WEATHER CONDITIONS (W/C):

1 = Clear
2 = Foggy
3 = Cloudy
4 = Rain
5 = Snow
6 = Sleet
7 = Unknown

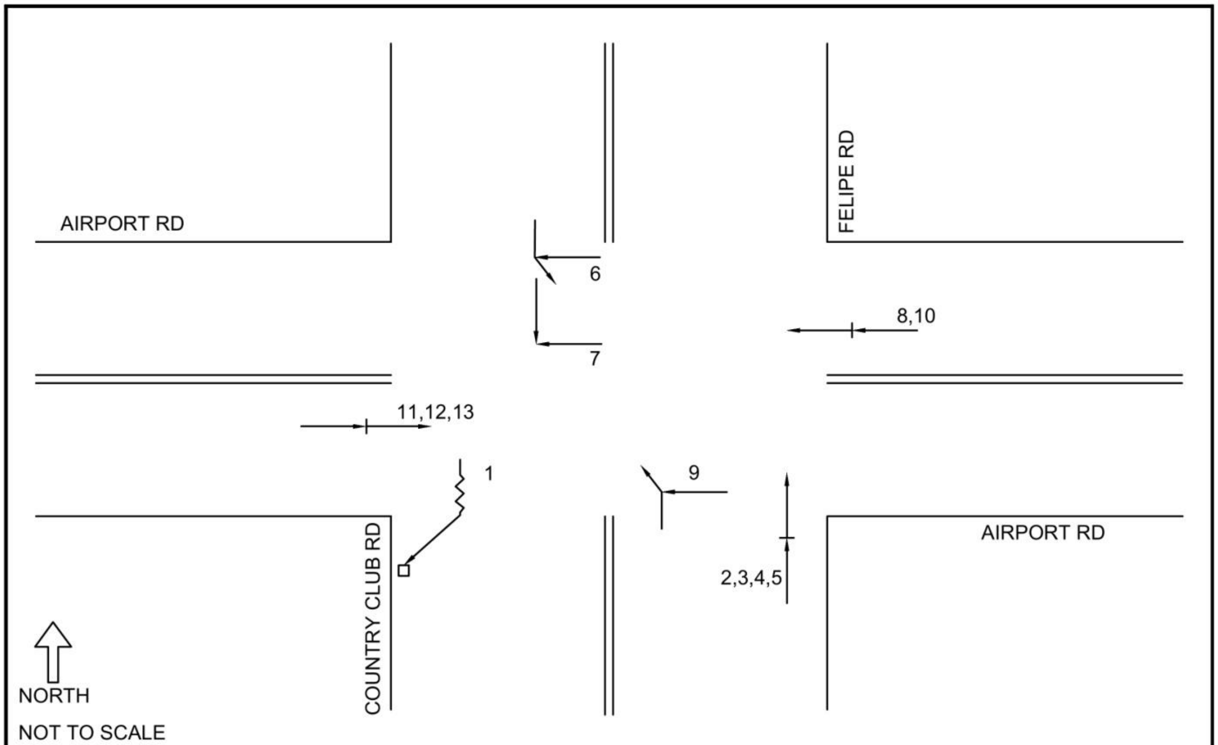
LIGHT CONDITIONS (L/C):

1 = Daylight
2 = Dawn or Dusk
3 = Darkness - Road Lighted
4 = Darkness - Road Unlighted
5 = Unknown

* Indicates Alcohol Involvement

#	DATE	DAY	TIME	EPDO	R/S	W/C	L/C	#	DATE	DAY	TIME	EPOD	R/S	W/C	L/C
1	1/7/2010	Thu	1:15 PM	1	1	1	1	15	7/23/2010	Fri	9:55 PM	1	2	1	3
2	2/25/2010	Thu	8:08 AM	1	1	1	1	16	8/4/2010	Thu	8:10 AM	1	2	4	1
3	6/23/2010	Wed	1:22 PM	1	1	1	1	17	8/28/2010	Sat	3:26 PM	5	2	4	1
4	11/12/2010	Fri	3:48 PM	5	1	1	1	18	9/10/2010	Fri	8:17 AM	1	1	1	1
5	1/11/2010	Mon	3:21 PM	1	1	1	1	19	9/14/2010	Tues	4:01 PM	1	1	1	1
6	4/4/2010	Sun	4:28 PM	5	1	1	1	20	11/12/2010	Fri	5:00 PM	1	1	1	2
7	4/11/2010	Sun	1:38 PM	5	1	1	1	21	12/10/2010	Fri	8:03 PM	1	1	1	3
8	4/15/2010	Thu	4:30 PM	1	1	1	1	22	12/11/2010	Sat	4:16 PM	1	1	1	1
9	6/1/2010	Thu	8:24 PM	1	1	1	3	23	12/25/2010	Sat	4:30 PM	1	1	1	1
10	5/18/2010	Tues	3:45 PM	5	1	1	1								
11	5/21/2010	Fri	11:27 AM	1	1	1	1								
12	6/19/2010	Tues	9:55 PM	1	1	1	3								
13	6/22/2010	Tues	11:17 AM	1	1	1	1								
14	7/8/2010	Thu	12:52 PM	1	1	1	1								

COLLISION DIAGRAM -- COUNTY CLUB RD @ AIRPORT RD, 2009-2011



CRASH TYPE

REAR-END

ANGLE

HEAD-ON

TURNING MOVEMENT

BACKING

HIT FIXED OBJECT

SIDE SWIPE

OUT OF CONTROL

OVERTURNED

PEDESTRIAN/ BICYCLE

PARKED VEHICLE

EPDO:

1 = Property Damage Only
5 = Injury
10 = Fatality

ROAD SURFACE (R/S):

1 = Dry
2 = Wet
3 = Snowy
4 = Icy
5 = Unknown

WEATHER CONDITIONS (W/C):

1 = Clear
2 = Foggy
3 = Cloudy
4 = Rain
5 = Snow
6 = Sleet
7 = Unknown

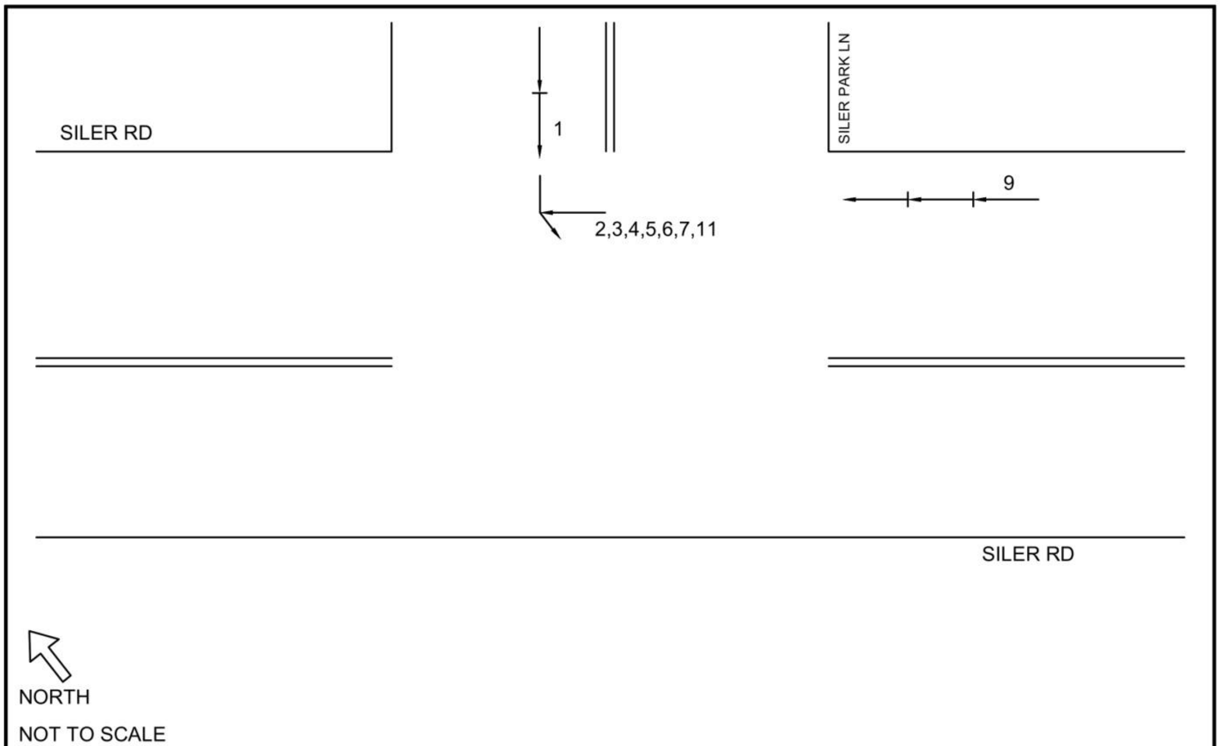
LIGHT CONDITIONS (L/C):

1 = Daylight
2 = Dawn or Dusk
3 = Darkness - Road Lighted
4 = Darkness - Road Unlighted
5 = Unknown

* Indicates Alcohol Involvement

#	DATE	DAY	TIME	EPDO	R/S	W/C	L/C	#	DATE	DAY	TIME	EPOD	R/S	W/C	L/C
1	5/15/2010	Sat	10:55 AM	1*	1	1	1								
2	11/2/2009	Mon	10:27 AM	1	1	1	1								
3	11/29/2011	Tues	9:55 AM	5	1	1	1								
4	4/27/2010	Tues	3:45 PM	5	1	1	1								
5	9/25/2010	Sat	1:56 PM	1	1	1	1								
6	6/5/2010	Sun	7:31 PM	1	1	7	2								
7	1/28/2010	Thu	2:30 PM	1	2	1	1								
8	3/9/2010	Tues	7:33 PM	1	1	1	3								
9	3/11/2011	Fri	6:54 AM	1	1	1	1								
10	7/23/2011	Sat	4:44 PM	1	1	7	5								
11	7/30/2011	Sat	7:50 AM	1	1	7	5								
12	8/4/2011	Thu	9:25 AM	1	1	1	1								
13	8/5/2011	Fri	12:20 PM	1	1	1	1								

COLLISION DIAGRAM -- SILER PARK LN @ SILER RD, 2008-2011



CRASH TYPE

- REAR-END
- ANGLE
- HEAD-ON
- TURNING MOVEMENT
- BACKING
- HIT FIXED OBJECT
- SIDE SWIPE
- OUT OF CONTROL
- OVERTURNED
- PEDESTRIAN/ BICYCLE
- PARKED VEHICLE

EPDO:

1 = Property Damage Only
5 = Injury
10 = Fatality

ROAD SURFACE (R/S):

1 = Dry
2 = Wet
3 = Snowy
4 = Icy
5 = Unknown

WEATHER CONDITIONS (W/C):

1 = Clear
2 = Foggy
3 = Cloudy
4 = Rain
5 = Snow
6 = Sleet
7 = Unknown

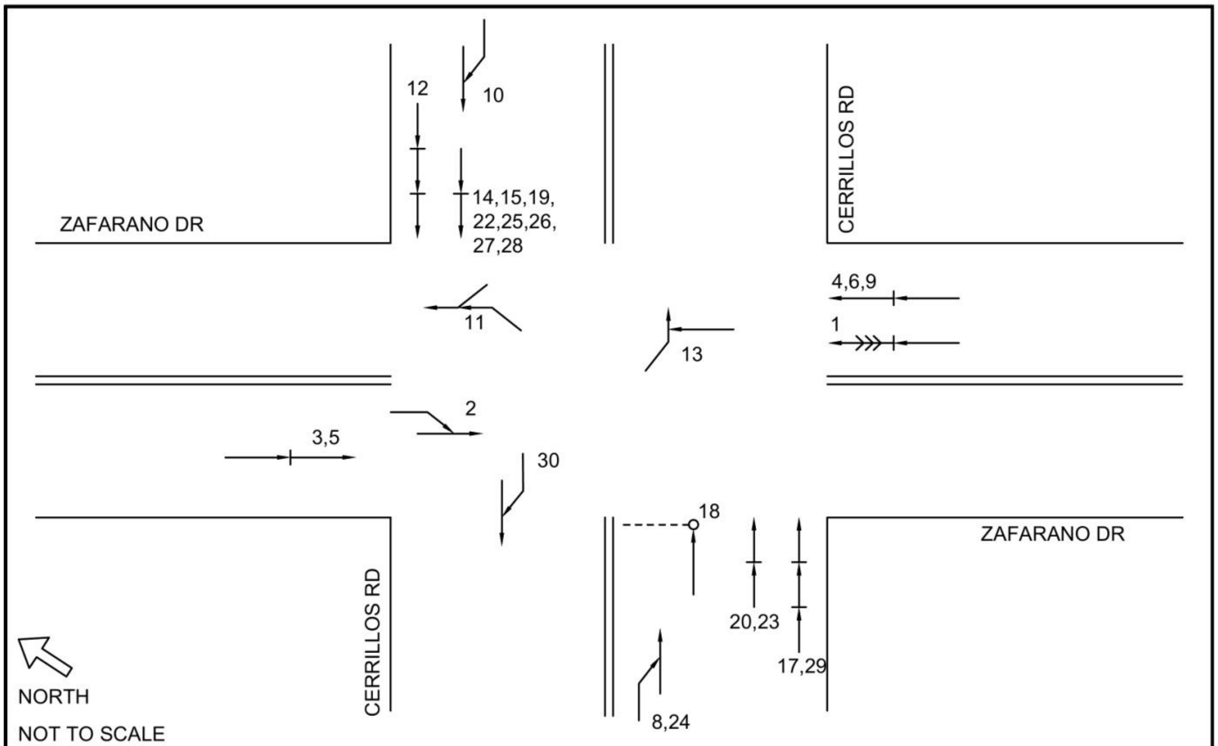
LIGHT CONDITIONS (L/C):

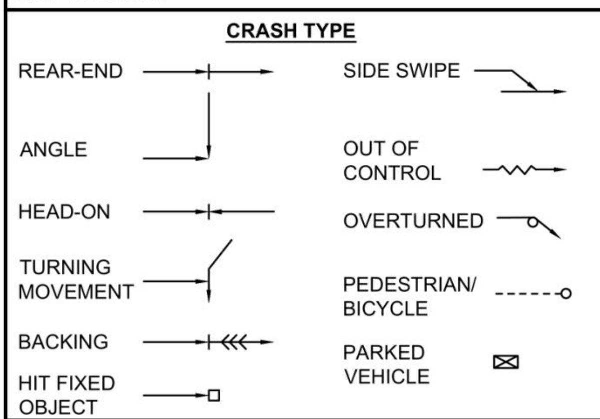
1 = Daylight
2 = Dawn or Dusk
3 = Darkness - Road Lighted
4 = Darkness - Road Unlighted
5 = Unknown

* Indicates Alcohol Involvement

#	DATE	DAY	TIME	EPDO	R/S	W/C	L/C	#	DATE	DAY	TIME	EPOD	R/S	W/C	L/C
1	9/17/2008	Wed	2:33 PM	1	1	1	1								
2	9/19/2008	Fri	4:35 PM	1	1	1	1								
3	12/17/2008	Wed	12:11 PM	1	1	1	1								
4	3/13/2009	Fri	3:45 PM	1	1	1	1								
5	7/28/2010	Wed	1:51 PM	1	2	1	1								
6	11/6/2010	Sat	12:18 PM	1	1	1	1								
7	2/25/2011	Fri	3:23 PM	5	1	1	1								
8	6/3/2011	Fri	3:32 AM	1	1	1	1								
9	7/19/2011	Tues	3:13 PM	1	1	1	1								
10	11/2/2011	Wed	4:44 PM	5	1	1	1								
11	11/21/2011	Mon	3:36 PM	1	2	4	1								

COLLISION DIAGRAM -- CERRILLOS RD @ ZAFARANO DR, 2010





EPDO:

1 = Property Damage Only
5 = Injury
10 = Fatality

ROAD SURFACE (R/S):

1 = Dry
2 = Wet
3 = Snowy
4 = Icy
5 = Unknown

WEATHER CONDITIONS (W/C):

1 = Clear
2 = Foggy
3 = Cloudy
4 = Rain
5 = Snow
6 = Sleet
7 = Unknown

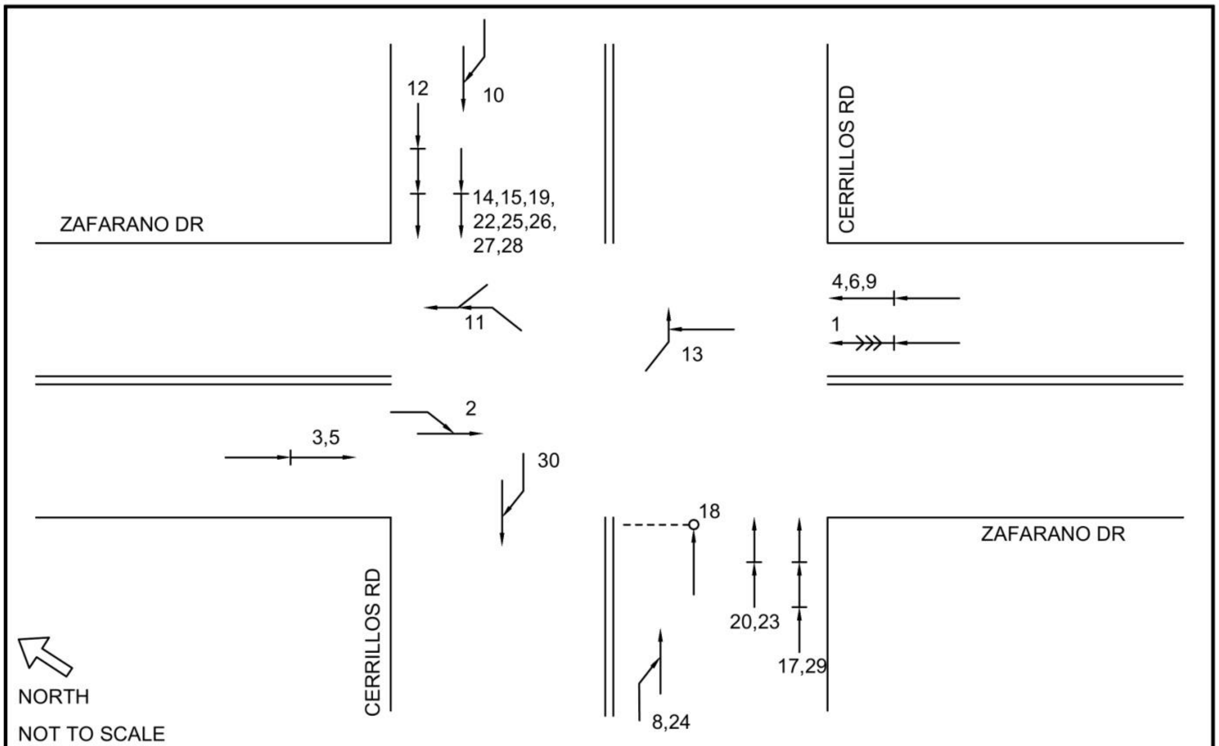
LIGHT CONDITIONS (L/C):

