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LOCAL ROAD SAFETY PRACTICES AND PERCEPTIONS IN NORTH DAKOTA

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16. Abstract

Annually, many injuries and fatal crashes happen on local rural roads in North Dakota. The local road safety program (LRSP) strategy has been proven effective in reducing crashes on these roads. It relies on state engagement with local stakeholders to collectively reduce crash injuries in their communities. The LRSP presents a framework for stakeholders to identify, analyze, and prioritize traffic safety improvements for their roadways. In this study, local road managers were surveyed about road safety activities with special emphasis on the western counties in the oil impact region. The results reflect current practices in local government road management. It will be a resource for growing program participation and activities by providing best practices and peer knowledge sharing. One in five counties reported applying for LRSP projects over the past five years. Comparison to a previous survey shows a notable expansion in counties adopting low-cost safety strategies. The benefits of federal and state support in instituting local road safety practices were evident in funding sources and planning activities reported by counties. Several opportunities to carry this forward in proactive safety opportunities for individual counties with specific crash-type prevention strategies and for systemwide site-based safety countermeasures were evident. The survey investigation can inform other states by providing insight regarding LRSP practices and perceptions, with regard to improvements in local road safety and the potential to grow local agencies as champions in the effort.

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Local Road Safety Practices and Perceptions in North Dakota

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ABSTRACT

Annually, many injuries and fatal crashes happen on local rural roads in North Dakota. The local road safety program (LRSP) strategy has been proven effective in reducing crashes on these roads. It relies on state engagement with local stakeholders to collectively reduce crash injuries in their communities. The LRSP presents a framework for stakeholders to identify, analyze, and prioritize traffic safety improvements for their roadways. In this study, local road managers were surveyed about road safety activities with special emphasis on the western counties in the oil impact region. The results reflect current practices in local government road management. It will be a resource for growing program participation and activities by providing best practices and peer knowledge sharing. One in five counties reported applying for LRSP projects over the past five years. Comparison to a previous survey shows a notable expansion in counties adopting low-cost safety strategies. The benefits of federal and state support in instituting local road safety practices were evident in funding sources and planning activities reported by counties. Several opportunities to carry this forward in proactive safety opportunities for individual counties with specific crash-type prevention strategies and for systemwide site-based safety countermeasures were evident. The survey investigation can inform other states by providing insight regarding LRSP practices and perceptions, with regard to improvements in local road safety and the potential to grow local agencies as champions in the effort.

TABLE OF CONTENTS

LIST OF FIGURES

1. INTRODUCTION

Local agency ownership accounts for almost 75% of the U.S. roadway miles. About 50% of U.S. roadway deaths occurred on the local system in 2016, based on Strategic Highway Safety Plans (SHSP) and Highway Safety Improvement Program (HSIP) figures (Roberts, Keierleber, Davis, Isebrands, Roche, & Walsh, 2018). The prominence of local road traffic varies by state considering the public road safety system context governing the federal road investment planning. States with substantial agricultural and other natural-resource-based industries often rely heavily on local roads, with more than 80% of all miles traveled on this network segment (National Highway Traffic Safety Administration, 2016). Serving this local travel demand in an efficient and safe manner is a priority in rural economies but is persistently challenging in a sparsely populated landscape. According to Hall and Tarko (2019), local roads commonly suffer from outdated geometrical designs, low visibility, and roadside obstructions that make them relatively dangerous for users. Legacy investments and constrained local funding provide little opportunity to proactively address rural road safety concerns amid challenges to adequately serve basic needs such as maintenance.

Rural local roads are usually identified as low-traffic volume roads. Hall (2017) noted that the low-volume road classification can vary significantly among jurisdictions. For example, rural local roads typically have traffic of 400 to 2,000 vehicles per day, depending on factors such as proximity to major urban centers and/or rural economic activity hubs. Efforts have been made to quantify safety for these rural roads and bring focus to primary safety issues. Despite having fewer total crashes than their rural state-road counterparts, rural local roads are susceptible to higher crash risk rates when travel is adjusted for exposure in vehicle miles traveled (VMT) (Souleyrette et al., 2010).

Thus, continued work to heighten local rural road safety awareness is coupled with a need to identify resources for investment, operation, and outreach on this network. The primary federal road infrastructure safety program is the HSIP. Under the Fixing America's Surface Transportation (FAST) Act, lump-sum apportionments flowed to states with a directive to reduce severe and fatal traffic injuries on all public roads. This directive came with a requirement for strategic and data-driven improvements. The state SHSP guides allocations of HSIP funds to reduce roadway traffic injuries most effectively. Waldheim, Gaines, and Isebrands (2017) point out that HSIP funds dedicated to local rural roads, however, have not been proportionate to safety issues in terms of frequency and severity of crashes. As leaders and champions in this domain, state DOTs have a critical role in engaging local partners in strategically investing road safety resources to save lives and prevent injuries.

The SHSP is a framework for reducing severe injuries and fatalities on all public roads using a statewide and interdisciplinary approach. To develop a plan focused on informed safety decisions for local roads, communities are encouraged to identify priorities and address challenges in their own local road safety plans (LRSP). The champion for these plans is often the local road manager. The LRSP is a performance-based framework aimed at reducing traffic crashes on roads owned by local agencies. In concept, it is generated through a partnership that engages experts, agencies, and communities in identifying priorities to improve community traffic safety. To reflect changing local needs and preferences, the plan must be continuously revised and updated based on local road safety issues (Roberts et al., 2018). These local plans typically share themes with the state's SHSP framework.

1.1 Local Rural Road Crashes in North Dakota

Crashes on the local rural road network, with the exception of those within towns, were analyzed in the state's early work with counties and tribal nations LRSPs (ND LRSP, 2014). The local rural road crash trend for severe crashes, defined to include events with fatal and disabling injury outcomes, is presented in Figure 1.1. The trend over the past 15 years shows a peak in severe crash events in 2012, following a steep incline after 2009. Crashes on local rural and other rural roads in the state have generally trended downward since 2012. The severe crash trend on other roads fell below the 2005 benchmark count in 2019, while the local road crash trend remained slightly above that baseline after a slight spike in 2017. The local road definition used in the graph is based on the legacy classification system so does not represent HSIP eligibility. It does, however, offer a proxy in the road group safety trends.

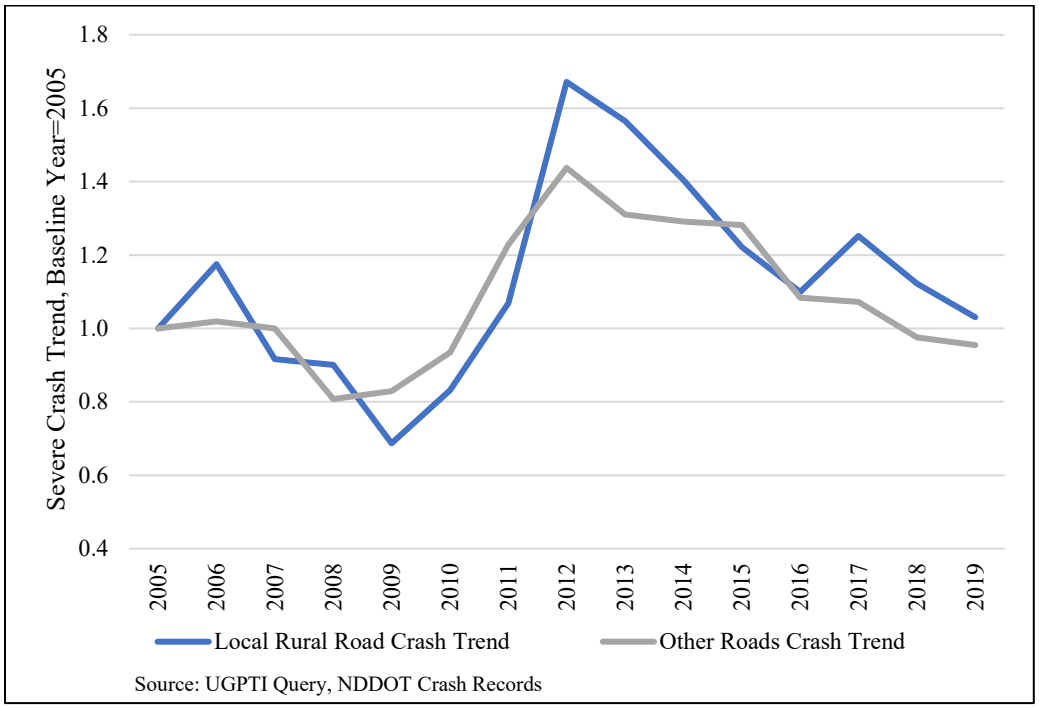

Figure 1.1 North Dakota road network safety trends, fatal and disabling crashes by road group

Annual traffic estimates for two major industries in the state provides context for the local road crash trends. Agriculture and oil products are sourced primarily from locations adjacent to local roads. Traffic impacts were especially evident in the state's oil impact region. This region has faced traffic safety issues due to an exponential increase in its traffic volumes. The area consists of 17 counties in the western part of the state: Adams, Billings, Bowman, Burke, Divide, Dunn, Golden Valley, Grant, Hettinger, McKenzie, McLean, Mercer, Mountrail, Renville, Slope, Stark, and Williams. Adams, Grant, and Hettinger counties do not currently produce oil, but still might be affected by traffic caused by oil-related activities in their adjacent locations. The crash increase has been associated with economic growth and the oil boom in the region. While investments in road safety infrastructure, driver education, and traffic enforcement have increased road capacity and reduced crash risk, pressure on the region's local road systems continues as oil extraction and drilling remain active. While oil increasingly moved in pipelines from ND origins, the steep slope in oil production associated with the development phase in the mid-2000s greatly impacted local rural road traffic. In addition, the state's road safety is impacted by longstanding seasonal agricultural traffic and increasing agricultural productivity (Figure 1.2).

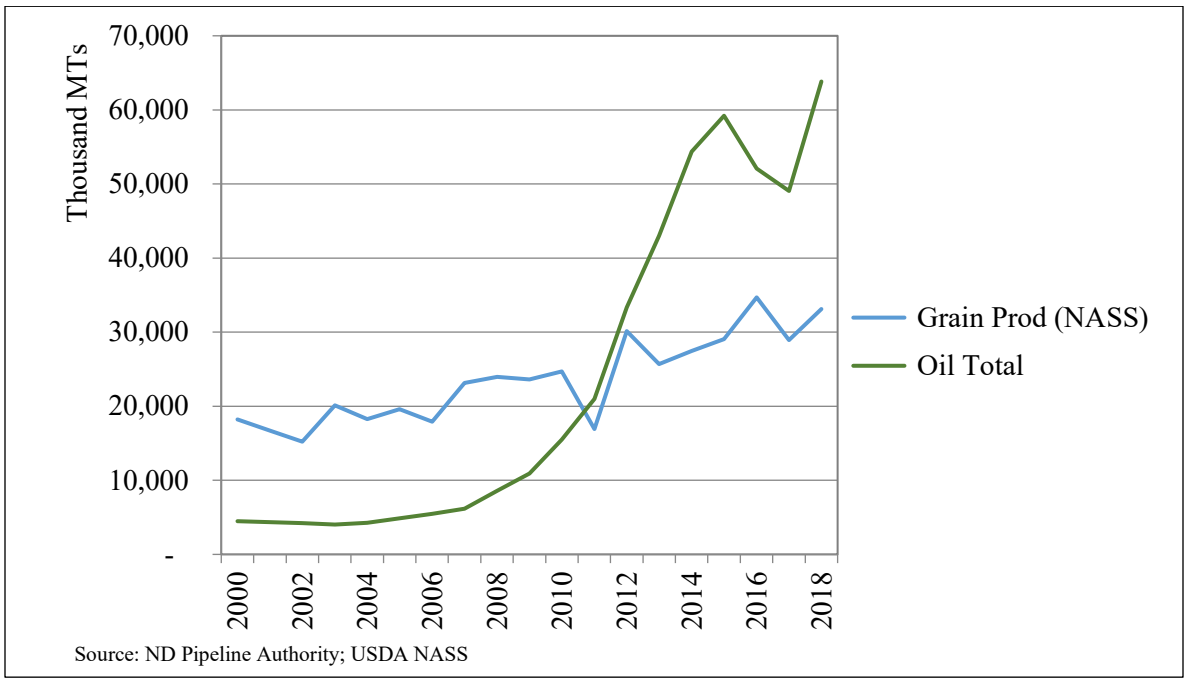

Figure 1.2 ND grain production and oil traffic trends, estimated

Local roads remain a network priority in North Dakota's traffic safety efforts. State crash records show that 18.1% to 24.4% of injury crashes were on the local roads annually between 2010 and 2019. This share peaked in 2012 at 24.4%. These crashes are not equally dispersed across the state as depicted in county crash counts between 2015 and 2019 (Figure 3). Western ND counties suffered more crashes on local roads along with counties in more densely populated eastern border region counties. Evidence of the oil region's traffic impact in the west, during an intense exploration and development starting in 2011, is evident in Figures 1.1 and 1.3.

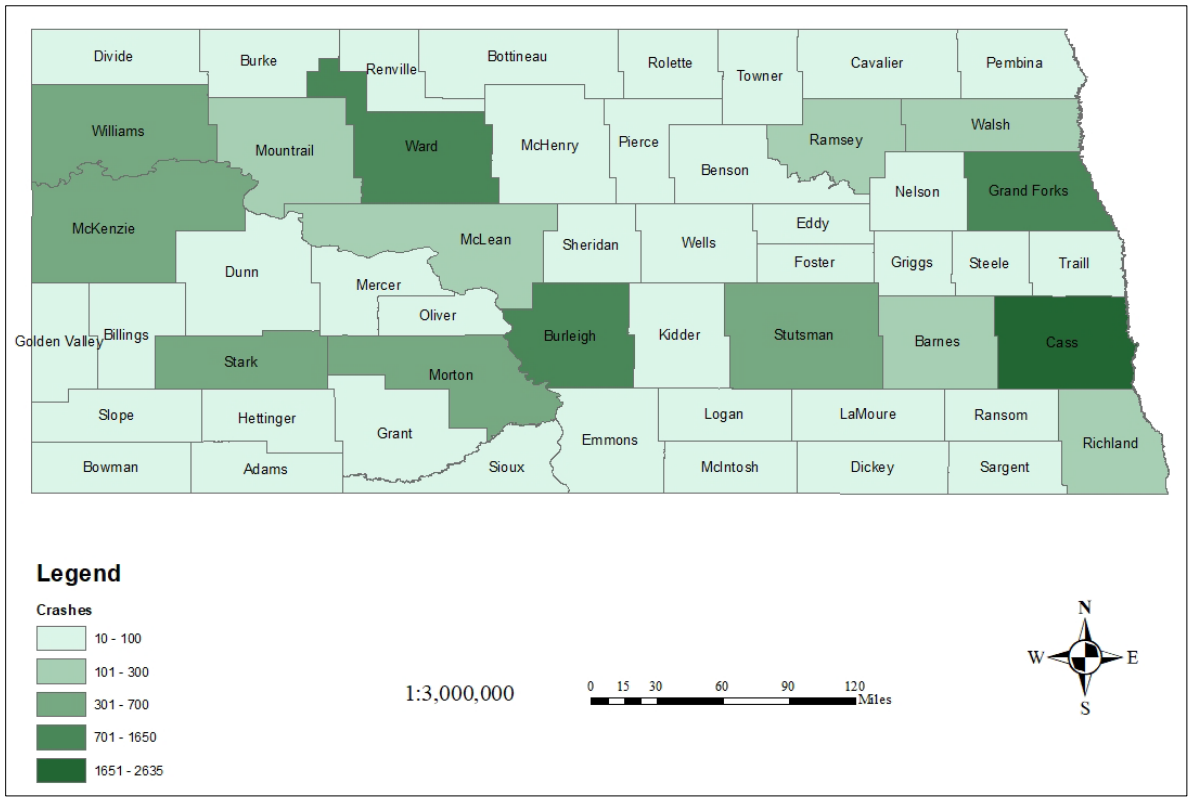

Figure 1.3 Local road crashes in ND counties, between 2015 to 2019

In addressing crash risk, emphasis is typically given to more severe injury outcomes. Fatal crash analysis at the county level unveils a crash cluster in western oil impact region counties (Figure 1.4) These counties are at the core of the 17 counties. NDDOT reported that one in two serious injury crashes were located in oil-impact counties between 2012 and 2016 (North Dakota Highway Safety Improvement Program, 2018). These counts do not account for exposure, which is an important aspect in spatial crash risk comparisons. Additional investigation, considering a standardized crash risk metric, was needed to discuss relative crash injury risk in prioritizing resource commitment to LRSP activities.

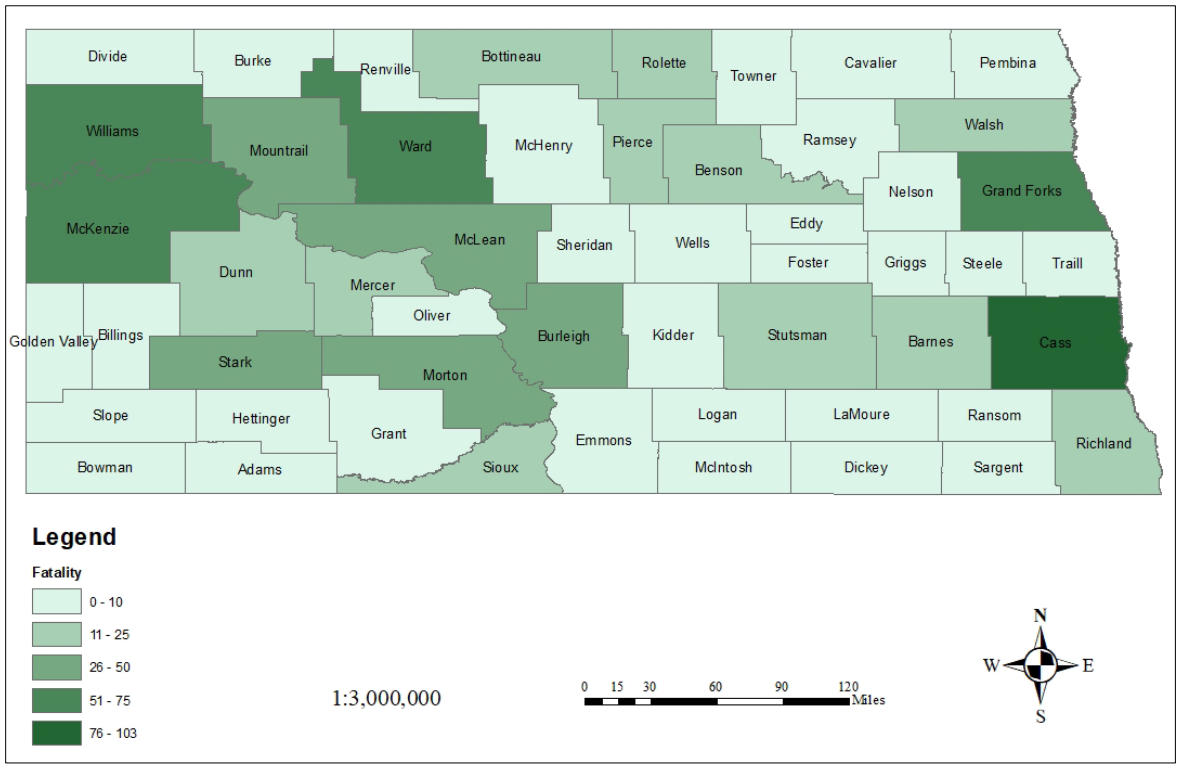

Figure 1.4 Local road fatal crashes in ND counties, between 2015 and 2019

To better compare crashes and injuries from different counties, crash incidence computations are documented in the following maps. Figure 1.5 illustrates local road crash incidence. In this case, all local road crash counts between 2015 and 2019 were normalized by population of the respective counties to calculate a crash incidence rate. Accounting for the underlying population counts as a proxy for traffic activity exposes a relatively high local road crash-risk area in the west central region.

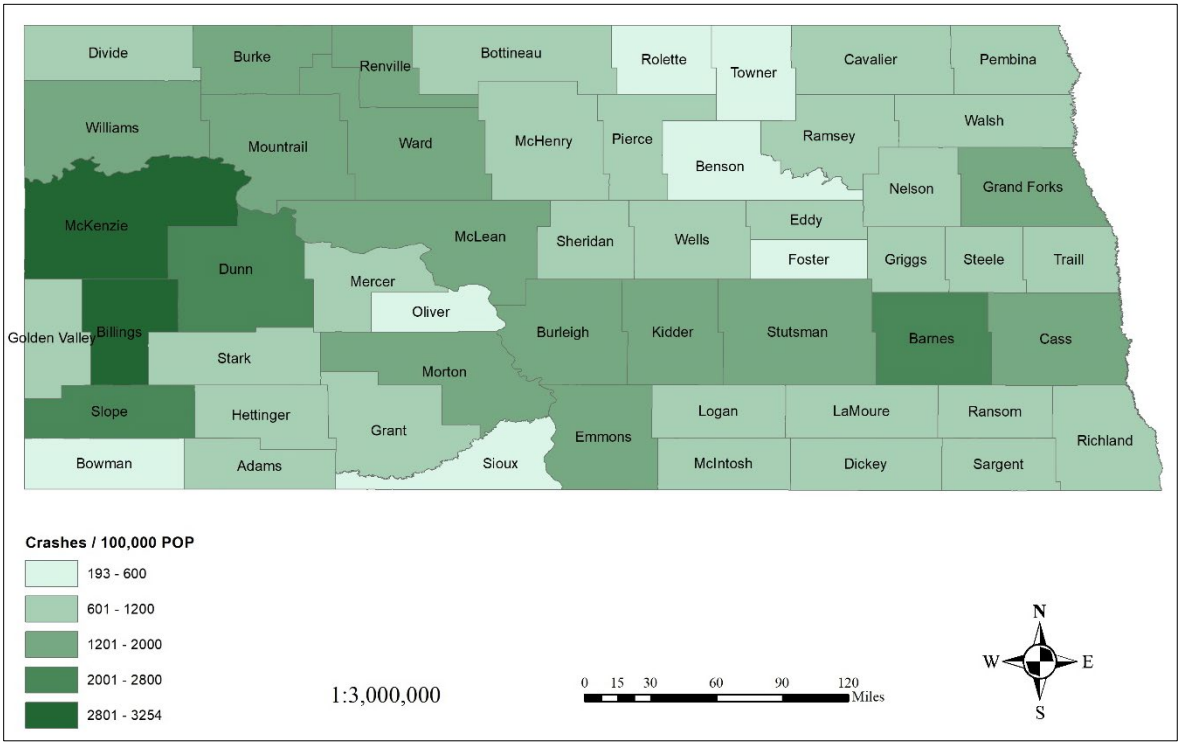

Figure 1.5 Local road crashes per 100,000 population in ND counties, between 2015 and 2019

Figure 1.6 focuses on injury crash occurrences within all local crashes, disregarding those with only property damage reported. The number of crash injuries and fatalities in ND counties was scaled across a five-level color map scale, from fewest crash counts in lighter-shaded counties to highest crash counts in the darker-shaded counties. While similar to the previous local road crash count metric, the occupant-level crash injury counts were normalized by the respective population of the counties. Both VMT and population were considered as moderating factors in calculating exposure. Unfortunately, the traffic information could not be disaggregated to accurately represent rural local road traffic. Therefore, population was selected with a unit set at 100,000 residents. These maps provide an early overview for the county road manager traffic safety survey and investigation into the LRSP implementation across the state.

