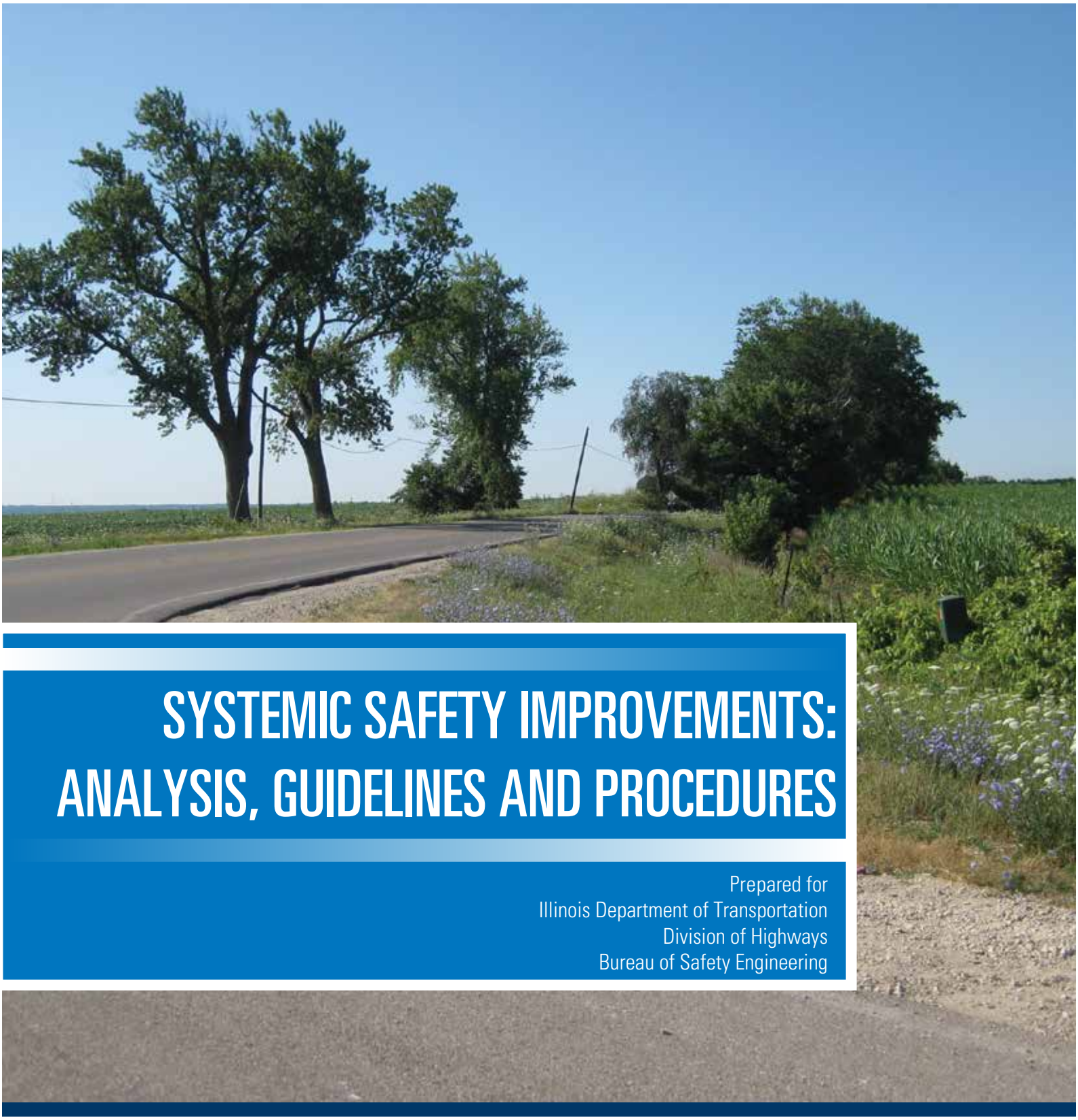
Illinois Department of Transportation

MAY 2014



SYSTEMIC SAFETY IMPROVEMENTS: ANALYSIS, GUIDELINES AND PROCEDURES

Prepared for
Illinois Department of Transportation
Division of Highways
Bureau of Safety Engineering

Driving Zero Fatalities to a Reality
Partnering for Illinois

Illinois Department of Transportation
Division of Highways
Bureau of Safety Engineering

Prepared by
CH2M HILL

May 2014

Table of Contents

Acronyms and Abbreviations ..... **iii**

1.0 Introduction **1-1**

2.0 Systemic Safety Analysis Tools **2-1**

3.0 Network Screening Tools **3-1**
- 3.1 Emphasis Area Tables 3-2
- 3.2 Data Trees 3-5
- 3.3 Heat Maps 3-14
- 3.4 FIVE PERCENT Report 3-17

4.0 Detailed Systemic Analysis Process **4-1**
- 4.1 Location Types 4-2
  - 4.1.1 Intersections 4-2
  - 4.1.2 Segments 4-2
  - 4.1.3 Curves 4-2
- 4.2 Process of Data Collection 4-3
  - 4.2.1 Highway Safety Manual Roadside Hazard Rating (RHR) 4-10
- 4.3 Table/Data Formatting 4-12
- 4.4 Data Organization 4-16
- 4.5 Obtaining Critical Values 4-21
- 4.6 Compilation and Presentation of Results 4-24
- 4.7 Field Assessment 4-29

5.0 Countermeasure Selection **5-1**

6.0 Benefit/Cost Analysis **6-1**

7.0 References and Additional Resources **7-1**

Tables

3-1 Illinois County Emphasis Area Table – Statewide Comparison (2007-2011 Collisions) 3-3
4-1 Roadside Hazard Ratings 4-11
4-2 Intersections Inputs and Conventions 4-13
4-3 Segments Inputs and Conventions 4-14
4-4 Curves Inputs and Conventions 4-15
4-5 Data Collection Excel Intersection Layout 1 4-17
4-6 Data Collection Excel Intersection Layout 2 4-18
4-7 Data Collection Excel Layout - Segment 4-19
4-8 Curves Radius Data Distribution 4-22
4-9 Sample of Priority Group (PG) Qualifiers 4-28
5-1 Comprehensive List of Older Driver Safety Strategies 5-1
5-2 Comprehensive List of Young Driver Safety Strategies 5-2
5-3 Comprehensive List of Aggressive Driving Safety Strategies 5-3
5-4 Comprehensive List of Impaired Driving Safety Strategies 5-4
5-5 Comprehensive List of Seat Belt Usage Safety Strategies 5-5
5-6 Comprehensive List of Road Departure Safety Strategies 5-6
5-7 Comprehensive List of Curve Safety Strategies 5-7

5-8 Comprehensive List of Signalized Intersection Safety Strategies 5-8
5-9 Comprehensive List of Unsignalized Intersection Safety Strategies 5-9
5-10 Comprehensive List of Head-on Safety Strategies 5-11
5-11 Comprehensive List of Heavy Vehicle Safety Strategies 5-12
5-12 Comprehensive List of Emergency Services Safety Strategies 5-13
5-13 Comprehensive List of Motorcycle Collision Safety Strategies 5-14
5-14 Comprehensive List of Distracted, Inattentive, and Asleep Driver Safety Strategies 5-15
5-15 Comprehensive List of Pedestrian Safety Strategies 5-16

Figures

1-1 Safety in the Transportation Management Process 1-1
2-1 Geographic Information System Query Analysis Example 2-1
2-2 Geographic Information System Fatal/A-Injury Crash Query Analysis 2-2
3-1 Network Screening Tools 3-1
3-2 Illinois County Data Tree – County and Municipality Roadway Systems 3-7
3-3 Illinois County Data Tree – Township Roadway System 3-9
3-4 Illinois County Data Tree – State and Private/Toll Roadway Systems 3-11
3-5 Illinois County Data Tree – State Routes Urban Areas Branches 3-13
3-6 Example Illinois County Heat Map – KAB Younger Driver Crashes Per Section Square 3-15
3-7 Behavioral Crash Summaries by County – Older and Younger Drivers 3-19
4-1 IDOT Systemic Safety Detailed Analysis Process 4-1
4-2 Visual Traps 4-4
4-3 Intersection on Curve 4-5
4-4 Lane/Shoulder Widths 4-5
4-5 Roadway Features 4-6
4-6 Curve Radius and Length 4-6
4-7 Commercial Development and On/Near Curve 4-7
4-8 Skewed Intersection 4-7
4-9 Major Residential Access Point 4-8
4-10 Other Access Density Entry Points 4-9
4-11 Critical Values for Curve Radii 4-22
4-12 County Detailed Location Template 4-25
4-13 Map of Priority Group Locations Shown by Color 4-27
6-1 Summary Sheet from Benefit/Cost Tool 6-3

Acronyms and Abbreviations

4E	Engineering, Enforcement, Education, and Emergency Medical Services
AADT	Annual Average Daily Traffic
AASTHO	American Association of State Highway and Transportation Officials
BSE	Bureau of Safety Engineering
CMF	Crash Modification Factor
Department	Illinois Department of Transportation
FHWA	Federal Highway Administration
FO/OVT	Fixed Object/Overturned
GIS	Geographic Information System
HSM	Highway Safety Manual
ID	identification number
IDOT	Illinois Department of Transportation
K/A	Fatal/A-Injury crashes
KAB	Fatal, A-injury and B-Injury Combined
RD	Road Departure (fixed object, overturned, sideswipe opposite direction and head-on crashes)
RE/SSD	Rear End/Sideswipe Opposite Direction
RHR	Roadside Hazard Rating
SDM	Safety Data Mart
SHSP	Strategic Highway Safety Plan
TEV	Total Entering Vehicles
VMT	Vehicle Miles Traveled

1.0 Introduction

As outlined in the Illinois Strategic Highway Safety Plan (ISHSP), Illinois is focused on saving lives and reducing severe injuries on Illinois roadways. The State of Illinois is planning to make zero fatalities a reality through a variety of data-driven, collaborative safety initiatives and programs. The 4E safety partners Engineering, Enforcement, Education, and Emergency Medical Services are collaborating to address safety needs.

As shown in Figure 1-1, roadway safety is a continuum. A completely safe road would have no crashes, and less safe roads would have more frequent and more severe crashes. By this standard, perfect safety is impossible, but it is possible to affect the frequency and severity of crashes to make the road more or less safe. The challenge is to apply limited resources to provide meaningful improvements to safety. The Illinois Department of Transportation (IDOT) is incorporating safety into the overall transportation management process, namely Planning and Programming, Scoping and Phase I, Design and Construction, Operations and Maintenance and Performance Management, to ensure that safety is considered explicitly in all decisions of the project development process. Incorporating safety in planning and programming allows for improvements to be addressed early in the process but safety improvements may be considered in all stages of the process.

FIGURE 1-1
Safety in the Transportation Management Process

A variety of tools have been developed to help identify high priority areas for improvement that may benefit from implementation of safety countermeasures. These tools include, but are not limited to, the American Association of State Highway and Transportation Officials (AASTHO) *Highway Safety Manual 1st Edition* (HSM), the Federal Highway Administration (FHWA) Systemic Tool, and the IDOT *Systemic Safety Improvements: Analysis, Guidelines and Procedures* document.

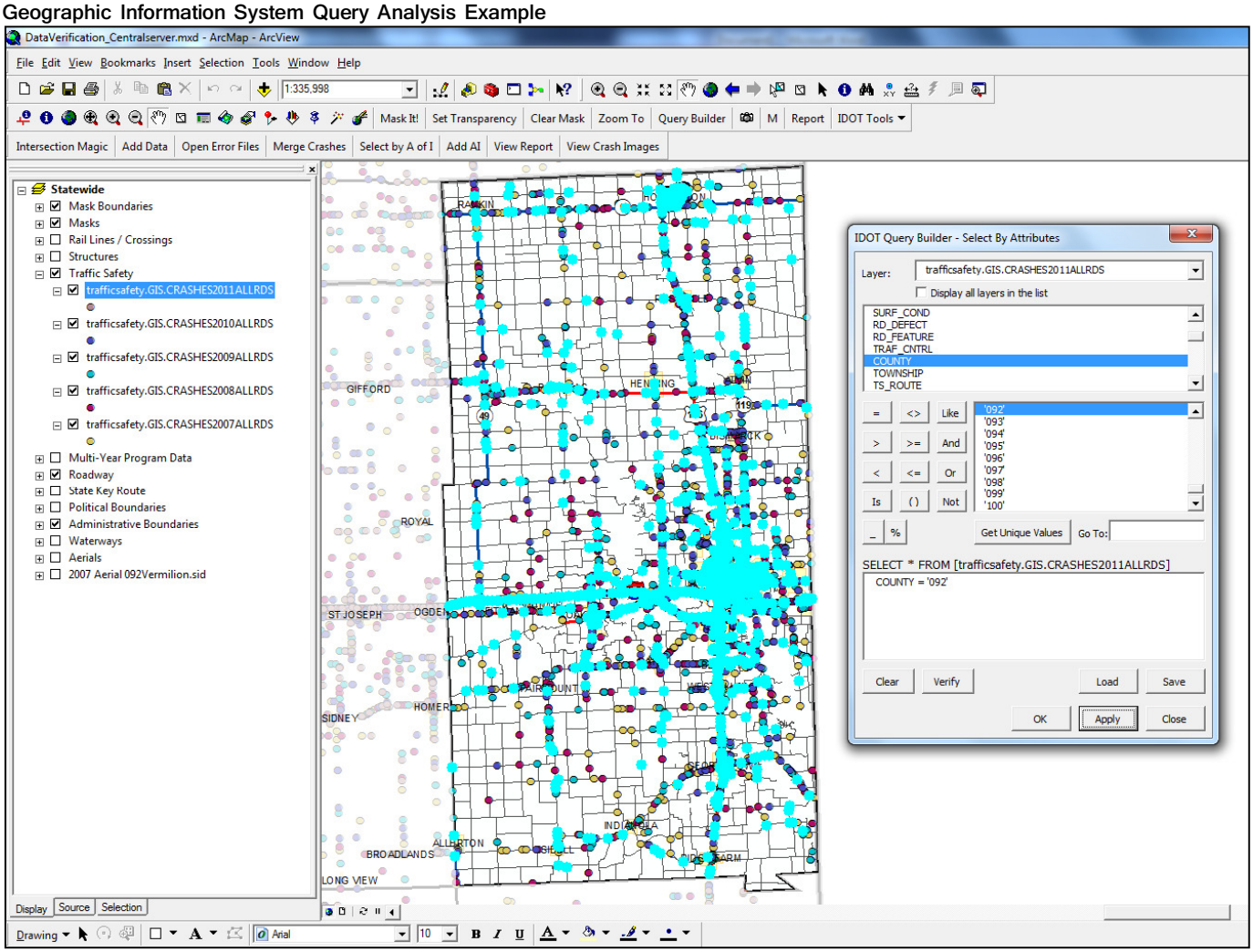
HSM Part B outlines the roadway safety management process, which includes network screening, diagnosis, countermeasure selection, economic appraisal, project prioritization, and safety effectiveness evaluation. The FHWA Systemic Tool outlines an approach for proactive safety screening and project development. The IDOT *Systemic Safety Improvements: Analysis, Guidelines and Procedures* are similar. The Guidelines outline an approach for identifying high priority areas to integrate safety into projects and plans throughout the transportation management process. These Guidelines are intended to be used by IDOT district staff, local municipalities, and others to help direct and enhance their safety programs.

This document explains how to collect crucial safety data that is not readily available, analyze safety data, use available resources to implement strategies effectively and make proactive infrastructure improvements, and to target enforcement and education programs. The information presented in this document will assist in better identifying potential safety performance issues on a roadway system and guide efforts to save lives. Specifically, this document includes the tools necessary for conducting safety analysis, network screening and the systemic approach. These Guidelines detail the systemic process which includes collecting data, organizing the data, obtaining critical values, compiling the results, field assessment and countermeasure selection. This document also includes an example of a systemic Benefit/Cost analysis using the Illinois Benefit/Cost Tool.

2.0 Systemic Safety Analysis Tools

Geographic Information Systems (GIS) is one of the primary tools used to analyze crash data. Being a very versatile program, ArcGIS allows the user to view and manipulate data layers as desired. Queries can be performed to focus on a certain aspect of a database which gives the ability to investigate on a crash by crash basis. Figure 2-1 shows how a certain type of crash can be selected and highlighted in blue to distinguish the selected data from all other data.

FIGURE 2-1
Geographic Information System Query Analysis Example

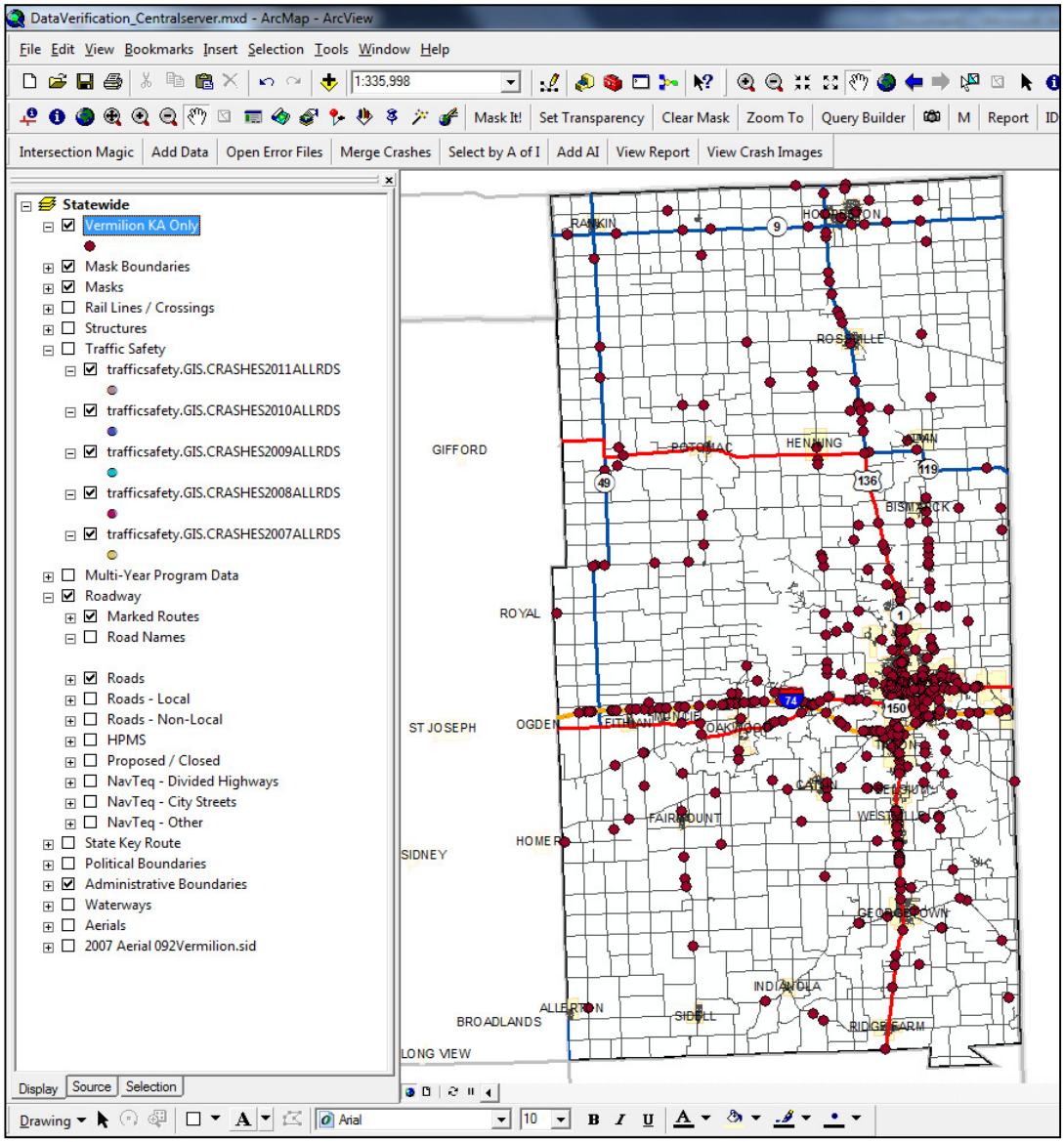


GIS layers should be used that contain crash data for the district, county or municipality of interest. If the data layer contains crashes for the entire state, the query builder is very useful in slimming down the specific crash data information to a specific area. This helps keep the data layer smaller and easier to use.

Because the main focus is on severe crashes, a query can be developed to highlight Fatal/A-injury (K/A) injury crashes within county borders, as shown in Figure 2-2. From here, any of the specific locations can be considered for further analysis and field assessment. The three major location categories are intersections, segments, and curves.

Safety Data Mart (SDM) is another valuable tool for analyzing crash data if GIS is not readily available. All 9 IDOT District offices have the internal SDM, and other safety stakeholders should be able to use the external SDM, which is readily available upon request through the Bureau of Safety Engineering (BSE).

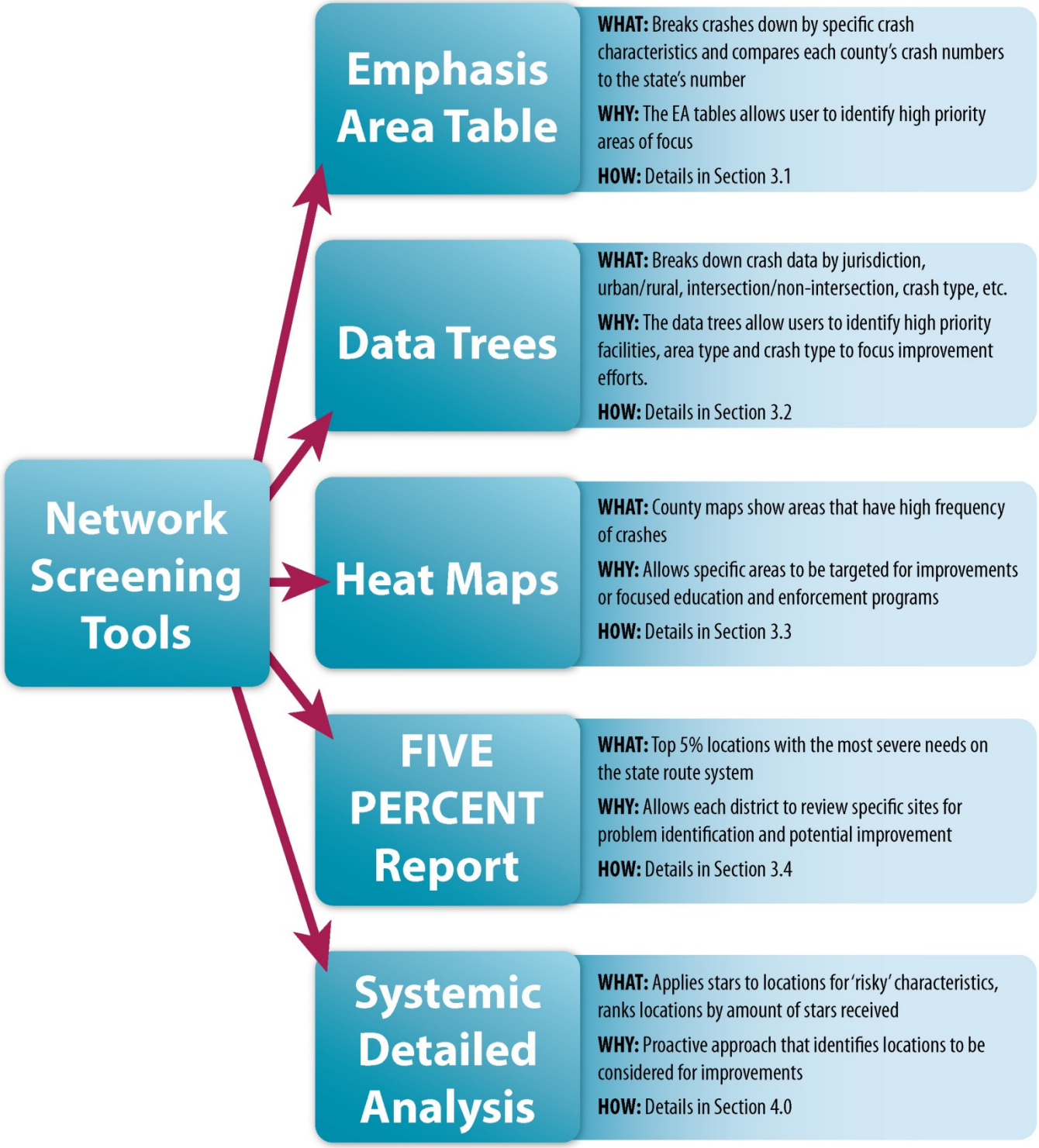
FIGURE 2-2
Geographic Information System Fatal/A-Injury Crash Query Analysis



ArcGIS is one of the major instruments used for creating network screening tools. Other programs which the user should have basic knowledge include Microsoft Excel, Microsoft Access, Google Earth Pro®, and the Illinois Benefit/Cost Tool.

