

# Improving Safety for Slow Moving Vehicles on Iowa's High-Speed Rural Roadways



**Final Report**  
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**IOWA STATE UNIVERSITY**  
**Institute for Transportation**

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<b>16. Abstract</b>  Among the variety of road users and vehicle types that travel on U.S. public roadways, slow moving vehicles (SMVs) present unique safety and operations issues. SMVs include vehicles that do not maintain a constant speed of 25 mph, such as large farm equipment, construction vehicles, or horse-drawn buggies. Though the number of crashes involving SMVs is relatively small, SMV crashes tend to be severe. Additionally, SMVs can be encountered regularly on non-Interstate/non-expressway public roadways, but motorists may not be accustomed to these vehicles.  This project was designed to improve transportation safety for SMVs on Iowa's public roadway system. This report includes a literature review that shows various SMV statistics and laws across the United States, a crash study based on three years of Iowa SMV crash data, and recommendations from the SMV community.					
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# **IMPROVING SAFETY FOR SLOW MOVING VEHICLES ON IOWA'S HIGH-SPEED RURAL ROADWAYS**

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**Principal Investigator**

Neal R. Hawkins  
Associate Director for Traffic Operations  
Institute for Transportation, Iowa State University

**Co-Principal Investigator**

Shauna Hallmark  
Associate Professor  
Institute for Transportation, Iowa State University

**Research Assistant**

Cari Kinzenbau

**Authors**

Neal Hawkins, Cari Kinzenbau, Shauna Hallmark

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A report from  
**Institute for Transportation**  
**Iowa State University**  
2711 South Loop Drive, Suite 4700  
Ames, IA 50010-8664  
Phone: 515-294-8103  
Fax: 515-294-0467  
[www.intrans.iastate.edu](http://www.intrans.iastate.edu)



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## **EXECUTIVE SUMMARY**

This project was designed to improve transportation safety for slow moving vehicles (SMVs) on Iowa's public roadway system. This report includes a literature review that describes regional and national SMV crash statistics and laws across the United States, a crash study based on three years of Iowa SMV crash data, and the results of an inquiry into the concerns and recommendations of SMV communities in Iowa.

### **Background**

Among the variety of road users and vehicle types that travel on U.S. public roadways, SMVs present unique safety and operations issues. SMVs are generally defined as any vehicle that cannot maintain a constant speed of at least 25 mph, such as large farm equipment, construction vehicles, or horse-drawn buggies. These vehicles vary greatly in size, visibility, operating speeds (typically well below the posted speed), and maneuverability (dictated by driver experience).

Though the number of crashes involving SMVs is lower than the number of crashes involving other vehicle types, SMV crashes tend to be severe. A crash involving a slow moving agricultural vehicle is about five times more likely to result in a fatality than other crash types, and crashes involving horse-drawn vehicles tend to involve a high speed differential for the colliding vehicles and minimal safety protection for the horse-drawn vehicle occupants. Additionally, though SMVs can be encountered regularly on non-Interstate/non-expressway public roadways, motorists may not be accustomed to sharing the road with SMVs.

### **Current Safety Practices for Slow Moving Vehicles**

To accommodate SMVs safely on public roadways, various warning devices, countermeasures, and policies have been researched and developed. To improve visibility, devices such as a triangular SMV emblem with retroreflective tape or different configurations of flashing and static lights have been proposed for the SMVs. Additionally, warning signage has been installed in areas with potential safety issues. However, several studies have questioned the effectiveness of these devices. Other safety strategies may include requiring a learner's permit for SMV drivers (who often begin at a young age) or developing public education campaigns. Roadway improvements may also improve SMV safety, such as widening shoulders or installing pull-off lanes.

### **SMV Crash Characteristics in Iowa**

Crash data from 2004 to 2006 was used to characterize SMV crashes in Iowa. A total of 1,203 of these crashes occurred over the analysis period, with farm vehicles involved in half of the total (50%), construction/maintenance vehicles involved in 19%, and horse-drawn vehicles involved in 1%. The specific crash patterns for each of these SMV types differed by time of day, driver age, major cause, and other variables.

## **Feedback from Slow Moving Vehicle Communities**

To understand the concerns of SMV drivers, opinions were solicited from two of Iowa's Amish communities (in Buchanan and Davis Counties) and from a small sample of Marion County farmers in fall 2008. The major concerns for all SMV types include speed differential between the SMV and other vehicles, size and condition of the roadway shoulder, and motorist judgment/frustration.

Concerns specific to the horse-drawn vehicle drivers included the following:

- During shoulder maintenance, the Iowa Department of Transportation (Iowa DOT) has used large chunks of asphalt, which is jarring and dangerous for the horses.
- More shoulder room would help separate the horses from large trucks, which frighten the animals.
- Recently installed rumble strips can impede or injure the horses and are hard on the buggies.

Concerns specific to farm vehicle operators included the following:

- Due to the distance between farmers' fields and homes, farmers regularly travel on roads posted at 55 mph and sometimes along expressways posted at 65 mph.
- Generally, pulling over to let other motorists pass can put both drivers at risk due to obstacles in the shoulder, a soft shoulder, or limited maneuvering space.
- Vehicles do not give enough clear distance away from the tractor when passing.
- With the increasing size of farm equipment, the space available for a passing maneuver is diminishing, and seeing around the SMV to select a safe passing gap is difficult.
- Flashing yellow lights placed on tractors seem to get a better reaction than the SMV emblem.

## **Findings and Recommendations**

SMV safety on Iowa's high speed roadways should be based on an understanding of crash performance and input from these special groups. A practical approach should include the following:

- A systematic approach to identifying specific safety problems
- Close coordination with the community
- Identification of solutions
- Local involvement in the process

Agencies can begin by taking the following steps:

- Identifying roadways where horses and buggies or other SMVs mix with vehicular traffic

- Reviewing and analyzing routes with evident buggy traffic to identify problem areas
- Recognizing that the needs and solutions for different SMV types vary greatly, e.g., horse versus motor powered SMV
- Considering the adequacy of existing roadway signage, lighting, grade, curvature, pavement treatments, shoulder treatments, and shoulder widths
- Identifying short and long term needs and solutions
- Reaching out to local groups and creating a dialogue to exchange ideas, share constraints, and plan for long term solutions
- Coordinating activities between City, County, and State agencies in order to maintain consistent signage and roadway treatments and address the safety needs of the SMV roadway users
- Developing consistent safety campaign information for driver awareness and understanding

SMV operators should take the following steps:

- Go beyond minimal lighting and conspicuity requirements to alert motorists of their presence
- Notify agencies of their concerns in areas which offer minimal sight distance and no shoulder or ability to get out of the traveled lane
- Educate operators to drive safely on the roadway and operate their vehicles consistently



## 1. BACKGROUND

State and local agencies within the United States are tasked with providing public roadways that serve a wide variety of user and vehicle types. This report places a focus on the safety and operations for slow moving vehicles (SMVs) on the public roadway. Motivation for this review is based upon the fact that a crash involving a slow moving agricultural vehicle is about five times more likely to result in a fatality than other types of crashes (Iowa Highway Safety Management System, 2001) and the fact that past research suggests that fatal crashes involving farm vehicles are related to vehicle and environmental factors that are changeable (Gerberich et al., 1996).

As illustrated in Figure 1-1, the SMV can be encountered regularly on the public roadway (with the exception of expressway and Interstate public roadways). These vehicles vary greatly in size, visibility, and operating speeds (typically well below the posted speed). The ability to start, stop, and basically guide the vehicle down the roadway is dictated by driver experience, which can also vary greatly. By definition, an SMV is considered to be any vehicle that cannot keep a constant speed of 25 mph or greater (Farm Safety Association, 2002). For the purposes of this report, the above definition is taken loosely to include all farm and agricultural-related vehicles (regardless of specific speed capabilities). High-speed roadways are considered to be those roadways having a posted speed of 45 mph and above.



**Figure 1-1. Common slow moving vehicles on the public roadway**

As illustrated in Figure 1-2, horse-drawn vehicles are also considered within the SMV classification, but these vehicles are not as common and are typically localized to areas populated by followers of the “Old Order” of their religious heritage (Scott, 1998). This unique type of SMV can be alarming to motorists, given the large speed differential (compared to normal vehicle traffic), unpredictability (horse reaction to traffic), and minimal vehicle protection (exposure to impact).



**Figure 1-2. Horse-drawn SMV examples on the public roadway**

When passenger vehicles and trucks meet up with an SMV on the public roadway, the SMV can become a nuisance and safety concern for all involved. A few of the major concerns for all SMV types are noted below:

- **Speed Differential.** With a 20 to 40 mph speed differential between vehicles, an unfortunate element of surprise often exists. The gravity of the situation for vehicles interacting with SMVs becomes apparent when considering the rate of closure between vehicles. For example, a vehicle traveling at 55 mph will completely close a 500 foot gap on a lead vehicle traveling 45 mph in 34 seconds. If the lead vehicle is traveling at 25 mph, as is the case with many farm vehicles, the time to react goes down to 11.2 seconds. If the lead vehicle is traveling at 5 mph, as with horse-drawn buggies, the time to react falls to 6.8 seconds. The speed differential between SMVs and normal traffic flow has created a serious transportation safety concern over the last 50 years (Garvey, 2003).

- **Roadway Shoulder.** An SMV operator may try to scan behind the vehicle for approaching traffic, but simply moving onto the roadway shoulder is not always an option. In some cases, the SMV may be extra wide or there may be insufficient shoulder width or shoulder stability. In these situations, motorists can make poor choices in maneuvering around the much slower traveling SMV.
- **Driver Judgment/Frustration.** Passing maneuvers around SMVs can become dangerous for all involved due to misjudged gaps in traffic or simply the inability to see around the SMV. SMV safety equipment (e.g. tail reflectors, turn signals, head lights, flashers, etc.) can be faulty or nonexistent so that the slow moving vehicle's intent, such as intent to turn, is not communicated to other drivers. SMV operators can also misjudge gaps. While crossing a public roadway, the SMV operator may misjudge the needed gap time to clear all lanes. Sight distance issues on rural two-lane roads also increase risk for all drivers.

This study is focused on improving transportation safety for SMVs on the public roadway system in Iowa. This report includes a literature review showing various SMV statistics and laws across the United States, a crash study based on three years of Iowa SMV crash data, and recommendations from the SMV community. Improving the visibility and safety of SMVs should be a continuous goal, with a focus and effort equal to that given to vehicles and pedestrians.

## 2. MAGNITUDE OF THE PROBLEM

### 2.1 Agricultural Equipment

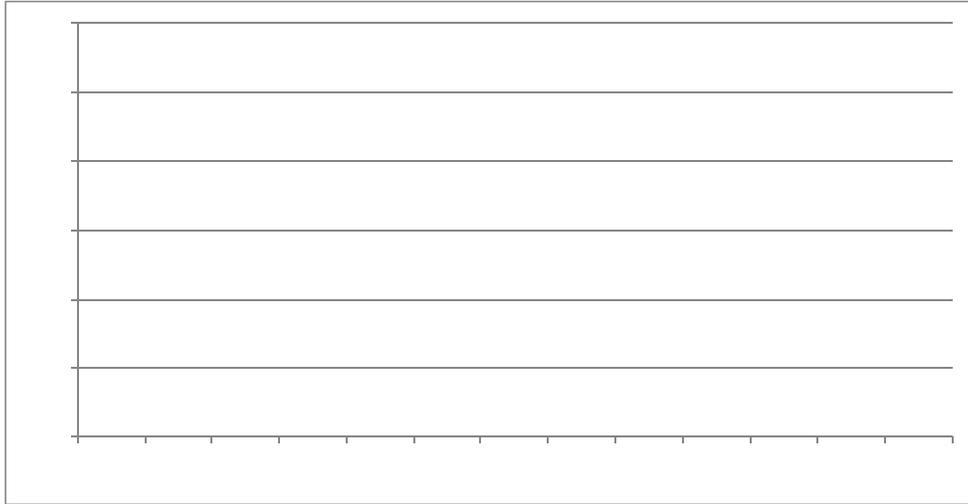
#### *Nationally*

The United States census definition of a farm is any place from which \$1,000 or more of agricultural products were produced and sold, or normally would have been sold, during the census year. According to the U.S. Department of Agriculture (USDA), 2.2 million farms were recorded in the United States during the 2007 census, and of these almost 90% had at least one motorized tractor in use for farming purposes and pulling agricultural equipment. Table 2-1 shows other relevant farm census information, including the fact that approximately 50% of the tractors had a rollover protective structure (ROPS) (USDA, 2002a). A ROPS is “a cab or frame that provides a safe environment for the tractor operator in the event of a rollover” (University of Illinois Safety Specialist).

**Table 2-1. 2007 census of agriculture**

2007 Census – National	
Total Number of Farms	2,204,792
Average Farm Size in Acres	418
Average Age of Principal Operator	57.1
Farms having at least 1 tractor	89%
Farms having at least 2 or 3 tractors	33%
Farms having at least 4 or more tractors	17%
Average Tractor Age in Years	25.7
Tractors having (ROPS)	50%

According to the Fatal Accident Reporting System (FARS), the number of farm vehicles (not trucks) involved in fatal crashes over the eight-year period from 1994 to 2007 averaged 98 vehicles per year. Figure 2-1 shows this information graphically by year, and Figure 2-2 shows 2007 data for the total acres of land in farms as a percent of total land area.



**Figure 2-1. Number of farm vehicles (not trucks) in fatal crashes by year for USA from 1994 to 2007 (FARS)**

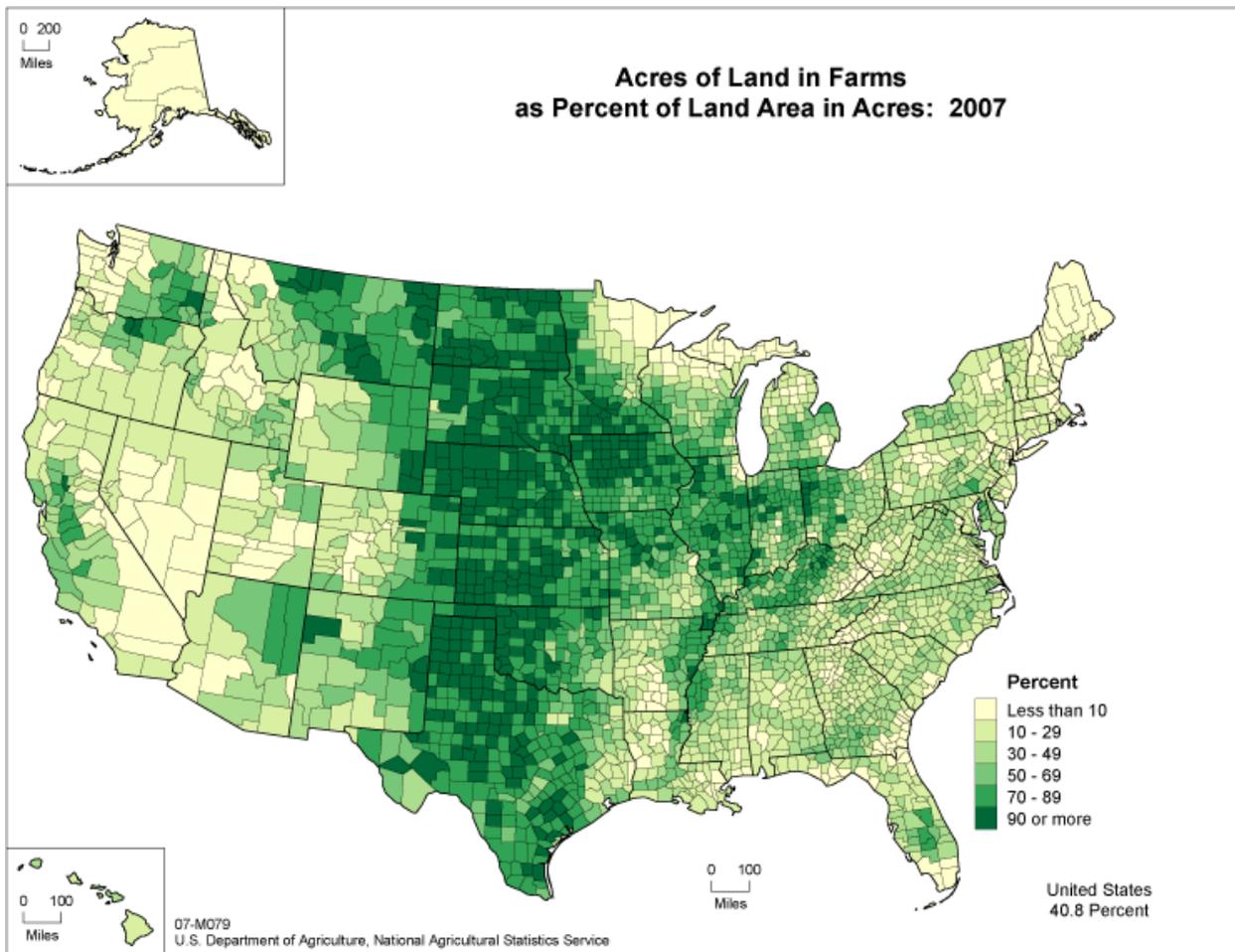


Image source: USDA, 2007

**Figure 2-2. Total acres of land in farms as a percent of total acres 2007**

Agricultural-related collision fatalities and injuries have more significance when placed in the context of the agricultural population or when evaluated based on exposure rates in the agricultural industry. A 2003 report on work-related roadway crashes by the National Institute for Occupational Safety and Health (NIOSH) showed that while the agriculture, forestry, and fishing industries had a comparatively low frequency of fatal crashes among all industrial divisions (7.2%, the 4th lowest of the 11 major divisions), the industries' rate per 100,000 full-time-equivalent (FTE) workers (2.58 FTEs) was the third highest rate (Pratt, 2003).

Because the proportion of incidents is so small in comparison to all public roadway crashes, federal, state, and local government bodies rarely give this area of roadway safety any attention. Nor do non-agricultural industry groups. For example, the American Traffic Safety Services Association (ATSSA) recently published *Toward Zero Deaths: A Vision for Safer Roads in America*. This document contains a section and recommendations for improving high-risk rural roads but does not mention agricultural equipment (ATSSA, 2008).

### *Iowa*

According to USDA, there were 92,856 farms in Iowa with a total of 30,747,550 acres in the 2007 census. The proportion of total land area used as farms was 86%. (USDA, 2007b).

Lehtola et al. (1994) reported that the percentage of Iowa tractor-related crashes resulting in a fatality increased from a rate of 9% (1988–1990) to a rate of 22% (1991–1992).

The Iowa Department of Transportation (Iowa DOT) reported a total of 1,477 farm vehicle crashes on public roads during the 1988 to 1990 time period. The month of October had nearly twice as many crashes as any other month. The three most common crash types were left-turn (22% of total), rear-end (20%), and passing (4%). Consistent with national statistics, "Iowa DOT crash data also indicate that a crash involving a slow moving agricultural vehicle is about five times more likely to result in a fatality than other types of crashes" (Iowa Highway Safety Management System, 2001).

In a separate study, Flynn (1994) reported that there were 1,490 SMV crashes in Iowa from 1988 to 1992, and the percentage of left turn crashes was 22.4%. Sideswipe and angle crashes accounted for 38.3% of all crashes (including left-turn crashes). The road surface conditions were dry in 79.1% of the crashes, and the drivers' ages were found to be a noncontributing factor. Crashes by time of day showed that 81% were during daylight hours, with peaks occurring between the hours of noon to 4:00 P.M. and 4:00 to 8:00 P.M (Flynn, 1994).

The Iowa DOT reported that there were a total of 586 farm vehicle-related crashes from 2004 to 2006, roughly 195 per year. Of these, 22 resulted in fatalities. Seasonally, the majority of crashes occurred during the month of October, with more than 250, followed by November with around 180 and June with just over 150 crashes (Falb, 2008).

Gerberich et al. (1996) investigated injury fatality rates for workers in all occupations within Iowa. In contrast to the overall injury rate of 9 in 100,000, the farm fatality rate was found to be 48 in 100,000. This farm fatality rate was among the highest in the nation in 1988. In 1993 the rates were still 8 and 35 in 100,000, respectively, which had not dropped significantly from the previous high in 1988. The researchers also suggested from their findings that fatal crashes involving farm vehicles are related to vehicle and environmental factors that are changeable. These factors include the design characteristics of the farm vehicles that experience a high percentage of overturns associated with farm vehicle crashes (21%) as compared to non-farm vehicles (9%). Visibility factors are also common because a large percentage of farm vehicle crashes are rear-end crashes, compared to 4% of non-farm vehicle crashes. This suggests a need to consider visibility aids to allow for better perception of the farm vehicles by other vehicles on the roadway (Gerberich et al., 1996).

### *Ohio*

According to USDA, there were 75,861 farms in Ohio with a total of 13,956,563 acres in the 2007 census. The proportion of total land area used as farms was 53%. (USDA, 2007b).

Glascok (1995) reported 1,432 farm vehicle crashes in Ohio from 1989 to 1992. Left turning crashes were the most common type at 52%. A significant crash factor was the failure by the other driver to recognize that the farm vehicle was making a left turn. Of the total, 78% occurred during daylight hours, with the majority of crashes between the hours of noon and 6:00 P.M. Roughly 42% of the crashes under dark conditions were rear-end crashes (Glascok, 1995).

### *North Carolina*

According to USDA, there were 52,913 farms in North Carolina with a total of 8,474,671 acres in the 2007 census. The proportion of total land area used as farms was 27%. (USDA, 2007b).

Costello et al. (2002) showed that the North Carolina farmers' greatest safety concern was driving farm vehicles on public roads. A common opinion among survey respondents was that sharing public roads had become more dangerous between the years of 1995 and 1999. The increased population in counties that are major agricultural producers has caused increased competition for public road use. A study of crashes during that five year period showed a peak between 3:00 P.M. and 6:00 P.M. (Costello et al., 2002). Another North Carolina study of farm vehicle crashes from 1991 through 1999 indicated that rear-end and left turning crashes made up more than 50% of the crashes reported. This study also indicated that the frequency of farm vehicle crashes over the last 35 years in North Carolina had changed very little. Even though there was little change in crash frequency, the fatality rate for the agricultural industry was still six times higher than the rate for all industries in 1999 (Lacy et al., 2003).

## 2.2 Horse-Drawn Vehicles

Old Order Amish, Mennonite, German Baptist, or River Brethren communities commonly use horse-drawn vehicles as a form of transportation. These religious communities are found in 20 different states in the U.S., as well as Ontario and other places in Canada. In 1990, it was estimated that the Amish population in the United States was 127,800, which was a significant increase from the 3,700 estimated in 1900 (Meyers, 1990).

The types and styles of horse-drawn vehicles used are subject to local custom and church regulation. Distinctive features have developed over the years in each community and group. Variations due to personal preference are at a minimum. Horse-drawn vehicles follow four general styles: Pennsylvania, Ohio, Indiana, and Swiss (Scott, 1998). The average horse-drawn buggy is six feet wide and travels at 5 to 8 mph. Since they are legally allowed to use non-expressway public roadways, the interaction between motor vehicles and horse-drawn buggies can lead to conflicts and delays. The interaction between buggies and motor vehicles can be particularly problematic when drivers are not accustomed to sharing the road with horse-drawn vehicles. According to an Ohio study, tourists who are unfamiliar with the Amish communities tend to drive more slowly while observing buggies due to the tourists' unfamiliarity with the road system. Because of this, tourists are seen as less of a problem to the traffic mix than the local motoring public (O'Connor, 2000).

Crash severity for horse-drawn vehicles is severe. This is a result of the high speed differential and the minimal safety protection for the horse-drawn vehicle occupants. A fire chief responding to a horse-drawn buggy crash in Ohio described the crash as, "The buggy just blew apart, ejecting two adults and seven children onto the roadway." Figure 2-3 shows a photo of this crash occurring on June 13, 2007 in Middlefield, Ohio.



(image source: Whitaker, 2007)

**Figure 2-3. Amish buggy in crash in Middeltown, Ohio**

Another example occurred on October 29, 2006 in Salisbury, Pennsylvania, which resulted in two serious injuries to children. Figure 2-4 shows the remains of the buggy after it was struck from behind by a sport utility vehicle (SUV). The driver of the SUV was reported to have had obscured vision when she was blinded by the sun and came up on the buggy too quickly, rear-ending it (Bal, 2007).



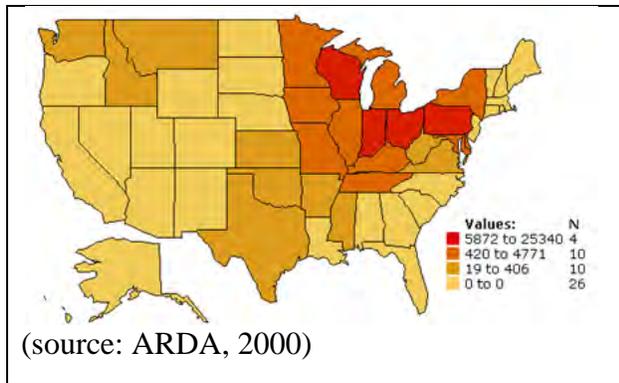
(image source: Bal, 2007)

**Figure 2-4. Horse and buggy crash with SUV in Salisbury, Pennsylvania**

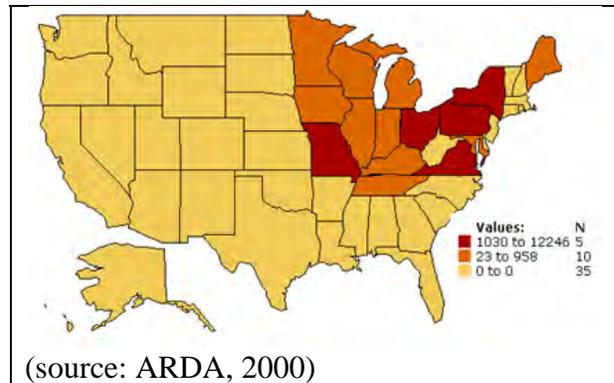
This literature search did not reveal any published national horse-drawn vehicle statistics. However, the scope of the crash problem in Iowa and Ohio are discussed in the following sections.

### *Iowa*

Horse-drawn buggies are used by the Old Order community members, including both Amish and Mennonite congregations. These groups do not use automobiles in an effort to remove themselves from easy access to the ways of the world (Pa Dutch, 2007). The U.S. Census does not produce data on the religious population throughout the United States. However, the Association of Religion Data Archives (ARDA, 2000) does collect and report this information. The Old Order Amish population in the United States is shown in Figure 2-5. and the Old Order Mennonite population is shown in Figure 2-6.

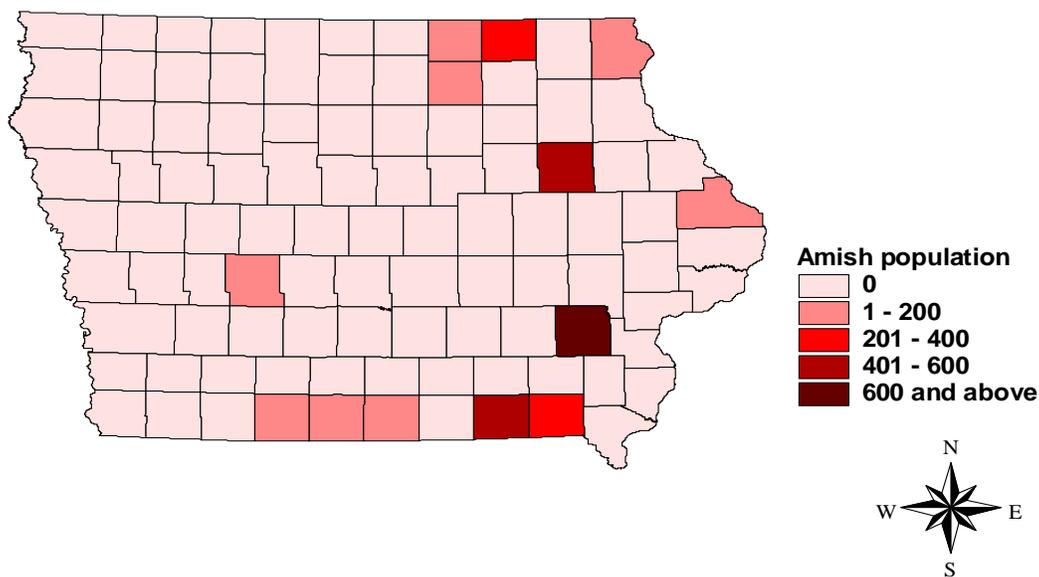


**Figure 2-5. Total adherents to the Old Order Amish Congregation**



**Figure 2-6. Total adherents to the Old Order Mennonite Congregation**

ARDA reports that in 2000 Iowa ranked 5<sup>th</sup> among states having Old Order Amish populations (38 congregations and 2,601 adherents and 24<sup>th</sup>, among states having Old Order Mennonite populations (4,584 adherents) Figure 2-7 shows the Amish population across Iowa in 2000. The Old Order communities are located in northeast and south/southeastern Iowa. The most heavily populated Amish county is Washington County in southeastern Iowa, with a large Old Order Amish community in the Kalona, Iowa, community that has 621 adherents. Davis and Buchanan Counties in southern Iowa also have large Old Order Amish populations, with communities of 483 and 420 adherents, respectively (State Data Center of Iowa, 2000).



**Figure 2-7. Iowa Amish population (2000)**

## *Ohio*

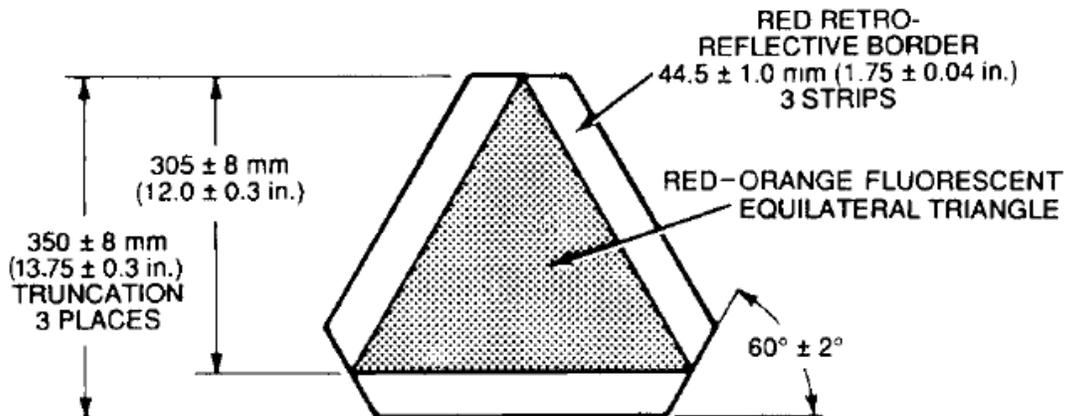
The Ohio State University Extension website provides various statistics for horse-drawn vehicle crashes. The Ohio Department of Public Safety performed an analysis on 500 incidences with horse-drawn buggies between 1990 and 1993. Of the total horse and buggy crashes, 42% were rear-impact crashes, 37% were side-impact crashes, and 8% of the crashes were fatal crashes. Buggy-related crashes were found to occur during both daytime and nighttime hours between the hours of 5:00 A.M. to 10:00 P.M., respectively. Peak periods for crashes were found to occur during the following hours, along with the corresponding percentage of total horse and buggy crashes that occurred during that time period: 21% between 5:00 and 7:00 A.M., 18% between 1:00 and 3:00 P.M., and 29% between 5:00 P.M. and 7:00 P.M. (OSU Extension Agricultural Safety and Public Health, 2007).

### 3. CURRENT PRACTICES TO MITIGATE SLOW MOVING VEHICLE CRASHES

In order to facilitate safer road use between slow moving and regular vehicles, national organizations have proposed various safety measures. Most states also have requirements for the markings on an SMV. This section discusses current national, state, and local practices to mitigate crashes involving slow moving vehicles.

