WISCONSIN LARGE TRUCK SAFETY AND ENFORCEMENT STUDY

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The Wisconsin Large Truck Safety and Enforcement Study (LTS&E) focused on a system-wide evaluation of large truck safety in the state of Wisconsin. This study analyzes crash data related to large trucks that are close to the following criteria: greater than or equal to 13 feet 6 inches in height, greater than or equal to 8 feet 6 inches in width, greater than 80,000 pounds and any truck at or longer than legal limits as allowed by Wisconsin Statutes chapter 348 for any and all legal length based on semi-tractor trailer combinations, that are operating with or without a permit in the state of Wisconsin and with or without exceptions as provided in either state statues or regulations. The crash data used during the development of this study is extracted from the WisTransPortal database of MV-4000 crash reports and additional MV-4000 data from the Wisconsin Truck and Bus data between 2004 and 2009.

Part of this study includes the identification and analysis of the targeted large truck data in order to refine the amplitude of the project and to describe potential safety issues reflected by the historical crash data. Roadway characteristics and driver behavior seem to be the most significant variable in determining the severity of crash incidents. Certain features of roadway condition as well as driver factor might lead to an increase of certain type of crashes. Most harmful event was chosen over first harmful event as a potential predictor of crash severity: however, further analysis reveals that there is no striking difference in crash severity across different levels of most harmful event. Vehicle factors and highway factors were dropped from the model early in the analysis process as their composition does not seem to vary across different levels of crash severity.</td></tr>
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Wisconsin Large Truck Safety and Enforcement Study

Technical Memorandum #1
Wisconsin Large Truck Safety Analysis

Prepared by Wilbur Smith Associates

July, 2011

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Glossary of Terms and Acronyms

Term / Acronym	Definition
AADT	Annual Average Daily Traffic
AASHTO	American Association of State Highway and Transportation Officials
ATA	American Trucking Association
A-Train Combination	A classification of articulated vehicle combinations consisting of a tractor and two or more trailers that are coupled together, using a converter dolly with a single connection point between trailers
B-Train Combination	A unique trailer assembly that extends from the frame of the first trailer to the fifth wheel of the second trailer
CMV	Commercial Motor Vehicle
FARS	Fatal Accident Reporting System
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
LCV	Longer Combination Vehicles
MCMIS	Motor Carrier Management Information System
Mississippi Valley Conference	Mississippi Valley is one of the four regional AASHTO groups. It consists of Illinois, Indiana, Iowa, Kansas, Kentucky, Michigan, Minnesota, Missouri, Ohio and Wisconsin.
NAICS	North American Industry Classification System - a numerical coding system adopted by the U.S. Census Bureau in 1997. NAICS replaces the 1987 Standard Industry Classification system.
NHTSA	National Highway Traffic Safety Administration
National Network (NN) Highways	The National Network of Highways includes: (1) the Interstate Highway System and (2) other designated highways, which on June 1, 1991, were part of the Federal-Aid Primary System in effect at that time. There are highways that have been certified by the states to FHWA as being capable of safely handling larger commercial motor vehicles. The total National Network system is about 200,000 miles, and a complete listing of the highways included in the NN can be found in 23 CFR Part 658, Appendix A
STAA	Surface Transportation Assistance Act of 1982
VMT	Vehicle Miles Traveled – an often used denominator for computing a "crash rate" typically expressed as crashes per 100 million VMT.

Executive Summary

The Wisconsin Large Truck Safety and Enforcement Study (LTS&E) is the result of an integrated effort with the Wisconsin Traffic Operations and Safety Laboratory (TOPS Lab) and Wilbur Smith Associates (WSA) together with C J Petersen & Associates and focused on a system-wide evaluation of large truck safety in the state of Wisconsin.

The primary focus of the safety evaluation and recommendations for engineering countermeasures is on large truck configurations. Most crash reports for large trucks are based upon their being defined as commercial motor vehicles which for crash reporting purposes are generally defined as vehicles with a gross vehicle weight of 10,000 pounds (lbs.) or more.

This document reports on three primary activities undertaken to assess large truck safety in Wisconsin:

1. The first activity, undertaken by WSA, was to examine in the large truck safety in Wisconsin compares crash data reported by the State to federal databases: The Fatal Analysis Reporting System (FARS) and the Motor Carrier Management Information System (MCMIS). The comparative analysis used the Analysis and Information Online application from the Federal Motor Carrier Safety Administration (FMCSA). The purpose of this activity was to develop a high-level profile of large truck crashes in Wisconsin to determine trends or issues that should be examined more closely in subsequent safety tasks.

2. The second safety analysis activity undertaken by the TOPS Lab, extracted crash records from the WisTransPortal database of MV-4000 crash reports and additional MV-4000 data from the Wisconsin Truck and Bus data between 2004 and 2009. In this task data analysis of the MV-4000 crash records is used to drill down to examine underlying causation associated with large truck crashes in Wisconsin.

3. The third safety analysis activity undertaken by C.J. Petersen Associates (CJPA) involved phone interviews with county transportation officials. CJPA was provided a list of counties where the highest numbers of truck crashes have occurred in the state. CJPA then contacted county representatives to discuss potential engineering related reasons as to why these crashes may be occurring.

Key Findings

Findings from the first safety activity; the high-level comparative analysis of federal truck crash statistics suggests a number of conclusions regarding truck operations and safety in Wisconsin, including:

- **Overall, CMV fatal crashes are declining:** The number of fatal CMV related crashes in Midwestern states is declining. In 1999, Wisconsin and the four surrounding states experienced a total of 551 CMV related fatal crashes; in 2009 that number had declined to 300, a decline of 46 percent in eleven years. In both 2000 Wisconsin had 91 fatal crashes involving large truck; just 48 in 2009. *In the eleven year time frame, Wisconsin's truck involved fatal crashes declined 33 percent; a decline of nearly 4 percent annually*.

- Fatal crashes involving large trucks nationally, in the Midwest and in Wisconsin have been declining. *Between 2000 and 2009 the number of large truck involved fatal crashes declined 35 percent in Wisconsin.*

- **Fatal CMV crash rates are declining as well:** The rate of crashes involving large truck per 100 million vehicle miles of travel (VMT) have been declining. *In Wisconsin the crash rate for CMV involved fatal accidents declined over the past six years from 1.7 fatal crashes per 100 million VMT to 1.0, a decline of 41 percent.*

- **Wisconsin is safer than the average with regard to truck crashes**: With the exception of Iowa, Midwestern states perform as well as, or better than average when compared to truck related crash rates for the U.S. as a whole (i.e., 0.15 nationwide). ***In 2009, Wisconsin trailed only Michigan and Illinois in terms of the lowest CMV fatality rates in the Midwest.*** The fatality rate for large truck crashes in Wisconsin is also lower than the national average. Based on an average based on a six year period, ***Wisconsin's CMV fatality rate of .15 per 100 million VMT ranked 19th among all states and the District of Columbia.***

- **Single Unit Trucks Over-represented:** Several recent years of data comparing fatal and non-fatal CMV crashes in Wisconsin to national averages suggest that single unit trucks are over-represented in Wisconsin's large truck crash statistics. **In particular, single unit trucks such as cement mixers and dump trucks appear over-represented in Wisconsin's large truck crash profile.**

- **Crash prevalence toward rural collector routes**: Large truck crashes in Wisconsin are more prevalent in rural areas than they are nationally. ***Over 70 percent of Wisconsin's large truck crashes took place in rural areas.*** Rural collector roads saw the most truck crashes, and throughout the state trucks over 26,000 pounds were much more likely to be involved in fatal crashes.

Findings from second safety activity; the statistical analysis of large truck crash severity using MV-4000 crash records found:

- **Driver factors are significant**: Driver factor and driver behavior seem to be the most significant variables in determining the severity of crash incidents.

- **Some roadway conditions and geometrics are also significant**: The results also revealed that substandard features or obsolete designs of the roadway might lead to an increase of certain types of large truck crashes.

- **Crash severity not dependent on first harmful event**: No particular difference in crash severity was observed across different levels of most harmful event; although most of them are very significant. This might be due to the fact that in 73 percent of the sample no particular event tends to contributes to determining crash severity. Other considerations involving vehicle factors and highway factors were excluded from the model early in the analysis because their influence does not seem to vary across different levels of crash severity.

Key findings from the third safety activity; interviews conducted with county transportation officials included:

- **The safety analysis of large trucks is somewhat limited by data formats**: Oversize/Overweight commercial vehicle crash data is not separated from passenger vehicle crash data when analyzing cause, effect and solution.

- **The division of responsibility for truck safety is sometimes cloudy**: County representatives indicated that they are under contract to WisDOT to maintain the roads and access points at the intersections with state and interstate routes. They further stated that they do not have responsibility for design of the system and the access points.

- **Four counties declined to participate**: There were four counties that declined the invitation to participate in the survey, since this was either outside the scope of their jurisdiction or they do not have information to share regarding the design of the system in relation to crash rates. The counties were Dane, Racine, Brown and Grant.

- **Roundabout designs on the rise**: Roundabouts are being incorporated into design plans by Jefferson, Manitowoc, Milwaukee, Outagamie, Sheboygan and WisDOT SE Region for Milwaukee County. Specific routes were identified by respondents and are noted in this report. These counties are attempting to reduce traffic speeds through signage when it is warranted by the infrastructure.

- **Most counties feel driver decisions supersede design criteria in crash causation**: Driver error was mentioned as a primary cause of crashes rather than the infrastructure and the system they drive on.

Introduction

The Wisconsin Large Truck Safety and Enforcement Study (LTS&E) is the result of an integrated effort with the Wisconsin Traffic Operations and Safety Laboratory (TOPS Lab) and Wilbur Smith & Associates together with C J Petersen & Associates and focused on a system-wide evaluation of large truck safety in the state of Wisconsin.

The primary focus of the safety evaluation and recommendations for engineering countermeasures is on large truck configurations. Most crash reports for large trucks are based upon their being defined as commercial motor vehicles which for crash reporting purposes are generally defined as vehicles with a gross vehicle weight of 10,000 pounds (lbs.) or more. The routes evaluated with regard to pavement and bridge wear due to large trucks are the highways designated in Wisconsin as "long truck routes".

For clarity 'large truck' is used as an all encompassing term to describe commercial vehicles (over 10,000 lbs or more). The analysis also broadly examines OS/OW truck operations, defined as those vehicles requiring a permit per state regulations to travel within Wisconsin. The crash analysis conducted for this study was performed under three distinct activities, drawing from multiple data sources:

1. The first activity, undertaken by WSA, was to examine in the large truck safety in Wisconsin compares crash data reported by the State to federal databases: The Fatal Analysis Reporting System (FARS) and the Motor Carrier Management Information System (MCMIS). The comparative analysis used the Analysis and Information Online application from the Federal Motor Carrier Safety Administration (FMCSA). The purpose of this activity was to develop a high-level profile of large truck crashes in Wisconsin to determine trends or issues that should be examined more closely in subsequent safety tasks.

2. The second safety analysis activity undertaken by the TOPS Lab, extracted crash records from the WisTransPortal database of MV-4000 crash reports and additional MV-4000 data from the Wisconsin Truck and Bus data between 2004 and 2009. In this task data analysis of the MV-4000 crash records is used to drill down to examine underlying causation associated with large truck crashes in Wisconsin.

3. The third safety analysis activity undertaken by C.J. Petersen Associates (CJPA) involved phone interviews with county transportation officials. CJPA was provided a list of counties where the highest numbers of truck crashes have occurred in the state. CJPA then contacted county representatives to discuss potential engineering related reasons as to why these crashes may be occurring.

For the first task of the safety analysis, the study team conducted a state-wide review of existing truck crash data reported to federal agencies, wherein the total number of crashes involving trucks in Wisconsin were compared to national totals from crash databases maintained by the Federal Motor Carrier Safety Administration (FMCSA). The Fatality Analysis Reporting System (FARS) was used to analyze factors pertaining to fatal crashes. Other data sources included the

Motor Carrier Management Information System (MCMIS). Data were generally accessed and queried using the FMCSA Analysis and Information Online (A&I Online) analysis tool. The application can be accessed at: http://ai.fmcsa.dot.gov/CrashProfile/CrashProfileMainNew.asp
The first step of the safety analysis was intended to provide a benchmark for the more detailed analysis of crashes involving large trucks in Wisconsin using the MV-4000 records. The second task of the safety evaluation includes the identification and analysis of the targeted large truck data in order to refine the amplitude of the project and to describe potential safety issues reflected by the historical crash data. Moreover, the study also conducted a survey directed to County officials and transportation engineers in charge of counties reporting the highest incidence of large truck crashes between 2004 and 2009.

Overview of Truck Safety Trends (1988-2008)

Data collected by FMCSA, including data analyzed as part of the Large Truck Causation Study (LTCS), shows a number of trends regarding large truck crashes in the U.S. These trends are also summarized in **Exhibit 1**:

- More trucks on the road: The number of large trucks registered in the U.S. increased nearly 50 percent between 1988 and 2008, from over 6 million to just over 9 million.
- More truck miles: Truck vehicle miles traveled (VMT) has increased by 65 percent. In 1988, trucks traveled just under 137 billion miles. In 2008, truck VMT exceeded 227 billion.
- Fewer trucks involved in crashes: The number of large trucks involved in fatal crashes declined 22 percent between 1988 and 2008, from 5,241 to 4,066.
- Fewer fatalities resulting from large truck crashes: In 1988, large truck crashes resulted in 5,679 fatalities in the U.S. By 2008, the number of fatalities resulting from large truck crashes had decreased by 26 percent, to 4,229.
- Crash rates fell by half: The fatal crash rate for large trucks (i.e. number of crashes resulting in a fatality per 100 million VMT) for large trucks decreased from 3.54 per 100 million VMT in 1988 to 1.64 per 100 million VMT in 2008. In the same period, total fatalities per 100 million VMT decreased from 4.12 to 1.86.

Exhibit 1: Comparison of Truck Crash Measures in the U.S. 1988-2008

	1988	*2008*	*change*
Fatal Crashes	4,885	3,733	-24%
Vehicles Involved	5,241	4,066	-22%
Occupant Fatalities	911	677	-26%
Total Fatalities	5,679	4,229	-26%
Million VMT	137,985	227,458	65%
Fatal CMV Crashes per 100 Million VMT	3.54	1.64	-54%
CMV Involved in Fatal Crashes per 100 Million VMT	3.8	1.79	-53%
Fatalities per 100 Million VMT	4.12	1.86	-55%
Large Trucks Registered	6,136,884	9,006,738	47%

Source: Federal Motor Carrier Safety Administration, *Large Truck and Bus Crash Facts 2008*

The decrease in fatal truck crash rates in the past two decades has been dramatic, particularly in light of the increasing use of trucks to transport goods and the corresponding increase of truck VMT. Nonetheless, while trucks account for about 7 percent of VMT, in 2008 large trucks accounted for 8 percent of all vehicles involved in a fatal crash and crashes involving a large truck accounted for 11 percent of all traffic fatalities reported.[*]

Impacts of Truck Configuration, Size and Weight

There have not been significant changes to federal truck size and weight standards in nearly three decades. The last major change in federal policy toward truck size and weight was contained in the Surface Transportation Assistance Act of 1982, which established 80,000 lbs. as the allowable gross weight limit on National Network (NN) highways. The NN includes: (1) the Interstate Highway System; and, (2) other highways designated by the states in response to the Surface Transportation Assistance Act (STAA) of 1982. The NN, often referred to as the national truck network, consists of highways considered capable of safely handling larger commercial motor vehicles.

However, as the world economy becomes more integrated many traditional U.S. industries are seeking greater transportation productivity to remain competitive. For highway transport adopting special truck size and weight limits on state routes may mean the difference between retaining local jobs or a plant closure. For instance, many states, including Wisconsin allow special size and weight limits for timber, agriculture and other local industries. In addition, new technologies such as wind power generation have resulted in an increasing number of oversize/overweight (OS/OW) special permit operations. As volume of large truck operations increases, their ability to safety navigate secondary road systems raise safety concerns.

While truck size and weight is a highway safety concern, the actual role that truck size and/or weight plays in contributing to highway safety remains unclear:

> *"No existing truck crash data set was found to have sufficient information for a scientific analysis of the contributions of size and weight (especially OS/OW) to crash causation or severity. The complex, confounding relationships between the contributing factors and the small sample sizes for different configurations of the largest commercial vehicles are two examples of why existing data is not sufficient.*[†]

While there is a shortage of data directly correlating truck size and weight with the type, frequency, and casualties of roadway crashes, there is evidence that points to a number of trends relevant to truck safety:

> *"Analyses of crash data bases have noted that truck travel on lower performance roads, (e.g., undivided, higher speed-limit roads with numerous intersections and entrances), significantly increases crash risks compared to travel on Interstates and other higher*

[*] National Highway Traffic Safety Administration, *Traffic Safety Facts, 2008 Data.* DOT HS 811 158. Accessed at: http://www-nrd.nhtsa.dot.gov/Pubs/811158.PDF

[†] *A Synthesis of Safety Implications of Oversize/Overweight Commercial Vehicles;* American Association of State Highway and Transportation Officials, 2010, pp. 37-38.

quality roads… The majority of fatal crashes involving trucks occur on non-Interstate, U.S. and State routes, many of which are undivided and have high posted speed limits."[‡]

Based on the existing evidence, truck size and weight policy and potential changes to those policies should especially focus on truck travel patterns and truck performance capabilities in terms of use on lower performance roads and roads with high or high growth traffic densities.

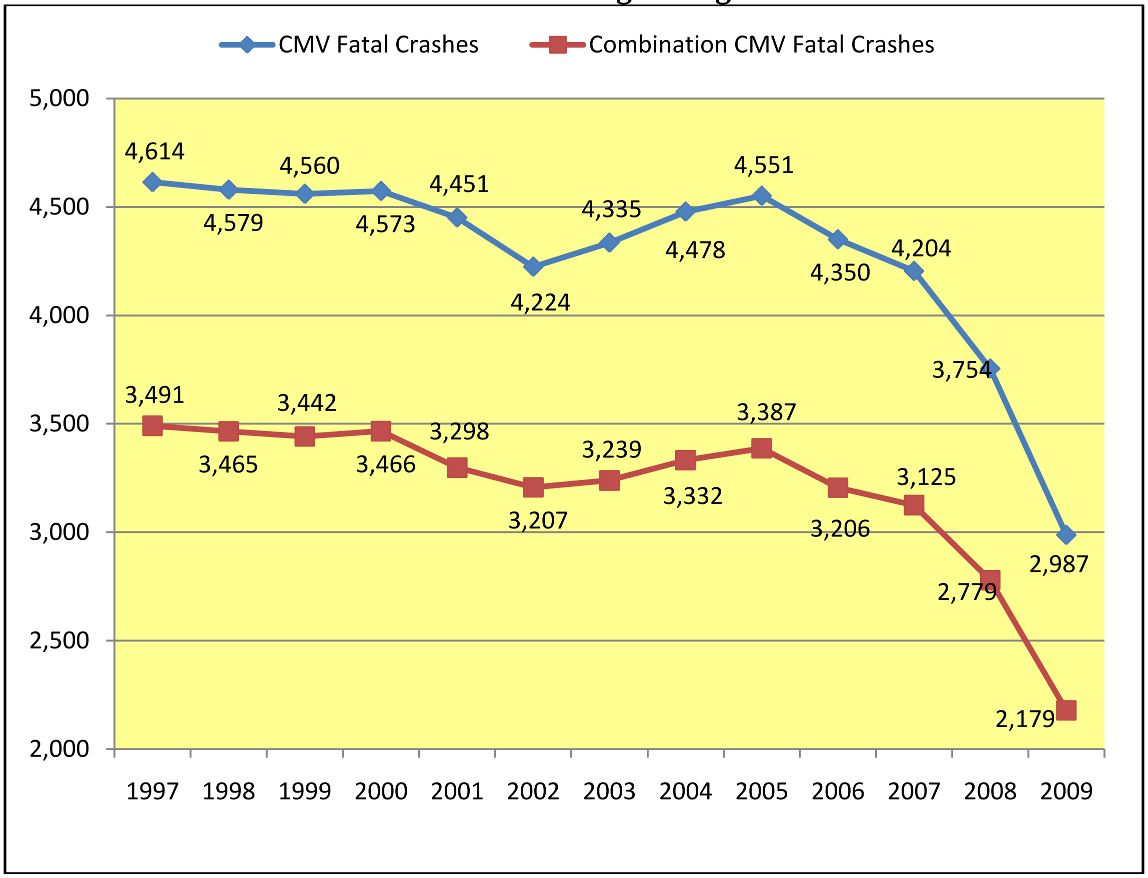
A synthesis report examining truck safety completed for the American Association of State Highway and Transportation Officials (AASHTO) reviewed a wide number of previous studies and concluded that the distribution of truck crash fatalities largely mirrors the distribution of truck types, with the nearly 90 percent of crashes involving straight trucks or single semi-trailers. In 2005, triple trailers were involved in only four crashes across the U.S.; however the AASHTO report notes that this may be due to their being used largely on Interstate highways. Another possible factor is that the largest vehicles are typically driven by the most experienced drivers.[§]

Comparing Truck Safety: Wisconsin vs. the U.S. and Midwest

Vehicular travel has generally become safer in the U.S. for both passenger and commercial vehicles. However, concerns regarding the safe operation of large commercial vehicles have often been considered a barrier in the U.S. regarding changes to federal policy that might allow the operation of larger and/or heavier commercial motor vehicles (CMV) on national highway facilities. Historically, fatal crashes involving CMVs have been over-represented in crash statistics relative to other vehicle classes. Fatal crashes involving combination CMVs, such as a tractor-semitrailer combination, typically are involved in about three-quarters of all CMV fatal crashes. Nationally, the number of fatal crashes involving CMVs over 10,000 pounds fluctuated roughly between 4,200 and 4,600 for the years spanning 1997 and 2007. However, since 2005 the number of fatal crashes involving large trucks in the U.S. has shown a steady decline, and in 2008 the number of fatal CMV involved crashes dropped below 4,000 for the first time since 1975. The number dropped significantly again in 2009. It should be noted that in 2005 the FMCSA implemented a significant change in the hours of service regulations governing interstate truck drivers. Under the new regulations total drive time was reduced from 14 hours to 11 hours, with rest periods intended to keep drivers on their natural circadian rhythm.

[‡] *Comprehensive Truck Size and Weight Study Volume III, Chapter 8*, Federal Highway Administration, pg. 2, September 2000. Accessed at: https://www.fhwa.dot.gov/reports/tswstudy/index.htm
[§] Ibid., p. 40.

Exhibit 2: Fatal Crashes Involving a Large Truck in the U.S.



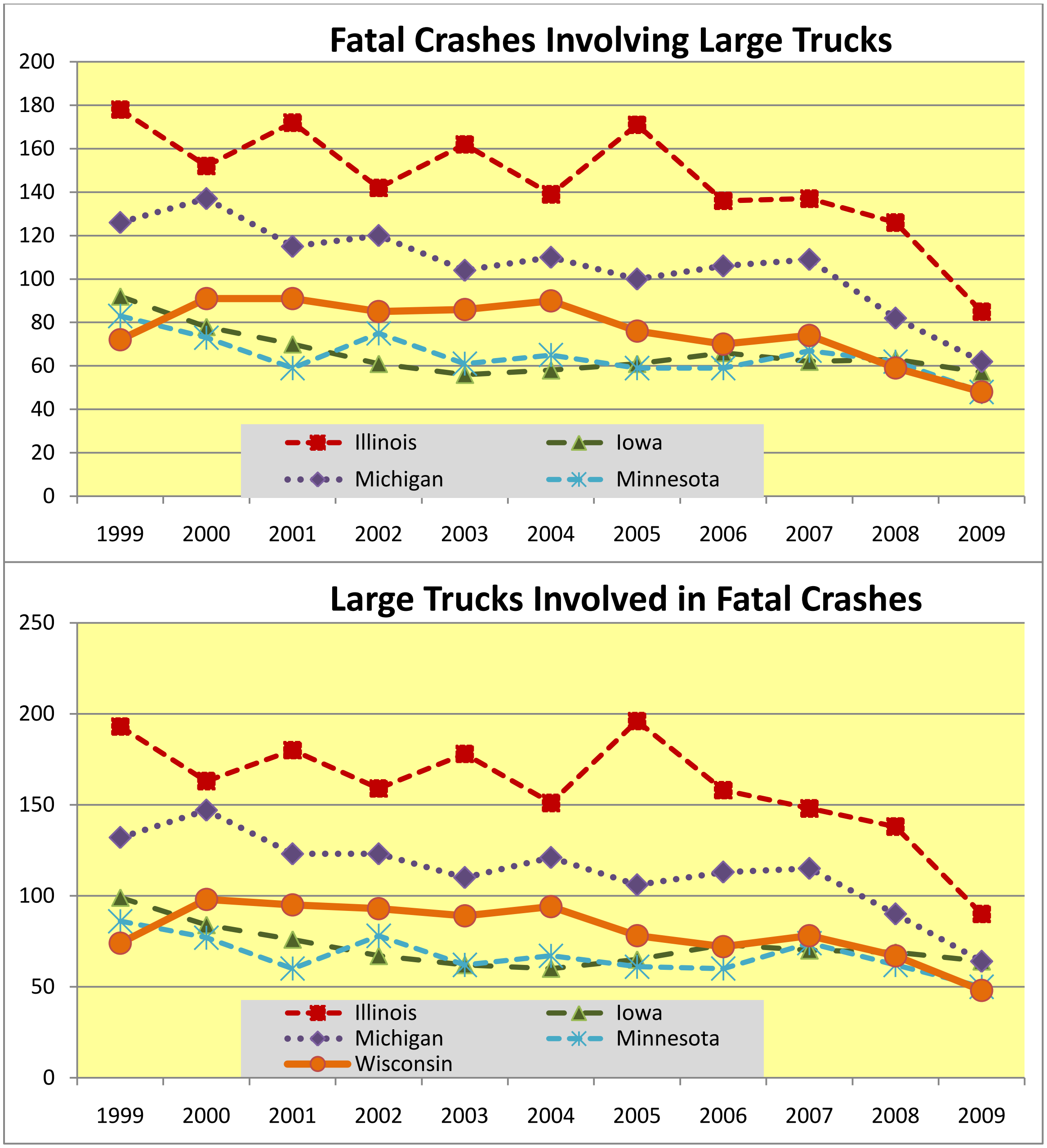
Source: Federal Highway Administration, Fatality Analysis Reporting System (FARS)

Nationwide between 1975 and 2008 fatal crashes per 100 million VMT for commercial trucks declined 64 percent from 4.58 to 1.65. Over the same period, the fatal crash rate for passenger vehicles declined 62 percent from 2.84 to 1.09.

Exhibit 3 displays the trend in fatal crashes involving large trucks in Wisconsin and surrounding states over a thirteen year period. The top chart shows the number of fatal crash events that involved a large truck. The bottom chart shows the total number of trucks involved in fatal crashes; this chart accounts for fatal crashes involving more than one large truck.

As with the national trend, overall the number of fatal CMV related crashes in Midwestern states is declining. In 1999, Wisconsin and the four surrounding states experienced a total of 551 CMV related fatal crashes; in 2009 that number had declined to 300, a decline of 46 percent in eleven years. In both 2000 Wisconsin had 91 fatal crashes involving large truck; just 48 in 2009. In the eleven year time frame, Wisconsin's truck involved fatal crashes declined 33 percent; a decline of nearly 4 percent annually.

Exhibit 3: Large Truck Involved Fatal Crashes for Wisconsin & Surrounding States

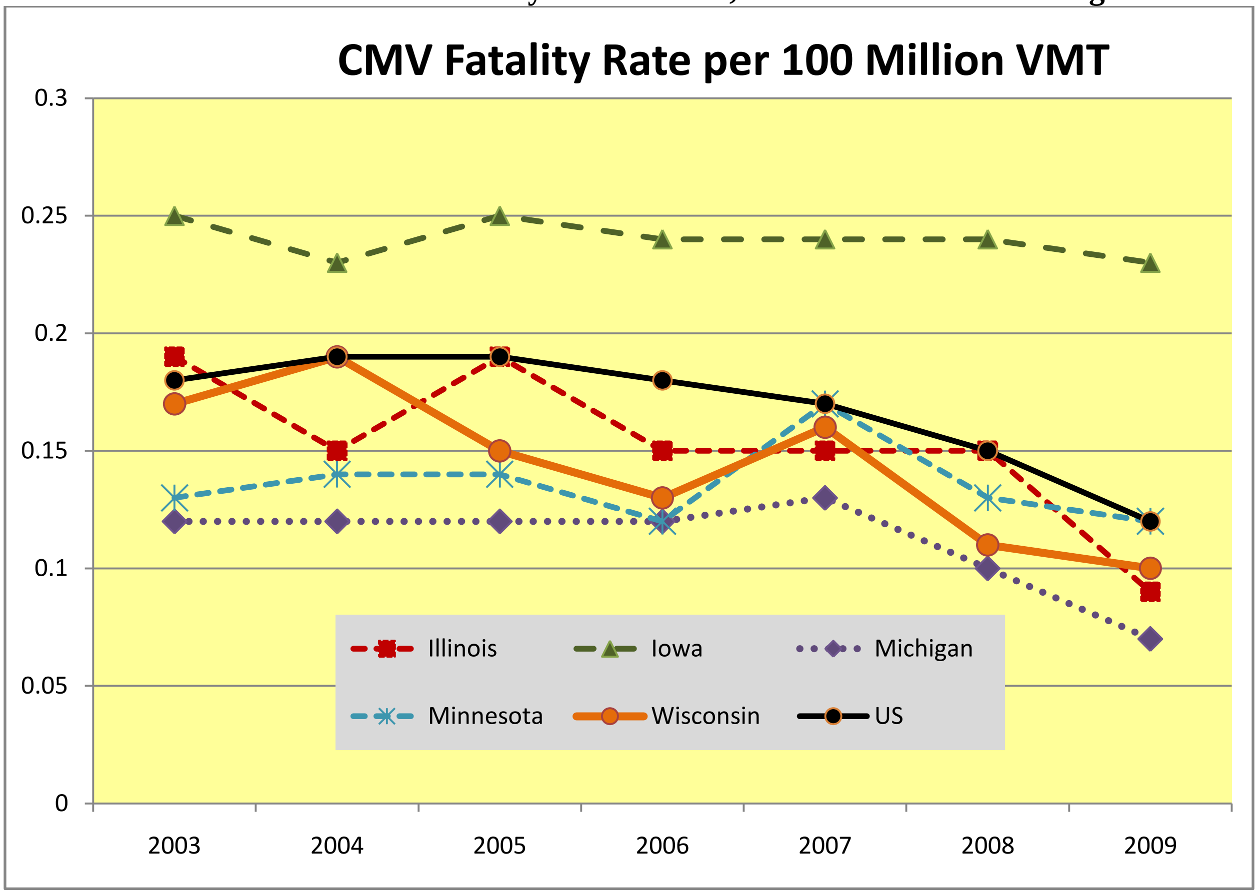


Sources: Vehicle Miles of Travel and Registered Vehicles: Federal Highway Administration. Fatal Crashes, Vehicles Involved, and Fatalities: National Highway Traffic Safety Administration, Fatality Analysis Reporting System (FARS). A large truck is defined as a truck with a gross vehicle weight rating (GVWR) greater than 10,000 pounds (includes medium and heavy trucks).

