APPENDIX C

HISTORICAL CRASH EVALUATION

To:	City of Spearfish
From:	SRF Consulting Group
Date:	12/16/2025
Subject:	City of Spearfish Safety Action Plan – Historical Crash Evaluation

EXECUTIVE SUMMARY

The City of Spearfish is developing a comprehensive Safety Action Plan (SAP) to support and coordinate efforts to reduce the number of fatal and serious injury crashes within the city. The SAP is designed to evaluate how people get around the City, identify safety challenges, and prepare a comprehensive strategy to prevent fatal and serious injury crashes on city roads for people who walk, bike, roll, take transit, and drive. The Safety Action Plan report includes five sections:

1. What is a Safety Action Plan?
2. **Roadway Safety in Spearfish**
3. Community Outreach and Feedback
4. Vision and Goals
5. Implementation

This memorandum will inform the second section, Roadway Safety in Spearfish, in laying out the key findings of the historical crash evaluation in support of Plan recommendations in the Implementation Section.

WHAT IS INCLUDED IN THIS MEMORANDUM

A key step in developing the Safety Action Plan is analyzing the crashes that occurred in the city to gain a better understanding of where, when, and how those crashes occur. This memorandum lays out this evaluation in two parts:

- **Crash Trend Summary** – a review of historical (2020-2024) crash characteristics through the development of crash figures and tables.
- **High-Injury Network (HIN) Analysis** – identifies a subset of a road network that has been identified as having high concentrations of crashes that result in fatality and/or serious injury (herein referred to as “severe crashes”).

This evaluation is critical to addressing safety in Spearfish by providing a preliminary understanding of how, when, and how many crashes occurred in the City between 2020-2024.

KEY FINDINGS

From 2020 to 2024 with the City of Spearfish collection area, there were 1,439 reportable crashes, including 31 which involved fatal or serious (incapacitating) injuries. The City of Spearfish and the crash evaluation area with fatal, serious injury, and minor injury crashes is shown in **Figure 1**.

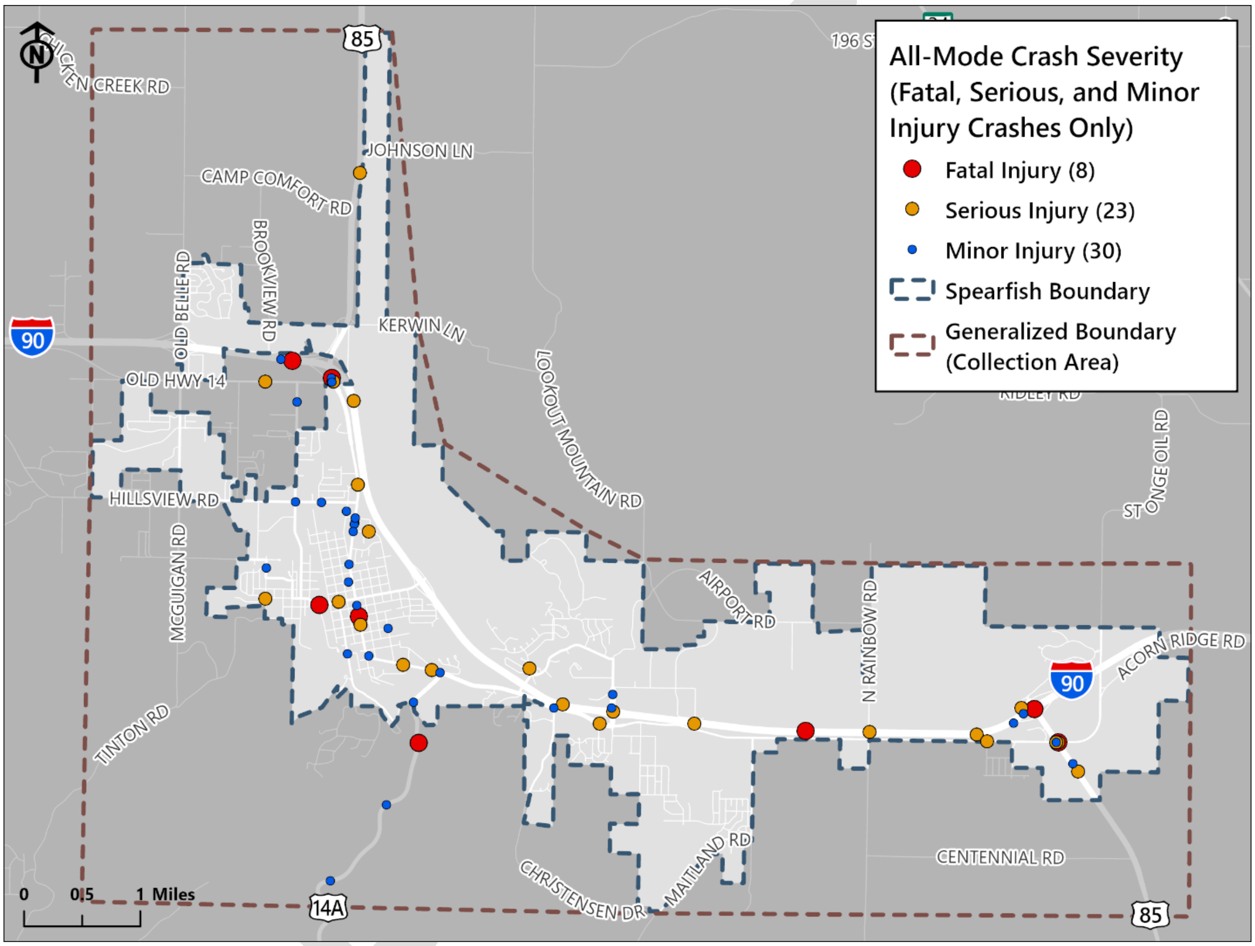

Figure 1: Crash Location Overview

Below are several key findings of the evaluation:

- Crashes at intersections (rather than segments between intersections) were more likely to result in fatal or serious injuries.
- Crashes that resulted in fatal or serious injuries were most likely to occur between 2 PM and 6 PM.
- The roads with the highest concentrations of crashes resulting in fatal or serious injuries are also the roads with some of the highest traffic volumes, such as North Ave/Main

St/Colorado Blvd (generally greater than 10,000 average daily traffic or ADT) and US 85 (over 6,000 ADT). Most of these roads also include four and five lane configurations.

- Despite their relative infrequency, crashes involving motorcyclists or nonmotorized modes (walking and biking) were far more likely than average to result in fatal or serious injuries.
- Given the low amount and dispersed nature of nonmotorized crashes, site or area-specific analysis of each nonmotorized crash is necessary in conjunction with public and stakeholder input.

The evaluation provides insights into historical crash data and contributing factors and will guide targeted strategies to reduce future crashes in Spearfish.

TYPES OF CRASHES

Table 1 includes descriptions of each of the codes and categorizes each into severe and non-severe groups. These include five crash severities that are used as a national standard when describing and reporting crash severity. Throughout the summary, the notation "severe" indicates crashes that resulted in fatal or serious injuries and "non-severe" indicates crashes that resulted in less serious injuries or no apparent injury crashes.

Table 1. Injury scale

Severe (more injurious)	Non-Severe (less injurious)
• fatal injury • serious injury	• minor injury • possible injury • no apparent injury

CRASH DATA SOURCE AND SETUP

The project team utilized crash data provided by the South Dakota Department of Transportation (SDDOT) for crashes that occurred in Spearfish city limits between 2020-2024. The data was provided to the project team in a multi-table format, with each table including crash-level, vehicle/unit-level, or person-level data. Each unit (a vehicle or a pedestrian) involved in a crash was assigned a crash mode based on the fields describing the unit type and configuration. The crash modes include:

- Passenger Automobile
- Heavy Vehicle (commercial/freight truck)
- Motorcycle
- Pedestrian
- Bicycle

In addition to the five modes listed above, units could be sorted into three additional mode types which were then excluded from analysis: other (people riding on/in ATVs, farm equipment, horses, etc.), parked/unoccupied automobiles, and hit-and-run automobiles. The crashes were then sorted into the three categories described in **Table 2** to denote whether they would be included in the calculations for the all-mode, nonmotorized, and/or motorized HIN categories.

Table 2. Modes of transportation and the modal HINs in which they are included

Modal Category	Modes Included
All-Mode	All
Nonmotorized	Bike and Pedestrian
Motorized	Passenger Automobile, Heavy Vehicle, and Motorcycle

After classifying each unit by mode and excluding units with atypical characteristics, such as units without occupants and units on which there was little to no information, the project team determined the Most Severe Injury (MSI) suffered by a person using each of the five modes of travel. The severity of injuries is denoted using a five-term scale outlined in **Table 1**, indicating the severity of the crash. As an example of assigning modal MSIs using the scale, if a passenger car with a driver and two passengers strikes a person walking in a crosswalk and the pedestrian is killed, the driver receives a non-incapacitating injury, and the two passengers are suspected of having minor injuries, the MSI for someone in an automobile would be a minor injury, the MSI for a pedestrian would be a fatality, and the MSI for the other modes (heavy vehicle, cyclist, and motorcycle) would be null. MSIs were also calculated for all modes, motorized only, and non-motorized only.

CRASH TREND SUMMARY

The purpose of the Crash Trend Summary is to aid in identifying patterns in the crash data and to spot key trends to better understand the cause behind recorded crash incidents in Spearfish. Assessing the severity of injuries in crashes is essential for evaluating crashes as a part of the Safe System Approach.

All the tables in the following section include seven data points in the columns:

- **Crash Variable Field** – the variable by which crashes are being grouped (e.g. year, roadway functional classification, speed limit, etc.)
- **Severe Crashes** – the number of severe crashes with a given value for the crash variable
- **Non-Severe Crashes** – the number of non-severe crashes with a given value for the crash variable
- **Subtotal Crashes** – the number of crashes of any severity with a given value for the crash variable

- **Severe Crashes Percent of Total Severe Crashes** – the proportion of the total severe crash count that the severe crashes with a given value for the crash variable account for. This metric is calculated by dividing the number of severe crashes with a given crash variable value by the number of severe crashes with any crash variable value. As seen in **Table 4** , the Severe Crashes Percent of Total Severe Crashes for single-vehicle crashesTable 4 is 42 percent (13 out of 31 total Severe crashes). This metric illustrates the relative frequency of severe crashes with a given value for the crash variable and allows for easier comparison between crashes with different values for the crash variable.
- **Subtotal Crashes Percent of Total Crashes** – the proportion of the total crash count (any severity) that the crashes with a given value for the crash variable (any severity) account for. This metric is calculated by dividing the number of crashes (any severity) with a given crash variable value by the number of crashes with any crash variable value (any severity). As seen in **Table 4**, the Subtotal Crashes Percent of Total Crashes for single-vehicle crashesTable 4 is 49 percent (699 out of 1,439 total crashes). This metric illustrates the relative frequency of crashes with a given value for the crash variable and allows for easier comparison between crashes with different values for the crash variable.
- **Severe Crashes Percent of Subtotal Crashes** – the proportion of the crash count (any severity) for a given crash variable value that the severe crashes with a given value for the crash variable account for. This is calculated by dividing the Severe Crashes column by the Subtotal Crashes column. As seen in **Table 4**, the Severe Crashes Percent of Subtotal Crashes for single-vehicle crashes Table 4is 2 percent (13 out of 699 single-vehicle crashes). This metric highlights the likelihood of a crash resulting in severe injuries when it does occur. As seen in **Table 3**, crashes involving passenger automobiles occurred almost 35 times more often than crashes involving motorcyclists (1,383 automobile-involved crashes vs 43 motorcyclist-involved crashes), but a crash involving a motorcyclist was 19 times more likely to result in a severe crash to a motorcyclist than crashes involving motorists were to result in a severe crash to a motorist (a 23% severe rate for motorcyclist-involved crashes vs a 1% severe rate for automobile-involved crashes).

CRASH FREQUENCY AND PARTIES INVOLVED

As seen in **Figure 2**, 1,439 crashes were recorded in Spearfish collection area limits between 2020 and 2024, equating to an average of 289 crashes per year. The majority of the 1,439 crashes resulted in property damage only, but 31 of them (2.2 percent of all crashes) resulted in at least one person involved receiving a fatal or serious injury. No apparent injury crashes were the most frequent (1,188 crashes) and accounted for 82 percent of the total crashes. Minor injury crashes were the second most frequent (111 crashes, 8 percent of total crashes), followed by possible injury crashes (109 crashes, 8 percent of total crashes), serious injury crashes (23 crashes, 2 percent of total crashes), and fatal injury crashes (8 crashes, less than 1 percent of total crashes).

