GRUNDY COUNTY

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Local Road Safety Plan

Kimley»Horn

GRUNDY COUNTY HIGHWAY DEPARTMENT

LOCAL ROAD SAFETY PLAN
GRUNDY COUNTY

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Statutory Notice

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Notwithstanding any other provision of law, reports, surveys, schedules, lists, or data compiled or collected for the purpose of identifying, evaluating, or planning the safety enhancement of potential accident sites, hazardous roadway conditions, or railway- highway crossings, pursuant to sections 130, 144, and 148 of this title or for the purpose of developing any highway safety construction improvement project which may be implemented utilizing Federal-aid highway funds shall not be subject to discovery or admitted into evidence in a Federal or State court proceeding or considered for other purposes in any action for damages arising from any occurrence at a location mentioned or addressed in such reports, surveys, schedules, lists, or data.

GRUNDY COUNTY PLEDGE

In this pledge, I formalize Grundy County's support for the goals in Iowa's 2019-2023 Strategic Highway Safety Plan (SHSP) and the overall vision of Zero Fatalities on Iowa's public roadways. Zero Fatalities is already the personal goal of every road user. Implementation of the safety strategies outlined in this Local Road Safety Plan (LRSP) will help road users keep that personal goal of staying safe while driving, walking, or riding on Grundy County's roadways. Grundy County has shown that dedication to proven safety programs and projects can reduce traffic fatalities and serious injuries. Grundy County is committed to enhancing existing programs that work and implementing the safety strategies outlined in the LRSP to continue to drive down fatalities and serious injuries. In accordance with the LRSP, Grundy County will continue to take the necessary steps to improve safety on the county's roadways in order to realize our goal of zero traffic fatalities by 2040.

Mark a. Schildroth

Mark Schildroth, Chairman

Grundy County Board of Supervisors

10-3-22

Date

EXECUTIVE SUMMARY

In the United States over 37,000 people lost their lives in motor vehicle crashes in 2017. According to the Federal Highway Administration (FHWA), rural road safety is a concern because rural fatalities account for nearly half of all fatalities across the United States, yet less than 20% of the population lives in rural areas. In addition, the fatality rate on rural roads is 2.5 times higher than the fatality rate in urban areas.

> ***"In 2016, 19% of the US population lived in rural areas but rural road fatalities accounted for 50% of all fatalities. Even with reductions in the number of fatalities on the roadways, the fatality rate in rural areas was 2.5 times higher than the fatality rate in urban areas."***
>
> ***FHWA – Office of Traffic Safety***

In Iowa from 2008 to 2017 the fatal and serious injury crash rates on rural roads were more than twice that of state-maintained roads. There was an average of 4.3 fatal and serious injury crashes per year on county roads in Grundy County from 2008 to 2017, resulting in a county road fatal and serious injury crash rate of 5.68 crashes per hundred million vehicle miles traveled (HMVMT), more than the 4.99 statewide average fatal and serious injury crash rate over the same period.

In the past, many efforts have focused on safety for higher volume roads and reactionary or "black spot" analysis of high crash locations. However, there is a growing trend across the United States to focus on proactive safety improvements for rural roads.

The Iowa Department of Transportation (DOT) developed a Strategic Highway Safety Plan (SHSP) to provide technical assistance in prioritization and deployment of safety countermeasures within various jurisdictions throughout the state. The Local Road Safety Plan (LRSP) concept is designed to build on the foundation established by the SHSP. The LRSP provides the basis for proactive implementation of safety countermeasures specific to individual counties across Iowa. This allows the county to leverage the road safety planning process to meet county-specific needs.

E.1. What is an LRSP?

An LRSP is a document that provides a basis for systemic safety improvements along local roads. Rather than addressing "black spots," the LRSP identifies systemic safety improvements along the roadway based on a risk factor analysis of the roadway. LRSPs not only assist local practitioners in understanding the types of crashes occurring on local roadways, but they also define a locally focused plan for practitioners to make informed, prioritized safety decisions. Additional benefits of LRSPs include:

- Coordination between various agencies within the county
- Use of the results of the analysis to leverage and apply for funding
- Focus on all the five E's of safety (Engineering, Emergency response, Education, Enforcement, and Everyone)

The LRSP process has been successfully initiated in several states including Minnesota, North Dakota, and Kansas.

E.1.1. Five E's of Safety

In some states, LRSPs generally focus on engineering improvements to mitigate crashes at the county level. In Iowa, LRSPs are also assessing what is being conducted at the county level to address all of the five E's of safety.

While engineering improvements can make the roadways safer, engineering improvements alone cannot prevent all motor vehicle crashes. According to the National Highway Traffic Safety Administration (NHTSA), over 90% of all crashes are the result of driver-related factors. Because such a high percentage of crashes are a result of driver-related factors, making roadways safer requires all of the five E's to be involved.

Working together with all of the E's at the county level will help make the county roads safer.

E.2. Purpose of the LRSP

The LRSP identifies a prioritized list of safety improvement projects that can be implemented within the county to address specific crash characteristics identified during the data collection portion of the project. The recommendations in this plan focus on transportation improvements with a high benefit of crash reductions by applying the principles established in the SHSP and through a systemic data analysis performed specifically for Grundy County. The recommended improvements take into consideration constraints within the local county network and incorporate feedback from the County Engineer and local stakeholders.

Phase 1 of the LRSP project was completed in March 2016, which included 12 Iowa counties throughout the state, two from each Iowa DOT District. Phase 2 of the project concluded in November 2017 and included 17 additional counties in the southeast part of the state. Phase 3 of the project concluded in August 2018 and included 18 counties.

Grundy County is part of the fourth phase of the project which includes 11 counties, located throughout the state. The following counties are included within Phase 4 of the Iowa DOT LRSP project.

- Black Hawk County
- Cass County
- Dallas County
- Delaware County
- Dubuque County
- **Grundy County**
- Harrison County
- Ida County
- Jasper County
- Ringgold County
- Scott County
- Taylor County

Figure E-1 illustrates the counties completed in Phases 1, 2, and 3 as well as those included in Phase 4 with respect to the state of Iowa.

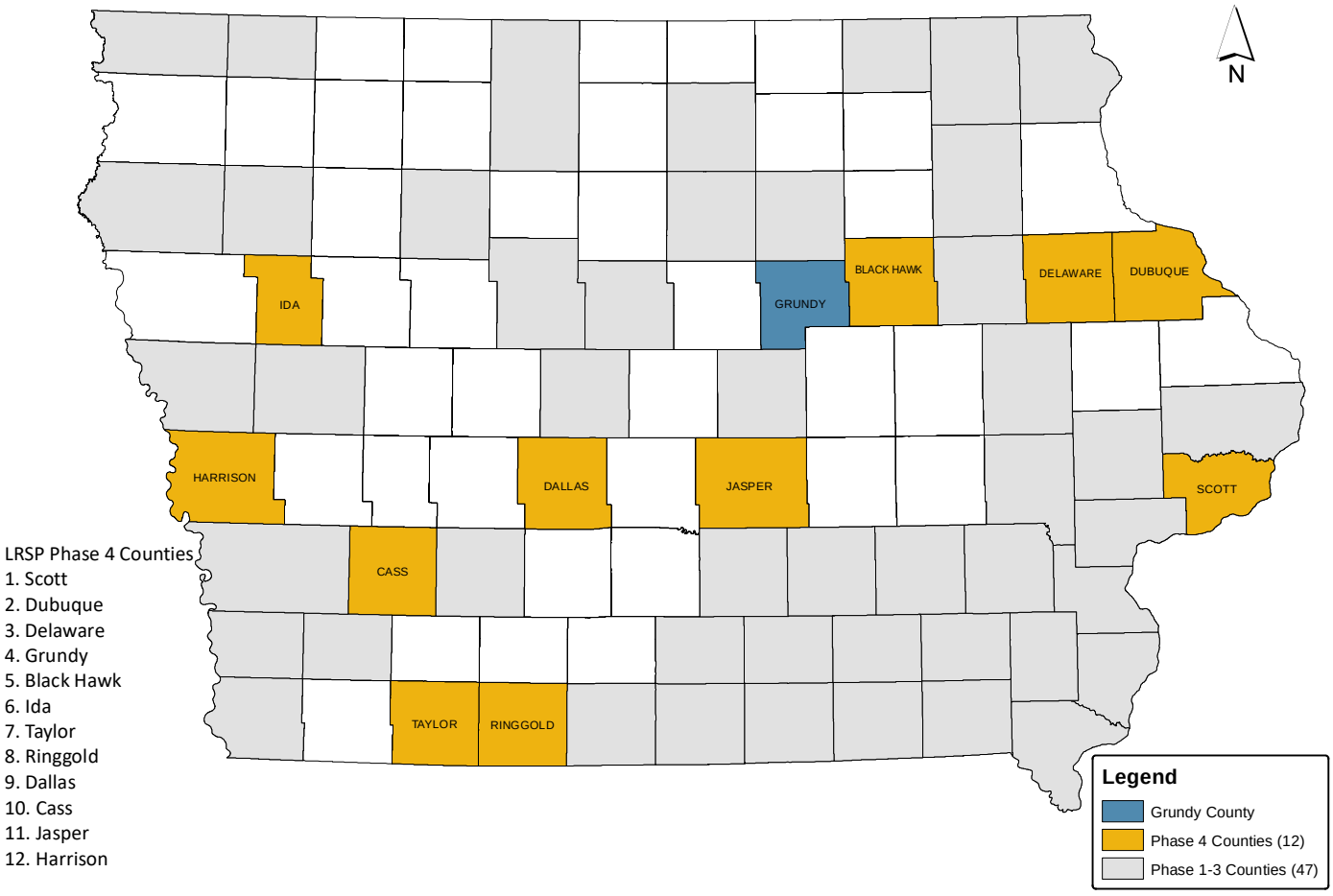

Figure E-1 – Location of LRSP Counties with Respect to Iowa

E.3. Grundy County

Grundy County is located in central Iowa and was named for Felix Grundy, who was a statesman and senator for the State of Tennessee. According to the 2010 census, the population of Grundy County is 12,453. Grundy Center, the county seat, is also the county's most populous city at 2,706.

The county maintains approximately 830 miles of county roads, of which approximately 190 are paved. From 2008 to 2017 there were 805 crashes on Grundy County roads, of which 43 crashes resulted in fatal and serious injuries.

E.4. LRSP Project Overview

The LRSP project includes seven primary task assignments. The following is a brief description of the tasks associated with this project, with a more detailed description of each task in subsequent sections of this document. **Figure E-2** illustrates the LRSP project process and timeline.

E.4.1. Gather Background Information

Under this task, relevant documents provided by the counties were reviewed as well as the Iowa SHSP, and potential funding sources. Data requests were made of the counties to provide the location and presence of rumble strips, destination lighting, stop signs, and other pertinent safety improvements.

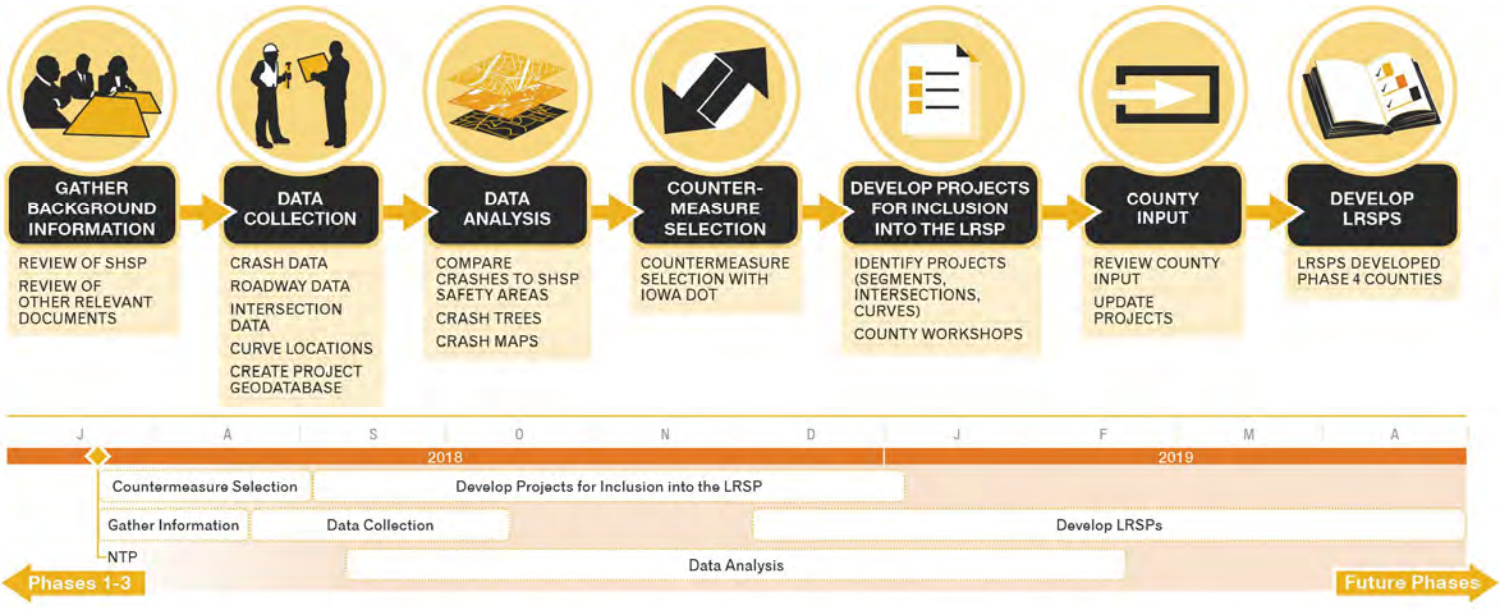

Figure E-2 – LRSP Project Process

E.4.2. Data Collection

A comprehensive Geographic Information System (GIS) project database was developed utilizing the following databases as provided by the Iowa DOT, the county, or collected as part of this project:

- Crash database
- Roadway database
- Access point database (911 address database)
- Pavement management database
- Roadside hazard database
- Horizontal curve database
- Stop sign database
- Intersection database

E.4.3. Data Analysis

After development of the comprehensive GIS project database, the crash data was analyzed for Grundy County. Crashes were compared to the Safety Emphasis Areas for the State of Iowa (as defined in the SHSP) and crash trees and maps were prepared. Relevant information from the crash data analysis is included within this document.

E.4.4. Countermeasure Selection

In coordination with the Iowa DOT, a list of low-cost engineering-related safety countermeasures was developed for use as recommendations in the LRSP project. These countermeasures are discussed in **Section 5** of this report.

In addition, a workshop was held with the safety stakeholders of Grundy County. Prior to the workshop, a list of safety topics was developed and distributed to the county to foster discussion at the workshop on driver-related safety countermeasure implementation. During this workshop, the following items were discussed:

- The background and purpose of the LRSP
- The five E's of safety
- Crash data
- Driver-related countermeasures

Driver-related countermeasures were reviewed, and stakeholders discussed existing and proposed driver-related countermeasures. A summary of the countermeasures currently underway in the county, as well as those proposed at the workshop, are included within this document.

E.4.5. Develop Projects for Inclusion into the LRSP

A risk factor ranking process was developed for segments, intersections, and curves. Risk factors were calculated for all paved segments, intersections, and curves and within the county. Risk factors included roadway features such as curve radius, shoulder width, and traffic volumes. After conducting the risk factor analysis, recommended safety improvements were developed for the feature types based on the project selection decision trees. Improvements included items such as additional signage, pavement markings, and rumble strips. Project sheets detailing the recommended safety improvements at specific locations were then provided to the County Engineer for review.

E.4.6. County Input

As the systemic analysis was based solely upon available GIS data, the associated recommended countermeasures did not incorporate data regarding geometrics, turning movements, right-of-way, etc. Additional safety countermeasures could be applied at locations that were determined to have a high risk factor ranking but may require additional site-specific information that may be known by the County Engineer. The project sheets, recommending countermeasures as determined by the project selection decision trees, were provided to the County Engineer for input for additional safety countermeasures. This step allowed the County Engineer to use engineering judgment and site-specific knowledge to recommend additional safety countermeasures at the identified/prioritized locations. At the county workshop, the project sheets and recommendations were reviewed.

E.4.7. Develop LRSPs

An LRSP was developed for the county including a summary of the LRSP process along with recommended safety projects for implementation by the county.

E.5. Recommendations

This LRSP identifies both driver- and engineering-related countermeasures. The following sections summarize the recommended countermeasures and improvements for the county.

E.5.1. Driver-Related Countermeasures

The 2013 Iowa SHSP has ten Key Safety Emphasis Areas, of which six are driver-related emphasis areas:

- Speed-related
- Unprotected persons
- Younger drivers
- Impaired driving
- Older drivers
- Inattentive/distracted driving

Figure E-3 – Iowa SHSP Driver-Related Emphasis Areas

During the workshop, attendees were provided information regarding fatal and serious injury crashes within the county and how that data aligned with the Iowa SHSP Key Safety Emphasis Areas. Potential countermeasures from the *National Cooperative Highway Research Program (NCHRP) Report 500 Series, Toward Zero Deaths* documents, and the results from Phases 1, 2, and 3 of the LRSPs were provided to stakeholders to facilitate discussion on what action items were currently underway in the county with respect to driver-related crashes. The following statuses of implementation for the various driver-related countermeasures were defined based on the results of the discussion at the county workshop:

- Underway/Ongoing (currently being done);
- Area for Improvement (ongoing, but could be enhanced);
- Opportunity (not being done, but could be implemented); or
- Completed in the Past (has been completed in the past, but not planned to be implemented in the future).

Table E-1 provides a summary of the status of implementation of the driver-related countermeasures within Grundy County. It is recommended that the county continue to implement countermeasures that are currently underway/ongoing and look for opportunities to implement additional countermeasures not currently being implemented. This will require input from and coordination with all of the five E's of safety. **Section 5.5** provides details on the implementation of the following countermeasures.

Table E-1 – County Driver-Related Countermeasure Summary

Countermeasure	Status
Speed-Related	
Conduct targeted speed enforcement	Underway/Ongoing
Prosecute and impose sanctions on drivers not obeying school bus stop bars	Underway/Ongoing
Conduct education and awareness campaigns	Area for Improvement
Unprotected Persons	
Conduct targeted enforcement of restraint use	Underway/Ongoing
Instruction in proper child restraint use	Underway/Ongoing
Check for proper child restraint use in all motorist encounters	Underway/Ongoing
Positive Reinforcement	Opportunity
Conduct education and awareness campaigns	Underway/Ongoing
Younger Drivers	
Enforcement of graduated driver's license laws	Underway/Ongoing
Mock prom disaster events	Opportunity
Additional training in schools	Opportunity
Conduct education and awareness campaigns	Opportunity
Impaired Driving	
Conduct targeted OWI enforcement	Underway/Ongoing
Conduct safety checkpoints	Opportunity
Compliance checks for alcohol sales	Opportunity
Alternative transportation choices	Area for Improvement
Prosecute, impose sanctions on, and treat OWI offenders	Underway/Ongoing
Conduct education and awareness campaigns	Opportunity
Older Drivers	
Promote safe mobility choices	Opportunity
Encourage external reporting of at-risk drivers to licensing authorities	Underway/Ongoing
Conduct education and awareness campaigns	Opportunity
Inattentive/Distracted Driving	
Visibly enforce existing statutes to deter distracted driving	Area for Improvement
Agency policy for hands-free devices	Underway/Ongoing
Mobile simulator for distracted driving	Area for Improvement
Conduct education and awareness campaigns	Opportunity

E.5.2. Engineering Countermeasures

In addition to driver-related countermeasures, a list of safety engineering projects was developed for locations with high risk factor rankings along county paved roads. Projects were developed for high-priority county paved segments, intersections, and curves. Segment and curve projects included improvements such as enhanced signing and striping, rumble strips, and shoulders with safety edges. Intersection projects included improvements such as destination lighting, upgrading signs and pavement markings, and transverse rumble strips on stop-controlled approaches. **Table E-2** provides a consolidated cost summary of the recommended safety improvements developed for the county. **Section 6** of the LRSP and the **Appendices** include detailed project information.

Table E-2 – Engineering Countermeasures Cost Summary

Facility Type	Number of Locations	Estimated Project Cost
Segments	12	$ 2,238,000
Intersections	14	$ 1,429,000
Curves	5	$ 95,000
Total Improvement Costs	**31**	**$ 3,762,000**

Due to the limited amount of available data, low traffic volumes, and limitations on the types of safety improvement projects that can be implemented on unpaved roads, location-specific recommendations were not developed for unpaved roadways. However, this LRSP includes safety recommendations that can be considered for implementation on the unpaved roadway system by the County Engineer.

E.6. Implementation

One of the goals of the LRSP project is to provide a document that is usable and can be frequently consulted by the County Engineer to aid in requesting funding and in the completion of traffic safety improvement projects on county-maintained roads. This section describes some recommendations on how this plan can be implemented within the county.

The project sheets developed and provided in **Appendix B2**, **Appendix C2**, and **Appendix D2** are intended to be used as a straightforward way to apply for safety improvement funding through the Highway Safety Improvement Program for Secondary Roads (HSIP-S). The recommendations contained within the project sheets lend themselves well to HSIP-S funding because they were developed based on a proactive risk factor assessment, with a focus on reducing the potential for fatal and serious injury crashes.

Additionally, there is a list of high-crash locations contained within **Section 7** of this document. It is recommended that the County Engineer consider applying for Traffic Safety Improvement Program (TSIP) funding at these locations because TSIP funding considers benefit-cost analysis. The County Engineer can review these locations to determine if safety improvements, similar to the ones outlined within **Section 6.2**, **Section 6.3**, and **Section 6.4** are applicable, and develop a TSIP application based on the recommended improvements.

The County Engineer should also review the projects within the Five-Year Program and consider including safety recommendations from the project sheets into those projects, where applicable.

In future cycles of the Five-Year Program, it is recommended that the safety projects included on the project sheets be considered for inclusion in the program.

The County Engineer should also consider consulting the LRSP when developing a project for design or addressing a maintenance issue, in order to incorporate the types of safety improvement recommendations in the LRSP and in the project sheets. Doing so can help prioritize projects and emphasize safety in design and maintenance.

Finally, the LRSP can be consulted during routine maintenance activities such as striping and mowing (clearing and grubbing). The document can be used to provide instruction or education to maintenance crews about the safety implications of their work.

E.7. Next Steps

Project sheets containing the prioritized list of projects have been provided in **Appendix B2**, **Appendix C2**, and **Appendix D2** to aid the County Engineer in obtaining funding for safety improvements and/or for incorporating recommendations into planned roadway improvement projects. These sheets may require updating for funding applications in future years. The County Engineer may also make changes to the prepared project sheets based on local knowledge of the site, available funding, and/or specific needs.

It is recommended that the county continue to foster cooperation with other stakeholders and look for opportunities to improve and expand implementation of driver-related countermeasures. The county should continue its history of implementing a number of safety improvement projects annually. Based on current funding levels, it is anticipated that many of the engineering improvements listed in this plan could be implemented within five to ten years, or sooner. Additionally, this LRSP should be updated within five to ten years to reflect improvements that have been implemented, additional availability of roadway feature data, and changes in crash types and patterns.

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List of Abbreviations

A	Serious Injury
AASHTO	American Association of State Highway and Transportation Officials
ADT	Average Daily Traffic
ARIDE	Advanced Roadside Impaired Driving Enforcement
Caltrans	California Department of Transportation
CMF	Crash Modification Factor
CRF	Crash Reduction Factor
CPST	Child Passenger Safety Technician
C-STEP	County-State Traffic Engineering Program
DARE	Drug Abuse Resistance Education
DEV	Daily Entering Vehicles
DOT	Department of Transportation
DRE	Drug Recognition Expert
EMS	Emergency Medical Services
FHWA	Federal Highway Administration
Five E's	Engineering, Emergency response, Education, Enforcement, and Everyone
FTYROW	Failure to Yield Right-of-Way
GDL	Graduated Driver's License
GIMS	Geographic Information Management System
GIS	Geographic Information System
GTSB	Governor's Traffic Safety Bureau
HFST	High Friction Surface Treatment
HPS	High Pressure Sodium
HSIP-S	Highway Safety Improvement Program – Secondary
HSM	Highway Safety Manual
HMVMT	Hundred Million Vehicle Miles Traveled
ICE	Intersection Configuration Evaluation
ICWS	Intersection Conflict Warning System
InTrans	Institute for Transportation at Iowa State University
INRCOG	Iowa Northland Regional Council of Governments
IRI	International Roughness Index
ITSDS	Iowa Traffic Safety Data Service
K	Fatality
LED	Light-Emitting Diode
LRSP	Local Road Safety Plan
LRTF	Living Roadway Trust Fund
LTAP	Local Technical Assistance Program

MDST	Multi-Disciplinary Safety Team
MnDOT	Minnesota Department of Transportation
mph	miles per hour
MUTCD	Manual on Uniform Traffic Control Devices
NCHRP	National Cooperative Highway Research Program
NHTSA	National Highway Traffic Safety Administration
OWI	Operating While Intoxicated
RSA	Road Safety Assessment
SHSP	Strategic Highway Safety Plan
SICL	Safety Improvement Candidate Location
SRPFCC	Sign Replacement Program for Cities and Counties
sTEP	Special Traffic Enforcement Program
SUDAS	Statewide Urban Design and Specifications
TEAP	Traffic Engineering Assistance Program
TSIP	Traffic Safety Improvement Program
usRAP	United States Road Assessment Program

1. INTRODUCTION

In the United States over 37,000 people lost their lives in motor vehicle crashes in 2017. According to the Federal Highway Administration (FHWA), rural road safety is a concern because rural fatalities account for nearly half of all fatalities across the United States, yet less than 20% of the population lives in rural areas. In addition, the fatality rate on rural roads is 2.5 times higher than the fatality rate in urban areas.

"In 2016, 19% of the US population lived in rural areas but rural road fatalities accounted for 50% of all fatalities. Even with reductions in the number of fatalities on the roadways, the fatality rate in rural areas is 2.5 times higher than the fatality rate in urban areas."

FHWA – Office of Traffic Safety

In Iowa from 2008 to 2017 the fatal and serious injury crash rates on rural roads were more than twice that of state-maintained roads. There was an average of 4.3 fatal and serious injury crashes per year on county roads in Grundy County from 2008 to 2017, resulting in a county road fatal and serious injury crash rate of 5.68 crashes per hundred million vehicle miles traveled (HMVMT), less than the 4.99 statewide average fatal and serious injury crash rate over the same period.

In the past, many efforts have focused on safety for higher volume roads and reactionary or "black spot" analysis of high crash locations. However, there is a growing trend across the United States to focus on proactive safety improvements for rural roads.

The Iowa Department of Transportation (DOT) developed a Strategic Highway Safety Plan (SHSP) to provide technical assistance in prioritization and deployment of safety countermeasures within various jurisdictions throughout the state. The Local Road Safety Plan (LRSP) concept is designed to build on the foundation established by the SHSP. The LRSP provides the basis for proactive implementation of safety countermeasures specific to individual counties across Iowa. This allows the county to leverage the road safety planning process to meet county-specific needs.