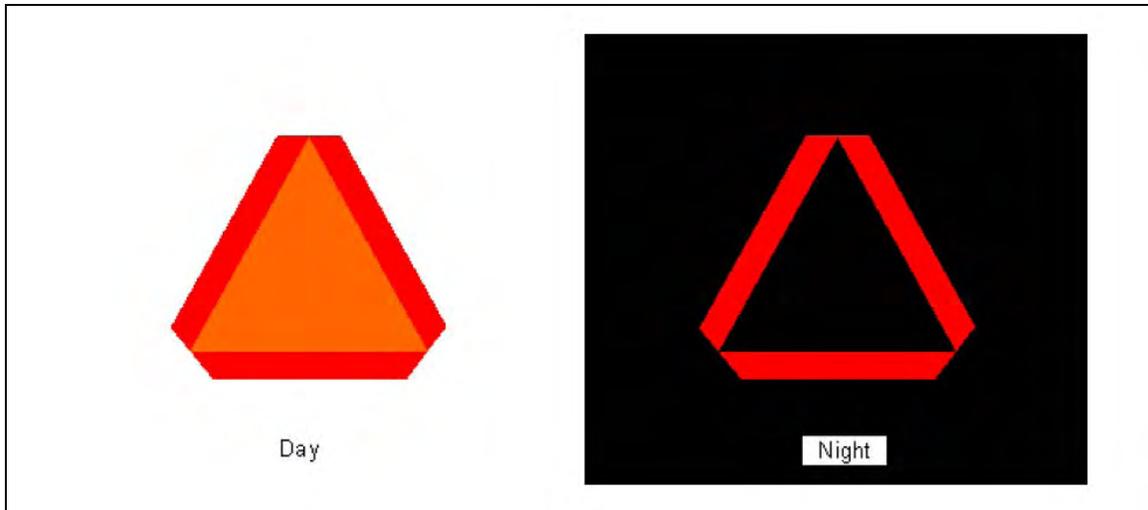
#### 3.1 SMV Warning Devices

The SMV emblem was developed to identify slower vehicles on the roadway. According to the Farm Safety Association (2002), an SMV is considered any vehicle that cannot keep a constant speed of 25 mph or greater. However, different states define a SMV differently for the purposes of requiring a SMV emblem. Iowa requires an SMV emblem on vehicles traveling 35 mph or less, while Minnesota has a speed requirement of 30 mph or less. One other state requires vehicles traveling 25 mph or less to use SMV emblems. The SMV emblem is identified as a “fluorescent, orange equilateral triangle with a red retroreflective tape.” The red-orange fluorescent triangle provides for daylight identification. The red retroreflective border “appears as a hollow red triangle in the path of motor vehicle headlights at night” (ASAE, 2005). Dimensioning and other specifics of the emblem are shown in Figure 3-1, and the emblem’s coloring is shown in Figure 3-2.



(image source: ASAE, 2005)

**Figure 3-1. Dimensions for SMV identification emblem**



(image source: Garvey, 2003)

**Figure 3-2. SMV identification emblem: day vs. night**

### *SMV Emblem - History*

In the late 1950s, a 10-year retrospective study of fatal tractor accidents was conducted by Walter McClure and Ben Lamp, both of the Department of Agricultural Engineering at The Ohio State University (AEOSU), to understand the crashes' nature and causes. The research indicated a significant number of fatalities related to highway travel of SMVs. A research proposal written by Ken Harkness (AEOSU) and funded through the Automotive Safety Foundation (1961–62) further focused understanding of SMV accidents and resulted in the development of a unique SMV emblem (Harkness and Stuckey, 1963). Early data estimated that 65% of the motor vehicle accidents involving SMVs were rear-end collisions. The Ohio State Highway Patrol, county sheriffs, and municipal police cooperated in the research by gathering detailed data on 708 SMV accidents.

In 1962, under the supervision of Ken Harkness, the design and testing of the SMV emblem was completed. A 1/16 scale highway simulator had been constructed to test human recognition rates of different shapes and colors mounted on simulated SMVs. After testing various designs, a triangular-shaped emblem with a 12 inch high fluorescent orange center and three 1 3/4 inch wide reflective borders was determined to be the most effective design for day and night visual identification.

The Goodyear Rubber and Tire Company sponsored initial public exposure to the SMV emblem in 1962. An emblem mounted on the back of a farm wagon and towed by a Ford tractor made a 3,689 mile trip from Portland, Maine, to San Diego, California.

The first formal introduction of the SMV emblem was at a University of Iowa Invitational Safety Seminar in 1962. Carlton Zink of Deere and Company then became an avid promoter of the

SMV emblem and played a major role in the adoption of the emblem by the American Society of Agricultural Engineers (ASAE).

In 1963, Novice G. Fawcett, President of The Ohio State University, dedicated the SMV emblem to the public. Also in 1963, the Agricultural Engineering Journal printed its first article with color illustrations of the SMV emblem. The National Safety Council promoted the adoption of the emblem and awarded a Certificate of Commendation to Ken Harkness.

In less than two years from the emblem's first date of availability, Nebraska, Michigan, Ohio, and Vermont adopted legislation requiring the emblem to be used on SMVs. Safety Leader Bill Stuckey, an Ohio Farm and Home Safety Committee member, spearheaded the adoption of the SMV emblem in Ohio. In 1967, the Canadian Standards Association (CSA) adopted the SMV emblem as a CSA standard. In 1971, the SMV emblem became the first ASAE standard to be adopted as a national standard by the American National Standards Institute (ANSI).

#### *SMV Emblem – Comprehension Studies*

The comprehensibility of the emblem was evaluated in a study by Philip Garvey (2003). The study suggested that the public does not comprehend the SMV emblem due to the symbol's non-uniformity (different night versus day appearance). Two reasons were proposed. The SMV emblem is used for other purposes in addition to marking SMVs, such as marking driveways and mailboxes or trees, even though it is illegal to do so (NASD, 2002). Also, the warning triangles used by the driver of a stalled truck look like the SMV emblem at night, yet they have a different meaning. These factors may contribute to a misunderstanding of the SMV meaning. In Garvey's study, open-ended responses to the presentation of a scale-model SMV emblem displayed in its daytime and nighttime appearance were given by over 100 male and female drivers from 18 to 84 years of age. The overall correct response for the recognition of the SMV emblem was under 30%. Just over half of the participants recognized that the nighttime and daytime appearance of the symbol were actually two manifestations resulting from the same device, which means that just under half failed to even recognize that the two pictures were of the same SMV emblem.

Another study by Lehtola (2007) was conducted at the University of Florida, in which 30 students were polled to determine what they knew about the "orange triangle" (SMV emblem) that was displayed in an Agricultural Operations Management class. Two-thirds of the students responded incorrectly. The two most common incorrect responses were that it was the hazard symbol placed near disabled vehicles or that it was used to warn about construction hazards. This is consistent with Garvey's (2003) theory that the incomprehensibility of the emblem may be due to a similarity between appearances of the SMV emblem and the warning triangles placed by stalled trucks. Lehtola also mentions the inconsistency in driver education on the SMV emblem. The study suggests the need for a national model that states can adopt for their driver manuals, such as the "sharing the road with trucks" pages that were developed by the Share the Road Safely Coalition and were adopted by 46 states.

Though certain problems may exist with the SMV emblem, a study does show a decline in certain types of accidents after the introduction of the SMV emblem (Rooney, 2007). So although

the SMV emblem may not prove to be the most effective mitigation strategy, it is determined to be effective against the do-nothing alternative.

#### *Other Warning Devices - Warning Flag*

The warning flag device is a red flag to be attached to the rear of a slow moving vehicle or trailer when used on highways. The purpose of the flag is to provide a warning device that is inexpensive to construct. It is also intended to be easily fitted and mountable to a slow moving vehicle or trailer and also conveniently stored. The device also provides a durable and weather-resistant warning apparatus. A study by Asper (1972) compared the visibility of the SMV emblem and the red flag. The results of the study showed that subjects detected the SMV emblem at a significantly greater distance than the red flag regardless of age, sex, or place of residence. The mean detection times of the SMV emblem over the red flag would allow motorists traveling at 50 mph an additional 270 feet of warning when approaching the rear of a farm vehicle displaying the SMV emblem.

#### *Other Warning Devices - Rear Signaling System*

Rear-end crashes are the most frequently occurring type of crashes involving SMVs, making up more than one fourth of all accidents and crashes in which the lead vehicle is stopped or moving very slowly prior to the collision. These crashes are especially serious, accounting for about two thirds of all crashes. The magnitude of the rear-end crash problem has been a source of concern for a number of years, and much effort has been put forth to reduce this type of crash. A study by Wierwille et al. (2006), which has possible carryover to SMVs, was conducted to facilitate improvement of the attention-getting capability of an alternating pair of lamps. In the main experiment, an oscillating narrow beam lamp and an improved alternating pair were compared with ordinary rear lighting (see Figure 3-3). In the study, 72 drivers were purposely distracted by in-vehicle tasks as the lead (surrogate) vehicle braked hard. Results showed improvements of 0.25 to 0.35 seconds in brake activation times for the two enhanced configurations as compared to ordinary rear lighting. The conclusion was that the two enhanced lighting configurations show promise in reducing the number and severity of rear-end crashes. The methods and results of this study can be applied to the future design and evaluation of automotive rear-end lighting design. The findings could also benefit other SMV traffic.



(image source: Weirwille, 2006)

**Figure 3-3. Example of an imminent warning lighting signal**

#### *Other Warning Devices - Triangle with Amber Flashing Lights*

Another symbol with potential to reduce accidents for SMVs was analyzed by A.J. Francis in a 1971 study, where a red hollow triangle with a 4 inch amber flashing light on each corner was evaluated (Francis, 1971). The symbol was evaluated on a four-lane divided road and was intended for low-speed trucks. The findings were that the drivers changed lanes at a greater distance from the truck and approached it more slowly when the symbol was present. The study suggests that the device is likely to reduce the possibility of a collision and that the symbol could be used when trucks are traveling at less than 20 mph outside of a 30 mph area.

#### *Other Warning Devices - Four-Way Flashers*

Disabled and slow moving vehicles were examined in a study of the effectiveness of four-way flashers. The study was done under both daylight and nighttime conditions. For the SMV tests, the effects of red and amber flashers at 30 and 40 mph were examined. The four-way flashers were found to be effective at reducing the inherent danger. Vehicles overtaking the slow moving vehicles approached more cautiously and passed more carefully (Knoblauch and Tobey, 1980).

Another study by Lanman et al. (1979) examined the relative effectiveness of roadside signs and vehicle markings for warning motorists of a SMV ahead on a rural two-lane road. The results of the study showed that the use of standard four-way flashers is an effective device for reducing the hazardousness of the overtaking situation relative to reaction distance, speed reduction, and following characteristics. The other strategies, particularly roadside signage, had no lasting effects relative to the overtaking maneuver. An article on the same study explained results consistent with Lanman et al. (1979). The study was conducted in Maine on a two-lane road and examined the effects of using four-way flashers and advance warning signs for SMVs. When comparing the results of the devices tested, the four-way flashers proved to be the most effective for decreasing the potential of a dangerous conflict when a faster moving vehicle overtakes an SMV on an upgrade. Positive effects included improved initial reaction distance, closing rate, and minimum headways. The study also showed that the four-way flashers were as effective during the day as they were at night (Lyles, 1982).

Lacy et al. (2003) also recommended research into the costs and benefits of requiring all new farm vehicles to have flashing beacons permanently fixed to the vehicle.

### *Advanced Warning Signage*

Figure 3-4 shows the most recent MUTCD SMV-related advanced warning signage. The W11-5 is shown as a diamond-shaped sign with a symbol of a left-facing tractor and driver. The W11-5a is shown as a diamond-shaped sign with an oblique symbol of a tractor. The W11-14 is shown as a diamond-shaped sign with a symbol of a left-facing horse and closed buggy.

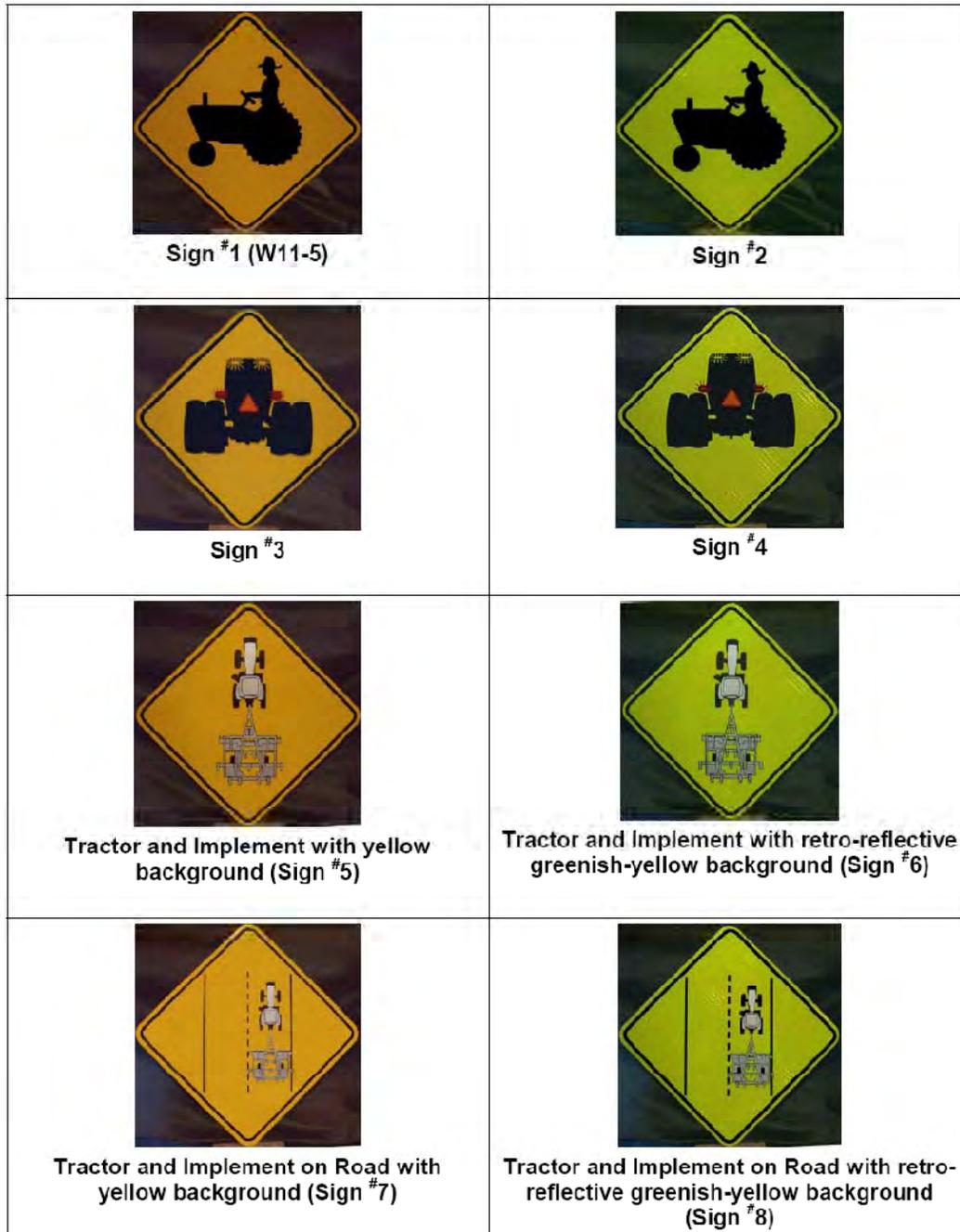


(image source: FHWA, MUTCD 2003)

**Figure 3-4. Current MUTCD advance warning signs for SMV**

The farm equipment hazard roadway sign, W11-5, has been available for more than 40 years. One project took on the task of updating the sign to better represent such a tractor and alert motorists to be aware of the possible presence of farm machinery on the road ahead. A survey was done with the original sign and three updated signs to determine which sign conveyed the meaning of “be aware of farm machinery ahead” the best. These signs are shown in Figure 3-5. The four different signs are shown with two different backgrounds to determine which color would be best for the hazard warning sign. Most of the high school and farm bureau member respondents thought the meaning of the current farm machinery hazard sign was to warn of a farm tractor crossing ahead. Most of those who participated in the online survey thought the correct meaning. Thus, from the study it is unclear if the intended meaning is really understood

by persons who may be affected by the sign. Furthermore, no one sign was found to display the intended meaning any better than another. Therefore, it was acknowledged that more research would need to be done in order to come up with proper signage to warn of farm machinery ahead (Legault & Sheldon, 2004).



(image source: Legault & Sheldon, 2004)

**Figure 3-5. Experimental advance warning signs for SMV**

### *Other Possible Strategies – Learner’s Permit*

In the North Carolina study by Lacy et al. (2003), one of the recommendations was to require a learner’s permit in order to operate a farm vehicle on the public highways. The report indicated that three of the top five contributing factors for the farm vehicle operators in farm vehicle crashes were driver behavior violations such as safe movement violations, improper or lack of signal, and failure to yield. In North Carolina, farm vehicle operators are not required to have a license, with exemptions in the North Carolina General Statutes. Individuals as young as 14 years old can operate farm vehicles on highways adjacent to their homes or fields if the person is actually engaged in farm operations. Therefore, farm equipment operators are not exposed to or required to learn the laws of operating a farm vehicle on the public roadways. Farm operators may be uninformed and, therefore, unqualified to operate machinery on public roadways. Requiring a learner’s permit would allow all operators of farm vehicles to have been exposed to the minimum requirements to safely operate a vehicle on the highways.

### *Other Possible Strategies – Safety Sticker/Safety Brochure*

Other SMV signage has been developed as another possible strategy. One such sign is a sticker to be placed on agricultural equipment driven on highways. Figure 3-6 shows the sticker, which says, “Sorry for the delay. Farmgate to dinner plate – good food comes to those who wait....” It has been developed by NFU Scotland in hopes of decreasing rural road deaths. The purpose of the sticker is to apologize to motorists for the delay caused by the tractors while also reminding drivers that the farmers are busy producing the food that they eat. By relieving drivers’ frustrations, the sign may help to prevent accidents (Gillanders, 2007).



(image source: Gillanders, 2007)

**Figure 3-6. Special (safety plea) sticker for SMVs**

*Other Possible Strategies – Safety Information Campaign*

There are numerous examples illustrating print, radio, and other media designed to address safety issues related to SMVs. These media deal with such issues as proper use of the SMV sign, tips for farmers on driving, tips for vehicle drivers, etc. Figures 3-7 and 3-8 show an Ohio example sponsored by the Pennsylvania Farm Bureau.

**Do You Recognize these Symbols?**

Less than 30% of drivers know what these symbols mean.\* But it's a matter of life and death for drivers of automobiles, farm equipment, and animal-drawn vehicles on rural roads.

This is a daytime view of the slow moving vehicle emblem. It is to be displayed on animal-drawn vehicles and on other vehicles designed to travel at speeds of 25 mph or less. It is not simply a reflector- it is a warning to slow down.



Occasionally you may encounter slow moving vehicles traveling at night. The SMV emblem's red border is designed for nighttime visibility. Your car's headlights will reflect off the red border of the SMV emblem, and appear to you to be a glowing red triangle floating in the darkness. It is extremely important to slow down immediately because reduced lighting will make it difficult to judge how rapidly you are closing in on a slow moving vehicle, or what the dimensions of the slow moving vehicle may be.



\*According to findings of Penn State researcher Philip M. Garvey, author of "Motorist Comprehension of the Slow-Moving Vehicle Emblem."

**It is illegal for any resident of Pennsylvania to display the slow moving vehicle emblem on permanent, stationary objects such as mail box posts, driveway entrances and fences.**

**Tips for Farmers**

Farmers have a role in rural road safety too. Here are some tips to alleviate some hazards when taking wide equipment onto the road:

- Pennsylvania law requires you to place a slow moving vehicle reflector on any machine that travels the road slower than 25 mph. Always point the triangle up, keep the SMV emblem clean to maximize reflectivity, and replace the emblem when it fades, normally every 2-3 years.
- Mark the edges of tractors and machines with reflective tape and reflectors. Consider installing retrofit lighting on older machinery to increase visibility.
- Turn on your lights, but turn off rear spotlights when going onto the road. From a distance they can be mistaken for headlights.
- Avoid the highway during rush hours and bad weather. Don't drive before sunrise or after sunset.
- Use pilot cars, one in front and one in back if you are going a considerable distance. Hang an orange flag out the window of these pilot vehicles.
- Consider installing mirrors on equipment to enable you to be aware of motorists around you.

**Rural Roads Safety**

*It's a matter of life and death*

**PFB** Pennsylvania Farm Bureau  
510 S. 31st Street - Box 8736, Camp Hill, PA 17001-8736  
717-761-2740 • [www.pfb.com](http://www.pfb.com)



(image source: PFB, 2006)

**Figure 3-7. Special (safety plea) brochure (side A)**

**W**hile driving on a rural road, you may encounter farm equipment. This equipment comes in a variety of shapes and sizes. Sometimes you will see a single vehicle, such as a tractor or combine. Other times the equipment will consist of a tractor with an implement in tow.

Farm equipment is designed to be used primarily in a field and is not designed to travel at typical highway speeds. Most farm equipment is designed to travel at speeds of 15-25 miles per hour. Farm equipment may be wider than other vehicles, and perhaps even wider than the lane of travel. However, farm equipment must be operated on highways in order to travel between a farm and a field or field to field.

Just as motorists are entitled to operate their vehicles on public roadways, farmers are legally allowed to operate farm equipment on these same roadways. Caution, courtesy and special attention to the following safety tips will help ensure the safety of motorists, passengers, and operators of slow-moving farm equipment.

**If you're driving 55 mph and come upon a tractor that's moving 15 miles per hour, it only takes five seconds to close a gap the length of a football field between you and the tractor.**

**Recognize the Slow Moving Vehicle Emblem-Brake Immediately!**

When you see the slow moving vehicle (SMV) emblem, you should immediately slow down. SMV emblems must be visible at least 500 feet away from the vehicle, but because it may be difficult for you to judge the speed at which you are closing in on a vehicle, you should slow down immediately. Think of the slow moving vehicle emblem as a warning to adjust your speed.

**Be Patient**

A farmer understands that your trip is being delayed, so he or she will pull off the road at the first available safe location to allow you to pass. Don't assume that the farmer can move aside to let you pass. Shoulders may be soft, wet, or steep, and this can cause the farm vehicle to tip, or they may not be able to support a heavy farm vehicle.

**Even if you have to slow down to 20 mph and follow a tractor for two miles, it takes only six minutes of your time, which is approximately equivalent to waiting for two stoplights.**

**Yield to Wide Vehicles**

Some farm equipment may be wider than the lane of travel. If you approach a piece of wide farm equipment traveling in the opposite direction and you cannot pass safely, stop. Then pull off the road or safely turn around or back-up to a location that will allow the equipment to pass you.

**Don't Assume that the Farmer Knows You're There**

Most operators of farm equipment will regularly check to see if there is traffic behind them. However, the farmer must spend most of the time looking ahead to keep the equipment safely on the road, and to watch for oncoming traffic. Also, most farm equipment is very loud, and the farmer will probably not be able to hear your vehicle. Therefore, do not assume that the farmer knows where your vehicle is. Before you attempt to pass, use your car's horn to signal to the farmer that you are there.

**Pass with Caution**

If a farmer has pulled off the road to allow you to pass, or if the farmer cannot pull off the road and you feel you must pass, do so with caution.

- Be watchful of vehicles behind you that may also try to pass.
- If you must enter the oncoming lane of traffic, do not pass unless you can see clearly ahead of both you and the vehicle you will pass.
- If there are any curves or hills ahead that may block your view or the view of oncoming vehicles, do not pass.
- Do not pass if you are in a designated "No Passing Zone" or within 100 feet of any intersection, railroad grade crossing, bridge, elevated structure or tunnel.
- Do not assume that a farm vehicle that pulls to the right side of the road is going to turn right or is letting you pass. Due to the size of some farm implements, the farmer must execute wide lefthand turns. If you are unsure, check the operator's hand signals and check the left side of the road for gates, driveways or any place a farm vehicle might turn.

*In 2006, there were 88 crashes in Pennsylvania involving farm equipment and other vehicles. Four people died in these accidents.*

\*Statistics from PennDot

*By being aware of farm equipment during your travels on rural roads, you can help make the trip safe for both you and Pennsylvania's farmers.*

For more information, email: [GovCom@pfb.com](mailto:GovCom@pfb.com)

(image source: PFB, 2006)

**Figure 3-8. Special (safety plea) brochure (side B)**

### *Other Possible Strategies – Telematics*

Another possible mitigation strategy for SMV crashes is the use of telematics on rural two-lane roads. This system divides traffic into fast moving vehicles (motorized transportation) and slow moving vehicles. If both groups can be aware of each other at the exact time to make speed adjustments, traffic safety would be improved. A Road Traffic Information System can be used to solve the safety problem between these two groups of vehicles (Bovy and Botma, 1999). The system used in the study was intended for non-motorized SMVs, such as pedestrians, cyclists, wheel-chair users, and horsemen. However, it may be possible to use a similar system for motorized SMV as well. It is noted that the telematics system is already being used in the Netherlands, but Bovy and Botma's (1999) abstract does not discuss whether the system has been successful or unsuccessful.

### *Other Possible Strategies – Ultrasonic Sensors*

Guo et al. (2001) discussed a new safety detection system with ultrasonic sensors. This system would be used in agricultural machinery to detect the presence of a moving object around the

machine. The system involved two ultrasonic sensors and a computer data acquisitions system. A test was done to determine the validity of the sensors, and it was found that the safety detecting system could in fact detect the position of the moving object related to an agricultural machine. If this can be done, then a warning signal could be generated if the detected object is close to the machine. The effects of such a warning signal have not yet been tested.

### **3.2 Safety Features – Agricultural Equipment**

The American Society of Agricultural and Biological Engineers (ASABE, 2006) provides advisory standards for the lighting and marking of agricultural field equipment. Despite attempts to create uniform standards for all states to follow regarding lighting and markings, practices still differ from state to state. Glascock et al. (1995) have conducted a study of state traffic codes. Lighting and marking strategies that are commonly used on agricultural equipment include headlights, turn signals, amber flashers, reflectors, taillights, and SMV emblems.

According to the ASABE (2006) standards, headlamps should be used and mounted at the same height and be placed symmetrically and as widely apart as practicable on the front of the equipment. Glascock et al. (1995) found that thirteen states required only one headlamp. Thirty-six states require two headlamps. Nine of those states make special provisions for tractors without electrical systems to require only one lamp. Alaska and Massachusetts have no code for headlamps. Forty-eight states did not require the use of headlamps during the daytime. Eight states require the headlamps to be visible from a distance of no less than 1,000 feet. Twenty-five states require visibility from 500 feet, and ten states require a distance of 200 feet visibility. Vermont requires 150 foot visibility, Kentucky and Texas 100 feet, Rhode Island 75 feet, and Maine 50 feet.

ASABE (2006) also recommends the use of two red taillights symmetrically mounted to the rear of the machine that are widely spaced but are no farther than 5 feet to the left and right of the machine center and between 1.3 and 10 feet high. Glascock et al. (1995) reported that 35 states require only one taillight. Fourteen states require two taillights, two of which states allowed the use of two reflectors and one taillight as an alternative if a vehicle had no electrical system. Two other states had the same requirements, but additionally required that one lamp or reflector be placed as far left as possible. Kentucky requires that taillights must be used during daytime hours. Taillight visibility distance ranged from states having no requirement up to states requiring a visibility of 1,000 feet. The shortest distance requirement was 100 feet. Taillights for agricultural machinery must be red in 47 states, while Kentucky allowed white, red, or a combination of the two and Alaska and Oregon have no color requirement (Glascock et al., 1995).

Amber flashing lights are commonly visible on the front of tractors. The lights are used in conjunction with turn signals for greater visibility. ASABE (2006) standards recommend using at least two amber flashing warning lamps to flash in unison at a rate of 60 to 85 flashes per minute. They are to be symmetrically mounted and as wide as possible between 1.3 and 12 feet high. On machines more than 12 feet wide, at least two amber flashing lamps should be mounted between 1.3 and 12 feet high and within 16 inches of the lateral extremities of the machine. If a machine

is less than 4 feet wide, only one lamp should be used and should be placed as close to the center as practical. Eleven states require amber flashing lamps. Three states do not permit the use of amber flashers. The rest of the states have no code for amber flashing lights (Glascock et al., 1995).

ASABE (2006) recommends the use of turn signals to indicate the SMV's intentions to other vehicles. Amber flashing warning lamps may be used for this purpose. In this case, the amber flashing warning lamps in the direction of travel should increase the flashing frequency while the opposite amber lamp should burn steadily. Also, a rear-facing red or amber lamp symmetrically mounted and positioned, as widely spaced as practical, should flash in the direction of the turn and in unison with the amber flashing warning lamp. The additional rear-facing lamp opposite the turn may remain off or on or become brighter but should not flash. If the vehicle is equipped with stop lamps, the additional rear-facing red or amber turn indicators are not required, regardless of velocity. None of the states, however, require turn signals (Glascock et al., 1995).

SMV emblems are also recommended for use by ASABE (2006). Forty-one states require the use of an SMV emblem for agricultural equipment, while eight states do not. One state permits the use of the SMV emblem or a flashing or rotating amber light.

ASABE (2006) recommends that at least two red retroreflective devices be placed on the rear of the vehicle and shall be visible at night from all distances between 100 and 1,000 feet. It is recommended that these emblems be spaced horizontally no farther than six feet apart. A study by Glascock et al. (1995) did not inquire about the requirement or lack thereof for red retroreflective devices.

In addition to lighting and marking requirements of the SMV self-propelled agricultural equipment (SPAE), requirements also exist for the towed agricultural equipment and implements of husbandry which are non-self-propelled equipment (NSP). ASABE (2006) recommends that NSP equipment obscuring the SMV emblem on the SPAE be equipped with an SMV emblem as well. ASABE also recommends that any NSP equipment that obscures any lighting, including any flashing warning lamp, tail lamp, extremity lamp, or stop lamp on the NSP equipment, should be fitted similarly to take the place of the lamp(s) obscured. According to a survey by Glascock et al. (1995), eight states have no requirement for taillights on NSP equipment. Thirty states require at least one taillight. Of these, one state requires no taillight if the NSP equipment displays an SMV emblem. Four states require that one light or reflector be placed as far left as practicable. Fifteen states require two taillights on the NSP equipment. Some states had other specific provisions.

Amber flashing lights are not required on NSP equipment in 35 states, 3 states do not permit their usage, 5 didn't mention flashing lights in the code, and 7 require their usage, but 3 of those 7 require the lights' usage only when the flashers of the SPAE equipment are obscured. Forty-four states do not require turn signals on the NSP equipment, and six states do not mention turn signals on NSP equipment.

Equipment that is wider than the roadway also has specifications that should be followed. If NSP equipment is wider than 12 feet or extends more than 6 feet to the left or right of the centerline and beyond the left or right of the SPAE, ASABE (2006) suggests that the equipment should have lighting in the form of at least two amber flashing warning lamps visible from the front and the rear, two red tail lamps, and turn indicators. Equipment length should also be considered for safety precautions. ASABE (2006) recommends that NSP equipment extending more than 25 feet to the rear of the hitch point should have the same lighting as described for wide vehicles. Glascock et al. (1995) did not address the width or length of towed vehicles in the survey.

The inconsistent state code requirements suggests a need for a standardization of these codes so as to allow uniform traffic communication among motorists from state to state (Glascock et al., 1995).

In order to inform the public of these laws and to warn the motorists of the potential hazards of SMVs, organizations within many states act as educators by putting together informational brochures and handouts. Local newspapers also educate the public by including articles about the dangers of encountering an SMV and provide tips to be a safe and aware driver on the public highways. Examples include, but are not limited to the Farm Bureau Safety Program of Georgia (Farm Bureau Safety Program Georgia, n.d.), Alabama A&M and Auburn Universities (LaPrade, n.d.), Kokoma Tribune of Indiana (2007), Iowa Department of Public Safety (Iowa Department of Public Safety, 2004), Iowa DOT (Falb, 2003), Ohio State University (Jepsen, 2002), and Pennsylvania Farm Bureau (2006).

In addition to informing the public on how to drive safely when sharing the road with SMVs, some organizations are attempting to educate the operators of SMVs. Examples include, but are not limited to, Farm Safety 4 Just Kids (Farm Safety 4 Just Kids, n.d.); University of Maine (Cyr and Johnson, 2006); Cornell Agricultural and Health Safety Program; Ohio State University; Pennsylvania State College of Agricultural Sciences (Murphy and Shufran, 1998); Texas Department of Insurance, Division of Workers' Compensation Safety Education and Training Programs (2004); and National Ag Safety Database (Karsky, 1998).