3.0 Network Screening Tools

FIGURE 3-1
Network Screening Tools



3.1 Emphasis Area Tables

Emphasis Area (EA) tables compare a county's crash numbers to the entire state's numbers. Roadway systems are broke down into State and County/Local. This is similar to Data Trees, but unlike Data Trees, the Emphasis Area Tables also show overrepresented categories and behavioral categories. Overrepresented categories are highlighted by orange cells, as shown in Table 3-1. Section 4.5, Obtaining Critical Values explains the concept of overrepresentation.

These additional behavioral categories are younger drivers, older drivers, aggressive drivers, drug/alcohol related crashes, inattentive/distracted/sleeping drivers and unbelted/no safety restraint crashes. By comparing each Emphasis Area against the others, it can be seen which types of crashes should be considered for implementing safety efforts.

Table 3.1
Illinois County Emphasis Area Tables:
Statewide Comparison (2007-2011 Collisions)

		Comparison [a]				Illinois County			
		State System		County/Local		State System		County/Local	
Emphasis Area		Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency
Total Fatal and Serious Injury Collisions (K+A)			28,894		25,971		1,326		1,731
Drivers	Younger Drivers (16-20)	18.8%	5,431	21.6%	5,618	21.5%	285	25.1%	435
	Older Drivers (65+)	15.6%	4,516	12.3%	3,187	14.6%	193	16.7%	289
	Aggressive Driving/Speed Related [b]	41.0%	11,856	37.9%	9,847	**51.9%**	688	43.8%	758
	Drug/Alcohol Related	14.6%	4,231	16.3%	4,221	11.6%	154	11.8%	204
	Inattentive/Distracted/Asleep Drivers	6.9%	1,998	5.7%	1,484	6.8%	90	5.6%	97
	Unbelted/No Safety Restraint Occupants	19.8%	5,712	22.2%	5,754	13.7%	182	16.6%	288
Special Users	Pedestrian	7.2%	2,068	12.2%	3,170	4.7%	62	9.6%	167
	Bicycle	2.6%	756	5.5%	1,430	1.6%	21	6.9%	119
Vehicles	Motorcycle	10.1%	2,918	10.6%	2,742	6.9%	92	8.3%	143
	Heavy Vehicle	10.2%	2,948	4.3%	1,110	12.4%	165	4.4%	77
Highways	Train-Vehicle	0.0%	12	0.3%	83	0.0%	0	0.3%	5
	Road Departure [c]	25.0%	7,221	31.6%	8,194	14.6%	194	17.5%	303
	Head-On/Sideswipe Opposite Direction	6.7%	1,938	4.5%	1,175	4.1%	54	4.7%	81
	Intersection Related [d]	44.1%	12,736	40.9%	10,633	48.9%	648	**54.1%**	937
	Work Zone Related	2.1%	614	1.1%	276	3.2%	42	1.6%	27

Areas for Potential Safety Program Focus:

- Orange fill indicates overrepresentation
- **0.00%** - Red text indicates largest category percentage

[a] Comparison data is from Statewide Crash Data

[b] Includes exceeding authorized speed limit, following too closely, exceeding safe speeds for conditions, failure to reduce speed to avoid crash, or operating vehicle in erratic, reckless, careless, negligent or aggressive manner.

[c] Includes Overturned, Fixed Object, and Other Object collision types

[d] Defined as collisions located within 250 feet of a rural intersection or 150 feet of an urban intersection and also coded as intersection related by the reporting officer. State system intersections are defined as intersection with at least one state roadway leg. County/Local intersection are defined as intersection with all County/Local roadway legs .

* Toll/Private systems are excluded due to insignificant number of crashes.

Emphasis Area categories types are NOT mutually exclusive, meaning one Emphasis Area collision type can occur with or without another Emphasis Area collision type. If mutliple Emphasis Area collision types occur in the same collision, the collision will be counted once for each Emphasis Area collision type. Hence, the sum of all Emphasis Area category collision types for each system may be greater than the overall frequency for that system.

3.2 Data Trees

To determine which roadway systems to analyze, safety engineers should look at County Data Trees, which are provided by BSE. These Data Trees will help determine a direct area of focus. The Data Tree separates crash data between the state, toll/private, county, township, and municipal roadway systems. Depending on the jurisdiction of interest, the Data Tree may branch out into more detail. The primary focus should be on severe crashes from the most recent 5-year period (for example, 2007 through 2011). 'A-injury' crashes are crashes that result in an incapacitating injury, which is any injury, other than fatal, that prevents the person from walking, driving, or normally continuing the activities that he or she was able to perform before the crash occurred. A-injuries include, but are not limited to severe lacerations, broken/distorted limbs, skull injuries, chest injuries, and abdominal injuries.

A 5-year period is used to give an overall understanding of the crashes, rather than looking at random crashes for each year. It is important to ensure that any and all locations where severe crashes have occurred are considered for safety improvements to reduce fatal and severe crashes in the near future. In the example Illinois County Data Trees illustrated in Figures 3-2, 3-3, and 3-4, the majority of the severe crashes are on state roads (40 percent). County routes have the second highest severe crash rate in the example Data Tree (26 percent). Because the majority of severe crashes are happening on state roads, these crashes can be investigated using the next branches of the Data Tree, shown in Figure 3-5.

These next branches break the crashes down into urban and rural areas. In the example, urban areas account for all of the severe crashes on state routes, so continuing to follow this branch would help to narrow down specific crashes that seem to be a frequent problem. Figure 3-5 also shows the last few branches for urban, state routes. This shows that crashes are next broken down between intersection crashes and non-intersection crashes. On the non-intersection branch, the green oval shows that 'Road Departure' (RD) and 'Rear End/Sideswipe Same Direction' (RE/SSD), severe crashes account for the largest percentages.

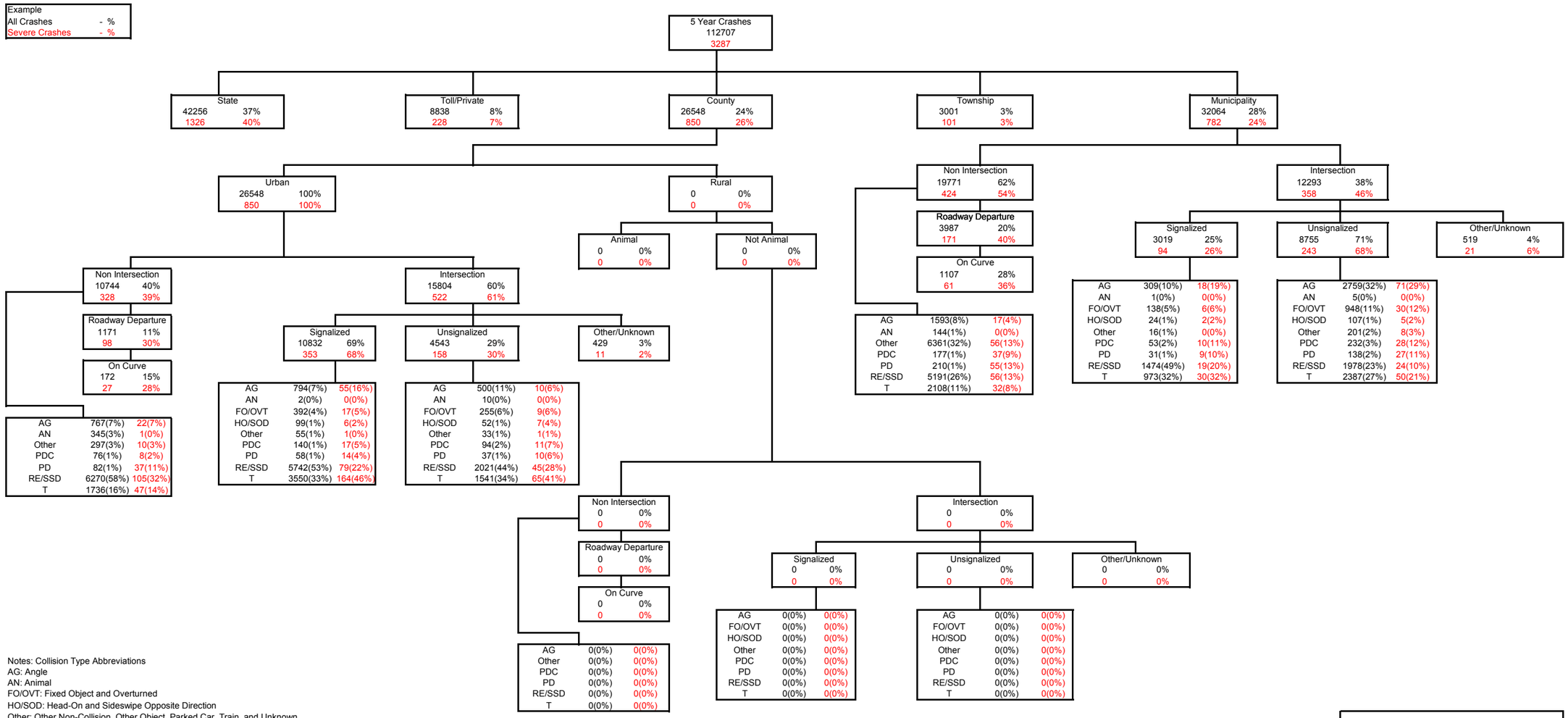
For the example Data Tree, the main focus would be on non-intersection, state routes that are in urban areas. Collecting data on these systems may be necessary to better understand why the system continues to have these types of problems. Data Trees are a highly beneficial first step in determining which jurisdiction of roadway systems should be the primary concern focus area.

Figure 3-2

Illinois County: 2007 to 2011 Crash Data Overview

County and Municipality Roadway Systems

Source: IDOT Safety Analyst 2007 - 2011 Crash Data
All crashes include fatal, all injury and property damage only crashes
Severe crashes include fatal and serious injury crashes only (K + A)



Notes: Collision Type Abbreviations
AG: Angle
AN: Animal
FO/OVT: Fixed Object and Overturned
HO/SOD: Head-On and Sideswipe Opposite Direction
Other: Other Non-Collision, Other Object, Parked Car, Train, and Unknown
PDC: Pedalcyclist
PD: Pedestrian
RE/SSD: Rear End and Sideswipe Same Direction
T: Turning

Query Assumptions for Roadway Departure and On-Curve
Roadway Departure: Fixed Object, Overturned, Head-On, and Sideswipe Opposite Direction
On-Curve: Road Departure Crashes on Level Curve, Curve on Grade, and Curve on Hillcrest

Urban and Rural designations are defined by the Urban Area code in the Illinois Roadway Inventory System

Intersection crashes are defined as crashes located within 250 feet of a rural intersection or 150 feet of a urban intersection and also coded as intersection related by the reporting police officer

Intersection crashes are counted only once and are represented by only one jurisdiction using the following hierarchy.
S: State, C: County, T: Township, M: Municipality, T/P: Toll/Private

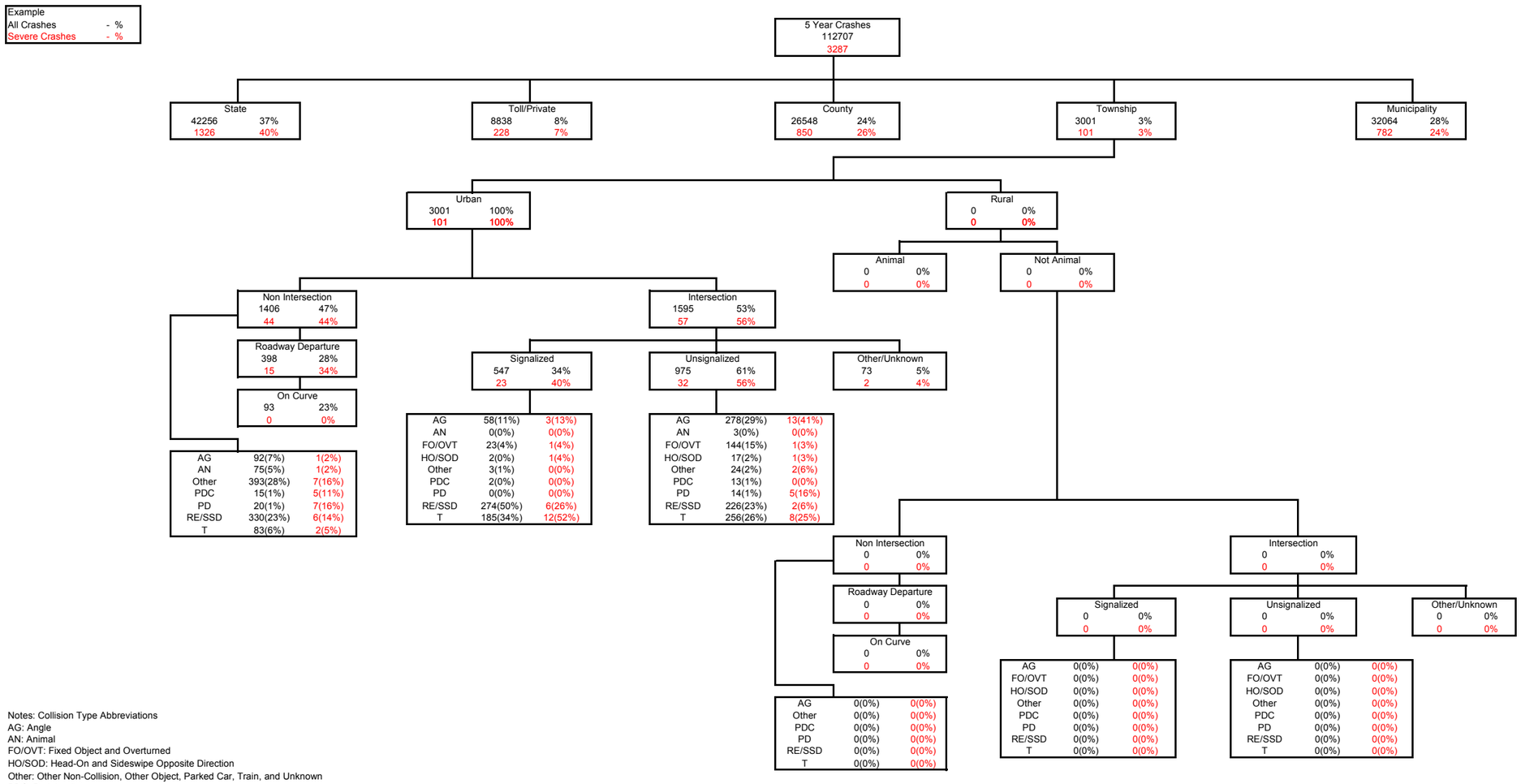
Results of the analyses shown in this table are based on data that was received from the Illinois Department of Transportation on May 23, 2012. Crash data represents years 2007 to 2011 and the roadway data represents the end of the 2009 year conditions. The data was used "as is" for analysis purposes and should be interpreted accordingly

Intersection Crashes by Cross Street Jurisdiction		
County		
County-County	2384(15%)	82(16%)
County-Township	1771(11%)	59(11%)
County-Municipal	11177(71%)	375(72%)
County-Toll/Private	472(3%)	6(1%)
Municipality		
Municipal-Municipal	12225(99%)	356(99%)
Municipal-Toll/Private	68(1%)	2(1%)

Illinois Department of Transportation
CH2MHILL
July 2012

Figure 3-3
Illinois County: 2007 to 2011 Crash Data Overview
Township Roadway System

Source: IDOT Safety Analyst 2007 - 2011 Crash Data
All crashes include fatal, all injury and property damage only crashes
Severe crashes include fatal and serious injury crashes only (K + A)



Notes: Collision Type Abbreviations
AG: Angle
AN: Animal
FO/OVT: Fixed Object and Overturned
HO/SOD: Head-On and Sideswipe Opposite Direction
Other: Other Non-Collision, Other Object, Parked Car, Train, and Unknown
PDC: Pedalcyclist
PD: Pedestrian
RE/SSD: Rear End and Sideswipe Same Direction
T: Turning

Query Assumptions for Roadway Departure and On-Curve
Roadway Departure: Fixed Object, Overturned, Head-On, and Sideswipe Opposite Direction
On-Curve: Road Departure Crashes on Level Curve, Curve on Grade, and Curve on Hillcrest

Urban and Rural designations are defined by the Urban Area code in the Illinois Roadway Inventory System

Intersection crashes are defined as crashes located within 250 feet of a rural intersection or 150 feet of a urban intersection and also coded as intersection related by the reporting police officer

Intersection crashes are counted only once and are represented by only one jurisdiction using the following hierarchy.
S: State, C: County, T: Township, M: Municipality, T/P: Toll/Private

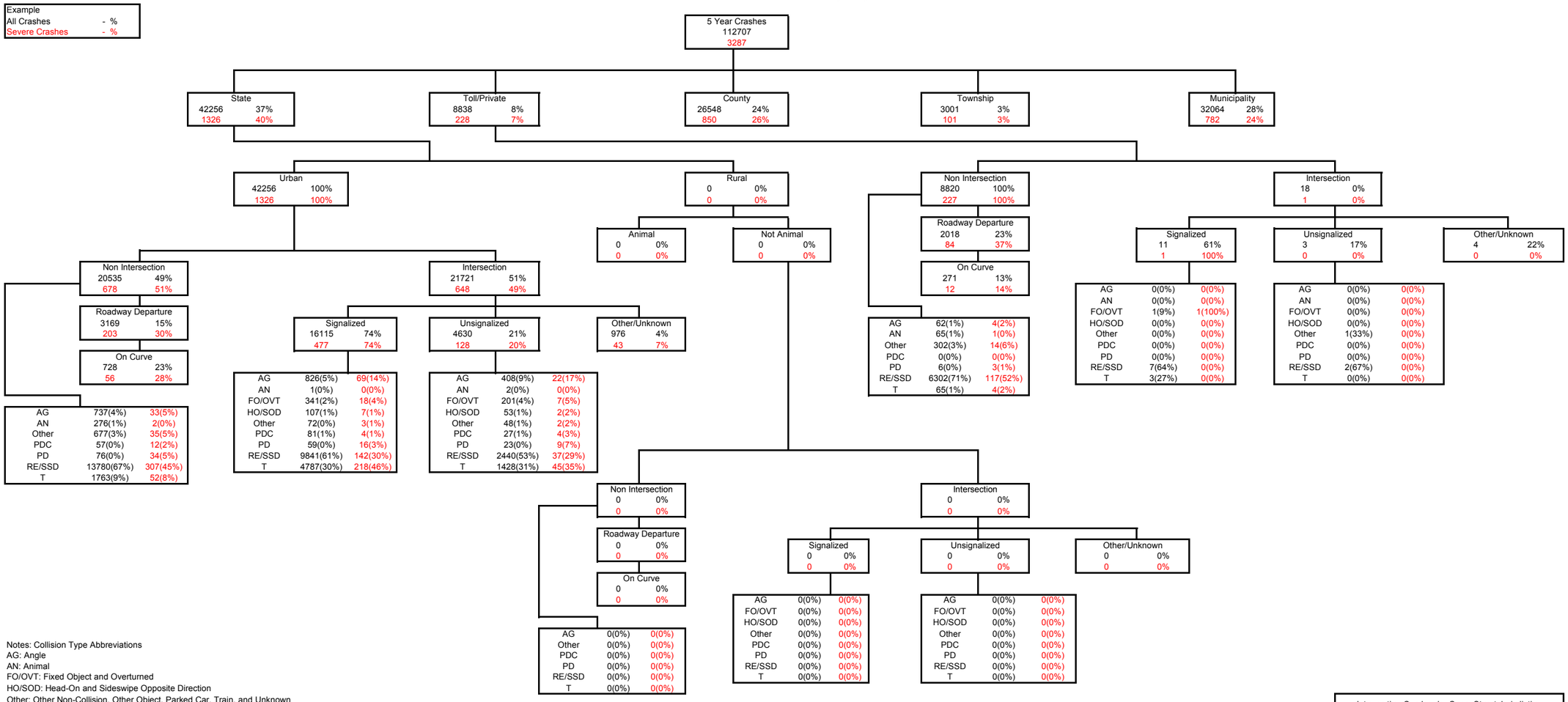
Results of the analyses shown in this table are based on data that was received from the Illinois Department of Transportation on May 23, 2012. Crash data represents years 2007 to 2011 and the roadway data represents the end of the 2009 year conditions. The data was used "as is" for analysis purposes and should be interpreted accordingly

Intersection Crashes by Cross Street Jurisdiction		
Township		
Township-Township	466(29%)	14(25%)
Township-Municipal	1097(69%)	41(72%)
Township-Toll/Private	32(2%)	2(4%)

Illinois Department of Transportation
CH2MHILL
July 2012

Figure 3-4
Illinois County: 2007 to 2011 Crash Data Overview
State and Private/Toll Roadway Systems

Source: IDOT Safety Analyst 2007 - 2011 Crash Data
All crashes include fatal, all injury and property damage only crashes
Severe crashes include fatal and serious injury crashes only (K + A)



Notes: Collision Type Abbreviations
AG: Angle
AN: Animal
FO/OVT: Fixed Object and Overturned
HO/SOD: Head-On and Sideswipe Opposite Direction
Other: Other Non-Collision, Other Object, Parked Car, Train, and Unknown
PDC: Pedalcyclist
PD: Pedestrian
RE/SSD: Rear End and Sideswipe Same Direction
T: Turning

Query Assumptions for Roadway Departure and On-Curve
Roadway Departure: Fixed Object, Overturned, Head-On, and Sideswipe Opposite Direction
On-Curve: Road Departure Crashes on Level Curve, Curve on Grade, and Curve on Hillcrest

Urban and Rural designations are defined by the Urban Area code in the Illinois Roadway Inventory System

Intersection crashes are defined as crashes located within 250 feet of a rural intersection or 150 feet of a urban intersection and also coded as intersection related by the reporting police officer

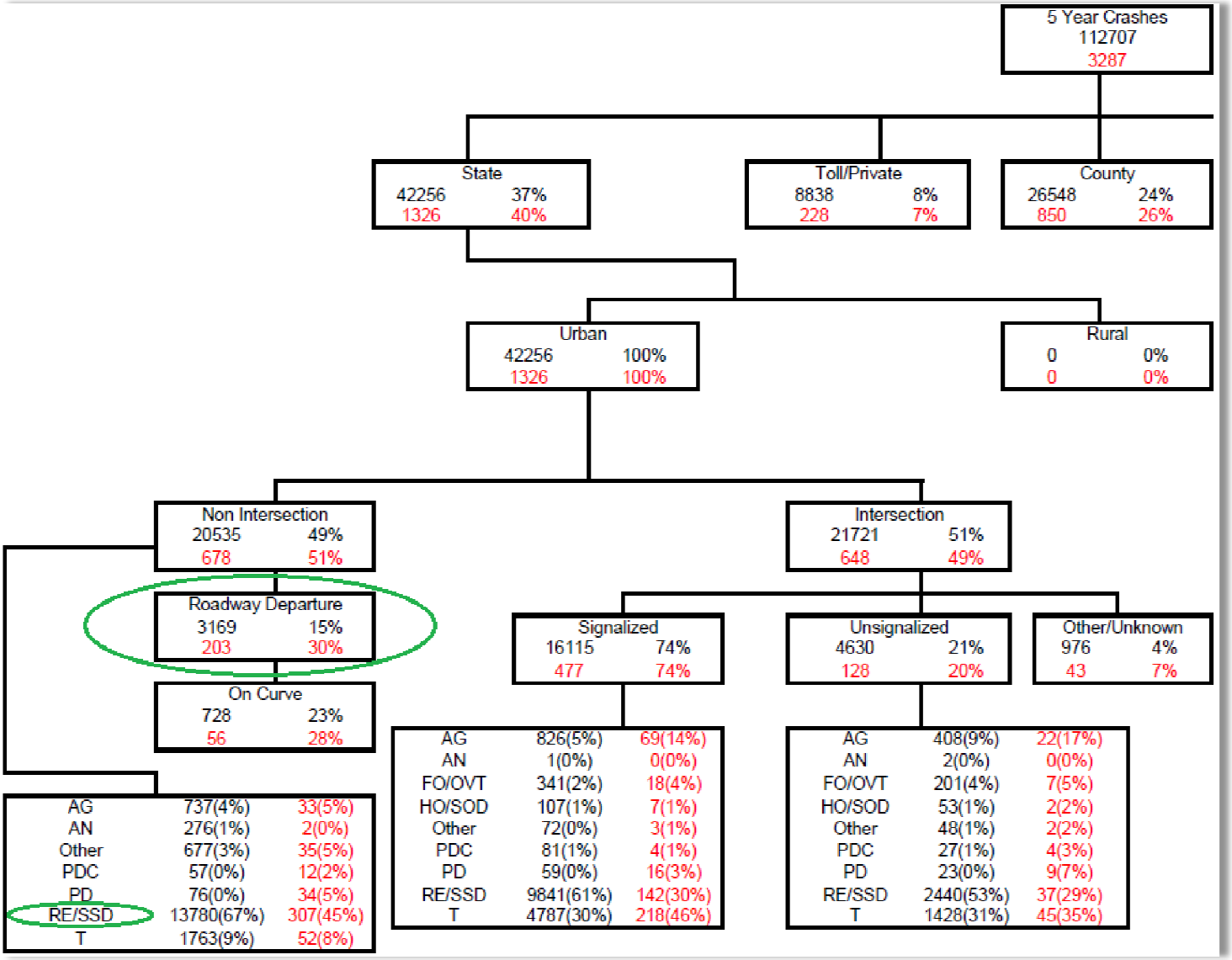
Intersection crashes are counted only once and are represented by only one jurisdiction using the following hierarchy.
S: State, C: County, T: Township, M: Municipality, T/P: Toll/Private