1.1. What is an LRSP?

An LRSP is a document that provides a basis for systemic safety improvements along local roads. Rather than addressing "black spots," the LRSP identifies systemic safety improvements along the roadway based on a risk factor analysis of the roadway. LRSPs not only assist local practitioners in understanding the types of crashes occurring on local roadways, but they also define a locally focused plan for practitioners to make informed, prioritized safety decisions. Additional benefits of LRSPs include:

- Coordination between various agencies within the county
- Use of the results of the analysis to leverage and apply for funding
- Focus on all the five E's of safety (Engineering, Emergency response, Education, Enforcement, and Everyone)

The LRSP process has been successfully initiated in several states including Minnesota, North Dakota, and Kansas.

1.1.1. Five E's of Safety

In some states, LRSPs generally focus on engineering improvements to mitigate crashes at the county level. In Iowa, LRSPs are also assessing what is being conducted at the county level to address all of the five E's of safety.

While engineering improvements can make the roadways safer, engineering improvements alone cannot prevent all motor vehicle crashes. According to the National Highway Traffic Safety Administration (NHTSA), over 90% of all crashes are the result of driver-related factors. Because such a high percentage of crashes are a result of driver-related factors, making roadways safer requires all of the five E's to be involved.

Working together with all of the E's at the county level will help make the county roads safer.

1.2. Purpose of the LRSP

The LRSP identifies a prioritized list of safety improvement projects that can be implemented within the county to address specific crash characteristics identified during the data collection portion of the project. The recommendations in this plan focus on transportation improvements with a high benefit of crash reductions by applying the principles established in the SHSP and through a systemic data analysis performed specifically for Grundy County. The recommended improvements take into consideration constraints within the local county network and incorporate feedback from the County Engineer and local stakeholders.

Phase 1 of the LRSP project was completed in March 2016, which included 12 Iowa counties throughout the state, two from each Iowa DOT District. Phase 2 of the project concluded in November 2017 and included 17 additional counties in the southeast part of the state. Phase 3 of the project concluded in August 2018 and included 18 counties.

Grundy County is part of the fourth phase of the project which includes 11 counties, located throughout the state. The following counties are included within Phase 4 of the Iowa DOT LRSP project.

- Black Hawk County
- Cass County
- Dallas County
- Delaware County
- Dubuque County
- **Grundy County**
- Harrison County
- Ida County
- Jasper County
- Ringgold County
- Scott County
- Taylor County

Figure 1 illustrates the counties completed in Phases 1, 2, and 3 as well as those included in Phase 4 with respect to the state of Iowa.

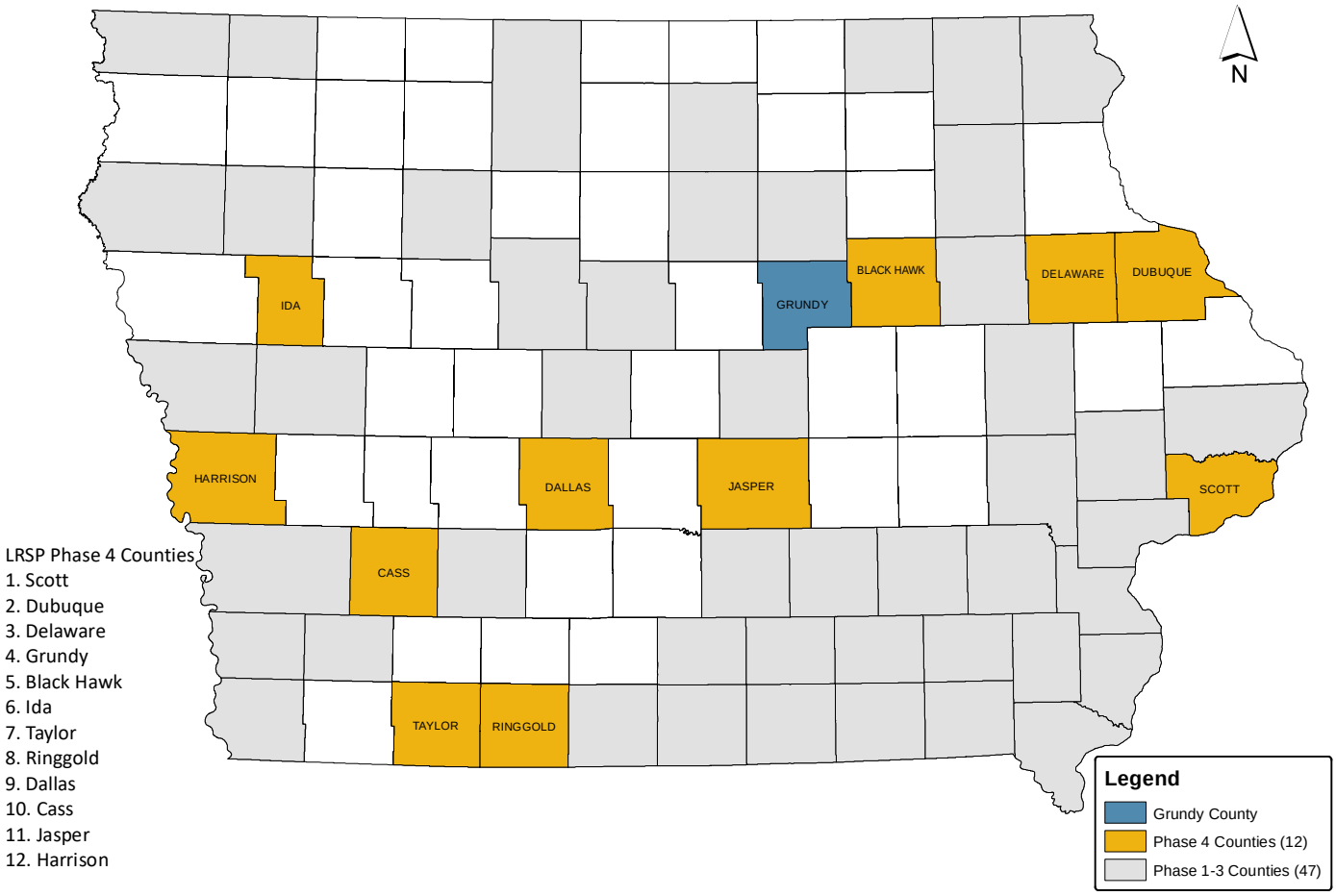


Figure 1 – Location of LRSP Counties with Respect to Iowa

1.3. Grundy County

Grundy County is located in central Iowa and was named for Felix Grundy who was a statesman and senator for the State of Tennessee. According to the 2010 census, the population of Grundy County is 12,453. Grundy Center, the county seat, is also the county's most populous city at 2,706.

The county maintains approximately 830 miles of county roads, of which approximately 190 are paved. From 2008 to 2017 there were 805 crashes on Grundy County roads, of which 43 crashes resulted in fatal and serious injuries.

1.4. LRSP Project Overview

The LRSP project includes seven primary task assignments. The following is a brief description of the tasks associated with this project, with a more detailed description of each task in subsequent sections of this document. **Figure 2** illustrates the LRSP project process and timeline.

1.4.1. Gather Background Information

Under this task, relevant documents provided by the counties were reviewed as well as the Iowa SHSP, and potential funding sources. Data requests were made of the counties to provide the location and presence of rumble strips, destination lighting, stop signs, and other pertinent safety improvements.

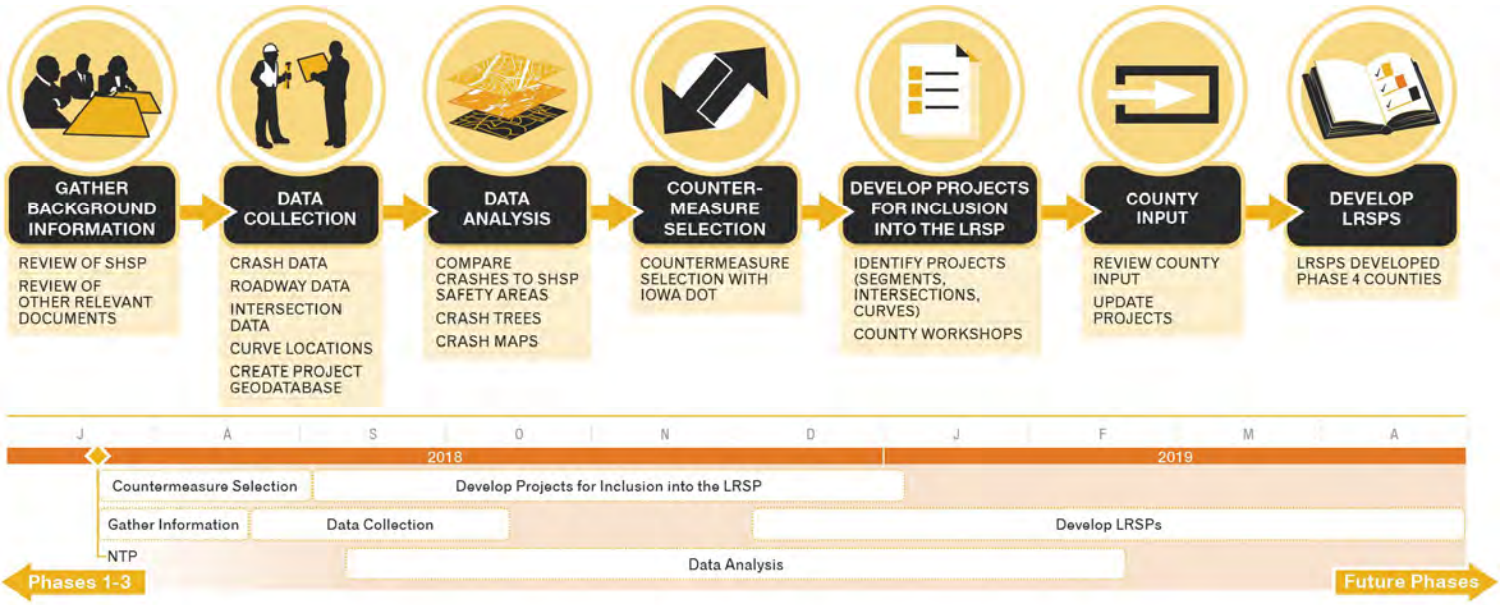


Figure 2 – LRSP Project Process

1.4.2. Data Collection

A comprehensive Geographic Information System (GIS) project database was developed utilizing the following databases as provided by the Iowa DOT, the county, or collected as part of this project:

- Crash database
- Roadway database
- Access point database (911 address database)
- Pavement management database
- Roadside hazard database
- Horizontal curve database
- Stop sign database
- Intersection database

1.4.3. Data Analysis

After development of the comprehensive GIS project database, the crash data was analyzed for Grundy County. Crashes were compared to the Safety Emphasis Areas for the State of Iowa (as defined in the SHSP) and crash trees and maps were prepared. Relevant information from the crash data analysis is included within this document.

1.4.4. Countermeasure Selection

In coordination with the Iowa DOT, a list of low-cost engineering-related safety countermeasures was developed for use as recommendations in the LRSP project. These countermeasures are discussed in **Section 5** of this report.

In addition, a workshop was held with the safety stakeholders of Grundy County. Prior to the workshop, a list of safety topics was developed and distributed to the county to foster discussion at the workshop on driver-related safety countermeasure implementation. During this workshop, the following items were discussed:

- The background and purpose of the LRSP
- The five E's of safety
- Crash data
- Driver-related countermeasures

Driver-related countermeasures were reviewed, and stakeholders discussed existing and proposed driver-related countermeasures. A summary of the countermeasures currently underway in the county, as well as those proposed at the workshop, are included within this document.

1.4.5. Develop Projects for Inclusion into the LRSP

A risk factor ranking process was developed for segments, intersections, and curves. Risk factors were calculated for all paved segments, intersections, and curves and within the county. Risk factors included roadway features such as curve radius, shoulder width, and traffic volumes. After conducting the risk factor analysis, recommended safety improvements were developed for the feature types based on the project selection decision trees. Improvements included items such as additional signage, pavement markings, and rumble strips. Project sheets detailing the recommended safety improvements at specific locations were then provided to the County Engineer for review.

1.4.6. County Input

As the systemic analysis was based solely upon available GIS data, the associated recommended countermeasures did not incorporate data regarding geometrics, turning movements, right-of-way, etc. Additional safety countermeasures could be applied at locations that were determined to have a high risk factor ranking but may require additional site-specific information that may be known by the County Engineer. The project sheets, recommending countermeasures as determined by the project selection decision trees, were provided to the County Engineer for input for additional safety countermeasures. This step allowed the County Engineer to use engineering judgment and site-specific knowledge to recommend additional safety countermeasures at the identified/prioritized locations. At the county workshop, the project sheets and recommendations were reviewed.

1.4.7. Develop LRSPs

An LRSP was developed for the county including a summary of the LRSP process along with recommended safety projects for implementation by the county.

1.5. Document Organization

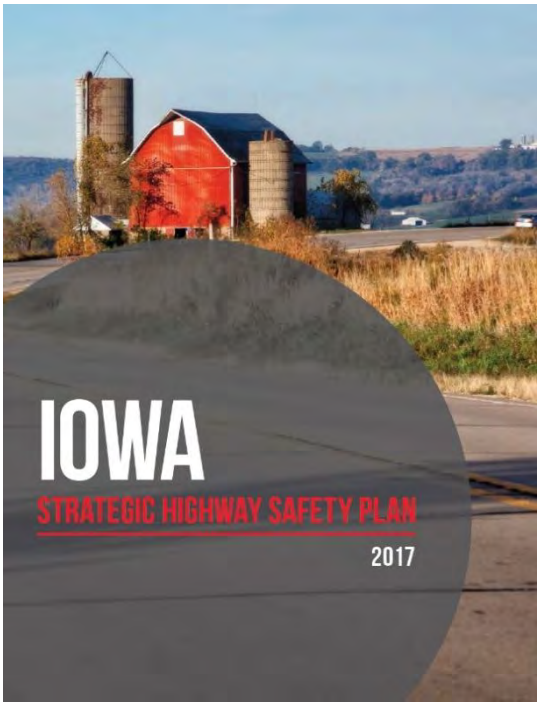
This document is organized into the following sections:

- **Section 1** presents the project background and purpose of the LRSP.
- **Section 2** provides a summary of relevant information reviewed as part of the study.
- **Section 3** summarizes the data collected and geodatabase developed for the analysis.
- **Section 4** describes the county crash data analysis.
- **Section 5** provides a summary of potential countermeasures and a summary of the driver-related countermeasure selection portion of the workshop.
- **Section 6** describes the methodology for project selection and safety improvement recommendations and provides a summary of the project selection portion of the workshop.
- **Section 7** includes a list of high crash segments, intersections, and curves for reference.
- **Section 8** provides a summary of the LRSP recommendations.
- **Appendices** include detailed county project sheets for paved segments, intersections, and curves as well as summary sheets including all locations that were analyzed as part of this LRSP.

2. BACKGROUND

Under this task, relevant documents were reviewed including the Iowa SHSP, funding sources, and other documents provided by the county. The following subsections summarize the background information that was gathered and reviewed as part of the LRSP.

2.1. Iowa SHSP



At the beginning of the LRSP project, the most current Iowa SHSP was the 2013 SHSP, which was in effect until December 31, 2016. The Iowa DOT has since published the 2017 SHSP, documenting progress in transportation safety and identifying older drivers and motorcycle-related severe injuries as rising trends. As part of the 2017 Iowa SHSP, five years of crash data for crashes resulting in fatalities and serious injuries were separated into 17 safety emphasis areas, which are generally defined by the American Association of State Highway and Transportation Officials (AASHTO) SHSP. This process determined the safety emphasis areas with the greatest number of crashes within Iowa and resulted in the focused opportunities for safety improvements on Iowa roadways.

There are 10 Key Safety Emphasis Areas that were determined by a data-driven process that took into account fatal and serious injury crashes by emphasis area, but also investigated trends within the emphasis areas. Identifying safety emphasis areas allows stakeholders to develop and prioritize strategies that can reduce fatal and serious injury crashes on Iowa roadways. Eight of the Key Safety Emphasis Areas which were defined in the 2013 SHSP are also presented in the 2017 SHSP. Two additional Key Safety Emphasis Areas were noted: Roadside Collisions and Motorcycles. The Key Safety Emphasis Areas can be broken down into two categories: driver-related and roadway/infrastructure. Following is a summary of the 10 Key Safety Emphasis Areas for Iowa based on crash data from 2010 - 2014:

- Driver-Related
  - Speed-related (49% of fatal and serious injury crashes)
  - Unprotected persons (37% of fatal and serious injury crashes)
  - Younger drivers (35% of fatal and serious injury crashes)
  - Impaired driving (20% of fatal and serious injury crashes)
  - Older drivers (18% of fatal and serious injury crashes)
  - Motorcycles (16% of fatal and serious injury crashes)
- Roadway/Infrastructure
  - Lane departure (54% of fatal and serious injury crashes)
  - Local roads (53% of fatal and serious injury crashes)
  - Intersections (30% of fatal and serious injury crashes)
  - Roadside collisions (34% of fatal and serious injury crashes)

As reported in the 2017 SHSP, the goal to reduce fatalities by 15% on Iowa's roadways by the year 2020, was achieved in 2015. Also, as of 2015, the goal to reduce serious injuries by 15% by 2020was on track. The 2017 SHSP established two new goals to achieve by 2020:

- Reduce fatality rate to 1.0 per HMVMT
- Reduce serious injury rate to 4.3 per HMVMT

The Iowa SHSP identifies five basic components essential to meeting the goal:

- Education
- Enforcement
- Engineering
- Policy
- Data management and use

By focusing on all of these components, Iowa believes it is possible to achieve the improved safety goal set forth in the SHSP.

2.2. Iowa DOT Safety Programs

There are a wide variety of transportation safety funding sources available to counties within the State of Iowa. These funding programs can be used to implement treatments and recommendations for roadways and locations identified for improvements as part of this LRSP. The following Iowa DOT safety programs are available for the county to apply for funding to aid in implementation of the safety countermeasures identified within this LRSP.

- County-State Traffic Engineering Program (C-STEP)
  http://www.iowadot.gov/pol_leg_services/Funding-Guide.pdf
- Highway Safety Improvement Program – Secondary (HSIP-S)
  https://www.iowadot.gov/traffic/sections/HSIP
- Sign Replacement Program for Cities and Counties (SRPFCC)
  https://www.iowadot.gov/traffic/traffic-and-safety-programs/sign-replacement-program
- Traffic Engineering Assistance Program (TEAP)
  https://www.iowadot.gov/traffic/traffic-and-safety-programs/traffic-engineering-assistance-program-teap
- Traffic Safety Improvement Program (TSIP)
  https://iowadot.gov/traffic/traffic-and-safety-programs/tsip/tsip-program

2.3. Other Safety Funding Opportunities and Resources

This section describes various transportation safety funding opportunities and resources that are available for counties to improve safety on their roadways. It is recommended that the County Engineer review these resources and find programs or resources that are valuable and could be applied within the county.

2.3.1. Iowa DOT Resources

2.3.1.1. Zero Fatalities

The Iowa DOT, the Department of Public Health, and the Department of Public Safety have committed to the ultimate goal of zero fatalities and have teamed up to provide safety information,

answers to frequently asked safety questions, general crash statistics, and marketing materials at https://ia.zerofatalities.com/.

2.3.1.2. Crash Maps

The Iowa DOT has a crash mapping website, which can be used to develop crash maps and data to compare crash history within a county. Crash maps can be created by anyone with an internet connection. There are also options to develop data summaries of crashes. https://icat.iowadot.gov/.

Crash maps can also be requested through the Iowa Traffic Safety Data Service (ITSDS). More information is available on the following website: www.ctre.iastate.edu/itsds/. ITSDS can provide crash analysis maps, diagrams, and reports such as:

- Crash histories for specific areas, roads, and intersections
- Fatalities and/or injuries
- Alcohol-related crashes
- Seatbelt status
- Cross-median crashes
- Pedestrian crashes
- Weather conditions

2.3.1.3. "Message Monday"

Iowa DOT's "Transportation Matters" blog includes an update every Monday that shows the week's safety message. Individuals can either check the blog each Monday, or sign up to receive updates via email by clicking the "Subscribe" button in the upper right corner of the page: http://www.transportationmatters.iowadot.gov/. The information contained in the "Message Mondays" can be posted to county websites or social media pages and can be used in the schools to educate students. **Figure 3** shows an example message from January 2018.

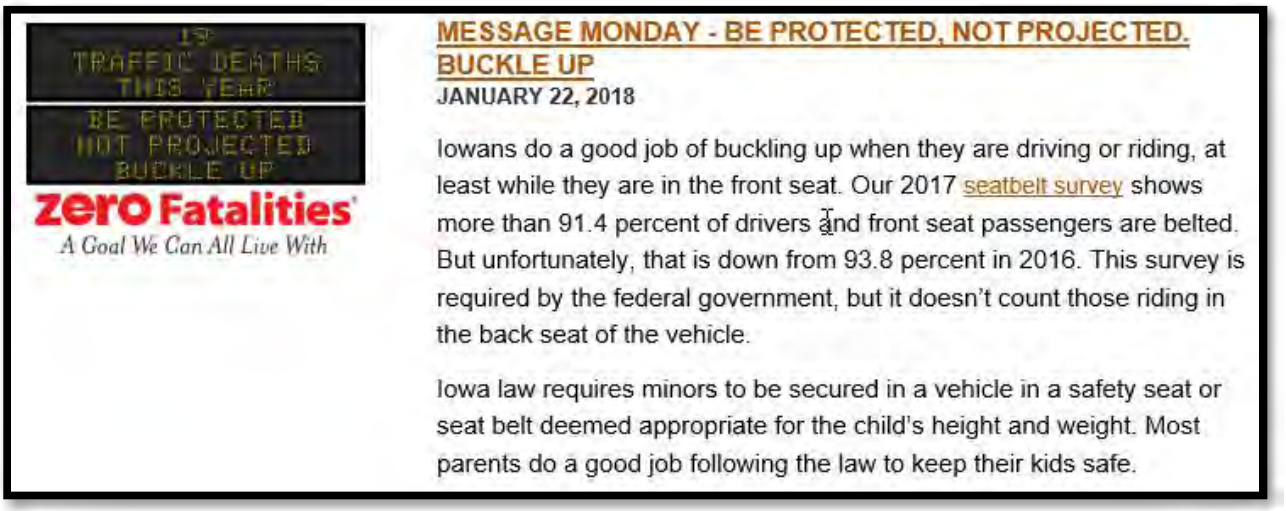


Figure 3 – Example Iowa DOT Transportation Matters Blog Post

2.3.1.4. Iowa Living Roadway Trust Fund (LRTF)

Since 1990, the LRTF has funded more than $17 million for research and demonstration projects, vegetation inventories, education and training programs, gateway landscaping, snow and erosion

control, roadside enhancement, and more. Establishing prairie plants in roadside rights-of-way reduces snow drift and winter glare and provides low-maintenance weed and erosion control. Additional information is available at: https://www.iowadot.gov/lrtf.

2.3.1.5. CarFit

This program includes organized events designed to provide a quick and comprehensive check on how the driver and vehicle work together. Developed by the American Society on Aging, the focus of the program is on older drivers, but could benefit all drivers. Check the CarFit website at www.car-fit.org for an event in your community, or contact Iowa DOT's Driver and Identification Services to schedule an event (515-244-8725 or ods@iowadot.us). Visit the Iowa DOT website for more information on this program: https://iowadot.gov/mvd/carfit

2.3.2. Iowa Local Technical Assistance Program (LTAP)

Iowa LTAP serves local governments and helps them keep up with growing demands on local roads, streets, bridges, and public transportation. The center provides technical and management assistance to local transportation officials through multiple programs and trainings. https://www.iowaltap.iastate.edu/

2.3.2.1. Multi-Disciplinary Safety Teams (MDSTs)

Iowa's MDST Program facilitates the development and operations of local multi-discipline safety teams to help identify and resolve local crash causes and enhance local crash response practices (https://www.iowaltap.iastate.edu/MDST/). By coordinating communication and collaborating with other stakeholders, participants gain a broader perspective on safety issues and learn best practices from professionals outside their area of expertise. This ultimately leads to the development of solutions that may not have been considered otherwise. If you are interested in developing an MDST for your area, contact Theresa Litteral, Statewide MDST Facilitator, for more information (515-294-7465 or litteral@iastate.edu).

2.3.2.2. Road Safety Assessments (RSAs)

An RSA is a formal safety performance examination that reviews, in detail, the geometry of a roadway facility. As part of an RSA, an independent, multi-disciplinary team assesses the condition of a given roadway and provides short-, mid-, and long-term recommendations for safety improvements for all modes provided, or planned to be provided by the facility. RSAs have been conducted throughout the United States and are generally accepted as a proactive, low-cost approach to improve safety. This countermeasure cost estimate listed in the project sheets does not include the cost of implementing the recommendations of the RSA.

If you are interested in identifying funding for and conducting an RSA in your county, please contact David Veneziano, the LTAP Safety Circuit Rider, for more information (515-294-5480 or dvenez@iastate.edu).

2.3.3. Iowa Department of Public Safety Governor's Traffic Safety Bureau (GTSB)

"The Mission of the GTSB is to identify traffic safety problems and, partnering with city, county, state and local agencies, develop and implement traffic safety programs to reduce death and injury on Iowa's streets and highways. The GTSB provides federally-funded grants to city, county and state

entities, as well as hospitals, universities, and other non-profit agencies working to improve traffic safety in the State of Iowa." http://www.dps.state.ia.us/commis/gtsb/.

2.3.3.1. Educational Materials

Educational materials are available from GTSB, and can be requested through an online application or accessed via their website and printed on your own (http://www.dps.state.ia.us/commis/gtsb/brochures.shtml). A copy of the request form along with some of the available materials are included in **Appendix F.** Materials available include the following:

- Rural Road Safety Information Card
- 0.8 Iowa's Operating While Intoxicated (OWI) Law
- Child Passenger Safety Guides

2.3.3.2. Fact Sheets

GTSB maintains fact sheets and media campaign information for the following driver-related countermeasures:

- Child Passenger Safety
- Impaired Driving
- Motorcycle Safety
- Seat Belts
- Distracted Driving

More information can be found at http://www.drivesmartiowa.com/.

2.3.3.3. Enforcement Funding

Iowa's special Traffic Enforcement Program (sTEP) invites participation from law enforcement agencies to conduct "high-visibility" enforcement events in connection with national campaigns. This program provides up to $4,200 for overtime enforcement or equipment targeting traffic safety during designated sTEP waves throughout the year. A copy of the application for 405d funding is located in **Appendix F**.

2.3.3.4. Non-Enforcement Funding

Most non-enforcement agencies (hospitals, schools, etc.) have the option to apply for 402 funding because it is a broader traffic safety program that focuses specifically on alcohol/impairment programs. A copy of the application for 402 funding is located in **Appendix F**.

2.3.3.5. Safety Checkpoint Trailer

GTSB has a safety checkpoint trailer that contains all the equipment needed to set up a safety checkpoint. The trailer is available free of charge, and those wishing to use it should contact GTSB to schedule a date and pick-up/drop-off time.

2.3.3.6. Advanced Roadside Impaired Driving Enforcement (ARIDE)

GTSB provides training for Advanced Roadside Impaired Driving Enforcement (ARIDE) for law enforcement officers. This course is designed such that officers become more proficient at detecting, apprehending, testing, and successfully prosecuting impaired drivers.

