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Indian Reservation Safety Improvement Program: A Methodology and Case Study

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Indian Reservation Safety Improvement Program: A Methodology and Case Study

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ABSTRACT

Improving roadway safety on Indian reservations requires a comprehensive approach. Limited resources, lack of crash data, and few cross-jurisdictions coordination has made it difficult for Native American communities to address their roadway safety concerns. A methodology to improve roadway safety has been developed and successfully implemented on the Wind River Indian Reservation (WRIR). Key to the success of such a process is collaboration among safety stakeholders.

Strategic highway safety plans are used to assist agencies to determine effective safety improvements to their roadways. The WRIR has successfully developed a strategic plan utilizing the available crash data, identified ways to improve reporting, and incorporated their safety improvement program into the strategic plan.

Statistical models have been used to help researchers determine related factors and identify countermeasures to improve roadway safety. This study analyzes crash severity for rural highway systems in Wyoming using a multiple logistic regression model.

In order to improve transportation safety and other transportation issues in tribal communities, they need programs that meet their specific needs and culture. This report presents several programs that address livability and sustainability. Roadway safety is a primary goal among Native Americans in their efforts to improve the quality of life among their people.

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EXECUTIVE SUMMARY

The need to reduce fatal and injury crashes on tribal lands has been recognized for years. The United States has realized a decline in fatal crashes over the past several years, but fatal crashes continue to increase on tribal lands. Limited resources, lack of crash data, and little coordination across jurisdictions has made it difficult for Native American communities to address their roadway safety concerns. A methodology able to address these challenges has been developed and successfully implemented on the Wind River Indian Reservation (WRIR). Key to the success of such a process is collaboration among safety stakeholders, namely the state departments of transportation, tribal leadership, Local Technical Assistance Program (LTAP), Tribal Technical Assistance Program (TTAP), Bureau of Indian Affairs (BIA), and local and tribal law enforcement.

Strategic highway safety plans are used to assist agencies to determine effective safety improvements to their roadways. Crash data are important to properly identify strategies to accomplish their goals. The WRIR has successfully developed a strategic plan utilizing the available crash data, identified ways to improve reporting, and incorporated their safety improvement program into the strategic plan.

Statistical models have been used to help researchers determine related factors and identify countermeasures to improve roadway safety. Many models have been developed for urban applications and intersections, but few have addressed crashes on rural roadways and apparently none have analyzed crashes on Indian reservations. This study analyzes crash severity for rural highway systems in Wyoming using a multiple logistic regression model. Four rural highway systems were analyzed for crash severity, including the WRIR. Five main effects predictor variables were prevalent in all four crash severity models: crashes involving animals, driver impairment, motorcycles, mean speed, and the use of safety equipment. These results validate the concerns of the tribal communities.

Few resources exist to address the livability and sustainability of rural and tribal communities. In order to improve transportation safety and other transportation issues in these communities, they need programs that meet their specific needs and culture. This report presents several programs that address livability and sustainability. It identifies the challenges tribes face in providing opportunities and quality living options. Each tribe has different goals and priorities that would affect how they define livability. Transportation is a large factor in improving quality of life and economic opportunities in rural and tribal communities. Roadway safety is a primary goal among Native Americans in their efforts to improve the quality of life among their people.

1. INTRODUCTION

Safety on U.S. highways is of primary concern for all agencies. Since the 1950s, the United States has strived to make our highways safer and reduce fatal crashes. The 1966 Highway Safety Act was one of the first of many efforts by the U.S. government to reduce severe crashes by requiring states to develop and maintain highway safety programs (FHWA, 2012). Although fatal crashes have dropped over the last several years, the U.S. has not kept pace with the rest of the developing world. In 2007, fatalities per 100,000 population in the U.S. was at 13.6; whereas, it was 5.0 in the United Kingdom and 7.6 in Australia. Even our neighbors to the north in Canada have a lower rate at 8.4 (Monash Injury Research Institute). These rates are even higher on rural and Indian reservation roadways.

The goal of the Wyoming Strategic Highway Safety Plan (WSHSP) is to reduce the number of fatal and serious injury crashes (Wyoming Highway Safety Management System Committee, 2012). These efforts are supportive of the national goal to eliminate traffic deaths through a campaign known as "Towards Zero Deaths" (TZD). The Wind River Indian Reservation (WRIR) is among the many partners in the state striving to achieve this goal. The Wyoming Department of Transportation (WYDOT) has funded this study to develop a methodology for Indian reservations to identify high-risk crash locations and implement low-cost safety improvements to work toward this goal.

1.1 Background

The U.S. government has recognized for years the need for improved tribal traffic safety. Numerous reports have been published on the high fatality rates among Native Americans and the trends that persist. In 2002, the motor vehicle crash mortality rate for American Indians per 100,000 persons was more than two times the national average for all races (Mickelson & Corbett, 2004). These high rates are attributable to many factors including unsafe roads, driving error, non-use of safety restraints and the disregard of roadway rules. This has a great impact on the tribal communities and their families. With limited tribal government resources, the development and sustainability of a traffic safety program is challenging (Mickelson & Corbett, 2004).

An understanding of their roadway system is necessary in addition to other factors that are unique to tribal lands. Many reservations are typically rural with a rural roadway system. They face similar challenges that other rural communities face in trying to improve safety on their roadways. Local governments also frequently lack the resources to address safety on their roadways. Rural roads account for about 40% of the vehicle miles traveled in the country but have the highest fatality rates on the highway systems across the United States (FHWA, 2012). In 2007, 57% of traffic fatalities occurred on rural roads with only 23% of the nation's population living in rural areas (Chandler & Anderson, 2010). The reason crashes on rural roadways are more serious and result more often in fatalities is due to several factors, including extreme terrain, higher speeds, higher number of crashes involving alcohol use, and longer response time for emergency services. Indian reservations experience similar crash statistics at an even greater magnitude.

Other factors to consider are the behavioral issues that contribute to the safety of their roadways. The "National Tribal Transportation Safety Summit Report" (Herbel & Kleiner, 2010) indicates that among the many safety concerns facing Native Americans on reservation roadways, impaired driving and the use of seat belts/child safety seats are the highest concerns (Herbel & Kleiner, 2010). The report also notes that crash data are inadequate for many Indian reservations.

The Native American community has suffered greatly over the years with higher fatality rates on their roadways than the general population across the U.S. In a report by the National Center for Statistics & Analysis (National Center for Statistics & Analysis, 2004), fatal crashes in the United States dropped at a rate of 2.2% between 1975 and 2002, but on Indian reservations they increased by 52.5%. Nearly 63% of these fatalities involved persons aged 35 years or younger. In 2002, 38% of passenger occupant fatalities across the nation were restrained; whereas, only 16% were restrained on Indian reservations. In addition, 42% of fatal crashes on Indian reservations were related to speeding. Alcohol accounted for 65% of fatal crashes since 1982 on reservations (National Center for Statistics & Analysis, 2004).

As previously stated, the safety goal for the U.S. Department of Transportation is to work toward eliminating fatal and serious injury crashes (FHWA, 2006-2011). Under the previous transportation bill, Safe Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU), the High Risk Rural Roads Program (HRRRP) as a subset of the Highway Safety Improvement Program (HSIP) was established to address the high fatality and serious injury crash rates on rural roadways. High-risk rural roads are defined as roadways with a functional classification of rural major collector, rural minor collector, or rural local roads, which have a fatality and incapacitating injury rate greater than a state's average, or the roadway is likely to experience an increase in traffic volumes that would lead to a crash rate higher than the state's average (FHWA, 2012).

According to a report published by Federal Highway Administration (FHWA) Office of Safety, many states have had difficulty meeting their obligation of funds and the criteria set forth to access them to improve safety on their rural roads (Chandler & Anderson, 2010). Wyoming has developed the Wyoming Rural Road Safety Program (WRRSP) through the Wyoming Technology Transfer Center/Local Technical Assistance Program (WYT^2/LTAP) to assist the counties across the state to overcome the challenges of meeting the criteria of the HRRRP.

WYT^2/LTAP received funding from WYDOT and FHWA to assist Wyoming counties to identify high-risk rural crash locations and develop a strategy to obtain funding for safety improvements for the highest rank locations (WYT^2/LTAP). The WRRSP program was developed in 2009 and is a five-step methodology that includes the analysis of crash data, field evaluation, and benefit-cost analysis to identify and prioritize low-cost safety improvements (Ksaibati & Evans, 2008). This methodology helps direct the selection of high-risk locations based both on field conditions and historical crash data. This program was initially implemented in three counties and has since been implemented by more than half the 23 counties throughout the state. Each year, counties successfully apply to WYDOT for safety funds for low-cost safety improvements utilizing this methodology to identify their high-risk crash locations.

In all the strides that have been made across the country, including Wyoming, to provide assistance to localities to identify and apply for funding for safety improvements on their rural roadway systems, none has provided comprehensive tools for the Indian reservations. Indian nations are unique from their other rural counterparts in that they are sovereign nations and do not fall under the jurisdiction of the states. Their government structure is typically smaller, stretching their expertise and resources to their limits. This often brings them short of successfully implementing a highway safety improvement program. They need to have some mechanism to assist them in identifying sites for improvement, to help them better assess their priorities, and to determine how they can allocate resources for safety improvements.

WYDOT has provided funding to WYT^2/LTAP to similarly develop a methodology for Indian reservations that was developed for Wyoming counties. With an understanding of the challenges and unique needs of tribal communities, a program needs to be developed that can aid Tribes in addressing their highway safety concerns. A safety improvement program that helps tribes identify high crash locations and implement low-cost improvements will have a substantial impact on reducing fatal and serious injury crashes on reservations.

1.2 Research Objectives

The main objective of this research was to develop a methodology for identifying high-risk locations on Indian reservation roads. Such methodology would result in implementing a low-cost safety improvement program, which should help in reducing the high crash rates on Indian reservations. WYT^2/LTAP in cooperation with WYDOT developed the WRRSP to help local governments in improving safety on their high risk locations. Since Indian reservation roads are similar to rural local roads, modifying the WRRSP to fit the needs of Indian reservations provides Indian nations with the opportunity to identify low-cost safety improvements and then apply for and allocate funding for these improvements. This methodology also provides a tool for Indian nations across the country to be able to utilize funds for safety improvements on their roadway systems.

A secondary objective to the development of the methodology was to identify gaps in crash data on Indian reservations and make recommendations to bridge these gaps. Crash data are critical to identify high-risk locations, therefore it is imperative that the incomplete or lack of crash data be resolved to provide a successful program for identifying safety improvements on Indian reservations.

The next objective of this research was to develop a statistical model to model crash severity for rural roadways for several highway systems to include interstates, state and U.S. highways, county local rural roads, and Indian reservation roads. The model identifies the main effects that contribute to severity for these highway systems for rural roads in Wyoming. The purpose behind these models was to provide helpful information to address the WSHSP goal of reducing critical crashes. This information would consist of (1) identification of important predictors of crash severity and (2) separate identification of these predictors based upon highway systems. Of particular interest is the identification of these predictors for Indian reservations and how they compare to other systems across the state.

The final objective of this research was to explore the concept of livability in the context of tribal lands and to discuss challenges that are encountered when applying principles of livability to the specific conditions and needs of tribal culture.

Because Indian nations are sovereign, they have a right to self-governance and to protect their heritage. However, they typically have limited resources to manage the vast responsibilities needed to provide their people with quality transportation infrastructure and services. Much of their transportation infrastructure is primitive and minimally maintained and they must rely on state and federal agencies as well as local governments to obtain the support needed to improve these facilities. However, they have their own unique needs and concerns that do not necessarily fit the frame of requirements set forth by the federal government for other localities.

As tribes struggle with addressing their transportation safety concerns with high crash rates and roadway fatalities, livability is tied closely with improving their roadway safety as well as expanding transportation to areas of their culture that are in need of safe facilities. This paper will discuss how transportation safety is a key element in livability on tribal lands. It will explore how tribes can partner with other agencies to obtain sustainability of their programs that address these concerns.

This report includes a case study of the WRIR in Wyoming. The methodology developed was implemented on the WRIR and the results were analyzed to demonstrate the effectiveness of the methodology.

1.3 Report Organization

This report consists of seven sections. A literature review comprises Section 2, which identifies the various components of safety that went into the development of the Indian Reservation Safety Improvement Program. Section 3 is a discussion of crash trends identified on Indian reservations. Section 4 lays out the methodology developed for the Indian reservation safety improvement program. Section 5 discusses the results of the implementation of the program on the WRIR. Section 6 presents the problems with crash reporting discovered on the WRIR and remedies to improve it. Section 7 is a discussion of the WRIR Strategic Safety Highway Safety Plan that was borne out of the efforts involved in the development of the safety improvement program methodology. Section 8 is the presentation of a statistical analysis of crash severity prediction in the context of the WRIR compared with models for other highway systems in the state of Wyoming. Section 9 explores the concept of livability and how highway safety is an important aspect of quality of life for Indian tribes. Finally, Section 10 provides conclusions and recommendations to the objectives laid out in this report.

2. LITERATURE REVIEW

2.1 Roadway Safety History on Indian Reservations

Relations between the U.S. government and American Indian tribes have evolved over the past 200 years. Changes in these relationships were a result of the different approaches the government took at the time to address the current situation. Six time periods define these changes starting with the Formative period from 1780 to 1825 and the current period of Self-Determination that started in 1961 (Hamilton, 2000). Between the Assimilation and Allotment period (1871-1928) and the Reorganization period (1928-1945), the Indian Reservation Road (IRR) program was established by Congress on May 26, 1928 (The Osage Nation, 2006). IRR roads are identified as public roads that provide access on and to Indian reservations. These roads are managed by the Bureau of Indian Affairs (BIA). The IRR program provides the means by which tribes can obtain funding for the planning, design, construction, and maintenance of these roads (US Department of the Interior, 2013).

The Tribal Transportation Program (TTP) was established in 1983 through a Memorandum of Agreement between the BIA and FHWA. This program is intended to address the transportation needs of tribes across the U.S. and provide safe and adequate transportation on these public roads (FHWA). It is through these programs that tribes can receive funding directly from the federal government for their transportation systems. The transportation authorization bills that are passed by Congress provide specific funding for their IRR roads.

As tribes were given more authority since the Self-determination period (1961-present) has emerged, they found that they lacked the resources and expertise to carry out many of the responsibilities formerly assumed by the state or federal government. In 1991, FHWA created the Tribal Technical Assistance Program (TTAP) to assist tribes with the management of their transportation networks (Sullivan & Martin, 2009). With seven regional centers across the country, they provide tribes with training, information, updates on new technology, and personalized assistance with their transportation programs and are helping tribes improve their roadway safety. TTAPs work closely with the FHWA to provide assistance with the many federal programs available to the tribes concerning safety. (Sullivan & Martin, 2009)

These programs have provided the tools for tribal governments to get organized and obtain funding to address their highway safety concerns. However, the Native American communities still lag far behind the U.S. in being able to effectively reduce fatal and serious injury crashes on their reservations.

According to the Centers for Disease Control (CDC), injuries are the leading cause of death for American Indian and Alaskan natives up to age 44, and motor vehicle crashes are the leading cause of unintentional injury for them. The motor-vehicle-related death rate is more than twice that of whites. Low seat belt use, low child safety seat use, and alcohol impaired driving are the major risk factors found among American Indians and Alaskan natives (Centers for Disease Control and Prevention, 2012).

Tribal transportation safety summits have been held across the country since 2008. The primary goal of these summits is to reduce crash-related injuries and deaths among American Indians. They are a collaborative effort to identify the challenges, share successes, and explore opportunities to improve safety. FHWA, BIA, tribal representatives, state departments of transportation (DOTs), Local Transportation Assistance Program (LTAP), and TTAP are among the safety stakeholders at these summits (Herbel & Kleiner, 2010).

The challenges that have been identified at these summits have common themes. Tribes across the country share similar safety concerns of impaired driving, seat belt/child safety seat use, lane departures, speeding, and pedestrian safety. Tribal stakeholders suffer from a lack of resources including funding, personnel, and technology. Crash data are commonly inadequate among the tribal communities. Tribes often lack the expertise needed to perform the various tasks involved in identifying and developing a traffic safety program. These summits have recognized the need for better communication and collaboration among the stakeholders. Lastly, jurisdictional issues have hindered the tribes' ability to effectively manage their transportation safety (Herbel & Kleiner, 2010). The summits have performed an important role in increasing awareness of the problems faced by American Indians in improving transportation safety on tribal lands.

An earlier study written in the mid-1980s by Phillip A. May (May, 1983) identified some relationships that should be considered when addressing the high crash fatality rates among American Indians. The American Indian population has been growing at twice the rate of the rest of the U.S. population. This has brought the median age of the American Indian down to 22.9 years in 1980; whereas, the median age of the U.S. population as a whole was at 30.3 years during the same time frame. This could account for much when reviewing crash data and alcohol involvement (May, 1983). Other considerations include the fact that most Indians live in the rural western United States. Also, the average income among Indians was about half that of the U.S. and education levels remain lower than the national average (May, 1983).

Other issues that contribute to the high fatal crash rates on Indian reservations could be attributed to the condition of their roadways. Of the 90,000 miles of IRR roads maintained by the BIA across the U. S., less than half of them are paved. According to condition ratings reported by FHWA, 45% of their roads are rated as poor and only 16% as good (FHWA, 2013). Compounding this with the nature of their roadway system being typically rural, driving behaviors such as higher speeds, and the use of alcohol increases the chances of fatal and serious injury crashes on their roadways.

These many issues are well recognized by tribal leadership, and through collaborative efforts they are making strides toward addressing the safety of their roadways. As sovereign nations, many tribes are starting to pass and enforce laws on their reservations to address their roadway safety problems. They are sensitive to the behavioral issues that are contributing to fatal and serious injury crash rates. They are aware of the poor condition of their roads and struggle to access the resources needed to improve them. Their recognition of the cultural differences and challenges faced by their young people has led the tribal leadership to take other proactive measures to reach out to their people to help shape their attitudes and change their driving behaviors for improved traffic safety. Safety stakeholders such as FHWA, TTAPs, and LTAPs can provide resources and technical expertise to assist tribes in fulfilling their goals to reduce fatal and serious injury crashes.

2.2 Crash Reporting

The importance of complete and proper crash reporting is recognized as inadequate among tribal communities (Herbel & Kleiner, 2010). Many factors include the lack of information on the severity, location, and contributing causes. Crashes will often go unreported altogether. This is a result of several issues such as limited law enforcement resources and lack of training for proper data collection and data entry. In addition, the vehicles will often be removed from the crash scene before any law enforcement is notified or arrives.

A South Dakota study on crash reporting among its nine reservations (Bailey & Huft, 2008) indicated that even though reported crashes showed that crash fatality rates among Native Americans in South Dakota were three times greater than others, they also lacked sufficient crash data. The study group obtained additional crash reports from the tribes, which were not in the standard form used by the state. After obtaining these data, it was estimated that 64% of crashes on tribal lands was under-reported (Bailey & Huft, 2008). Figure 2.1 indicates the actual crashes for 2005 for before the additional crash data were collected during the study and the total after the study. The crash data collected during the study were reports that the state, county, city, or tribes did not previously have in their systems.

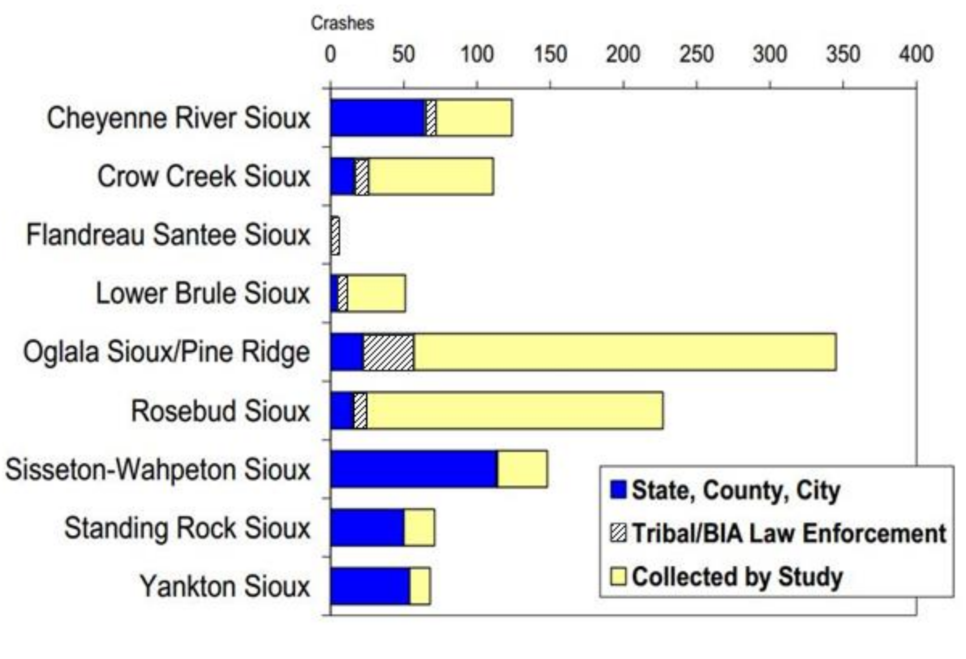

Figure 2.1 South Dakota Motor Vehicle Crashes for 2005, Before and After Study, Within Reservation Boundaries as Defined by 2000 Census. (Bailey & Huft, 2008)

The study identified that the main problem areas were tribal law enforcement's ability to report crashes and the tribes' relationships with the state. Factors that contribute to the incomplete reporting include the inability of the tribal law enforcement to properly report the crashes either because of lack of resources, unclear understanding of state reporting requirements, and limited information technology sources.

Another factor is the standardization of reporting methods. These vary among tribal administrations, and conflict exists between the state and BIA requirements. They also follow different crash reporting and investigation protocols. (Bailey & Huft, 2008) If the state has an electronic reporting system the tribal law enforcement needs to have the same system as well as training on the use of it.

As sovereign nations, the tribes are not obligated to submit their crash reports to the state agency. They are often hesitant to provide detailed information to outside agencies, not understanding or knowing how that information will be used. Tribes need to be assured that data collection is essential to improving traffic safety and that the information would not be used to adversely impact the tribe or the individual driver involved in a crash. Better communications among agencies need to be established and a more formal understanding between the tribes and the state are necessary to improve crash reporting. (Bailey & Huft, 2008)

The Native American communities across the U.S. have recognized the need for improved crash reporting. The Tribal Transportation Summits have made it a theme issue in their efforts to improve transportation safety (Herbel & Kleiner, 2010). States and individual tribes are starting to engage in efforts to improve the reporting and management of crash data so they can be utilized more effectively in identifying both physical and behavioral safety improvements. Tribal leadership and government agencies are endeavoring to overcome the many obstacles that hinder progress on this effort.

The use of crash data to improve the safety of their roadways needs to be understood by tribal governments. Performing crash analysis can take on many forms and provides decision makers with critical information on what improvements or programs should be initiated. Accurate and complete crash data can be confidently used to develop safety models that can provide specific information on problem areas, causal factors, and behavioral factors involved and how they affect the seriousness of the crash. Trends are easily identified when the data are complete. Having accurate locations is important and can be incorporated into a geographical information system (GIS) that could be connected to roadway inventories. This would provide more specific information on roadway geometrics and pavement conditions that can be included in the analysis of crashes.

Building trust between the tribes and the government is key to this success. Tribal sovereignty has been in jeopardy before; therefore, tribes must be assured that they will remain sovereign. As this trust is built among the leadership, they can reach out to their people to change the culture to improve the safety on their roadways by getting the agencies to cooperate and provide the needed crash information and by preserving crash scenes for law enforcement to properly report crashes. As states reach out to the tribes by offering assistance, including funding for safety improvements and identifying the need for accurate crash data in order to be able to provide assistance, these trends of inadequate crash reporting can be reversed.

2.3 Communication, Collaboration and Coordination

In order for any tribal transportation program to be a success, there must be open communication, extensive coordination efforts, as well as full cooperation among the many agencies involved. “Cooperation on transportation issues is affected by complex issues such as tribal sovereignty, intergovernmental agreements, jurisdiction, regional planning efforts, right-of-way acquisition, funding, and maintenance. Similarly, planning, design, and implementation of transportation projects require collaboration among tribal, federal, and state agencies." (Martinez, Migliaccio, Albert, & Holt, 2009). Collaboration is essential among the tribal, federal, state and local governments to implement a transportation safety program. Many stakeholders are necessary in the development of such plan and buy-in is absolutely necessary by every stakeholder.

In 1998, the president signed Executive Order 13084, requiring government agencies to consult with tribes on any projects that affect their communities. This helped formalize government-to-government agreements with the tribes as well as streamlining the federal processes for them. Many states have established a tribal liaison position between the DOT and the tribes; they have organized intergovernmental summits and developed best practices guides and references. To further strengthen relations with the tribes, some agencies have launched research studies and assessments to identify the issues, practices, and programs affecting transportation projects on tribal lands (Martinez, Migliaccio, Albert, & Holt, 2009).

Some weaknesses that exist between state agencies and tribal governments are evident in specific project execution. Though the preconstruction process requires extensive involvement, post construction as it relates to operations and maintenance is lacking (Martinez, Migliaccio, Albert, & Holt, 2009). Responsibilities for maintenance and operations need to be clearly agreed upon to ensure lasting benefits. This is the area where many transportation safety issues exist. There is no clear understanding among the agencies and tribes as to who is responsible to address these concerns and how to obtain the necessary resources.

Transportation program management and operations issues have evolved over the years to accommodate the relationships between government agencies such as the federal and state governments. The formation of AASHTO and legislative and financial support has facilitated such relationships. However, only recently have tribal-state-federal relationships been identified as needing improvement and development (Committee on Historic and Archeological Preservation in Transportation [A1F05], Subcommittee on Native American Issues in Transportation, 2002). In 1999, the Transportation Research Board (TRB) resolved to have a conference to specifically address the issue of communication, coordination, and cooperation among the agencies to identify ways to improve these efforts to better accomplish the transportation goals on tribal lands.

Best practice cases were presented at the conference to determine effective development of these relationships. It is imperative to the success of the transportation programs and projects that occur on Indian reservations. The New Mexico and Arizona departments of transportation, as well as various tribal transportation agencies, presented these cases and their experiences to what is working well and what still needs to be accomplished to improve these relationships between the tribes and local and state governments. The DOTs and many tribes have worked diligently to develop relationships to ensure that the transportation needs are addressed in the context of the tribes' priorities and culture.

The New Mexico Highway and Transportation Department (NMSHTD) recognized that the 22 tribes represented in the state had been involved at the project level but not in the long-range and strategic planning level. They held a summit to address these issues and developed a framework for policies and processes to include coordination with the tribes. With the improved coordination efforts to address tribal issues statewide, they recognized the uniqueness of each tribe and the importance of dealing with them individually (Committee on Historic and Archeological Preservation in Transportation [A1F05], Subcommittee on Native American Issues in Transportation, 2002).

Sovereignty issues are continually arising when states and tribes judicial systems have conflicting jurisdictional views. When legislation does not specifically address these issues, the state and tribal governments are left with resolving these issues through agreements or resorting to the state or tribal courts. Whether it is the state or the tribe, their perception of government-to-government relationships is assumed to be only with the federal government. However, the states have been more empowered through the years in transportation matters and funding. Regional transportation planning is being emphasized more for both state and tribal governments requiring more local coordination efforts. Intergovernmental agreements (IGAs) are essential and need to be executed to assign responsibilities for actions between the agencies to ensure compliance to those responsibilities (Committee on Historic and Archeological Preservation in Transportation [A1F05], Subcommittee on Native American Issues in Transportation, 2002). This requires the full cooperation for each agency involved.

There are many factors that impact tribal transportation decisions. They include cultural competency, protection and preservation of tribal-sensitive resources, confidentiality of tribal sensitive matters, sovereignty, land ownership, and funding issues (NCHRP, 2011). These factors are complex and must be considered during intergovernmental collaboration on transportation projects. Since the 1960s, the U.S. government has worked to increase tribal self-determination, giving the tribes more power to decide their own direction on transportation issues. This is a shift from the direction the government had been taking concerning tribal sovereignty. From the early days of the "Agreements between Equals" in the late eighteenth and early nineteenth century, the notion was to endeavor to assimilate rather than allow self-determination.

With this shift, the tribal-state-federal relationships in regard to transportation issues are a fairly new concept with no precedence to turn to for guidance on how to proceed. From formal legislative actions to state level initiatives, collaboration efforts between the agencies are being launched to address the transportation needs on tribal lands. Knowing how to identify their needs and who to go to for assistance is fundamental in Tribes being able to proceed with their transportation programs. From the state and local government perspective, roadway systems that traverse the reservations require tribal input and collaboration to ensure the tribe's cultural assets are protected and the state or local government is able to pursue the needed roadway improvement or expansion.

The National Cooperative Highway Research Program (NCHRP) Report 690 (NCHRP, 2011) provides the background of these issues. One of the greatest challenges in coordinating jurisdictional issues is right-of-way, whether they concern work on or regulatory jurisdiction of travelers and crashes. Many times the courts have had to rule on the interpretation of the law and yet there is still conflict between agencies on who has the authority to act and make decisions. The report provides guidelines for successful collaboration among agencies with specific cases across the states that have implemented successful programs to collaborate with their respective tribes. Every tribe is different and must be treated individually in the context of their culture. Forging trusting relationships is the beginning of understanding and working together to achieve everyone's goals of improving transportation safety.

2.4 Strategic Highway Safety Program

The mission of the FHWA Office of Safety is to reduce highway fatalities by providing information and resources to safety decision-makers and champions. Under the previous highway transportation bill, SAFETEA-LU, the Highway Safety Improvement Program (HSIP) was established. This program was designed to address the high rate of fatal and serious injury crashes on roadways across the U.S. A major component of the program is a Strategic Highway Safety Plan (SHSP), which is required for all states. The SHSP is a statewide plan that is comprehensive and driven by crash data. It sets goals and objectives, identifying key focus areas and integrating the four E's of safety (Engineering, Education, Enforcement and Emergency response) (FHWA). This plan is a collaborative process involving the state DOT and other local, state, and federal safety stakeholders.

The Federal Lands Highways (FLH) under the FHWA provides tribal transportation safety initiatives to support the tribes in their highway safety improvement efforts. The Tribal Transportation Safety Management System (SMS) is a program that encourages communication, coordination, collaboration, and cooperation among the safety stakeholders committed to tribal transportation safety with the goal of implementing effective transportation safety programs to save lives while respecting the American Indian culture and traditions (FLH, undated). This program includes an SHSP for Indian lands. It is a model for all tribes to follow and addresses the common concerns found among tribes across the country. The following eight emphasis areas address the safety concerns of reducing fatal and serious injury crashes:

- Decision-making process
- Data collection
- Run off the road crashes
- Occupant protection/child restraint
- Alcohol/drug impaired driving
- Other driver behavioral and awareness
- Drivers under the age of 35
- Pedestrian safety

Each of these emphasis areas contains goals and strategies to accomplish them through physical and behavioral solutions. The first emphasis area (decision-making process) can be challenging for tribes as they may have to work with safety stakeholders across jurisdictions. Tribes also need better data collection (second emphasis area). The remaining emphasis areas are data driven.

The State of Wyoming is committed to reducing the number of fatal and serious injury crashes and has established priorities in their WSHSP to accomplish this goal (Wyoming Highway Safety Management System Committee, 2012). They have established six focus areas based on analysis of crash data, which include lane departure, safety equipment use/non-use, young drivers (25 years and younger), curve crashes, speeding, and impaired driving. The state is committed to working with local governments to meet this goal and expects all local level partners to implement the plan to the degree possible based on their resources and needs. The coordination efforts set forth in the strategic plan allow the local partners to identify their own specific safety concerns and the best countermeasures for them (Wyoming Highway Safety Management System Committee, 2012).

Among the local partners in Wyoming is the WRIR. Both tribal leadership and state officials recognize the need for the reservation to adopt its own safety program that addresses their unique challenges to reduce fatal and serious injury crashes. The emphasis areas identified in the WSHSP, which include roadway departure crashes, use of safety restraints, impaired driving, and speeding are also priorities for the WRIR. High-risk rural roads, a special safety area addressed in the plan, are a primary focus for the reservation since virtually all of its roadway system is rural.

Through the Inter Tribal Council of Arizona, Inc., a four-task model process and guidelines were developed in 2004 to assist tribes to get organized and develop a traffic safety program (Mickelson & Corbett, 2004). The process consists of the following:

1) Determine whether a tribe has a highway safety problem.
2) Select funding sources.
3) Plan for a Tribal Highway Safety Improvement Project (THSIP) or highway safety project.
4) Implement the Tribal Hazard Elimination Safety (HES) program project based on the plan.

The first three tasks are administrative in nature and are designed to help the tribes get organized to incorporate traffic safety into their government structure. The fourth task is the implementation of the HES. This process is intended to assist the tribes to be in the position to compete for highway safety funds effectively.

The process and implementation guidance is based on the HES program, which was replaced by the Highway Safety Improvement Program (HSIP) SAFETEA-LU. SAFETEA-LU has since been replaced by the new transportation bill, Moving Ahead for Progress in the 21st Century Act (MAP-21), which is more streamlined and performance-based.

However, many of the principals can apply concerning the development of the program. The implementation would require changes that are applicable today. Specifically, tasks one and two are beneficial in getting tribes started with a safety program and to identify possible funding options. The next step of determining the scope of the program or projects as well as the implementation needs to follow the current requirements. Task three provides an outline for tribes to develop their Transportation Safety Management Program, which is required under the current law.

In 2007, the same group that developed the four-task process and implementation guidelines performed a study utilizing the guidelines for three tribes in Arizona, which were selected through a competitive process (Corbett & Mickelson, 2007). This research was intended to provide the tribes the tools to build their traffic safety capacity. At the same time the project was used to assess the tribal model process and guidelines previously established. In order to assist the tribes in developing their safety capacity, five areas were identified:

- Decision-making
- Data collection and storage
- Equipment and software
- Project prioritization
- Project development, implementation and evaluation

Teams were formed under the tribal leadership and were composed of the various safety stakeholders. Progress was realized by the three tribes in building their traffic safety capacity but not to the extent necessary to realize the potential success. The lack of good crash data as well as limited resources constrained this success (Corbett & Mickelson, 2007).

Strategic highway safety plans are essential in addressing the many safety concerns faced by any community. They provide a means to get organized and identify the responsibilities of the many stakeholders. It should reflect the specific goals of the community. Each tribe has its own unique culture and understands best how to affect change in their community to improve roadway safety. A strategic highway safety plan developed by each individual tribe in collaboration with their safety stakeholders is an effective tool that provides a clear path for them to follow to realize their goals of improved safety on their roadways.

2.5 Road Safety Audits

Road Safety Audits (RSA) are intended to provide an objective analysis of the safety of a particular roadway location. Safety concerns are identified and mitigating opportunities to improve safety performance are presented. The FHWA defines an RSA as a "formal safety performance evaluation of an existing or future road or intersection by an independent, multidisciplinary team" (Nabors, Moriarty, & Gross, 2010). They are unlike the traditional informal safety reviews, which are typically performed by small design teams. RSAs are formal reviews that are more comprehensive than a safety review. Table 2.1 presents the differences between an RSA and a safety review (FHWA, 2013). The field review is an essential part of the audit, which is performed by a multidisciplinary team. RSAs are comprehensive and proactive. They consider all factors that may contribute to a crash and all users of the roadway system.

They have been proven to be effective in reducing roadway crashes (Ksaibati, Zhong, & Evans, 2009).

Table 2.1 Difference Between RSA and Safety Review (FHWA, 2013)

Road Safety Audit	Traditional Safety Review
Performed by a team independent of the project.	The safety review team is usually not completely independent of the design team.
Performed by a multi-disciplinary team.	Typically performed by a team with only design and/or safety expertise.
Considers all potential road users.	Often concentrates on motorized traffic.
Accounting for road user capabilities and limitations is an essential element of an RSA.	Safety reviews do not normally consider human factor issues.
Always generates a formal RSA report.	Often does not generate a formal report.
A formal response report is an essential element of an RSA.	Often does not generate a formal response report.

RSAs on tribal lands have unique challenges because of the multi-jurisdictional issues and cultural, historical, and environmental constraints. One of the key elements of success is the selection of the team. One example of success is an RSA that was conducted for the Navajo Nation in Utah. The team consisted of the Navajo DOT, Navajo police, Utah DOT, BIA, Indian Health Services (IHS), FHWA, and county officials. The different insights and perspectives contributed to identifying improvements that included educational road safety campaigns unique to the demographics of the reservation (Nabors, Moriarty, & Gross, 2010).

The FHWA Office of Safety and FHWA Office of Federal Lands commissioned four tribal road safety audits in 2005-2007 to demonstrate the usefulness and effectiveness of RSAs for tribal agencies (Gibbs, Zein, & Nabors, 2008). Through these RSA case studies, the team members identified six key elements for a successful RSA (Gibbs, Zein, & Nabors, 2008):

1. The RSA team must acquire a clear understanding of the project background.
2. Recurring concerns identified in multiple tribal RSAs may reflect safety issues typical of tribal transportation environments.
3. The involvement of multiple road agencies in the design, operation, and maintenance of roads on tribal lands can present a challenge, and can also help promote a successful RSA outcome.
4. The RSA team and design team need to work in a cooperative fashion to achieve a successful RSA result.
5. A "local champion" can greatly help to facilitate the establishment of RSAs.
6. The RSA field review should be scheduled during regular recurring traffic conditions.

In a tech brief published by WYT^2/LTAP (Wilson, 2007), RSAs and RSA Reviews (RSAR) are identified as proactive safety tools that most local agencies do not utilize. Localities fear they would become vulnerable to tort liability once they have identified safety deficiencies and do not have the resources to address them. However, these tools can be utilized with as little or as much sophistication the locality wants to be able to build a safety program. A documented program is a stronger defense than no program. In reference to the NCHRP Synthesis 336, these tools are designed to fit the specific needs of the agency. Safety solutions are specific to each and they should be tailored to those needs (Wilson, 2007).

RSAs can be used as a template to perform field reviews for a safety improvement program. Along with crash analysis, field reviews provide an opportunity to identify conditions that would contribute to the hazards. A multidisciplinary team provides insights and can identify the various factors involved and recognize countermeasures necessary to address the safety concerns.

2.6 Wyoming Rural Road Safety Program

The WRRSP was developed to assist counties and cities in Wyoming to identify low-cost safety improvements on their local and rural roads (Ksaibati, Zhong, & Evans, 2009). This program was in response to the provisions set forth in the SAFETEA-LU legislation passed in 2005. This legislation established the HSIP as a core program with specific funding set aside for states to address safety improvements on high-risk rural roads (FHWA, 2012). The HRRRP was not being utilized to its potential and the obligation rate of funds was low. States lacked clear direction on how to determine the criteria and implement the program for their rural roads.

With very low population and high vehicle miles traveled, Wyoming needed a methodology to identify these high-risk locations beyond the criteria set forth in the HRRRP. The WRRSP utilizes methodology that was developed to address these unique challenges. It is designed to help local agencies reduce crashes and fatalities on their rural roads. The methodology incorporates both historical crash data and field conditions to determine the high-risk locations.

The research that went into this program first looked at the roadway classification systems used throughout the state. Then a methodology was developed to use available data to include crash records, traffic volumes, speed, and so forth to predict crashes on rural roads. With this, a five-step methodology was established so specific safety countermeasures could be identified. Finally, a procedure was developed to perform an economic analysis for the safety countermeasures. The methodology instituted by the WRRSP includes the following steps (Ksaibati, Zhong, & Evans, WRRSP Wyoming Rural Road Safety Program, 2009):

1. Crash data analysis
2. Level I field evaluation
3. Combined ranking of steps 1 and 2 to identify high-risk locations
4. Level II field evaluation to identify countermeasures
5. Benefit-cost analysis

Through the analysis of crash data, initial high-risk locations are identified and selected for a field evaluation to determine the various factors that identify the condition of the roadway. These roadways are ranked based on worst to best condition, and then the crash rank and the field evaluation rank are combined. A combined rank provides the list of the highest risk roads that are then selected for another field evaluation. This evaluation identifies safety improvements as possible countermeasures to reduce crashes at these locations. Cost estimates of the improvements are produced. Based on crash reduction factors (CRF) and the benefits of crashes being avoided, a benefit-cost analysis is performed. The benefit-cost ratio calculated for each project reveals how much improvement in crash reduction can be realized, and these are ranked to determine the priority of the projects. From this, projects are selected for a funding request from the state.

The study also included the establishment of a Local Road Safety Advisory Group (LRSAG) made up of representatives from WYDOT, WT^2/LTAP, Wyoming Association of County Engineers and Road Supervisors (WACERS), Wyoming Association of Municipalities (WAM), and FHWA. This group's purpose was to provide input and advice into the process as the research proceeded (Ksaibati, Zhong, & Evans, WRRSP Wyoming Rural Road Safety Program, 2009).

As part of the project of developing the five-step methodology, a pilot study was executed in three counties throughout the state to assess the effectiveness of the program. The five-step methodology was initially implemented in Carbon, Laramie, and Johnson counties under this pilot study (Ksaibati, Zhong, & Evans, WRRSP Wyoming Rural Road Safety Program, 2009). Projects were submitted to WYDOT and approved for funding in 2009. Projects were submitted for each of the roads determined as the high-risk locations and included low-cost safety improvements such as advanced warning signs, installation of wider cattle guards, object markers and delineators, and pavement markings.

WYDOT funds 90.49% of project costs up to $100,000 of federal funds and the counties are responsible for a 9.51% match. WYT^2/LTAP worked with WYDOT to develop a program guide for counties across the state to use to establish a safety improvement program in their county. WYT^2/LTAP also provides assistance to the individual counties to identify low-cost safety improvement projects using the methodology. They also assist them with the project proposals (Ksaibati, Zhong, & Evans, WRRSP Wyoming Rural Road Safety Program, 2009). The WRRSP program has since been successfully implemented in over half of the 23 counties in the state and many low-cost safety improvement projects have been funded and installed. Table 2.2 contains the list of the projects submitted for funding by the program.

As a final stage in the program, WYT^2/LTAP monitors the progress of the projects and identifies the actual benefits realized by the improvement project (Ksaibati, Zhong, & Evans, 2009). After studies at least three years subsequent to project completion are performed to determine the actual crash reduction at the high-risk locations. Then true crash reduction factors can be concluded. This would provide more accurate assessments for future safety improvements in the benefit-cost analysis.

The WRRSP was used as a template to formulate the methodology used for the Indian Reservation Safety Improvement Program. Enough similarities exist because of the rural nature of the roadway systems on Indian reservations. By combining crash data with field reviews, along with input from the tribes, a comprehensive safety improvement program can be implemented.

Table 2.2 Projects Submitted for WRRSP Funding

	County / Project Number	Project Type	Completed Application	Cooperative Agreement
ROU ND #1	Carbon CN06065	Signs, Del., & Culvert Ext.	10/1/2008	7/23/2009
	Johnson CN16022	Signs, Del. Striping	10/1/2008	6/15/2009
	Laramie CN02090	Signs & Cattle Guards	10/1/2008	8/6/2009
	Lincoln CN12051	Striping 11 Rds.	4/28/2009	9/18/2009
	Lincoln CN12052	Signs 5 Rds.	4/28/2009	9/18/2009
	Lincoln CN12053 GR	Guardrail 2 Rds.	4/28/2009	9/18/2009
	Sheridan CN03033	Signs Spot Grading	5/5/2009	9/30/2009
	Sheridan CN03034	Signs Spot Grading	5/5/2009	9/30/2009
ROU ND # 2	Big Horn CN09056	Signs & Realignment	6/6/2009	8/5/2010
	Fremont CN10095	Guardrail	1/12/2010	8/5/2010
	Fremont CN10096	Guardrail	1/12/2010	8/5/2010
	Lincoln CN12054	Shoulder/Slope Imp 2 Rds.	8/16/2010	9/5/2010
	Lincoln CN12055	Culvert Extension 3 Rds.	8/16/2010	9/5/2010
	Lincoln CN12056	Fence Removal	8/16/2010	9/5/2010
	Lincoln CN12057	Guardrail	8/16/2010	9/5/2010
	Lincoln CN12058 MB	Reset Mailboxes	8/16/2010	9/5/2010
	Lincoln CN12059	Striping 11 Rds.	8/16/2010	9/5/2010
ROU ND # 3	Big Horn CN09057	Signs & Realignment	8/26/2010	8/12/2011
	Carbon CN06067	Signs, Rumble St., & Striping	8/24/2010	8/19/2011
	Crook CN18059	Signs, Del., & Striping	9/16/2010	8/15/2011
	Goshen CN07104	Road Widening	9/7/2010	8/15/2011
	Lincoln CN12060 MB	Reset Mailboxes	8/16/210	9/12/2011
	Sheridan CN03036	Culverts, Grading, & Gravel	3/4/2011	8/15/2011
	SIGN PROGAM	10 Counties	Dec-10	Summer 2011
ROU ND #4	Lincoln 12065	Shoulder Improvement	10/1/2011	6/21/2013
	Converse	Signs & Delineators	5/13/2013	
	Converse	Striping	5/13/2013	
	Big Horn	RAP	1/31/2013	Not Awarded
	Lincoln 12067	Delineators	1/31/2013	6/21/2013
	Lincoln 12064	Signs	1/31/2013	7/3/2013
	Lincoln 12063	Striping 11 Rds.	1/31/2013	6/21/2013
	Lincoln 12062	Guardrail	1/31/2013	7/3/2013
	Lincoln 12066	Shoulder Improvement		7/3/2013
	Park CN11070	Striping 15 Rds.	1/31/2013	5/24/2013
	Sheridan CN03038	Realignment	1/31/2013	6/11/2013
	Shoshone Arapaho DOT	Signs 16 Rds.	1/31/2013	
	Shoshone Arapaho DOT	Guardrail	1/31/2013	
	Shoshone Arapaho DOT	Striping 16 Rds	1/31/2013	

Completed Projects

2.7 Statistical Analysis

In order to determine the most appropriate model for the statistical analysis of crashes, the first step was to determine whether crash frequency or crash severity should be analyzed. Because the primary goal of the WSHSP is to reduce critical crashes, a model is needed to predict crash severity. Crash severity is a binary or dichotomous (0 and 1) value. In this setting, a crash is severe (1) or not severe (0). Thus, logistic regression is appropriate for this binary response, because the response variable, severity, is binary.

A Bernoulli distribution is used to model a binary random variable. A Bernoulli distribution is a discrete probability distribution where the value 1 is "success" and 0 is "failure" probability (*p* and *1-p*) (Kutner, Nachtsheim, & C.J., 2004). The method of maximum likelihood is used to estimate parameters.

Andreen (Andreen, 2012) used multiple logistic regression to model crash severity on Interstates 80 and 25 in Wyoming based upon several predictor variables. The intent was to model crashes to identify factors associated with crash severity on interstates in Wyoming. The recommendations from that study suggested the consideration of more predictor variables to include roadway geometrics, driver distraction (use of cell phones), seat belt use, and emergency response time.

Ordinal logistic regression can also be used to model crash severity. Mooradian presented a paper titled, "Temporal Modeling of Highway Crash Severity for Seniors and Other Involved Persons," (Mooradian, Ivan, Ravishanker, & Hu, 2012) where ordinal logistic regression was used. In this model, crash severity was expanded to five levels involving fatal, serious injury, minor injury, possible injury, or no injury crashes. In this case, a polytomous or multicategory logistic regression model is appropriate (Kutner, Nachtsheim, & C.J., 2004). Based on the WSHSP goal of reducing critical crashes, a binary response variable is more appropriate rather than an ordinal response. Another disadvantage of polytomous response is to ensure enough observations in each response category.

Logistic regression models have been used for urban applications to identify the effects of different factors contributing to crashes. Bham discussed the use of logistic regression models of collision crashes on urban highways (Bham, Javvadi, & Manepalli, 2012). Crash severity was modeled as severe or not severe. The basis for this choice was that the crash reporting is most accurate for severe crashes than the other three non-severe categories. The response variables were collisions types.

As in the logistic regression models, the response outcomes for a Poisson regression model are also discrete. The Poisson regression model is useful for count outcomes based on a number of explanatory variables and large counts are rare events. This is of particular interest for crash frequency. The Poisson regression model is the most widely used for prediction of crash frequency (Uhm, Chitturi, & Bill, 2012). However, the model assumes that the predicted values are independently distributed with equal mean and variance. Because the variance often exceeds the mean with crash frequency data, the assumption is violated and the Poisson regression model cannot be used (Uhm, Chitturi, & Bill, 2012).

The negative binomial regression model addresses this over-dispersion problem. This model includes an additional parameter to allow the variance to differ from the mean (Uhm, Chitturi, & Bill, 2012). Taking this a step further, the high number of zero crashes contributes to the over-dispersion. This is remedied by the use of a zero-inflated Poisson model. It uses a weighted average of the zero count probabilities with the non-zero counts (Uhm, Chitturi, & Bill, 2012).

The Highway Safety Manual (HSM) (American Association of State Highway and Transportation Officials, 2010) utilizes a negative binomial distribution for the Safety Performance Functions (SPF) models. The SPFs are modeled for different facility and site types and are applied to the associated predictive method described in the HSM. These models enable analysts to consider different safety improvements to determine their effectiveness for a given roadway segment by predicted crash rates based on historical crash data and the application of the SPF for a given improvement. A big advantage of the crash predictive method laid out in the HSM is that it addresses the regression-to-the-mean bias because it considers long-term expected average crash frequency. It also utilizes the Empirical Bayes method, which provides for a weighted adjustment to combine the observed crash frequency with the predictive model estimate (American Association of State Highway and Transportation Officials, 2010).

Given the different models discussed above, the most appropriate application to predict crash severity on rural roads would be the multiple logistic regression model. However, the drawback of logistic regression is that it is conditional on the occurrence of crashes. It does not provide analysis that would conclude the reason crashes are occurring. In the application of predicting the level of severity, the logistic regression model provides analysis that would conclude the reason for a severe crash. Severity is a qualitative response and should be modeled as a binary response (severe or not severe). Since analysis of severity of crashes aligns with the WSHSP goal of reducing critical crashes across the state, the logistic regression model was selected for the forthcoming analysis.

2.8 Livability

The concept of livability emerged in the 1980s as planners and designers examined the effects of current practices. Urban centers were deteriorating, suburbs were continuing to spread farther from the urban centers, and rural communities were being neglected. As a result, communities have become totally dependent on vehicular travel. Integrating transportation, land use, housing, and environmental issues became the focus of community and urban design (FHWA, 2010). Many studies questioned the traditional model and identified the need for sustainable growth as it relates to jobs, transportation, and housing. Economic, environmental, and social issues became the foundations of smart growth.

The Livable Communities Initiative was established during the Clinton-Gore administration so that the federal government could work with communities to help them sustain prosperity and expand economic opportunity, enhance the quality of life, and build a stronger sense of community (Clinton-Gore Administration, 2000). Under this initiative, the Federal Transit

Administration formalized efforts to expand transit and transit-oriented development (TOD) by publishing *Building Livable Communities with Transit* (Federal Transit Administration).

What is livability? The concept "does not come packaged in a single accepted definition" (Godschalk, 2004). And consensus is lacking among government agencies. However, most definitions include transportation, community, and quality of life (Young & Hermanson, 2012).

In the context of transportation engineering, U.S. DOT Secretary Ray LaHood defined livability as, "Livability means being able take your kids to school, go to work, see a doctor, drop by the grocery or post office, go out to dinner and a movie, and play with your kids at the park—all without having to get in your car" (US DOT). This definition does not necessarily address the broad spectrum of what different communities consider important. However, it includes the key elements of transportation, community, and quality of life.