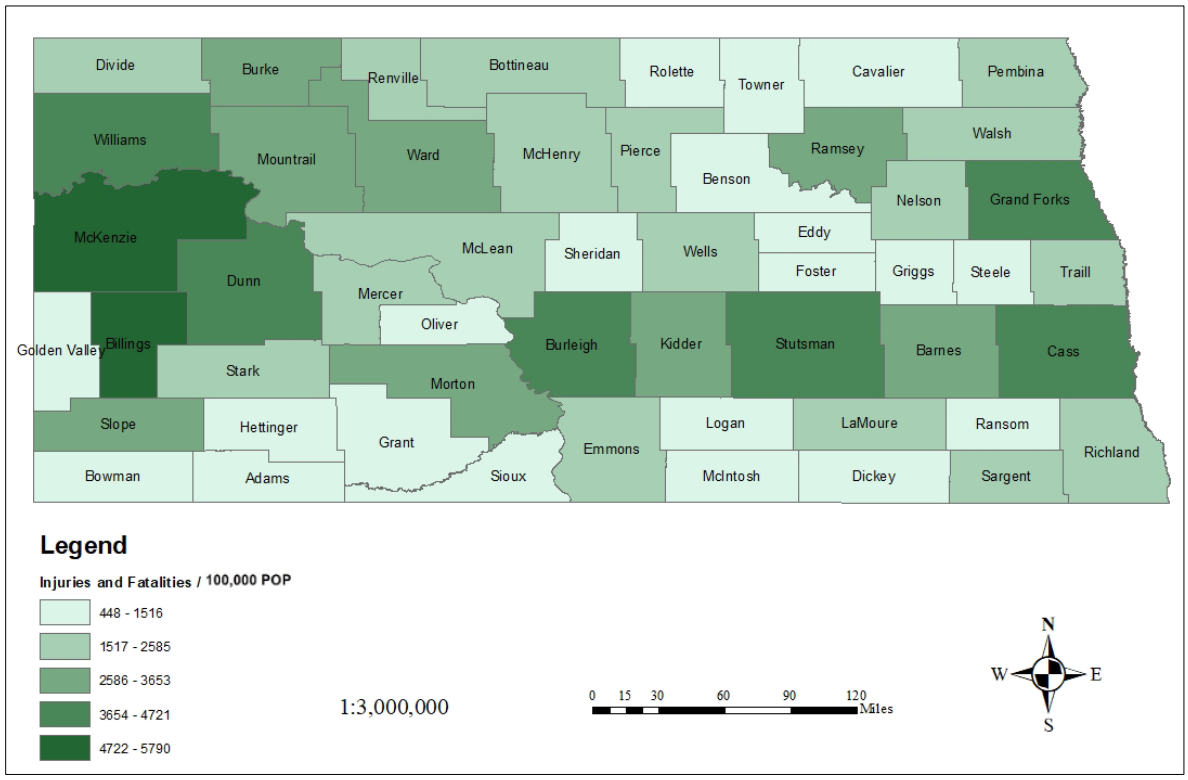

Figure 1.6 Local road injuries and fatalities per 100,000 population in ND counties, between 2015 and 2019

Additional insight into local road safety was available in considering rural gravel roads. Low traffic counts and limited local resources mean these roads generally have the lowest priority and not substantial funding for safety treatment. Figure 1.7 also shows the severe injury crashes differentiated by fatalities and other injuries between 2017 and 2019. Since many local road crashes occur on gravel roads, Figure 1.8 presents a map indicating the number of severe injury crashes on ND local gravel roads.

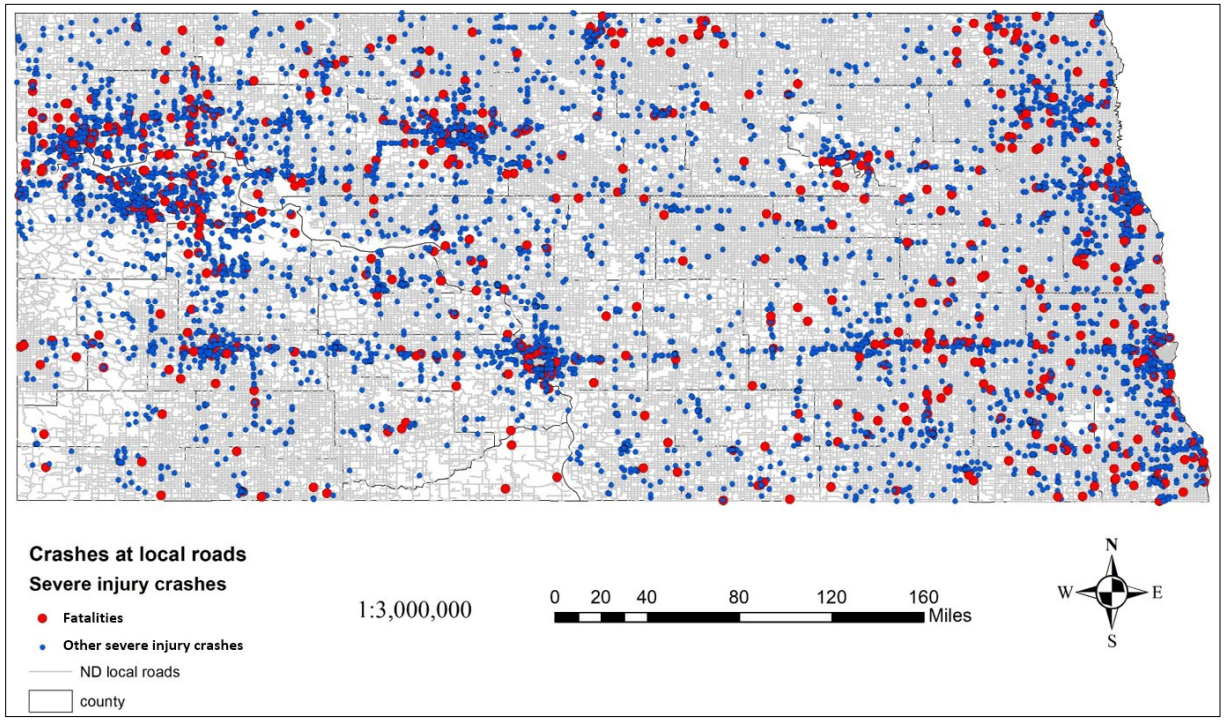

Figure 1.7 Local road severe injury crashes in ND counties on gravel and paved surfaces, between 2017 and 2019

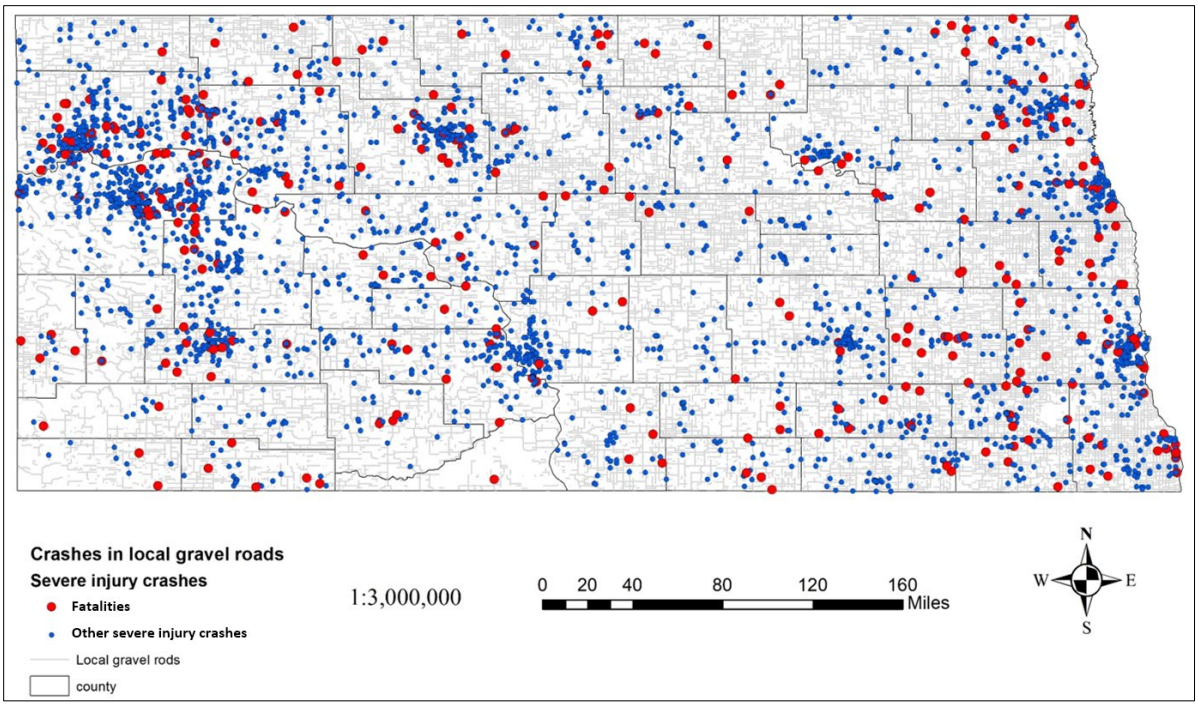

Figure 1.8 Local road severe injury crashes in ND counties at gravel surfaces, between 2017 and 2019

1.2 North Dakota endorses LRSPs

North Dakota was an early adopter of the LRSP strategy, recognizing that most local road jurisdictions had limited institutional capacity and resources for robust traffic safety planning. Similar to the SHSP, the LRSP uses available countermeasures in the 4Es (i.e., enforcement, education, emergency response, and engineering) to prioritize safety issues and select appropriate countermeasures based on resources available. All government levels, including local, state, and federal, can be involved in LRSP programs and improving safety on local roads. Data-driven planning was mandated under the federal transportation bill that preceded the FAST Act, Moving Ahead for Progress in the 21st Century (MAP-21) Act. This legislation prohibited the use of HSIP funds on projects unless supporting data were collected. The state transportation department used an abbreviated network screening exercise to identify projects that may be eligible for HSIP. The projects were documented in the LRSP for expeditated funding applications as a primary rural road safety investment tool stemming from the SHSP (ND LRSP, 2014).

Work here was to explore progress related to that immense local road safety effort. A first step in this process was to revisit the data used to compile county LRSPs. Robust crash data were essential for this work. Crash records include details such as location, contributing factors, and environmental conditions that were used to identify problems and safety project investment priorities. Fortunately, North Dakota has a reliable state crash record system comprised of law enforcement-reported events. The state began associating geospatial locations with crashes about 15 years ago, so ND counties were well ahead of some other locales in data collection. The state shared these crash records in a limited-use agreement for this follow-up research.

Initial queries generated from the crash records were shown in the county crash rate maps previously presented in this section. In discussions with the state transportation department, we learned that the state crash record legacy road system designations were not consistent with the current state road infrastructure designations. Therefore, it would not be possible to clearly delineate local roads based on HSIP funding

eligibility. The state safety investments in local roads and outcomes, such as trends in severe injury crash incidence, would be centered on these as eligible roads. The legacy system can, however, be used to proxy the trends in local road safety as presented in Figure 1.1.[1]

The data-driven crash knowledge foundation was established with the state-supported LRSP plans developed for each county beginning in 2012. While data gaps and inconsistencies were identified, these plans presented a new opportunity for county road managers to pursue systematic and site-specific safety investments based on data-driven priorities and strategies. Benefits from this investment were anticipated in increased local knowledge regarding traffic safety strategies and increased safety investments in local road management plans. Not surprisingly, subsequent action in terms of investments and proactive traffic safety decisions has been mixed. Since the LRSPs were created more than five years ago, anecdotal evidence in conversations with experts and reviews of road managers have been the basis for understanding progress in incorporating safety into local road planning and knowledge.

ND road managers had also previously been queried about safety plans and practices. Berwick et al. (2010), in cooperation with the ND Association of County Engineers, conducted a county road manager survey. Study results established a benchmark that could be useful in identifying common practices to improve safety measures and planning activities. After that, the LRSP was introduced to promote local road safety by providing a point of comparison for low-cost safety countermeasures and planning initiatives. In 2012, studying crash data from 2006 to 2010, Vachal (2012) detected several critical contributing factors to local road safety and provided insights for policy decisions that could improve local road safety in North Dakota. These early studies provide baseline information in assessing local progress concerning knowledge and proactive traffic safety investment and management practices.

Although attention to and knowledge of local road safety have substantially advanced since the LRSP county plans were completed and county road managers were surveyed about their safety practices, this is the first study to couple LRSP activities and local road manager safety practices. In this study, we conducted a survey to gather knowledge about local traffic safety asset characteristics and management tools applied to each ND county to bridge the gap. Survey response follow-up was targeted to western oil region counties because these areas have had an elevated crash risk in recent years. The goal of this project was to support ongoing local traffic safety efforts by state and local champions by improving their understanding of (1) LRSP implementation and investments, (2) county road manager practices and awareness, and (3) data gaps and inconsistencies. The oil impact region was highlighted due to recent experience as a relatively high-risk area for local road crashes.

[1] The state crash record system relies on a legacy Federal Highway Administration (FHWA) functional class designation for local roads. The FHWA guidance for functional class was first disseminated in 1989, then updated in 2013. The North Dakota Department of Transportation (NDDOT) crash record management system relied on this legacy, 10-level road classification system that included a rural local road class. The current functional class system reworked the single rural local road designations to include county major collector and other rural local road classifications.

The remainder of this paper includes the following. Section two presents a review of the previous studies. Section three introduces the approach to obtain the results, and section four discusses those results. Section five concludes this study by identifying appropriate methods and approaches to detect and counteract the region's deficiencies.

2. LITERATURE REVIEW

Although factors affecting rural road safety have been studied frequently, the extant literature on local road safety is not well developed (Hall, 2017). Additionally, studies have rarely used a qualitative approach to study the LRSP. To support this study with enough related research resources, the authors decided to first provide studies applying quantitative methods to promote traffic safety in LRSPs. Then, investigations using qualitative approaches are summarized.

2.1 Assessment of LRSP using Quantitative Approaches

Using correlation analysis and multivariate linear regression, Ewan et al. (2016) examined safety on low-volume road segments with AADTs of 1,000 vehicles per day or fewer in Oregon. They studied crash rates and crash severity rates and examined characteristics such as lane width, shoulder width, driveway density, horizontal curve metrics (degree of curvature and curve length), vertical curve metrics (grade and curve length), and roadside conditions. Results from the application of the systematic approach revealed there was a much higher possibility for crashes on roads with lanes less than 12 feet wide compared to those with a standard lane width of 12 feet. Road geometric features were also considered in several other rural road safety studies using systematic approaches.

Labi (2006) appraised safety on rural two-lane roads in Indiana. The author proposed a crash prediction equation where crash reduction factors for lane width, shoulder width, shoulder type, driveway density, horizontal curve density, and surface type were developed. Schneider et al. (2014) determined the components and intersections needed to be improved. They applied a framework to evaluate crashes based on the AADT and features such as the lane width, shoulder width, curves, driveway density, and speed limits for segments and turn lanes and traffic controls for intersections. Hall & Tarko (2019) studied the suitability of using negative binomial models for managing safety on local roads. The study results indicated that the application of Highway Safety Manual methodology on local roads focused on safety-deficient road features had a better performance compared with approaches focused on individual high-crash locations.

Rural roads have also been considered for site-based safety investigations. Assessing safety performance functions (SPFs), Avelar et al. (2015) appraised low-volume road segments (AADTs of 1,000 or fewer) in Washington State. Applying a stepwise model, the authors first determined roads that had abnormally high fatal and injury crashes. Using crash prediction models, they evaluated the severity of crashes and assessed the efficiency of their application for potential safety improvements on the roads.

Gates et al. (2018) developed SPFs to improve rural road segment safety in the State of Michigan. Results of the study provided tools to identify high-risk sites in Michigan local roads. The study also offered approaches and procedures to maintain SPFs over time. In their research, Geedipally et al. (2019) claimed that most of the earlier works related to local road safety only considered road feature maintenance. Their study estimated the application of SPFs in local roads. They counted the number of crashes at a given highway segment and used crash modification factors to determine the impacts of various roadway geometric characteristics. They also used severity distribution functions (SDFs) to predict crash severity.

Using statistical analysis, Hall (2017) described a framework in which they shifted the concentration of a benefit-cost study from costly safety improvements used at individual locations to low-cost improvement programs implemented uniformly over numerous sites. They provided appropriate low-cost safety improvements to reduce crash risks. They assessed crash risks on rural local roads by applying a bivariate ordered probit model, which could handle the lower crash numbers on local rural roads.

2.2 Assessment of LRSP using Qualitative Approaches

Hall et al. (2003) reviewed the safety works for low-volume road facilities by distributing surveys to local agencies to better understand the methods applied in identifying safety deficiencies. Additionally, they evaluated safety on low-volume roads (AADTs under 400 vpd) in New Mexico by analyzing crash characteristics and locations and conducting field studies. Using field studies and complaints from road users, the local agencies identified sites that needed safety improvements. The survey results indicated that more than 80% of crashes were animal, single-vehicle, or fixed object crashes. They also identified specific shortcomings of the roads such as insufficient or lost warning signs for road and roadside, narrow lanes, extreme vegetation in the road's right-of-way, lack of shoulders, lack of guardrails at locations with steep side slopes, and guardrails in a poor state that could be improved through the application of safety countermeasures.

In another report, McDonald et al. (2010) concluded that traditional approaches to address safety problems such as the black spot approach are not cost-effective because local roads in Iowa comprise a vast area (90,000 miles). They alleged that a more systemic approach was critical to mitigating the crash risks happening in the state. Their study identified safety concerns and proposed risk mitigation strategies to address them. In a report, Gaines et al. (2013) provided examples of an agency's successes in funding local road safety programs and supporting local agencies with information, training, and technical assistance. The results extracted from expert opinions indicated that the level of support needed to improve local road safety differed across states and depended on the severity of local road safety problems.

In 2016, the Iowa Department of Transportation provided an LRSP plan based on an SHSP for Buchanan County, Iowa (Keierleber et. al, 2016). Their study considered both driver and engineering-related countermeasures. They also focused on applying the 5Es of safety: engineering, emergency response, education, enforcement, and everyone. Further, a national study reviewed the local road safety challenges and summarized recommendations for DOTs in California, Florida, Texas, Ohio, Michigan, New York, Georgia, Illinois, Arizona, and Alabama to facilitate better collaboration in local road safety investments (Roberts et. al, 2018). The study considered the HSIP investments in the studied counties when the number of fatal crashes by ownership was also presented. They determined that the 10 states with the highest local road fatalities had only 7% of the total HSIP funds allocated to them.

2.3 North Dakota Local Road Safety Initiative

As part of its periodic update to the SHSP, NDDOT made substantial LRSP program investments in 2013 and 2014. The state hired consultants to develop safety plans for each county, the National Park, each major urban area, and four tribal nations in North Dakota. Involving all potential stakeholders as planning groups, they prioritized traffic safety issues and discussed possible countermeasures to mitigate them (ND Vision Zero Plan, 2019). According to the 2016 annual HSIP report, LRSP recommended low-cost countermeasures for high-risk locations (North Dakota HSIP Annual Report, 2016). The report documented an expedited process for county road managers to apply for low-cost safety improvements in 2016 (Appendix C). Formerly, an application description accompanied with an engineering study was required to be submitted to the state by district engineers. However, counties can now submit the information about roadway, traffic, and safety issues through LRSP forms to receive funding for implementing a set of proven low-cost safety countermeasures with this augmented process. The proven safety countermeasures that could be implemented include enhanced intersection signing and marking, curve signing and marking, intersection destination lighting, 6-inch edge line pavement markings, and edge line rumble strips.

Counties continued to apply safety projects as several projects from the LRSP system assessments were funded on local roads in 2017 and 2018. HSIP's 2019 report also shows two projects, in Bottineau and Steele counties, have been implemented (North Dakota HSIP Annual Report, 2019). NDDOT released a report including a local road safety project as part of HSIP at the high-risk local region (North Dakota HSIP Annual Report, 2018). Further, in a report conducted by NDDOT, they provided information about the projects to be implemented regarding preplanned LRSP (Lee Potter & Terwilliger, 2019). According to the Statewide Transportation Improvement Program (STIP), provided in the report, for 2020 to 2023, NDDOT sets aside HSIP funding to cover priority projects from tribal and local community LRSPs each year.

In 2010, North Dakota county managers were surveyed about safety practices training and resources. That survey, conducted to understand safety activities related to high-risk rural roads, was used here as a benchmark. The survey results concluded that knowledge investments and safety promotion would help reduce crashes on local roads (Berwick et al., 2010). Due to the long gap between the aforementioned benchmarking study on ND traffic safety programs and having the recently added features of LRSP in ND counties, the current research will do a more comprehensive study in benchmarking the implementation of LRSP in the oil region when safety gaps will also be identified.

3. METHODOLOGY

A mail survey was conducted to engage county road managers in assessing the LRSP program in North Dakota. The survey consisted of four parts: the first section defines assets, scope, and resources explicitly targeted at safety; the second part determines current practices examined by each county regarding maintaining existing infrastructure and employed safety practices; the third and fourth parts of the survey collect information related to training and resource needs. A copy of the questionnaire is presented in Appendix A. The questionnaire was mailed to 53 ND county road managers, with 33 (62%) of the managers responding to the survey. The North Dakota Local Technical Assistance program (NDLTAP) was an essential partner in working with local road managers to encourage survey response with follow-up calls and on-site visits. Topics that entered into the local road safety space discussion during the survey process, such as gravel surface safety management and intersection lighting, will be identified in consultation with NDLTAP subject matter experts.

The survey was designed to elicit baseline information about common road safety management practices, road system characteristics, system safety standards, and traffic safety countermeasure selection/implementation. Understanding current practices and activities is essential in inspiring collaboration and innovation in future local road safety efforts such as LRSPs. It has been a decade since the previous county road manager survey regarding road safety was conducted. In addition, it has been over five years since NDDOT supported work with county road managers in publishing local road safety plans. Therefore, this was an opportune time to gather information about the current state of local road safety planning in the state and investigate how to promote it in the future.

We revisit these topics to provide a new resource in LRSP activities. It expands topic coverage from the previous work to capture more recent additions to the commonly posed local road low-cost safety countermeasures. Further, exploring how the LRSP has been implemented by local road managers, in the oil region and other areas of the state, will help to identify leading practices and potential gaps to be addressed regarding the efficacy and effectiveness of current safety practices among local road agencies. Also, overarching opportunities to improve safety under the LRSP will be discussed and proposed. Moreover, the oil region results will be compared with all surveyed county results to see how the LRSP differs in that region.

Road managers were asked about several aspects related to traffic safety activities in the studied region, including their management experience, road characteristics such as lane width and shoulder width, safety practices such as rumble strips, sign inventory, township road inventories, construction and road safety budgets, the share of HSIP projects, current safety practices and maintenances, training, and resource needs. A concerted effort was made to collect surveys from each of the 17 counties in the oil region. In the current study, a descriptive analysis is the main method used to evaluate answers to the survey questions.

4. RESULTS AND DISCUSSION

In the following sections, descriptive analysis and visualizations are used to share results from the 32 county road managers' survey responses. The subtopics in this section were selected based on the questionnaire content that had been reviewed by stakeholders. Results from the current survey are compared with the findings from an earlier study by Berwick et al. (2010), as appropriate. The former study provides a bit of longitudinal insight that would be difficult to attain from other sources, such as state records regarding local road safety practices and investments.

4.1 Management Experience

Management experience may be highly influential in safety. In some instances, long-time managers may have strong histories of attention to safety while others may have little regard to it in their practices. The same case may be found with inexperienced managers that have not had sufficient exposure to pragmatic means to integrate sustained safety considerations into their activities. Regarding the managers' years of experience, results show a wide range. The distribution ranged from a low of one year in Dunn County to a high of more than 35 years in Stark County. A majority of managers had under 12 years of experience in the position. Experience can be an essential factor that decision-makers consider with associating weights to the managers' opinions on decision processes. Figure 4.1 depicts the variety of road managers' experiences in the oil region and all surveyed counties in North Dakota. Responses showed that most road managers had less than 11 years of experience. The oil impact region did have a slightly more experienced manager group.

