RESEARCH

2008-31

Review of Nevada's Rural Intersection Crashes:

Application of Methodology for Identifying Intersections for Intersection Decision Support (IDS)

Report #7 in the Series: Toward a Multi-State Consensus on Rural Intersection Decision Support

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16. Abstract (Limit: 200 words)

The Intersection Decision Support (IDS) research project is sponsored by a consortium of states (Minnesota, California, and Virginia) and the Federal Highway Administration (FHWA) whose objective is to improve intersection safety. The Minnesota team's focus is to develop a better understanding of the causes of crashes at rural unsignalized intersections and then develop a technology solution to address the cause(s).

In the original study, a review of Minnesota's rural crash records and of past research identified poor driver gap selection as a major contributing cause of rural intersection crashes. Consequently, the design of the rural IDS technology has focused on enhancing the driver's ability to successfully negotiate rural intersections by communicating information about the available gaps in the traffic stream to the driver.

In order to develop an IDS technology that has the potential to be nationally deployed, the regional differences at rural intersections must first be understood. Only then can a universal solution be designed and evaluated. To achieve this goal of national consensus and deployment, the University of Minnesota and the Minnesota Department of Transportation initiated a State Pooled Fund study, in which nine states are cooperating in intersection-crash research. This report documents the crash analysis phase of the pooled fund study for the State of Nevada.

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Review of Nevada’s Rural Intersection Crashes: Application of Methodology for Identifying Intersections for Intersection Decision Support (IDS)

Report #7 in the Series: Toward a Multi-State Consensus on Rural Intersection Decision Support

Final Report

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- California
- Georgia
- Iowa
- Michigan
- Minnesota
- Nevada
- New Hampshire
- North Carolina
- Wisconsin

We would also like to especially acknowledge several individuals at the Nevada Department of Transportation (NDOT) who played key roles in the analysis of Nevada intersections and development of this report. We would like to thank Kelly Anrig, Chief Safety Engineer, and Jim Ceragioli, Senior Safety Coordinator, who oversaw the selection process and coordinated the transfer of crash records. The research team also wishes to acknowledge David Hutchinson, Assistant Program Coordinator, who provided the crash records and took photographs at the two final candidate locations. Additionally, we would like to acknowledge Scott Thorson, retired Chief Traffic Engineer, who helped initiate this pooled fund study.

Finally, we wish to acknowledge the assistance provided by Ginny Crowson of the Minnesota Department of Transportation (Mn/DOT), who serves as technical manager of the pooled fund project, the late Jim Klessig of Mn/DOT, who previously served as administrative liaison of the pooled fund, and Deb Fick, who serves as the administrative liaison.

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Executive Summary

The objective of the Intersection Decision Support (IDS) research project, sponsored by a consortium of states (Minnesota, California, and Virginia) and the Federal Highway Administration (FHWA), was to improve intersection safety. The Minnesota team's focus was to develop a better understanding of the causes of crashes at rural unsignalized intersections and then develop a solution to address the cause(s).

In the original study, a review of Minnesota's rural crash records and of past research identified poor driver lag selection as a major contributing cause of rural intersection crashes. Consequently, the design of the rural IDS system has focused on enhancing the driver's ability to successfully negotiate rural intersections by communicating information to the driver when the lags in the traffic stream are unsafe.

Based on the Minnesota crash analysis, one intersection was identified for instrumentation (collection of driver behavior information) and the IDS vehicle surveillance system was deployed and tested. Also underway, alternative Driver Infrastructure Interfaces (DII) designs are being tested in a driving simulator at the University of Minnesota.

In order to develop an IDS system that has the potential to be nationally deployed, the regional differences at rural intersections must first be understood. Only then can a universal solution be designed and evaluated. To achieve this goal of national consensus and deployment, the University of Minnesota and the Minnesota Department of Transportation (Mn/DOT) initiated a State Pooled Fund study, in which nine states are cooperating on intersection-crash research. The participating states are:

- California
- Georgia
- Iowa
- Michigan
- Minnesota
- Nevada
- New Hampshire
- North Carolina
- Wisconsin

The first facet of this pooled fund project is a review of intersection crash data from each participating state, applying methods developed in previous IDS research. The crash data will be used to understand rural intersection crashes on a national basis, and to identify candidate intersections for subsequent instrumentation and study. The second facet is to instrument one candidate intersection in each participating state, as a means to acquire data regarding the behavior of drivers at rural intersections over a wide geographical base. States choosing to instrument intersections will be well positioned to reap the benefits of the new Cooperative Intersection Collision Avoidance System (CICAS) research funded by the United States Department of Transportation (USDOT) and the Mn/DOT. The CICAS Stop Sign Assist Program will investigate the human factors and technical considerations associated with the proposed IDS approach used to communicate with the driver at the intersection. A planned Field Operational Test will be designed to evaluate the performance of these systems.

Thus far among the states where the crash analysis has been completed, the states where the focus was on rural, four-lane expressways (i.e., divided roadways) were Iowa, Minnesota, Nevada, North Carolina and Wisconsin. While the states with a focus on two-lane highways (i.e., undivided) include Georgia, Michigan and New Hampshire.

Review of Nevada's Intersections

This report documents the initial phase of the pooled fund study for the State of Nevada. The crash analysis initially focused on thru-STOP intersections of two-lane US or State routes throughout rural Nevada because of the relatively few miles of rural expressway in Nevada. This search on two-lane highways turned up no rural intersections with a high frequency of crossing path crashes to warrant further investigation. As a result, the focus of the Nevada analysis was on four rural expressway corridors that were known by the Nevada Department of Transportation to have a history of traffic safety issues.

Within the four corridors, 25 intersections were identified where at least one crash occurred between January 1, 2002 and December 31, 2006. From the 25 intersections, five locations were identified for further study because of the high frequency and percentage of angle crashes — the target crash type. Three of the intersections were eliminated because many of the angle crashes were actually determined to be an on-coming left-turn crash after the investigating officer's narrative was reviewed — the Nevada crash records system does not easily distinguish between a right angle crash (involves one vehicle from both the major and minor roads) and a left-turn crash (involves two vehicles on the major road, one of which is turning left) without having to review the travel direction and action for every vehicle involved. The two remaining intersections that best fit the study's criteria were:

1. US 50 & Sheckler Cutoff in Churchill County
2. US 395 & Muller Lane in Douglas County

A review of photos provided by the Nevada Department of Transportation (NDOT) revealed that the NDOT had already deployed safety countermeasures at these intersections, specifically intersection lighting, turn lanes, and two stop signs on the south approach at the US 50 & Sheckler Cutoff intersection. However, these strategies would be most effective at addressing crashes in which the driver fails to recognize that he/she is approaching the intersection and thus runs the STOP sign. Neither countermeasure provides the driver with assistance in recognition and selection of safe lags in the stream of cross-traffic.

Examination of the crash data indicated that these strategies did prove effective at reducing run-the-STOP crashes since there were none of these crash types. However, the large numbers of crossing path crashes at the two candidate intersections were predominately associated with a driver's poor lag identification and selection.

Using the crash factors of at-fault driver age, crash severity, contributing factors associated with the driver, along with several other factors, the intersection selected as the overall best candidate for test deployment of the IDS vehicle surveillance system was US 50 and Sheckler Cutoff. This intersection has one of the worst crash experiences, including the highest number and percentage of crashes that were classified as a crossing path crash, the highest number and percentage of injury crashes, and the highest percentage of lag recognition crashes.

1. Project Background

The objective of the Intersection Decision Support (IDS) research project, sponsored by a consortium of states (Minnesota, California, and Virginia) and the Federal Highway Administration (FHWA), was to improve intersection safety. The Minnesota team's focus was to develop a better understanding of the causes of crashes at rural unsignalized intersections and then develop a solution to address the cause(s).

In the original study, a review of Minnesota's rural crash records and of past research identified poor driver lag selection as a major contributing cause of rural intersection crashes. Consequently, the design of the rural IDS system has focused on enhancing the driver's ability to successfully negotiate rural intersections by communicating information about the safety of the lags in the traffic stream to the driver.

Based on the Minnesota crash analysis, one intersection was identified for instrumentation (collection of driver behavior information) and the IDS vehicle surveillance system was deployed and tested. Also underway, alternative Driver Infrastructure Interfaces (DII) designs are being tested in a driving simulator at the University of Minnesota.