Results of the analyses shown in this table are based on data that was received from the Illinois Department of Transportation on May 23, 2012. Crash data represents years 2007 to 2011 and the roadway data represents the end of the 2009 year conditions. The data was used "as is" for analysis purposes and should be interpreted accordingly

Intersection Crashes by Cross Street Jurisdiction		
County		
State-State	1859(9%)	40(6%)
State-County	7307(34%)	216(33%)
State-Township	2130(10%)	77(12%)
State-Municipal	9819(45%)	298(46%)
State-Toll/Private	606(3%)	17(3%)
Toll/Private		
Toll/Private-Toll/Private	18(100%)	1(100%)

Illinois Department of Transportation
CH2MHILL
July 2012

FIGURE 3-5
Illinois County Data Tree – State Routes Urban Areas Branches

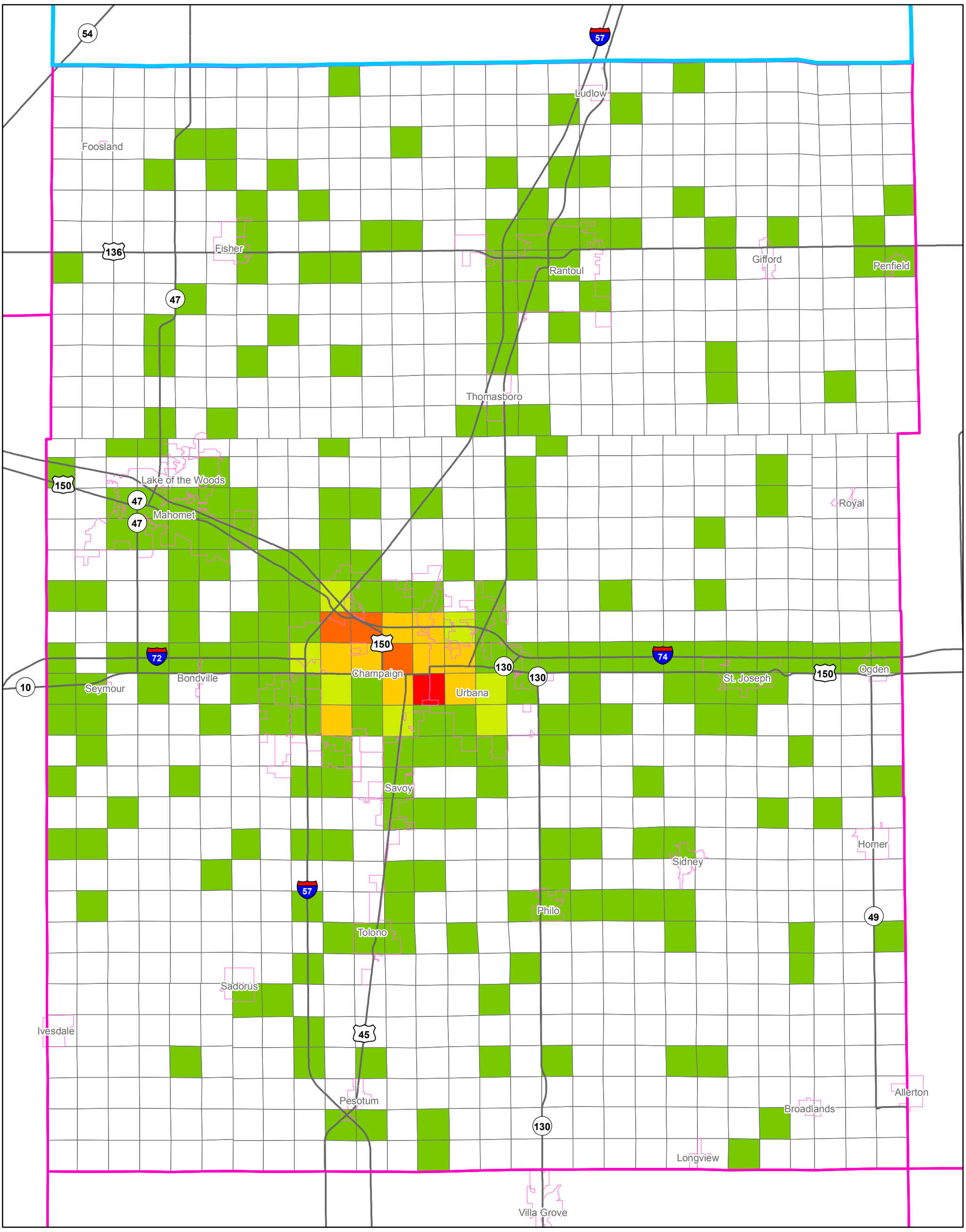


3.3 Heat Maps

Reviewing Heat Maps is another way to screen locations based on driver behavior and crash patterns. These maps cover a range of engineering and non-engineering focus areas, such as impaired drivers, older drivers, unrestrained drivers and/or occupants, younger drivers, intersection related crashes, non-intersection related crashes, and roadway departure crashes. Using the crash count intervals per section square in the legend (Figure 3-6), different colors show how an area “behaves.” Areas with a high frequency of red and orange squares are experiencing high levels of a certain problem.

Heat Maps can be very beneficial as a screening tool for law enforcement by pinpointing areas that show overrepresentation of crashes involving impaired or unrestrained drivers. Law enforcement can patrol these areas to prevent those drivers from causing severe injuries. Heat Maps also enable the use of the 4E concept of Engineering, Enforcement, Education, and Emergency Medical Services working together to reduce crashes and improve the safety of all roadway users.

The Heat Maps are readily available through BSE on a county by county basis.



Legend

- City Boundary
- County Boundary
- District Boundary

KAB Younger Driver Crashes Per Section Square

- 0
- 1 - 7
- 8 - 14
- 15 - 22
- 23 - 29
- 30 - 36

*Legend intervals are based on KAB younger driver crashes that occured in the Example Illinois County.

0 1.5 3 Miles

N

Illinois Department of Transportation

CH2MHILL

FIGURE 3-6
EXAMPLE ILLINOIS COUNTY
KAB Younger Driver Crashes Per Section Square
(All Routes Included)
Analysis Period: 2007-2011

Note: On average, section squares have an area of approximately 1 square mile.

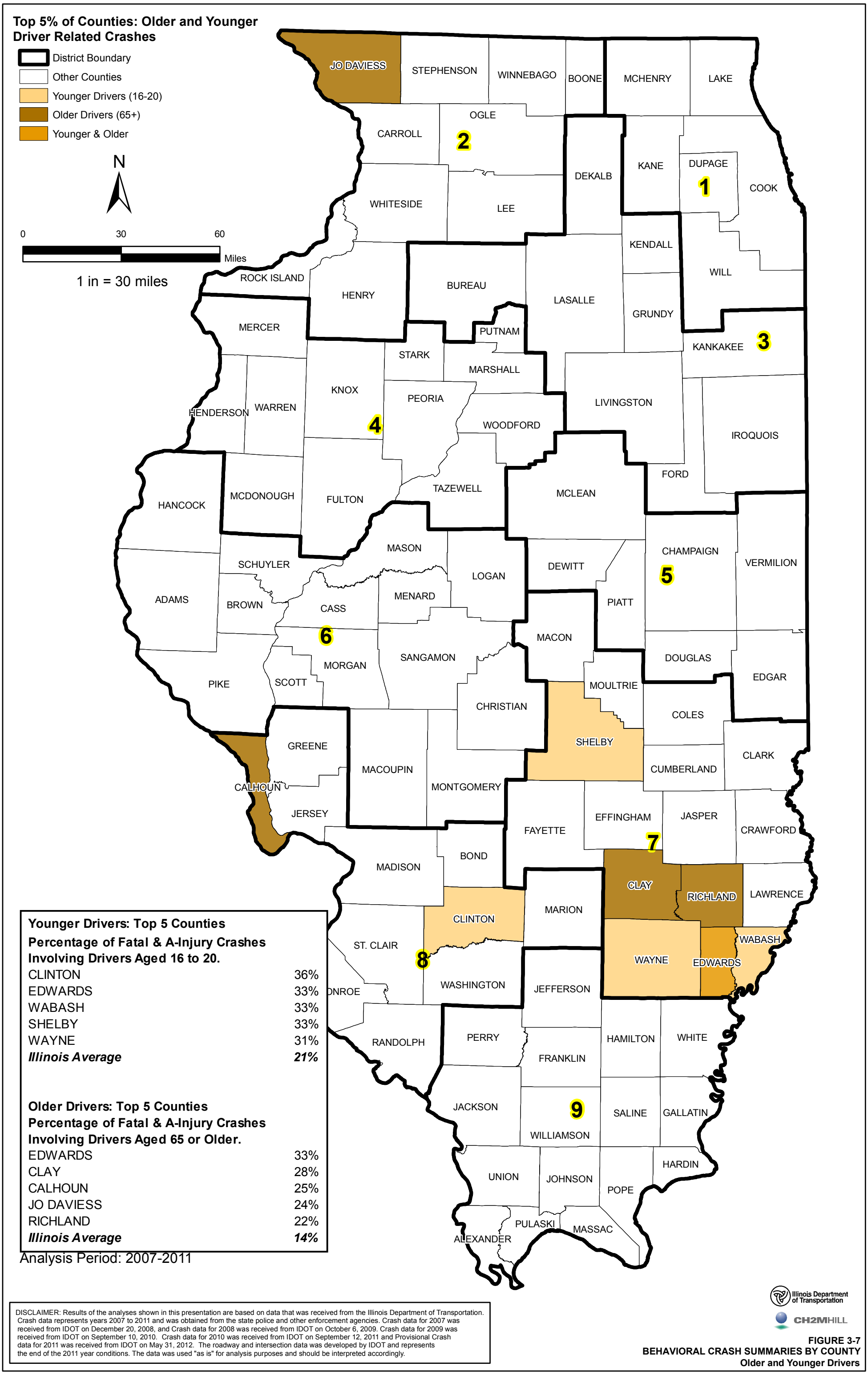
DISCLAIMER: Results of the analyses shown in this table are based on data that was received from the Illinois Department of Transportation. Crash data represents years 2007 to 2011 and was obtained from the state police and other enforcement agencies. Crash data for 2007 was received from IDOT on December 20, 2008, and Crash data for 2008 was received from IDOT on October 6, 2009. Crash data for 2009 was received from IDOT on September 10, 2010. Crash data for 2010 was received from IDOT on September 12, 2011 and Provisional Crash data for 2011 was received from IDOT on May 31, 2012. The roadway and intersection data was developed by IDOT and represents the end of the 2011 year conditions. The data was used "as is" for analysis purposes and should be interpreted accordingly.

Draft_June 21, 2013 WOXX_CountySafety\County_SHSPs\Champaign Template\Databases Spatial\SHSP maps

3.4 FIVE PERCENT Report

The FIVE PERCENT Report is submitted annually to the Federal Highway Administration describing at least 5 percent of state jurisdiction highway locations exhibiting the most pressing safety needs. The FIVE PERCENT Report can help gain a better understanding of the characteristics of the roads and the nature of the road's safety problems, help steer efforts towards areas that are in need of safety investments and provide a basis for tracking the progress toward improving their county. Utilizing the FIVE PERCENT Report is another network screening tool that gives users more insight on where to implement the most cost-effective countermeasures.

Figure 3-7 shows one of the many maps that are included in the FIVE PERCENT Report. This figure concentrates on crashes that involved younger or older drivers. The top 5 counties are shown in the lower left box for each of the two categories. Their respective percentage is also listed and can be compared to the Illinois average. Visuals like this are just another tool that can help in the network screening process.



DISCLAIMER: Results of the analyses shown in this presentation are based on data that was received from the Illinois Department of Transportation. Crash data represents years 2007 to 2011 and was obtained from the state police and other enforcement agencies. Crash data for 2007 was received from IDOT on December 20, 2008, and Crash data for 2008 was received from IDOT on October 6, 2009. Crash data for 2009 was received from IDOT on September 10, 2010. Crash data for 2010 was received from IDOT on September 12, 2011 and Provisional Crash data for 2011 was received from IDOT on May 31, 2012. The roadway and intersection data was developed by IDOT and represents the end of the 2011 year conditions. The data was used "as is" for analysis purposes and should be interpreted accordingly.

FIGURE 3-7
BEHAVIORAL CRASH SUMMARIES BY COUNTY
Older and Younger Drivers

4.0 Detailed Systemic Analysis Process

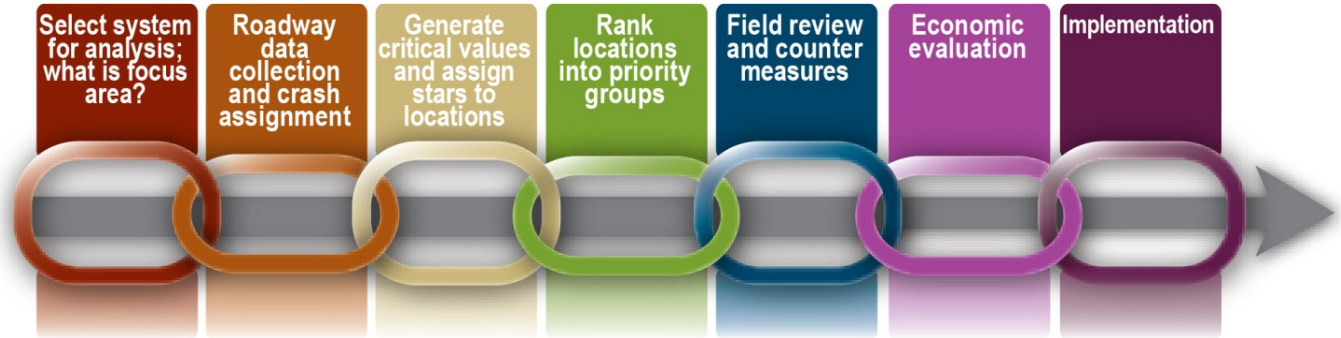
To isolate each component of study, the roadways can be broken down into categories. Each piece should be considered as an intersection or segment. Within the segments, there are corridors and curves. One approach is to see where severe K/A crashes are occurring on a map using GIS, like shown in Figure 2-2. If a cluster of K/A crashes is occurring on a specific stretch of road, this stretch can be identified as a potential “site” to review. Once these types of locations are identified, it is recommended that all the crash data for that particular segment/corridor or intersection be gathered. Simply reviewing the crash data for crashes at the same location may help to determine the contributing factors of a crash.

Another approach is a method developed that considers several elements using a star rating system as explained in Section 4.6. Stars are assigned to locations based on certain risk features, such as skewed intersections, curves with intersections, or segments with hazardous roadside characteristics. If a location acquires multiple stars, it is an indication that the location needs further attention.

This detailed analysis methodology is discussed in the following sections of the report and the general process is shown in Figure 4-1 below. Some of the items that are eligible to receive stars were AADT, RD crash density, total K/A crashes, and access density, among others.

A complete list of the items that earned stars is in Section 4.5, Obtaining Critical Values.

FIGURE 4-1
IDOT Systemic Safety Detailed Analysis Process



4.1 Location Types

4.1.1 Intersections

Intersections are examined first. Data collection should include urban or rural setting, how many vehicles travel through the intersection, the angular skew of the intersection, and the presence/absence of crosswalks, among others. Each intersection should be given a unique identification number (ID). Data collection through use of Google Earth Pro® can help populate the data fields of interest. Vehicular crashes should be assigned to the respective intersections in GIS for comparison and review.

A buffer zone can be used when assigning crashes to an intersection. If a crash occurs within this buffer zone, it would be considered an intersection-related crash. This method is used because it would be inefficient to go through large numbers of crash reports (in some cases, thousands) to determine whether a crash should be considered an intersection-related crash.

4.1.2 Segments

The next step is to examine each segment, which are usually broken into 1- to 3-mile-long segments. All crashes that have not been assigned to an intersection would now be considered a segment crash.

4.1.3 Curves

Isolating the curves of each segment is the next step in the data collection process. Using Google Earth Pro®, all curves with radii of 3,000 feet or smaller can be identified. The information documented includes length of curve, presence of chevrons, warnings, and advisories, visual traps, and whether or not there was an intersection at the curve.

When all of the crashes have been correctly assigned and all necessary data have been collected, the team can use the crash database to add specific crash information to the Excel spreadsheet. Crash types, severity, time of day, and so forth, can all be catalogued. By combining all of the data, the team is able to provide an accurate summary of all important elements of vehicle-related crashes within all of the study locations.

The complete list of desired characteristics for intersections, segments and curves is included in Section 4.3, Table/Data Formatting.

4.2 Process of Data Collection

Once all of the location types are correctly identified, the process of collecting all necessary data can begin. The majority of non-crash related data can be obtained using Google Earth, although some measurements require Google Earth Pro®. Both versions allow the user to "fly" over an area with the Aerial View, and also "drive" down a street or through an intersection with the Street View feature. If the presence of signage/chevrons or shoulder type is being considered, then Street View is ideal because it would be much easier to view a sign from street-level than from an Aerial View. For measuring lane width or checking if intersection skew is present, the Aerial View works best. Yet many roadway features can be found in either view, like the presence of commercial buildings or access points. It is up to the user to decide which view works best for them.

To determine roadway characteristics, each corridor was observed for the following: length and type of on-street parking (parallel, angle, or no street parking in urban and suburban areas only within the right-of-way); presence of passing lanes and short, four-lane sections; two-way left turn lanes; and number of lanes, among others. Some categories may not be included for the entirety of the segment or curve, such as the presence of two-way, left-turn lanes and lighting. The features are rounded to the majority answer. For example, if lighting was present for 10 percent of a 2.2 mile segment, it would be considered absent for the overall corridor.

Many of the roadway or intersection characteristics are self-explanatory, but a few, more complicated ones are shown below with brief descriptions of how to collect the data.

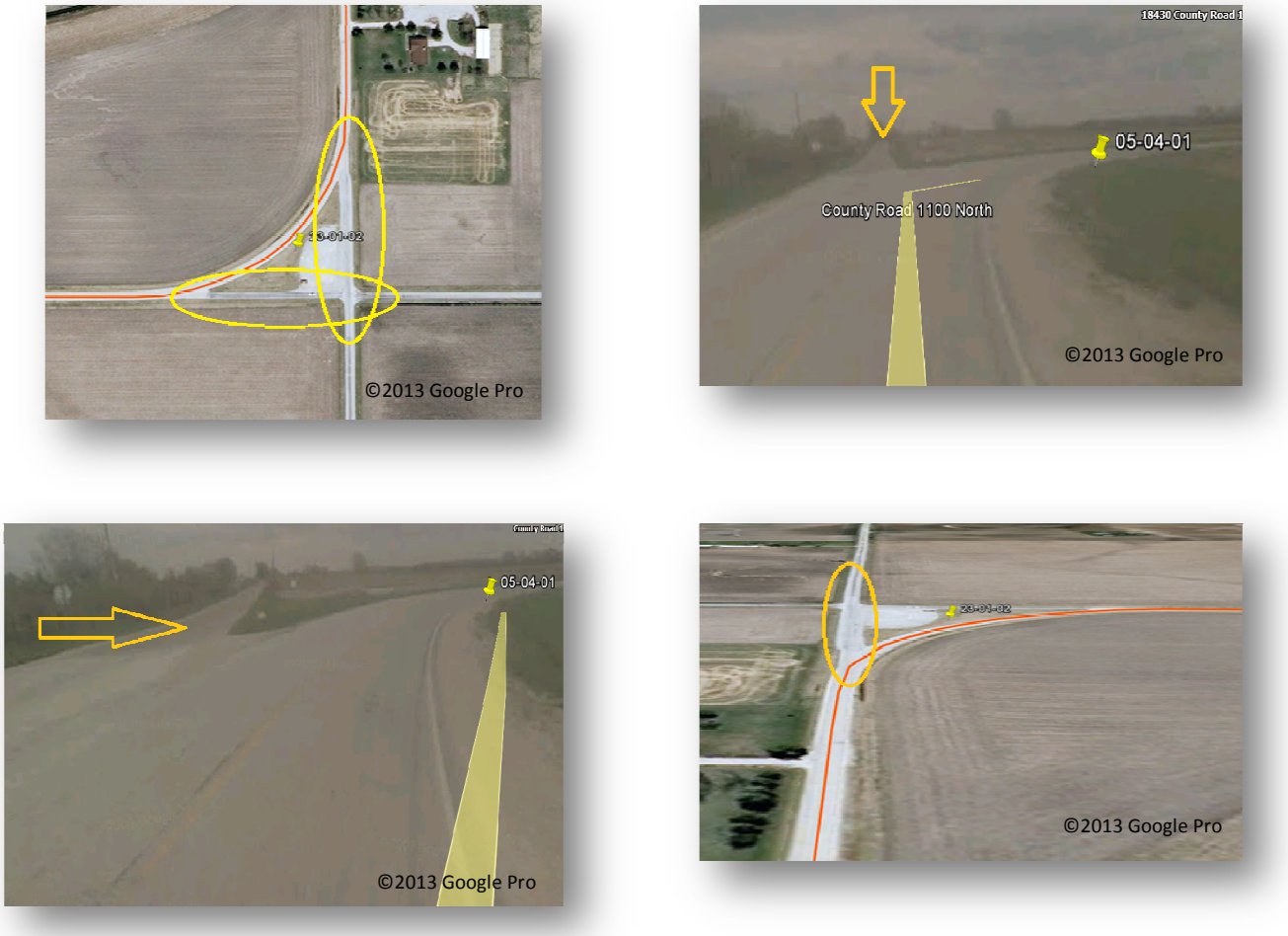
"Curve Critical Radius Density" is one ranking factor that is star eligible. Consider a segment that measures 1.6 miles. Along this segment, there are six horizontal curves. Of these six horizontal curves, two of them have a radius that falls into the critical radius interval (explained in Section 4.5). To find the density of curves that have a critical radius measurement, we would simply divide the count of curves along this segment that have a critical radius, two, by the length, 1.6 miles. This gives us a "Curve Critical Radius Density" of 1.25 critical curves per mile. If any segment has a density over 0.5, it receives a star.

"Road Departure Crash Density" is simply a measurement of how many road departure crashes occur along a segment's length. Recall that road departure crashes are considered any of the following crash types: fixed object, overturned, sideswipe opposite direction or head-on. By taking the count of road departure crashes and dividing by the segment's length, the "Road Departure Crash Density" is obtained.

A ranking factor for intersections is "Previous Stop 5+ Miles". If all legs have the nearest stop at least five miles from the intersection, an additional star would be assigned to this intersection.

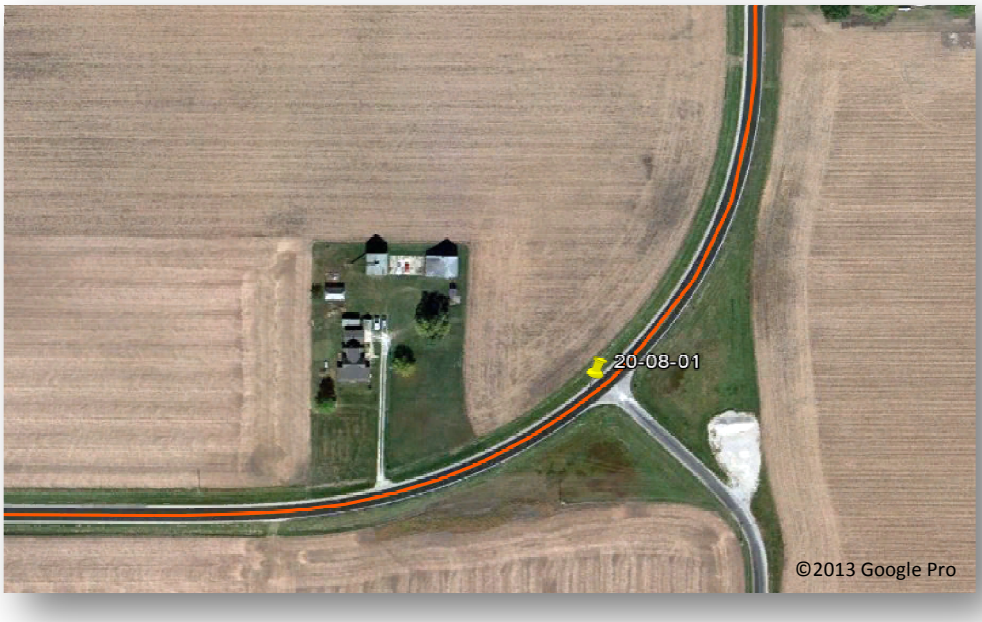
Visual Traps. Upon approaching a curve, the existence of the road appearing to continue straight can be considered a visual trap. In reality, the vehicle path follows a curve instead of the tangent road. The arrows in the two Figure 4-2 photos show visual traps.