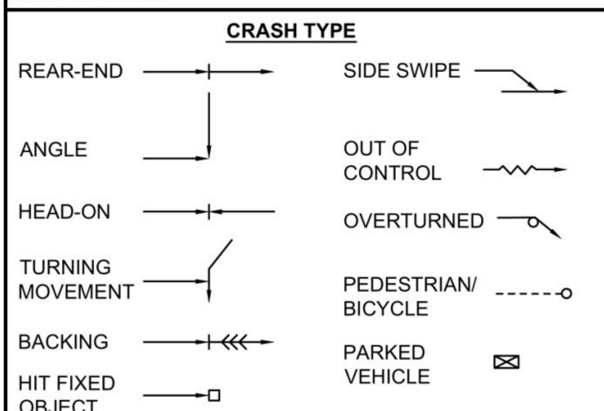
1 = Daylight
2 = Dawn or Dusk
3 = Darkness - Road Lighted
4 = Darkness - Road Unlighted
5 = Unknown

* Indicates Alcohol Involvement

#	DATE	DAY	TIME	EPDO	R/S	W/C	L/C	#	DATE	DAY	TIME	EPOD	R/S	W/C	L/C
1	5/8/2010	Sat	11:39 AM	1	1	1	1	15	3/27/2010	Sat	11:26 AM	1	1	1	1
2	11/23/2010	Tues	8:38 PM	1*	1	1	3	16	4/12/2010	Mon	12:06 PM	1	1	1	1
3	12/17/2010	Fri	4:55 PM	1	2	7	2	17	4/20/2010	Tues	7:09 PM	1	1	1	1
4	5/19/2010	Wed	7:15 PM	5	1	1	1	18	4/24/2010	Sat	8:11 PM	1	1	1	3
5	7/28/2010	Wed	1:20 PM	1	2	1	1	19	4/30/2010	Fri	5:58 PM	1	1	1	1
6	8/4/2010	Wed	4:30 PM	1	1	1	1	20	5/14/2010	Fri	1:12 PM	1	1	1	1
7	11/6/2010	Sat	7:10 PM	1	1	1	3	21	6/19/2010	Sat	2:48 PM	1	1	1	1
8	11/8/2010	Mon	12:57 PM	1	1	1	1	22	7/10/2010	Sat	9:37 PM	1	2	4	3
9	12/22/2010	Wed	11:24 AM	1	2	4	1	23	7/16/2010	Fri	11:40 AM	1	1	1	1
10	12/10/2010	Fri	2:15 PM	1	1	1	1	24	8/25/2010	Wed	9:31 AM	1	1	1	1
11	2/6/2010	Sat	1:35 PM	1	1	1	1	25	9/1/2010	Tues	9:20 PM	1	1	1	1
12	2/23/2010	Tues	10:40 AM	1	4	1	1	26	9/13/2010	Mon	8:55 AM	1	1	1	1
13	2/28/2010	Sun	7:41 PM	5	1	1	3	27	9/22/2010	Wed	8:33 AM	1	1	7	1
14	3/9/2010	Tues	12:50 PM	1	1	1	1	28	9/27/2010	Mon	10:46 PM	1	1	1	3

COLLISION DIAGRAM -- CERRILLOS RD @ ZAFARANO DR, 2010 (CONTINUED)





EPDO:

1 = Property Damage Only
5 = Injury
10 = Fatality

ROAD SURFACE (R/S):

1 = Dry
2 = Wet
3 = Snowy
4 = Icy
5 = Unknown

WEATHER CONDITIONS (W/C):

1 = Clear
2 = Foggy
3 = Cloudy
4 = Rain
5 = Snow
6 = Sleet
7 = Unknown

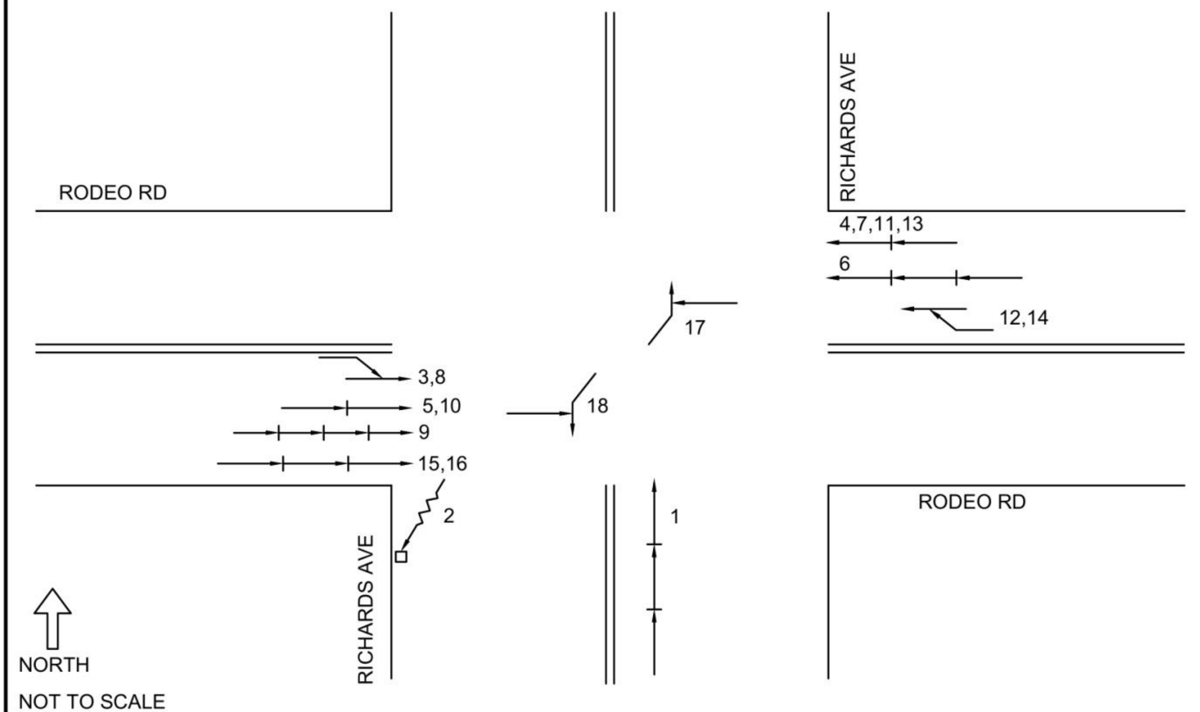
LIGHT CONDITIONS (L/C):

1 = Daylight
2 = Dawn or Dusk
3 = Darkness - Road Lighted
4 = Darkness - Road Unlighted
5 = Unknown

* Indicates Alcohol Involvement

#	DATE	DAY	TIME	EPDO	R/S	W/C	L/C	#	DATE	DAY	TIME	EPOD	R/S	W/C	L/C
29	10/15/2010	Fri	11:41 AM	1	1	1	1								
30	11/21/2010	Sun	5:19 PM	1	1	1	3								

COLLISION DIAGRAM -- RODEO RD @ RICHARDS AVE, 2010



CRASH TYPE

REAR-END
SIDE SWIPE
ANGLE
OUT OF CONTROL
HEAD-ON
OVERTURNED
TURNING MOVEMENT
PEDESTRIAN/ BICYCLE
BACKING
PARKED VEHICLE
HIT FIXED OBJECT

EPDO:

1 = Property Damage Only
5 = Injury
10 = Fatality

ROAD SURFACE (R/S):

1 = Dry
2 = Wet
3 = Snowy
4 = Icy
5 = Unknown

WEATHER CONDITIONS (W/C):

1 = Clear
2 = Foggy
3 = Cloudy
4 = Rain
5 = Snow
6 = Sleet
7 = Unknown

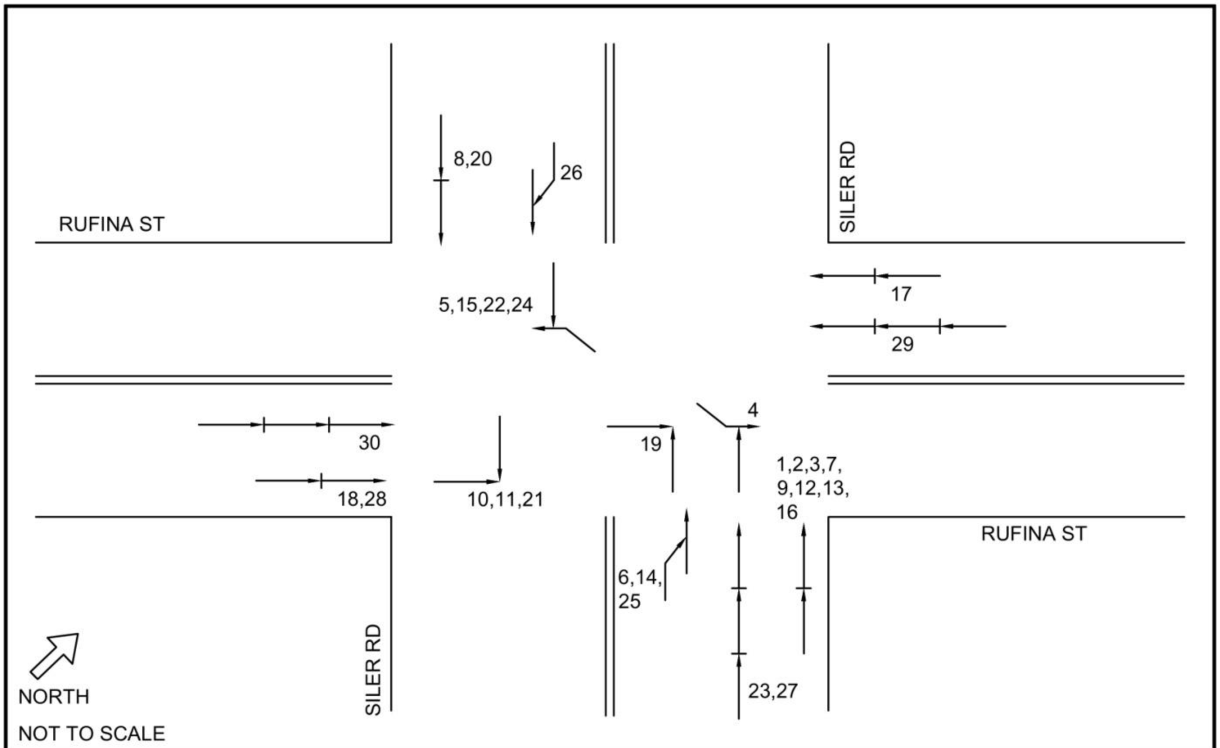
LIGHT CONDITIONS (L/C):

1 = Daylight
2 = Dawn or Dusk
3 = Darkness - Road Lighted
4 = Darkness - Road Unlighted
5 = Unknown

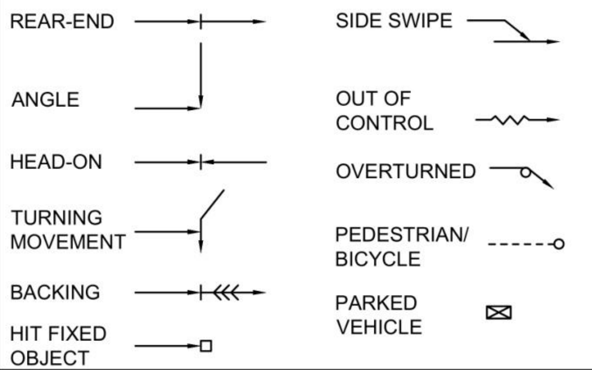
* Indicates Alcohol Involvement

#	DATE	DAY	TIME	EPDO	R/S	W/C	L/C	#	DATE	DAY	TIME	EPOD	R/S	W/C	L/C
1	3/20/2010	Sat	3:15 PM	1*	1	1	1	15	10/14/2010	Thu	4:50 AM	1	1	1	1
2	12/26/2010	Sun	2:49 PM	1	1	1	1	16	10/22/2010	Fri	4:41 PM	1	1	1	1
3	3/4/2010	Thu	7:45 AM	5	1	1	1	17	11/5/2010	Fri	4:42 PM	1	1	1	4
4	5/13/2010	Thu	7:17 PM	1	1	1	1	18	11/29/2010	Mon	5:54 PM	1	1	1	3
5	12/4/2010	Sat	5:53 PM	1	1	1	3								
6	1/31/2010	Sun	4:50 PM	5*	1	1	1								
7	2/4/2010	Thu	5:28 PM	1	2	1	2								
8	2/23/2010	Tues	5:19 PM	1	2	1	1								
9	3/3/2010	Wed	3:03 PM	1	1	1	1								
10	4/8/2010	Thu	4:28 PM	1	1	1	1								
11	4/27/2010	Tues	3:04 PM	5	1	1	1								
12	6/2/2010	Wed	9:51 AM	1	1	1	1								
13	6/28/2010	Mon	12:53 PM	1	2	1	1								
14	9/9/2010	Thu	5:00 PM	1	1	1	3								

COLLISION DIAGRAM -- RUFINA ST @ SILER RD, 2009-2011



CRASH TYPE



EPDO:

1 = Property Damage Only
5 = Injury
10 = Fatality

ROAD SURFACE (R/S):

1 = Dry
2 = Wet
3 = Snowy
4 = Icy
5 = Unknown

WEATHER CONDITIONS (W/C):

1 = Clear
2 = Foggy
3 = Cloudy
4 = Rain
5 = Snow
6 = Sleet
7 = Unknown

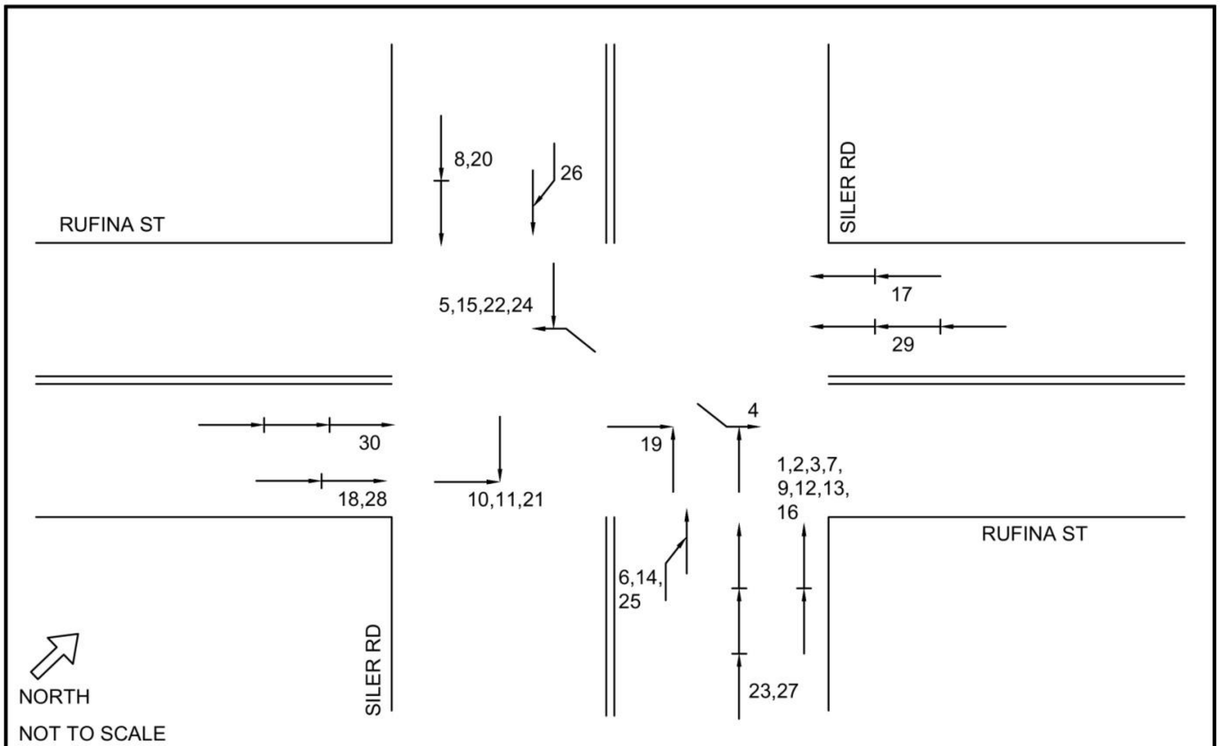
LIGHT CONDITIONS (L/C):

1 = Daylight
2 = Dawn or Dusk
3 = Darkness - Road Lighted
4 = Darkness - Road Unlighted
5 = Unknown

* Indicates Alcohol Involvement

#	DATE	DAY	TIME	EPDO	R/S	W/C	L/C	#	DATE	DAY	TIME	EPOD	R/S	W/C	L/C
1	12/1/2009	Tues	2:12 PM	1	1	1	1	15	8/28/2011	Sun	2:25 PM	1	1	1	1
2	12/7/2009	Mon	12:04 PM	1	2	5	1	16	12/9/2009	Wed	3:53 PM	1*	1	1	1
3	12/17/2009	Thu	7:58 AM	1	1	1	1	17	7/5/2011	Tues	11:19 AM	5	1	1	1
4	1/14/2010	Thu	9:22 AM	5	1	1	1	18	9/15/2009	Tues	11:44 AM	1	1	1	1
5	1/16/2010	Sat	1:16 PM	1	1	1	1	19	4/10/2009	Fri	12:20 PM	1	1	1	1
6	3/18/2010	Thu	7:48 AM	1	1	1	1	20	4/13/2009	Mon	5:06 PM	1	1	1	1
7	4/15/2010	Thu	4:08 PM	1	1	1	1	21	4/24/2009	Fri	12:46 PM	5	1	1	1
8	6/18/2010	Fri	2:57 PM	1	1	1	1	22	5/4/2009	Mon	6:48 PM	1	1	1	1
9	11/23/2010	Tues	11:13 AM	1	1	1	1	23	9/23/2009	Wed	9:42 AM	1	1	1	1
10	12/14/2010	Tues	7:53 AM	1	1	1	1	24	10/7/2009	Wed	2:34 PM	1	1	1	1
11	1/8/2011	Sat	5:22 PM	1	1	1	2	25	10/9/2009	Fri	11:00 AM	1	1	1	1
12	5/4/2011	Wed	3:42 PM	1	1	1	1	26	11/25/2009	Wed	8:08 AM	1	1	1	1
13	5/26/2011	Thu	12:19 PM	1	1	1	1	27	10/30/2010	Sat	10:00 AM	5	1	1	1
14	8/1/2011	Mon	5:52 PM	1	1	1	1	28	5/13/2011	Fri	3:43 PM	1	1	1	1

