Improvement of Road Safety:

Route-based Assessment on Major Roads in Namibia

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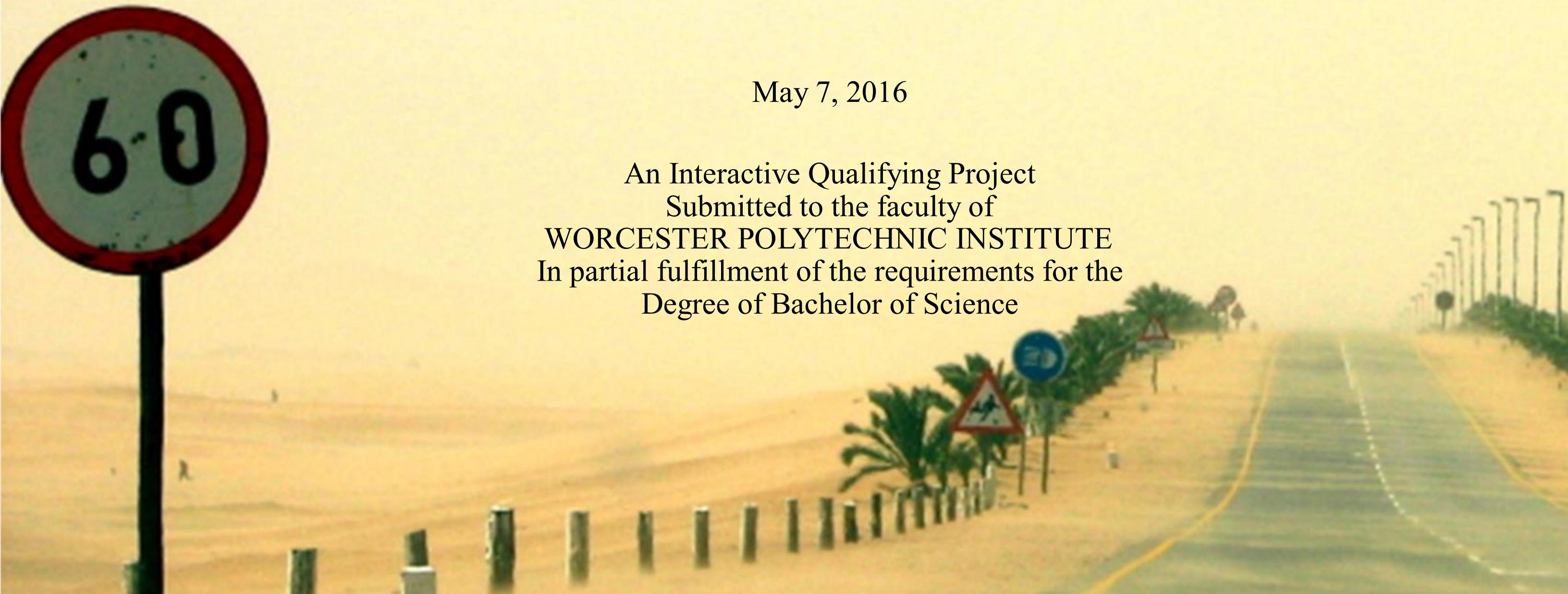


Abstract

The major roadways in Namibia, B1 and B2, have a high number of road accidents. To address this problem, the team organized and analyzed road accident and traffic volume data collected from 2013 to 2015 to identify the most hazardous roadway sections and road stretches. The team then performed both statistical analysis and site evaluations to determine the common causes of accidents. Finally, the team proposed both stretch-specific and long-term recommendations to improve road safety, and suggested directions which future work can focus on.

Executive Summary

The Namibian roadways are considered some of the deadliest in the world. The number of fatalities has increased by 34% from 2011 to 2014, with 633 recorded fatalities out of 327,000 vehicles in 2014.

The Motor Vehicle Accident Fund (MVA Fund) of Namibia provides emergency road assistance for serious accidents and offers financial support for injured parties in the form of hospital fees, losses, and even coverage of funeral expenses. Every year, the MVA Fund compiles data about accidents that occurred in Namibia into an annual report, which details total compensation given to accident victims, as well as the national statistics for road fatalities and injuries. Together, the MVA Fund and its stakeholders, the Roads Authority (RA), the National Road Safety Council (NRSC), and the Namibian Police Force (NAMPOL) are determined to identify the causes and reduce the number of road accidents.

The main goal of this project was to assist the MVA Fund and its stakeholders in reducing road accidents on sections of the B1 (north of Windhoek) and B2 highways.

The first objective was to **organize and map the road accident data** for 2013 and 2015, which was provided by the National Road Safety Council (NRSC). The team identified 790 accidents that occurred on the target areas on B1 and B2 out of a total of 40,000 accidents in 2013 and 2015, and selected 560 accident records with valid location information for mapping.

These routes were divided into sections of concern and the sections were numbered based on the standards of the Roads Authorities (RA). As shown in Figure 1, the B1 route was divided into seven sections and the B2 was divided into three sections.

Figure 1. Focus Highway Routes and Sections.

After **organizing the accident data by section**, the team determined that in 2013 and 2015, the sections with the highest number of accidents are T0111, T0106, and T0110 on B1, and T0202 and T0701 on B2 (Figure 2).

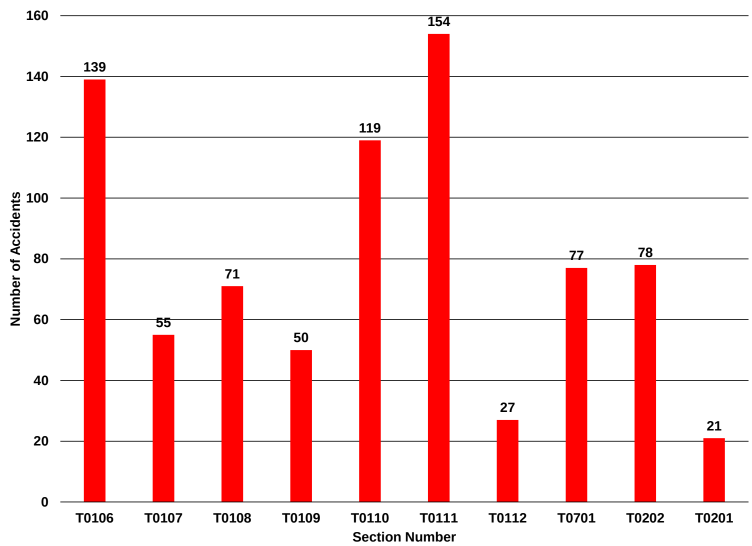


Figure 2. Number of Accidents of Different Highway Sections in 2013 and 2015 combined

A map of the accidents shows that a high number of them occurred on the section from Tsumeb to Ondangwa (T0110 and T0111) and the section from Usakos to Swakopmund (T0202) (as circled in Figure 3). **Average accident severities** of the sections were also analyzed by calculating the Average Accident Severity Index (AASI). On average, an accident occurring on T0112, T0110, T0202, and T0201 was more severe than that on other sections (Figure 4). As a result, T0110 and T0202 both have a high number of accidents and high average accident severity, which made these sections potential sections of concern.

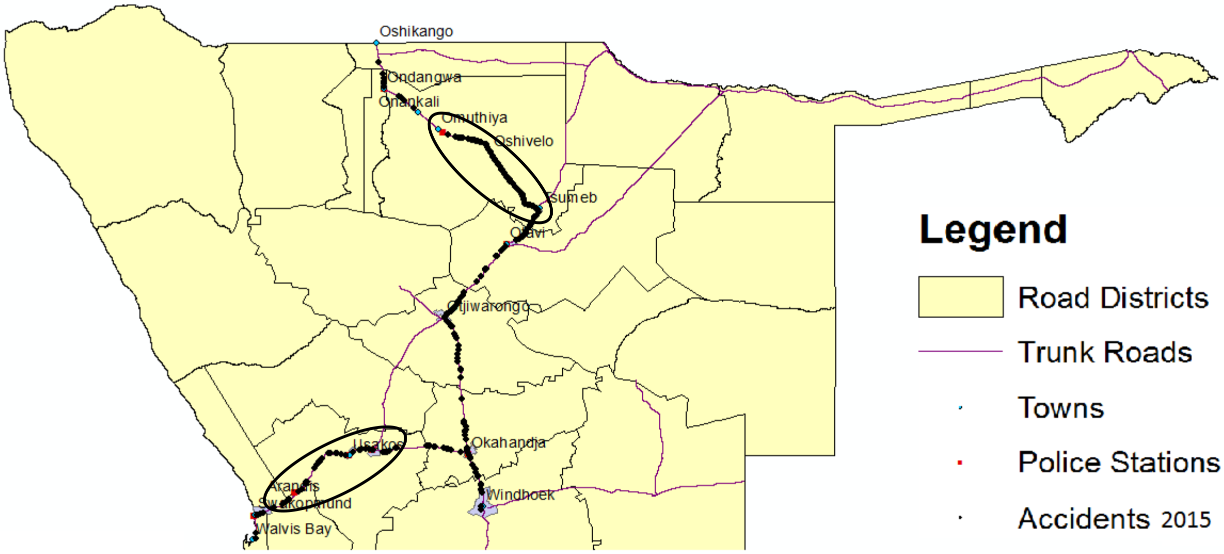


Figure 3. GIS Map of Road Accidents in 2015

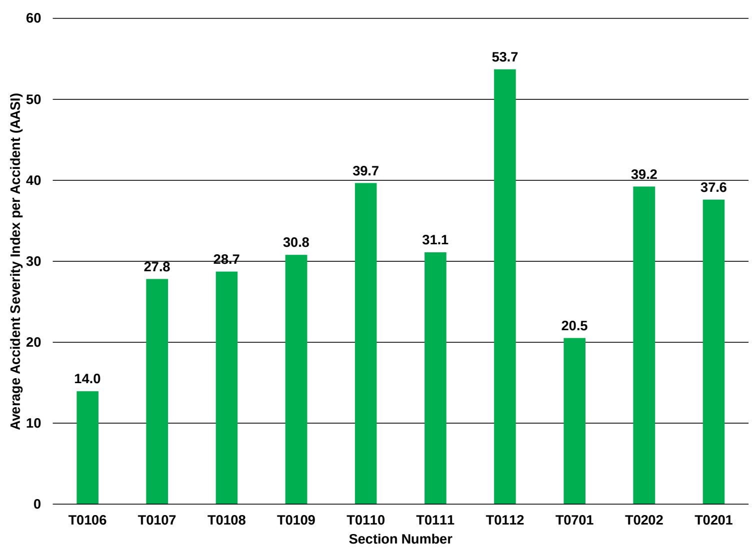


Figure 4. Average Accident Severity Indexes (AASI) in 2013 and 2015 Combined

The second objective was to **organize and map traffic volume data**, specifically the Daily Vehicle Kilometers Travelled (DVKT), which was provided by the Roads Authority. As shown in Figure 5, T0111, T0106, and T0107 have the highest traffic volumes on B1, while T0202 and T0701 have the highest traffic volumes on B2. The high traffic volumes might explain the high number of accidents on T0106, T0111, T0701, and T0202. However, T0110 does not experience high traffic, yet it has a high number of accidents.

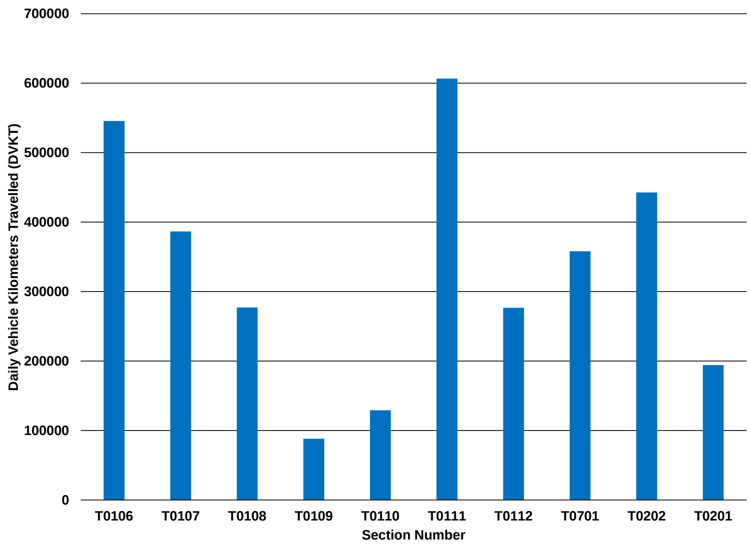


Figure 5. Daily Vehicle Kilometers Travelled (DVKT)

Moreover, traffic volume levels were determined for the B1 and B2 subsections by dividing the *DVKT* values into three levels. Mapping the traffic volume levels further approved the results obtained from statistical analysis. As circled in the Figure 6, the section from Tsumeb to Oshivelo (T0110) has a low traffic volume compared to other sections with a high number of accidents. This indicates that section T0110 is a high concern from having multiple accidents occurring on this section compared to other sections.

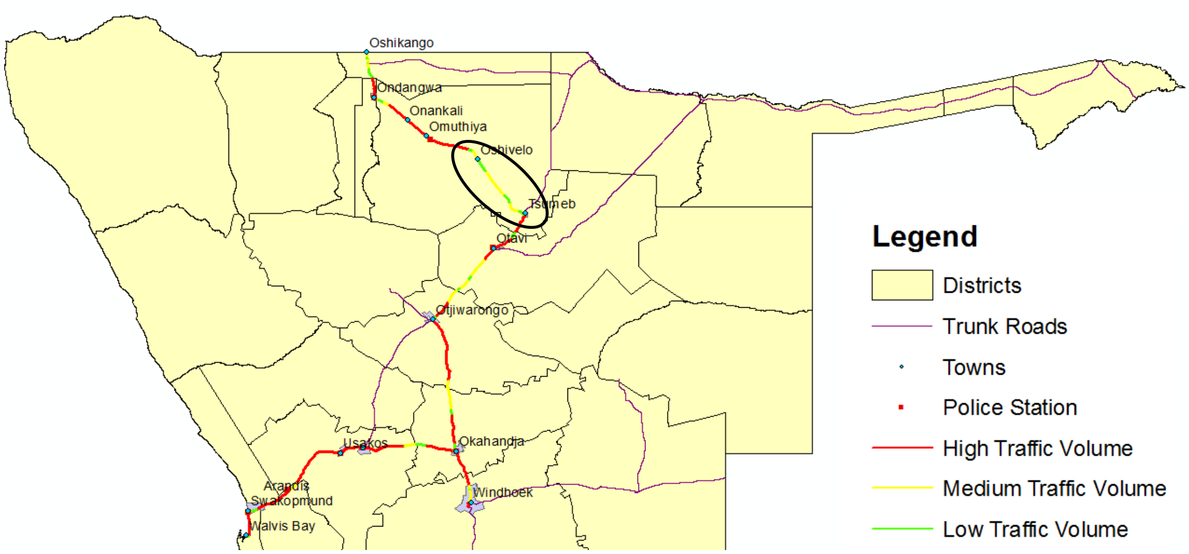


Figure 6. GIS Map of Traffic Volume Levels

The third objective was to **identify the unsafe sections** of highway. The team normalized the road accident data with respect to the traffic volume data. Specifically, the Total Accident Severity Index (TASI) was divided by the DVKT for each section to obtain the Accident Severity Index per Million Vehicle Kilometers Travelled (AMVKT), which was used to evaluate the overall accident severity of each section (Figure 7). On average, B1 has higher AMVKT than B2, indicating that **B1 is generally more hazardous than B2**. Additionally, T0110 and T0202 are identified as the most hazardous sections of B1 and B2.

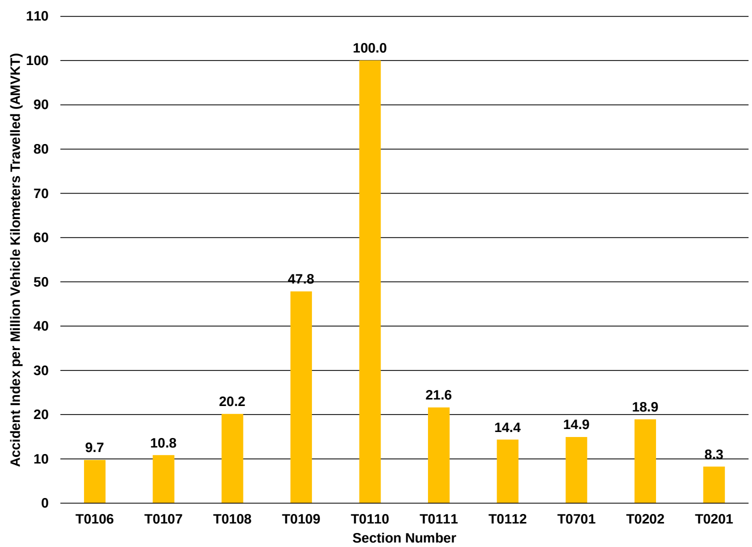


Figure 7. Accident Severity Index per Million Vehicle Kilometers Travelled (2013 and 2015 combined)

As circled in Figure 8, T0110, the section **from Tsumeb to Oshivelo, was identified to be the most hazardous section** due to its high number of accidents, high accident severity, and low traffic volume.

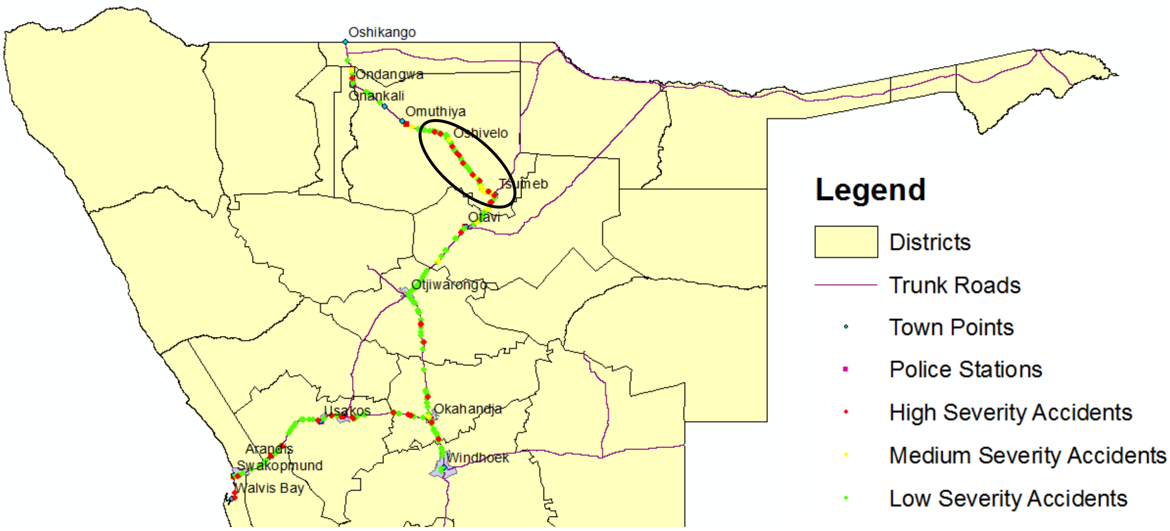
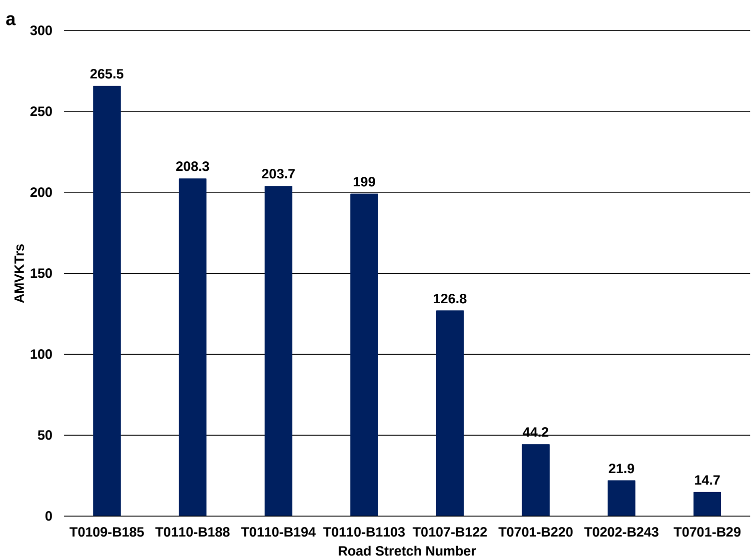


Figure 8. GIS Map of Severity Levels for 2015

To be able to pinpoint possible remedial actions, we examined our data in stretches of 5 kilometers. As shown in Figure 9, the most hazardous 5 km stretch of road is on T0109, which is the section from Otavi to Tsumeb. However, it is important to note that the next three most hazardous 5 km sections are *all* on T0110, in the longer segment from Tsumeb to Oshivelo, which was previously identified as the most hazardous highway section.



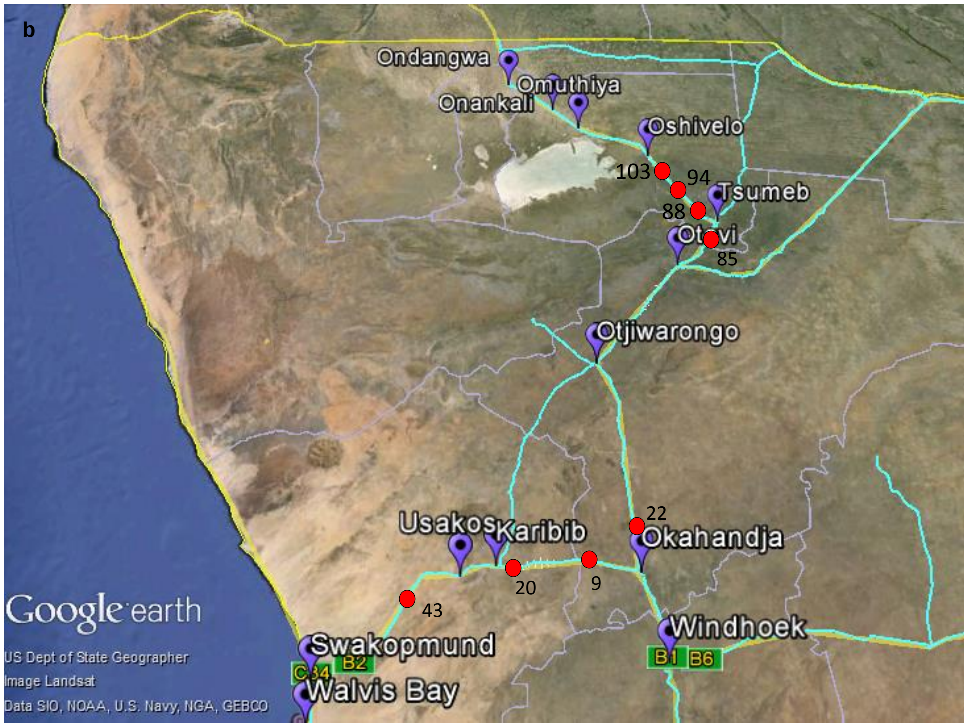


Figure 9. Most Hazardous 5 km Road Stretches. (a) AMVKT and (b) Map of Road Stretches

Site evaluations were conducted on the top eight road stretches to visualize the **recurring issues** with the roadway and the surrounding environments. The team identified four common causes of accidents, namely **animals**, **blind spots**, **shoulders**, and **speeding**.

The team determined **encountering animals at night, is the leading cause of accidents**. According to the accident descriptions, most animal accidents on these road stretches occurred with domestic animals such as cows and donkeys. The team additionally observed a lot of farms near the highway, many of which have broken fences, and we also frequently observed animals grazing on the sides of the roads. Those safety issues are prevalent on B1 and B2, especially on Stretches 22, 94, and 103 on B1, and Stretch 20 on B2.

Moreover, the team analyzed the elevation profiles of the 5 km road stretches and observed elevation changes on Stretch 9 on B2 and Stretch 85 on B1, which could potentially create blind spots. Site evaluations allowed us to verify the presence of blind spots and determined that crests of the roadway create the blind spot on Stretch 9 on B2 and that on Stretch 85 on B1 is due to the combination of a crest and curve.

The third common cause was identified to be road width of the roads. The team identified several accident types that may be caused by issues with road width, including single vehicle overturned, sideswipes, and went off road without rolling. Approximately 22% of accidents were caused by issues with road width, and single vehicle turned was identified as the most prevalent and most severe type of accidents that occurred with road width issues. Moreover, 85% of accidents with road width issues occurred at night. From site evaluations, we also observed lack of shoulders and sharp drop-offs on Stretch 22 on B1 and Stretches 20 and 43 on B2. In addition, the roadway is too narrow on Stretch 85 on B1 for large vehicles to maneuver.

Speeding was identified as another issue, which is prevalent on all sections on B1 and B2, especially on the most hazardous locations. On average, approximately 20% of vehicles exceeded the speed limit on B1 and B2 in 2013 and 2015. Additionally, approximately 30% of vehicles exceeded the speed limit on T0110, the section from Tsumeb to Oshivelo, previously identified as the most hazardous section.

The fifth objective was to **propose both stretch-specific and long-term recommendations to improve road safety**. On the four stretches with animal-related accidents, we recommended farmers to **reinforce fencing and put reflective tags on their livestock**. Additionally, we encouraged the RA to build **reflective warning signage for animals** on those stretches. With respect to blind spots, we recommended to add more **reflective road tags, guided signage, and warning signs** on Stretch 85 on B1 and Stretch 9 on B2. Regarding to the issues with shoulders, we suggested **widening the roadway** on Stretch 85 on B1 and **tapering off the shoulders** on Stretch 22 on B1 and Stretches 20 and 43 on B2. As for speeding, we proposed to **lower the speed limit** on the most hazardous sections such as T0110 and T0202. In addition, for long-term speed control, we recommended to **increase the presence of police officers** on the highways and introduce **demerit point system** to the licensing of drivers.

Finally, the team proposed several recommendations for future work. First, the team advised that Namibian Police Force strive to train the officers to fill out the Road Accident Forms to their entirety. This will allow the road accident data on future years to be more accurate. Second, analyze different combinations of factors, such as the relationship between different age groups and speeding. Third, highway sections with a low number of accidents and low severities could be analyzed to determine the reasons they are safer stretches of road. Forth, a feasibility study and cost analysis can be conducted to examine the cost-effectiveness of implementing the proposed countermeasures, which can assist the researchers in identifying the most appropriate methods of reducing road accidents in Namibia.

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Authorship

This project has been a culmination of research, organization writing, and editing by all group members: Zoe Eggleston, Debora Lopes, Zhehao Zhu, and Chris Zmuda. Each group member has put in countless hours to produce this report. Below is a complete list of the authorship of each section of this report. Each member of the group edited the entirety of the report.

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Terminology

AASI – Average Accident Severity Index

ADVKT – Average Daily Vehicle Kilometers Traveled

AMVKT – Accident Severity Index per Million Vehicles Kilometers Traveled

ASI – Accident Severity Index

ASOD – Average Speed Over Distance

DVKT – Daily Vehicle Kilometers Traveled

EAADT – Estimated Average Annual Daily Traffic

iRAP – International Road Assessment Programme

km – Kilometers

MVA Fund – Motor Vehicle Accident Fund of Namibia

mi – Miles

NAD – Namibian Dollar

NAMPOL – Namibian Police Force

NHTSA – National Highway Traffic Safety Administration of the United States

NRSC – National Road Safety Council of Namibia

RA – Roads Authority of Namibia

TASI – Total Accident Severity Index

TSS – Traffic Surveillance Systems

VKT – Vehicle Kilometers Traveled

WHO – World Health Organization

WIM – Weigh In Motion

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Acknowledgements

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1.0 Introduction

Road networks provide the necessary infrastructure for the movement of goods and people within and between countries, while allowing increased access to educational and economic opportunities, jobs, and health care (WHO, 2009). A high rate of road accidents limits the accessibility and dependability of these resources. Road networks cannot provide the intended benefits to the people if the roads are unsafe.

Namibia had 633 recorded fatalities from road accidents in 2014 with approximately 327,000 vehicles on the road (MVA Fund, 2015). By comparison, the United States had 32,719 recorded fatalities in 2013 with around 269,294,000 vehicles on the road (Miyanicwe, 2013). In other words, the United States had one fatality for every 10,000 vehicles on the road, while Namibia had over 20 fatalities. Namibia has recognized that this high rate of road accidents deserves a strong public policy response and is taking steps to improve road safety.

Recently, Namibia adopted "Wear. Believe. Act. A Decade for Road Safety 2011-2020," a strategic plan to highlight high risk areas and provide for public education, stricter enforcement, safer vehicle practices, safer roads, and improved emergency responses (NRSC, 2012). The National Road Safety Council (NRSC) aims to reduce accidents and increase the safety of Namibian drivers by establishing road safety countermeasures, making roadway improvements, and providing educational programs. A study conducted in 2013 by the World Health Organization (WHO), attempted to determine the causes of road accidents throughout Africa (WHO, 2011). They concluded that many African nations could improve law enforcement of safety laws, like wearing seat belts and observing speed limits.

The Motor Vehicle Accident (MVA) Fund of Namibia provides emergency assistance for road accidents and offers financial support for injured parties by covering hospital fees, losses, and even funeral expenses (MVA Fund, 2015). The MVA Fund's main mission is to provide long-term treatments to reduce the financial impact due to road accidents. Every year, the MVA Fund collects data on Namibian road accidents and compiles it into an annual report. This report details the total compensation to accident victims, as well as the national statistics for road deaths and injuries. Recent reports indicated that there has been a 34% increase in road deaths in Namibia, between 2011 and 2014 (MVA Fund, 2015).

The goal of this project is to assist the MVA Fund in reducing road accidents on specific sections of the B1 and B2 highways, the longest and most traveled routes in Namibia. The two areas of focus run from Windhoek to the Oshikango (B1) and Okahandja to Walvis Bay (B2). The Roads Authority (RA) of Namibia and the Namibian Police (NAMPOL) also keep track of road accidents. An overall study that brings these different sources of information has not been attempted for several years. This project provided a detailed analysis of available data on road safety provided by all of these sources.

The analysis enabled the team to identify the most dangerous sections of B1 and B2, and deliver recommendations for countermeasures to improve road safety. The team analyzed existing road accident data from multiple sources to assess the causes of road accidents as well as their specific location. Determining the causes and location of accidents were essential steps before proposing effective countermeasures to improve road safety. With this information, the MVA Fund, and other public authorities in Namibia, devoted resources effectively and efficiently to reduce fatal accidents on the most dangerous stretches of road.

2.0 Background

"Roads to Hell" is a common name in Namibia for the roads on which fatal accidents occur. The team considered a variety of factors that can influence road safety and may cause certain routes to become "Roads to Hell." In general, road accidents are due to the condition of the road itself, the roadworthiness of the vehicles, traffic volumes, and driving behaviors. To manage these factors, Namibian authorities have instituted a number of regulations which are enforced by the Namibian Police by levying fines to get dangerous vehicles off the roads, control speeding, address driving fatigue, and crack down on driving under the influence. Moreover, targeted interventions, such as education and rewards programs, intelligent transportation system (ITS), and other programs, have been implemented to prevent road accidents.

2.1 Road Safety in Namibia

Adequate and safe road infrastructure is necessary for economic growth. A 2008 study by the European Commission noted that there has been an increased demand for national and international travel for both work and pleasure (Vita, 2008). Namibia is no exception to these driving trends (Economy and Industry, 2016). The principal economic resources of Namibia are mining (Economy and Industry, 2016) and tourism (World Bank, 2009), which rely heavily on the use of road transport. Whether moving ore from mines in southern Namibia to the deep-water port at Walvis Bay, or moving tourists from Windhoek to the national parks and safaris, the road network is a strategic asset for Namibia.

As shown in Figure 10, the official Namibian road network consists of 45,645 km of public routes (RA, 2011). There is an additional 20,000 km of private roads, typically used to access farms, which are maintained by the owners through government subsidies (Belete, 2014). Only 15% of all Namibian routes are surfaced with high quality asphalt, called Bitumen, whereas the remaining recorded roads are unpaved with gravel, earth, or salt. Paved trunk routes, such as B1 and B2, are well-traveled roads that interconnect major cities and bordering countries. These paved roads carry 67% of all traffic; the remaining 33% are over unpaved district roads, which are routes used for local travel in Namibia. (Road Travel Report Namibia, 2014)

Roadway materials greatly affect how a driver acts on a roadway. Different materials, such as gravel or bitumen, allow for differing safe travel speeds. The higher quality materials, like asphalt, allow for higher speeds due to their safer accommodations and require less maintenance. The negative effect of driving at a higher speed is it creates an increase in more severe accidents.

The physical surface of a route, the material conditions of the road, and whether it is being maintained regularly are significant variables in road accidents.

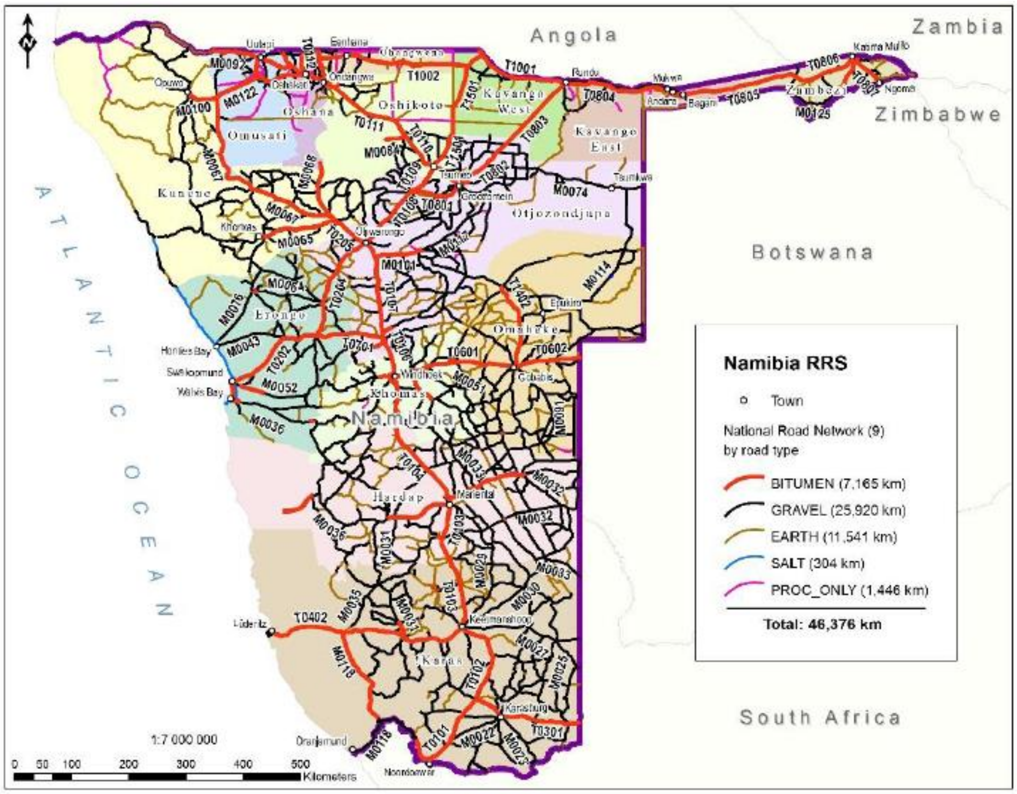


Figure 10. Road Network Map of Namibia

2.1.1 Road Surface Conditions

The Roads Authority of Namibia (RA) manages all official roads on behalf of the government. Majority of the roads are in good shape, but must be maintained due to the traffic volume. A 2012 Harvard University study estimated that the African continent would need to invest $93 billion per year to stop the degradation in road quality (Nsehe, 2012). This investment is necessary to be able to maintain a basic level of safe use of roads on the continent. The Namibian roads range from being paved with bitumen, or surfaced with earth graded dirt and sand, gravel, and salt (RA, 2009). Figure

11 is a graph from a report completed in 2010 by the Roads Authority displaying the difference in road material versus road purpose.

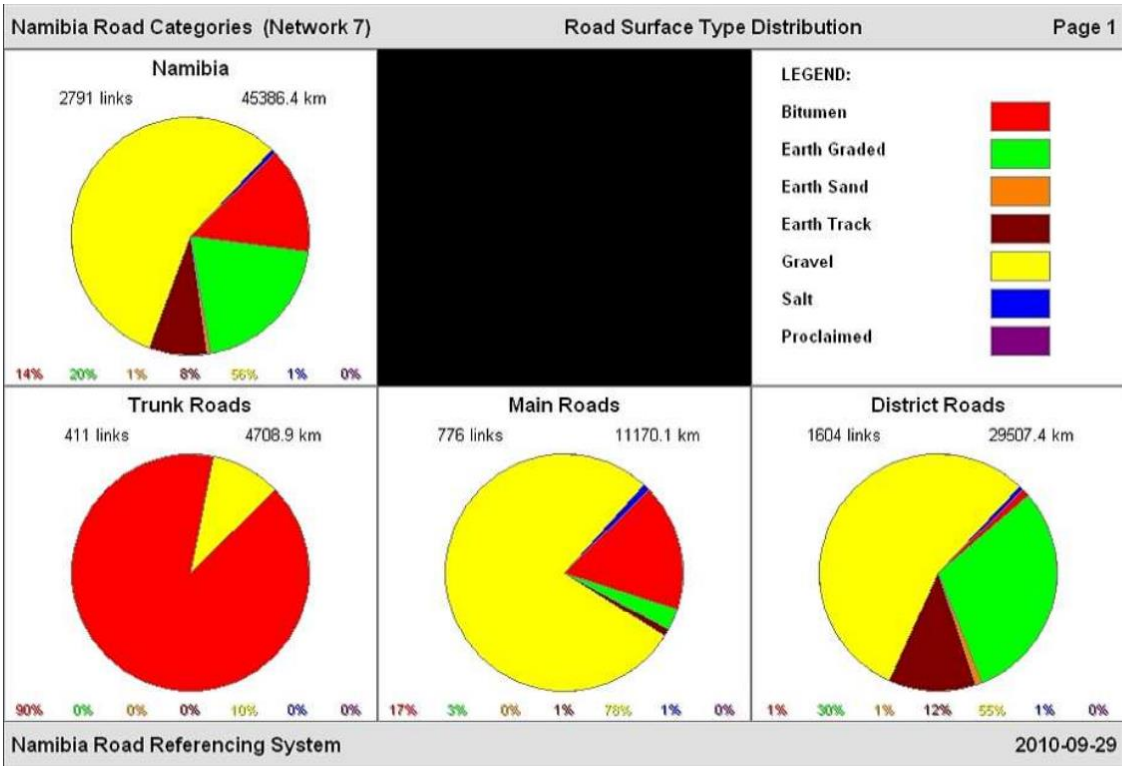


Figure 11. Road Surface Type Distribution (RA, 2009)

The majority of the Namibian roads are surfaced with gravel; however, the B1 and B2 routes consist of mostly pavement (bitumen) roadways. Drivers travel more cautiously on gravel road conditions in comparison to paved and other well-kept roadways, leading to a lower accident rate. According to a report completed for the “Wear. Believe. Act.”, paved roads increase the chances of reckless driving and speeding (NRSC, 2012). A study conducted in Lithuania demonstrated that gravel roads are preferable over asphalt for the reduction of traffic accidents. Lithuania’s national roads are paved with asphalt while their regional roads are gravel. The study found a higher rate of injuries on the national roads compared to regional ones. Gravel streets cover the Namibian land, which helps with the accident rate in those locations. The highly trafficked, paved truck routes that span across the country are the main concern when it comes to reducing motor vehicle accidents.

2.1.2 Road Maintenance in Namibia

In Namibia, the RA conducts annual inspections of roads to assess and maintain its conditions, which lead to high road quality in Namibia. Even though the roads are in good shape, there is a constant deterioration of paved roads. From 1989 to 2012, there was a physical difference in the safety of the roads, with the unmaintained roads transitioning from "very good condition" into the "worst condition" (Belete, 2014). A "very good condition" is a recently paved smooth road and the "worst condition" would be a road surface beyond repair, containing holes and cracks that could potentially harm the driver. With this, today, most trunk roads fall within the "very good condition" category.

Lack of investment into road maintenance greatly affects drivers (Belete, 2014). The NRSC helps the RA conduct repairs on Namibian roads by planning to reinforce 10% of the Namibian road network in the near future (NRSC, 2012). This initiative will be a step towards recovering and maintaining safe roadways.

2.1.3 Animals and Road Accidents in Namibia

In comparison to the inner cities, the rural areas in Namibia are a concerning location. Rural regions have the lowest total number of road accidents, but if an accident occurs, but if an accident does occur, they are more severe (NRSC, 2013). This may be in result to the slow emergency response time, due to the location of being far away from emergency services. Urban roads have a large number of reported accidents due to the high traffic volume, but majority of their severities are low.

The severe accidents in the rural regions could be due to wild or domestic animals. In rural roads, there is a higher chance of encountering an animal-induced accident. Animals, either farm or wild, may end up in the roadway causing obstacles for drivers. In a 2009 report, the most frequent cause of an accident was rear-ending (22.0%), followed by collisions with animals (10.9%) (NRSC, 2013). Agricultural animals, such as cattle, goats, and donkeys, typically roam freely due to the lack of enclosure implementation. Additionally, farmers guide their cattle to the end of the roads to feed due to the grass within the farm's barriers are overgrazed leaving no nutrients for the cattle. Larger animals, such as antelopes and elephants cross roadways creating a larger and more serious accident if a collision occurs (NRSC, 2013).

2.2 Vehicle Safety in Namibia

The characteristics of vehicles are an important variable in road safety. An examination of the relationship between vehicle characteristics and road accidents suggests that larger, modern vehicles are associated with lower accident rates compared to smaller, older vehicles. Specific aspects of vehicle characteristics that are commonly studied include the types, sizes, and ages.

Accidents and their corresponding severities differ with the various types of vehicles involved. More importantly, the type of vehicle associated with the highest accident rate may not necessarily be the kind associated with major injuries and fatalities. For example, the majority of vehicles that were involved in the 2014 reported accidents in Namibia were sedans (45%) and pick-ups (32%) (MVA Fund, 2014). By contrast, light-delivery vehicles, motorcycles, and station wagons were ranked the first among all types of vehicles responsible for injuries and casualties caused to all road user groups including drivers, passenger, and pedestrians (NRSC, 2015).

Vehicle sizes and masses also influence fatality risk for drivers in accidents. A study compared the effects of vehicle sizes and masses on fatality rates to identify which factor plays the most significant role (Evans et al., 1992). It provided evidence that when cars of identical or similar wheelbase, but different mass, crash into each other, the driver of the smaller mass car has an increased likelihood of death. In contrast, when cars of similar mass but different wheelbase crash into each other, no strong correlation between driver fatality risk and wheelbase was revealed. Therefore, in terms of vehicle size, mass was identified as the dominant factor in the correlations between driver risk and car size in two-car accidents, while size, measured by wheelbase, plays a secondary role. The RA has multiple road stations across major routes in Namibia that assess the weight and size of vehicles.

Vehicle age is also related to the severity of driver injury in accidents. In research conducted by the National Highway Traffic Safety Administration (NHTSA) of the U.S. Department of Transportation, data has revealed that the driver of an older vehicle is more prone to fatal injury in an accident compared to the driver of a newer vehicle (NHTSA, 2013). It was estimated that at the time of the accident, the driver of a vehicle that was more than 18 years old was 71% percent more likely to be fatally injured than the driver of a vehicle that was 3 years old or less. The decreased accident rate associated with newer vehicles is mainly attributed to modern vehicle design, which incorporates more built-in safety features for both vehicles and drivers. For example, SUVs used to have some of the highest accident rates due to their tendency to roll over (Insurance Institute for Highway Safety, 2005). However, the wide use of electronic stability control (ESC) has significantly decreased the risk of rollover accidents in all vehicles. With ESC, SUVs have now demonstrated greater safety than other vehicles by their inherent advantages, such as, greater size, weight, and height (Karush, 2015).

2.3. Driver Safety in Namibia

Driver behaviors and attitudes are closely associated with road accidents and the corresponding accident severities. An examination of these factors in Namibia suggests that accident rates are inevitably affected by personal characteristics and inappropriate driver behaviors. While personal characteristics such as gender and age cannot be changed, inappropriate behaviors, which include alcohol and drug abuse, speeding, and fatigue driving, can be actively controlled by human interventions such as law enforcement and educational programs. For example, the Namibian RA has implemented "speed flashers" to automatically and continuously apply enforcement of speed limits. These speed flashers do not issue tickets, but they are used as tools to keep drivers aware of their speeding behaviors.

According to the statistical report commissioned by NRSC in 2015, it has been reported that in 2010, Namibian male drivers (91.9%) are involved in road accidents more frequently compared to female drivers (8.1%) (NRSC, 2015). Additionally, male drivers have a higher rate of injuries caused by accidents than female drivers (NRSC, 2015). Moreover, statistics collected by NRSC have shown the highest collision rate occurs in the age category of 30 to 44 years. However, the age factor is a variable associated with other risk factors such as experience, speeding, and driving skills (NRSC, 2015).

In terms of inappropriate behaviors, alcohol and drug consumption, reckless speeding, and fatigue driving have all been widely identified as variables that increase the road accident rates (NRSC, 2015). However, data on these factors have not been collected by the NRSC, which suggests a potential subject for future investigation and enforcement initiatives.

2.3.1 Driver Licensing in Namibia

Licensing in Namibia covers three different types of road vehicles. The three codes are: Code A for motorcycles, Code B for small vehicles, and Code C for larger vehicles. Certain allowances for age are considered as well, with drivers being able to obtain a license for a small-engine motorcycle at the age of 16, rather than the normal age of 18 for other vehicles (RA, 2011). Learner's licenses allow for driving without a license until one is earned. Professional licensure is also available, and is required for operating Code C vehicles. Age restrictions for professional drivers licensing varies, from 21 years of age for passenger conveyance to 25 years of age for dangerous goods conveyance. Professionally licensed drivers must not have been convicted of driving under the influence of liquor or narcotic drugs, or of reckless or neglectful driving within 5 years of applying or reapplying for the license (RA, 2011). Ensuring that these regulations are followed and enforced is necessary to ensure basic driver safety for all.

2.3.2 Enforcement of Driving Regulations

In Namibia, as elsewhere in the world, the use of traffic officers to enforce traffic rules is an important method of accident prevention. When traffic officers are present on the roads during patrols, the accident rate is significantly lower in comparison when an officer is not present (WHO, 2011). The visibility of officers causes drivers to be more cautious and avoid potential risk factors such as speeding. By being present on the road, the traffic officers encourage drivers to be safer and consequently lower the accident rate.

Traffic fines can be a deterrent for regulating road behaviors. Namibian traffic fines cover a wide variety of legal violations, from vehicle malfunctions to speeding. The scale for speeding fines is based on deviation from the posted speed limit, with higher-speeds resulting in larger fines (Traffic Fine and Regulations, 2016). These fines seek to discourage unsafe behavior and protect Namibians from road accidents. In 2010, these traffic fines were increased by a significant amount (Menges, 2010). However, a study in Botswana suggests that fine increases have little to no effect on accident trends. The study seems to indicate that an increase in fines does not add to the overall safety of Namibia (Mphela, 2011).

However, Namibia employs relatively few traffic officers. A division in the Namibian Police Force (NAMPOL) is strictly for Traffic Law Enforcement; the police officers in this division are responsible for maintaining road safety and enforcing road laws by patrolling, roadblocks, or other methods. The department is comparatively understaffed, with only 232 officers (Miyanicwe, 2013) on payroll to account for 326,862 vehicles on the road (MVA Fund, 2014), or one patrolling officer for every 1,408 vehicles in Namibia. By comparison, the United States has approximately 765,000 patrolling officers for 350,000,000 vehicles on the road (Quinn, 2011), or one patrolling officer for every 458 vehicles in the United States. Not only does NAMPOL lack the manpower to patrol the routes frequently, but also the technology to provide effective enforcement of traffic laws. There is a shortage of supplies such as breathalyzers, roadblocks, and speed traps (Miyanicwe, 2013).

The NRSC has invested approximately 3 million NAD to enhance the enforcement of traffic law during the festive season (House, 2015). Yet, this donation is a short-term solution for a high period of traffic, the festive season, and does not provide the necessary long-term funds to provide the department with the financial support to equip with the necessary technologies and the employment of more officers.

Another form of enforcement, a demerit point system, is being implemented in the Southern Africa region, particularly in South Africa. A demerit point system is a way to enforce rules of the road in the form of calculating offences, which are semi-permanently, marked on a driver's license. Namibia has not implemented this system, but it has been successful in South Africa. This system was implemented in 2016. A driver starts off with zero points on their license and every time the driver is involved in a traffic infringement, points will be added in parallel with an increase of fines. If a South African driver has a specific number of offences or breaks the law, the driver's license will be suspended or revoked (Mybroadband, 2015). For a driver who has lost his or her license, he or she must go through the licensing procedure again. This method punishes the driver by creating an incentive to receive less traffic tickets and fines.

2.4 Safety Programs and Technologies in Namibia

Namibia has used educational and reward methods to instruct drivers about the dangers of driving and to incentivize good driving behavior. Namibian organizations such as Road Transport Management System and the National Institute for Educational Development have employed road safety education programs in their primary schools beginning at the first grade and progressing to the third grade (Kangootui, 2014). These road safety education plans have been integrated into the school curriculum to teach children the hazards of not wearing a seatbelt and other road safety measures. Likewise, a study was performed with non-drivers, including children, to gauge the effectiveness of road safety campaigns in Namibia (Lipinge et al., 2014). This study provided insight for the NRSC and served as an educational opportunity for future Namibian drivers to learn about different road safety campaigns. Educational programs such as these teach future drivers the dangers of the road and the safety procedures to prevent future accidents.

By directing educational programs at children, the benefits will only be received in the future, thus making this a long-term solution. Educating children early about road safety does not necessarily mean that the accident rate will be lower. A study conducted in Sweden found that children active in traffic safety awareness clubs did not have lower accident risk than children not involved in the organization (Gregerson, 1994).

In 2014, Vivo Energy Namibia and the NRSC operated a month-long campaign called "Let's Be One on B1." This campaign consisted of rewarding safe drivers who followed the speed limits and regulations on the B1 route with a 300 NAD fuel voucher (AllAfrica, 2014). This specific program gave current drivers the opportunity to reap a benefit from safe driving practices. A study conducted in the Netherlands showed a positive correlation between safe driving habits and reward programs (Mazureck, 1980). By giving the driver a benefit for their safe driving practices it enforces this behavior causing them to continue to drive safely.

However, a reward system in Namibia is not financially sustainable. The "Let's Be One on B1" cost NRSC and the Vivo Energy Namibia approximately 60,000 NAD. The program only lasted for three weeks. The short duration of such programs does not provide drivers with more consistent reward for good behavior, thus its long-term impact in reinforcing safe driving is unclear.

2.4.1 Intelligent Transportation Systems (ITS)

The RA and the MVA Fund have also implemented a Traffic Surveillance System (TSS). In 2015, these organizations cooperated together to establish "Weigh In Motion (WIM)" and "Average Speed Over Distance (ASOD)" (Adamu, 2015). These TSSs were applied on the Namibian roads to aid law enforcement by capturing traffic data and reducing the number of road accidents. WIM is a surveillance system that measures the weight of vehicles and assesses whether the vehicles damage the road surface. This system is useful in helping the RA to maintain the road infrastructures by controlling overload of vehicles. ASOD, also called the "Speed Flashers," are speed cameras that measure the average speed over distance at certain stretch of road. The implementation of these speed cameras has enabled unmanned speeding detection at all hours and reduced over-speeding issues along these routes. For example, as shown in Figure 12, the application of these systems has decreased speeding between the Otijwarango and Otavi sections of the B1 route. The implementation of these traffic surveillance devices has led to a decrease in dangerous driving behaviors, and the application of more technological tools can improve management of road conditions and driving behaviors and lead to a decrease in road accidents.

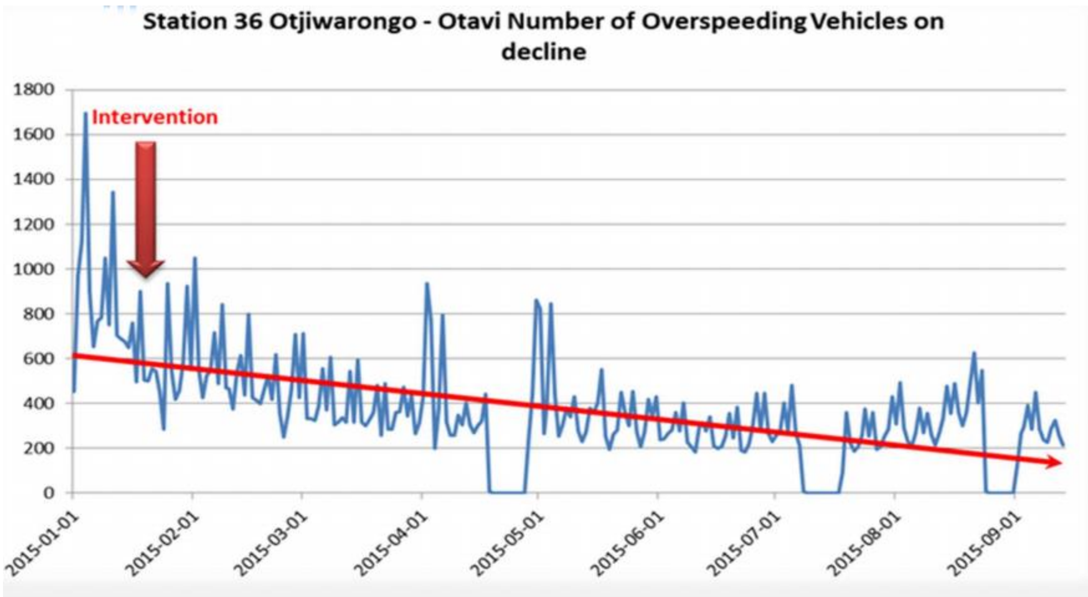


Figure 12. Example of Speed Camera Performance (Adamu, 2015)

2.4.2 Targeted Interventions

During the 2014/15 festive seasons, NAMPOL, MVA Fund, RA, and NRSC established the "Festive Season Road Safety Campaign" (MVA Fund et. al, 2014). This program was created to augment traffic law enforcement, increase the emergency response services, and augment road safety awareness campaigns on Namibian roadways. This program established 18 checkpoints for the police to test for speed, alcohol and other dangerous road behaviors. The program marketed the MVA Fund's Call Centre, which provides paramedic assistance to people in accidents all over the country. The Namibian Defense Force provides additional medical assistance in response to road accidents. Lastly, this program spread educational road safety material via social media, radio and television interviews, and billboards. Temporary rest stops were also constructed along the B1, B2, and B6 routes.

The Festive Season campaign increased road safety in Namibia. This multifaceted approach decreased the festive-season fatality rate from 115 deaths in 2013/14 to 97 deaths in 2014/15 (MVA Fund et. al). The program was also a model for successful collaboration amongst multiple organizations that can work together to accomplish a common goal. However, this program is only a short-term countermeasure in the broader context of lowering the overall accident rate in Namibia. In order to lower the accident rate, a more permanent program might maintain a lower accident rate over a longer period.

3.0 Methodology

The mission of this project is to reduce road accidents on major routes, B1 and B2, in Namibia by identifying leading causes of traffic accidents and proposing appropriate countermeasures. To complete this mission, our team accomplished these objectives:

1. To Organize and Map Road Accidents
2. To Organize and Map Traffic Volumes
3. To Identify Unsafe Sections of Highway
4. To Identify Common Causes of Road Accidents
5. To Propose Appropriate Countermeasures

For the scope of this project, the team focused on the B1 route from Windhoek to Oshikango and the B2 route from Okahandja to Walvis Bay, which can be seen in Figure 13.