In order to develop an IDS system that has the potential to be nationally deployed, the regional differences at rural intersections must first be understood. Only then can a universal solution be designed and evaluated. To achieve this goal of national consensus and deployment, the University of Minnesota and the Minnesota Department of Transportation (Mn/DOT) initiated a State Pooled Fund study, in which nine states are cooperating on intersection-crash research. The participating states are:

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This report documents the initial phase of the pool fund study for the State of Nevada. In the following sections are a description of the crash analysis performed for Nevada and a recommendation of an intersection as a test site for studying driver entry behavior. The data acquired from this site and from other selected intersections across the country will provide information needed to design an IDS system for national deployment.

1.1. Typical Countermeasures for Rural Intersections

A typical crossing path crash (i.e., right angle) crash at a rural unsignalized intersection is most often caused by the driver's (on a minor street approach) inability to recognize the intersection (which consequently results in a run the STOP sign violation), or his/her inability to recognize and select a safe lag in the major street traffic stream.

Traditional safety countermeasures deployed at rural high crash intersections include:

- Upgrading traffic control devices
  - Larger STOP signs
  - Multiple STOP signs
  - Advance warning signs and pavement markings
- Minor geometric improvements
  - Free right turn islands
  - Center splitter islands
  - Off-set right turn lanes
- Installing supplementary devices
  - Flashing beacons mounted on the STOP signs
  - Overhead flashing beacons
  - Street lighting
  - Transverse rumble strips

All of these countermeasures are relatively low cost and easy to deploy, but are typically designed to assist drivers with intersection recognition and have not exhibited an ability to address lag recognition and acceptance problems. Yet, up to 80% of crossing path crashes are related to selection of an insufficient lag (*1*). In addition, a Minnesota study of rural thru-STOP intersections for rural two-lane roadways found that only one-quarter of right angle crashes were caused by the driver on the minor street failing to stop because they did not recognize they were approaching an intersection (*2*). At the same set of intersections, 56% of the right angle crashes were related to selecting an unsafe lag while 17% were classified as other or unknown.

The concept of lag recognition being a key factor contributing to rural intersection safety appears to be a recent idea. As a result, there are relatively few devices in the traffic engineer's safety toolbox to assist drivers with lag recognition and they mainly consist of a few high cost geometric improvements and a variety of lower cost strategies that are considered to be experimental because they have not been widely used in rural applications. **Figure 1-1** illustrates the range of strategies currently available to address safety deficiencies associated with lag recognition problems, organized in order of the estimated cost to deploy (based on Minnesota conditions and typical implementation costs). The strategies include:

- The use of supplemental devices such as street light poles to mark the threshold between safe and unsafe lags
- Minor geometric improvements to reduce conflicts at intersection such as inside acceleration lanes, channelized median openings to eliminate certain maneuvers (sometimes referred to as a J-Turn), or revising a 4-legged intersection to create off-set T's
- Installing a traffic signal to assign right-of-way to the minor street

- Major geometric improvements such as roundabout or grade separated interchanges to eliminate or reduce crossing conflicts. (Refer to *Rural Expressway Intersection Synthesis of Practice and Crash Analysis* for a review of various alternatives [*3*].)

The use of these strategies may not be appropriate, warranted or effective in all situations. Also, the construction cost or right of way may prove to be prohibitive at some locations. All of this combined with a recommendation in AASHTO's Strategic Highway Safety Plan to investigate the use of technology to address rural intersection safety led to the on-going research to develop a cost-effective IDS system, including a new driver interface. The IDS system is intended to be a relatively low cost strategy (similar to the cost of a traffic signal), but at the same time is technologically advanced, using roadside sensors and computers to track vehicles on the major road approaches, computers to process the tracking data and measure available lags and then using the driver interface to provide minor road traffic with real-time information as to when it is unsafe to enter the intersection.

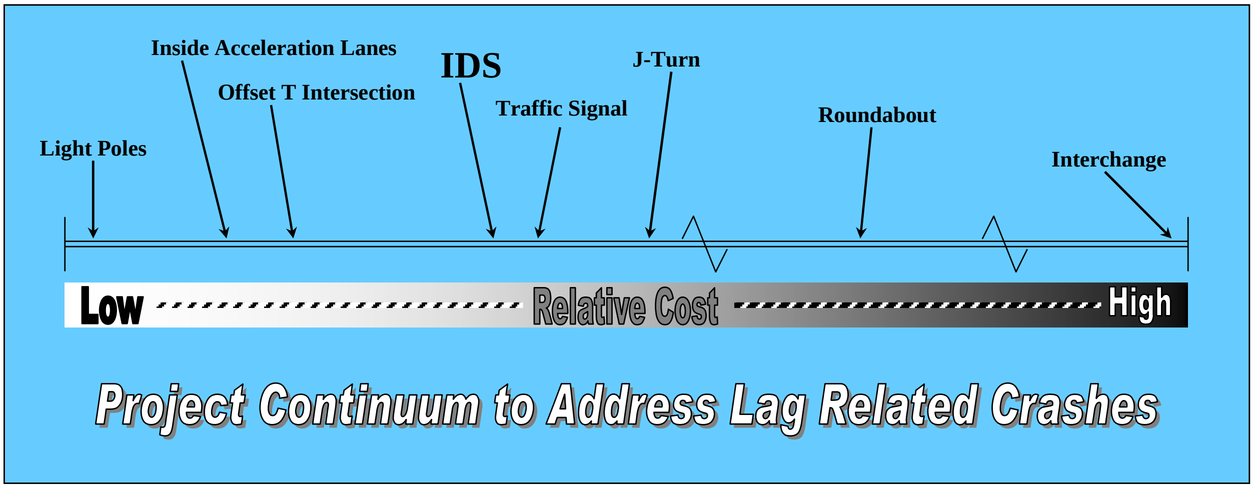


FIGURE 1-1
Lag Selection Related Safety Strategies

2. Crash Analysis Methods and Candidate Intersection Identification

A comprehensive method for intersection identification was developed using Minnesota's crash record system (see **Figure 2-1**).

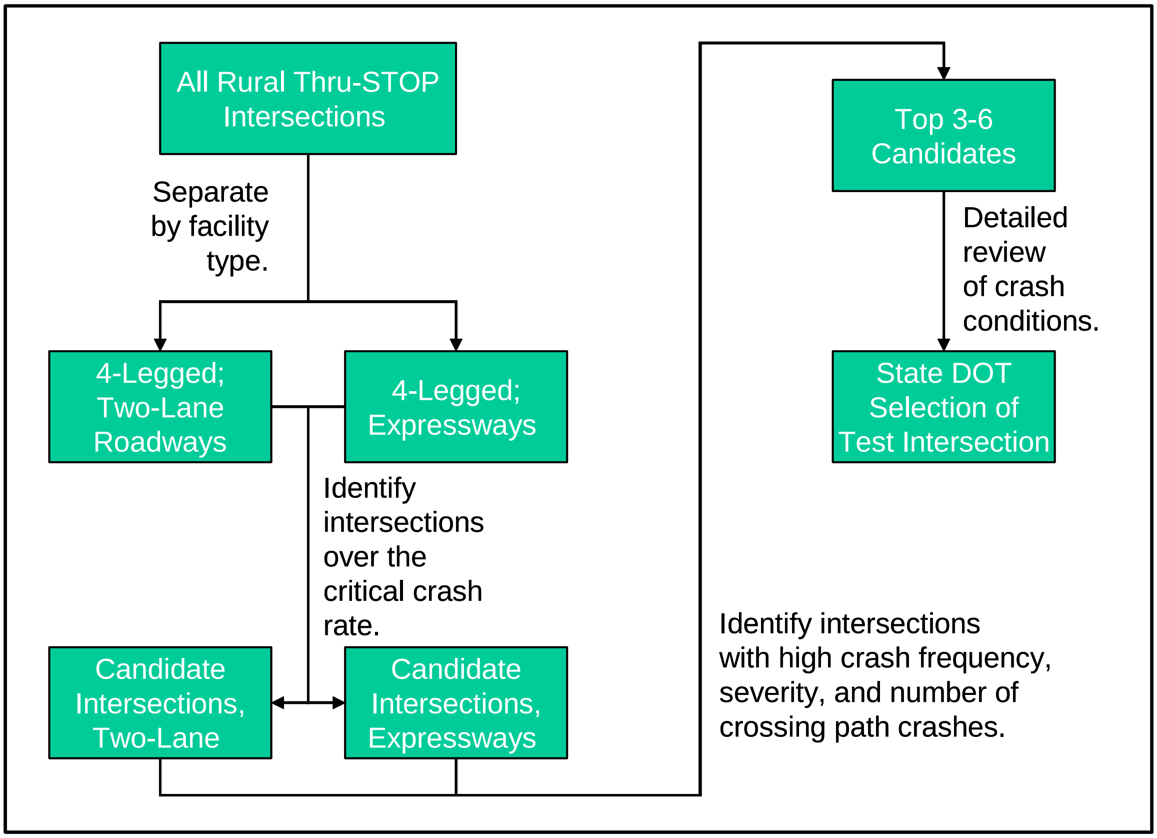


FIGURE 2-1
Preferred Crash Analysis Process

The method was applied to all rural, thru-STOP intersections in Minnesota, as this is the most frequent intersection situation in Minnesota. This intersection type is also the most likely where a driver will have to judge and select a lag at a rural intersection (i.e., stopped vehicle on the minor approach). The approach to identify the intersection selected for a potential field test of the technology used the three screens described in the following:

- **Critical Crash Rate –** The first screen was to identify the rural thru-STOP intersections that have a crash rate greater than the critical crash rate. The critical crash rate is a statistically significant rate higher than the statewide intersection crash rate. Therefore, any intersection with a crash rate equal to or above the critical crash rate can be identified as an intersection with a crash problem due to an existing safety deficiency.