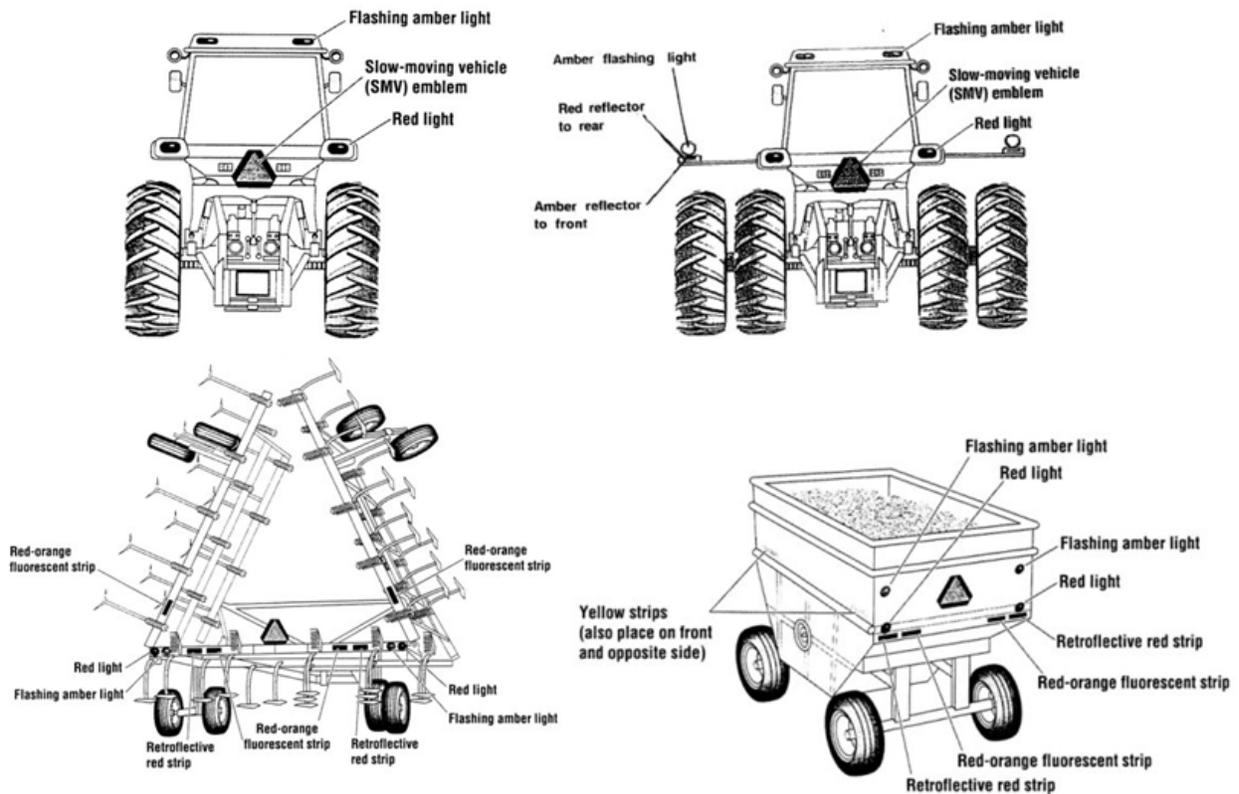
The Agricultural Safety and Health Program has established a website through The Ohio State University Extension to educate farmers on using appropriate lighting and marking on their farm equipment. The Ohio Revised Code requires all tractors (non-multi-wheeled) and self-propelled equipment to display the following lighting from "sunset to sunrise or when there is insufficient lighting to render discernable persons, vehicles, and substantial objects at a distance of 1000 feet ahead:

- One white headlight on the front of the vehicle, visible from at least 1,000 feet in front of the vehicle
- Two red lamps as wide apart as possible on the rear of the vehicle, visible from at least 1,000 feet behind the vehicle, or one light and two red reflectors" (Agricultural Safety and Health Program, 2008a)

The Ohio State University Extension's website also explains the Ohio House Bill 484, which illustrates the lighting and marking requirements for multi-wheeled tractors. The bill was revised in 2001 to require the appropriate lighting from sunset to sunrise or when there is "insufficient light to render discernable persons, vehicles, and substantial objects at a distance of 1000 feet ahead," which is different from the previous law requiring lighting from 1/2 hour after sunset to 1/2 hour before sunrise. Additionally, the revised law requires multi-wheeled tractors to display lighting and marking as follows:

- Two flashing amber lamps visible to the front and to the rear mounted within 16 inches of the left and right extremities of the machine and between 3.3 and 12 feet above the ground
- Two red reflective strips visible to the rear and two amber reflective strips visible to the front mounted within 16 inches of the left and right extremities of the machine and between 3.3 and 12 feet above the ground (in conjunction with amber flashing lights)
- Reflective strips must be 2 by 4.5 inches in size for vehicles 6.7 feet wide or less and 2 by 9 inches in size for vehicles wider than 6.7 feet (Agricultural Safety and Health Program, 2008a)

The bill also requires that all agricultural equipment models, year 2002 and later, follow the ASABE lighting and marking standard 279.10. The site also has lighting and marking diagrams to show the placement of such devices. Figure 3-9 shows the various lighting and marking placement schemes on a tractor, a multi-wheeled tractor, an implement, and a grain wagon. Another feature is a publications link in which different fact sheets are offered as helpful safety information. These articles include "Hand Signals for Agricultural Safety," "Rotary Agricultural Mower Safety," "Preventing Farm Machine Hazards," and "ATV's (All-Terrain Vehicles) in Ohio." Youth safety articles are also linked, entitled "Tractor Tips," "Tractor Talk," and "Machinery Hazards."



(image source: Agricultural Safety and Health Program, 2008a)

**Figure 3-9. SMV lighting and marking standards**

### 3.3 Safety Features - Horse-Drawn Vehicles

Most states classify buggies as SMVs and require adherence to corresponding laws. Some states have additional requirements for horse-drawn vehicles. Ohio requires animal-drawn vehicles to have an SMV emblem and/or reflective materials that are black, gray, or silver in color mounted on the animal-drawn vehicle so as to be visible from a distance of not less than 500 feet to the rear when illuminated by the lawful lower beams of headlamps.

The Jackson County Chronicle in Wisconsin discusses different SMV crashes and potential causes for the crashes. In Wisconsin, Amish buggies are not required to carry an SMV emblem, but they do need to have lights and reflectors visible from 500 feet away (Hesselberg, 2007). One problem identified in the report is that the use of red tail lights on horse-drawn buggies makes the buggies look like regular highway vehicles so that a vehicle approaching a horse-drawn buggy may mistake it for a vehicle traveling at normal speeds. One solution proposed by Green County, Wisconsin, is to widen shoulders in areas with heavy horse-drawn buggy traffic to 8 feet. This would also be a benefit to bicyclists and for highway maintenance operations (Hesselberg, 2007).

From 1999–2003, the State of Ohio holds a Geauga County Sharing the Road with Amish Travelers Forum each year. During this annual meeting, Amish community members meet with state and local officials to discuss possible development to help prevent Amish horse and buggy crashes. It was hoped by officials that targeted public education for local citizens and visitors would significantly reduce Amish horse and buggy crashes. Before the forum was first held in 1999, Amish horse and buggy crashes and fatalities were increasing. Since the forum began, Amish buggy crashes have been decreasing. The specific actions taken to reduce these crashes were not stated in the source material.

Ohio has two of the largest Amish settlements in the United States. The Ohio State University Extension has coordinated safety programs for the Amish communities in Ohio. This has been ongoing for the last 13 years. These programs focus on many safety issues, such as roadway safety and other important issues.

The Agricultural Safety and Health Program with The Ohio State University Extension put together the following Amish buggy lighting and marking recommendations, and diagrams for a buggy and wagon are shown in Figure 3-10 (Agricultural Safety and Health Program, 2008b):

#### Lighting:

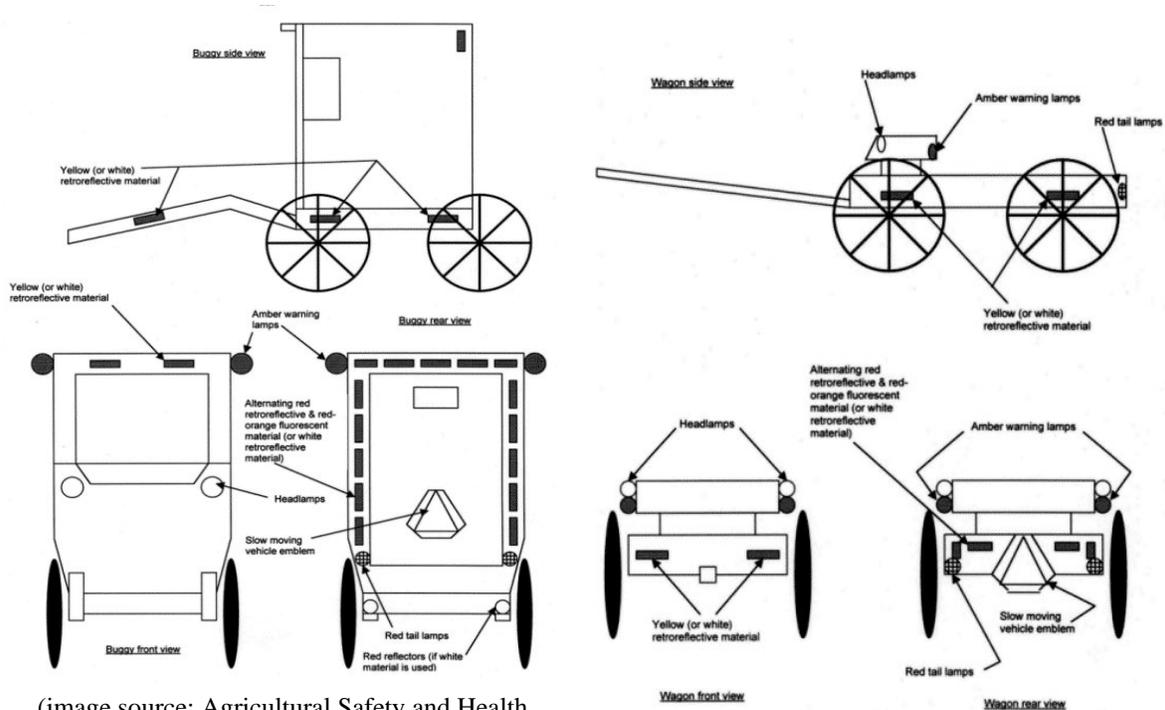
- Animal-drawn vehicles should be equipped with a battery-operated lighting system or a generator-powered lighting system. Batteries may be typical storage, deep cycle, or gel cell and should conform to SAE J537.
- At least two headlamps, conforming to SAE J975, should be mounted symmetrically about the vehicle centerline, facing forward on the front of the vehicle in a position that provides the least blockage from the drawing animal(s).
- At least two red tail lamps, conforming to SAE J585, should be mounted symmetrically about the vehicle centerline on the rear of the vehicle and as widely spaced laterally as practical and between .6 and 3 meters (2 and 10 feet) high.
- At least two flashing amber warning lamps conforming to SAE J974 should be mounted symmetrically about the centerline and as widely spaced laterally as practicable. They should be visible from front and rear and mounted between 1 and 3.7 meters (3.3 and 12 feet) high.
- An optional turn signal system may be incorporated into the rear red tail lamps or the flashing amber lamps. If the system is incorporated into the flashing amber lamps or red tail lamps, the lamp that is positioned on the side of the turn should flash and the lamp on the side away from the turn should go to steady burn.

#### Marking:

- Marking for the rear of the vehicle should be 50 millimeter by 230 millimeter (2 inch by 9 inch) strips alternating between red retroreflective material and red orange fluorescent material. The material should be used to outline the sides and top of the rear of the vehicle.
- Where local culture prohibits the use of red and or red-orange materials, white

retroreflective material with a minimum width of 25 millimeters (1 inch) may be used. If white retroreflective material is used, two red reflex reflectors should be mounted symmetrically about the centerline as widely spaced laterally as practicable.

- Marking for the front of the vehicle should be 50 millimeter by 230 millimeter (2 inch by 9 inch) strips of yellow retroreflective material. At least two strips should be placed symmetrically about the centerline as widely spaced as practicable on the front of the machine.
- Where local culture prohibits the use of yellow material, white retroreflective material with a minimum width of 25 millimeters (1 inch) may be used.
- Marking for the side of the vehicle should be 50 millimeter by 230 millimeter (2 inch by 9 inch) strips of yellow retroreflective material. A minimum of two strips should be symmetrically spaced and mounted along each side of the vehicle frame. If the vehicle is equipped with a tongue or shaft that is visible on the outside of the animal, an additional yellow strip should be placed on it.
- Where local culture prohibits the use of yellow material, white retroreflective material with a minimum width of 25 millimeters (1 inch) may be used.
- Optional yellow or white retroreflective material may be attached to the harness or to the animal's legs to enhance visibility.



(image source: Agricultural Safety and Health Program, 2008b)

**Figure 3-10. Buggy and wagon view**

### 3.4 Discussion of Possible Alternative Safety Improvements

A separate study effort by the Ohio Department of Transportation (ODOT) recently used public meeting comments and survey findings to identify possible alternative safety improvements related to SMVs (ODOT, 2000). These alternative solutions are listed below, together with some of the pros, cons, and other issues associated with each.

#### *Roadway Improvements*

##### Separate Trail, Possible Buggy/Bike Trail

- Pro - Gets buggies off of roadway and away from stronger faster moving vehicles
- Pro - Safety issues are of a lesser degree due to size, speed, and maneuverability of bikes and buggies when compared to tractor trailer trucks and buggies.
- Con - Public comment and survey respondents did not rate this option very high, given they preferred to travel routes that take them to their desired locations, which is typically where the existing roadways go.
- Con - Cost and maintenance issues: who pays and who maintains?
- Con - Can they be located in places useful to the users?
- Con - Safety issues involving bikes and buggies together on same trail

##### 6 - 8 ft Wide Paved/Treated Shoulder

- Pro - This is the option overwhelmingly preferred by most respondents to the survey.
- Pro - Would get buggies off of the roadway and into their own “buggy lane”
- Pro - Quick construction time if conditions are right
- Con - Construction costs could be high if right of way must be purchased, regarding the improvements needed in areas with no shoulder or steep grades.
- Con - Need to widen bridges and culverts so buggies do not need to merge in and out of traffic

##### 6 – 8 ft Wide Graded Shoulder (compacted dirt with compact gravel)

- Con - Possible extensive right-of-way needs
- Con - Would need to widen bridges and culverts so buggies do not need to merge in and out of traffic

Expand resurfacing program to include paving graded shoulders when road is scheduled for reconstruction or resurfacing

- Pro - Can be done over time, and costs can be merged into other construction costs
- Pro - Shoulders can also be used to maintain two-way traffic during resurfacing or other construction projects.

- Con - Would also have to look at bridge and culvert widening in order to avoid the issue of having to merge in and out of traffic and possibility of having buggies choose to stay on the roadway

#### Buggy Pull-Off or Hill Climbing Lanes for Buggies

- Pro - Avoids long cue lines that form behind buggies going up hills, allows vehicles to pass
- Pro - Helps with visibility issues if the lane is continued over the hill
- Pro - Less costly to build than complete shoulder reconstruction
- Con - Potential safety concerns when buggies need to merge in and out of the lane

#### Widened Shoulders on Downhill Side of Roadways

- Pro - Helps with visibility issues if on the downhill side of the roadway
- Pro - Less costly to build than complete shoulder reconstruction
- Con - Potential safety concern when buggies need to merge in and out of lane

#### *Types of Treatments*

##### Asphalt Paving

- Pro - Fast construction time
- Pro - Ease of maintenance
- Pro - Several heavy duty mix standards are available.
- Con - Not the most durable under buggy traffic, primarily due to horse shoe modifications for traction that tear out the aggregate like cleats

##### Concrete Paving

- Pro - Durable in comparison to other options
- Con - Expensive in comparison to other options
- Con - Concrete becomes slippery to horses when wet or dirty.
- Con - Maintenance is labor intensive.
- Con - Concrete causes shin splint-like leg problems for the horses.

##### Aggregate covering

- Pro - Very fast to construct
- Pro - Very inexpensive
- Pro - Easy to repair
- Con - Will require constant maintenance
- Con - The joint area between roadway and shoulder aggregate can have a 2 inch or more mismatch, which could be a problem for buggies, as indicated by comments during public meetings. This destroys buggy wheels.

- Con - The Amish prefer to use their own buggies.
- Con - Limited rural transit funding is available.
- Con - The survey found this to be the least desirable alternative.

### *Education and Enforcement Programs*

In addition to roadway improvements and treatments, Ohio law enforcement and educational programs and materials were identified as a needed part of the multifaceted solution.

### *Priority Roadways*

Based on an ODOT crash location map, a number of state roadways that had SMV crashes along their length were identified for further analysis and possible improvements.

### *Roadway Prioritization Criteria*

Routes with evident buggy traffic were recommended for review and analysis to identify problem areas. Appropriate countermeasures to improve the safety conditions for shared usage were to be determined. In the analysis, consideration was to be given to items such as crash history, traffic volumes, cross corner, and stopping sight distance. Potential projects derived for the analysis may then be prioritized based on a variety of factors:

- Crash density (crashes per mile for sections)
- Crash frequency (number of crashes at a spot location, such as an intersection)
- Crash severity (fatal, injury, or property damage only)
- Roadways maintenance and resurfacing schedule
- Preference based on public input (from a survey)
- Project costs

### *Priority System Goals*

For rehabilitation projects on the priority system, ODOT stated that the goal of “creating a safer transportation environment in which horse-drawn buggies and motor vehicles can share state highways is the purpose of this program. Eligible locations are determined by buggy/motorized vehicle crash data from the previous five years. Activities include paved shoulders, buggy pull-off areas, and buggy climbing lanes” (ODOT, 2007).

### *Peer Review of Buggy Safety*

In a review of Ohio’s study of Amish buggy safety, which addressed and identified a sector of the population, the Federal Highway Administration (FHWA, 2001) deemed the program a success for the following reasons:

- A systematic approach was used to identify specific safety problems.
- There was close coordination with the community.
- Solutions were identified.
- Localities were involved in the process.

### 3.5 Identified Needed Research

A recent report by the Committee on Agricultural Safety and Health Research (ASHR, 2009) provides recommendations on guiding future research, standards, policy, and education/outreach among federal, state, and local levels as follows:

#### *Research Needs*

1. Develop criteria to better describe characteristics of crashes between motor vehicles and agricultural equipment using standard reporting terminology. This would include developing model definitions, methods, and data collection instruments. Examples of standard data elements would include the following:
  - a. Road and visibility conditions
  - b. Ages of victims
  - c. Vehicle and agricultural equipment features (including type and size of equipment, whether machine or animal-drawn, and compliance with current lighting and marking, braking, and other related standards)
  - d. Environmental conditions (e.g., time of day, rain, icy conditions)
  - e. Driving actions of motorists and equipment operators
  - f. Whether victim(s) was (were) operator(s) or rider(s)
  - g. Alcohol and/or drug abuse
2. Assess the understandability, effectiveness, and best use practices of lighting and marking of agricultural equipment on public roadways. This should include both urban and rural motorists and would focus on topics such as the following:
  - a. SMV and speed indicator symbol (SIS) emblems
  - b. Animal-drawn buggies, wagons, and implements, including culturally acceptable lighting and marking systems for Anabaptist populations
3. Improve engineered systems for higher speed tractors, self-propelled machines, and towed equipment. This would include such topics as the following:
  - a. Braking systems
  - b. Suspension systems
  - c. Steering controls
  - d. Hitching/attachment mechanisms
  - e. Proximity sensors to motor vehicles
  - f. Tires

g. ROPS

4. Examine the existence and consistency of farm equipment roadway safety information in driver education programs across the United States.
5. Expand behavioral studies on allowing extra riders on farm equipment to include adults and on such factors as extra riders on public roads for work-related purposes.
6. Determine the effects of graduated licensing for youth to operate agricultural equipment on public roads, including higher speed tractors and self-propelled machines.
7. Examine impacts and implications of county and state land use policies regarding operation of agricultural equipment on public roadways. This would include topics such as the following:
  - a. Risks of crashes with motor vehicles
  - b. Exclusions and exemptions from road traffic regulations and restrictions
  - c. Transportation of agricultural hazardous materials on rural public roads
  - d. Economic issues and costs associated with heavy agricultural loads on rural public road

*Engineering Design Standards Needs*

1. Better connect standards to research findings.
2. Have better representation during the standards' development by researchers and end users.
3. Incorporate automatic and passive protection for drivers and riders of agricultural equipment during public road use.
4. Continually review the standards for the possibility of adoption of new technologies into design standards and practices.

*Safety Education Program Needs*

1. Educate both the public and farmers on the following:
  - a. Best practices for operating agricultural equipment on public roads
  - b. Approaching SMVs on public roads, including the purpose and use of the SMV and SIS emblems
  - c. The effects of exclusions and exemptions from road traffic regulations and restrictions
2. Work with local and state law enforcement agencies to increase awareness of county and state traffic laws related to farm equipment among law enforcement officers.

3. Encourage Amish buggy manufacturers to utilize marking and lighting systems and components that meet current ASABE, SAE, and state department of transportation standards.

*Policy Needs*

1. Promote the purpose and use of the SMV and SIS emblems in every state's driver's license manuals and driver education programs.
2. Encourage a more comprehensive Uniform Vehicle Code to be developed and adopted nationally and by states. This new code should better address modern types and uses of agricultural equipment on public roads. Topics that should be addressed include the following:
  - a. Registration of farm equipment for use on public roads
  - b. Qualifications and training for operating agricultural equipment on public roads
  - c. Extra riders on farm equipment, including on tractors, self-propelled machines, and towed equipment
  - d. Animal-drawn buggies, wagons, and equipment
3. Provide for a consistent source of funding for research into hazards, risks, and best safety practices for operating agricultural equipment on public roads.
4. Encourage land-use policies by state and local governments to better manage the interaction of farming and non-farming uses of public roadways in their jurisdictions.
5. Encourage stricter enforcement by local and state police of SMV emblem misuse.

## 4. SLOW MOVING VEHICLE CRASH CHARACTERISTICS

This section provides a crash analysis based upon SMV crashes within Iowa. Data from 2004 to 2006 were used to evaluate crashes that occurred in both urban and rural areas. For the purposes of this report, “rural” is defined as being one or more miles outside corporate city boundaries. Crashes with an “unknown” location were excluded from the analysis. SMV crashes were identified by vehicle type, given that the Iowa crash database allows officers to enter vehicle configuration, vehicle make, and vehicle model. The configuration categories for slow moving vehicles within this analysis included the following:

- Horse and Buggy
- Farm Vehicle
- Construction/Maintenance
- Moped/ATV

In some cases, farm vehicle/equipment or construction/maintenance equipment can travel at highway speeds and would not technically be identified as SMVs. However, it was not possible to differentiate between subcategories. Also, there were two SMV categories, “Bicycle” and “Other,” that were included within the data review and can be found in the full data set within Appendix A. However, these were not part of this analysis. Bicycle concerns have an established focus effort at the Iowa DOT. Crashes labeled as “unknown,” “not reported,” or “other” were reviewed to pull out any associated crashes meeting the above four SMV categories. Miscellaneous crash records not included within this analysis consisted of the following vehicle types: electric wheelchairs, snowmobiles, scooters, lawn mowers, golf carts, floats, go-carts, and gators. The SMV data were manually extracted from the database using crash report narratives and vehicle type descriptions. A full description of the data analysis can be found in Appendix B.

### 4.1 Frequency and Severity

Table 4-1 shows SMV crash frequency, with a total of 1,203 crashes occurring over the three-year (2004–2006) analysis period. Farm vehicle crashes made up half of the total at 50%, Moped/ATV followed at 30%, Construction/Maintenance was 19%, and Horse and Buggy was 1%.

**Table 4-2. SMV crash frequency by year**

Year	Horse and Buggy	Farm Vehicle	Construction/Maintenance	Moped/ATV	Total
2004	7	203	100	118	<b>428</b>
2005	6	192	81	132	<b>411</b>
2006	5	199	49	111	<b>364</b>
<b>Total</b>	<b>18</b>	<b>594</b>	<b>230</b>	<b>361</b>	<b>1,203</b>

Overall, these crashes were split evenly between rural (48%) and urban (50%) settings, with 2% Unknown. The urban/rural split varied between vehicle class as follows: Horse and Buggy crashes were split 56% rural to 44% urban. Farm Vehicles were split 64% rural to 34% urban, with 1% unknown. Construction/Maintenance vehicles were split 27% rural to 70% urban, with 3% unknown. Moped/ATV vehicles were split 33% rural to 63% urban, with 3% unknown.

Given that this research was focused on high-speed roadways (45 mph and above), which are typically found outside urban settings, the analysis placed a focus on rural crashes. Table 4-2 shows SMV crash severity within rural areas. As shown, none of the Horse and Buggy crashes resulted in a fatality, but at least half (five crashes) resulted in injury. For Farm Vehicles, 5% of the crashes resulted in a fatality, 24% injury, and 18% property damage only, and a large number were of unknown severity (53%). For Construction/Maintenance vehicles, 3% of the crashes resulted in a fatality, 24% injury, and 15% property damage only, and again a large number were of unknown severity (58%). For Moped/ATV vehicles, a much higher 9% of the crashes resulted in a fatality, 69% injury, and 13% property damage only, and only 9% were of unknown severity.

**Table 4-3. SMV crash frequency by severity (rural areas)**

<b>Severity</b>	<b>Horse and Buggy</b>	<b>Farm</b>	<b>Construction/ Maintenance</b>	<b>Moped/ATV</b>	<b>Total</b>
Fatality	0	18	2	11	<b>31</b>
Major Injury	2	30	5	37	<b>74</b>
Minor Injury	3	62	10	46	<b>121</b>
Property Damage	0	70	9	15	<b>94</b>
Unknown	5	202	36	11	<b>254</b>

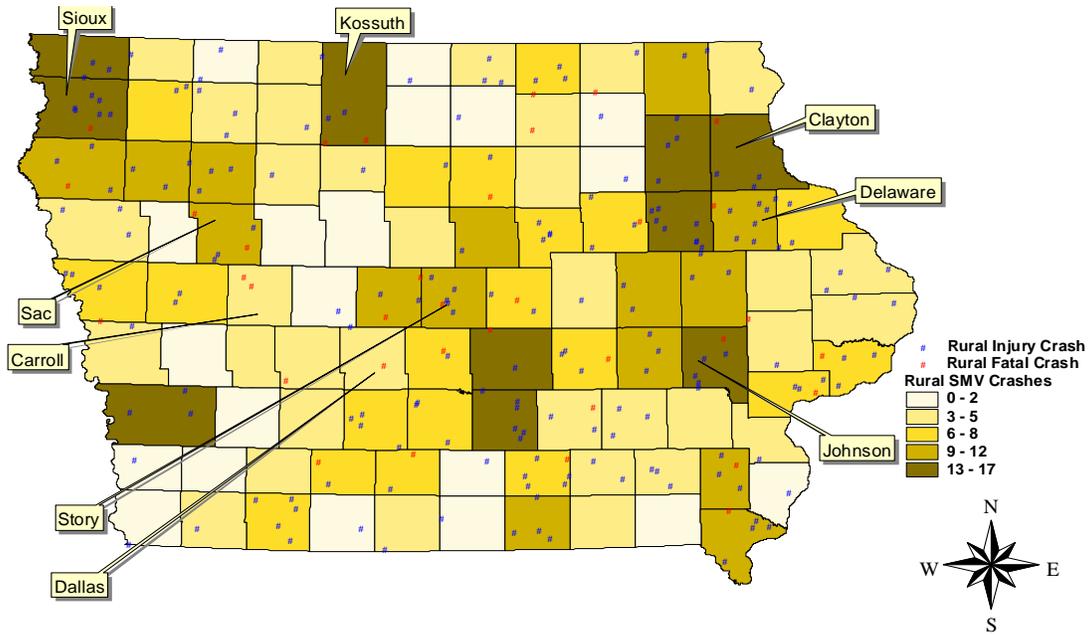
Figure 4-1 maps overall SMV crash frequency and severity in Iowa. Kossuth County had a high number of rural crashes, including two fatal and three injury crashes. Johnson, Sioux, and Clayton Counties also had a large number of rural SMV crashes, and each also had one fatality over the three-year analysis period. Carroll County and Dallas County were in the second lowest category in terms of total rural crashes, with three and four crashes, respectively. However, each county had two fatal crashes, which represents 50% or more of the crashes.

Figure 4-2 maps SMV crashes for Horse and Buggy vehicles. Davis County had the highest crash frequency. Injury crashes occurred in Buchanan, Mitchell, Howard, Johnson, and Decatur Counties.

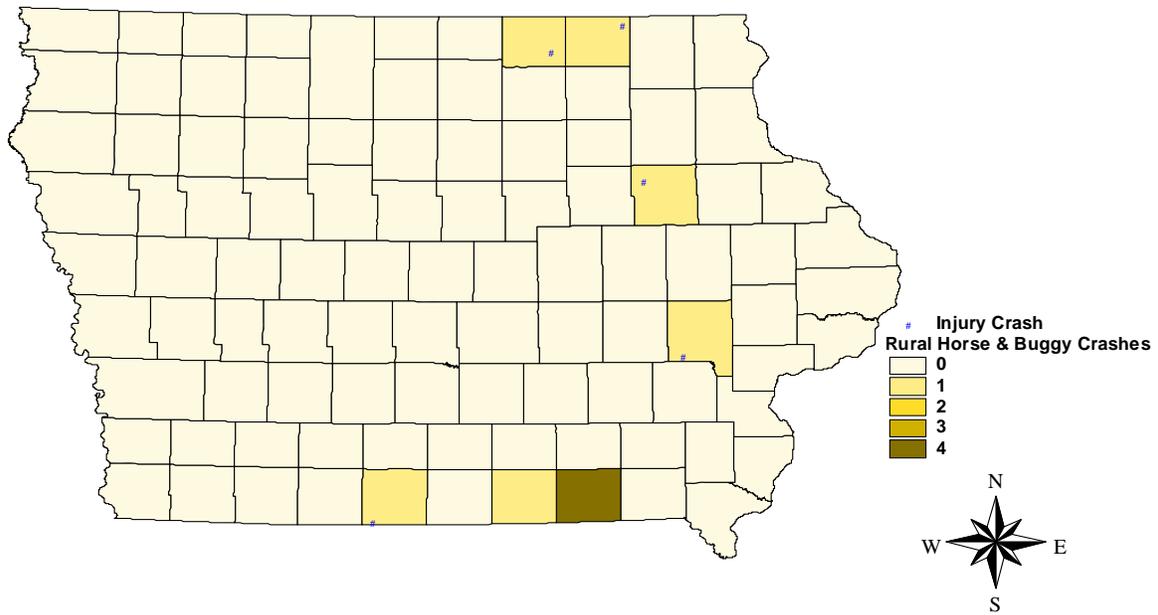
Figure 4-3 maps SMV crashes for Farm Vehicles/Equipment. Lyon, Kossuth, Hardin, Jasper, Pottawattamie, and Henry Counties had the largest number of crashes. Carroll County had two fatal crashes (over 50% of the total), and Kossuth County had two fatal crashes.

Figure 4-4 maps SMV crash for Construction/Maintenance vehicles. Pottawattamie and Buchanan Counties had the highest number of total crashes, and Story County had the highest number of injury crashes.

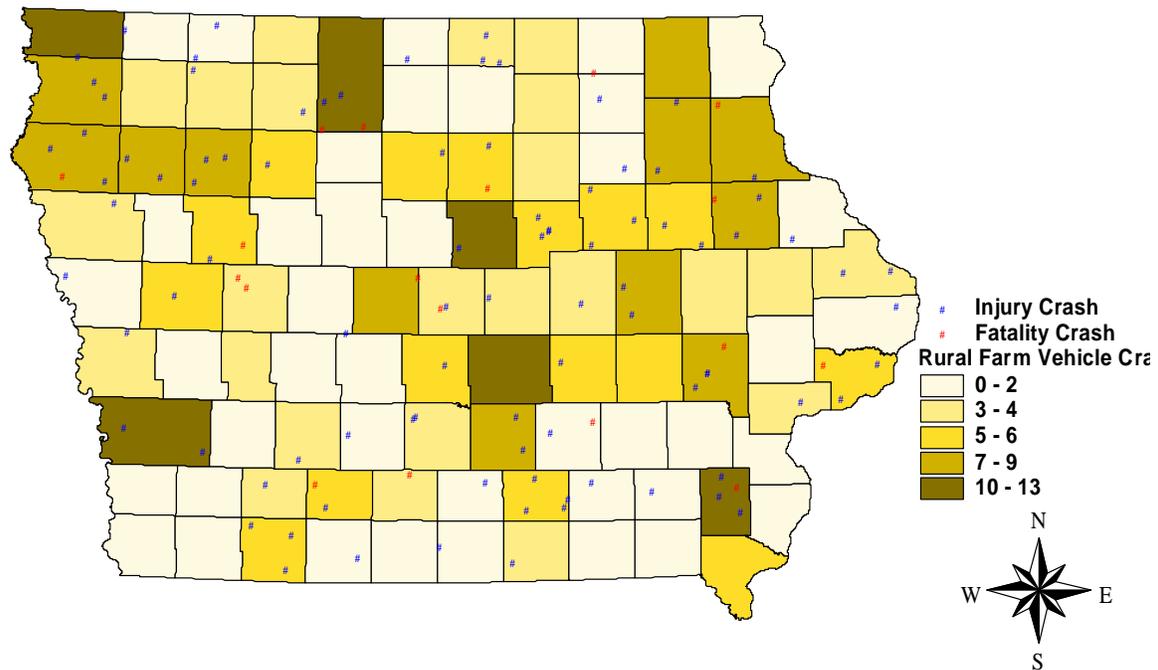
Figure 4-5 maps SMV crashes for Moped/ATV vehicles. Sioux, Monona, Marion, Iowa, Muscatine, Lee, Buchanan, Delaware, and Dubuque Counties had the highest number of crashes, and Buchanan and Delaware Counties had the highest number of injury crashes.