COLLISION DIAGRAM -- RUFINA ST @ SILER RD, 2009-2011 (CONTINUED)



CRASH TYPE

REAR-END
ANGLE
HEAD-ON
TURNING MOVEMENT
BACKING
HIT FIXED OBJECT
SIDE SWIPE
OUT OF CONTROL
OVERTURNED
PEDESTRIAN/ BICYCLE
PARKED VEHICLE

EPDO:

1 = Property Damage Only
5 = Injury
10 = Fatality

ROAD SURFACE (R/S):

1 = Dry
2 = Wet
3 = Snowy
4 = Icy
5 = Unknown

WEATHER CONDITIONS (W/C):

1 = Clear
2 = Foggy
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5 = Snow
6 = Sleet
7 = Unknown

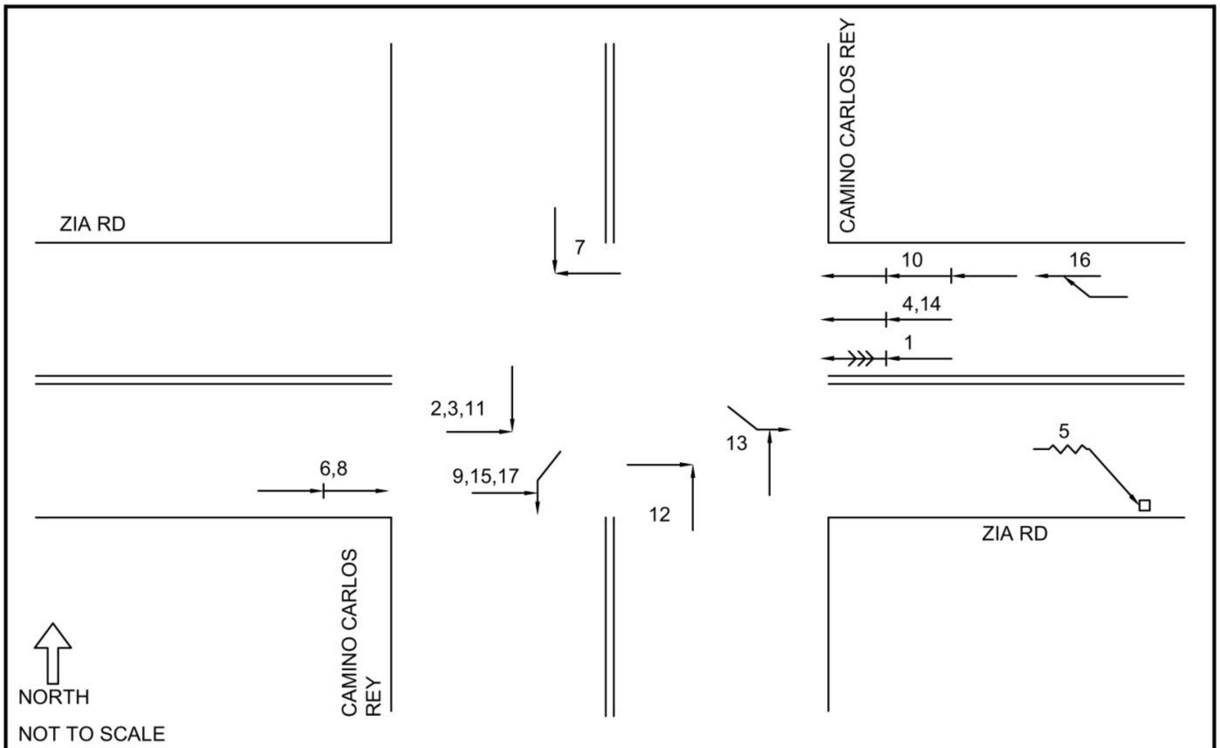
LIGHT CONDITIONS (L/C):

1 = Daylight
2 = Dawn or Dusk
3 = Darkness - Road Lighted
4 = Darkness - Road Unlighted
5 = Unknown

* Indicates Alcohol Involvement

#	DATE	DAY	TIME	EPDO	R/S	W/C	L/C	#	DATE	DAY	TIME	EPOD	R/S	W/C	L/C
29	7/26/2011	Tues	12:32 PM	1	1	1	1								
30	10/7/2011	Fri	5:05 PM	1	2	4	1								

COLLISION DIAGRAM -- CAMINO CARLOS REY @ ZIA RD, 2009-2010



CRASH TYPE

- REAR-END
- ANGLE
- HEAD-ON
- TURNING MOVEMENT
- BACKING
- HIT FIXED OBJECT
- SIDE SWIPE
- OUT OF CONTROL
- OVERTURNED
- PEDESTRIAN/ BICYCLE
- PARKED VEHICLE

EPDO:

1 = Property Damage Only
5 = Injury
10 = Fatality

ROAD SURFACE (R/S):

1 = Dry
2 = Wet
3 = Snowy
4 = Icy
5 = Unknown

WEATHER CONDITIONS (W/C):

1 = Clear
2 = Foggy
3 = Cloudy
4 = Rain
5 = Snow
6 = Sleet
7 = Unknown

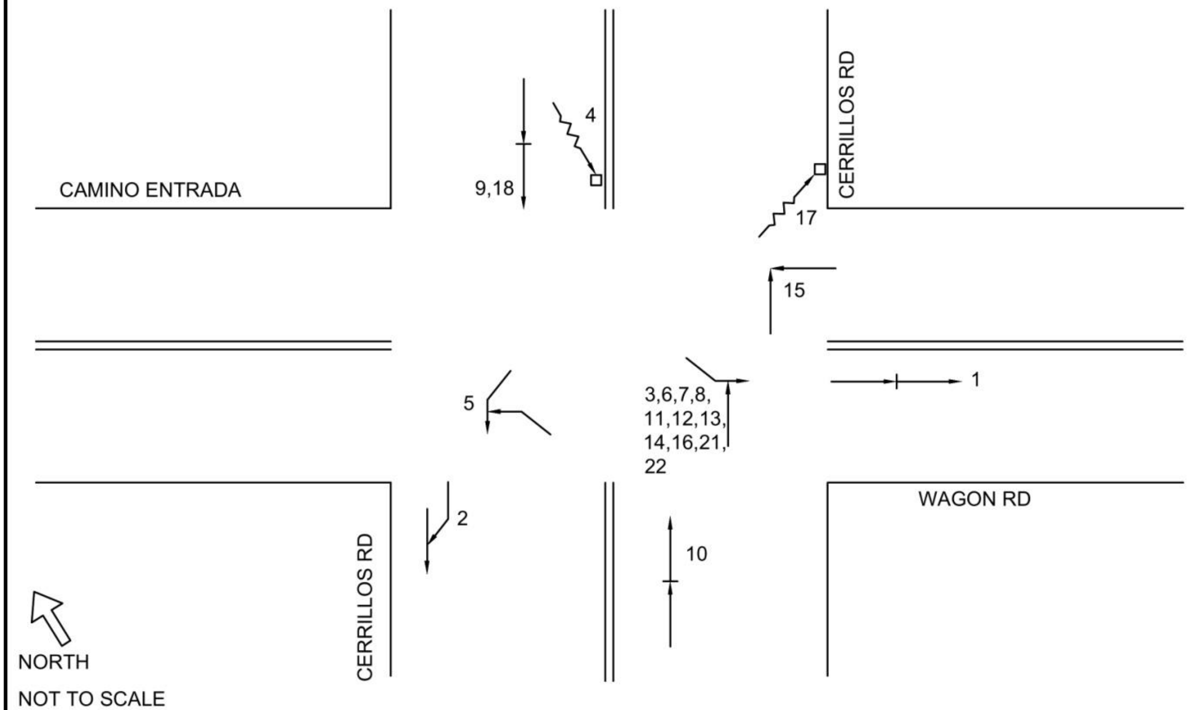
LIGHT CONDITIONS (L/C):

1 = Daylight
2 = Dawn or Dusk
3 = Darkness - Road Lighted
4 = Darkness - Road Unlighted
5 = Unknown

* Indicates Alcohol Involvement

#	DATE	DAY	TIME	EPDO	R/S	W/C	L/C	#	DATE	DAY	TIME	EPOD	R/S	W/C	L/C
1	1/26/2009	Mon	5:21 PM	1	1	1	2	15	3/2/2010	Tues	6:20 PM	5	1	1	3
2	5/29/2009	Sat	4:16 PM	1	2	1	1	16	3/29/2010	Mon	3:55 PM	1	1	1	1
3	2/28/2009	Sat	8:01 AM	1	1	1	1	17	10/4/2010	Mon	4:05 PM	5	1	7	5
4	9/23/2009	Wed	3:35 PM	1	1	1	1								
5	1/4/2009	Sun	10:35 AM	1	4	5	1								
6	1/28/2009	Wed	11:18 AM	5	1	4	1								
7	2/2/2009	Mon	2:29 PM	5	1	1	1								
8	4/14/2009	Tues	12:51 PM	1	7	1	1								
9	10/14/2009	Wed	9:26 AM	1	1	1	1								
10	8/27/2009	Thu	4:14 PM	1	4	1	1								
11	2/16/2009	Mon	8:27 PM	1	1	1	3								
12	5/8/2010	Sat	10:35 PM	1	1	1	3								
13	10/31/2010	Sun	4:32 PM	1	1	1	1								
14	12/8/2010	Wed	11:51 AM	1	1	1	1								

COLLISION DIAGRAM -- CERRILLOS RD @ WAGON RD, 2009-2011



CRASH TYPE

REAR-END
ANGLE
HEAD-ON
TURNING MOVEMENT
BACKING
HIT FIXED OBJECT
SIDE SWIPE
OUT OF CONTROL
OVERTURNED
PEDESTRIAN/ BICYCLE
PARKED VEHICLE

EPDO:

1 = Property Damage Only
5 = Injury
10 = Fatality

ROAD SURFACE (R/S):

1 = Dry
2 = Wet
3 = Snowy
4 = Icy
5 = Unknown

WEATHER CONDITIONS (W/C):

1 = Clear
2 = Foggy
3 = Cloudy
4 = Rain
5 = Snow
6 = Sleet
7 = Unknown

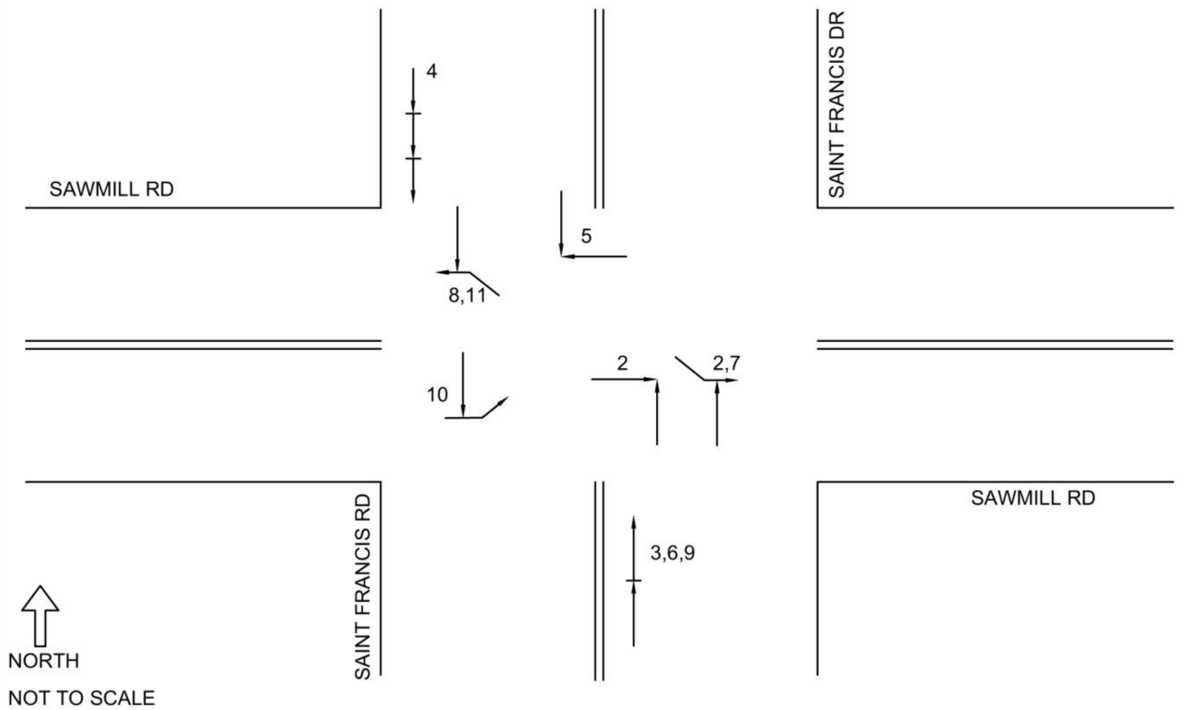
LIGHT CONDITIONS (L/C):

1 = Daylight
2 = Dawn or Dusk
3 = Darkness - Road Lighted
4 = Darkness - Road Unlighted
5 = Unknown

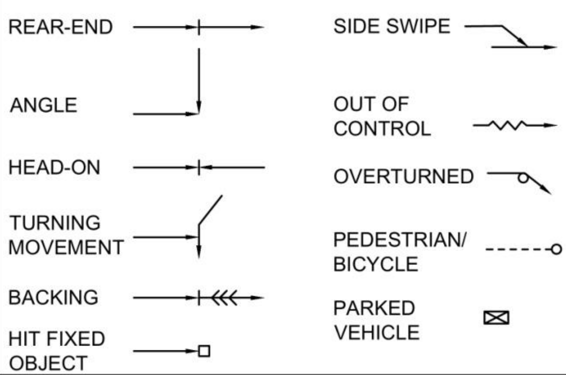
* Indicates Alcohol Involvement

#	DATE	DAY	TIME	EPDO	R/S	W/C	L/C	#	DATE	DAY	TIME	EPOD	R/S	W/C	L/C
1	10/8/2009	Thu	2:07 PM	1	1	1	1	15	9/28/2010	Tues	3:38 PM	5	1	1	1
2	2/27/2009	Fri	6:37 PM	1	1	1	3	16	11/6/2010	Sat	12:57 PM	5	1	1	1
3	11/3/2010	Wed	7:49 PM	5	1	1	3	17	2/3/2011	Thu	9:42 AM	1	4	1	1
4	12/28/2010	Tues	5:23 PM	1	1	1	3	18	3/16/2011	Wed	6:50 PM	1	1	1	1
5	3/15/2009	Sun	2:54 PM	1	1	1	1	19	4/4/2011	Mon	6:59 PM	1	1	1	1
6	5/24/2009	Sun	11:30 AM	1	1	1	1	20	4/10/2011	Sun	1:04 PM	1	1	1	1
7	7/14/2009	Tues	12:30 AM	1*	1	1	4	21	6/26/2011	Sun	10:40 PM	1	1	1	3
8	7/19/2009	Sun	12:21 AM	1	1	1	3	22	9/17/2011	Sat	3:20 PM	5	1	1	1
9	8/21/2009	Fri	10:28 PM	1	1	1	3								
10	12/18/2009	Fri	8:43 AM	1	1	1	1								
11	4/21/2010	Wed	8:06 AM	5	1	1	1								
12	7/26/2010	Mon	9:29 PM	1	1	1	3								
13	8/21/2010	Sat	3:59 PM	1	1	1	1								
14	9/20/2010	Mon	1:22 PM	5	1	1	1								

COLLISION DIAGRAM -- SAWMILL RD @ SAINT FRANCIS DR, 2010



CRASH TYPE



EPDO:

1 = Property Damage Only
5 = Injury
10 = Fatality

ROAD SURFACE (R/S):

1 = Dry
2 = Wet
3 = Snowy
4 = Icy
5 = Unknown

WEATHER CONDITIONS (W/C):

1 = Clear
2 = Foggy
3 = Cloudy
4 = Rain
5 = Snow
6 = Sleet
7 = Unknown

LIGHT CONDITIONS (L/C):

1 = Daylight
2 = Dawn or Dusk
3 = Darkness - Road Lighted
4 = Darkness - Road Unlighted
5 = Unknown

* Indicates Alcohol Involvement

#	DATE	DAY	TIME	EPDO	R/S	W/C	L/C
1	3/11/2010	Thu	5:41 AM	1	4	5	3
2	6/14/2010	Mon	11:45 PM	1	1	1	3
3	9/21/2010	Tues	4:25 PM	1	1	1	1
4	11/16/2010	Wed	5:32 PM	5	1	1	4
5	1/1/2010	Fri	12:25 PM	1	1	1	3
6	3/6/2010	Sat	11:19 AM	1	1	1	1
7	3/18/2010	Thu	10:01 AM	1	1	1	1
8	5/7/2010	Fri	10:18 AM	1	1	1	1
9	7/14/2010	Wed	7:58 AM	1	1	1	1
10	8/18/2010	Wed	10:56 AM	1	1	1	1
11	11/23/2010	Tues	6:26 PM	1	1	1	3