- **Number and Severity of Correctable Crashes –** Once the intersections meeting the first criteria were identified, this second screen was performed to identify intersections where a relatively high number and percentage of crashes were potentially correctable by the

IDS technologies being developed. In Minnesota's crash record system, "right angle" crashes were the crash type most often related to poor lag selection. Therefore the ideal candidate intersections had a high number and percentage of right angle collisions and tended to have more severe crashes. This screen was used to identify the top three candidate intersections for the final screen.

- **Crash Conditions and At-Fault Driver Characteristics –** The IDS system is believed to have the greatest benefit for older drivers. Therefore, the at-fault driver age was reviewed to identify intersections where older drivers were over represented. Other aspects of the crashes that were reviewed include whether the crashes were typically a problem with intersection recognition or lag recognition and the crash location (near lanes or far lanes).

In Nevada, application of the preferred process was not feasible due to the State DOT's current crash record system. The State has no database of intersection characteristics (i.e., rural versus urban, traffic control device, roadway type, etc.) that is linked to the crash records. Essentially, Nevada is currently unable to automatically identify and query intersections (including crash records) based on physical characteristics and type of traffic control. Therefore, a modification of the approach was needed since it was impractical to manually search the State for all rural, thru-STOP intersections.

The screening process in Nevada began with the Nevada Department of Transportation (NDOT) providing crash records for rural thru-STOP intersections along two-lane highways. The NDOT selected two-lane highways as the focus because of the relatively few miles of rural expressway that have been constructed in Nevada. (NOTE: In IDS studies of the states completed to date, most states elected to focus on expressway intersections because the traditional solution to a lag-selection crash problem is to install a traffic signal, which will have significant impacts on mobility.) However, none of the identified intersections had a frequency of crossing path crashes that warranted further investigation. As a result, the focus was shifted to Nevada's expressway system, specifically four corridors that previously had traffic safety issues. The four corridors reviewed included:

- US 50 in Churchill County (from mile point 11.23 to 15.20)
- US 95 in Clark County (from mile point 96.6 to 132.14)
- US 395 in Douglas County (from mile point 24.08 to 31.21)
- State Route (SR) 430 in Washoe County (from mile point 7.0 to 16.0)

Five years of crash data (January 1, 2002 through December 31, 2006) was provided for each corridor. From this data, 25 intersections were identified where at least one crash had occurred during the study period. Using the crash information, the five intersections with the highest frequency and percentage of angle crashes were identified

Of the crashes at the five locations, the vehicle travel directions, vehicle movements, and narrative from the investigating officer was provided. This information was used to construct collision diagrams and revealed that the Nevada crash reporting system does not easily differentiate between a right angle crashes (crash involving one driver from the major and minor approaches) and on-coming left-turn crashes (crash where both vehicles were on the major road and one driver was turning left in front of an approaching vehicle). At three of the reviewed locations, many of the crossing path crashes were left-turn crashes and these locations were not considered for further analysis. As a result, the following two locations were identified as the final candidate intersections for further study and possible deployment of the IDS vehicle surveillance equipment.

1. US 50 & Sheckler Cutoff in Churchill County
2. US 395 & Muller Lane in Douglas County

3. Crash Record Review of Candidate Intersections

It was already known that the two candidate intersections had a relatively high frequency of crossing path crashes, but the decision was made to investigate each intersection further for specific information pertinent to the IDS system and also to learn of any unusual circumstances at the intersections. At the candidate intersections, the factors reviewed included at-fault driver age, crash severity, crash location, contributing factors, and the effects of weather. For all of these summaries, the focus is on correctable crossing path crashes only (see following section for definition), which are the crash types that have the greatest potential to be corrected by the IDS system.

3.1. Correctable Crash Types

The General Estimates System (GES) crash database is a national sample of police-reported crashes used in many safety studies. In the GES, five crossing path crash types have been identified (see **Figure 3-1**), they are:

- Left Turn Across Path – Opposite Direction (LTAP/OD),
- Left Turn Across Path – Lateral Direction (LTAP/LD),
- Left Turn Into Path – Merge (LTIP),
- Right Turn Into Path – Merge (RTIP), and
- Straight Crossing Path (SCP).

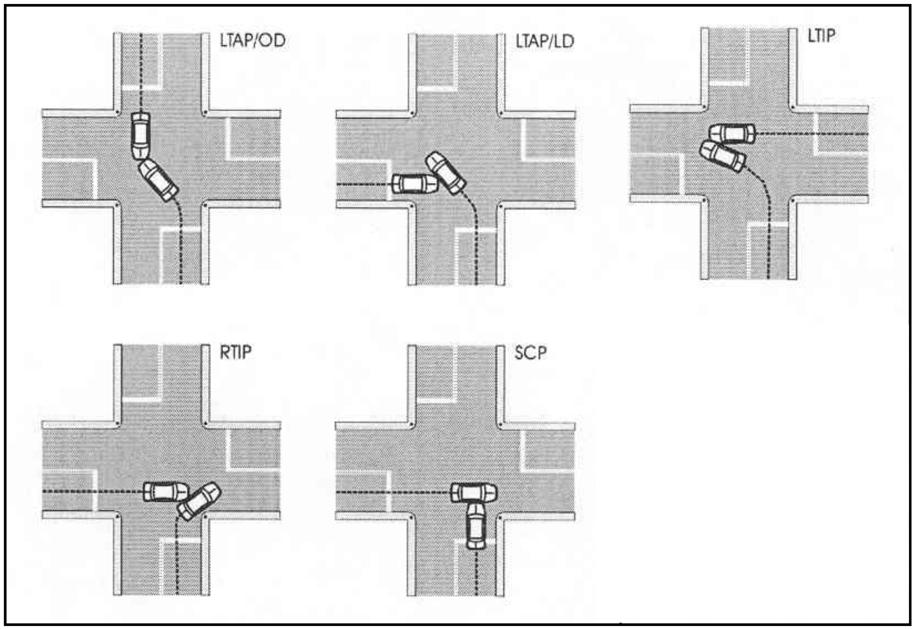


FIGURE 3-1
GES Crossing Path Crash Types

At this time, the IDS system under development is intended to address the crash types involving at least one vehicle from the major and minor street, which includes all five GES crash types except for LTAP/OD. This research has not focused on the LTAP/OD crash type at unsignalized rural intersections because they are a relatively small problem at many locations. However, it is believed the system could be adapted to address LTAP/OD crashes if an intersection had a significant number of these crashes. For example, LTAP/OD crashes involving two vehicles from the minor street may be reduced if the device is designed to detect potential conflicts with vehicles from the opposing approach.

At the candidate intersections, the number and percent of correctable crashes is summarized in **Table 3-1**. Correctable crashes were identified using the collisions diagrams included in **Appendix A**. As shown in **Table 3-1**, 60% and 69% of the crashes at the two candidate intersections are potentially correctable. Out of the two intersections, US 50 & Sheckler Cutoff had the higher frequency and percentage of correctable crashes.

TABLE 3-1
Potential Correctable Crashes for IDS System at the Candidate Intersections

	US 50 & Sheckler Cutoff (Churchill County)	**US 395 & Muller Lane (Douglas County)**
Total Crash Frequency	16	15
Number of Correctable Crashes	11	9
Percent of Crashes that are Correctable	69%	60%

NOTE: Correctable crashes have been defined as SCP, LTAP/LD, LTIP, and RTIP.
Crash data from January 1, 2002 to December 31, 2006.