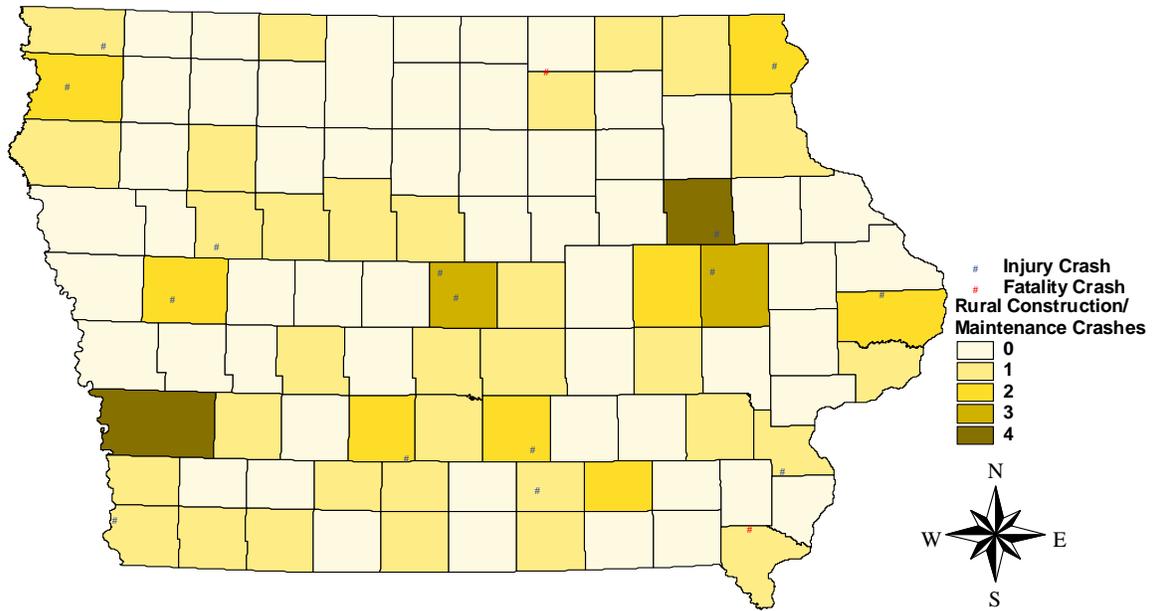
**Figure 4-1. Overall SMV rural crash, frequency and severity**



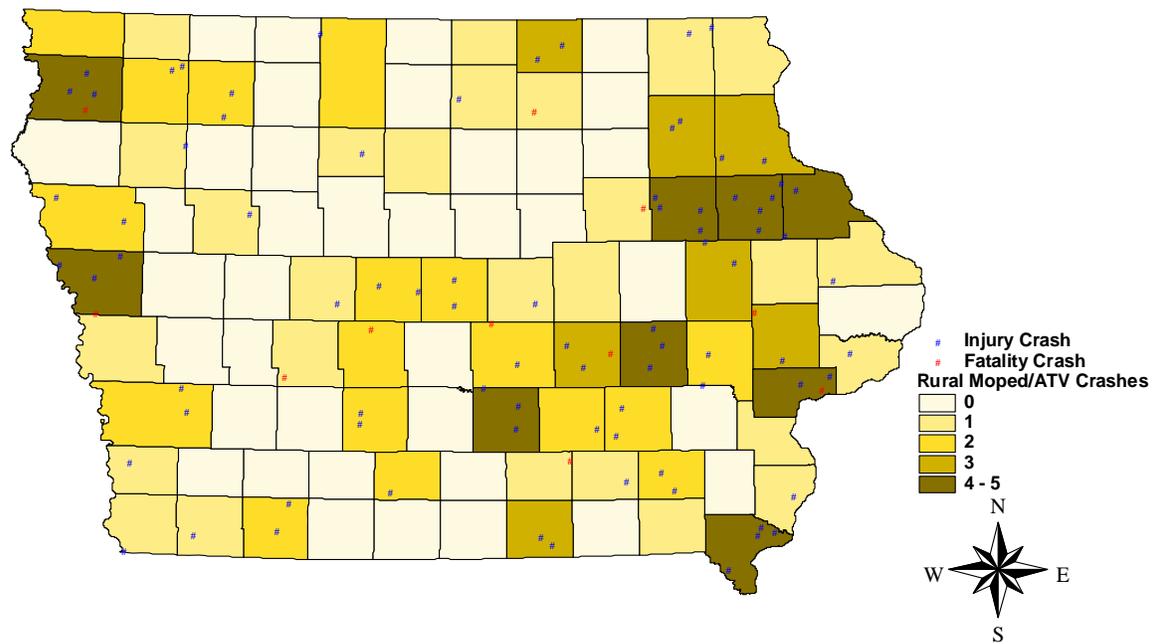
**Figure 4-2. Rural horse and buggy SMV, frequency and severity (2004–2006)**



**Figure 4-3. Rural farm vehicle/equipment SMV, frequency and severity (2004–2006)**



**Figure 4-4. Rural construction/maintenance SMV, frequency and severity (2004–2006)**



**Figure 4-5. Rural moped/ATV SMV, frequency and severity (2004–2006)**

## 4.2 Time of Day

SMV crash by time of day was analyzed using sunrise and sunset data from the United States Naval Observatory. Night crashes were defined as any crash occurring before sunrise or after sunset. The night-to-day crash ratio ( $R_{N-D}$ ) was calculated by Equation 4-1:

$$R_{N-D} = \frac{\text{Night Crashes}}{\text{Day Crashes}} \quad (\text{Equation 4-1})$$

The night-to-day crash ratios for each vehicle type were computed for rural crashes. Table 4-3 shows the night and day crash frequency, as well as detailed “day” crash breakdown by time period (A.M., Midday, P.M).

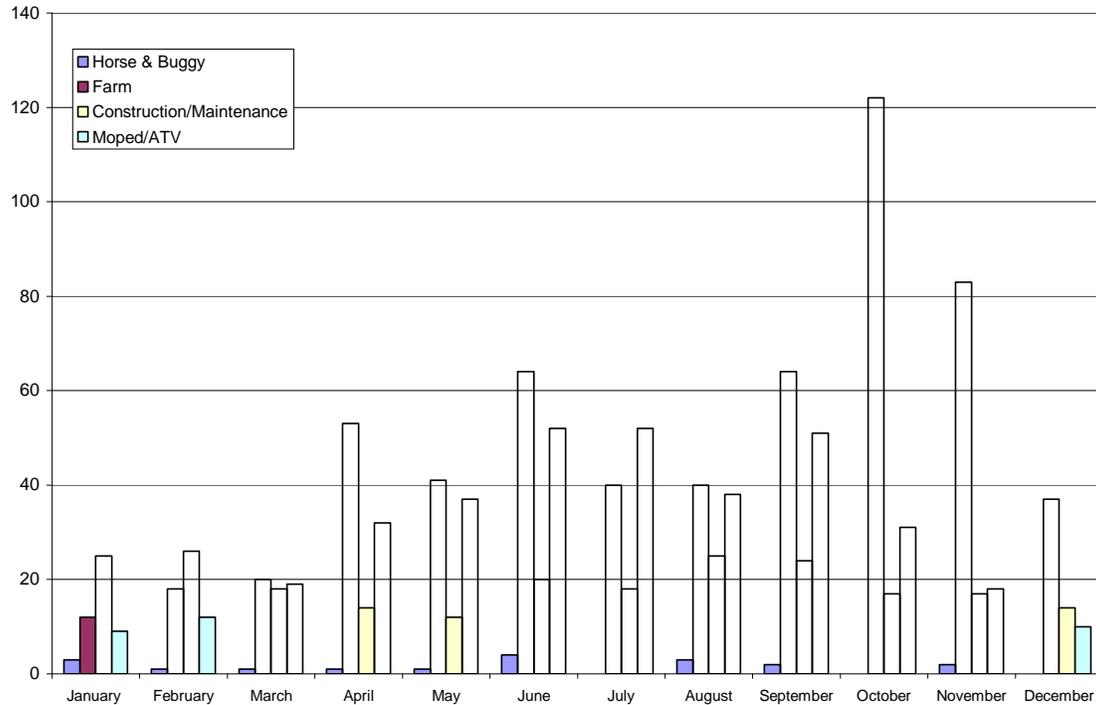
The overall  $R_{N-D}$  was found to be 0.3 (i.e., 30% of the crashes were at night). Two-thirds of the Horse and Buggy crashes occurred at night (minimal data points). One-third of the Farm Vehicle and Moped/ATV crashes were at night. Less than 10% of all Construction/Maintenance crashes were at night.

Crashes were also disaggregated by peak periods. The majority of crashes for all vehicle types occurred during the P.M. peak period and midday off-peak versus the A.M. peak period. Midday off-peak was the most frequent crash period for Farm Vehicles. More crashes involving Moped/ATV vehicles occurred during the P.M. peak period than at any other peak time. Alternatively, more crashes involving Construction/Maintenance vehicles occurred during the A.M. peak period than during the P.M. peak period.

**Table 4-4. SMV crash frequency by time of day (rural areas)**

Time Period	Horse and Buggy	Farm	Construction/Maintenance	Moped/ATV
Night	4	83	4	30
Day	6	293	58	90
Unknown	0	6	0	0
Night/Day Ratio	0.67	0.28	0.07	0.33
AM Peak	2	27	13	4
Mid-Day	2	86	8	26
PM Peak	3	194	37	42

Rural SMV crashes were analyzed by month, as shown in Figure 4-6. As anticipated, the majority of Farm Vehicle crashes occurred during the month of October (harvest season). The adjacent months of November and September follow with the next highest crash volumes, respectively. June and July are the most prominent months for Moped/ATV vehicle crashes, followed by May and October. Construction/Maintenance vehicle crashes occurred more frequently in September and August than during any other month.



**Figure 4-6. Overall rural SMV crash by month (2004–2006)**

### 4.3 Surface Condition

The reported condition of the roadway surface at the time of the crashes was analyzed. Each SMV class showed similar results: Dry 69%, Wet/Ice/Snow/Slush 16%, Sand/Mud/Dirt/Oil/Gravel 12%, Other/Unknown 3%.

### 4.4 Speed Limit

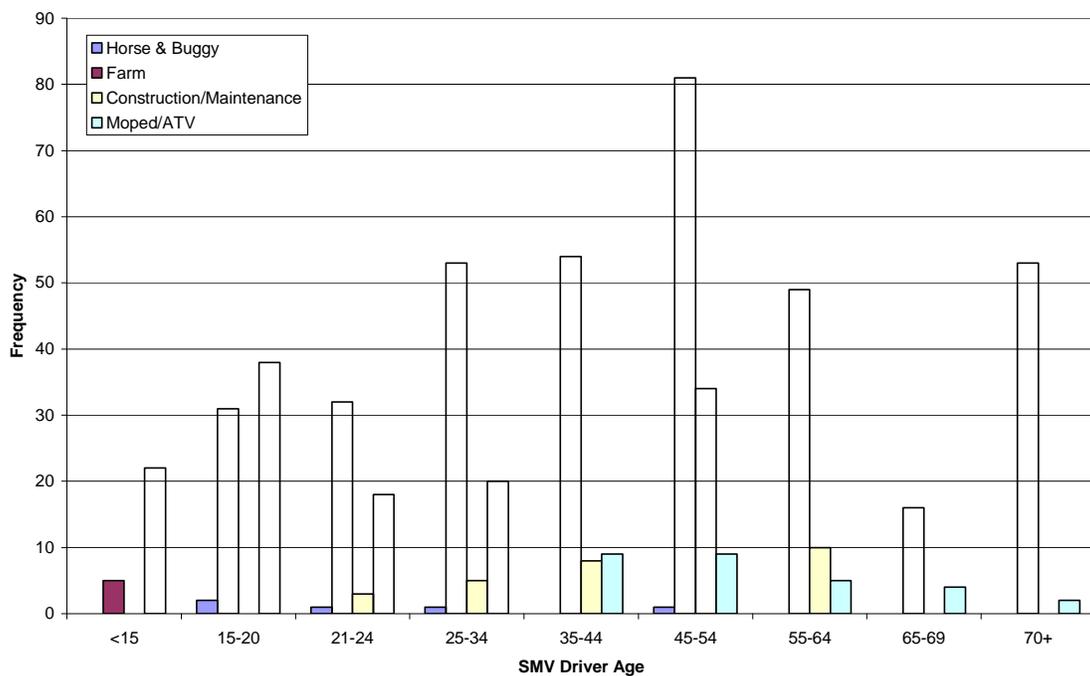
Figure 4-7 shows rural SMV crashes by posted speed limit. Excluding the “unknown” category, 97% of the SMV crashes were on roadways that were posted at 45 mph and above.

**Table 4-5. SMV crash frequency by speed limit (rural areas)**

Speed Limit	Horse and Buggy	Farm	Construction/Maintenance	Moped/ATV
< 25 mph	0	1	0	0
25 – 34 mph	0	4	0	4
35 – 44 mph	0	3	0	6
45 – 54 mph	0	38	3	25
55 – 64 mph	5	305	49	68
65 mph and above	0	11	1	1
Unknown	5	24	9	27

## 4.5 Driver Age

Figure 4-7 provides a visual comparison of crash frequency by SMV driver age. When the age of the driver was known, the most common age group for rural horse and buggy crashes was 15–20 years old (few data points). Farm vehicle crashes involving drivers between the ages of 45 and 54 were the most common, representing 21%, and drivers over 70 years of age represented 16% of the rural farm vehicle crashes. Construction/maintenance vehicle crashes involving drivers between the ages of 45 and 54 were the most common, representing 57% of the drivers. Moped/ATV vehicle crashes involving drivers between the ages of 15 and 20 were the most common, representing 30% of the drivers, and 77% of the drivers involved in a crash were less than 34 years of age.



**Figure 4-7. Crash frequency by SMV driver age (rural)**

## 4.6 Collision Type

The type of collision for each rural SMV crash was analyzed, and Table 4-5 shows the crash percentage by collision and SMV type (excluding the categories of non-collision, unknown, and not-reported). The most common collision for rural crashes overall is rear-end (35%), followed by sideswipe same direction (26%) and broadside (18%).

**Table 4-6. SMV crash percentage by collision type (rural areas)**

<b>Collision Type</b>	<b>Horse and Buggy</b>	<b>Farm</b>	<b>Construction/Maintenance</b>	<b>Moped/ATV</b>
Head-On	10%	4%	12%	15%
Rear-End	40%	35%	41%	27%
Angle, Oncoming Left Turn	10%	6%	0%	5%
Broadside	30%	16%	16%	33%
Sideswipe same direction	10%	29%	24%	15%
Sideswipe opp direction	0%	11%	8%	5%

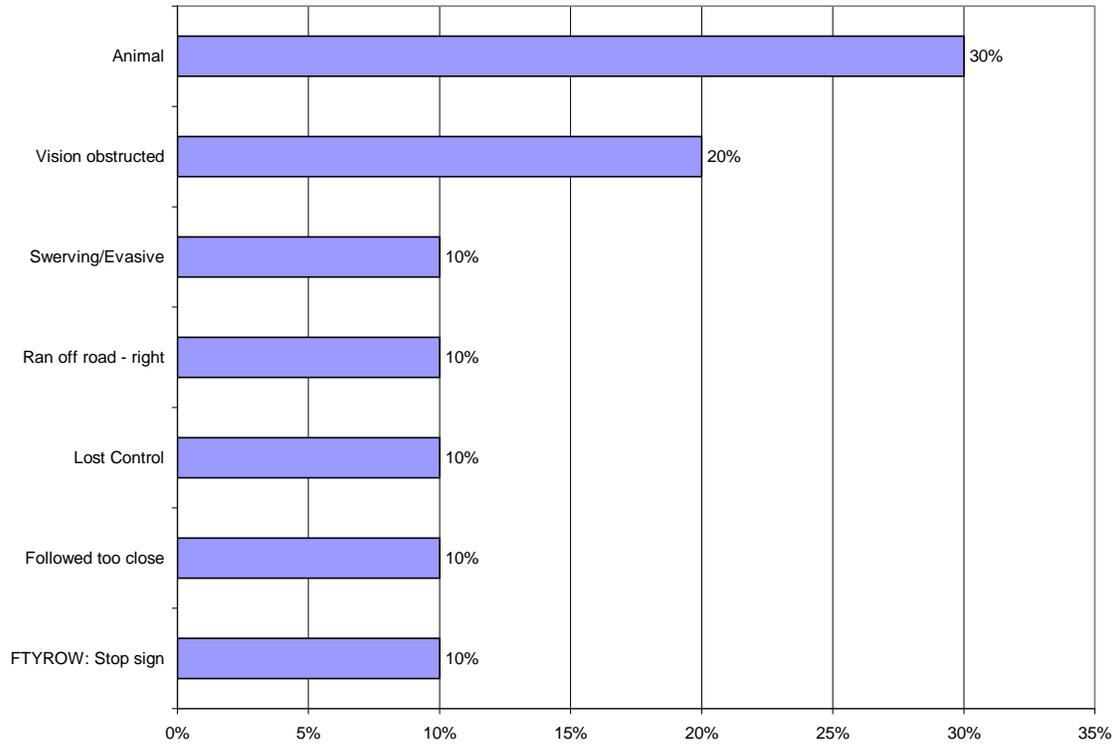
#### **4.7 Vehicle Action**

The action of the SMV prior to crashing was analyzed from crash records. The horse and buggies were moving straight or were not reported in the majority of the rural crashes. Farm vehicles were moving straight 54% of the time and were turning left in 30% of the crashes. Construction/maintenance vehicles were moving straight 63% of the time, turning left 11% of the time, and backing 11% of the time. Mopeds/ATVs were moving straight in 63% of the crashes and turning left in 8% of the crashes.

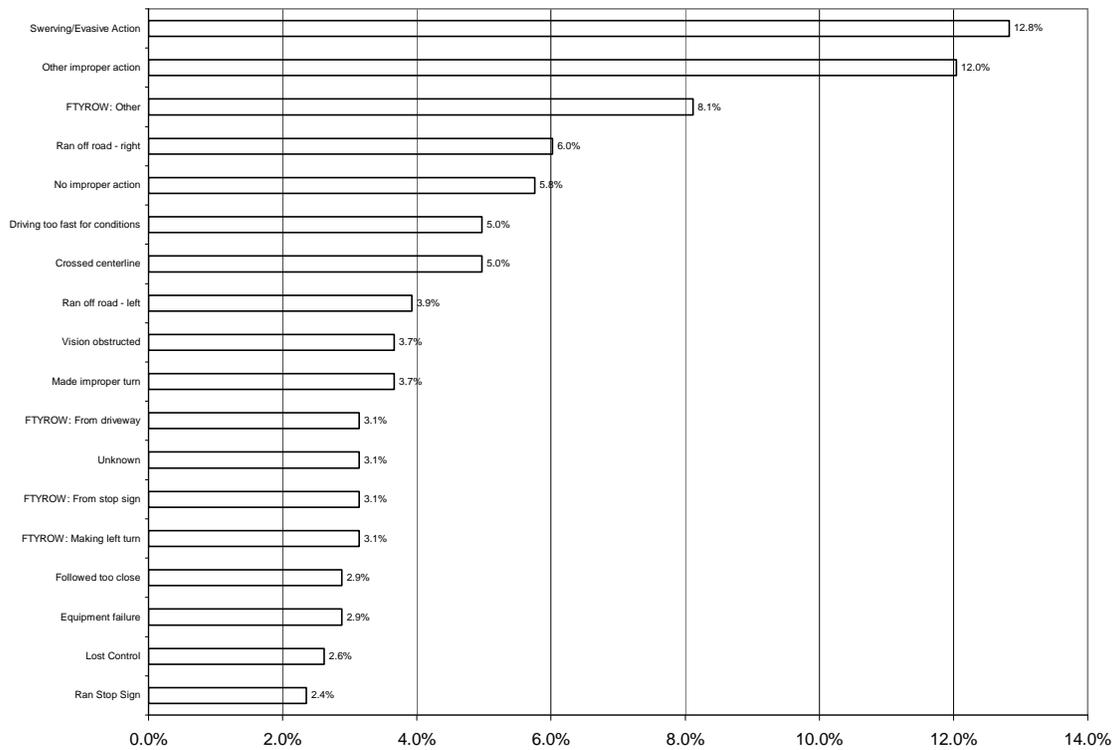
#### **4.8 Major Cause**

Another factor analyzed was major cause of the collision. Within the Iowa Crash Database there are 44 different major cause categories. The major cause describes the contributing circumstance from any vehicle involved in the crash deemed to represent the major cause for the crash. This means that the SMV involved in the crash may or may not have been the major contributor to the cause of the crash.

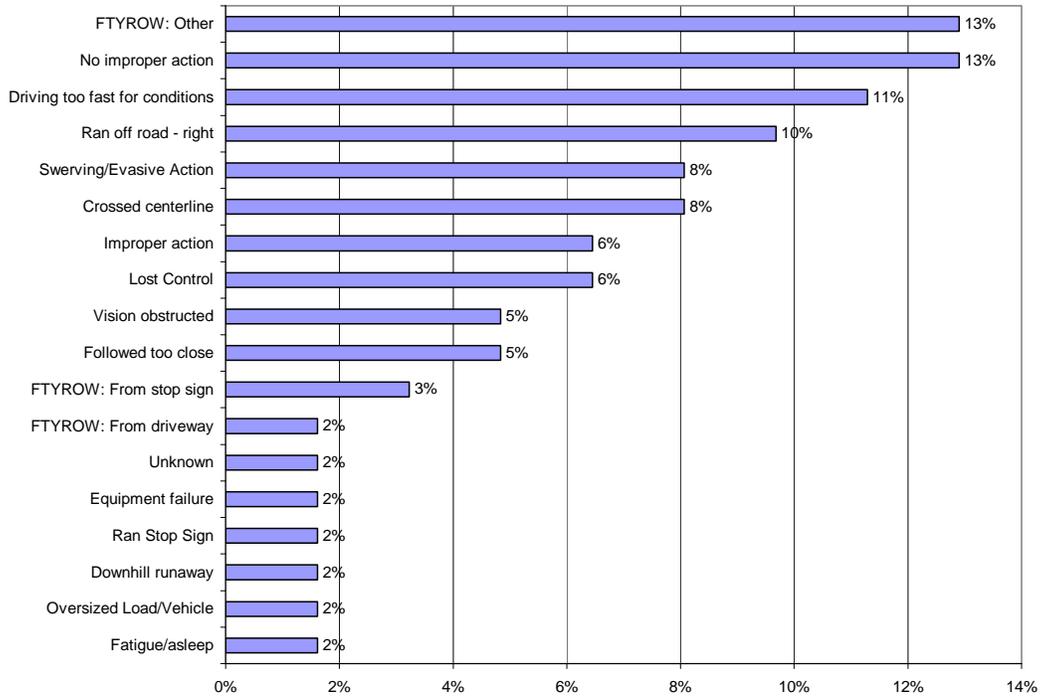
Figure 4-8 shows the major causes for rural Horse and Buggy crashes, where “animal” was the most common cause (30%), followed by vision obstructed at 20%. Figure 4-9 shows Farm Vehicle major cause. The graphic only shows the 18 most frequent causes out of a total of 31. The most common major cause was swerving/evasive action (12.8%). Figure 4-10 shows major cause for Construction/Maintenance SMV crashes, where there were 18 different categories, with the most common major cause being failure to yield (13%). Figure 4-11 shows major cause for Moped/ATV crashes, where there were 28 different categories, with the most common major cause was swerving/evasive action (13%).



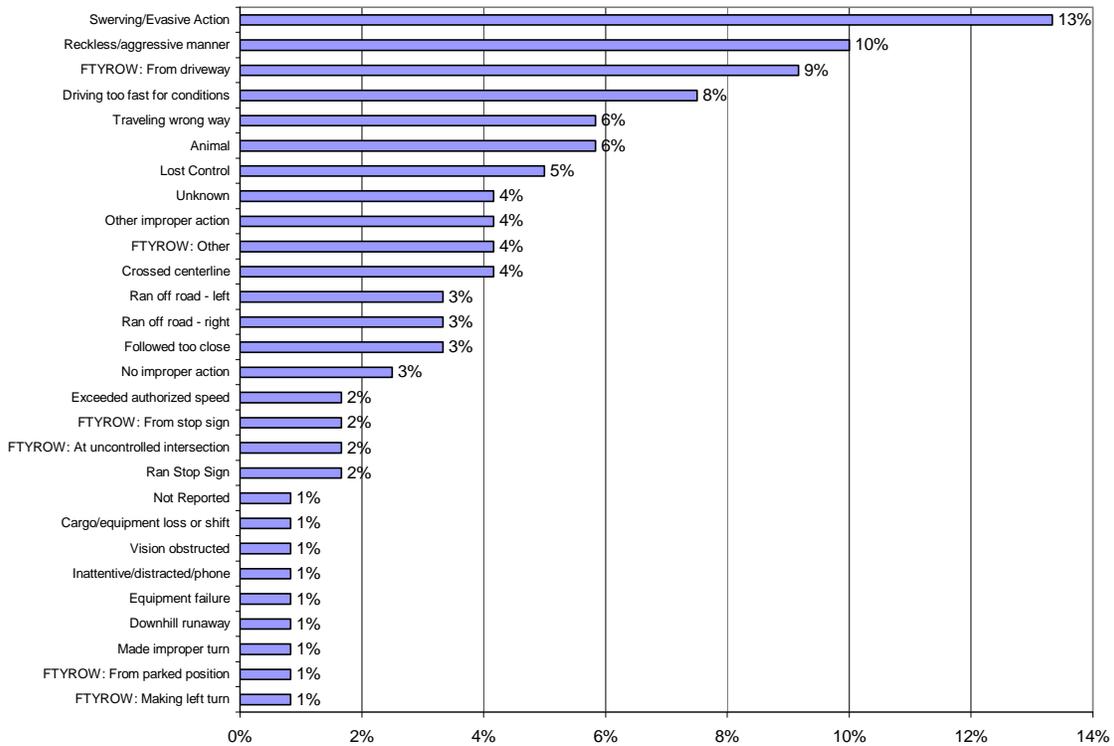
**Figure 4-8. Major cause for SMV crash, horse and buggy**



**Figure 4-9. Major cause for SMV crash, farm equipment**



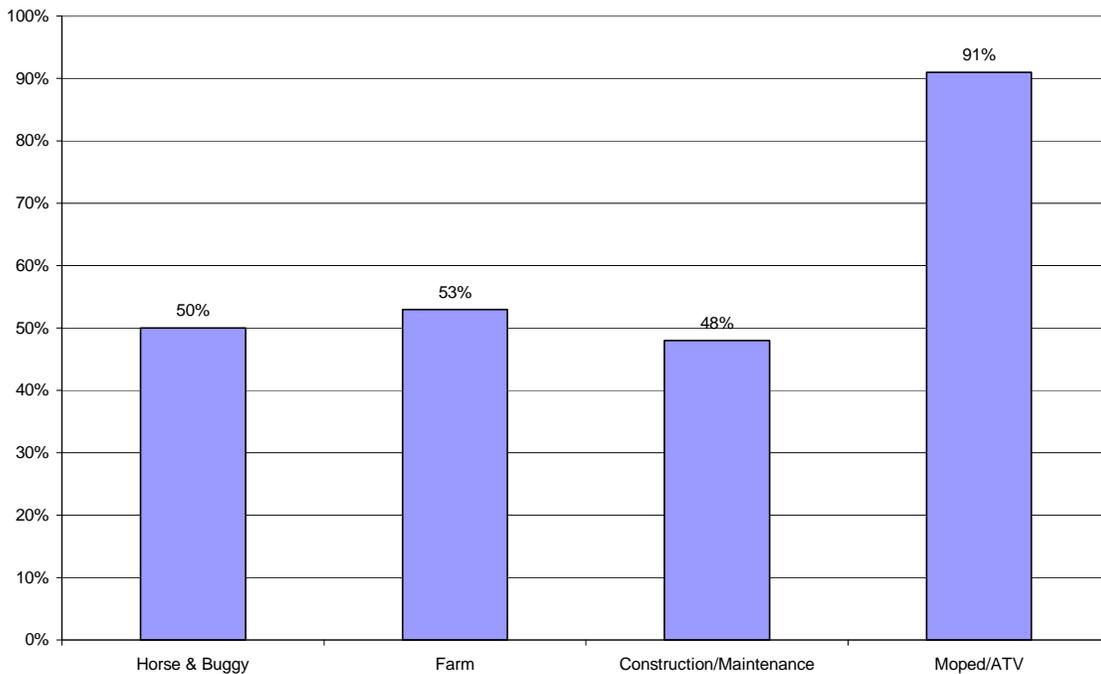
**Figure 4-10. Major cause for SMV crash, construction/maintenance**



**Figure 4-11. Major cause for SMV crash, moped/ATV**

## 4.9 Crash Responsibility

Crash responsibility was determined by matching the major cause for the crash with the contributing circumstances or sequence of events for the individual vehicle. The major cause derivation used by the Iowa DOT was used to determine the contributing circumstance, or sequence of events, most likely to be responsible for each rural crash. Figure 4-12 shows the percent of instances in which different SMV drivers were most likely to be responsible for the multi-vehicle crash. Moped/ATV drivers were significantly higher than other vehicle types at 91%, in contrast to all the other categories, at around 50% at fault.



**Figure 4-12. Percentage of crashes, SMV driver most likely at fault**

## **5. FEEDBACK FROM THE HORSE AND BUGGY COMMUNITY WITHIN IOWA**

The research team wanted to include direct feedback from Iowa’s horse and buggy community specific to roadway safety issues faced when traveling along the higher speed roadways within the state. To accomplish this, a meeting was arranged with the Amish community within Buchanan County. In addition, feedback was also provided by the Amish community within Davis County.

### **5.1 Buchanan County Public Meeting**

On September 23, 2008, a meeting was held with members of the horse and buggy (Amish) community within Buchanan County, Iowa. The meeting was organized by InTrans with the assistance of the Buchanan County Engineer (Brian Keierleber). The meeting was held at Fontana County Park, which is a Buchanan County Conservation Board facility and a regular and convenient meeting location for the horse and buggy community (see Figure 5.1). The meeting was attended by approximately 20 local Amish citizens ranging in age, gender, and profession (e.g., farmer, buggy-maker, horse-trainer, etc.). The meeting was also attended by the mayor of the adjacent City of Hazelton, Troy Jerman from the Iowa DOT Office of Traffic and Safety, and Neal Hawkins and Shauna Hallmark of InTrans.



**Figure 5-1. Horse and buggy perspective at Fontana County Park**

The meeting began with a brief introduction from the county engineer, followed by general comments regarding recent shoulder widening work and related improvements made statewide by the Iowa DOT. Hawkins then presented an overview of the project and the crash findings on SMVs and then led a discussion with the group regarding their experiences and perspectives while traveling within the area.

The overall tone was very positive and open, as noted in the summarized discussion notes below.

Discussion Notes, September 23, 2008:

**Where does everyone live?**

All within Buchanan County.

**What is the primary means of transportation?**

Horse and buggy is the primary means of transportation, except for long trips, which would be on a bus or with a hired driver. Buggies were defined as having four wheels, while a cart is the same width but has two wheels. A pony cart was much smaller, having no top and typically being lower to the ground. The group used the general term “English” to refer to non-Amish citizens.

**When are normal driving times?**

Travel can occur at any time during the day, but typically occurs more towards morning and evening, with some after dark travel up until around 10:00 P.M. Women typically leave the home around 8:00 to 10:00 A.M. and then return between 5:00 and 6:00 P.M. The travel is usually to the women’s parents or friends to help during the day or to another community member’s home to prepare for hosting church services. Although transportation may occur at any time during the day, it is unusual to travel between the hours of 10:00 P.M. and 5:00 A.M. There are more buggies on the road on Sunday.