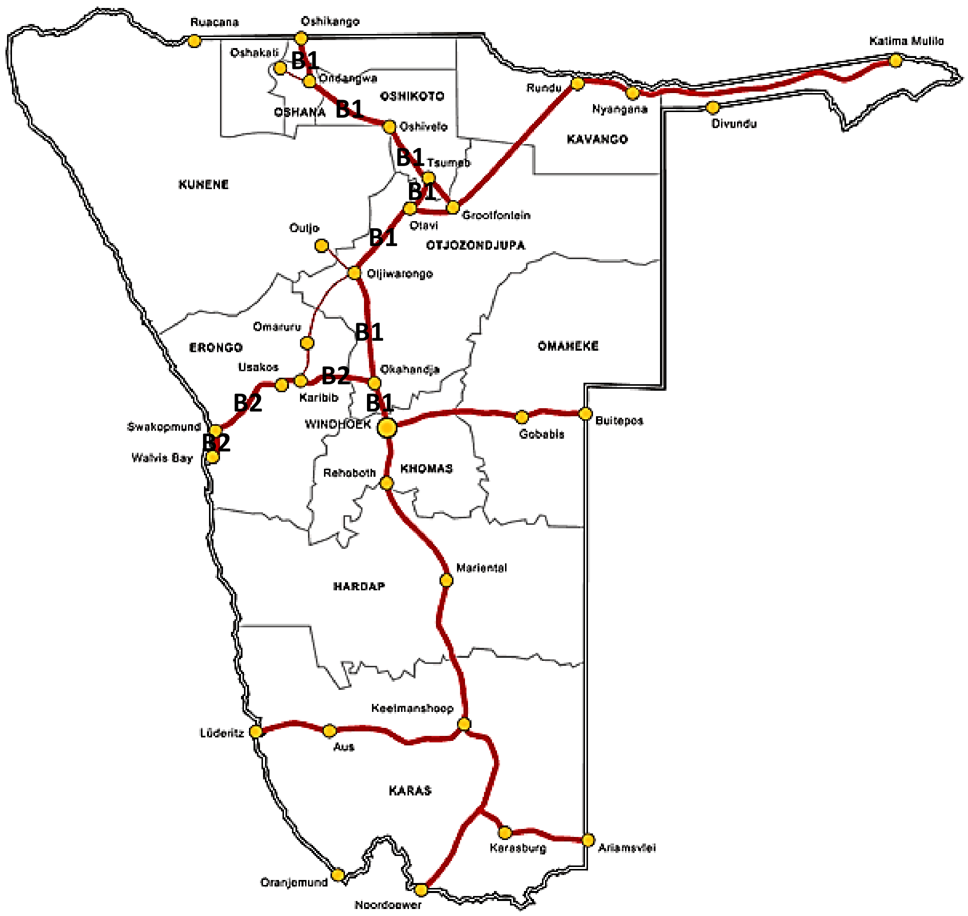


Figure 13. Focus Routes: B1 (North of Windhoek) and B2

The team obtained existing data from 2012, 2013, and 2015, which was provided by several stakeholders, including the Motor Vehicle Accident (MVA) Fund, Roads Authority (RA), and the National Road Safety Council (NRSC). New data was provided between March 14th, 2016 and May 6th, 2016, and included road accident and volume data on sections of the B1 and B2 highways in Namibia (Figure 13).

3.1 Organizing and Mapping Road Accidents

To understand the severity and distribution of road accidents on B1 and B2 routes, the accident data was organized and mapped by accident location for effective analysis. The team obtained 2013 and 2014 traffic volume data from the Roads Authority, in addition to 2012, 2013, and 2015 accident police reports from National Road Safety Council. The team interviewed personnel to obtain pertinent information from each stakeholder.

3.1.1 Organizing Accident data by Road Sections

To organize road accident data for further analysis, the team divided the highway routes B1 and B2 into specific sections and subsections by adopting the segmentation system created by the Roads Authority. First, the team divided the highway routes by considering the major towns that the routes pass through as starting and ending points of certain sections. Along the B1 route from south to north, the roads connecting Windhoek, Okahandja, Otjiwarongo, Otavi, Tsumeb, Oshivelo, Ondangwa, and Oshakati created seven sections of concern (Figure 1). Along the B2 route from west to east, the roads connecting Okahandja, Usakos, Swakopmund, and Walvis Bay created three sections of concern (Figure 1). Second, the team divided each town-to-town section into various junction-to-junction segments based on the existing segmentation in use in Namibia. This segmentation considers the junctions at which the highway trunk roads cross with other roads, such as the main roads or district roads, as starting and ending points of each subsection. Finally, the team adopted the numbering system of RA for each section and subsection.

3.1.2 Organizing Road Accident Data

The team obtained data about all road accidents of Namibia for 2012, 2013, and 2015. The data for 2014 was being processed and was not available. The road accident data had been transferred from handwritten road accident forms into Excel spreadsheets by the National Road Safety Council (NRSC). As mentioned earlier, for the scope of the present study, the team only first considered accidents that occurred "Outside the Towns," then those reported to relevant police stations, and finally accidents that occurred on B1 north of Windhoek and the entirety of B2.

The original raw data included 500 fields, and our analysis focused on the following pieces of information:

1. Time and Date of Accident
2. Accident Location
3. Accident Severity (fatalities or injuries)
4. Accident Type (with animals, head-on collision, etc.)
5. Road Environments (surface, signage, weather)
6. Vehicle Information (make, model and year)
7. Driver Information (age, behaviors)

The accident location data gave the distance of an accident from the nearest town. Accident type indicated how an accident occurred. The severity of the accidents was broken down into four levels: "Fatality," "Serious Injury," "Slight Injury," and "No Injury."

Road environments included specific information about road type, road surface, road mark, road direction, road shape, traffic control type, road signage, obstructions, weather, visibility, and lighting condition. The vehicle information included type, year/model, and position before accident, while the driver information contained age and behaviors before accident. While road environment information related objective impacts to the occurrence of accidents, vehicle and driver information were subjective aspects to consider for analysis of road safety factors.

3.1.3 Calculating the Accident Severity Index

After the team selected accident reports for investigation, we assigned each incident an Accident Severity Index (*ASI*). The index is dependent on the number of people involved and the level of injuries sustained during the accident. First the team gave each accident an index of 10, regardless of the severity of the accident. Each fatality (FT) was assigned an index of 10, a serious injury (SR) a 5, a slight injury (SL) a 3, and a non-injury a 0. The severity index for each accident was then calculated using the equation (adapted from Casola et al., 2012):

$$ASI = 10 \times (10 \times FT + 5 \times SR + 3 \times SL) + 10,$$

A factor of 10 was used to simply scale up the *ASI* value. This was used to inflate the scores to achieve values larger than 1 for the ASI. The *ASI* of all accidents for each section was summed and this assigned the section a Total Accident Severity Index (*TASI*). The team used this value to calculate the average accident severity index per accident (*AASI*) for each section by using the equation:

$$AASI = \frac{TASI}{N_{acc}}$$

The N_{acc} is the number of accidents on a certain section.

3.1.4 Creating Geographic Display of Road Accidents

The team used the organized data set from *3.1.2 Organizing Road Accident Data* and filtered the data set further to only include the information that would be needed to establish the location of accidents. The final data set was filtered by the following parameters:

1. Police Station
2. Direction outside of Town
3. KM outside of Town

The reporting police station of the accident indicated the nearest town to the accident. The direction outside of town was used to note whether the accident was north, south, east or west of the town. The KM outside of town was used to accurately pinpoint the accident on B1 and B2.

The team created a map of the accidents using Arc-Geographic Information System (ArcGIS). The team used the existing Geographic Information System (GIS) layers provided by the RA as a foundation, which included the "Road Districts," "Police Stations," "TrunkRoads9," and "TownPoints." The "Road Districts" layer provided the outline of Namibia along with the different regions. "Police Stations" and "TownPoints" layers provided the locations of relevant police stations and towns. "TrunkRoads9" layer provided the outline of the B1 and B2 highways, along with their subsequent road sections. The team then pinpointed each accident on a GIS map based on the distance from the nearest town/police station, as indicated in the accident report forms, under "Accident Location." In addition, each accident attached relevant information to the accident point, including the accident ID, time, date, day of the week, type of accident, and the accident severity score. The accident severity information contained the number of fatalities, serious injuries, and slight injuries, and the *ASI*.

Some accident records contained insufficient information to pinpoint their location and thus were not included in the GIS map. However, if they could be assigned to a specific highway section based on the reported town and direction, their severity data was included in calculating the *TASI* for each road segment.

3.2 Organizing and Mapping Traffic Volumes

3.2.1 Organizing Traffic Volume Data

The team obtained traffic volume data for 2013 and 2014 from the Roads Authority (RA). The RA collects volume data from traffic stations installed on various sections on the targeted highway routes, B1 and B2. The volume data contained specific information of subsections which included the length (*L*), estimated average annual daily traffic (*EAADT*), and daily vehicle kilometers travelled (*DVKT*) (Figure 14). The average daily vehicle kilometers travelled (*ADVKT*) for each town-to-town section was then calculated by using the equation:

$$ADVKT = \frac{DVKT \times TL}{N_{sub}},$$

The *TL* is the total length of the section and N_{sub} is the number of subsections on that section.

The data was then paired with road accident data for each well-defined section, as shown in Figure 15.

EAADT per Road Number for 2014 Namibia

Road Nr.	District	Start-End Node		Start-End KM		Length	EAADT		EAADT			VKT/Day
							Date	Source	LIGHT	HEAVY	TOTAL	
Road :	T0110											
T0110	Grootfontein North	ZG3222N	ZG3221N	0.0	6.5	6.55 km	24/03/2015	TSS Est	450	400	850	5 567.5
T0110	Grootfontein North	ZG3221N	ZG3220N	6.5	10.0	3.43 km	24/03/2015	TSS Est	820	480	1 300	4 459.0
T0110	Grootfontein North	ZG3220N	ZG3219N	10.0	25.7	15.73 km	24/03/2015	TSS Est	800	480	1 280	20 134.4
T0110	Grootfontein North	ZG3219N	ZG3218N	25.7	39.4	13.73 km	24/03/2015	TSS Est	800	480	1 280	17 574.4
T0110	Grootfontein North	ZG3218N	ZG3217N	39.4	61.1	21.70 km	24/03/2015	TSS Est	800	480	1 280	27 776.0
T0110	Grootfontein North	ZG3217N	ZG3216N	61.1	75.6	14.49 km	24/03/2015	TSS Est	800	480	1 280	18 547.2
T0110	Grootfontein North	ZG3216N	ZG3215N	75.6	84.1	8.48 km	24/03/2015	TSS Est	640	460	1 100	9 328.0
T0110	Grootfontein North	ZG3215N	DT9278C	84.1	95.0	10.84 km	24/03/2015	019B	640	460	1 100	11 924.0
Number of Road Links :		8										

Figure 14. Excerpt of Traffic Volume Data per Road Number for 2014 (RA, 2014)

Year: 20XX								
Highway Routes	Highway Sections	Accidents	Fatalities	Serious Injuries	Slight Injuries	Length (km)	EAADT	ADVKT
B1	Windhoek - Okahandja T0106							
	Okahandja - Otjiwarongo T0107							
	Otjiwarongo - Otavi T0108							
	Otavi - Tsumeb T0109							
	Tsumeb - Oshivelo T0110							
	Oshivelo - Ondangwa T0111							
	Ondangwa - Oshikango T0112							
B2	Okahandja - Usakos T0701							
	Usakos - Swakopmund T0202							
	Swakopmund - Walvis Bay T0201							
National Average	Namibia							

Figure 15. Sample Compilation of Accident and Traffic Data

3.2.2 Creating Geographical Display of Traffic Volumes

After the team organized the traffic volume data, we then determined the threshold for low, medium, or high traffic volume by calculating the 1/3 and 2/3 point of the *DVKT* data for subsections of B1 and B2 based on the following equation:

$$DVKT_{1/3} = DVKT_{avg} \times \frac{2}{3}, DVKT_{2/3} = DVKT_{avg} \times \frac{4}{3},$$

The $DVKT_{1/3}$ is the 1/3-point, $DVKT_{2/3}$ is the 2/3-point, $DVKT_{avg}$ is the average *DVKT* of all subsections of concern.

By that means, subsections with *DVKT* higher than $DVKT_{2/3}$ were assigned a high traffic volume, those with *DVKT* between $DVKT_{1/3}$ and $DVKT_{2/3}$ were assigned a medium traffic volume, and those with *DVKT* below $DVKT_{1/3}$ were assigned a low traffic volume. After the subsections were given a traffic volume, the team used ArcGIS to display these subsections. A red section in this layer represented high traffic volume, a yellow section for medium traffic volume, and a green section for low traffic volume.

3.3 Identifying Unsafe Sections of Highway

After different highway sections organized the road accident data, the team normalized the accident severity data by the traffic volume data of each section to identify sections of concern, which assisted them in narrowing the research scope. The team used Excel spreadsheets to perform calculations on the accident data and created a map to pinpoint the high-severity sites.

3.3.1 Normalizing Road Accident Data by Traffic Volumes

Using the road segmentation, the team normalized the *TASI* by the *ADVKT* data of each section and obtained the accident rate using the equation (adapated from Casola et al., 2012):

$$AMVKT = \frac{TASI \times 1{,}000{,}000}{ADVKT \times 365},$$

The accident rate is represented by *AMVKT*, which is accident index per million vehicle kilometers travelled.

3.3.2 Identifying Unsafe Town-to-Town Sections

Once the road accident rates were calculated, the team presented the results in a bar chart for comparison to identify the three most hazardous sections on B1 and the most hazardous one on B2, which were the sections of concern for further analysis. A bar chart showing *TASI* per section was produced to compare the absolute accident severity of different sections.

3.3.3 Creating Geographic Display of Severity Levels

Once the sections of concern were determined, the team modified the previous map produced in objective one to create another map of these high-severity sites using ArcGIS. First, the team determined the thresholds for low, medium, or high severity level by calculating the 1/3 and 2/3 point of the *ASI* data for sections of B1 and B2 based on the following equation:

$$ASI_{1/3} = ASI_{avg} \times \frac{2}{3}, ASI_{2/3} = ASI_{avg} \times \frac{4}{3},$$

The $ASI_{1/3}$ is the 1/3-point, $ASI_{2/3}$ is the 2/3-point, and ASI_{avg} is the average *ASI* of all accidents in a section.

By that means, accidents with *ASI* higher than $ASI_{2/3}$ were assigned a high severity level, those with *ASI* between $ASI_{1/3}$ and $ASI_{2/3}$ were assigned a medium severity level, and those with *ASI* below $ASI_{1/3}$ were assigned a low severity level. Then, in the GIS map, a red dot represented high-severity sites, a yellow dot for medium-severity sites, and a green dot for low-severity sites. This map provided the team with a visual to locate specific stretches of road with high number of road accidents and high accident severities.

3.3.4 Identifying Unsafe Stretches of Road

After the team produced the GIS map with accidents distinguished by severity levels, they identified certain unsafe stretches of road from the map for further analysis. The group determined the hazardous road stretches by examining the highway in stretches of 5 kilometers. All 5 km road stretches were ranked by the $AMVKT_{rs}$, which was calculated by using the equation:

$$AMVKT_{rs} = \frac{TASI_{rs}}{L_{rs} \times EAADT_{rs}},$$

The $AMVKT_{rs}$ is the accident severity index per million vehicle kilometers travelled of the road stretch, $TASI_{rs}$ is the total accident severity index of the road stretch, L_r is the length of the road stretch (~5 km), and $EAADT_{rs}$ is the estimated average annual daily traffic of the road stretch. The traffic volume data of specific road stretches were extracted from the original data provided by the RA.

After the road stretches were ranked based on accident severity, the team selected five stretches that have the highest $AMVKT_{rs}$ on B1 and three stretches that have the highest $AMVKT_{rs}$ on

B2. After further analysis of these eight sites, the team chose the top 5 sites to perform a site evaluation and to analyze common causes of accidents.

3.4 Identifying Common Causes of Accidents

After the unsafe highway stretches for the year 2015 were identified, the team examined each stretch to determine common risk factors involved in each accident. By discovering what these major factors are, the team provided targeted solutions to reduce road accidents caused by those factors. Additionally, the team looked at the accidents on B1 and B2 as a whole to determine if general countermeasures will lower the accident rate all of B1 and B2.

3.4.1 Analysis of Geodetic Information

Before going on site evaluations to the stretches of most concern, the team assessed whether the geography of the road network was a factor in road accidents. Google Earth Pro was utilized to assess the elevation of the road stretch, and it was used as a preliminary step before site evaluations to have an understanding of the road stretch. The elevation profile was a tool that demonstrated the elevation change in a specific stretch of concern. Also, the program provided the team with the specific GPS coordinates of the stretches of most concern and the accidents. It also gave a basic real-life view of the stretches.

The following ArcGIS data layers were imported into Google Earth Pro:

1. "5km Marker,"
2. "5km Marker B2,"
3. "B1HighRisk_2015Accidents,"
4. "B1LowRisk_2015Accidents,"
5. "B2HighRisk_2015Accidents,"
6. "B2MediumRisk_2015Accidents,"
7. "B2LowRisk_2015Accidents

These data layers provided the location of the stretches, the locations of the accidents, and the severity of the accident.

3.4.2 Observations from Site Evaluations

The team performed site evaluations and observations to provide further and more complex assessments of the geography surrounding the road and the road condition. The team observed and noted several factors on an evaluation sheet. Figure 16 displays an example of the evaluation sheet used for site evaluations. Also, the team took several pictures at each stretch to provide further evidence for the evaluations performed.

Site: 22	
[Location]	
Date	Time
1.Road alignment	Comments
Visibility:sight distance	
Speed limit	
Overtaking:delineation	
Shoulders: steep decline	
2. Signage	
General signs issues	
Sign legibility	
Sign supports	
3. Road Markings and delineations	
General issues	
Centrelines, edge lines	
Guide posts and reflectors	
Curve warning and delineation	
4. Road reserve	
Clear reserve	
Fences	
5. Pavememt	
Type	
Skid resistance	
Ponding	
Loose stones	
Incline	
curvature	
6. Other issues	
Surrounding area	
Animals	
Speed Limit	
Other:	
Recommendations:	

Figure 16. Example Evaluation Sheet

These factors were noted to help further assess the risk factors for these stretches of road. The site evaluations were used to corroborate the geographic information gained from ArcGIS and Google Earth Pro. The inspections were also used to analyze the design of the road and assess whether changes needed to be made.

3.4.3 Determining Risk Factors

The team identified risk factors by utilizing information in the police reports, as shown in **Figure 17**. Four divisions of factors were analyzed: road condition, environmental, regional, and driver factors. The road condition factors included the "Road Type," "Road Surface Type and Quality," and "Road Marking Type and Quality." Regional factors consisted of junction type, road sign visibility, road sign condition, road direction, road shape, obstructions, and traffic control type. Driver factors were defined as vehicle type, the position of the vehicle before the accident, and what the driver was doing before the accident.

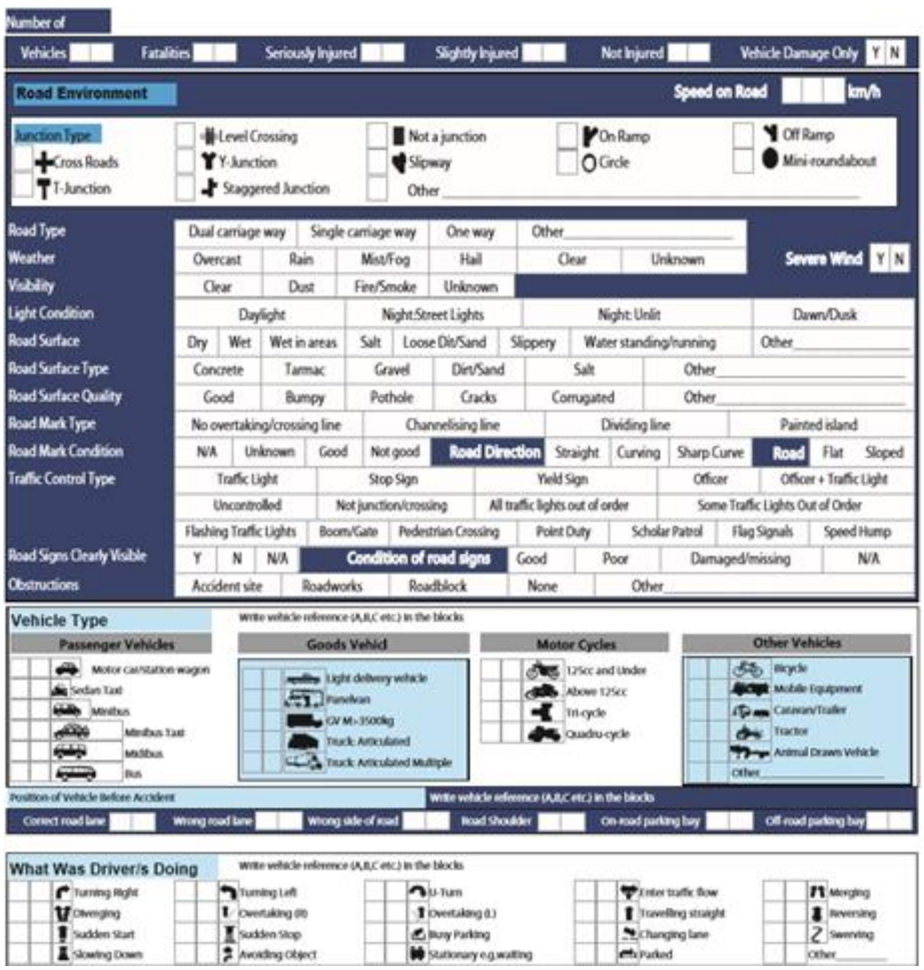


Figure 17. Namibian Police Report Rad Environment and Driver Behavior Section

The identified section of largest concern's relevant accident data was then placed in a table with the related accident factors from the report.

3.4.4 Selecting Significant Factors

The team then determined the prevalence of safety factors. This was done by observing the various possible entries into a single category of information and collecting the counts of each item in each category. These counts were then used to create charts to visualize the data counts, and show percentages of accidents that fell into each category. These charts were created for all categories given in the table, and then for a select number of combinations of these categories. These categories include, but are not limited to, animal accidents and time of day, specific sections of road and accident type, and accident types in clusters.

The team was able to use these charts and each category's prevalence to identify what issues were the most prevalent in the population of accidents. Identification of these issues allows for a wide variety of combinations of analyses to be applied, ensuring that all angles of the data can be seen. By doing this, the team was able to ensure that we had identified the factor or factors of largest concern with regards to accident causes.

3.5 Identifying Appropriate Countermeasures

The proposed countermeasures were based on the analysis of statistical data in addition to the observations from the site visits. The two observations guided the team to develop the leading concerns on B1 and B2. The team began to develop appropriate countermeasures to achieve the final goal of reducing road accidents on the major routes in Namibia. These proposed countermeasures are in the form of recommendations for the MVA Fund and the stakeholders to implement.

The team recommended potential long-term countermeasures and stretch-specific interventions. The stretch-specific countermeasures address the road safety factors on the top eight 5km road stretches. The team considered that the interventions of these road safety problems could possibly be used on the entirety of B1 and B2, but for realistic expectations, focusing on the specific locations would be an economic and time efficient start. For the long-term recommendations, the team expected that these countermeasures could be successfully implemented and would reduce the future accident rate.

The team additionally used the site evaluations to witness current implementations along B1 and B2. We saw routes with interventions that could be potentially to be applied at other road stretches. The team conversed with fellow stakeholders, such as NAMPOL, NRSC, and RA to see, if their own opinion, on whether the current countermeasures have made a difference in the road accident rate. Additionally, the team asked if there were any recommendations on what implementations should be included on the stretches. Reliable information was collected and considered when finalizing the leading recommendations to the MVA Fund and the stakeholders.

4.0 Results and Analysis

The following results were obtained by analyzing the data provided by the MVA Fund's stakeholders: the National Road Safety Council (NRSC) provided road accident data and the Roads Authority (RA) provided traffic volume data. To identify the most hazardous highway section, the team ranked town-to-town sections by the total number of accidents and their severities, and then ranked the most hazardous 5 km road stretches by their severities. Moreover, the team performed both statistical analysis and visual site evaluations to identify the common causes of accidents, and proposed countermeasures accordingly.

4.1 Road Accidents

4.1.1 Road Accident Data and Accident Severity Index

The 2012, 2013, and 2015 Namibian road accident data was provided by the NRSC. However, the 2012 data was not utilized due to it having insufficient information for data analysis and GIS mapping. The 2013 and 2015 years' both contained a total of 19,240 and 20,674 road accidents respectively, with 491 columns of information recorded for each accident. After the data was organized, a total of 430 valid and complete accident reports were selected for 2013 and 361 for 2015, with a focus on 66 columns of information. Appendix C displays an example of the 2013 and 2015 road accident data organized by sections. The tables contain the calculated accident severity index (*ASI*) and necessary information extracted from accident reports that were used to pinpoint accidents and identify potential causes. The total number of accidents (N_{acc}), the total accident severity index (*TASI*), and the average accident severity index per accident (*AASI*) were calculated for each highway section and the results are shown in Figure 18 and Figure 19.

Highway	Section	Number of Accidents (Nacc)			Total Accident Severity Index (TASI)		
		2013	2015	2013 & 2015	2013	2015	2013 & 2015
B1	T0106	85	54	139	1070	870	1940
	T0107	23	32	55	290	1240	1530
	T0108	33	38	71	740	1300	2040
	T0109	16	34	50	250	1290	1540
	T0110	52	67	119	2280	2440	4720
	T0111	104	50	154	4010	780	4790
	T0112	13	14	27	1030	420	1450
B2	T0701	46	31	77	520	1060	1580
	T0202	44	34	78	2550	510	3060
	T0201	14	7	21	590	200	790

Figure 18. Number of Accidents and Total Accident Severity Index of Highway Sections

Highway	Section	Average Accident Severity Index per Accident (AASI)		
		2013	2015	2013 & 2015
B1	T0106	12.6	16.1	14.0
	T0107	12.6	38.8	27.8
	T0108	22.4	34.2	28.7
	T0109	15.6	37.9	30.8
	T0110	43.8	36.4	39.7
	T0111	38.6	15.6	31.1
	T0112	79.2	30.0	53.7
B2	T0701	11.3	34.2	20.5
	T0202	58.0	15.0	39.2
	T0201	42.1	28.6	37.6

Figure 19. Average Accident Severity Index per Accident of Highway Sections

For reference, the sections the team analyzed are:

T0106: Windhoek to Okahandja

T0107: Okahandja to Otjiwarongo

T0108: Otjiwarongo to Otavi

T0109: Otavi to Tsumeb

T0110: Tsumeb to Oshivelo

T0111: Oshivelo to Ondangwa

T0112: Ondangwa to Oshikango

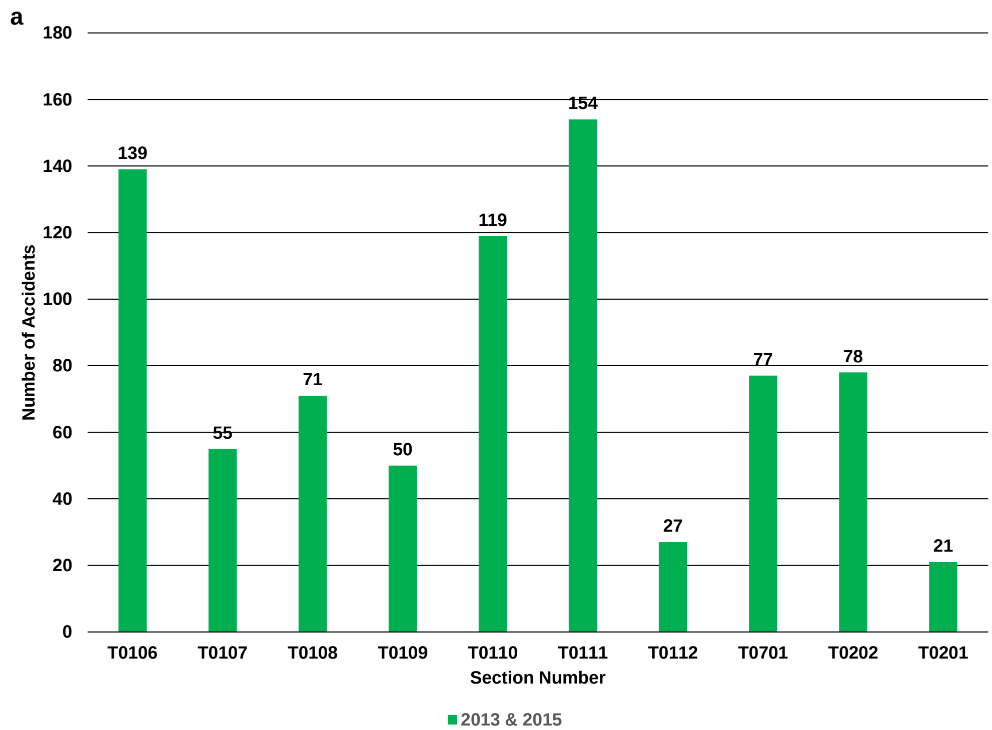
T0701: Okahandja to Usakos

T0202: Usakos to Swakopmund

T0201: Swakopmund to Walvis Bay

4.1.2 Rank of Highway Sections by Road Accidents

With the road accident data organized by year and section, the total number of road accidents can be compared against the year in addition to the highway sections. Bar charts were produced from the data in Figure 20 to compare the number of accidents on sections of B1 and B2 in 2013 and 2015.



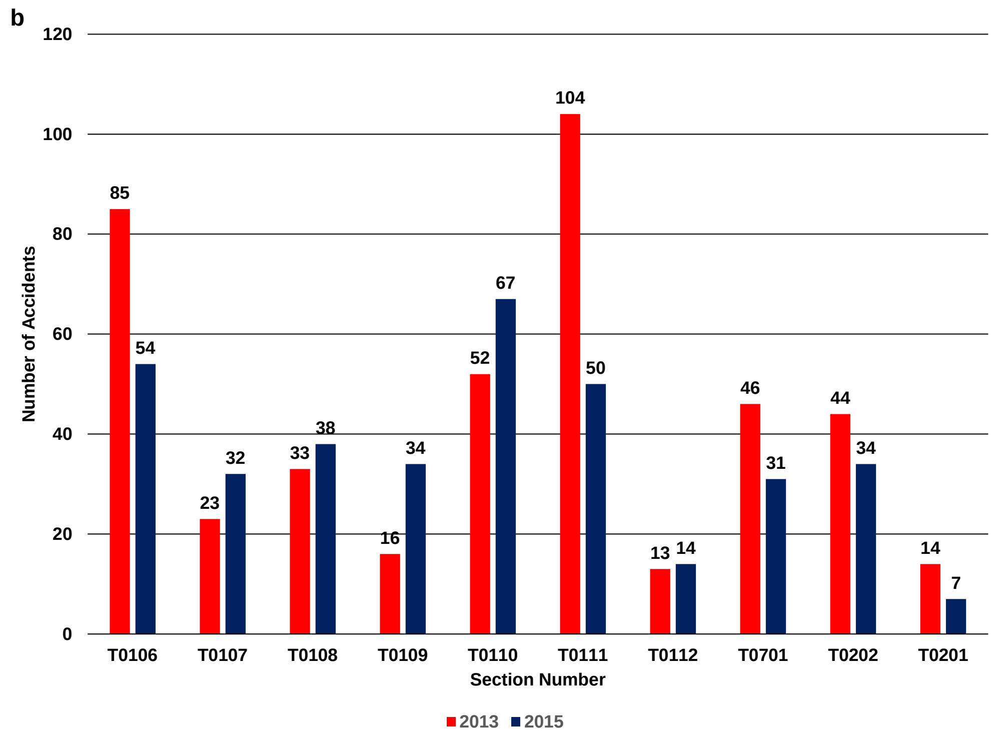


Figure 20. Number of Accidents of Different Highway Sections in (a) 2013 and 2015 and (b) 2013 and 2015 Respectively

Looking at the two-year total, **about 67% of accidents on B1 occurred on T0111, T0106, and T0110, and about 88% of accidents on B2 occurred on T0202 and T0701** (Figure 20a). By contrast, T0112 only constitutes 4% of the accidents on B1, and T0201 12% on B2. Each section was then examined for both years separately.

As shown Figure 20b, in both 2013 and 2015, the majority of accidents on B1 occurred on T0111, T0106, and T0110, and the majority on B2 occurred on T0701 and T0202. In comparison, T0112 and T0201 account for the least number of accidents on B1 and B2 respectively.

Thus, by three means of analysis, **T0111, T0106, T0110, T0701, and T0202 are identified to be sections where a high number of accidents occurred**, while T0112 and T0201 are sections of low number of accidents. Additionally, the number of accidents on T0106, T0111, T0701, and T0202 decreases from 2013 to 2015, while that on T0110 increases from 2013 to 2015. Such changes may be due to inherent fluctuation of the accident data from different years. Thus, for future work, accident data from more years should be analyzed to justifiably establish a trend across years for specific highway sections.

4.1.3 GIS Map of Road Accidents

For the 2013 road accident data, 279 out of 430 accident reports contained specific information on accident locations that could be used to pinpoint them on the Arc-Geographical Information System (ArcGIS) map. For the 2015 data, 280 accidents of the 361 could be pinpointed. The ArcGIS maps of accidents in 2013 and 2015 are shown in Figure 21. A sample attribute table with relevant information attached to each accident is shown in Figure 22. The attribute table displays all the useful information that would be needed to identify the accident.

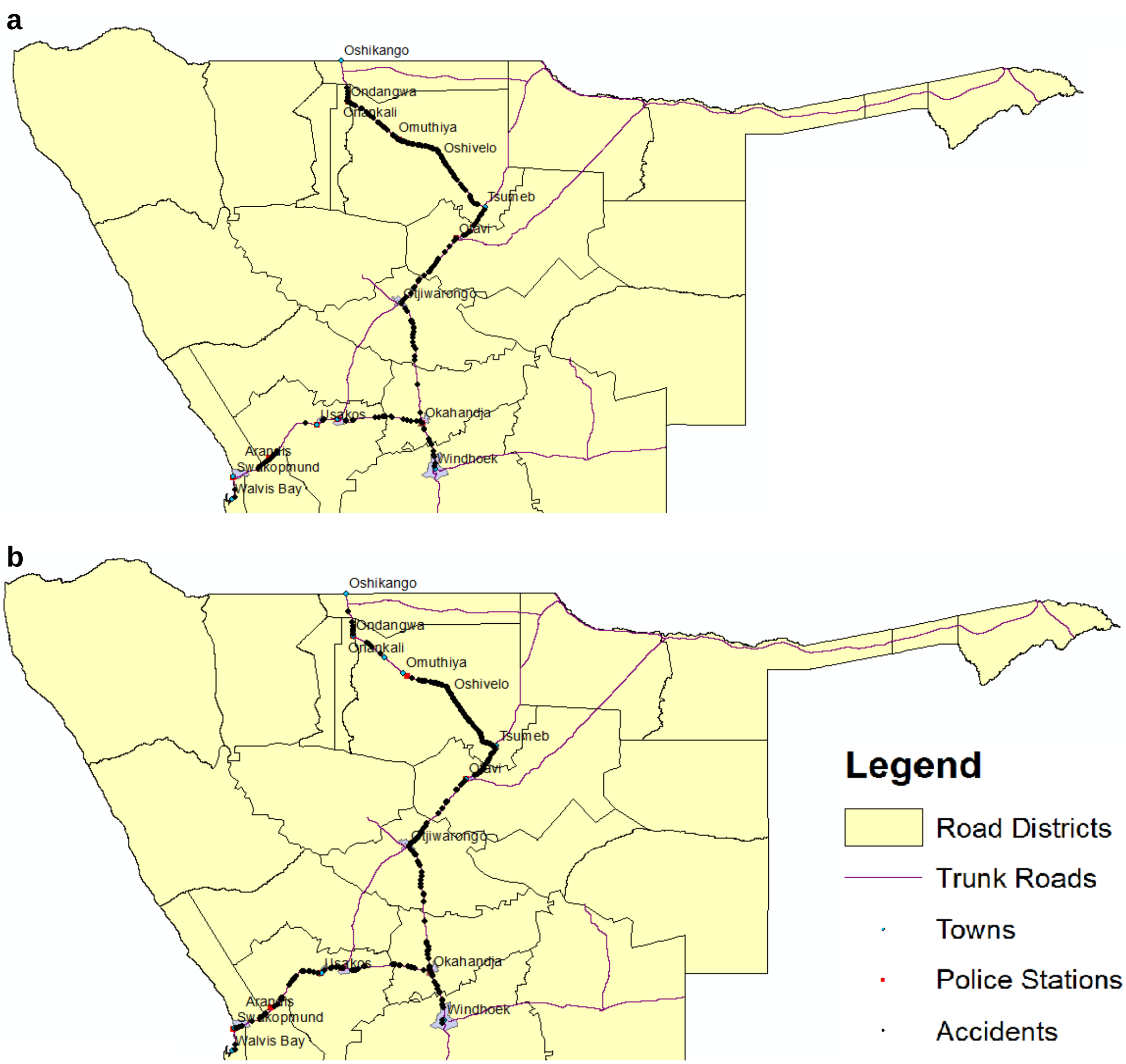


Figure 21. GIS Maps of Accidents on B1 and B2 in (a) 2013 and (b) 2015.

Table

AccidentsBoth1

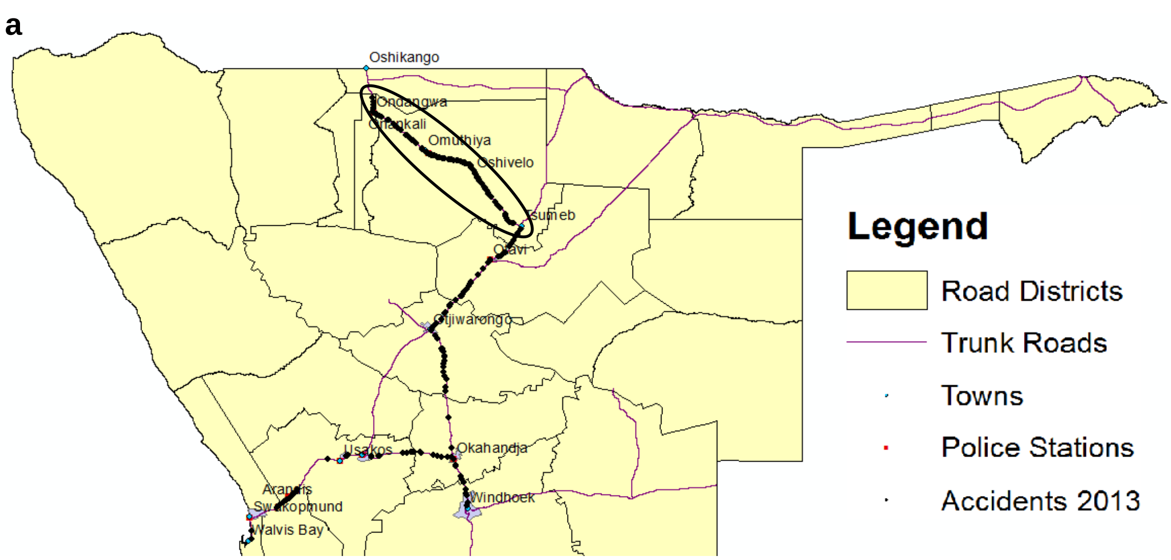
OBJECTID *	Shape *	Id	Date	TOD	DOW	Acc_Type	Severity	Fatalities	SER_INJ	SLT_INJ
1	Point	11980	9/23/2013	1130	Monday	Side Swipe, Same Direction	10	0	0	0
2	Point	12311	12/26/2013	1300	Thursday	Head/Rear End	10	0	0	0
3	Point	11430	4/18/2013	1200	Thursday	Other	10	0	0	0
4	Point	12623	10/10/2013	100	Thursday	Single Vehicle Overturn	10	0	0	0
5	Point	12595	4/9/2013	2000	Tuesday	Other	10	0	0	0
6	Point	12624	10/13/2013	1130	Sunday	Other	10	0	0	0
7	Point	12603	1/8/2013	510	Tuesday	Side Swipe, Opposite Direction	10	0	0	0
8	Point	12607	1/26/2013	2235	Saturday	Other	10	0	0	0
9	Point	12702	10/22/2013	730	Tuesday	Side Swipe, Same Direction	10	0	0	0
10	Point	12702	12/8/2013	557	Sunday	Single Vehicle Overturn	10	0	0	0
11	Point	12606	1/18/2013	2140	Friday	Side Swipe, Opposite Direction	10	0	0	0
12	Point	12689	9/9/2013	2310	Monday	Single Vehicle Overturn	10	0	0	0
13	Point	12667	6/25/2013	800	Tuesday	Other	10	0	0	0
14	Point	12624	4/25/2013	1645	Thursday	Head/Rear End	10	0	0	0
15	Point	12662	6/3/2013	1410	Monday	Single Vehicle Overturn	200	0	2	3
16	Point	12674	8/16/2013	2130	Friday	Side Swipe, Opposite Direction	200	1	0	3
17	Point	12690	9/10/2013	900	Tuesday	Single Vehicle Overturn	140	0	2	1
18	Point	12695	11/3/2013	1200	Sunday	Single Vehicle Overturn	130	0	0	4
19	Point	12693	9/29/2013	1615	Sunday	Single Vehicle Overturn	110	0	2	0
20	Point	12611	2/2/2013	2030	Saturday	Single Vehicle Overturn	100	0	0	3
21	Point	11423	4/11/2013	1745	Thursday	Single Vehicle Overturn	40	0	0	1
22	Point	12626	5/2/2013	1230	Thursday	Side Swipe, Same Direction	40	0	0	1
23	Point	12655	5/20/2013	720	Monday	With Animal	40	0	0	1
24	Point	11527	6/23/2013	1515	Sunday	Single Vehicle Overturn	40	0	0	1
25	Point	11298	3/2/2013	2010	Saturday	With Animal	10	0	0	0
26	Point	11323	3/13/2013	715	Wednesda	With Animal	10	0	0	0
27	Point	11356	3/31/2013	3100	Sunday	Other	10	0	0	0
28	Point	12947	1/25/2013	2100	Friday	Other	10	0	0	0

1 (0 out of 559 Selected)

AccidentsBoth1

Figure 22. Sample Attribute Table Used for Mapping Accidents in ArcGIS

As circled in Figure 23, a high number of accidents are on the highway section from Tsumeb to Ondangwa (T0110 and T0111), which is consistent with the results obtained in the section above.



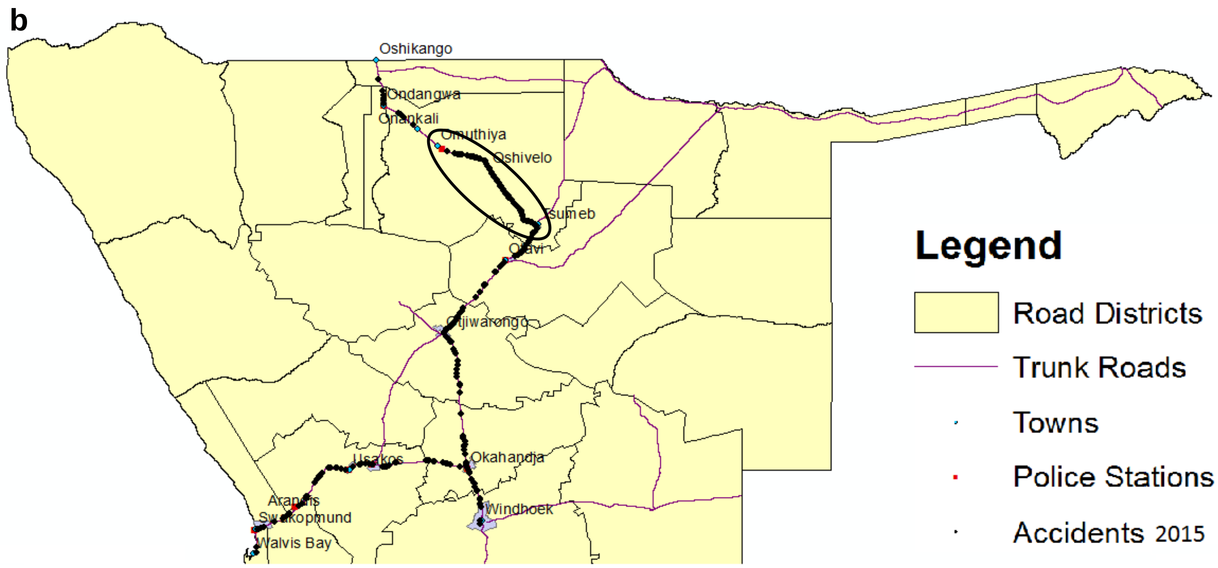
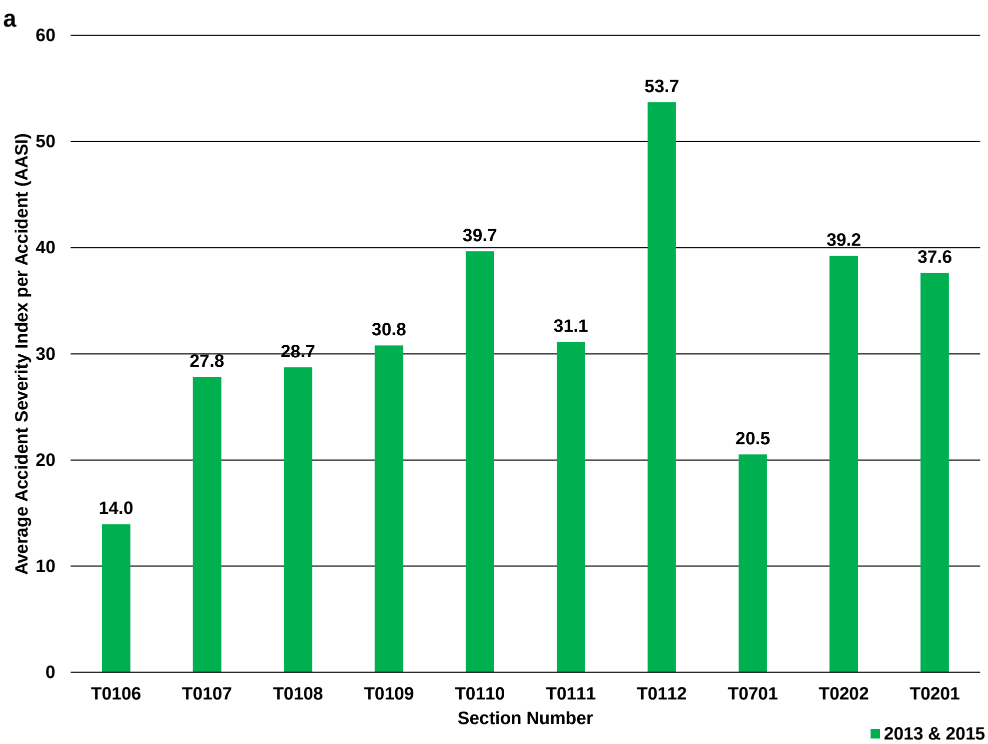


Figure 23. GIS Maps of Circled High Accident Region (T0110 and T0111) in (a) 2013 and (b) 2015

4.1.4 Rank of Highway Sections by Accident Severities

The Average Accident Severity Index per accident (*AASI*) was calculated for each section. Bar charts were produced based on Figure 19 to compare the average severity of an accident that occurred for different sections. The results are shown below in Figure 24.



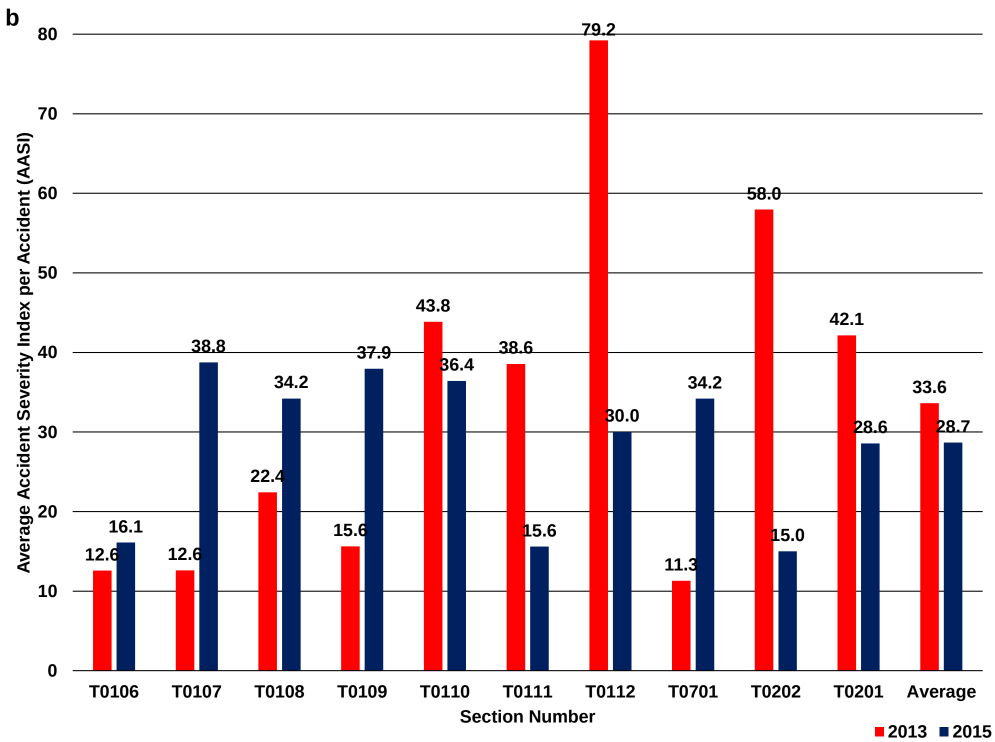


Figure 24. Average Accident Severity Index per Accident of Different Highway Sections in (a) 2013 and 2015 combined and (b) 2013 and 2015 respectively.

As shown in Figure 24b, in 2013, the average *AASI* of all sections is 34.0, while it is 28.7 in 2015, which suggests that the severity of an accident decreases form 2013 to 2015. Moreover, in 2013 and 2015, T0112, T0110, T0202, and T0201 have the highest *AASI*'s, while T0111, T0109, T0108, and T0107 have similar *AASI*.

This indicates that on average**, an accident occurring on T0112, T0110, T0202, and T0201 was more severe than that on other sections** (Figure 24a). Considered that T0112 and T0201 have a low number of accidents, the high *AASI* value could possibly be due to the presence of unusually severe accidents.

By contrast, **T0110 and T0202 both have a high number of accidents and high average accident severity, which made these sections potential sections of concern.**

However, T0106 and T0701, which have high number of accidents, have the least average accident severity on B1 and B2 respectively. Possible reasons for this may be due to a higher quality of road, which would prevent severe accidents. Additionally, these two locations are closer to the capital causing efficient medical emergency services. Thus, future work could be done on investigating the common contributing factors to safe roads.

4.2 Traffic Volumes

4.2.1 Traffic Volume Data

The traffic volume data provided by the Roads Authority (RA) was organized by sections and broken into subsections. The data included the length (L), estimated average annual daily traffic ($EAADT$), and daily vehicle kilometers travelled ($DVKT$) for each subsection. To display how the traffic volume data was organized by subsection, Figure 25 shows one of the sections analyzed in the report. The total length (TL), average estimated average annual daily traffic ($EAADT_{avg}$), and the average daily vehicle kilometers travelled ($ADVKT$) were calculated for each section and organized as shown in Figure 25.

Highway	Section	Subsection	Start - End KM		Length (km)	EAADT	DVKT
			Start	End			
B1	Windhoek - Okahandja, T0106	T0106A	3.33	9.10	5.73	11620	66582.6
		T0106B	9.10	9.20	0.15	11620	1743.0
		T0106C	9.20	15.90	6.74	5350	36059.0
		T0106D	15.90	20.40	4.42	5140	22718.8
		T0106E	20.40	25.20	4.80	5140	24672.0
		T0106F	25.20	26.90	1.78	10290	18316.2
		T0106G	26.90	31.30	4.33	7600	32908.0
		T0106H	31.30	39.00	7.68	6285	48268.8
		T0106I	39.00	45.80	6.83	6285	42926.6
		T0106J	45.80	76.00	30.22	6300	190386.0
		T0106K	76.00	77.80	1.74	6620	11518.8

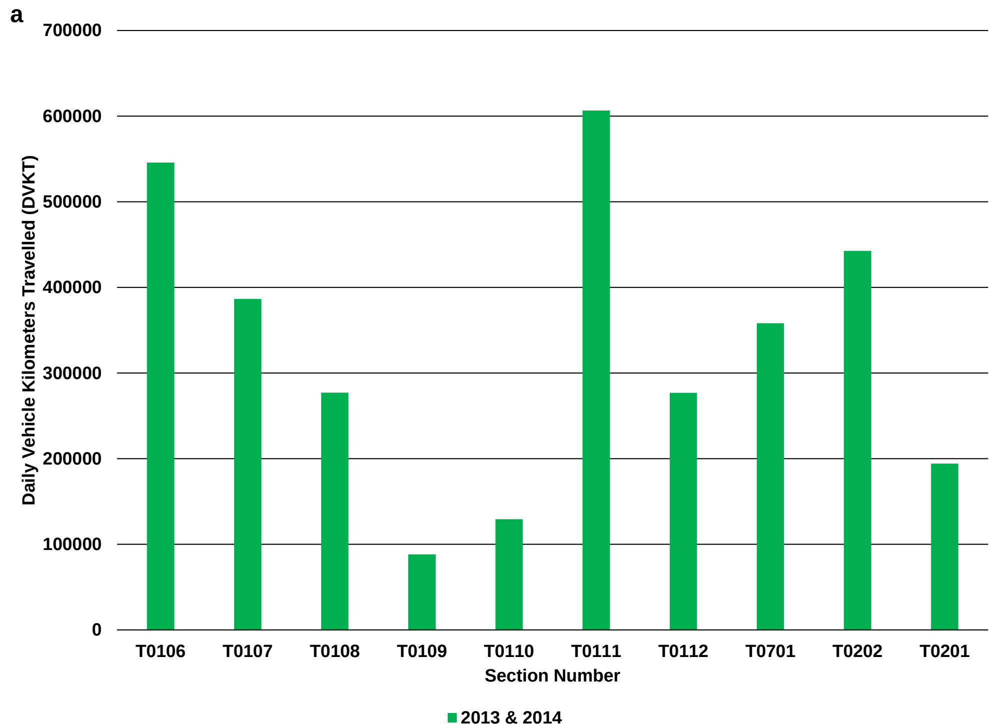
Figure 25. Sample Organization of Traffic Volume Data by Subsection

Section	Length (km)	EAADT		ADVKT		
		2013	2014	2013	2014	2013 & 2014
Windhoek - Okahandja, T0106	74.47	7178	7477	534559.2	556832.5	545695.9
Okahandja - Otjiwarongo, T0107	174.60	2138	2290	373375.4	399834.0	386604.7
Otjiwarongo - Otavi, T0108	117.80	2193	2511	258276.5	295776.2	277026.3
Otavi - Tsumeb,T0109	61.30	1268	1610	77697.8	98693.0	88195.4
Tsumeb - Oshivelo, T0110	95.00	1538	1184	146062.5	112456.3	129259.4
Oshivelo - Ondangwa, T0111	155.10	3903	3920	605303.6	607992.0	606647.8
Ondangwa - Oshikango, T0112	60.00	4608	4618	276490.9	277050.0	276770.5
Okahandja - Usakos, T0701	146.20	1360	2605	198813.6	380894.0	289853.8
Usakos - Swakopmund, T0202	145.70	3076	3000	448195.6	437100.0	442647.8
Swakopmund - Walvis Bay, T0201	31.80	10539	5958	335142.0	189464.4	262303.2

Figure 26. Organization of Traffic Volume Data by Section

4.2.2 Rank of Highway Sections by Traffic Volumes

Bar charts were produced based on the information in Figure 26 to compare the traffic volumes in the different sections, shown in Figure 27.



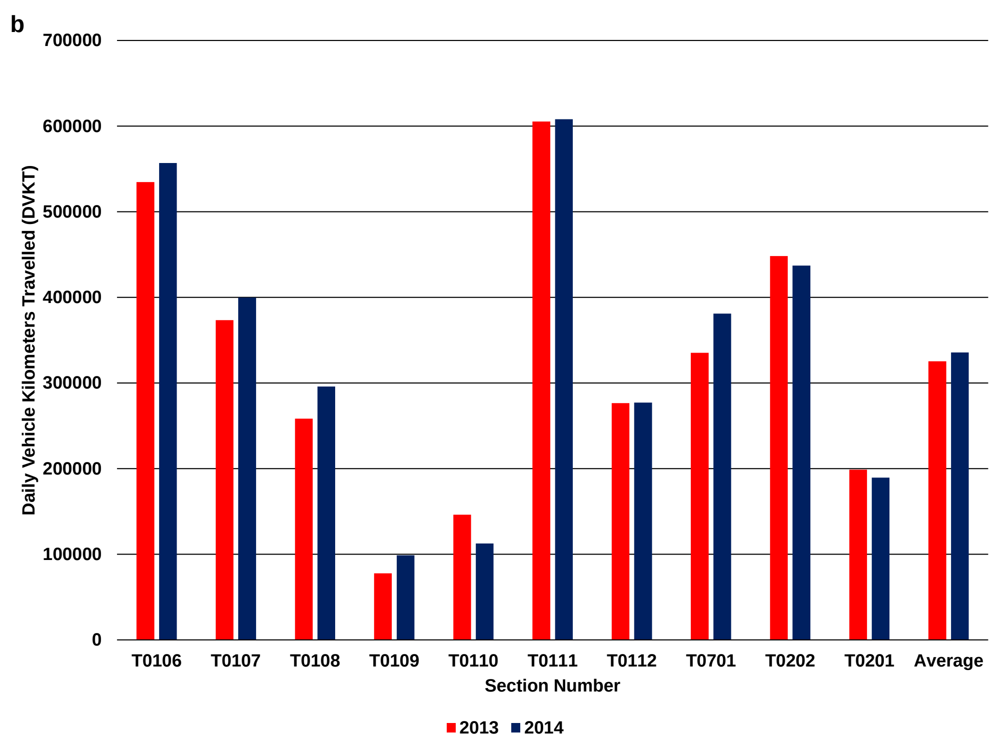


Figure 27. Daily Vehicle Kilometers Travelled of Different Highway Sections in (a) 2013 and 2015 combined and (b) 2013 and 2015 respectively.

