Appendix B

Existing and Projected Conditions Report

US 2 - Badrock Canyon Corridor Planning Study

EXISTING AND PROJECTED CONDITIONS REPORT

PREPARED FOR:

MONTANA MDT DEPARTMENT OF TRANSPORTATION

PREPARED BY:

DOWL HKM
104 East Broadway, Suite G-1
P.O. Box 1009
Helena, Montana 59624
(406) 442-0370

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1.0 INTRODUCTION

This report presents updated information about existing and projected conditions within the study area for the US 2 - Badrock Canyon Corridor Planning Study. The report will serve as a planning level overview to assist in identifying constraints and opportunities in the corridor.

The study area extends approximately one-quarter mile on either side of US Highway 2 (US 2) beginning at Reference Post (RP) 140.0 and ending at RP 142.4. The study area is located within Sections 6 and 7, Township 30 North, Range 19 West, Montana Meridian and Sections 1, 2, 11 and 12, Township 30 North, Range 20 West, Montana Meridian, all within Flathead County. Figure 1-1 illustrates the study area.

1.1 Previous Planning Efforts in US 2 – Badrock Canyon Corridor

In 1995, the Columbia Heights-Hungry Horse Final Environmental Impact Statement (FEIS) / Section 4(f) Evaluation was completed to assess the impacts of reconstructing 4.5 miles of US 2 from approximate RP 138.3 to RP 142.7 between Columbia Heights and Hungry Horse in Flathead County, Montana. The Federal Highway Administration (FHWA) signed a Record of Decision (ROD) on the FEIS on December 22, 1995. The ROD approved Alternative 1, which entailed a four- and five-lane design for the reconstruction of US 2. Pursuant to the FEIS, MDT initiated two reconstruction projects within the Columbia Heights-Hungry Horse corridor. The Columbia Heights-East project extended from RP 138.3 to RP 140.1, and the Hungry Horse-West project extended from RP 140.1 to RP 142.7.

In the years following completion of the Columbia Heights-Hungry Horse FEIS and ROD, Flathead County experienced substantial growth, which resulted in the need to update traffic volumes and accident rates. Federal and state regulations relevant to some of the project activities had changed. Additionally, other concerns were identified that required MDT to make minor design modifications or that had the potential to dictate new and more notable project design changes. Some of these design activities resulted in more accurate quantification of the environmental effects disclosed in the FEIS. Lastly, controversy surrounded the alternative approved in the ROD. For these reasons, MDT conducted an Environmental Re-evaluation of the FEIS and Section 4(f) Evaluation in 2002.

The Re-evaluation concluded that the FEIS adequately described the impacts associated with reconstruction of US 2 within the limits of the Columbia Heights-East project. This reconstruction project proceeded and was completed in 2004. The Re-evaluation also concluded the FEIS adequately discussed the environmental effects of building a new bridge across the South Fork of the Flathead River (referred to in this report as the South Fork Flathead River Bridge). The Re-evaluation found that the preferred alternative discussion in the FEIS and ROD did not adequately address environmental effects of reconstructing US 2 through Badrock Canyon (RP 140.1 to RP 141.2) on an alignment that minimized or totally avoided rock excavation near Berne Memorial Park. Since the Re-evaluation, additional information was identified regarding Native American cultural concerns in the area and potential impacts to a natural gas transmission pipeline. The Re-evaluation called for a Supplemental Environmental Impact Statement (SEIS) to be prepared for this segment of the corridor.

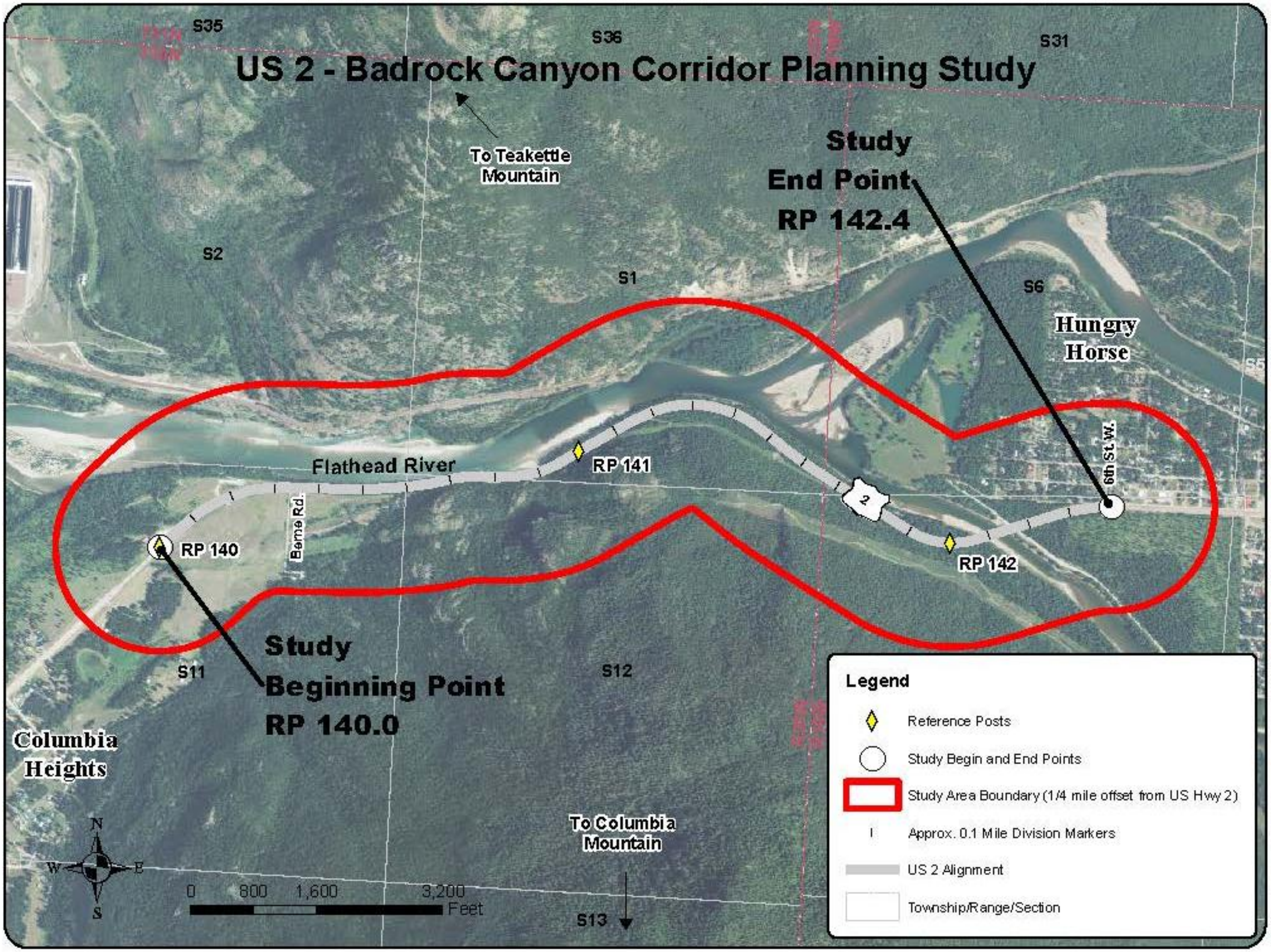
In early 2011, members of communities in proximity to Badrock Canyon approached MDT regarding potential improvements to US 2 through Badrock Canyon. In lieu of preparing a SEIS at this time, MDT hosted an informational meeting to identify community concerns within the corridor. Based on comments provided during the meeting as well as written comments submitted during the comment period from May 12 to May 20, 2011, MDT determined there is local interest in pursuing further analysis of the corridor. This effort, referred to as Phase I, was completed in June 2011. Phase II will entail further analysis and completion the corridor study for the portion of the corridor from US 2 between RP 140.0 and RP 142.4 (the approximate intersection of US 2/6th Street West).

Using information previously gathered as a baseline guide, this report provides updated information about existing and projected conditions within the study area for the US 2 - Badrock Canyon Corridor Planning Study. The report will serve as a planning level overview to assist in identifying constraints and opportunities in the corridor.

1.2 Report Organization

The report is divided into five chapters. Following the introduction provided in Chapter 1, Chapter 2 discusses existing conditions in the corridor, focusing on transportation system conditions, including physical features and characteristics, geometric characteristics, crash statistics, traffic volumes, and operational characteristics, as well as existing land use and environmental conditions. Chapter 3 presents projected transportation system conditions relating to anticipated future traffic volumes and transportation system operations. Chapter 4 discusses recent projects in the study corridor, and Chapter 5 provides a summary of issues and concerns in the corridor.

Figure 1-1 Study Area



Source: MDT, 2011; NRIS, 2011; DOWL HKM, 2011.

2.0 EXISTING CONDITIONS

2.1 Transportation System Conditions

This section discusses the highway transportation system within the study corridor including physical features, geometric characteristics, crash history to date, traffic volumes, and operational characteristics.

2.1.1 Physical Features and Characteristics

Physical features and characteristics of the highway corridor were identified through field observation and a review of published statistics, documentation, GIS data, and MDT record drawings (also called as-built drawings). A field review of the corridor was conducted in October 2011 to assist in identifying opportunities and constraints within the corridor. Appendix 1 contains a summary memorandum and a photo log documenting conditions observed in the field.

Roadway Functional Classification

Functional classification is a system that classifies public roads and highways in accordance with Federal Highway Administration (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. US 2 is part of the National Highway System (NHS). The NHS includes highways Congress has determined to have the greatest national importance to transportation, commerce, and defense. US 2 is functionally classified as a rural principal arterial. Arterials generally have higher design standards than other roads and many principal arterials have multiple lanes with some degree of access control.

US 2 is the northern-most east-west U.S. highway in the United States and spans a total distance of nearly 2,600 miles. Within the study area, US 2 is a two-lane highway serving the neighboring communities of Columbia Falls and Hungry Horse.