The Interagency Partnership for Sustainable Communities was formed in June 2009 between the U.S. Department of Housing and Urban Development (HUD), U.S. Department of Transportation (DOT), and the U.S. Environmental Protection Agency (EPA). These agencies joined together to help communities across the country improve access to affordable housing, increase transportation options, and lower transportation costs while protecting the environment (HUD, USDOT, EPA).

They developed six livability principles as the foundation of their partnership:

- Provide more transportation choices
- Promote equitable, affordable housing
- Enhance economic competitiveness
- Support existing communities
- Coordinate policies and leverage investment
- Value communities and neighborhoods

Since the formation of the partnership, many communities have adopted livability goals that are defined by these six principles. This has helped agencies and communities find common ground when working together to plan and build their communities.

In 1987, the United Nations' Report of the World Commission on Environment and Development identified the need for sustainability, stating, "Concerned about the accelerating deterioration of the human environment and natural resources and the consequences of that deterioration for economic and social development" (DESA, 1987). In other words, the commission is saying that we need to look at being able to meet the needs of the current generation without compromising the ability to meet the needs of future generations.

This concept takes into account the social, economic, and environmental quality of life issues, which are also referred to as the triple bottom line. According to this model, sustainability can only be achieved by considering the impact on all three of these aspects of quality living. It serves well as a compass for communities when determining their development needs.

In simpler terms, a livable community is expected to survive at its defined quality of life through self-supporting strategies that will sustain for future generations. Applying these principles to transportation takes on various forms depending on the specific needs and concerns of the community. Typically, more and affordable transportation choices are needed. Transportation decisions, which are made based on the triple bottom line, will provide for a more comprehensive cost-effective transportation system that actually meets the needs of the community.

There is not one all-encompassing program that provides direction or guidance to planners and engineers for the development of livable communities (Young & Hermanson, 2012). Several programs and initiatives have emerged as a result of government and community organizations recognizing the need to change how we address growth and transportation needs. Some common programs and initiatives that are being utilized by communities to achieve their livability goals and sustainability strategies include:

- Smart Growth
- New Urbanism
- Transit-Oriented Development
- Complete Streets
- Lifelong Communities
- Safe Routes to School
- Context Sensitive Solutions & Design
- Placemaking
- Leadership in Energy and Environmental Design

Smart growth initiatives are a result of communities developing policies that support their needs, providing flexibility in funding to allow for innovation and addressing environmental concerns. The U.S. Environmental Protection Agency has run the Smart Growth Program since the 1990s and defines smart growth as development that supports sustainability goals and the triple bottom line with a vision to achieve economic growth, strong neighborhoods and healthy communities (Young & Hermanson, 2012). Smart growth planners generally seek compact urban patterns, revitalization, infill development, and less automobile dependence (Godschalk, 2004).

New Urbanism, similarly, is based on a critique of traditional patterns of sprawl. The Charter of the New Urbanism proposed 27 principles for development, including, "Many activities of daily living should occur within walking distance, allowing independence to those who do not drive, especially the elderly and the young" (Calthrope & Fulton, 2001). Other principles promote public space, mixed-use neighborhoods, and historic preservation.

Transit-oriented development (TOD) is a complementary strategy that focuses on creating dense mixed-use development at public transportation nodes. The Federal Transit Administration (FTA) defines TOD as "compact, mixed-use development near transit facilities and high-quality walking environments" (Federal Transit Administration).

Many communities are adopting *complete streets* initiatives and developing policies to support the construction of roadway networks that meet the needs of and are safe for all users. It is about increasing transportation options (Young & Hermanson, 2012). Complete streets policies provide consistency for roadways to be planned and designed for use by people of all ages and abilities, including pedestrians, bicyclists, and public transportation users. (Smart Growth America, 2010).

With the aging population, many communities are facing unique challenges to provide accommodations for people to age in place (Young & Hermanson, 2012). *Lifelong communities* programs adopt livability principles to provide for these needs.

Safe Routes to School is a federally funded program designed to promote walking and biking to school for primary and middle school children. These funds are provided to states through grants to improve and construct facilities and develop programs that will give children safe walking and biking access to school and encouraging alternatives in transportation (FHWA, 2013).

Context Sensitive Solutions (CSS) has its roots in the National Environmental Policy Act passed in 1969. It requires that transportation agencies are to consider the impacts of roadway construction on the environment. The FHWA advanced the efforts of CSS in its 2003 Performance Plan, which includes an objective to incorporate context-sensitive solutions into planning and project development (FHWA).

Placemaking is a way to achieve livability goals through collaboration with the citizens and stakeholders of a particular community (Young & Hermanson, 2012). This is a targeted approach for a community to define its own livability priorities, which includes transportation choices, affordable housing choices, increased economic development, and support of the existing community.

The U.S. Green Building Council developed the *Leadership in Energy and Environmental Design for Neighborhood Development* (LEED-ND) for local governments to be able to include livability and sustainability principles into their local plans, codes, and policies to incorporate national standards for green planning and design (US Green Building Council, 2013). This program has been a powerful tool for local governments to re-write their codes, strengthen their comprehensive plans, and overall provide a standard to measure their livability and sustainability goals.

All these programs are built on the principles of livability, which improve the social quality of life, economic growth, and environmental preservation. They provide a means to implement sustainable strategies. All have a transportation element. For most, transportation is the main focus of improving livability.

2.9 Summary

This section provided a literature review that lays out the background for this study. Understanding the history of roadway safety on Indian reservations provides the basis for how to approach the development of a program. Indian-government relations have evolved over the years. Only recently, self-determination has been recognized by the federal government. With this, programs have been established to assist tribes with their transportation needs.

Crash reporting has been documented as being insufficient on Indian reservations. Many factors contribute to this, including lack of resources and training as well as a lack of trust by the tribes to provide sensitive information to outside agencies. Tribal sovereignty is closely guarded by the tribes. Through continued efforts by government agencies to reinforce the need for cooperation, they can begin to build relationships to work together to address their highway safety concerns.

Strategic highway safety programs are required by the federal government for all states. Their purpose is to establish goals and objectives, and to identify key focus areas to reduce fatal and serious injury crashes on their roadways. Tribal governments need to develop their own strategic plans that identify their goals that are unique to their culture.

RSAs are a powerful tool that provides objective analysis of the safety of the roadways. They have been successfully utilized on Indian reservations across the U.S. to determine the areas of concern. They have demonstrated the effectiveness of collaboration among the many safety stakeholders involved.

Wyoming has developed the WRRSP to meet the criteria set forth in the HRRRP. They have developed a five-step methodology that utilizes crash data and field evaluation along with a benefit-cost analysis to determine high-risk crash locations. They have successfully implemented this program across the state in several counties. This approach can be used for Indian reservations because there are many similarities.

Statistical models have been used to predict crash frequency and crash severity. The WSHSP goal is to reduce critical crashes, therefore a model that analyzes crash severity is desired. The logistic regression model is the most appropriate for the analysis of crash severity since the response variable severity is modeled as a binary variable, severe or not severe.

Livability has a broad definition when applied to different types of communities. Transportation, community, and quality of life are the main issues that form the foundation of livability. Many programs exist that provide communities tools to address their desired goals of providing sustained, quality living, and transportation choices.

3. CRASH TRENDS ON INDIAN RESERVATIONS

3.1 National Statistics

The main report cited for crash statistics related to Indian reservations is the Fatal Motor Vehicle Crashes in Indian Reservations 1975-2002, by the National Center for Statistics and Analysis (National Center for Statistics & Analysis, 2004). During that time period, 213 fatal crashes a year occurred on Indian reservations, totaling 5,962 fatal crashes with 7,093 fatalities. Fatal crashes on average were 187 crashes per year for the first five years (1975-1979), but increased by 29.5% for the five most recent years (1998-2002) to 239 crashes per year. See Figure 3.1 for breakdown by year of fatal crashes on Indian reservations in the U.S.

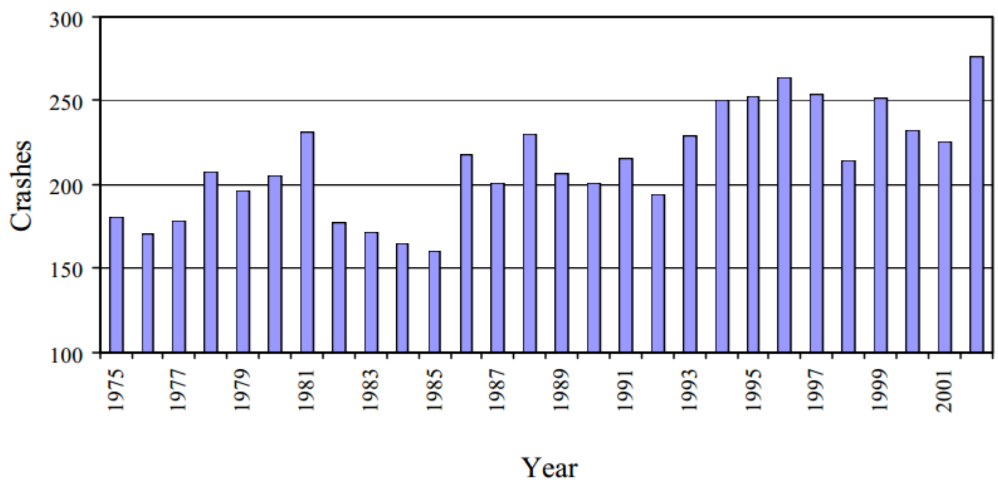

Figure 3.1 Fatal Crashes on Indian Reservations 1975-2002
Source: NCSA, NHTSA, FARS 1975-2002

As previously cited, the number of fatal crashes per year on Indian reservations increased 52.5% (181 fatal crashes in 1975 and 276 fatal crashes in 2002), whereas fatal crashes per year nationally decreased by 2.2% over the same period (39,161 fatal crashes in 1975 and 38,309 fatal crashes in 2002) (National Center for Statistics & Analysis, 2004).

Several characteristics of the fatal crashes on Indian reservations were compared with U.S. statistics in the report. The most noteworthy findings include single vehicle crashes, age, restraint use, speeding, and alcohol involvement. On reservations, 73% of the fatal crashes were single vehicle where 58% of all fatal crashes in the U.S. were single vehicle (Figure 3.2).

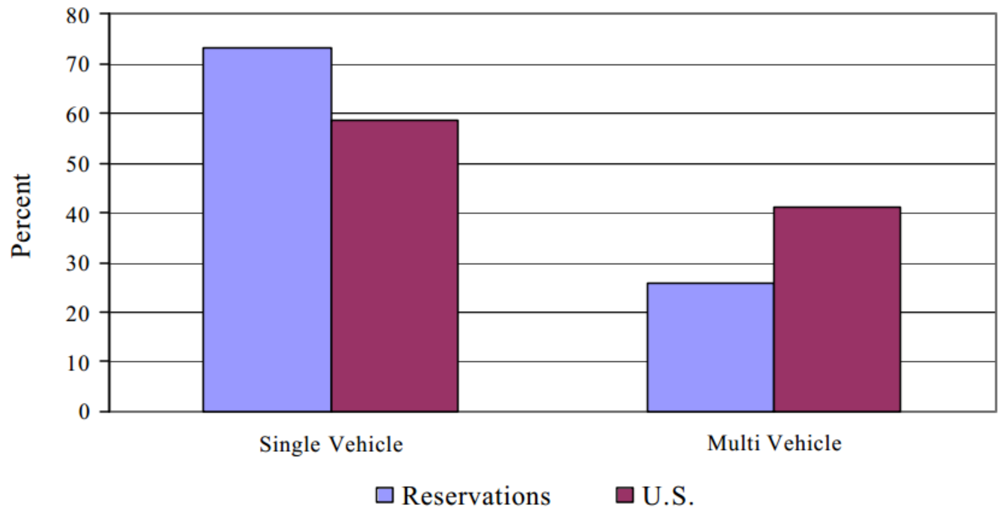

Figure 3.2 Fatal Crashes by Crash Type
Source: NCSA, NHTSA, FARS 1975-2002

Of the fatalities on reservations, 63% were under the age of 35, compared with 57% in the nation (Figure 3.3). On reservations, 76% of the fatally injured occupants were unrestrained where 68% were unrestrained nationally. As observed in Figure 3.4, restraint use has increased since 1983 for both U.S. and Indian reservations. However, use continues to increase across the U.S., but leveled off around 1994 on reservations.

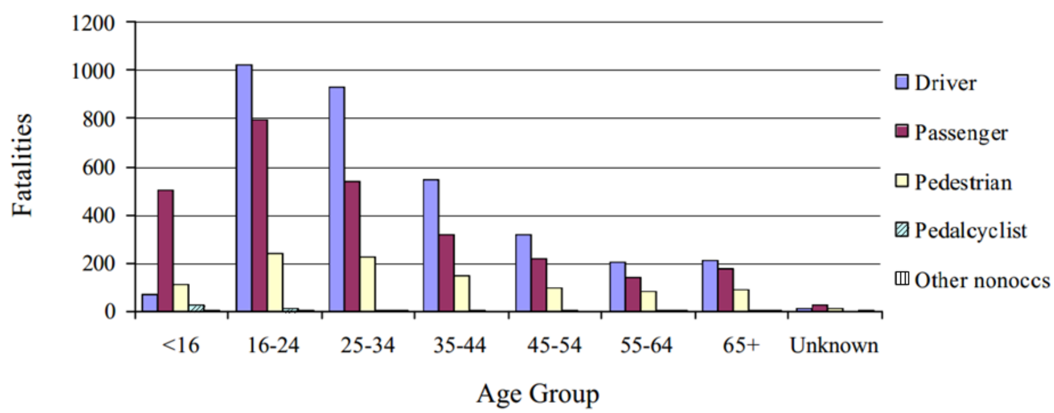

Figure 3.3 Crash Fatalities by Person Type and Age on Indian Reservations
Source: NCSA, NHTSA, FARS 1975-2002

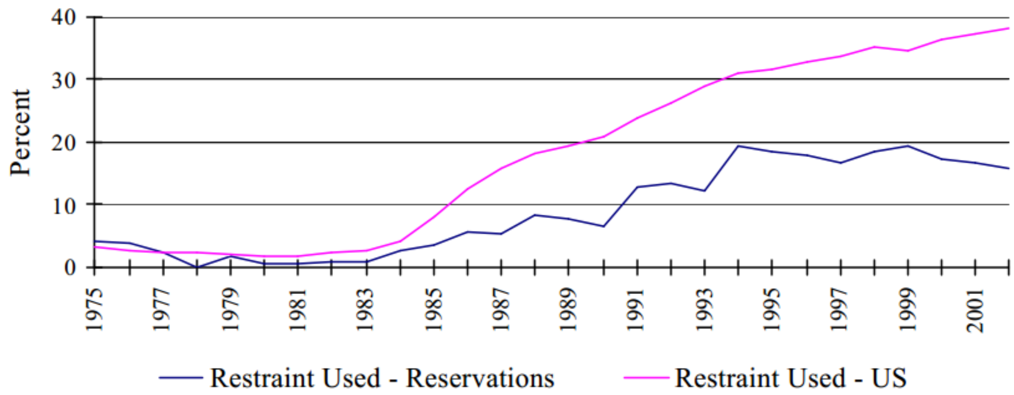

Figure 3.4 Fatalities by Restraint Usage for U.S. and Indian Reservations
Source: NCSA, NHTSA, FARS 1975-2002

Speed-related fatalities were also higher on the reservations at 43% compared with 35% nationwide. Finally, 48% of the drivers in the crashes had a BAC of 0.01 or more on reservations compared with 30% nationwide. Since 1982, 66% of all crash fatalities on reservations were alcohol related (Figure 3.5).

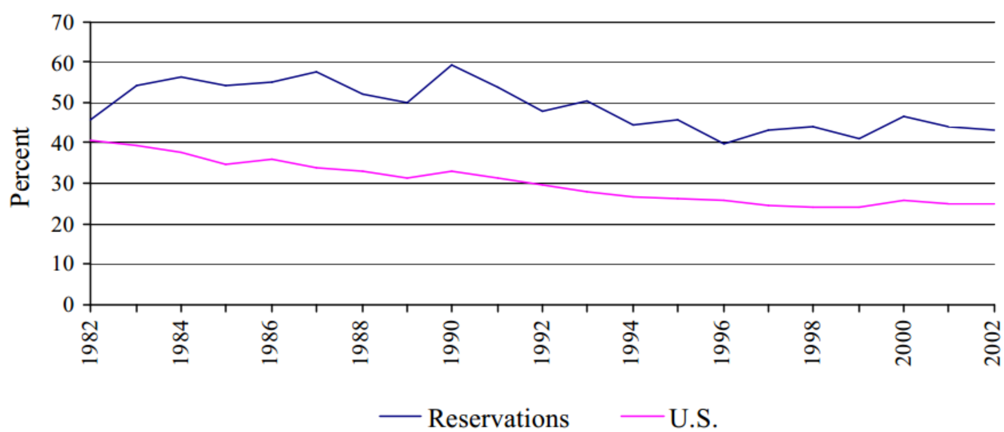

Figure 3.5 Percent Fatalities Driver Alcohol Involvement for U.S. and Reservations
Source: NCSA, NHTSA, FARS 1975-2002

Both the U.S. and Indian reservation statistics showed that 80% of fatal crashes occurred between midnight and 3 a.m., and both trend higher fatalities on Saturday or Sunday at 44% for reservations and 36% for all fatal crashes in the U.S.

It should be noted that the report identified that the number of crashes on Indian reservations increased dramatically between 2001 and 2002 at 25%, while crashes across the U.S. only increased by 1%. This could be as a result of increased and improved reporting of crashes on reservations. Thus, the report recommends further analysis to provide more accurate results.

3.2 Wind River Indian Reservation Crash Analysis

A preliminary crash analysis was performed by WYT^2/LTAP and compared to statewide local roads and counties of similar size. A similar report presented by the Montana Department of Transportation (MTDOT, 2011) was utilized in the development of the preliminary analysis. Crash data for the WRIR were analyzed over an 11-year period (2000-2010) and the categories included severity, driver age group, driver gender, first harmful event (FHE), FHE location, safety devices, and driver impairment.

The preliminary analysis revealed several weaknesses with the data. Of the BIA inventory, a total of 245 crashes, including county roads, were extracted from the database for the 11-year period. Only six roads contained crash data and only 79 crashes were identified with these roads. Crash data on 166 crashes on Indian Reservation Roads (IRR) did not have roadway locations. The low number of reported crashes was determined to be a result of crash reports not being entered into the system. The total number of crashes reported annually for the WRIR dropped sharply after 2006, where 36 crashes were reported in 2006 while only nine were reported in 2010. This indicated that crashes were not being reported properly or somehow not being received by WYDOT.

Efforts among the tribal transportation personnel, Wind River law enforcement, WYDOT, and WYT^2/LTAP have resulted in the inclusion of all crash reports from the WRIR. Through the communications developed in the early meetings, it was discovered that the WRIR law enforcement had crash reports on file for the past several years but lacked the ability to transfer these data to WYDOT. The coordinated efforts resulted in inclusion of the backlog of reports into the database.

With the additional crash data added to the WYDOT database, crash analysis was again performed. During the time the data were being added, the crash database system was revised and new data sets were released. These data sets began in 2002 and include data through 2012. The new analysis was performed for the WRIR and compared to the statewide rural local roads and in some cases all crashes statewide for a 10-year period from 2002 through 2011. Although the numbers were greater, the trends were similar to those found in the preliminary analysis. There were a total of 673 crashes reported for the WRIR and 5,316 for statewide rural local roads. The following provides a summary of the crash analysis with respect to crash severity, driver information, causal factors, and other factors.

3.2.1 Crash Severity

The severity of crashes is divided into three categories: critical, serious, and property damage only (PDO). Critical crashes include fatalities and incapacitating injuries. Serious crashes include non-incapacitating, minor, and possible injuries. PDO crashes include those that had no injuries and incurred damage to the vehicle only. As shown in Figure 3.6, the statewide trend for severe crashes (critical and serious injury) was slightly lower than that for the WRIR at 31% and 37%, respectively. When the statewide and WRIR crashes are compared, the WRIR had more than two times as many critical crashes.

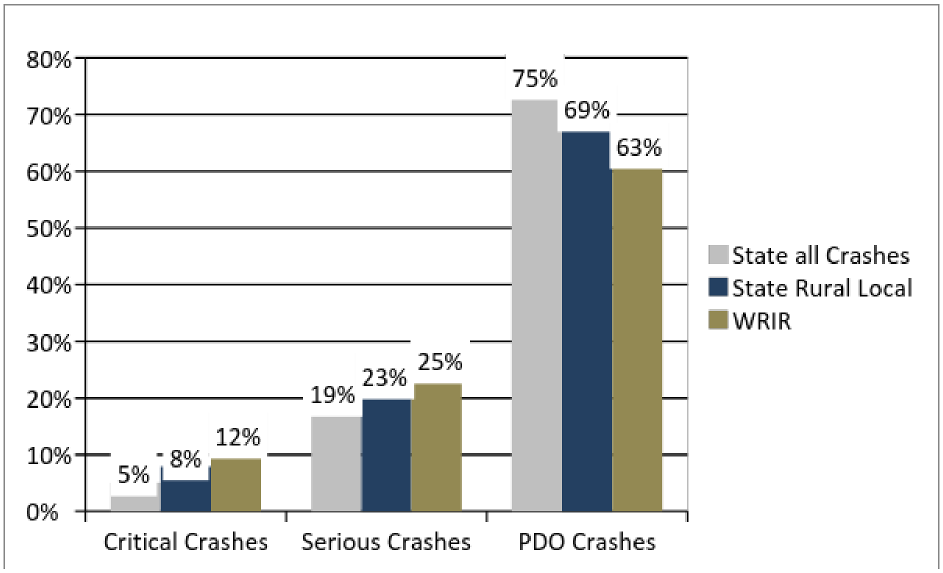

Figure 3.6 WRIR Crash Severity 2002-2011

3.2.2 Driver Information

More women were involved in crashes on the WRIR compared with the state (Figure 3.7). Young drivers involved in crashes ages 34 and younger are noticeably high for both the state and the WRIR (55% and 58%, respectively). However, the WRIR had a greater number of young drivers involved in crashes between the ages of 25 and 34 (Figure 3.8). Alcohol was involved in a greater number of WRIR crashes compared with the state at 23% and 13%, respectively (Figure 3.9). When comparing the WRIR to all crashes in the state, alcohol was involved more than three times more on the reservation than the state as a whole.

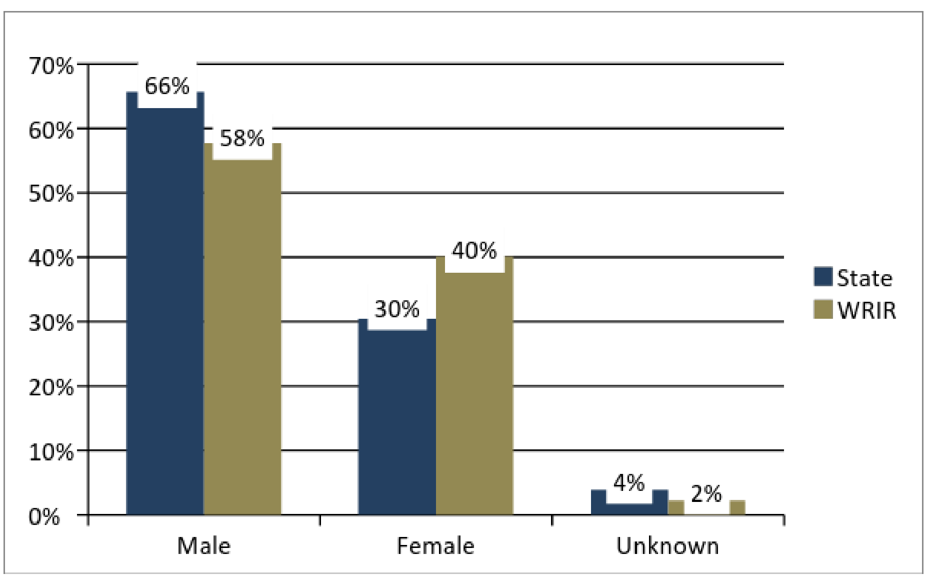

Figure 3.7 WRIR Driver Gender 2002-2011

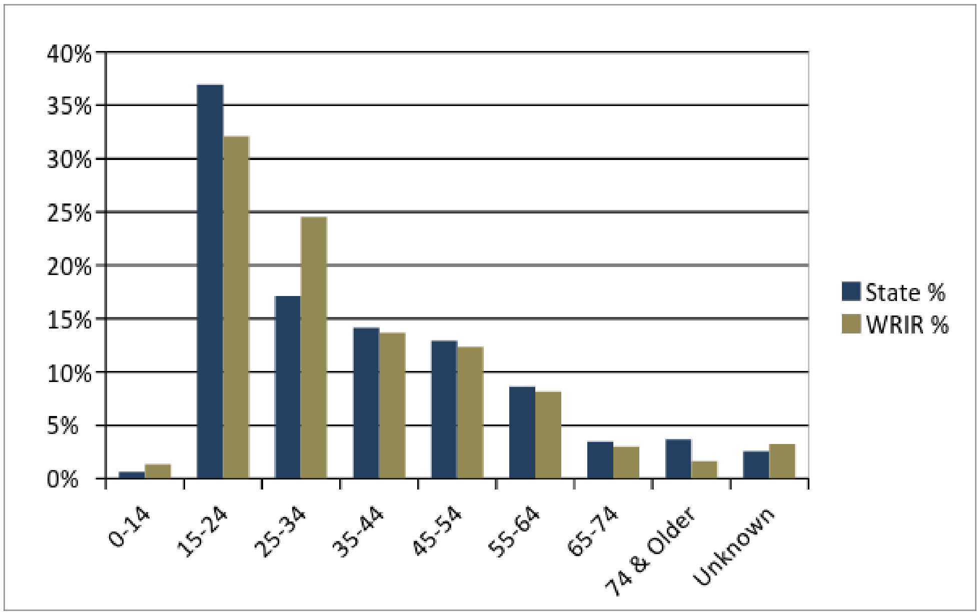

Figure 3.8 WRIR Driver Age 2002-2011

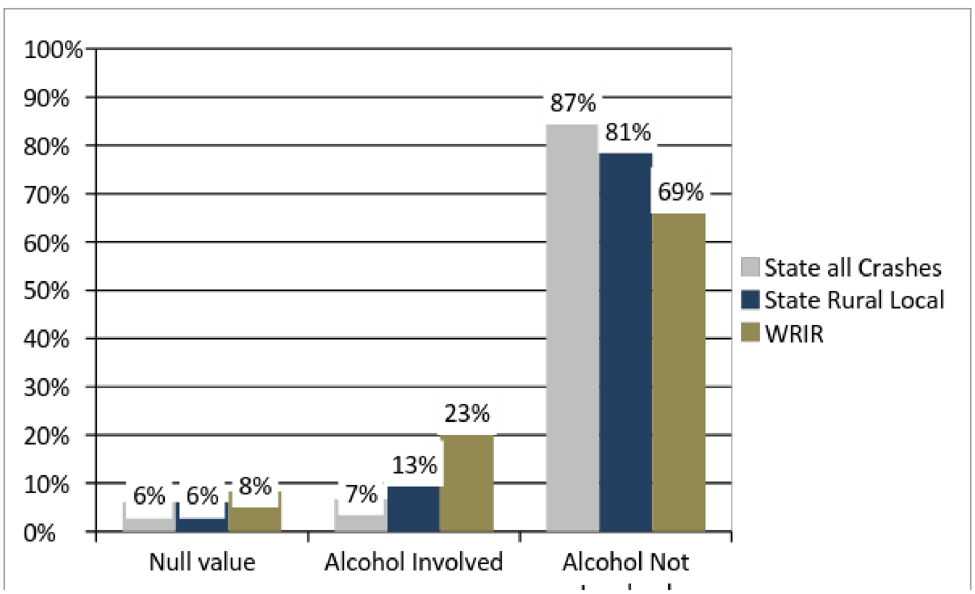

Figure 3.9 WRIR Alcohol Involvement 2002-2011

3.2.3 Causal Factors

The FHE for statewide and WRIR had similar trends with the exception of a much greater number of animal collisions at 24% for the WRIR compared with 10% for the state (Figure 3.10). When these were broken down by animal type, farm (cows, horses, pigs, etc.), domestic (dogs and others), and wildlife (deer, elk, moose, etc.), over half of the animal crashes on the WRIR involved farm animals (Table 3.1). Both farm animal and wildlife crashes are a major problem on the reservation. Finally, The FHE location revealed that the state and WRIR trend the same for on- and off-road crashes (Figure 3.11).

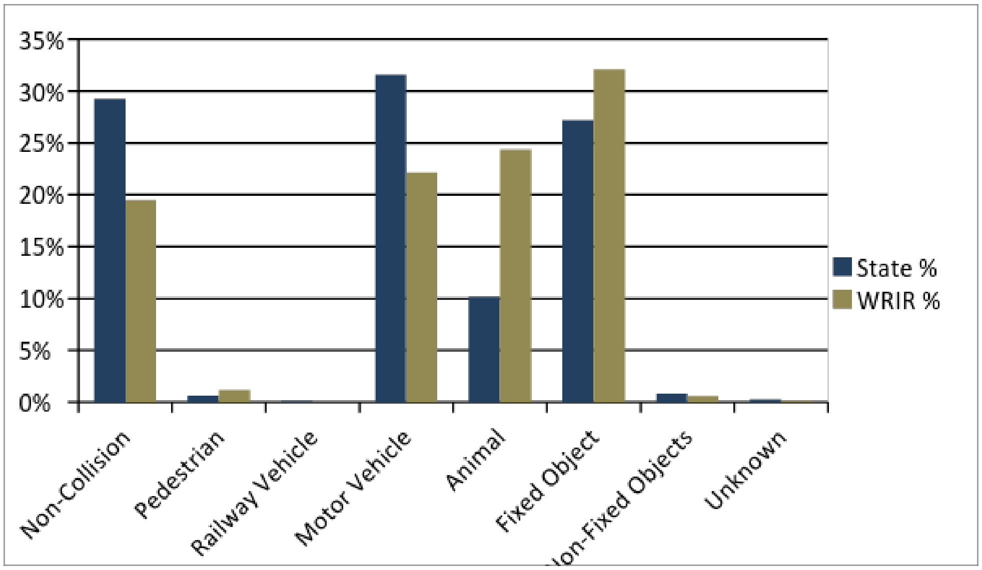

Figure 3.10 WRIR First Harmful Event 2002-2011

Table 3.1 WRIR Animal Crashes 2002-2011

FHE Animal Crashes		
Animal Type	State 10% of all crashes	WRIR 24% of all crashes
Farm	37%	55%
Domestic	1%	4%
Wild	62%	41%

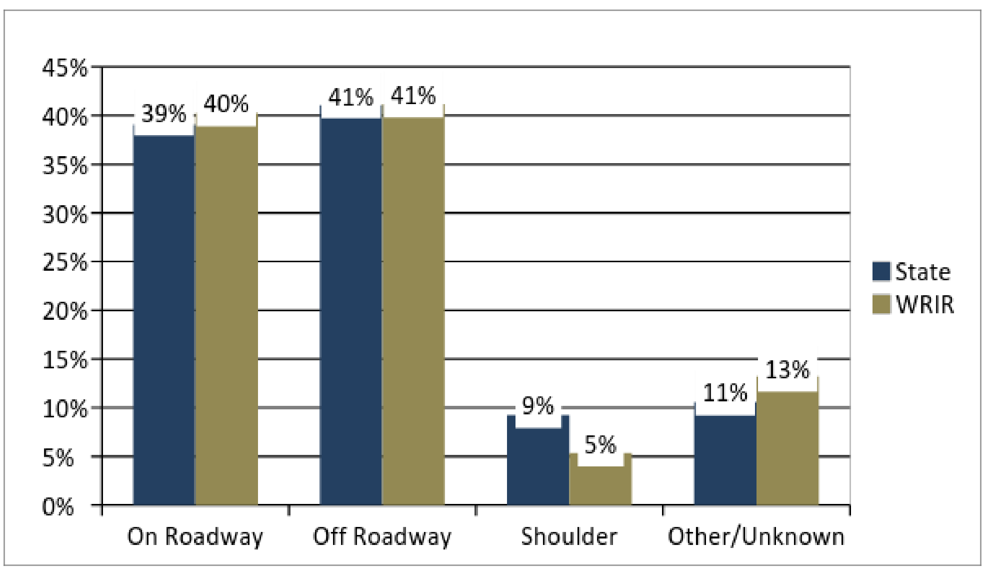

Figure 3.11 WRIR FHE Location 2002-2011

3.2.4 Other Factors

Because of the revisions to the crash data sets described previously, speeding and safety equipment use could not be directly analyzed but should be included in future analyses. However, safety equipment use was analyzed under the preliminary analysis (2000-2010), which revealed that state use was much higher than WRIR at 60% compared with 34% (Figure 3.12), but a greater number of crashes on the WRIR had an unknown value for use at 40%. As safety equipment use relates to critical crashes, the WRIR had a higher rate of critical crashes for non-use than the state (Figure 3.13).

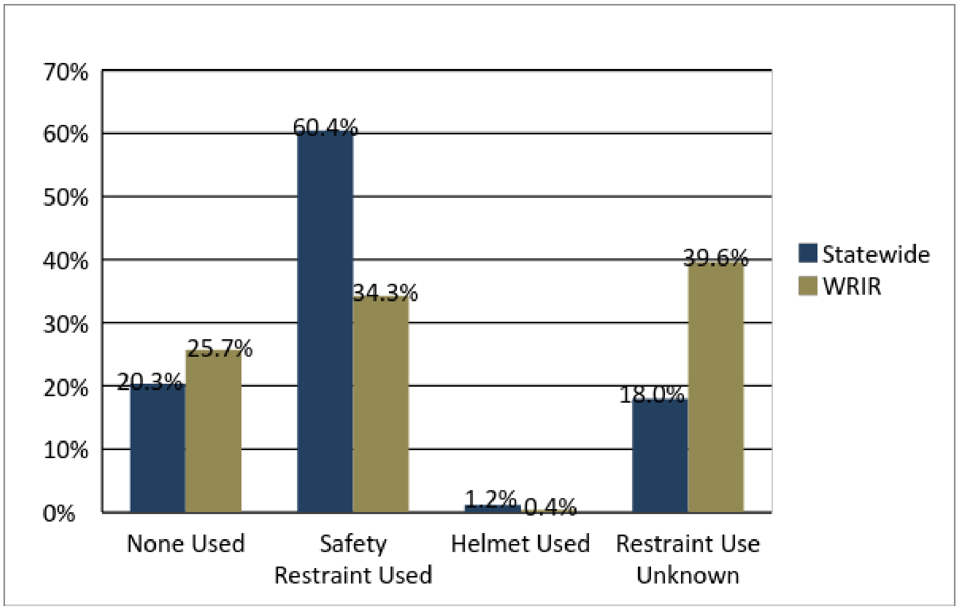

Figure 3.12 WRIR Safety Equipment Use 2000-2010

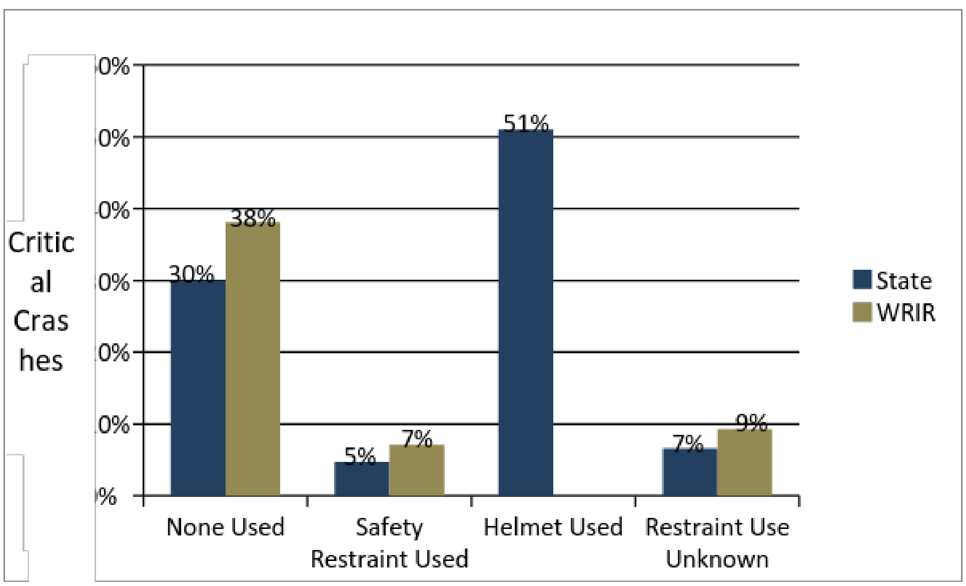

Figure 3.13 WRIR Safety Equipment Use Related to Critical Crashes 2000-2010

The revised analysis also revealed that there were no additional crashes on IRR roads and only county roads within the reservation had locations. This reveals that there is still a disparity with the state crash reporting system and the reservation's ability to capture all crashes in their reporting.

The main issues remain; crash severity is higher on the reservation than throughout the state, alcohol related crashes account for almost a quarter of all crashes, fixed objects are the highest first harmful event with animals being the greatest risk, and most crashes are occurring off the roadway.

3.3 Summary

National statistics indicate that fatal crashes on Indian reservations continue to increase, but fatal crashes across the U.S. have decreased. Restraint use nationally has increased since the early 1980s for both the U.S. and Indian reservations. However, that use has leveled off on Indian reservations since 1994. Alcohol involvement is higher on Indian reservations. A higher rate of fatalities on reservations involved persons under the age of 35.

The analysis performed for the WRIR had similar results with higher severity rates, more people under the age of 35 involved in crashes, and alcohol involvement three times higher on the reservations than across the state of Wyoming. Animal crashes are more than double in the WRIR than in the state with most being farm animals. As with national trends, safety equipment use on the WRIR is much lower than that of the state.

The analysis also revealed that crash reporting was deficient. And though collaborative efforts have resulted in the inclusion of many previously unreported crashes, other problems reveal that a disconnect exists with BIA roads not being recognized in the crash database and therefore crash locations are not identified.

4. INDIAN RESERVATION SAFETY IMPROVEMENT PROGRAM

4.1 Methodology

In this study, the methodology from the WRRSP is used (Ksaibati & Evans, 2008) as a template to develop the program for Indian reservations. Depending on available data, preference by the tribes, and other factors, this process has been altered to meet the needs of the tribes. Part of this process includes looking at trends in crash data and developing a systemic approach. A combination of data driven, field verification, and trend analysis is utilized. The proposed five-step procedure is as follows:

1. Crash data analysis
2. Level I field evaluation
3. Combined ranking to identify potential high risk locations based on steps 1 and 2
4. Level II field evaluation to identify countermeasures
5. Benefit-cost analysis

This procedure is shown graphically in Figure 4.1. As in the WRRSP methodology, crash data are analyzed, and a ranking is established based on the high crash locations. From this ranking, a list of roadways is proposed for field evaluation. From the field evaluation, a ranking of the conditions of the roadway is developed. The two rankings are combined to provide a list of proposed roadways considered for safety improvements. Another field evaluation is performed to identify safety improvements. Cost estimates are developed and a benefit-cost analysis is performed. The combination of historical crash data and field evaluations provides a substantive basis for identifying high-risk locations. The benefit-cost analysis gives the tribes a measure to prioritize the projects.

This methodology will provide tools for the tribes to utilize in prioritizing safety improvements. More detail is provided in the following descriptions. Other processes within the methodology are intended to give the tribes the ability to make changes and identify other factors involved in the high-risk locations such as behavioral factors.

Another critical component in the process of identifying safety improvement is evaluation of the effectiveness of those improvements. Once projects have been established, funded, and implemented, an after study will be performed to determine the actual crash reduction resulting from the safety improvement.

This program is intended for low-cost safety improvements, but other improvements can be identified and presented to the tribes for other funding consideration. The methodology provides flexibility for the tribes to utilize the results the way they consider best.

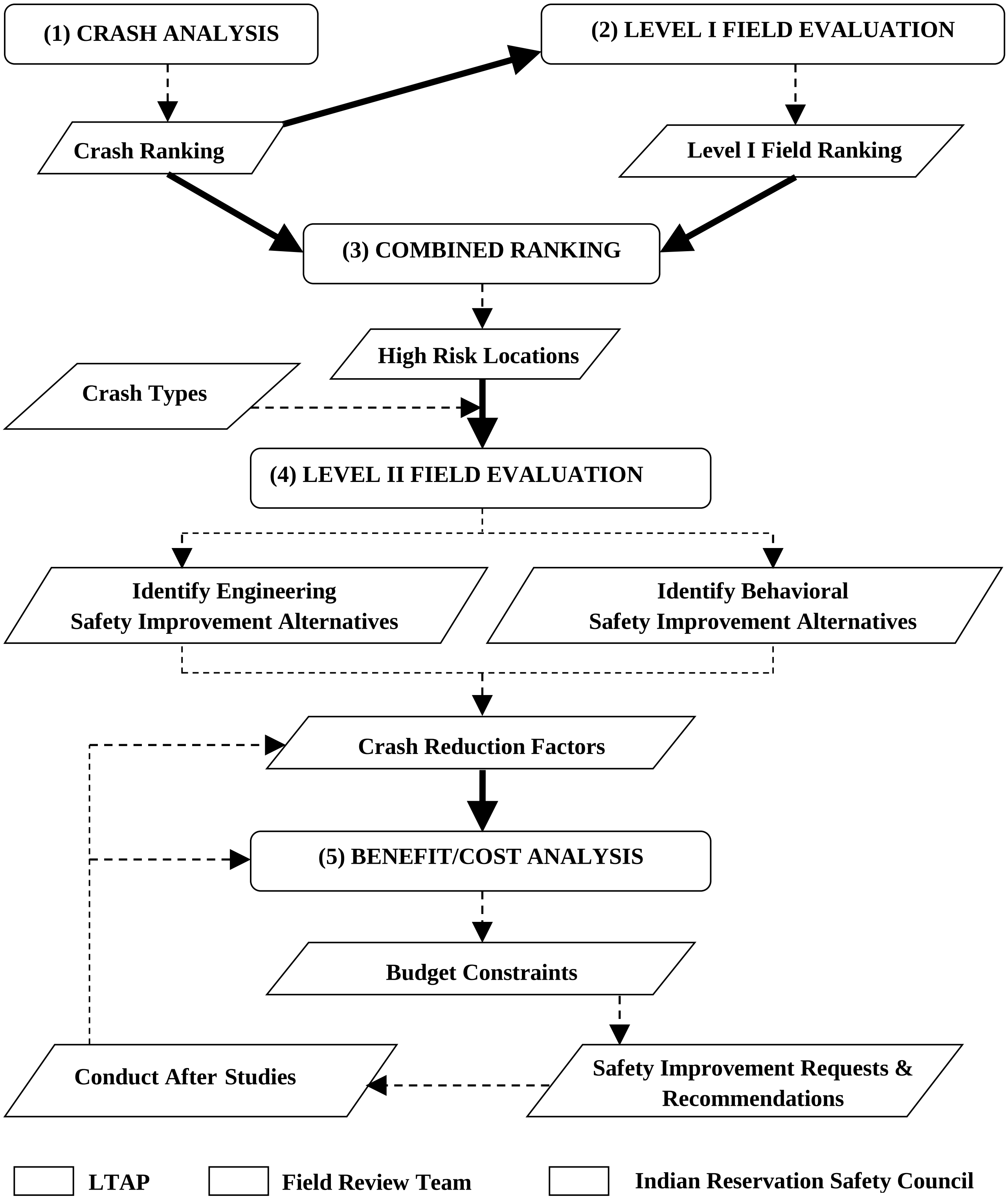

Figure 4.1 Five-Step Process for Indian Reservation Safety Improvement Program

4.1.1 Crash Data Analysis

The first step in determining high-risk crash locations is the analysis of crash data. All states have some form of crash data analysis capabilities. These data are maintained by either the state DOT, law enforcement, other state agency, or consultant. An analysis should be done for a recent period of time. Five to 10 years provides enough data to identify trends or hot spots depending on the state and the volume of traffic experienced on the local tribal roads. Typically, these roads are low volume because of their rural nature. Crash rates are difficult to quantify because of the lack of traffic data and challenges in maintaining accurate and updated crash data. As discussed previously, tribes often lack complete and accurate crash data.

The crash history obtained will provide the basis for initial ranking of the sites. Based on the number of crashes for a given hot spot, the highest number would receive the highest rank. If traffic volume is available, these crashes can be converted to a crash rate that provides a more accurate assessment of high crash occurrence.

Beside the total number of crashes and crash rate, several other factors can be analyzed to determine causal effects and severity to identify ways to reduce fatal and serious injury crashes. The following criteria are considered for this analysis:

- Total number of crashes
- Total number of crashes per mile
- Severity of crashes – critical, serious or property damage only (PDO)
- Road conditions
- Lighting conditions
- First harmful event
- Driver’s gender
- Driver’s age
- Alcohol-drug related crashes
- Safety device use
- Speed

The first six criteria above identify physical aspects of the crashes along with the severity. These will provide a basis for determining high-risk locations. Based on direction from the tribes, several factors are being analyzed that are behavioral in nature. The last five criteria are intended more for the behavioral characteristics of the crash data.

The crash analysis includes the number of crashes per one-mile segment, which are known as hot spots. Each segment is ranked from the largest number of crashes per hot spot to the least number of crashes. Based on this ranking, the top high crash routes are selected and proposed for a Level I field evaluation as the tribes determine.

A route may appear several times at different mile post segments and some segments may contain the same number of crashes. These are ranked accordingly and the crash rank value assigned would be the same. The next lower number of crashes segment would be assigned the rank value that corresponds to the line number. An example of ranking the segments according to crash number is located in Table 4.1.

Table 4.1 Example of Crash Ranking

Line Number	Route	Mile Post	Number of Crashes	Crash Rank
1	C	2	15	1
2	A	4	14	2
3	D	3	14	2
4	A	6	12	4
5	B	10	9	5

Once the segments have been ranked, then the top routes are selected. The top 15 to 25 routes should be selected for the Level I evaluation as determined by the tribes.

4.1.2 Level I Field Evaluation

With the high crash locations identified, a Level I field evaluation is performed on the selected routes. A team of tribal members and transportation experts such as LTAP, TTAP, and/or the BIA should perform this evaluation. This team should be selected by the tribes. The tribal personnel are essential in providing the site expertise because they have first-hand knowledge of the problem areas.

The roadways are reviewed at one-mile segments and each segment is rated from 0 to 10, with 0 being the worst and 10 the best. All segments should begin with a 5 rating as the average. See Figure 4.2 for an example of scoring the roadway segment. These ratings are applied to five categories as follows:

- General Category. The general category covers the geometrics and condition of the roadway. Conditions such as sharp horizontal curves, poor sight distance at vertical curves, and poor pavement quality are looked at for this rating.
- Intersections. The presence, number, and sight visibility of intersections are rated.
- Signage and Pavement Markings. The existence and condition of pavement markings and signs are rated.
- Fixed Objects and Clear Zones. The presence of fixed objects and condition of the clear zone is rated.
- Shoulder and Right-of-Way. The quality of the shoulder treatment and adequacy of the right-of-way are rated.

As in the example in Figure 4.2, the condition was about average. However, where there was no shoulder, a below average rating of 2 was assigned. For a team of evaluators, either discussion could be ensued to determine one score or each member could score independently. Then these scores would be averaged for each segment of a roadway. Maintaining the same team throughout the evaluation period would ensure consistency in results.

Level I Field Evaluation	Evaluator:	Date:	Page of
Notes:		Road Name:	Road Length: 6.0 miles
		Road No.: A	Road Surface: Asphalt
		Road Class:	Speed Limit:

Mile Post	General	Intersections / RR Crossings	Signage /Pavement Markings	Fixed Objects/ Clear Zones	Shoulder / ROW	Segment Score	
0.0 - 1.0	5	7	4	7	2	25	No shoulder
1.1 - 2.0	5	7	4	7	2	25	
2.1 - 3.0	6	7	4	2	2	21	Power pole in clear zone
3.1 - 4.0	6	6	5	7	2	26	
4.1 - 5.0	5	7	5	7	2	26	
5.1 - 6.0	6	7	5	7	2	27	

Figure 4.2 Example of Level I Field Evaluation Scoring Spreadsheet

Each segment receives a total score as the sum of the score for each category. All segments from all routes that were evaluated are then ranked from lowest to highest score. The lowest score value is considered to have the highest risk. Similar to the crash ranking, a Level I rank is assigned. Ranking proceeds down the list. If two scores are the same, they receive the same rank. The next rank value would correspond to that line number. Table 4.2 provides an example of ranking the Level I scores.

Table 4.2 Example of Level I Ranking

Line Number	Route	Mile Post	Level I Score	Level I Rank
1	A	2	20	1
2	B	4	24	2
3	A	3	25	3
4	C	6	25	3
5	C	10	27	5

4.1.3 Combined Ranking

The third step in the process is to combine the crash ranking with the Level I ranking. Crash ranking and Level I ranking are tabulated and combined to develop a final ranking for the Level II field evaluation. These rankings are tabulated by road name and/or number, beginning and ending milepost, crash ranking, Level I ranking, and combined ranking. To combine the ranking, the crash ranking and Level I ranking are added. Table 4.3 provides an example of how the crash rank and Level I rank are combined.

Table 4.3 Example of Combining Crash Rank and Level I Rank

Route	Beg MP	End MP	Total Crashes	Crash Rank	Level I Rank	Combined Rank
A	0	1	2	14	15	29
A	1.01	2	4	12	10	22
A	2.01	3	2	14	13	27
A	3.01	4	14	2	1	3
A	4.01	5	12	4	3	7
B	0	1	14	2	2	4
B	1.01	2	8	6	12	18
B	2.01	3	9	5	2	7
C	0	1	9	8	9	17
C	1.01	2	15	1	3	4
D	0	1	3	10	11	21
D	1.01	2	11	2	5	7
E	0	1	1	20	6	26
E	1.01	2	4	8	4	12

The segments are then sorted by the combined rank value from smallest to largest. The segments with the smallest numbers are considered the most hazardous. From these segments, the roads with the smallest combined ranking value are considered for Level II field evaluation for determining countermeasures. Although other segments of the same road may have a much lower rank, each road is looked at in its entirety for safety improvements. Ten to 15 roads should be selected for the Level II evaluation. Table 4.4 provides an example of routes selected from the combined ranking.

Table 4.4 Example of Top Five Roads Selected from Combined Ranking

Route	Total Crashes	Crash Rank	Level I Rank	Combined Rank
A	14	2	1	3
C	15	1	3	4
D	14	2	5	7
B	9	5	2	7
E	4	8	4	12

The rankings, along with the selected roads, are provided to the tribes for their review and approval to proceed with the Level II evaluation. The tribes have the option of including more sites or adjusting the rankings based on their insights.

4.1.4 Level II Field Evaluation

Once the tribes have identified their priority sites, a Level II evaluation is performed on each of the routes selected. This should consist of a team determined by the tribes and should include tribal personnel and transportation experts. Further data may need to be collected. This could include traffic counts, review of behavioral factors, and other causal factors that would guide decisions on safety improvements. The team reviews each road and revisits the sites as needed to determine the proper countermeasures.