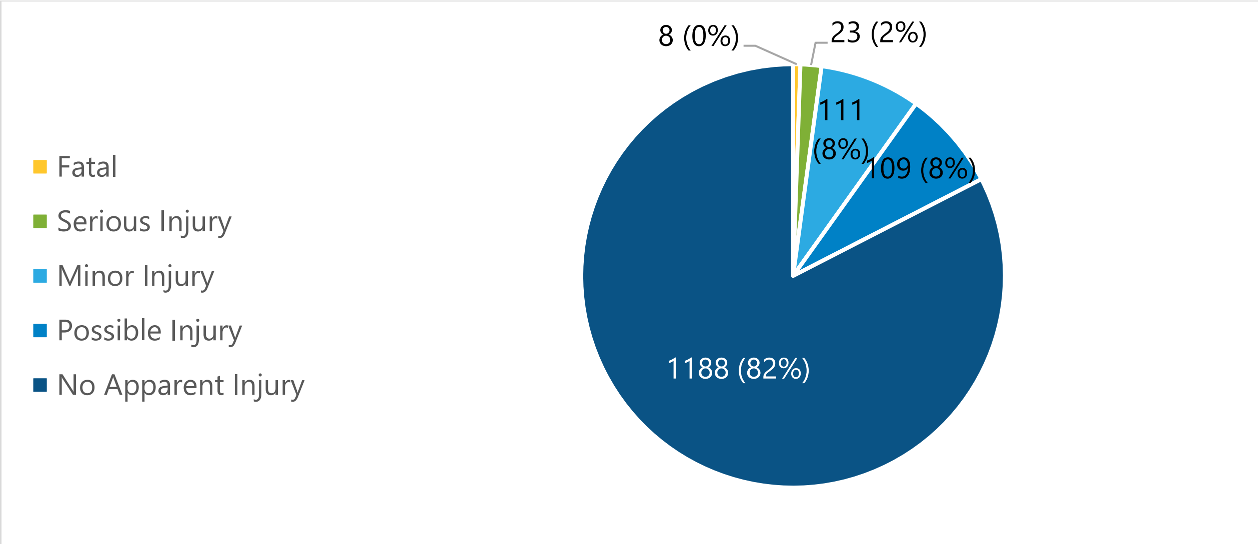

Figure 2. Breakdown of crash severity

As shown in **Figure 3** and **Table 3**, severe crashes most frequently involved automobiles (17 crashes), followed by motorcycles (10 crashes), and pedestrians (4 crashes). Non-severe crashes most frequently involved automobiles (1,366 crashes), followed by heavy vehicles (60 crashes), and motorcycles (33 crashes). Even though crashes involving passenger automobiles occurred almost 32 times more often than crashes involving motorcyclists (1,383 automobile-involved crashes vs 43 motorcyclist-involved crashes), a crash involving a motorcyclist was 19 times more likely to result in a severe crash to a motorcyclist than crashes involving motorists were to result in a severe crash to a motorist (a 23% severe rate for motorcyclist-involved crashes vs a 1% severe rate for automobile-involved crashes)

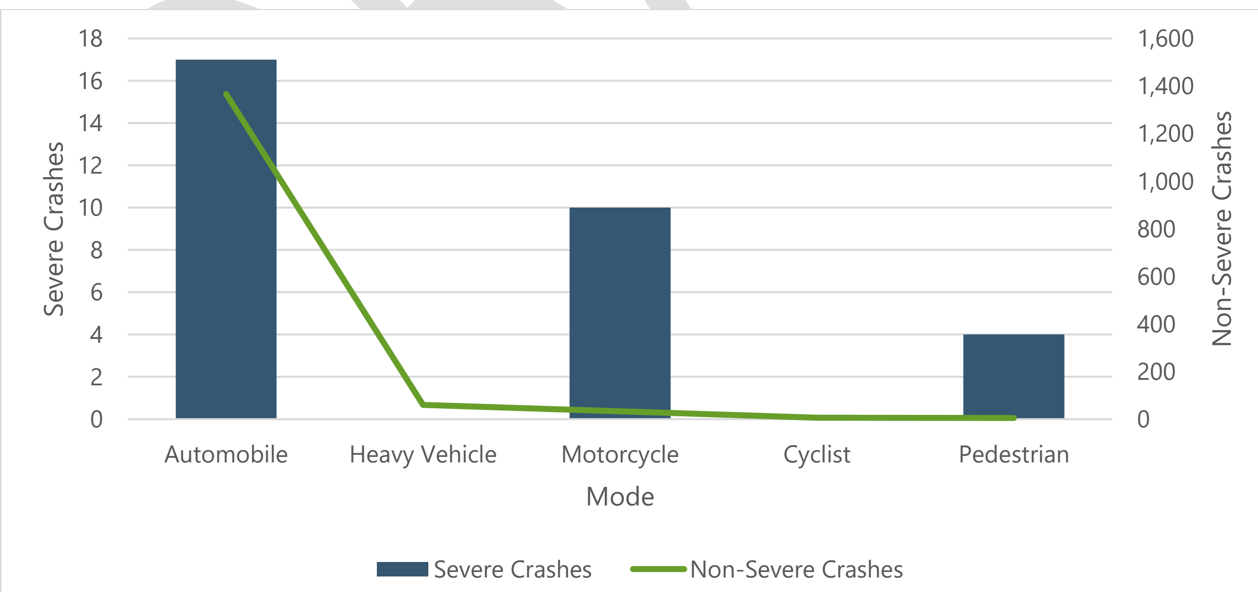

Figure 3. Crash severity by mode

Table 3. Crash severity by mode

Mode	Severe Crashes	Non-Severe Crashes	Subtotal Crashes	Severe Crashes Pct. of Total Severe Crashes	Subtotal Crashes Pct. of Total Crashes	Severe Crashes Pct. of Subtotal Crashes
Passenger Automobile	17	1,366	**1,383**	13%	95%	1%
Heavy Vehicle	0	60	**60**	0%	4%	0%
Motorcycle	10	33	**43**	8%	3%	23%
All Motorized	**27**	**1,411**	**1,438**	**21%**	**99%**	**2%**
Bicycle	0	6	**6**	0%	0%	0%
Pedestrian	4	5	**9**	3%	1%	44%
All Nonmotorized	4	11	**15**	3%	1%	27%
All Modes	**32**	**1,418**	**1,450**	**25%**	**100%**	**2%**

As seen in **Figure 4** and **Table 4,** severe crashes were most frequent with 2 vehicles/parties involved (14 crashes), followed by 1 vehicle/party involved (13 crashes), and 3 vehicles/parties involved (3 crashes). Non-severe crashes were most frequent with 2 vehicles/parties involved (699 crashes), followed by 1 vehicle/party involved (686 crashes), and 3 vehicles/parties involved (19 crashes). 33 percent (1 of 3) of crashes involving 5 or more vehicles/parties resulted in a severe crash, 14 percent of 3 vehicles/parties involved crashes resulted in a severe crash, and 2 percent of 1 and 2 vehicles/parties involved crashes resulted in a severe crash.

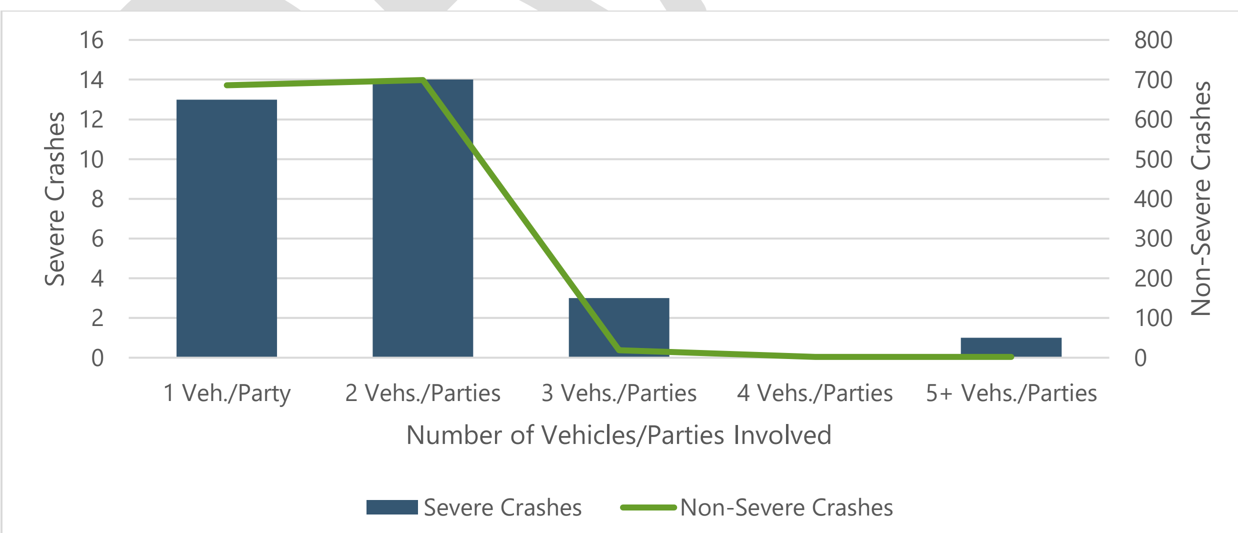

Figure 4. Crash severity by number of vehicles/parties involved

Table 4. Crash severity by number of vehicles/parties involved

Number of Vehicles/ Parties Involved	Severe Crashes	Non-Severe Crashes	Subtotal Crashes	Severe Crashes Pct. of Total Severe Crashes	Subtotal Crashes Pct. of Total Crashes	Severe Crashes Pct. of Subtotal Crashes
1 Veh./Party	13	686	**699**	42%	49%	2%
2 Vehs./Parties	14	699	**713**	45%	50%	2%
3 Vehs./Parties	3	19	**22**	10%	2%	14%
4 Vehs./Parties	0	2	**2**	0%	0%	0%
5+ Vehs./Parties	1	2	**3**	3%	0%	33%
Total	**31**	**1,408**	**1,439**	**100%**	**100%**	**2%**

TIME OF CRASH (YEAR, MONTH OF YEAR, DAY OF WEEK, HOUR OF DAY)

*As seen in **Figure 5** and **Table 5***

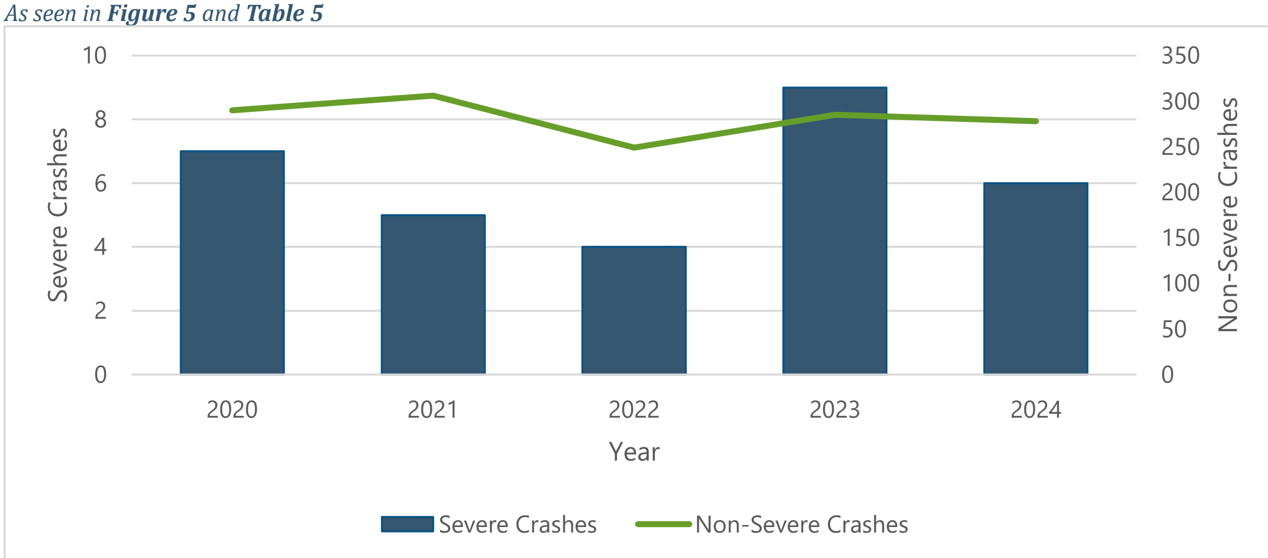

Figure 5. Crash severity by year

, Severe crashes were most frequent during 2023 (9 crashes), followed by 2020 (7 crashes) and 2024 (6 crashes). Non-severe crashes were most frequent during 2021 (306 crashes), followed by 2020 (290 crashes) and 2023 (285 crashes). Three percent of 2023 crashes resulted in a severe crash; 2 percent of 2020, 2021, 2022, and 2024 crashes resulted in a severe crash.

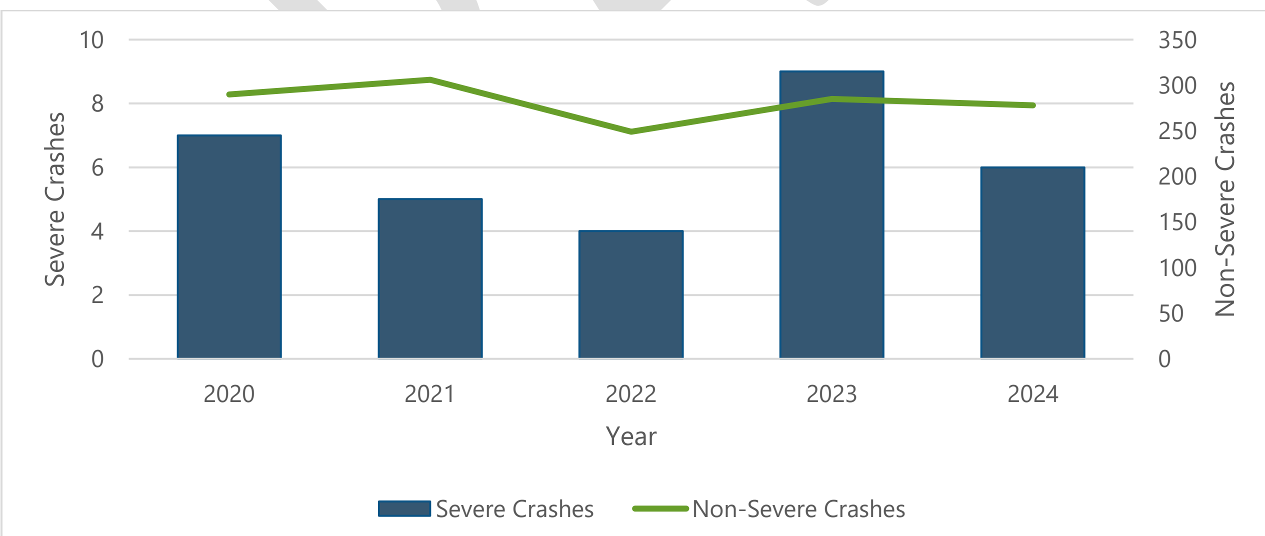

Figure 5. Crash severity by year

Table 5. Crash severity by year

Year	Severe Crashes	Non-Severe Crashes	Subtotal Crashes	Severe Crashes Pct. of Total Severe Crashes	Subtotal Crashes Pct. of Total Crashes	Severe Crashes Pct. of Subtotal Crashes
2020	7	290	**297**	23%	21%	2%
2021	5	306	**311**	16%	22%	2%
2022	4	249	**253**	13%	18%	2%
2023	9	285	**294**	29%	20%	3%
2024	6	278	**284**	19%	20%	2%
Total	**31**	**1,408**	**1,439**	**100%**	**100%**	**2%**

As seen in **Figure 6** and **Table 6,** severe crashes were most frequent during June (7 crashes), followed by August (6 crashes), April (4 crashes), and January (4 crashes). Non-severe crashes were most frequent during November (158 crashes), February (141 crashes), and December (139 crashes). Crashes in Junen and August were most likely to result in a fatal or serious injury with approximately 6 percent of crashes during those months resulting in fatal or serious injuries.