Bridges

MDT evaluates the current sufficiency of bridges in terms of structural adequacy and safety, serviceability and functional obsolescence, and essentiality for public use. The MDT Bridge Bureau identified a single bridge within the study area. The bridge crosses the South Fork of the Flathead River before entering Hungry Horse at RP 142.3.

Originally constructed in 1938, the bridge has five main spans and two approach spans, with a deck width of 26 feet. Recent scheduled bridge inspections have noted some deterioration, including concrete deck cracking and spalling (i.e., a depression in the surface of a concrete slab resulting from fracture), exposed reinforcing bars, and rusting of steel components. The bridge is functionally obsolete and structurally deficient.

The term "functionally obsolete" indicates that the bridge was built to standards that are no longer used today. This does not imply that the bridge is unsafe, rather, the bridge does not meet current standards for lane widths, shoulder widths, or approach geometry to serve current traffic demand.

Bridges are considered structurally deficient if significant load carrying elements are found to be in poor condition due to deterioration or if they were designed using smaller loads than the current legal load limit. The term "structurally deficient" does not imply that the bridge is unsafe. A structurally deficient bridge, when left open to traffic, typically requires higher levels of maintenance and repair to remain in service and eventual rehabilitation or replacement to address deficiencies.

Eligibility for federal aid for rehabilitation or replacement of a bridge is determined based on the functional or structural status of the bridge and its sufficiency rating. The sufficiency rating point calculation is based on a 0 to 100 scale and compares the existing bridge to a new bridge designed to current engineering standards. A lower sufficiency rating indicates a higher priority for funding. Based on an October 2010 inspection conducted by MDT, the South Fork Flathead River Bridge has a sufficiency rating of 27.6. The bridge crossing the South Fork of the Flathead River is eligible for replacement due to its classification as structurally deficient/functionally obsolete and its low sufficiency rating.

Appendix 2 includes a detailed bridge inspection form containing additional information about the South Fork Flathead River Bridge, as well as plan sheets and detail drawings. Due to the planning level focus of this study, a separate structural analysis of the bridge was not conducted. Although the 2002 Re-evaluation concluded the FEIS adequately discussed the environmental effects of building a new bridge across the South Fork of the Flathead River, the bridge crossing is included in this corridor study because it has not yet been replaced.

Guardrail

W-beam guardrail is currently in place on the north side of US 2 throughout much of the corridor, while thrie-beam guardrail is used at the South Fork Flathead River Bridge. Guardrail end sections in the study corridor do not meet current MDT design standards, with the exception of the end section located at RP 141.4±.

Railroad Facilities

A rail line owned and operated by BNSF Railway generally parallels the main stem of the Flathead River north of and across the river from US 2 throughout the length of the corridor. Figure 2-1 illustrates the location of the rail facility.

Bicycle and Pedestrian Facilities

There are no dedicated bicycle or pedestrian facilities directly adjacent to US 2. Bicycle and pedestrian usage data was not collected for this study. Berne Memorial Park, located to the south of US 2 at RP 140.9±, includes isolated walking trails. As described in more detail in Section 2.3.3, this area was deeded to MDT in 1953 for use as a roadside park.

Drainage Conditions

Roadside ditches run adjacent to US 2, and culverts convey water beneath US 2 at various locations. Appendix 1 contains photographs of culverts observed in the field. Figure 2-1 illustrates culvert locations surveyed in 2004.

Based on information from MDT maintenance personnel, ice forms on the rock outcroppings adjacent to US 2 in winter months. During periods of snow melt, water ponds and flows across the roadway near RP 140.7 and RP 140.9.

Utilities

NorthWestern Energy owns and operates a 10-inch diameter high pressure natural gas transmission pipeline that generally runs along the south side of US 2 and is the only line serving the Flathead Valley area. In some locations where the rock outcroppings encroach upon the roadway, the line may be located directly under the road surface.

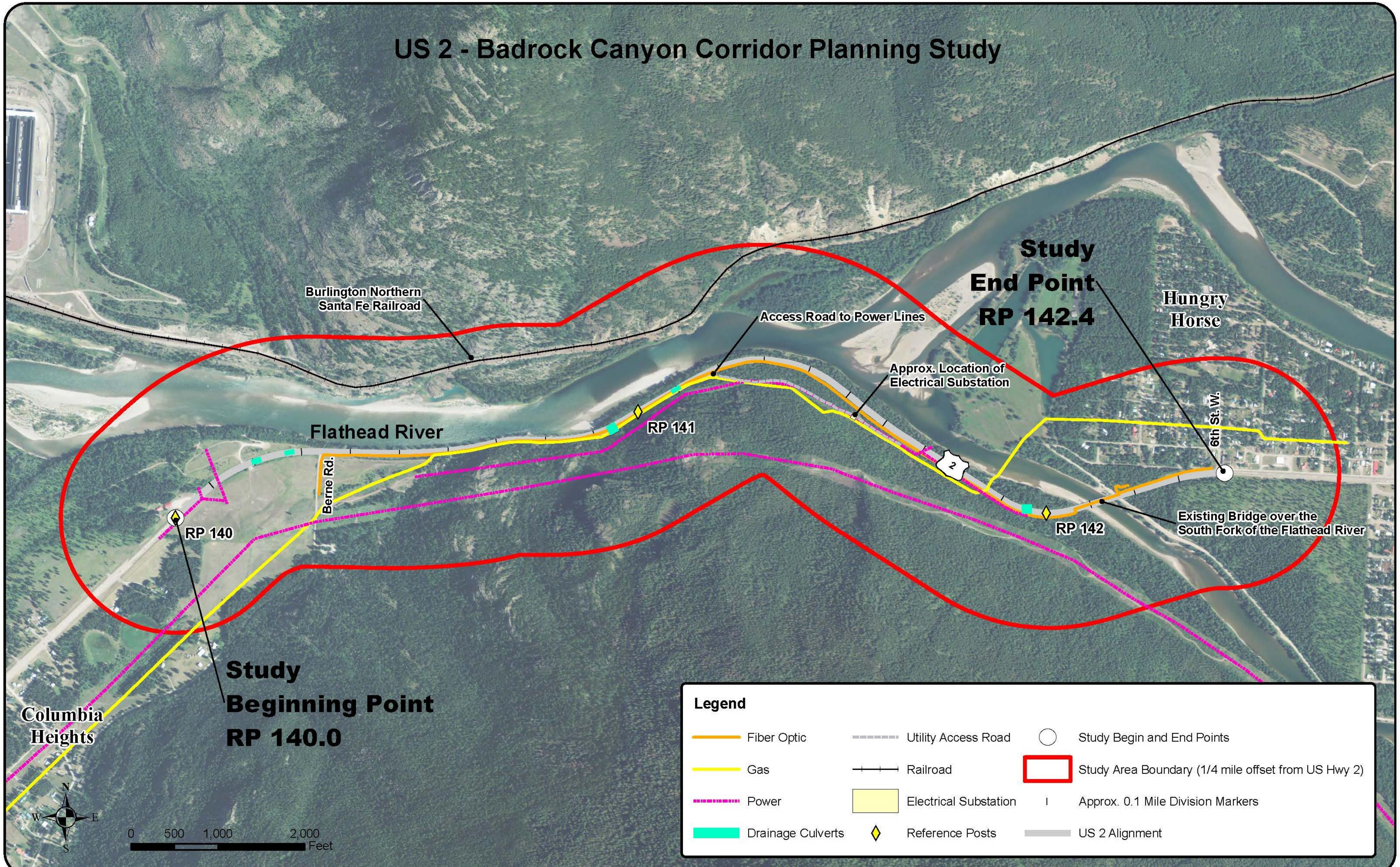
Overhead power transmission lines owned by Flathead Electric Cooperative, Inc. (FEC) generally run south of and roughly parallel to US 2 through the canyon. An FEC electrical substation is located approximately 200 ft south of US 2 at RP 141.8±. Unpaved road approaches at RP 141.1± and RP 141.8± provide access to the FEC facilities.

A high voltage transmission line owned and operated by Bonneville Power Administration (BPA) runs from Hungry Horse Dam along the ridgeline at the southerly study area margin.

AT&T owns and operates an underground fiber optic cable that generally runs along the south side of US 2.

Figure 2-1 illustrates the approximate location of utilities in the corridor.

Figure 2-1 Physical Features



Source: MDT, 1995, 2011; NRIS, 2011; DOWL HKM, 2011.