#	DATE	DAY	TIME	EPOD	R/S	W/C	L/C

Appendix J: Top 142 Most Hazardous Intersections

Rank	INTERSECTION	AADT	STUDY LENGTH	TOTAL # OF CRASHES	TOTAL EPDO	MEVcrash	MEVedpo
1	COTTONWOOD AVE @ AGUA FRIA ST NM 588	4997	6	24	52	2.1930967	4.7517095
2	5TH ST @ SIRINGO RD	5977	6	20	52	1.5279271	3.9726104
3	BECKNER ROAD @ CERRILLOS RD	29470	6	80	256	1.2395758	3.9666427
4	SIRINGO RD @ YUCCA ST	18539	6	45	121	1.1083931	2.9803459
5	ST FRANCIS DR US 84/285 @ CERRILLOS RD	72209	6	215	463	1.3595839	2.9278482
6	JEMEZ RD @ RUFINA ST	4395	6	11	27	1.1429812	2.8054994
7	RICHARDS AVE @ CERRILLOS RD	52210	6	133	309	1.1631985	2.7024687
8	OLD PECOS TRAIL @ OLD LAS VEGAS HWY	25838	6	58	150	1.0250225	2.6509202
9	BERRY AVE @ 5TH ST	4685	6	7	27	0.6822512	2.6315405
10	ST MICHAELS DR @ PACHECO ST	36805	6	75	207	0.9304997	2.5681791
11	NM 599 @ AIRPORT RD NM 284	16541	6	37	93	1.0214	2.5673027
12	SAWMILL RD @ ST FRANCIS DR US 84/285	33853	6	80	188	1.0790837	2.5358467
13	SAN MATEO RD @ ST FRANCIS DR US 84/285	47160	6	104	256	1.0069781	2.4787154
14	ST MICHAELS DR @ ST FRANCIS DR US 84/28	41356	6	92	224	1.0157929	2.473235
15	SILER PARK LN @ SILER RD	11289	6	19	60	0.7685179	2.4268988
16	COUNTRY CLUB RD @ AIRPORT RD NM 284	21191	6	34	110	0.732645	2.3703221
17	SIRINGO RD @ ST FRANCIS DR US 84/285	50804	6	100	261	0.8987895	2.3458405
18	RODEO RD NM 300 @ CERRILLOS RD	67636	6	152	337	1.0261753	2.2751387
19	ZAFARINO DR @ CERRILLOS RD	48187	6	123	239	1.1655505	2.2647689
20	BACA ST @ CERRILLOS RD	37004	6	70	182	0.8637959	2.2458693
21	RICHARDS AVE @ RODEO RD NM 300	35346	6	63	167	0.8138836	2.1574375
22	ST FRANCIS DR US 84/285 @ ZIA RD	66400	6	133	313	0.9146243	2.1524616
23	ZEPOL RD @ AIRPORT RD NM 284	29553	6	50	134	0.7725459	2.0704231
24	SILER RD @ RUFINA ST	23158	6	45	105	0.8872936	2.0703517
25	CORDOVA RD @ ST FRANCIS DR US 84/285	57714	6	100	260	0.7911858	2.057083
26	CERRILLOS RD @ OSAGE AVE	62619	6	131	279	0.9552664	2.0344988
27	WAGON RD @ CERRILLOS RD	40458	6	73	177	0.8239099	1.9976993
28	CAMINO CARLOS REY @ ZIA RD	25546	6	43	111	0.7686169	1.9841041
29	BARCELONA RD @ DON GASPAR AVE	6915	6	10	30	0.6603341	1.9810022
30	ALARID ST @ CERRILLOS RD	5415	6	11	23	0.927663	1.9396589
31	JEMEZ RD @ AIRPORT RD NM 284	24575	6	35	103	0.6503249	1.9138134
32	GUADALUPE ST @ PASEO DE PERALTA	26530	6	54	110	0.9294208	1.8932646
33	AGUA FRIA ST NM 588 @ AVENIDA CRISTOBA	16536	6	24	68	0.6627301	1.8777351
34	SAWMILL RD @ RODEO RD NM 300	15501	6	27	63	0.795353	1.8558237
35	VEGAS VERDES DR @ CERRILLOS RD	46018	6	74	187	0.7342849	1.8555577
36	LLANO ST @ SIRINGO RD	17218	6	28	68	0.7425594	1.8033586
37	CAMINO CONSUELO @ CERRILLOS RD	40409	6	67	159	0.7570988	1.7966973
38	PASEO DEL SOL @ AIRPORT RD NM 284	20999	6	26	82	0.5653672	1.7830812
39	RUFINA ST @ LOPEZ LN	18251	6	29	69	0.7255498	1.7263081
40	CATRON ST @ GUADALUPE ST	15063	6	23	55	0.6972239	1.6672745
41	W. FRONTAGE RD @ NM 599	13307	6	15	47	0.5147345	1.6128349
42	5TH ST @ ST MICHAELS DR	30865	6	45	109	0.6657361	1.6125608
43	RODEO RD @ ZAFARANO	39185	6	54	138	0.6292675	1.6081282
44	GUADALUPE ST @ PASEO DE PERALTA	34740	6	58	122	0.7623604	1.6035856
45	CALLE DEL CIELO @ CERRILLOS RD	45459	6	67	159	0.6730008	1.5971213
46	RUFINA ST @ RICHARDS AVE	19222	6	27	67	0.6413884	1.5915933
47	SAN MATEO RD @ PACHECO ST	13899	6	19	47	0.6242256	1.5441369
48	GALISTEO ST @ ST MICHAELS DR	32158	6	35	108	0.4969754	1.5335241
49	OCATE RD @ CERRILLOS RD	5958	6	8	20	0.6131713	1.5329283
50	GUADALUPE ST @ CERRILLOS RD	35990	6	60	120	0.761257	1.5225141
51	SILER RD @ CERRILLOS RD	50347	6	79	164	0.7164888	1.4873944
52	RUFINA ST @ CALLE ATAJO	8691	6	12	28	0.6304743	1.4711067
53	CORDOVA RD @ GALISTEO ST	18414	6	18	58	0.4463548	1.4382545
54	LOPEZ LN @ AIRPORT RD NM 284	8280	6	10	26	0.5514746	1.4338341
55	FIESTA ST @ PASEO DE PERALTA	16590	6	16	52	0.4403819	1.4312412
56	CONSTELLATION DR @ AIRPORT RD NM 284	11738	6	20	36	0.7780218	1.4004393
57	CAMINO CARLOS REY @ SIRINGO RD	18030	6	27	55	0.6837919	1.3929093
58	ALAMEDA @ ST FRANCIS DR US 84/285	53246	6	70	162	0.6002981	1.3892612
59	ARROYO CHAMISO RD @ ST MICHAELS DR	27954	6	29	85	0.4737071	1.3884519
60	2ND ST @ CERRILLOS RD	36304	6	62	110	0.7798285	1.3835666
61	GUADALUPE ST @ SABINO ST	15928	6	16	48	0.4586851	1.3760553
62	ALAMO DR @ ST FRANCIS DR US 84/285	35398	6	37	105	0.4772862	1.3544609
63	PASEO DE PERALTA @ ST FRANCIS DR US 8	51609	6	51	148	0.4512328	1.3094598
64	COLUMBIA ST @ ST FRANCIS DR US 84/285	7364	6	9	21	0.5580648	1.3021512
65	CAMINO CARLOS REY @ CERRILLOS RD	48987	6	59	139	0.5499549	1.2956564
66	SOUTH MEADOWS ROAD @ AIRPORT RD NM	27554	6	38	78	0.6297306	1.292605
67	ZAFARANO @ DAMINO DE LAS ARROYOS	14260	6	23	39	0.7364855	1.2488232
68	CERRILLOS RD @ PASEO DE PERALTA	37788	6	50	102	0.6041878	1.2325432
69	ZIA RD @ YUCCA ST	29567	6	31	79	0.4787517	1.2200446
70	PASEO DE PERALTA @ ST FRANCIS DR US 8	53848	6	55	143	0.4663897	1.2126133

70	PASEO DE PERALTA @ ST FRANCIS DR US 8	53848	6	55	143	0.4663897	1.2126133
71	JAGUAR RD. @ CERRILLOS RD	47757	6	54	126	0.5163125	1.2047291
72	HOSPITAL DR @ ST MICHAELS DR	28974	6	30	75	0.4727904	1.1819761
73	PASEO DE PERALTA @ OLD SANTA FE TR	33676	6	41	85	0.5559289	1.1525355
74	ARMENTA ST @ OLD PECOS TRAIL	21382	6	20	52	0.4271079	1.1104804
75	AVENIDA DE LAS AMERICAS @ CERRILLOS R	44470	6	39	103	0.4004547	1.0576111
76	PACHECO ST @ ALTA VISTA ST	12864	6	9	29	0.3194643	1.029385
77	YUCCA ST @ RODEO RD NM 300	20409	6	14	46	0.3132368	1.0292068
78	LUJAN ST @ CERRILLOS RD	49879	6	54	110	0.494347	1.0070032
79	CAMINO CARLOS REY @ RODEO RD NM 300	25920	6	21	57	0.3699476	1.0041434
80	PACHECO ST @ SIRINGO RD	13243	6	13	29	0.4482592	0.9999629
81	HENRY LYNCH RD @ AGUA FRIA ST NM 588	13418	6	13	29	0.4424127	0.9869207
82	RODEO RD NM 300 @ OLD PECOS TRAIL	30584	6	23	64	0.3433914	0.9555239
83	GRIFFIN ST @ PASEO DE PERALTA	22528	6	15	47	0.3040356	0.952645
84	CALLE LORCA @ ST MICHAELS DR	39352	6	34	82	0.3945191	0.9514872
85	ALAMEDA @ GUADALUPE ST	24555	6	22	50	0.4091086	0.9297923
86	OSAGE AVE @ AGUA FRIA ST NM 588	19897	6	20	40	0.4589963	0.9179926
87	MONTEZUMA AVE @ GUADALUPE ST	13499	6	15	27	0.5073943	0.9133097
88	ALTA VISTA ST @ ST FRANCIS DR US 84/285	57095	6	58	114	0.4638588	0.9117225
89	AGUA FRIA ST NM 588 @ LOPEZ LN	15991	6	19	31	0.5425596	0.8852288
90	PASEO DE PERALTA @ DELGADO ST	25807	6	22	50	0.3892611	0.8846844
91	ROSINA ST @ OSAGE DR	14898	6	8	28	0.2451986	0.8581949
92	ISLETA AVE @ CERRILLOS RD	12303	6	7	23	0.2598022	0.853636
93	ST MICHAELS DR @ PLAZA DEL SUR	14550	6	11	27	0.3452236	0.8473671
94	CAMINO CORRALES @ OLD SANTA FE TR	13612	6	9	25	0.3019093	0.8386369
95	AIRPORT RD NM 284 @ CALLE ATAJO	33079	6	27	59	0.3727068	0.8144333
96	CORDOVA RD @ CERRILLOS RD	34408	6	40	60	0.5308312	0.7962468
97	GOVERNER RD @ RICHARDS AVE	19826	6	14	34	0.3224481	0.7830882
98	RODEO RD NM 300 @ ZIA RD	28870	6	21	49	0.3321513	0.7750196
99	AGGIE RD @ CERRILLOS RD	14637	6	11	23	0.3431599	0.7175161
100	HICKOX ST @ AGUA FRIA ST NM 588	17621	6	11	27	0.2850561	0.6996832
101	MANHATTAN AVE @ CERRILLOS RD	16981	6	10	26	0.268909	0.6991635
102	DON DIEGO AVE @ CORDOVA RD	17635	6	15	27	0.3883933	0.6991079
103	SABINO ST @ PASEO DE PERALTA	15693	6	8	24	0.2327843	0.698353
104	AVENIDA LAS CAMPANAS @ RODEO RD NM	32730	6	18	50	0.2511206	0.6975573
105	GALISTEO RD @ RODEO RD NM 300	17704	6	11	27	0.2837116	0.6963831
106	PASEO DE LOS PUEBLOS @ RODEO RD NM 3	28405	6	14	42	0.2250552	0.6751657
107	PASEO DE LOS PUEBLOS @ RODEO RD NM 3	29102	6	18	42	0.2824266	0.6589953
108	ALAMEDA @ OLD SANTA FE TR	19042	6	11	27	0.2637764	0.6474513
109	CAMINO TIERRA REAR @ AIRPORT RD NM 2	19439	6	7	27	0.1644296	0.6342285
110	ST MICHAELS DR @ LLANO ST	32667	6	24	44	0.3354784	0.6150437
111	CLARK RD @ CERRILLOS RD	42106	6	19	55	0.2060466	0.5964507
112	CALLE LUCIA @ AIRPORT RD NM 284	22568	6	9	29	0.1820981	0.5867604
113	ALAMEDA @ DE FOURI ST	16200	6	8	20	0.2254919	0.5637296
114	GRANT AVE @ PASEO DE PERALTA	26279	6	16	32	0.2780195	0.556039
115	MIMBERS LN @ RODEO RD NM 300	30760	6	17	37	0.2523588	0.5492515
116	CAMINO ALIRE @ AGUA FRIA ST NM 588	20456	6	8	24	0.1785768	0.5357305
117	MERCER ST @ ST FRANCIS DR US 84/285	43525	6	18	50	0.1888381	0.5245503
118	ZIA RD @ OLD PECOS TRAIL	31592	6	8	36	0.1156295	0.5203329
119	SAN FELIPE AVE @ CERRILLOS RD	33321	6	8	36	0.1096312	0.4933406
120	OLD SANTA FE TR @ ST MICHAELS DR	26309	6	6	26	0.1041384	0.4512666
121	DON GASPAR AVE @ PASEO DE PERALTA	23405	6	10	22	0.1950997	0.4292193
122	MAEZ RD @ CERRILLOS RD	46871	6	15	43	0.1461312	0.4189094
123	SAN MATEO RD @ OLD PECOS TRAIL	31359	6	15	27	0.2184162	0.3931492
124	CAMINO CARLOS REY @ CERRILLOS RD	48987	6	16	40	0.1491403	0.3728508
125	HARRISON RD @ CERRILLOS RD	27006	6	6	22	0.1014488	0.3719789
126	AGUA FRIA ST NM 588 @ ST FRANCIS DR US	50415	6	17	41	0.1539747	0.3713507
127	CERRILLOS RD @ 5TH ST	36090	6	13	29	0.1644797	0.3669163
128	APACHE AVE @ CERRILLOS RD	26970	6	9	21	0.1523763	0.3555447
129	SAN FRANCISCO ST @ GUADALUPE ST	26123	6	8	20	0.1398372	0.3495931
130	WASHINGTON AVE @ PASEO DE PERALTA	27596	6	13	21	0.2151102	0.3474857
131	ZIA RD @ GALISTEO ST	29474	6	9	21	0.139431	0.325339
132	CAMINO DE LOS MARQUEZ @ CORDOVA RD	33677	6	15	23	0.2033856	0.3118579
133	LA MADERA RD @ AGUA FRIA ST NM 588	39338	6	6	26	0.0696458	0.3017984
134	MARQUEZ PL @ DON DIEGO AVE	31805	6	13	21	0.1866426	0.3014995
135	CRISTOS RD @ CERRILLOS RD	33887	6	8	20	0.1077985	0.2694963
136	ST FRANCIS DR US 84/285 @ ST MICHAELS D	34637	6	8	20	0.1054643	0.2636608
137	JEMEZ RD @ AGUA FRIA ST NM 588	40867	6	7	23	0.0782134	0.2569869
138	SANDOVAL ST @ ALAMEDA	42782	6	10	22	0.1067333	0.2348132
139	CHAMA AVE @ CERRILLOS RD	39833	6	4	20	0.0458541	0.2292706
140	ROYBAL ST @ ST FRANCIS DR US 84/285	42155	6	8	20	0.0866556	0.2166391
141	LLANO ST @ ST MICHAELS DR	45171	6	9	21	0.0909785	0.2122831
142	6TH ST @ ST MICHAELS DR	49187	6	4	21	0.0371335	0.1949507

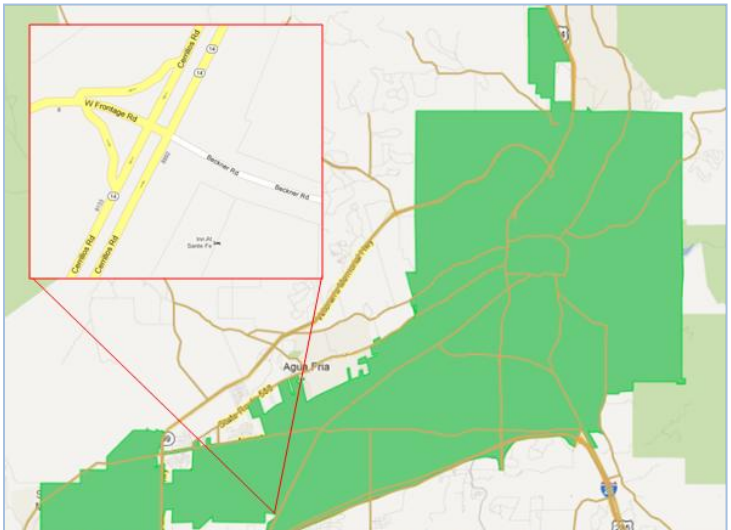
Appendix K: Overview of Suggested Countermeasures

Intersection	Crash Pattern	Countermeasure
5th St. & Berry Ave.	Angle crashes, failure to yield	Improve signage by adding "Cross Traffic Does Not Stop" sign
Cerrillos Rd. & Beckner Rd.	Rear-ends going southbound	Improve sightlines by trimming shrubbery, remove raised median
Agua Fria St. & Cottonwood Dr.	Angle crashes between southbound and left turn	Improve sightlines by removing bus stop and shrubbery, road diet, signalize intersection
Siringo Rd. & Yucca St.	Rear-ends going northbound	Remove right turn lane
Saint Michaels Rd. & Pacheco St.	Rear-ends	Backplates with retroreflective boarders, increase yellow signal timing
Baca St. & Cerrillos Rd.	Rear-ends going west	Backplates with retroreflective boarders, increase yellow signal timing
Airport Rd. & Country Club Rd	Rear-ends	Backplates with retroreflective boarders, increase yellow signal timing
Siler Park Ln. & Siler Rd.	Angle crashes	Road diet
Cerrillos Rd. & Zafarano Dr.	Rear-ends	Backplates with retroreflective boarders, increase yellow signal timing
Rodeo Rd. & Richards Ave.	Rear-ends	Backplates with retroreflective boarders, increase yellow signal timing
Rufina St. & Siler Rd.	Rear-ends	Backplates with retroreflective boarders, increase yellow signal timing
Camino Carlos Rey & Zia Rd.	Rear-ends, angle crashes	Backplates with retroreflective boarders, increase yellow signal timing, changed left turn from Protected/Permissive to Protected
Cerrillos Rd. & Wagon Rd.	Angle crashes between northbound and left turn	Improve sightlines by trimming shrubbery, remove raised median
Sawmill Rd. & Saint Francis Dr.	Rear-ends	Backplates with retroreflective boarders, increase yellow signal timing

Appendix L: Crash Patterns and Appropriate Safety Improvements

Cerrillos Rd. & Beckner Rd. Intersection Analysis

Intersection Description and Crash Characteristics



Rank	AADT	Total Crashes	Expected Crashes	Total EPDO	MEV_{CRASH}	MEV_{EPDO}
2	31134	80	>24	256	1.17	3.75

Figure 45—Cerrillos Rd. & Beckner Rd.