**While traveling, what is your biggest safety concern?**

Shoulder width: having to drive half-on/off the roadway is a problem. Respondents prefer to get off on the shoulder and don’t like to see Amish driving in the traveled lane. Also, the back buggy window is very small, making it difficult to see traffic behind. They prefer a 10 foot wide shoulder and feel that 6 feet is too narrow. Several commented that 8 foot shoulders do allow getting completely off the roadway, as the buggies were typically 5 feet 10 inches wide (hub to hub). Going from the shoulder to the roadway lane can be an issue, especially where there is a big pavement-edge drop off. Another issue mentioned was the concern that school children had to walk along the same high-speed roadways to school each day.

**How would you prioritize where shoulders are needed?**

Actual roadways were noted (i.e., W-13, C -57).

**Specific to roadway shoulder treatments, what is preferred?**

Respondents prefer 10 foot shoulder width, but 8 foot is acceptable. A 6 foot shoulder is challenging. Asphalt shoulders are preferred over concrete (too hard on the horses, even

though the horses usually have shoes). They liked gravel as a shoulder surface, but rutting and drainage can be an issue.

They do not like rumble strips, as these are hard on the buggy wheels and the sound can scare the horses. There had been no experience with edge line rumble strips.

**What about pulling out from side-street intersections?**

This is really only a problem when corn is high, as the SMV driver can't see cross-traffic. Several commented that horse and buggy drivers seem to have problems placing themselves on the roadway when turning at an intersection (left lane, thru lane etc).

**Any comments regarding nighttime travel?**

Nighttime travel can be better because of low traffic, and respondents feel safer on gravel than major roads and feel that they can see and stay away from the traffic better (on gravel, the vehicles often drive in the center).

**What is used for visibility of the buggies at night?**

Most buggies have battery lights, one tail light (left), and one reflector (right). Most use a black reflectorized tape and the SMV sign.

**Is there any training for horse and buggy drivers?**

This is left up to parents. Children begin driving the pony carts in the field at a young age.

**Should there be training for vehicle drivers specific to operating around horse and buggies?**

Yes, especially for young drivers. One of the biggest problems is that people don't understand animals. They drive with little appreciation of the fact that these animals can be unpredictable. People do not shy away from the horses, and this includes maintenance vehicles, which can be very loud as they pass. There are few if any speed limit signs on some roads, and the buggy signs seem to get stolen.

Findings from an Ohio study (ODOT, 2000) were shared with the group, and most were in agreement with the following:

**Three most typical causes for horse-drawn buggy and vehicle crashes as noted:**

1. Motor vehicle drivers underestimating speed differential by drivers/operators
2. Lack of visibility of the horse and buggy between dusk and dawn or because of the rolling terrain
3. Vehicle actions by both buggies and motor vehicles (i.e., not signaling, sudden unexpected stops, etc.)

**The group generally agreed with the following Ohio concerns and opinions:**

- The opinion of many attendees is that the slowness of the buggies and the inattentiveness of motor vehicle drivers is the main safety issue.

- Many attendees felt that the tourists were less of a problem than the locals. Tourists are looking to see buggies. Locals do not see the buggies as a novelty, but rather as an interference to their getting where they want to go quickly.
- Meeting attendees felt that it is more important to widen the downhill side than the uphill side of a hill, since a buggy going down the back side of a hill is not visible from a fast approaching vehicle traveling uphill.
- There were several concerns that buggy markings were not consistent and were difficult to see. Speakers mentioned that the red flashing lights were confusing because when the buggy was to make a turn, only the one of the flashers continues to flash. The other stays red. This pattern may be confusing to people who think this flashing is a malfunction.
- It was suggested that when roadways are plowed for snow, the shoulders should also be plowed to allow buggies to ride on them or pull off to the side.
- The need for more education was expressed by many attendees. All attendees agreed that both the Amish and the “English” need better driver education. The “English” need education about slow moving vehicles, and the Amish need safety training at a very early age. Many Amish children start driving buggies at 12 to 14 years old.
- Signs and vegetation at intersections make it difficult for the Amish buggy drivers (who sit at a different height to the road and distance from the intersection than an automobile driver sits) to see around corners and intersections. Consideration of this should be made.
- Some speakers felt there is a need for more roadside warning signs indicating that it is a buggy area. Others felt the warning signs are ignored by the locals, who see them regularly and no longer notice them.
- Amish attendees commented that buggy drivers can be part of both the problem and the solution.

## **5.2 Field Review of Buchanan County Horse and Buggies**

Following the meeting, the research team was invited to review and ride in the horse and buggies used to travel to the meeting. Photos and comments follow.

Figure 5-2 shows the variety of horse-drawn SMV styles used to attend the meeting. These SMVs were pulled with either one or two horses and included large and small buggies and a steel-wheeled wagon.



**Figure 5-2. Buchanan County horse-drawn SMV examples**

Figure 5-3 is a photo of a single-horse buggy, which is a common means of transportation within Buchanan County. Figure 5-4 shows other buggy features, including the left side windows (which are small rectangles), the SMV emblem, the battery operated side reflector (left side only), and rear strip of grey conspicuity or reflective tape (bottom left), with right and top reflectorized tape strips (not shown). Note that mud and gravel are commonly found on the SMV emblems (two out of the three are visible within the photo).



**Figure 5-3. Profile view of a one-horse buggy**



**Figure 5-4. Left-side view of a one-horse buggy**

Figure 5-5 shows the rear view window, lighted reflector (left), non-lighted reflector (right), reflective tape (reflecting from the camera flash), and SMV emblem. Figure 5-6 shows a side and interior view of the floor-board brake pedal.



**Figure 5-5. Rear view of a one-horse buggy**



**Figure 5-6. Side and interior view of a one-horse buggy**

Figure 5-7 shows a two-horse wagon with SMV emblem and steel wheels. Figure 5-8 is a side view of a one-horse buggy when leaving the meeting.



**Figure 5-7. Rear view of a two-horse wagon**



**Figure 5-8. One-horse buggy traveling down the road**

### 5.3 Field Review of Buchanan County Roadway Conditions

After the meeting, the research team and Buchanan County Engineer conducted a field review of the higher traveled vehicle and horse/buggy roadways within the county. Photos and comments follow. Figure 5-9 shows the county roads reviewed. Figure 5-10 shows a typical buggy traveling on the shoulder along a 55 mph county roadway. Figure 5-11 shows the buggy tracks in the gravel merging with the traveled lane due to a lack of shoulder width on the bridge. Areas like this are a concern for the buggy drivers due to limited sight distance out of the back of the buggy, the speed of vehicles in the traveled lane, inattentive drivers, and the fact that the buggy wheels can catch on the pavement edge drop off.

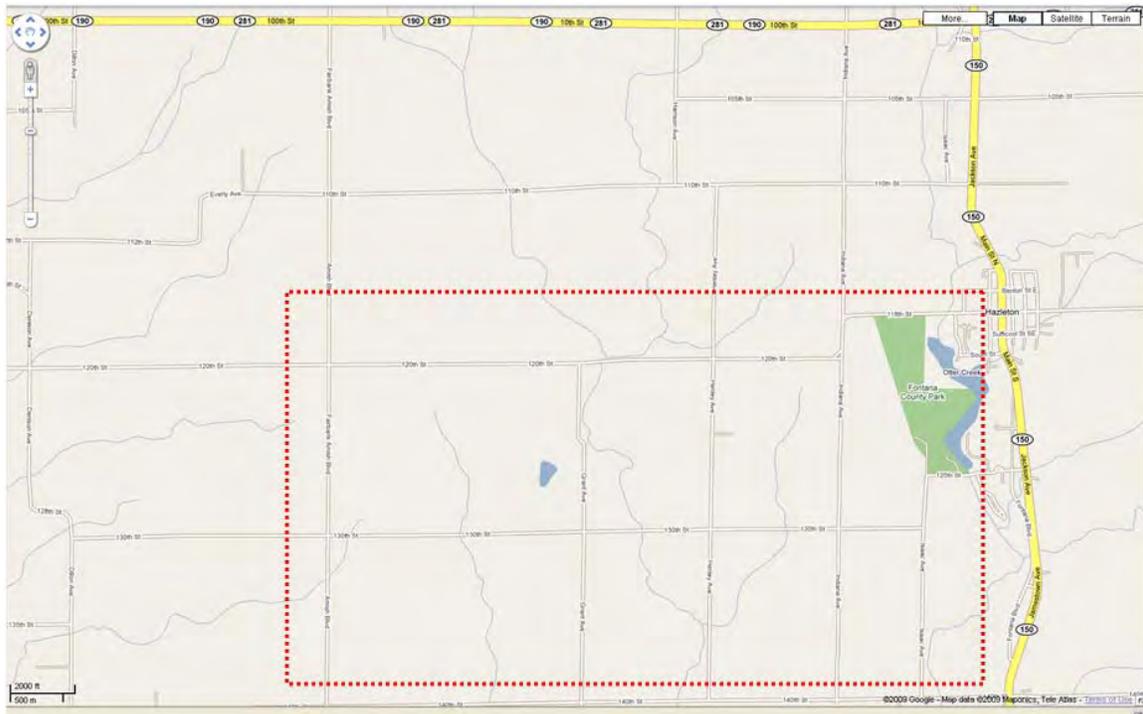


image source: (Google maps)

**Figure 5-9. General map of area driven (all county roads)**



**Figure 5-10. Heavily used county roadway for both vehicles and horse and buggies**



**Figure 5-11. Bridge requiring buggies to merge into the vehicle lane**

Figure 5-12 shows another example where buggies have to merge into the travel lane due to a roadside mailbox.



**Figure 5-12. Roadside obstacles for buggies**

Figure 5-13 shows the horse and buggy impact on a roadway gravel shoulder. As shown, the buggies' wheels pack down the gravel on the shoulder edges, and the horse hoofs pulverize the area between the wheel tracks. The end result is a low spot near the center of the shoulder where water does not drain. The lack of drainage negatively impacts shoulder stability. The packed buggy wheel paths can also accelerate pavement edge drop off distances, which is a safety issue for both vehicles and buggies.



**Figure 5-13. Drainage problem on non-paved shoulders caused by horse and buggy tracks: horse hoofs create a low spot that retains water**

Figure 5-14 shows how the steel-wheeled wagons can pack down the edges of a gravel shoulder (also notice the lack of SMV signage on the wagon).



**Figure 5-14. Steel-wheeled wagons, Buchanan County, Iowa**

Figure 5-15 shows typical signage near one of several Amish community schools. The schools are spaced roughly one per mile, given that children all walk to school. It was noted that the Amish families are concerned with the safety of their children when walking along these busy roadways.



**Figure 5-15. Signage for horse and buggy SMV, Buchanan County, Iowa**

Figure 5-16 shows a typical intersection and the location for potential conflicts between vehicular and horse and buggy traffic. The Amish community also noted that when pulling up to a side-street stop sign, buggy drivers are at a disadvantage in trying to view gaps in traffic. Buggy drivers often pull forward well ahead of the stop location, and this can position the horse uncomfortably close to high-speed traffic. The seasonal issue also varies by crop. Corn presents much more of a problem than soy beans.



**Figure 5-16. Typical county intersection, Buchanan County, Iowa**

Figure 5-17 shows a challenging area for horse and buggy operators, given the multiple curves and narrow shoulders. The edge line rumble strip shown can be annoying to horse and buggy operators. However, in this lesser traveled area no specific comments were made by attendees at the meeting.

Figure 5-18 shows a typical non-paved roadway that has daily horse and buggy traffic. The Amish community felt much safer traveling on these types of roadway, given the lower vehicular speeds and volumes, the ability to hear oncoming traffic, and the convenience of traveling on the road as opposed to the shoulder.



**Figure 5-17. Curve location with narrow shoulders, Buchanan County, Iowa**



**Figure 5-18. Gravel roadway, Buchanan County, Iowa**

## 5.4 Davis County Public Meeting

On April 28, 2009, a meeting was held with members of the horse and buggy (Amish) community within Davis County, Iowa. The meeting was organized by the Iowa DOT in response to some expressed concerns over recently installed pavement marking rumble strips within the area (see Figure 5-19).



**Figure 5-19. Rumble strips on IA 2, Davis County, Iowa**

The meeting was held at the Southern Iowa Produce Auction, which is an Amish-run sale barn. Over 50 local Amish citizens attended the meeting, representing a range of ages and professions. The meeting was led by the Iowa DOT District 5 District Engineer, Assistant District Engineer, and Traffic Technician. Other participants included Troy Jerman from the Iowa DOT Office of Traffic and Safety and Neal Hawkins of InTrans.

Following introductions, both the Iowa DOT and local leader of the Amish safety committee expressed their concerns and outlined the nature of the meeting. Neal Hawkins then presented an overview of recent research findings regarding SMVs. The group generally agreed with the Amish in Buchanan County regarding their primary means of transportation, normal driving times, and days of worship. The Davis County group asked for nothing from the Iowa DOT but offered the following new information:

Wedding events, predominantly in the spring and fall, last until after dark, and this is a concern given that there can be up to 10 horse and buggies on the same road at the same time during dark conditions. Figure 5-20 shows several horse and buggies on the same road during daylight conditions.



**Figure 5-20. Buggies heading to the sale barn, Davis County, Iowa**

Local vehicle drivers often show their frustration in having to maneuver around the horse and buggies. In some locations, the Amish wish there could be a sign letting vehicle drivers know that there isn't enough shoulder to get completely off the roadway (see Figure 5-21).



**Figure 5-21. Narrow shoulder on a curve, Davis County, Iowa**

The recently installed rumble strips are a real problem for the horse and buggies, as the horse does not want to go across them and could easily turn a hoof. Also, these rumbles are “teeth shattering” and hard on the buggies. Some noted that the buggies can fishtail when crossing the rumble strips. The Amish community would humbly prefer not to have any rumble strips within their small area.

The group would greatly prefer that the Iowa DOT did not use large chunks of asphalt for shoulder maintenance, as this too is very bumpy and dangerous for the horses (see Figure 5-22).

The group would also prefer more shoulder room, if possible, to further separate the horse from large trucks (see Figure 5-23).



**Figure 5-22. Asphalt waste used for shoulder maintenance, Davis County, Iowa**



**Figure 5-23. Narrow shoulder, trucks, rumble strips, and vertical grade on IA 2, Davis County, Iowa**

Some schools teach safety on the public roadway. Children begin driving on the roadway at around 12 years of age and often take other children to school in the same buggy.

The Amish community would prefer a full paved shoulder in an ideal situation, as the transition from paved lane to gravel shoulder often has a “drop off” that can cause problems for both horse and buggy (see Figure 5-24).



**Figure 5-24. Transition from road to shoulder, Davis County, Iowa**

This local Amish community is growing modestly within the immediate area. Their buggies are typically equipped with battery operated lights, SMV emblems, and tape (see Figure 5-25).



**Figure 5-25. Covered buggy, Davis County, Iowa**

SMV signage differed according to the road the buggies were (state versus county). The Amish group has its own safety committee to discuss these types of issues with roadway authorities. The group was more than humble in voicing its concerns and was very willing to be part of the solution where possible.

## **6. FEEDBACK FROM THE AG/FARM COMMUNITY IN IOWA**

The research team wanted to include direct feedback from the agricultural and farm-based community of roadway users, but the project did not include a formal survey or group meeting. As an alternative, a Marion County farmer was asked to solicit feedback/opinions from other farmers over a one-year period and then share this information through conversations with the research team. This information is not presented as a complete survey of current practice, but rather as a localized point of input.

### **6.1 Farm Operator Input**

The research team discussed SMV issues with a Marion County farmer who relayed his and others' experiences specific to operating their equipment on public roadways. These comments are summarized below, along with relevant photos from the field (VanVliet, 2009).

#### *Use of the Public Roadway*

- As equipment has increased in size, it seems that people (farmers) are traveling longer distances to farm more ground. Farmers are, and will continue to be, on the public roadways every day that they can be in the fields.
- It is common to have pieces of rented land well away from the homestead. Over 50% of one individual's land is rented away from his homestead, and these rented acres are located more than 20 miles away. This is typical: his neighbor rents additional land over 40 miles away, with everything being driven down there as opposed to loaded on a trailer.
- Farmers are on the road at all times, including during dusk and dawn conditions.
- Farmers regularly travel on roads posted at 55 mph and sometimes along expressways posted at 65 mph.
- Between Pella and Knoxville, farmers regularly travel over the Red Rock Dam, which is the only river crossing in the area. This is also a major commuter route for traffic.

#### *Equipment on the Road*

- All equipment, except for the bean planter, which is 30 feet wide, is moved back and forth over public roadways. This includes 10 foot wide tractors with implements as well as combines that have 20 foot wide corn heads on them.
- The general rule is to not pull over to let folks around, as this usually puts both drivers at risk due to hitting of a mailbox, a soft shoulder, or simply not having enough width to move over.
- Sometimes a gravel shoulder is needed just to accommodate tractor width and keep the machinery off the centerline.

## *Safety Concerns and Issues*

- Farmers don't feel that motorists pay attention nor respect the tractor operator, and motorists often create nerve wracking situations in trying to pass. Vehicles regularly pass in no-passing areas. Groups of four and five cars often pass, with the last vehicle having to brake and swerve back into the travel lane dangerously close to the front of the tractor. This sometimes requires the tractor operator to slam on the brakes.
- Farmers realize that the increasing size of farm equipment causes issues for vehicles trying to pass in terms of space and seeing around to select a safe passing gap.
- Some farmers put flashing yellow lights on each of their tractors and use these when on the public roadway. They feel people react better to these than just the SMV emblem.
- The larger the implement, the safer the farm operator feels. For example, farmers feel much safer driving the large combine as opposed to a smaller tractor. People respect the larger equipment, can see it at a distance, realize it will be traveling much slower, and are forced to be more patient in following or passing.
- The typical 55 mph road with no shoulders is a challenge, especially if there is traffic. For example, farmers try to avoid roadways where a factory has let out, e.g., around 4 P.M. People will be backed up behind the farm vehicle and tend to be impatient.
- The worst times seem to be in the fall, when the afternoon sun adds to the difficulty of vehicles trying to pass.
- Gravel roads often have three paths. One example was given where a vehicle came upon a tractor very quickly. As the vehicle passed, the tractor tires rubbed the side of the vehicle, causing an accident.
- Vehicles do not slow down quickly enough around SMVs, and this seems to be the worst when the implement looks less like a large combine and more like something that might be traveling at normal speeds. An example is wagons. In the fall, there seems to be a wagon rear-ended by a vehicle every year. These wagons can sometimes look similar to the back of a dump truck.
- Vehicles do not give enough clear distance away from the tractor when passing. An example is a farm tractor pulling into a field entrance. While making the tight turn, an articulating tractor's back tires actually turn, and an example was cited where a car was passing the tractor and hit the rear back dual tires.

### **6.2 Field Observations of Iowa Farm and Construction Vehicles**

A number of examples related to the farm comments above were observed within central Iowa, as illustrated in Figures 6-1 through 6-7.



**Figure 6-1. Forward perspective for tractor**



**Figure 6-2. Variety of farm equipment on the roadway**



**Figure 6-3. Farm equipment on 65 mph roadways**



**Figure 6-4. Passing on two-lane 55 mph roadways**



**Figure 6-4. Queuing and driver frustration on two-lane 55 mph roadways**



**Figure 6-5. Difficult-to-recognize wagon at night**



**Figure 6-6. Wagons of various sizes and shapes**



**Figure 6-7. Construction vehicles on the roadway**

## 7. SUMMARY

This report provides a literature review showing various SMV statistics and laws across the United States, a crash study based on three years of Iowa SMV crash data, and recommendations from the SMV community. Improving the visibility and safety of SMVs should be a continuous goal, with a focus and effort equal to that given to vehicles and pedestrians.

This report also includes a section which identifies future research needs and includes the following subjects:

- Overall research
- Engineering design standards
- Safety education programs
- Policy

Improving the safety of SMVs along Iowa's high speed roadways should begin with an understanding of the following:

- SMV crashes will always be a small fraction of overall vehicle crashes.
- It is not a question of whether or not a vehicle will pass an SMV, it is a question of when. SMV safety directly impacts vehicle safety.
- A crash involving a slow moving agricultural vehicle is about five times more likely to result in a fatality than other crash types.
- Crashes involving horse-drawn vehicles tend to involve a high speed differential for the colliding vehicles and minimal safety protection for the occupants of the horse-drawn vehicle.
- Existing SMV emblems do not distinguish between a motorized vehicle and a buggy pulled by a horse.
- Federal, State, and Local agencies need to give this area of roadway safety more attention.

SMV safety on Iowa's high speed roadways should be based on an understanding of crash performance and input from these special groups. A practical approach should include the following:

- A systematic approach to identifying specific safety problems
- Close coordination with the community
- Identification of solutions
- Local involvement in the process

Agencies can begin by taking the following steps:

- Identifying roadways where horses and buggies or other SMVs mix with vehicular traffic
- Reviewing and analyzing routes with evident buggy traffic to identify problem areas
- Recognizing that the needs and solutions for different SMV types vary greatly, e.g., horse versus motor powered SMV

- Considering the adequacy of existing roadway signage, lighting, grade, curvature, pavement treatments, shoulder treatments, and shoulder widths
- Identifying short and long term needs and solutions
- Reaching out to local groups and creating a dialogue to exchange ideas, share constraints, and plan for long term solutions
- Coordinating activities between City, County, and State agencies in order to maintain consistent signage and roadway treatments and address the safety needs of the SMV roadway users
- Developing consistent safety campaign information for driver awareness and understanding

SMV operators should take the following steps:

- Go beyond minimal lighting and conspicuity requirements to alert motorists of their presence
- Notify agencies of their concerns in areas which offer minimal sight distance and no shoulder or ability to get out of the traveled lane
- Educate operators to drive safely on the roadway and operate their vehicles consistently

This report serves as a starting point and resource for agencies to address SMV safety within Iowa. The information supplements the exchange ideas for both the SMV community and practitioners within other states facing similar challenges to those mentioned in this report.

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APPENDIX A. SMV CRASH DATA

2004 - 2006 Total Crash Data									
Description	SMV Crashes	Horse & Buggy	Farm	Construction/Maintenance	Moped/ATV	Bicycle	Other	Total	
<b># Crashes involving at least one SMV</b>	<b>Total</b>	18	594	230	361	110	39	1352	
# SMVs in Crashes in area:	Rural	10	382	62	120	8	9	591	
	Urban	8	204	161	229	100	28	730	
	Unknown	0	8	7	12	2	2	31	
# of SMV Crashes With crash severity of:	Fatality	0	21	4	16	5	1	47	
	Major Injury	3	46	11	74	14	3	151	
	Minor Injury	4	93	24	158	44	10	333	
	Property Damage Only	9	334	157	40	5	15	560	
	Possible/Unknown	2	100	34	73	42	10	261	
# of Crashes involving one or more SMVs during	NIGHT (Sunset-Sunrise)	5	125	17	83	28	11	269	
	DAY (Sunrise - Sunset)	13	459	22	273	82	26	1067	
	Unknown	0	10		5	0	0	16	
	Night-to-Day Crash Ratio	0.384615385	0.272331	0.680188679	0.3040293	0.34146	0.392857	0.252109	
# of Crashes involving one or more SMVs during	AM Peak	2	51	35	24	6	3	121	
	PM Peak	3	115	20	84	24	8	254	
	Midday (Offpeak)	8	303	150	123	39	14	637	
	January	3	12	25	9	3	7	59	
	February	1	18	26	12	4	1	62	
	March	1	20	18	19	3	0	61	
	April	1	53	14	32	6	1	107	
	May	1	41	12	37	11	2	104	
	June	4	64	20	52	13	6	159	
	July	0	40	18	52	21	3	134	
	August	3	40	25	38	16	8	130	
	September	2	64	24	61	16	4	161	
	October	0	122	17	31	6	1	177	
	November	2	83	17	18	4	3	127	

2004 - 2006 Total Crash Data										
Description	SMV Crashes December	Horse & Buggy	Farm	Construction/Maintenance	Moped/ATV	Bicycle	Other	Total		
		0	37	14	10	7	3	71		
# of Crashes involving one or more SMVs with surface conditions of:	Dry	13	460	133	246	97	22	971		
	Wet	2	30	20	21	8	4	85		
	Ice	0	7	14	4	0	1	26		
	Snow	1	14	34	10	1	5	65		
	Slush	0	2	2	3	0	0	4		
	Sand/mud/dirt/oil/gravel	2	63	19	60	1	2	147		
	Water (standing/moving)	0	0	1	3	0	0	1		
	Other/Unknown/Not Reported	0	18	7	20	3	5	53		
	below 25 mph	0	3	5	17	1	2	28		
	25-34 mph	3	53	80	158	2	14	310		
35-44 mph	1	24	18	27	3	2	75			
45-54 mph	0	66	17	39	0	4	126			
55-64 mph	9	397	74	84	0	6	570			
65 mph and above	0	20	2	1	0	0	23			
Unknown	5	35	35	57	107	11	250			
Animal	5	1	1	9	0	0	16			
Ran Traffic Signal	1	1	2	4	0	0	8			
Ran Stop Sign	0	10	3	11	2	0	26			
Crossed centerline	1	30	8	7	0	0	46			
FTYROW: At uncontrolled intersection	0	6	2	3	1	1	19			
FTYROW: Making right turn on red signal	0	0	0	3	5	1	9			
FTYROW: From stop sign	2	17	6	16	3	2	46			
FTYROW: From yield sign	0	1	1	3	0	0	5			
FTYROW: Making left turn	0	28	2	18	2	1	51			
FTYROW: From driveway	0	14	4	15	1	4	38			
FTYROW: From parked position	0	1	1	3	0	0	5			
FTYROW: To pedestrian	0	0	1	1	1	6	8			

2004 - 2006 Total Crash Data								
Description	SMV Crashes	Horse & Buggy	Farm	Construction/Maintenance	Moped/ATV	Bicycle	Other	Total
FTYROW: Other (explain in narrative)	1		52	23	11	8	6	101
Traveling wrong way or on wrong side of road	0	0	10	0	3	0	0	19
Driving too fast for conditions	0	0	22	19	20	0	0	61
Exceeded authorized speed	0	0	4	2	4	0	0	10
Made improper turn	0	0	17	3	4	0	1	25
Improper Lane Change	0	0	0	0	0	0	0	0
Followed too close	2	0	25	11	15	2	1	56
Disregarded RR Signal	0	0	0	1	0	0	0	1
Disregarded Warning Sign	0	0	0	1	0	0	0	1
Operating vehicle in an erratic/reckless/careless/negligent/aggressive manner	0	0	12	3	26	2	5	48
Improper Backing	0	0	0	0	0	0	0	0
Illegally Parked/Unattended	0	0	0	0	0	0	0	0
Swerving/Evasive Action	1	0	72	13	29	3	4	122
Over correcting/over steering	0	0	6	2	3	0	0	11
Downhill runaway	0	0	1	3	1	0	0	5
Equipment failure	0	0	13	2	5	1	0	21
Separation of units	0	0	8	1	0	0	0	9
Ran off road - right	1	0	38	11	10	2	0	62
Ran off road - straight	0	0	4	0	0	0	0	4
Ran off road - left	0	0	19	2	3	0	1	28
Lost Control	1	0	18	13	52	0	2	86
Inattentive/distracted by: Passenger	0	0	1	0	1	1	0	3
Inattentive/distracted by Use of phone or other device	0	0	4	0	2	0	0	6
Inattentive/distracted by: Fallen object	0	0	0	0	0	0	0	0
Inattentive/distracted by: Fatigue/asleep	0	0	0	1	0	0	0	1

2004 - 2006 Total Crash Data								
Description	SMV Crashes	Horse & Buggy	Farm	Construction/Maintenance	Moped/ATV	Bicycle	Other	Total
Other (explain in narrative): Vision obstructed		2	21	14	5	1	0	43
Oversized Load/Vehicle		0	0	1	0	0	0	1
Cargo/equipment loss or shift		0	1	1	1	0	0	3
Other (explain in narrative): Other improper action		1	71	39	25	6	2	144
Unknown		0	24	14	17	11	3	69
Other (explain in narrative): No improper action		0	35	18	14	42	4	113
Not Reported		0	7	1	2	11	1	22
<b>Non-Collision</b>								
Non-Collision		0	95	24	139	66	15	369
Head-on		2	25	12	10	1	2	52
Rear-end		6	166	65	51	1	2	291
Angle, oncoming left turn		1	33	5	18	3	1	61
Broadside		7	65	46	75	34	14	241
Sideswipe, same direction		2	150	54	22	0	3	231
Sideswips, opposite direction		0	51	12	9	0	0	72
Unknown		0	6	8	2	4	0	20
Not Reported		0	3	4	5	1	2	15
<b>Driver age of SMVs involved in crashes</b>								
<15		0	8	0	130	0	4	112
15-20		4	48	5	138	1	7	173
21-24		1	42	14	39	0	2	98
25-34		1	77	35	41	0	6	160
35-44		0	88	45	27	2	3	165
45-54		1	129	75	25	5	8	243
55-64		1	77	32	10	1	2	123
65-69		0	24	4	9	0	2	39
70+		1	81	1	13	0	1	97
Unknown		9	24	20	11	104	4	172
<b>Animal</b>								
Animal		4	1	1	9	0	0	15

2004 - 2006 Total Crash Data									
Description	SMV Crashes	Horse & Buggy	Farm	Construction/Maintenance	Moped/ATV	Bicycle	Other	Total	Total
Ran Traffic Signal	0	0	0	0	1	0	0	1	1
Ran Stop Sign	0	8	2	0	8	0	0	18	18
Crossed centerline	1	16	3	0	5	0	0	25	25
FTYROW: At uncontrolled intersection	0	3	0	0	7	0	0	10	10
FTYROW: Making right turn on red signal	0	0	0	0	0	0	0	0	0
FTYROW: From stop sign	2	13	6	0	8	0	2	31	31
FTYROW: From yield sign	0	1	0	0	2	0	0	3	3
FTYROW: Making left turn	0	27	1	0	5	0	0	34	34
FTYROW: From driveway	0	10	3	0	11	0	3	27	27
FTYROW: From parked position	0	1	1	0	2	0	0	4	4
FTYROW: To pedestrian	0	0	1	0	1	1	0	3	3
FTYROW: Other (explain in narrative)	1	19	16	0	10	2	5	53	53
Traveling wrong way or or wrong side of road	0	5	0	0	9	0	0	14	14
Driving too fast for conditions	0	7	2	0	19	0	0	28	28
Exceeded authorized speed	0	0	0	0	3	0	0	3	3
Made improper turn	0	15	3	0	2	0	1	21	21
Improper Lane Change	0	0	0	0	0	0	0	0	0
Followed too close	0	2	1	0	12	0	1	16	16
Disregarded RR Signal	0	0	1	0	0	0	0	1	1
Disregarded Warning Sign	0	0	1	0	0	0	0	1	1
Operating vehicle in an erratic/reckless/careless/negligent/aggressive manner	0	3	1	0	25	0	5	34	34
Improper Backing	0	0	0	0	0	0	0	0	0
Illegally Parked/Unattended	0	0	0	0	0	0	0	0	0
Swerving/Evasive Action	1	17	6	0	22	1	4	51	51
Overcorrecting/over steering	0	4	1	0	3	0	0	8	8
D downhill runaway	0	1	2	0	1	0	0	4	4
Equipment failure	0	12	2	0	5	1	0	20	20

2004 - 2006 Total Crash Data									
Description	SMV Crashes	Horse & Buggy	Farm	Construction/Maintenance	Moped/ATV	Bicycle	Other	Total	
other vehicle involved in the crash	Separation of units	0	7	1	0	0	0	8	
	Ran off road - right	1	34	9	10	2	0	56	
	Ran off road - straight	0	2	0	0	0	0	2	
	Ran off road - left	0	14	1	5	0	1	22	
	Lost Control	0	6	6	52	0	2	66	
	Inattentive/distracted by: Passenger	0	0	0	1	0	0	1	
	Inattentive/distracted by Use of phone or other device	0	0	0	2	0	0	2	
	Inattentive/distracted by: Fallen object	0	0	0	0	0	0	0	
	Inattentive/distracted by: Fatigue/asleep	0	0	0	0	0	0	0	
	Other (explain in narrative): Vis on obstructed	0	9	9	3	0	0	21	
	Oversized Load/Vehicle	0	0	1	0	0	0	1	
	Cargo/equipment loss or shift	0	1	1	1	0	0	3	
	Other (explain in narrative): Other improper action	1	27	26	24	0	2	80	
	Unknown	0	15	10	13	2	2	42	
	Other (explain in narrative): No improper action	0	27	12	12	0	2	53	
	Not Reported	0	0	0	0	0	0	0	
	Animal	80.0%	100.0%	100.0%	100.0%	0.0%	0.0%	93.8%	
	Ran Traffic Signal	0.0%	0.0%	0.0%	25.0%	0.0%	0.0%	12.5%	
	Ran Stop Sign	0.0%	80.0%	65.7%	72.7%	0.0%	0.0%	69.2%	
	Crossed centerline	100.0%	53.3%	37.5%	71.4%	0.0%	0.0%	54.3%	
	FTYROW: At uncontrolled intersection	0.0%	50.0%	0.0%	77.8%	0.0%	0.0%	52.6%	
	FTYROW: Making right turn on red signal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
	FTYROW: From stop sign	100.0%	76.5%	100.0%	50.0%	0.0%	100.0%	67.4%	