A list of countermeasures is developed for typical applications on rural roadways and crash reduction factors assigned. Information on proven safety countermeasures and crash reduction factors can be obtained from the FHWA Safety website (FHWA, 2008). Individual states also may have their own countermeasures and crash reduction factors. Tribes typically have similar conditions as the state they are located within and can utilize the same information. Included are behavioral countermeasures that the tribes can apply.

Typical countermeasures that are considered low-cost safety improvements include the installation of advanced warning signs, chevrons at curves, delineators, and pavement markings. Others that may require more design and resources would be culvert widening, installation of guardrails, and flashing warning beacons. Countermeasures should be applied based on the type of crashes. For run-off-the-road crashes, countermeasures such as advanced curve warning signs, pavement marking, and chevrons are effective, low cost options.

Each route is evaluated and proposed countermeasures identified. A spreadsheet with typical countermeasures and locations can be used to tabulate these improvements (Figure 4.3). Each route can be assigned one or more countermeasure.

Jurisdiction:					**Road Name:**						**Route:** D						**Date:**		
Road Class: Rural Local				**ADT:**		**85th Speed:**			**Road Surface:** Asphalt										
LOCATION	PAVEMENT MARKINGS	STOP R1-1	STOP AHEAD W3-1	CURVE W1-1 (90°)	CURVE W1-2	CHEVRON W1-8	WINDING ROAD W1-5	INTERSECTION W2-1	INTERSECTION W2-2 (T)	PAVEMENT ENDS W8-3	OBJECT MARKER OM-3	SPEED LIMIT 20 R2-1	SPEED LIMIT 35 W13-1	ARROW W1-7	ROAD NARROWS W5-1	OPEN RANGE	SHOULDER DROP OFF W8-9A	OTHER SIGN	COMMENTS
0	CL																1		
0.1											4	At Bridge		1					Relocate & Replace
0.6							1	West Side											double arrow to end of int.
0.7						6													Double Chevrons (12)
1.0																			
1.0																	1		
1.1			1	West Side															
1.2	↓																		
TOTAL		0	1	0	0	6	1	0	0	0	4	0	0	1	0	0	2	0	
TOTAL SIGNS =			15																

Figure 4.3 Example Level II Field Evaluation Countermeasures Assigned

Once all routes have been evaluated and improvements identified, a cost is estimated. This information is used to perform the benefit-cost analysis.

4.1.5 Benefit-Cost Analysis

Based on the selected countermeasures and associated costs, a benefit-cost analysis is performed for each project. If the project is set up for each road, then all the improvements identified for that road are included in the estimate. This provides the tribes information on the most effective safety improvements. Construction costs are estimated for the safety improvements.

A benefit value associated with each improvement is calculated based on crash reduction factors (CRF) and societal costs of crashes. The CRF is an estimation of the percent reduction of crashes expected from the implementation of the associated countermeasure. Other factors must be considered that apply specifically to the site. The benefit is calculated using the CRF assigned to the particular countermeasure and the cost of that type of crash being avoided (Equation 4.1). Values for fatal, injury, and PDO crashes are assigned and can be obtained from federal or state sources. When two or more countermeasures are applied to a site, then a weighted combined value is calculated (Equation 4.2).

$$\begin{aligned} Benefit = \; & (\#PDO\ Crashes \times PDOCRF \times PDO\ Crash\ Cost) \\ & + (\#Injury\ Crashes \times Injury\ CRF \times Injury\ Crash\ Cost) \\ & + (\#Fatal\ Crashes \times Fatal\ CRF \times Fatal\ Crash\ Cost) \end{aligned}$$

Equation 4.1 Benefit

$$Combined\ CRF = 1 - [(1 - CRF1) \times (1 - CRF2) \times \dots (1 - CRFn)]$$

Equation 4.2 Combined Crash Reduction Factor

It is helpful to develop a spreadsheet, such as the one used for the implementation on the WRIR, to perform the calculations for each countermeasure that are applied to one roadway or project. The ratio of calculated benefit of the countermeasure to the estimated construction cost is then calculated. If any ratio is less than 1.0, it should not be considered because the benefit is actually decreased by the countermeasure. In other words, the countermeasure is increasing the hazard.

Once the benefit-cost analysis is completed for each site, a recommended prioritized list of improvements is provided to the tribes for their review and approval. Several methods can be employed to identify priorities among the projects such as net present value or an incremental benefit-cost analysis among other prioritization and optimization methods.

Once the tribes have agreed upon the improvements, they can determine what resources they want to allocate to these projects. For the low-cost improvements, the state can provide HSIP funds under the HRRRP. Although the new transportation authorization does not specifically mandate the old criteria, the states are still responsible to provide funding for these types of projects.

4.2 Summary

This section lays out the five-step methodology designed to assist tribal governments with developing a safety improvement program. Understanding that tribes have unique challenges and cultural differences, collaboration between their members, government agencies, and other safety stakeholders is key to successfully implementing such programs. Starting with a review of crash data provides trends attributed to the crashes and identification of hot spots is necessary to know where to look for roadway improvements. A priority ranking is determined based on the high crash locations.

The top locations are considered for field evaluation. The field evaluation provides a scoring of the locations based on the roadway conditions. These locations are then ranked according to the worst condition to best. Then the crash rank and the Level I field evaluation rank are combined to provide a new list of priority locations.

The whole road is considered for a Level II evaluation to determine countermeasures for the hot spot locations. Countermeasures are identified and tabulated for each road. Construction cost estimates are calculated for the safety improvement projects determined from the countermeasures. Low-cost improvements include pavement markings, signage, and delineators. Other improvements should be considered as well such as culvert widening and guardrail installation. The tribes can determine whether to pursue all or part of the proposed improvements.

The benefit of installing each countermeasure is calculated based on CRFs and crash costs. A benefit-cost ratio (BCR) is then calculated. Projects with large benefit-to-cost ratios should be considered first for implementation. A high benefit-to-cost ratio indicates that for a small investment of funds there is potential for reduction in fatal and injury crashes. The following chapter discusses this methodology in detail, applying it to the Wind River Indian Reservation.

5. IMPLEMENTATION

5.1 Wind River Indian Reservation

The methodology herein described was implemented on the Wind River Indian Reservation (WRIR). This report provides insight to the challenges and opportunities that exist for Indian reservations in implementing a traffic safety improvement program. It provides the opportunity to test the applicability and identify any modification necessary to provide a process useful to tribes across the country.

The WRIR consists of the Eastern Shoshone and Northern Arapaho Tribes who operate their own transportation program and contract with the Bureau of Indian Affairs (BIA) for some transportation functions (NCHRP, 2007). The reservation has a land area of approximately 2.2 million acres, which encompasses about one-third of Fremont County and one-fifth of Hot Springs County. The Wind River 2011 Road Inventory Summary lists a total BIA inventory of 1,227.8 miles of roadway, of which 174.7 miles is paved. Like many other tribal governments, they work with limited resources to manage and maintain their roadway system. Many of the county roads (over 400 miles) are jointly maintained by WRIR transportation and the county road and bridge department. The state maintains roughly 200 miles of U.S. and state highways on the reservation.

The transportation director of the WRIR has worked extensively to coordinate with various government agencies to access funding and resources available to improve the WRIR roadway safety. Efforts between the WRIR transportation authorities, WYDOT, and WYT^2/LTAP became more focused in the fall of 2011 when meetings were held to develop a safety improvement program for high-risk crash locations on the reservation. From this, several efforts were launched between the agencies to further develop the WRIR safety program.

The first step in developing a methodology appropriate for Indian reservations is communication and coordination with the tribes. Several meetings were held between transportation officials from the WRIR, WYDOT, Northern Plains Tribal Technical Assistance (NPTTAP), WYT^2/LTAP, BIA, and Wind River law enforcement. These meetings proved productive and established the necessary protocols to proceed. Early meetings opened the lines of communication and identified the expectations from all parties. The WRIR is eager to expand their capabilities to address transportation safety on the reservation and have since extended the scope of the collaboration to the development of a strategic transportation safety plan.

The methodology previously described was presented at these meetings. Feedback was provided by the reservation and its consultants. WRIR transportation personnel identified the need to include behavioral safety improvements. They also agreed that the field evaluation teams needed to include various tribal stakeholders. Responsibilities were further defined to include the appropriate stakeholders in the process. The methodology flowchart in Figure 4.1 reflects the input from the tribes that fosters the collaborative effort needed for the success of the program.

Three areas of responsibility were assigned to the process. WYT^2/LTAP, a Field Review Team, and a Tribal Safety Council would be formed to carry out the responsibilities. WYT^2/LTAP was responsible for performing the crash analysis, crash ranking, Level I field ranking, and combined ranking, as well as identifying crash types, determining accident reduction factors, performing the benefit/cost analysis, and conducting the after studies. The field review team was selected by the tribes to include WYT^2/LTAP, tribal transportation and its consultant, and tribal law enforcement. This team was responsible for conducting the Level I and Level II field evaluations and identifying engineering and behavioral safety improvement alternatives. A tribal safety council was not formally organized, but consisted of coordination of program status and review of field results by tribal transportation officials along with tribal leadership. The involvement of the tribal safety council begins with input on high-risk locations. They complete their project review by identifying budget constraints and determining which safety improvement projects to recommend for funding.

5.2 Applied Methodology

Once the described methodology was reviewed and approved by the WRIR tribal transportation director, plans were made to proceed with the implementation of the methodology. WYT^2/LTAP prepared the crash data and coordinated the efforts between the different agencies. Through the implementation, IRR roads were not recognized initially for improvements because of the lack of crash locations. The methodology was revised for IRR roads based on feedback from the tribes and a systemic approach was used to address safety improvements on these roads. See Figure 5.1.

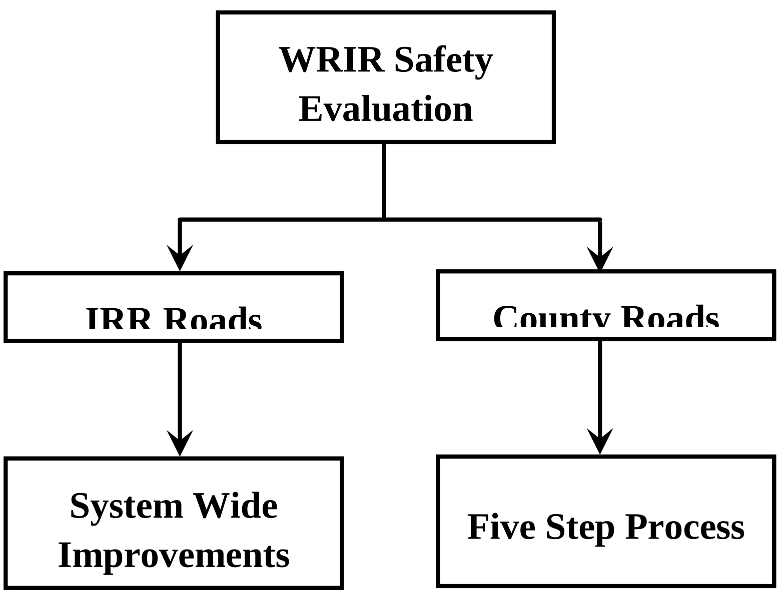

Figure 5.1 Revised Methodology for IRR Roads

5.2.1 WRIR Crash Data

The analysis of crash data is the first step in the roadway safety program methodology. Safety goals and strategies are driven by data that document the safety problems. Many factors must be reviewed to determine appropriate safety measures and the four E's of safety (Engineering, Education, Enforcement, and Emergency response) must be considered.

The analysis and subsequent ranking proceeded using the crash analysis described above. The crash analysis database only produced crash locations on county roads on the reservation. As discussed previously, a discrepancy exists with the ability of the system to identify IRR crash locations because the state inventory does not include them. The inventory is what links the crash data to a location. This was brought to the attention of the tribal transportation personnel and discussions concluded to proceed with the county roads and IRR roads simultaneously to try to reconcile at a later date.

The road segments were then sorted by the highest number of crashes per one-mile segment. Ranking was assigned starting at the number one (1). Progressing through the list, equal scores received equal rank. However, the next rank number would be that associated with the total number of segments so far ranked. The ranking can be observed in Table 5.1.

The top 24 roads were selected for Level I field evaluation and included roads that had three (3) or more crashes per one-mile segment. Seventeen Mile Road has some of the highest number of crashes per mile, but was removed from the ranking since a TIGER grant roadway improvement construction project for this road had recently been approved. The roads ranked by crashes are listed in Table 5.2.

Table 5.1 County Road Crash Ranking on WRIR

Row No.	County Route	IRR Route	Road Name	Beg MP	End MP	Total Crashes	Crash Rank
1	54	169	Riverview Road	2.01	3	18	1
2	54	169	Riverview Road	7.01	8	12	2
3	385	385	Eight Mile Road	5.01	6	12	2
4	54	169	Riverview Road	4.01	5	9	4
5	320	132	Burma Road	0	1	9	4
6	346	72	South Fork Road	0	1	9	4
7	320	132	Burma Road	5.01	6	8	7
8	335	52	Ethete Road	0	1	8	7
9	385	385	Eight Mile Road	1.01	2	8	7
10	385	385	Eight Mile Road	4.01	5	8	7
11	320	132	Burma Road	1.01	2	7	11
12	320	132	Burma Road	4.01	5	7	11
13	335	52	Ethete Road	1.01	2	7	11
14	54	169	Riverview Road	3.01	4	6	14
15	54	169	Riverview Road	6.01	7	6	14
16	315	315	Paradise Valley Road	4.01	5	6	14
17	320	132	Burma Road	3.01	4	6	14
18	335	52	Ethete Road	5.01	6	6	14
19	345	B029	North Fork Road	3.01	4	6	14
20	385	385	Eight Mile Road	2.01	3	6	14
21	54	169	Riverview Road	5.01	6	5	21
22	272	141	Hutchinson Road	0	1	5	21
23	345	B029	North Fork Road	2.01	3	5	21
24	346	72	South Fork Road	2.01	3	5	21
25	367	367	Pingetzer Road	0	1	5	21
26	12	CO12	Williams Road	1.01	2	4	26
27	54	169	Riverview Road	1.01	2	4	26
28	320	132	Burma Road	2.01	3	4	26
29	335	52	Ethete Road	3.01	4	4	26
30	335	52	Ethete Road	4.01	5	4	26
31	335	52	Ethete Road	6.01	7	4	26
32	345	B029	North Fork Road	1.01	2	4	26
33	360	162	Country Acres Road	1.01	2	4	26
34	385	385	Eight Mile Road	7.01	8	4	26
35	480	170	Kinnear Spur Road	1.01	2	4	26
36	496		Zuber Road	0	1	4	26
37	273		Cliff Drive	0	1	3	37
38	315	315	Paradise Valley Road	0	1	3	37
39	333	333	Elkhorn Drive	0	1	3	37

Table 5.2 County Road High Risk Crash Locations on WRIR

Rank	WYDOT Route	County Route	Road Name	Total Crashes	Max Hot Spot	Fatalities	Injuries	Length (miles)	Crash Rate/ Mile
1	ML5716	54	Riverview	67	18	3	32	23	2.9
2	ML5827	334	Seventeen Mile	105	12	11	84	13	8.1
3	ML5849	385	Eight Mile	48	12	1	17	10	4.8
4	ML5813	320	Burma	45	9	1	27	9	5.0
5	ML5836	345	North Fork	19	6	1	20	6	3.2
6	ML5837	346	South Fork	18	9	0	20	5	3.6
7	ML5828	335	Ethete	40	8	2	26	10	4.0
8	ML5807	315	Paradise Valley	22	6	0	8	11	2.0
9	ML5875	428	North Pavillion	7	5	0	3	7	1.0
10	ML5783	272	Hutchinson	6	5	0	1	2	3.0
11	ML5848	367	Pingetzer	5	5	0	5	1	5.0
12	ML5916	496	Zuber	5	4	0	1	2	2.5
13	ML5838	347	Trout Creek	8	4	1	5	4	2.0
14	ML5844	360	Country Acres	5	4	0	6	2	2.5
15	ML5891	463	Peterson	6	4	0	0	4	1.5
16	ML5902	480	Kinnear Spur	7	4	0	2	2	3.5
17	ML5784	273	Cliff Drive	4	4	0	0	2	2.0
18	ML5825	333	Elkhorn Drive	4	4	0	2	2	2.0
19	ML5876	430	Bass Lake	18	3	1	4	12	1.5
20	ML5822	300	East Pavillion	6	3	0	2	5	1.2
21	ML6216	1	Owl Creek	7	3	0	4	15	0.5
22	ML5823	331	Buckhorn Flats	5	3	0	1	7	0.7
23	ML5831	339	Two Valley	7	3	0	8	6	1.2
24	ML5697	12	Williams	5	3	0	4	2	2.5

Additionally, a GIS map was produced showing the crash locations and indicated them by Fatal, Injury, or PDO crashes (refer to Appendix 1). The map was a useful tool to capture both the magnitude and patterns of the crashes.

5.2.2 WRIR Level I Field Evaluation

After consultation with the tribes, each of the 24 roads selected were evaluated in one-mile segments. Five categories were evaluated; general roadway conditions, intersections, signage and pavement markings, fixed objects and clear zone, and shoulder and right-of-way.

The same criterion that was used to score the segments in the WRRSP was used for the WRIR. This is because these efforts will be coordinated with the state and counties to provide consistency in collaborative efforts to implement improvements. Each category was evaluated separately for each one-mile segment assigning a score of 0 to 10 for each category. Zero (0) would be the worst condition and 10 would be the best. The starting level is five (5). For each segment, the score is totaled for all six categories providing a final score per segment.

The five categories were evaluated based on the following criteria:

1. General:
    - Presence of sharp horizontal or vertical curve
    - Visibility
    - Pavement defects that could result in safety problems
    - Ponding or sheet flow areas that could result in safety problems
    - Presence of loose aggregate/gravel that could cause safety problems

2. Intersection and Rail Road Crossings:
    - Intersections free of sight restrictions that could result in safety problems
    - Intersections free of abrupt changes in grade or conditions
    - Presence of advanced warning signs when intersection traffic control sight restrictions exist
    - Presence of railroad crossing signs at RR crossing approach
    - Presence of railroad advanced warning signs when crossing sight restrictions exist
    - Vegetation and other obstructions restricting sight distance at railroad crossing
    - Roadway approach grade at railroad crossing level enough to prevent snagging

3. Signage and Pavement Markings:
    - Signing present at appropriate locations to improve safety
    - Presence of unnecessary signage that may cause a safety problem
    - Effective signage for existing conditions
    - Presence of pavement markings
    - Presence of ineffective pavement markings for present conditions
    - Presence of old or faded pavement markings affecting the safety of the roadway
    - Presence of needed delineators
    - Presence of improper or unsuitable delineators

4. Fixed Objects and Clear Zone:
    - Clear zones free of hazards, non-traversable side slopes without safety barriers
    - Presence of narrow bridges or cattle guards
    - Presence of culverts with inadequate extensions

5. Shoulder and right-of-way:
    - Standard shoulder width
    - Slope greater than 3:1
    - Presence of hazards along shoulder
    - High rollover potential

The spreadsheets developed for each roadway for Level I can be observed in Appendix 2. This process is very subjective. The evaluating team consisted of three individuals. One member from WYT^2/LTAP, one tribal transportation member, and one BIA engineering consultant comprised the team, which was selected by the tribes. Each individual evaluated each roadway, and the values were combined and averaged. By evaluating all roads together with the same team members, the results would be consistent.

This process was repeated for each segment of each roadway that was selected from the crash ranking. Each roadway ranged from one mile up to 23 miles long. Field decisions were made by WRIR team members to reduce the length evaluated based on knowledge of recent or upcoming construction and maintenance that would address safety issues. Looking at the hot spots in the context of the entire roadway is a practical approach to address roadway safety improvements. For example, if the field evaluation reveals that the roadway is in poor condition, pavement markings are missing, or shoulders are narrow, the improvement would not only be applied to the hot spot, but to the entire portion of the roadway.

Once evaluation of all the roads was complete, the segment scores were tabulated. The combined score for each segment was assigned and the segments were sorted from lowest to highest score. From this, ranking was assigned starting at the number one (1). Progressing through the list, equal scores received equal rank. The next rank number would be that associated with the total number of segments ranked so far. Table 5.3 summarizes the Level I ranking.

Table 5.3 County Road Level I Ranking on WRIR

Row No.	County Route	Road Name	Beg MP	End MP	Total Crashes	Level I Score	Level I Rank
1	273	Cliff Drive	0.0	1.0	3	18	1
2	335	Ethete Road	5.01	6.0	6	20	2
3	335	Ethete Road	7.01	8.0	2	20	2
4	339	Two Valley Road	2.01	3.0	0	21	4
5	347	Trout Creek Road	3.01	4.0	2	21	4
6	335	Ethete Road	8.01	9.0	1	22	6
7	347	Trout Creek Road	0.0	1.0	1	23	7
8	347	Trout Creek Road	1.01	2.0	2	23	7
9	331	Buckhorn Flats Road	1.01	2.0	0	24	9
10	335	Ethete Road	6.01	7.0	4	24	9
11	335	Ethete Road	9.01	10.0	1	24	9
12	345	North Fork Road	5.01	6.0	1	24	9
13	346	South Fork Road	2.01	3.0	5	24	9
14	480	Kinnear Spur Road	0.0	1.0	3	24	9
15	345	North Fork Road	4.01	5.0	1	25	15
16	463	Peterson Road	0.0	1.0	2	25	15
17	463	Peterson Road	1.01	2.0	2	25	15
18	463	Peterson Road	2.01	3.0	1	25	15
19	480	Kinnear Spur Road	1.01	2.0	4	25	15
20	1	Owl Creek Road	2.01	3.0	0	26	20
21	1	Owl Creek Road	3.01	4.0	2	26	20
22	330	East Pavillion Road	1.01	2.0	2	26	20
23	339	Two Valley Road	4.01	5.0	2	26	20
24	345	North Fork Road	0.0	1.0	2	26	20
25	345	North Fork Road	2.01	3.0	5	26	20
26	346	South Fork Road	3.01	4.0	1	26	20
27	347	Trout Creek Road	2.01	3.0	3	26	20
28	1	Owl Creek Road	4.01	5.0	1	27	28
29	1	Owl Creek Road	5.01	6.0	2	27	28
30	1	Owl Creek Road	6.01	7.0	0	27	28
31	54	Riverview Road	6.01	7.0	6	27	28
32	272	Hutchinson Road	0.0	1.0	5	27	28
33	315	Paradise Valley Road	9.01	10.0	2	27	28
34	345	North Fork Road	1.01	2.0	4	27	28
35	367	Pingetzer Road	0.0	1.0	5	27	28
36	463	Peterson Road	3.01	4.0	1	27	28
37	54	Riverview Road	2.01	3.0	18	28	37
38	54	Riverview Road	5.01	6.0	5	28	37
39	339	Two Valley Road	0.0	1.0	1	28	37

5.2.3 Combining the Crash Ranking and the Level 1 Ranking

With a list of all the segments ranked by highest number of crashes and lowest Level I score, the two rankings were combined. This was done by sorting each route and adding the respective ranks for the respective segment. Appendix 3 provides the combined ranking for all roadway segments.

Once these were all totaled, the segments were sorted from smallest to largest combined rank value. The road segments with the lowest score were used to select the roads that would be evaluated for safety improvements. Table 5.4 is a list of the top 12 roads with their respective combined ranking.

Table 5.4 County Roads Selected for Level II Evaluation on WRIR

County Route	Road Name	Beg MP	End MP	Crash Rank	Level 1 Rank	Combined Rank
335	Ethete Road	5.01	6.0	14	2	16
346	South Fork Road	2.01	3.0	21	9	30
54	Riverview Road	2.01	3.0	1	37	38
273	Cliff Drive	0.0	1.0	37	1	38
345	North Fork Road	2.01	3.0	21	20	41
480	Kinnear Spur Road	1.01	2.0	26	15	41
272	Hutchinson Road	0.0	1.0	21	28	49
367	Pingetzer Road	0.0	1.0	21	28	49
347	Trout Creek Road	3.01	4.0	47	4	51
320	Burma Road	0.0	1.0	4	50	54
463	Peterson Road	0.0	1.0	47	15	62
385	Eight Mile Road	1.01	2.0	7	57	64

5.2.4 WRIR Level II Field Evaluation

Twelve roads were selected by the team from the 24 based on the combined ranking to be evaluated for countermeasures. WRIR transportation reviewed the list and agreed to proceed with the Level II evaluation of these roads. At this time, the WRIR transportation director requested that 16 IRR roads be evaluated as well for safety improvements. These roads were identified by WRIR as having several crashes and known fatalities. As previously noted, the crash data did not contain locations for the crashes on these roads, but did contain information that crashes had occurred on IRR roads. Therefore, a similar evaluation was proposed for the 16 IRR roads identified by WRIR transportation.

Each selected road was reviewed as a whole along with the identified hot spots. Many of the countermeasures are site specific and would be applied to these hot spot locations. Other countermeasures would include pavement marking, vegetation clearing, or other improvement that would be applied to an entire portion of roadway. Based on the Level I evaluation and crash data, countermeasures were identified for each road. This was a collaborative exercise that entailed making decisions as a team on what can and should be done for the various locations.

A spreadsheet was set up for each roadway that included standard countermeasures, typically signs, and was broken in one-tenth mile segments. As each road was driven and possible improvements were identified, these were recorded on the spreadsheet. A spreadsheet for each road was created and all possible improvements identified. This was accomplished for each of the 12 county roads and the 16 IRR roads. See Appendix 4.

Many of the countermeasures included pavement marking and signage. Several roads are narrow with no shoulder and steep slopes. Future long-term improvements would include rebuilding these roads. These types of projects would require acquiring right-of-way and major reconstruction. These types of improvements are not within the scope of the High Risk Rural Road Program designed to provide funding for low-cost improvements. However, several were noted and were provided to the tribes for future consideration.

5.2.5 WRIR Benefit-Cost Analysis

Once the safety improvements were identified, WYT^2/LTAP proceeded with the benefit-cost analysis. Based on countermeasures provided by FHWA in their Desktop Reference for Crash Reduction Factors (FHWA, 2008), the improvements were matched with the countermeasures and crash reduction factors (CRF) were assigned. The countermeasures and their respective reduction factors are listed in Table 5.5.

Table 5.5 Countermeasures and Respective CRFs used for WRIR Safety Improvements

Countermeasures	Crash Type	Crash Reduction Factors			Service Life
		Fatal	Injury	PDO	
Install guide signs (general)	All	15%	15%	15%	5
Install advance warning signs	All	40%	40%	40%	5
Install chevron signs on horizontal curves	All	35%	35%	35%	5
Install curve advance warning signs	All	30%	30%	30%	5
Install delineators (general)	All	11%	11%	11%	4
Install delineators (on bridges)	All	40%	40%	40%	4
Install edge lines, centerlines and delineators	All	0%	45%	0%	4
Install centerline markings	All	33%	33%	33%	2
Improve sight distance to intersection	All	56%	37%	0%	15
Flatten crest vertical curve	All	20%	20%	20%	15
Flatten horizontal curve	All	39%	39%	39%	15
Improve horizontal and vertical alignments	All	58%	58%	58%	15
Flatten side slopes	All	43%	43%	43%	15
Install guardrail (at bridge)	All	22%	22%	22%	10
Install guardrail (at embankment)	All	0%	42%	0%	10
Install guardrail (outside curves)	All	63%	63%	0%	10
Improve guardrail	All	9%	9%	9%	10
Improve super-elevation	All	40%	40%	40%	15
Widen bridge	All	45%	45%	45%	15
Install shoulder	All	9%	9%	9%	5
Pave shoulder	All	15%	15%	15%	5
Install transverse rumble strips on approaches	All	35%	35%	35%	3
Improve pavement friction	All	13%	13%	13%	5
Install animal fencing	Animal	80%	80%	80%	10
Install snow fencing	Snow	53%	53%	53%	10

The cost of a countermeasure is calculated based on present construction costs (Equation 5.1). A simplified cost adjustment was used to provide a normalized cost value. Present worth of future costs was not considered. The cost estimates are preliminary in nature and do not provide the level of detail used for final project development. Since the crash analysis was performed for a 10-year period, all countermeasures were converted to a 10-year cost. For example, if a countermeasure had a service life of five years, the current construction cost would be two times the cost of one application.

$$Cost = \frac{10\ years}{service\ life} \times Present\ Cost$$

Equation 5.1 Cost Adjustment to Service Life

Cost estimates were developed based on WYDOT 2011 bid tabs and WYT^2/LTAP resources from other similar safety improvements and were categorized by the selected countermeasures. The total cost was calculated for each road and compared to an overall benefit in crash reduction for the entire roadway. This was done for each county and IRR road. Table 5.6 and Table 5.7 contain the results of the initial estimates developed for the county and IRR roads.

The benefit-cost analysis proceeded for the county roads. Since the calculated benefit is based on the number and severity of crashes at a location, this analysis could not proceed for the specified IRR roads. However, as the evaluations have demonstrated, the IRR roads and county roads had similar conditions. The results of the benefit-cost analysis could be assumed to be similar between the IRR roads and the county roads.

Table 5.6 WRIR County Roads Safety Improvement Estimates

WRIR County Roads Safety Improvements by Project Type						
Project Type	Ethete	South Fork	Riverview	Cliff*	North Fork	Kinnear Spur
Signs	$10,800	$6,400	$4,400	$2,400	$6,800	$4,100
Pavement Marking	$0	$0	$4,224	$0	$6,825	$0
Trans. Rumble Strip	$500	$0	$0	$0	$0	$0
Clear Vegetation	$0	$0	$0	$0	$5,550	$0
Guard Rail	$0	$18,000	$0	$0	$0	$0
Hazard Flashers	$0	$0	$25,000	$0	$0	$0
Extend Culvert	$3,750	$0	$0	$0	$0	$0
Total	$15,050	$24,400	$33,624	$2,400	$19,175	$4,100
Project Type	Hutchinson	Pingetzer*	Trout Creek	Burma	Peterson*	Eight Mile
Signs	$1,800	$3,100	$8,500	$400	$5,200	$2,400
Pavement Marking	$0	$0	$5,280	$6,336	$0	$0
Trans. Rumble Strip	$0	$0	$0	$0	$0	$500
Clear Vegetation	$0	$0	$0	$0	$3,000	$150
Guard Rail	$0	$0	$0	$0	$0	$0
Hazard Flashers	$0	$0	$0	$0	$0	$0
Extend Culvert	$0	$0	$0	$0	$0	$0
Total	$1,800	$3,100	$13,780	$6,736	$8,200	$3,050

*Unpaved

Table 5.7 WRIR IRR Roads Safety Improvement Estimates

WRIR IRR Roads Safety Improvements by Project Type								
Project Type	Cemetery	Stuart*	Old WR Hwy	Dead Horse	Yellow Calf	Shipton	Thunder	Trosper
Signs	$1,200	$6,900	$2,800	$4,400	$1,200	$3,200	$1,600	$1,200
Pavement Marking	$0	$0	$3,168	$0	$0	$0	$0	$0
Trans. Rumble Strip	$0	$0	$0	$0	$0	$0	$0	$500
Clear Vegetation	$0	$0	$0	$0	$0	$0	$500	$0
Guard Rail	$0	$0	$0	$0	$0	$0	$0	$0
Total	$1,200	$6,900	$5,968	$4,400	$1,200	$3,200	$2,100	$1,700
Project Type	Mill Creek	Gibbons	Little WR	LH Ditch	C'Hare	Goes In Lodge	St Clair Spur	Shoyo
Signs	$1,600	$2,400	$2,000	$5,300	$2,800	$5,600	$2,800	$4,000
Pavement Marking	$2,957	$2,323	$3,168	$0	$4,435	$0	$0	$0
Trans. Rumble Strip	$0	$0	$0	$500	$0	$500	$0	$0
Clear Vegetation	$0	$0	$0	$0	$0	$0	$13,464	$0
Guard Rail	$0	$0	$0	$63,000	$0	$0	$0	$0
Total	$4,557	$4,723	$5,168	$68,800	$7,235	$6,100	$16,264	$4,000

*Stuart Road is unpaved for 0.5 mile

The benefit is calculated based on societal crash costs. It represents the "cost savings" of crashes reduced. A value is assigned to each type of crash severity (fatal, injury, or PDO). The values used for this analysis are those used by WYT^2/LTAP for all safety improvements across the state of Wyoming and were obtained from WYDOT. The following table lists these values (Table 5.8).

Table 5.8 Societal Crash Costs

Crash Cost	
Fatal	$2,500,000
Injury	$60,000
PDO	$6,000

The benefit is equal to the sum of the number of each crash type that is recorded for that roadway multiplied by its respective societal crash cost and crash reduction factor (Equation 5.2). For a combined CRF for the site, the CRF are multiplied to produce a combined value that is included in the benefit equation for the respective crash type (Equation 5.3). Benefit-cost analysis spreadsheets for the county roads are located in Appendix 5.

$$\begin{aligned} Benefit = {} & (\#PDO\ Crashes\ \times PDOCRF\ \times PDO\ Crash\ Cost) \\ & + (\#Injury\ Crashes\ \times Injury\ CRF\ \times\ Injury\ Crash\ Cost) \\ & + (\#Fatal\ Crashes\ \times Fatal\ CRF\ \times Fatal\ Crash\ Cost) \end{aligned}$$

Equation 5.2 Benefit

$$Combined\ CRF = 1 - [(1 - CRF1) \times (1 - CRF2) \times \ldots (1 - CRFn)]$$

Equation 5.3 Combined Crash Reduction Factor

To demonstrate, Pingetzer Road has two countermeasures identified: general installation of delineators along roadway and installation of delineators at a bridge (Appendix 5). The CRFs for these two countermeasures are 0.11 and 0.40, respectively, for all types of crashes. The combined CRF for each type of crash is then 0.466. There were zero (0) fatal, five (5) injury, and two (2) PDO crashes recorded for this roadway segment. From Equation 5.2, the total benefit for the application of the two countermeasures is $145,392. At a cost of $2,800 and $300, and each having a service life of four years, the total cost for the installation of delineators is $7,750, which yields a B/C ratio of 18.76.

The ratio of benefit-to-cost was calculated for all roadway segments identified in Table 5.6. Values less than 1.0 would indicate that there is no benefit in the improvement and the project should be eliminated. None of the roads fell into this category. The roads had a ratio ranging from 2.0 to as high as 399.46. These higher values were surprising since, typically, benefit-cost ratios are usually between 1 and 100. A closer look at the roads over 100 reveals that many of the improvements are very low cost, but the benefit of the lives saved and injuries prevented is substantial.

Table 5.9 lists the projects with the benefit-to-cost analysis results and ranking. An incremental benefit-to-cost analysis ranking was performed as defined in the Highway Safety Manual, Section 8 (American Association of State Highway and Transportation Officials, 2010).

Table 5.9 WRIR Benefit-Cost Analysis Results on County Roads

Road	Benefit	Cost	B/C Ratio	Incremental BCR Rank
Riverview Road	$7,155,772	$44,360	161.31	1
North Fork Road	$3,585,894	$36,863	97.28	2
Eight Mile Road	$2,962,691	$7,417	399.46	3
Ethete Road	$2,657,358	$27,017	98.36	4
Trout Creek Road	$2,421,742	$30,900	78.37	5
Burma Road	$1,262,850	$16,640	75.89	6
South Fork Road	$1,117,816	$31,600	35.37	7
Pingetzer Road	$145,392	$7,750	18.76	8
Kinnear Spur Road	$130,447	$8,100	16.10	9
Cliff Road	$14,281	$5,600	2.55	10
Hutchinson Road	$57,600	$3,400	16.94	11
Peterson Road	$29,137	$14,600	2.00	12

The projects were arranged in increasing order of estimated cost. Beginning with the first two projects, the incremental BCR was calculated. Equation 5.4 was used to calculate the incremental benefit-cost ratios. If the incremental BCR is greater than one (1), then the higher cost project is compared with the next project on the list. If it is less than one (1), the lower cost project is then used to compare with the next project on the list (American Association of State Highway and Transportation Officials, 2010). This process was repeated through the last pairing of projects. The final project selected is the first priority.

$$Incremental\ BCR = \frac{B\ of\ Project\ 2 - B\ of\ Project\ 1}{C\ of\ Project\ 2 - C\ of\ Project\ 1}$$

Equation 5.4 Incremental Benefit-to-Cost Analysis

5.2.6 IRR Roads

As discussed previously, the crashes on IRR roads had no specific locations and they were analyzed separately to identify trends. Crash severity is higher on the reservation than throughout the state and fixed objects are the highest first harmful event (FHE) with most crashes occurring off the roadway. For the FHE, the analysis showed that the percent of crashes was 19% with animals, 31% with fixed objects, and 23% were non-collision. For the FHE location, 68% of the crashes were off the roadway. These trends indicate that run-off-the-road crashes are prevalent on the IRR roads and animals and fixed objects in the clear zone are the greatest risk. Of the 166 crashes that occurred on IRR roads, there were nine fatalities and 62 injuries. These statistics warrant further investigation into crash location. These trends will be used in combination with the field evaluation to determine safety improvements.
The methodology was revised for this contingency.

For IRR roads, or roads without crash locations, the methodology was followed for the field evaluations only and system wide improvements were identified. Figure 5.1 illustrates the revised methodology used to identify safety improvements on the IRR Roads.

During the Level II field evaluation, the 16 IRR roads selected by the tribes were similarly evaluated as the county roads. Utilizing the Level I spreadsheet, the IRR roads were driven by the team and given Level I scores per segment. At the same time, safety improvements were identified and discussed. These improvements were recorded on the Level II spreadsheet.

These roads can be given a Level I score, but there is no way to tie crash data directly to them. Since these roads are similar in quality as the county roads and based on the tribe's knowledge of crashes on these roads, a systemic approach to improvements was proposed. Referring back to the crash trends, run-off-the-road crashes were high as were the crashes with fixed objects. Based on the field evaluation, the systemic improvements proposed included improved signage at curves, intersections, bridges, and clearing vegetation in the right-of-way. The following system-wide improvements were proposed to the tribes (Table 5.10).

Table 5.10 Initially Proposed WRIR IRR System-Wide Improvements

IRR Roads System-Wide Improvements	
Project Type	Cost
Signs	$49,000
Pavement Marking	$16,051
Transverse Rumble Strip	$1,500
Clear Vegetation	$13,964
Guard Rail	$63,000
Total	$143,515

5.2.7 Funded Projects

The projects identified on county roads and the system-wide improvements for IRR were submitted to the tribal leadership for review and funding requests. The WRIR leadership decided to move forward with three system-wide improvements for the IRR roads. They determined that signs, pavement markings, and guardrails should be installed on the 16 IRR roads that were reviewed.

The team returned to the field and identified the specific locations where signs should be installed or replaced. The roads that needed pavement markings were identified and miles measured. And finally, its transportation staff and consultants provided locations for guard rail installation. The WYT^2/LTAP provided technical assistance to the tribes to develop the cost estimates and submit funding requests to WYDOT. The final system-wide improvement projects are listed in Table 5.11.

Table 5.11 Final WRIR System-Wide Improvements on IRR Roads

IRR Roads System-Wide Improvements	
Project	Cost
Signs	$140,114
Pavement Marking	$125,539
Guard Rail	$14,815
Total	$280,468

With help from WYT^2/LTAP, WRIR submitted applications to WYDOT for the low-cost safety improvements. Since these were system-wide improvements, no benefit-cost analysis was performed. The tribal joint business council approved the projects for submittal and provided a resolution to the state authorizing the tribal match of funds. WRIR intends to use its own labor force for the tribal match.

These applications were considered along with several other applications from counties around the state. The Safety Management System Committee (SMS) approved the projects for submission to the state transportation commission. They in turn approved the projects and WYDOT prepared contracts with the tribes. A copy of the three applications is included in Appendix 6.

Once the reservation has completed these projects, an analysis of crash data will be performed at least three years after the completion to determine the effectiveness of the countermeasure. The WYT^2/LTAP center will provide technical assistance to the tribes to perform the needed crash analysis.

5.3 Summary

The five-step methodology developed through this research was implemented on the WRIR. WYT^2/LTAP worked in collaboration with WRIR transportation personnel and BIA consultants. The methodology was revised for the IRR roads because crash locations could not be established. However, WRIR was aware of fatal and serious injury crashes on the IRR roads and identified 16 roads to review for system-wide safety improvements.

Three system-wide projects were submitted to WYDOT for funding. These included the installation of signage, pavement markings, and the installation of guardrails. The projects have been approved by the state and contracts have been issued. WRIR has completed one of the projects. The remaining two projects will be implemented in the summer of 2016. WYT^2/LTAP will provide after studies to determine the effectiveness of the improvements.

Coordinated efforts between the WRIR and Fremont County have been pursued to address the needed improvements on the county roads located on the reservation. Fremont County has initiated some improvements on the WRIR, but more collaboration is necessary to ensure consistent application of safety improvements throughout the reservation.

6. CRASH REPORTING FOR WRIR

Since crash data are critical to determining high-risk locations, it is imperative that remedies be applied to improve crash reporting. There were deficiencies found with the WRIR crash data and alternative measures were taken to overcome this in the initial implementation of the safety improvement program methodology. However, in order to have an effective program, crash reporting must be a priority.

6.1 Deficiencies Found

When the methodology was being first implemented on the WRIR, gaps were discovered in the crash reporting. Preliminary crash analysis was performed for an 11-year period from 2000 through 2010 and revealed a total of 245 crashes, including county roads with only six roads containing crash data. Of those roads, only 79 crashes were identified and 166 crashes were identified as occurring on IRR roads but had no associated location. The total number of crashes reported annually for the WRIR dropped sharply after 2006. Thus, several crashes had gone unreported and crashes on IRR roads could not be located. These issues were brought to one of the initial meetings between WRIR, WYDOT, TTAP, and WYT^2/LTAP. BIA law enforcement was also represented and they were able to address the issue with the low crash report numbers.

6.2 Unreported Crashes

The low number of reported crashes was determined to be a result of crash reports not being entered into the system. BIA had no means of submitting crashes into the WYDOT system. They had all the reports in hard copy files at the reservation.

Efforts among the tribal transportation personnel, Wind River law enforcement, WYDOT, and WYT^2/LTAP have resulted in the inclusion of all crash reports from the WRIR. WYDOT worked with the BIA to provide access to its system so that all future reports could be uploaded directly. WYT^2/LTAP collected the hard copy reports and delivered them to WYDOT. After several months, WYDOT was able to finish the upload of the backlog of reports.

6.3 Incompatible Inventories

With the additional crash data added to the WYDOT database, crash analysis was again performed. The new analysis was performed for the WRIR for a 10-year period from 2002 through 2011. There were a total of 673 crashes reported for the WRIR including IRR and county roads. The identity of where crashes occurred on IRR roads was still not included.

The discrepancy that exists was discussed by WYDOT staff and BIA consultants. The state system does not have the ability to identify IRR crash locations because they are not included in the state inventory. The BIA has a different numbering system of its routes. Its inventories were kept in spreadsheet form.

However, the BIA has contracted to have the entire roadway inventory transformed into a GIS. Once this is completed, base maps can be shared between the WRIR and WYDOT and the routes can be linked to the crash database. The WRIR has been working on this system and should have it completed in the near future. Once that is done, WYT^2/LTAP will assist the WRIR to get the needed information to WYDOT.

6.4 Remaining Challenges

Many of the gaps in the original WRIR crash reporting have been resolved or are in the process of being so. What remains for the WRIR is to be able to retain resources to keep the crash reporting up to date. This may be challenging since the BIA is responsible for law enforcement and they may not always be able to apply the necessary resources. In addition, new people must be trained as turnover occurs. This has been a challenge for other Indian reservations.

The WRIR has taken proactive measures to ensure quality data collection and reporting. They understand the need for complete and accurate crash reporting. They have included it as a safety issue emphasis area in their strategic highway safety plan and have developed strategies to address it.

6.5 Summary

The deficiency of crash data on the WRIR was due to two problems. One, several crash reports had never been uploaded to the WYDOT database. This was quickly resolved through coordinated efforts between WYDOT and BIA law enforcement by getting its system connected to WYDOT and the backlog of hard copy reports uploaded.

The second problem with the gaps in crash data is the identification of crash locations on IRR roads. This is due to the conflicting inventories of WRIR and WYDOT. The WRIR has hired a consultant to inventory its entire roadway system and have it transformed into a GIS. When this work is complete, the WYDOT crash database can link to the IRR route numbers.

Follow-up with the tribes needs to occur to ensure that the new inventory is complete. The WRIR inventory and base maps must be obtained and delivered to WYDOT. WYT2/LTAP will follow up with the WRIR and deliver the necessary information to WYDOT.

7. WRIR STRATEGIC HIGHWAY SAFETY PLAN

The FHWA sent applications in 2011 to all tribes across the country to participate in a pilot tribal Transportation Safety Management Program (TSMP). This program was set up by FHWA to assist tribes with the implementation of a comprehensive safety program in partnership with their involved safety organizations. WYT^2/LTAP provided assistance with the application and the WRIR was selected as one of three pilots.

The WRIR received notification from FHWA in February 2012 that it were selected to participate in the pilot tribal TSMP. The kickoff meeting for the development of the TSMP was conducted in April 2012. FHWA, tribal leaders, BIA, WYDOT, WYT^2/LTAP, and the National Highway Transportation Safety Administration (NHTSA) were among the participants. Although participation was high, some key stakeholders were not present, including law enforcement, emergency and health services, and Fremont County. The meeting proceeded with input from tribal leadership and transportation personnel on the importance of recognizing safety needs. A vision and mission were established, safety issues were identified, strategies were developed to target the issues, and a partnership agreement was drafted. The following provides an overview of each step.

7.1 Vision, Mission, and Goals

The tribal community engaged in the process of developing a vision, mission, and goals. They understood the problems they faced and were decisive in what they wanted out of this program. The draft vision was to "foster safety awareness and provide safe access throughout the Wind River Indian Reservation for all users and modes of travel." The mission was "to improve and sustain safety for all modes of transportation through education, enforcement, engineering and emergency medical services strategies." Three goals were set for the program:

- Raise awareness of transportation safety challenges to promote a positive change in our safety culture.
- Reduce the emotional and physical burden inflicted upon families because of a fatality or serious injury that occurs on our transportation system.
- Promote non-motorized travel by improving safety, security, and infrastructure.

A common theme evident in the vision, mission, and goals was concern for pedestrian safety, and one emphasis area was dedicated to the safety of the walking community.

7.2 Communication, Coordination, and Cooperation

One of the first steps in developing the strategic plan was to identify the many stakeholders and how much communication and coordination previously occurred. By identifying these levels of communication, the strengths and weaknesses could be easily identified. The stakeholders were grouped into eight categories:

- Transportation safety advocates, which included tribal leadership
- Traffic engineering/safety professionals
- Traffic law adjudication professionals
- Driver education curriculum management

- Traffic law enforcement professionals
- Health department professionals
- Emergency Medical Services (EMS) professionals
- Other safety stakeholders

There is strong coordination among the traffic engineering/safety professionals and safety advocates, the driver education curriculum management, and traffic law enforcement professionals. However, very little communication existed between the various groups and the health and EMS professionals. This was evidenced by the lack of participation from these groups in the initial meeting. Subsequent meetings drew more participation from all stakeholders. Also, more cooperation and coordination was needed between the tribal law enforcement and the state and county counterparts.

7.3 Identification of Safety Issues and Concerns

The safety stakeholders were asked to identify safety issues and concerns during the initial part of the kickoff meeting. They included such issues as behavioral, roadway, vehicle, weather, non-motorized, and others.

Among the many issues and concerns raised by the WRIR, behavioral safety issues were by far its greatest concern. Speed, restraint use, distracted and impaired driving, along with underage, unlicensed, and young drivers, were the focus of the behavioral issues. These are major concerns that have been identified throughout the Indian nations across the country as previously reported from the National Tribal Transportation Safety Summit (Herbel & Kleiner, 2010). As a primary concern, the stakeholders recognized that in order to tackle the behavioral issues, the safety culture must change. This was addressed in the strategies as well as identified as a primary goal of the TSMP.

The other issues identified in the plan are roadway safety, vehicle safety, weather, environmental, non-motorized (bicycle and pedestrian), EMS response, and limited resources. Pedestrian safety on their rural roadways is a primary concern because many residents walk. Limited facilities are available and many walk along the rural highways unprotected.

7.4 Emphasis Areas and Strategies

From the above safety issues, specific emphasis areas were identified and strategies were developed to address them. These strategies were grouped into eight emphasis areas:

- Safety data
- Emergency services
- Roadway infrastructure
- Safety restraints
- Impaired driving
- Speeding
- Pedestrians and bicycles
- Young driver safety

These focus areas are complementary to the Wyoming Strategic Highway Safety Plan (WSHSP). Lane departures and curve crashes in the WSHSP is comparable to roadway infrastructure in the WRIR TSMP. Safety equipment, young drivers, speeding, and impaired driving directly correlate with the state strategies. See Table 7.1 for these comparisons. These strategies are data driven. As discussed previously, with the exception of speeding, crash data analysis supports these emphasis areas (Table 7.2). However, speeding is a well-documented problem that can be verified through the citation records of law enforcement.

Table 7.1 Comparison of Strategic Plan Focus Areas

WYDOT	WRIR
Lane Departure	
Safety Equipment	Safety Equipment
Young Drivers	Young Drivers
Curve Crashes	Roadway Infrastructure
Speeding	Speeding
Impaired Driving	Impaired Driving
	Safety Data
	Emergency Services
	Pedestrian and Bicycles

Table 7.2 Crash Data Results for Focus Areas

Focus Areas	WRIR Crashes 2002-2011
Run Off Road/Lane Departure	41%
Use of Safety Restraint*	26%
Alcohol Involved	23%
Speeding/Driving too fast	Not yet analyzed
Young Drivers	33%

* From preliminary analysis for 2000-2010, 40% reported unknown

The goal established for safety data is to improve the completeness and accuracy of safety data to support the decision-making process. There are major discrepancies in the reporting of crashes, and strategies are being developed to improve crash reporting. Improving communication and collaboration among law enforcement is a key element in capturing all crashes. Integration of data through GIS is underway to link roadway, traffic volume, and crash data. These elements are identified in the plan.

Improving the quality and efficiency of emergency services is the goal of the second emphasis area, emergency services. Response time has been a major problem for the WRIR. Information on EMS response times within the WRIR indicates a 40- to 60-minute total response time from the responder location within the highway network to the accidents and then to the medical service provider. Factors which influence this response time are: 1) Fremont County Fire District comprises rural volunteer fire departments and must be summoned by siren and/or pagers to respond for duty, and 2) the WRIR does not have a fire station house within its boundary. EMS responders come from Fort Washakie, Milford, Kinnear, or Riverton fire stations, which are 20 miles, at a minimum, from the geographic center of the WRIR. The same 20 miles must then be traveled back to either Riverton Memorial Hospital or Lander Medical Center for emergency care/Life Flight services. A 30-minute increase means half that time involves driving. A review and modification of the dispatch protocols is one strategy that will improve this situation. Another strategy that will require greater resources is the addition of medical facilities or dispatch stations.

The goal for the roadway infrastructure is to improve the design and maintenance practices to reduce the frequency and severity of crashes. WYT^2/LTAP has been working on developing a safety improvement program to assist the WRIR to identify and prioritize low cost safety improvements on its roadways. This program, known as the Indian Reservation Roadway Safety Program (IRRSP), is currently underway and initial implementation were completed in 2013. By implementing the IRRSP, many low-cost safety improvements can be identified. Coordination with Fremont County is also necessary to establish maintenance responsibilities and possibly transfer ownership of county roads on the reservation to the WRIR transportation agency. County representatives were not present at the initial meeting.

