



US16 Corridor Study Crash History Review (2014 – 2018)

US16 Corridor Study

Pennington County, SD
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Introduction

This memorandum documents the 2014 through 2018 crash history analysis for the US16 corridor between the Keystone Wye (south end) and Cathedral Drive/Fairmont Boulevard (north end). The crash history analysis was conducted to help identify areas that may warrant consideration of safety-related improvements in future design.

Methodology

Crash data for years 2014 through 2018 was provided by the South Dakota Department of Transportation (SDDOT) through a GIS geodatabase. Crashes were reviewed to identify any historical crash trends or high frequency areas to help develop potential crash mitigation measures for consideration in design. The US16 corridor was broken up into the following for analysis:

- Intersections
- Roadway segments

All crashes occurring on the US16 corridor were sorted based on whether they were related to a corridor intersection or roadway segment. Low-volume crossroads and private driveways were typically not considered a primary analysis intersection.

Crash rates and critical crash rates were calculated for both intersections and roadway segments. Intersection crash rates were calculated in terms of crashes per million entering vehicles (crashes/MEV). Roadway segment crash rates were calculated in terms of million vehicle miles traveled (crashes/MVMT).

Critical crash rates were calculated based on the statistical populations for each crash location (intersection or segment), using methods presented in the Highway Safety Manual (American Association of State Highway and Transportation Officials (AASHTO), 2010). A critical crash rate accounts for a desired level of confidence, vehicle exposure, and similar facility types. Intersections and segments where the crash rate exceeds the critical rate should be investigated further.

Weighted crash rates were also calculated for corridor segments by weighting each crash in accordance with its severity: fatal crash (12), injury crash (3), and property damage crash (1). Weights were assigned to each crash in accordance with methodology used by the SDDOT in determining statewide average crash rates. This method differs from the calculation of an average crash rate in that the weighted crash rate accounts for injury and fatal crashes through the weighting process. An average crash rate calculation reflects total crash frequency, regardless of injury severity.

Intersection and segment crash rates were calculated with available daily traffic count data provided by the SDDOT or collected as part of this study.

US16 Corridor Existing Conditions Summary

The US16 corridor study area extends for approximately 16.3 miles between the Keystone Wye at the southern end of the corridor and the Cathedral Drive/Fairmont Boulevard intersection in Rapid City.

US16 is currently a 4-lane divided highway throughout the study area with varying cross-sections that include various median widths and median types. Turn lanes are included at several access points. The US16 intersections with US16 Bypass/Catron Boulevard and Cathedral Drive/Fairmont Boulevard are the lone signalized intersections along the corridor. All other intersections, except for the merge/diverge locations around the Rockerville area, are stop-controlled from the minor street approach.

Much of the corridor traverses through wooded areas, particularly towards the western/southern half of the corridor. There are pockets of tourist-related industry around the Neck Yoke Road intersection and to the south. Towards the north, the area is becoming more urbanized with Rapid City-area development extending southward beyond US16B/Catron Boulevard.

Traffic along the corridor is highly seasonal with a peaks in daily traffic occurring during the summer tourist months and around the Sturgis rally. Highly variable terrain along the corridor can cause weather conditions to differ significantly, even within adjacent roadway segments. Winter weather conditions also impact travel along the entirety of the study corridor.

Posted speeds through the study area range from 50 mph to 65 mph as follows:

- 35 mph from the northern study limits just south of Cathedral Drive/Fairmont Boulevard
- 50 mph from just south of Cathedral Drive/Fairmont Boulevard to the service road north of Highwood Road (includes US16/US16B/Catron Boulevard intersection)
- 60 mph between the service road north of Highwood Road and just south of Neck Yoke Road (includes US16/Neck Yoke Road intersection)
- 65 mph from just south of Neck Yoke Road to the Keystone Wye

US16 Corridor Crash History Summary

Overall, there were 580 crashes reported along the US16 study corridor between 2014 and 2018. Of the 580 total crashes, 159 occurred at intersections (27.5 percent) and 421 occurred along a roadway segment, or not at an intersection (72.5 percent).

From a corridor-wide perspective for US16, the following chart and tables summarize segment, intersection, and total corridor crashes based on injury severity, manner of collision, and other crash characteristics.

US16 Corridor – Crash Severity

Crashes sorted by year and whether they occurred on a US16 corridor segment or at a US16 intersection are summarized in **Figure 1**. There was a spike in segment crashes in 2017 compared to the other five years. Further review indicated that there were 85 vehicle-animal crashes in 2017. This represents over 30 percent of the 5-year vehicle-animal crash total.

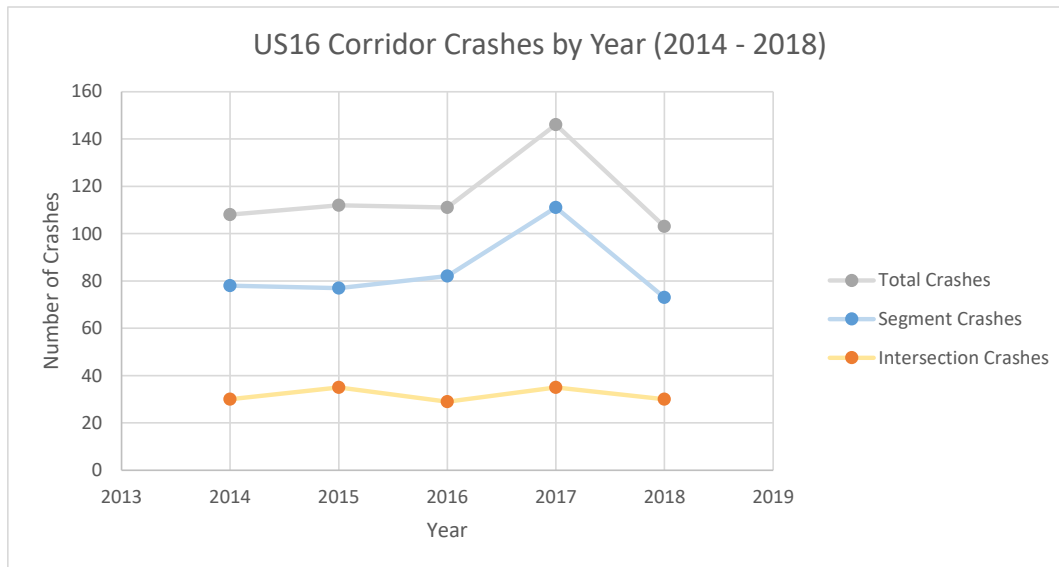


Figure 1: US16 Corridor – Crashes by Year (2014 - 2018)

Of the 580 crashes, four resulted in a fatality and 120 resulted in an injury. Crashes sorted by 'fatal', 'injury', and 'no injury' (property damage only, or PDO) are summarized in **Table 1** presented spatially in **Figure 2**.

Crashes occurring on other study area roadways, such as US16B, Catron Boulevard, or Neck Yoke Road, are not included in these totals. They are discussed further in a separate section.

There were four fatal crashes over the 5-year analysis period, two at intersections and two along roadway segments. There was a greater propensity for injury crashes at intersections, as approximately 43 percent of the intersection crashes resulted in injury or fatality, compared to 13.5 percent of the segment crashes resulting in injury. A summary of all fatal and incapacitating injury crashes are shown in **Figure 3**.

There is a high propensity for vehicle-animal crashes along this corridor, representing nearly half of all crashes along the study area corridor. For US16 corridor segments, vehicle-animal crashes represented over 65 percent of all segment-related crashes.

Maps representing crashes that did not involve (vehicle only crashes) and involve (vehicle-animal crashes) animals are provided in **Figure 4** and **Figure 5**, respectively.

Table 1: US16 Corridor – Crash Severity Summary (2014 – 2018)

Injury Severity	Segments		Intersections		Corridor	
	Total # Crashes	% of Segment Total	Total # Crashes	% of Intersection Total	Total # Crashes	% of Corridor Total
Fatal Crash	2	0.5%	2	1%	4	1%
Injury Crash						
<i>Incapacitating Injury</i>	9	2%	11	7%	20	3.5%
<i>Non-Incapacitating Injury</i>	31	7.5%	22	14%	53	9%
<i>Possible Injury</i>	14	3.5%	33	21%	47	8%
No Injury Crash (PDO)						
<i>Vehicle only crash</i>	89	21%	91	57%	180	31%
<i>Vehicle-Animal crash</i>	276	65.5%	0	0%	276	47.5%
Total	421		159		580	

US16 Corridor – Manner of Collision

Manner of collision identifies whether there were two or more vehicles involved in a collision, and if so, the manner in which the multiple vehicles come together. This is also commonly referred to as the type of crash, or crash type. **Table 2** presents a manner of collision summary for the US16 study corridor.

Table 2: US16 Corridor – Manner of Collision Summary (2014 – 2018)

Manner of Collision	Segments		Intersections		Corridor	
	Total # Crashes	% of Segment Total	Total # Crashes	% of Intersection Total	Total # Crashes	% of Corridor Total
Rear-End	14	3.5%	42	26.5%	56	9.5%
Head On	0	0%	1	0.5%	1	<0.5%
Angle	13	3%	101	63.5%	114	20%
Side Swipe	10	2.5%	4	2.5%	14	2.5%
No Collision between 2 Vehicles						
<i>Single Vehicle</i>	104	24.5%	11	7%	115	20%
<i>Animal</i>	280	66.5%	0	0%	280	48%
Total	421		159		580	100%

The manner of collision summary table indicates that the vast majority of segment-related crashes were single-vehicle crashes, particularly vehicle-animal crashes. It should be noted that there were no head-on (median crossing) crashes reported on segments throughout the corridor.

At intersections, the predominant manner of collision was angle crashes, representing the turning conflict each intersection presents. Rear-end crashes represented just over a quarter of all intersection crashes and indicates a need to review intersections for turn lanes, congested conditions, and whether approaching motorists are aware of access locations.

US16 Corridor – Other Crash Characteristics

Table 3 presents additional crash characteristics to support emphasis areas identified in the 2014 South Dakota Strategic Highway Safety Plan¹.

Table 3: US16 Corridor – Other Crash Characteristic Summary (2014 – 2018)

Crash Characteristic	Segments		Intersections		Corridor	
	Total # Crashes	% of Segment Total	Total # Crashes	% of Intersection Total	Total # Crashes	% of Corridor Total
Motorcycles	17	4%	9	5.5%	26	4.5%
Speed	31	7.5%	22	14%	53	9%
Alcohol/Drugs	22	5%	4	2.5%	26	4.5%
Distracted Driving	5	1%	9	5.5%	14	2.5%
<i>Total Study Area Crashes</i>	421		159		580	

Notes:

% represents percentage of crashes each characteristic occurred in the respective segment, intersection or total crash columns, respectively.

Some crash reports noted more than one characteristic contributing to the crash.

Table 4 summarizes fatal and serious injury (F&SI) that occurred along the US16 study corridor, broken out by segment, intersection or total (segment + intersection). The % column represents the percentage of F&SI crashes noted for each crash characteristic with respect to the total number of F&SI crashes occurring for the respective column (study segment, intersection, or corridor total). The table also presents percentages from the 2014 South Dakota Strategic Highway Safety Plan from a statewide and state highway basis for comparison. The statewide and state highway % columns represent the percentage of all F&SI crashes that noted the respective crash characteristic in the crash report.

Motorcycles are involved in approximately 38 percent of all US16 Corridor F&SI crashes. This percentage is greater than both the statewide averages for all roads (21 percent of all F&SI crashes involved motorcycles) and statewide average for state highways (26 percent). F&SI crashes noted with alcohol/drugs as a contributing factor were near the statewide averages. Speed and distracted driving were lower than the statewide averages.

¹ South Dakota Strategic Highway Safety Plan, February 2014.

<http://www.sddot.com/transportation/highways/traffic/safety/Default.aspx>

Table 4: US16 Corridor – Fatal and Serious Injury (F&SI) Crashes by Crash Characteristic (2014 – 2018)

Crash Characteristic	US16 Segments		US16 Intersections		US16 Corridor Total		Statewide	State Highways
	Total # F&SI Crashes	% of Segment F&SI Total	Total # F&SI Crashes	% of Inters. F&SI Total	Total # F&SI Crashes	% of Corridor F&SI Total	% of Statewide F&SI Total	% of State Highway F&SI Total
Motorcycles	4	36%	5	38%	9	38%	21%	26%
Speed	3	27%	0	0%	3	13%	28%	29%
Alcohol/Drugs	3	27%	2	15%	5	21%	24%	20%
Distracted Driving	0	0%	0	0%	0	0%	13%	14%
<i>Total Study Area F&SI Crashes</i>	11	-	13	-	24	-	-	-

Notes:

US16 study corridor crashes, the % represents percentage of fatal and serious injury crashes that occurred for each characteristic, with respect to the total occurring for each US15 column category of corridor segment, intersection or total (segment + intersection). Statewide crash % represents the percentage of all fatal and serious injury crashes statewide that noted the characteristic contributed to the crash. See Table 3 of the South Dakota Strategic Highway Safety Plan, November 2014. State Highway crash % represents the percentage of all fatal and serious injury crashes statewide that noted the characteristic contributed to the crash. See Table 3 of the South Dakota Strategic Highway Safety Plan, November 2014. Some crash reports noted more than one characteristic contributing to the crash. Tan highlight indicates where US16 corridor percentage exceeds a statewide average.

The following provides additional information on all injury-related crashes, highlighting the propensity of injury crashes associated with these characteristics. Note that in some cases, crashes having several contributing circumstances may be included in multiple crash characteristic categories.