2004 - 2006 Total Crash Data								
Description	SMV Crashes	Horse & Buggy	Farm	Construction/Maintenance	Moped/ATV	Bicycle	Other	Total
Inattentive/distracted by Use of phone or other device		0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	33.3%
Inattentive/distracted by: Fallen object		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Inattentive/distracted by: Fatigue/asleep		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Other (explain in narrative): Vis on obstructed		0.0%	42.9%	64.3%	60.0%	0.0%	0.0%	48.8%
Oversized Load/Vehicle		0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	100.0%
Cargo/equipment loss or shift		0.0%	100.0%	100.0%	100.0%	0.0%	0.0%	100.0%
Other (explain in narrative): Other improper action		100.0%	38.0%	65.7%	96.0%	0.0%	100.0%	55.6%
Unknown		0.0%	62.5%	71.4%	76.5%	18.2%	66.7%	60.9%
Other (explain in narrative): No improper action		0.0%	77.1%	65.7%	65.7%	0.0%	50.0%	46.9%
Not Reported		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
<b>Total</b>		<b>61.1%</b>	<b>50.2%</b>	<b>54.9%</b>	<b>62.3%</b>	<b>15.2%</b>	<b>83.9%</b>	<b>59.8%</b>
Animal	1	0	0	0	0	0	0	1
Ran Traffic Signal	1	1	2	0	3	0	0	7
Ran Stop Sign	0	2	1	3	2	0	0	8
Crossed centerline	0	14	5	2	0	0	0	21
FTYROW: At uncontrolled intersection	0	3	2	2	1	1	1	9
FTYROW: Making right turn on red signal	0	0	0	0	0	5	1	6
FTYROW: From stop sign	0	4	0	0	3	0	0	15
FTYROW: From yield sign	0	0	1	4	0	0	0	5
FTYROW: Making left turn	0	1	1	12	2	1	1	17
FTYROW: From driveway	0	4	1	4	1	1	1	11
FTYROW: From parked position	0	0	0	0	1	0	0	1
FTYROW: To pedestrian	0	0	0	0	0	5	0	5

## 2004 - 2006 Total Crash Data

Description	SMV Crashes	Horse & Buggy	Farm	Construction/Maintenance	Moped/ATV	Bicycle	Other	Total
FTYROW: Other (explain in narrative)		0	33	7	1	6	1	48
Traveling wrong way or on wrong side of road		0	5	0	0	0	0	5
Driving too fast for conditions		0	15	17	1	0	0	33
Exceeded authorized speed		0	4	2	1	0	0	7
Made improper turn		0	2	0	2	0	0	4
Improper Lane Change		0	0	0	0	0	0	0
Followed too close		2	23	10	3	2	0	40
Disregarded RR Signal		0	0	0	0	0	0	0
Disregarded Warning Sign		0	0	0	0	0	0	0
Operating vehicle in an erratic/reckless/careless/negligent/aggressive manner		0	9	2	1	2	0	14
Improper Backing		0	0	0	0	0	0	0
Illegally Parked/Unattended		0	0	0	0	0	0	0
Swerving/Evasive Action		0	55	7	7	2	0	71
Over correcting/over steering		0	2	1	0	0	0	3
D downhill runaway		0	0	1	0	0	0	1
Equipment failure		0	1	0	0	0	0	1
Separation of units		0	1	0	0	0	0	1
Ran off road - right		0	4	2	0	0	0	6
Ran off road - straight		0	2	0	0	0	0	2
Ran off road - left		0	5	1	0	0	0	6
Lost Control		1	12	7	0	0	0	20
Inattentive/distracted by: Passenger		0	1	0	0	1	0	2
Inattentive/distracted by Use of phone or other device		0	4	0	0	0	0	4
Inattentive/distracted by: Fallen object		0	0	0	0	0	0	0
Inattentive/distracted by: Fatigue/asleep		0	0	1	0	0	0	1

Major cause of crashes involving one or more SMVs with matching circumstances from the Non-SMV vehicle involved that indicate more responsibility on the particular **Non-SMV** than any other vehicle involved in the crash

2004 - 2006 Total Crash Data								
Description	SMV Crashes	Horse & Buggy	Farm	Construction/Maintenance	Moped/ATV	Bicycle	Other	Total
Other (explain in narrative): Vision obstructed	2	12	5	0	2	1	0	22
Oversized Load/Vehicle	0	0	0	0	0	0	0	0
Cargo/equipment loss or shift	0	0	0	0	0	0	0	0
Other (explain in narrative): Other improper action	0	44	13	1	6	0	0	64
Unknown	0	9	4	4	9	1	1	27
Other (explain in narrative): No improper action	0	8	6	2	42	2	2	60
Not Reported	0	7	1	2	11	1	1	22
Animal	20.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	6.3%
Ran Traffic Signal	100.0%	100.0%	100.0%	100.0%	75.0%	0.0%	0.0%	87.5%
Ran Stop Sign	0.0%	20.0%	33.3%	27.3%	100.0%	0.0%	0.0%	30.8%
Crossed centerline	0.0%	46.7%	62.5%	28.6%	0.0%	0.0%	0.0%	45.7%
FTYROW: At uncontrolled intersection	0.0%	50.0%	100.0%	22.2%	100.0%	100.0%	100.0%	47.4%
FTYROW: Making right turn on red signal	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	100.0%	100.0%
FTYROW: From stop sign	0.0%	23.5%	0.0%	50.0%	100.0%	0.0%	0.0%	32.6%
FTYROW: From yield sign	0.0%	0.0%	100.0%	66.7%	0.0%	0.0%	0.0%	62.5%
FTYROW: Making left turn	0.0%	3.6%	50.0%	66.7%	100.0%	100.0%	100.0%	33.3%
FTYROW: From driveway	0.0%	28.6%	25.0%	26.7%	100.0%	100.0%	25.0%	28.9%
FTYROW: From parked position	0.0%	0.0%	0.0%	33.3%	0.0%	0.0%	0.0%	20.0%
FTYROW: To pedestrian	0.0%	0.0%	0.0%	0.0%	0.0%	83.3%	0.0%	62.5%
FTYROW: Other (explain in narrative)	0.0%	63.5%	30.4%	3.1%	75.0%	16.7%	16.7%	47.5%
Traveling wrong way or wrong side of road	0.0%	50.0%	0.0%	0.0%	0.0%	0.0%	0.0%	26.3%
Driving too fast for conditions	0.0%	63.2%	83.5%	5.0%	0.0%	0.0%	0.0%	54.1%
Exceeded authorized speed	0.0%	100.0%	100.0%	25.0%	0.0%	0.0%	0.0%	70.0%
Made improper turn	0.0%	11.3%	0.0%	50.0%	0.0%	0.0%	0.0%	16.0%

2004 - 2006 Total Crash Data									
Description	SMV Crashes	Horse & Buggy	Farm	Construction/Maintenance	Moped/ATV	Bicycle	Other	Total	
Percentage of crashes involving one or more slow moving vehicles in which a <b>Non-SMV</b> is considered more responsible for the crash than any other vehicles involved in the crash	Improper Lane Change	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Followed too close	100.0%	0.0%	92.0%	90.9%	20.0%	0.0%	71.4%	0.0%
	Disregarded RR Signal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Disregarded Warning Sign	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Operating vehicle in an erratic/reckless/careless/negligent/aggressive manner	0.0%	0.0%	75.0%	66.7%	3.3%	100.0%	0.0%	29.2%
	Improper Backing	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Illegally Parked/Unattended	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Swerving/Evasive Action	0.0%	0.0%	76.4%	53.8%	24.1%	66.7%	0.0%	58.2%
	Over correcting/over steering	0.0%	0.0%	33.3%	50.0%	0.0%	0.0%	0.0%	27.3%
	D downhill runaway	0.0%	0.0%	0.0%	33.3%	0.0%	0.0%	0.0%	20.0%
	Equipment failure	0.0%	0.0%	7.7%	0.0%	0.0%	0.0%	0.0%	4.8%
	Separation of units	0.0%	0.0%	12.5%	0.0%	0.0%	0.0%	0.0%	11.1%
	Ran off road - right	0.0%	0.0%	10.5%	18.2%	0.0%	0.0%	0.0%	9.7%
	Ran off road - straight	0.0%	0.0%	50.0%	0.0%	0.0%	0.0%	0.0%	50.0%
	Ran off road - left	0.0%	0.0%	26.3%	50.0%	0.0%	0.0%	0.0%	21.4%
Lost Control	100.0%	0.0%	66.7%	53.8%	0.0%	0.0%	0.0%	23.3%	
Inattentive/distracted by:									
Passenger		0.0%	100.0%	0.0%	0.0%	100.0%	0.0%	66.7%	
Inattentive/distracted by Use of phone or other device		0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	66.7%	
Inattentive/distracted by:									
Fallen object		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
Inattentive/distracted by:									
Fatigue/asleep		0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	100.0%	
Other (explain in narrative):		100.0%	57.1%	35.7%	40.0%	100.0%	0.0%	51.2%	
Vision obstructed		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
Oversized Load/Vehicle									
Cargo/equipment loss or shift		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
Other (explain in narrative):		0.0%	62.0%	33.3%	4.0%	100.0%	0.0%	44.4%	
Other improper action		0.0%	37.5%	28.6%	23.5%	81.8%	33.3%	39.1%	
Unknown									

2004 - 2006 Total Crash Data									
Description	SMV Crashes	Horse & Buggy	Farm	Construction/Maintenance	Moped/ATV	Bicycle	Other	Total	
Other (explain in narrative):									
No improper action	0.0%	22.9%	33.3%	14.3%	100.0%	50.0%	53.1%		
Not Reported	0.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%		
<b>Total</b>	<b>38.9%</b>	<b>49.8%</b>	<b>45.2%</b>	<b>17.7%</b>	<b>84.8%</b>	<b>16.1%</b>	<b>40.2%</b>		
<b>Multiple Vehicle Crashes</b>									
	18	514	209	139	96	25	1061		
Animal	5	0	0	0	0	0	5		
Ran Traffic Signal	1	1	2	4	0	0	8		
Ran Stop Sign	0	10	3	5	2	0	23		
Crossed centerline	1	29	8	7	0	0	45		
FTYROW: At uncontrolled intersection	0	6	2	3	1	1	19		
FTYROW: Making right turn on red signal	0	0	0	0	0	1	6		
FTYROW: From stop sign	2	17	6	16	3	2	46		
FTYROW: From yield sign	0	1	1	5	0	0	7		
FTYROW: Making left turn	0	28	2	18	2	1	51		
FTYROW: From driveway	0	14	4	15	1	4	38		
FTYROW: From parked position	0	0	1	3	0	0	4		
FTYROW: To pedestrian	0	0	0	0	0	0	5		
FTYROW: Other (explain in narrative)	1	51	21	11	7	6	97		
Traveling wrong way or wrong side of road	0	10	0	5	0	0	16		
Driving too fast for conditions	0	16	19	5	0	0	40		
Exceeded authorized speed	0	4	2	1	0	0	7		
Made improper turn	0	17	3	3	0	1	24		
Improper Lane Change	0	0	0	0	0	0	0		
Followed too close	2	25	11	15	2	1	56		
Disregarded RR Signal	0	0	1	0	0	0	1		
Disregarded Warning Sign	0	0	0	0	0	0	0		

## 2004 - 2006 Total Crash Data

Description	SMV Crashes	Horse & Buggy	Farm	Construction/Maintenance	Moped/ATV	Bicycle	Other	Total	
Major cause of multiple vehicle crashes involving one or more SMVs	Operating vehicle in an erratic/reckless/careless/negligent/aggressive manner	0	11	3	11	2	1	28	
	Improper Backing	0	0	0	0	0	0	0	
	Illegally Parked/Unattended	0	0	0	0	0	0	0	
	Swerving/Evasive Action	1	65	12	14	2	0	94	
	Over correcting/over steering	0	3	2	0	0	0	5	
	Downhill runaway	0	1	2	0	0	0	3	
	Equipment failure	0	5	2	2	1	0	10	
	Separation of units	0	7	1	0	0	0	8	
	Ran off road - right	1	14	4	1	1	0	21	
	Ran off road - straight	0	2	0	0	0	0	2	
	Ran off road - left	0	10	1	0	0	0	11	
	Lost Control	1	15	11	10	0	1	38	
	Inattentive/distracted by: Passenger	0	1	0	0	0	1	0	2
	Inattentive/distracted by Use of phone or other device	0	4	0	0	0	0	0	4
	Inattentive/distracted by: Fallen object	0	0	0	0	0	0	0	0
	Inattentive/distracted by: Fatigue/asleep	0	0	1	0	0	0	0	1
	Other (explain in narrative): Vision obstructed	2	20	13	5	1	0	0	41
	Oversized Load/Vehicle	0	0	0	0	0	0	0	0
	Cargo/equipment loss or shift	0	1	1	0	0	0	0	2
	Other (explain in narrative): Other improper action	1	69	38	16	6	2	2	132
Unknown	0	23	14	9	9	1	1	56	
Other (explain in narrative): No improper action	0	28	17	5	42	2	2	94	
Not Reported	0	6	1	0	3	1	1	11	

2004 - 2006 Total Crash Data									
Description	SMV Crashes	Horse & Buggy	Farm	Construction/Maintenance	Moped/ATV	Bicycle	Other	Total	Total
	Animal	4	0	0	0	0	0	4	4
	Ran Traffic Signal	0	0	0	0	1	0	1	1
	Ran Stop Sign	0	8	2	5	0	0	15	15
	Crossed centerline	1	15	3	5	0	0	24	24
	FTYROW: At uncontrolled intersection	0	3	0	7	0	0	10	10
	FTYROW: Making right turn on red signal	0	0	0	0	0	0	0	0
	FTYROW: From stop sign	2	13	6	8	0	2	31	31
	FTYROW: From yield sign	0	1	0	1	0	0	2	2
	FTYROW: Making left turn	0	27	1	5	0	0	34	34
	FTYROW: From driveway	0	10	3	11	0	3	27	27
	FTYROW: From parked position	0	0	1	2	0	0	3	3
	FTYROW: To peestrian	0	0	0	0	0	0	0	0
	FTYROW: Other (explain in narrative)	1	18	14	10	1	5	49	49
	Traveling wrong way or wrong side of road	0	5	0	5	0	0	11	11
	Driving too fast for conditions	0	1	2	4	0	0	7	7
	Exceeded authorized speed	0	0	0	0	0	0	0	0
	Made improper turn	0	15	3	1	0	1	20	20
	Improper Lane Change	0	0	0	0	0	0	0	0
	Followed too close	0	2	1	12	0	1	16	16
	Disregarded RR Signal	0	0	1	0	0	0	1	1
	Disregarded Warning Sign	0	0	0	0	0	0	0	0
	Operating vehicle in an erratic/reckless/careless/negligent/aggressive manner	0	2	1	10	0	1	14	14
	Improper Backing	0	0	0	0	0	0	0	0
	Illegally Parked/Unattended	0	0	0	0	0	0	0	0
	Swerving/Evasive Action	1	10	5	7	0	0	23	23
	Over correcting/over steering	0	1	1	0	0	0	2	2
	Downhill runaway	0	1	1	0	0	0	2	2

Major cause of multiple vehicle crashes involving one or more SMVs with matching circumstances from the slow moving vehicle involved that indicate more responsibility on the slow-moving

2004 - 2006 Total Crash Data									
Description	SMV Crashes	Horse & Buggy	Farm	Construction/Maintenance	Moped/ATV	Bicycle	Other	Total	
<b>vehicle than any other vehicle involved in the crash</b>									
Equipment failure	0	4	2	1	0	0	0	9	
Separation of units	0	6	1	0	0	0	0	7	
Ran off road - right	1	10	2	0	1	1	0	15	
Ran off road - straight	0	0	0	0	0	0	0	0	
Ran off road - left	0	5	0	0	0	0	0	5	
Lost Control	0	3	4	0	10	0	1	18	
Inattentive/distracted by:									
Passenger	0	0	0	0	0	0	0	0	
Inattentive/distracted by Use of phone or other device	0	0	0	0	0	0	0	0	
Inattentive/distracted by:									
Fallen object	0	0	0	0	0	0	0	0	
Inattentive/distracted by:									
Fatigue/asleep	0	0	0	0	0	0	0	0	
Other (explain in narrative):									
Vision obstructed	0	8	8	0	3	0	0	19	
Oversized Load/Vehicle	0	0	0	0	0	0	0	0	
Cargo/equipment loss or shift	0	1	1	0	0	0	0	2	
Other (explain in narrative):									
Other improper action	1	25	25	0	15	0	2	68	
Unknown	0	14	10	0	5	0	0	29	
Other (explain in narrative):									
No improper action	0	20	11	0	3	0	0	34	
Not Reported	0	0	0	0	0	0	0	0	
Animal	80.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	80.0%	
Ran Traffic Signal	0.0%	0.0%	0.0%	0.0%	25.0%	0.0%	0.0%	12.5%	
Ran Stop Sign	0.0%	80.0%	66.7%	0.0%	62.5%	0.0%	0.0%	65.2%	
Crossed centerline	100.0%	51.7%	37.5%	0.0%	71.4%	0.0%	0.0%	53.3%	
FTYROW: At uncontrolled intersection	0.0%	50.0%	0.0%	0.0%	77.8%	0.0%	0.0%	52.6%	
FTYROW: Making right turn on red signal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	

2004 - 2006 Total Crash Data								
Description	SMV Crashes	Horse & Buggy	Farm	Construction/Maintenance	Moped/ATV	Bicycle	Other	Total
	FTYROW: From stop sign	100.0%	76.5%	100.0%	50.0%	0.0%	100.0%	67.4%
	FTYROW: From yield sign	0.0%	100.0%	0.0%	20.0%	0.0%	0.0%	28.6%
	FTYROW: Making left turn	0.0%	96.4%	50.0%	33.3%	0.0%	0.0%	66.7%
	FTYROW: From driveway	0.0%	71.4%	75.0%	73.3%	0.0%	75.0%	71.1%
	FTYROW: From parked position	0.0%	0.0%	100.0%	66.7%	0.0%	0.0%	75.0%
	FTYROW: To peccetrian	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	FTYROW: Other (explain in narrative)	100.0%	35.3%	66.7%	50.9%	14.3%	83.3%	50.5%
	Traveling wrong way or wrong side of road	0.0%	50.0%	0.0%	100.0%	0.0%	0.0%	66.6%
	Driving too fast for conditions	0.0%	6.3%	10.5%	60.0%	0.0%	0.0%	17.5%
	Exceeded authorized speed	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Made improper turn	0.0%	88.2%	100.0%	33.3%	0.0%	100.0%	83.3%
	Irproper Lane Change	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Followed too close	0.0%	8.0%	9.1%	60.0%	0.0%	100.0%	28.6%
	Disregarded RR Signal	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	100.0%
	Disregarded Warning Sign	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Operating vehicle in an erratic/reckless/careless/negligent/aggressive manner	0.0%	18.2%	33.3%	50.9%	0.0%	100.0%	50.0%
	Improper Backing	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Illegally Parked/Unattended	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Swerving/Evasive Action	100.0%	15.4%	41.7%	50.0%	0.0%	0.0%	24.5%
	Over correcting/over steering	0.0%	33.3%	50.0%	0.0%	0.0%	0.0%	40.0%
	Downhill runaway	0.0%	100.0%	50.0%	0.0%	0.0%	0.0%	66.7%
	Equipment failure	0.0%	80.0%	100.0%	100.0%	100.0%	0.0%	90.0%
	Separation of units	0.0%	85.7%	100.0%	0.0%	0.0%	0.0%	87.5%
	Ran off road - right	100.0%	71.4%	50.0%	100.0%	100.0%	0.0%	71.4%
	Ran off road - straight	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Ran off road - left	0.0%	50.0%	0.0%	0.0%	0.0%	0.0%	45.5%
	Lost Control	0.0%	20.0%	36.4%	100.0%	0.0%	100.0%	47.4%
	Inattentive/distracted by: Passenger	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

### 2004 - 2006 Total Crash Data

Description	SMV Crashes	Horse & Buggy	Farm	Construction/Maintenance	Moped/ATV	Bicycle	Other	Total
Inattentive/distracted by Use of phone or other device	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Inattentive/distracted by: Fallen object	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Inattentive/distracted by: Fatigue/asleep	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Other (explain in narrative): Vision obstructed	0.0%	0.0%	40.0%	61.5%	60.0%	0.0%	0.0%	46.3%
Oversized Load/Vehicle	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Cargo/equipment loss or shift	0.0%	0.0%	100.0%	100.0%	0.0%	0.0%	0.0%	100.0%
Other (explain in narrative): Other improper action	100.0%	0.0%	36.2%	65.8%	93.8%	0.0%	100.0%	51.5%
Unknown	0.0%	0.0%	60.9%	71.4%	55.6%	0.0%	0.0%	51.8%
Other (explain in narrative): No improper action	0.0%	0.0%	71.4%	64.7%	60.0%	0.0%	0.0%	36.2%
Not Reported	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
<b>Total</b>	<b>61.1%</b>	<b>42.5%</b>	<b>49.7%</b>	<b>68.6%</b>	<b>7.1%</b>	<b>76.2%</b>	<b>48.8%</b>	

2004 - 2006 Rural Crash Data									
Description	SMV Crashes	Horse & Buggy	Farm	Construction/Maintenance	Moped/ATV	Bicycle	Other	Total	
<b># Crashes involving at least one SMV</b>	<b>Total</b>	10	382	62	120	8	9	591	
# SMVs in Crashes in area:	Rural	10	382	62	120	8	9	591	
	Urban	0	0	0	0	0	0	0	
	Unknown	0	0	0	0	0	0	0	
# of SMV Crashes With crash severity of:	Fatality	0	18	2	11	4	1	36	
	Major Injury	2	30	5	37	1	0	75	
	Minor Injury	3	62	10	46	1	4	126	
	Property Damage Only	0	70	9	15	2	3	99	
	Possible/Unknown	5	202	36	11	0	1	255	
# of Crashes involving one or more SMVs during	NIGHT (Sunset-Sunrise)	4	83	4	30	2	4	127	
	DAY (Sunrise - Sunset)	6	293	58	90	6	5	458	
	Unknown	0	6	0	0	0	0	6	
	Night-to-Day Crash Ratio	0.666666667	0.283276	0.068965517	0.333333333	0.333333	0.8	0.277293	
# of Crashes involving one or more SMVs during:	AM Peak	2	27	13	4	1	0	47	
	PM Peak	2	85	8	26	2	4	128	
	Midday (Offpeak)	3	194	37	42	2	1	279	
	January	2	6	4	5	0	4	21	
	February	0	9	6	2	0	0	17	
	March	1	12	3	10	0	0	26	
	April	1	31	1	12	0	0	45	
	May	1	27	5	13	1	0	47	
	June	1	37	5	17	1	1	62	
	July	0	27	6	21	2	1	57	
	August	2	26	9	9	0	1	46	
	September	1	42	12	10	3	2	70	
	October	0	85	5	13	0	0	103	
	November	1	58	5	5	0	0	69	

2004 - 2006 Rural Crash Data									
Description	SMV Crashes	Horse & Buggy	Farm	Construction/Maintenance	Moped/ATV	Bicycle	Other	Total	
December	0	22	2	4	0	0	0	28	
	Dry	8	281	36	63	8	4	400	
	Wet	1	22	3	5	0	1	33	
	Ice	0	3	3	3	0	0	9	
	Snow	0	7	5	3	0	2	17	
	Slush	0	0	1	0	0	0	1	
	Sand/mud/dirt/oil/gravel	1	55	14	37	0	1	108	
	Water (standing/moving)	0	0	0	0	0	0	0	
	Other/Unknown/Not Reported	0	14	0	5	0	1	23	
	below 25 mph	0	1	0	0	0	0	1	
	25-34 mph	0	4	0	4	0	1	9	
	35-44 mph	0	3	0	5	0	0	9	
	45-54 mph	0	38	3	25	0	1	67	
	55-64 mph	5	305	49	68	0	6	433	
	65 mph and above	0	11	1	1	0	0	13	
	Unknown	5	24	9	27	8	1	74	
	Animal	3	1	0	7	0	0	11	
	Ran Traffic Signal	0	0	0	0	0	0	0	
	Ran Stop Sign	0	9	1	2	2	0	14	
	Crossed centerline	0	19	5	5	0	0	29	
	FTYROW: At uncontrolled intersection	0	5	0	2	0	0	7	
	FTYROW: Making right turn on red signal	0	0	0	0	0	0	0	
	FTYROW: From stop sign	1	12	2	2	0	0	17	
	FTYROW: From yield sign	0	1	0	0	0	0	1	
	FTYROW: Making left turn	0	12	0	1	0	0	13	
	FTYROW: From driveway	0	12	1	11	0	0	24	
	FTYROW: From parked position	0	1	0	1	0	0	2	
	FTYROW: To pedestrian	0	0	0	0	0	0	0	

## 2004 - 2006 Rural Crash Data

Description	SMV Crashes	Horse & Buggy	Farm	Construction/Maintenance	Moped/ATV	Bicycle	Other	Total
FTYROW: Other (explain in narrative)		0	31	8	5	2	2	48
Traveling wrong way or wrong side of road		0	6	0	7	0	0	13
Driving too fast for conditions		0	19	7	9	0	0	35
Exceeded authorized speed		0	2	0	2	0	0	4
Made improper turn		0	14	0	1	0	0	15
Improper Lane Change		0	0	0	0	0	0	0
Followed too close		1	11	3	4	1	0	20
Disregarded RR Signal		0	0	0	0	0	0	0
Disregarded Warning Sign		0	0	0	0	0	0	0
Operating vehicle in an erratic/reckless/careless/negligent/aggressive manner		0	7	0	12	1	2	22
Improper Backing		0	0	0	0	0	0	0
Illegally Parked/Unattended		0	0	0	0	0	0	0
Swerving/Evasive Action		1	49	5	16	1	1	73
Over correcting/over steering		0	5	0	0	0	0	5
Downhill runaway		0	1	1	1	0	0	3
Equipment failure		0	11	1	1	0	0	13
Separation of units		0	2	0	0	0	0	2
Ran off road - right		1	23	6	4	0	0	34
Ran off road - straight		0	3	0	0	0	0	3
Ran off road - left		0	15	0	4	0	1	20
Lost Control		1	10	4	5	0	1	22
Inattentive/distracted by: Passenger		0	0	0	0	1	0	1
Inattentive/distracted by Use of phone or other device		0	3	0	1	0	0	4
Inattentive/distracted by: Fallen object		0	0	0	0	0	0	0
Inattentive/distracted by: Fatigue/asleep		0	0	1	0	0	0	1

2004 - 2006 Rural Crash Data									
Description	SMV Crashes	Horse & Buggy	Farm	Construction/Maintenance	Moped/ATV	Bicycle	Other	Total	
Other (explain in narrative):									
Vision obstructed	2	14	3	1	0	0	0	20	
Oversized Load/Vehicle	0	0	1	0	0	0	0	1	
Cargo/equipment loss or shift	0	0	0	0	1	0	0	1	
Other (explain in narrative):									
Other improper action	0	46	4	5	0	0	0	55	
Unknown	0	12	1	5	0	1	1	19	
Other (explain in narrative):									
No improper action	0	22	8	3	0	0	1	34	
Not Reported	0	4	0	1	0	0	0	5	
<b>Non-Collision</b>									
Non-Collision	0	73	8	64	3	8	8	156	
Head-on	1	11	6	5	0	0	0	26	
Rear-end	4	105	21	15	1	0	0	146	
Angle, oncoming left turn	1	18	0	3	0	0	0	22	
Broadside	3	47	8	18	3	1	1	80	
Sideswipe, same direction	1	89	12	5	0	0	0	110	
Sideswips, opposite direction	0	33	4	3	0	0	0	40	
Unknown	0	2	2	0	1	1	0	5	
Not Reported	0	4	1	1	0	0	0	6	
<b>Driver age of SMVs involved in crashes</b>									
<15	0	5	0	22	0	0	0	27	
15-20	2	31	0	38	0	5	5	76	
21-24	1	32	3	18	0	1	1	55	
25-34	1	53	5	20	0	1	1	80	
35-44	0	54	8	9	0	0	0	71	
45-54	1	81	34	3	1	0	0	126	
55-64	0	49	10	5	0	1	1	65	
65-69	0	16	0	4	0	0	1	21	
70+	0	53	0	2	0	0	0	55	
Unknown	5	12	2	4	7	0	0	30	
<b>Animal</b>									
Animal	2	1	0	7	0	0	0	10	

2004 - 2006 Rural Crash Data									
Description	SMV Crashes	Horse & Buggy	Farm	Construction/Maintenance	Moped/ATV	Bicycle	Other	Total	Total
Ran Traffic Signal	0	0	0	0	0	0	0	0	0
Ran Stop Sign	0	7	1	0	2	0	0	10	10
Crossed centerline	0	11	2	0	4	0	0	17	17
FTYROW: At uncontrolled intersection	0	3	0	0	2	0	0	5	5
FTYROW: Making right turn on red signal	0	0	0	0	0	0	0	0	0
FTYROW: From stop sign	1	9	2	0	2	0	0	14	14
FTYROW: From yield sign	0	1	0	0	0	0	0	1	1
FTYROW: Making left turn	0	11	0	0	1	0	0	12	12
FTYROW: From driveway	0	10	1	0	10	0	0	21	21
FTYROW: From parked position	0	1	0	0	1	0	0	2	2
FTYROW: To pedestrian	0	0	0	0	0	0	0	0	0
FTYROW: Other (explain in narrative)	0	12	4	0	5	0	2	23	23
Traveling wrong way or or wrong side of road	0	4	0	0	7	0	0	11	11
Driving too fast for conditions	0	6	0	0	3	0	0	15	15
Exceeded authorized speed	0	0	0	0	1	0	0	1	1
Made improper turn	0	13	0	0	1	0	0	14	14
Improper Lane Change	0	0	0	0	0	0	0	0	0
Followed too close	0	0	0	0	3	0	0	3	3
Disregarded RR Signal	0	0	0	0	0	0	0	0	0
Disregarded Warning Sign	0	0	0	0	0	0	0	0	0
Operating vehicle in an erratic/reckless/careless/negligent/aggressive manner	0	2	0	0	12	0	2	16	16
Improper Backing	0	0	0	0	0	0	0	0	0
Illegally Parked/Unattended	0	0	0	0	0	0	0	0	0
Swerving/Evasive Action	1	10	2	0	12	0	1	26	26
Overcorrecting/over steering	0	3	0	0	0	0	0	3	3
D downhill runaway	0	1	0	0	1	0	0	2	2
Equipment failure	0	10	1	0	1	0	0	12	12

2004 - 2006 Rural Crash Data									
Description	SMV Crashes	Horse & Buggy	Farm	Construction/Maintenance	Moped/ATV	Bicycle	Other	Total	
other vehicle involved in the crash	Separation of units	0	1	0	0	0	0	1	
	Ran off road - right	1	21	5	4	0	0	31	
	Ran off road - straight	0	2	0	0	0	0	2	
	Ran off road - left	0	13	0	4	0	1	18	
	Lost Control	0	3	0	5	0	1	10	
	Inattentive/distracted by: Passenger	0	0	0	0	0	0	0	
	Inattentive/distracted by Use of phone or other device	0	0	0	1	0	0	1	
	Inattentive/distracted by:								
	Fallen object	0	0	0	0	0	0	0	
	Inattentive/distracted by:								
	Fatigue/asleep	0	0	0	0	0	0	0	
	Other (explain in narrative): Vis on obstructed	0	6	0	0	0	0	6	
	Oversized Load/Vehicle	0	0	1	0	0	0	1	
	Cargo/equipment loss or shift	0	0	0	1	0	0	1	
	Other (explain in narrative): Other improper action	0	17	2	5	0	0	24	
	Unknown	0	8	1	5	0	1	15	
	Other (explain in narrative): No improper action	0	15	8	2	0	1	26	
	Not Reported	0	0	0	0	0	0	0	
	Animal	66.7%	100.0%	0.0%	100.0%	0.0%	0.0%	90.9%	
	Ran Traffic Signal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
	Ran Stop Sign	0.0%	77.8%	100.0%	100.0%	0.0%	0.0%	71.4%	
	Crossed centerline	0.0%	57.9%	40.0%	80.0%	0.0%	0.0%	58.6%	
	FTYROW: At uncontrolled intersection	0.0%	60.0%	0.0%	100.0%	0.0%	0.0%	71.4%	
	FTYROW: Making right turn on red signal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
	FTYROW: From stop sign	100.0%	75.0%	100.0%	100.0%	0.0%	0.0%	82.4%	