For the two emphasis areas, safety restraint and impaired driving, changing the safety culture was determined to be the primary strategy to employ to increase restraint use and reduce the prevalence of impaired driving. Educational campaigns directed to the Indian community are ongoing and will continue. Media campaigns, targeted enforcement, education partnering with injury prevention resources, and imposing stronger sentences to offenders in a blitz-type manner will begin to impact the cultural attitude of transportation safety.

Reducing speeds to minimize the severity of crashes is the goal of the sixth emphasis area. A review of the existing posted speeds and a comprehensive speed study throughout the reservation will help determine appropriate speeds and identify where traffic calming measures could be employed.

Pedestrian and bicycles are an emphasis area for which strategies are identified to reduce the conflict between these users and vehicles by providing designated facilities. The WRIR has implemented a Pedestrian and Walkway Long-Range Transportation Plan. Including it in the strategic plan will help ensure that it will receive the needed attention. Other strategies identified to achieve the goal for pedestrians and bicyclists include the addition of crossings, promotion of bike rodeos, and education efforts in the schools.

Young driver safety is the last emphasis area; its goal is to reduce the prevalence of crashes involving young drivers. As identified from the crash data, 33% of all crashes on the reservation between 2001 and 2010 were drivers under the age of 25. Including those under the age of 35 increases it to 58%. Education and enforcement of distracted driving are the main strategies to address this area.

7.5 Roles and Responsibilities

In order to carry out the TSMP successfully, roles and responsibilities need to be identified and assigned to the appropriate stakeholders. This is an integral part of coordination and collaboration. The following areas of responsibility were identified:

- Traffic engineering
- Driver education
- Law enforcement
- Fire/emergency medical services
- Data management

The traffic engineering partners include the Shoshone and Arapaho Department of Transportation (SADOT), WYT^2/LTAP, TTAP, WYDOT, BIA, and consultants. SADOT will obtain and provide traffic, crash, and roadway data. WYT^2/LTAP will provide evaluation of high-risk locations, BIA will provide technical assistance, and consultants will provide engineering services.

The driver education partners include SADOT, WYT^2/LTAP, TTAP, WYDOT, BIA law enforcement, injury prevention resources, school superintendents, and children advisory groups. WYT^2/LTAP will provide crash analysis and recommendations for behavioral safety improvements to SADOT and BIA. SADOT and BIA will provide the educational opportunities for drivers. Partners will team with WYDOT as necessary for media and educational campaigns.

Law enforcement partners include the Wind River Police Department (WRPD), WYDOT, local law enforcement, tribal courts, BIA law enforcement, the county coroner, and State Highway Patrol. WRPD will provide law enforcement teaming with WYDOT to improve crash reporting and strengthen partnerships with local law enforcement. Tribal courts will support law enforcement and enforce penalties.

Fire and emergency medical services partners include the Wind River Indian Health Services (WRIHS), Fremont County Fire Department, and first responders. WRIHS and Fremont County Fire Department provide the emergency medical services. The need to improve response time is recognized.

Lastly, the data management partners are SADOT, WYDOT, WRPD, WYT^2/LTAP, BIA law enforcement, and the county coroner. WYDOT manages the crash data. WRPD submits crash data directly to WYDOT. WYT^2/LTAP coordinates with BIA and WYDOT to retrieve any records not submitted electronically.

As recognized under the communications section of the TSMP, the roles and responsibilities require cooperation and collaboration. Many weaknesses were identified in the communication among the various stakeholders and further development is necessary to ensure the roles and responsibilities are carried out successfully.

7.6 Next Steps

A final stakeholders' meeting needs to be conducted to finalize the Transportation Safety Plan, finalize and sign the commitment to safety agreement by the Safety Management Committee, and refine the strategies and priorities within the plan. A copy of the plan is located in Appendix 7.

The benefit of the partnering agreement is the development of lasting relationships and responsibilities. These can last beyond specific personnel, and it sets up long-term partnerships by defining roles and responsibilities. The agreement includes the vision, mission, and goals of the plan. It identifies the executive committee responsible to commit to the plan and includes all major stakeholders, including the Joint Tribal Business Council. The plan must be reviewed, responsible stakeholders assigned, funding options identified, and opportunities to enhance the communication, coordination, and cooperation must be sought.

Tremendous progress has been made, but there is still much to do in order to have a functional and effective TSMP. The tribal community and many of the safety stakeholders are optimistic in being able to carry it out. The greatest challenges are to foster the cooperation and collaboration of all stakeholders and secure the resources necessary to carry it out.

7.7 Summary

Strategic highway safety plans are necessary for communities to be able to carry out their safety programs effectively. Tribes often lack the resources and technical expertise to develop a plan that works for them. FHWA sent out applications in 2011 to all tribes across the country to be part of a pilot tribal TSMP to assist them in developing such plans. The WRIR was selected as one of three pilots. The many stakeholders involved include tribal leadership, Local Technical Assistance Program (LTAP), Tribal Technical Assistance Program (TTAP), BIA, local and tribal law enforcement, Indian Health Services (IHS), and other local partners.

The first step in developing a TSMP is to analyze crash data and identify trends to determine where the problem areas lie. Preliminary analysis revealed that crash data were incomplete. Safety data became one of the focus areas. Crash trends confirmed many of the concerns by the tribes. The severity of crashes is higher on the reservation than throughout the state. Alcohol, young drivers, and safety equipment use are main problem areas.

The tribal community was resolute in identifying its vision, mission, and goals. It envisions raising safety awareness and improving the safety of all users of the roadways. Pedestrians are a major concern on their reservation because facilities do not exist and many walk on the rural highways.

The WRIR stakeholders recognize the importance of good communication and cooperation. They identified where the weaknesses are and set up strategies to overcome these barriers. The major safety issues included behavioral, roadway, vehicle, weather, and non-motorized users. Behavioral was recognized as their greatest concern and their goals included strategies to change the safety culture of their people.

8. LOGISTIC REGRESSION MODEL

8.1 Introduction

Strategic highway safety plans are implemented to establish goals and objectives for agencies and communities to reduce crash rates on their roadway systems. In order to know what strategies to employ, a solid understanding of crashes and their effects must be evaluated. In addition, the comparison between Indian reservation roadways and other roadways has been analyzed to determine if any factors are of more or less significance on reservations.

Crash data have been analyzed through various types of statistical models in order to help safety engineers determine related factors and identify countermeasures to improve roadway safety. Many models have been developed for urban applications and intersections, but few have addressed crashes on rural roadways. There does not seem to be any that have analyzed crashes on reservations.

This research analyzes crash severity for rural highway systems in Wyoming. The goal of the Wyoming Strategic Highway Safety Program (WSHSP) is to reduce critical crashes (Wyoming Highway Safety Management System Committee, 2012). These crashes are defined as fatal and incapacitating injury crashes. Wyoming is uniquely characterized by a vast rural roadway network ranging from interstates, state and U.S. highways, and county and reservation roads. Rural roadways typically have lower population density, longer travel distances, higher speeds, and complex road geometrics.

Each highway system has unique characteristics to consider when attempting to assess crash severity on rural roads. For example, reservations have many similarities to other rural communities concerning their roadway system. There are also other behavioral factors that may come into play when analyzing severity of crashes and associated effects. Alcohol and seat belt use, among other factors, have been identified by the Native American community as some of the greatest concerns in improving highway safety (Herbel & Kleiner, 2010).

The logistic regression model was chosen for this analysis. Determining the factors that affect severity and their significance is the focus of this research since the goal is to reduce these types of crashes.

8.2 Description of Data

The Wyoming Department of Transportation (WYDOT) maintains a crash analysis database for all roadways in Wyoming that contains information for every recorded crash in the state. The raw crash data from this database were requested from WYDOT along with data on traffic counts, roadway geometrics, pavements, driver behaviors, and vehicle information.

The raw data were compiled for all rural crashes across the state for the 10-year period 2002-2011 resulting in 96,791 crashes. Four bulk data sets were used, which included base bulk data on every crash, vehicle, driver, and geometric data. The geometric data were a compilation of inventory records on the roadway types, vertical and horizontal alignment, pavement width, shoulders, medians, rumble strip locations, and traffic data. In addition, the highway system type was identified for each crash location. The highway systems that were included in the statistical analysis were the interstate, state highways, U.S. primary and secondary highways, county rural local roads, and Indian Reservation Roads (IRR). Since the Wind River Indian Reservation contains all highway system types except interstates, a separate dataset was developed for the reservation that included all the highway systems within its boundaries. The driving behaviors are the same across the reservation, the geometrics of the roadways are similar, and there are high crash locations throughout the roadway network on the reservation.

Once all the crash data were compiled, this information was used to create a list of predictor variables. All predictor variables considered were assigned a binary value of zero (0) or one (1).

Several crashes involved more than two vehicles and the record of a particular crash contained driver and vehicle information for all vehicles in that crash. It was decided to incorporate information on multiple vehicles simply through an indicator that takes the value one (1) if more than one vehicle was involved in the crash and zero (0) otherwise. This approach avoided having unequal amounts of information on a particular crash resulting from unequal numbers of vehicles.

Many of the geometrics were related so these were reduced to unique variables that explained most of the geometrics. Left and right shoulder information included width and shoulder type. One variable was used for each shoulder (left and right) whether a shoulder existed or not. The horizontal and vertical alignment each had several categories that needed to be consolidated. Initially, vertical alignment was consolidated into level grade, uphill grade, and downhill grade. Since these were related, vertical alignment was reduced to level (0) or not level (1). Horizontal alignment was reduced to curve (1) or no curve (0).

The largest reduction in the number of predictors came with consideration of the first harmful event (FHE). In the crash report, there are over 60 characterizations for FHE. These were consolidated into five categories of animal, rollover, collision with another vehicle, fixed object, guardrail, and other based upon preliminary analysis. The “other” category contained a variety of events that accounted for less than 10% of all crashes and thus not included in the variable selection.

Age was considered in several ways. The best approach was to divide age into groups and code each age group separately. According to the Centers for Disease Control (CDC), injuries from vehicle crashes are the greatest health threat to young drivers ages 16 to 19 (CDC). Among American Indians, vehicle crashes are the leading cause of unintentional injury for ages up to 44 and the leading cause of death to young people under 20 years old (CDC, 2012). Senior drivers are also at high risk to experience severe crashes. Drivers over 65 years tend to have longer perception reaction times and lower visual acuity (Mooradian, Ivan, Ravishanker, & Hu, 2012). Based upon these trends and preliminary analysis, two age groups were selected for the model. These included indicators for drivers ages 25 and under and drivers over 65.

A list of possible predictors is shown in Table 8.1. Details for the development of this list are also presented in the Univariable Analysis subsection. This list also shows the number of missing observations for a predictor. In particular, there are large percentages of missing data for the variables distraction, ADT, ADTT, VMT, and TVMT.

Table 8.1 Possible Predictors and Corresponding Missing Data for Crashes by System

Variable Name	Global	Interstate	State	County	WRIR
Weekend	620	71	356	124	17
Animal (FHE)	654	78	368	128	17
Rollover (FHE)	654	78	368	128	17
Guardrail (FHE)	654	78	368	128	17
Fixed Object (FHE)	654	78	368	128	17
Number of Vehicles	622	71	356	124	17
FHE Location	6884	908	4345	696	307
Lighting	935	106	532	180	34
Impaired	9478	1209	6322	680	387
Road Condition	7387	1955	2853	680	91
Mean Posted Speed	5036	420	2383	1742	201
Pavement (Surface)	9794	1259	6494	725	396
Level Grade	10279	1357	6729	769	402
Horizontal Alignment	10320	1350	6756	793	402
Truck	9798	1241	6558	706	392
Motorcycle	9798	1241	6558	706	392
Mean Speed	5042	641	3040	748	134
Vehicle State	2117	71	1335	301	62
Vehicle Maneuver	1056	126	621	183	30
Driver Age ≤ 25	1642	183	1057	209	56
Driver Age > 65	1642	183	1057	209	56
Driver Gender	1394	141	907	181	39
Driver Safety Equip.	7974	587	5293	1453	307
Driver Distraction	34654	6834	16440	4483	978
Median	620	71	356	124	17
Rumble Strip	620	71	356	124	17
Left Shoulder	620	71	356	124	17
Right Shoulder	620	71	356	124	17
ADT	10825	412	1880	7980	589
ADTT	10825	412	1880	7980	589
VMT	10825	412	1880	7980	589
TVMT	10825	412	1880	7980	589

8.3 Study Methodology

8.3.1 The Logistic Regression Model

The response variable, Y, represents whether a crash is severe (1) or not severe (0). Severe crashes include fatal and incapacitating injuries. A non-severe crash includes non-incapacitating injury, possible injury, and no injury.

Since the response is binary, a Bernoulli distribution is assumed, which is a discrete probability distribution where the value 1 is a "success" with probability π and 0 is a "failure" with probability $1 - \pi$. Thus, the expected value of Y equals π.

Several predictor variables were used to model crash severity on rural roads in Wyoming. Thus, multiple logistic regression was used to formulate the model. Let $\mathbf{x}$ denote a $q \times 1$ vector of p predictor variables and h pairwise interactions specified in the set $\mathcal{H}$ Let $\boldsymbol{\beta}$ denote the corresponding $q \times 1$ of regression coefficients. More specifically,

$$\mathbf{x}'\boldsymbol{\beta} = \beta_0 + \sum_{j=1}^{p} \beta_j x_j + \sum_{\{(k,k') \in \mathcal{H}\}} \beta_{kk'} x_k x_{k'} \ .$$

Equation 8.1 Multiple Logistic Regression Model

Kutner (Kutner, Nachtsheim, & C.J., 2004) presents the multiple logistic model with logit link as having the form:

$$\log_e\left(\frac{\pi}{1-\pi}\right) = \mathbf{x}'\boldsymbol{\beta} \text{ or } \pi = \frac{\exp(\mathbf{x}'\boldsymbol{\beta})}{1+\exp(\mathbf{x}'\boldsymbol{\beta})} \ .$$

Equation 8.2 Multiple Logistic Regression Model with Logit Link

In Equation 8.2, $\text{odds} = \frac{\pi}{1-\pi}$ denotes the odds of a severe crash. It is often of interest to examine the odds ratio or $\text{OR} = (\frac{\pi_1}{1-\pi_1})(\frac{1-\pi_2}{\pi_2})$ which is the ratio of odds from the probability π_1 obtained from one combination of regressors s $\mathbf{x}_1$ and from the probability π_2 obtained from another combination of regressors $\mathbf{x}_2$.

Using maximum likelihood, it is possible to obtain estimates of the quantities corresponding to Equation 8.2. A hat will be used to denote an estimate of the corresponding quantity. Thus, consider the estimates of the regression coefficients $(\widehat{\boldsymbol{\beta}})$, probability $(\widehat{\pi})$, odds $(\widehat{\text{odds}})$, and odds ratio $(\widehat{\text{OR}})$. It is often of interest to obtain $\widehat{\text{OR}}$ for interpretation. There are particular choices of $\mathbf{x}_1$ and $\mathbf{x}_2$ which are often of interest. First, consider a binary predictor x_j that is not involved in any interaction effect. Then the estimated odds ratio for $x_j = 1$ compared to $x_j = 0$ is $\widehat{\text{OR}} = \exp(\hat{\beta}_j)$. Even though it will not be explicitly stated, this expression assumes all other regressor variables are the same for $\mathbf{x}_1$ and $\mathbf{x}_2$. Now, consider a particular binary predictor x_k that is involved in exactly one interaction effect, say involving the binary predictor $x_{k'}$. When there is an interaction effect, the effects of the predictors x_k and $x_{k'}$ cannot be assessed separately. For example, the estimated odds ratio when $(x_k = 1, x_{k'} = 0)$ compared to when $(x_k = 0, x_{k'} = 0)$

is $\widehat{\text{OR}} = \exp(\hat{\beta}_k)$. On the other hand, the estimated odds ratio when $(x_k = 1, x_{k'} = 1)$ compared to when $(x_k = 0, x_{k'} = 1)$ is $\widehat{\text{OR}} = \exp(\hat{\beta}_k + \hat{\beta}_{kk'})$. Again, these expressions assume all regression variables are the same for $\mathbf{x}_1$ and $\mathbf{x}_2$.

The model defined above needs to be built through suitable selection of the *p* predictors and *h* interactions. The model building strategy described by Hosmer et al. (Hosmer, Lemeshow, & Sturdivant, 2013) is utilized. These steps include univariable analysis to identify and to specify possible predictors, stepwise variable selection to select the set of *p* predictors, a detailed evaluation of possible pairwise interactions among the *p* predictors, and checks of the model fits. The implementation of each of these steps is discussed below.

8.3.2 Univariable Analysis

Univariable analysis consisted of fitting the logistic regression model in Equation 8.2 with only a single predictor. Such models are also called simple logistic regression models (Kutner, Nachtsheim, & C.J., 2004). Two by two frequency tables were also examined to visualize the relationships between the binary predictor and severity. A predictor was included in the possible set of predictors if it either had a relationship with severity in the simple logistic regression model or if it is recognized as an important predictor in the literature.

Over 50 variables were initially considered. Through the univariable analysis, these 50 variables were reduced to 33. The results from the univariable analysis are shown in Table 8.2. Notice that the predictors VMT and driver age were not statistically significant in the univariable analysis. However, given the support in the literature for these variables, they were included in the set of predictors in order to assess their role in the presence of the other predictors.

8.3.3 Variable Selection

Stepwise variable selection was used to identify the statistically significant predictors for the model from the set of predictors in Table 8.2. This approach is similar to forward selection, except that predictors already in the model in a previous step do not necessarily remain in the model (Kutner, Nachtsheim, & C.J., 2004). The significance levels (α) for the predictor to enter and stay are from the Wald Chi-square test. The value used for a covariate to enter the model was α_{enter}=0.10 and to stay in the model was α_{stay}=0.05. These selected values were based upon the use in two cited works (Andreen, 2012) and (Mooradian, Ivan, Ravishanker, & Hu, 2012).

8.3.4 Interactions

Interaction terms were examined next for inclusion into the logistic regression model. Candidates included pairwise interactions between the variables identified from the stepwise variable selection. It was not feasible to consider all possible interactions because of the large number of variables that were selected. An interaction term indicates that the impact of a predictor on severity is not the same across the values of the other predictor. Thus, specific interactions of interest were considered in which it might be expected that the impact of a variable on crash severity might be affected by another variable. In particular, interactions might be expected among the variables lighting, impairment, speed, and distraction. A list of the interactions that were considered is given in Table 8.3.

Each of the interactions were tested in the models. Insignificant interactions were removed through an iterative process starting with the removal of interactions that had a Wald Chi-Square p-value greater than 0.5. This was done until all the interaction p-values were less than 0.05. Once the interaction effects were selected, insignificant main effect terms were removed from the model if they were not involved in any of the interaction terms. This was done since the interaction effect could be interpreted as accounting for that main effect statistically.

Table 8.2 Predictor Variables, Variable Codes, and P-Values in the Univariate Analysis

Variable Name	**Code/ Value**	**Wald Chi Sq P-value**	**Variable Name**	**Code/ Value**	**Wald Chi Sq P-value**
Weekend	0 = M,T,W,R 1 = F,Sa, Su	<.0001	Mean Speed	0 = <Mean Speed 1= >Mean Speed	<.0001
Animal (FHE)	0 = No Animal 1 = Animal	<.0001	Vehicle State	0 = Wyoming 1 = Out of State	<.0001
Rollover (FHE)	0 = No Rollover 1 = Rollover	<.0001	Vehicle Maneuver	0 = Straight 1 = Not straight	<.0001
Guardrail (FHE)	0 = Guardrail 1 = No Guardrail	<.0001	Driver Age	1= <26	0.0593
Fixed Object (FHE)	0 = No FO 1 = Fixed Object	<.0001	Driver Age	1 = >65	0.261
Number of Vehicles	0 = One Vehicle 1 = > One vehicle	<.0001	Driver Gender	0 = Female 1 = Male	<.0001
FHE Location	0 = On Roadway 1 = Off Roadway	<.0001	Driver Safety Equipment	0 = Used 1 = Not Used	<.0001
Lighting	0 = Daylight 1 = Darkness	<.0001	Driver Distraction	0 = Not Distracted 1 = Distracted	<.0001
Impaired	0 = Not Impaired 1 = Impaired	<.0001	Median	0 = Median 1 = No Median	<.0001
Road Conditions	0 = Dry 1 = Wet, snow, etc.	<.0001	Rumble Strip	0 = Rumble Strip 1 = No rumble Strip	0.0409
Mean Posted Speed	0 = <Mean Post Sp 1 = >Mean Post Sp	<.0001	Left Shoulder	0 = Left Shoulder 1 = No Lft Shoulder	0.0011
Pavement (Surface)	0 = Paved 1 = Unpaved	0.0106	Right Shoulder	0 = Right Shoulder 1 = No Rt Shoulder	0.001
Level Grade	0 = Level 1 = Not Level	<.0001	ADT	0 = < Mean ADT 1 = > Mean ADT	<.0001
Horizontal Alignment	0 = Straight 1 = Curve	<.0001	ADTT	0 = < Mean ADTT 1 = > Mean ADTT	0.0117
Truck	0 = Truck 1 = Not Truck	<.0001	VMT	0 = < Mean VMT 1 = > Mean VMT	0.2648
MC	0 = Not MC 1 = MC	<.0001	TVMT	0 = < Mean VMTT 1 = > Mean VMTT	<.0001

Table 8.3 Interactions Considered for Inclusion in Logistic Regression Model

Possible Interactions	
Animal*Lighting	Weekend*Impaired
Rollover*Lighting	Median*Lft Shoulder
Guardrail*Lighting	Rumble Strip*Rt Shoulder
Fixed Object*Lighting	Mean Speed*MC
FHE Location*Lighting	Mean Speed*Animal
Lighting*Impaired	Mean Speed*Rollover
Lighting*Road Cond	Mean Speed*Fixed Object
Lighting*Age > 65	Mean Speed*Impaired
Impaired*Rollover	Mean Speed*Road Cond
Impaired*Fixed Object	Mean Speed*Surface
Impaired*Road Cond	Mean Speed*Alignment
Impaired*Alignment	Mean Speed*Age ≤ 25
Impaired*Maneuver	Mean Speed*Gender
Impaired*Level	Distracted*Mean Speed
Impaired*Age ≤ 25	Distracted*Lighting
Impaired*MC	Distracted*Impaired
Impaired*Gender	Distracted*Road Cond
Road Cond*MC	Distracted*Alignment
Road Cond*Alignment	Distracted*Maneuver
Road Cond*Age > 65	Distracted*Level
Mean Post Sp*Surface	Distracted*Rollover
Mean Post Sp*Level	Distracted*Age ≤ 25
Mean Post Sp*Alignment	Distracted*Gender

8.3.5 Model Adequacy

The adequacy of the model was assessed once the predictors were incorporated and the interactions were chosen. Model adequacy can be assessed by examining model fit and model prediction.

Goodness of fit assesses the difference between observed and fitted values in order to check how well the model fits the set of observations. A standard test for goodness of fit in logistic regression is the Hosmer-Lemeshow test (Kutner, Nachtsheim, & C.J., 2004) (Hosmer, Lemeshow, & Sturdivant, 2013). The data are grouped into classes with similar fitted values with approximately the same number of observations (Kutner, Nachtsheim, & C.J., 2004). Based upon these groupings, the Pearson Chi-Square statistic is calculated.

Model adequacy can also be assessed by its classification or predictive ability. The model can be used to obtain the estimated probability ($\hat{\pi}$). When $\hat{\pi}$ is high, then the outcome 1 (severe crash) is predicted, and if $\hat{\pi}$ is low, then the outcome 0 (not severe crash) is predicted. The sensitivity is the proportion of severe crashes that are predicted by the model to be severe. The specificity is the proportion of non-severe crashes predicted to be non-severe. A good model is one with high sensitivity and high specificity. However, these calculations depend upon a cut-off value to determine how large ⍰ is to be to classify a crash as severe. A more complete description of the predictive ability of a model is the Receiver Operating Characteristic (ROC) curve (Hosmer, Lemeshow, & Sturdivant, 2013). The ROC curve is a plot of the sensitivity and $1 -$ specificity across a range of cut-points. The area under the ROC curve is commonly used as a summary measure of the predictive ability of the model. General guidelines provided by Hosmer et al. (Hosmer, Lemeshow, & Sturdivant, 2013) suggest that values greater than 0.7 indicate acceptable prediction ability, values greater than 0.8 indicate excellent predictive ability, and values greater than 0.9 indicate outstanding predictive ability.

8.3.6 Models for Highway System

Multiple logistic regression models were developed for five different rural highway systems across the state. These five highway systems included the: Global System, Interstate System, State System, County System, and the WRIR System. The Global System included all the other systems. The State System included U.S. and state highways maintained by WYDOT. The County System included all county rural local highways. The WRIR maintains the IRR and some of the county roads. State and U.S. highways also transverse the reservation. Therefore, all highway systems were included in the WRIR model.

Each of these models started with the same set of predictor variables listed in Table 8.2 from the univariable analysis. Stepwise variable selection was applied separately to the model for each highway system. The interaction terms in Table 8.3 were then assessed separately for each highway system. Through this process, the important predictors of crash severity could be identified for each system and then compared across systems.

8.4 Results

8.4.1 Main Effects Models

The main effects model refers to those models obtained from the stepwise variable selection procedure before incorporating interaction terms. The modeling at this stage was affected by the combinations of the missing values for the variables shown in Table 8.1. Thus, a crash was dropped from the analysis at this stage if any of the variables included in the stepwise selection procedure contained a missing value. This issue resulted in a number of crashes being dropped from the analysis. An alternative would have been to use multiple imputation, which uses a specified model to predict values for the missing data in order to obtain a complete data set (Hosmer, Lemeshow, & Sturdivant, 2013). This approach was not used in order to work with the existing information provided by WYDOT and to avoid making the subjective and complex assumptions required for the model specification in the multiple imputation.

The variables obtained from the stepwise procedure for each roadway system are shown in Table 8.4. This table also shows the number and percent of crashes used to obtain these models.

Two main effects models were created for each highway system and the global system. One includes all the variables from Table 8.2 (All) and another is based upon removal of driver distraction and the traffic data (ADT, ADTT, VMT, TVMT) (Removed). These five predictors were removed since they contained a large amount of missing values. By excluding these predictors, the models were based upon far more crashes (an increase from 19% to 32%). However, one major drawback is that some of these predictors are important in some of the models.

Table 8.4 also shows the frequencies for crash severity for the various roadway systems and in light of the missing values. When all variables are included, the percent of severe crashes is relatively homogeneous. When the five variables are deleted, the percent of severe crashes increases slightly with the larger percentages being in the County System and WRIR System.

The variables animal, impaired, motorcycle, and seatbelts were included in every model and in all cases. In addition to these variables, the Global, Interstate, and State Systems contain the variables number of vehicles, FHE location, road surface condition, mean posted speed, level grade, horizontal alignment, mean speed, driver age >65, driver age 14-25, gender, and ADT (when included). Only the model for the County System included the variable pavement surface. Only the Global (Removed) and the WRIR System models contained the variable state.

Final models were obtained for each roadway system as described in the Methodology section. The interaction terms in Table 8.3 were examined provided the corresponding terms were included in the main effects model. The final models were obtained separately for each roadway system. The Global System was modeled both with all 33 regressors (All model) and without driver distraction and traffic data (Removed model). The final models for the other systems were obtained without driver distraction and traffic data (Removed model).

8.4.2 Global System

The two final models that were obtained for the Global System are given in Table 8.5. For the All model, the estimated coefficients for ADT and ADTT were negative. This indicated that crashes in higher traffic volumes are less likely to result in severe crashes. This may be a result of reduced speeds, more attentive driving behaviors, or higher likelihoods of crashes which happen to not be severe. The positive estimate 0.1279 for mean VMT indicated the estimated odds of a severe crash are 1.136 times higher for a vehicle exceeding mean VMT.

The effect of distracted and impaired driving behavior on crash severity could not be separated as indicated by the presence of the corresponding interaction term. In particular, the estimated odds of a severe crash for a non-impaired (x_k=0), distracted driver ($x_{k'}$=1) is 1.27 times more than for a non-impaired (x_k=0), non-distracted driver ($x_{k'}$=0). On the other hand, the estimated odds of a severe crash for an impaired (x_k=1), distracted driver ($x_{k'}$=1) is 6.15 times more than for an impaired (x_k=1), non-distracted driver ($x_{k'}$=0). The effect of impaired driving also cannot be separated from the effects of lighting and rollover due to the presence of these corresponding interaction terms. The All Global System model shows that distracted driving and traffic data do have important associations with crash severity. Thus, it is imperative that crash investigators do what they can to insure this information is recorded into the crash record.

Many of the estimated coefficients for the Removed Global System model increased in magnitude, particularly for those that are expected to be associated with crash severity. This included animal, impaired, and safety equipment use. This model also contained various interactions with mean speed showing how its effect on crash severity depends upon the other variables of motorcycles, level, road conditions, and gender.

Both Global System models demonstrate excellent predictive ability with areas under the ROC curve of 0.7998 for the All model and 0.8101 for the Removed model. However, the Hosmer-Lemeshow goodness of fit test showed that the model is not a good fit for the observations with a p-value of <0.0001 for the All model and 0.0006 for the Removed model. This evidence of lack of fit indicates a failure to adequately account for the large amount of information in the Global System consisting of nearly 40,000 crashes for the All model and over 60,000 crashes for the Removed model. Recall that the Global System embodies all the other highway systems. Thus, lack of fit might be detected if there was lack of fit in any other system or if there were differences between the systems since such differences were not accounted for by this model. The different roadway systems are discussed separately below.

Table 8.4 Main Effects Models Variables Using Forward Stepwise Selection with Number of Observations Used in Selection Procedure

	Global		Interstate		State		County		WRIR	
Variable Name	**All**	**Rem**	**All**	**Rem**	**All**	**Rem**	**All**	**Rem**	**All**	**Rem**
Weekend									X	
Animal (FHE)	X	X	X	X	X	X	X	X	X	X
Rollover (FHE)	X	X	X	X		X			X	
Guardrail (FHE)	X	X		X	X	X				
Fixed Object (FHE)				X	X	X	X	X		X
Number of Vehicles	X	X	X	X	X	X				
FHE Location	X	X	X	X	X	X				
Lighting	X				X					
Impaired	X	X	X	X	X	X	X	X	X	X
Road Condition	X	X	X	X	X	X	X	X		X
Mean Posted Speed	X	X	X	X	X	X	X	X		
Pavement (Surface)							X	X		
Level Grade	X	X	X	X	X	X		X	X	
Horizontal Alignment	X	X	X	X	X	X				
Truck		X		X						
MC	X	X	X	X	X	X	X	X	X	X
Mean Speed	X	X	X	X	X	X		X		X
Vehicle State		X								X
Vehicle Maneuver	X	X		X		X				
Driver Age ≤ 25		X		X		X		X		
Driver Age > 65	X	X	X	X	X	X				X
Driver Gender	X	X	X	X	X	X				
Driver Safety Equip	X	X	X	X	X	X	X	X	X	X
Driver Distraction	X	R	X	R		R		R		R
Median		X		X						
Rumble Strip										
Left Shoulder										
Right Shoulder										
ADT	X	R	X	R	X	R	NA	R		R
ADTT	X	R		R		R	NA	R		R
VMT	X	R		R		R	NA	R		R
TVMT		R		R	X	R	NA	R		R
Total Crashes	96791	96791	34266	34266	54381	54381	7980	7980	2212	2212
Missing Data	57324	32030	20374	9256	28788	18427	6223	4169	1568	1042
Data Used	39467	64761	13892	25010	25593	35954	1757	3811	644	1170
% Data Used	41%	67%	41%	73%	47%	66%	22%	48%	29%	53%
% Severe	6%	8%	6%	8%	6%	8%	7%	11%	8%	13%

Table 8.5 Final Logistic Regression Model Results for Global System for All Variables (All) and for Removal of Driver Distraction and Traffic Data (Removed)

	Estimated Coefficient		Estimated Odds Ratio	
Parameter	All	Removed	All	Removed
Intercept	-4.536	-4.4096		
Animal	-0.9741	-1.3776		0.252
Rollover	0.8754	0.9020		
Guardrail	0.6279	0.5414	1.874	1.718
Vehicles	1.1461	0.6600	3.146	1.935
FHE Location	0.2674	0.2746	1.307	1.316
Lighting	0.1531			
Impaired	0.7947	1.0498		
Road Condition	-0.4449	-0.5105	0.641	
Mean Posted Speed	0.5725	0.4190	1.773	
Level	-0.219	-0.4719	0.803	
Alignment	0.3313	0.2499	1.393	1.284
Truck		0.2222		1.249
Motorcycle (MC)	1.9571	1.8571		
Mean Speed	0.4665	0.7514		
State		0.0743		1.077
Maneuver	-0.1214	-0.1511	0.886	0.86
Age 25		-0.2394		0.787
Age > 65	0.4263	0.3046	1.532	1.356
Gender	-0.1748	-0.0747	0.840	
Safety Equipment Use	1.2226	1.4527	3.396	4.275
Distracted	0.2403			
Median		0.1132		1.120
Mean ADT	-0.6329		0.531	
Mean ADTT	-0.2831		0.753	
Mean VMT	0.1279		1.136	
Animal*Lighting	-0.3937			
Lighting*Impaired	0.4965			
Rollover*Impaired	-1.1246	-0.2264		
MC*Mean Speed	0.6677	0.4520		
Mean Posted Speed*Level		0.4017		
Impaired*Distracted	1.5755			
Road Cond*Mean Speed		-0.1779		
Mean Speed*Gender		-0.1523		

8.4.3 Interstate System

The results for the final model that was obtained for the Interstate System are shown in Table 8.6. Many of the same variables remained in the final models for the Interstate System and the Global System. One surprise was that the estimated coefficient associated with Median was negative for the Interstate System, which indicated that the probability of a severe crash was less when there was not a median. Only 2.6% (889) of all crashes on the Interstate occurred without a median. Of these crashes, 5% (44) were severe compared with the 7% (2310) of crashes that were severe without the median. Nevertheless, it is expected that most interstates would have a median. Further investigation should be made about the locations of these crashes to determine why there were no medians.

Some of the important contributors to crash severity on the Interstate System included vehicles, impaired, and safety equipment use (seatbelt use) where the estimated odds ratios are 2.936, 2.193, and 5.504, respectively. This means that the estimated odds of a severe crash are 5.5 times more likely without a seatbelt. The effects of rollovers, mean speed, and motorcycles are linked through various interactions. For example, the estimated odds of a severe crash when traveling above the mean speed are 26.6 times more likely when the crash involves a motorcycle.
The Interstate System model shows excellent predictive ability with area under the ROC curve of 0.7961. The Hosmer-Lemeshow test also shows no evidence against the assumption of adequate model fit as the p-value is 0.1137.

8.4.4 State System

The results for the final model that were obtained for the State System model are shown in Table 8.6. The mean posted speed plays an important role in this model as it interacts with level and alignment. In particular, the estimated odds of a severe crash involving a vehicle exceeding the mean posted speed is 1.2 times higher if that crash occurred on a horizontal curve. Due to this adjustment on the effect of alignment, the estimated odds ratio is quite close to what it was for the Interstate System. Animal and safety equipment are the most predominant main effects with coefficients of -1.70 and 1.32, respectively. Impairment, motorcycles, and mean speed also play important roles in this model through interaction terms. For example, the estimated odds of a severe crash while exceeding the mean speed is 1.4 times more likely for a crash involving a rollover. While this effect of rollover is important, it is not as large as it was for the Interstate System.

The predictive ability of the state model is excellent with an area under the ROC curve of 0.8287. However, the Hosmer-Lemeshow test shows that the model does not provide an adequate fit with a p-value of 0.0059. This could be because the highways included in the Wyoming state system vary considerably between state highways and primary and secondary U.S. highways in their geometry and maintenance levels. In addition, this model includes these highways across the entire state where terrain and surrounding conditions are different from one location to the next. Additional modeling may be necessary to account for such differences. The lack of fit in the State System also contributes to the lack of fit found in the Global System.

8.4.5 County System

The results for the final model that were obtained for the County System are shown in Table 8.6. This model is based upon a much smaller number of crashes (around 4,000). As a result, it is expected that fewer predictors might be identified by the model selection. However, this is the only model to identify pavement surface as an important predictor. This is understandable since many county roads are unpaved. The effect of surface interacts with mean speed. Thus, the estimated odds of a severe crash while on an unpaved road are 1.95 times higher when exceeding the mean speed. Impairment, motorcycles, and seatbelt use are the predominant main effects in this model with estimated odds ratios of 3.255, 6.302, and 4.279, respectively. Thus, the estimated odds of a severe crash are more than six times higher if that crash involves a motorcycle.

The predictive ability of the County System model is excellent with area under the ROC curve of 0.8345. The Hosmer-Lemeshow test also provides no evidence against the assumption of an adequate model fit as the p-value is 0.7797.

8.4.6 WRIR System

The results for the final model that were obtained for the WRIR System are shown in Table 8.6. The model for this system involved the fewest number of crashes. Of these roughly 1,200 crashes, just over 150 were severe. Animal, impairment, motorcycles, and seat belt use were the predominant predictors of crash severity. The estimates of these effects were similar in magnitude to the model for the County System, with the exception of motorcycles. The estimated odds ratios for these effects were -2.01 for animal, 3.21 for impairment, 4.18 for motorcycles, and 4.83 for seat belt use. Driver age was an important effect in this model and interacted with road condition. The estimated odds ratio of a severe crash for an elderly person is 2.84 times more likely if the road is not dry. This is also the only system model, other than Global, which included state. The estimated odds of a severe crash are 2.17 times higher if that vehicle is from Wyoming.

The model for the WRIR system had excellent predictive ability with an area under the ROC curve of 0.8545. This Hosmer-Lemeshow test also provides no evidence against the assumption of adequate model fit as the p-value is 0.7401.

8.5 Summary

Rural roadway systems have been recognized to differ from urban systems because of the lower population densities, longer travel times, more extreme terrain, and other nonurban conditions. These factors along with behavioral factors need to be considered when developing a highway safety program. This study examined crash severity in Wyoming based upon the objectives set forth in the Wyoming Strategic Highway Safety Plan to reduce critical crashes. Since crash severity was defined as a dichotomous variable (whether a crash was severe or not), multiple logistic regression was used. A careful methodology was followed for model development in order to identify important predictors of crash severity on rural highway systems and on reservation roads in Wyoming. A Global System model was first developed for the entire state and then refined for each of four rural highway systems. These included the state highway system, interstate system, county rural local roads, and the roadway system on the Wind River Indian Reservation.

All the models identified the predictors of animals, impairment, motorcycles, mean speed, and safety equipment use as related to crash severity. The odds ratios were similar in magnitude except when there was an interaction involved. Mean speed interacted with motorcycles, rollovers, and fixed objects in the Interstate model. This was the same for the State System with the exception of fixed objects. The State System also contained interactions with the mean posted speed where the others did not. The County System was the only system that included pavement surface in the model. The WRIR was the only system that included state and contained an interaction between age over 65 and road conditions.

The effects on the reservation were of similar magnitude compared to the other systems, especially the county roads. The Indian community recognizes that impairment, seat belt usage, and speeding are major contributors to critical crashes on their reservations. The results of this model verify their concerns. However, they also share the same type of issues in addressing roadway safety as their rural counterparts. This model could be used not only for reservations to look at safety countermeasures, but for other rural communities as well.

Table 8.6 Final Logistic Regression Model Results for Interstate, State, County and WRIR Systems after Removal of Driver Distraction and Traffic Data (Removed)

	Maximum Likelihood Estimate				Estimated Odds Ratio			
Parameter	Interstate	State	County	WRIR	Interstate	State	County	WRIR
Intercept	-4.5934	-3.8063	-2.2242	-2.6931				
Animal	-1.1634	-1.6995	-2.0636	-2.0115	0.312	0.183	0.127	0.134
Rollover	1.1417	0.7432						
Guardrail	0.6901	0.3048			1.994	1.356		
FO	0.0752	-0.4347	-0.6146	-0.7068		0.647	0.541	0.493
Vehicles	1.0771	0.4671			2.936	1.595		
FHE Location	0.3577	0.2073			1.430	1.230		
Impaired	0.7854	0.9929	1.1802	1.1651	2.193	2.699	3.255	3.206
Road Condition	-0.5643	-0.6751	-0.8168	-0.8376	0.569	0.509	0.442	
Mean Posted Speed	0.5303	0.867	0.5711		1.700		1.770	
Surface			-0.7552				0.690	
Level	-0.1472	-0.4291	-0.3717		0.863			
Alignment	0.2562	0.6343			1.292			
Truck	0.1679				1.183			
MC	1.8277	1.6724	1.8408	1.4304			6.302	4.180
Mean Speed	0.2047	0.6569	-0.0138	0.6418				1.900
State				-0.7752				0.461
Maneuver	-0.1824	-0.1365			0.833	0.872		
Age ≤ 25	-0.2217	-0.2294	-0.3224		0.801	0.795	0.724	
Age > 65	0.2816	0.3088		0.3543	1.325	1.362		
Gender	-0.2594	-0.1637			0.771	0.849		
Safety Equipment	1.7054	1.3159	1.4538	1.5741	5.504	3.728	4.279	4.827
Median	-0.4616				0.630			
MC*Mean Speed	1.4522	0.3065						
Rollover*Mean Speed	0.5134	-0.429						
FO*Mean Speed	0.6647							
Mean Post Sp*Level		0.3765						
Mean Post Sp*Alignment		-0.4523						
Surface*Mean Speed			0.6835					
Road Cond*Age > 65				1.8828				
Area Under ROC Curve	0.7961	0.8287	0.8345	0.8545				
Hosmer-Lemeshow p-value	0.1137	0.0059	0.7797	0.7401				

9. LIVABILITY ON INDIAN RESERVATIONS

9.1 Livability Applications

Livability is a broad subject and specific applications vary depending on the type of community. There are significant differences between urban and rural communities. Urban communities have high density populations with concentrated service areas. Rural communities have dispersed populations and greater travel distances. Tribal lands have their own unique characteristics that would define livability differently than urban or rural.

9.1.1 Urban Areas

Many of the livability programs described in the literature review are designed for urban communities. Even though each have their own character, they all suffer from some of the same symptoms of urban sprawl, traffic congestion, run down and abandoned neighborhoods, and city centers. Much of the work that has been accomplished focuses on urban communities and the redevelopment of these densely populated areas incorporating transit and multi-modal transportation modes.

Cities are investing in revitalizing these areas and addressing the transportation needs. Transportation initiatives such as ride sharing, tele-commuting, enhancement of public transportation, and complete streets initiatives are transforming these cities to livable, sustainable communities.

9.1.2 Rural Areas

Rural communities are more challenging to address because higher density may not be achievable, and the needs vary greatly from one community to the next. One rural community could be heavily influenced by tourism where another may be driven by agriculture.

Rural America makes up about 16% of the country's population and covers 75% of the land area. It includes towns and small cities as well as working lands, farms, prairies, forests, and rangelands (Partnership for Sustainable Communities & USDA, 2011). The geographic challenges alone call for a different perspective on livability. Small towns struggle to attract business so their citizens are forced to travel long distances to quality shopping and other necessary services. Their town centers no longer have the life and character that at one time made them a great place to live. Many small towns were built adjacent to some type of transportation hub—whether a river, railroad, or major highway—in order to transport agricultural goods or natural resources.

What does livability and sustainability mean to these communities? How can they address the problems they face with better transportation options, mobility, and accessibility? Typically, rural communities lack transportation choices and must rely heavily on personal vehicles. This can be a problem for the elderly, disabled, or financially disadvantaged. Also, requiring people to drive long distances or frequently affects their quality of life in time and fuel expense and has an adverse impact on the environment.

Many of the challenges in transportation choices could be addressed by enhancing town centers, providing inter-city public transportation, and safe travel ways for bicycles along rural networks. Additionally, rural communities struggle with attracting business. The lack of diverse shopping and entertainment choices requires citizens to travel in personal vehicles to larger metropolitan communities to obtain these choices. Ideally, these small towns wish to stay small and provide their citizens with quality services. Most of these communities struggle with lack of resources.

9.1.3 Tribal Lands

Tribal lands have their own unique challenges with livability and sustainability. Many reservations are rural in nature and face many of the same struggles as other rural communities. Like so many of their rural counterparts, they also suffer from lack of resources. They are sovereign nations and do not fall under the jurisdiction of the respective states. Their governments are small and the several responsibilities are distributed among a few individuals. A tribe will rarely have its own planners, engineers, and public works department. They must rely heavily on a variety of outside sources. The Bureau of Indian Affairs (BIA), Tribal Technical Assistance Program (TTAP), Local Assistance Programs (LTAP), the Federal Highway Administration (FHWA), and state agencies are among the many agencies that can provide the tribes with assistance in addressing their development and transportation needs.

In order for them to address their livability concerns, collaborative efforts are required to provide them with the resources needed. With all the programs and initiatives available, having partners with state, federal, and other local governments is key to successfully implementing programs to improve their transportation options, preserve the natural beauty of their lands, and improve the quality of life among their people.

9.2 Tribal Challenges

9.2.1 Sovereignty and Jurisdiction

Relations between the U.S. government and American Indian tribes have evolved over the past 200 years. Changes in these relationships were a result of the different approaches the government took at the time to address the current situation. Six time periods define these changes starting with the Formative period from 1780 to 1825 and the current period of Self-Determination that started in 1961 (Hamilton, 2000). The Tribal Transportation Program (TTP) was established in 1983 through a Memorandum of Agreement between the BIA and FHWA. This program is intended to address the transportation needs of the tribes across the U.S. and provide safe and adequate transportation on these public roads (FHWA).

Since the 1960s, the U.S. government has worked to increase tribal self-determination, giving the tribes more power to decide their own direction on transportation issues. This is a shift from the direction the government had been taking concerning tribal sovereignty. From the early days of the “Agreements between Equals” in the late eighteenth and early nineteenth century, the notion was to assimilate rather than allow self-determination. Building trust between the tribes and the government is key to this success.

On reservations, the roadway system is typically made up of reservation roads, state and U.S. highways, and even local county roads. The cross jurisdictional network makes it sometimes difficult for tribes to prioritize their roadway improvements.

9.2.2 Demographics and Traffic Safety

Traffic safety is a concern for tribes. They have recognized the need to reduce fatal crashes. According to the Centers for Disease Control (CDC), injuries are the leading cause of death for American Indians and Alaskan natives up to age 44, and motor vehicle crashes are the leading cause of unintentional injury. The motor vehicle-related death rate is more than twice that of whites. Low seat belt use, low child safety seat use, and alcohol impaired driving are the major risk factors found among American Indians and Alaskan natives (Centers for Disease Control and Prevention, 2012).

9.2.3 Geographic

Like many rural communities, reservations are typically remote and members must travel great distances to places of employment, health and social services, and shopping. Often, there is not a center to the community, but it is dispersed throughout the reservations. The rural setting of reservations is uniquely different from typical rural America. The community is often spread out and separated by forest and rangeland.

9.2.4 Transportation Needs

With disconnected communities, tribal members find it hard to get around. As in rural communities, reliance on personal vehicles is essential. On reservations, many residents do not drive or own a vehicle (Barry, not dated). Without transportation options, this presents a major concern, especially for the elderly or disabled. The elderly and disabled do not have adequate access to needed services. Additionally, for younger tribal members, immobility tends to create social problems. It has been documented that Indian reservations typically have a high rate of unemployment, high poverty level, and lower educational achievement with the resulting social problems that follow these characteristics (Massey & Blevins, 1999).

Walking is a significant part of their culture, but they lack adequate facilities for pedestrians. Rural highways are not conducive to pedestrian traffic. Vehicles are traveling at high speeds and the roadways lack adequate shoulders, refuge areas, and lighting. However, Native Americans will use rural highways for foot travel without concern for their personal safety.

A system of public transportation should be incorporated into a livability development and transportation plan. Of course, the major challenge is to obtain the resources to sustain one.

9.3 Tribal Opportunities

Each tribe has its own identity with its own culture and they are committed to keeping their culture alive and pass their traditions on to the next generation. They have a strong sense of community and the elders take responsibility for the wellbeing of those communities. Although there could be many solutions for tribal livability due to the diversity of those communities, there are many shared commonalities among the tribes. It may be easier for tribes to define livability for their community than for most rural communities. Each tribe already has a sense of community and its members generally share the same values. By focusing on the core needs and cultural values of each tribe, specific livability principles can be identified for implementation.

Four types of transportation initiatives for livability in tribal nations are offered, based on examples that have been implemented successfully. These include regional planning, rural transit systems, pedestrian safety plans, and roadway safety plans.

9.3.1 Regional Planning

In order to integrate housing, land use, economics, and transportation infrastructure, many stakeholders are involved that hold varying perspectives of priorities for the community. Regional planning becomes critical for tribal communities because of the multi-jurisdictional issues that must be addressed when planning development.

For example, the Oglala Lakota Tribe in South Dakota has led the way in developing their "Regional Plan for Sustained Development" for the Pine Ridge Indian Reservation (HUD). With no planning office and limited resources, they have set out to collaborate with several agencies to develop the plan. They received a grant from HUD for this effort. This plan is built on the livability principles established by the Interagency Partnership for Sustainable Communities. It includes strategies for economic development, improved housing opportunities for their residents, leveraging federal policies and investments, and ultimately strengthening their cultural heritage.

9.3.2 Rural Transit Systems

In order to sustain the triple bottom line, transportation options need to expand to include non-motorized modes of travel. Public and mass transportation that can be supported locally also enhances opportunities for communities, allowing for those who cannot or choose not to drive a personal vehicle. This would be extremely beneficial, especially for the elderly and disabled.

A positive example is represented by the Menominee Indian Reservation in Wisconsin, which has partnered with the College of the Menominee Nation, local schools, veterans' services, county human services, and others to provide a rural transit system for their residents. Many of their residents do not own vehicles and the reservation is a vast rural countryside with hundreds of miles of streams and rivers that need to be protected. They established a transit system through the partnership and provide transportation to over 90% of their tribal population. This system makes over 80,000 trips a year getting their people to the places they need or want to go (Barry, not dated).

9.3.3 Pedestrian Safety Plans

Having safe and secure pedestrian facilities are an important necessity for the culture of tribal communities. Pedestrian walkway plans for a rural setting are not common and are considered recreational. Developing a pedestrian access plan is the first step in identifying the needs for facilities and finding funding sources to construct such facilities. For example, the Wind River Indian Reservation (WRIR) has developed the "Pedestrian and Walkway Long Range Transportation Plan" to address their need for improved and secure facilities. The WRIR covers over 2 million acres in central Wyoming and is very rural with no pedestrian facilities connecting the services, schools, residents, and other community centers. Only rural highways tie these facilities together and tribal members have no other way to traverse the reservation on foot except by use of these highways. The tribal community is extremely concerned for the safety of these pedestrians (Shinstine, Ksaibait, Gross, & Genzlinger, 2013).

9.3.4 Roadway Safety Plans

Indian nations recognize that improving roadway safety is critical to improving their quality of life. Many young people are dying because of roadway crashes (CDC, 2012). Alcohol, the lack of safety belt use, speeding, and the poor quality of many roads are issues that the Native Americans share and want to change (Herbel & Kleiner, 2010). The Wyoming Technology Transfer/Local Technical Assistance Program (WYT^2/LTAP) at the University of Wyoming has developed a methodology to identify low-cost safety improvements on reservation roads (Shinstine & Ksaibati, 2013). This methodology was successfully implemented on the WRIR, and system-wide safety improvements were funded by the state.