Exhibit 4 displays the fatality rate (truck related crash fatalities per 100 million VMT) for CMVs in Wisconsin and surrounding states, as well as the entire U.S. over a seven year period. With the exception of Iowa, Midwestern states perform as well as, or better than average when compared to truck related crash rates for the U.S. as a whole (i.e., 0.15 nationwide). In 2009, Wisconsin trailed only Michigan and Illinois in terms of the lowest CMV fatality rate in the Midwest with

0.10 truck involved crash fatalities per 100 million VMT. Over the seven years of data, Wisconsin's commercial vehicle fatality rate declined 41 percent.

Exhibit 4: Commercial Vehicle Fatality Rate for U.S., Wisconsin & Surrounding States



Sources: Vehicle Miles of Travel and Registered Vehicles: Federal Highway Administration. Fatal Crashes, Vehicles Involved, and Fatalities: National Highway Traffic Safety Administration, Fatality Analysis Reporting System (FARS). A large truck is defined as a truck with a gross vehicle weight rating (GVWR) greater than 10,000 pounds (includes medium and heavy trucks).

Exhibit 5 ranks CMV fatality rates for all 50 states and the District of Columbia, using averages based on six years of crash and traffic count data. The most recent six years of available data for each state, from 2003 to 2008, are averaged and the resulting fatality rates for each state are shown in descending rank. Wisconsin averaged 91 fatalities per year from CMV crashes, with a normalized fatality rate of 1.53 fatalities per 100 MVMT. Wisconsin had the 19^{th} lowest rate of commercial vehicle related fatalities. Only the surrounding states of Michigan and Minnesota had lower average fatal CMV crash rates.

Exhibit 5: Comparison of State Commercial Vehicle Fatality Rates, 2003-2008*

Rank	State	Avg. Annual Fatalities	Avg. Total VMT (millions)	Fatalities per 100 million VMT	Rank	State	Avg. Annual Fatalities	Avg. Total VMT (millions)	Fatalities per 100 million VMT

1	MA	32	54,775	0.06	27	FL	370	198,661	0.19
2	RI	6	8,377	0.07	28	NV	40	20,846	0.19
3	HI	9	9,988	0.09	29	PA	212	107,881	0.20
4	CT	27	31,708	0.09	30	AZ	120	59,682	0.20
5	NH	13	13,340	0.10	31	TN	144	70,359	0.20
6	NJ	85	73,599	0.11	32	MS	85	40,938	0.21
7	MI	121	103,126	0.12	33	IN	150	71,795	0.21
8	WA	67	55,863	0.12	34	SC	104	49,668	0.21
9	DC	5	3,648	0.12	35	GA	236	111,917	0.21
10	NY	172	137,385	0.13	36	ID	32	15,019	0.21
11	CA	418	327,475	0.13	37	TX	507	234,446	0.22
12	VT	10	7,786	0.13	38	ND	17	7,698	0.22
13	MD	72	55,689	0.13	39	MO	157	68,710	0.23
14	AK	7	4,992	0.14	40	MT	27	11,099	0.24
15	UT	35	25,442	0.14	41	AL	143	59,740	0.24
16	MN	78	56,753	0.14	42	IA	76	31,171	0.24
17	VA	111	80,255	0.14	43	NE	47	19,250	0.24
18	ME	21	14,904	0.14	44	NM	61	24,945	0.25
19	WI	91	59,397	0.15	45	KY	118	47,479	0.25
20	OH	170	110,211	0.15	46	OK	120	47,325	0.25
21	CO	76	47,074	0.16	47	KS	78	29,572	0.26
22	DE	15	9,292	0.16	48	WV	55	20,522	0.27
23	IL	175	107,301	0.16	49	LA	121	44,938	0.27
24	OR	58	34,947	0.17	50	AR	107	32,267	0.33
25	NC	182	99,626	1.83	51	WY	33	9,293	0.36
26	SD	16	8,811	1.83		**US Avg**	**5,228**	**2,976,981**	**0.18**

*Source: USDOT/FHWA, Highway Statistics (annual series); FARS.

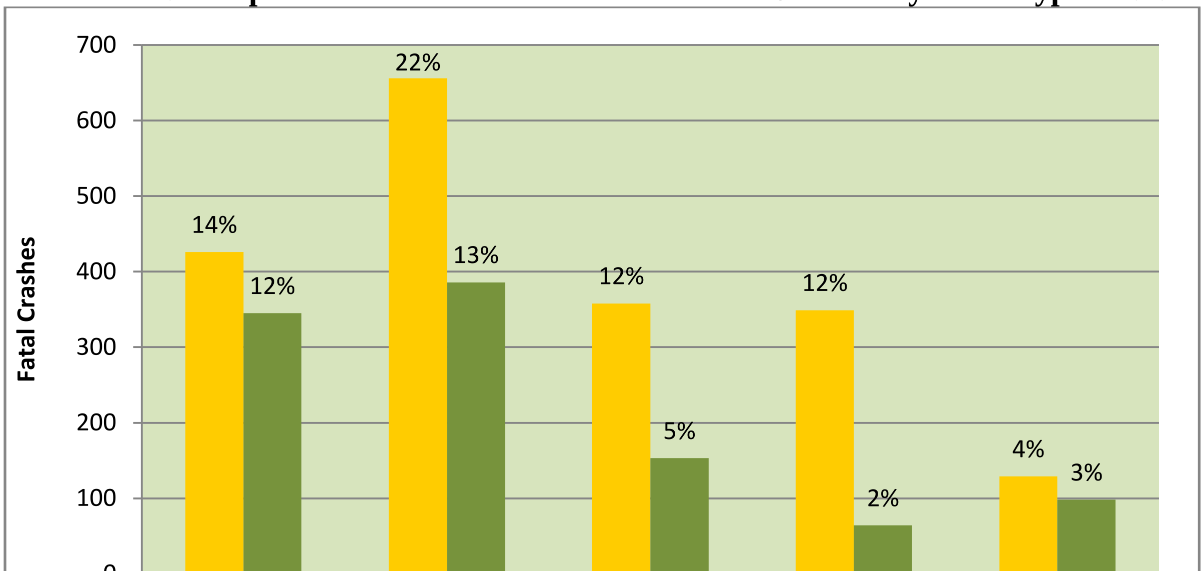
Other Notes:

1. CMV includes large trucks (over 10,000 lbs. gross vehicle weight rating) and buses.
2. The Fatalities heading includes the number of fatalities involved in Large Truck and Bus fatal crashes.
3. Fatality Rate: equal to the 'Number of Fatalities Involved in Commercial Motor Vehicle Fatal Crashes' divided by the 'State Total VMT' multiplied by 100. Fatality Rate figures represent Fatalities per 100 Million Commercial Motor Vehicle-Miles Traveled.
4. The average annual fatalities for each state is an annualized average rounded to the nearest whole number.

Factors Relating to Large Truck Fatalities and Crashes

Road classification is a well-documented crash factor affecting all vehicle types that concerns highway design and traffic engineering. **Exhibit 6** compares the number of commercial vehicle crashes in the U.S. for different vehicle types across highway functional classes for the year 2009. The chart below shows that the greatest number of crashes occurs on rural arterial routes, while urban collector routes have the lowest number of fatal crashes.

Exhibit 6: Comparison of Fatal Crash Counts for All Vehicles by Road Type - U.S.



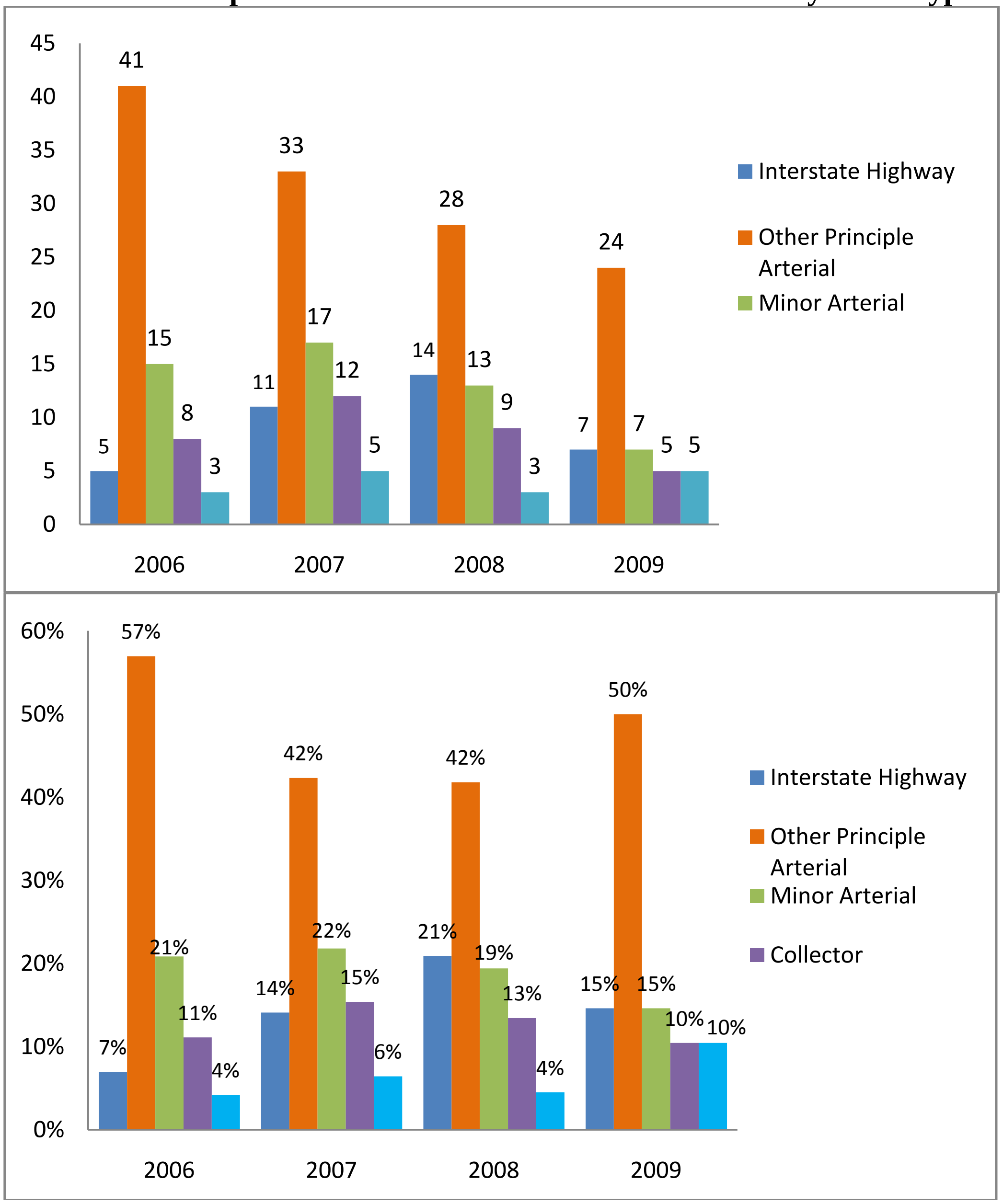
	Interstate Highways	Other Principal Arterials	Minor Arterials	Collectors	Local Roads
Rural	426	656	358	349	129
Urban	345	386	153	64	98

Source: Fatality Analysis Reporting System / National Center for Statistics & Analysis, NHTSA

Exhibit 7 shows the number and shares of CMV involved in fatal crashes by roadway functional class in Wisconsin. Overall, from 2006 to 2009, the number of CMV involved in fatal crashes dropped from 72 to 48, down by nearly 33 percent. Although the greatest share has occurred on non-Interstate principal arterials, these roads have experienced a significant decline in the number of CMV involved in fatal crashes (i.e., a reduction of 41 percent in 2009 compared to 2006). Other two functional classes with a significant drop in the number of fatal truck crashes are minor arterials and collectors with -53 percent and -38 percent, respectively. In contrast, Interstate highways and local roads/streets reported an increase in the number of CMV fatality crashes in 2009 compared to that in 2006, with 40 percent and 67 percent, respectively.

This trend can likely be attributed to several factors. In general truck involved crashes have been declining, which many attribute to stricter hours of service rules governing truck drivers. The beginning of 2008 also witnessed the beginning of the "Great Recession" which extended into mid-2009. During the recession trucking activity at both the state and national levels declined significantly. In addition, factors such as highway design, weather conditions (e.g., fog or snow), road surface (e.g., slippery pavement), light conditions (e.g., dark or dusk), driver-related factors (e.g., speeding or driving while intoxicated), vehicle conditions (e.g., impaired braking system), or highway construction zones can all have an impact on crashes from year to year. The spectrum of issues cannot be easily separated since crash causes are numerous and often difficult to determine. The investigation of MV-4000 crash records discussed later in this report, will examine some of these factors more thoroughly. In spite of the increasing use of trucks to transport goods, this high-level analysis shows a decrease in the number of CMV involved in fatal crashes in Wisconsin over the 2006 to 2009 period as well as a significant decrease in the CMV fatality rate in Wisconsin in 2008 compared to the previous three years (**Exhibit 4**).

Exhibit 7: Comparison of Wisconsin Fatal Truck Crashes by Road Type

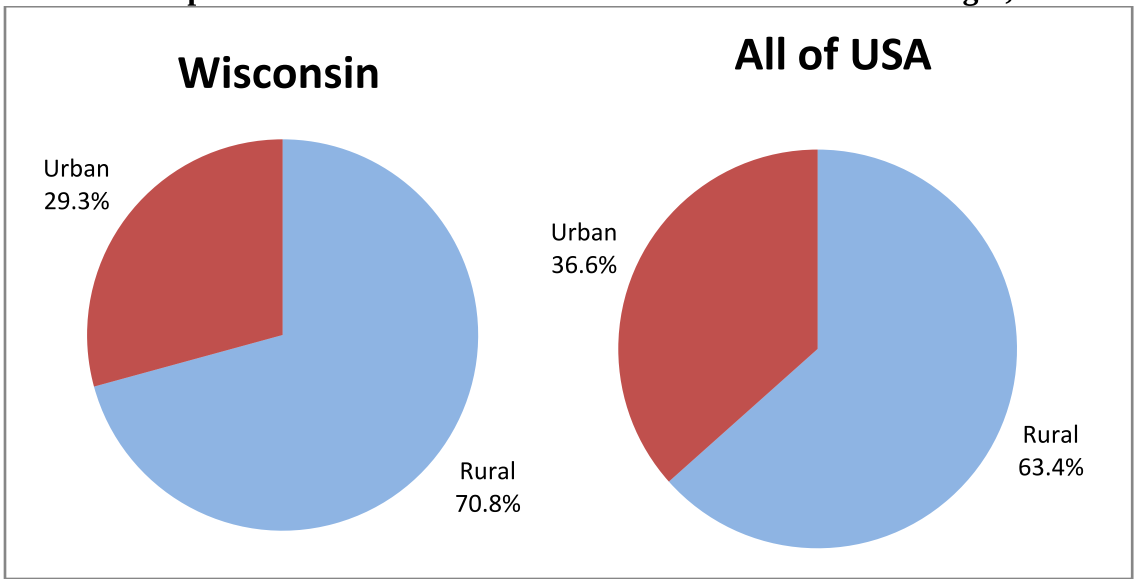


Source: Analysis and Information System, Federal Motor Carrier Safety Administration (FMCSA) and FARS

Exhibit 8 compares the shares of fatal truck crashes occurring in rural vs. urban environments for Wisconsin and the U.S. as a whole. The pie charts show that in Wisconsin a greater share of fatal crashes occur in rural areas as compared to the rest of the nation. Because of the relatively low numbers of total crashes in Wisconsin, the years 2005 to 2008 were averaged together. In

Wisconsin, over 74 percent of fatal truck crashes occur in rural environments. In the entire U.S., about 63 percent of fatal truck crashes occur on rural highways.

Exhibit 8: Comparison of Urban and Rural Fatal Truck Crash Percentages, 2005-2008



Source: Analysis and Information System, Federal Motor Carrier Safety Administration (FMCSA) and FARS

Data limitations make it difficult to positively identify why the percentage of fatal truck crashes occurring on rural facilities in Wisconsin is higher than the national rate. However, in combination with the other findings, it can be inferred that reducing the number of fatal truck crashes on rural arterial highways in Wisconsin would likely have a significant impact on the total number of truck crashes occurring in the state. Additional information obtained from the FMCSA online application regarding truck crashes that occurred during 2009 in Wisconsin include the following points of interest:

- Fifty-three percent of fatal truck crashes were attributed to carriers domiciled outside of Wisconsin. Carriers, based in Arkansas, Illinois, Michigan and Utah were involved in the most fatal crashes in Wisconsin.

- The percentage of fatal truck crashes in Wisconsin involving drivers younger than 26 years old was much lower than the national rate. Only 5.2 percent of the drivers involved in fatal crashes in Wisconsin in 2009 were age 26 or younger. Nationally, about 23 percent of fatal crashes involved drivers age 26 or younger.

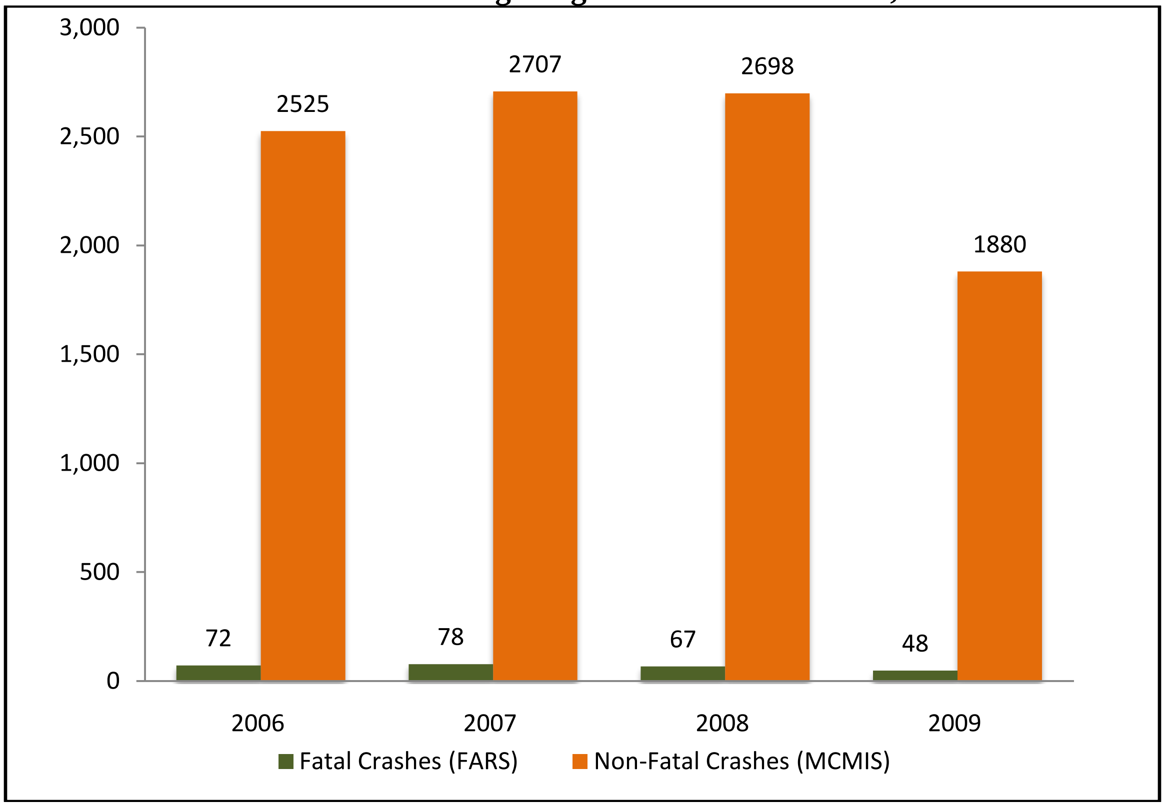
- The highest share of fatal crashes in Wisconsin involved drivers aged 46 to 55. Nationally, this group is involved in just fewer than 15 percent of crashes.

- Fatal crashes involving CMV on rural roads in Wisconsin decreased by 40 percent over the 2006 to 2009 period (i.e., from 53 in 2006 to 32 in 2009). Urban roads also reported a 16 percent decrease on fatal crashes involving large trucks (i.e., from 19 in 2006 to 16 in 2009).

Truck Crash Profile for Wisconsin

This section examines the available data from federal databases on CMV crashes in Wisconsin. **Exhibit 9** below shows the number of fatal and non-fatal crashes involving large trucks in Wisconsin for the period of 2006 to 2009.

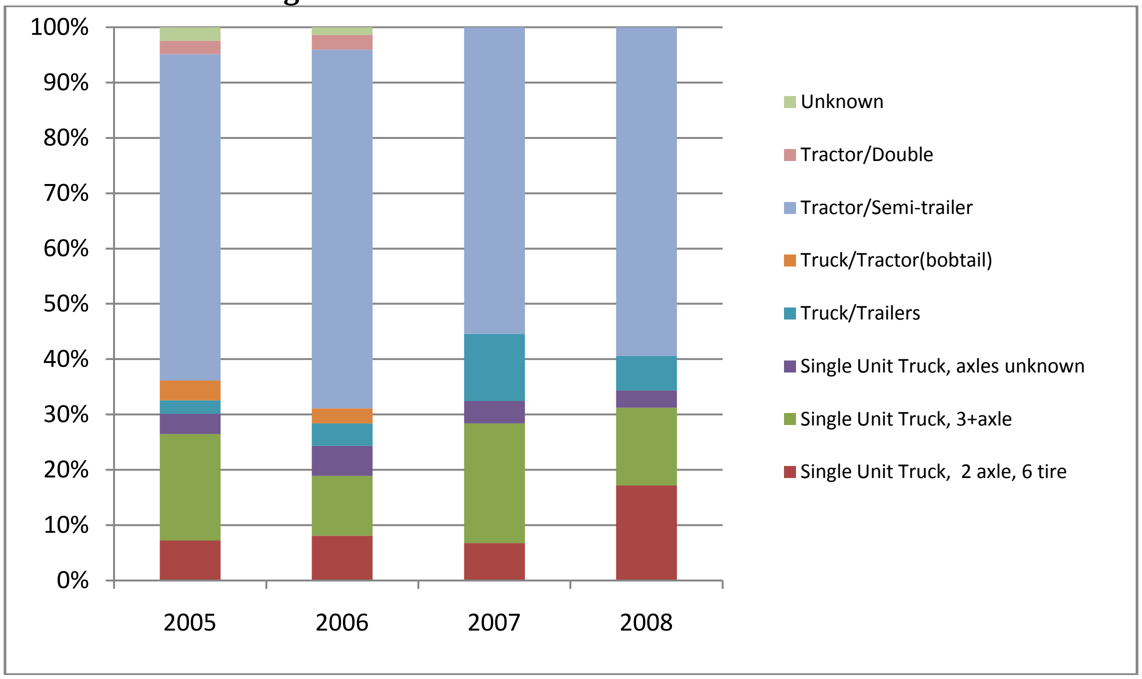
Exhibit 9: Crashes Involving Large Trucks in Wisconsin, 2006-2009



Source: Federal Motor Carrier Safety Administration (FMCSA), Motor Carrier Management Information System (MCMIS)

Data supplied to FMCSA shows that the number of non-fatal crashes has decreased by 26 percent over the past four years for which data are available. The number of fatal truck crashes in Wisconsin also declined significantly in 2009 relative to the three previous years; this trend represents a decrease of 33 percent in 2009 compared to that in 2006. As notes earlier, more stringent hours of service regulation, and a significant decline in economic activity during 2008 and 2009 likely contributed to these declines. **Exhibit 10** shows the distribution of configurations of trucks involved in fatal crashes from 2005 to 2008. Tractor/semi-trailer configurations show the largest share of crashes; however, significant fluctuations can be observed for each configuration.

Exhibit 10: Configurations of Trucks Involved in Fatal Crashes in Wisconsin



The table in **Exhibit 11** on the following page provides crash statistics, both fatal and non-fatal by truck configuration for Wisconsin. The table created from the FMCSA application *Information and Analysis Online* compares the percentage of Wisconsin's truck crashes by vehicle grouping to the averages for the nation. When the percentage difference between a crash category in Wisconsin and the U.S. exceeds 25 percent, the table cell is bolded and shown in red. This percentage comparison assumes that state vehicle fleets operate similar to the national average. A state percentage that is significantly higher, suggests an issue may exist that warrants further investigation.

Of note in the table for fatal crashes, is that single unit vehicles appear to be over-represented in Wisconsin's CMV crashes. In three of the four analysis years, 3-axle single unit CMVs, and single unit CMVs with an unknown number of axles appear to be over-represented with respect to national averages. Two other vehicle groups also appear to be sometimes over-represented: tractors with full trailers, and tractors with no trailer or semitrailer (bobtail).

For non-fatal crashes, the most consistent pattern appears to be "missing" data. Often non-fatal crash reports are compiled by local law enforcement agencies that may not always have adequate training for properly understanding and subsequently documenting the various vehicle types.

Exhibit 12 provides a comparable table based on "Cargo Body Type". Here again, two types of single unit CMV appear to be over-represented in three of the four years of data; "Concrete Mixer" for fatal crashes, and "Dump" for Non-fatal crashes.

Exhibit 11: Large Trucks Involved in Crashes by Vehicle Configuration - 2008 Wisconsin

Fatal Crashes

	2005			2006			2007			2008		
Vehicle Configuration	**State Total**	**State %**	**State-USA %**	**State Total**	**State %**	**State-USA %**	**State Total**	**State %**	**State-USA %**	**State Total**	**State %**	**State-USA %**
Single Unit Truck, 2 axle, 6 tire	6	7.7%	-33.6%	6	8.3%	-24.5%	5	6.4%	-46.7%	11	16.4%	**26.2%**
Single Unit Truck, 3+axle	16	20.5%	**84.7%**	8	11.1%	-9.0%	16	20.5%	**84.7%**	9	13.4%	**31.4%**
Single Unit Truck, axles unknown	3	3.8%	**46.2%**	4	5.6%	**124.0%**	3	3.8%	**72.7%**	2	3.0%	0.0%
Truck/Trailers	2	2.6%	-39.5%	3	4.2%	-8.7%	9	11.5%	**134.7%**	4	6.0%	**27.7%**
Truck/Tractor (bobtail)				3	4.2%	**133.3%**				2	3.0%	**87.5%**
Tractor/Semi-trailer	49	62.8%	0.6%	48	66.7%	6.4%	41	52.6%	-16.0%	38	56.7%	-8.4%
Tractor/Double	2	2.6%	-23.5%				2	2.6%	-13.3%			
Unknown							2	2.6%	4.0%	1	1.5%	-44.4%
Total	78			72			78			67		

Non- Fatal Crashes

Vehicle Configuration	**State Total**	**State %**	**State-USA %**	**State Total**	**State %**	**State-USA %**	**State Total**	**State %**	**State-USA %**	**State Total**	**State %**	**State-USA %**
Single Unit Truck, 2 axle, 6 tire	641	22.1%	**44.4%**	525	20.8%	23.1%	551	20.4%	17.2%	529	19.6%	9.5%
Single Unit Truck, 3+axle	394	13.6%	8.8%	349	13.8%	8.7%	349	12.9%	0.8%	362	13.4%	12.6%
Truck/Trailers	78	2.7%	-76.3%	54	2.1%	-80.9%	58	2.1%	-81.3%	79	2.9%	-73.4%
Truck/Tractor (bobtail)	115	4.0%	**33.3%**	114	4.5%	**28.6%**	110	4.1%	13.9%	85	3.1%	-3.1%
Tractor/Semi-trailer	1,352	46.6%	0.0%	1,171	46.4%	-0.6%	1,307	48.3%	2.5%	1,476	54.6%	14.5%
Tractor/Double	37	1.3%	-48.0%	29	1.1%	-63.3%	34	1.3%	-56.7%	41	1.5%	-40.0%
Tractor/Triple	1	0.0%	-100.0%	1	0.0%	-100.0%	1	0.0%	-100.0%	4	0.1%	0.0%
Unknown	121	4.2%	-2.3%	89	3.5%	2.9%	107	4.0%	21.2%	98	3.6%	-26.5%
Missing	165	5.7%	**32.6%**	193	7.6%	**181.5%**	190	7.0%	**337.5%**	27	1.0%	**42.9%**
Total	2904			2525			2707			2701		

Data Sources: FARS & MCMIS; The MCMIS Crash File is intended to be a census of trucks and buses involved in fatal, injury and towaway crashes; however some states do not report all FMCSA-eligible crashes

The State-USA Percent Difference is computed by the following formula: **(State Percent - USA Percent) / USA Percent**
When this value is greater than or equal to 25, the crash statistics for the category will be highlighted in red.

Exhibit 12: Large Trucks Involved in Crashes by Cargo Body Type - 2008 Wisconsin

	Fatal Crashes											
	2005			2006			2007			2008		
Cargo Body Type	**State Total**	**State Percent**	**State - USA %**	**State Total**	**State Percent**	**State - USA %**	**State Total**	**State Percent**	**State - USA %**	**State Total**	**State Percent**	**State - USA %**
Van/Enclosed Box	39	50.0%	1.6%	37	51.4%	7.1%	28	35.9%	-23.6%	27	40.3%	-15.2%
Cargo Tank	8	10.3%	**41.1%**	5	6.9%	-5.5%	10	12.8%	**58.0%**	6	9.0%	7.1%
Flatbed	12	15.4%	**28.3%**	9	12.5%	0.0%	13	16.7%	**35.8%**	6	9.0%	-21.1%
Dump	9	11.5%	11.7%	6	8.3%	-20.2%	9	11.5%	**33.7%**	6	9.0%	-1.1%
Concrete Mixer	4	5.1%	**264.3%**	1	1.4%	16.7%	3	3.8%	**171.4%**	1	1.5%	**36.4%**
Auto Transporter				1	1.4%	**55.6%**				1	1.5%	**150.0%**
Garbage/Refuse	2	2.6%	13.0%	1	1.4%	-48.1%	4	5.1%	**131.8%**	3	4.5%	**80.0%**
Grain, Chips, Gravel										1	1.5%	-48.3%
Pole				1	1.4%	0.0%						
Logging							1	1.3%	62.5%	4	6.0%	300.0%
Other /Unknown	4	5.1%	-59.7%	11	15.3%	10.1%	10	12.8%	-13.8%	12	17.9%	28.7%
Total	78			72			78			67		
	Non-Fatal Crashes											
Van/Enclosed Box	1,241	42.7%	13.9%	1,097	43.4%	19.9%	1,272	47.0%	22.1%	1,538	56.9%	**36.8%**
Cargo Tank	172	5.9%	9.3%	148	5.9%	11.3%	175	6.5%	20.4%	187	6.9%	19.0%
Flatbed	346	11.9%	-0.8%	290	11.5%	-4.2%	264	9.8%	-14.8%	242	9.0%	-23.1%
Dump	403	13.9%	**54.4%**	271	10.7%	**25.9%**	315	11.6%	**36.5%**	246	9.1%	7.1%
Concrete Mixer	34	1.2%	9.1%	20	0.8%	-27.3%	24	0.9%	-10.0%	24	0.9%	12.5%
Auto Transporter	16	0.6%	-45.5%	12	0.5%	-50.0%	13	0.5%	-54.5%	16	0.6%	-40.0%
Garbage/Refuse	87	3.0%	15.4%	76	3.0%	**25.0%**	71	2.6%	4.0%	72	2.7%	3.8%
Grain, Chips, Gravel										2	0.1%	-94.1%
Pole										2	0.1%	-83.3%
Logging										2	0.1%	-66.7%
Other/Unknown	218	7.5%	-60.7%	203	8.0%	-64.0%	259	9.6%	-55.8%	355	13.1%	-40.2%
Missing	387	13.3%	38.5%	408	16.2%	97.6%	314	11.6%	61.1%	15	0.6%	-80.6%
Total	2904			2525			2707			2701		

Notes: Data sources FARS and MCMIS.
Some vehicle categories with blank cells were deleted (Intermodal, Not Applicable, Missing (FARS data)), and some were combined (Other & Unknown).