2004 - 2006 Rural Crash Data									
Description	SMV Crashes	Horse & Buggy	Farm	Construction/Maintenance	Moped/ATV	Bicycle	Other	Total	
	FTYROW: From yield sign	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	100.0%	
	FTYROW: Making left turn	0.0%	91.7%	0.0%	100.0%	0.0%	0.0%	92.3%	
	FTYROW: From driveway	0.0%	83.3%	100.0%	90.9%	0.0%	0.0%	87.5%	
	FTYROW: From parked position	0.0%	100.0%	0.0%	100.0%	0.0%	0.0%	100.0%	
	FTYROW: To pedestrian	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
	FTYROW: Other (explain in narrative)	0.0%	38.7%	50.0%	100.0%	0.0%	100.0%	47.9%	
	Traveling wrong way or on wrong side of road	0.0%	66.7%	0.0%	100.0%	0.0%	0.0%	84.6%	
	Driving too fast for conditions	0.0%	31.6%	0.0%	100.0%	0.0%	0.0%	42.9%	
	Exceeded authorized speed	0.0%	0.0%	0.0%	50.0%	0.0%	0.0%	25.0%	
	Made improper turn	0.0%	92.9%	0.0%	100.0%	0.0%	0.0%	93.3%	
	Improper Lane Change	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
	Followed too close	0.0%	0.0%	0.0%	75.0%	0.0%	0.0%	15.0%	
	Disregarded RR Signal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
	Disregarded Warning Sign	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
	Operating vehicle in an erratic/reckless/careless/negligent/aggressive manner	0.0%	28.6%	0.0%	100.0%	0.0%	100.0%	72.7%	
	Improper Backing	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
	Illegally Parked/Unattended	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
	Swerving/Evasive Action	100.0%	20.4%	40.0%	75.0%	0.0%	100.0%	35.6%	
	Over correcting/over steering	0.0%	60.0%	0.0%	0.0%	0.0%	0.0%	60.0%	
	D downhill runaway	0.0%	100.0%	0.0%	100.0%	0.0%	0.0%	66.7%	
	Equipment failure	0.0%	90.9%	100.0%	100.0%	0.0%	0.0%	92.3%	
	Separation of units	0.0%	50.0%	0.0%	0.0%	0.0%	0.0%	50.0%	
	Ran off road - right	100.0%	91.3%	83.3%	100.0%	0.0%	0.0%	91.2%	
	Ran off road - straight	0.0%	66.7%	0.0%	0.0%	0.0%	0.0%	66.7%	
	Ran off road - left	0.0%	86.7%	0.0%	100.0%	0.0%	100.0%	90.0%	
	Lost Control	0.0%	30.0%	0.0%	100.0%	0.0%	100.0%	45.5%	
	Inattentive/distracted by: Passenger	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	

2004 - 2006 Rural Crash Data							
Description	SMV Crashes	Horse & Buggy	Farm	Construction/Maintenance	Moped/ATV	Bicycle	Total
Inattentive/distracted by Use of phone or other device		0.0%	0.0%	0.0%	100.0%	0.0%	25.0%
Inattentive/distracted by: Fallen object		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Inattentive/distracted by: Fatigue/asleep		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Other (explain in narrative): Vis on obstructed		0.0%	42.9%	0.0%	0.0%	0.0%	30.0%
Oversized Load/Vehicle		0.0%	0.0%	100.0%	0.0%	0.0%	100.0%
Cargo/equipment loss or shift		0.0%	0.0%	0.0%	100.0%	0.0%	100.0%
Other (explain in narrative): Other improper action		0.0%	37.0%	50.0%	100.0%	0.0%	43.6%
Unknown		0.0%	66.7%	100.0%	100.0%	0.0%	78.9%
Other (explain in narrative): No improper action		0.0%	68.2%	100.0%	66.7%	0.0%	76.5%
Not Reported		0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
<b>Total</b>		<b>50.0%</b>	<b>51.7%</b>	<b>39.6%</b>	<b>91.9%</b>	<b>0.0%</b>	<b>58.7%</b>
Animal	1	0	0	0	0	0	1
Ran Traffic Signal	0	0	0	0	0	0	0
Ran Stop Sign	0	2	0	0	0	2	4
Crossed centerline	0	8	3	0	1	0	12
FTYROW: At uncontrolled intersection	0	2	0	0	0	0	2
FTYROW: Making right turn on red signal	0	0	0	0	0	0	0
FTYROW: From stop sign	0	3	0	0	0	0	3
FTYROW: From yield sign	0	0	0	0	0	0	0
FTYROW: Making left turn	0	1	0	0	0	0	1
FTYROW: From driveway	0	2	0	0	1	0	3
FTYROW: From parked position	0	0	0	0	0	0	0
FTYROW: To peccstrian	0	0	0	0	0	0	0

2004 - 2006 Rural Crash Data									
Description	SMV Crashes	Horse & Buggy	Farm	Construction/Maintenance	Moped/ATV	Bicycle	Other	Total	
FTYROW: Other (explain in narrative)		0	19	4	0	2	0	25	
Traveling wrong way or wrong side of road		0	2	0	0	0	0	2	
Driving too fast for conditions		0	13	7	0	0	0	20	
Exceeded authorized speed		0	2	0	1	0	0	3	
Made improper turn		0	1	0	0	0	0	1	
Irproper Lane Change		0	0	0	0	0	0	0	
Followed too close		1	11	3	1	1	0	17	
Disregarded RR Signal		0	0	0	0	0	0	0	
Disregarded Warning Sign		0	0	0	0	0	0	0	
Operating vehicle in an erratic/reckless/careless/negligent/aggressive manner		0	5	0	0	1	0	6	
Improper Backing		0	0	0	0	0	0	0	
Illegally Parked/Unattended		0	0	0	0	0	0	0	
Swerving/Evasive Action		0	39	3	4	1	0	47	
Over correcting/over steering		0	2	0	0	0	0	2	
D downhill runaway		0	0	1	0	0	0	1	
Equipment failure		0	1	0	0	0	0	1	
Separation of units		0	1	0	0	0	0	1	
Ran off road - right		0	2	1	0	0	0	3	
Ran off road - straight		0	1	0	0	0	0	1	
Ran off road - left		0	2	0	0	0	0	2	
Lost Control		1	7	4	0	0	0	12	
Inattentive/distracted by: Passenger		0	0	0	0	1	0	1	
Inattentive/distracted by Use of phone or other device		0	3	0	0	0	0	3	
Inattentive/distracted by: Fallen object		0	0	0	0	0	0	0	
Inattentive/distracted by: Fatigue/asleep		0	0	1	0	0	0	1	

Major cause of crashes involving one or more SMVs with matching circumstances from the Non-SMV vehicle involved that indicate more responsibility on the particular **Non-SMV** than any other vehicle involved in the crash

2004 - 2006 Rural Crash Data								
Description	SMV Crashes	Horse & Buggy	Farm	Construction/Maintenance	Moped/ATV	Bicycle	Other	Total
Other (explain in narrative): Vision obstructed	2	8	3	1	0	0	0	14
Oversized Load/Vehicle	0	0	0	0	0	0	0	0
Cargo/equipment loss or shift	0	0	0	0	0	0	0	0
Other (explain in narrative): Other improper action	0	29	2	0	0	0	0	31
Unknown	0	4	0	0	0	0	0	4
Other (explain in narrative): No improper action	0	7	0	1	0	0	0	8
Not Reported	0	4	0	1	0	0	0	5
Animal	33.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	9.1%
Ran Traffic Signal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Ran Stop Sign	0.0%	22.2%	0.0%	0.0%	0.0%	100.0%	0.0%	28.6%
Crossed centerline	0.0%	42.1%	60.0%	20.0%	0.0%	0.0%	0.0%	41.4%
FTYROW: At uncontrolled intersection	0.0%	40.0%	0.0%	0.0%	0.0%	0.0%	0.0%	28.6%
FTYROW: Making right turn on red signal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
FTYROW: From stop sign	0.0%	25.0%	0.0%	0.0%	0.0%	0.0%	0.0%	17.6%
FTYROW: From yield sign	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
FTYROW: Making left turn	0.0%	8.3%	0.0%	0.0%	0.0%	0.0%	0.0%	7.7%
FTYROW: From driveway	0.0%	16.7%	0.0%	0.0%	3.1%	0.0%	0.0%	12.5%
FTYROW: From parked position	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
FTYROW: To pedestrian	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
FTYROW: Other (explain in narrative)	0.0%	61.3%	50.0%	0.0%	0.0%	100.0%	0.0%	52.1%
Traveling wrong way or wrong side of road	0.0%	33.3%	0.0%	0.0%	0.0%	0.0%	0.0%	15.4%
Driving too fast for conditions	0.0%	68.4%	100.0%	0.0%	0.0%	0.0%	0.0%	57.1%
Exceeded authorized speed	0.0%	100.0%	0.0%	50.0%	0.0%	0.0%	0.0%	75.0%
Made improper turn	0.0%	7.1%	0.0%	0.0%	0.0%	0.0%	0.0%	6.7%

2004 - 2006 Rural Crash Data									
Description	SMV Crashes	Horse & Buggy	Farm	Construction/Maintenance	Moped/ATV	Bicycle	Other	Total	
	Improper Lane Change	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Followed too close	100.0%	100.0%	100.0%	25.0%	100.0%	0.0%	85.0%	
	Disregarded RR Signal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
	Disregarded Warning Sign	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
	Operating vehicle in an erratic/reckless/careless/negligent/aggressive manner	0.0%	71.4%	0.0%	0.0%	100.0%	0.0%	27.3%	
	Improper Backing	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
	Illegally Parked/Unattended	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
	Swerving/Evasive Action	0.0%	78.6%	60.0%	25.0%	100.0%	0.0%	64.4%	
	Over correcting/over steering	0.0%	40.0%	0.0%	0.0%	0.0%	0.0%	40.0%	
	D downhill runaway	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	33.3%	
	Equipment failure	0.0%	9.1%	0.0%	0.0%	0.0%	0.0%	7.7%	
	Separation of units	0.0%	50.0%	0.0%	0.0%	0.0%	0.0%	50.0%	
	Ran off road - right	0.0%	8.7%	15.7%	0.0%	0.0%	0.0%	8.3%	
	Ran off road - straight	0.0%	33.3%	0.0%	0.0%	0.0%	0.0%	33.3%	
	Ran off road - left	0.0%	13.3%	0.0%	0.0%	0.0%	0.0%	10.0%	
	Lost Control	100.0%	70.0%	100.0%	0.0%	0.0%	0.0%	54.5%	
	Inattentive/distracted by:								
	Passenger	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	100.0%	
	Inattentive/distracted by Use of phone or other device	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	75.0%	
	Inattentive/distracted by:								
	Fallen object	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
	Inattentive/distracted by:								
	Fatigue/asleep	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	100.0%	
	Other (explain in narrative):								
	Vision obstructed	100.0%	57.1%	100.0%	100.0%	0.0%	0.0%	70.0%	
	Oversized Load/Vehicle	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
	Cargo/equipment loss or shift	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
	Other (explain in narrative):								
	Other improper action	0.0%	63.0%	50.0%	0.0%	0.0%	0.0%	56.4%	
	Unknown	0.0%	33.3%	0.0%	0.0%	0.0%	0.0%	21.1%	

2004 - 2006 Rural Crash Data									
Description	SMV Crashes	Horse & Buggy	Farm	Construction/Maintenance	Moped/ATV	Bicycle	Other	Total	
Other (explain in narrative):									
No improper action	0.0%	31.8%	0.0%	0.0%	33.3%	0.0%	0.0%	23.5%	
Not Reported	0.0%	100.0%	0.0%	0.0%	100.0%	0.0%	0.0%	100.0%	
Total	50.0%	48.3%	60.4%	3.1%	100.0%	0.0%	0.0%	41.3%	
<b>Multiple Vehicle Crashes</b>									
	10	319	57	60	8	2	456		
Animal	3	0	0	0	0	0	3		
Ran Traffic Signal	0	0	0	0	0	0	0		
Ran Stop Sign	0	9	1	1	2	0	13		
Crossed centerline	0	18	5	5	0	0	28		
FTYROW: At uncontrolled intersection	0	5	0	2	0	0	7		
FTYROW: Making right turn on red signal	0	0	0	0	0	0	0		
FTYROW: From stop sign	1	12	2	2	0	0	17		
FTYROW: From yield sign	0	1	0	0	0	0	1		
FTYROW: Making left turn	0	12	0	1	0	0	13		
FTYROW: From driveway	0	12	1	11	0	0	24		
FTYROW: From parked position	0	0	0	1	0	0	1		
FTYROW: To pecestrian	0	0	0	0	0	0	0		
FTYROW: Other (explain in narrative)	0	30	7	5	2	2	46		
Traveling wrong way or wrong side of road	0	6	0	3	0	0	12		
Driving too fast for conditions	0	14	7	2	0	0	23		
Exceeded authorized speed	0	2	0	1	0	0	3		
Made improper turn	0	14	0	1	0	0	15		
Inproper Lane Change	0	0	0	0	0	0	0		
Followed too close	1	11	3	4	1	0	20		
Disregarded RR Signal	0	0	0	0	0	0	0		
Disregarded Warning Sign	0	0	0	0	0	0	0		

## 2004 - 2006 Rural Crash Data

Description	SMV Crashes	Horse & Buggy	Farm	Construction/Maintenance	Moped/ATV	Bicycle	Other	Total	
Major cause of multiple vehicle crashes involving one or more SMVs	Operating vehicle in an erratic/reckless/careless/negligent/aggressive manner	0	6	0	7	1	0	14	
	Improper Backing	0	0	0	0	0	0	0	
	Illegally Parked/Unattended	0	0	0	0	0	0	0	
	Swerving/Evasive Action	1	44	5	7	1	0	58	
	Over correcting/over steering	0	2	0	0	0	0	2	
	Downhill runaway	0	1	1	0	0	0	2	
	Equipment failure	0	4	1	0	0	0	5	
	Separation of units	0	2	0	0	0	0	2	
	Ran off road - right	1	6	3	0	0	0	10	
	Ran off road - straight	0	1	0	0	0	0	1	
	Ran off road - left	0	6	0	0	0	0	6	
	Lost Control	1	8	4	0	0	0	13	
	Inattentive/distracted by: Passenger	0	0	0	0	0	1	0	1
	Inattentive/distracted by Use of phone or other device	0	3	0	0	0	0	0	3
	Inattentive/distracted by: Fallen object	0	0	0	0	0	0	0	0
	Inattentive/distracted by: Fatigue/asleep	0	0	1	0	0	0	0	1
	Other (explain in narrative): Vision obstructed	2	13	3	1	0	0	0	19
	Oversized Load/Vehicle	0	0	0	0	0	0	0	0
	Cargo/equipment loss or shift	0	0	0	0	0	0	0	0
	Other (explain in narrative): Other improper action	0	45	4	1	0	0	0	50
Unknown	0	11	1	1	0	0	0	13	
Other (explain in narrative): No improper action	0	18	8	1	0	0	0	27	
Not Reported	0	3	0	0	0	0	0	3	

2004 - 2006 Rural Crash Data									
Description	SMV Crashes	Horse & Buggy	Farm	Construction/Maintenance	Moped/ATV	Bicycle	Other	Total	Total
	Animal	2	0	0	0	0	0	2	2
	Ran Traffic Signal	0	0	0	0	0	0	0	0
	Ran Stop Sign	0	7	1	1	0	0	9	9
	Crossed centerline	0	10	2	4	0	0	16	16
	FTYROW: At uncontrolled intersection	0	3	0	2	0	0	5	5
	FTYROW: Making right turn on red signal	0	0	0	0	0	0	0	0
	FTYROW: From stop sign	1	9	2	2	0	0	14	14
	FTYROW: From yield sign	0	1	0	0	0	0	1	1
	FTYROW: Making left turn	0	11	0	1	0	0	12	12
	FTYROW: From driveway	0	10	1	10	0	0	21	21
	FTYROW: From parked position	0	0	0	1	0	0	1	1
	FTYROW: To pedestrian	0	0	0	0	0	0	0	0
	FTYROW: Other (explain in narrative)	0	11	3	5	0	2	21	21
	Traveling wrong way or wrong side of road	0	4	0	3	0	0	10	10
	Driving too fast for conditions	0	1	0	2	0	0	3	3
	Exceeded authorized speed	0	0	0	0	0	0	0	0
	Made improper turn	0	13	0	1	0	0	14	14
	Improper Lane Change	0	0	0	0	0	0	0	0
	Followed too close	0	0	0	3	0	0	3	3
	Disregarded RR Signal	0	0	0	0	0	0	0	0
	Disregarded Warning Sign	0	0	0	0	0	0	0	0
	Operating vehicle in an erratic/reckless/careless/negligent/aggressive manner	0	1	0	7	0	0	8	8
	Improper Backing	0	0	0	0	0	0	0	0
	Illegally Parked/Unattended	0	0	0	0	0	0	0	0
	Swerving/Evasive Action	1	5	2	3	0	0	11	11
	Over correcting/over steering	0	0	0	0	0	0	0	0
	Downhill runaway	0	1	0	0	0	0	1	1

Major cause of multiple vehicle crashes involving one or more SMVs with matching circumstances from the slow moving vehicle involved that indicate more responsibility on the slow-moving

2004 - 2006 Rural Crash Data									
Description	SMV Crashes	Horse & Buggy	Farm	Construction/Maintenance	Moped/ATV	Bicycle	Other	Total	
vehicle than any other vehicle involved in the crash	Equipment failure	0	3	1	0	0	0	4	
	Separation of units	0	1	0	0	0	0	1	
	Ran off road - right	1	4	2	0	0	0	7	
	Ran off road - straight	0	0	0	0	0	0	0	
	Ran off road - left	0	4	0	0	0	0	4	
	Lost Control	0	1	0	0	0	0	1	
	Inattentive/distracted by:								
	Passenger	0	0	0	0	0	0	0	
	Inattentive/distracted by Use of phone or other device	0	0	0	0	0	0	0	
	Inattentive/distracted by:								
	Fallen object	0	0	0	0	0	0	0	
	Inattentive/distracted by:								
	Fatigue/asleep	0	0	0	0	0	0	0	
	Other (explain in narrative):								
	Vision obstructed	0	5	0	0	0	0	5	
	Oversized Load/Vehicle	0	0	0	0	0	0	0	
	Cargo/equipment loss or shift	0	0	0	0	0	0	0	
	Other (explain in narrative):								
	Other improper action	0	15	2	1	0	0	19	
	Unknown	0	7	1	1	0	0	9	
	Other (explain in narrative):								
	No improper action	0	11	8	0	0	0	19	
	Not Reported	0	0	0	0	0	0	0	
	Animal	66.7%	0.0%	0.0%	0.0%	0.0%	0.0%	66.7%	
	Ran Traffic Signal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
	Ran Stop Sign	0.0%	77.8%	100.0%	100.0%	0.0%	0.0%	69.2%	
	Crossed centerline	0.0%	55.6%	40.0%	60.0%	0.0%	0.0%	57.1%	
	FTYROW: At uncontrolled intersection	0.0%	60.0%	0.0%	100.0%	0.0%	0.0%	71.4%	
	FTYROW: Making right turn on red signal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	

2004 - 2006 Rural Crash Data								
Description	SMV Crashes	Horse & Buggy	Farm	Construction/Maintenance	Moped/ATV	Bicycle	Other	Total
	FTYROW: From stop sign	100.0%	75.0%	100.0%	100.0%	0.0%	0.0%	82.4%
	FTYROW: From yield sign	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	100.0%
	FTYROW: Making left turn	0.0%	91.7%	0.0%	100.0%	0.0%	0.0%	92.3%
	FTYROW: From driveway	0.0%	83.3%	100.0%	90.9%	0.0%	0.0%	87.5%
	FTYROW: From parked position	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	100.0%
	FTYROW: To peccetrian	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	FTYROW: Other (explain in narrative)	0.0%	36.7%	42.9%	100.0%	0.0%	100.0%	45.7%
	Traveling wrong way or wrong side of road	0.0%	66.7%	0.0%	100.0%	0.0%	0.0%	83.3%
	Driving too fast for conditions	0.0%	7.1%	0.0%	100.0%	0.0%	0.0%	13.0%
	Exceeded authorized speed	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Made improper turn	0.0%	92.9%	0.0%	100.0%	0.0%	0.0%	93.3%
	Irproper Lane Change	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Followed too close	0.0%	0.0%	0.0%	75.0%	0.0%	0.0%	15.0%
	Disregarded RR Signal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Disregarded Warning Sign	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Operating vehicle in an erratic/reckless/careless/negligent/aggressive manner	0.0%	16.7%	0.0%	100.0%	0.0%	0.0%	57.1%
	Improper Backing	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Illegally Parked/Unattended	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Swerving/Evasive Action	100.0%	11.4%	40.0%	42.9%	0.0%	0.0%	19.0%
	Over correcting/over steering	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	D downhill runaway	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	50.0%
	Equipment failure	0.0%	75.0%	100.0%	0.0%	0.0%	0.0%	80.0%
	Separation of units	0.0%	50.0%	0.0%	0.0%	0.0%	0.0%	50.0%
	Ran off road - right	100.0%	66.7%	66.7%	0.0%	0.0%	0.0%	70.0%
	Ran off road - straight	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Ran off road - left	0.0%	66.7%	0.0%	0.0%	0.0%	0.0%	66.7%
	Lost Control	0.0%	12.5%	0.0%	0.0%	0.0%	0.0%	7.7%
	Inattentive/distracted by: Passenger	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

### 2004 - 2006 Rural Crash Data

Description	SMV Crashes	Horse & Buggy	Farm	Construction/Maintenance	Moped/ATV	Bicycle	Other	Total
Inattentive/distracted by Use of phone or other device	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Inattentive/distracted by: Fallen object	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Inattentive/distracted by: Fatigue/asleep	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Other (explain in narrative): Vis on obstructed	0.0%	38.5%	0.0%	0.0%	0.0%	0.0%	0.0%	26.3%
Oversized Load/Vehicle	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Cargo/equipment loss or shift	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Other (explain in narrative): Other improper action	0.0%	35.6%	50.0%	50.0%	100.0%	0.0%	0.0%	38.0%
Unknown	0.0%	63.6%	100.0%	100.0%	100.0%	0.0%	0.0%	69.2%
Other (explain in narrative): No improper action	0.0%	61.1%	100.0%	100.0%	0.0%	0.0%	0.0%	70.4%
Not Reported	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
<b>Total</b>	<b>50.0%</b>	<b>42.2%</b>	<b>33.3%</b>	<b>84.5%</b>	<b>100.0%</b>	<b>0.0%</b>	<b>100.0%</b>	<b>46.7%</b>

2004 - 2006 Urban Crash Data									
Description	SMV Crashes	Horse & Buggy	Farm	Construction/Maintenance	Moped/ATV	Bicycle	Other	Total	
<b># Crashes involving at least one SMV</b>	<b>Total</b>	8	204	161	228	100	28	730	
# SMVs in Crashes in area:	Rural	0	0	0	0	0	0	0	
	Urban	8	204	161	228	100	28	730	
	Unknown	0	0	0	0	0	0	0	
# of SMV Crashes With crash severity of:	Fatality	0	3	2	5	1	0	11	
	Major Injury	1	16	6	36	13	2	74	
	Minor Injury	1	29	14	133	42	6	195	
	Property Damage Only	2	28	24	66	36	6	156	
	Possible/Unknown	4	128	115	29	5	14	296	
# of Crashes involving one or more SMVs during	NIGHT (Sunset-Sunrise)	1	39	12	48	26	6	132	
	DAY (Sunrise - Sunset)	7	162	148	176	74	22	589	
	Unknown	0	3	1	5	0	0	9	
	Night-to-Day Crash Ratio	0.142857143	0.240741	0.081081081	0.27272727	0.35135	0.272727	0.224109	
# of Crashes involving one or more SMVs during:	AM Peak	1	27	26	11	5	2	72	
	PM Peak	1	28	12	58	21	4	124	
	Midday (Offpeak)	5	107	109	76	37	13	347	
	January	1	6	20	4	3	3	37	
	February	1	8	20	9	4	1	43	
	March	0	7	13	8	3	0	31	
	April	0	22	13	19	6	1	61	
	May	0	14	8	23	9	2	56	
	June	3	25	15	34	11	4	92	
	July	0	12	11	28	18	2	71	
	August	1	14	15	27	16	7	80	
	September	1	21	12	40	13	2	89	
	October	0	36	12	18	6	1	73	
	November	1	24	10	13	4	3	55	

2004 - 2006 Urban Crash Data									
Description	SMV Crashes December	Horse & Buggy	Farm	Construction/Maintenance	Moped/ATV	Bicycle	Other	Total	
	0	15	12	5	7	3	2	42	
# of Crashes involving one or more SMVs with surface conditions of:									
Dry	5	174	91	178	87	17	17	552	
Wet	1	8	17	13	8	3	3	50	
Ice	0	4	10	0	0	1	1	15	
Snow	1	7	29	5	1	2	2	46	
Slush	0	2	1	0	0	0	0	3	
Sand/mud/dirt/oil/gravel	1	6	5	21	1	1	1	35	
Water (standing/moving)	0	0	1	0	0	0	0	1	
Other/Unknown/Not Reported	0	3	7	11	3	4	4	28	
below 25 mph	0	2	2	14	1	3	3	22	
25-34 mph	3	49	75	150	5	11	11	293	
35-44 mph	1	22	18	18	7	2	2	68	
45-54 mph	0	28	14	15	0	2	2	59	
55-64 mph	4	88	26	16	0	0	0	134	
65 mph and above	0	9	1	0	0	0	0	10	
Unknown	0	6	26	25	90	10	10	157	
Animal	2	0	1	2	0	0	0	5	
Ran Traffic Signal	1	1	2	4	0	0	0	8	
Ran Stop Sign	0	1	2	9	0	0	0	12	
Crossed centerline	1	10	3	2	0	0	0	16	
FTYROW: At uncontrolled intersection	0	1	2	7	1	1	1	12	
FTYROW: Making right turn on red signal	0	0	0	0	0	5	1	6	
FTYROW: From stop sign	1	5	4	14	3	2	2	29	
FTYROW: From yield sign	0	0	1	5	0	0	0	7	
FTYROW: Making left turn	0	15	2	17	2	1	1	37	
FTYROW: From driveway	0	2	3	4	1	4	4	14	
FTYROW: From parked position	0	0	1	1	0	0	0	2	
FTYROW: To pedestrian	0	0	1	1	1	6	0	8	

2004 - 2006 Urban Crash Data								
Description	SMV Crashes	Horse & Buggy	Farm	Construction/Maintenance	Moped/ATV	Bicycle	Other	Total
FTYROW: Other (explain in narrative)	1		20	13	5	6	4	50
Traveling wrong way or on wrong side of road	0	0	4	0	2	0	0	6
Driving too fast for conditions	0	0	3	11	10	0	0	24
Exceeded authorized speed	0	0	2	2	2	0	0	6
Made improper turn	0	0	2	2	3	0	1	8
Improper Lane Change	0	0	0	0	0	0	0	0
Followed too close	1	1	14	7	11	1	1	35
Disregarded RR Signal	0	0	0	1	0	0	0	1
Disregarded Warning Sign	0	0	0	1	0	0	0	1
Operating vehicle in an erratic/reckless/careless/negligent/aggressive manner	0	0	5	3	12	1	2	23
Improper Backing	0	0	0	0	0	0	0	0
Illegally Parked/Unattended	0	0	0	0	0	0	0	0
Swerving/Evasive Action	0	0	23	8	11	2	3	47
Over correcting/over steering	0	0	0	2	2	0	0	4
D downhill runaway	0	0	0	2	0	0	0	2
Equipment failure	0	0	2	1	4	1	0	8
Separation of units	0	0	6	1	0	0	0	7
Ran off road - right	0	0	15	5	3	2	0	28
Ran off road - straight	0	0	1	0	0	0	0	1
Ran off road - left	0	0	4	2	2	0	0	8
Lost Control	0	0	8	8	44	0	0	60
Inattentive/distracted by: Passenger	0	0	1	0	1	0	0	2
Inattentive/distracted by Use of phone or other device	0	0	1	0	1	0	0	2
Inattentive/distracted by: Fallen object	0	0	0	0	0	0	0	0
Inattentive/distracted by: Fatigue/asleep	0	0	0	0	0	0	0	0

2004 - 2006 Urban Crash Data								
Description	SMV Crashes	Horse & Buggy	Farm	Construction/Maintenance	Moped/ATV	Bicycle	Other	Total
Other (explain in narrative):								
Vision obstructed	0	7	11	3	0	0	0	21
Oversized Load/Vehicle	0	0	0	0	0	0	0	0
Cargo/equipment loss or shift	0	1	1	0	0	0	0	2
Other (explain in narrative):								
Other improper action	1	23	34	19	5	2	2	84
Unknown	0	12	13	11	11	2	2	49
Other (explain in narrative):								
No improper action	0	13	10	11	42	3	3	79
Not Reported	0	2	1	1	11	1	1	16
<b>Non-Collision</b>								
Non-Collision	0	22	15	97	61	6	6	201
Head-on	1	14	6	2	1	1	1	25
Rear-end	2	59	42	34	0	2	2	139
Angle, oncoming left turn	0	14	5	15	3	1	1	38
Broadside	4	17	36	55	31	13	13	156
Sideswipe, same direction	1	58	40	14	0	3	3	116
Sideswips, opposite direction	0	17	8	5	0	0	0	31
Unknown	0	2	5	1	3	0	0	11
Not Reported	0	1	4	5	1	2	2	13
<b>Driver age of SMVs involved in crashes</b>								
<15	0	3	0	76	0	4	4	83
15-20	2	17	5	62	1	1	1	88
21-24	0	10	11	20	0	1	1	42
25-34	0	23	28	21	0	4	4	76
35-44	0	33	36	15	2	3	3	89
45-54	0	47	38	16	4	8	8	113
55-64	1	26	22	5	1	1	1	56
65-69	0	8	4	5	0	0	1	18
70+	1	25	1	11	0	1	1	39
Unknown	4	12	17	7	95	4	4	139
<b>Animal</b>								
Animal	2	0	1	2	0	0	0	5

2004 - 2006 Urban Crash Data									
Description	SMV Crashes	Horse & Buggy	Farm	Construction/Maintenance	Moped/ATV	Bicycle	Other	Total	
Ran Traffic Signal	0	0	0	0	1	0	0	1	
Ran Stop Sign	0	0	1	1	5	0	0	8	
Crossed centerline	1	5	5	1	1	0	0	8	
FTYROW: At uncontrolled intersection	0	0	0	0	5	0	0	5	
FTYROW: Making right turn on red signal	0	0	0	0	3	0	0	0	
FTYROW: From stop sign	1	4	4	4	3	0	2	17	
FTYROW: From yield sign	0	0	0	0	2	0	0	2	
FTYROW: Making left turn	0	15	15	1	5	0	0	21	
FTYROW: From driveway	0	0	0	2	1	0	3	6	
FTYROW: From parked position	0	0	0	1	3	0	0	1	
FTYROW: To pedestrian	0	0	0	1	1	1	0	3	
FTYROW: Other (explain in narrative)	1	6	6	11	5	2	3	28	
Traveling wrong way or or wrong side of road	0	0	1	0	2	0	0	3	
Driving too fast for conditions	0	0	1	2	3	0	0	12	
Exceeded authorized speed	0	0	0	0	2	0	0	2	
Made improper turn	0	0	1	2	1	0	1	5	
Improper Lane Change	0	0	0	0	3	0	0	0	
Followed too close	0	0	2	1	3	0	1	13	
Disregarded RR Signal	0	0	0	1	3	0	0	1	
Disregarded Warning Sign	0	0	0	1	3	0	0	1	
Operating vehicle in an erratic/reckless/careless/negligent/aggressive manner	0	0	1	1	11	0	2	15	
Improper Backing	0	0	0	0	3	0	0	0	
Illegally Parked/Unattended	0	0	0	0	3	0	0	0	
Swerving/Evasive Action	0	0	7	4	3	1	3	23	
Overcorrecting/over steering	0	0	0	1	2	0	0	3	
D downhill runaway	0	0	0	2	3	0	0	2	
Equipment failure	0	0	2	1	4	1	0	8	