2.3.3.7. Other GTSB Resources

GTSB has "drunk goggles" and a driving simulator that can be used for events to simulate the effects of impaired and distracted driving including reduced alertness, slow reaction time, visual distortion, alteration of depth and poor decision making. In addition, GTSB has summary sheets that can be provided to law enforcement succinctly summarizing Iowa child passenger safety, seat belts, and cell phone laws. Examples are included in **Appendix F**.

2.3.4. Blank Children's Hospital

2.3.4.1. Child Passenger Safety

The Blank Children's Hospital provides an entire webpage focused on child passenger safety: https://www.unitypoint.org/blankchildrens/child-passenger-safety.aspx.

2.3.4.2. For Parents

Resources are available for parents including instructions on proper child restraint as well as registration for a free one-hour car seat safety class that is held twice a month. There is also information on locations for child safety seat inspections throughout the state.

2.3.4.3. National Child Passenger Safety Certification Training Program

The National Child Passenger Safety Certification Training Program is a three- to four-day training course that is paid for with funding provided by GTSB. The certification fee is $85.00.

2.3.4.4. Bike Safety

The Blank Children's Hospital has an *All Heads Covered: Our Wheeled-Sports Safety Program*. This program includes a curriculum kit that is designed to help educators teach bike and wheeled-sports safety in the classroom or community for elementary-aged children. They also have a Bike Safety Van that houses all the equipment to host a bike rodeo and is offered free of charge. Additionally, low-cost helmets are available through the program. Additional information is available on the following website: https://www.unitypoint.org/blankchildrens/bike-safety.aspx.

2.3.5. Other Websites and Resources

The following sections contain information on other websites and resources for traffic safety related information. Counties can use this information on their websites, social media outlets, or consider posting materials on bulletin boards in public spaces. An example can be seen in **Figure 4**, as found in Cedar County. Additionally, there are materials that can be used in schools to educate future and young drivers on the importance of wearing seatbelts.

Figure 4 – Safety Bulletin Board in Cedar County

2.3.5.1. National Highway Traffic Safety Administration (NHTSA)

NHTSA has a wide variety of resources related to traffic safety which could be used by the county. NHTSA offers materials for numerous traffic safety campaigns, including drunk driving, car seats, vehicle safety, distracted driving, and motorcycles. These marketing tools offer a way to get involved through traditional media and online media (https://www.nhtsa.gov/).

2.3.5.2. Traffic Safety Marketing

Traffic Safety Marketing is an online resource for safety materials and can be used for safety campaigns. Counties are encouraged to download and use the traffic safety materials provided during campaigns and throughout the year. There are various materials that are free of charge and others that can be paid for. More information can be found at: https://www.trafficsafetymarketing.gov/.

2.3.5.3. Insurance Company Safety Information

Transportation safety information for young drivers is provided by various insurance companies, that could be used as a resource.

- Allstate Helping Teen Drivers Build Good Habits Website
  - https://www.allstate.com/auto-insurance/auto-insurance-for-teen-drivers.aspx
- GEICO Car Insurance Information and Resources for Teen Drivers Website
  - https://www.geico.com/information/safety/auto/teendriving/parents/
- Progressive Teen Driver Website
  - https://www.progressive.com/answers/teen-driver-insurance/
- State Farm Teen Driver Safety Website
  - https://www.statefarm.com/simple-insights/auto-and-vehicles/teen

2.3.5.4. Cell Phone Providers and Apps

AT&T has a virtual reality experience/simulator that can be used to demonstrate the impacts of distracted driving. More information can be found on their website: http://itcanwait.com/VR

There are various mobile applications (apps) that can be installed on phones to help prevent drivers from using their phones while driving. A few examples include:

- AT&T DriveMode
- Cellcontrol
- Drivesafe.ly
- Drive Safe Mode
- EverDrive
- LifeSaver
- Live2Txt
- Mojo
- Overwatch
- Safe Drive
- TrueMotion

Verizon provides a website with a brief review of recommended apps to discourage texting while driving:

- https://www.verizonwireless.com/archive/mobile-living/home-and-family/apps-to-block-texting-while-driving/

DMV.org provides a resource and review of “Apps to Fight Distracted Driving” here:

- https://www.dmv.org/distracted-driving-apps.php

3. DATA COLLECTION

As part of the LRSP project, a comprehensive GIS project database was developed utilizing crash data, roadway data, horizontal curve data, and the intersection database. The following sections describe the databases utilized for creation of the project geodatabase and later used for analysis.

3.1. Crash Data

The Iowa DOT statewide crash database includes crash history for all crashes occurring on a public roadway in the state that involve a personal injury or that satisfy a minimum property damage threshold of $1,500. This database is updated monthly.

The crash database provides crash-, driver/vehicle-, and person-level attributes. All crashes are geocoded with respect to the Iowa DOT Geographic Information Management System (GIMS) roadway database. This LRSP utilizes 10 years of crash data for crashes occurring on roadways of interest between January 1, 2008 and December 31, 2017 (as of the June 11, 2018 database update).

Crashes included in the crash database were identified based on their "County" and "Concatenated System" attribute values. "Concatenated System" is an Iowa DOT-derived attribute, conveying the roadway system(s) on which a crash was located. The three roadway systems in Iowa are the Primary system (state-owned), the Secondary system (county-owned), and the Municipal system (city-owned). All crashes with a "Concatenated System" value containing "Secondary," including intersections with state roadways, were selected for analysis.

"County" attributes were added to the database to clearly identify on which system a crash likely occurred, as well as address any possible ambiguities in the initial "Concatenated System" derivation. This was initially accomplished by analyzing the spatial proximity of crashes with respect to county roads, as defined in the GIMS database. Additional analysis was performed for a limited number of crashes not located through the aforementioned technique.

3.2. Roadway Data

Various databases were used that contain different roadway data elements, including the GIMS, horizontal curve, intersection, pavement management, and roadside hazard databases. Information on location of existing stop signs and updates to the databases were also considered.

3.2.1. GIMS Database

The Iowa DOT GIMS database includes various roadway characteristics for all public roads in Iowa. Roadway attributes are regularly updated by the Iowa DOT from various sources, including local agency submittals. An annual GIMS history snapshot is created, representing the prior calendar year. This LRSP utilizes the GIMS history snapshot representing the year 2016.

3.2.2. Horizontal Curve Database

A horizontal curve geospatial database was created for the Iowa DOT by the Wisconsin Traffic Operations and Safety Laboratory. This database includes horizontal curve alignments on the county road system. This project utilizes the January 25, 2016 version of the database.

3.2.3. Intersection Database

The Institute for Transportation at Iowa State University (InTrans) and the Iowa DOT have collaborated over the past several years to create a statewide intersection database. The

foundation of this database is a GIS-based intersection point file created by the Iowa DOT's Office of Traffic and Safety. A selected set of inventory elements are being captured for each intersection and approach roadway with aerial imagery and street-level images. This LRSP utilizes the August 2017 version of the intersection database.

3.2.4. Pavement Management Database

The Iowa DOT provided the 2015-2016 pavement management database for use in this project. The *Highway Safety Manual* (HSM) suggests that pavement in better condition provides less potential for crashes. The use of this database and the recorded International Roughness Index (IRI) help determine additional potential for crashes along roadway segments.

3.2.5. Roadside Hazard Database

In coordination with InTrans, a roadside hazard ranking was developed using the United States Road Assessment Program (usRAP) guidance on roadside hazards and severity (www.usrap.org). The roadside assessment for the LRSPs is intended to represent the conditions along a half-mile section of roadway. The protocol was adapted from the usRAP approach. The following summarizes the general intent of the roadside assessment:

- Objects within 66 feet (20 meters) of the edge line were captured.
- A combination of the Street View and the aerial image was used to judge roadside distances and roadside conditions.
- Assessment based on the visible portion of Street View. Navigation along the roadway was limited, unless necessary to perform a better assessment.
- If the aerial image was clearly more recent than Street View, it was given additional consideration during assessment.
- Emphasis was on roadside conditions that could lead to a fatal or serious crash upon roadway departure.
- Generally overlooked isolated features, such as boulders, guardrail, etc.
- If the assessment point was at a special feature, like a bridge, the assessment point was repositioned to a more representative location.
- When no physical object was present along the roadside, the shape, foreslope, and backslope of the ditch were the primary consideration in the assessment.
- In some cases, multiple roadside hazards were present. The most hazardous was recorded.

A roadside assessment rating was assigned based on a combination of posted speed, distance to an object, and the object itself. The rating assignments used usRAP Road Attribute Risk Factors (operating and mean speed, roadside severity – object, roadside severity – distance). Ratings were calculated for both the driver and passenger side and averaged for each point. Finally, all the points within a roadway segment were averaged and an average roadside assessment rating was used to determine risk factor points, as described in later sections.

The roadside hazard rating was documented at half-mile intervals along each county paved roadway to assign crash risk factor points to individual segments.

3.2.6. 911 Address Database

The Grundy County 911 address database documents driveway addresses for businesses, homes, and structures within the county. It was utilized to obtain driveway locations along the county paved roadway system for this project. While this database does not document all access points along the roadway system, such as farm access roadways, it does capture locations with

a higher number of vehicular turning movements, such as homes and businesses. Roadway segments with a greater number of access points have a higher risk for crashes, due to increased potential for vehicle conflicts.

3.2.7. Stop Sign Locations

While the intersection database contains the control type for the intersection (all-way stop, two-way stop, one-way stop, etc.), stop control at the approach level is not included. The County Engineer provided information indicating where stop signs were located along the county paved roadway system. This information was geocoded into the GIS database.

3.2.8. Existing Condition Updates to the Databases

Throughout the LRSP process, the County Engineer provided feedback on locations where the information contained within the existing databases was not current (for example, location of rumble strips, shoulder type and/or width, etc.). When these locations were identified, updates were made to the database.

3.3. Crash Tree Development

The following sections describe the development of crash trees as a means of displaying county crashes. As previously noted, "County" road attributes were added to the crash database to identify on which system a crash likely occurred as well as to address any possible ambiguities in the initial "Concatenated System" derivation. This was initially completed through analysis of the spatial proximity of crashes with respect to county roadways, as defined in the GIMS database. Additional review was performed for a limited number of crashes not addressed through the aforementioned technique. Crashes occurring along county roads that were on the border were identified as occurring in both counties.

3.3.1. County Roadways

To supplement the crash database with additional available data sets, two new attributes relating to horizontal curvature and intersection traffic control were added and populated. Specifically, a horizontal curvature attribute was populated for all crashes within 200 feet of a horizontal curve on a paved county roadway. This was necessary because roadway alignment information is not currently captured on the standard Iowa DOT crash report form. The traffic control for county paved and unpaved roadway intersection crashes was populated based on their spatial proximity to the current statewide intersection database points and the corresponding reported traffic control at these intersections.

Upon identifying all "County" road crashes from the crash database, the Iowa DOT-derived "Paved" attribute was used to segregate the county roadway crashes into paved and unpaved surface types. For each of these surface types, the standard Iowa DOT crash database attributes of "Type of Roadway Junction/Feature," "Manner of Crash/Collision," and "Major Cause" were used to populate the trees. The new traffic control attribute was used to separate county paved and unpaved roadway intersection crashes into the different traffic control type categories. The new horizontal curvature attribute was used to separate non-intersection crashes into "on curve" and "off curve" categories.

A second set of crash trees was then created in a similar manner, simply limiting the crashes to "Fatal" and "Major Injury," based on the Iowa DOT derived "Crash Severity" attribute. The two sets of crash trees were combined and were utilized in the development of this LRSP.

3.3.2. Major Cause and Manner of Crash

"Major Cause" and "Manner of Crash" statistics are provided in the crash trees and are based on total crashes. The fatal and serious injury crashes had similar characteristics to the total crashes for the county.

4. DATA ANALYSIS

From January 1, 2008 to December 31, 2017, there were a total of 805 crashes on county roads in Grundy County, of which 43 resulted in serious injuries and fatalities. The following sections contain crash maps and summarize the data analysis prepared for the county, noting how it compares to the state of Iowa as a whole. Crash trees, high crash locations, and additional crash data analysis are included in this section.

4.1. Comparison of County Crashes to SHSP Key Safety Emphasis Areas

As part of the 2017 Iowa SHSP, five years of crash data for crashes resulting in fatalities and serious injuries were separated into 17 safety emphasis areas, which are generally defined by the AASHTO SHSP. This process determined the safety emphasis areas with the greatest number of crashes within Iowa and resulted in the focused opportunities for safety improvements on Iowa roadways.

For consistency with the three prior phases of the LRSP project, **Table 1** contains a comparison of Grundy County crashes resulting in fatalities and serious injuries to the Key Safety Emphasis Areas from the 2013 Iowa SHSP. Because the SHSP was based on five years of crash data, five years of crash data (2013 to 2017) for the county was utilized to compare the crashes to the Iowa Key Safety Emphasis Areas. As shown in the table, the county crashes generally follow the same Key Safety Emphasis Areas as the state. **Table 2** shows the difference in rank for comparison. As shown in **Table 1** and **Table 2**, the Key Safety Emphasis Areas for the county generally rank the same as the Key Safety Emphasis Areas from the SHSP. It should be noted that this analysis includes all fatal and serious injury crashes within the county, not just on county roads.

Table 1 – County Fatalities and Serious Injuries by Safety Emphasis Area

Category	Safety Emphasis Area	Statewide Totals			Grundy County			Key Safety Emphasis Area
		Fatal and Serious Injury	% of Total	Rank	Fatal and Serious Injury	% of Total	Rank	
		9,194	100%	N/A	47	100%	N/A	
Drivers	Younger Drivers	3,075	33%	6	18	38%	5	X
	Older Drivers	1,696	18%	9	18	38%	5	X
	Speed-Related	4,699	51%	3	29	62%	2	X
	Impaired Driving	1,978	22%	8	8	17%	8	X
	Inattentive/Distracted Driving	1,209	13%	11	2	4%	14	X
	Unprotected Persons	3,091	34%	5	19	40%	4	X
Highway	Train	42	0%	18	0	0%	18	
	Lane Departures	5,125	56%	1	35	74%	1	X
	Roadside Collision	3,415	37%	4	26	55%	3	X
	Intersections	2,714	30%	7	7	15%	11	X
	Work Zone	154	2%	17	0	0%	18	
	Local Roads	4,818	52%	2	15	32%	7	X
	Winter Road Conditions	727	8%	13	8	17%	8	
Special Users	Pedestrian	498	5%	14	0	0%	18	
	Bicycle	215	2%	15	1	2%	15	
Vehicles	Motorcycle	1,483	16%	10	8	17%	8	
	Heavy Truck	927	10%	12	3	6%	13	
	Other Special Vehicle	179	2%	16	4	9%	12	

Numbers in the columns may not add up to the totals because the injuries in one crash may be associated with multiple emphasis areas. For example, there could be a lane departure crash with serious injuries involving an impaired young driver on a local road.
Source: Iowa crash data records 2013-2017.

Table 2 – County Fatalities and Serious Injuries Rank by Safety Emphasis Area

Category	Safety Emphasis Area	Rank			Key Safety Emphasis Area
		Statewide Totals	Grundy County	Change in Rank	
Drivers	Younger Drivers	6	5	+1	X
	Older Drivers	9	5	+4	X
	Speed-Related	3	2	+1	X
	Impaired Driving	8	8	-	X
	Inattentive/Distracted Driving	11	14	-3	X
	Unprotected Persons	5	4	+1	X
Highway	Train	18	18	-	
	Lane Departures	1	1	-	X
	Roadside Collision	4	3	+1	X
	Intersections	7	11	-4	X
	Work Zone	17	18	-1	
	Local Roads	2	7	-5	X
	Winter Road Conditions	13	8	+5	
Special Users	Pedestrian	14	18	-4	
	Bicycle	15	15	-	
Vehicles	Motorcycle	10	8	+2	
	Heavy Truck	12	13	-1	
	Other Special Vehicle	16	12	+4	

4.2. Crash Maps

Crash severity maps for the county were created by employing an InTrans-developed, GIS-based crash stacking tool. The purpose of this tool is to produce maps in which spatially proximate crashes are vertically offset to produce crash "stacks," better conveying crash experience and severity at higher frequency locations. All crashes indicated as "County" were selected and stacked by ascending severity. In other words, the more serious crashes were located at the bottom of the crash stack, nearer to the actual crash location on the roadway. Given the small map scale (county-level), a 300-meter (985-foot) spatial proximity was utilized to provide a clearer map.

Figure 5 contains a map illustrating all crashes on county roads within the county stacked by ascending severity.

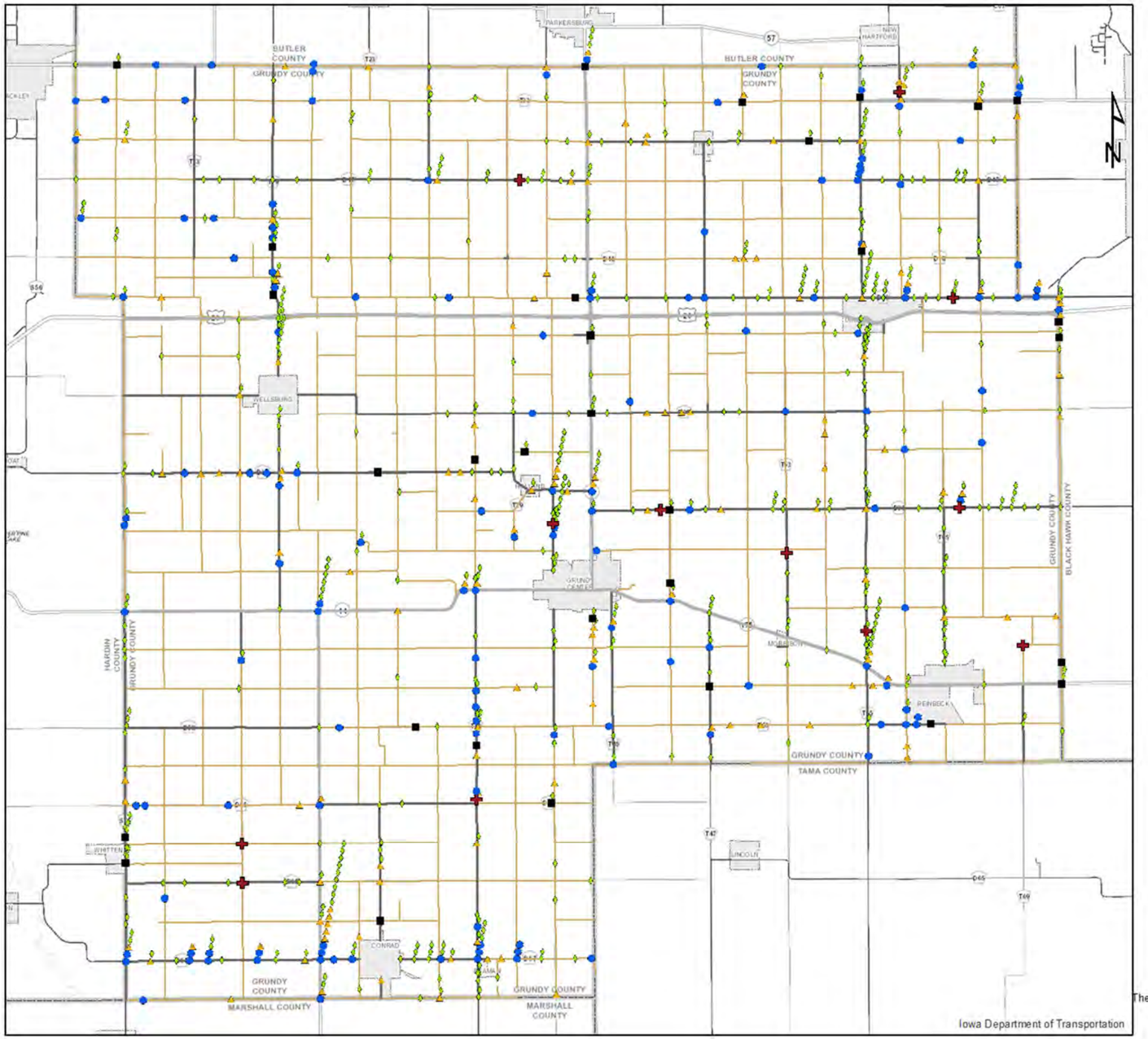
Figure 6 contains a map illustrating all fatal and serious injury crashes stacked by ascending severity. As shown in the maps, the majority of the county road crashes occurred on county paved roads as opposed to unpaved roads.

4.3. Crash Trees

In order to further define the types of roadway features associated with crashes, two crash trees were developed for the county:

- County Paved Road Crashes (**Figure 7**)
- County Unpaved Road Crashes (**Figure 8**)

The crash trees include total crashes as well as fatal and serious injury crashes; however, the major cause of the crash and manner of crash are reported only for total crashes. In the county, the fatal and serious injury crashes had similar major causes and manners of crash as the total crashes.



All Crashes
County Roads
Grundy County, Iowa
2008 - 2017

Crash Severity

- Fatal (12)
- Serious Injury (31)
- Minor Injury (146)
- Possible/Unknown Injury (144)
- Property Damage Only (472)

Highways

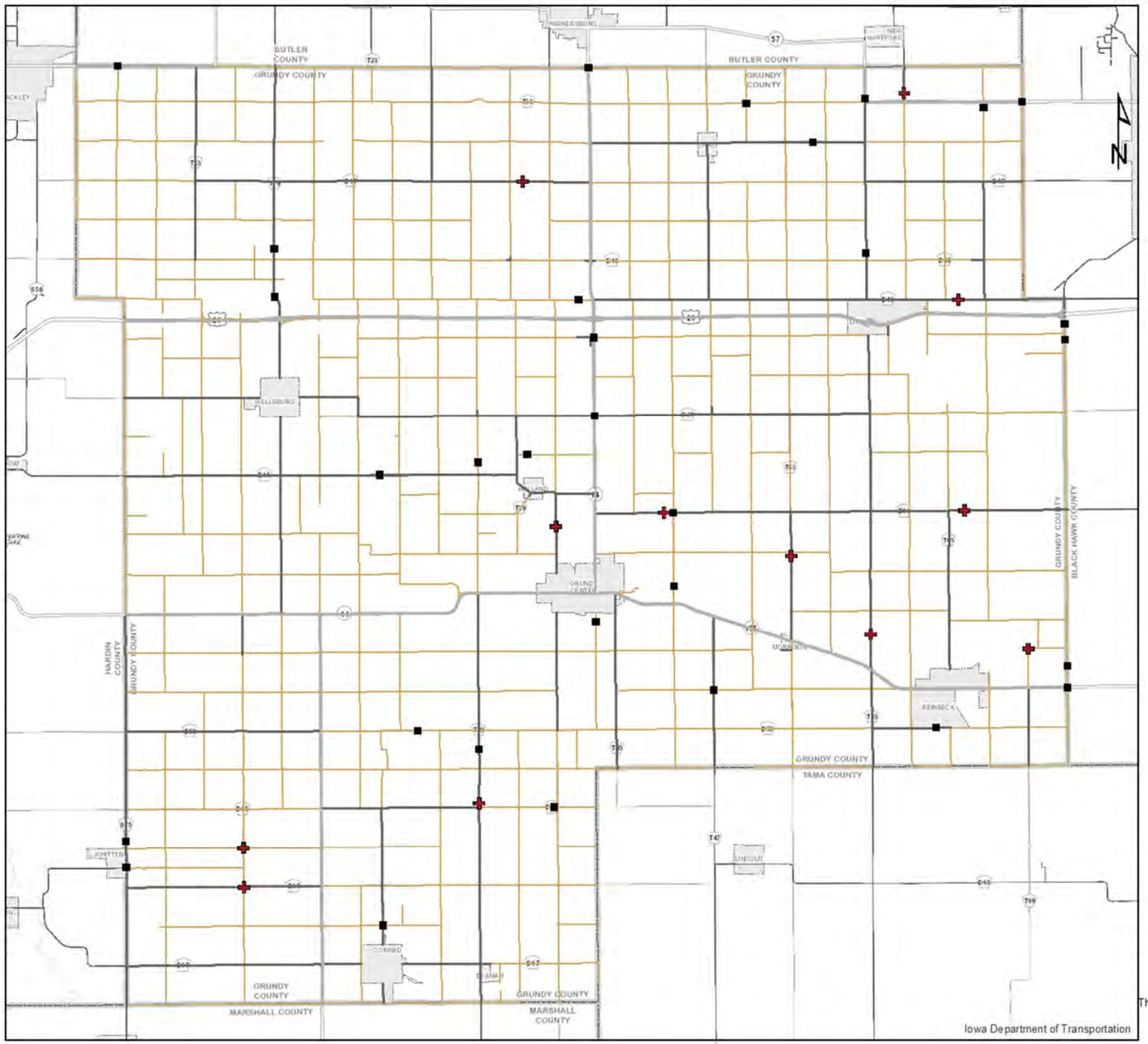
- State
- County Paved
- County Unpaved

0 1 2 4 6 8 Miles

The information contained in this map was derived from the June 11, 2018 Iowa DOT crash database.

Date: 7/31/2018

Figure 5 – All Crashes County Roads



Fatal and Serious Injury Crashes
County Roads
Grundy County, Iowa
2008 - 2017

Crash Severity

- Fatal (12)
- Serious Injury (31)

Highways

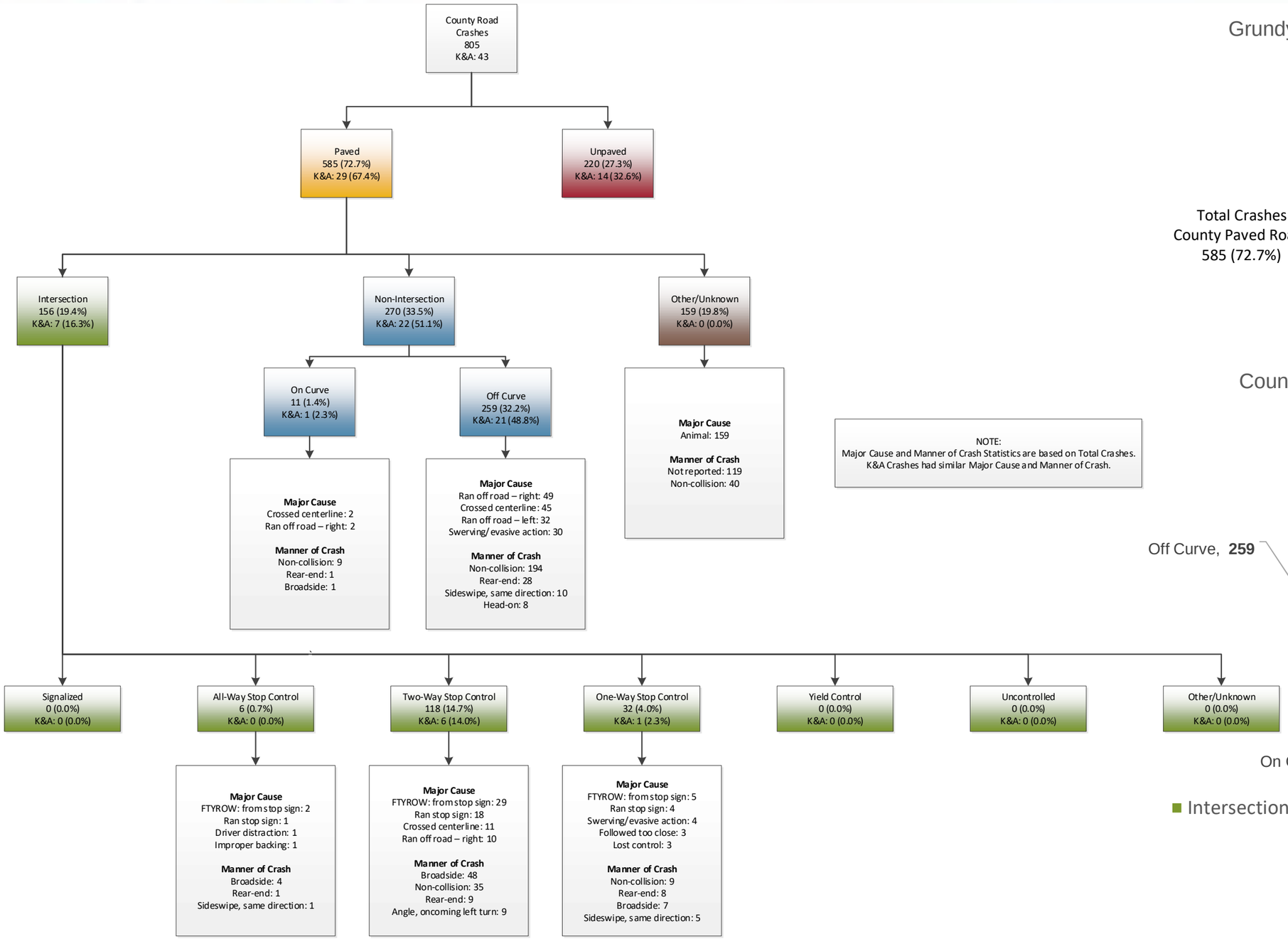
- State
- County Paved
- County Unpaved

0 1 2 4 6 8 Miles

The information contained in this map was derived from the June 11, 2018 Iowa DOT crash database.