The average vehicle kilometers travelled on B1 and B2 slightly increases from 2013 to 2014, which may be due to the increase in the number of vehicles (Figure 27). Moreover, as shown in Figure 27a, T0111, T0106, and T0107 have the highest traffic volumes on B1, while T0202 and T0701 have the highest traffic volumes on B2. **The high traffic volumes might cause the high number of accidents on T0106, T0111, T0701, and T020. However, T0110 has a low traffic volume, yet a high number of accidents. This indicates that location T0110 is a high concern** from having multiple accidents occurring on this section compared to other sections.

4.2.3 GIS Map of Traffic Volumes

Traffic volume levels were calculated for the B1 and B2 subsections. Subsections with *DVKT* lower than 18487 were put into the category of low traffic volumes; those with *DVKT* between 18487 and 36974 are medium, and those higher than 36974 are high. The GIS map of the traffic volumes of subsections is displayed in Figure 28, with green being the subsection with a low traffic volume, yellow being medium, and red being high.

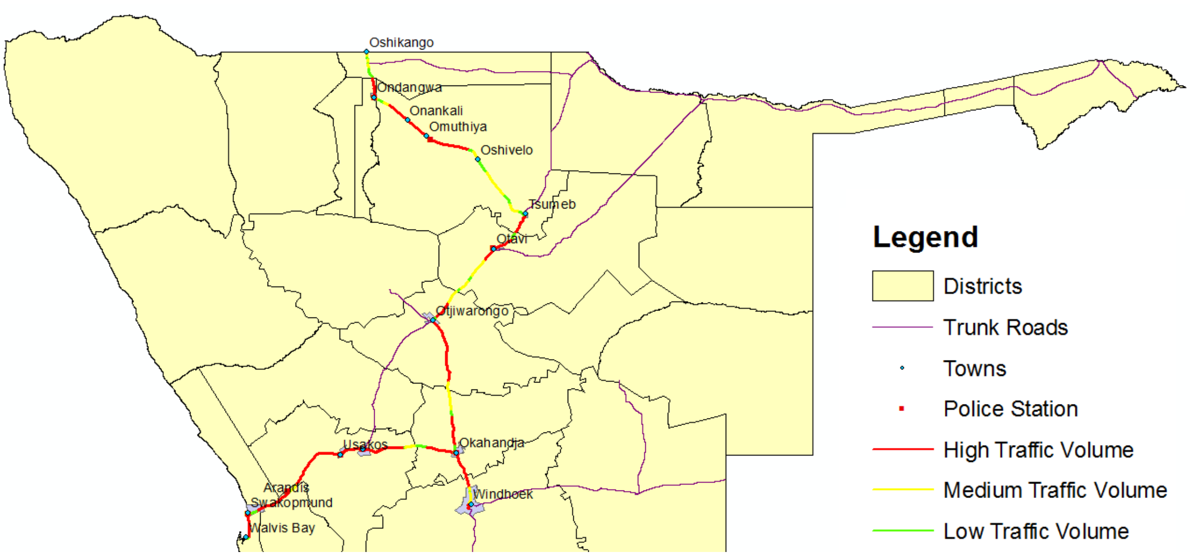


Figure 28. ArcGIS Map of Traffic Volumes for Subsections on B1 and B2

As circled in the Figure 29, the section from Tsumeb to Oshivelo has a low traffic volume compared to other sections with a high number of accidents. The lower traffic volume and higher number of accidents in this region suggest that road safety factors may be lacking.

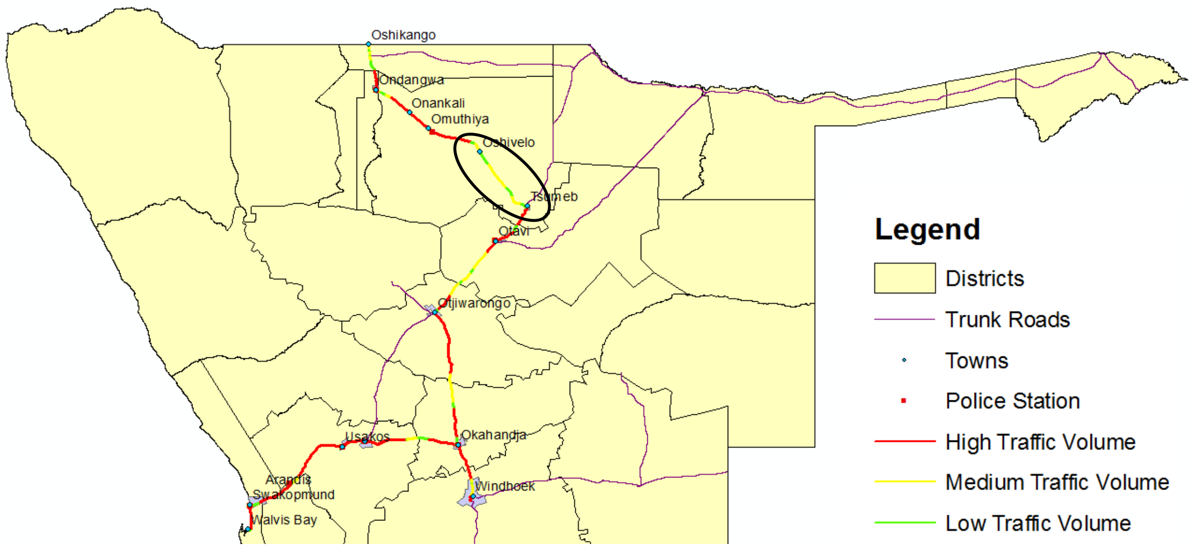


Figure 29. ArcGIS Map of Circled Sections with Low Traffic Volumes (T0110)

4.3 Unsafe Sections of Highway

4.3.1 Normalized Road Accident Data

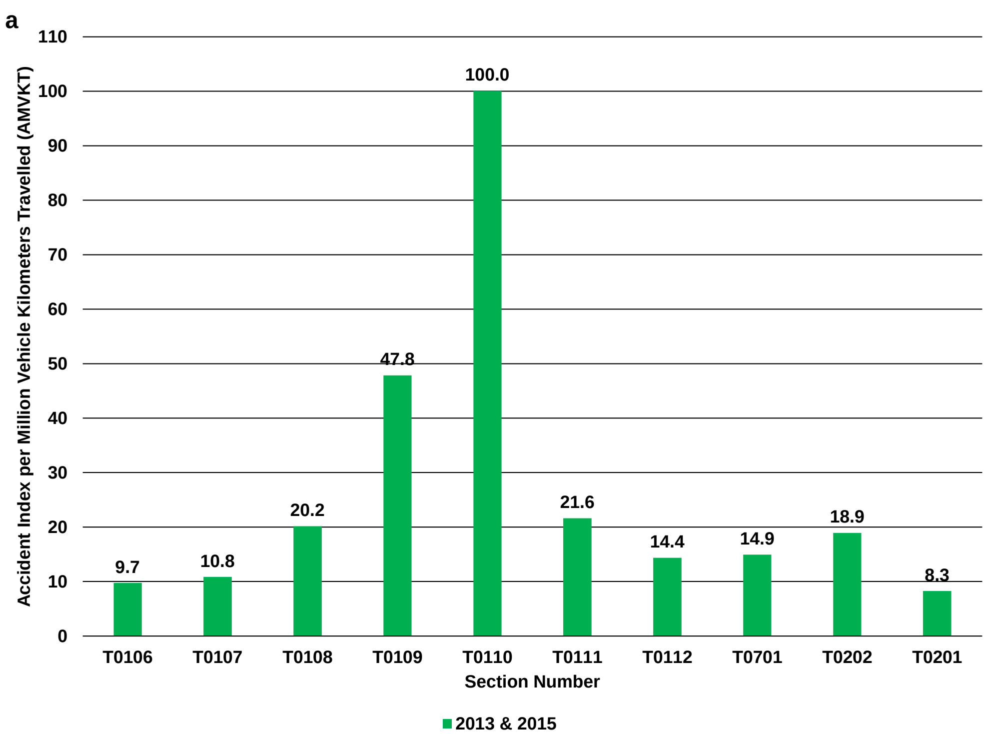
Once the total accident severity index (*TASI*) and the Average Daily Vehicle Kilometers Travelled (*ADVKT*) were calculated, the *TASI* was normalized by *ADVKT* for each section to obtain Accident Index per Million Vehicle Kilometers Travelled (*AMVKT*), presented in Figure 30. The *AMVKT* was calculated by considering the number of accidents, the severities of accidents, and the traffic volume. Thus, this value was used to represent the overall accident severity of each section.

Highway	Section	Accident Index per Million Vehicle Kilometers Travelled (AMVKT)		
		2013	2015	2013 & 2015
B1	T0106	5.5	4.3	9.7
	T0107	2.1	8.5	10.8
	T0108	7.8	12.0	20.2
	T0109	8.8	35.8	47.8
	T0110	42.8	59.4	100.0
	T0111	18.2	3.5	21.6
	T0112	10.2	4.2	14.4
B2	T0701	7.2	7.6	14.9
	T0202	15.6	3.2	18.9
	T0201	4.8	2.9	8.3

Figure 30. Accident Index per Million Vehicle Kilometers Travelled for Each Section

4.3.2 Unsafe Town-to-Town Sections

Bar charts were produced based on the information displayed in Figure 30 to compare the overall accident severities of different sections and different years. The results are shown below in Figure 31.



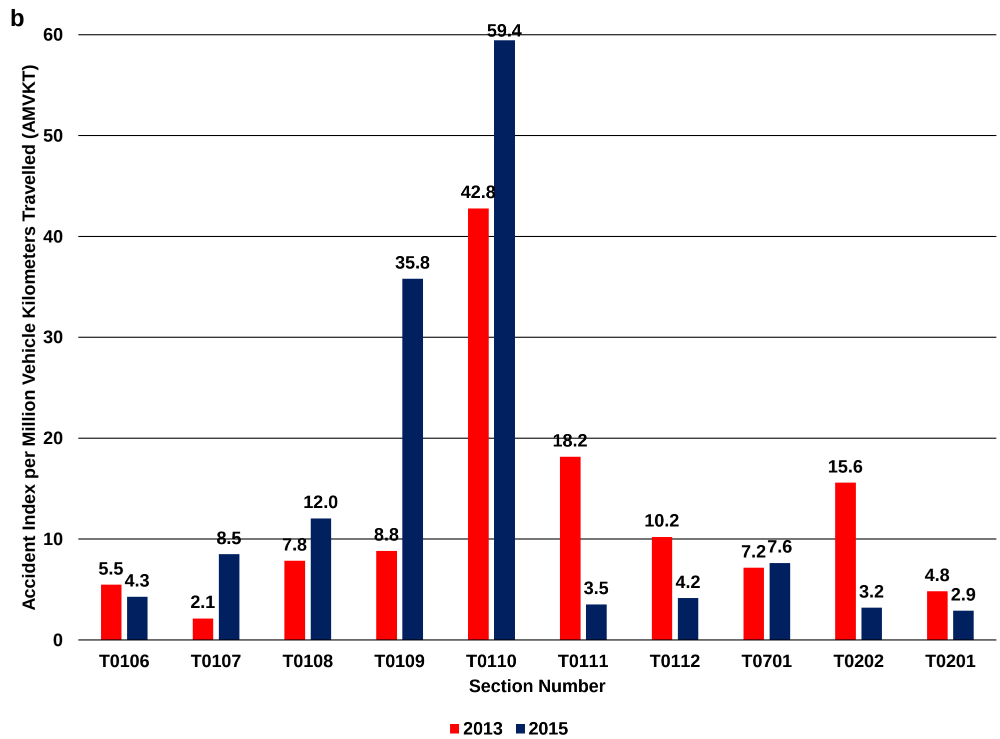


Figure 31. Accident Index per Million Vehicle Kilometers Travelled of Different Highway Sections in (a) 2013 and 2015 combined and (b) 2013 and 2015 respectively.

According to the combined results for 2013 and 2015, T0110, T0109, and T0111 have the highest *AMVKT* on B1, and T0202 and T0701 have the highest *AMVKT* on B2 (Figure 31a). Additionally, **on average, B1 has higher *AMVKT* than B2, indicating that B1 is generally more hazardous than B2**. Each section was separately examined for both 2013 and 2015 (Figure 31b). In 2013, T0111, T0110, and T0106 have the highest *AMVKT* on B1, and T0202 and T0201 have the highest *AMVKT* on B2. In 2015, T0110, T0109, and T0108 have the highest *AMVKT* on B1, and T0701 and T0202 have the highest *AMVKT* on B2. **Therefore, with the presence three separate analyses, T0110 and T0202 are indicated as the most hazardous sections of B1 and B2.**

It is important to note that **T0110, the section from Tsumeb to Oshivelo, was identified to be the most hazardous section mainly due to its high number of accident, high accident severity, and low traffic volume**. In contrast, sections like T0106 and T0111, which have high number of accidents, appear to be of less concern after normalization, due to their moderate accident severities and high traffic volumes.

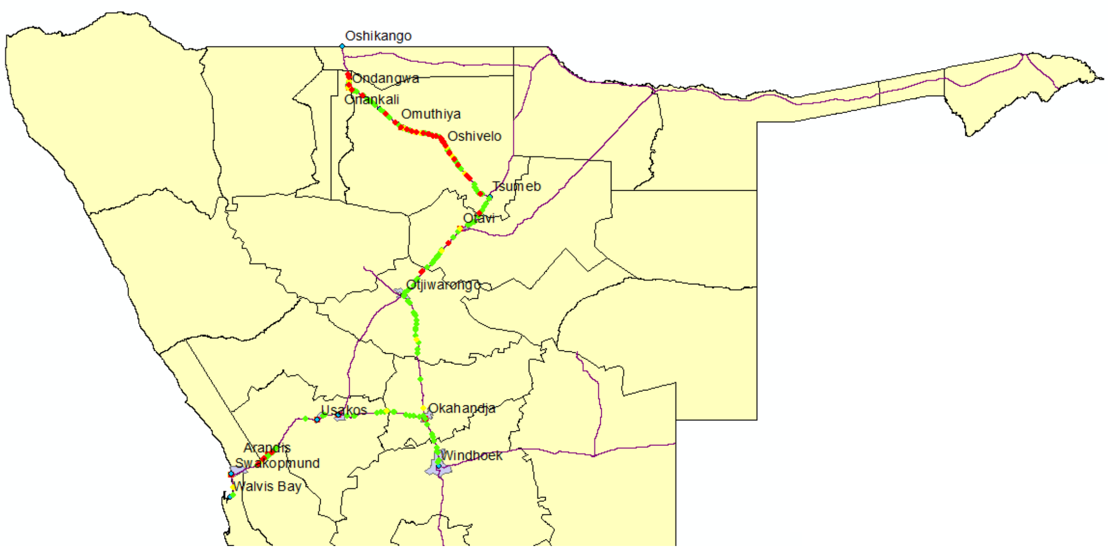
4.3.3 GIS Maps of Severity Levels

As shown in Figure 32, the severity level thresholds were calculated for B1 and B2 separately. For 2013, accidents on B1 with an Accident Severity Index (*ASI)* lower than 19.8 are considered low-severity; those with *ASI* between 19.8 and 39.6 are medium-severity, and those with *ASI* higher than 39.6 are high-severity. Accidents on B2 with *ASI* lower than 25.8 are considered low-severity; those with *ASI* between 25.8 and 51.5 are medium-severity, and those with *ASI* higher than 51.5 are high-severity. The same process was applied to the 2015 data and the 2013-2015 combined data to determine the division ranges. Modified GIS maps indicating the severity level of each accident are shown in Figure 33.

Highway	2013		2015		2013 & 2015	
	⅓ Point	⅔ Point	⅓ Point	⅔ Point	⅓ Point	⅔ Point
B1	19.8	39.6	22.2	44.5	19.5	39.0
B2	25.8	51.5	16.4	32.8	10.9	21.9

Figure 32. Severity Level Thresholds

a



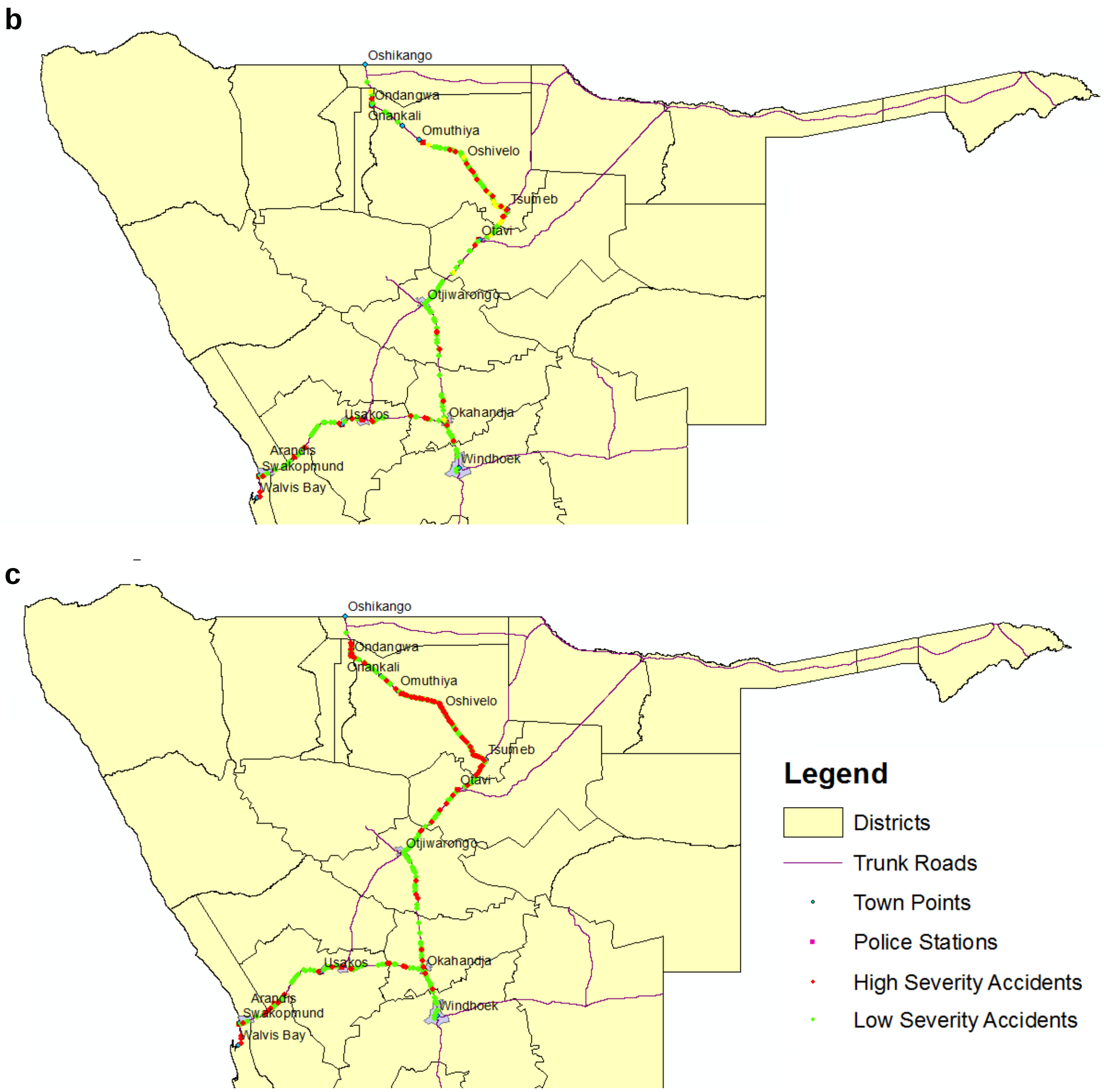


Figure 33. GIS Map of Accidents with Severity Levels for (a) 2013, (b) 2015, and (c) 2013 and 2015 Combined

As circled in Figure 34**, accidents on the section from Tsumeb to Oshivelo (T0110) have relatively high severity levels compared to other sections**, which is consistent with the results obtained from statistical analysis. T0110 is the most hazardous section.

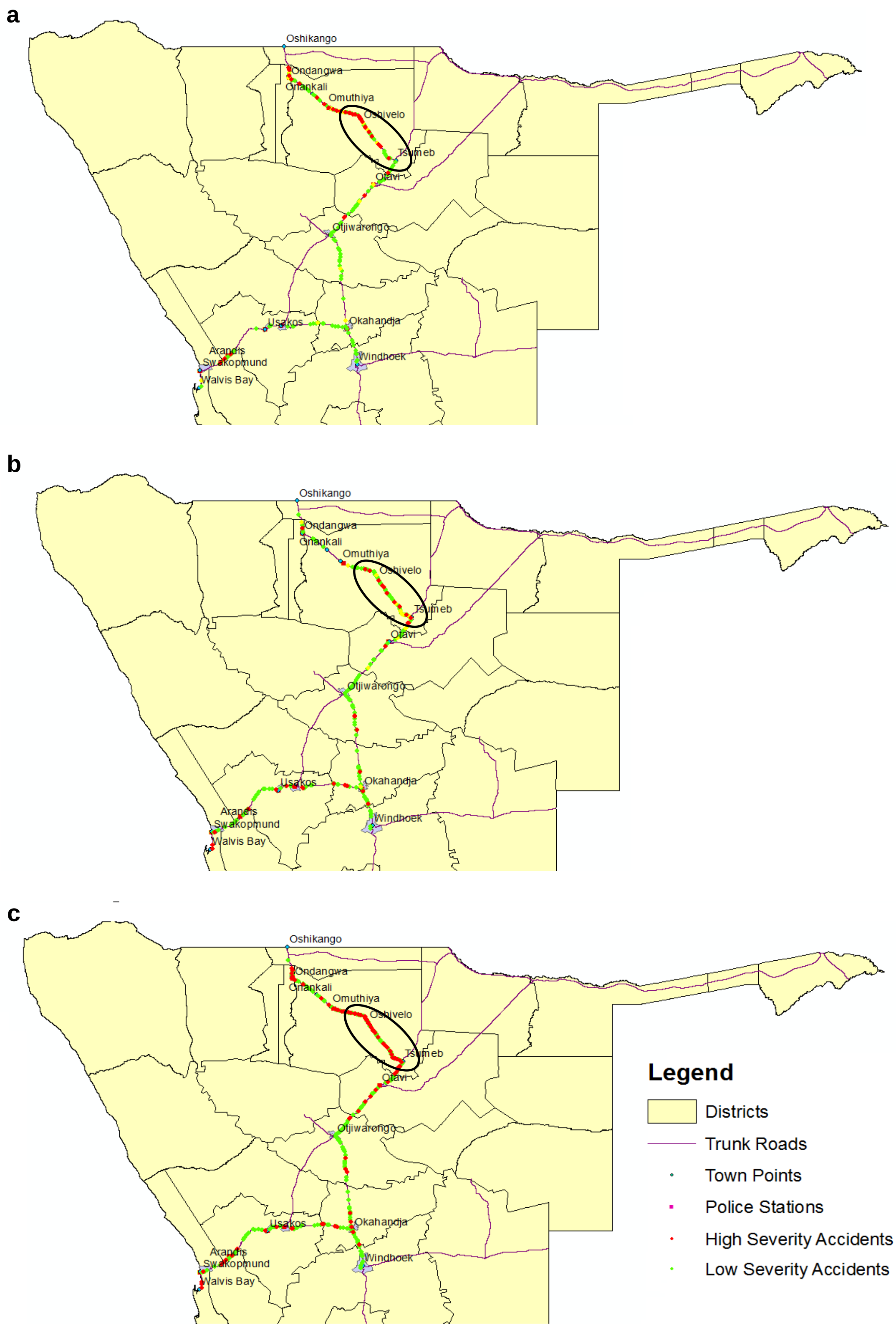


Figure 34. GIS Maps of Accidents with Severity Levels for the year 2013 (a), 2015 (b), and the combined 2013 and 2015 year (c), respectively

4.3.4 Unsafe Stretches of Road

Unsafe road stretches were determined by examining the highway in stretches of 5 kilometers. Each road stretch was examined for the $AMVKT_{rs}$, and recorded in a tabular format with its relevant information (Appendix C). An excerpt of the table is shown in Figure 35. The road stretches with the highest $AMVKT_{rs}$ are also ranked (Figure 36) and pinpointed in Google Earth (Figure 37).

5 km Road Stretch No. (B1)	Section No.	No. of Accidents	ID	ASI	TASIrs	EAADT	ADVKT	AMVKTrs
B11	T0106	2	146558	10	20	7477	37385	1.465682
			142056	10				
B15	T0106	1	145834	10	10	7477	37385	0.732841
B16	T0106	1	139201	10	10	7477	37385	0.732841
B17	T0106	2	144932	10	20	7477	37385	1.465682
			150567	10				
B19	T0106	4	137225	10	140	7477	37385	10.25977
			137335	10				
			142041	10				
			143614	110				
B110	T0106	1	145854	10	10	7477	37385	0.732841
B111	T0106	4	145650	10	40	7477	37385	2.931364
			146244	10				
			146342	10				
			146392	10				
B112	T0106	3	146204	10	30	7477	37385	2.198523
			146294	10				
			146394	10				

Figure 35. Excerpt of the Table of 5 km Road Stretches

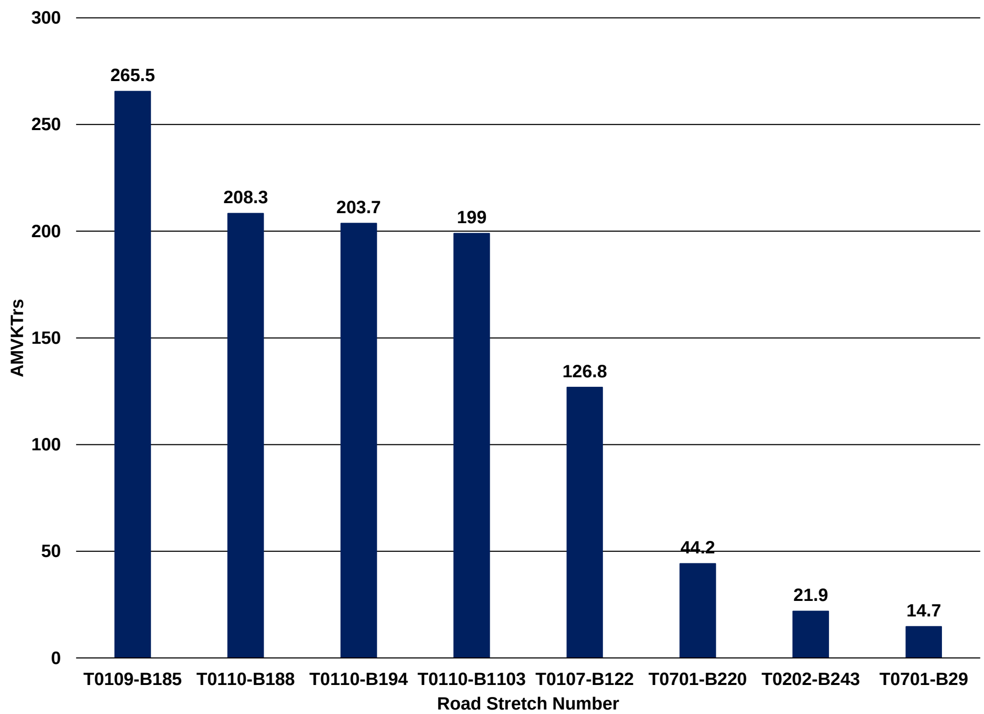


Figure 36. Top Unsafe Road Stretches on B1 and B2 for 2015.

A road stretch is denoted by the section it is on and order of the 5 km stretch on the corresponding highway route. For example, T0109-B185 indicates that the road stretch is on section T0109 and is the 85th 5 km road stretch on B1.

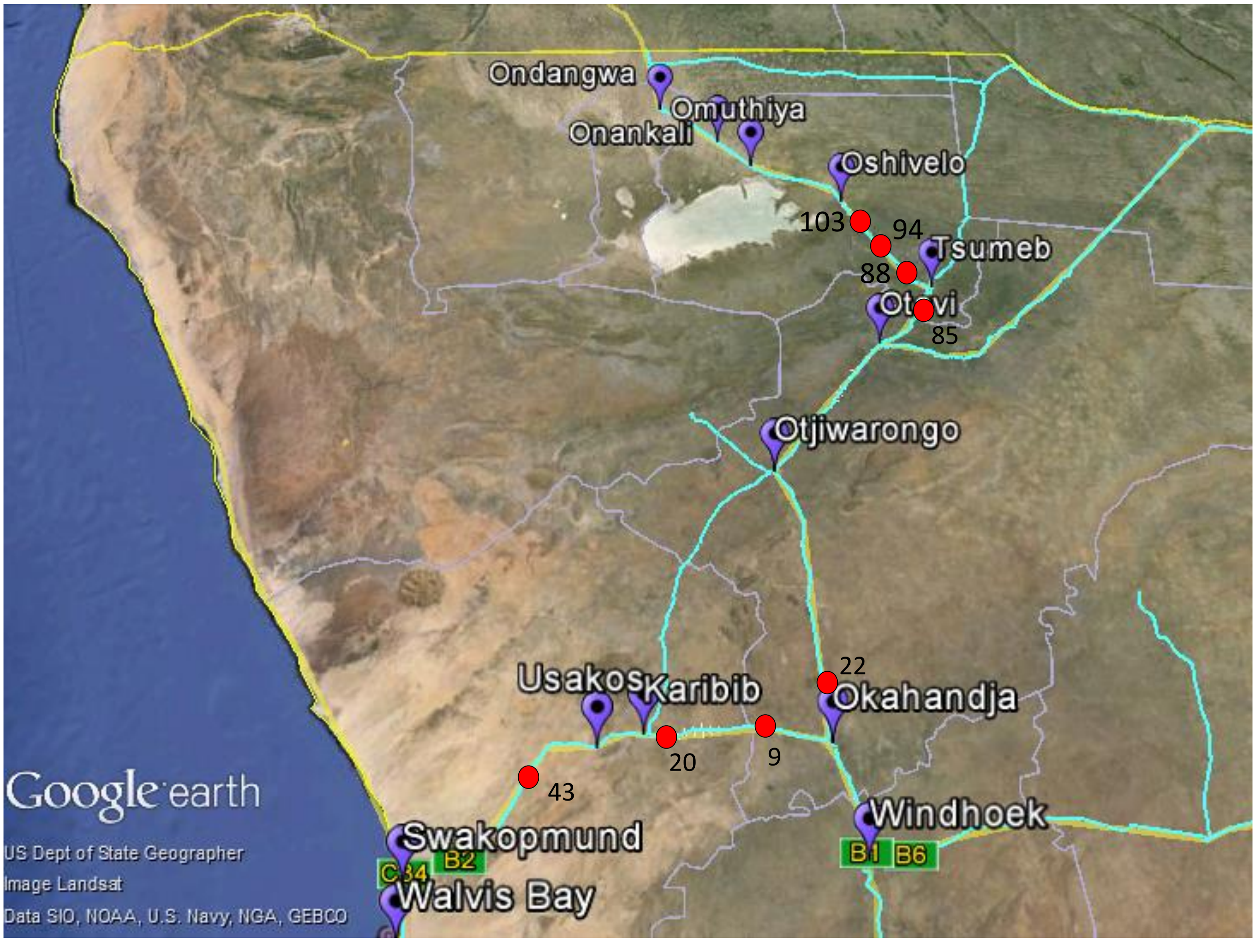


Figure 37. Google Earth Map of the Top Eight Most Hazardous Road Stretches. A Red Dot indicates a 5 km Road Stretch

The worst road stretches from B1 in order are: stretch 85, 10 km south of Tsumeb; stretch 88, 5 km north of Tsumeb; stretch 94, 35 km north of Tsumeb; stretch 103, 75 km north of Tsumeb; and stretch 22, 25 km north of Okahandja. The worst road stretches from B2 in order are: stretch 20, 15 km east of Karibib; stretch 43, 75 km west of Usakos; and stretch 9, 40 km west of Okahandja.

As shown in Figure 36 and 37**, the most hazardous 5 km stretch of road is on T0109, 5 km in the longer segment from Otavi to Tsumeb**. However, it is important to note that **the next three most hazardous 5 km sections are *all* on T0110, in the longer segment from Tsumeb to Oshivelo**. In the previously section, T0110 was identified as the most hazardous section due to the highest *AMVKT* value.

The eight most hazardous road stretches were analyzed in more details to identify the common causes of accidents through site evaluations.

4.4 Common Causes of Accidents

The team conducted statistical analysis by analyzing non-mapped and mapped road accident data for 2015 and in addition, the team performed site evaluations to visualize the issues of the road that were not clearly validated by the data. The completed site evaluations for stretches 85, 88, 103, 94 and 22 for B1 and 20, 43, and 9 for B2 are located under Appendix G.

By performing statistical analyses of the data and site evaluations, the team identified **four common causes of accidents on B1 and B2, namely animals, blind spots, shoulders, and speeding**. These causes mainly focus on road environments and driver behavior. The team is aware that there are other factors that contribute to accidents, such as: weather, age of vehicles, and drug or alcohol use of the drivers. However, due to time constraints, the team was unable to perform an extensive analysis of all possible combinations of factors.

4.4.1 Animals

One of the four common causes of accidents identified was animals. Animal accidents are collisions caused by either domestic or game animals as well as birds. The team performed statistical analysis of the road accident data to determine the prevalence of animal related accidents, which was further confirmed by the site evaluations.

A pie chart was produced to determine the distribution of accidents with respect to different accident types (Figure 38). Accident types were re-grouped into five different categories, and accident records with missing information on accident types were excluded from the analysis. "Accident with animals" are collisions caused by either domestic or game animals as well as birds. "Collisions with other vehicles" includes head on collisions, sideswipes, approaching at angle, and head/rear end. "Sudden exit from roadway" includes single vehicle overturned, and went off the road without rolling. "Collisions with environment" includes collisions with fixed object, with stones, and with pedestrians.

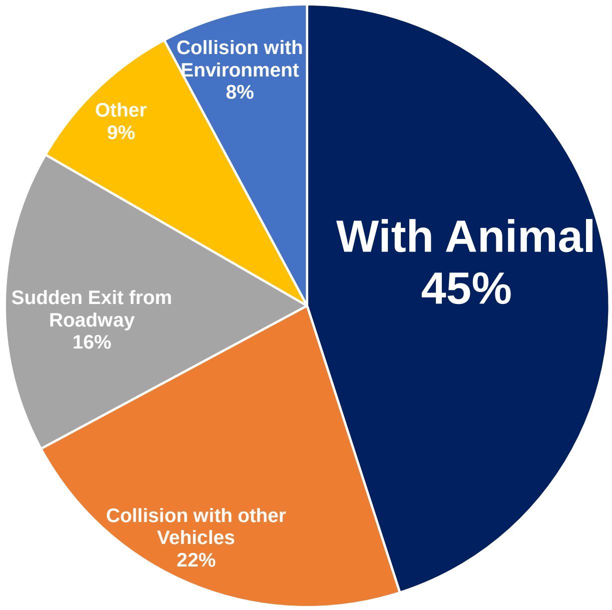


Figure 38. Percentage of Accidents by Accident Types in 2013 and 2015 on B1 and B2

As shown in Figure 38**, accidents with animals are the most common type of accidents, with 45% of accidents occurring with animals in 2013 and 2015** (Figure 38). Mapping all accidents with animals on a GIS map validated the statistical analysis (Figure 39).

Figure 39. GIS Map of Accidents with Animals on B1 and B2 in 2015. Accidents are indicated by blue dots.

According to Figure 39, **not only are accidents with animals the most common accident type, they are also the most prevalent,** occurring on all sections on B1 and B2. Moreover, the average severities of different accident types were analyzed. A bar chart was produced to compare the average accident severity indexes of different accident types (Figure 40).

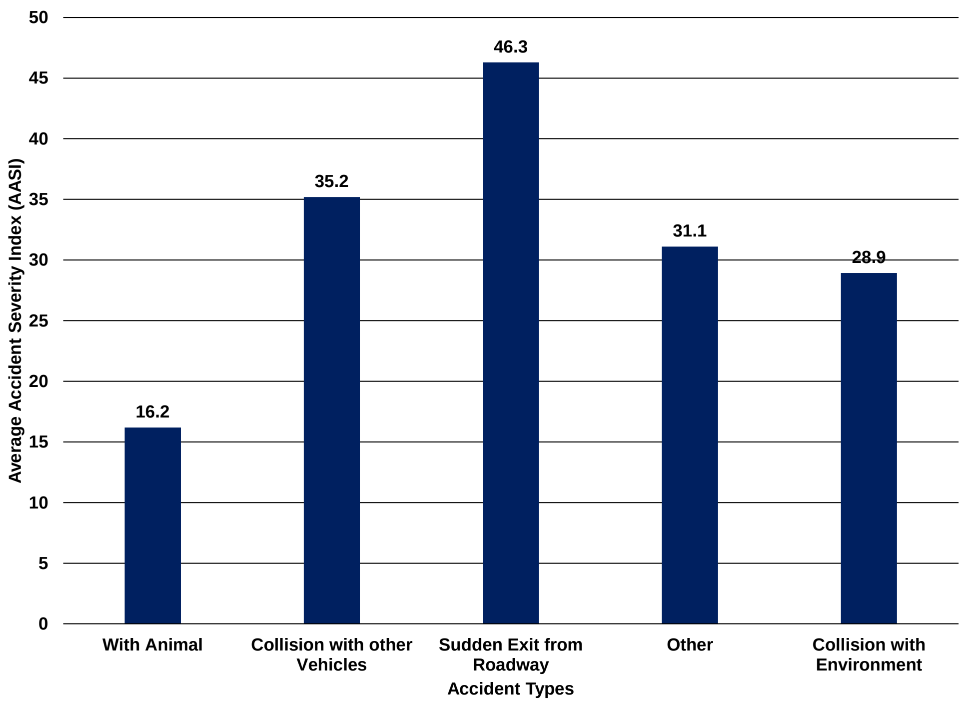


Figure 40. Average Accident Severity Indexes of Different Accident Types on B1 and B2

As shown in Figure 40, accidents with animals have the lowest average severities, indicating the animal accidents, on average, are not as severe as other types of accidents. Furthermore, the distribution of animal accidents and their average severities were analyzed for different times. A pie chart was produced to compare the number of animal accidents occurring at day (6:00 to 18:00) and night (18:00 to 6:00) (Figure 41). A bar chart was produced to compare the average accident severity indexes of animal accidents occurring at day and night.

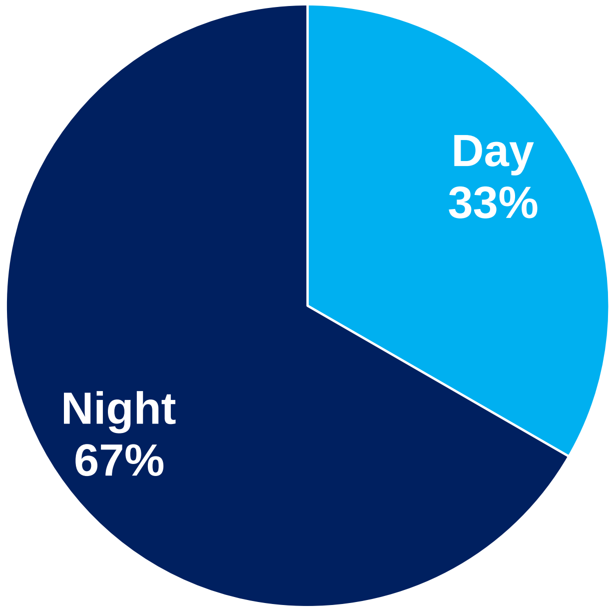


Figure 41. Distribution of Accidents with Animals at Day and Night in 2013 and 2015. Day is considered as the time from 6:00 to 18:00, and Night is considered from 18:00 to 6:00.

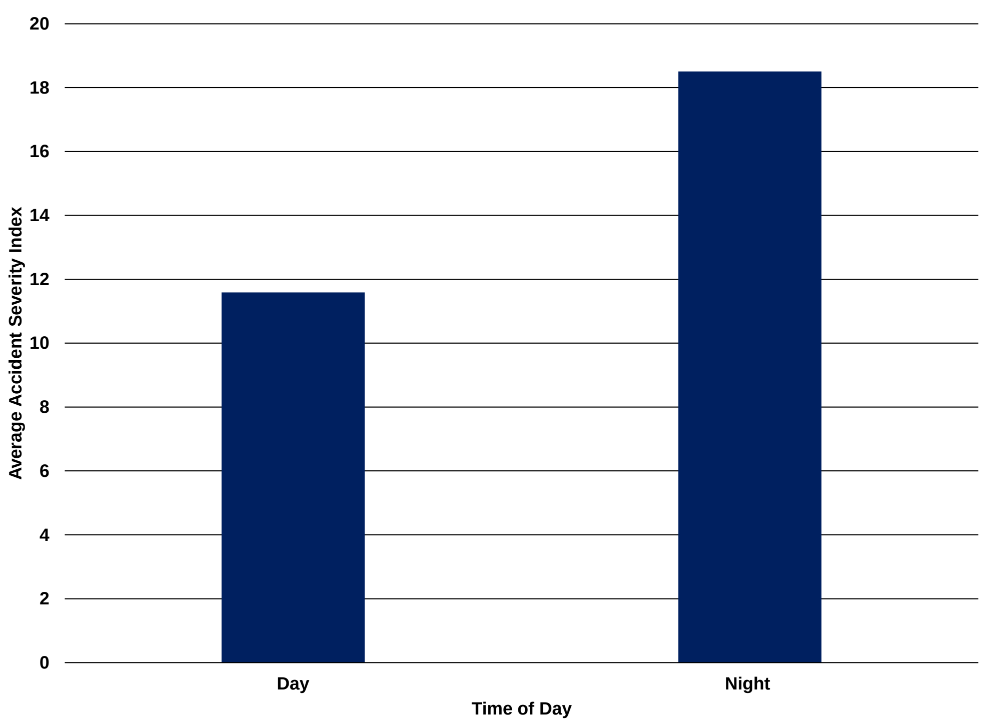


Figure 42. Average Severity Indexes of Animal Accidents Occurring at Day and Night in 2013 and 2015

Figure 41 shows that 67% of animal accidents occurred at night, from 18:00 to 6:00. In addition, Figure 42 shows that animal accidents occurring at night are more severe than those during the day. **These results indicate that animal, especially encountering animals at night, is the most concerning cause of accidents.**

Apart from statistical analysis of the data, the team also observed specific safety factors with animals during the site evaluations. Out of the eight road stretches that the team assessed, four stretches have animal-involved accidents. Those road stretches are indicated with red dots in Figure 42.

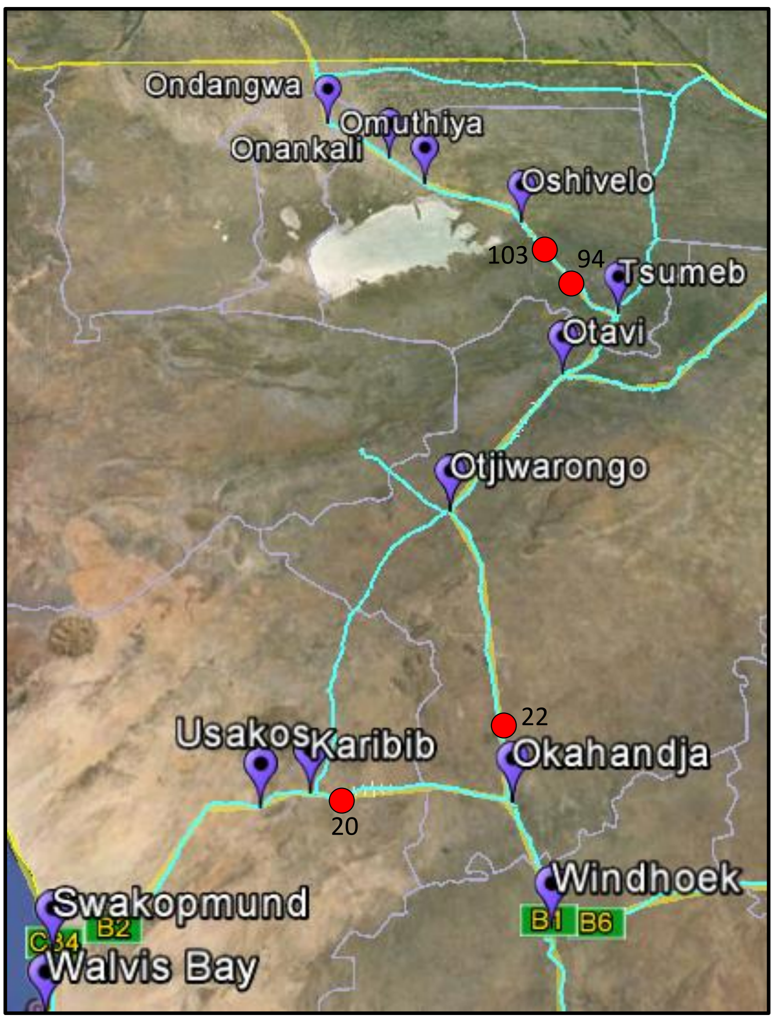


Figure 43. Google Map of 5 km Road Stretches where Animal Accidents Occurred in 2015

From the site evaluation of those road stretches, the team then identified specific safety factors that would potentially cause accidents with animals. According to the accident descriptions**, most**

animal accidents on these road stretches occurred with domestic animals such as cows and donkeys. The team observed a lot of **farms** near the highway, which would increase the presence of domestic animals (see picture in Appendix H). The team also observed **broken fences** along the highway, which would allow animals to migrate onto the road. In addition, the team frequently **saw animals grazing on the sides of the roads**, which pose potential risks to drivers (see picture in Appendix H). Some personnel from the stakeholders assumed that this might be a seasonal issue. They stated that it might be more likely for domestic animals to graze on the sides of the roads during dry seasons when the resources in the farm might be limited. However, this assumption was disapproved by the data, which shows that the number of animal accidents occurring during dry season is similar to that during rainy season (Figure 44). All factors would increase the possibility of animals being on the road and causing an accident.

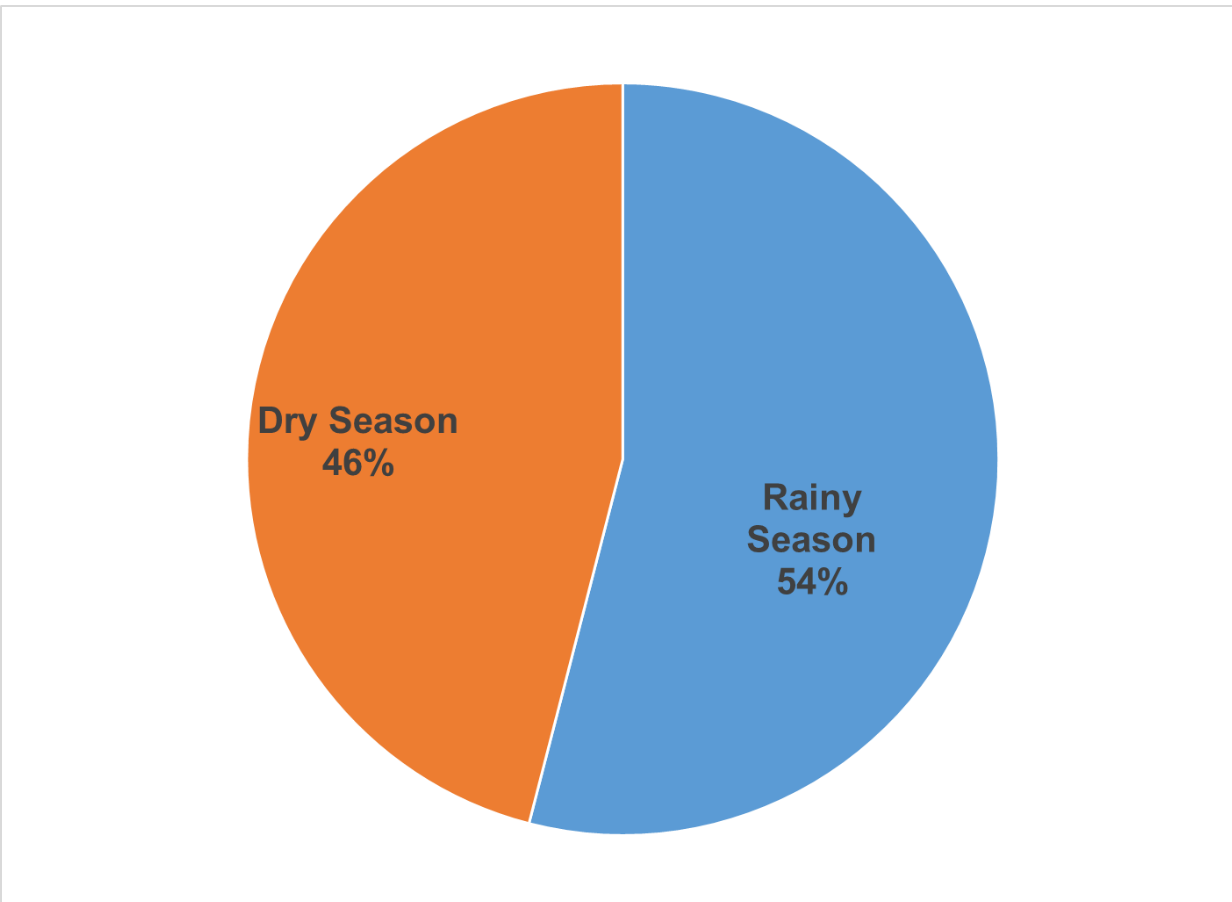


Figure 44. Distribution of Accidents with Animals during Dry and Rainy Seasons in 2013 and 2015.

4.4.2 Blind Spots

A blind spot is an area of road where the driver cannot see all the elements of the road due to an obstruction. A crest is essentially a change in elevation, and these areas are typically blind spots due to the driver not being able to see over the crest. Also, curves create blind spots as well due to the driver not being able to see around the turn.

The B1 road stretches 85, 88, 94, 103, and 22 and the B2 road stretches 20, 43, and 9 were analyzed via Google Earth Pro to note whether an elevation change occurred. These elevation profiles of the road stretches provided pertinent information on whether the accidents were occurring on road sections that had severe inclines or declines. Figure 45 is the elevation profile analyzed in Google Earth Pro of stretch 9 on B2. The other elevation profile images will be located under the Appendix F.

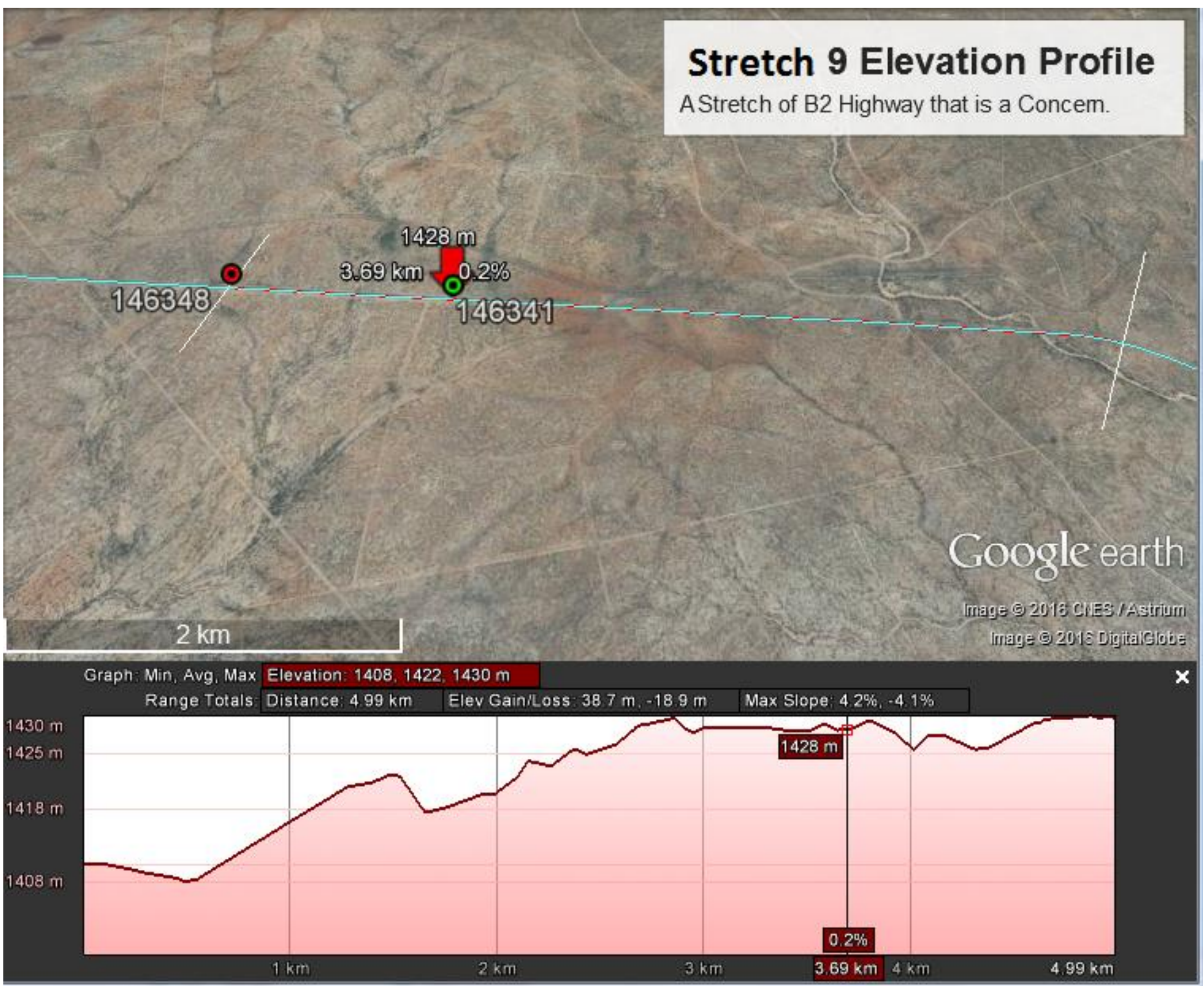


Figure 45. Elevation Profile for Stretch 9 on B2

The elevation profile of Stretch 9 signifies that the accident, 146341, occurred at the middle of a crest right before an incline. The accident occurred at 1428 meters with an 8-meter incline occurring. A crest, such as this one, is an indicator of a blind spot. A similar analysis was performed for all stretches of concern.

Similarly, the Google Earth Pro program was able to identify curves in the road.