Motorcycles

- Segments: 14 of 17 resulting in injury
 - 1 fatal, 3 incapacitating, 8 non-incapacitating, and 2 possible
- Intersections: 8 of 9 resulting in injury
 - 2 fatal, 3 incapacitating, 1 non-incapacitating, and 2 possible
- Total: 22 of 26 resulting in injury (85 percent)
 - 9 of 26 resulting in fatality or serious injury (35 percent)

Speed

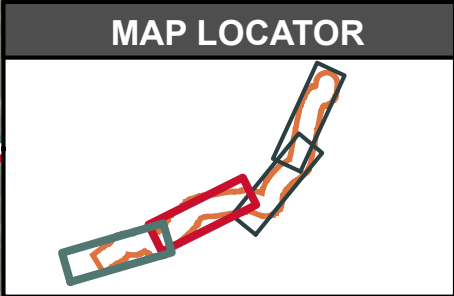
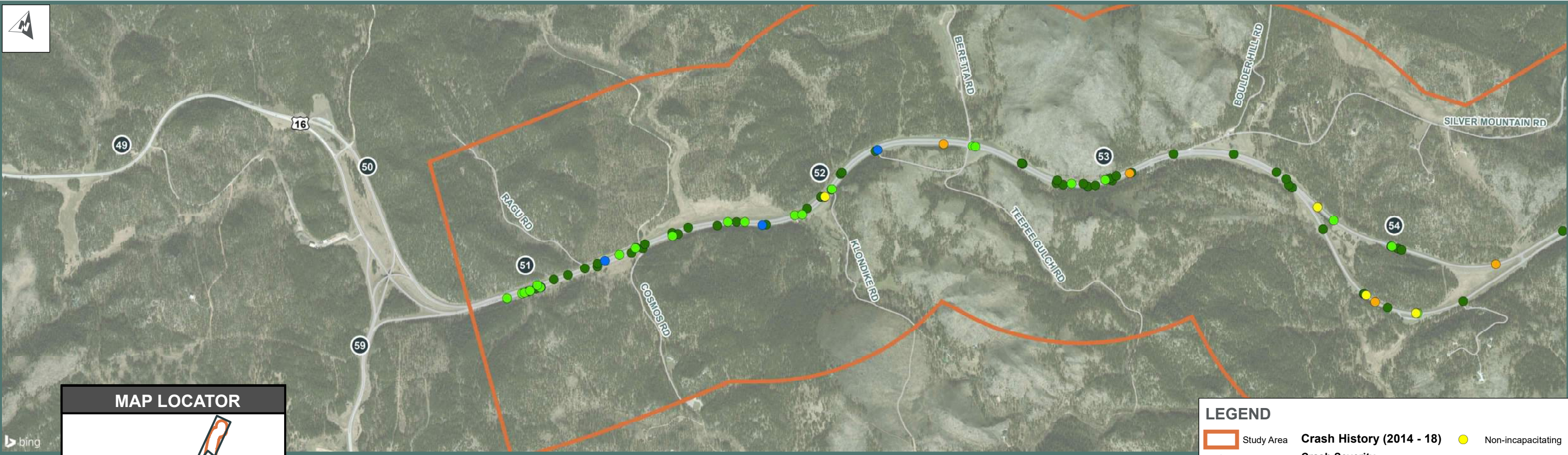
- Segments: 12 of 31 resulting in injury
 - 3 incapacitating, 7 non-incapacitating, 2 possible
- Intersections: 6 of 22 resulting in injury
 - 3 non-incapacitating and 3 possible
- Total: 18 of 53 resulting in injury (34 percent)

Alcohol/drugs

- Segments: 10 of 22 resulting in injury
 - 1 fatal, 2 incapacitating, 5 non-incapacitating, 2 possible
- Intersections: 3 of 4 resulting in injury
 - 1 fatal, 1 incapacitating, and 1 possible
- Total: 13 of 26 resulting in injury (50 percent)

Inattentive, distracted, and fatigued driving

- Segments: 2 of 6
 - 2 non-incapacitating
- Intersections: 4 of 9 resulting in injury
 - 4 possible
- Total: 6 of 15 resulting in injury (43 percent)



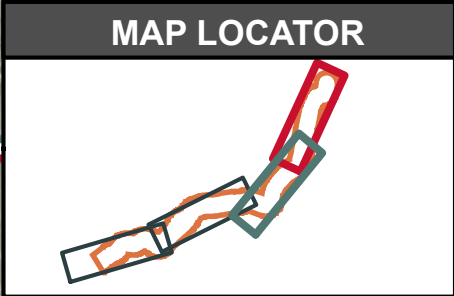
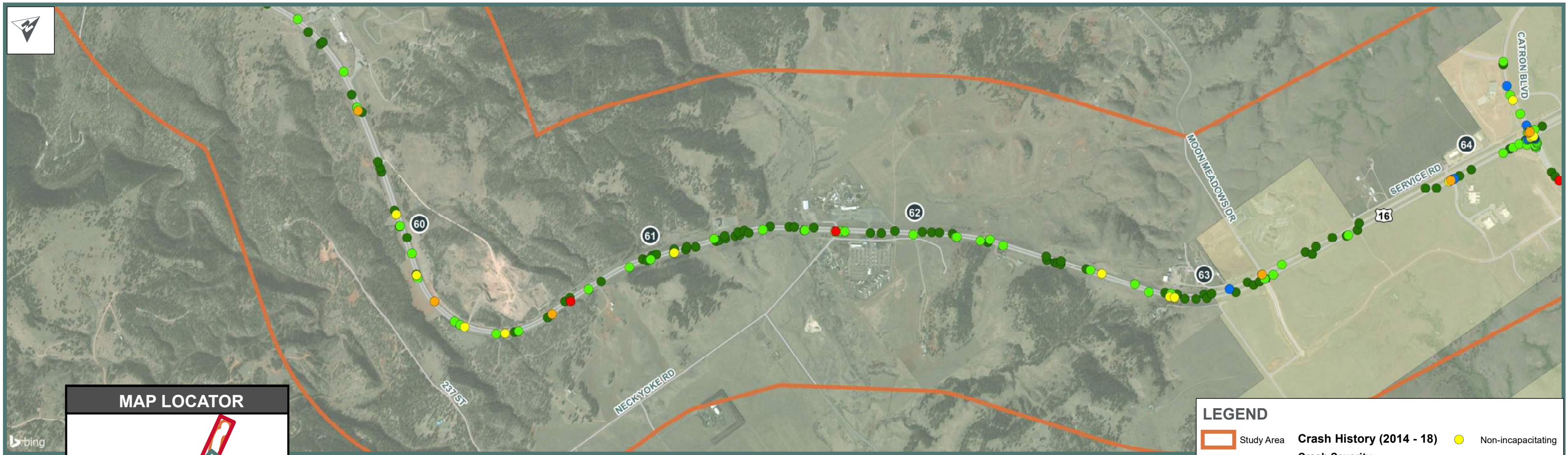
LEGEND

Study Area	Crash History (2014 - 18)	Non-incapacitating
Mile Markers	Crash Severity	Possible
Roads	Fatal injury	No injury
	Incapacitating	Wild animal hit



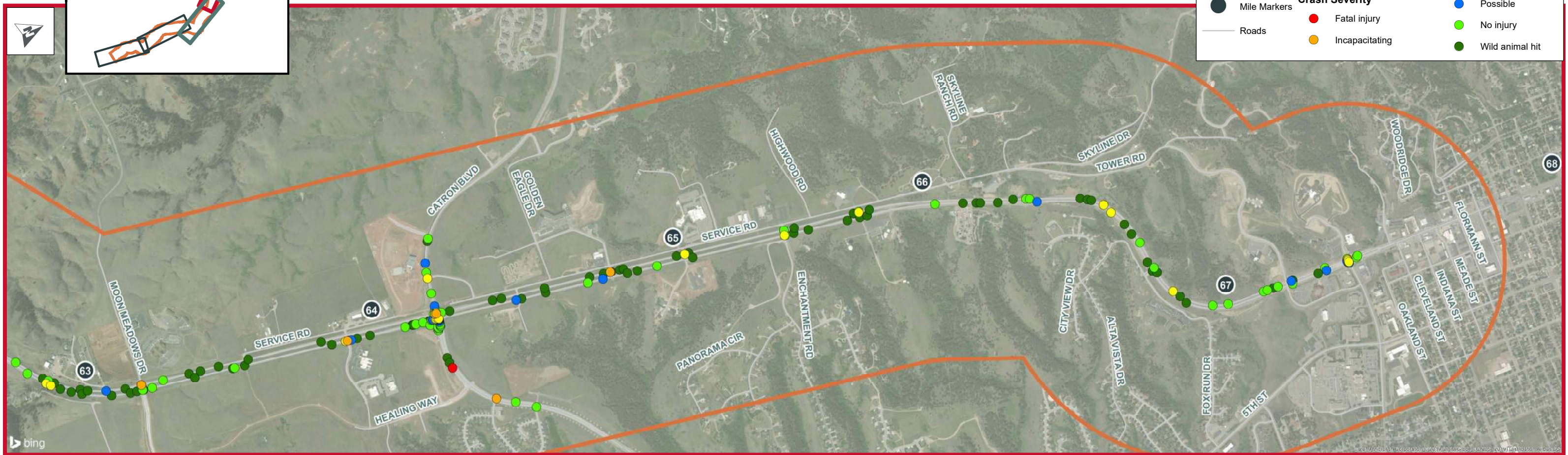
CRASH HISTORY (2014-2018)

FIGURE 2



LEGEND

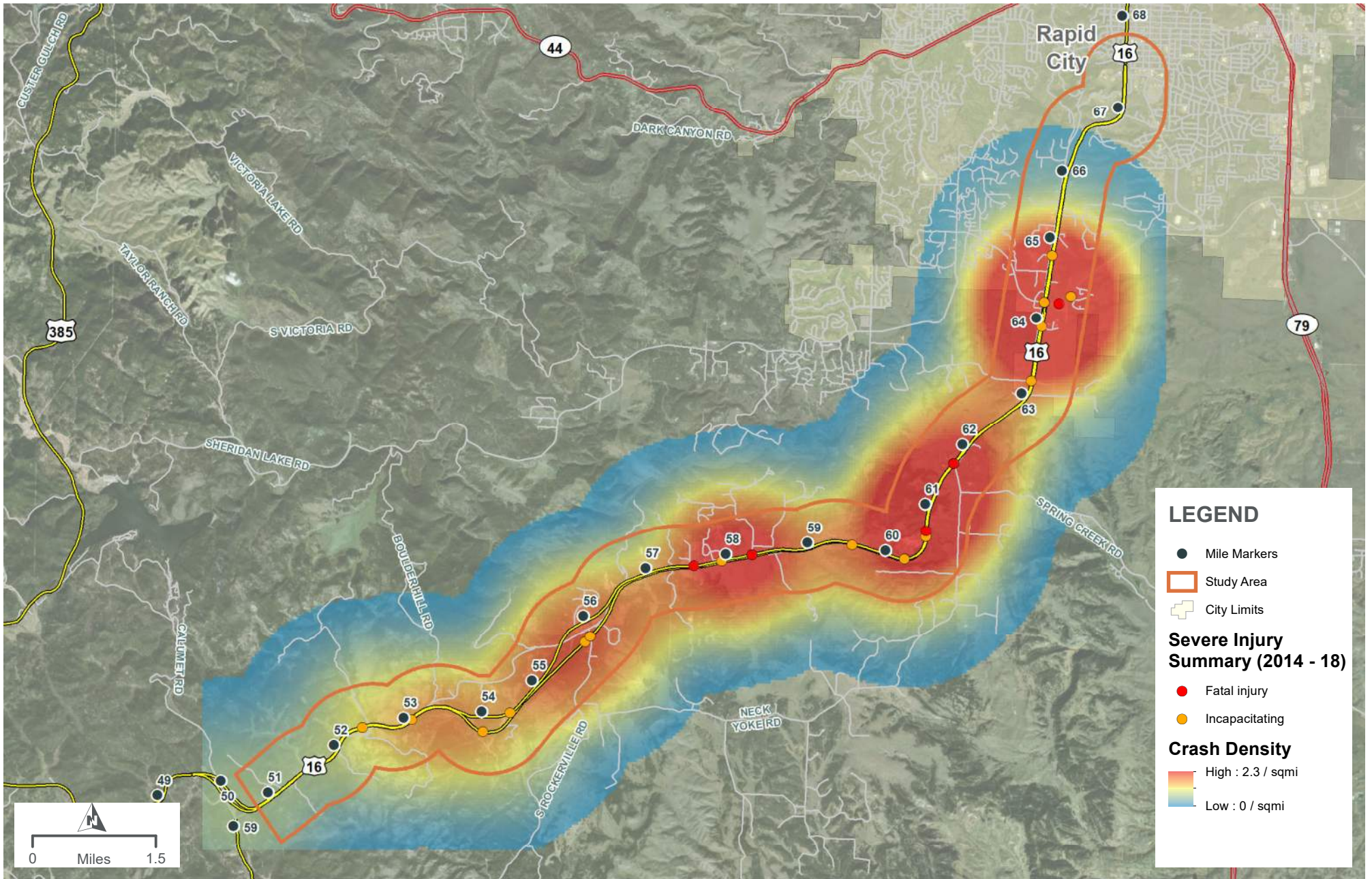
Study Area	Crash History (2014 - 18)	Non-incapacitating
Mile Markers	Crash Severity	Possible
Roads	Fatal injury	No injury
	Incapacitating	Wild animal hit



CRASH HISTORY (2014-2018)

FIGURE 2





LEGEND

- Mile Markers
- ▭ Study Area
- ⊕ City Limits

Severe Injury Summary (2014 - 18)