FIGURE 4-2
Visual Traps



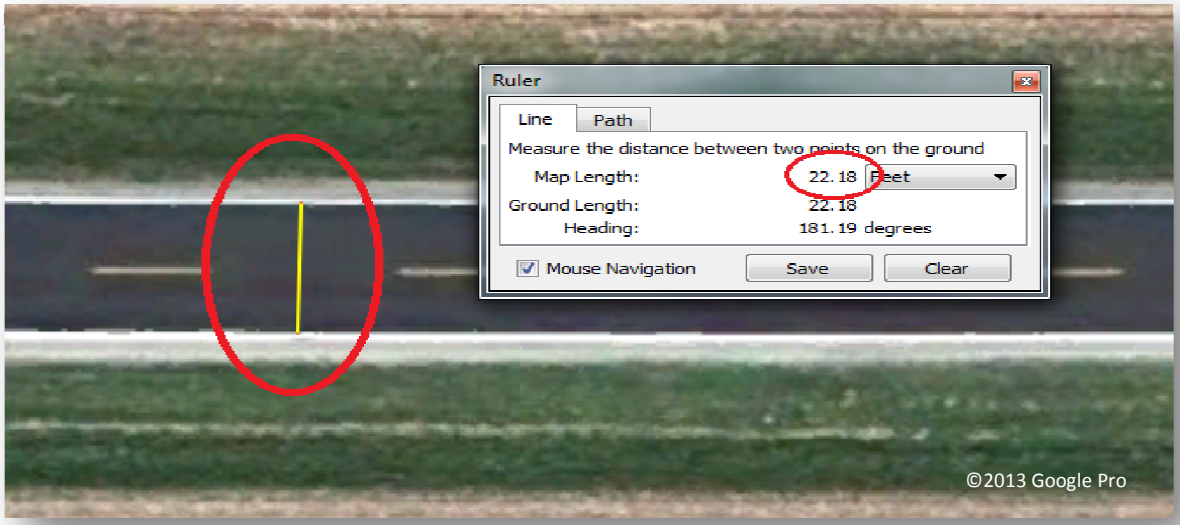
Intersection on Curve. A curve that has one or more intersections somewhere between the beginning and end points of the curve (residential drives are not considered for intersection on curves). See Figure 4-3.

FIGURE 4-3
Intersection on Curve



Lane/Shoulder Widths. Lane/shoulder widths are measured with the ruler tool in Google Earth (Figure 4-4). Measurements can only be made from the Aerial View in Google Earth, and the unit of measurement can be switched to miles or feet, depending on which is needed.

FIGURE 4-4
Lane/Shoulder Widths

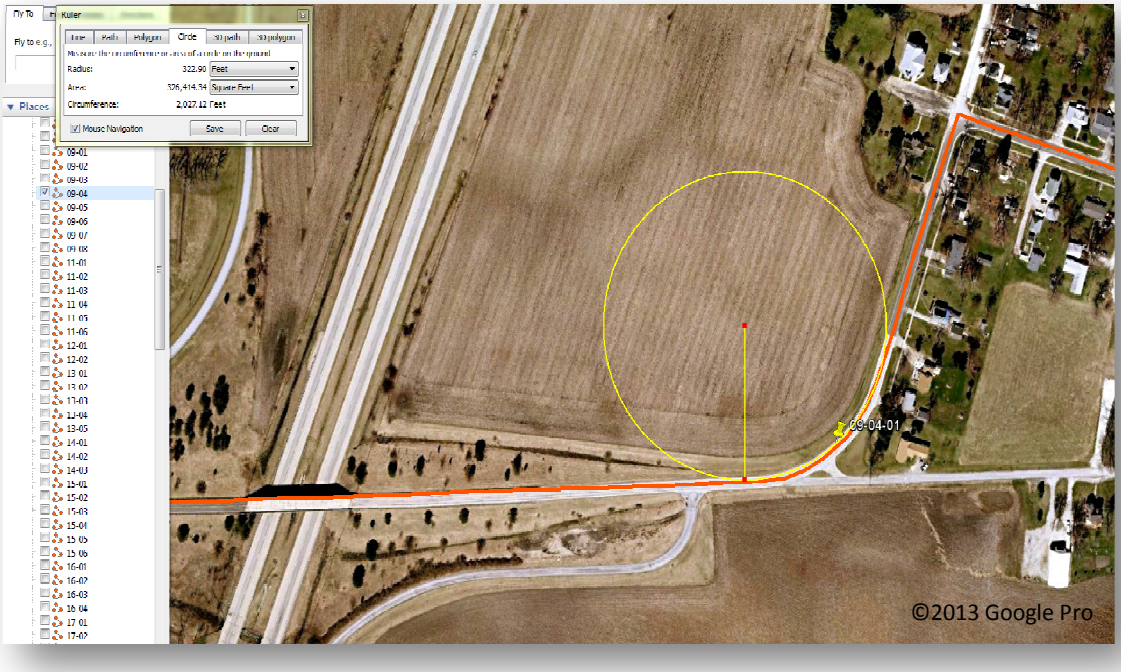


Roadway Features. Roadway features include Shoulder Type, Roadside Signage, Intersection Signage, Median Type, Road Hazard Rating (RHR), Pedestrian Signals, Traffic Control Device, Turn Lanes, Photo Speed Enforcement Equipment, and so forth. All of these, and more, can be observed in Street View; see Figure 4-5. Roadway GIS layers may also be available through BSE that provide other crucial roadway features. This layer may reduce the effort level spent performing data collection.

FIGURE 4-5
Roadway Features

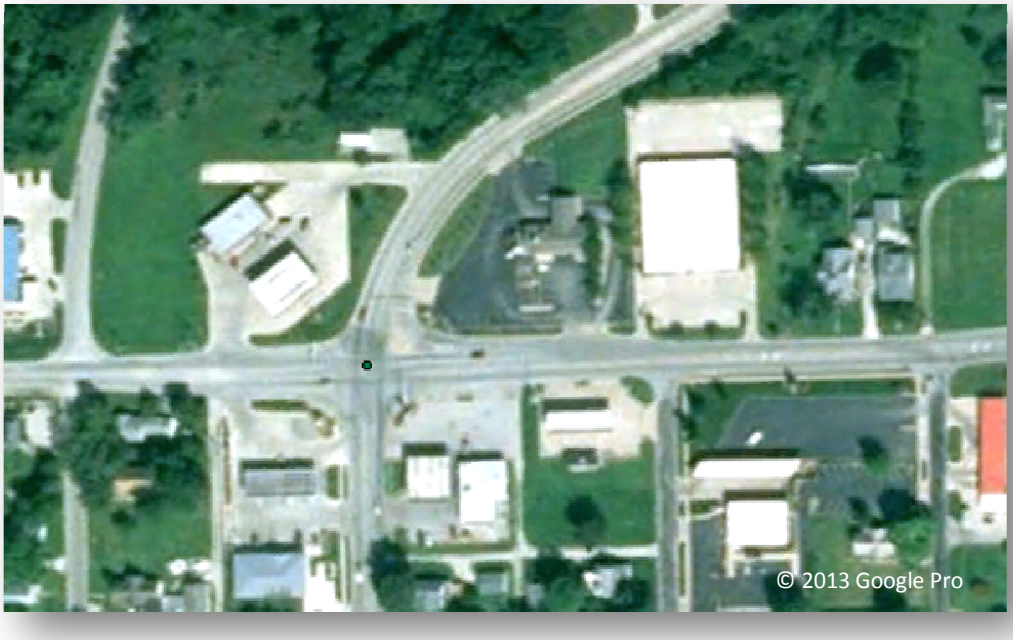
Curve Radius and Length. The 'circle' option within the ruler tool in Google Earth Pro® can measure the radius of curves (Figure 4-6).

FIGURE 4-6
Curve Radius and Length



Commercial Development and On/Near Curve. An intersection with any type of commercial building access nearby can be seen from either Aerial or Street View. If the commercial building access is within 500 feet of the intersection, it should be considered. Also, an intersection in close proximity to a curved segment can also be seen from the Aerial View. See Figure 4-7.

FIGURE 4-7
Commercial Development and On/Near Curve



Skewed Intersection. Any intersection with legs that intersect at angles other than 90 degrees should be measured. Intersections with skew of more than 15 degrees in either direction earn a star. These can be measured in Google Earth Pro®. See Figure 4-8.

FIGURE 4-8
Skewed Intersection

Access Density. To determine the frequency of access to corridors, each corridor should be examined for the following categories:

Major Access

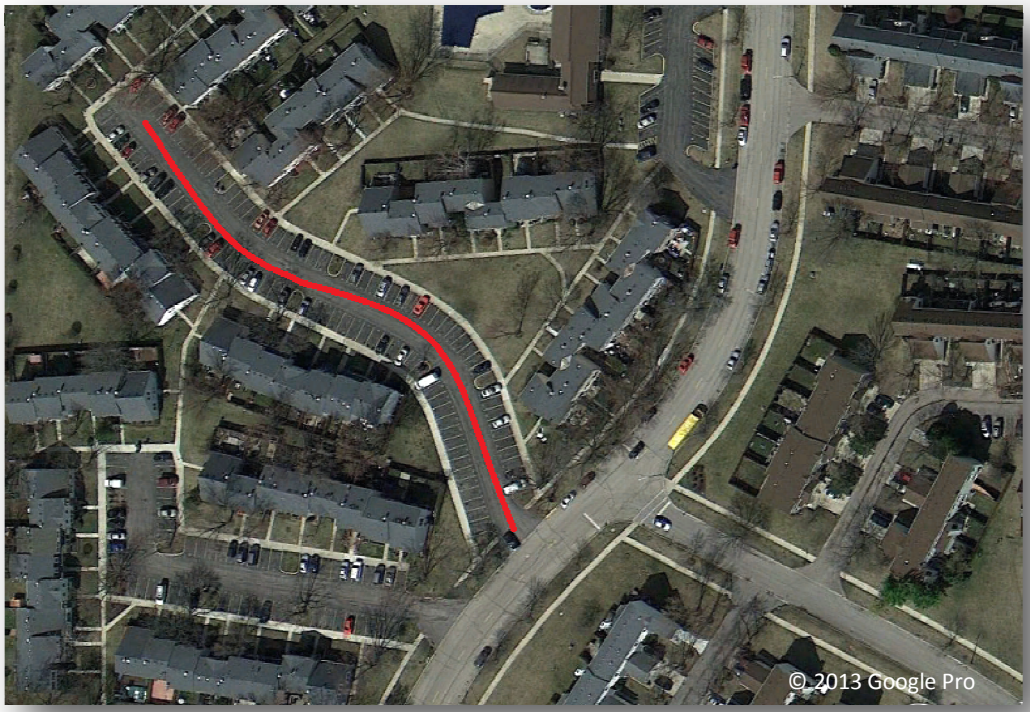
- Commercial: Commercial parking lots with approximately 50 or more spaces, including department stores, restaurants, shopping malls, office buildings, churches, sports facilities, and so forth.
- Residential: Residential parking lots with approximately 50 or more spaces, including apartment complexes and condominiums with group parking; example shown in red line in the figure below.
- Industrial: Industrial or manufacturing parking lots with approximately 50 or more spaces.

Minor Access

- Commercial: Commercial parking lots with 1 to 50 spaces.
- Residential: Residential parking lots with 1 to 50 spaces, including single-family homes.
- Industrial: Industrial or manufacturing parking lots with 1 to 50 spaces.

The number of access points divided by the length of each corridor (measured in miles) yields the access density (number of access points per mile).

FIGURE 4-9
Major Residential Access Point



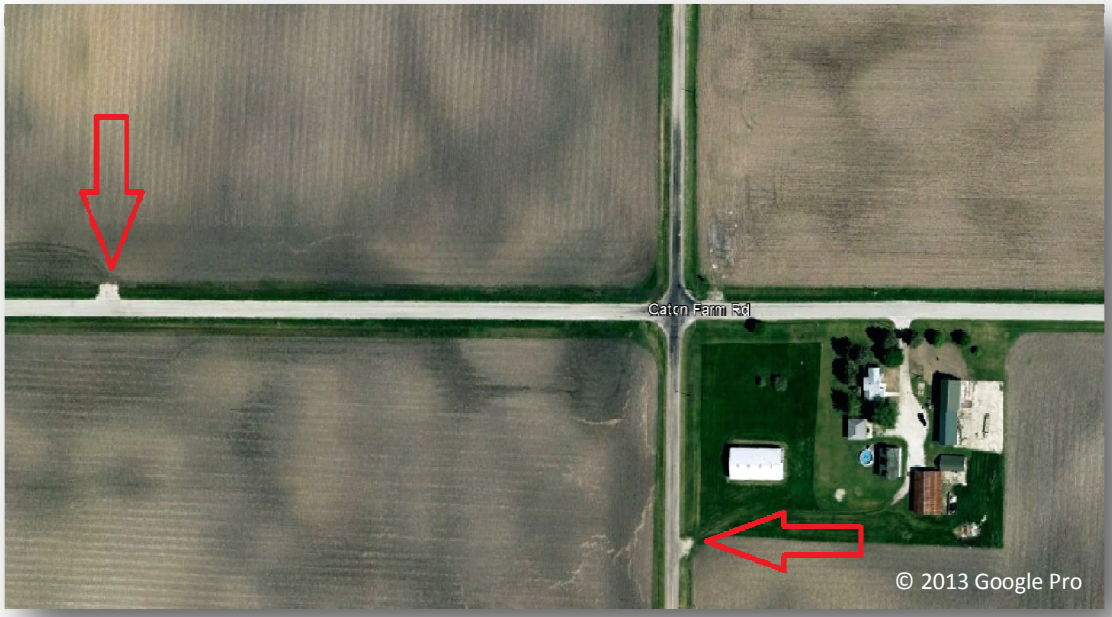
Intersection Access

Access to a corridor via an intersection with another roadway and all points of access are considered. For example, a four-way intersection would have two points of access for a segment that continued through an intersection.

Other Access Entry Points

Any other entry point that does not qualify for other categories, such as graveyards, parks, farm entrances, and indistinguishable sites are considered. Two examples are shown by the red arrows in Figure 4-10.

FIGURE 4-10
Other Access Density Entry Points



4.2.1 Highway Safety Manual Roadside Hazard Rating (RHR)

Roadside Hazards. The Roadside Hazard Rating, (RHR), is assigned based on a scale of 1 to 7, with 1 meaning nonhazardous conditions exist and 7 meaning extremely hazardous conditions exist. Hazardous conditions include high frequency, density, and proximity of foreign objects along the corridor. The average of the conditions makes up the RHR for a segment. The RHR can be collected by entering Street View in Google Earth by following the segment from start to finish. The following is an example of determining the average for a segment:

Segment Example 1:

- 2-mile segment of road
- Very rural area with farmland on both sides of road
- Flat, paved shoulders
- No light/utility poles along the side of the road

Segment Example 1 would be a very forgiving system because drivers would have the opportunity to correct any mistakes on 100 percent of the system; this should be considered an RHR of 1.

Segment Example 2:

- 1-mile segment of road
- Very rural area with farmland on both sides of road
- Flat, paved shoulders
- No light/utility poles along the side of the road
- 30 percent of this segment is narrow bridge with:
  - 4-foot concrete barrier walls as shoulder
  - No median
  - Narrow lanes

Roughly two-thirds of the road is very forgiving, just like Example 1, but the other third of the roadway is relatively dangerous. It deserves neither a 1 nor a 7. The entire 1-mile stretch of road could be considered a 3 or 4 on the RHR scale.

Consistency while assigning the RHR is essential. Since this is such a subjective process, the data collection process for RHR should be a frequently discussed topic among the group performing the data collection. This rating system is listed in Table 4-1 and is explained in more detail in Appendix D of FHWA's publication*, Prediction of the Expected Safety Performance of Rural Two-Way Highways*, which is available at: http://www.fhwa.dot.gov/publications/research/safety/99207/appd.cfm.

TABLE 4-1
Roadside Hazard Ratings

Rating	Criteria
1	• Wide clear zones greater than or equal to 9 meters (30 feet) from the pavement edge line • Sideslope flatter than 1:4 • Recoverable
2	• Clear zone between 6 and 7.5 meters (20 and 25 feet) from pavement edge line • Sideslope about 1:4 • Recoverable
3	• Clear zone about 3 meters (10 feet) from pavement edge line • Sideslope about 1:3 or 1:4 • Rough roadside surface • Marginally recoverable
4	• Clear zone between 1.5 and 3 meters (5 to 10 feet) from pavement edge line • Sideslope about 1:3 or 1:4 • May have guardrail (1.5 to 2 meters [5 to 6.5 feet] from pavement edge line) • May have exposed trees, poles, or other objects (about 3 meters or 10 feet from pavement edge line) • Marginally forgiving, but increased chance of a reportable roadside collision
5	• Clear zone between 1.5 and 3 meters (5 to 10 feet) from pavement edge line • Sideslope about 1:3 • May have guardrail within 0 to 1.5 meters (0 to 5 feet) from pavement edge line • May have rigid obstacles or embankment within 2 to 3 meters (6.5 to 10 feet) of pavement edge line • Virtually non-recoverable
6	• Clear zone less than or equal to 1.5 meters (5 feet) • Sideslope about 1:2 • No guardrail • Exposed rigid obstacles within 0 to 2 meters (0 to 6.5 feet) of the pavement edge line • Non-recoverable
7	• Clear zone less than or equal to 1.5 meters (5 feet) • Sideslope 1:2 or steeper • Cliff or vertical rock cut • No guardrail • Non-recoverable with high likelihood of severe injuries from roadside collision

Source: FHWA, 2000.[1]

[1] Photo examples are available at http://www.fhwa.dot.gov/publications/research/safety/99207/appd.cfm

4.3 Table/Data Formatting

The tables in this section show information that should be considered during the data collection process. Some of the items may be supplied by BSE, such as AADT and traffic control. Others, such as street lighting and HSM RHR, can be obtained in Google Earth. The left side of Table 4-2, 4-3 and 4-4 shows the data that should be considered for data collection while the right side refers to one of the bullet points listed below. A brief description and some examples are provided here to elaborate on the options.

- The units that should be used – Units can be listed in feet, degrees, miles, miles per hour, and so forth. Ex: The skew angle of an intersection should be measured in degrees.

- Possible options for identifying a feature – Possible options for a feature are suggested. Ex: If the shoulder type is being collected, five options are available: Earth/Sod, Aggregate, Paved, “V” Gutter, Curb and Gutter.

- A blank space is left to be filled – Features like township, ending street, or minor cross street name are left blank because there are endless choices.

- Yes/No – These typically are looking at the presence of something, like street lights, two-way left-turn lanes, restricted right-turn signage, bus stops, and so forth.

- A listing as “Count” – Taking a count of a feature, such as number of lanes, crash counts, and through lanes.

TABLE 4-2
Intersections Inputs and Conventions

Excel Column Header Name		Excel Cell Input Format
Unique Intersection ID		
Major Cross Street Name		
Minor Cross Street Name		
Urban/Rural		
Total Approaches/Legs		Count
Township		
EB AADT		Count
WB AADT		Count
NB AADT		Count
SB AADT		Count
TEV		
Skew Angle		In Degrees
Traffic Control Device		1 or 2 Way Stop, All Way Stop, Traffic Signals (2-Phase, Multi-Phase)
On/Near Curve		Yes/No
Right-Turn Lane Present		Yes/No (must have storage available)
Left-Turn Lane Present		Yes/No (must have storage available)
Major Route Through Lanes Present		Count
Minor Route Through Lanes Present		Count
Commercial Development Nearby		Yes/No
Access Point(s) within 500 feet of Intersection		Yes/No
500 feet from Railroad Crossing		Yes/No
Pedestrian Signal Present?		Yes/No
Restricted Right Turn Signing		Yes/No
Photo Speed Enforcement Present		Yes/No
Bus Stop(s) Present		Yes/No
Street Lights present		Yes/No
Flashers Approaching Intersection?		Yes/No
Nearest Stop more than 5 miles?		Yes/No
Crash Severity Counts	K	Count
	A	Count
	B	Count
	C	Count
	PDO	Count

Notes:
EB = eastbound
NB = northbound
SB = southbound
TEV =Total Entering Vehicles
WB = westbound

TABLE 4-3
Segments Inputs and Conventions

Excel Column Header Name		Excel Cell Input Format
Unique Corridor ID		
Route Number		
Starting Street		
Ending Street		
Alternate Road Name		
Urban/Rural		
Facility		
Township		
Length		Feet
Length		Miles
AADT		Count
Shoulder Type		Earth/Sod, Aggregate, Paved, “V” Gutter, Curb and Gutter
Shoulder Width		Feet
Number of lanes		Count
Median Type		Divided/Undivided, Sod/Earth/Gravel, Curbed, Barrier, Rumble Strip, Painted, Traversable Low Profile Median
Median Width		Feet
Posted Speed Limit		List as XX mph or NA
On-street Parking Type, Length Available in %		Parallel, Angle, 90 degree, None (Urban/Suburban only)
HSM RHR		1 to 7 according to Section 4.2.1
Access Points/Types		Count by each type according to Section 4.2
Street Lighting		Yes/No
Two-way Left-turn Lane		Yes/No
Passing Lane or Short Four-Lane Section		Yes/No
Crash Severity Counts	K	Count
	A	Count
	B	Count
	C	Count
	PDO	Count
Road Departure Crash Types (All Severity)	FO/OVT	Count
	HO/SOD	Count

Notes:
FO/OVT =Fixed Object/Overturned
HO/SOD = Head On/Sideswipe Opposite Direction
mph = miles per hour
NA = not applicable

TABLE 4-4
Curves Inputs and Conventions

Excel Column Header Name		Excel Cell Input Format
Unique Corridor ID		
Route Number		
Urban/Rural		
Facility		
Horizontal Curve Length		Miles
Horizontal Curve Length		Feet
Curve Radius		Feet
AADT		Count
Chevrons Installed		Yes/No
Curve Warning/Speed Advisory Sign Installed		Yes/No
Shoulder Type		Earth/Sod, Aggregate, Paved, “V” Gutter, Curb and Gutter
Shoulder Width		Feet
Number of lanes		Count
Median Type		Divided/Undivided, Sod/Earth/Gravel, Curbed, Barrier, Rumble Strip, Painted, Traversable Low Profile Median
Median Width		Feet
Posted Speed Limit		List as XX mph or NA
On-Street Parking Type, Length Available in % (Urban and Suburban only)		Parallel, Angle, 90 degree, None
Intersection on Curve		Yes/No
Visual Trap on Curve		Yes/No
HSM RHR		1 to 7 according to Section 4.2.1
Access Points/Types		Count by each type according to Section 4.2
Street Lighting		Yes/No
Two-way Left-turn Lane		Yes/No
Passing Lane or Short Four-Lane Section		Yes/No
Crash Severity Counts	K	Count
	A	Count
	B	Count
	C	Count
	PDO	Count
Road Departure Crash Types (All Severity)	FO/OVT	Count
	HO/SOD	Count

Notes:
FO/OVT =Fixed Object/Overturned
HO/SOD = Head On/Sideswipe Opposite Direction
mph = miles per hour
NA = not applicable

4.4 Data Organization

Arranging all of the data listed in Section 4.3, Tables/Data Formatting can be intimidating and time consuming. For some locations, the data sheet containing all of the information can exceed 50 columns wide. It is best to take an organized and consistent approach. An intersection file is shown in two parts in Table 4-5 and 4-6. Since these files can contain so much information, it is beneficial to group some columns together if they describe a similar attribute. For example, columns in Table 4-6 that have a red heading show the priority group the location was assigned to and the rank of each location.