The intersection between Cerrillos Rd. and Beckner Rd.—shown in Figure 45—is a 4 way, signalized intersection. Cerrillos Rd. runs from north to south, while Beckner Rd. turns into West Frontage Rd. west of the intersection. At the northbound entrance to the intersection, Cerrillos Rd. has three lanes of through traffic and a left turn lane. It also has three lanes of through traffic and a left turn lane at the southbound entrance, but it has a right turn lane as well. Beckner Rd. has one lane of through traffic as well as left and right turn lanes. West Frontage Rd. has two through lanes and a right turn lane. Each approaching road has a Protected/Permissive left turn, which means that the left turn lane is protected and has the right of way for a short time before it must yield to incoming traffic. Figure 46 displays the contributing factors obtained from the crash data for this intersection.

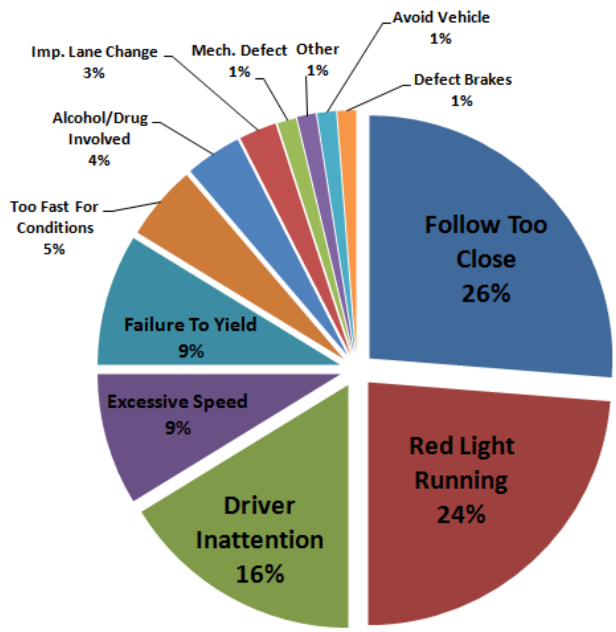


Figure 46—Cerrillos Rd. & Beckner Rd. contributing factors

Crash Patterns and Observations

A collision diagram was created for this intersection, which can be found in Appendix I. This diagram was created using crash data from 2010, provided by the Santa Fe Police Department. The collision diagram showed that almost 60% of the crashes that occurred at this intersection were rear-end crashes. While the majority of these rear-ends occurred on the southbound segment of Cerrillos Rd., they also happened on the northbound segment of Cerrillos Rd. and West Frontage Rd. Figure 47 displays the most commonly occurring crash type on an aerial image of the actual intersection, while Figure 48 displays each approach to the intersection.

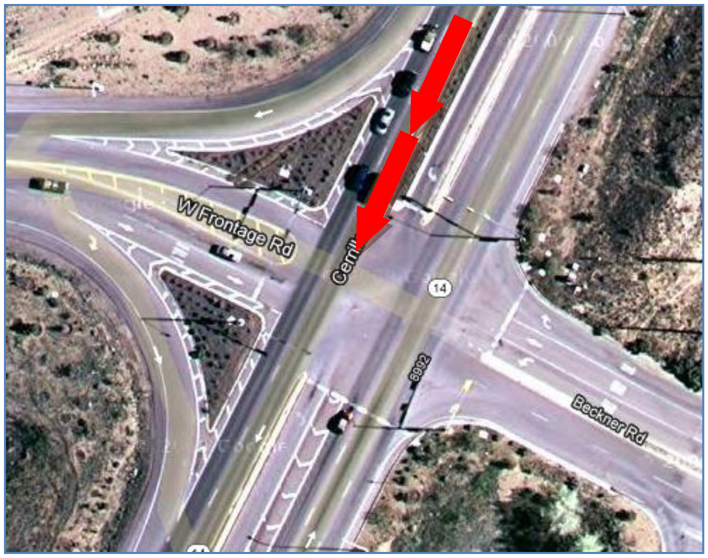


Figure 47—Cerrillos Rd. & Beckner Rd. with most commonly occurring crash type

Figure 48—Views from approaching roads

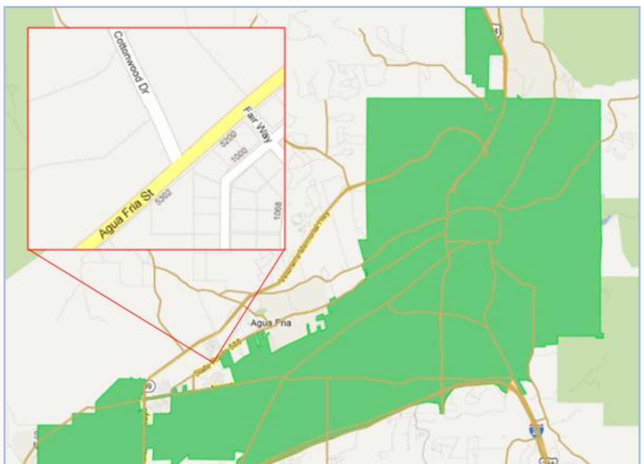
Intersection Conclusions and Recommendations

The combination of this data has led to the conclusion that these crashes are occurring because there is a sightline issue for drivers traveling southbound on Cerrillos Rd. After consulting further with the city's traffic engineering department, the sightline issue appears to be caused by the left turn lane of northbound Cerrillos Rd. It is believed that when a car is idle in the left turn lane of southbound Cerrillos Rd. and a car is also idle in the left turn lane of northbound Cerrillos Rd, the southbound vehicle cannot sufficiently view the through traffic on northbound Cerrillos Rd., leading them to pull out in front of oncoming traffic.

Pending future engineering analysis, one potential solution would be to improve the sightline issue by trimming shrubbery in the median of northbound Cerrillos Rd. The implications of this solution are obvious as it would improve driver's sight of northbound traffic on Cerrillos Rd. Another possible solution that could be adopted alongside shrubbery trimming would be to shift the left turn lanes out of sync. This would involve removing the median between the left turn lane and trough traffic lane going both northbound and southbound on Cerrillos Rd. This solution would allow drivers to see around each other as they sit in the left turn lane waiting to turn. The adoption of these two improvements has the potential to decrease the number of crashes at this intersection.

Agua Fria St. & Cottonwood Dr. Intersection Analysis

Intersection Description and Crash Characteristics



Rank	AADT	Total Crashes	Expected Crashes	Total EPDO	MEV_{CRASH}	MEV_{EPDO}
3	31134	24	>2	52	1.47	3.18

Figure 49—Agua Fria St. & Cottonwood Dr.

The intersection between Agua Fria St. and Cottonwood Dr.—shown in Figure 49— is an unsignalized T intersection, with Agua Fria St. being the major road. Agua Fria St. has one lane of travel in each direction, with a right turn lane going westbound and a left turn lane going eastbound. Cottonwood Dr. has one lane of travel in each direction as well, and splits into left and right turn lanes as it approaches the intersection. Because they are on the minor road in the T junction, drivers on Cottonwood Dr. must yield to drivers on Agua Fria St. Figure 50 displays the contributing factors obtained from the crash data for this intersection.

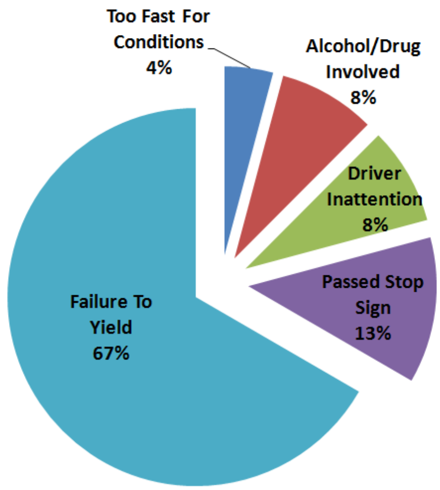


Figure 50—Agua Fria St. & Cottonwood Dr. contributing factors

Crash Patterns and Observations

A collision diagram was created for this intersection, which can be found in Appendix I. This diagram was created using crash data from 2006-2011, provided by the NMDOT. This diagram showed that about 70% of the crashes were angle crashes that occurred between vehicles traveling west on Agua Fria St. and vehicles turning left out of Cottonwood Dr. Figure 51 displays the most commonly occurring crash type on an aerial image of the actual intersection, while Figure 52 displays the sightlines of vehicles traveling west on Agua Fria St., south on Cottonwood Dr., and of vehicles turning left out of Cottonwood Dr.

Figure 51—Agua Fria St. & Cottonwood Ave. with most commonly occurring crash type

Figure 52—Views from approaching roads

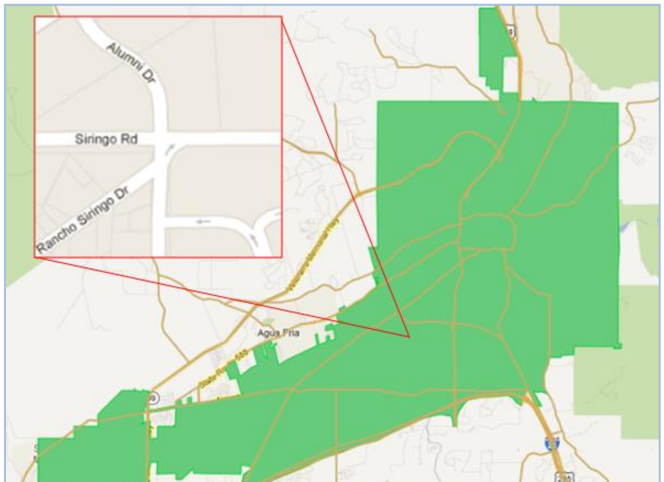
Intersection Conclusions and Recommendations

The combination of this data has led to the conclusion that these crashes are occurring because drivers turning left onto Agua Fria St. from Cottonwood Dr. cannot clearly see traffic approaching from Agua Fria St. This lack of visibility is most likely due to several factors, the first being automobiles turning right into Cottonwood Dr. from Agua Fria St. Vehicles sitting in the right turn lane on Agua Fria St. waiting to turn block the line of sight for vehicles leaving Cottonwood Dr. The location of the Santa Fe Trails bus stop and the foliage around it also limits this sightline. The result is that drivers on Cottonwood Dr. must either pull into the intersection in order to see westbound traffic, or must attempt to make the turn without a good understand of the location of incoming traffic. Both the collision diagrams and the contributing factors support this theory.

Pending further engineering analysis, a number of countermeasures are recommended. One such improvement would be the relocation of the bus stop and the removal of the foliage surrounding it. This would improve the line of sight for drivers traveling westbound on Agua Fria St. and drivers pulling out of Cottonwood Dr. Another solution would be to introduce road dieting by removing the right turn lane in the westbound segment of Agua Fria St. This would eliminate the problem of vehicles in the right turn lane blocking the line of site for vehicles trying to turn out of Agua Fria St. The final option would be to consider signalizing the intersection, which could potentially solve the problem all together by giving the vehicles at Cottonwood Dr. a chance to safely turn either way onto Agua Fria St. Each of these improvements has the potential to decrease the number of crashes at this intersection.

Siringo Rd. & Yucca St. Intersection Analysis

Intersection Description and Crash Characteristics



Rank	AADT	Total Crashes	Expected Crashes	Total EPDO	MEV_{CRASH}	MEV_{EPDO}
8	21300	45	>14	121	0.96	2.59

Figure 53—Siringo Rd. & Yucca St.

The intersection between Siringo Rd. and Yucca St.—shown in Figure 53—is a 4 way, signalized intersection. Siringo Rd. runs from east to west, while Yucca St. approaches from the south and then changes into Alumni Dr. north of the intersection. Both the westbound and eastbound approaches to the intersection have a left turn lane and a through lane. The southbound approach from Alumni Dr. also has a left turn lane and a through lane, while the northbound approach from Yucca St. has a through lane, a right turn lane, and a left turn lane. Each approach except the northbound approach have Protected/Permissive left turns, which means that the left turn lane is protected and has the right of way for a short time before it must yield to incoming traffic. Figure 54 displays the contributing factors obtained from the crash data for this intersection.

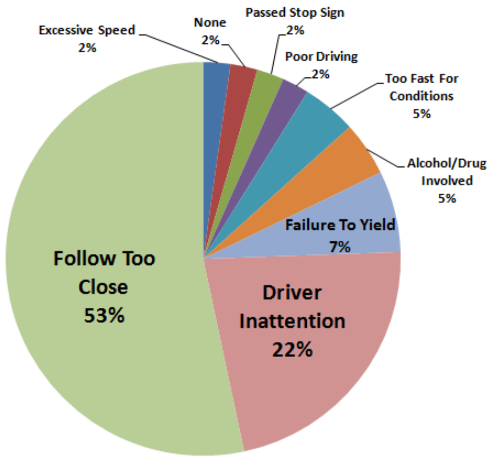


Figure 54—Siringo Rd. & Yucca St. contributing factors

Crash Patterns and Observations

A collision diagram was created for this intersection, which can be found in Appendix I. This diagram was created using crash data from 2010, provided by the Santa Fe Police Department. The collision diagram showed that 75% of the crashes the occurred at this intersection were rear-end crashes, with the majority of happening on northbound Yucca St. Figure 55 displays the most commonly occurring crash type on an aerial image of the actual intersection, while Figure 56 displays the northbound approach to the intersection.

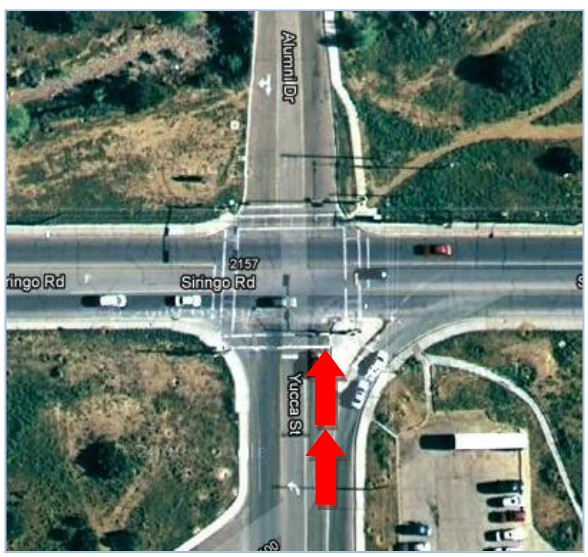


Figure 55—Siringo Rd. & Yucca St.

Figure 56—View from approaching road

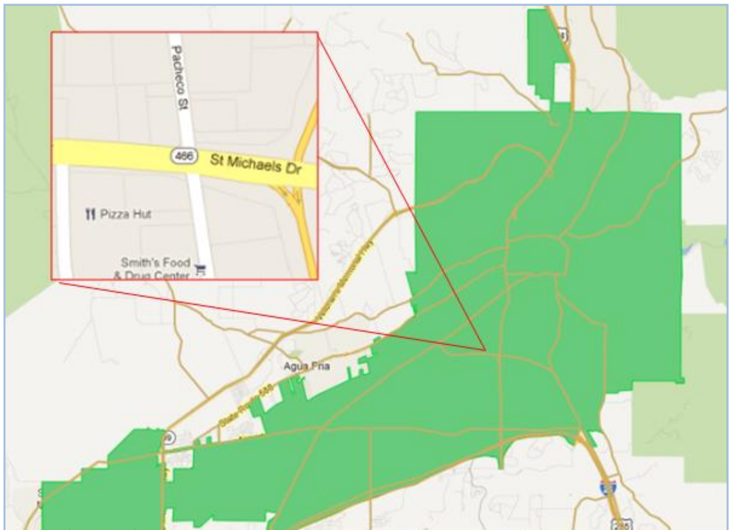
Intersection Conclusions and Recommendations

The combination of this data has led to the conclusion that these crashes are occurring because drivers are either unaware that the automobiles in front of them are stopped, or because they are slowing down suddenly for the light and crashing into the automobiles in front of them. About 50% of all the crashes are contributed to either driver inattention, drivers following too closely, or excessive speed, which all contribute heavily to rear-end crashes.

Pending future engineering analysis, one potential solution would be to remove the right turn lane ramp going northbound, because it is not a true right turn lane ramp. A right turn lane like that should turn into its own lane, which later merges with the rest of the westbound lanes. However, in this case the lane simply turns to the center lane. This makes it difficult for drivers to turn right, because they still have to yield for cross traffic. It is likely that drivers are trying to enter the lane then stopping and getting hit from the car behind them. Replacing the current turn lane with a true right turn lane has the potential to decrease the number of crashes at this intersection.

Saint Michaels Dr. & Pacheco St. Intersection Analysis

Intersection Description and Crash Characteristics



Rank	AADT	Total Crashes	Expected Crashes	Total EPDO	MEV_{CRASH}	MEV_{EPDO}
9	36805	75	>38	207	0.93	2.57

Figure 57—Saint Michaels Rd. & Pacheco St.

The intersection between Saint Michaels Dr. & Pacheco St.—shown in Figure 57—is a 4 way, signalized intersection. Saint Michaels Dr. runs from east to west, while Pacheco St. runs from north to south and turns into S. Pacheco St. south of the intersection. At the northbound entrance to the intersection, Pacheco St. has one lane of through traffic, a left turn lane, and a right turn lane. It also has one lane of through traffic, a left turn lane, and a right turn lane at the southbound entrance. At the westbound entrance of the intersection, Saint Michaels Dr. has a left turn lane and three lanes of through traffic, one of which also serves as a right turn lane. At the eastbound entrance of the intersection, Saint Michaels Dr. also has a left turn lane and three lanes of through traffic, one of which also serves as a right turn lane. Each approaching road has a Protected/Permissive left turn, which means that the left turn lane is protected and has the right of way for a short time before it must yield to incoming traffic. Figure 58 displays the contributing factors obtained from the crash data for this intersection.

