Rosebud Sioux Tribe
Road Safety Audit

MAY 2020



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ENGINEERING, REIMAGINED

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1.0 EXECUTIVE SUMMARY

During the studied five-year time interval (2014-2018), there were 1,005 crashes reported or approximately 201 crashes per year in Gregory, Mellette, Todd and Tripp Counties for the Rosebud Sioux Tribe Study Area. Wild Animal Crashes were the most common reoccurring event throughout the four-county area, accounting for 603 of the 1,005 crashes or 60.0% of all reported crashes. The second leading crash type is Angle Crashes, accounting for 96 of the 1,005 crashes or 9.6% of all reported crashes. Approximately 60.4% of the reported Angle crashes occurred in Tripp county and are heavily concentrated with in the urban limits of Winner, SD. The two other top leading crash types included Overturn Rollover Crashes accounting for 93 of the 1,005 crash or 9.3% of all reported crashes and Fixed Object Crashes accounting for 93 of the 1,005 crashes or 7.4% of all reported crashes. There were 17 fatal accidents, 149 injury accidents and 839 property damage only accidents for a total of 1,005 accidents reported, where 1,240 occupants were involved. Fatal and Incapacitating injuries account for 5.3% of the injuries that occurred within the four counties which is approximately two times higher when comparing to the state-wide percentages for South Dakota of 2.7%.

Fatal and incapacitating injury crashes stand out due to their impact on lives. Gregory and Todd County account for approximately 70.6% of the Fatal Injuries for the four counties. Of the 17 fatal injuries, ten were from result of Overturn Rollover crashes, three were Angle crashes, and two were Pedestrians and Head On crashes. Of the 48 incapacitating injuries, 17 were from the result of Overturn Rollover crashes, 15 were from Angle crashes, seven from Head On crashes, five from Fixed Objects, two were Pedestrian crashes and one Rear End and Wild Animal crash. Countermeasures that address Overturn Rollover crashes could be effective in addressing approximately 56.3% of the fatal and incapacitating injury crashes.

Tribal Law Enforcement was able to provide crash data from January 1, 2019 – March 31, 2019 within Todd County. The three months of provided data show a reported 54 crashes or 18 crashes per month. The reported 54 crashes are much higher than the 42 reported crashes in Todd County by the South Dakota Department of Transportation (SDDOT) database over a five-year period showing how under reported crashes are from the Tribal Law Enforcement. Extrapolating the average monthly reported crashes by Tribal Law Enforcement, Todd County could have seen a potential 216 crashes for the current year. The data provided is very vague and does not provide complete information about the crash. Adequate crash information plays a crucial role for the Tribe as this information can be used to assist in applying and securing TTPSF funds for safety improvements on roadways throughout the Reservation.

The roads included in this RSA were Bureau of Indian Affairs (BIA) routes listed below:

- BIA 1
- BIA 4
- BIA 5
- BIA 7
- BIA 9
- BIA 12
- BIA 30
- BIA 37
- BIA 501

Safety issues along the studied corridors were assigned specific countermeasures to address each issue location based on the available crash data. Recommended countermeasures includes the following:

- Add Shoulders and Flatten Side Slopes
- Install Guardrail
- Remove Guardrail
- Maintain Vegetation Control Along Roadside
- Install Centerline and Shoulder Rumble Strips
- Install Chevron Alignment Signs
- Improve Roadway and Ditch Drainage
- Improve Culverts
- Improve Roadway Surface
- Improve Intersection Sight Distance

- Install Delineators
- Install Pedestrian Refuge Island
- Flatten Inslopes
- Install Retroreflective Pavement Marking
- Install Retroreflective Signs
- Install Horizontal Alignment Signs
- Install Advisory Speed Plaque with Horizontal Alignment Signs
- Remove/Relocate Fixed Objects outside Clear Zone
- Improve Bridge Ends
- Install Separated Shared Use Pathway
- Install Sidewalks
- Install Signed, Marked Cross walks
- Install Pedestrian Rectangle Rapid Flashing Beacon
- Install Transverse Rumble Strips on Stop Controlled Approaches

Safety issues prevalent along the rural and urban roadways include poor road surfaces, poor road cross section, fixed objects and wild animals, and sign and pavement marking issues. Discretion was used in deciding whether a safety issue should be addressed with countermeasures. Although this Road Safety Audit is only limited to nine routes throughout the Study Area, these countermeasures can be used on other routes that the Tribe maybe experiencing similar issues.

The SDDOT will be replacing all the roadway signs in Todd County on paved routes including BIA Route's in 2020. The SDDOT plans to upgrade all signing on gravel roadways in Todd County in 2022. These signs will be upgraded to meet current design standards. In addition to upgrading the signs, the SDDOT is planning intersection improvements for the intersection of BIA 7 and BIA 1. SDDOT is a great source with providing safety improvements as they have plans to install rumble strips for the Tribe as a safety project within the next year or two on the western section of BIA 7 between the US Highway 18 and just west of Rosebud. The Tribe should consider working with SDDOT to help identify any potential safety projects and any safety funding.

The Rosebud Sioux Tribe Road Maintenance Department has done a great job with vegetation control overall on most of the BIA routes. This practice should be carried forward along on all other routes that are in need of vegetation control.

One area that improvements are recommended is on BIA Route 1. The route provides a concrete pavement travel way with a wide gravel shoulder. In some areas the gravel shoulder was approximately four to six inches in difference creating a drop off between the travel roadway and the shoulder north of Rosebud. The drop off can potentially create a hazard for vehicles that may depart the roadway or pulling over for an emergency situation. It is recommended that the MAP-21 Program consider using a more rigid material for the shoulder such as asphalt pavement or concrete pavement to potentially eliminate the grade separation between the road travel way and the shoulder. Using the more rigid material would allow the Tribe to install shoulder rumble strips, this which could decrease the number of road departure crashes by alerting motorist through vibration and noise that alert the motorist they are leaving the travel way.

There is intersection sight distances issues at the intersection of BIA 1 and BIA 9 due the shared-use path and its separation from BIA 1. The path crosses the approach at a large offset, causing vehicles having to stop approximately 15-20 feet back from the intersection to allow pedestrians to cross. This causes vehicles having to creep forward and wait within the crosswalk in order to see if there is any oncoming traffic. It is recommended that realignment of the pathway be considered by bringing the pathway closer to the intersection. This will allow vehicles to stop closer to the intersection. Along with moving the pathway closer to the intersection, it is recommended that a raised median with a pedestrian refuge island be installed to create a physical barrier at the intersection. This would allow a free right turn from BIA 9 onto BIA 1 where traffic would only need to yield to pedestrians and prevent vehicles using the terminating right turn lane

on BIA 1 continuing through the intersection. **Figure 1.1** shows the recommended improvements to the intersection of BIA 1 and BIA 9.

Figure 1.1: BIA 1 and BIA 9 Recommended Safety Improvements



Along with the inventory of the BIA routes, the following communities were analyzed for pedestrian safety issues and pedestrian connectivity throughout the community.

- Antelope
- Corn Creek
- Horse Creek
- Ideal
- Milks Camp
- Norris
- Okreek
- Parmelle
- Sicangu Village
- White Horse
- White River
- Winner
- Wood
- Saint Francis

Throughout the inventory of the communities, it appeared that there was no standard for when to provide sidewalks within the community or the surfacing section for the roadway to use. These standards are usually adopted with a LRTP and is beyond the scope of this RSA. It is recommended that the Rosebud Sioux Tribe update their current LRTP and have it adopted by the tribal council. The LRTP should consider pedestrian connectivity to/from schools and tribal community centers.

Along with sidewalk connectivity, shared use paths were considered between certain communities where high pedestrian traffic has been observed by tribal members. Like sidewalk standards, shared-use pathway locations are typically defined in the LRTP and it is recommended locations for shared-use pathways be considered when updating the LRTP.

For specific recommendations for improvements by route, refer to the rest of the report.

2.0 INTRODUCTION

The Rosebud Indian Reservation encompasses nearly one million acres in south central South Dakota and is home to the Sicangu Oyate Nation. The Reservation was established in 1889 and includes all of Todd County, South Dakota. The Tribe also has communities and extensive lands and population in Lyman, Mellette, Gregory and Tripp Counties. Mellette County in particular has large Tribal Trust Lands and a significant portion of the nearly 32,505 enrolled members live there.

Figure 2.1: Rosebud Indian Reservation Location[1]



The Oyate capital is the town of Rosebud, established when the Spotted Tail Indian Agency was moved from northwestern Nebraska to the banks of Rosebud Creek near its confluence with the Little White River. The largest town on the Reservation is Mission, located at the intersections of US Highways 18 and 83. Mission's nearby neighbor of Antelope is one of the many tribal communities established in the late 1870's and has been growing ever since. Another major town on the Reservation is Saint Francis, located southwest of Rosebud and home of the Saint Francis Indian School. Saint Francis, with a current population of about 2,000, is the largest incorporated town in South Dakota without a state highway for access. While much of the traffic volume is from agriculture operations, there is a considerable amount of tourist and truck traffic that cross the Reservation each year, with the Black Hills to the west and two US highways traversing the Reservation. With approximately 3,500 miles of Indian Reservation roads, the safety of the tribal transportation system is an important factor for these visitors and residents.

Past planning efforts undertaken by the Rosebud Sioux Tribe have typically addressed transportation safety concerns on a case by case basis. In August 2014, a Tribal Transportation Safety Management Plan was implemented to address transportation safety with engineering, enforcement, education and emergency disaster services. The safety plan identified existing programs on the Reservation and identified additional strategies that needed to be implemented to address safety issues.

The Rosebud Sioux Tribe's Long-Range Transportation Plan (LRTP) was last updated in 2007. This document assists the Tribe in responding to existing and anticipated future transportation issues. Federal regulations allow for this document be updated every five years. It is recommended that the Tribe update their LRTP and the plan should undertake efforts to develop a master plan for transportation infrastructure with a purpose of:

- Collect and examine information on current and future transportation improvement needs

[1] https://sdtribalrelations.sd.gov/images/rst.jpg

- Consider the needs of all modes of travel and develop strategies and recommend projects to accommodate them
- Develop a strategy to maintain the transportation system
- Provide a basis for future transportation improvement programming this sustainable and is tied to project cost and potential funding

The Rosebud Sioux Tribe MAP-21 Program determined an inventory of safety-related transportation conditions was merited and applied for and received TTPSF Funding in 2018. Further a detailed description of corridor level safety concerns and potential opportunities to improve safety would enable the Rosebud Sioux Tribe to use a systemic approach to better prioritize future safety improvement projects. As a result, this Road Safety Audit (RSA) was undertaken.

Plan Purpose

According to the Federal Highway Administrations' website, *a Road Safety Audit (RSA) is the formal safety performance examination of an existing or future road or intersection by an independent, multidisciplinary team. It qualitatively estimates and reports on potential road safety issues and identifies opportunities for improvements in safety for all road users*[2].

The purpose of this RSA is to inventory and assess the safety attributes of roads and intersections within the Rosebud Sioux Tribe Study Area. Specific, low cost policies and countermeasure improvements are to be recommended to address identified safety deficiencies.

A systemic approach was used for analysis on roadways throughout the Rosebud Indian Reservation. *A systemic approach to safety involves widely implemented improvements based on high-risk roadway features correlated with specific severe crash types. The approach helps agencies broaden their traffic safety efforts at little extra cost,* according to the Federal Highway Administration[3].

Further analysis and design detail will be required as projects proceed to fruition.

Study Area

The Rosebud Sioux Tribe is located in south central South Dakota and includes the communities of Antelope, Corn Creek, Ghost Hawk, He Dog, Horse Creek, Ideal, Mission, Norris, Ok Reek, Parmelee, Rosebud, Spring Creek, St. Francis, White Horse, White River, Winner and Wood. The Study Area is primarily located in Todd County within the Rosebud Indian Reservation boundary and extends into the counties of Gregory, Mellette, and Tripp where there are Tribal communities.

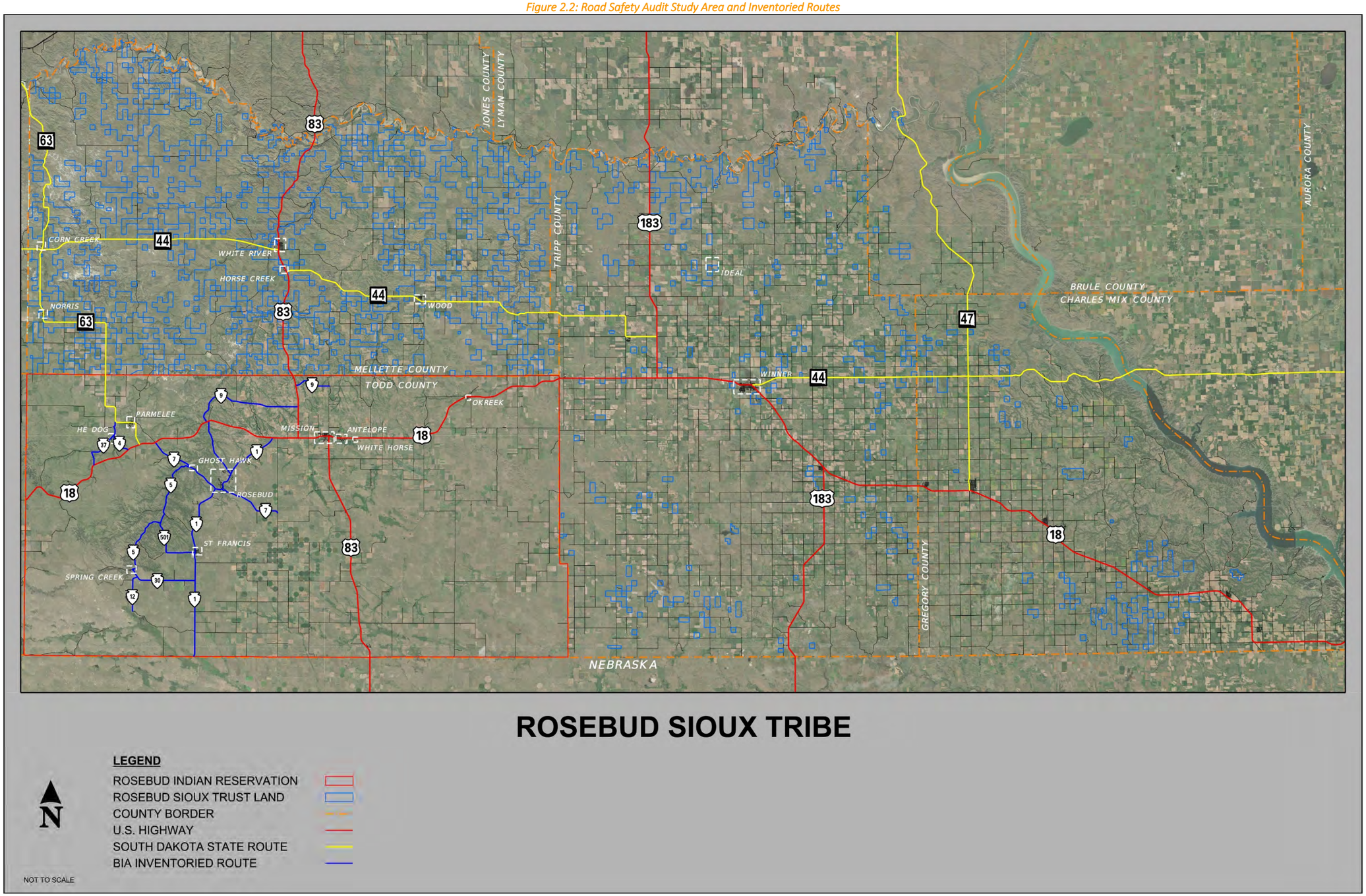
The roads included in this report included the following BIA routes:

- BIA 1
- BIA 4
- BIA 5
- BIA 7
- BIA 9
- BIA 12
- BIA 30
- BIA 37
- BIA 501

Approximately 100-miles of roadway was inventoried where approximately 65% of the road surface is paved asphalt, 9% of the road surface is paved concrete and the remaining 27% of road surface is gravel/dirt. **Figure 2.2** shows the study area and inventoried routes.

[2] https://safety.fhwa.dot.gov/rsa/
[3] https://safety.fhwa.dot.gov/systemic/

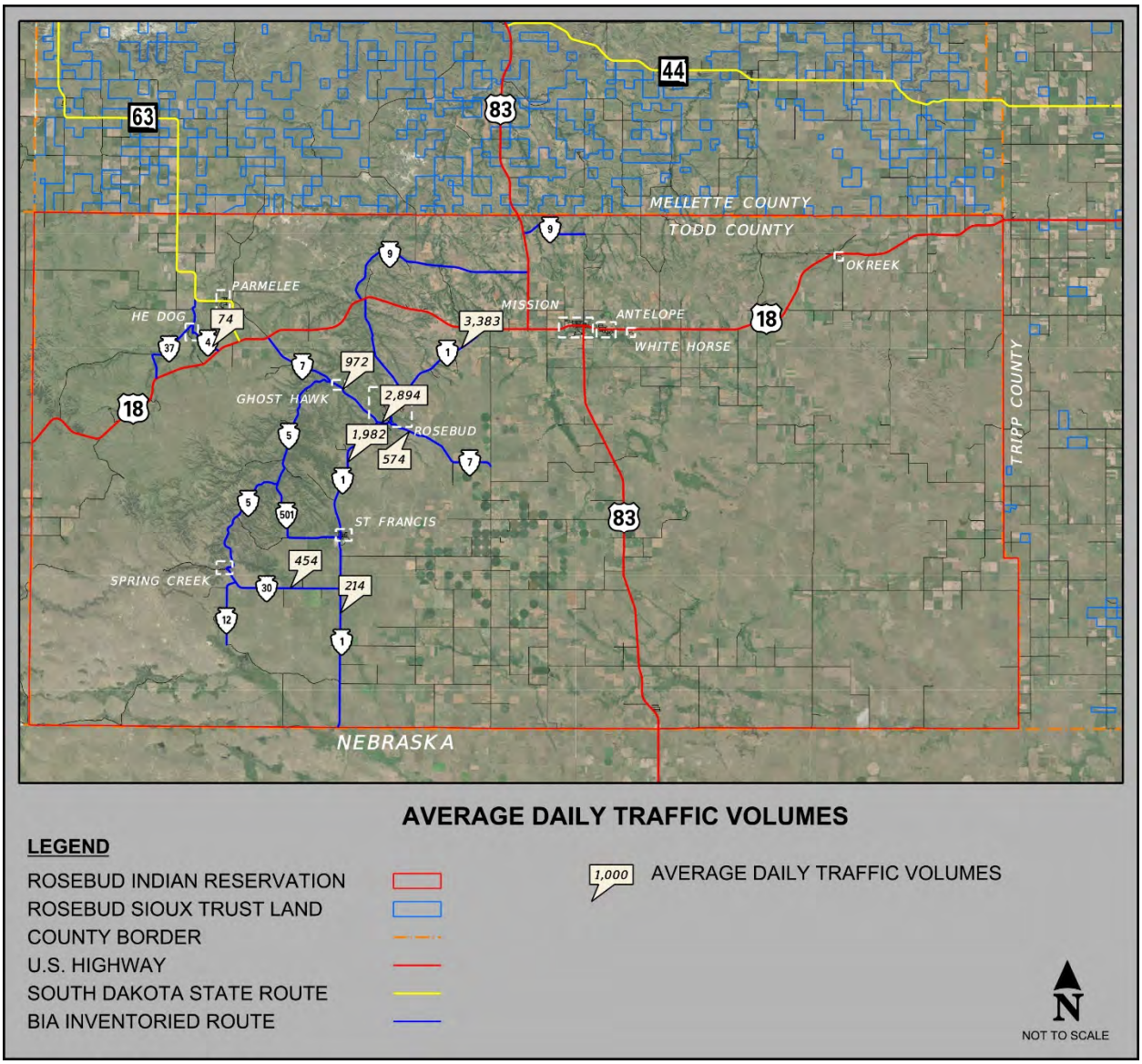
Figure 2.2: Road Safety Audit Study Area and Inventoried Routes



ROSEBUD SIOUX TRIBE

Roads that were addressed by this RSA are rural in nature and carry low traffic volumes (less than or equal to 500 Average Daily Traffic (ADT) with exception to BIA 1 carrying close to 2,000 - 3,400 ADT near Rosebud, SD. **Figure 2.3** shows ADT traffic volumes that was obtained from the South Dakota Department of Transportation (SDDOT) GIS website[4].