- Fatal injury
- Incapacitating

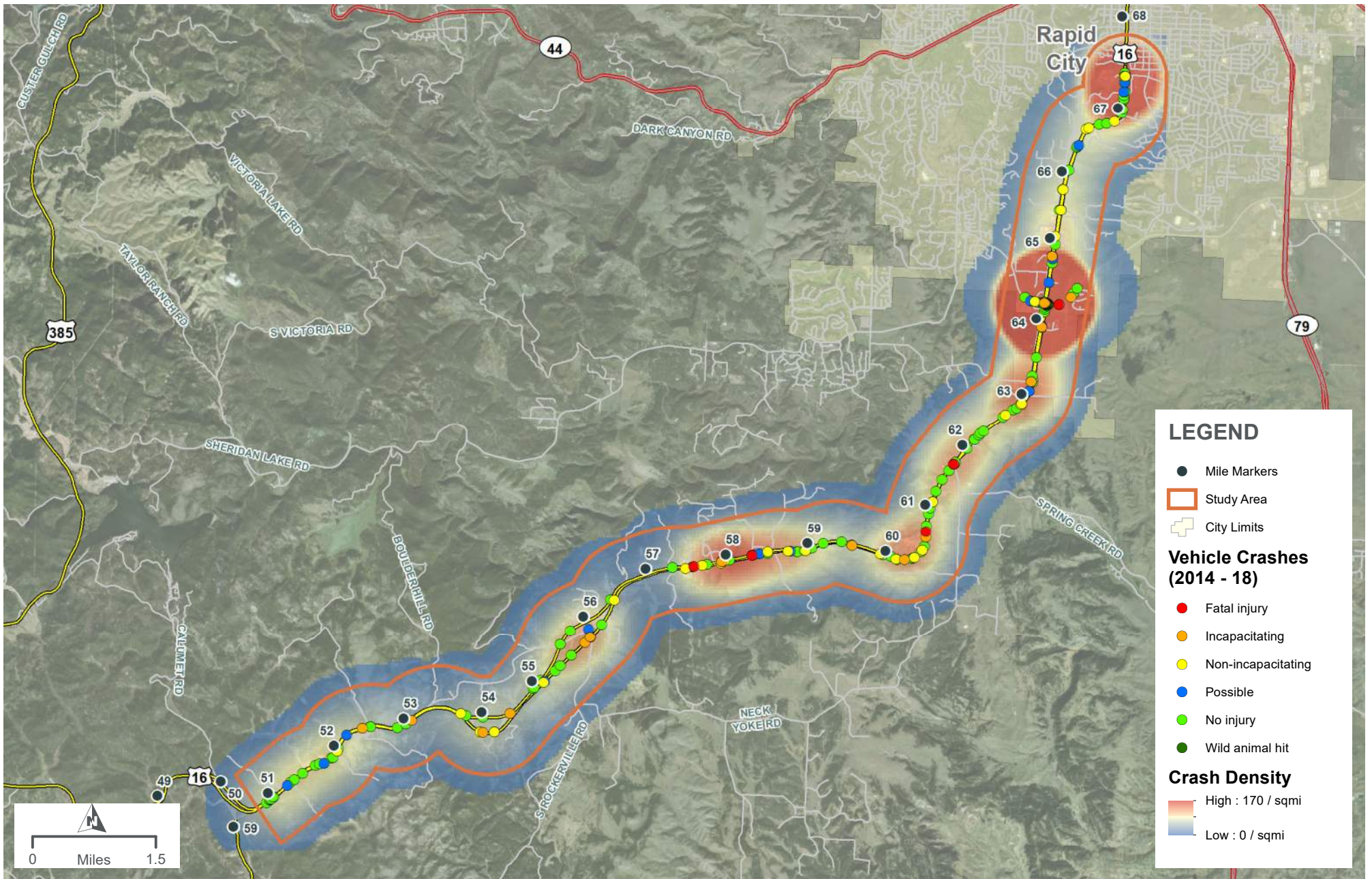
Crash Density

- High : 2.3 / sqmi
- Low : 0 / sqmi

SEVERE INJURY SUMMARY (2014 – 2018)



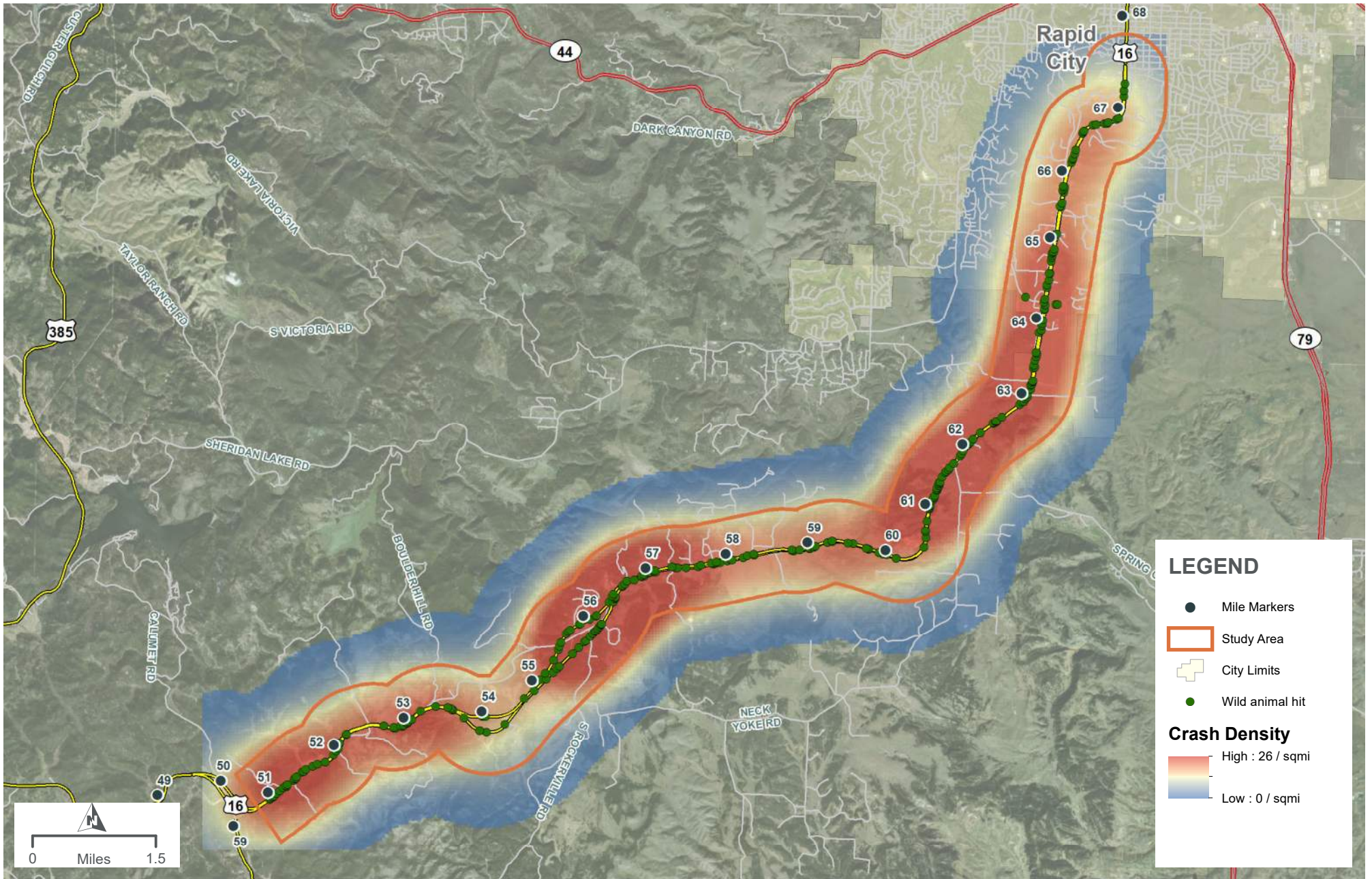
FIGURE 3



VEHICLE CRASHES (2014 – 2018)

FIGURE 4





VEHICLE - ANIMAL CRASHES (2014 – 2018)

FIGURE 5



US16 Corridor Seasonal and Daily Crash Trends

This section reviews crashes by month of the year, time of the day (based on light condition), and winter-weather conditions. The following table presents a summary of crashes by time of day and month of year.

Table 5: US16 Corridor – Time of Day/Month of Year Summary (2014 – 2018)

Month	Light Condition				Total
	Dawn	Daylight	Dusk	Dark	
January	1	19	0	17	37 (6%)
February	1	20	0	11	32 (6%)
March	2	23	2	9	36 (6%)
April	3	21	1	12	37 (6%)
May	2	26	1	14	43 (7%)
June	2	48	1	21	72 (12%)
July	1	30	2	21	54 (9%)
August	0	28	2	22	52 (9%)
September	1	25	1	23	50 (9%)
October	3	17	2	31	53 (9%)
November	6	15	4	53	78 (13%)
December	3	12	0	21	36 (6%)
Total	25 (4%)	284 (49%)	16 (3%)	255 (44%)	580 (100%)

As shown, the greatest proportion of crashes occur during the months of June (12 percent) and November (13 percent). These two months coincide with the beginning of the peak Black Hills tourist season (June) and the first winter-weather events, less daylight, and increased exposure to wild animals (November). The summer months, in general, exhibit higher crash totals than the winter months after November.

The time of day analysis depicts a trend where crashes during the day are more prevalent during the first eight months of the year and then it transitions to nighttime crashes in August and September. The months of October and November are highly proportional towards nighttime crashes. The vast majority of nighttime crashes occurred on unlit roadways (221 of the 255 dark light condition crashes).

Winter weather-related crashes were also reviewed from a corridor perspective. **Figure 6** depicts all crashes where the crash report noted road condition of ice, snow, slush, or frost. In total, there were 68 winter weather-related crashes corridor-wide.

As part of this study, a conference call was held with SDDOT maintenance staff responsible for maintaining this corridor to identify common problematic areas during the winter. These locations are summarized as follows:

- MRM 63 to 65 (Moon Meadows north to Rapid City)
- MRM 57 to 59 (between Bear Country to Strato Bowl Road)
- MRM 60 to 62 noted in discussion for an area with higher cashes (around the large horizontal curve and steep grade south of Neck Yoke Road)
- Fog in the US16/US16B/Catron Blvd intersection area

Further investigation of fog-related crashes indicates 20 crashes throughout the corridor over the 5 study years. Twelve occurred at intersections and four were vehicle-animal crashes. There were no fatal crashes and eight resulted in injuries.

It can be concluded that from a corridor-wide perspective, winter weather and inclement travel conditions has an effect on safety through the corridor.

Potential Mitigation Measures:

Review lighting warrants at unlit intersections that may experience higher turning demand during nighttime hours. Also, review winter weather/blowing snow locations for potential modifications to existing cross-sections, implementation of motorist information technologies for winter weather and fog conditions, and/or installation of snow fence.

US16 Corridor Median Crossing Review

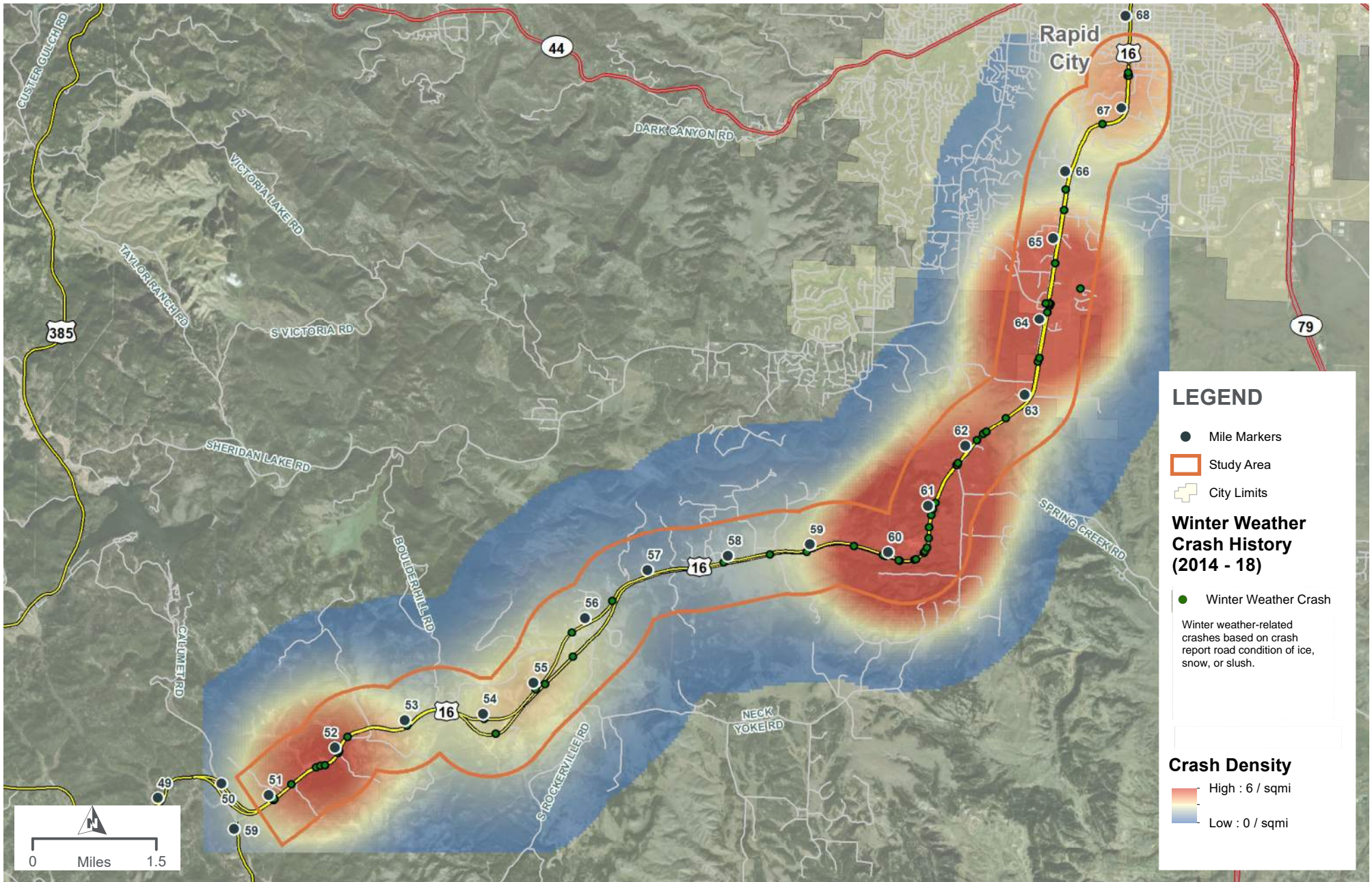
The crash data was queried for crashes that involved a vehicle crossing the centerline and/or median. A summary of median/centerline crossing crashes is presented in **Figure 7**, which identifies these crashes by injury. None of these crashes involved a fatality, however, there were three incapacitating injury and six other non-incapacitating or possible injury crashes.