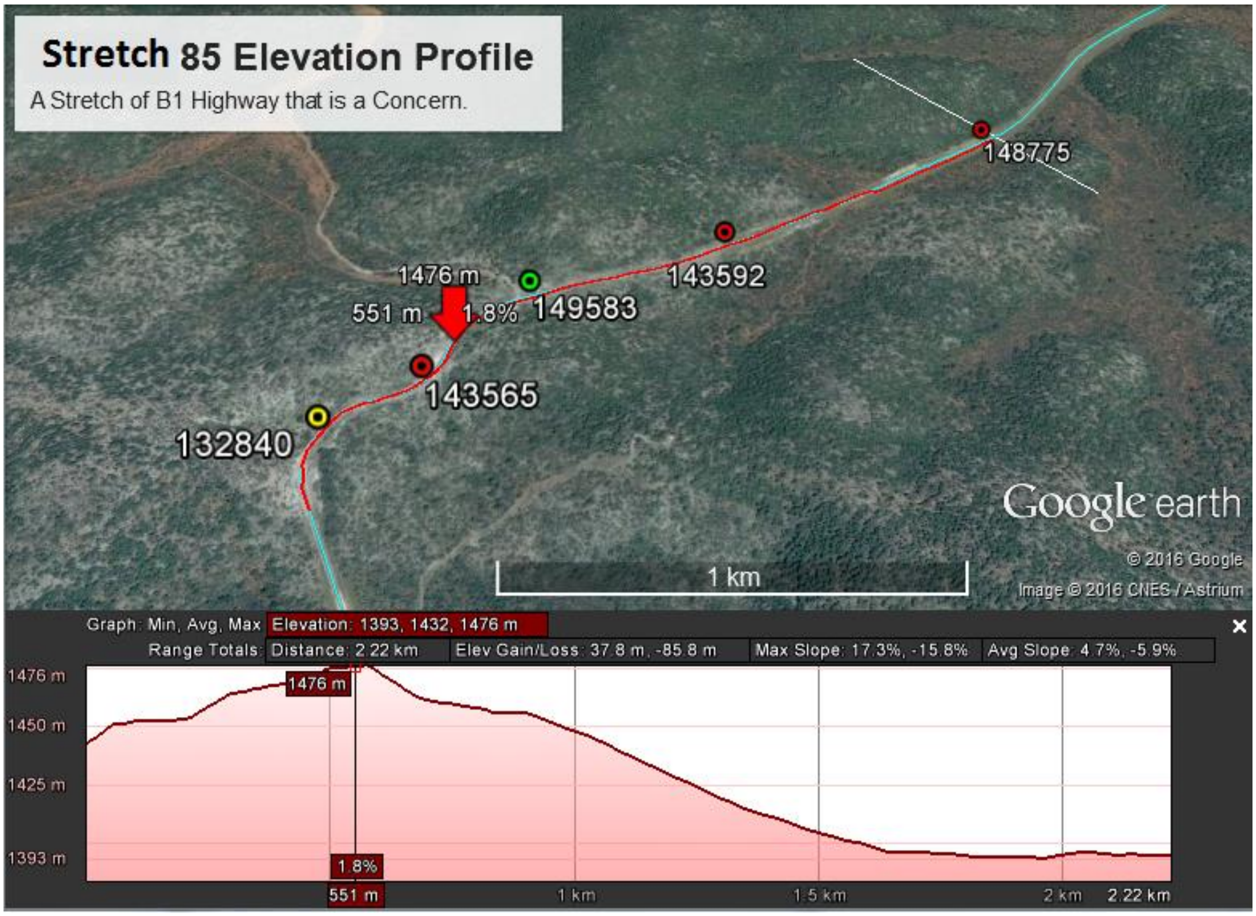


Figure 46. Elevation Profile for Stretch 85 on B1

In Figure 46, a curve in the road can be identified as well as a change in the elevation. The image displays the stretch having multiple curves, and the second curve is at the top of the crest at 1476 meters with an approximate 15-meter incline to a 60-meter decline. This data suggests that this area is a blind spot.

The team went site evaluations to verify the presence of blind spots, either by crests or curves, which were indicated by the data from Google Earth Pro. The following images were taken during these site visits.

Figure 47. Blind Spot due to a Crest on Stretch 9 on B2

Figure 48. Blind Spot due to a Curve on Stretch 85 on B1

As seen in Figure 48, the team observed a blind spot on Stretch 9 on B2. This validates the data collected from the elevation profiles. **This B2 crest is an obstruction on this stretch of road due to it limiting the visibility of all aspects of the road**. Similarly as shown in Figure 4.4.2-4, the team observed a blind spot on Stretch 85 on B1. **This B1 blind spot was due to the combination of a crest and curve**, which also validated the data from the Google Earth Pro analysis.

4.4.4 Road Width

The fourth identified safety risk factor was road width. Road width issues were identified as pertaining to the size of the road shoulder, the size of the road lanes, and the quality of the edge of the road. The team identified several accident types that may have issues with the road width as a possible cause. These accident types were: sideswipe, same direction; sideswipe, opposite direction; single vehicle overturn; and went off road without rolling. These were then compared to the remainder of the accident types. Figure 49 shows the chart that was generated as a result.

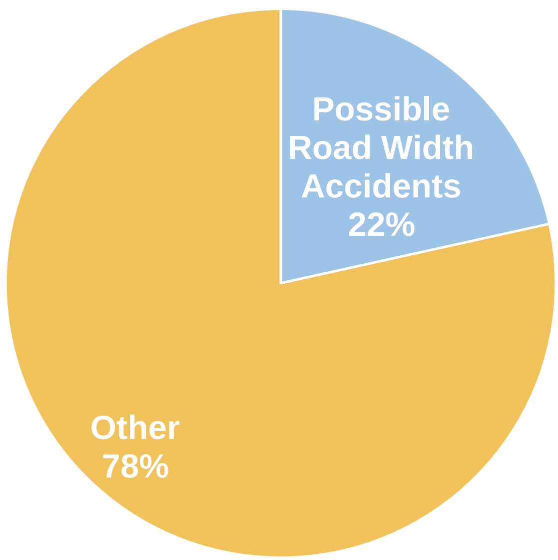


Figure 49. Road Width Accidents Compared to Others

Nearly a quarter of all accidents for both 2013 and 2015 were caused by these accident types, making the issue with road widths and shoulders a major concern. **On the team's site evaluations, the team identified problems with the road width to be present at stretches 22 and 85 on B1 and stretches 20 and 43 on B2**. Figure 50 shows the percentage of the road width accidents at these locations.

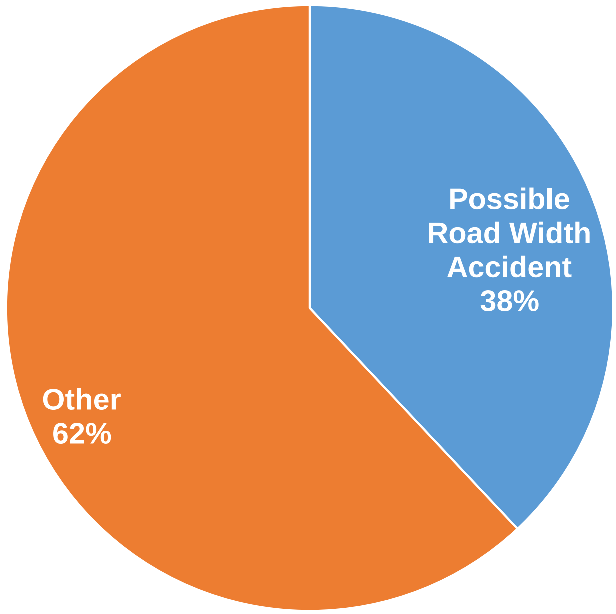


Figure 50. Road Width Sites Accident Types

38% of accidents in these stretches were made up of the road width accident types. This is nearly double the proportion of accidents for the entire highway section. **Locations where we identified one or more problems with the road edges had a higher incidence of the denoted "Road Width Accidents."**

Average Accident Severity Index (AASI) for these road width accidents were compared to other types of accidents. Figure 51 shows a bar graph with the AASI for each road width accident type.

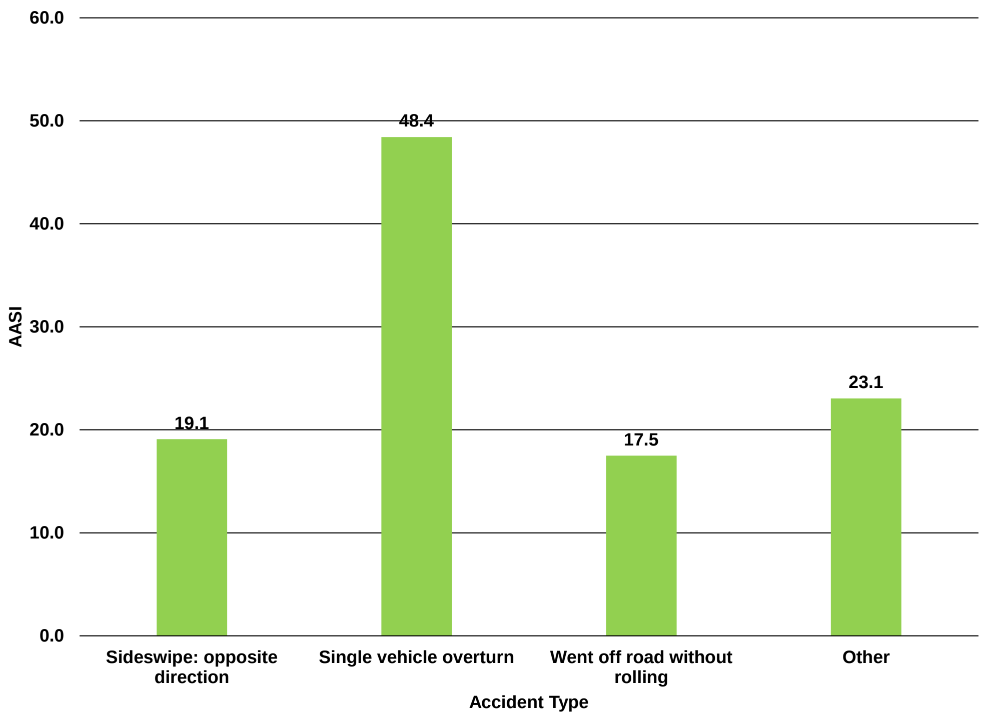


Figure 51. AASI for Road Width Accidents

As shown in Figure 51, **single vehicle overturn accidents are the most dangerous category**, with an AASI of 48.4. It is also worth noting that this category was the **most prevalent** of the road width accidents, with 108 accidents. As a collective, the AASI for all road width accidents was 42.0, which is much higher than the average for all other types, 23.1.

Additionally, due to the fact that drivers may have a more difficult time seeing the narrower roadway at night, the shoulder accidents were analyzed for time. Figure 52 shows this in a pie chart.

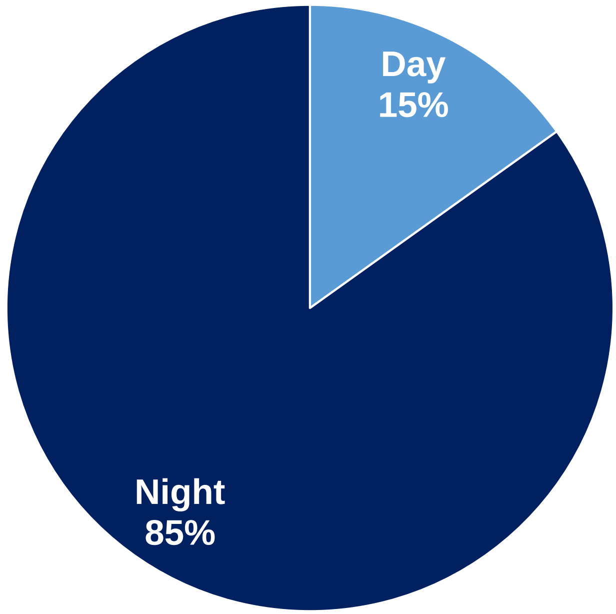


Figure 52. Time Analysis for Road Width Accidents

This chart shows **an overwhelming majority of accidents in the road width category occurring at night.** Drivers at night may not see or misjudge the edge of the road or lane, which results in an accident.

The team then went on site evaluations to observe whether the issues of road widths and shoulders were present on these road stretches. Figure 53 shows an image taken at Stretch 20.

Figure 53. Stretch 20 Shoulder Width

The image shows **the lack of an appropriately sized asphalt shoulder**, in addition to the lack of any dirt or gravel shoulder. The risk that this generates prevents drivers from being able to get off the road safely. This site in particular had a steep drop-off after a minimal shoulder, leaving no space for a vehicle to get out of the roadway if it has a breakdown. This poses serious dangers to the driver, as they are helpless against other vehicles coming towards them.

At stretch 20 as well, we noticed **that the asphalt shoulder had a sharp edge**. There was no gradual curve from the regular roadway onto the ground. This poses danger to the vehicle by preventing it from being able to easily maneuver back onto the road after swerving. In conjunction with the lack of a shoulder, the vehicle has a much higher likelihood of going down the sharp hill at the edge of the roadway.

At stretch 85, the team noticed **the narrow roadway** on the curving hill. The team also witnessed two large articulated trucks passing each other on this hill. There was little room for any sort of deviation on the trucks' paths, making an accident likely if the drivers were less cautious.

4.4.4 Speeding

The team obtained the speed data from the Roads Authority, collected by the Traffic Surveillance System (TSS). A bar chart was produced to show the percentage of vehicles in excess of speed limit on different sections (Figure 54).

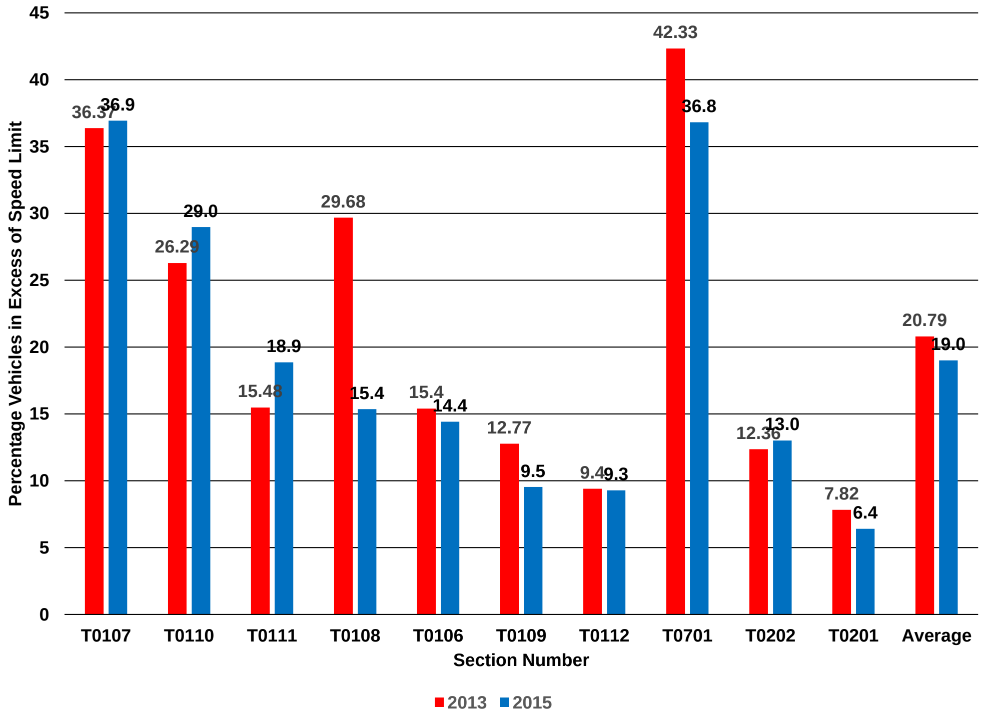


Figure 54. Percentages of Vehicles in Excess of Speed Limit on Different Highway Sections in 2013 and 2015

As shown in Figure 4.4.4-1, **speeding is a prevalent issue on all sections on B1 and B2, especially on the most hazardous highway sections**. **On average, approximately 20% of vehicles exceeded the speed limit on B1 and B2 in 2013 and 2015.** Additionally, approximately 30% of vehicles exceeded the speed limit on T0110, the section from Tsumeb to Oshivelo, which was previously identified as the most hazardous section on B1 and B2. Roughly 13% of vehicles exceed the speed limit on T0202, the section from Usakos to Swakopmund, which is the most hazardous section on B2. Therefore, although there is no direct correlation between speeding and the occurrence of accidents in the accident data, the team speculates that speeding may contribute as a cause of accidents.

4.4.5 Other Analyses

Interest from stakeholders showed desire for additional analysis beyond the four factors identified from the data and site visits. These factor combinations are:

1. Average Accident Severity Index by Vehicle Type

2. Injury Type by Vehicle Type
3. Involvement of Commercial Vehicles in Accidents
4. AASI By Time of Year
5. AASI By Time of Day

Due to time constraints, the team was unable to perform an extensive analysis of these factors, such as map identification, but instead performed a short pure data analysis of the information. For the AASI by Vehicle Type, the team produced Figure 55.

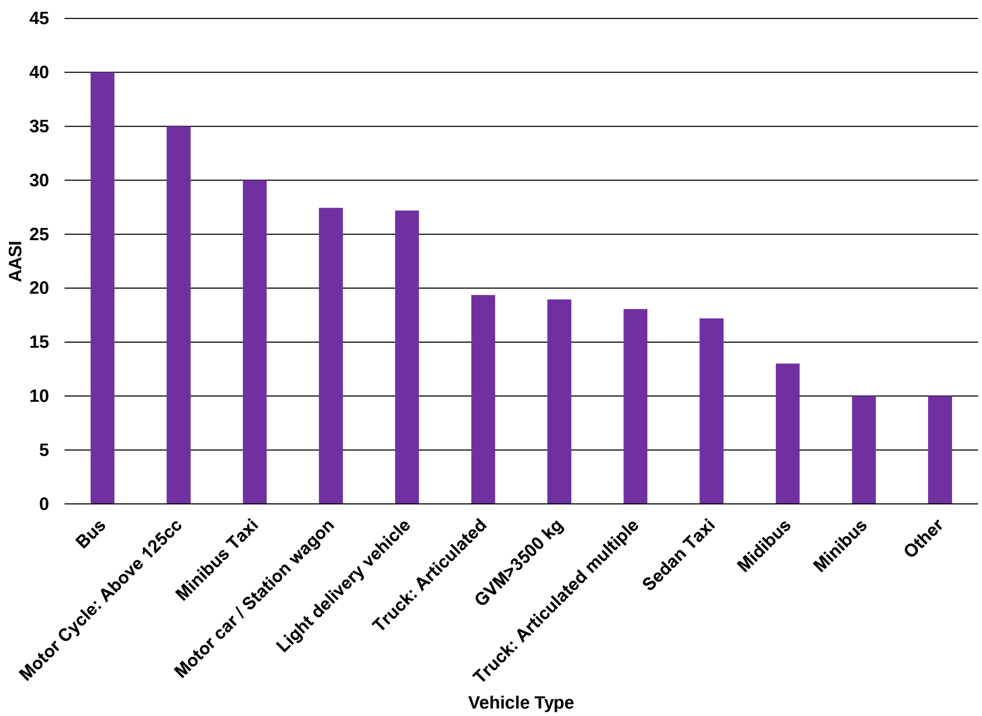


Figure 55. AASI of Different Vehicle Types

Figure 55 shows that Buses are, on average, are in the most severe accidents. Motor Cycle: Above 125cc is second to this and Minibus Taxi is in third, but there are only 2 and 3 accidents for each type, respectively. This may cause a single severe accident for these vehicle types to dominate, possible skewing the data. In terms of injuries per vehicle type, Figure 56 was generated to visualize the data.

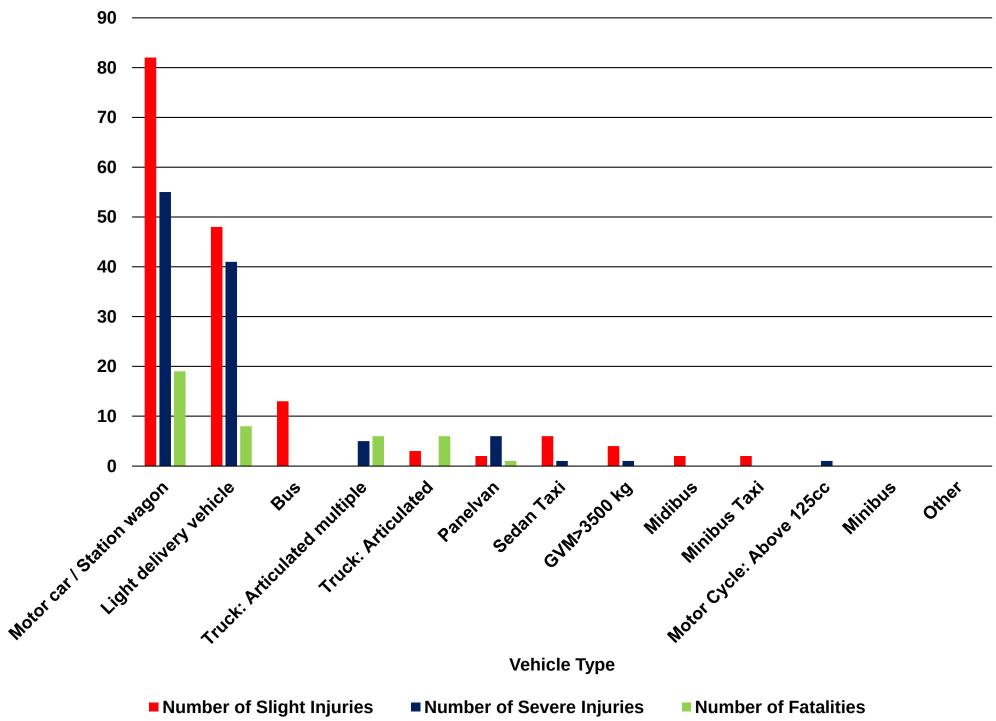


Figure 56. Accident Severities of Different Vehicle Types

Figure 56 clearly shows that Motor car/Station wagon is the most injury prone vehicle type, followed by Light delivery vehicle. It is also worth noting that the "Minibus" and "Other" categories did not have any injuries or fatalities associated with them.

The involvement of commercial vehicles, here categorized by articulated trucks and light delivery vehicles, in accidents was analyzed next. As shown in Figure 57, Motor car/Station wagon is the most prevalent vehicle type in accidents, with 44% of all accidents. Once more, Light delivery vehicle follows, taking up 30%. Panelvan, Motor cycle: Above 125cc, and Minibus Taxi were all listed as having an extremely small percentage of accident involvements.

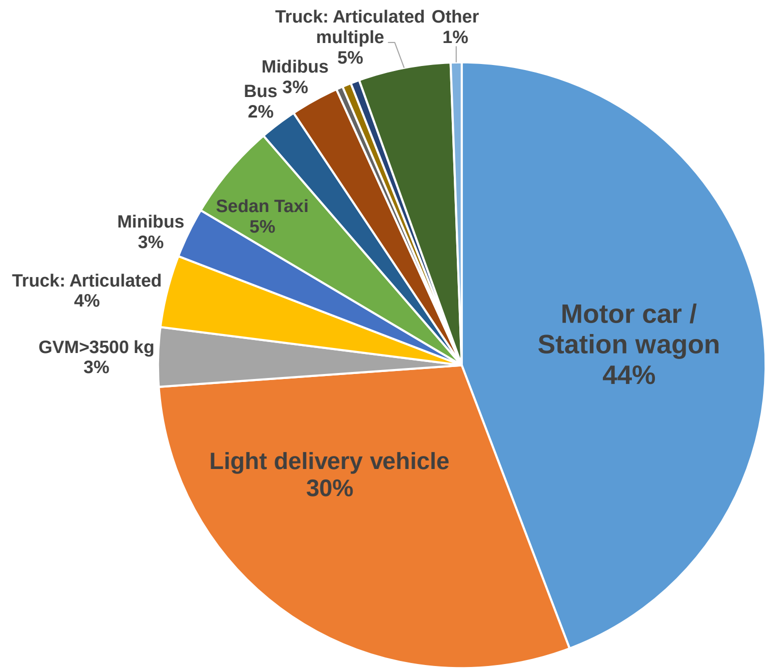


Figure 57. Distribution of Accidents by Vehicle Type

Moreover, the frequency of accident by month and time of day was analyzed. The results are shown in Figure 58 and Figure 59.

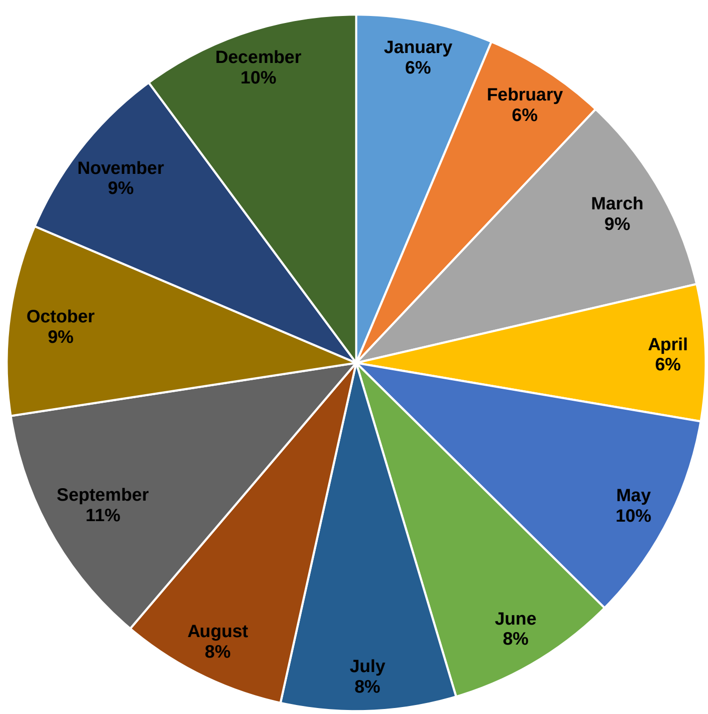


Figure 58. Distribution of Accidents by Month in 2013 and 2015

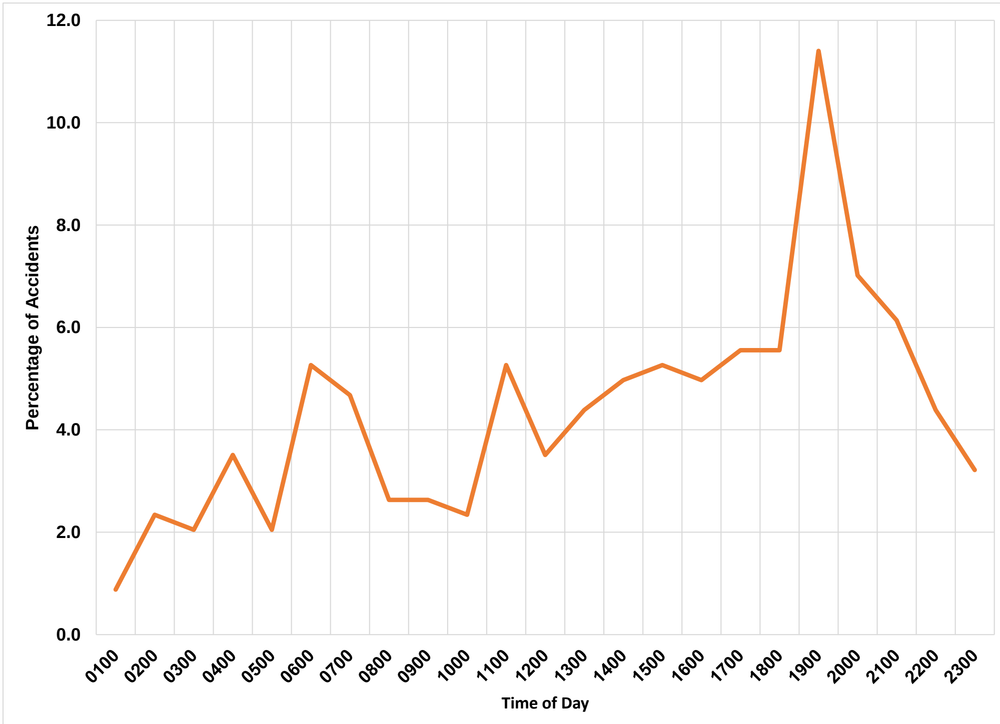


Figure 59. Percentages of Accidents by Time of Day

Figure 58 shows that there is generally an even distribution of accidents per month. However, there are spikes in the months of May, September, and December. This may be due to an increase in holidays during these times, and therefore more drivers on the roads. By hour, however, is much less homogenous (Figure 59). There are few accidents in the early morning, and then a peak in the 06:00 and 07:00 hours. Additionally, there is a second peak of similar magnitude in the 11:00 hour. Accidents slowly increase in number after this point, until 19:00, where there is a peak of 11.4%. The peaks seem to occur at the times of commuting to work, lunch, and the beginnings of dusk, respectively. After this time, however, there is a significant decrease in the number of accidents.

4.*5 Recommendations for Reducing Accidents*

The team analyzed the common causes of accidents and proposed recommendations to mitigate these accidents. Through data analysis and site evaluations, the team developed stretch-specific and long-term recommendations for the entire B1 and B2 routes. These recommendations ranged from structural countermeasures to changing the Namibian procedure.

4.5.1 Stretch-specific Recommendations for Countermeasures

The team formulated potential countermeasures to reduce accidents on the stretches of most concern directly from the primary data. Some of the potential recommendations were reinforced after site evaluations were performed while others went through revisions. Through the site evaluations, the team encountered successfully established countermeasures, such as the Speed Flashers, on the B1 and B2 highways; however, the team also observed a lack of safety previsions. The team proposed several different recommendations to effectively reduce the number of road accidents caused by the common causes in a variety of methods.

4.5.1.1 Animal Countermeasures

Out of the team's selected stretches, there were specific locations where animals are a reoccurring accident type. Stretches 20, 22, 94, and 103 were the locations with the highest presence of domestic and/or wild animals. To mitigate animal related accidents, the team proposed structural and agricultural solutions.

The site evaluations indicated to the team that multiple areas along the selected stretches lack effective fencing. The team noticed multiple areas with broken fences as well. In locations where fencing is in good condition, there are a low number, if any, animal induced accidents. **Implementing fencing and repairing the broken fences** on the indicated stretches will increase the difficulty for animals to migrate onto and across the road. The team proposes that the responsibility of the repair and construction of these fences fall upon the farmer due to the domestic animals being their property thus their responsibility.

There are multiple commercial and private farms along B1 and B2, resulting in a larger presence of cattle around the area. The team proposes making drivers travel cautiously in the highly animal populated area. By **installing warning signage** when a farm is approaching, such as the one on stretch 22, Figure 60, drivers will be aware of the possibility of a domestic animal being on the road.

Figure 60. A farm on Stretch 22 on the B1 Highway

As said in the statistical analysis, a large portion of animal caused road accidents occurred at night. With this, the team recommends the **signage to be reflective**. Vehicle headlights do not capture the driver's entire surrounding thus by having a reflective warning sign, it will catch the road user's eye before it is too late.

Around these farming areas, cattle graze right along the edge of the street. At night drivers are only capable of seeing domestic or wild animals only when the headlights of the vehicle catch their eyes or when the animal is directly in front of them. With the accidents occurring mainly at night, the team recommends advising farmers to **tag their cattle with non-invasive reflective tags**. This will help drivers see domestic animals along and in the road before a collision occurs. This will prevent injuries to the driver in addition to the animal, therefore benefiting both parties.

4.5.1.2 Blind Spot Countermeasures

Blind spots are an issue that were seen and experienced on the B1 and B2 routes. Stretches 43, 9, 22, 85, 88, and 94 were the leading locations where blind spots have caused accidents. Blind spots reduce the driver's ability to visualize all the elements of the road due to the obstructed view. Elevation changes and/or road curvature on these routes without warnings pose serious hazards to drivers on both directions of the road.

To address this issue, the team recommends **installing reflective road tags** along the painted lines. These tags were previously installed on known dangerous locations, such as site 85, as shown in Figure 61. By implementing this in other concerning stretches, it will guide road users up to and through a hazardous blind spot. Drivers will be able to see a change in elevation at night in addition to a sudden turn on the road. Reflective road tags are a recommended countermeasure to reduce accidents.

Figure 61. Reflective road tag on Stretch 85 on B1

Guided signage and warning signs are highly recommended for these site-specific blind spots. The purpose of this type of signage is to alert drivers as soon as possible when a blind spot is approaching. Guided signs, Figure 62a, are installed right along the turn to guide the road users along the entirety of the turn with the goal to keep them on the road. Warning signs, figure 62b, are displayed to indicate to drivers when a hazard is approaching. Prior to a change in elevation or curve is where the team recommends this signage to be used. For large occurrence of night accidents, the team recommends this signage to be reflective. This is similar to the reflective road tags due to the signs being able to reflect the headlights; this will establish a more effective warning sign due to it being more visible.

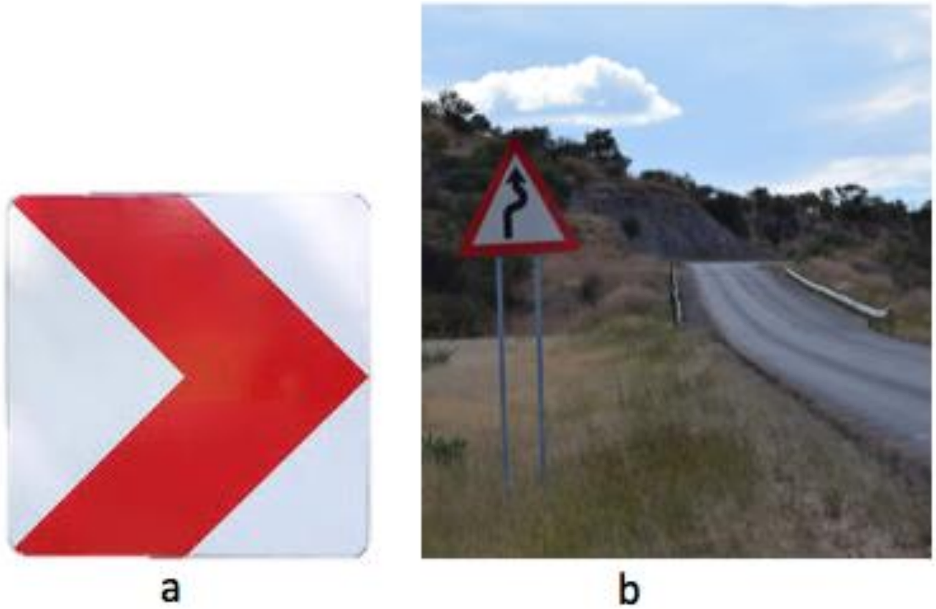


Figure 62. Example of (a) Guided Signage and (b) Warning Signage.

4.5.1.3 Road Width Countermeasures

Shoulders along B1 and B2 have a range of different widths and heights. The team also witnessed a difference of materials, such as gravel, earth, and paved shoulders, in addition to no shoulders. Out of all the stretches visited, four of them stood out with the lack of room beyond the painted line, which were stretches 43 on B2, as well as 22 and 85 on B1. The team recommends that the current effective countermeasures should additionally be used on these sites where it lacks.

On site visits, the team photographed stretch 9, where there is a **wide shoulder**. The extra space, shown in Figure 63, allows slower vehicles to move over to the side when overtaking occurs. In addition, larger trucks could comfortably move over when traveling and not be concerned about touching the centerline. The team advises implementing this shoulder size for the selected sections.

Figure 63. Expanded Roadway on Stretch 9

The dangers of a drop off shoulder cause a variety accident types, such as vehicle overturn. These drop offs are easily preventable and countermeasures are already being implemented along B1 and B2. The team advises that the selected stretches additionally get treated with the similar interventions. The issues were addressed with **pavement and tar being on the drop off to taper off the road**, such as on stretch 94, as shown in Figure 64.

Figure 64. A Paved Drop-off on Stretch 94

Also, earth was raised to the road surface level to eliminate the drop off all together. The team believes these countermeasures will reduce the number vehicles running off the road and being unable to return back safely.

4.5.1.4 Speeding Countermeasures

Speeding is the human behavior of deciding to travel at a rate above what is considered to be legal. The team witnessed multiple vehicles driving above the posted speed limit. Speeding puts the driver, passengers, pedestrians and other road users at risk. The team determined that stretch-specific interventions would be the first step to protect road users from reckless driving. However, the team concluded that long-term recommendations would more effectively reduce speeding related accidents.

If no speeding sign is posted then 120 km/hr is assumed to be the speeding limit. This is the national speed limit. However, drivers travel well above this speed putting them at risk. Therefore, the team recommends **that all the top stretches the speed limit should be reduced to 100 km/hr**. The team does not expect this countermeasure to stop speeding all together, but it will alert drivers that the area is hazardous.

Also, the team recommends that **intelligent transportation system (ITS)** be implemented on the stretches of most concern. The team witnessed the Roads Authority's "Speed Flasher" in progress. The data as well as the site evaluations validated that these specific ITS caused drivers to reduce their speeds around it. Thus, by implementing these systems, such as the speed flashers, along with the lower posted legal speed limit on these stretches will cause drivers to reduce their speed in fear of possibly being ticketed.

4.5.2 Long-Term Recommendations

The team determined that stretch-specific recommendations will improve the roadways on those stretches, but there are many other reported accidents that are preventable. Long-term recommendations were made in regards to the B1 and B2 as a whole. The team believes that these interventions will reduce the overall the accident rate and decrease the road fatalities.

An observation the team made from the site visits is the **presence of the Namibian Police** on B1 and B2. Besides the occasional officer driving out of the city station, the team passed one officer on duty. There was noticeably a decrease in speed around the officer. With this, the team advises that with an increase of police presence on B1 and B2. Road users will be increasingly more cautious in the fear of receiving a speeding ticket.

The speeding ticketing procedure in Namibia only has a maximum ticketing price of NAD $4000 with the driver receiving no penalties on their insurance or license. Thus, the team recommends that a **points system** be implemented in Namibia. This demerit point system will cause strikes to be added to a driver's license every time a police officer catches them performing bad road behavior such as speeding or drunk driving. If the driver accumulates a certain amount of points their license may be taken away. However, there are multiple levels of punishment due to this demerit point system. The team recommends that the Namibian Police Force research more about the demerit point systems, specifically the one being implemented by South Africa. By implementing a demerit points system in Namibia it will cause more road users to drive cautiously due to the potential punishments they could receive for bad road behavior.

5.0 Conclusions and Recommendations

The team successfully completed the project by accomplishing all the objectives. We analyzed the road accident data and the traffic volume data to identify the most hazardous highway sections then identified the most hazardous 5 km road stretches. Moreover, we created GIS maps of road accidents and traffic volumes, respectively. We indicated the road accidents with the severity levels and traffic volumes with traffic levels. We analyzed several factors that that could potentially trigger accidents, and from those analyses the team identified four common causes of accidents by performing data analysis and site evaluations. Finally, we proposed stretch-specific recommendations to reduce road accidents on the most hazardous 5 km road stretches.

In addition to accomplishing the main objectives, the team also created two tutorials, which contain detailed guidelines on how to perform data analysis and GIS mapping. The tutorial on data analysis mainly covered the organization of data using Microsoft Excel and the section-based analysis of accident severities using different parameters such as *AASI*, *TASI*, and *AMVKT*. The tutorial on GIS mapping provided instructions on how to use the basic functions of the program, ArcGIS, to pinpoint and color-code accidents. These tutorials, along with the report, will be distributed through the MVA Fund and to the other stakeholders, such as the RA, NRSC, and NAMPOL, to establish a framework of conducting route-based assessment projects in the future.

Moreover, besides the recommendations that the team proposed to improve road safety in Section 4.5, we would like to make suggestions on improving the quality of data collection. The preliminary road accident data that the team received from NRSC was transferred directly from police reports. However, many of the police reports do not contain valid location information such as the direction and kilometers outside of town, which establishes challenges in locating the accidents. Lack of such information caused a number of accident records to be disregarded from the analysis. Therefore, the team advises that Namibian Police Force strive to train the officers to fill out the Road Accident Forms to their entirety. This will allow the road accident data on future years to be more accurate due to the fact that a higher percentage of the data can be used.

Due to the time constraint of the project, the team was not able to perform extensive analysis of all aspects of road accidents. However, we would like to suggest several directions which future work could focus on, specific examples of correlations future teams could work on can be seen in Section 4.5.5. However, some correlations that can be done that we did not have the data for but would be important information would be to analyze the relationship between different age groups and speeding. Determining such correlations will assist the researchers to analyze the causes of accidents in more depth and propose more targeted countermeasures. Future work can also focus on analyzing the highway sections with low number of accidents and low severities to determine the positive influences on road safety. In addition, a feasibility study and cost analysis can be conducted to examine the cost-effectiveness of implementing the proposed countermeasures, which can assist the researchers in identifying the most appropriate methods of reducing road accidents in Namibia.

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Appendix A - Blank Road Accident Form

Figure A-1. Blank Namibian Road Accident Form

Namibia Road Accident Form

Form ___ of ___

Identification Codes

AR Code	N N N N / M M / Y Y Y Y
CR No.	

Date & Time of Accident

Date of Accident (DD/MM/YYYY)	D D M M Y Y Y Y
Time of Accident (HH:MM - 24hrs)	h

Magisterial District	
Police Station	

Accident Location

Built-Up Area? Y N — Street/Road/Road No.

Town/City

At intersection with (street/road name/road number)		N E S W
Or between (street/road name/road number)		N E S W
and (street/road name/road number)		N E S W
Suburb (If in City or Town)		
City / Town Name		

Outside Town / City

At Intersection with (road name/road number)	
Or approximately	km measured N E S W from Road/City/Town
Information on Km Marker: Road no/ Section	km
Between (City/Town/Road	and (Next City/Town/Road
GPS X Co-ordinate	GPS Y Co-ordinate

Number of

Vehicles — Fatalities — Seriously Injured — Slightly Injured — Not Injured — Vehicle Damage Only Y N

Road Environment

Speed on Road ___ km/h

Junction Type

Cross Roads	Level Crossing	Not a junction	On Ramp	Off Ramp
T-Junction	Y-Junction	Slipway	Circle	Mini-roundabout
	Staggered Junction	Other ______		

Road Type	Dual carriage way	Single carriage way	One way	Other ______				
Weather	Overcast	Rain	Mist/Fog	Hail	Clear	Unknown	Severe Wind	Y N
Visibility	Clear	Dust	Fire/Smoke	Unknown				
Light Condition	Daylight	Night Street Lights	Night: Unlit	Dawn/Dusk				
Road Surface	Dry	Wet	Wet in areas	Salt	Loose Dirt/Sand	Slippery	Water standing/running	Other ______
Road Surface Type	Concrete	Tarmac	Gravel	Dirt/Sand	Salt	Other ______		
Road Surface Quality	Good	Bumpy	Pothole	Cracks	Corrugated	Other ______		
Road Mark Type	No overtaking/crossing line	Channelising line	Dividing line	Painted island				
Road Mark Condition	N/A	Unknown	Good	Not good				
Road Direction	Straight	Curving	Sharp Curve					
Road	Flat	Sloped						
Traffic Control Type	Traffic Light	Stop Sign	Yield Sign	Officer	Officer + Traffic Light			
	Uncontrolled	Not junction/crossing	All traffic lights out of order	Some Traffic Lights Out of Order				
	Flashing Traffic Lights	Boom/Gate	Pedestrian Crossing	Point Duty	Scholar Patrol	Flag Signals	Speed Hump	
Road Signs Clearly Visible	Y	N	N/A					
Condition of road signs	Good	Poor	Damaged/missing	N/A				
Obstructions	Accident site	Roadworks	Roadblock	None	Other ______			

Form | of

Vehicle Information

Vehicle Reference A or		Vehicle Reference B or
	Number Plate No.	
	Chassis Number	
	Color	
	Make e.g BMW	
	Series e.g. 3 Series	
	Vehicle Model e.g. 328i	
	Licence Disk No.	
Year Model		Year Model
Y N	Licence Valid?	Y N
Spillage? Y N / Gas Emission? Y N / Y N	Dangerous Goods?	Y N / Gas Emission? Y N / Spillage? Y N
	Breakdown Company	
	Breakdown RegNo	
	No.Passengers (excl Driver)	
Length of Skid Marks (m) / Y N Unknown	Tyre Appears to Have Burst	Y N Unknown / Length of Skid Marks (m)

Vehicle Type

Write vehicle reference (A,B,C etc.) in the blocks

Passenger Vehicles	Goods Vehicle	Motor Cycles	Other Vehicles
Motor car/station wagon	Light delivery vehicle	125cc and Under	Bicycle
Sedan Taxi	Panelvan	Above 125cc	Mobile Equipment
Minibus	GVM>3500kg	Tri-cycle	Caravan/Trailer
Minibus Taxi	Truck Articulated	Quadru-cycle	Tractor
Midibus	Truck Articulated Multiple		Animal Drawn Vehicle
Bus			Other__________________

Position of Vehicle Before Accident — Write vehicle reference (A,B,C etc.) in the blocks

Correct road lane | Wrong road lane | Wrong side of road | Road Shoulder | On-road parking bay | Off-road parking bay

What Was Driver/s Doing

Write vehicle reference (A,B,C etc.) in the blocks

Turning Right	Turning Left	U-Turn	Enter traffic flow	Merging
Diverging	Overtaking (R)	Overtaking (L)	Travelling straight	Reversing
Sudden Start	Sudden Stop	Busy Parking	Changing lane	Swerving
Slowing Down	Avoiding Object	Stationary e.g.waiting	Parked	Other_________

Accident Type

Only one Accident Type per Accident should be specified. Tick the appropriate box

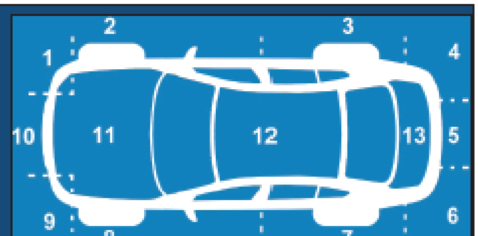
Head/rear end	Head on	Sideswipe opposite directions	Sideswipe same direction
Turn right in face of incoming traffic	Approach at angle-both travelling straight	Approach at angle-one or both turning	With fixed object (Specify)____________
Single vehicle overturned	With pedestrian	With train	Other (Specify)__________________
With animal Specify________	With Bird	With Stones	Passenger Fell off Car
Went off road without rolling			

Vehicle Damage

Write vehicle reference (A,B,C etc.) in the blocks

1. Right front	8. Left mid-front	15. Caught Fire
2. Right mid-front	9. Left front	16. Rolled
3. Right mid-back	10. Front center	17. Damage (undercarriage)
4. Back right	11. Bonnet	18. Damage (no detail)
5. Back center	12. Roof	19. Windscreen/windows
6. Back left	13. Boot	20. No damage
7. Left mid-back	14. Multiple	

Y N Damage to Public Property? Specify_____________________



Form | of

Persons Involved (Person Reference P1 or)		Persons Involved (Person Reference P2 or)
	Name / Surname	
	Phone Number at Home	
	Phone Number at Work	
	Cell Phone Number	

Person is (Tick appropriate box/es)

Person P1	Person P2
Driver	Driver
Passenger	Passenger
Pedestrian	Pedestrian
Cyclist	Cyclist
In vehicle? (Vehicle Reference e.g. A)	In vehicle? (Vehicle Reference e.g. A)
Witness	Witness
Injured	Injured

Complete this Section if ticked: Driver or Injured

P1		P2
	ID Number	
Age / Male / Female	Gender	Male / Female / Age
Y / N	Employed?	Y / N
	Nationality	
Y / N	Foreigner?	Y / N
	Residential/Home Address	
	Work Address	
No Injury / Slight / Serious / Dead	Severity of Injury	No Injury / Slight / Serious / Dead
D D M M Y Y Y Y	Date of Death	D D M M Y Y Y Y
	Ambulance Service	
	Paramedic Name/Surname	
	Paramedic ID	
	Paramedic Contact No.	
	Case Ref No. / Hospital	
Y / N	Tested for Drugs?	Y / N
Tested for Alcohol? Y / N; Y / N	Liquor/Drug Use Suspected?	Y / N; Tested for Alcohol? Y / N
	Seat/Breath Evidential Ref.No.	
Y / N	Seatbelt/Helmet Used	Y / N

Complete this Section if ticked: Driver

P1		P2
	Driving Licence Number	
A1 / A / B / C1 / C / BE / C1E / CE	Driving Licence Code	A1 / A / B / C1 / C / BE / C1E / CE
D D M M Y Y Y Y	Driving Licence Expiry	D D M M Y Y Y Y

Complete this Section if ticked: Pedestrian/Cyclist

P1		P2
Roadway / Sidewalk/Verge / Shoulder of Road / Median	Position	Roadway / Sidewalk/Verge / Shoulder of Road / Median
Not at Crossing / Within 50m of Crossing / Within marked pedestrian crossing	Location	Not at Crossing / Within 50m of Crossing / Within marked pedestrian crossing
Facing Traffic / Back To Traffic / Crossing Road	Manoeuvre	Facing Traffic / Back To Traffic / Crossing Road
Walking / Running / Standing / Playing / Sitting / Lying / Working / Jaywalking	Pedestrian Action	Walking / Running / Standing / Playing / Sitting / Lying / Working / Jaywalking
Light / Dark / Light and Dark / Reflective	Clothing	Light / Dark / Light and Dark / Reflective

Additional Witness

Additional Witness		Additional Witness
	Person Reference	
	Name / Surname	
	Phone Number at Home	
	Phone Number at Work	
	Cell Phone Number	

Description of Accident

Form ___ of ___

Description of Road User A or ___ | Description of Road User B or ___

Road User A	Road User B
Signature	Signature

Rough Sketch of Accident

In case of prosecution, a detailed sketch has to be provided. The sketch should only be the view of the Investigating Officer

OFFICIAL DETAILS

☐ Particulars have been recorded at ☐☐h☐☐

☐ A plan of the collision was available on D D M M Y Y Y Y

☐ The collision was investigated on D D M M Y Y Y Y

Recording Officer

Official No.

Rank

Investigating Officer

Official No.

Rank

Date Stamp

Signature

Extra Page for: Additional Driver Information

Persons Involved

Person Reference P1 or

Person Reference P2 or

Name / Surname
Phone Number at Home
Phone Number at Work
Cell Phone Number

ID Number
Gender — Male / Female
Age
Employed? Y N
Nationality
Foreigner? Y N
Residential/Home Address

Work Address

Severity of Injury — No Injury / Slight / Serious / Dead
Date of Death — D D M M Y Y Y Y
Ambulance Service

Paramedic Name/Surname
Paramedic ID
Paramedic Contact No.
Case Ref No. / Hospital
Tested for Drugs? Y N
Liquor/Drug Use Suspected? Y N
Tested for Alcohol? Y N
Seal/Breath Evidential Ref.No.
Seatbelt/Helmet Used Y N

Driving Licence Number
Driving Licence Code — A1 / A / B / C1 / C / BE / C1E / CE
Driving Licence Expiry — D D M M Y Y Y Y

Extra Page for: Additional Vehicle Information

Vehicle Information

Vehicle Reference A or

Vehicle Reference B or

Number Plate No.
Chassis Number
Color
Make e.g. BMW
Series e.g. 3 Series
Vehicle Model e.g. 328i
Licence Disk No.
Year Model
Licence Valid? Y N
Dangerous Goods? Y N
Spillage? Y N
Gas Emission? Y N
Breakdown Company

Breakdown Reg.No
No. Passengers (excl Driver)
Tyre Appears to Have Burst Y N Unknown
Length of Skid Marks (m)

Vehicle Type

Write vehicle reference (A,B,C etc.) in the blocks

Passenger Vehicles	Goods Vehicl	Motor Cycles	Other Vehicles
Motor car /station wagon	Light delivery vehicle	125cc and Under	Bicycle
Sedan Taxi	Panelvan	Above 125cc	Mobile Equipment
Minibus	GV M>3500kg	Tri-cycle	Caravan/Trailer
Minibus Taxi	Truck Articulated	Quadru-cycle	Tractor
Midibus	Truck Articulated Multiple		Animal Drawn Vehicle
Bus			Other ___________

Ar No.