Figure 2.3 Average Daily Traffic Volumes on Inventoried BIA Routes



Along with the inventory of the BIA routes, the following communities were analyzed for pedestrian safety issues and pedestrian connectivity throughout the community.

- Antelope
- Corn Creek
- Horse Creek
- Ideal
- Milks Camp
- Norris
- Okreek
- Parmelle
- Sicangu Village
- White Horse
- White River
- Winner
- Wood
- Saint Francis

[4] http://sdbit.maps.arcgis.com/apps/webappviewer/index.html?id=93bd565a70a94f138f90ceed29ce1b12

3.0 EXISTING CONDITIONS

The existing conditions inventory was initiated and completed in September 2019. It included a field inventory of sign and roadway elements covering the 9 inventoried RSA routes within the Study Area that serves the tribal community. It also included a review and analysis of historical crash data over a five-year period from January 1, 2014 to December 31, 2018 throughout Gregory, Mellette, Todd, and Tripp Counties with a focus of the 9 studied routes. The SDDOT will be replacing all the signs in Todd County on paved routes including BIA Route's in 2020. The SDDOT plans to upgrade all signing on gravel roadways in Todd County in 2022. These signs will be upgraded to meet current design standards.

Sign and Roadside Elements Field Inventory

The sign and roadside elements were field inventoried for analysis. The purpose of conducting this inventory was so that a systematic review and correction of substandard conditions could be addressed by tribal representatives in the future.

BIA 1

BIA 1 is approximately 24.9-mile paved north/south rural major collector roadway. It begins at the junction of U.S. Highway 18 and heads south passing through the towns of Rosebud and St. Francis where it then terminates approximately 10-miles south of St. Francis at the South Dakota/Nebraska state line.

BIA 1 Northern Section

The northern section of BIA 1 begins at the intersection of U.S. Highway 18 that heads south for approximately 5.2-miles intersecting few local roads before terminating near the beginning of the urban section of BIA 1 in Rosebud north of the intersection of BIA 1 and BIA 9 near Marshmallow Street. The northern section of BIA 1 has a concrete pavement top width of 24-feet with gravel shoulders. The posted speed is 65 mph and this section carries the largest amount of traffic of approximately 3,400 ADT. Pavement marking are heavily worn with low visibility and there is no roadside delineation. The gravel shoulder has settled creating a large grade difference between the edge of the concrete roadway and the gravel shoulder. The slopes are relatively 4:1 or flatter and had no fixed objects within the clear zone.

Figure 3.1: Northern Section of BIA 1 Looking North



BIA 1 Urban Section

The urban section of BIA 1 begins near Marshmallow Street then heads south for approximately 2.9-miles intersecting many local roads including BIA 9 and BIA 7, where the urban section ends near First Street at the western edge of Rosebud. The speed limit varies from 20 mph within school zones, 45 mph in the northern part of the urban section, and 15 mph from the Tribal Council Headquarters to the western edge of Rosebud. The roadway transitions from a 24-foot wide asphalt or concrete pavement section with two travel lanes in the southern section to a five-lane concrete roadway with four travel lanes and a two-way left turn lane (TWLTL) 60-foot concrete pavement section in the northern section.

Along the northern section there is a shared-used path with pedestrian lights along the westside of BIA 1. There is intersection sight distances issues at the intersection of BIA 1 and BIA 9 due the shared-use path and its separation from BIA 1. The path crosses the approach at a large offset, causing vehicles having to stop approximately 15-20 feet back from the intersection to allow pedestrians to cross. This causes vehicles having to creep forward and wait within the crosswalk in order to see if there is any oncoming traffic. Figure 3.2 shows an example of this large offset at the intersection of BIA 1 and BIA 9.

Figure 3.2: Intersection of BIA 1 and BIA 9 Looking North



The intersection of BIA 1 and BIA 9 is fairly unique in the aspect that BIA 1 has a southbound right turn lane terminates at the intersection. However, the south leg of the intersection on BIA 1 has four lanes of travel and the outside southbound lane is only stripped as a median for vehicles not to use for approximately 275-feet where it opens for vehicles to use the travel lane. Community members have shared that some vehicles using the right turn lane have treated it as a through lane going through the intersection. This creates a conflict for vehicles wanting to turn right from BIA 9 onto BIA 1 and could potentially increase angle crashes at the intersection.

The 60-foot section continues to Long Street were BIA 1 then transitions back down to 48-foot concrete pavement section with four travel lanes. The 48-foot section continues to Wasta Drive where the roadway then transitions to a varying 24 to 36-foot concrete or asphalt pavement section to the western edge of Rosebud.

At the Tribal Headquarters, BIA 1 turns at greater than 90-degree angle and intersects Circle Dr. At this intersection, BIA 1 is a through street with traffic stopping on Circle Dr. Even though the speed limit in this section is 15 mph, tribal members have expressed concern there have been several crashes entering the residence lot adjacent to the intersection, prompting the BIA to install a guardrail in front of the residence. The existing guardrail does not have terminal safety ends.

Figure 3.3: Intersection of BIA 1 and Circle Drive



The intersection of BIA 1 and BIA 7 in Rosebud is a dangerous intersection and currently signed as such. The adjacent gas station has an unrestricted access onto BIA 1 for approximately 175 feet. BIA 7 intersects BIA 1 at a skew and opposite to this intersection is a parking area which backs into BIA 1. Additionally, BIA 7 is not offset the existing Main St intersection and combined with the nearby gas station, opposite streets, and parking, there is approximately 265 feet of unrestricted traffic entering BIA 1. Finally, there is a high volume of pedestrians which cross BIA 1 between the Tribal offices and gas station.

Figure 3.4: Intersection of BIA 1 and BIA 7



BIA 1 Southern Section

The southern section of BIA 1 begins at the western edge of Rosebud and travels approximately 0.6-miles west of Rosebud to the intersection of BIA 1 and BIA 7. Tribal members have expressed concern of this intersection as many vehicles have passed through the stop sign on BIA 1 and have departed the roadway on the northside resulting in some serious injuries and fatal crashes. SDDOT has implemented a safety project for this intersection and is discussed later in the report under the recommendation section.

Figure 3.5: Intersection of BIA 1 and BIA 7 Looking North



The roadway is asphalt pavement with a pavement top width of 40-feet including shoulders and shoulder rumble strips between the intersection of BIA 1 and BIA 7 and the community of St. Francis, intersecting many local roads including BIA 501 and terminating at the intersection of BIA 1 and BIA 30. The roadway then transitions to a 24-foot section with no shoulders and heads south where it terminates at the South Dakota/Nebraska State line approximately 10-miles south of St. Francis.

The shoulders and rumble strips were installed in 2018 by SDDOT for the 40-foot section. Overall the southern section the pavement markings are heavily worn with low visibility and there is no roadside delineation. The pavement for BIA 1 from the intersection of BIA 1 and BIA 7 to the intersection of BIA 1 and BIA 30 is heavily cracked with transverse and longitudinal cracking. The pavement section going south of the intersection of BIA 1 and BIA 30 is showing signs of distress with potholes, pavement heaving, cracking and rutting to name a few. This is creating a road surface that is undesirable to drive on and could lead to loss of vehicle control when traveling at high speeds. The posted speed limit for the southern section is 55 mph with exception within the town of St. Francis the speed limit drops to 25 mph. The slopes are relatively 4:1 or flatter and has fixed objects within the clear zone including culverts not having flared or sloped end sections, trees, and vegetation.

Figure 3.6: Southern Section of BIA 1 Looking South



BIA 4

BIA 4 is a north/south route that is approximately 4.4-miles long with a 24-foot asphalt pavement roadway width with no shoulders. The route begins at the intersection of South Dakota State Route 63 and BIA 4 just west of the community of Parmelle. The route heads south then west for approximately 0.5-miles before meeting with 282nd Street at a T-Intersection. Stop control should be considered for 282nd Street versus the yield control on the south leg of BIA 4, the predominant traffic movement use both the south and east leg of BIA 4 to travel to the school in He Dog. This section of BIA 4 is functionally classified as a rural minor collector.

The route then continues south for approximately 1.5-miles to the community of He Dog where the pavement section of BIA 4 ends at the school then turns a low maintenance gravel roadway for the last 2.4-mile where BIA 4 terminates at the intersection of U.S. Highway 18 and BIA 4. The roadway between 282nd Street and the school in He Dog is functionally classified as rural major collector. The only posted speed limit for the route is near the school where it is posted 20 mph. Pavement markings for the asphalt pavement section are heavily worn and have low visibility. There is limited roadside delineation along the roadway. There is one bridge on BIA 4 that is approximately 0.5-miles south of 282nd Street. The bridge does have bridge end treatments on all four sides of the bridge. However, portions of the guardrail have been detached from their supports. The slopes throughout the entire route are relatively 4:1 or flatter with majority of the clear zone having no obstacles within it. Closer towards He Dog there is a large tree and some wood bollards with metal cable within the clear zone.

Figure 3.7: Existing Bridge on BIA 4



BIA 5

BIA 5 is a 13.7-mile asphalt paved north/south rural local road that follows along the Little White River. The route has a pavement top width of 24-feet and no shoulders. It begins at the intersection of BIA 5 and BIA 7 west of the community of Ghost Hawk then heads south intersecting local roads including BIA 501, where it jogs west for approximately 1 mile then heads south again for approximately 5.4-miles where it terminates at the intersection of BIA 5 and BIA 30 within the community of Spring Creek.

BIA 5 is locally signed as a scenic byway. The route has a posted speed limit of 55 mph which reduces to 25 mph near the community of Spring Creek. There are no advance warning signs warning vehicles of the speed reduction or posted speed limit sign notifying vehicle of the increase in speed. The pavement markings are heavily worn and have low visibility. There is no delineation along the roadside. Trees and vegetation are overgrown in many locations throughout the route and cover many of the roadway signs. This creates a hazard as roadway signs are intended to communicate with roadway users for potential conflicts ahead such as intersection ahead signs or horizontal curve ahead signs. The asphalt pavement is showing signs of aging with many transverse and longitudinal cracking throughout the route. Many of the horizontal curve have no advance warning signs or proper signing going through the curve.

BIA 5 has four bridges that cross over the Little White River. One of the bridges has recently been replaced and include bridge end treatments on all four sides of the bridge. The remaining three bridges on BIA 5 have no bridge end treatments. Intersection sight distance issues were also observed along the route at two different locations where a secondary road intersect BIA 5 at a large skew. These two intersections are BIA 5 and BIA 501, and BIA 5 and Tutle Road.

Figure 3.8: Intersection of BIA 5 and Tutle Road



BIA 7

BIA 7 is a rural major collector 13.6-mile northwest/southeast route with the western section having an average top width of 36-feet and eastern section having a top width of 24-feet. The route begins at the intersection of U.S. Highway 18 and heads southeast intersecting local roads including BIA 5 and ending at BIA 1 approximately 0.6-miles west of Rosebud. The route then begins again in the town of Rosebud at the intersection of BIA 1 and BIA 7 and continues southeast over Rosebud Dam and ends 6-miles east of Rosebud at the intersection of Lakeview Road. The roadway has a very wide section throughout the western section of the route with good shoulder width and the slopes are relatively 4:1 or flatter. The eastern 6-mile section is narrow, without shoulders, steep side slopes, and sharp curves. There are currently no shoulder rumble strips for the entire route but the SDDOT plans to install them for the Tribe as a safety project within the next year or two on the western section. The eastern section is planned for reconstruction and needs rumble strips following the reconstructed section.

There is no delineation along the roadway and the pavement markings are worn and have low visibility. The asphalt surface is showing signs of aging with many transverse and longitudinal cracking. There is one bridge on the route that is approximately 350-feet west of the intersection of BIA 7 and BIA 5. The bridge utilizes bridge end treatments only for the direction of travel side and none for the opposing traffic.

Near Ghost Hawk Lake on BIA 7, outdated cable guardrail is installed on both sides of the roadway. The slopes where the guardrail is installed are relatively flat and there is adequate clear zone space between the roadway and the lake on the south. The use of guardrail in this area becomes more of safety hazard versus more of a safety benefit.

Figure 3.9: Cable Guardrail on BIA 7



The intersection of BIA 7 and BIA 1 in Rosebud is a dangerous intersection as described previously with BIA 1. The alignment of BIA 7 should be realigned to intersect BIA 1 directly across from Main St at a 90-degree angle, however reconstructing the intersection may negatively impact the gas station's access and need for fuel truck movement. Another option for BIA 7 to intersect BIA 1 is at the existing Circle Dr intersection.

Pedestrians walk along BIA 7 to the Rosebud Dam, across the Dam, and some run on the roadway to the top of hill approximately 1 mile for exercise. Pedestrians are forced to use the road top since there are no available shoulders or adjacent sidewalk.

Figure 3.10: Eastern Section of BIA 7 Looking West



BIA 9

BIA 9 is a 20.6-mile-long roadway. The roadway is paved for approximately 5.8-miles with an average top width of 36-feet. The remaining 14.8-miles of roadway is gravel with an average top width of 20-feet.

BIA 9 Paved Section

The paved section of BIA 9 is functionally classified as a rural local road and begins in Rosebud at the intersection BIA 1 and BIA 9. The roadway then heads north/northwest for approximately 5.8-miles where it terminates at the intersection of BIA 9 and U.S. Highway 18. The posted speed limit on this section of the route is 55 mph and has a one mile separated shared-use pathway with pedestrian lighting that begins approximately 1.5-miles south of the intersection of BIA 9 and U.S. Highway 18 that heads north connecting pedestrians to the various tribal housing communities in the area.

There is no delineation along the roadway and the pavement markings are worn with low visibility. There are currently no shoulder rumble strips throughout this section and the current shoulders are adequate to accommodate them. The slopes of the roadway are relatively 4:1 or flatter and no objects within the clear zone of the roadway.

BIA 9 Gravel Section

The gravel section of BIA is functionally classified as rural major collector and begins approximately 1,200 feet west of where the pavement section ends on U.S. Highway 18. The route then heads north/northeast for approximately 3.3-miles before jogging east for 8-miles ending at the intersection of BIA 9 and U.S. Highway 83. BIA 9 then begins again from U.S. Highway 83 approximately two miles north, where it heads east for an additional 3.5-miles terminating at the intersection of BIA 9/278th Street and 274th Avenue.

BIA 9 has one bridge on the route that crosses over Dry Creek approximately three miles north/northeast of where the gravel section begins. The guardrail on the bridge is lower the standard practice and there are no bridge end treatments.

The gravel in this section is in exceptional condition and the slopes a relatively 4:1 or flatter. The Rosebud Sioux Tribe Road Maintenance Departmenthas done a tremendous job with vegetation control along this section of roadway and no objects were seen within the clear zone of the roadway.

Figure 3.11: Gravel Section of BIA 9 Looking West



BIA 12

BIA 12 is approximately a 3.6-mile gravel rural local road with a roadway width of 22-feet. The route begins at the intersection of BIA 30 and BIA 12 then heads southwest for 0.4-miles before heading south for 3.2 mile and terminates at the intersection of BIA 12 and Two Eagle Road. The posted speed limit on BIA 12 is 35 mph.

Figure 3.12: BIA 12 Looking Southwest



The gravel is washboard and rutting, curves are not properly signed with advance warnings and/or chevrons and there is no delineation along the roadway. The slopes are relatively 4:1 or flatter. Water is pooling on the roadway as there are sections of the roadway the are lower than the roadside ditches.

BIA 30

BIA 30 is approximately 9.3-mile asphalt paved rural major collector roadway with a width of 24-feet and no shoulders. It begins in the community of Spring Creek approximately 2.7-miles west of the intersection of BIA 30 and BIA 5. Then heads through a series of curve before heading east for five miles where it terminates at the intersection of BIA 30 and BIA 1. The posted speed limit is 25 mph within the community of Spring Creek then increases to 65 mph. Going into Spring Creek from the east there is no advance warning signs for vehicles notify them of the change in speed from 65 mph to 25 mph.

Pavement markings are worn and have low visibility and the there are no delineation along the roadside. The slopes of the roadway are relatively 4:1 or flatter but there are sections of the roadway where vegetation has overgrown, and some trees are covering roadway signs. This creates a hazard as roadway signs are intended to communicate with roadway users for potential conflicts ahead such as intersection ahead signs or horizontal curve ahead signs.

Figure 3.13: Overgrown Trees on BIA 30



Within the community of Spring Creek there is no school zone signing near the school off Yellow Cloud Road. Along with the no school zone signing there is no designated area for school aged children to easily walk to and from school to the tribal housing areas. This creates hazards as children may then walk on the road to get to their destinations.

BIA 37

BIA 37 is approximately 4.2-mile gravel rural local roadway. The route begins at the intersection of BIA 37 and BIA 4 and head southwest for approximately 2.9-miles. This section of BIA 37 has a roadway top width of 24-feet with no shoulders. The route then heads south at the intersection of BIA 37 and He Dog Road for approximately 1.3-miles where it then terminates at the intersection of BIA 37 and U.S. Highway 18. The north/south section of the roadway has a roadway top width of 20-feet with no shoulders.