Exhibit 13 compares percentages of truck crashes in Wisconsin and the U.S. as a whole by first event type. Because of the relatively small percentage of fatal crashes, the exhibit includes both fatal and non-fatal crashes. About 75 percent of crashes in Wisconsin began with a collision involving a motor vehicle in transport; nationally, less than 68 percent of crashes began this way. Jackknife events accounted for 3.5 percent of Wisconsin crashes, but just 1.3 percent of crashes nationally.

Exhibit 13: Truck Crashes in 2008 by First Event Type

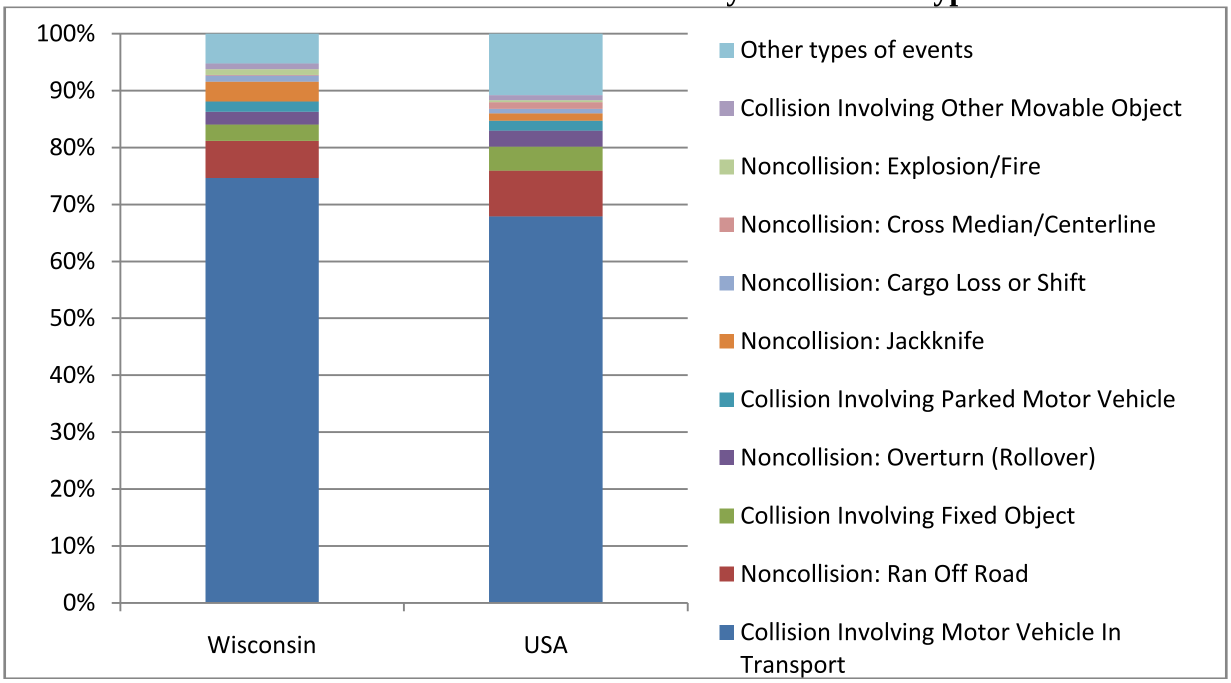
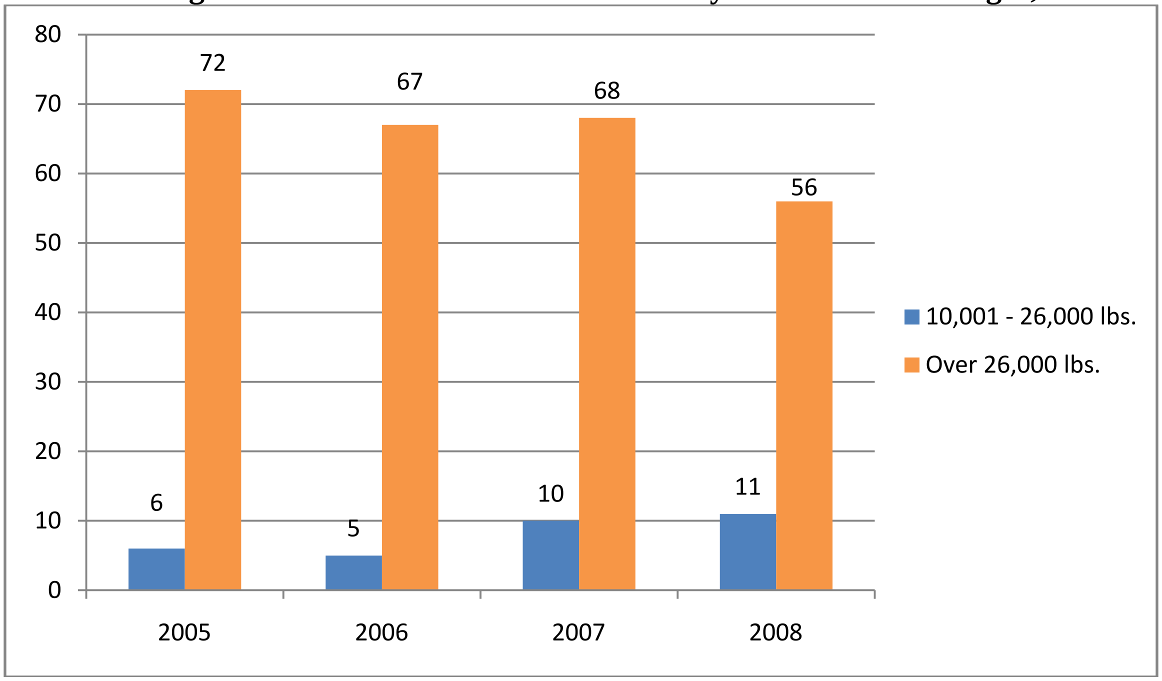


Exhibit 14 shows the numbers of large trucks involved in fatal crashes in Wisconsin by gross vehicle weight (GVW) from 2005 to 2008. Although trucks over 26,000 pounds accounted for the overwhelming majority of fatal crashes during the four years, their numbers appear to be declining. However, in the same period, the number of light truck crashes though small overall, increased significantly, doubling from 5 to 10 from 2006 to 2007, and increasing again to 11 in 2008.

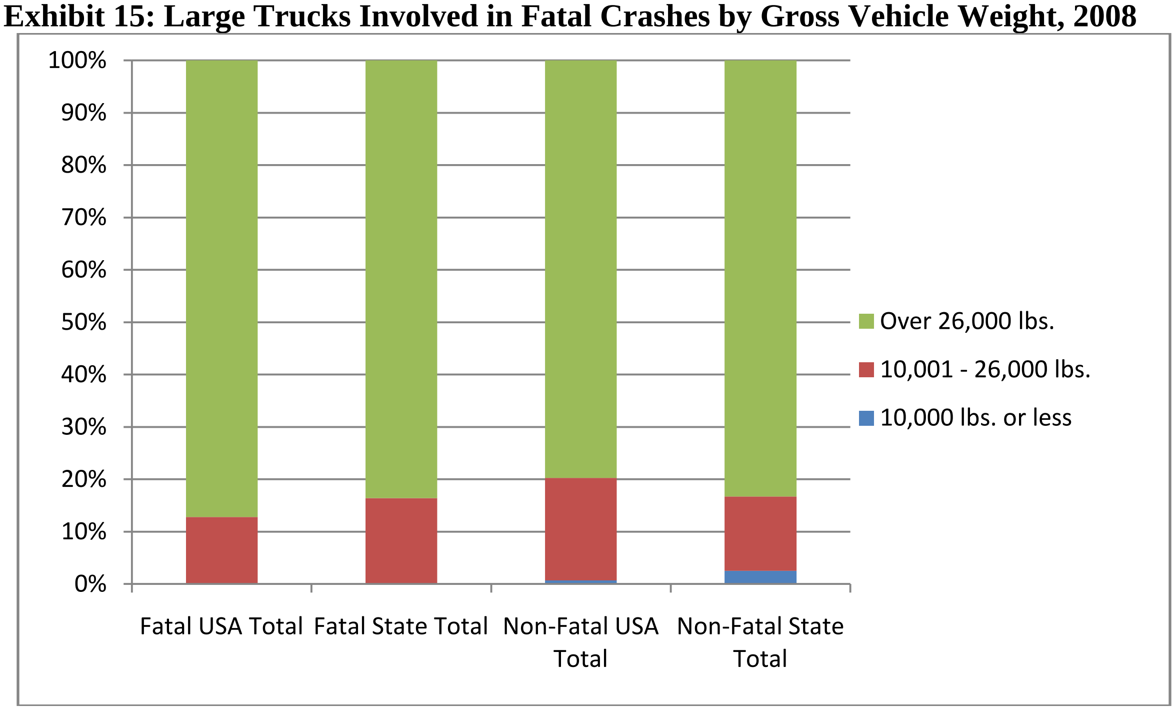
Exhibit 14: Large Trucks Involved in Fatal Crashes by Gross Vehicle Weight, 2005-2008



Source: FARS

Exhibit 15 compares the relative shares of large trucks involved in crashes by vehicle weight and fatality between Wisconsin and the U.S. as a whole in 2008. Wisconsin had a higher share of trucks over 26,000 pounds involved in fatal crashes, but a slightly lower share involved in non-fatal crashes. However, the relatively small share of trucks less than 10,000 pounds involved in non-fatal crashes in Wisconsin was higher than the U.S. average.

Exhibit 15: Large Trucks Involved in Fatal Crashes by Gross Vehicle Weight, 2008



Large Truck Data Identification and Analysis

The TOPS Lab conducted the identification and analysis of large truck data which primarily considers the sections of crash reports mostly completed by highway patrol officials. This crash report form, called MV-4000, includes a description of the crash scene, the people affected and the type of vehicles. For purposes of the LTS&E study, the MV-4000 provides a characterization of large vehicles involved in highway crashes that consequently are used for the development of a dataset targeting potential large trucks (equal or greater than 80,000 pounds) crashes through the state of Wisconsin. Other considerations during the selection process of large truck crashes involve the Wisconsin Statutes (WS) Chapter 348 which regulates the size, weight and load of large trucks on Wisconsin's highways in order to reduce the impact of these vehicles on the pavement surface. Information presented by the Wisconsin Statutes states that large trucks equal or greater than 80,000 pounds are required by law to use at least five axles to distribute the load to the pavement surface. This criterion contributed in the selection of large truck crash cases by minimizing the truck configurations to be targeted during the MV-4000 data filtering process. After considering a series of options available and constraints of the MV-4000 database, a methodology designed to extract the large truck crash data of interest was performed resulting in 19,939 crash cases between January 2005 and December 2009. An initial description of the final large truck crash dataset includes the distribution of crashes from three different perspectives: by severity, by county and severity, and overturn type crashes.

Incident Severity

The severity of large truck crashes is considered one of the main safety concerns due to the massiveness of these types of vehicles. To understand the severity distribution of large truck crashes in Wisconsin between 2005 and 2009, the dataset is divided in three categories describing the worst level of the crash severity to life and property. The results from this distribution that includes 19,939 cases are summarized next.

- Fatal crashes (K) were reported 236 times or 1 percent of the total. The amount of fatalities reported was 271 resulting in a rate of 1.15 fatalities per fatal incident.

- Injury crashes (A) were reported 4,795 times or 24 percent of the total. The amount of injuries reported was 6,818 resulting in a rate of 1.42 injuries per injury incident. The number of injuries that occurred in fatal crashes is not considered in this particular rate, only the injuries that occurred in injury crashes.

- Property damage only (PDO) crashes were reported 14,908 times or 75 percent of the total.

Moreover, the injuries reported are subdivided between three types of severity in order to understand the magnitude of the injuries caused by the large truck crashes. The results from this distribution of 4,795 cases are summarized next.

- Incapacitating injuries (type A) were reported 736 times or 15 percent of the total.

- Non-incapacitating injuries (type B) were reported 1,715 times or 36 percent of the total.

- Possible injuries (type C) were reported 2,344 times or 49 percent of the total.

These numbers represent the total injury incidents reported (do not represent the total number of person injuries) and are cataloged based on the worst level of the injury severity that occurred in the incident.

County and Incident Severity

Another approach used to describe the large truck dataset considers the county where the crash was reported and the severity related to each of these crashes. The purpose is to identify counties with higher incidence of large truck crashes within the state of Wisconsin. This analysis was used to help prioritize the surveys completed by CJ Petersen & Associates. The evaluation included 19,939 cases that were reported from 2005 to 2009. Due to limitations of the data, it was not possible to normalize the crashes reported in each county by the number of vehicle miles traveled (VMT). Consequently, the results of this analysis only shows the crashes per county, its distribution based on the severity reported in the MV-4000 and the normalization of the results by the total number of crashes reported in each of these counties. The highlights of the evaluation are shown next:

- Dane County and Milwaukee County are the locations with the first most and the third most number of large truck crashes, respectively. These results are expected considering these are the two biggest counties in Wisconsin.

- Moreover, other counties like Dodge (2nd), Columbia (4th), Jefferson (8th), Manitowoc (9th) and Marinette (10th) presents a higher rate of fatalities related to large truck crashes when the data is normalized by the total number of crashes in each County. This may be an indicator of higher hazards for large trucks in these counties compared to Dane and Milwaukee counties.

Overturn Type Crashes

The overturning of large trucks can generate potential safety impacts to the people involved in the incident, cause operational impacts to the highway facility and adjacent highways, and can affect the economy substantially due to delays and detours related to the crash scene. An evaluation of this type of crash serves to determine the truck configurations more susceptible to overturn based on MV-4000 data related to heavy vehicles which was provided by the Wisconsin Police Department. Also, the gross weight, body type and the number of axles of each truck involved in overturn type crashes contributes to the identification of large trucks that are prone to overturn in the state of Wisconsin. The dataset used for this analysis is delineated as presented next:

- The main dataset including the MV-4000 heavy vehicle data provided by the Wisconsin Police Department has a total of 17,201 cases of large truck crashes that were reported from August 2004 to December 2009.

- Only 5,030 cases provided a response to the most harmful event category; 12,171 cases did not report a response to the most harmful event.

- Considering the data available in the most harmful event category, 1,091 cases reported overturn type crash as the most harmful event during the incident.

After the identification of overturn type crashes within the large trucks dataset, the evaluation is concentrated on the following elements characterizing large trucks.

Vehicle Type or Configuration

The vehicle type or configuration describes the variety of large trucks involved in overturn type crashes. The purpose is to identify which are more prone to overturn based on data extracted from the MV-4000. Due to the merge of MV-4000 data from both sources the WisTransPortal and the Wisconsin Police Department, the vehicle type or configuration can be evaluated using either of two fields available in the dataset.

WisTransPortal – Vehicle Type

- 602 overturn type crashes or 55 percent of the total are related to truck tractor semi attached.
- Straight truck (insert truck) accounts for 362 of the cases or 33 percent of the total.
- The remaining percent of overturn type crashes are distributed between other types of trucks.

Wisconsin Police Department – Vehicle Configuration

- Truck tractor semi trailer accounts for 475 of the overturn type crashes cases or 44 percent of the total.
- Single unit trucks (2 axles, 6 tires) are related to 210 cases or 19 percent of the total.
- Single trucks (+3 axles) represent 148 cases or 14 percent of the total.
- Double and triple tractor trailers, which are expected to manage the heaviest load, accounts for 31 cases or 3 percent of the total.
- For 112 cases or 10 percent of the total the vehicle type is unknown.

Gross Weight

The gross weight of trucks included in this evaluation distributes the overturn crash data in the following categories:

- 407 of the overturn crash cases evaluated or 37 percent of the total are related to trucks over 80,000 lbs.
- 383 of the overturn cases or 35 percent of the total are related to trucks with a gross weight lower than 80,000 lbs.
- 301 of the overturn cases or 28 percent of the total does not reported the gross weight of the trucks considered in the dataset.

Body Type

The body type distribution of trucks involved in overturn type crashes are described in the following categories:

- 372 of the overturn crash cases in the dataset or 34 percent of the total are categorized as van/enclosed box.
- 161 cases or 15 percent of the total are categorized as dump trucks.
- 154 cases or 14 percent of the total are reported in the category of cargo tank truck.
- 165 cases or 15 percent of the total does not provide information related to the body type of overturn crashes.

Number of Axles

The overturn type crashes distributed by the number of truck's axles are presented to describe indirectly the weight of the trucks within the dataset:

- 503 of the overturn crash cases or 46 percent of the total are related to trucks with 5 axles.
- 260 cases or 24 percent of the total overturn type crashes involved trucks with less than 3 axles.
- Other trucks with six or more axles account for 53 cases or 5 percent of the total.
- For about 20 percent of the dataset (219 of 1,091 cases) the number of axle's data is unknown or was not reported.

Statistical Analysis of Large Truck Crash Severity

As part of the analysis of large truck crashes in the state of Wisconsin, the LTS&E study discuses a statistical approach about the severity of this type of incidents. The statistical analysis includes a dataset of 14,715 cases and considers the following truck categories: utility truck, straight truck (insert truck), truck tractor (not attached), truck tractor (semi attached), truck tractor (double bottom). The results respective to this analysis are based on crash-related variables that describe severity, driver conditions and environmental conditions.

Accident Severity	Weather Condition	Driver Factor
First Harmful Event	Light Condition	Driver behavior
Most Harmful Event	Road Condition	Vehicle Factor
Traffic Way	Vehicle Type	Highway Factor

A series of exploratory graphical methods, followed by classification tree and multinomial logistic regression were applied for the purpose of the analysis.

Large Truck Safety & Enforcement Survey

As part of the effort in developing the LTS&E study, C J Petersen & Associates, LLC conducted a survey focused on the identification of roadway segments within large truck routes that do not meet current design standards or policies, have a history of large truck operational problems/incidences, or have a strong likelihood of causing large truck bottlenecks and crashes based on past knowledge of similar problems. The survey was directed to county and state engineers through counties with high incidence of large truck crashes between August 2004 and December 2009 based on data analysis performed by the TOPS Lab. The survey was completed at ten of twenty-one counties that have the highest large truck crash rates.

Jackson County	Milwaukee County	Shawano County
Jefferson County	Monroe County	Sheboygan County
Juneau County	Outagamie County	Brown County
Manitowoc County		

Conclusions and Findings

The high-level comparative analysis of federal truck crash statistics suggests a number of conclusions regarding truck operations and safety in Wisconsin, including:

- The number of fatal CMV related crashes in Midwestern states is declining. In 1999, Wisconsin and the four surrounding states experienced a total of 551 CMV related fatal crashes; in 2009 that number had declined to 300, a decline of 46 percent in eleven years. In both 2000 Wisconsin had 91 fatal crashes involving large truck; just 48 in 2009. *In the eleven year time frame, Wisconsin's truck involved fatal crashes declined 33 percent; a decline of nearly 4 percent annually*.

- **Fatal CMV crash rates are declining as well:** The rate of crashes involving large truck per 100 million vehicle miles of travel (VMT) have been declining. *In Wisconsin the crash rate for CMV involved fatal accidents declined over the past six years from 1.7 fatal crashes per 100 million VMT to 1.0, a decline of 41 percent.*

- **Wisconsin is safer than the average with regard to truck crashes**: With the exception of Iowa, Midwestern states perform as well as, or better than average when compared to truck related crash rates for the U.S. as a whole (i.e., 0.15 nationwide). *In 2009, Wisconsin trailed only Michigan and Illinois in terms of the lowest CMV fatality rates in the Midwest.* The fatality rate for large truck crashes in Wisconsin is also lower than the national average. Based on an average based on a six year period, *Wisconsin's CMV fatality rate of .15 per 100 million VMT ranked 19th among all states and the District of Columbia.*

- **Single Unit Trucks Over-represented:** Several recent years of data comparing fatal and non-fatal CMV crashes in Wisconsin to national averages suggest that single unit trucks are over-represented in Wisconsin's large truck crash statistics. In particular, single unit trucks such as cement mixers and dump trucks appear over-represented in Wisconsin's large truck crash profile.

- **Crash prevalence toward rural collector routes**: Large truck crashes in Wisconsin are more prevalent in rural areas than they are nationally. *Over 70 percent of Wisconsin's* *large truck crashes took place in rural areas.* Rural collector roads saw the most truck crashes, and throughout the state trucks over 26,000 pounds were much more likely to be involved in fatal crashes.

Findings from second safety activity; the statistical analysis of large truck crash severity using MV-4000 crash records found:

- **Driver factors are significant**: Driver factor and driver behavior seem to be the most significant variables in determining the severity of crash incidents.

- **Some roadway conditions and geometrics are also significant**: The results also revealed that substandard features or obsolete designs of the roadway might lead to an increase of certain types of large truck crashes.

- **Crash severity not dependent on first harmful event**: No particular difference in crash severity was observed across different levels of most harmful event; although most of them are very significant. This might be due to the fact that in 73 percent of the sample no particular event tends to contributes to determining crash severity. Other considerations involving vehicle factors and highway factors were excluded from the model early in the analysis because their influence does not seem to vary across different levels of crash severity.

Key findings from the third safety activity; interviews conducted with county transportation officials included:

- **The safety analysis of large trucks is somewhat limited by data formats**: Oversize/Overweight commercial vehicle crash data is not separated from passenger vehicle crash data when analyzing cause, effect and solution.

- **The division of responsibility for truck safety is sometimes cloudy**: County representatives indicated that they are under contract to WisDOT to maintain the roads and access points at the intersections with state and interstate routes. They further stated that they do not have responsibility for design of the system and the access points.

- **Four counties declined to participate**: There were four counties that declined the invitation to participate in the survey, since this was either outside the scope of their jurisdiction or they do not have information to share regarding the design of the system in relation to crash rates. The counties were Dane, Racine, Brown and Grant.

- **Roundabout designs on the rise**: Roundabouts are being incorporated into design plans by Jefferson, Manitowoc, Milwaukee, Outagamie, Sheboygan and WisDOT SE Region for Milwaukee County. Specific routes were identified by respondents and are noted in this report. These counties are attempting to reduce traffic speeds through signage when it is warranted by the infrastructure.

- **Most counties feel driver decisions supersede design criteria in crash causation**: Driver error was mentioned as a primary cause of crashes rather than the infrastructure and the system they drive on.

Attachment 1

SYSTEM-WIDE LARGE TRUCK SAFETY ANALYSIS IN WISCONSIN

LARGE TRUCK CRASH DATA IDENTIFICATION AND ANALYSIS

By

Wisconsin Traffic Operations and Safety (TOPS) Laboratory
University of Wisconsin-Madison
Department of Civil and Environmental Engineering

SYSTEM-WIDE LARGE TRUCK SAFETY ANALYSIS IN WISCONSIN

LARGE TRUCK CRASH DATA IDENTIFICATION AND ANALYSIS

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1 SYSTEM-WIDE LARGE TRUCK SAFETY ANALYSIS IN WISCONSIN

The System-Wide Large Truck Safety Analysis in Wisconsin is expected to address the existing infrastructural deficiencies in the Wisconsin highway system by locating crash-prone locations. The characteristics of the targeted large trucks for this study are defined as a vehicle greater than or equal to 13 feet 6 inches in height, greater than or equal to 8 feet 6 inches in width, greater than 80,000 pounds and any truck at or longer than legal limits as allowed by Wisconsin Statutes chapter 348 for any and all legal length based on semi-tractor trailer combinations, that are operating with or without a permit in the state of Wisconsin and with or without exceptions as provided in either state statues or regulations. The project will focus on data collected during a five year period (2005 – 2009).

The first step is to identify the data that fit the large truck profile previously described. The main data collection results from the Wisconsin Motor Vehicle Accident Report Form (MV-4000) which are better known as the crash reports filled by the police officer in charge of the crash scene. The Traffic Operations and Safety Laboratory (TOPS Lab) at University of Wisconsin-Madison in collaboration with the Wisconsin Department of Transportation (WisDOT) and through the WisTransPortal (web database) provide a digital interface with MV-4000 from 1994 to present. The next section provides a couple of alternatives to filter the data from the crash reports in order to get the information of interest.

Large Truck Data Identification

To identify the data related to large trucks (80,000 lbs or more), a review of the MV-4000 crash report form and the Law Enforcement Officer's Instruction Manual for Completing the MV-4000 was conducted. The WisTransPortal Crash Data User Guide was reviewed to understand the codes and the format of the WisTransPortal web database. The Wisconsin Truck Size and Weight Study (Cambridge Systematics, 2009) was also used to include information relevant to large trucks and their weight/size relationship.

MV-4000 Field Review

During the review of the MV-4000 crash forms the following fields were considered as potential large trucks identifiers (Table 1)[**].

[**] Law Enforcement Officer's Instruction Manual for Completing the Wisconsin Motor Vehicle Accident Report Form (MV4000); WisDOT, Division of Motor Vehicles, 1998

Table 1 MV-4000 Field Review

Field	Description
21 – Unit Type	Identifies the type of unit involved in the crash. From the field options, Number 2 = Truck: Includes sport utility vehicle or van with truck registration, pickup and other utility truck, straight truck, fire truck, truck/tractor (not attached), semi-tractor/trailer or double bottom, motor home, etc.
35 – CMV	Commercial Motor Vehicle field separates this type of vehicles from non-commercial and motorcycles. If vehicle is within class A, B, C the field is marked by "Y". For purposes of this project, CMV Class A would be the target.
36 – Class (CMV Class)	From the field options, Class A: Any combination of vehicles with a GVWR over 26,000 lbs. provided the GVWR of the towed vehicle (s) is more than 10,000 lbs.  For purposes of this project, Large trucks over 80,000 lbs are part of this category.
57 – Plate Type	The standard 3 letter abbreviation for plate type. This field must coincide with the unit type in field 21 (previously presented).
143 – Gross Vehicle Weight Rating (GVWR)	Field to indicate the GVWR in pounds. Source: a) Manufacturer's specification plate in the driver's door area b) On the side of the vehicle c) Asking the driver For purposes of this project, This information field is the most specific in terms of GVWR and can be used once the dataset is partially filtered by the fields previously presented which can be done automatically. The use of GVWR field must be through a manual process.
144 – Total # Axes	Total number of axles on the truck or bus; includes the axles on the truck or bus, semi-trailers and trailers. For purposes of this project, This field can be compared with weight/size relationship table which is based on the number and type of axles.
145 – Vehicle Configuration	Selection of 1 vehicle concept which best describe the vehicle involved in the accident; 10 alternatives. For purposes of this project, Categories 6, 7 and 8 are more likely to fit the large truck profile of 80,000 lbs or more.

* GCWR = Gross Combined Weight Rating

** GVWR = Gross Vehicle Weight Rating

Wisconsin Statutes Chapter 348

After the review of the Wisconsin Statutes (WS) Chapter 348, it was identified information about truck vehicles which relates size, weight and load. The objective of this information is to regulate the size, weight and load in order to reduce the impacts of truck vehicles on the roadway pavements. A summary table which presents the adequate size and axle combinations to handle an 80,000 lbs truck within the regulations imposed by the WS Chapter 348 is presented below[††].

Table 2 Size, Weight and Load – Wisconsin Statutes Chapter 348

Axle Configuration	Distance between foremost and rear-most axles of a group (ft)	Weight (lbs)
5 consecutive axles of any combination of vehicles having a total of 5 or more axles	51 feet	80,000 lbs****
6 consecutive axles of any combination of vehicles having a total of 6 or more axles	43 feet	80,000 lbs
	44 feet	80,000 lbs
	45 feet	80,000 lbs
	46 feet	80,000 lbs
	47 feet	80,000 lbs
	48 feet	80,000 lbs
	49 feet	80,000 lbs
	50 feet	80,000 lbs
	51 feet	80,000 lbs****
7 consecutive axles of a 7-axle vehicle or of any vehicle or combination of vehicles having a total of 7 or more axles	34 feet	80,000 lbs***
8 consecutive axles of a 8-axle vehicle or of any vehicle or combination of vehicles having a total of 8 or more axles	25 feet	80,000 lbs
	26 feet	80,000 lbs
	27 feet	80,000 lbs
	28 feet	80,000 lbs
	29 feet	80,000 lbs
	30 feet	80,000 lbs
	31 feet	80,000 lbs
	32 feet	80,000 lbs**

** Maximum at 32 or more feet between axles
*** Maximum at 34 or more feet between axles
**** Maximum at 51 or more feet between axles

[††] Wisconsin Statutes Chapter 348, Vehicles – Size, Weight and Load; Wisconsin State Legislature, Legislative Reference Bureau; http://www.legis.state.wi.us/rsb/stats.html

Potential Configurations

The following large truck concepts are representing potential configuration of trucks with Gross Vehicle Weight Rating (GVWR) of 80,000 lbs or heavier[‡‡].

