APPENDIX B
Existing and Projected Conditions Report

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Prepared for:

MONTANA MDT DEPARTMENT OF TRANSPORTATION

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Contents

Figures

Tables

Attachments

Abbreviations and Acronyms

AADT	Annual Average Daily Traffic
CAPS	Crucial Areas Planning System
CTSP	Community Transportation Safety Plan
DEQ	Montana Department of Environmental Quality
ETW	Edge of Traveled Way
FFS	Free-Flow Speed
FHWA	Federal Highway Administration
FWP	Montana Department of Fish, Wildlife, and Parks
GNF	Gallatin National Forest
HCM	Highway Capacity Manual
HCS	Highway Capacity Software
HUC	Hydrologic Unit Code
LOS	Level of Service
MDT	Montana Department of Transportation
mph	miles per hour
MT 86	Montana Highway 86
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places
NRIS	Natural Resource Information System
PTSF	Percent Time-Spent-Following
RP	Reference Post
SFHA	Special Flood Hazard Area
STIP	State Transportation Improvement Program
TMDL	Total Maximum Daily Load
US 89	United States Route 89
USACE	United States Army Corps of Engineers
USC	United States Code
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service

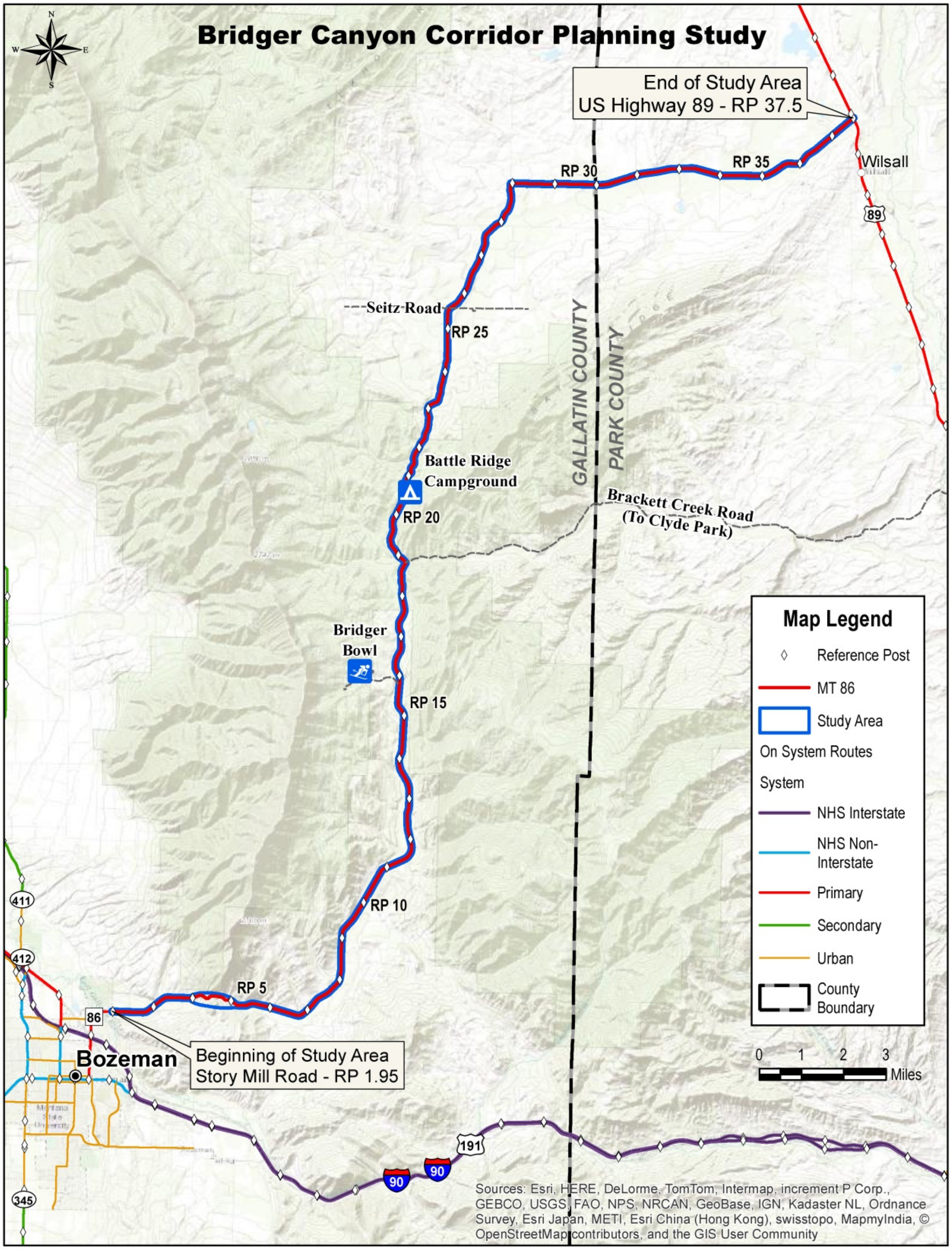
1.0 Introduction

The Montana Department of Transportation (MDT), in cooperation with Gallatin and Park Counties and the Federal Highway Administration (FHWA), initiated a corridor planning study on Montana Highway 86 (MT 86) between the intersection of Story Mill Road and the junction with United States Route 89 (US 89).

This existing and projected conditions report provides a planning-level summary of transportation system features and physical, biological, social, and cultural characteristics to help identify issues, constraints, and opportunities within the study area.

Figure 1 illustrates the study area, which begins at the MT 86 intersection with Story Mill Road at Reference Post (RP) 1.95 just east of Bozeman, MT, and ends at the intersection with US 89 at RP 37.5 near Wilsall, MT. The study area includes the MT 86 corridor and a 300-foot buffer on both sides of the roadway (for a total buffer width of 600 feet) throughout the majority of the corridor. A buffer width ranging up to approximately 1,700 feet is included from approximate RP 4.0 to RP 5.0 to include a landslide and historic quarry at approximate RP 4.4.

Figure 1 Study Area



2.0 Transportation System Conditions

The transportation system within the study corridor is discussed in terms of its features, geometric characteristics, crash history, access points, and traffic volumes and operational characteristics.

2.1 Features

Corridor features were identified through field observation and a review of published statistics, documentation, GIS data, and MDT as-built drawings. A field review of the corridor was conducted on June 25, 2014, to assist in identifying existing conditions and constraints. Attachment 1 contains a photo log documenting conditions observed in the field.

Functional Classification and Roadway System

Functional classification is used to characterize public roads and highways in accordance with FHWA guidelines according to the type of service provided by the facility and the corresponding level of travel mobility and access to and from adjacent property. MT 86 is classified as a rural minor arterial on the primary system. Minor arterials provide service for trips of moderate length, serve geographic areas that are smaller than their principal arterial counterparts, and offer connectivity to the principal arterial system. In a rural setting, such as this, minor arterials are typically designed to provide relatively high overall travel speeds, with minimum interference to through movement.[1]

Right-of-way

Right-of-way boundaries and widths have been estimated for the purpose of this study based on a review of available MDT as-built drawings, right-of-way plans, and cadastral information. Right-of-way widths vary throughout the corridor, ranging from a 30-foot to 200-foot offset in a single direction from the roadway centerline. Attachment 2 lists estimated right-of-way offset distances throughout the corridor.

Structures

The MDT Bridge Bureau identified 10 bridges within the study area. Currently, three of the 10 bridges are candidates for repair. Table 1 presents bridge data within the study area. A future project will remove and/or replace structures at RP 6.7, RP 8.1, RP 8.9, and RP 9.5.

[1] FHWA, Highway Functional Classification Concepts, Criteria and Procedures, 2013.

Table 1 Bridge Data

RP	Feature Crossed	Year Built	Road Width (ft)	Length (ft)	Sufficiency Rating	Structure Condition	Field Review Remarks[3]	Guardrail Height (Center of Bolt)[4]
3.1	Bridger Creek	2005	38.7	84.5	85.7	Good	Good condition	21”
6.7[1]	Drainage	1939	27.0	12.0	61.6	Good	Damaged guardrail	20”
7.8	Stock Pass	1939	26.4	12.0	70.4	Fair[2]	Fair condition	18”
8.1[1]	Drainage	1939	26.3	12.0	65.4	Good	Good condition	21”
8.9[1]	Drainage	1939	26.3	12.0	64.8	Good	Good condition	23”
9.5[1]	Stock Pass/ Drainage	1939	26.3	12.0	64.8	Good	Damaged wing wall and abutment	21”
18.8	Brackett Creek	1953	28.0	20.0	58.8	Good	Good condition	22”
24.4	Cache Creek	1939	28.5	12.0	79.1	Fair[2]	Fair condition	20”
26.8	Carrol Creek	1986	22.3	12.0	68.9	Fair[2]	Damaged wing wall and pavement section near abutment	15”
28.0	Flathead Creek	1939	22.0	17.0	71.1	Good	Good condition	22”

Source: Information was obtained from MDT bridge shape files (inspections conducted in 2011), the 2014 MDT Existing Conditions Summary, DOWL HKM June 2014 field review, and 2014 communication with MDT.
(1) Future project will remove and/or replace structures.
(2) Fair condition based on rating of 5 for superstructure (Stock Pass) or substructure (Cache Creek and Carrol Creek), indicating candidate for repair.
(3) Field review conducted by DOWL HKM, June 2014.
(4) Field review conducted by DOWL HKM, June 2014. Minimum guardrail height (center of bolt) is 20” for existing installations, and 23” for new installations.

Bicycle and Pedestrian Facilities

There are no dedicated bicycle or pedestrian facilities directly adjacent to MT 86 in the study area. Shoulder widths vary throughout the corridor, ranging in width from zero to five feet, providing limited opportunity for non-motorized usage along the edge of the traveled way. The first 2.5 miles of the corridor provide connections to the Bozeman “M” Trail System and the Drinking Horse Mountain Trails. The Gallatin Valley Bicycle Club hosts weekly bicycle rides within the study area including travelling to the top of Battle Ridge Pass and to Wilsall, MT. Numerous cycling and outdoor websites promote the corridor as a destination for cycling. Multiple bicycle races and events are held in the corridor annually.

MDT staff reports that parking sometimes overflows onto the highway near the “M” trail and fish hatchery parking lots (RP 4.2), and at Bridger Bowl (RP 15.8), leading to pedestrians walking along MT 86.

Utilities

Utilities in the study area include underground telephone, underground cable television, underground natural gas, and overhead and underground electric power.

Air Service

There is no air service in the study area. The nearest airport is the Bozeman Yellowstone International Airport located in Belgrade.

Rail Service

There are no rail facilities located in the study area.

Transit

The Streamline transit service provides a shuttle bus to and from Bridger Bowl and Bohart Ranch with seasonal operation on Saturday and Sunday only. Table 2 lists the seasonal Streamline route schedule. There are no other transit providers in the study area.

Table 2 Transit Service Route Schedule

Route Stops	Direction	Trip 1	Trip 2	Trip 3	Trip 4	Trip 5
K Mart Arrive/Depart	To Bridger Bowl/ Bohart Ranch	8:00 am	8:45 am	12:00 pm	1:25 pm	
Fairground Arrive/Depart	To Bridger Bowl/ Bohart Ranch	8:15 am	9:00 am	11:50 am	1:15 pm	
Bridger Bowl	To Bridger Bowl/ Bohart Ranch	8:45 am	9:00 am	12:30 pm	1:55 pm	
Bohart Ranch	To Bridger Bowl/ Bohart Ranch	9:00 am	9:30 am	12:45 am	2:05 pm	
Bohart Ranch	From Bridger Bowl/ Bohart Ranch	11:10 am	12:45 pm	2:05 pm	3:25 pm	4:05 pm
Bridger Bowl	From Bridger Bowl/ Bohart Ranch	11:20 a	12:30 pm	1:55 pm	3:40 pm	4:15 pm
Fairgrounds Arrive/Depart	From Bridger Bowl/ Bohart Ranch	11:50 am	1:15 pm	2:35 pm	4:10 pm	4:45 pm
K Mart Arrive/Depart	From Bridger Bowl/ Bohart Ranch	12:00 pm	1:25 pm	2:45 pm	4:20 pm	4:55 pm

Source: Streamline, 2014.

Drainage Conditions

Drainage throughout the corridor is generally sufficient. Graded side slopes carry run-off to natural drainage conveyances through constructed ditches within the right-of-way or via natural drainage patterns formed by the topographic conditions of the adjacent lands. Culverts, situated at various locations throughout the corridor, convey water beneath MT 86.

Although drainage is generally sufficient, the roadway section is suffering in some areas due to excess water on the roadway, poor drainage, and saturated subgrade. Areas of insufficient drainage identified during the June 2014 field review are listed below.

- RP 15.9 – Standing water was noted in the ditch adjacent to the roadway.
- RP 23.4 – Standing water was noted adjacent to the roadway. The culvert extending under the roadway appears to be plugged and does not appear to meet minimum cover depths. Based on the deteriorated pavement, water likely saturates the subgrade at times.
- RP 26.8 - The pavement section above the bridge abutment is failing due to insufficient drainage.

Pavement Conditions

The 2013 MDT Road Log indicates the MT 86 highway corridor is generally composed of 0.3 foot asphalt course overlying 1.0 foot of crushed base course. Overall, the pavement is in good condition throughout the corridor. Table 3 lists pavement deficiencies observed during the June 2014 field review.

Table 3 Pavement Deficiencies

RP±	Deficiencies Noted
6.7	Transverse cracking of pavement adjacent to bridge.
15.9	Subgrade and pavement is failing due to poor drainage.
23.4	Subgrade and the surface are deteriorating due to failing culvert.
24.4	Transverse and longitudinal cracking of pavement adjacent and on top of the bridge.
26.8	Transverse and longitudinal cracking of pavement adjacent and on top of the bridge. The pavement section above the bridge abutment is failing due to insufficient drainage.
28.0	Transverse and longitudinal cracking of pavement adjacent and on top of the bridge.

DOWL HKM, 2014. Transverse cracking: pavement cracks perpendicular to the roadway centerline. Longitudinal cracking: pavement cracks parallel to the roadway centerline.

MDT has received public comments indicating the portion of MT 86 near the Battle Ridge campground is sometimes slippery, and the portion near the landslide (RP 4.4) is sometimes icy.

Rockfall Hazard

A slide area near RP 4.4 has been the subject of investigation by Montana State University geologists and state highway personnel since the late 1950s. The rock face south of the original MT 86 alignment was undermined at its base due to the roadway cut slope and quarry operations, which removed material used for construction of the interstate highway and other roadways in the area. As a result of blasting and material removal, a landslide developed in the upper reaches of the quarry shortly after completion of quarrying operations. At that time, the toe of the slide was several feet above the ditchline of the roadway. During the spring of 1975, heavy precipitation and surface run-off re-activated the slide resulting in the movement of a considerable quantity of material onto the highway. In 1975, MT 86 traffic was redirected to the north via a detour route which is still in use today. The former MT 86 alignment is barricaded. Past studies have warned that the slide area is unstable and susceptible to continuous sloughing, and that an earthquake or heavy precipitation event could activate another slide event. MDT has also reported a minor slide on the north side of MT 86 east of the major slide, although no documentation was identified for the minor slide. Figure 2 illustrates the major and minor slide locations. Additional slope stability evaluation may need to be conducted on slopes immediately adjacent to MT 86 for any improvements forwarded from this study.

Figure 2 Slide Area

Image source: Google, 2014.

MDT maintains the Montana Rockfall Hazard Rating System to better manage rock slope assets along Montana highways. A 2003-2005 MDT research program evaluated rockfall history and behavior throughout the state. "A"-rated sites indicate a high potential for rockfall hazard. Detailed ratings were completed at approximately 850 "A"-rated sites. The top 100 "A"-rated sites were further evaluated, and conceptual designs and construction cost-to-cure estimates were prepared. The Rockfall Hazard Classification and Mitigation System report (MDT, 2005) lists nine sites within the Bridger Canyon corridor, located from approximately RP 4.4 to 19.1. "A" ratings were assigned to two of the nine sites, one of which (located at approximately RP 4.4) was ranked 36 out of the top 100 sites. The other "A"-rated site is located at approximately RP 15.9-16.0, where MDT identified a spring in the lower portion of the cut slope during an investigation of a pavement failure. Improvements adjacent to the nine sites listed in Table 4 will require an engineering analysis to determine if rockfall hazard mitigation is practicable.

Table 4 Rockfall Hazard Sites Within Bridger Canyon Corridor

RP Start	RP End	Side	Rating
004+0.370	004+0.450	Left	**A**
004+0.730	004+0.820	Left	B
005+0.120	005+0.210	Left	B
012+0.310	012+0.370	Right	B
012+0.410	012+0.470	Right	B
012+0.650	012+0.800	Right	B
015+0.930	016+0.030	Right	**A**
018+0.520	018+0.580	Right	B
018+0.930	019+0.100	Right	B

Source: Rockfall Hazard Classification and Mitigation System, 2005. Site at RP 4.4± ranked 36 out of top 100 sites statewide. "A"-rated sites received a detailed rating score greater than 350 points.

2.2 Geometric Characteristics

Design Criteria

Table 5 presents MDT's geometric design criteria for rural minor arterials (National Highway System – Non-Interstate). Additionally, Chapters 8, 9, 10, and 12 of the MDT Roadway Design Manual (December 2004) were consulted for guidance regarding horizontal and vertical alignments.

Table 5 Design Criteria for Rural Minor Arterials

Element			Criteria
Design Controls	Design Forecast Year (Geometrics)		20 Years
	Design Speed	Rolling Terrain	55 mph
		Mountainous Terrain	45 mph
	Level of Service (LOS)		B (Rolling)
			C (Mountainous)
Roadway Elements	Travel Lane Width		12 ft
	Shoulder Width		Varies
	Cross Slope	Travel Lane	2%
		Shoulder	2%
	Median Width		Varies
Earth Cut Sections	Ditch	Inslope	6:1 (Width: 10 ft)
		Width	10 ft Minimum
		Slope	20:1 towards back slope
	Backslope; Cut Depth at Slope Stake	0 to 5 ft	5:1
		5 ft to 10 ft	4:1 (Rolling)
			3:1 (Mountainous)
		10 ft to 15 ft	3:1 (Rolling)
			2:1 (Mountainous)
		15 ft to 20 ft	2:1 (Rolling)
			1.5:1 (Mountainous)
		> 20 ft	1.5:1
Earth Fill Slopes	Fill Height at Slope Stake	0 to 10 ft	6:1
		10 ft to 20 ft	4:1
		20 ft to 30 ft	3:1
		> 30 ft	2:1
Alignment Elements	Stopping Sight Distance		495 ft (Rolling)
			360 ft (Mountainous)
	Passing Sight Distance		1885 ft (Rolling)
			1625 ft (Mountainous)
	Minimum Horizontal Curve Radius (e=8%)		960 ft (Rolling)
			590 ft (Mountainous)
	Superelevation Rate		e_{max}=8.0%
	Vertical Curvature (K-Value)	Crest Vertical Curve	114 (Rolling)
			61 (Mountainous)
	Vertical Curvature (K-Value)	Sag Vertical Curve	115 (Rolling)
			79 (Mountainous)

Element		Criteria
Alignment Elements	Maximum Grade	4% (Rolling)
		7% (Mountainous)
	Minimum Vertical Clearance	17 ft

Source: MDT Road Design Manual, Chapter 12, page 12(12), Figure 12-4, "Geometric Design Criteria for Rural Minor Arterials (Non-NHS – Primary) U.S. Customary," December 2004.

The existing roadway alignment generally exhibits rolling terrain characteristics; however, portions of the corridor exceed maximum grades for rolling terrain and exhibit characteristics of a mountainous terrain. The design speed used for analysis of the MT 86 study corridor is 55 miles per hour (mph) in combination with a rolling terrain topography type from RP 1.95 to RP 15.63 and from RP 29.16 to RP 37.5. A design speed of 45 mph in combination with a mountainous terrain type was utilized from RP 15.64 to RP 29.15.

The posted speed limit within the corridor varies from 35 mph and 45 mph at the southern portion of the corridor near Bozeman, 60 mph through middle portions of the corridor, up to 70 mph (60 mph for trucks) in middle and northern portions of the corridor. Posted speed limits reflect 2014 speed study recommendations, which were approved by the Montana Transportation Commission on July 31, 2014, and have been implemented in the corridor. Advisory signing for several horizontal curves within the corridor range between 25 mph and 50 mph. Table 6 details posted and advisory speeds throughout the corridor.

Table 6 Posted Speed Limits and Advisory Signing

Beginning RP	Ending RP	Posted/Advisory Speed (mph)	Sign Type
1.95	2.29	35	Regulatory Sign Posted Speed Limit
2.29	5.64	45	
5.64	8.32	60	
8.32	15.64	70 (60 for trucks)	
15.64	29.15	60	
29.15	37.5	70 (60 for trucks)	
4.08	NA	35	Advisory Sign Curves Ahead
4.61	NA	35	
4.89	NA	45	
6.51	NA	50	
9.05	NA	45	
18.56	NA	35	
18.69	NA	25	
20.51	NA	25	
23.91	NA	45	
25.15	NA	40	
25.28	NA	40	
27.02	NA	45	
27.27	NA	45	
27.58	NA	45	
27.95	NA	45	
28.44	NA	35	
28.68	NA	25	

Source: DOWL HKM Field Review, June 2014; MDT Speed Limit Recommendation for Commission Action, June 2014. Speeds listed for northbound direction only.

Roadway Width

Within the study area, MT 86 is a two-lane undivided highway with two 12-foot travel lanes and varying shoulder widths. Table 7 provides information on the roadway width and surface thickness throughout the corridor based on the 2013 MDT Road Log.

Table 7 Highway Width and Surface Thickness

Beginning RP	Surface Thickness (inches)	Base Thickness (inches)	Surface Width (feet)	Lanes	Lane Width (feet)	Shoulder Width (feet)
1.95	4.2	18.0	35	2	12	5
2.837	3.0	18.0	25	2	12	0
2.999	3.0	18.0	25	2	12	0
3.005	3.0	18.0	25	2	12	0
3.824	3.0	13.8	30	2	12	3
9.584	3.0	9.0	30	2	12	3
15.771	3.0	9.0	30	2	12	3
16.330	1.5	12.0	24	2	12	0
17.796	1.5	12.0	24	2	12	0
18.402	5.0	12.0	24	2	12	0
18.774	5.0	12.0	24	2	12	0
18.795	5.0	12.0	24	2	12	0
20.677	5.0	12.0	24	2	12	0
21.602	5.0	12.0	24	2	12	0
22.145	5.0	12.0	24	2	12	0
24.591	4.0	12.0	24	2	12	0
30.835	4.0	12.0	22	2	12	0
30.964	2.4	12.0	22	2	12	2

Source: MDT Road Log, 2013.

Horizontal Alignment

Horizontal alignment includes consideration of horizontal curvature, superelevation, curve type, and stopping and passing sight distance.

MDT as-built drawings were provided from RP 1.95 to RP 18.75 and from RP 30.5 to RP 37.5. A complete geometric analysis of the roadway was conducted where as-built information was available. Horizontal geometrics for RP 18.75 to RP 30.5 were fit to the alignment based on aerial imagery, and may not conform to constructed conditions. A total of 120 horizontal curves were analyzed for this report, of which 54 horizontal curves were assumed due to lack of as-built information.

Based on a review of available data, it appears that 38 of the 120 horizontal curves analyzed within the corridor do not meet current MDT design criteria for curve radius, superelevation, and stopping sight distance. Attachment 3 presents horizontal alignment information for the corridor including a pass/fail rating for each curve. It is MDT practice to use a spiral curve when the curve radius is less than 3,820 feet. According to the MDT Road Design Manual, the minimum horizontal curve length for rolling terrain and a design speed of 55 mph is 825 feet. The minimum horizontal curve length for mountainous terrain and a design speed of 45 mph is 675 feet. Because curve type and curve length are not listed in the MDT Road Design Manual as a design requirement, curve type and curve length are not considered in the pass/fail determination listed in Attachment 3. Limited superelevation data was available, and therefore the superelevation could not be analyzed for the majority of curves within the corridor. Design elements listed in Attachment 3 are approximated, and determinations are based on the best available data.

Vertical Alignment

Vertical alignment includes consideration of grade, vertical curve length, vertical curve type (either a sag curve or a crest curve), and K value. K value is the horizontal distance needed to produce a one percent change in gradient and is directly correlated to the roadway design speed and stopping sight distance.

As-built information was unavailable from approximately RP 18.75 to RP 30.96. In order to analyze the vertical geometrics, DOWL HKM surveyed the vertical alignment by mounting GPS devices on a vehicle and collecting a series of points while driving through this portion of the corridor. A vertical alignment was generated from the survey data and vertical curve data was analyzed on a best fit basis. Available data indicates that 128 of the 229 vertical curves analyzed within the study boundaries do not meet current MDT design criteria. According to the MDT Road Design Manual, the minimum vertical curve length for rolling terrain and a design speed of 55 mph is 165 feet; the minimum vertical curve length for mountainous terrain and a design speed of 45 mph is 135 feet; and the desirable curve length for aesthetic purposes is 1000 feet minimum. Because minimum curve length is not listed in the MDT Road Design Manual as a design requirement it is not considered in the vertical curve pass/fail determination. Attachment 3 presents vertical alignment information for the MT 86 corridor. Design elements listed in Attachment 3 are approximated, and determinations are based on the best available data.

Clear Zones

The MDT Road Design Manual specifies an offset distance from the edge of the traveled way (ETW) to be free of any obstructions. The ETW is delineated by the white pavement marking located on the right-hand side of the travel lane. This offset distance, known as the "clear zone," includes the roadway shoulder and is defined based on design speed, annual average daily traffic (AADT), cut/fill slopes, and offsets from the ETW.

A cut section occurs when a roadway facility is located below the natural ground elevation and excavation of earthen materials is required. Within cut sections, a roadside ditch is required by MDT for drainage. The dimensions of the ditch also provide a recovery area within the required clear zone for vehicles exiting the traveled way. Cut slopes greater than a 3:1 are considered non-traversable and may warrant protection.

A fill section occurs when a roadway facility is located above the natural ground elevation and addition of earthen materials is required. Table 8 was used to analyze fill slopes and dimensions throughout the MT 86 corridor. The slopes and dimensions within the clear zone provide a recovery area for vehicles exiting the traveled way. If the specified dimensions cannot be achieved, a roadway barrier may be warranted. During a field review, several areas were noted as lacking slope protection and containing inadequate clear zone distance from approximately RP 4.0 to RP 24.0.

Table 8 Fill Slope Clear Zone Distances

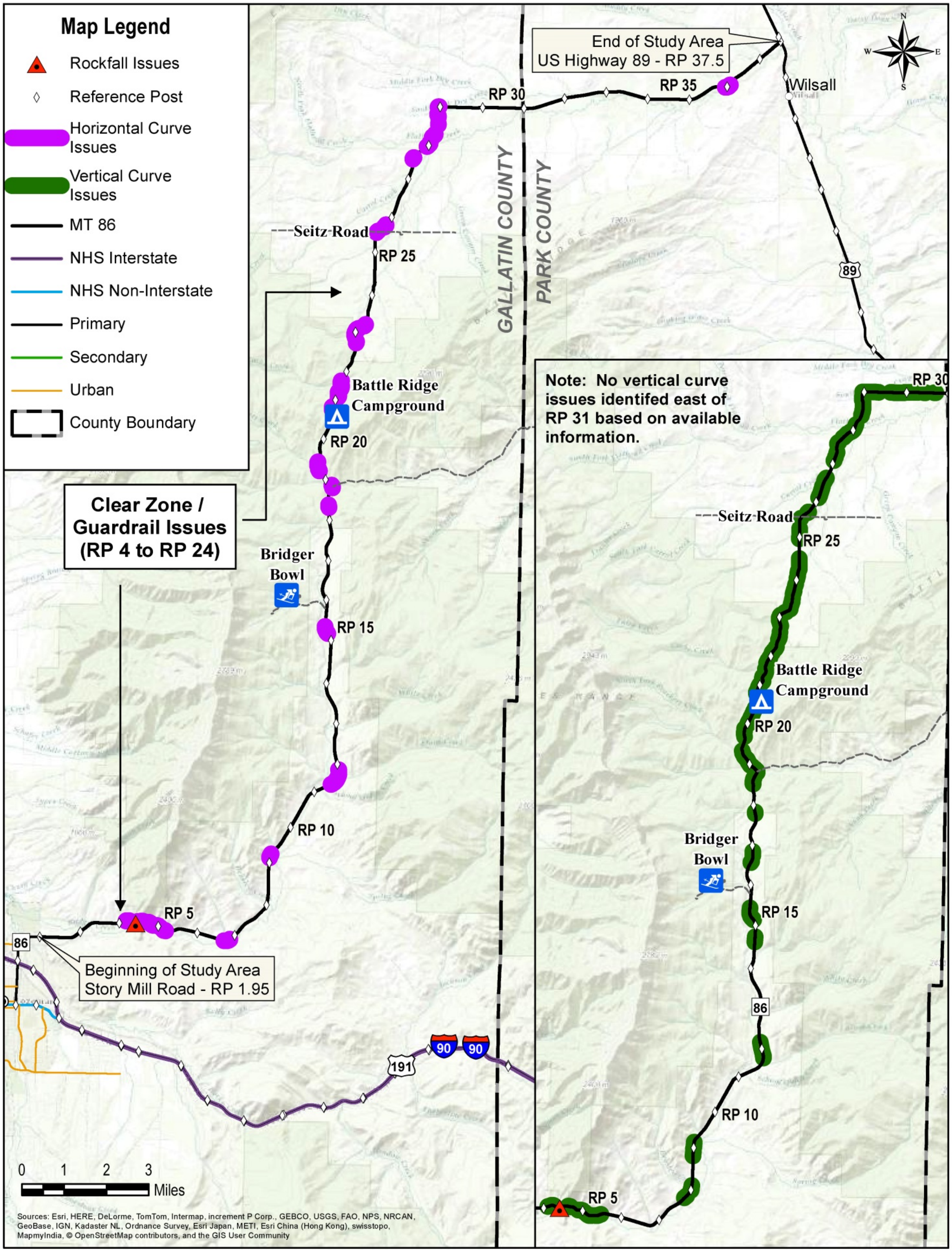
Design Speed	Design AADT	Fill Slope/Foreslopes			
		6:1 or Flatter	5:1	4:1	3:1
55 mph (Rolling)	<750	12’	14’	18’	Non-recoverable. Must include 10’ of recoverable area beyond the toe of the slope. Barrier warranted if 10’ is unachievable.
	750-1499	16’	20’	24’	
	1500-6000	20’	24’	30’	
	>6000	22’	26’	32’	
45 mph (Mountainous)	<750	10’	12’	14’	
	750-1499	12’	16’	18’	
	1500-6000	16’	20’	24’	
	>6000	18’	24’	26’	

Source: MDT Road Design Manual, Chapter 14, Page 14.2(2), US Customary Units, 2004.

Summary of Geometric Issues

Figure 3 presents the location of existing horizontal curve, vertical curve, and clear zone/guardrail issues within the corridor.

Figure 3 Geometric Issues



2.3 Crash History

MDT provided crash data for MT 86 from RP 1.95 to RP 37.5 for the five-year period from January 1, 2009, to December 31, 2013. During the five-year analysis period, a total of 173 crashes occurred on MT 86. As a result of the crashes in the corridor, a total of 59 injuries and 6 fatalities occurred during the analysis period.

A higher number of crashes, injuries, and fatalities occurred within the southern portion of the corridor from RP 1.95 to RP 21.5 compared to the northern portion of the corridor RP 21.5 to RP 37.5. This higher number of crashes in the southern portion of the corridor may be due to higher AADT volumes, higher number of ingress/egress points, and higher number of curves that do not meet current MDT horizontal geometric criteria compared to the northern portion of the corridor.

Table 9 presents the number and percentage of crashes, injuries, (including incapacitating, non-incapacitating, and possible injuries), and fatalities attributed to types of collisions during the five-year analysis period on MT 86 from RP 1.95 to RP 37.5.

Table 9 MT 86 Collision Type

Collision Type	Number of Crashes	Percent of Total Crashes	Number of Injuries	Percent of Total Injuries	Number of Fatalities	Percent of Total Injuries
Backing Vehicle	1	0.6%	0	0.0%	0	0.0%
Bicycle	1	0.6%	1	1.7%	0	0.0%
Domestic Animal	4	2.3%	1	1.7%	0	0.0%
Fixed Object	46	26.6%	17	29.3%	0	0.0%
Head On	5	2.9%	5	8.6%	3	50.0%
Jackknife	1	0.6%	0	0.0%	0	0.0%
Left Turn Same Direction	1	0.6%	0	0.0%	0	0.0%
Lost Control	4	2.3%	2	3.5%	0	0.0%
Not Fixed Object or Debris	6	3.5%	0	0.0%	0	0.0%
Other	5	2.9%	3	5.2%	0	0.0%
Rear End	10	5.8%	3	5.2%	0	0.0%
Right Angle	3	1.7%	4	6.9%	1	16.7%
Roll Over	63	36.3%	18	31.0%	2	33.3%
Sideswipe, Opposite Direction	1	0.6%	0	0.0%	0	0.0%
Sideswipe, Same Direction	4	2.3%	1	1.7%	0	0.0%
Wild Animal	18	10.4%	3	5.2%	0	0.0%
Total	**173**	**100%**	**58**	**100%**	**6**	**100%**

Source: MDT, 2014. Data provided from RP 1.95 to RP 37.5 from 1/1/2009 to 12/31/2013.

Roll-over and fixed-object crashes were the most common crash types and injury-related crash types, with 109 (63 percent) combined crashes and 35 (60 percent) combined injuries. Head-on type crashes were the majority of fatal crashes, at 3 out of 6, or 50 percent. Two roll-over type crashes and one right-angle type crash made up the remaining fatal crashes.

Weather, Road, and Light Conditions

Table 10 presents the number and percentage of crashes, injuries (including incapacitating, non-incapacitating, and possible injuries) and fatalities attributed to weather, road, and light conditions within the corridor during the five-year analysis period.