BIA 37 has a posted speed limit of 35 mph. There are many soft spots throughout BIA 37 where the gravel has not been maintained and only dirt is present on the roadway. There is heavy rutting in some locations and berms have formed along the edges of the roadway due to erosion creating the roadway slopes and ditches to be a higher grade compared to the top of the roadway surface. This can create pools of water on the roadway as water can not properly drain off the road. There is no delineation along the roadway and the slopes are relatively 4:1 or flatter and had no fixed objects within the clear zone.

Figure 3.14: Heavy Rutting on BIA 37



BIA 501

BIA 501 is approximately 5.9-mile asphalt paved local roadway with a width of 24-feet and no shoulders. The route begins at the intersection of BIA 5 and BIA 501 the heads south for approximately three miles. BIA 501 then heads east for approximately 2.9-miles where it terminates at the intersection of West Street and BIA 501/Maple Avenue within the town of St. Francis.

BIA 501 has a posted speed limit of 55 mph then transitions to 35 mph as the route enters St. Francis. There are no advance warning signs alerting vehicles of the speed reduction. Pavement markings are worn and have low visibility. The pavement surface is showing signs of aging with many transverse and longitudinal cracking along with many areas have large asphalt patches. There is no delineation along the roadway and there are areas where slopes exceed the recommended 4:1 slope. There are no advance warning signs for horizontal cures or chevrons within the curves. There are many areas along BIA 501 that have trees within the clear zone and pooing of water along the roadside.

Figure 3.15: BIA 501 Looking South



Tribal Communities

Along with the inventory of the BIA routes, the following communities were analyzed for pedestrian safety issues and pedestrian connectivity throughout the community.

- Antelope
- Corn Creek
- Horse Creek
- Ideal
- Milks Camp
- Norris
- Okreek
- Parmelle
- Sicangu Village
- White Horse
- White River
- Winner
- Wood
- Saint Francis

Throughout the inventory of the communities, it appeared that there was no standard for when to provide sidewalks within the community or the surfacing section for the roadway to use. These standards are usually adopted with a LRTP and is beyond the scope of this RSA. It is recommended that the Rosebud Sioux Tribe update their current LRTP and have it adopted by the tribal council. The LRTP should consider pedestrian connectivity to/from schools and tribal community centers.

Along with sidewalk connectivity, shared use paths were considered between certain communities where high pedestrian traffic has been observed by tribal members. One area for consideration was between the South Antelope Community and White Horse Community. Like sidewalk standards, shared-use pathway locations are typically defined in the LRTP and it is recommended locations for shared-use pathways be considered when updating their LRTP.

4.0 HISTORICAL CRASH DATA

Historical crash data contained in the South Dakota Office of Highway Safety and South Dakota Department of Public Safety (SDDPS) Crash Database, occurring on the Rosebud Indian Reservation on all public roads was obtained through their website for the five-year time interval covering January 1, 2014 through December 31, 2018[5]. The crash data that was collected were crashing occurring in Gregory, Mellette, Todd and Tripp County. Crash data from Lyman County was excluded from this analysis as majority of the crashes reported occurred on Interstate 90. Crash data is submitted to SDDPS Crash Database by law enforcement using the South Dakota Accident Records System (SDARS) or Traffic and Criminal Software (TraCS). Limited historical crash data was provided by Tribal Law Enforcement for the first three months of 2019. Crashes this agency respond to do not get reported to the SDDPS. Although it is a start for the Tribal Law Enforcement to share crash data with the Rosebud Sioux Tribe MAP-21 Program, the information is very limited and does not show a complete picture of the number of collisions and types of collisions that maybe occurring within the Reservation. Obtaining information from Tribal Law Enforcement can be a lengthy process due to the Freedom of Information Act (FOIA), as tribal members must submit a request to release the information. Once a request is submitted the information released to the applicant can take years with redacted information. Thus, resulting in a long process to obtain the information. The crash data that was available from Tribal Law Enforcement is discussed later in the report under its own section.

With crash data only being limited to what was reported to the SDDPS Crash Database, the data only shows a small portion of crashes that occur throughout the Rosebud Indian Reservation. The 1,005 crashes that were reported could be higher if more crash information was available through Tribal Law Enforcement. As current crash data shows crashes are primarily occurring on State and U.S. routes. A systemic approach was used for analysis on roadways throughout the Rosebud Indian Reservation where crashes were not reported.

The 2014 Tribal Transportation Safety Plan provided an in-depth analysis of available crash data and trends from 2005 through 2012. The Safety Plan provides strategies and recommendations to improve education, enforcement/EMS, engineering and safety planning/other provisions to address safety needs within the Reservation. Please refer to that document for additional recommendations to improve safety on the Rosebud Indian Reservation.

Location of Crash

During the studied five-year time interval, there was a reported 1,005 or approximately 201 crashes per year within the four-counties that Rosebud Sioux Tribe resides in. This is slightly higher than what was reported from the 2014 Safety Plan, where there were 1,537 crashes or 153.7 crashes per year over the 10-year time interval. Of the reported 1,005 crashes reported within the four-county area from 2014-2018, 680 crashes occurred on U.S. or State system roadways, only 5 crashes reported occurred on BIA routes and 320 crashes occurred on county and local roads. Table 4.1 shows crashes on roadway classification.

[5] http://safesd.gov/raw-data.html

Roadway Functional Classification	Number of Crashes					Percentage
	Gregory County	Mellette County	Todd County	Tripp County	Total	
Rural Principal Other Arterial	43	32	25	166	266	26.5%
Rural Local Road	33	11	1	135	180	17.9%
Rural Major Collector	25	9	5	162	201	20.0%
Rural Minor Arterial	31	26	0	178	235	23.4%
Rural Minor Collector	2	1	1	31	35	3.5%
Rural Other Expressways	12	13	10	53	88	8.8%
Rural Principal Other Arterial	43	32	25	166	266	26.5%
Total	**146**	**92**	**42**	**725**	**1005**	**100.0%**

Table 4.1: Roadway Functional Classification (2014-2018)

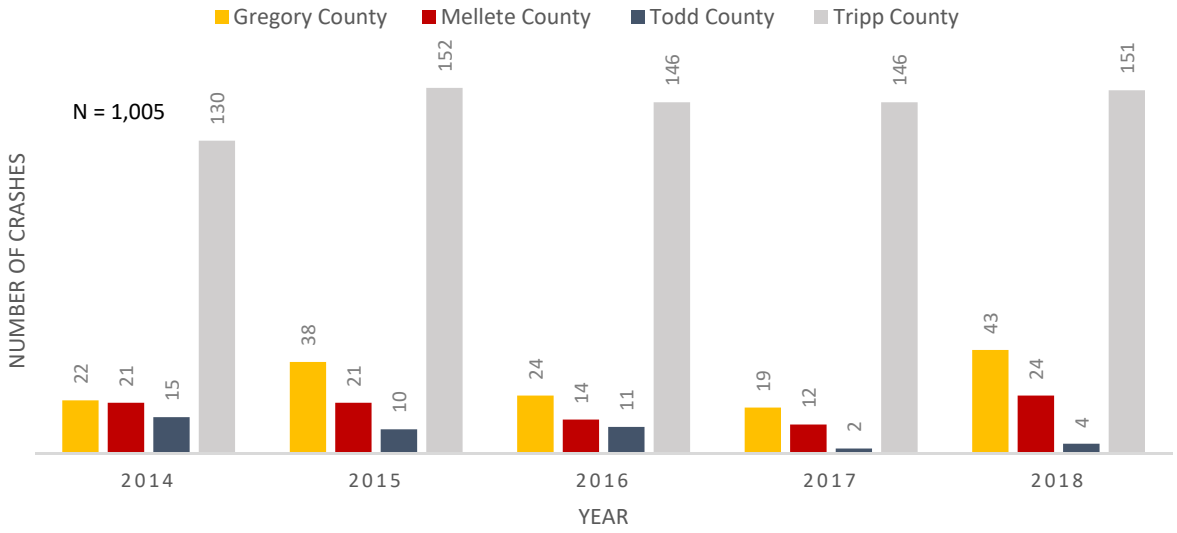
Of the 1,005 crashes reported, 839 crashes occurred as non-junction related. Table 4.2 shows crashes and relations to junctions throughout the Study Area.

Roadway Junction Relation	Number of Crashes					Percentage
	Gregory County	Mellette County	Todd County	Tripp County	Total	
Alley Intersection Related	0	1	0	0	1	0.1%
Driveway Access	3	1	1	12	17	1.7%
Driveway Access Related	0	2	0	0	2	0.2%
Four-Way Intersection	19	2	1	36	58	5.8%
Intersection Related	4	2	0	22	28	2.8%
Non-Junction	114	82	40	603	839	83.5%
Not Reported	2	1	0	41	44	4.4%
T- Intersection	4	1	0	11	16	1.6%
Total	**146**	**92**	**42**	**725**	**1005**	**100.0%**

Table 4.2: Roadway Junction Relation Crashes (2014-2018)

Of the 1,005 reported crashes, 725 crashes or 72.1% of the reported crashes occurred in Tripp County over the five-year period. Todd County had the lowest reported crashes of the four counties with 42 crashes or 4.2% of all reported crashes. Gregory County had a reported 146 crashes or 14.5% of all reported crashes and Mellette County has a reported 92 crashes or 9.2% of all reported crashes over the five-year period. Figure 4.1 shows the number of reported crashes per year for the four counties.

Figure 4.1 Crash Totals (2014-2018)

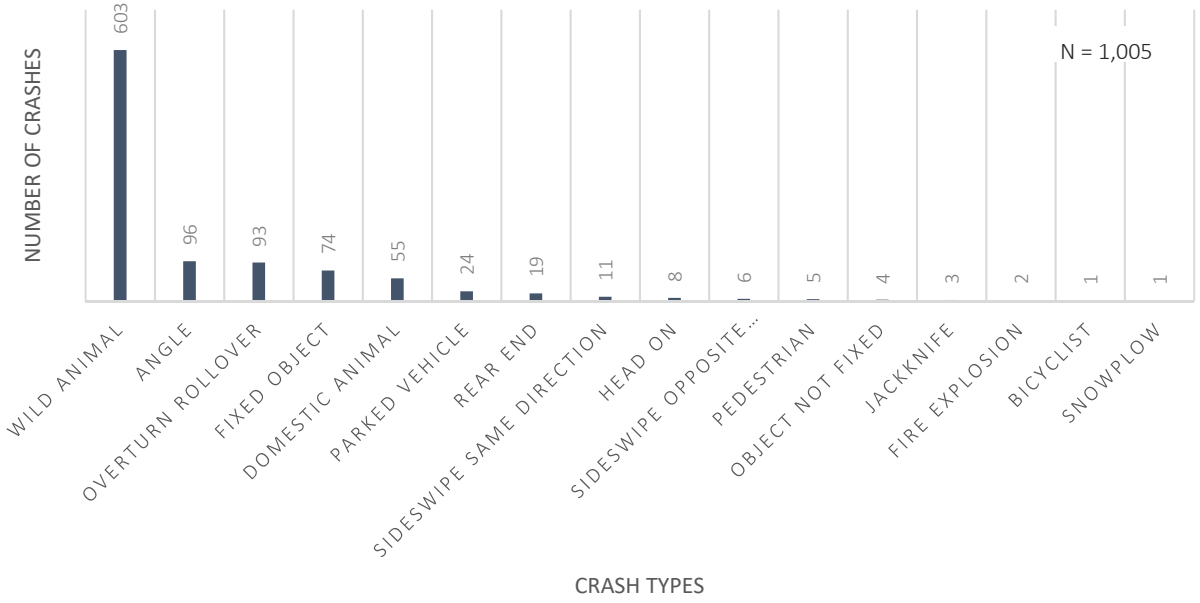


Tripp County's higher reported crashes are primarily due to the large geographic area, higher number of road miles, and higher population, including the city of Winner. However, the total crashes reported in Todd County are lower than the other counties in the four-county area. Todd County includes the towns of Mission and Rosebud which are the population centers for the county, and it is expected that a significant number of crashes would occur there. However, the reported crashes do not support this expectation, therefore, it could be an indication of unreported tribal crashes.

Crash Type

Wild Animal crashes were the most common reoccurring event throughout the Study Area, accounting for 603 of the 1,005 crashes or 60.0% of all reported crashes. Tripp County had the highest number of Wild Animal crashes with 489 crashes or 81.1% of all reported crashes in all four counties. The other three top crash types observed are Angle crashes accounting for 96 crashes or 9.6% of all reported crashes, Overturn Rollover crashes accounting for 93 crashes or 9.3% of all reported crashes and Fixed Object crashes accounting for 74 crashes or 7.4% of all reported crashes. These top crash types reported in the four counties for the analysis years from 2014 – 2018 are consistent when comparing them to the leading crash types from the 2014 Rosebud Sioux Tribal Transportation Safety Plan. Figure 4.2 shows the different crash types that occurred in the four counties from 2014 – 2018.

Figure 4.2 Crash Types All Counties (2014-2018)



Key Observation: Given that the three of the four top crash types, wild animal, overturn rollover and fixed object, account for approximately 77% of crashes occurring in the four counties on the Rosebud Indian Reservation, it appears the greatest impact on crash reduction could be from the following:

- Provide wildlife friendly fencing in areas showing a high concentration of wild animal collisions
- Maintaining vegetation along the roadway
- Improve inslope flattening inside the clear zone along roadway corridors
- Where inslopes cannot be flatten, install guardrail in areas where the inslope exceeds the recommended 4:1 slope.
- Remove fixed objects from the clear zone
- Objects that cannot be removed from clear zone (e.g. utility poles or large trees) provide a protective barrier or place objects on a crash worthy breakaway device (e.g. roadway signs and mailboxes)
- Proper signing of horizontal curves may reduce rollover crashes by given guidance to motorist of the change in the alignment of the roadway.
- Proper delineation along the roadway, used for motorist guidance at night and during adverse weather.
- Centerline and shoulder rumble strips, alert motorist as they cross the center or edge line of the roadway through creating noise and vibration inside the vehicle. This allows them to take corrective countermeasures to return to the travel lane safely.
- Add shoulders along routes to increase the recoverable area for vehicles

Approximately 60.4% of the reported Angle crashes occurred in Tripp county and are heavily concentrated with in the urban limits of Winner, SD. Angle crashes typically occur in urban settings at intersections that are either controlled or uncontrolled. There are low cost countermeasures and safety improvements that can address this crash trend. The nature of this Road Safety Audit primarily looks at rural highway, where

angle crashes are not typically seen. If the Rosebud Sioux Tribe begins to experience more of this crash type on BIA routes especially in the more urban areas, it is recommended that the MAP-21 Program review FHWA's *"Low-Cost Safety Enhancements for Stop-Controlled and Signalized Intersections"* manual (FHWA-SA-09-020) for recommended low cost countermeasure to use to address crashes.

Crash Injury Severity

During the studied five-year time interval, there were 17 fatal accidents, 149 injury accidents and 839 property damage only accidents for a total of 1,005 accidents within the four-county Study Area. The 1,005 accidents involved 1,240 occupants. Table 4.3 breaks down the injury type for the occupants involved in the crashes in the four counties.

Study Area						
Crash Injury Severity	Number of Injuries					Percentage
	Gregory County	Mellette County	Todd County	Tripp County	Total	
Fatal injury	7	3	5	2	17	1.4%
Incapacitating	21	6	4	17	48	3.9%
No injury	95	43	17	278	433	34.9%
Non-incapacitating	21	18	1	32	72	5.8%
Not applicable	0	0	0	3	3	0.2%
*Not Reported	46	40	19	464	569	45.9%
Possible	29	6	5	58	98	7.9%
Total	**219**	**116**	**51**	**854**	**1,240**	**100.0%**

* - Not Reported, Injuries were listed as Wild Animal Crashes

Table 4.3 Crash Injury Severity (2014-2018)

Fatal and Incapacitating injuries account for 5.3% of the injuries that occurred within the four counties which is approximately two times higher when comparing to the state-wide percentages for South Dakota of 2.7%. Table 4.4 shows the different types of injuries that have occurred throughout the entire state of South Dakota.

South Dakota - Statewide		
Crash Injury Severity	Number of Injuries	Percentage
Fatal injury	644	0.4%
Incapacitating	3,451	2.3%
No injury	98,309	66.8%
Non-incapacitating	9,452	6.4%
Not applicable	204	0.1%
*Not Reported	21,990	14.9%
Possible	13,206	9.0%
Total	**147,256**	**100.0%**

* - Not Reported, Injuries were listed as Wild Animal Crashes

Table 4.4: South Dakota Crash Injury Severity (2014-2018)

Key Observation: Fatal and incapacitating injury crashes stand out due to their impact on lives. Gregory and Todd County account for approximately 70.6% of the Fatal Injuries for the four counties. Of the 17 fatal injuries, ten were from result of Overturn Rollover crashes, three were Angle crashes, and two were Pedestrians and Head On crashes. Of the 48 incapacitating injuries, 17 were from the result of Overturn Rollover crashes, 15 were from Angle crashes, seven from Head On crashes, five from Fixed Objects, two

were Pedestrian crashes and one Rear End and Wild Animal crashes. Countermeasures that address Overturn Rollover crashes could be effective in addressing approximately 56.3% of the fatal and incapacitating injury crashes. **Figure 4.3** summarizes different crash types for Fatal and Incapacitating Injuries.

Figure 4.3 Fatal and Incapacitating Injuries (2014-2018)

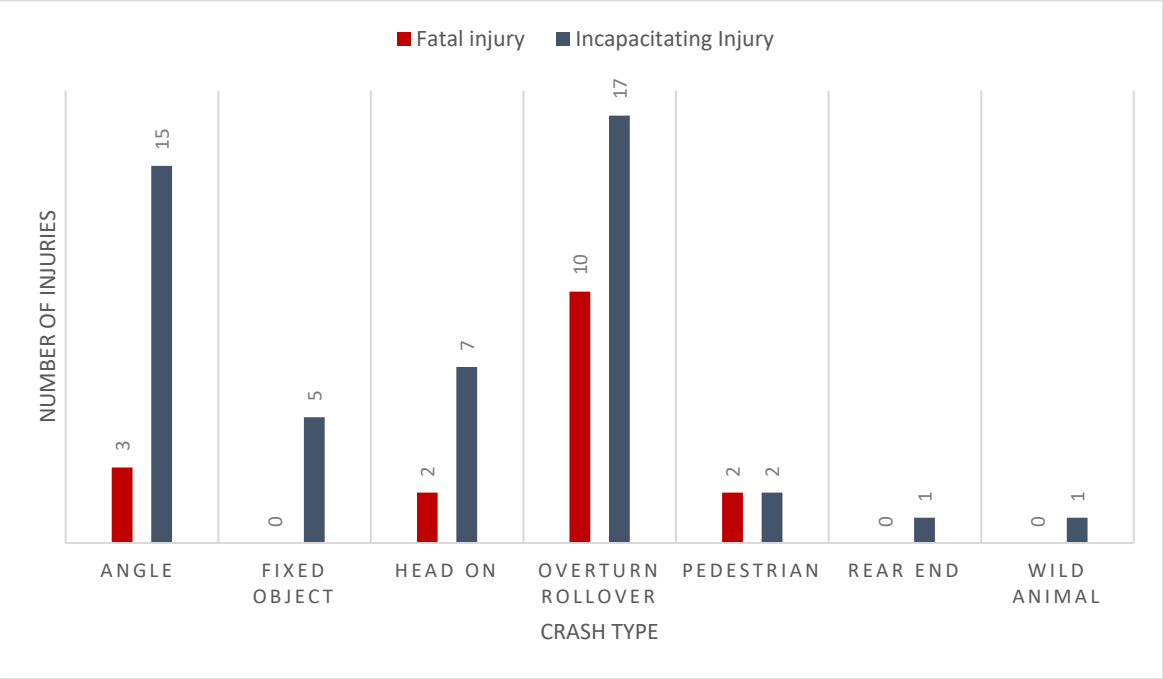


Figure 4.4 shows the locations of collision types and **Figure 4.5** shows the crash severities within the four-county area.