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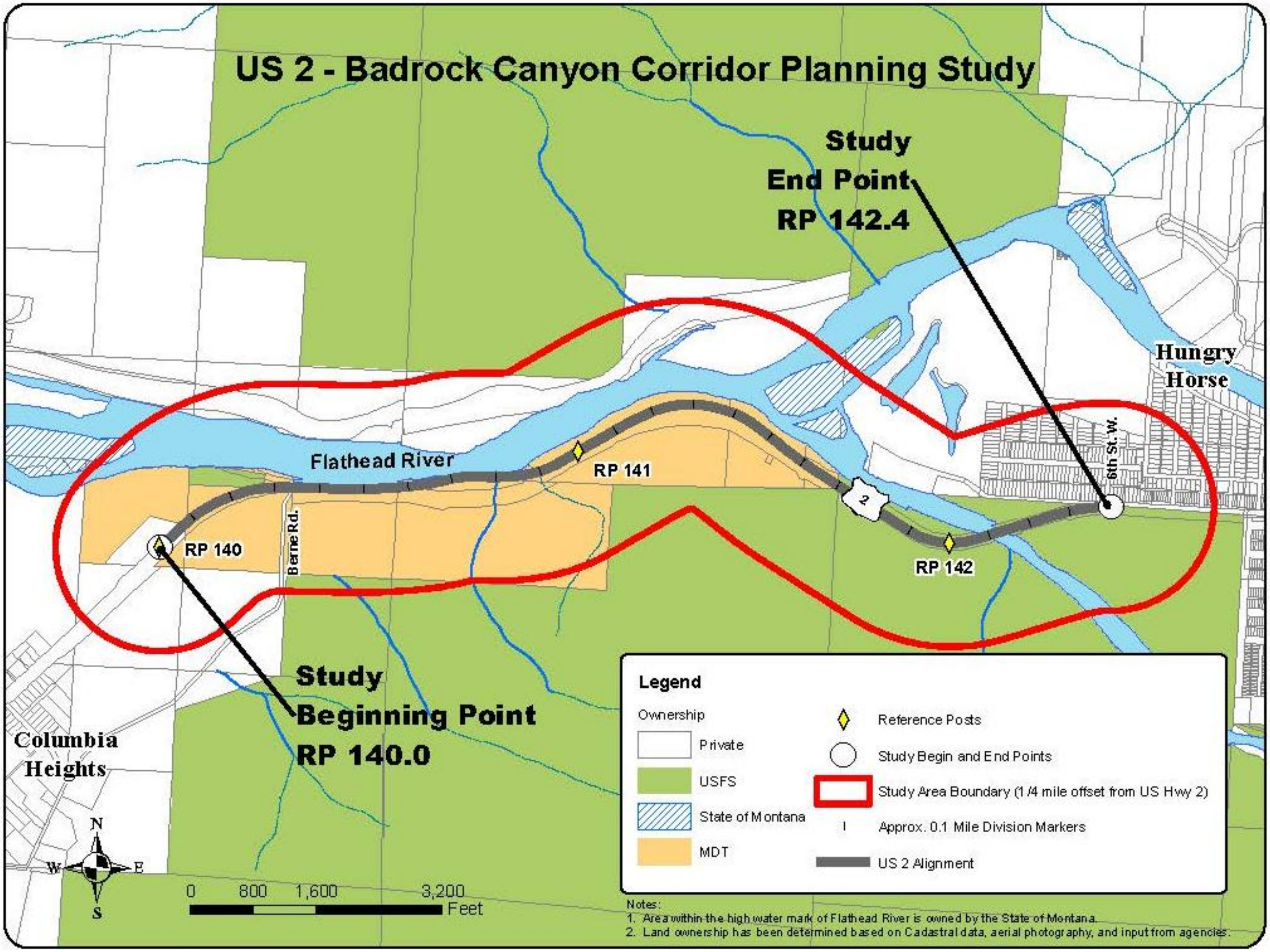
Right-of-Way and Land Ownership

Right-of-way boundaries and widths have been estimated for the purpose of this study based upon a review of cadastral data, available MDT record drawings, and MDT right-of-way plans. Right-of-way widths vary throughout the corridor. Figure 2-2 illustrates land owned by MDT within the corridor. Appendix 3 includes plans showing approximated right-of-way boundaries.

Within the study area, US 2 is bordered by land held in private ownership, lands owned by MDT, and land areas administered by the U.S. Forest Service (USFS). As noted in the Re-evaluation, MDT acquired a series of parcels owned by the Simpson Family Trust following completion of the FEIS. The parcels comprised a large private landholding south of US 2 between Berne Road (RP 140.3±) and Hungry Horse. This acquisition provided MDT with right-of-way for roadway improvements and prevented the development of incompatible land uses along US 2. MDT obtained an easement from USFS for the portions of US 2 traversing USFS land areas at the eastern end of the study corridor.

Figure 2-2 Land Ownership in Study Corridor



Source: NRIS, 2011; MDT, 2011; DOWL HKM, 2011, USFS 2012.

2.1.2 Geometric Characteristics and Roadway Elements

Design Criteria and Guidelines

Table 2.1 presents MDT geometric design criteria for rural principal arterials (National Highway System – Non Interstate). Additionally, Chapters 9, 10, and 12 of the MDT Roadway Design Manual (December 2008) were consulted for guidance regarding horizontal and vertical alignments. Previous studies conducted for the 1995 FEIS and 2004 SEIS efforts were also reviewed.

The design speed used for analysis of the US 2 study corridor is 60 miles per hour (mph) in combination with a rolling terrain type as used in the FEIS and Re-evaluation. The posted speed limit within the corridor is 55 mph.

Initial design work conducted in 2004 used a design speed of 60 mph in combination with a mountainous terrain type. The existing roadway alignment generally exhibits rolling characteristics despite mountainous conditions occurring directly to the south of US 2. In an effort to maintain consistency with MDT's design criteria guidelines and the characteristics of the existing roadway alignment, a rolling terrain type was used in conducting the geometric analysis for this study.

Table 2.1 Design Criteria for Rural Principal Arterials

Element			Criteria
Design Controls	Design Forecast Year (Geometrics)		20 Years
	Design Speed	Rolling Terrain	60 mph
	Level of Service (LOS)		B
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
		10 ft to 15 ft	3:1
		15 ft to 20 ft	2:1
		> 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		570 ft
	Passing Sight Distance		2135 ft
	Minimum Horizontal Curve Radius (e=8%)		1200 ft
	Vertical Curvature (K-Value)	Crest Vertical Curve	151
		Sag Vertical Curve	136
	Maximum Grade	Rolling Terrain	4%
	Minimum Vertical Clearance		17 ft

Source: MDT Road Design Manual, Chapter 12, page 12(7), Figure 12-3, "Geometric Design Criteria for Rural Principal Arterials (National Highway System – Non Interstate) U.S. Customary," December 2008.

Roadway Width

Within the study area, US 2 is a two-lane undivided highway with two 12-foot travel lanes and nonexistent shoulders. Table 2.2 provides information on the roadway width and surface thickness throughout the corridor based on the 2011 MDT Road Log. According to the MDT NHS Route Segment Map reference, the suggested roadway width for US 2 is 40 feet or greater, which would allow two 12-foot travel lanes and two eight-foot shoulders. However, the Route

Segment Plan no longer defines a standard roadway width. The MDT Roadway Width Committee would determine the appropriate width during future project development.

Table 2.2 Highway Width and Surface Thickness

Location (RP)	Surface Thickness (inches)	Base Thickness (inches)	Surface Width (feet)	Lanes	Lane Width (feet)	Shoulder Width (feet)
140.084	4.0	4.0	24	2	12	0
140.119	5.0	4.0	24	2	12	0
140.414	4.0	5.0	24	2	12	0

Source: MDT, 2011.

Horizontal Alignment

Horizontal alignment is a measure of the degree of turns and bends in the road, and includes consideration of horizontal curvature, superelevation, curve type, and entering and passing sight distance. For a design speed of 60 mph, the MDT Road Design Manual recommends a minimum curve radius of 1,200 feet (ft), a minimum stopping sight distance of 570 ft, and a minimum curve length of 900 ft (which is applicable only for curves with deflection angles of five degrees or less).[1] Based on these criteria and a review of available data, it appears that nine of the 14 horizontal curves within the corridor do not meet current MDT design standards for curve radius, stopping sight distance, and/or curve length. Superelevation was not assessed due to lack of available data. Table 2.3 and Figure 2-3 present horizontal alignment information for the corridor. It is MDT practice to use a spiral curve when the curve radius is less than 3,820 ft. Because curve type is not listed in the MDT Road Design Manual as a design requirement, curve type is not considered in the Pass/Fail determination listed in Table 2.3.

Exact values for curve design elements, including radius, superelevation, and type of curve, could not be precisely determined based on available survey data and record drawings. Design elements listed in Table 2.3 are approximated, and determinations are based on the best available data.

[1] Per MDT Road Design Manual, page 9.2(7), Section 9.2.7.1b.

Vertical Alignment

Vertical alignment is a measure of the elevation change on a roadway, and 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. Table 2.4 and Figure 2-3 present vertical alignment information for the US 2 corridor. Available data indicate that six vertical curves fail to meet current MDT design standards.

Exact values for curve design elements could not be precisely determined based on available survey data and record drawings. Design elements listed in Table 2.4 are approximated, and determinations are based on the best available data.

Table 2.3 Horizontal Alignment Analysis

Curve PI[1] (RP)	Curve PI[1] (Station)	Curve Type	Curve Length (ft)	Radius (ft)	Deflection Angle[2]	Design Speed (mph)	Min. Sight Obstruction (ft)	Meet Min. Stopping Sight Distance (570 ft)	Curve Type Correct[3]	Meet Min. Radius (1200 ft)	Meet Min. Curve Length (900 ft)	Curve Pass/Fail
140.2	21+37	Simple	1,490	1,910	44°41'42"	60	21.2	YES	NO	YES	N/A	**PASS**
140.5	37+71	Simple	123	1,910	3°40'30"	60	21.2	YES	NO	YES	NO	**FAIL**
140.6	42+69	Simple	118	1,910	3°32'00"	60	21.2	YES	NO	YES	NO	**FAIL**
140.6	46+11	Simple	275	1,910	8°15'00"	60	21.2	NO	NO	YES	N/A	**FAIL**
140.7	50+51	Simple	249	1,000	14°17'35"	60	40.3	NO	NO	NO	N/A	**FAIL**
140.8	56+32	Simple	304	2,700	6°26'37"	60	15.0	YES	NO	YES	N/A	**PASS**
140.9	60+79	Simple	583	1,400	23°52'33"	60	28.9	NO	NO	YES	N/A	**FAIL**
141.5	75+59	Simple	492	1,910	14°45'41"	60	21.2	YES	NO	YES	N/A	**PASS**
141.6	81+47	Simple	411	900	26°08'32"	60	44.7	NO	NO	NO	N/A	**FAIL**
141.7	88+20	Simple	538	1,150	26°49'12"	60	35.1	NO	NO	NO	N/A	**FAIL**
141.7	93+47	Simple	40	1,910	1°11'09"	60	21.2	YES	NO	YES	NO	**FAIL**
141.7	98+14	Simple	311	2,950	6°02'03"	60	13.8	YES	NO	YES	N/A	**PASS**
141.9	118+92	Simple	912	1,050	49°45'37"	60	38.4	NO	NO	NO	N/A	**FAIL**
142.1	138+48	Simple	844	2,400	20°08'21"	60	16.9	YES	NO	YES	N/A	**PASS**