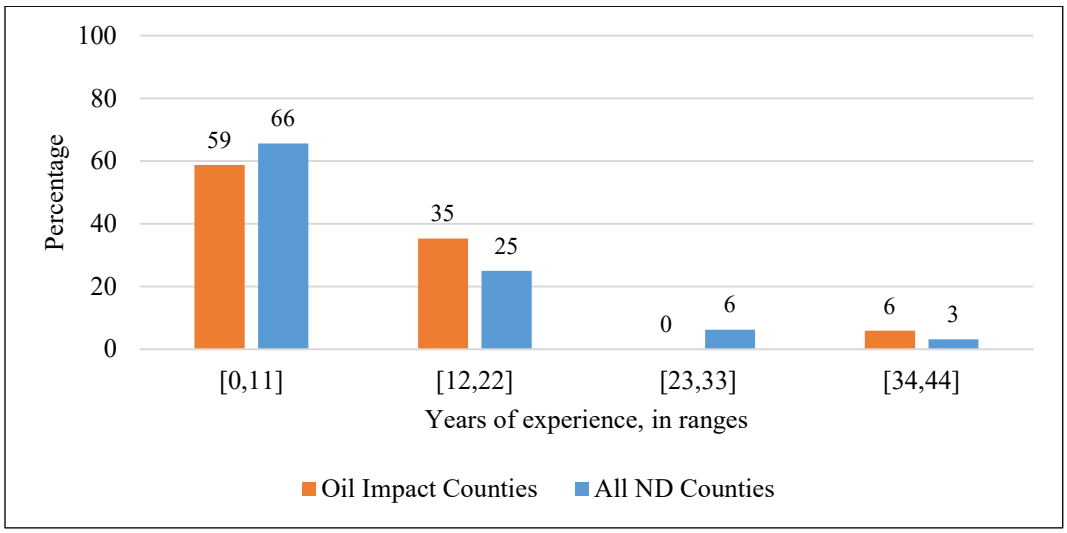

Figure 4.1 County road managers experience, in the oil impact region and statewide

4.2 Typical Lane Width and Shoulder Width

Road design is an essential investment decision in road system management. Road designs, adjusted to driving environment and traffic characteristics, optimize operation under normal driving conditions. Local road design cannot often be determined by factors such as traffic projections due to information and monetary resource constraints. Thus, the local roadway network has evolved based on expert design guidance and local investment decisions with regard to driving lane characteristics.

According to AASHTO, the recommended lane width range for local roads is from 9 to 12 feet (AASHTO Green Book, 2018). Rista et al. (2018) found increased lane width was a factor that effectively reduces the number of crashes when roadways with a 10-ft lane width were compared with 11- and 12-ft width roadways. According to Ewan et al. (2016), crash rates tend to be higher on roads with lane widths less than 12 feet. Another safety factor for drivers is the availability of a lane shoulder and its width. Shoulders provide space for emergency storage of disabled vehicles, space for enforcement activities, space for maintenance activities, an area for drivers to maneuver when avoiding crashes, and a recovery zone that enables drivers to safely reenter the roadway.

According to AASHTO guidelines, recommended shoulder width for local roads is between two and eight feet (AASHTO Green Book, 2018). In discussing effectiveness of shoulder width in reducing crashes, Ewan et al. (2016) concluded that roads with narrow or no shoulders tended to have higher crash rates than roads with shoulders four or five feet wide. In

Figure 4.2 and Figure 4.3, the variations in lane and shoulder width are indicated in the oil region counties as a subpopulation in the survey of all ND counties.

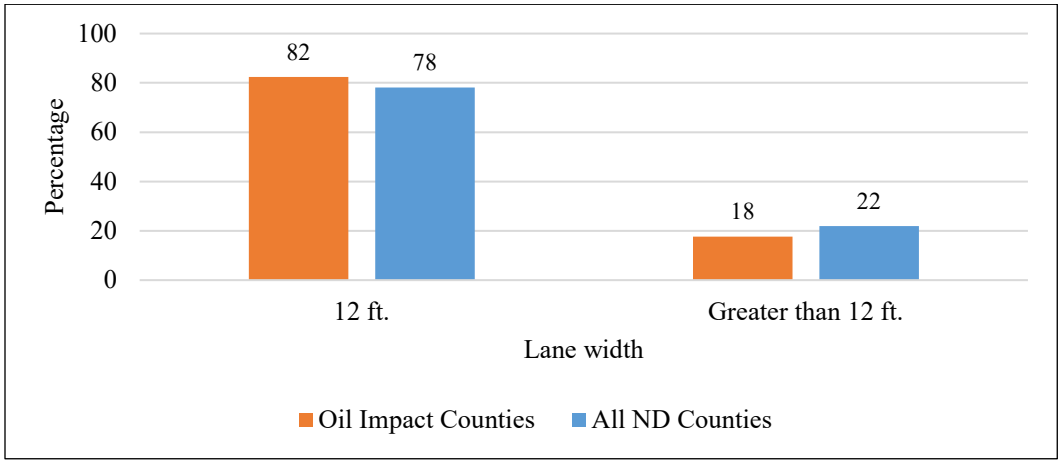

Figure 4.2 Lane width distributions in the oil impact region and statewide

From the results, it could be concluded that 12-ft lane width was the most widely used lane width in both the oil region and all the surveyed ND counties. The average lane width in the oil impact counties was 12.29 feet versus 12.30 in all ND counties. The narrowest and widest shoulder width reported were zero and four feet, respectively. However, the results from a similar study in 2010 shows similar numbers, with 12.35 feet reported as the average lane width.

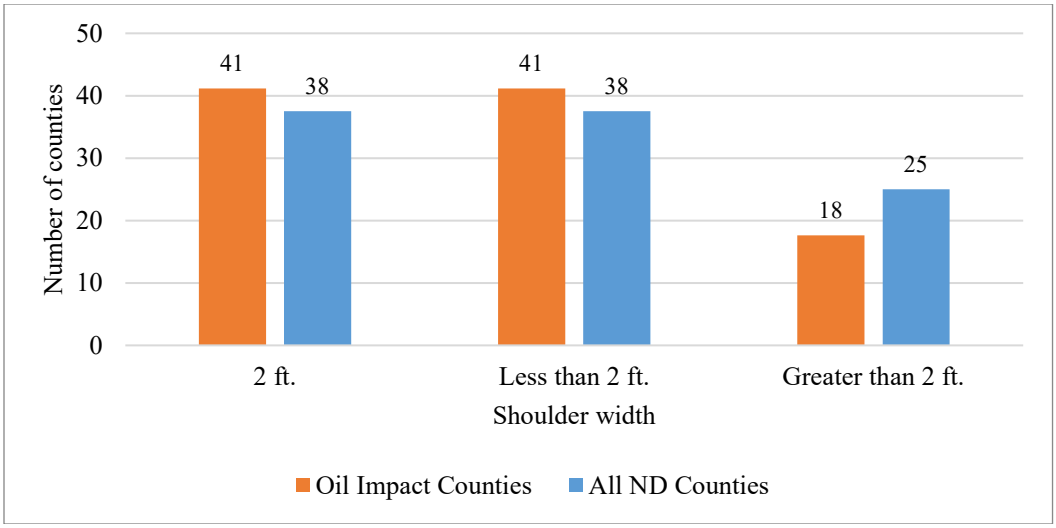

Figure 4.3 Shoulder width distributions in the oil impact region and statewide

Moreover, the most common width considered for road shoulders either in the oil region or in the surveyed ND counties was at most two feet. Shoulder width of one to two feet was common in ND local roadway manager responses. Several counties reported they did not typically have any shoulder on their local roads. The average shoulder width in the oil region was reported as 1.72 feet and the average width for all surveyed ND counties was 1.58 feet, very close to the results from the survey study in 2010 (2 feet). According to Gross et al. (2009), differences in lane and shoulder width in rural roadways are consistent with the truck and commercial vehicle traffic rates, which can also be the origin of the oil region's differences.

4.3 Rumble Strips and Rumble Stripes

Rumble strips are grooves in the roadway or rows of raised pavement markers placed on a roadway so that if a vehicle tire touches these areas on the roadway, noise and vibration would be produced. Rumble stripes are painted with highly reflective colors, while rumble strips are not. The noise and physical vibration let drivers know potential lane departures, making them a highly effective countermeasure (Kirk, 2008). In North Dakota, about 62% of the fatal crashes involved lane departure during the past three years. In a study, Kirk (2008) concluded that two-lane rural roads with continuous shoulder rumble strips have statistically significant lower crash rates than roads without constant shoulder rumble strips. According to Figure 4.4, among the 17 counties in the oil region, only nine, Bottineau, Burke, McKenzie, Mercer, Slope, Stark, Williams, Mountrail, and Ward, have rumble strips in their roads.

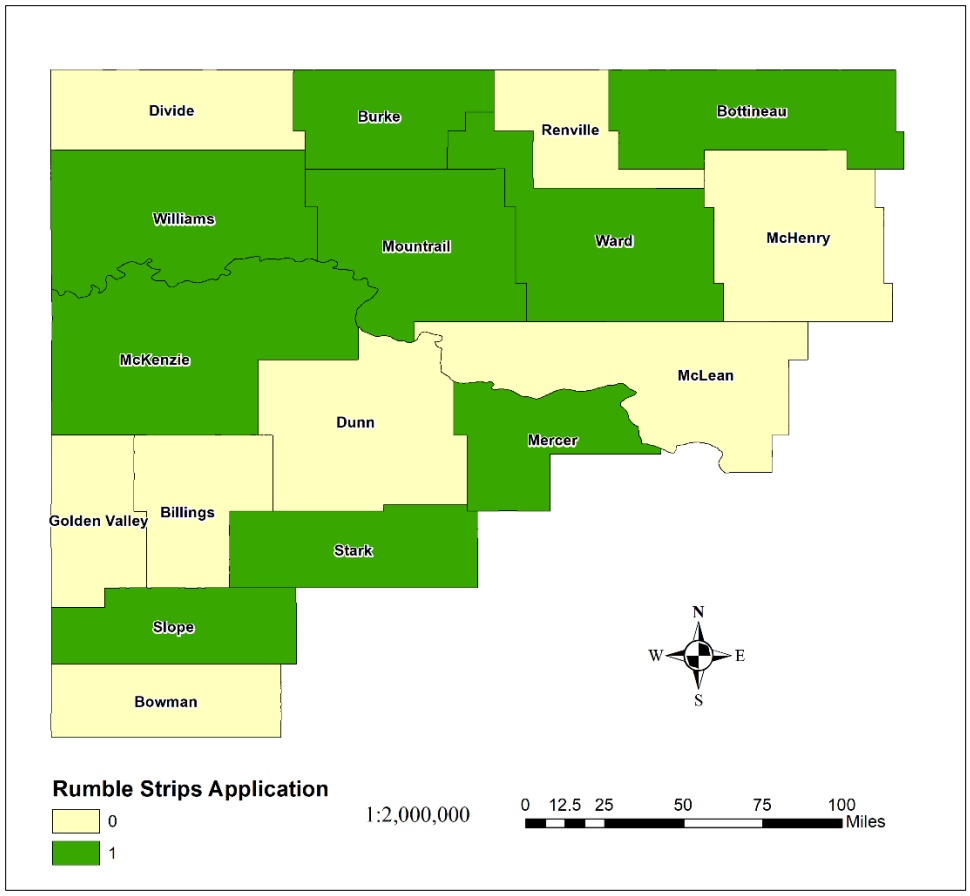

Figure 4.4 Availability of rumble strips in the oil region counties

Figure 4.5 also indicates the share of rumble strip usage in the oil region counties compared with all surveyed ND counties. According to the survey results, it was noted that the number of counties using rumble strips in the oil region was 47%, which was lower than the 53% in statewide application.

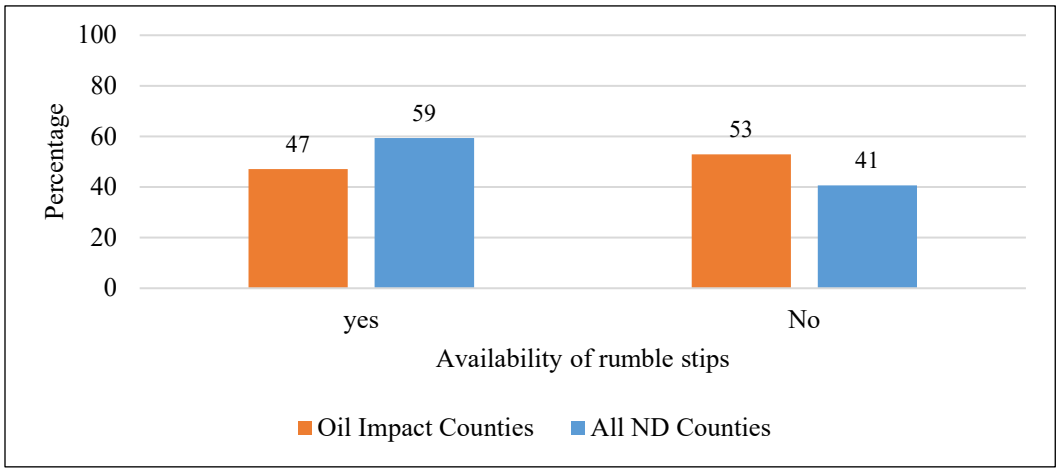

Figure 4.5 Use of rumble strips in ND counties

4.4 Number of Signs in the County Road System

Road signage is vital in providing drivers with the information needed for navigation and vehicle control (Kubas et al., 2012). A significant dispersion was observed in the number of signs on local roads across ND counties. Among respondents, 24 out of 32 reported their sign count. According to the survey results, the average number of signs reported by a county from the oil impact region was 2,806, while the average from all surveyed ND counties was 2,754, which shows no considerable difference in sign usage in the regions. Figure 4.6 shows the variation in road sign density, in sign counts per 1,000 vehicle miles traveled, across the respondent counties. The road sign use can be a function of topology, road geometry, traffic density, life-cycle cost, and engineers' discretion. To make the sign counts comparable, we normalized each county's count with its associated rural vehicle miles traveled (VMT). According to the results, Billings, Bottineau, and Burke counties have the highest number of signs per 1,000 VMT, while Benson and Stark maintain the lowest signage density.

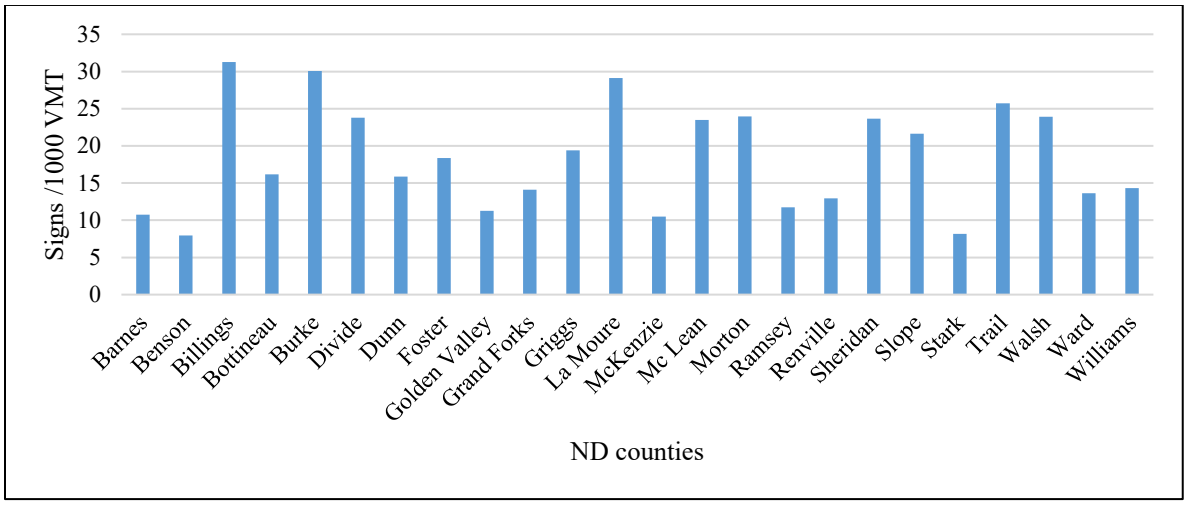

Figure 4.6 Road sign density, all responses

County road department participation in supplying township or municipal road sign inventories was also explored. Although townships lie within counties, they are independent local political jurisdictions. Each county includes several townships that may be considered when conducting an inventory for roadside sign assets. The results are illustrated in Figure 4.7. The results show that more than half of the counties in the oil region and all the surveyed ND counties have a role in the township/municipal sign inventory process. This sign inventory process is essential in road safety because it allows county road managers to develop a comprehensive sign maintenance program and determine the desired level of traffic sign maintenance activities. As Torbic et al. (2009) stated, many DOTs have recognized the usefulness of considering sign inventories to help preserve their signs and ensure their visibility in various circumstances. Ensuring appropriate sign placement and reflectivity is a continuous local road safety activity.

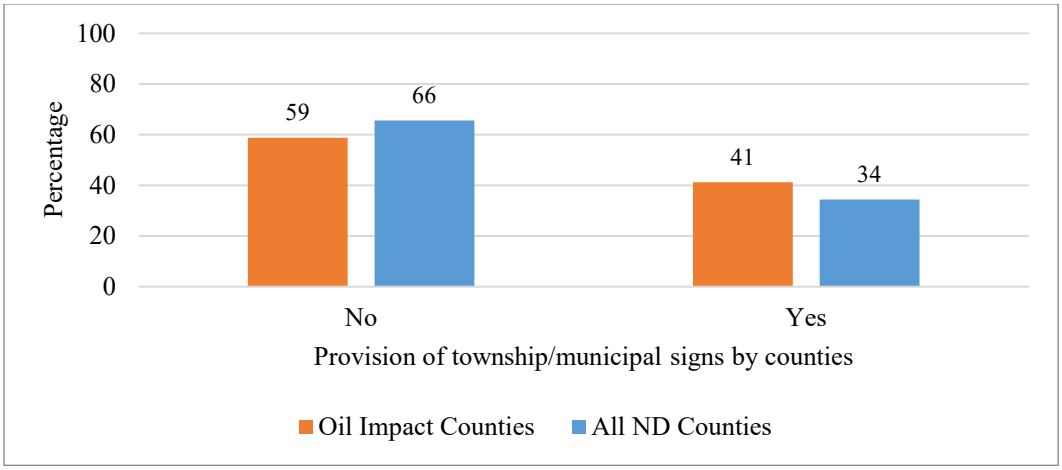

Figure 4.7 County participation in township or municipal signage programs, in the oil impact region and statewide

4.5 Maintaining Township Roads by Counties

The road surface is a crucial aspect of road safety. Performance recovery from use and environmental stresses such as rain and snow are directly related to the road surface conditions (Edvardsson & Magnusson, 2009). Counties also often play a role in township road maintenance. Township roads are segregated into gravel and paved categories with unique service levels and construction or maintenance requirements. The two categories of township roads are separately discussed as follows.

4.5.1 Paved Town Roads

Town roads are defined as any road that has been either established, constructed, or improved under the authority of a town board (Sulem, 2002). These roads are usually considered over-improved and paved for convenience factors such as dust suppression or other public satisfaction justifications. Due to the small number of crashes on paved township roads, they are not considered a priority in the LRSP. According to the survey results, four counties (24%) of the oil impact region, Billings, Burke, Dunn, and Bowman, maintained paved township roads. Among all surveyed counties, the share increased to 39% that maintained paved township roads. The results are depicted in Figure 4.8.

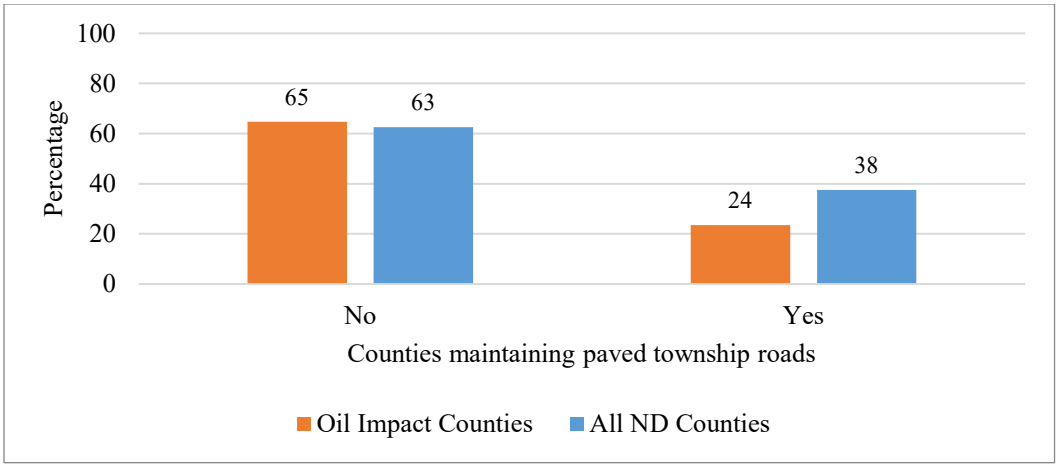

Figure 4.8 Counties maintaining paved township roads, in the oil impact region and statewide

4.5.2 Gravel Township Roads

Gravel roads are designed to provide lower-quality services than paved roads. Gravel town roads typically remain unpaved because of low traffic volume or a shortage of funding to pave them (Pratt et al., 2013). Considering the level of commercial vehicle traffic in the region, the importance of gravel roads in the oil region counties was evident in this stratum. Gravel roads present challenges when supporting higher traffic volumes. One of the most significant drawbacks of gravel roads is the difficulty in plowing or clearing snow with a snow blower. The gravel surface cannot be scraped clean without displacing the gravel. Moreover, traffic-generated fugitive dust from gravel roads impairs visibility, deposits on the adjacent property, and impairs traffic safety (Edvardsson & Magnusson, 2009). Many different chemicals, called dust suppressants, are commonly used to reduce dust emissions from gravel roads.

The recent tremendous increase in commercial traffic, much of it in the form of heavy vehicles, resulting from oil extraction activity in western North Dakota has caused more wear to the gravel roads. To maintain the quality of gravel roads, Kunz et al. (2018) practiced a combination of real-time monitoring and surface condition evaluation approaches. They found these quantitative data to be useful to road managers.

According to the survey results, 88% of the oil impact counties maintain gravel township roads. Only 12% of the counties located in the oil region (or two counties – McKenzie and Williams) do not maintain gravel township roads located in their areas. In comparison, the percentage was 22% in the surveyed ND counties statewide. The results show that most (78%) of the ND counties maintain gravel township roads in their road systems. The survey results are illustrated in Figure 4.9.

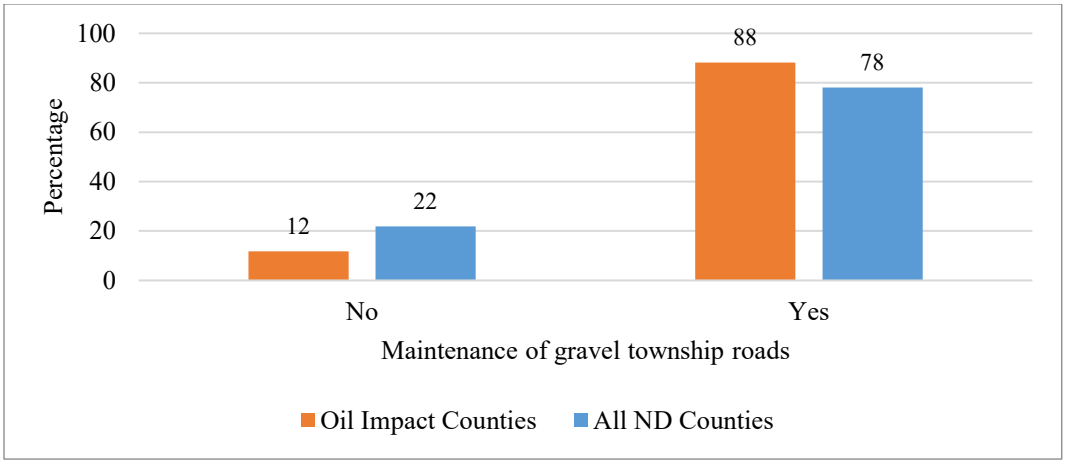

Figure 4.9 Maintaining gravel township roads in the oil region and all surveyed ND counties

4.6 Share of the Annual Budget to Construction

The road managers were asked to report the amount of the total construction budget allocated to traffic safety. The results showed considerable differences between the annual budget designated to construction in counties in the oil region compared with counties statewide. The survey results indicated that the average percentage of the annual budget designated for construction was about 35% for all the surveyed counties compared with about 42% in oil region counties. Figure 4.10 illustrates the share of the annual budget allocated to construction in the oil region and all the surveyed counties. As results show, the number of counties allocating less than 30% of their budgets to construction is greater than the number of counties allocating more than 30% of their budget.