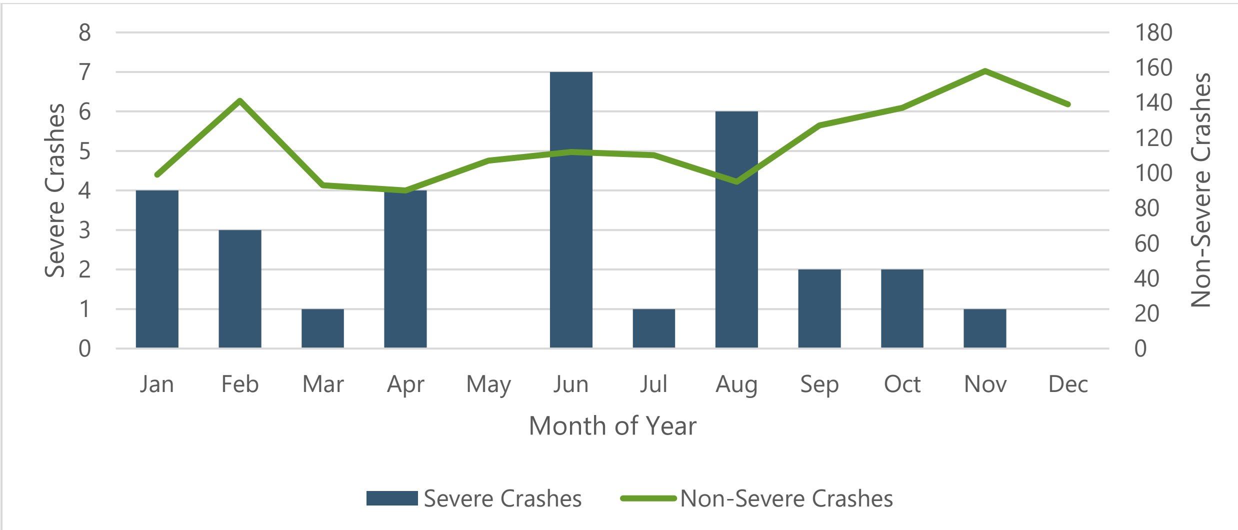

Figure 6. Crash severity by month of year

Table 6. Crash severity by month of year

Month of Year	Severe Crashes	Non-Severe Crashes	Subtotal Crashes	Severe Crashes Pct. of Total Severe Crashes	Subtotal Crashes Pct. of Total Crashes	Severe Crashes Pct. of Subtotal Crashes
Jan	4	99	**103**	13%	7%	4%
Feb	3	141	**144**	10%	10%	2%
Mar	1	93	**94**	3%	7%	1%
Apr	4	90	**94**	13%	7%	4%
May	0	107	**107**	0%	7%	0%
Jun	7	112	**119**	23%	8%	6%
Jul	1	110	**111**	3%	8%	1%
Aug	6	95	**101**	19%	7%	6%
Sep	2	127	**129**	6%	9%	2%
Oct	2	137	**139**	6%	10%	1%
Nov	1	158	**159**	3%	11%	1%
Dec	0	139	**139**	0%	10%	0%
Total	**31**	**1,408**	**1,439**	**100%**	**100%**	**2%**

As seen in **Figure 7** and **Table 7,** severe crashes were most frequent on Wednesdays (6 crashes) and Tuesdays (6 crashes), followed by Sundays (5 crashes), Thursdays (5 crashes), and Fridays (5 crashes). Non-severe crashes were most frequent during Fridays (242 crashes), Tuesdays (221 crashes), Wednesdays (219 crashes) and Mondays (211 crashes).

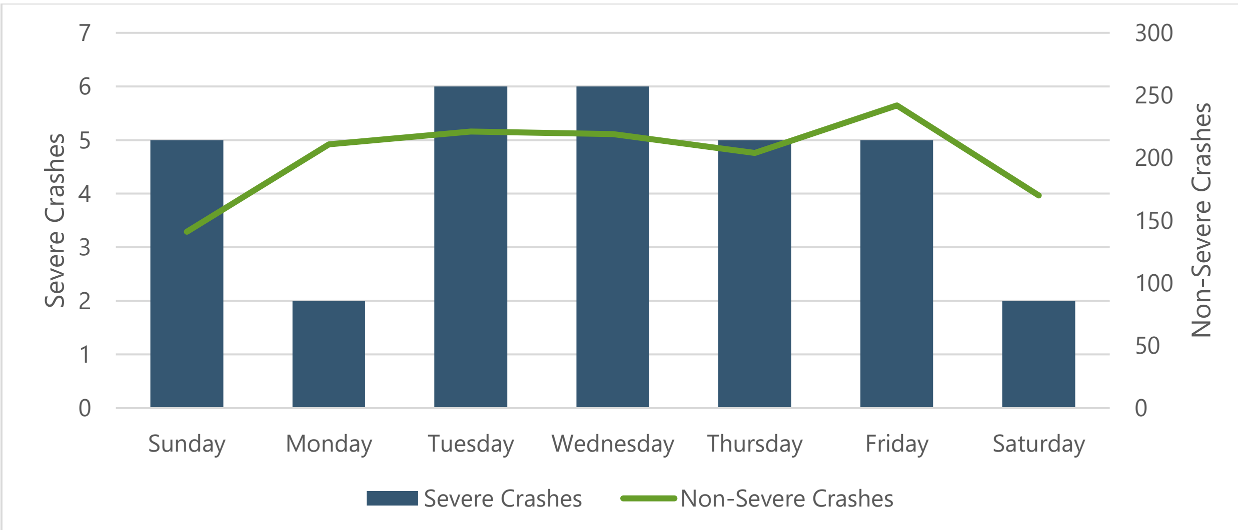

Figure 7. Crash severity by day of week

Table 7. Crash severity by day of week

Day of Week	Severe Crashes	Non-Severe Crashes	Subtotal Crashes	Severe Crashes Pct. of Total Severe Crashes	Subtotal Crashes Pct. of Total Crashes	Severe Crashes Pct. of Subtotal Crashes
Sunday	5	141	**146**	16%	10%	3%
Monday	2	211	**213**	6%	15%	1%
Tuesday	6	221	**227**	19%	16%	3%
Wednesday	6	219	**225**	19%	16%	3%
Thursday	5	204	**209**	16%	15%	2%
Friday	5	242	**247**	16%	17%	2%
Saturday	2	170	**172**	6%	12%	1%
Total	**31**	**1,408**	**1,439**	**100%**	**100%**	**2%**

As seen in **Figure 8** and **Table 8,** severe crashes were most frequent during 3 PM (5 crashes), followed by 6 PM (4 crashes), 4 PM (3 crashes), and 2 PM (3 crashes). Non-severe crashes were most frequent during 5 PM (139 crashes), followed by 4 PM (108 crashes), and 6 PM (96 crashes).

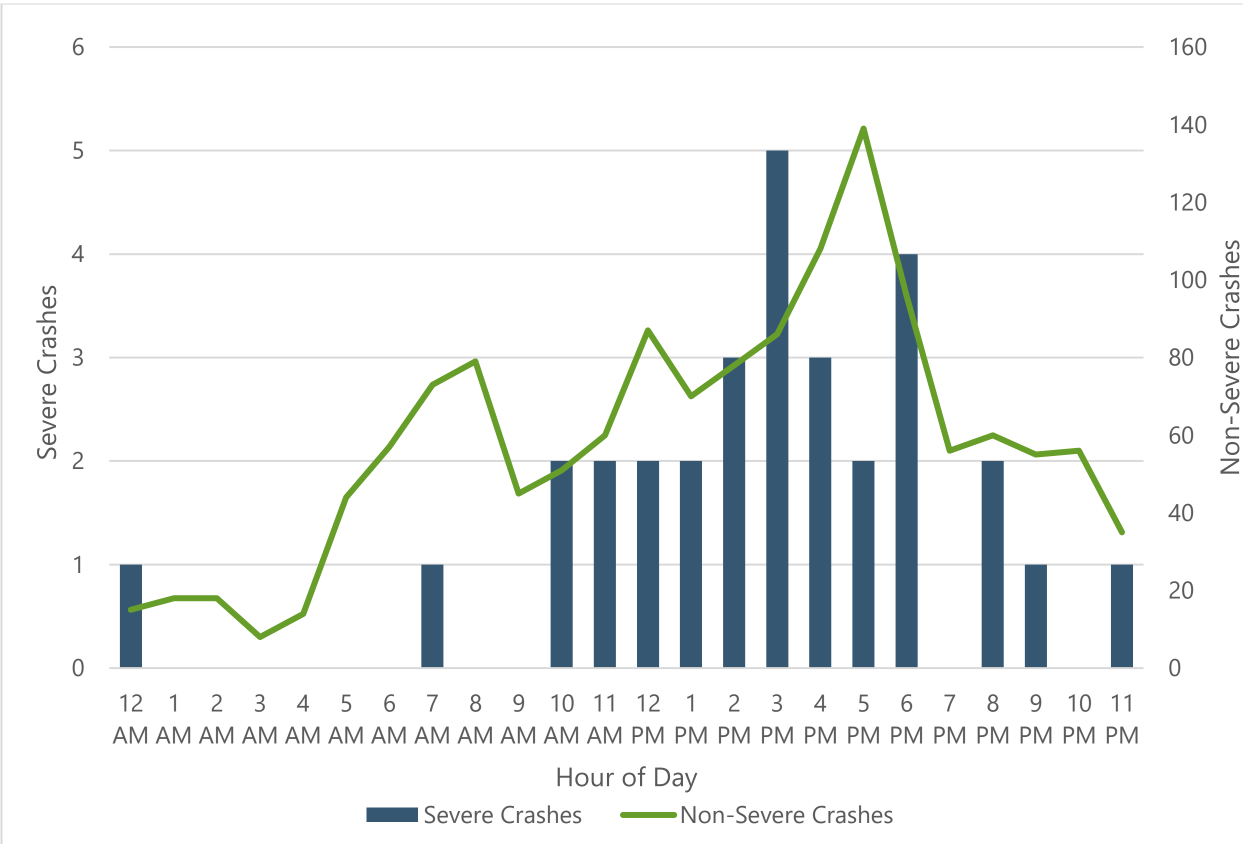

Figure 8. Crash severity by hour of day

Table 8. Crash severity by hour of day

Hour of Day	Severe Crashes	Non-Severe Crashes	Subtotal Crashes	Severe Crashes Pct. of Total Severe Crashes	Subtotal Crashes Pct. of Total Crashes	Severe Crashes Pct. of Subtotal Crashes
12 AM	1	15	**16**	3%	1%	6%
1 AM	0	18	**18**	0%	1%	0%
2 AM	0	18	**18**	0%	1%	0%
3 AM	0	8	**8**	0%	1%	0%
4 AM	0	14	**14**	0%	1%	0%
5 AM	0	44	**44**	0%	3%	0%
6 AM	0	57	**57**	0%	4%	0%
7 AM	1	73	**74**	3%	5%	1%
8 AM	0	79	**79**	0%	5%	0%
9 AM	0	45	**45**	0%	3%	0%
10 AM	2	51	**53**	6%	4%	4%
11 AM	2	60	**62**	6%	4%	3%
12 PM	2	87	**89**	6%	6%	2%
1 PM	2	70	**72**	6%	5%	3%
2 PM	3	78	**81**	10%	6%	4%
3 PM	5	86	**91**	16%	6%	5%
4 PM	3	108	**111**	10%	8%	3%
5 PM	2	139	**141**	6%	10%	1%
6 PM	4	96	**100**	13%	7%	4%
7 PM	0	56	**56**	0%	4%	0%
8 PM	2	60	**62**	6%	4%	3%
9 PM	1	55	**56**	3%	4%	2%
10 PM	0	56	**56**	0%	4%	0%
11 PM	1	35	**36**	3%	3%	3%
Total	**31**	**1,408**	**1,439**	**100%**	**100%**	**2%**

LIGHTING CONDITIONS

As seen in **Figure 9** and **Table 9**, severe crashes were most frequent during daylight conditions (25 crashes), followed by dark lighted conditions (3 crashes), and dark unlighted conditions (2 crashes). Non-severe crashes were most frequent during daylight conditions (840 crashes), followed by dark unlighted conditions (318 crashes) and dark lighted conditions (155 crashes). Three percent of daylight and sunset crashes resulted in a severe crash, 2 percent of dark (lighted) and sunset crashes resulted in a severe crash, and 1 percent of dark (not lighted) crashes resulted in a severe crash. Note that 12 out of 15 total nonmotorized crashes (80%) occurred in daylight conditions.