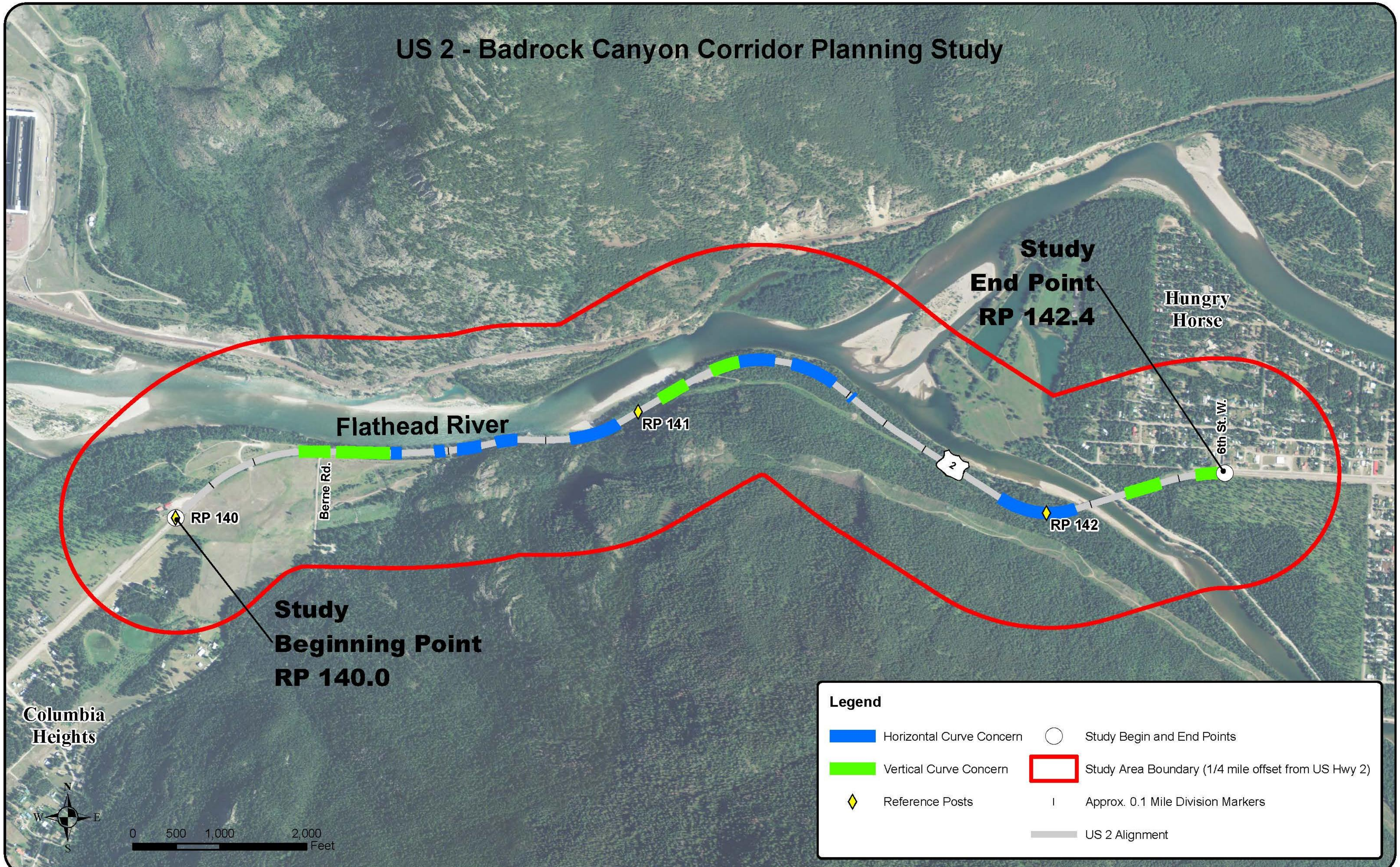
Source: MDT, 2011; DOWL HKM, 2011; MDT Record Drawings; MDT Road Design Manual, pages 9.2(1), 9.2(7), 9.5(1), 12(7). All values are approximated based on available data.
(1) PI indicates the point of tangent intersection, which is defined as the intersection of the initial and final tangents.
(2) Deflection 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) 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.

Table 2.4 Vertical Alignment Analysis

Curve PVI[1] (RP)	Curve PVI[1] (Station)	Curve Type[2]	Curve Length (ft)	K Value[3]	Grade Back	Grade Ahead	Design Speed (mph)	Meet Min. K Value (151 Crest / 136 Sag)	Meet Max. Grade (4%)	Meet Min. Curve Length[4] (180 ft required / 1000 ft recommended)	Curve Pass/Fail
140.00	10+00	NA	NA	NA	-1.896%	-1.896%	60	N/A	YES	N/A	**PASS**
140.04	12+23	NA	NA	NA	-1.896%	-1.531%	60	N/A	YES	N/A	**PASS**
140.07	13+98	NA	NA	NA	-1.531%	-2.150%	60	N/A	YES	N/A	**PASS**
140.18	20+28	SAG	720	193	-2.150%	1.583%	60	YES	YES	YES	**PASS**
140.33	28+30	CREST	360	53	1.583%	-5.272%	60	NO	NO	YES	**FAIL**
140.42	33+86	SAG	615	116	-5.272%	0.047%	60	NO	NO	YES	**FAIL**
141.51	70+98	SAG	350	72	0.047%	4.912%	60	NO	NO	YES	**FAIL**
141.57	77+87	CREST	375	75	4.912%	-0.085%	60	NO	NO	YES	**FAIL**
141.60	81+60	NA	NA	NA	-0.085%	0.429%	60	N/A	YES	N/A	**PASS**
141.66	89+38	NA	NA	NA	0.429%	0.079%	60	N/A	YES	N/A	**PASS**
141.74	99+17	CREST	500	251	0.079%	-1.915%	60	YES	YES	YES	**PASS**
141.84	111+00	SAG	750	325	-1.915%	0.394%	60	YES	YES	YES	**PASS**
141.94	122+73	NA	NA	NA	0.394%	0.324%	60	N/A	YES	N/A	**PASS**
142.01	131+25	SAG	420	75	0.324%	5.904%	60	NO	NO	YES	**FAIL**
142.10	141+26	CREST	750	128	5.904%	0.042%	60	NO	NO	YES	**FAIL**
142.16	149+41	NA	NA	NA	0.042%	0.042%	60	N/A	YES	N/A	**PASS**

Source: MDT, 2011; DOWL HKM, 2011; MDT Record Drawings; MDT Road Design Manual, pages 10.5(1), 10.5(3), 10.5 (5), 10.5(7), 12(7). All values are approximated based on available data.
(1) PVI indicates the point of vertical intersection, which is defined as the intersection of the initial and final grades.
(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) See MDT Road Design Manual pages 10.5(3) and 10.5(7).
NA indicates locations with no vertical curve (vertical grade only).

Figure 2-3 Geometric Features in Study Corridor



Source: NRIS, 2011; MDT, 2011; DOWL HKM, 2011.

2.1.3 Crash Analysis

MDT provided crash data for the portion of the US 2 corridor from RP 140.0 to 142.4 for the five-year period from January 1, 2006 to December 31, 2010. During this period, a total of 77 crashes occurred within the corridor, as illustrated in Figure 2-4.

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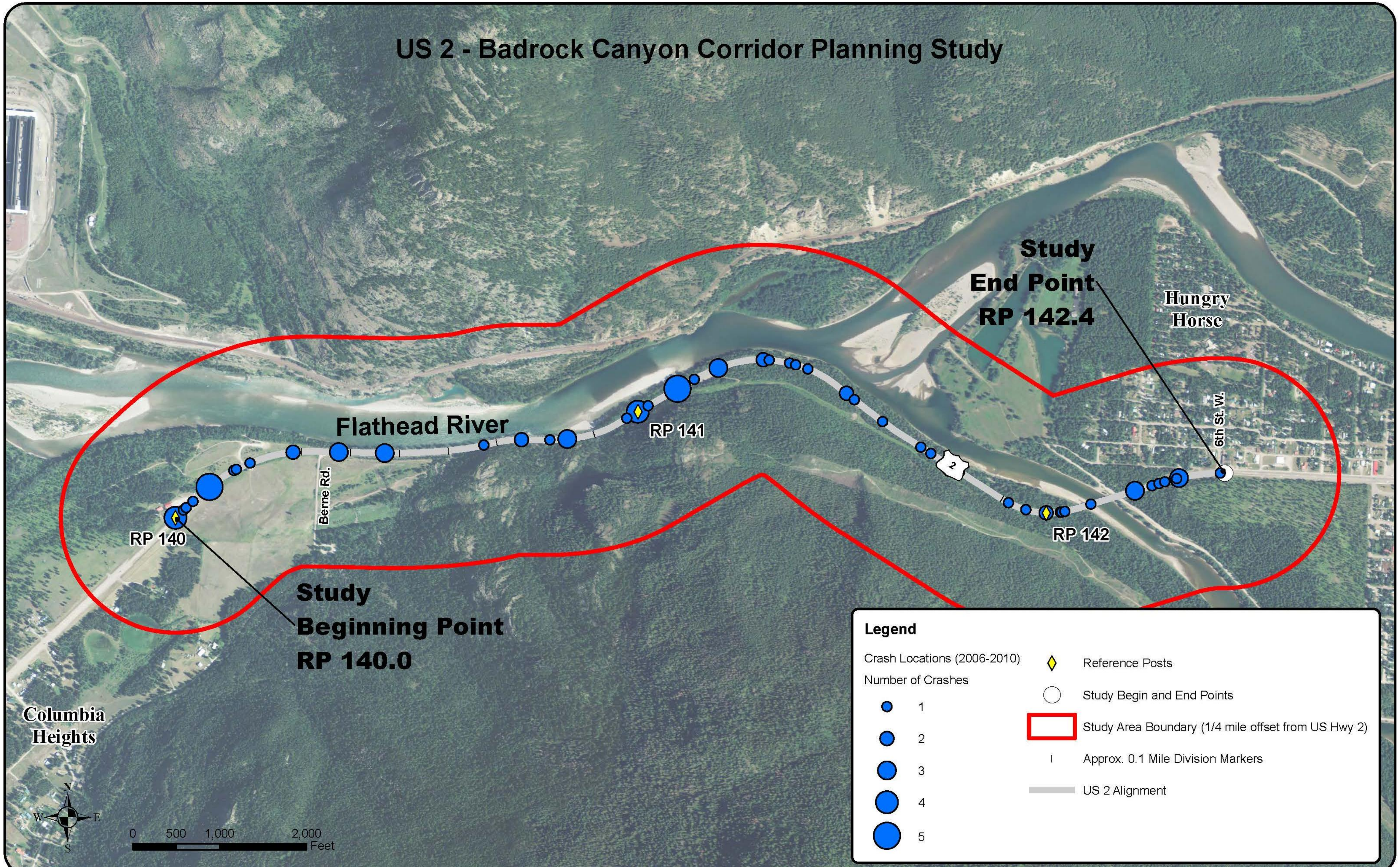
Figure 2-4 Crash Locations (2006 – 2010)



Source: NRIS, 2011; MDT, 2011; DOWL HKM, 2011.