Table 10 MT 86 Weather, Road, and Light Conditions

Attributes		Number of Crashes	Percent of Total Crashes	Number of Injuries	Percent of Total Injuries	Number of Fatalities	Percent of Total Fatalities
Weather Conditions	Blowing Snow	7	4%	4	6.8%	1	16.7%
	Clear	79	46%	30	50.8%	3	50.0%
	Cloudy	51	29%	15	25.4%	2	33.3%
	Rain	5	3%	4	6.8%	0	0.0%
	Sever Crosswinds	1	1%	0	0.0%	0	0.0%
	Sleet/Hail/Freezing Rain/Drizzle	2	1%	0	0.0%	0	0.0%
	Snow	27	16%	6	10.2%	0	0.0%
	Unknown	1	1%	0	0.0%	0	0.0%
	Total	173	100%	59	100%	6	100%
Road Conditions	Dry	95	54.9%	42	71.2%	5	83.3%
	Ice	31	17.9%	1	1.7%	0	0.0%
	Snow or Slush	31	17.9%	8	13.6%	1	16.7%
	Unknown	1	0.6%	0	0.0%	0	0.0%
	Wet	15	8.7%	8	13.6%	0	0.0%
	Total	173	100%	59	100%	6	100%
Light Conditions	Dark - Lighted	2	1.2%	0	0.0%	0	0.0%
	Dark - Not Lighted	57	32.9%	13	22.0%	1	16.7%
	Dawn	1	0.6%	0	0.0%	0	0.0%
	Daylight	109	63.0%	44	74.6%	4	66.7%
	Dusk	3	1.7%	2	3.4%	1	16.7%
	Unknown	1	0.6%	0	0.0%	0	0.0%
	Total	173	100%	59	100%	6	100%

Source: MDT, 2014. Data provided from RP 1.95 to RP 37.5 from 1/1/2009 to 12/31/2013.

The majority of crashes, injuries, and fatalities occurred during clear or cloudy weather conditions, dry road conditions, and daylight light conditions.

Contributing factors indicate the majority of crashes were a result of driver error, including driving under the influence of alcohol, careless driving, disregarding traffic mark/sign/signal, and improper passing. Excluding the 51 crashes without an identified contributing factor, only four crashes out of the remaining 122, or 3 percent were identified as weather, road, or light related.

Animal/Vehicle Conflicts

Wild animals were involved in 18 of 173 (10 percent) reported crashes. Reported crashes involving wild animals were dispersed throughout the corridor, with 10 out of 18 crashes occurring between RP 8.0 to RP 10.0.

A review of the MDT maintenance animal carcass database between January 1, 2009, and December 31, 2013, indicates at least 44 animal carcasses were collected throughout the length of the Bridger Canyon corridor. Carcass collections were concentrated between RP 1.75 and RP 12. This may be due to higher traffic volumes in this portion of the corridor, however carcass data may not accurately reflect animal-vehicle conflicts throughout the corridor, and not all carcasses result from vehicle collisions. Animal carcasses in areas along the corridor with steeper topography or denser roadside vegetation may have evaded collection by maintenance personnel due to a lack of visibility. These factors may affect collections reported in the MDT animal carcass database.

Table 11 summarizes large mammal carcass collections during the five-year period.

Table 11 Large Mammal Carcasses (2009 – 2013)

Animal	Carcasses Collected	% by Species
Elk	1	2.3
Mule Deer	9	20.5
Other (Wild)	3	6.8
Whitetail Deer	31	70.4
Total	44	100

Source: MDT, 2013.

Whitetail deer (70.4 percent) accounted for the majority of carcasses collected along this portion of MT 86, followed by mule deer (20.5 percent). The majority (70.4 percent) of carcasses were collected between RP 1.95 and RP 11.5.

Level of Service of Safety

MDT has conducted an analysis to assess the magnitude of safety problems within the Bridger Canyon corridor through the use of safety performance functions (SPFs). An SPF reflects the relationship between traffic exposure measured in AADT and crashes per mile per year. SPF models provide an estimate of the normal expected crash frequency and severity for a range of AADT among similar facilities. MDT uses separate SPF models to assess crash frequency (i.e., the total number of crashes) and crash severity (i.e., only crashes involving an injury or fatality).

Information from the SPF models is used to assess the level of service of safety (LOSS) for corridor segments. LOSS categories listed in Table 12 represent the degree of deviation from the normal expected crash frequency and severity for a range of AADT, and the associated potential for crash reduction.

Table 12 Level of Service of Safety

Level of Service of Safety	Potential for Crash Reduction
LOSS I	Low potential for crash reduction
LOSS II	Low to moderate potential for crash reduction
LOSS III	Moderate to high potential for crash reduction
LOSS IV	High potential for crash reduction

Source: MDT, 2014.

Figure 4 presents total crash LOSS, which indicates deviations from the normal expected crash frequency. Figure 5 presents crash severity LOSS, which indicates deviations from the normal expected crash severity. Corridor segments identified as LOSS IV represent the highest deviation from normal expected conditions, and the highest potential for crash reduction. Areas identified as LOSS IV for both total crashes and severe crashes occur near RP 5, 9, 19, 21, 29, 30, and 36.

Attachment 4 provides tables listing beginning and ending RPs for LOSS categories within the corridor.

MDT has also prepared a Safety Assessment Report for the portion of the corridor from RP 2.7 to RP 5.0. The report noted that the frequency and severity of crashes in this portion of the corridor are occurring above the rate expected for this roadway type, indicating a high potential for crash reduction (LOSS IV).

Figure 4 Total Crash LOSS

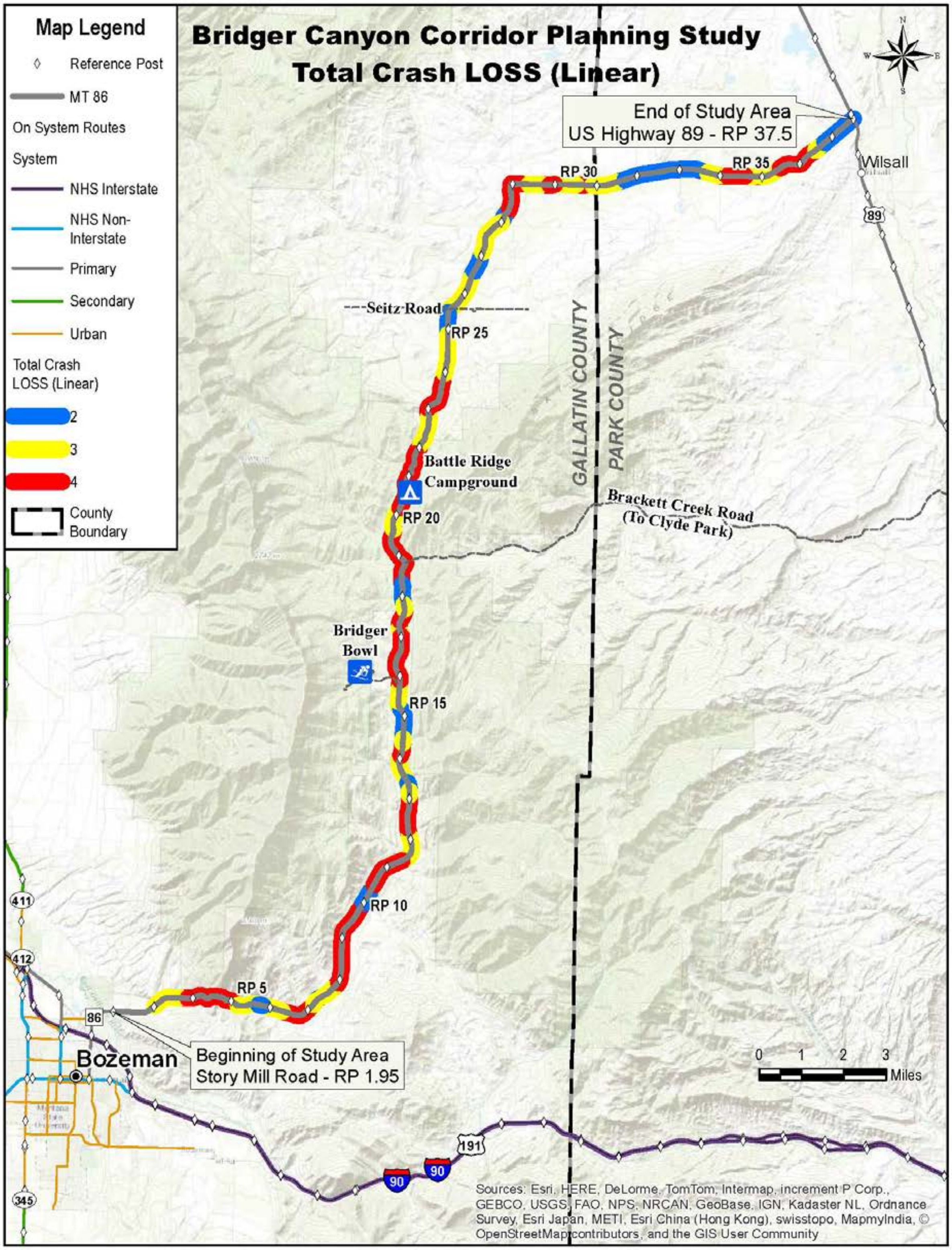
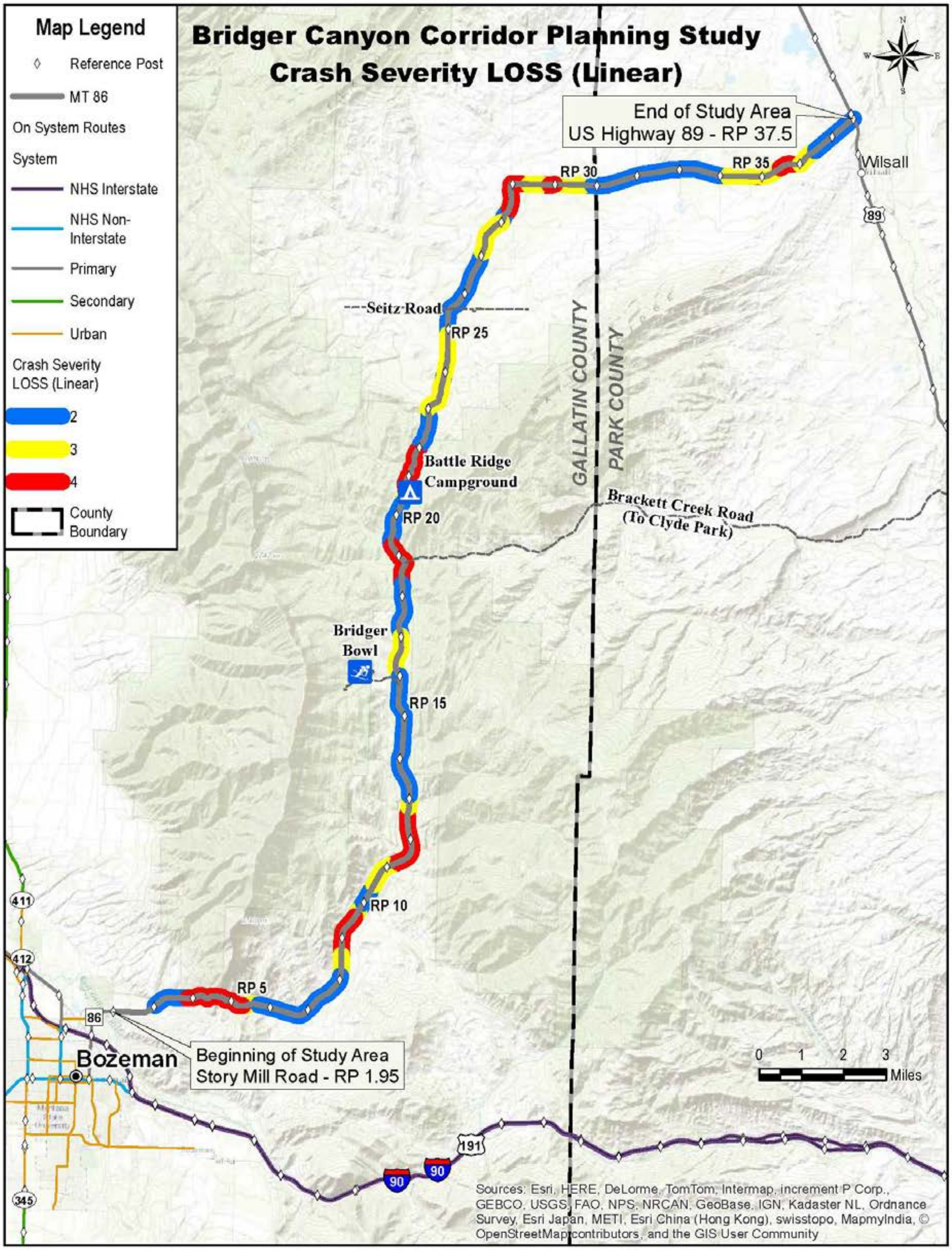


Figure 5 Crash Severity LOSS



If a safety problem is identified within a corridor, the LOSS concept will describe its magnitude in terms of frequency and severity. The nature of the safety problem may be determined, in part, through pattern recognition techniques. MDT conducted an analysis of the Bridger Canyon corridor to identify abnormal crash patterns compared to normative patterns generally correlating to a range of AADT volumes on Montana highways. Abnormal patterns indicate a higher crash type frequency compared to normal expected crash frequency. Eight abnormal patterns were identified for the Bridger Canyon corridor, including embankment, fixed object, guardrail, icy road, injury, off road, overturning, and snowy road crashes.

Attachment 4 illustrates the locations of the eight abnormal crash pattern types occurring within the Bridger Canyon corridor. Abnormal embankment, fixed object, guardrail, and snowy road crash patterns generally overlap from approximate RP 3 to RP 8. Overlapping abnormal crash patterns for icy road, fixed object, off road, overturning, and snowy road crashes occur from approximate RP 10 to RP 25. Specific beginning and ending RPs for each crash pattern are provided in Attachment 4.

2.4 Access Analysis

An access point is an ingress/egress route from a roadway to an adjacent land parcel. Access points spaced further apart allows orderly merging of traffic and presents fewer challenges to drivers. Conversely, access points spaced closer together can become a factor in reducing the free-flow speed[2] (FFS) of a roadway. The quantification of this effect is estimated through the identification of access point density on a highway segment. Access point density is calculated by dividing the total number of unsignalized intersections and driveways on both sides of the roadway segment by the length of the segment in miles.

For the access, traffic, and operational analysis effort, three study segments were defined to provide a more detailed assessment of conditions within the corridor. Segment 1 begins at Story Mill Rd (RP 1.95) and extends to Bridger Bowl Road (RP 15.7). Segment 2 begins at Bridger Bowl Road and extends to Seitz Rd (RP 25.3). Segment 3 begins at Seitz Rd and extends to US 89 (RP 37.5). The three study segments were identified based on estimated similarities in roadway characteristics.

High resolution aerial imagery and Google Street View were used to review access points within the corridor. A total of 223 access points were identified throughout the corridor, with 138 located within Segment 1, 35 located within Segment 2, and 50 located within Segment 3. Segment access point densities and the resulting reduction in free-flow speeds are listed in Table 13.

[2] Free-flow speed is defined as the theoretical speed when the density and flow rate on a study segment are both zero. Density is defined as the number of vehicles occupying a given length of a lane or roadway at a particular instant. Free-flow is defined as a flow of traffic unaffected by upstream or downstream conditions.

Table 13 Access Density per Segment

	Segment	Start RP	End RP	Total Access Points	Total Length (Miles)	Access Point Density (Access Points Per Mile) [1]	Reduction in FFS [2] (mph)
1	Story Mill Rd to Bridger Bowl Rd	1.95	15.7	138	13.8	10	2.5
2	Bridger Bowl Rd to Seitz Rd	15.7	25.3	35	9.6	4	0.9
3	Seitz Rd to US 89	25.3	37.5	50	12.1	4	1.0

Source: DOWL HKM, 2014; HCM 2010; Exhibit 15-8 Adjustment Factor for Access-Point Density.
[1] Numbers are rounded to the nearest whole number. [2] Free-flow speed (miles/hour).

MDT has received public comments that the Brackett Creek intersection is confusing due to the number and angle of intersection roadways. Figure 6 illustrates United States Forest Service routes and Brackett Creek Road intersecting MT 86 near RP 18.8.

Figure 6 Brackett Creek Intersection

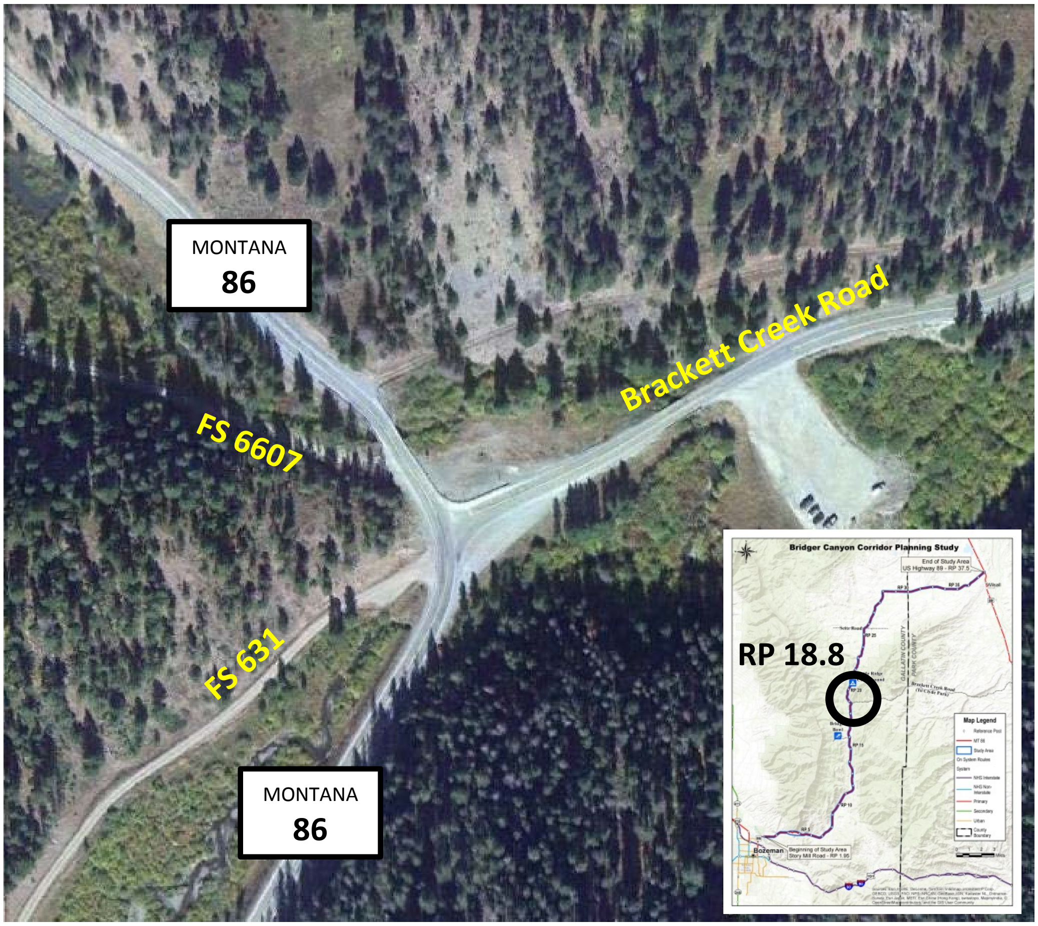


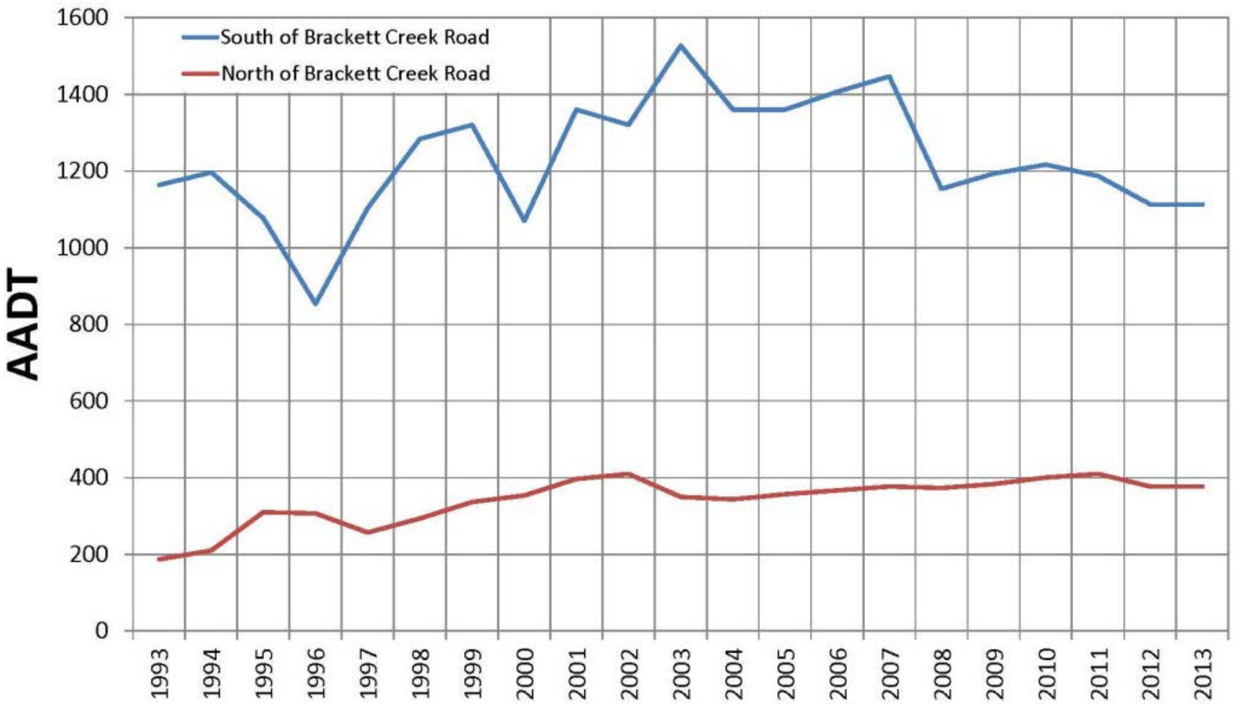
Image source: Google, 2014.

2.5 Traffic Volumes and Operations

Historic AADT Volumes

Annual Average Daily Traffic (AADT) is the total of all motorized vehicles traveling in both directions on a highway on an average day. AADT volumes from short-term counters 16-3-5, 16-2-1, and 16-2-2 located at RP 7.0, RP 15.0, and RP 17.0, respectively, were averaged to represent historic traffic volumes south of Brackett Creek Road (RP 18.8). Traffic volume counts from short-term counters 16-2-3, 34-1-6, and 34-1-5 located at RP 28.0, RP 32.0, and RP 37.5, respectively, were averaged to represent historic traffic volumes north of Brackett Creek Road. Historic traffic volumes north and south of Brackett Creek Road are represented in Figure 7.

Figure 7 Historic Traffic Volumes



Source: MDT, 2014.

The AADT volumes for the three short-term counters north of Brackett Creek Road fall between 16 to 36 percent of the AADT volumes for the three short-term traffic counters south of Brackett Creek Road. Traffic volumes south of Brackett Creek Road were generally more erratic from year to year compared to traffic volumes north of Brackett Creek Road.

Existing Peak-hour Traffic Volumes

MDT collected traffic volumes from the previous short-term counters listed above in June 2014. Data from the June 2014 field count collection effort was used to identify the highest peak hour of the day (defined as the four consecutive 15-minute periods with the highest volumes during the count period). Peak-hour traffic volumes for the three study segments are listed in Table 14.

Table 14 Existing (2014) Peak Hour Volumes

Segment		Start RP	End RP	Peak Hour Volume (2014)
1	Story Mill Rd to Bridger Bowl Rd (northbound)	1.95	15.7	77
	Story Mill Rd to Bridger Bowl Rd (southbound)	15.7	1.95	72
2	Bridger Bowl Rd to Seitz Rd (northbound)	15.7	25.3	54
	Bridger Bowl Rd to Seitz Rd (southbound)	25.3	15.7	56
3	Seitz Rd to US 89 (northbound)	25.3	37.5	29
	Seitz Rd to US 89 (southbound)	37.5	25.3	27

Source: DOWL HKM, 2014.

Growth Rates and Projected Traffic Volumes

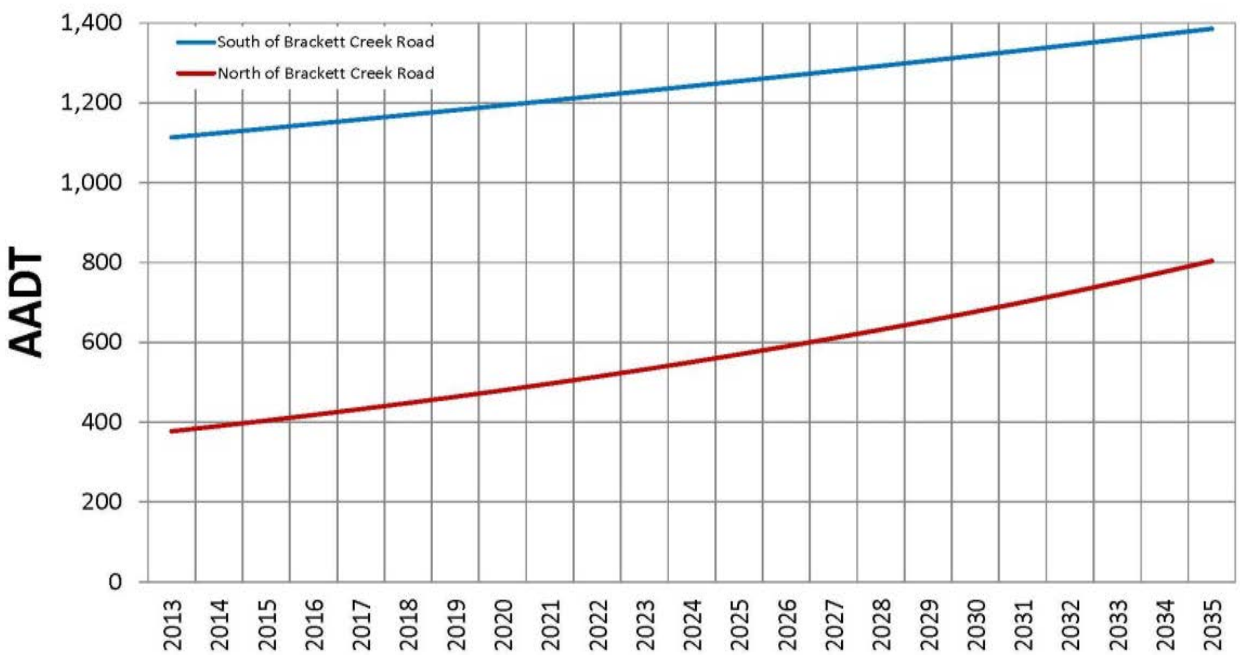
Growth rates within the corridor were determined by MDT through a review of six traffic count stations, three to the north and three to the south of Brackett Creek Road. Brackett Creek Road is located near the middle of the corridor at approximate RP 18.8. MDT determined a 1.0 percent annual growth rate should be applied south of Brackett Creek Road and a 3.5 percent annual growth rate should be applied north of Brackett Creek Road.

Projected traffic volumes were calculated based on growth rates provided by MDT using the following compound annual growth rate formula.

$$(\text{Existing Volume})*(1+[\text{Growth Rate in Decimal Form}])^{\text{Number of Years}} = \text{Future Volume}$$

Projected AADT volumes are illustrated in Figure 8 and projected peak-hour volumes are presented in Table 15.

Figure 8 Projected AADT Volumes



Source: DOWL HKM, 2014.

Table 15 Projected (2035) Peak Hour Volumes

Segment		Start RP	End RP	Peak Hour Volume (2035)
1	Story Mill Rd to Bridger Bowl Rd (northbound)	1.95	15.7	95
	Story Mill Rd to Bridger Bowl Rd (southbound)	15.7	1.95	89
2	Bridger Bowl Rd to Seitz Rd (northbound)	15.7	23.3	67
	Bridger Bowl Rd to Seitz Rd (southbound)	23.3	15.7	69
3	Seitz Rd to US 89 (northbound)	23.3	37.5	60
	Seitz Rd to US 89 (southbound)	37.5	23.3	56

Source: DOWL HKM, 2014.

Operational Characteristics

Traffic conditions on transportation facilities are commonly defined using the level of service (LOS) concept. The Highway Capacity Manual (HCM) 2010 defines LOS based on a variety of factors to provide a qualitative assessment of the driver's experience. Within the study corridor, MT 86 falls under the HCM classification of a Class II two-lane highway. Class II two-lane highways commonly pass through rugged or scenic areas where motorists do not necessarily expect to travel at high speeds. The HCM defines LOS for Class II two-lane highway on the basis of the percent time-spent-following (PTSF) concept. PTSF represents the freedom to maneuver and the comfort and convenience of travel. It reflects the average percentage of time vehicles must travel in platoons behind slower vehicles due to an inability to pass. The two major factors affecting PTSF include passing capacity and passing demand. On a two-lane highway, the ability to pass is limited by the opposing flow rate and by the distribution of gaps in the opposing flow. At the same time, demand for passing maneuvers increases as more drivers are caught in a platoon behind a slow-moving vehicle (i.e., as PTSF increases in a given direction). Both passing capacity and passing demand are related to flow rates. When flow in both directions increases, passing demand increases and passing capacity decreases.

For a Class II two-lane highway, six LOS categories ranging from A to F are used to describe traffic operations, with A representing the best conditions and F representing the worst. LOS F exists whenever demand flow in one or both directions exceeds the capacity of the segment, operating conditions are unstable, and heavy congestion exists.

Table 16 presents LOS criteria for Class II two-lane highway segments.

Table 16 LOS Criteria for Class II Two-lane Highways

Level of Service	Class II Two-lane Highways PTSF (%)
A	≤40.0
B	>40.0 to 55.0
C	>55.0 to 70.0
D	>70.0 to 85.0
E	>85
F	Demand Exceeds Capacity

Source: HCM 2010, Exhibit 15-3 Automobile LOS for Two-lane Highways. PTSF: Percent time spent following

Highway Capacity Software (HCS) 2010 was used to analyze LOS for a Class II two-lane highway in the corridor. Table 17 presents the results of the operational analysis for existing (2014) and projected (2035) conditions. LOS values represent estimated operational conditions within each specified corridor segment. Attachment 5 contains HCS operational analysis worksheets.

Table 17 Class II Two-lane Highway Operational Analysis Results (2014 and 2035)

Segment		Start RP	End RP	2014		2035	
				PTSF (%)	LOS	PTSF (%)	LOS
1	Story Mill Rd to Bridger Bowl Rd (NB)	1.95	15.74	40.9	B	44.8	B
	Bridger Bowl Rd to Story Mill Rd (SB)	15.74	1.95	42.5	B	46.6	B
2	Bridger Bowl Rd to Seitz Rd (NB)	15.74	25.33	36.4	A	39.3	A
	Seitz Rd to Bridger Bowl (SB)	25.33	15.74	38.9	A	42.7	B
3	Seitz Rd to US 89 (NB)	25.33	37.50	26.9	A	31.1	A
	US 89 to Seitz Rd (SB)	37.50	25.33	23.2	A	27.4	A

Source: DOWL HKM, 2014. PTSF: Percent time spent following.

The MDT Traffic Engineering Manual defines desirable operations for minor arterial facilities in rolling terrain as LOS B and in mountainous terrain as a LOS C. MT 86 currently operates at LOS B or better throughout the corridor, and is projected to operate at LOS B or better throughout the 2035 planning horizon.

3.0 Environmental Conditions

An environmental scan report was prepared in support of the Bridger Canyon Corridor Planning Study to identify environmental resource constraints and opportunities within the study corridor. Information was gathered from previously-published documents, websites, GIS data, and a field review conducted on June 25, 2014. The following sections summarize key information from the environmental scan report.

3.1 Physical Environment

Soil Resources and Prime Farmland

United States Department of Agriculture Natural Resources Conservation Service (NRCS) soil surveys indicate the majority of the corridor is either prime farmland, farmland of state or local importance, or prime farmland if irrigated. Specifically, areas classified as prime farmland, prime farmland if irrigated, and farmland of state or local importance are located between RP 1 to RP 15 and RP 22.5 to RP 31 (refer to Exhibit 3).

Any forwarded improvement options that require right-of-way within identified farmlands and are supported with federal funds will require a CPA-106 Farmland Conversion Impact Rating Form for Linear Projects completed by MDT and coordinated with NRCS. The NRCS uses information from the impact rating form to keep inventory of the prime and important farmlands within the state.

Geologic Resources

Numerous faults have been mapped within the study corridor. Most of these are old, inactive thrust faults. There are four main Quaternary (younger) faults surrounding the Bozeman area: the Central Park, Bridger, Gallatin Range, and the Elk Creek faults all with offset during the last

1.6 million years (Stickney and others, 2000). The Bridger fault is the only fault located within the study area, and although concealed by surficial deposits, it most likely crosses the study corridor between RP 2.5 and 3.0. The northern portion of the Emigrant fault is located to the east of the study area near Livingston and has had offset during the last 130,000 years (Stickney and others, 2000). No faults have been identified near or within the study area that have had offset in the past 15,000 years.

Quaternary alluvium (Qal) is present along much of the corridor. Alluvium and other unconsolidated deposits in this area are typically described as a mixture of gravel, sand, silt, and clay. The presence of alluvium consisting predominantly of sand and potentially susceptible to liquefaction is possible, although unlikely. Bedrock along the study corridor consists of Cambrian- to Cretaceous-aged sedimentary rocks from RP 5 to RP 6. The bedrock along the remainder of the study corridor consists of Cretaceous-aged sedimentary rocks. Landslide deposits (Qls) are present in the area along the valley sides.

Improvements forwarded from the study should be prepared to advance borings to evaluate soils at the location work is anticipated to take place to ensure soil suitability.

Surface Waters

Named streams within the study area are listed below.

Brackett Creek	Fairy Creek	Olson Creek
Bridger Creek	Flathead Creek	North Fork Brackett Creek
Cache Creek	Lyman Creek	Place Creek
Carrol Creek	Maynard Creek	South Fork Brackett Creek
Dry Creek	Middle Fork Brackett Creek	Stone Creek
East Gallatin River	Muddy Creek	White Creek

A variety of additional surface waters, including unnamed streams, natural drainages, wetlands, and ponds are also present in the study area. Impacts to these surface waters may occur from improvements such as culverts under the roadway, placement of fill, or rip rap armoring of banks. Coordination with federal, state, and local agencies would be necessary to determine appropriate permits if improvement options are forwarded from this study, as any work within these waters may be regulated by the United States Army Corps of Engineers (USACE), the Montana Department of Fish, Wildlife and Parks (FWP), Montana Department of Natural Resources and Conservation (DNRC), and the Montana Department of Environmental Quality (DEQ). Impacts should be avoided and minimized to the maximum extent practicable. Stream and wetland impacts may trigger compensatory mitigation requirements of the USACE. In addition, forwarded improvement options may trigger the need to obtain coverage under the Montana Pollutant Discharge Elimination System General Permit for Storm Water Discharges Associated with Construction Activity and comply with the requirements outlined in MDT's Storm Water Management Plan.