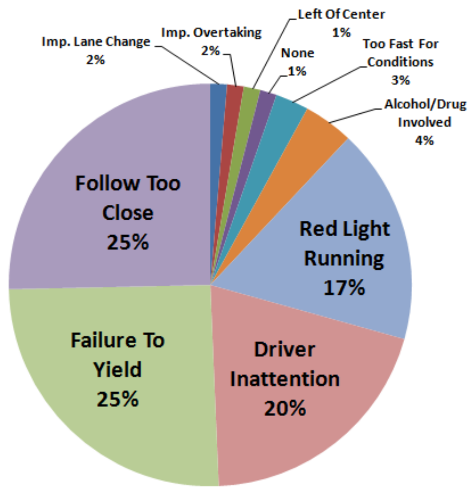


Figure 58—Saint Michaels Dr. & Pacheco St. contributing factors

Crash Patterns and Observations

A collision diagram was created for this intersection, which can be found in Appendix I. This diagram was created using crash data from 2010, provided by the Santa Fe Police Department. The collision diagram showed the most commonly occurring crash type at this intersection was rear-end crashes. While the majority of these rear-ends occurred on the westbound segment of Saint Michaels Dr., they also happened on the eastbound segment. Figure 59 displays the most commonly occurring crash type on an aerial image of the actual intersection, while Figure 60 displays each approach to the intersection.

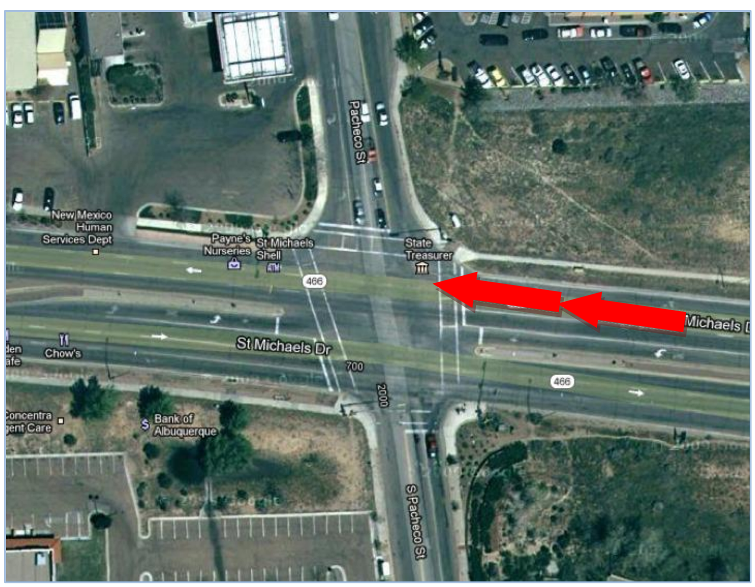


Figure 59—Saint Michaels Dr. & Pacheco St. with most commonly occurring crash type

Figure 60—Views from approaching roads

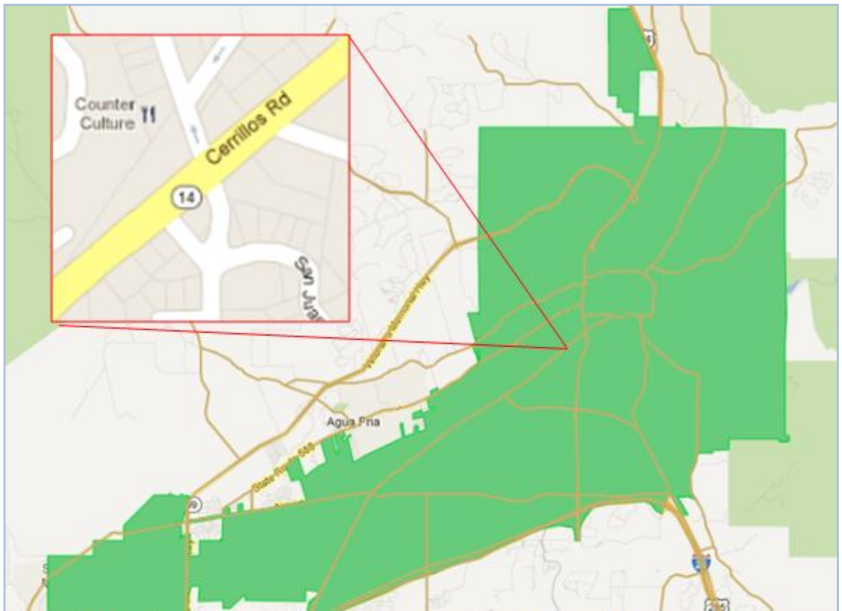
Intersection Conclusions and Recommendations

The combination of this data has led to the conclusion that these crashes are occurring because drivers are either unaware that the automobiles in front of them are stopped, or because they are slowing down suddenly for the light and crashing into the automobiles in front of them. These crashes are contributed to drivers following too closely, which contributes heavily to rear-end crashes.

Pending future engineering analysis, one potential solution would be to add backplates with retroreflective borders to the traffic signals. This simple addition would increase the contrast between the signal and the background, thus increasing the visibility of the signal. This would decrease the number of crashes that occur due to drivers failing to notice the red light quickly enough. Another recommended improvement that could be adopted alongside the backplates would be to increase the time that the traffic signal is yellow. Increasing the time would allow drivers more time to react to the change and decelerate smoother, decreasing the chance that they will be rear-ended by the car behind them. The adoption of these two improvements has the potential to decrease the number of crashes at this intersection.

Baca St. & Cerrillos Rd. Intersection Analysis

Intersection Description and Crash Characteristics



Rank	AADT	Total Crashes	Expected Crashes	Total EPDO	MEV_{CRASH}	MEV_{EPDO}
10	34320	70	>34	182	0.93	2.42

Figure 61—Baca St. & Cerrillos Rd.

The intersection between Cerrillos Rd. and Baca St.—shown in Figure 61—is a 4 way, signalized intersection. Cerrillos Rd. runs from west to east, while Baca St. turns into Monterey Dr. south of the intersection. At the northbound entrance to the intersection, Baca St. has one lane of through traffic. Monterey Dr. has one lane of through traffic and a left turn lane at the southbound entrance, but it has a right turn lane as well. Cerrillos Rd. has two through lanes and a left turn lane at both entrances, but it has a right turn lane as well. Each approaching road has a Protected/Permissive left turn, which means that the left turn lane is protected and has the right of way for a short time before it must yield to incoming traffic. Figure 62 displays the contributing factors obtained from the crash data for this intersection.

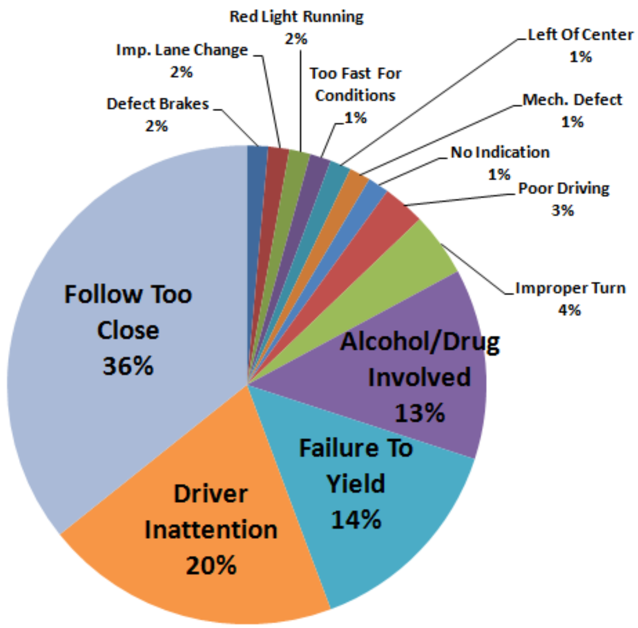


Figure 62—Baca St. & Cerrillos Rd. contributing factors

Crash Patterns and Observations

A collision diagram was created for this intersection, which can be found in Appendix I. This diagram was created using crash data from 2010, provided by the Santa Fe Police Department. The collision diagram showed that 60% of the crashes that occurred at this intersection were rear-end crashes. While the majority of these rear-ends occurred on the westbound segment of Cerrillos Rd., they also happened on the southbound segment of Baca St. and eastbound segment of Cerrillos Rd. Figure 63 displays the most commonly occurring crash type on an aerial image of the actual intersection, while Figure 64 displays each approach to the intersection.

Figure 63—Baca St. & Cerrillos Rd. with most commonly occurring crash

Figure 64—Views from approaching roads

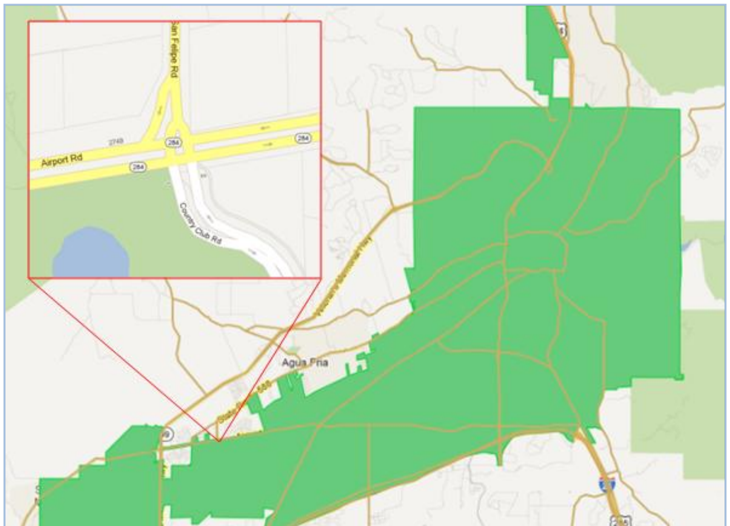
Intersection Conclusions and Recommendations

The combination of this data has led to the conclusion that these crashes are occurring because drivers are either unaware that the automobiles in front of them are stopped, or because they are slowing down suddenly for the light and crashing into the automobiles in front of them. About 50% of all the crashes are contributed to either driver inattention, drivers following too closely, or excessive speed, which all contribute heavily to rear-end crashes.

Pending future engineering analysis, one potential solution would be to add backplates with retroreflective borders to the traffic signals. This simple addition would increase the contrast between the signal and the background, thus increasing the visibility of the signal. This would decrease the number of crashes that occur due to drivers failing to notice the red light quickly enough. Another recommended improvement that could be adopted alongside the backplates would be to increase the time that the traffic signal is yellow. Increasing the time would allow drivers more time to react to the change and decelerate smoother, decreasing the chance that they will be rear-ended by the car behind them. The adoption of these two improvements has the potential to decrease the number of crashes at this intersection.

Airport Rd. & Country Club Rd. Intersection Analysis

Intersection Description and Crash Characteristics



Rank	AADT	Total Crashes	Expected Crashes	Total EPDO	MEV_{CRASH}	MEV_{EPDO}
11	21191	34	>14	110	0.73	2.37

Figure 65—Airport Rd. & Country Club Rd.

The intersection between Airport Rd. and Country Club Rd.—shown in Figure 65—is a 4 way, signalized intersection. Airport Rd. runs both east and west, while Country Club Dr. turns into San Felipe Rd. north of the intersection. Both Country Club Rd. and Felipe Rd. have one lane in each direction, and then expand to include left and right turn lanes as they approach the intersection. Airport Rd. has two lanes of traffic in each direction, but as it approaches the intersection it changes to one lane of through traffic and right and left turn lanes to match Country Club Dr. and Felipe Rd. Each approaching road has a Protected/Permissive left turn, which means that the left turn lane is protected and has the right of way for a short time before it must yield to incoming traffic. Figure 66 displays the contributing factors obtained from the crash data for this intersection.

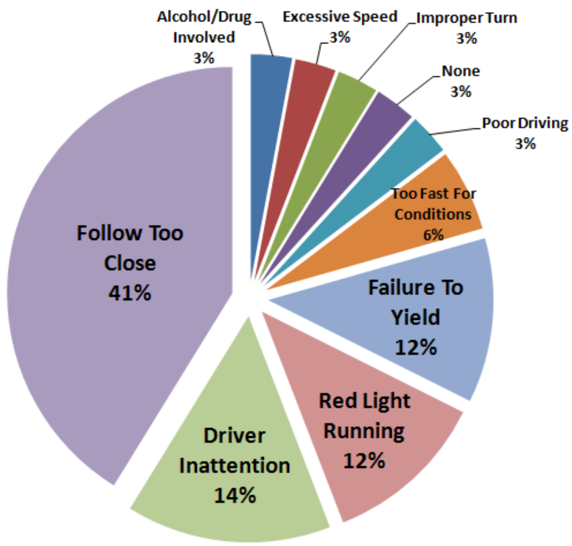


Figure 66—Airport Rd. & Country Club Rd. contributing factors

Crash Patterns and Observations

A collision diagram was created for this intersection, which can be found in Appendix I. This diagram was created using crash data from 2009-2011, provided by the Santa Fe Police Department. The collision diagram showed that almost 70% of the crashes that occurred at this intersection were rear-end crashes. These rear-ends were distributed evenly over three of the four approaching roads, with the southbound approach being the only road with no rear-ends. Figure 67 displays the most commonly occurring crash type on an aerial image of the actual intersection, while Figure 68 displays the northbound, westbound, and eastbound approaches.

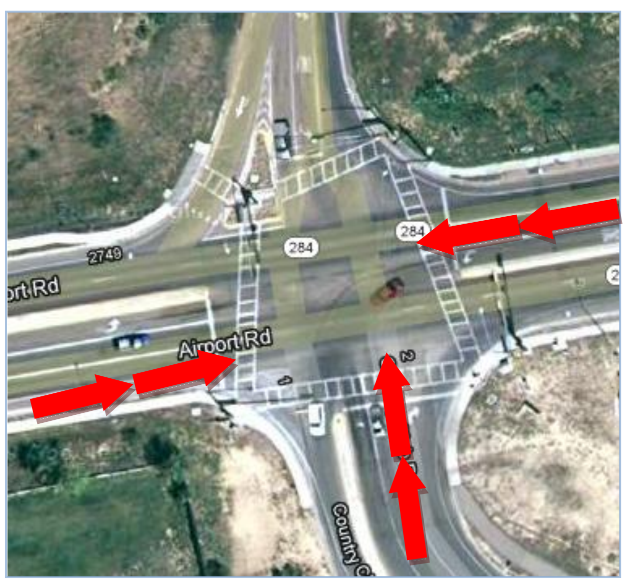


Figure 67—Airport Rd. & Country Club Rd. with most commonly occurring factors

Figure 68—Views from approaching roads

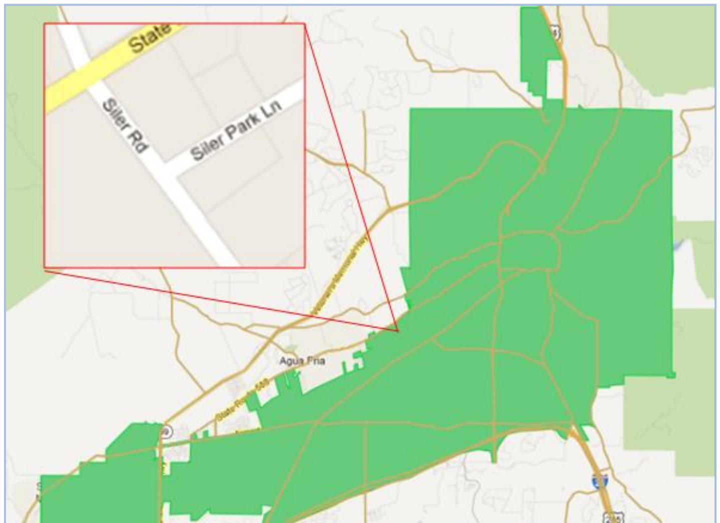
Intersection Conclusions and Recommendations

The combination of this data has led to the conclusion that these crashes are occurring because drivers are either unaware that the automobiles in front of them are stopped, or because they are slowing down suddenly for the light and crashing into the automobiles in front of them. More than 50% of all the crashes are contributed to either driver inattention or drivers following too closely.

Pending future engineering analysis, one potential solution would be to add backplates with retroreflective borders to the traffic signals. This simple addition would increase the contrast between the signal and the background, thus increasing the visibility of the signal. This would decrease the number of crashes that occur due to drivers failing to notice the red light quickly enough. Another recommended improvement that could be adopted alongside the backplates would be to increase the time that the traffic signal is yellow. Increasing the time would allow drivers more time to react to the change and decelerate smoother, decreasing the chance that they will be rear-ended by the car behind them. The adoption of these two improvements has the potential to decrease the number of crashes at this intersection.

Siler Park Ln. & Siler Rd. Intersection Analysis

Intersection Description and Crash Characteristics



Rank	AADT	Total Crashes	Expected Crashes	Total EPDO	MEV_{CRASH}	MEV_{EPDO}
13	12060	19	>5	60	0.72	2.27

Figure 69—Siler Park Ln. & Siler Rd.

The intersection between Siler Park Ln. and Siler Rd.—shown in Figure 69—is a 3 way, unsignalized T intersection. Siler Rd. runs east to west, while Siler Park Ln. runs north. Siler Rd. has two lanes of traffic in each direction, while Siler Park Ln. has a single lane. Because Siler Rd. is the major road in the T junction, drivers on Siler Park Ln. must yield to cross traffic. Figure 70 displays the contributing factors obtained from the crash data for this intersection.

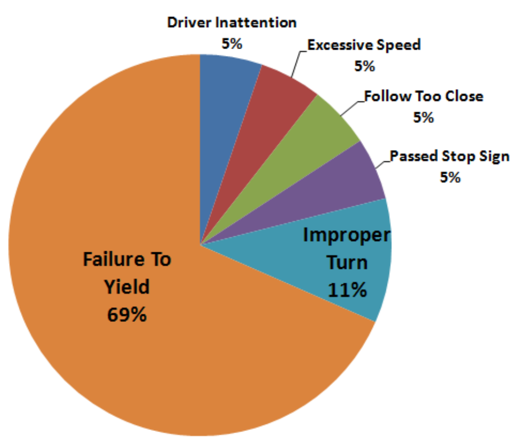


Figure 70—Siler Park Ln. & Siler Rd. contributing factors

5.2.8.2 Crash Patterns and Observations

A collision diagram was created for this intersection, which can be found in Appendix I. This diagram was created using data from 2008-2011, provided by the Santa Fe Police Department.