It is also beneficial to keep columns organized because it makes the data sheet easier to read. Consider the columns in Table 4-6 that have green headers. These columns contain information about whether or not a star was assigned. If the cell contains a “0” the star was not assigned, but if the cell contains a “1” the star has in fact been assigned to that location for that specific star category. This allows a simple equation to be written in Excel to sum how many stars have been earned for each location, shown in the red “Stars” column in Table 4-6. Since more stars translate to more risk, all locations can then be sorted based on how many stars they have. From here, ranks and priority groups can be assigned. For reasons like this, grouping all of the columns that are related helps keep the data sheet functional and easy to use.

TABLE 4-5

Data Collection Excel Intersection Layout 1

Intersection Data Sheet																						2007-2011 Crashes				
																						Crash Severity				
Intx ID	Intersection Streets	Rural/Urban	Traffic Control	Leg Count	Township	Right Turn Lane Present	Left Turn Lane Present	Major Route Through Lanes	Minor Route Through Lanes	NB AADT	SB AADT	NB/SB Max	EB AADT	WB AADT	EB/WB Max	Major AADT	Minor AADT	Total Entering Vehicles	Min/Maj Ratio Value	Street Lights	Flashers	K	A	B	C	PDO
06-03	CH 6 & Hwy 10	Rural	1 or 2 Way Stop	4	Scott	No	No	2	2	150	1,500	1,500	2,800	1,900	2,800	2,800	1,500	3,175	0.536	No	No	0	2	0	0	2
25-03	CH 25 & Hwy 10	Urban	Signalized; Mulit-Phase; Actuated	4	Champaign	Yes	Yes	2	2	5,800	9,200	9,200	7,900	5,500	7,900	9,200	7,900	14,200	0.859	Yes	No	0	2	0	0	13
50-06	CH 50 & US Hwy 150	Rural	Signalized; 2-Phase; Actuated	4	Mahomet	Yes	Yes	2	2	7,900	450	7,900	7,700	9,700	9,700	9,700	7,900	12,875	0.814	Yes	No	0	1	2	1	14
01-01	CH 1 & CH 20	Rural	1 or 2 Way Stop	4	Hensley	No	No	2	2	3,850	2,700	3,850	1,200	800	1,200	3,850	1,200	4,275	0.312	No	No	0	1	3	1	2
18-07	CH 18 & IL 130	Rural	1 or 2 Way Stop	4	Philo	No	Yes	2	2	10,700	9,700	10,700	4,200	200	4,200	10,700	4,200	12,400	0.393	Yes	No	0	1	2	0	3
22-01	CH 22 & US Hwy 136	Rural	1 or 2 Way Stop	4	Kerr	No	No	2	2	275	1,300	1,300	2,050	2,250	2,250	2,250	1,300	2,938	0.578	No	No	0	1	0	1	3
06-02	CH 6 & CH 18	Rural	1 or 2 Way Stop	4	Colfax	No	No	2	2	700	950	950	2,650	2,250	2,650	2,650	950	3,275	0.358	Yes	No	0	1	0	0	0
09-02	CH 9 & US Hwy 45	Rural	1 or 2 Way Stop	4	Ludlow	No	No	2	2	3,300	3,450	3,450	650	550	650	3,450	650	3,975	0.188	Yes	No	0	0	0	0	4
11-01	CH 11 & US Hwy 45	Rural	1 or 2 Way Stop	4	Rantoul	No	No	4	2	8,650	10,350	10,350	1,550	2,000	2,000	10,350	2,000	11,275	0.193	Yes	No	0	3	2	3	8
55-01	CH 55 & US Hwy 136	Urban	Signalized; 2-Phase; Fixed	4	Ludlow	Yes	Yes	4	4	9,500	7,800	9,500	7,100	9,900	9,900	9,900	9,500	17,150	0.960	Yes	No	0	1	4	5	13
15-01	CH 15 & Hwy 130	Rural	1 or 2 Way Stop	4	Philo	No	Yes	2	2	7,400	5,800	7,400	4,200	79	4,200	7,400	4,200	8,740	0.568	Yes	No	1	0	0	1	8
18-02	CH 18 & CH 25	Rural	1 or 2 Way Stop	4	Tolono	No	No	2	2	2,050	275	2,050	4,000	3,300	4,000	4,000	2,050	4,813	0.513	No	No	0	1	1	2	1
16-02	CH 16 & Hwy 130	Rural	1 or 2 Way Stop	4	Crittenden	No	No	2	2	3,300	3,550	3,550	150	750	750	3,550	750	3,875	0.211	No	No	0	1	0	0	1
18-04	CH 18 & I-57 NB Ramps	Rural	Unknown	4	Tolono	Yes	Yes	2	0	0	500	500	4,900	4,900	4,900	4,900	500	5,400	0.102	Yes	No	0	1	0	0	1
11-03	CH 11 & CH 32	Rural	1 or 2 Way Stop	3	Compromise	No	No	2	2	2,100	275	2,100	1,050	250	1,050	2,100	1,050	1,838	0.500	No	No	0	0	0	1	1
15-02	CH 15 (West) & Hwy 49	Rural	1 or 2 Way Stop	4	South Homer	No	No	2	2	3,100	2,650	3,100	250	2,700	2,700	3,100	2,700	4,350	0.871	Yes	No	0	0	0	0	0
25-02	CH 25 & Kirby Rd	Urban	Signalized; 2-Phase; Actuated	4	Champaign	Yes	Yes	2	2	7,200	5,800	7,200	4,600	2,950	4,600	7,200	4,600	10,275	0.639	No	No	0	2	2	0	8
20-03	CH 20 & US Hwy 45	Rural	1 or 2 Way Stop	4	Somer	Yes	Yes	4	2	10,350	8,550	10,350	800	2,900	2,900	10,350	2,900	11,300	0.280	Yes	No	0	2	2	1	6
12-01	CH 12 & CH 20	Rural	Unknown	4	Stanton	No	No	2	2	850	1,100	1,100	1,000	950	1,000	1,100	1,000	1,950	0.909	No	Yes	0	2	2	0	1
14-01	CH 14 & Hwy 49	Rural	1 or 2 Way Stop	4	South Homer	No	No	2	2	2,800	2,800	2,800	200	450	450	2,800	450	3,125	0.161	No	No	0	2	0	0	2
18-06	CH 18 & US Hwy 45	Rural	1 or 2 Way Stop	3	Tolono	Yes	Yes	4	2	9,700	8,500	9,700	200	2,900	2,900	9,700	2,900	10,650	0.299	No	No	0	1	1	0	8
18-01	CH 18 & CH 19	Rural	1 or 2 Way Stop	4	Tolono	No	No	2	2	75	750	750	3,300	1,000	3,300	3,300	750	2,563	0.227	Yes	No	0	1	1	0	3
18-05	CH 18 & US Hwy 45	Urban	Signalized; 2-Phase; Fixed	3	Tolono	Yes	Yes	4	0	11,500	10,500	11,500	0	4,200	4,200	11,500	4,200	13,100	0.365	Yes	No	0	0	2	1	10
51-04	CH 51 & US Hwy 136	Urban	Signalized; 2-Phase; Fixed	3	Rantoul	Yes	Yes	4	0	4,100	0	4,100	9,900	10,000	10,000	10,000	4,100	12,000	0.410	Yes	No	0	0	0	0	4
51-01	CH 51 & US Hwy 136	Urban	1 or 2 Way Stop	4	Rantoul	No	Yes	4	2	1,200	500	1,200	12,600	12,600	12,600	12,600	1,200	13,450	0.095	Yes	No	0	0	1	1	1
32-01	CH 32 & US Hwy 136	Rural	1 or 2 Way Stop	4	Harwood	No	No	2	2	1,200	2,400	2,400	2,250	3,100	3,100	3,100	2,400	4,475	0.774	Yes	Yes	0	0	1	0	2
50-02	CH 50 & CH 54 West	Rural	1 or 2 Way Stop	4	Mahomet	Yes	No	2	2	2,300	3,600	3,600	2,100	250	2,100	3,600	2,100	4,125	0.583	Yes	No	0	0	1	1	1
01-02	CH 1 & CH 11	Rural	1 or 2 Way Stop	3	Hensley	No	No	2	0	0	2,350	2,350	750	2,850	2,850	2,850	2,350	2,975	0.825	No	No	0	0	0	0	1
13-01	CH 13 & CH 15	Rural	1 or 2 Way Stop	4	South Homer	No	No	2	2	250	700	700	2,500	2,700	2,700	2,700	700	3,075	0.259	No	No	0	0	0	0	0
11-02	CH 11 & CH 12	Rural	1 or 2 Way Stop	4	Compromise	No	No	2	2	450	800	800	1,050	1,200	1,200	1,200	800	1,750	0.667	No	No	0	0	0	0	0
15-03	CH 15 (East) & Hwy 49	Rural	1 or 2 Way Stop	4	South Homer	No	No	2	2	3,100	3,100	3,100	2,150	250	2,150	3,100	2,150	4,300	0.694	Yes	No	0	0	0	0	0
06-01	CH 6 & CH 17	Rural	1 or 2 Way Stop	4	Sadorus	No	No	2	2	1,100	25	1,100	700	1,600	1,600	1,600	1,100	1,713	0.688	No	No	0	0	0	0	0
08-02	CH 8 & CH 30	Rural	1 or 2 Way Stop	4	East Bend	No	No	2	2	300	650	650	400	400	400	650	400	875	0.615	No	No	0	0	0	0	0
17-01	CH 17 & CH 19	Rural	1 or 2 Way Stop	4	Pesotum	No	No	2	2	900	250	900	1,100	1,150	1,150	1,150	900	1,700	0.783	No	No	0	0	0	0	0
51-03	CH 51 (East) & Hwy 45	Urban	Signalized; 2-Phase; Fixed	4	Ludlow	Yes	Yes	4	2	5,300	7,100	7,100	4,550	4,300	4,550	7,100	4,550	10,625	0.641	Yes	No	0	0	2	0	10
01-03	CH 1 & US Hwy 136	Rural	1 or 2 Way Stop	4	East Bend	No	No	2	2	750	2,600	2,600	2,650	2,500	2,650	2,650	2,600	4,250	0.981	No	No	0	0	2	0	8
50-04	CH 50 & I-74 WB Ramps	Rural	Unknown	4	Mahomet	Yes	Yes	2	0	9,700	9,700	9,700	0	1,300	1,300	9,700	1,300	11,000	0.134	Yes	No	0	0	0	1	8
18-03	CH 18 & I-57 SB Ramps	Rural	Unknown	4	Tolono	No	No	2	0	900	0	900	4,000	4,000	4,000	4,000	900	4,900	0.225	Yes	No	0	0	1	0	5
50-01	CH 50 & US Hwy 150	Rural	1 or 2 Way Stop	3	Mahomet	No	Yes	2	0	2,550	0	2,550	10,400	10,400	10,400	10,400	2,550	11,675	0.245	Yes	No	0	0	0	1	5
17-02	CH 17 & US Hwy 45	Rural	1 or 2 Way Stop	4	Pesotum	Yes	Yes	2	2	8,500	3,650	8,500	300	1,300	1,300	8,500	1,300	6,875	0.153	Yes	No	0	0	1	0	3
50-05	CH 50 & I-74 EB Ramps	Rural	Unknown	4	Mahomet	No	Yes	2	0	7,900	7,900	7,900	0	1,200	1,200	7,900	1,200	9,100	0.152	Yes	No	0	0	1	0	3
50-03	CH 50 & CH 54 East	Rural	All-Way Stop	4	Mahomet	No	No	2	2	6,500	9,700	9,700	650	2,550	2,550	9,700	2,550	9,700	0.263	Yes	No	0	0	0	1	2
20-02	CH 20 & I-57 NB Ramps	Rural	Unknown	4	Hensley	No	No	2	0	0	950	950	5,600	5,600	5,600	5,600	950	6,550	0.170	No	No	0	0	0	0	2
51-02	CH 51 (West) & Hwy 45	Urban	Signalized; 2-Phase; Fixed	4	Rantoul	Yes	Yes	4	2	7,100	7,100	7,100	700	450	700	7,100	700	7,675	0.099	Yes	No	0	0	0	0	2
25-01	CH 25 & Windsor Rd	Urban	All-Way Stop	4	Champaign	No	Yes	2	2	5,600	2,650	5,600	5,400	2,850	5,400	5,600	5,400	8,250	0.964	No	No	0	0	0	0	1
20-05	CH 20 & CH 22	Rural	1 or 2 Way Stop	4	Ogden	No	No	2	2	950	800	950	650	1,050	1,050	1,050	950	1,725	0.905	Yes	No	0	0	0	0	1
20-04	CH 20 & CH 24	Rural	1 or 2 Way Stop	4	Stanton	No	No	2	2	275	400	400	950	800	950	950	400	1,213	0.421	No	No	0	0	0	0	1
30-01	CH 30 & US Hwy 136	Rural	1 or 2 Way Stop	3	Brown	No	No	2	0	1,800	0	1,800	2,500	2,500	2,500	2,500	1,800	3,400	0.720	No	No	0	0	0	0	1
08-01	CH 8 & Hwy 47	Rural	1 or 2 Way Stop	4	Brown	No	No	2	2	3,400	3,550	3,550	175	250	250	3,550	250	3,688	0.070	No	No	0	0	0	0	1
09-04	CH 9 & CH 22	Rural	1 or 2 Way Stop	4	Kerr	No	No	2	2	175	175	175	75	200	200	200	175	313	0.875	No	No	0	0	0	0	1
55-02	CH 55 & US Hwy 45	Rural	1 or 2 Way Stop	4	Ludlow	No	No	2	2	3,450	3,300	3,450	600	375	600	3,450	600	3,863	0.174	Yes	No	0	0	0	0	1
20-01	CH 20 & I-57 SB Ramps	Rural	Unknown	4	Hensley	No	No	2	0	1,500	0	1,500	1,350	1,350	1,350	1,500	1,350	2,850	0.900	No	No	0	0	0	0	0
09-01	CH 9 & CH 23	Rural	1 or 2 Way Stop	4	East Bend	No	No	2	2	1,050	950	1,050	250	59	250	1,050	250	1,155	0.238	No	No	0	0	0	0	0
09-03	CH 9 & CH 32	Rural	All-Way Stop	4	Harwood	No	No	2	2	200	450	450	550	400	550	550	450	800	0.818	No	No	0	0	0	0	0
16-01	CH 16 & US Hwy 45	Rural	1 or 2 Way Stop	3	Pesotum	No	Yes	2	2	3,650	3,650	3,650	250	0	250	3,650	250	3,775	0.068	Yes	Yes	0	0	0	0	0
23-01	CH 23 & US Hwy 136	Rural	1 or 2 Way Stop	3	Condit	No	No	2	0	500	0	500	2,850	2,650	2,850	2,850	500	3,000	0.175	No	No	0	0	0	0	0
24-01	CH 24 & US Hwy 150	Rural	1 or 2 Way Stop	4	St Joseph	No	No	2	2	650	200	650	4,950	5,700	5,700	5,700	650	5,750	0.114	Yes	No	0	0	0	0	0

TABLE 4-6

Data Collection Excel Intersection Layout 2

Intersection Data Sheet										Stars									
Intx ID	Total All Severity Crashes	Total K+A Crashes	Crash Rate (All Severity Crashes)	Skewed Intx	On/Near Curve	RR X-ing Within 500 ft.	Nearest Stop Distance (miles)	Nearest Stop >5 miles?	Commercial Development Nearby	Skewed Intx	On/Near Curve	RR X-ing Within 500 ft.	Previous Stop >5 miles	Commercial Development Nearby	Total Crashes (K+A)	Min/Maj Ratio	Stars	Priority Group	Rank
06-03	4	2	0.690	Yes	Yes	No	0.91	No	No	1	1	0	0	0	1	1	4	1	1
25-03	15	2	0.579	No	No	Yes	0.99	No	Yes	0	0	1	0	1	1	0	3	1	2
50-06	18	1	0.766	Yes	Yes	No	0.63	No	No	1	1	0	0	0	1	0	3	1	3
01-01	7	1	0.897	No	No	No	1.00	No	Yes	0	0	0	0	1	1	1	3	1	4
18-07	6	1	0.265	No	No	No	1.00	No	Yes	0	0	0	0	1	1	1	3	1	5
22-01	5	1	0.933	No	No	No	3.03	No	Yes	0	0	0	0	1	1	1	3	1	6
06-02	1	1	0.167	No	No	No	>5.00	Yes	No	0	0	0	1	0	1	1	3	1	7
09-02	4	0	0.551	Yes	Yes	No	0.36	No	Yes	1	1	0	0	1	0	0	3	1	8
11-01	16	3	0.778	No	No	No	>5.00	Yes	No	0	0	0	1	0	1	0	2	1	9
55-01	23	1	0.735	No	No	No	0.27	No	Yes	0	0	0	0	1	1	0	2	1	10
15-01	10	1	0.627	No	No	No	1.01	No	No	0	0	0	0	0	1	1	2	1	11
18-02	5	1	0.569	No	No	No	2.01	No	No	0	0	0	0	0	1	1	2	1	12
16-02	2	1	0.283	No	Yes	No	3.04	No	No	0	1	0	0	0	1	0	2	1	13
18-04	2	1	0.203	No	Yes	No	2.37	No	No	0	1	0	0	0	1	0	2	1	14
11-03	2	0	0.596	No	Yes	No	1.01	No	No	0	1	0	0	0	0	1	2	2	15
15-02	0	0	0.000	No	No	No	>5.00	Yes	Yes	0	0	0	1	1	0	0	2	2	16
25-02	12	2	0.640	No	No	No	0.99	No	No	0	0	0	0	0	1	0	1	2	17
20-03	11	2	0.533	No	No	No	3.52	No	No	0	0	0	0	0	1	0	1	2	18
12-01	5	2	1.405	No	No	No	4.18	No	No	0	0	0	0	0	1	0	1	2	19
14-01	4	2	0.701	No	No	No	2.44	No	No	0	0	0	0	0	1	0	1	2	20
18-06	10	1	0.515	No	No	No	1.65	No	No	0	0	0	0	0	1	0	1	2	21
18-01	5	1	1.069	No	No	No	2.04	No	No	0	0	0	0	0	1	0	1	2	22
18-05	13	0	0.544	No	No	No	1.01	No	No	0	0	0	0	0	0	1	1	0	23
51-04	4	0	0.183	No	Yes	No	0.27	No	No	0	1	0	0	0	0	0	1	0	24
51-01	3	0	0.122	Yes	No	No	0.15	No	No	1	0	0	0	0	0	0	1	0	25
32-01	3	0	0.367	No	No	No	>5.00	Yes	No	0	0	0	1	0	0	0	1	0	26
50-02	3	0	0.399	No	No	No	0.70	No	No	0	0	0	0	0	0	1	1	0	27
01-02	1	0	0.184	No	Yes	No	2.56	No	No	0	1	0	0	0	0	0	1	0	28
13-01	0	0	0.000	No	Yes	No	1.92	No	No	0	1	0	0	0	0	0	1	0	29
11-02	0	0	0.000	No	No	No	4.17	No	Yes	0	0	0	0	1	0	0	1	0	30
15-03	0	0	0.000	No	No	No	0.27	No	Yes	0	0	0	0	1	0	0	1	0	31
06-01	0	0	0.000	No	No	Yes	0.95	No	No	0	0	1	0	0	0	0	1	0	32
08-02	0	0	0.000	No	Yes	No	1.02	No	No	0	1	0	0	0	0	0	1	0	33
17-01	0	0	0.000	Yes	No	No	0.12	No	No	1	0	0	0	0	0	0	1	0	34
51-03	12	0	0.619	No	No	No	0.08	No	No	0	0	0	0	0	0	0	0	0	35
01-03	10	0	1.289	No	No	No	3.03	No	No	0	0	0	0	0	0	0	0	0	36
50-04	9	0	0.448	No	No	No	0.32	No	No	0	0	0	0	0	0	0	0	0	37
18-03	6	0	0.671	No	No	No	2.67	No	No	0	0	0	0	0	0	0	0	0	38
50-01	6	0	0.282	No	No	No	0.42	No	No	0	0	0	0	0	0	0	0	0	39
17-02	4	0	0.319	No	No	No	1.36	No	No	0	0	0	0	0	0	0	0	0	40
50-05	4	0	0.241	No	No	No	0.09	No	No	0	0	0	0	0	0	0	0	0	41
50-03	3	0	0.169	No	No	No	0.70	No	No	0	0	0	0	0	0	0	0	0	42
20-02	2	0	0.167	No	No	No	0.45	No	No	0	0	0	0	0	0	0	0	0	43
51-02	2	0	0.143	No	No	No	0.08	No	No	0	0	0	0	0	0	0	0	0	44
25-01	1	0	0.066	No	No	No	0.99	No	No	0	0	0	0	0	0	0	0	0	45
20-05	1	0	0.318	No	No	No	2.99	No	No	0	0	0	0	0	0	0	0	0	46
20-04	1	0	0.452	No	No	No	2.66	No	No	0	0	0	0	0	0	0	0	0	47
30-01	1	0	0.161	No	No	No	0.40	No	No	0	0	0	0	0	0	0	0	0	48
08-01	1	0	0.149	No	No	No	2.01	No	No	0	0	0	0	0	0	0	0	0	49
09-04	1	0	1.753	No	No	No	0.98	No	No	0	0	0	0	0	0	0	0	0	50
55-02	1	0	0.142	No	No	No	0.46	No	No	0	0	0	0	0	0	0	0	0	51
20-01	0	0	0.000	No	No	No	0.27	No	No	0	0	0	0	0	0	0	0	0	52
09-01	0	0	0.000	No	No	No	1.00	No	No	0	0	0	0	0	0	0	0	0	53
09-03	0	0	0.000	No	No	No	1.00	No	No	0	0	0	0	0	0	0	0	0	54
16-01	0	0	0.000	No	No	No	0.05	No	No	0	0	0	0	0	0	0	0	0	55
23-01	0	0	0.000	No	No	No	4.20	No	No	0	0	0	0	0	0	0	0	0	56
24-01	0	0	0.000	No	No	No	2.02	No	No	0	0	0	0	0	0	0	0	0	57
									Total Stars Earned	5	10	2	4	9	19	10			
									% That Earn Star	8.8%	17.5%	3.5%	7.0%	15.8%	33.3%	17.5%			