Figure 4.4 Crash Type Locations (2014-2018)

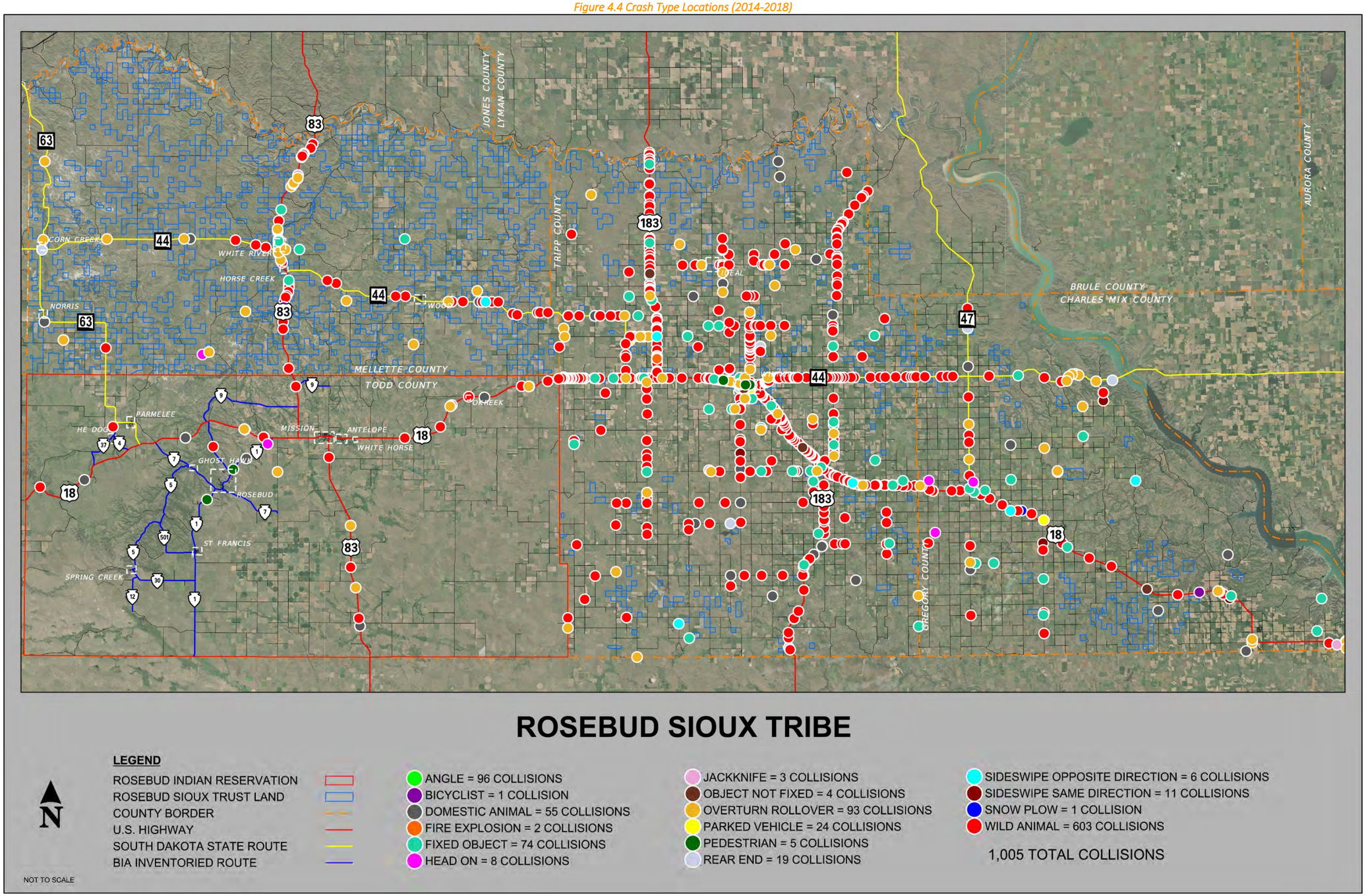
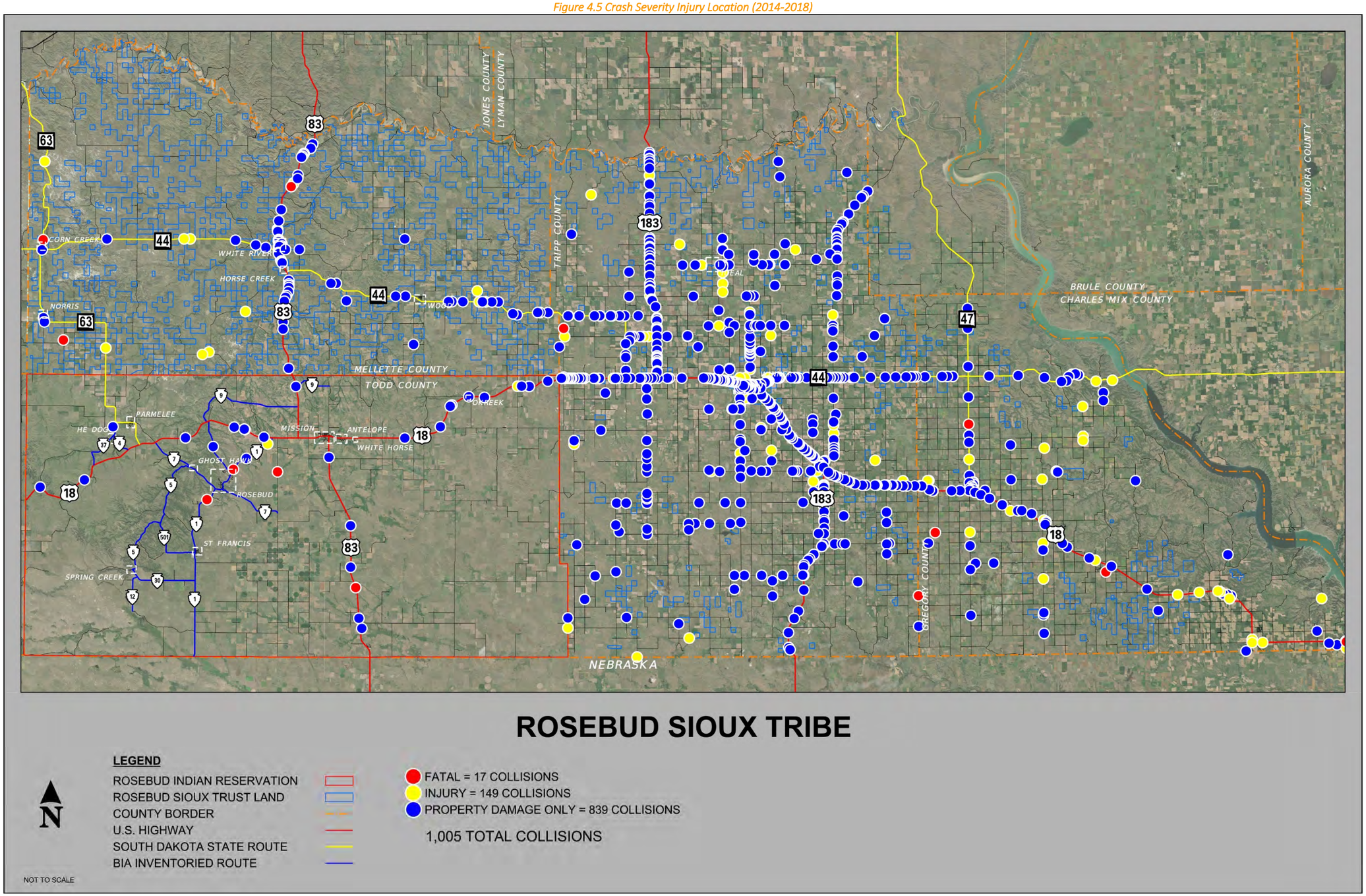


Figure 4.5 Crash Severity Injury Location (2014-2018)



Road Surface Conditions

Crash records indicate that of the 1.005 crashes that occurred, 305 crashes were reported on a paved surface (asphalt or concrete), 103 crashes were reported on dirt, gravel or other type of surface, one crash was reported as unknown and 596 crashes, a surface type was not reported as they were coded as Wild Animal Crashes.

When considering the influence of road surface on crashes, approximately 30.4% of the reported crashes occurred on a paved surface. This number maybe higher if the road surface was reported with the Wild Animal Crashes. 133 of the crashes were reported with the road surface being wet, ice, snow covered or slush. Table 4.5 shows the number of crashes in the four-county area based on the condition of the roadway.

Road Surface Condition	Number of Crashes					Percentage
	Gregory County	Mellette County	Todd County	Tripp County	Total	
Dry	115	68	36	612	831	82.7%
Ice	6	3	0	16	25	2.5%
Not Reported	1	0	0	0	1	0.1%
Sand, Mud, Dirt, Gravel	3	6	0	7	16	1.6%
Slush	5	1	0	1	7	0.7%
Snow	5	7	3	18	33	3.3%
Unknown	1	0	0	21	22	2.2%
Water (Standing, Moving)	0	2	0	0	2	0.2%
Wet	10	5	3	50	68	6.8%
Total	**146**	**92**	**42**	**725**	**1005**	**100.0%**

Table 4.5: Road Surface Condition (2014-2018)

Road Grade and Horizontal Alignment

Roadways within the four-county area are primarily straight and level. Approximately 29.2% of the reported crashes occurred on straight and level roadway segments. This percentage maybe higher as the road grade and alignment information for Wild Animal crashes was not reported and account for approximately 59.4% of the reported crashes. Table 4.6 shows the number of reported crashes in relation to the road grade and horizontal alignment of the roadway.

Road Alignment Description	Number of Collisions					Percentage
	Gregory County	Mellette County	Todd County	Tripp County	Total	
Curve and hill crest	1	2	0	3	6	0.6%
Curve and level	12	3	4	11	30	3.0%
Curve on grade	8	2	0	6	16	1.6%
Not Reported	47	43	22	485	597	59.4%
Straight and hill crest	15	8	0	16	39	3.9%
Straight and level	60	29	12	192	293	29.2%
Straight on grade	3	5	4	11	23	2.3%
Unknown	0	0	0	1	1	0.1%
Total	**146**	**92**	**42**	**725**	**1005**	**100.0%**

Table 4.6: Road Alignment Description (2014-2018)

Key Observation: Proper signing of horizontal curves may reduce crashes by given guidance to motorist of the change in the alignment of the roadway and proper delineation along the roadway gives motorist guidance at night and during adverse weather.

Light Conditions

There were 390 of 1,005 crashes that occurred in daylight. There were 16 crashes that occurred on lighted roadways when dark, 477 crashes on non-lighted roadways when dark, 64 crashes during dawn and 48 crashes occurring at dusk, ten crashes were reported as unknown. The number of crashes that occurred in the dark is significant from the standpoint that efforts to improve nighttime visibility could have a positive impact on reducing nighttime crashes.

Key Observation: An analysis of corridors where there were a higher number of crashes after dark was not conducted. It was assumed that a street lighting project was not applicable for rural corridors. However, recommendations for countermeasures to reduce the potential for after dark crashes or crash severity would be beneficial by the following:

- Proper signing of horizontal curves may reduce non-daylight hours by given guidance to motorist of the change in the alignment of the roadway.
- Proper delineation along the roadway, used for motorist guidance at night and during adverse weather.
- Centerline and shoulder rumble strips, alert motorist as they cross the center or edge line of the roadway through creating noise and vibration inside the vehicle. This allows them to take corrective countermeasures to return to the travel lane safely.

Street lighting projects for urban areas could be beneficial especially along existing and future shared use pathways.

Safety Restraint Use

The use of proper safety restraints in a moving vehicle helps reduce the severity of injuries for occupants in the event of a crash. Of the 17 reported Fatal crashes, 14 of the occupants were not using proper safety restraints. The three remaining fatalities, one occupant was only using a lap belt and two occupants used a lap belt and shoulder harness. Table 4.7 shows the frequency safety restraints being used.

Type of Safety Restraint Used	Number of Occupants					Percentage
	Gregory County	Mellette County	Todd County	Tripp County	Total	
Child/Youth restraint system used properly	1	0	1	0	2	0.2%
Helmet and eye protection	3	1	0	1	5	0.4%
Helmet only	1	0	0	0	1	0.1%
Lap belt and shoulder harness used	73	35	10	179	297	24.0%
Lap belt only used	3	4	0	4	11	0.9%
None used	38	20	6	43	107	8.6%
Not applicable	5	2	0	23	30	2.4%
Not Reported	47	43	22	492	604	48.7%
Shoulder harness only used	3	0	0	3	6	0.5%
Unknown	45	11	12	109	177	14.3%
Total	**219**	**116**	**51**	**854**	**1240**	**100.0%**

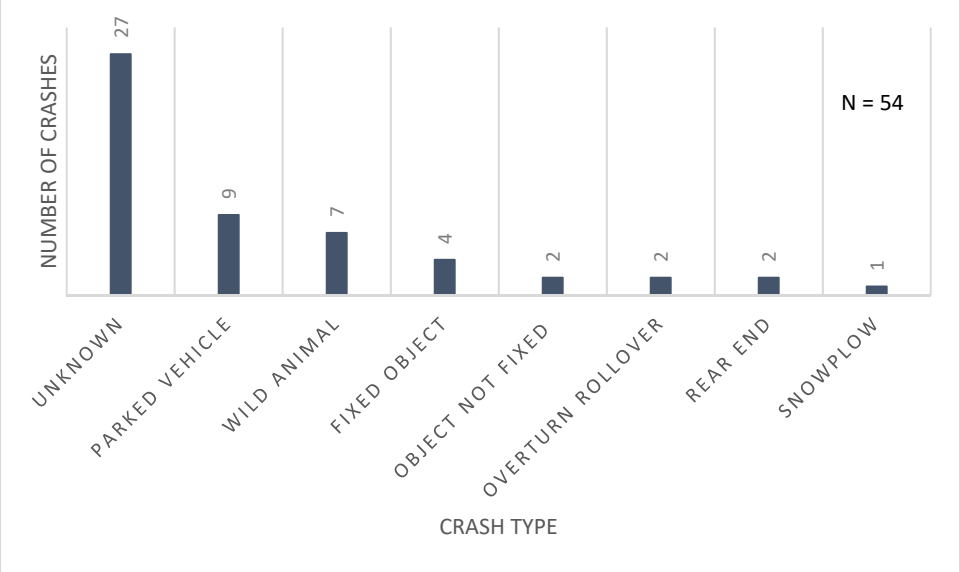
Table 4.7: Safety Restraint Used for Crashes (2014-2018)

Key Observation: Approximately 24% of occupants within the four-county area used a proper safety restraint. This percentage maybe higher as type of safety restraint used information for Wild Animal crashes was not reported and account for approximately 48.7% of the reported crashes. Recommendations to address increase use of safety restraints are contained in the 2014 Tribal Transportation Safety Plan and is recommended to reviewed for implementation.

Tribal Law Enforcement Reported Crashes

Tribal Law Enforcement was able to provide crash data from January 1, 2019 – March 31, 2019 in Todd County. The three months of provided data show a reported 54 crashes or 18 crashes per month. The reported 54 crashes are much higher than the 42 reported crashes in Todd County by the SDDOT database over a five-year period. Showing how under reported crashes are from the Tribal Law Enforcement. Extrapolating the average monthly reported crashes by Tribal Law Enforcement, Todd county could have seen a potential 216 crashes for the current year. The data provided is very vague and does not provide complete information about the crash. Figure 4.6 shows the different types of crashes reported by the Tribal Law Enforcement.

Figure 4.6: Reported Crashes in Todd County by Tribal Law Enforcement



Unknown crashes are the leading crash type reported by Tribal Law Enforcement, crash descriptions provided for these crashes include medical, diver error, or weather related for some examples. These descriptions provide a contributing circumstance to the crash but does not provide adequate information for the crash type. Locations of these reported crashes are given but the descriptions are very limited as they only provide either a roadway route name or a community name and not the exact physical location. Thus, making it difficult for one to identify if there are any crash patterns or clusters occurring in a particular area that needs to be address with possible safety improvements or other countermeasures. There were no reported fatalities by the Tribal Law Enforcement, 15 of the reported crashes resulted in an injury and 39 of the reported crashes resulted in property damage only.

Adequate crash information plays a crucial role for the Tribe as this information can be used to assist in applying and securing TTPSF funds for safety improvements on roadways throughout the Reservation.

5.0 COUNTERMEASURES

Safety issues along the studied corridors were assigned specific countermeasure to address each issue location based on the available crash data. Recommended countermeasure includes the following:

- Add Shoulders and Flatten Slopes
- Install Guardrail
- Remove Guardrail
- Maintain vegetation along roadway
- Install Centerline and Shoulder Rumble Strips on paved routes
- Install Delineators
- Improve Horizontal Alignment
- Flatten Inslopes
- Install Retroreflective Pavement Marking
- Install Retroreflective Signs
- Install Horizontal Alignment Signs
- Install Advisory Speed Plaque with Horizontal Alignment Signs
- Install Chevron Alignment Signs
- Improve Road Ditch Drainage
- Improve Culverts
- Improve Roadway Surface
- Improve Intersection Sight Distance
- Improve Intersection Alignment
- Remove/Relocate Fixed Objects outside Clear Zone
- Improve Bridge Ends
- Install Separated Shared Use Pathway
- Install Sidewalks
- Install Signed, Marked Crosswalks
- Install Pedestrian Rectangle Rapid Flashing Beacon
- Install Pedestrian Refuge Islands

Safety issues prevalent along the Rosebud Sioux Reservation rural and urban roadways include poor road surfaces, poor road cross section, fixed objects and wild animal, grade or curve issues, and sign and pavement marking issues. Discretion was used in deciding whether a safety issue should be addressed with countermeasures. Although this Road Safety Audit is only limited to nine routes throughout the Reservation, these countermeasures can be used on other routes that the Tribe maybe experiencing similar issues.