The WRIR has also developed a strategic highway safety plan that includes many livability principles (Shinstine, Ksaibait, Gross, & Genzlinger, 2013). They recognize the need to improve their safety culture through education and enforcement. Their strategic plan has also adopted the Pedestrian and Walkway Long Range Transportation Plan as well as the Safety Improvement Program.

The federal government has committed to partnering with local governments and communities to implement livable community programs. Indian tribes are also eligible for this support. TTAPs and LTAPS are available for technical support. State agencies and other local partners are important to the success of these programs. All of these entities working together with the tribes, can bring about the needed changes to improve quality of life, increase economic growth, and preserve the natural environment.

9.4 Summary

Urban definitions of livability are difficult to apply to Indian Reservations. For Native Americans, livability is strongly identified with traffic safety, pedestrian safety, and access to transportation. Tribes have long recognized the need to improve their safety culture and to expand programs that enhance their way of life. By expanding the definition of livability to accommodate the specific needs of tribes, they can begin to implement and prioritize new initiatives.

Despite the many programs emphasizing livability, Indian nations have not been very successful in implementing livability strategies and goals. There are institutional barriers in terms of expertise, funding, and cultural barriers.

Tribal governments need to draw upon the growing support of the federal and state governments in their efforts to improve transportation facilities and safety. Agencies are starting to realize that support needs to allow flexibility in implementation of livability goals. Successful pilot programs, such as those identified above, provide models that can be adapted by other tribal communities. By implementing programs such as intercommunity transit, safe pedestrian facilities, and roadway safety improvement programs, tribes can improve their economy, provide more job opportunities, increase access throughout their community, and provide safer roads. These are the elements that characterize livability on Indian reservations.

10. CONCLUSIONS AND RECOMMENDATIONS

10.1 Summary

Tribal communities have suffered greatly over the years with higher fatality rates on their roadways than the general population across the U.S. As the country has been successful in decreasing fatal and injury crashes over the past several years, Native Americans have experienced an increase in these types of crashes.

Many factors need to be considered when addressing roadway safety on tribal lands. Limited resources, lack of crash data, and little coordination across jurisdictions have made it difficult for tribes to address their roadway safety concerns. They also face similar challenges as other rural communities with low volumes, high speeds, alcohol involvement, and inadequate geometrics. Behavioral factors such as lack of seatbelt use and impaired driving are also a major concern across tribal communities.

This report has addressed roadway safety on tribal lands through a comprehensive approach. First, a methodology was developed to identify high crash locations and apply low-cost safety improvements working with limited crash information. This methodology was successfully implemented on the Wind River Indian Reservation (WRIR) with three system-wide improvement projects funded for IRR roads. Fremont County has passed a 1% sales tax to specifically fund the safety improvements identified in the research on their county roads on the reservation. This process led to the development of a strategic highway safety plan for the WRIR that expands the scope of addressing safety to include the behavioral factors and the tribe's specific goals. The analysis of crash data is a critical component of these plans. Initially, crash trends were analyzed. Then a statistical model was developed to model crash severity to identify the significant contributing factors. Taking into consideration the impact on the quality of life that high fatal crash rates have on tribal communities, improving roadway safety becomes a focal issue in defining livability among tribal nations.

Tribes are sovereign nations and they have their own cultures they strive to preserve. However, because their governments are small and many responsibilities are shared, they struggle to acquire the necessary resources to achieve their safety improvement goals and improve their quality of life. The success of the programs developed and implemented in this research was facilitated by the coordination and collaborative efforts among the many safety stakeholders. The tribes are passionate about roadway safety on their reservations and need to draw upon the resources available through the state and federal government and others to make their goals a reality. In return, the resources need to be extended to the tribes through manageable programs that provide the technical, administrative, and funding resources necessary for them to carry out their plans and realize improved safety on their roadways.

10.2 Conclusions

This research demonstrates that reducing fatal and serious injury crashes on Indian reservation roadways requires analysis that is comprehensive and addresses physical and behavioral improvements. Based on the analysis performed through this research, the following conclusions are derived:

10.2.1 Crash Data

Crash analysis was the first step in the development of a comprehensive methodology. The literature review and the WRIR crash data analysis showed the following:

- Fatal and serious injury crashes among Native Americans are much higher than those among whites and other races across the United States.
- Reservation roads are typically rural in nature. Rural roads have considerably higher fatal crash rates than urban roads because of extreme terrain, higher speeds, alcohol use, speed, and longer response time for emergency services, and many are run-off-the-road crashes.
- Many tribes lack complete and accurate crash data.
- The WRIR had missing crash data due to the ability to upload it into the state system.
- The WRIR had more than two times as many critical crashes than statewide.
- Crashes involving alcohol were three times higher on the WRIR than statewide.
- Most crashes involved young drivers under the age of 35 on the WRIR.
- Safety restraint use on the WRIR was almost half that of the state.
- Collisions with animals and fix objects in the clear zone are high on the WRIR.
- Most crashes were run-off-the road crashes on the WRIR.

10.2.2 Indian Reservation Safety Improvement Program

A methodology was developed for high-risk locations on Indian reservation roads, which are typically rural and experience low volumes of traffic. The methodology developed provides a means to address this problem.

- This methodology is a five-step process of:
    1. Crash analysis
    2. Level I field evaluation
    3. Combined ranking
    4. Level II field evaluation
    5. Benefit-cost analysis
- This methodology addresses the rural, local road issues of lack of resources and the difficulty of identifying high-risk locations on low volume roads.
- It is intended to address the unique needs of tribal transportation networks.

10.2.3 Implementation on the Wind River Indian Reservation

The methodology was successfully implemented on the WRIR. High-risk locations were identified and rankings were applied. The WRIR has received funding from WYDOT for the system-wide improvements, and Fremont County is proceeding with the safety improvements identified for the county roads on the reservation. Each step of the process was reviewed by the WRIR for their concurrence. Through collaboration among WRIR, law enforcement, WYDOT, and WYT^2/LTAP, the program was tailored for the needs of tribal communities.

- The methodology was adjusted to identify systemic improvements where crash data are lacking.
- Great progress was made with improving crash reporting on the WRIR. Through coordinated efforts among the tribes, WYDOT, TTAP, and WYT^2/LTAP, the discrepancies were identified and improvements made.
- The tribes selected the team to perform the Level I and Level II field evaluations.
- None of the proposed safety improvements have a benefit-to-cost ratio less than one.
- Two of the proposed safety improvements have benefit-to-cost ratios over 100. This is an indication that small improvements on these rural roads have a considerable impact on the number of fatal and serious injury crashes.

The application of this methodology revealed that extensive collaboration is necessary to the success of a safety improvement program for tribes. Because of their sovereignty and the several agencies involved in delivering a successful traffic safety program, flexibility is necessary to allow the tribes to make adjustments to fit their specific needs.

- A program that fits the specific needs of the tribe can make the task of safety improvement manageable for them as well as encourage them. They can realize effective results and be in a position to make better informed decisions on allocating funds for safety improvements.
- The methodology provides the tribal leadership to give input throughout the process and to make the final decisions on safety improvement projects.

The implementation on the WRIR also revealed and confirmed many weaknesses in crash reporting that have been prevalent on many reservations.

- Weaknesses in crash data were due to challenges in crash reporting across jurisdictions of the state and the tribes.
- The discovery of the lack of crash data and their inaccuracy prompted immediate collaboration to resolve.
- Continued efforts between WRIR law enforcement and WYDOT are necessary to improve and maintain good data.
- With the lack of crash data, the methodology can be adjusted to address high-risk locations on a systemic basis. Looking at trends together with field verification of roadway conditions, logical countermeasures can be applied system-wide.
- Coordination and collaboration is critical to the success of these programs. The state DOTs, LTAP, and TTAP centers have expertise that is accessible to the tribes. Other agencies including FHWA, BIA, and law enforcement are key stakeholders that contribute to the success. Many of these groups can help facilitate communication and cooperation between the local government and the tribes. The FHWA, state DOTs, LTAP, TTAP, BIA, and tribal leadership should continue to pursue relationships and combine expertise and resources to advance traffic safety on tribal lands.
- Tribes recognize the need for safety improvements, but they lack resources to follow through on many solutions. The combined efforts will assist them with fulfilling the goal of reducing fatal and serious injury crashes on their roadways.

- A methodology as presented in this report can be adapted to the individual needs of tribes across the United States with these collaborative efforts.

10.2.4 WRIR Strategic Highway Safety Plan

Strategic highway safety plans are required of all states and are just as necessary for tribal governments. Reducing fatal and serious injury crashes is a primary transportation safety goal for the federal, state, local, and tribal governments. The WRIR was selected for a pilot Tribal Safety Management Program (TSMP) and work has progressed on its own strategic plan.

- These plans require communication, cooperation, and collaboration of all safety stakeholders. The success of their safety programs is dependent on coordination across jurisdictional lines.
- As sovereign nations, they face different challenges than a typical American community.
- Crash trends on Indian reservations indicate that speeding, impaired driving, and safety equipment use are the highest concerns among American Indians.
- Crash data are essential to the development of a strategic plan to identify the weaknesses and safety issues that are resulting in fatal and injury crashes. Tribal leadership has recognized for some time the lack and incompleteness of crash data. Improving crash data collection and management has become an emphasis area in strategic plans for tribal lands.

The WRIR held several stakeholder meetings between April 2012 and April 2013 and has a TSMP ready for implementation. Strong support from the tribal leadership as well as many of the safety stakeholders was demonstrated. The group was engaged and extremely focused on developing a vision, mission, and goals. Emphasis areas were developed and strategies were identified to address specific issues and concerns.

- Based on crash data, use of safety equipment, impaired driving, and young drivers were targeted for behavioral improvements.
- The group recognized that the success of implementing behavioral improvements is dependent on successfully changing the safety culture.
- Pedestrian access is a major concern for the WRIR and they were resolute in including its pedestrian long-range plan as an emphasis area.
- Work has been ongoing in improving crash reporting and is an emphasis area.
- The main weakness recognized was some stakeholders were not initially involved and communications need to be improved.
- Safety partners working together can make these strategic plans a reality for tribal governments across the country. The federal and state governments have extensive resources in expertise and personnel that can facilitate the development of these plans.
- As states include tribal lands in their strategic plans, it commits them to a partnership to improve traffic safety on all roadways within their states, including those on tribal lands.

10.2.5 Statistical Model

A logistic regression model was used to analyze factors contributing to severe crashes, which follows the goal of the Wyoming SHSP to reduce critical crashes. Severity was modeled as a binary response variable. Many predictors were considered for the model and a systematic methodology was followed to develop the model to ensure important predictors of crash severity were identified. A Global System model was first developed for the entire state and then refined for each of four rural highway systems: the interstate system, the state highway system, county rural local roads, and the roadway system on the Wind River Indian Reservation. The analysis of the global system initially included traffic volume data and distracted driving.

- Distracted driving and traffic data have important associations with crash severity. However, few crashes reported these factors.
- The main predictors for all models included animal, impairment, motorcycles, mean speed, and safety equipment use.
- The county system and the WRIR had very similar results with impairment, motorcycles, and safety equipment use, all having odds ratios greater than a value of 3 and as high as 6.302 for motorcycles on county roads.
- The WRIR included an interaction of age 65 and older with road conditions, which was not identified in any other model.
- The results of this model verify tribal concerns of impairment, seat belt usage, and speeding as major contributors to critical crashes on reservations.

10.2.6 Livability

Livability has a broad definition and varies from one community to the next. There appears to be little or nothing published that addresses livability on tribal lands.

- Many programs have been developed that are most applicable in urban areas.
- Rural applications are broader and difficult to assess.
- Tribal communities have many of the same challenges as rural communities.
- Tribes struggle with lack of resources as well as overcoming cultural barriers.
- Livability is closely tied to traffic safety, pedestrian safety, and access to transportation for Native Americans.
- Tribes recognize the need to improve their safety culture and to expand programs that enhance their way of life.

10.3 Recommendations

10.3.1 Crash Data

Historically, crash data are either incomplete or non-existent on Indian reservations. Efforts by state DOTs, BIA, TTAPs, LTAPs, and tribal leadership need to continue with persistence to reconcile the problems that block good crash reporting.

- As part of safety reviews and strategic plan development, crash reporting must be addressed.
- The individuals and organizations that are responsible for maintaining and reporting crash data should communicate regularly to determine where improvements need to be made.
- Continued coordination needs to take place to ensure all improvements to reporting have been applied.

10.3.2 Indian Reservation Safety Improvement Program

- This program is recommended for use by Indian reservations across the country.
- States need to recognize their unique relationship with the tribes and understand that through coordination, communication, and cooperation, a program can be successfully implemented.

10.3.3 Implementation on the WRIR

- Either annually or bi-annually, the WRIR is recommended to review their roadway system through this methodology to identify other high-risk crash locations and continue funding requests for improvements.
- Once the IRR roads are established in a GIS system, work should proceed to reference them in the WYDOT crash database. This will allow crash analysis for specific locations on IRR roads.
- The complete five-step methodology could then be utilized and benefit-cost analysis could be included.
- It is recommended that a benefit-cost analysis be further studied for a system-wide application where crash information is available, but location of crashes is not.

10.3.4 WRIR Strategic Highway Safety Plan

- This plan needs to be finalized and implemented by the Tribal Safety Council of the WRIR.
- Annual stakeholder meetings are recommended to keep the community engaged in the improvement of the roadway safety on the WRIR.
- The process that was utilized for the development of this plan is recommended to be applied to reservations across the country.

10.3.5 Statistical Model

- As crash reporting improves, more precise modeling should be accomplished.
- Based on the significant impact that distracted driving has on prediction of crash severity, it is recommended that priority be given to increase reporting. Crash investigators need to provide accurate and complete information in the crash record.
- This model could be used not only for reservations to look at safety countermeasures, but also for other rural communities.

10.3.6 Livability

- Tribal governments need to draw upon the growing support of the federal and state governments in their efforts to improve transportation facilities and safety.
- Flexibility in measuring livability needs to be incorporated in the implementation of livability goals.
- Tribes should consider programs such as intercommunity transit, safe pedestrian facilities, and roadway safety improvement programs to address their livability goals.
- Further research is required to develop a comprehensive livability program for tribal communities.
- Recommend investigation of what programs exist today that tribes have implemented to address livability issues.
- Recommend the development of a methodology to measure livability on reservations.

Roadway safety on Indian reservations requires a comprehensive approach to addressing the various issues surrounding it. This report has identified specific recommendations to accomplish this goal. Some of the recommended analysis was intentionally simplified to provide practical and usable applications for the tribes. As tribes apply the methodology and processes developed in this research, further research should follow to provide accurate assessment of the effectiveness of the implemented safety improvements. Finally, by understanding that improving roadway safety is a quality of life issue among Native Americans, livability programs can be developed to guide their decision-making for all projects.

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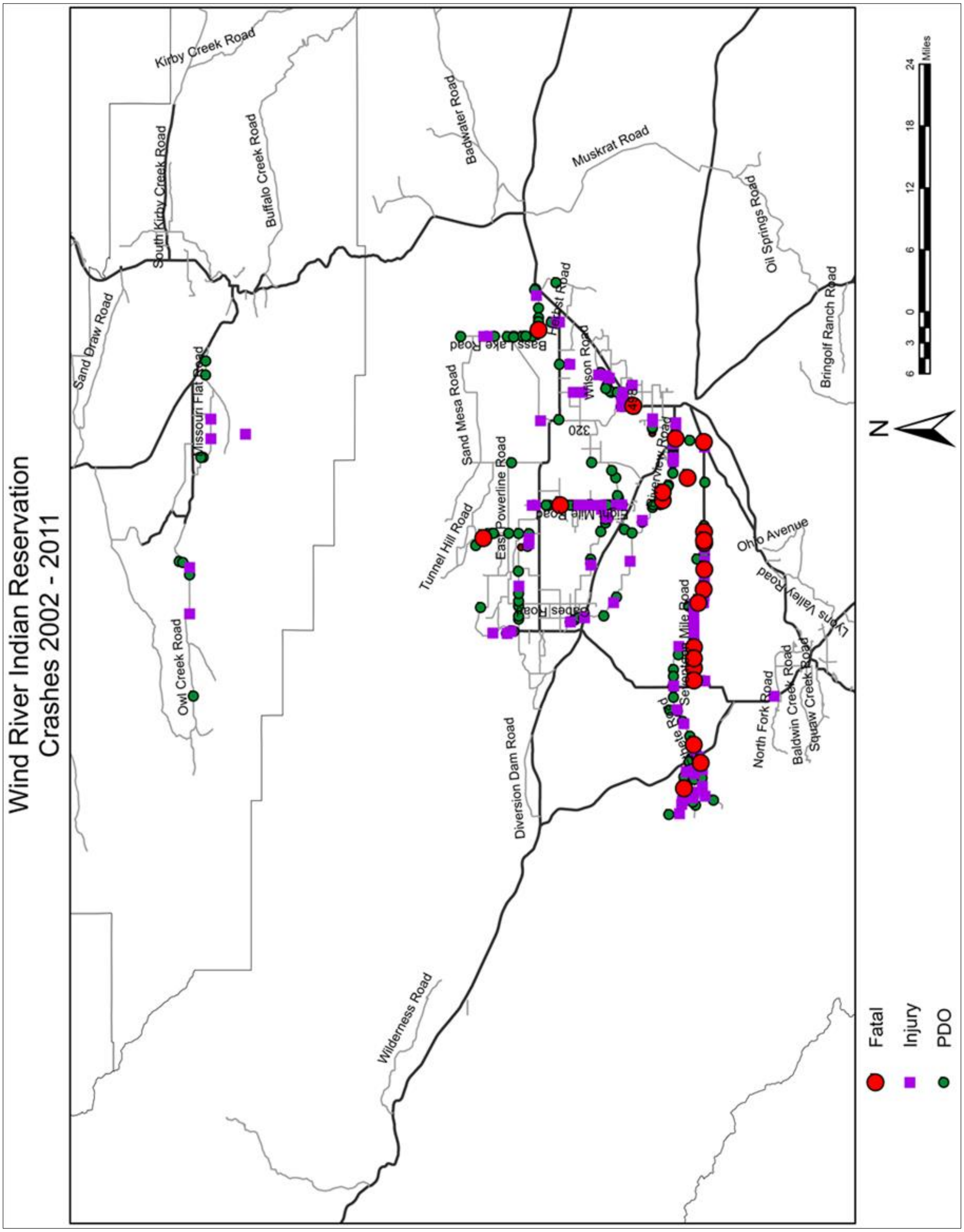
APPENDIX 1:
MAP OF WRIR CRASH LOCATIONS ON COUNTY ROADS



APPENDIX 2: WRIR LEVEL I FIELD EVALUATION FORMS

WRIR Level I Field Evaluation	Evaluator: LTAP & WRIR	Date: 6/5/12	Page: of
Notes: Combined data.		Road Name: Riverview Road	Road Length:
		Road No.: ML5716 (Co. Rt. 54)	Road Surface:
		Road Class:	Speed Limit:

Mile Post	General	Intersections / RR Crossings	Signage / Pavement Markings	Fixed Objects/ Clear Zones	Shoulder / ROW	Segment Score	Comments	WRIR Segment Score	WRIR Segment Score	Average
0.0 - 1.0	0	0	0	0	0	0	Urban in city limits	0	0	0
1.01 - 2.0	7	7	7	7	6	34	No Crashes Reported	31	31	32
2.01 -3.0	6	5	6	5	7	29	curves, bridge on curve at int.	27	29	28
3.01 - 4.0	7	5	7	7	7	33	several driveways, deer crossing sign	31	32	32
4.01 - 5.0	7	6	6	7	6	32	couple curves not too sharp	29	28	30
5.01 - 6.0	5	7	4	6	5	27	windy	28	28	28
6.01 - 7.0	5	7	5	6	5	28	curvy, cross at curve, drop off at curves	27	25	27
7.01 - 8.0	6	7	6	6	6	31	good super on curve	33	32	32
8.01 - 9.0	5	7	6	7	6	31	long curves	33	33	32
9.01 - 10.0	6	7	6	7	6	32	No Crashes Reported	36	35	34
10.01 - 11.0	6	7	6	7	6	32	No Crashes Reported	36	36	35
11.01 - 12.0	7	7	6	7	6	33	turned off onto Riverview Cut off Road	36	36	35
12.01 - 13.0						0	No Crashes Reported			
13.01 - 14.0						0	No Crashes Reported			
14.01 - 15.0						0	No Crashes Reported			

WRIR Level I Field Evaluation | Evaluator: LTAP & WRIR | Date: 6/5/12 | Page: of

Notes: Combined data. This road is scheduled for reconstruction within the next two year

Road Name: 17 Mile Road	Road Length:
Road No.: ML5827 (Co. Rt. 334)	Road Surface:
Road Class:	Speed Limit:

Mile Post	General	Intersections / RR Crossings	Signage / Pavement Markings	Fixed Objects/ Clear Zones	Shoulder / ROW	Segment Score	Comments
0.0 - 1.0	7	8	7	8	7	37	reconstructed first .5 mile, rest to be reconstructed within 2 years
1.01 - 2.0	7	7	6	7	6	33	high speed, high adt
2.01 - 3.0	7	7	7	7	6	34	
3.01 - 4.0	6	7	7	7	6	33	
4.01 - 5.0	6	7	6	7	6	32	
5.01 - 6.0	6	7	5	6	5	29	Curve not marked
6.01 - 7.0	6	7	6	6	4	29	sharp curve, delineators down, ditches
7.01 - 8.0	6	7	6	6	4	29	ditches
8.01 - 9.0	6	7	6	6	4	29	
9.01 - 10.0	9	9	9	9	9	45	new construction to end
10.01 - 11.0	9	9	9	9	9	45	
11.01 - 12.0	9	9	9	9	9	45	11.9 begin state maintenance
12.01 - 13.0	9	9	9	9	9	45	

WRIR Segment Score	WRIR Segment Score	Average
50	44	44
27	28	29
27	28	30
27	29	30
27	26	28
27	25	27
27	23	26
27	22	26
42	21	31
42	45	44
42	45	44
42	45	44
42	48	45

WRIR Level I Field Evaluation	Evaluator: D. Shinstine	Date: 6/5/12	Page: of
Notes: Combined data.		Road Name: Eight Mile Road	Road Length:
		Road No.: ML5849 (Co. Rt. 385)	Road Surface:
		Road Class:	Speed Limit:

Mile Post	General	Intersections / RR Crossings	Signage / Pavement Markings	Fixed Objects/ Clear Zones	Shoulder / ROW	Segment Score	Comments
0.0 - 1.0	8	7	8	8	7	38	40 mph
1.01 - 2.0	8	7	8	8	7	38	
2.01 - 3.0	8	7	8	8	7	38	
3.01 - 4.0	8	7	8	8	7	38	
4.01 - 5.0	8	7	8	8	7	38	
5.01 - 6.0	8	8	8	8	7	39	
6.01 - 7.0	8	8	8	8	7	39	
7.01 - 8.0	8	8	8	8	7	39	
8.01 - 9.0	8	8	8	8	7	39	
9.01 - 10.0						0	

WRIR Segment Score	Average
26	32
24	31
24	31
24	31
26	32
26	33
26	33
26	33
26	33

WRIR Level I Field Evaluation	Evaluator: LTAP & WRIR	Date: 6/5/12	Page: of
Notes: Combined data.		Road Name: Burma Road	Road Length:
		Road No.: ML5813 (Co. Rt. 320)	Road Surface:
		Road Class:	Speed Limit:

Mile Post	General	Intersections / RR Crossings	Signage / Pavement Markings	Fixed Objects/ Clear Zones	Shoulder / ROW	Segment Score	Comments
0.0 - 1.0	6	6	6	5	5	28	several entrances, 35 mph
1.01 - 2.0	9	9	9	9	9	45	start new construction, 45 mph
2.01 - 3.0	9	9	9	9	9	45	
3.01 - 4.0	9	9	9	9	9	45	
4.01 - 5.0	8	9	9	9	9	44	sight distance at hill but signed so
5.01 - 6.0	9	9	9	9	9	45	end new construction
6.01 - 7.0	7	6	5	6	5	29	speed limit increases to 50 mph
7.01 - 8.0	7	6	6	7	5	31	
8.01 - 9.0	6	7	7	7	6	33	ends at 8.1

WRIR Segment Score	Average
31	30
34	40
47	46
47	46
47	46
47	46
31	30
33	32

WRIR Level I Field Evaluation	Evaluator: LTAP & WRIR	Date: 6/5/12	Page: of
Notes: Combined data. Intersection needs sign. Need delineators, need speed limit, no guard rail at bridge.		Road Name: North Fork Road	Road Length:
		Road No.: ML5836 (Co. Rt. 354)	Road Surface:
		Road Class:	Speed Limit:

Mile Post	General	Intersections / RR Crossings	Signage / Pavement Markings	Fixed Objects/ Clear Zones	Shoulder / ROW	Segment Score	Comments
0.0 - 1.0	7	4	6	5	5	27	fairly urban. 30 mph, poor int, bridge no GR
1.01 - 2.0	7	7	6	5	4	29	
2.01 - 3.0	7	7	4	7	4	29	high crash area
3.01 - 4.0	6	7	7	7	4	31	
4.01 - 5.0	6	7	7	7	4	31	
5.01 - 6.0	5	6	4	6	3	24	poor road surface w/ vegitation encroaching in travelway

WRIR Segment Score	WRIR Segment Score	Average
25	27	26
26	27	27
26	24	26
26	27	28
21	24	25
24	24	24

WRIR Level I Field Evaluation	Evaluator: LTAP & WRIR	Date: 6/5/12	Page: of
Notes: Combined data. No intersection signageNo guardrail at canal.		Road Name: South Fork Road	Road Length:
		Road No.: ML5837 (Co. Rt. 346)	Road Surface:
		Road Class:	Speed Limit:

Mile Post	General	Intersections / RR Crossings	Signage / Pavement Markings	Fixed Objects/ Clear Zones	Shoulder / ROW	Segment Score	Comments
0.0 - 1.0	7	7	5	7	5	31	
1.01 - 2.0	6	6	6	7	5	30	No shoulder
2.01 - 3.0	6	7	5	3	2	23	Major culvert no GR in curve
3.01 - 4.0	7	7	6	6	3	29	high drop off may warrant GR
4.01 - 5.0						0	Route ends at 3.8

WRIR Segment Score	WRIR Segment Score	Average
35	30	32
37	29	32
24	24	24
27	23	26

WRIR Level I Field Evaluation	Evaluator: LTAP & WRIR	Date: 6/5/12	Page: of
Notes: Combined data. a lot of pedestrian, a lot of entrances, school, no pvmt markings, no delineators, no intersection signage, open ditch.		Road Name: Ethete Road	Road Length:
		Road No.: ML5828 (Co. Rt. 335)	Road Surface:
		Road Class:	Speed Limit:

Mile Post	General	Intersections / RR Crossings	Signage / Pavement Markings	Fixed Objects/ Clear Zones	Shoulder / ROW	Segment Score	Comments
0.0 - 1.0	8	6	7	8	8	37	wide shoulders, reconstructed 5 yrs ago
1.01 - 2.0	8	8	8	8	8	40	1 fatality crossing centerline
2.01 - 3.0	8	8	8	8	8	40	
3.01 - 4.0	8	8	8	8	8	40	
4.01 - 5.0	8	8	8	8	8	40	
5.01 - 6.0	7	4	3	3	3	20	Section evaluated from 5.6 - 6.0 only. First .6 new construction.
6.01 - 7.0	6	6	5	5	4	26	busy int no signs
7.01 - 8.0	5	6	2	6	2	21	90 turns, wrong speed warning sign, drop off at curve
8.01 - 9.0	5	7	2	4	3	21	2 sharp curves
9.01 - 10.0	7	7	5	5	3	27	fairly straight, no shoulders, some drop off
10.01 - 10.5	7	7	6	7	3	30	
							verify mile mark direction

WRIR Segment Score	WRIR Segment Score	Average
47	44	43
48	45	44
48	45	44
48	45	44
48	44	44
23	16	20
25	20	24
20	20	20
24	21	22
24	22	24
24	23	26

WRIR Level I Field Evaluation | Evaluator: LTAP & WRIR | Date: 6/5/12 | Page: of

Notes: Combined data.

Road Name: Paradise Valley Road | Road Length:
Road No.: ML5807 (Co. Rt. 315) | Road Surface:
Road Class: | Speed Limit:

Mile Post	General	Intersections / RR Crossings	Signage / Pavement Markings	Fixed Objects/ Clear Zones	Shoulder / ROW	Segment Score	Comments	WRIR Segment Score	Average
0.0 - 1.0	7	8	8	8	7	38		32	35
1.01 - 2.0	7	8	8	8	7	38		32	35
2.01 - 3.0	7	8	8	8	7	38		32	35
3.01 - 4.0	7	7	8	8	7	37		31	34
4.01 - 5.0	7	7	8	8	7	37		31	34
5.01 - 6.0	7	7	6	8	6	34	curve good super no chevrons	31	33
6.01 - 7.0	7	7	7	7	6	34		30	32
7.01 - 8.0	7	6	6	7	7	33	intersection on curve	30	32
8.01 - 9.0	7	6	6	7	7	33	intersection on curve	32	33
9.01 - 10.0	7	7	5	4	4	27	intersection begin gravel road at 9.0 miles, narrow brig	27	27
10.01 - 11.0	7	8	5	5	5	30		27	29

WRIR Level I Field Evaluation	Evaluator: LTAP & WRIR	Date: 6/5/12	Page: of
Notes: Combined data.		Road Name: North Pavillion Road	Road Length:
		Road No.: ML5875 (Co. Rt. 428)	Road Surface:
		Road Class:	Speed Limit:

Mile Post	General	Intersections / RR Crossings	Signage / Pavement Markings	Fixed Objects/ Clear Zones	Shoulder / ROW	Segment Score	Comments
0.0 - 1.0	6	7	6	7	6	32	gravel, some curves
1.01 - 2.0	6	6	6	7	6	31	cattle guard in curve
2.01 - 3.0	6	7	6	7	6	32	
3.01 - 4.0						0	drove only first 3 miles
4.01 - 5.0						0	
5.01 - 6.0						0	
6.01 - 7.0						0	

WRIR Segment Score	Average
29	31
29	30
29	31
0	0

WRIR Level I Field Evaluation	D. Shinstine	Date: 6/5/12	Page: of
Notes:		Road Name: Hutchison Road	Road Length:
		Road No.: ML5783 (Co. Rt. 272)	Road Surface:
		Road Class:	Speed Limit:

Mile Post	General	Intersections / RR Crossings	Signage / Pavement Markings	Fixed Objects/ Clear Zones	Shoulder / ROW	Segment Score	Comments
0.0 - 1.0	6	5	7	6	6	30	
1.01 - 2.0	6	4	6	6	6	28	90 degree turn
2.01 - 2.6	7	5	7	6	6	31	misaligned intersection at two valley road, 35 mph

WRIR Segment Score	Average
24	27
31	30
30	31

WRIR Level I Field Evaluation	Evaluator: LTAP & WRIR	Date: 6/5/12	Page: of
Notes: Combined data.		Road Name: Pingetzer Road	Road Length:
		Road No.: ML5848 (Co. Rt. 367	Road Surface:
		Road Class:	Speed Limit:

Mile Post	General	Intersections / RR Crossings	Signage / Pavement Markings	Fixed Objects/ Clear Zones	Shoulder / ROW	Segment Score	Comments
0.0 - 1.0	6	5	5	3	4	23	gravel, cattle guard at .9, end not marked

WRIR Segment Score	Average
31	27
0	0

WRIR Level I Field Evaluation	Evaluator: LTAP & WRIR	Date: 6/5/12	Page: of
Notes: Combined data.		Road Name: Zuber Road	Road Length:
		Road No.: ML5916 (Co. Rt. 496)	Road Surface:
		Road Class:	Speed Limit:

Mile Post	General	Intersections / RR Crossings	Signage / Pavement Markings	Fixed Objects/ Clear Zones	Shoulder / ROW	Segment Score	Comments
0.0 - 1.0	7	6	7	6		26	sharp curve at beginning, gravel road to stop sign at 0.2 miles then paved
1.01 - 2.0						0	

WRIR Segment Score	Average
35	31
0	0

WRIR Level I Field Evaluation | Evaluator: LTAP & WRIR | Date: 6/5/12 | Page: of

Notes: Combined data. 2011 fatality not in crash data. Several run off the road crashes at curve.

Road Name: Trout Creek Road | Road Length:
Road No.: ML5838 (Co. Rt. 347) | Road Surface:
Road Class: | Speed Limit:

Mile Post	General	Intersections / RR Crossings	Signage / Pavement Markings	Fixed Objects/ Clear Zones	Shoulder / ROW	Segment Score	Comments
0.0 - 1.0	7	5	4	4	3	23	min. pvmnt marking, 1" shoulder, fixed objects, steep side slopes
1.01 - 2.0	7	7	5	5	2	26	no shoulder, steep
2.01 - 3.0	7	8	4	5	3	27	chevrons at curve would help
3.01 - 4.0	7	3	4	4	3	21	evidence of several ROR at curve (curve sign present, no chevrons)
4.01 - 5.0	7	7	6	7	4	31	

WRIR Segment Score	WRIR Segment Score	Average
20	25	23
22	21	23
25	25	26
19	24	21
32	33	32

WRIR Level I Field Evaluation	Evaluator: LTAP & WRIR	Date: 6/5/12	Page: of
Notes: Combined data.		Road Name: Country Acres Road	Road Length:
		Road No.: ML5844 (Co. Rt. 360)	Road Surface:
		Road Class:	Speed Limit:

Mile Post	General	Intersections / RR Crossings	Signage / Pavement Markings	Fixed Objects/ Clear Zones	Shoulder / ROW	Segment Score	Comments
0.0 - 1.0	7	7	7	5	7	33	40 mph
1.01 - 2.0	7	7	7	6	6	33	gravel begins at 1.0 at intersection

WRIR Segment Score	Average
30	32
27	30

WRIR Level I Field Evaluation	Evaluator: LTAP & WRIR	Date: 6/5/12	Page: of
Notes: Combined Data.		Road Name: Peterson Road	Road Length:
		Road No.: ML5891 (Co. Rt. 463)	Road Surface:
		Road Class:	Speed Limit:

Mile Post	General	Intersections / RR Crossings	Signage / Pavement Markings	Fixed Objects/ Clear Zones	Shoulder / ROW	Segment Score	Comments
0.0 - 1.0	6	7	5	6	5	29	gravel, blind curve w/ temp sign "rough Road"
1.01 - 2.0	6	7	6	5	5	29	Large irrigation ditch adjacent
2.01 - 3.0	5	6	5	2	3	21	power pole on edge of travel way, irrigation well on edge of travelway
3.01 - 4.0	7	6	6	4	4	27	narrow bridge
							ends at 3.6 miles

WRIR Segment Score	Average
20	25
20	25
29	25
26	27
0	0

WRIR Level I Field Evaluation	Evaluator: LTAP & WRIR	Date: 6/5/12	Page: of
Notes: Combined data.		Road Name: Kinnear Spur Road	Road Length:
		Road No.: ML5902 (Co. Rt. 480)	Road Surface:
		Road Class:	Speed Limit:

Mile Post	General	Intersections / RR Crossings	Signage / Pavement Markings	Fixed Objects/ Clear Zones	Shoulder / ROW	Segment Score	Comments
0.0 - 1.0	5	6	5	7	6	29	Narrow, 55 mph, no shoulder, sharp curve w/ drop off
1.01 - 2.0	5	6	6	7	5	29	

WRIR Segment Score	WRIR Segment Score	Average
24	20	24
24	21	25

WRIR Level I Field Evaluation	Evaluator: LTAP & WRIR	Date: 6/5/12		Page: of
Notes: Combined data.		Road Name: Cliff Drive	Road Length:	
		Road No.: ML5784 (Co. Rt. 273)	Road Surface:	
		Road Class:	Speed Limit:	

Mile Post	General	Intersections / RR Crossings	Signage / Pavement Markings	Fixed Objects/ Clear Zones	Shoulder / ROW	Segment Score	Comments
0.0 - 1.0	4	5	4	3	4	20	gravel, windy, poor sight distance around curves
1.01 - 2.0						0	ends at 1.0

WRIR Segment Score	Average
16	18
0	0

Notes: Combined data.

Road Name: Elkhorn Drive	Road Length:
Road No.: ML5825 (Co. Rt. 333)	Road Surface:
Road Class:	Speed Limit:

Mile Post	General	Intersections / RR Crossings	Signage / Pavement Markings	Fixed Objects/ Clear Zones	Shoulder / ROW	Segment Score	Comments	WRIR Segment Score	Average
0.0 - 1.0	6	6	6	5	6	29	gravel and curves	34	32
1.01 - 2.0						0	ends at 1.2	34	34

WRIR Level I Field Evaluation	Evaluator: LTAP & WRIR	Date: 6/5/12	Page: of
Notes: Combined data. Roadway surface in poor condition.		Road Name: Bass Lake Road	Road Length:
		Road No.: ML5876 (Co. Rt. 430)	Road Surface:
		Road Class:	Speed Limit:

Mile Post	General	Intersections / RR Crossings	Signage / Pavement Markings	Fixed Objects/ Clear Zones	Shoulder / ROW	Segment Score	Comments	WRIR Segment Score	Average
0.0 - 1.0	8	8	8	9	8	41	first .7 mile reconstructed. Posted 45 mph.	40	41
1.01 - 2.0	7	9	8	9	8	41		39	40
2.01 - 3.0	6	9	8	9	8	40		39	40
3.01 - 4.0	6	9	8	9	7	39		35	37
4.01 - 5.0	6	9	8	9	7	39		35	37
5.01 - 6.0	6	9	7	9	8	39		35	37
6.01 - 7.0	6	9	6	9	8	38		35	37
7.01 - 8.0	6	9	6	9	8	38		35	37
8.01 - 9.0	6	9	5	6	8	34		32	33
9.01 - 10.0	6	7	5	5	7	30	end of pavement 9.4	32	36
10.01 - 11.0	7	7	7	7	6	34	No Crashes Reported	30	34
11.01 - 12.0	7	7	8	7	6	35	end 11.2	30	34

WRIR Level I Field Evaluation	Evaluator: LTAP & WRIR	Date: 6/5/12	Page: of
Notes: Combined data		Road Name: East Pavillion Road	Road Length:
		Road No.: ML5822 (Co. Rt. 330)	Road Surface:
		Road Class:	Speed Limit:

Mile Post	General	Intersections / RR Crossings	Signage / Pavement Markings	Fixed Objects/ Clear Zones	Shoulder / ROW	Segment Score	Comments	WRIR Segment Score	Average
0.0 - 1.0	6	7	7	7	6	33	50 mph, narrow	29	31
1.01 - 2.0	5	7	6	6	6	30	vertical curve no sight distance w/ horizontal curve at top, another vc	21	26
2.01 - 3.0	6	7	7	6	6	32		30	31
3.01 - 4.0	6	7	7	7	6	33		26	30
4.01 - 5.0	6	7	7	6	5	31		27	29
							road ends at 5.5, last .5 miles urban 9in Pavillion)		

WRIR Level I Field Evaluation | Evaluator: LTAP & WRIR | Date: 6/5/12 | Page: of

Notes: Combined data. Appears that all new signs have been recently installed and probably address the crash problems

Road Name: Owl Creek Road | Road Length:

Road No.: ML6216 (HS Co. Rt. 1) | Road Surface:

Road Class: | Speed Limit:

Mile Post	General	Intersections / RR Crossings	Signage / Pavement Markings	Fixed Objects/ Clear Zones	Shoulder / ROW	Segment Score	Comments	WRIR Segment Score	Average
0.0 - 1.0	5	7	5	6	6	29	Narrow, no pavement markings	22	26
2.01 - 3.0	6	7	6	6	5	30	No Crashes Reported	22	26
3.01 - 4.0	6	7	6	6	6	31	curve signs	22	27
4.01 - 5.0	6	7	6	6	6	31	chevrons. Power pole at sharp curve	22	27
5.01 - 6.0	6	7	6	7	6	32	sharp curve, with sign and chevrons	22	27
6.01 - 7.0	6	7	6	7	6	32	No Crashes Reported	25	29
7.01 - 8.0	6	7	5	7	6	31	sharp curve no chevrons	27	29
8.01 - 9.0	6	7	5	6	6	30	No Crashes Reported two curves entrance at curve	27	29
9.01 - 10.0						0	No Crashes Reported		
10.01 - 11.0						0	No Crashes Reported		
11.01 - 12.0						0	No Crashes Reported		
12.01 - 13.0						0	No Crashes Reported		
13.01 - 14.0						0	No Crashes Reported		
14.01 - 15.0						0			

WRIR Level I Field Evaluation	Evaluator: LTAP & WRIR	Date: 6/5/12	Page: of
Notes: Combined data. Evaluated only first two miles. Crash data begins from 1.01 to 2.0		Road Name: Buckhom Flats Road	Road Length:
		Road No.: ML5823 (Co. Rt. 331)	Road Surface:
		Road Class:	Speed Limit:

Mile Post	General	Intersections / RR Crossings	Signage / Pavement Markings	Fixed Objects/ Clear Zones	Shoulder / ROW	Segment Score	Comments
0.0 - 1.0	6	6	5	6	5	28	No Crashes Reported narrows at .9 mile
1.01 - 2.0	5	5	5	5	4	24	No Crashes Reported
2.01 - 3.0						0	tumed to gravel, did not complete
3.01 - 4.0						0	
4.01 - 5.0						0	No Crashes Reported
5.01 - 6.0						0	
6.01 - 7.0						0	

WRIR Segment Score	WRIR Segment Score	Average
26	18	24
0	0	24

WRIR Level I Field Evaluation	Evaluator: LTAP & WRIR	Date: 6/5/12	Page: of
Notes: Combined data. North to South, ends at 6.2 at Rt. 26.		Road Name: Two Valley Road	Road Length:
		Road No.: ML5831 (Co. Rt. 339)	Road Surface:
		Road Class:	Speed Limit:

Mile Post	General	Intersections / RR Crossings	Signage / Pavement Markings	Fixed Objects/ Clear Zones	Shoulder / ROW	Segment Score	Comments
0.0 - 1.0	6	5	6	6	5	28	45 mph, narrow, no shoulder
1.01 - 2.0	6	6	6	6	6	30	
2.01 - 3.0	6	6	3	4	6	25	gravel begins, irrigation ditch at curve w/ no signs or barrier
3.01 - 4.0	7	7	7	7	7	35	No Crashes Reported
4.01 - 5.0	6	5	6	5	5	27	pavement at 4.4
5.01 - 6.0	6	6	6	6	6	30	sharp curve

WRIR Segment Score	Average
28	28
26	28
17	21
26	31
24	26
28	29

WRIR Level I Field Evaluation	Evaluator: LTAP & WRIR	Date: 6/5/12	Page: of
Notes: Combined data		Road Name: Williams Road	Road Length:
		Road No.: ML5697 (Co. Rt. 12)	Road Surface:
		Road Class:	Speed Limit:

Mile Post	General	Intersections / RR Crossings	Signage / Pavement Markings	Fixed Objects/ Clear Zones	Shoulder / ROW	Segment Score	Comments	WRIR Segment Score	Average
0.0 - 1.0	5	7	6	6	6	30	narrow, windy	27	29
1.01 - 2.0	6	7	6	5	6	30		27	29

APPENDIX 3:
TABLE. WRIR COMBINED RANKING FOR COUNTY ROADS

County Route	Road Name	Beg MP	End MP	Total Crashes	Crash Rank	Level I Rank	Combined Rank
430	Bass Lake Road	0.0	1.0	2	47	106	153
430	Bass Lake Road	1.01	2.0	1	73	103	176
430	Bass Lake Road	2.01	3.0	2	47	103	150
430	Bass Lake Road	3.01	4.0	2	47	98	145
430	Bass Lake Road	4.01	5.0	3	37	98	135
430	Bass Lake Road	5.01	6.0	1	73	98	171
430	Bass Lake Road	6.01	7.0	1	73	98	171
430	Bass Lake Road	7.01	8.0	1	73	98	171
430	Bass Lake Road	8.01	9.0	1	73	79	152
430	Bass Lake Road	9.01	10.0	3	37	97	134
430	Bass Lake Road	10.01	11.0	0	103	86	189
430	Bass Lake Road	11.01	12.0	1	73	86	159
331	Buckhorn Flats Rd	1.01	2.0	0	103	9	112
320	Burma Road	0.0	1.0	9	4	50	54
320	Burma Road	1.01	2.0	7	11	103	114
320	Burma Road	2.01	3.0	4	26	112	138
320	Burma Road	3.01	4.0	6	14	112	126
320	Burma Road	4.01	5.0	7	11	112	123
320	Burma Road	5.01	6.0	8	7	112	119
320	Burma Road	6.01	7.0	1	73	50	123
320	Burma Road	7.01	8.0	2	47	66	113
273	Cliff Drive	0.0	1.0	3	37	1	38
360	Country Acres Rd	0.0	1.0	1	73	66	139
360	Country Acres Rd	1.01	2.0	4	26	50	76
330	East Pavillion Rd	0.0	1.0	1	73	57	130
330	East Pavillion Rd	1.01	2.0	2	47	20	67
330	East Pavillion Rd	2.01	3.0	2	47	57	104
330	East Pavillion Rd	3.01	4.0	1	73	50	123
330	East Pavillion Rd	4.01	5.0	1	73	42	115
385	Eight Mile Road	0.0	1.0	2	47	66	113
385	Eight Mile Road	1.01	2.0	8	7	57	64
385	Eight Mile Road	2.01	3.0	6	14	57	71
385	Eight Mile Road	3.01	4.0	2	47	57	104
385	Eight Mile Road	4.01	5.0	8	7	66	73
385	Eight Mile Road	5.01	6.0	12	2	79	81
385	Eight Mile Road	6.01	7.0	1	73	79	152
385	Eight Mile Road	7.01	8.0	4	26	79	105

385	Eight Mile Road	8.01	9.0	2	47	79	126
333	Elkhorn Drive	0.0	1.0	3	37	66	103
333	Elkhorn Drive	1.01	2.0	1	73	86	159
335	Ethete Road	0.0	1.0	8	7	107	114
335	Ethete Road	1.01	2.0	7	11	108	119
335	Ethete Road	2.01	3.0	3	37	108	145
335	Ethete Road	3.01	4.0	4	26	108	134
335	Ethete Road	4.01	5.0	4	26	108	134
335	Ethete Road	5.01	6.0	6	14	2	16
335	Ethete Road	6.01	7.0	4	26	9	35
335	Ethete Road	7.01	8.0	2	47	2	49
335	Ethete Road	8.01	9.0	1	73	6	79
335	Ethete Road	9.01	10.0	1	73	9	82
272	Hutchinson Road	0.0	1.0	5	21	28	49
272	Hutchinson Road	1.01	2.0	1	73	50	123
480	Kinnear Spur Road	0.0	1.0	3	37	9	46
480	Kinnear Spur Road	1.01	2.0	4	26	15	41
345	North Fork Road	0.0	1.0	2	47	20	67
345	North Fork Road	1.01	2.0	4	26	28	54
345	North Fork Road	2.01	3.0	5	21	20	41
345	North Fork Road	3.01	4.0	6	14	37	51
345	North Fork Road	4.01	5.0	1	73	15	88
345	North Fork Road	5.01	6.0	1	73	9	82
428	North Pavillion Rd	0.0	1.0	3	37	57	94
428	North Pavillion Rd	1.01	2.0	2	47	50	97
428	North Pavillion Rd	2.01	3.0	0	103	57	160
1	Owl Creek Road	2.01	3.0	0	103	20	123
1	Owl Creek Road	3.01	4.0	2	47	20	67
1	Owl Creek Road	4.01	5.0	1	73	28	101
1	Owl Creek Road	5.01	6.0	2	47	28	75
1	Owl Creek Road	6.01	7.0	0	103	28	131
1	Owl Creek Road	7.01	8.0	1	73	42	115
1	Owl Creek Road	8.01	9.0	0	103	42	145
1	Owl Creek Road	9.01	10.0	0	103	42	145
315	Paradise Valley Rd	0.0	1.0	3	37	92	129
315	Paradise Valley Rd	1.01	2.0	1	73	92	165
315	Paradise Valley Rd	2.01	3.0	2	47	92	139
315	Paradise Valley Rd	3.01	4.0	2	47	86	133
315	Paradise Valley Rd	4.01	5.0	6	14	86	100
315	Paradise Valley Rd	5.01	6.0	0	103	79	182
315	Paradise Valley Rd	6.01	7.0	2	47	66	113
315	Paradise Valley Rd	7.01	8.0	1	73	66	139
315	Paradise Valley Rd	8.01	9.0	1	73	79	152

315	Paradise Valley Rd	9.01	10.0	2	47	28	75
315	Paradise Valley Rd	10.01	11.0	2	47	42	89
463	Peterson Road	0.0	1.0	2	47	15	62
463	Peterson Road	1.01	2.0	2	47	15	62
463	Peterson Road	2.01	3.0	1	73	15	88
463	Peterson Road	3.01	4.0	1	73	28	101
367	Pingetzer Road	0.0	1.0	5	21	28	49
54	Riverview Road	1.01	2.0	4	26	66	92
54	Riverview Road	2.01	3.0	18	1	37	38
54	Riverview Road	3.01	4.0	6	14	66	80
54	Riverview Road	4.01	5.0	9	4	50	54
54	Riverview Road	5.01	6.0	5	21	37	58
54	Riverview Road	6.01	7.0	6	14	28	42
54	Riverview Road	7.01	8.0	12	2	66	68
54	Riverview Road	8.01	9.0	0	103	66	169
54	Riverview Road	9.01	10.0	0	103	86	189
54	Riverview Road	10.01	11.0	2	47	92	139
54	Riverview Road	11.01	12.0	0	103	92	195
346	South Fork Road	0.0	1.0	9	4	66	70
346	South Fork Road	1.01	2.0	2	47	66	113
346	South Fork Road	2.01	3.0	5	21	9	30
346	South Fork Road	3.01	4.0	1	73	20	93
347	Trout Creek Road	0.0	1.0	1	73	7	80
347	Trout Creek Road	1.01	2.0	2	47	7	54
347	Trout Creek Road	2.01	3.0	3	37	20	57
347	Trout Creek Road	3.01	4.0	2	47	4	51
339	Two Valley Road	0.0	1.0	1	73	37	110
339	Two Valley Road	1.01	2.0	3	37	37	74
339	Two Valley Road	2.01	3.0	0	103	4	107
339	Two Valley Road	3.01	4.0	0	103	57	160
339	Two Valley Road	4.01	5.0	2	47	20	67
339	Two Valley Road	5.01	6.0	1	73	42	115
12	Williams Road	0.0	1.0	1	73	42	115
12	Williams Road	1.01	2.0	4	26	42	68
496	Zuber Road	0.0	1.0	4	26	57	83

APPENDIX 4: WRIR LEVEL II ROADWAY SAFETY IMPROVEMENTS

Wind River Indian Reservation | **County:** Fremont | **Road Name:** Ethete Road | **County Route:** 335 | **IRR Route:** 52 | **Date:** 7/5/12

Road Class: Rural Collector | **ADT:** | **85th Speed:** | **Road Surface:** Asphalt 0.0 to 10.5 Gravel/natural earth to