3.2. At-Fault Drivers

For both candidate intersections, all crash records from January 1, 2002 to December 31, 2006 were reviewed to identify the age of the driver whose action most likely caused the accident, also known as the at-fault driver (see **Figure 3-2**). The at-fault driver was determined using the narrative recorded by the investigating officer. The age of the at-fault driver is important since the IDS system may have its greatest benefit in assisting older drivers in particular. From the *Nevada Traffic Crashes 2003* (*4*) report (most recent report available), 12.3% of involved drivers were under the age of 21, 74.5% between the age of 21 and 64, 6.1% over the age of 64, and the age was unknown for 7.2% of drivers. *Note: Age distributions in the 2003 Nevada Traffic Crashes report list all involved drivers and not specifically at-fault drivers. This difference must be considered when making any comparisons.*

Older drivers (age > 64-years) were classified as the at-fault driver between 9% and 11% of crossing path crashes at the two candidate intersections. This is only a three to five percentage points above the age distribution of involved drivers and is not considered to be a significant difference. At the intersection of US 50 & Sheckler Cutoff, young drivers accounted for 36% of at-fault drivers, approximately three times what would be expected given the distribution of all drivers involved in a crash. Young drivers are also a potential segment of the population that may benefit from technology that assists in lag selection and identification because of their inexperience behind-the-wheel. However, at this time it is unknown if young drivers will routinely be patient enough to follow the guidance of the system's final design. Ongoing testing of the potential DII in the driving simulator will help answer the question regarding the expected compliance rate of young drivers.

3.3. Crash Severity

Another goal of the IDS system is to address the most serious intersections crashes, especially fatal crashes. Therefore, the most appropriate candidate intersection would have a high percentage of fatal and injury crashes. Of Nevada's 2003 crashes, fatal crashes represented approximately 0.5% of all of crashes, with injury crashes at 33.3% and property damage (PD) crashes accounting for 66.2% of all crashes (*4*). **Figure 3-3** shows that neither intersection had a fatal crash; however, this is not unusual given that fatal crashes are a rare event in comparison to injury and PD crashes. Of the two intersections, only US 50 & Sheckler Cutoff had an injury crash rate that exceeded the statewide level.

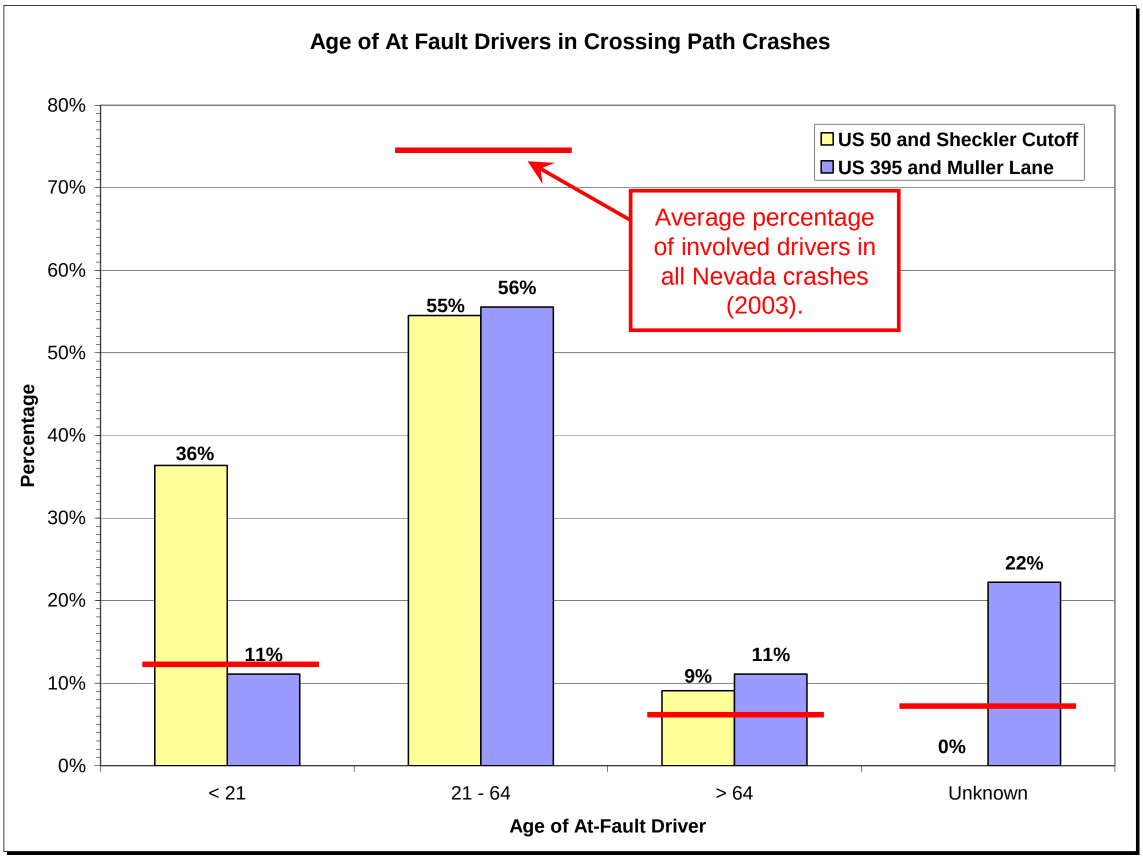


FIGURE 3-2
Age of At-Fault Drivers in Correctable Crash Types at the Candidate Intersections

Note: Crossing path crashes at the candidate intersections occurred between January 1, 2002 and December 31, 2006. Average of involved drivers in all Nevada crashes (2003) was from Nevada Traffic Crashes 2003 *(4).*

3.4. Crash Location

From the initial review of Minnesota's crash records (*5*), it was observed that crossing path crashes at the candidate intersections were predominately on the far side of the intersection. [NOTE: For the divided expressway in Minnesota, a far-side crash occurs when the stopped vehicle safely negotiates the first two lanes it crosses, but is involved in a crash when leaving the median to either cross or merge into traffic in the second set of lanes.] The primary cause of the high number of far-side crashes was not evident from review of the crash records. However, it was speculated that drivers used a one-step process for crossing rather than a two-step process. When a driver enters the median, rather than stopping to reevaluate whether the lag is still safe (a two-step process), it is believed that drivers simply proceeded into the far lanes without stopping (a one-step process). At the selected intersection in Minnesota (U.S. 52 and Goodhue County 9), vehicle detection equipment has already been installed along with video cameras. The information recorded at the intersection will be used to quantify how drivers typically cross this and similar intersections. Similar to what was observed in the crash data; all crashes recorded at the Minnesota test intersection have been far-side crashes. The one crash recorded during the deployment at the test intersection in Wisconsin was a near-side crash; however, that intersection was unique in that crossing path crashes were nearly spilt equally between far-side and near-side.