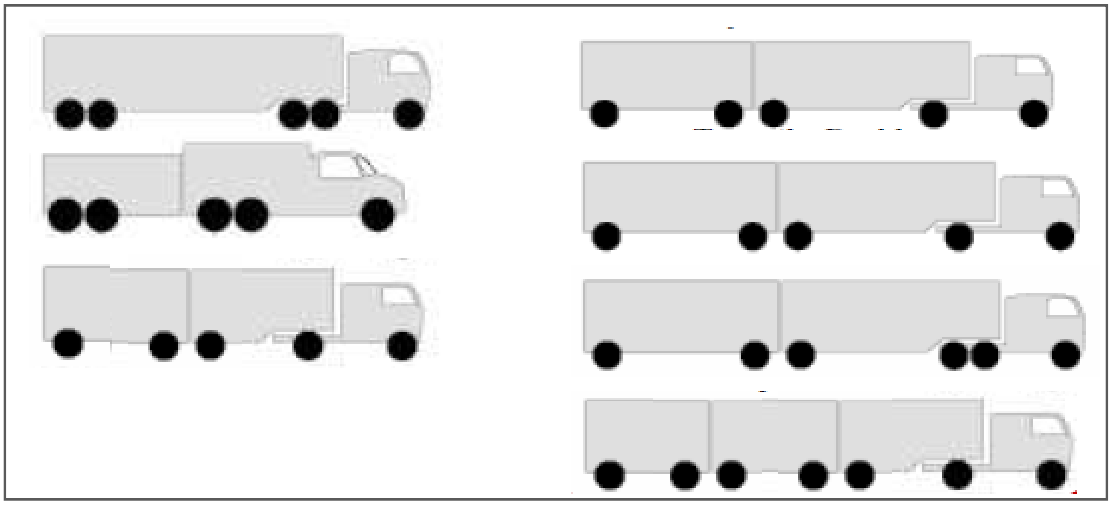


Figure 1 Large Truck Potential Configurations – WisDOT , 2008

Vehicles able to manage 80,000 lbs or more have at least 5 axles. For purposes of the study, this fact provides a guideline that can be used to filter the data from the MV-4000 by selecting the vehicle configurations (field 145) that fit 5 or more axles.

Summary of Permitting Practices for Commercial Vehicle Weights in Wisconsin

The following information was obtained from the Wisconsin Truck Size and Weight Study (Cambridge Systematics, Inc; 2009) and shows the regulations imposed by the State of Wisconsin on commercial vehicle weights[§§].

Table 3 State of Wisconsin Regulations on Commercial Vehicle Weight

	Category	**Weight (lbs)**
Wisconsin Maximum Routine Permit	Gross Vehicle Weight	130,000 lbs *
	Single Axle	35,000 lbs **
	Double Axle	65,000 lbs ***
****** Superload Permitting Procedure**		Yes

* 130,000 lbs is the GVW that triggers automated analysis by Structural Evaluation Program (SEP)
** 20,000 lbs maximum for steer axles
*** 55,000 lbs tandem axle loads are allowed on nondivisible multiple trip permits
**** "Superload" refers to loads that are exceptionally large or heavy and typically exceed OS/OW permitting standards

‡‡ Wisconsin Truck Size and Weight Study, Summary of Existing Truck Size and Weight Laws; WisDOT, 2008
§§ Wisconsin Truck Size and Weight Study, Final Report; Cambrigde Systematics, 2009

Preliminary Alternatives for the Identification of Large Truck Data

The background information and the crash data available for this study provides a guideline to follow in order to obtain the large truck crash data for the five year interval 2005 – 2009. This section shows the alternatives for the identification of this dataset.

Table 4 Alternatives for the Identification of Large Truck Data

Alternative	Description	Level of Detail
Filter the MV-4000 dataset by Class A	Filtering the data of the MV-4000 by Class A (field 36) provides a dataset of truck-related crashes with the following characteristics: • Any combination of vehicles with a GVWR over 26,000 lbs. provided the GVWR of the towed vehicle (s) is more than 10,000 lbs. Working with this data is an option for the study targeting a broader range of large trucks throughout the Wisconsin Highway System.	General large truck crash dataset; much broader than the initially proposed 80,000 lbs large truck crash dataset.
Filter the MV-4000 dataset by Class A and by Vehicle Configuration	Filtering the data of the MV-4000 by both Class A and vehicle configuration (field 145) provides a dataset more specific to larger truck crashes within the large truck data. The background information indicates that large trucks with configuration of 5 axles or more can manage 80,000 lbs Gross Vehicle Weight Rating (GVWR). The vehicle configuration section of the MV-4000 shows 10 different truck configurations where the categories 6, 7 and 8 are more likely to fit the 80,000 lbs large truck profile.	More specific large truck crash dataset concentrated in 3 categories of truck axle configuration.
Filter the MV-4000 dataset by Class A, by Vehicle Configuration and a manual evaluation of Gross Vehicle Weight Rating (GVWR)	Comparing with the previous alternatives, the addition for this alternative is a manual check of the GVWR (field 143). For this field, the police officer in charge of the accident scene directly fills the weight of the truck. This field cannot be read electronically and if can only be filtered by a manual process. It is unknown if this data is consistently completed by the police officer when the crash involves a truck vehicle. This task would take considerably more time than the previous alternatives but the results would be targeting more accurately vehicles of 80,000 lbs or heavier; as proposed in the project.	Highly detailed dataset targeting just large trucks of 80,000 lbs or heavier. More accurate dataset based on the objectives of the proposed study.

* MV-4000 dataset from WisTransPortal is the main data source for all the alternatives

2 SUMMARY OF LARGE TRUCK DATA

This section presents a summary of the Large Truck crash data extracted from the WisTransPortal used for the analysis of the large truck impact on highway safety in the state of Wisconsin. The data considered for this analysis includes all crashes reported from 2005 through 2009 years for a total sample of 19,939 cases. This sample is the result of a filtering process based on the available MV-4000 information related to the targeted large trucks and it is limited to the WisTransPortal database format.

Methodology – Extracting Sample of Interest

The methodology selected to narrow down the data in the WisTransPortal (crashes from 2005 through 2009) in order to extract the sample of interest was based on the flexibility and constrains offered by the database itself. To have a clearer idea about the data availability and the filtering options of the database, Steven Parker who is the TOPS IT Program Manager and the person responsible of the WisTransPortal's development and maintenance was consulted about the best way to extract the large truck data. During the discussion, the potential ways to narrow down the data in order to get closer to the targeted large trucks with a weight profile of 80,000lbs or higher were identified. As a result, Table 5 presents the steps that were applied to extract the sample of interest.

Table 5 Filtering Process Performed to Extract the Sample of Interest

Step	Filtering Flags	WisTransPortal Code	Cases	Description
1	CMV, Truck Flag, Trailer in Tow	CMVFLAG, TRKFLAG, TRLRFLAG	159,909	This filtering step provides crash data related to commercial vehicles, trucks and trailer in tow. These flags results in a broad sample of crash data from where the further filtering will derived. *WisTransPortal Filtering
2	Large Truck Flag	LRTRFLAG	35,066	The sample dataset is reduced to crashes flagged as large trucks (as defined by the WisTransPortal). The large truck category includes the following type of vehicles: • Straight Truck • Truck Tractor (Not Attached) • Truck Tractor (Semi Attached) • Truck Tractor (Double Bottom) *WisTransPortal Filtering

Step	Filtering Flags	WisTransPortal Code	Cases	Description
3	Vehicle Unit was Towing a Trailer	TRLRFLAG	19,939	The new sample considers only the cases where a truck unit is towing a trailer. The assumption behind the use of this flag is derived from the idea that large trucks without towing a trailer are far behind the weight-related selection criteria of 80,000lbs. *Excel Software Filtering
4	Crash Categorization	---------	19,939	Additional information attached to each of the 19,939 crash cases is used to categorize the data by crash severity. *Excel Software Filtering

Crash Severity Profile of Targeted Large Trucks

The crash severity profile of large trucks included in the sample of 19,393 cases was grouped in the following categories: Fatal (K), Injury (A) and Property Damage Only (PDO). This categorization was based on WisTransPortal data stored as "the worst level of the crash severity to life and property" (code ACCDSVR). In other words, the highway user involved in the collision with the highest severity condition defines the category adjudicated for each crash. In this analysis, the injury category considers all level of severities; Incapacitating (A), Non-incapacitating (B) and Possible (C).

Table 6 Severity of Targeted Large Truck Crashes (2005-2009)

Incidents by Highest Crash Severity			
Fatal	Injury	PDO	Total
236	4,795	14,908	19,939
Fatalities and Injuries Reported			
Category	Fatalities	Injuries	Total
Number	271	6,818	19,939
Number/Total	0.014	0.342	-----
Fatalities-Injuries/Fatal-Injury Incident	1.15	1.42	-----
Incidents Reported as Injury per Severity Type			
Injury	Type (A)	Type (B)	Type (C)
4,795	736	1,715	2,344
Percent	15%	36%	49%

* This analysis is based on the previously filtered dataset (2005 – 2009)

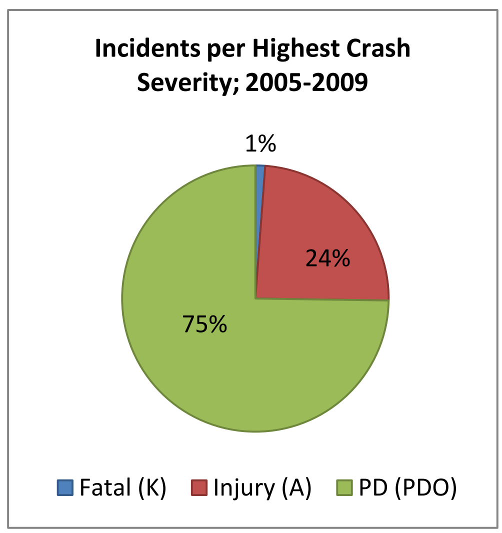


Figure 2 Distribution of Targeted Large Truck Crashes per Highest Severity Reported (2005-2009)

Table 6 presents the results obtained from this analysis. The analysis, including five years of data, showed that only one percent of the incidents reported was fatal while about one quarter were categorized as injury. The rest of the incidents (75%) resulted in property damage only.

Also, Table 6 presents the number of fatalities and injuries corresponding to the fatal and injury incidents reported during the timeline of this study. The rate of fatalities and injuries per the amount of cases evaluated are 0.01 and 0.34 respectively. This represents that one percent of the incidents related to the targeted large trucks presented a fatal scenario while 34% of the incidents reported some type of injury as the highest severity within the highway users involved in the crash. In terms of fatalities per fatal incidents and injuries per injury incident, the sample data recorded rates of 1.2 and 1.4 respectively. It is important to highlight that this injury rate include injuries that occurred in fatal crashes and consequently the rate is not exclusively of "injury severity" crashes. Contrary to this, the fatalities per fatal crash rate are exclusively because there is not a higher severity category to rank the incidents. During the timeline of this research (5 years), 7,089 highway users resulted physically affected during collisions related to the targeted large trucks. About 96% of the highway users had some type of injury and 4% lost their lives (Figure 3).

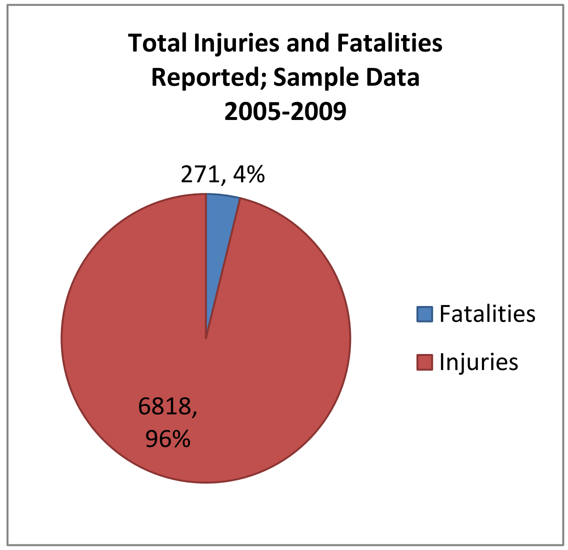


Figure 3 Total Injuries and Fatalities Reported; Sample Data (2005-2009)

Other results presented in Table 6 show the amount of incidents categorized as "injury severity" per magnitude of the injury; Incapacitating (A), Non-incapacitating (B) and Possible (C). It is important to mention that each injury incident type is defined based on the highest injury registered in the crash. These incidents represent the total injury incidents reported (do not represent the total injuries reported). About 15% of the incidents where the highest severity was an injury were identified as incapacitated (type A), 36%

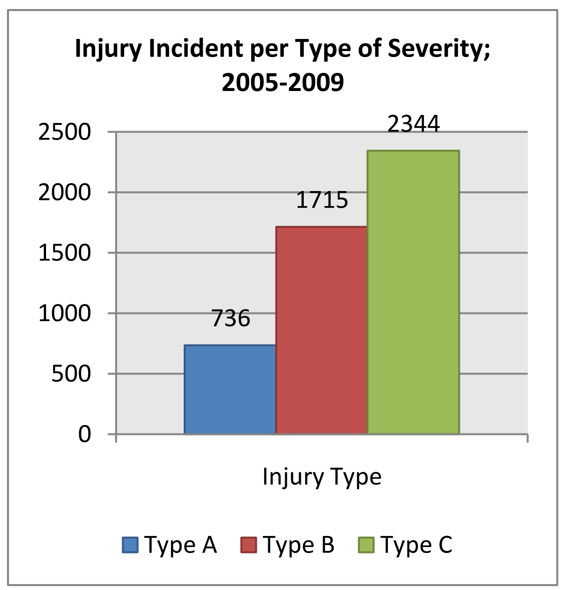


Figure 4 Injury Incidents per Type of Severity; Sample Data (2005-2009)

were reported as non-incapacitated (type B) and 49% were categorized as possible (type C). (Figure 4)

Summary of Large Truck Data by County and Severity

Table 7 Summary of Large Truck Data by County and Severity

Rank (K)	County #	County	Fatal (K)	Injury (A)	Property Damage	Total Crashes	K/Total Crashes	A/Total Crashes
1	13	Dane	13	404	1177	1594	0.008	0.253
2	**14**	**Dodge**	**12**	**100**	**248**	**360**	**0.033**	**0.278**
3	40	Milwaukee	11	793	2990	3794	0.003	0.209
4	11	Columbia	9	100	296	405	0.022	0.247
5	70	Winnebago	9	187	516	712	0.013	0.263
6	53	Rock	8	192	599	799	0.010	0.240
7	5	Brown	7	167	498	672	0.010	0.249
8	28	Jefferson	7	66	217	290	0.024	0.228
9	36	Manitowoc	7	47	193	247	0.028	0.190
10	38	Marinette	7	37	118	162	0.043	0.228
11	41	Monroe	7	77	214	298	0.023	0.258
12	51	Racine	7	181	413	601	0.012	0.301
13	58	Shawano	7	38	91	136	0.051	0.279
14	29	Juneau	6	82	197	285	0.021	0.288
15	16	Douglas	5	20	107	132	0.038	0.152
16	22	Grant	5	50	114	169	0.030	0.296
17	27	Jackson	5	47	167	219	0.023	0.215
18	44	Outagamie	5	107	324	436	0.011	0.245
19	56	Sauk	5	101	260	366	0.014	0.276
20	59	Sheboygan	5	58	242	305	0.016	0.190
21	67	Waukesha	5	248	848	1101	0.005	0.225
22	18	Eau Claire	4	93	263	360	0.011	0.258
23	30	Kenosha	4	144	359	507	0.008	0.284
24	37	Marathon	4	100	403	507	0.008	0.197
25	45	Ozaukee	4	54	162	220	0.018	0.245
26	64	Walworth	4	90	234	328	0.012	0.274
27	1	Adams	3	16	54	73	0.041	0.219
28	20	Fond Du Lac	3	98	278	379	0.008	0.259
29	23	Green	3	26	70	99	0.030	0.263
30	25	Iowa	3	28	73	104	0.029	0.269
31	47	Pierce	3	11	51	65	0.046	0.169
32	50	Price	3	5	29	37	0.081	0.135
33	66	Washington	3	120	331	454	0.007	0.264

Rank (K)	County #	County	Fatal (K)	Injury (A)	Property Damage	Total Crashes	K/Total Crashes	A/Total Crashes
34	68	Waupaca	3	35	120	158	0.019	0.222
35	9	Chippewa	2	42	131	175	0.011	0.240
36	10	Clark	2	43	120	165	0.012	0.261
37	12	Crawford	2	13	61	76	0.026	0.171
38	15	Door	2	9	37	48	0.042	0.188
39	21	Forest	2	9	25	36	0.056	0.250
40	32	La Crosse	2	54	334	390	0.005	0.138
41	39	Marquette	2	14	36	52	0.038	0.269
42	42	Oconto	2	35	57	94	0.021	0.372
43	46	Pepin	2	3	11	16	0.125	0.188
44	48	Polk	2	14	46	62	0.032	0.226
45	49	Portage	2	67	203	272	0.007	0.246
46	55	St. Croix	2	91	257	350	0.006	0.260
47	61	Treampealeau	2	40	88	130	0.015	0.308
48	62	Vernon	2	11	59	72	0.028	0.153
49	2	Ashland	1	10	33	44	0.023	0.227
50	3	Barron	1	21	64	86	0.012	0.244
51	4	Bayfield	1	7	18	26	0.038	0.269
52	17	Dunn	1	60	194	255	0.004	0.235
53	34	Langlade	1	14	29	44	0.023	0.318
54	35	Lincoln	1	19	59	79	0.013	0.241
55	43	Oneida	1	13	80	94	0.011	0.138
56	54	Rusk	1	8	25	34	0.029	0.235
57	57	Sawyer	1	12	28	41	0.024	0.293
58	63	Vilas	1	15	24	40	0.025	0.375
59	69	Waushara	1	40	92	133	0.008	0.301
60	72	Wood	1	71	201	273	0.004	0.260
61	6	Buffalo	0	16	25	41	0.000	0.390
62	7	Burnett	0	5	15	20	0.000	0.250
63	8	Calumet	0	27	90	117	0.000	0.231
64	19	Florence	0	3	12	15	0.000	0.200
65	24	Green Lake	0	9	31	40	0.000	0.225
66	26	Iron	0	5	6	11	0.000	0.455
67	31	Kewaunee	0	10	11	21	0.000	0.476
68	33	Lafayette	0	20	35	55	0.000	0.364
69	52	Richland	0	17	35	52	0.000	0.327
70	60	Taylor	0	10	23	33	0.000	0.303
71	65	Washburn	0	13	50	63	0.000	0.206
72	73	Menominee	0	3	7	10	0.000	0.300
Total	**-----**	**-----**	**236**	**4,795**	**14,908**	**19,939**	**-----**	**-----**

The crash sample profile was analyzed by county in order to identify which areas are being more susceptible to large truck crashes within the state of Wisconsin. Milwaukee and Dane counties showed the highest amount of crashes with 3,794 and 1,594 cases respectively. A surprising fact is the fatal crash number recorded in Dodge County ranked as second most within all the counties and shares the top three places in this category with the biggest counties in Wisconsin; Dane (1st) and Milwaukee (3rd). The data summary shown in Table 7 was extracted from information stored in the WisTransPortal crash database and related to crashes where large trucks were involved. This table is ordered through a ranking which considers the number of fatalities reported per County within the limits of the dataset.

Figure 5 shows a graphical representation of the injury (A) and property damage (PD) incidents per County reported within this dataset while Figure 6 shoes the fatal (K) incidents for the same conditions. The numbers in the horizontal axis are linked to the County number presented in Table 7.

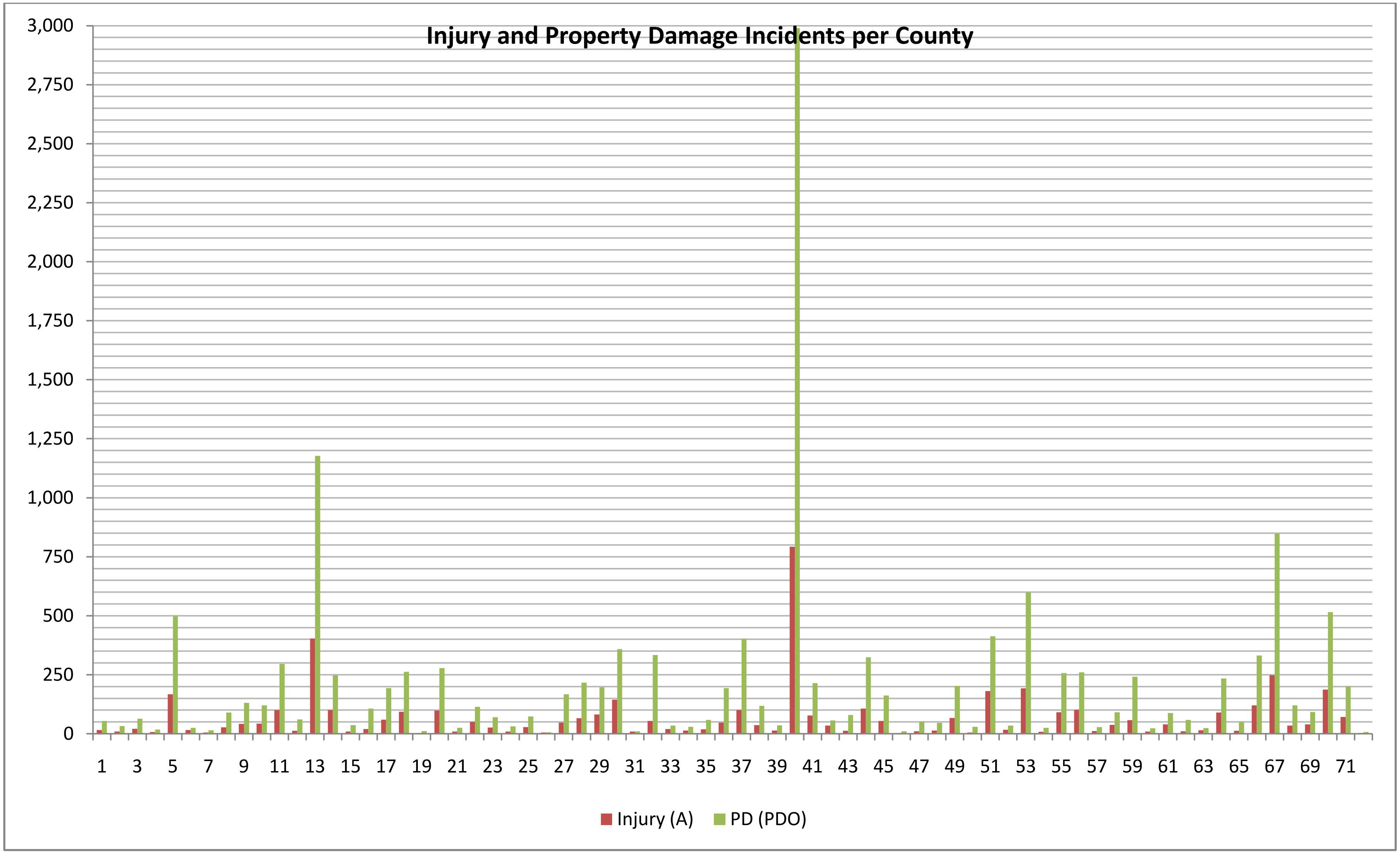


Figure 5 Injury and Property Damage Incidents per County

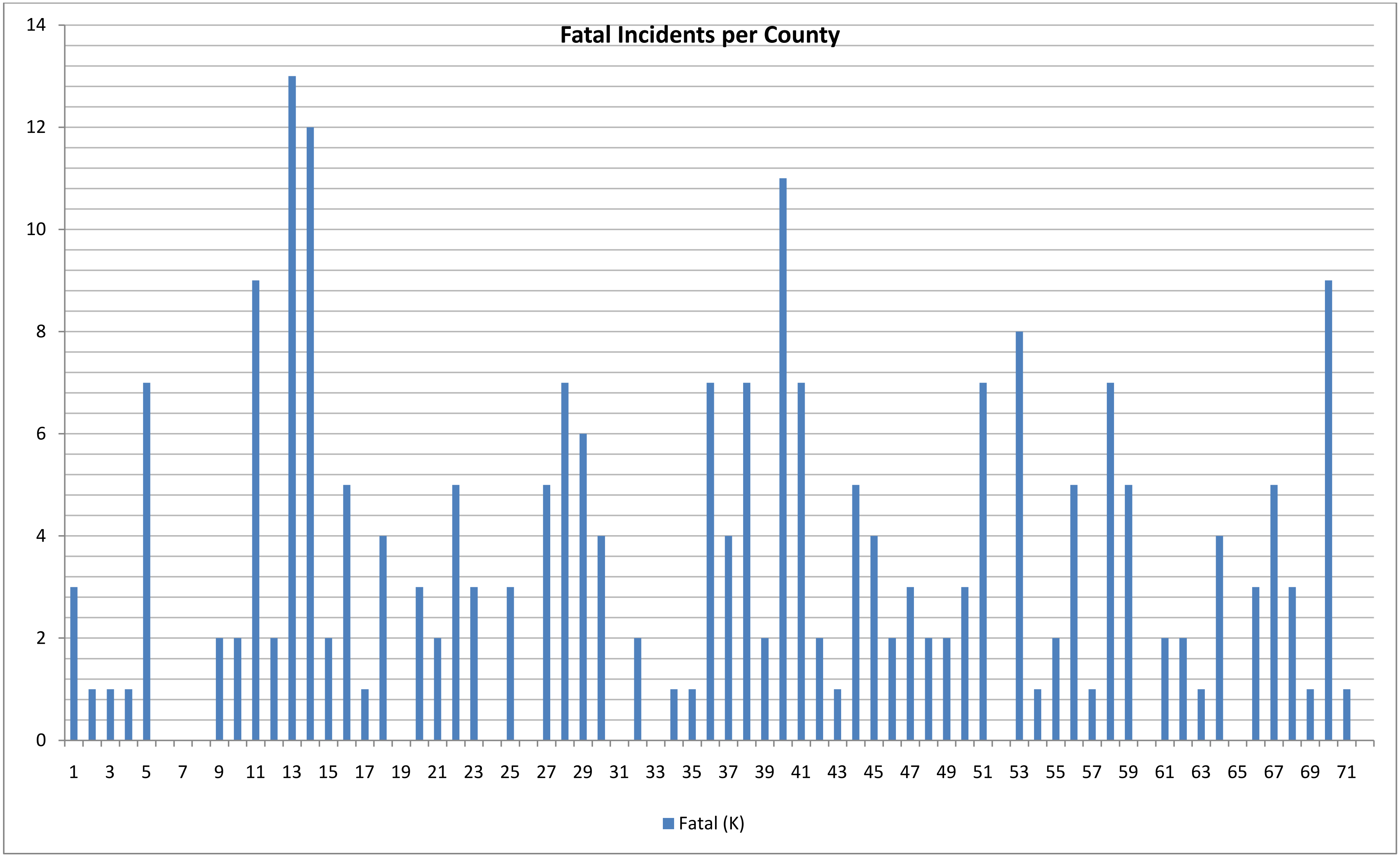
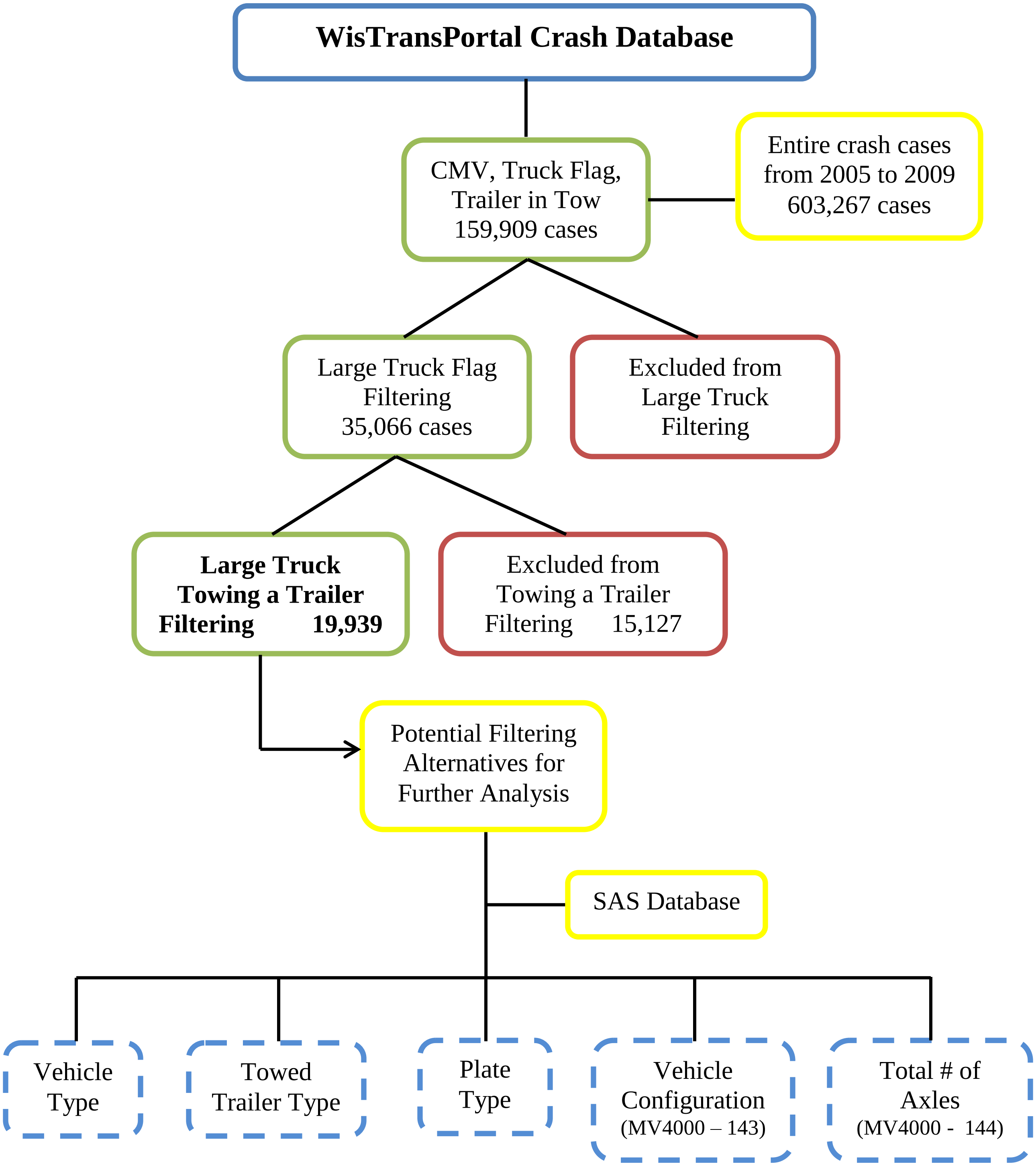


Figure 6 Fatal Incidents per County

WisTransPortal Crash Data Filtering Flowchart



Overturn Type Crashes

A Summary from the Large Truck Crash Data Sample

The evaluation of crashes involving large trucks within the Wisconsin's highway system is fundamental in order to identify potential factors involved in these types of crashes. It is also necessary to understand the safety impacts of large truck vehicles on other users of the system. One of the most impacting large truck incidents is related to overturn type crashes. This is not only significant on generating injuries and fatalities; it also produces a chaining effect of negative events like congestion, contamination (hazardous materials), cost of damaged public and private property, and the economic impact due to delays.