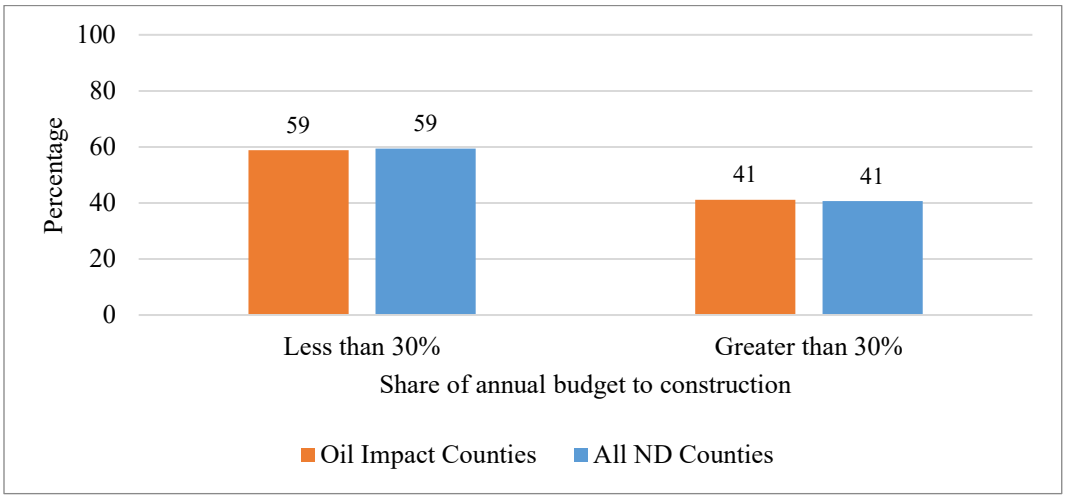

Figure 4.10 Share of annual budget to construction

4.6.1 Share of Annual Construction Budget Dedicated to Road Safety Improvements

The county road managers were also asked about the share of the annual construction budget dedicated to road safety improvements. According to Figure 4.11, most of the counties that allocated more than 10% of their annual construction budget to road safety improvement are located in the oil region. Statewide, counties allocated an average of 11.1% of their annual construction budget to road safety improvements. In comparison, the average ratio was 15.7% in the oil region.

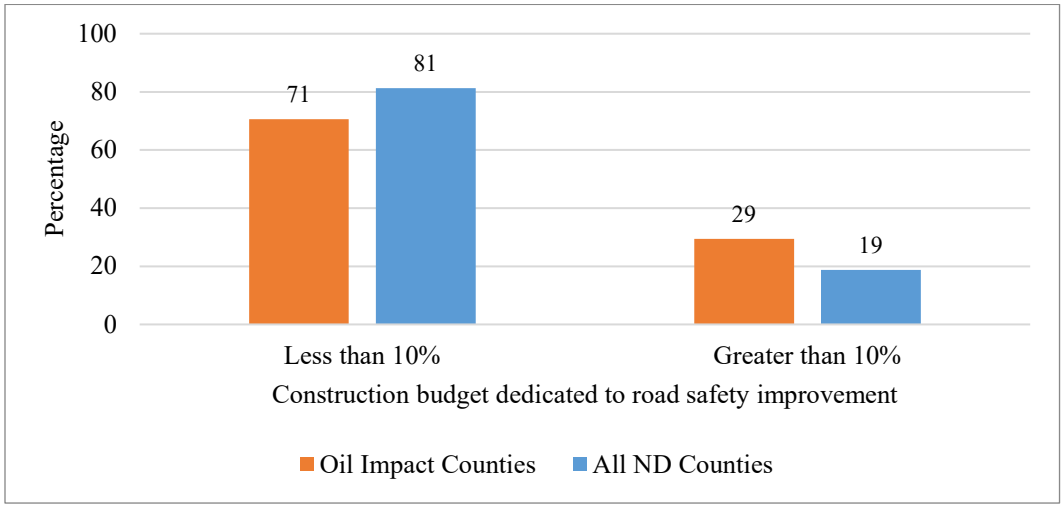

Figure 4.11 Construction budget dedicated to road safety improvement

4.7 Funding dedicated to safety projects

Since safety projects were of keen interest, county road managers were asked if they considered funding assigned to safety projects outside funding dedicated to construction. Figure 4.12 shows the results regarding the counties that considered funding for safety projects. Almost half of the counties either in the oil region or among all ND counties allocated their funding to safety projects beyond that designated in construction projects.

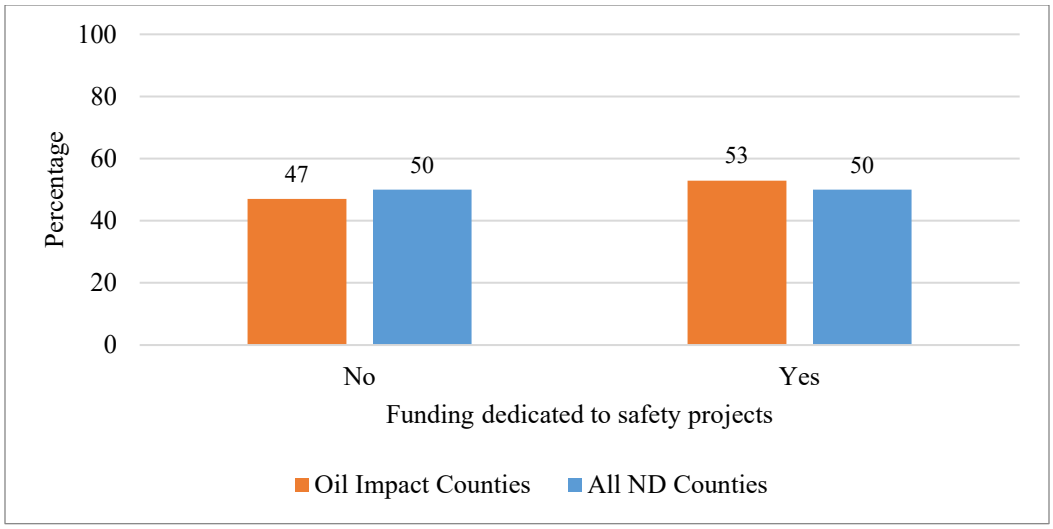

Figure 4.12 Funding dedicated to safety projects

4.7.1 Share of Annual Budget Spent on Safety Improvements, Except Construction Projects

Further, the managers were asked to state the annual budget ratio spent on safety improvements such as striping and signs. Sixteen county road managers responded to this question. The results from Figure 4.13 indicate that 22% (two of nine) of the counties in the oil region, Bottineau and Mountrail, allocated more than 10% of their funding to safety projects.

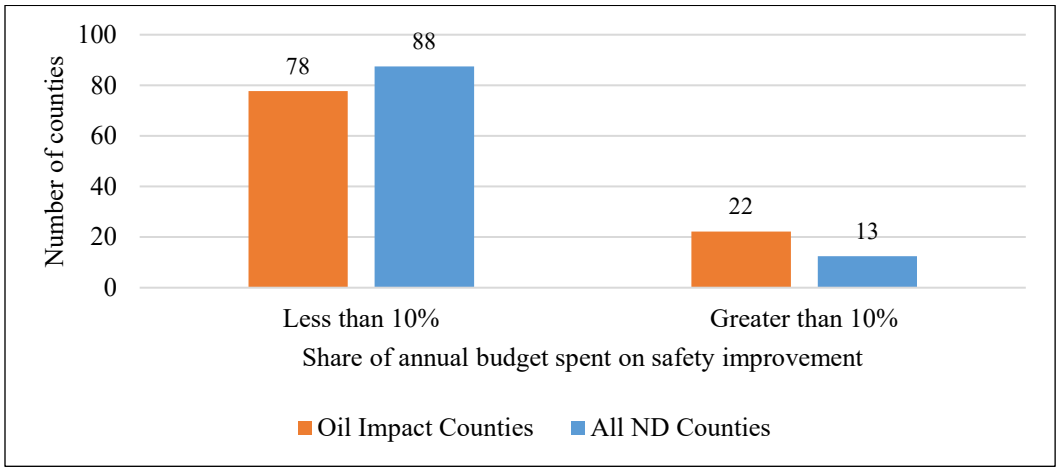

Figure 4.13 Share of annual budget spent on safety improvement

4.8 Local road safety program implementation

4.8.1 Projects Implemented from the 2014 LRSP

The Highway Safety Improvement Program (HSIP) is a principal federal aid program intended to significantly reduce fatalities and severe injuries on all roadways. As previously described, North Dakota made a concerted effort to elevate support for county HSIP projects with the systemwide LRSPs. Figure 4.14 illustrates the implemented, planned, and/or completed projects from the 2014 LRSP initiative in the oil region and among all ND counties. Considering the LRSP as the local action plan proxy, the results showed that many counties had an LRSP implemented (71% of oil impact counties and 63% of all ND counties). However, two counties in the oil region, McHenry and Bowman, did not report any LRSP project implementations since the plans were established in 2014.

The state-supported plan development likely provided a significant boost in progress compared with results from the 2010 survey, in which only five out of 25 respondent counties (25%) reported having road safety plan activities implemented or under discussion (Berwick et al., 2010). Note that five counties, including two in the oil impact area, were unsure about the status of their LRSP. This suggests that it is an opportune time for the state to again elevate communication and encouragement for safety activities, potentially leaning on the LRSP recommendations.

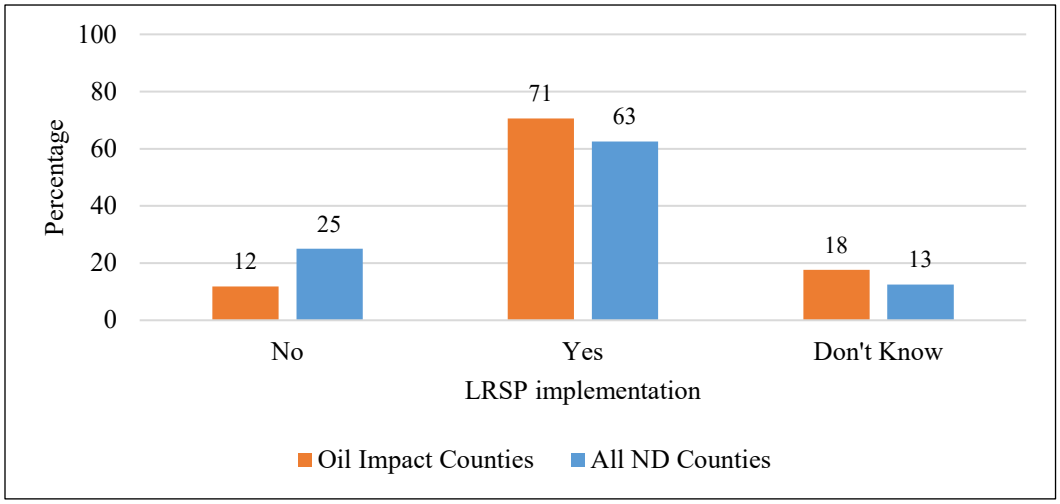

Figure 4.14 LRSP Implementation in the oil region and surveyed ND counties, from the 2014 LRSP

Road managers were also asked about the funding associated with these safety investments. Results showed that most funding used to implement the safety strategies came from local and state resources. Billings and Stark were the only counties with projects solely funded by the state. McKenzie reported its projects funded by sources other than local or state sources (likely a federal program). Considering the results from LRSP implementation in ND counties, it was concluded that most of the counties used local and state funding sources jointly. The results are shown in Figure 4.15.

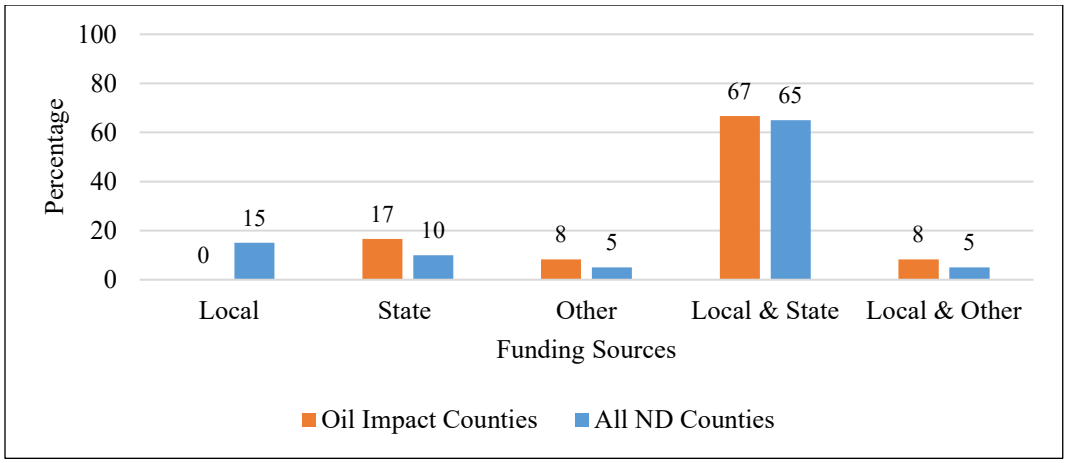

Figure 4.15 Share of funding sources for the 2014 LRSP projects in ND counties

4.8.2 Projects from the 2014 LRSP Scheduled for the Future

As shown in Figure 4.16, only 24% of counties in the oil region reported that they had applied for infrastructure projects from 2014 LRSPs that were scheduled for future implementation. The number of counties acquiring projects from the 2014 LRSPs increased by only two when we compared results for the oil impact area with all ND counties. This finding implies that either the oil impact counties have more awareness regarding funding opportunities and/or local road safety needs are relatively high in the oil impact counties compared with other counties. This finding implies that additional promotion may be needed to encourage other counties to become active in safety planning and projects. While some counties have histories of strong safety emphasis, it is reasonable to assume other counties would benefit from better understanding how these peers maintain a safety focus in their activities and investments. A small entry-level safety project may go a long way to encourage counties inexperienced with HSIP and LRSP to move toward sustained safety activities.

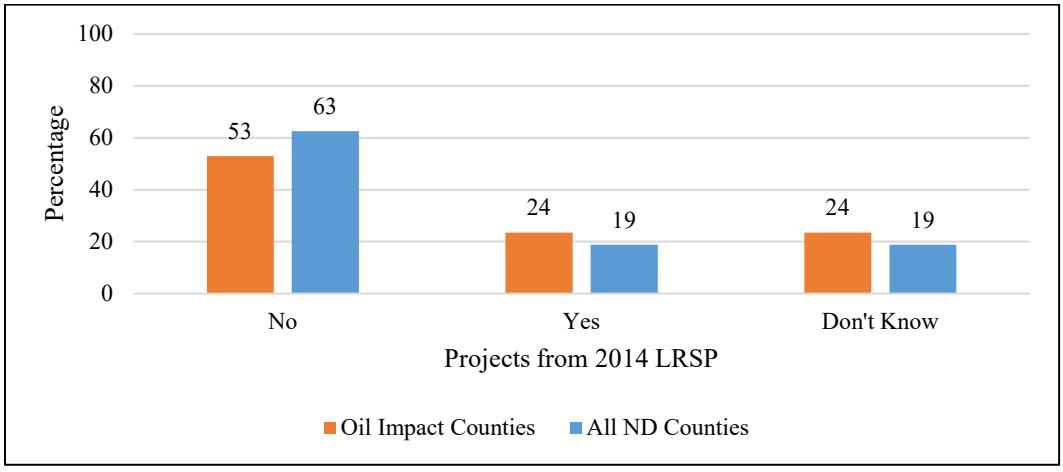

Figure 4.16 Scheduled LRSP programs for future

4.8.3 Incorporation of LRSP Programs into Counties' Safety Plans

Managers were also asked about their interests and plans for incorporating LRSP projects into their other safety plans. Regarding the results illustrated in Figure 4.17, almost half of the counties in the oil region or the entire surveyed counties, 47% and 44%, respectively, confirmed they plan to incorporate LRSP projects. As with the previous results, counties that do not know if they will incorporate ideas from the LRSP initiative may benefit from follow-up with the state or other stakeholders regarding opportunities. Those counties with LRSP projects planned may also benefit from expert support and encouragement to follow through with applications.

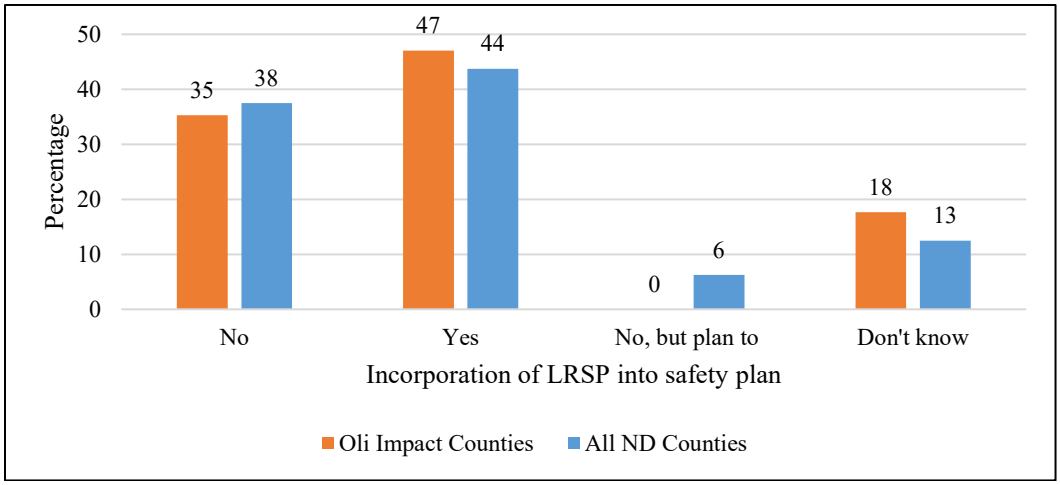

Figure 4.17 Incorporation of LRSP programs into counties' safety plans

4.8.4 Application for HSIP Funding

It was observed that among the oil impact counties, all, with the exception of Bowman and Billings, had already applied for the HSIP funding. Three county road managers answered the question as "Do not know," which may be due to their short tenure as the road manager in those counties. Figure 4.18 shows the application status of the oil region and surveyed ND counties for HSIP funding. The results show that about two-thirds of ND counties had applied for HSIP funding. As with the previous comment, the managers that had not previously applied may benefit from peer discussions or expert stakeholder discussions regarding local road safety priorities and funding opportunities.

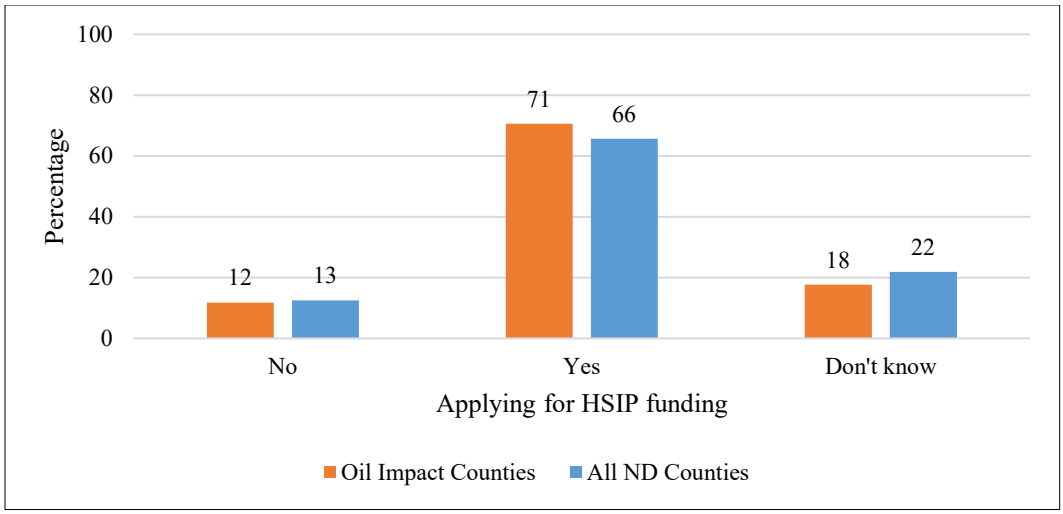

Figure 4.18 Application for HSIP funding

Managers were also asked specifically about the number of HSIP projects identified for funding in the 2014 LRSP process. Figure 4.19 shows it was apparent that most of the HSIP funding applications were based on projects identified and planned in the 2014 LRSP – 83% for oil impact counties and 76% for all the ND counties. This finding may imply that state support for the LRSP initiative, as well as the associated funding application process changes that allowed direct application by county road departments, were key in inducing local safety projects. The state's longer-term encouragement may also prove important in instituting and sustaining attention to local road safety.

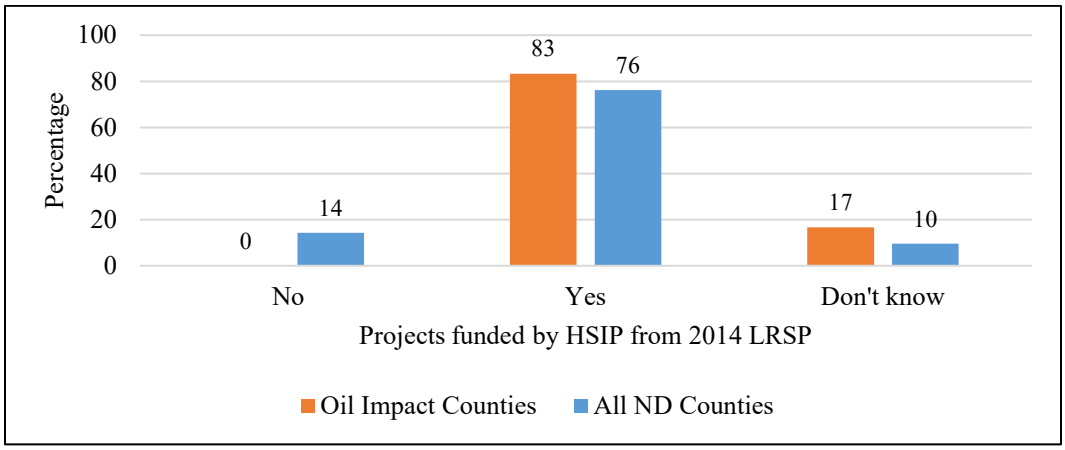

Figure 4.19 Projects funded by HSIP from 2014 LRSP

A site-level safety investment inventory was completed to support the maps with related data (Appendix C. Planned/Bid HSIP Projects). Figure 4.20, Figure 4.21, and Figure 4.22 illustrate the implemented and expected HSIP projects in 2018, 2019, and 2020. The investment values in the figures are presented in thousand dollars.