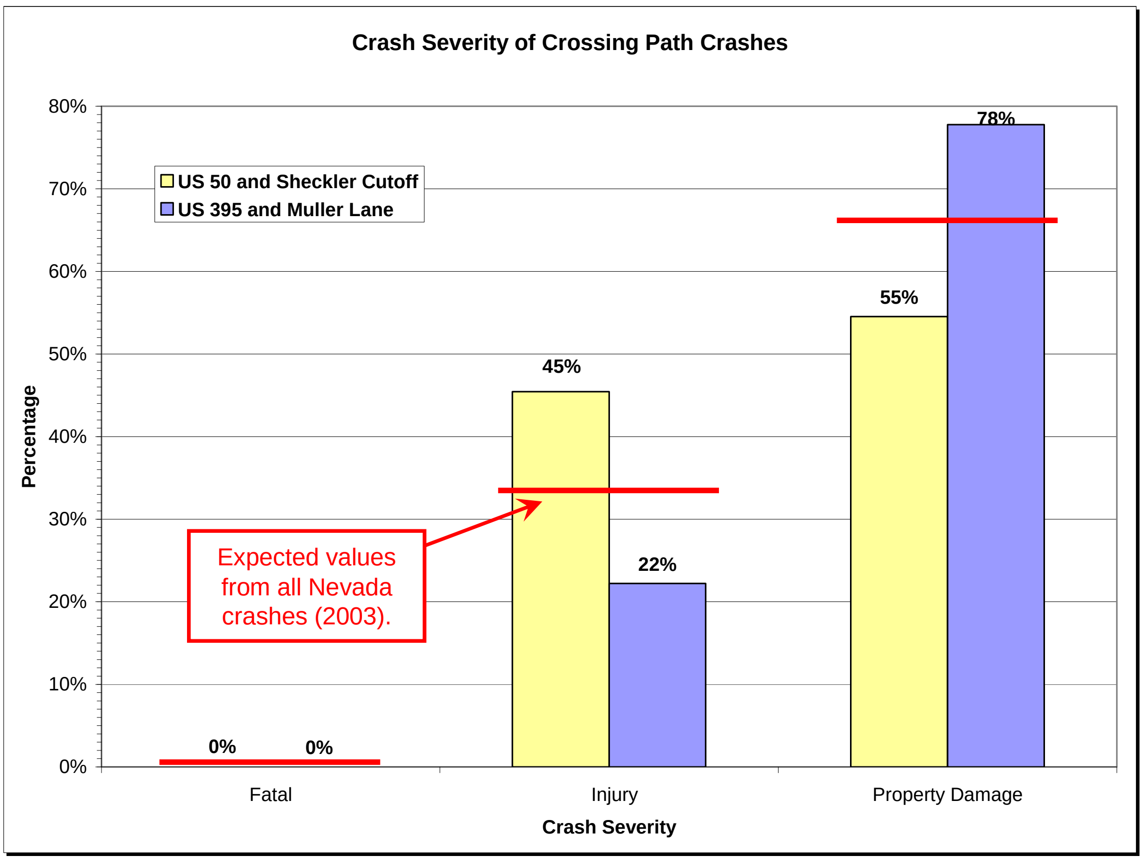


FIGURE 3-3
Crash Severity of Correctable Crash Types at the Candidate Intersections

Note: Crossing path crashes at the candidate intersections occurred between January 1, 2002 and December 31, 2006. Average severity of all Nevada crashes (2003) was from Nevada Traffic Crashes 2003 *(4).*

For the pooled fund study to date, rural expressway intersections in North Carolina, Wisconsin, and Iowa have been reviewed. For the candidate intersections in these states, the pattern was similar to what was observed in Minnesota with a majority of crossing path crashes occurring in the far-side lanes.

At the Nevada candidate intersections (see **Figure 3-4**), all correctable crossing path crashes at US 50 & Sheckler Cutoff were near -side crashes. Additionally, 78% of correctable crossing path crashes at US 395 & Muller Lane were near-side crashes. This pattern is generally opposite of what was found in the other states that selected rural expressways. This may be a result of the narrow median on US 50 and US 395. Data recorded by the vehicle surveillance system at the selected location may help understand why near-side crash problems are an issue in Nevada.

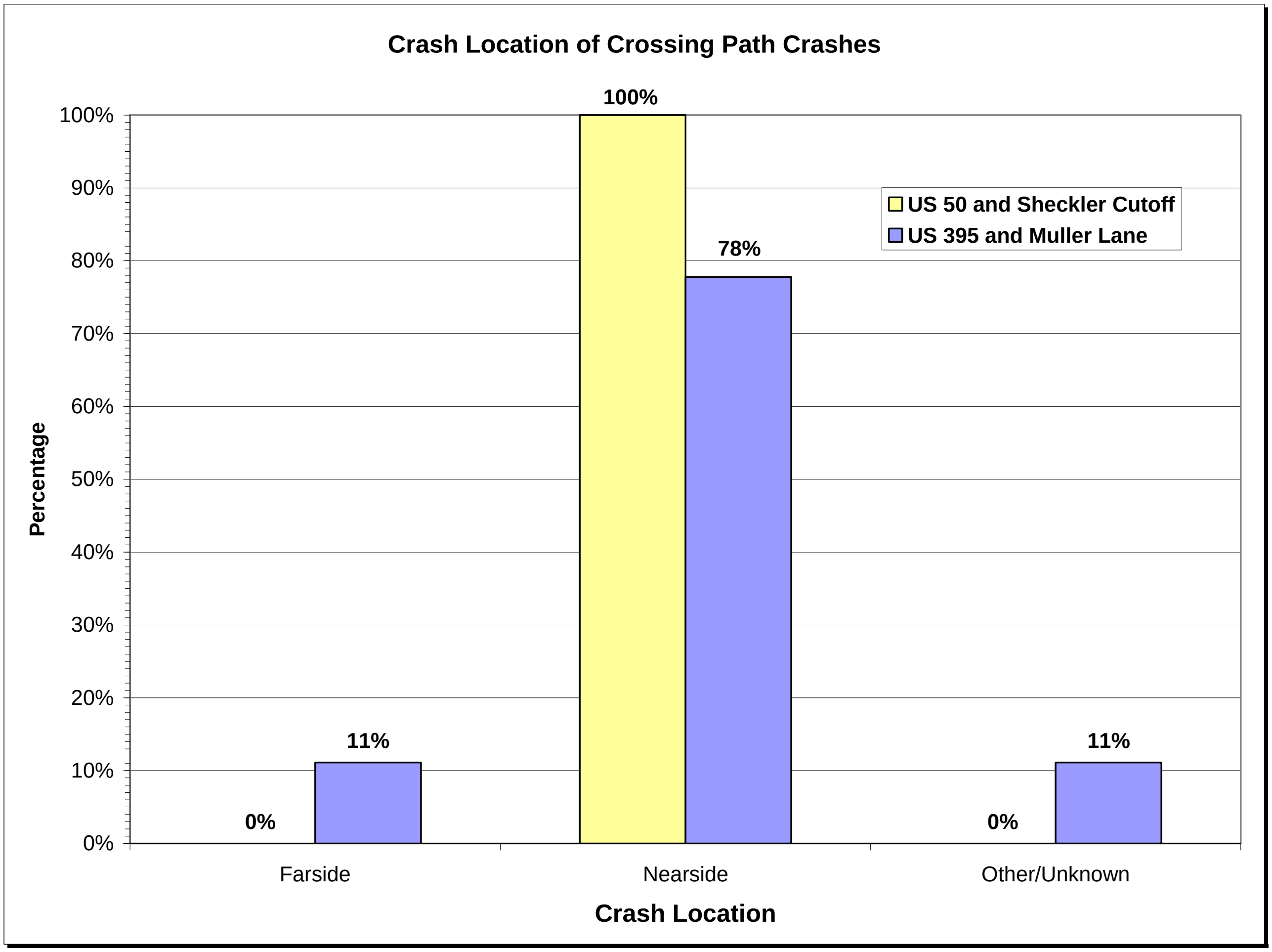


FIGURE 3-4
Crash Location of Correctable Crash Types at the Candidate Intersections

Note: Crossing path crashes at the candidate intersections occurred between January 1, 2002 and December 31, 2006.

3.5. Driver Recognition

Another important crash characteristic is whether the at-fault driver failed to recognize the intersection (i.e., ran-the-STOP) or failed to select a safe lag (i.e., stopped, pulled out). Since the IDS device is primarily intended to help drivers with selecting safe lags, crashes where the driver ran-the-STOP may not be correctable by the proposed IDS system. To classify the crashes as either intersection recognition or lag recognition, the narrative recorded by the investigating officer was used. In many instances the investigating officer reported whether or not the at-fault driver stopped or failed to stop. However, some crash reports did not include this information in the narrative. For these crashes, additional information may have been available to determine the contributing factor. For example, the investigating officer may have reported that the driver was turning onto the highway. Even though the officer did not comment if the driver stopped, the driver's decision to turn at the intersection is a strong indication that they were aware of the intersection but was unable to select a safe lag. This scenario would have been classified as a lag recognition crash. Even considering the secondary information, some crashes had to be classified as "unknown."

As shown in **Figure 3-5**, at least 67% of the crossing path crashes at the intersections were lag recognition crashes and no crashes were intersection recognition. This strongly suggests that a high percentage of these crashes could have been prevented if the at-fault drivers had assistance in identifying, judging and selecting a safe lag. Of the two candidate intersections, US 50 & Sheckler Cutoff had the higher percentage of crossing path crashes that were related to lag recognition (82%).