Date: 7/31/2018

Figure 6 – Fatal and Serious Injury Crashes County Roads



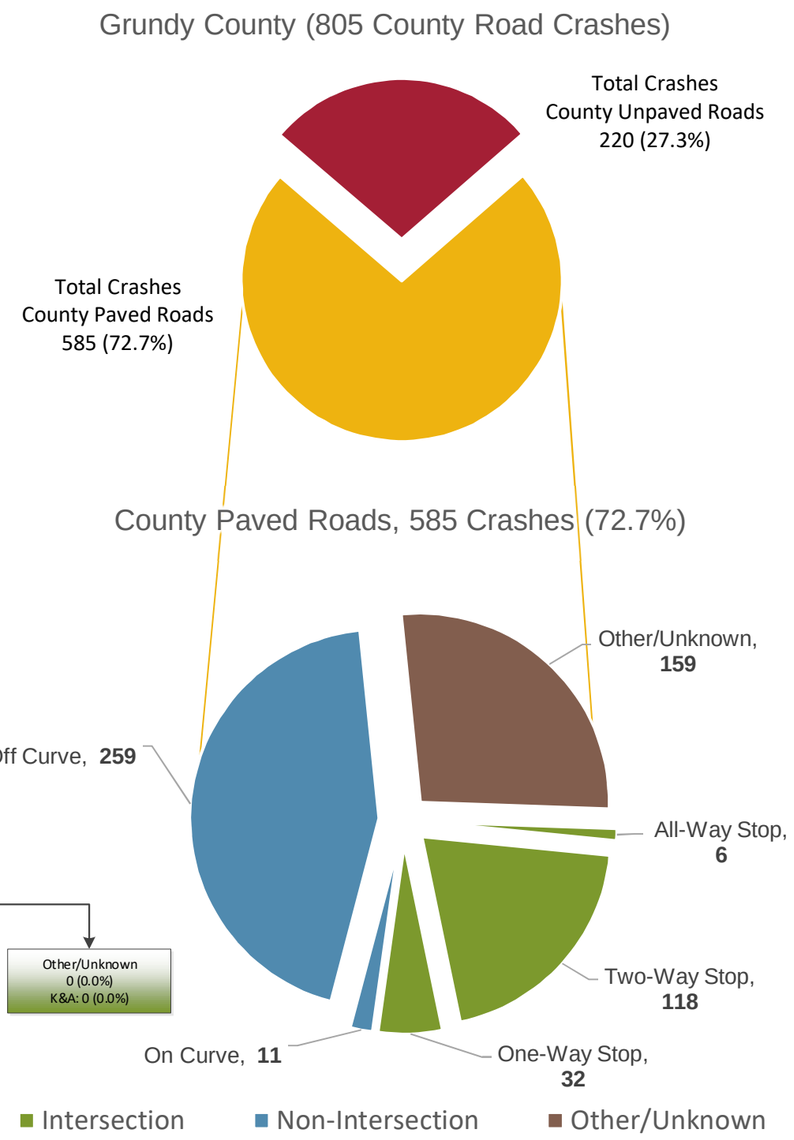


Figure 7 – County Paved Road Crash Tree

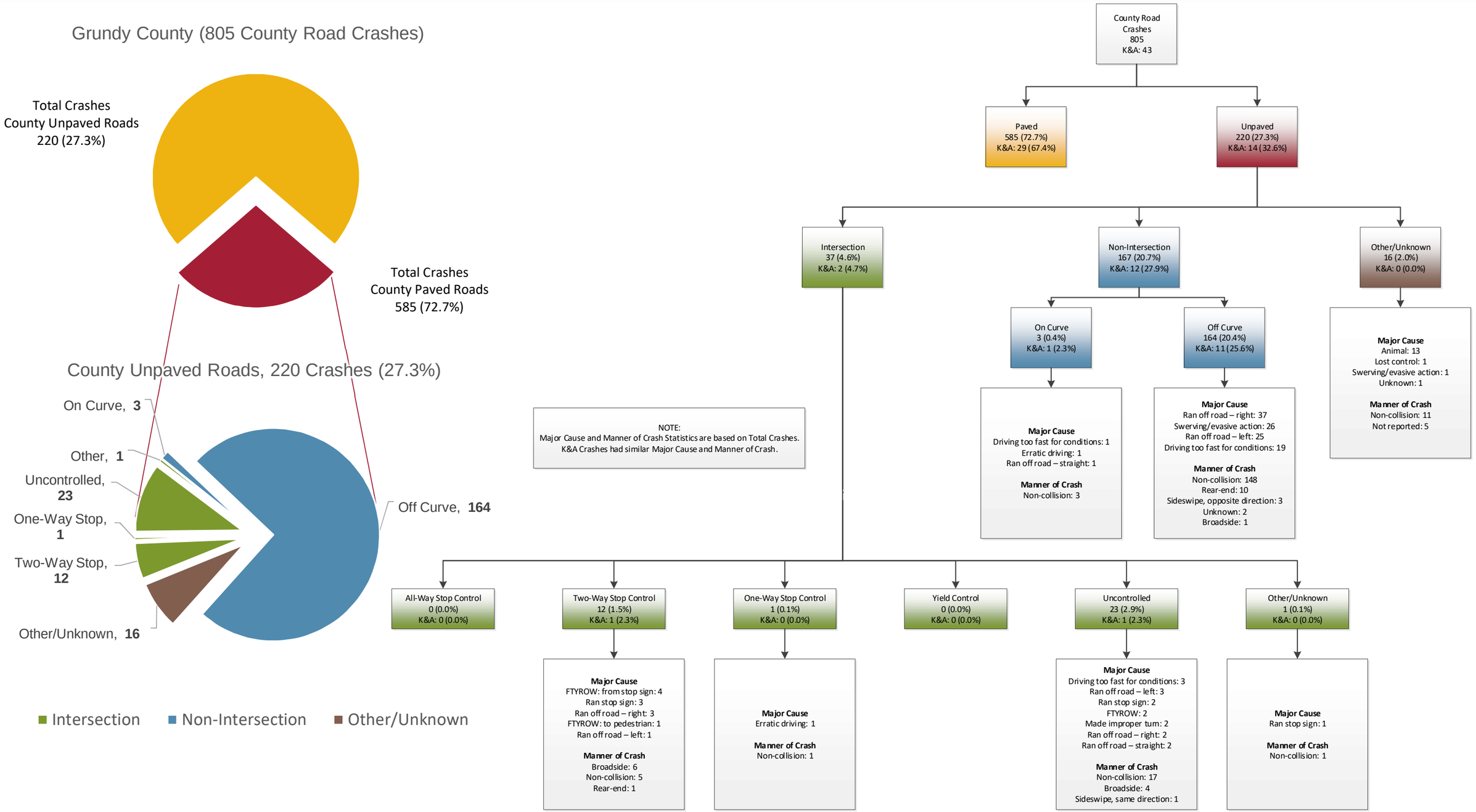


Figure 8 – County Unpaved Road Crash Tree

Table 3 contains a tabular summary of the county crashes by roadway type and **Figure 9** contains a graphical summary of the county crashes by roadway type, which is the same information presented in the crash trees. K denotes a fatality and A denotes a serious injury.

Table 3 – County Crashes by Roadway Type

Roadway Type		Total Crashes		Fatal and Serious Injury (K & A) Crashes	
		Count	Percent	Count	Percent
County Paved	Intersection	156	19%	7	16%
	Curve	11	1%	1	2%
	Segment	259	33%	21	49%
	Other/Unknown	159	20%	0	0%
	Subtotal	585	73%	29	67%
County Unpaved	Intersection	37	5%	2	5%
	Curve	3	<1%	1	2%
	Segment	164	20%	11	26%
	Other/Unknown	16	2%	0	0%
	Subtotal	220	27%	14	33%
Total		**805**		**43**	

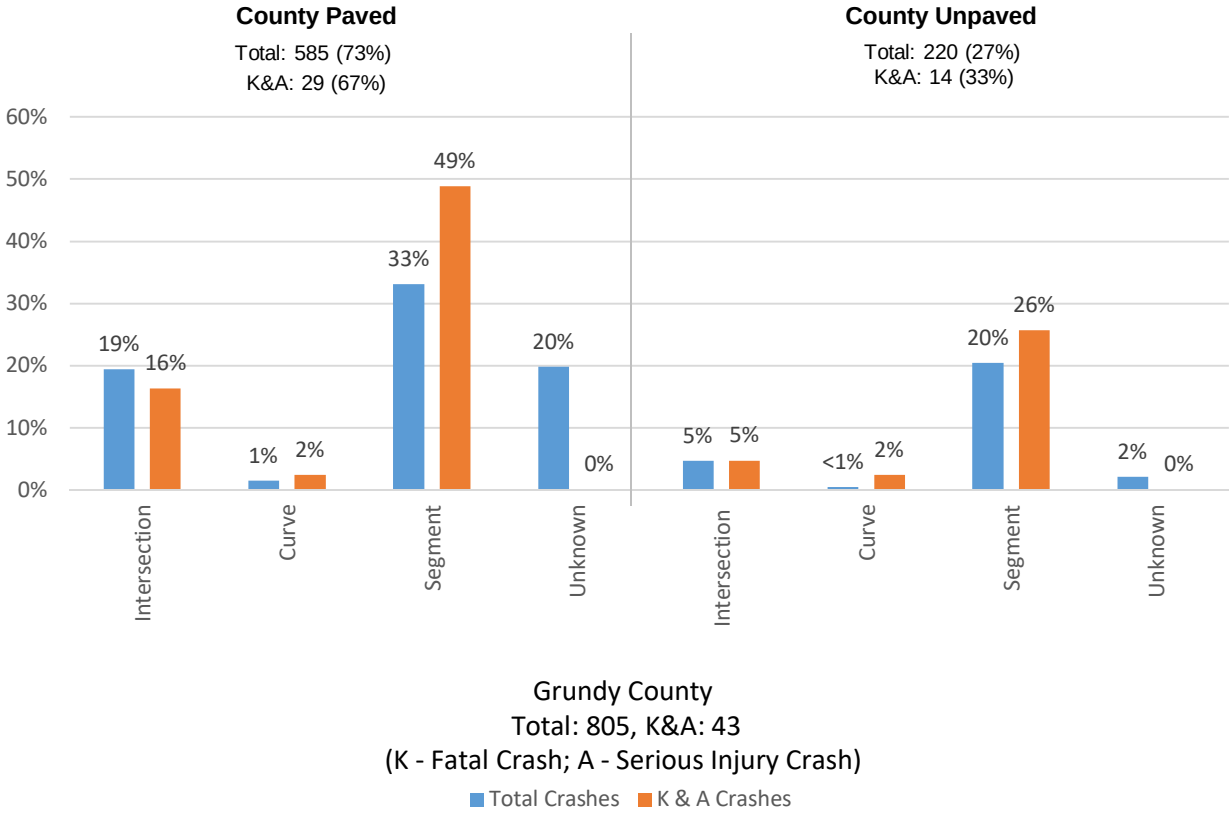


Figure 9 – County Crashes by Roadway Type

4.4. Total Crash Rates

From 2008 to 2017, there were a total of 805 crashes on county roadways within Grundy County. **Figure 10** illustrates the comparison of the Grundy County crash rate on county roads to the overall Grundy County crash rate, and the Iowa crash rate during the same timeframe. As shown in **Figure 10**, the Grundy County crash rate on county roads was lower than the Iowa crash rate.

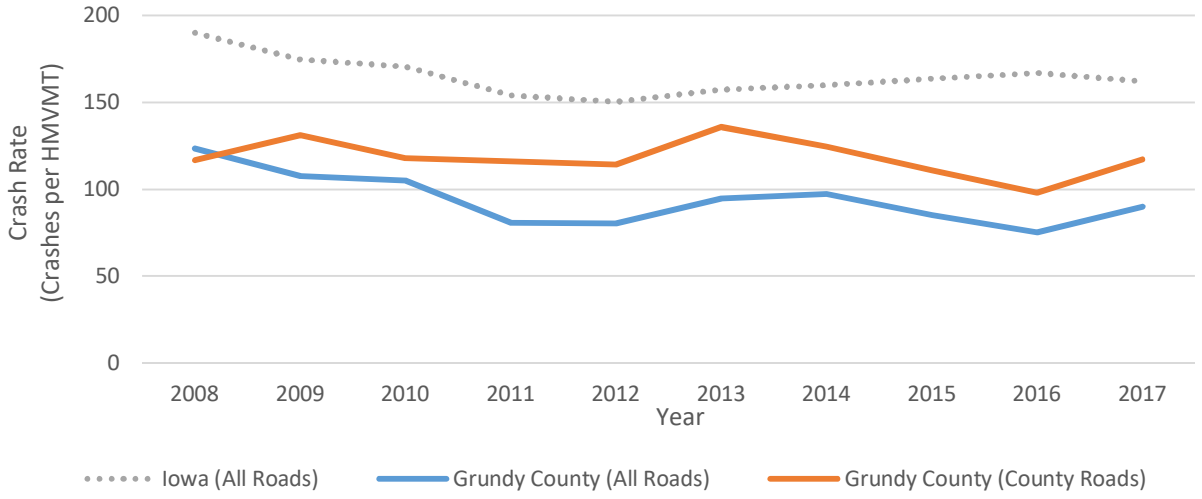


Figure 10 – Crash Rates (All Crash Severities)

4.5. Fatal and Serious Injury Crash Rates

From 2008 to 2017 there were a total of 43 fatal and serious injury crashes on county roads within Grundy County. Fatal and serious injury crash rates for all roads in Grundy County, the county-owned roads, and all roads in Iowa are illustrated in **Figure 11**. The Grundy County fatal and serious injury crash rate on county roads was higher than the Iowa crash rate for five of the ten years of the study period.

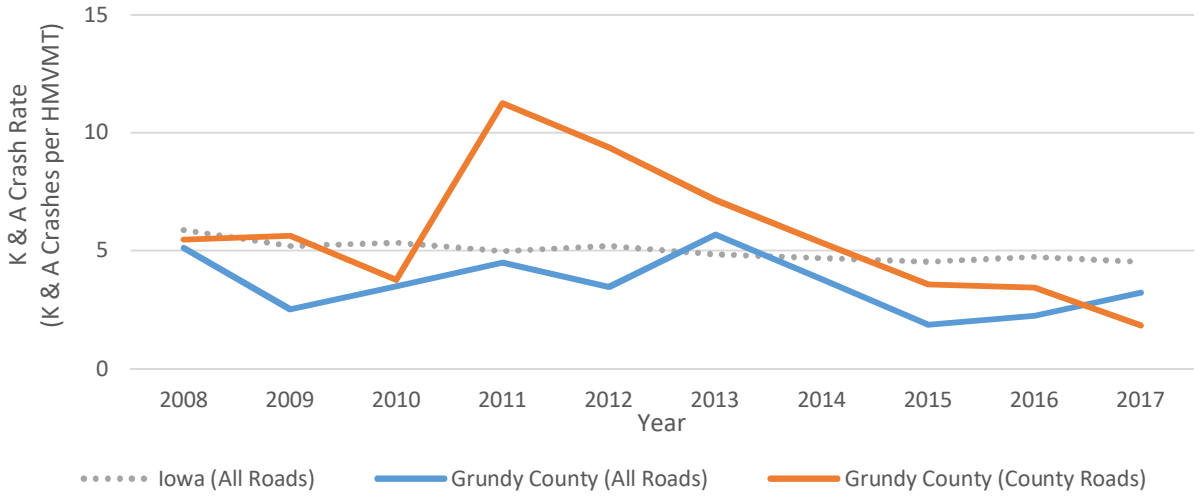


Figure 11 – Crash Rates (Fatal and Serious Injury Crashes)

4.6. Crash Rate Comparison

Figure 12 shows the average crash rates for all crashes as well as fatal and serious injury crash rates for both the county roads and statewide from 2008 to 2017. As illustrated in the figure, the county road crash rate for all crashes is lower than the statewide crash rate but the fatal and serious injury crash rate on county roads is higher than the fatal and serious injury crash rate statewide, demonstrating the importance of a focus on fatal and serious injury crashes on county roads.

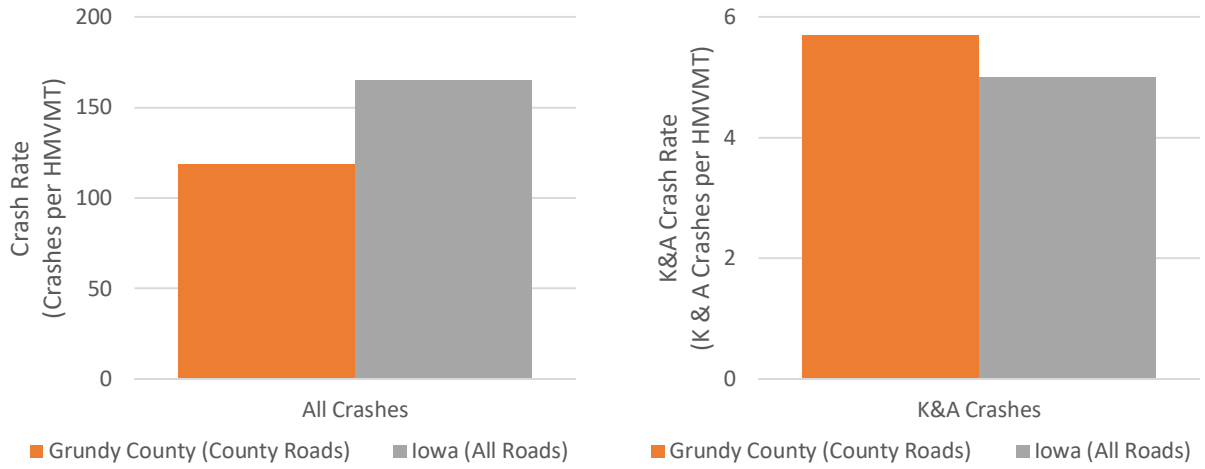


Figure 12 – County Road to Statewide Crash Rate Comparison

4.7. Additional Data Analysis

It should be noted that the Iowa DOT has made crash data available through a crash mapping website, which can be used to develop additional crash maps: https://icat.iowadot.gov. Crash maps can also be requested through the Iowa Traffic Safety Data Service (ITSDS). More information is available on the following website: www.ctre.iastate.edu/itsds/.

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5. COUNTERMEASURE SELECTION

The following section summarizes systemic safety improvement countermeasures considered for this LRSP, risk factors, crash modification factors (CMFs), and countermeasures considered for inclusion in the LRSP. Additional information is provided summarizing the driver-related countermeasures underway within the county.

5.1. Potential Systemic Safety Improvement Countermeasures

The purpose of the LRSP project is to identify systemic safety improvements that can be implemented on county roads. The systemic approach takes a broad view of risk, examining it across an entire roadway system, rather than applying improvements to locations where crashes have previously occurred.

"The systemic approach to safety involves widely implemented improvements based on high-risk roadway features correlated with specific severe crash types. The approach provides a more comprehensive method for safety planning and implementation that supplements and complements traditional site analysis. It helps agencies broaden their traffic safety efforts and consider risk as well as crash history when identifying where to make low cost safety improvements."

FHWA – Office of Traffic Safety

5.2. Risk Factors

When developing systemic safety improvements, it is important to note potential risk factors associated with the crash types. The FHWA, as part of their Systemic Safety Project Selection Tool, has developed a list of potential risk factors that can help identify locations for systemic safety improvements. While not all the risk factors outlined below are utilized for the LRSP project due to data availability and crash types to be addressed, they have been included below for reference.

- Roadway and Intersection Features
  - Number of lanes
  - Lane width
  - Shoulder surface width and type
  - Median width and type
  - Horizontal curvature, superelevation, delineation, or advance warning devices
  - Horizontal curve density
  - Horizontal curve and tangent speed differential
  - Presence of a visual trap at a curve or combinations of vertical grade and horizontal curvature
  - Roadway gradient
  - Pavement condition and friction
  - Roadside or edge hazard rating (potentially including sideslope design)
  - Driveway presence, design, and density
  - Presence of shoulder or centerline rumble strips
  - Presence of lighting
  - Presence of on-street parking
  - Intersection skew angle
  - Intersection traffic control device

- Number of signal heads vs. number of lanes
- Presence of backplates
- Presence of advanced warning signs
- Intersection located in or near horizontal curve
- Presence of left-turn or right-turn lanes
- Left-turn phasing
- Allowance of right-turn-on-red
- Overhead versus pedestal-mounted signal heads
- Pedestrian crosswalk presence, crossing distance, signal head type

- Traffic Volume
  - Average Daily Traffic volumes (ADT)
  - Average Daily Entering Vehicles (DEV)
  - Proportion of commercial vehicles in traffic stream

- Other Features
  - Posted speed limit or operating speed
  - Presence of nearby railroad crossing
  - Presence of automated enforcement
  - Adjacent land use type (e.g., schools, commercial, or alcohol-sales establishments)
  - Location and presence of bus stops

5.3. Crash Modification Factors (CMFs)

When identifying potential systemic safety improvements, it is important to look at CMFs for the proposed improvements. The CMF Method is found in Part D of the HSM. CMFs are defined as the ratio of effectiveness of one condition in comparison to another condition and represents the relative change in crash frequency due to a change in one specific condition. In other words, a CMF is a multiplicative factor used to compute the expected number of crashes after implementing a given countermeasure at a specific site. Countermeasures with CMFs less than one are expected to reduce crashes if applied, while those countermeasures with CMFs greater than one are expected to increase crashes. **Figure 13** illustrates the definition of CMFs.

$$CMF = \frac{\text{EXPECTED CRASHES WITH TREATMENT}}{\text{EXPECTED CRASHES WITHOUT TREATMENT}}$$

CMF = 1.0	Expected to have no impact on safety
CMF < 1.0	Expected to reduce crashes
CMF > 1.0	Expected to increase crashes

Figure 13 – CMF Calculation

The CMF Method is used to calculate the expected number of crashes by taking the observed number of crashes and multiplying those crashes by the applicable CMF for the proposed countermeasure. It is recommended that CMFs be applied to a minimum of three years of crash data for urban and suburban sites and five years of crash data for a rural site. **Figure 14** is a sample calculation of the CMF method with one CMF being applied to a particular site for a single year.

10.1 crashes / year x 0.91 (CMF) =	9.2 crashes / year: a reduction of 0.9 total crashes per year and a CRF of 9%

Figure 14 – CMF Method Sample Calculation

A Crash Reduction Factor (CRF) is similar to a CMF but stated in different terms. A CRF is defined as a percentage of crash reduction that might be expected after the implementation of a given countermeasure at a specific site. **Figure 15** shows how a CRF is calculated in relationship to a CMF.

$$CRF = (1 - CMF) \times 100$$

Figure 15 – CRF Calculation

Caution should be used in the selection of appropriate CMFs. The following guidance should be considered when selecting CMFs:

- CMFs should be selected from the HSM Part D or from FHWA's CMF Clearinghouse website (http://www.cmfclearinghouse.org).
- Read the countermeasure abstract to determine if the CMF is applicable to the proposed improvement.
- Only CMFs with a four-star rating or higher should be considered for use in analysis.
- Be sure the selected CMF is applicable to the set of crash data being used for analysis. Some CMFs may only be applicable to a subset of the crash data.
- The application of multiple CMFs can overestimate the expected crash reduction. Unless each CMF addresses independent crash types, multiple CMFs should not be used. It is suggested that no more than three independent CMFs be applied to a particular site.

5.4. Engineering Countermeasures

In **Section 6** of this report countermeasures are discussed and detailed in **Appendix B1**, **Appendix C1** and, **Appendix D1**. CMFs are also provided for countermeasures in this report when four-star or five-star CMFs are available. In some cases, CMFs are not available for particular countermeasures because sufficient data has yet to be collected, but the countermeasures are still believed to result in crash reductions. In other cases, the countermeasure is a proven FHWA countermeasure and the CMFs vary significantly based on the existing and proposed conditions. CMFs provided within this report were identified from the FHWA's CMF Clearinghouse (www.cmfclearinghouse.org) and are referenced in this report for information only to show the general benefit of the recommended countermeasures.

During Phases 1, 2, and 3 of the LRSP project, the project team worked with 47 counties and the Iowa DOT to identify potential safety engineering countermeasures related to paved roadway segments, intersections, and curves. Additional countermeasures were identified during the District Road Safety Plan process that are incorporated into this project. The following sections summarize the proposed safety countermeasures for the county's LRSP.