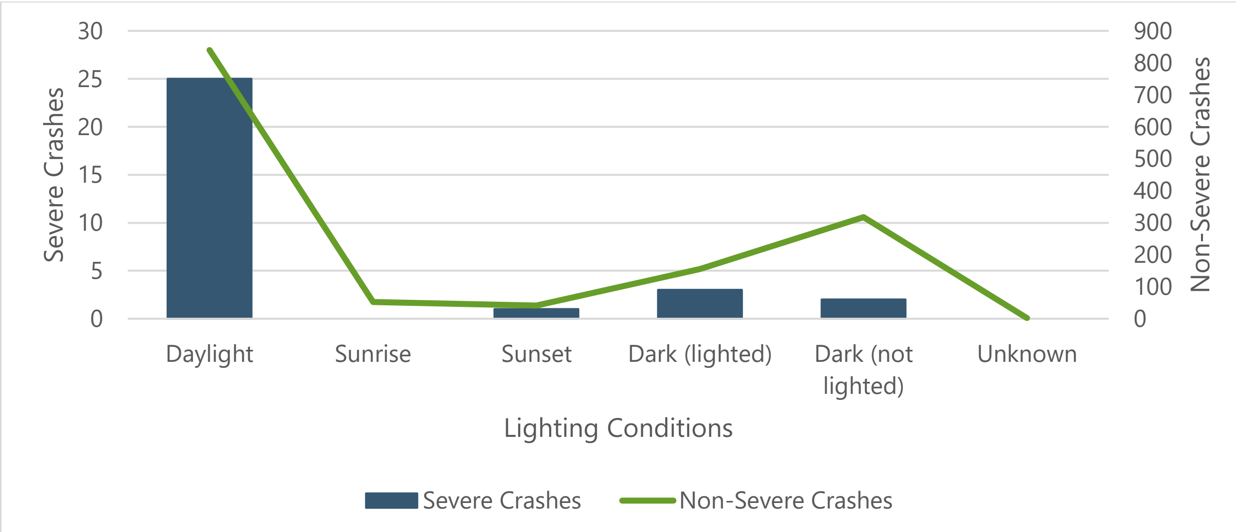

Figure 9. Crash severity by lighting conditions

Table 9. Crash severity by lighting conditions

Lighting Conditions	Severe Crashes	Non-Severe Crashes	Subtotal Crashes	Severe Crashes Pct. of Total Severe Crashes	Subtotal Crashes Pct. of Total Crashes	Severe Crashes Pct. of Subtotal Crashes
Daylight	25	840	**865**	81%	60%	3%
Sunrise	0	52	**52**	0%	4%	0%
Sunset	1	41	**42**	3%	3%	2%
Dark (lighted)	3	155	**158**	10%	11%	2%
Dark (not lighted)	2	318	**320**	6%	22%	1%
Unknown	0	2	**2**	0%	0%	0%
Total	**31**	**1,408**	**1,439**	**100%**	**100%**	**2%**

MANNER OF CRASH

Manner of crash includes an "other" category, which includes crashes such as single vehicle run off road crashes, animal hits, and other crashes that only involved one vehicle/party. As seen in **Figure 10** and **Table 10**, aside from the 'other' category, severe crashes were most frequent at an angle (9 crashes), front to rear collisions (2 crashes), sideswipe opposing direction (1 crash) and sideswipe same direction collisions (1 crash). Review of the HIN corridors helps to understand the context surrounding the higher percentage of angle crashes, for example if they are the result of intersection movements and, if so, specific intersections within HIN corridors.

Nine percent of sideswipe (opposing direction) crashes resulted in a severe crash, 3 percent of angle crashes resulted in a severe crash, 1 percent of front to rear (rear end) crashes resulted in a severe crash, and 1 percent of sideswipe (same direction) crashes resulted in a severe crash. Over half (18 crashes) of all severe crashes in Spearfish had a manner of collision categorized as "other".

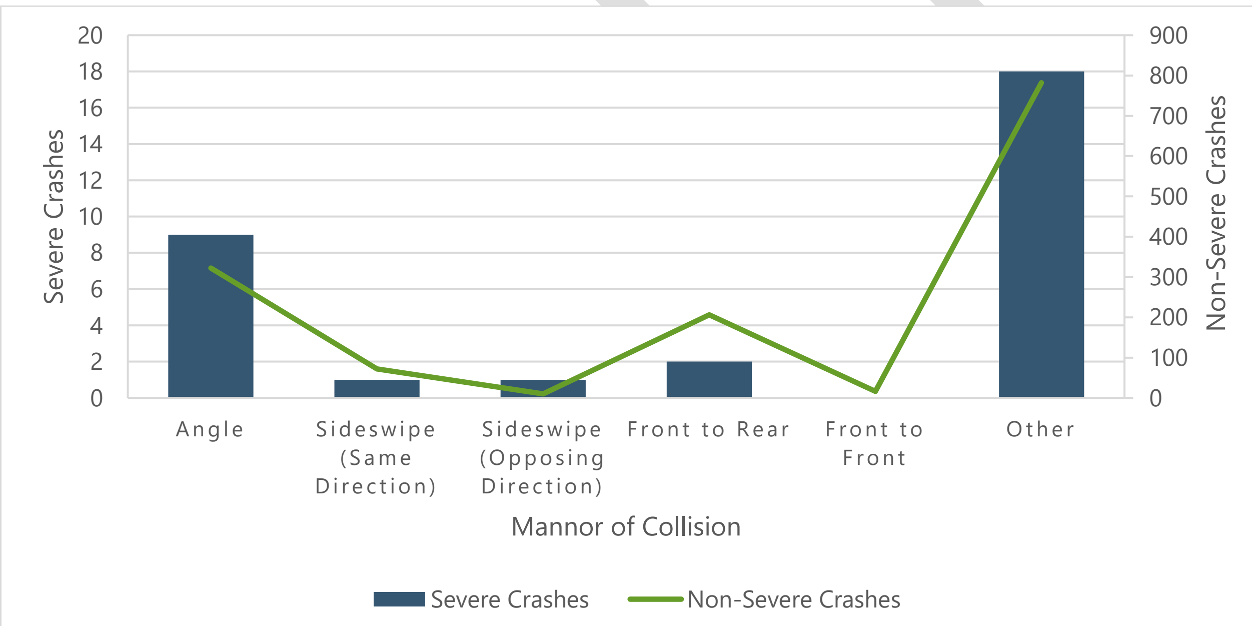

Figure 10. Crash severity by manner of collision

Table 10. Crash severity by manner of collision

Manner of Collision	Severe Crashes	Non-Severe Crashes	Subtotal Crashes	Severe Crashes Pct. of Total Severe Crashes	Subtotal Crashes Pct. of Total Crashes	Severe Crashes Pct. of Subtotal Crashes
Angle	9	322	**331**	29%	23%	3%
Sideswipe (Same Direction)	1	72	**73**	3%	5%	1%
Sideswipe (Opposing Direction)	1	10	**11**	3%	1%	9%
Front to Rear	2	206	**208**	6%	14%	1%
Front to Front	0	16	**16**	0%	1%	0%
Other (including single-vehicle crashes)	18	782	**800**	58%	56%	2%
Total	**31**	**1,408**	**1,439**	**100%**	**100%**	**2%**

CRASH LOCATION

As seen in **Figure 11**, severe crashes were concentrated on some of the streets and intersections with the highest Annual Average Daily Traffic (AADT) in Spearfish. U.S. Highway 85 and Interstate 90 (I-90) areas near intersections/interchanges, I-90 Business Route or Colorado Blvd., North Ave., N. Main St., Jackson Blvd, and Hillsview Rd. stand out as corridors with higher crash severities compared to the rest of the system.

Figure 12 shows that crashes of all severities are concentrated on high AADT streets, but they appear to follow a different distribution than the severe crashes. These differences in the distributions of severe crashes and all crashes highlight the need for an HIN that solely focuses on severe crashes. The HIN Analysis conducted as part of this evaluation will be critical to identifying locations with high densities of fatal and serious injuries and prioritizing streets in Spearfish where strategies can have the largest impact toward saving lives.

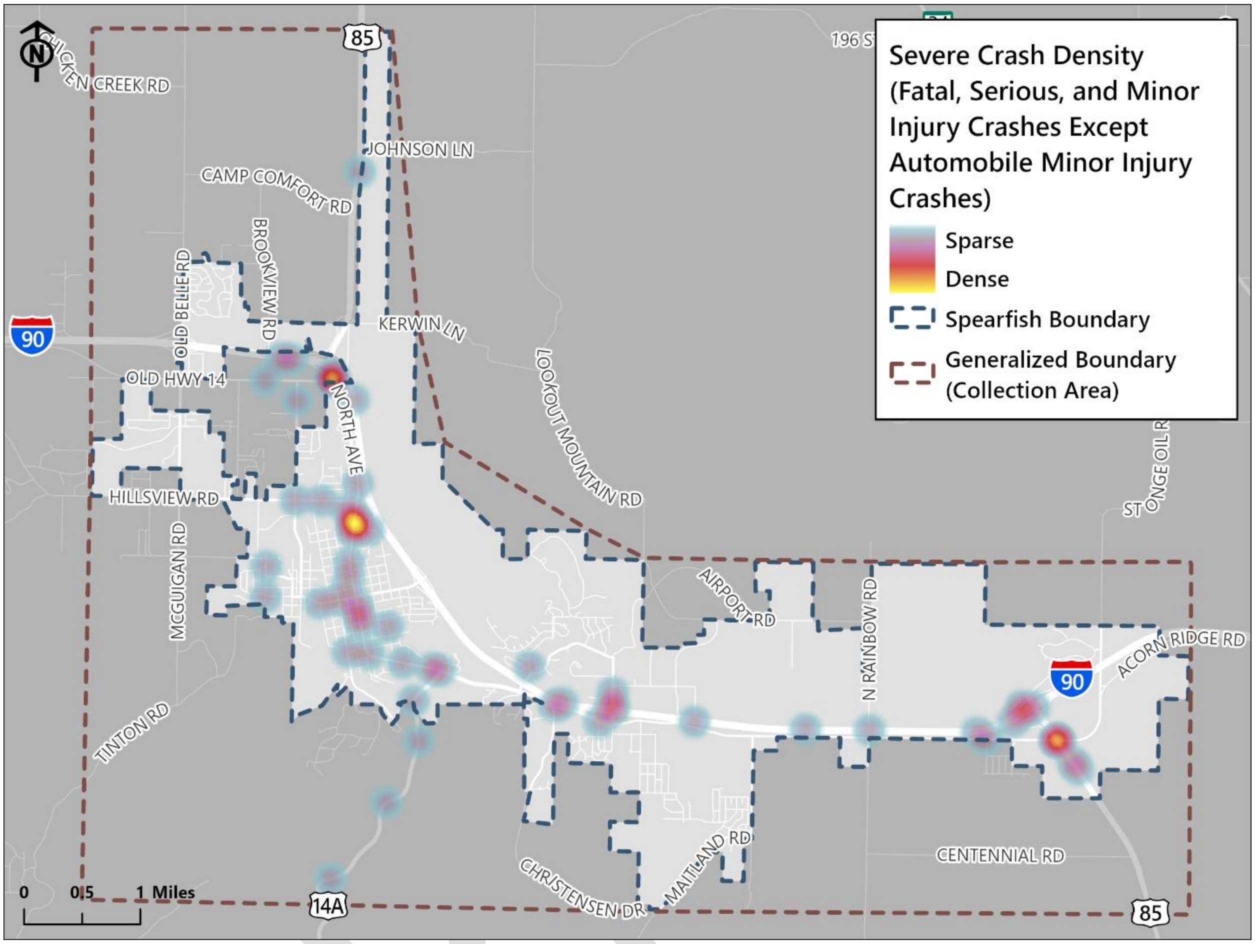

Figure 11. All mode severe crash heat map

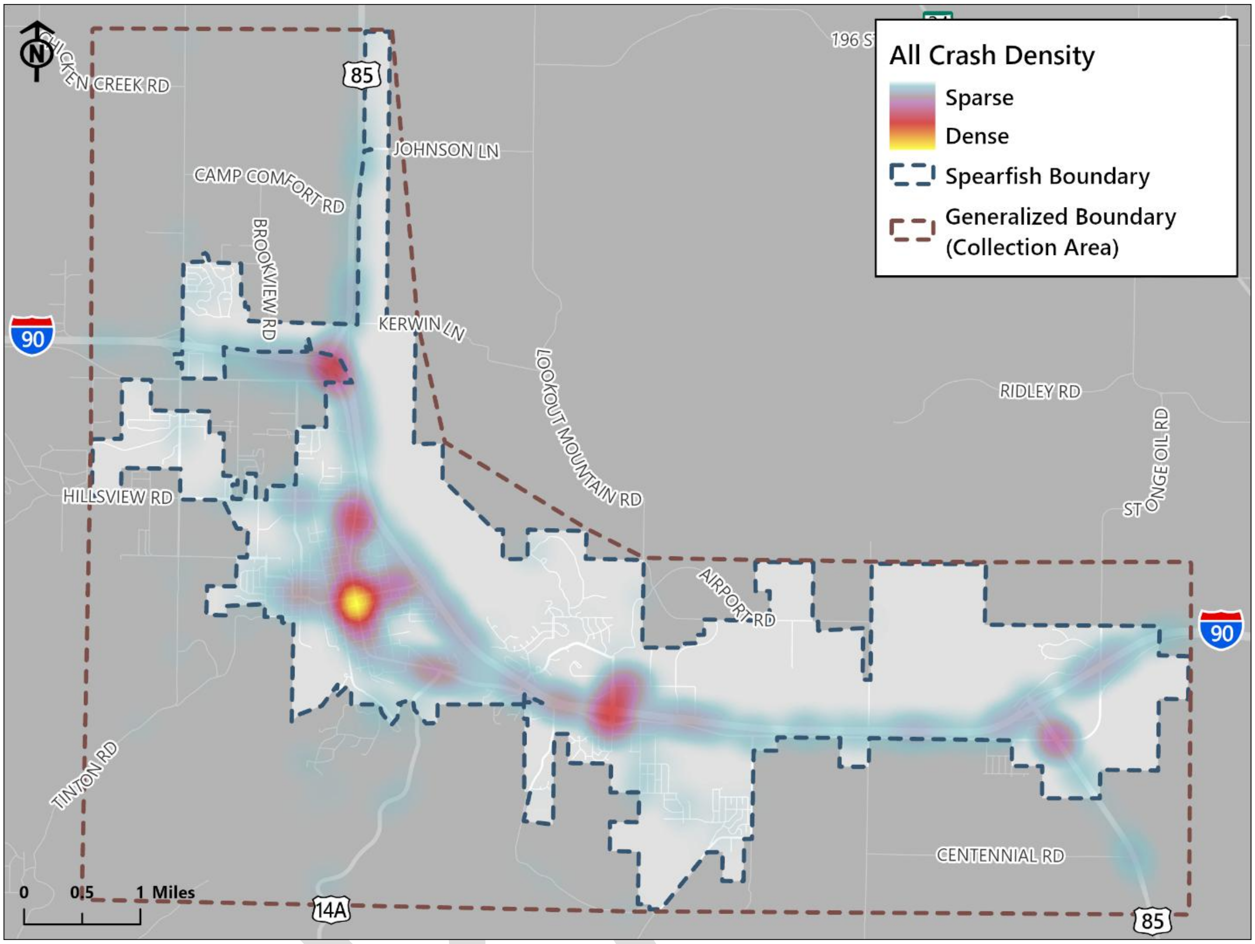

Figure 12. All-mode crash heatmap

Crashes were also categorized as taking place at an intersection or on a segment between intersections. Crashes located within 50 meters (about 164 feet) of an intersection were considered intersection crashes, and crashes located within 50 meters of a segment but more than 50 meters from any intersection were considered segment crashes.