Where applicable, Crash Reduction Factors (CRF) were listed for each countermeasure. These CRF's were taken from the FHWA's Crash Modification Factors Clearinghouse located at https://safety.fhwa.dot.gov/tools/crf/resources/. A CRF is an estimate of the percentage reduction in crashes due to a particular countermeasure. The CRF's gives the Rosebud Sioux Tribe staff additional information on the expected benefit of implementing a particular countermeasure. The intent is to support the process used by the Rosebud Sioux Tribe to prioritize future projects. Table 5.1 summarizes the CRF's for the recommended countermeasures.

Recommended Countermeasure	CRF (%)
Add Shoulders and Flatten Side Slopes	42
Install Guardrail	26
Remove Guardrail	N/A
Maintain Vegetation Control Along Roadside	N/A
Install Centerline and Shoulder Rumble Strips	23
Install Delineators	15
Install Transverse Rumble Strips on Stop Controlled Approaches	25.5
Flatten Inslopes	42
Install Retroreflective Pavement Markings	24
Install Retroreflective Signs	18
Install Horizontal Alignment Signs	18
Install Advisory Speed Plaque with Horizontal Alignment Signs	18
Install Chevron Alignment Signs	18
Improve Roadway and Ditch Drainage	N/A
Improve Culverts	N/A
Improve Roadway Surface	N/A
Improve Intersection Sight Distance	F(x)*
Improve Intersection Alignment	N/A
Remove/Relocate Fixed Objects outside Clear Zone	38
Improve Bridge Ends	N/A
Install Separated Shared Use Pathway	N/A
Install Sidewalks	N/A
Install Signed, Marked Crosswalks	15
Install Pedestrian Rectangle Rapid Flashing Beacon	28
Install Pedestrian Refuge Island	25.8

* - CRF% based off a function relating AADT, existing available intersection sight distance and condition of interest

Table 5.1: Crash Reduction Factors for Recommended Countermeasures

Guidance for application of these countermeasures is contained in the Manual on Uniform Traffic Control Devices (MUTCD) and American Association of State highway and Transportation Officials (AASHTO) A Policy on Geometric Design of Highways and Streets. It is strongly recommended that these manuals be consulted and adhered to prior to application of these countermeasures.

The sections below summarize how the CFR's can be applied.

Add Shoulders and Flatten Side Slopes

Many older two-lane roadways were constructed with little to no shoulder width and slopes that were extremely steep causing vehicles to roll over if they leave the roadway. As design standards have advanced, they now require wider surfaces and flattened slopes for safety reasons. Guidance on minimum widths and slopes can be found in the AASHTO A Policy on Geometric Design of Highways and Streets and the AASHTO Roadside Design Guide.

IMPROVE SHOULDER SURFACE

Few of the routes that were inventoried provided shoulders along the roadway. One route in particular, BIA 1, provided a concrete pavement travel way with a wide gravel shoulder. In some areas the gravel should was approximately four to six inches in difference creating a drop off between the travel roadway and the shoulder as showing in Figure 5.1. The drop off can potentially create a hazard for vehicles that

may depart the roadway or pulling over for an emergency situation. It is recommended that the MAP-21 Program consider using a more rigid material for the shoulder such as asphalt pavement or concrete pavement to potentially eliminate the grade separation between the road travel way and the shoulder. Using the more rigid material would allow the Tribe to install shoulder rumble strips as well, which could decrease the number of road departure crashes by alerting motorist through vibration and noise that they are leaving the travel way.

Figure 5.1: Grade Separation Between Roadway Travel Way and Gravel Shoulder



Guardrail

Guardrail is a safety barrier that is intended to prevent vehicles leaving the roadway in areas that have objects inside of the clear zone that cannot be removed, steep embankments or side slopes. Given the high cost of guardrail, significant discretion was used in selecting the locations where the greatest need appeared to exist. Decisions regarding the extent and type of guardrail to serve the needs of given location will need to be addressed as projects are programmed for implementation. Figure 5.2 shows an example of guardrail used on the roadway that has steep side slopes.

Figure 5.2: Guardrail Installed for Steep Side Slopes



Vegetation Control Along the Roadside

Vegetation along the roadside has the potential to become a hazard if not properly maintained. Trees close to the roadside can create fixed object within the clear zone and become hazard if a vehicle were to depart the roadway. Overgrown grass, weeds, brush and tree limbs can obscure or limit motorist's view of roadway

signs, oncoming traffic, wildlife and livestock, and pedestrian and bicycles. Figure 5.3 show an example of overgrown vegetation observed on the studied routes. Overall the Rosebud Sioux Tribe Road Maintenance Departmenthas done well maintaining vegetation along the roadside on other routes. FHWA does have a guide, "Vegetation Control for Safety *A Guide for Local Highway and Street Maintenance Personnel*" and should be reviewed if any maintenance issues may arise in the future.

Figure 5.3: Overgrown Vegetation Along the Roadside on BIA 5



Centerline and Shoulder Rumble Strips

Centerline rumble strips are at the centerline of the paved roadway intended to alert motorist crossing over to the opposing driving lane. Shoulder rumble strips are placed on the edge of the driving lane to warn drivers that they are departing the roadway not intended for routine traffic use. They are an effective countermeasure for reducing roadway departure crashes and head on crashes. Rumble strips are used on highspeed rural roads. Figure 5.4 shows an example of shoulder rumble strips.

Figure 5.4: Shoulder Rumble Strips



Delineators

Proper delineation along the roadway is used for motorist guidance at night and during adverse weather. Delineators are also beneficial at locations where roadway alignment changes and are considered as guidance devices rather than warning devices. They come in various sizes and designs to address varying

applications. Delineators are typically used on rural roadways with no street lighting and marking approaches. Figure 5.5 shows various examples of delineators. The MUTCD and the SDDOT Sign and Delineator Design Guidelines for Local Roads gives recommendations and guidance for placement of delineators.

Figure 5.5: Roadside Delineators Example



Transverse Rumble Strips

Transverse Rumble Strips alert motorist in rural areas that they are approaching a stop sign at an intersection. The transverse strips typically consist of grooves crossing the roadway surface in a single travel lane that provides a tactile and audible warning for drivers.

Flatten Inslopes

It is desirable to have inslopes be 4:1 or flatter if site conditions allow for it. This allows for a greater recovery area if a vehicle departs the roadway. Where slopes exceed a 4:1, flatting (regrading) them could significantly reduce crashes and severity and is a cheaper alternative to roadside barriers. Information on desirable side slopes can be found in the AASHTO Roadside Design Guide.

Pavement Markings

Pavement markings communicate to motorist the intended travel path on roadways and roadway alignment for long-range delineation. The delineation of pavement markings improves nighttime highway visibility and guide the motorist of the intended travel path. Pavement markings are typically either a waterborne traffic paint or epoxy traffic paint with glass beads mixed into the paint to provide retroreflectivity. A high-performance pavement marking tape can be used as a replacement to either waterborne or epoxy traffic paint. This option provides a more durable pavement marking and can be

beneficial in areas with higher traffic volumes and high pedestrian traffic such as BIA 1. Figure 5.6 shows an example of high-performance pavement marking tape for a marked school crossing.

Figure 5.6: High-Performance Pavement Marking Tape



Retroreflective Signs

Roadway signs provide valuable information to motorist. For these signs to be effective, traffic sign visibility must be maintained during daytime and nighttime conditions. The reflective sheeting used on roadway signs allows better visibility for motorist at nighttime. The SDDOT is in the process of updating all the signing on paved route in Todd County in 2020 to meet current standards of the MUTCD. In 2023, SDDOT plans to do the same upgrade on signs on all other routes in Todd County. Many of the signs on the routes are showing signs of deteriorating and have little to no reflectivity. It is recommended that signs be checked and replaced if needed every five years to maintain proper reflective sheeting. It is also recommended that an inventory of signs be completed using GPS and photos to give MAP-21 program staff a list of signs that need to be maintained. Current practices use Type IV reflective sheeting or XI high intensity reflective sheeting for signs. Fluorescent yellow type XI-high intensity reflective sheeting should be used for horizontal alignment warning signs. Fluorescent yellow green type XI-high intensity reflective sheeting should be used for roadway signs used for school areas. Figure 5.7 shows examples of the different types of reflective sheeting for roadway signs.

Figure 5.7: Different Types of Reflective Sheeting for Roadway signs



Type IV Reflective Sheeting



Type XI Fluorescent Yellow Reflective Sheeting



Type XI Fluorescent Yellow Green Reflective Sheeting

Horizontal Alignment Signs

Advance horizontal alignment signs provide a warning to motorist of the presence of a curve ahead and of the need to possible slow down to safely navigate a curve. If the difference of the speed to safely navigate a curve differs by 10-miles per hour or greater from the posted speed limit on the roadway, a supplemental advisory speed plaque is required to alert motorist to slow down. The advisory speed is determined by an engineering study that follows established engineering practices. Traditionally a ball-bank indicator is used to establish an advisory speed and should be determined based on free-flowing traffic conditions. **Figure 5.8** shows an example of the use of a horizontal alignment sign with a supplemental advisory speed plaque.

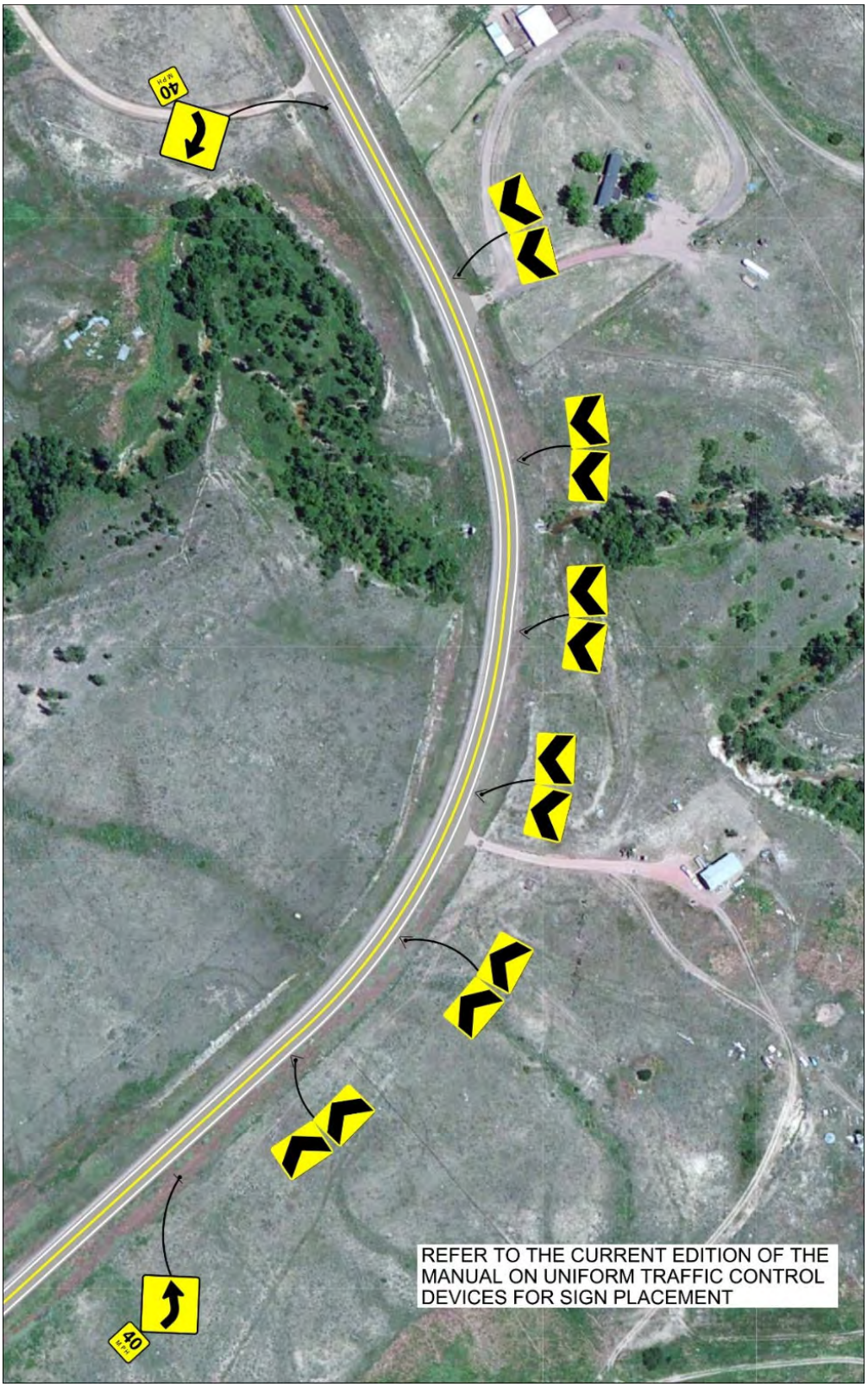
Figure 5.8: Horizontal Alignment Sign with Supplemental Advisory Speed Plaque



Chevrons

A chevron is a type of horizontal alignment warning sign used instead of or in addition to standard delineators to highlight the presence of a change in the roadway alignment. In some locations, chevrons were missing and/or the spacing between the signs were not consistent. The MUTCD provides guidance for the placement of chevrons and spacing requirements depending on the radius of the curve. **Figure 5.9** shows an example of chevron spacing.

Figure 5.9: Curve Warning Signs Example



Roadway Drainage, Ditch Drainage and Culverts

Drainage plays an important part on the roadway system as it allows to move water off and away from the roadway. Many areas along the studied routes were showing buildup of water in the ditches or roadway surface as shown in Figure 5.10, creating a hazard for vehicles. It is important to maintain the roadway surface by maintaining a proper crown for the roadway if the surface is gravel/dirt so water can drain off the roadway into the ditches. Additionally, it is necessary to maintain these ditches by regrading them over to time to allow water to flow and properly drain. Culverts help maintain the drainage by allowing water to flow under the roadway without damaging the road subbase. Many of the culverts in the study area do not have flared end sections on them and create an obstacle for drivers to hit along with steeper slopes near the culvert ends. Flared end sections suitable to be within the clear zone should be added to theses culverts and the slope be regraded. The SDDOT Roadway Design Manual and standard plates for culverts shows examples of different flared end sections to use with different types of culverts. It is recommended to refer to these standard plates when replacing culvert ends.

Figure 5.10: Water Pooling on Roadway



Roadway Surface

Many of the gravel roads within the Rosebud Indian Reservation are showing signs of washboarding and rutting as shown in Figure 5.11, creating an undesirable surface to drive on. Washboarding can lead to loss of vehicle control when traveling at high speeds. The four primary causes of washboarding are:

1. The driving habits of people
2. Lack of Moisture
3. Poor quality of gravel
4. Lack of crown on the surface[6]

The Gravel Roads Construction & Maintenance Guide by the U.S. Department of Transportation provides guidance on how to prevent and maintain washboarding and should be referred to.

[6] Gravel Roads Construction & Maintenance Guide, U.S. Department of Transportation, August 2015

Figure 5.12: Washboarding on Gravel Surface



Many of the asphalt paved routes on the Rosebud Indian Reservation are showing signs of distress with potholes, pavement heaving, cracking and rutting to name a few. This is creating a road surface that is undesirable to drive on and could lead to loss of vehicle control when traveling at high speeds. It is recommended that the Rosebud Sioux Tribe MAP-21 Program consider establishing a Pavement Management Plan (PMP) and conduct a Pavement Surface Evaluation and Rating (PASER). A PASER Study method is a method developed by the Federal Highway Administration (FHWA). This method is based on visual assessment of the current roadway conditions and provides recommended roadway treatments based on the current pavement condition. PASER is based on engineering principles, for evaluating paved roads in a time-efficient and consistent manner. The PASER method outputs a simple 1-through-10 rating for each section of roadway studied. One being the roadway has failed and ten being the roadway is in excellent condition. This provides a simple and understandable way to communicate pavement conditions to elected officials and the public and allows more time for scheduling and budgeting. The ability to know and understand roadway conditions is an extremely useful tool in scheduling preventative maintenance, instead of waiting until roads are degraded to the point where costlier corrective and emergency maintenance treatments are required. PASER ratings assist in identifying roadway conditions and prioritizing improvements based on a range of factors including roughness (ride), surface distress (condition), surface skid characteristics, and structural characteristics (potholes, cracking, etc.). Based on the PASER rating, different maintenance tasks are required to maintain or raise the rating for a section of roadway. By continuing to ensure that a good roadway remains in good condition, the life of a roadway can be extended for a far-lower upfront cost than by waiting until a more-intensive and expensive maintenance method is required. The PASER study would allow the Tribe to establish a PMP, allowing the Tribe to prioritize which roadways require immediate attention for maintenance needs and fiscally plan for future maintenance needs. Figure 5.13 shows poor asphalt pavement conditions observed during the roadway inventory.

Figure 5.13: Poor Asphalt Pavement Conditions



Intersection Sight Distance

Crashes and crash severity can potentially increase at intersections if there is insufficient sight distance. Multiple intersections throughout the studied routes had intersection sight distance issues for both controlled and uncontrolled intersections due to skewed intersections, overgrown vegetation and trees, and setback stopping location resulting from shared-use paths crossing an intersection. Removal of overgrown vegetation or trees within a driver's sight triangles will allow them to anticipate and avoid potential collisions. Information for required intersection sight distance and calculations can be found in the AASHTO Roadside Design Guide. Figure 5.14 shows an example of an intersection with limited sight distance because of overgrown vegetation and trees.

Figure 5.14: Intersection with Limited Intersection Sight Distance



Remove Fixed Objects from the Clear Zone

Fixed objects such as trees and dense vegetation, utility poles, guy wire anchors, mailboxes and rocks, such as shown in Figure 5.15, that are within the designated clear zone near the roadway have been found to be a significant cause of crashes, particularly injuries and fatalities in rural areas. Removal of these hazards can significantly reduce crashes and severity. Information on clear zone limits and calculation can be found in the AASHTO Roadside Design Guide.

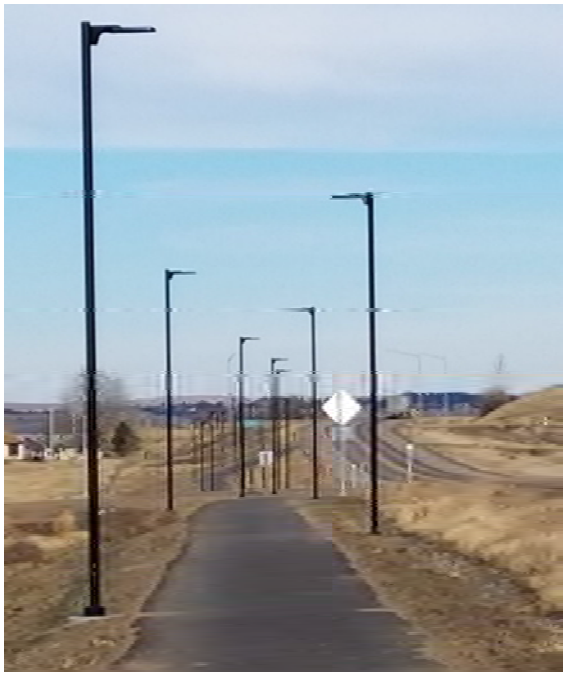
Figure 5.15: Example Fixed Objects within the Clear Zone



Separated Shared Use Pathway

Shared use paths are facilities that are separated from a roadway and occupy an exclusive right-of-way. Intended users are non-motorized and may include bicyclists, in-line skaters, roller skaters, wheelchair users (both non-motorized and motorized) and pedestrians, including walkers, runners, people with baby strollers, people walking dogs, etc. These facilities are most commonly designed for two-way travel. An example is shown in Figure 5.16.