TABLE 4-7

Data Collection Excel Layout - Segment

Segments Data Sheet					2007-2011 Crashes																	Stars								
					Crash Severity					RD Crash Types (All Sev.)																				
Segment ID	County Highway	Alt. Road Name	Length (mi.)	AADT	K	A	B	C	PDO	FO/OVT	HO/SOD	Total All Severity Crashes	Total K+A Crashes	Roadway Description	Shoulder Type	Lane Width (ft.)	Posted Speed Limit	On-Street Parking Type, Length Available	RD Crash Density Value	HSM RHR	Access Density Values	ADT Range	RD Crash Density	Critical Curve Radius Density	HSM RHR	Total K+A Crashes	Access Density	Stars	Priority Group	Individual Rank
55-01	CH 55	Maplewood Dr/Co Rd 1700 E	1.49	7,130	0	1	2	2	19	3	1	24	1	Urban, Multilane, Undivided	Composite, 2	11	N/A	None	0.535	4	70.94	1	1	0	1	1	1	5	1	1
50-02	CH 50	Co Rd 525 E/Prairie View Rd	1.62	7,450	1	4	1	0	18	4	0	24	5	Rural, 2-Lane, Undivided	Composite, 6	11	N/A	None	0.495	4	29.71	1	0	0	1	1	1	4	1	2
15-02	CH 15	Co Rd 1000 N/Co Rd 15/Main St	3.03	4,400	0	4	2	1	19	9	0	26	4	Rural, 2-Lane, Undivided	Composite, 4	12	40	None	0.593	3	21.42	1	1	0	0	1	1	4	1	3
20-02	CH 20	Market St/ Leverett Rd	1.80	3,750	0	1	1	0	7	2	3	9	1	Rural, 2-Lane, Undivided	Gravel, 6	12	55	None	0.557	3	5.01	1	1	1	0	1	0	4	1	4
51-02	CH 51	Grove Ave	0.77	4,220	0	1	0	0	5	1	0	6	1	Urban, 2-Lane, Undivided	Paved, 10	17	35	Parallel, 59%	0.261	4	87.52	1	0	0	1	1	1	4	1	5
18-04	CH 18	Co Rd 18	2.45	3,450	1	2	0	0	7	7	0	10	3	Rural, 2-Lane, Undivided	Gravel, 4	11	N/A	None	0.573	2	9.00	1	1	0	0	1	0	3	1	6
18-05	CH 18	Co Rd 18/Co Rd 1000 N	2.53	4,340	1	1	3	3	17	9	1	25	2	Rural, 2-Lane, Undivided	Gravel, 2	12	N/A	None	0.790	3	9.08	1	1	0	0	1	0	3	1	7
15-01	CH 15	Co Rd 15	2.01	4,200	1	1	0	0	6	5	1	8	2	Rural, 2-Lane, Undivided	Gravel, 4	12	55	None	0.597	2	5.47	1	1	0	0	1	0	3	1	8
30-01	CH 30	3rd St	1.15	1,190	0	1	0	0	4	1	0	5	1	Rural, 2-Lane, Undivided	Paved, 2	11	N/A	Angle, 13%	0.174	4	72.26	0	0	0	1	1	1	3	1	9
50-01	CH 50	Lake of the Woods Rd/Co Rd 50/Golf Dr	2.14	2,100	0	0	0	0	14	7	1	14	0	Rural, 2-Lane, Undivided	Paved, 4	11	N/A	None	0.748	4	28.04	0	1	0	1	0	1	3	1	10
25-03	CH 25	Staley Rd	2.01	7,100	0	0	4	0	7	6	2	11	0	Urban, 2-Lane, Undivided	Paved, 6	12	25	None	0.796	3	26.37	1	1	0	0	0	1	3	1	11
54-01	CH 54	Co Rd 2175	0.70	2,310	0	0	2	0	3	2	0	5	0	Rural, 2-Lane, Undivided	Paved, 4	11	N/A	Parallel, 14%	0.571	4	31.39	0	1	0	1	0	1	3	1	12
18-01	CH 18	Co Rd 18	1.97	2,250	1	1	2	0	4	6	1	8	2	Rural, 2-Lane, Undivided	Gravel, 2	12	N/A	None	0.710	2	6.08	0	1	0	0	1	0	2	2	13
01-01	CH 01	Co Rd 1	1.94	3,100	1	1	3	0	3	4	0	8	2	Rural, 2-Lane, Undivided	Gravel, 4	12	N/A	None	0.412	2	8.76	1	0	0	0	1	0	2	2	14
22-05	CH 22	Co Rd 22	3.26	320	0	2	3	0	2	7	0	7	2	Rural, 2-Lane, Undivided	Gravel, 2	10	55	None	0.430	3	6.14	0	0	1	0	1	0	2	2	15
18-06	CH 18	Co Rd 900 N	2.62	3,130	0	1	1	0	9	4	0	11	1	Rural, 2-Lane, Undivided	Gravel, 4	11	55	None	0.305	2	8.00	1	0	0	0	1	0	2	2	16
20-08	CH 20	Co Rd 2100 N/Co Rd 20	2.18	1,000	1	0	0	1	2	2	1	4	1	Rural, 2-Lane, Undivided	Composite, 2	11	55	None	0.275	2	6.88	0	0	1	0	1	0	2	2	17
11-01	CH 11	Co Rd 2400 N/ Co Rd 1100 E	2.52	750	1	0	1	0	1	2	0	3	1	Rural, 2-Lane, Undivided	Composite, 4	11	55	None	0.158	2	7.92	0	0	1	0	1	0	2	2	18
18-07	CH 18	Co Rd 900 N/Monroe St	2.52	3,800	0	1	0	0	1	2	0	2	1	Rural, 2-Lane, Undivided	Gravel, 4	11	55	None	0.159	2	13.90	1	0	0	0	1	0	2	2	19
22-01	CH 22	Co Rd 2700 E/Co Rd 22	2.39	950	0	1	0	1	0	1	0	2	1	Rural, 2-Lane, Undivided	Gravel, 2	11	N/A	None	0.084	3	7.95	0	0	1	0	1	0	2	2	20
01-03	CH 01	Co Rd 1	1.93	2,850	0	0	1	1	7	5	2	9	0	Rural, 2-Lane, Undivided	Gravel, 4	12	N/A	None	0.725	2	5.69	0	1	1	0	0	0	2	2	21
51-01	CH 51	Meyers St/Sangamon Ave	0.43	1,070	0	0	0	0	8	0	0	8	0	Urban, 2-Lane, Undivided	Paved, 4	16	30	Angle, 28%	0.000	4	57.69	0	0	0	1	0	1	2	2	22
01-04	CH 01	Co Rd 1	2.52	2,750	0	2	2	0	3	6	0	7	2	Rural, 2-Lane, Undivided	Gravel, 4	12	N/A	None	0.476	2	5.96	0	0	0	0	1	0	1	3	23
09-06	CH 09	Co Rd 3500 N	2.04	470	0	2	0	0	1	3	0	3	2	Rural, 2-Lane, Undivided	Gravel, 2	12	55	None	0.294	2	6.37	0	0	0	0	1	0	1	3	24
13-03	CH 13	Co Rd 2500 E	3.02	770	1	1	0	0	1	2	0	3	2	Rural, 2-Lane, Undivided	Gravel, 4	9	55	None	0.133	2	6.30	0	0	0	0	1	0	1	3	25
22-04	CH 22	Co Rd 22/West St	2.00	1,200	0	2	0	0	1	1	0	3	2	Rural, 2-Lane, Undivided	Gravel, 2	11	N/A	None	0.100	3	16.97	0	0	0	0	1	0	1	3	26
11-03	CH 11	Co Rd 33/Flatville Rd	2.22	1,700	0	1	1	0	2	4	0	4	1	Rural, 2-Lane, Undivided	Composite, 4	11	N/A	None	0.360	2	15.74	0	0	0	0	1	0	1	3	27
06-01	CH 06	Co Rd 6	2.11	1,100	0	1	0	0	2	3	0	3	1	Rural, 2-Lane, Undivided	Gravel, 4	11	55	None	0.284	2	7.58	0	0	0	0	1	0	1	3	28
17-01	CH 17	Co Rd 17	3.03	1,230	0	1	0	0	1	1	0	2	1	Rural, 2-Lane, Undivided	Composite, 2	11	N/A	None	0.066	2	9.23	0	0	0	0	1	0	1	3	29
08-02	CH 08	Co Rd 3300 N	2.09	200	0	1	0	0	0	0	0	1	1	Rural, 2-Lane, Undivided	Gravel, 4	11	N/A	None	0.000	2	4.79	0	0	0	0	1	0	1	3	30
01-02	CH 01	Co Rd 1	2.59	2,930	0	0	4	1	10	7	1	15	0	Rural, 2-Lane, Undivided	Gravel, 4	12	N/A	None	0.617	2	10.41	0	1	0	0	0	0	1	0	31
17-06	CH 17	Co Rd 600 N	2.00	1,050	0	0	3	1	4	7	0	8	0	Rural, 2-Lane, Undivided	Gravel, 4	12	55	None	0.700	3	5.50	0	1	0	0	0	0	1	0	32
32-03	CH 32	Co Rd 2300 E/Co Rd 32	2.02	1,830	0	0	0	1	6	1	0	7	0	Rural, 2-Lane, Undivided	Composite, 2	11	55	Angle, 6%	0.099	3	40.17	0	0	0	0	0	1	1	0	33
15-05	CH 15	Co Rd 15/ Sidney Rd/ 1st St	1.93	2,540	0	0	3	0	3	2	1	6	0	Rural, 2-Lane, Undivided	Composite, 4	12	35	Parallel, 1%	0.312	3	21.81	0	0	0	0	0	1	1	0	34
22-02	CH 22	Co Rd 22	2.10	900	0	0	1	0	2	1	0	3	0	Rural, 2-Lane, Undivided	Gravel, 2	11	N/A	None	0.095	2	8.10	0	0	1	0	0	0	1	0	35
22-06	CH 22	Co Rd 22	2.95	310	0	0	0	0	3	1	0	3	0	Rural, 2-Lane, Undivided	Gravel, 2	10	55	None	0.068	3	6.78	0	0	1	0	0	0	1	0	36
20-04	CH 20	Leverett Rd/Co Rd 2100 N	2.08	800	0	0	1	0	1	2	0	2	0	Rural, 2-Lane, Undivided	Gravel, 4	11	55	None	0.192	2	4.80	0	0	1	0	0	0	1	0	37
15-06	CH 15	Co Rd 15/ 2nd St	1.09	1,930	0	0	0	0	1	1	0	1	0	Rural, 2-Lane, Undivided	Composite, 4	11	35	None	0.183	2	24.77	0	0	0	0	0	1	1	0	38
20-09	CH 20	Co Rd 20/Co Rd 2150 N	1.77	1,120	0	0	1	0	0	1	0	1	0	Rural, 2-Lane, Undivided	Gravel, 2	11	55	None	0.113	3	39.64	0	0	0	0	0	1	1	0	39
09-04	CH 09	Co Rd 3500 N/Thomas St	2.13	340	0	0	0	0	1	0	0	1	0	Rural, 2-Lane, Undivided	Composite, 4	11	N/A	None	0.000	2	24.41	0	0	0	0	0	1	1	0	40
12-02	CH 12	Co Rd 2400 N/ Co Rd 12	1.52	800	0	0	0	0	0	0	0	0	0	Rural, 2-Lane, Undivided	Gravel, 2	11	55	Parallel, 3%	0.000	2	14.46	0	0	1	0	0	0	1	0	41
55-03	CH 55	Co Rd 3200 N	0.45	1,670	0	0	0	0	0	0	0	0	0	Rural, 2-Lane, Undivided	Composite, 4	12	N/A	None	0.000	2	57.78	0	0	0	0	0	1	1	0	42
19-01	CH 18	Co Rd 19	2.12	900	0	0	0	0	0	0	0	0	0	Rural, 2-Lane, Undivided	Gravel, 2	12	35	None	0.000	3	20.30	0	0	0	0	0	1	1	0	43
15-03	CH 15	Co Rd 1000 N/Co Rd 12	2.07	2,680	0	0	1	0	12	2	0	13	0	Rural, 2-Lane, Undivided	Composite, 2	12	40	None	0.194	2	10.16	0	0	0	0	0	0	0	0	44
15-04	CH 15	Co Rd 15	1.90	2,700	0	0	2	0	9	4	0	11	0	Rural, 2-Lane, Undivided	Composite, 2	12	55	None	0.420	2	9.98	0	0	0	0	0	0	0	0	45
16-04	CH 16	Co Rd 200 N	3.02	830	0	0	0	0	10	1	0	10	0	Rural, 2-Lane, Undivided	Composite, 4	11	55	None	0.066	3	7.29	0	0	0	0	0	0	0	0	46
14-02	CH 14	Co Rd 14	1.55	850	0	0	0	0	8	1	0	8	0	Rural, 2-Lane, Undivided	Gravel, 4	11	56	None	0.129	2	14.20	0	0	0	0	0	0	0	0	47
20-03	CH 20	Leverett Rd	2.04	2,900	0	0	0	0	8	1	0	8	0	Rural, 2-Lane, Undivided	Gravel, 4	12	55	None	0.098	2	11.28	0	0	0	0	0	0	0	0	48
24-01	CH 24	Co Rd 24	2.50	650	0	0	2	0	5	1	0	7	0	Rural, 2-Lane, Undivided	Gravel, 2	11	N/A	None	0.080	3	13.61	0	0	0	0	0	0	0	0	49
11-02	CH 11	Co Rd 33	2.75	1,790	0	0	0	1	5	3	0	6	0	Rural, 2-Lane, Undivided	Gravel, 4	11	30	None	0.218	2	6.17	0	0	0	0	0	0	0	0	50
17-05	CH 17	Market St/ Co Rd 17/Co Rd 600 N	2.13	1,060	0	0	1	0	5	2	0	6	0	Rural, 2-Lane, Undivided	Gravel, 4	12	35	Parallel, 4%	0.188	2	16.43	0	0	0	0	0	0	0	0	51
01-05	CH 01	Co Rd 1	2.01	2,600	0	0	1	0	5	4	0	6	0	Rural, 2-Lane, Undivided	Composite, 4	12	N/A	None	0.397	2	5.46	0	0	0	0	0	0	0	0	52
20-07	CH 20	Co Rd 2100 N	2.01	980	0	0	0	0	4	1	0	4	0	Rural, 2-Lane, Undivided	Gravel, 2	10	55	None	0.099	3	14.41	0	0	0	0	0	0	0	0	53
11-06	CH 11	Co Rd 11	1.94	1,050	0	0	2	1	1	4	0	4	0	Rural, 2-Lane, Undivided	Gravel, 4	11	55	Parallel, 1%	0.413	2	9.81	0	0	0	0	0	0	0	0	54
17-04	CH 17	Co Rd 500 N	1.53	800	0	0	0	0	4	0	0	4	0	Rural, 2-Lane, Undivided	Gravel, 4	10	55	None	0.000	2	7.86	0	0	0	0	0	0	0	0	55
14-03	CH 14	Co Rd 14	1.24	450	0	0	0	0	4	0	0	4	0	Rural, 2-Lane, Undivided	Gravel, 4	11	N/A	None	0.000	2	8.84	0	0	0	0	0	0	0	0	56
06-04	CH 06	Co Rd 6	2.03	700	0	0	1	0	2	2	0	3	0	Rural, 2-Lane, Undivided	Gravel, 4	11	55	None	0.197	2	9.36	0	0	0	0	0	0	0	0	57
09-07	CH 09	Co Rd 3500 N	2.67	490	0	0	1	0	2	1	0	3	0	Rural, 2-Lane, Undivided	Gravel, 6	11	N/A	None	0.075	2	6.74	0	0	0	0	0	0	0	0	58
11-04	CH 11	Co Rd 11	3.04	1,430	0	0	0	0	3	1	0	3	0	Rural, 2-Lane, Undivided	Gravel, 4	11	N/A	None	0.066	2	7.57	0	0	0	0	0	0	0	0	59
11-05	CH 11	Co Rd 11	2.03	1,200	0	0	1	0	1	1	0	2	0	Rural, 2-Lane, Undivided	Gravel, 4	11	N/A	None	0.098	2	9.36	0	0	0	0	0	0	0	0	60
17-03	CH 17	Co Rd 17/Co Rd 6/Co Rd 500 N	3.06	1,010	0	0	1	0	1	2	0	2	0	Rural, 2-Lane, Undivided	Gravel, 4	10	55	None	0.131	1	3.59	0	0	0	0	0	0	0	0	61
20-01	CH 20	Hensley Rd/ Co Rd 2100 N/Market St	1.87	1,230	0	0	0	0	2	0	0	2	0	Rural, 2-Lane, Undivided	Gravel, 4	11	30	None	0.000	3	10.70	0	0	0	0	0	0	0	0	62
25-02	CH 25	Staley Rd	2.01	2,650	0	0	0	0	2	2	0	2	0	Urban, 2-Lane, Undivided	Gravel, 4	12	35	None	0.199	2	12.43	0	0	0	0	0	0	0	0	63
17-07	CH 17	Co Rd 600 N	1.52	1,300	0	0	1	0	1	0	1	2	0	Rural, 2-Lane, Undivided	Gravel, 2	12	35	None	0.132	2	11.86	0	0	0	0	0	0	0	0	64
																				Total Stars Earned		12	13	10	7	25	16			
																				% That Earn Star		12.0%	13.0%	10.0%	7.0%	25.0%	16.0%			

4.5 Obtaining Critical Values

Critical values are used to help determine the risk potential at a particular location(s). Risk is measure by both infrastructure features and crashes that occurred at the location. Some critical values are based on answering simple yes or no questions; while others are to be quantified, as shown in the list at the end of this section. Determining the other critical values that need to be quantified can require much more effort.

Critical values that require more effort are determined by observing overrepresentation. In Figure 4-11, the distribution of curve radii is shown in intervals of 250 feet. By comparing the three colored bars for each interval, it can be seen where overrepresentation occurs. The intervals from 750 to 999, 1,250 to 1,499, and 1,750 to 1,999 feet in the yellow boxes are considered to be overrepresented for Figure 4-11. Since this process is not immediately obvious, the next few paragraphs discuss the process.

Imagine that all necessary data collection steps were performed, each curve radius had been measured and crashes were properly assigned to each curve. A table can then be constructed, as shown in Table 4-8, to represent how many curves fall into each radii range; this is shown in the first and second columns. Next, a tally can be made for each of these intervals to find how many crashes occur in the respective interval. Remember, the crashes need to be assigned to each curve prior to this step. Once the crashes have been assigned to each curve, the crashes can be manipulated in Excel to produce a table similar to Table 4-8. After the second, third and fourth columns on the left of Table 4-8 are populated, the right half (percentage of county curves, percentage of total crashes, percentage of severe crashes) can be easily calculated.

The percentages generated on the right half of Table 4-8 aid in creating Figure 4-11. In Figure 4-11, three of the intervals have red (percentage of total crashes) and green (percentage of severe crashes) bars that show a higher percentage than the blue (percentage of county curves) bar. The blue bar shows what percent a specific curve radius range represents over the entire system. Fifteen (15) percent of county curves have a radius that falls in the range of 750 to 999 feet (see Table 4-8). Since the percentage of severe crashes, shown by the green bar, that occur in the same range of 750 to 999 feet is noticeably larger than 15 percent, it can be considered overrepresented or “critical”. The same can be said for the range of 1,250 to 1,499 and 1,750 to 1,999 feet.

For curves with a radius that falls in the range of 750 to 999, 1,250 to 1,499, or 1,750 to 1,999 feet, all of the red and green bars are larger than their coordinating blue bars, which is why these curve radius intervals were chosen to be critical value intervals. If all crashes were distributed evenly across the entire system, then one would expect the blue, red and green bars to represent the same percentages; however, this is not the case. Some curve radii intervals simply account for more crashes than they do curves. This is why the process of generating critical values is possible.

It should be noted that this is a subjective process. Two individuals may look at the same crash distribution and come up with different results. For this reason, a rule of thumb was developed. Identify intervals that show severe crash overrepresentation of at least 10%. For example, if a blue bar in Figure 4-11 were to represent 20% of the system, the corresponding green bar should be at least 22%, or an overrepresentation of 10%, to be considered a critical interval.

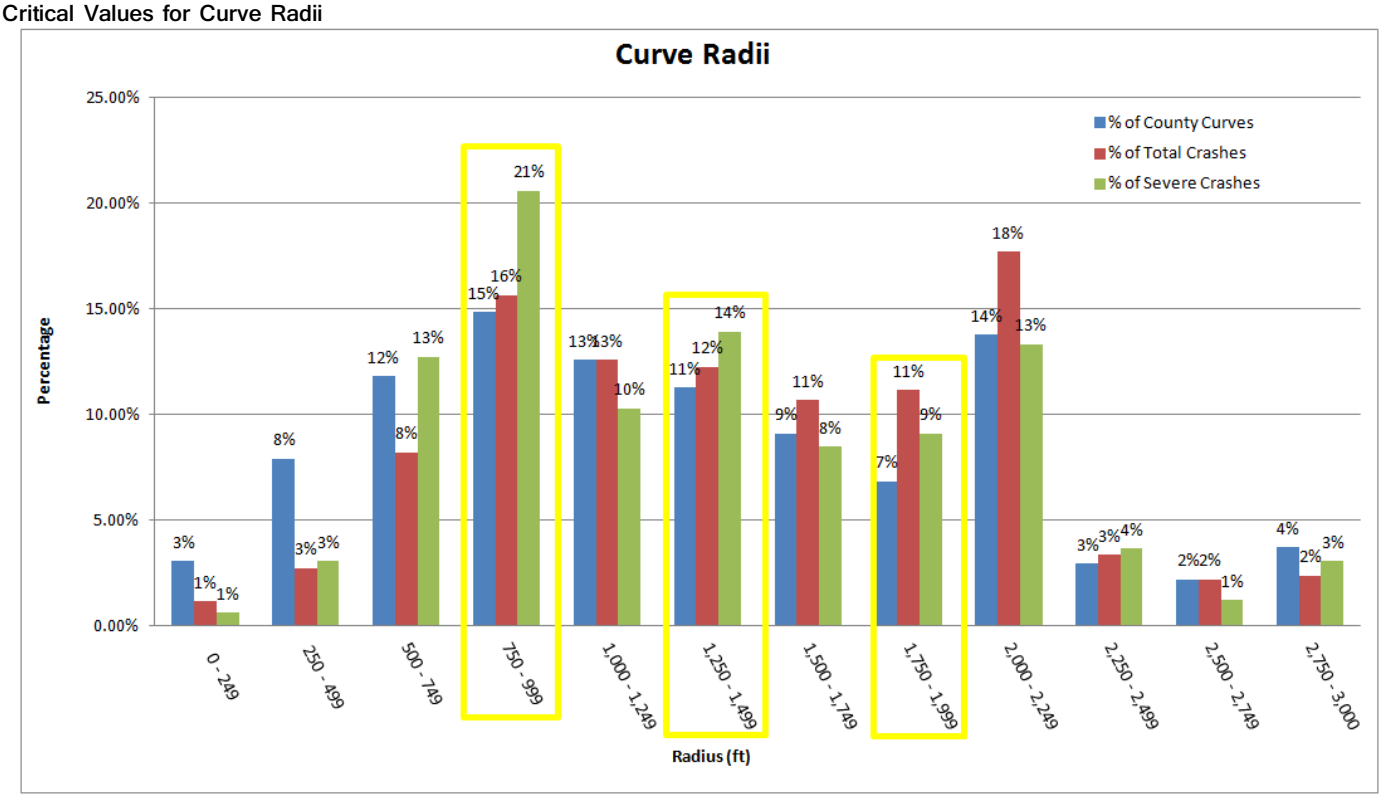
Another matter that should be discussed is whether or not these critical values can be used interchangeably between districts, counties or municipalities. Multiple agencies could work together in compiling data to produce these various critical values. As the database for the critical value calculations becomes larger, the statistical reliability also increases. But, the characteristics of these agencies should also be considered. If one agency is rural with relatively low vehicle miles traveled (VMT), and many unsignalized intersections, it may not be a good decision to compare it to an urban area with many signalized intersections and high VMT. These two locations are very different and one wouldn’t expect them to behave similarly. If it is expected that these locations do not behave similarly, it may be best to

calculate critical values for each location individually, or to pair them with another location that is similar. Again, factors like this should be considered throughout the entire process of generating critical values.

TABLE 4-8
Curves Radius Data Distribution

Radii Range	Curves	Total Crashes	Total Severe Crashes	% of County Curves	% of Total Crashes	% of K+A Crashes
0 - 249	28	36	1	3.04%	1.15%	0.61%
250 - 499	73	85	5	7.92%	2.72%	3.03%
500 - 749	109	257	21	11.82%	8.21%	12.73%
750 - 999	137	490	34	14.86%	15.65%	20.61%
1,000 - 1,249	116	394	17	12.58%	12.59%	10.30%
1,250 - 1,499	104	384	23	11.28%	12.27%	13.94%
1,500 - 1,749	84	334	14	9.11%	10.67%	8.48%
1,750 - 1,999	63	349	15	6.83%	11.15%	9.09%
2,000 - 2,249	127	554	22	13.77%	17.70%	13.33%
2,250 - 2,499	27	105	6	2.93%	3.35%	3.64%
2,500 - 2,749	20	68	2	2.17%	2.17%	1.21%
2,750 - 3,000	34	74	5	3.69%	2.36%	3.03%
	922	3,130	165			

FIGURE 4-11
Critical Values for Curve Radii



Other critical values were used to assign stars but detailed bar charts and numerical analysis were not necessary since they were a simple “yes/no” relating to the existence of a particular characteristic of each curve. The entire list of features that can be used to assign stars includes:

Segments
- Roadside Hazard Rating (ranked from 1 to 7 with stars assigned to values 4 or greater 3)
- Total Severe Crashes (earning a star determined by critical value)
- Access Density (earning a star determined by critical value)
- Road Departure Crash Density (earning a star determined by critical value)
- Critical Curve Radius Density (greater than 0.5 curves with a critical radius per mile earned a star)
- AADT (earning a star determined by critical value)

Intersections
- Total Severe Crashes (earning a star determined by critical value)
- Skewed Intersection (skew angle of +/- 15 degrees in either direction earned a star)
- Being on or Near a Curve (yes/no; yes earned a star)
- Commercial Development Nearby (yes/no; yes earned a star)
- Previous Stop was 5+ Miles Away (yes/no; yes earned a star; rural intersections only)
- Railroad Crossing Being within 500 Feet of Intersection (yes/no; yes earned a star)
- Minor Road/Major Road Volume Ratio (earning a star determined by critical value)

Curves
- Intersection on the Curve (yes/no; yes earned a star)
- Total Severe Crashes (earning a star determined by critical value)
- Visual Trap on the Curve (yes/no; yes earned a star)
- Radius (earning a star determined by critical value)
- AADT (earning a star determined by critical value)

4.6 Compilation and Presentation of Results

Once all of the data is collected and analyzed, the data can be sorted into priority groups. The priority groups are determined by the number of stars a location has earned, the count of severe crashes and the total amount of all severity crashes. For example, if Intersection ABC has 5 stars, and Intersection XYZ has 2 stars, then Intersection ABC would be placed in a higher priority. If multiple locations have the same amount of stars, the count of how many severe and all severity crashes can be used as tie breakers. Typically, three priority groups should be sufficient for one system in one county. Locations included in Priority Group 1 would require the most attention. An example of the criteria used to pick priority groups is shown in Table 4-9.