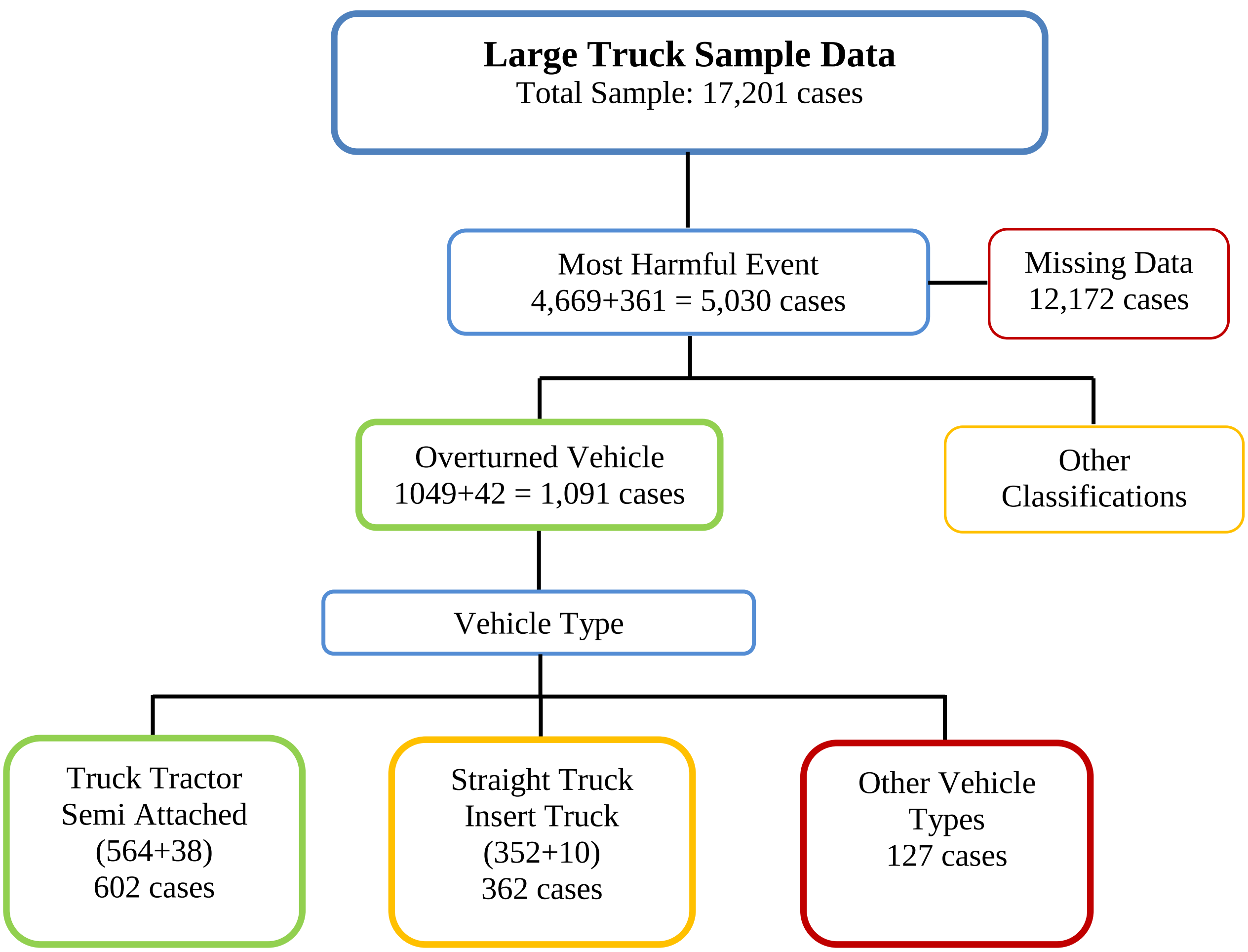
To understand these and other effects caused by overturn type of large truck crashes, it was necessary to perform a data filtering process based on overturn-related incidents. This process was derived from the large truck dataset previously obtained from the WisTransPortal and the Wisconsin State Police; both sources are supported by the MV-4000 crash report forms used to document highway crashes in Wisconsin. The data filtering process is described as the following:

- Sample Data of Large Truck Crashes – it is a large truck sample data previously developed considering a series of large truck characteristics like gross weight, number of axles, truck's body type, and vehicle configuration. This sample data includes 17,201 cases of large truck crashes reported in Wisconsin from August 2004 to December 2009.
- Most Harmful Event – the first data filtering step is based on the most harmful event per vehicle reported on the MV-4000 (MOSTHARM1, MOSTHARM2). This category is distributed through a series of descriptions characterizing the event that caused more damage during the collision sequence; including overturn type crashes. From the 17,201 cases in the large truck sample data, only 5,030 cases provided a response to the most harmful event category; 12,172 cases missing.
- Overturn Vehicle – the second step consist on a data filtering used to extract only the cases where the most harmful event was reported as overturn. From the 5,030 cases with data available, only 1,091 cases identified overturn as the most harmful event. During the filtering, the coding MOSTHARM1 and MOSTHARM2 were considered to account for overturning events related to vehicle one (1), vehicle two (2) or both. Additional considerations were applied to avoid duplicity of cases.
- Additional Filtering

- Vehicle Type – it distributes the overturn type crashes in three (3) groups based on data coding VEHTYPE1 and VEHTYPE2. The results showed that truck tractor semi attached (TRK SA) was the most common truck overturned (602 cases) followed by the straight truck (TRK ST, 362 cases) based on the sample data.
- Gross Weight – it groups the overturn type crashes by weight. The category used for this filtering is coded as GVWRLBS. From the information available on the gross weight category, 407 of the overturn cases were related to trucks over 80,000 lbs, 383 cases were lower than 80,000 lbs and data was missing on 301 of the cases.

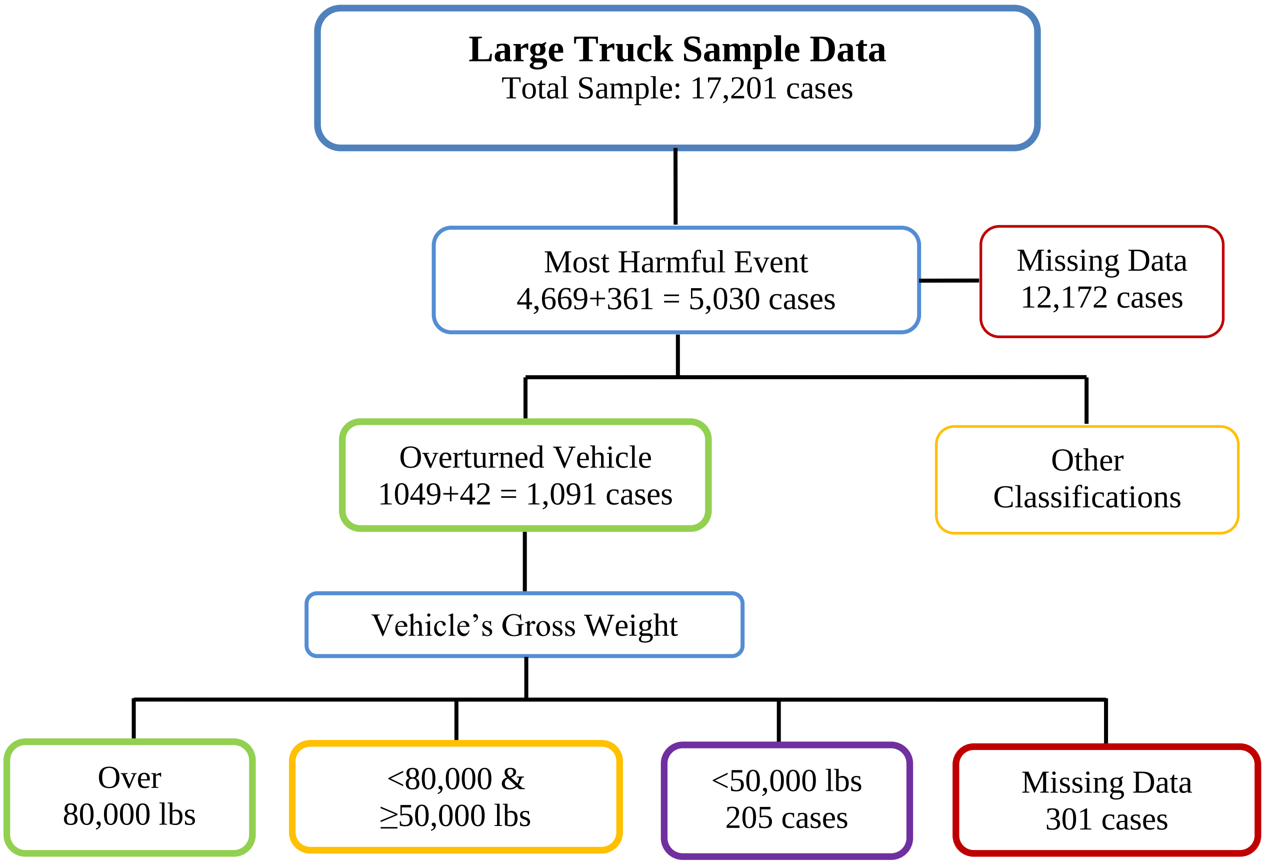
Sample of Overturn Type Crashes

Vehicle Type Category – WisTransPortal Database



Sample of Overturn Type Crashes

Gross Weight Category – Wisconsin State Police Database



Sample of Overturn Type Crashes

Overturn Crashes by Body Type – Large Truck Sample Data

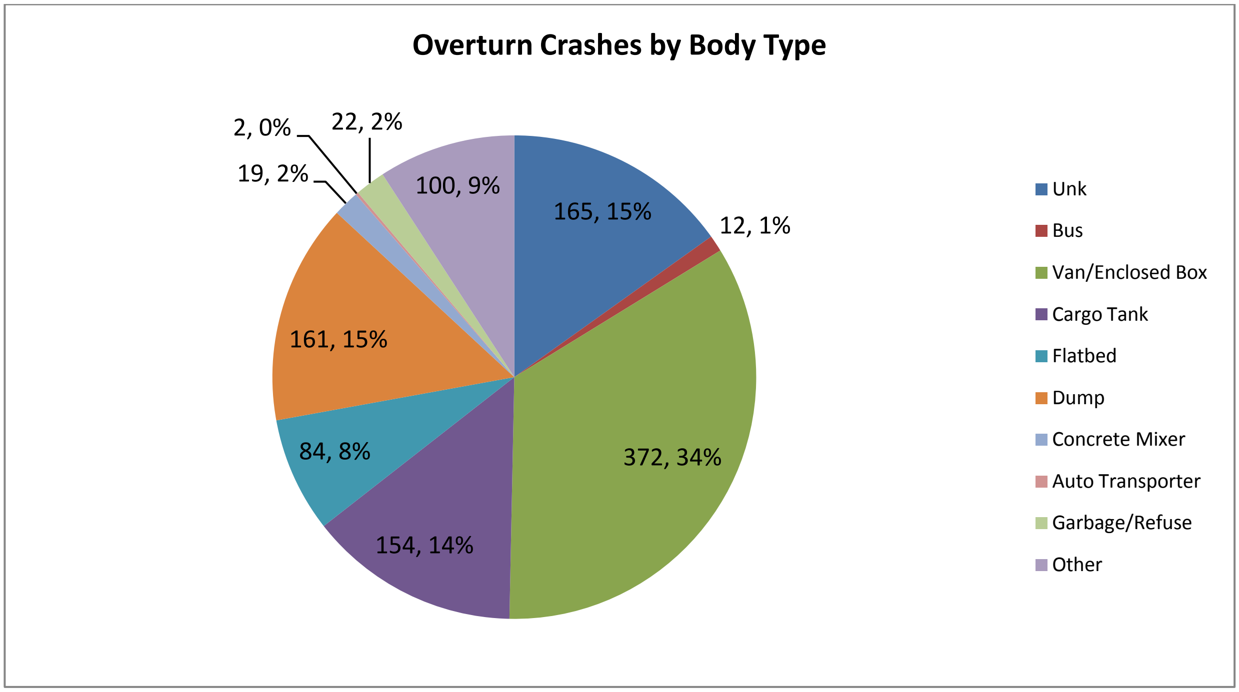


Figure 7 Overturn Crashes by Body Type – Large Truck Sample Data (Wisconsin State Police Database)

Overturn Crashes by Vehicle Configuration – Large Truck Sample Data

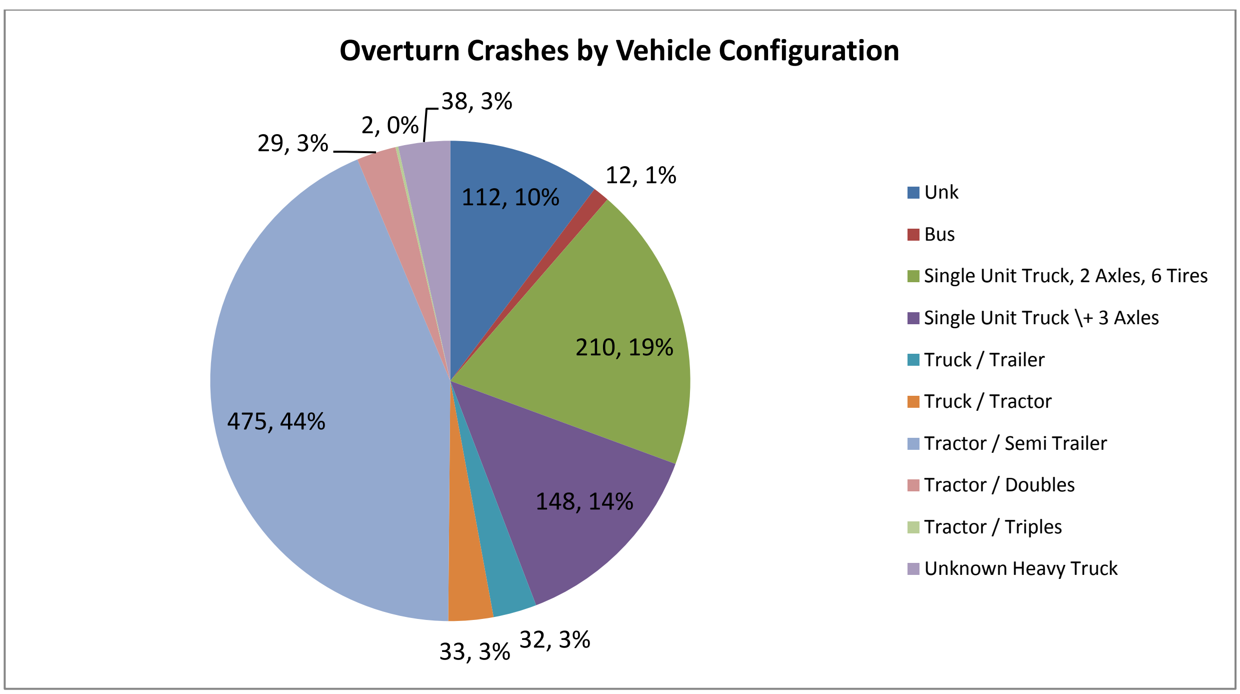


Figure 8 Overturn Crashes by Vehicle Configuration – Large Truck Sample Data (Wisconsin State Police Database)

Sample of Overturn Type Crashes

Overturn Crashes by Gross Weight – Large Truck Sample Data

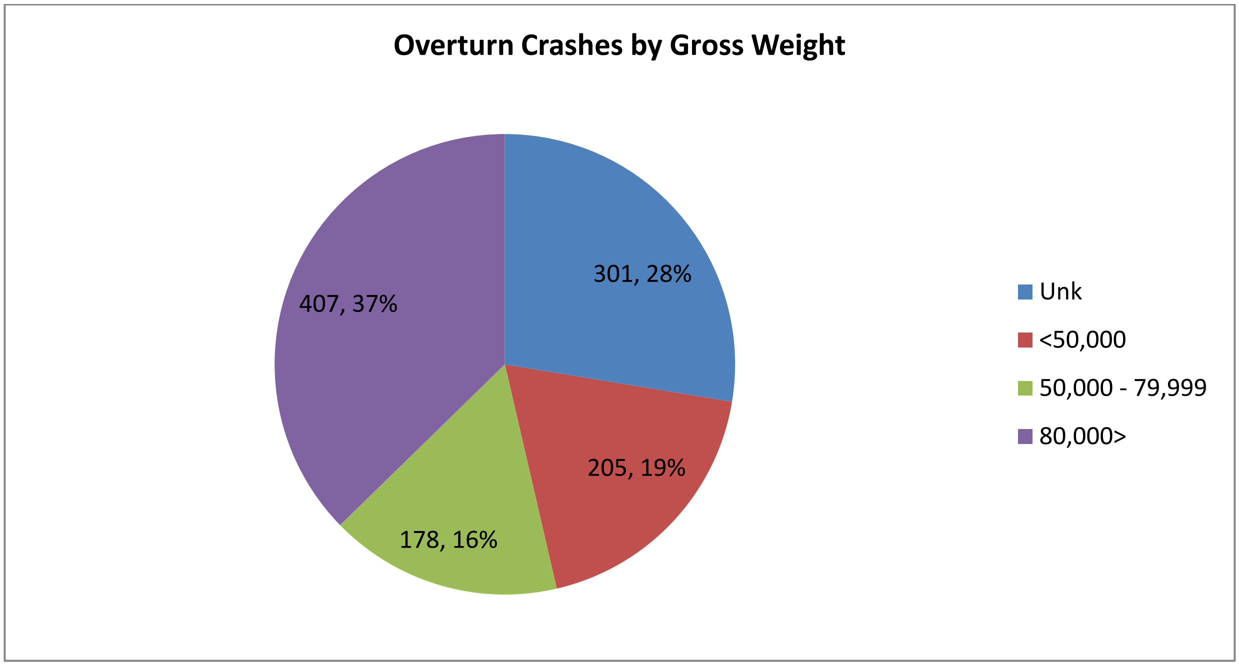


Figure 9 Overturn Crashes by Gross Weight – Large Truck Sample Data (Wisconsin State Police Database)

Overturn Crashes by Number of Axles – Large Truck Sample Data

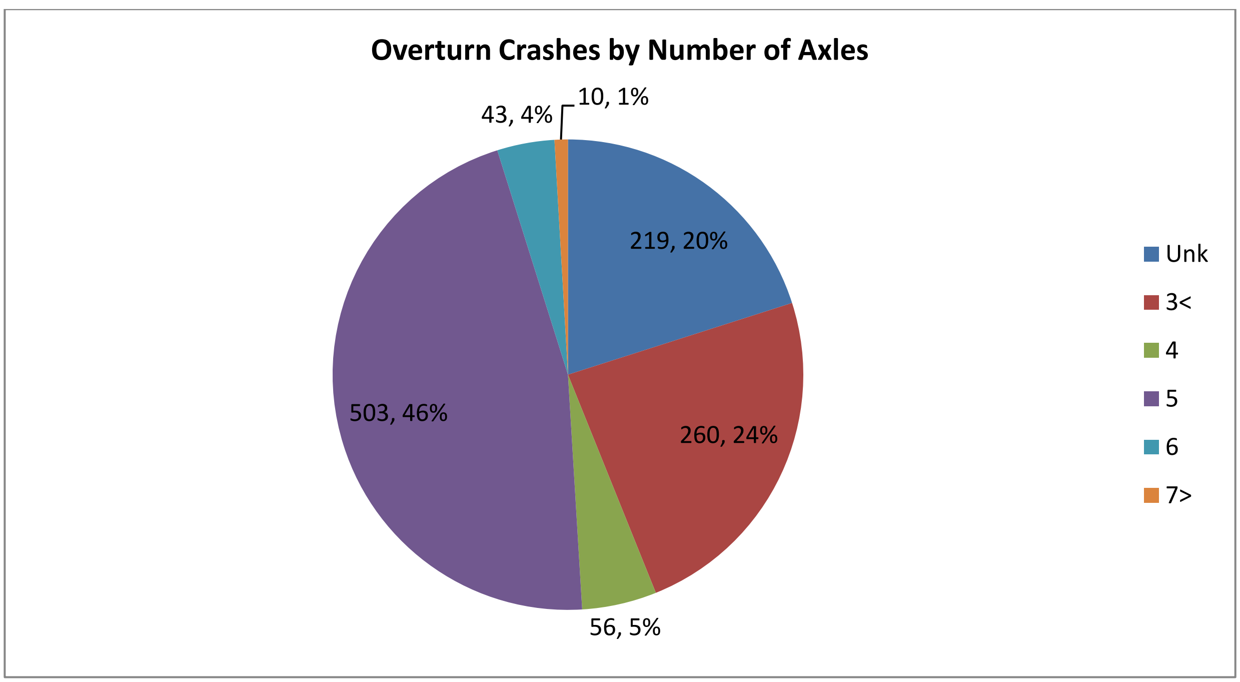


Figure 10 Overturn Crashes by Number of Axles – Large Truck Sample Data (Wisconsin State Police Database)

STATISTICAL ANALYSIS OF LARGE TRUCK CRASH DATA

Introduction

The goal of the analysis is to identify factors that determine the severity of large-truck related crashes. When a crash is reported, police officers are required to fill out the crash report form when there is property damage of more than $1,000 or an injury or fatality occurs that contains a set of information regarding the nature of the crash, factors that are related to vehicle(s) and driver(s) involved in a crash and geometric characteristics of roadway as well as the natural surroundings at the point of the crash.

Of the data sampled from August 2004 until December 2009, 14,715 crashes of which one (or more) of the vehicles involved is large-truck are considered for the analysis. Large-trucks are defined as vehicles that belong to the following categories: Utility truck, straight truck (insert truck), truck tractor (not attached), truck tractor (semi attached), truck tractor (double bottom). Crashes are classified into one of the five groups with respect to severity; Fatality, Injury A/B/C, and Property Damage Only.

To identify factors that best predict the severity of large-truck related crashes, several variables associated with the crash incident, such as first harmful event, most harmful event, vehicle factor, driver factor, driver behavior, roadway characteristics, highway factor, road condition, weather condition, and light condition were pulled from the police reports. Detailed explanation of variables that are used in the analysis is compiled into Table 8.

Table 8 Description of Variable

Variable Name	Description	Categorization
Accident Severity (Response)	Severity classified into five categories.	a) Fatality b) Injury_A c) Injury_B d) Injury_C e) Property Damage Only
First Harmful Event (Type 2)	Event that started the course of crash.	a) Moving vehicle in transport b) Bridge/Guardrail/Median Barrier/Other Attenuator c) Culvert/Curb/Ditch/Embankment d) Blank e) Other collision with fixed object f) Other collision with non-fixed g) Other non-collision h)Overturn i) Traffic sign and signal post/Other pole and post/Tree
Most Harmful Event(*) (Harm)	Event that most severely caused the damage to the vehicle	Categorized same as the first harmful event

Variable Name	Description	Categorization
	and/or to the driver.	
Weather Condition (WeatherCond)	Weather at the point of crash.	a) Cloudy/Fog b) Clear c) Rain d) Sleet/Snow e) Unknown/Other/Blank f) Wind/xWind
Light Condition (LightCond)	Light condition at the point of crash.	a) Blank/Unknown b) Dark c) Dawn or Dusk d) Light
Road Condition (RoadCondition)	Condition of the road at the point of crash.	a)Blank/Other/Unknown b) Ice c)Mud d) Snow e) Wet
Traffic Way (TrafficWay)	Geometric characteristics of the roadway.	a) Divided w/barrier b) Divided w/o barrier c) Non-divided d) One-way e) Unknown/Blank/Other
Driver Factor(*) (DRVRF)	Specific driver factor that may have contributed to the crash incident.	a) Driver condition/Physically disabled/Other b) Fail to have control c) Improper turn/overtaking/unsafe backing d) Inattentive driving/Disregarded Traffic Control e) Exceeding speed limit/Speed too fast f) Too close/Left of center g) Fail to Yield right of way
Driver behavior(*) (DRVRDO)	Driving maneuver taken at the point of crash.	a) Backing/Parking maneuver b) Changing lane/Merging c) Negotiating curve/Overtake left or right d) Other/blank/(Il)legal parking/Violating NPZ e) Right turn f) Slow/Stopping/Stop in traffic g) Straight h) Turn on red/Left turn/U-turn
Vehicle Type(*)	Type of vehicle involved in a crash.	
Vehicle Factor(*) (VEHFC)	Specific vehicle factor that may have contributed to the crash incident.	1) Brake 2) Blank/Other 3) Tire
Highway Factor (HWYPC)	Factors that may have contributed to the crash incident - Binary flags indicate whether or not such factor exists.	1) Construction zone flag 2) Visibility flag 3) Snow/Ice/Wet (SIW) flag 4) Debris flag 5) Geometric abnormality (Geom) flag

Often times, there were two vehicles involved in a crash, and in such cases, some of the information was gathered on both of the vehicles. If there are more than two vehicles involved in a crash, third and subsequent vehicles are omitted from the police crash reports. Variables with the asterisk (*) indicate those that have entries for both of the vehicles involved. It is, however, important to distinguish which vehicle provides more relevant information with respect to the crash process to base our analysis upon. Since this research is interested in crashes related to large truck, the information gathered from one of the vehicles that is a large-truck, was chosen to be used in the ensuing analysis, if there was such a conflict.

Preliminary Analysis

For exploratory purposes, graphical analysis was conducted and presented along with two-way frequency table of crash severity (response) and each predictor variable. The histograms of response, which is the severity of crash, was first presented in Figure 11, followed by bar charts of crash severity in Figure 12 through Figure 15.

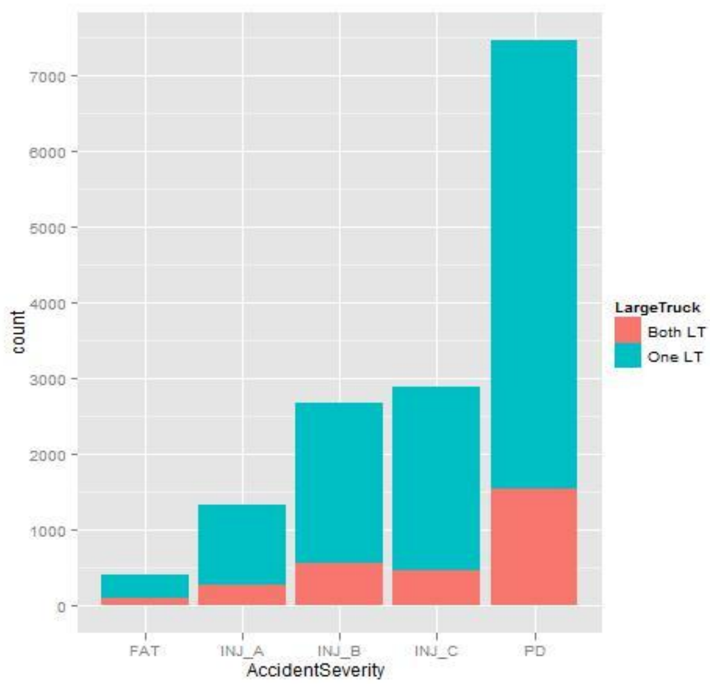


Figure 11 Distribution of Crash Severity (Blue indicates that only one of the vehicles involved in a crash is a large truck, whereas pink indicates that both of the vehicles are large truck)

First of all, the distribution of crash severity is featured by the histogram. As one can easily predict, property damage only (PDO) comprises most of the crashes: 7,748 out of the 14,715 samples (50.61%) are PDO, whereas Injury C takes up 19.52%, Injury B 18.17%, Injury A 9.03% and Fatality constitutes 2.67% of the total sample. Different colors were applied to indicate whether the vehicles involved in the crash were both large-trucks or only one of them is. Other than Injury_C, the proportion of incidents where both of the vehicles involved in the crash are large trucks seems pretty consistent and therefore an indicator of whether both of the vehicles are large trucks or not is unlikely to be a significant predictor of crash severity.

Categories of fatality and Injury_A, Injury_B and Injury_C were combined later in the classification tree analysis in order to correct some imbalance in sample sizes. Since the tree algorithm continues to classify samples into sub-samples and the information is derived from the classification criteria, if the classification on a specific category stops earlier than others because of significantly less sample size, relatively less information is drawn about a category with smaller sample size. Classification tree is known to be biased toward larger sample size in that regard. Here, more interest lies in identifying factors that contributes to fatal or more severe types of crashes than PDO or less severe ones that some degree of correction seemed needed. Besides, the crash dynamics that result in fatality and those that cause the most severe type of injury might be similar, validating the argument of combining categories. Same logic may extend to combining Injury B and C.

Each of the categorical predictors (First harmful event, most harmful event, weather condition, light condition, road condition, traffic way, driver factor and driver behavior) was analyzed across crash severity, by the two-way contingency table and bar charts. The bar charts of Vehicle factor and Highway factors that are binary indicators are not reported as they have many missing values and turned out to be less informative about the nature of the crash incidents. Bars on each levels of crash severity are filled with a number of colors, with different colors indicating different levels of specific predictor. Bar charts are reported in Figure 12 through Figure 15. If the distribution of a specific predictor variable is different across different levels of crash severity, it is likely to be a potential predictor in determining the crash severity. On the other hand, if there is no difference in distribution of categorical predictors across different levels crash severity, it is unlikely to provide any additional information in predicting crash severity. For example, if the same proportion of fatal crashes occurred in snowy road condition as that of injury – A/B/C or PDO crashes, it is hard to argue that snowy road condition is more likely to cause any specific type of crashes. Thus, if the distribution of categorical predictor is more or less the same across different levels of crash severity, the variable is less likely to be significant in predicting crash severity.