Total Maximum Daily Loads

The study area traverses the Gallatin River Watershed (hydrologic unit code [HUC] 10020008) and the Shields River Watershed (HUC 10070003).

DEQ lists Bridger Creek, East Gallatin River, and Stone Creek as having an impairment in the Draft 2014 Integrated 303(d)/305(b) Water Quality Report for Montana. These three water bodies are listed as Category 4A, defined as waters where all total maximum daily loads (TMDLs) required to rectify all identified threats or impairments have been completed and approved. Should improvement options be advanced, it will be necessary to consider DEQ TMDL standards and potential impacts to water quality within receiving streams and watersheds in the study area.

Wild and Scenic Rivers

None of the waterways within the study area carry a wild and scenic designation.

Groundwater

According to the Montana Bureau of Mines and Geology (MBMG) Groundwater Information Center (GWIC), there are 16,506 wells on record in Gallatin County, and 5,545 wells on record in Park County. Some of these wells are located within the study area. The newest well on record is from June 23, 2014, and the oldest well on record is from January 1860. The majority of wells within Gallatin County (approximately 10,075) are at a depth of 0 to 99 feet. In Park County, approximately half of the wells (2770) are at a depth of 0 to 99 feet. There are 76 statewide monitoring network wells in Gallatin County, and 19 in Park County. The wells in Gallatin and Park Counties have widely varying uses, with domestic wells being the most common. Impacts to existing wells will need to be considered if improvement options are forwarded from the study.

Wetlands

Wetlands were observed throughout the study area during the June 25, 2014, field review. Wetlands typically border streams that traverse or parallel the MT 86 corridor. Several large emergent and scrub/shrub wetland complexes border the riparian areas of Bridger Creek (RP 5.7 to RP 6.7), Carrol Creek (RP 26.8 to 27.4), South Fork Dry Creek (RP 29.2 to RP 29.7), Flathead Creek (RP 30.0 to RP 30.3), and Dry Creek (RP 32.6). Some of these wetland systems were well developed and provide ample wetland functions and values.

Future wetland delineations would be required if improvement options are forwarded from the study that could potentially impact wetlands. Future projects in the corridor would need to incorporate project design features to avoid and minimize adverse impacts to wetlands to the maximum extent practicable. Unavoidable impacts to wetlands must be compensated through mitigation in accordance with the USACE regulatory requirements and requirements of Executive Order 11990. Work within jurisdictional wetlands would require a Clean Water Act 404 permit from the USACE.

Floodplains and Floodways

Federal Emergency Management Agency-issued flood maps for Gallatin and Park Counties indicate that four floodplain zones exist within the study area at the following locations.

- <u>Zone A</u>: Special Flood Hazard Area (SFHA) - 100-Year Flood, No Base Flood Elevations Determined (RP 4.2 – RP 7.4 and RP-31.0 to 37.2);
- <u>Zone AE</u>: SFHA - 100-Year Flood, Base Flood Elevations Determined (RP 3.2);
- <u>Zone AE</u>: SFHA – 100-Year Flood, Stream Channel Plus Adjacent Floodplains (RP 3.2, RP 4.3); and
- <u>Zone X</u>: 500-Year Flood (RP 1.95 – RP 3.2).

If improvement options are forwarded from this study that result in the placement of fill within the regulatory floodplain, impacts to floodplains would need to be identified and evaluated. Project development could require coordination with Gallatin and Park Counties to minimize floodplain impacts and obtain necessary floodplain permits for project construction.

Irrigation

Irrigated grazing land exists in Gallatin and Park Counties adjacent to the study area. Depending on the improvement option(s) proposed during the corridor study, there is potential to impact irrigation facilities. Impacts to irrigation facilities should be avoided to the greatest extent practicable. Any future modifications to existing irrigation canals, ditches, or pressurized systems would be redesigned and constructed in consultation with the owners to minimize impacts to agricultural operations.

Air Quality

The study area is not located in a non-attainment area for any criteria pollutants designated by the United States Environmental Protection Agency. Additionally, there are no nearby non-attainment areas. Depending on the scope of improvements being considered along this corridor, an evaluation of mobile source air toxics may be required.

Hazardous Substances

Four underground storage tanks were identified within the corridor, all of which are classified as leaking underground storage tank sites. Additional investigation regarding the precise locations of the USTs may be warranted if improvement options are forwarded from this study. If leaking underground storage tanks (LUSTs) or contaminated soils are encountered, removal and cleanup will likely be required.

A single abandoned and inactive quarry site is located at approximate RP 4.4 along an abandoned portion of MT 86. A 1975 landslide associated with this quarry covered a portion of the MT 86 alignment, which is currently bordered with concrete barriers. MT 86 traffic was redirected to the north via a detour route which is still in use today. If improvements are proposed in this area, the quarry has the potential to affect project design and construction, and additional investigation may be necessary.

One hazardous waste handler was identified within the study area. According to the location indicated in the NRIS database, the site is likely the USFWS Bozeman Fish Technology Center at RP 4.0. If improvements to MT 86 are proposed in this area, additional coordination may be required.

3.2 Biological Resources

Vegetation

A combination of conifer-dominated forests, cultivated crops, sagebrush steppe, and Rocky Mountain grasslands habitat dominate the land cover in the vicinity of the study area. Riparian woodland and shrub-dominated rangeland line the riparian corridors of the numerous creeks and drainages that transect the study area. North and east of RP 23, the study area is buffered by rangeland, grassland, and riparian wetlands bordering the low-gradient streams in the area. If improvement options are forwarded from the study, practices outlined in MDT's standard specifications should be followed to minimize adverse impacts to vegetation. Removal of mature trees and shrubs should be limited to the extent practicable.

Noxious Weeds

The Invaders Database System lists 262 exotic plant species and 49 noxious weed species in Gallatin County, and 144 exotic plant species and 32 noxious weed species in Park County, some of which may be present in the study area.

To reduce the spread and establishment of noxious weeds and to re-establish permanent vegetation, disturbed areas should be seeded with desirable plant species. If improvements are forwarded from the study, field surveys for noxious weeds should commence prior to any ground disturbance and coordination with Gallatin and Park County Control Boards should occur.

General Wildlife Species

Mammals

The study area is home to a variety of mammal species including white-tail deer, mule deer, elk, moose, black bear, mountain lion, gray wolf, and coyote. Other common mammals potentially occurring in the study area include porcupine, raccoon, striped skunk, badger, bobcat, red fox, beaver, muskrat, Richardson's ground squirrel, deer mouse, vole species, and a variety of bat species.

According to electronic mail communications between FWP and MDT, elk are plentiful in the southern portion of the study area, and local citizens have expressed concern about elk on the highway, especially in the winter months. Specifically, from RP 6 to RP 10 in the Kelly Canyon area, as well as near the intersection with Bridger Canyon Spur Road (RP 8.3) and Jackson Creek Road (RP 9.5), elk are frequently observed crossing the road in the winter months. The design and scoping of any future projects in this location should consider occupied habitat adjacent to and the movement of the elk herd across the highway during winter months relative to recreational traffic accessing the Bridger Bowl ski area.

Whitetail and mule deer are prevalent within the study area and the surrounding vicinity. In the morning hours (7 am to 9 am), numerous deer were observed crossing MT 86 during the June 25, 2014, field review. The majority of the deer were observed in the southern portion of the study area, from approximately RP 5 to RP 22.

Moose and black bear also inhabit the study area, with both species' habitat predominantly found from RP 5 to RP 22. Based on FWP input, moose are relatively abundant in the area, particularly in the areas of Kelly Canyon, Drinking Horse Reservoir, and Green Mountain. One moose was observed during the field review at approximate RP 28. FWP also reported several mountain lion harvested within a mile of MT 86.

If improvement options are forwarded from the study, wildlife crossing structures and other wildlife mitigation strategies should be explored during the project development process. Additional coordination with the FWP area wildlife biologist should be undertaken for local expertise on the wintering elk herd in the study area.

Amphibians and Reptiles

Amphibian species known to occur within the study area include, but are not limited to, the boreal chorus frog, American bullfrog, northern leopard frog, Columbia spotted frog, snapping turtle, painted turtle, rubber boa, gophersnake, and common gartersnake.

Birds

There are more than two hundred species of birds documented with the potential to occur and nest in the study area. These species include representative songbirds, birds of prey, waterfowl, owls, and shorebirds.

According to FWP, there are multiple bald eagle nests located in the general vicinity; however, none are located within the study area or within approximately five miles of the study area. While bald eagle nests are not found within the study area, information from the Montana Field Guide states, "numerous eagles have been observed migrating over Rogers Pass and the Bridger Mountains" (Hawk Watch International 2003). Bald and golden eagles are protected under the Migratory Bird Treaty Act and managed under the Bald and Golden Eagle Protection Act, which prohibits anyone, without a permit issued by the Secretary of the Interior, from "taking" bald eagles, including their parts, nests, or eggs. Multiple nesting raptors have been observed in the northern portion of the corridor, specifically from RP 25 to RP 38. Any improvements forwarded from this study should consider potential constraints that may result from nesting/breeding periods of migratory birds and presence of bald and golden eagles nests.

Fisheries

Many perennial, intermittent, and ephemeral streams intersect the study area. Fish species commonly found within named streams in the study area vicinity include brook trout, brown trout, lake chub, longnose dace, longnose sucker, mottled sculpin, mountain sucker, mountain whitefish, rainbow trout, westslope cutthroat trout, white sucker, and Yellowstone cutthroat trout.

According to Montana Natural Heritage Program, the Brackett Creek and Flathead Creek drainages contain populations of genetically-pure Yellowstone cutthroat trout. Other unnamed stream crossings exist that could also support fish species within the study area. Fish passage and/or barrier opportunities should be considered in cooperation with resource agencies at affected drainages if improvements are forwarded from this study. Permitting from regulatory agencies for any future corridor improvements may also require incorporation of design measures to facilitate aquatic species passage.

Crucial Areas Planning System

The FWP Crucial Areas Planning System (CAPS) is a resource intended to provide non-regulatory information during early planning stages of projects, conservation opportunities, and environmental review. The finest data resolution within CAPS is at the square-mile section scale or water body. Use of these data layers at a more localized scale is not appropriate and may lead to inaccurate interpretations since the classification may or may not apply to the entire square-mile section. The CAPS system was consulted to provide a general overview of the study area.

The online CAPS mapping tool provides FWP general recommendations and recommendations specific to transportation projects for both terrestrial and aquatic species and habitat. These recommendations can be applied generically to possible future improvements carried forward from the study.

Threatened and Endangered Species

Table 18 presents the six threatened, proposed threatened, or candidate species listed as occurring in Gallatin and Park Counties.

Table 18 Threatened and Endangered Species in Gallatin and Park Counties

Species		Status
Wildlife Species	Greater sage-grouse	Candidate
	Sprague's pipit	Candidate
	Grizzly bear	Threatened
	Canada lynx	Threatened
Plant Species	Whitebark pine	Candidate
	Ute ladies'-tresses	Threatened

Source: USFWS, 2014.

All of the federally-listed species potentially occurring in Gallatin and Park Counties have occurrence buffers overlapping the study area. If improvements are forwarded from the study, an evaluation of potential effects to federally-listed species will need to be completed during the project development process. As federal status of protected species changes over time, reevaluation of the listed status and afforded protection to each species should be completed prior to issuing a determination of effect relative to potential impacts.

Species of Concern

Table 19 lists species of concern in Gallatin and Park Counties with potential to occur in the study area based on presence of suitable habitat. Each species is assigned a state rank that ranges from S1 (greatest concern) to S5 (least concern). State ranks may be followed by modifiers, such as B (breeding).

Table 19 Species of Concern Overlapping the Study Area

Animal Subgroup	Common Name	State Rank	Habitat Description
Amphibians	Western toad	S2	Wetlands, floodplain pools
Birds	Great blue heron	S3	Riparian forest
	Northern goshawk	S3	Mixed conifer forests
	Ferruginous hawk	S3B	Sagebrush grassland
	Great gray owl	S3	Conifer forest near open meadows
	Clark's nutcracker	S3	Conifer forest
	Brown creeper	S3	Moist conifer forests
	Veery	S3B	Riparian forest
	Sage thrasher	S3B	Sagebrush
	Brewer's sparrow	S3B	Sagebrush
	Sagebrush sparrow	S3B	Sagebrush
	Bobolink	S3B	Moist grasslands
	Cassin's finch	S3B	Drier conifer forest
Fish	Yellowstone cutthroat trout	S2	Mountain streams, rivers, lakes
	Westslope cutthroat trout	S2	Mountain streams, rivers, lakes
Mammals	Wolverine	S3	Boreal forest and alpine habitats
Invertebrates	Warm Spring Zaitzevian riffle beetle	S1	Springs
	Brown's microcylloepus riffle beetle	S1	Springs
Plants	Rocky Mountain twinpod	S3	Gravelly slopes/talus
	Small yellow lady's-slipper	S3S4	Fens and moist forest-meadows
	Slender wedgegrass	S3S4	Wet sites (low-elevation)

Source: MNHP, 2014.

Of particular note, the only known global population of the Warm Spring Zaitzevian riffle beetle occurs within the project area in spring and seepage habitat (total area = 35 square meters) in and along Bridger Creek where it flows through the USFWS-owned Bozeman Fish Technology Center (Montana Field Guide, 2014). Because this is the only globally-known location of this species, every effort should be made to avoid disturbance to this beetle and its habitat. Any potential disturbance to the beetle or its habitat should be coordinated with Montana FWP and the USFWS.

Other sensitive species, including bald eagles, are not listed in Table 19, but have the potential to occur within the study area. A thorough field investigation for the presence and extent of these species should be conducted if improvement options are forwarded from this study. If present, special conditions to the project design or during construction should be considered to avoid or minimize impacts to these species.

3.3 Social and Cultural Resources

Population Demographics and Economic Conditions

Under the National Environmental Policy Act/Montana Environmental Policy Act (NEPA/MEPA) and associated implementing regulations, state and federal agencies are required to assess potential social and economic impacts resulting from proposed actions. FHWA guidelines recommend consideration of impacts to neighborhoods and community cohesion, social groups including minority populations, and local and/or regional economies, as well as growth and development that may be induced by transportation improvements. Demographic and economic information presented in this section is intended to assist in identifying human populations that might be affected by improvements within the study area.

Title VI of the United States Civil Rights Act of 1964, as amended (USC 2000(d)) and EO 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations, require that no minority, or, by extension, low-income person shall be disproportionately adversely impacted by any project receiving federal funds. For transportation projects, this means that no particular minority or low-income person may be disproportionately isolated, displaced, or otherwise subjected to adverse effects. If a project is forwarded from the improvement option(s), environmental justice will need to be further evaluated during the project development process.

Table 20 summarizes population and demographic data for Gallatin and Park Counties based on 2010 Census data and includes Montana for comparison.

Table 20 2010 Census Data for Gallatin and Park Counties

		Gallatin	Park	Montana
Population	County	89,513	15,636	989,415
	Bozeman City	37,280		
	Belgrade City	7,389		
	Three Forks City	1,869		
	Livingston City		7,044	
	Clyde Park Town		288	
Race	White	97%	98%	89.4%
	Black or African American	0.3%	0.1%	0.4%
	American Indian & Alaska Native	2%	1%	6.3%
	Asian	1%	0.3%	0.6%
Ethnicity	Hispanic or Latino	2%	1%	2.9%

Source: U.S. Census Bureau, 2010.

Gallatin County's population increased by approximately 31 percent from 2000 to 2010, while the population of Park County remained relatively constant over the 10-year period. Regionally, the combined population from both counties shows an increase by a mean of 2 percent each year from 2000 to 2013. From 2012 to 2030, the region's population is projected to increase to approximately 158 percent of its 2000 population (with the addition of 25,000 people). This increase follows an upward trend of population growth typical throughout western Montana.

Gallatin and Park Counties' population ethnicity in 2010 is primarily white/Caucasian (97 percent and 98 percent, respectively), with American Indian and Alaska Native individuals comprising 1 to 2 percent of the population. A number of races make up the remainder of the population.

From 2006 to 2010, the United States Census Bureau indicated Gallatin County has approximately 42,467 employed individuals in the labor force, while Park County consisted of 5,172 employed individuals. For Gallatin County, the top fields of employment are public administration, followed by the arts, entertainment, recreation, and foods industry. For Park County the top fields of employment are the arts, entertainment, recreation, and foods industry, followed by public administration.

Unemployment in the Gallatin and Park County region has been similar to the statewide unemployment rate for the last decade. As the recession began in 2007 and unemployment increased, Montana, Gallatin County, and Park County all did relatively well in comparison to the nation as a whole with an unemployment rate below the national average. However, after 2007 Park County has continuously had a higher unemployment rate than the state average. Gallatin County has stayed below both the national and state average over time. The most recent unemployment figures from the state and federal labor departments suggest favorable current employment conditions in the study area. In 2013, the average unemployment rate for Gallatin County and Park County was 4.4 and 5.8 percent, respectively. Although Park County has a slightly higher rate than the Montana rate, both counties fall short of the national unemployment rate of 7.4 percent.

Land Ownership and Land Use

Ownership of land in the study area is predominantly private, with some interspersed state and federal owners. Specifically, the USFWS owns a parcel of land associated with the Bozeman Fish Technology Center from approximately RP 4.1 to RP 4.6, and, as part of the Gallatin National Forest, the USFS owns from approximate RP 18.4 to RP 19.5 and from RP 19.7 to RP 20.9. Additionally, state-owned land is located within the northern portion of the study area from RP 34.0 to RP 34.4. Much of the private land adjacent to MT 86 includes low- to moderate-intensity development.

Mixed land use arises from the varied land ownership throughout the study area. These land uses include commercial, industrial, crop/pasture, mine/quarry, mixed urban, and recreational. If improvements are forwarded from this study, land use adjacent to possible projects will need to be considered during design.

Recreational Resources

Bridger Canyon provides access to the Bridger Mountains and the Gallatin National Forest, and offers a variety of recreational opportunities, including hiking, downhill skiing at the Bridger Bowl ski area, cross-county skiing at Bohart Ranch, birding and wildlife viewing, cycling, snowshoeing, fishing, hunting, hiking, and camping.

The “M” trail is a popular recreation site offering hiking and biking trails in the Bridger Mountain Range which can be accessed year round. A small parking lot serves the overpopulated trail head. Bridger Bowl is an alpine ski area which also has insufficient parking for the number of people who use the area. The parking areas are often full causing parking to overflow across and/or onto the highway. The tight corridor and minimal shoulders adjacent to the “M” trail and Bridger Bowl Ski area causes a hazardous situation for vehicles parked along the roadway and pedestrians crossing the roadway.

Table 21 lists publically-owned recreational resources identified in the study area. These recreational areas may be protected under Section 4(f) of the U.S. Department of Transportation Act of 1966, which was enacted to protect publically-owned parks, recreation areas, wildlife and waterfowl refuges, and public and private historic sites of local, state, and national significance. Federally-funded transportation projects cannot impact these properties unless there are no feasible and prudent avoidance alternatives and all possible planning to minimize harm has occurred. Potential effects on recreational use would need to be considered in accordance with Section 4(f) if improvements are forwarded from this study.

Table 21 Potential Section 4(f) Recreational Resources

Resource	Approximate RP
Story Mill Spur Trail	1.95
Bozeman Fish Technology Center Trails (including College “M” Trailhead and Trail System)	4.2
Stone Creek USFS Access	11.7
Olson Creek USFS Access	14.3
USFS Battle Ridge Campground, Picnic Area, and USFS 500 Trailhead	20.5
Fairy Lake USFS Trailhead	21.6

Source: USFS, 2014.

According to FWP Land and Water Conservation Fund Act (LWCFA) Sites by County, no Section 6(f) resources were identified in the study area. To confirm the accuracy/completeness of the literature, additional coordination with FWP will be necessary if improvements are forwarded from this study.

Cultural Resources

A file search through the Montana State Historic Preservation Office revealed two historic properties located within 0.15 miles of the existing alignment (24GA1394 and 24GA0802). Table 22 lists the properties, their approximate locations, and National Register of Historic Places (NRHP) eligibility. An examination of the Montana Cadastral Survey information for the designated corridor indicates that at least 76 historic-age properties are located within 0.15 mile of the existing MT 86 alignment.

Table 22 Recorded Cultural Resource Sites

Site Name	Site No.	RP	Township	Range	Section	NRHP Eligibility
Flaming Arrow Ranch House & Office	24GA1394	15.3±	1N	7E	29	Listed
Sedan School	24GA0802	22.6±	2N	7E	3	Listed

Source: Montana State Historic Preservation Office (SHPO), 2014.

There are likely unrecorded archaeological sites within the project corridor. Based on an MDT field review on May 12, 2014, the east end of the project corridor has a higher likelihood of archaeological sites than the west end.

There is a high likelihood of encountering buried archaeological sites near the following stream crossings: Dry Creek, Carrol Creek, Fairy Creek, and Cache Creek. Brackett Creek, and Bridger Creek and its various tributaries, all have the potential to harbor buried archaeological deposits at MT 86 crossings. Tipi ring sites may be located where MT 86 approaches the valley wall of Flathead Creek. Tribal consultation will be necessary for the Battle Ridge Pass area.

If a project is forwarded from the corridor study, a cultural resource survey for unrecorded historic and archaeological properties within the area of potential conflict (APE) will need to be completed during the project development process. Flexibility in design will be important to avoid and/or minimize impacts to significant sites in the study corridor.

Noise

Traffic noise may need to be evaluated for any future improvements to the Bridger Canyon corridor. Noise analysis is necessary for "Type I"-classified projects. If future roadway improvements are limited (e.g., the horizontal and vertical alignments are not changed and the highway remains a two-lane facility), then the project would not be considered a Type I project. If forwarded improvements include a substantial shift in the horizontal or vertical alignments, increasing the number of through lanes, providing passing lanes, or increasing traffic speed and volume, then the project would be considered a Type I project.

Type I projects require a detailed noise analysis, consistent with FHWA requirements and MDT policy, which includes measuring ambient noise levels at selected receivers and modeling design year noise levels using projected traffic volumes. Noise abatement measures would be considered for the project if noise levels approach or substantially exceed noise abatement criteria. The noise abatement measures must be considered reasonable and feasible prior to implementation.

Visual Resources

The visual resources of an area include landforms, vegetation, water features, and physical modifications caused by human activities that give the landscape its visual character and aesthetic qualities. Visual resources are typically assessed based on the landscape character (what is seen), visual sensitivity (human preferences and values regarding what is seen), scenic integrity (degree of intactness and wholeness in landscape character), and landscape visibility (relative distance of seen areas) of a geographically defined view shed.

The landscape throughout the study area contains an array of biological, topographic, historic, ecological, and cultural resources in a relatively remote location. MT 86 serves as the access point to the Bridger Bowl ski area from Bozeman and the greater Gallatin valley. MT 86 also provides access to the Gallatin National Forest, with numerous trailheads, access points, and a campground accessed via the highway. While the area surrounding the corridor has been slightly developed, the rural and scenic landscape remains, offering aesthetically-pleasing views to residents and motorists.

A rock formation, known as “Maiden Rock,” is located near RP 4.4 on the north side of MT 86. Some accounts indicate the named formation is a stone spire or pinnacle at the entrance to the canyon. A Museum of the Rockies archival photograph circa 1900 shows a formation that appears to resemble a maiden’s head. Although the spire still remains, much of the larger formation was damaged or removed during blasting by road crews in the 1970s.

Evaluation of the potential effects on visual resources would need to be conducted if improvement options are forwarded from this study.

4.0 Local Facilities and Services

The Montana Outdoor Science School is located at 4056 Bridger Canyon Drive (across from the "M" trailhead) near RP 4.2 within the study area. The mission of the Montana Outdoor Science School is to promote an awareness, understanding and appreciation of the natural world through quality educational experiences. The school offers classroom programs and multi-day overnight residential camp experiences.

The Bridger Canyon Rural Fire District serves the study area with 28 volunteer firefighters and five non-firefighting volunteers. The Bridger Canyon Fire Hall is located at the intersection of Bealey Creek Road and Bridger Canyon Drive at approximately RP 8.

5.0 Local Planning

Bozeman Community Plan

The Bozeman Community Plan was prepared by the city to guide growth in an orderly fashion and to prevent or minimize negative impacts to the community’s interests and values. The planning area covers the city of Bozeman, as well as an area outside the city limits which includes a small portion of the Bridger Canyon corridor. However, this plan does not identify any specific proposals that would affect the Bridger Canyon corridor.

Bozeman Community Transportation Safety Plan

MDT established a program through which communities could apply for assistance for the development of a community transportation safety plan (CTSP) to address transportation safety needs. The city of Bozeman applied for and received assistance to develop a CTSP. The plan addresses the frequency and severity of crashes through MDT's four elements of transportation safety: education, enforcement, emergency response, and engineering. The plan does not identify any specific proposals that would affect the Bridger Canyon corridor.

Bozeman Creek Enhancement Plan

The Bozeman Creek Enhancement Plan was prepared by the Bozeman Creek Enhancement Committee. The plan serves to help guide the protection and enhancement of the Bozeman Creek within the city limits of Bozeman. The plan sets out goals, objectives, and strategies and identifies potential projects to protect and enhance Bozeman Creek. Bozeman Creek crosses through the center east portion of the city extending from the northern city boundary to the southern city boundary. This plan does not identify any specific proposals that would affect the Bridger Canyon corridor.

Bozeman Creek Neighborhood Plan

The Bozeman Creek Neighborhood Plan was prepared for the Bozeman City Commission by the City of Bozeman Department of Planning and Community Development. The plan serves as a proactive plan to direct and shape growth within the neighborhood. The Bozeman Creek Neighborhood is generally defined as the area south of East Story Street, north of Kagy Boulevard, west of South Church Street, and east of Gallagator Linear Trail and South Rouse Avenue. The desires of property owners and residents within and adjacent to the area were considered. Some of the prevailing themes include protection for critical lands and open spaces; context-sensitive and orderly growth; safe, walkable neighborhoods; historic preservation; creating a sense of place; and a functional transportation system (motorized and non-motorized). This plan does not identify any specific proposals that would affect the Bridger Canyon corridor.

Bozeman Deaconess Health Services Subarea Plan

The Bozeman Deaconess Health Services Subarea Plan aims to identify the highest and best use for real estate holdings owned by Bozeman Deaconess Health Services (BDHS) in the southeastern portion of the city of Bozeman. The plan was prepared in accordance with the Bozeman 2020 Community Plan to promote future land uses that are compatible with existing land uses. The plan generally considers the area south of Ellis Street, west of Bozeman Trail Road, north of Kagy Boulevard, and east of Church Street. This plan does not identify any specific proposals that would affect the Bridger Canyon corridor.

Bozeman Storm Water Facilities Plan

The Bozeman Storm Water Facilities Plan describes the city's existing storm water infrastructure. The plan recommends full documentation of the city's storm water infrastructure using electronic mapping software programs. The plan generally considers the area within the city limits, which includes a small portion of the Bridger Canyon corridor. This plan does not identify any specific proposals that would affect the Bridger Canyon corridor.

Bozeman Wastewater Facilities Plan

The Bozeman Wastewater Facilities Plan describes the existing wastewater infrastructure and estimates the city's future demands for wastewater infrastructure. The plan recommends improving the city's wastewater infrastructure. The plan generally considers the area within the city limits. This plan does not identify any specific proposals that would affect the Bridger Canyon corridor.

Bridger Canyon General Plan and Development Guide – Bridger Canyon Bozeman, MT

The Bridger Canyon General Plan and Development Guide was prepared by the Gallatin County Land Use Planning staff for the Bridger Canyon Planning and Zoning Commission. The plan serves to guide future physical growth within the Bridger Canyon and to protect the natural beauty, open space, and agricultural character of the area. The following property owners' goals may apply to the Bridger Canyon Corridor Planning Study.

- Maintain continuous coordination and cooperation between citizens and public and semi-public agencies in operation in and around the canyon.
- Preserve and protect environmental qualities and resources.
- Maintain high water quality standards.
- Set limits on areas of high intensity recreational use based on access, sensitivity of surrounding uses, influence on water quality, traffic generation, fire hazard, and environmental effects.
- Insist on attention to vegetation, sanitation, wildlife habitat, erosion, and public safety concerns for new development.
- Plan elements of community design (e.g., roads and utilities) in consideration of environmental factors in addition to safety and engineering considerations.
- Design residences, commercial facilities, public buildings, and street signs to fit the rural character of the area.

Bridger Bowl Base Area Plan

The Bridger Bowl Base Area Plan was prepared by the Gallatin County Zoning Commission to guide decision making, and to set forth policy direction to respond to the special needs, problems, and future development of the base area. The Bridger Canyon Zoning Regulation provides the framework for the implementation of this plan. The following goals may apply to the Bridger Canyon Corridor Planning Study.

- Help control traffic within the limits of the two-lane Bridger Canyon Road.
- Conserve the natural resources within the base area and Bridger Canyon in general.

City of Bozeman Economic Development Plan

The City of Bozeman Economic Development Plan guides the City Commission, city staff, and the community regarding economic and business development issues in Bozeman. The plan provides an opportunity to address the community's economic development concerns and develop strategies to support economic development and to maintain Bozeman's high quality of life. This plan does not identify any specific proposals that would affect the Bridger Canyon corridor.

City of Bozeman Fire Protection Master Plan

The Fire Protection Plan details the Bozeman Fire Department operations and provides recommendations to meet the existing and future fire protection needs of the city. The primary recommendation of the plan is for the city to pass Commission Resolution Number 3972, which details procedures and policies consistent with the National Fire Protection Association. Resolution 3972 was formally adopted by the city Commission of Bozeman in November of 2006. The plan does not identify any specific proposals that would affect the Bridger Canyon corridor.

Downtown Bozeman Improvement Plan

The Downtown Bozeman Improvement Plan was prepared by the Downtown Bozeman Partnership for the city of Bozeman. The plan serves as a broad planning tool to ensure the long-term economic health, historic character, and cultural vitality of Bozeman's downtown urban center. The plan was adopted in 2009 by the City Commission, which grants it legal status as a guiding document for related planning documents like the Bozeman Community Plan and the City's growth policy. The planning area is an asymmetric boundary generally extending several blocks north and south of Main Street from 5th Street to Broadway. This plan does not identify any specific proposals that would affect the Bridger Canyon corridor.

Gallatin National Forest - Forest Plan

The Gallatin National Forest (GNF) – Forest Plan was prepared by the United States Department of Agriculture – Forest Service for the Gallatin National Forest. The plan serves to guide all natural resource management activities and establishes management standards for the GNF. The plan describes resource management practices, levels of resource production and management, and the availability and suitability of lands for resource management. The following GNF goals may apply to the Bridger Canyon Planning Study.

- Provide directional and interpretive signing for visitor information, as appropriate for the recreation setting.
- Provide forest visitors with visually-appealing scenery.
- Meet or exceed state of Montana water quality standards.
- Maintain and enhance fish habitat to provide for an increased fish population.
- Provide habitat for viable populations of all indigenous wildlife species and for increasing populations of big game animals.
- Provide sufficient habitat for recovered populations of threatened and endangered species (i.e., grizzly bear, bald eagle, and peregrine falcon).
- Strive to prevent any human-caused grizzly bear losses.
- Provide additional public access to National Forest lands.
- Provide a road and trail management program that is responsive to resource management needs.

Greater Bozeman Area Transportation Plan

The Greater Bozeman Area Transportation Plan serves as a blueprint for guiding existing and future transportation infrastructure in the city of Bozeman. The plan considers non-motorized transportation infrastructure equally as important as motorized transportation infrastructure. The plan attempts to balance the desire to address existing deficiencies while recognizing the importance to plan for future needs. The study area includes the Bozeman city limits, as well as substantial portions of unincorporated lands surrounding the city. These lands are generally located to the north and south of the city, and extend from an eastern limit of the Bridger Mountains to a western limit of the Gallatin River. A portion of the Bridger Canyon corridor falls within the Greater Bozeman Area Transportation Plan study limits. The plan conducted a "Greater Bozeman Area Bicycling and Walking Survey," which discusses "high priority" projects residents would like realized. Among the projects identified were "better connections to the 'M' Trail" and bike lane/shared use path and bike racks along MT 86. Other projects identified within the plan include greater transit service and wider roadway shoulders along MT 86.

N 19th Avenue/Oak Corridor Master Plan

The N 19th Avenue/Oak Corridor Master Plan was prepared by the Bozeman City-County Planning Office for the City of Bozeman and Gallatin County City-County Planning Board. The plan serves as a supplement to the Bozeman Area Master Plan. The plan aims to provide a vision for the future growth of the corridor, which is compatible with existing plans and land uses. The N 19th Avenue/Oak corridor is generally defined as N. 19th Avenue between Durston Road and Interstate 90 and Oak Street between N. 7th Avenue and Rose Park. This plan does not identify any specific proposals that would affect the Bridger Canyon corridor.

North 7th Avenue Plan

The North 7th Avenue Plan aims to establish a distinct identity for the North 7th Avenue corridor, which is an established entryway into Bozeman that extends from I-90 south to Main Street. The plan also considers the adjacent roadways of 5th Street to 8th Street from I-90 to Main Street. The plan considers automobile circulation, bicycle circulation, development patterns, landscape opportunities, pedestrian circulation, public transit, and wayfinding. This plan does not identify any specific proposals that would affect the Bridger Canyon corridor.

Parks, Recreation, Open Space and Trails Master Plan

The Parks, Recreation, Open Space and Trails Master Plan was prepared by the Gallatin County Planning Office for the city of Bozeman. The plan provides a framework for integrating existing facilities and programs and further developing a system of parks, recreation facilities and programs, open spaces, and trails. The plan strives to enhance the quality of life through the provision of high-quality parks, recreational facilities and programs, trails, and open spaces. This plan does not identify any specific proposals that would affect the Bridger Canyon corridor.

Statewide Transportation Improvement Program (STIP) – 2014-2018

The Statewide Transportation Improvement Program (STIP) is developed in accordance with the requirements of Section 135 of 23 USC (United States Code). This STIP details projects that will address Montana's transportation needs for fiscal years 2014 through 2018. There are several MT 86 projects programmed in the current STIP that fall within the study area. Recent and planned projects are discussed in Section 6.0.