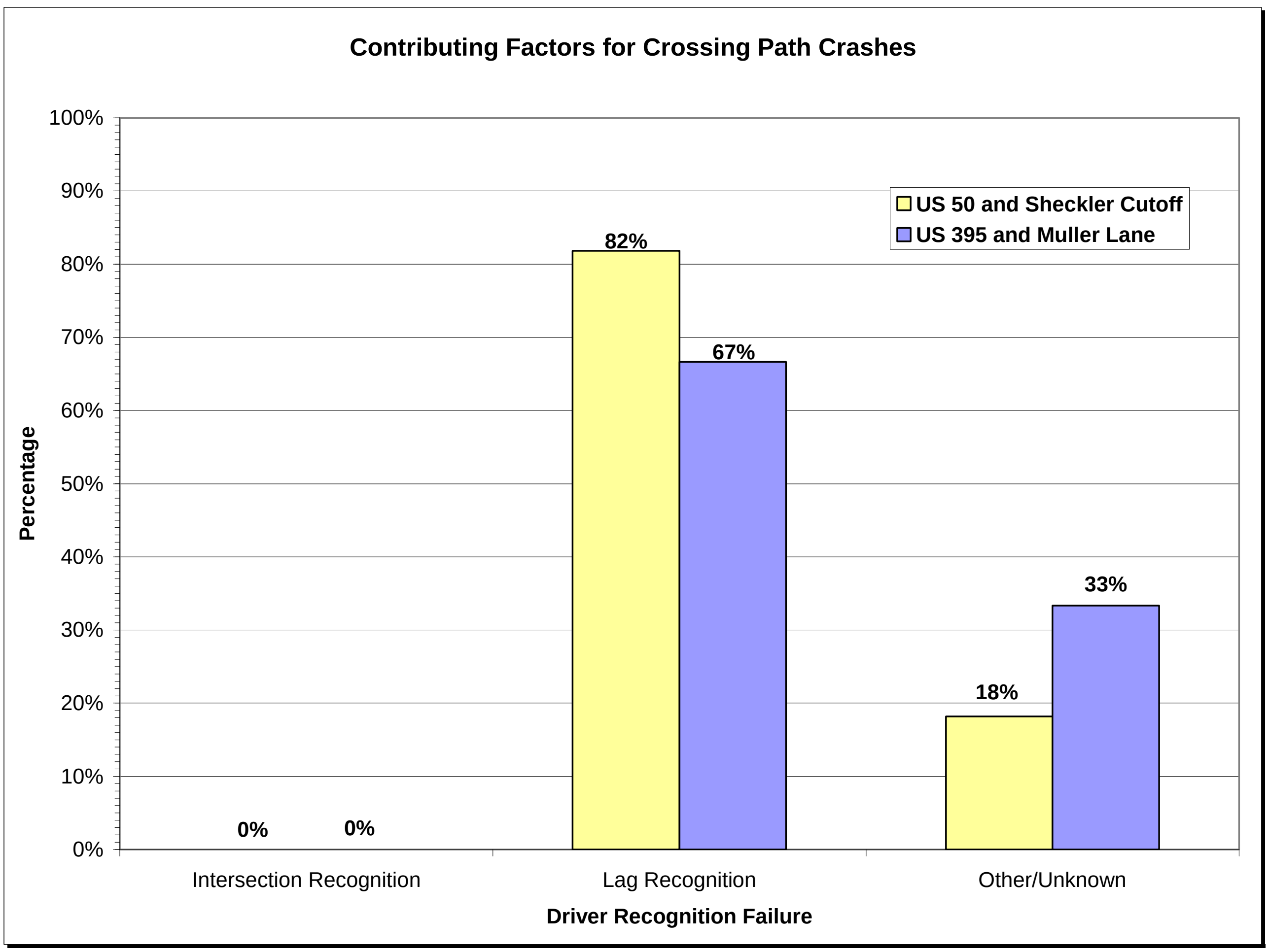


FIGURE 3-5
Contributing Factors of Correctable Crash Types at the Candidate Intersections

Note: Crossing path crashes at the candidate intersections occurred between January 1, 2002 and December 31, 2006.

3.6. Effect of Weather, Road Condition, and Light Condition

The final factors reviewed for the crossing path crashes at each candidate intersection were the weather, road, and light conditions. If the crashes tended to occur during adverse weather conditions (i.e., snow, rain, dark), then deployment of a new technology may have a limited benefit unless it can be coordinated with a local RWIS station.

The weather condition at the time of the crashes (see **Table 3-2**) was overwhelmingly good weather conditions. This indicates that weather was not a significant contributing factor to the crossing path crashes that occurred at the candidate intersections.

TABLE 3-2
Weather Condition for Correctable Crash Types at the Candidate Intersections

	US 50 & Sheckler Cutoff (Churchill County)	US 395 & Muller Lane (Douglas County)
Clear or Cloudy	91%	100%
Rain	0%	0%
Snow or Sleet	9%	0%

Note: Crossing path crashes at the candidate intersections occurred between January 1, 2002 and December 31, 2006.

The road surface condition (see **Table 3-3)** was reported as dry except for one crash at the intersection of US 50 & Sheckler Cutoff. This single crossing path crash occurred on a snowy/icy pavement. This is also indicates that adverse weather was not a causal factor in crossing path crashes.

TABLE 3-3
Roadway Surface Condition for Correctable Crash Types at the Candidate Intersections

	US 50 & Sheckler Cutoff (Churchill County)	US 395 & Muller Lane (Douglas County)
Dry	91%	100%
Wet	0%	0%
Snow or Ice	9%	0%

Note: Crossing path crashes at the candidate intersections occurred between January 1, 2002 and December 31, 2006.

The percentage of crossing path crashes reported during daylight conditions at both intersections was at or above 89% (see **Table 3-4**), indicating dark or low-light driving conditions were not a substantial factor in causing crossing path crashes.

TABLE 3-4
Light Condition for Correctable Crash Types at the Candidate Intersections

	US 50 & Sheckler Cutoff (Churchill County)	US 395 & Muller Lane (Douglas County)
Daylight	100%	89%
Dawn or Dusk	0%	0%
Dark	0%	11%

Note: Crossing path crashes at the candidate intersections occurred between January 1, 2002 and December 31, 2006.

4. Intersection Field Conditions

Because only two candidate locations were identified in Nevada, the research team did not conduct field reviews of the locations. Instead, the NDOT provided site photos for the two intersections and a conference call including the research team and the NDOT was held to discuss any potential factors that may affect the locations feasibility for use in this study.

Following is a brief description of each of the intersections. For each intersection, crash diagrams are included in **Appendix A** and aerial photos are in **Appendix B**.

4.1. US 50 & Sheckler Cutoff (Churchill County)

The intersection is located in Churchill County, approximately four miles west of Fallon, NV (2000 Census Population = 7,536). US 50 is a rural expressway with the through approaches, generally running east-west and provides a connection to Reno and Carson City area to the west of Fallon. Sheckler Cutoff is the stopped approach from the south and also carries the designation of State Route (SR) 117. The stopped approach from the north is Roberson Lane, a local street under the County's jurisdiction.

The area to the west of Fallon is sprawling low-density residential. Along the US 50 corridor, access to numerous businesses is provided and US 50 also has numerous intersections with local streets that connect to residential neighborhoods. Specifically at the intersection with Sheckler Cutoff, the southeast quadrant includes a business, the southwest quadrant is an electrical transformer station (see **Figure 4-1**), and the northern quadrants are vacant.

US 50 is classified as a rural expressway, but the cross-section design is four-lane undivided with a continuous two-way left-turn lane. The posted speed limit on US 50 is 65 mph and US 50 carries between 11,000 and 12,000 vehicle per day near the intersection. Both US 50 approaches include left- and right-turn lanes (see **Figure 4-2**).

The Sheckler Cutoff approach (south approach) is stopped controlled. A channelized right-turn lane can be seen in **Figure 4-3**, along with double mounted STOP signs. The Roberson Lane approach is a two-way, two-lane street with a single STOP sign (see **Figure 4-1**). The other noticeable improvement at the intersection is the street lighting, which is visible in all photos.

The collision diagram in **Appendix A** reveals that seven of the eleven correctable crossing path collisions involved a driver on the Sheckler Cutoff approach, which has the higher volume of the two minor street approaches. However, the Roberson Lane approach still had four crossing path crashes during the study period. Regardless of which approach, all crashes were nearside collisions.

FIGURE 4-1
Business in the Southeast Quadrant (left) and an Electrical Transformer Station in the Southwest (right) Quadrant

FIGURE 4-2
US 50 Turn Lanes on the West (left photo) and East (right photo) Approaches

FIGURE 4-3
Sheckler Cutoff Approach (south approach)

4.2. US 395 & Muller Lane (Douglas County)

The intersection of US 395 and Muller Lane is located on the northern fringe of Minden (2000 Census Population = 2,836) in Douglas County. US 395 is a north-south corridor that connects Minden to Carson City and Reno. US 395 has a posted speed limit of 65 mph and carries approximately 31,000 vehicles per day. The area around the intersection is currently vacant.

US 395 is a four-lane divided expressway, but the median is a simple narrow concrete curb (see **Figure 4-4**). On both US 395 approaches, left- and right-turn lanes are in place. In addition to the intersection of Muller Lane, three other intersections were studied by the NDOT and had safety countermeasures implemented.