From a spatial review of crash locations, there were four of these crashes through the horizontal curve and steep grade between MRM 60 and 61. Expanding the segment, there were nine median/centerline crossing crashes through a 3-mile stretch extending from just south of MRM 59 to just south of MRM 62. This segment of US16 includes the narrower cross-section with a depressed, paved median. No median guardrail or barrier is present through this segment.

There were five median/centerline crossing crashes just north of the Keystone Wye, from approximately MRM 51 to MRM 52. Two resulted in possible injuries. The US16 cross-section here includes a narrower cross-section with a depressed, 26-foot wide paved median. The lone median guardrail/barrier through this segment is around a southbound truss with guide signs.

Potential Mitigation Measures:

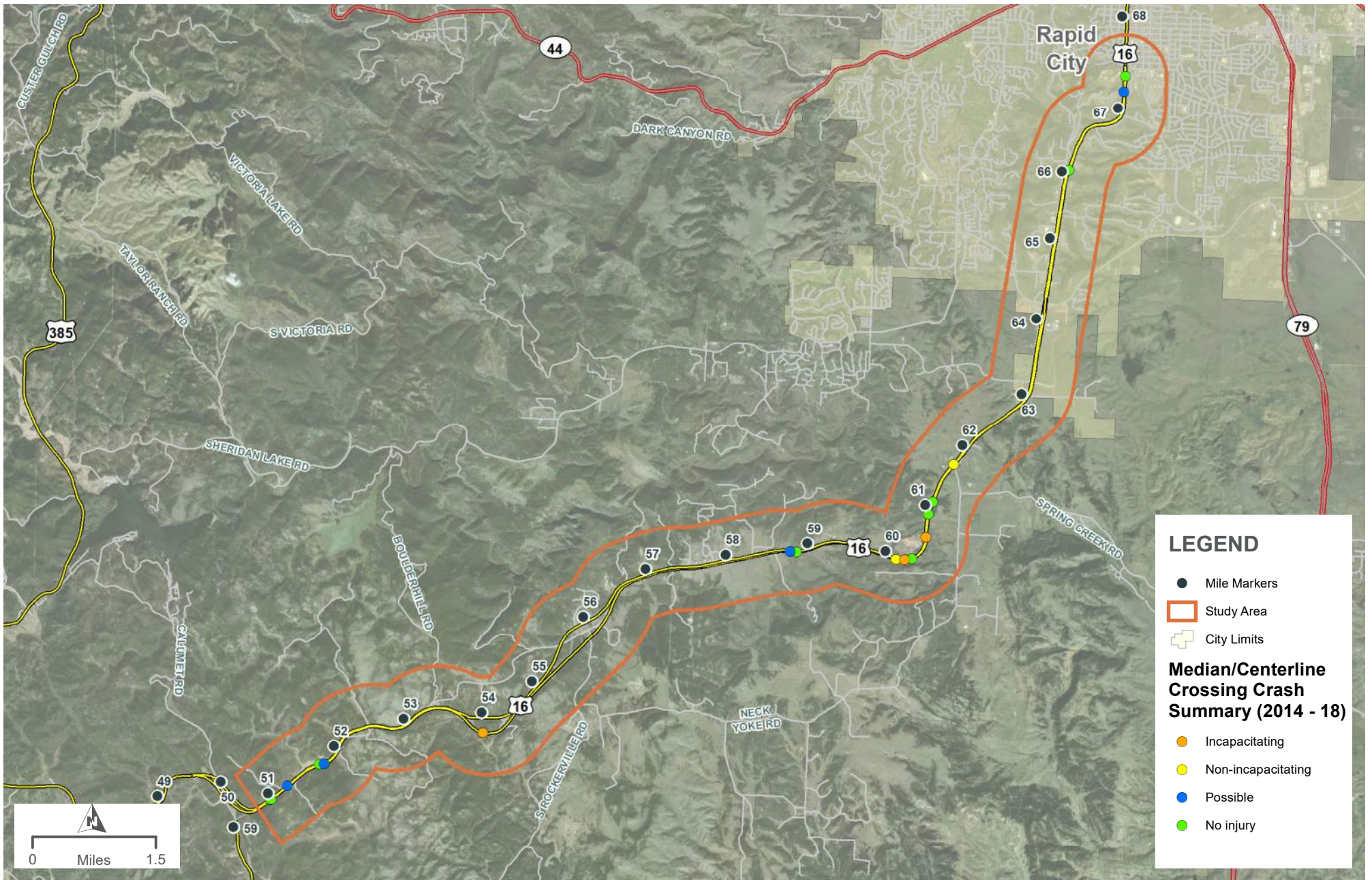
It is recommended that additional evaluation be conducted to analyze the potential need for median guardrail/barriers through these narrower cross-section segments.



WINTER WEATHER CRASH HISTORY (2014 – 2018)



FIGURE 6



MEDIAN/CENTERLINE CRASH SUMMARY (2014 – 2018)



FIGURE 7

US16 Corridor Segments

The US16 corridor was divided into segments based on the following criteria:

- Location of analysis intersections
- Changes in roadway typical cross-sections or geometrics, and/or
- Changes in US16 corridor volumes.

Crashes not associated with the analysis intersections were categorized as corridor segment crashes. This included all vehicle-animal crashes regardless of whether they may have occurred within the functional area of an intersection.

A map that cross-references the segments in these tables with the respective location on the corridor is provided in **Appendix A**.

US16 Corridor Crash Segment Summary

Table 6 and **Table 7** present a summary of US16 corridor segment crashes by crash severity for segments north and south of Neck Yoke Road, respectively.

Table 6: US16 Corridor Segments – Crash Severity (North of Neck Yoke Road)

#	Location (from south to north)		Fatal	Injury			PDO		Total
	From	To		A	B	C	Vehicle Only	Animal	
1	Echo Ridge Drive	Cathedral Blvd	0	0	1	2	7	6	16
2	Service Road	Echo Ridge Drive	0	0	3	1	5	16	25
3	Enchantment Road	Service Road	0	0	0	0	0	6	6
4	Table Rock Road	Enchantment Road	0	0	1	0	0	2	3
5	Promise Road	Table Rock Road	0	0	0	0	1	6	7
6	US16B/Catron Blvd	Promise Road	0	0	0	1	1	8	10
7	Skyline Drive/ Addison Ave	US16B/Catron Blvd	0	0	0	1	1	6	8
8	Moon Meadows Drive	Skyline Drive/ Addison Ave	0	0	1	0	3	9	13
9	Ft Hayes/Sammis Trail	Moon Meadows Drive	0	0	0	0	0	6	6
10	Unknown road	Ft Hayes/ Sammis Trail	0	0	3	0	9	21	33
11	Neck Yoke Road	Unknown road	0	0	1	0	3	4	8

PDO: Property Damage Only (no reported injury) crashes

Injury severity categories:

A: Incapacitating injury B: Non-incapacitating injury C: Possible injury

Table 7: US16 Corridor Segments – Crash Severity (South of Neck Yoke Road)

#	Location (from south to north)		Fatal	Injury			PDO		Total
	From	To		A	B	C	Vehicle Only	Animal	
12	Curve (east)	Neck Yoke Road	0	0	1	0	7	24	32
13	Curve (west)	Curve (east)	1	2	3	0	6	6	18
14	Sitting Bull Road (east)	Curve (west)	0	1	3	1	11	21	37
15	Wilderness Canyon Road	Sitting Bull Road (east)	0	0	1	1	1	2	5
16	Busted Five Lane	Wilderness Canyon Road	0	0	1	0	1	5	7
17	Strato Rim Drive	Busted Five Lane	1	1	5	2	2	8	19
18	Rockerville east ramp	Strato Rim Drive	0	0	2	0	2	28	32
19	Pine Haven Drive	Rockerville east ramp	0	0	0	0	0	5	5
20	Main Street	Pine Haven Drive	0	0	0	0	2	4	6
21	Golden Hills Drive	Rockerville east (WB) ramp	0	0	0	0	0	0	0
22	Rockerville Road	Golden Hills Drive	0	0	0	0	0	9	9
23	Rockerville west ramp	Rockerville Road	0	1	0	1	1	6	9
24	Curve/split (east)	Rockerville west ramps	0	0	1	1	5	11	18
25	Silver Mountain Road	Curve/split (east)	0	1	1	0	2	6	10
26	Silver Mountain Road	Curve/split (east)	0	1	2	0	1	8	12
27	Beretta Road	Silver Mountain Road	0	1	0	0	4	15	20
28	Klondike Road	Beretta Road	0	1	0	1	0	4	6
29	Cosmos Road	Klondike Road	0	0	1	1	6	11	19
30	North of Keystone Wye	Cosmos Road	0	0	0	1	8	13	22

PDO: Property Damage Only (no reported injury) crashes

Injury severity categories:

A: Incapacitating injury B: Non-incapacitating injury C: Possible injury

Table 8 and **Table 9** present the US16 corridor segment weighted crash rate and critical crash rate comparisons. The weighted crash rate provides two evaluations:

- A. Comparison to statewide averages based on roadway functional classification and
- B. Segment rank to determine which segments are more prone to severe crashes.

The statewide average weighted crash rate for highway segments in this study area are as follows:



- Urban Principal Arterial: 2 weighted crashes/MVMT
- Urban Freeway and Expressway: 1.71 weighted crashes/MVMT
- Rural Freeway and Expressway: 1.45 weighted crashes/MVMT

Segments that exceed these values are highlighted in yellow.

The second weighted crash rate evaluation identifies segments with the greatest weighed crash rates. Those that are reflective of the greatest 25 percent (top 7 segments) in weighted crash rate are highlighted in orange.

With regard to critical crash rates, segments that exhibited a crash rate greater than the critical crash rate are highlighted in blue.

Table 8: US16 Corridor Segments – Crash Rates (North of Neck Yoke Road)

#	Location (from south to north)		FC	Weighted Crash Rates (crashes per MVMT)			Critical Crash Rates (crashes per MVMT)		
	From	To		Weighted Crash Rate	State Rate	Ratio	Crash Rate	Critical Rate	Ratio
1	Echo Ridge Drive	Cathedral Blvd	UPA	1.39	2	0.69	1.00	2.06	0.49
2	Service Road	Echo Ridge Drive	UPA	1.29	2	0.64	1.00	1.94	0.52
3	Enchantment Road	Service Road	UPA	1.03	2	0.51	1.00	2.44	0.41
4	Table Rock Road	Enchantment Road	UPA	0.64	2	0.32	0.40	2.31	0.17
5	Promise Road	Table Rock Road	UPA	1.25	2	0.62	1.20	2.47	0.49
6	US16B/Catron Blvd	Promise Road	UPA	1.09	2	0.55	0.90	2.18	0.41
7	Skyline Drive/ Addison Ave	US16B/Catron Blvd	UF&E	1.93	1.71	1.13	1.50	2.51	0.60
8	Moon Meadows Drive	Skyline Drive/ Addison Ave	UF&E	0.97	1.71	0.56	0.80	2.07	0.39
9	Ft Hayes/Sammis Trail	Moon Meadows Drive	UF&E	2.32	1.71	1.36	2.30	2.97	0.77
10	Unknown road	Ft Hayes/ Sammis Trail	UF&E	1.37	1.71	0.80	1.20	1.92	0.63
11	Neck Yoke Road	Unknown road	RF&E	2.27	1.45	1.57	1.80	2.60	0.69

Functional Classification categories and statewide weighted average crash rate (weighted rate crashes/MVMT):

UPA: Urban Principal Arterial (2 weighted crashes/MVMT)

UF&E: Urban Freeway & Expressway (1.71 weighted crashes/MVMT)

RF&E: Rural Freeway & Expressway (1.45 weighted crashes/MVMT)

Table 9: US16 Corridor Segments – Crash Rates (South of Neck Yoke Road)



#	Location (from south to north)		FC	Weighted Crash Rates (crashes per MVMT)			Critical Crash Rates (crashes per MVMT)		
	From	To		Weighted Crash Rate	State Rate	Ratio	Crash Rate	Critical Rate	Ratio
12	Curve (east)	Neck Yoke Road	RF&E	2.41	1.45	1.66	2.30	2.10	1.10
13	Curve (west)	Curve (east)	RF&E	4.01	1.45	2.76	1.80	2.22	0.81
14	Sitting Bull Road (east)	Curve (west)	RF&E	2.14	1.45	1.48	1.70	1.98	0.86
15	Wilderness Canyon Road	Sitting Bull Road (east)	RF&E	1.64	1.45	1.13	0.90	2.48	0.36
16	Busted Five Lane	Wilderness Canyon Road	RF&E	1.55	1.45	1.07	1.20	2.45	0.49
17	Strato Rim Drive	Busted Five Lane	RF&E	8.37	1.45	5.78	3.50	2.48	1.41
18	Rockerville east ramp	Strato Rim Drive	RF&E	1.99	1.45	1.38	1.80	2.03	0.89
19	Pine Haven Drive	Rockerville east ramp	RF&E	1.27	1.45	0.88	1.30	2.67	0.49
20	Main Street	Pine Haven Drive	RF&E	2.83	1.45	1.95	2.80	3.15	0.89
21	Golden Hills Drive	Rockerville east (WB) ramp	RF&E	0.00	1.45	0.00	0.00	3.15	0.00
22	Rockerville Road	Golden Hills Drive	RF&E	6.37	1.45	4.39	6.40	3.58	1.79
23	Rockerville west ramp	Rockerville Road	RF&E	4.73	1.45	3.26	3.30	2.93	1.13
24	Curve/split (east)	Rockerville west ramps	RF&E	1.61	1.45	1.11	1.30	2.11	0.62
25	Silver Mountain Road	Curve/split (east)	RF&E	1.49	1.45	1.03	1.10	2.23	0.49
26	Silver Mountain Road	Curve/split (east)	RF&E	1.64	1.45	1.13	1.10	2.18	0.51
27	Beretta Road	Silver Mountain Road	RF&E	1.87	1.45	1.29	1.70	2.15	0.79
28	Klondike Road	Beretta Road	RF&E	1.33	1.45	0.92	0.80	2.33	0.34
29	Cosmos Road	Klondike Road	RF&E	2.25	1.45	1.55	1.90	2.20	0.86
30	North of Keystone Wye	Cosmos Road	RF&E	2.55	1.45	1.76	2.30	2.23	1.03

Functional Classification categories:

UPA: Urban Principal Arterial

UF&E: Urban Freeway & Expressway

RF&E: Rural Freeway & Expressway

It was found that the weighted crash rate exceeded the corresponding statewide average weighted crash rate for 19 of the 30 segments (highlighted in yellow in the table). 16 of these segments are located west/south of Neck Yoke Road. The seven intersections with the greatest weighted crash rate are highlighted in orange (upper 25 percent), and all are located west/south of Neck Yoke Road.