Additional Person | Person Reference | Additional Person
Name / Surname
Phone Number at Home
Phone Number at Work
Cell Phone Number

Additional Person | Person Reference | Additional Person
Name / Surname
Phone Number at Home
Phone Number at Work
Cell Phone Number

Additional Person | Person Reference | Additional Person
Name / Surname
Phone Number at Home
Phone Number at Work
Cell Phone Number

Additional Person | Person Reference | Additional Person
Name / Surname
Phone Number at Home
Phone Number at Work
Cell Phone Number

Additional Person | Person Reference | Additional Person
Name / Surname
Phone Number at Home
Phone Number at Work
Cell Phone Number

Additional Person | Person Reference | Additional Person
Name / Surname
Phone Number at Home
Phone Number at Work
Cell Phone Number

Additional Person | Person Reference | Additional Person
Name / Surname
Phone Number at Home
Phone Number at Work
Cell Phone Number

Additional Person | Person Reference | Additional Person
Name / Surname
Phone Number at Home
Phone Number at Work
Cell Phone Number

Additional Person | Person Reference | Additional Person
Name / Surname
Phone Number at Home
Phone Number at Work
Cell Phone Number

Additional Person | Person Reference | Additional Person
Name / Surname
Phone Number at Home
Phone Number at Work
Cell Phone Number

Appendix B - Major Trunk Roads in Namibia

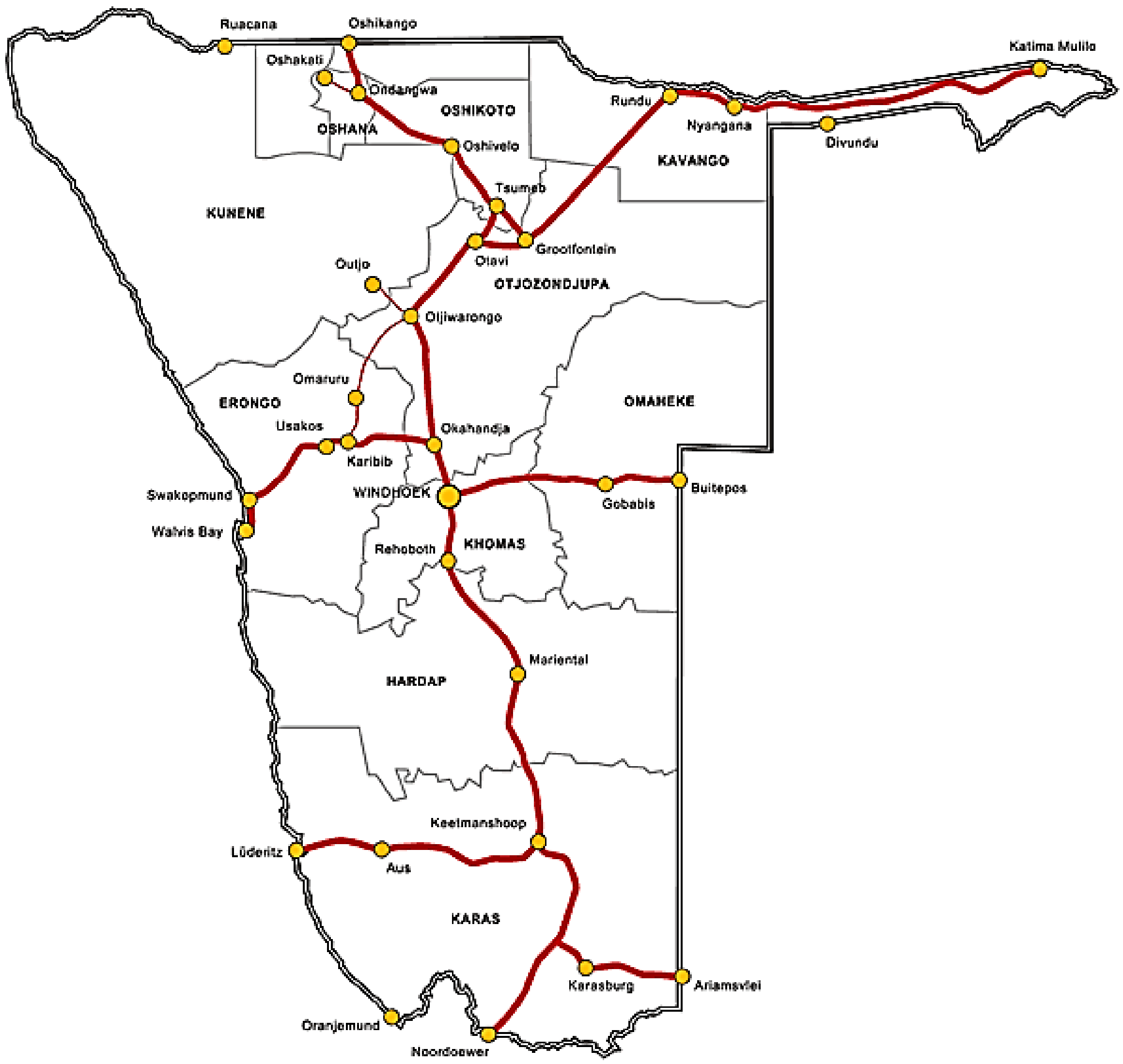


Figure B-1. Map of Major Trunk Routes in Namibia

Appendix C - Organization of Road Accident Data

ID	Date/time	Day of We	Time Of Da	Police Stati	Number of	Number of	Number of	Number of	Number of	Junction Ty	Road Type	Weather	Visibility	Light Condi	Road Surfa	Road Surfa	Road Mark	Road Direc	Flat/Sloped	Traffic Con	Road Sign (	Sign condit	Obstructio
112737	########	Wednesda	########	Okahandja	1	0	0	0	1	0	Single carri	Clear	0	Daylight	Dry	Good	0	Straight	0	Uncontroll	0	Good	None
112748	########	Thursday	########	Okahandja	1	0	0	0	1	0	Dual carria	Clear	Clear	Dawn/dusk	Dry	Good	0	Straight	Flat	0	0	0	None
112990	########	Sunday	########	Okahandja	1	0	0	0	1	0	Single carri	Rain	Clear	Daylight	Wet	Good	Dividing lin	Straight	Sloped	Uncontroll	0	0	0
113395	########	Friday	########	Okahandja	1	0	0	0	1	Not a Junct	Dual carria	Clear	Clear	Night: Unli	Dry	Good	Dividing lin	0	0	0	TRUE	Good	None
113598	########	Tuesday	########	Okahandja	2	0	0	0	2	Not a Junct	Dual carria	Clear	Clear	Daylight	Dry	Good	0	Straight	0	0	TRUE	Good	None
115065	########	Thursday	########	Katutura	1	0	0	0	0	Not a Junct	Dual carria	Clear	0	Night: Unli	Dry	Good	Dividing lin	Straight	Sloped	Uncontroll	0	N/A	0
116030	########	Monday	########	Katutura	1	0	0	0	0	On Ramp	Dual carria	Clear	Clear	Night: Unli	Dry	Good	0	0	0	Uncontroll	0	Good	None
117164	########	Monday	########	Katutura	1	0	0	0	0	Not a Junct	One way	Clear	Clear	Daylight	Dry	Good	Dividing lin	Straight	Flat	0	0	Good	None
117215	########	Saturday	########	Katutura	1	0	0	0	0	On Ramp	Single carri	Clear	Unknown	Night: Unli	Dry	Cracks	0	Straight	0	0	0	N/A	None
117261	########	Saturday	########	Katutura	1	0	0	0	0	Not a Junct	Single carri	Clear	Clear	Night: Stre	Dry	Good	0	Straight	Flat	0	0	0	0
117290	########	Saturday	########	Katutura	1	0	0	0	0	Not a Junct	Dual carria	Clear	Clear	Daylight	Dry	Good	0	0	0	0	TRUE	Good	None
117921	########	Wednesda	########	Katutura	1	0	0	0	0	Not a Junct	0	Clear	Clear	Night: Stre	Dry	Good	0	0	0	Not junctio	0	N/A	None
117925	########	Tuesday	########	Katutura	1	0	0	1	0	Not a Junct	0	Clear	Clear	Night: Unli	Dry	Good	0	Straight	Sloped	0	0	0	0
117945	########	Thursday	########	Katutura	1	0	0	0	0	Other	0	Clear	Clear	0	Dry	Good	0	Straight	0	Uncontroll	0	N/A	None
118674	########	Friday	########	Katutura	1	0	1	0	4	Not a Junct	Single carri	Clear	Clear	Daylight	Dry	Good	0	0	0	Not junctio	TRUE	Good	None
119269	########	Friday	########	Katutura	1	0	0	0	1	Not a Junct	Dual carria	0	Clear	Night: Unli	Slippery	Good	Channelisi	Straight	0	0	TRUE	0	None
119292	########	Thursday	########	Katutura	1	0	0	0	1	Not a Junct	One way	Clear	Clear	Night: Stre	Dry	Good	No overtak	Straight	Flat	Uncontroll	0	Good	None
119670	########	Saturday	########	Windhoek	1	0	0	0	0	Not a Junct	One way	Clear	Clear	Dawn/dusk	Dry	Good	Painted isl	Straight	0	0	TRUE	Good	None
119731	########	Sunday	########	Windhoek	2	0	0	1	2	T-Junction	Single carri	Rain	Clear	Daylight	Wet	Good	Dividing lin	0	Sloped	Uncontroll	0	N/A	None
119853	########	Monday	########	Windhoek	1	0	0	0	1	0	0	Clear	Dust	Night: Stre	Dry	Good	0	0	0	0	0	0	0
119873	########	Monday	########	Windhoek	2	0	0	0	3	Other	Dual carria	Clear	Clear	Daylight	Dry	Good	Dividing lin	Straight	0	Traffic Ligh	TRUE	Good	Accident si
119918	########	Monday	########	Windhoek	1	0	0	0	1	0	Dual carria	Clear	Clear	Daylight	Dry	Good	No overtak	0	0	0	0	0	0
120145	########	Tuesday	########	Windhoek	1	0	0	0	2	Not a Junct	Single carri	Clear	Clear	Night: Stre	Dry	Good	Dividing lin	0	0	Uncontroll	TRUE	Good	None
120157	########	Friday	########	Windhoek	1	0	0	0	1	Not a Junct	Single carri	Clear	Clear	Night: Unli	Dry	Good	Dividing lin	Straight	0	0	0	0	0
120209	########	Wednesda	########	Windhoek	1	0	0	0	1	Not a Junct	Single carri	Clear	Clear	Daylight	Dry	Good	Dividing lin	0	0	Uncontroll	0	N/A	None

Figure C-1. Sample Spreadsheet of Preliminary Road Accident Data Organization

Road stretch number (5 km sections)	ID	Score	Section	Total Section Severity	EAADT	ADVKT	True Score	Number of Accidents	Rank By True Score	Rank By Number of Accidents
B1										
B11	146558	10	T0106	20	7477	37385	1.465681973	2	83	32
	142056	10								
B15	145834	10	T0106	10	7477	37385	0.732840986	1	91	59
B16	139201	10	T0106	10	7477	37385	0.732840986	1	91	59
B17	144932	10	T0106	20	7477	37385	1.465681973	2	83	32
	150567	10								
B19	137225	10	T0106	140	7477	37385	10.25977381	4	27	9
	137335	10								
	142041	10								
	143614	110								
B110	145854	10	T0106	10	7477	37385	0.732840986	1	91	59
B111	145650	10	T0106	40	7477	37385	2.931363945	4	62	9
	146244	10								
	146342	10								
	146392	10								
B112	146204	10	T0106	30	7477	37385	2.198522959	3	77	20
	146294	10								
	146394	10								
B114	137698	10	T0106	10	7477	37385	0.732840986	1	91	59
B115	137976	10	T0106	130	7477	37385	9.526932822	3	28	20
	146332	10								
	146294	110								
B117	146267	40	T0107	50	2290	11450	11.96386912	2	24	32
	146410	10								
B118	142142	10	T0107	10	2290	11450	2.392773823	1	67	59
B120	146237	10	T0107	10	2290	11450	2.392773823	1	67	59
B121	146064	10	T0107	10	2290	11450	2.392773823	1	67	59
B122	146181	10	T0107	530	2290	11450	126.8170126	3	5	20
	152112	10								
	146282	510								
B123	152119	10	T0107	10	2290	11450	2.392773823	1	67	59
B124	138160	10	T0107	20	2290	11450	4.785547646	2	45	32
	146443	10								
B130	146554	10	T0107	10	2290	11450	2.392773823	1	67	59
B135	143288	10	T0107	10	2290	11450	2.392773823	1	67	59
B137	136993	10	T0107	120	2290	11450	28.71328588	2	14	32
	143088	110								
B139	142583	10	T0107	10	2290	11450	2.392773823	1	67	59
B140	142061	10	T0107	10	2290	11450	2.392773823	1	67	59
B141	142614	10	T0107	20	2290	11450	4.785547646	2	45	32
	149383	10								
B142	137076	70	T0107	310	2290	11450	74.17598851	2	7	32
	136744	240								
B143	137064	10	T0107	10	2290	11450	2.392773823	1	67	59
B146	137084	10	T0107	20	2290	11450	4.785547646	2	45	32
	149462	10								
B147	149505	10	T0107	20	2290	11450	4.785547646	1	45	59
B148	136739	10	T0107	10	2290	11450	2.392773823	1	67	59
B149	136677	10	T0107	20	2290	11450	4.785547646	2	45	32
	149832	10								
B150	137015	10	T0107	30	2290	11450	7.178321469	3	34	20
	149378	10								
	136717	10								
B152	143169	10	T0108	40	2510.833333	12554.16667	8.729296337	4	32	9
	138052	10								
	143389	10								
	149865	10								
B153	136729	10	T0108	20	2510.833333	12554.16667	4.364648168	2	53	32
	136771	10								
B154	137798	10	T0108	40	2510.833333	12554.16667	8.729296337	4	32	9
	143321	10								
	148920	10								
	137100	10								
B155	137039	10	T0108	30	2510.833333	12554.16667	6.546972253	3	39	20
	137108	10								
	143126	10								

B156	137054	10	T0108	30	2510.833333	12554.16667	6.546972253	3	39	20
	137094	10								
	143291	10								
B157	143156	10	T0108	10	2510.833333	12554.16667	2.182324084	1	78	59
B158	143239	10	T0108	10	2510.833333	12554.16667	2.182324084	1	78	59
B159	148952	10	T0108	10	2510.833333	12554.16667	2.182324084	1	78	59
B163	137033	10	T0108	50	2510.833333	12554.16667	10.91162042	2	26	32
	137060	40								
B165	148818	10	T0108	10	2510.833333	12554.16667	2.182324084	1	78	59
B167	148842	10	T0108	30	2510.833333	12554.16667	6.546972253	3	39	20
	143361	10								
	149663	10								
B171	148801	10	T0108	20	2510.833333	12554.16667	4.364648168	2	53	32
	143344	10								
B173	137756	70	T0108	70	2510.833333	12554.16667	15.27626859	1	20	59
B174	141212	10	T0108	20	2510.833333	12554.16667	4.364648168	2	53	32
	148780	10								
B175	137790	10	T0108	10	2510.833333	12554.16667	2.182324084	1	78	59
B177	142503	10	T0109	10	1610	8050	3.403386369	1	57	59
B178	148826	40	T0109	40	1610	8050	13.61354548	1	23	59
B179	130870	10	T0109	20	1610	8050	6.806772739	2	36	32
	148846	10								
B180	132898	10	T0109	10	1610	8050	3.403386369	2	57	32
	148863	10								
B181	149161	10	T0109	20	1610	8050	6.806772739	2	36	32
	148887	10								
B182	143416	10	T0109	20	1610	8050	6.806772739	2	36	32
	143763	10								
B183	148877	10	T0109	70	1610	8050	23.82370459	4	15	9
	143505	10								
	143762	10								
	143621	40								
B184	149119	10	T0109	10	1610	8050	3.403386369	1	57	59
B185	149583	10	T0109	780	1610	8050	265.4641368	5	1	5
	132840	40								
	148775	60								
	143592	140								
	143565	550								
B186	143680	10	T0109	10	1610	8050	3.403386369	1	57	59
B187	142517	10	T0109	10	1610	8050	3.403386369	1	57	59
B188	143714	10	T0110	450	1183.75	5918.75	208.3001837	4	2	9
	143683	40								
	143739	360								
	143469	40								
B189	143788	10	T0110	30	1183.75	5918.75	13.88667891	3	21	20
	143766	10								
	149306	10								
B190	143421	10	T0110	90	1183.75	5918.75	41.66003674	4	11	9
	143737	10								
	143746	10								
	143644	60								
B191	143776	10	T0110	130	1183.75	5918.75	60.17560863	7	9	3
	143612	10								
	143673	10								
	149407	10								
	143781	10								
	149209	40								
	143580	40								
B192	143790	10	T0110	50	1183.75	5918.75	23.14446486	2	16	32
	143432	40								
B193	143453	10	T0110	20	1183.75	5918.75	9.257785943	2	29	32
	143730	10								

B194	143760	10	T0110	440	1183.75	5918.75	203.6712907	9	3	2
	143757	10								
	143428	10								
	143439	10								
	143446	10								
	143448	10								
	143608	10								
	143667	10								
	149381	360								
B195	143524	10	T0110	10	1183.75	5918.75	4.628892971	1	50	59
B196	143609	140	T0110	180	1183.75	5918.75	83.32007348	2	6	32
	143746	40								
B197	1473611	10	T0110	20	1183.75	5918.75	9.257785943	2	29	32
	143454	10								
B198	134451	10	T0110	30	1183.75	5918.75	13.88667891	3	21	20
	143021	10								
	143095	10								
B199	143643	10	T0110	40	1183.75	5918.75	18.51557189	4	18	9
	143577	10								
	143626	10								
	143636	10								
B1100	143627	10	T0110	150	1183.75	5918.75	69.43339457	6	8	4
	143479	10								
	143491	10								
	143622	10								
	149180	10								
	143620	100								
B1101	143630	10	T0110	10	1183.75	5918.75	4.628892971	1	50	59
B1102	143581	10	T0110	20	1183.75	5918.75	9.257785943	2	29	32
	143603	10								
B1103	143112	60	T0110	430	1183.75	5918.75	199.0423978	3	4	20
	143535	150								
	149239	220								
B1104	143072	10	T0110	40	1183.75	5918.75	18.51557189	4	18	9
	143501	10								
	143513	10								
	143553	10								
B1105	143571	10	T0110	120	1183.75	5918.75	55.54671566	4	10	9
	143004	10								
	143671	10								
	143451	90								
B1106	143582	10	T0110	10	1183.75	5918.75	4.628892971	1	50	59
B1107	143528	10	T0111	80	3920	19600	11.18255521	5	25	5
	143039	10								
	143569	10								
	143618	10								
	149219	40								
B1108	134492	10	T0111	30	3920	19600	4.193458205	3	56	20
	143012	10								
	143068	10								
B1109	134499	10	T0111	20	3920	19600	2.795638803	2	63	32
	143648	10								
B1110	134435	10	T0111	140	3920	19600	19.56947162	5	17	5
	135614	10								
	143030	10								
	143035	10								
	143506	100								
B1111	143002	10	T0111	20	3920	19600	2.795638803	2	63	32
	143654	10								

B1112	134412	10	T0111	230	3920	19600	32.14984624	13	13	1
	143471	10								
	143523	10								
	143528	10								
	143530	10								
	143544	10								
	143551	10								
	143573	10								
	143576	10								
	149207	10								
	143623	10								
	143662	10								
	143589	110								
B1113	143511	10	T0111	10	3920	19600	1.397819402	1	85	59
B1114	134487	10	T0111	50	3920	19600	6.989097009	5	35	5
	143054	10								
	143599	10								
	143641	10								
	143639	10								
B1115	138299	10	T0111	20	3920	19600	2.795638803	2	63	32
	143555	10								
B1116	134427	10	T0111	40	3920	19600	5.591277607	4	43	9
	143591	10								
	143489	10								
	143686	10								
B1118	143058	40	T0111	40	3920	19600	5.591277607	1	43	59
B1129	144740	10	T0111	10	3920	19600	1.397819402	1	85	59
B1131	137902	10	T0111	10	3920	19600	1.397819402	1	85	59
B1133	137883	10	T0111	20	3920	19600	2.795638803	2	63	32
	138754	10								
B1138	144375	10	T0112	10	4617.5	23087.5	1.186670721	1	88	59
B1139	144327	10	T0112	280	4617.5	23087.5	33.22678019	3	12	20
	136915	10								
	138075	260								
B1140	144379	10	T0112	10	4617.5	23087.5	1.186670721	1	88	59
B1141	144738	10	T0112	50	4617.5	23087.5	5.933353606	2	42	32
	144779	40								
B1144	144370	10	T0112	10	4617.5	23087.5	1.186670721	1	88	59

B2										
Road stretch number (5 km sections)	ID	Score	Section	Total Section Severity	EAADT	ADVKT	True Score	Number of Accidents	Rank By True Score	Rank By Number of Accidents
B22	146386	10	T0701	10	2605.294118	13026.47059	2.103199028	1	21	59
B24	146334	10	T0701	10	2605.294118	13026.47059	2.103199028	1	21	59
B25	146422	10	T0701	50	2605.294118	13026.47059	10.51599514	2	6	32
	146412	40								
B26	152029	40	T0701	40	2605.294118	13026.47059	8.41279611	1	8	59
B28	146174	10	T0701	20	2605.294118	13026.47059	4.206398055	2	11	32
	151965	10								
B29	146341	10	T0701	70	2605.294118	13026.47059	14.72239319	2	3	32
	146348	60								
B210	137850	10	T0701	10	2605.294118	13026.47059	2.103199028	1	21	59
B217	148332	10	T0701	20	2605.294118	13026.47059	4.206398055	2	11	32
	151487	10								
B219	139376	10	T0701	20	2605.294118	13026.47059	4.206398055	2	11	32
	139597	10								
B220	148181	10	T0701	210	2605.294118	13026.47059	44.16717958	3	1	20
	151492	90								
	139372	110								
B223	139575	60	T0701	60	2605.294118	13026.47059	12.61919417	1	4	59
B224	136958	10	T0701	20	2605.294118	13026.47059	4.206398055	2	11	32
	137001	10								
B226	154488	10	T0701	60	2605.294118	13026.47059	12.61919417	3	4	20
	134777	10								
	134744	40								
B228	139401	10	T0202	10	3000	15000	1.826484018	1	24	59
B230	134654	40	T0202	40	3000	15000	7.305936073	1	9	59
B231	139901	10	T0202	20	3000	15000	3.652968037	2	16	32
	139921	10								
B232	134732	10	T0202	20	3000	15000	3.652968037	2	16	32
	134044	10								
B233	134692	10	T0202	10	3000	15000	1.826484018	1	24	59
B234	134669	10	T0202	10	3000	15000	1.826484018	1	24	59
B236	132047	10	T0202	10	3000	15000	1.826484018	1	24	59
B237	132217	10	T0202	20	3000	15000	3.652968037	2	16	32
	134705	10								
B238	148128	10	T0202	20	3000	15000	3.652968037	2	16	32
	148188	10								
B239	148480	10	T0202	10	3000	15000	1.826484018	1	24	59
B243	141929	10	T0202	120	3000	15000	21.91780822	4	2	9
	142356	10								
	141994	10								
	140103	90								
B245	142384	10	T0202	10	3000	15000	1.826484018	1	24	59
B246	141791	10	T0202	10	3000	15000	1.826484018	1	24	59
B249	139704	10	T0202	20	3000	15000	3.652968037	2	16	32
	141767	10								
B250	148223	10	T0202	10	3000	15000	1.826484018	1	24	59
B251	142339	10	T0202	10	3000	15000	1.826484018	1	24	59
B253	142350	10	T0202	10	3000	15000	1.826484018	1	24	59
B255	139647	10	T0202	10	3000	15000	1.826484018	1	24	59
B256	151433	10	T0201	10	5958	29790	0.919679768	1	35	59
B257	136342	10	T0201	60	5958	29790	5.518078605	3	10	20
	151276	10								
	151390	40								
B262	137175	40	T0201	40	5958	29790	3.67871907	1	15	59
B263	140248	110	T0201	110	5958	29790	10.11647744	1	7	59

Figure C-2. Spreadsheets of Data for 5 km Road Stretches

Route	Police Stations:	Section	Subsection	Start - End KM		Length (km)	EAADT	DVKT	Ranking
				Start	End				
B1	**Windhoek - Okahandja**	**T0106**		**3.33**	**77.80**	**74.47**	**7477**	**556832.5**	**High**
B1			T0106A	3.33	9.10	5.73	11620	66582.6	High
B1			T0106B	9.10	9.20	0.15	11620	1743.0	High
B1			T0106C	9.20	15.90	6.74	5350	36059.0	High
B1			T0106D	15.90	20.40	4.42	5140	22718.8	High
B1			T0106E	20.40	25.20	4.80	5140	24672.0	High
B1			T0106F	25.20	26.90	1.78	10290	18316.2	High
B1			T0106G	26.90	31.30	4.33	7600	32908.0	High
B1			T0106H	31.30	39.00	7.68	6285	48268.8	High
B1			T0106I	39.00	45.80	6.83	6285	42926.6	High
B1			T0106J	45.80	76.00	30.22	6300	190386.0	High
B1			T0106K	76.00	77.80	1.74	6620	11518.8	High
B1	**Okahandja - Otjiwarongo**	**T0107**		**1.9**	**176.5**	**174.60**	**2290**	**399,834.00**	**High**
B1			T0107A	1.9	3	1.07	1610	1,722.70	High
B1			T0107B	3	3.3	0.31	1610	499.10	High
B1			T0107C	3.3	10.2	6.89	2545	17,535.05	High
B1			T0107D	10.2	32.7	22.53	2445	55,085.85	High
B1			T0107E	32.7	48.1	15.39	2415	37,166.85	High
B1			T0107F	48.1	55.8	7.67	2325	17,832.75	High
B1			T0107G	55.8	67.3	11.49	2315	26,599.35	High
B1			T0107H	67.3	82.2	14.93	2315	34,562.95	High
B1			T0107I	82.2	92.9	10.68	2315	24,724.20	High
B1			T0107J	92.9	112	19.18	2315	44,401.70	High
B1			T0107K	112	148	35.92	2325	83,514.00	High
B1			T0107L	148	174.7	26.69	2785	74,331.65	High
B1			T0107M	174.7	176.5	1.85	2450	4,532.50	High
B1	**Otjiwarongo - Otavi**	**T0108**		**0**	**117.8**	**117.80**	**2510.833333**	**295,776.17**	**High**
B1			T0108A	0	0.8	0.84	2690	2,259.60	High
B1			T0108B	0.8	1	0.17	2610	443.70	High
B1			T0108C	1	4.2	3.23	2575	8,317.25	High
B1			T0108D	4.2	27.3	23.01	2545	58,560.45	High
B1			T0108E	27.3	39.2	11.95	2535	30,293.25	High
B1			T0108F	39.2	46.7	7.48	2475	18,513.00	High
B1			T0108G	46.7	51.5	4.81	2505	12,049.05	High
B1			T0108H	51.5	66.3	14.80	2455	36,334.00	High
B1			T0108I	66.3	71.6	5.29	2435	12,881.15	High
B1			T0108J	71.6	85.2	13.62	2435	33,164.70	High
B1			T0108K	85.2	98.4	13.24	2435	32,239.40	High
B1			T0108L	98.4	117.8	19.31	2435	47,019.85	High

B1	**Otavi - Tsumeb**	**T0109**		**0**	**61.3**	**61.30**	**1610**	**98,693.00**	**High**
B1			T0109A	0	24.3	24.27	1840	44,656.80	High
B1			T0109B	24.3	33.6	9.38	1840	17,259.20	High
B1			T0109C	33.6	60.7	27.02	1840	49,716.80	High
B1			T0109D	60.7	61.3	0.64	920	588.80	High
B1	**Tsumeb - Oshivelo**	**T0110**		**0**	**95**	**95.00**	**1183.75**	**112,456.25**	**High**
B1			T0110A	0	6.5	6.55	850	5,567.50	High
B1			T0110B	6.5	10	3.43	1300	4,459.00	High
B1			T0110C	10	25.7	15.73	1280	20,134.40	High
B1			T0110D	25.7	39.4	13.73	1280	17,574.40	High
B1			T0110E	39.4	61.1	21.70	1280	27,776.00	High
B1			T0110F	61.1	75.6	14.49	1280	18,547.20	High
B1			T0110G	75.6	84.1	8.48	1100	9,328.00	High
B1			T0110H	84.1	95	10.84	1100	11,924.00	High
B1	**Oshivelo - Omuthiya - Onankali - Ondangwa**	**T0111**		**0**	**155.1**	**155.10**	**3920**	**607,992.00**	High
B1			T0111A	0	12.7	12.71	2170	27,580.70	High
B1			T0111B	12.7	18.1	5.36	2170	11,631.20	High
B1			T0111C	18.1	65.4	47.35	2170	102,749.50	High
B1			T0111D	65.4	71.5	6.07	2170	13,171.90	High
B1			T0111E	71.5	75.2	3.66	2170	7,942.20	High
B1			T0111F	75.2	95.5	20.36	2170	44,181.20	High
B1			T0111G	95.5	111.2	15.66	3770	59,038.20	High
B1			T0111H	111.2	132.5	21.37	3270	69,879.90	High
B1			T0111I	132.5	141.3	8.75	3370	29,487.50	High
B1			T0111J	141.3	146.5	5.17	3470	17,939.90	High
B1			T0111K	146.5	147.3	0.84	5500	4,620.00	High
B1			T0111L	147.3	150.5	3.16	8800	27,808.00	High
B1			T0111M	150.5	150.8	0.38	8800	3,344.00	High
B1			T0111N	150.8	151.6	0.80	4400	3,520.00	High
B1			T0111O	151.6	155.1	3.44	4400	15,136.00	High
B1	**Ondangwa - Engela - Oshikango**	**T0112**		**0**	**60**	**60.00**	**4617.5**	**277,050.00**	**High**
B1			T0112A	0	24.9	24.89	3310	82,385.90	High
B1			T0112B	24.9	28	3.12	3310	10,327.20	High
B1			T0112C	28	30.8	2.82	3310	9,334.20	High
B1			T0112D	30.8	31.3	0.46	3310	1,522.60	High
B1			T0112E	31.3	34.7	3.44	3540	12,177.60	High
B1			T0112F	34.7	38.8	4.09	3540	14,478.60	High
B1			T0112G	38.8	44	5.20	3650	18,980.00	High
B1			T0112H	44	45.3	1.30	3670	4,771.00	High
B1			T0112I	45.3	51	5.67	3670	20,808.90	High
B1			T0112J	51	53.8	2.78	3670	10,202.60	High
B1			T0112K	53.8	57.5	3.70	9980	36,926.00	High
B1			T0112L	57.5	60	2.56	10450	26,752.00	High

B2	**Okahandja - Usakos**	**T0701**		**0**	**146.2**	**146.20**	**2605.294118**	**380,894.00**	**High**
B2			T0701A	0	0.3	0.33	4170	1,376.10	High
B2			T0701B	0.3	1.9	1.53	3980	6,089.40	High
B2			T0701C	1.9	3.2	1.35	3980	5,373.00	High
B2			T0701D	3.2	3.7	0.47	3980	1,870.60	High
B2			T0701E	3.7	4.9	1.25	3980	4,975.00	High
B2			T0701F	4.9	5.7	0.81	2520	2,041.20	High
B2			T0701G	5.7	38.2	32.49	1880	61,081.20	High
B2			T0701H	38.2	46	7.78	1860	14,470.80	High
B2			T0701I	46	51.3	5.32	1850	9,842.00	High
B2			T0701J	51.3	64.4	13.03	1850	24,105.50	High
B2			T0701K	64.4	65.6	1.28	1810	2,316.80	High
B2			T0701L	65.6	90.4	24.74	1730	42,800.20	High
B2			T0701M	90.4	112.9	22.51	1730	38,942.30	High
B2			T0701N	112.9	116	3.18	2720	8,649.60	High
B2			T0701O	116	144.9	28.90	2500	72,250.00	High
B2			T0701P	144.9	145.7	0.73	2500	1,825.00	High
B2			T0701Q	145.7	146.2	0.50	1250	625.00	High
B2	**Usakos - Swakopmund**	**T0202**		**-1.7**	**144**	**145.70**	**3000**	**437,100.00**	**High**
B2			T0202A	-1.7	-0.7	0.99	5750	5,692.50	High
B2			T0202B	-0.7	0	0.69	5750	3,967.50	High
B2			T0202C	0	4.7	4.97	3400	16,898.00	High
B2			T0202D	4.7	5.5	0.83	3200	2,656.00	High
B2			T0202E	5.5	9.9	4.39	2890	12,687.10	High
B2			T0202F	9.9	38	28.11	2635	74,069.85	High
B2			T0202G	38	54.9	16.89	2635	44,505.15	High
B2			T0202H	54.9	55.3	0.42	2250	945.00	High
B2			T0202I	55.3	67.9	12.61	2250	28,372.50	High
B2			T0202J	67.9	120.1	52.18	2250	117,405.00	High
B2			T0202K	120.1	143.5	23.40	2360	55,224.00	High
B2			T0202L	143.5	143.8	0.32	1180	377.60	High
B2			T0202M	143.8	144	0.19	2450	465.50	High
B2	**Swakopmund - Walvis Bay**	**T0201**		**0**	**31.8**	**31.80**	**5958**	**189,464.40**	**High**
B2			T0201A	0	0	0.04	6250	250.00	High
B2			T0201B	0	0.9	0.87	5885	5,119.95	High
B2			T0201C	0.9	30.8	29.86	5885	175,726.10	High
B2			T0201D	30.8	31.4	0.66	5885	3,884.10	High
B2			T0201E	31.4	31.8	0.40	5885	2,354.00	High

Figure C-3. Spreadsheets for Traffic Volume Data

Appendix D - Data Organization for GIS Map

Figure D-1. Data Organization for ArcGIS Map

T0106

ID	Date/Time	Day of Week	Time of Day	Police Station	Accident Type	KM Outside of Town	Direction Outside of Town	Slight Severity	Severe Severity	Fatal Severity	Net Severity	Road Denotation	Severity Ranking
112737	2/20/2013 10:50	Wednesday	10:50	Okahandja	Other/unknown (Specify)	10	South	0	0	0	0	T0106	Low
112748	2/21/2013 6:15	Thursday	6:15	Okahandja	With animal (Specify)	25	South	0	0	0	0	T0106	Low
112990	3/3/2013 15:15	Sunday	15:15	Okahandja	With animal (Specify)	0	South	0	0	0	0	T0106	Low
113395	3/22/2013 1:30	Friday	1:30	Okahandja	With animal (Specify)	65	South	0	0	0	0	T0106	Low
113598	4/2/2013 15:50	Tuesday	15:50	Okahandja	Head/rear end	10	South	0	0	0	0	T0106	Low
115065	1/3/2013 0:00	Thursday	0:00	Katutura	Other/unknown (Specify),With animal (Specify)	10		0	0	0	0	T0106	Low
116030	1/28/2013 21:25	Monday	21:25	Katutura	With Fixed Object (Specify)	10	West	0	0	0	0	T0106	Low
117164	5/20/2013 17:00	Monday	17:00	Katutura		5		0	0	0	0	T0106	Low
117215	5/25/2013 22:30	Saturday	22:30	Katutura		35		0	0	0	0	T0106	Low
117261	5/25/2013 23:10	Saturday	23:10	Katutura	With animal (Specify)	10		0	0	0	0	T0106	Low
117290	5/18/2013 9:00	Saturday	9:00	Katutura	With Fixed Object (Specify)	16	North	0	0	0	0	T0106	Low
117921	6/26/2013 23:30	Wednesday	23:30	Katutura		15		0	0	0	0	T0106	Low
117925	2/5/2013 3:00	Tuesday	3:00	Katutura	Single vehicle overturned	10	South	30	0	0	30	T0106	Low
117945	6/27/2013 10:00	Thursday	10:00	Katutura		1		0	0	0	0	T0106	Low
118674	3/22/2013 17:00	Friday	17:00	Katutura	With pedestrian	25	West	0	50	0	50	T0106	Low
119269	9/27/2013 1:10	Friday	1:10	Katutura	Other/unknown (Specify)	30	North	0	0	0	0	T0106	Low
119292	11/14/2013 19:30	Thursday	19:30	Katutura	With pedestrian	30		0	0	0	0	T0106	Low
119670	1/12/2013 19:30	Saturday	19:30	Windhoek	With animal (Specify)	15		0	0	0	0	T0106	Low
119731	2/3/2013 16:30	Sunday	16:30	Windhoek	Head/rear end	18		30	0	0	30	T0106	Low
119853	4/1/2013 19:00	Monday	19:00	Windhoek	With animal (Specify)	15		0	0	0	0	T0106	Low
119873	4/1/2013 18:20	Monday	18:20	Windhoek	Approach at angle: both travelling straight	8	North	0	0	0	0	T0106	Low
119918	4/1/2013 17:20	Monday	17:20	Windhoek	Head/rear end	1		0	0	0	0	T0106	Low
120145	4/2/2013 22:15	Tuesday	22:15	Windhoek	With animal (Specify)	35	North	0	0	0	0	T0106	Low
120157	5/3/2013 21:15	Friday	21:15	Windhoek	Single vehicle overturned	45		0	0	0	0	T0106	Low
120209	2/6/2013 16:30	Wednesday	16:30	Windhoek	With Bird	50		0	0	0	0	T0106	Low
120474	1/11/2013 22:30	Friday	22:30	Windhoek	With animal (Specify)	20		0	0	0	0	T0106	Low
120640	4/4/2013 22:00	Thursday	22:00	Windhoek	Other/unknown (Specify)	30		0	0	0	0	T0106	Low
120688	4/4/2013 9:45	Thursday	9:45	Windhoek	With animal (Specify)	30		0	0	0	0	T0106	Low
120850	2/5/2013 17:00	Tuesday	17:00	Windhoek	With animal (Specify)	80	West	0	0	0	0	T0106	Low
120887	2/8/2013 12:30	Friday	12:30	Windhoek	Head/rear end	40		0	0	0	0	T0106	Low
120954	5/10/2013 19:20	Friday	19:20	Windhoek	With animal (Specify)	20		0	0	0	0	T0106	Low
120967	4/6/2013 21:10	Saturday	21:10	Windhoek	With animal (Specify)	40		0	0	0	0	T0106	Low
121170	10/21/2013 7:10	Monday	7:10	Windhoek	With animal (Specify)	80		0	0	0	0	T0106	Low
121209	6/8/2013 23:00	Saturday	23:00	Windhoek	With animal (Specify)	30		0	0	0	0	T0106	Low
121243	2/12/2013 17:00	Tuesday	17:00	Windhoek	With animal (Specify)	100		0	0	0	0	T0106	Low
121321	1/18/2013 9:00	Friday	9:00	Windhoek	With Fixed Object (Specify)	50		0	0	0	0	T0106	Low
121500	4/6/2013 20:00	Saturday	20:00	Windhoek	With animal (Specify)	15		0	0	0	0	T0106	Low
121513	4/8/2013 16:00	Monday	16:00	Windhoek	With animal (Specify)	10		0	0	0	0	T0106	Low
121523	6/9/2013 20:18	Sunday	20:18	Windhoek	With animal (Specify)	20		0	0	0	0	T0106	Low
121798	2/17/2013 17:45	Sunday	17:45	Windhoek	Other/unknown (Specify)	17		0	0	0	0	T0106	Low
122000	4/11/2013 6:01	Thursday	6:01	Windhoek		20		0	0	0	0	T0106	Low
122299	7/28/2013 2:00	Sunday	2:00	Katutura		7	South	60	0	0	60	T0106	Moderate
122669	2/23/2013 15:30	Saturday	15:30	Windhoek	Other/unknown (Specify)	30		0	0	0	0	T0106	Low
122700	10/20/2013 8:00	Sunday	8:00	Windhoek	Single vehicle overturned	60	North	0	0	0	0	T0106	Low
122752	4/15/2013 20:40	Monday	20:40	Windhoek	With Fixed Object (Specify)	60		0	0	0	0	T0106	Low
122794	7/1/2013 22:00	Monday	22:00	Windhoek	With animal (Specify)	10		0	0	0	0	T0106	Low
123177	4/18/2013 19:26	Thursday	19:26	Windhoek		40	North	0	0	0	0	T0106	Low
123203	5/23/2013 9:45	Thursday	9:45	Windhoek		50		0	0	0	0	T0106	Low
123251	7/3/2013 13:22	Wednesday	13:22	Windhoek	Approach at angle: both travelling straight	20		0	50	0	50	T0106	Low
123395	4/19/2013 17:30	Friday	17:30	Windhoek	With animal (Specify)	30		0	0	0	0	T0106	Low
123459	5/26/2013 19:00	Sunday	19:00	Windhoek	With Stones,With Bird	30		0	0	0	0	T0106	Low
123670	7/6/2013 21:15	Saturday	21:15	Windhoek	Other/unknown (Specify)	10		0	0	0	0	T0106	Low
123727	7/6/2013 15:50	Saturday	15:50	Windhoek	Sideswipe: same direction	20		0	0	0	0	T0106	Low
123772	4/3/2013 9:30	Wednesday	9:30	Windhoek	With animal (Specify)	140		0	0	0	0	T0106	Low
124160	4/26/2013 15:30	Friday	15:30	Windhoek		25	North	0	0	0	0	T0106	Low
124455	6/30/2013 15:30	Sunday	15:30	Windhoek	Head/rear end	30		0	0	0	0	T0106	Low
124470	9/1/2013 18:45	Sunday	18:45	Windhoek	With animal (Specify)	1		0	0	0	0	T0106	Low
124541	6/1/2013 22:00	Saturday	22:00	Windhoek		15		0	0	0	0	T0106	Low
124686	11/3/2013 19:30	Sunday	19:30	Windhoek	Other/unknown (Specify)	20	North	0	0	0	0	T0106	Low
124757	12/10/2013 21:00	Tuesday	21:00	Windhoek	Sideswipe: opposite directions	5	West	0	0	0	0	T0106	Low
124842	11/4/2013 21:05	Monday	21:05	Windhoek	With animal (Specify)	70		0	0	0	0	T0106	Low
124876	11/3/2013 22:00	Sunday	22:00	Windhoek	With animal (Specify)	20		0	0	0	0	T0106	Low
125003	4/30/2013 23:30	Tuesday	23:30	Windhoek	Other/unknown (Specify)	110		0	0	0	0	T0106	Low
125059	11/7/2013 7:30	Thursday	7:30	Windhoek	With animal (Specify)	30		0	0	0	0	T0106	Low
125241	4/28/2013 23:00	Sunday	23:00	Windhoek	With animal (Specify)	40		0	0	0	0	T0106	Low

125834	12/29/2013 21:31	Sunday	21:31	Windhoek		30		0	0	0	0	T0106	Low
125914	7/10/2013 6:00	Wednesday	6:00	Windhoek	With animal (Specify)	10		0	0	0	0	T0106	Low
125926	7/7/2013 17:00	Sunday	17:00	Windhoek	With Bird	200		0	0	0	0	T0106	Low
125945	8/19/2013 15:00	Monday	15:00	Windhoek	With animal (Specify)	40	East	0	0	0	0	T0106	Low
125973	9/30/2013 21:40	Monday	21:40	Windhoek	With animal (Specify)	18	North	0	0	0	0	T0106	Low
125986	7/10/2013 18:20	Wednesday	18:20	Windhoek	With animal (Specify)	10		0	0	0	0	T0106	Low
126110	11/29/2013 9:00	Friday	9:00	Windhoek	With Fixed Object (Specify)	20		0	0	0	0	T0106	Low
126180	7/11/2013 20:20	Thursday	20:20	Windhoek		10		0	0	0	0	T0106	Low
126322	7/12/2013 18:15	Friday	18:15	Windhoek	Head/rear end	22		0	0	0	0	T0106	Low
126407	7/12/2013 19:00	Friday	19:00	Windhoek	Single vehicle overturned	0		0	0	0	0	T0106	Low
126559	7/15/2013 8:15	Monday	8:15	Windhoek	Head/rear end	0		0	0	0	0	T0106	Low
126564	7/14/2013 21:30	Sunday	21:30	Windhoek	With Fixed Object (Specify)	40		0	0	0	0	T0106	Low
126789	11/28/2013 18:51	Thursday	18:51	Windhoek		30		0	0	0	0	T0106	Low
126882	7/23/2013 19:00	Tuesday	19:00	Windhoek	With animal (Specify)	20		0	0	0	0	T0106	Low
127047	7/25/2013 0:00	Thursday	0:00	Windhoek	Single vehicle overturned	40		0	0	0	0	T0106	Low
127142	11/11/2013 22:00	Monday	22:00	Windhoek		40		0	0	0	0	T0106	Low
127459	7/26/2013 16:30	Friday	16:30	Windhoek	Single vehicle overturned	12		0	0	0	0	T0106	Low
127510	7/27/2013 19:00	Saturday	19:00	Windhoek	Single vehicle overturned	40		0	0	0	0	T0106	Low
128874	9/30/2013 20:30	Monday	20:30	Windhoek	With animal (Specify)	5	East	0	0	0	0	T0106	Low
133508	1/31/2013 4:30	Thursday	4:30	Windhoek		40		0	0	0	0	T0106	Low

T0107

ID	Date/Time	Day of Week	Time of Day	Police Station	Accident Type	KM Outside of Town	Direction Outside of Town	Slight Severity	Severe Severity	Fatal Severity	Net Severity	Road Denotation	Severity Ranking
110803	11/21/2013 20:20	Thursday	20:20	Otjiwarongo	With animal (Specify)	15	South	0	0	0	0	T0107	Low
111166	1/15/2013 11:15	Tuesday	11:15	Otjiwarongo	Other/unknown (Specify)	32	South	0	0	0	0	T0107	Low
111276	1/23/2013 11:00	Wednesday	11:00	Otjiwarongo	Sideswipe: opposite directions	53	South	0	0	0	0	T0107	Low
111448	2/2/2013 6:00	Saturday	6:00	Otjiwarongo		120	South	0	0	0	0	T0107	Low
111605	2/6/2013 8:30	Wednesday	8:30	Otjiwarongo	With animal (Specify)	40	South	0	0	0	0	T0107	Low
112291	3/19/2013 6:00	Tuesday	6:00	Otjiwarongo	With animal (Specify)	65	South	30	0	0	30	T0107	Low
112715	2/19/2013 22:00	Tuesday	22:00	Okahandja	With animal (Specify)	2	North	0	0	0	0	T0107	Low
112765	2/24/2013 13:00	Sunday	13:00	Okahandja		13	North	30	0	0	30	T0107	Low
112867	6/13/2013 22:00	Thursday	22:00	Otjiwarongo	Head/rear end	80	South	0	0	0	0	T0107	Low
113022	6/27/2013 15:00	Thursday	15:00	Otjiwarongo	Other/unknown (Specify)	70	South	0	0	0	0	T0107	Low
113667	5/19/2013 8:00	Sunday	8:00	Otjiwarongo	With animal (Specify)	29	South	0	0	0	0	T0107	Low
113687	5/13/2013 18:30	Monday	18:30	Otjiwarongo	Single vehicle overturned	1	South	0	0	0	0	T0107	Low
114475	8/2/2013 21:00	Friday	21:00	Otjiwarongo	With animal (Specify)	33	South	0	0	0	0	T0107	Low
114503	8/22/2013 21:00	Thursday	21:00	Otjiwarongo		10	South	0	0	0	0	T0107	Low
115385	7/12/2013 20:00	Friday	20:00	Otjiwarongo		85	South	0	0	0	0	T0107	Low
115691	9/11/2013 21:30	Wednesday	21:30	Otjiwarongo	With animal (Specify)	45	South	0	0	0	0	T0107	Low
116031	9/13/2013 0:00	Friday	0:00	Otjiwarongo		40	South	0	0	0	0	T0107	Low
116536	10/11/2013 21:00	Friday	21:00	Otjiwarongo	With animal (Specify)	60	South	0	0	0	0	T0107	Low
129452	11/14/2013 19:30	Thursday	19:30	Otjiwarongo	With animal (Specify)	30	South	0	0	0	0	T0107	Low
129525	11/17/2013 20:13	Sunday	20:13	Otjiwarongo	With animal (Specify)	50	South	0	0	0	0	T0107	Low
129564	6/6/2013 13:00	Thursday	13:00	Otjiwarongo	Other/unknown (Specify)	2	South	0	0	0	0	T0107	Low
129577	11/25/2013 15:00	Monday	15:00	Otjiwarongo	Single vehicle overturned	70	South	0	0	0	0	T0107	Low
129634	11/24/2013 17:20	Sunday	17:20	Otjiwarongo	Other/unknown (Specify)	50	South	0	0	0	0	T0107	Low

T0108

ID	Date/Time	Day of Week	Time of Day	Police Station	Accident Type	KM Outside of Town	Direction Outside of Town	Slight Severity	Severe Severity	Fatal Severity	Net Severity	Road Denotation	Severity Ranking
110783	3/16/2013 15:30	Saturday	15:30	Otjiwarongo	With pedestrian	40	North	0	50	0	50	T0108	Low
110828	1/5/2013 16:30	Saturday	16:30	Otjiwarongo		40	North	0	0	0	0	T0108	Low
111151	12/12/2013 1:30	Thursday	1:30	Otjiwarongo	Sideswipe: same direction	60	North	0	0	0	0	T0108	Low
111314	1/27/2013 20:20	Sunday	20:20	Otjiwarongo	With animal (Specify)	50	North	0	0	0	0	T0108	Low
111411	1/31/2013 8:30	Thursday	8:30	Otjiwarongo	With animal (Specify)	40	North	0	0	0	0	T0108	Low
111590	2/6/2013 5:30	Wednesday	5:30	Otjiwarongo	Other/unknown (Specify)	60	North	0	0	0	0	T0108	Low
111738	2/15/2013 20:05	Friday	20:05	Otjiwarongo	With animal (Specify)	10	North	0	0	0	0	T0108	Low
111780	2/15/2013 10:00	Friday	10:00	Otjiwarongo	With animal (Specify)	80	North	0	0	0	0	T0108	Low
112744	8/18/2013 6:15	Sunday	6:15	Otavi	With animal (Specify)	15	South	0	0	0	0	T0108	Low
113196	1/11/2013 21:30	Friday	21:30	Otavi	With pedestrian	49	South	0	0	0	0	T0108	Low
114138	7/24/2013 12:30	Wednesday	12:30	Otjiwarongo	With animal (Specify)	75	North	0	0	0	0	T0108	Low
114347	7/28/2013 16:20	Sunday	16:20	Otavi	Head/rear end	5	South	0	0	0	0	T0108	Low
114599	8/11/2013 17:15	Sunday	17:15	Otjiwarongo		42	North	0	100	100	200	T0108	High
114668	8/18/2013 9:00	Sunday	9:00	Otjiwarongo		60	North	0	0	0	0	T0108	Low
114726	12/23/2013 3:40	Monday	3:40	Otavi	Sideswipe: same direction	60	South	0	0	0	0	T0108	Low
114750	12/22/2013 23:30	Sunday	23:30	Otavi	Head/rear end	25	South	0	100	0	100	T0108	Moderate
114778	8/22/2013 12:45	Thursday	12:45	Otjiwarongo	With animal (Specify)	30	North	0	0	0	0	T0108	Low
115730	9/15/2013 18:45	Sunday	18:45	Otjiwarongo		63	North	0	0	0	0	T0108	Low
115997	9/22/2013 22:05	Sunday	22:05	Otjiwarongo	With animal (Specify)	60	North	0	0	0	0	T0108	Low
116355	10/7/2013 12:15	Monday	12:15	Otjiwarongo	Single vehicle overturned	80	North	0	0	0	0	T0108	Low

116413	10/8/2013 19:52	Tuesday	19:52	Otjiwarongo	With animal (Specify)	20	North	0	0	0	0	T0108	Low
116688	10/23/2013 9:50	Wednesday	9:50	Otjiwarongo	With animal (Specify)	65	North	0	0	0	0	T0108	Low
116730	10/28/2013 6:25	Monday	6:25	Otjiwarongo	With animal (Specify)	29	North	0	0	0	0	T0108	Low
116903	10/31/2013 18:30	Thursday	18:30	Otjiwarongo	With animal (Specify)	70	North	0	0	0	0	T0108	Low
117357	12/20/2013 8:00	Friday	8:00	Otjiwarongo		5	North	0	0	0	0	T0108	Low
129226	4/20/2013 16:30	Saturday	16:30	Otjiwarongo	Other/unknown (Specify)	80	North	30	0	0	30	T0108	Low
129440	11/12/2013 18:30	Tuesday	18:30	Otjiwarongo	With animal (Specify)	40	North	0	0	0	0	T0108	Low
129454	11/9/2013 8:30	Saturday	8:30	Otjiwarongo	With animal (Specify)	20	North	0	0	0	0	T0108	Low
129455	11/16/2013 5:25	Saturday	5:25	Otjiwarongo	With animal (Specify)	20	North	0	0	0	0	T0108	Low
129478	11/8/2013 12:00	Friday	12:00	Otjiwarongo	Turn right in face of oncoming traffic	78	North	0	0	0	0	T0108	Low
129538	11/22/2013 5:46	Friday	5:46	Otjiwarongo	With animal (Specify)	30	North	0	0	0	0	T0108	Low
129581	11/4/2013 0:00	Monday	0:00	Otjiwarongo		12	North	0	0	0	0	T0108	Low
129714	9/8/2013 14:00	Sunday	14:00	Otavi	Sideswipe: opposite directions	0	South	30	0	0	30	T0108	Low

ID	Date/Time	Day of Week	Time of Day	Police Station	Accident Type	KM Outside of Town	Direction Outside of Town	Slight Severity	Severe Severity	Fatal Severity	Net Severity	Road Denotation	Severity Ranking
112622	8/2/2013 11:20	Friday	11:20	Otavi	With Fixed Object (Specify)	15	North	0	0	0	0	T0109	Low
112909	9/9/2013 7:40	Monday	7:40	Otavi	With animal (Specify)	20	North	0	0	0	0	T0109	Low
113612	10/28/2013 16:15	Monday	16:15	Otavi	Single vehicle overturned	35	North	90	0	0	90	T0109	Moderate
113678	10/11/2013 4:45	Friday	4:45	Otavi	With animal (Specify)	47	North	0	0	0	0	T0109	Low
114220	7/15/2013 21:30	Monday	21:30	Otavi	Head/rear end	60	North	0	0	0	0	T0109	Low
121050	1/11/2013 9:00	Friday	9:00	Tsumeb		10	South	0	0	0	0	T0109	Low
121210	2/10/2013 21:00	Sunday	21:00	Tsumeb		20	South	0	0	0	0	T0109	Low
121650	3/11/2013 12:00	Monday	12:00	Tsumeb		30	South	0	0	0	0	T0109	Low
121776	5/24/2013 0:55	Friday	0:55	Tsumeb	Head/rear end	10	South	0	0	0	0	T0109	Low
122396	6/9/2013 16:44	Sunday	16:44	Tsumeb		40	South	0	0	0	0	T0109	Low
122992	9/1/2013 8:15	Sunday	8:15	Tsumeb	Single vehicle overturned	15	South	0	0	0	0	T0109	Low
123039	9/10/2013 15:00	Tuesday	15:00	Tsumeb	Single vehicle overturned	50	South	0	0	0	0	T0109	Low
123109	9/16/2013 14:30	Monday	14:30	Tsumeb		25	South	0	0	0	0	T0109	Low
123272	8/7/2013 19:00	Wednesday	19:00	Tsumeb	With animal (Specify)	30	South	0	0	0	0	T0109	Low
124122	12/23/2013 8:30	Monday	8:30	Tsumeb	Head/rear end	15	South	0	0	0	0	T0109	Low
129699	3/5/2013 3:23	Tuesday	3:23	Otavi	With animal (Specify)	20	North	0	0	0	0	T0109	Low

ID	Date/Time	Day of Week	Time of Day	Police Station	Accident Type	KM Outside of Town	Direction Outside of Town	Slight Severity	Severe Severity	Fatal Severity	Net Severity	Road Denotation	Severity Ranking
110825	1/4/2013 13:01	Friday	13:01	Oshivello	Sideswipe: same direction	16	South	0	0	0	0	T0110	Low
110940	1/14/2013 7:00	Monday	7:00	Oshivello	With animal (Specify)	70	South	0	0	0	0	T0110	Low
111293	2/13/2013 12:30	Wednesday	12:30	Oshivello	Other/unknown (Specify)	10	South	0	0	0	0	T0110	Low
111348	2/20/2013 17:06	Wednesday	17:06	Oshivello	Single vehicle overturned	1	South	30	0	0	30	T0110	Low
111390	2/25/2013 8:30	Monday	8:30	Oshivello	With animal (Specify)	6	East	0	0	0	0	T0110	Low
111458	3/3/2013 8:30	Sunday	8:30	Oshivello	With animal (Specify)	23	South	0	0	0	0	T0110	Low
111489	3/7/2013 20:30	Thursday	20:30	Oshivello	With animal (Specify)	30	South	30	0	0	30	T0110	Low
111574	3/19/2013 20:05	Tuesday	20:05	Oshivello		36	South	0	0	0	0	T0110	Low
111630	3/24/2013 20:00	Sunday	20:00	Oshivello	With animal (Specify)	10	East	0	100	0	100	T0110	Moderate
111684	3/30/2013 22:19	Saturday	22:19	Oshivello	With Bird	27	South	0	0	0	0	T0110	Low
111744	4/1/2013 9:30	Monday	9:30	Oshivello	With Fixed Object (Specify)	0	East	0	0	0	0	T0110	Low
111763	4/1/2013 11:30	Monday	11:30	Oshivello	Sideswipe: opposite directions	15	South	30	0	0	30	T0110	Low
112119	4/16/2013 19:45	Tuesday	19:45	Oshivello	With animal (Specify)	35	South	0	0	0	0	T0110	Low
112180	4/23/2013 11:00	Tuesday	11:00	Oshivello	Single vehicle overturned	30	East	0	0	100	100	T0110	Moderate
112234	4/25/2013 9:15	Thursday	9:15	Oshivello	With Bird	31	South	0	0	0	0	T0110	Low
112266	4/24/2013 22:45	Wednesday	22:45	Oshivello	With animal (Specify)	24	South	0	0	0	0	T0110	Low
112277	4/25/2013 18:16	Thursday	18:16	Oshivello	With animal (Specify)	4	South	0	0	0	0	T0110	Low
112705	7/9/2013 18:15	Tuesday	18:15	Oshivello	With animal (Specify)	22	South	0	0	0	0	T0110	Low
112743	7/15/2013 16:40	Monday	16:40	Oshivello	With animal (Specify)	20	East	0	0	0	0	T0110	Low
112850	8/2/2013 12:35	Friday	12:35	Oshivello	Single vehicle overturned	81	South	0	150	200	350	T0110	High
112929	8/18/2013 18:59	Sunday	18:59	Oshivello	With animal (Specify)	20	South	0	0	0	0	T0110	Low
112976	8/20/2013 19:40	Tuesday	19:40	Oshivello	With animal (Specify)	7	South	0	0	0	0	T0110	Low
113062	8/24/2013 23:20	Saturday	23:20	Oshivello	With animal (Specify)	6	South	0	0	0	0	T0110	Low
113076	8/25/2013 20:42	Sunday	20:42	Oshivello	With animal (Specify)	10	South	0	0	0	0	T0110	Low
113182	9/14/2013 15:30	Saturday	15:30	Oshivello	Other/unknown (Specify)	45	East	30	0	0	30	T0110	Low
113205	9/19/2013 3:00	Thursday	3:00	Oshivello	With animal (Specify)	30	South	0	0	0	0	T0110	Low
113298	10/3/2013 17:59	Thursday	17:59	Oshivello	Single vehicle overturned	14	South	30	0	0	30	T0110	Low
113317	10/3/2013 19:59	Thursday	19:59	Oshivello	Single vehicle overturned	21	South	60	0	0	60	T0110	Moderate
113523	10/27/2013 4:39	Sunday	4:39	Oshivello	With animal (Specify)	10	South	30	0	0	30	T0110	Low
113604	11/8/2013 21:20	Friday	21:20	Oshivello	With animal (Specify)	10	South	0	100	0	100	T0110	Moderate
113614	11/8/2013 23:30	Friday	23:30	Oshivello	With animal (Specify)	6	South	0	0	0	0	T0110	Low
113798	12/7/2013 2:55	Saturday	2:55	Oshivello	With Fixed Object (Specify)	5	South	0	0	0	0	T0110	Low
113923	12/20/2013 4:30	Friday	4:30	Oshivello	Single vehicle overturned	54	South	30	100	0	130	T0110	High
113973	12/20/2013 18:36	Friday	18:36	Oshivello	With Bird	45	South	0	0	0	0	T0110	Low

114037	12/20/2013 20:25	Friday	20:25	Oshivello	Single vehicle overturned	1	South	0	0	0	0	T0110	Low
114062	12/23/2013 18:23	Monday	18:23	Oshivello	Head/rear end	1	South	0	0	0	0	T0110	Low
114080	12/28/2013 17:00	Saturday	17:00	Oshivello	Single vehicle overturned	49	East	30	100	0	130	T0110	High
114775	8/8/2013 19:45	Thursday	19:45	Tsumeb	With animal (Specify)	15	West	0	0	0	0	T0110	Low
121070	1/27/2013 14:00	Sunday	14:00	Tsumeb	Single vehicle overturned	40	West	60	0	0	60	T0110	Moderate
121597	1/13/2013 18:00	Sunday	18:00	Tsumeb		15	North	0	0	0	0	T0110	Low
121680	3/16/2013 20:30	Saturday	20:30	Tsumeb		27	North	0	0	0	0	T0110	Low
121979	4/11/2013 6:30	Thursday	6:30	Tsumeb	With animal (Specify)	15	North	0	0	0	0	T0110	Low
122087	5/29/2013 6:25	Wednesday	6:25	Tsumeb		110	North	0	0	0	0	T0110	Low
122348	5/27/2013 19:13	Monday	19:13	Tsumeb	With pedestrian	300	North	0	50	0	50	T0110	Low
122373	5/2/2013 14:50	Thursday	14:50	Tsumeb		40	North	0	0	0	0	T0110	Low
122425	6/15/2013 19:00	Saturday	19:00	Tsumeb		15	North	0	0	0	0	T0110	Low
122625	7/10/2013 14:25	Wednesday	14:25	Tsumeb	Head/rear end	10	North	0	0	0	0	T0110	Low
122644	7/13/2013 21:00	Saturday	21:00	Tsumeb		22	North	0	0	0	0	T0110	Low
122813	7/10/2013 14:25	Wednesday	14:25	Tsumeb	Head/rear end	10	North	0	0	0	0	T0110	Low
123081	9/1/2013 0:00	Sunday	0:00	Tsumeb		30	North	0	0	0	0	T0110	Low
123284	8/19/2013 19:45	Monday	19:45	Tsumeb		10	North	0	0	0	0	T0110	Low
123524	10/23/2013 7:30	Wednesday	7:30	Tsumeb		40	North	0	0	500	500	T0110	High