FIGURE 4-4
US 395 Median Design

FIGURE 4-5
US 395 Turn Lanes on the North (left photo) and South (right photo) Approaches

The east-west crossing route, Muller Lane, has stop controlled approaches on both sides of the intersections. Also, left- and right-turn lanes have been provided on both approaches (see **Figure 4-6**). However, each approach has a single STOP sign. The intersection has had intersection lighting installed in all four quadrants.

FIGURE 4-6
Approach Design for the West (left photo) and East (right photo) Approaches

The collision diagram (**Appendix A**) shows that seven of the nine correctable crossing path crashes involved a vehicle on the west approach. However, the aerial image (**Appendix B**) does show that the east approach was a recent addition.

During the conference call to review the two intersections, the NDOT shared that a fatal crossing path crash had recently occurred at the intersection of US 395 & Muller Lane. While this elevated the interest in studying driver behavior at the intersection, the NDOT also shared that it is likely the intersection will be signalized within a year. This however makes the site less desirable for the research study.

5. Summary and Intersection Recommendation

A summary of the pertinent crash statistics has been summarized in **Table 5-1** for the two candidate intersections. Following is a set of general observations from the analysis and review of the New Hampshire candidate intersections.

- NDOT has applied various safety countermeasures at these intersections. It appears these countermeasures (minor street improvements such as street lights, and dual stop signs) have been very effective at preventing intersection recognition crashes at many of these locations, but have not been effective at addressing lag related crashes – a crash type which is over represented at the candidate intersections.
- The crash characteristics for the subset of high crash frequency intersections examined are very similar to the data for comparable intersections in Minnesota. The intersections have a crash rate greater than the critical crash rate (statistically significantly different than the expected value), the distribution of crash types is skewed to angle crashes, lag related, more severe than expected, and typically not caused by weather and/or light conditions.

5.1. Recommended Intersection for Deployment

Of the candidate intersections, US 50 & Sheckler Cutoff is the recommend location for the next phase of the study — temporary deployment of the vehicle surveillance system to monitor driver behavior. US 50 & Sheckler Cutoff was selected largely because it led in many of the investigated categories: the intersection had the highest frequency and percentage of crossing path crashes, the only intersection where the crash rate was above the critical crash rate, highest percentage of crossing path crashes resulting in an injury, and the greatest frequency and percentage of crossing path crashes where the driver error was attributed to selection of an unsafe lag.

Despite that US 50 & Sheckler Cutoff led most of the performance measurements, US 395 and Muller Lane was initially considered for implementation due to the recent fatal crossing path crash and the history of safety problems on that portion of the US 395 corridor. However, the probability that the intersection will be signalized in the near future will prevent the ability to perform a before-after analysis after an IDS design is finalized.

TABLE 5-1
Nevada Intersection Summary

Performance Measure	US 50 & Sheckler Cutoff (Churchill County)	US 395 & Muller Lane (Douglas County)
Crash Frequency	16	15
Crash Severity		
Fatal	0 (0%)	0 (0%)
Injury	5 (31%)	2 (13%)
PDO	11 (69%)	13 (87%)
Daily Entering ADT	12,950	32,000
Crash Rate	0.7	0.3
Expected Rate	0.4 (MN)	0.4 (MN)
Critical Crash Rate	0.6	0.5
Correctable Crash Type♦	11 (69%)	9 (60%)
Crash Severity		
Fatal	0 (0%)	0 (0%)
Injury	5 (45%)	2 (22%)
PDO	6 (55%)	7 (78%)
At-Fault Driver		
< 21	4 (36%)	1 (11%)
21 – 64	6 (55%)	5 (56%)
> 64	1 (9%)	1 (11%)
Unknown	0 (0%)	2 (22%)
Crash Location		
Farside	0 (0%)	1 (11%)
Nearside	11 (100%)	7 (78%)
Unknown	0 (0%)	1 (11%)
Contributing Factors		
Int Recg	0 (0%)	0 (0%)
Lag Recg	9 (82%)	6 (67%)
Unknown	2 (18%)	3 (33%)

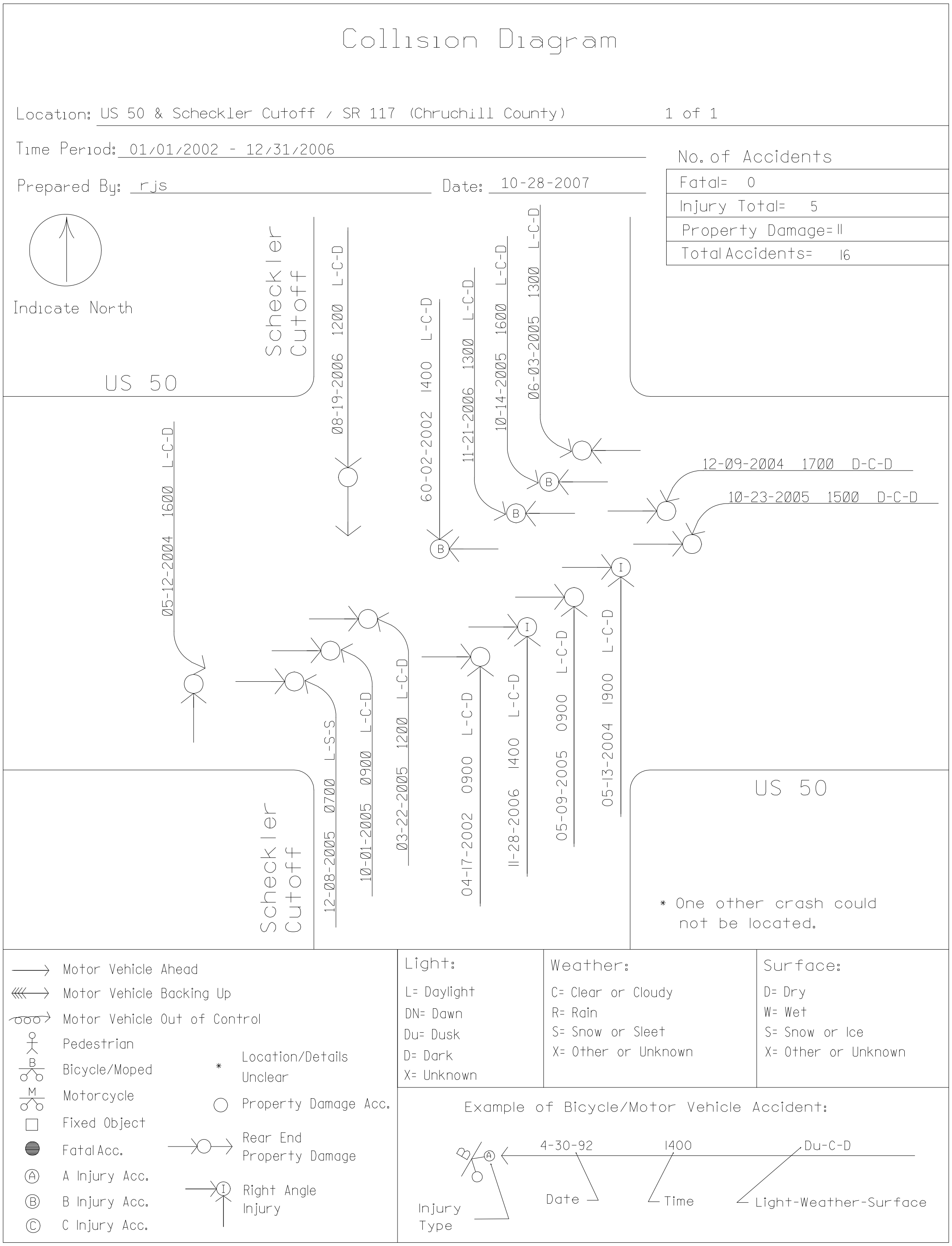
Note: Crashes at the candidate intersections occurred between January 1, 2002 and December 31, 2006.