Water Facility Plan

The Water Facility Plan evaluates the condition of the existing city of Bozeman water system, analyzes improvements, and makes recommendations for improvements. Cost estimates are provided for recommendations, which are then included in the city's Capital Improvement Plan. The plan covers the twenty-year time period from 2006 – 2026. This plan does not identify any specific proposals that would affect the Bridger Canyon corridor.

6.0 Recent and Future Projects and Maintenance Efforts

Recent MDT projects in the study area vicinity are listed below in letting date order.

Park County Line – West; UPN 7583 STPP 86-1(47)24; STPP 86-1(48)24

MT 86, RP 23.9 to 30.9, mill and fill, seal and cover with new pavement markings. Let date March 2013.

Legends at Bridger Creek II

Roadway widening, turn lane installation, new pavement markings, and signing from approximately RP 2.03 to RP 2.29. Let in 2013.

Table 23 lists planned construction and maintenance activities from 2014 through 2016 in RP order.

Table 23 Planned MDT Maintenance and Construction Activities

Begin RP	End RP	Const. Treatment 2014	Const. Treatment 2016	Maint. Treatment 2014	Maint. Treatment 2016
0.0	2.8	AC_Major Rehab	AC_Major Rehab	AC Reactive Maintenance	AC Reactive Maintenance
2.8	9.6	Do Nothing	AC Crack Seal & Cover	Do Nothing	AC Crack Seal & Cover
9.6	16.3	Do Nothing	AC Crack Seal & Cover	Do Nothing	AC Crack Seal & Cover
16.3	20.6	AC Thin Overlay	AC Thin Overlay	AC Thin Overlay	AC Thin Overlay
20.6	23.9	AC Thin Overlay	AC_Major Rehab	AC Thin Overlay	AC Reactive Maintenance
23.9	31.0	None	Do Nothing	None	Do Nothing
31.0	37.7	AC Thin Overlay	AC Thin Overlay	AC Thin Overlay	AC Thin Overlay

Source: Existing Conditions Summary (MDT, 2014). AC: Asphalt concrete.

Table 24 identifies projects listed in the 2014-2018 STIP within the MT 86 corridor in date and RP order.

Table 24 MDT STIP Projects 2014 – 2018

MDT Highway Program Project Name	Fiscal Year (Construction Phase)	Ref. Point	Project Length	Project Scope
SF-119-SIGNING GR N BOZEMAN; UPN 7857	2015	20.80	0.60	Guardrail, Skid Treatment
ROUSE-OAK/STORY MILL-BOZEMAN; UPN 4805	2016	0.85	1.13	Reconstruction
SF-129-SFTY IMPRV BRDGR CANYON; UPN 8028	2016	4.30	0.50	Safety
SF 109-G.R. NE OF BOZEMAN; UPN 7520	2016	6.50	0.46	Guardrail, Skid Treatment
BRIDGER CANYON; UPN 8112	2018	9.58	6.76	Overlay and Widen
Federal Lands Access Program Project Name	**Obligation Year**	**Begin Point**	**End Point**	**Project Scope**
MT DOT T 86(1) Bozeman to Bridger Mountains Trail	2015	Story Mill Rd.	“M” and Drinking Horse Mountain trail heads	Address pedestrian-bicycle/vehicle crashes on MT 86

Source: MDT STIP, 2014 – 2018.

7.0 Conclusion

Table 25 summarizes transportation system issues and environmental constraints in the corridor.

Table 25 Summary of Corridor Issues and Constraints

Category	Issues and Constraints
Transportation System Conditions	Bridges • Three bridges in the study corridor are candidates for repair. Bicycle and Pedestrian Facilities • There are no dedicated bicycle or pedestrian facilities directly adjacent to MT 86. Drainage Condition • Insufficient drainage occurs at RP 15.9, RP 23.4, and RP 26.8. Pavement Condition • Pavement deficiencies (including transverse cracking, longitudinal cracking, and/or subgrade/pavement failure) were identified at RP 6.7, RP 15.9, RP 23.4, RP 24.4, RP 26.8, RP 28.0. Rockfall Hazard • A slide near RP 4.4 is reported to be unstable and susceptible to continuous sloughing; an earthquake or heavy precipitation event could activate a slide event in this location. Horizontal Alignment • Thirty-eight curve locations do not meet current MDT design criteria. Vertical Alignment • One hundred twenty-eight curve locations do not meet current MDT design criteria. Clear Zones • The portion of the corridor from RP 4.0 to RP 24.0 contains unprotected slopes and inadequate clear zone distances. Crash History • Areas identified with high potential for crash reduction occur near RP 5, 9, 19, 21, 29, 30, and 36.
Category	**Issues and Constraints**
Environmental Conditions	Prime Farmland • Areas classified as prime farmland, prime farmland if irrigated, and farmland of state or local importance are located between RP 1 to RP 15 and RP 22.5 to RP 31. Surface Water Impairment • Bridger Creek, East Gallatin River, and Stone Creek are listed as impaired in the Draft 2014 Integrated 303(d)/305(b) Water Quality Report for Montana. Wetlands • Wetlands are located throughout the study area. • Several large emergent and scrub/shrub wetland complexes border the riparian areas of Bridger Creek (RP 5.7 to RP 6.7), Carrol Creek (RP 26.8 to 27.4), South Fork Dry Creek (RP 29.2 to RP 29.7), Flathead Creek (RP 30.0 to RP 30.3), and Dry Creek (RP 32.6). Floodplains • Mapped floodplain zones occur within the study area from RP 1.95 to RP 3.2, RP 4.2 to RP 7.4, and RP-31.0 to 37.2. Hazardous Substances • Four leaking underground storage tanks were identified within the study area. • A single abandoned and inactive quarry site is located at approximate RP 4.4.

Category	Issues and Constraints
Environmental Conditions	Fish and Wildlife • Elk are frequently observed crossing the road in the winter months from RP 6 to RP 10 in the Kelly Canyon area, as well as near the intersection with Bridger Canyon Spur Road (RP 8.3) and Jackson Creek Road (RP 9.5). Deer, moose, black bear, and mountain lion have also been observed in the corridor. • Brackett Creek and Flathead Creek drainages contain populations of genetically-pure Yellowstone cutthroat trout. • Four threatened, proposed threatened, or candidate animal species and 18 species of concern may occur in the study area. • The only known global population of the Warm Spring Zaitzevian riffle beetle occurs within the project area in and along Bridger Creek where it flows through the USFWS-owned Bozeman Fish Technology Center near RP 4.2. Vegetation • One threatened, one candidate, and three plant species of concern may occur in the study area. Recreational Resources • Six potential Section 4(f) recreational resources occur at RP 1.95, 4.2, 11.7, 14.3, 20.5, and 21.6. Cultural and Archaeological Resources • Two NRHP-listed historic properties are located within 0.15 miles of the existing alignment at RP 15.3 and 22.6. • Unrecorded historic-age properties and archaeological sites likely occur within the study area.

8.0 References

City of Bozeman. (1997). N 19th Avenue/Oak Corridor Master Plan. Retrieved June 2014 from: http://www.bozeman.net/Departments-(1)/Planning/Plans-and-Planning

City of Bozeman. (2005). Bozeman Creek Neighborhood Plan. Retrieved June 2014 from: http://www.bozeman.net/Departments-(1)/Planning/Plans-and-Planning

City of Bozeman. (2006). City of Bozeman Fire Protection Master Plan. Retrieved June 2014 from: http://www.bozeman.net/Departments-(1)/Planning/Plans-and-Planning

City of Bozeman. (2006). North 7th Avenue Plan. Retrieved August 2014 from: http://www.bozeman.net/Departments-(1)/Planning/Plans-and-Planning

City of Bozeman. (2006). Water Facility Plan. Retrieved June 2014 from: http://www.bozeman.net/Departments-(1)/Planning/Plans-and-Planning

City of Bozeman. (2007). Bozeman Wastewater Facilities Plan. Retrieved June 2014 from: http://www.bozeman.net/Departments-(1)/Planning/Plans-and-Planning

City of Bozeman. (2007). Parks, Recreation, Open Space and Trails Master Plan. Retrieved August 2014 from: http://www.bozeman.net/Departments-(1)/Planning/Plans-and-Planning

City of Bozeman. (2009). City of Bozeman Economic Development Plan. Retrieved June 2014 from: http://www.bozeman.net/Departments-(1)/Planning/Plans-and-Planning

City of Bozeman. (2009). Community Plan Bozeman. Retrieved June 2014 from http://www.mdt.mt.gov/pubinvolve/bozemanctsp/

City of Bozeman. (2009). Downtown Bozeman Improvement Plan. Retrieved June 2014 from: http://www.bozeman.net/Departments-(1)/Planning/Plans-and-Planning

City of Bozeman. (2010). Bozeman Storm Water Facilities Plan. Retrieved June 2014 from: http://www.bozeman.net/Departments-(1)/Planning/Plans-and-Planning

City of Bozeman. (2012). Bozeman Creek Enhancement Plan. Retrieved June 2014 from: http://www.bozeman.net/Departments-(1)/Planning/Plans-and-Planning

City of Bozeman. (2012). Greater Bozeman Area Transportation Plan. Retrieved May 2014 from: http://www.bozeman.net/Departments-(1)/Planning/Plans-and-Planning

City of Bozeman. (2013). Bozeman Community Transportation Safety Plan. Retrieved June 2014 from: http://www.mdt.mt.gov/pubinvolve/bozemanctsp/

DOWL HKM. (2014). Bridger Canyon Environmental Scan Report.

FHWA. (2013). Highway Functional Classification Concepts, Criteria and Procedures.

Gallatin County. (1979). Bridger Bowl Base Area Plan. Retrieved August 2014: http://www.gallatin.mt.gov/Public_Documents/gallatincomt_plandept/1zoning/districts/zd

Gallatin County. (1989). Bridger Canyon General Plan and Development Guide. Retrieved July 2014 from: http://www.gallatin.mt.gov/Public_Documents/gallatincomt_plandept/1zoning/districts/zd

Montana Department of Transportation. (Various). As-built Drawings.

Montana Department of Transportation. (2004). Road Design Manual. Retrieved July 2014 from: http://www.mdt.mt.gov/publications/manuals.shtml

Montana Department of Transportation. (2005). Rockfall Hazard Classification and Mitigation System.

Montana Department of Transportation. (2007). Traffic Engineering Manual. Retrieved July 2014 from: http://www.mdt.mt.gov/publications/manuals.shtml

Montana Department of Transportation. (2014). Corridor 86 Safety Assessment Report MP 2.70 to 5.00 East of Bozeman.

Montana Department of Transportation. (2013). MDT Bridge Program under MAP-21.

Montana Department of Transportation. (2014-2017). Statewide Transportation Improvement Program. Retrieved August 2014 from: http://www.mdt.mt.gov/pubinvolve/stip.shtml

Montana Outdoor Science School. (n.d.) MOSS School Programs. Retrieved August 2014 from: http://www.outdoorscience.org/schools

Streamline. (n.d.). Bridger Bowl/Bohart Ranch Service. Retrieved August 2014 from: http://www.streamlinebus.com

Transportation Research Board. (2010). Highway Capacity Manual.

United Stated Department of Agriculture. (1987) Gallatin National Forest Plan. Retrieved June 2014 from: http://www.fs.usda.gov/detail/gallatin/landmanagement/planning/?cid=stelprdb5130417

Attachment 1
Field Review
Photo Log

Field Review Photo Log

August 2014

Prepared for:

MONTANA
MDT
DEPARTMENT OF TRANSPORTATION

Prepared by:

DOWL HKM

This photo log illustrates conditions observed along Montana Highway 86 (MT 86) from approximate Reference Post (RP) 1.95 to RP 37.5 during a field review conducted on June 25, 2014. Photo categories include environmental conditions and transportation system conditions. This photo log does not provide a comprehensive account of all conditions within the study area. Conditions were visually inspected; no testing, delineations, or measurements were conducted. Photos within each category progress south/west to north/east. RP locations are approximated.

Environmental Conditions

Photo 1. Looking at the Story Mill Spur Trail marker south of MT 86. RP 1.95.

Photo 2. Looking north at the Story Mill Spur Trail crossing of MT 86. RP 1.95.

Photo 3. Looking upstream (south) on the MT 86 crossing of Bridger Creek. RP 3.1.

Photo 4. Looking east at the USFWS Bozeman Fish Technology Center sign, which is located on the south side of MT 86. RP 4.0.

Photo 5. Looking north at the USFS College "M" trailhead on the north side of MT 86. RP 4.2.

Photo 6. Looking east at a rock slide associated with abandoned quarry, south of MT 86. RP 4.4.

Photo 7. Looking east on MT 86 at a wildlife crossing sign. RP 5.5.

Photo 8. Looking south at the Lower Bridger School, listed on the National Register of Historic Places and located south of MT 86. RP 5.9.

Photo 9. Looking downstream (southeast) at Place Creek. RP 7.1.

Photo 10. Looking northeast on MT 86. Per 2014 communications from Montana Fish, Wildlife, and Parks (FWP), elk cross MT 86 in this area during winter months. RP 7.3.

Photo 11. Looking downstream (south) at an unnamed tributary to Bridger Creek. RP 8.1.

Photo 12. Looking at the Bridger Canyon Fire Department station located on the west side of MT 86. RP 8.3.

Photo 13. Looking northeast toward a farm pond on the eastern side of MT 86. RP 8.3.

Photo 14. Looking upstream (northwest) at an unnamed tributary to Bridger Creek on the west side of MT 86. RP 9.5.

Photo 15. Looking northeast toward the USFS access point to Stone Creek, east of MT 86. RP 11.7.

Photo 16. Looking north at the USFS access point to Olson Creek, east of MT 86. RP 14.3.

Photo 17. Looking west at the Bridger Bowl ski area on the Gallatin National Forest on the west side of MT 86. RP 15.3.

Photo 18. Looking north at the entrance to Bridger Bowl ski area on the west side of MT 86. The Bridger Bowl Ski Area is a major traffic generator in the corridor. RP 15.8.

Photo 19. Looking south on a scrub/shrub wetland along the South Fork of Brackett Creek on the west side of MT 86. RP 18.8.

Photo 20. Looking downstream (east) where MT 86 crosses the South Fork Brackett Creek. RP 19.9.

Photo 21. Looking downstream (southeast) where MT 86 crosses the Middle Fork Brackett Creek. Also pictured is a stream gauging station on the left bank. RP 19.9.

Photo 22. Looking northeast at the USFS Battle Ridge Trailhead and parking area on the west side of MT 86. RP 20.5.

Photo 23. Looking southwest at the Bridger Range, Gallatin National Forest. RP 20.5.

Photo 24. Looking northeast at the USFS Battle Ridge campground, east of MT 86. RP 20.5.

Photo 25. Looking west at the USFS 500 trailhead, across MT 86 from the Battle Ridge campground. This trailhead immediately abuts the west shoulder of MT 86 in an area with limited sight distance. RP 20.7.

Photo 26. Looking northeast at the USFS access for Fairy Lake on the west side of MT 86. RP 21.6.

Photo 27. Looking north on a scrub/shrub wetland along Cache Creek, west of MT 86. RP 22.5.

Photo 28. Looking upstream (southwest) on the MT 86 crossing of Cache Creek. RP 24.5.


Photo 29. Looking upstream (west) on MT 86 crossing of Carrol Creek. RP 28.0.

Photo 30. Looking east on MT 86 at the Park County boundary. RP 31.0

Photo 31. Looking west on MT 86 at the Gallatin County boundary. RP 31.0.

Photo 32. Looking north on an emergent wetland and culvert, north of MT 86. RP 31.0.

Photo 33. Looking south on the Dry Fork and riparian floodplain, south of MT 86. RP 32.0.

Photo 34. Looking southwest on a riparian wetland along Flathead Creek, south of MT 86. RP 34.0.

Transportation System Conditions

Photo 35. Looking north at the western/southern terminus of the corridor at the intersection of MT 86 and Story Mill Road. RP 1.95.

Photo 36. Looking south on MT 86 near the city limits of Bozeman. RP 3.0.

Photo 37. Looking north on MT 86 near the city limits of Bozeman. RP 3.0.

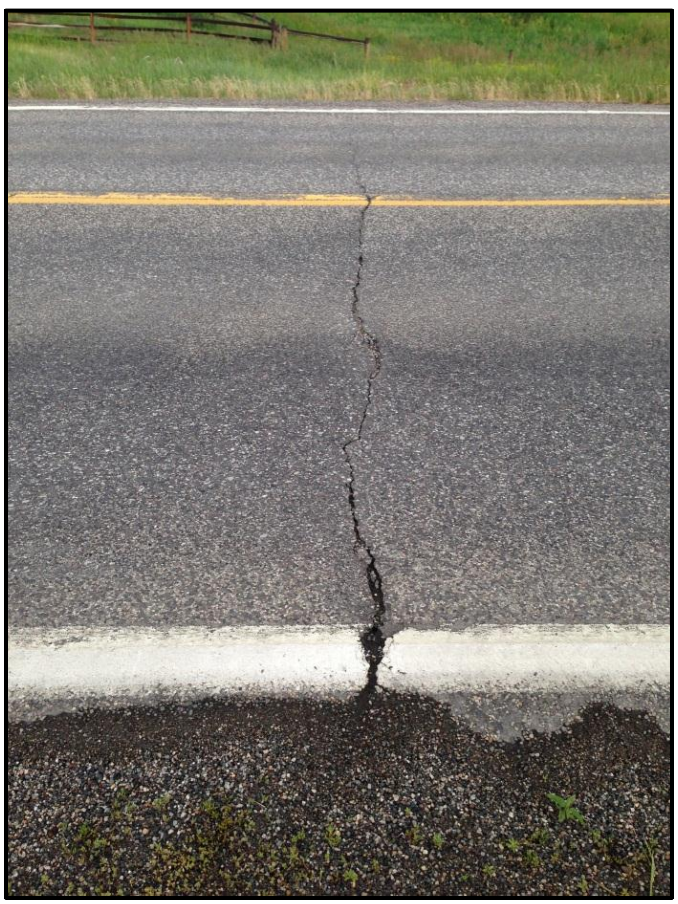


Photo 38. Looking at surface cracks on MT 86. RP 3.2.

Photo 39. Looking at insufficient shoulder width along MT 86. RP 3.2.

Photo 40. Looking at unprotected substandard cut/fill slopes along MT 86. RP 4.1.

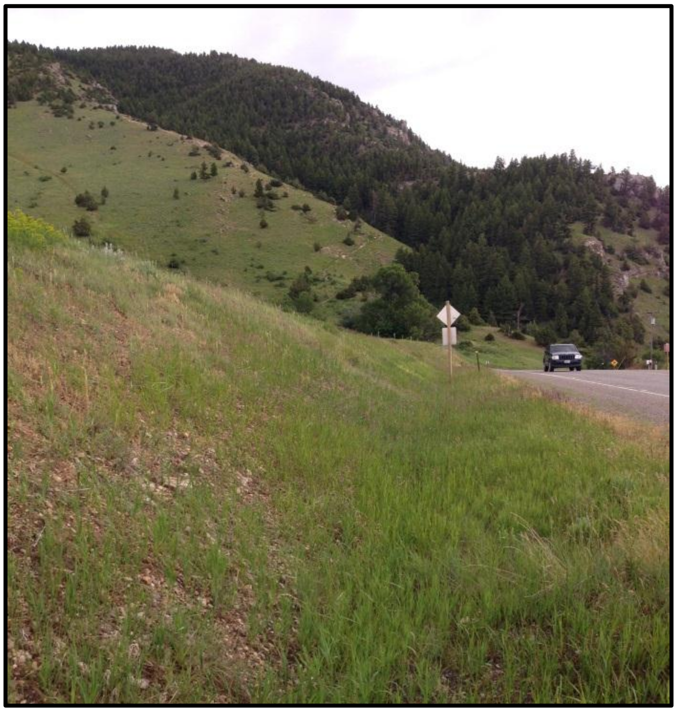


Photo 41. Looking at substandard back slopes along MT 86. RP 4.1.

Photo 42. Looking north at insufficient sight distance due to vertical and horizontal curves on MT 86 at the access to “M” trail parking lot. RP 4.2.

Photo 43. Looking south at insufficient sight distance due to vertical and horizontal curves on MT 86 at the access to "M" trail parking lot. RP 4.2.

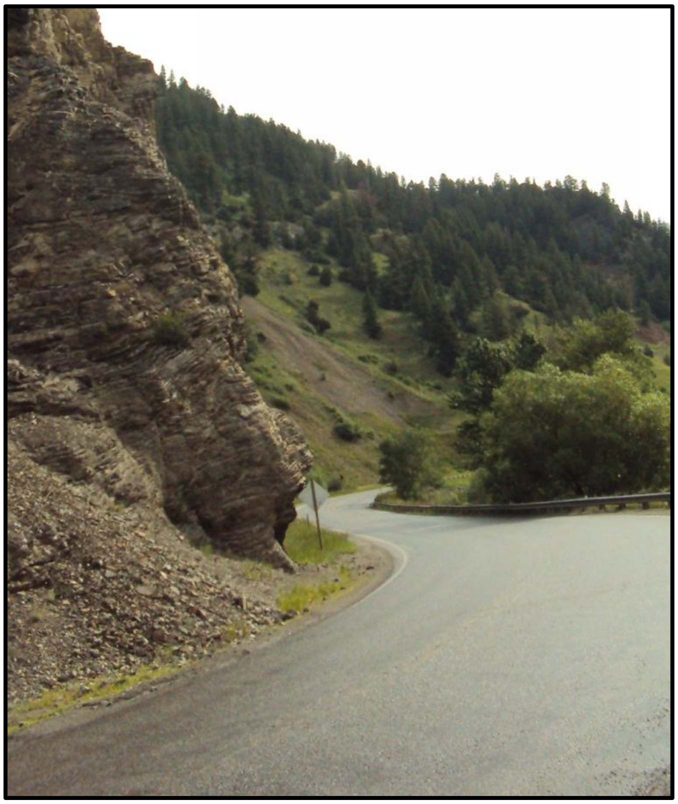


Photo 44. Looking north on MT 86, a rock outcropping is directly adjacent to the traveled way on the west side of the road. RP 4.4.

Photo 45. Looking at insufficient sight distance due to horizontal curves and natural features on MT 86 at the access to the old highway. RP 4.4.

Photo 46. Looking north at insufficient sight distance due to horizontal curves and natural features on MT 86 at the access to the old highway looking east. RP 4.4.

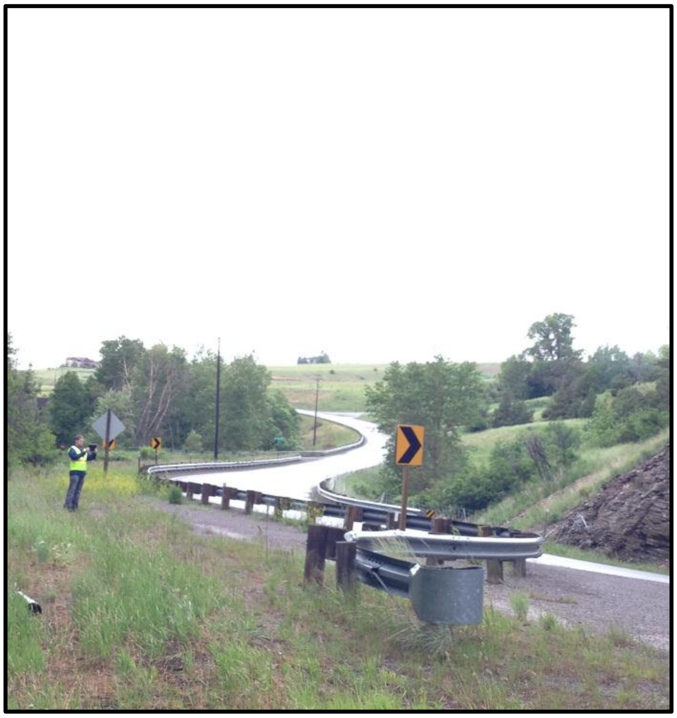


Photo 47. Looking south at insufficient sight distance on MT 86 due to horizontal curves at the access to the old highway. RP 4.4.

Photo 48. Looking north on MT 86, the roadway narrows with rock outcroppings along the west side of the road. RP 4.4.

Photo 49. Looking at insufficient sight distance due to horizontal curves on MT 86. Substandard back slopes are also visible. RP 4.6.

Photo 50. Looking west on MT 86 at insufficient sight distance due to horizontal curves. Unprotected substandard fill slopes and substandard back slopes are also visible. RP 4.8.

Photo 51. Looking at damaged guardrail on MT 86 bridge crossing Place Creek. RP 6.8.

Photo 52. Looking at pavement deterioration at MT 86 bridge crossing Place Creek. RP 6.8.

Photo 53. Looking north on MT 86 at a cyclist traveling southbound. RP 7.7.

Photo 54. Looking at eroded abutment on a MT 86 bridge crossing an unnamed tributary to Bridger Creek. RP 7.9.

Photo 55. Looking at insufficient sight distance due to a horizontal curve on MT 86. RP 7.9.

Photo 56. Looking north on MT 86, a white cross is visible on the east side of the roadway. RP 9.0.

Photo 57. Looking at unprotected substandard fill slopes on MT 86. RP 9.5.

Photo 58. Looking at a damaged wing wall on a MT 86 bridge crossing an unnamed tributary to Bridger Creek. RP 9.5.

Photo 59. Looking at a damaged abutment on a MT 86 bridge crossing an unnamed tributary to Bridger Creek. RP 9.5.

Photo 60. Looking at unprotected substandard fill slopes on MT 86. RP 12.6.

Photo 61. Looking south on MT 86, guardrail runs adjacent to the highway narrowing the traveled way. RP 13.7.

Photo 62. Looking north at substandard guardrail (insufficient height and end treatment) and substandard back slopes on MT 86. RP 13.8.

Photo 63. Looking at pavement deterioration on MT 86. RP 14.3.

Photo 64. Looking at pavement deterioration due to saturated subgrade on MT 86. RP 15.7.

Photo 65. Looking at sight distance issues due to horizontal and vertical curves on MT 86. RP 17.9.

Photo 66. Looking north on MT 86 at the intersection with Brackett Creek Road. This location has reduced sight distance due to horizontal and vertical curves. RP 18.8.

Photo 67. Looking at insufficient sight distance due to horizontal and vertical curves on MT 86 near Brackett Creek. RP 18.8.

Photo 68. Looking at insufficient sight distance due to horizontal and vertical curves on MT 86 near Brackett Creek. RP 18.8.

Photo 69. Looking at insufficient sight distance due to horizontal and vertical curves on MT 86 near Brackett Creek. RP 18.8.

Photo 70. Looking at insufficient sight distance due to horizontal curves on MT 86. RP 19.5.

Photo 71. Looking at insufficient sight distance due to horizontal and vertical curves and steep grades on MT 86. RP 20.5.

Photo 72. Looking at insufficient sight distance due to horizontal and vertical curves at the Battle Ridge campground access on MT 86. RP 20.5.

Photo 73. Looking at unprotected substandard fill slopes and substandard back slopes along MT 86. RP 21.0.

Photo 74. Looking at unprotected substandard fill slopes and substandard back slopes on MT 86 due to embankment erosion on Cache Creek. RP 22.7.

Photo 75. Looking at insufficient sight distance due to horizontal and vertical curves on MT 86. RP 24.5.

Photo 76. Looking at a plugged culvert on an unnamed tributary to Cache Creek. RP 24.7.

Photo 77. Looking at a deteriorated roadway due to a plugged culvert on an unnamed tributary to Cache Creek. RP 24.7.

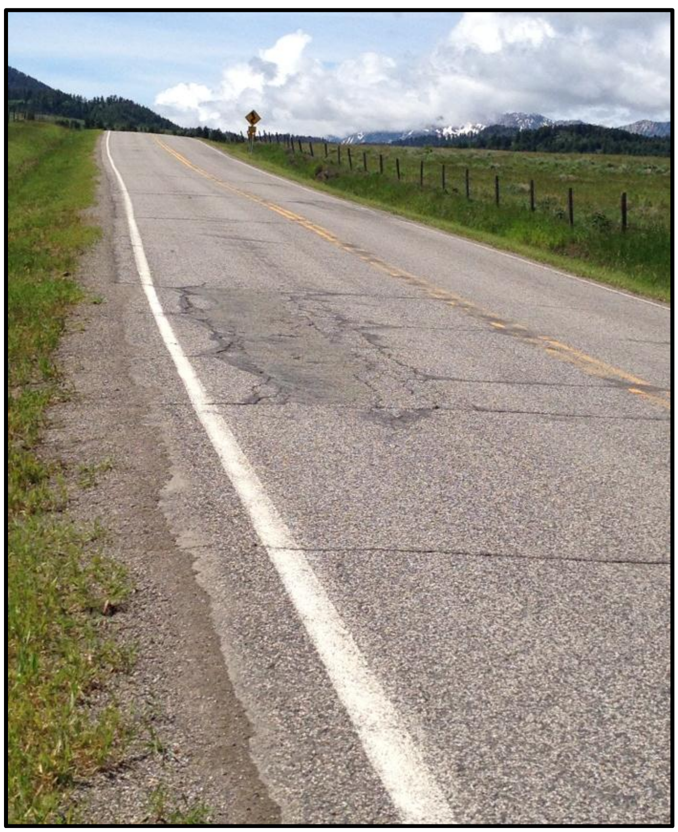


Photo 78. Looking at insufficient sight distance due to horizontal and vertical curves on MT 86. RP 24.7.

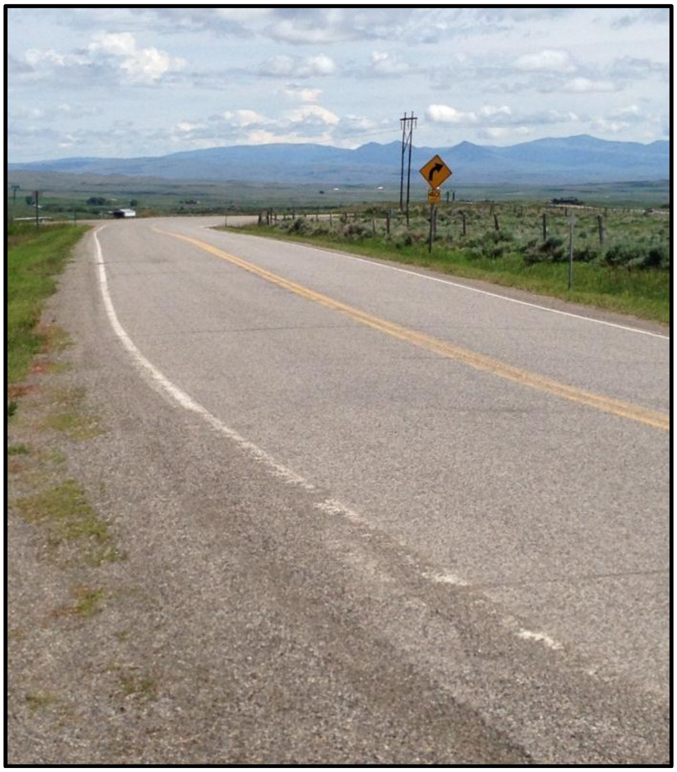


Photo 79. Looking at insufficient sight distance due to a horizontal curve on MT 86. RP 25.2.

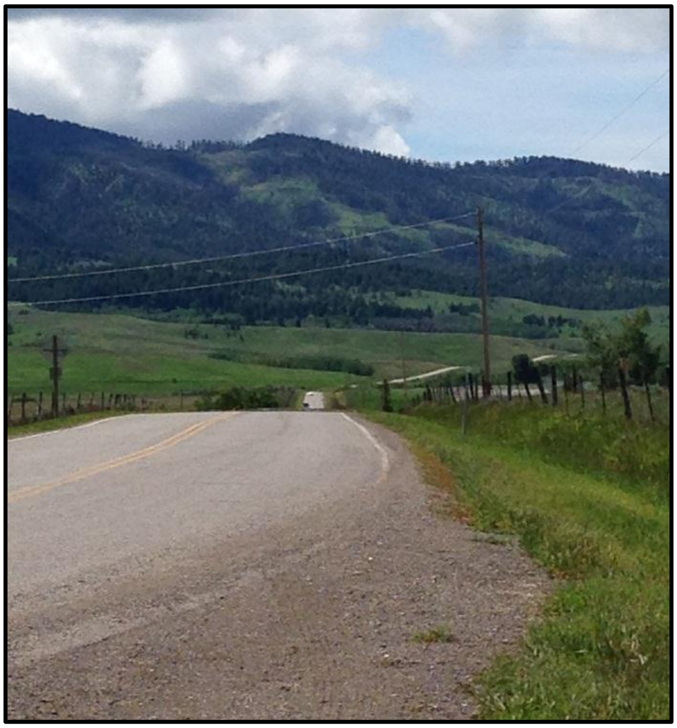


Photo 80. Looking at insufficient sight distance due to a horizontal and vertical curves on MT 86. RP 25.2.

Photo 81. Looking at insufficient sight distance due to horizontal and vertical curves on MT 86. RP 26.8.

Photo 82. Looking at eroded bank of Carrol Creek. RP 26.8.

Photo 83. Looking north on MT 86, the highway and adjacent land transitions into a more level terrain relative to the highway within the canyon. RP. 27.0.

Photo 84. Looking at pavement deterioration at a bridge crossing Carrol Creek. RP 27.1.

Photo 85. Looking at a damaged bridge crossing Carrol Creek. RP 27.1.

Photo 86. Looking at erosion at Carrol Creek bridge abutment. RP 27.1.

Photo 87. Looking at erosion at Carrol Creek bridge abutment. RP 27.1.

Photo 88. Looking south on MT 86, the horizontal curve and vegetation combine to reduce sight distance. RP 28.0.