As shown in **Figure 13** and **Table 11**, crashes were fairly evenly split between segments (46 percent of all crashes) and intersections (53 percent of all crashes), but segment crashes were more likely to result in a severe crash than intersection crashes were (3 percent and 2 percent of segment and intersection crashes, respectively, resulted in a severe crash).

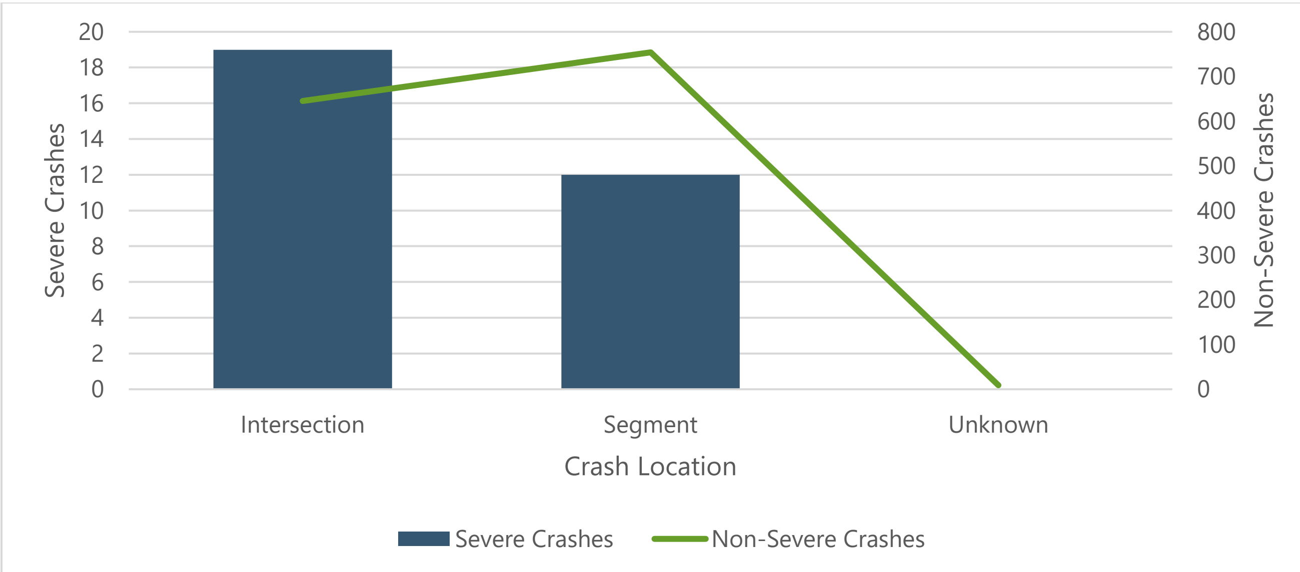

Figure 13. Crash severity by crash location

Table 11. Crash severity by crash location

Crash Location (Intersection vs. Segment)	Severe Crashes	Non-Severe Crashes	Subtotal Crashes	Severe Crashes Pct. of Total Severe Crashes	Subtotal Crashes Pct. of Total Crashes	Severe Crashes Pct. of Subtotal Crashes
Intersection	19	645	**664**	61%	46%	3%
Segment	12	754	**766**	39%	53%	2%
Unknown	0	9	**9**	0%	1%	0%
Total	**31**	**1,408**	**1,439**	**100%**	**100%**	**2%**

ROADWAY CHARACTERISTICS – SEGMENT CRASHES ONLY

As seen in **Figure 14** and **Table 12**, segment severe crashes occurred on the Interstate (8 crashes), principal arterials (1 crash), major collectors (1 crash), minor arterials (1 crash) and freeways/expressways (1 crash). 3 percent of principal arterial segment crashes resulted in a severe crash and 2 percent of Interstate, freeway/express way, and major collector segment crashes resulted in a severe crash.

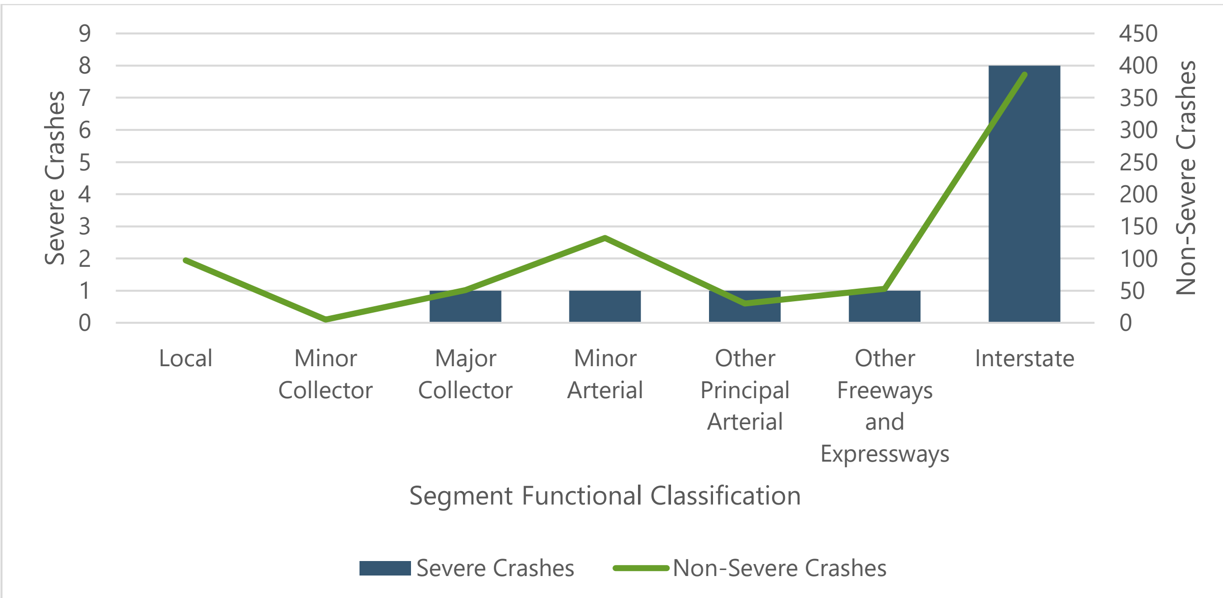

Figure 14. Crash severity by functional classification (segment crashes only)

Table 12. Crash severity by functional classification (segment crashes only)

Segment Functional Classification	Severe Crashes	Non-Severe Crashes	Subtotal Crashes	Severe Crashes Pct. of Total Severe Crashes	Subtotal Crashes Pct. of Total Crashes	Severe Crashes Pct. of Subtotal Crashes
Local	0	97	**97**	0%	13%	0%
Minor Collector	0	5	**5**	0%	1%	0%
Major Collector	1	51	**52**	8%	7%	2%
Minor Arterial	1	132	**133**	8%	17%	1%
Other Principal Arterial	1	30	**31**	8%	4%	3%
Other Freeways and Expressways	1	53	**54**	8%	7%	2%
Interstate	8	386	**394**	67%	51%	2%
Total	**12**	**754**	**766**	**100%**	**100%**	**2%**

ROADWAY CHARACTERISTICS – INTERSECTION CRASHES ONLY

As shown in **Figure 15** and **Table 13**, severe crashes were most frequent at two-way stop controlled (14 crashes) but also occurred at signalized (3 crashes), and uncontrolled intersections (2 crash). Four percent of two-way stop-controlled and uncontrolled crashes resulted in a severe crash.

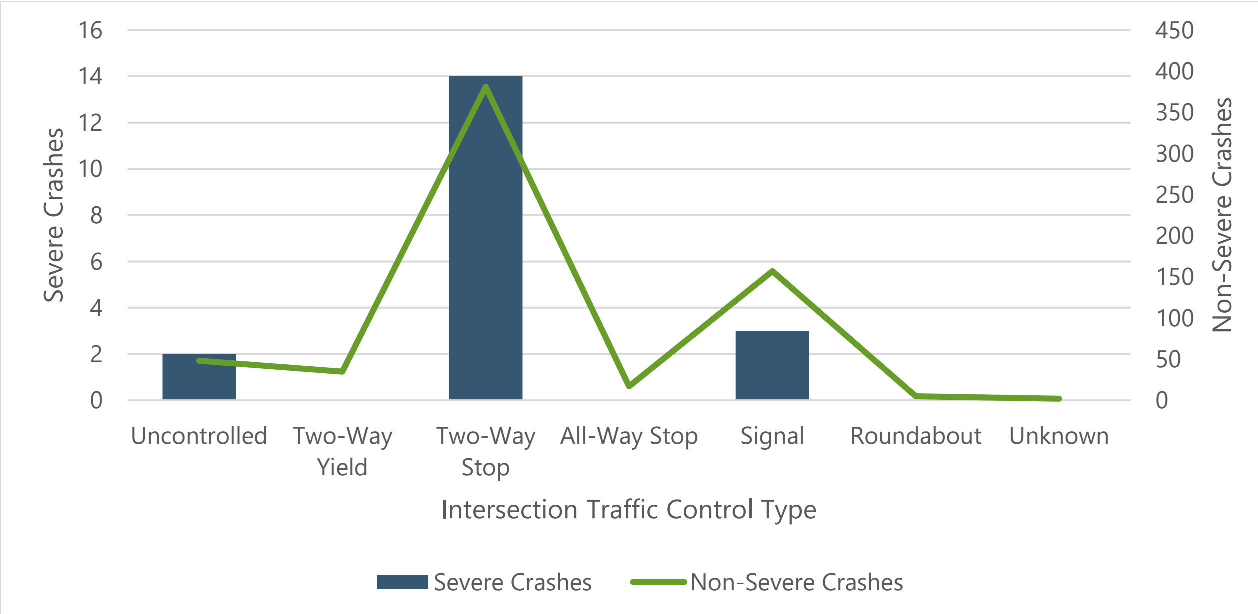

Figure 15. Crash severity by intersection traffic control device (intersection crashes only)

Table 13. Crash severity by intersection traffic control device (intersection crashes only)

Intersection Traffic Control Type	Severe Crashes	Non-Severe Crashes	Subtotal Crashes	Severe Crashes Pct. of Total Severe Crashes	Subtotal Crashes Pct. of Total Crashes	Severe Crashes Pct. of Subtotal Crashes
Uncontrolled	2	48	**50**	11%	8%	4%
Two-Way Yield	0	35	**35**	0%	5%	0%
Two-Way Stop	14	381	**395**	74%	59%	4%
All-Way Stop	0	17	**17**	0%	3%	0%
Signal	3	157	**160**	16%	24%	2%
Roundabout	0	5	**5**	0%	1%	0%
Unknown	0	2	**2**	0%	0%	0%
Total	**19**	**645**	**664**	**100%**	**100%**	**3%**

As described in **Table 14**, the functional classifications of the legs of each intersection were simplified to be "high" or "low". The minimum and maximum functional classes were used to categorize the intersections. This provides greater insight into the types of intersections that crashes are occurring at – whether the legs of the intersection are more evenly balanced ("High vs High" or "Low vs Low") or imbalanced ("Low vs High") in terms of functional class. Imbalanced intersections tend to be low-volume, low speed limit streets crossing high-volume, high speed limit streets, often with a simple two-way stop. As seen in **Figure 16** and Error! Reference source not found., severe crashes were most frequent at low vs. high intersections (12 crashes) and less frequent at low vs. low intersections (4 crashes) and high vs. high intersections (3 crash). Crashes at low vs. high and low vs. low intersections were more likely to result in a severe crash (3 percent of all crashes) compared to crashes at high vs. high intersections which had a 2 percent severe crash rate.