LOCATION	PAVEMENT MARKINGS	STOP R1-1	STOP AHEAD W3-1	CURVE LT W1-1 (90)	CURVE RT W1-1 (90)	CURVE LT W1-2	CURVE RT W1-2	CHEVRON W1-8	WINDING ROAD W1-5	INTERSECTION W2-1	INTERSECTION W2-2 (T)	PAVEMENT ENDS W8-3	OBJECT MARKER OM-3	SPEED LIMIT 20 R2-1	SPEED LIMIT 35 W13-1	ARROW W1-6	ROAD NARROWS W5-1	OPEN RANGE	SHOULDER DROP OFF W8-9A	COMMENTS
0.0 - 5.6																				Speed and Safety Study
5.6 - 10.5																				Speed and Safety Study
5.61R																				Congested Area Sign
5.6 - 7.0																				Clear Vegitation
5.8R																				School sign
6.1 L																				School sign
5.8R																				School Flashers
6.1 L																				School Flashers
6.0																				Crosswalk at school
6.5R										1										
6.6L										1										
7.4R					1															Replace existing
7.5-7.7								5												Both Directions
7.8L				1																Replace Existing
7.9R					1															Replace Existing
8.0 - 8.2								5												Both directions
8.1L				1																Replace Existing
8.0R																				Extend Culvert south end
8.8R							1													Replace Existing
8.9-9.1								5												Both directions
9.2L						1														Replace Existing
9.6R											1									
9.8L											1									
10.3R										1										Replace existing
10.4R			1																	Replace existing
10.3	1																			Rumble Strips for Stop
0.0-10.5																				Long Term - Wedge Shoulders
TOTAL		0	1	2	2	1	1	15	0	3	2	0	0	0	0	0	0	0	0	

TOTAL SIGNS = 27

Wind River Indian Reservation | **County:** Fremont | **Road Name**: South Fork Road | **County Route:** 346 | **IRR Route:** 72 | **Date:** 7/5/12

Road Class: Rural Local | **ADT:** | **85th Speed:** | **Road Surface:** Asphalt 0.0 to 3.7 Gravel/natural earth to

LOCATION	PAVEMENT MARKINGS	STOP R1-1	STOP AHEAD W3-1	CURVE LT W1-1 (90°)	CURVE RT W1-1 (90°)	CURVE LT W1-2	CURVE RT W1-2	CHEVRON W1-8	WINDING ROAD W1-5	INTERSECTION W2-1	INTERSECTION W2-2 (T)	PAVEMENT ENDS W8-3	OBJECT MARKER OM-3	SPEED LIMIT 20 R2-1	SPEED LIMIT 35 W13-1	ARROW W1-6	ROAD NARROWS W5-1	OPEN RANGE	SHOULDER DROP OFF W8-9A	COMMENTS
0.3R																				Curve and Int. with N. Fork
0.5L																				Consider Revising Int. or W1-10
1.3R											1									
1.4L											1									
2.4																				ALT 1: Extend Culvert (8' Dia)
2.4																				ALT 2: GR with Object Markers
0.5R							1													
0.7L							1													
0.6								3												Both Directions
2.9						1				1										
3.7													1							"End County Maintenance" sign
TOTAL		0	0	0	0	1	2	3	0	1	2	0	1	0	0	0	0	0	0	

TOTAL SIGNS = 10

Wind River Indian Reservation				**County:** Fremont			**Road Name**: Riverview Road						**County Route:** 54			**IRR Route:** 169		**Date:** 7/5/12			
Road Class: Rural Collector						**ADT:**			**85th Speed:**		**Road Surface:**		Asphalt 0.0 to 15.0 Gravel/natural earth to								
LOCATION	PAVEMENT MARKINGS	STOP R1-1	STOP AHEAD W3-1	CURVE LT W1-1 (90)	CURVE RT W1-1 (90)	CURVE LT W1-2	CURVE RT W1-2	CHEVRON W1-8	WINDING ROAD W1-5	INTERSECTION W2-1	INTERSECTION W2-2 (T)	PAVEMENT ENDS W8-3	OBJECT MARKER OM-3	SPEED LIMIT 20 R2-1	SPEED LIMIT 35 W13-1	ARROW W1-6	ROAD NARROWS W5-1	OPEN RANGE	SHOULDER DROP OFF W8-9A	OTHER SIGN	COMMENTS
0.0 - 4.0																					Speed and Safety Study
0.0 - 4.1	1																				Re-stripe
0.0 - 3.0																					"Conjested Area"
1.3R											1										
1.4L											1										
2.0R																		1			"Next 10 Miles"
2.2R																				1	"Dangerous Intersection"
2.4L																					Possibly add Flashers
2.4											2										
2.9																				1	Repl. Lft Turn Ln. Sign (M5-1 & M5-4)
3.1											1										
3.6											1										
5.4R						1															
7.00																		1			
2.50																					Long Term Replace Bridge
TOTAL		0	0	0	0	1	0	0	0	0	6	0	0	0	0	0	0	2	0	2	
TOTAL SIGNS =			11																		

Wind River Indian Reservation		County: Fremont			Road Name: Cliff Road				County Route: 273			IRR Route:			Date: 7/5/12					
Road Class: Rural local				ADT:				85th Speed:		Road Surface:		Asphalt to	Gravel/natural earth 0.0 to 1.0							
LOCATION	PAVEMENT MARKINGS	STOP R1-1	STOP AHEAD W3-1	CURVE LT W1-1 (90)	CURVE RT W1-1 (90)	CURVE LT W1-2	CURVE RT W1-2	CHEVRON W1-8	WINDING ROAD W1-5	INTERSECTION W2-1	INTERSECTION W2-2 (T)	PAVEMENT ENDS W8-3	OBJECT MARKER OM-3	SPEED LIMIT 20 R2-1	SPEED LIMIT 35 W13-1	ARROW W1-6	ROAD NARROWS W5-1	OPEN RANGE	SHOULDER DROP OFF W8-9A	COMMENTS
0.1									1											
0.5													4							GR at Bridge
TOTAL		0	0	0	0	0	0	0	1	0	0	0	4	0	0	0	0	0	0	
TOTAL SIGNS =			5																	

Wind River Indian Reservation				County: Fremont			Road Name: North Fork Road						County Route: 354			IRR Route: BO29			Date: 7/5/12		
Road Class: Rural local					ADT:			85th Speed:			Road Surface:		Asphalt 0.0 to 5.8		Gravel/natural earth to						
LOCATION	PAVEMENT MARKINGS	STOP R1-1	STOP AHEAD W3-1	CURVE LT W1-1 (90)	CURVE RT W1-1 (90)	CURVE LT W1-2	CURVE RT W1-2	CHEVRON W1-8	WINDING ROAD W1-5	INTERSECTION W2-1	INTERSECTION W2-2 (T)	PAVEMENT ENDS W8-3	OBJECT MARKER OM-3	SPEED LIMIT 20 R2-1	SPEED LIMIT 35 W13-1	ARROW W1-6	ROAD NARROWS W5-1	OPEN RANGE	SHOULDER DROP OFF W8-9A	OTHER SIGN	COMMENTS
0.01	1																			1	Crosswalk & Ped Crossing Sign
0.0 - 5.8	1																				Re-stripe
0.7																					Consider Revising Int. or W1-10
0.8																				1	No Shoulder (W8-23) next 5 miles
1.0R						1															
3.2R											1										
3.5R											1										
3.6L											1										
4.2R								3													Both Directions
4.3L							1														
4.2-4.3	1																				Double Yellow Centerline thru curve
4.9 - 5.6																					Clear vegitation in ROW
5.0													4								At Bridge
5.8																				1	Dead End (W14-1)
5.8																				1	Barricade (Type 3) Red & White
5.8																					Remove pvmnt to gravel sign
0.0 - 5.8																					Long Term - Wedge Shoulders
TOTAL		0	0	0	0	1	1	3	0	0	3	0	4	0	0	0	0	0	0	4	
TOTAL SIGNS =			16																		

Wind River Indian Reservation | **County:** Fremont | **Road Name**: Kinnear Spur Road | **County Route:** 480 | **IRR Route:** 170 | **Date:** 7/5/12

Road Class: Rural local | **ADT:** | **85th Speed:** | **Road Surface:** Asphalt 0.0 to 2.4 Gravel/natural earth to

LOCATION	PAVEMENT MARKINGS	STOP R1-1	STOP AHEAD W3-1	CURVE LT W1-1 (90)	CURVE RT W1-1 (90)	CURVE LT W1-2	CURVE RT W1-2	CHEVRON W1-8	WINDING ROAD W1-5	INTERSECTION W2-1	INTERSECTION W2-2 (T)	PAVEMENT ENDS W8-3	OBJECT MARKER OM-3	SPEED LIMIT 20 R2-1	SPEED LIMIT 35 W13-1	ARROW W1-6	ROAD NARROWS W5-1	OPEN RANGE	SHOULDER DROP OFF W8-9A	OTHER SIGN	COMMENTS
0.0 - 2.4																					Speed Study
0.3R						1															
0.9L						1															
0.2 - 0.8								5													Both Directions
0.3L																					Move Stop Ahead Sign
1.2R																					
1.3R						1															
1.4L						1															
1.4																				1	"Blind Curve" Sign
0.0 - 2.4																					Long Term - Widen Shoulders
TOTAL		0	0	0	0	4	0	5	0	0	0	0	0	0	0	0	0	0	0	1	

TOTAL SIGNS = 10

Wind River Indian Reservation | **County:** Fremont | **Road Name**: Hutchinson Road | **County Route:** 272 | **IRR Route:** 141 | **Date:** 7/5/12

Road Class: Rural local | **ADT:** | **85th Speed:** | **Road Surface:** Asphalt 0.0 to 2.4 Gravel/natural earth to

LOCATION	PAVEMENT MARKINGS	STOP R1-1	STOP AHEAD W3-1	CURVE LT W1-1 (90)	CURVE RT W1-1 (90)	CURVE LT W1-2	CURVE RT W1-2	CHEVRON W1-8	WINDING ROAD W1-5	INTERSECTION W2-1	INTERSECTION W2-2 (T)	PAVEMENT ENDS W8-3	OBJECT MARKER OM-3	SPEED LIMIT 20 R2-1	SPEED LIMIT 35 W13-1	ARROW W1-6	ROAD NARROWS W5-1	OPEN RANGE	SHOULDER DROP OFF W8-9A	OTHER SIGN	COMMENTS
0.10			1																		
0.15																					Move Mailbox or breakaway
2.0										2											Both Directions
																					Both Directions
																					Move Stop Ahead Sign
																				1	"Blind Curve" Sign
																					Long Term - Widen Shoulders
TOTAL		0	1	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	1	
TOTAL SIGNS =			4																		

Wind River Indian Reservation | **County:** Fremont | **Road Name**: Pingetzer Road | **County Route:** 367 | **IRR Route:** 367 | **Date:** 7/5/12

Road Class: Rural local | **ADT:** | **85th Speed:** | **Road Surface:** Asphalt to Gravel/natural earth 0.0 to 1.0

LOCATION	PAVEMENT MARKINGS	STOP R1-1	STOP AHEAD W3-1	CURVE LT W1-1 (90)	CURVE RT W1-1 (90)	CURVE LT W1-2	CURVE RT W1-2	CHEVRON W1-8	WINDING ROAD W1-5	INTERSECTION W2-1	INTERSECTION W2-2 (T)	PAVEMENT ENDS W8-3	OBJECT MARKER OM-3	SPEED LIMIT 20 R2-1	SPEED LIMIT 35 W13-1	ARROW W1-6	ROAD NARROWS W5-1	OPEN RANGE	SHOULDER DROP OFF W8-9A	OTHER SIGN	COMMENTS
0.4													4								GR or Delineators
1.0																					Barricade (Type 3) Red & White
1.0													2								For Cattleguard
TOTAL		0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	
TOTAL SIGNS =			6																		

Wind River Indian Reservation | **County:** Fremont | **Road Name**: Trout Creek Road | **County Route:** 354 | **IRR Route:** 25 | **Date:** 7/5/12

Road Class: Rural Collector | **ADT:** | **85th Speed:** | **Road Surface:** Asphalt 0.0 to 5.0 Gravel/natural earth to

LOCATION	PAVEMENT MARKINGS	STOP R1-1	STOP AHEAD W3-1	CURVE LT W1-1 (90)	CURVE RT W1-1 (90)	CURVE LT W1-2	CURVE RT W1-2	CHEVRON W1-8	WINDING ROAD W1-5	INTERSECTION W2-1	INTERSECTION W2-2 (T)	PAVEMENT ENDS W8-3	OBJECT MARKER OM-3	SPEED LIMIT 20 R2-1	SPEED LIMIT 35 W13-1	ARROW W1-6	ROAD NARROWS W5-1	OPEN RANGE	SHOULDER DROP OFF W8-9A	OTHER SIGN	COMMENTS
0.0 - 5.0	1																				Re-stripe
0.0 - 2.0																				1	No Shoulder (W8-23) next 2 miles
1.1R										1											
1.2L										1											
1.80																					Clear Vegitation in ROW
2.0R											1										
2.1L											1										
2.6								4													Both Directions
3.3	1							4													Both Directions
4.7																					Curve Sign down
4.8R						1							4								
5.0L						1															
0.0 - 5.0																					Long Term - Wedge Shoulders
TOTAL		0	0	0	0	2	0	8	0	2	2	0	4	0	0	0	0	0	0	1	

TOTAL SIGNS = 19

Wind River Indian Reservation	**County:** Fremont	**Road Name**: Burma Road	**County Route:** 320	**IRR Route:** 132	**Date:** 7/5/12
Road Class: Rural local	**ADT:**	**85th Speed:**	**Road Surface:**	Asphalt 1.0 to 8.1 Gravel/natural earth to	

LOCATION	PAVEMENT MARKINGS	STOP R1-1	STOP AHEAD W3-1	CURVE LT W1-1 (90°)	CURVE RT W1-1 (90°)	CURVE LT W1-2	CURVE RT W1-2	CHEVRON W1-8	WINDING ROAD W1-5	INTERSECTION W2-1	INTERSECTION W2-2 (T)	PAVEMENT ENDS W8-3	OBJECT MARKER OM-3	SPEED LIMIT 20 R2-1	SPEED LIMIT 35 W13-1	ARROW W1-6	ROAD NARROWS W5-1	OPEN RANGE	SHOULDER DROP OFF W8-9A	OTHER SIGN	COMMENTS
1.1 - 5.9	1																				Centerline striping
0.01																				1	Congested Area Sign
7.9L							1														
1.1 - 5.9																					Check County for Overlay Project
1.1 - 5.9																					Long Term - Finish Reconstruction
TOTAL		0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	
TOTAL SIGNS =			2																		

Wind River Indian Reservation | **County:** Fremont | **Road Name**: Peterson Road | **County Route:** 463 | **IRR Route:** 463 | **Date:** 7/5/12

Road Class: Rural local | **ADT:** | **85th Speed:** | **Road Surface:** Asphalt to Gravel/natural earth 0.0 to 3.6

LOCATION	PAVEMENT MARKINGS	STOP R1-1	STOP AHEAD W3-1	CURVE LT W1-1 (90)	CURVE RT W1-1 (90)	CURVE LT W1-2	CURVE RT W1-2	CHEVRON W1-8	WINDING ROAD W1-5	INTERSECTION W2-1	INTERSECTION W2-2 (T)	PAVEMENT ENDS W8-3	OBJECT MARKER OM-3	SPEED LIMIT 20 R2-1	SPEED LIMIT 35 W13-1	ARROW W1-6	ROAD NARROWS W5-1	OPEN RANGE	SHOULDER DROP OFF W8-9A	OTHER SIGN	COMMENTS
0.3R						1															
0.6L						1															
0.3L			1																		
0.8																					Extend Culvert
0.8																				1	"Blind Curve" Sign
2.1													1								On Power Pole
2.3													1								On Power Pole
3.5													4								Replace with larger
3.4R																				1	"Narrow Bridge Ahead" (W5-2)
3.6L																				1	"Narrow Bridge Ahead" (W5-2)
3.6R			1																		
0.0 - 3.6																					Clear Vegitation in ROW
TOTAL		0	2	0	0	2	0	0	0	0	0	0	6	0	0	0	0	0	0	3	
TOTAL SIGNS =			13																		

Wind River Indian Reservation | **County:** Fremont | **Road Name**: Eight Mile Road | **County Route:** 463 | **IRR Route:** 385 | **Date:** 7/5/12

Road Class: Rural Collector | **ADT:** | **85th Speed:** | **Road Surface:** Asphalt 0.0 to 9.0 Gravel/natural earth to

LOCATION	PAVEMENT MARKINGS	STOP R1-1	STOP AHEAD W3-1	CURVE LT W1-1 (90)	CURVE RT W1-1 (90)	CURVE LT W1-2	CURVE RT W1-2	CHEVRON W1-8	WINDING ROAD W1-5	INTERSECTION W2-1	INTERSECTION W2-2 (T)	PAVEMENT ENDS W8-3	OBJECT MARKER OM-3	SPEED LIMIT 20 R2-1	SPEED LIMIT 35 W13-1	ARROW W1-6	ROAD NARROWS W5-1	OPEN RANGE	SHOULDER DROP OFF W8-9A	OTHER SIGN	COMMENTS
0.1R																		1		1	"Next 9 Miles"
9.0L																		1		1	"Next 9 Miles"
1.0													4								At Bridge
2.0																					Clear Vegitation in ROW
6.0																					Clear Vegitation in ROW
8.9	1																				Rumble strips at int
TOTAL		0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	2	0	2	

TOTAL SIGNS = 8

Wind River Indian Reservation | **Road Name**: Cemetary Road | **County Route:** | **IRR Route: 19** | **Date:** 10/18/12

Road Class: Rural Local | **ADT:** | **85th Speed:** | **Road Surface:** Asphalt 0.0 to 6.0 Gravel/natural earth to

LOCATION	PAVEMENT MARKINGS	STOP R1-1	STOP AHEAD W3-1	CURVE W1-1 (90°)	CURVE W1-2	CHEVRON W1-8	WINDING ROAD W1-5	INTERSECTION W2-1	INTERSECTION W2-2 (T)	PAVEMENT ENDS W8-3	OBJECT MARKER OM-3	SPEED LIMIT 20 R2-1	SPEED LIMIT 35 W13-1	ARROW W1-7	ROAD NARROWS W5-1	OPEN RANGE	SHOULDER DROP OFF W8-9A	OTHER SIGN	COMMENTS
0.1	CL		1																Start at intersection with South Fork,
0.1	↓																		South on Cemetary
0.7														1					At Trout Creek
																			Total 1 mile CL
TOTAL		0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	
TOTAL SIGNS =			2																

Wind River Indian Reservation | **Road Name**: Stuart Road | **County Route:** | **IRR Route:** | **Date:** 10/18/12

Road Class: Rural Local | **85th Speed:** | **Road Surface:** Asphalt 0.8 to 1.3 Gravel/natural earth 0 to 0.5

LOCATION	PAVEMENT MARKINGS	STOP R1-1	STOP AHEAD W3-1	CURVE W1-1 (90°)	CURVE W1-2	CHEVRON W1-8	WINDING ROAD W1-5	INTERSECTION W2-1	INTERSECTION W2-2 (T)	PAVEMENT ENDS W8-3	OBJECT MARKER OM-3	SPEED LIMIT 20 R2-1	SPEED LIMIT 35 W13-1	ARROW W1-7	ROAD NARROWS W5-1	OPEN RANGE	SHOULDER DROP OFF W8-9A	OTHER SIGN	COMMENTS
0.1																		1	Dead End
0.4																			
0.5																		2	Narrow Bridge
0.5	CL & EL							2			4								at bridge
1.1	↓				1														Curve Left ↰
1.2	↓		1			4													Double Chevrons (8)
1.3	↓																		
1.3	↓													1					Double arrow at intersection
																			Verify location and direction
																			Paving project in next 2 years
TOTAL		0	1	0	1	4	0	2	0	0	4	0	0	1	0	0	0	3	

TOTAL SIGNS = 16

Wind River Indian Reservation					Road Name: Old Wind River Highway						County Route:		IRR Route: 27			Date: 10/18/12			
Road Class: Rural Local				ADT:		85th Speed:			Road Surface:		Asphalt 0.0 to 4.0		Gravel/natural earth to						
LOCATION	PAVEMENT MARKINGS	STOP R1-1	STOP AHEAD W3-1	CURVE W1-1 (90°)	CURVE W1-2	CHEVRON W1-8	WINDING ROAD W1-5	INTERSECTION W2-1	INTERSECTION W2-2 (T)	PAVEMENT ENDS W8-3	OBJECT MARKER OM-3	SPEED LIMIT 20 R2-1	SPEED LIMIT 35 W13-1	ARROW W1-6	ROAD NARROWS W5-1	OPEN RANGE	SHOULDER DROP OFF W8-9A	OTHER SIGN	COMMENTS
0.1	CL														1				Start at North Fork Int
1.0-2.0																			
0.2									1	West Side									Curve Left ↰ West Side
0.5					1	West Side			1	East Side									East Side
1.0						5													Double (10)
1.1					1	East Side		1	West Side										Curve Left ↰ East Side
1.2																			Intersection with Trout Creek
1.3			1	East Side					1										
1.3											2								
2.2																			Intersecction with 287
2.2			1	South Side															Transverse Rumple Strip
2.4			1	North Side															Transverse Rumble Strip
2.8																		1	T Intersection W2-4
3.0									1										
3.1			1	East Side															
3.4																			
4.0	↓																		Transverse Rumble Strip
TOTAL		0	4	0	2	5	0	1	4	0	2	0	0	0	1	0	0	1	
TOTAL SIGNS =			20																

Wind River Indian Reservation | **Road Name**: Dead Horse Road | **County Route:** | **IRR Route:** | **Date:** 10/18/12

Road Class: Rural Local | **ADT:** | **85th Speed:** | **Road Surface:** Asphalt 0.0 to 1.4 Gravel/natural earth to

LOCATION	PAVEMENT MARKINGS	STOP R1-1	STOP AHEAD W3-1	CURVE W1-1 (90°)	CURVE W1-2	CHEVRON W1-8	WINDING ROAD W1-5	INTERSECTION W2-1	INTERSECTION W2-2 (T)	PAVEMENT ENDS W8-3	OBJECT MARKER OM-3	SPEED LIMIT 20 R2-1	SPEED LIMIT 35 W13-1	ARROW W1-7	ROAD NARROWS W5-1	OPEN RANGE	SHOULDER DROP OFF W8-9A	OTHER SIGN	COMMENTS
0	CL																		Start at Old Wind River Hwy
0.1					1														Curve Left ↰ South Side
0.3						6													Double Chevrons (12)
1.3			1																
1.4	↓	1												1					Replace Exist. Stop Sign
																			End at Ethete Road
TOTAL		1	1	0	1	6	0	0	0	0	0	0	0	1	0	0	0	0	

TOTAL SIGNS = 10

Wind River Indian Reservation | **Road Name**: Yellow Calf Road | **County Route:** | **IRR Route: 38** | **Date:** 7/6/12

Road Class: Rural Local | **ADT:** | **85th Speed:** | **Road Surface:** Asphalt 0.0 to 2.7 Gravel/natural earth to

LOCATION	PAVEMENT MARKINGS	STOP R1-1	STOP AHEAD W3-1	CURVE W1-1 (90°)	CURVE W1-2	CHEVRON W1-8	WINDING ROAD W1-5	INTERSECTION W2-1	INTERSECTION W2-2 (T)	PAVEMENT ENDS W8-3	OBJECT MARKER OM-3	SPEED LIMIT 20 R2-1	SPEED LIMIT 35 W13-1	ARROW W1-6	ROAD NARROWS W5-1	OPEN RANGE	SHOULDER DROP OFF W8-9A	OTHER SIGN	COMMENTS
0	CL & EL																		Start at North End
0.6			1					1											
0.8			1																Replace North bound
0.9									1										
2.7																		2	Type III Barricades
																		1	Dead End W14-1
																		1	Ahead W16-9p
																			End at 17 Mile Road
																			*Residential at North End
																			want speed limit
TOTAL		0	2	0	0	0	0	1	1	0	0	0	0	0	0	0	0	4	
TOTAL SIGNS =			8																

Wind River Indian Reservation | **Road Name**: Shipton Road | **County Route:** | **IRR Route: 40** | **Date:** 10/18/12

Road Class: Rural Local | **ADT:** | **85th Speed:** | **Road Surface:** Asphalt 0.0 to 1.0 Gravel/natural earth to

LOCATION	PAVEMENT MARKINGS	STOP R1-1	STOP AHEAD W3-1	CURVE W1-1 (90°)	CURVE W1-2	CHEVRON W1-8	WINDING ROAD W1-5	INTERSECTION W2-1	INTERSECTION W2-2 (T)	PAVEMENT ENDS W8-3	OBJECT MARKER OM-3	SPEED LIMIT 20 R2-1	SPEED LIMIT 35 W13-1	ARROW W1-6	ROAD NARROWS W5-1	OPEN RANGE	SHOULDER DROP OFF W8-9A	OTHER SIGN	COMMENTS
0	CL & EL																		Begin at 287
0		1																	Replace Exist.
0.4																			
0.5						6													Double Chevrons (12)
0.6																		1	Add Advisory Speed W13-1p
0.7																		1	Add Advisory Speed W13-1p
1.0																			with exist W1-1 (90)
TOTAL		1	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	2	

TOTAL SIGNS = 9

Wind River Indian Reservation | **Road Name**: Thunder Road | **County Route:** | **IRR Route: 33** | **Date:** 7/6/12

Road Class: Rural Local | **ADT:** | **85th Speed:** | **Road Surface:** Asphalt 0.0 to 0.7 Gravel/natural earth to

LOCATION	PAVEMENT MARKINGS	STOP R1-1	STOP AHEAD W3-1	CURVE W1-1 (90°)	CURVE W1-2	CHEVRON W1-8	WINDING ROAD W1-5	INTERSECTION W2-1	INTERSECTION W2-2 (T)	PAVEMENT ENDS W8-3	OBJECT MARKER OM-3	SPEED LIMIT 20 R2-1	SPEED LIMIT 35 W13-1	ARROW W1-7	ROAD NARROWS W5-1	OPEN RANGE	SHOULDER DROP OFF W8-9A	OTHER SIGN	COMMENTS
0	CL & EL																		Begin at Ethete Road
0.1			1											1					Double Arrow at Intersection
0.6											2							1	Dead End W14-1
0.7																		1	Ahead W16-9P
																			Clear debris at culvert
TOTAL		0	1	0	0	0	0	0	0	0	2	0	0	1	0	0	0	2	

TOTAL SIGNS = 6

Wind River Indian Reservation				Road Name: Trosper Road							County Route:			IRR Route: 16			Date: 7/6/12		
Road Class: Rural Local				ADT:		85th Speed:			Road Surface:		Asphalt 0.0 to 2.5	Gravel/natural earth to							
LOCATION	PAVEMENT MARKINGS	STOP R1-1	STOP AHEAD W3-1	CURVE W1-1 (90°)	CURVE W1-2	CHEVRON W1-8	WINDING ROAD W1-5	INTERSECTION W2-1	INTERSECTION W2-2 (T)	PAVEMENT ENDS W8-3	OBJECT MARKER OM-3	SPEED LIMIT 20 R2-1	SPEED LIMIT 35 W13-1	ARROW W1-7	ROAD NARROWS W5-1	OPEN RANGE	SHOULDER DROP OFF W8-9A	OTHER SIGN	COMMENTS
0	CL & EL																		Begin at Hwy 132 (Blue Sky Hwy)
0.1	↓																1	South Side	
0.1			1															1	T Intersection W2-4 North Side
0.5									1										
0.6											4								
0.7									1										
2.4			1																Transverse Rumble Strips*
2.5	↓													1				2	Type 2 Barricade 24 in wide
																			*Verify no residences nearby
TOTAL		0	2	0	0	0	0	0	2	0	4	0	0	1	0	0	1	3	
TOTAL SIGNS =			13																

Wind River Indian Reservation | **Road Name**: Mill Creek Road | **County Route:** | **IRR Route: 21** | **Date:** 7/6/12

Road Class: Rural Local | **ADT:** | **85th Speed:** | **Road Surface:** Asphalt 0.0 to 2.8 Gravel/natural earth to

LOCATION	PAVEMENT MARKINGS	STOP R1-1	STOP AHEAD W3-1	CURVE W1-1 (90°)	CURVE W1-2	CHEVRON W1-8	WINDING ROAD W1-5	INTERSECTION W2-1	INTERSECTION W2-2 (T)	PAVEMENT ENDS W8-3	OBJECT MARKER OM-3	SPEED LIMIT 20 R2-1	SPEED LIMIT 35 W13-1	ARROW W1-6	ROAD NARROWS W5-1	OPEN RANGE	SHOULDER DROP OFF W8-9A	OTHER SIGN	COMMENTS
0	CL & EL																		Start at Trosper Road
1.5																			
2.5			1																Replace Exist
2.8																			
TOTAL		0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
TOTAL SIGNS =			1																

Wind River Indian Reservation | **Road Name**: Gibbons Road | **County Route:** | **IRR Route: 12** | **Date:** 7/6/12

Road Class: Rural Local | **ADT:** | **85th Speed:** | **Road Surface:** Asphalt 0.0 to 2.2 Gravel/natural earth to

LOCATION	PAVEMENT MARKINGS	STOP R1-1	STOP AHEAD W3-1	CURVE W1-1 (90°)	CURVE W1-2	CHEVRON W1-8	WINDING ROAD W1-5	INTERSECTION W2-1	INTERSECTION W2-2 (T)	PAVEMENT ENDS W8-3	OBJECT MARKER OM-3	SPEED LIMIT 20 R2-1	SPEED LIMIT 35 W13-1	ARROW W1-6	ROAD NARROWS W5-1	OPEN RANGE	SHOULDER DROP OFF W8-9A	OTHER SIGN	COMMENTS
0	CL & EL																		
1.2	↓										4								At cattleguard
1.2	↓																	1	Arrow W1-6
1.3	↓																	1	Dead End W14-1
1.3	↓																	1	Ahead W16-9P
2.2	↓																		
TOTAL		0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	3	

TOTAL SIGNS = 7

Wind River Indian Reservation | **Road Name**: Little Wind River Road | **County Route:** | **IRR Route:** | **Date:** 7/6/12

Road Class: Rural Local | **ADT:** | **85th Speed:** | **Road Surface:** Asphalt 0.0 to 4.6 Gravel/natural earth to

LOCATION	PAVEMENT MARKINGS	STOP R1-1	STOP AHEAD W3-1	CURVE W1-1 (90°)	CURVE W1-2	CHEVRON W1-8	WINDING ROAD W1-5	INTERSECTION W2-1	INTERSECTION W2-2 (T)	PAVEMENT ENDS W8-3	OBJECT MARKER OM-3	SPEED LIMIT 20 R2-1	SPEED LIMIT 35 W13-1	ARROW W1-7	ROAD NARROWS W5-1	OPEN RANGE	SHOULDER DROP OFF W8-9A	OTHER SIGN	COMMENTS
0														1					Begin at 17 Mile Intersection
0.2											4								At Bridge
0.6						6													Double Chevrons (12)
1.0	CL & EL																		
2.3						6													Double Chevrons (12)
2.5					1	East Side													Curve Right ↗ East Side
2.8					1	West Side													Curve Left ↖ West Side
2.8									1										
3.0									1										
3.8									1										
4.0									1										
4.3						4													Double Chevrons (8)
4.5			1															1	T Intersection W2-4
4.6														1					End at Left Hand Ditch
																		1	*Stop when occupied under Ped sign
																			at school
TOTAL		0	1	0	2	16	0	0	4	0	4	0	0	2	0	0	0	2	

TOTAL SIGNS = 31

Wind River Indian Reservation					Road Name: Left Hand Ditch Road						County Route:			IRR Route: 8		Date: 7/6/12			
Road Class: Rural Local				ADT:		85th Speed:			Road Surface:		Asphalt 0.0 to 5.5 Gravel/natural earth to								
LOCATION	PAVEMENT MARKINGS	STOP R1-1	STOP AHEAD W3-1	CURVE W1-1 (90°)	CURVE W1-2	CHEVRON W1-8	WINDING ROAD W1-5	INTERSECTION W2-1	INTERSECTION W2-2 (T)	PAVEMENT ENDS W8-3	OBJECT MARKER OM-3	SPEED LIMIT 20 R2-1	SPEED LIMIT 35 W13-1	ARROW W1-6	ROAD NARROWS W5-1	OPEN RANGE	SHOULDER DROP OFF W8-9A	OTHER SIGN	COMMENTS
0	CL													1					Double Arrow at 138 Intersection
0.1																			Tranverse Rumble Strips
0.1			1																- verify residence not in area
0.1																		1	T Intersection W2-4
0.7																		1	Curve Right w/int W1-10
0.7						5													Double Chevrons (10)
0.8									1										
1.0					1				1										Curve Left
1.5						6													Double Chevrons (12)
1.9									1										
2.0									1										
2.3			1					1	At 17 Mile Rd										
2.3																			
3.0					1														Curve Left North Bound
3.3					1														Curve Right South Bound
3.6																		1	Steep Grade W7-1
3.8									1	East side									
4.1									1	West side									
4.3							1	West side											
5.2																			Curve Right East Side
5.2																		1	Dead End
5.5	↓																		*GR at curve (?)
TOTAL		0	2	0	4	11	1	1	6	0	0	0	0	1	0	0	0	4	
TOTAL SIGNS =			30																

Wind River Indian Reservation | **Road Name**: C'Hare Lane | **County Route:** | **IRR Route: 49** | **Date:** 7/6/12

Road Class: Rural Local | **ADT:** | **85th Speed:** | **Road Surface:** Asphalt 0.0 to 1.4 Gravel/natural earth to

LOCATION	PAVEMENT MARKINGS	STOP R1-1	STOP AHEAD W3-1	CURVE W1-1 (90°)	CURVE W1-2	CHEVRON W1-8	WINDING ROAD W1-5	INTERSECTION W2-1	INTERSECTION W2-2 (T)	PAVEMENT ENDS W8-3	OBJECT MARKER OM-3	SPEED LIMIT 20 R2-1	SPEED LIMIT 35 W13-1	ARROW W1-7	ROAD NARROWS W5-1	OPEN RANGE	SHOULDER DROP OFF W8-9A	OTHER SIGN	COMMENTS
0	CL													1					Start at Left Hand Ditch
0.1	↓																	1	T Intersection W2-4
0.8	↓			1														1	Advisory Speed W13-1p
0.9	↓					6													Double chevrons (12)
1.0	↓																	1	Add Advisory Speed W13-1p
1.3	↓		1					1											
1.5	↓																		
TOTAL		0	1	1	0	6	0	1	0	0	0	0	0	0	0	0	0	3	

TOTAL SIGNS = 12

Wind River Indian Reservation					**Road Name**: Goes In Lodge Road						**County Route:**			**IRR Route:**			**Date:** 7/6/12		
Road Class: Rural Local				**ADT:**		**85th Speed:**			**Road Surface:**		Asphalt 0.0 to 3.2 Gravel/natural earth to								
LOCATION	PAVEMENT MARKINGS	STOP R1-1	STOP AHEAD W3-1	CURVE W1-1 (90°)	CURVE W1-2	CHEVRON W1-8	WINDING ROAD W1-5	INTERSECTION W2-1	INTERSECTION W2-2 (T)	PAVEMENT ENDS W8-3	OBJECT MARKER OM-3	SPEED LIMIT 20 R2-1	SPEED LIMIT 35 W13-1	ARROW W1-7	ROAD NARROWS W5-1	OPEN RANGE	SHOULDER DROP OFF W8-9A	OTHER SIGN	COMMENTS
0	CL & EL																		Begin at 17 Mile Road
0.1			1	Replace Esixt		2								1					Remove Arrow
1.4								1	South Bound										
1.6					1														Curve Right ↗ South Bound
1.6																		1	Advisory Speed W13-1p
1.6						6													Double Chevrons (12)
1.8																		1	Add Advisory Speed W13-1p
3.0				1															Curve Right ↱
3.1			1																
3.2						6													Replace existing - Single Chevrons
3.2	↓	1												1					Rumble Strips at curve at 17 Mile Int
																			-verify residence not in area
0.0 - 3.2											16								Power poles in clear zone
TOTAL		1	2	1	1	12	0	1	0	0	16	0	0	2	0	0	0	2	
TOTAL SIGNS =			38																

Wind River Indian Reservation					**Road Name**: St Clair Spur						**County Route:**			**IRR Route: 4004**		**Date:** 7/6/12			
Road Class: Rural Local				**ADT:**		**85th Speed:**			**Road Surface:**		Asphalt 0.0 to 1.7 Gravel/natural earth to								
LOCATION	PAVEMENT MARKINGS	STOP R1-1	STOP AHEAD W3-1	CURVE W1-1 (90°)	CURVE W1-2	CHEVRON W1-8	WINDING ROAD W1-5	INTERSECTION W2-1	INTERSECTION W2-2 (T)	PAVEMENT ENDS W8-3	OBJECT MARKER OM-3	SPEED LIMIT 20 R2-1	SPEED LIMIT 35 W13-1	ARROW W1-7	ROAD NARROWS W5-1	OPEN RANGE	SHOULDER DROP OFF W8-9A	OTHER SIGN	COMMENTS
0	CL																		Start at North end
0.1			1	North Side															
0.7					1	West Side			2										Curve Right ↗ West Side
1.0					1	East Side													Curve Left ↖ East Side
1.7														1					
																			Clear vegitation
																			Verify location and direction
TOTAL		0	1	0	2	0	0	0	2	0	0	0	0	1	0	0	0	0	
TOTAL SIGNS =			6																

Wind River Indian Reservation | **Road Name**: Shoyo Road | **County Route:** | **IRR Route:** | **Date:** 7/6/12

Road Class: Rural Local | **ADT:** | **85th Speed:** | **Road Surface:** Asphalt 0.0 to 1.0 Gravel/natural earth to

LOCATION	PAVEMENT MARKINGS	STOP R1-1	STOP AHEAD W3-1	CURVE W1-1 (90°)	CURVE W1-2	CHEVRON W1-8	WINDING ROAD W1-5	INTERSECTION W2-1	INTERSECTION W2-2 (T)	PAVEMENT ENDS W8-3	OBJECT MARKER OM-3	SPEED LIMIT 20 R2-1	SPEED LIMIT 35 W13-1	ARROW W1-7	ROAD NARROWS W5-1	OPEN RANGE	SHOULDER DROP OFF W8-9A	OTHER SIGN	COMMENTS
0	CL																1		Begin at South Fork Intersection
0.1											4	At Bridge		1					Relocate & Replace
0.6							1	West Sid											double arrow to end of int.
0.7						6													Double Chevrons (12)
1.0																			
1.0																	1		
1.1			1	West Side															
1.2																			
TOTAL		0	1	0	0	6	1	0	0	0	4	0	0	1	0	0	2	0	
TOTAL SIGNS =			15																

APPENDIX 5: WRIR BENEFIT COST ANALYSIS SPREADSHEETS

Benefit to Cost (B/C) Ratio Analysis for Safety Improvement

General Information	
Analyst	D. Shinstine
Agency/Company	UW
Project	WRIR
Date Performed	7/11/2012

Site Information	
Facility	IRR
Road	Burma Road
Analysis Time Period	2001 - 2011
Analysis Year	2012
Segment Length (mi.)	8.1

Inputs

Crash Cost

Fatal	2,500,000
Injury	60,000
Property Damage Only (PDO)	6,000

	Number of Crashes			Countermeasures				
Road Segment	*Fatal*	*Injury*	*PDO*	*A*	*B*	*C*	*D*	*E*
Burma Road	1	27	28	1	7			

Calculation

	Countermeasures					
	A	*B*	*C*	*D*	*E*	Combined
Cost	$800.00	$15,840.00				$16,640.00
Benefit	$643,200.00	$729,000.00				$1,262,850.00
B/C Ratio	804.00	46.02				75.89

Burma Road							
Countermeasure Number	Countermeasures	Crash Type	Crash Reduction Factors			Cost	Service Life
			Fatal	Injury	PDO		
1	Install guide signs (general)	All	15%	15%	15%	$400	5
2	Install advance warning signs (positive guidance)	All	40%	40%	40%		5
3	Install chevron signs on horizontal curves	All	35%	35%	35%		5
4	Install curve advance warning signs	All	30%	30%	30%		5
5	Install delineators (general)	All	11%	11%	11%		4
6	Install delineators (on bridges)	All	40%	40%	40%		4
7	Install edgelines, centerlines and delineators	All	0%	45%	0%	$6,336	4
8	Install centerline markings	All	33%	33%	33%		2
9	Improve sight distance to intersection	All	56%	37%	0%		15
10	Flatten crest vertical curve	All	20%	20%	20%		15
11	Flatten horizontal curve	All	39%	39%	39%		15
12	Improve horizontal and vertical alignments	All	58%	58%	58%		15
13	Flatten side slopes	All	43%	43%	43%		15
14	Install guardrail (at bridge)	All	22%	22%	22%		10
15	Install guardrail (at embankment)	All	0%	42%	0%		10
16	Install guardrail (outside curves)	All	63%	63%	0%		10
17	Improve guardrail	All	9%	9%	9%		10
18	Improve superevlevation	All	40%	40%	40%		15
19	Widen bridge	All	45%	45%	45%		15
20	Install shoulder	All	9%	9%	9%		5
21	Pave shoulder	All	15%	15%	15%		5
22	Install transverse rumble strips on approaches	All	35%	35%	35%		3
23	Lengthen Culvert	All	40%	40%	40%		15
24	Install animal fencing	Animal	80%	80%	80%		10
25	Relocate Fixed Object - Mail Boxes	All	40%	40%	40%		15
26	Convert Yield to Stop	All	29%	29%	29%		5
27	Install School Zone Warning Signs	All	20%	20%	20%		5
28	Install Flashing Beacons as Advanced Warning	All	25%	25%	25%		10
29	Install Pedestrian Crossing	All	37%	37%	37%		5
30	Widen Shoulders	All	15%	15%	15%		10

Benefit to Cost (B/C) Ratio Analysis for Safety Improvement

General Information

Analyst	D. Shinstine
Agency/Company	UW
Project	WRIR
Date Performed	7/11/2012

Site Information

Facility	IRR
Road	Cliff Road
Analysis Time Period	2001 - 2011
Analysis Year	2012
Segment Length (mi.)	1.0 (MP5-6)

Inputs

Crash Cost

Fatal	2,500,000
Injury	60,000
Property Damage Only (PDO)	6,000

	Number of Crashes			Countermeasures				
Road Segment	*Fatal*	*Injury*	*PDO*	*A*	*B*	*C*	*D*	*E*
Cliff Road	0	0	4	3	4	5		

Calculation

	Countermeasures					
	A	*B*	*C*	*D*	*E*	Combined
Cost	$800.00	$800.00	$4,000.00			$5,600.00
Benefit	$8,400.00	$7,200.00	$2,640.00			$14,281.20
B/C Ratio	10.50	9.00	0.66			2.55

Cliff Road							
Countermeasure Number	Countermeasures	Crash Type	Crash Reduction Factors			Cost	Service Life
			Fatal	Injury	PDO		
1	Install guide signs (general)	All	15%	15%	15%		5
2	Install advance warning signs (positive guidance)	All	40%	40%	40%		5
3	Install chevron signs on horizontal curves	All	35%	35%	35%	$400	5
4	Install curve advance warning signs	All	30%	30%	30%	$400	5
5	Install delineators (general)	All	11%	11%	11%	$1,600	4
6	Install delineators (on bridges)	All	40%	40%	40%		4
7	Install edgelines, centerlines and delineators	All	0%	45%	0%		4
8	Install centerline markings	All	33%	33%	33%		2
9	Improve sight distance to intersection	All	56%	37%	0%		15
10	Flatten crest vertical curve	All	20%	20%	20%		15
11	Flatten horizontal curve	All	39%	39%	39%		15
12	Improve horizontal and vertical alignments	All	58%	58%	58%		15
13	Flatten side slopes	All	43%	43%	43%		15
14	Install guardrail (at bridge)	All	22%	22%	22%		10
15	Install guardrail (at embankment)	All	0%	42%	0%		10
16	Install guardrail (outside curves)	All	63%	63%	0%		10
17	Improve guardrail	All	9%	9%	9%		10
18	Improve superevlevation	All	40%	40%	40%		15
19	Widen bridge	All	45%	45%	45%		15
20	Install shoulder	All	9%	9%	9%		5
21	Pave shoulder	All	15%	15%	15%		5
22	Install transverse rumble strips on approaches	All	35%	35%	35%		3
23	Lengthen Culvert	All	40%	40%	40%		15
24	Install animal fencing	Animal	80%	80%	80%		10
25	Relocate Fixed Object - Mail Boxes	All	40%	40%	40%		15
26	Convert Yield to Stop	All	29%	29%	29%		5
27	Install School Zone Warning Signs	All	20%	20%	20%		5
28	Install Flashing Beacons as Advanced Warning	All	25%	25%	25%		5
29	Install Pedestrian Crossing	All	37%	37%	37%		5
30	Widen Shoulders	All	15%	15%	15%		10

Benefit to Cost (B/C) Ratio Analysis for Safety Improvement

General Information

Analyst	D. Shinstine
Agency/Company	UW
Project	WRIR
Date Performed	7/11/2012

Site Information

Facility	IRR
Road	Eight Mile Road
Analysis Time Period	2001 - 2011
Analysis Year	2012
Segment Length (mi.)	9.0

Inputs

Crash Cost

Fatal	2,500,000
Injury	60,000
Property Damage Only (PDO)	6,000

	Number of Crashes			Countermeasures				
Road Segment	*Fatal*	*Injury*	*PDO*	*A*	*B*	*C*	*D*	*E*
Eight Mile Road	1	17	37	2	5	22	25	

Calculation

	Countermeasures					
	A	*B*	*C*	*D*	*E*	Combined
Cost	\$1,600.00	\$4,000.00	\$1,666.67	\$150.00		\$7,416.67
Benefit	\$1,496,800.00	\$411,620.00	\$1,309,700.00	\$1,496,800.00		\$2,962,691.08
B/C Ratio	935.50	102.91	785.82	9978.67		399.46

Eight Mile Road							
Countermeasure Number	Countermeasures	Crash Type	Crash Reduction Factors			Cost	Service Life
			Fatal	Injury	PDO		
1	Install guide signs (general)	All	15%	15%	15%		5
2	Install advance warning signs (positive guidance)	All	40%	40%	40%	$800	5
3	Install chevron signs on horizontal curves	All	35%	35%	35%		5
4	Install curve advance warning signs	All	30%	30%	30%		5
5	Install delineators (general)	All	11%	11%	11%	$1,600	4
6	Install delineators (on bridges)	All	40%	40%	40%		4
7	Install edgelines, centerlines and delineators	All	0%	45%	0%		4
8	Install centerline markings	All	33%	33%	33%		2
9	Improve sight distance to intersection	All	56%	37%	0%		15
10	Flatten crest vertical curve	All	20%	20%	20%		15
11	Flatten horizontal curve	All	39%	39%	39%		15
12	Improve horizontal and vertical alignments	All	58%	58%	58%		15
13	Flatten side slopes	All	43%	43%	43%		15
14	Install guardrail (at bridge)	All	22%	22%	22%		10
15	Install guardrail (at embankment)	All	0%	42%	0%		10
16	Install guardrail (outside curves)	All	63%	63%	0%		10
17	Improve guardrail	All	9%	9%	9%		10
18	Improve superevlevation	All	40%	40%	40%		15
19	Widen bridge	All	45%	45%	45%		15
20	Install shoulder	All	9%	9%	9%		5
21	Pave shoulder	All	15%	15%	15%		5
22	Install transverse rumble strips on approaches	All	35%	35%	35%	$500	3
23	Lengthen Culvert	All	40%	40%	40%		15
24	Install animal fencing	Animal	80%	80%	80%		10
25	Relocate Fixed Object - Mail Boxes	All	40%	40%	40%	$150	15
26	Convert Yield to Stop	All	29%	29%	29%		5
27	Install School Zone Warning Signs	All	20%	20%	20%		5
28	Install Flashing Beacons as Advanced Warning	All	25%	25%	25%		10
29	Install Pedestrian Crossing	All	37%	37%	37%		5
30	Widen Shoulders	All	15%	15%	15%		10

Benefit to Cost (B/C) Ratio Analysis for Safety Improvement

General Information

Analyst	D. Shinstine
Agency/Company	UW
Project	WRIR
Date Performed	7/11/2012

Site Information

Facility	IRR	
Road	Ethete Road	
Analysis Time Period	2001 - 2011	
Analysis Year	2012	
Segment Length (mi.)	5.0	Begin at mile mark 5

Inputs

Crash Cost

Fatal	2,500,000
Injury	60,000
Property Damage Only (PDO)	6,000

	Number of Crashes			Countermeasures				
Road Segment	*Fatal*	*Injury*	*PDO*	*A*	*B*	*C*	*D*	*E*
Ethete Road	1	7	9	2	3	4	22	23

Calculation

	Countermeasures					
	A	*B*	*C*	*D*	*E*	Combined
Cost	$4,800.00	$12,000.00	$4,800.00	$1,666.67	$3,750.00	$27,016.67
Benefit	$1,189,600.00	$1,040,900.00	$892,200.00	$1,040,900.00	$1,189,600.00	$2,657,358.22
B/C Ratio	247.83	86.74	185.88	624.54	317.23	98.36

Ethete Road							
Countermeasure Number	Countermeasures	Crash Type	Crash Reduction Factors			Cost	Service Life
			Fatal	Injury	PDO		
1	Install guide signs (general)	All	15%	15%	15%		5
2	Install advance warning signs (positive guidance)	All	40%	40%	40%	$2,400	5
3	Install chevron signs on horizontal curves	All	35%	35%	35%	$6,000	5
4	Install curve advance warning signs	All	30%	30%	30%	$2,400	5
5	Install delineators (general)	All	11%	11%	11%		4
6	Install delineators (on bridges)	All	40%	40%	40%		4
7	Install edgelines, centerlines and delineators	All	0%	45%	0%		4
8	Install centerline markings	All	33%	33%	33%		2
9	Improve sight distance to intersection	All	56%	37%	0%		15
10	Flatten crest vertical curve	All	20%	20%	20%		15
11	Flatten horizontal curve	All	39%	39%	39%		15
12	Improve horizontal and vertical alignments	All	58%	58%	58%		15
13	Flatten side slopes	All	43%	43%	43%		15
14	Install guardrail (at bridge)	All	22%	22%	22%		10
15	Install guardrail (at embankment)	All	0%	42%	0%		10
16	Install guardrail (outside curves)	All	63%	63%	0%		10
17	Improve guardrail	All	9%	9%	9%		10
18	Improve superevlevation	All	40%	40%	40%		15
19	Widen bridge	All	45%	45%	45%		15
20	Install shoulder	All	9%	9%	9%		5
21	Pave shoulder	All	15%	15%	15%		5
22	Install transverse rumble strips on approaches	All	35%	35%	35%	$500	3
23	Lengthen Culvert	All	40%	40%	40%	$3,750	15
24	Install animal fencing	Animal	80%	80%	80%		10
25	Relocate Fixed Object - Mail Boxes	All	40%	40%	40%		15
26	Convert Yield to Stop	All	29%	29%	29%		5
27	Install School Zone Warning Signs	All	20%	20%	20%		5
28	Install Flashing Beacons as Advanced Warning	All	25%	25%	25%		10
29	Install Pedestrian Crossing	All	37%	37%	37%		5
30	Widen Shoulders	All	15%	15%	15%		10