(a) First harmful Event

Table 9 First Harmful Event – Statistical Analysis

Category	Fatality		Injury – A		Injury - B		Injury – C		PDO	
Bridge/Guardrail/ Median Barrier/	8	0.0204	63	0.0474	85	0.0318	89	0.0310	305	0.0409

Category	Fatality		Injury – A		Injury - B		Injury – C		PDO	
Other Atten										
Culvert/Curb/ Ditch/Emkmt	9	0.0229	32	0.0241	118	0.0441	86	0.0299	337	0.0452
Traffic sign/post and poles	1	0.0025	30	0.0226	59	0.0221	75	0.0261	291	0.0391
Other collision w/ fixed	2	0.0051	13	0.0098	24	0.0090	32	0.0111	99	0.0133
MVIT	333	0.8473	1035	0.7788	2016	0.7542	2295	0.7991	4799	0.6443
Other collision w/non - fixed	26	0.0662	62	0.0467	124	0.0464	104	0.0362	582	0.0781
Overturn	7	0.0178	73	0.0549	204	0.0763	140	0.0487	406	0.0545
Other non - collision	7	0.0178	21	0.0158	43	0.0161	51	0.0178	629	0.0845
Total	393	1.0000	1329	1.0000	2673	1.0000	2872	1.0000	7448	1.0000

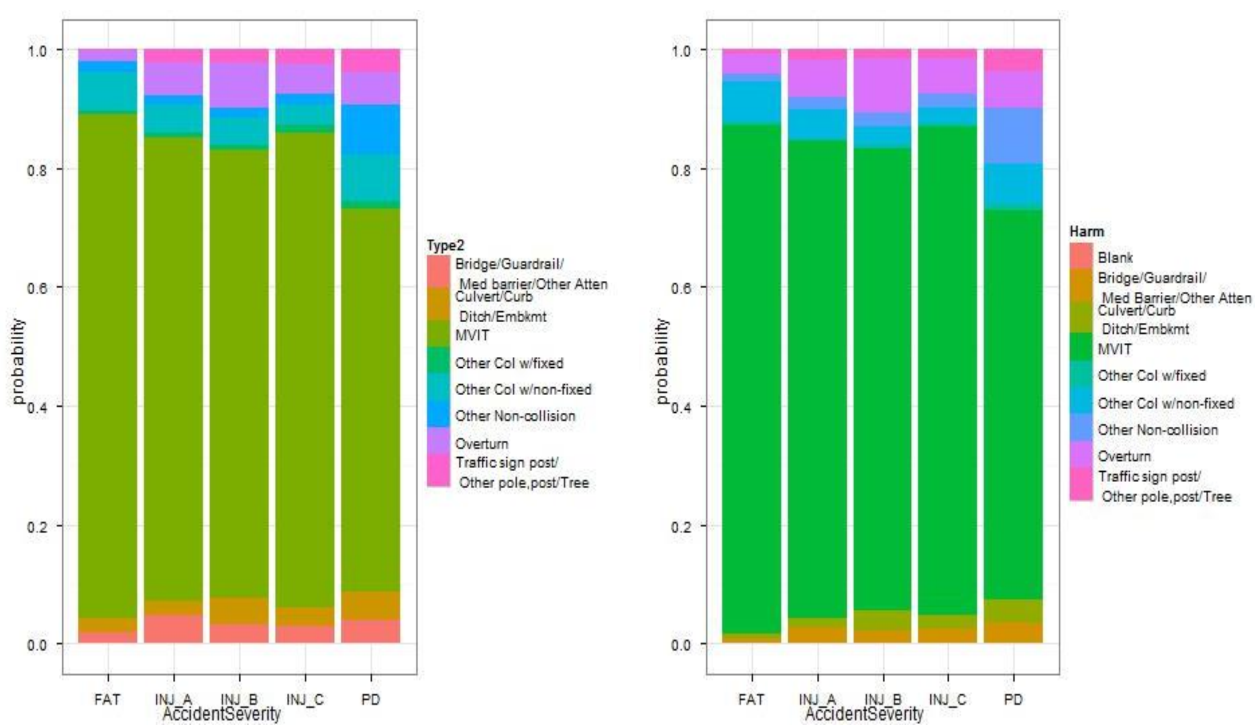


Figure 12 Probability bar chart of crash severity partitioned by different levels of first harmful event (left) and most harmful event (right)

(b) Most Harmful Event

Table 10 Most Harmful Event – Statistical Analysis

Category	Fatality		Injury – A		Injury - B		Injury - C		PDO	
Blank	0	0.0000	2	0.0015	3	0.0011	6	0.0021	15	0.0020
Bridge/Guardrail/ Median Barrier/	4	0.0102	35	0.0263	59	0.0221	62	0.0216	250	0.0336

Category	Fatality		Injury – A		Injury - B		Injury - C		PDO	
Other Atten										
Culvert/Curb/ Ditch/Emkmt	3	0.0076	21	0.0158	84	0.0314	68	0.0237	278	0.0373
Traffic sign/ post and poles	3	0.0076	23	0.0173	38	0.0142	48	0.0167	270	0.0362
Other collision w/ fixed	2	0.0051	5	0.0038	20	0.0075	15	0.0052	85	0.0114
MVIT	336	0.8550	1065	0.8014	2078	0.7774	2359	0.8214	4885	0.6559
Other collision w/non - fixed	27	0.0687	67	0.0504	83	0.0310	81	0.0282	502	0.0674
Overturn	13	0.0331	83	0.0624	247	0.0924	167	0.0581	476	0.0639
Other non - collision	5	0.0127	28	0.0211	61	0.0228	66	0.0230	687	0.0922
Total	393	1.0000	1329	1.0000	2673	1.0000	2872	1.0000	7448	1.0000

The data shows that fatal crashes are more likely to happen at collision with moving vehicle in transport (MVIT), whereas they are less likely to occur at non-collision, including overturn. Especially in the case of PDO, about 15% of the crashes are associated with non-collision, including overturn, when about 66% crashes are involved with MVIT.

(c) Weather Condition

Table 11 Weather Condition – Statistical Analysis

Condition	Fatality		Injury – A		Injury - B		Injury - C		PDO	
Cloudy	132	0.3359	370	0.2784	805	0.3012	927	0.3228	2211	0.2969
Clear	193	0.4911	601	0.4522	1226	0.4587	1319	0.4593	3231	0.4338
Fog	12	0.0325	26	0.0196	49	0.0183	40	0.0139	77	0.0103
Rain	17	0.0433	63	0.0474	214	0.0801	221	0.0769	465	0.0624
Sleet	2	0.0051	15	0.0113	237	0.0769	30	0.0104	107	0.0144
Snow	37	0.0941	234	0.1761	304	0.1045	304	0.1058	1229	0.1650
Unknown/ other/ blank	0	0.0000	4	0.0030	5	0.0019	2	0.0007	31	0.0042
Wind/ xwind	0	0.0000	16	0.0120	33	0.0123	29	0.0101	97	0.0130
Total	393	1.0000	1329	1.0000	2673	1.0000	2872	1.0000	7448	1.0000

The data shows that fewer fatal crashes are likely to occur in the sleet or snow when about 49% of the fatal crashes occurred in clear days. It is interesting to note that the proportion of fatal crashes that happen in cloudy or foggy days are slightly higher than that of Injury A, B, C type or PDO crashes.

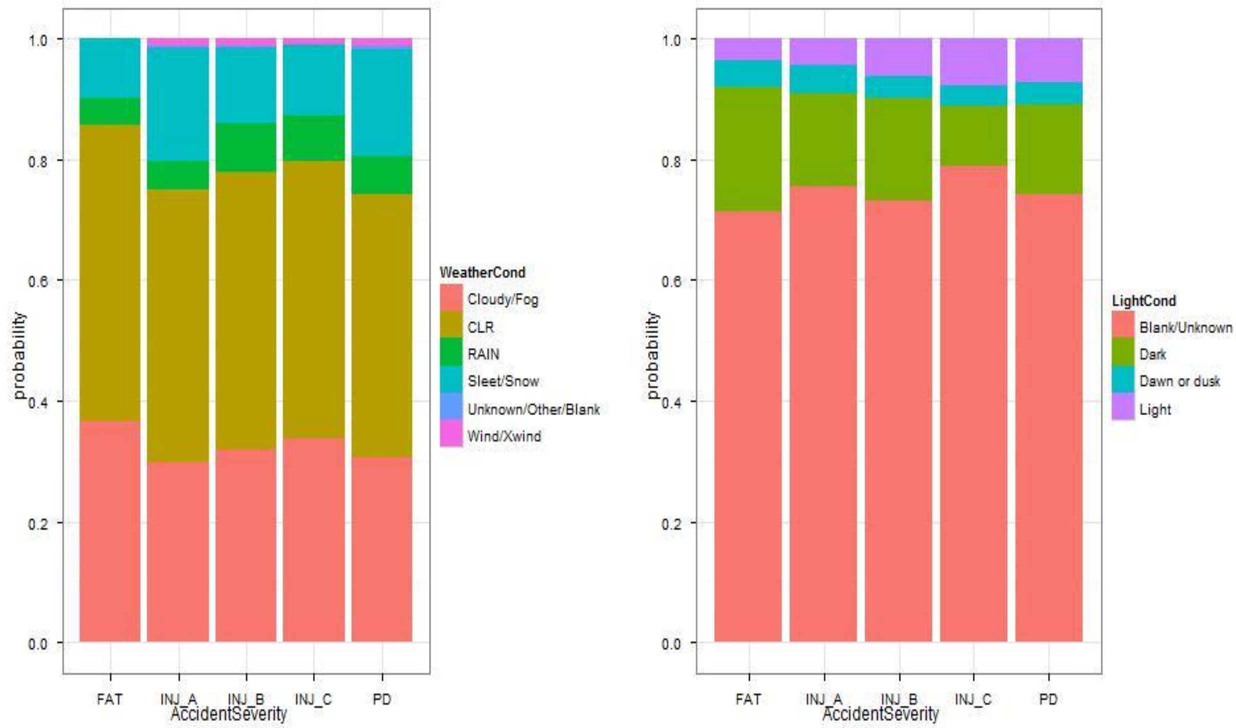


Figure 13 Probability bar chart of crash severity partitioned by different levels of weather condition (left) and light condition (right)

(d) Light Condition

Table 12 Light Condition – Statistical Analysis

Condition	Fatality		Injury – A		Injury - B		Injury - C		PDO	
Blank/Unknown	280	0.7125	1002	0.7539	1958	0.7325	2268	0.7897	5526	0.7419
Dark	81	0.2061	206	0.1550	448	0.1676	281	0.0978	1108	0.1488
Dawn/ Dusk	18	0.0458	62	0.0466	102	0.0382	102	0.0355	263	0.0353
Light	14	0.0356	59	0.0444	165	0.0617	221	0.0769	551	0.0740
Total	393	1.0000	1329	1.0000	2673	1.0000	2872	1.0000	7448	1.0000

Majority of the information is missing with respect to light condition. However, among available information, larger proportion of fatal crashes in likely to happen in the dark.

(e) Roadway Condition

Table 13 Road Condition – Statistical Analysis

Condition	Fatality		Injury – A		Injury - B		Injury - C		PDO	
Blank/Other/ Unknown	304	0.7735	887	0.6674	1807	0.6761	1964	0.6838	4627	0.6212
Ice	15	0.0382	180	0.1354	138	0.0516	141	0.0491	579	0.0777
Mud	0	0.0000	2	0.0015	10	0.0037	3	0.0010	20	0.0027

Condition	Fatality		Injury – A		Injury - B		Injury - C		PDO	
Snow	33	0.0840	123	0.0925	319	0.1193	358	0.1246	1298	0.1743
Wet	41	0.1043	137	0.1031	399	0.1493	406	0.1414	924	0.1241
Total	393	1.0000	1329	1.0000	2673	1.0000	2872	1.0000	7448	1.0000

Majority of the information is also missing with respect to roadway condition. As contingency table of weather condition has shown, more property-damage only crashes occurred under snowy or wet condition. Thirteen percent of the injury- A type crashes occurred on icy roads, when much smaller portion of crashes occurred on ice for other types.

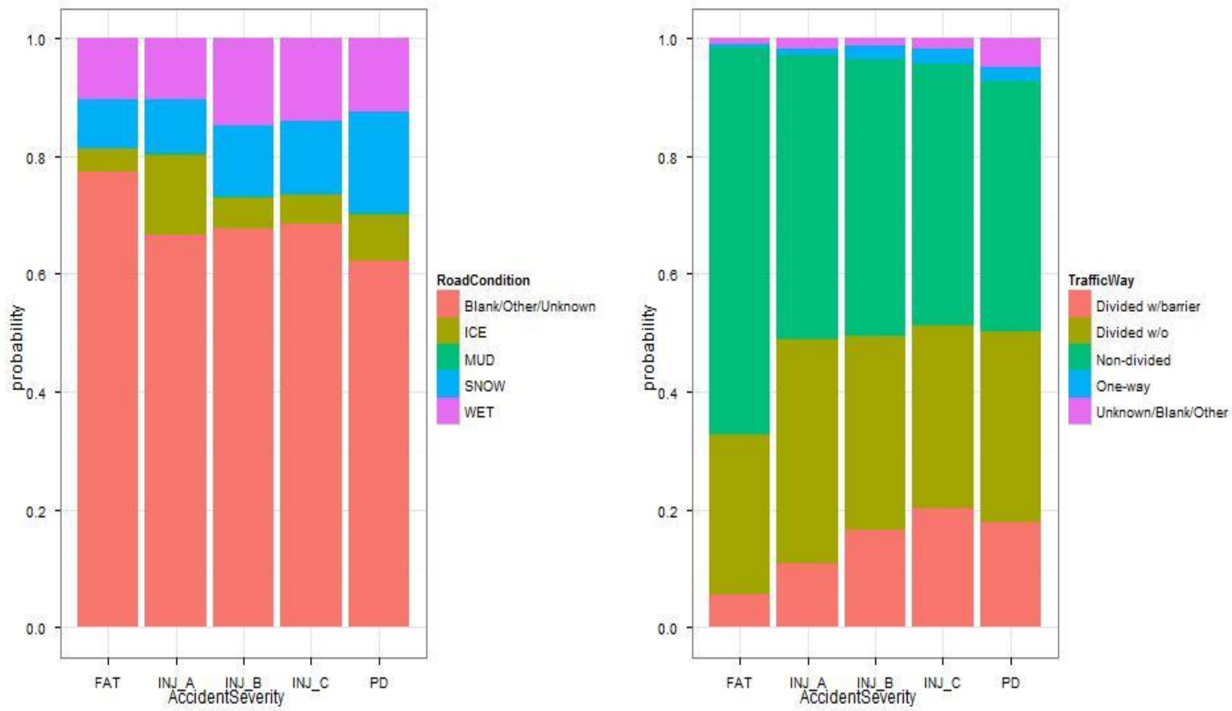


Figure 14 Probability bar chart of crash severity partitioned by different levels of road condition (left) and traffic way (right)

(f) Traffic Way

Table 14 Traffic Way – Statistical Analysis

Category	Fatality		Injury – A		Injury – B		Injury - C		PDO	
Divided w/ barrier	22	0.0560	145	0.1091	441	0.1650	581	0.1774	1321	0.1774
Divided w/o barrier	107	0.2723	504	0.3792	879	0.3288	890	0.3099	2422	0.3252
Non-divided	258	0.6565	641	0.4823	1258	0.4706	1276	0.4443	3167	0.4252
One-way	2	0.0051	16	0.0120	70	0.0217	70	0.0244	169	0.0227
Unknown/Blank/ Other	4	0.0102	23	0.0173	37	0.0138	55	0.0191	369	0.0495
Total	393	1.0000	1329	1.0000	2673	1.0000	2872	1.0000	7448	1.0000

It is interesting to note that more fatal crashes are associated with non-divided highways. Divided highways with and without barrier are more likely to be related to property damage only or less severe crashes like Injury B and C.

(g) Driver Behavior

Table 15 Driver Behavior – Statistical Analysis

Category	Fatality		Injury – A		Injury – B		Injury - C		PDO	
Backing/Parking maneuver	8	0.0204	22	0.0165	36	0.0135	58	0.0202	260	0.0349
Changing lane/Merging	2	0.0051	38	0.0286	137	0.0512	180	0.0627	355	0.0477
Negotiating curve/ Overtake left or right	38	0.0967	112	0.0843	237	0.0887	184	0.0641	506	0.0679
Other/Blank/ (Il)legal parking/ Violating NPZ	15	0.0382	55	0.0414	96	0.0359	97	0.0338	347	0.0466
Right turn	8	0.0204	36	0.0271	70	0.0262	144	0.0501	554	0.0744
Slow/Stopping/ Stop in traffic	29	0.0738	256	0.1926	263	0.0984	360	0.1253	818	0.1098
Straight	264	0.6718	689	0.5184	1573	0.5885	1584	0.5515	4015	0.5391
Turn on red/ Left turn/U-turn	29	0.0738	121	0.0910	261	0.0976	265	0.0923	593	0.0796
Total	393	1.000	1329	1.000	2673	1.000	2872	1.0000	7448	1.000

Approximately 67 % of the fatal crashes occurred when driver was going straight, when there is more diversity in driver behavior for other types of crashes. Slightly larger proportion of fatal crashes occurred when a driver was negotiating curve or overtaking left or right than that of other types of crashes. About 19 percent of injury – A crashes occurred when driver was slowing or stopping, which seems to be significantly higher proportion of crashes occurring at slow/stopping/stop in traffic than for other type of crashes.

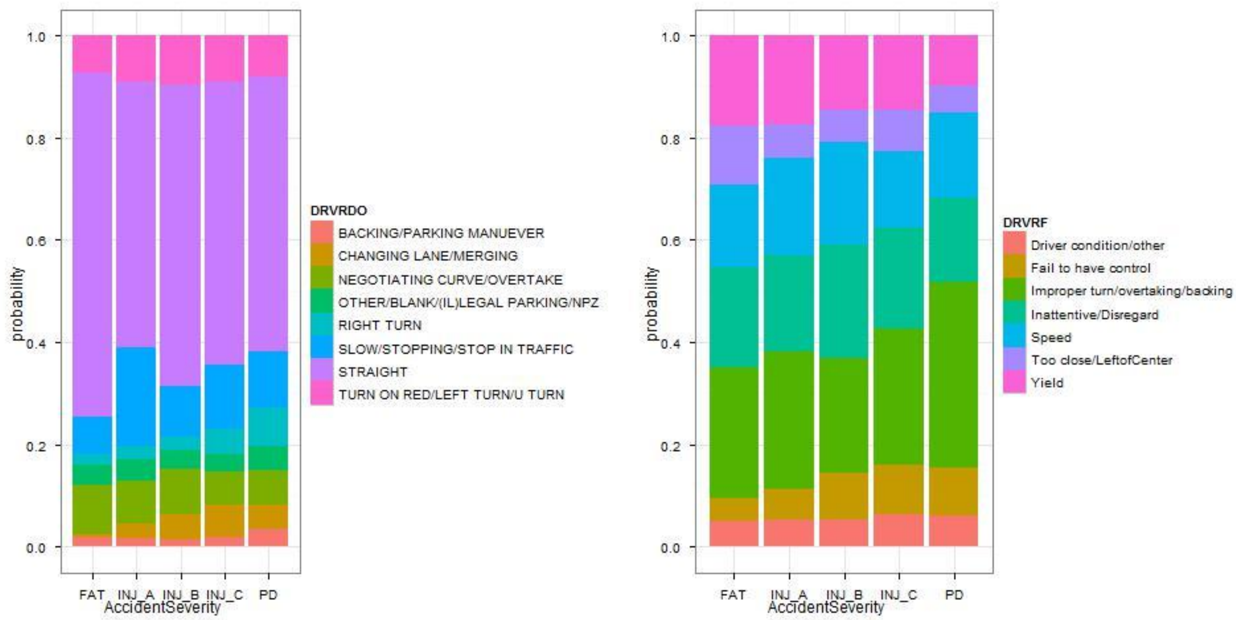


Figure 15 Probability bar chart of crash severity partitioned by different levels of driver behavior (left) and driver factor (right)

(h) Driver Factor

Table 16 Driver Factor – Statistical Analysis

Category	**Fatality**		**Injury – A**		**Injury – B**		**Injury - C**		**PDO**	
Driver Condition/Physically Disabled/Other	20	0.0509	72	0.0542	145	0.0542	185	0.0644	456	0.0612
Fail to have control	17	0.0433	77	0.0579	244	0.0913	276	0.0961	702	0.0942
Improper turn/ Overtake/Unsafe Backing	101	0.2570	358	0.2694	598	0.2237	762	0.2653	2694	0.3617
Inattentive driving/ Disregarded traffic signal	77	0.1959	251	0.1889	594	0.2222	569	0.1981	1219	0.1637
Exceeding speed limit	63	0.1603	253	0.1904	538	0.2013	428	0.1490	1261	0.1693
Following too close/ Left of Center	45	0.1145	86	0.0647	165	0.0617	230	0.0801	383	0.0514
Fail to yield right of way	70	0.1781	232	0.1746	389	0.1455	422	0.1469	733	0.0984
Total	393	1.0000	1329	1.0000	2673	1.0000	2872	1.0000	7448	1.0000

It seems that more severe types of crashes are associated with fail to yield right of way and following too close or being left of center, whereas more property-damage-only crashes are related to improper turn/overtake and unsafe backing than other driver factors.

Classification Tree

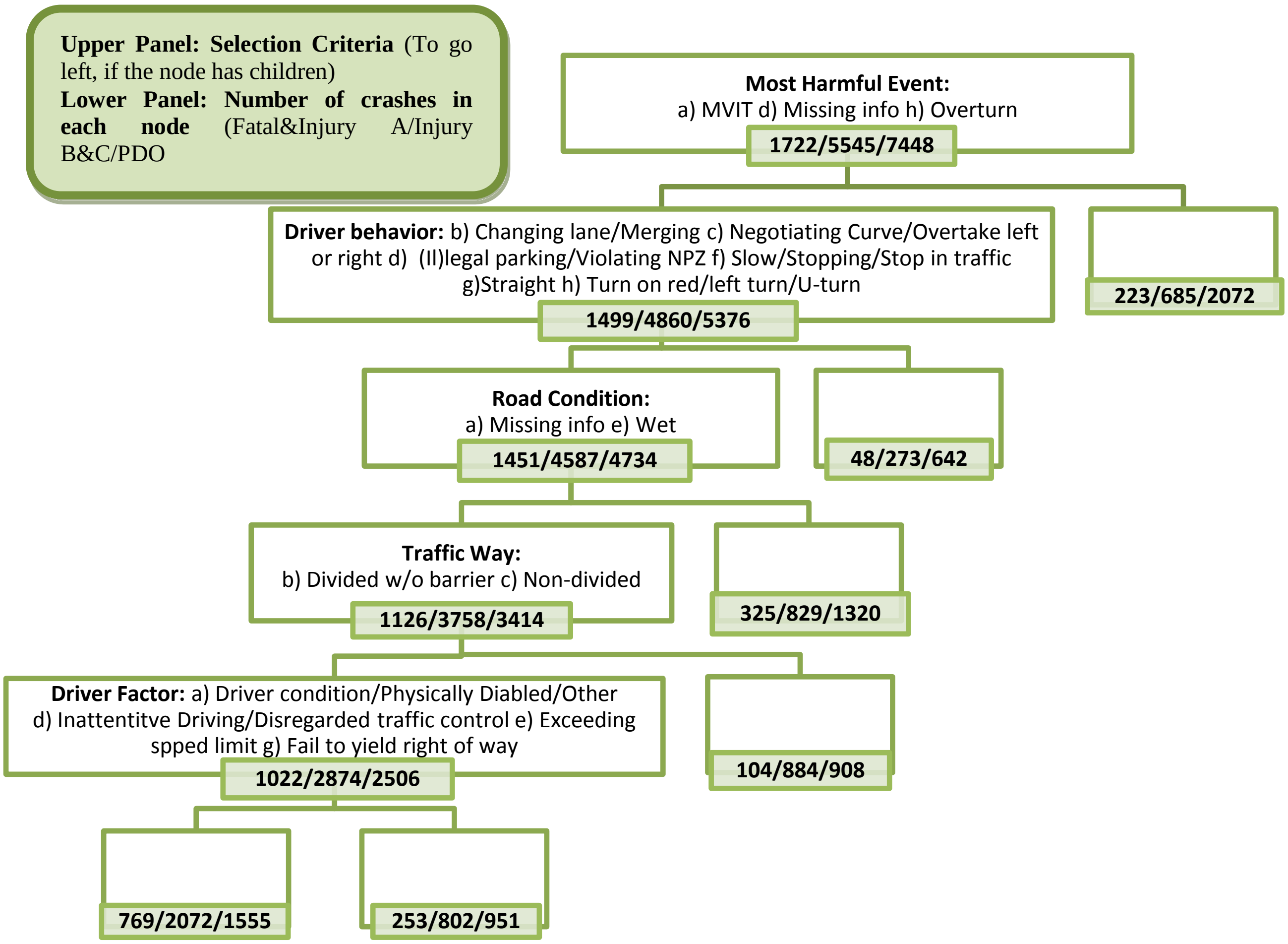


Figure 16 Classification Tree Results (Starting from the top, binary split on (sub)- samples is conducted. Large rectangular boxes (upper panel) contain classification criteria on the samples in that specific node. Those of which meet the classification criteria move to the left node and the remainder goes to the right node. Empty text-box means that there is no classification criterion, and hence the node does not produce any children

Merely looking at the numbers on a contingency table and probability bar charts only have limited benefits to identifying factors that have effect on determining crash severity. For a more statistically sophisticated analysis, classification tree and multinomial logit regression were created.

Classification tree is a strong candidate of prediction model for categorical response and serves the purpose of data mining well. Tree analysis especially has benefits in situations where there are many variables which interact in complicated, non-linear ways. The tree starts with a single node, and then looks for the binary distinction which provides the most information about the class. The results of the tree analysis are featured in Figure 16. Researchers first start with the entire sample of 1722 fatality and injury - A type crashes, 5545 of injury B and C type crashes and 7448 PDO crashes and traverse the tree by the classification criteria. Large rectangular boxes (upper panel) contain classification criteria on the samples in that specific node. Along with classification criteria, the number of crashes in each category of crash severity is reported in the smaller rectangular box (lower panel) at each node. From left to right, the number belongs to that of Fatality and Injury A/ Injury B and C / PDO. For example, the root (top) node starts with the entire sample of 1722 fatality and injury – A, 5545 of injury B and C and 7448 of PDO and those numbers are contained in the small box (lower panel) at the root node, separated by slash.

Samples that meet the classification criteria move down toward the left (children) node and otherwise to the right (children) node. For example, at the root (top) node, the crash incidents whose most harmful event falls into either of the three categories: a) moving vehicle in transport (MVIT) d) missing information or h) overturn should move to the left, whereas those that fall into other categories of most harmful event should traverse to the right. The number of crashes that meet such criteria is 1499 for fatal and injury - A type crashes, 4860 for injury B and C type of crashes and 5376 for the PDO. Of these subsets of samples, the crashes are further split into two, second time by driver behavior and third by road condition and so on. The process is repeated through each of the resulting new nodes until reaching some stopping criterion.

Note that featured diagram is the result of pruning that is aimed for minimizing cross-validated error: in theory, the tree will continue to grow can continue as far as each of the final nodes (leaves) has only single and universal type of crash severity. Pruning the tree (here, by cross-validation criteria), however, is essential to avoid the problem of over-fitting. Here, the criteria that were used to split the tree in Figure 16 did not overlap at all, but is merely a matter specific to the problem. For example, most harmful event was used to split the sample at the root node, but never used again further down. However, the same variable could have been used again at the node deeper down to split the sample: hypothetically, most harmful event can be used once again as a classification criterion at the terminal node on the very left to split the subsample of 769 fatal and injury – A crashes, 2072 injury – B and C crashes and 1555 PDO crashes. Also the fact that binary splits were conducted only on the left node while right node was intact is coincidental in this particular case.

Classification tree can be helpful for variable selection in the large-truck related crashes analysis since certain dependence structures are suspected but hard to be proved. For example, first harmful event and most harmful event do not always overlap, but a strong correlation between the two is suspected; road condition, which is classified into icy, wet, mud and snow, and certain highway factors, such as SIW or visibility and even weather condition are closely related too. In such situations, choosing one variable over the other can be determined by the occurrence of certain factors in classification tree model. Despite the advantages, interpreting the results directly from the tree is tricky: it is not straightforward to identify exactly what factors contribute more (or less) to certain types of crashes. The binary split is conducted in a way to provide the most information about the sub-sample on that particular node, but it does not provide any unique set of factors that contribute to a particular type of crash in terms of severity: tree presents several sets of factors that relate to a classification of response and moreover each type of crash severity is still all contained in the sample at terminal (leaf) node. Ideally, the tree can expand further to have exactly one type of crash severity at each of the final node, but the issue of over-fitting is the trade-off as mentioned.

Therefore, analysis based upon classification tree should be accepted with some caution. Classification tree analysis might better serve the purpose of variable selection for the regression analysis than the final model to base our decision upon. In that regard, multinomial logit model was fitted and the results of which are presented in the following section. Multinomial logit model in the next section is a restricted one after some variable selection from the full model. Full multinomial logit model with every available and relevant predictor is run but not reported here due to complexity.

Multinomial Logit Regression

With three categories of crash severity as a response variable, multinomial logit regression model was fitted. Simple binomial logit model that compares the fatality and injury A-type crashes to the rest of all crashes was considered as well. However, the results from binomial logit model is not reported as more interest lied in comparing factors that lead to fatality and injury A and those that lead to injury B and C than simply identifying factors that relate to fatality and injury A. Table 16, that contains the results from multinomial logit model, is reported in the appendix section. Overall, the multinomial logit model reaffirms what was suggested by frequency table analysis and classification tree.

Classification tree suggests that after removing several variables, the interaction between variables is minimal and additive model would be sufficient. Also based on the classification tree, most harmful event was chosen over the first harmful event; vehicle factor and highway factors are dropped as the histograms also suggest that there is seemingly no striking difference between different levels of crash severity. Weather condition was also not included in the final model, while indicator of whether there was or not was used since snow turned out to be the only significant factor in determining the crash severity from the full multinomial logit analysis, which considered every available predictor. Removing weather condition as a predictor from the multinomial logit model seemed a reasonable choice since there is an obvious correlation between weather and road condition and severe weather condition is likely to be already incorporated into information on road condition. Light condition was also removed from the final model. The coefficient estimates and the standard errors are reported in Table 17 on the appendix.

In multinomial logit model, coefficient estimates measure the effect of each variable on the odds-ratio of response category on a log scale to a reference level, which is PDO crash here. Therefore significant variable with positive coefficient means that the effect of that variable is likely to increase the log odds ratio. Since the predictors used in the analysis are all categorical, the effect of each predictor variable denote the relative effect compared to the reference category of that variable.

Predictor variables presented here, most harmful event, road condition, road way geometrics, driver factor and driver behavior, turned out to be significant. No particular difference in crash severity was observed across different levels of most harmful event: although most of them are very significant, with all of them presenting negative coefficient. No difference across crash severity with respect to most harmful event might be due to the fact that the reference category, moving vehicle in transport constitutes 72.87% of the sample that no one particular event tends to contribute to determining crash severity. Furthermore, the collision process might not have much effect in determining crash severity: crashes, whether they are fatal/ severe or relatively non-severe, might occur under similar circumstances and other factors are more important in determining the severity of crashes.

One very significant factor that might lead to fatal/Injury A-type crashes is the geometric features of the roadway. More fatal/severe crashes tend to occur on the traffic way of which is b) divided without barrier or c) non-divided. When traffic way is non-divided, Injury B or C crashes are also more likely to occur.

When road condition is snowy, less fatal/Injury A or injury B or C crashes are likely to occur than PDO crashes, and when the road condition is wet, less fatal/Injury A type crashes are likely to occur than any other types of crashes. Driver factor does not show any noteworthy features in identifying the factors that determine crash severity. Nonetheless, one particular driver factor seems to lead to more fatal/Injury_A crashes: g) fail to yield right of way.

Driver behavior at the point of crash seems to contribute more in determining crash severity. Although the magnitude of effect may vary, certain behaviors, such as c) negotiating curve/overtake left or right d) Legal or Illegal parking, violating NPZ or other f) Slow/Stopping/Stop in traffic and h)

Turn on red, Left turn or U-turn, are more likely to increase non-PDO type crashes – either fatal/injury_A or injury_B/C.