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Engineers assess crash rate, severity rate, and severity index to identify safety concerns. MDT defines the crash rate as a measure of total reported crashes per million vehicle miles of travel. The severity index provides a weighted assessment of crashes, with fatal crashes and crashes resulting in incapacitating injuries weighted more heavily than crashes resulting in less serious injuries or property damage only. The severity rate is calculated by multiplying the crash rate and severity index, providing a weighted measure of crashes per million vehicle miles of travel. Crash rate, severity rate, and severity index for the US 2 corridor are presented in Table 2.5.

The crash rate for the US 2 corridor over the 2006 to 2010 period was nearly 2.5 times higher than statewide averages for similar facilities, while the severity rate was more than three times higher than statewide average figures during this time period.

Table 2.5 Crash History Comparison (Statewide Average vs. US 2 Corridor)

Criteria	Statewide Average for Rural Non-Interstate National Highway System (2006 – 2010)	US 2 Corridor RP 140.0 – 142.4 (2006 – 2010)	Comparison of US 2 Corridor to Statewide Average
Crash Rate (All Vehicles)	1.04	2.56	2.46 times higher
Severity Index (All Vehicles)	2.09	2.68	1.28 times higher
Severity Rate (All Vehicles)	2.18	6.86	3.15 times higher

Source: MDT, 2011.

As a result of the crashes in the corridor, a total of 45 injuries and 5 fatalities occurred during the analysis period. All of the fatal crashes within the US 2 corridor occurred at the western end of the study corridor (RP 140.0 – 140.5). Speed was identified as a factor in 22% (17 out of 77) of all crashes within the corridor during the analysis period.

The majority of crashes within the US 2 corridor (56 out of 77, or 73%) were classified as "other." Crashes classified as "other" generally were single vehicle incidents (53 out of 56, or 95%). Half of crashes classified as "other" (28 out of 56, or 50%) occurred during daylight conditions, while over one-third occurred during dark not lit conditions (20 out of 56, or 36%). With regard to road conditions, 22 out of 56 (39%) crashes classified as other occurred on dry roads, while 17 out of 56 (30%) of other crashes occurred during ice conditions.

Rear-end crashes accounted for 10% (8 out of 77) of all crashes in the corridor. Rear-end crashes were evenly split between the eastbound (EB) and westbound (WB) directions.

Head-on crashes accounted for 10% (8 of 77) of all crashes in the corridor, which is a particularly high percentage since the entire corridor is striped as a no-passing zone. Four (50%) of the eight head-on crashes occurred under snow or icy roadway conditions and dawn or dark/not lit conditions, while the remaining four crashes occurred under dry daylight conditions. Four of the head-on crashes occurred during winter months, while the remaining four crashes occurred during summer or fall months. Alcohol was listed as a contributing factor in one crash and inattentive driving was listed as a contributing factor in another crash. Wild animals were not listed as a factor in any of the head-on crashes. Head-on crashes occurred predominantly during week days, with only one crash occurring on a weekend. Of particular note, seven (88%) of the eight total head-on crashes occurred within the first half-mile of the corridor from RP 140.0 to RP 140.5.

In terms of weather conditions, the largest percentage (30 out of 77, or 39%) of crashes occurred during clear conditions. One-third of crashes (23 out of 77) occurred under cloudy conditions and 18 out of 77 (23%) of crashes occurred during snowy conditions.

Over the five-year analysis period from 2006 to 2010, a total of eight reported crashes (10%) involved wild animals; additional unreported crashes involving wild animals may have occurred during this period. Of the eight reported crashes involving wild animals that occurred within the corridor during the analysis period, six (75%) occurred in the first-half-mile of the corridor from RP 140.0 to 140.5 west of the canyon. Similarly, maintenance data indicate that 11 (85%) of the 13 total carcasses collected from 2006 to 2010 were recorded in the first half-mile of the corridor from RP 140.0 to 140.5 No carcasses were observed during field surveys in 2004 and 2011 that might indicate usage or movement patterns or conflict points with vehicles.

The highest number of crashes occurred in January (11 out of 77, or 14%) and December (10 out of 77, or 13%) despite low average daily traffic (ADT) volumes during these months as compared to other months of the year. A higher number of crashes occurred on a Saturday (17 out of 77, or 22%) as compared to other days of the week.

Appendix 4 contains additional crash data for the corridor according to time of crash, light, road, and weather conditions; type of crash; and contributing circumstances.

2.1.4 Traffic Volumes

Traffic Characteristics and Travel Patterns

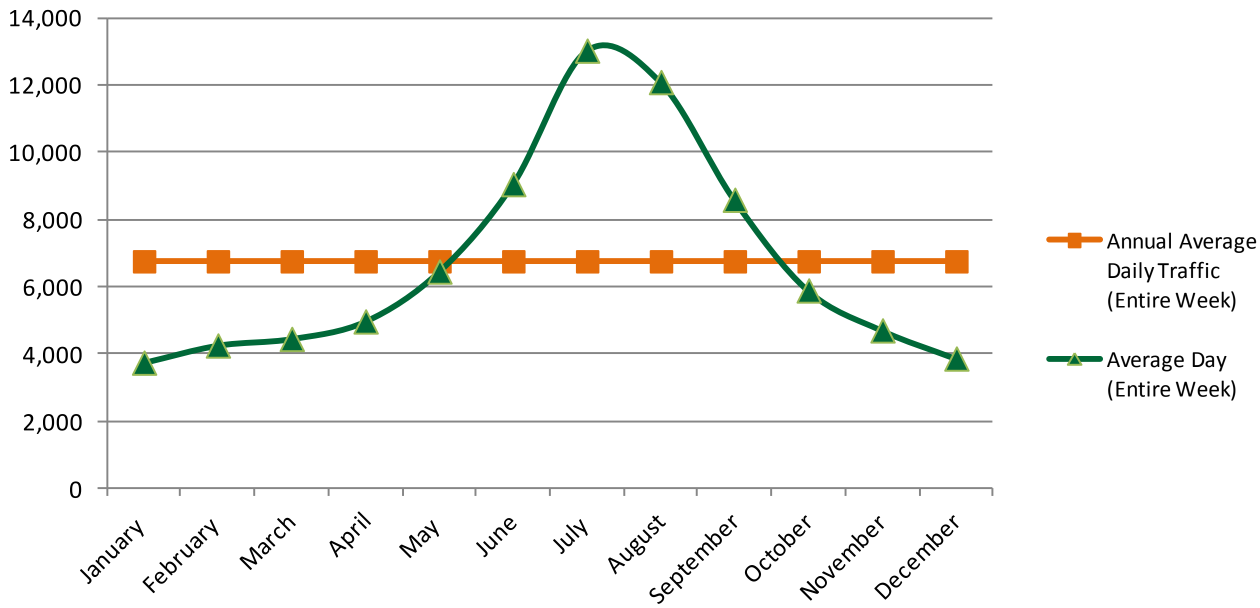
The primary users of this route are local residents, commuters, commercial truck drivers, recreational users, and tourists traveling to Glacier National Park and other regional attractions. The motorized vehicle mix includes automobiles, light trucks, delivery vans, intercity passenger buses, school buses, motorcycles, tractor trailers, and semi-trucks.

During the Phase I effort conducted for this study, community members commented on the usage of the US 2 – Badrock Canyon corridor by Canadian tourists and questioned whether the characteristics of the corridor influence potential routes of travel from Canada to Glacier National Park (GNP). Canadian travelers originating from the east side of the Continental Divide would generally enter the country using Montana highways located on the east side of GNP (including I-15, US 89, and US 2 east of the study area). Badrock Canyon would not affect route decisions for these travelers. Canadian travelers originating from points west of the study corridor would generally enter the country using US 93 and ultimately US 2 west of GNP, necessitating travel through Badrock Canyon. For these travelers, a detour route avoiding Badrock Canyon and instead following Highway 3 east through Canada would increase the total trip distance substantially. Based on overall trip distances from Canadian communities to GNP, it is unlikely that the 2.4-mile Badrock Canyon corridor would influence route selection.

Annual Average Daily Traffic Volumes

Annual Average Daily Traffic (AADT) is the total of all motorized vehicles traveling in both directions on a highway on an average day. MDT operates an Automatic Traffic Recorder (ATR) just west of the US 2 study corridor (RP 139.6). Figure 2-5 and Appendix 5 present AADT volumes from this ATR location in 2010. The US 2 study corridor is traveled more heavily during summer months as compared to other months of the year, with an average of 13,036 and 12,100 vehicles per day traveling through the corridor in July and August, respectively. Higher summer volumes reflect recreational use of this route. The volumes represented in Figure 2-5 account for all vehicles, including domestic and international travelers.