Benefit to Cost (B/C) Ratio Analysis for Safety Improvement

General Information

Analyst	D. Shinstine
Agency/Company	UW
Project	WRIR
Date Performed	7/11/2012

Site Information

Facility	IRR
Road	Hutchinson Road
Analysis Time Period	2001 - 2011
Analysis Year	2012
Segment Length (mi.)	2.6

Inputs

Crash Cost

Fatal	2,500,000
Injury	60,000
Property Damage Only (PDO)	6,000

	Number of Crashes			Countermeasures				
Road Segment	*Fatal*	*Injury*	*PDO*	*A*	*B*	*C*	*D*	*E*
Hutchinson Road	0	1	5	2	25			

Calculation

	Countermeasures					
	A	*B*	*C*	*D*	*E*	Combined
Cost	$3,200.00	$200.00				$3,400.00
Benefit	$36,000.00	$36,000.00				$57,600.00
B/C Ratio	11.25	180.00				16.94

Hutchinson Road							
Countermeasure Number	Countermeasures	Crash Type	Crash Reduction Factors			Cost	Service Life
			Fatal	Injury	PDO		
1	Install guide signs (general)	All	15%	15%	15%		5
2	Install advance warning signs (positive guidance)	All	40%	40%	40%	$1,600	5
3	Install chevron signs on horizontal curves	All	35%	35%	35%		5
4	Install curve advance warning signs	All	30%	30%	30%		5
5	Install delineators (general)	All	11%	11%	11%		4
6	Install delineators (on bridges)	All	40%	40%	40%		4
7	Install edgelines, centerlines and delineators	All	0%	45%	0%		4
8	Install centerline markings	All	33%	33%	33%		2
9	Improve sight distance to intersection	All	56%	37%	0%		15
10	Flatten crest vertical curve	All	20%	20%	20%		15
11	Flatten horizontal curve	All	39%	39%	39%		15
12	Improve horizontal and vertical alignments	All	58%	58%	58%		15
13	Flatten side slopes	All	43%	43%	43%		15
14	Install guardrail (at bridge)	All	22%	22%	22%		10
15	Install guardrail (at embankment)	All	0%	42%	0%		10
16	Install guardrail (outside curves)	All	63%	63%	0%		10
17	Improve guardrail	All	9%	9%	9%		10
18	Improve superevlevation	All	40%	40%	40%		15
19	Widen bridge	All	45%	45%	45%		15
20	Install shoulder	All	9%	9%	9%		5
21	Pave shoulder	All	15%	15%	15%		5
22	Install transverse rumble strips on approaches	All	35%	35%	35%		3
23	Lengthen Culvert	All	40%	40%	40%		15
24	Install animal fencing	Animal	80%	80%	80%		10
25	Relocate Fixed Object - Mail Boxes	All	40%	40%	40%	$200	15
26	Convert Yield to Stop	All	29%	29%	29%		5
27	Install School Zone Warning Signs	All	20%	20%	20%		5
28	Install Flashing Beacons as Advanced Warning	All	25%	25%	25%		10
29	Install Pedestrian Crossing	All	37%	37%	37%		5
30	Widen Shoulders	All	15%	15%	15%		10

Benefit to Cost (B/C) Ratio Analysis for Safety Improvement

General Information

Analyst	D. Shinstine
Agency/Company	UW
Project	WRIR
Date Performed	7/11/2012

Site Information

Facility	IRR
Road	Kinnear Spur Road
Analysis Time Period	2001 - 2011
Analysis Year	2012
Segment Length (mi.)	2.4

Inputs

Crash Cost

Fatal	2,500,000
Injury	60,000
Property Damage Only (PDO)	6,000

	Number of Crashes			Countermeasures				
Road Segment	*Fatal*	*Injury*	*PDO*	*A*	*B*	*C*	*D*	*E*
Kinnear Spur Road	0	2	6	2	3	4	25	

Calculation

	Countermeasures					
	A	*B*	*C*	*D*	*E*	Combined
Cost	$800.00	$4,000.00	$3,200.00	$100.00		$8,100.00
Benefit	$62,400.00	$54,600.00	$46,800.00	$62,400.00		$130,447.20
B/C Ratio	78.00	13.65	14.63	624.00		16.10

Kinnear Spur Road							
Countermeasure Number	Countermeasures	Crash Type	Crash Reduction Factors			Cost	Service Life
			Fatal	Injury	PDO		
1	Install guide signs (general)	All	15%	15%	15%		5
2	Install advance warning signs (positive guidance)	All	40%	40%	40%	$400	5
3	Install chevron signs on horizontal curves	All	35%	35%	35%	$2,000	5
4	Install curve advance warning signs	All	30%	30%	30%	$1,600	5
5	Install delineators (general)	All	11%	11%	11%		4
6	Install delineators (on bridges)	All	40%	40%	40%		4
7	Install edgelines, centerlines and delineators	All	0%	45%	0%		4
8	Install centerline markings	All	33%	33%	33%		2
9	Improve sight distance to intersection	All	56%	37%	0%		15
10	Flatten crest vertical curve	All	20%	20%	20%		15
11	Flatten horizontal curve	All	39%	39%	39%		15
12	Improve horizontal and vertical alignments	All	58%	58%	58%		15
13	Flatten side slopes	All	43%	43%	43%		15
14	Install guardrail (at bridge)	All	22%	22%	22%		10
15	Install guardrail (at embankment)	All	0%	42%	0%		10
16	Install guardrail (outside curves)	All	63%	63%	0%		10
17	Improve guardrail	All	9%	9%	9%		10
18	Improve superevlevation	All	40%	40%	40%		15
19	Widen bridge	All	45%	45%	45%		15
20	Install shoulder	All	9%	9%	9%		5
21	Pave shoulder	All	15%	15%	15%		5
22	Install transverse rumble strips on approaches	All	35%	35%	35%		3
23	Lengthen Culvert	All	40%	40%	40%		15
24	Install animal fencing	Animal	80%	80%	80%		10
25	Relocate Fixed Object - Mail Boxes	All	40%	40%	40%	$100	15
26	Convert Yield to Stop	All	29%	29%	29%		5
27	Install School Zone Warning Signs	All	20%	20%	20%		5
28	Install Flashing Beacons as Advanced Warning	All	25%	25%	25%		10
29	Install Pedestrian Crossing	All	37%	37%	37%		5
30	Widen Shoulders	All	15%	15%	15%		10

Benefit to Cost (B/C) Ratio Analysis for Safety Improvement

General Information

Analyst	D. Shinstine
Agency/Company	UW
Project	WRIR
Date Performed	7/11/2012

Site Information

Facility	IRR
Road	North Fork Road
Analysis Time Period	2001 - 2011
Analysis Year	2012
Segment Length (mi.)	5.8

Inputs

Crash Cost

Fatal	2,500,000
Injury	60,000
Property Damage Only (PDO)	6,000

	Number of Crashes			Countermeasures								
Road Segment	*Fatal*	*Injury*	*PDO*	*A*	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*
North Fork Road	1	20	9	1	2	3	4	5	7	8	25	29

Calculation

	Countermeasures									
	A	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*I*	Combined
Cost	$2,400.00	$4,000.00	$2,400.00	$1,600.00	$4,000.00	$16,312.50	$0.00	$5,550.00	$600.00	$36,862.50
Benefit	$563,100.00	$1,501,600.00	$1,313,900.00	$1,126,200.00	$412,940.00	$540,000.00	$1,238,820.00	$1,501,600.00	$1,388,980.00	$3,585,893.67
B/C Ratio	234.63	375.40	547.46	703.88	103.24	33.10		270.56	2314.97	97.28

North Fork Road							
Countermeasure Number	Countermeasures	Crash Type	Crash Reduction Factors			Cost	Service Life
			Fatal	Injury	PDO		
1	Install guide signs (general)	All	15%	15%	15%	$1,200	5
2	Install advance warning signs (positive guidance)	All	40%	40%	40%	$2,000	5
3	Install chevron signs on horizontal curves	All	35%	35%	35%	$1,200	5
4	Install curve advance warning signs	All	30%	30%	30%	$800	5
5	Install delineators (general)	All	11%	11%	11%	$1,600	4
6	Install delineators (on bridges)	All	40%	40%	40%		4
7	Install edgelines, centerlines and delineators	All	0%	45%	0%	$6,525	4
8	Install centerline markings	All	33%	33%	33%		2
9	Improve sight distance to intersection	All	56%	37%	0%		15
10	Flatten crest vertical curve	All	20%	20%	20%		15
11	Flatten horizontal curve	All	39%	39%	39%		15
12	Improve horizontal and vertical alignments	All	58%	58%	58%		15
13	Flatten side slopes	All	43%	43%	43%		15
14	Install guardrail (at bridge)	All	22%	22%	22%		10
15	Install guardrail (at embankment)	All	0%	42%	0%		10
16	Install guardrail (outside curves)	All	63%	63%	0%		10
17	Improve guardrail	All	9%	9%	9%		10
18	Improve superevlevation	All	40%	40%	40%		15
19	Widen bridge	All	45%	45%	45%		15
20	Install shoulder	All	9%	9%	9%		5
21	Pave shoulder	All	15%	15%	15%		5
22	Install transverse rumble strips on approaches	All	35%	35%	35%		3
23	Lengthen Culvert	All	40%	40%	40%		15
24	Install animal fencing	Animal	80%	80%	80%		10
25	Relocate Fixed Object - Mail Boxes	All	40%	40%	40%	$5,550	15
26	Convert Yield to Stop	All	29%	29%	29%		5
27	Install School Zone Warning Signs	All	20%	20%	20%		5
28	Install Flashing Beacons as Advanced Warning	All	25%	25%	25%		10
29	Install Pedestrian Crossing	All	37%	37%	37%	$300	5
30	Widen Shoulders	All	15%	15%	15%		10

Benefit to Cost (B/C) Ratio Analysis for Safety Improvement

General Information

Analyst	D. Shinstine
Agency/Company	UW
Project	WRIR
Date Performed	7/11/2012

Site Information

Facility	IRR
Road	Peterson Road
Analysis Time Period	2001 - 2011
Analysis Year	2012
Segment Length (mi.)	3.6

Inputs

Crash Cost

Fatal	2,500,000
Injury	60,000
Property Damage Only (PDO)	6,000

	Number of Crashes			Countermeasures				
Road Segment	*Fatal*	*Injury*	*PDO*	*A*	*B*	*C*	*D*	*E*
Peterson Road	0	0	6	1	2	4	5	25

Calculation

	Countermeasures					
	A	*B*	*C*	*D*	*E*	Combined
Cost	$2,400.00	$1,600.00	$1,600.00	$6,000.00	$3,000.00	$14,600.00
Benefit	$5,400.00	$14,400.00	$10,800.00	$3,960.00	$14,400.00	$29,137.03
B/C Ratio	2.25	9.00	6.75	0.66	4.80	2.00

Peterson Road							
Countermeasure Number	Countermeasures	Crash Type	Crash Reduction Factors			Cost	Service Life
			Fatal	Injury	PDO		
1	Install guide signs (general)	All	15%	15%	15%	$1,200	5
2	Install advance warning signs (positive guidance)	All	40%	40%	40%	$800	5
3	Install chevron signs on horizontal curves	All	35%	35%	35%		5
4	Install curve advance warning signs	All	30%	30%	30%	$800	5
5	Install delineators (general)	All	11%	11%	11%	$2,400	4
6	Install delineators (on bridges)	All	40%	40%	40%		4
7	Install edgelines, centerlines and delineators	All	0%	45%	0%		4
8	Install centerline markings	All	33%	33%	33%		2
9	Improve sight distance to intersection	All	56%	37%	0%		15
10	Flatten crest vertical curve	All	20%	20%	20%		15
11	Flatten horizontal curve	All	39%	39%	39%		15
12	Improve horizontal and vertical alignments	All	58%	58%	58%		15
13	Flatten side slopes	All	43%	43%	43%		15
14	Install guardrail (at bridge)	All	22%	22%	22%		10
15	Install guardrail (at embankment)	All	0%	42%	0%		10
16	Install guardrail (outside curves)	All	63%	63%	0%		10
17	Improve guardrail	All	9%	9%	9%		10
18	Improve superevlevation	All	40%	40%	40%		15
19	Widen bridge	All	45%	45%	45%		15
20	Install shoulder	All	9%	9%	9%		5
21	Pave shoulder	All	15%	15%	15%		5
22	Install transverse rumble strips on approaches	All	35%	35%	35%		3
23	Lengthen Culvert	All	40%	40%	40%		15
24	Install animal fencing	Animal	80%	80%	80%		10
25	Relocate Fixed Object - Mail Boxes	All	40%	40%	40%	$3,000	15
26	Convert Yield to Stop	All	29%	29%	29%		5
27	Install School Zone Warning Signs	All	20%	20%	20%		5
28	Install Flashing Beacons as Advanced Warning	All	25%	25%	25%		10
29	Install Pedestrian Crossing	All	37%	37%	37%		5
30	Widen Shoulders	All	15%	15%	15%		10

Benefit to Cost (B/C) Ratio Analysis for Safety Improvement

General Information

Analyst	D. Shinstine
Agency/Company	UW
Project	WRIR
Date Performed	7/11/2012

Site Information

Facility	IRR
Road	Pingetzer Road
Analysis Time Period	2001 - 2011
Analysis Year	2012
Segment Length (mi.)	1.0

Inputs

Crash Cost

Fatal	2,500,000
Injury	60,000
Property Damage Only (PDO)	6,000

	Number of Crashes			Countermeasures				
Road Segment	*Fatal*	*Injury*	*PDO*	*A*	*B*	*C*	*D*	*E*
Pingetzer Road	0	5	2	5	6			

Calculation

	Countermeasures					
	A	*B*	*C*	*D*	*E*	Combined
Cost	$7,000.00	$750.00				$7,750.00
Benefit	$34,320.00	$124,800.00				$145,392.00
B/C Ratio	4.90	166.40				18.76

Pingetzer Road							
Countermeasure Number	Countermeasures	Crash Type	Crash Reduction Factors			Cost	Service Life
			Fatal	Injury	PDO		
1	Install guide signs (general)	All	15%	15%	15%		5
2	Install advance warning signs (positive guidance)	All	40%	40%	40%		5
3	Install chevron signs on horizontal curves	All	35%	35%	35%		5
4	Install curve advance warning signs	All	30%	30%	30%		5
5	Install delineators (general)	All	11%	11%	11%	$2,800	4
6	Install delineators (on bridges)	All	40%	40%	40%	$300	4
7	Install edgelines, centerlines and delineators	All	0%	45%	0%		4
8	Install centerline markings	All	33%	33%	33%		2
9	Improve sight distance to intersection	All	56%	37%	0%		15
10	Flatten crest vertical curve	All	20%	20%	20%		15
11	Flatten horizontal curve	All	39%	39%	39%		15
12	Improve horizontal and vertical alignments	All	58%	58%	58%		15
13	Flatten side slopes	All	43%	43%	43%		15
14	Install guardrail (at bridge)	All	22%	22%	22%		10
15	Install guardrail (at embankment)	All	0%	42%	0%		10
16	Install guardrail (outside curves)	All	63%	63%	0%		10
17	Improve guardrail	All	9%	9%	9%		10
18	Improve superevlevation	All	40%	40%	40%		15
19	Widen bridge	All	45%	45%	45%		15
20	Install shoulder	All	9%	9%	9%		5
21	Pave shoulder	All	15%	15%	15%		5
22	Install transverse rumble strips on approaches	All	35%	35%	35%		3
23	Lengthen Culvert	All	40%	40%	40%		15
24	Install animal fencing	Animal	80%	80%	80%		10
25	Relocate Fixed Object - Mail Boxes	All	40%	40%	40%		15
26	Convert Yield to Stop	All	29%	29%	29%		5
27	Install School Zone Warning Signs	All	20%	20%	20%		5
28	Install Flashing Beacons as Advanced Warning	All	25%	25%	25%		10
29	Install Pedestrian Crossing	All	37%	37%	37%		5
30	Widen Shoulders	All	15%	15%	15%		10

Benefit to Cost (B/C) Ratio Analysis for Safety Improvement

General Information

Analyst	D. Shinstine
Agency/Company	UW
Project	WRIR
Date Performed	7/11/2012

Site Information

Facility	IRR
Road	Riverview Road
Analysis Time Period	2001 - 2011
Analysis Year	2012
Segment Length (mi.)	12

Inputs

Crash Cost

Fatal	2,500,000	4008900
Injury	60,000	82600
Property Damage Only (PDO)	6,000	7400

	Number of Crashes			Countermeasures				
Road Segment	*Fatal*	*Injury*	*PDO*	*A*	*B*	*C*	*D*	*E*
Riverview Road	3	29	41	1	2	4	7	28

Calculation

	Countermeasures					
	A	*B*	*C*	*D*	*E*	Combined
Cost	$1,600.00	$6,400.00	$800.00	$10,560.00	$25,000.00	$44,360.00
Benefit	$1,422,900.00	$3,794,400.00	$2,845,800.00	$783,000.00	$2,371,500.00	$7,155,771.75
B/C Ratio	889.31	592.88	3557.25	74.15	94.86	161.31

Riverview Road							
Countermeasure Number	Countermeasures	Crash Type	Crash Reduction Factors			Cost	Service Life
			Fatal	Injury	PDO		
1	Install guide signs (general)	All	15%	15%	15%	$800	5
2	Install advance warning signs (positive guidance)	All	40%	40%	40%	$3,200	5
3	Install chevron signs on horizontal curves	All	35%	35%	35%		5
4	Install curve advance warning signs	All	30%	30%	30%	$400	5
5	Install delineators (general)	All	11%	11%	11%		4
6	Install delineators (on bridges)	All	40%	40%	40%		4
7	Install edgelines, centerlines and delineators	All	0%	45%	0%	$4,224	4
8	Install centerline markings	All	33%	33%	33%		2
9	Improve sight distance to intersection	All	56%	37%	0%		15
10	Flatten crest vertical curve	All	20%	20%	20%		15
11	Flatten horizontal curve	All	39%	39%	39%		15
12	Improve horizontal and vertical alignments	All	58%	58%	58%		15
13	Flatten side slopes	All	43%	43%	43%		15
14	Install guardrail (at bridge)	All	22%	22%	22%		10
15	Install guardrail (at embankment)	All	0%	42%	0%		10
16	Install guardrail (outside curves)	All	63%	63%	0%		10
17	Improve guardrail	All	9%	9%	9%		10
18	Improve superevlevation	All	40%	40%	40%		15
19	Widen bridge	All	45%	45%	45%		15
20	Install shoulder	All	9%	9%	9%		5
21	Pave shoulder	All	15%	15%	15%		5
22	Install transverse rumble strips on approaches	All	35%	35%	35%		3
23	Lengthen Culvert	All	40%	40%	40%		15
24	Install animal fencing	Animal	80%	80%	80%		10
25	Relocate Fixed Object - Mail Boxes	All	40%	40%	40%		15
26	Convert Yield to Stop	All	29%	29%	29%		5
27	Install School Zone Warning Signs	All	20%	20%	20%		5
28	Install Flashing Beacons as Advanced Warning	All	25%	25%	25%	$25,000	10
29	Install Pedestrian Crossing	All	37%	37%	37%		5
30	Widen Shoulders	All	15%	15%	15%		10

Benefit to Cost (B/C) Ratio Analysis for Safety Improvement

General Information

Analyst	D. Shinstine
Agency/Company	UW
Project	WRIR
Date Performed	7/11/2012

Site Information

Facility	IRR
Road	South Fork Road
Analysis Time Period	2001 - 2011
Analysis Year	2012
Segment Length (mi.)	3.8

Inputs

Crash Cost

Fatal	2,500,000
Injury	60,000
Property Damage Only (PDO)	6,000

	Number of Crashes			Countermeasures					
Road Segment	*Fatal*	*Injury*	*PDO*	*A*	*B*	*C*	*D*	*E*	*F*
South Fork Road	0	20	9	1	2	3	4	6	14

Calculation

	Countermeasures						
	A	*B*	*C*	*D*	*E*	*F*	Combined
Cost	$800.00	$3,200.00	$2,400.00	$3,200.00	$4,000.00	$18,000.00	$31,600.00
Benefit	$188,100.00	$501,600.00	$438,900.00	$376,200.00	$501,600.00	$275,880.00	$1,117,816.35
B/C Ratio	235.13	156.75	182.88	117.56	125.40	15.33	35.37

South Fork Road							
Countermeasure Number	Countermeasures	Crash Type	Crash Reduction Factors			Cost	Service Life
			Fatal	Injury	PDO		
1	Install guide signs (general)	All	15%	15%	15%	$400	5
2	Install advance warning signs (positive guidance)	All	40%	40%	40%	$1,600	5
3	Install chevron signs on horizontal curves	All	35%	35%	35%	$1,200	5
4	Install curve advance warning signs	All	30%	30%	30%	$1,600	5
5	Install delineators (general)	All	11%	11%	11%		4
6	Install delineators (on bridges)	All	40%	40%	40%	$1,600	4
7	Install edgelines, centerlines and delineators	All	0%	45%	0%		4
8	Install centerline markings	All	33%	33%	33%		2
9	Improve sight distance to intersection	All	56%	37%	0%		15
10	Flatten crest vertical curve	All	20%	20%	20%		15
11	Flatten horizontal curve	All	39%	39%	39%		15
12	Improve horizontal and vertical alignments	All	58%	58%	58%		15
13	Flatten side slopes	All	43%	43%	43%		15
14	Install guardrail (at bridge)	All	22%	22%	22%	$18,000	10
15	Install guardrail (at embankment)	All	0%	42%	0%		10
16	Install guardrail (outside curves)	All	63%	63%	0%		10
17	Improve guardrail	All	9%	9%	9%		10
18	Improve superevlevation	All	40%	40%	40%		15
19	Widen bridge	All	45%	45%	45%		15
20	Install shoulder	All	9%	9%	9%		5
21	Pave shoulder	All	15%	15%	15%		5
22	Install transverse rumble strips on approaches	All	35%	35%	35%		3
23	Lengthen Culvert	All	40%	40%	40%		15
24	Install animal fencing	Animal	80%	80%	80%		10
25	Relocate Fixed Object - Mail Boxes	All	40%	40%	40%		15
26	Convert Yield to Stop	All	29%	29%	29%		5
27	Install School Zone Warning Signs	All	20%	20%	20%		5
28	Install Flashing Beacons as Advanced Warning	All	25%	25%	25%		5
29	Install Pedestrian Crossing	All	37%	37%	37%		5
30	Widen Shoulders	All	15%	15%	15%		10

Benefit to Cost (B/C) Ratio Analysis for Safety Improvement

General Information

Analyst	D. Shinstine
Agency/Company	UW
Project	WRIR
Date Performed	7/11/2012

Site Information

Facility	IRR
Road	Trout Creek Road
Analysis Time Period	2001 - 2011
Analysis Year	2012
Segment Length (mi.)	5.0

Inputs

Crash Cost

Fatal	2,500,000
Injury	60,000
Property Damage Only (PDO)	6,000

	Number of Crashes			Countermeasures					
Road Segment	*Fatal*	*Injury*	*PDO*	*A*	*B*	*C*	*D*	*E*	*F*
Trout Creek Road	1	5	2	2	3	4	5	7	25

Calculation

	Countermeasures						
	A	*B*	*C*	*D*	*E*	*F*	Combined
Cost	$4,000.00	$8,000.00	$1,600.00	$4,000.00	$13,200.00	$100.00	$30,900.00
Benefit	$1,124,800.00	$984,200.00	$843,600.00	$309,320.00	$135,000.00	$1,124,800.00	$2,421,741.59
B/C Ratio	281.20	123.03	527.25	77.33	10.23	11248.00	78.37

Trout Creek Road							
Countermeasure Number	Countermeasures	Crash Type	Crash Reduction Factors			Cost	Service Life
			Fatal	Injury	PDO		
1	Install guide signs (general)	All	15%	15%	15%		5
2	Install advance warning signs (positive guidance)	All	40%	40%	40%	$2,000	5
3	Install chevron signs on horizontal curves	All	35%	35%	35%	$4,000	5
4	Install curve advance warning signs	All	30%	30%	30%	$800	5
5	Install delineators (general)	All	11%	11%	11%	$1,600	4
6	Install delineators (on bridges)	All	40%	40%	40%		4
7	Install edgelines, centerlines and delineators	All	0%	45%	0%	$5,280	4
8	Install centerline markings	All	33%	33%	33%		2
9	Improve sight distance to intersection	All	56%	37%	0%		15
10	Flatten crest vertical curve	All	20%	20%	20%		15
11	Flatten horizontal curve	All	39%	39%	39%		15
12	Improve horizontal and vertical alignments	All	58%	58%	58%		15
13	Flatten side slopes	All	43%	43%	43%		15
14	Install guardrail (at bridge)	All	22%	22%	22%		10
15	Install guardrail (at embankment)	All	0%	42%	0%		10
16	Install guardrail (outside curves)	All	63%	63%	0%		10
17	Improve guardrail	All	9%	9%	9%		10
18	Improve superevlevation	All	40%	40%	40%		15
19	Widen bridge	All	45%	45%	45%		15
20	Install shoulder	All	9%	9%	9%		5
21	Pave shoulder	All	15%	15%	15%		5
22	Install transverse rumble strips on approaches	All	35%	35%	35%		3
23	Lengthen Culvert	All	40%	40%	40%		15
24	Install animal fencing	Animal	80%	80%	80%		10
25	Relocate Fixed Object - Mail Boxes	All	40%	40%	40%	$100	15
26	Convert Yield to Stop	All	29%	29%	29%		5
27	Install School Zone Warning Signs	All	20%	20%	20%		5
28	Install Flashing Beacons as Advanced Warning	All	25%	25%	25%		10
29	Install Pedestrian Crossing	All	37%	37%	37%		5
30	Widen Shoulders	All	15%	15%	15%		10

APPENDIX 6:
WRIR APPLICATIONS FOR SYSTEM-WIDE IMPROVEMENTS

CHIEF WASHAKIE

SHOSHONE & ARAPAHO TRIBES
TRANSPORTATION PROGRAM
15 NORTH FORK ROAD
P.O. BOX 217
FORT WASHAKIE, WYOMING 82514
(307) 335-7669 FAX (307) 332-4557

CHIEF BLACK COAL

December 21, 2012

Kalede Ksaibati
Director
University of Wyoming, Technology Transfer Center
Dept. 3295
100 E. University Avenue
Laramie, WY 82071

Dear Sir:

Please Accept this incomplete application on behalf of the Shoshone and Arapaho Tribes, Safety Projects for the benefit of the traveling public on our Reservation Road System. As you have along with the Wyoming Department of Transportation, Mr. Matt Carlson along with both State Office and Regional offices of the Great State of Wyoming.

Have been, instrumental in the success of the upgrading the Safety of our efforts both with the development of our Pilot Safety Project that is being displayed in both National, Regional and Local levels of discussion and development as far as the overall issue of Safety is being discussed are both your personal efforts and those of data collection and reviews of problematic areas of our Road System is being engaged an brought to the table by Debbie Shinstein, of the University Staff is noteworthy.

I, have been approved by verbal approval of the Chairman of each Tribe to submit the applications at this time, They will be officially approved by the first Joint Business Council after the First of the year. Both Tribes are involved in Elections in the few weeks. Your understanding of our current status is appreciated. Please Accept Mr. Smith's Letter and signature be used as official notice of our intent to participate at the requested funding amount and contributing fund match that will required for a successful completion.

Sincerely,

John P. Smith

John P. Smith

Application
WYDOT Highway Safety Program
High Risk Rural Road Program (HRRRP)
Application is available at http://wwweng.uwyo.edu/wyt2/

Instructions to Applicants

☑	Complete all sections of the attached application Consult the *HRRRP Program Guide* and LTAP to aid in completing the application	☑	A Funding Request for Safety Improvement table, provided by LTAP, of the proposed HRRRP project site must be attached to this application (8.5" X 11" is preferred for reproduction purposes)
☐	Application must be signed and dated on the spaces below by the individual(s) authorized to sign for the Project Sponsor	☑	Please include any pictures, maps or other visual aids of the proposed project with this application (8.5" X 11" is preferred for reproduction purposes)
☐	An Authorizing Resolution from the sponsor must be attached to this application	☐	**Application deadline:** the application must be postmarked/received by the agency shown below <u>no later than September 30, 2009.</u>

Mail completed application to:

University of Wyoming
Technology Transfer Center
Wyoming T^2/LTAP
Dept. 3295
100 E. University Avenue
Laramie, WY 82071
Attn: Khaled Ksaibati, Director

Phone #: 800-231-2815
Fax #: (307) 766-6784
Email: khaled@uwyo.edu

http://wwweng.uwyo.edu/wyt2

Name of Applicant / Project Sponsor:

Wind River Joint Tribal Business Council

Date of Application:

Signature of Authorized Official:

Title of Authorized Official:

Project Name and Sponsor

Note: The project sponsor is a Wyoming County Government. The sponsor must initiate appropriate authorizing action – Authorizing Resolution – approved at a public meeting and signed by the sponsoring body. A sample copy of this resolution is included with this application. A copy of the Authorizing Resolution and/or reference to the meeting minutes should be included with this application. If the project application is approved by the Wyoming Transportation Commission, the Project Sponsor agrees to enter into a project agreement with WYDOT for funding and project responsibilities.

Project Sponsor: Wind River Joint Tribal Business Council
Project Name: System-Wide Sign Placement on IRR Roads

Sponsor Information

	Primary Contact	Secondary Contact (if Applicable)
Contact Person and Title:	John P. Smith, Transportation Director	Howard Brown, Transportation Assist.
	Shoshone Arapaho DOT	
Address:	Box 217	
	Ft. Washakie, WY 82514	
Phone:	(307) 330-7669	
Fax:		
Email:	johnsmith@wyoming.com	draw_oh_2000@yahoo.com

Project Type

Identify the type of project being proposed for funding with the High Risk Rural Road Program (HRRRP) funding: The type of project must be taken from the Wyoming Rural Road Safety Program (WRRSP) developed jointly by the County and LTAP. The needed information is summarized in the WRRSP Funding Request for Safety Improvements.

System-Wide Sign Placement
Installation of advanced warning signs, chevrons, curve warning signs, delineators, and stop signs.
For a complete list and quantities, see attached listing.

Project Description

Please give a brief, but concise description of the proposed project. Include a description of any geographical or environmental features which may be sensitive and will be impacted by this project i.e., a stream crossing or wetland intrusion to the work site. Please include a map of the general project area. It is preferred, for reproduction purposes, that this map and other supporting documents are in standard letter size (8.5" X 11") format.
If available, attach photo(s) which illustrate current road conditions.

Installation of signs throughout the Wind River Indian Reservation on roads designated as Indian Reservation Roads (IRR). Signage includes advanced warning signs, chevrons at curves, curve warning signs, stop signs, delineators at bridges and fixed objects, and dead-end barricades.

Signs will be installed on sixteen (16) IRR routes which are:
Route 19 – Cemetery Road
Route 25 – Stuart Road
Route 27 – Old Wind River Highway
Route 9003 – Dead Horse Road
Route 38 – Yellow Calf Road
Route 40 – Shipton Road
Route 33 – Thunder Lane
Route 16 – Trosper Road
Route 21 – Mill Creek Road
Route 12 – Givens Road
Route 46 – Little Wind River Bottom Road
Route 8 – Left Hand Ditch Road
Route 49 – C'Hare Lane
Route 8005 – Goes In Lodge Road
Route 4004 – St Clair Spur
Route 5 – Shoyo Road

Planning and Preliminary Considerations

Please describe the project planning and road selection criteria prior to this application being submitted. Please include the following information in the spaces provided below:

1. Has the County completed a WRRSP and coordinated with the Local Technical Assistance Program (LTAP)?	Yes
2. Does the project conform to the applicable design standards?	Yes
3. Will the County use an in-kind match in lieu of the required cost match?	Yes, own workforce and equipment

Note: If the County uses its own equipment, workforce, or materials, a Public Interest Finding must be sent to and approved by the WYDOT prior to beginning work (see Appendix C).

Real Property Acquisition

The ownership of the Right of Way or easement, for a HRRR project must vest with the County. It is advised that the Right of Way for any project be secured before the application for the project is submitted. The location of the roadway may be assumed under the County Road System, yet encumbered in some way. The title to the property must not be encumbered with conditions or reservations which prohibit the requested HRRR project. If the there is any question as to ownership or title for the property is in question, a title search would be advisable.

The county will be required to complete a WYDOT Right-of-Way Certification Form, WYDOT Form LP-2, prior to constructing the proposed HRRRP Project. A copy of WYDOT Form LP-2 is included with this application and must be submitted to WYDOT, as required by Appendix A of the *HRRRP Program Guide*. Please identify the current status of rights-of-way ownership and proposed project acquisitions.

☑ The project will be constructed within existing right-of-way and ownership is vested with the County. No additional acquisitions are needed.

☐ The project will require additional right-of-way acquisitions and they have been secured with ownership vested with the County.

☐ The project will require additional right-of-way and it will be secured, using HRRRP funds, with ownership vested with the County.

Environmental Considerations

The sponsor must comply with all Federal and State environmental regulations. Projects involving construction or combined with a larger construction/reconstruction project will require completion of an ***Environmental Document***, typically a Categorical Exclusion. The sponsor must identify the type of document required for compliance with Federal environmental regulations.
Three types of Categorical Exclusions are available for use by the project sponsor.

☑ *Categorical Exclusion Type 1*: This document is available for use on those project types presented in the *HRRRP Program Guide* Table 1. with a **design reference 1. and 2**, as these project types are all within existing rights-of-way, require minimal ground disturbance, and are not associated with any stream or drainage. For these types of projects, NEPA requirements are satisfied when the sponsor provides WYDOT with a letter presenting the project description followed by: This project is a Programmatic Categorical Exclusion under 23 CFR 771.117 (c) or (d) as approved by the Federal Highway Administration, as CE 02-27, on April 3, 2002.

☐ *Categorical Exclusion Type 2*: This document is available for use on those project types, presented in the *HRRRP Program Guide Table 1.* with a **design reference 3**, and are within existing rights-of-way, require minimal ground disturbance, and are not in proximity to a stream or drainage. For these types of projects, NEPA requirements are satisfied when the sponsor provides WYDOT with a letter presenting the project description followed by: This project is a Programmatic Categorical Exclusion under 23 CFR 771.117 (d) as approved by the Federal Highway Administration, as CE 02-27, on April 3, 2002.

☐ *Categorical Exclusion Type 3:* This document is available for use for those project types, presented in the *HRRRP Program Guide Table 1.* with a **design reference 3**, and may require minor amounts of additional rights-of-way or construction permits, or may require ground disturbance for cuts or fills, or may require work in or adjacent to streams or drainages. For these types of projects, NEPA requirements are satisfied when the sponsor analyzes project impacts to environmental resources present in the project area and provides WYDOT with a letter presenting the project description and, at a minimum, addressing the following: 1) impacts to water quality and wetlands if the project includes excavation or fill into or adjacent to streams for drainages (proposed work must qualify for a Nationwide Permit by the U.S. Army Corps of Engineers); 2) impacts to threatened or endangered species or habitat if the project includes excavation or fill into or adjacent to streams or drainages; 3) impacts to cultural resources to include a cultural survey and coordination under Section 106 of the National Historic Preservation Act.
The analysis should identify all impacts and the efforts made to avoid or minimize impacts including any proposed mitigation. This Categorical Exclusion must be signed by the Federal Highway Administration (FHWA) prior to construction.

Utility Accommodation

The sponsor must certify, prior to project construction, that utility accommodation has been completed. Please identify the current status of utility accommodation.

- [x] Project will not require the relocation or adjustment of utilities.
- [ ] Project may require the relocation or adjustment of utilities, using HRRRP funds, and a Utility Certification will be completed, as required by Appendix A of the *HRRRP Program Guide*.

Project Maintenance

Project maintenance and perpetual care will be the responsibility of the project sponsor. Another party may do the actual physical maintenance, if an agreement is entered into between that party and the project sponsor. Should the public interest and ownership change in the future, the public maintenance responsibility can be passed along with the public title. (i.e.: County road ownership would be changed from County to City via annexation). Please state whether the project sponsor will be responsible for the maintenance directly or whether an agreement for maintenance will be entered into with another party. A copy of that agreement must be on file in the Local Government Office and should be included with this application.

Project Sponsor will be responsible for the maintenance directly.

Project Administration

Please provide the following information:

Name & Contact Information of the Project Administrator (if different than the contact person listed in section 2 above) The County's Administrator will also act as the liaison between the sponsor and WYDOT/LTAP. The project administrator will ensure compliance with various State and Federal Program requirements.	Same as contact person
Will the project design and contract bidding documents be produced by the sponsor's staff or by a consultant? If a consultant is used, WYDOT Operating Policy 40-1 must be followed.	Shoshone Arapaho DOT or their consultant will design. Project not going to bid. SADOT will order materials and perform installation with in-house forces.
Who will review the project design and contract bid documents for the sponsor, or sponsor staff?	LTAP

What governing body awards the contract?	Wind River Joint Tribal Business Council
Who will perform the construction management, including final inspection and final acceptance?	Secondary Contact (Howard Brown)

Project Budget

Cost estimates should be incorporated in this budget to reflect the costs that are expected to be incurred in the project. While project totals may exceed $100,000, Federal participation in this project is limited to $100,000.00 and must be matched at the 90.49/9.51% ratio. Any amount in excess of the required 9.51% match contributed by the sponsor is allowable and will be considered overmatch as noted below. This budget will aid in the process of selection of any project proposal for a HRRR project. The budget line items should not be understood to be absolute, as they may be changed later, if necessary, to reflect actual costs after the project has begun.

Project Element	HRRRP Funds (90.49%)	Local Match (9.51%)	Total (100%)
Engineering Costs			
Right of Way Costs			
Utility Adjustment Costs			
Construction Engineering Costs			
Construction Costs	$100,000	$9,510	$109,510
Total	$100,000	$9,510	$109,510

Note: A cash match is much easier to track, with little documentation. Also, please include a line item summary of the details of the proposed project cost estimate to include charges for engineering, design, right of way, utilities and construction items. Again, if there questions about these items, please do not hesitate to call the WYDOT office listed on the cover of this application.

Project Funding Summary

Federal HRRR funds requested (90.49% of project costs)	$100,000
Local Match (cash or other match) (9.51% of project costs)	$9,510
Other funds available as overmatch (not required)	$30,604
Total Project Cost	$140,114

Public Interest Finding

The WYDOT Highway Safety Program has determined that the HRRR Program will allow the project sponsor, as part of its proposal, to use an in-kind match in lieu of the minimum 9.51% cost match. The use of in-kind match requires WYDOT LGC advance approval, and will require that the project sponsor provide appropriate documentation to support the credited amount.

An in-kind match must have equal value to the cost match and can come from sources including:

+ a credit from donation of funds, materials, or services, and/or
+ a credit from County Force Account Work – equipment, labor, and materials, provided or performed by the project sponsor. The use of Force Account must be supported by a Public Interest Finding documented on WYDOT Form LGC-PIF and submitted with the Project Proposal.

This Appendix provides additional guidance on the documentation required to support the use of in-kind matches.

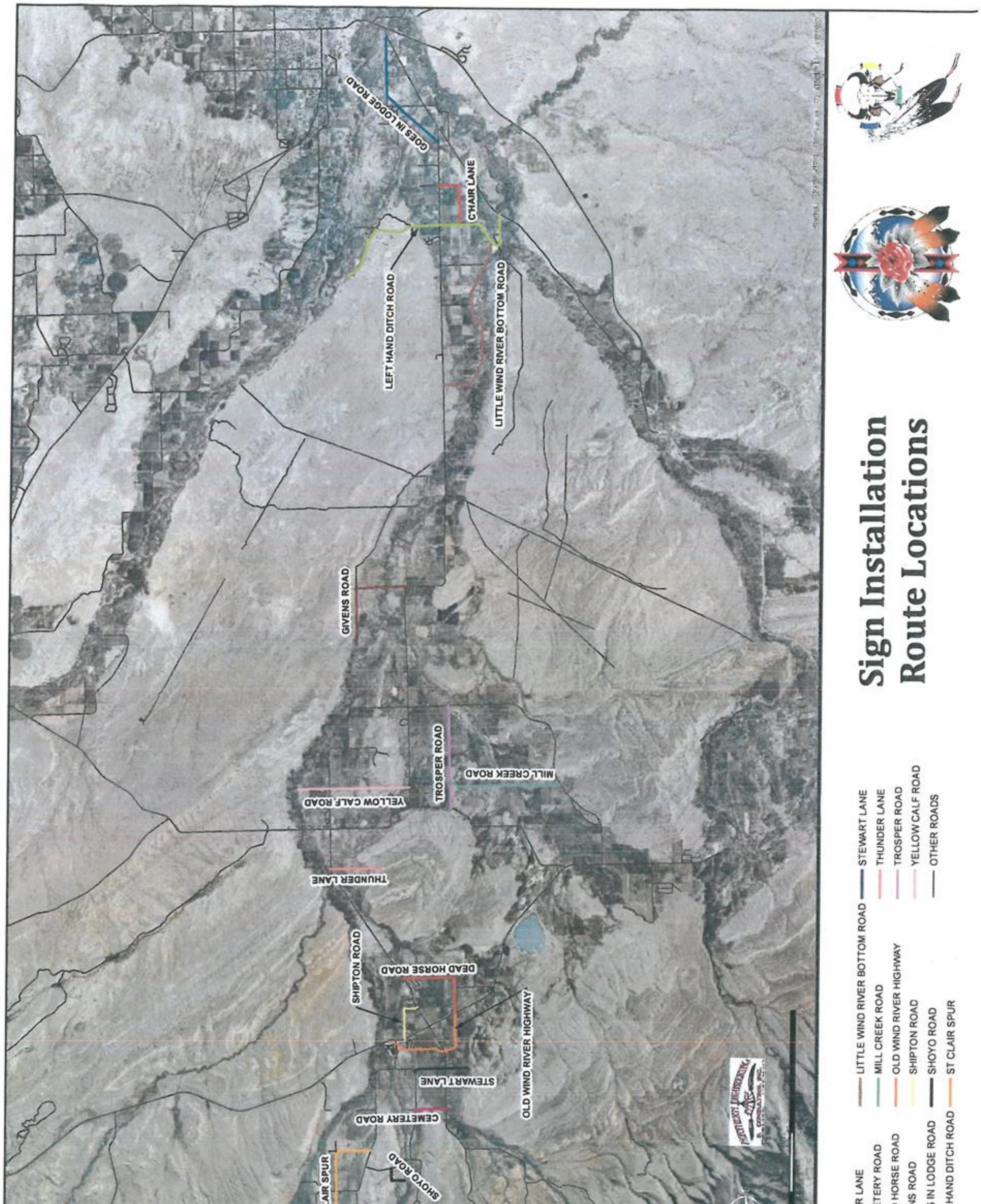
Public-owned Equipment: The project proposal must identify the type of equipment, the proposed use, the equipment hourly rental rate, and the hours of use. Mobilization, Standby, Overhead, and Profit costs will not be eligible for reimbursement, except as provided by the agreed hourly rental rate. The hourly rental rate should be determined using established Rental Rate Guides, such as Blue Book, with regional adjustments. The transporting of equipment or materials to the project site will be reimbursed using applicable equipment rental rates and operator labor rates.

Labor: Public employee equipment operator and labor rates will be supported by Sponsor records of actual standard pay, and may be adjusted to include the value of employee benefits. Overtime pay is not eligible for reimbursement.

Materials: Manufactured materials, provided by the Project Sponsor, must be acquired through open, competitive bidding and will be reimbursed at invoice costs, including delivery to the project. Local materials, such as borrow, aggregates, or recycled materials, must be identified in the Proposal and identified by the type, the proposed use, the quantity, and a unit cost based on prices typical to the area.

Donated Materials and Labor: The monetary value of donated materials must be supported by evidence of current retail market value. The monetary value of donated labor/services must be consistent with public employee labor rates for similar services.

WRIR System-Wide Signs		
Description	**Designation**	**Quantity**
Stop	R1-1	3
Stop Ahead	W3-1	21
90° Curve Right	W1-1	2
90° Curve Left	W1-2	0
Curve Right	W1-2	5
Curve left	W1-3	8
Curve Right with Intersection	W1-10	1
Chevron	W1-8	138
Winding Road	W1-5	2
Intersection	W2-1	7
Intersection	W2-2	19
Intersection	W2-4	5
Road Narrows	W5-1	0
Narrow Bridge	W5-2	3
Object Marker	OM-3	40
Dead End	W14-1	5
Ahead	W16-9P	3
Advisory Speed (25 mph)	W13-1P	2
Advisory Speed (15 mph)	W13-1P	4
Double Arrow	W1-7	12
Arrow	W1-6	1
Shoulder Drop Off	W8-9A	3
Barricade (24" Wide)	Type 2	2
Barricade	Type 3	2
Steep Grade	W7-1	1
Misc		1


Sign Installation
Route Locations
Legend
C'HAIR LANE
CEMETERY ROAD
DEAD HORSE ROAD
GIVENS ROAD
GOES IN LODGE ROAD
LEFT HAND DITCH ROAD
LITTLE WIND RIVER BOTTOM ROAD
MILL CREEK ROAD
OLD WIND RIVER HIGHWAY
SHIPTON ROAD
SHOYO ROAD
ST CLAIR SPUR
STEWART LANE
THUNDER LANE
TROSPER ROAD
YELLOW CALF ROAD
OTHER ROADS
GOES IN LODGE ROAD
C'HAIR LANE
LEFT HAND DITCH ROAD
LITTLE WIND RIVER BOTTOM ROAD
GIVENS ROAD
TROSPER ROAD
MILL CREEK ROAD
YELLOW CALF ROAD
THUNDER LANE
SHIPTON ROAD
DEAD HORSE ROAD
OLD WIND RIVER HIGHWAY
STEWART LANE
CEMETERY ROAD
ST. CLAIR SPUR
SHOYO ROAD

Methodology for Determining Safety Improvements
Wind River Indian Reservation

According to the Wyoming Rural Roads Safety Program (WRRSP), a methodology was followed to identify safety improvements for high risk locations for the Wind River Indian Reservation (WRIR). The five step methodology under the WRRSP was modified to meet the needs of the Tribes.

Crash analysis was performed for both county and Indian Reservation Roads (IRR) on the reservation. Crash locations for the IRR roads could not be determined because the inventory has no link to the WYDOT inventories. Therefore, a full review of the county roads was performed and improvements were identified.

A benefit-cost analysis was performed for the improvements on the county roads. All ratios were above 1.0 and many resulted in values over 50.0. This is an indication that the low cost improvements would in fact reduce crash risk. Since the crashes on IRR roads could not be specifically located, a benefit-cost analysis could not be performed.

However, the WRIR transportation personnel requested system wide improvements on the IRR roads that they have knowledge of crashes. These roads had similar characteristics as the county roads. By applying the same type of safety improvements on a system-wide basis, similar results would be expected.

CHIEF WASHAKIE

SHOSHONE & ARAPAHO TRIBES
TRANSPORTATION PROGRAM
15 NORTH FORK ROAD
P.O. BOX 217
FORT WASHAKIE, WYOMING 82514
(307) 335-7669 FAX (307) 332-4557

CHIEF BLACK COAL

December 21, 2012

Kalede Ksaibati
Director
University of Wyoming, Technology Transfer Center
Dept. 3295
100 E. University Avenue
Laramie, WY 82071

Dear Sir:

Please Accept this incomplete application on behalf of the Shoshone and Arapaho Tribes, Safety Projects for the benefit of the traveling public on our Reservation Road System. As you have along with the Wyoming Department of Transportation, Mr. Matt Carlson along with both State Office and Regional offices of the Great State of Wyoming.

Have been, instrumental in the success of the upgrading the Safety of our efforts both with the development of our Pilot Safety Project that is being displayed in both National, Regional and Local levels of discussion and development as far as the overall issue of Safety is being discussed are both your personal efforts and those of data collection and reviews of problematic areas of our Road System is being engaged an brought to the table by Debbie Shinstein, of the University Staff is noteworthy.

I, have been approved by verbal approval of the Chairman of each Tribe to submit the applications at this time, They will be officially approved by the first Joint Business Council after the First of the year. Both Tribes are involved in Elections in the few weeks. Your understanding of our current status is appreciated. Please Accept Mr. Smith's Letter and signature be used as official notice of our intent to participate at the requested funding amount and contributing fund match that will required for a successful completion.

Sincerely,

John P. Smith

John P. Smith

Application
WYDOT Highway Safety Program
High Risk Rural Road Program (HRRRP)
Application is available at http://wwweng.uwyo.edu/wyt2/

Instructions to Applicants

☑	Complete all sections of the attached application Consult the *HRRRP Program Guide* and LTAP to aid in completing the application	☑	A Funding Request for Safety Improvement table, provided by LTAP, of the proposed HRRRP project site must be attached to this application (8.5" X 11" is preferred for reproduction purposes)
☐	Application must be signed and dated on the spaces below by the individual(s) authorized to sign for the Project Sponsor	☑	Please include any pictures, maps or other visual aids of the proposed project with this application (8.5" X 11" is preferred for reproduction purposes)
☐	An Authorizing Resolution from the sponsor must be attached to this application	☐	**Application deadline:** the application must be postmarked/received by the agency shown below no later than September 30, 2009. N/A

Mail completed application to:

University of Wyoming
Technology Transfer Center
Wyoming T^2/LTAP
Dept. 3295
100 E. University Avenue
Laramie, WY 82071
Attn: Khaled Ksaibati, Director

Phone #: 800-231-2815
Fax #: (307) 766-6784
Email: khaled@uwyo.edu

http://wwweng.uwyo.edu/wyt2

Name of Applicant / Project Sponsor:

Wind River Joint Tribal Business Council

Date of Application:

Signature of Authorized Official:

Title of Authorized Official:

Project Name and Sponsor

Note: The project sponsor is a Wyoming County Government. The sponsor must initiate appropriate authorizing action – Authorizing Resolution – approved at a public meeting and signed by the sponsoring body. A sample copy of this resolution is included with this application. A copy of the Authorizing Resolution and/or reference to the meeting minutes should be included with this application. If the project application is approved by the Wyoming Transportation Commission, the Project Sponsor agrees to enter into a project agreement with WYDOT for funding and project responsibilities.

Project Sponsor: Wind River Joint Tribal Business Council

Project Name: System-Wide Pavement Marking on IRR Roads

Sponsor Information

	Primary Contact	Secondary Contact (if Applicable)
Contact Person and Title:	John P. Smith, Transportation Director	Howard Brown, Transportation Assist.
Address:	Shoshone Arapaho DOT	
	Box 217	
	Ft. Washakie, WY 82514	
Phone:	(307) 330-7669	
Fax:		
Email:	johnsmith@wyoming.com	draw_oh_2000@yahoo.com

Project Type

Identify the type of project being proposed for funding with the High Risk Rural Road Program (HRRRP) funding: The type of project must be taken from the Wyoming Rural Road Safety Program (WRRSP) developed jointly by the County and LTAP. The needed information is summarized in the WRRSP Funding Request for Safety Improvements.

System-Wide Pavement Marking
Centerline and Edgelines

187,440 linear feet (35.5 miles) of centerline, double yellow striped
46,860 Linear feet (8.9 miles) of centerline, single yellow dash
124,080 linear feet (23.5 miles) of edgeline, single white stripe

Project Description

Please give a brief, but concise description of the proposed project. Include a description of any geographical or environmental features which may be sensitive and will be impacted by this project i.e., a stream crossing or wetland intrusion to the work site. Please include a map of the general project area. It is preferred, for reproduction purposes, that this map and other supporting documents are in standard letter size (8.5" X 11") format.
If available, attach photo(s) which illustrate current road conditions.