Figure 5.16: Separated Pathway



Attached Sidewalks

An attached sidewalk in urban areas is intended to remove pedestrians from the travelled way and reduce or eliminate interaction with vehicles. There may be additional separation provided if on street parking is allowed. Generally, these are used behind a curb and gutter section and may include a buffer area for trees or grass.

Marked Crosswalks

Providing marked crosswalks traditionally has been one measure used in an attempt to facilitate pedestrian crossings. Such crosswalks commonly are used at uncontrolled locations (i.e., sites not controlled by a traffic signal or stop sign) and sometimes at midblock locations. The use of these marked crosswalks such as shown in Figure 5.17 have been shown to be an effective countermeasure in the reduction of pedestrian injuries and fatalities.

Figure 5.17: Marked Crosswalk



Pedestrian Rapid Flashing Beacon

Rectangular rapid-flash beacons are devices that are placed on both sides of a crosswalk below the pedestrian crossing sign and above the arrow indication pointing at the crossing, see Figure 5.18. These devices should not be used if the crossing is controlled by a YIELD sign, STOP sign or traffic signal. If there is a pedestrian refuge or other type of median, a beacon can be installed in the median rather than the far-side of the roadway. The pedestrian activation can be with pushbuttons or automated through pedestrian detection and should be unlit when not activated.

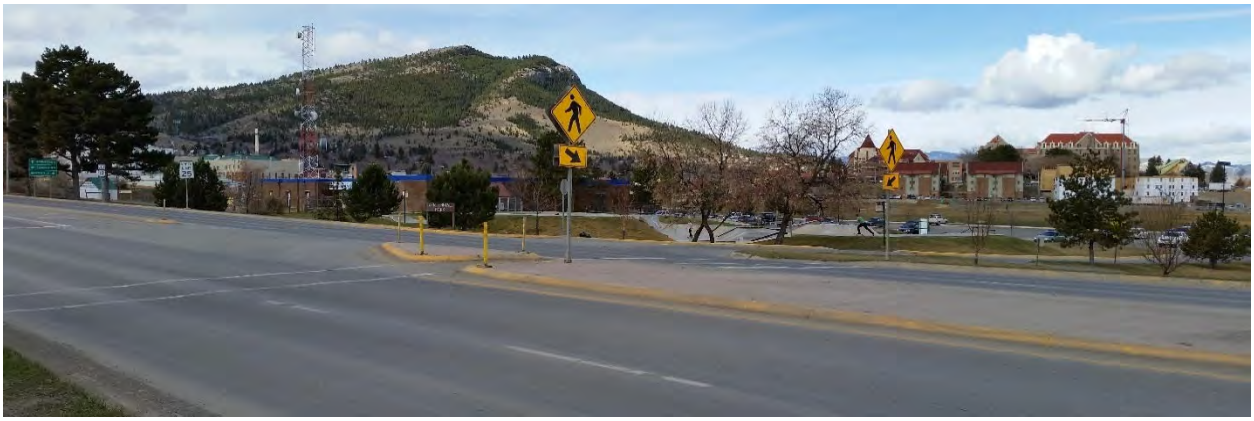
Figure 5.18: Pedestrian Rapid Flashing Beacon



Pedestrian Refuge Island

Pedestrian Refuge Islands are channelized raised medians between opposing lanes of traffic that allow pedestrians cross one direction of traffic at time. This helps reduce the delay for pedestrian trying to wait for an acceptable gap clearance in traffic to cross the roadway. Pedestrian Refuge Islands are ideal for multilane urban roadway such as BIA 1 in Rosebud, as they have been known to significantly reduce pedestrian related crashes. Figure 5.19 shows an example of a Pedestrian Refuge Island.

Figure 5.19: Pedestrian Refuge Island



6.0 RECOMMEND IMPROVEMENTS

Although this Road Safety Audit is only limited to nine routes throughout the Reservation, recommendations for each route can be used on other routes that the Tribe maybe experiencing similar issues.

Reservation Wide Improvements

The following are recommendations for improvements throughout the entire Rosebud Indian Reservation.

Delineators

During the inventory process it was noted that a vast majority of the routes do not have or have very limited delineation along the roadway. Delineation is used for motorist guidance at night and during adverse weather. It is beneficial at locations where roadway alignment changes and are considered as guidance devices rather than warning devices. They come in various sizes and designs to address varying applications. Delineators are typically used on rural roadways with no street lighting and marking approaches. It is recommended that all routes within the Rosebud Indian Reservation be delineated using proper spacing for tangent and horizontal sections of the roadway. The MUTCD and the SDDOT Sign and Delineator Design Guidelines for Local Roads gives recommendations and guidance for placement of delineators and should be referred to when placing delineators.

Vegetation Control Along the Roadside

Vegetation along the roadside has the potential to become a hazard if not properly maintained. Trees close to the roadside can create fixed object within the clear zone and become hazard if a vehicle were to depart the roadway. Overgrown grass, weeds, brush and tree limbs can obscure or limit motorist's view of roadway signs, oncoming traffic, wildlife and livestock, and pedestrian and bicycles. The Rosebud Sioux Tribe Road Maintenance Departmentis currently doing very well maintaining vegetation along the roadside as shown in Figure 6.1 below on majority of the BIA routes that were inventoried with exception to a few. It is recommended that overgrown vegetation be addressed and referral to FHWA guide, "Vegetation Control for Safety *A Guide for Local Highway and Street Maintenance Personnel*" and should be reviewed if any maintenance issues may arise in the future.

Figure 6.1: Maintained Vegetation Along the Roadside on BIA 9



Roadway Drainage, Ditch Drainage and Culverts

Drainage plays an important part on the roadway system as it allows to move water away from the roadway. Many areas along the studied routes were showing buildup of water in the ditches and on the roadway, primarily on gravel/dirt roads, creating another hazard for vehicles if they were to depart the roadway. It is recommended that gravel/dirt roads be maintained to ensure a proper crown is on the road through grading the roadway, allowing the roadway to properly drain. Along with maintaining the roadway, ditches should be maintained and be part of a normal maintenance schedule by regrading them over time to allow water to flow and properly drain. Culverts help maintain the drainage by allowing water to flow under the roadway without damaging the road subbase. Many of the culverts in the study area do not have flared end sections on them and create an obstacle for drivers to hit along with steeper slopes near the culvert ends. It is recommended that flared end sections suitable to be within the clear zone be added to theses culverts and the slope be regraded during normal maintenance activities or as projects transpire. The SDDOT standard plates for culverts show examples of different flared end sections to use with different types of culverts. It is recommended to refer to these standard plates when replacing culvert ends. Figure 6.2 shows an example of a culvert with a flared end section. The Gravel Roads Construction & Maintenance Guide by the U.S. Department of Transportation provides guidance on maintaining gravel roads.

Figure 6.2: Culvert with Flared End Section Example



Guardrail

Guardrail is a safety barrier that is intended to prevent vehicles leaving the roadway in areas that have objects inside of the clear zone that cannot be removed, steep embankments or side slopes. Given the high cost of guardrail, significant discretion was used in selecting the locations where the greatest need appeared to exist. Decisions regarding the extent and type of guardrail to serve the needs of given location will need to be addressed as projects are programmed for implementation. Figure 6.4 shows areas were guardrail or slope flattening is recommended along the inventoried routes.

Flatten Inslopes

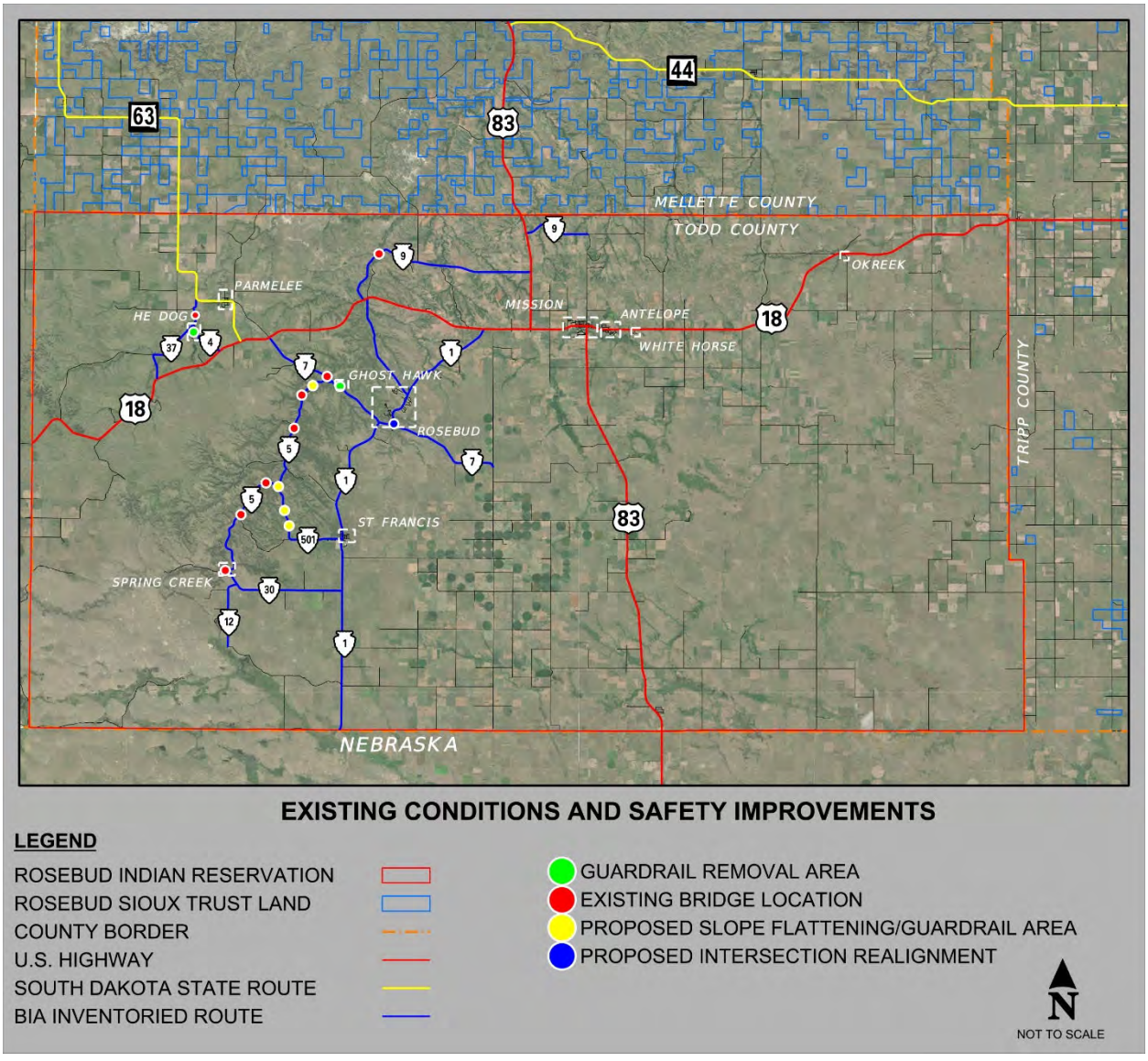
It is desirable to have inslopes be 4:1 or flatter if site conditions allow for it. This allows for a greater recovery area if a vehicle departs the roadway. Where slopes exceed a 4:1, flatting (regrading) them could significantly reduce crashes and severity and is a cheaper alternative to roadside barriers. Information on desirable side slopes can be found in the AASHTO Roadside Design Guide. Figure 6.4 shows areas were slope flattening is recommended if site conditions allow for it (e.g. limits of right-of-way). If site conditions

do not allow for slope flattening, guardrail is recommended. This would need to be decided during the engineering design process. Along with slope flattening, slopes of private and public approaches should be regraded to meet a desirable 4:1 slope of flatter.

Bridge End Treatments

There was a total of eight bridges along the inventoried routes. Five of the eight ridges had no end treatments and were only marked with object markers, one bridge utilizes bridge end treatments only for the direction of travel side and none for the opposing traffic. The remaining two bridges, one on BIA 4 and one on BIA 5, bridge end treatments on all four bridge ends. It is recommended that proper bridge end treatments be installed for these bridges including any bridge that was not inventoried during the RSA field review. The SDDOT Design Manual and Standard Plates provides guidance on proper bridge end treatments and should be referred to when selecting end treatments. Figure 6.4 shows the locations of existing bridges that were inventoried during the field visit.

Figure 6.4: Existing Conditions and Safety Improvements



Improve Roadway Surface

Many of the asphalt paved routes on the Rosebud Indian Reservation are showing signs of distress with potholes, pavement heaving, cracking and rutting to name a few. This is creating a road surface that is undesirable to drive on and could lead to loss of vehicle control when traveling at high speeds. It is recommended that the Rosebud Sioux Tribe MAP-21 Program consider establishing a PMP and conduct a PASER study. Establishing a PMP will allow the Tribe to prioritize which roadways require immediate attention for maintenance needs and fiscally plan for future maintenance needs.

Route Specific Improvements

The following are recommendations for improvements that are route specific within the Rosebud Indian Reservation.

BIA 1

BIA 1 is approximately 24.9-mile paved north/south rural major collector roadway. It begins at the junction of U.S. Highway 18 and heads south passing through the towns of Rosebud and St. Francis where it then terminates approximately 10-miles south of St. Francis at the South Dakota/Nebraska state line.

BIA 1 Northern Section

The northern section of BIA 1 begins at the intersection of U.S. Highway 18 that heads south for approximately 5.2-miles intersecting few local roads before terminating near the beginning of the urban section of BIA 1 in Rosebud north of the intersection of BIA 1 and BIA 9 near Marshmallow Street.

Due to the crash history throughout the four-county area and the crash countermeasures discussed in section 5.0, the recommended improvements for this route include the following:

- Maintain vegetation along roadway
- Improve Shoulder Surface
- Install Centerline and Shoulder Rumble Strips
- Install Delineators
- Install Retroreflective Pavement Marking

Roadway signs should be inspected every five years to check the condition and reflectivity of them at night and replaced as needed using retroreflective sheeting and background colors meeting current designs standards.

Pavement marking throughout this route are worn and have low visibility. It is recommended that the pavement marking be restriped using either waterborne or epoxy traffic paint with glass beads mixed into them. Inspection of the pavement markings should occur every other year to identify any places where they have deteriorated and be restriped.

BIA 1 provides a concrete pavement travel way with a wide gravel shoulder. In some areas the gravel shoulder was approximately four to six inches in difference creating a drop off between the travel roadway and the shoulder north of Rosebud. The drop off can potentially create a hazard for vehicles that may depart the roadway or pulling over for an emergency situation. It is recommended that the MAP-21 Program consider using a more rigid material for the shoulder such as asphalt pavement or concrete pavement to potentially eliminate the grade separation between the road travel way and the shoulder. Using the more rigid material would allow the Tribe to install shoulder rumble strips as well, which could

decrease the number of road departure crashes by alerting motorist through vibration and noise that alert the motorist they are leaving the travel way.

BIA 1 Urban Section

The urban section of BIA 1 begins near Marshmallow Street that head south for approximately 2.9-miles intersecting many local roads including BIA 9 were it terminates at the western edge of Rosebud. The speed limit varies from 20 mph within school zones, 45 mph in the northern part of the urban section, and 15 mph near the Tribal Headquarters. The roadway transitions from a 24-foot wide concrete and asphalt pavement sections with two travel lanes in the southern section to a five-lane concrete roadway with four travel lanes and a two-way left turn lane (TWLTL) 60-foot concrete pavement section in the northern section.

Due to the crash history throughout the four-county area, crashes at the 90-degree corner near Tribal Headquarters, and the crash countermeasures discussed in section 5.0, the recommended improvements for this route include the following:

- Install Retroreflective Pavement Marking
- Improve Intersection Sight Distance
- Manage access to BIA 1 at the Gas Station and BIA 7 Intersection
- Install 3-way Stop at BIA 1 and Circle Drive Intersection
- Install Signed, Marked Crosswalks
- Install Pedestrian Rectangle Rapid Flashing Beacon
- Install Pedestrian Refuge Islands

Roadway signs should be inspected every five years to check the condition and reflectivity of them at night and replaced as needed using retroreflective sheeting and background colors meeting current designs standards.

Pavement marking throughout this route are worn and have low visibility. It is recommended that the pavement marking be restriped using either waterborne or epoxy traffic paint with glass beads mixed into them. Inspection of the pavement markings should occur every other year to identify any places where they have deteriorated and be restriped.

The large 60-foot section within Rosebud creates a large distance for pedestrians to cover when crosses the street. It is recommended that a Pedestrian Crossing Study be completed in the area to identify known pedestrian crossing areas throughout the urban section. By identifying these locations, a raised pedestrian refuge island is recommended to helps reduce the delay for pedestrian trying to wait for an acceptable gap clearance in traffic to cross the roadway and increase pedestrian safety.

There is intersection sight distances issues at the intersection of BIA 1 and BIA 9 due the shared-use path and its separation from BIA 1. The path crosses the approach at a large offset, causing vehicles having to stop approximately 15-20 feet back from the intersection to allow pedestrians to cross. This causes vehicles having to creep forward and wait within the crosswalk in order to see if there is any oncoming traffic. It is recommended that realignment of the pathway be considered by bringing the pathway closer to the intersection. This will allow vehicles to stop closer to the intersection. Along with moving the pathway closer to the intersection, it is recommended that a raised median with a pedestrian refuge island be installed to create a physical barrier at the intersection. This would allow a free right turn from BIA 9 onto BIA 1 where

traffic would only need to yield to pedestrians and prevent vehicles using terminating right turn lane on BIA 1 continuing through the intersection. Figure 6.5 shows the recommended improvements to the intersection of BIA 1 and BIA 9.