5.4.1.1. County Paved Roadway Segment Countermeasures

The following roadway segment safety countermeasures were identified:

- Conduct an RSA
- Conduct an access control evaluation
- Wider pavement markings
- Improved pavement markings
- Shoulder width increase
- Safety edge
- Edgeline rumble strips
- Centerline rumble strips
- Install/enhance curve chevron, advanced curve warning, and advisory speed signs
- Remove obstructions within right-of-way (clearing and grubbing)
- Improve sight distance (clearing and grubbing)
- Flatten and widen foreslopes *
- On-pavement markings for speed control *
- Delineate roadside hazards (trees of utility poles) with retroreflective strips *
- Use of guardrails *
- Install post-mounted delineators *
- Install retroreflective strips on chevron sign posts *
- Transverse rumble strips prior to curves *
- Remove/relocate objects in hazardous locations *
- Superelevation correction on curves *
- Install High Friction Surface Treatment (HFST) on curves *
- Speed-activated flashers on chevron signs *
- Duplication of signage *
- Improved lighting *
- Improve access management (driveway policy) *
- Conduct speed studies *
- Modify lane width *

5.4.1.2. County Paved Intersection Countermeasures

The following paved intersection safety countermeasures were identified:

- Coordinate with local jurisdiction on signal modifications
- Signal warrant analysis to consider removal of signal
- Intersection Configuration Evaluation (ICE)
- Implement the results of ICE
- All-way stop analysis to convert two-way stop to all-way stop or remove stop signs
- Install destination lighting
- Increase size and/or retroreflectivity of stop signs
- Duplication of signage
- Wider pavement markings
- Improve pavement markings
- Flashing beacons on stop/yield signs
- Transverse rumble strips
- Install intersection warning signs and advanced street name plaques
- Improved sight distance (clearing and grubbing)
- Provide right-turn and/or left-turn lanes *
- Realign intersection approaches to reduce or eliminate intersection skew *
- Provide bypass lane on shoulder at T-intersections *
- Convert offset T-intersections to four-legged intersections *
- Use indirect left-turn treatments to minimize conflicts at divided highway intersections *
- Convert four-legged intersections to offset T-intersections *
- Flashing beacon on intersection warning signs *
- Stop signs with LED flashing lights

- Low-cost Intersection Conflict Warning Systems (ICWS) *
- Install a roundabout *
- Shoulder width increase *
- Safety edge *
- Use of retroreflective markers for trees or utility poles *
- Use of guardrails *
- Install retroreflective strips on stop sign posts *
- Access management *

5.4.1.3. County Paved Curve Countermeasures

The following horizontal curve safety countermeasures were identified:

- Wider pavement markings
- Shoulder width increase (paved)
- Safety edge
- Edgeline rumble strips
- Centerline rumble strips
- Install/enhance curve chevron signs
- Provide advance warning signage
- Remove obstructions within right of way (clearing and grubbing)
- Additional curve signage *
- Install retroreflective strips on chevron sign posts *
- Transverse rumble strips prior to curve *
- Superelevation correction *
- Install HFST on curves *
- Speed-activated flashers on chevron signs *
- Use of guardrails *
- On-pavement markings for speed control *
- Install post-mounted delineators *
- Use of retroreflective markers for trees or utility poles *
- Enhanced delineation and horizontal friction *

* Upon consultation with the Phase 1, 2, and 3 counties and the Iowa DOT, these countermeasures were determined to not be implemented at a systemic level; however, they should still be considered on a case-by-case basis by the County Engineer depending on the specific issues at a particular location and many have been provided on the back side of the project sheets.

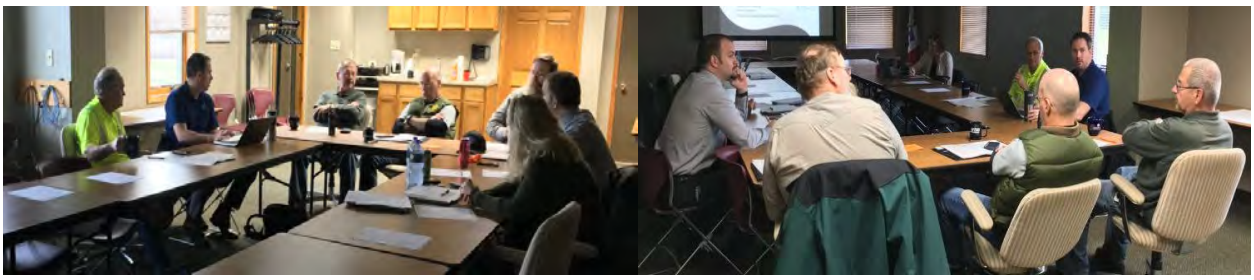
5.4.1.4. Additional Potential Countermeasures

The back side of the project sheets includes additional potential countermeasures for consideration by the County Engineer. For each location, there are a variety of other safety improvements that could be considered even though they were not recommended as part of this project due to availability of data, the need for site-specific information, and/or the appetite for the countermeasure to be deployed throughout the county. These additional countermeasures are discussed in **Section 6.2.6.**, **Section 6.3.6.**, and **Section 6.4.6.**

5.5. Driver-Related Countermeasures

A workshop was conducted in Grundy County on Thursday, November 1, 2018, to discuss driver-related countermeasures and project selection. Representatives at the workshop included:

- Gary Mauer (Grundy County Engineer)
- Kyle Durant (Iowa Northland Regional Council of Governments)
- Nicole Moore (Iowa DOT)
- Jon Hillard (Dike-New Hartford Transportation)
- Todd Olmstead (GTSB)
- Erik Smith (AGWSR Community School District)
- Rick Penning (Grundy County Sheriff)
- Tim Wolthoff (Grundy County Sheriff's Office)



The 2013 Iowa SHSP has ten Key Safety Emphasis Areas, of which six are driver-related emphasis areas:

- Speed-related
- Unprotected persons
- Younger drivers
- Impaired driving
- Older drivers
- Inattentive/distracted driving

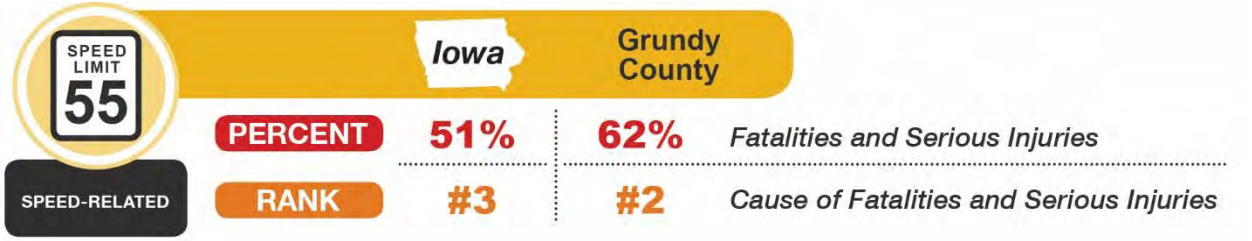
Figure 16 – Iowa SHSP Driver-Related Emphasis Areas

During the workshop, attendees were provided information regarding fatal and serious injury crashes within the county and how that data aligned with the Iowa SHSP Key Safety Emphasis Areas. Potential countermeasures from the *National Cooperative Highway Research Program (NCHRP) Report 500 Series, Toward Zero Deaths* documents, and the results from Phases 1, 2, and 3 of the LRSPs were provided to stakeholders to facilitate discussion on what action items were currently underway in the county with respect to driver-related crashes.

The following statuses of implementation for the various driver-related countermeasures were defined based on the results of the discussion at the county workshop:

- Underway/Ongoing (currently being done);
- Area for Improvement (ongoing, but could be enhanced);
- Opportunity (not being done, but could be implemented); or
- Completed in the Past (has been completed in the past, but not planned to be implemented in the future).

The following sections provide a summary of the status of implementation of the driver-related countermeasures within the county. It is recommended that the county continue to implement countermeasures that are currently underway/ongoing and look for additional opportunities to implement countermeasures that are not currently being implemented. This will require input from and coordination with all of the five E's of safety.



5.5.1.1. Speed-Related

Speed-related crashes are a common concern within all the LRSP Phase 4 counties, and account for half (51%) of fatal and serious injuries across the state of Iowa. Many counties are facing budgetary constraints which limit the number of officers available to proactively conduct speed enforcement. Some counties stated that they could provide better enforcement with their available resources if speeding locations were identified on a map and/or if a speed trailer with the ability to log speed data by time of day and day of week were available to them. There is a common opportunity to provide an educational campaign with respect to speed-related crashes.

A topic of discussion in many of the workshops involved drivers illegally passing school buses. While law enforcement in most counties are ticketing drivers for illegally passing school buses, it is unclear whether or not the Keep Aware Driving – Youth Need School Safety Act (Kadyn's Law) is being implemented in the court system. This law states that driving privileges will be suspended for 30 days for a first conviction, 90 days for a second conviction, and 180 days for a third or subsequent conviction along with fines.

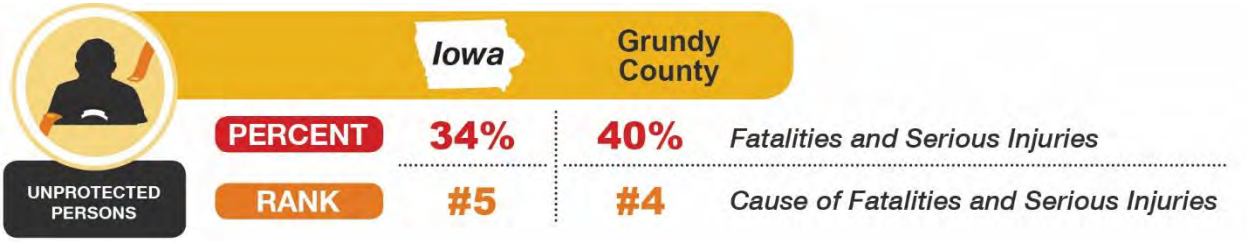
Grundy County School District has equipped new school buses with external cameras to document those illegally passing school buses and intends to retrofit their entire fleet with this equipment. The School District noted that four to five violations occurred within one month in 2018. It was noted that these buses are shared with Butler county, and it was noted that convictions are upheld in both Grundy and Butler Counties for these violations. There is a radio station in Grundy County that provides messages at the beginning of the school year to remind listeners to stop for school buses.

Speed-related crashes resulted in 29 (62%) of the fatalities and serious injuries in Grundy County. The Grundy County Sheriff has a portable speed trailer to record speeds at various locations throughout the day and uses the information for targeted law enforcement. This trailer can also be loaned to other agencies for their use. Grundy County Sheriff's Office participates in GTSB funding.

Table 4 provides a summary of the level of implementation of speed-related countermeasures in the county.

Table 4 – Speed-Related Countermeasure Implementation Status

Countermeasure	Status
Conduct targeted speed enforcement - County participates in Governor's Traffic Safety Bureau (GTSB) funding - The County has a portable speed trailer that can record data	Underway/Ongoing
Prosecute and impose sanctions on drivers not obeying school bus stop bars - County enforces the Keep Aware Driving – Youth Need School Safety Act (Kadyn's Law) - Offenders of Kadyn's Law are given a 30-day license suspension - New school buses in county are equipped with external cameras and existing school buses are being retrofitted	Underway/Ongoing
Conduct education and awareness campaigns - Opportunities to develop safety education programs within the county at the elementary, middle, or junior high level - Programs in elementary schools have officers teach kids about safe driving	Area for Improvement



5.5.1.2. Unprotected Persons

Many counties have seat belt compliance rates over 90%; however, unprotected persons still comprise more than one-third (34%) of the fatalities and serious injuries on Iowa roads. Most counties have at least one location within their community for instruction on proper child restraint use; however, there are opportunities to conduct "child restraint inspections and/or installation" events either individually or as part of a larger community event, such as the county fair, a safety fair, or a Fire Department open house. Additionally, counties could provide training to middle school children potentially through the Drug Abuse Resistance Education (DARE) program.

Several counties have trained law enforcement to check for proper child restraints and provide them with a "cheat sheet" to keep in their vehicle so they are aware of the current laws. Marshall County is in the process of developing a program where individuals who are cited for providing improper child restraint can attend a course on proper child restraints in lieu of paying the fine. A program such as this could provide valuable education on proper child restraints that can improve safety within Grundy County as well.

Many Iowa counties offer positive reinforcement in programs to hand out rewards (e.g., ice cream, slice of pizza, candy, stickers, etc.) for children wearing their helmets while riding their bikes. **Figure 17** shows some examples of certificates given out by Monroe County for bicycle helmet use. This is an excellent opportunity for positive reinforcement and encouragement for children to wear helmets and is an opportunity in Grundy County. It is important to note that since helmets

are not required for motorcyclists in Iowa, there is little to no effort put forth to educate citizens on the importance of wearing a helmet when riding a motorcycle.

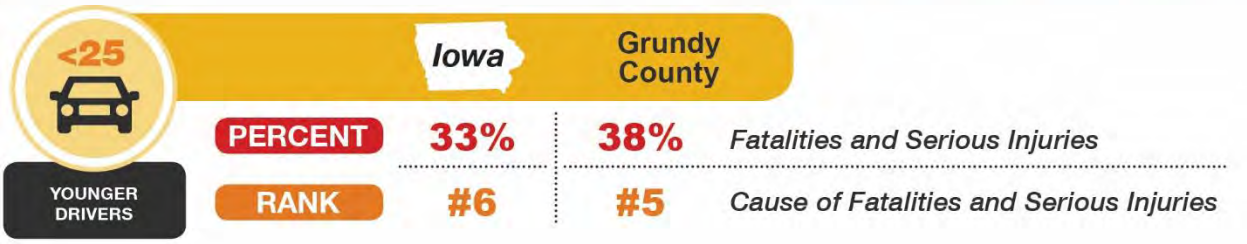
Source: Monroe County, IA

Figure 17 – Example Bicycle Helmet Reward Coupons

Unprotected person crashes resulted in 19 (40%) of the fatalities and serious injuries in Grundy County. Grundy Center has a permanent location where parents can have their child restraints inspected to determine if they are installed properly. Publicized community events are held to help people install their child restraints properly. A summary of unprotected persons countermeasure implementation in the county is included in **Table 5**.

Table 5 – Unprotected Persons Countermeasure Implementation Status

Countermeasure	Status
Conduct targeted enforcement of restraint use - Law enforcement regularly issues citations for not wearing a seat belt, however it is not taking place in contract towns	Underway/Ongoing
Instruction in proper child restraint use - There is a location in the county where child restraints can be inspected - The nearest hospital checks to see if car seats are present when a newborn leaves the hospital	Underway/Ongoing
Check for proper child restraint use in all motorist encounters - Law enforcement have Governor's Traffic Safety Bureau (GTSB) "cheat sheets" to aid in enforcement of child restraint laws - Law enforcement are told to check for proper restraint use as part of a standard traffic stop	Underway/Ongoing
Positive reinforcement - Opportunity to hand out ice cream gift certificates for children wearing bicycle helmets (law enforcement, Emergency Medical Services (EMS), and/or fire department)	Opportunity
Conduct education and awareness campaigns - Public child restraint events are held and publicized	Underway/Ongoing



5.5.1.3. Younger Drivers

Crashes involving younger drivers account for one-third (33%) of the fatalities and serious injuries in Iowa. In counties where driver's education is still taught through the high schools, there is an opportunity for law enforcement to participate and provide training on targeted topic areas such as distracted driving, impaired driving, and seatbelt use. In locations where driver's education is privatized, it can be more difficult for law enforcement to become involved in additional training during driver's education courses.

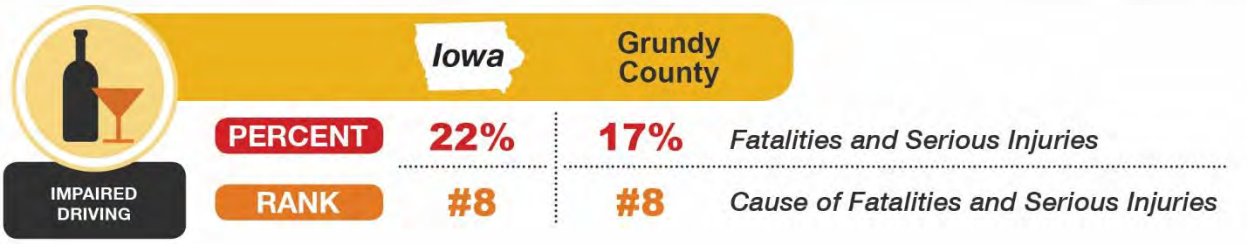
Although schools have strict curricula to adhere to, there is still the opportunity for education with respect to younger drivers' issues such as "don't veer for deer"; texting and driving; what to do on an edge drop-off; etc. to occur through health classes or other programs within the schools. Many schools are participating in mock prom disaster events to raise awareness of impaired and distracted driving. It is important to note that counties can apply for TEAP funding to obtain assistance in reviewing traffic/safety issues around existing school sites.

Younger driver crashes account for 18 (38%) of the fatalities and serious injuries in Grundy County. Law enforcement stated they do not believe there are too many issues of graduated driver's license (GDL) law compliance within Grundy County, however they also stated there is general disagreement among Grundy law enforcement against the current GDL laws in place. Mock-Prom disaster events were held in Grundy County Schools in the past; however, these have not been held recently and attendees were not aware of any programs within schools that have provided other educational materials.

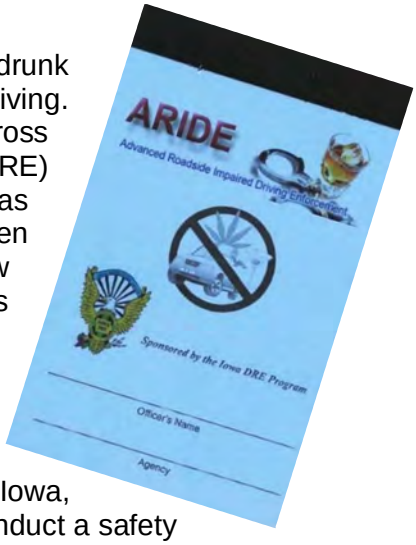
Table 6 provides a summary of the level of implementation of younger driver-related countermeasures in the county.

Table 6 – Younger Drivers Countermeasure Implementation Status

Countermeasure	Status
Enforcement of graduated driver's license laws - Law enforcement stated they do not believe there are too many issues of graduated driver's license (GDL) law compliance within Grundy County	Underway/Ongoing
Mock prom disaster events - Mock prom disaster/crash events have been conducted in the past	Opportunity
Additional training in schools - Opportunity for individual teachers of health, physics, or other classes - Governor's Traffic Safety Bureau (GTSB) and the University of Iowa have simulators that can be used at events - "Drunk goggles" can be used as part of after prom or other events	Opportunity
Conduct education and awareness campaigns	Opportunity



5.5.1.4. Impaired Driving



During the workshops, many counties noted that, while they felt that drunk driving was on the decline, there has been an increase in "drug" driving. Impaired driving accounts for 22% of fatalities and serious injuries across the state. Most counties have access to a Drug Recognition Expert (DRE) to assist in determining intoxication in routine traffic stops as well as crashes. Some counties noted the difficulty in reaching DREs when needed. GTSB can provide ARIDE training for interested law enforcement officers. ARIDE is a course designed such that officers become more proficient at detecting, apprehending, testing, and successfully prosecuting impaired drivers.

Most counties proactively conduct OWI enforcement, and some counties receive GTSB grants for additional targeted enforcement. Over the years, some counties have conducted safety checkpoints. In Iowa, law enforcement cannot have an alcohol checkpoint, but they can conduct a safety checkpoint where they have a set method for pulling drivers over (e.g., all vehicles, every fifth vehicle) and they check for a variety of safety items including tail lights, seatbelts, horn, etc. Safety checkpoints require a significant amount of resources from multiple jurisdictions, thus making them more difficult to conduct with the limited resources available. GTSB has a trailer that is available to counties and contains all of the supplies required to conduct a safety checkpoint. Law enforcement noted that they do not conduct safety checkpoints but do saturation patrols.

In multiple workshops the topic of repeat OWIs was discussed. Officers stated that they try not to conduct OWI enforcement next to bars, due to possible accusations of entrapment. Law enforcement stated that they think impaired driving is on the decline in the county, and citations issued for OWI are nearly half of previous years. Offenses are not being booked as a lower offense under the new County Attorney.

In Muscatine County, they allow OWI offenders to perform manual labor as part of an alternative sentencing program. More information on the program can be found on the county website: http://www.co.muscatine.ia.us/159/Alternative-Sentencing and could be considered in Grundy County.

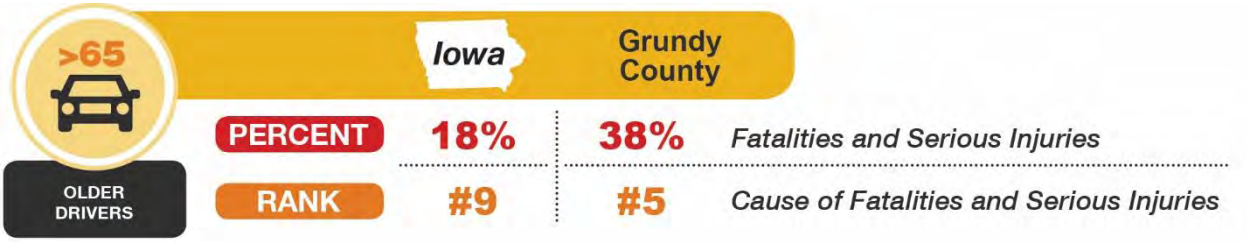
Another idea for helping rehabilitate OWI offenders that has been successfully implemented in other states is the "24/7 Sobriety Program." More information on the current program in South Dakota is available at: https://atg.sd.gov/legal/DUI247/default.aspx. With the support of its county officials, Woodbury County was recently selected to pilot the program in Iowa.

Grundy County is not currently performing compliance checks for over-serving or serving underage customers. Attendees have stated that there are alternative transportation options in the county for impaired drivers, such as taxis or rideshares, but these are scarce.

A total of 8 (17%) of the fatalities and serious injuries involved impaired driving in Grundy County over the study period. A summary of the impaired driving countermeasures discussed during the workshop along with the county's level of implementation is included in **Table 7**.

Table 7 – Impaired Driving Countermeasure Implementation Status

Countermeasure	Status
Conduct targeted Operating While Intoxicated (OWI) enforcement - Law enforcement is conducting saturation patrols	Underway/Ongoing
Conduct safety checkpoints	Opportunity
Compliance checks for alcohol sales	Opportunity
Alternative transportation choices - Taxis and rideshares are not readily available within the county	Area for Improvement
Prosecute, impose sanctions on, and treat OWI offenders - Offenses are not currently being booked as a lower offense	Underway/Ongoing
Conduct education and awareness campaigns	Opportunity



5.5.1.5. Older Drivers

Older driver crashes accounted for 18% of fatalities and serious injuries statewide. The counties mentioned that engineering countermeasures such as larger text, signs, and advanced intersection signage could be useful for older drivers. Law enforcement in many of the counties do recommend retesting for driver's licenses when older drivers are involved in a citation or at fault in a crash, but at times this can be difficult as some County Attorney's Offices are concerned about profiling. Retesting is successfully being implemented in many counties in situations where older drivers were at fault in a crash or as a result of a traffic stop. However, law enforcement in several counties noted that even when older drivers lose their driver's license, they still tend to drive due to the rural nature of the state and their need to access services. Older drivers are a consistent issue as driving is considered a form of independence that can be difficult to deny for life-long rural drivers.

In several counties, law enforcement noted a high percentage of older drivers on the roads during severe weather because they were following their daily routine regardless of the weather. There are opportunities to use local radio/TV stations to raise awareness of adverse weather conditions when drivers (particularly older drivers) should not drive. General weather/driving education could be given through community centers as well.

The Iowa DOT Driver and Identification Services sponsors events through the CarFit program, helping older drivers with the "fit" of their vehicle. This program could be an opportunity for the county. Grundy County Law enforcement stated that they would investigate hosting a "Car Fit"

event. Iowa Northland Regional Council of Governments (INRCOG) stated that they would be open to hosting the event as well.

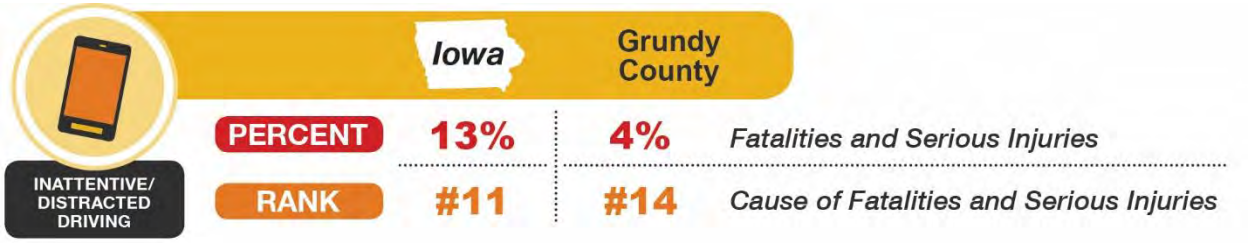
Older driver crashes resulted in 18 (38%) of the fatalities and serious injuries in Grundy County. Family and church groups provide volunteer driving services for seniors.

Grundy County does require license retesting for older drivers involved in a crash and does request retesting of an older driver that receives a driving citation, but this does not occur often in the county. Law enforcement noted that they can check a box in the crash report to request retesting for older drivers. Reporting of at-risk drivers to licensing authorities is on the decline in Grundy County, and it was noted that this may be due to the reporting of older drivers not being anonymous any longer. Law enforcement stated that they do not believe older drivers continuing to drive after their license has been revoked is a problem in the county.

A summary of older driver countermeasure implementation by the county is included in **Table 8**.

Table 8 – Older Driver Countermeasure Implementation Status

Countermeasure	Status
Promote safe mobility choices - Opportunity to provide paratransit service materials at locations throughout the county - Opportunity to use the Farm Bureau, veterans' groups, AARP, etc. to communicate transportation options to older drivers - Opportunity to host a CarFit event within the county	Opportunity
Encourage external reporting of at-risk drivers to licensing authorities - External reporting of older drivers is on the decline as it is no longer anonymous - Law enforcement requests retesting of drivers as appropriate	Underway/Ongoing
Conduct education and awareness campaigns	Opportunity



5.5.1.6. Inattentive/Distracted Driving

During the workshops, it was noted that inattentive/distracted driving was most likely largely underreported, as it is difficult for law enforcement to determine what events specifically led to the crash. Workshop attendees noted that as cell phone coverage increases in rural areas, drivers using their cell phones will most likely increase. In April 2017, Iowa passed legislation making it illegal, and a primary offense while driving to use a mobile device to "write, send, or view an electronic message", or "play, browse, or access electronic messages". Phone calls and using navigation on a cell phone are still permitted under this legislation. It was noted in the workshops that even with this new legislation, compliance is difficult to enforce. Also, the crash forms used by law enforcement were recently modified to include more options specific to distracted driving; in the future, it is anticipated that data quality will improve. Cell phone records are sometimes

needed to prove what took place, and the pursuit of those records typically only occurs when there is a serious injury or fatality in a crash. It was noted that sometimes people do not think texting while stopped at an intersection is illegal, when in fact it is.

The Cerro Gordo County Sheriff utilized the distracted driving video simulator from *It Can Wait* at their county fair. According to the Sheriff, it was very popular, easy to use, and they are looking for opportunities to utilize similar simulators at future events. The simulator was a free download from the website, and all that was needed was a video game steering wheel, cell phone, and laptop. A similar simulator can be found at: https://www.itcanwait.com/vr. GTSB and the University of Iowa also have simulators that can be used for events, free of charge.

Many counties in Iowa have policies permitting hands-free only cell phone usage while on county business or within a county vehicle. The county has a hands-free no cellphone policy for employees. Newer county vehicles are equipped with Bluetooth for employees. Additionally, county employees undertake a mandatory defensive driving class in which a mobile simulator is used.

Inattentive/distracted driving crashes resulted in two (4%) of the fatalities and serious injuries in Grundy County. **Table 9** summarizes the implementation status of the inattentive/distracted driver countermeasures as recorded in the workshop.