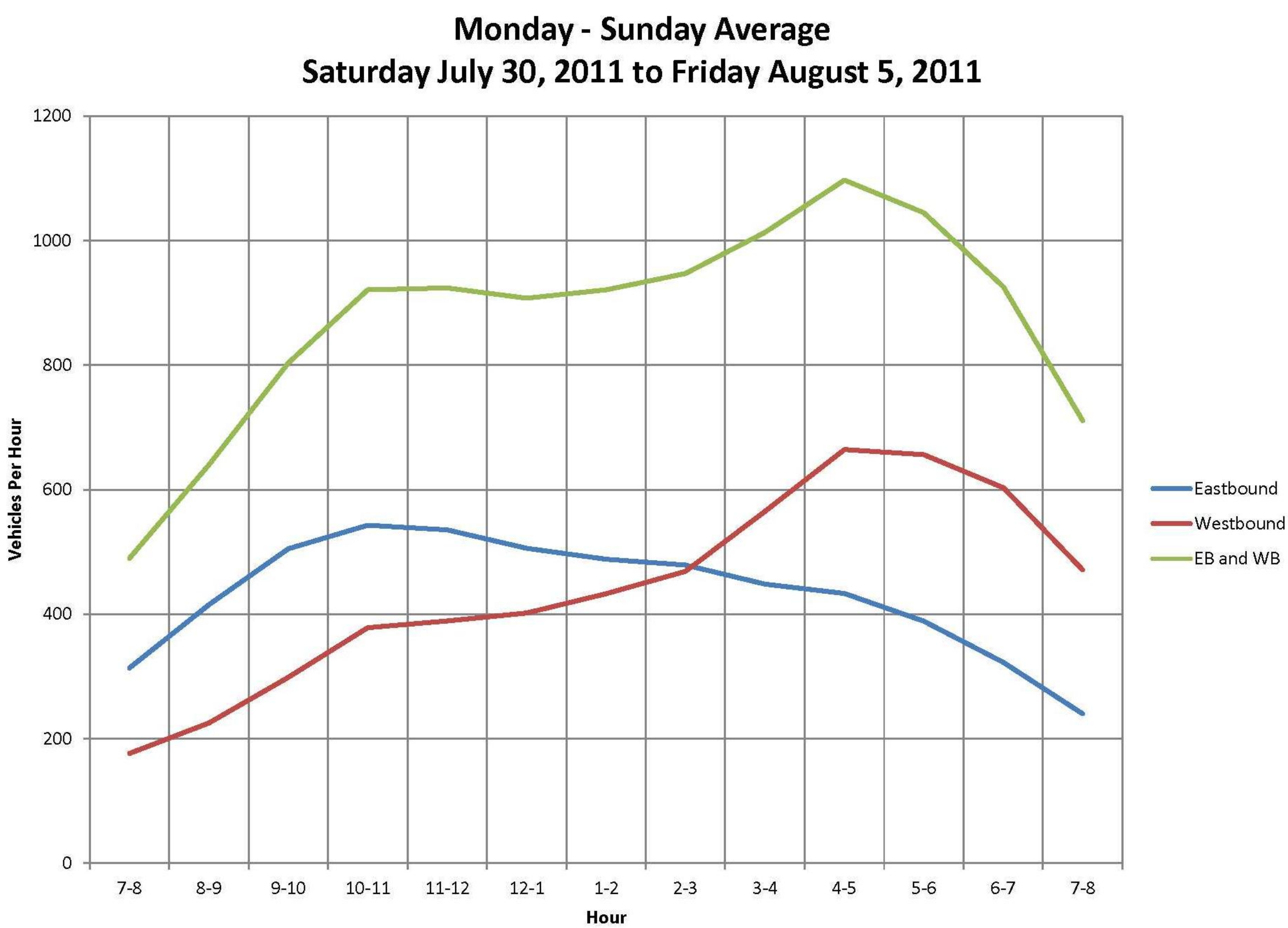
Figure 2-5 ATR A-60 Average Daily & Annual Average Daily Volumes (2010)



Peak-Hour and Off-Peak Hour Traffic Volumes

Counts for this analysis were taken during a one-week (seven-day) period beginning Saturday, July 30, 2011 and concluding Friday, August 5, 2011. Hourly traffic volumes between the hours of 7:00 a.m. and 8:00 p.m. are illustrated in Figure 2-6.

Figure 2-6 Peak Season Hourly Traffic Volumes (July 30, 2011 – August 5, 2011)



Data from the July/August field count collection effort was used to identify the four consecutive 15-minute periods with the highest volumes occurring in the hours between 7:00 a.m. to 11:00 a.m. and 4:00 p.m. to 6:00 p.m. (i.e., the a.m. and p.m. peak hours of the day). The median off-peak hour was also analyzed. The median off-peak hour is defined as the four consecutive 15-minute periods mid-way between the highest and lowest hourly volumes occurring between the a.m. and p.m. peak hours of the day (11:00 a.m. to 4:00 p.m.).

The July/August field count collection occurred during the peak season summer months when traffic volumes in the US 2 corridor are typically at their highest. A seasonal adjustment factor was applied to the respective month and day of the July/August counts to calculate annual average hourly traffic volumes.

2.1.5 Operational Characteristics

Methodology

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, US 2 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 that 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. The concept of passing capacity for a two-lane highway reflects that the ability to pass is limited by the opposing flow rate and by the distribution of gaps in the opposing flow. The concept of passing demand reflects that the 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. The entire length of the study corridor is striped as a no passing zone, essentially eliminating passing capacity and thereby negatively affecting LOS.

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

Table 2.6 LOS Criteria for Class II Two-lane Highways

Level of Service	Class II Two-lane Highways PTSF[1] (%)
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.
(1) Percent time-spent-following

Highway Capacity Software (HCS) Version 2010 was used to analyze LOS for a Class II two-lane highway in the corridor.

The percentage of heavy vehicles in the traffic stream was considered as part of the HCS analysis. Heavy vehicles are defined as vehicles that have more than four tires touching the pavement. Trucks, buses and recreational vehicles (RVs) are examples of heavy vehicles. Trucks cover a wide range of vehicles, from lightly loaded vans and panel trucks to the most heavily loaded haulers.

The entry of heavy vehicles into the traffic stream affects the number of vehicles that can be served in two ways. They are larger than passenger cars and occupy more roadway space and they also have poorer operating capabilities than passenger cars, particularly with respect to acceleration, deceleration, and the ability to maintain speed on upgrades. The inability of heavy vehicles to keep pace with passenger cars in many situations creates large gaps in the traffic stream. The resulting inefficiencies in the use of roadway space may be especially pronounced in the study corridor due to the absence of passing opportunities.

Eastbound and westbound traffic volumes within the US 2 corridor were observed during four consecutive 15 minute periods between 7:45 a.m. to 8:45 a.m. and 4:45 p.m. to 5:45 p.m. during a field review in October. The percent of heavy vehicles observed during these periods ranged from 1.0% to 5.4%. The HCS two-lane highway segment module default value for percent heavy vehicles of 6.0% was used for this study. Default values are often used for planning applications of the Highway Capacity Manual that do not require the accuracy provided by a detailed operational evaluation. In addition, using the HCS percent heavy vehicle default value of 6.0% provides a more conservative analysis than using the lower values observed during a single a.m. and p.m. peak hour.

Appendix 6 contains HCS operational analysis worksheets.

Analysis Results

Table 2.7 presents the results of the Class II two-lane highway operational analysis for existing peak season and adjusted annual average (2011) conditions for an average week (Monday – Sunday). Results for morning, evening, and off-peak hours are reported.

Table 2.7 Class II Two-lane Highway Operational Analysis Results (2011)

Time Period		2011	
		PTSF[1] (%)	LOS
Peak Season	AM Peak Hour	76.9	D
	Median Off-Peak Hour	74.9	D
	PM Peak Hour	82.2	D
Adjusted Annual Average	AM Peak Hour	68.3	C
	Median Off-Peak Hour	64.6	C
	PM Peak Hour	70.8	D

Source: DOWL HKM, 2011.
[1] Percent time-spent-following

The MDT Traffic Engineering Manual defines desirable operations for a principal arterial facility in rolling terrain as LOS B. Using this criterion, the US 2 corridor currently operates at an undesirable LOS C or LOS D, depending on the hour and season.

2.2 Demographic and Economic Conditions

2.2.1 Population Characteristics

Flathead County experienced strong population growth during the 1980s and 1990s. Continuing this trend, Flathead County grew at a faster rate than the State of Montana and the United States over the 2000 to 2010 period, as presented in Table 2.8. Five of the six communities in the study area vicinity exceeded Flathead County's growth rate over this period, while Hungry Horse declined in population.

Table 2.8 Population Growth (2000 – 2010)