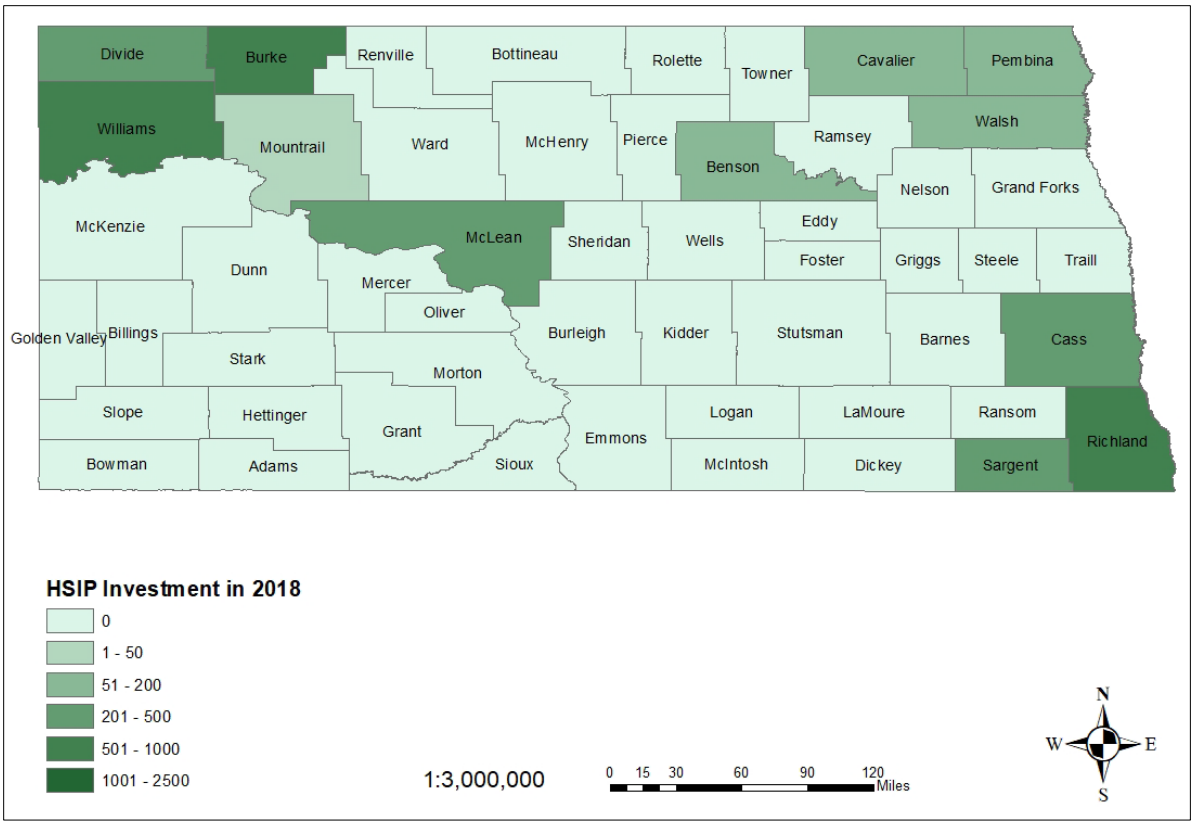

Figure 4.20 HSIP investments in ND counties in 2018

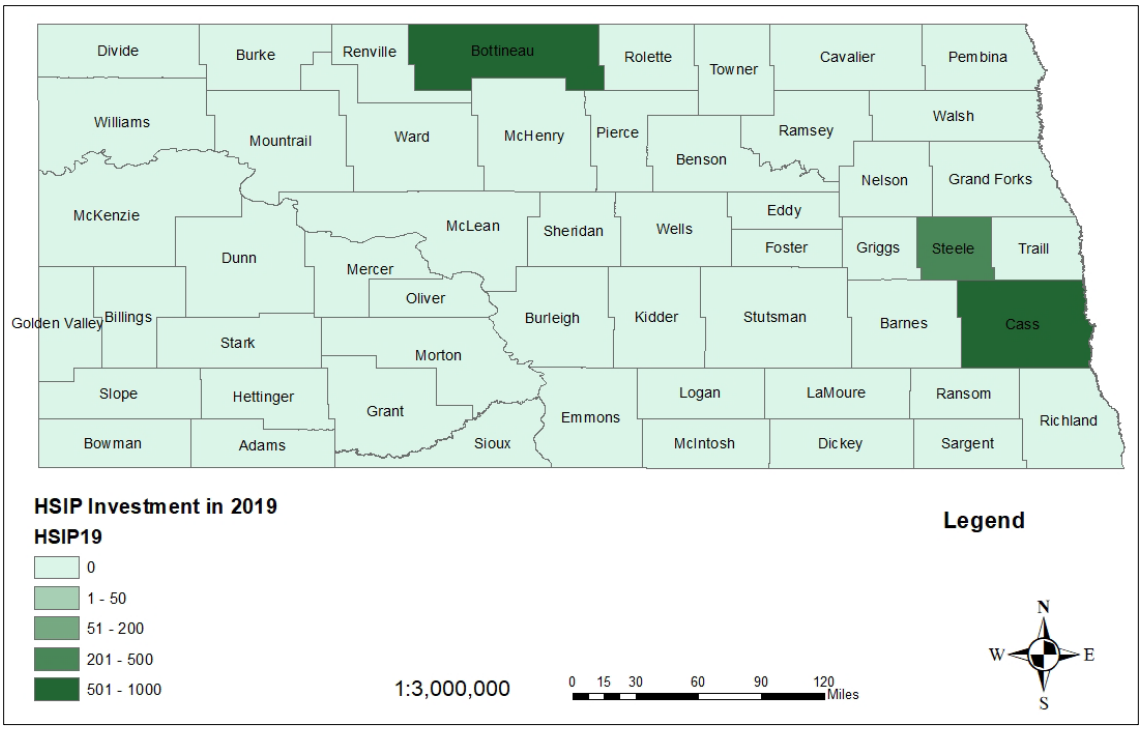

Figure 4.21 HSIP investments in ND counties in 2019

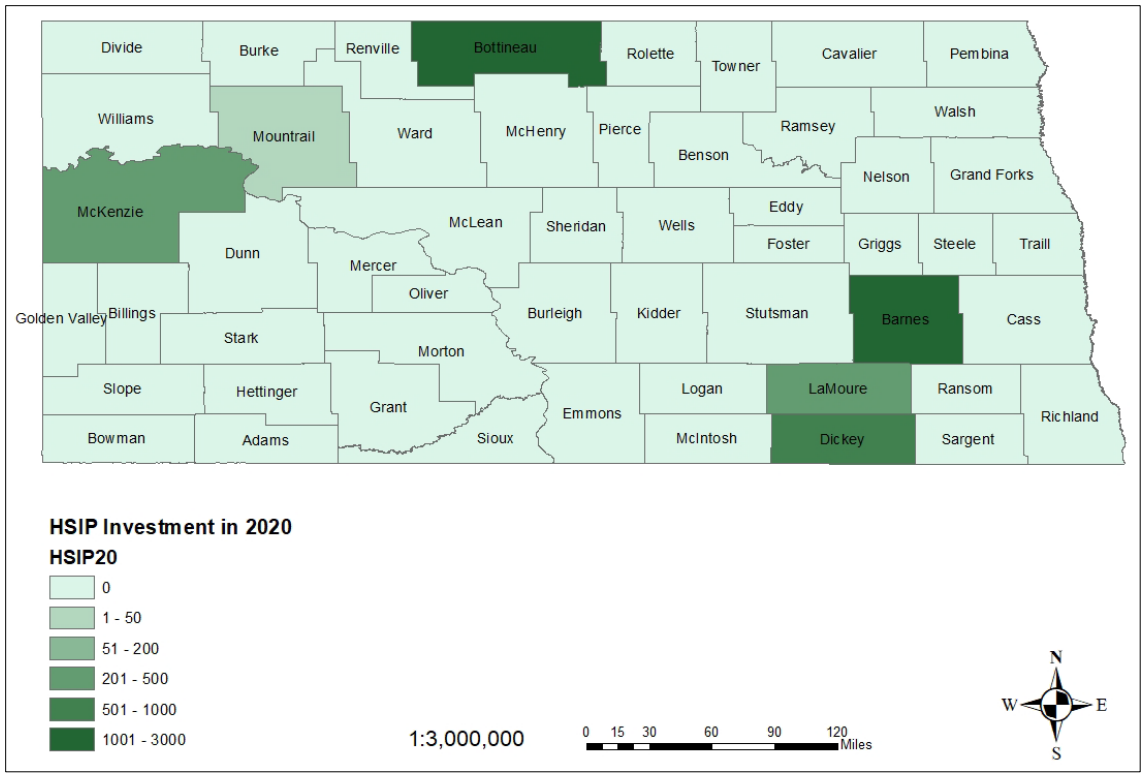

Figure 4.22 HSIP investment in ND counties in 2020

4.9 Safety Practices

Understanding common practice in applying the low-cost safety practices and approaches among county road managers is important in identifying opportunities for peer-learning, sharing best practices, and inducing future activity. The associated results regarding the application of several safety countermeasures and the frequency of their application were summarized.

Context was given to county safety investments by querying managers about their practices prior to 2014, which was before the state's LRSP initiative. Road managers were also asked about the nature of safety-related infrastructure investments. As shown in Figure 4.23, before the LRSP reports in 2014, the most common safety strategies implemented were advisory signs for speed, stop, and curve locations. Forty-one percent of counties, both within the oil region and statewide, reported using speed advisory signs.

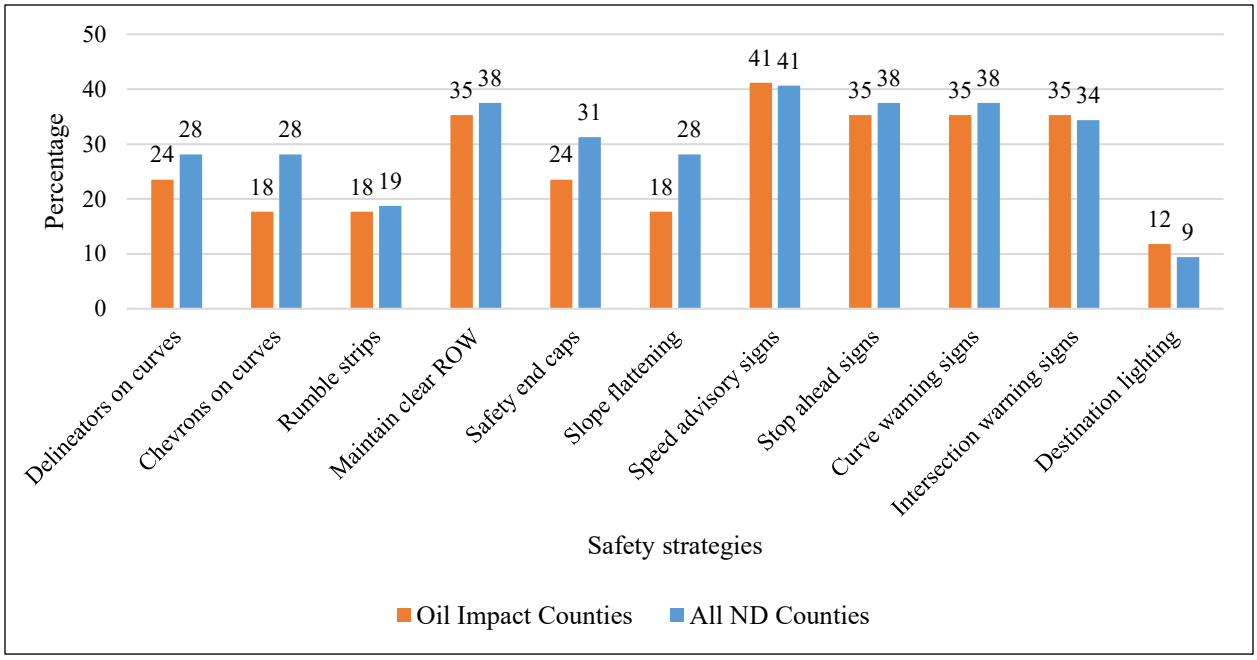

Figure 4.23 Application of safety strategies before the LRSP reports in 2014

Delineators and chevrons have proven effective for reducing lane departure crash risk on corridors where horizontal curves pose safety challenges. Advisory and guidance signs are among the lowest-cost strategies compared with other safety investments such as destination lighting and rumble strips. Among all responding counties, 19% report rumble strip investments (versus 18% for the oil impact counties) while destination lighting strategies have been implemented in 9% of counties (versus 12% in oil impact counties).

Other strategies that contribute to driver field of site and recovery zones were also noted. A commitment to maintaining clear zone visibility during right-of-way maintenance has been reported to be a challenge for local roads because they are often adjacent to cropland where "farming into the ROW" and tall crops such as corn may have seasonal impacts. Slope flattening has also been shown to be a proven strategy in reducing serious crash risk with an improved recovery zone for lane departure events where the vehicle leaves the roadway. Eighteen percent of oil impact counties and 28% of all ND counties used slope flattening in their roads.

4.10 Current Practices

4.10.1 Road System Signage

According to (McGee, 2010), traffic signs need to be repaired or replaced because they have been hit by vehicles; been relocated and/or adjusted by private individuals; been damaged by weather, other climatic events, or vandalism; or reached the end of their useful lives. They stated that if repeated maintenance is required for some traffic signs or in specific regions, the reason for the issue should be studied more specifically. North Dakota's Local Technical Assistance Program (NDLTAP) has a Road Signing Resource section that is a one-stop shop for signing reference material, providing various local roadway

signing classes and technology transfer opportunities that help those responsible for installing and maintaining signs in North Dakota. To achieve the desired goal of quality sign maintenance, a comprehensive sign management system should be developed. As Torbic et al. (2009) reported, many DOTs have recognized the effectiveness of sign inventories in better maintaining their signs and ensuring their visibility in different situations.

Respondents reported that in all counties, road signs were replaced as needed. This practice is somewhat different from that in 2010 when 89% of the surveyed counties replaced signs as needed while others followed predefined intervals to replace the signs, such as every seven years. Among the the oil region counties, 71% reportedly had completed an inventory of their road signs (75% statewide). Eight counties (47%) used third-party programs to inventory the signs (i.e., AcquiSIGN). Statewide, it was indicated that 14 counties (44%) had a sign inventory. The recent federal requirement for jurisdictional sign inventories may have provided the impetus for increased commitment to documenting sign type, age, location, and quality/retro reflectivity compared with 2010. Ten years ago, only 57% of counties reported maintaining a sign inventory. The results are shown in Figure 4.24 and Figure 4.25.

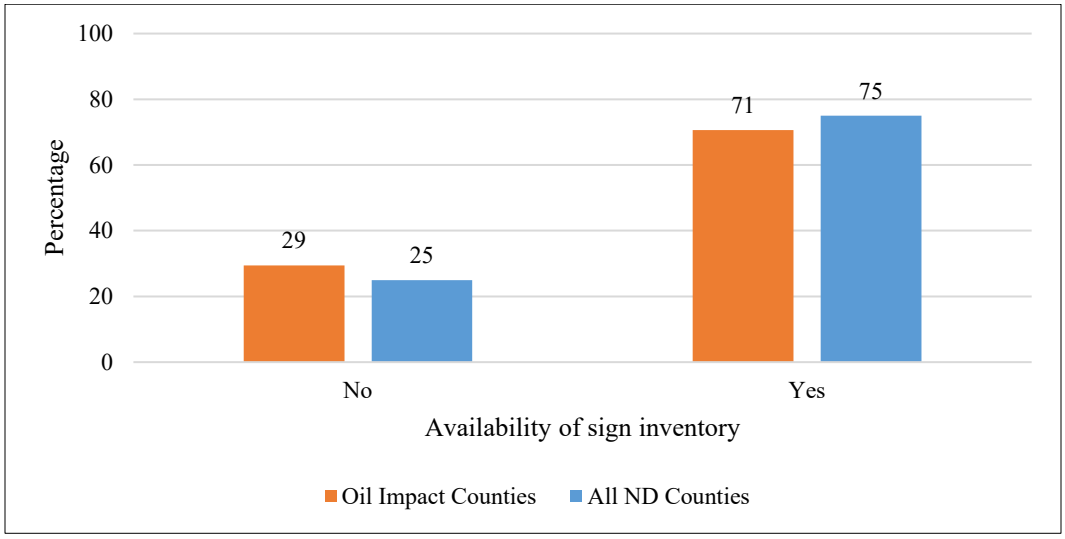

Figure 4.24 Signage inventory ownership

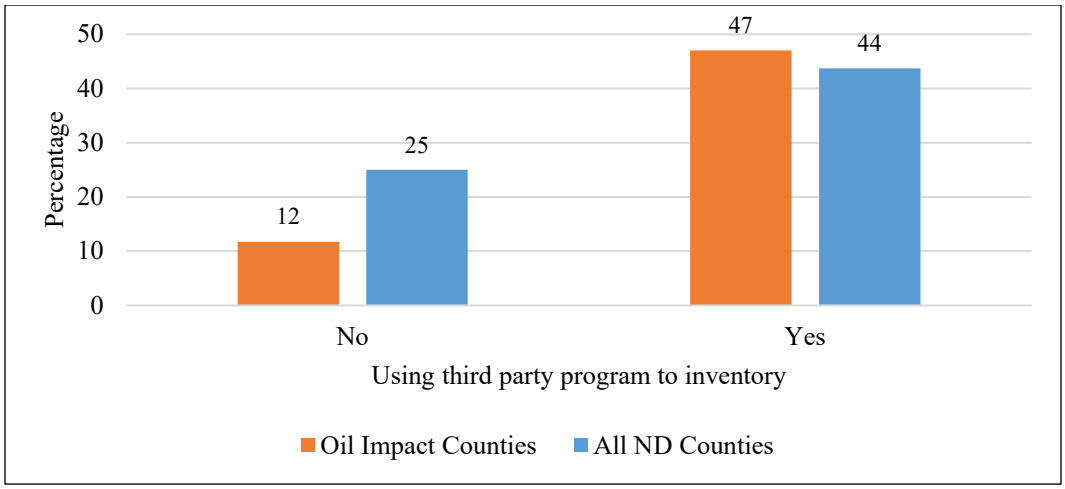

Figure 4.25 Share of using a third-party program to inventory

4.10.2 Pavement Markings and Road Striping

Pavement markings and road striping, essential safety features on paved roads, help motorists position their vehicles appropriately (Jung, Che, Olsen, & Parrish, 2019). Because of the continuous wear on pavement markings caused by traffic, winter maintenance, and exposure of the markings to weather conditions, it is necessary to maintain the quality of markings and update them as soon as needed (Donnell, Chehab, Tang, & Schall, 2009). According to the survey results, 35% of the counties in the oil region reported that they updated striping on their roads in intervals of three years. Also, within the region, Burke, Divide, and McLean reported intervals of five years. However, some of the road managers also considered updating striping as soon as damage was detected (Figure 4.26). Comparing the differences between the results from the oil region and all counties, we found the distribution similar. These findings were consistent compared with results from the 2010 survey. The most common interval used was reported as three years (29%).

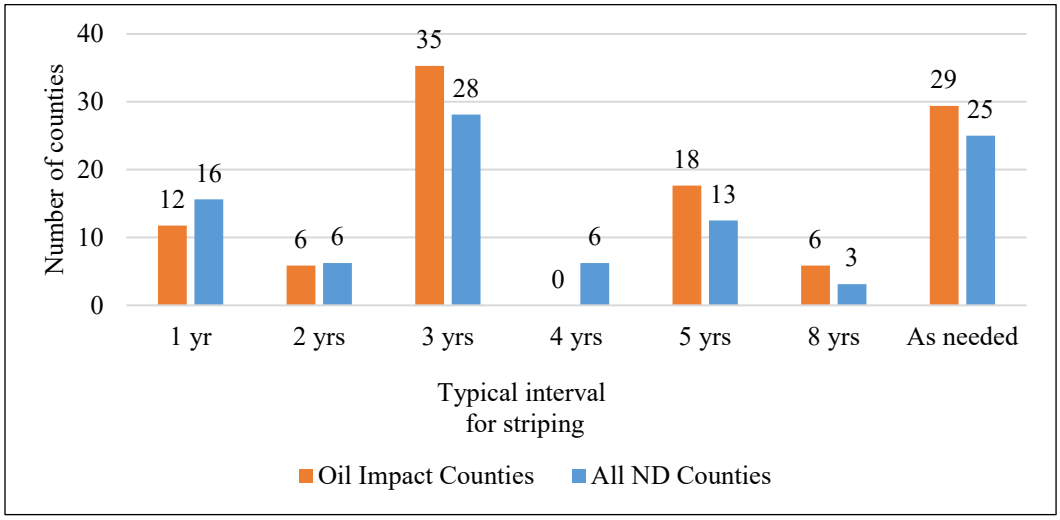

Figure 4.26 The typical interval for striping in ND counties

4.10.3 Rumble Strips on the Edge Lines

Rumble strips on the edge lines are primarily used to reduce single-vehicle run-off-road crashes. The study conducted by Torbic et al. (2009) states that rumble strips on the edge lines can reduce injuries and fatalities by nearly 29%. They note the minimum required shoulder width for implementing rumble strips ranges from 2 to 10 feet, with 4 feet as the most common value.

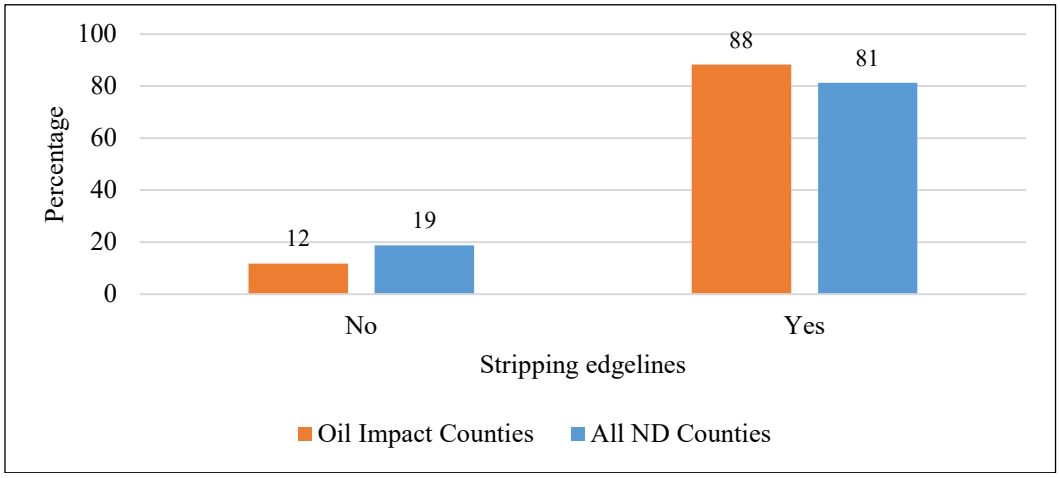

Figure 4.27 Rumble striping edge lines in the oil region and ND surveyed counties

Based on the survey results, only two counties in the oil region, Divide and McHenry, did not use edge line rumble strips in any situation. Figure 4.27 depicts the variation in renewing striping in the oil region counties compared with all the surveyed ND counties, which shows most of the counties, either located in the oil region or other ND counties, used striping on their edge lines.

4.10.4 Road Surface and Roadside Features

Gravel replacement contributes to maintaining the quality of these roads. In the survey conducted by Berwick et al. (2010), it was reported that almost 82% of counties replenished gravel on their roads as needed while others reported making this investment in a cycle of two- to three-year intervals (Figure 4.28). The share for replacing the gravel road surface as needed was 84% higher in oil impact counties compared to 82% in all ND counties in the 2010 survey. in the 2010 survey. The NDLTAP promotes training to support sound gravel road maintenance practices. Gravel roads may not receive as much attention as paved roads, but these roads are often essential corridors in remote rural community accessibility and economic mobility.