Table 14. Intersection functional class combination criteria

Minimum Leg Functional Class	Maximum Leg Functional Class	Intersection Functional Class Combination Label
Arterial	Arterial	High vs High
Local Road or Collector	Arterial	Low vs High
Local Road or Collector	Local Road or Collector	Low vs Low

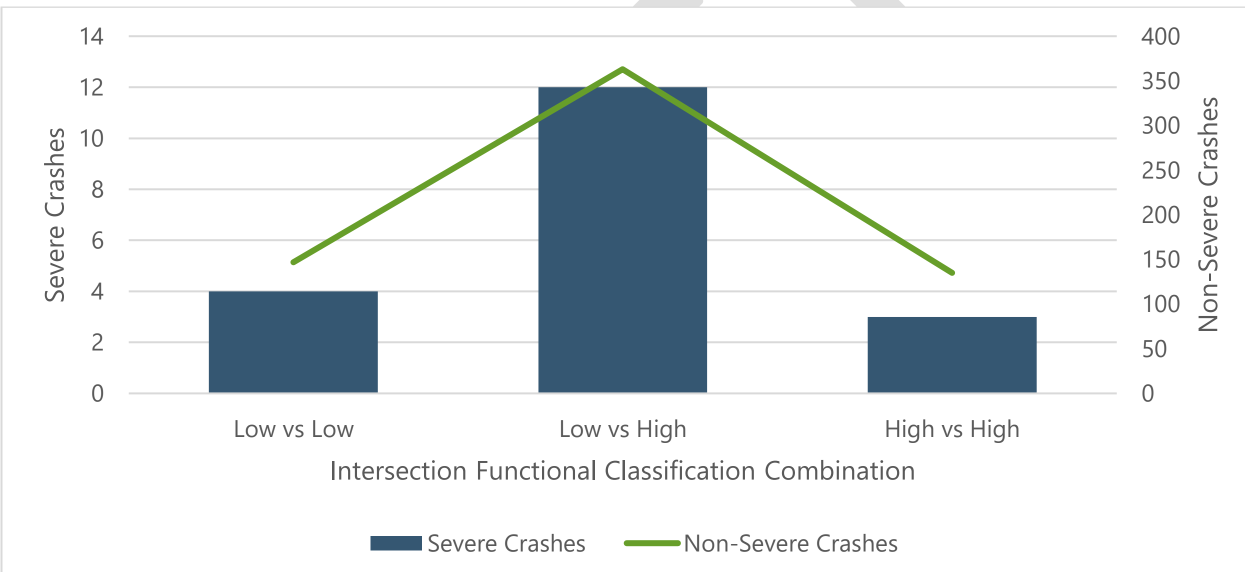

Figure 16. Crash severity by intersection functional class combination (intersection crashes only)

Table 15. Crash severity by intersection functional class combination (intersection crashes only)

Intersection Functional Classification Combination	Severe Crashes	Non-Severe Crashes	Subtotal Crashes	Severe Crashes Pct. of Total Severe Crashes	Subtotal Crashes Pct. of Total Crashes	Severe Crashes Pct. of Subtotal Crashes
Low vs Low	4	147	**151**	21%	23%	3%
Low vs High	12	363	**375**	63%	56%	3%
High vs High	3	135	**138**	16%	21%	2%
Total	**19**	**645**	**664**	**100%**	**100%**	**3%**

ROADWAY CHARACTERISTICS - ROADWAY CONFIGURATION

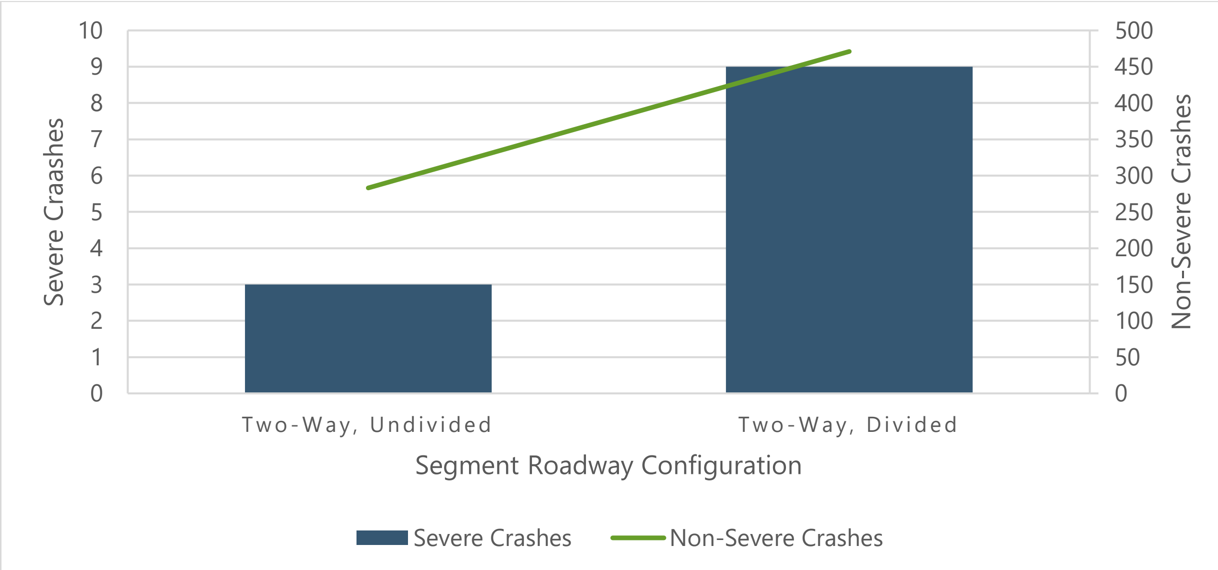

Figure 17. Crash severity by segment roadway configuration (segment crashes only)

Table 16. Crash severity by segment roadway configuration (segment crashes only)

Segment Roadway Configuration	Severe Crashes	Non-Severe Crashes	Subtotal Crashes	Severe Crashes Pct. of Total Severe Crashes	Subtotal Crashes Pct. of Total Crashes	Severe Crashes Pct. of Subtotal Crashes
Two-Way, Undivided	3	283	**286**	25%	37%	1%
Two-Way, Divided	9	471	**480**	75%	63%	2%
Total	**12**	**754**	**766**	**100%**	**100%**	**2%**

As shown in **Figure 17**, severe crashes were most frequent on two-way, divided segments, totaling 9 crashes and 75% of severe crashes as described in **Table 16**. There were 3 recorded severe crashes on two-way, undivided segments, which was 25% of total severe crashes as described in **Table 16**. Two-way divided crashes did have the most frequent number of non-severe crashes (471 crashes), followed by two-way, undivided segments (283 crashes).

EMPHASIS AREAS

Emphasis areas are data-driven priorities identified by the State of South Dakota that focus on the most serious highway safety problems. Safety emphasis areas are defined and identified in SDDOT's *2024 South Dakota Strategic Highway Safety Plan*. For the purposes of this analysis, the emphasis areas differ slightly from those laid out in the SHSP, but generally cover the same categories. As seen in **Figure 18**and **Table 17**, severe crashes were most likely to be flagged as older driver-related (13 crashes), single vehicles run off the road (12 crashes), or intersection related (12 crashes). Non-severe crashes were most frequently categorized as intersection related (485 crashes), animal collision related (416 crashes), or younger driver-related (302 crashes). The high number of non-severe collisions with wild animals is likely driven by the requirement that drivers report any collision with an animal. The emphasis areas most associated with a high likelihood of severe crashes were pedestrian-related crashes (44 percent severe crashes), motorcycle-related (23 percent severe crashes), and speeding-related (12 percent severe crashes). These likelihoods of severe crashes are much higher than the overall rate of 2 percent.

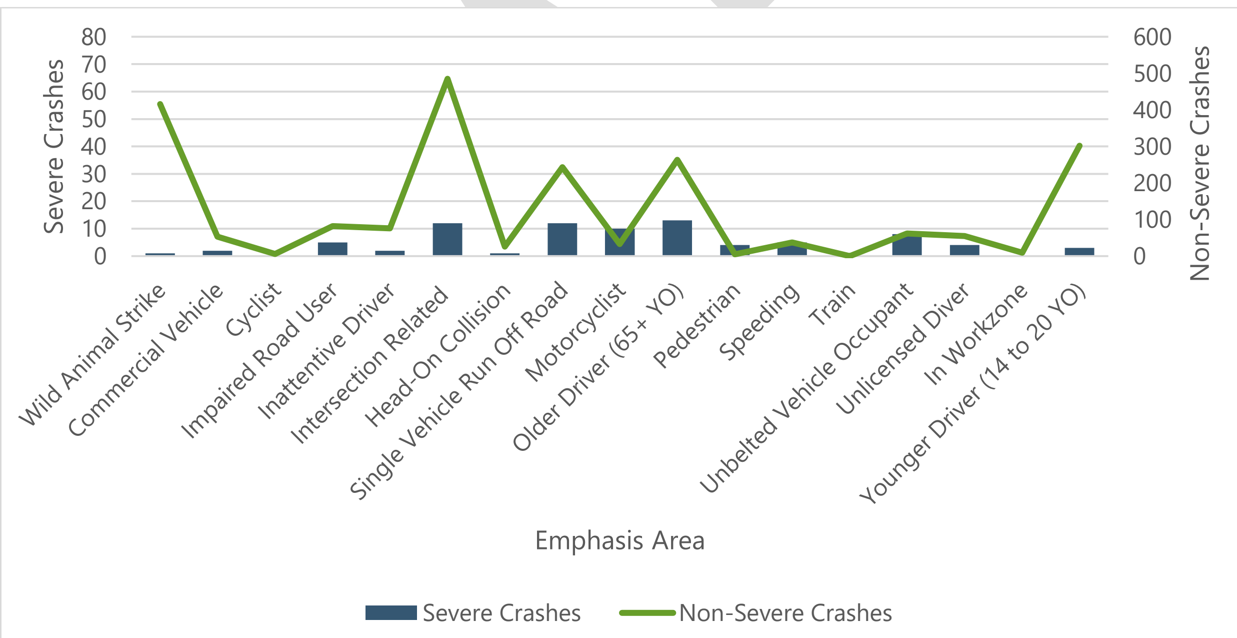

Figure 18. Crash severity by emphasis area

Table 17. Crash severity by emphasis area

Emphasis Area	Severe Crashes	Non-Severe Crashes	Subtotal Crashes	Severe Crashes Pct. of Total Severe Crashes	Subtotal Crashes Pct. of Total Crashes	Severe Crashes Pct. of Subtotal Crashes
Wild Animal Strike	1	416	**417**	1%	19%	0%
Commercial Vehicle	2	53	**55**	2%	2%	4%
Cyclist	0	6	**6**	0%	0%	0%
Impaired Road User	5	82	**87**	6%	4%	6%
Inattentive Driver	2	76	**78**	2%	3%	3%
Intersection Related	12	485	**497**	15%	22%	2%
Head-On Collision	1	26	**27**	1%	1%	4%
Single Vehicle Run Off Road	12	243	**255**	15%	11%	5%
Motorcyclist	10	33	**43**	12%	2%	23%
Older Driver (65+ YO)	13	263	**276**	16%	12%	5%
Pedestrian	4	5	**9**	5%	0%	44%
Speeding	5	37	**42**	6%	2%	12%
Train	0	0	**0**	0%		
Unbelted Vehicle Occupant	8	62	**70**	10%	3%	11%
Unlicensed Diver	4	55	**59**	5%	3%	7%
In Workzone	0	9	**9**	0%	0%	0%
Younger Driver (14 to 20 YO)	3	302	**305**	4%	14%	1%

CRASH EVALUATION SUMMARY – NON-MOTORIZED ONLY

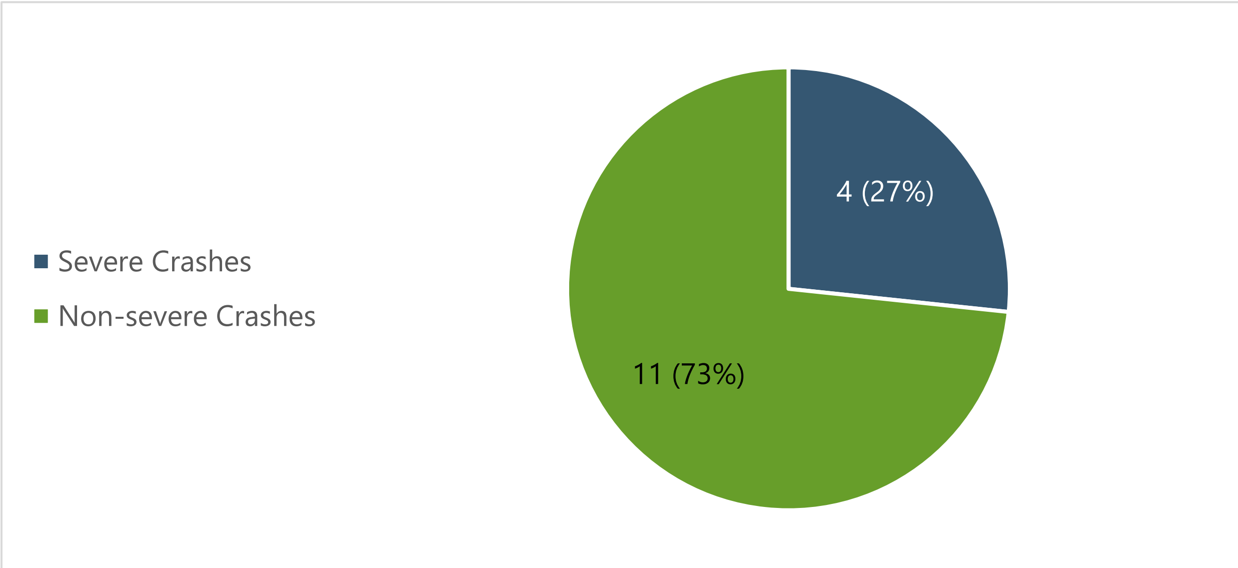

Figure 19In **Figure 19**, there were a total of 15 crashes involving a nonmotorized mode of transport. Four crashes were severe (fatal and serious injury) and 11 were non-severe (minor injury/possible injury/no apparent injury). Nine of these crashes involved pedestrians and six involved cyclists.