ID	Date/Time	Day of Week	Time of Day	Police Station	Accident Type	KM Outside of Town	Direction Outside of Town	Slight Severity	Severe Severity	Fatal Severity	Net Severity	Road Denotation	Severity Ranking
110843	1/5/2013 19:00	Saturday	19:00	Oshivello	Single vehicle overturned	10	North	0	0	0	0	T0111	Low
110861	1/25/2013 18:00	Friday	18:00	Ondangwa	With animal (Specify)	5	East	0	0	0	0	T0111	Low
110968	2/19/2013 19:30	Tuesday	19:30	Oshivello	With animal (Specify)	30	North	0	0	0	0	T0111	Low
111022	1/20/2013 14:00	Sunday	14:00	Oshivello	With Fixed Object (Specify)	20	North	0	0	0	0	T0111	Low
111050	1/22/2013 16:00	Tuesday	16:00	Oshivello	Sideswipe: same direction	8	North	0	0	0	0	T0111	Low
111162	2/2/2013 10:20	Saturday	10:20	Oshivello	Single vehicle overturned	40	North	0	0	0	0	T0111	Low
111199	2/7/2013 20:10	Thursday	20:10	Oshivello	With Fixed Object (Specify)	15	North	0	0	0	0	T0111	Low
111235	2/10/2013 23:30	Sunday	23:30	Oshivello	Other/unknown (Specify)	30	North	0	300	0	300	T0111	High
111369	2/22/2013 21:10	Friday	21:10	Oshivello	Head on	1	North	0	50	300	350	T0111	High
111477	3/5/2013 19:50	Tuesday	19:50	Oshivello	With animal (Specify)	34	North	0	0	0	0	T0111	Low
111507	3/10/2013 18:03	Sunday	18:03	Oshivello	Head/rear end	30	North	30	50	0	80	T0111	Moderate
111532	3/11/2013 5:45	Monday	5:45	Oshivello	With animal (Specify)	55	North	0	0	0	0	T0111	Low
111546	3/13/2013 20:10	Wednesday	20:10	Oshivello	With animal (Specify)	60	North	0	0	0	0	T0111	Low
111570	3/9/2013 7:00	Saturday	7:00	Oshivello	With Fixed Object (Specify)	40	North	30	0	0	30	T0111	Low
111609	3/22/2013 7:10	Friday	7:10	Oshivello		30	North	0	0	0	0	T0111	Low
111617	3/20/2013 17:30	Wednesday	17:30	Oshivello	With animal (Specify)	45	North	0	0	0	0	T0111	Low
111653	3/28/2013 20:43	Thursday	20:43	Oshivello	With animal (Specify)	20	North	90	0	0	90	T0111	Moderate
111673	3/28/2013 15:30	Thursday	15:30	Oshivello	With Bird	8	North	0	0	0	0	T0111	Low
111697	3/31/2013 11:25	Sunday	11:25	Oshivello	Other/unknown (Specify)	23	North	0	100	0	100	T0111	Moderate
111710	3/31/2013 5:06	Sunday	5:06	Oshivello	Other/unknown (Specify)	20	North	0	0	0	0	T0111	Low
111836	4/11/2013 21:30	Thursday	21:30	Oshivello	With animal (Specify)	2	North	0	0	0	0	T0111	Low
112138	4/17/2013 19:45	Wednesday	19:45	Oshivello	With animal (Specify)	1	North	0	0	0	0	T0111	Low
112154	4/14/2013 19:00	Sunday	19:00	Oshivello	With animal (Specify)	5	North	0	0	0	0	T0111	Low
112169	4/22/2013 15:13	Monday	15:13	Oshivello	With Bird	30	North	0	0	0	0	T0111	Low
112196	4/24/2013 9:28	Wednesday	9:28	Oshivello	Head/rear end	10	North	0	0	0	0	T0111	Low
112216	4/24/2013 20:30	Wednesday	20:30	Oshivello	With animal (Specify)	7	North	60	0	0	60	T0111	Moderate
112352	5/9/2013 7:16	Thursday	7:16	Oshivello	Single vehicle overturned	29	North	60	0	0	60	T0111	Moderate
112364	5/10/2013 22:00	Friday	22:00	Oshivello	Single vehicle overturned	12	North	30	0	0	30	T0111	Low
112406	5/24/2013 20:40	Friday	20:40	Oshivello	With animal (Specify)	47	North	30	0	0	30	T0111	Low
112439	5/28/2013 18:09	Tuesday	18:09	Oshivello	With animal (Specify)	51	North	0	100	0	100	T0111	Moderate
112450	5/31/2013 18:24	Friday	18:24	Oshivello	With animal (Specify)	12	North	90	0	0	90	T0111	Moderate
112543	6/11/2013 17:00	Tuesday	17:00	Oshivello	With Bird	5	West	0	0	0	0	T0111	Low
112611	6/25/2013 0:11	Tuesday	0:11	Oshivello	With animal (Specify)	38	North	0	0	0	0	T0111	Low
112754	7/16/2013 19:34	Tuesday	19:34	Oshivello		58	West	0	0	200	200	T0111	High
112863	8/4/2013 9:00	Sunday	9:00	Oshivello	Single vehicle overturned	45	North	0	0	0	0	T0111	Low
112875	8/5/2013 7:50	Monday	7:50	Oshivello	With Fixed Object (Specify)	36	North	0	150	0	150	T0111	High
113145	9/1/2013 21:45	Sunday	21:45	Oshivello		10	North	120	0	0	120	T0111	High
113220	9/19/2013 5:30	Thursday	5:30	Oshivello	Other/unknown (Specify)	30	North	0	0	0	0	T0111	Low
113236	9/28/2013 20:30	Saturday	20:30	Oshivello	With animal (Specify)	25	North	0	0	0	0	T0111	Low
113423	10/11/2013 5:10	Friday	5:10	Oshivello	With animal (Specify)	40	North	0	0	0	0	T0111	Low
113433	10/12/2013 20:00	Saturday	20:00	Oshivello	Head/rear end	7	North	90	50	0	140	T0111	High
113532	10/26/2013 14:23	Saturday	14:23	Oshivello	Single vehicle overturned	8	North	30	150	0	180	T0111	High
113589	11/7/2013 6:30	Thursday	6:30	Oshivello	With Fixed Object (Specify)	13	North	90	0	0	90	T0111	Moderate
113628	11/12/2013 5:02	Tuesday	5:02	Oshivello	With animal (Specify)	45	North	0	0	0	0	T0111	Low
113641	11/14/2013 5:15	Thursday	5:15	Oshivello	Sideswipe: same direction	19	North	0	0	0	0	T0111	Low
113652	11/15/2013 8:41	Friday	8:41	Oshivello	Single vehicle overturned	45	West	0	150	0	150	T0111	High
113665	11/15/2013 20:30	Friday	20:30	Oshivello	With animal (Specify)	10	North	0	0	0	0	T0111	Low

113680	11/19/2013 23:18	Tuesday	23:18	Oshivello	With animal (Specify)	10	North	0	0	0	0	T0111	Low
113704	11/22/2013 18:15	Friday	18:15	Oshivello	With animal (Specify)	8	North	30	50	0	80	T0111	Moderate
113724	11/25/2013 17:30	Monday	17:30	Oshivello	With Bird	39	North	0	0	0	0	T0111	Low
113731	11/23/2013 2:30	Saturday	2:30	Oshivello	With animal (Specify)	40	North	0	0	0	0	T0111	Low
114123	8/18/2013 9:00	Sunday	9:00	Ondangwa	Other/unknown (Specify)	3	East	0	0	0	0	T0111	Low
114240	8/23/2013 12:00	Friday	12:00	Ondangwa	With animal (Specify)	20	East	0	0	0	0	T0111	Low
114681	2/2/2013 18:30	Saturday	18:30	Ondangwa	Single vehicle overturned	60	East	0	100	0	100	T0111	Moderate
114697	9/8/2013 9:00	Sunday	9:00	Ondangwa	Single vehicle overturned	29	East	0	0	0	0	T0111	Low
115455	10/10/2013 3:00	Thursday	3:00	Ondangwa	Single vehicle overturned	3	South	60	0	0	60	T0111	Moderate
115846	11/22/2013 7:50	Friday	7:50	Ondangwa	Head/rear end	10	South	0	0	0	0	T0111	Low
116044	11/1/2013 4:00	Friday	4:00	Ondangwa	With animal (Specify)	7	South	0	0	0	0	T0111	Low
116491	12/21/2013 4:00	Saturday	4:00	Ondangwa	Single vehicle overturned	20	South	30	50	100	180	T0111	High
116717	12/11/2013 13:30	Wednesday	13:30	Ondangwa	Turn right in face of oncoming traffic	2	East	30	0	0	30	T0111	Low
128887	7/12/2013 7:20	Friday	7:20	Omuthiya		25	West	0	0	0	0	T0111	Low
128888	12/4/2013 18:00	Wednesday	18:00	Omuthiya	With animal (Specify)	5	South	0	0	0	0	T0111	Low
128894	12/7/2013 20:30	Saturday	20:30	Omuthiya	With animal (Specify)	20	West	0	0	0	0	T0111	Low
128898	12/8/2013 19:50	Sunday	19:50	Omuthiya	Head/rear end	5	West	0	50	0	50	T0111	Low
128905	7/15/2013 7:00	Monday	7:00	Omuthiya	With Fixed Object (Specify)	15	North	0	0	0	0	T0111	Low
128906	12/11/2013 19:45	Wednesday	19:45	Omuthiya	With animal (Specify)	5	East	0	0	0	0	T0111	Low
128910	9/20/2013 11:35	Friday	11:35	Omuthiya	Approach at angle: both travelling straight	8	East	0	0	0	0	T0111	Low
128920	7/25/2013 19:30	Thursday	19:30	Omuthiya	With animal (Specify)	2	East	0	0	0	0	T0111	Low
128927	12/21/2013 11:50	Saturday	11:50	Omuthiya	Head/rear end	50	West	0	0	0	0	T0111	Low
128932	8/5/2013 0:00	Monday	0:00	Omuthiya		7	East	0	0	0	0	T0111	Low
128940	8/8/2013 18:00	Thursday	18:00	Omuthiya	With animal (Specify)	30	North	0	0	0	0	T0111	Low
128941	12/26/2013 11:45	Thursday	11:45	Omuthiya	Head/rear end	15	North	0	0	0	0	T0111	Low
128944	12/27/2013 18:00	Friday	18:00	Omuthiya	Went off the road without rolling	50		0	0	0	0	T0111	Low
128951	8/12/2013 18:25	Monday	18:25	Omuthiya	With animal (Specify)	45	West	0	0	0	0	T0111	Low
128952	2/21/2013 11:08	Thursday	11:08	Omuthiya	With Fixed Object (Specify)	27	East	0	0	0	0	T0111	Low
128970	3/3/2013 14:20	Sunday	14:20	Omuthiya	With animal (Specify)	10	South	30	0	0	30	T0111	Low
128974	3/4/2013 14:10	Monday	14:10	Omuthiya	Sideswipe: same direction	4		30	0	0	30	T0111	Low
128987	8/18/2013 21:50	Sunday	21:50	Omuthiya	Head/rear end	10	East	0	0	0	0	T0111	Low
128988	11/1/2013 6:15	Friday	6:15	Omuthiya	Single vehicle overturned	15	West	0	0	0	0	T0111	Low
128998	8/20/2013 16:30	Tuesday	16:30	Omuthiya	Single vehicle overturned	4	South	0	0	0	0	T0111	Low
128999	4/28/2013 15:00	Sunday	15:00	Omuthiya		2		0	0	0	0	T0111	Low
129000	5/3/2013 19:45	Friday	19:45	Omuthiya		20		0	0	0	0	T0111	Low
129016	8/21/2013 18:15	Wednesday	18:15	Omuthiya	With animal (Specify)	20	East	0	0	0	0	T0111	Low
129028	3/28/2013 23:00	Thursday	23:00	Omuthiya		5	South	60	0	0	60	T0111	Moderate
129029	5/13/2013 18:00	Monday	18:00	Omuthiya		4		0	0	0	0	T0111	Low
129030	8/21/2013 20:30	Wednesday	20:30	Omuthiya	With animal (Specify)	4	East	0	0	0	0	T0111	Low
129031	11/1/2013 12:20	Friday	12:20	Omuthiya	Head/rear end	30	West	0	0	0	0	T0111	Low
129043	8/24/2013 19:30	Saturday	19:30	Omuthiya	With animal (Specify)	20		0	0	0	0	T0111	Low
129053	11/2/2013 21:00	Saturday	21:00	Omuthiya	With animal (Specify)	5	West	0	0	0	0	T0111	Low
129056	11/2/2013 12:00	Saturday	12:00	Omuthiya	Other/unknown (Specify)	5	South	0	0	0	0	T0111	Low
129059	8/25/2013 13:30	Sunday	13:30	Omuthiya	Head/rear end	10	South	0	0	0	0	T0111	Low
129064	5/19/2013 21:59	Sunday	21:59	Omuthiya		22		0	0	0	0	T0111	Low
129066	11/3/2013 19:03	Sunday	19:03	Omuthiya	Head/rear end	5	East	0	0	0	0	T0111	Low
129070	8/29/2013 19:10	Thursday	19:10	Omuthiya	Head/rear end	5	North	0	0	0	0	T0111	Low
129073	5/22/2013 21:30	Wednesday	21:30	Omuthiya	With animal (Specify)	25		0	0	0	0	T0111	Low
129076	5/25/2013 0:00	Saturday	0:00	Omuthiya		10		0	0	0	0	T0111	Low
129080	3/26/2013 16:54	Tuesday	16:54	Omuthiya	With animal (Specify)	40	North	0	0	0	0	T0111	Low
129086	3/31/2013 13:00	Sunday	13:00	Omuthiya	With animal (Specify)	30		0	0	0	0	T0111	Low
129090	4/6/2013 1:25	Saturday	1:25	Omuthiya	With animal (Specify)	4	West	0	0	0	0	T0111	Low
129093	5/19/2013 19:15	Sunday	19:15	Omuthiya		20		0	0	0	0	T0111	Low
129100	11/22/2013 20:30	Friday	20:30	Omuthiya	With animal (Specify)	20	West	0	0	0	0	T0111	Low
129164	4/30/2013 8:51	Tuesday	8:51	Omuthiya	Turn right in face of oncoming traffic	10	South	0	0	0	0	T0111	Low
129167	4/30/2013 8:00	Tuesday	8:00	Omuthiya	Single vehicle overturned	5	East	0	0	0	0	T0111	Low
130277	10/20/2013 21:00	Sunday	21:00	Omuthiya	With animal (Specify)	18	South	0	0	0	0	T0111	Low

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113215	5/5/2013 16:00	Sunday	16:00	Ondangwa	With Fixed Object (Specify)	1	North	30	0	0	30	T0112	Low
113315	7/3/2013 12:34	Wednesday	12:34	Ondangwa	With Fixed Object (Specify)	5	West	0	0	0	0	T0112	Low
113347	7/6/2013 21:30	Saturday	21:30	Ondangwa		20	North	0	0	100	100	T0112	Moderate
114446	8/15/2013 17:00	Thursday	17:00	Ondangwa	Head/rear end	7	North	0	0	0	0	T0112	Low
114754	9/8/2013 17:20	Sunday	17:20	Ondangwa	Single vehicle overturned	7	North	0	0	0	0	T0112	Low
115332	10/20/2013 21:00	Sunday	21:00	Ondangwa		3	West	0	0	0	0	T0112	Low
115344	10/18/2013 8:40	Friday	8:40	Ondangwa	Sideswipe: same direction	5	North	90	0	0	90	T0112	Moderate
115389	10/10/2013 20:28	Thursday	20:28	Ondangwa	Sideswipe: opposite directions	20	North	60	50	0	110	T0112	High

115577	8/16/2013 15:30	Friday	15:30	Ondangwa		10	West	30	0	0	30	T0112	Low
115648	10/1/2013 20:00	Tuesday	20:00	Ondangwa	Sideswipe: same direction	5	West	0	0	0	0	T0112	Low
116611	12/17/2013 14:00	Tuesday	14:00	Ondangwa	Approach at angle: one or both turning	5	North	270	100	0	370	T0112	High
116705	11/30/2013 14:00	Saturday	14:00	Ondangwa	Single vehicle overturned	15	North	90	50	0	140	T0112	High
129911	6/29/2013 22:30	Saturday	22:30	Ondangwa	With Fixed Object (Specify)	10	North	30	0	0	30	T0112	Low

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111445	1/24/2013 13:09	Thursday	13:09	Walvisbay	With Fixed Object (Specify)	40	North	0	100	200	300	T0201	High
111736	1/20/2013 16:30	Sunday	16:30	Walvisbay	Single vehicle overturned	35	South	30	0	0	30	T0201	Low
112117	2/9/2013 1:20	Saturday	1:20	Walvisbay	Other/unknown (Specify)	40		30	0	0	30	T0201	Low
112449	2/23/2013 8:00	Saturday	8:00	Walvisbay	Single vehicle overturned	30		30	0	0	30	T0201	Low
113672	4/2/2013 14:20	Tuesday	14:20	Walvisbay	Head/rear end	15		0	0	0	0	T0201	Low
114236	4/11/2013 17:45	Thursday	17:45	Walvisbay	Single vehicle overturned	15	North	30	0	0	30	T0201	Low
114309	4/18/2013 12:00	Thursday	12:00	Walvisbay	Other/unknown (Specify)	5	North	0	0	0	0	T0201	Low
118561	8/25/2013 22:00	Sunday	22:00	Walvisbay	With animal (Specify)	20		0	0	0	0	T0201	Low
119706	9/17/2013 17:00	Tuesday	17:00	Walvisbay	Single vehicle overturned	50		30	0	0	30	T0201	Low
119733	9/15/2013 14:15	Sunday	14:15	Walvisbay	Single vehicle overturned	100		0	0	0	0	T0201	Low
119768	9/18/2013 15:30	Wednesday	15:30	Walvisbay	Other/unknown (Specify)	20	South	0	0	0	0	T0201	Low
119804	9/23/2013 11:30	Monday	11:30	Walvisbay	Sideswipe: same direction	15	North	0	0	0	0	T0201	Low
122979	12/13/2013 0:30	Friday	0:30	Walvisbay	Single vehicle overturned	40		0	0	0	0	T0201	Low
123118	12/26/2013 13:00	Thursday	13:00	Walvisbay	Head/rear end	15	North	0	0	0	0	T0201	Low

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125959	4/9/2013 20:00	Tuesday	20:00	Usakos	Other/unknown (Specify)	15	West	0	0	0	0	T0202	Low
126015	1/2/2013 19:35	Wednesday	19:35	Arandis	Single vehicle overturned	15		0	0	0	0	T0202	Low
126025	1/3/2013 18:00	Thursday	18:00	Arandis	Other/unknown (Specify)	40		0	0	0	0	T0202	Low
126034	1/8/2013 5:10	Tuesday	5:10	Arandis	Sideswipe: opposite directions	15	East	0	0	0	0	T0202	Low
126068	1/18/2013 21:40	Friday	21:40	Arandis	Sideswipe: opposite directions	7	East	0	0	0	0	T0202	Low
126071	1/26/2013 22:35	Saturday	22:35	Arandis		15	North	0	0	0	0	T0202	Low
126113	2/2/2013 20:30	Saturday	20:30	Arandis	Single vehicle overturned	5	North	90	0	0	90	T0202	Moderate
126121	2/22/2013 5:25	Friday	5:25	Arandis	Sideswipe: opposite directions	30		0	0	0	0	T0202	Low
126123	1/10/2013 19:30	Thursday	19:30	Arandis	Other/unknown (Specify)	6		0	0	0	0	T0202	Low
126165	3/29/2013 4:20	Friday	4:20	Arandis	Single vehicle overturned	15		0	50	0	50	T0202	Low
126193	4/3/2013 16:00	Wednesday	16:00	Arandis	Single vehicle overturned	20		0	0	0	0	T0202	Low
126220	4/21/2013 19:30	Sunday	19:30	Arandis	With animal (Specify)	75	South	0	0	0	0	T0202	Low
126224	3/25/2013 14:15	Monday	14:15	Arandis		5		0	0	0	0	T0202	Low
126230	4/22/2013 18:00	Monday	18:00	Arandis		20		0	0	0	0	T0202	Low
126236	10/10/2013 1:00	Thursday	1:00	Usakos	Single vehicle overturned	92	West	0	0	0	0	T0202	Low
126241	4/25/2013 16:45	Thursday	16:45	Arandis	Head/rear end	1	West	0	0	0	0	T0202	Low
126248	10/13/2013 11:30	Sunday	11:30	Usakos		15	West	0	0	0	0	T0202	Low
126251	4/26/2013 2:55	Friday	2:55	Arandis	Single vehicle overturned	22		30	150	100	280	T0202	High
126269	5/2/2013 12:30	Thursday	12:30	Arandis	Sideswipe: same direction	16	South	30	0	0	30	T0202	Low
126550	5/20/2013 7:20	Monday	7:20	Arandis	With animal (Specify)	15	West	30	0	0	30	T0202	Low
126617	6/3/2013 0:15	Monday	0:15	Arandis	With animal (Specify)	20		0	0	0	0	T0202	Low
126620	6/3/2013 14:10	Monday	14:10	Arandis	Single vehicle overturned	10	West	90	100	0	190	T0202	High
126635	6/6/2013 11:00	Thursday	11:00	Arandis	Single vehicle overturned	10		0	200	100	300	T0202	High
126667	6/21/2013 18:28	Friday	18:28	Arandis	Single vehicle overturned	25		30	0	0	30	T0202	Low
126672	6/25/2013 8:00	Tuesday	8:00	Arandis		5	West	0	0	0	0	T0202	Low
126676	6/29/2013 14:40	Saturday	14:40	Arandis	Other/unknown (Specify)	5		0	0	0	0	T0202	Low
126696	7/19/2013 16:45	Friday	16:45	Arandis	Sideswipe: opposite directions	25		0	0	0	0	T0202	Low
126720	8/10/2013 20:20	Saturday	20:20	Arandis	Sideswipe: opposite directions	1		0	0	0	0	T0202	Low
126749	8/16/2013 21:30	Friday	21:30	Arandis	Sideswipe: opposite directions	10	West	90	0	100	190	T0202	High
126754	8/19/2013 12:00	Monday	12:00	Arandis	Single vehicle overturned	10		0	200	200	400	T0202	High
126899	9/9/2013 23:10	Monday	23:10	Arandis	Single vehicle overturned	20	West	0	0	0	0	T0202	Low
126904	9/10/2013 9:00	Tuesday	9:00	Arandis	Single vehicle overturned	18	West	30	100	0	130	T0202	High
126916	9/22/2013 17:20	Sunday	17:20	Arandis	Other/unknown (Specify)	9		0	0	0	0	T0202	Low
126922	9/25/2013 15:30	Wednesday	15:30	Arandis	Single vehicle overturned	22		0	0	0	0	T0202	Low
126931	9/29/2013 16:15	Sunday	16:15	Arandis	Single vehicle overturned	18	West	0	100	0	100	T0202	Moderate
126935	10/10/2013 17:30	Thursday	17:30	Arandis	With animal (Specify)	10		0	0	0	0	T0202	Low
126956	11/3/2013 12:00	Sunday	12:00	Arandis	Single vehicle overturned	8	West	120	0	0	120	T0202	High
126963	11/8/2013 11:45	Friday	11:45	Arandis	Head on	10		0	50	0	50	T0202	Low
126974	11/8/2013 20:15	Friday	20:15	Arandis	Single vehicle overturned	8		0	0	0	0	T0202	Low
126979	11/15/2013 21:50	Friday	21:50	Arandis	Sideswipe: opposite directions	10		120	0	0	120	T0202	High
127020	10/22/2013 7:30	Tuesday	7:30	Arandis	Sideswipe: same direction	15	North	0	0	0	0	T0202	Low
127024	12/8/2013 0:23	Sunday	0:23	Arandis	Single vehicle overturned	6		0	0	0	0	T0202	Low
127026	12/8/2013 5:57	Sunday	5:57	Arandis	Single vehicle overturned	13.39999962	North	0	0	0	0	T0202	Low
127039	12/12/2013 2:15	Thursday	2:15	Arandis	With Fixed Object (Specify)	2		0	0	0	0	T0202	Low

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112984	3/2/2013 20:10	Saturday	20:10	Okahandja	With animal (Specify)	50	West	0	0	0	0	T0701	Low
113238	3/13/2013 17:15	Wednesday	17:15	Okahandja	With animal (Specify)	50	West	0	0	0	0	T0701	Low
113337	3/19/2013 6:20	Tuesday	6:20	Okahandja	With Stones	20	West	0	0	0	0	T0701	Low
113564	3/31/2013 21:00	Sunday	21:00	Okahandja	Other/unknown (Specify)	40	West	0	0	0	0	T0701	Low
114003	4/22/2013 0:00	Monday	0:00	Okahandja	With animal (Specify)	15	West	0	0	0	0	T0701	Low
114710	5/20/2013 13:35	Monday	13:35	Okahandja		7	West	0	0	0	0	T0701	Low
115272	6/23/2013 15:15	Sunday	15:15	Okahandja	Single vehicle overturned	50	West	30	0	0	30	T0701	Low
125827	3/19/2013 23:30	Tuesday	23:30	Usakos	With animal (Specify)	40	North	0	0	0	0	T0701	Low
126198	7/24/2013 9:00	Wednesday	9:00	Usakos		12	East	0	0	0	0	T0701	Low
126242	10/13/2013 20:30	Sunday	20:30	Usakos	With animal (Specify)	10	North	0	0	0	0	T0701	Low
126343	11/18/2013 16:30	Monday	16:30	Usakos	With Fixed Object (Specify)	40	North	0	0	0	0	T0701	Low
129273	7/7/2013 5:30	Sunday	5:30	Karibib	Single vehicle overturned	3		0	0	0	0	T0701	Low
129275	1/3/2013 22:30	Thursday	22:30	Karibib	With Fixed Object (Specify)	20		0	0	0	0	T0701	Low
129281	2/7/2013 4:15	Thursday	4:15	Karibib	Single vehicle overturned	40		0	0	0	0	T0701	Low
129287	2/12/2013 23:20	Tuesday	23:20	Karibib		23		0	0	0	0	T0701	Low
129301	11/23/2013 16:30	Saturday	16:30	Karibib	Single vehicle overturned	8		0	0	0	0	T0701	Low
129303	7/4/2013 1:00	Thursday	1:00	Karibib	With animal (Specify)	10	East	0	0	0	0	T0701	Low
129304	2/2/2013 18:00	Saturday	18:00	Karibib	Head/rear end	20		0	0	0	0	T0701	Low
129309	3/11/2013 18:14	Monday	18:14	Karibib	With animal (Specify)	20	North	0	0	0	0	T0701	Low
129319	2/16/2013 4:00	Saturday	4:00	Karibib		25		0	0	0	0	T0701	Low
129321	3/14/2013 10:45	Thursday	10:45	Karibib		20	East	0	0	0	0	T0701	Low
129331	2/23/2013 17:25	Saturday	17:25	Karibib	With animal (Specify)	2		0	0	0	0	T0701	Low
129335	3/3/2013 18:00	Sunday	18:00	Karibib	With Bird	10		0	0	0	0	T0701	Low
129339	2/26/2013 22:30	Tuesday	22:30	Karibib	With animal (Specify)	5		0	0	0	0	T0701	Low
129343	12/26/2013 0:15	Thursday	0:15	Karibib	Single vehicle overturned	7	North	30	0	0	30	T0701	Low
129351	5/2/2013 18:00	Thursday	18:00	Karibib	With animal (Specify)	25		0	0	0	0	T0701	Low
129356	2/26/2013 20:10	Tuesday	20:10	Karibib	With animal (Specify)	10		0	0	0	0	T0701	Low
129358	5/3/2013 9:05	Friday	9:05	Karibib	Head/rear end	40		0	0	0	0	T0701	Low
129362	4/18/2013 11:00	Thursday	11:00	Karibib		1100		0	0	0	0	T0701	Low
129366	6/3/2013 5:50	Monday	5:50	Karibib		20		0	0	0	0	T0701	Low
129374	12/19/2013 8:00	Thursday	8:00	Karibib	With Fixed Object (Specify)	20	East	0	0	0	0	T0701	Low
129377	12/18/2013 22:00	Wednesday	22:00	Karibib	With animal (Specify)	60	East	0	0	0	0	T0701	Low
129387	5/5/2013 17:00	Sunday	17:00	Karibib		25	North	0	0	0	0	T0701	Low
129395	5/25/2013 18:30	Saturday	18:30	Karibib	With animal (Specify)	25		0	0	0	0	T0701	Low
129397	5/25/2013 19:30	Saturday	19:30	Karibib	With animal (Specify),With Stones	45	North	0	0	0	0	T0701	Low
129398	3/22/2013 20:15	Friday	20:15	Karibib	With animal (Specify)	55	East	0	0	0	0	T0701	Low
129399	5/26/2013 14:50	Sunday	14:50	Karibib	With animal (Specify)	20		0	0	0	0	T0701	Low
129404	5/28/2013 12:00	Tuesday	12:00	Karibib	Single vehicle overturned	2	South	0	0	0	0	T0701	Low
129410	5/28/2013 17:00	Tuesday	17:00	Karibib	With animal (Specify)	30		0	0	0	0	T0701	Low
129413	6/9/2013 23:00	Sunday	23:00	Karibib	With animal (Specify)	20	West	0	0	0	0	T0701	Low
129415	5/18/2013 21:00	Saturday	21:00	Karibib	With animal (Specify)	30		0	0	0	0	T0701	Low
129417	3/29/2013 15:30	Friday	15:30	Karibib	With animal (Specify),With train	50	East	0	0	0	0	T0701	Low
129418	6/25/2013 14:30	Tuesday	14:30	Karibib	Other/unknown (Specify)	70	East	0	0	0	0	T0701	Low
129419	6/1/2013 18:00	Saturday	18:00	Karibib	With animal (Specify)	40	West	0	0	0	0	T0701	Low
129479	1/25/2013 21:00	Friday	21:00	Okahandja		25	West	0	0	0	0	T0701	Low
132119	12/10/2013 22:30	Tuesday	22:30	Karibib	With animal (Specify)	40		0	0	0	0	T0701	Low