The collision diagram showed that over 75% of the crashes that occurred at this intersection were angle crashes, where drivers turning left out of Siler Park Ln. were being hit by drivers going west on Siler Rd. Figure 71 displays the most commonly occurring crash type on an aerial image of the actual intersection, while Figure 71 displays the southbound and westbound approaches to the intersection.

Figure 71—Siler Park Ln. & Siler Rd. with most commonly occurring crash type

Figure 72—Views from approaching roads

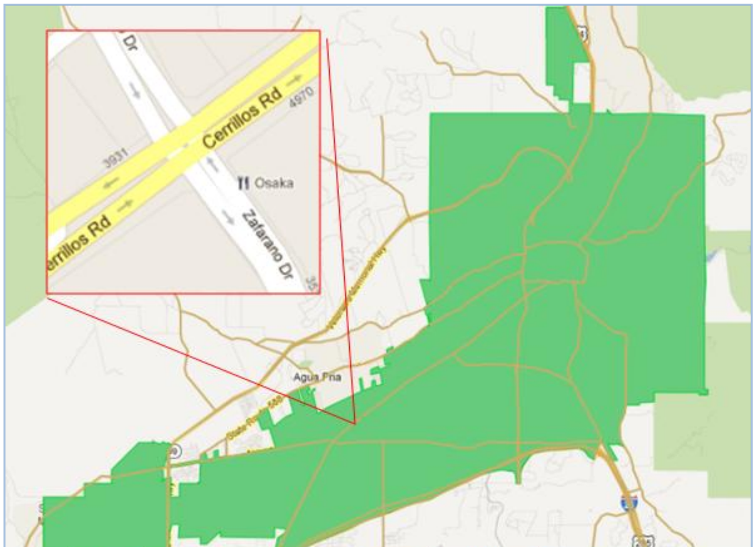
Intersection Conclusions and Recommendations

The combination of this data has led to the conclusion that these crashes are occurring because of the layout of the lanes on Siler Rd. Because there are two lanes in each direction on Siler Rd., drivers turning left from Siler Park Ln. must cross at least two or three lanes of traffic in order to complete the turn, increasing the likelihood of a crash.

Pending future engineering analysis, one potential solution would be to introduce road diet by remarking Siler Rd. so it only has one lane of traffic in each direction. In fact, the city of Santa Fe was already planning on making this change before this project came about. The introduction of road diet on Siler Rd. has the potential to decrease the number of crashes at this intersection.

Cerrillos Rd. & Zafarano Dr. Intersection Analysis

Intersection Description and Crash Characteristics



Rank	AADT	Total Crashes	Expected Crashes	Total EPDO	MEV_{CRASH}	MEV_{EPDO}
14	48187	123	>30	239	1.17	2.26

Figure 73—Cerrillos Rd. & Zafarano Dr.

The intersection between Cerrillos Rd. and Zafarano Dr.—shown in Figure 73—is a 4 way, signalized intersection. Cerrillos Rd. runs from north to south, while Zafarano Dr. runs from east to west. At the northbound entrance to the intersection, Cerrillos Rd. has two lanes of through traffic, two left turn lanes, and one right turn lane. Traveling southbound on Cerrillos Rd., the intersection hosts two through lanes, two left turn lanes, and one bicycle lane. Traveling eastbound on Zafarano Dr., the intersection hosts one through lane, two left turn lanes, and one right turn lane. Westbound on Zafarano Dr. also hosts a single through lane, two left turn lanes, and one right turn lane. Each approaching road has a Protected left turn, which means that the left turn lane is protected and has the right of way. Figure 74 displays the contributing factors obtained from the crash data for this intersection.

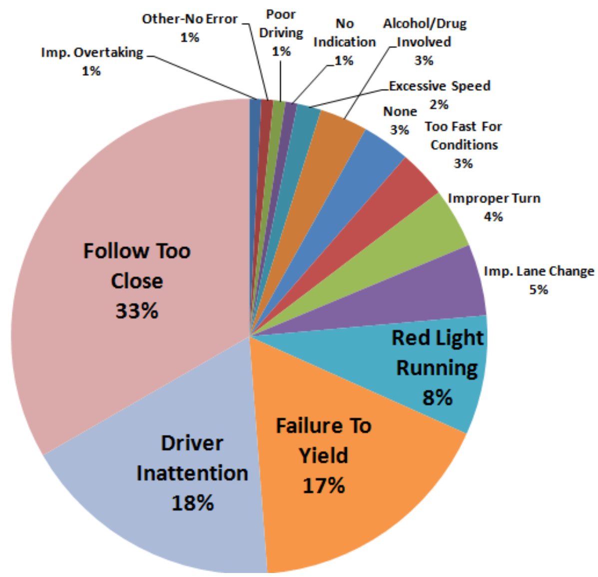


Figure 74—Cerrillos Rd. & Zafarano Dr. contributing factors

Crash Patterns and Observations

A collision diagram was created for this intersection, which can be found in Appendix I. This diagram was created using crash data from 2010, provided by the Santa Fe Police Department. The collision diagram showed that 60% of the crashes that occurred at this intersection were rear-end crashes. While the majority of these rear-ends occurred on the southbound segment of Cerrillos Rd., they also occurred on the other legs of the intersection. Figure 75 displays the most commonly occurring crash type on an aerial image of the actual intersection, while Figure 76 displays approaches to the intersection with the most crashes.

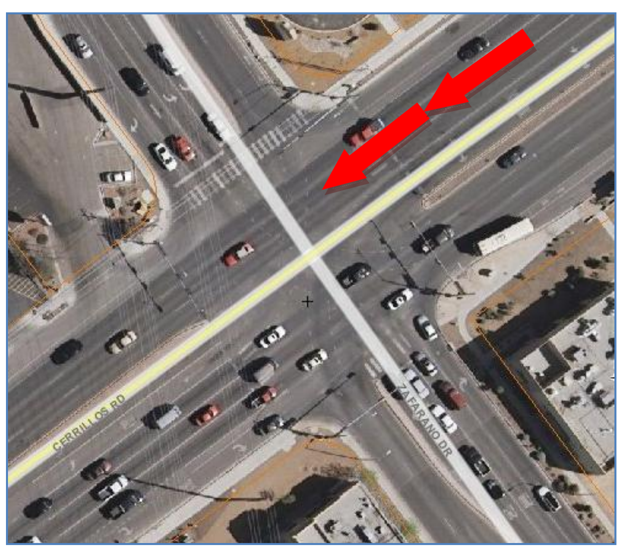


Figure 75—Cerrillos Rd. & Zafarano Dr. with most commonly occurring crash type

Figure 76—Views from approaching roads

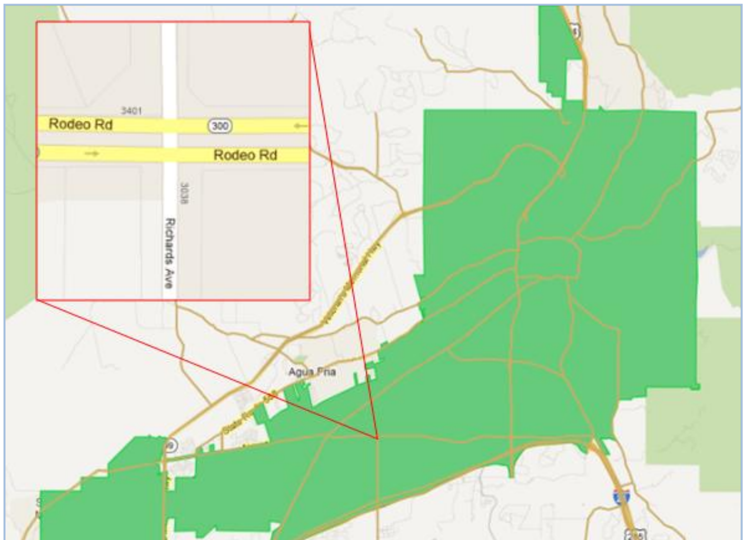
Intersection Conclusions and Recommendations

The combination of this data has led to the conclusion that these crashes are occurring because drivers are either unaware that the automobiles in front of them are stopped, or because they are slowing down suddenly for the light and crashing into the automobiles in front of them. Over 50% of all the crashes are contributed to either driver inattention, drivers following too closely, or excessive speed, which all contribute heavily to rear-end crashes.

Pending future engineering analysis, one potential solution would be to add backplates with retroreflective borders to the traffic signals. This simple addition would increase the contrast between the signal and the background, thus increasing the visibility of the signal. This would decrease the number of crashes that occur due to drivers failing to notice the red light quickly enough. Another recommended improvement that could be adopted alongside the backplates would be to increase the time that the traffic signal is yellow. Increasing the time would allow drivers more time to react to the change and decelerate smoother, decreasing the chance that they will be rear-ended by the car behind them. The adoption of these two improvements has the potential to decrease the number of crashes at this intersection.

Rodeo Rd. & Richards Ave. Intersection Analysis

Intersection Description and Crash Characteristics



Rank	AADT	Total Crashes	Expected Crashes	Total EPDO	MEV_{CRASH}	MEV_{EPDO}
16	34260	63	>26	167	0.84	2.23

Figure 77—Rodeo Rd. & Richards Ave.

The intersection between Rodeo Rd. and Richards Ave.—shown in Figure 77—is a 4 way, signalized intersection. Rodeo Rd. runs from east to west, while Richards Ave. runs from north to south. The westbound segment of Rodeo Rd. has two left turn lanes and two through lanes, while the eastbound approach has a right turn lane, a left turn lane, and two through lanes. The northbound segment of Richards Ave. has two left turn lanes and a single through lane, while the southbound approach has a left turn lane and two through lanes. The eastbound and southbound approaches to the intersection each have a Protected/Permissive left turn, which means that the left turn lane is protected and has the right of way for a short time before it must yield to incoming traffic. By contrast, the northbound and westbound approaches each have Protected left turns, which means that drivers in the left turn lane may only turn when they have the green arrow. Figure 78 displays the contributing factors obtained from the crash data for this intersection.

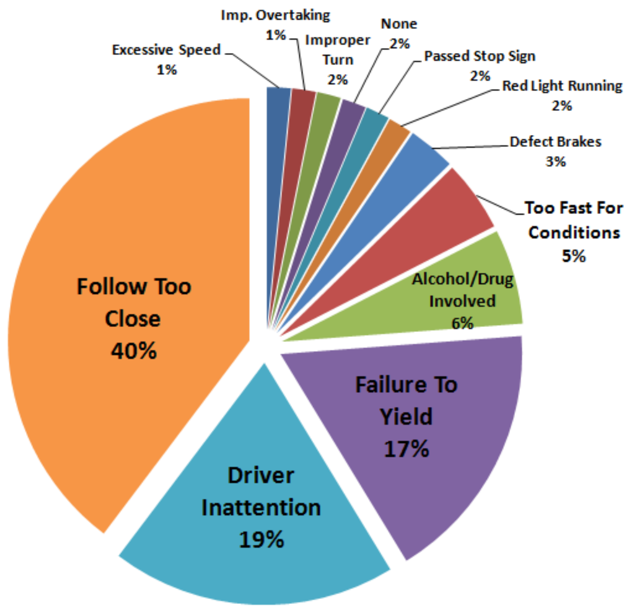


Figure 78—Rodeo Rd. & Richards Ave. contributing factors

Crash Patterns and Observations

A collision diagram was created for this intersection, which can be found in Appendix I. This diagram was created using crash data from 2010, provided by the Santa Fe Police Department. The collision diagram showed that over 60% of the crashes that occurred at this intersection were rear-end crashes, with the majority happening on the westbound approach to the intersection. Figure 79 displays the most commonly occurring crash type on an aerial image of the actual intersection, while Figure 80 displays the northbound, westbound, and eastbound approaches.

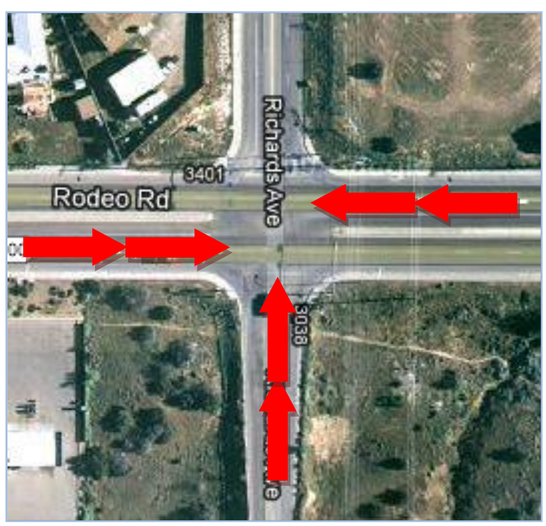


Figure 79—Rodeo Rd. & Richards Ave with most commonly occurring crash type

Figure 80—Views from approaching roads

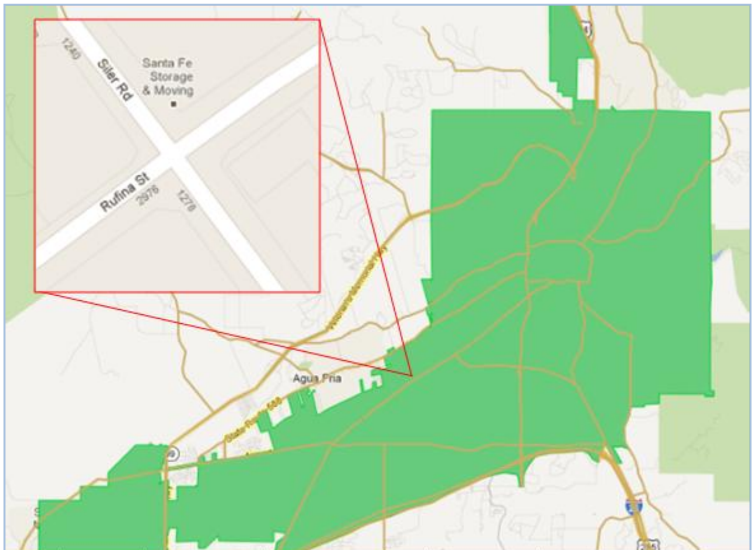
Intersection Conclusions and Recommendations

The combination of this data has led to the conclusion that these crashes are occurring because drivers are either unaware that the automobiles in front of them are stopped, or because they are slowing down suddenly for the light and crashing into the automobiles in front of them. More than 50% of all the crashes are contributed to either driver inattention or drivers following too closely.

Pending future engineering analysis, one potential solution would be to add backplates with retroreflective borders to the traffic signals. This simple addition would increase the contrast between the signal and the background, thus increasing the visibility of the signal. This would decrease the number of crashes that occur due to drivers failing to notice the red light quickly enough. Another recommended improvement that could be adopted alongside the backplates would be to increase the time that the traffic signal is yellow. Increasing the time would allow drivers more time to react to the change and decelerate smoother, decreasing the chance that they will be rear-ended by the car behind them. The adoption of these two improvements has the potential to decrease the number of crashes at this intersection.

Rufina St. & Siler Rd. Intersection Analysis

Intersection Description and Crash Characteristics



Rank	AADT	Total Crashes	Expected Crashes	Total EPDO	MEV_{CRASH}	MEV_{EPDO}
19	23158	45	>17	45	0.89	2.07

Figure 81—Rufina St. & Siler Rd.

The intersection between Rufina St. and Siler Rd.—shown in Figure 81—is a 4 way, signalized intersection. Rufina St. runs east to west, while Siler Rd. runs north to south. Both the eastbound and westbound segments of Rufina St. have a left turn lane and a through lane, while both segments of Siler Rd. have two lanes of through traffic. While Siler Rd. does not have designated left turn lanes, all four approaches to the intersection have Protected/Permissive left turn signal lighting, which means that the left turn is protected and has the right of way for a short time before it must yield to incoming traffic. Figure 82 displays the contributing factors obtained from the crash data for this intersection.

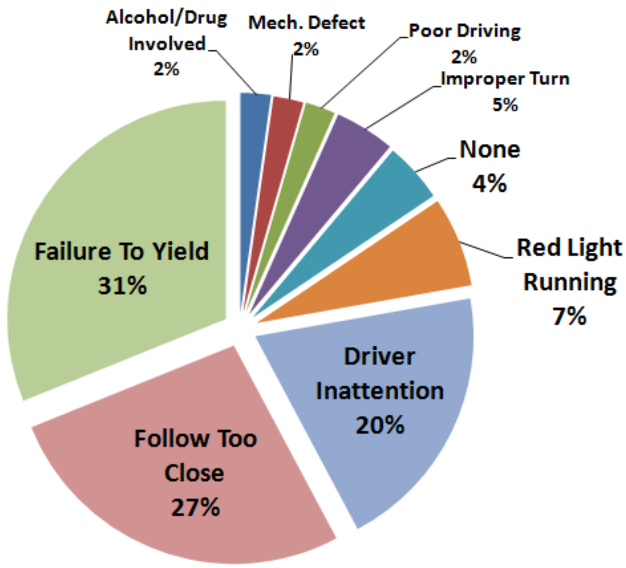


Figure 82—Rufina St. & Siler Rd. contributing factors

Crash Patterns and Observations

A collision diagram was created for this intersection, which can be found in Appendix I. This diagram was created using crash data from 2009-2011, provided by the Santa Fe Police Department. The collision diagram showed that over 50% of the crashes that occurred at this intersection were rear-end crashes, with the majority happening on the northbound approach to the intersection. Figure 83 displays the most commonly occurring crash type on an aerial image of the actual intersection, while Figure 84 displays the approaches to the intersection.

Figure 83—Rufina St. & Siler Rd. with most commonly occurring crash type

Figure 84—Views from approaching roads

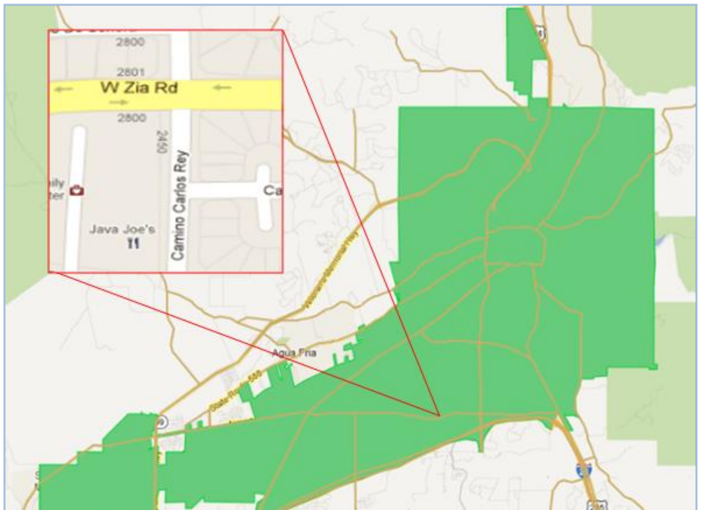
Intersection Conclusions and Recommendations

The combination of this data has led to the conclusion that these crashes are occurring because drivers are either unaware that the automobiles in front of them are stopped, or because they are slowing down suddenly for the light and crashing into the automobiles in front of them. More than 50% of all the crashes are contributed to either driver inattention or drivers following too closely.