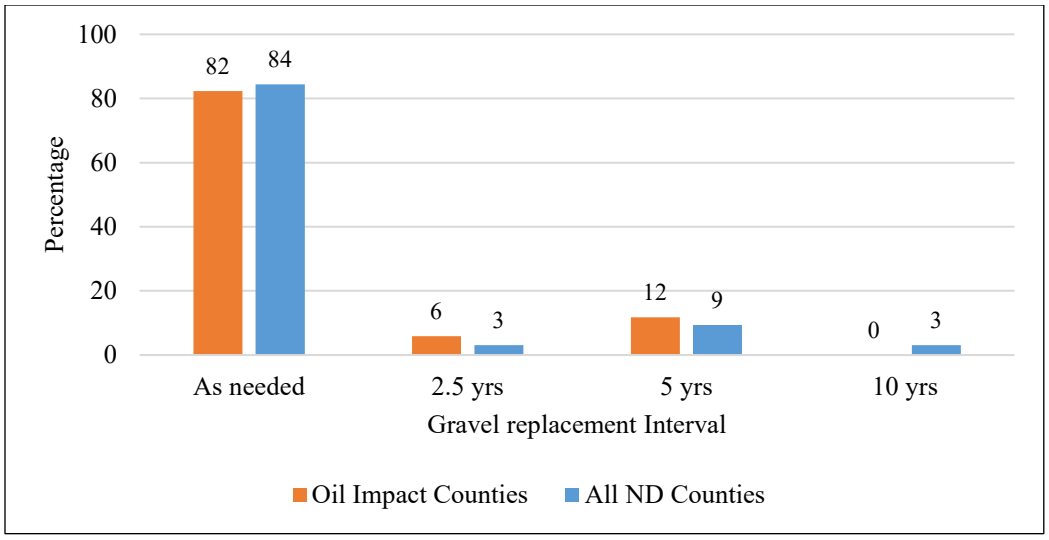

Figure 4.28 Gravel replacement interval in ND counties

In addition to sufficient aggregate material to maintain a gravel road appropriately, Skorseth and Selim (2000) stated that road operators need to correctly maintain a proper crowned driving surface. According to the study, half an inch of crown per foot (approximately 4%) on the cross slope is ideal. The results in Figure 4.29 indicate that most ND county gravel roads (76% in oil impact counties and 66% in all ND counties) are maintained based on the recommended road crown grade of 4%.

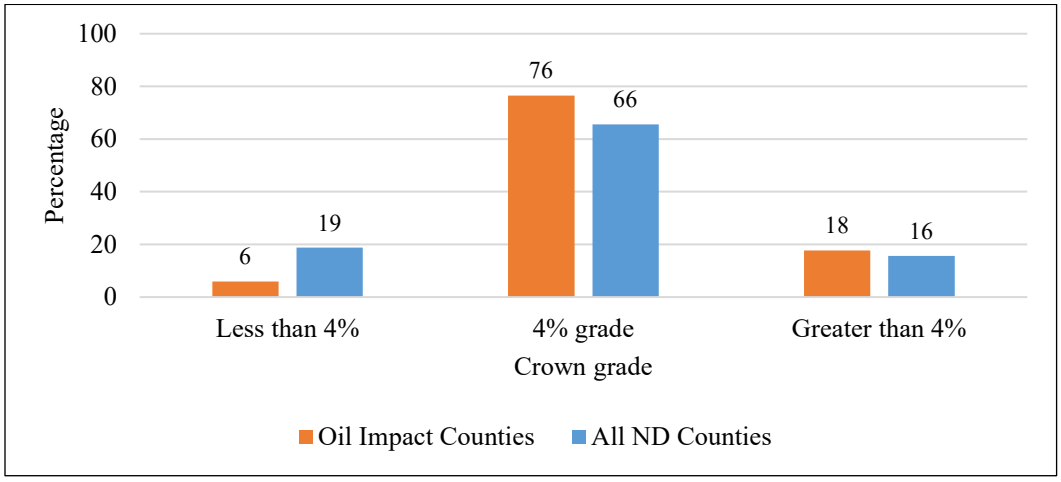

Figure 4.29 Usual specification for gravel road crown in the oil region and ND surveyed counties

Aggregate composition is also an essential feature in gravel road maintenance standards. The standard gravel specification was different in various counties (Figure 4.30.). Some counties were using Class 5 (12% in oil impact counties versus 9% in all ND counties), while others were using Class 13 (24% in oil impact counties versus 31% in all ND counties) or Class 13 modified (41% in oil impact counties versus 38% in all ND counties), and sometimes counties were using Class 13 and Class 13 modified jointly (12% in oil impact counties versus 13% in all ND counties). The gravel quality and cost trade-off, along

with binding material characteristics, is continuously assessed by counties in effectively managing fresh and regular maintenance for good performing gravel road surfaces.

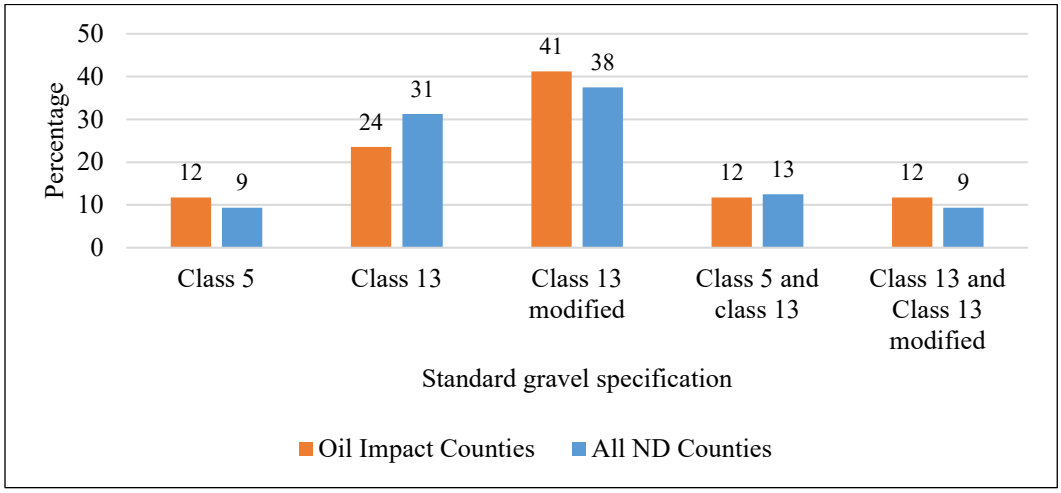

Figure 4.30 Standard gravel specification in ND counties

4.10.5 Delineators and Chevrons on Curves

Delineators are countermeasures implemented where there is uncertainty by drivers on following road alignments, often occurring at lane-reduction transitions and curves. A significant advantage of delineators is visibility, even if the roadway is wet or snow-covered. Chevrons are also used to emphasize the edge of the road and dangerous curves, keeping drivers alert to an upcoming need for roadway navigation attention and driver maneuver. Figure 4.31 and Figure 4.33 show the use of delineators and chevrons on curves in the oil impact region and all counties. Figure 4.32 and Figure 4.34 convey the average application use for safety practices in the oil impact counties, other counties, and statewide based on a scale of 1=never to 5=always. This Likert scale was used to assess county use of several safety countermeasures. Responses indicate a broader adoption of delineators, with 50% of counties reporting their use, compared with 12.5% in 2010 (Berwick et al., 2010). The application of chevrons on ND roadways also increased considerably from no usage in 2010 to almost 50% reporting frequent application as a county local road safety practice in the current survey. As a proven low-cost safety strategy, it is evident that county road managers see this as a pragmatic safety enhancement. Given the level of adoption, it may be one easily promoted with peer experience in looking to other counties with crashes associated with road alignment changes.

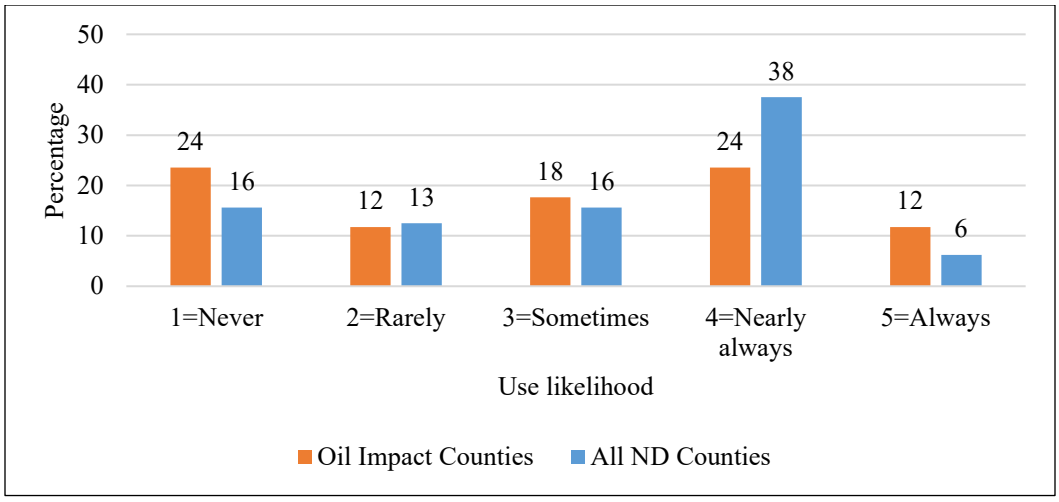

Figure 4.31 Delineators use likelihood on curves for all counties

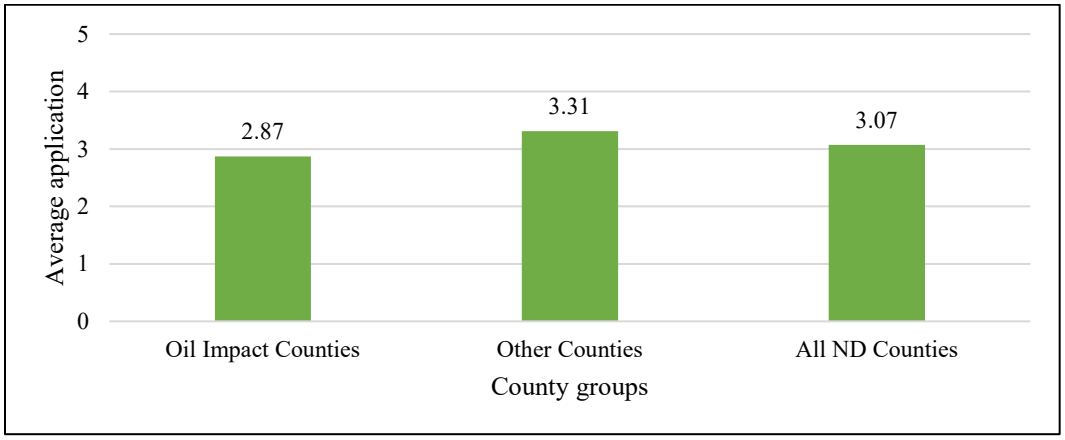

Figure 4.32 Delineators use propensity on curves, by county groups

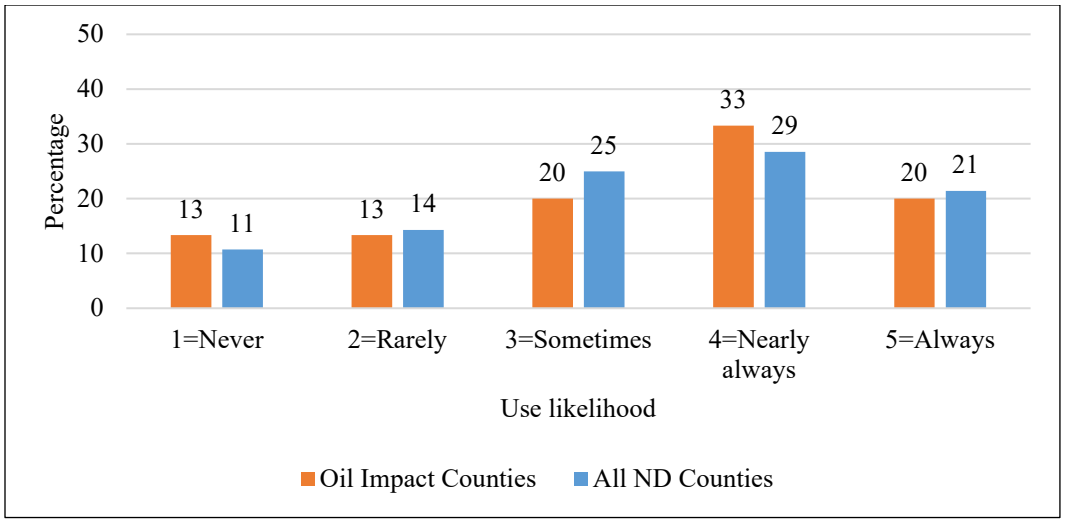

Figure 4.33 Chevrons use likelihood for all counties

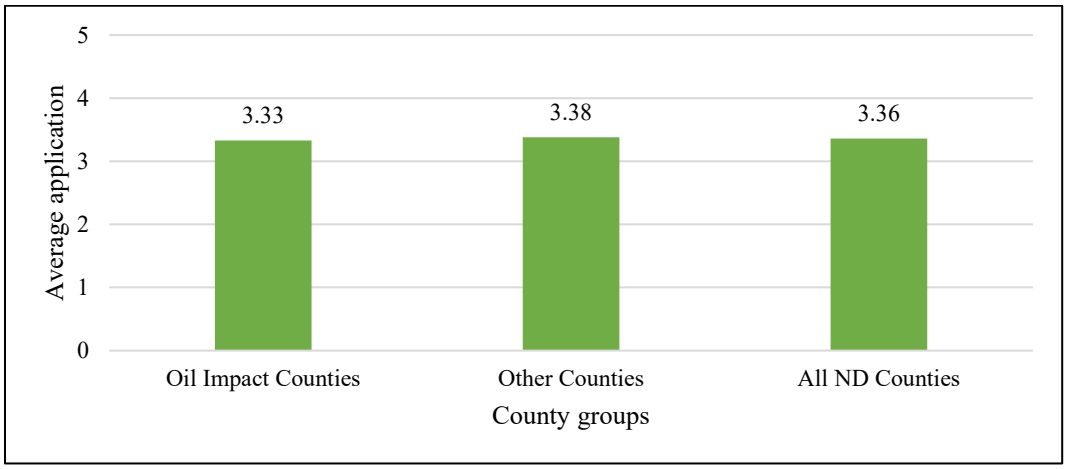

Figure 4.34 Chevrons use propensity on curves, by county groups

Based on the results, McHenry, Renville, Divide, and Bowman counties did not have delineators on their curves. Looking at their related historical crash data in four years, from 2014 to 2018, the authors found six crashes that occurred on curves in Bowman County, five in Renville and 23 in McHenry. Also, the results show that nearly 73% of the counties located in the oil region never used delineators in their curves, which could be a suitable countermeasure in reducing the number of crashes in these counties. HSIP funds can be considered a proper source to be allocated to the counties with a high level of crashes on curves. In addition, Bowman and Mercer did not have chevrons on their road curves. The historical data on crashes in Mercer indicates 30 crashes on curves likely could have been prevented by applying chevrons as one of the countermeasures in reducing crashes on curves.

4.10.6 Rumble Strips

As stated by the North Dakota Department of Transportation, the uses of centerline and edge line rumble stripes/strips are considered to be cost-effective improvements in reducing the number of head-on crashes, opposite direction sideswipe crashes, and run-off-the-road (ROR) crashes. According to a study conducted by Himes et al. (2017), considering the various geometric road designs, there may be instances where implementing rumble strips is not an appropriate countermeasure. For example, having centerline rumble stripes implemented on narrow roadways may make drivers shift their vehicles closer to the outside edge of roadways, leading to increased road departures.

It was noted that Mercer, Mclean, McHenry, and Bowman counties never used rumble strips. In Figure 4.35, results from the oil region counties are compared with results for the application of rumble strips in all the surveyed ND counties. It could be concluded that the ratio of counties from all ND counties not using rumble strips was proportionally higher than for the oil impact counties. Figure 4.36 also shows a higher average frequency of rumble strip usage in the oil region than the other areas illustrated. Almost half of all surveyed counties reported using rumble strips or stripes compared with the 2010 survey with almost 60% of respondents.

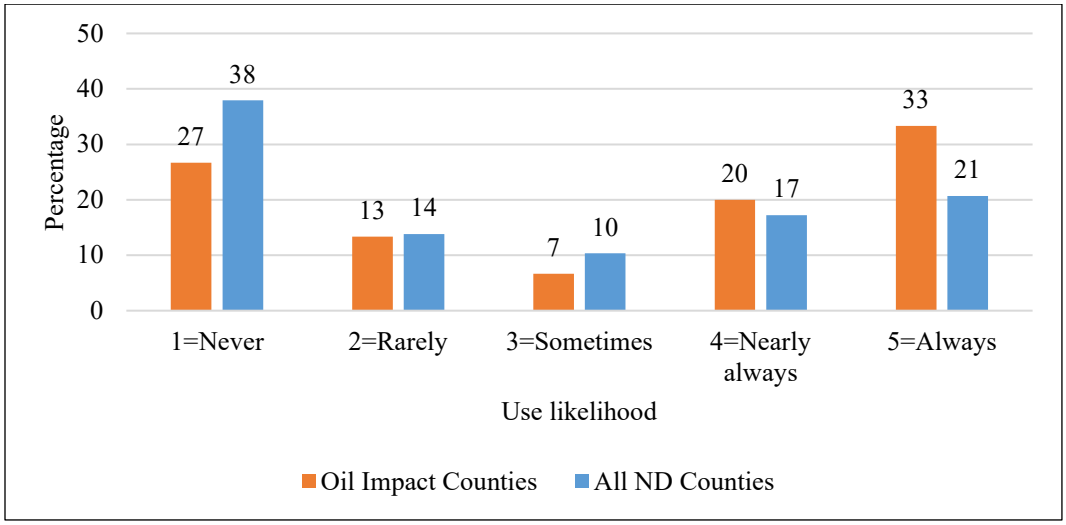

Figure 4.35 Rumble strips use likelihood for all counties

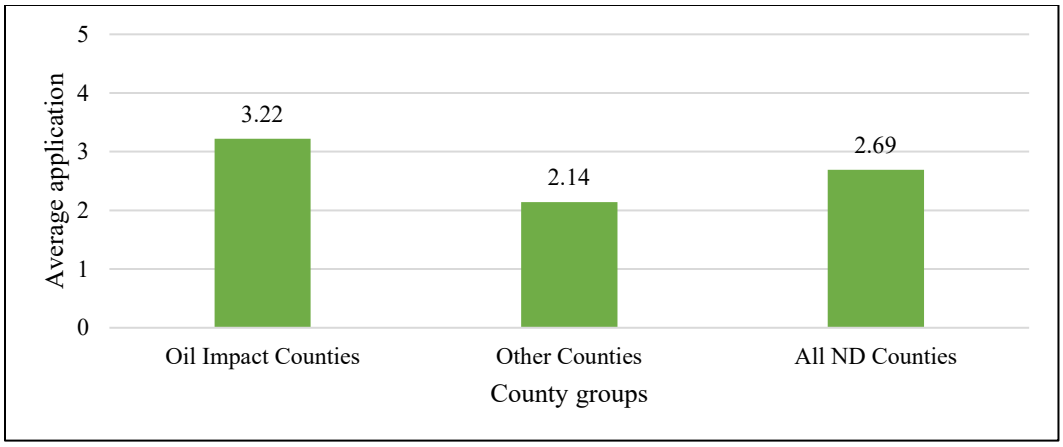

Figure 4.36 Rumble strips use propensity by county groups

4.10.7 Maintaining Clear Right of Way

The right of way (ROW) enforcement program coordinated permitting, inspections, and enforcement of safety guidelines during maintenance or construction work in the public right of way. According to the survey, most counties in the oil region (93%) and other surveyed ND counties (92%) had a ROW enforcement program (Figure 4.37), while the results from the 2010 survey showed only more than half of the surveyed counties reported they maintained a clear ROW. Figure 4.38 shows the difference in frequency of maintaining clear ROW in the oil region compared with other areas in the state. According to the results, it could be concluded that, on average, ND counties are generally committed to maintaining clear ROW for their roadways.

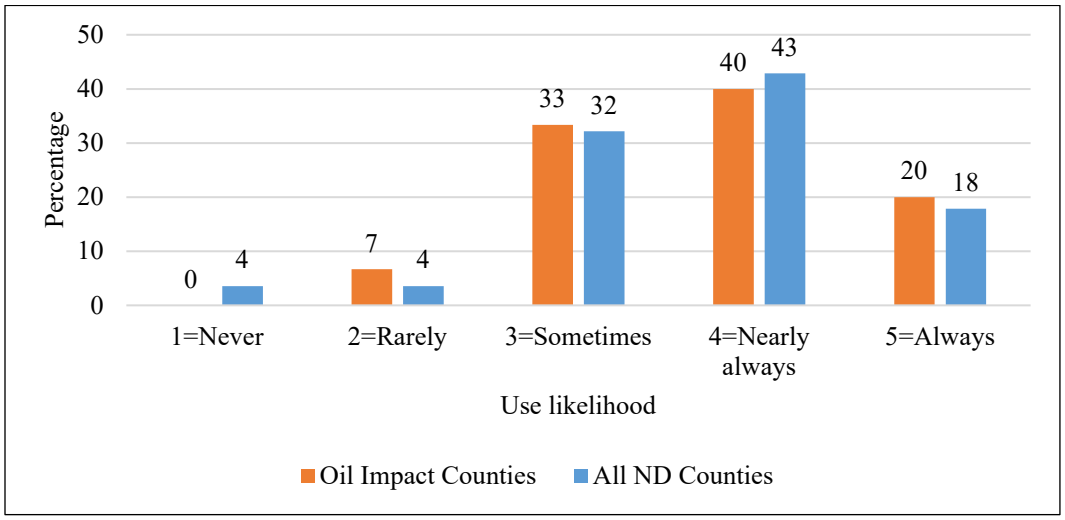

Figure 4.37 Clear right of way maintenance use likelihood for all counties

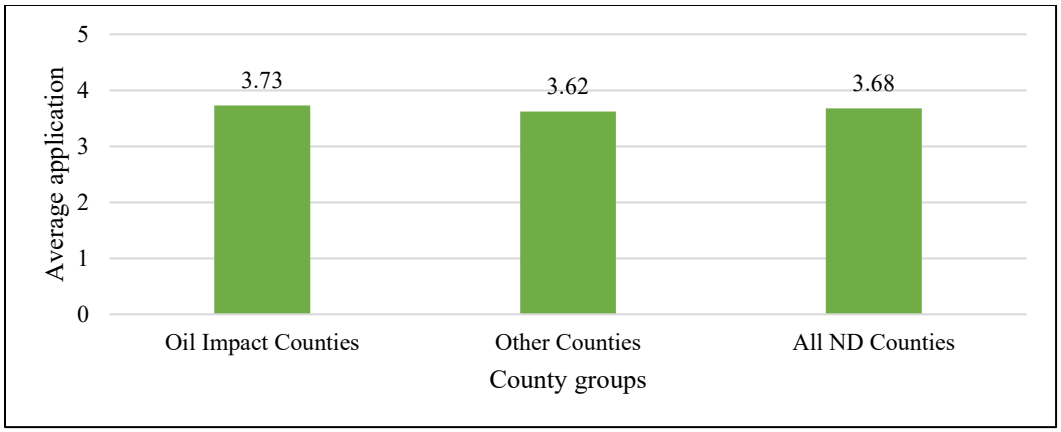

Figure 4.38 Right of way maintenance use propensity by county groups

4.10.8 Safety End Caps on Guardrails

Guardrail end caps are components installed at the traffic-facing end of guardrails to protect drivers who crash into them. Based on the survey results, three counties, Divide, Dunn, and Bowman (20%), out of the 15 oil impact counties that responded to the survey did not apply safety end caps on their guardrails (Figure 4.39). Further, the average of responses from county road managers shows that safety end caps have sometimes been used on guardrails in ND roadways (Figure 4.40). According to the results, almost 75% of the surveyed counties used safety end caps on their guardrails. In comparison, the application rate was greatly improved compared with the 50% use from the 2010 survey.