Five segments exhibited a crash rate that exceeded a critical crash rate, highlighted in blue in the table, and are also all located west/south of Neck Yoke Road. Each of these five segments were among the seven segments with the greatest weighted crash rates.

Given the high frequency of vehicle-animal crashes throughout most of the study area, a supplemental critical crash rate analysis was run without vehicle-animal crashes. It was found that the following segments exhibited crash rates that exceeded the critical rate when vehicle-animal crashes were removed:

- Horizontal curve (west end) to horizontal curve (east end)
 - Segment 13
- Strato Rim Drive to Busted Five Lane
 - Segment 17
- North of Keystone Wye to Cosmos Road
 - Segment 30

US16 Corridor Segments Identified for Further Review

The following provides additional details on the seven segments where the crash rate exceeded the critical crash rate and/or the intersection exhibited a weighted crash rate in the top 25 percent.

Horizontal Curve (east end) to Neck Yoke Road (Segment 12)

- *Weighted crash rate in top 25 percent*
- *Crash rate exceeds critical crash rate*

This segment is primarily on a downgrade ranging from -4.7% to -6% when traveling northbound (upgrade traveling southbound) and includes a 26-foot, paved median.

Vehicle-animal crashes represented 24 of the 32 crashes along this segment and thus was the primary contributing factor to the elevated crash rate. The other 8 crashes included 1 angle, 1 sideswipe, and 6 roadway departure crashes.

Of the six roadway departure crashes, five involved a vehicle traveling northbound or down the hill. The roadway condition was noted as ice, snow, or wet in five of the six roadway departure crashes.

Table 10: Horizontal Curve (east end) to Neck Yoke Road Crash Summary

<p>Total Crashes: 32 Crash Rate: 2.41 crashes/MVMT Weighted Crash Rate: 2.30 crashes/MVMT Approx. Segment Length: 0.9 miles</p> <p><u>Injury Crash Summary</u> Non-incapacitating: 1</p> <p><u>Manner of Collision Summary</u> Angle: 1 Sideswipe: 1 Roadway departure: 6 Vehicle-animal: 24</p> <p><u>Winter Road Conditions</u> Snow/ice: 4</p>	
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Potential Mitigation Measures:

Review measures to inform motorists of current roadway conditions, such as variable speed limits or winter weather advisory messaging. Review warrants for median barrier/guardrail and considerations for high-friction surface treatment.

Horizontal Curve (west end) to Horizontal Curve (east end) (Segment 13)

- Weighted crash rate in top 25 percent
- Crash rate exceeds critical crash rate when vehicle-animal crashes removed from calculation

This segment extends through the horizontal curve that traverses around the southern edge of an existing quarry. This segment is primarily on a downgrade ranging from -4.7% to -6% when traveling northbound (upgrade traveling southbound) and includes a narrower (compared to other rural cross-sections along the corridor), depressed paved median.

Five of the 18 crashes along this segment resulted in an injury crash, including one fatal. All five of these injury crashes were roadway departure type crashes, two of which running off the road right (which included the fatal crash) and the other three crossed the median/centerline.

Overall, the 7 of the 10 roadway departure type crashes involved inclement road conditions such as snow or ice. While these crashes occurred throughout the horizontal curve, there was a cluster of three eastbound roadway departure crashes that occurred at the start of the horizontal curve. This point is also located at the end of a long tangent section at a -6% slope.

High speeds, or motorists driving faster than the road conditions, were noted in five of the 10 crashes. Given the continuous downgrade from south to north and horizontal curve, high speeds and inclement weather can create challenging driving conditions through this area.

Table 11: Horizontal Curve (west end) to Horizontal Curve (east end) Crash Summary

<p>Total Crashes: 18 Crash Rate: 2.30 crashes/MVMT Weighted Crash Rate: 4.01 crashes/MVMT Approx. Segment Length: 0.62 miles</p> <p><u>Injury Crash Summary</u> Fatal: 1 Incapacitating: 2 Non-incapacitating: 3</p> <p><u>Manner of Collision Summary</u> Rear-end: 1 Sideswipe: 1 Roadway departure: 10 Vehicle-animal: 6</p> <p><u>Winter Road Conditions</u> Snow/ice: 9</p>	
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Potential Mitigation Measures:

Review measures to inform motorists of current roadway conditions, such as variable speed limits or winter weather advisory messaging. Review warrants for median barrier/guardrail, existing signage, roadway geometrics, and considerations for high-friction surface treatment.

Strato Rim Drive to Busted Five Lane (Segment 17)

- Weighted crash rate in top 25 percent
- Crash rate exceeds critical crash rate

Table 12: Strato Rim Drive to Busted Five Lane Crash Summary

<p>Total Crashes: 19 Crash Rate: 3.50 crashes/MVMT Weighted Crash Rate: 8.37 crashes/MVMT Approx. Segment Length: 0.35 miles</p> <p><u>Injury Crash Summary</u> Fatal: 1 Incapacitating: 1 Non-incapacitating: 5 Possible: 2</p> <p><u>Manner of Collision Summary</u> Angle: 4 Rear-end: 2 Roadway departure: 4 Vehicle-animal: 9</p> <p><u>Winter Road Conditions</u> Snow/ice: 1</p>	
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This segment exhibited the greatest weighted average crash rate of all US16 corridor segments within the study area. Nearly half of the crashes resulted in an injury.

Eight crashes were noted in the crash reports of having some relation to the two access points along this segment. Of these eight crashes, six result in an injury. Other characteristics of these intersection/access-related crashes include:

- 7 of the 8 crashes involved a westbound vehicle on US16
- 3 of the 8 crashes involved a motorcycle
- 6 of the 8 crashes occurred on dry pavement

Five crashes involved single-vehicle roadway departure type crashes, four of which included injuries include the fatal crash. Following too close and driving too fast for conditions were common contributing circumstances through this segment, which can lead to safety challenges with access points on high-speed segments.

Potential Mitigation Measures:

Review access spacing, intersection control/permitted movements and the potential for access modifications, and turn lane needs.

US16 W Main Street/Silver Mountain Road (16WF 55.70) to Pine Haven Drive (Segment 20)

- *Weighted crash rate in top 25 percent*

This segment applies to the westbound direction of travel for US16, from the Pine Haven Drive intersection to the Main Street/Silver Mountain Road intersection, in the Rockerville area. This short section is along a horizontal curve and predominantly on a downgrade in the westbound direction of travel. The roadway is lined by trees and there are a couple locations with rock faces beyond the ditch section.

Table 13: US16 W Main Street/Silver Mountain Road (16 WF 55.70) to Pine Haven Drive Crash Summary (Segment 20)

<p>Total Crashes: 6 Approx. Segment Length: 0.27 miles</p> <p><u>Injury Crash Summary</u> 0 injury crashes</p> <p><u>Manner of Collision Summary</u> Sideswipe: 1 Roadway departure: 1 Vehicle-animal: 4</p> <p><u>Winter Road Conditions</u> Snow/ice: 1</p>	
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Through this section, four of the 6 crashes were due to wild animal collisions. The other two crashes were non-injury crashes with one involving a sideswipe and the other a roadway departure.

The short segment length, one direction of traffic, and relatively high number of vehicle-animal crashes contributed to the higher crash rate. The lone crash trend identified on this segment was related to vehicle-animal crashes.

Potential Mitigation Measures:

Consider wildlife-vehicle collision reduction measures, such as wildlife fences and/or crossings.

US16 E Rockerville Road to Golden Hills Drive (Segment 22)

- Weighted crash rate in top 25 percent
- Crash rate exceeds critical crash rate

This is a short section of eastbound US16 through the Rockerville area. The roadway exhibits a fairly flat grade and a slight horizontal curve heading back towards the westbound lanes of US16. Trees line the segment on both sides of the roadway.

Table 14: US16 E Rockerville Road to Golden Hills Drive Crash Summary (Segment 22)

<p>Total Crashes: 9 Approx. Segment Length: 0.18 miles</p> <p><u>Injury Crash Summary</u> 0 injury crashes</p> <p><u>Manner of Collision Summary</u> Vehicle-animal: 9</p> <p><u>Winter Road Conditions</u> Snow/ice: 0</p>	
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This section had the second highest weighted crash rate of analyzed segments, however, all crashes along this segment were vehicle-animal crashes. No injuries were reported.

Potential Mitigation Measures:

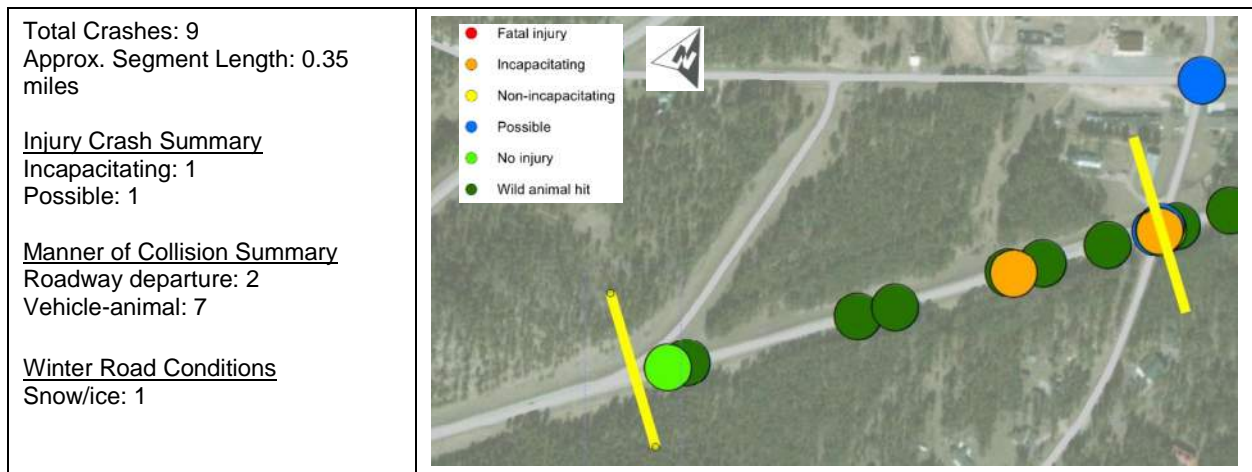
Consider wildlife-vehicle collision reduction measures, such as wildlife fences and/or crossings.

US16 E Rockerville West Ramp (16 E1 55.42) to Rockerville Road (16 EF 55.78) (Segment 23)

- *Weighted crash rate in top 25 percent*
- *Crash rate exceeds critical crash rate*

This segment applies to the eastbound direction of travel for US16 as the highway enters the Rockerville area. The roadway is predominantly straight and on a downgrade in the eastbound direction of travel. The roadway is lined by trees and there are a couple locations with rock faces beyond the ditch section.

Table 15: US16 E Rockerville West Ramp (16 E1 55.42) to Rockerville Road (16 EF 55.78) Crash Summary (Segment 23)



Seven of the nine crashes along this segment were vehicle-animal crashes, with one resulting in an injury. The other two were roadway departure crashes that hit an embankment or rock (possible injury crash). Both of those crashes occurred during inclement weather conditions of snow or rain, respectively.

The short segment length, one direction of traffic, and relatively high number of vehicle-animal crashes contributed to the higher crash rate. Besides the frequency of vehicle-animal crashes, no other crash trends were identified along this segment.

Potential Mitigation Measures:

Consider wildlife-vehicle collision reduction measures, such as wildlife fences and/or crossings.

North of Keystone Wye to Cosmos Road (Segment 30)

- *Weighted crash rate in top 25 percent*
- *Crash rate exceeds critical crash rate*

This segment exhibits a rural cross-section with the narrower paved (depressed) median present at other locations along the study corridor. The roadway is generally on a downgrade in the eastbound direction from the Keystone Wye and straight.

Table 16: North of Keystone Wye to Cosmos Road Crash Summary (Segment 30)

<p>Total Crashes: 22 Approx. Segment Length: 0.6 miles</p> <p><u>Injury Crash Summary</u> Possible: 1</p> <p><u>Manner of Collision Summary</u> Sideswipe: 1 Roadway departure: 8 Vehicle-animal: 13</p> <p><u>Winter Road Conditions</u> Snow/ice: 3</p>	
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Thirteen of the 22 crashes involved animals along this segment, which is tree-lined through its entirety.

The other nine crashes exhibited a variety of contributing circumstances and outcomes. Roadway departure right or left was the most common, many due to driver error and/or speed. Three of these crashes involved a vehicle crossing the median/centerline and striking a fixed object or stopping in the ditch. Six of the nine crashes occurred on dry pavement.

Potential Mitigation Measures:

Consider wildlife-vehicle collision reduction measures, such as wildlife fences and/or crossings.

US16 Corridor Intersections

Intersection-related crashes were evaluated at public roadway intersections with US16. Intersections were sorted by existing traffic control, which included two-way stop-control (TWSC) from the minor street approaches and traffic signal control.

Other intersections within the study area not located on the US16 corridor were also reviewed, but are presented separately from US16 corridor intersections in a subsequent section.

US16 Corridor Intersection Summary

Table 17 and **Table 18** present a summary of intersection crashes by crash severity for US16 TWSC and signalized intersections and study area intersections off of US16. These crashes are shown spatially in **Figure 8**. Note that there may be more crashes shown in the figure than what is presented on the table, as all minor access-related crashes coded as an intersection crash in the crash report are shown.