Once the priority groups are chosen and the locations are ranked, all of the collected data can be presented in the format shown in Figure 4-12. In this template, the upper right corner shows an aerial view of the location. The top portion provides the name and some of the intersection infrastructure features. Pie charts and crash tables show vital information about the location's crashes. The pie charts can be displayed as a weighted chart (as shown in Figure 4-12) or as a non-weighted chart. If weights are used to emphasize severe crashes, fatal crashes have a 25:1 ratio, incapacitating crashes have a 10:1 ratio, and all other crashes have a 1:1 ratio.

The crash tables are simply pivot tables that can be developed in Excel or Access, with crash severity on the horizontal axis and collision type, driver behavior, surface condition or lighting condition on the vertical axis. Then, the frequency of each crash occurrence can aid in populating the table.

The bottom portion of the template shows the 'Ranking Factors' and their respective values that make them eligible to receive a star; these are the factors used to rank each location against other locations. These values are compared to the critical value for that specific characteristic. If the value qualifies for a star, then a star is assigned. The intersection example in Figure 4-12 shows seven characteristics that qualify for a star. The 'Skewed Intersection' is listed as 'Yes' (shown in 'This Intersection's Value' column), and the 'Critical Value' for 'Skewed Intersection' is 'Yes'. Because the value for this location matches the critical value, it earns a star. The same process would be done if the critical value was a number instead of a 'Yes' or 'No' answer.

Consider the 'Total Severe Crashes (K+A)' in Figure 4-12. The value listed is '1'. Since the 'Critical Value' is '1+' and 'This Intersection's Value' is '1', the critical value is met. This implies a star would be assigned. The same process is applied for the other 'Ranking Factors'. Remember, earning stars indicates more risk is associated with the locations.

Figure 4-12
County Detailed Location Template

Intersection at:

CH 50 & US Hwy 350

Intersection Data

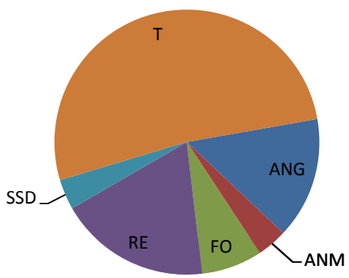
Description: Rural, 4 Legs
Traffic Control: Signalized; 2-Phase; Actuated
Major AADT: 9,700
Minor AADT: 7,900
TEV: 12,875
Crash Rate: 0.766
Township: Mahomet

Street Lights: Yes
Flashers: No
Presence of Right Turn Lane: Yes
Presence of Left Turn Lane: Yes
Number of Through Lanes on Major Route: 2
Number of Through Lanes on Minor Route: 2

Crash Data

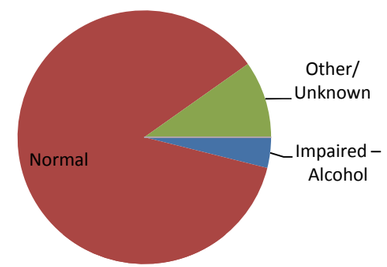
*Weighted values: K=25, A=10, B/C/PDO=1

Weight By Crash Type



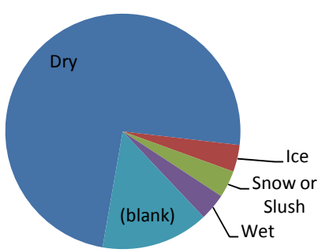
	Crashes Type					Weighted	Crash Type
	K	A	B	C	PDO	Totals*	Frequency
ANG			1		3	4	22.2%
ANM					1	1	5.6%
FO					2	2	11.1%
RE				1	4	5	27.8%
SSD					1	1	5.6%
T		1	1		3	14	27.8%

Weight By Driver Behavior



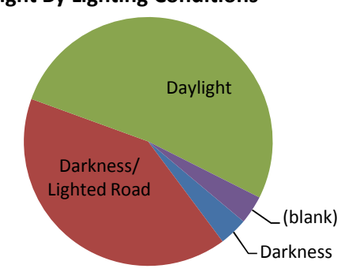
	Driver 1/2/3/4 Behaviors					Weighted	Crash Type
	K	A	B	C	PDO	Totals*	Frequency
Impaired – Alcohol			2			2	6.1%
Normal		2	2	2	20	44	78.8%
Other/ Unknown					5	5	15.2%

Weight By Surface Conditions



	Surface Conditions					Weighted	Crash Type
	K	A	B	C	PDO	Totals*	Frequency
Dry		1	2	1	7	20	61.1%
Ice					1	1	5.6%
Snow or Slush					1	1	5.6%
Wet					1	1	5.6%
(blank)					4	4	22.2%

Weight By Lighting Conditions



	Lighting Conditions					Weighted	Crash Type
	K	A	B	C	PDO	Totals*	Frequency
Darkness					1	1	5.6%
Darkness/ Lighted Road		1			1	11	11.1%
Daylight			2	1	11	14	77.8%
(blank)					1	1	5.6%

Ranking Factors

	This Intersection's Value	Critical Value	Star Given?
Skewed Intersection	Yes	Yes	★
On/Near Curve	Yes	Yes	★
Railroad Crossing Within 500 feet	No	Yes	
Previous Stop 5+ miles?	No	Yes	
Commercial Development Nearby	No	Yes	
Total Severe Crashes (K+A)	1	1+	★
Minor/Major AADT Ratio	0.814	0.3-0.399 or 0.5-0.599	

Intersection ID: 50-06
Stars Acquired for this Intersection: ★★★
Priority Group: 1
Individual Rank: 3

Once all possible stars are assigned, a summary is presented near the bottom of the template. The location ID, total number of stars acquired, which priority group the location belongs to, and potential countermeasures are typically listed. A list of potential countermeasures is included in Section 5.0, Countermeasures Selection. If other attributes are desired, they can also be shown here.

If an entire system was considered for analysis, all locations can be displayed by priority groups, as shown in Figure 4-13. In this figure, each color represents a different priority group. The legend shows what shapes and colors represent each location and priority group. For example, the yellow circles represent intersections in the 2nd priority group, while light blue lines represent the 1st priority group for segments. For convenience, the location ID is also displayed on the map. This location ID can be matched with the location ID shown near the bottom of Figure 4-12.

Mapping these locations helps to expose areas of concern. If one area has many locations in high priority groups, these locations can be potentially be grouped as a corridor and packaged for an HSIP project.

FIGURE 4-13
Map of Priority Group Locations Shown by Color

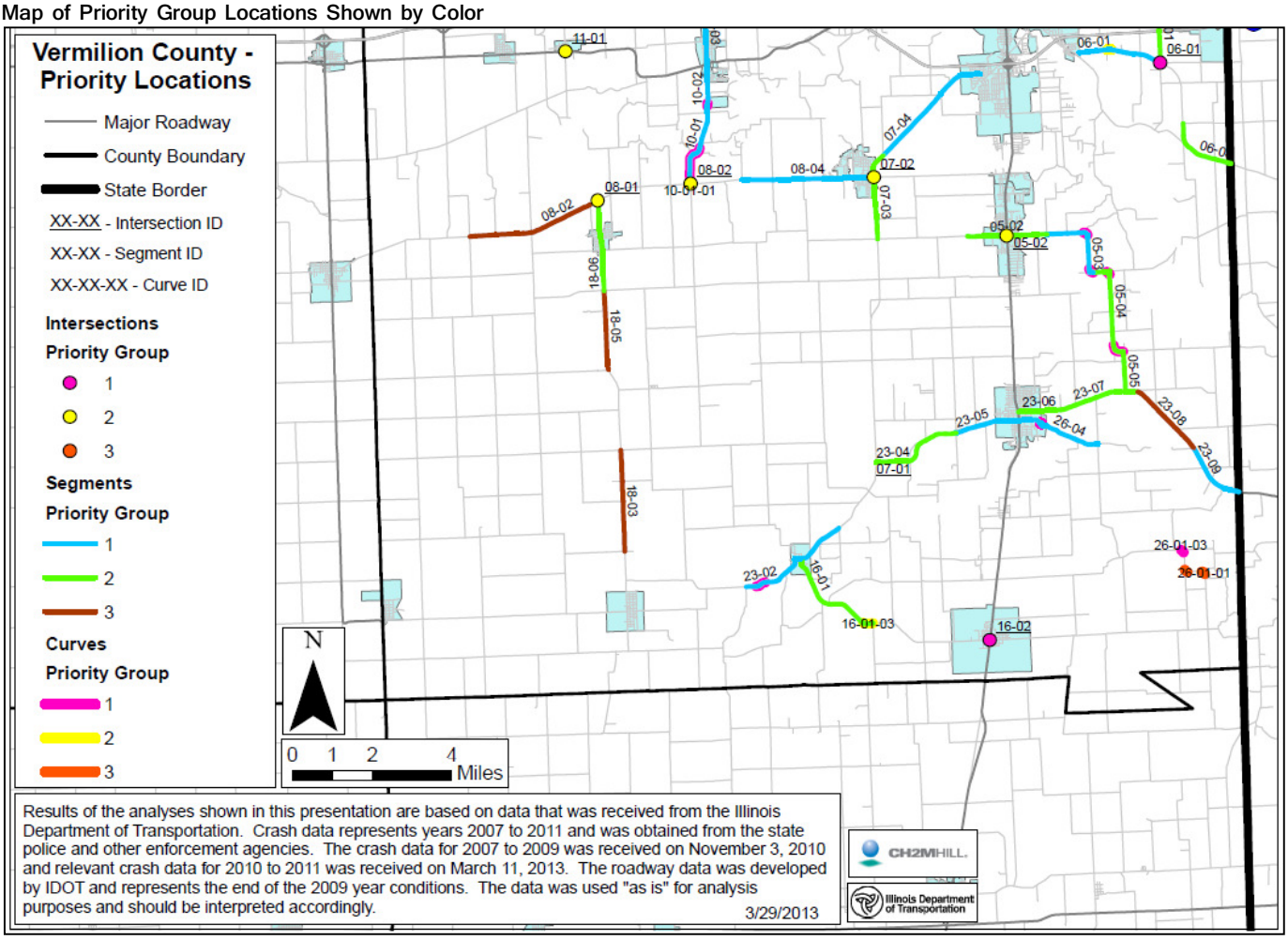


Table 4-9 shows how intersections, segments, and curves may be eligible for a high priority list. Note that the qualifiers will be unique to each system. For example, curves on *state* routes in County XYZ would not necessarily have the same qualifiers as curves on *county* routes in County XYZ. For reasons like this, choosing these groups is a very subjective process.

TABLE 4-9
Sample of Priority Group (PG) Qualifiers

Intersections	Segments	Curves
PG1: Any locations with 3 or more stars PG2: Any 2-star locations PG3: Any 1-star location with at least 1 severe crash	PG1: Any locations with 4 or more stars PG2: Any 3-star location with PG3: Any 2-star location with at least 1 severe crash	PG1: Any locations with 2 or more stars PG2: Any 1-star location with at least 5 all severity crashes

Once the qualifiers are determined, a GIS layer can be updated to include all desired data (star ratings, high priority group of 1, 2, or 3, and so forth). Layers can be used, along with unique symbology, to display the priority groups or high priority list in different colors, as shown in Figure 4-13.

4.7 Field Assessment

Once locations have been identified as high priority, a field assessment can be conducted. The goal of a field assessment is to visualize, characterize, and record the typical experience of a person travelling through the site. Once a field assessment is complete, all site information can be compiled to identify specific crash patterns. The crash patterns can be addressed through implementing appropriate safety countermeasures. Comparing observations from the field assessment, crash data review, and supporting documentation assessment may lead to observations that would not have otherwise been identified.

5.0 Countermeasure Selection

The tables included in this section are examples of what types of countermeasures may be selected. In order to maximize safety dollars, selecting ideal countermeasures that are low-cost and effective across any roadway system should be considered for implementation.

Once the user knows what and where their problem is, one or many countermeasures should be selected. There may be many countermeasures available to address a certain problem, but identifying the most efficient and appropriate countermeasure will only increase the benefit of the effort.

If the desired countermeasure cannot be found in Tables 5-1 through 5-15[2] of this section, other resources are available. NCHRP 500 and CMF Clearinghouse may be good sources for identifying any additional countermeasures.

TABLE 5-1
Comprehensive List of Older Driver Safety Strategies

Objectives	Strategies	Effectiveness
3.1 A – Plan for an aging population	3.1 A1 Establish a broad-based coalition to plan to address older adults' transportation needs	Tried
3.1 B – Improve the roadway and driving environment to better accommodate the special needs of older drivers	3.1 B1 Provide advance warning signs	Tried
	3.1 B2 Provide advance-guide and street name signs	Tried
	3.1 B3 Increase the size and letter height of roadway signs	Tried
	3.1 B4 Provide all-red clearance intervals at signalized intersections	Tried
	3.1 B5 Provide more protected left-turn signal phases at high-volume intersections	Tried
	3.1 B6 Provide offset left-turn lanes at intersections	Tried
	3.1 B7 Improve lighting at intersections, horizontal curves, and railroad grade crossings	Tried
	3.1 B8 Improve roadway delineation	Tried
	3.1 B9 Replace painted channelization with raised channelization	Proven
	3.1 B10 Reduce intersection skew angle	Tried
	3.1 B11 Improve traffic control at work zones	Tried
3.1 C – Identify older drivers at increased risk of crashing and intervene	3.1 C1 Strengthen the role of medical advisory boards	Tried
	3.1 C2 Update procedures for assessing medical fitness to drive	Proven
	3.1 C3 Encourage external reporting of at-risk drivers to licensing authorities	Tried
	3.1 C4 Provide remedial assistance to help functionally impaired older drivers lower their crash risk	Tried
3.1 D – Improve the driving competency of older adults in the general driving population	3.1 D1 Establish resource centers within communities to promote safe mobility choices	Tried
	3.1 D2 Provide educational and training opportunities to the general older driver population	Tried
3.1 E – Reduce the risk of injury and death to older drivers and passengers involved in crashes	3.1 E1 Increase seatbelt use by older drivers and passengers	Proven

Source: Transportation Research Board of the National Academies (TRB) 2004b.

[2] This plan contains many references. See Section 7 for complete list of references.

TABLE 5-2
Comprehensive List of Young Driver Safety Strategies

Objectives	Strategies	Effectiveness
A. Implement or Improve Graduated Driver Licensing Systems	A1. – Enact a Graduated Licensing System	Proven
	A2. – Require at Least 6 Months of Supervised Driving for Beginners Starting at Age 16	Proven
	A3. – Implement a Nighttime Driving Restriction that Begins at 9 p.m.	Proven
	A4. – Engage parents through outreach programs designed to educate parents about driving tips for their teens	Tried
	A5. – Develop parent-teen driver's education presentations and handbook aimed at educating individuals on the risk of teen driving	Tried
B. Publicize, enforce, and adjudicate laws pertaining to young drivers	B1. – Publicize and Enforce GDL Restrictions	Experimental
	B2. – Publicize and Enforce Laws Pertaining to Underage Drinking and Driving	Proven
	B3. – Publicize and Enforce Safety Belt Laws	Proven
C. Assist parents in managing their teens' driving	C1. – Facilitate Parental Supervision of Learners	Tried
	C2. – Facilitate Parental Management of Intermediate Drivers	Experimental
	C3. – Encourage Selection of Safer Vehicles for Young Drivers	Experimental
D. Improve young driver training	D1. – Improve Content and Delivery of Driver Education/Training	Tried
E. Employ School-Based Strategies	E1. – Eliminate Early School Start Times	Tried
	E2. – Review Transportation Plans for New/Expanded High School Sites	Experimental

Source: Transportation Research Board of the National Academies (TRB) 2007.
Note:
GDL = Graduated Driver's License

TABLE 5-3
Comprehensive List of Aggressive Driving Safety Strategies

Objectives	Strategies	Effectiveness	*Programs and Tactics
4.1 A – Deter aggressive driving in specific populations, including those with a history of such behavior, and at specific locations	4.1 A1-Target enforcement	Tried	Publicizing is best done through community events for the local media and a public education campaign in the community about the enforcement. High visibility enforcement is when multiple jurisdictions and/or multiple squads are out at the same time, patrolling in brightly colored vests, in conjunction with signage about the enforcement.
	4.1 A2-Conduct educational and public information campaigns	Tried	
	4.1 A3-Educate and impose sanctions against repeat offenders	Experimental	
4.1 B – Improve the driving environment to eliminate or minimize the external "triggers" of aggressive driving	4.1 B1-Change or mitigate the effects of identified elements in the environment	Experimental	
	4.1 B2-Reduce nonrecurring delays and provide better information about these delays	Experimental	

Source: Transportation Research Board of the National Academies (TRB) 2003a.

TABLE 5-4
Comprehensive List of Impaired Driving Safety Strategies

Objectives	Strategies	Effectiveness
5.1 A – Reduce Excessive Drinking and Underage Drinking	5.1 A1-Increase the State Excise Tax on Beer	Tried
	5.1 A2-Require Responsible Beverage Service Policies for Alcohol Servers and Retailers	Proven
	5.1 A3-Conduct Well-Publicized Compliance Checks of Alcohol Retailers to Reduce Sales to Underage Persons	Tried
	5.1 A4-Employ Screening and Brief Interventions in Health Care Settings	Tried
5.1 B – Enforce DWI Laws	5.1 B1-Conduct Regular Well-Publicized DWI Checkpoints	Proven
	5.1 B2-Enhance DWI Detection Through Special DWI Patrols and Related Traffic Enforcement	Tried
	5.1 B3-Publicize and Enforce Zero Tolerance Laws for Drivers Under Age 21	Proven
5.1 C – Prosecute, Impose Sanctions on, and Treat DWI Offenders	5.1 C1-Suspend Driver's License Administratively Upon Arrest	Proven
	5.1 C2-Establish Stronger Penalties for BAC Test Refusal Than for Test Failure	Tried
	5.1 C3 – Eliminate Diversion Programs and Plea Bargains to Non-Alcohol Offenses	Tried
	5.1 C4 – Incarcerate Offenders	Proven
5.1 D – Control High-BAC and Repeat Offenders	5.1 D1 – Seize Vehicles or Vehicle License Plates Administratively Upon Arrest	Proven
	5.1 D2 – Require Ignition Interlocks as a Condition for License Reinstatement	Proven
	5.1 D3 – Monitor All Convicted DWI Offenders Closely	Proven
	5.1 D4 – Incarcerate Offenders	Proven

Source: Transportation Research Board of the National Academies (TRB) 2005c.
Notes:
BAC = blood alcohol content
DWI = Driving While Intoxicated

TABLE 5-5
Comprehensive List of Seat Belt Usage Safety Strategies

Objectives	Strategies	Effectiveness
8.1 A – Maximize use of occupant restraints by all vehicle occupants	8.1 A1 – Conduct highly publicized enforcement campaigns to maximize restraint use.	Proven
	8.1 A2 – Provide enhanced public education to population groups with lower than average restraint use rates.	Proven
	8.1 A3 – Encourage the enactment of local laws that will permit standard enforcement of restraint laws.	Tried
8.1 B – Insure that restraints, especially child and infant restraints, are properly used	8.1 B1 – Provide community locations for instruction in proper child restraint use, including both public safety agencies and health care providers that are almost always available.	Tried
	8.1 B2 – Conduct high-profile “child restraint inspection” events at multiple community locations.	Proven
	8.1 B3 – Train law enforcement personnel to check for proper child restraint use in all motorist encounters.	Tried
8.1 C – Provide access to appropriate information, materials, and guidelines for those implementing programs to increase occupant restraint use	8.1 C1 – Create state-level clearing houses for materials that offer guidance in implementing programs to increase restraint use.	Experimental

Source: Transportation Research Board of the National Academies (TRB) 2004d.

TABLE 5-6
Comprehensive List of Road Departure Safety Strategies

Objectives	Strategies	Effectiveness
15.1 A – Keep vehicles from encroaching on the roadside	15.1 A1 – Install shoulder rumble strips	Tried
	15.1 A2 – Install edge lines "profile marking", edge line rumble strips or modified shoulder rumble strips on section with narrow or no paved shoulders	Experimental
	15.1 A3 – Install midlane rumble strips	Experimental
	15.1 A4 – Provide enhanced shoulder or delineation and marking for sharp curves	Tried / Proven
	15.1 A5 – Provide improved highway geometry for horizontal curves	Proven
	15.1 A6 – Provide enhanced pavement markings	Tried
	15.1 A7 – Provide skid-resistance pavement surfaces	Proven
	15.1 A8 – Apply shoulder treatments *Eliminate shoulder drop-offs *Shoulder wedge *Widen and/or pave shoulders	Experimental / Proven
15.1 B – Minimize the likelihood of crashing into an object or overturning if the vehicle travels off the shoulder	15.1 B1 – Design safer slopes and ditches to prevent rollovers	Proven
	15.1 B2 – Remove/relocate objects in hazardous locations	Proven
	15.1 B3 – Delineate trees or utility poles with retroreflective tape	Experimental
15.1 C – Reduce the severity of the crash	15.1 C1 – Improve design of roadside hardware	Tried
	15.1 C2 – Improve design and application of barrier and attenuation systems	Tried
15.1 C – Reduce the severity of the crash	18.1 A1 – Install centerline rumble strips for two-lane roads	Tried
	18.1 B2 – Install median barriers for narrow-width medians on multilane roads	Tried

Source: Transportation Research Board of the National Academies (TRB) 2003c.

TABLE 5-7
Comprehensive List of Curve Safety Strategies

Objectives	Strategies	Effectiveness
A. Reduce the likelihood of a vehicle leaving its lane and either crossing the roadway centerline or leaving the roadway at a horizontal curve	A1. – Provide advance warning of unexpected changes in horizontal alignment	Tried
	A2. – Enhance delineation along the curve	Tried
	A3. – Provide adequate sight distance	Tried
	A4. – Install shoulder rumble strips	Proven
	A5. – Install centerline rumble strips	Tried
	A6. – Prevent edge drop-offs	Tried
	A7. – Provide skid-resistant pavement surfaces	Tried
	A8. – Provide grooved pavement	Tried
	A9. – Provide lighting of the curve	Tried
	A10. – Provide dynamic curve warning system	Tried
	A11. – Widen the roadway	Proven
	A12. – Improve or restore superelevation	Proven
	A13. – Modify horizontal alignment	Proven
	A14. – Install automated anti-icing systems	Tried
	A15. – Prohibit/restrict trucks with very long semitrailers on roads with horizontal curves that cannot accommodate truck offtracking	Tried
B. Minimize the adverse consequences of leaving the roadway at a horizontal curve	B1. – Design safer slopes and ditches to prevent rollovers	Proven
	B2. – Remove/relocate objects in hazardous locations	Proven
	B3. – Delineate roadside objects	Experimental
	B4. – Add or improve roadside hardware	Tried
	B5. – Improve design and application of barrier and attenuation systems	Tried

Source: Transportation Research Board of the National Academies (TRB) 2004a.

TABLE 5-8
Comprehensive List of Signalized Intersection Safety Strategies

Objectives	Strategies	Effectiveness
17.2 A – Reduce frequency and severity of intersection conflicts through traffic control and operational improvements	17.2 A1 – Employ multiphase signal operation	Tried / Proven
	17.2 A2 – Optimize clearance intervals	Proven
	17.2 A3 – Restrict or eliminate turning maneuvers (including right turns on red)	Tried
	17.2 A4 – Employ signal coordination along a corridor or route	Proven
	17.2 A5 – Employ emergency vehicle preemption	Proven
	17.2 A6 – Improve operation of pedestrian and bicycle facilities at signalized intersections	Tried / Proven
	17.2 A7 – Remove unwarranted signal	Proven
17.2 B – Reduce frequency and severity of intersection conflicts through geometric improvements	17.2 B1 – Provide/improve left-turn channelization	Proven
	17.2 B2 – Provide/improve right-turn channelization	Proven
	17.2 B3 – Improve geometry of pedestrian and bicycle facilities	Tried / Proven
	17.2 B4 – Revise geometry of complex intersections	Tried / Proven
	17.2 B5 – Construct special solutions	Tried
17.2 C – Improve sight distance at signalized intersections	17.2 C1 – Clear sight triangles	Tried
	17.2 C2 – Redesign intersection approaches	Proven
17.2 D – Improve driver awareness of intersections and signal control	17.2 D1 – Improve visibility of intersections on approach(es)	Tried
	17.2 D2 – Improve visibility of signals and signs at intersections	Tried
17.2 E – Improve driver compliance with traffic control devices	17.2 E1 – Provide public information and education	Tried
	17.2 E2 – Supplement conventional enforcement of red-light running with confirmation lights	Tried
	17.2 E3 – Implement automated enforcement of red-light running (cameras)	Tried
	17.2 E4 – Implement automated enforcement of approach speeds (camera)	Tried
	17.2 E5 – Control speed approaches	Experimental
17.2 F – Improve access management near signalized intersections	17.2 F1 – Restrict access to properties using driveway closures or turn restrictions	Tried
	17.2 F2 – Restrict cross-median access near intersections	Tried
17.2 G – Improve safety through other infrastructure treatments	17.2 G1 – Improve drainage in intersection and on approaches	Tried
	17.2 G2 – Provide skid resistance in intersection and on approaches	Tried
	17.2 G3 – Coordinate closely spaced signals near at-grade railroad crossings	Tried
	17.2 G4 – Relocate signal hardware out of the clear zone	Tried
	17.2 G5 – Restrict or eliminate parking on intersection approaches	Proven

Source: Transportation Research Board of the National Academies (TRB) 2004e.