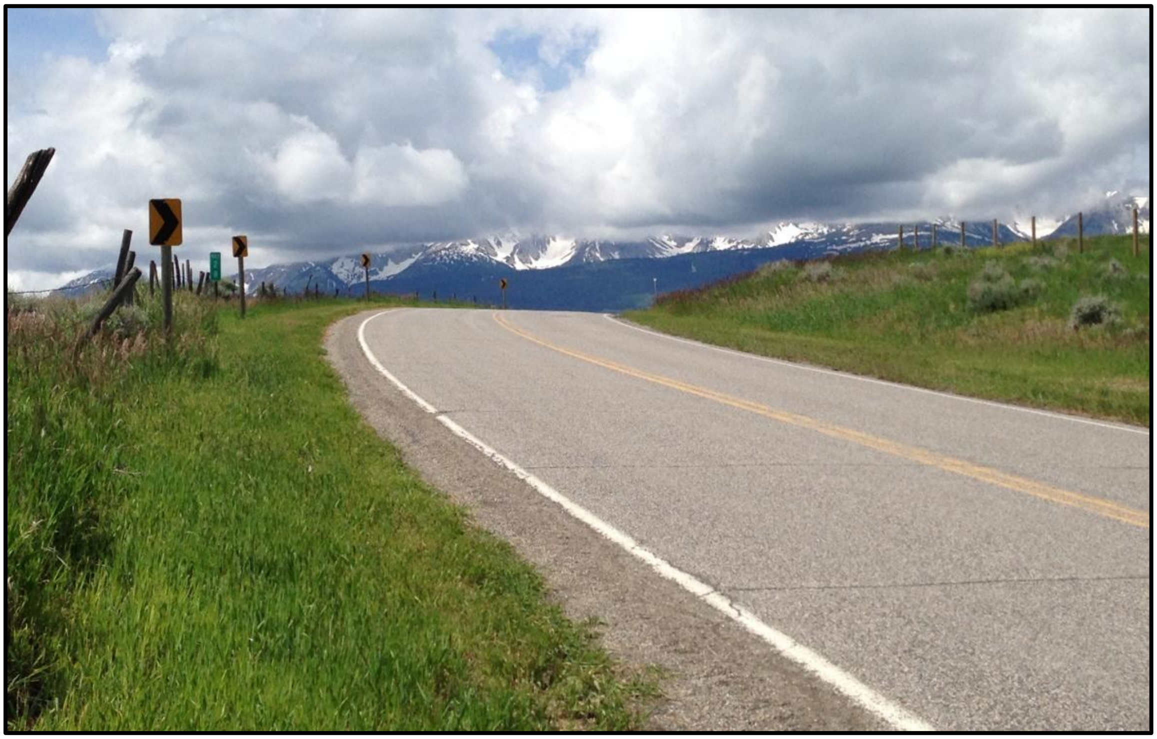


Photo 89. Looking south at insufficient sight distance due to horizontal and vertical curves on MT 86. RP 28.7.

Photo 90. Looking north at insufficient sight distance due to horizontal and vertical curves on MT 86. RP 28.7.

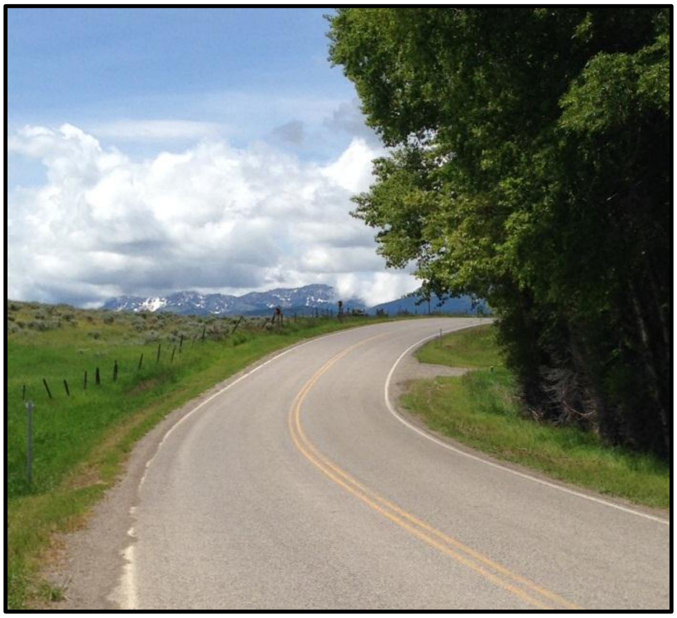


Photo 91. Looking south at insufficient sight distance due to horizontal and vertical curves on MT 86. RP 28.7.

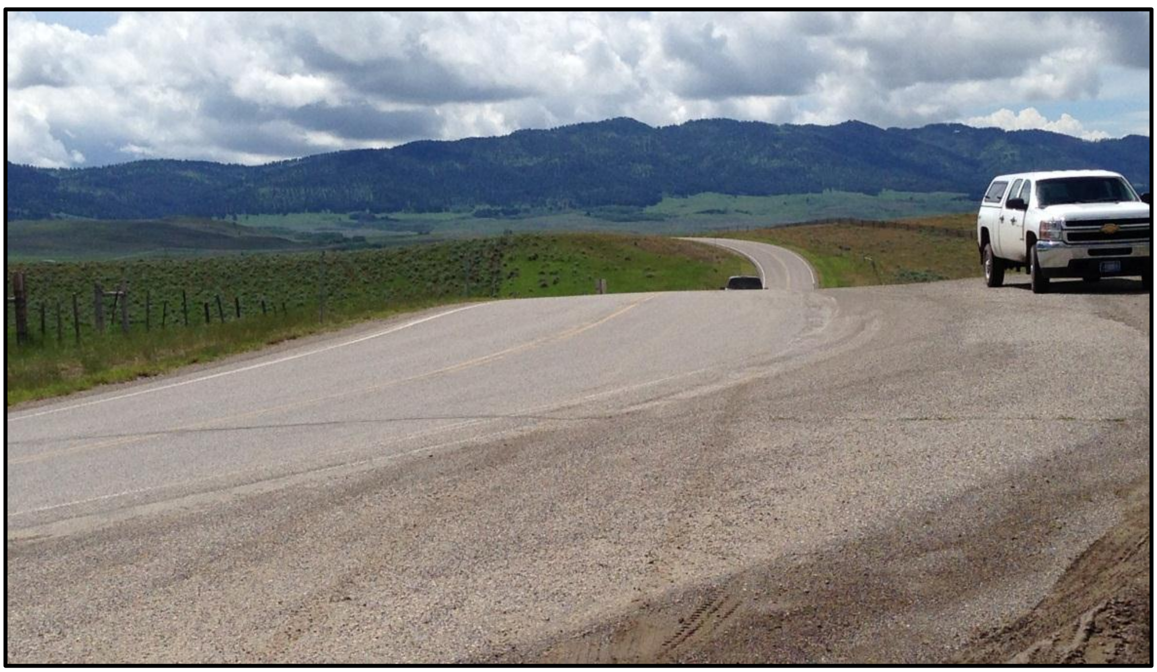


Photo 92. Looking at insufficient sight distance due to horizontal and vertical curves on MT 86. RP 28.9.

Photo 93. Looking north on MT 86, signage advises roadway users of a 90-degree turn. RP 28.8.

Photo 94. Looking at a tight horizontal curve on MT 86. RP 28.9.

Photo 95. Looking east at the eastern/northern terminus of the corridor at the intersection of MT 86 and US 89. RP 37.5.

Attachment 2

Right-of-way Data

Left		
RP		R/W Offset from Centerline (ft)
Begin	End	
1.95	2.68	40
2.68	2.83	30
2.83	3.11	60
3.11	3.8	50
3.8	3.87	80
3.87	4.23	70
4.23	4.6	UNKNOWN
4.6	5.1	100
5.1	5.17	115
5.17	5.39	60
5.39	5.95	50
5.96	6.18	60
6.18	6.46	55
6.49	6.56	90
6.58	6.87	70
6.9	6.98	110
6.98	7.01	55
7.01	7.08	75
7.08	7.16	60
7.19	7.64	80
7.66	7.88	55
7.88	8.15	60
8.15	8.38	70
8.38	8.64	100
8.64	8.96	70
8.96	9.52	80
9.52	10.28	90
10.28	11.24	80
11.24	12.37	90
12.37	13.89	60
13.89	14.03	90
14.03	14.72	80
14.72	16.46	40
16.46	16.73	50
16.73	17.06	40
17.06	17.77	50
17.77	18.3	66
18.3	18.5	100
18.5	30.5	UNKNOWN
30.5	31.32	60
31.32	31.96	50
31.96	32.43	70
32.43	32.51	80
32.51	33.11	70
33.11	33.39	60
33.39	33.78	50
33.78	34.52	60
34.52	34.87	50
34.87	34.99	70
34.99	36.75	60
36.75	37.25	70
37.25	37.46	50
37.46	37.5	150

Right		
RP		R/W Offset from Centerline (ft)
Begin	End	
1.95	1.97	50
1.97	2.07	70
2.07	3.38	50
3.38	4.23	70
4.23	4.6	UNKNOWN
4.6	4.68	80
4.68	4.95	112.5
4.99	5.15	80
5.15	5.17	100
5.17	5.95	50
5.96	6.01	60
6.01	6.05	80
6.05	6.13	120
6.13	6.57	50
6.58	6.66	60
6.66	7.5	50
7.5	7.58	60
7.58	9.16	90
9.16	9.52	80
9.52	10.28	60
10.28	10.48	90
10.48	10.96	100
10.96	11.11	120
11.11	13.23	100
13.23	13.82	90
13.82	14.56	100
14.56	14.76	120
14.79	14.83	200
14.83	14.85	120
14.85	16.73	50
16.73	17.09	60
17.09	17.77	50
17.77	17.93	60
17.93	18.3	66
18.3	18.5	100
18.5	30.5	UNKNOWN
30.5	31.17	60
31.17	31.85	50
31.85	32.58	60
32.58	32.7	70
32.7	33.78	60
33.78	34.87	50
34.87	35.75	60
35.75	36.01	50
36.01	36.75	60
36.75	37.25	80
37.25	37.5	60
37.5	37.5	135

Source: Available record drawings and cadastral information, MDT, 2014.

Attachment 3

Horizontal and Vertical Alignment Data

Curve PI [1] (RP)	Curve Type	Curve Length (ft)	Radius (ft)	Deflection Angle [2]	Design Speed (mph)	Superelevation Rate [3]	Min. Sight Obstruction Distance (Rolling: 495') (Mountinous: 360')	Meets Max. Superelevation (8%)	Meets Min. Sight Distance (Rolling: 495') (Mountinous: 360') [4]	Curve Type Correct [5]	Meets Min. Radius (Rolling: 960') (Mountainous: 590') [6]	Meets Min. Curve Length (Rolling: 825') (Mountainous: 675') [7]	Curve Pass/Fail
2.76	SIMPLE	810	1,146	40° 30' 0"	55	UNKNOWN	26.6	N/A	YES	NO	YES	NO	**PASS**
3.31	SIMPLE	810	1,146	40° 29' 05"	55	UNKNOWN	26.6	N/A	YES	NO	YES	NO	**PASS**
3.96	SIMPLE	435	1,146	21° 45' 00"	55	UNKNOWN	26.6	N/A	YES	NO	YES	NO	**PASS**
4.18	SIMPLE	568	573	10° 00' 00"	55	UNKNOWN	52.6	N/A	**NO**	NO	**NO**	NO	**FAIL**
4.33	SIMPLE	235	295	45° 39' 51.812"	55	UNKNOWN	97.8	N/A	**NO**	NO	**NO**	NO	**FAIL**
4.36	SIMPLE	131	194	38° 53' 28.113"	55	UNKNOWN	137.8	N/A	**NO**	NO	**NO**	NO	**FAIL**
4.45	SIMPLE	345	433	45° 41' 14.732"	55	UNKNOWN	68.8	N/A	**NO**	NO	**NO**	NO	**FAIL**
4.55	SIMPLE	275	873	18° 01' 42.281"	55	UNKNOWN	34.9	N/A	YES	NO	**NO**	NO	**FAIL**
4.63	SIMPLE	272	1,975	7° 53' 52.562"	55	UNKNOWN	15.5	N/A	YES	NO	YES	NO	**PASS**
4.72	SIMPLE	390	449	49° 45' 00"	55	UNKNOWN	66.4	N/A	**NO**	NO	**NO**	NO	**FAIL**
4.81	SIMPLE	442	478	53° 00' 00"	55	UNKNOWN	62.7	N/A	YES	NO	**NO**	NO	**FAIL**
4.94	SIMPLE	544	819	7° 00' 00"	55	UNKNOWN	37.1	N/A	YES	NO	**NO**	NO	**FAIL**
5.13	SIMPLE	374	573	37° 25' 00"	55	UNKNOWN	52.6	N/A	YES	NO	**NO**	NO	**FAIL**
5.34	SIMPLE	522	1,146	26° 07' 00"	55	UNKNOWN	26.6	N/A	YES	NO	YES	NO	**PASS**
5.49	SIMPLE	713	1,146	35° 38' 00"	55	UNKNOWN	26.6	N/A	YES	NO	YES	NO	**PASS**
6.68	SIMPLE	817	819	57° 11' 00"	55	UNKNOWN	37.1	N/A	**NO**	NO	**NO**	NO	**FAIL**
6.99	SIMPLE	353	1,910	10° 36' 00"	55	UNKNOWN	16.0	N/A	YES	NO	YES	NO	**PASS**
7.24	SIMPLE	622	1,520	22° 23' 00"	55	UNKNOWN	20.1	N/A	YES	NO	YES	NO	**PASS**
7.53	SIMPLE	322	1,146	16° 06' 00"	55	UNKNOWN	26.6	N/A	YES	NO	YES	NO	**PASS**
7.91	SIMPLE	713	1,146	35° 38' 00"	55	UNKNOWN	26.6	N/A	YES	NO	YES	NO	**PASS**
8.18	SIMPLE	294	1,910	8° 49' 00"	55	UNKNOWN	16.0	N/A	YES	NO	YES	NO	**PASS**
8.72	SIMPLE	417	5,730	4° 10' 00"	55	UNKNOWN	5.3	N/A	YES	YES	YES	NO	**PASS**
9.11	SIMPLE	547	819	38° 17' 00"	55	UNKNOWN	37.1	N/A	YES	NO	**NO**	NO	**FAIL**
9.51	SIMPLE	799	3,820	11° 59' 00"	55	UNKNOWN	8.0	N/A	YES	NO	YES	NO	**PASS**
10.17	SIMPLE	372	11,460	01° 51' 30"	55	UNKNOWN	2.7	N/A	YES	YES	YES	NO	**PASS**
10.59	SIMPLE	372	11,460	01° 51' 30"	55	UNKNOWN	2.7	N/A	YES	YES	YES	NO	**PASS**
10.84	SIMPLE	731	1,146	36° 32' 45"	55	6.00%	26.6	YES	YES	NO	YES	NO	**PASS**
11.65	SIMPLE	2,258	1,637	79° 01' 45"	55	6.00%	18.7	YES	**NO**	NO	YES	YES	**FAIL**
12.22	SIMPLE	597	2,865	11° 56' 00"	55	6.00%	10.7	YES	YES	NO	YES	NO	**PASS**
12.58	SIMPLE	435	1,146	21° 43' 30"	55	6.00%	26.6	YES	YES	NO	YES	NO	**PASS**
12.70	SIMPLE	392	1,146	19° 34' 45"	55	6.00%	26.6	YES	YES	NO	YES	NO	**PASS**
13.26	SIMPLE	1,566	2,865	31° 19' 00"	55	6.00%	10.7	YES	YES	NO	YES	YES	**PASS**
13.69	SIMPLE	684	1,910	20° 32' 00"	55	6.00%	16.0	YES	YES	NO	YES	NO	**PASS**
13.89	SIMPLE	642	1,146	32° 06' 00"	55	6.00%	26.6	YES	YES	NO	YES	NO	**PASS**
14.11	SIMPLE	472	1,433	18° 51' 45"	55	6.00%	21.3	YES	YES	NO	YES	NO	**PASS**
15.03	SIMPLE	1,163	1,433	46° 32' 00"	55	6.00%	21.3	YES	YES	NO	YES	YES	**PASS**
15.24	SIMPLE	962	1,146	48° 06' 00"	55	6.00%	26.6	YES	**NO**	NO	YES	YES	**FAIL**
15.92	SIMPLE	665	1,146	33° 14' 30"	45	6.00%	14.1	YES	YES	NO	YES	NO	**PASS**
16.18	SIMPLE	992	1,433	39° 41' 15"	45	6.00%	11.3	YES	YES	NO	YES	YES	**PASS**
16.39	SIMPLE	306	955	18° 20' 00"	45	UNKNOWN	16.9	N/A	YES	NO	YES	NO	**PASS**
16.62	SIMPLE	436	819	30° 31' 00"	45	UNKNOWN	19.7	N/A	YES	NO	YES	NO	**PASS**
17.02	SIMPLE	446	819	31° 11' 00"	45	UNKNOWN	19.7	N/A	YES	NO	YES	NO	**PASS**
17.10	SIMPLE	428	716	34° 12' 00"	45	UNKNOWN	22.5	N/A	YES	NO	YES	NO	**PASS**
17.26	SIMPLE	408	819	28° 33' 00"	45	UNKNOWN	19.7	N/A	YES	NO	YES	NO	**PASS**

Curve PI (1) (RP)	Curve Type	Curve Length (ft)	Radius (ft)	Deflection Angle (2)	Design Speed (mph)	Superelevation Rate (3)	Min. Sight Obstruction Distance (Rolling: 495') (Mountinous: 360')	Meets Max. Superelevation (8%)	Meets Min. Sight Distance (Rolling: 495') (Mountinous: 360') (4)	Curve Type Correct (5)	Meets Min. Radius (Rolling: 960') (Mountainous: 590') (6)	Meets Min. Curve Length (Rolling: 825') (Mountainous: 675') (7)	Curve Pass/Fail
17.56	SIMPLE	1,026	1,500	41° 03' 00"	45	UNKNOWN	10.8	N/A	YES	NO	YES	YES	**PASS**
17.95	SIMPLE	412	1,433	16° 28' 00"	45	UNKNOWN	11.3	N/A	YES	NO	YES	NO	**PASS**
18.19	SIMPLE	507	955	30° 25' 00"	45	UNKNOWN	16.9	N/A	YES	NO	YES	NO	**PASS**
18.26	SIMPLE	355	750	31° 56' 00"	45	UNKNOWN	21.5	N/A	**NO**	NO	YES	NO	**FAIL**
18.40	SIMPLE	427	1,146	31° 56' 00"	45	UNKNOWN	14.1	N/A	YES	NO	YES	NO	**PASS**
18.48	SIMPLE	432	716	34° 34' 30"	45	UNKNOWN	22.5	N/A	YES	NO	YES	NO	**PASS**
18.58	SIMPLE	498	2,865	9° 57' 00"	45	UNKNOWN	5.7	N/A	YES	NO	YES	NO	**PASS**
18.74	SIMPLE	165	241	39° 11' 6.827"	45	UNKNOWN	64.1	N/A	**NO**	NO	**NO**	NO	**FAIL**
18.77	SIMPLE	217	543	22° 52' 44.183"	45	UNKNOWN	29.6	N/A	**NO**	NO	**NO**	NO	**FAIL**
19.00	SIMPLE	519	1,061	28° 1' 41.078"	45	UNKNOWN	15.2	N/A	YES	NO	YES	NO	**PASS**
19.11	SIMPLE	260	1,672	8° 54' 39.333"	45	UNKNOWN	9.7	N/A	YES	NO	YES	NO	**PASS**
19.28	SIMPLE	404	450	38° 58' 10.56"	45	UNKNOWN	35.5	N/A	YES	NO	**NO**	NO	**FAIL**
19.42	SIMPLE	460	400	43° 38' 26.46"	45	UNKNOWN	39.8	N/A	YES	NO	**NO**	NO	**FAIL**
19.65	SIMPLE	459	1,273	20° 39' 58.856"	45	UNKNOWN	12.7	N/A	YES	NO	YES	NO	**PASS**
19.79	SIMPLE	261	735	20° 17' 59.31"	45	UNKNOWN	21.9	N/A	YES	NO	YES	NO	**PASS**
19.92	SIMPLE	496	675	42° 6' 52.611"	45	UNKNOWN	23.9	N/A	YES	NO	YES	NO	**PASS**
20.03	SIMPLE	353	904	22° 22' 58.028"	45	UNKNOWN	17.9	N/A	YES	NO	YES	NO	**PASS**
20.73	SIMPLE	253	660	21° 56' 17.937"	45	UNKNOWN	24.4	N/A	YES	NO	YES	NO	**PASS**
20.83	SIMPLE	394	423	53° 21' 19.715"	45	UNKNOWN	37.7	N/A	YES	NO	**NO**	NO	**FAIL**
21.02	SIMPLE	354	832	24° 20' 34.083"	45	UNKNOWN	19.4	N/A	YES	NO	YES	NO	**PASS**
21.15	SIMPLE	269	190	81° 10' 2.31"	45	UNKNOWN	79.2	N/A	**NO**	NO	**NO**	NO	**FAIL**
21.24	SIMPLE	464	430	61° 54' 29.196"	45	UNKNOWN	37.1	N/A	**NO**	NO	**NO**	NO	**FAIL**
21.40	SIMPLE	681	600	56° 31' 52.939"	45	UNKNOWN	26.8	N/A	**NO**	NO	YES	YES	**FAIL**
21.51	SIMPLE	457	521	50° 19' 5.47"	45	UNKNOWN	30.8	N/A	YES	NO	**NO**	NO	**FAIL**
21.65	SIMPLE	277	1,144	13° 53' 34.118"	45	UNKNOWN	14.1	N/A	YES	NO	YES	NO	**PASS**
21.73	SIMPLE	297	2,197	7° 44' 25.154"	45	UNKNOWN	7.4	N/A	YES	NO	YES	NO	**PASS**
21.81	SIMPLE	295	1,163	14° 31' 23.136"	45	UNKNOWN	13.9	N/A	YES	NO	YES	NO	**PASS**
21.88	SIMPLE	410	1,144	20° 31' 14.292"	45	UNKNOWN	14.1	N/A	YES	NO	YES	NO	**PASS**
22.06	SIMPLE	396	681	33° 16' 31.571"	45	UNKNOWN	23.6	N/A	YES	NO	YES	NO	**PASS**
22.48	SIMPLE	440	1,484	16° 59' 48.916"	45	UNKNOWN	10.9	N/A	YES	NO	YES	NO	**PASS**
22.55	SIMPLE	264	435	34° 43' 20.244"	45	UNKNOWN	36.7	N/A	YES	NO	**NO**	NO	**FAIL**
22.73	SIMPLE	618	900	41° 27' 6.876"	45	UNKNOWN	17.9	N/A	**NO**	NO	YES	NO	**FAIL**
22.86	SIMPLE	562	645	49° 53' 23.169"	45	UNKNOWN	24.9	N/A	**NO**	NO	YES	NO	**FAIL**
23.08	SIMPLE	298	350	58° 7' 28.417"	45	UNKNOWN	45.3	N/A	YES	NO	**NO**	NO	**FAIL**
23.22	SIMPLE	251	2,115	6° 47' 29.874"	45	UNKNOWN	7.7	N/A	YES	NO	YES	NO	**PASS**
23.28	SIMPLE	241	606	22° 50' 54.561"	45	UNKNOWN	26.6	N/A	YES	NO	YES	NO	**PASS**
23.43	SIMPLE	263	870	17° 19' 8.303"	45	UNKNOWN	18.6	N/A	YES	NO	YES	NO	**PASS**
23.94	SIMPLE	277	870	17° 19' 8.303"	45	UNKNOWN	18.6	N/A	YES	NO	YES	NO	**PASS**
24.01	SIMPLE	282	877	18° 6' 1.843"	45	UNKNOWN	18.4	N/A	YES	NO	YES	NO	**PASS**
24.10	SIMPLE	293	657	24° 38' 29.506"	45	UNKNOWN	24.5	N/A	YES	NO	YES	NO	**PASS**
24.20	SIMPLE	382	689	24° 21' 26.342"	45	UNKNOWN	23.4	N/A	YES	NO	YES	NO	**PASS**
25.23	SIMPLE	274	2,150	10° 10' 52.764"	45	UNKNOWN	7.5	N/A	YES	NO	YES	NO	**PASS**
25.33	SIMPLE	266	405	38° 40' 40.155"	45	UNKNOWN	39.3	N/A	YES	NO	**NO**	NO	**FAIL**
25.56	SIMPLE	410	457	33° 24' 15.534"	45	UNKNOWN	35.0	N/A	YES	NO	**NO**	NO	**FAIL**

Curve PI [1] (RP)	Curve Type	Curve Length (ft)	Radius (ft)	Deflection Angle [2]	Design Speed (mph)	Superelevation Rate [3]	Min. Sight Obstruction Distance (Rolling: 495') (Mountinous: 360')	Meets Max. Superelevation (8%)	Meets Min. Sight Distance (Rolling: 495') (Mountinous: 360') [4]	Curve Type Correct [5]	Meets Min. Radius (Rolling: 960') (Mountainous: 590') [6]	Meets Min. Curve Length (Rolling: 825') (Mountainous: 675') [7]	Curve Pass/Fail
25.95	SIMPLE	593	827	28° 22' 2.218"	45	UNKNOWN	19.5	N/A	YES	NO	YES	NO	**PASS**
26.35	SIMPLE	822	2,119	16° 2' 31.969"	45	UNKNOWN	7.6	N/A	YES	NO	YES	YES	**PASS**
26.49	SIMPLE	260	2,289	20° 34' 17.355"	45	UNKNOWN	7.1	N/A	YES	NO	YES	NO	**PASS**
26.66	SIMPLE	197	709	15° 56' 56.185"	45	UNKNOWN	22.7	N/A	YES	NO	YES	NO	**PASS**
26.79	SIMPLE	172	686	14° 21' 50"	45	UNKNOWN	23.5	N/A	YES	NO	YES	NO	**PASS**
27.10	SIMPLE	289	715	23° 8' 54.604"	45	UNKNOWN	22.5	N/A	YES	NO	YES	NO	**PASS**
27.23	SIMPLE	331	993	19° 4' 16.985"	45	UNKNOWN	16.3	N/A	YES	NO	YES	NO	**PASS**
27.32	SIMPLE	245	386	36° 17' 0.519"	45	UNKNOWN	41.2	N/A	YES	NO	**NO**	NO	**FAIL**
27.67	SIMPLE	291	847	19° 42' 36.899"	45	UNKNOWN	19.1	N/A	YES	NO	YES	NO	**PASS**
27.82	SIMPLE	663	800	46° 31' 29.151"	45	UNKNOWN	20.2	N/A	**NO**	NO	YES	NO	**FAIL**
28.01	SIMPLE	178	352	28° 53' 12.371"	45	UNKNOWN	45.0	N/A	YES	NO	**NO**	NO	**FAIL**
28.10	SIMPLE	172	440	22° 24' 11.462"	45	UNKNOWN	36.3	N/A	YES	NO	**NO**	NO	**FAIL**
28.36	SIMPLE	125	373	19° 10' 2.975"	45	UNKNOWN	42.6	N/A	YES	NO	**NO**	NO	**FAIL**
28.54	SIMPLE	171	689	14° 14' 38.427"	45	UNKNOWN	23.4	N/A	**NO**	NO	YES	NO	**FAIL**
28.59	SIMPLE	127	261	27° 58' 36.205"	45	UNKNOWN	59.7	N/A	**NO**	NO	**NO**	NO	**FAIL**
28.78	SIMPLE	189	117	92° 40' 57.254"	45	UNKNOWN	113.4	N/A	**NO**	NO	**NO**	NO	**FAIL**
29.73	SIMPLE	307	1,259	13° 57' 12.506"	55	UNKNOWN	24.2	N/A	YES	NO	YES	NO	**PASS**
29.82	SIMPLE	234	2,457	5° 27' 13.024"	55	UNKNOWN	12.5	N/A	YES	NO	YES	NO	**PASS**
30.64	SIMPLE	263	2,865	05° 15' 00"	55	UNKNOWN	10.7	N/A	YES	NO	YES	NO	**PASS**
30.69	SIMPLE	263	2,865	05° 15' 00"	55	UNKNOWN	10.7	N/A	YES	NO	YES	NO	**PASS**
31.05	SIMPLE	1,391	4,298	18° 32' 30"	55	UNKNOWN	7.1	N/A	YES	YES	YES	YES	**PASS**
31.86	SIMPLE	501	2,865	10° 01' 00"	55	UNKNOWN	10.7	N/A	YES	NO	YES	NO	**PASS**
32.29	SIMPLE	198	2,865	03° 57' 00"	55	UNKNOWN	10.7	N/A	YES	NO	YES	NO	**PASS**
32.59	SIMPLE	491	2,865	09° 49' 00"	55	UNKNOWN	10.7	N/A	YES	NO	YES	NO	**PASS**
33.15	SIMPLE	575	1,910	17° 15' 00"	55	UNKNOWN	16.0	N/A	YES	NO	YES	NO	**PASS**
33.82	SIMPLE	490	1,910	14° 41' 30"	55	UNKNOWN	16.0	N/A	YES	NO	YES	NO	**PASS**
34.90	SIMPLE	739	1,433	29° 34' 30"	55	UNKNOWN	21.3	N/A	YES	NO	YES	NO	**PASS**
35.13	SIMPLE	303	2,865	06° 04' 00"	55	UNKNOWN	10.7	N/A	YES	NO	YES	NO	**PASS**
35.44	SIMPLE	747	1,146	37° 20' 30"	55	UNKNOWN	26.6	N/A	YES	NO	YES	NO	**PASS**
35.80	SIMPLE	723	716	57° 49' 30"	55	UNKNOWN	42.3	N/A	YES	NO	**NO**	NO	**FAIL**
36.02	SIMPLE	464	1,146	23° 11' 30"	55	UNKNOWN	26.6	N/A	YES	NO	YES	NO	**PASS**
36.28	SIMPLE	395	2,865	07° 53' 30"	55	UNKNOWN	10.7	N/A	YES	NO	YES	NO	**PASS**

Source: MDT, 2014; DOWL HKM, 2014; MDT Record Drawings; MDT Road Design Manual, 2004. All values are approximated based on available data.

(1) PI indicates the point of tangent intersection, which is defined as the intersection of the initial and final tangents.

(2) Deflection angle indicates the average degree of curvature and is a measure of the sharpness of the curve. A larger deflection angle indicates a sharper curve.

(3) Superelevation rate was considered in the Pass/Fail determination where necessary data was available.

(4) Shaded "No" cells result in "Fail" determination.

(5) Per MDT Road Design Manual page 9.2(1), it is MDT practice to use a spiral curve when the radius is less than 3,820 ft. Because curve type is not listed as a design requirement, curve type is not considered in the pass/fail determination.

(6) Shaded "No" cells result in "Fail" determination.

(7) Per MDT Road Design Manual page 9.2(7), it is MDT practice to specify a minimum curve length of 825 ft. for a design speed of 55 mph and a minimum curve length of 675 ft. for a design speed of 45 mph. Because curve length is not listed as a design re

Note: As-built information unavailable from RP 4.3 to RP 4.7 and from RP 18.75 to RP 30.96; curve data estimated on a best-fit basis using aerial photography.
Geometrics were analyzed as rolling terrain from RP 1.95 to RP 15.63 and from RP 29.16 to RP 37.5. Geometrics were analyzed as mountainous terrain from RP 15.64 to RP 29.15.