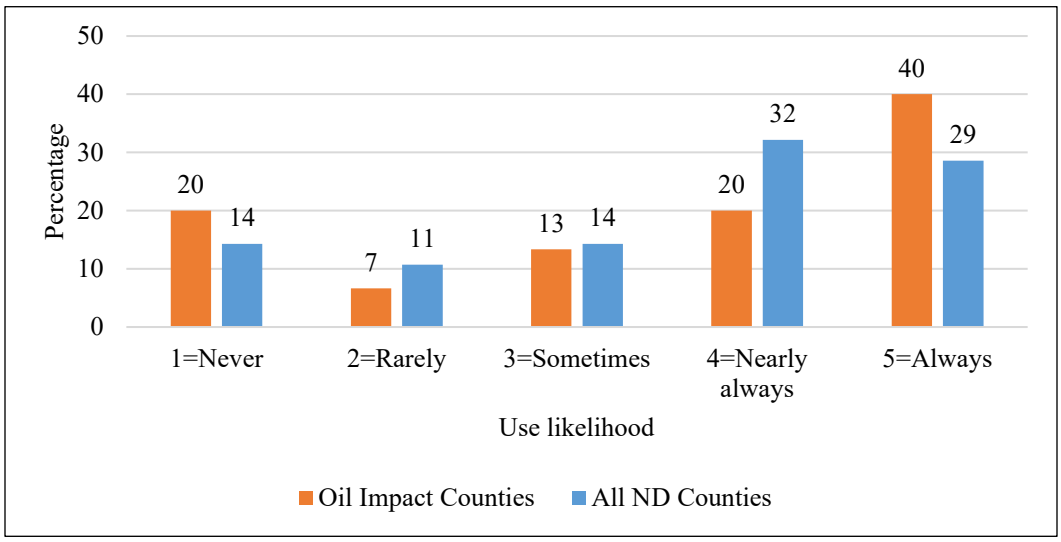

Figure 4.39 Safety end caps use likelihood for all counties

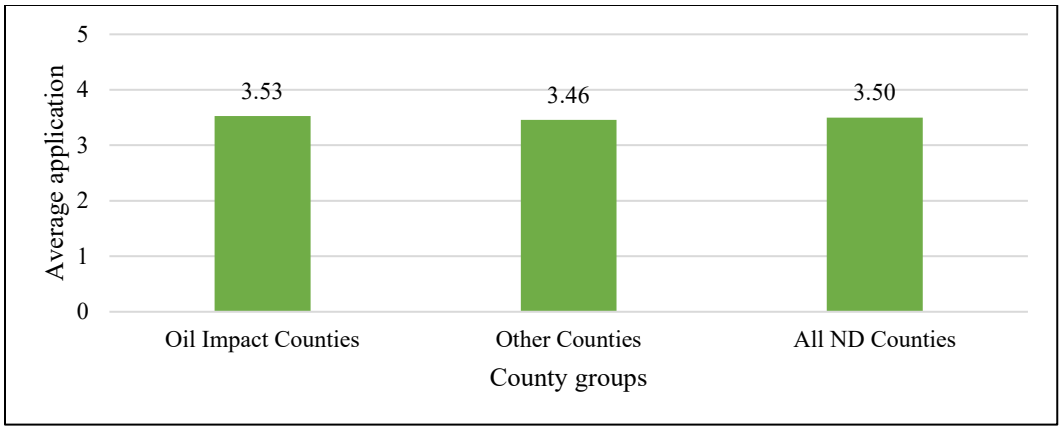

Figure 4.40 Safety end caps use propensity by county groups

4.10.9 Slope Flattening

Lane departure crashes have been identified as a priority in ND crash prevention efforts (ND Vision Zero plan, 2019). After a vehicle leaves the traveled way and traverses over the shoulder, the steepness of the sideslope is a critical factor in driver opportunity to keep the vehicle stable, regain control of the vehicle, and avoid obstacles. From a vehicle stability standpoint, the ideal roadside would be flat (slopes of 1V:10H are considered essentially flat). The AASHTO Roadside Design Guide considers foreslopes that are 1V:4H or flatter to be traversable and recoverable, meaning that the driver could bring the vehicle under control and even stop on these slopes. Slopes between 1V:3H and 1V:4H are considered traversable but non-recoverable, meaning, in most cases, the driver will not be able to recover until reaching a flatter slope. Slopes steeper than 1V:3H are considered critical slopes, meaning the vehicle could become unstable on these slopes to the point that the vehicle overturning risk is increased. Depending on the height of the slope, a barrier might be considered for critical slopes.

While it may not be practical to flatten all slopes along a corridor, flattening the slopes outside of curves may significantly benefit. FARS data indicate that 45% of overturning fatal crashes occur on curves. As a cost-saving measure, agencies can repurpose material excavated from other locations to flatten slopes.

Figure 4.41 shows the survey results where the application of slope flattening in the oil region and in all the surveyed counties is compared. The results in Figure 4.42 indicate that oil impact counties were more interested in using the safety practice compared with the other regions.

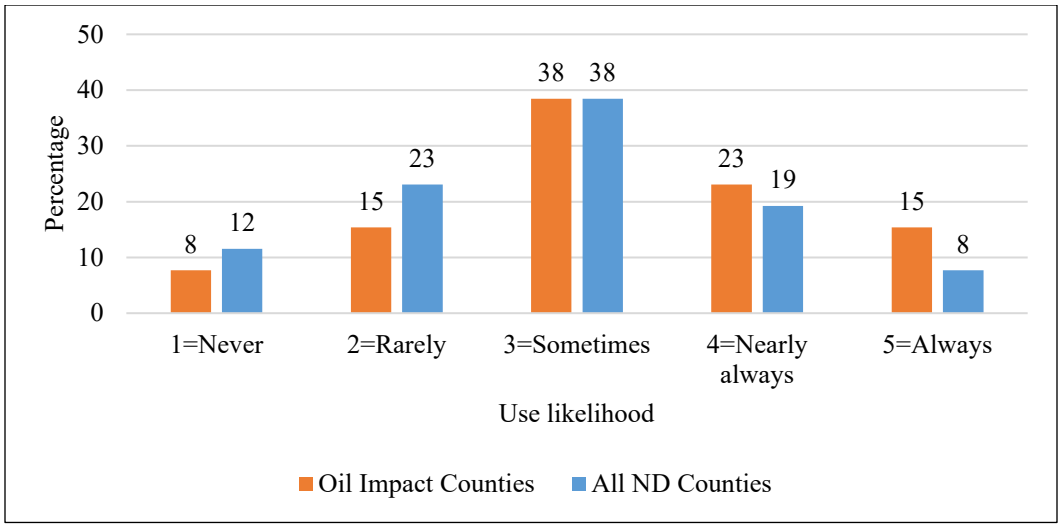

Figure 4.41 Slope flattening use likelihood for all counties

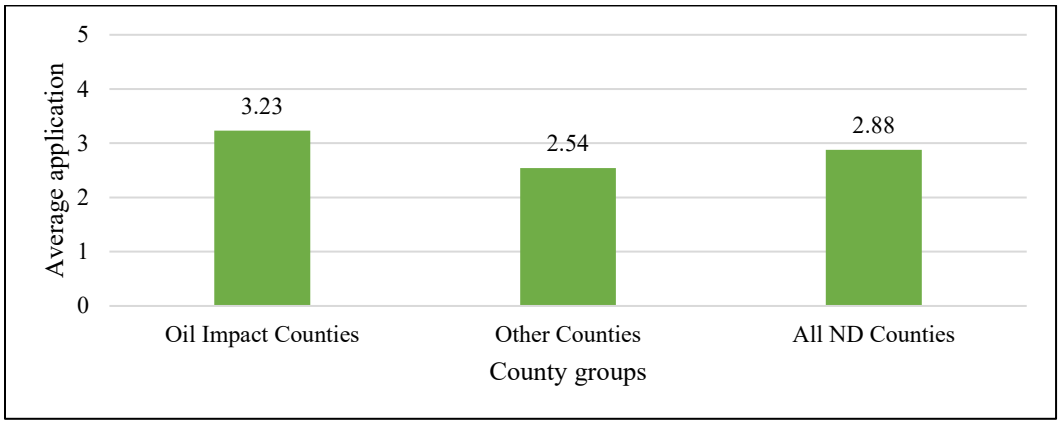

Figure 4.42 Slope flattening use propensity by county groups

4.10.10 Advisory Speed Signs and Stop Ahead Signs

Advisory speed signs inform drivers that the driving situation will not be the same for the conditions ahead, so drivers are advised to reduce their speed. Similar to chevrons and delineators, these signs alert drivers that the road alignment and/or operation will change. According to McGee (2010), damaged or missing speed advisory signs, sharp curve signs, railroad crossing signs, and stop ahead signs should be replaced or repaired as soon as they are identified as lost or damaged. Based on the survey results presented in Figure 4.43, except for Renville, all the oil region counties were using speed advisory signs in their systems. This practice was consistent with results for counties not located in the oil region. Figure 4.44 compares the likelihood of using speed advisory signs in oil region counties with other counties across the state.

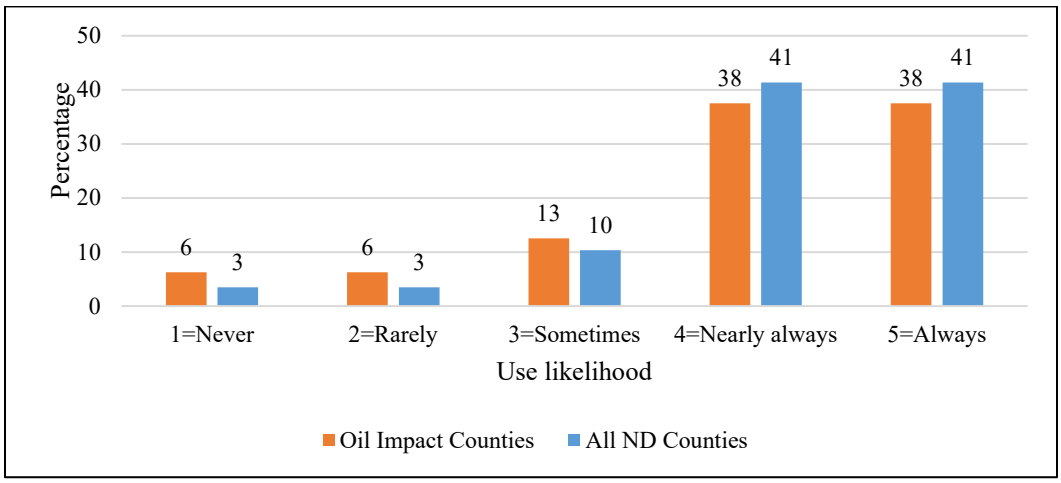

Figure 4.43 Speed advisory sign use likelihood for all counties, 1=never to 5=always

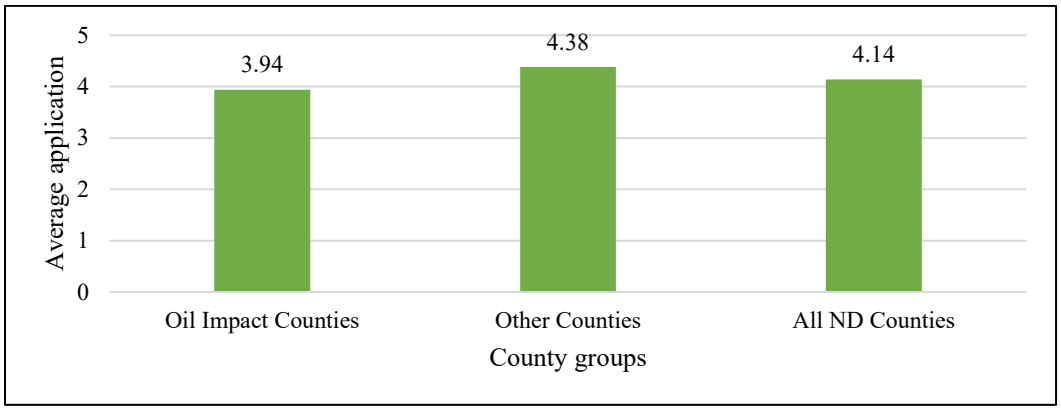

Figure 4.44 Speed advisory sign use propensity by county groups

Stop ahead signs were frequently used by most of the counties except Bowman and Renville. Among oil impact counties, 76% reported “nearly always” or “always” use likelihood compared with 62% statewide. Figure 4.45 and Figure 4.46 show that stop ahead signs have been a commonly used safety countermeasure throughout North Dakota, with slightly higher use in non-oil impact counties.

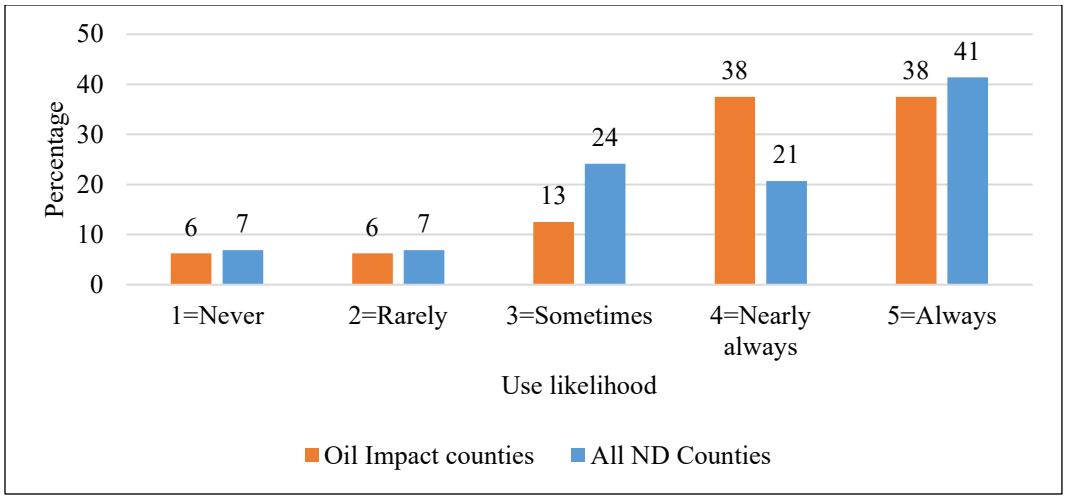

Figure 4.45 Stop ahead signs use likelihood for all counties

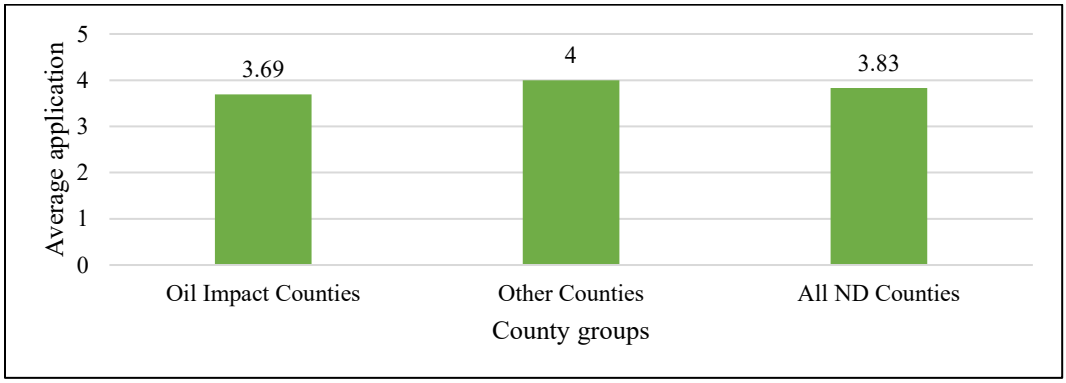

Figure 4.46 Stop ahead signs use propensity by county groups

4.10.11 Curve Warning Signs

Installing and maintaining curve warning signs is another recommended safety practice. Inquiry about practices shows all county road managers use curve warning signs. Figure 4.47 and Figure 4.48 indicate that almost all counties located in the oil region and across the state used warning signs on their roadway curves.

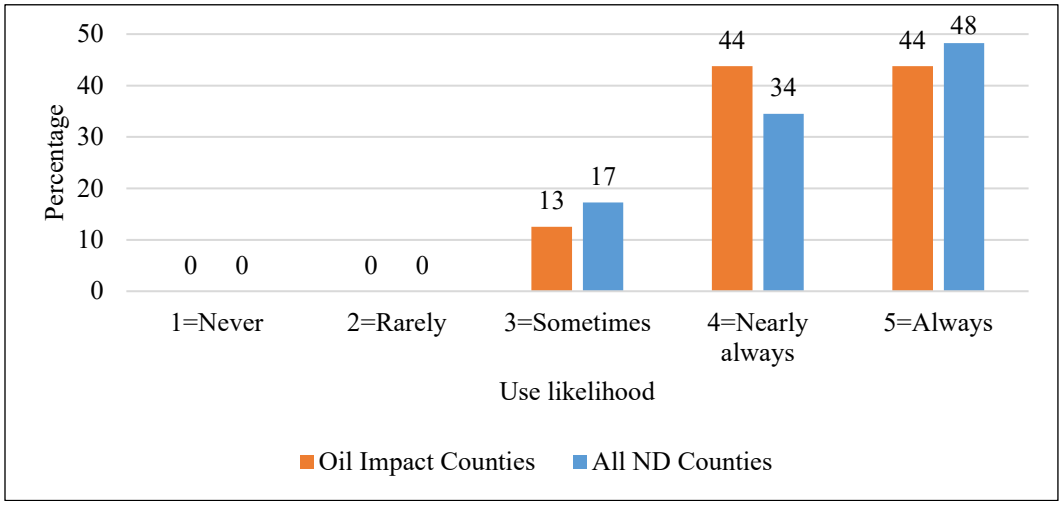

Figure 4.47 Curve warning signs use likelihood for all counties

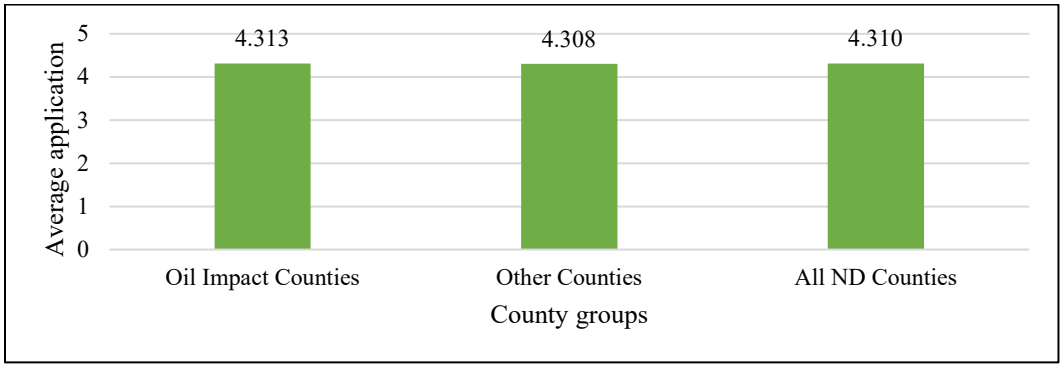

Figure 4.48 Curve warning signs use propensity by county groups

4.10.12 Intersection Warning Signs

Driving through intersections is one of the most dangerous tasks of driving. Almost 90% of crashes that happen at intersections may stem from a lack of driver advisement (Verneke & Vollrath, 2013). Therefore, it would be beneficial to provide drivers with appropriate intersection warning signs that provide timely warnings when approaching intersections.

All the counties used intersection warning signs with the exception of Ward. According to statewide responses, five counties rarely used this safety practice. Results in Figure 4.49 and Figure 4.50 show that

the average application of using warning signs at intersections was reported in a range between using them sometimes and almost always.

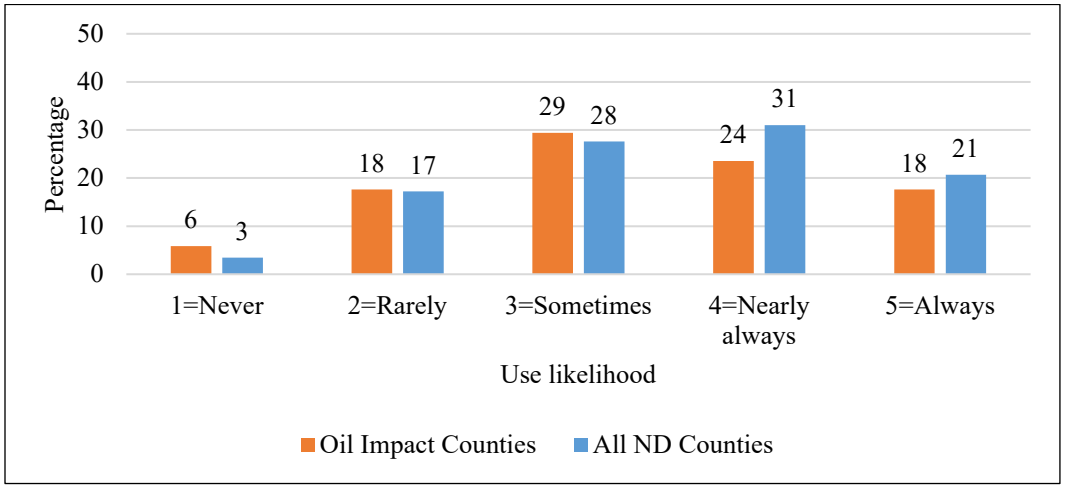

Figure 4.49 Intersection warning sign use likelihood for all counties, 1=never to 5=always

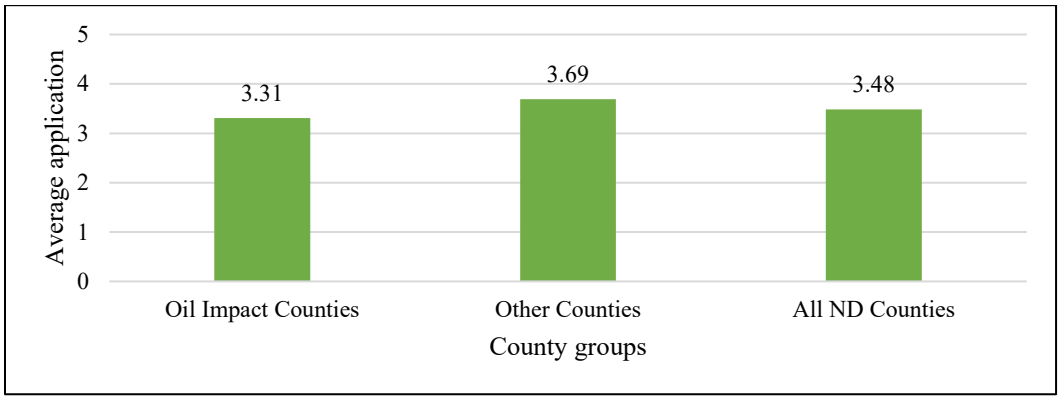

Figure 4.50 Intersection warning sign use propensity by county groups

4.10.13 Destination Lighting

Destination lighting is usually defined as lighting at an intersection to help drivers visually locate intersections in the distance and navigate to intersections with a minimum of distraction. This safety countermeasure is among proven strategies in the county road HSIP funding application (Appendix B). Based on the survey results, it was noted that destination lighting was applied by two counties in the oil region before the implementation of LRSP in 2014. However, once the counties implemented the LRSP, seven counties in the oil region considered implementing this countermeasure. The results for all the surveyed ND counties are consistent with results from the oil region (Figure 4.51). It is assumed that the reason for not considering destination lighting could be related to the low rate of road usage during the night or existing proper geometric features that might make driving on the roads safe. However, Figure 4.52 indicates that destination lighting is used slightly more in the oil region than in the counties not located in the region.