Appendix E – GIS Maps

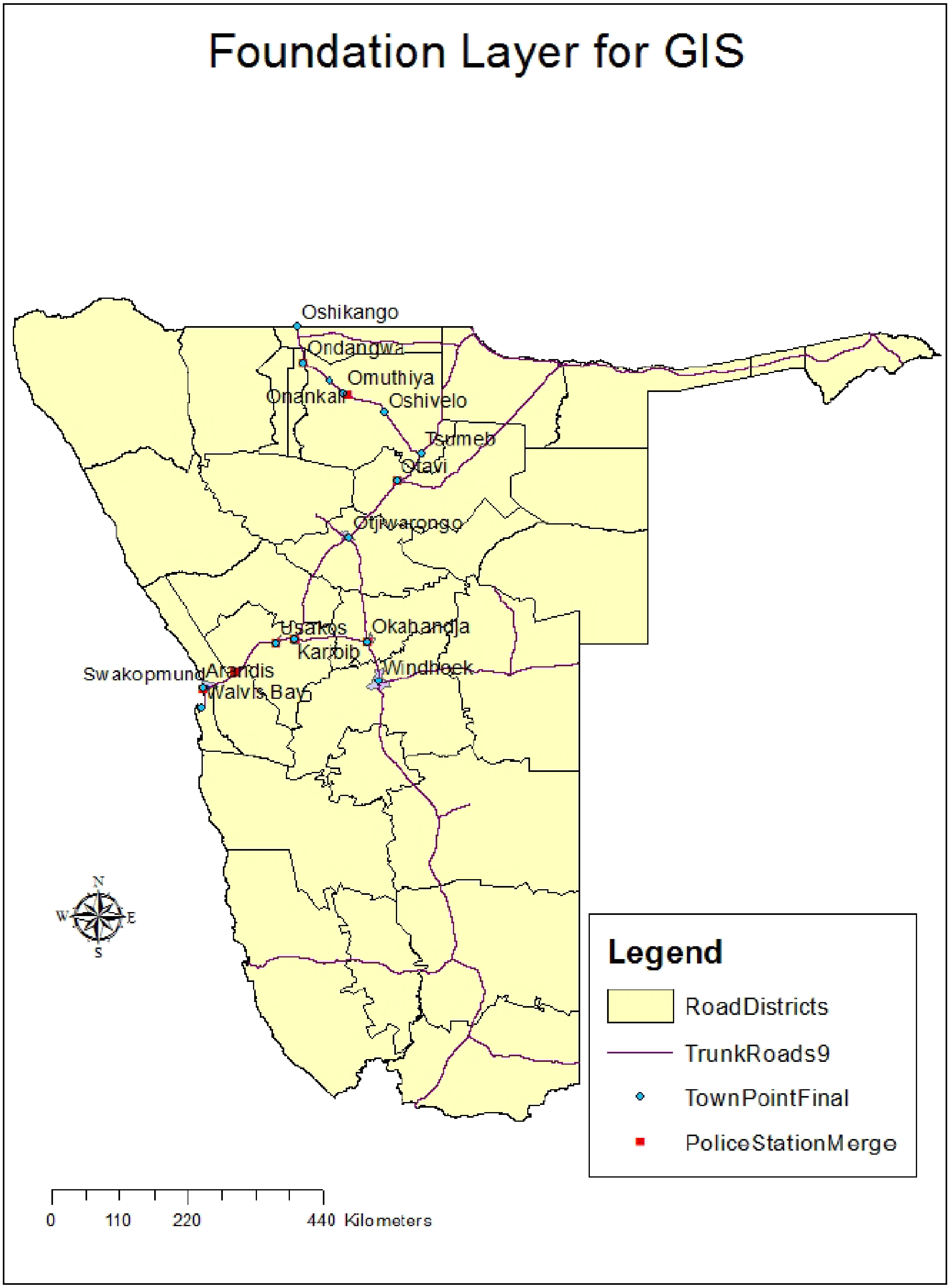

Figure E-1. Foundation layer for GIS

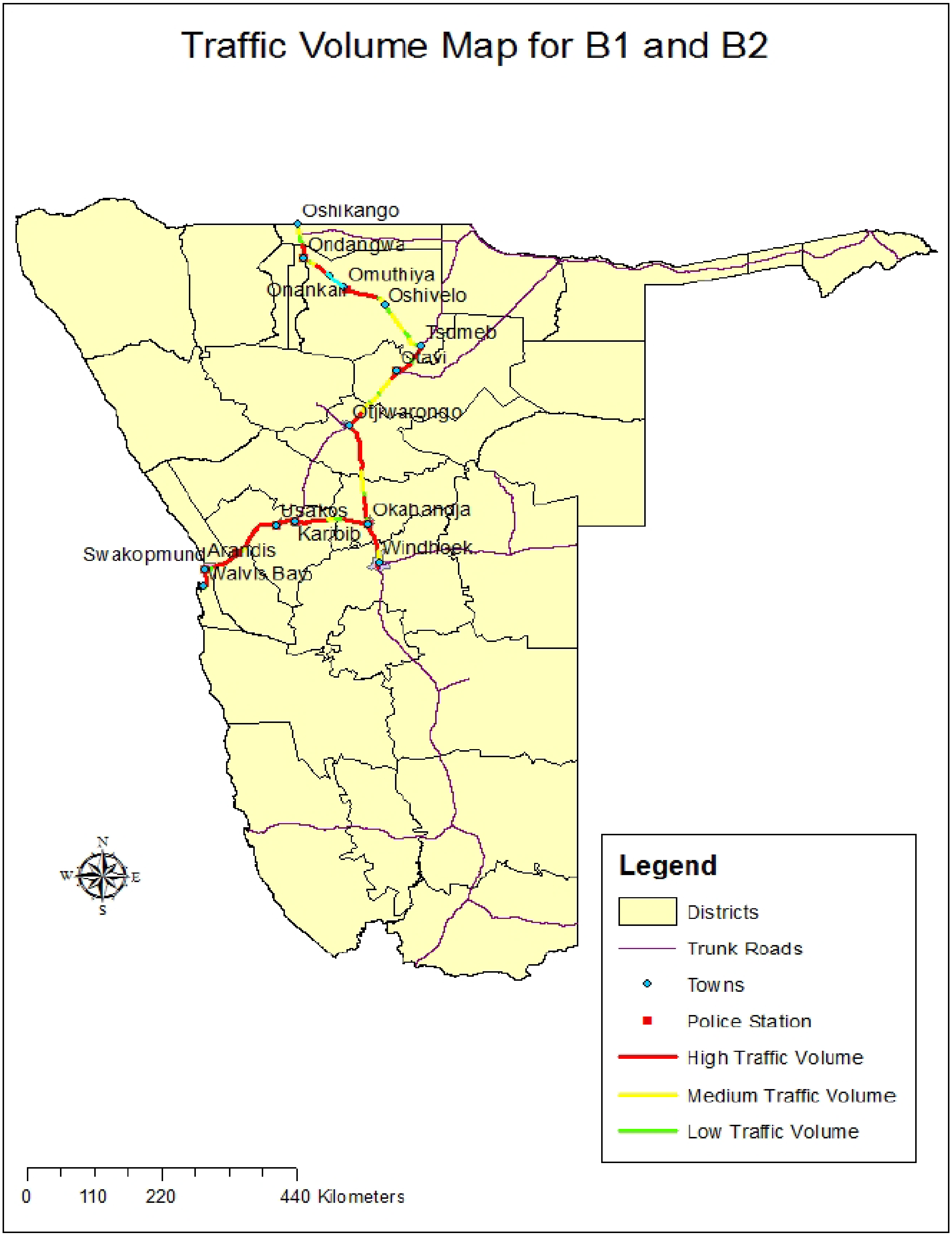

Figure E-2. Traffic Volume Map for B1 and B2

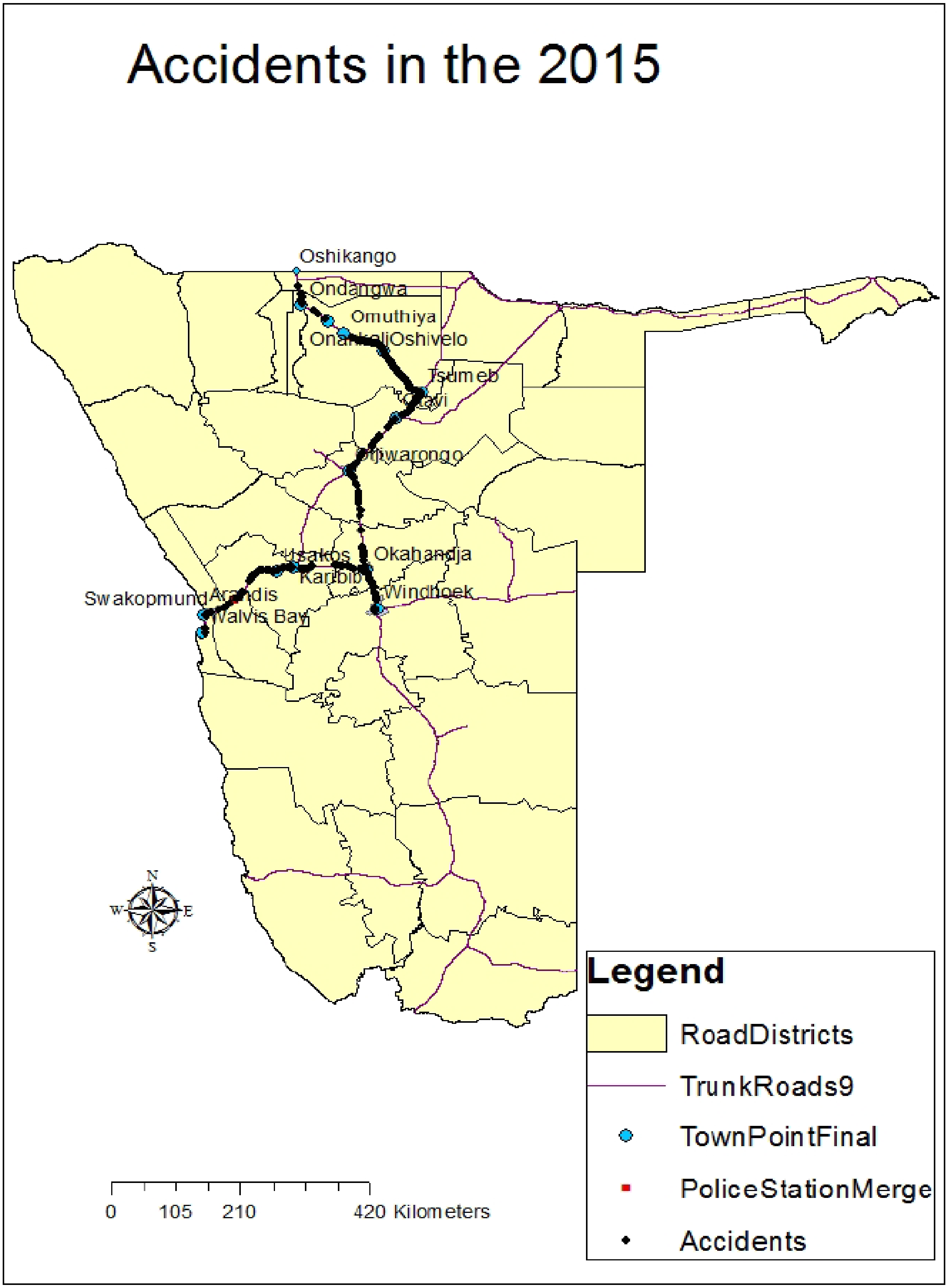

Figure E-3. Accidents in 2015

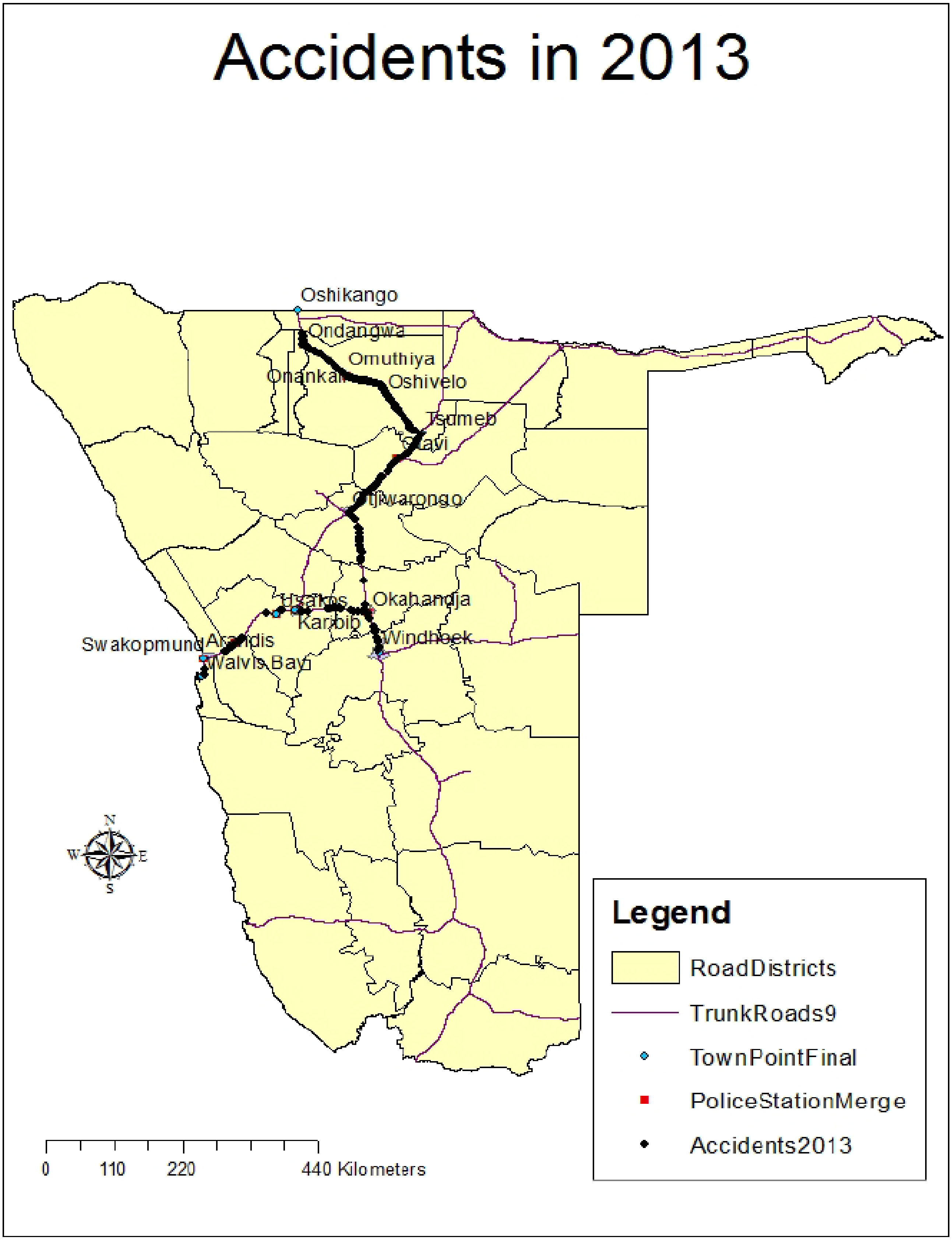

Figure E-4. Accidents in 2013

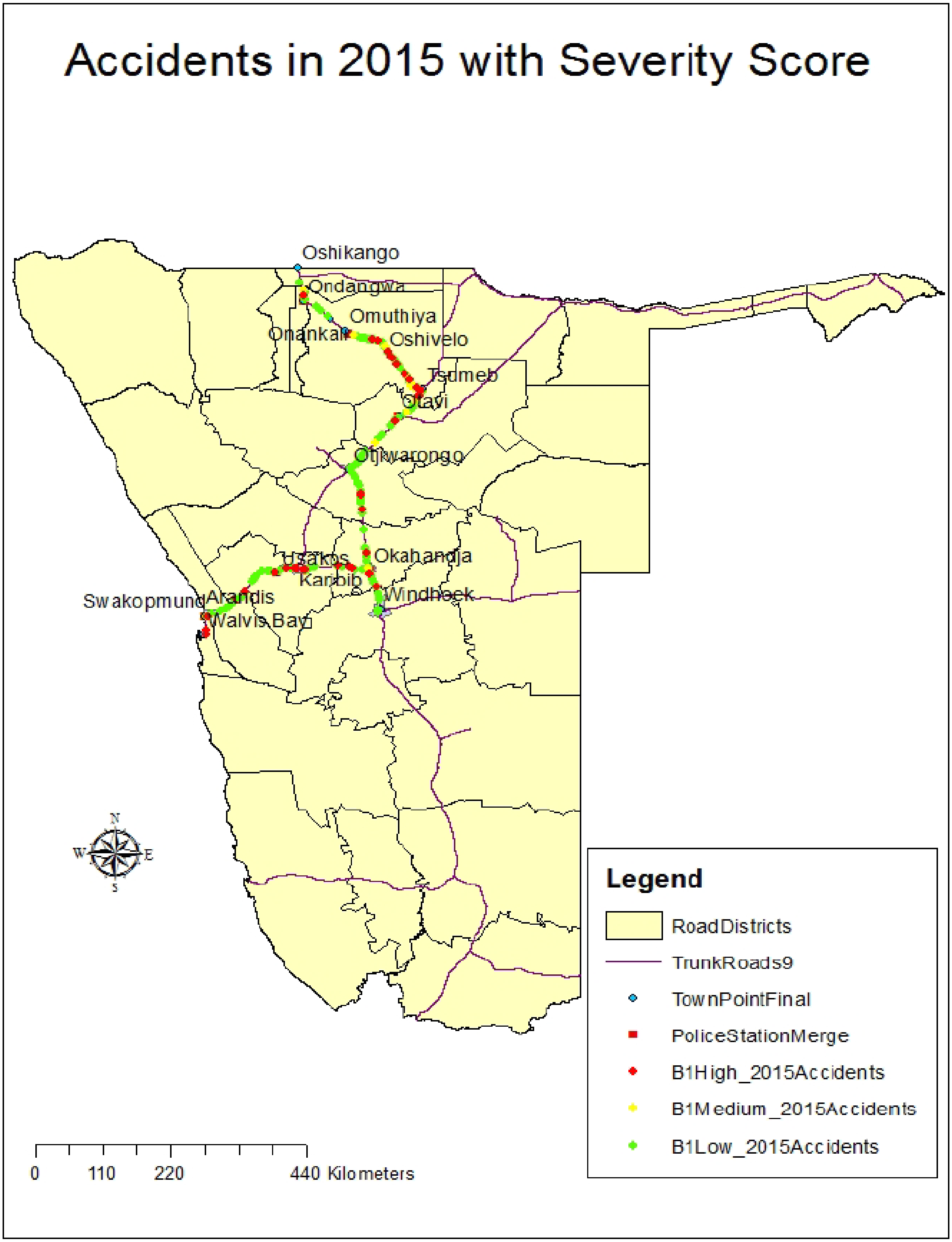

Figure E-5. Accidents in 2015 with Severity Levels

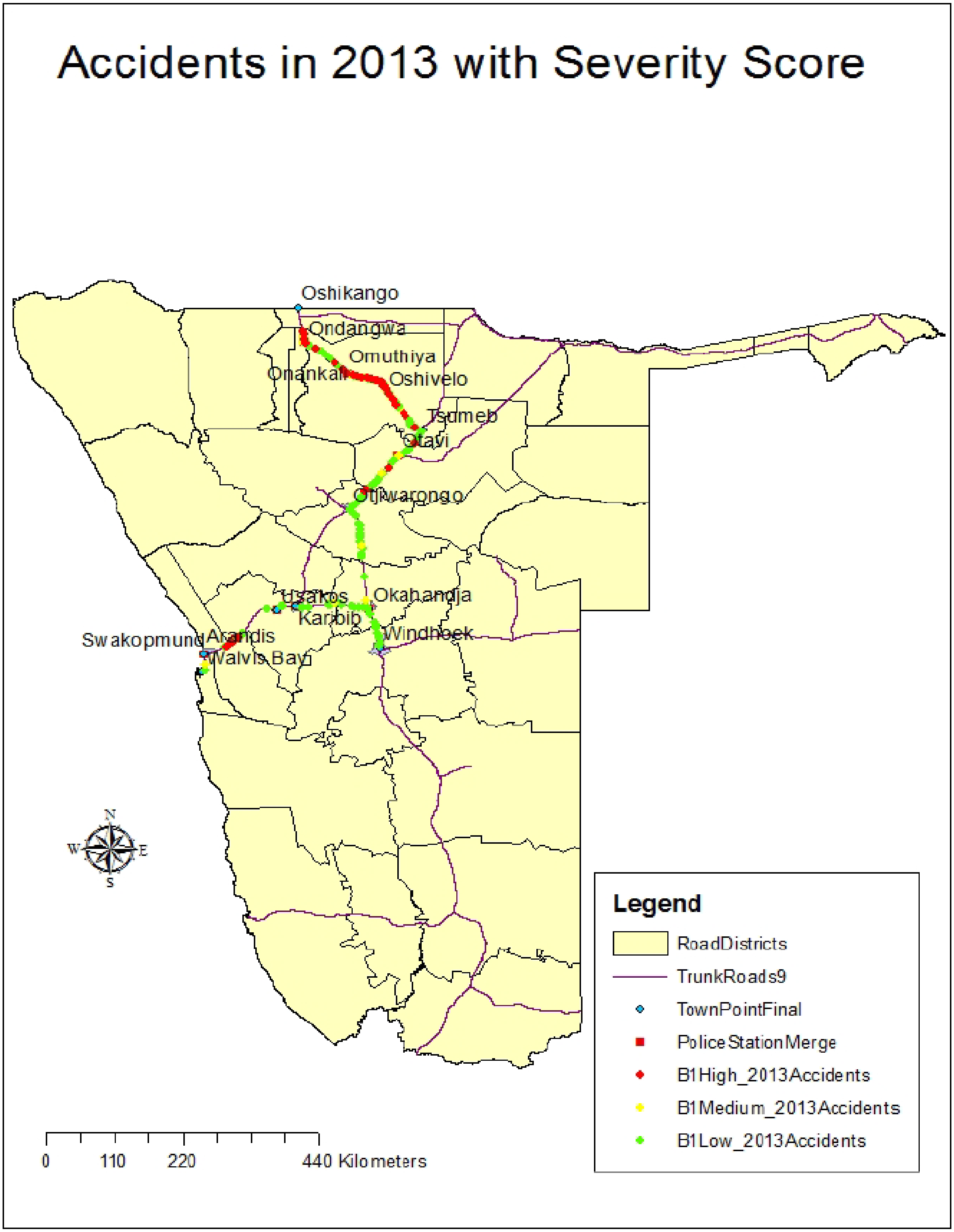

Figure E-6. Accidents in 2013 with Severity Score

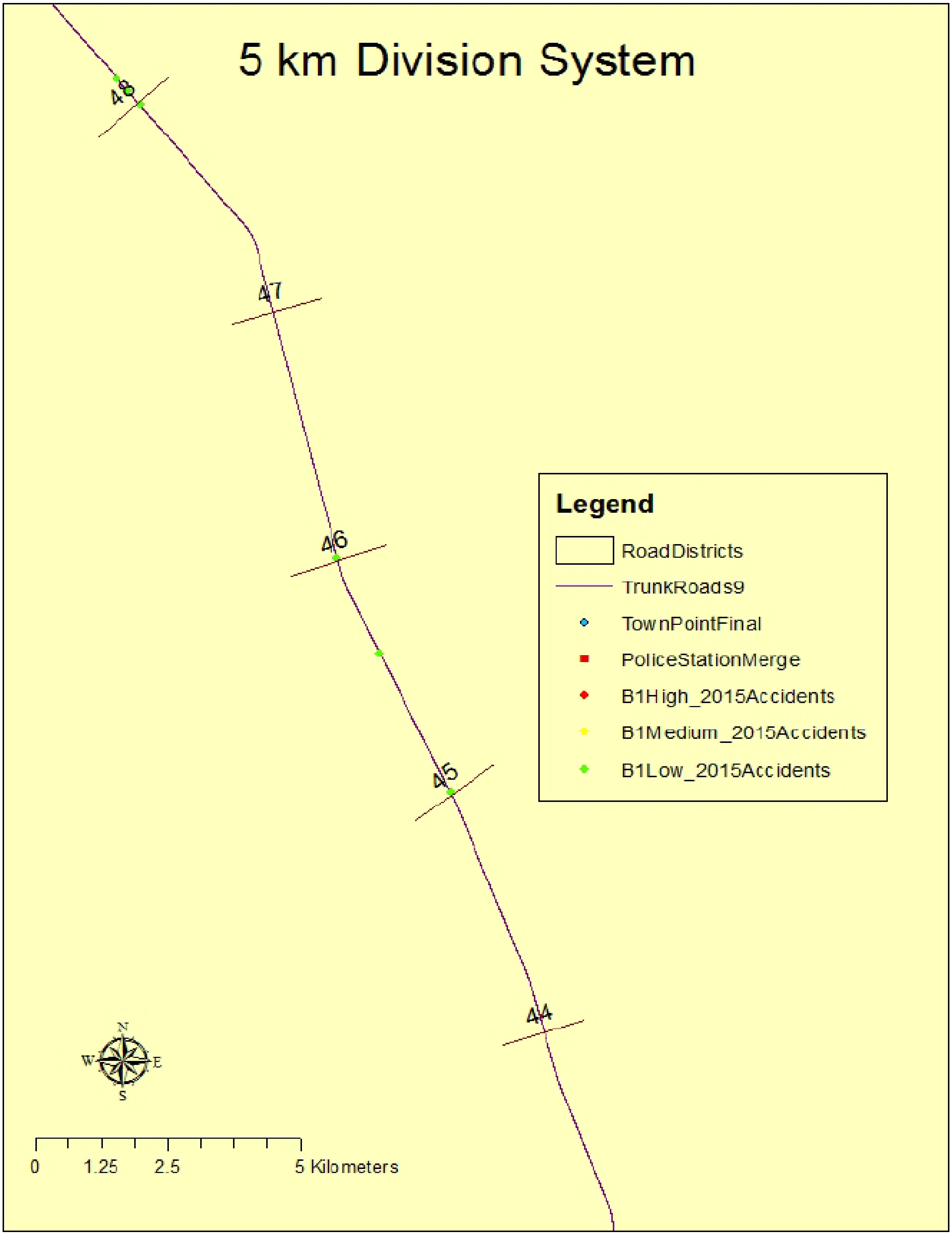

Figure E-7. 5km Division System

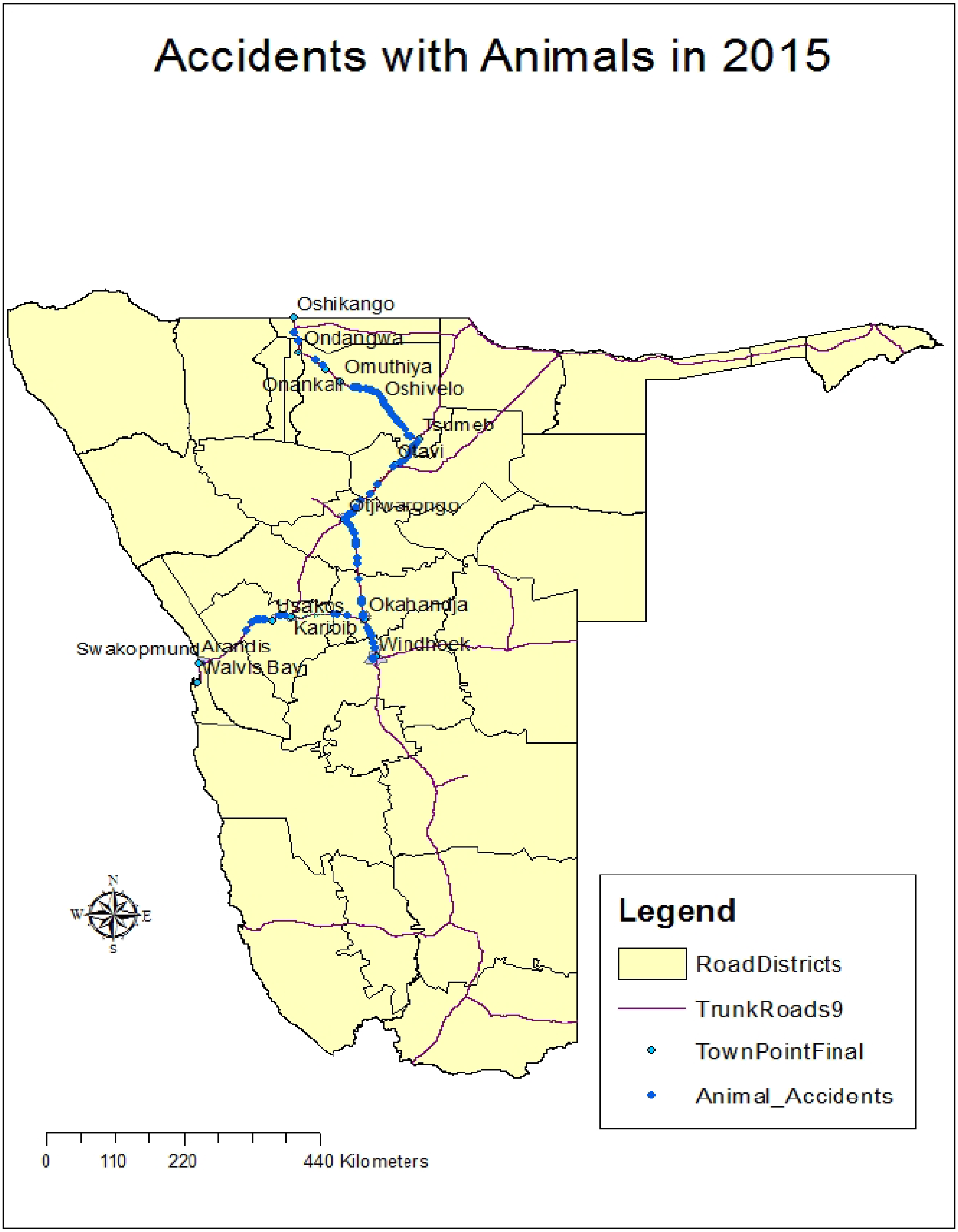

Figure E-8. Accidents with Animals in 2015

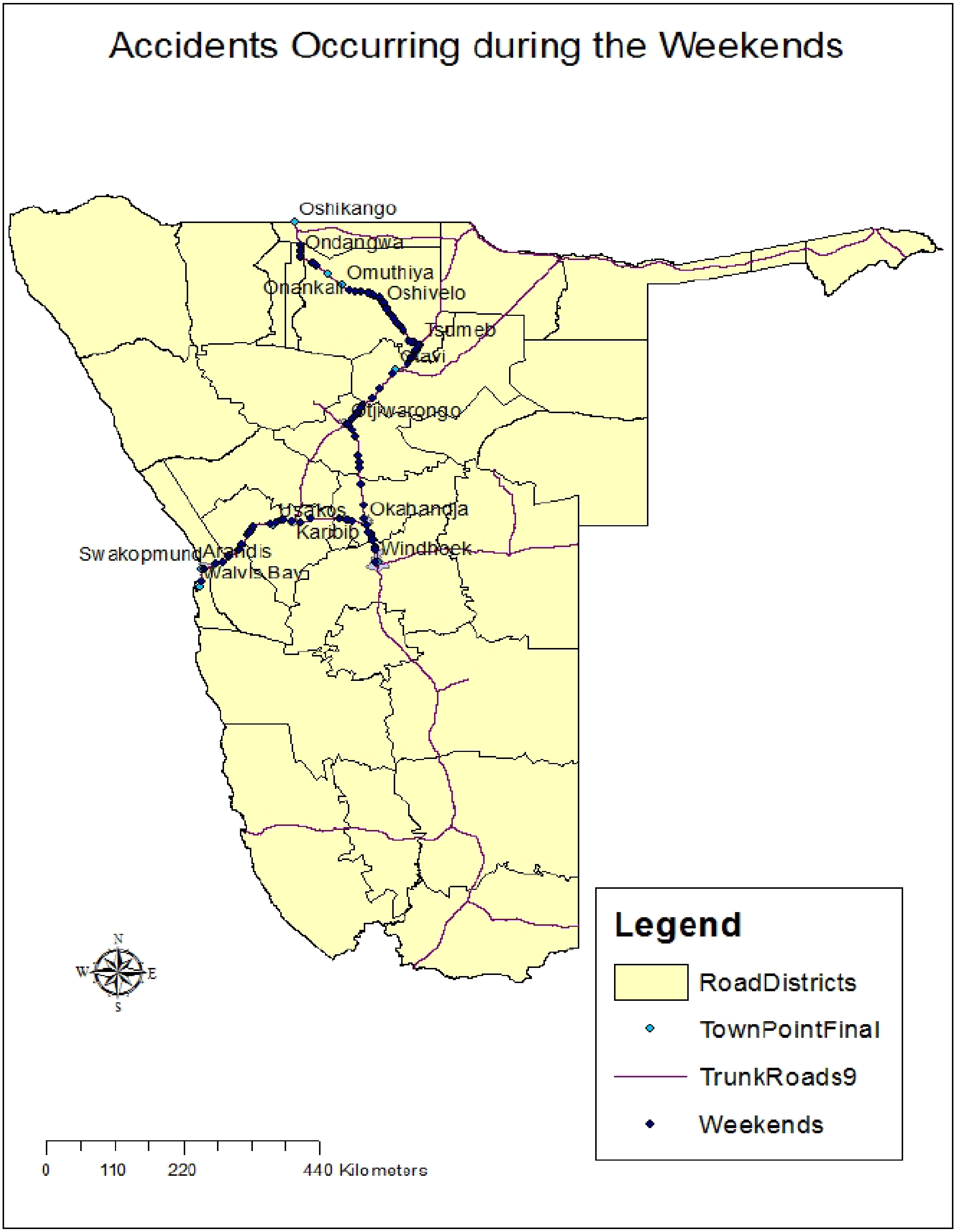

Figure E-9. Accidents occurring during the weekends

Appendix F – Maps Created from Google Earth Pro

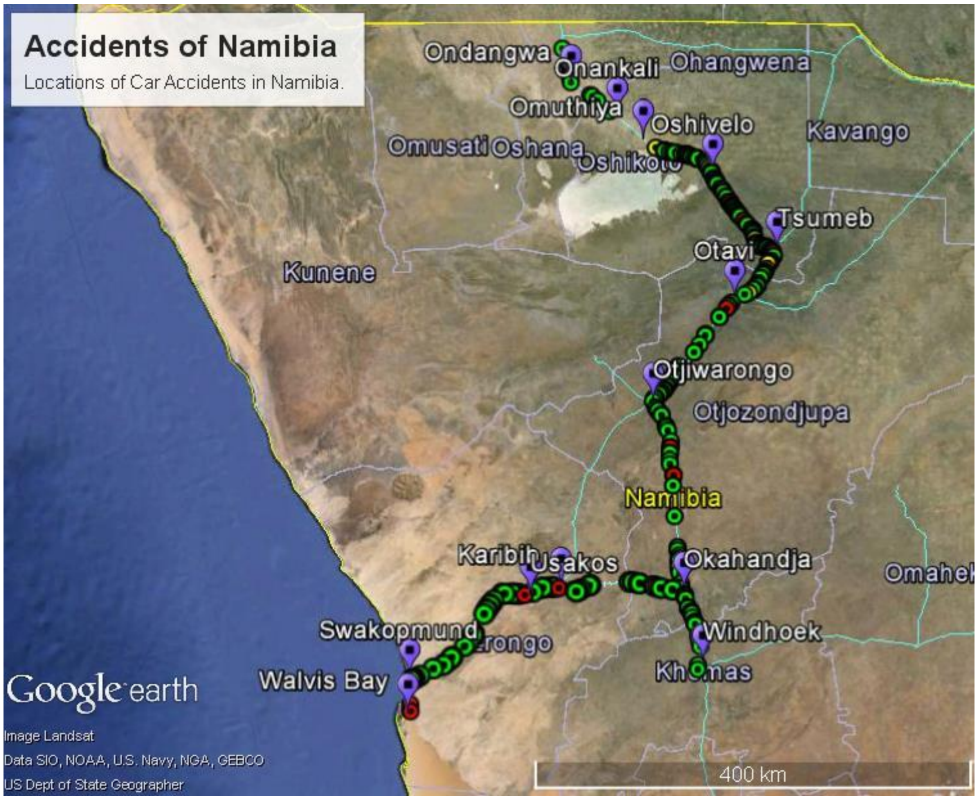

Figure F-1. Google Image of Accidents in Namibia for 2015.

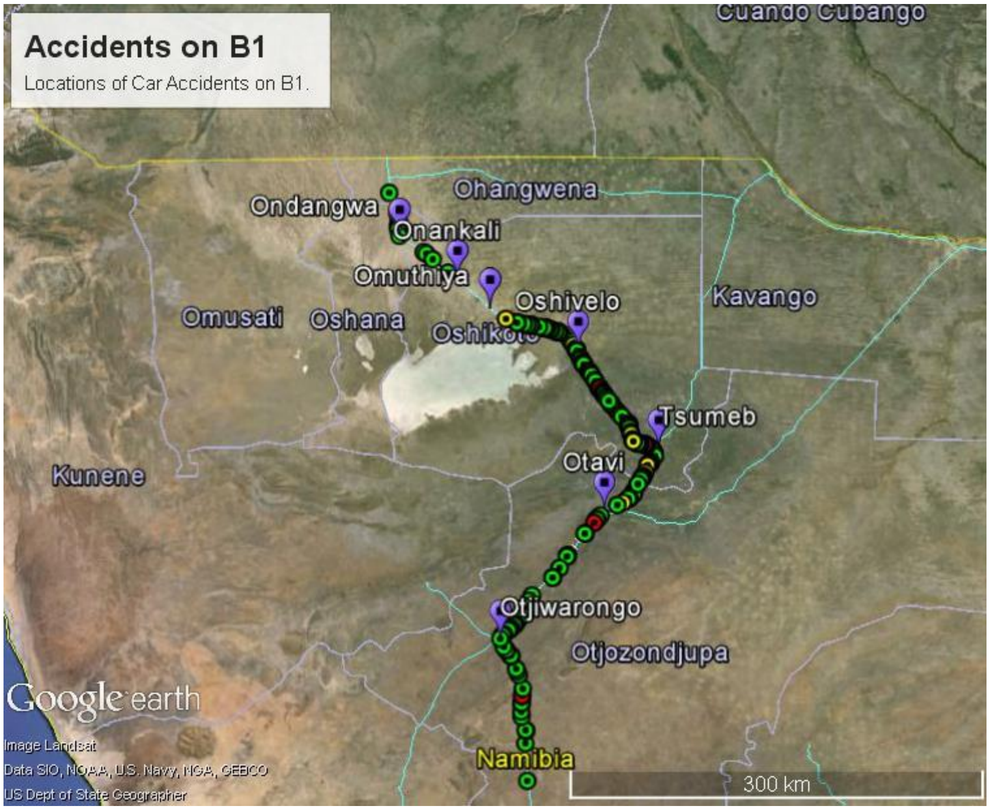

Figure F-2. Google Image of Accidents on B1 for 2015.

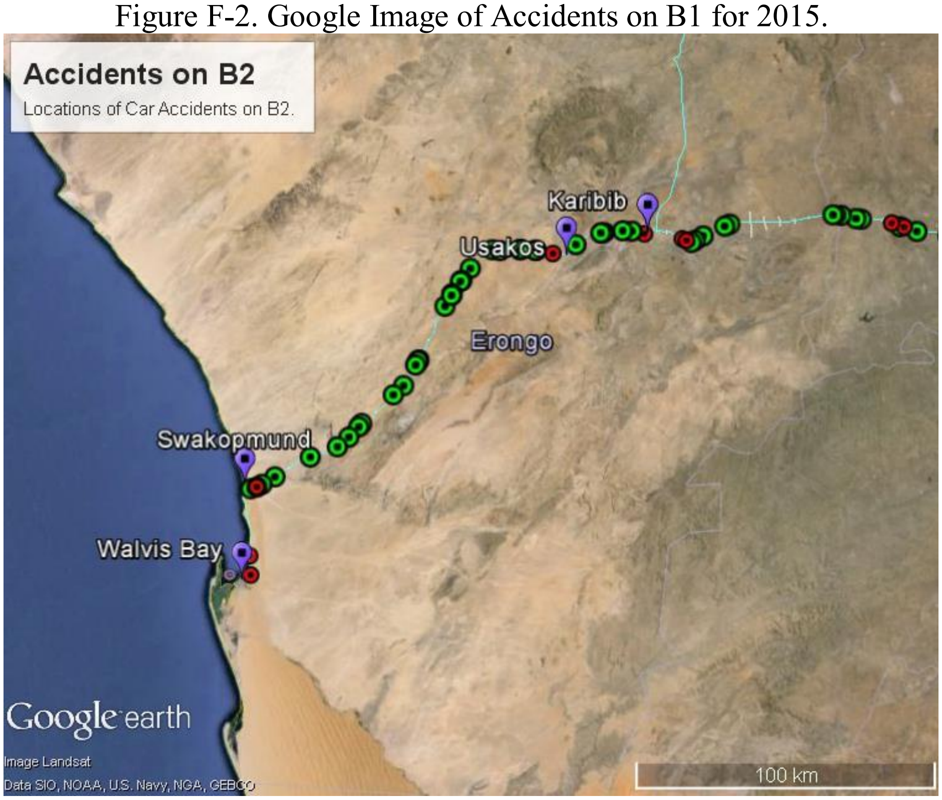

Figure F-3. Google Image of Accidents on B2 for 2015.

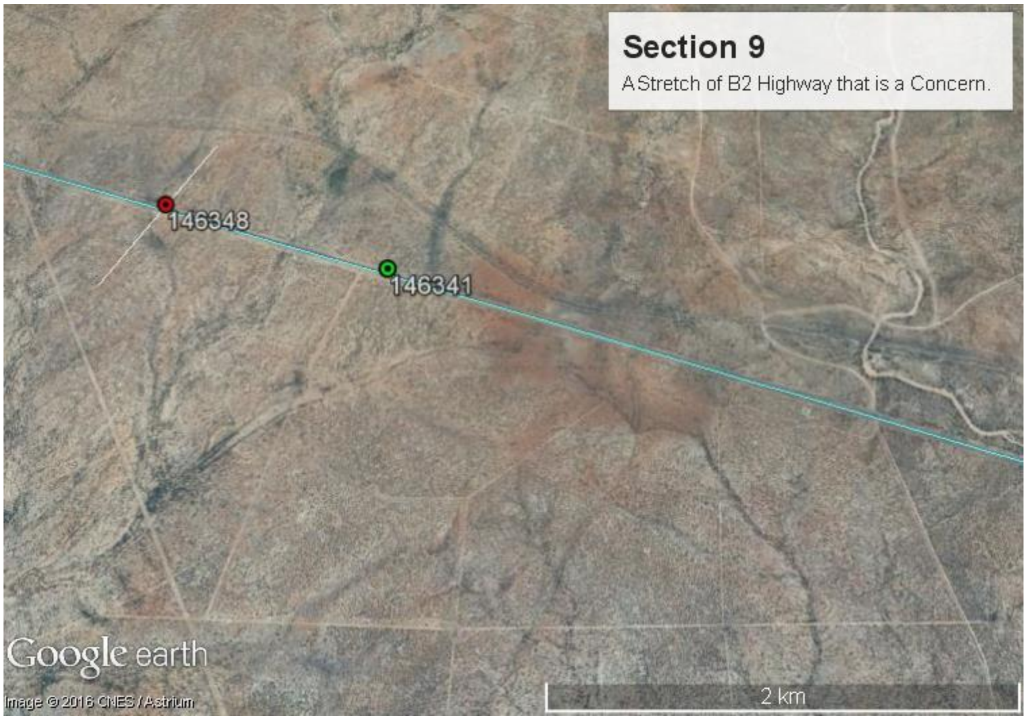

Figure F-4. Google Image of Accidents of Stretch 9 on B2.

Figure F-5. Google Image of Accidents on Stretch 20 on B2.

Figure F-6. Google Image of Accidents on Stretch 22 on B1.

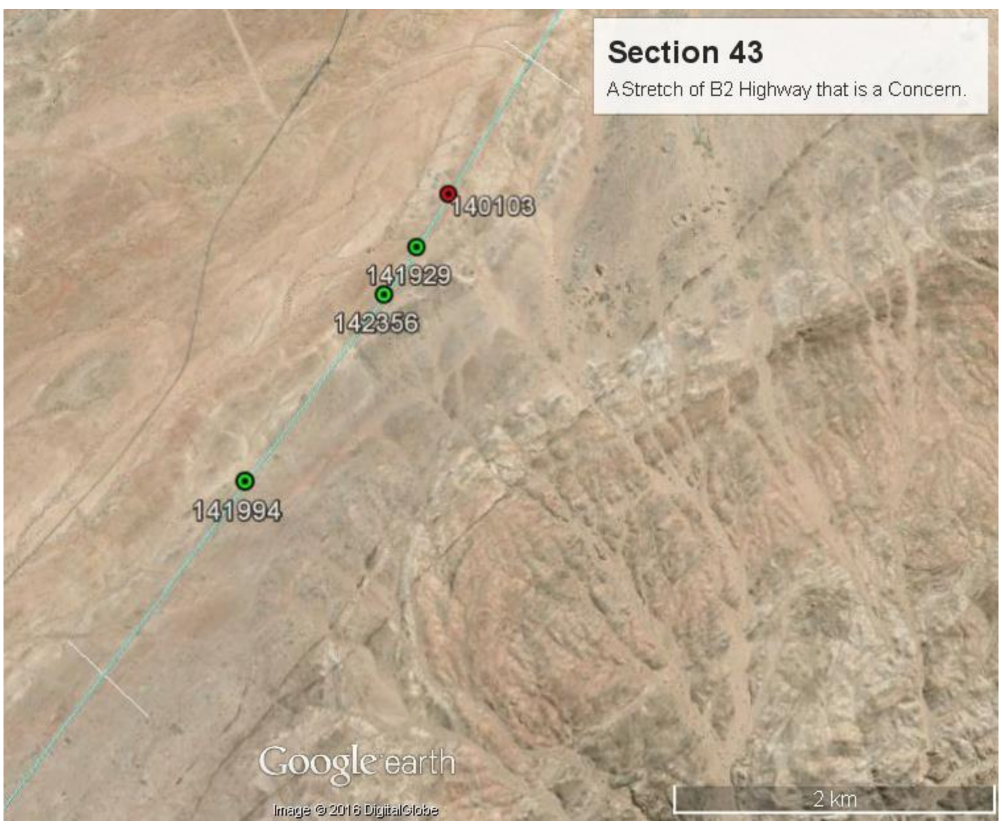

Figure F-7. Google Image of Accidents on Stretch 43 on B2.

Figure F-8. Google Image of Accidents on Stretch 85 on B1.

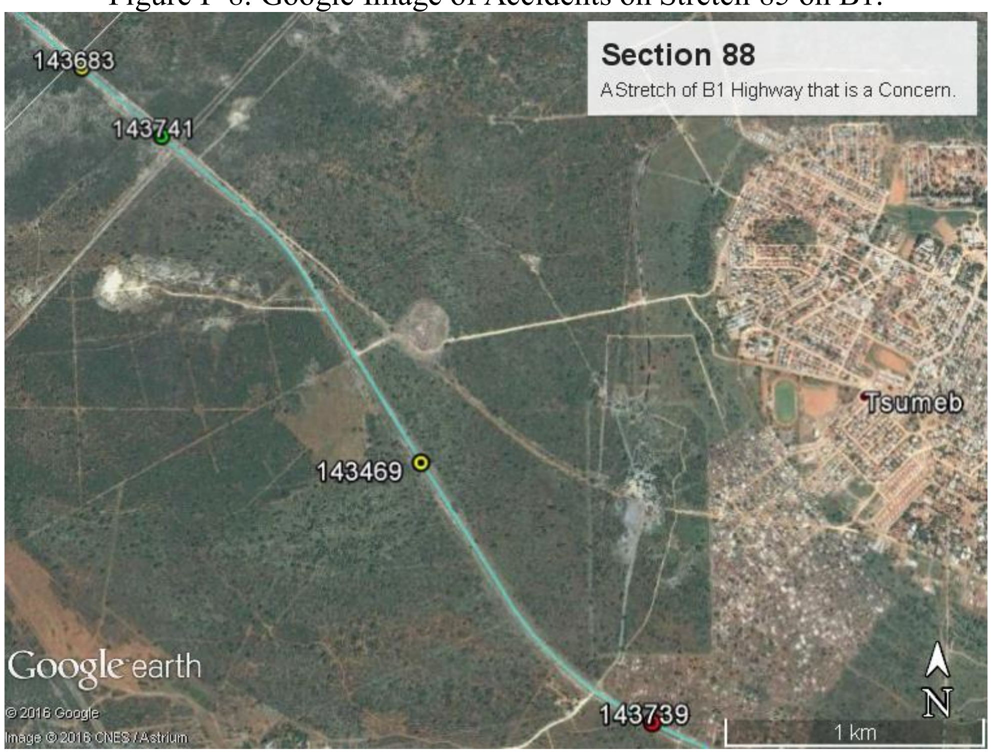

Figure F-9. Google Image of Accidents on Stretch 88 on B1.

Figure F-10. Google Image of Accidents on Stretch 94 on B1.

Figure F-11. Google Image of Accidents on Stretch 103 on B1.

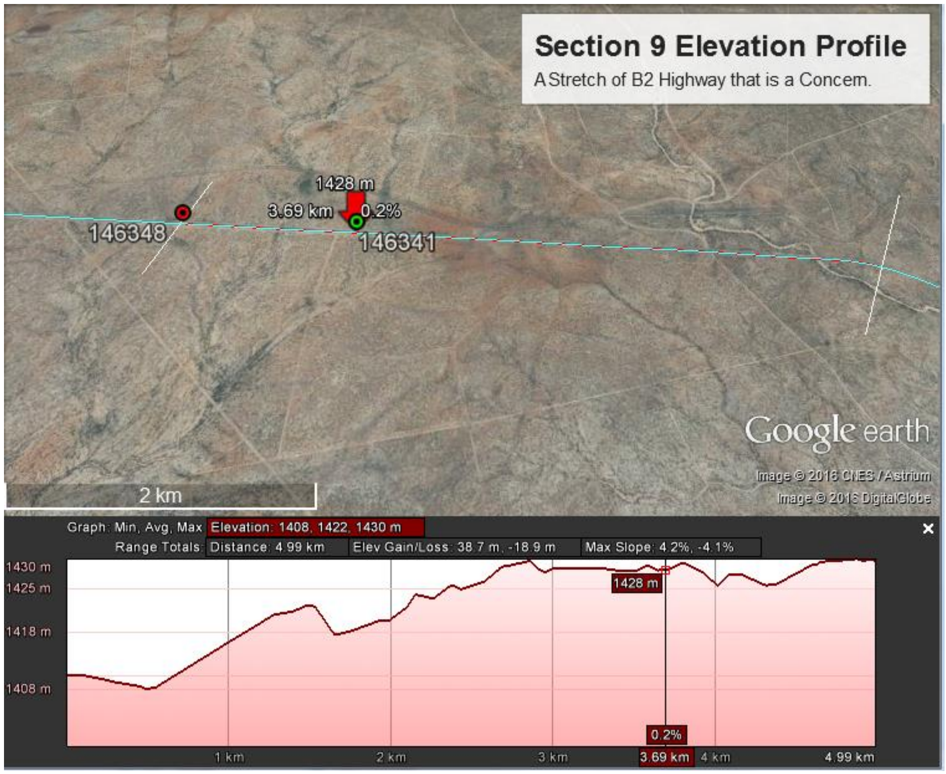

Figure F-12. Google Image of the Elevation Profile of Stretch 9 on B2, marker on Accident 1.

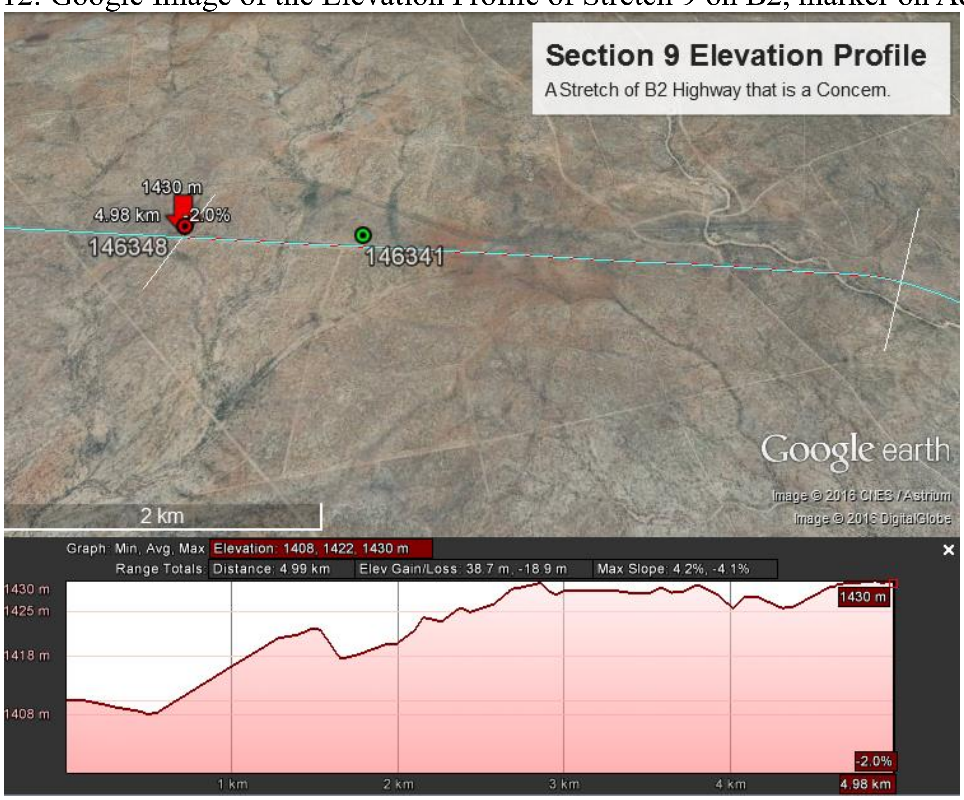

Figure F-13. Google Image of the Elevation Profile of Stretch 9 on B2, marker on Accident 2.

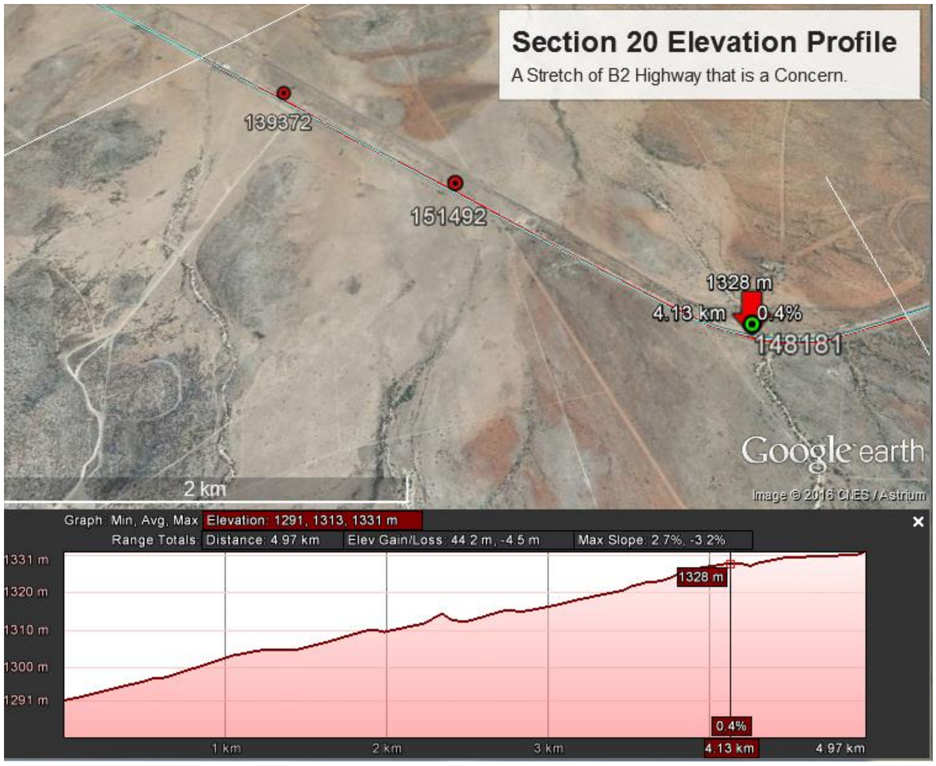

Figure F-14. Google Image of the Elevation Profile of Stretch 20 on B2, marker on Accident 1.

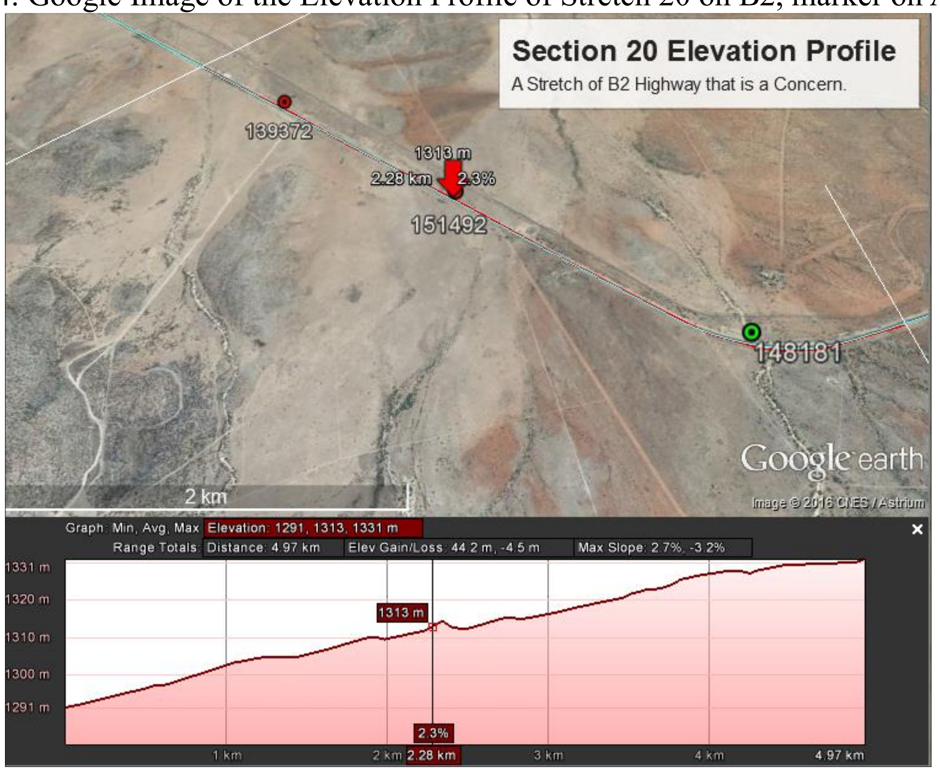

Figure F-15. Google Image of the Elevation Profile of Stretch 20 on B2, marker on Accident 2.

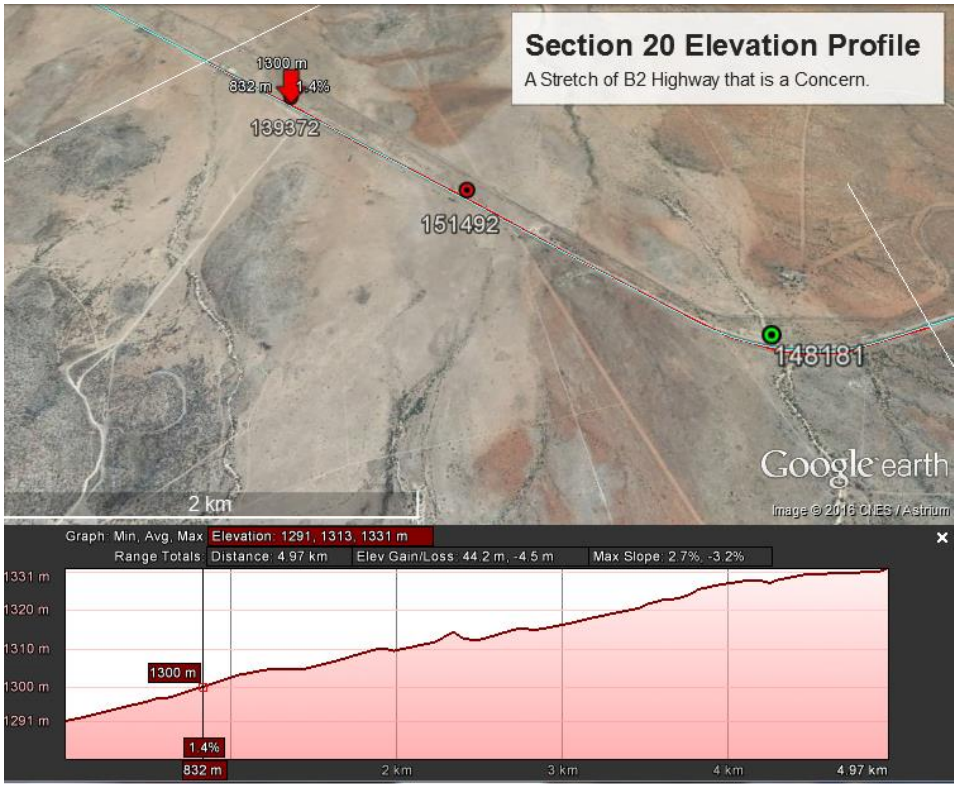

Figure F-16. Google Image of the Elevation Profile of Stretch 20 on B2, marker on Accident 3.

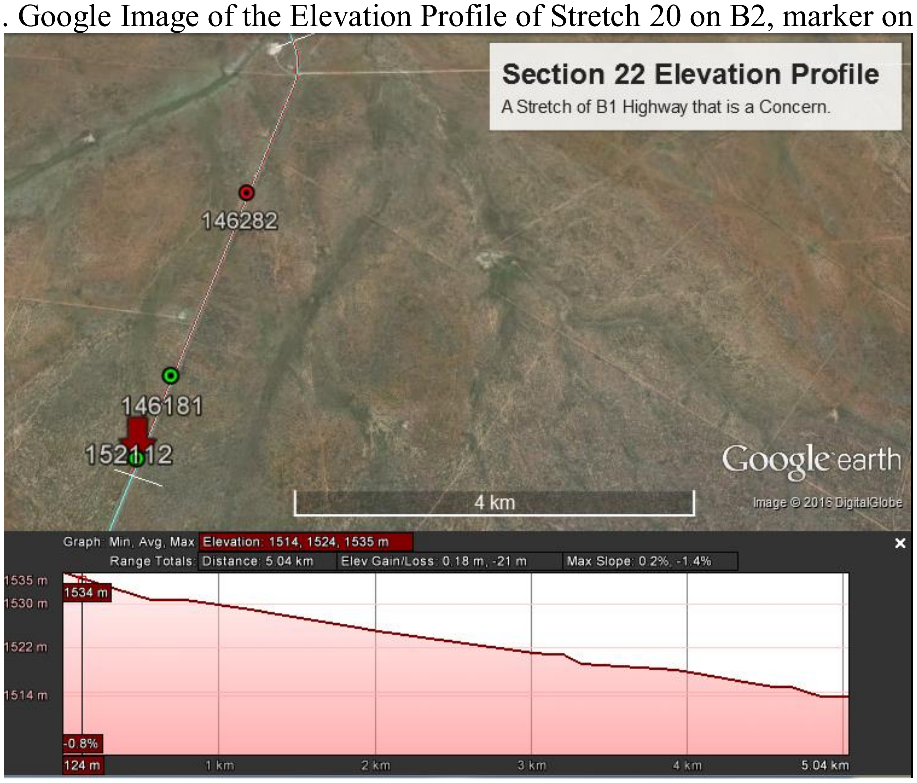

Figure F-17. Google Image of the Elevation Profile of Stretch 22 on B1, marker on Accident 1.

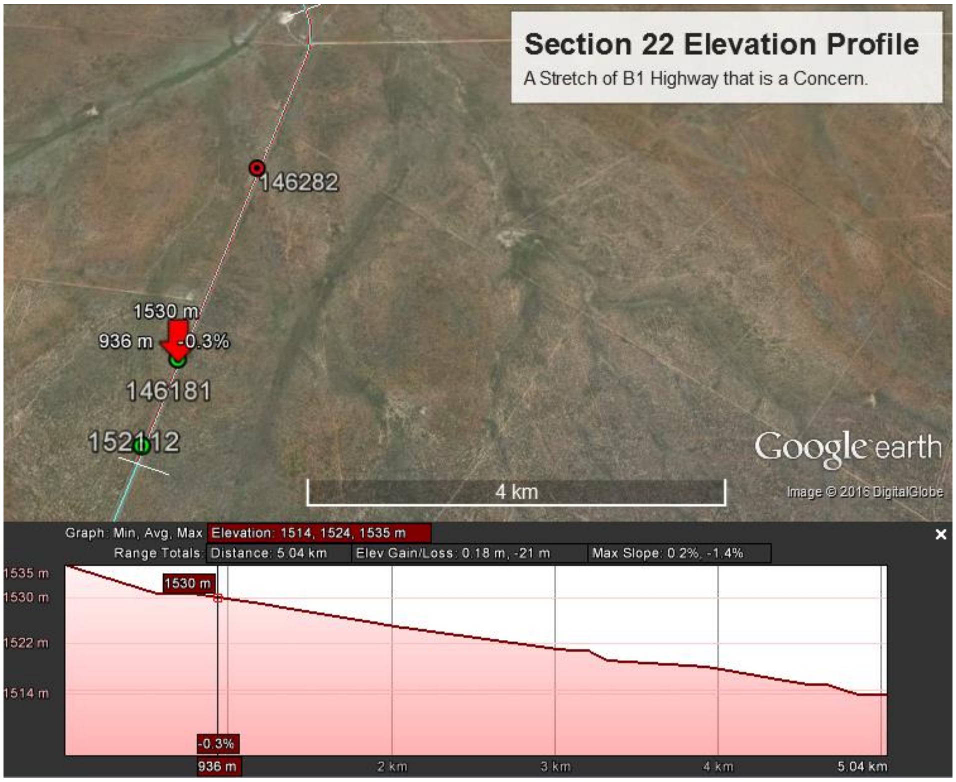

Figure F-18. Google Image of the Elevation Profile of Stretch 22 on B1, marker on Accident 2.

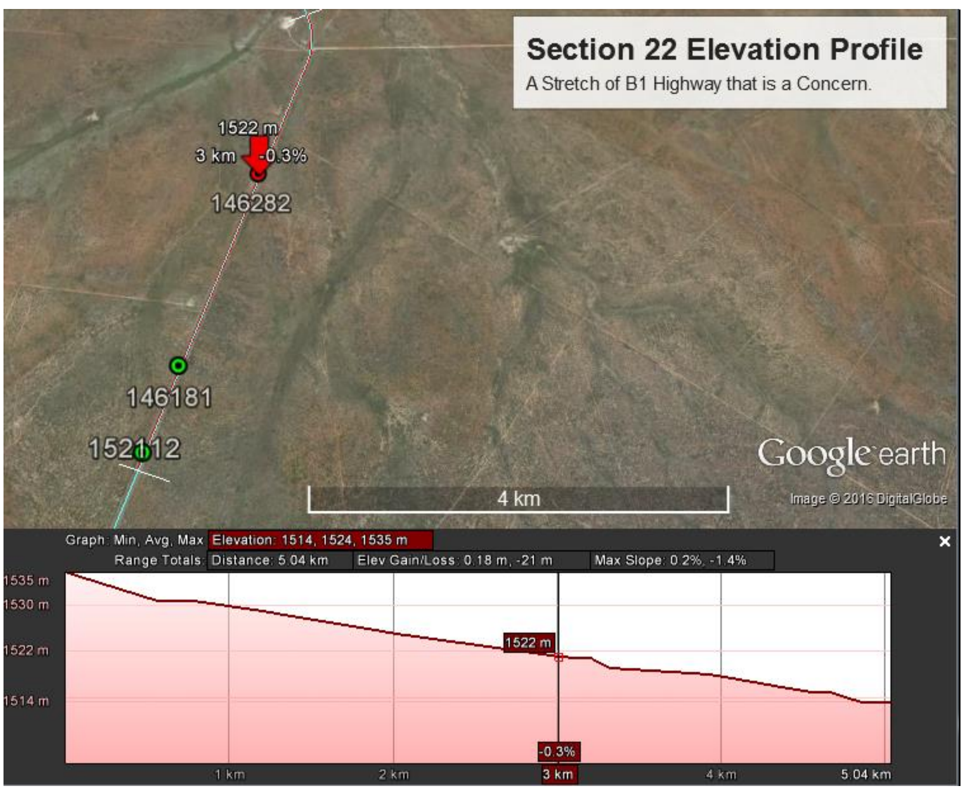

Figure F-19. Google Image of the Elevation Profile of Stretch 22 on B1, marker on Accident 3.

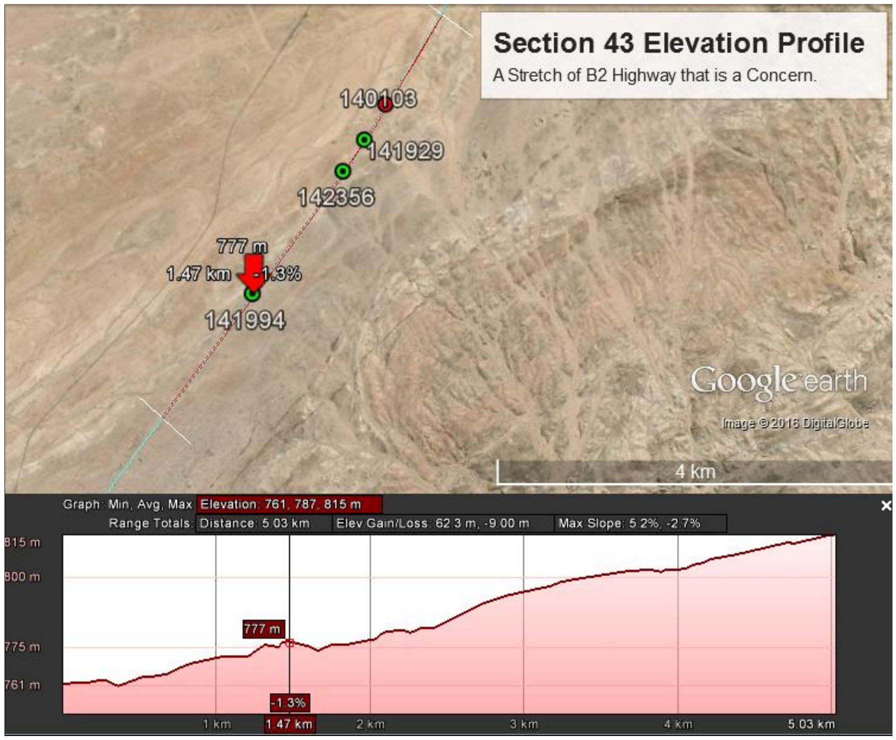

Figure F-20. Google Image of the Elevation Profile of Stretch 43 on B2, marker on Accident 1.

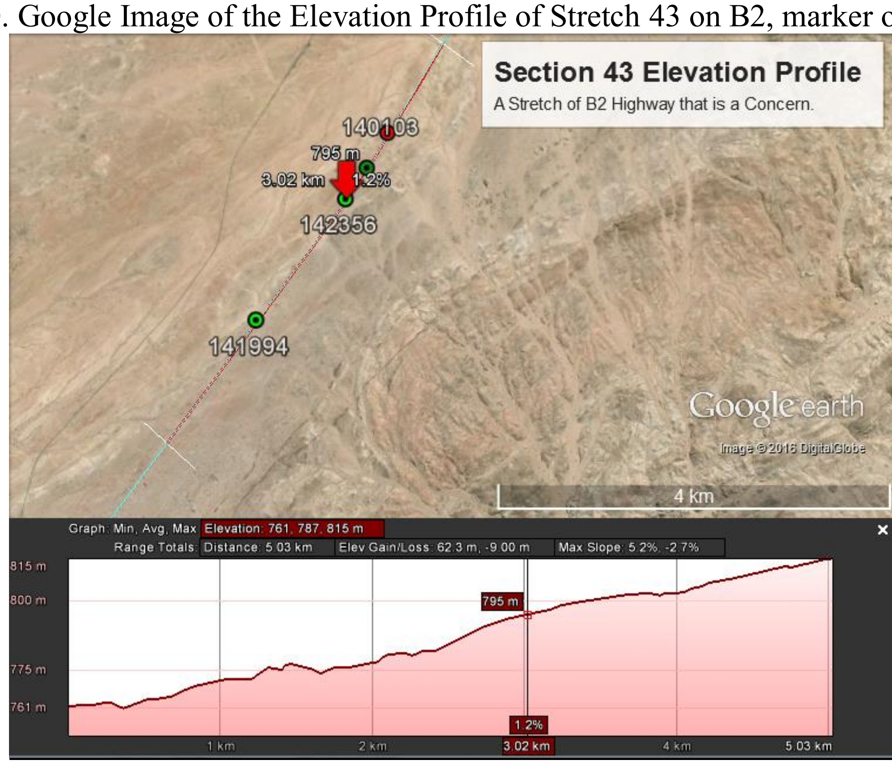

Figure F-21. Google Image of the Elevation Profile of Stretch 43 on B2, marker on Accident 2.

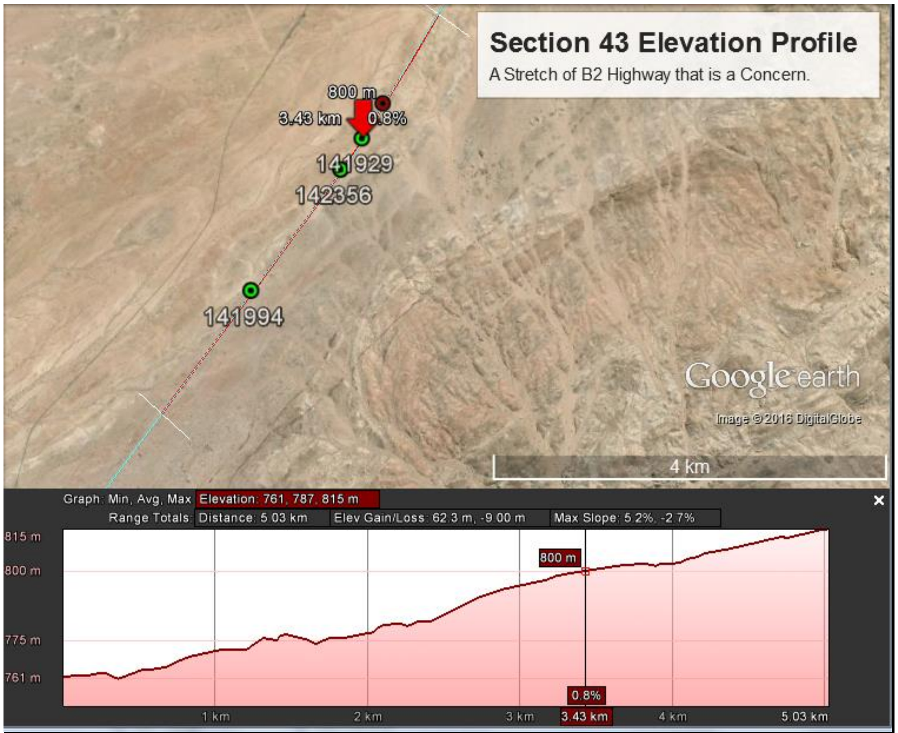

Figure F-22. Google Image of the Elevation Profile of Stretch 43 on B2, marker on Accident 3

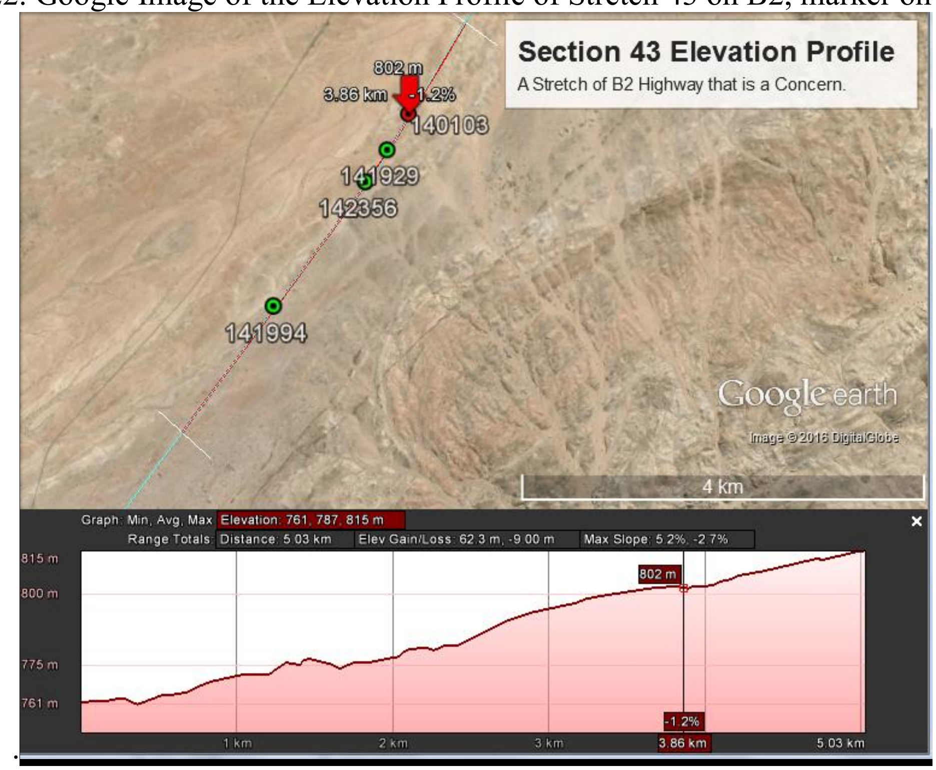

Figure F-23. Google Image of the Elevation Profile of Stretch 43 on B2, marker on accident 4.

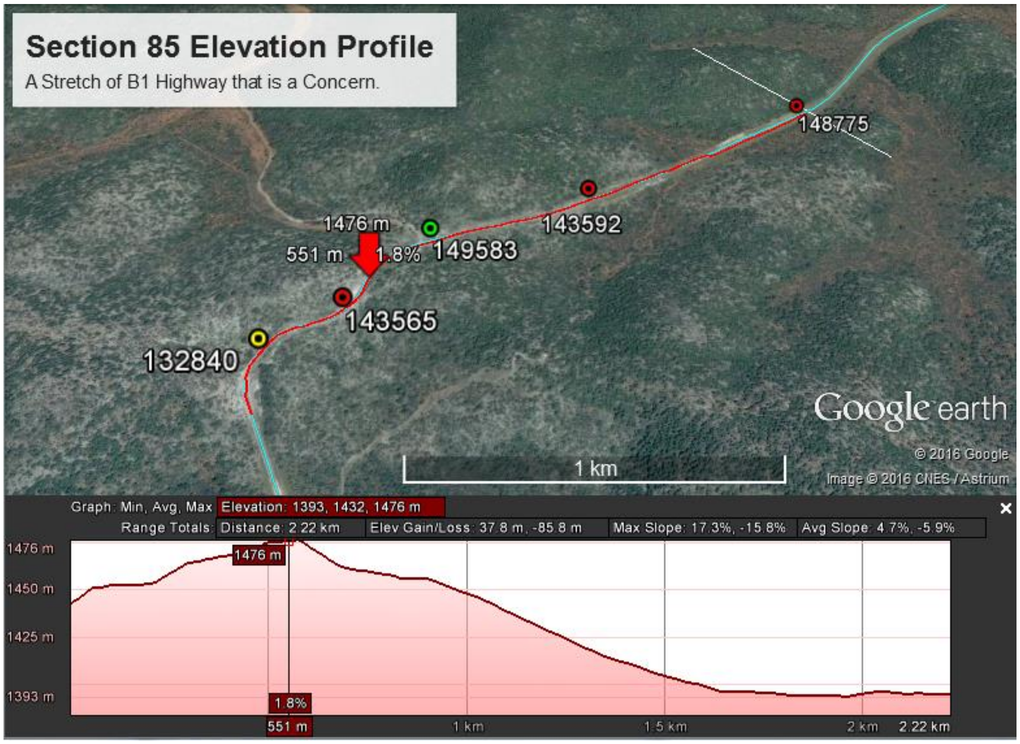

Figure F-24. Google Image of the Elevation Profile of Stretch 85 on B1, marker on top of hill.

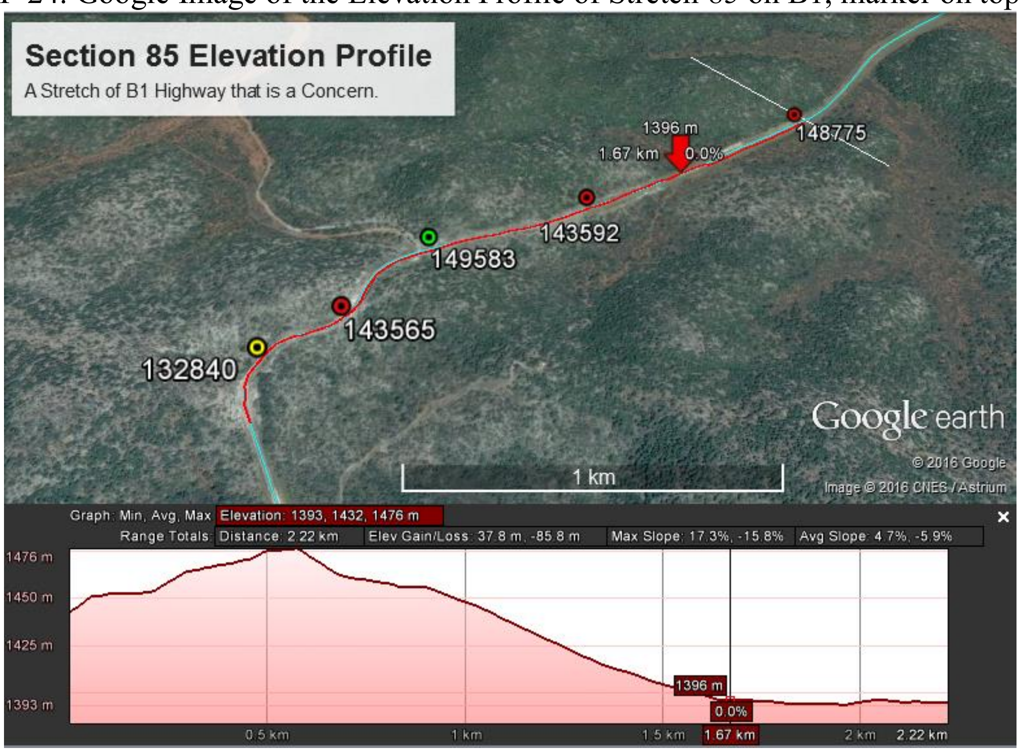

Figure F-25. Google Image of the Elevation Profile of Stretch 85 on B2, marker on end of hill.