Major cause of crashes involving one or more SMVs with matching circumstances from the slow moving vehicle involved that indicate more responsibility on the particular slow-moving vehicle than any

2004 - 2006 Urban Crash Data									
Description	SMV Crashes	Horse & Buggy	Farm	Construction/Maintenance	Moped/ATV	Bicycle	Other	Total	
other vehicle involved in the crash	Separation of units	0	6	1	3	0	0	7	
	Ran off road - right	0	13	4	5	2	0	25	
	Ran off road - straight	0	0	0	3	0	0	0	
	Ran off road - left	0	1	1	2	0	0	4	
	Lost Control	0	3	5	44	0	0	52	
	Inattentive/distracted by: Passenger	0	0	0	1	0	0	1	
	Inattentive/distracted by Use of phone or other device	0	0	0	1	0	0	1	
	Inattentive/distracted by: Fallen object	0	0	0	3	0	0	0	
	Inattentive/distracted by: Fatigue/asleep	0	0	0	3	0	0	0	
	Other (explain in narrative): Vis on obstructed	0	3	9	3	0	0	15	
	Oversized Load/Vehicle	0	0	0	3	0	0	0	
	Cargo/equipment loss or shift	0	1	1	3	0	0	2	
	Other (explain in narrative): Other improper action	1	9	23	18	0	2	53	
	Unknown	0	7	9	7	2	1	26	
	Other (explain in narrative): No improper action	0	12	4	10	0	1	27	
	Not Reported	0	0	0	3	0	0	0	
	Animal	100.0%	0.0%	100.0%	100.0%	0.0%	0.0%	100.0%	
	Ran Traffic Signal	0.0%	0.0%	0.0%	25.0%	0.0%	0.0%	12.5%	
	Ran Stop Sign	0.0%	100.0%	50.0%	66.7%	0.0%	0.0%	66.7%	
	Crossed centerline	100.0%	50.0%	33.3%	50.0%	0.0%	0.0%	50.0%	
	FTYROW: At uncontrolled intersection	0.0%	0.0%	0.0%	71.4%	0.0%	0.0%	41.7%	
	FTYROW: Making right turn on red signal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
	FTYROW: From stop sign	100.0%	80.0%	100.0%	42.9%	0.0%	100.0%	58.6%	

2004 - 2006 Urban Crash Data								
Description	SMV Crashes	Horse & Buggy	Farm	Construction/Maintenance	Moped/ATV	Bicycle	Other	Total
	FTYROW: From yield sign	0.0%	0.0%	0.0%	33.3%	0.0%	0.0%	28.6%
	FTYROW: Making left turn	0.0%	100.0%	50.0%	29.4%	0.0%	0.0%	56.8%
	FTYROW: From driveway	0.0%	0.0%	66.7%	25.0%	0.0%	75.0%	42.9%
	FTYROW: From parked position	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	50.0%
	FTYROW: To pedestrian	0.0%	0.0%	100.0%	100.0%	16.7%	0.0%	37.5%
	FTYROW: Other (explain in narrative)	100.0%	30.0%	84.5%	63.3%	33.3%	75.0%	56.0%
	Traveling wrong way or wrong side of road	0.0%	25.0%	0.0%	100.0%	0.0%	0.0%	50.0%
	Driving too fast for conditions	0.0%	33.3%	18.2%	90.0%	0.0%	0.0%	50.0%
	Exceeded authorized speed	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	33.3%
	Made improper turn	0.0%	50.0%	100.0%	33.3%	0.0%	100.0%	62.5%
	Improper Lane Change	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Followed too close	0.0%	14.3%	14.3%	81.8%	0.0%	100.0%	37.1%
	Disregarded RR Signal	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	100.0%
	Disregarded Warning Sign	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	100.0%
	Operating vehicle in an erratic/reckless/careless/negligent/aggressive manner	0.0%	20.0%	33.3%	91.7%	0.0%	100.0%	65.2%
	Improper Backing	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Illegally Parked/Unattended	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Swerving/Evasive Action	0.0%	30.4%	50.0%	72.7%	50.0%	100.0%	48.9%
	Over correcting/over steering	0.0%	0.0%	50.0%	100.0%	0.0%	0.0%	75.0%
	D downhill runaway	0.0%	0.0%	100.0%	0.0%	0.0%	0.0%	100.0%
	Equipment failure	0.0%	100.0%	100.0%	100.0%	100.0%	0.0%	100.0%
	Separation of units	0.0%	100.0%	100.0%	0.0%	0.0%	0.0%	100.0%
	Ran off road - right	0.0%	86.7%	80.0%	100.0%	100.0%	0.0%	89.3%
	Ran off road - straight	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Ran off road - left	0.0%	25.0%	50.0%	100.0%	0.0%	0.0%	50.0%
	Lost Control	0.0%	37.5%	62.5%	100.0%	0.0%	0.0%	86.7%
	Inattentive/distracted by: Passenger	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	50.0%

2004 - 2006 Urban Crash Data								
Description	SMV Crashes	Horse & Buggy	Farm	Construction/Maintenance	Moped/ATV	Bicycle	Other	Total
Inattentive/distracted by Use of phone or other device	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	50.0%
Inattentive/distracted by: Fallen object	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Inattentive/distracted by: Fatigue/asleep	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Other (explain in narrative): Vis on obstructed	0.0%	0.0%	42.9%	81.8%	100.0%	0.0%	0.0%	71.4%
Oversized Load/Vehicle	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Cargo/equipment loss or shift	0.0%	0.0%	100.0%	100.0%	0.0%	0.0%	0.0%	100.0%
Other (explain in narrative): Other improper action	100.0%	0.0%	39.1%	67.6%	94.7%	0.0%	100.0%	63.1%
Unknown	0.0%	0.0%	58.3%	63.2%	63.6%	18.2%	50.0%	53.1%
Other (explain in narrative): No improper action	0.0%	0.0%	92.3%	40.0%	90.9%	0.0%	33.3%	34.2%
Not Reported	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Total	75.0%	46.3%	60.6%	76.7%	19.4%	77.3%	60.2%	
Animal	0	0	0	0	0	0	0	0
Ran Traffic Signal	1	1	2	0	3	0	0	7
Ran Stop Sign	0	0	1	0	3	0	0	4
Crossed centerline	0	5	2	0	1	0	0	8
FTYROW: At uncontrolled intersection	0	1	2	0	2	1	1	7
FTYROW: Making right turn on red signal	0	0	0	0	0	5	1	6
FTYROW: From stop sign	0	1	0	0	8	3	0	12
FTYROW: From yield sign	0	0	1	0	4	0	0	5
FTYROW: Making left turn	0	0	1	1	12	2	1	16
FTYROW: From driveway	0	2	1	0	3	1	1	8
FTYROW: From parked position	0	0	0	0	1	0	0	1
FTYROW: To pedestrian	0	0	0	0	0	5	0	5

2004 - 2006 Urban Crash Data									
Description	SMV Crashes	Horse & Buggy	Farm	Construction/Maintenance	Moped/ATV	Bicycle	Other	Total	
FTYROW: Other (explain in narrative)		0	14	2	1	4	1	22	
Traveling wrong way or wrong side of road		0	3	0	0	0	0	3	
Driving too fast for conditions		0	2	9	1	0	0	12	
Exceeded authorized speed		0	2	2	0	0	0	4	
Made improper turn		0	1	0	2	0	0	3	
Irproper Lane Change		0	0	0	0	0	0	0	
Followed too close		1	12	6	2	1	0	22	
Disregarded RR Signal		0	0	0	0	0	0	0	
Disregarded Warning Sign		0	0	0	0	0	0	0	
Operating vehicle in an erratic/reckless/careless/negligent/aggressive manner		0	4	2	1	1	0	8	
Improper Backing		0	0	0	0	0	0	0	
Illegally Parked/Unattended		0	0	0	0	0	0	0	
Swerving/Evasive Action		0	16	4	3	1	0	24	
Over correcting/over steering		0	0	1	0	0	0	1	
D downhill runaway		0	0	0	0	0	0	0	
Equipment failure		0	0	0	0	0	0	0	
Separation of units		0	0	0	0	0	0	0	
Ran off road - right		0	2	1	0	0	0	3	
Ran off road - straight		0	1	0	0	0	0	1	
Ran off road - left		0	3	1	0	0	0	4	
Lost Control		0	5	3	0	0	0	8	
Inattentive/distracted by: Passenger		0	1	0	0	0	0	1	
Inattentive/distracted by Use of phone or other device		0	1	0	0	0	0	1	
Inattentive/distracted by: Fallen object		0	0	0	0	0	0	0	
Inattentive/distracted by: Fatigue/asleep		0	0	0	0	0	0	0	

Major cause of crashes involving one or more SMVs with matching circumstances from the Non-SMV vehicle involved that indicate more responsibility on the particular **Non-SMV** than any other vehicle involved in the crash

2004 - 2006 Urban Crash Data									
Description	SMV Crashes	Horse & Buggy	Farm	Construction/Maintenance	Moped/ATV	Bicycle	Other	Total	
Other (explain in narrative): Vision obstructed	0	4	2	0	0	0	0	6	
Oversized Load/Vehicle	0	0	0	0	0	0	0	0	
Cargo/equipment loss or shift	0	0	0	0	0	0	0	0	
Other (explain in narrative): Other improper action	0	14	11	1	5	0	0	31	
Unknown	0	5	4	4	9	1	1	23	
Other (explain in narrative): No improper action	0	1	6	1	42	2	2	52	
Not Reported	0	2	1	1	11	1	1	16	
Animal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
Ran Traffic Signal	100.0%	100.0%	100.0%	100.0%	75.0%	0.0%	0.0%	87.5%	
Ran Stop Sign	0.0%	0.0%	50.0%	50.0%	33.3%	0.0%	0.0%	33.3%	
Crossed centerline	0.0%	50.0%	66.7%	66.7%	50.0%	0.0%	0.0%	50.0%	
FTYROW: At uncontrolled intersection	0.0%	100.0%	100.0%	100.0%	28.6%	100.0%	100.0%	58.3%	
FTYROW: Making right turn on red signal	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	100.0%	100.0%	
FTYROW: From stop sign	0.0%	20.0%	0.0%	0.0%	57.1%	100.0%	0.0%	41.4%	
FTYROW: From yield sign	0.0%	0.0%	100.0%	100.0%	66.7%	0.0%	0.0%	71.4%	
FTYROW: Making left turn	0.0%	0.0%	50.0%	50.0%	70.6%	100.0%	100.0%	43.2%	
FTYROW: From driveway	0.0%	100.0%	33.3%	33.3%	75.0%	100.0%	25.0%	57.1%	
FTYROW: From parked position	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%	0.0%	50.0%	
FTYROW: To pedestrian	0.0%	0.0%	0.0%	0.0%	0.0%	83.3%	0.0%	62.5%	
FTYROW: Other (explain in narrative)	0.0%	70.0%	15.4%	15.4%	16.7%	66.7%	25.0%	44.0%	
Traveling wrong way or wrong side of road	0.0%	75.0%	0.0%	0.0%	0.0%	0.0%	0.0%	50.0%	
Driving too fast for conditions	0.0%	66.7%	81.9%	81.9%	10.0%	0.0%	0.0%	50.0%	
Exceeded authorized speed	0.0%	100.0%	100.0%	100.0%	0.0%	0.0%	0.0%	66.7%	
Made improper turn	0.0%	50.0%	0.0%	0.0%	66.7%	0.0%	0.0%	37.5%	

2004 - 2006 Urban Crash Data									
Description	SMV Crashes	Horse & Buggy	Farm	Construction/Maintenance	Moped/ATV	Bicycle	Other	Total	
	Improper Lane Change	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Followed too close	100.0%	85.7%	0.0%	85.7%	18.2%	0.0%	62.9%	
	Disregarded RR Signal	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
	Disregarded Warning Sign	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
	Operating vehicle in an erratic/reckless/careless/negligent/aggressive manner	0.0%	80.0%	0.0%	66.7%	3.3%	0.0%	34.8%	
	Improper Backing	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
	Illegally Parked/Unattended	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
	Swerving/Evasive Action	0.0%	68.8%	0.0%	50.0%	27.3%	0.0%	51.1%	
	Over correcting/over steering	0.0%	0.0%	0.0%	50.0%	0.0%	0.0%	25.0%	
	D downhill runaway	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
	Equipment failure	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
	Separation of units	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
	Ran off road - right	0.0%	13.3%	0.0%	20.0%	0.0%	0.0%	10.7%	
	Ran off road - straight	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	100.0%	
	Ran off road - left	0.0%	75.0%	0.0%	50.0%	0.0%	0.0%	50.0%	
	Lost Control	0.0%	62.5%	0.0%	37.5%	0.0%	0.0%	13.3%	
	Inattentive/distracted by:								
	Passenger	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	50.0%	
	Inattentive/distracted by Use of phone or other device	0.0%	100.0%	0.0%	0.0%	0.0%	0.0%	50.0%	
	Inattentive/distracted by:								
	Fallen object	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
	Inattentive/distracted by:								
	Fatigue/asleep	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
	Other (explain in narrative):								
	Vision obstructed	0.0%	57.1%	0.0%	18.2%	0.0%	0.0%	28.6%	
	Oversized Load/Vehicle	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
	Cargo/equipment loss or shift	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
	Other (explain in narrative):								
	Other improper action	0.0%	60.9%	0.0%	32.4%	5.3%	0.0%	36.9%	
	Unknown	0.0%	41.7%	0.0%	30.8%	36.4%	81.8%	46.9%	

### 2004 - 2006 Urban Crash Data

Description	SMV Crashes	Horse & Buggy	Farm	Construction/Maintenance	Moped/ATV	Bicycle	Other	Total
Other (explain in narrative):								
No improper action	0.0%	0.0%	7.7%	60.0%	3.1%	100.0%	66.7%	65.8%
Not Reported	0.0%	0.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
<b>Total</b>	<b>25.0%</b>	<b>53.7%</b>	<b>39.4%</b>	<b>23.3%</b>	<b>80.6%</b>	<b>22.7%</b>	<b>39.8%</b>	

## APPENDIX B. CRASH ANALYSIS METHODOLOGY

### Methodology

Slow-moving vehicle crashes in Iowa from 2004-2006 were gathered and analyzed. The Iowa crash database has a vehicle configuration category for the construction/maintenance vehicles, farm vehicles, and moped/all-terrain vehicles. These crashes were gathered out of the database and put into excel and ArcGIS format. The horse and buggy crashes did not have their own vehicle configuration category so the categories used to classify those crashes would be unknown, not reported, or other. All crashes from 2004-2006 in these three categories were gathered. The narratives were used to determine what kinds of vehicles were involved in each crash and they were marked as such. Slow-moving vehicle crashes were then added to the list of slow moving vehicle crashes for each year analyzed. Other construction/maintenance vehicles, farm vehicles, and moped/all-terrain vehicles were located in these three categories as well. They were gathered out and added into the list of slow moving vehicle crashes.

A dbase file was created called "smv\_200\_\_arcgis\_format.dbf". This included the crash key, d1unitkey, type, and smv categories (smv=1, other=0). This table was added to ArcGIS and joined by crash keys to the zshp\_200\_ file. A query was then done to select all slow moving vehicle crashes (smv = 1). Shapefiles were then created for each year to show the slow moving vehicle crashes (all\_smv\_crashes\_200\_.shp). The crash key was used instead of the d1unitkey because there is only one location for each crash in the zshp\_200\_ file, regardless of the number of vehicles involved in each crash.

Once the new slow moving vehicle shapefile was created, the table was then used to query out each of the different types of vehicles involved in the slow moving vehicle crashes. Shapefiles for each type were then created and placed on the map of Iowa. Crash keys were also used for creating these shapefiles instead of the d1unitkeys because there is only one location for each crash regardless of the number of vehicles involved in each crash.

To add the total number of slow moving vehicles involved in crashes to the excel document "SMV Analysis," the smv\_200\_\_arcgis\_format.dbf was opened in excel and the crashes were sorted by type. They could then be manually counted and entered onto the excel document.

### Sunrise/Sunset Data

Night crashes were then separated from day crashes for all the slow moving vehicle crashes. The United States Naval Observatory online source was used to determine the appropriate dawn and dusk times for each crash. Hours before sunrise and after sunset were used to determine nighttime crashes for the slow moving vehicles. The U.S. Naval Observatory gives times for sunrise and sunset each city in the U.S. on each day of each year. A midpoint east-west of State Center, IA was used to determine a common location for each crash. Similarly, the 15th of each month was used to determine the sunrise and sunsets to compare with the times of all crashes within the month. Once this was determined, the zltf\_200\_.dbf was then joined to the

all\_smv\_crashes\_200\_.shp theme table by crash keys (once again because there was only one crash and the individual vehicles do not have an influence on the time of crash). The file was then exported as a .dbf to adjust in excel. Within excel, the crashes were then sorted in increased order by month. The sunset and sunrise times for each month were then manually added to the .dbf files and saved as smv\_with\_time\_and\_sunrise\_sunset.dbf. This file was then added to the tables in ArcGIS 3.3. A query could then be done to select all night crashes with time<sunrise or time>=sunset. A shapefile with these crashes was then created, smv\_crashes\_night.shp.

## Rural vs. Urban Separation

Rural slow moving vehicle crashes were separated from urban slow moving vehicle crashes. This was done by defining rural crashes to be at least 1 mile (1609 meters) outside the corporate city boundaries. This is to incorporate the extension of the city limits beyond the boundary by about one mile into the urban area. The slow moving vehicle shapefile “all\_smv\_crashes\_200\_.shp” was used to select the crashes on the basis of rural vs. urban. The st\_corp shapefile was added to the map and a “select by theme” command was done on the slow moving vehicle theme table to select those slow moving vehicle crashes within 1609 meters of a city boundary. A shapefile of urban slow moving vehicle crashes was then created with this command (“urban.shp”). Then the Edit>Switch Selection command was used to select all the other slow moving vehicle crashes, which would then be classified as rural. This was then converted into a shapefile “rural.shp” and added to the map of Iowa.

The total number of slow moving vehicles involved in crashes was used for the description in the excel document. This was done by doing a one-to-many join of the rural.dbf file to the smv\_2004\_arcgis\_format.dbf file by crash key. This allows us to get the total number of rural crashes. Then a query was done with rural=1 and exported as rural\_smv\_crashes.dbf. The same method was used to export all slow moving vehicles involved in crashes in an urban setting. That file was saved as urban\_smv\_crashes.dbf.

## Crash Severity

Crash severity of all crashes involving slow moving vehicles were plotted on a map of Iowa. This was done by joining “all\_smv\_crashes\_200\_.shp” theme table to the “zsev\_200\_.dbf” file by crash key. Crash keys were used instead of d1unitkeys because there is only one location for each crash involving a slow moving vehicle and each class is either classified as fatality, major injury, minor injury, unknown, or property damage only according to the most severe event occurring as a result of the crash. Once these were joined, a query for each value of the Cseverity column was done and shapefiles (“fatality\_severity.shp, major\_injury\_severity.shp, minor\_injury.shp, unknown\_severity.shp, pdo.shp”) were created for each of the 5 possible categories of crash severity.

The two rural and urban shapefiles were then used to classify each crash by the crash severity according to rural or urban. The rural.shp theme table was exported as a dbf and a column was added in excel title “rural” and all crashes within this .dbf were given a value of 1. The file was then resaved as rural.dbf. This could now be joined to the zsev\_200\_.dbf file by crash key. A

query could then be done selecting rural = 1 and cseverity = \_ for each crash severity type. Shapefiles for each of these crash severity types were created. A similar approach was followed for the “urban.dbf” file.

An analysis excel document was created called “SMV Crash Analysis.” The total vehicles involved in slow moving vehicle crashes for each vehicle type were recorded first. This was done by sorting the smv\_200\_\_arcgis\_format.dbf by type and then manually counting the number of each vehicle type. The number of crashes will be more than the total on the shapefile because this number includes all slow moving vehicles involved in crashes instead of just the number of crashes involved slow moving vehicles. Each crash may involve more than one slow moving vehicle and this is the number that is reflected here.

#### Redo of Rural Crashes to Exclude Unknown Location

The number of slow moving vehicles involved in slow moving vehicle crashes were then separated by rural vs. urban and also according to vehicle type. This was done by completing a one to many join of rural.dbf to smv\_200\_\_arcgis\_format.dbf by crash key. A query of rural=1 could then be done to select all the rural crashes. These were then exported as rural\_smv\_crashes.dbf in the rural folder. They could then be sorted by type and then counted and entered manually into the SMV Analysis excel document. Once this was done, the rural crashes had to be redone because the crashes with unknown location would be added into the rural crashes. This would be an incorrect representation. In order to account for this, the st\_bord.shp was joined spatially to the rural.dbf. file by the “shape” field. The crashes with unknown location (or blanks in the location fields) were exported as smv\_location\_unknown.dbf. This file was then reopened in arcgis and was joined to smv\_200\_\_arcgis\_format by crash key because the smv\_2004\_argis\_format has the total number of vehicles involved in the crashes. The crashes with data in the fields that were added were queried out and saved as smvs\_location\_unknown.dbf. Back in the rural.dbf file, the selection was switched to select all the rural crash keys that have a known location. This file was then exported as rural\_.dbf. This was then reopened in arcGIS and joined to smv\_crashes\_arcgis\_format.dbf by crash key to account for all vehicles involved in crashes. A query was then done to select all rural=1 crashes and they were then exported as rural\_smv\_crashes\_redo.dbf. This file was then opened in excel and counted and manually entered onto the excel document.

The number of slow moving vehicle crashes were then sorted according to crash severity on the excel document. This is similar to the shapefiles created for each crash severity type in ArcGIS 3.3. The .dbf files for each of those crash severity types were opened and then sorted by type and counted and entered manually onto the excel document. The total crashes here still depicts just the number of crashes involving slow moving vehicles as opposed to the number of slow moving vehicles involved in crashes because each crash was only given one crash severity rating.

#### Night Crashes

The night crashes were then entered onto the excel document. The smv\_with\_time\_and\_sunrise\_sunset.dbf file was queried with “time<sunrise or time>=sunset.”

This period was chosen because the time equal to sunrise would be considered daytime and the time equal to sunset would be the time when the sun falls below the surface of the earth and would be considered a night crash. This was then exported as time\_night.dbf or night\_crashes.dbf and the crashes were then sorted by type and counted and entered manually onto the excel document. In order to enter the day crashes, a query was done on the smv\_with\_time\_and\_sunrise\_sunset.dbf file with time>=sunrise and time<sunset. This was then exported as day\_crashes.dbf. The crashes could then be sorted by vehicle type and then counted and entered manually on the SMV Analysis document. A query could then be done on the smv\_with\_time\_and\_sunrise\_sunset.dbf with time=7777, which represents unknown time. These were then manually entered by type onto the SMV Analysis excel document. A night-to-day crash ratio was then entered for each vehicle type by dividing the night crashes by the day crashes.

### Peak Hour Crashes

Peak hour crashes were next to be entered onto the SMV Analysis excel document. The smv\_with\_time\_and\_sunrise\_sunset.dbf file was queried to find all crashes during the AM peak hour with time>=700 and time<=900. These crashes were then exported as a .dbf file as "am peak.dbf." These were then sorted by vehicle type and counted and entered manually onto the SMV Analysis excel document. The PM peak hour crashes were then queried with time>=1600 and time<=1800. These crashes were then exported as "pm peak.dbf." These were then sorted by vehicle type and counted and entered manually onto the SMV Analysis excel document. The midday crashes were then queried from smv\_with\_time\_and\_sunrise\_sunset.dbf as time<1600 and time>900. These crashes were exported as "midday.dbf." These were then sorted by vehicle type and counted and entered manually onto the SMV Analysis excel document.

### Month

Crashes were then sorted by month for each vehicle type. The smv\_with\_time\_and\_sunrise\_sunset.dbf file was queried using month=1 up to month=12 for each of the 12 months. These were each exported as a .dbf file and saved as "month\_\_\_\_.dbf." Each file was sorted by vehicle type and counted and entered manually onto the SMV Analysis excel document.

### Surface Conditions

The surface conditions of the crashes were then recorded onto the SMV Analysis document. The all\_smv\_crashes\_200\_.dbf file was joined to the zenv\_200\_.dbf file by crash key. The environment characteristics for the crashes are considered the same for all vehicles involved in the crash and thus, the crash key is as specific as the zenv\_200\_.dbf file gets. The surface conditions were queried (csurfcond=\_\_ ) and exported as a .dbf file as "surfcond\_\_\_\_.dbf." Categories 1-7 remained the same, but other, unknown and not reported surface conditions were all grouped into one category for simplification purposes. This is expressed as the last row in the surface condition section on the SMV analysis excel document and is titled

“Other/Unknown/Not Reported.” These were then sorted by vehicle type and counted and entered manually onto the SMV Analysis excel document.

Speed limit of each crash was then recorded according to vehicle type. The speed limits for different vehicles involved in a crash would be different. Therefore, the speed limits are specified for each d1unitkey of the crash key. For this reason, the all\_smv\_arcgis\_format.dbf file was joined to the zrdb\_200\_.dbf file by d1unitkey. The speed limits were then queried according to different speed groups: below 25, 25-34, 35-44, 45-54, 55-64, 65 and above, and unknown. Each group was exported and saved as a .dbf file as “speed\_limit\_\_\_\_.dbf.” These were then sorted by vehicle type and counted and entered manually onto the SMV Analysis excel document.

### Major Cause

Major cause of the slow moving vehicle crashes were then recorded according to vehicle type. The zcta\_200\_.dbf file shows the major cause for each crash, but is only specific to each crash key, not each d1unitkey. So a many to one join was done using the crash keys from all\_smv\_arcgis\_format.dbf to zcta\_200\_.dbf. The file was then exported and saved as “crash\_type\_characteristics.dbf.” It was then opened in excel and sorted by type and then by major cause value. These were then counted and entered manually onto the SMV Analysis excel document.

### Manner of Crash/Collision

Manner of collision for each crash was then recorded for each vehicle type. Each crash has one specific manner of collision, so there will only be a total of recordings for this category as there were total crashes involving one or more slow moving vehicles. The “crash\_type\_characteristics.dbf” file was sorted by type and then by manner of collision. These were then counted and entered manually onto the SMV Analysis excel document.

### Driver Age

Driver age was then entered onto the SMV Analysis document. Each vehicle had a specific driver age, so the d1unitkeys were used as a join method in this case. The all\_smv\_arcgis\_format.dbf file was joined to zdrv\_200\_.dbf by d1unitkey. Each age group was then queried as “driverage<15, driverage>14 and driverage<21, etc...). The different groups can be seen on the excel document. These age groups were chosen because this is the method used by the Fatality Analysis Reporting System when sorting by driver age. They were then exported and saved as “driver\_age\_\_\_\_.dbf.” These were then sorted by vehicle type and counted and entered manually onto the SMV Analysis excel document.

### Rural and Urban Worksheets

Rural and urban worksheets were then created using the rural\_.dbf file (file with the crashes of unknown location taken out) and urban.dbf file for each year. These tables were added to the

attributes of all\_smv\_crashes\_200\_.shp along with the zltf\_200\_.dbf, zsev\_200\_.dbf, zenv\_200\_.dbf, zcta\_200\_.dbf. by crash key as well as the st\_bord.dbf file joined by the shape field in order to access the data more easily.

### Three Year Combination Project

To combine the three years of data into one, I opened all three shapefiles in a new view. I then merged the themes together (view>geoprocessing wizard>merge themes together). A new shapefile was then created by merging the 3 years of data together and was titled all\_smv\_crashes\_2004\_to\_2006. This file was then opened in ArcGIS and a summary was done on the county number field and was titled summary\_all\_smv\_crashes.dbf. This new table was then joined to the st\_bord.shp file by county number. A shapefile was created with the new data and added to the map called smv\_crashes\_by\_county. From this shapefile, a thematic map showing all slow moving vehicle crashes was then created by double clicking on the shapefile, the legend type drop down list was clicked on and graduated color was chosen. The classification field selected is "count." The categories used to display the crashes were 0-8, 9-17, 18-26, and More Than 26 crashes.

### Injury Map

An injury map was then created by selecting all crashes with cseverity=2 or 3 for major or minor injury. A summary was done on this data by county number and was saved as smv\_injury\_summary.dbf. This table was then joined to st\_bord.dbf by county number. A shapefile was then created titled smv\_injury\_crashes.shp. A thematic map could then be made from this data. The classification field selected is again "count." The categories used to display the thematic map were 0-3, 4-6, 6-10, and More Than 10. This is to stay consistent with the map created by Ohio.

### Fatality Map

Farm fatalities were then added to the map by selecting type=farm and cseverity=1 from the attributes of all\_smv\_crashes\_2004\_to\_2006.shp table. A shapefile was created called farm\_fatalities.shp and was added to the map. There were no fatalities from horse and buggy crashes, so those could not be added to the map. The same method was followed to add construction/maintenance and moped/atv fatalities as a shapefile to the map. Rural construction and maintenance and farm fatalities were then added to the map by querying out rural=1, farm=1, and cseverity=1.

### Responsibility of Collision

To determine how many of the major causes of the crashes involving one or more slow moving vehicles were correlated to an individual slow moving vehicle involved in the crash, the zcta\_ files was joined to the smv\_argis\_format table by crash key and the zdrv\_ and zctb\_ tables were joined to the smv\_argis\_format table by d1unitkey. The rural.dbf file was also joined to the

smv\_arcgis\_format table by crash key in order to depict rural from urban crashes. The excel file majorcausederivation was used to determine if the major cause was a result of the action of the individual slow moving vehicle involved in the crash. A separate table majorcauseconversion.pdf was made with the values from the major cause category and the values of the contributing circumstances of the driver (1 & 2), sequence of event values, and other values that would be required in order to place a specific value in the major cause category. This file could then be opened in ArcView GIS and joined by major cause field to the smv\_arcgis\_format table with the zcta, zctb, and zdrv tables already joined to it. This file was then exported as all\_smv\_crashes\_major\_cause\_cont\_cir.pdf. This was then opened in excel and then sorted by major cause. The crashes were then analyzed manually to determine the number of slow moving vehicles that were at fault for the specific crashes. These vehicles were cut out of the document and resaved in another document called all\_crashes\_major\_cause\_smv\_responsibility. The remaining crashes were saved under a different file names called all\_crashes\_major\_cause\_other\_responsibility. Once this was done, the crashes in which more than one slow moving vehicle was involved were analyzed and subtracted from the responsibility category to make sure that I wasn't counting two vehicles that were responsible for the same crash. These vehicles were highlighted in the all\_crashes\_major\_cause\_cont\_cir document as well as in the all\_crashes\_major\_cause\_other\_responsibility document. This is because placing a SMV in the "other" responsibility document where a different SMV was actually responsible for the crash would give a false indication with its presence in the "other" document that would attempt to indicate responsibility lying with a vehicle other than a SMV. In these cases, a SMV was responsible for the crash with another SMV not being responsible for the crash. Therefore, these SMVs in the "other" responsibility document would not be counted as part of the "other" responsibility crash numbers. This did not have an effect in the Slow Moving Vehicle Analysis spreadsheet because the crashes in which a SMV was more responsible for the crash were just subtracted from each total crashes for each major cause and type category to get the number of crashes in which an other vehicle was responsible for the crash. The purpose of highlighting the crashes in the "other" spreadsheet is merely for my own comfort because the number of crashes in that spreadsheet will not add up to be the same number of crashes listed in the other responsibility category of the SMV Analysis spreadsheet. The percentage of crashes was then computed for each cell by dividing the number of crashes in which a slow moving vehicle was more responsible for the crash than any other vehicle by the total number of crashes for each cell. The total percentage of crashes in which a cause for the crash was known and a slow moving vehicle was more responsible for the crash was calculated by adding all crashes where the slow moving vehicle was more responsible for the crash in categories in which the cause was known (all categories except 1) unknown, 2) other (explain in narrative): no improper action, and 3) not reported) and dividing it by the sum of all crashes in which the cause was known (all categories except 1) unknown, 2) other (explain in narrative): no improper action, and 3) not reported).

## Multiple Vehicle Crashes

For the purpose of total analysis over the three year period, multiple vehicle crashes were analyzed separately on the 2004-2006 combined data in the excel spreadsheet. This was done to get a feel for the number of crashes during which another vehicle involved could have been responsible for the crash, but actually slow moving vehicle was more responsible. Subtracting out single vehicle collisions in which most always the slow moving vehicle would be at fault

makes for a more reasonable determination of who is actually responsible a majority of the time for those crashes involving more than one vehicle. This was done by sorting out all crashes that involved more than one vehicle and analyzing the responsibility of collision in a similar manner as stated above.