Conclusion

Roadway characteristics and driver behavior seem to be the most significant variable in determining the severity of crash incidents. Certain features of roadway condition as well as driver factor might lead to an increase of certain type of crashes. Most harmful event was chosen over first harmful event as a potential predictor of crash severity: however, further analysis reveals that there is no striking difference in crash severity across different levels of most harmful event. Vehicle factors and highway factors were dropped from the model early in the analysis process as their composition does not seem to vary across different levels of crash severity.

APPENDIX

Table 17 Results from Multinomial Logit (*** significant at 0.1%, ** at 1%, * at 5% and . at 10%)

Code	**Fatality and Injury_A**		**Injury_B and Injury_C**	
	Estimate (St.Error)	**p-value**	**Estimate (St.Error)**	**p-value**
(Intercept)	-2.2867 (0.2489)	< 2.2e-16 (***)	-0.4845 (0.1560)	0.0024(**)
Harm _ b	-0.5493 (0.1811)	0.0024 (**)	-0.7352 (0.1162)	2.483e-10(***)
Harm _ c	-1.3575 (0.2197)	6.447e-10 (***)	-0.6186 (0.1070)	7.318-09(***)
Harm _ d	-1.0780 (0.4002)	0.007 (**)	-0.7574 (0.2071)	0.0002(***)
Harm _ e	-0.2350 (0.1236)	0.057 (.)	-0.8855 (0.0968)	< 2.2e-16 (***)
Harm _ f	-1.7808 (0.1841)	< 2.2e-16 (***)	-1.5138 (0.1011)	< 2.2e-16 (***)
Harm _ g	-0.5308 (0.1268)	2.831e-05 (***)	-0.1739 (0.0774)	0.0247(*)
Harm _ h	-1.1479 (0.2123)	6.385e-08 (***)	-1.0614 (0.1291)	2.220e-16 (***)
RoadCondition _ b	0.1199 (0.1025)	0.2420	-0.5683 (0.0835)	1.010e-11(***)
RoadCondition _ c	-0.6611 (0.7615)	0.3853	0.2582 (0.3756)	0.4918
RoadCondition _ d	-0.9884 (0.1022)	< 2.2e-16 (***)	-0.6215 (0.0605)	< 2.2e-16 (***)
RoadCondition _ e	-0.3748 (0.0908)	3.637e-05 (***)	-0.0217 (0.0552)	0.6941
TrafficWay _ b	0.7666 (0.0979)	4.885e-15 (***)	0.0794 (0.0556)	0.2122
TrafficWay _ c	0.8458 (0.0966)	< 2.2e-16 (***)	0.1012 (0.0550)	0.0660(.)
TrafficWay _ d	-0.0920 (0.2666)	0.7299	0.0514 (0.1304)	0.6935
TrafficWay _ e	-0.1045 (0.2304)	0.6501	-0.5770 (0.1360)	2.213e-05(***)
DRVRF _ b	-0.3927 (0.1652)	0.0175(*)	0.0322 (0.0983)	0.7436
DRVRF _ c	-0.3297 (0.1308)	0.0117(*)	-0.3465 (0.0842)	3.844e-05
DRVRF _ d	-0.0618 (0.1350)	0.6472	0.0463 (0.0870)	0.5941
DRVRF _ e	0.1775 (0.1430)	0.2144	0.1451 (0.0930)	0.1187
DRVRF _ f	-0.0405 (0.1605)	0.8006	-0.0107 (0.1074)	0.9206
DRVRF _ g	0.3292 (0.1418)	0.0203(*)	0.0984 (0.0946)	0.2986
DRVRDO _ b	-0.1418 (0.2656)	0.5934	0.5202 (0.1530)	0.0007 (***)
DRVRDO _ c	1.0756 (0.2250)	1.753e-06(***)	0.6792 (0.1470)	3.823e-06(***)
DRVRDO _ d	0.5826 (0.2405)	0.0154(*)	0.3986 (0.1574)	0.0113 (*)
DRVRDO _ e	-0.5720 (0.2526)	0.0236(*)	-0.1554 (0.1497)	0.2989
DRVRDO _ f	0.9733 (0.2135)	5.162e-06(***)	0.4865 (0.1395)	0.0005(***)
DRVRDO _ g	0.6612 (0.2041)	0.0012(**)	0.5988 (0.1302)	4.236e-06(***)
DRVRDO _ h	0.3735 (0.2216)	0.0919(.)	0.5667 (0.1417)	0.0002(***)
McFadden R^2 = 0.0541 Likelihood Ratio Test: Chi-sq = 1534.1 (p-value = < 2.22e-16)				

Attachment 2

WisDOT SYSTEM-WIDE LARGE TRUCK SAFETY AND ENFORECMENT SURVEY

By

C J Petersen & Associates, LLC

WisDOT System-Wide Large Truck Safety and Enforcement (LTS&E) Survey

Prepared for Wisconsin Department of Transportation
By C J Petersen & Associates, LLC

30 March 2011

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System-Wide LTS&E Survey Report

1. Purpose

Wilbur Smith Associates (WSA) is the project lead whose objective is to perform a system-wide review of existing large truck commercial vehicle operations, and address current problem areas using crash and engineering data.

This report summarizes the responses to a survey administered by C J Petersen & Associates, LLC (CJPA) in February and March, 2011 for WisDOT and WSA regarding OS/OW commercial vehicle crash sites.

2. Survey Goals

CJPA surveyed county and state engineers for counties that have had the highest incidence of crashes involving large trucks between 2004 and 2009. The purpose of this survey was to identify roadway segments along truck routes that do not meet current design standards or policies, have a history of large truck operational problems/crashes, or have a strong likelihood of causing large truck bottlenecks and crashes based on past knowledge of similar problems.

3. Survey Findings: Highlights

The following is a summary of comments made by more than one respondent (county or state) to the survey.

- OS/OW commercial vehicle crash data is not separated from passenger vehicle crash data when analyzing cause, effect and solution.
- County representatives indicated that they are under contract to WisDOT to maintain the roads and access points at the intersections with state and interstate routes. They further stated that they do not have responsibility for design of the system and the access points.
- There were four counties that declined the invitation to participate in the survey, since this was either outside the scope of their jurisdiction or they do not have information to share regarding the design of the system in relation to accident rates. The counties were Dane, Racine, Brown and Grant.
- Round-a-bouts are being incorporated into design plans by Jefferson, Manitowac, Milwaukee, Outagamie, Sheboygan, and WisDOT SE Region for Milwaukee County. Specific routes were identified by respondents and are noted in this report.
- These counties are attempting to reduce traffic speeds through signage when it is warranted by the infrastructure.
- Driver error was mentioned as a primary cause of accidents rather than the infrastructure and the system they drive on.

4. Survey Methodology

The University of Wisconsin's TOPS Laboratory analyzed 2004 to 2009 data to identify the critical links, corridors, and specific locations that were identified as truck crash-prone. All of the Wisconsin counties were ranked using this data. Twenty-one counties were identified as having the high numbers of truck related crash incidents:

Dane	Brown	Waukesha
Dodge	Monroe	Outagamie
Milwaukee	Jefferson	Sauk
Winnebago	Manitowoc	Sheboygan
Columbia	Shawano	Grant
Rock	Marinette	Jackson
Racine	Juneau	Douglas

The study team created a list of all listed contacts for these counties utilizing the Wisconsin County Highway Association website: http://www.wcha.net/CO/CO_page.html. We produced a database of contacts (commissioners, engineers, accountants, etc.) which included phone numbers, email and physical addresses. This list was presented to WisDOT, who then specified the commissioners of each county as the preferred survey participants.

In addition to the county commissioners, an invitation was sent by the TOPS Laboratory to nine individuals in WisDOT's Risk, Safety & Facility Section, Highway Maintenance Section, Bureau of Traffic Operations, Roadway Standards/Methods Section, Bureau of Transportation Safety, Southeast Region, and North Central Region. Two individuals agreed to respond to the request for the survey; they represent the WisDOT SE Region that in part includes Milwaukee County and the NE Region that in part includes Brown and Outagamie.

The TOPS Laboratory provided maps, which indicated motor carrier accident location using the following legend:

- Red Dot=Fatal,
- Orange Dot=Injury, and
- Blue Dot=Property Damage.

The state and county representatives agreed to participate in this hour-long survey; due to the time constraints, we focused our discussion on those locations where accidents resulted in a fatality. The second priority was discussing those locations where there was a cluster of accidents resulting in injury and property damage.

4.1 Invitation Script

A phone script was developed to uniformly present prospects with the intent of the survey, verify receipt of the initial information, seek permission to interview, and set an interview appointment. Phone contact was made over the period of three days. Thirteen interviews were scheduled to be conducted between February 15 and March 8. See Appendix.

4.2 Cover Letter

Prior to setting up interviews for the survey, an introductory letter was sent via fax and email to each commissioner to introduce the survey, explain its importance, and alert the commissioner or their designee to the subsequent phone call eliciting their participation. See Appendix.

5. Survey Results

Each respondent was provided with a map of their county or counties with OS/OW vehicle crash locations marked at the intersections. The maps had been prepared by the TOPS Laboratory. The county or state representative was invited to participate in a WebEx on-line meeting to enable the discussion regarding the accident locations and drawing on the map utilizing the tools provided through WebEx Meeting. When the respondent was unable to access WebEx, we conducted the survey via teleconference; the map was used as a reference point during the conversation.

The survey results are provided by county in alphabetical order. The respondents weren't able to answer all questions as data was not available to them for some questions; the survey results are provided for those questions where there was a response.

5.1. Jackson County

Interviewed: Randy Anderson, Highway Commissioner 3/2/2011

Mr. Anderson has been Highway Commission for Jackson County for 2 years.

5.1.1. General Comments:

We advise the state when we have a problem on their highway, but we don't have any control. We don't make the decisions on a state highway. Our role is advisory to WisDOT. We don't look at accident data; we report on problem areas.

We report accidents or a fatality to DOT. If there is a problem, we take the problem to the County Safety Committee which is made up of representatives from WisDOT, the Sheriff's Department, and County Maintenance. Representatives of the County Safety Committee are designated statutorily.

Also, we need to do a better job of vegetation management:

- There are more motorcycle or car/deer accidents - in the past we were able to mow to the right-of-way line – including the vegetation.
- We have noticed an increase in car/deer accidents. It is a gut feeling (that excessive vegetation is the cause) on why there's an increase in car/deer accidents.

Don't know why there are so many incidents at Black River Falls.

Primary maintenance activity in summer and fall is mowing, as well as patching any type of defects/potholes; then shoulder maintenance to ensure it pulls up to the asphalt. If the road has severe road rutting, then we look at overlays.

We are putting band aids on these roads; when we look at problems on roads, we usually put overlay on the road for a 10-year fix. We have wheel ruts on the roads for the drivers. For example, Clark County has completed studies; the problems have been identified, but we have no money to fix the problem.

5.1.2. Survey Questions:

Questions 1., 3. and 4. were designed to identify specific locations where improvements, maintenance, or redesign are planned or recently implemented. The map is hyperlinked here. The responses are noted here.

Number 1 on map: It is the interstate between Northfield and Osseo; we just have problems with this stretch of the interstate. There are odd things that happen along that stretch with trucks. It can be situations where there are unusual accidents, which range from driving conditions to driver error to falling asleep to slippery roads to alcohol involved. Accidents do not have one single cause involved.

Number 3 on map: There was a turn-off lane that was put in going westbound, which was a cooperative effort between DOT and the Ho-Chunk Nation.

He used the WebEx toolbar to draw lines where the most maintenance patching and shoulder repairs occurred, such as re-graveling and pulling up the shoulders. The following locations where specific activities occurred include:

1. TH 54 where there is the most patching,
2. TH 12 is south of the interstate's,
3. TH 27 is south of the interstate west of 12, and
4. TH 12/27 run together north of the interstate.

In 2011, the state will be redoing US 12 East and State Trunk Highway 27 on the north side of the interstate. In 2012, the segment through Black River Falls the state will start on US 12 and go towards Tomah; it will be resurfaced.

5. What has inhibited upgrades or improvements?

   b. Ranking for funding:
   Lower volume state trunk highways just don't get the attention that the higher volume highways receive. It's not a lot of rebuilding but resurfacing.

6. WisDOT also has its own Highway Safety Plan that includes 24 safety action items. Do you agree that these safety action items have had an impact on reducing crashes?

   f. Minimize consequences of leaving roadway:
   The county is proactive in this area, especially for mailboxes or signage; we want to maintain

the clear zone to avoid them from becoming a missile. It is why vegetation is so important to cut down; we want to avoid vegetation from becoming a tree.
g. Design safer work zones:
Trying to make work zones safer; every year we're looking at setting them up more safely. We put more trucks out with flashing lights, more barrels, more cones, spreading them out longer in an area, have a patrol car parked out to make people think there's an officer there)
o. Improve traffic incident management:
This would be for any of the roads – yes; improving communication between the levels of government and trying to do things that may quicken our response to get to that incident with equipment that the patrol or sheriff's department needs.

5.1.3. Additional Comments:

- I have not heard of the State Safety Plan; but it may have been shared with the Patrol Superintendents.
- It would be nice to have more permanent message boards to enable ease of creating detours; we do borrow message boards from other counties.
- We are moving towards closing the interstate when there is inclement weather; they (WisDOT) need to add more gates to close the Interstate to avoid more people coming on to the interstate.
- The biggest priority is to follow through on safety goals with actual dollars from the legislature.

5.2. Jefferson County

Interviewed: Brian Udovich, Highway Commissioner 2/23/2011

5.2.1. General Comments:

I have been with highway department for about 2 years; when I first arrived we examined the possibility for highway improvements funding. We utilized the County GIS system to identify similar accident data, however it included deer crash data; accidents due to deer were removed from the data results. We tried to determine where the hotspots were. We went so far as to get the hotspots from the county to examine the accident reports. The hotspot locations involved texting or alcohol. We didn't have enough of a case to get funding for geometric changes, unfortunately.

The reports are available through the sheriff's department or WisDOT offices. Through WisDOT there is a website that is maintained by the state patrol; data can be downloaded from their website. It is a password protected website. It is a slick system that is fairly new. It will bring up all the highways involved, and it will bring up specific accident reports through two separate portals. It is instantaneous even though it is two separate portals.

Where the state patrol does not respond to the accident, and it is a county sheriff's department response, then we go to them for data. You can search within a township and then on a highway – it is a 2-step process.

There were 3 or 4 or 5 hotspots; there were a few locations where there was a need for minor improvements such as chevrons or signing. We are doing a project right now to address the minor improvements.

The map provided by the TOPS Laboratory show accidents on state highways; we look at the county highways where there are problems. I am aware of some of the locations.

5.3.2. Survey Questions:

Questions 1., 3. and 4. were designed to identify specific locations where improvements, maintenance, or redesign are planned or recently implemented. The map is hyperlinked here. The responses are noted here.

1. The survey questions were developed from the data provided by Traffic and Operations (TOPS) Laboratory at the University of Wisconsin for Large Truck Crash Data by Severity for incidents between 2005 and 2009. Participants were asked to rank the following in order of crashes factor at the locations specified here and on the map depicting accident locations. The responses were categorized under "Other."

o. Other: We are proposing a round-about as it is a concern for both the county and the state at 'location 2' on the map at HIGHWAY F & 16.

p. Other: The corridor between Oconomowoc & Watertown on Highway 16 is being studied. The WisDOT study results will be reviewed with county and townships where there will be impact an impact on the infrastructure. They will ask for input and thoughts.

q. Other: Points 3, 4, 6, 8 –

- There is one bypass at Watertown by 4 blue dots;
- Second bypass at cluster by 6 & 7 for city of Jefferson;
- Third bypass at 8 off of existing Highway 26, which will result in higher degree of safety. Highway 26 is heavily travelled; WisDOT is constructing a bypass that will take some of the traffic; it is a series of 3 bypasses.

2. What is your opinion about the locations identified here relative to commercial vehicle crashes?

At interchanges between a major interstate and the local road system, trucks are more likely to have accidents. This observation is partially based on accidents that have occurred at interchanges due to weather – i.e. accidents that occurred between a truck (semi) and a snow plow driver.

Further, accidents are more likely to occur where there are intersections on any major route. Where Highways 18 and 89 intersect is another location where they will do improvements; it is an off-set intersection. Highway 89 comes into 18; it makes a jog. They can't place an interchange there, but it is being designed to improve traffic flow.

With the economy as it is right now, we can't do a lot. We have been cutting back on maintenance, but safety is a high priority. The state would like the county to minimize the maintenance; the exception is vision problems that occur with snow and vegetation.

3. Have you identified solutions to prevent crashes at these locations?
(Answers in a checklist supplemented by written comments)

There are minor things that can be done – if there's an intersection between a state and county highway; it will likely be a 2-way stop. At those intersections with the stop sign, we put warning signs and rumble strips in the pavement; the driver feels the rumble strip and avoids a T-bone accident when somebody runs a stop sign.

Our county is pretty low-tech: if we're going to have a construction project we put the information at our county website along with a newsletter to residents to travel with caution. On the county highways we can take action. If it is a state highway, then there is other signage (variable message signing) that is used. We are not using ITS (Intelligent Transportation System) messaging.

We are stuck between 2 dense urban areas and the state is getting us up to speed. If you go east and west of us, there are digital boards regarding accidents or congestion.

For traffic that wants to go westbound on a cloverleaf, the loop will be removed and a diamond interchange ramp will be put into the NW from the NE.

If the traffic must be kept from the interstate, then the state is working with the counties to put in ramp gates to prevent traffic from accessing the interstate. The county will be responsible for maintenance of the ramp gate.

5. What has inhibited upgrades or improvements?

   a. Funding - if there were more dollars, more could be done.

6. WisDOT also has its own Highway Safety Plan that includes 24 safety action items.
Do you agree that these safety action items have had an impact on reducing crashes?

The primary activities with safety include ensuring that the signs are in place (such as advisory signs and stop signs), refreshing pavement markings so that passing/no-passing zones are easy to see, and improve reflectivity of signs. This is a national initiative at this moment. This is especially important on some of the town roads where there is a high level of concern.

We ensure potholes are filled; there is asphalt on county roads, but state highways are concrete and we must address blowouts as quickly as possible. After storms, we ensure that debris is quickly removed.

For the most part the answer would be yes: different roads are given different priority. The highways and interstates that are heavily travelled are given priority. There's a list that has been agreed upon between WisDOT and the county that identifies the priority and hierarchy for plowing and maintenance.

Another example: in 2008 when there was all the flooding, Jefferson County was hit severely. The interstate was closed down as there was concern of waters overtopping the highway system. Then the county put up appropriate signage so folks wouldn't drive through these areas.

We don't have the issues that other counties that are more developed have; always looking for best practices.

Jefferson County's representative then identified who, besides the county, will address issues included in this list.

a. Increase safety belt use/air bag effectiveness:
Response – this is a law enforcement issue.
b. Improve design/operation of intersections:
Response – this is a priority for Jefferson County.
c. Improve data/decision support systems:
Response - ITS issues wouldn't impact us as much.
d. Reduce speed-related crashes:
Response – This is especially a concern at intersections in Jefferson County.
e. Reduce impaired driving:
Response: This is a law enforcement issue.
f. Minimize consequences of leaving roadway.
Response: It is relatively inexpensive to address this concern; instead of construction, we can address by adding beam guards alongside the road.
g. Design safer work zones.
Response: We do our own road construction; our county crews are doing the work in the zones, so very important to us.
h. Reduce head-on and cross-median crashes.
Response: We have very few highways divided by medians, in the more urban counties this is a concern to improve.
i. Keep vehicles on the roadway.
j. Increase driver safety awareness.
Response: This is an education issue.
k. Sustain proficiency in older drivers.
Response: This is a Department of Motor Vehicle (DMV) activity.
l. Insure drivers licensed / competent.

Response: This is an enforcement or DMV activity.

m. Improve motorcycle safety.
Response: There are no initiatives in place right now.

n. Curb aggressive driving.
Response: This is an enforcement issue.

o. Improve traffic incident management.
Response: I and my superintendents attend quarterly meetings; we are pretty active in this.

p. Drive more safely in inclement weather.
Response: Through our plowing efforts we try to make the roads as safe as we can.

q. Make truck travel safer.
Response: See ‘p.’ above.

r. Institute Graduated Driver Licensing.
Response: This is a DMV issue.

s. Create more effective processes/SMS.

t. Make walking/street crossing safer:
Response: This is brought up from time to time; it relates to a discussion to ensure crossing at intersections instead of mid-road.

u. Insure safer bicycle travel.
Response: Until we do a major reconstruction, there’s not a lot we can do; but when we do we try to increase the width of the pavement to include a wide bike lane on the outside.

v. Keep drivers alert.
Response: Put in the rumble strips prior to intersections.

w. Enhance EMS to increase survivability.
Response: We’re in constant contact with EMS services; the EMS will alert us when there’s a blockage at an intersection to alert authorities.

x. Reduce deer and other animal crashes.
Response: Put up deer crossing signs.

y. Reduce vehicle-train crashes.
Response: We don’t have many; we have a few but not many locations. Where trains cross our highways at grade, there will be flashing lights or gates. The Watertown by-pass includes a separated grade crossing.

z. Increase safety enhancements in vehicles.
Response: This is an auto industry responsibility.

5.3. Juneau County

Interviewed: Mr. Dennis Weiss, Highway Commissioner 2/15/2011

5.3.1. General Comments:

Questions 1., 3. and 4. were designed to identify specific locations where improvements, maintenance, or redesign are planned or recently implemented. The map is hyperlinked here. Responses to these questions are noted here.

In our county, large truck crashes have not occurred on county or state secondary roads, instead they are occurring on the interstate system. Trucks are going too fast for conditions rather than the infrastructure. There were three in the last two weeks. One semi went off the road in the morning at 6:00 A.M. There were a couple of accidents on Highway 21, between Tomah and Necedah.

In the past, Highway 80 from New Lisbon (1. on map) to Elroy (2. on map) has had a couple of roll-overs with tankers involved; they were going too fast for the corners. It was noted that these specific corners are set to be redone.

5.3.2. Survey Questions:

There were not any answers to questions '1.' and '2.'

3. Have you identified solutions to prevent crashes at these locations?
   (Answers in a checklist supplemented by written comments)

Redoing ramps on Highway 82 in city of Austin – the traffic is backing up on interstate.

Andy Wingra at WisDOT La Crosse is doing a traffic flow study at Exit 69 regarding the speed. They are moving signs to improve visual access and location, but that is a state initiative. WisDOT is addressing all of the design / engineering for the interstate.

The ramps on Highway 82 in city of Austin are being redone; the traffic is backing up on the interstate.

5. What has inhibited upgrades or improvements?

   a. Funding

6. WisDOT also has its own Highway Safety Plan that includes 24 safety action items.
   Do you agree that these safety action items have had an impact on reducing crashes?

   Three items identified as safety action items by the county include:
   - Drive more safely in inclement weather
   - Insure safer bicycle travel
   - Reduce deer and other animal crashes

5.4. Manitowoc County

Interviewed: Gary Kennedy, Highway Commissioner 3/2/2011

5.4.1. General Comments:

Our county does not have electronic access to the data that is on this map. We have access to the data through our Safety Commission that has hand written map of accident locations; they track every accident. A written report is provided every 3 months; there is information provided at every county location. Safety Commission is DOT, county highway, sheriff's department and public. They meet to review the accident locations and they make recommendation regarding maintenance and changes to the infrastructure such as sight distance for hills and curves.

The information about the accidents is a big part of the decision making process for maintenance and improvements.

5.4.2. Survey Questions:

Questions 1., 3. and 4. were designed to identify specific locations where improvements, maintenance, or redesign are planned or recently implemented. The map is hyperlinked here. Responses to these questions are noted here.

Not aware of any road hazards at TH 47 and Cherney.

Along US Highway 10, we asked that it be rebuilt all the way through our county as it is a narrow and curvy road. We've had numerous accidents on this stretch of highway; it is a dangerous state highway due to narrow shoulders and curves combined with insufficient sight distance. WisDOT did install three round-abouts east of the Interstate at Q and at R (see squares) in 2009/2010.

State TH 67 at State TH 32: a round-about was put in at the location where there is an orange dot (see map) where numerous accidents have occurred. The round-about was put in 2010 by DOT.

At the Interstate and State TH 42, the sight distances are supported by traffic lights. There is a high volume of traffic at this location; I'm unsure why accidents occur at this location. Traffic lights were installed, but I'm unsure of the date of installation.

We physically examine intersections with accidents, especially for signage. At some of these intersections we have put up flashing stop signs on some county trunk highways, but we don't have the data for the state intersections since the state controls whether there are additional signs added. It is strictly WisDOT's call whether any additional surfacing or signage is added or additional maintenance is completed. We ride with the WisDOT representative to make recommendations, but it is their call.

3. Have you identified solutions to prevent crashes at these locations?
(Answers in a checklist supplemented by written comments)

We give recommendations regarding traffic light installation, resurfacing, creating and graveling shoulders and lighting at intersections.

- USH 10, that whole stretch – to improve the corridor.
- Relating to round-a-bouts, we suggested that WisDOT do them.
- WisDOT puts out news bulletins when there's going to be maintenance; it's put out to the whole region. Our county emails the radio stations, newspapers, fire departments and police departments and government officials. We do not have a direct line to the trucking firms.

6. WisDOT also has its own Highway Safety Plan that includes 24 safety action items.
Do you agree that these safety action items have had an impact on reducing crashes?

We meet with DOT regarding safety, but we don't have a safety plan. This county indicated that the following safety actions have an impact on reducing crashes:

- Increase safety belt use/air bag effectiveness
- Improve design/operation of intersections
- Improve data/decision support systems
- Reduce impaired driving
- Minimize consequences of leaving roadway
- Design safer work zones
- Reduce head-on and cross-median crashes
- Increase driver safety awareness
- Sustain proficiency in older drivers
- Improve motorcycle safety
- Drive more safely in inclement weather
- Make truck travel safer:
  Response: I-43 is all truck accidents. It is the drivers of the trucks; there are well-built roads, shoulders are plenty wide. It is the error of the driver and the speed at which they travel
- Create more effective processes/SMS
- Insure safer bicycle travel
- Keep drivers alert
- Enhance EMS to increase survivability
- Reduce deer and other animal crashes
- Increase safety enhancements in vehicles

5.5. Milwaukee County

Interviewed: Jack Takerian, Director of Transportation & Public Works, Chuck Smeltzer, Highway Maintenance Manager, Rollin Bertran, Director of Highway Operations, Department of Transportation and Public Works, Milwaukee County 2/23/2011

5.5.1. General Comments:

Access for trucks, the radius of the intersection to accommodate larger trucks, truck size; Westbound 67 accommodates an overall length of truck-trailer combination at 74', which has 53' trailer (more or less).

On and off ramps are designed by the state of Wisconsin. When it comes to intersections we look at clearances, disability triangles at the intersection, lane width, median openings, and speed.

We go to the WisDOT database to log in to examine accident locations hosted through the TOPS Laboratory at Madison, WI. We look at the axiom data that is hosted at the state of Wisconsin; we look at mitigation for the type of collision. If we see a large number of trucks, we try to provide adequate clearance.

We have very few county roads that enter the state freeway system; these are designed by WisDOT.

At Dean and Bradley to Interstate IH43, at the off-ramp of the freeway to Co Road W; a signal light was introduced. The surge length was extended by the County and WisDOT together.

We do not do anything specific for trucks; we determine if signal timing needs modification for clearances for the trucks. Every time we do a safety check within the corridor we apply for funds under Highway Safety Improvement Program (HSIP). We usually report the conditions of accidents, such as a disabled signal and other actions that we are experiencing.

5.5.2. Survey Questions:

Questions 1., 3. and 4. were designed to identify specific locations where improvements, maintenance, or redesign are planned or recently implemented. The map is hyperlinked here. Responses to these questions are noted here.

a. Lane Width:
Response: The maximum lane widths are now 12 foot, up from 11 feet throughout the county. Any county trunk highway is a truck route; it was accomplished between 1978 and 2011; 98% has been completed.

b. Speed Limit:
Response: We adjust the speed limit every time there is rehabilitation to the infrastructure, which is based on data. The reduction or increase in speed is appropriate; the speed is typically decreased.

c. Median Width:
Response: We have different widths depending on facility, 6-24' widths; for the most part the roads have a median or have been widened. It depends on right of way we have available. Examples include:

- Rawson Avenue & 68th Street; CTH BB (E/W bound) increased median, number of lanes, and lane widths to handle additional traffic and at the same speed, which was completed 2003.
- Good Hope Road to 76th Street and CTH PP, which was completed in 2008.

d. Right Shoulder Width:
Response: Beloit Road done in 2006 from 100 West to the end of the county line.

e. Left Shoulder Width:
Response: None

f. Passing Sight Distance:
Response: Rawson Avenue (see above) Highway 100 west, changed from passing to a no passing zone.

g. Number of Peak Lanes:
Response: None

h. Left Turning Lanes:
Response: Good Hope Road, Rawson Avenue, Silver Spring south of Good Hope (CTH PP) that would be E, Port Washington Road, Ryan Road, College Avenue (north of Rawson – known as Co Rd ZZ), Layton Avenue north of College – County TH Y.

i. Right Turning Lanes:
Response: See above, both left and right turning lanes.

j. Access Control:
Response: Several actions were taken; we closed multiple access points throughout the system. The decision was driven by the number of accidents and when a business is seeking an improvement. Those changes are addressed throughout the system. This has occurred during last 7-10 years.

n. Construction Zone: We try to maintain the traffic on the road we're reconstruction. We'll push traffic to east, west or south/north while constructing the opposite side.

2. What is your opinion about the locations identified here relative to commercial vehicle crashes?

- 112th & 894: 112th is under city jurisdiction in city of West Allis – not a county jurisdiction. The access points are maintained by county, but WisDOT directs everything where there is an intersection with city instead of county roads. One would say that the commission would have control, but the city of Milwaukee has their own traffic department with ordinances that supersede our (county) authority. Highway commissioner has control over all county highways and contracts with state to deal with states roadways.

- There is a greater need for transparency and collaboration on improvements and changes on the system – Milwaukee, West Allis and Wauwatosa.

3. Have you identified solutions to prevent crashes at these locations?
(Answers in a checklist supplemented by written comments)

   a. Reduced speed controls
   Response: We've reduced speed. For example, in the Rawson area we reduced the speed limit due to the traffic volumes and accidents that were examined, but determined

that the speed could be maintained. It was noted that there are several points where we've reduced the speed based on similar conditions.

b. Signage:
Response: This goes along with improvements – if we are seeing a greater number of accidents to reduce accidents/improve flow and control we will add signage. Never at a status quo.

c. Advance information:
Response: At the county level – the answer is no; this is something we can look at when we do major reconstructing in the future.

d. Engineering & design solutions:
Response: See above

A proposed geometric solution and location:
Roundabout: In 2011, we have a round-about going in at College Ave at County TH ZZ east of Howell Avenue. We have a number that have been installed at Drexel Avenue east of HIGHWAY 100.