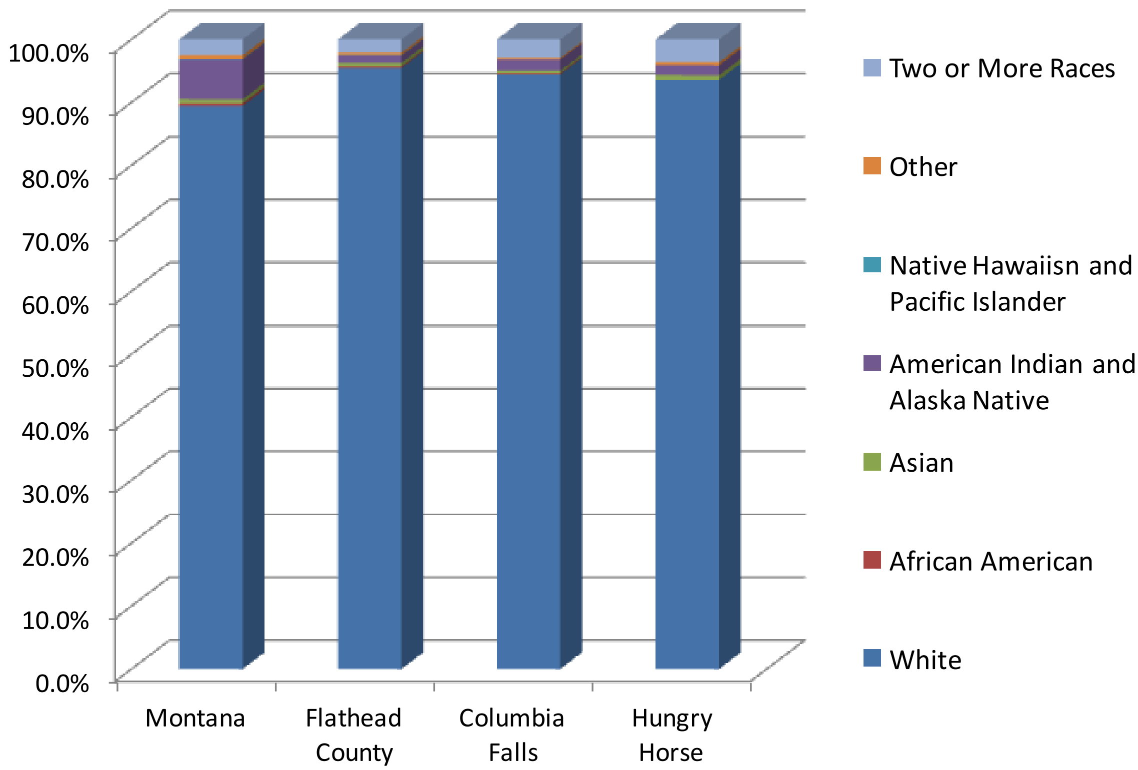
Location	Population		Percent Growth	Compound Annual Growth Rate
	2000	2010		
United States	281,421,906	308,745,538	9.7%	0.93%
Montana	902,195	989,415	9.7%	0.93%
Flathead County	74,471	90,928	22.1%	2.02%
Kalispell	14,223	19,927	40.1%	3.43%
Whitefish	5,032	6,357	26.3%	2.36%
Columbia Falls City	3,645	4,688	28.6%	2.55%
Hungry Horse CDP	934	826	-11.6%	-1.22%
Martin City CDP	331	500	51.1%	4.21%
Coram CDP	337	539	59.9%	4.81%

Source: MDT, 2011; US Census Bureau, 2011. CDP = Census Designated Place

Age distribution varies among communities in the study area vicinity. The Cities of Columbia Falls and Kalispell have a larger percentage of children under the age of 18 while the communities of Coram, Martin City, and Hungry Horse have a larger percentage of people in the 35 to 64 age range as compared to Flathead County and the state of Montana.

A greater percentage of people identify themselves as white, and American Indians account for a smaller percentage of the population in the study area vicinity and in Flathead County as compared to Montana as a whole. Racial composition is illustrated in Figure 2-7.

Figure 2-7 Race Alone or in Combination with Other Races (2010)



Source: US Census Bureau, 2011.

Apart from the Census Designated Place (CDP) of Hungry Horse, the study area is sparsely populated, with low numbers of racial minority populations.

2.2.2 Employment and Income

The largest income-generating industries in the county from 2008 to 2010 were non-resident travel, federal government, wood products, and other manufacturing. The area is a minor retail trade center for northwestern Montana. Shopping, medical, and entertainment establishments in Kalispell and Whitefish serve nearby communities. Larger trade centers in the greater region include Missoula and Spokane, WA.

According to the 2006-2010 American Community Survey five-year estimates, the majority of residents in the immediate study area vicinity commuted to a location outside their place of residence using a motorized vehicle. Commuters generally drove alone, with mean travel time to work ranging from 13 to 24 minutes. Table 2.9 presents commuting statistics for the resident populations of Columbia Falls, Coram, Hungry Horse, and Martin City.

Table 2.9 Commuting Statistics (2006-2010)

Subject		Columbia Falls	Coram	Hungry Horse	Martin City
Place of Work	Worked in place of residence	38.9%	4.2%	6.2%	26.6%
	Worked outside place of residence	61.1%	95.8%	93.8%	73.4%
Means of Transportation	Car, truck, or van	92.7%	95.8%	100.0%	73.4%
	Drove alone	77.3%	95.8%	82.4%	73.4%
	Carpooled	15.3%	0.0%	17.6%	0.0%
	Public Transportation	0.5%	0.0%	0.0%	0.0%
	Walked	2.4%	4.2%	0.0%	20.9%
	Bicycle	0.7%	0.0%	0.0%	0.0%
	Taxicab, motorcycle, or other means	0.0%	0.0%	0.0%	0.0%
	Worked at home	3.8%	0.0%	0.0%	5.6%
Travel Time to Work	Less than 10 minutes	34.7%	8.8%	54.2%	3.6%
	10 to 14 minutes	20.6%	9.6%	0.0%	56.9%
	15 to 19 minutes	4.8%	18.8%	1.8%	13.2%
	20 to 24 minutes	16.0%	11.3%	27.8%	0.0%
	25 to 29 minutes	7.3%	0.0%	14.5%	0.0%
	30 to 34 minutes	14.7%	23.8%	1.8%	18.6%
	35 to 44 minutes	0.0%	27.9%	0.0%	0.0%
	45 to 59 minutes	0.0%	0.0%	0.0%	7.8%
	60 or more minutes	1.8%	0.0%	0.0%	0.0%
	Mean travel time to work (minutes)	15.0	23.8	12.7	16.9

Source: US Census Bureau, 2011.

Flathead County experienced a decrease in employment of over 10 percent in 2009, more than double the state and national trends compared to 2008. This followed years of employment growth significantly higher than the state or nation between 2000 and 2007.

As of September 2011, Flathead County had a higher rate of unemployment than the state as a whole. Table 2.10 presents employment statistics for Flathead County and Montana.

Table 2.10 Employment Statistics (2011)

Area	Total Labor Force	Employed	Unemployed	Unemployment Rate
Montana	502,217	468,156	34,061	6.8
Flathead County	43,404	39,097	4,307	9.9

Source: MT Department of Labor and Industry, County Labor Force Statistics, September 2011.
Note: Data is not seasonally adjusted.

According to the 2010 American Community Survey (ACS) estimates available from the U.S. Census Bureau, 14.4% of the Flathead County population was estimated as living below the poverty level, approximately equivalent to the state poverty level of 14.6%. American Community Survey estimates for the 2005-2009 period indicate that 22.3% of the Hungry Horse civilian labor force was estimated to be unemployed and approximately 36.4 % were estimated to earn an income below the poverty level.

Environmental Justice

Minority and low-income persons likely live in the study corridor vicinity. If improvement options are forwarded from the study, environmental justice issues will need to be further evaluated during the project development process.

2.3 Environmental and Physical Setting

An Environmental Scan Report was prepared in support of the US 2 – Badrock 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 October 26, 2011. The following sections summarize key information from the Environmental Scan Report.

2.3.1 Physical Environment

Soil Resources and Prime Farmland

Soils found within the study area have been classified as prime farmland if irrigated and farmland of statewide importance according to Section 4201 of the Farmland Protection Policy Act (FPPA) of 1981 (Title 7 United States Code, Chapter 73, Sections 4201-4209). If improvement options are forwarded from this study, a U.S. Department of Agriculture Natural Resource Conservation Service Farmland Conversion Impact Rating Form for Linear Projects (form CPA-106) would need to be completed to document any impacts to farmland.

Geologic Features and Hazards

Previous geotechnical studies have determined the US 2 study area is comprised of alluvial deposits immediately bordering the Flathead River, with glacial and fluvioglacial deposits spread further into outlying areas. Rock outcroppings bordering US 2 are comprised of quartzite, siltite, and argillite ranging from 25 to 60 feet in height. These rock outcrops exhibit tension cracks which may indicate long term instability. Fault lines are located to the east and west of the immediate study area. The US 2 corridor is located in an area of mid-range hazard for earthquake ground motions.

The bedding and joint structure of the rock outcrops within in Badrock Canyon provide a potential for rock falls. If improvement options involving rock excavation are forwarded from this study, additional geotechnical analysis, including rock mapping and borings, would be needed to assess the stability of rock outcroppings in the study area.

Surface Water Impairment

Surface water resources in the immediate study area include the main stem of the Flathead River and the South Fork of the Flathead River. The study area lies within the Flathead Lake watershed (Hydraulic Unit Code [HUC] 17010208) and the South Fork Flathead River watershed (HUC 17010209), both of which are listed in the DEQ 2010 Integrated 303(d)/305(b) Water Quality Report for Montana. Within the study area, the main stem of the Flathead River from its headwaters to Flathead Lake is listed as Category 3, which indicates waters for which there is insufficient data to assess the use support of any applicable beneficial use. No use support determinations have been made for the main stem as of the 2010 reporting cycle. Additionally, the South Fork of the Flathead River from the Hungry Horse Dam to its mouth is listed as Category 4C, which indicates that non-pollutant-related use impairment has been identified and TMDLs are not required.

If improvement options are forwarded from this study, impacts to surface waters should be minimized to the extent practicable. Building on the analysis conducted in support of the FEIS effort, an updated water quality analysis may be required during the project development process.

Wild and Scenic Rivers

Within the study area, the Middle Fork of the Flathead River upstream from its confluence with the South Fork of the Flathead River near Hungry Horse is designated as a Recreational River. Its values include recreation, scenery, historic sites, unique fisheries, and wildlife such as grizzly bears and wolves. A Management Corridor for the Middle Fork Recreational River segment has been designated and is administered by the USFS.

If improvement options are forwarded from this study, MDT will coordinate with USFS during the project development process to identify potential effects on Middle Fork Flathead River ORVs and any measures needed to mitigate impacts to the Middle Fork Recreational River Corridor.

Groundwater

There are two public water supplies and a number of domestic water supplies within the study area. The two public water supplies include the Hungry Horse County Water and Sewer District (located at the east end of the corridor in Hungry Horse), and the Crooked Tree Motel and RV Park system (also located at the east end of the corridor in Hungry Horse). Health-based drinking water violations have occurred at each location with the most recent violations occurring in 2009 and 2011.

If improvement options are forwarded from this study, impacts to domestic and public water supplies should be avoided where practicable.

Wetlands

Based on delineations conducted in 2002 in support of the Re-evaluation effort, five wetland areas were identified within the current study area. Most sites are considered moderately to highly disturbed due to fill placement, proximity to the highway and other roads, hydrological alteration, and/or degradation associated with foot traffic and garbage placement.