TABLE 5-9
Comprehensive List of Unsignalized Intersection Safety Strategies

Objectives	Strategies	Effectiveness
17.1 A – Improve management of access near unsignalized intersections	17.1 A1 – Implement driveway closure/relocations	Tried
	17.1 A2 – Implement driveway turn restrictions	Tried
17.1 B – Reduce the frequency and severity of intersection conflicts through geometric design improvements	17.1 B1 – Provide left-turn lanes at intersections	Proven
	17.1 B2 – Provide longer left-turn lanes at intersections	Tried
	17.1 B3 – Provide offset left-turn lanes at intersections	Tried
	17.1 B4 – Provide bypass lanes on shoulders at T-intersections	Tried
	17.1 B5 – Provide left-turn acceleration lanes at divided highway intersections	Tried
	17.1 B6 – Provide right-turn lanes at intersections	Proven
	17.1 B7 – Provide longer right-turn lanes at intersections	Tried
	17.1 B8 – Provide offset right-turn lanes at intersections	Tried
	17.1 B9 – Provide right-turn acceleration lanes at intersections	Tried
	17.1 B10 – Provide full-width paved shoulders in intersection areas	Tried
	17.1 B11 – Restrict or eliminate turning maneuvers by signing	Tried
	17.1 B12 – Restrict or eliminate turning maneuvers by providing channelization or closing median openings	Tried
	17.1 B13 – Close or relocate "high-risk" intersections	Tried
	17.1 B14 – Convert four-legged intersections to two T-intersections	Tried
	17.1 B15 – Convert offset T-intersections to four legged intersections	Tried
	17.1 B16 – Realign intersection approaches to reduce or eliminate intersection skew	Proven
	17.1 B17 – Use indirect left-turn treatments to minimize conflicts at divided highway intersections	Tried
	171. B18 – Improve pedestrian and bicycle facilities to reduce conflicts between motorists and nonmotorists	Varies
17.1 C – Improve sight distance at unsignalized intersections	17.1 C1 – Clear sight triangle on stop- or yield-controlled approaches to intersections	Tried
	17.1 C2 – Clear sight triangles in the medians of divided highways near intersections	Tried
	17.1 C3 – Change horizontal and/or vertical alignment of approaches to provide more sight distance	Tried
	17.1 C4 – Eliminate parking that restricts sight distance	Tried

TABLE 5-9
Comprehensive List of Unsignalized Intersection Safety Strategies (continued)

Objectives	Strategies	Effectiveness
17.1 D – Improve availability of gaps in traffic and assist drivers in judging gap sizes at unsignalized intersections	17.1 D1 – Provide an automated real-time system to inform drivers of suitability of available gaps for making turning and crossing maneuvers	Experimental
	17.1 D2 – Provide roadside markers or pavement markings to assist drivers in judging the suitability of available gaps for making turning and crossing maneuvers	Experimental
	17.1 D3 – Retime adjacent signals to create gaps at stop-controlled intersections	Tried
17.1 E – Improve driver awareness of intersections as viewed from the intersection approach	17.1 E1 – Improve visibility of intersections by providing enhanced signing and delineation	Tried
	17.1 E2 – Improve visibility of intersections by providing lighting	Proven
	17.1 E3 – Install splitter islands on the minor-road approach to an intersection	Tried
	17.1 E4 – Provide a stop bar (or provide a wider stop bar) on minor-road approaches	Tried
	17.1 E5 – Install larger regulatory and warning signs at intersections	Tried
	17.1 E6 – Call attention to the intersection by installing rumble strips on intersection approaches	Tried
	17.1 E7 – Provide dashed markings (extended left edge lines) for major-road continuity across the median opening at divided highway intersections	Tried
	17.1 E8 – Provide supplementary stop signs mounted over the roadway	Tried
	17.1 E9 – Provide pavement markings with supplementary messages, such as STOP AHEAD	Tried
	17.1 E10 – Provide improved maintenance of stop signs	Tried
	17.1 E11 – Install flashing beacons at stop-controlled intersections	Tried
17.1 F – Choose appropriate intersection traffic control to minimize crash frequency and severity	17.1 F1 – Avoid signalizing through roads	Tried
	17.1 F2 – Provide all-way stop control at appropriate intersections	Proven
	17.1 F3 – Provide roundabouts at appropriate locations	Proven
17.1 G – Improve driver compliance with traffic control devices and traffic laws at intersections	17.1 G1 – Provide targeted enforcement to reduce stop sign violations	Tried
	17.1 G2 – Provide targeted public information and education on safety problems at specific intersections	Tried
17.1 H – Reduce operating speeds on specific intersection approaches	17.1 H1 – Provide targeted speed enforcement	Proven
	17.1 H2 – Provide traffic calming on intersection approaches through a combination of geometrics and traffic control devices	Proven
	17.1 H3 – Post appropriate speed limit on intersection approaches	Tried
17.1 I – Guide motorists more effectively through complex intersections	17.1 I1 – Provide turn path markings	Tried
	17.1 I2 – Provide a double yellow centerline on the median opening of a divided highway at intersections	Tried
	17.1 I3 – Provide lane assignment signing or marking at complex intersections	Tried

Source: Transportation Research Board of the National Academies (TRB) 2003b.

TABLE 5-10
Comprehensive List of Head-on Safety Strategies

Objectives	Strategies	Effectiveness
18.1 A – Keep vehicles from encroaching into opposite lane	18.1 A1 – Install centerline rumble strips for two-lane roads	Tried
	18.1 A2 – Install profiled thermoplastic strips for centerlines	Tried
	18.1 A3 – Provide wider cross sections on two-lane roads	Experimental
	18.1 A4 – Provide center two-way left-turn lanes for four- and two-lane roads	Tried
	18.1 A5 – Reallocate total two-lane roadway width (lane and shoulder) to include a narrow "buffer median"	Tried
18.1 B – Minimize the likelihood of crashing into an oncoming vehicle	18.1 B1 – Use alternating passing lanes or four-lane sections at key locations	Tried
	18.1 B2 – Install median barriers for narrow-width medians on multilane roads	Tried

Source: Transportation Research Board of the National Academies (TRB) 2003d.

TABLE 5-11
Comprehensive List of Heavy Vehicle Safety Strategies

Objectives	Strategies	Effectiveness
12.1 A – Reduce fatigue-related crashes	12.1 A1 – Increase efficiency of use of existing parking spaces	Experimental
	12.1 A2 – Create additional parking spaces	Tried
	12.1 A3 – Incorporate rumble strips into new and existing roadways	Proven
12.1 B – Strengthen CDL program	12.1 B1 – Improve test administration for the CDL	Tried
	12.1 B2 – Increase fraud detection by state and third-party testers	Experimental
12.1 C – Increase knowledge about sharing the road	12.1 C1 – Incorporate Share the Road information into driver materials	Tried
	12.1 C2 – Promulgate Share the Road information through print and electronic media	Tried
12.1 D – Improve maintenance of heavy trucks	12.1 D1 – Increase and strengthen truck maintenance programs and inspection performance	-
	12.1 D2 – Conduct post-crash inspections to identify major problems and problem conditions	Experimental
12.1 E – Identify and correct unsafe roadway infrastructure and operational characteristics	12.1 E1 – Identify and treat truck crash roadway segments—signing	Experimental
	12.1 E2 – Install interactive truck rollover signing	Proven
	12.1 E3 – Modify speed limits and increase enforcement to reduce truck and other vehicle speeds	Tried
12.1 F – Improve and enhance truck safety data	12.1 F1 – Increase the timeliness, accuracy, and completeness of truck safety data	-
12.1 G – Promote industry safety initiatives	12.1 G1 – Perform safety consultations with carrier safety management	Proven
	12.1 G2 – Promote development and deployment of truck safety technologies	Experimental

Source: Transportation Research Board of the National Academies (TRB) 2004f.
Note:
CDL =commercial Drivers License

TABLE 5-12
Comprehensive List of Emergency Services Safety Strategies

Objectives	Strategies	Effectiveness
20.1 A – Integrate services to enhance emergency medical capabilities	20.1 A1 – Establish programs with organizations to utilize nontraditional employees as EMS responders	Tried
	20.1 A2 – Facilitate development of regional resources and/or cooperatives	Tried
	20.1 A3 – Integrate support of EMS into rural hospital financing programs	Tried
	20.1 A4 – Integrate information systems and highway safety activities	Tried
	20.1 A5 – Integrate EMS systems into the Safe Communities effort	Tried
	20.1 A6 – Use mobile data technologies that are interoperable with hospital systems	Tried
	20.1 A7 – Require all communication systems to be interoperable with surrounding and state jurisdictions	Tried
20.1 B – Provide or improve management and decision-making tools	20.1 B1 – Develop resource and performance standards unique to the specific rural EMS	Tried
	20.1 B2 – Identify, provide, and mandate efficient and effective methods for collection of necessary EMS data	Tried
	20.1 B3 – Identify and evaluate model rural EMS operations	Tried
	20.1 B4 – Provide evaluation results to elected and administrative officials at the county and local levels	Tried
20.1 C – Provide better education opportunities for rural EMS	20.1 C1 – Utilize technology-based instruction for rural EMS training	Proven
	20.1 C2 – Establish an exchange program to allow rural EMS providers to spend a specified number of hours in urban/suburban systems	Experimental
	20.1 C3 – Include principles of traffic safety and injury prevention as part of EMS continuing education	Experimental
	20.1 C4 – Require first care training for all public safety emergency response personnel, including law enforcement officers	Tried
	20.1 C5 – Educate rural residents about the availability, capability, and limitations of existing systems	Tried
	20.1 C6 – Provide “bystander care” training programs targeting new drivers, rural residents, truck drivers, interstate commercial bus drivers, and motorcyclists	Tried
	20.1 C7 – Provide EMS training programs in high schools in rural areas	Tried
20.1 D – Reduce time from injury to appropriate definitive care	20.1 D1 – Improve cellular telephone coverage in rural areas	Tried
	20.1 D2 – Improve compliance of rural 9-1-1 centers with Federal Communications Commission wireless “Phase II” automatic location capability	Tried
	20.1 D3 – Utilize geographic positioning system (GPS) technology to improve response time	Tried
	20.1 D4 – Integrate automatic vehicle location (AVL) and computer-aided navigation (CAN) technologies into all computer-aided dispatch (CAD) systems	Tried
	20.1 D5 – Equip EMS vehicles with multi-service and/or satellite-capable telephones	Tried

Source: Transportation Research Board of the National Academies (TRB) 2005b.
Notes:
EMS = emergency medical services

TABLE 5-13
Comprehensive List of Motorcycle Collision Safety Strategies

Objectives	Strategies	Effectiveness
11.1 A – Incorporate motorcycle-friendly roadway design, traffic control, construction, and maintenance policies and practices	11.1 A3 – Identify pavement markings, surface material, and other treatments that reduce traction for motorcycles and treat or replace with high-traction material	Tried
	11.1 A8 – Incorporate motorcycle safety considerations into routine roadway inspections	Experimental
11.1 B – Reduce the number of motorcycle crashes due to rider impairment	11.1 B1 – Increase motorcyclist awareness of the risks of impaired motorcycle operation	Tried
11.1 C — Reduce the number of motorcycle crashes due to unlicensed or untrained motorcycle riders	11.1 C1 – Increase awareness of the causes of crashes due to unlicensed or untrained motorcycle riders	Experimental
	11.1 C2 – Ensure that licensing and rider training programs adequately teach and measure skills and behaviors required for crash avoidance	Tried
11.1 D – Increase the visibility of motorcyclists	11.1 D1 – Increase the awareness of the benefit of high-visibility clothing	Experimental
	11.1 D2 – Identify and promote night visibility-enhancement methods and technology	Tried
11.1 E – Reduce the severity of motorcycle crashes	11.1 E1 – Increase the use of FMVSS 218 compliant helmets	Proven
11.1 F – Increase motorcycle rider safety awareness	11.1 E2 – Increase the use of protective clothing	Tried
	11.1 F1 – Form strategic alliances with motorcycle user community to foster and promote motorcycle safety	Tried
	11.1 F2 – Increase awareness of the consequences of aggressive riding, riding while fatigued or impaired, unsafe riding, and poor traffic strategies	Tried
	11.1 F3 – Educate operators of other vehicles to be more conscious of the presence of motorcyclists	Tried

Source: Transportation Research Board of the National Academies (TRB) 2009.

TABLE 5-14
Comprehensive List of Distracted, Inattentive, and Asleep Driver Safety Strategies

Objectives	Strategies	Effectiveness
Objective 6.1 A – Make roadways safer for drowsy or distracted drivers	Strategy 6.1 A1 – Install shoulder and/or centerline rumble strips	Proven
	Strategy 6.1 A2 – Implement other roadway improvements to reduce the likelihood and severity of run-off-road and/or head-on collisions	Proven
	Strategy 6.1 A3 – Implement roadway improvements to reduce the likelihood and severity of other types of distracted and drowsy driving crashes	Tried
Objective 6.1 B – Provide safe stopping and resting areas	Strategy 6.1 B1 – Improve access to safe stopping and resting areas	Tried
	Strategy 6.1 B2 – Improve rest area security and services	Tried
Objective 6.1 C – Increase driver awareness of the risks of drowsy and distracted driving and promote driver focus	Strategy 6.1 C1 – Conduct education and awareness campaigns targeting the general driving public	Tried
	Strategy 6.1 C2 – Visibly enforce existing statutes to deter distracted and drowsy driving	Experimental
Objective 6.1 D – Implement programs that target populations at increased risk of drowsy and distracted driving crashes	Strategy 6.1 D1 – Strengthen graduated driver licensing requirements for young novice drivers	Proven
	Strategy 6.1 D2 – Incorporate information on distracted and fatigued driving into education programs and materials for young drivers	Tried
	Strategy 6.1 D3 – Encourage employers to offer fatigue management programs to employees working nighttime or rotating shifts	Proven
	Strategy 6.1 D4 – Enhance enforcement of commercial motor vehicle hours-of-service regulations	Proven
	Strategy 6.1 D5 – Encourage trucking companies and other fleet operators to implement fatigue management programs	Tried
	Strategy 6.1 D6 – Implement targeted interventions for other high-risk populations	Experimental

Source: Transportation Research Board of the National Academies (TRB) 2005a.

TABLE 5-15
Comprehensive List of Pedestrian Safety Strategies

Objectives	Strategies	Effectiveness
9.1 A – Reduce pedestrian exposure to vehicular traffic	9.1 A1 – Provide sidewalks/walkways and curb ramps	Proven
	9.1 A2 – Install or upgrade traffic and pedestrian signals	Varies
	9.1 A3 – Construct pedestrian refuge islands and raised medians	Proven
	9.1 A4 – Provide vehicle restriction/diversion measures	Proven
	9.1 A5 – Install overpasses/underpasses	Proven
9.1 B – Improve sight distance and/or visibility between motor vehicles and pedestrians	9.1 B1 – Provide crosswalk enhancements	Varies
	9.1 B2 – Implement lighting/crosswalk illumination measures	Proven
	9.1 B3 – Eliminate screening by physical objects	Tried
	9.1 B4 – Signals to alert motorists that pedestrians are crossing	Experimental
	9.1 B5 – Improve reflectorization/conspicuity of pedestrians	Tried
9.1 C – Reduce vehicle speed	9.1 C1 – Implement road narrowing measures	Tried
	9.1 C2 – Install traffic calming – road sections	Proven/Tried
	9.1 C3 – Install traffic calming – intersections	Proven/Tried
	9.1 C4 – Provide school route improvements	Tried
9.1 D – Improve pedestrian and motorist safety awareness and behavior	9.1 D1 – Provide education, outreach, and training	Proven
	9.1 D2 – Implement enforcement campaigns	Tried

Source: Transportation Research Board of the National Academies (TRB) 2004c.

6.0 Benefit/Cost Analysis

Once countermeasures are chosen for a specific site, the impact of these countermeasures can be measured. Using the Benefit/Cost Tool allows the ability to fairly assess the effectiveness of the countermeasures that have been selected for implementation at a site.

By considering the number of crashes occurring at a site, along with their respective severity level, and the cost of the desired countermeasures, a measurement of benefit can be calculated. This tool takes into account many pieces of information. Some of these pieces of information include the cost of the countermeasure, the type of collisions the countermeasure is meant to reduce/eliminate, the amount of crashes that have occurred at the site, and so forth.

An example “Summary Sheet” produced by the Benefit/Cost Tool is shown in Figure 6-1. The figure shows what type of information is used. Crash counts by crash severity and countermeasure type are the most important aspects but simply having crash counts and countermeasures does not guarantee promising results. Choosing the best sites for implementation will help maximize the potential benefit.

Benefit/Cost Example:

This example shows how the user identified multiple curves throughout the county that have a considerable number of RD crashes. Once these potential curves are chosen, data can be collected and the curves can be prioritized. Understanding the issues at the priority locations will help in the countermeasures selection. It should be remembered that Data Trees or any of the other network screening tools can assist in determining these problematic areas.

For the curves considered by the user in this example, the major crash types are fixed object, head-on and overturned. The suggested countermeasures to reduce, or potentially eliminate these crashes, are shown in the bottom, left portion of the figure as “2.1.8.S1.1 - Pavement Treatments – Install Rumble Strips (Shoulder)” and “2.6.7.S1.1 - Curves – Install Chevron Signs on Horizontal Curves”. It is important to make sure the suggested countermeasures directly affect the most common crash types.

After choosing the desired countermeasures, a cost estimate can be prepared for shoulder rumble strips and chevron installation. Once the cost calculations and all of the necessary information is inserted, the user can calculate the Benefit/Cost ratio. This step shows the value and impact of the selected countermeasures.

In general, a higher Benefit/Cost ratio is more desirable. This indicates the countermeasure having a large impact on the troublesome crash types.

Figure 6-1
Summary Sheet from Benefit/Cost Tool

PROJECT DESCRIPTION - PROJECT DATA INPUT (SEGMENTS)

Project:	Curve Improvements					*Prepared by:*	TJM
District:	21	*County:*	Clearskies	*City:*	Safetytown	*Date*	11/1/2013
Key Route:	Various	*Marked Route:*	Various	*MilePost:*	Various	*Current AADT:*	450-11,000
Location Descriptio	Multiple horizontal curves throughout county						
						Length (miles):	Approx. 3 miles
Crash data:	5	Years				*Traffic Growth factor*	3.0%
	From	2008	to	2012		*Interest rate*	4.0%
Peer Group:	Peer Group 1 - Rural Two-Lane Highway						

Messages
2.6.7.S1.1 - Curves - Install Chevron Signs on Horizontal Curves AADT is not within HSM limits

SEGMENTS CRASH SEVERITY DISTRIBUTION BY CRASH TYPE FOR ANALYSIS PERIOD

Crash Type	All Crashes	Angle	Animal	Fixed Object	Head On	Left Turn	Other Noncollision	Other Object	Overturned	Pedestrian	Pedalcyclist	Parked Vehicle	Rear End	Right Turn	Sideswipe Same Direction	Sideswipe Opposite Direction	Turning	Train	Night Time	Wet Pavement	Total
Crash Severity	*ALL*	*AG*	*AN*	*FO*	*HO*	*LT*	*OtherNC*	*OtherO*	*OVT*	*PD*	*PDC*	*PKV*	*RE*	*RT*	*SSD*	*SOD*	*T*	*TR*	*NGT*	*WP*	*TOT*
Fatal Crashes					1																1
A-Injury Crashes		1		3	2				1							1					8
B-Injury Crashes			1	5	2		1	2	5		1	1				1					19
C-Injury Crashes				13	2				7							3					25
PDO Crashes				16	8				12			4									40

SEGMENTS BENEFIT COST ANALYSIS

BENEFIT CALCULATIONS				COUNTERMEASURE COST CALCULATIONS						
COUNTERMEASURE		*CMF **	*Crash Type affected by this improvement*	*Unit Cost*	*Quantity*	*Units*	*Total Cost*	*Service Life*	*Present worth*	*EUAC ***
2.1.8.S1.1 - Pavement Treatments - Install Rumble Strips (Shoulder)		0.78	FO, OVT	$25,000	3	Miles	$75,000	8	$75,000	$11,140
2.6.7.S1.1 - Curves - Install Chevron Signs on Horizontal Curves		0.84	All	$5,000	12	Unit Qnty	$60,000	4	$111,288	$16,529
			All							
			All							
TOTAL BENEFIT	***$587,962***			***TOTAL COST***						***$27,669***

BENEFIT/ COST	**21.20**	**ANNUAL NUMBER OF FATALITIES POTENTIALLY PREVENTED**	**0.03**	**TOTAL FATALITIES PREVENTED**	**0.15**

* CMF = Crash Modification Factor
** EUAC = Estimated Uniform Annual Cost

7.0 References and Additional Resources

Federal Highway Administration (FHWA). 2000. *Prediction of the Expected Safety Performance of Rural Two-Lane Highways.* Appendix D: Publication No. FHWA-RD-99-207. Available at: http://www.fhwa.dot.gov/publications/research/safety/99207/appd.cfm.

Transportation Research Board of the National Academies (TRB). 2003a. *NCHRP 500 Series, Volume 1: A Guide for Addressing Aggressive-Driving Collisions.*

Transportation Research Board of the National Academies (TRB). 2003b. *NCHRP 500 Series, Volume 5: A Guide for Addressing Unsignalized Intersection Collisions.*

Transportation Research Board of the National Academies (TRB). 2003c. *NCHRP 500 Series, Volume 6: A Guide for Addressing Run-Off-Road Collisions.*

Transportation Research Board of the National Academies (TRB). 2003d. *NCHRP 500 Series, Volume 4: A Guide for Addressing Head-On Collisions.*

Transportation Research Board of the National Academies (TRB). 2004a. *NCHRP 500 Series, Volume 7: A Guide for Reducing Collisions on Horizontal Curves.*

Transportation Research Board of the National Academies (TRB). 2004b. *NCHRP 500 Series, Volume 9: A Guide for Reducing Collisions Involving Older Drivers.*

Transportation Research Board of the National Academies (TRB). 2004c. *NCHRP 500 Series, Volume 10: A Guide for Reducing Collisions Involving Pedestrians.*

Transportation Research Board of the National Academies (TRB). 2004d. *NCHRP 500 Series, Volume 11: A Guide for Increasing Seatbelt Use*

Transportation Research Board of the National Academies (TRB). 2004e. *NCHRP 500 Series, Volume 12: A Guide for Reducing Collisions at Signalized Intersections.*

Transportation Research Board of the National Academies (TRB). 2004f. *NCHRP 500 Series, Volume 13: A Guide for Reducing Collisions Involving Heavy Trucks.*

Transportation Research Board of the National Academies (TRB). 2005a. *NCHRP 500 Series, Volume 14: A Guide for Reducing Crashes Involving Drowsy and Distracted Drivers.*

Transportation Research Board of the National Academies (TRB). 2005b. *NCHRP 500 Series, Volume 15: A Guide for Enhancing Rural Emergency Medical Services.*

Transportation Research Board of the National Academies (TRB). 2005c. *NCHRP 500 Series, Volume 16: A Guide for Reducing Alcohol-Related Collisions.*

Transportation Research Board of the National Academies (TRB). 2007. *NCHRP 500 Series, Volume 19: A Guide for Reducing Collisions Involving Younger Drivers.*

Transportation Research Board of the National Academies (TRB). 2009. *NCHRP 500 Series, Volume 22: A Guide for Addressing Collisions Involving Motorcycles.*

Other helpful resources

CMFClearinghouse.org

Highwaysafetymanual.org

Illinois Department of Transportation

CH2MHILL®

Priscilla A. Tobias, PE
State Safety Engineer, Bureau Chief
Illinois Department of Transportation, Bureau of Safety Engineering
2300 S. Dirksen Parkway, Room 323
Springfield, IL 62764
phone: 217-782-3568
fax 217-782-0377
email: Priscilla.Tobias@illinois.gov

Driving Zero Fatalities to a Reality
Partnering for Illinois