Curve PVI [1] (RP)	Point Type	Curve Type [2]	Curve Length (ft)	K Value[3]	Grade Back	Grade Ahead	Design Speed (mph)	Meet Min. K Value (Rolling: 114/115) (Mountainous: 61/79) [4]	Meet Max. Grade (Rolling: 4%) (Mountainous: 7%) [5]	Meet Min. Curve Length (Rolling: 165'/1000') (Mountainous: 135'/1000') [6]	Curve/Tangent Pass/Fail
2.27	VPI	SAG	300	500	0.980%	1.580%	55	YES	YES	YES	**PASS**
2.40	VPI	CREST	300	652	1.580%	1.120%	55	YES	YES	YES	**PASS**
2.97	VPI	CREST	200	385	1.120%	0.600%	55	YES	YES	YES	**PASS**
3.17	VPI	SAG	300	123	0.600%	3.040%	55	YES	YES	YES	**PASS**
3.27	VPI	SAG	394	193	1.010%	3.050%	55	YES	YES	YES	**PASS**
4.13	VPI	CREST	800	110	1.450%	-5.830%	55	**NO**	**NO**	YES	**FAIL**
4.62	VPI	SAG	300	115	4.397%	7.000%	55	YES	**NO**	YES	**FAIL**
4.88	VPI	SAG	400	93	-1.060%	3.260%	55	**NO**	YES	YES	**FAIL**
4.98	VPI	CREST	600	95	3.260%	-3.080%	55	**NO**	YES	YES	**FAIL**
5.12	VPI	SAG	900	113	-3.080%	4.860%	55	**NO**	**NO**	YES	**FAIL**
5.36	VPI	CREST	700	88	4.860%	-3.090%	55	**NO**	**NO**	YES	**FAIL**
5.58	VPI	SAG	1,000	158	-3.090%	3.250%	55	YES	YES	YES	**PASS**
5.75	VPI	CREST	700	323	3.250%	1.080%	55	YES	YES	YES	**PASS**
6.33	VPI	SAG	1,800	706	-1.080%	1.470%	55	YES	YES	YES	**PASS**
6.62	VPI	SAG	400	429	1.470%	2.403%	55	YES	YES	YES	**PASS**
6.72	VPI	CREST	400	124	2.403%	-0.813%	55	YES	YES	YES	**PASS**
6.82	VPI	SAG	400	199	-0.813%	1.200%	55	YES	YES	YES	**PASS**
7.13	VPI	SAG	400	339	1.200%	2.380%	55	YES	YES	YES	**PASS**
7.29	VPI	CREST	400	362	2.380%	1.275%	55	YES	YES	YES	**PASS**
7.57	VPI	CREST	200	396	1.275%	0.770%	55	YES	YES	YES	**PASS**
7.73	VPI	SAG	400	116	0.770%	4.230%	55	YES	**NO**	YES	**FAIL**
7.99	VPI	CREST	600	173	4.230%	0.760%	55	YES	**NO**	YES	**FAIL**
8.12	VPI	CREST	600	262	0.760%	-1.534%	55	YES	YES	YES	**PASS**
8.25	VPI	SAG	700	179	-1.534%	2.370%	55	YES	YES	YES	**PASS**
8.38	VPI	CREST	600	213	2.370%	-0.450%	55	YES	YES	YES	**PASS**
8.54	VPI	SAG	1,000	230	-0.450%	3.890%	55	YES	YES	YES	**PASS**
8.71	VPI	CREST	400	129	3.890%	0.790%	55	YES	YES	YES	**PASS**
8.80	VPI	SAG	500	93	0.790%	6.180%	55	**NO**	**NO**	YES	**FAIL**
9.00	VPI	CREST	800	162	6.180%	1.234%	55	YES	**NO**	YES	**FAIL**
9.12	VPI	CREST	540	272	1.234%	-0.750%	55	YES	YES	YES	**PASS**
9.37	VPI	SAG	200	172	-0.750%	0.412%	55	YES	YES	YES	**PASS**
9.43	VPI	CREST	400	198	0.412%	-1.610%	55	YES	YES	YES	**PASS**
9.60	VPI	SAG	400	148	-1.617%	1.077%	55	YES	YES	YES	**PASS**
10.25	VPI	SAG	400	434	1.077%	2.000%	55	YES	YES	YES	**PASS**
10.60	VPI	CREST	600	600	2.000%	1.000%	55	YES	YES	YES	**PASS**
10.77	VPI	SAG	600	270	1.000%	3.222%	55	YES	YES	YES	**PASS**
11.21	VPI	CREST	1,800	679	3.222%	0.571%	55	YES	YES	YES	**PASS**
11.42	VPI	SAG	400	207	0.571%	2.500%	55	YES	YES	YES	**PASS**
11.61	VPI	CREST	1,400	969	2.500%	1.055%	55	YES	YES	YES	**PASS**
11.82	VPI	SAG	800	218	1.055%	4.717%	55	YES	**NO**	YES	**FAIL**
12.04	VPI	CREST	800	128	4.717%	-1.542%	55	YES	**NO**	YES	**FAIL**
12.29	VPI	SAG	800	329	-1.542%	0.889%	55	YES	YES	YES	**PASS**
12.46	VPI	SAG	600	206	0.889%	3.800%	55	YES	YES	YES	**PASS**
12.69	VPI	CREST	1,800	545	3.800%	0.495%	55	YES	YES	YES	**PASS**
13.05	VPI	SAG	800	311	0.495%	3.071%	55	YES	YES	YES	**PASS**
13.31	VPI	CREST	600	707	3.071%	2.222%	55	YES	YES	YES	**PASS**
13.48	VPI	SAG	400	327	2.222%	3.444%	55	YES	YES	YES	**PASS**
13.65	VPI	CREST	800	128	3.444%	-2.788%	55	YES	YES	YES	**PASS**
13.81	VPI	SAG	800	136	-2.788%	3.103%	55	YES	YES	YES	**PASS**

Curve PVI [1] (RP)	Point Type	Curve Type [2]	Curve Length (ft)	K Value[3]	Grade Back	Grade Ahead	Design Speed (mph)	Meet Min. K Value (Rolling: 114/115) (Mountainous: 61/79) [4]	Meet Max. Grade (Rolling: 4%) (Mountainous: 7%) [5]	Meet Min. Curve Length (Rolling: 165'/1000') (Mountainous: 135'/1000') [6]	Curve/Tangent Pass/Fail
14.41	VPI	CREST	1,600	846	3.103%	1.211%	55	YES	YES	YES	**PASS**
14.62	VPI	SAG	600	119	1.211%	6.243%	55	YES	**NO**	YES	**FAIL**
15.25	VPI	CREST	1,600	190	6.243%	-2.166%	55	YES	**NO**	YES	**FAIL**
15.57	VPI	SAG	800	235	-2.166%	1.240%	55	YES	YES	YES	**PASS**
15.98	VPI	SAG	800	207	1.240%	5.110%	45	YES	YES	YES	**PASS**
16.35	VPI	CREST	200	100	4.994%	3.000%	45	YES	YES	YES	**PASS**
16.41	VPI	CREST	300	112	3.000%	0.310%	45	YES	YES	YES	**PASS**
16.53	VPI	SAG	200	38	0.310%	5.540%	45	**NO**	YES	YES	**FAIL**
16.59	VPI	CREST	200	75	5.540%	2.860%	45	YES	YES	YES	**PASS**
16.71	VPI	SAG	200	39	2.860%	8.000%	45	**NO**	**NO**	YES	**FAIL**
16.76	VPI	CREST	300	51	8.000%	2.128%	45	**NO**	**NO**	YES	**FAIL**
17.06	VPI	CREST	400	66	2.128%	-3.960%	45	YES	YES	YES	**PASS**
17.29	VPI	CREST	300	197	-3.960%	-5.486%	45	YES	YES	YES	**PASS**
17.42	VPI	N/A	N/A	N/A	-5.486%	-5.560%	45	N/A	YES	N/A	**PASS**
17.51	VPI	SAG	200	93	-5.560%	-3.400%	45	YES	YES	YES	**PASS**
17.59	VPI	CREST	400	267	-3.400%	-4.900%	45	YES	YES	YES	**PASS**
17.68	VPI	CREST	200	149	-4.900%	-6.240%	45	YES	YES	YES	**PASS**
17.74	VPI	SAG	200	70	-6.240%	-3.400%	45	**NO**	YES	YES	**FAIL**
17.89	VPI	SAG	200	83	-3.400%	-1.000%	45	YES	YES	YES	**PASS**
17.96	VPI	CREST	300	545	-1.000%	-0.450%	45	YES	YES	YES	**PASS**
18.07	VPI	SAG	300	698	-0.450%	-0.880%	45	YES	YES	YES	**PASS**
18.14	VPI	CREST	200	133	-0.880%	-2.380%	45	YES	YES	YES	**PASS**
18.27	VPI	CREST	600	169	-2.380%	-5.940%	45	YES	YES	YES	**PASS**
18.38	VPI	SAG	400	84	-5.940%	-1.150%	45	YES	YES	YES	**PASS**
18.46	VPI	CREST	300	43	-1.150%	-8.160%	45	**NO**	**NO**	YES	**FAIL**
18.54	VPI	SAG	300	39	-8.160%	-0.480%	45	**NO**	**NO**	YES	**FAIL**
18.66	VPI	CREST	400	93	-0.480%	-4.760%	45	YES	YES	YES	**PASS**
18.74	VPI	SAG	300	60	-4.760%	0.280%	45	**NO**	YES	YES	**FAIL**
18.82	VPI	CREST	50	10	9.915%	5.095%	55	**NO**	**NO**	NO	**FAIL**
18.97	VPI	CREST	500	64	5.0954%	-2.7583%	55	**NO**	**NO**	YES	**FAIL**
19.05	VPI	SAG	200	35	-2.7583%	2.8788%	55	**NO**	YES	YES	**FAIL**
19.12	VPI	SAG	300	127	2.8788%	5.2430%	55	YES	**NO**	YES	**FAIL**
19.19	VPI	CREST	400	338	5.2430%	4.0588%	55	YES	**NO**	YES	**FAIL**
19.33	VPI	SAG	400	124	4.0588%	7.2792%	55	YES	**NO**	YES	**FAIL**
19.78	VPI	CREST	700	414	7.2792%	5.5874%	55	YES	**NO**	YES	**FAIL**
19.88	VPI	SAG	300	105	5.5874%	8.4435%	55	**NO**	**NO**	YES	**FAIL**
20.06	VPI	CREST	500	250	8.4435%	6.4462%	55	YES	**NO**	YES	**FAIL**
20.23	VPI	SAG	700	780	6.4462%	7.3441%	55	YES	**NO**	YES	**FAIL**
20.39	VPI	CREST	500	183	7.3441%	4.6187%	55	YES	**NO**	YES	**FAIL**
20.44	VPI	SAG	50	41	4.6187%	5.8385%	55	**NO**	**NO**	NO	**FAIL**
20.63	VPI	CREST	300	19	5.8385%	-9.5894%	55	**NO**	**NO**	YES	**FAIL**
20.83	VPI	SAG	250	77	-9.5894%	-6.3348%	55	**NO**	**NO**	YES	**FAIL**
20.88	VPI	CREST	250	68	-6.3348%	-9.9930%	55	**NO**	**NO**	YES	**FAIL**
20.99	VPI	SAG	300	47	-9.9930%	-3.6572%	55	**NO**	**NO**	YES	**FAIL**
21.07	VPI	CREST	400	161	-3.6572%	-6.1346%	55	YES	**NO**	YES	**FAIL**
21.16	VPI	CREST	200	36	-6.1346%	-11.7620%	55	**NO**	**NO**	YES	**FAIL**
21.23	VPI	SAG	350	95	-11.7620%	-8.0590%	55	**NO**	**NO**	YES	**FAIL**
21.32	VPI	SAG	400	102	-8.0590%	-4.1410%	55	**NO**	**NO**	YES	**FAIL**
21.42	VPI	CREST	400	206	-4.1410%	-6.0845%	55	YES	**NO**	YES	**FAIL**

Curve PVI [1] (RP)	Point Type	Curve Type [2]	Curve Length (ft)	K Value[3]	Grade Back	Grade Ahead	Design Speed (mph)	Meet Min. K Value (Rolling: 114/115) (Mountainous: 61/79) [4]	Meet Max. Grade (Rolling: 4%) (Mountainous: 7%) [5]	Meet Min. Curve Length (Rolling: 165'/1000') (Mountainous: 135'/1000') [6]	Curve/Tangent Pass/Fail
21.64	VPI	SAG	300	35	-6.0845%	2.6103%	55	**NO**	**NO**	YES	**FAIL**
21.70	VPI	CREST	350	102	2.6103%	-0.8051%	55	**NO**	YES	YES	**FAIL**
21.76	VPI	SAG	200	101	-0.8051%	1.1798%	55	**NO**	YES	YES	**FAIL**
21.89	VPI	CREST	150	49	1.1798%	-1.8882%	55	**NO**	YES	NO	**FAIL**
21.97	VPI	CREST	200	44	-1.8882%	-6.4152%	55	**NO**	**NO**	YES	**FAIL**
22.03	VPI	SAG	300	281	-6.4152%	-5.3482%	55	YES	**NO**	YES	**FAIL**
22.25	VPI	SAG	250	44	-5.3482%	0.3890%	55	**NO**	**NO**	YES	**FAIL**
22.32	VPI	CREST	200	49	0.3890%	-3.6866%	55	**NO**	YES	YES	**FAIL**
22.41	VPI	SAG	50	35	-3.6866%	-2.2530%	55	**NO**	YES	NO	**FAIL**
22.57	VPI	CREST	50	14	-2.2530%	-5.8968%	55	**NO**	**NO**	NO	**FAIL**
22.64	VPI	SAG	400	112	-5.8968%	-2.3221%	55	**NO**	**NO**	YES	**FAIL**
22.71	VPI	SAG	100	67	-2.3221%	-0.8378%	55	**NO**	YES	NO	**FAIL**
22.76	VPI	SAG	200	73	-0.8378%	1.9001%	55	**NO**	YES	YES	**FAIL**
22.81	VPI	CREST	250	89	1.9001%	-0.9026%	55	**NO**	YES	YES	**FAIL**
22.88	VPI	SAG	450	157	-0.9026%	1.9690%	55	YES	YES	YES	**PASS**
22.98	VPI	CREST	200	47	1.9690%	-2.3017%	55	**NO**	YES	YES	**FAIL**
23.11	VPI	SAG	50	17	-2.3017%	0.7155%	55	**NO**	YES	NO	**FAIL**
23.22	VPI	CREST	300	35	0.7155%	-7.8905%	55	**NO**	**NO**	YES	**FAIL**
23.30	VPI	SAG	200	89	-7.8905%	-5.6467%	55	**NO**	**NO**	YES	**FAIL**
23.35	VPI	SAG	200	26	-5.6467%	2.1430%	55	**NO**	**NO**	YES	**FAIL**
23.48	VPI	CREST	250	45	2.1430%	-3.4465%	55	**NO**	YES	YES	**FAIL**
23.52	VPI	SAG	200	55	-3.4465%	0.2219%	55	**NO**	YES	YES	**FAIL**
23.56	VPI	CREST	100	15	0.2219%	-6.2459%	55	**NO**	**NO**	NO	**FAIL**
23.70	VPI	SAG	150	24	-6.2459%	0.0733%	55	**NO**	**NO**	NO	**FAIL**
23.84	VPI	CREST	100	17	0.0733%	-5.8738%	55	**NO**	**NO**	NO	**FAIL**
23.92	VPI	SAG	500	92	-5.8738%	-0.4186%	55	**NO**	**NO**	YES	**FAIL**
24.01	VPI	CREST	300	59	-0.4186%	-5.4627%	55	**NO**	**NO**	YES	**FAIL**
24.10	VPI	SAG	400	73	-5.4627%	0.0014%	55	**NO**	**NO**	YES	**FAIL**
24.16	VPI	CREST	150	103	0.0014%	-1.4496%	55	**NO**	YES	NO	**FAIL**
24.26	VPI	SAG	350	49	-1.4496%	5.6261%	55	**NO**	**NO**	YES	**FAIL**
24.32	VPI	CREST	150	24	5.6261%	-0.6347%	55	**NO**	**NO**	NO	**FAIL**
24.39	VPI	CREST	250	244	-0.6347%	-1.6594%	55	YES	YES	YES	**PASS**
24.56	VPI	SAG	400	144	-1.6594%	1.1138%	55	YES	YES	YES	**PASS**
24.66	VPI	CREST	500	209	1.1138%	-1.2787%	55	YES	YES	YES	**PASS**
24.75	VPI	SAG	400	166	-1.2787%	1.1366%	55	YES	YES	YES	**PASS**
24.81	VPI	CREST	150	14	1.1366%	-9.4432%	55	**NO**	**NO**	NO	**FAIL**
24.84	VPI	SAG	200	23	-9.4432%	-0.5974%	55	**NO**	**NO**	YES	**FAIL**
24.97	VPI	SAG	300	36	-0.5974%	7.8249%	55	**NO**	**NO**	YES	**FAIL**
25.02	VPI	CREST	200	45	7.8249%	3.3519%	55	**NO**	**NO**	YES	**FAIL**
25.13	VPI	CREST	700	159	3.3519%	-1.0372%	55	YES	YES	YES	**PASS**
25.27	VPI	CREST	150	110	-1.0372%	-2.4025%	55	**NO**	YES	NO	**FAIL**
25.31	VPI	SAG	200	214	-2.4025%	-1.4671%	55	YES	YES	YES	**PASS**
25.40	VPI	CREST	300	179	-1.4671%	-3.1389%	55	YES	YES	YES	**PASS**
25.51	VPI	SAG	200	110	-3.1389%	-1.3222%	55	**NO**	YES	YES	**FAIL**
25.97	VPI	CREST	300	54	-1.3222%	-6.9199%	55	**NO**	**NO**	YES	**FAIL**
26.12	VPI	SAG	650	112	-6.9199%	-1.0910%	55	**NO**	**NO**	YES	**FAIL**
26.22	VPI	CREST	100	23	-1.0910%	-5.3663%	55	**NO**	**NO**	NO	**FAIL**
26.39	VPI	SAG	500	130	-5.3663%	-1.5093%	55	YES	**NO**	YES	**FAIL**
26.52	VPI	CREST	700	1,291	-1.5093%	-2.0515%	55	YES	YES	YES	**PASS**

Curve PVI [1] (RP)	Point Type	Curve Type [2]	Curve Length (ft)	K Value[3]	Grade Back	Grade Ahead	Design Speed (mph)	Meet Min. K Value (Rolling: 114/115) (Mountainous: 61/79) [4]	Meet Max. Grade (Rolling: 4%) (Mountainous: 7%) [5]	Meet Min. Curve Length (Rolling: 165'/1000') (Mountainous: 135'/1000') [6]	Curve/Tangent Pass/Fail
26.71	VPI	SAG	600	493	-2.0515%	-0.8349%	55	YES	YES	YES	**PASS**
26.83	VPI	CREST	650	545	-0.8349%	-2.0268%	55	YES	YES	YES	**PASS**
26.90	VPI	SAG	50	81	-2.0268%	-1.4101%	55	**NO**	YES	NO	**FAIL**
26.95	VPI	SAG	200	145	-1.4101%	-0.0330%	55	YES	YES	YES	**PASS**
26.99	VPI	CREST	100	40	-0.0033%	-2.5138%	55	**NO**	YES	NO	**FAIL**
27.10	VPI	SAG	200	64	-2.5138%	0.6342%	55	**NO**	YES	YES	**FAIL**
27.17	VPI	CREST	400	435	0.6342%	-0.2854%	55	YES	YES	YES	**PASS**
27.27	VPI	CREST	200	137	-0.2854%	-1.7410%	55	YES	YES	YES	**PASS**
27.31	VPI	CREST	150	105	-1.7410%	-3.1708%	55	**NO**	YES	NO	**FAIL**
27.34	VPI	SAG	100	71	-3.1708%	-1.7665%	55	**NO**	YES	NO	**FAIL**
27.37	VPI	CREST	250	310	-1.7665%	-2.5730%	55	YES	YES	YES	**PASS**
27.42	VPI	SAG	200	145	-2.5730%	-1.1964%	55	YES	YES	YES	**PASS**
27.48	VPI	SAG	100	172	-1.1964%	-0.6152%	55	YES	YES	NO	**PASS**
27.51	VPI	SAG	100	36	-0.6152%	2.1669%	55	**NO**	YES	NO	**FAIL**
27.55	VPI	CREST	150	22	2.1669%	-4.6055%	55	**NO**	**NO**	NO	**FAIL**
27.58	VPI	SAG	250	46	-4.6055%	0.8796%	55	**NO**	**NO**	YES	**FAIL**
27.63	VPI	CREST	200	89	0.8796%	-1.3797%	55	**NO**	YES	YES	**FAIL**
27.67	VPI	SAG	200	131	-1.3797%	0.1414%	55	YES	YES	YES	**PASS**
27.73	VPI	SAG	100	33	0.1414%	3.1565%	55	**NO**	YES	NO	**FAIL**
27.77	VPI	CREST	250	25	3.1565%	-6.9219%	55	**NO**	**NO**	YES	**FAIL**
27.85	VPI	SAG	200	26	-6.9219%	0.8838%	55	**NO**	**NO**	YES	**FAIL**
27.89	VPI	CREST	100	55	0.8838%	-0.9452%	55	**NO**	YES	NO	**FAIL**
27.92	VPI	SAG	250	97	-0.9452%	1.6385%	55	**NO**	YES	YES	**FAIL**
27.97	VPI	CREST	100	165	1.6385%	1.0317%	55	YES	YES	NO	**PASS**
28.08	VPI	SAG	200	125	1.0317%	2.6283%	55	YES	YES	YES	**PASS**
28.15	VPI	SAG	100	169	2.6283%	3.2214%	55	YES	YES	NO	**PASS**
28.21	VPI	CREST	100	11	3.2214%	-5.5952%	55	**NO**	**NO**	NO	**FAIL**
28.26	VPI	SAG	200	21	-5.5952%	3.8549%	55	**NO**	**NO**	YES	**FAIL**
28.29	VPI	SAG	100	27	3.8549%	7.5665%	55	**NO**	**NO**	NO	**FAIL**
28.32	VPI	CREST	150	16	7.5665%	-1.8159%	55	**NO**	**NO**	NO	**FAIL**
28.38	VPI	SAG	300	48	-1.8159%	4.4863%	55	**NO**	**NO**	YES	**FAIL**
28.43	VPI	CREST	200	51	4.4863%	0.5874%	55	**NO**	**NO**	YES	**FAIL**
28.46	VPI	SAG	50	241	0.5874%	0.7953%	55	YES	YES	NO	**PASS**
28.48	VPI	SAG	200	65	0.7953%	3.8626%	55	**NO**	YES	YES	**FAIL**
28.52	VPI	CREST	150	54	3.8626%	1.0923%	55	**NO**	YES	NO	**FAIL**
28.58	VPI	CREST	150	11	1.0923%	-12.3407%	55	**NO**	**NO**	NO	**FAIL**
28.61	VPI	SAG	200	24	-12.3407%	-4.1629%	55	**NO**	**NO**	YES	**FAIL**
28.67	VPI	SAG	250	19	-4.1629%	8.8967%	55	**NO**	**NO**	YES	**FAIL**
28.70	VPI	CREST	100	24	8.8967%	4.7518%	55	**NO**	**NO**	NO	**FAIL**
28.75	VPI	CREST	200	19	4.7518%	-5.9826%	55	**NO**	**NO**	YES	**FAIL**
28.89	VPI	SAG	500	102	-5.9826%	-1.0854%	55	**NO**	**NO**	YES	**FAIL**
28.99	VPI	CREST	200	64	-1.0854%	-4.2066%	55	**NO**	**NO**	YES	**FAIL**
29.10	VPI	SAG	500	180	-4.2066%	-1.4286%	55	YES	**NO**	YES	**FAIL**
29.44	VPI	CREST	100	106	-1.4286%	-2.3741%	55	**NO**	YES	NO	**FAIL**
29.49	VPI	SAG	200	107	-2.3741%	-0.5032%	55	**NO**	YES	YES	**FAIL**
29.56	VPI	SAG	100	26	-0.5032%	3.3753%	55	**NO**	YES	NO	**FAIL**
29.59	VPI	CREST	150	30	3.3753%	-1.6566%	55	**NO**	YES	NO	**FAIL**
29.64	VPI	CREST	100	36	-1.6566%	-4.4588%	55	**NO**	**NO**	NO	**FAIL**
29.69	VPI	SAG	300	30	-4.4588%	5.6108%	55	**NO**	**NO**	YES	**FAIL**

Curve PVI [1] (RP)	Point Type	Curve Type [2]	Curve Length (ft)	K Value[3]	Grade Back	Grade Ahead	Design Speed (mph)	Meet Min. K Value (Rolling: 114/115) (Mountainous: 61/79) [4]	Meet Max. Grade (Rolling: 4%) (Mountainous: 7%) [5]	Meet Min. Curve Length (Rolling: 165'/1000') (Mountainous: 135'/1000') [6]	Curve/Tangent Pass/Fail
29.74	VPI	CREST	150	17	5.6108%	-3.4397%	55	**NO**	**NO**	NO	**FAIL**
29.79	VPI	SAG	150	33	-3.4397%	1.1537%	55	**NO**	YES	NO	**FAIL**
29.82	VPI	CREST	200	27	1.1537%	-6.3731%	55	**NO**	**NO**	YES	**FAIL**
29.87	VPI	SAG	150	18	-6.3731%	1.9669%	55	**NO**	**NO**	NO	**FAIL**
29.91	VPI	CREST	150	37	1.9669%	-2.0384%	55	**NO**	YES	NO	**FAIL**
29.97	VPI	SAG	300	41	-2.0384%	5.2291%	55	**NO**	**NO**	YES	**FAIL**
30.02	VPI	CREST	200	36	5.2291%	-0.2532%	55	**NO**	**NO**	YES	**FAIL**
30.08	VPI	CREST	100	95	-0.2532%	-1.3012%	55	**NO**	YES	NO	**FAIL**
30.12	VPI	SAG	200	149	-1.3012%	0.0393%	55	YES	YES	YES	**PASS**
30.24	VPI	SAG	200	94	0.0393%	2.1715%	55	**NO**	YES	YES	**FAIL**
30.34	VPI	CREST	600	186	2.1715%	-1.0575%	55	YES	YES	YES	**PASS**
30.48	VPI	CREST	200	82	-1.0575%	-3.4913%	55	**NO**	YES	YES	**FAIL**
30.60	VPI	SAG	350	144	-3.4913%	-1.0598%	55	YES	YES	YES	**PASS**
30.78	VPI	SAG	750	1,340	-1.0598%	-0.5000%	55	YES	YES	YES	**PASS**
30.96	VPI	CREST	500	852	-0.5000%	-1.0870%	55	YES	YES	YES	**PASS**
30.99	VPI	CREST	400	1,000	-0.667%	-1.067%	55	YES	YES	YES	**PASS**
31.27	VPI	SAG	400	1,111	-1.067%	-0.707%	55	YES	YES	YES	**PASS**
31.56	VPI	SAG	400	368	-0.707%	-1.794%	55	YES	YES	YES	**PASS**
32.28	VPI	SAG	600	195	-2.125%	0.959%	55	YES	YES	YES	**PASS**
32.64	VPI	CREST	800	1,675	-0.376%	-0.853%	55	YES	YES	YES	**PASS**
32.96	VPI	CREST	800	2,015	-0.853%	-1.250%	55	YES	YES	YES	**PASS**
33.11	VPI	SAG	400	1,762	-1.250%	-1.023%	55	YES	YES	YES	**PASS**
33.36	VPI	SAG	400	1,270	-1.023%	-0.708%	55	YES	YES	YES	**PASS**
33.83	VPI	CREST	1,000	1,008	-0.708%	-1.700%	55	YES	YES	YES	**PASS**
34.02	VPI	SAG	600	556	-1.700%	-0.622%	55	YES	YES	YES	**PASS**
34.72	VPI	CREST	800	882	-0.622%	-1.529%	55	YES	YES	YES	**PASS**
34.89	VPI	SAG	600	284	-1.529%	0.581%	55	YES	YES	YES	**PASS**
35.07	VPI	CREST	1,000	833	0.581%	-0.619%	55	YES	YES	YES	**PASS**
35.72	VPI	SAG	400	1,826	-0.619%	-0.400%	55	YES	YES	YES	**PASS**
36.01	VPI	CREST	800	1,882	-0.400%	-0.825%	55	YES	YES	YES	**PASS**
36.39	VPI	SAG	800	8,065	-0.825%	-0.924%	55	YES	YES	YES	**PASS**
37.01	VPI	SAG	800	596	-0.924%	0.417%	55	YES	YES	YES	**PASS**
37.24	VPI	SAG	400	576	0.417%	1.112%	55	YES	YES	YES	**PASS**

Source: MDT, 2014; DOWL HKM, 2014; MDT Record Drawings; MDT Road Design Manual, 2004. All values are approximated based on best available data.

(1) PVI indicates the point of vertical intersection, which is defined as the intersection of the initial and final tangents.

(2) Sag curves have a positive grade change (as in a valley); crest curves have a negative grade change (as on a hill).

(3) K value is the horizontal distance needed to produce a one percent change in gradient.

(4) Shaded "No" cells result in "Fail" determination.

(5) Shaded "No" cells result in "Fail" determination.

(6) Per MDT Road Design Manual pages 10.5(3) and 10.5(7), it is MDT practice to specify a minimum curve length of 165 ft. for a design speed of 55 mph and a curve length of 135 ft. for a design speed of 45 mph. For aesthetic purposes, a curve length of 1

Note: Geometrics were analyzed as rolling terrain from RP 1.95 to RP 15.63 and from RP 29.16 to RP 37.5. Geometrics were analyzed as mountainous terrain from RP 15.64 to RP 29.15.
As-built information was unavailable between RP 18.75 to RP 30.96 therefore the vertical alignment was measured with a GPS and curve data was estimated on a best fit basis.

Attachment 4

LOSS and Crash Patterns

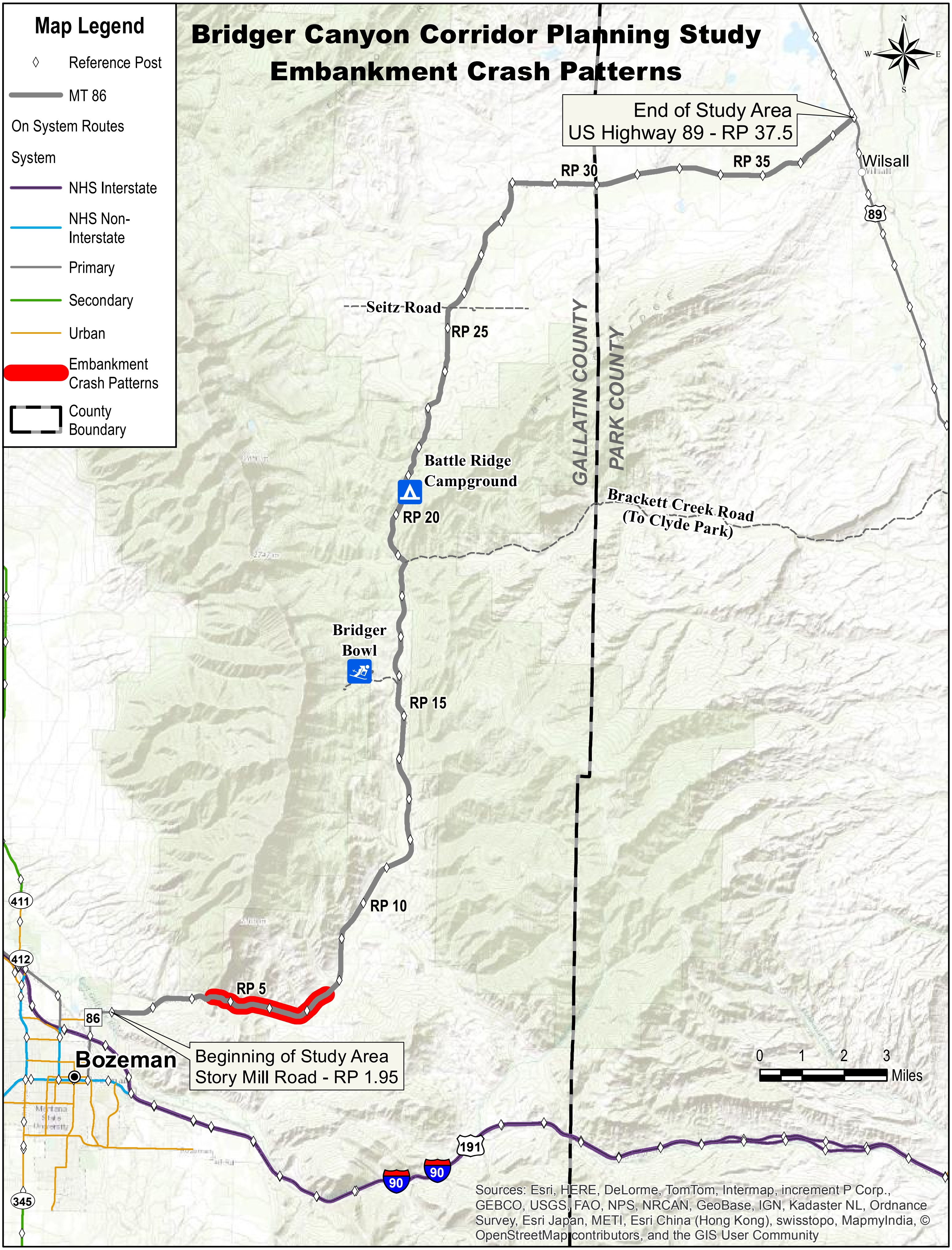
Beginning RP	Ending RP	Total Crash LOSS
3.04	3.79	3
3.79	5.09	4
5.09	5.69	3
5.69	5.79	2
5.79	6.29	3
6.29	6.99	4
6.99	7.29	3
7.29	7.49	2
7.49	7.89	3
7.89	9.79	4
9.79	9.89	3
9.89	10.39	2
10.39	10.49	3
10.49	11.09	4
11.09	11.19	3
11.19	11.39	4
11.39	12.09	3
12.09	13.09	4
13.09	13.19	3
13.19	13.39	2
13.39	14.09	3
14.09	14.39	4
14.39	14.49	3
14.49	15.29	2
15.29	15.79	3
15.79	17.09	4
17.09	17.19	3
17.19	17.69	4
17.69	17.79	3
17.79	18.29	2
18.29	19.69	4
19.69	20.19	3
20.19	21.99	4
21.99	22.79	3
22.79	23.89	4
23.89	24.99	3
24.99	25.49	2
25.49	26.49	3
26.49	26.99	2
26.99	27.99	3
27.99	28.19	2
28.19	28.29	3
28.29	29.29	4
29.29	29.69	3
29.69	29.99	4
29.99	30.49	3
30.49	30.79	4
30.79	31.49	3
31.49	33.59	2
33.59	33.99	3
33.99	34.69	4
34.69	34.79	3
34.79	34.99	4
34.99	35.49	3
35.49	36.49	4
36.49	36.69	3
36.69	37.66	2

Beginning RP	Ending RP	Crash Severity LOSS
3.04	3.89	2
3.89	5.29	4
5.29	5.69	3
5.69	8.09	2
8.09	8.59	3
8.59	9.59	4
9.59	9.89	3
9.89	10.39	2
10.39	11.19	3
11.19	11.39	4
11.39	11.49	3
11.49	12.59	4
12.59	13.09	3
13.09	15.99	2
15.99	16.99	3
16.99	18.29	2
18.29	19.29	4
19.29	20.39	2
20.39	20.59	3
20.59	21.89	4
21.89	22.79	2
22.79	23.79	3
23.79	23.99	2
23.99	24.99	3
24.99	26.99	2
26.99	27.99	3
27.99	28.19	2
28.19	28.29	3
28.29	29.29	4
29.29	29.69	3
29.69	29.99	4
29.99	30.79	3
30.79	33.99	2
33.99	34.79	3
34.79	34.99	4
34.99	35.49	3
35.49	35.79	4
35.79	36.49	3
36.49	37.66	2

Beginning and Ending RPs listed above correspond to Total Crash LOSS and Crash Severity LOSS figures in the Existing and Projected Conditions Report.