Table 9 – Inattentive/Distracted Driving Countermeasure Implementation Status

Countermeasure	Status
Visibly enforce existing statutes to deter distracted driving - Law enforcement stated that it is difficult to enforce this law as a secondary offense as it is written	Area for Improvement
Agency policy for hands-free devices - County policy requires hands-free use in agency vehicles - Some vehicles with hands-free equipment are available	Underway/Ongoing
Mobile simulator for distracted driving - County employees undertake a mandatory self-defense driving class in which a mobile simulator is used - Opportunity to bring in simulators from Governor's Traffic Safety Bureau (GTSB) or the University of Iowa for events	Area for Improvement
Conduct education and awareness campaigns	Opportunity

6. SAFETY PROJECT DEVELOPMENT

Safety improvement projects were developed at high-priority locations along paved roadway segments, intersections, and horizontal curves within the county. Due to the limited amount of available data, low traffic volumes, and limitations on the types of systemic safety improvement projects that can be implemented on unpaved roads, location-specific recommendations were not developed for unpaved roadways. However, this LRSP includes safety recommendations that can be considered for implementation on the unpaved roadway system by the County Engineer.

This section describes the methodology of data analysis for project selection and prioritization for safety improvement projects for paved roadway segments, intersections, and horizontal curves.

6.1. Methodology

As shown in **Figure 18**, GIS data, as described in **Section 3**, was utilized to rank each of the county paved roadway segments, intersections, and curves based on risk factors. After the facilities were ranked, a decision tree was used to develop safety improvement recommendations along the facilities with the highest risk factor rankings. Draft project sheets for the highest-ranking facilities were developed summarizing the recommendations and estimated implementation costs for the project recommendations. The project sheets were provided to the county for review and comment, then finalized. Each of the methodology steps is described in detail in the following sections.

Figure 18 – Project Analysis Methodology

6.1.1. GIS Data

GIS data for the county paved road segments, intersections, and curves was utilized to perform a systemic analysis of the county-owned roadway facilities. Databases were obtained through collaboration and coordination with Iowa DOT, InTrans, and the county. Descriptions of the databases utilized for the analysis are included in **Section 3** of this document.

Once obtained, the data was analyzed using ArcMap GIS software as described in the following sections. Every roadway segment, intersection, and curve along the county-owned paved roadway system was analyzed.

6.1.2. Risk Factor Ranking

Iowa DOT crash data from 2008 to 2017 (as of the June 11, 2018 database update) was utilized for analysis. This represents the most recent 10 years of crash data available at the time this project phase began. Risk factors along roadway segments, at intersections, and along curves were assessed to determine locations that may be more susceptible to crashes involving serious

injuries and/or fatalities in the future, as opposed to focusing only on locations that have had such crashes previously. In this analysis, various attributes were assessed in determining risk. The attributes that were assessed for determining risk are included in the subsequent sections for segments, intersections, and curves. Rankings of those attributes were developed for the LRSP in coordination with the Iowa DOT.

6.1.3. Project Selection Decision Tree

To aid in the systematic selection of safety improvement recommendations for the roadway segments, intersections, and curves with the highest risk factor rankings, three project decision trees were developed. A decision tree was developed for each facility type and are individually described in subsequent sections. A logical flow was created within the decision trees based on traffic volumes and roadway characteristics. Facility data was utilized to select which safety countermeasures (projects) were recommended at each location.

6.1.4. Draft Project Sheets

To summarize the information used in the analysis of the roadway segments, intersections, and curves within the county, individual project sheets were developed for those facilities with the highest risk factor scores. The draft project sheets included location, systematic ranking data, crash data, geometric data, and opinion of probable cost for the recommended safety improvements. **Figure 19** summarizes the general organization of and information contained within the project sheets.

6.1.5. Driver-Related Countermeasure and Project Selection Workshop

After development of the potential location-specific safety improvements and project sheets, an in-person workshop was conducted in Grundy County on Thursday, November 1, 2018, to review implementation of the driver-related countermeasures along with the engineering safety countermeasures that were recommended for specific locations on the draft project sheets.

6.1.6. Project Sheets

After addressing the comments from the county, the project sheets for segments, intersections, and curves were finalized. The project sheets included in **Appendix B2**, **Appendix C2**, and **Appendix D2** are based on the best available information as of November 2018.

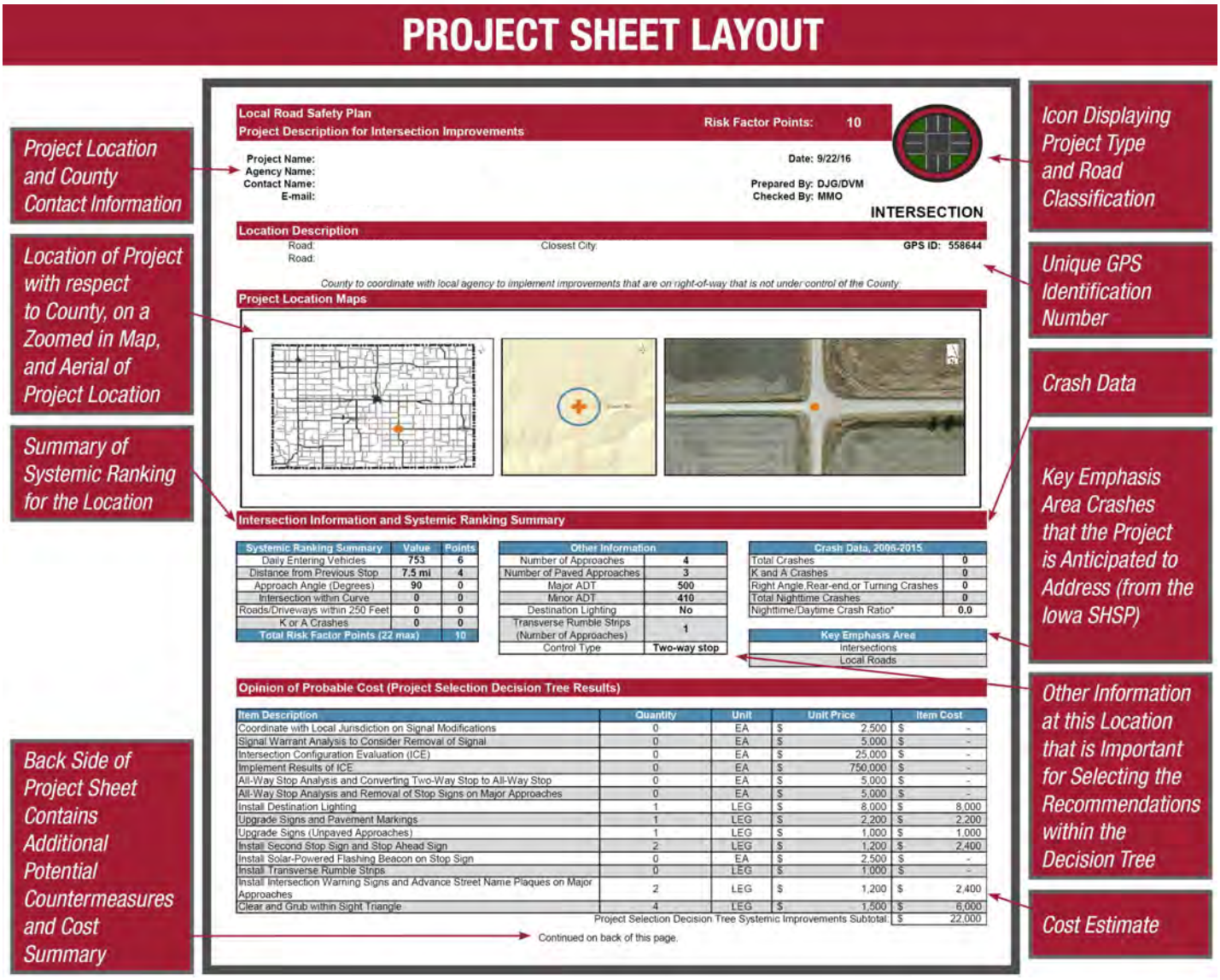


Figure 19 – Project Sheet Summary

6.1.6.1. Project Recommendations Disclaimer

The recommended improvements contained in the project sheets were developed through a system-wide GIS database risk assessment and project decision tree selection process, as described previously. Kimley-Horn could not confirm or control the accuracy of the GIS databases nor the suitability of the specific improvements for the location and has provided recommended improvements for consideration by the County Engineer. Site surveys were not conducted at the specific locations detailed in the project sheets. The County Engineer may use these project sheets as part of due diligence, but these project sheets should not be used as the sole basis for the County Engineer's decision-making. The County Engineer can make changes to the prepared project sheets using individual discretion. Kimley-Horn endeavored to research issues and constraints to the extent practical given the scope, budget, and schedule of the project. This assessment is based in large part on information provided by others (DOT, county staff, etc.) and therefore is only as accurate and complete as the information provided. The project sheets

included in **Appendix B2**, **Appendix C2**, and **Appendix D2** are based on the best available information as of November 2018.

6.2. Segments

The methodology described in **Section 6.1** was followed for county-wide analysis of roadway segments based on the determined risk factors.

The road segment limits were determined based on relevant roadway attribute changes along a roadway including pavement width, shoulder width, and street name.

6.2.1. Risk Factor Summary

Each county paved road segment was assigned risk factor points based on the following seven roadway attributes:

- **Traffic Volume (ADT):** the daily average number of vehicles along the roadway segment. The ADTs for all the segments within the county were compared against each other to assign higher risk factor points to segments with higher ADTs within the county.
- **Pavement and Shoulder Width:** the width of pavement and shoulders were used to assign risk factor points to each segment. Segments with narrower pavement and shoulder widths were assigned more risk factor points. **Table 10** further describes the amount of points assigned for various width combinations.
- **Roadside Hazards:** the average roadside hazard rating from both sides of the road for the length of the segment. Segments with higher roadside hazard ratings, as collected using usRAP procedures (see **Section 3.2.5.**), received higher risk factor points.
- **Access Density:** risk factor points were assessed based on the number of driveways and/or intersections per mile. Segments with higher access densities were assigned more points.
- **Curve Density:** the number of curves per mile with a radius less than 1,000 feet and with a length greater than 100 feet. Segments with a higher curve density were assigned more risk factor points.
- **Pavement Condition:** the average of the recorded roughness indices for the length of the segment. Segments with an IRI value over 95 could potentially cause safety concerns and were assigned risk factor points. Per the FHWA, roadways with IRI values less than 95 are considered “good” condition, 95-170 are “acceptable”, and less than 170 are “poor”. Risk factor points were assigned to roadways with acceptable or poor ratings. Research has shown that a rougher ride can contribute to loss of control of a vehicle, particularly when braking or turning.
- **Crash Experience:** the number of lane departure crashes for each segment in the county was reviewed to assign risk factor points to segments where there was a history of lane departure crashes.

Recommendations were only made where segments were greater than 0.5 miles in length and where the posted speed limit was 40 miles per hour (mph) or higher. This was agreed upon based on the nature of the recommendations, which are more applicable to rural roadway segments, and to provide segments of sufficient length to justify mobilization of construction/maintenance crews and equipment.

Table 10 summarizes the risk factors used as well as the points developed in coordination with the Iowa DOT. As can be seen, the maximum number of available points for roadway segment risk was 23 points.

Table 10 – County Paved Roadway Segments – Risk Factor Ranking

Risk Factor	Measurement	Points	Max Points Available
Traffic volume	Average Daily Traffic (ADT)	0: ADT percentile is 0%-14.3%	6
		1: ADT percentile is 14.3%-28.6%	
		2: ADT percentile is 28.6%-42.9%	
		3: ADT percentile is 42.9%-57.1%	
		4: ADT percentile is 57.1%-71.4%	
		5: ADT percentile is 71.4%-85.7%	
		6: ADT percentile is 85.7%-100%	
Pavement and shoulder width	Pavement and shoulder width in feet (ft)	0: Pavement width ≥ 22 ft and shoulder width ≥ 2 ft	4
		0: Pavement width > 18 ft and < 22 ft, and shoulder width ≥ 4 ft	
		2: Pavement width ≥ 22 ft and shoulder width < 2 ft	
		2: Pavement width > 18 ft and < 22 ft and shoulder width ≥ 2 ft and < 4 ft	
		2: Pavement width ≤ 18 ft and shoulder width ≥ 4 ft	
		4: Pavement width > 18 ft and < 22 ft, and shoulder width < 2 ft	
		4: Pavement width ≤ 18 ft and shoulder width < 4 ft	
Roadside hazards	Average roadside hazard rating	0: Less than 1.5	4
		2: 1.5-3.0	
		4: More than 3.0	
Access density	Number of intersections and driveways per mile (driveway location per 911 address database)	0: Bottom fourth of the access density Crash Modification Factor (CMF) *	3
		1: Second lowest fourth of the access density CMF *	
		2: Second highest fourth of the access density CMF *	
		3: Top fourth of the access density CMF *	
Curve density	Number of curves per mile with a radius less than 1,000 ft	0: Segments with no curves	2
		1: Curve density percentile is 1%-50% of segments with curves	
		2: Curve density percentile is more than 50% of segments with curves	
Pavement condition	Average International Roughness Index (IRI)	0: Less than 95	2
		1: 95 to 170	
		2: More than 170	
Crash experience	Presence of a lane departure crash	0: No lane departure crashes	2
		2: One or more lane departure crashes	
Total available points			**23**

** Access Density CMF Equation as presented in the Highway Safety Manual (Equation 13-7)*

6.2.2. Risk Factor Rankings

Segment risk factor ranking calculations were performed on all county paved roadway segments (greater than 0.5 miles in length and with posted speed limits of 40 mph or greater). The result of the rankings is shown in **Figure 20**.

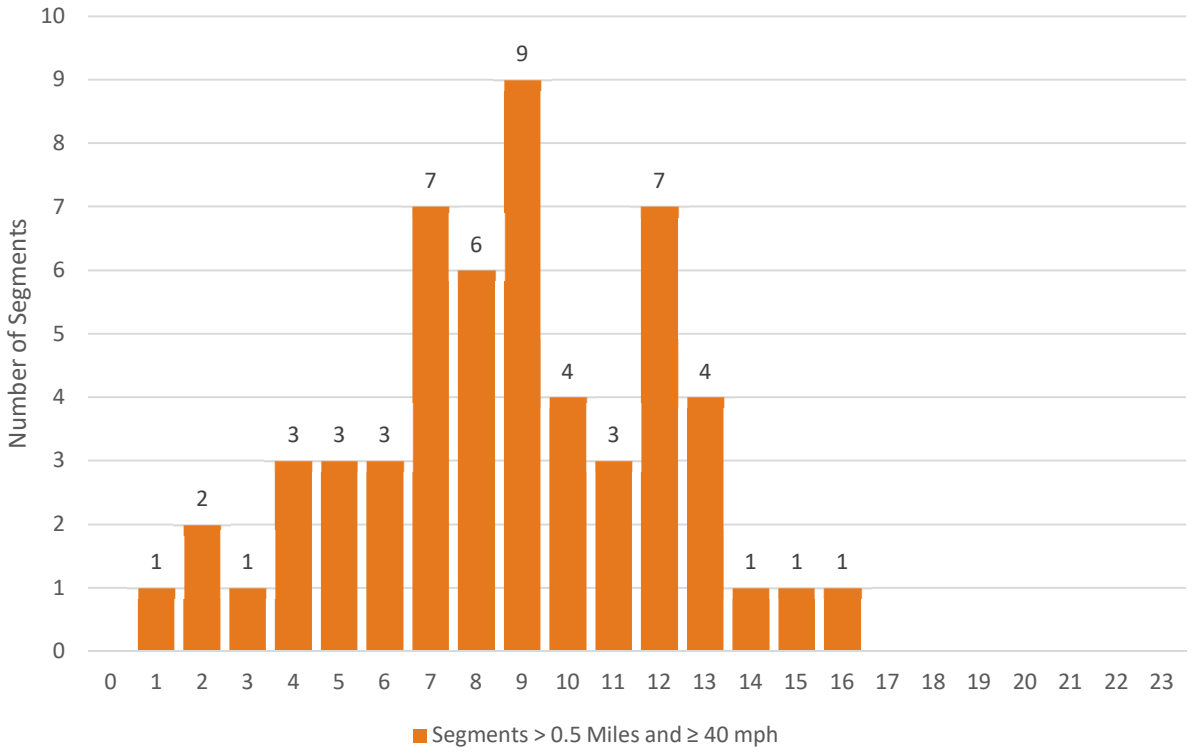


Figure 20 – County Paved Roadway Segment Risk Factor Ranking Summary

For visualization purposes, **Figure 21** shows the location and summary of risk factor ranking of each of the roadway segments analyzed within the LRSP.

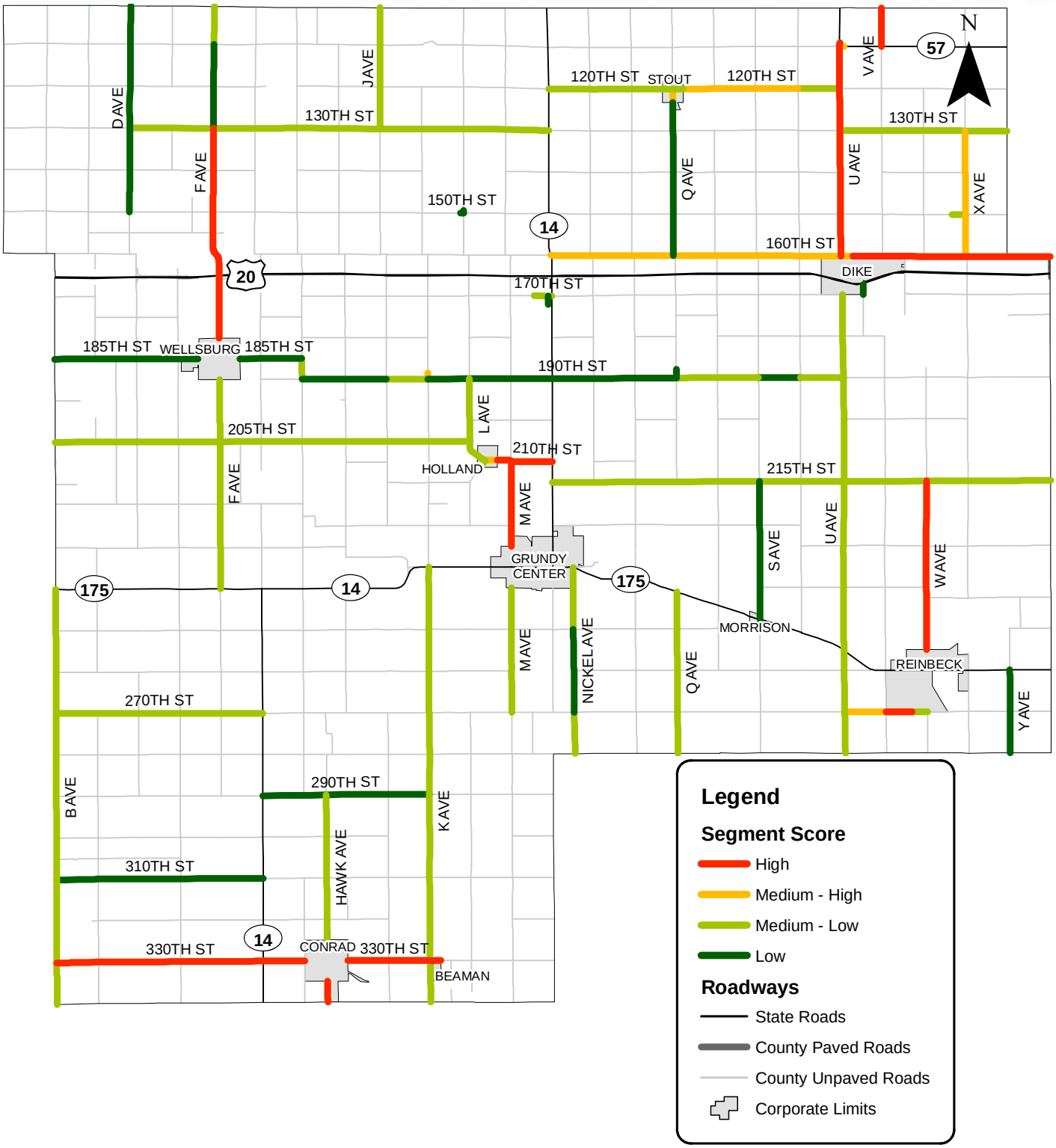


Figure 21 – County Roadway Segment Risk Factor Score Map

6.2.3. Segment Countermeasures

Table 11 summarizes the segment countermeasures for consideration including CMFs and estimated costs. **Appendix B1** provides detailed descriptions for each segment safety countermeasure.

Table 11 – County Paved Roadway Segment Safety Countermeasure Summary

Safety Countermeasure	Crash Modification Factor (CMF)	Estimated Cost
Conduct Road Safety Assessment (RSA)	CMF varies based on recommendations	$30,000/each
Conduct Access Control Analysis	CMF varies based on recommendations	$30,000/each
Install 4" Retroreflective Edgeline and Centerline	FHWA Proven Countermeasure 0.76	$800/mile (Centerline) $1,200/mile (Edgeline)
Install 6" Retroreflective Edgeline (Both Sides of Road)	FHWA Proven Countermeasure 0.64 – 0.83	$1,800/mile
Edgeline Rumble Strips	FHWA Proven Countermeasure 0.61 – 0.67	$2,500/mile
Centerline Rumble Strips	FHWA Proven Countermeasure 0.55 – 0.91	$1,000/mile
Pave Shoulder with Safety Edge	0.75 – 0.99 "Pave Shoulder" FHWA Proven Countermeasure 0.77 – 0.96 "Safety Edge"	$65,000/mile
Review and Provide Curve Chevrons, Curve Warning Signs, and Speed Advisory Plaques to Meet the Manual on Uniform Traffic Control Devices (MUTCD) and Iowa DOT Standards	FHWA Proven Countermeasure 0.59 – 0.96	$5,000/curve
Review and Upgrade Curve Chevrons, Warning Signs, and Speed Advisory Plaques to Meet the MUTCD and Iowa DOT Standards	FHWA Proven Countermeasure 0.59 – 0.96	$2,500/curve
Clear and Grub (Both Sides of Road)	0.78	$5,000-$10,000/mile

Figure 22 illustrates the proposed roadway segment safety improvements as described in the previous sections. It is important to note that the County Engineer should follow all applicable guidelines and standards when implementing the roadway segment improvements including the Manual on Uniform Traffic Control Devices (MUTCD).

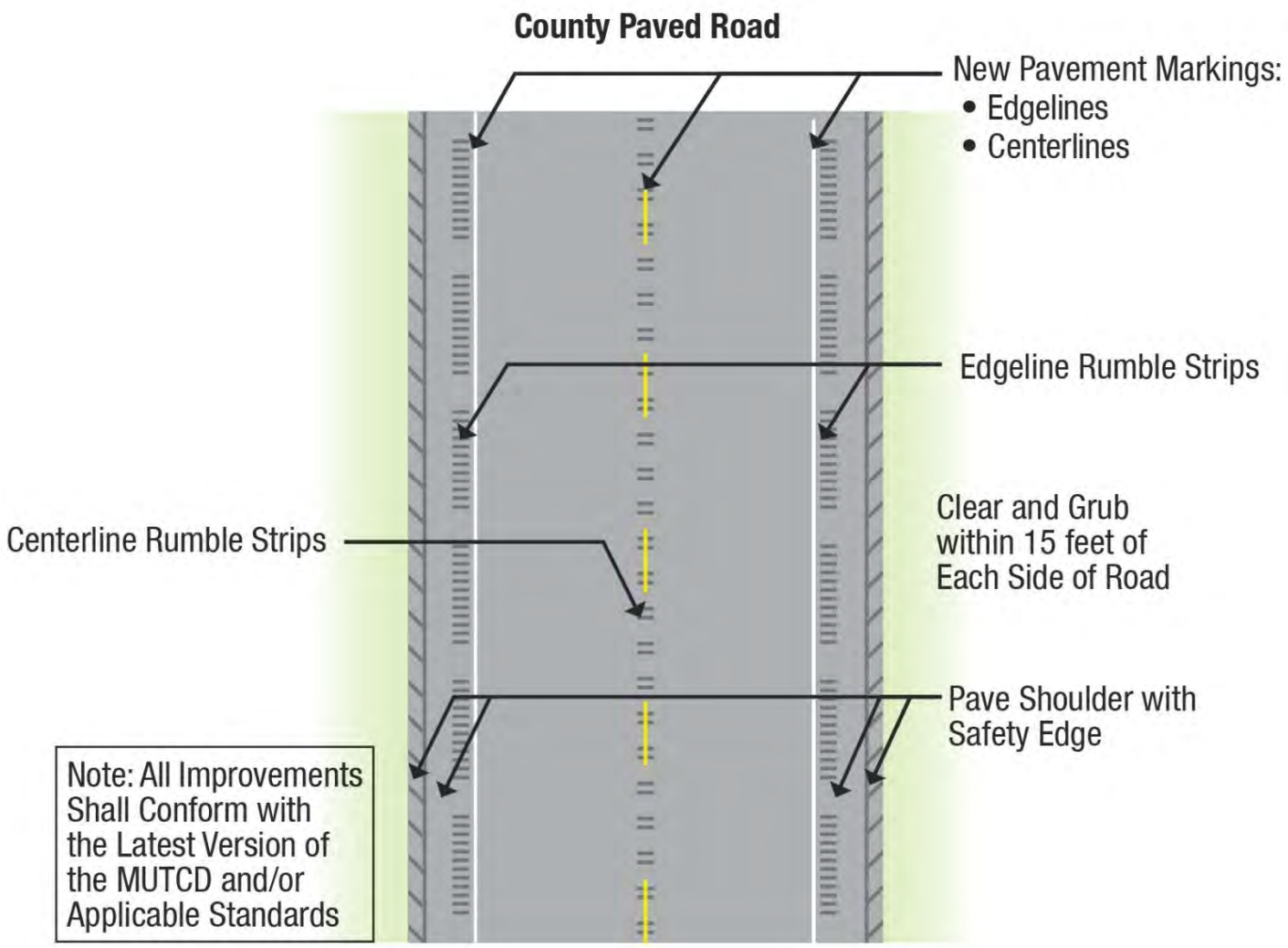


Figure 22 – County Paved Roadway Segment Safety Improvements

6.2.4. Project Selection Decision Tree

After conducting the risk factor calculations and rankings for all paved roadway segments within the county, and developing the segment safety countermeasures, a project selection decision tree was developed. The decision tree was utilized to develop and systemically define projects for the segments based on the characteristics of the segments (shoulder material type, lane width, etc.). The decision tree for roadway segment safety improvements is shown in **Figure 23**.

Each possible decision tree outcome represents a set of potential safety improvements for the roadway segment. The decision tree was utilized to determine projects for the segments with the highest risk factor rankings. Project sheets were developed for a minimum of the ten top-scoring segments in the county. Not all improvements are recommended at all locations and the project sheets contain the recommended improvements for the specific location based on the decision tree process, existing conditions, and defined criteria.