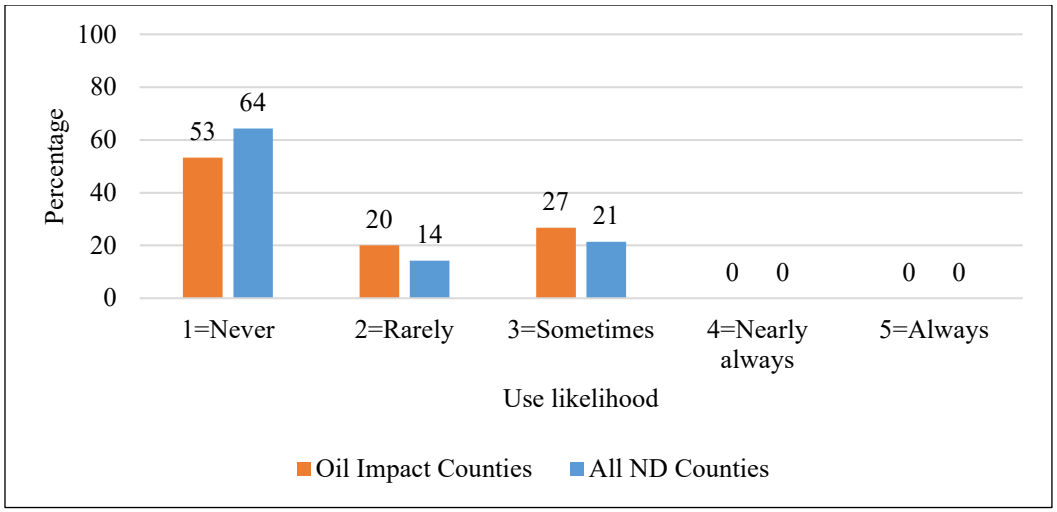

Figure 4.51 Destination lighting use likelihood for all counties

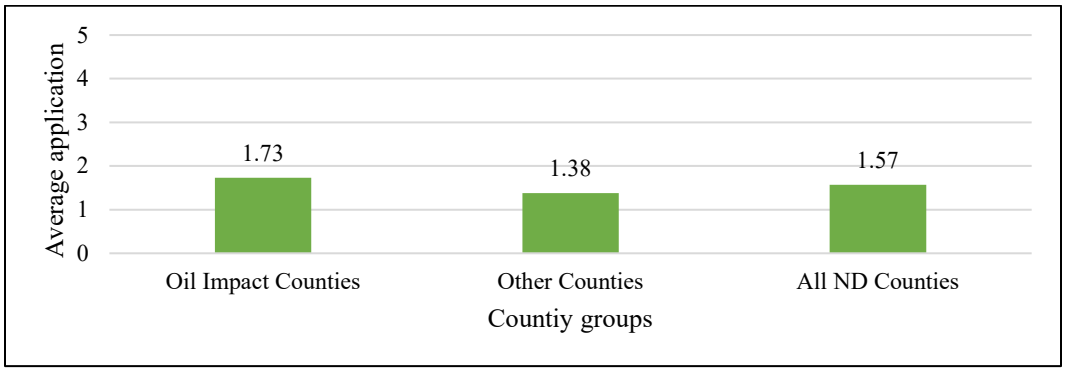

Figure 4.52 Destination lighting use propensity by county groups

4.11 Farming and Reactivity Infringement in Road Maintenance

Based on survey responses, only Pierce, Divide and McHenry counties report rare or no infringing farming and resident activities for their road system. Safety emphasis in road maintenance planning is one promising approach for dealing with the issue of interference and interruptions. Maintenance planning is defined as the function of road management, which involves a series of decisions on the type, location, and time of maintenance actions over the life span of the pavement. All activities aim to minimize the total maintenance costs and improve safety (Gerami Matin, Vatani Nezafat, & Golroo, 2017).

Figure 4.53 demonstrates that ROW maintenance experiences farming interference in most ND counties. However, three counties in the oil region and two other respondent counties reported never or rarely experiencing industry interference. According to the results, nearly 88% of all the surveyed counties experienced farming interference while the rate was 83% in the oil impact counties. Both results are close to the results from the 2010 survey (80%). The comparative results in Figure 4.54 also show that, on average, farming interference sometimes happens to ROW maintenance in all the surveyed counties, either in the oil region or all the surveyed counties.

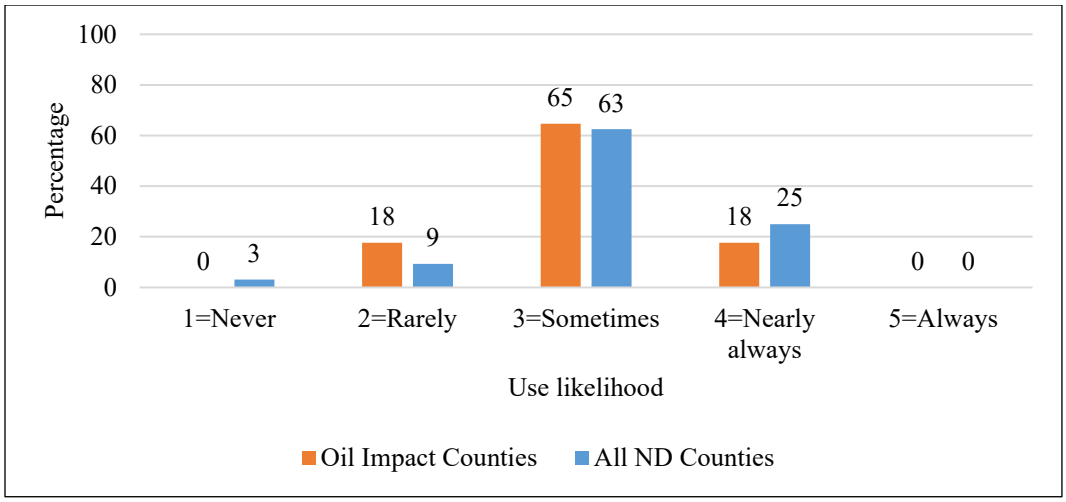

Figure 4.53 Farming interfering with the ROW maintenance likelihood for all counties

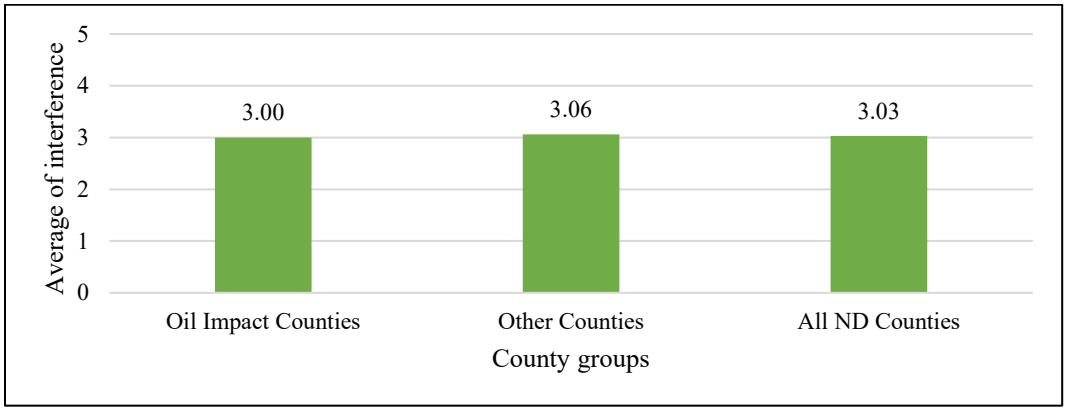

Figure 4.54 Farming interfering with the ROW maintenance propensity by county groups

4.12 Training and Techniques for Roadway Safety Improvement

Based on the survey results, all the counties have been using the NDLTAP program training. Some counties also used complementary programs, such as BROSZ Engineering or local engineers, to diagnose safety-related problems. Going forward, we must recognize the wide array in counties' experiences, interest, and need with regard to safety project support. The study showed a strong relationship between previous and current county road manager safety activity. It is not unexpected but does mean that an extra effort with the "inactive" managers may produce longer term benefits. Recognizing progress in common safety practices is one means to share best practices in promoting local road manager safety work.

5. CONCLUSION AND FUTURE RESEARCH

In this study, road managers were asked to complete surveys regarding the safety activities conducted in ND counties located in the oil region. The survey results show us that the dispersion of the road managers' experience is not equitably distributed. The experience could cause variations in the skill level and subjectivity of the managers' opinions in the survey. Studying the correlation of the managers' experience level and their efficiency and effectiveness of implementing the safety plans and mitigating the risk of crashes seems promising in this area. Additionally, information was collected to document local road safety investments related to the HSIP funds for eligible local roads.

The number of traffic signs in each county was also surveyed. It should be noted that signs should be used and located judiciously, minimizing their proliferation in order to maintain their effectiveness. Therefore, having more signs may not necessarily guarantee safer roads.

Lane width and shoulder width in the oil region's local roads play an important role to improve road safety. A report regarding the Freeborn County, Minnesota, roadway safety plan (Safety plan for Freeborn County, 2020) concluded that enhanced edge lines have also been used when lane width is less than 12 feet. The report offered safety measurements, such as centerline and shoulder rumble strips, shoulder paving, and safety edges, to improve safety on such roads. However, each county may certify with its auditor office what the construction specifications are for road and bridge design widths.

Gravel road dust is a real safety issue for the traveling public and a health issue for people and animals, and detrimental to crops living or growing next to dusty roads. Dust control products on the market that include hygroscopic (water-attracting salts) or vegetable oils (adhesion of dust fines to aggregate stones and sand) could be reliable options to apply. Even though HSIP may not have enough funding to participate in long segments, one option may be to identify hazardous gravel road intersections by the LRSPs and apply dust control products as spot treatments using HSIP funds. The problem is the product may last a few months to a year depending on weather and traffic.

Gravel surfacing specifications are also crucial for counties, tribes, and townships. It should be noted that the plasticity index (a measure of how sticky the fines or dust particles are when wet) is essential for surfacing gravel specs. A proper choice of the index for gravel can prevent washboards and unraveling issues on gravel roads.

The importance of delineators was highlighted in the studied regions where 50% of the oil region counties reported the application. However, it would be helpful for the counties to consider the effect of delineators when investigating the frequency and severity of crashes. More specifically, monitoring and maintaining bridge delineator signs and bridge load posting signs are of high importance. According to the reports from ND road managers, in some cases where there are narrow bridges, delineator signs are broken or taken down to move a wide load through and these signs are not put back up by the user. In addition, with about 684 local road bridges in North Dakota being posted for load maximums, these signs are a must for being maintained to insure reduced liability for the bridge owner and safety of the traveling public. Guard railings for bridges that had a relatively high ADT could also be considered where following the road alignments was a safety concern. Proper sign retro reflectivity could also be deemed as one of the important factors to reduce severity of crashes, specifically during night conditions. A

reasonable approach to tackle this issue could be highlighting the importance of sign management plans to road safety managers and documentation of inspections and age of sign inventory.

While survey findings were limited by the voluntary responses in a single state's county road managers, important information was gathered about common practices and leading peer traffic safety strategies. It did provide valuable insight regarding the need for state leadership and support with traffic safety initiatives, especially with counties that may have severe resource constraints and/or inexperience with regard to safety issues and improvement strategies. In addition, the value of a baseline and period survey with this group provides a means to assess progress quantitatively to support anecdotal qualitative insights. Sharing this work on ongoing improvement in the LRSP with other rural states may be especially helpful in sharing best practices to support local road safety efforts. Future work is planned for local road safety decision tools to enhance and promote best practices and ongoing emphasis on local department planning.

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APPENDIX A. ROAD SAFETY SURVEY FOR COUNTY ROAD MANAGERS

ROAD SAFETY SURVEY FOR COUNTY ROAD MANAGERS

Name:_____County:_____

Email: _____ Phone: _____

Years as County Road Manager: _____

County Assets

1. On paved roads, what is the typical? lane width_____shoulder width_____

2. Do you employ rumble strips/rumble stripes in your county? □ Yes □ No

3. How many signs are on your county road system?_____
   - Do you inventory township or municipal signs? □ Yes □ No

4. Do you maintain any township roads?
   a. Paved? □ Yes □ No
   b. Gravel? □ Yes □ No

5. Does your county cooperate with other jurisdictions on contracting for road safety services such as striping? Check all that apply.
   □ None □ Townships □ Counties □ State □ Other (please specify)_____

6. Share of annual budget dedicated to construction?_____%

7. Share of annual construction budget allocated to road safety improvements?_____%

8. Does your county have funding dedicated to safety projects? □ Yes □ No
   If yes, share of annual budget spent on road safety improvements such as striping and signs?

   _____%

Local Road Safety Program Implementation

9. Did your county implement projects from the 2014 Local Road Safety Program (LRSP)?
   □ Yes □ No □ Don't Know
   - If yes, funding source(s). Check all that apply.
     □ Local □ State □ Other (please specify) _____

10. Does your county have projects from the 2014 LRSP scheduled for the future?
    □ Yes □ No □ Don't Know

11. Has your county incorporated the LRSP it into your own Safety Plan?
    □ Yes □ No □ No, but plan to □ Don't Know

12. Has your county ever applied for NDDOT Highway Safety Improvement Program (HSIP) funding? □ Yes □ No □ Don't Know
    - If yes, was the project from those identified in the 2014 LRSP?
      □ Yes □ No □ Don't Know

Current Safety Practices

13. Signs on your county road system are typically replaced:
    □ As Needed □ Every 10 years □ Other (please specify) _____

14. Do you have a current sign inventory? □ Yes □ No
    - If yes, do you use a third party program to inventory (i.e. AcquiSIGN)? □ Yes □ No

15. What is the typical interval for striping on county paved roads?
    □ 1 year □ 2 years □ 3 years □ Other (please specify) _____

16. Do you stripe the edgelines in your county? □ Yes □ No

17. Routine gravel replacement is:
    □ As Needed □ Every 5 years □ Every 10 years □ Other (please specify) _____

18. What is your usual specification for gravel road crown?_____%grade □ Unknown

19. What do you use for standard gravel specification?
    □ Class 5 □ Class 13 □ Class 13 Modified □ Other (please specify) _____

20. In managing your roads, how often do you use these strategies:

    Please mark if you used the strategy before the LRSP reports in 2014

		Current Practice				
Strategy	Pre-LRSP	Never				Always
a. Delineators on curves	□	1	2	3	4	5
b. Chevrons on curves	□	1	2	3	4	5
c. Rumble strips or stripes	□	1	2	3	4	5
d. Maintain clear right-of-way	□	1	2	3	4	5
e. Safety end caps on guardrails	□	1	2	3	4	5
f. Slope flattening	□	1	2	3	4	5
g. Speed Advisory Signs	□	1	2	3	4	5
h. Stop Ahead Signs	□	1	2	3	4	5
i. Curve Warning Signs	□	1	2	3	4	5
j. Intersection Warning Signs	□	1	2	3	4	5
k. Destination Lighting	□	1	2	3	4	5

21. Farming or other resident activity interferes with the ROW maintenance.
    □ Never □ Rarely □ Sometimes □ Nearly Always □ Always □ Do Not Know

22. Do you have a ROW enforcement program? Briefly explain your program.

23. Briefly tell us about road safety management in your county.

24. What are your sources for training and techniques for roadway safety improvements?

APPENDIX B. NDDOT HSIP PROJECT APPLICATION

HIGHWAY SAFETY IMPROVEMENT PROGRAM (HSIP)
PROJECT APPLICATION
North Dakota Department of Transportation, Programming
SFN 59959 (1-2016)

23 USC § 409 Documents
NDDOT Reserves All Objections

Please attach a location map(s). You may use additional sheets to further describe your project.

Agency Name			NDDOT District
Contact Name			Telephone Number
Email Address		Project Cost Estimate(attach detailed copy)	Current Date
Location Description	Roadway Ownership ☐ State ☐ County ☐ City ☐ Tribe Speed Limit / Ref. Point(s) AADT	SHSP Emphasis Area(check all that apply) ☐ Younger Drivers ☐ Speeding or Aggressive Drivers ☐ Alcohol-Related ☐ Unbelted Vehicle Occupants ☐ Lane Departure ☐ Intersections	Functional Class ☐ Local Road or Street ☐ Minor Collector ☐ Major Collector ☐ Minor Arterial ☐ Principal Arterial

Improvement Category (check one)

☐ Access Management	☐ Intersection Geometry	☐ Parking	☐ Roadway Delineation
☐ Advanced Technology & ITS	☐ Intersection Traffic Control	☐ Pedestrians & Bicyclists	☐ Roadway Signs & Traffic Control
☐ Alignment	☐ Lighting	☐ Railroad Grade Crossings	☐ Shoulder Treatments
☐ Animal Related	☐ Miscellaneous	☐ Roadside	☐ Speed Management
☐ Interchange Design	☐ Non-infrastructure	☐ Roadway	☐ Work Zone

Describe Current Safety Issues

Describe Proposed Safety Improvements

For questions or comments contact:
Shawn Kuntz
701-328-2673
skuntz@nd.gov
Please email completed form to this address: hsip@nd.gov

What is HSIP?

The Highway Safety Improvement Program (HSIP) is a core Federal-aid highway program with the purpose to **achieve a significant reduction in fatalities and serious injuries on all public roads**. The HSIP is a Federally-funded, State-administered program. The NDDOT Programming Division Traffic Operations Section manages the HSIP program. Justin Schlosser, the NDDOT Traffic Operations Engineer, is the main contact for HSIP questions. (Email jjschlosser@nd.gov or telephone at 701-328-2673)

HSIP eligible project types?

A "highway safety improvement project" means strategies, activities, and projects on a public road that are consistent with the 2018 North Dakota Vision Zero Strategic Highway Safety Plan: https://www.dot.nd.gov/divisions/safety/docs/FINAL_NDDOT_SHSP.pdf
and—

(i) correct or improve a hazardous road location or feature; or
(ii) address a highway safety problem.

The Vision Zero Plan identifies 6 emphasis areas for the State of North Dakota. To be consistent with the plan, projects must relate to at least one of these six emphasis areas:

- **Lane Departure**
- **Intersections**
- **Alcohol and/or Drug Related**
- **Unbelted Vehicle Occupants**
- **Speeding/Aggressive Driving**
- **Young Drivers**

A "highway safety improvement project" includes a project for 1 or more of the following:

(i) An intersection safety improvement.
(ii) Pavement and shoulder widening (including addition of a passing lane to remedy an unsafe condition).
(iii) Installation of rumble strips or another warning device, if the rumble strips or other warning devices do not adversely affect the safety or mobility of bicyclists and pedestrians, including persons with disabilities.
(iv) Installation of a skid-resistant surface at an intersection or other location with a high frequency of crashes.
(v) An improvement for pedestrian or bicyclist safety or safety of persons with disabilities.
(vi) Construction and improvement of a railway-highway grade crossing safety feature, including installation of protective devices.
(vii) The conduct of a model traffic enforcement activity at a railway-highway crossing.
(viii) Construction of a traffic calming feature.
(ix) Elimination of a roadside hazard.
(x) Installation, replacement, and other improvement of highway signage and pavement markings, or a project to maintain minimum levels of retro reflectivity that addresses a highway safety problem consistent with a State strategic highway safety plan.
(xi) Installation of a priority control system for emergency vehicles at signalized intersections.
(xii) Installation of a traffic control or other warning device at a location with high crash potential.
(xiii) Transportation safety planning.
(xiv) Collection, analysis, and improvement of safety data.
(xv) Planning integrated interoperable emergency communications equipment, operational activities, or traffic enforcement activities (including police assistance) relating to work zone safety.
(xvi) Installation of guardrails, barriers (including barriers between construction work zones and traffic lanes for the safety of road users and workers), and crash attenuators.
(xvii) The addition or retrofitting of structures or other measures to eliminate or reduce crashes involving vehicles and wildlife.
(xviii) Installation of yellow-green signs and signals at pedestrian and bicycle crossings and in school zones.
(xix) Construction and operational improvements on high risk rural roads.
(xx) Geometric improvements to a road for safety purposes that improve safety.
(xxi) A road safety audit.
(xxii) Roadway safety infrastructure improvements consistent with the recommendations included in the publication of the Federal Highway Administration entitled "Highway Design Handbook for Older Drivers and Pedestrians" (FHWA–RD–01–103), dated May 2001 or as subsequently revised and updated.
(xxiii) Truck parking facilities eligible for funding under section 1401 of the MAP–21.
(xxiv) Systemic safety improvements.
(xxv) Installation of vehicle-to-infrastructure communication equipment.
(xxvi) Pedestrian hybrid beacons.
(xxvii) Roadway improvements that provide separation between pedestrians and motor vehicles, including medians and pedestrian crossing islands.
(xxviii) A physical infrastructure safety project not described in clauses (i) through (xxvii).

This list is from Title 23 U.S.C 148 **https://www.gpo.gov/fdsys/pkg/USCODE-2015-title23/pdf/USCODE-2015-title23-chap1-sec148.pdf** which includes the legislative and regulatory requirements.
Additional HSIP guidance and list of project categories can be found here:
https://safety.fhwa.dot.gov/legislationandpolicy/fast/hsip_reporting_guidance.cfm

Local Road Safety Program

The Local Road Safety Program (LRSP) is a part of the HSIP program. Any project listed in your LRSP document is considered HSIP eligible.

The following is a link to the NDDOT Traffic Safety Page:
https://www.dot.nd.gov/divisions/safety/trafficsafety.htm
Then click on "Local Road Safety Program" for a link to all the LRSP documents.

How to apply?

STEP 1:

Review your LRSP document and select any desired projects. The back of each document has completed HSIP project application forms. That form is all that needs to be submitted as documentation for LRSP projects. Consider grouping forms in an application to create larger projects.

STEP 2:

Use your knowledge of your system and your experience. Think about any other potential locations and projects that may fit eligibility and have the potential to reduce severe crashes.

STEP 3:

Complete a safety engineering study. A safety engineering study is an analysis and evaluation of available information to **diagnose safety concerns** and the **identification of countermeasures** to address the concerns. A study may include but is not limited to:

- ✓ Location map clearly indicating where the proposed project is located.
- ✓ Crash data analysis (Contact jjschlosser@nd.gov to get crash data from NDDOT).
  - Not all projects have to be high crash locations, projects may address a reduction in crash potential for an identified crash issue.
- ✓ Traffic volume data if applicable.
- ✓ Input from stakeholders such as law enforcement, EMS, roadway maintenance, schools, etc.
- ✓ Information from a site visit to document items such as sight lines, physical limitations, traffic movements, and adjacent land uses.
- ✓ Explanation of safety concern and how proposed countermeasure will address concern.

The level of study will depend on the scope and complexity of the proposed project. Use NDDOT traffic operations resources found at the following link to assist in completion of studies.
https://www.dot.nd.gov/divisions/programming/traffic-operations.htm

STEP 4:

Identify scope of project and prepare cost estimate.

STEP 5:

Complete your HSIP project application by completing the form provided by this link http://www.dot.nd.gov/forms/sfn59959.pdf and submit with your safety engineering study by email to hsip@nd.gov no later than December 31, 2019.

Feel free to contact Justin Schlosser (jjschlosser@nd.gov or 701-328-2 for assistance regarding questions you may have about project eligibility and/or the application process.

APPENDIX C. PLANNED/BID HSIP PROJECTS IN THE OIL REGION SINCE 2015

FY	Bid opening	County	PCN	Project	Funding Source	Funding Code	Location	Length	Type of work	Cost EST w/ CE
2020	11/13/2020	Bottineau	21872	HLC-0500(004)	Safety	HLC	Various Locations		Guardrail	$345,000
2020	2/7/2020	Bottineau	22517	HEC-0549(001)	Safety	HEC	OLD LAKE ROAD - CMC 0549 FROM 98TH STREET NE, N TO ND 43	9.4	Widening	$1,721,468
2019	2/7/2020	Bottineau	21676	HLC-0500(003)	Safety	HLC	County Wide	41	Rumble Strips, shoulder paving, signing, edge lines, street lights, mainline dynamic warning sign	$600,000
2017	11/18/2016	Burke	21136	HLC-0007(053)	Safety	HLC	County Wide	52.985	Shoulders, Striping, guardrail, signing and marking	$546,090
2018	5/11/2018	Divide	21323	HLC-1200(001)	Safety	HLC	VARIOUS LOCATIONS	34.959	Rumble Strips, Street Lights, Signing, Mainline dynamic warning	$209,550
2020	3/13/2020	LaMoure	21869	HLC-2311(054)	Safety	HLC	2.5 MI W & 5 MI S OF EDGELEY		Guardrail	$245,000
2020	3/13/2020	McKenzie	21874	HLC-2700(051)	Safety	HLC	Various Locations		Roadway Realignment, Rumble Strips	$500,000
2018	5/11/2018	McLean	21316	HLC-2800(052)	Safety	HLC	VARIOUS LOCATIONS	107.088	Edge Lines, Rumble Strips, Signs	$335,335
2021	11/13/2020	Mountrail	21875	HLC-3115(057)	Safety	HLC	2 MI W OF NEW TOWN		Skid Surfacing	$25,000
2018	6/15/2018	Mountrail	21326	HLC-3100(011)	Safety	HLC	VARIOUS LOCATIONS	1.19	Signs and Rumble Strips	$45,461
2018	4/13/2018	Williams	21324	HLC-5300(016)	Safety	HLC	VARIOUS LOCATIONS	54	Shoulder paving, curve signing	$545,656