Pending future engineering analysis, one potential solution would be to add backplates with retroreflective borders to the traffic signals. This simple addition would increase the contrast between the signal and the background, thus increasing the visibility of the signal. This would decrease the number of crashes that occur due to drivers failing to notice the red light quickly enough. Another recommended improvement that could be adopted alongside the backplates would be to increase the time that the traffic signal is yellow. Increasing the time would allow drivers more time to react to the change and decelerate smoother, decreasing the chance that they will be rear-ended by the car behind them. The adoption of these two improvements has the potential to decrease the number of crashes at this intersection.

Camino Carlos Rey & Zia Rd.

Intersection Description and Crash Characteristics



Rank	AADT	Total Crashes	Expected Crashes	Total EPDO	MEV_{CRASH}	MEV_{EPDO}
24	25546	43	>21	111	0.77	1.98

Figure 85—Camino Carlos Rey & Zia Rd.

The intersection between Camino Carlos Rey and Zia Rd.—shown in Figure 85— is a 4 way, signalized intersection. Camino Carlos Rey runs from north to south, while Zia Rd. runs from west to east. At the northbound entrance to the intersection, Camino Carlos Rey has one lane of through traffic and a left turn lane, but it has a right turn lane as well. It also has one lane of through traffic and a left turn lane at the southbound entrance. At the westbound entrance to the intersection, Zia Rd. has two lanes of through traffic and a left turn lane, but it has a right turn lane as well. It also has two lanes of through traffic and a left turn lane at the eastbound entrance as well as a right turn lane. Each approaching road has a Protected/Permissive left turn, which means that the left turn lane is protected and has the right of way for a short time before it must yield to incoming traffic. Figure 86 displays the contributing factors obtained from the crash data for this intersection.

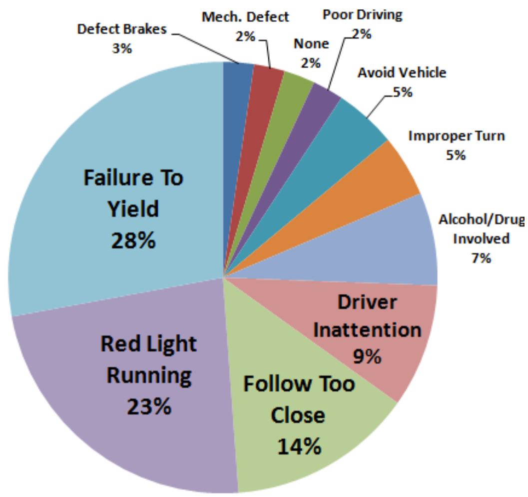


Figure 86—Camino Carlos Rey & Zia Rd.

Crash Patterns and Observations

A collision diagram was created for this intersection, which can be found in Appendix I. This diagram was created using crash data from 2010, provided by the Santa Fe Police Department. The collision diagram showed that 35% of the crashes that occurred at this intersection were rear-end crashes. While the majority of these rear-ends occurred on the eastbound segment of Zia Rd., they also happened on the westbound segment. Another common crash type that occurred at this intersection was angle crashes occurring between vehicles turning left from Zia Rd. onto Camino Carlos Rey and vehicles traveling westbound on Zia Rd. Vehicles traveling southbound on Camino Carlos Rey were also commonly hit by vehicles traveling eastbound on Zia Rd. Figure 87 displays the most commonly occurring crash type on an aerial image of the actual intersection, while Figure 88 displays the northbound and westbound approaches to the intersection.

Figure 87—Caino Carlos Rey & Zia Rd. with most commonly occurring crash

Figure 88—Views from approaching roads

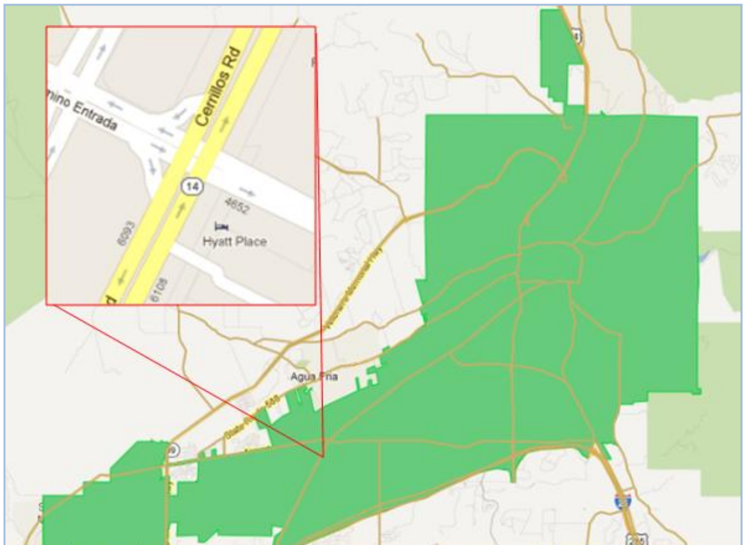
Intersection Conclusions and Recommendations

The combination of this data has led to the conclusion that these crashes are occurring because drivers are either unaware that the automobiles in front of them are stopped, or because they are slowing down suddenly for the light and crashing into the automobiles in front of them. About 50% of all the crashes are contributed to either driver inattention, drivers following too closely, or excessive speed, which all contribute heavily to rear-end crashes.

Pending future engineering analysis, one potential solution would be to add backplates with retroreflective borders to the traffic signals. This simple addition would increase the contrast between the signal and the background, thus increasing the visibility of the signal. This would decrease the number of crashes that occur due to drivers failing to notice the red light quickly enough. Another recommended improvement that could be adopted alongside the backplates would be to increase the time that the traffic signal is yellow. Increasing the time would allow drivers more time to react to the change and decelerate smoother, decreasing the chance that they will be rear-ended by the car behind them. One potential solution to the angle crashes would be to change the signals to Protected only instead of Protective/Permissive. This would prevent drivers from making risky turns across oncoming traffic by only allowing drivers to turn when there is a green arrow. The adoption of these three improvements has the potential to decrease the number of crashes at this intersection.

Cerrillos Rd. & Wagon Rd. Intersection Analysis

Intersection Description and Crash Characteristics



Rank	AADT	Total Crashes	Expected Crashes	Total EPDO	MEV_{CRASH}	MEV_{EPDO}
23	40458	73	>33	177	0.82	2.00

Figure 89—Cerrillos Rd. & Wagon Rd.

The intersection between Cerrillos Rd. and Wagon Rd.—shown in Figure 89—is a 4 way, signalized intersection. Cerrillos Rd. runs from north to south, while Wagon Rd. turns into Camino Entrada west of the intersection. At the northbound entrance to the intersection, Cerrillos Rd. has four lanes of through traffic and a left turn lane. It also has three lanes of through traffic and a left turn lane at the southbound entrance, while also including a right turn lane. Wagon Rd. has one lane of through traffic, one left turn lane, and one right turn lane. Camino Entrada has one through lanes and a right turn lane. Each approaching leg of Cerrillos Rd. and Wagon Rd. has a Protected/Permissive left turn, which means that the left turn lane is protected and has the right of way for a short time before it must yield to incoming traffic. Camino Entrada has a Permissive left turn lane, which means simply that the vehicle must yield to incoming traffic before executing a left turn maneuver. Figure 90 displays the contributing factors obtained from the crash data for this intersection.

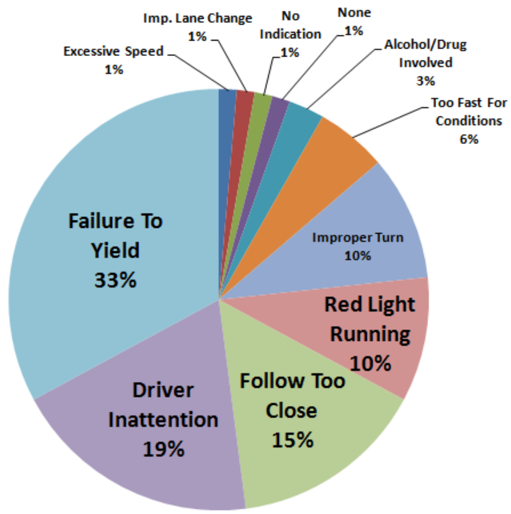


Figure 90—Cerrillos Rd. & Wagon Rd. contributing factors

Crash Patterns and Observations

A collision diagram was created for this intersection, which can be found in Appendix I. This diagram was created using crash data from 2009 to 2011, provided by the Santa Fe Police Department. The collision diagram showed that over 60% of the crashes that occurred at this intersection were angle crashes. The majority of these angle crashes occurred when vehicles traveling on southbound Cerrillos Rd. crossed northbound Cerrillos Rd. while turning left onto Wagon Rd. and were hit by vehicles traveling northbound on Cerrillos Rd. Figure 91 displays the most commonly occurring crash type on an aerial image of the actual intersection, while Figure 92 displays the northbound and southbound Cerrillos Rd. approaches to the intersection.

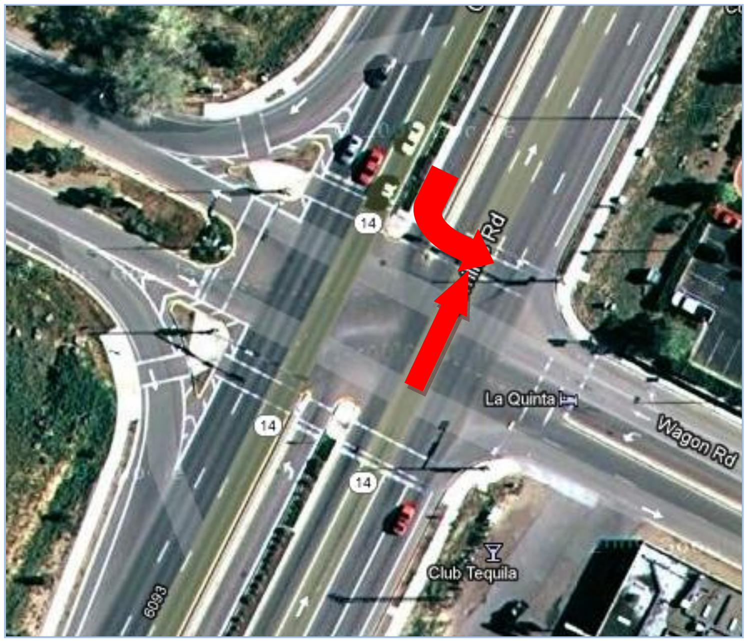


Figure 91—Cerrilos Rd. & Wagon Rd. with most commonly occurring crash type

Figure 92—Views from approaching road

Intersection Conclusions and Recommendations

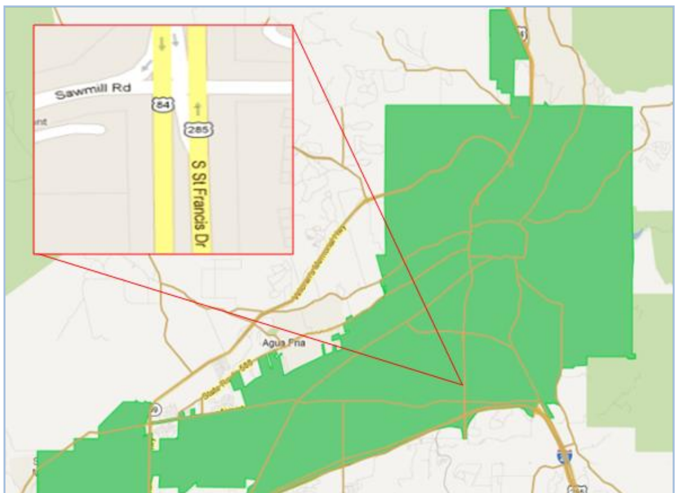
The combination of this data has led to the conclusion that these crashes are occurring because there is a sightline issue for drivers traveling southbound on Cerrillos Rd. After consulting further with the city's traffic engineering department, the sightline issue appears to be caused by the left turn lane of northbound Cerrillos Rd. It is believed that when a car is idle in the left turn lane of southbound Cerrillos Rd. and a car is also idle in the left turn lane of northbound Cerrillos Rd, the southbound vehicle cannot sufficiently view the through traffic on northbound Cerrillos Rd., leading them to pull out in front of oncoming traffic. Over 50% of all the crashes are contributed to either failure to yield or driver inattention, which contribute heavily to the described crash pattern.

Pending future engineering analysis, one potential solution would be to improve the sightline issue by trimming shrubbery in the median of northbound Cerrillos Rd. The implications of this solution are obvious as it would improve driver's sight of northbound traffic on Cerrillos Rd.

Another possible solution that could be adopted alongside shrubbery trimming would be to shift the left turn lanes out of sync. This would involve removing the median between the left turn lane and trough traffic lane going both northbound and southbound on Cerrillos Rd. This solution would allow drivers to see around each other as they sit in the left turn lane waiting to turn. The adoption of these two improvements has the potential to decrease the number of crashes at this intersection.

Sawmill Rd. & Saint Francis Dr. Intersection Analysis

Intersection Description and Crash Characteristics



Rank	AADT	Total Crashes	Expected Crashes	Total EPDO	MEV_{CRASH}	MEV_{EPDO}
25	43576	80	>24	188	0.84	1.97

Figure 93—Sawmill Rd. & Saint Francis Dr.

The intersection between Sawmill Rd. and Saint Francis Dr.—shown in Figure 93—is a 4 way, signalized intersection. Saint Francis Dr. runs from north to south, while Sawmill Rd. runs from east to west. At the northbound entrance to the intersection, Saint Francis Dr. has three lanes of through traffic and a left turn lane. It has two lanes of through traffic, a right turn lane, and a left turn lane at the southbound entrance. At the eastbound entrance, Sawmill Rd. has one lane of through traffic as well as two left turn lanes. At the westbound entrance, Sawmill Rd. has one lane of through traffic, a left turn lane, and a right turn lane. Each approaching road has a Protected/Permissive left turn, which means that the left turn lane is protected and has the right of way for a short time before it must yield to incoming traffic. Figure 94 displays the contributing factors obtained from the crash data for this intersection.

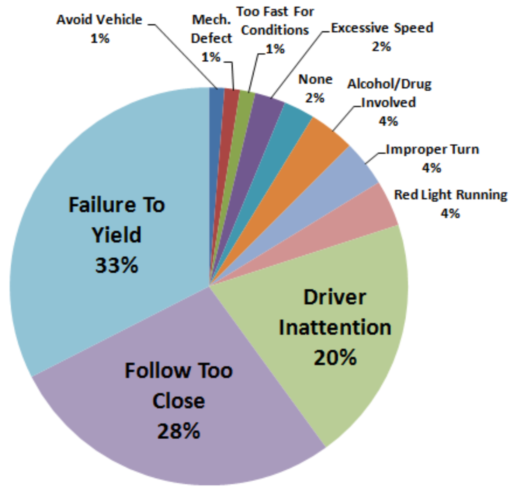


Figure 94—Sawmill Rd. & Saint Francis Dr. contributing factors

Crash Patterns and Observations

A collision diagram was created for this intersection, which can be found in Appendix I. This diagram was created using crash data from 2010, provided by the Santa Fe Police Department. The collision diagram showed that 36% of the crashes that occurred at this intersection were rear-end crashes. While the majority of these rear-ends occurred on the northbound segment of Saint Francis Dr., they also happened on the southbound segment. Figure 95 displays the most commonly occurring crash type on an aerial image of the actual intersection, while Figure 96 displays the northbound approach to the intersection.

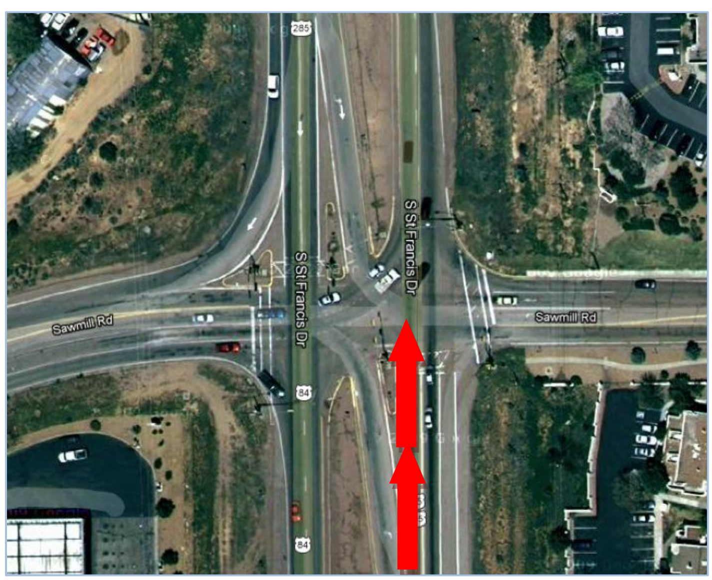


Figure 95—Sawmill Rd. & Saint Francis Dr. with most commonly occurring crash type

Figure 96—View from approaching road

Intersection Conclusions and Recommendations

The combination of this data has led to the conclusion that these crashes are occurring because drivers are either unaware that the automobiles in front of them are stopped, or because they are slowing down suddenly for the light and crashing into the automobiles in front of them. Most of these crashes are contributed to either driver inattention or drivers following too closely, which both contribute heavily to rear-end crashes.

Pending future engineering analysis, one potential solution would be to add backplates with retroreflective borders to the traffic signals. This simple addition would increase the contrast between the signal and the background, thus increasing the visibility of the signal. This would decrease the number of crashes that occur due to drivers failing to notice the red light quickly enough. Another recommended improvement that could be adopted alongside the backplates would be to increase the time that the traffic signal is yellow. Increasing the time would allow drivers more time to react to the change and decelerate smoother, decreasing the chance that they will be rear-ended by the car behind them. The adoption of these two improvements has the potential to decrease the number of crashes at this intersection.