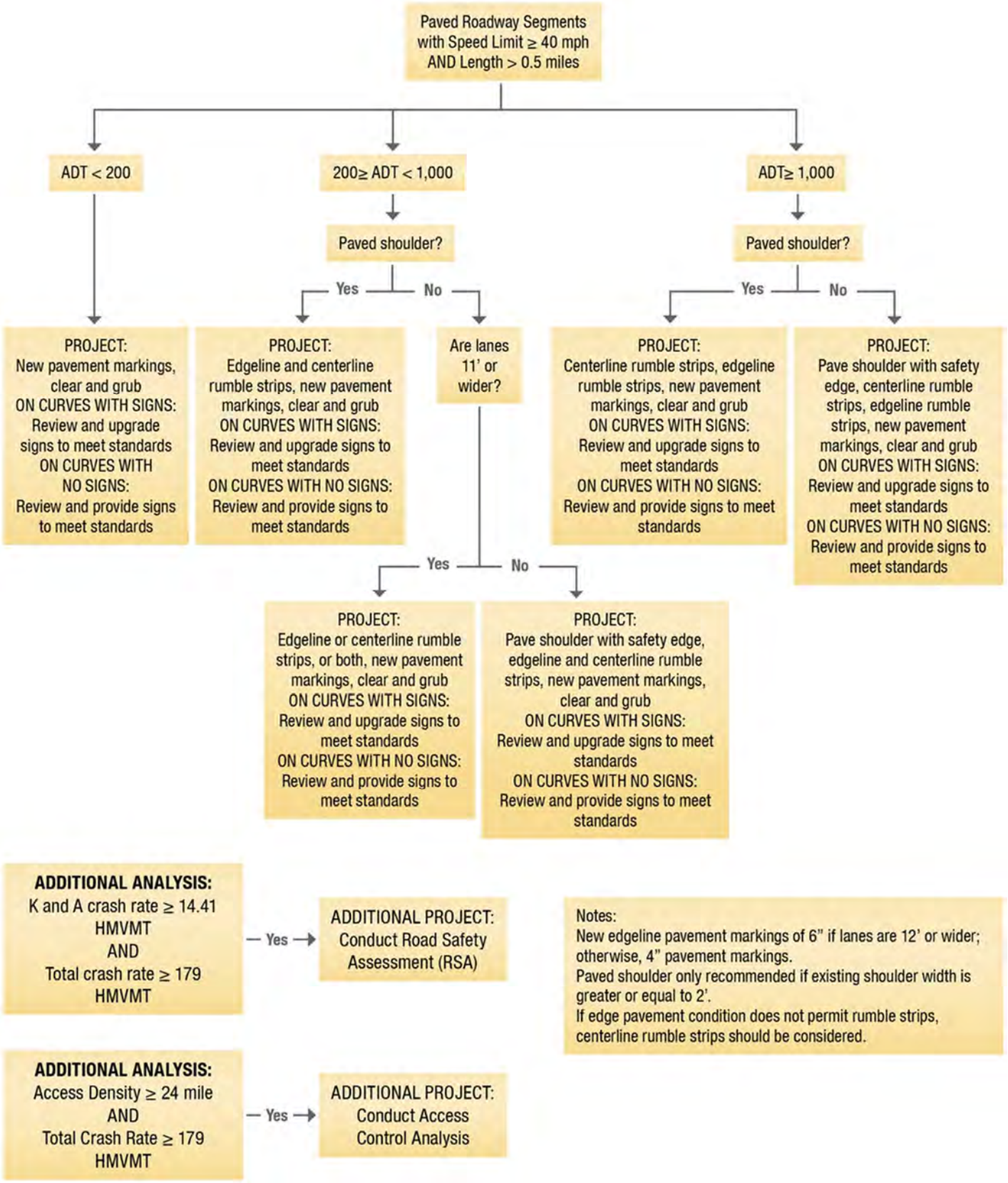


Figure 23 – County Paved Roadway Segment Project Decision Tree

6.2.5. Prioritized Segment Recommendations

After the decision tree was utilized to determine projects for the roadway segments with the greatest amount of risk factor points, project sheets were developed for these locations. The segments for which project sheets were developed (those with the greatest amount of risk factor points) are summarized in **Table 12** and the project sheets are included in **Appendix B2**. Also included in the table are the high scoring intersections and high scoring curves that fall within the segments.

Table 12 – County Paved Roadway Segment Prioritized Project Cost Summary

GPS ID	Segment	Segment Length (miles)	Risk Factor Points	High Scoring Intersections	High Scoring Curves	Estimated Project Cost
3570	270TH ST between V AVE and BLACKHAWK ST	0.62	16			$ 53,000
3951	W AVE between 215TH ST and 220 ft N of E KENWOOD ST	4.05	15			$ 80,000
3562	HAWK AVE between DUESENBURG DR and MARSHALL COUNTY LINE	0.50	14			$ 12,000
3899	210TH ST between STATE ST and N AVE	1.34	13	209359	20242	$ 143,000
3905	330TH ST between WILSON ST and BECKMAN ST	2.25	13	208976		$ 237,000
3912	F AVE between 130TH ST and 2500 ft S of 155TH ST	2.98	13		70394	$ 93,000
3934	V AVE between 110TH ST and BUTLER COUNTY LINE	0.92	13			$ 59,000
3889	160TH ST between UNIVERSITY AVE and MAIN ST	4.75	12	29573 208611		$ 488,000
3909	F AVE between 600 ft N of KENT LN and 2500 ft S of 155TH ST	2.08	12		70394	$ 223,000
3918	M AVE between 210TH ST and A AVE	2.05	12	209359	20242	$ 209,000
3949	U AVE between 110TH ST and 160TH ST	5.11	12	208571 209442 209448		$ 539,000
3906	330TH ST between B AVE and H AVE	5.98	12			$ 102,000
Total (12 Segments)						**$ 2,238,000**

Figure 24 shows the locations of the roadway segments with highest risk factor ranking, where project sheets and specific segment recommendations were made.

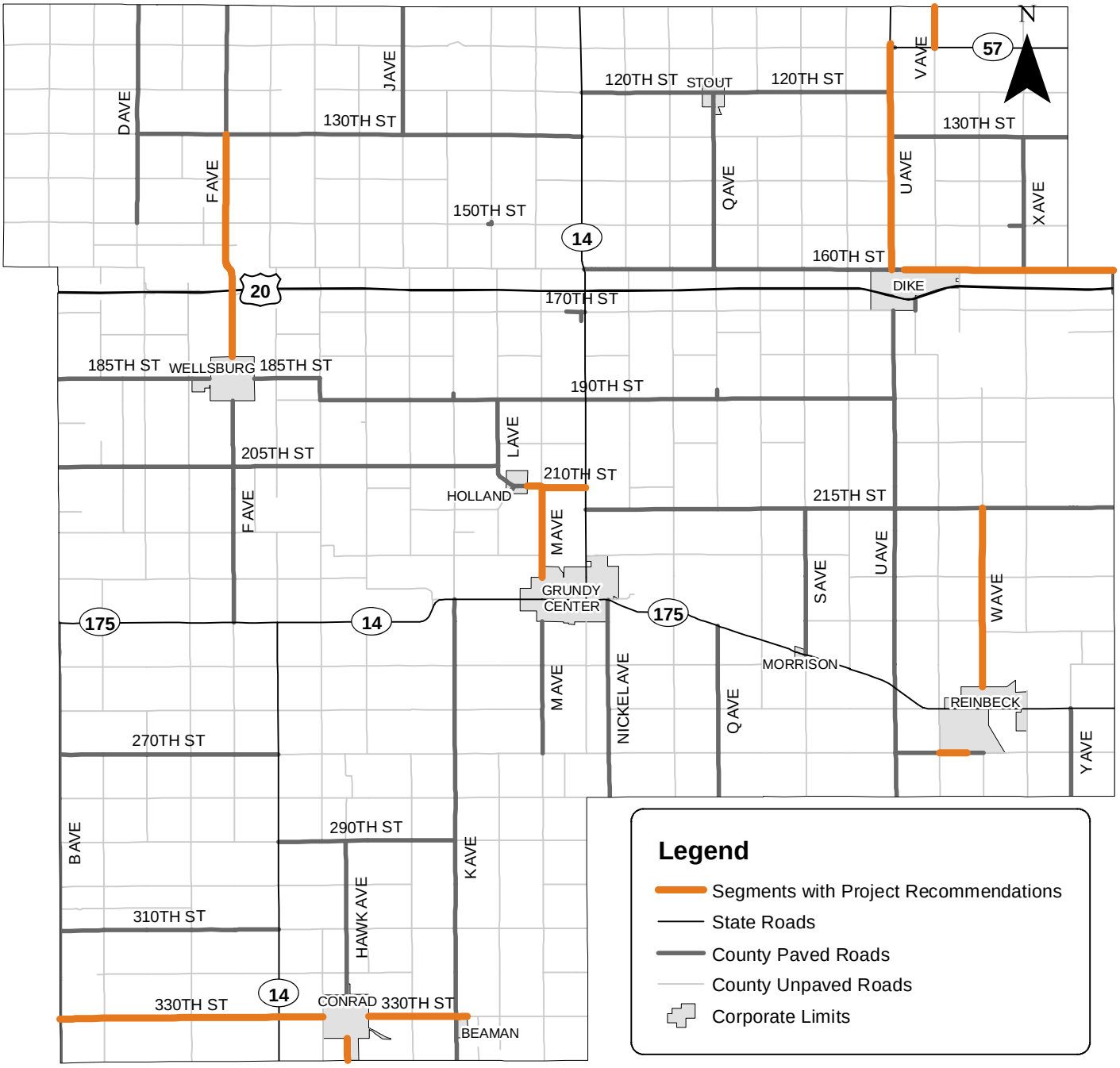


Figure 24 – County Paved Roadway Segment Prioritized Project Locations

Project sheets for the roadway segments with project recommendations are included in **Appendix B2**. The segment risk factor ranking results and relevant data for every analyzed roadway segment is included in **Appendix B3**.

6.2.6. Other Segment Countermeasures

As previously stated, the purpose of the LRSP project is to identify low-cost systemic safety improvement projects using a GIS analysis and a project selection decision tree. Safety improvements not included on the first page of the roadway segment project sheet may still merit consideration at a specific location. There are a variety of other safety improvements that could be considered that were not included in the project decision tree due to availability of data, the need for site-specific information, and/or the appetite for the countermeasure to be deployed at roadway segments throughout the county. **Table 13** provides a summary of several other roadway segment safety improvements that could be considered appropriate by the county and that were included on the back side of the project sheets as additional potential improvements. The CMFs, where they have been defined, and estimated costs of these countermeasures are included in the table. Detailed descriptions of each of the countermeasures is provided in **Appendix B1.** Estimated costs for these countermeasures were noted on the back side of the project sheet at the workshop, as directed by the County Engineer. However, the County Engineer could choose to add or remove such countermeasures from consideration at any time, based on engineering judgment or new information.

Table 13 – Additional Potential Roadway Segment Safety Countermeasure Summary

Safety Countermeasure	Crash Modification Factor (CMF)	Estimated Cost
Flattening and Widening Foreslopes	FHWA Proven Countermeasure 0.58 - 0.71	$75,000/mile
On-Pavement Marking for Speed Control	0.62	$500/each
Delineate Roadside Hazard with Retroreflective Marker	CMF not defined	$15/each
Guardrail	0.53 - 0.56 New Guardrail Along Embankment	$50,000/mile
Post-Mounted Delineators	0.55 when installed in combination with edgelines and centerlines	$4,000/mile
Review Curve and Provide Signage to Meet MUTCD and Iowa DOT Standards	FHWA Proven Countermeasure 0.59 - 0.96	$5,000/curve
Retroreflective Strip on Chevron Sign Post	CMF not defined	$100/each
Transverse Rumble Strips Prior to Curve	0.66 Install Transverse Rumble Strips as Traffic Calming Device	$2,000/curve
Remove/Relocate Object in Hazardous Location	FHWA Proven Countermeasure 0.62	$1,000/each
Superelevation Correction on Curve	CMF not defined	$100,000/each
Install High Friction Surface Treatment (HFST)	FHWA Proven Countermeasure 0.48 - 0.76	$150,000/mile
Speed Activated Flashers on Chevron Sign	CMF 0.59 - 0.61 Install Flashers, Chevron Signs, and Curve Warning Signs	$3,000/each

6.3. Intersections

The methodology described in **Section 6.1** was followed for a systematic analysis of county paved intersections based on the determined risk factors. Additional details on the risk factor calculations, risk factor ranking results, project selection decision tree, and project sheets are described in the following sections.

6.3.1. Risk Factor Summary

Every intersection containing at least one county-maintained paved roadway leg was analyzed for risk according to the following eight key attributes:

- **Distance from Previous Stop Sign:** if any stop-controlled approach had a distance of at least 1.5 miles from the previous stop sign, risk points were assigned. The longer the distance a driver travels without stopping, the more likely they are to fail to stop at the next stop sign because they are not expecting it.
- **Intersection Skew:** the intersection was assigned risk factor points if any of the side roads had an approach angle (skew) of less than 85 degrees. Based on Iowa crash data analyzed by InTrans, crash experience increases at intersections with skew at 85 degrees and 70 degrees. According to the *Highway Design Handbook for Older Drivers and Pedestrians*, "Skew angles in excess of 75 degrees often create special problems at stop-controlled rural intersections. The angle complicates the vision triangle for the stopped vehicle; increases the time to cross the through road; and results in a larger, more potentially confusing intersection."
- **Horizontal Curvature:** the number of curves (with length more than 100 feet and radius less than 1,000 feet) within 250 feet of the intersection on any county- or state-maintained approach. Risk factor points were assigned to intersections with one or more curves within close proximity of the intersection. Roadway curves in close proximity to intersections can limit sight distance, increasing crash potential.
- **Traffic Volume (DEV):** the average number of vehicles entering the intersection per day. The DEVs for all the intersections in the county were compared against each other to assign higher risk factor points to intersections with higher DEVs within the county. It is understood that more vehicles entering an intersection creates more exposure and therefore, increases the risk of a crash.
- **Minor Street Volume:** with a higher minor street volume, there is an increase in crash exposure, specifically with angle crashes. The third highest approach volume was used for the minor street volume, and volumes, as compared to other minor street volumes throughout the county were used to assign higher risk factor points where minor street volumes were higher.
- **Access Management:** risk points were assigned if an access point (driveway or other intersection) was located within 250 feet of the intersection. Driveways and other access points located within the functional area of intersections create additional opportunities for conflict points and cause drivers to make more decisions within the functional area of an intersection, increasing risk for a crash.
- **Crash Experience:** each intersection was assigned risk factor points if a K or A crash occurred within 150 feet of the intersection. This attribute takes into account crash history, which may be indicative of improvement needs.
- **Intersection Configuration:** as an additional risk factor to capture potential conflicts at an intersection, the number of approaches were considered as a risk factor. If an intersection had four or more approaches, it was assigned a risk factor point.

Table 14 summarizes the risk factors utilized for the risk factor analysis as well as the points developed in coordination with the Iowa DOT. The maximum number of available points for intersection risk was 22.

Table 14 – County Paved Intersections – Risk Factor Ranking

Risk Factor	Measurement	Points	Max Points Available
Distance from previous stop sign	Stop sign locations based on information provided by the County Engineer	0: Less than 1.5 miles	4
		4: 1.5 miles or more	
Intersection skew	Skew angle of most skewed approach	0: 85-90 degrees	4
		2: 70-85 degrees	
		4: Less than 70 degrees	
Horizontal curvature	Intersection on or within 250 feet of a curve (Length > 100' and Radius < 1,000')	0: None	4
		4: 1 or more	
Traffic volume	Daily Entering Vehicles (DEV)	0: DEV percentile is 0%-25%	3
		1: DEV percentile is 25%-50%	
		2: DEV percentile is 50%-75%	
		3: DEV percentile is 75%-100%	
Minor street volume	Average Daily Traffic (ADT)	0: Bottom third of county minor street ADTs	2
		1: Middle third of county minor street ADTs	
		2: Top third of county minor street ADTs	
Access management	Driveways or another intersection within 250 feet of the intersection	0: None	2
		1: 1 or 2	
		2: More than 2	
Crash experience	Fatal or serious injury (K or A) crash within 150 feet of the intersection	0: None	2
		2: 1 or more	
Intersection configuration	Number of approaches	0: Less than 4 approaches	1
		1: 4 or more approaches	
Total available points			**22**

6.3.2. Risk Factor Rankings

Risk factor calculations were performed for each of the intersections in the county containing at least one county-maintained paved approach. The results of the risk factor rankings are provided in **Figure 25**. To further aid the county in determining which projects they may want to pursue, the intersections were divided into two categories:

- **County-State:** This includes intersections of county roads with Iowa DOT-maintained roads.
- **County-County and County-Other:** This includes intersections of county roads with other county roads as well as intersections of county roads with other roads that are not maintained by the county or the Iowa DOT (such as city streets).

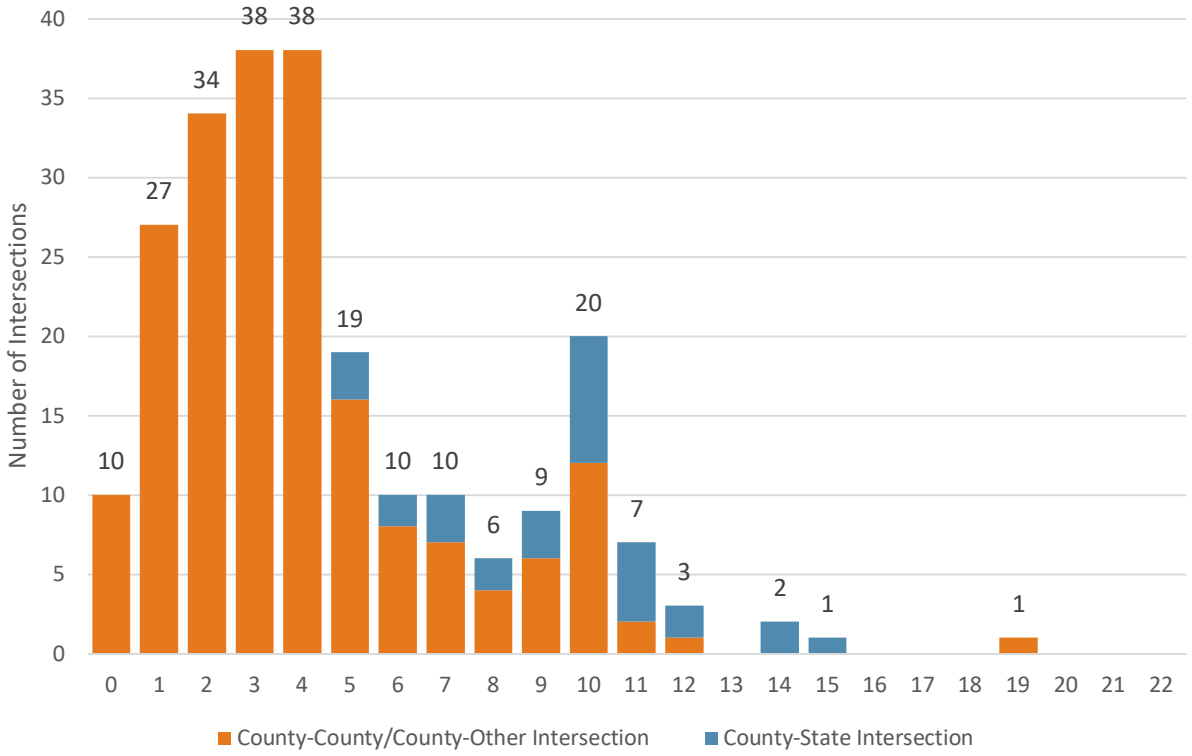


Figure 25 – County Paved Intersection Risk Factor Ranking Summary

For visualization purposes, **Figure 26** on the following page shows the location and risk factor score of each intersection analyzed within the LRSP.

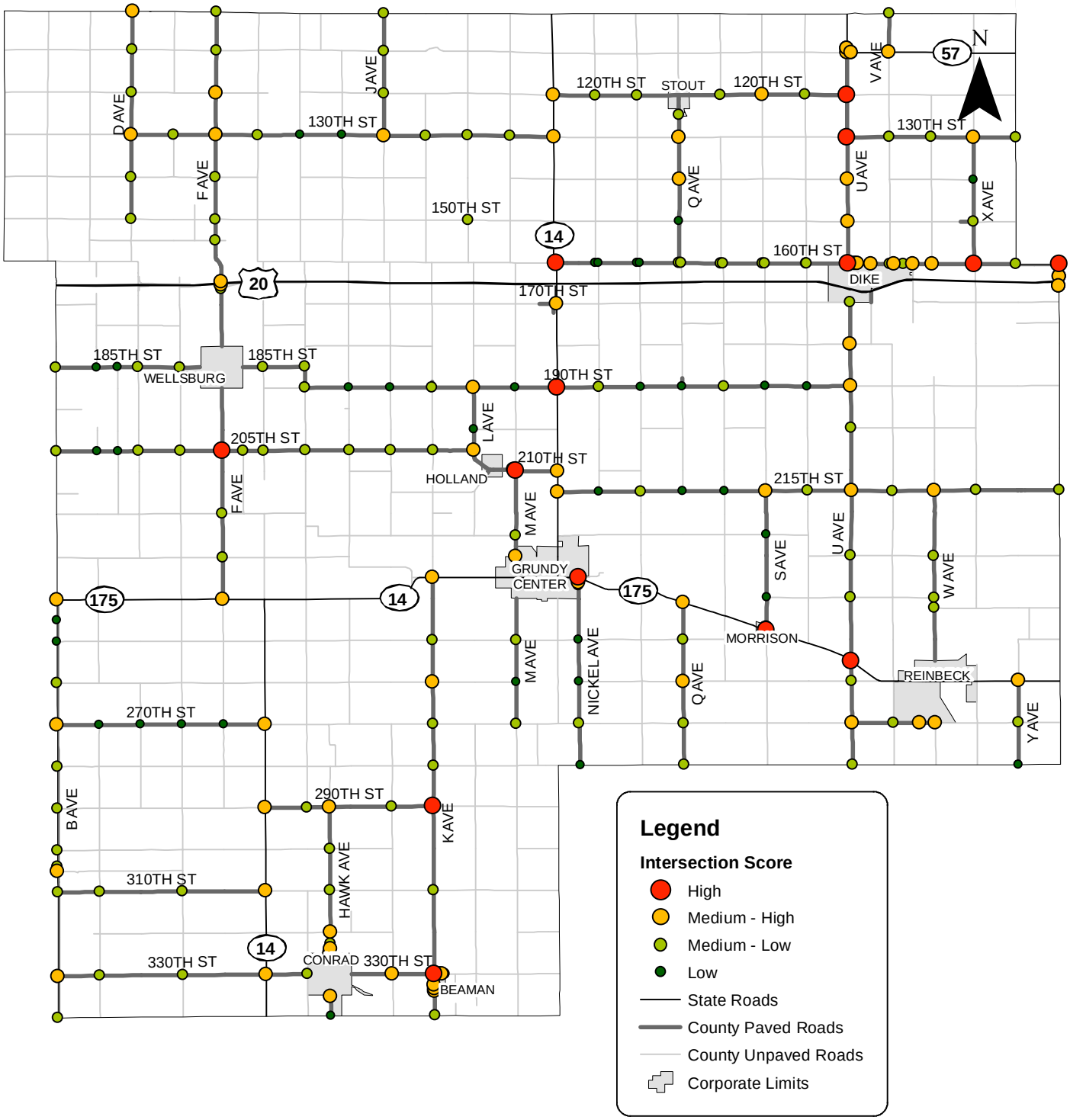


Figure 26 – County Paved Intersection Risk Factor Score Map

6.3.3. Intersection Countermeasures

Table 15 summarizes the intersection countermeasures for consideration including CMFs and estimated costs at the county paved intersections. **Appendix C1** provides detailed descriptions for each intersection safety countermeasure.

Table 15 – County Paved Intersection Safety Countermeasure Summary

Safety Countermeasure	Crash Modification Factor (CMF)	Estimated Cost
Coordinate with Local Jurisdiction on Signal Modifications	Varies based on modifications	$2,500/each
Signal warrant analysis to consider removal of signal	0.76 Remove Unwarranted Signal	$5,000/each
Intersection Configuration Evaluation (ICE)	Varies based on recommendations	$25,000/each
Implement Results of ICE	FHWA Proven Countermeasure 0.18 - 0.42 Convert Stop-Control to Roundabout 0.23 - 0.56 Install Traffic Signal FHWA Proven Countermeasure 0.65 - 0.8 Restrict Left Turn Movements	$750,000/each
All-Way Stop Warrant Analysis and Converting Two-Way Stop to All-Way Stop	0.39	$5,000/each
All-Way Stop Warrant Analysis and Removal of Stop Signs on Major Approach	CMF not defined	$5,000/each
Destination Lighting	0.62	$5,500/each
Upgrade Signs and Pavement Markings (Paved Approach)	FHWA Proven Countermeasures 0.4 - 0.69 “Stop Ahead”	$1,000/leg
Implement Systemic Signing and marking improvements at Stop-Controlled Intersections	FHWA Proven Countermeasure 0.89 - 0.92	$2,200/leg
Install Second Stop Sign and Stop Ahead Sign	CMF not defined	$1,200/leg
Flashing Beacon on All Stop Signs	0.42 - 0.87	$2,500/sign
Transverse Rumble Strips on All or Minor Approach	0.79 - 0.87	$1,000/leg
Install Intersection Warning Sign and Advance Street Name Plaque on Major Approach	CMF not defined	$1,200/leg
Clear and Grub	0.78	$1,500/leg

Figure 27 illustrates the proposed intersection improvements as described in the previous sections. It is important to note that the County Engineer should follow all applicable guidelines and standards when implementing the intersection improvements.