Placement of pavement markings throughout the Wind River Indian Reservation on roads designated as Indian Reservation Roads (IRR). Pavement markings include centerline and edgelines. Total miles of pavement marking is approximately 68 miles.

Pavement Markings will be placed on sixteen (16) IRR routes which are:
Route 19 – Cemetery Road
Route 25 – Stuart Road
Route 27 – Old Wind River Highway
Route 9003 – Dead Horse Road
Route 38 – Yellow Calf Road
Route 40 – Shipton Road
Route 33 – Thunder Lane
Route 16 – Trosper Road
Route 21 – Mill Creek Road
Route 12 – Givens Road
Route 46 – Little Wind River Bottom Road
Route 8 – Left Hand Ditch Road
Route 49 – C'Hare Lane
Route 8005 – Goes In Lodge Road
Route 4004 – St Clair Spur
Route 5 – Shoyo Road

Planning and Preliminary Considerations

Please describe the project planning and road selection criteria prior to this application being submitted. Please include the following information in the spaces provided below:

1. Has the County completed a WRRSP and coordinated with the Local Technical Assistance Program (LTAP)?	Yes
2. Does the project conform to the applicable design standards?	Yes
3. Will the County use an in-kind match in lieu of the required cost match?	Yes, own workforce and equipment

Note: If the County uses its own equipment, workforce, or materials, a Public Interest Finding must be sent to and approved by the WYDOT prior to beginning work (see Appendix C).

Real Property Acquisition

The ownership of the Right of Way or easement, for a HRRR project must vest with the County. It is advised that the Right of Way for any project be secured before the application for the project is submitted. The location of the roadway may be assumed under the County Road System, yet encumbered in some way. The title to the property must not be encumbered with conditions or reservations which prohibit the requested HRRR project. If the there is any question as to ownership or title for the property is in question, a title search would be advisable.

The county will be required to complete a WYDOT Right-of-Way Certification Form, WYDOT Form LP-2, prior to constructing the proposed HRRRP Project. A copy of WYDOT Form LP-2 is included with this application and must be submitted to WYDOT, as required by Appendix A of the *HRRRP Program Guide*. Please identify the current status of rights-of-way ownership and proposed project acquisitions.

☑ The project will be constructed within existing right-of-way and ownership is vested with the County. No additional acquisitions are needed.

☐ The project will require additional right-of-way acquisitions and they have been secured with ownership vested with the County.

☐ The project will require additional right-of-way and it will be secured, using HRRRP funds, with ownership vested with the County.

Environmental Considerations

The sponsor must comply with all Federal and State environmental regulations. Projects involving construction or combined with a larger construction/reconstruction project will require completion of an ***Environmental Document***, typically a Categorical Exclusion. The sponsor must identify the type of document required for compliance with Federal environmental regulations.
Three types of Categorical Exclusions are available for use by the project sponsor.

☑ *Categorical Exclusion Type 1*: This document is available for use on those project types presented in the *HRRRP Program Guide* Table 1. with a **design reference 1. and 2**, as these project types are all within existing rights-of-way, require minimal ground disturbance, and are not associated with any stream or drainage. For these types of projects, NEPA requirements are satisfied when the sponsor provides WYDOT with a letter presenting the project description followed by: This project is a Programmatic Categorical Exclusion under 23 CFR 771.117 (c) or (d) as approved by the Federal Highway Administration, as CE 02-27, on April 3, 2002.

☐ *Categorical Exclusion Type 2*: This document is available for use on those project types, presented in the *HRRRP Program Guide Table 1.* with a **design reference 3**, and are within existing rights-of-way, require minimal ground disturbance, and are not in proximity to a stream or drainage. For these types of projects, NEPA requirements are satisfied when the sponsor provides WYDOT with a letter presenting the project description followed by: This project is a Programmatic Categorical Exclusion under 23 CFR 771.117 (d) as approved by the Federal Highway Administration, as CE 02-27, on April 3, 2002.

☐ *Categorical Exclusion Type 3*: This document is available for use for those project types, presented in the *HRRRP Program Guide Table 1.* with a **design reference 3**, and may require minor amounts of additional rights-of-way or construction permits, or may require ground disturbance for cuts or fills, or may require work in or adjacent to streams or drainages. For these types of projects, NEPA requirements are satisfied when the sponsor analyzes project impacts to environmental resources present in the project area and provides WYDOT with a letter presenting the project description and, at a minimum, addressing the following: 1) impacts to water quality and wetlands if the project includes excavation or fill into or adjacent to streams for drainages (proposed work must qualify for a Nationwide Permit by the U.S. Army Corps of Engineers); 2) impacts to threatened or endangered species or habitat if the project includes excavation or fill into or adjacent to streams or drainages; 3) impacts to cultural resources to include a cultural survey and coordination under Section 106 of the National Historic Preservation Act.

The analysis should identify all impacts and the efforts made to avoid or minimize impacts including any proposed mitigation. This Categorical Exclusion must be signed by the Federal Highway Administration (FHWA) prior to construction.

Utility Accommodation

The sponsor must certify, prior to project construction, that utility accommodation has been completed. Please identify the current status of utility accommodation.

- [x] Project will not require the relocation or adjustment of utilities.
- [ ] Project may require the relocation or adjustment of utilities, using HRRRP funds, and a Utility Certification will be completed, as required by Appendix A of the *HRRRP Program Guide.*

Project Maintenance

Project maintenance and perpetual care will be the responsibility of the project sponsor. Another party may do the actual physical maintenance, if an agreement is entered into between that party and the project sponsor. Should the public interest and ownership change in the future, the public maintenance responsibility can be passed along with the public title. (i.e.: County road ownership would be changed from County to City via annexation). Please state whether the project sponsor will be responsible for the maintenance directly or whether an agreement for maintenance will be entered into with another party. A copy of that agreement must be on file in the Local Government Office and should be included with this application.

Project Sponsor will be responsible for the maintenance directly.

Project Administration

Please provide the following information:

Name & Contact Information of the Project Administrator (if different than the contact person listed in section 2 above) The County's Administrator will also act as the liaison between the sponsor and WYDOT/LTAP. The project administrator will ensure compliance with various State and Federal Program requirements.	Same as contact person
Will the project design and contract bidding documents be produced by the sponsor's staff or by a consultant? If a consultant is used, WYDOT Operating Policy 40-1 must be followed.	Shoshone Arapaho DOT or their consultant will design. Project not going to bid. SADOT will order materials and perform installation with in-house forces.

Who will review the project design and contract bid documents for the sponsor, or sponsor staff?	LTAP
What governing body awards the contract?	Wind River Joint Tribal Business Council
Who will perform the construction management, including final inspection and final acceptance?	Secondary Contact (Howard Brown)

Project Budget

Cost estimates should be incorporated in this budget to reflect the costs that are expected to be incurred in the project. While project totals may exceed $100,000, Federal participation in this project is limited to $100,000.00 and must be matched at the 90.49/9.51% ratio. Any amount in excess of the required 9.51% match contributed by the sponsor is allowable and will be considered overmatch as noted below. This budget will aid in the process of selection of any project proposal for a HRRR project. The budget line items should not be understood to be absolute, as they may be changed later, if necessary, to reflect actual costs after the project has begun.

Project Element	HRRRP Funds (90.49%)	Local Match (9.51%)	Total (100%)
Engineering Costs			
Right of Way Costs			
Utility Adjustment Costs			
Construction Engineering Costs			
Construction Costs	$100,00	$9,510	$109,510
Total	$100,00	$9,510	$109,510

Note: A cash match is much easier to track, with little documentation. Also, please include a line item summary of the details of the proposed project cost estimate to include charges for engineering, design, right of way, utilities and construction items. Again, if there questions about these items, please do not hesitate to call the WYDOT office listed on the cover of this application.

Project Funding Summary

Federal HRRR funds requested (90.49% of project costs)	$100,000.00
Local Match (cash or other match) (9.51% of project costs)	$9,510.00
Other funds available as overmatch (not required)	$16,029
Total Project Cost	$125,539

Public Interest Finding

The WYDOT Highway Safety Program has determined that the HRRR Program will allow the project sponsor, as part of its proposal, to use an in-kind match in lieu of the minimum 9.51% cost match. The use of in-kind match requires WYDOT LGC advance approval, and will require that the project sponsor provide appropriate documentation to support the credited amount.

An in-kind match must have equal value to the cost match and can come from sources including:

+ a credit from donation of funds, materials, or services, and/or
+ a credit from County Force Account Work – equipment, labor, and materials, provided or performed by the project sponsor. The use of Force Account must be supported by a Public Interest Finding documented on WYDOT Form LGC-PIF and submitted with the Project Proposal.

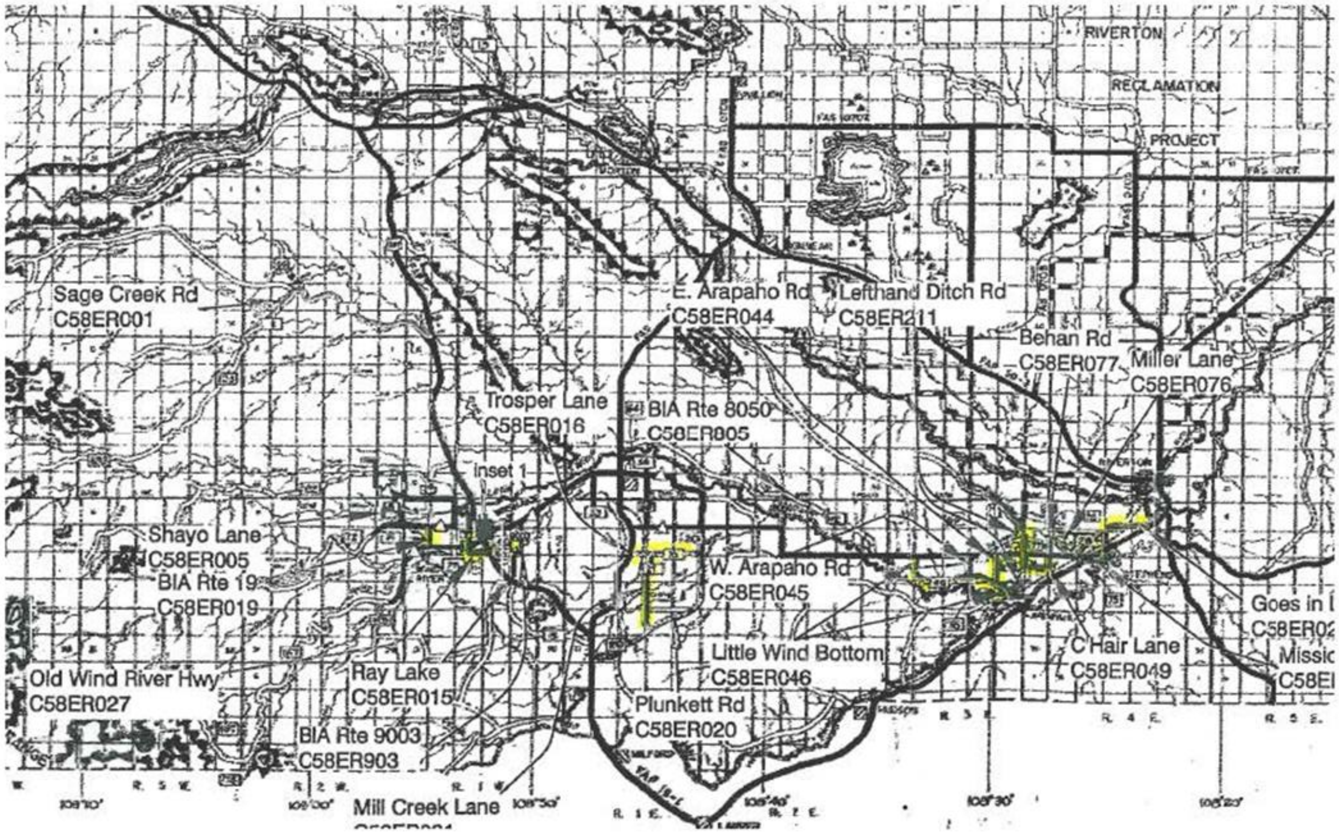
This Appendix provides additional guidance on the documentation required to support the use of in-kind matches.

Public-owned Equipment: The project proposal must identify the type of equipment, the proposed use, the equipment hourly rental rate, and the hours of use. Mobilization, Standby, Overhead, and Profit costs will not be eligible for reimbursement, except as provided by the agreed hourly rental rate. The hourly rental rate should be determined using established Rental Rate Guides, such as Blue Book, with regional adjustments. The transporting of equipment or materials to the project site will be reimbursed using applicable equipment rental rates and operator labor rates.

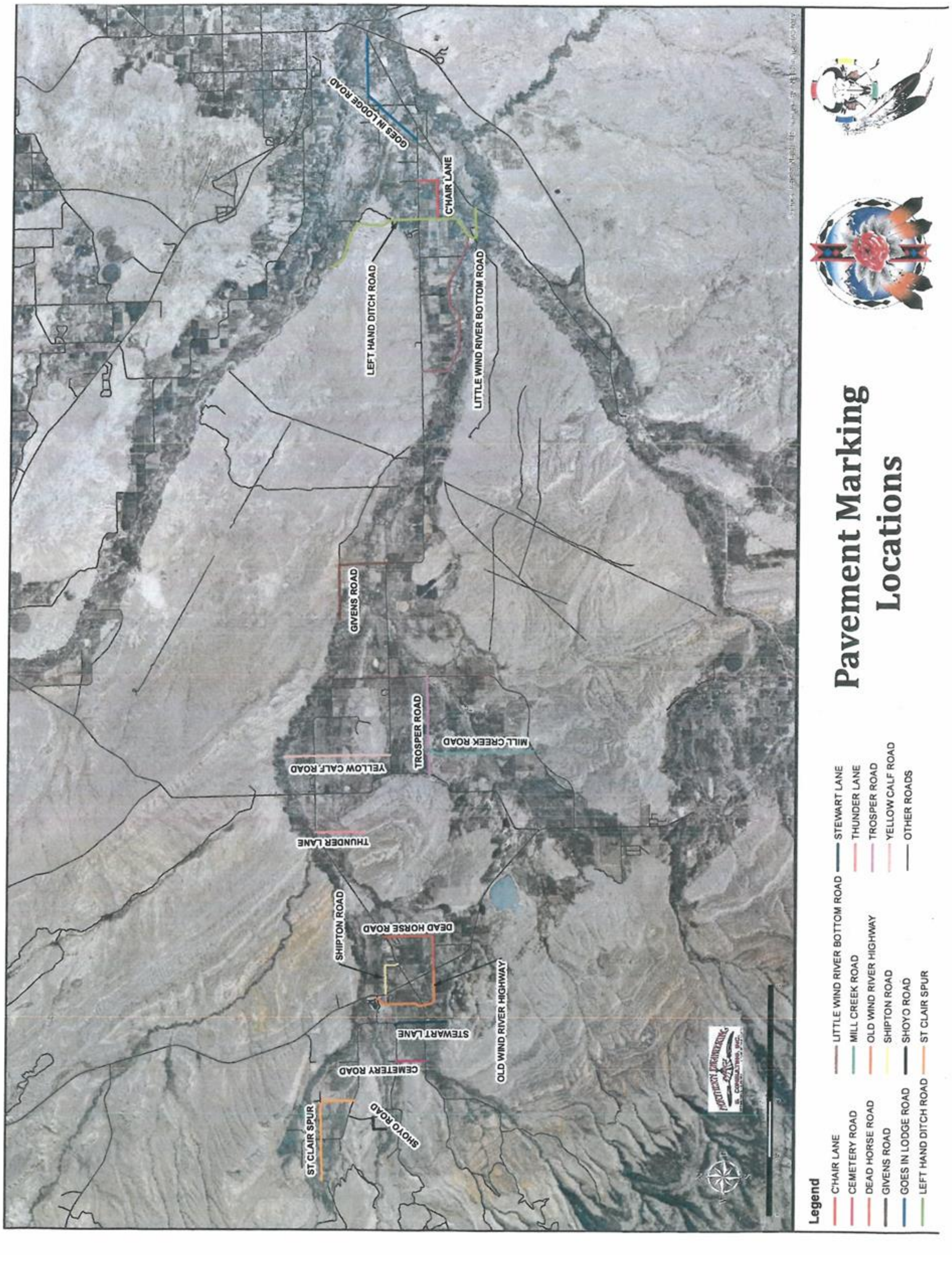
Labor: Public employee equipment operator and labor rates will be supported by Sponsor records of actual standard pay, and may be adjusted to include the value of employee benefits. Overtime pay is not eligible for reimbursement.

Materials: Manufactured materials, provided by the Project Sponsor, must be acquired through open, competitive bidding and will be reimbursed at invoice costs, including delivery to the project. Local materials, such as borrow, aggregates, or recycled materials, must be identified in the Proposal and identified by the type, the proposed use, the quantity, and a unit cost based on prices typical to the area.

Donated Materials and Labor: The monetary value of donated materials must be supported by evidence of current retail market value. The monetary value of donated labor/services must be consistent with public employee labor rates for similar services.



Wind River Indian Reservation Pavement Marking Locations


Pavement Marking Locations
Legend
C'HAIR LANE
CEMETERY ROAD
DEAD HORSE ROAD
GIVENS ROAD
GOES IN LODGE ROAD
LEFT HAND DITCH ROAD
LITTLE WIND RIVER BOTTOM ROAD
MILL CREEK ROAD
OLD WIND RIVER HIGHWAY
SHIPTON ROAD
SHOYO ROAD
ST CLAIR SPUR
STEWART LANE
THUNDER LANE
TROSPER ROAD
YELLOW CALF ROAD
OTHER ROADS
GOES IN LODGE ROAD
C'HAIR LANE
LEFT HAND DITCH ROAD
LITTLE WIND RIVER BOTTOM ROAD
GIVENS ROAD
TROSPER ROAD
MILL CREEK ROAD
YELLOW CALF ROAD
THUNDER LANE
SHIPTON ROAD
DEAD HORSE ROAD
OLD WIND RIVER HIGHWAY
STEWART LANE
CEMETERY ROAD
ST CLAIR SPUR
SHOYO ROAD

Methodology for Determining Safety Improvements
Wind River Indian Reservation

According to the Wyoming Rural Roads Safety Program (WRRSP), a methodology was followed to identify safety improvements for high risk locations for the Wind River Indian Reservation (WRIR). The five step methodology under the WRRSP was modified to meet the needs of the Tribes.

Crash analysis was performed for both county and Indian Reservation Roads (IRR) on the reservation. Crash locations for the IRR roads could not be determined because the inventory has no link to the WYDOT inventories. Therefore, a full review of the county roads was performed and improvements were identified.

A benefit-cost analysis was performed for the improvements on the county roads. All ratios were above 1.0 and many resulted in values over 50.0. This is an indication that the low cost improvements would in fact reduce crash risk. Since the crashes on IRR roads could not be specifically located, a benefit-cost analysis could not be performed.

However, the WRIR transportation personnel requested system wide improvements on the IRR roads that they have knowledge of crashes. These roads had similar characteristics as the county roads. By applying the same type of safety improvements on a system-wide basis, similar results would be expected.

CHIEF WASHAKIE

SHOSHONE & ARAPAHO TRIBES
TRANSPORTATION PROGRAM
15 NORTH FORK ROAD
P.O. BOX 217
FORT WASHAKIE, WYOMING 82514
(307) 335-7669 FAX (307) 332-4557

CHIEF BLACK COAL

December 21, 2012

Kalede Ksaibati
Director
University of Wyoming, Technology Transfer Center
Dept. 3295
100 E. University Avenue
Laramie, WY 82071

Dear Sir:

Please Accept this incomplete application on behalf of the Shoshone and Arapaho Tribes, Safety Projects for the benefit of the traveling public on our Reservation Road System. As you have along with the Wyoming Department of Transportation, Mr. Matt Carlson along with both State Office and Regional offices of the Great State of Wyoming.

Have been, instrumental in the success of the upgrading the Safety of our efforts both with the development of our Pilot Safety Project that is being displayed in both National, Regional and Local levels of discussion and development as far as the overall issue of Safety is being discussed are both your personal efforts and those of data collection and reviews of problematic areas of our Road System is being engaged an brought to the table by Debbie Shinstein, of the University Staff is noteworthy.

I, have been approved by verbal approval of the Chairman of each Tribe to submit the applications at this time, They will be officially approved by the first Joint Business Council after the First of the year. Both Tribes are involved in Elections in the few weeks. Your understanding of our current status is appreciated. Please Accept Mr. Smith's Letter and signature be used as official notice of our intent to participate at the requested funding amount and contributing fund match that will required for a successful completion.

Sincerely,

John P. Smith

Application
WYDOT Highway Safety Program
High Risk Rural Road Program (HRRRP)
Application is available at http://wwweng.uwyo.edu/wyt2/

Instructions to Applicants

☑	Complete all sections of the attached application Consult the *HRRRP Program Guide* and LTAP to aid in completing the application	☑	A Funding Request for Safety Improvement table, provided by LTAP, of the proposed HRRRP project site must be attached to this application (8.5" X 11" is preferred for reproduction purposes)
☐	Application must be signed and dated on the spaces below by the individual(s) authorized to sign for the Project Sponsor	☑	Please include any pictures, maps or other visual aids of the proposed project with this application (8.5" X 11" is preferred for reproduction purposes)
☐	An Authorizing Resolution from the sponsor must be attached to this application	☐	**Application deadline:** the application must be postmarked/received by the agency shown below no later than September 30, 2009. N/A

Mail completed application to:

University of Wyoming
Technology Transfer Center
Wyoming T^2/LTAP
Dept. 3295
100 E. University Avenue
Laramie, WY 82071
Attn: Khaled Ksaibati, Director

Phone #: 800-231-2815
Fax #: (307) 766-6784
Email: khaled@uwyo.edu

http://wwweng.uwyo.edu/wyt2

Name of Applicant / Project Sponsor:

Wind River Joint Tribal Business Council

Date of Application:

______________________________ ______________________________

Signature of Authorized Official:

Title of Authorized Official:

______________________________ ______________________________

Project Name and Sponsor

Note: The project sponsor is a Wyoming County Government. The sponsor must initiate appropriate authorizing action – Authorizing Resolution – approved at a public meeting and signed by the sponsoring body. A sample copy of this resolution is included with this application. A copy of the Authorizing Resolution and/or reference to the meeting minutes should be included with this application. If the project application is approved by the Wyoming Transportation Commission, the Project Sponsor agrees to enter into a project agreement with WYDOT for funding and project responsibilities.

Project Sponsor: Wind River Joint Tribal Business Council
Project Name: Guard Rail Placement on IRR Roads

Sponsor Information

	Primary Contact	**Secondary Contact (if Applicable)**
Contact Person and Title:	John P. Smith, Transportation Director	Howard Brown, Transportation Assist.
	Shoshone Arapaho DOT	
Address:	P.O. Box 217	
	Ft. Washakie, Wy 82514	
Phone:	307.335.7669	
Fax:		
Email:	johnsmith@wyoming.com	Draw_oh_2000@yahoo.com

Project Type

Identify the type of project being proposed for funding with the High Risk Rural Road Program (HRRRP) funding: The type of project must be taken from the Wyoming Rural Road Safety Program (WRRSP) developed jointly by the County and LTAP. The needed information is summarized in the WRRSP Funding Request for Safety Improvements.

Guard Rail Placement with End treatments

370 Linear feet of Guard Rail with End treatments

Project Description

Please give a brief, but concise description of the proposed project. Include a description of any geographical or environmental features which may be sensitive and will be impacted by this project i.e., a stream crossing or wetland intrusion to the work site. Please include a map of the general project area. It is preferred, for reproduction purposes, that this map and other supporting documents are in standard letter size (8.5" X 11") format.
If available, attach photo(s) which illustrate current road conditions.

Placement of guard rails at a critical location with in the Wind River Indian Reservation on a road designated as an Indian Reservation Road (IRR). The guard rail includes Corrugated Beam Guard Rail and Corrugated End Type A. Is estimated at 370 Linear Feet with Ends.

IRR Route:
Route 0046 Little Wind River Bottom Road

Planning and Preliminary Considerations

Please describe the project planning and road selection criteria prior to this application being submitted. Please include the following information in the spaces provided below:

1. Has the County completed a WRRSP and coordinated with the Local Technical Assistance Program (LTAP)?	Yes
2. Does the project conform to the applicable design standards?	Yes
3. Will the County use an in-kind match in lieu of the required cost match?	Yes, provide work force & equipment

Note: If the County uses its own equipment, workforce, or materials, a Public Interest Finding must be sent to and approved by the WYDOT prior to beginning work (see Appendix C).

Real Property Acquisition

The ownership of the Right of Way or easement, for a HRRR project must vest with the County. It is advised that the Right of Way for any project be secured before the application for the project is submitted. The location of the roadway may be assumed under the County Road System, yet encumbered in some way. The title to the property must not be encumbered with conditions or reservations which prohibit the requested HRRR project. If the there is any question as to ownership or title for the property is in question, a title search would be advisable.
The county will be required to complete a WYDOT Right-of-Way Certification Form, WYDOT Form LP-2, prior to constructing the proposed HRRRP Project. A copy of WYDOT Form LP-2 is included with this application and must be submitted to WYDOT, as required by Appendix A of the *HRRRP Program Guide*. Please identify the current status of rights-of-way ownership and proposed project acquisitions.

☑ The project will be constructed within existing right-of-way and ownership is vested with the County. No additional acquisitions are needed.

☐ The project will require additional right-of-way acquisitions and they have been secured with ownership vested with the County.

☐ The project will require additional right-of-way and it will be secured, using HRRRP funds, with ownership vested with the County.

Environmental Considerations

The sponsor must comply with all Federal and State environmental regulations. Projects involving construction or combined with a larger construction/reconstruction project will require completion of an ***Environmental Document***, typically a Categorical Exclusion. The sponsor must identify the type of document required for compliance with Federal environmental regulations.
Three types of Categorical Exclusions are available for use by the project sponsor.

☑ *Categorical Exclusion Type 1*: This document is available for use on those project types presented in the *HRRRP Program Guide* Table 1. with a **design reference 1. and 2**, as these project types are all within existing rights-of-way, require minimal ground disturbance, and are not associated with any stream or drainage. For these types of projects, NEPA requirements are satisfied when the sponsor provides WYDOT with a letter presenting the project description followed by: This project is a Programmatic Categorical Exclusion under 23 CFR 771.117 (c) or (d) as approved by the Federal Highway Administration, as CE 02-27, on April 3, 2002.

☐ *Categorical Exclusion Type 2*: This document is available for use on those project types, presented in the *HRRRP Program Guide Table 1*. with a **design reference 3**, and are within existing rights-of-way, require minimal ground disturbance, and are not in proximity to a stream or drainage. For these types of projects, NEPA requirements are satisfied when the sponsor provides WYDOT with a letter presenting the project description followed by: This project is a Programmatic Categorical Exclusion under 23 CFR 771.117 (d) as approved by the Federal Highway Administration, as CE 02-27, on April 3, 2002.

☐ *Categorical Exclusion Type 3*: This document is available for use for those project types, presented in the *HRRRP Program Guide Table 1*. with a **design reference 3**, and may require minor amounts of additional rights-of-way or construction permits, or may require ground disturbance for cuts or fills, or may require work in or adjacent to streams or drainages. For these types of projects, NEPA requirements are satisfied when the sponsor analyzes project impacts to environmental resources present in the project area and provides WYDOT with a letter presenting the project description and, at a minimum, addressing the following: 1) impacts to water quality and wetlands if the project includes excavation or fill into or adjacent to streams for drainages (proposed work must qualify for a Nationwide Permit by the U.S. Army Corps of Engineers); 2) impacts to threatened or endangered species or habitat if the project includes excavation or fill into or adjacent to streams or drainages; 3) impacts to cultural resources to include a cultural survey and coordination under Section 106 of the National Historic Preservation Act.
The analysis should identify all impacts and the efforts made to avoid or minimize impacts including any proposed mitigation. This Categorical Exclusion must be signed by the Federal Highway Administration (FHWA) prior to construction.

Utility Accommodation

The sponsor must certify, prior to project construction, that utility accommodation has been completed. Please identify the current status of utility accommodation.

- [x] Project will not require the relocation or adjustment of utilities.
- [ ] Project may require the relocation or adjustment of utilities, using HRRRP funds, and a Utility Certification will be completed, as required by Appendix A of the *HRRRP Program Guide.*

Project Maintenance

Project maintenance and perpetual care will be the responsibility of the project sponsor. Another party may do the actual physical maintenance, if an agreement is entered into between that party and the project sponsor. Should the public interest and ownership change in the future, the public maintenance responsibility can be passed along with the public title. (i.e.: County road ownership would be changed from County to City via annexation). Please state whether the project sponsor will be responsible for the maintenance directly or whether an agreement for maintenance will be entered into with another party. A copy of that agreement must be on file in the Local Government Office and should be included with this application.

Project Sponsor will be responsible for maintain directly.

Project Administration

Please provide the following information:

Name & Contact Information of the Project Administrator (if different than the contact person listed in section 2 above) The County's Administrator will also act as the liaison between the sponsor and WYDOT/LTAP. The project administrator will ensure compliance with various State and Federal Program requirements.	Same as contact person
Will the project design and contract bidding documents be produced by the sponsor's staff or by a consultant? If a consultant is used, WYDOT Operating Policy 40-1 must be followed.	Shoshone Arapaho DOT or their consultant will design. Project not going to bid. SADOT will order materials and perform installation with in-house forces.
Who will review the project design and contract bid documents for the sponsor, or sponsor staff?	LTAP
What governing body awards the contract?	Wind River Joint Tribal Business Council
Who will perform the construction management, including final inspection and final acceptance?	Secondary contact, Howard Brown

Project Budget

Cost estimates should be incorporated in this budget to reflect the costs that are expected to be incurred in the project. While project totals may exceed $100,000, Federal participation in this project is limited to $100,000.00 and must be matched at the 90.49/9.51% ratio. Any amount in excess of the required 9.51% match contributed by the sponsor is allowable and will be considered overmatch as noted below. This budget will aid in the process of selection of any project proposal for a HRRR project. The budget line items should not be understood to be absolute, as they may be changed later, if necessary, to reflect actual costs after the project has begun.

Project Element	HRRRP Funds (90.49%)	Local Match (9.51%)	Total (100%)
Engineering Costs			
Right of Way Costs			
Utility Adjustment Costs			
Construction Engineering Costs	2,682	282	2,963
Construction Costs	10,724	1,127	11,852
Total	13,406	1,409	14,815

Note: A cash match is much easier to track, with little documentation. Also, please include a line item summary of the details of the proposed project cost estimate to include charges for engineering, design, right of way, utilities and construction items. Again, if there questions about these items, please do not hesitate to call the WYDOT office listed on the cover of this application.

Project Funding Summary

Federal HRRR funds requested (90.49% of project costs)	$13,406.00
Local Match (cash or other match) (9.51% of project costs)	$ 1,409.00
Other funds available as overmatch (not required)	
Total Project Cost	$ 14,815.00

Public Interest Finding

The WYDOT Highway Safety Program has determined that the HRRR Program will allow the project sponsor, as part of its proposal, to use an in-kind match in lieu of the minimum 9.51% cost match. The use of in-kind match requires WYDOT LGC advance approval, and will require that the project sponsor provide appropriate documentation to support the credited amount.

An in-kind match must have equal value to the cost match and can come from sources including:

+ a credit from donation of funds, materials, or services, and/or
+ a credit from County Force Account Work – equipment, labor, and materials, provided or performed by the project sponsor. The use of Force Account must be supported by a Public Interest Finding documented on WYDOT Form LGC-PIF and submitted with the Project Proposal.

This Appendix provides additional guidance on the documentation required to support the use of in-kind matches.

Public-owned Equipment: The project proposal must identify the type of equipment, the proposed use, the equipment hourly rental rate, and the hours of use. Mobilization, Standby, Overhead, and Profit costs will not be eligible for reimbursement, except as provided by the agreed hourly rental rate. The hourly rental rate should be determined using established Rental Rate Guides, such as Blue Book, with regional adjustments. The transporting of equipment or materials to the project site will be reimbursed using applicable equipment rental rates and operator labor rates.

Labor: Public employee equipment operator and labor rates will be supported by Sponsor records of actual standard pay, and may be adjusted to include the value of employee benefits. Overtime pay is not eligible for reimbursement.

Materials: Manufactured materials, provided by the Project Sponsor, must be acquired through open, competitive bidding and will be reimbursed at invoice costs, including delivery to the project. Local materials, such as borrow, aggregates, or recycled materials, must be identified in the Proposal and identified by the type, the proposed use, the quantity, and a unit cost based on prices typical to the area.

Donated Materials and Labor: The monetary value of donated materials must be supported by evidence of current retail market value. The monetary value of donated labor/services must be consistent with public employee labor rates for similar services.

Wind River Indian Reservation Guard Rail Project Location

Project Location
Legend
LITTLE WIND RIVER BOTTOM ROAD
PROJECT LOCATION
OTHER ROADS
Guard Rail
Project Location

Methodology for Determining Safety Improvements
Wind River Indian Reservation

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APPENDIX 7: DRAFT WRIR TRANSPORTATION SAFETY PLAN

TRANSPORTATION SAFETY PLAN

Vision

Foster safety awareness and provide safe access throughout the Wind River Indian Reservation for all users and modes of travel.

Alternative: Transportation safety is a personal and shared responsibility. Through our partnerships, we foster safety awareness and provide safe access throughout the Wind River Indian Reservation for all users and modes of travel such that everyone arrives safely at their destination.

Mission

Improve and sustain safety for all modes of transportation through education, enforcement, engineering, and emergency medical service strategies.

Alternative: To determine how our partnerships will best improve and sustain safety for all modes of transportation and to leverage resources to save lives and prevent serious injuries from motor vehicle crashes through education, enforcement, engineering, and emergency medical service strategies.

Goals

- Raise awareness of transportation safety challenges to promote a positive change in our safety culture.
- Reduce the emotional and physical burden inflicted upon families because of a fatality or serious injury that occur on our transportation system.
- Promote non-motorized travel by improving safety, security, and infrastructure.

Commitment to Safety

The parties to this agreement will commit to continue their support of the work of the Wind River Indian Reservation's Safety Management Executive Committee, which includes representation as follows:

The *Executive Committee* is comprised of the following agencies:

- Joint Tribal Business Council
- Shoshone and Arapaho Department of Transportation
- Wyoming Department of Transportation (WYDOT)
- University of Wyoming Local Technical Assistance Program (LTAP)
- Northern Plains Tribal Technical Assistance Program
- Bureau of Indian Affairs Indian Reservation Roads (IRR) Program
- Tribal Engineering Department
- County Road Maintenance
- Tribal Courts
- Injury Prevention Resources
- Wind River Police Department (WRPD)
- County Sheriff Department
- Wyoming State Highway Patrol
- Bureau of Indian Affairs Law Enforcement
- Wind River Indian Health Services (WRIHS)
- Lander Medical Facility
- Riverton Medical Facility
- Fremont County Coroner
- Tribal Health
- Fremont County Fire Department
- Hot Springs County EMS

Ad hoc Membership includes:

- Federal Highway Administration (FHWA)
- National Highway Traffic Safety Administration (NHTSA)
- School Superintendents
- Children Advisory Groups
- Homeland Security
- First Responders
- Shoshone Planning and Grants Office

The committee is chaired/co-chaired by *** and *** representatives and plans to meet semi-annually, at a minimum, although the chair/co-chairs may call special meetings as necessary.

The purpose of this committee is to integrate and coordinate all transportation safety programs to improve and sustain transportation safety for all modes and users throughout the Wind River Indian Reservation.

The general tasks to be performed by this committee are as follows:

1. Prepare and update a Strategic Tribal Safety Management Plan.
    a. Establish and prioritize tribal safety goals and objectives.
    b. Regularly gather, analyze, and distribute information for selecting and implementing effective highway safety strategies and projects.
2. Ensure that all opportunities to improve highway safety are identified, prioritized, supported, and implemented as appropriate and evaluated in all phases of enforcement, education, engineering, and emergency response.
    a. Establish multidisciplinary subcommittees, such as a Road Safety Audit (RSA) Committee, and develop communication plans as needed, to review, recommend, implement, and report on safety emphasis areas.
3. Identify funding sources.

Current Members of the WRIR Safety Management Executive Committee

NAME, Joint Tribal Business Council	Date
NAME, Joint Tribal Business Council	Date
John Smith, Shoshone and Arapaho Department of Transportation	Date
Matthew Carlson, Wyoming Department of Transportation (WYDOT)	Date
Khaled Ksaibati, University of Wyoming Local Technical Assistance Program (LTAP)	Date
Dennis Trusty, Northern Plains Tribal Technical Assistance Program	Date
NAME, Tribal Engineering Department	Date
NAME, County Road Maintenance	Date
NAME, Injury Prevention Resources	Date
NAME, Wind River Police Department (WRPD)	Date
NAME, County Sheriff Department	Date
NAME, Wyoming State Highway Patrol	Date

NAME, Wind River Indian Health Services (WRIHS) Date

NAME, Environmental Health Services Date

NAME, Lander Medical Facility Date

NAME, Riverton Medical Facility Date

Edward McAuslan, Fremont County Coroner Date

NAME, Fremont County Fire Department Date

NAME, Hot Springs County EMS Date

Emphasis Areas and Strategies

Eight emphasis areas were identified by the safety stakeholders during a safety planning meeting on April 25-26, 2012. Several strategies were also developed and are presented under each emphasis area to address specific safety concerns.

1. Safety Data
2. Emergency Services
3. Roadway Infrastructure
4. Safety Restraints
5. Impaired Driving
6. Speeding
7. Pedestrians and Bicycles
8. Young Driver Safety

Emphasis Area 1: Safety Data

Goal: Improve the completeness and accuracy of safety data to support the decision-making process.

Strategies:

- Improve completeness, accuracy, and consistency of crash data
- Improve roadway inventory data
- Continue efforts to integrate data through GIS
- Improve understanding of behavioral issues

Emphasis Area 2: Emergency Services

Goal: Improve the quality and efficiency of emergency services.

Strategies:

- Improve rural location identifier
- Improve access for emergency vehicles during poor weather
- Enhance planning for snow plow operations
- Improve emergency response times

Emphasis Area 3: Roadway Infrastructure

Goal: Improve design and maintenance practices to reduce the frequency and severity of crashes.

Strategies:
- Implement Indian Reservation Roadway Safety Program (IRRSP)
- Regain ownership of county roads
- Establish Road Safety Audit (RSA) program
- Address roadway design deficiencies
- Incorporate safety principles (e.g., forgiving roadside) in design practices
- Address maintenance issues for signing, vegetation, and debris
- Address curve safety issues (design and delineation)
- Address intersection safety issues (visibility and friction)

Emphasis Area 4: Safety Restraints

Goal: Increase the use of safety restraints.

Strategies:
- Change culture on restraint use
- Increase awareness of safety restraint laws
- Increase compliance with safety restraint laws
- Encourage motorcycle helmet use

Emphasis Area 5: Impaired Driving

Goal: Reduce the prevalence of impaired driving.

Strategies:
- Change culture on impaired driving
- Increase awareness of the dangers of impaired driving
- Increase compliance with impaired driving laws
- Consider collaborating with Injury Prevention Resources

Emphasis Area 6: Speeding

Goal: Reduce vehicle speeds, particularly in pedestrian and work zones, to minimize the severity of crashes.

Strategies:

- Reduce speeds in priority areas (school/work zones)
- Review existing posted speeds
- Education – raise awareness of fatality risk as speed increases
- Engineering – refer to Roadway Infrastructure (maintenance of signs)

Emphasis Area 7: Pedestrians and Bicycles

Goal: Reduce conflicts by providing and connecting designated facilities for pedestrians and bicyclists.

Strategies:

- Improve continuity and connectivity of pedestrian/bicycle network
- Raise awareness of pedestrian and bicycle safety issues
- Promote a safe and friendly walking and biking environment
- Identify pedestrian safety issues for school children

Emphasis Area 8: Young Driver Safety

Goal: Reduce the prevalence of crashes involving young drivers.

Strategies

- Increase awareness of young driver safety issues
- Increase compliance with distracted driving laws (cell phones, texting, etc)

Action Items and Responsible Stakeholders

This section presents the action items to be considered for each strategy within the eight emphasis areas.

Emphasis Area: Safety Data		
Strategy	Action Item	Stakeholder
Improve completeness, accuracy, and consistency of crash data	Continue efforts to input missing crashes into CARE database	
	Communicate data needs and uses to enforcement partners, including the reporting of GPS coordinates and behavioral factors	
	Install mile-markers to assist with referencing and locating	
	Improve electronic reporting capabilities	
Improve roadway inventory data	Implement Sign Inventory Program	
Continue efforts to integrate data through GIS	Coordinate link of roadway, traffic volume, and crash data	
	Tie-in with E-9-1-1 system	
Improve understanding of behavioral issues	Review citation/conviction data, conduct attitudinal surveys	

Emphasis Area: Emergency Services		
Strategy	Action Item	Stakeholder
Improve rural location identifier	Implement rural addressing system	
Provide emergency response gear	Budget for emergency response gear and update as necessary and coordinate with other partners to help with supplies	
Improve access for emergency vehicles during poor weather	Refer to Roadway Infrastructure (address roadway design deficiencies)	
Enhance planning for snow plow operations	Potential to utilize weather reporting system	
	Opportunity for weather band on WRIR	
Improve emergency response times	Review and modify emergency dispatch protocol (better understand underlying issues)	
	Consider adding medical facilities or dispatch stations to improve response times	
	Identify locations for emergency call boxes and security lighting	
	Establish an Incident Command System (ICS)	

Emphasis Area: Roadway Infrastructure		
Strategy	Action Item	Stakeholder
Implement Indian Reservation Roadway Safety Program (IRRSP)	Identify and Prioritize Safety Improvements	
Regain ownership of county roads	Coordinate with county	
Establish Road Safety Audit (RSA) program	Continue existing efforts and coordinate with IRRSP	
Address roadway design deficiencies	Upgrade roads to current standards	
Incorporate safety principles (e.g., forgiving roadside) in design practices	Identify and prioritize safety improvements in larger projects	
Address maintenance issues for signing, vegetation, and debris	Develop maintenance schedule for signing, vegetation, debris	
Address curve safety issues (design and delineation)	Identify opportunities for design and delineation improvements	
Address intersection safety issues (visibility and friction)	Identify opportunities for visibility and friction improvements	

Emphasis Area: Safety Restraints		
Strategy	Action Item	Stakeholder
Change culture on restraint use	Coordinate educational efforts with waves of enforcement	
Increase awareness of safety restraint laws	Continue educational campaigns on seatbelt use through multi-media and bilingual messages	
	Continue efforts to encourage proper installation and use of child seats	
	Coordinate with Environmental Health Services to get car seats for those in need	
	Discourage riding in the back of trucks	
	Look for opportunities to provide educational messages through School Resource Officer and at tribal events (e.g., Sundance Festival)	
Increase compliance with safety restraint laws	Continue enforcement efforts that couple rewards for good behavior with citations for non-compliance	
Encourage motorcycle helmet use	Look for opportunities to provide educational messages at tribal events (e.g., Sundance Festival)	

Emphasis Area: Impaired Driving

Strategy	Action Item	Stakeholder
Change culture on impaired driving	Coordinate educational efforts with waves of enforcement	
Increase awareness of the dangers of impaired driving	Create and deliver educational campaigns to raise awareness of the dangers of impaired driving	
Increase compliance with impaired driving laws	Create and deliver media campaigns to alert public of enforcement efforts	
	Determine existing resources for enforcement (people, training, equipment)	
	Continue targeted enforcement efforts (checkpoints)	
	Cross-deputize BIA enforcement officers to minimize issues related to jurisdictional boundaries (look at other tribes for examples)	
Consider collaborating with Injury Prevention Resources	Coordinate with judges and prosecutors office to ensure proper discipline for severe/repeat offenders	
	Consider roving or additional BAC testing locations	

Emphasis Area: Speeding

Strategy	Action Item	Stakeholder
Reduce speeds in priority areas (school/work zones)	Determine existing resources (people, training, equipment)	
	Increase police presence in priority areas (school/work zones)	
Review existing posted speeds	Coordinate with LTAP and BIA to develop a plan and conduct speed studies in problem areas	
	Determine if the posted speed is appropriate	
	Consider traffic calming measures in problem areas	
	Identify locations for additional speed limit signs, speed feedback signs, and automated enforcement	
Education – raise awareness of fatality risk as speed increases	Create and deliver educational campaigns to raise awareness of the dangers of speeding	
Engineering – refer to Roadway Infrastructure (maintenance of signs)	Refer to Roadway Infrastructure (maintenance of signs)	

Emphasis Area: Pedestrians and Bicycles		
Strategy	Action Item	Stakeholder
Improve continuity and connectivity of pedestrian/bicycle network	Implement Pedestrian and Walkway Long-Range Plan	
	Prioritize locations near schools and pedestrian destinations	
	Enhance pedestrian crossings at intersections and primary mid-block crossing locations	
Raise awareness of pedestrian and bicycle safety issues	Continue and enhance bike rodeos by Injury Prevention	
	Enhance pedestrian education in schools	
Promote a safe and friendly walking and biking environment	Continue and increase efforts to educate community members and implement and enforce animal laws	
Identify pedestrian safety issues for school children	Review bus stop locations, policies, and procedures to determine need for improvements	

Emphasis Area: Young Driver Safety		
Strategy	Action Item	Stakeholder
Increase awareness of young driver safety issues	Create and deliver educational campaigns to raise awareness of young driver safety issues	
	Create and deliver media campaigns to raise awareness of young driver safety issues	
Increase compliance with distracted driving laws (cell phones, texting, etc)	Create and deliver media campaigns to alert public of enforcement efforts	
	Provide targeted enforcement efforts	

Safety Management Structure

Various safety management structures were identified and considered during a safety stakeholder meeting. The strengths and limitations were discussed for each structure along with options to integrate the safety management system within the existing organizational structure.

The existing safety management efforts are operating similar to a "Function-based" structure as shown in Figure 1. The individual roles and responsibilities are clearly defined for the primary safety partners as discussed in the following section. Additionally, the SADOT has established redundancy in the roles of individuals within the agency to ensure the long-term success of the safety program in the event of staff turn-over or retirement.

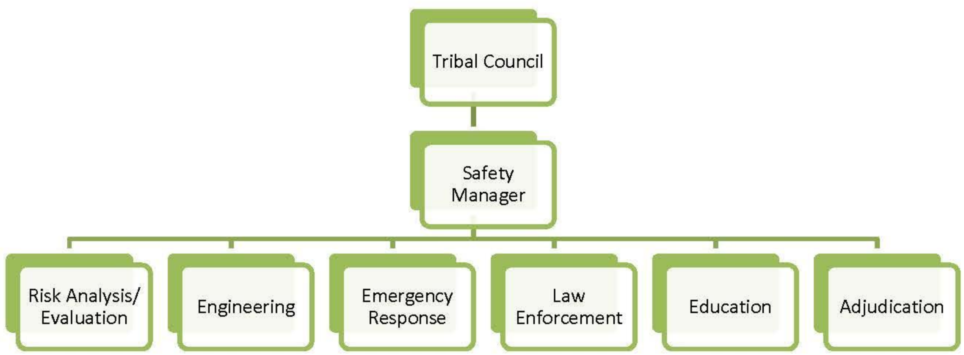

Figure 1. Sample Function-Based Safety Management Structure

Roles and Responsibilities

Safety stakeholders have been identified to support the WRIR Transportation Safety Partnership. The following list identifies the various activities to be performed under the safety management system followed by a discussion of the roles and responsibilities of stakeholders within each activity.

- Risk Analysis/Evaluation
- Traffic Engineering
- Driver Education
- Traffic Law Enforcement
- Fire/Emergency Medical Services
- Crash Data Management

Risk Analysis/Evaluation

The first step in the safety management process is to identify sites for further investigation. This will be accomplished through solicitation of input from stakeholders as well as a formal safety analysis. SADOT will obtain and provide traffic, crash, and roadway data for further analysis. The University of Wyoming (WYT^2/LTAP) will perform the data analysis and provide a summary of high risk locations. The Northern Plains TTAP, WYDOT, and BIA will provide technical assistance as necessary. Examples of technical assistance may include input on countermeasure selection and prioritization using the methods in the Highway Safety Manual. If a formal RSA program is established, this will involve a partnership between the SADOT, BIA, WRPD, and others as necessary to review specific locations, identify potential safety issues, and develop suggestions to mitigate the identified issues.

Traffic Engineering

Once the safety issues have been identified at a given location, then it is necessary to prioritize and implement the suggested strategies. SADOT will provide overall project management for the implementation of strategies and will be supported by consultants to provide engineering services. The Northern Plains TTAP, WYDOT, and BIA will provide technical assistance as necessary.

Driver Education

The University of Wyoming (WYT^2/LTAP) will conduct the crash analysis and provide recommendations for behavioral safety improvements to SADOT and BIA. SADOT and BIA will be responsible for developing the educational opportunities and reaching out to other stakeholders for support as necessary. For example, WYDOT has implemented related programs and may be able to provide examples, including:

- Roadside signing to discourage drug and substance abuse while driving.
- “Tough Guys Buckle Up” campaign to encourage seatbelt use.

Other potential partners may include Injury Prevention Resources, school superintendents, and children advisory groups. Tribal elders often command the attention and respect of the younger generation and could get involved in the process as needed, particularly for the delivery of messages. Subway has also been an effective partner in working with school age kids by providing positive reinforcement in the form of Subway gift cards.

Traffic Law Enforcement

The traffic law enforcement efforts will be led by WRPD and supported by BIA law enforcement, State Highway Patrol, and local law enforcement. WRPD is currently working with WYDOT to improve crash data through electronic reporting. They are also aggressively pursuing partnerships with other local law enforcement agencies to strengthen their enforcement efforts. The County Coroner may be a valuable partner in this effort, providing feedback on drug and alcohol use in fatal crashes. Tribal courts will be a critical partner in this area as they need to support law enforcement efforts by enforcing penalties. The state legislature could be engaged to help deal with the issue of citations for non-tribal members. The prosecutor may be able to provide a list of things to do that would help with convictions. While past efforts to solicit input from the prosecutor have been unsuccessful, it may be worth another attempt, perhaps with a letter of support from the Committee.

Fire/Emergency Medical Services

The Wind River Indiana Health Services (WRIHS) and Freemont County Fire Department provide the emergency medical services for traffic accidents on the WRIR. These emergency services recognize the need to improve response time and will be instrumental in developing this aspect of the program.

Crash Data Management

There are several stakeholders currently involved in the management of crash data for the Wind River Indian Reservation. The WRPD submits crash data directly to WYDOT and is working with WYDOT to improve the process. WYDOT ultimately manages the crash data and uploads it to the Critical Accident Reporting Environment (CARE) database. The CARE database can then be used for analysis by other stakeholders (e.g., WYT^2/LTAP) to identify safety issues and locations of concern. The WYT^2 / LTAP center will coordinate with BIA Law Enforcement and WYDOT to retrieve records that are not submitted electronically and ensure the data are collected and entered in an appropriate format for the data analysis component. The County Coroner should continue to provide feedback on roadway-related deaths to ensure that all fatal crashes are ultimately captured in the CARE database. A similar feedback loop could be established with the local hospitals to help capture injury-related crashes.