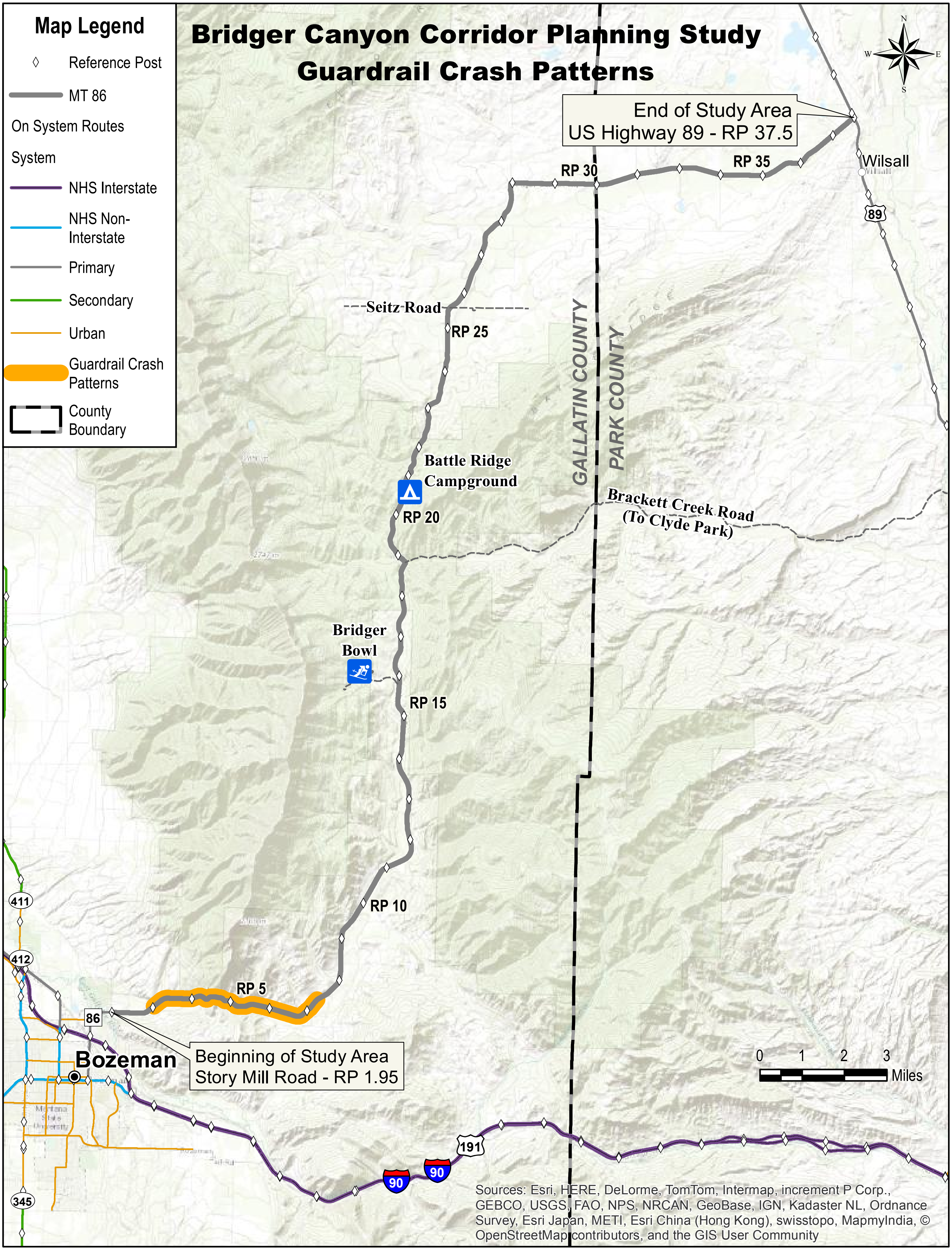
LOSS I: Indicates low potential for crash reduction
LOSS II: Indicates low to moderate potential for crash reduction
LOSS III: Indicates moderate to high potential for crash reduction
LOSS IV: Indicates high potential for crash reduction

Beginning RP	Ending RP	Pattern
4.52	7.52	Embankment
3.02	6.02	Fixed Object
16.27	20.27	
3.02	7.27	Guardrail
13.27	16.77	Icy Road
27.27	30.27	Injury
5.27	9.27	Off Road
10.02	16.52	
19.02	24.02	
12.77	16.27	Overturning
18.02	24.27	
3.27	6.27	Snowy Road
9.77	19.27	

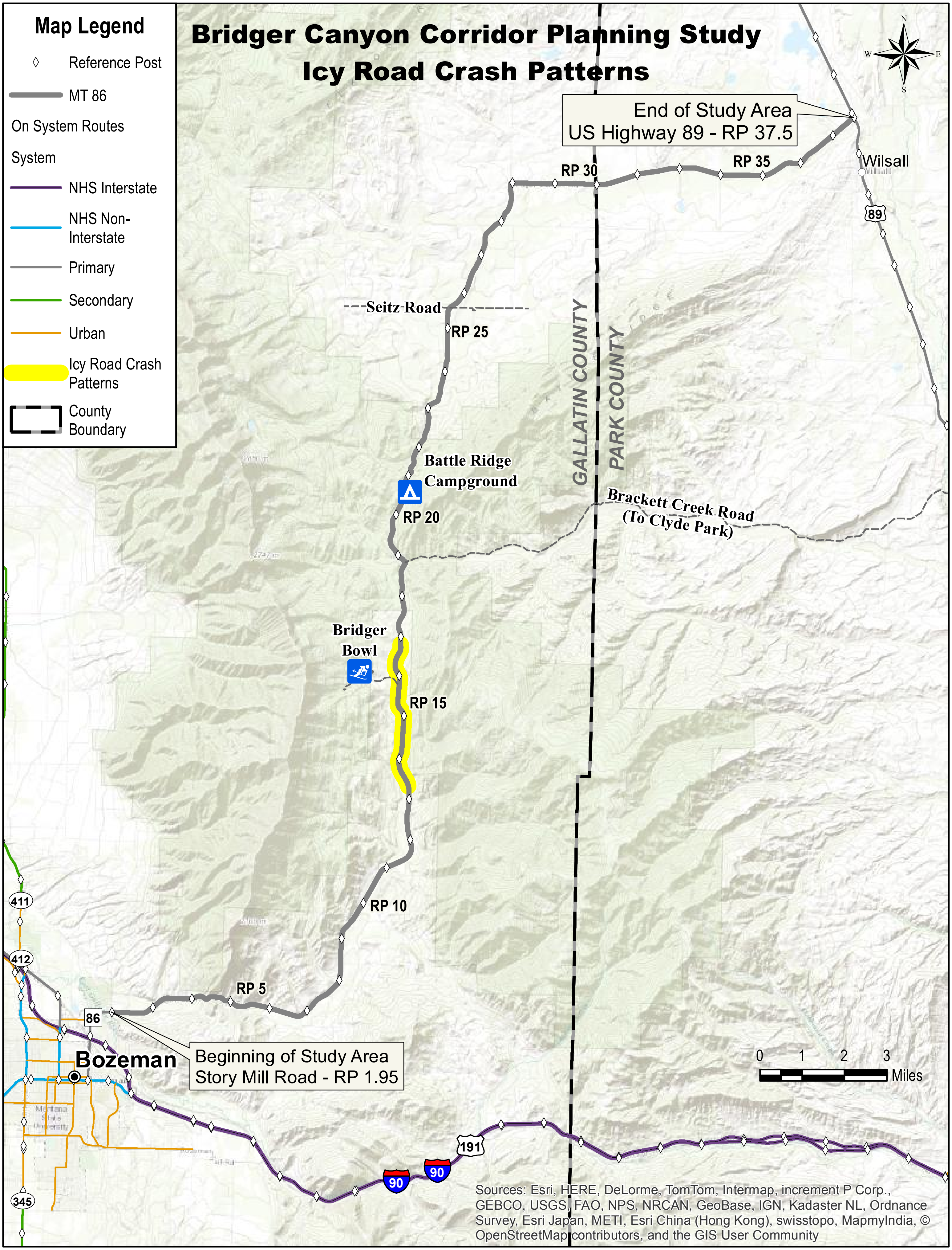


Bridger Canyon Corridor Planning Study
Embankment Crash Patterns
Map Legend
Reference Post
MT 86
On System Routes
System
NHS Interstate
NHS Non-Interstate
Primary
Secondary
Urban
Embankment Crash Patterns
County Boundary
End of Study Area
US Highway 89 - RP 37.5
Wilsall
RP 30
RP 35
89
Seitz Road
RP 25
GALLATIN COUNTY
PARK COUNTY
Battle Ridge Campground
RP 20
Brackett Creek Road
(To Clyde Park)
Bridger Bowl
RP 15
RP 10
RP 5
411
412
86
Bozeman
Beginning of Study Area
Story Mill Road - RP 1.95
0 1 2 3
Miles
191
90
90
345
Sources: Esri, HERE, DeLorme, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

Bridger Canyon Corridor Planning Study
Fixed Object Crash Patterns
Map Legend
Reference Post
MT 86
On System Routes
System
NHS Interstate
NHS Non-Interstate
Primary
Secondary
Urban
Fixed Object Crash Patterns
County Boundary
End of Study Area
US Highway 89 - RP 37.5
Wilsall
RP 30
RP 35
Seitz Road
RP 25
GALLATIN COUNTY
PARK COUNTY
Battle Ridge Campground
RP 20
Brackett Creek Road (To Clyde Park)
Bridger Bowl
RP 15
RP 10
RP 5
Bozeman
Beginning of Study Area
Story Mill Road - RP 1.95
0 1 2 3 Miles
89
411
412
86
345
191
90
Sources: Esri, HERE, DeLorme, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

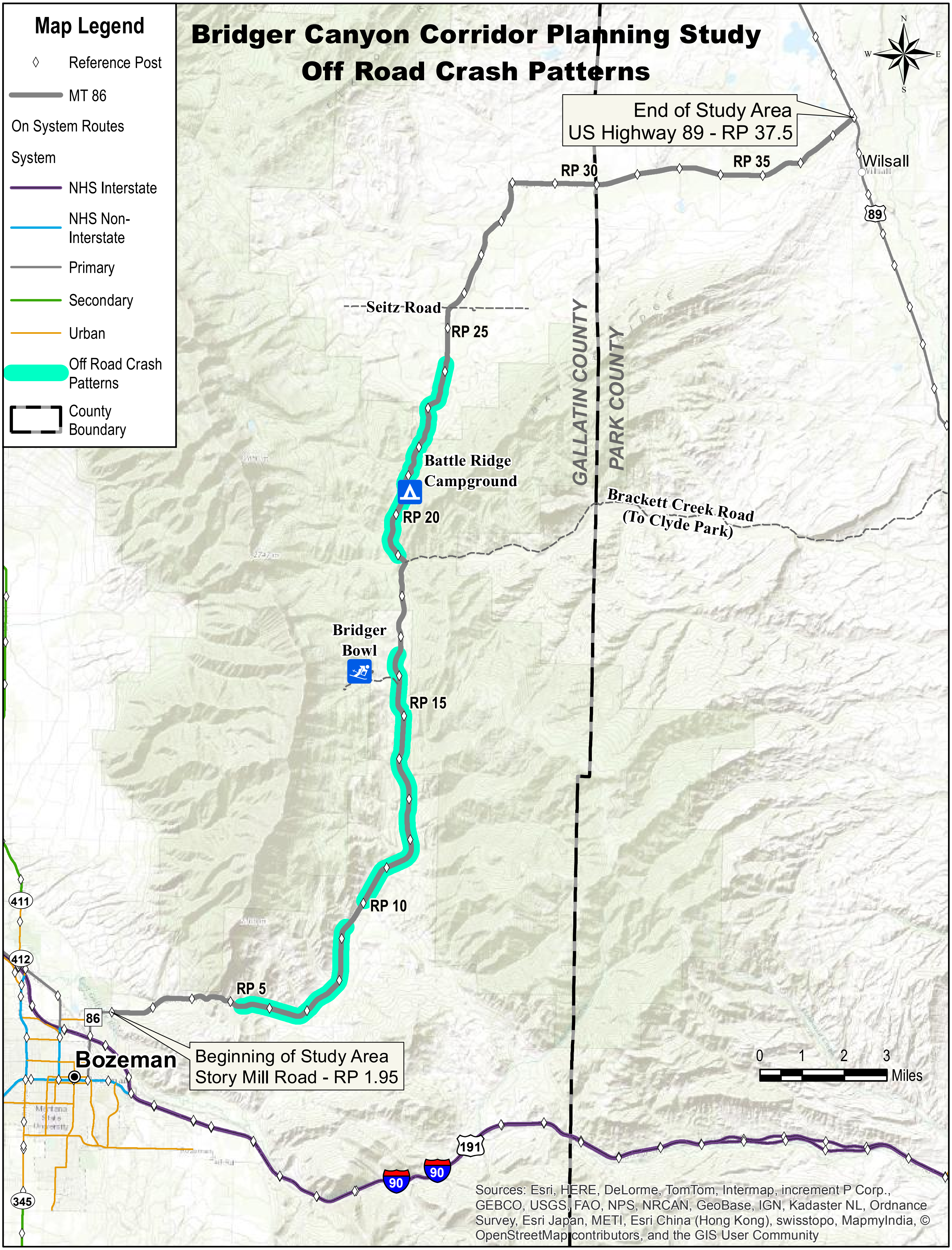


Bridger Canyon Corridor Planning Study
Guardrail Crash Patterns
Map Legend
Reference Post
MT 86
On System Routes
System
NHS Interstate
NHS Non-Interstate
Primary
Secondary
Urban
Guardrail Crash Patterns
County Boundary
End of Study Area
US Highway 89 - RP 37.5
RP 30
RP 35
Wilsall
89
Seitz Road
RP 25
GALLATIN COUNTY
PARK COUNTY
Battle Ridge Campground
RP 20
Brackett Creek Road
(To Clyde Park)
Bridger Bowl
RP 15
RP 10
RP 5
411
412
86
345
Bozeman
Beginning of Study Area
Story Mill Road - RP 1.95
0 1 2 3 Miles
191
90
90
Sources: Esri, HERE, DeLorme, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

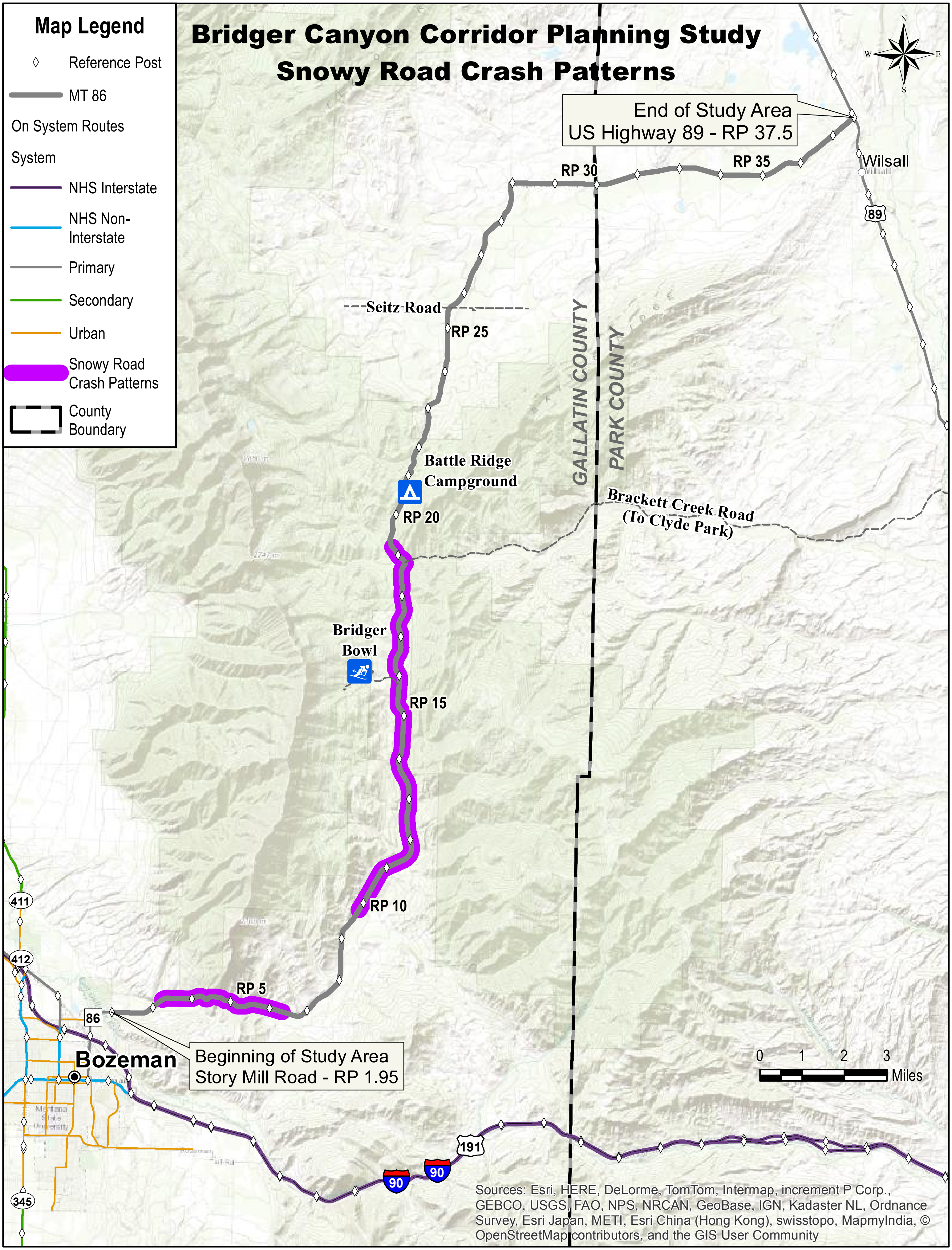


Bridger Canyon Corridor Planning Study
Icy Road Crash Patterns
Map Legend
Reference Post
MT 86
On System Routes
System
NHS Interstate
NHS Non-Interstate
Primary
Secondary
Urban
Icy Road Crash Patterns
County Boundary
End of Study Area
US Highway 89 - RP 37.5
Wilsall
RP 30
RP 35
89
Seitz Road
RP 25
GALLATIN COUNTY
PARK COUNTY
Battle Ridge Campground
RP 20
Brackett Creek Road
(To Clyde Park)
Bridger Bowl
RP 15
RP 10
RP 5
411
412
86
Bozeman
Beginning of Study Area
Story Mill Road - RP 1.95
0 1 2 3
Miles
191
90
90
345
Sources: Esri, HERE, DeLorme, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community


Bridger Canyon Corridor Planning Study
Injury Crash Patterns
Map Legend
Reference Post
MT 86
On System Routes
System
NHS Interstate
NHS Non-Interstate
Primary
Secondary
Urban
Injury Crash Patterns
County Boundary
End of Study Area
US Highway 89 - RP 37.5
Wilsall
RP 30
RP 35
89
Seitz Road
RP 25
GALLATIN COUNTY
PARK COUNTY
Battle Ridge Campground
RP 20
Brackett Creek Road
(To Clyde Park)
Bridger Bowl
RP 15
RP 10
RP 5
411
412
86
Bozeman
Beginning of Study Area
Story Mill Road - RP 1.95
0 1 2 3 Miles
191
90
345
Sources: Esri, HERE, DeLorme, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community


Bridger Canyon Corridor Planning Study
Off Road Crash Patterns
Map Legend
Reference Post
MT 86
On System Routes
System
NHS Interstate
NHS Non-Interstate
Primary
Secondary
Urban
Off Road Crash Patterns
County Boundary
End of Study Area
US Highway 89 - RP 37.5
Wilsall
RP 30
RP 35
89
Seitz Road
RP 25
Battle Ridge Campground
RP 20
GALLATIN COUNTY
PARK COUNTY
Brackett Creek Road
(To Clyde Park)
Bridger Bowl
RP 15
RP 10
RP 5
411
412
86
Bozeman
Beginning of Study Area
Story Mill Road - RP 1.95
0 1 2 3
Miles
191
90
90
345
Sources: Esri, HERE, DeLorme, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

Bridger Canyon Corridor Planning Study
Overturning Crash Patterns
Map Legend
Reference Post
MT 86
On System Routes
System
NHS Interstate
NHS Non-Interstate
Primary
Secondary
Urban
Overturning Crash Patterns
County Boundary
End of Study Area
US Highway 89 - RP 37.5
Wilsall
RP 30
RP 35
89
Seitz Road
RP 25
GALLATIN COUNTY
PARK COUNTY
Battle Ridge Campground
RP 20
Brackett Creek Road
(To Clyde Park)
Bridger Bowl
RP 15
RP 10
RP 5
411
412
86
Bozeman
Beginning of Study Area
Story Mill Road - RP 1.95
0 1 2 3
Miles
191
90
90
345
Sources: Esri, HERE, DeLorme, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community



Bridger Canyon Corridor Planning Study
Snowy Road Crash Patterns
Map Legend
Reference Post
MT 86
On System Routes
System
NHS Interstate
NHS Non-Interstate
Primary
Secondary
Urban
Snowy Road Crash Patterns
County Boundary
End of Study Area
US Highway 89 - RP 37.5
Wilsall
RP 30
RP 35
89
Seitz Road
RP 25
GALLATIN COUNTY
PARK COUNTY
Battle Ridge Campground
RP 20
Brackett Creek Road
(To Clyde Park)
Bridger Bowl
RP 15
RP 10
RP 5
411
412
86
Bozeman
Beginning of Study Area
Story Mill Road - RP 1.95
0 1 2 3 Miles
191
90
345
Sources: Esri, HERE, DeLorme, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

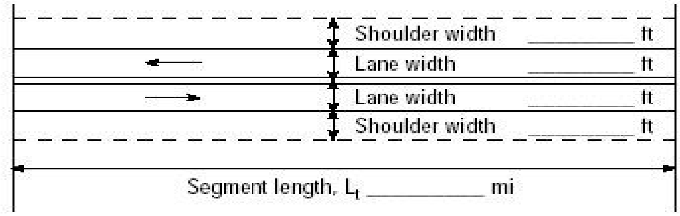
Attachment 5
Operational Analysis Worksheets

DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

General Information		Site Information	
Analyst	*David Stoner*	Highway / Direction of Travel	*MT 86*
Agency or Company	*DOWL HKM*	From/To	*Story Mill to Bridger Bowl*
Date Performed	*7/10/2014*	Jurisdiction	*Gallatin County*
Analysis Time Period	*Peak Hour*	Analysis Year	*2014*

Project Description: *Bridger Canyon Corridor*

Input Data



☐ Class I highway ☑ Class II highway ☐ Class III highway

Terrain ☐ Level ☑ Rolling

Grade Length mi Up/down

Analysis direction vol., V_d	*77*veh/h
Opposing direction vol., V_o	*72*veh/h
Shoulder width ft	*3.0*
Lane Width ft	*12.0*
Segment Length mi	*13.8*
Peak-hour factor, PHF	*0.88*
No-passing zone	*65%*
% Trucks and Buses , P_T	*3* %
% Recreational vehicles, P_R	*1%*
Access points *mi*	*10*/mi

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	*2.7*	*2.7*
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	*1.1*	*1.1*
Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/ (1+ P_T (E_T -1)+P_R (E_R -1))$	*0.951*	*0.951*
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	*0.67*	*0.67*
Demand flow rate[2], v_i (pc/h) $v_i=V_i$ / (PHF* $f_{g,ATS}$ * $f_{HV,ATS}$)	*137*	*128*

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
Mean speed of sample[3], S_{FM}		Base free-flow speed[4], BFFS	*58.9 mi/h*
Total demand flow rate, both directions, *v*		Adj. for lane and shoulder width,[4] f_{LS}(Exhibit 15-7)	*2.6 mi/h*
Free-flow speed, FFS=S_{FM}+0.00776(*v*/ $f_{HV,ATS}$)		Adj. for access points[4], f_A (Exhibit 15-8)	*2.5 mi/h*
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	*2.6 mi/h*	Free-flow speed, FFS (FSS=BFFS-f_{LS}-f_A)	*53.8 mi/h*
		Average travel speed, ATS_d=FFS-0.00776($v_{d,ATS}$ + $v_{o,ATS}$) - $f_{np,ATS}$	*49.1 mi/h*
		Percent free flow speed, PFFS	*91.3 %*

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T(Exhibit 15-18 or 15-19)	*1.9*	*1.9*
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	*1.0*	*1.0*
Heavy-vehicle adjustment factor, $f_{HV}=1/ (1+ P_T(E_T-1)+P_R(E_R-1))$	*0.974*	*0.974*
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	*0.73*	*0.73*
Directional flow rate[2], v_i(pc/h) $v_i=V_i/(PHF*f_{HV,PTSF}* f_{g,PTSF})$	*123*	*115*
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	*14.0*	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	*52.1*	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}*(v_{d,PTSF} / v_{d,PTSF} + v_{o,PTSF})$	*40.9*	

Level of Service and Other Performance Measures

Level of service, LOS (Exhibit 15-3)	*B*
Volume to capacity ratio, *v/c*	*0.07*

Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h	*1102*
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	*1229*
Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only)	*91.3*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*87.5*
Effective width, Wv (Eq. 15-29) ft	*24.23*
Effective speed factor, S_t (Eq. 15-30)	*5.19*
Bicycle level of service score, BLOS (Eq. 15-31)	*1.96*
Bicycle level of service (Exhibit 15-4)	*B*

Notes

1. Note that the adjustment factor for level terrain is 1.00,as level terrain is one of the base conditions. For the purpose of grade adjustment, specific downgrade segments are treated as level terrain.
2. If v_i(v_d or v_o) >=1,700 pc/h, terminate analysis--the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only
5. Exhibit 15-20 provides coefficients a and b for Equation 15-10.
6. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

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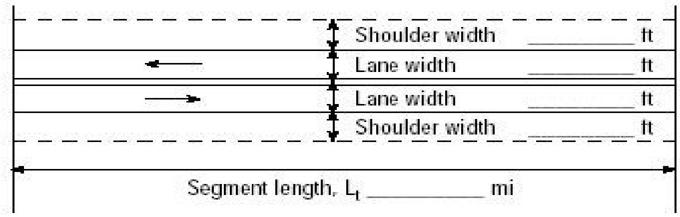
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

General Information		Site Information	
Analyst	*David Stoner*	Highway / Direction of Travel	*MT 86*
Agency or Company	*DOWL HKM*	From/To	*Bridger Bowl to Story Mill*
Date Performed	*7/10/2014*	Jurisdiction	*Gallatin County*
Analysis Time Period	*Peak Hour*	Analysis Year	*2014*

Project Description: *Bridger Canyon Corridor*

Input Data



Analysis direction vol., V_d *72*veh/h

Opposing direction vol., V_o *77*veh/h

Shoulder width ft *3.0*

Lane Width ft *12.0*

Segment Length mi *13.8*

☐ Class I highway ☑ Class II highway ☐ Class III highway

Terrain ☐ Level ☑ Rolling

Grade Length mi Up/down

Peak-hour factor, PHF *0.72*

No-passing zone *63%*

% Trucks and Buses , P_T *3 %*

% Recreational vehicles, P_R *0%*

Access points *mi* *10*/mi

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	*2.7*	*2.7*
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	*1.1*	*1.1*
Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.951*	*0.951*
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	*0.67*	*0.68*
Demand flow rate[2], v_i (pc/h) $v_i=V_i/(PHF^* f_{g,ATS} * f_{HV,ATS})$	*157*	*165*

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
Mean speed of sample[3], S_{FM}		Base free-flow speed[4], BFFS	*58.3 mi/h*
Total demand flow rate, both directions, *v*		Adj. for lane and shoulder width,[4] f_{LS}(Exhibit 15-7)	*2.6 mi/h*
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Adj. for access points[4], f_A (Exhibit 15-8)	*2.5 mi/h*
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	*3.0 mi/h*	Free-flow speed, FFS $(FSS=BFFS-f_{LS}-f_A)$	*53.2 mi/h*
		Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	*47.7 mi/h*
		Percent free flow speed, PFFS	*89.6 %*

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T(Exhibit 15-18 or 15-19)	*1.9*	*1.8*
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	*1.0*	*1.0*
Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.974*	*0.977*
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	*0.73*	*0.73*
Directional flow rate[2], v_i(pc/h) $v_i=V_i/(PHF^*f_{HV,PTSF}^* f_{g,PTSF})$	*141*	*150*
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	*15.9*	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	*54.8*	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	*42.5*	

Level of Service and Other Performance Measures

Level of service, LOS (Exhibit 15-3)	*B*
Volume to capacity ratio, *v/c*	*0.08*

Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h	*1155*
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	*1262*
Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only)	*89.6*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*100.0*
Effective width, Wv (Eq. 15-29) ft	*24.60*
Effective speed factor, S_t (Eq. 15-30)	*5.19*
Bicycle level of service score, BLOS (Eq. 15-31)	*1.94*
Bicycle level of service (Exhibit 15-4)	*B*

Notes

1. Note that the adjustment factor for level terrain is 1.00,as level terrain is one of the base conditions. For the purpose of grade adjustment, specific downgrade segments are treated as level terrain.
2. If v_i(v_d or v_o) >=1,700 pc/h, terminate analysis--the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only
5. Exhibit 15-20 provides coefficients a and b for Equation 15-10.
6. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

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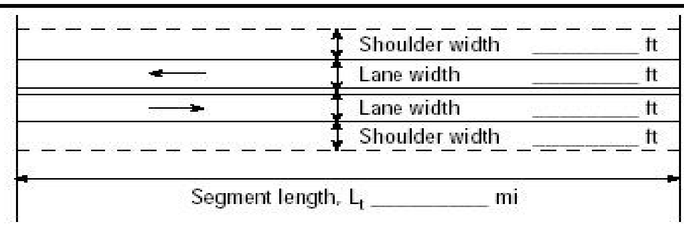
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

General Information		Site Information	
Analyst	*David Stoner*	Highway / Direction of Travel	*MT 86*
Agency or Company	*DOWL HKM*	From/To	*Bridger Bowl to Seitz Road*
Date Performed	*7/10/2014*	Jurisdiction	*Gallatin County*
Analysis Time Period	*Peak Hour*	Analysis Year	*2014*

Project Description: *Bridger Canyon Corridor*

Input Data



☐ Class I highway ☑ Class II highway ☐ Class III highway

Terrain ☐ Level ☑ Rolling

Analysis direction vol., V_d	*54*veh/h
Opposing direction vol., V_o	*56*veh/h
Shoulder width ft	*3.0*
Lane Width ft	*12.0*
Segment Length mi	*9.6*
Grade Length mi	Up/down
Peak-hour factor, PHF	*0.84*
No-passing zone	*97%*
% Trucks and Buses , P_T	*2* %
% Recreational vehicles, P_R	*2%*
Access points *mi*	*4*/mi

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	*2.7*	*2.7*
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	*1.1*	*1.1*
Heavy-vehicle adjustment factor, $f_{HV,ATS}$=1/ (1+ P_T(E_T-1)+P_R(E_R-1))	*0.965*	*0.965*
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	*0.67*	*0.67*
Demand flow rate[2], v_i (pc/h) v_i=V_i / (PHF* $f_{g,ATS}$ * $f_{HV,ATS}$)	*99*	*103*

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
Mean speed of sample[3], S_{FM}		Base free-flow speed[4], BFFS	*50.6 mi/h*
Total demand flow rate, both directions, *v*		Adj. for lane and shoulder width,[4] f_{LS}(Exhibit 15-7)	*2.6 mi/h*
Free-flow speed, FFS=S_{FM}+0.00776(*v*/ $f_{HV,ATS}$)		Adj. for access points[4], f_A (Exhibit 15-8)	*1.0 mi/h*
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	*2.5 mi/h*	Free-flow speed, FFS (FSS=BFFS-f_{LS}-f_A)	*47.0 mi/h*
		Average travel speed, ATS_d=FFS-0.00776($v_{d,ATS}$ + $v_{o,ATS}$) - $f_{np,ATS}$	*43.0 mi/h*
		Percent free flow speed, PFFS	*91.4 %*

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T(Exhibit 15-18 or 15-19)	*1.9*	*1.9*
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	*1.0*	*1.0*
Heavy-vehicle adjustment factor, f_{HV}=1/ (1+ P_T(E_T-1)+P_R(E_R-1))	*0.982*	*0.982*
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	*0.73*	*0.73*
Directional flow rate[2], v_i(pc/h) v_i=V_i/(PHF*$f_{HV,PTSF}$* $f_{g,PTSF}$)	*90*	*93*
Base percent time-spent-following[4], $BPTSF_d$(%)=100(1-$e^{av_d^b}$)	*10.6*	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	*52.4*	
Percent time-spent-following, $PTSF_d$(%)=$BPTSF_d$+$f_{np,PTSF}$ *($v_{d,PTSF}$ / $v_{d,PTSF}$ + $v_{o,PTSF}$)	*36.4*	

Level of Service and Other Performance Measures

Level of service, LOS (Exhibit 15-3)	*A*
Volume to capacity ratio, *v/c*	*0.05*

Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h	*1099*
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	*1219*
Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only)	*91.4*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*64.3*
Effective width, Wv (Eq. 15-29) ft	*25.95*
Effective speed factor, S_t (Eq. 15-30)	*5.19*
Bicycle level of service score, BLOS (Eq. 15-31)	*1.10*
Bicycle level of service (Exhibit 15-4)	*A*

Notes

1. Note that the adjustment factor for level terrain is 1.00,as level terrain is one of the base conditions. For the purpose of grade adjustment, specific downgrade segments are treated as level terrain.
2. If $v_i(v_d$ or $v_o)$ >=1,700 pc/h, terminate analysis--the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only
5. Exhibit 15-20 provides coefficients a and b for Equation 15-10.
6. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

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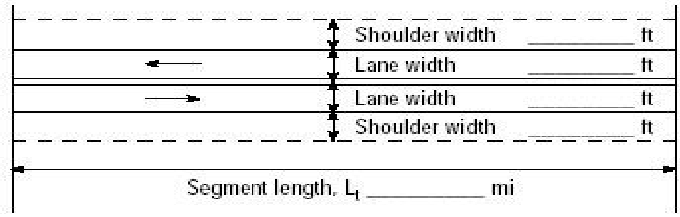
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

General Information		*Site Information*	
Analyst	*David Stoner*	Highway / Direction of Travel	*MT 86*
Agency or Company	*DOWL HKM*	From/To	*Seitz Road to Bridger Bowl*
Date Performed	*7/10/2014*	Jurisdiction	*Gallatin County*
Analysis Time Period	*Peak Hour*	Analysis Year	*2014*

Project Description: *Bridger Canyon Corridor*

Input Data



☐ Class I highway ☑ Class II highway ☐ Class III highway

Terrain ☐ Level ☑ Rolling

Grade Length mi Up/down

Analysis direction vol., V_d	*56*veh/h
Opposing direction vol., V_o	*54*veh/h
Shoulder width ft	*3.0*
Lane Width ft	*12.0*
Segment Length mi	*9.6*
Peak-hour factor, PHF	*0.74*
No-passing zone	*95%*
% Trucks and Buses , P_T	*0* %
% Recreational vehicles, P_R	*0%*
Access points *mi*	*4*/mi

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	*2.7*	*2.7*
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	*1.1*	*1.1*
Heavy-vehicle adjustment factor, $f_{HV,ATS}$=1/ (1+ P_T(E_T-1)+P_R(E_R-1))	*1.000*	*1.000*
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	*0.67*	*0.67*
Demand flow rate[2], v_i (pc/h) $v_i=V_i$ / (PHF* $f_{g,ATS}$ * $f_{HV,ATS}$)	*113*	*109*

Free-Flow Speed from Field Measurement		**Estimated Free-Flow Speed**	
		Base free-flow speed[4], BFFS	*49.4 mi/h*
		Adj. for lane and shoulder width,[4] f_{LS}(Exhibit 15-7)	*2.6 mi/h*
Mean speed of sample[3], S_{FM}		Adj. for access points[4], f_A (Exhibit 15-8)	*1.0 mi/h*
Total demand flow rate, both directions, *v*		Free-flow speed, FFS (FSS=BFFS-f_{LS}-f_A)	*45.8 mi/h*
Free-flow speed, FFS=S_{FM}+0.00776(*v*/ $f_{HV,ATS}$)		Average travel speed, ATS_d=FFS-0.00776($v_{d,ATS}$ + $v_{o,ATS}$) - $f_{np,ATS}$	*41.6 mi/h*
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	*2.5 mi/h*	Percent free flow speed, PFFS	*90.8 %*