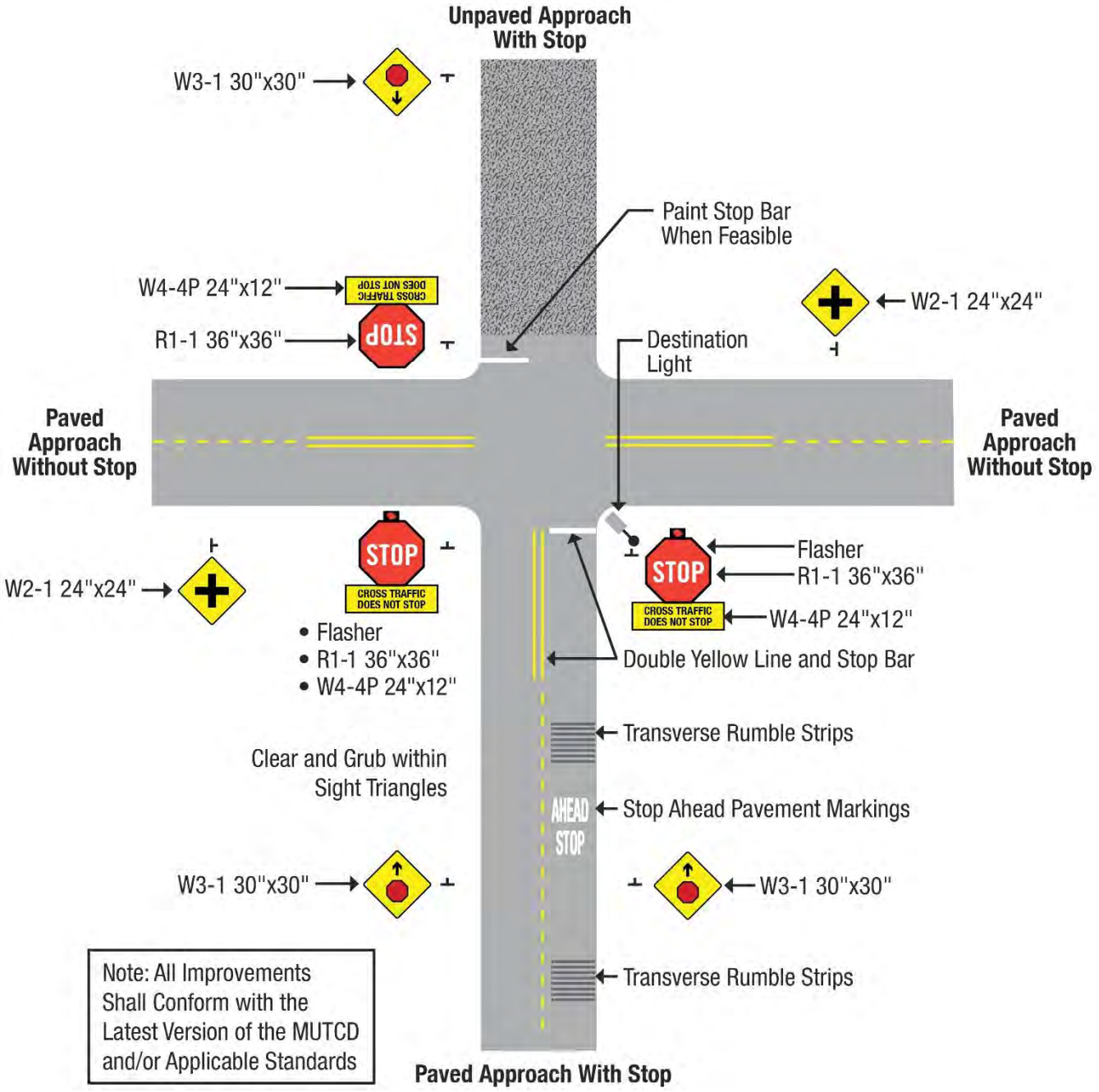


Figure 27 – County Paved Intersection Safety Improvements

6.3.4. Project Selection Decision Tree

After conducting the risk factor calculations and rankings for all intersections within the county, and developing the county paved intersection countermeasures, a project selection decision tree was developed. The decision tree was utilized to develop and systemically define location-specific safety recommendations for the intersections based on the characteristics of the intersections (DEV, paved approaches, crash history, major approach ADT, minor approach ADT, etc.). The decision tree for intersection safety improvements is shown in **Figure 28**.

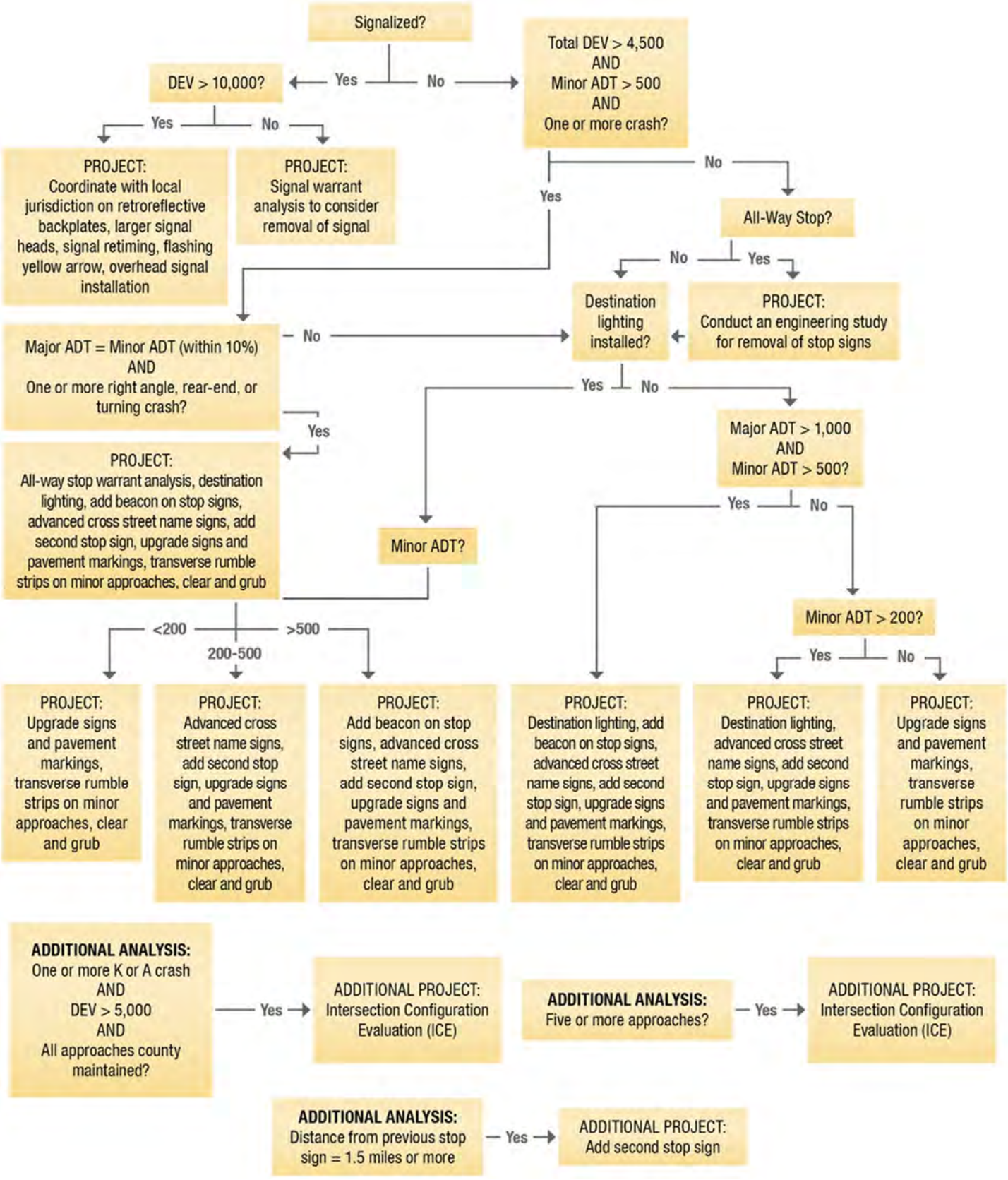


Figure 28 – County Paved Intersection Project Decision Tree

Each possible decision tree outcome represents a set of potential safety improvements for the intersection. The decision tree was utilized to determine projects for the intersections with the highest risk factor rankings. Project sheets were developed for a minimum of the five top-scoring intersections in the County-County and County-Other and County-State categories. Not all improvements are recommended at all locations and the project sheets contain the recommended improvements for the specific location based on the decision tree process, existing conditions, and defined criteria.

6.3.5. Prioritized Intersection Recommendations

After the decision tree was utilized to identify safety improvement projects for the intersections with the greatest amount of risk factor points, project sheets were developed for these locations. The intersections for which project sheets were developed (those with the greatest amount of risk factor points) are summarized in **Table 16** and the project sheets are located in **Appendix C2**. For those intersections located on a high scoring roadway segment, the GPS ID of the segment is listed in the table.

Table 16 – County Paved Intersection Prioritized Project Cost Summary

GPS ID	Intersection	Risk Factor Points	High Scoring Segments	Estimated Project Cost
County-County / County-Other Intersections				
209359	CO RD D35/210TH ST & CO RD T37/M AVE	19	3899 3918	$ 1,071,000
208930	CO RD D55/290TH ST & CO RD T29/K AVE	12		$ 20,000
208976	CO RD D67/330TH ST & CO RD T29/K AVE	11	3905	$ 28,000
208903	CO RD D35/205TH ST & CO RD T19/F AVE	11		$ 35,000
29573	D18 & D19	10	3889	$ 71,000
208611	CO RD D19/160TH ST & CO RD T65/X AVE	10	3889	$ 15,000
208571	CO RD D19/160TH ST & CO RD T55/U AVE	10	3949	$ 22,000
209442	CO RD D17/120TH ST & CO RD T55/U AVE	10	3949	$ 25,000
209448	CO RD D17/130TH ST & CO RD T55/U AVE	10	3949	$ 27,000
County-County / County-Other Total (9 Intersections)				**$ 1,314,000**
County-State Intersections				
652802	IA 175/G AVE/DIAGONAL RD & CO RD T45/NICKEL AVE & 235TH ST	15		$ 20,000
208855	IA 175/DIAGONAL RD & CO RD T55/U AVE	14		$ 28,000
208845	IA 175/DIAGONAL RD & CO RD T53/S AVE	14		$ 20,000
3001123	IA 14 & CO RD D25/190TH ST	12		$ 22,000
208524	IA 14 & CO RD D19/160TH ST	12		$ 25,000
County-State Total (5 Intersections)				**$ 115,000**
Intersection Total (14 Intersections)				**$ 1,429,000**

Figure 29 illustrates the locations of the intersections with highest risk factor ranking, where project sheets and specific intersection improvement recommendations were made.

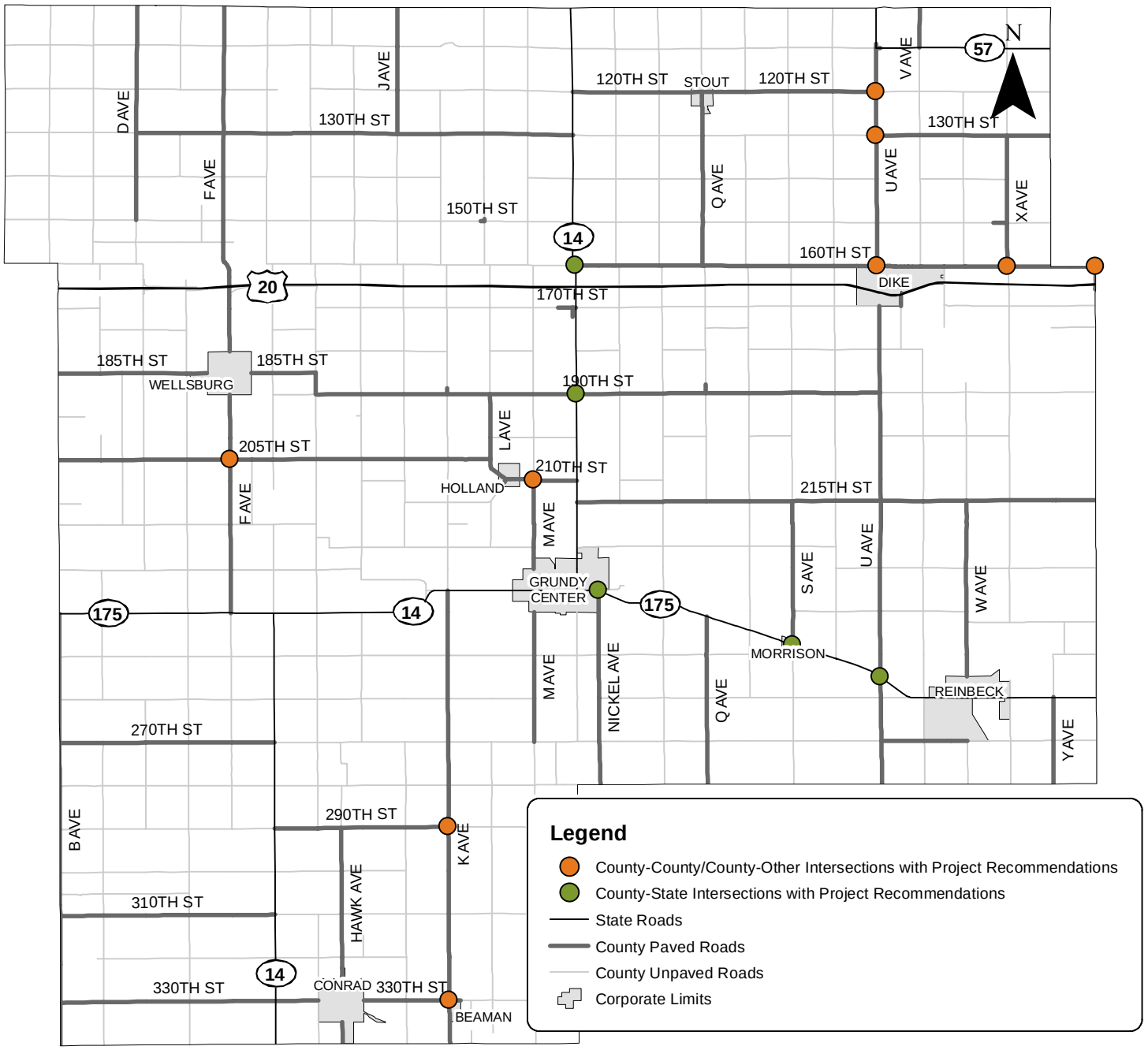


Figure 29 – County Paved Intersection Prioritized Project Location

Project sheets for the intersections with project recommendations are included in **Appendix C2**. The intersection risk factor ranking results and relevant data for every analyzed intersection is included in the summary spreadsheet included in **Appendix C3**.

6.3.6. Other Intersection Countermeasures

The purpose of the LRSP project is to identify low-cost systemic safety improvement projects using a GIS analysis and a project selection decision tree. A safety improvement that is not included on the project sheet may still merit consideration at a particular location. There are a variety of safety improvements that could be considered that were not included in the project decision tree due to availability of data, the need for site-specific information, and/or the appetite for the countermeasure to be deployed at intersections throughout the county. **Table 17** provides a summary of several other intersection safety improvements that could be considered appropriate by the county and that were included on the back side of the project sheets as additional potential improvements. The CMFs, where they have been defined, and estimated costs of these countermeasures are included in the table. Detailed descriptions of each of the countermeasures is provided in **Appendix C1.** Estimated costs for these countermeasures were noted on the back side of the project sheet at the workshop, as directed by the County Engineer. However, the County Engineer could choose to add or remove such countermeasures from consideration at any time, based on engineering judgment or new information.

Table 17 – County Paved Intersection Additional Project Improvement Summary

Safety Countermeasure	Crash Modification Factor (CMF)	Estimated Cost
Provide Left-Turn Lane at Intersection	FHWA Proven Countermeasure 0.52	$75,000/leg
Provide Right-Turn Lane at Intersection	FHWA Proven Countermeasure 0.74	$75,000/leg
Realign Intersection Approaches to Reduce or Eliminate Skew	CMF varies based on original skew angle	$200,000/leg
Provide Bypass Lane on Shoulder at T-Intersection	CMF not defined	$50,000/each
Convert Offset T-Intersection to Four-Legged Intersection	CMF not defined	$300,000/each
Use Indirect Left-Turn Treatments to Minimize Conflicts	FHWA Proven Countermeasure 0.8	$75,000/leg
Convert Four-Legged Intersection to Offset T-Intersection	CMF not defined for rural areas	$300,000/each
Install Solar-Powered Flashing Beacon on Intersection Warning Sign	CMF not defined	$2,500/leg
Install Stop Sign with LED Flashing Lights	CMF not defined	$2,500/leg
Install Retroreflective Strip on Stop Sign Post	CMF not defined	$100/each
Low-Cost Intersection Conflict Warning System (ICWS)	0.45 - 0.7	$15,000/each

6.4. Horizontal Curves

The methodology described in **Section 6.1** was followed for county-wide analysis of paved horizontal curves based on the determined risk factors. Additional details on the risk factor calculations, risk factor ranking results, project selection decision tree, and project sheets are described in the following sections.

6.4.1. Risk Factor Summary

Each paved horizontal curve that was identified in the horizontal curve database (January 2016 update) within the county was systematically analyzed for risk according to the following six key attributes:

- **Traffic Volume (ADT):** the average number of vehicles per day along the roadway curve. The ADTs for all the curves within the county were compared against each other to assign higher risk to curves with a higher ADT within the county. It is understood that more vehicles traveling along a curve increases the risk of a crash.
- **Curve Radius:** all curves with radii smaller than 2,500 feet and with a length greater than 100 feet were assessed risk factor points. Curves with smaller radii were assigned additional points based on the crash data reviewed for county paved horizontal curves, showing more crashes on curves with smaller radii.
- **Shoulder Width:** risk factor points were assigned to all curves with shoulder widths less than six feet, with more risk factor points associated with narrower shoulders. This was based on the HSM Chapter 10, Table 10-9 and 10-10, which illustrates that with wider shoulders, crash risk is reduced.
- **Access Management:** risk was assessed if a driveway was within 250 feet of the curve. Additional risk points were assessed if an intersection was within 250 feet of the curve. Driveways and other access points located on or near curves create additional opportunities for conflict points and cause drivers to make additional decisions within the curve, with a potential for reduced sight distance, increasing risk of a crash.
- **Pavement Condition:** the average of the recorded roughness indices for the length of the segment. Pavement with an IRI value over 95 could potentially cause safety concerns and were assigned risk factor points.
- **Crash Experience:** each curve was assigned risk factor points if a K or A crash occurred within 150 feet of the curve. This attribute takes into account crash history, which may be indicative of improvement needs.

Table 18 summarizes the risk factors used for the risk factor analysis as well as the points developed in coordination with the Iowa DOT. As can be seen, the maximum number of available for curve risk factor points was 21.

Table 18 – County Paved Horizontal Curves – Risk Factor Ranking

Risk Factor	Measurement	Points	Max Points Available
Traffic volume	Average Daily Traffic (ADT)	0: ADT percentile is 0%-14.3%	6
		1: ADT percentile is 14.3%-28.6%	
		2: ADT percentile is 28.6%-42.9%	
		3: ADT percentile is 42.9%-57.1%	
		4: ADT percentile is 57.1%-71.4%	
		5: ADT percentile is 71.4%-85.7%	
		6: ADT percentile is 85.7%-100%	
Curve radius	Radius of curve in feet	0: Greater than 2,500 feet	4
		1: 1,000 to 2,500 feet	
		3: 500 to 1,000 feet	
		4: Less than or equal to 500 feet	
Shoulder width	Shoulder width in feet	0: 6-foot shoulder and greater	4
		2: 2-foot shoulder to 6-foot shoulder	
		4: less than 2-foot shoulder	
Access management	Intersections and driveways within 250 feet of the curve	0: no intersection or driveway within 250 feet	3
		1: driveway within 250 feet	
		3: intersection within 250 feet	
Pavement condition	Average International Roughness Index (IRI)	0: Less than 95	2
		1: 95 to 170	
		2: More than 170	
Crash experience	Fatal or serious injury (K or A) crash within 150 feet of the curve	0: none	2
		2: 1 or more	
Total available points			**21**

6.4.2. Risk Factor Rankings

The risk factor calculations were performed on each of the curves on paved roads in the county which have a length greater than or equal to 100 feet and a radius less than 2,500 feet. The results of the risk factor rankings are provided in **Figure 30**.

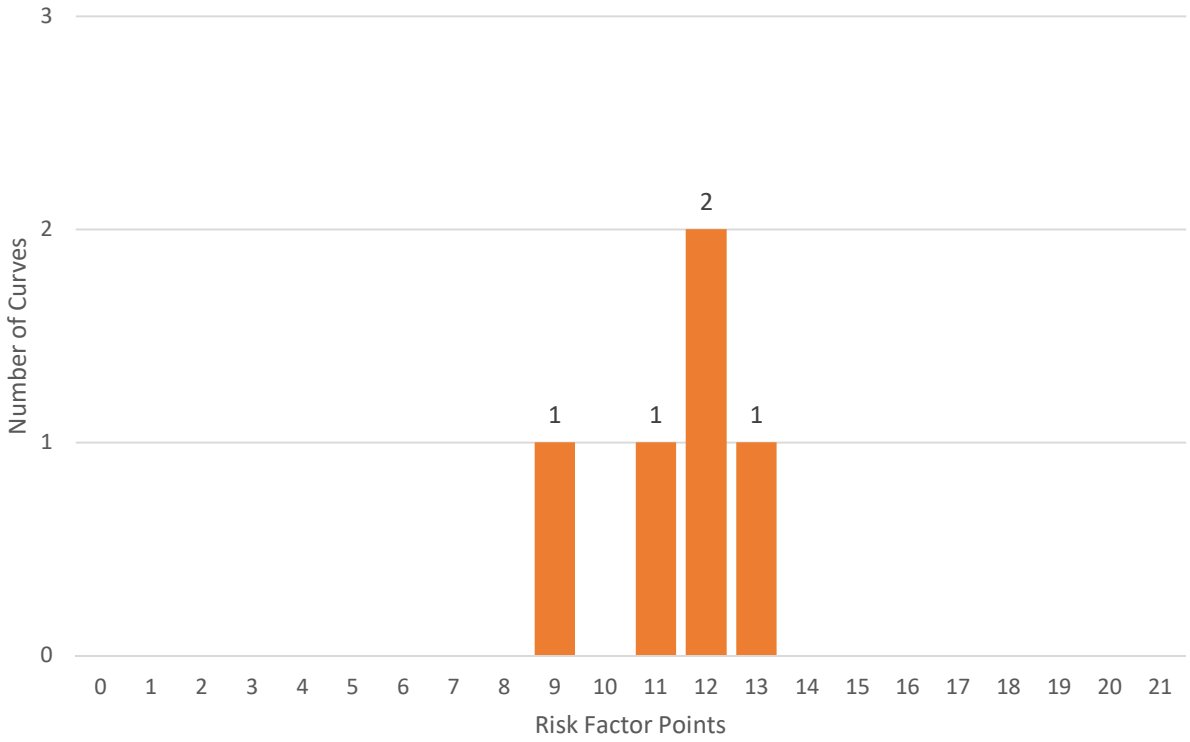


Figure 30 – County Paved Horizontal Curve Risk Factor Ranking Summary

For visualization purposes, **Figure 31** on the following page shows the location and risk factor ranking of each curve analyzed within the LRSP.

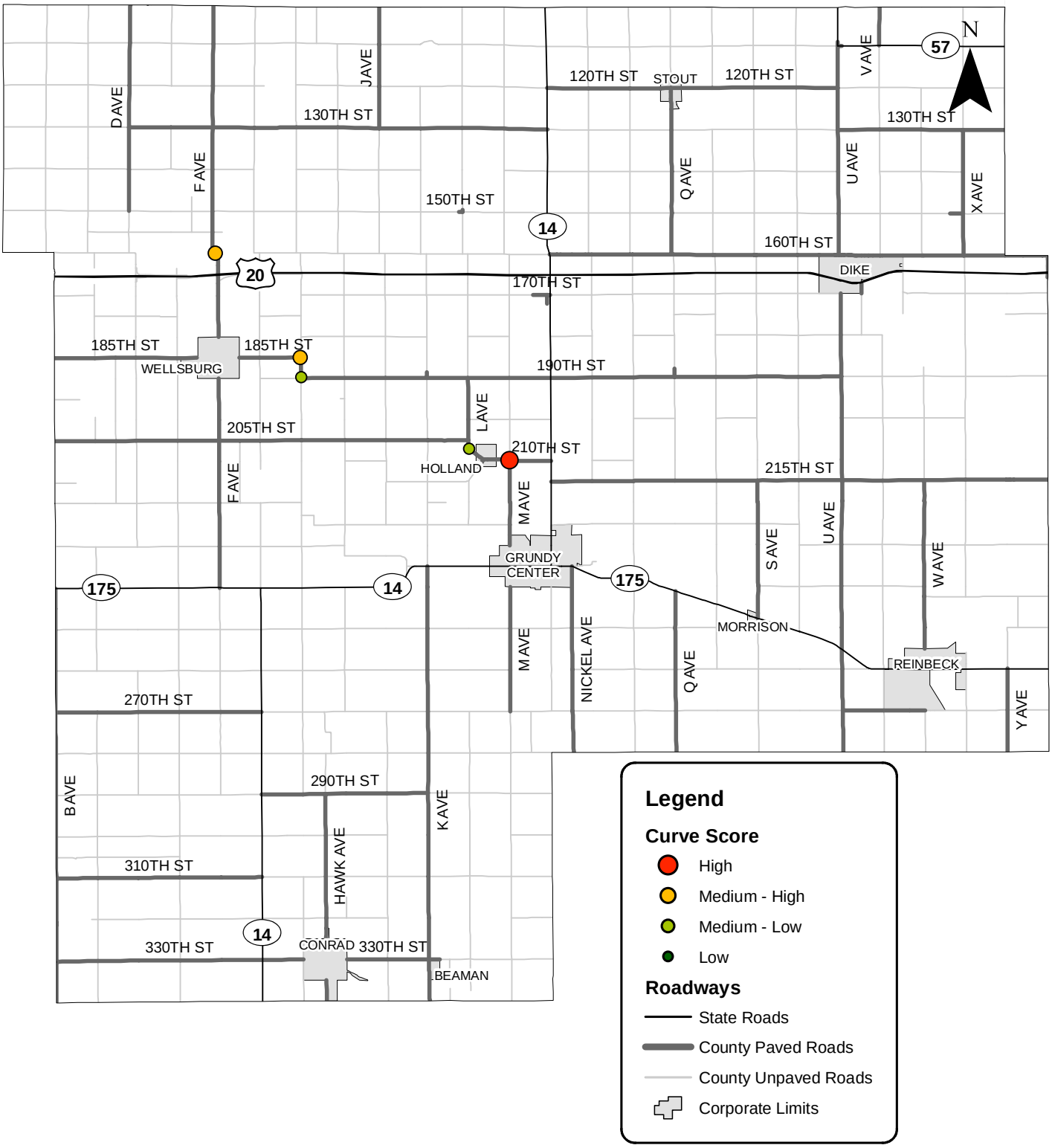


Figure 31 – Horizontal Curve Risk Factor Score Map

6.4.3. Curve Countermeasures

Table 19 summarizes the curve countermeasures for consideration including CMFs and estimated costs. **Appendix D1** provides detailed descriptions for each curve safety countermeasure.

Table 19 – County Paved Horizontal Curve Safety Countermeasure Summary

Safety Countermeasure	Crash Modification Factor (CMF)	Estimated Cost
Install 4" Retroreflective Edgeline and Centerline	FHWA Proven Countermeasure 0.61 - 0.74	$800/mile (Centerline) $1,200/mile (Edgeline)
Install 6" Retroreflective Edgeline (Both Sides of Road)	FHWA Proven Countermeasure 0.64 - 0.83	$1,800/mile
Pave Shoulder with Safety Edge	0.82 - 0.9 "Pave Shoulder" FHWA Proven Countermeasure 0.85 - 0.92 "Safety Edge"	$65,000/mile
Edgeline Rumble Strips	FHWA Proven Countermeasure 0.61 - 0.67	$2,500/mile
Centerline Rumble Strips	FHWA Proven Countermeasure 0.55 - 0.91	$1,000/mile
Review and Provide Curve Chevrons, Curve Warning Signs, and Speed Advisory Plaques to Meet the Manual on Uniform Traffic Control Devices (MUTCD) and Iowa DOT Standards	FHWA Proven Countermeasure 0.59 - 0.96	$5,000/curve
Review and Upgrade Curve Chevrons, Curve Warning Signs, and Speed Advisory Plaques to Meet MUTCD and Iowa DOT Standards, if needed	FHWA Proven Countermeasure 0.59 - 0.96	$2,500/curve
Clear and Grub	0.78	$10,000/mile

Figure 32 illustrates the proposed horizontal curve safety improvements as described in the previous sections. It is important to note that the County Engineer should follow all applicable guidelines and standards when implementing the curve improvements.