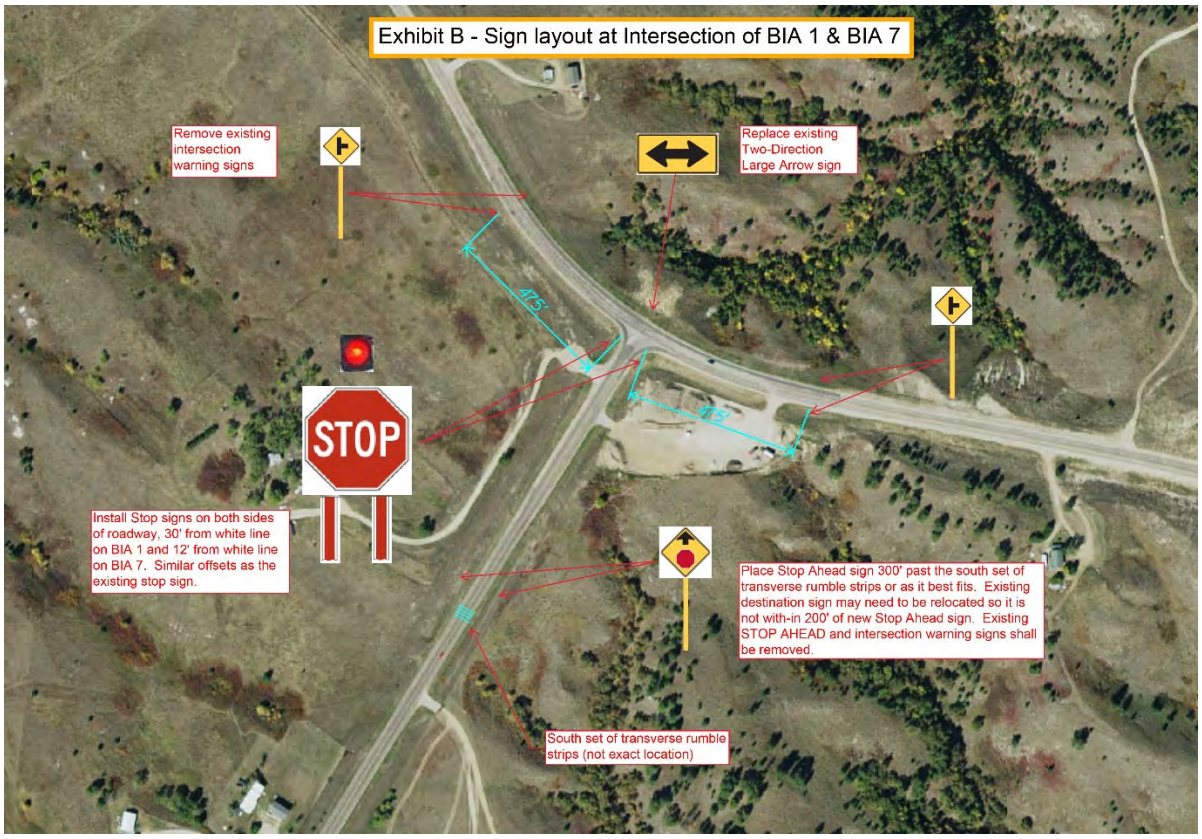
Figure 6.5: BIA 1 and BIA 9 Recommended Safety Improvements



BIA 1 Southern Section

The southern section of BIA 1 begins at the western edge of Rosebud, travels approximately 0.6-miles west to the intersection of BIA 1 and BIA 7. Tribal members have expressed concern of this intersection as many vehicles have passed through the stop sign on BIA 1 and have departed the roadway on the northside resulting in some serious injuries and fatal crashes. SDDOT has implemented a safety project for this intersection and is showing in Figure 6.6. By installing transverse rumble strips on BIA 1 along with the flashing beacons on the stop signs which will alert vehicles of the approaching intersection and the need for them to stop.

Figure 6.6: BIA 1 and BIA 7 Recommended Safety Improvements[7]



Due to the crash history throughout the four-county area and the crash countermeasures discussed in section 5.0, the recommended improvements for this route include the following:

- Add Shoulders
- Install Centerline and Shoulder Rumble Strips
- Install Delineators
- Install Retroreflective Pavement Marking
- Improve Culverts
- Improve Roadway Surface
- Remove/Relocate Fixed Objects outside Clear Zone

There currently are no shoulders south of the intersection of BIA 30 and BIA 1 to the South Dakota/Nebraska State line. It is recommended that shoulders be installed with shoulder rumble strips. This would provide increase safety benefits and would align with the remainder of the route north of the intersection of BIA 30 and BIA 1.

Roadway signs should be inspected every five years to check the condition and reflectivity of them at night and replaced as needed using retroreflective sheeting and background colors meeting current designs standards.

[7] Layout design Provided by the South Dakota Department of Transportation

Flared end sections are recommended to be added to culverts throughout the route and regrading of the slope around the culverts to meet desirable recovery slopes.

Pavement marking throughout this route are worn and have low visibility. It is recommended that the pavement marking be restriped using either waterborne or epoxy traffic paint with glass beads mixed into them. Inspection of the pavement markings should occur every other year to identify any places where they have deteriorated and be restriped.

BIA 4

BIA 4 is a north/south route that is approximately 4.4-miles long with a 24-foot asphalt pavement roadway width with no shoulders. The route begins at the intersection of South Dakota State Route 63 and BIA 4 just west of the community of Parmelle. The route heads south then west for approximately 0.5-miles before meeting with 282nd Street at a T-Intersection. Stop control should be considered for 282nd Street versus the yield control on the south leg of BIA 4, the predominant traffic movement use both the south and east leg of BIA 4 to travel to the school in He Dog.

Due to the crash history throughout the four-county area and the crash countermeasures discussed in section 5.0, the recommended improvements for this route include the following:

- Add Shoulders
- Remove Guardrail
- Install Centerline and Shoulder Rumble Strips
- Install Delineators
- Install Retroreflective Pavement Marking
- Install Horizontal Alignment Signs
- Install Advisory Speed Plaque with Horizontal Alignment Signs
- Install Chevron Alignment Signs
- Remove/Relocate Fixed Objects outside Clear Zone
- Improve Bridge Ends

Roadway signs should be inspected every five years to check the condition and reflectivity of them at night and replaced as needed using retroreflective sheeting and background colors meeting current designs standards.

Pavement marking throughout this route are worn and have low visibility. It is recommended that the pavement marking be restriped using either waterborne or epoxy traffic paint with glass beads mixed into them. Inspection of the pavement markings should occur every other year to identify any places where they have deteriorated and be restriped.

Horizontal alignment signs, advisory speed plaques and chevron signs are needed for placement, suggested advisory speed and chevron spacing along horizontal curves using current standards are outlined in the MUTCD. It is recommended that the suggested advisory speed be determined using a ball-bank indicator and should be determined based on free-flowing traffic conditions.

There currently there is no advance warning signs alerting drivers of the speed change going into He Dog. It is recommended that an advance warning signs be installed to alert drivers of the change in the posted speed limit as outlined in the MUTCD.

BIA 5

BIA 5 is a 13.7-mile asphalt paved north/south rural local road that follows along the Little White River. The route has a pavement top width of 24-feet and no shoulders. It begins at the intersection of BIA 5 and BIA 7 west of the community of Ghost Hawk then heads south intersecting local roads including BIA 501, where it jogs west for approximately 1 mile then heads south again for approximately 5.4-miles where it terminates at the intersection of BIA 5 and BIA 30 within the community of Spring Creek.

Due to the crash history throughout the four-county area and the crash countermeasures discussed in section 5.0, the recommended improvements for this route include the following:

- Maintain vegetation along roadway
- Install Delineators
- Install Retroreflective Pavement Marking
- Install Horizontal Alignment Signs
- Install Advisory Speed Plaque with Horizontal Alignment Signs
- Install Chevron Alignment Signs
- Improve Intersection Sight Distance
- Improve Roadway Surface
- Remove/Relocate Fixed Objects outside Clear Zone
- Improve Bridge Ends

BIA 5 is considered by many tribal members as a scenic byway. The nature of the roadway and following the Little White River it is anticipated that the route would be traveled at lower speeds. Shoulders, guardrail and rumble strips are not recommended for this route.

Roadway signs should be inspected every five years to check the condition and reflectivity of them at night and replaced as needed using retroreflective sheeting and background colors meeting current designs standards.

Pavement marking throughout this route are worn and have low visibility. It is recommended that the pavement marking be restriped using either waterborne or epoxy traffic paint with glass beads mixed into them. Inspection of the pavement markings should occur every other year to identify any places where they have deteriorated and be restriped.

There currently are no advance warning signs alerting drivers of the speed changes throughout the route. It is recommended that an advance warning signs be installed to alert drivers of the change in the posted speed limit as outlined in the MUTCD.

Intersection sight distance issues were also observed along the route at two different locations where a secondary road intersect BIA 5 at a large skew. These two intersections are BIA 5 and BIA 501, and BIA 5 and Tutle Road. Figure 6.7 and Figure 6.8 shows low cost recommended improvements for the two intersection.

Figure 6.7: BIA 5 and BIA 501 Recommended Improvements

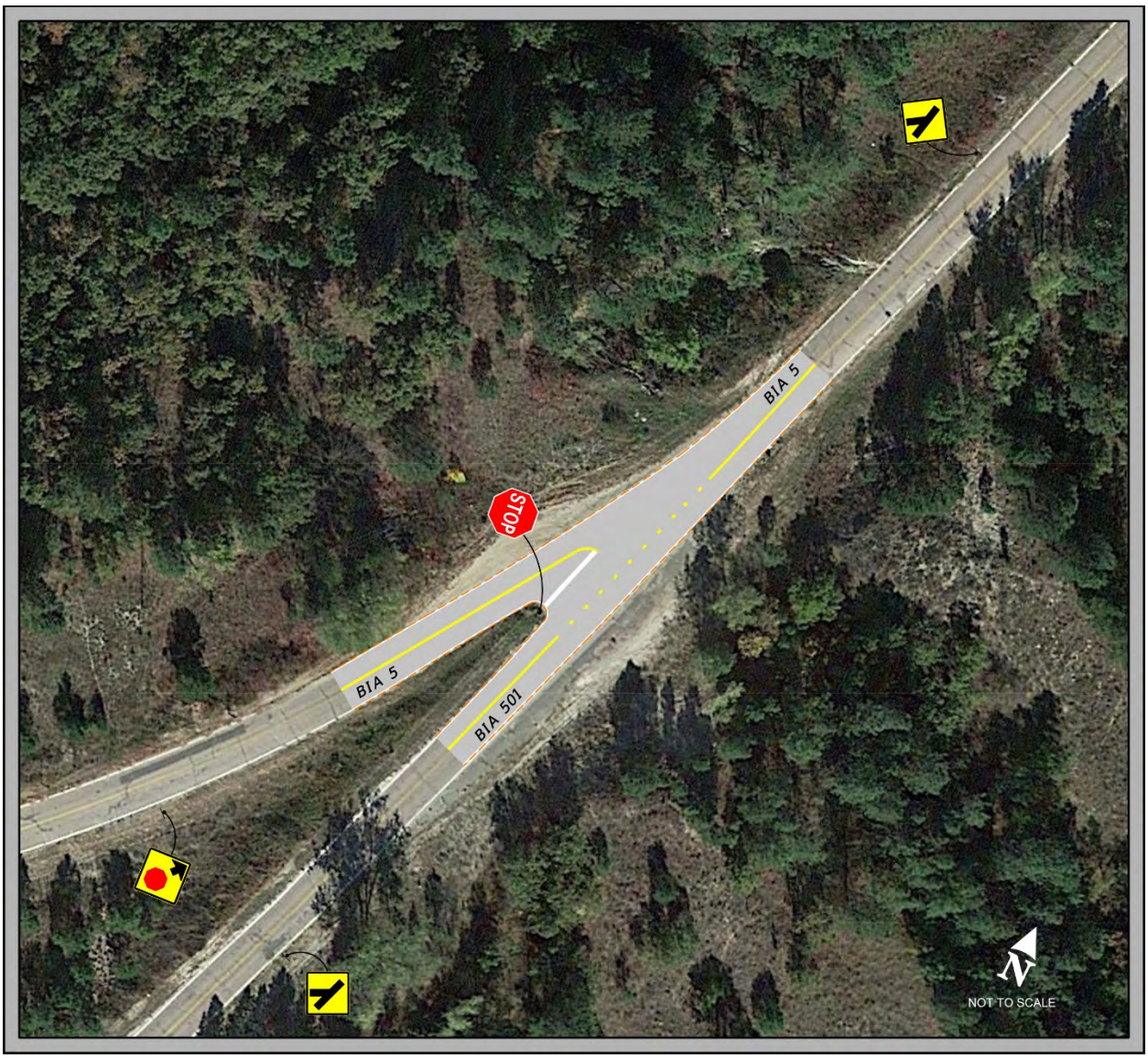
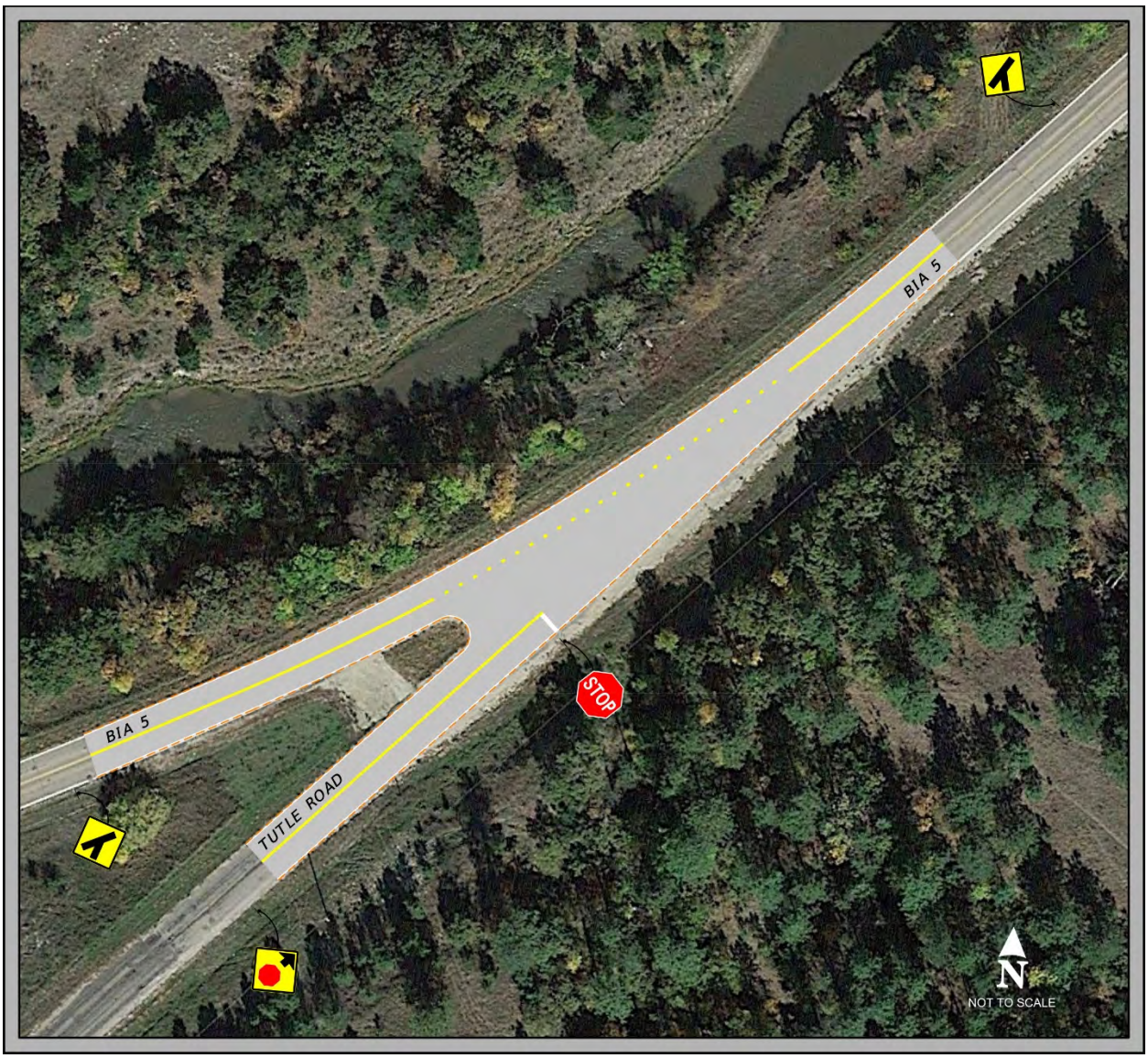


Figure 6.8: BIA 5 and Tutle Road Recommended Improvements



BIA 7

BIA 7 is a rural major collector 13.6-mile northwest/southeast route with an average top width of 36-feet for the western section and 24-feet for the eastern section. The route begins at the intersection of U.S. Highway 18 and heads southeast intersecting local roads including BIA 5 and BIA 1 approximately 0.6-miles west of Rosebud. The route then continues from BIA 1 in the town of Rosebud to 6-miles where it terminates at the intersection of Lakeview Road.

Due to the crash history throughout the four-county area and the crash countermeasures discussed in section 5.0, the recommended improvements for this route include the following:

- Improve Intersection with BIA 1 in Rosebud
- Maintain Vegetation Along Roadway
- Remove Guardrail at Ghost Hawk Lake

- Improve Guardrail at Rosebud Dam
- Install Delineators
- Improve Intersection Alignment
- Install Retroreflective Pavement Marking
- Remove/Relocate Fixed Objects outside Clear Zone

The SDDOT is currently planning on installing shoulder rumble strips on the western section of the route for the Tribe as a safety project within the next year or two. Rumble strips should also be added to the western section of BIA 7 after reconstruction.

Roadway signs should be inspected every five years to check the condition and reflectivity of them at night and replaced as needed using retroreflective sheeting and background colors meeting current designs standards.

Pavement marking throughout this route are worn and have low visibility. It is recommended that the pavement marking be restriped using either waterborne or epoxy traffic paint with glass beads mixed into them. Inspection of the pavement markings should occur every other year to identify any places where they have deteriorated and be restriped.

There currently are no advance warning signs alerting drivers of the speed changes going into Rosebud. It is recommended that an advance warning signs be installed to alert drivers of the change in the posted speed limit as outlined in the MUTCD.