Table 17: US16 Corridor TWSC Intersections – Crash Severity (2014 – 2018)

US16 Corridor Intersection	Intersection Control	Fatal	Injury			PDO	Total
			A	B	C	Vehicle Only	
Service Road (N of Highwood Rd)	TWSC	0	0	1	0	1	2
Enchantment Road	TWSC	0	0	0	0	4	4
Table Rock Road	TWSC	0	0	1	0	0	1
Promise Road	TWSC	0	1	0	1	2	4
Tucker Street	TWSC	0	0	0	1	0	1
Skyline Drive / Addison Avenue	TWSC	0	1	0	0	0	1
Moon Meadows Drive	TWSC	0	1	1	1	5	8
Ft Hayes/Sammis Trail	TWSC	0	0	0	1	1	2
Neck Yoke Road	TWSC	1	2	0	0	1	4
Sitting Bull Road	TWSC	0	0	0	0	1	1
Wilderness Canyon Road	TWSC	1	1	0	1	2	5
Busted Five Lane	TWSC	0	1	2	2	1	6
Strato Rim Drive	TWSC	0	0	0	1	0	1
US16 WB: Silver Mountain Road / Main Street	TWSC	0	0	0	0	1	1
US16 EB: Golden Hills Drive	TWSC	0	0	0	0	1	1
US16 EB: Rockerville Road	TWSC	0	2	0	2	1	5

PDO: Property Damage Only (no reported injury) crashes

Injury severity categories:

A: Incapacitating injury B: Non-incapacitating injury C: Possible injury

Table 18: US16 Corridor Signalized Intersections – Crash Severity (2014 – 2018)

US16 Corridor Intersection	Intersection Control	Fatal	Injury			PDO	Total
			A	B	C	Vehicle Only	
Cathedral Drive/Fairmont Blvd	Signal	0	0	3	5	15	23
US16B/Catron Blvd	Signal	0	2	14	18	54	88

PDO: Property Damage Only (no reported injury) crashes

Injury severity categories:

A: Incapacitating injury B: Non-incapacitating injury C: Possible injury

Table 19 and **Table 20** present the weighted crash rate and critical crash rate comparisons. Because the State of South Dakota does not calculate statewide averages for intersection crash rates, the weighted crash rate evaluation only presents a ranking of intersections to determine which segments are prone to more severe crashes based on intersection control type and location. Intersections with the greatest weighted crash rate are highlighted in orange.

With regard to critical crash rates, US16 corridor intersections that exhibited a crash rate greater than the critical crash rate are highlighted in blue.

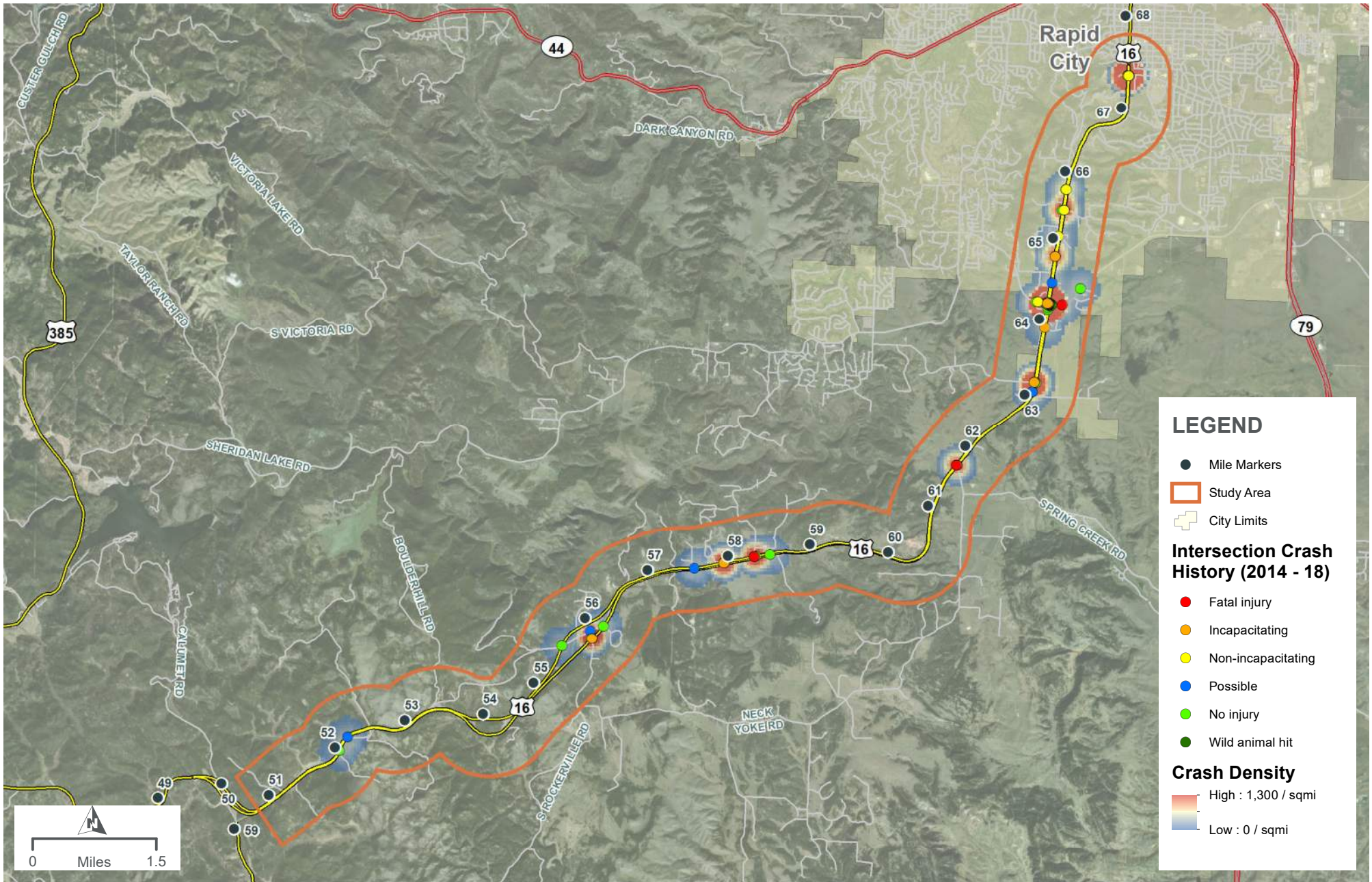
Table 19: US16 Corridor TWSC Intersections – Crash Rates (2014 – 2018)

US16 Corridor Intersection	Intersection Control	Weighted Crash Rates (crashes per MEV)		Critical Crash Rates (crashes per MEV)		
		Weighted Crash Rate	Rank	Crash Rate	Critical Rate	Ratio
Service Road (N of Highwood Rd)	TWSC	0.18	8	0.09	0.29	0.31
Enchantment Road	TWSC	0.17	9	0.17	0.28	0.61
Table Rock Road	TWSC	0.12	14	0.04	0.28	0.15
Promise Road	TWSC	0.31	6	0.15	0.27	0.55
Tucker Street	TWSC	0.12	13	0.04	0.28	0.14
Skyline Drive / Addison Avenue	TWSC	0.09	15	0.03	0.25	0.12
Moon Meadows Drive	TWSC	0.41	5	0.23	0.25	0.91
Ft Hayes/Sammis Trail	TWSC	0.13	11	0.06	0.26	0.23
Neck Yoke Road	TWSC	0.74	4	0.16	0.27	0.58
Sitting Bull Road	TWSC	0.06	17	0.06	0.32	0.19
Wilderness Canyon Road	TWSC	1.23	2	0.31	0.32	0.98
Busted Five Lane	TWSC	0.97	3	0.37	0.32	1.17
Strato Rim Drive	TWSC	0.19	7	0.06	0.32	0.19
US16 WB: Silver Mountain Road / Main Street	TWSC	0.13	10	0.13	0.41	0.31
US16 EB: Golden Hills Drive	TWSC	0.12	12	0.12	0.41	0.29
US16 EB: Rockerville Road	TWSC	1.40	1	0.54	0.39	1.39

Table 20: US16 Corridor Signalized Intersections – Crash Rates (2014 – 2018)

US16 Corridor Intersection	Intersection Control	Weighted Crash Rates (crashes per MEV)		Critical Crash Rates (crashes per MEV)		
		Weighted Crash Rate	Rank	Crash Rate	Critical Rate	Ratio
Cathedral Drive/Fairmont Blvd	Signal	1.12	2	0.66	**	**
US16B/Catron Blvd	Signal	2.96	1	1.67	**	**

** Critical rate not calculated due to low signalized intersection sample size.



INTERSECTION CRASH HISTORY (2014 – 2018)



FIGURE 8

US16 Corridor Intersections Identified for Further Review

Based on a review of the intersection weighted crash rates and critical crash rates, the following US16 corridor intersections were identified for further investigation.

US16 and Wilderness Canyon Road Intersection

- *Weighted crash rate in top 5 intersections*

The US16 and Wilderness Canyon Road intersection is a T-intersection along a US16 tangent (straight) roadway segment. Wilderness Canyon Road heads northward to several residences in the hills. There is currently a field access that extends south from the intersection.

Median width at this intersection is approximately 62 feet and provides median storage for a two-stage crossing of US16. No turn lanes are currently striped on US16.

Table 21: US16 and Wilderness Canyon Road Intersection Crash Summary

<p>Total Crashes: 5 Crash Rate: 0.31 crashes/MEV Weighted Crash Rate: 1.23 crashes/MEV Intersection Control: TWSC</p> <p><u>Injury Crash Summary</u> Fatal: 1 Incapacitating: 1 Possible: 1</p> <p><u>Manner of Collision Summary</u> Angle: 4 Sideswipe: 1 (same direction)</p>	
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There were four angle crashes reported at this intersection, three of which resulting in injuries (including the fatality). Three of these four crashes involved a southbound left-turning vehicle and westbound through vehicle. The fatal crash involved a motorcycle.

The right-of-way is clear of large sight obstructions, but there are a number of signs and delineators in the northeast quadrant of the intersection that may intermittently block approaching vehicles and motorcycles. The vertical curve east of the intersection and high speeds along this segment of US16 may create challenges for Wilderness Canyon Road motorists to judge gaps in traffic.

Potential Mitigation Measures:

Review sight angles and potential modification to access and median treatment/width.

US16 and Moon Meadows Drive Intersection

- *Weighted crash rate in top 5 intersections*

The US16 and Moon Meadows Drive intersection has seen increasing traffic as development extends southward from Rapid City. The east leg of the intersection and offset northbound and southbound left-turn lanes were constructed in 2015. Seven of the 8 crashes occurred in the three years following 2015.

The surrounding terrain is flat to the north of the intersection and flat-rolling to the south. There is a horizontal curve south of the intersection. Median width is approximately 62 feet and right-turn lanes are also included on both US16 approaches.

Table 22: US16 and Moon Meadows Drive Intersection Crash Summary

<p>Total Crashes: 8 Crash Rate: 0.23 crashes/MEV Weighted Crash Rate: 0.41 crashes/MEV Intersection Control: TWSC</p> <p><u>Injury Crash Summary</u> Incapacitating: 1 Non-incapacitating: 1 Possible: 1</p> <p><u>Manner of Collision Summary</u> Angle: 6 Rear-end: 1 Roadway departure: 1</p>	
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Six of the 8 crashes were angle crashes. Each of these six crashes involved a southbound vehicle and accounted for all three injury crashes. Citations in four of these crashes were failure to stop for stop sign/yield after stop.

Sight angles, size of the intersection, and availability of gaps in traffic to complete may be contributing to these angle crashes. Large vehicles in the northbound and southbound right-turn lanes on US16 may also block a driver's view of oncoming US16 traffic

On the east leg of the intersection, aerial imagery indicates that stop bar is located approximately 35 feet east of the edge of northbound through travel lane. This increases the needed gap in traffic to complete the first maneuver. Aerial imagery indicates no stop bars painted on the west leg, which may encourage motorists to stop closer to the US16 travel lane.

Potential Mitigation Measures:

Review intersection control warrants, current pavement marking placement, and stop-controlled approach sight angles. Consider rural intersection control warning system as interim measure.

US16 and Neck Yoke Road Intersection

- *Weighted crash rate in top 5 intersections*

The US16 and Neck Yoke Road intersection experiences a diverse range of vehicle types and driver familiarity. The Neck Yoke Road intersection is the southern-most access in a series of four access locations in the area. On the north/west side of US16 is Reptile Gardens, which has three access points to/from their parking lot, and other tourist destinations. On the south/east side of US16, there is a service road with connections to all four US16 access points. The service road provides access to a motel, campground, and residences. Neck Yoke Road extends southward and provides access to a golf course, residential development, a large campground and RV storage facility, and a school.

Table 23: US16 and Neck Yoke Road Intersection Crash Summary

<p>Total Crashes: 4 Crash Rate: 0.16 crashes/MEV Weighted Crash Rate: 0.74 crashes/MEV Intersection Control: TWSC</p> <p><u>Injury Crash Summary</u> Fatal: 1 Incapacitating: 2</p> <p><u>Manner of Collision Summary</u> Angle: 4</p>	
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All four crashes at this intersection were angle crashes, resulting in one fatal crash and two incapacitating crashes. The three injury crashes involved an eastbound and westbound vehicle, with one of them turning left onto the crossroad. The fatal crash and one incapacitating crash involved a motorcycle.

Median width is approximately 26 feet, which does not facilitate two-stage crossings of US16. A 2015 project removed a narrow raised median and shifted left-turn lanes closer to the opposing direction to create more of an offset to view oncoming traffic. However, the three injury crashes occurred after this modification was implemented.

Potential Mitigation Measures:

Review access spacing, intersection traffic control, and potential access modifications and median treatments. This intersection was identified for individual study as part of the US16 Corridor Study to develop and evaluate potential safety modifications.

US16 and Busted Five Lane Intersection

- *Weighted crash rate in top 5 intersections*
- *Crash rate exceeds critical crash rate*

The US16 and Busted Five Lane intersection is a 4-leg intersection that includes a driveway access extending to the south and Busted Five Lane extending north. This intersection experiences notable tourist traffic as Busted Five Lane provides access to several tourist destinations, residences, and a large campground.

Median width at this intersection is approximately 62 feet and provides median storage for a two-stage crossing of US16. No turn lanes are currently striped on US16.