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T(Exhibit 15-18 or 15-19)	*1.9*	*1.9*
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	*1.0*	*1.0*
Heavy-vehicle adjustment factor, f_{HV}=1/ (1+ P_T(E_T-1)+P_R(E_R-1))	*1.000*	*1.000*
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	*0.73*	*0.73*
Directional flow rate[2], v_i(pc/h) $v_i=V_i$/(PHF*$f_{HV,PTSF}$* $f_{g,PTSF}$)	*104*	*100*
Base percent time-spent-following[4], $BPTSF_d$(%)=100(1-$e^{av_d^b}$)	*12.1*	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	*52.5*	
Percent time-spent-following, $PTSF_d$(%)=$BPTSF_d$+$f_{np,PTSF}$ *($v_{d,PTSF}$ / $v_{d,PTSF}$ + $v_{o,PTSF}$)	*38.9*	

Level of Service and Other Performance Measures

Level of service, LOS (Exhibit 15-3)	*A*
Volume to capacity ratio, *v/c*	*0.06*

Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h	*1139*
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	*1241*
Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only)	*90.8*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*75.7*
Effective width, Wv (Eq. 15-29) ft	*25.80*
Effective speed factor, S_t (Eq. 15-30)	*5.19*
Bicycle level of service score, BLOS (Eq. 15-31)	*0.75*
Bicycle level of service (Exhibit 15-4)	*A*

Notes

1. Note that the adjustment factor for level terrain is 1.00,as level terrain is one of the base conditions. For the purpose of grade adjustment, specific downgrade segments are treated as level terrain.
2. If v_i(v_d or v_o) >=1,700 pc/h, terminate analysis--the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only
5. Exhibit 15-20 provides coefficients a and b for Equation 15-10.
6. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

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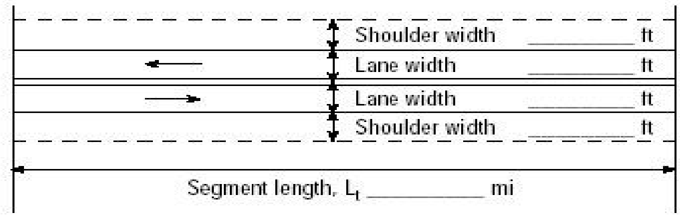
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

General Information		***Site Information***	
Analyst	*David Stoner*	Highway / Direction of Travel	*MT 86*
Agency or Company	*DOWL HKM*	From/To	*Seitz Road to US 89*
Date Performed	*7/10/2014*	Jurisdiction	*Gallatin County*
Analysis Time Period	*Peak Hour*	Analysis Year	*2014*

Project Description: *Bridger Canyon Corridor*

Input Data



☐ Class I highway ☑ Class II highway ☐ Class III highway

Terrain ☑ Level ☐ Rolling

Grade Length mi	Up/down
Peak-hour factor, PHF	*0.81*
No-passing zone	*40%*
% Trucks and Buses , P_T	*0* %
% Recreational vehicles, P_R	*0%*
Access points *mi*	*4*/mi

Analysis direction vol., V_d	*29*veh/h
Opposing direction vol., V_o	*27*veh/h
Shoulder width ft	*3.0*
Lane Width ft	*12.0*
Segment Length mi	*12.2*

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	*1.9*	*1.9*
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	*1.0*	*1.0*
Heavy-vehicle adjustment factor, $f_{HV,ATS}$=1/ (1+ P_T(E_T-1)+P_R(E_R-1))	*1.000*	*1.000*
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	*1.00*	*1.00*
Demand flow rate[2], v_i (pc/h) $v_i=V_i$ / (PHF* $f_{g,ATS}$ * $f_{HV,ATS}$)	*36*	*33*

Free-Flow Speed from Field Measurement		**Estimated Free-Flow Speed**	
		Base free-flow speed[4], BFFS	*61.1 mi/h*
		Adj. for lane and shoulder width,[4] f_{LS}(Exhibit 15-7)	*2.6 mi/h*
Mean speed of sample[3], S_{FM}		Adj. for access points[4], f_A (Exhibit 15-8)	*1.0 mi/h*
Total demand flow rate, both directions, *v*		Free-flow speed, FFS (FSS=BFFS-f_{LS}-f_A)	*57.5 mi/h*
Free-flow speed, FFS=S_{FM}+0.00776(*v*/ $f_{HV,ATS}$)		Average travel speed, ATS_d=FFS-0.00776($v_{d,ATS}$ + $v_{o,ATS}$) - $f_{np,ATS}$	*55.5 mi/h*
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	*1.5 mi/h*	Percent free flow speed, PFFS	*96.5 %*

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T(Exhibit 15-18 or 15-19)	*1.1*	*1.1*
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	*1.0*	*1.0*
Heavy-vehicle adjustment factor, f_{HV}=1/ (1+ P_T(E_T-1)+P_R(E_R-1))	*1.000*	*1.000*
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	*1.00*	*1.00*
Directional flow rate[2], v_i(pc/h) $v_i=V_i$/(PHF*$f_{HV,PTSF}$* $f_{g,PTSF}$)	*36*	*33*
Base percent time-spent-following[4], $BPTSF_d$(%)=100(1-$e^{av_d^b}$)	*4.5*	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	*43.0*	
Percent time-spent-following, $PTSF_d$(%)=$BPTSF_d$+$f_{np,PTSF}$ *($v_{d,PTSF}$ / $v_{d,PTSF}$ + $v_{o,PTSF}$)	*26.9*	

Level of Service and Other Performance Measures

Level of service, LOS (Exhibit 15-3)	*A*
Volume to capacity ratio, *v/c*	*0.02*

Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h	*0*
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	*1700*
Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only)	*96.5*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*35.8*
Effective width, Wv (Eq. 15-29) ft	*27.83*
Effective speed factor, S_t (Eq. 15-30)	*4.94*
Bicycle level of service score, BLOS (Eq. 15-31)	*-0.22*
Bicycle level of service (Exhibit 15-4)	*A*

Notes

1. Note that the adjustment factor for level terrain is 1.00,as level terrain is one of the base conditions. For the purpose of grade adjustment, specific downgrade segments are treated as level terrain.
2. If v_i(v_d or v_o) >=1,700 pc/h, terminate analysis--the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only
5. Exhibit 15-20 provides coefficients a and b for Equation 15-10.
6. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

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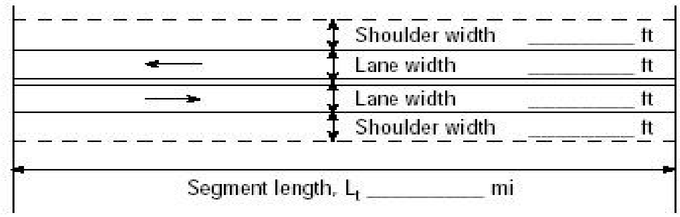
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

General Information		**Site Information**	
Analyst	*David Stoner*	Highway / Direction of Travel	*MT 86*
Agency or Company	*DOWL HKM*	From/To	*US 89 to Seitz Road*
Date Performed	*7/10/2014*	Jurisdiction	*Gallatin County*
Analysis Time Period	*Peak Hour*	Analysis Year	*2014*

Project Description: *Bridger Canyon Corridor*

Input Data



☐ Class I highway ☑ Class II highway ☐ Class III highway

Terrain ☑ Level ☐ Rolling

Analysis direction vol., V_d	27veh/h
Opposing direction vol., V_o	29veh/h
Shoulder width ft	3.0
Lane Width ft	12.0
Segment Length mi	12.2
Grade Length mi	Up/down
Peak-hour factor, PHF	0.84
No-passing zone	36%
% Trucks and Buses , P_T	4 %
% Recreational vehicles, P_R	0%
Access points *mi*	4/mi

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	1.9	1.9
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	1.0	1.0
Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	0.965	0.965
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	1.00	1.00
Demand flow rate[2], v_i (pc/h) $v_i=V_i/(PHF^* f_{g,ATS} * f_{HV,ATS})$	33	36

Free-Flow Speed from Field Measurement		**Estimated Free-Flow Speed**	
Mean speed of sample[3], S_{FM}		Base free-flow speed[4], BFFS	64.8 mi/h
Total demand flow rate, both directions, *v*		Adj. for lane and shoulder width,[4] f_{LS}(Exhibit 15-7)	2.6 mi/h
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Adj. for access points[4], f_A (Exhibit 15-8)	1.0 mi/h
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	1.6 mi/h	Free-flow speed, FFS $(FSS=BFFS-f_{LS}-f_A)$	61.2 mi/h
		Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	59.0 mi/h
		Percent free flow speed, PFFS	96.5 %

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T(Exhibit 15-18 or 15-19)	1.1	1.1
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	1.0	1.0
Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	0.996	0.996
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	1.00	1.00
Directional flow rate[2], v_i(pc/h) $v_i=V_i/(PHF^*f_{HV,PTSF}^* f_{g,PTSF})$	32	35
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	4.0	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	40.3	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	23.2	

Level of Service and Other Performance Measures

Level of service, LOS (Exhibit 15-3)	A
Volume to capacity ratio, *v/c*	0.02

Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h	*1641*
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	*1693*
Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only)	*96.5*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*32.1*
Effective width, Wv (Eq. 15-29) ft	*27.98*
Effective speed factor, S_t (Eq. 15-30)	*5.19*
Bicycle level of service score, BLOS (Eq. 15-31)	*0.76*
Bicycle level of service (Exhibit 15-4)	*A*

Notes

1. Note that the adjustment factor for level terrain is 1.00,as level terrain is one of the base conditions. For the purpose of grade adjustment, specific downgrade segments are treated as level terrain.
2. If v_i(v_d or v_o) >=1,700 pc/h, terminate analysis--the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only
5. Exhibit 15-20 provides coefficients a and b for Equation 15-10.
6. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

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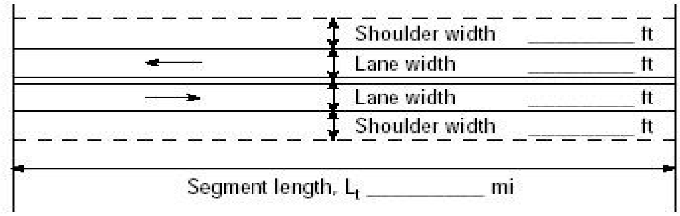
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

General Information		**Site Information**	
Analyst	*David Stoner*	Highway / Direction of Travel	*MT 86*
Agency or Company	*DOWL HKM*	From/To	*Story Mill to Bridger Bowl*
Date Performed	*7/10/2014*	Jurisdiction	*Gallatin County*
Analysis Time Period	*Peak Hour*	Analysis Year	*2014*

Project Description: *Bridger Canyon Corridor*

Input Data



☐ Class I highway ☑ Class II highway ☐ Class III highway

Terrain ☐ Level ☑ Rolling

Grade Length mi Up/down

Analysis direction vol., V_d	*95*veh/h
Opposing direction vol., V_o	*89*veh/h
Shoulder width ft	*3.0*
Lane Width ft	*12.0*
Segment Length mi	*13.8*
Peak-hour factor, PHF	*0.88*
No-passing zone	*65%*
% Trucks and Buses , P_T	*3* %
% Recreational vehicles, P_R	*1%*
Access points *mi*	*10*/mi

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	*2.7*	*2.7*
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	*1.1*	*1.1*
Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.951*	*0.951*
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	*0.68*	*0.67*
Demand flow rate[2], v_i (pc/h) $v_i=V_i$ / (PHF* $f_{g,ATS}$ * $f_{HV,ATS}$)	*167*	*159*

Free-Flow Speed from Field Measurement		**Estimated Free-Flow Speed**	
Mean speed of sample[3], S_{FM}		Base free-flow speed[4], BFFS	*58.9* *mi/h*
Total demand flow rate, both directions, *v*		Adj. for lane and shoulder width,[4] f_{LS}(Exhibit 15-7)	*2.6* *mi/h*
Free-flow speed, FFS=S_{FM}+0.00776(*v*/ $f_{HV,ATS}$)		Adj. for access points[4], f_A (Exhibit 15-8)	*2.5* *mi/h*
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	*3.0* *mi/h*	Free-flow speed, FFS (FSS=BFFS-f_{LS}-f_A)	*53.8* *mi/h*
		Average travel speed, ATS_d=FFS-0.00776($v_{d,ATS}$ + $v_{o,ATS}$) - $f_{np,ATS}$	*48.3* *mi/h*
		Percent free flow speed, PFFS	*89.7* *%*

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T(Exhibit 15-18 or 15-19)	*1.8*	*1.8*
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	*1.0*	*1.0*
Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.977*	*0.977*
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	*0.74*	*0.73*
Directional flow rate[2], v_i(pc/h) $v_i=V_i/(PHF*f_{HV,PTSF}*f_{g,PTSF})$	*149*	*142*
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	*16.7*	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	*54.9*	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	*44.8*	

Level of Service and Other Performance Measures

Level of service, LOS (Exhibit 15-3)	*B*
Volume to capacity ratio, *v/c*	*0.09*

Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h	*1138*
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	*1262*
Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only)	*89.7*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*108.0*
Effective width, Wv (Eq. 15-29) ft	*22.88*
Effective speed factor, S_t (Eq. 15-30)	*5.19*
Bicycle level of service score, BLOS (Eq. 15-31)	*2.38*
Bicycle level of service (Exhibit 15-4)	*B*

Notes

1. Note that the adjustment factor for level terrain is 1.00,as level terrain is one of the base conditions. For the purpose of grade adjustment, specific downgrade segments are treated as level terrain.
2. If v_i(v_d or v_o) >=1,700 pc/h, terminate analysis--the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only
5. Exhibit 15-20 provides coefficients a and b for Equation 15-10.
6. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

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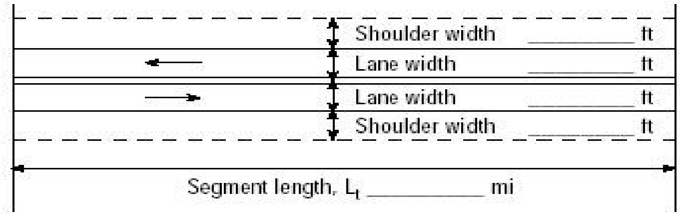
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

General Information		Site Information	
Analyst	*David Stoner*	Highway / Direction of Travel	*MT 86*
Agency or Company	*DOWL HKM*	From/To	*Bridger Bowl to Story Mill*
Date Performed	*7/10/2014*	Jurisdiction	*Gallatin County*
Analysis Time Period	*Peak Hour*	Analysis Year	*2014*

Project Description: *Bridger Canyon Corridor*

Input Data



☐ Class I highway ☑ Class II highway ☐ Class III highway

Terrain ☐ Level ☑ Rolling

Grade Length mi	Up/down
Peak-hour factor, PHF	*0.72*
No-passing zone	*63%*
% Trucks and Buses , P_T	*3* %
% Recreational vehicles, P_R	*0%*
Access points *mi*	*10*/mi

Analysis direction vol., V_d	*89*veh/h
Opposing direction vol., V_o	*95*veh/h
Shoulder width ft	*3.0*
Lane Width ft	*12.0*
Segment Length mi	*13.8*

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	*2.6*	*2.6*
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	*1.1*	*1.1*
Heavy-vehicle adjustment factor, $f_{HV,ATS}$=1/ (1+ P_T (E_T -1)+P_R (E_R -1))	*0.954*	*0.954*
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	*0.69*	*0.70*
Demand flow rate[2], v_i (pc/h) v_i=V_i / (PHF* $f_{g,ATS}$ * $f_{HV,ATS}$)	*188*	*198*

Free-Flow Speed from Field Measurement		**Estimated Free-Flow Speed**	
Mean speed of sample[3], S_{FM}		Base free-flow speed[4], BFFS	*58.3 mi/h*
Total demand flow rate, both directions, *v*		Adj. for lane and shoulder width,[4] f_{LS}(Exhibit 15-7)	*2.6 mi/h*
Free-flow speed, FFS=S_{FM}+0.00776(*v*/ $f_{HV,ATS}$)		Adj. for access points[4], f_A (Exhibit 15-8)	*2.5 mi/h*
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	*3.5 mi/h*	Free-flow speed, FFS (FSS=BFFS-f_{LS}-f_A)	*53.2 mi/h*
		Average travel speed, ATS_d=FFS-0.00776($v_{d,ATS}$ + $v_{o,ATS}$) - $f_{np,ATS}$	*46.7 mi/h*
		Percent free flow speed, PFFS	*87.8 %*

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T(Exhibit 15-18 or 15-19)	*1.8*	*1.8*
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	*1.0*	*1.0*
Heavy-vehicle adjustment factor, f_{HV}=1/ (1+ P_T(E_T-1)+P_R(E_R-1))	*0.977*	*0.977*
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	*0.75*	*0.75*
Directional flow rate[2], v_i(pc/h) v_i=V_i/(PHF*$f_{HV,PTSF}$* $f_{g,PTSF}$)	*169*	*180*
Base percent time-spent-following[4], $BPTSF_d$(%)=100(1-$e^{av_d^b}$)	*18.6*	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	*57.9*	
Percent time-spent-following, $PTSF_d$(%)=$BPTSF_d$+$f_{np,PTSF}$ *($v_{d,PTSF}$ / $v_{d,PTSF}$ + $v_{o,PTSF}$)	*46.6*	

Level of Service and Other Performance Measures

Level of service, LOS (Exhibit 15-3)	*B*
Volume to capacity ratio, *v/c*	*0.10*

Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h	*1191*
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	*1312*
Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only)	*87.8*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*123.6*
Effective width, Wv (Eq. 15-29) ft	*23.33*
Effective speed factor, S_t (Eq. 15-30)	*5.19*
Bicycle level of service score, BLOS (Eq. 15-31)	*2.35*
Bicycle level of service (Exhibit 15-4)	*B*
Notes	

1. Note that the adjustment factor for level terrain is 1.00,as level terrain is one of the base conditions. For the purpose of grade adjustment, specific downgrade segments are treated as level terrain.
2. If v_i(v_d or v_o) >=1,700 pc/h, terminate analysis--the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only
5. Exhibit 15-20 provides coefficients a and b for Equation 15-10.
6. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

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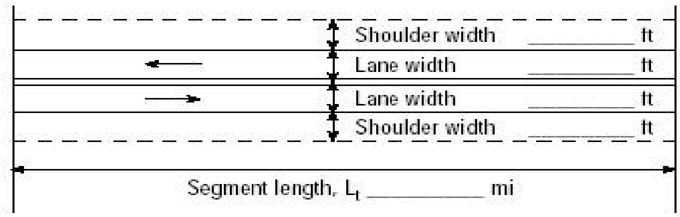
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

General Information		**Site Information**	
Analyst	*David Stoner*	Highway / Direction of Travel	*MT 86*
Agency or Company	*DOWL HKM*	From/To	*Bridger Bowl to Seitz Road*
Date Performed	*7/10/2014*	Jurisdiction	*Gallatin County*
Analysis Time Period	*Peak Hour*	Analysis Year	*2014*

Project Description: *Bridger Canyon Corridor*

Input Data



☐ Class I highway ☑ Class II highway ☐ Class III highway

Terrain ☐ Level ☑ Rolling

Grade Length mi Up/down

Analysis direction vol., V_d	*67*veh/h
Opposing direction vol., V_o	*69*veh/h
Shoulder width ft	*3.0*
Lane Width ft	*12.0*
Segment Length mi	*9.6*
Peak-hour factor, PHF	*0.84*
No-passing zone	*97%*
% Trucks and Buses , P_T	*2* %
% Recreational vehicles, P_R	*2%*
Access points *mi*	*4*/mi

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	*2.7*	*2.7*
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	*1.1*	*1.1*
Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.965*	*0.965*
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	*0.67*	*0.67*
Demand flow rate[2], v_i (pc/h) $v_i=V_i$ / (PHF* $f_{g,ATS}$ * $f_{HV,ATS}$)	*123*	*127*

Free-Flow Speed from Field Measurement

Mean speed of sample[3], S_{FM}	
Total demand flow rate, both directions, *v*	
Free-flow speed, FFS=S_{FM}+0.00776(*v*/ $f_{HV,ATS}$)	
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	*2.8 mi/h*

Estimated Free-Flow Speed

Base free-flow speed[4], BFFS	*50.6 mi/h*
Adj. for lane and shoulder width,[4] f_{LS}(Exhibit 15-7)	*2.6 mi/h*
Adj. for access points[4], f_A (Exhibit 15-8)	*1.0 mi/h*
Free-flow speed, FFS (FSS=BFFS-f_{LS}-f_A)	*47.0 mi/h*
Average travel speed, ATS_d=FFS-0.00776($v_{d,ATS}$ + $v_{o,ATS}$) - $f_{np,ATS}$	*42.2 mi/h*
Percent free flow speed, PFFS	*89.8 %*

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T(Exhibit 15-18 or 15-19)	*1.9*	*1.9*
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	*1.0*	*1.0*
Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.982*	*0.982*
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	*0.73*	*0.73*
Directional flow rate[2], v_i(pc/h) $v_i=V_i$/(PHF*$f_{HV,PTSF}$* $f_{g,PTSF}$)	*111*	*115*
Base percent time-spent-following[4], $BPTSF_d$(%)=100($1-e^{av_d^b}$)	*12.8*	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	*54.0*	
Percent time-spent-following, $PTSF_d$(%)=$BPTSF_d$+$f_{np,PTSF}$ *($v_{d,PTSF}$ / $v_{d,PTSF}$ + $v_{o,PTSF}$)	*39.3*	

Level of Service and Other Performance Measures

Level of service, LOS (Exhibit 15-3)	*A*
Volume to capacity ratio, *v/c*	*0.07*

Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h	*1118*
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	*1238*
Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only)	*89.8*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*79.8*
Effective width, Wv (Eq. 15-29) ft	*24.98*
Effective speed factor, S_t (Eq. 15-30)	*5.19*
Bicycle level of service score, BLOS (Eq. 15-31)	*1.46*
Bicycle level of service (Exhibit 15-4)	*A*

Notes

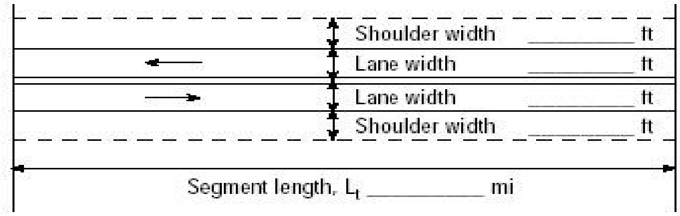
1. Note that the adjustment factor for level terrain is 1.00,as level terrain is one of the base conditions. For the purpose of grade adjustment, specific downgrade segments are treated as level terrain.
2. If v_i(v_d or v_o) >=1,700 pc/h, terminate analysis--the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only
5. Exhibit 15-20 provides coefficients a and b for Equation 15-10.
6. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

General Information		Site Information	
Analyst	*David Stoner*	Highway / Direction of Travel	*MT 86*
Agency or Company	*DOWL HKM*	From/To	*Seitz Road to Bridger Bowl*
Date Performed	*7/10/2014*	Jurisdiction	*Gallatin County*
Analysis Time Period	*Peak Hour*	Analysis Year	*2014*

Project Description: *Bridger Canyon Corridor*

Input Data



☐ Class I highway ☑ Class II highway ☐ Class III highway

Terrain ☐ Level ☑ Rolling

Grade Length mi Up/down

Analysis direction vol., V_d	*69*veh/h
Opposing direction vol., V_o	*67*veh/h
Shoulder width ft	*3.0*
Lane Width ft	*12.0*
Segment Length mi	*9.6*
Peak-hour factor, PHF	*0.74*
No-passing zone	*95%*
% Trucks and Buses , P_T	*0* %
% Recreational vehicles, P_R	*0%*
Access points *mi*	*4*/mi

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	*2.7*	*2.7*
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	*1.1*	*1.1*
Heavy-vehicle adjustment factor, $f_{HV,ATS}$=1/ (1+ P_T (E_T -1)+P_R (E_R -1))	*1.000*	*1.000*
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	*0.67*	*0.67*
Demand flow rate[2], v_i (pc/h) v_i=V_i / (PHF* $f_{g,ATS}$ * $f_{HV,ATS}$)	*139*	*135*

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
Mean speed of sample[3], S_{FM}		Base free-flow speed[4], BFFS	*49.4 mi/h*
Total demand flow rate, both directions, *v*		Adj. for lane and shoulder width,[4] f_{LS}(Exhibit 15-7)	*2.6 mi/h*
Free-flow speed, FFS=S_{FM}+0.00776(*v*/ $f_{HV,ATS}$)		Adj. for access points[4], f_A (Exhibit 15-8)	*1.0 mi/h*
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	*2.9 mi/h*	Free-flow speed, FFS (FSS=BFFS-f_{LS}-f_A)	*45.8 mi/h*
		Average travel speed, ATS_d=FFS-0.00776($v_{d,ATS}$ + $v_{o,ATS}$) - $f_{np,ATS}$	*40.7 mi/h*
		Percent free flow speed, PFFS	*89.0 %*

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T(Exhibit 15-18 or 15-19)	*1.9*	*1.9*
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	*1.0*	*1.0*
Heavy-vehicle adjustment factor, f_{HV}=1/ (1+ P_T(E_T-1)+P_R(E_R-1))	*1.000*	*1.000*
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	*0.73*	*0.73*
Directional flow rate[2], v_i(pc/h) v_i=V_i/(PHF*$f_{HV,PTSF}$* $f_{g,PTSF}$)	*128*	*124*
Base percent time-spent-following[4], $BPTSF_d$(%)=100(1-$e^{av_d^b}$)	*14.5*	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	*55.5*	
Percent time-spent-following, $PTSF_d$(%)=$BPTSF_d$+$f_{np,PTSF}$ *($v_{d,PTSF}$ / $v_{d,PTSF}$ + $v_{o,PTSF}$)	*42.7*	

Level of Service and Other Performance Measures

Level of service, LOS (Exhibit 15-3)	*B*
Volume to capacity ratio, *v/c*	*0.08*

Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h	*1173*
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	*1275*
Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only)	*89.0*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*93.2*
Effective width, Wv (Eq. 15-29) ft	*24.83*
Effective speed factor, S_t (Eq. 15-30)	*4.94*
Bicycle level of service score, BLOS (Eq. 15-31)	*1.05*
Bicycle level of service (Exhibit 15-4)	*A*

Notes

1. Note that the adjustment factor for level terrain is 1.00,as level terrain is one of the base conditions. For the purpose of grade adjustment, specific downgrade segments are treated as level terrain.
2. If v_i(v_d or v_o) >=1,700 pc/h, terminate analysis--the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only
5. Exhibit 15-20 provides coefficients a and b for Equation 15-10.
6. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

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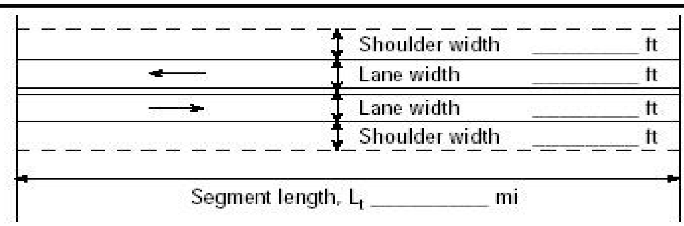
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

General Information		Site Information	
Analyst	*David Stoner*	Highway / Direction of Travel	*MT 86*
Agency or Company	*DOWL HKM*	From/To	*Seitz Road to US 89*
Date Performed	*7/10/2014*	Jurisdiction	*Gallatin County*
Analysis Time Period	*Peak Hour*	Analysis Year	*2014*

Project Description: *Bridger Canyon Corridor*

Input Data



☐ Class I highway ☑ Class II highway ☐ Class III highway

Terrain ☑ Level ☐ Rolling

Grade Length	mi	Up/down
Peak-hour factor, PHF		*0.81*
No-passing zone		*40%*
% Trucks and Buses , P_T		*0* %
% Recreational vehicles, P_R		*0%*
Access points *mi*		*4*/mi

Analysis direction vol., V_d	*60*veh/h
Opposing direction vol., V_o	*56*veh/h
Shoulder width ft	*3.0*
Lane Width ft	*12.0*
Segment Length mi	*12.2*

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	*1.9*	*1.9*
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	*1.0*	*1.0*
Heavy-vehicle adjustment factor, $f_{HV,ATS}$=1/ (1+ P_T(E_T-1)+P_R(E_R-1))	*1.000*	*1.000*
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	*1.00*	*1.00*
Demand flow rate[2], v_i (pc/h) v_i=V_i / (PHF* $f_{g,ATS}$ * $f_{HV,ATS}$)	*74*	*69*

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
Mean speed of sample[3], S_{FM}		Base free-flow speed[4], BFFS	*61.1 mi/h*
Total demand flow rate, both directions, *v*		Adj. for lane and shoulder width,[4] f_{LS}(Exhibit 15-7)	*2.6 mi/h*
Free-flow speed, FFS=S_{FM}+0.00776(*v*/ $f_{HV,ATS}$)		Adj. for access points[4], f_A (Exhibit 15-8)	*1.0 mi/h*
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	*1.5 mi/h*	Free-flow speed, FFS (FSS=BFFS-f_{LS}-f_A)	*57.5 mi/h*
		Average travel speed, ATS_d=FFS-0.00776($v_{d,ATS}$ + $v_{o,ATS}$) - $f_{np,ATS}$	*54.9 mi/h*
		Percent free flow speed, PFFS	*95.5 %*

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T(Exhibit 15-18 or 15-19)	*1.1*	*1.1*
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	*1.0*	*1.0*
Heavy-vehicle adjustment factor, f_{HV}=1/ (1+ P_T(E_T-1)+P_R(E_R-1))	*1.000*	*1.000*
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	*1.00*	*1.00*
Directional flow rate[2], v_i(pc/h) v_i=V_i/(PHF*$f_{HV,PTSF}$* $f_{g,PTSF}$)	*74*	*69*
Base percent time-spent-following[4], $BPTSF_d$(%)=100(1-$e^{av_d^b}$)	*8.8*	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	*43.0*	
Percent time-spent-following, $PTSF_d$(%)=$BPTSF_d$+$f_{np,PTSF}$ *($v_{d,PTSF}$ / $v_{d,PTSF}$ + $v_{o,PTSF}$)	*31.1*	

Level of Service and Other Performance Measures

Level of service, LOS (Exhibit 15-3)	*A*
Volume to capacity ratio, *v/c*	*0.04*

Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h	*0*
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	*1700*
Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only)	*95.5*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*74.1*
Effective width, Wv (Eq. 15-29) ft	*25.50*
Effective speed factor, S_t (Eq. 15-30)	*5.19*
Bicycle level of service score, BLOS (Eq. 15-31)	*0.81*
Bicycle level of service (Exhibit 15-4)	*A*

Notes

1. Note that the adjustment factor for level terrain is 1.00,as level terrain is one of the base conditions. For the purpose of grade adjustment, specific downgrade segments are treated as level terrain.
2. If $v_i(v_d$ or $v_o)$ >=1,700 pc/h, terminate analysis--the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only
5. Exhibit 15-20 provides coefficients a and b for Equation 15-10.
6. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

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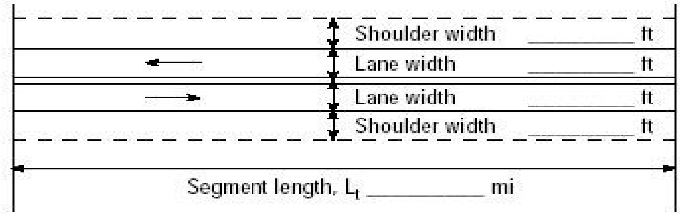
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

General Information		*Site Information*	
Analyst	*David Stoner*	Highway / Direction of Travel	*MT 86*
Agency or Company	*DOWL HKM*	From/To	*US 89 to Seitz Road*
Date Performed	*7/10/2014*	Jurisdiction	*Gallatin County*
Analysis Time Period	*Peak Hour*	Analysis Year	*2014*

Project Description: *Bridger Canyon Corridor*

Input Data



☐ Class I highway ☑ Class II highway ☐ Class III highway

Terrain ☑ Level ☐ Rolling

Grade Length mi Up/down

Peak-hour factor, PHF *0.84*

No-passing zone *36%*

% Trucks and Buses , P_T *4 %*

% Recreational vehicles, P_R *0%*

Access points *mi* *4/mi*

Analysis direction vol., V_d *56*veh/h

Opposing direction vol., V_o *60*veh/h

Shoulder width ft *3.0*

Lane Width ft *12.0*

Segment Length mi *12.2*

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	*1.9*	*1.9*
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	*1.0*	*1.0*
Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.965*	*0.965*
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	*1.00*	*1.00*
Demand flow rate[2], v_i (pc/h) $v_i=V_i/(PHF*f_{g,ATS}*f_{HV,ATS})$	*69*	*74*

Free-Flow Speed from Field Measurement		**Estimated Free-Flow Speed**	
Mean speed of sample[3], S_{FM}		Base free-flow speed[4], BFFS	*64.8 mi/h*
Total demand flow rate, both directions, *v*		Adj. for lane and shoulder width,[4] f_{LS}(Exhibit 15-7)	*2.6 mi/h*
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Adj. for access points[4], f_A (Exhibit 15-8)	*1.0 mi/h*
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	*1.6 mi/h*	Free-flow speed, FFS $(FSS=BFFS-f_{LS}-f_A)$	*61.2 mi/h*
		Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	*58.5 mi/h*
		Percent free flow speed, PFFS	*95.5 %*

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T(Exhibit 15-18 or 15-19)	*1.1*	*1.1*
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	*1.0*	*1.0*
Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.996*	*0.996*
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	*1.00*	*1.00*
Directional flow rate[2], v_i(pc/h) $v_i=V_i/(PHF*f_{HV,PTSF}*f_{g,PTSF})$	*67*	*72*
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	*8.0*	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	*40.3*	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	*27.4*	

Level of Service and Other Performance Measures

Level of service, LOS (Exhibit 15-3)	*A*
Volume to capacity ratio, *v/c*	*0.04*

Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h	*1641*
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	*1693*
Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only)	*95.5*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*66.7*
Effective width, Wv (Eq. 15-29) ft	*25.80*
Effective speed factor, S_t (Eq. 15-30)	*5.19*
Bicycle level of service score, BLOS (Eq. 15-31)	*1.72*
Bicycle level of service (Exhibit 15-4)	*B*
Notes	

1. Note that the adjustment factor for level terrain is 1.00,as level terrain is one of the base conditions. For the purpose of grade adjustment, specific downgrade segments are treated as level terrain.
2. If v_i(v_d or v_o) >=1,700 pc/h, terminate analysis--the LOS is F.
3. For the analysis direction only and for v>200 veh/h.
4. For the analysis direction only
5. Exhibit 15-20 provides coefficients a and b for Equation 15-10.
6. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.

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