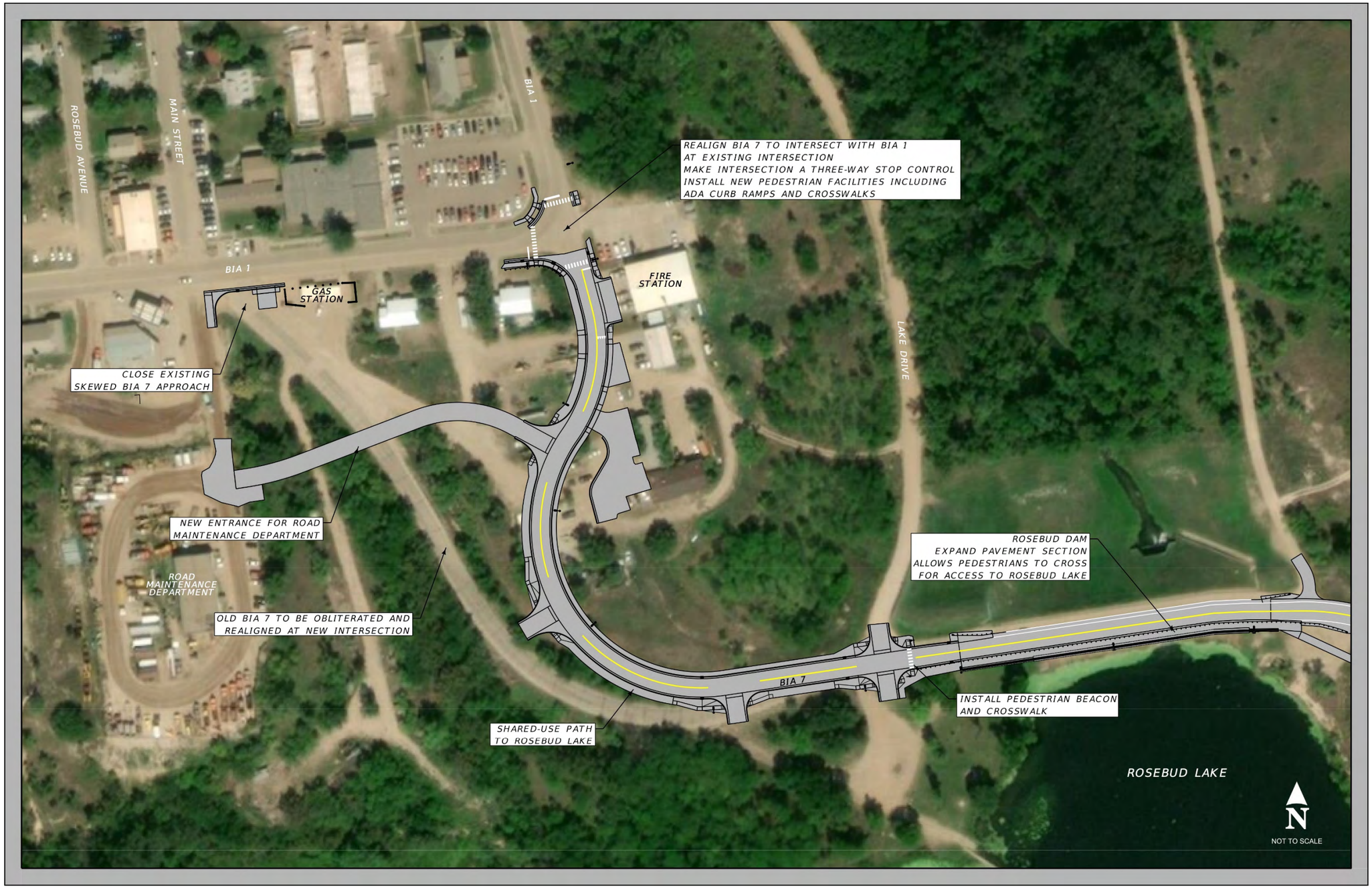
As guardrail can be used as a safety improvement along the roadway when deemed as a necessary safety improvement, it can also become a roadside hazard by creating a fixed object within the clear zone when there is no added benefit for the guardrail. During the inventory process it was observed on BIA 7 near Ghost Hawk Lake, outdated cable guardrail is present and served more as a safety hazard versus a safety benefit. Where the guardrail is installed the slopes are relatively flat on both sides of the roadway and there is adequate clear zone space between the roadway and the lake on the south side of the roadway. It is recommended that this guardrail be removed from the areas along with additional wood post that are within the clear zone of the roadway.

BIA 7 REALIGNMENT

The intersecting angle of BIA 7 to BIA 1 in Rosebud is at an acute angle and results in reduced sight distance. The intersection is further complicated by uncontrolled access to the adjacent gas station, parking on north side of BIA 1 and opposite street intersections in close proximity. Since realigning BIA 7 to intersect BIA 1 at 90 degrees and placing directly across from Main St reduces access to the gas station, an alternate placement of BIA 7 is recommended. See **Figure 6.9** for recommended location of BIA 7 and BIA 1 intersection. A 3-way stop, pedestrian pathways, ADA ramps, and crosswalks are also recommended. The gas station access should be better managed and truck traffic from road maintenance shop rerouted.

Since pedestrians are currently using BIA 7 to approximately 1 mile east of Rosebud, a lighted pathway should be incorporated with reconstruction to provide a safe, separated location for pedestrians.

Figure 6.9: BIA 7 Realignment



BIA 9

BIA 9 is a 20.6-mile-long roadway. The roadway is paved for approximately 5.8-miles with an average top width of 36-feet. The remaining 14.8-miles of roadway is gravel with an average top width of 20-feet.

BIA 9 Paved Section

The paved section of BIA 9 is functionally classified as a rural local road and begins in Rosebud at the intersection BIA 1 and BIA 9. The roadway then heads north/northwest for approximately 5.8-miles where it terminates at the intersection of BIA 9 and U.S. Highway 18.

Due to the crash history throughout the four-county area and the crash countermeasures discussed in section 5.0, the recommended improvements for this route include the following:

- Maintain vegetation along roadway
- Install Delineators
- Install Retroreflective Pavement Marking
- Install Centerline and Shoulder Rumble Strips

Roadway signs should be inspected every five years to check the condition and reflectivity of them at night and replaced as needed using retroreflective sheeting and background colors meeting current designs standards.

Pavement marking throughout this route are worn and have low visibility. It is recommended that the pavement marking be restriped using either waterborne or epoxy traffic paint with glass beads mixed into them. Inspection of the pavement markings should occur every other year to identify any places where they have deteriorated and be restriped.

BIA 9 Gravel Section

The gravel section of BIA is functionally classified as rural major collector and begins approximately 1,200 feet west of where the pavement section ends on U.S. Highway 18. The route then heads north/northeast for approximately 3.3-miles before jogging east for 8-miles ending at the intersection of BIA 9 and U.S. Highway 83. BIA 9 then begins again off U.S. Highway 83 approximately two miles north where it heads east for an additional 3.5 terminating at the intersection of BIA 9/278th Street and 274th Avenue.

Due to the crash history throughout the four-county area and the crash countermeasures discussed in section 5.0, the recommended improvements for this route include the following:

- Maintain vegetation along roadway
- Install Delineators
- Improve Bridge Ends

Roadway signs should be inspected every five years to check the condition and reflectivity of them at night and replaced as needed using retroreflective sheeting and background colors meeting current designs standards.

The gravel section on BIA 9 has been well maintained by the Rosebud Sioux Tribe Road Maintenance Department. It is recommended that their practices be continued and be carried over to other gravel routes within the Reservation.

BIA 12

BIA 12 is approximately a 3.6-mile gravel rural local road with a roadway width of 22-feet. The route begins at the intersection of BIA 30 and BIA 12 then heads southwest for 0.4-miles before heading south for 3.2 mile and terminates at the intersection of BIA 12 and Two Eagle Road.

Due to the crash history throughout the four-county area and the crash countermeasures discussed in section 5.0, the recommended improvements for this route include the following:

- Maintain vegetation along roadway
- Install Delineators
- Install Retroreflective Pavement Marking
- Install Horizontal Alignment Signs
- Install Advisory Speed Plaque with Horizontal Alignment Signs
- Install Chevron Alignment Signs
- Improve Road Drainage and Ditch Drainage
- Remove/Relocate Fixed Objects outside Clear Zone

Roadway signs should be inspected every five years to check the condition and reflectivity of them at night and replaced as needed using retroreflective sheeting and background colors meeting current designs standards.

The gravel section is currently showing signs of washboarding and rutting creating an unsafe driving surface for drivers. It is recommended that the gravel be regraded to correct the washboarding and rutting. The Gravel Roads Construction & Maintenance Guide by the U.S. Department of Transportation provides guidance on how to prevent and maintain washboarding and should be referred to.

BIA 30

BIA 30 is approximately 9.7-mile asphalt paved rural major collector roadway with a width of 24-feet and no shoulders. It begins in the community of Spring Creek approximately 2.7-miles west of the intersection of BIA 30 and BIA 5. The head through a series of curve before heading east for five miles where it terminates at the intersection of BIA 30 and BIA 1.

Due to the crash history throughout the four-county area and the crash countermeasures discussed in section 5.0, the recommended improvements for this route include the following:

- Maintain vegetation along roadway
- Install Delineators
- Install Centerline Rumble Strips
- Install Retroreflective Pavement Marking
- Install Horizontal Alignment Signs
- Install Advisory Speed Plaque with Horizontal Alignment Signs
- Install Chevron Alignment Signs
- Remove/Relocate Fixed Objects outside Clear Zone
- Install Sidewalks
- Install Signed, Marked Crosswalks

Within the community of Spring Creek there is no school zone signing near the school off Yellow Cloud Road. Along with the no school zone signing there is no designated area for school aged children to easily

walk to and from school to the tribal housing areas. This creates hazards as children may then walk on the road to get to their destinations. It is recommended that sidewalk and proper signing and crosswalks be installed for the school zone following the guidelines from the MUTCD.

There currently are no advance warning signs alerting drivers of the speed changes going into Spring Creek and near the school. It is recommended that an advance warning signs be installed to alert drivers of the change in the posted speed limit as outlined in the MUTCD.

There are currently no shoulders throughout the entire route. Due to the absence of shoulders, shoulder rumble strips are not recommended but a centerline rumble strip is recommended. It is recommended that thicker white edge line be striped on the roadway to provide more emphasis on the edge of the travel way.

Roadway signs should be inspected every five years to check the condition and reflectivity of them at night and replaced as needed using retroreflective sheeting and background colors meeting current designs standards.

Pavement marking throughout this route are worn and have low visibility. It is recommended that the pavement marking be restriped using either waterborne or epoxy traffic paint with glass beads mixed into them. Inspection of the pavement markings should occur every other year to identify any places where they have deteriorated and be restriped.

BIA 37

BIA 37 is approximately 4.2-mile gravel rural local roadway. The route begins at the intersection of BIA 37 and BIA 4 and head southwest for approximately 2.9-miles. This section of BIA 37 has a roadway top width of 24-feet with no shoulders. The route then heads south at the intersection of BIA 37 and He Dog Road for approximately 1.3-miles where it then terminates at the intersection of BIA 37 and U.S. Highway 18.

Due to the crash history throughout the four-county area and the crash countermeasures discussed in section 5.0, the recommended improvements for this route include the following:

- Maintain vegetation along roadway
- Install Delineators
- Install Horizontal Alignment Signs
- Install Advisory Speed Plaque with Horizontal Alignment Signs
- Install Chevron Alignment Signs
- Improve Road Drainage and Ditch Drainage
- Remove/Relocate Fixed Objects outside Clear Zone

The gravel section is currently showing signs of washboarding and rutting. There are many soft spots throughout BIA 37 where the gravel has not been maintained and only dirt is present on the roadway. creating an unsafe driving surface for drivers. It is recommended that the gravel be regraded to correct the washboarding, soft spots, rutting and road drainage issues. The Gravel Roads Construction & Maintenance Guide by the U.S. Department of Transportation provides guidance on how to prevent and maintain washboarding and should be referred to.

Roadway signs should be inspected every five years to check the condition and reflectivity of them at night and replaced as needed using retroreflective sheeting and background colors meeting current designs standards.

BIA 501

BIA 501 is approximately 5.9-mile asphalt paved local roadway with a width of 24-feet and no shoulders. The route begins at the intersection of BIA 5 and BIA 501 the heads south for approximately three miles. BIA 501 then heads east for approximately 2.9-miles where it terminates at the intersection of West Street and BIA 501/Maple Avenue within the town of St. Francis.

Due to the crash history throughout the four-county area and the crash countermeasures discussed in section 5.0, the recommended improvements for this route include the following:

- Install Guardrail
- Maintain vegetation along roadway
- Install Centerline and Shoulder Rumble Strips on paved routes
- Install Delineators
- Install Retroreflective Pavement Marking
- Install Horizontal Alignment Signs
- Install Advisory Speed Plaque with Horizontal Alignment Signs
- Install Chevron Alignment Signs
- Improve Roadway Surface
- Remove/Relocate Fixed Objects outside Clear Zone

There is no guardrail present were the slope exceeds a 4:1. It is recommended that guardrail be installed, and some slope flattening be done along the route if found feasible during the design phase. Refer to **Figure 6.4** for the locations of these recommendations.

Roadway signs should be inspected every five years to check the condition and reflectivity of them at night and replaced as needed using retroreflective sheeting and background colors meeting current designs standards.

There currently are no advance warning signs alerting drivers of the speed changes going into St. Francis. It is recommended that an advance warning signs be installed to alert drivers of the change in the posted speed limit as outlined in the MUTCD.

Pavement marking throughout this route are worn and have low visibility. It is recommended that the pavement marking be restriped using either waterborne or epoxy traffic paint with glass beads mixed into them. Inspection of the pavement markings should occur every other year to identify any places where they have deteriorated and be restriped.

Tribal Communities

Along with the inventory of the BIA routes, the following communities were analyzed for pedestrian safety issues and pedestrian connectivity throughout the community.

- Antelope
- Corn Creek
- Horse Creek
- Ideal
- Milks Camp
- Norris
- Okreek
- Parmelle
- Sicangu Village
- White Horse
- White River
- Winner
- Wood
- Saint Francis

Throughout the inventory of the communities, it appeared that there was no standard for when to provide sidewalks within the community or the surfacing section for the roadway to use. These standards are usually adopted with a LRTP and is beyond the scope of this RSA. It is recommended that the Rosebud Sioux Tribe update their current LRTP and have it adopted by the tribal council. The LRTP should consider pedestrian connectivity to/from schools and tribal community centers.

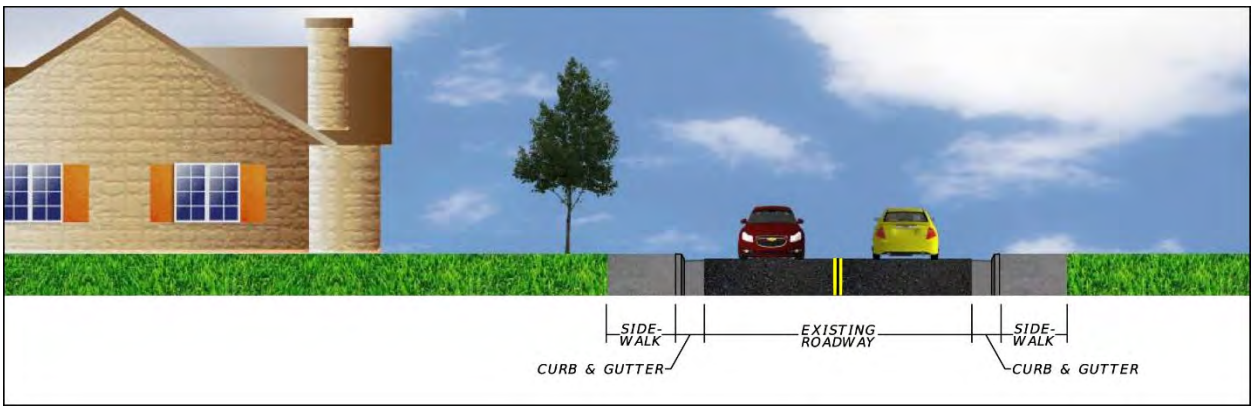
Along with sidewalk connectivity, shared use paths were considered between certain communities where high pedestrian traffic has been observed by tribal members. Like sidewalk standards, shared-use pathway locations are typically defined in the LRTP and it is recommended locations for shared-use pathways be considered when updating the LRTP.

The following are recommendations for areas within the Rosebud Indian Reservations.

SAINT FRANCIS COMMUNITY

The community of Saint Francis has BIA 1 passing through it and BIA 501 terminates inside Saint Francis. There currently are no advance warning signs alerting drivers of the speed changes going into St. Francis. It is recommended that an advance warning signs be installed to alert drivers of the change in the posted speed limit as outlined in the MUTCD. There are no pedestrian facilities along BIA 1 going through Saint Francis. The Tribe should consider an urban roadway section that would allow the addition of curb and gutter and attached sidewalks along both sides of the route to allow pedestrians to safely walk along the BIA 1 without having to walk on the roadway. Figure 6.10 shows a recommended urban roadway typical section the Tribe should consider for BIA 1. This typical section should be considered beginning approximately 800-feet north of the intersection of Cherry Street and BIA 1 then head south for approximately 0.9-miles, terminating at the approach to the school housing for the Saint Francis Indian School.

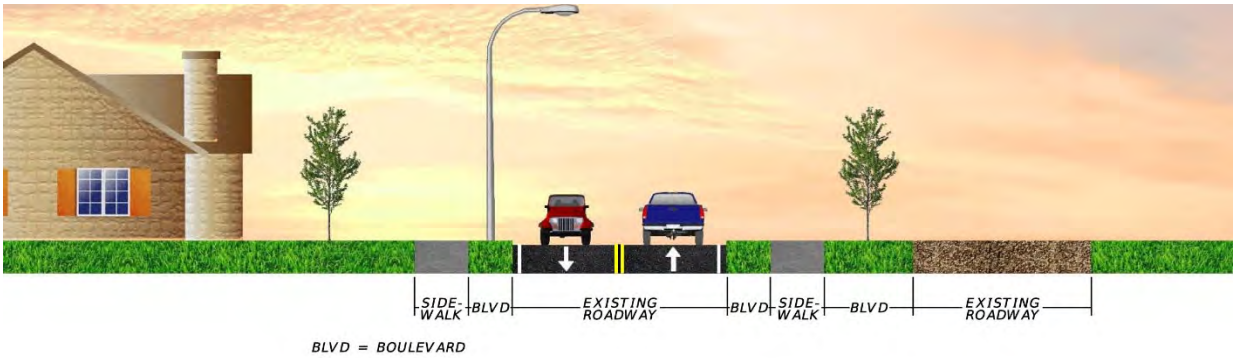
Figure 6.10: Proposed Typical Section Through Saint Francis on BIA 1



PARMELEE COMMUNITY

The community of Parmelee has South Dakota State Highway 63 passing through it. The posted speed limit through the community 30 mph and there are currently no pedestrian facilities along the route. It is recommended that the Tribe consider the addition of detached sidewalks with boulevards and roadway lighting to allow pedestrians to safely walk along the state highway without having to walk on the roadway. Figure 6.11 shows a recommended roadway typical section the tribe should consider. Coordination with SDDOT will be need if a project were to come fruition.

Figure 6.11: Proposed Typical Section Through Parmelee



ANTELOPE AND WHITE HORSE COMMUNITIES

One area for consideration for pathways and additional sidewalk was between the South Antelope Community and White Horse Community. Figure 6.12 shows the proposed recommended improvements for pedestrian connectivity to consideration when updating the LRTP. Coordination with SDDOT will be needed if a project were to come fruition for the Pathway along US Highway 18.

Figure 6.12: Proposed Pedestrian Connectivity