Table 24: US16 and Busted Five Lane Intersection Crash Summary

<p>Total Crashes: 6 Crash Rate: 0.37 crashes/MEV Weighted Crash Rate: 0.97 crashes/MEV Intersection Control: TWSC</p> <p><u>Injury Crash Summary</u> Incapacitating: 1 Non-incapacitating: 2 Possible: 2</p> <p><u>Manner of Collision Summary</u> Angle: 4 Roadway departure: 2</p>	
---	--

Four of the six crashes involved angle crashes, accounting for four of the five injury crashes. Two of these crashes involved alcohol. All four angle crashes were between a US16 through vehicle and a vehicle turning from the crossroad access.

The other injury crash involved a motorcycle and roadway departure due to following too close to another vehicle.

Potential Mitigation Measures:

Review access spacing, intersection traffic control, and potential modification to access and median treatment/width.

US16 EB and Rockerville Road Intersection

- *Weighted crash rate in top 5 intersections*
- *Crash rate exceeds critical crash rate*

The eastbound US16 intersection with Rockerville Road is at a skew as the Rockerville Road crosses US16 on a tangent. From the south, Rockerville is on a downgrade heading into the intersection. The roadway is tree-lined and cut into the hill, so a motorist’s view of approaching US16 traffic is restricted until they get to the intersection. To the north, Rockerville Road is on an upgrade when approaching the intersection and provides access to the historic Rockerville area.

There is currently an eastbound US16 left-turn lane into the historic Rockerville area. Existing stop bar locations from the edge of travel lane is approximately 45 and 30 feet for southbound and northbound respectively, measured from the center of the Rockerville Road lane.

Table 25: US16 E and Rockerville Road Intersection Crash Summary

<p>Total Crashes: 5 Intersection Control: TWSC</p> <p><u>Injury Crash Summary</u> Incapacitating: 2 Possible: 2</p> <p><u>Manner of Collision Summary</u> Angle: 4 Roadway departure: 1</p>	
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The angle crashes were evenly split between a northbound and southbound crash with an eastbound vehicle. All four angle crashes resulted in a failure to stop for stop sign/yield after stop citation. One of the angle crashes involved a motorcycle.

The roadway departure crash involved a motorcycle and distracted driving on the southbound Rockerville Road approach.

Potential Mitigation Measures:
Review intersection layout and sight limitations.

US16 and US16B/Catron Boulevard

- *High weighted crash rate and crash rate*

The US16/US16B/Catron Boulevard intersection is a signalized intersection that experiences notable traffic demand compared to most of the other intersections along the corridor. This intersection serves as the crossroad for both commuter and tourist traffic in one of the fastest-growing areas of the Rapid City MPO. Thus, the intersection has seen considerable growth in traffic volumes and is expected to continue to see growth for the foreseeable future.

Current posted speed limits are 60 mph on US16 and 45 mph on US16B/Catron Boulevard through the intersection. Turn lanes are included on all approaches. All left-turn movement signal phasing is currently protected-only. However, the US16B/Catron Boulevard left-turn phasing included a flashing yellow (permitted) phase and single left-turn lanes during much of the crash history review period. There is a free northbound to eastbound right-turn movement.

Table 26: US16 and US16B/Catron Boulevard Intersection Crash Summary

<p>Total Crashes: 88 Crash Rate: 1.67 crashes/MEV Weighted Crash Rate: 2.96 crashes/MEV Intersection Control: Traffic signal</p> <p><u>Injury Crash Summary</u> Fatal: 0 Incapacitating: 2 Non-incapacitating: 14 Possible: 18</p> <p><u>Manner of Collision Summary</u> Angle: 48 Rear-end: 32 Head-on: 1 Sideswipe: 1 Roadway departure: 6</p> <p><u>Weather-Related</u> Fog: 7 Snow/ice road conditions: 9</p>	
--	--

While the type of intersection is considerably different than most other intersections along the corridor, the crash rate and weighted crash rate is notably higher. However, crash severity appears to be fairly low compared to other intersections identified for further review. Of the 88 intersection crashes, there were no fatalities and two incapacitating injuries.

Angle crashes were the most common manner of collision at the intersection, comprising 48 of the 88 total crashes. The majority of these 48 angle crashes are between eastbound and westbound vehicles (totals below include both through and turning vehicles):

- 40 crashes involved an eastbound vehicle.
- 39 involved a westbound vehicle.

- 11 involved a northbound US16 vehicle.
- 5 involved a southbound US16 vehicle.

Twenty of the 34 injury crashes were angle crashes.

Rear-end crashes were the second most-frequent crash type, comprising 32 of the 88 total crashes. Crash distribution by approach is as follows:

- Eastbound approach: 9
- Westbound approach: 14
- Northbound US16 approach: 7
- Southbound US16 approach: 2

Rear-end crashes resulted in 13 injury crashes, 7 of which occurred on the westbound US16B approach.

Weather-related impacts were also reviewed, including winter road conditions and fog. Nine crashes involved snow or ice road conditions, resulting in 5 rear-end crashes, 3 angle crashes, and 1 roadway departure crash. All five rear-end crashes occurred on US16B/Catron Boulevard (eastbound or westbound directions of travel). The angle and roadway departure crashes involved a variety of directions of travel. Fog was noted in seven crashes, 5 resulting in rear-end crashes and two resulting in angle crashes. Four of the 5 rear-end crashes involved a northbound vehicle.

A review of crash rates, type, and location of crashes suggests some impact of congestion, unexpected queue lengths, unexpected signal location, and weather on intersection safety.

Potential Mitigation Measures:

Review intersection type, evolving traffic patterns, and future capacity with respect to anticipated demand. Short-term mitigation measures may include advance intersection warning for congestion and weather-related events. Similar to the US16/Neck Yoke Road intersection, a detailed intersection study is being conducted at the US16/US16B/Catron Boulevard intersection as part of the overall corridor study.

Other Study Area Intersections

The crash history at study area intersections within the study area not on US16 was also reviewed. This included corridors such as US16B, Catron Boulevard, Neck Yoke Road, and US16 service roads. **Table 27** and **Table 28** present a summary of crashes at these intersections.



Table 27: Other Study Area Intersections – Crash Severity (2014 – 2018)

Intersection		Fatal	Injury			PDO	Total
Crossroad 1	Crossroad 2		A	B	C	Vehicle Only	
Main Street	Rockerville Road	0	0	0	1	0	1
service road	Promise Road	0	0	0	1	3	4
US16B/Catron Blvd	Healing Way	1	0	0	0	0	1
US16B/Catron Blvd	Wellington Drive (east)	0	0	0	0	1	1
Neck Yoke Road	Spring Creek Road	0	0	0	0	2	2

PDO: Property Damage Only (no reported injury) crashes

Injury severity categories:

A: Incapacitating injury B: Non-incapacitating injury C: Possible injury

Table 28: Other Study Area Intersections – Crash Rates (2014 – 2018)

Intersection		Intersection Control	Weighted Crash Rates (crashes per MVMT)	Critical Crash Rates (crashes per MVMT)		
Crossroad 1	Crossroad 2			Crash Rate	Crash Rate	Ratio
Main Street	Rockerville Road	TWSC	***	***	***	***
service road	Promise Road	TWSC	***	***	***	***
US16B/Catron Blvd	Healing Way	TWSC	0.45	0.04	0.27	0.15
US16B/Catron Blvd	Wellington Drive (east)	TWSC	0.04	0.04	0.28	0.14
Neck Yoke Road	Spring Creek Road	TWSC	0.39	0.39	0.50	0.78

Notes:

0 crashes reported at Les Hollers Way

*** No traffic counts available

There was one fatal crash noted at the US16B and Healing Way intersection in 2018, involving an angle collision between northbound and eastbound vehicles. Driver contributing circumstance was noted as disregarding traffic signs or signals.

The service road (north of Highwood Road) and Promise Road intersection has experienced the greatest number of crashes over the last five years of these other intersections with four. All four were angle crashes, with three of them related to disregarding traffic signs or signals. The roadway is currently stop-controlled from the northbound and southbound service road approaches to let traffic turning off of US16 to clear the intersection.

These intersections will be reviewed in greater detail for any potential improvements as the study progresses.

Conclusions and Next Steps

There were several crash trends evident throughout the US16 corridor. Findings and potential mitigation measures identified throughout this report will help guide the next steps in the study, which include the analysis and development of supporting memoranda regarding the following:

- Winter weather/blowing snow review
- Access review
- Turn lane warrant review
- Intersection traffic control warrant review
- Intelligent Transportation System (ITS) structure and component review
- Geometric review
- Traffic operations analysis of existing and future No-Build conditions

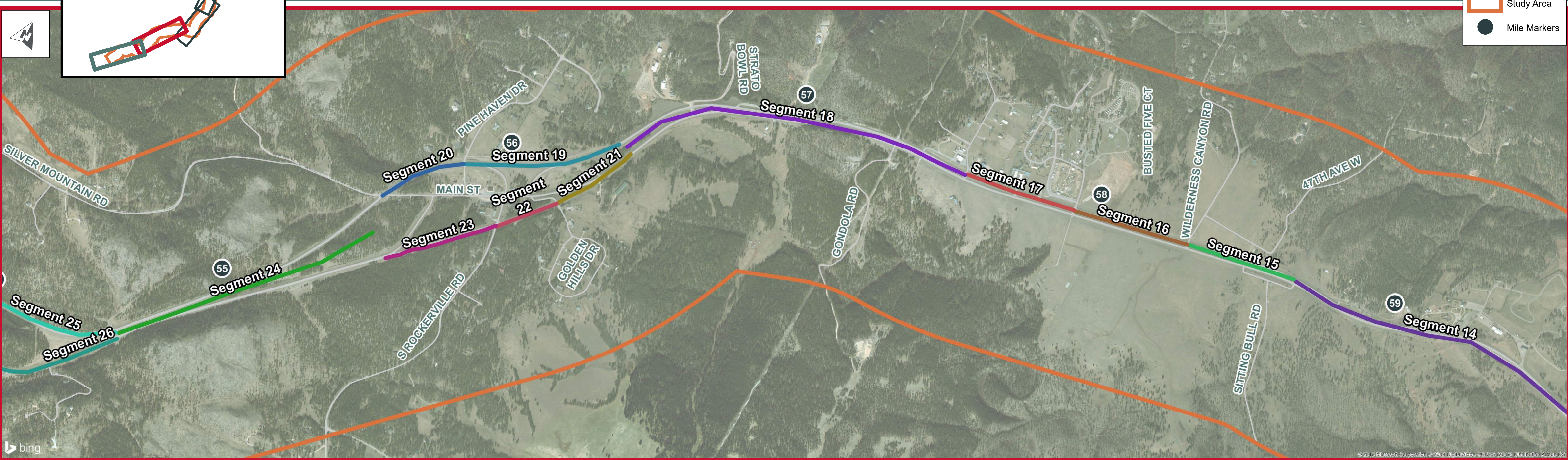
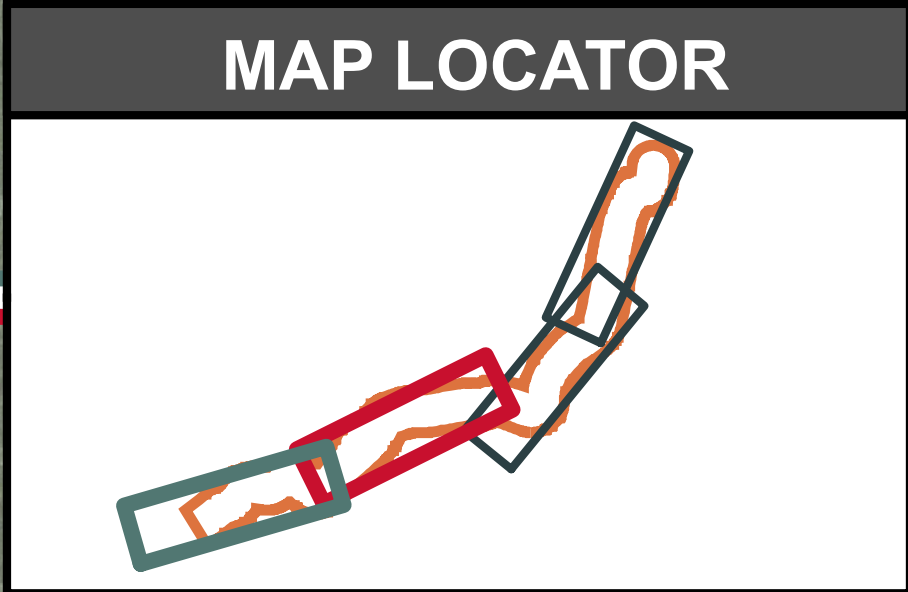
These upcoming reviews and analyses, coupled with findings from this safety analysis, will help the study team develop potential concepts to address established needs.