5. What has inhibited upgrades or improvements? Funding was the response provided.

5.6. Monroe County

Interviewed: Mr. Jack Dittmar, Highway Commissioner 2/23/2011

5.6.1. General Comments:

Mr. Dittmar reported that the last time that he saw similar data was for 2001 to 2010 with a spot map. Sheriff's department does not provide data regularly – they look at the maps for justification for doing more major works on highways. Like everybody else, spending money is hard; pretty tight to do more than just put down pavement unless there is an area with high accident history. Even that is kind of tough.

Our maintenance for the state is routine, not a lot of county work going on. Routine maintenance work like mowing grass, grading gravel shoulders, minor pot-hole patching, removing debris from travel lane and shoulders.

The map will be a useful tool. Before 2001, they would draw on the flip charts; I go down to the TOPS Laboratory, which is very helpful to us.

5.6.2. Survey Questions:

Questions 1., 3. and 4. were designed to identify specific locations where improvements, maintenance, or redesign are planned or recently implemented. The map is hyperlinked here. Responses to these questions are noted here.

Response: The interstates are the heaviest trafficked routes for truck accidents. TH 27 is a cut-across from Sparta to junction with IH 94 a few miles outside of the county. TH 21 is major route to get across middle of state and is a major truck route; TH 173 also has a large amount of truck traffic.

The latest map provided by WisDOT is from 2008. TH 27 has 3-4,000 ADT, TH 21 is > 4-6,000 ADT, TH 173 1,500-2,000 (All traffic). The IH is 10s of thousands.

Response: No work scheduled or has been done at the county level for the four locations where there are fatalities listed on the map.

a. Not at the county level on TH 21 – the state did some work on TH 21 – with new stoplights coming off of the off-ramps through TH 12 with overpasses by the state. There's routine winter and summer maintenance, hauling snow in winter and keeping pavement bare. This is concrete, so no patching; there are limited maintenance costs or effort.

b. I-90 goes over TH 12 and 16, straight east-west route. Nothing planned as this was redone three years ago by the state with resurfacing of the blacktop; WisDOT redid that all the way through. Winter maintenance is completed along with mowing once per year. This is a rural cross-section with grading up to the pavement with gravel shoulders.

The county has not studied any of these locations for improvements. County maintenance employees will identify specific potholes or other repairs necessary. County OO has a lot of potholes and they spend a lot of time patching.

None of the items listed in the survey under "Proposed Geometric Solutions" have been examined; we have county crews and we have state crews that work with WisDOT state supervisors. It is definitely an informal process for submission of suggestions. We do what the state tells us to do except for the routine maintenance that we do on our own initiative. WisDOT has control over improvements.

5. What has inhibited upgrades or improvements?

Response: Both funding at county and state level and ranking for funding inhibit upgrades and improvements, but still it is the public's distaste for any new taxes.

6. WisDOT has its own Highway Safety Plan that includes 24 safety action items.
Do you agree that these safety action items have had an impact on reducing crashes?

It is a focus on the driver rather than route. There are areas in the county that have hilly curvy rough terrain. WisDOT has been doing a good job of designing safety into the design improvements.

Actions items from WisDOT's Safety Plan the county identified as important to reducing crashes are listed here:

a. Insure drivers licensed / competent
b. Curb aggressive driving:
Response: If you look at the accidents, you can build your way out of crashes, but it is the driver who must take responsibility. In the winter, drivers don't slow down on the

interstate when it's snowing and they don't slow down until they see someone turned upside down in the ditch.

c. Keep drivers alert:
Response: They're doing so many other things besides driving and it looks to me that the on/off ramps with the merging moves where people are moving and people have a tough time doing that courteously and safely.

d. Increase safety enhancements in vehicles:
Response: The next step is the smart vehicle that communicates with the roadway, which is a ways off. If you think of us driving, if everybody was respectful of everybody else and courtesy you could have cars at bumper to bumper and merging off respectfully it would be possible to double capacity on the highway system. The people factor needs to be added for their decisions, including poor ones.

5.7. Outagamie County

Interviewed: Alvin J. Geurts, Highway Commissioner 2/15/2011

5.7.1. General Comments:

We have not looked at truck versus other types of crashes or incidents; it's very difficult to single out a particular location. Injuries and accidents are tracked at Highway Department or commissioner's office; the information is shared between agencies including the state and sheriff's department.

We look at highway capacity or crash issues or insufficient intersections – we try to target construction to add:

- Deceleration lanes
- Wider shoulders: stalled vehicles on shoulders have been difficult due to narrow shoulders
- Passing lanes
- Arterial highway – have made improvements in form of wider shoulders and radiuses

There are a couple of concerns with heavy trucks:

- There is nothing at the county level to designate 10-ton routes.
- County employees have provided feedback that vehicles, including trucks, are driving faster than conditions warrant on occasion.
- It is a huge concern of staff working on the side of shoulders that more and more trucks are running at high rates of speed through work zones. The state is looking at night time work zones and more trucks are moving at night which wasn't true in the past. The percentage of trucks moving at night is heavier than during daytime. There is a need to be aware of the higher volume and the lane shutdown at night can inconvenience commercial carriers.
- We try to schedule plow operators to run during the day, but not recognizing or accommodating commercial carriers at night.

5.7.2. Survey Questions:

Questions 1., 3. and 4. were designed to identify specific locations where improvements, maintenance, or redesign are planned or recently implemented. The map is hyperlinked here. Responses to these questions are noted here.

Logging, aggregate industries generate a lot of traffic; County S is affected from Waupaca to Green Bay for truck traffic that is generated by the transport of sand and aggregate and forestry products.

County S from 76 to Rexford Road is deficient; it has a narrow shoulder, ditches are steep (doesn't meet slope standards), deceleration, turning, passing and an S curve in road doesn't meet the standard as well. Average daily traffic on that route for trucks is 4,000 to 5,000 vehicles – largely reduced. It was reduced due to 10-ton usage restriction for posted bridge just past County M on County S.

County A is the second; there's a grade separation at US Highway 41, no ramps or connection. This route has heavy truck traffic due to movement of gravel and aggregate, which comes from seven to eight quarries just north of the green line marked on the map when going south into Fox Cities, (all the communities in the area – Neenah, Menasha, etc.). They continue to watch County Road A; they put in a round-about, the corridor is working well. There is a concern at the northern end; County Road A intersects with Highway 47 is a crash prone location. The current alignment is poor; Highway 47 has free flow, 55 MPH is moving north-south on Highway 47. To access Highway 47 from County A at right angle at peak times can be very difficult with a heavy truck. The best solution the State engineers came up with years ago is waiting funding to list as a construction project at the state level. It is a combination of priority and funding. Need for project is down due to shifting of traffic to other routes.

Not 100% certain of change for vehicles that use Highway 55 instead of Highway 47. Fox Cities can access Highway 55 easier than Highway 47 due to state improvements. We do have a lot of intersections in the Fox Cities where the traffic signals or stop signs are knocked down as they are deficient in turning radiuses to accommodate heavy trucks. We do not keep a record of the property damage locations, but we track injuries and fatalities at intersections.

2. Have you identified solutions to prevent crashes at these locations?
(Answers in a checklist supplemented by written comments)

- Reduced speed controls:
  Response: The county has used speed controls where we have been made aware through crash data and public outcry; we are using data from state studies.
- Signage:
  Response: It is an option; we want to ensure that there is a proper warning device. It is a cost effective way to warn motorists.
- Radio, GPS and email:
  Response: We do not do a lot of advance information with radio, GPS, and email.

5 . What has inhibited upgrades or improvements?
Response: It doesn't take rocket science to find the need, but it is the funding that is the difficulty.

6. WisDOT also has its own Highway Safety Plan that includes 24 safety action items. Do you agree that these safety action items have had an impact on reducing crashes?

Actions items from WisDOT's Safety Plan the county identified as important to reducing crashes are listed here:

a. Improve design/operation of intersections
b. Reduce speed-related crashes
c. Reduce impaired driving
d. Minimize consequences of leaving roadway
e. Design safer work zones
f. Reduce head-on and cross-median crashes
g. Increase driver safety awareness
h. Sustain proficiency in older drivers
i. Insure drivers licensed / competent
j. Curb aggressive driving
k. Improve traffic incident management
l. Drive more safely in inclement weather
m. Keep drivers alert
n. Reduce deer and other animal crashes
o. Reduce vehicle-train crashes
p. Increase safety enhancements in vehicles

5.8. Shawano County

Interviewed: Grant Bystol, County Commissioner 3/2/2011

5.8.1. Survey Questions:

Questions 1., 3. and 4. were designed to identify specific locations where improvements, maintenance, or redesign are planned or recently implemented. The map is hyperlinked here. Responses to these questions are noted here.

Along Highway 29 at Hickory Road we moved the median crossing .25 mile to another location for better vision/site lines – it had been an at-grade crossing.

We removed access from County Q to TH 29 on the north side of 29. There are plans to remove at grade crossing on County Q. There are plans to eliminate the current at grade connection of County Q and TH 29 by new construction connecting Q to Q (there's a half mile of Q that runs along 29 and that is being removed).

For routine maintenance we pull up shoulders to remove lip between gravel and paved surface.

Highway 29 conversion study is being undertaken. WisDOT is looking at Highway 29 and examining whether to reconstruct it as a freeway; it is currently an expressway. WisDOT's reconstruction as a freeway will cause removal of at grade crossings.

There's one other intersection, which is at TH 22 and County BE. Vehicles turning right onto County BE from 22; the vehicle is hidden behind the first one, then they turn and they are hit as they turn. There have been a handful of crashes due to the turn-lane, its geometrics, and available sight lines that impede accurate visibility of on-coming traffic. We would like to see it fixed, we could build it right now – but the funding is not available. WisDOT would like to let the bid, but we have the equipment to fix the intersection.

1. What is your opinion about the locations identified here relative to commercial vehicle crashes?

   Response: We do the maintenance, but it is the state's decision. They have oversight but they give us the direction – lately it has been nothing. It is due to lack of funding.

   Region has already mapped the changes for interchanges and mapped and addressed in other studies.

   County U and MMM – it would be best to get a map that the region has produced.

   We have a routine maintenance agreement, mowing, concrete repair, roadside maintenance, asphalt overlay.

   We will probably go with U and MMM as a priority for maintenance due to the amount of traffic and number of crashes. We will do our everyday winter maintenance and summer maintenance to ensure vision is there.

2. Have you identified solutions to prevent crashes at these locations?

   Most of the red dots are along 29. We will not be dropping the speed limits. We cut vision corners.

   Any time there is lane closures, we turn in our lane closures we add to the WisDOT lane closure website. We send our work updates to WisDOT's website.

5.9. Sheboygan County

Interviewed: Greg Schnell, Patrol Superintendent; Mark Leiberman, WisDOT; Brandon Hytinen, WisDOT 2/15/2011

5.9.1. General Comments:

WisDOT has all the crash incident information. We are guessing by what we picked regarding incidents.

If we have issues on a trunk route or county highway then we will look into changing the intersections at the local level.

We do not have a clue what the ADT for routes in our county. We do all the maintenance for the DOT in WisDOT, if we want the data, such as the ADT, we rely on WisDOT.

5.9.2. Survey Questions:

Questions 1., 3. and 4. were designed to identify specific locations where improvements, maintenance, or redesign are planned or recently implemented. The map is hyperlinked here. Responses to these questions are noted here.

State Highway 23 will be improved with two new lanes from Plymouth west to Fond Du Lac resulting in 4-lanes all the way; it will be FY 2013 construction.

3. Have you identified solutions to prevent crashes at these locations?

   WisDOT looks at all of that data – for road improvements – we must meet their criteria to upgrade roads, and a consultant is hired to design the road. DOT spells out for us or through design specifications.

   We work with our local Metropolitan Planning O, anticipating the growth for the next 20 years; they help with analysis. We do plan for growth and improvements for geometric solution. It is not being driven by crash data; it is for expansion purposes. There are a couple of intersections where we're building a round-about. It is a factor, but it is not generated by the crash data.

5. What has inhibited upgrades or improvements?
   Response: It was a two-part answer, first it is lack of funding; second, there's resistance from property owners (NIMBY).

6. WisDOT also has its own Highway Safety Plan that includes 24 safety action items.
   Do you agree that these safety action items have had an impact on reducing crashes?

   Actions items from WisDOT's Safety Plan the county identified as important to reducing crashes are listed here:

   a. Improve design/operation of intersections
   b. Minimize consequences of leaving roadway
   c. Design safer work zones
   d. Reduce head-on and cross-median crashes
   e. Drive more safely in inclement weather
   f. Make walking/street crossing safer
   g. Insure safer bicycle travel
   h. Keep drivers alert

5.10. WisDOT SE Region for Milwaukee County

Interviewed: Stacey Pierce, Safety and Regulation Engineer 3/8/2011

5.10.1. General Comments:

WisDOT does the planning for all of these routes. We involve the counties in the process, but we set the priorities for construction and improvement projects. Maintenance is handled by another department within WisDOT. We reimburse them for maintenance on these routes.

We look at a spot intersection; look at corridor for crash history when a project is coming up. We look at the top 5% of all of the accident locations within our region. We ask, are our planned future projects addressing the issues? What we have not done is look at truck crashes and transit zones. This is the first time I've seen this crash data for truck.

Main response: it is congestion and volume and speed – its 55 mph speed limit in Milwaukee County, but most drive faster.

Most crashes occur at interchanges as identified on maps; crashes are evaluated using roadway contributing factors.

We have not worked directly with carriers in the region; we have not looked at mainline crashes – it is not infrastructure – none of items really apply from list in the survey.

Metrics: we don't target motor carrier crashes in analysis; we haven't had the resources.

5.10.2. Survey Questions:

Questions 1., 3. and 4. were designed to identify specific locations where improvements, maintenance, or redesign are planned or recently implemented. The map is hyperlinked here. Responses to these questions are noted here.

We're trying to design for oversize vehicles along a corridor with round-a-bouts.

Clybourn is the 2nd busiest interchange in WI; work began in 2006 and was completed 2008. It was completely redesigned and reconstructed. They eliminated the left side ramps; new bridges, etc.

At 35th street and going west, which is resurfacing and minor improvements - pavement condition safety was taken into account.

No interchange at I-94 is a curve there that may have contributed; there is substantial horizontal.

Highway 100 – number three at signalized locations; there are a lot of crashes at signalized locations on high volume arterial.

Our goal is to increase visibility by changing light pole heights from a 25' trombone; WisDOT is being replaced with 75' mono-tube poles. They are used in SE Wisconsin extensively to increase visibility – lot of rear ends and right angle crashes.

We are trying to align left turn lanes with arrow and green ball – protected signal turning for our crash locations throughout system on state highway systems.

Some of these roadways transfer from state to connecting highway that are maintained on western county, but eastern side is operated at local level (city of Milwaukee). Most of the larger municipalities have engineering staff – have strong staff doing studies; we defer to locals.

3. Have you identified solutions to prevent crashes at these locations?

   a. Reduced speed controls
   b. Signage
   c. Advance information
      Stacey-we have overhead message signs that are at specific locations. We tried pavement markings that are chevron pattern that was successful in slowing down traffic strategic optical illusion. There is higher volume of accidents in winter with blowing / drifting of snow; snow fences outside of county do need to look at seasonality on maps with accident locations.

5.11. NE Region WisDOT

Interviewed: Scott Nelson, Regional Safety Engineer 3/1/2011

5.11.1. General Comments:

Position: working with counties – from Safety Issues where county and state highways intersect, we provide traffic control when there are safety incidents – from an operational perspective, we have regional incident manager coordinators. We don't send resources; we ensure that they have the resources to set up the traffic control. If not properly set up we make recommendations. We are there for assistance. If we see safety issues, we identify those.

5.12. Brown County

5.12.1. Survey Questions:

Questions 1., 3. and 4. were designed to identify specific locations where improvements, maintenance, or redesign are planned or recently implemented. The map is hyperlinked here. Responses to these questions are noted here.

At number 1, we have an interchange that's going at Co. Rd FF at woodland –to west -& sunlight road – to east – the interchange will be eliminated when the by-pass has been installed. Planned construction to occur in 2013 and 2014; it was the crash rate at the intersections along the corridor that triggered the improvement. The decision was made approximately 2 years ago for a J turn, but as we got into design the geometrics (the vertical alignment) wouldn't allow the J turn: it was upgraded to an interchange (overpass with on/off ramps). Green Bay is about 100,000 people & the county itself is 200,000 in population.

At number 2, we have no plans for that location.

At number 3, near Highway 172 E/W to 41 N/S which is a highway to highway interchange – there is a highway capacity expansion project planned for this area. It is expanding from 4 to 6 lanes and all the ramps will be modified; at this system interchange there are minor modifications with a collector distributor road in this area. There will be changed ramp lengths, tapers, and marking. There will be significant changes compared to existing road system. There are multiple loop ramps at this interchange that are tight that create issues for trucks specific to load shifting if they are entering at too high a speed.

At number 4, I don't have information as it is on a local system. There's a bridge there that crosses the Fox River – that route was redone about 2 years ago.

I review all of the safety issues; it is typically driver error rather than the system or vehicle failure.

WisDOT is a bit unique; our focus is solely on the state highway system. Outside of the urban areas we take of the numbered systems; the county highways are maintained by the counties and we don't review the data. This is an inherited system.

For example, if you pick TH 54, which is a connecting highway, it is not reviewed at state level. City of Green Bay is paid to maintain that stretch of highway for any repairs and accidents are not monitored. The system from the state level is the numbered highways outside of the urban areas.

The state safety highway coordinators are not able to have visibility throughout the system in the rural or small municipality. When TH 54 has pavement is falling apart then they will take a deeper look at the system for correction. We're not seeking out hotspots in City of Green Bay.

5.13. Outagamie County

5.13.1. Survey Questions:

Questions 1., 3. and 4. were designed to identify specific locations where improvements, maintenance, or redesign are planned or recently implemented. The map is hyperlinked here. Responses to these questions are noted here.

Fox Valley is multijurisdictional due to larger townships that are responsible for maintenance. Trunk Highway 41 on east/west side within last year was upgraded through the median; there was a cable guard (three-strand high tension) added.

Engineering and design solutions: Brown Co – flattening curves – collector distributor – for merge and diverge issues along US Highway 41 – approximately to Southbridge Road resulting in less congestion, with taller barriers to prevent gawking ($1 billion in funding) with 100 structures.

2. What is your opinion about the locations identified here relative to commercial vehicle crashes?

The county is paid to conduct the maintenance; no equipment is owned by WisDOT. WisDOT instructs the counties on maintenance. We have staff for 2-3 counties who instruct and evaluate whether they are done to the standards that have been established. As a safety engineer, we don't look at just truck crashes, but we look at all the crashes to examine the reasons. A lot of issues (drugs, alcohol) cannot be addressed by maintenance. The counties are to plow roads, fill cracks, maintain the ditches, etc.

3. Have you identified solutions to prevent crashes at these locations?
(Answers in a checklist supplemented by written comments)

   a. Reduced speed controls – we do not
   b. Signage – can't think of situations where that has been the case, generally our highways through urban areas are over signed
   c. Advance information – with 4 lane to 6 lanes we are adding cameras, system detection, variable message signs, crash investigation sites, law enforcement pads. Also use the following in communication with motor carriers – there is a 511 system that allows the carriers to access advance information.
      i. Radio
      ii. GPS alerts
      iii. Email
      iv. Other

Appendix

Figure 17
Invitation Script

Contact Date:
Name:
Title:
Agency
Address
City, State Zip Code
Phone:
Cell:
Fax:
Email:

CJPA Representative text:
Hello, my name is XXX, I am calling on behalf of C J Petersen & Associates who is working with WisDOT to help them with a system-wide, large truck safety study. I'm calling today, first of all, to confirm that you received our letter inviting you to participate in this project.
A [IF YES]: [if no: go to B]
Great! WisDOT will really appreciate your help on this study. What we are asking of you is to participate in a teleconference interview, conducted by CJ Petersen, which will survey your experiences related to the subject of this study. We anticipate that the interview will only take 30 to 50 minutes of your time. I'm scheduling one-hour time slots on the following dates: February 15, 16, 22, 23 or March 1 or 2. Is there a day that works best for you? [with date(s) selected, offer time slots]
[identify the date :____________ & the time: __________________]
We will send you a confirmation of this appointment. Which is the best way to send you this – email, fax or letter? Email Fax USPS
Finally, I'd like to confirm your contact information. [refer to data sheet]. Thank you very much for your time today. We'll be in touch.
B [IF NO]:
If I could take a minute to describe the study, perhaps we could still set an interview date, or, if you'd prefer, I'll send the letter out again.
B-1 [If yes, describe study]
WisDOT has undertaken a project to study crash-prone locations and examine whether engineering design may be a crash causation factor at these locations. WisDOT has hired Wilbur Smith Associates and our firm to assist in identifying crash-prone locations and determining whether design is a contributing factor. With that, can I accept your participation in a teleconference interview? [yes: go to B-1a; no: go to B-2]
B-1a [if yes] [if no, go to B-2]
The interview will be conducted by C J Petersen, and will survey your experiences related to the subject of this study. We anticipate that the interview will only take 30 to 50 minutes of your time. I'm scheduling one-hour time slots on the following dates: February 15, 16, 22, 23 or March 1 or 2. Is there a day that works best for you? [with date(s) selected, offer time slots]
[identify the date :____________ & the time: __________________]
B-2 [if no, send letter again] Very well. I'll have the information sent out to you. Would you prefer I send it via email, fax or USPS? Email Fax USPS
Let me confirm your contact information. Thank you for your time today. We'll be in touch.

Figure 2 Cover Letter

Name, Title
Agency
Address
City, State Zip Code
Phone: Cell:
Fax: Email:

Dear __________ :

Wisconsin has one of the best highway safety records in the United States, with a motor vehicle fatality rate consistently below the national average. WisDOT and its safety partners continuously challenge themselves to lower these numbers and improve overall highway safety.

As a part of this continuing effort, WisDOT is conducting a system-wide large truck safety and enforcement (LTS&E) study to proactively identify truck crash-prone locations and examine whether engineering design may be a contributing crash causation factor at these locations. The objective of this study is to perform a system-wide review of existing "large truck" and other oversize/overweight (OS/OW) commercial vehicle operations, and address current problem areas using crash and engineering data.

WisDOT has hired Wilbur Smith Associates (WSA) and our firm, C J Petersen & Associates, LLC (CJPA), to assist them in identifying truck crash-prone locations and examining whether engineering design is a contributing factor. The purpose of this study is to identify roadway segments along the large truck routes that do not meet current design standards or policies, have a history of large truck operational problems / incidences, or have a strong likelihood of causing large truck bottlenecks and crashes based on past knowledge of similar problems. The goal of this study is to make recommendations for future changes to help alleviate the probability of future crashes involving large trucks at these "sites of opportunity."

We are asking for your assistance. The knowledge and experience of you and your staff will greatly assist our efforts in making Wisconsin's highways safer. We will contact you in the next two weeks to ask for your participation in a teleconference interview and survey in February and March at a time convenient to you or your responding team member. Our contact information is 651-690-4324 (office), 651-261-1806 (cell), email: cjpetersen@train2export.com, fax: 206-333-1980.

If you have questions about the study, please contact me or Peter Lynch by phone or email:
Peter Lynch, Freight Operations Program Manager
WisDOT DTSD - BHO Room 501 4802 Sheybogan Avenue Madison, WI 53707
WisDOT Office: (608) 267-4486 WisDOT Cell: (608) 516-6395
DOT Fax: (608) 267-7856 peter.lynch@dot.wi.gov
Sincerely,

Catherine J. Petersen Phone: 651-690-4324
C J Petersen & Associates, LLC email: cjpetersen@train2export.com

Figure 3 Survey

Wisconsin Department of Transportation

Survey

1. The survey questions were developed from the data provided by Traffic and Operations (TOPS) Laboratory at the University of Wisconsin for Large Truck Crash Data by Severity for incidents between 2005 and 2009. Please rank the following in order of crashes factor at the locations specified here and on the map depicting accident locations.

Factor	Location	Location	Location	Location
a. Lane Width				
b. Speed Limit				
c. Median Width				
d. Right Shoulder Width				
e. Left Shoulder Width				
f. Passing Sight Distance				
g. Number of Peak Lanes				
h. Left Turning Lanes				
i. Right Turning Lanes				
j. Access Control				
k. Median Type				
l. Type of Terrain				
m. Aging Infrastructure				
n. Construction Zone				
o. Other:				
p. Other:				
q. Other:				
r. Other:				

2. What is your opinion about the locations identified here relative to commercial vehicle crashes?
3. Have you identified solutions to prevent crashes at these locations?
   (Answers in a checklist supplemented by written comments)
   a. Reduced speed controls
   b. Signage
   c. Advance information
      i. Radio
      ii. GPS alerts

iii. Email
iv. Other

d. Engineering & design solutions:
   i. Lane Width
   ii. Median Width
   iii. Right Shoulder Width
   iv. Left Shoulder Width
   v. Number of Peak Lanes
   vi. Add Left Turning Lanes
   vii. Add Right Turning Lanes
   viii. Access Control
   ix. Median Type
   x. Modify Terrain
   xi. Other:

Proposed Geometric Solutions	Location	Location	Location	Location
a. Two-Lane Major Roadway with No Left-Turn Lane				
b. Two-Lane Major Roadway with Left-Turn Lane				
c. Four-Lane Major Undivided Roadway with No Left-Turn Lane				
d. Four-Lane Major Divided Roadway with No Left-Turn Lane				
e. Four-Lane Major Divided 55+ mph Roadway with Signal or Dual Left-Turn Lane				
f. Four-Lane Major Divided Roadway with Left-Turn Lane				
g. Four-Lane Major Divided Roadway with Dual Left-Turn Lane				
h. Two-Lane Major Roadway with No Left-Turn Lane				
i. Two-Lane Major Roadway with Left-Turn Lane				
j. Four-Lane Major Undivided Roadway with No Left-Turn Lane				
k. Four-Lane Major Divided Roadway with No Left-Turn Lane				
l. Four-Lane Major Divided 55+ mph Roadway with Signal or Dual Left-Turn Lane				
m. Four-Lane Major Divided Roadway with Left-Turn Lane				
n. Four-Lane Major Divided Roadway with Dual Left-Turn Lane				
o. Two-Lane Major Roadway with No Left-Turn Lane				
p. Two-Lane Major Roadway with Left-Turn Lane (One or Both Approaches)				
q. Four-Lane Major Undivided Roadway with No Left-Turn Lane				
r. Four-Lane Major Divided Roadway with No Left-Turn Lane				
s. Four-Lane Major Divided 55+ mph Roadway with Signal or Dual Left-Turn Lane (One or Both Approaches) Posted Speed on at least one major roadway approach.				
t. Four-Lane Major Divided Roadway with Left-Turn Lane				

(One or Both Approaches)				
u. Four-Lane Major Divided Roadway with Dual Left-Turn Lane (One or Both Approaches)				
v. Five or More Intersection Approaches				
w. Roundabout				
x. Four-Lane Major Undivided Roadway with Left-Turn Lane (One or Both Approaches)				
y. Four-Lane Major Undivided Roadway with Dual Left-Turn Lane (One or Both Approaches)				
z. Other				

4. What solutions have been implemented? List below provided to participant to complete.

Implemented Geometric Solutions	Location	Location	Location	Location
a. Two-Lane Major Roadway with No Left-Turn Lane				
b. Two-Lane Major Roadway with Left-Turn Lane				
c. Four-Lane Major Undivided Roadway with No Left-Turn Lane				
d. Four-Lane Major Divided Roadway with No Left-Turn Lane				
e. Four-Lane Major Divided 55+ mph Roadway with Signal or Dual Left-Turn Lane				
f. Four-Lane Major Divided Roadway with Left-Turn Lane				
g. Four-Lane Major Divided Roadway with Dual Left-Turn Lane				
h. Two-Lane Major Roadway with No Left-Turn Lane				
i. Two-Lane Major Roadway with Left-Turn Lane				
j. Four-Lane Major Undivided Roadway with No Left-Turn Lane				
k. Four-Lane Major Divided Roadway with No Left-Turn Lane				
l. Four-Lane Major Divided 55+ mph Roadway with Signal or Dual Left-Turn Lane				
m. Four-Lane Major Divided Roadway with Left-Turn Lane				
n. Four-Lane Major Divided Roadway with Dual Left-Turn				

Lane				
o. Two-Lane Major Roadway with No Left-Turn Lane				
p. Two-Lane Major Roadway with Left-Turn Lane (One or Both Approaches)				
q. Four-Lane Major Undivided Roadway with No Left-Turn Lane				
r. Four-Lane Major Divided Roadway with No Left-Turn Lane				
s. Four-Lane Major Divided 55+ mph Roadway with Signal or Dual Left-Turn Lane (One or Both Approaches) Posted Speed on at least one major roadway approach.				
t. Four-Lane Major Divided Roadway with Left-Turn Lane (One or Both Approaches)				
u. Four-Lane Major Divided Roadway with Dual Left-Turn Lane (One or Both Approaches)				
v. Five or More Intersection Approaches				
w. Roundabout				
x. Four-Lane Major Undivided Roadway with Left-Turn Lane (One or Both Approaches)				
y. Four-Lane Major Undivided Roadway with Dual Left-Turn Lane (One or Both Approaches)				
z. Other				

5. What has inhibited upgrades or improvements?
    a. funding
    b. ranking for funding
    c. other:
6. WisDOT also has its own Highway Safety Plan that includes 24 safety action items. Do you agree that these safety action items have had an impact on reducing crashes?
    a. Increase safety belt use/air bag effectiveness
    b. Improve design/operation of intersections
    c. Improve data/decision support systems
    d. Reduce speed-related crashes
    e. Reduce impaired driving
    f. Minimize consequences of leaving roadway
    g. Design safer work zones
    h. Reduce head-on and cross-median crashes
    i. Keep vehicles on the roadway
    j. Increase driver safety awareness
    k. Sustain proficiency in older drivers
    l. Insure drivers licensed / competent

m. Improve motorcycle safety
n. Curb aggressive driving
o. Improve traffic incident management
p. Drive more safely in inclement weather
q. Make truck travel safer
r. Institute Graduated Driver Licensing
s. Create more effective processes/SMS
t. Make walking/street crossing safer
u. Insure safer bicycle travel
v. Keep drivers alert
w. Enhance EMS to increase survivability
x. Reduce deer and other animal crashes
y. Reduce vehicle-train crashes
z. Increase safety enhancements in vehicles

Figure 18 County Maps

This portion of the report is a placeholder for the maps referenced.

5.1. Jackson County

5.2. Jefferson County

5.3. Juneau County

5.4. Manitowoc County

5.5. Milwaukee County

5.6. Monroe County

5.7. Outagamie County

5.8. Shawano County

5.9. Sheboygan County

5.10. WisDOT SE Region for Milwaukee County

5.11. NE Region WisDOT

5.11.2. Brown County

5.11.3. Outagamie County