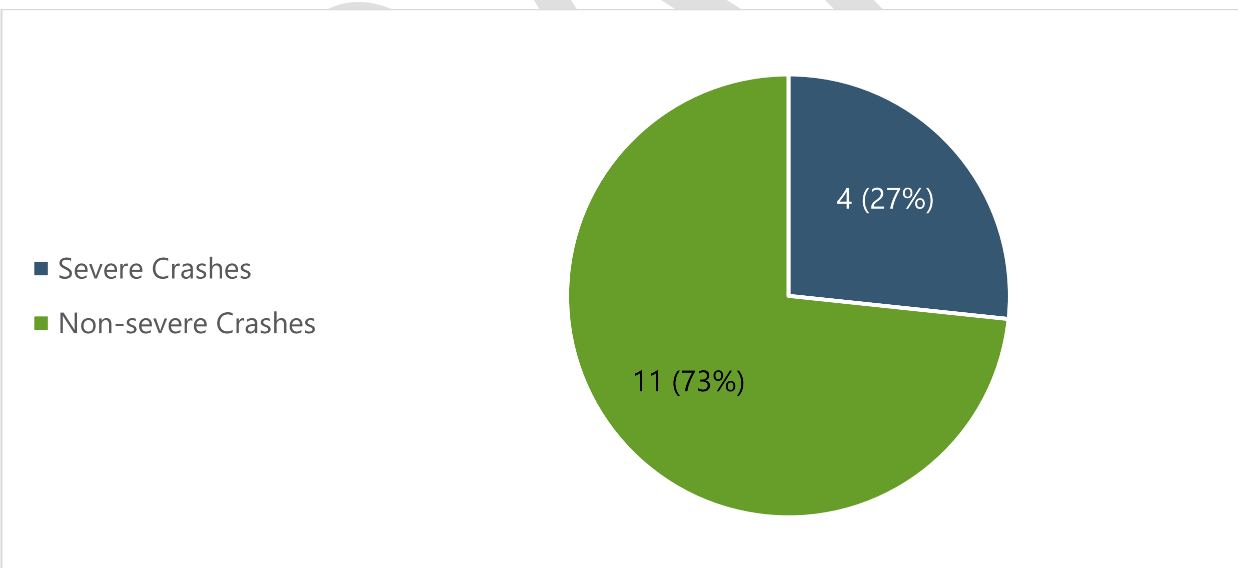

Figure 19. Crash severity by nonmotorized severe and minor/no injury crashes

Due to the limited number of total nonmotorized crashes (15), detailed analysis of these crashes yields limited insight into contextual issues. Instead, analysis of specific crash locations (segments and intersections) is shown in **Figure 20**.

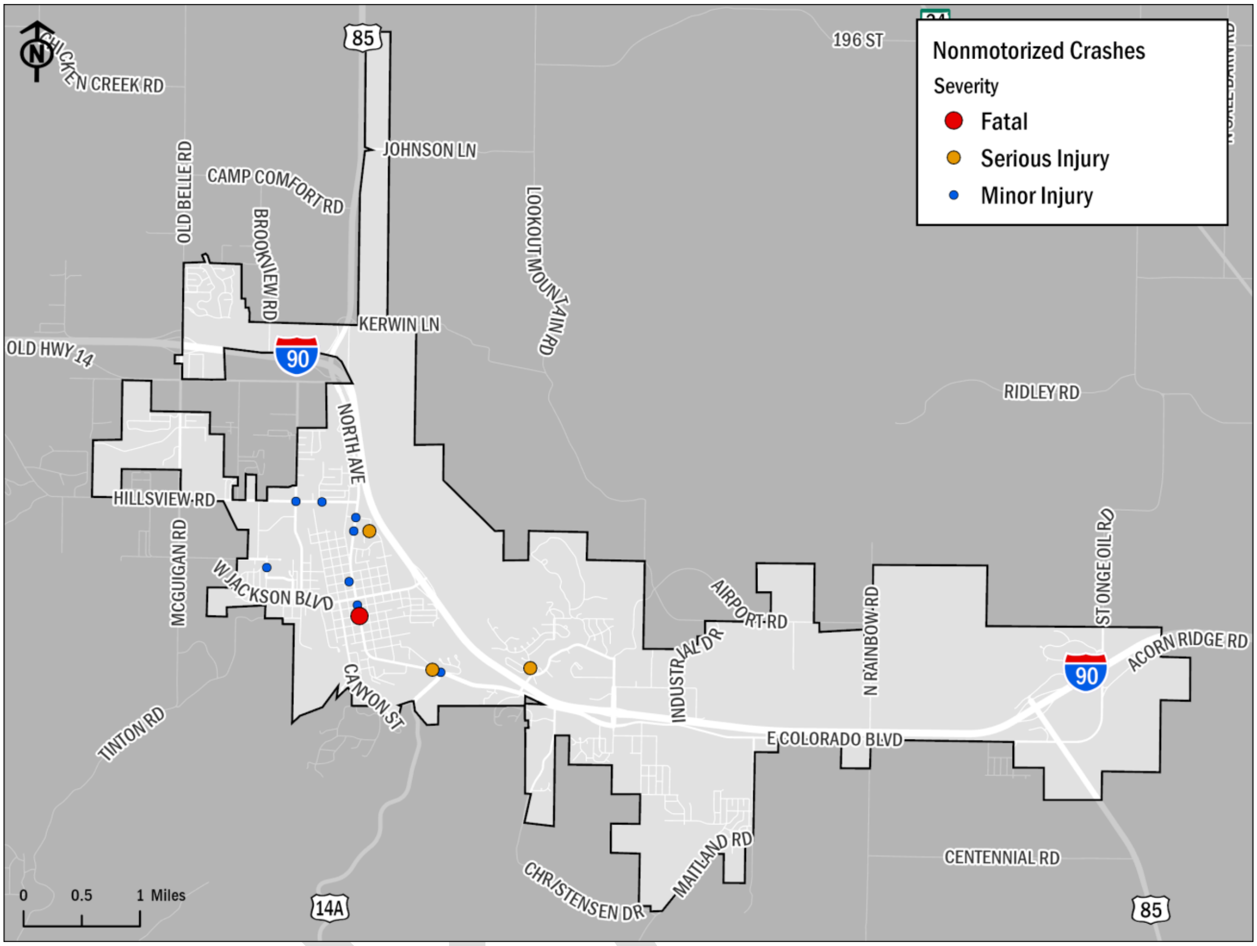

Figure 20: Nonmotorized crash map (2020 – 2024)

HIGH-INJURY NETWORK (HIN) ANALYSIS

The Spearfish SAP relies on a thorough understanding of crash trends to inform strategic investments in projects aimed at improving the safety of all road users throughout the region. Complimenting the Crash Trend Summary is the second component of the evaluation – defining an HIN for the city. An HIN is a subset of a road network that has been identified as having high concentrations of crashes that result in severe injuries. Unlike the heatmap shown on **Figure 11.** All mode severe crash heat map, the HIN looks at the densities of severe crashes along a corridor and selects the portions of corridors that have concerningly high concentrations of crashes. The crash densities are calculated using a sliding window approach where a "window" of a predetermined length "slides" along the corridor at a specific increment and the density of injuries that occurred within that window are calculated and assigned to the segments within that window. This reduces edge effects at the ends of corridors, allows injuries along a corridor to be included in the analysis whether they occurred at an intersection or somewhere midblock, and ensures that the segments selected are an appropriate length (i.e. the length of the sliding window). Based on user-defined criteria, a minimum crash density is selected and any road segment with a calculated injury density above that threshold is included on the HIN. The resulting HIN represents a prioritized subset of the road network, focusing on roadway corridors with the highest prevalence of severe crashes.

DEVELOPING THE HIGH-INJURY NETWORK

The development of an HIN consists of six steps: (1) compiling the crash data, (2) creating a base road network, (3) creating short and long windows from a base road network, (4) assigning crashes to long windows, (5) calculating short and long window scores, and (6) setting a minimum short window crash score threshold for inclusion in the final selection. All six steps are described below.

HIN STEP 1: COMPILING THE CRASH DATA

The same crash dataset (including the modal MSI designations) used in the Crash Trend Summary was also used for the HIN analysis.

HIN STEP 2: CREATING THE BASE NETWORK

To reduce the number of artificial breaks in the analysis network, the project team manually validated the network topology and geometrics. The first step of this process consisted of adjusting road segments that were missing or improperly aligned and simplifying complex intersections such as roundabouts to ensure contiguous road segments that intersect at only one location. The second part of creating a base network consisted of merging the individual segments that form each road into contiguous corridors by dissolving the lines based on the street name. These contiguous lines were then used to create the short and long window analysis segments.

HIN STEP 3: CREATING THE SHORT AND LONG WINDOWS FROM THE BASE NETWORK

Once the base network was finished, the corridors were then split into 0.1-mile segments, called “short windows” that correspond to the increment by which the long window is moved along the corridor. In the example shown in **Figure 21**, the main corridor is shown as a road at the top of the diagram and measures 0.8 miles long. The short windows (represented by the green line segments at the top of the diagram in **Figure 21** are the same length as the increment by which the sliding long window slides. The short windows are split from the corridor starting at one end (in this case, on the left end) which results in short windows of 0.1 mile each.

The sliding windows, often referred to as “long windows” (represented by the blue lines in Figure 21), are created by merging short windows in overlapping groups of five or ten to create 0.5- or 1.0-mile-long windows, respectively. In **Figure 21**, the standard long window length is 0.5 miles and therefore consists of five short windows. As the long windows get closer to the ends of the corridor, the long windows decrease in length to ensure that each short window has the same number of long windows overlapping it. In the example, Long Windows A, B, C, D, H, I, J, K, and L are shorter than the standard 0.5 miles.

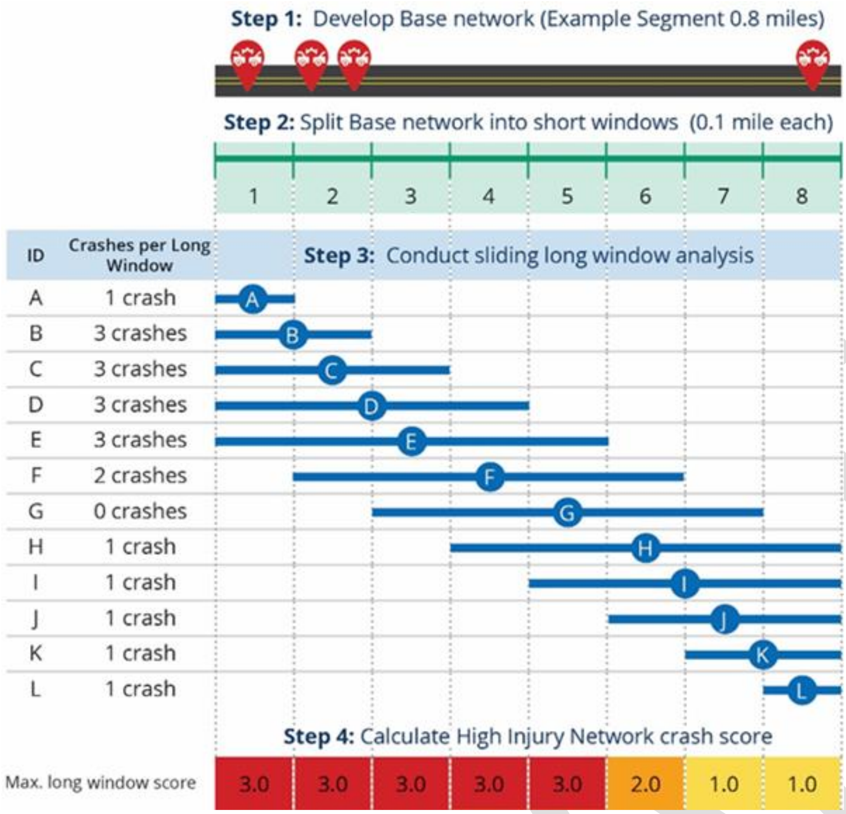

Figure 21. Diagram illustrating the sliding window analysis

HIN STEP 4: ASSIGNING CRASHES TO LONG WINDOWS

Once the long windows have been created from the short windows, the individual crashes are mapped to the long windows. To account for the width of the road, minor inaccuracies in the coordinates assigned to each crash, and discrepancies in the geometries representing roads in different datasets, a buffer of 50 meters (~164 feet) is used when joining the crashes to the long windows. Fifty meters was selected as the buffer distance because it captures the majority of crashes along segments even in cases where crashes occurred on divided roadways or were imprecisely geolocated. While using a buffer helps reduce the number of crashes that are unintentionally left off a long window, it does increase the likelihood of crashes being assigned to too many long windows – especially at intersections and in locations where two roads run parallel to each other such as frontage roads along freeways. The effects of this over-assignment of crashes to long windows is mitigated by manually excluding short windows that have been assigned an erroneously high injury score. Because an individual crash that occurred at an intersection may be assigned to long windows from both of the intersecting corridors, there is no need to split the crash between the two corridors. After all, a crash that occurs at an intersection occurs on both corridors and splitting the crash between the two corridors would result in the undercounting of intersection crashes across the entire network.

HIN STEP 5: CALCULATING SHORT WINDOW CRASH SCORES

Once the crash points were joined to the long windows, the crash score for each long window was calculated based on the number and severity of crashes that are joined to it. The long window crash scores were, in turn, used to calculate the short window crash scores. In the example shown in **Figure 21**, the long window crash score (equal to the Crashes per Long Window column on the righthand side of the figure) simply reflects the number of crashes that lie within a given long window. For simplicity's sake, the example does not employ any weighting by severity. In other words, one crash equates to one point as opposed to the relative weights (discussed later in this section) that are assigned to each severity.

The short window score is calculated as the maximum score of any of the long windows that overlap it. In **Figure 21**, Short Window 6 has a maximum long window score of 2.0, which comes from long window F. In the example shown in **Figure 21**, if the threshold for inclusion in the HIN is set to 2.0, six short windows (1, 2, 3, 4, 5, and 6) have scores above the threshold (3.0, 3.0, 3.0, 3.0, 3.0, and 2.0, respectively), resulting in a total of 0.6 miles included in the HIN.