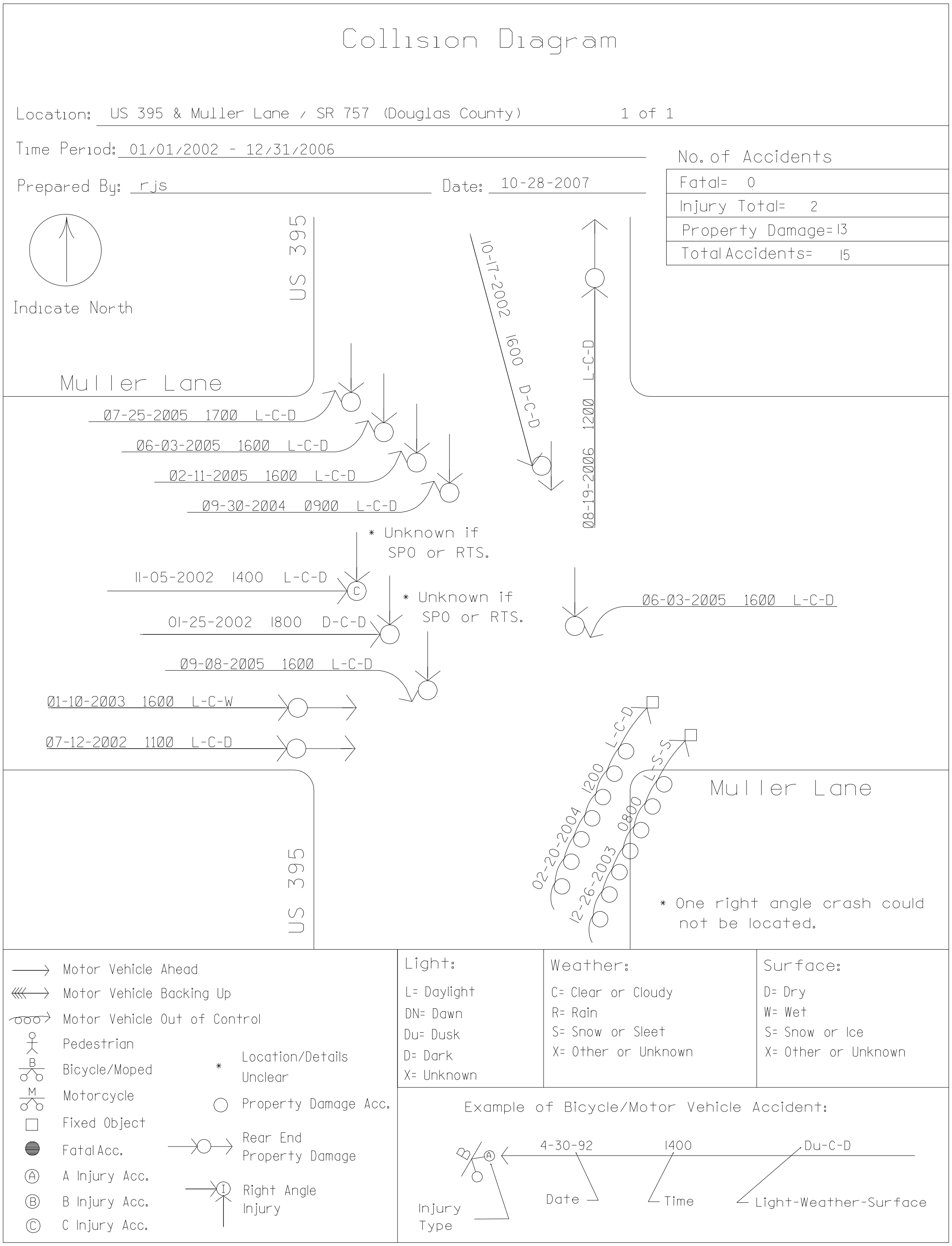
References

1. W.J Najm, J.A. Koopmann and D.L. Smith. *Analysis of Crossing Path Crash Countermeasure Systems*. Proceedings of the 17th International Technical Conference on the Enhanced Safety of Vehicles, Amsterdam, The Netherlands. June 2001.
2. K.A. Harder, J. Bloomfield, B.J. Chihak. *Crashes at Controlled Rural Intersection*. Report MN/RC-2003-15. (St. Paul: Local Road Research Board, Minnesota Department of Transportation. July 2003.)
3. T. Maze, N. Hawkins, G. Burchett. *Rural Expressway Synthesis of Practice and Crash Analysis*. CTRE Project 03-157. (Ames: Iowa Department of Transportation. October 2004.)
4. *Nevada Traffic Crashes 2003*. Available at http://www.nevadadot.com/reports_pubs/nv_crashes/2003/pdfs/intro.pdf. Nevada Department of Transportation, Carson City, Nevada. Last accessed July 2008.
5. H. Preston, R. Storm, M. Donath, C. Shankwitz. *Review of Minnesota's Rural Intersection Crashes: Methodology for Identifying Intersections for Intersection Decision Support*. Report MN/RC-2004-31. (St. Paul: Minnesota Department of Transportation. May 2004.)

Appendix A

Intersection Crash Diagrams


Collision Diagram
Location: US 50 & Scheckler Cutoff / SR 117 (Chruchill County)
1 of 1
Time Period: 01/01/2002 - 12/31/2006
Prepared By: rjs
Date: 10-28-2007
No. of Accidents
Fatal= 0
Injury Total= 5
Property Damage= 11
Total Accidents= 16
Indicate North
Scheckler Cutoff
US 50
08-19-2006 1200 L-C-D
60-02-2002 1400 L-C-D
11-21-2006 1300 L-C-D
10-14-2005 1600 L-C-D
06-03-2005 1300 L-C-D
12-09-2004 1700 D-C-D
10-23-2005 1500 D-C-D
05-12-2004 1600 L-C-D
12-08-2005 0700 L-S-S
10-01-2005 0900 L-C-D
03-22-2005 1200 L-C-D
04-17-2002 0900 L-C-D
11-28-2006 1400 L-C-D
05-09-2005 0900 L-C-D
05-13-2004 1900 L-C-D
US 50
Scheckler Cutoff
* One other crash could not be located.
Motor Vehicle Ahead
Motor Vehicle Backing Up
Motor Vehicle Out of Control
Pedestrian
Bicycle/Moped
Motorcycle
Fixed Object
Fatal Acc.
A Injury Acc.
B Injury Acc.
C Injury Acc.
Location/Details Unclear
Property Damage Acc.
Rear End Property Damage
Right Angle Injury
Light:
L= Daylight
DN= Dawn
Du= Dusk
D= Dark
X= Unknown
Weather:
C= Clear or Cloudy
R= Rain
S= Snow or Sleet
X= Other or Unknown
Surface:
D= Dry
W= Wet
S= Snow or Ice
X= Other or Unknown
Example of Bicycle/Motor Vehicle Accident:
4-30-92
1400
Du-C-D
Injury Type
Date
Time
Light-Weather-Surface


Collision Diagram
Location: US 395 & Muller Lane / SR 757 (Douglas County) 1 of 1
Time Period: 01/01/2002 - 12/31/2006
Prepared By: rjs
Date: 10-28-2007
No. of Accidents
Fatal= 0
Injury Total= 2
Property Damage= 13
Total Accidents= 15
Indicate North
US 395
Muller Lane
07-25-2005 1700 L-C-D
06-03-2005 1600 L-C-D
02-11-2005 1600 L-C-D
09-30-2004 0900 L-C-D
10-17-2002 1600 D-C-D
08-19-2006 1200 L-C-D
* Unknown if SPO or RTS.
11-05-2002 1400 L-C-D
01-25-2002 1800 D-C-D
* Unknown if SPO or RTS.
06-03-2005 1600 L-C-D
09-08-2005 1600 L-C-D
01-10-2003 1600 L-C-W
07-12-2002 1100 L-C-D
02-20-2004 1200 L-C-D
12-26-2003 0800 L-S-S
Muller Lane
US 395
* One right angle crash could not be located.
Motor Vehicle Ahead
Motor Vehicle Backing Up
Motor Vehicle Out of Control
Pedestrian
Bicycle/Moped
Motorcycle
Fixed Object
Fatal Acc.
A Injury Acc.
B Injury Acc.
C Injury Acc.
* Location/Details Unclear
Property Damage Acc.
Rear End Property Damage
Right Angle Injury
Light:
L= Daylight
DN= Dawn
Du= Dusk
D= Dark
X= Unknown
Weather:
C= Clear or Cloudy
R= Rain
S= Snow or Sleet
X= Other or Unknown
Surface:
D= Dry
W= Wet
S= Snow or Ice
X= Other or Unknown
Example of Bicycle/Motor Vehicle Accident:
4-30-92
1400
Du-C-D
Injury Type
Date
Time
Light-Weather-Surface

Appendix B

Aerial Photographs

FIGURE B-1
Aerial Photo of US 50 & Sheckler Cutoff (Churchill County)

Source: The image has been modified from the original. The base map is from Google Earth Pro, but the data are from CH2M HILL.

FIGURE B-2
Aerial Photo of US 395 & Muller Lane (Douglas County)

Source: The image has been modified from the original. The base map is from Google Earth Pro, but the data are from CH2M HILL.