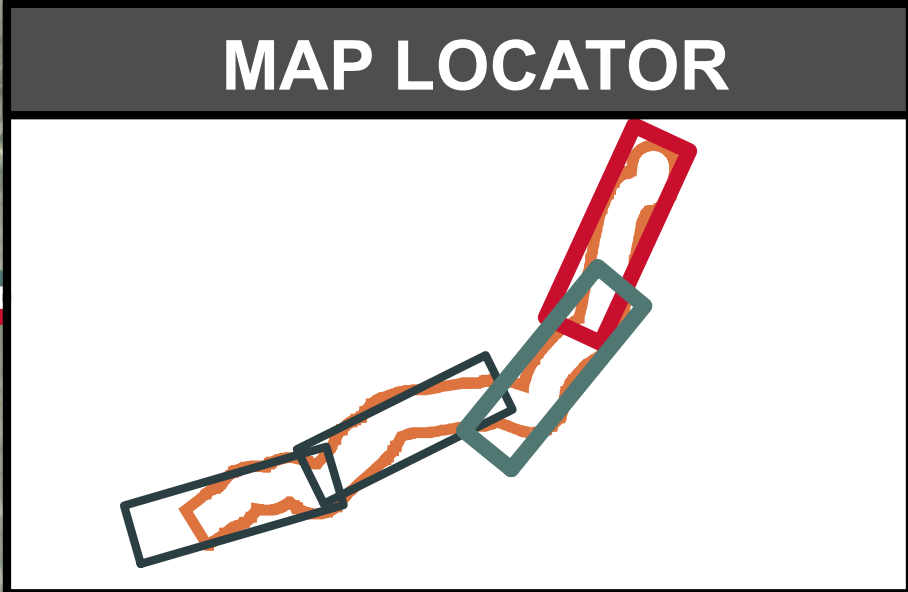
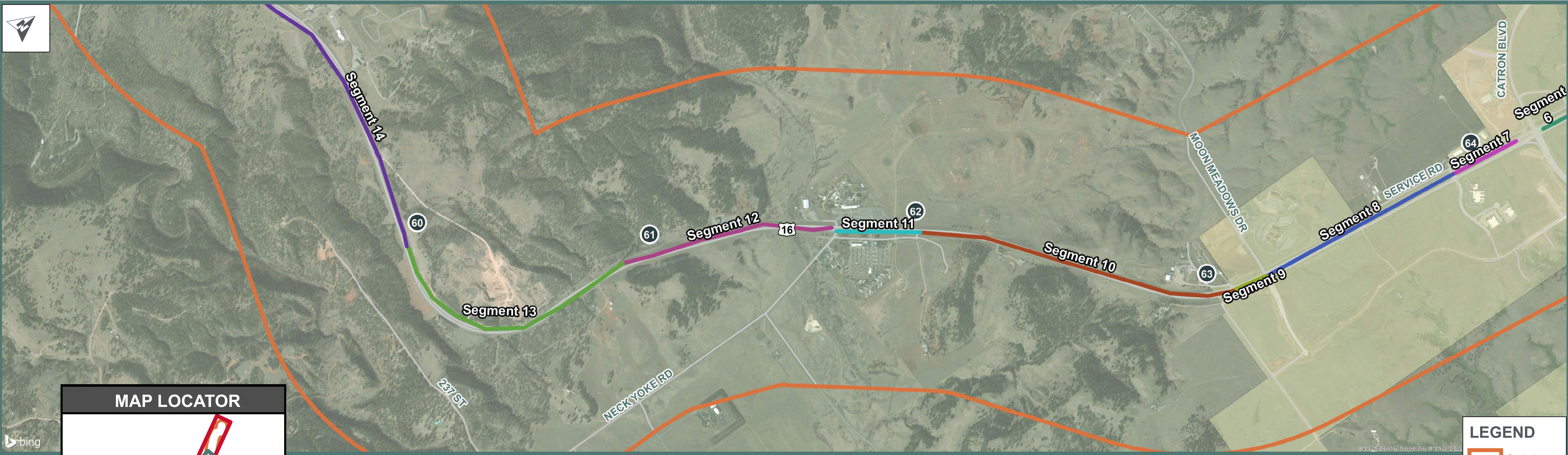
Appendix

- A. Crash Segment Key
- B. Segment Crash Tables
- C. Intersection Crash Tables



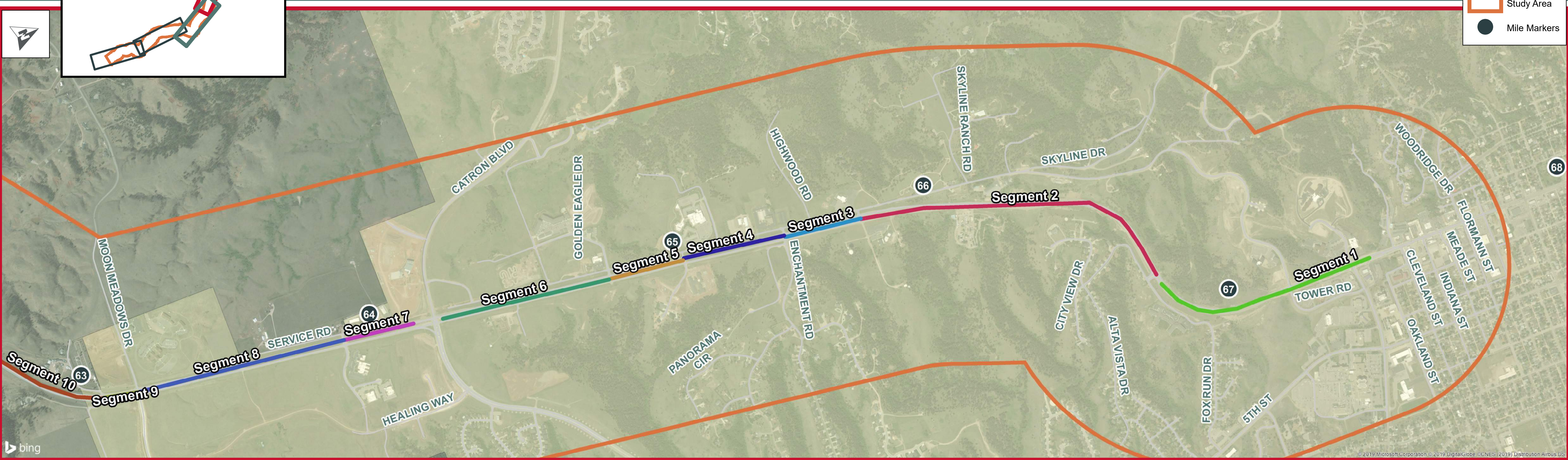
Appendix A – Crash Segment Key





LEGEND

- Study Area
- Mile Markers



CRASH REVIEW SEGMENTS

PL0100(79) 3616 P, PCN 073F, PENNINGTON COUNTY





Appendix B – Segment Crash Tables

US16 Corridor Study (2014-2018) - TWSC Intersections

rev. 7/1/2019

Roadway 1	Roadway 2	Fatal	Incap. A	Non-Inc B	Possible C	No injury Property	Total	Calculations					Weighted Crash Rates			Critical Crash Rates			No Collision btw 2 MV																
								EV N	EV S	EV W	EV E	AEV	MEV	TEV*R2	Calculated	Statewide	Rank	Crash Rate	Critical Rate	Ratio	Rear End	Head On	Angle	Side Swipe	Other	Animal	Single-Vehicle	Total							
US16	Service Road (N of Highwood Rd)	0	0	1	0	1	2	5846	5846	324	141	4437305	22.18653	1094	0.18		8	0.09	0.29	0.31			2						2						
US16	Enchantment Road	0	0	0	0	4	4	5846	6680	550	179	4838075	24.19038	2253	0.17		9	0.17	0.28	0.61			4						4						
US16	Tablerock Road	0	0	1	0	0	1	6680	6680	139	353	5055980	25.2799	554	0.12		14	0.04	0.28	0.15			1						1						
US16	Promise Road	0	1	0	1	2	4	6680	6680	922	0	5212930	26.06465	2142	0.31		6	0.15	0.27	0.55			1		3			4							
US16	Tucker Street	0	0	0	1	0	1	6680	6680	0	6	4878590	24.39295	535	0.12		13	0.04	0.28	0.14			1						1						
US16	Skyline Dr/Addison Ave	0	1	0	0	0	1	8680	8680	358	834	6771480	33.8574	557	0.09		15	0.03	0.25	0.12					1				1						
US16	Moon Meadows Drive	0	1	1	1	5	8	8680	8680	1220	243	6870395	34.35198	4329	0.41		5	0.23	0.25	0.91		1				1		8							
US16	Ft Hayes/Sammis Trail	0	0	0	1	1	2	8680	8680	146	0	6389690	31.94845	1050	0.13		11	0.06	0.26	0.23					1			2							
US16	Neck Yoke Road	1	2	0	0	1	4	232	2382	4300	7090	5111460	25.5573	2241	0.74		4	0.16	0.27	0.58								4							
US16	Sitting Bull	0	0	0	0	1	1	0	100	4300	4300	3175500	15.8775	522	0.06		17	0.06	0.32	0.19					1				1						
US16	Wilderness Canyon Road	1	1	0	1	2	5	286	0	4300	4300	3243390	16.21695	2755	1.23		2	0.31	0.32	0.98			4	1				5							
US16	Busted Five Lane	0	1	2	2	1	6	394	3	4300	4300	3283905	16.41953	3329	0.97		3	0.37	0.32	1.17						2		6							
US16	Strato Rim Drive	0	0	0	1	0	1	272	0	4300	4300	3238280	16.1914	532	0.19		7	0.06	0.32	0.19								1							
US16 WB	Silver Mountain/Main Street	0	0	0	0	1	1	5	11	0	4300	1575340	7.8767	561	0.13		10	0.13	0.41	0.31					1				1						
US16 EB	Golden Hills Drive	0	0	0	0	1	1	64	64	4300	0	1616220	8.0811	531	0.12		12	0.12	0.41	0.29					1				1						
US16 EB	Rockerville Road	0	2	0	2	1	5	408	396	4300	0	1862960	9.3148	2756	1.40		1	0.54	0.39	1.39							1		5						
US16	Klondike Road	0	0	0	0	1	1	0	29	4300	4300	3149585	15.74793	517.7	0.06		16	0.06	0.32	0.19					1				1						
Totals		2	9	5	10	22	48																												
%		4.2%	18.8%	10.4%	20.8%	45.8%	100.0%																												

Critical Rate Calculations

48

193729

353.5554 26259.56

0.14



Appendix C – Intersection Crash Tables

Roadway 1	Roadway 2	Fatal	Incap.	Non-Inc	Possible	No injury	Total	Calculations					Weighted Crash Rates			Critical Crash Rates			No Collision btw 2 MV									
			A	B	C	Property		EV N	EV S	EV W	EV E	AEV	MEV	TEV*R2	Calculated	Statewide	Rank	Crash Rate	Critical Rate	Ratio	Rear End	Head On	Angle	Side Swipe	Other	Animal	Single-Vehicle	Total
US16	Service Road (N of Highwood Rd)	0	0	1	0	1	2	5846	5846	324	141	4437305	22.18653	1094	0.18	8	0.09	0.29	0.31			2						2
US16	Enchantment Road	0	0	0	0	4	4	5846	6680	550	179	4838075	24.19038	2253	0.17	9	0.17	0.28	0.61			4					4	
US16	Tablerock Road	0	0	1	0	0	1	6680	6680	139	353	5055980	25.2799	554	0.12	14	0.04	0.28	0.15	1						1		
US16	Promise Road	0	1	0	1	2	4	6680	6680	922	0	5212930	26.06465	2142	0.31	6	0.15	0.27	0.55	1		3				4		
US16	Tucker Street	0	0	0	1	0	1	6680	6680	0	6	4878590	24.39295	535	0.12	13	0.04	0.28	0.14	1						1		
US16	Skyline Dr/Addison Ave	0	1	0	0	0	1	8680	8680	358	834	6771480	33.8574	557	0.09	15	0.03	0.25	0.12			1				1		
US16	Moon Meadows Drive	0	1	1	1	5	8	8680	8680	1220	243	6870395	34.35198	4329	0.41	5	0.23	0.25	0.91	1		6			1	8		
US16	Ft Hayes/Sammis Trail	0	0	0	1	1	2	8680	8680	146	0	6389690	31.94845	1050	0.13	11	0.06	0.26	0.23			1			1	2		
US16	Neck Yoke Road	1	2	0	0	1	4	232	2382	4300	7090	5111460	25.5573	2241	0.74	4	0.16	0.27	0.58			4				4		
US16	Sitting Bull	0	0	0	0	1	1	0	100	4300	4300	3175500	15.8775	522	0.06	17	0.06	0.32	0.19			1				1		
US16	Wilderness Canyon Road	1	1	0	1	2	5	286	0	4300	4300	3243390	16.21695	2755	1.23	2	0.31	0.32	0.98			4	1			5		
US16	Busted Five Lane	0	1	2	2	1	6	394	3	4300	4300	3283905	16.41953	3329	0.97	3	0.37	0.32	1.17			4			2	6		
US16	Strato Rim Drive	0	0	0	1	0	1	272	0	4300	4300	3238280	16.1914	532	0.19	7	0.06	0.32	0.19			1				1		
US16 WB	Silver Mountain/Main Street	0	0	0	0	1	1	5	11	0	4300	1575340	7.8767	561	0.13	10	0.13	0.41	0.31			1				1		
US16 EB	Golden Hills Drive	0	0	0	0	1	1	64	64	4300	0	1616220	8.0811	531	0.12	12	0.12	0.41	0.29				1			1		
US16 EB	Rockerville Road	0	2	0	2	1	5	408	396	4300	0	1862960	9.3148	2756	1.40	1	0.54	0.39	1.39			4			1	5		
US16	Klondike Road	0	0	0	0	1	1	0	29	4300	4300	3149585	15.74793	517.7	0.06	16	0.06	0.32	0.19			1				1		
	Totals	2	9	5	10	22	48														4	0	37	2	0	0	5	48
	%	4.2%	18.8%	10.4%	20.8%	45.8%	100.0%														8.3%	0.0%	77.1%	4.2%	0.0%	0.0%	10.4%	100.0%

Critical Rate Calculations

48

193729

353.5554 26259.56

0.14

US16 Corridor Study (2014-2018) - Signalized Intersections

rev. 7/1/2019

Roadway 1	Roadway 2	Fatal	Incap. A	Non-Inc B	Possible C	No injury Property	Total	Calculations						Weighted Crash Rates			No Collision btw 2 MV								
								EV N	EV S	EV W	EV E	AEV	MEV	TEV*R2	Calculated	Statewide	Ratio	Rear End	Head On	Angle	Side Swipe	Other	Animal	Single-Vehicle	Total
US16	Cathedral Drive	0	0	3	5	15	23	5846	5846	1058	6378	6981720	34.9086	12624.48	1.12		6		16	1					23
US16	US16B/Catron Blvd	0	2	14	18	54	88	6680	8680	6657	6828	10528425	52.64213	48171.15	2.96		32	1	48	1			6	88	
Totals		0	2	17	23	69	111										38	1	64	2	0	0	6	111	
		<i>0.0%</i>	<i>1.8%</i>	<i>15.3%</i>	<i>20.7%</i>	<i>62.2%</i>	<i>100.0%</i>										<i>34.2%</i>	<i>0.9%</i>	<i>57.7%</i>	<i>1.8%</i>	<i>0.0%</i>	<i>0.0%</i>	<i>5.4%</i>	<i>100.0%</i>	