To maintain the focus on the most harmful crashes despite their relative infrequency, only the fatal, serious, and minor injury crashes are considered in the HIN score calculations. To further reduce the likelihood of less severe (and far more prevalent) crash types overshadowing the most harmful crash types, two additional measures are employed: the fatal and serious injury crashes are given a relative weight of 3 and the minor injury crashes are given a weight of 1, and the minor injury automobile crashes are excluded entirely from the crash score calculations. As seen in **Table 18**, the 74 minor injury automobile crashes account for approximately 61 percent of the combined 122 fatal, serious, and minor injury crashes and 76 percent of the 97 total minor injury crashes; removing minor injury automobile crashes from the crash score calculations ensures that these relatively minor injuries do not overshadow the other modes' crashes. Note that, because a crash can involve multiple modes, the sums of the modal crash totals are often larger than the corresponding All Motorized, All Nonmotorized, or All Modes crash totals. For example, there were 1,146 crashes that involved at least one motorized mode (passenger automobiles, heavy vehicles, or motorcycles), but adding up the counts of passenger automobile crashes (1,103), heavy vehicle crashes (53), and motorcycle crashes (32) yields 1,188 – slightly more than the 1,146 motorized vehicle crashes – which indicates that some of the motorized vehicle crashes involved multiple motorized modes (i.e. 2 vehicles/parties involved or more).

Table 18: Most Severe Injury (MSI) by mode

Mode	Fatal Injuries	Serious Injuries	Minor Injuries	Suspected Injuries	No Apparent Injuries	Total Injuries
Passenger Automobile	4	13	82	98	1,186	1,383
Heavy Vehicle	0	0	1	2	57	60
Motorcycle	3	7	20	8	5	43
All Motorized	***7***	***20***	***102***	***107***	***1,202***	***1,438***
Bicycle	0	0	5	1	0	6
Pedestrian	1	3	4	1	0	9
All Nonmotorized	***1***	***3***	***9***	***2***	***0***	***15***
All Modes	**8**	**23**	**111**	**109**	**1,188**	**1,439**

HIN STEP 6: SETTING A THRESHOLD FOR INCLUSION IN THE HIN

The HIN is identified using crash score thresholds across Spearfish city limits. The project team uses the following rough targets to recommend thresholds, which vary by mode:

- **Coverage of target (fatal, serious, and minor injury) crashes** – are roughly 40-60% of target crashes covered by the HIN?

- **Mileage or extent of HIN streets and intersections** – is the total length of the HIN streets roughly 1-5% of the total length of the entire network?

- **Natural breaks** – does increasing or decreasing the threshold result in a significant change in severe crash density on the network? Are there natural breaks in the data where severe crash density dramatically changes?

- **Minimum threshold** – thresholds that are too low dilute the meaning of HIN. The team recommends a minimum crash score threshold of 6.0 for all modes, which equates to at least two severe crashes (e.g. two fatal or serious injury crashes, one fatal or serious injury crash and three minor injury crashes, etc.) per mile over the past five years.

In short: minimum thresholds should be set high enough to imply a focused, spatial pattern of severe crashes – HIN segment status should not be driven by just one severe crash.

The four targets above are sometimes at odds with one another and require a balanced and comprehensive approach. For example, covering 50% or more of severe crashes may result in a high number of miles being included in the HIN or may require a minimum crash score threshold that is so low that even segments with only one severe crash end up being included in the HIN. A higher minimum crash score threshold is recommended to provide a more targeted HIN.

HIGH-INJURY NETWORK RESULTS

A preliminary analysis of thresholds showed that the metrics/criteria listed above would be optimized by using the minimum threshold of 6 for all the HINs. **Table 19** shows the total number of fatal, serious, and minor injury crashes by mode and compares them to the count and percentage of the fatal, serious, and minor injury crashes covered by each mode on the HIN.

Table 19. Severe Crashes on the HIN, by Mode

Mode	Total Severe* Crashes	Severe* Crashes on HIN
Passenger Automobile	17	7 (17.6%)
Heavy Vehicle	0	0 (0.0%)
Motorcycle	30	11 (36.7%)
All Motorized	***47***	***18 (38.3%)***
Bicycle	5	2 (40.0%)
Pedestrian	8	4 (50.0%)
All Nonmotorized	***13***	***6 (46.2%)***
All Modes	**60**	**24 (40.0%)**

*Crash counts include all fatal, serious, and minor injury crashes except for minor injury automobile crashes

When crashes resulting in severe injuries to a given mode are particularly infrequent and/or sparsely distributed, there may not be any network segments with scores above the minimum meaningful threshold of 6.0. In this case, there are no segments on the heavy vehicle-, bicycle-, pedestrian-, and nonmotorized-specific HINs. Therefore, all modes were combined together in the HIN analysis to meet or exceed the threshold of 6.0—this creates the all-mode HIN.

As seen in **Figure 22 and Figure 23**, the all-mode HIN includes five corridors:

- US 85/North Ave from Yukon Pl to Brookview Rd/Kerwin Ln
- US 85/North Ave/Main St/Colorado Blvd from Spearfish Canyon Pkwy to Creekside Elementary School
- Jackson Blvd from Harvard Ave to 7th St
- US Hwy 85 from the City limits to Duke Pkwy
- Colorado Blvd from Sky Ridge Ave to approximately half a mile NE of US Hwy 85

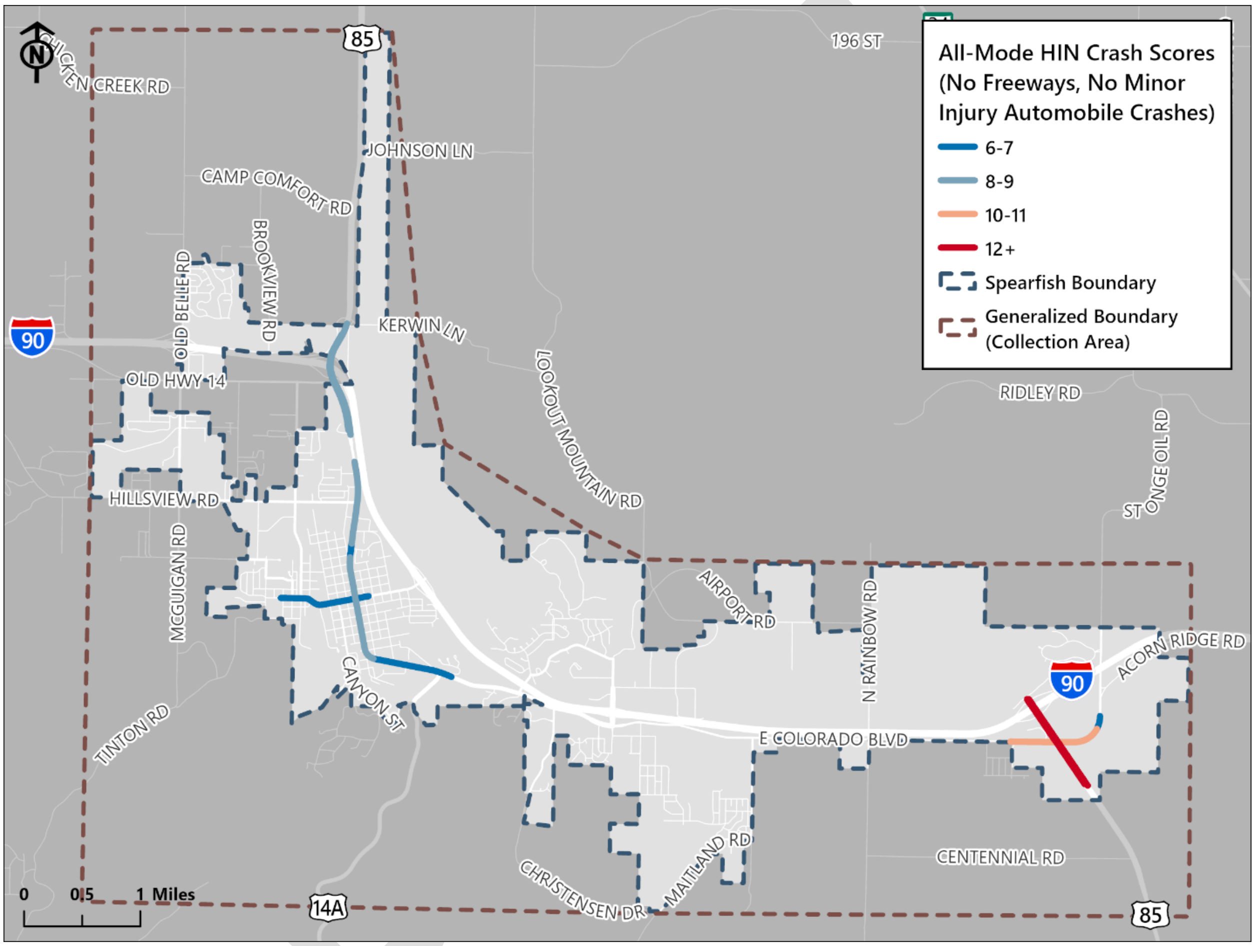

Figure 22. All-mode HIN (excludes freeways, does not include minor injury automobile crashes in crash scores)

The majority of the HIN (North Ave, Main St, US 85, and part of Jackson Blvd) are four- or five-lane roadways. The exception is a portion of Jackson Blvd that is a three-lane configuration and Colorado Blvd which is a two-lane configuration. The longest HIN segment, including North Ave/Main St/Colorado Blvd from Yankee St to east of Spearfish Canyon Hwy is a five-lane and four-lane undivided corridor. This segment also includes the majority of fatal, serious, and minor injury nonmotorized crashes.

Jackson Blvd stands out in that it was significantly improved in 2021, including median improvements, streetscaping, and intersection improvements. The portion of Jackson Blvd within the HIN consists of both four-lane and three-lane configuration. The crashes that contribute to this portion of Jackson Blvd being on the HIN were located at intersections between N 7th St and N Meier Ave—the roundabout at N Ames St/W Iris St is not a contributing factor.

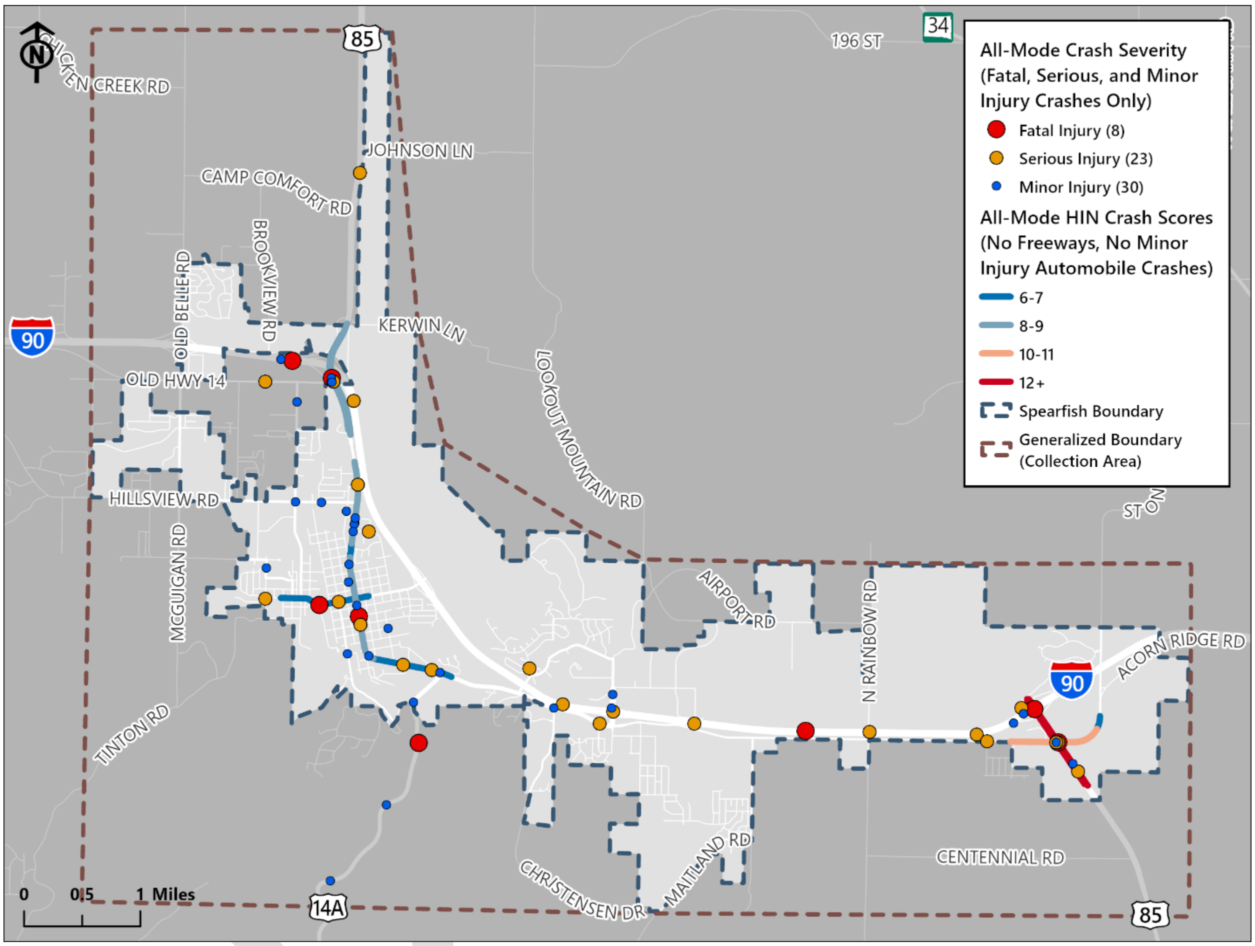

Figure 23. All-mode HIN and severe crashes (excludes freeways, does not include minor injury automobile crashes in crash scores)