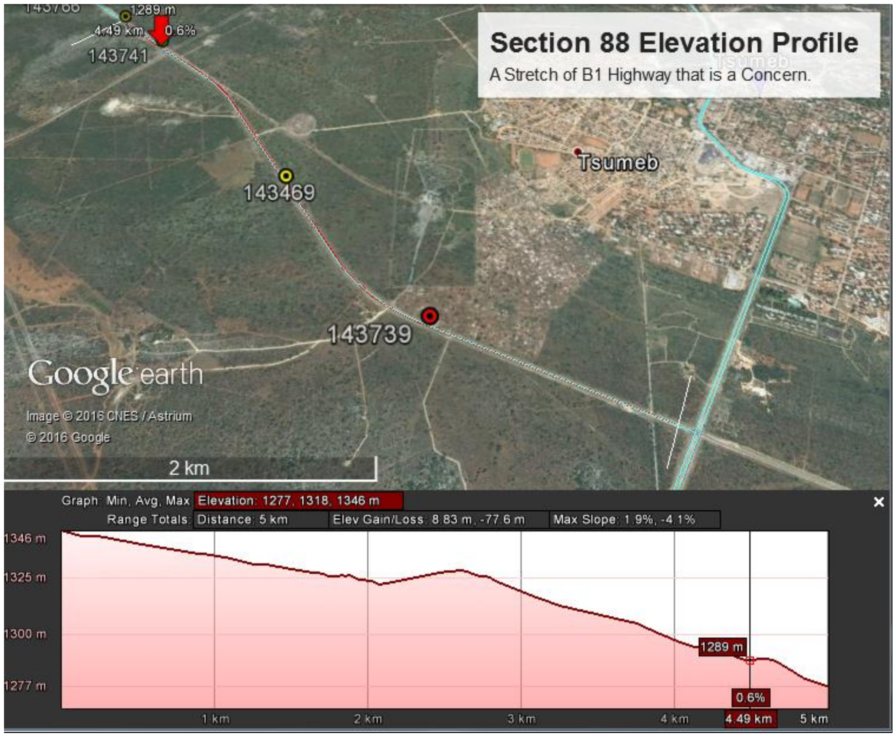

Figure F-26. Google Image of the Elevation Profile of Stretch 88 on B1, marker on accident 1.

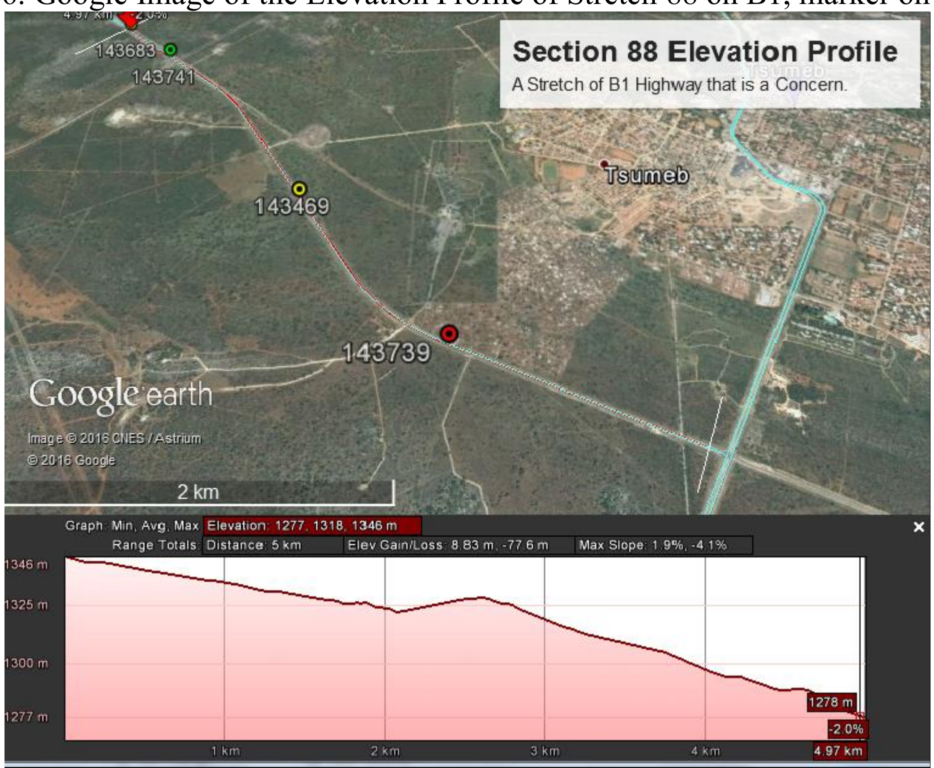

Figure F-27. Google Image of the Elevation Profile of Stretch 88 on B1, marker on accident 2.

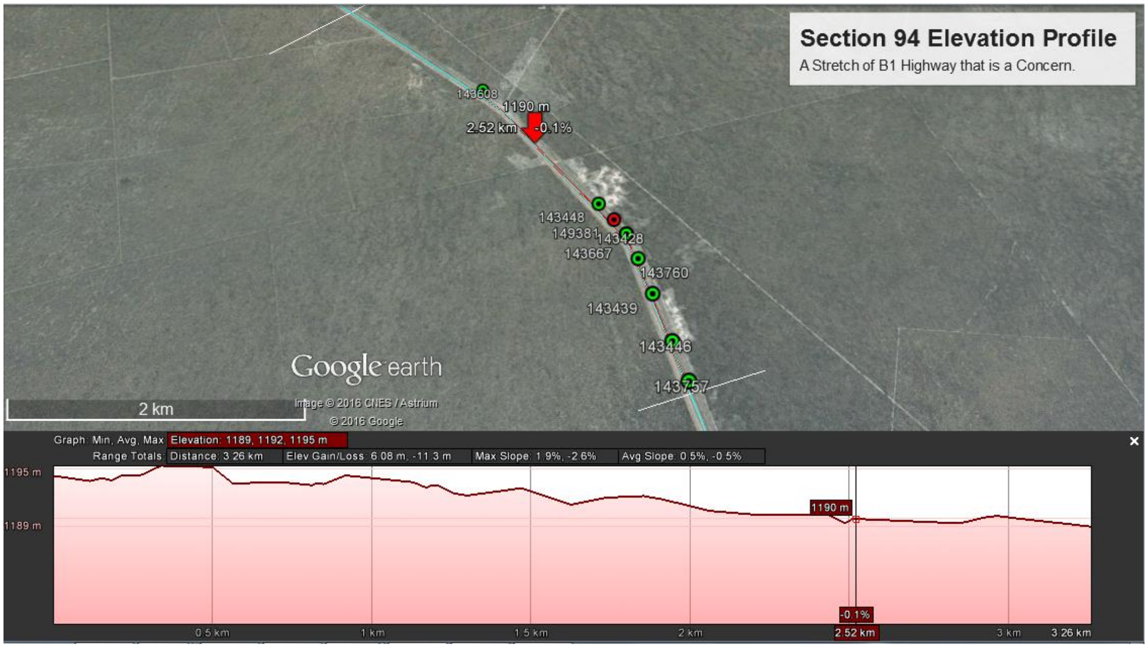

Figure F-28. Google Image of the Elevation Profile of Stretch 94 on B1, marker on flat terrain.

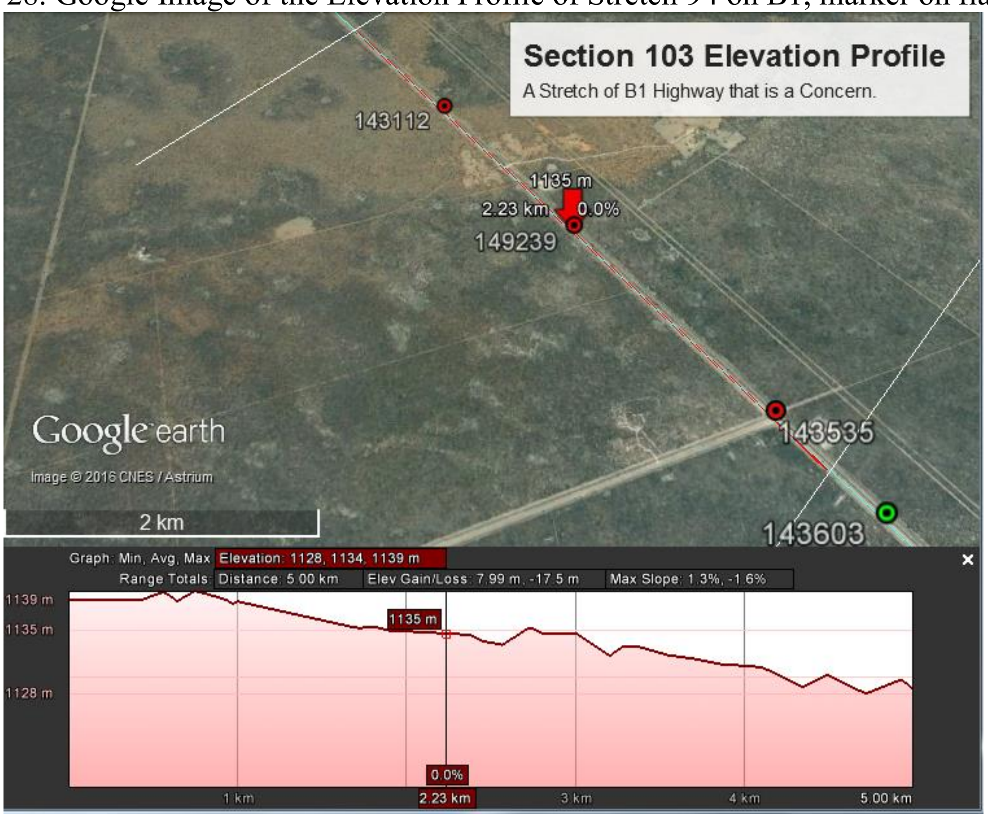

Figure F-29. Google Image of the Elevation Profile of Stretch 103 on B1, marker on accident 1.

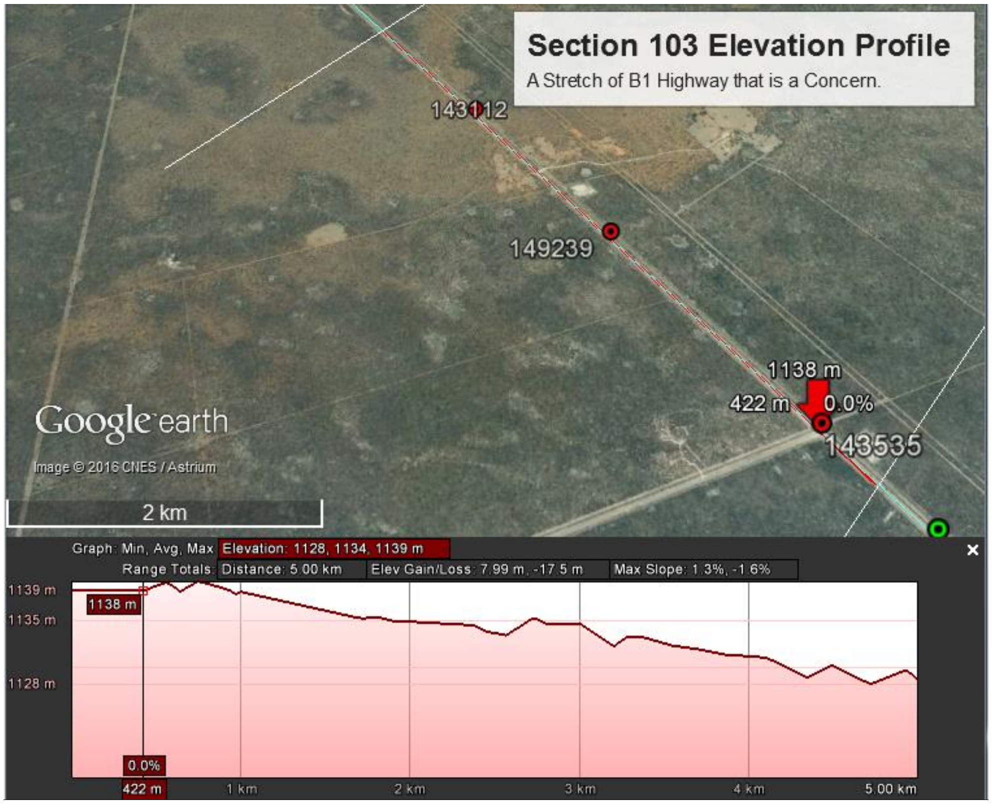

Figure F-30. Google Image of the Elevation Profile of Stretch 103 on B1, marker on accident 2.

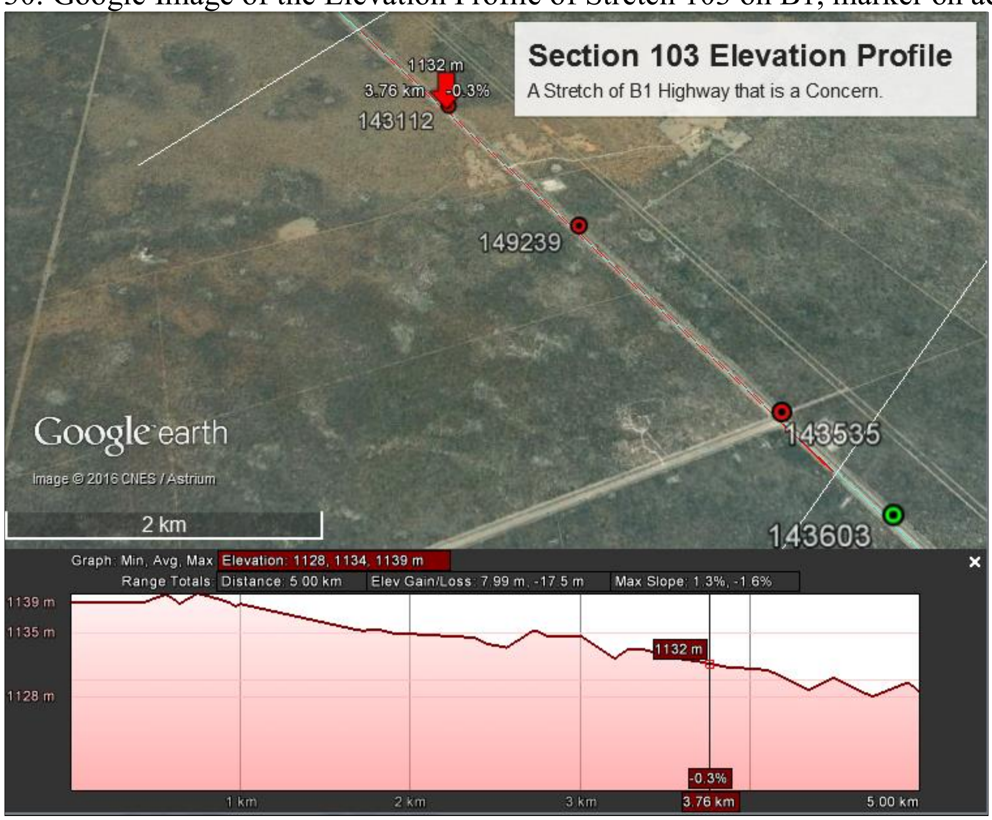

Figure F-31. Google Image of the Elevation Profile of Stretch 103 on B1, marker on accident 3.

Appendix G – Site Evaluations

Site: 22	B1
	T0106 35km west of Okahandja
Date: 2016/04/20	Time: 10:09
1.Road alignment	Comments
Visibility:sight distance	Good
Speed limit	120
Overtaking:delineation	Faded
Shoulders: steep decline	8 ft gravel shoulder with a 2 in dropoff
2. Signage	
General signs issues	No signage about upcoming curve No speed limit signs
Sign legibility	
Sign supports	
3. Road Markings and delineations	
General issues	Markings are faded.
Centrelines, edge lines	
Guide posts and reflectors	No reflectors
Curve warning and delineation	Not applicable, its straight road
4. Road reserve	
Clear reserve	
Fences	Low fence,1.5 meters
5. Pavememt	
Type	Paved
Skid resistance	Low
Ponding	none
Loose stones	none
Incline	flat, slight incline on curve
curvature	Southern side there is a curve
6. Other issues	
Surrounding area	Fencing is inadequate.
Animals	none visible
Speed Limit	120
Other:	
Recommendations:	Recommend high fence to restrict animal movement and speed limit signs. All accidents happened at night so impliment

	reflective signage and reflective tags on the road lines

Figure G-1. Site Evaluation Notes for Stretch 22

Site: 85	B1
[Location]	T0109 15km south of Tsumeb
Date: 2016/04/21	Time: 9:54 am
1.Road alignment	Comments
Visibility:sight distance	Limited visibility
Speed limit	80
Overtaking:delineation	Absence of No overtaking line
Shoulders: steep decline	north bound side 1 ft of backed gravel for tapering off and 8 ft of backed earth south bound just earth shoulder but 4 inch drop off
2. Signage	
General signs issues	Good and appropriate warning signs for incline, curve, no passing, and reflector tags. & guard rails on turns
Sign legibility	Good
Sign supports	Good
3. Road Markings and delineations	
General issues	The markings are fairly visible
Centrelines, edge lines	
Guide posts and reflectors	Yellow lines and reflectors present
Curve warning and delineation	No curve warning when facing north to south
4. Road reserve	
Clear reserve	Overgrown with grass.
Fences	Old and barely visible
5. Pavememt	
Type	Paved
Skid resistance	Fairly good
Ponding	None
Loose stones	None
Incline	Steep incline to the north
curvature	
6. Other issues	
Surrounding area	Land, brush
Animals	none present
Speed Limit	80
Other:	On turn: Guard rails, back and white curb, cant pass, rock on both sides. Signage: Curve, hill, no passing, speedlimit
Recommendations:	Clear the road reserve of grass and urge farmers to maintain their fences. Fix the fence/stronger fence

Figure G-2. Site Evaluation Notes for Stretch 85

Site: 88	B1
[Location]	T0110 10kms north of Tsumeb
Date: 21/04/2016	Time: 09:08
1.Road alignment	Comments
Visibility:sight distance	Limited
Speed limit	120
Overtaking:delineation	allowed
Shoulders: steep decline	No, but steep decline in road reserve
2. Signage	
General signs issues	No speed limit signs, no hazard marker signs,
Sign legibility	
Sign supports	
3. Road Markings and delineations	
General issues	Faded centrelines
Centrelines, edge lines	
Guide posts and reflectors	No reflectors
Curve warning and delineation	sharp curve warning signs
4. Road reserve	
Clear reserve	
Fences	
5. Pavememt	
Type	Paved
Skid resistance	low
Ponding	none
Loose stones	none
Incline	none
curvature	Straight but turns to the right heading north west, then continues strait
6. Other issues	
Surrounding area	Tall trees
Animals	none present
Speed Limit	120
Other:	A rear crash road crash involving two light delivery vehicles travelling in the northern-western direction. Cause of crash could be attributed to close following distance, wet road and sudden stopping. Minor injury. Low Fencing
Recommendations:	No overtaking line and signage would be recommended as there are curves at either ends of the road segment.

Figure G-3. Site Evaluation Notes for Stretch 88

Site: 94	B1
[Location]	T0110 40kms north of Tsumeb
Date: 21/04/2016	Time: 10:00
1.Road alignment	Comments
Visibility:sight distance	Good
Speed limit	120
Overtaking:delineation	
Shoulders: steep decline	Overgrown gravel side. No dropoff
2. Signage	
General signs issues	Good
Sign legibility	
Sign supports	
3. Road Markings and delineations	
General issues	Faded centrelines
Centrelines, edge lines	
Guide posts and reflectors	No reflectors
Curve warning and delineation	
4. Road reserve	
Clear reserve	Overgrown with grass
Fences	Old and shaggy
5. Pavememt	
Type	Paved
Skid resistance	low
Ponding	none
Loose stones	none
Incline	flat
curvature	Curve in the south eastern direction
6. Other issues	
Surrounding area	brush
Animals	none
Speed Limit	120
Other:	Benitho: I can see famers bringing cattle here to graze Broken fence, so animals can easily get through
Recommendations:	Recommend placement of guideposts,reflectors and hazard warning signs, i.e. Curve to the right or left. Fix the fence/stronger fence

Figure G-4. Site Evaluation Notes for Stretch 94

Site: 103	B1
75-80 km from Tsumeb	
Date: 04.21.2016	Time: 10:50 am
1.Road alignment	Comments
Visibility:sight distance	good
Speed limit	120
Overtaking:delineation	allowed
Shoulders: steep decline	March 17th 2016, new shoulder to get rid of drop off.
2. Signage	
General signs issues	none
Sign legibility	
Sign supports	
3. Road Markings and delineations	
General issues	Faint lines
Centrelines, edge lines	
Guide posts and reflectors	
Curve warning and delineation	
4. Road reserve	
Clear reserve	
Fences	Good condition
5. Pavememt	
Type	paved
Skid resistance	
Ponding	
Loose stones	
Incline	flat
curvature	strait
6. Other issues	
Surrounding area	Farm, railroad
Animals	none visible
Speed Limit	120
Other:	
Recommendations:	Signage for upcoming farm

Figure G-5. Site Evaluation Notes for Stretch 103

Site: 43	B2
105 km from C33 intersection with B2	
Date: 04.15.2016	Time: 11:30 am
1.Road alignment	Comments
Visibility:sight distance	good
Speed limit	100-120
Overtaking:delineation	allowed
Shoulders: steep decline	narrow, 4 inches between lines and edge
2. Signage	
General signs issues	no signs, 1 speed limit sign previous
Sign legibility	
Sign supports	
3. Road Markings and delineations	
General issues	
Centrelines, edge lines	good condition
Guide posts and reflectors	
Curve warning and delineation	none
4. Road reserve	
Clear reserve	
Fences	none
5. Pavememt	
Type	paved
Skid resistance	
Ponding	
Loose stones	Paved, raised 3 inches then drops off
Incline	Flat until after the turn Little beyond 105km there is a blind spot and dips and small turn Around 102km, there is a curve/hill/dip - Blind spot
curvature	Strait, then turns to right when heading east
6. Other issues	
Surrounding area	no civilization, dirt/gravel/sand mix
Animals	none
Speed Limit	120
Other:	Police= Narrow so people are more caution, but if there was a shoulder people would speed more Roads are made so things fall off the road When a Truck drove, one tire was over the center line and one was a foot away from the edge (Trucks cant fit)
Recommendations:	Mark license/penalized when speeding or raise insurance Drop speed limit

	Add shoulder Increase signage (Danger zone)

Figure G-6. Site Evaluation Notes for Stretch 43

Site: 20	B2
8km east from C33 (heading east)	
Date: 04.15.16	Time: 14:30
1.Road alignment	Comments
Visibility:sight distance	good
Speed limit	120
Overtaking:delineation	allowed
Shoulders: steep decline	5ft sholder, tapers off, the whole road is raised so major drop after sholder
2. Signage	
General signs issues	one sign for bridge
Sign legibility	
Sign supports	
3. Road Markings and delineations	
General issues	
Centrelines, edge lines	
Guide posts and reflectors	
Curve warning and delineation	
4. Road reserve	
Clear reserve	
Fences	yes
5. Pavememt	
Type	paved
Skid resistance	
Ponding	
Loose stones	
Incline	Flat until after the turn
curvature	Strait, then turns
6. Other issues	
Surrounding area	First a rest stop, then a farm on the right, just land on left, and a fence on the right
Animals	On turn there were cows and a person right on road side, on a blind spot,
Speed Limit	120
Other:	Could not see the animals, there were skid marks coming out of the rest stop
Recommendations:	more signage (farm up ahead), reduce speeding, manage animals

Figure G-7. Site Evaluation Notes for Stretch 20

Site: 9	B2
50km from site 9 (heading east)	
Date: 04.15.16	Time: 15:15
1.Road alignment	Comments
Visibility:sight distance	
Speed limit	
Overtaking:delineation	Passing isnt welcome, unless in double lane
Shoulders: steep decline	good!! 3ft and road is raised
2. Signage	
General signs issues	
Sign legibility	
Sign supports	
3. Road Markings and delineations	
General issues	good condition
Centrelines, edge lines	good condition
Guide posts and reflectors	no reflectors
Curve warning and delineation	none
4. Road reserve	
Clear reserve	
Fences	
5. Pavememt	
Type	paved
Skid resistance	good
Ponding	
Loose stones	
Incline	Two lanes going up hill, one lane going down. Decline, huge hill, then drop off (going east)
curvature	strait but blind
6. Other issues	
Surrounding area	bushes and empty land
Animals	none
Speed Limit	120
Other:	Passing lane is ending, people trying to pass just-one-more-car before the option to is over "At the bottome of the hill, left lane was moved to left so an additional lane could be added for an intersection exit Jones= the issue is the single lane, they still want to pass so they move over to the double lane."
Recommendations:	

Figure G-8. Site Evaluation Notes for Stretch 9

Appendix H – Site Images

Figure H-1.1. Stretch 9 on B2

Figure H-1.2. Stretch 9 on B2

Figure H-1.3. Stretch 9 on B2

Figure H-1.4. Stretch 9 on B2

Figure H-2.1. Stretch 20 on B2

Figure H-2.2. Stretch 20 on B2

Figure H-2.3. Stretch 20 on B2

Figure H-2.4. Stretch 20 on B2

Figure H-3.1. Stretch 43 on B2

Figure H-3.2. Stretch 43 on B2

Figure H-3.3. Stretch 43 on B2

Figure H-3.4. Stretch 43 on B2

Figure H-3.5. Stretch 43 on B2

Figure H-4.1. Stretch 22 on B1

Figure H-4.2. Stretch 22 on B1

Figure H-4.3. Stretch 22 on B1

Figure H-4.4. Stretch 22 on B1

Figure H-5.1. Stretch 85 on B1

Figure H-5.2. Stretch 85 on B1

Figure H-5.3. Stretch 85 on B1

Figure H-5.4. Stretch 85 on B1

Figure H-5.5. Stretch 85 on B1

Figure H-5.6. Stretch 85 on B1

Figure H-6.1. Stretch 88 on B1

Figure H-6.2. Stretch 88 on B1

Figure H-6.3. Stretch 88 on B1

Figure H-6.4. Stretch 88 on B1

Figure H-7.1. Stretch 94 on B1

Figure H-7.2. Stretch 94 on B1

Figure H-7.3. Stretch 94 on B1

Figure H-7.4. Stretch 94 on B1

Figure H-8.1. Stretch 103 on B1

Figure H-8.2. Stretch 103 on B1

Figure H-8.3. Stretch 103 on B1

Figure H-8.4. Stretch 103 on B1

Figure H-8.5. Stretch 103 on B1

Appendix I – Factor Analysis

Seasonality of Accidents: All Types	
Type	Count
Dry Season	425
Rainy Season	366

Seasonality of Accidents: Animal Accidents	
Type	Count
Rainy Season	175
Dry Season	149

AASI By Accident Type	
Type	AASI
Approach at angle: one or both turning	63.33333333
Head on	55
With pedestrian	50
Single vehicle overturned	48.42592593
With Fixed Object (Specify)	27.83783784
Turn right in face of oncoming traffic	25
Went off the road without rolling	17.5
Sideswipe: same direction	16.75675676
With animal (Specify)	16.74576271
Approach at angle: both travelling straight	15
With bird	10
With Stones	10
Other/unknown (Specify)	6.290322581
Sideswipe: opposite directions	5.454545455
Head/rear end	3.188405797

Count of Generalized Accident Types	
Accident Type	Count
With Animal	285
Collision with other Vehicle	143
Collision with Environment	48
Sudden Exit from Roadway	102
Other	128

Accident Count by Time of Day	
Time	Count
Day	176
Night	530

Vehicle Type By Accident	
Vehicle Type	Count
Motor car / Station wagon	379
Light delivery vehicle	254
GVM>3500 kg	27
Truck: Articulated	33
Minibus	23
Sedan Taxi	44
Bus	17
Midibus	22
Minibus Taxi	3
Motor Cycle: Above 125cc	4
Panelvan	4
Truck: Articulated multiple	42
Other	5

AASI For Road Width Accidents	
Type	AASI
Sideswipe: opposite directi	19.1
Single vehicle overturn	48.4
Went off road without rolli	17.5
Other	23.1

Vehicle Type by Acc. Count	
Vehicle Type	Count
Motor car / Station wagon	333
Light delivery vehicle	232
GVM>3500 kg	19
Truck: Articulated	31
Minibus	18
Sedan Taxi	32
Bus	13
Midibus	20
Minibus Taxi	3
Motor Cycle: Above 125cc	2
Panelvan	4
Truck: Articulated multiple	31
Other	2

Animal Accidets By Time of Day	
Time of Day	AASI
Day	11.58878505
Night	18.5046729

AASI By Generalized Acident Types	
Accident Type	AASI
With Animal	16.18012422
Collision with other Vehicles	35.18987342
Sudden Exit from Roadway	46.29310345
Other	31.11111111
Collision with Environment	28.92857143

Count of Animal Accidents By Time	
Time of Day	Count
Day	107
Night	214

Figure I-1. Factor Analysis

Appendix J – Tutorial for Data Creation

Tutorial 1: Data Creation

How to go from Raw Accident Data to a Concise Accident Table for Data Analysis

Since the data that comes from the raw accident reports contains information that is not useful for analysis of accidents, we must get it into a form that is usable for this purpose.

Attached to this tutorial should be an excel file. This file contains the Raw Accident Data as given to the WPI MVA team for 2013. This data is an as-is file, and no alterations have been made. The party using this tutorial should be aware that sensitive information is contained in this sheet, and should have permission from the relevant parties before use.

Step 1: Preparing the Final Data Table

Since this data sheet contains approximately 600 columns of information, we are now interested in finding what categories are needed for data analysis. The WPI Team used the following categories

ID	Date/time	Day of Week	Time Of Day	Police Station	Number of	Number of	Number of Severe
Number of Slight Injuries	Number of Non-	Junction Type	Road Type	Weather	Visibility	Light Condition	Road Surface
Road Surface Quality	Road Mark	Road Direction	Flat/Sloped	Traffic Control Type	Road Sign clearly visible	Sign condition	Obstructions
	Area Descriptio			Town Intersection	Town A Road	Town B Road	Direction Outside of Town
	Town Intersectio n Number		Vehicle A Number of Passengers	Vehicle A Position Before	Driver A Action Before	Vehicle A Model Year	
Vehicle B Number of Passengers	Vehicle B Position Before	Driver B Action Before			Vehicle C Number of	Vehicle C Position Before	Driver C Action Before
		Vehicle D Number of	Vehicle D Position Before Accident	Driver D Action Before	Vehicle D Model Year	Driver 1 Accident	Person1: Liquor/Drug Use
Driver 2 Accident	Person 2: Liquor/Drug Use	Driver 3 Accident	Person 3: Liquor/Drug Use	Driver 4 Accident	Person 4: Liquor/Drug Use Suspected		

The Team determined that these categories were appropriate for the purposes of both analyzing the accident causes, in addition to being able to map the accident data. These categories may not be all- inclusive for a detailed future analysis, so if the relevant analyzing parties feel more or less categories need to be added/removed, they may.

Since the raw accident data does not contain these more fleshed-out names, they must be extracted from the file names used in the raw accident data. For this purpose, the Team has laid out what we used for each category name in Row 1.

	date_time	day_of_week	time_of_day	police_station	no_vehicle	no_fatality
ID	Date/time	Day of Week	Time Of Day	Police Station	Number of Vehicles	Number of Fatalities

From Sheet "Step 1-Columns"

For future years' analyses, the names of the categories may have changed, so feel free to use judgement and best-guesses to make the categories line up to what is desired. An alternative to making the data fit the categories is to go through the data columns and choose the data columns that are desired.

Next we will get these columns from the accident data sheet into this new sheet.

VLOOKUP, A Short Explanation

Vlookup is a tool used by Microsoft Excel to quickly search through a table to identify a value in a column and return information from an indicated column to the right. We want to use this here to get a feel for the function, as it will prove very useful for future applications in this analysis.

The syntax for VLOOKUP is as follows:

=VLOOKUP(lookup_value,table_array,col_index
_num)

Where lookup_value is the value we are looking for, table_array is the table we are searching for the value, and col_index_num is the number of the column we are getting the information from.

To better understand this, we will now put the formula into practice. Copy the ID of any accident from the "2013 Accident Data" Sheet, and paste it into Cell A3 in the "Objective 1-Columns" Sheet.

	date_time	day_of_week	time_of_day	police_station	no_vehicle
ID	Date/time	Day of Week	Time Of Day	Police Station	Number of Vehicles
395					

Move one cell to the right into Cell B3, and type the following phrase:

=Vlookup(

This activates the function for use in excel. Now, we want to identify the value we are searching for. Either click Cell A3, or type it in to the equation. Cell A3 should now be selected. Type in a comma (,) to move onto the next part of the function.

The Equation Should now Look Like:

=Vlookup(A
3,

Now we will select the Table Array. Click onto the “2013 Accident Data” sheet tab, and then onto Cell A1. We will now select all of the accident data. Do this by holding the keys

Shift, Control, RightArrow

Followed by:

Shift, Control, DownArrow.

Making sure that the entire table is selected by the program. Now press Enter or Return, followed by another comma.

The Equation Should now Look Like:

=Vlookup(A3, '2013 Accident

Data'!A1:ATF19241, We will now talk about how we will select the

columns.

A powerful tool we can use is the MATCH function. By using this instead of typing in the column number, we are able to quickly expand the equation across all columns and rows in the table later on.

Match returns the position of a desired value in an array (table) of values.

Syntax for MATCH is as follows:

=MATCH(lookup_value,table_array)

If we type in

=MATCH(B1,

We will select the cell referring to “date_time” in Sheet “Objective 1-Columns”. Now we will select the array or table used. In Sheet “2013 Accident Data”, select on Cell A1, followed by a

Control Shift DownArrow

To select all of the column names for the accident data, followed by a comma and a 0 to ensure that the function gets an exact match. Press enter. This will produce the following:

MATCH(B1,'2013 Accident
Data'!A1:ATF1,0)

And return the number 2, the column number for the date_time column in the 2013 accident data, in the cell as a result.

Now, we will use this function in conjunction with the vlookup to dynamically get the column number. Type in

MATCH(B1,'2013 Accident
Data'!A1:ATF1,0)

For the third argument in the vlookup function to get the following complete function:

=Vlookup(A3, '2013 Accident Data'!A1:ATF19241,MATCH(B1,'2013 Accident Data'!A1:ATF1,0))

This will get the correct data for the date_time based on the ID given in cell A3. Try changing the ID to alternate values to verify this.

	date_time	day_of_week	time_of_day
ID	Date/time	Day of Week	Time Of Day
395	11:00:00PM		

Now, we will alter the formula to make it scalable to the entire data set. We do this by "locking" some aspects of the selected data. In Excel, this is done by putting a $ before the desired locked aspect.

If we wanted to lock Cell A1, we would have it read "$A$1". If we wanted to column to remain locked but have the row free to move, we would have it read "$A1", and "A$1" for the opposite.

Now, whenever we need to get the ID, we want the ID column to be selected, but the row to be free, so other IDs can be used in the same formula. So let us go back into the equation and change all references to A3 to be $A3. This gives us:

=Vlookup($A3, '2013 Accident Data'!A1:ATF19241,MATCH(B1,'2013 Accident

Data'!A1:ATF1,0)) Press enter to make sure that the same result as before appears.

Next we want to make sure that the ranges are the same for every cell instance. We will lock everything and make the equation read as follows:

=Vlookup($A3, '2013 Accident Data'!$A$1:$ATF$19241,MATCH(B1,'2013 Accident Data'!$A$1:$ATF$1,0))

Finally, we will lock the identifier for the column name. We want to only select the first row, but leave the actual column free to change, making the formula finally read:

=Vlookup($A3, '2013 Accident Data'!$A$1:$ATF$19241,MATCH(B$1,'2013 Accident Data'!$A$1:$ATF$1,0))

Now, make sure that Cell B3 reads the same as before, and drag out the equation to all the columns. Do this by clicking the small box in the bottom right of the highlighted cell, and dragging to the right until all data columns are selected.

Now, the data table should appear something like the following:

Now, we need to get the correct ID's that are in our regions of interest.

<u>Step 2: Getting the Proper Accident IDs</u>

To start, copy the entire ID Column from the "2013 Accident Data" Sheet by selecting Cell A2 and pressing Control Shift DownArrow, and copy this range to the clipboard (Control C or Command C). Go back to the "Step 1-Columns" Sheet and Navigate back to Cell A3. Paste the ID's into the cell (Control v or Command v), and watch as the equations are automatically extended to the new ID's, and the proper information is included. The "Step 1-Columns" Sheet should now look exactly like "Step 2-IDs". Verify this, and then select the entire data table, copy it to the clipboard by either pressing Control c

(Command C on mac), right clicking, and selecting Paste Cell Value (v). Doing this will Lock the table, and cut down on the size of the file. This step is entirely optional, but suggested.

Next, we will look at the regions that we are interested in. There is a file created by the Roads Authority that lists the official names of all roadways in Namibia (MAP). Select the road that you want to analyze. Here we used B1 and B2.

Take note of all towns along this route. Now, we will filter out the data set based on these towns.

<u>Filtering</u>

In column E of this tutorial (Police Station) you may notice a drop down arrow in Row 2.

Cell E2 with Drop Down arrow on far right

Clicking on this arrow will open up a menu similar to the following:

Uncheck the “(Select All)” tick box:

Doing this will unselect all the undesirable towns/police stations from our sheet. Now we will go through which towns we will select for our purposes.

The WPI Team, looking at B1 north of Windhoek had the following towns to analyze:

Katatura	Okahandja	Omuthiya	Ondangwa
Oshivello	Otavi	Otjiwarongo	Tsumeb
Windhoek			

For B2:

Arandis	Karibib
Okahandja	Swakopmund
Usakos	Walvisbay

Now, click on all of the corresponding tick marks for these or your identified towns. This will get you a list of all the accidents in the relevant towns.

<u>Step 3: Road Identification</u>

Next, we will identify which roads the accidents are on. We will do this in the following general format:

> IF(OR(AND("Police Station Cell"="Police Station Name 1", "Outside Town Direction Cell"="Correct Direction 1"), AND("Police Station Cell"="Police Station Name 2", "Outside Town Direction Cell"="Correct Direction 2")),"Road Name",IF(…

This format will allow us to systematically go through each town and determine which road the accident lies on, based on the town name and direction.

For example, looking at Okahandja for both B1 and B2. If an accident is South of the town, it is on T0106, if it is West the accident is on T0701, and if it is North, the accident is on T0107. This information can be gathered from the (MAP) file, as before.

After going through all accidents, the team developed the following code:

```
=IF(OR(AND(OR([@[Police Station]]="Katatura",[@[Police
Station]]="Windhoek"),[@[Direction Outside of Town]]="South"),AND([@[Police
Station]]="Swakopmund",[@[Direction Outside of Town]]="North"),AND([@[Police
Station]]="Otavi",OR([@[Direction Outside of Tow n]]="West",[@[Direction   Outside of
Town]]="East")),AND([@[Police Station]]="Otjiwarongo",[@[Direction Outside of
Town]]="West"),AND([@[Police Station]]="Otjiwarongo",[@[Direction   Outside of
Town]]="East"),AND([@[Police Station]]="Okahandja",[@[Direction Outside of
```

Town]]="East"),AND([@[Police Station]]="Tsumeb",[@[Direction Outside of Town]]="East")),"",IF(OR([@[Police Station]]="Windhoek",[@[Police Station]]="Katatura",AND([@[Police Station]]="Okahandja",[@[Direction Outside of Town]]="South"),[@[Police Station]]="Katutura"),"T0106",IF(OR(AND([@[Police Station]]="Okahandja",[@[Direction Outside of Town]]="North"),AND([@[Police Station]]="Otjiwarongo",[@[Direction Outside of Town]]="South")),"T0107",IF(OR(AND([@[Police Station]]="Otjiwarongo",[@[Direction Outside of Town]]="North"),AND([@[Police Station]]="Otavi",[@[Direction Outside of Town]]="South")),"T0108",IF(OR(AND([@[Police Station]]="Otavi",[@[Direction Outside of Town]]="North"),AND([@[Police Station]]="Tsumeb",[@[Direction Outside of Town]]="South")),"T0109",IF(OR(AND([@[Police Station]]="Tsumeb",OR([@[Direction Outside of Town]]="West",[@[Direction Outside of Town]]="North")),AND([@[Police Station]]="Oshivello",OR([@[Direction Outside of Town]]="East",[@[Direction Outside of Town]]="South"))),"T0110",IF(OR(AND([@[Police Station]]="Oshivello",OR([@[Direction Outside of Town]]="West",[@[Direction Outside of Town]]="North")),[@[Police Station]]="Omuthiya",[@[Police Station]]="Onankali",AND([@[Police Station]]="Ondangwa",OR([@[Direction Outside of Town]]="South",[@[Direction Outside of Town]]="East"))),"T0111",IF(OR(AND([@[Police Station]]="Ondangwa",OR([@[Direction Outside of Town]]="North",[@[Direction Outside of Town]]="West")),[@[Police Station]]="Engela",[@[Police Station]]="Oshikango"),"T0112",IF(OR([@[Police Station]]="WalvisBay",AND([@[Police Station]]="Swakopmund",[@[Direction Outside of Town]]="South")),"T0201",IF(OR(AND([@[Police Station]]="Swakopmund",[@[Direction Outside of Town]]="East"),[@[Police Station]]="Arandis",AND([@[Police Station]]="Usakos",OR([@[Direction Outside of Town]]="South",[@[Direction Outside of Town]]="West"))),"T0202",IF(OR(AND([@[Police Station]]="Usakos",OR([@[Direction Outside of Town]]="North",[@[Direction Outside of Town]]="East")),[@[Police Station]]="Karibib",[@[Police Station]]="Willhelmstal",AND([@[Police Station]]="Okahandja",[@[Direction Outside of Town]]="West")),"T0701","Err")))))))))))

Paste this formula, or develop your own, into the column titled: “Road Denotation”. This will collect all the proper road names for the towns along B1 and B2, and automatically assign the road to each correct road segment.

Severity Scores can be calculated in the following way. The assigned scores for each injury type were

Slight Injury	30
Severe Injury	50
Fatality	100

With a flat 10 points per accident.

The formula is

Total Severity=(Number of Slight*30+Number of Severe*50+Number of Fatalities*100)+10

We can do this in excel by setting the “Slight Severity” column to be equal to 30 multiplied by the number of slight injuries, and so on. We then sum the columns together, and add 10 points to get the net severity score.

We are then able to filter the “Road Denotation” Column (See above) to get the information we need for both Mapping (See Tutorial 2) and Data Analysis.

Appendix K – Script for ArcGIS Accident Mapping Lesson

Opening/Understand the Program

Hello, my name is Debora Lopes from Worcester Polytechnic Institute and I will be teaching you how to use the program ArcGIS to map accidents. First off, I will be teaching you the basics of the program so you can fully comprehend the essential functions. I will be using the software ArcMap, version 10.2.2. GIS stands for Geographic Information System and it is a program that allows the user to construct maps from geographic information.

As you see on the desktop of the computer, the program is in a shape of a globe with a magnifying glass. After clicking on it to start, you will be prompted with the "ArcMap – Getting Started" section. I will be clicking on "Blank Map" to start fresh; however, with this window you can open up saved maps like the ones I have saved here.

Learning the Basics

Now, that the program is open, I will show you some simple tools that you will need to know to map and analyze the accidents. It would be best if you follow along as I show you so you can fully comprehend what this program does.

Importing – First, I will show you how to import data layers, or more precisely shape files that you will need as a foundation for your map. Follow along where I go. Go to the yellow square with the plus sign, this will prompt you to add data. All my shape files are saved under a folder titled "Shape Files". I go to "Desktop" to "Shape Files" and then from there I am prompted with a bunch of different shape files. For accident mapping, I will need three specific shape files as a basis. I will need "Road Districts" which is the outline of Namibia along with all the Namibian Regions; "TrunkRoads9" which are the major routes in Namibia; "Towns" which are all the relevant cities along the B1 and B2 highways; and "Police Stations which are all the relevant police stations along the B1 and B2 Highways. Police Stations and Towns were modified to only include the cities on B1 and B2. There is a shape file of all towns and police stations in Namibia so when you need to assess accidents on different routes don't worry the file is out there. Also, all these data layers were provided by the Roads Authority.

Arranging – After these data layers are inserted, you can see them under the "Table Of Contents". The "Table of Contents" is where you can see all your data layers. It is also where you can select and deselect your data layers. A check mark next to a data layer means it is visible on the map. A non-check marked box means it is invisible. You can customize the data layers to arrange which can be shown and not shown on the map. You can change the order on which they appear under the "Table of Contents" "Layers" section. As you can see it is "Towns" on top then "Trunk Roads9" then "Road Districts". To change the order simply, drag the layer you want to the top. As you can see on the map it changes the order of how they appear thus it is crucial to know to always have the "bigger" or the file that is the bigger foundation on bottom then proceed in the order.

Attribute Table – These files include information that you can access at any time. If you right click a file and select "Open Attribute Table" something like this will appear. In this file for "TrunkRoads9" it includes the actual road name that the Roads Authority assigns it in this column; the beginning kilometer and ending kilometer in these columns, the district it is located in in this column and many others. This is attribute table is crucial because we will be making one for the accident file that we will be creating.

Coloring – Next is changing the color of the data layer you want. Simply click on square or circle or line that the file might be and this prompts you to the "Symbol Selector". From there on the right side is "fill color" click on that and you can select any color you would like. You can also adjust the size of your line file by changing the outline width. To adjust the size of your other files there is a section for "size" on the right hand side. If you want to change the shape of your "Towns" file click on any of the symbols on the left hand side. As you can see on the on the map, these changes are put into effect as soon as I click "OK". Understanding this is important because we will be changing the design of the accidents that we pinpoint.

Measure – Next, we will be learning how to use the measuring tool. This is tool allows you to measure the distance by drawing a line on the map, and it also allows you to measure areas and features; however for this project we will only be focusing on the distance. This will be used when plotting accidents because we will be measuring the distances from a town to an accident location. The tool is located on the homepage with the rule symbol with the arrows. After you select it, a small measure box will appear. Now to start measuring, click on the map where you want to measure the distance. For a more accurate measurement, it is best to zoom in using the zoom in function on the homepage and to have smaller segments rather than larger ones. I will now show you what I mean. After, I have zoomed in I will measure the distance between Tsumeb to Oshivello. Click on your starting point, now move along the road and click along the way. Make sure you click to accommodate the curves. As you can see in the measurement box as you click it will display the length of the segment which is the distance between your last two clicks and the length which is the total measured distance.

Merging – Next I will be teaching you about the geoprocessing tools. We will only be learning one of the geoprocessing tools called “Merge” the others are useful; however, for the scope of this mapping only “Merge” is necessary. This tool will be used after you have pinpointed the accidents on the map. However, it is important to learn the step now thus to learn this system I will be using one of my already made maps with accidents already pinpointed.

Data Extraction – Before we merge, we will need to extract data from a data layer. There are two ways you can do this and both methods will be used for accident mapping. The first method is to use the select tool on the tool bar. It is the blue and white box with the cursor. Select that tool and with it highlight the accidents you want to extract for example I will be extracting all the accidents between Walvis Bay and Swakopmund. After they are highlighted, I will right click on the “Accidents” layer. I will go to the “Data” tab and then click on “Export Data”. Name the file whatever you like but remember to name it something that will allow you to remember the data set. I will be naming it “WalvisSwakop_Accidents2015”. Click ok. This will prompt you to a window asking you whether you would like to export the data to the map as a layer. Select yes. This will export the selected data set onto the map as its own layer separate from the “accidents” layer. This will be useful later when you have all the exported data layers and will need to merge them.

The second option to extract data is to use the “Select (Analysis)” tool. To locate this tool, we must go to the geoprocessing tab and click on “Search For Tools” this will display a search bar for all tools on ArcGIS. Search for “Select”. Click on the “Select (Analysis)” tool. This will prompt a window with “Input Features” “Output Feature Class” and “Expression (optional)” to appear. In input features, we will input “Accidents” because that is our parameters. Once again, name the file something that will cause you to remember the data set. I will be naming this “HighRisk_Accidents2015”. The expression (optional) tab is what we will use to select the specific data we want to extract. There are many functions you can do with this but I will teach you the three because those are the ones that fall into the scope of accident mapping. Specifically for accidents, we want to know the “High Risk” “Medium Risk” and “Low Risk” accidents for this process. The severity score is what indicated whether it is “High Risk” “Medium Risk” or “Low Risk”. After, you have done the data analysis and found the severity score range for low, medium and high risk accidents then this is when you would divide the mapped accidents. For purposes of teaching you now, we will assume that “Low Risk” accidents are from 40 and below; “Medium Risk” accidents are from 40-90; and “High Risk” accidents are from 90 and above. In the Query Builder, scroll down until Severity appears. Select “Severity”. From there you can select “Get Unique Values” however, this is not relevant now because we will be using the greater than, less than and equal to functions thus knowing the values for severity scores are not needed.

First, we will be extracting the “Low Risk” accidents. There is a white box at the bottom, click on it to make sure it is selected. Then click on “Severity” this will prompt it to appear in the box. Then click on the “equal to and less than” symbol and then input 40. Click OK. This will input it into the “Expressions” box. Select OK. After a while, it will be inputted onto the map as a data layer with the name you gave it. You will repeat the same steps for Medium and High Risk Accidents. However, for Medium Risk you will input it as shown here. Select “Severity” then “equal to and greater than” 40 then AND then “severity” again then “equal to and less than” 90. This essentially is building a phrase selecting the accident data between 40 and 90 severity score. For “High Risk” you will input “Severity” then the “equal to and greater than” 90. This will give you the accident data above the 90 severity score.

All these data layers will be exported onto the map. After this, you can color and change the shape of the data to your pleasing. However, for the scope of accident mapping please color “Low Risk” green, “Medium Risk” yellow, and “High Risk” red. This data will not be used as an example for merging in this tutorial; however, it will be useful for merging when you want to construct a map of composite years.

Now, we will be learning about “Merging”. To reiterate, merging is useful when you want to combine multiple data layers into one layer. For this example, I have extracted multiple data layers primarily of accidents along the B2 route. We will be merging these files to create one data layer for all accidents on the B2 route. Thus to begin under the geoprocessing tab, click “Merge”. It will prompt you to a window with “Input Datasets” “Output Dataset” and Field Map (optional). We will only be working with the input and output. For this merger, we will input “WalvisSwakop_Accidents2015” “SwakopArandis_Accidents2015”

“ArandisUsakos_Accidents2015” “UsakosKaribib_Accidents2015” “KaribibOkahandja_Accidents2015”. We will name the file “B2Accidents_2015Year”. Remember to name the file something that will be useful to identify the data set. Click OK. This will export the file onto the map. After it is exported, you can change the color and shape of the layer to whatever you chose.

That is all the tools that you will need to know how to use for the scope of mapping accidents on ArcGIS. However, one hint before we move onto actually plotting accidents on the map. If somehow the “Table of Contents” “Search Box” or any of your tools on the homepage disappear they can be found under the “customize” and “windows” tabs. This is extremely useful because sometimes you can delete them from the homepage!

Plotting Accidents

After you have learned all the basics of the ArcGIS system, we will now we will begin plotting the accidents! First we must create a shape file. A shape file is a data layer in GIS that has geographic information along with other attributes for reference. To create a shape file, go to catalog on the right hand side of the program. Depending on where you want to save your shape file, you can select practically anything. For the purposes of this tutorial, we will be creating a shape file under “Documents”. Right click on documents and select “New”. Select “Shapefile”. This will prompt a box to open named “Create New Shapefile” with a “Name” “Feature Type” and Spatial Reference Section. We will only be worrying about the Feature Type and Name. Name the Shape File “Accidents” and whatever year you are pinpointing for. For sake of the project, I will pretend we are plotting for the year 2016. The feature type determines what type of shape file this will be. We will select “Point” due to the fact that we want to pinpoint one accident at a time. The other options are “polyline” “multipoint” and etc. which are useful for other types of files. Click OK. This will prompt you to another window which says you forgot GPS data, click OK. After that the new shape file will be established.

However, before we begin creating the accidents, we must first establish the attribute table for the information imputation. To create an attribute table, first right click on “Accidents 2016” and click “Open Attribute Table”. This will prompt the attribute table to open. Select the white box on the upper left hand corner, then select “Add Field”. We will be added multiple different fields. I will go through the steps to make each field. As you can see in the attribute table, there is already a section for ID thus we will not be making an Accident ID Field.

The first field we will make will be creating will be the date. After, we have selected "Add Field" it will prompt a window titled "Add Field" to appear with a section for "Name" "Type" and Field Properties. We will be naming it "Date" and will select the type Date. The type dictates the field property. Select OK. This will cause the field to be created.

The second field will be Time of Day, go through the same steps. However, name it TOD because we cannot spell out Time of Day in its entirety. Select the Field Type as long integer to be able to input up to 6 numbers. Time of Day and Date are two separate fields because when we go to analyze the map for different accident statistics Date and Time are two separate factors. In the field properties input the number 6. The precision entails the amount of numbers that can be inputted into this field.

The third field will be Day of Week, once again go through the same steps. Name it DOW. The field type will be text because you will be writing out the specific day of week with letters and not numbers.

The fourth field will be Accident Type. Name it ACC_Type. Also for this field the type will be text.

The fifth field will be the Severity Score. Name it Severity due to the entire name not being able to fit. The field for this will be Long Integer because of the capability to input larger numbers. In the precision box input the number 6.

The sixth, seventh and eighth fields will all be similar to one another. They are an extension of the severity score. The sixth field will be titled "Fatality" after the number of fatalities caused by the accident. The seventh field will be titled "SER_INJ" after the number of Serious Injuries caused by the accident. The eighth field will be titled "SLT_INJ" after the number of slight injuries caused by the accident. Each will be using the type "long integer" with approximately 6 as the precision. It does not matter how high the precision is; however, it does matter if it is too low thus it is always a good idea to input a large number for precision.

After establishing the attribute fields, we will finally start creating our accident pinpoints! I already have the editor toolbar established in my homepage; however, most of you will not thus you will need to access the editor toolbar. This can be found under the "Customize" tab, then under "toolbars". Click on EDITOR. This will prompt it to appear on your homepage. This editor toolbar will allow you to create and place the points on the map for the accidents.

Now click where it says “Editor” which will prompt the editing functions to open. Click on “Start Editing” this will prompt the “Start Editing” window to open. From here you will select the data layer you want to edit. We will be using the same data we created during this tutorial as an example. Click on “Accidents 2016” then click OK. You are now in editing mode.

Next, you must open the create features tab and the attributes tab. Under the same editing functions tab, go to “Editing Windows” this will open up a tab that will allow you to pinpoint the accidents on the map. In this window, select “Accident 2016” this will open up options in the “Construction Tools” at the bottom. The two options are “point” or “point at end of a line”. We will only be using point construction tool because we want to individually pinpoint each accident. Select “Point”, you will now see the same symbol for “Accident 2016” on the map.

The “Attributes” tab is located under the same “Editing Windows”. Select “Attributes”. This will cause a table to open that will allow you to input all the information for your attribute fields. This is important because this information is what will help you identify your accident later due to its different characteristics.

The process we used to establish the accidents on the map was to have an excel file with all the accident details already organized by town to town sections along with the data categories for the attributes and location identification. Here is an example of the excel data sheet, we used to help us locate the accidents.

To keep it simple, I will only be mapping an accidents from Swakopmund to Walvis Bay. The first example accident is 15km South of Swakopmund. To map this we will start at the city center of Swakopmund which is the blue circle on the map. We will open up the measure tool we have learned about previously and start measuring 15km south of Swakopmund. Once we have reached that location, we will place a point there. It will now be an established feature on the map. Once it is created, go to the attributes table and input the information for the accident. For this example, I will say that the accident occurred on January 1, 2016 at 1700 on Friday. It was an accident with an animal thus I will type in “with animal”. With a severity score of 100 with 3 slight injuries. Now that completes the accident! Congratulations, you have pinpointed your first accident!

From there you will continue to map all your accidents. After the accidents have been mapped. You will produce your Accident Map. From this map, you can create a severity map using the features I spoke about earlier with the select analysis tool. Also, you can create maps of just animal related accidents, accidents only on the weekends and etc. using the same select analysis tool.

This process is a lot of manual work with manual imputation of information as well as pinpointing accidents. This takes a long period of time, but as soon as you have the hang of it, the efficiency of pinpointing will be great.

Saving Work

Once, you have finished pinpointing your accidents or want to take a break. You must save the edits under the "editor" tool as well as save the entire document. To save your edits. Click the "Editor" tool and click either "Save Edits" or "Stop Editing". The first option will save your edits, but not close out of the editing function. The second option will prompt a window to open that says "Do you want to save your edits?" Select yes. This will save your edits and close the editing function.

It is crucial to save your edits due to the program closing sometimes. After you are done saving your edits remember to save the entire file.

Understanding the Difficulties

Before, we finish with this tutorial, I just want to inform you that ArcGIS does have some of its difficulties sometimes. The program does stop responding at times and can operate very slowly due to the large file sizes. Also, some glitches do occur. Do not stress because it will work out, just remember to save your work often!

Closing Remarks

Thank you so much for watching this tutorial! I hope it has been informative and you have learned how to use the software and how to map accidents on ArcGIS! If you have any questions about the procedure please reach out to MVAFUND16@wpi.edu. Thank you once again!