A subsequent wetland verification/delineation was conducted in 2004. Wetland locations and non-wetland channel locations were generally identical to those mapped in 2002, with some minor border modifications where sites had expanded or decreased in size since 2002. The 2004 assessment determined that the south riverbank is approximately 85% non-wetland, with the remaining 15% consisting of scattered two to four-foot wide wetland fringe from approximately Berne Memorial Park east to the study terminus. The remainder of the riverbank to the west study terminus is considered non-wetland. It was noted that the Wetland 4 adjacent to US 2 just east of Berne Road (RP 140.3±) offers minor (0.1 to 0.2 acre) mitigation potential via expansion.

If improvement options are forwarded from this study, updated wetland delineations conducted according to standard USACE procedures may be needed to verify wetland boundaries in the study area. Wetland impacts should be avoided to the greatest extent practicable. All unavoidable wetland impacts will be mitigated as required by the USACE and in accordance with Federal Highway Administration (FHWA) and MDT policies and Executive Order (EO) 11990, Protection of Wetlands.

Floodplains

Within the study corridor, portions of the existing US 2 alignment encroach into the 100-year floodplain for the Flathead River and the portion of the South Fork of the Flathead River north of the current bridge crossing.

Impacts to floodplains would need to be identified and evaluated for any improvement options forwarded from this study. Coordination with Flathead County would be conducted during the project development process to minimize floodplain impacts and obtain any necessary floodplain permits. Any increase in floodplain elevations within the study area may require a Letter of Map Revision (LOMR) and Conditional Letter of Map Revision (CLOMR) from the Federal Emergency Management Agency (FEMA).

Hazardous Materials

Based on a review of the Montana Natural Resource Information System (NRIS) database, a single leaking underground storage tank site was identified at the eastern terminus of the study area at RP 142.4.   Impacts to hazardous materials sites should be avoided. If contaminated soils or groundwater are encountered during construction activities, handling and disposing of the contaminated material will be conducted in accordance with applicable state, federal, and local laws and rules.

Air Quality

The study area is not located in a nonattainment area for any pollutant, including particulate matter (PM_{10} and $PM_{2.5}$), Carbon Monoxide (CO), Lead (Pb), or Sulfur Dioxide (SO_2). The study corridor is located approximately 1.5 miles directly east of the Columbia Falls Nonattainment Area for Particulate Matter (PM_{10}). If improvement options are forwarded from this study, an updated air quality analysis may be required based on current traffic volumes.

2.3.2 Biological Resources

Fish and Wildlife

A number of predators and furbearers are expected to occur in the study area vicinity, including coyotes, red fox, skunk, bobcat, black and grizzly bears, wolf, muskrat, mink, marten, and wolverine. Ungulate species expected to occur in the study area vicinity include white-tailed deer, mule deer, and elk. Moose are infrequently observed in the area , while white-tailed deer frequently use pastures and haylands adjoining the right-of-way at the western end of the study area throughout the year and often cross US 2 to access the river.

Fish species commonly found within the Flathead River and South Fork of the Flathead River in the vicinity of the study area include bull trout, lake trout, lake whitefish, largescale sucker, mountain whitefish, pygmy whitefish, rainbow trout, slimy sculpin, and westslope cutthroat trout.

Threatened and Endangered Wildlife Species

Three threatened and two candidate animal species are expected to occur in Flathead County, as listed in Table 2.11. Additionally, the study area falls within federally designated Critical Habitat for bull trout and Canada lynx.

Table 2.11 Threatened and Endangered Wildlife Species in Flathead County

Category	Scientific Name	Common Name	Federal Status
Fish	*Salvelinus confluentus*	Bull Trout	Listed Threatened, Designated Critical Habitat
Mammal	*Ursus arctos horribilis*	Grizzly Bear	Listed Threatened
Mammal	*Lynx canadensis*	Canada Lynx	Listed Threatened, Designated Critical Habitat
Insect	*Lednia tumana*	Meltwater Lednian Stonefly	Candidate
Mammal	*Gulo gulo luscus*	Wolverine	Candidate

Source: USFWS, 2011.

During a field reconnaissance conducted in 2004, no threatened or endangered species were observed within the study area. If improvement options are forwarded from this study, consultation with USFWS will be required and an updated evaluation of potential impacts to all endangered, threatened, proposed, or candidate species will need to be completed during the project development process.

Wildlife and Fish Species of Concern

Table 2.12 lists the animal species of concern documented by the MNHP within Township 30N, Range 19 West, Sections 6 and 7 and Township 30N, Range 20 West, Sections 1, 11, and 12 in Flathead County as of October 2011 and confirmed during a resource agency meeting on January 9, 2012. Each species is assigned a state rank that ranges from S1 (greatest concern) to S5 (least concern). Species previously listed in Table 2.11 are not repeated in Table 2.12.

Table 2.12 Animal Species of Concern in Study Area Vicinity

Group Name	Scientific Name	Common Name	State Rank
Mammals	*Martes pennanti*	Fisher	S3
Birds	*Falco peregrinus*	Peregrine Falcon	S3
	Haliaeetus leucocephalus	Bald Eagle	S3
Fish	*Oncorhynchus clarkii lewisi*	Westslope Cutthroat Trout	S2
	Prosopium coulteri	Pygmy Whitefish	S3
Invertebrates	*Prophysaon humile*	Smoky Taildropper	S2S3

Source: MNHP, 2011.

If improvement options are forwarded from this study, an updated evaluation of potential impacts to all species of concern will need to be completed during the project development process.

Wildlife Movement and Traffic Concerns

Local ungulate species are found in substantial numbers both north of the Flathead River and south of US 2. The area at the mouth of Badrock Canyon is often used by animals moving between Teakettle Mountain to the north and Columbia Mountain to the south. Animal species expected to use this corridor include mule and white-tailed deer, black and grizzly bears, elk, moose, mountain lions, wolves and many other smaller animals.

The Great Northern Environmental Stewardship Area (GNESA) group has identified and mapped wildlife movement areas of concern in this corridor. The group has identified Badrock Canyon as a key conservation area. Several locations within the study corridor are known wildlife crossing points for white-tailed deer, sheep, black bear, and mountain lion.

As noted previously in Section 2.1.3, 75 percent of crashes (6 out of 8) involving wild animals during the period 2006 to 2010 occurred in the first-half-mile of the corridor from RP 140.0 to RP 140.5 west of the canyon. Similarly, maintenance data indicate that 11 (85 percent) of the 13 total carcasses collected from 2006 to 2010 were recorded in the first half-mile of the corridor from RP 140.0 to 140.5 No carcasses were observed during field surveys in 2004 and 2011 that might indicate usage or movement patterns or conflict points with vehicles.

During the project development process, MDT will coordinate with FWP to determine what measures may be needed to address wildlife crossings within the corridor.

Vegetation

There are a number of distinct land types in the corridor, including wetlands, riparian communities, and upland communities. Field surveys conducted in 2004 indicated that general vegetation communities included disturbed right-of-way and pasture, coniferous forest, mixed conifer/deciduous forest, and cottonwood forest.

Threatened and Endangered Plant Species

Table 2.13 presents threatened and candidate plant species expected to occur in Flathead County.

Table 2.13 Threatened and Endangered Plant Species in Flathead County

Category	Scientific Name	Common Name	Federal Status
Flowering plant	*Silene spaldingii*	Spalding's catchfly	Listed Threatened
Conifers and Cycads	*Pinus albicaulis*	Whitebark pine	Candidate

Source: USFWS, 2011.

Silene spaldingii was observed in the vicinity of the study area in the 1890s, but has not been observed in more recent times. If improvement options are forwarded from the study, an evaluation of potential impacts to all endangered, threatened, proposed, or candidate plant species will need be conducted during the project development process.

Plant Species of Concern

Table 2.14 lists the plant species of concern documented by the MNHP within Township 30 North, Range 19 West, Sections 6 and 7 and Township 30 North, Range 20 West, Sections 1, 11, and 12 in Flathead County as of October 2011.

Table 2.14 Plant Species of Concern in Study Area Vicinity

Group Name	Scientific Name	Common Name	State Rank
Ferns and Fern Allies	*Asplenium trichomanes*	Maidenhair Spleenwort	SH
	Botrychium sp. (SOC)	Moonworts	S1S3
Flowering Plants - Dicots	*Castilleja cervina*	Deer Indian Paintbrush	SH
	Cirsium brevistylum	Short-styled Thistle	S1S2
	Lathyrus bijugatus	Latah Tule Pea	S1
Bryophytes	*Aloina brevirostris*	Aloina moss	S1
	Grimmia brittoniae	Britton's dry rock moss	S2

Source: MNHP, 2011.

Asplenium trichomanes was observed in the vicinity of the study area in the 1890s, but has not been observed in more recent times. Grimmia brittoniae was discovered in May 1997 on a partially shaded, seasonally wet vertical cliff face near US 2 within Badrock Canyon. Prior to the 1997 discovery, the moss had not been seen in the Columbia Falls area since 1896.

If improvement options are forwarded from the corridor study, MNHP should be contacted to determine if any new plant species of concern have been documented in the study area and on-site surveys may need to be completed during the project development process to determine any potential impacts to listed plant species of concern.

Noxious Weeds

There are 32 noxious weeds and three regulated plant species in Montana, as designated by the Montana Statewide Noxious Weed List (effective September 2010). Spotted knapweed is commonly found between Columbia Heights and Badrock Canyon and can also be found along the existing US 2 right-of-way at the South Fork Flathead River crossing.

If improvement options are forwarded from the study, the study area will need to be surveyed for noxious weeds during the project development process. Any construction activities resulting from a forwarded improvement option should abide by the MDT Roadside Vegetation Management Plan – Integrated Weed Management Component. County Weed Control Supervisors should be contacted prior to any construction activities regarding specific measures for weed control. To reduce the spread and establishment of noxious weeds and to re-establish permanent vegetation, areas disturbed by any improvement option will be seeded with desirable plant species.

2.3.3 Social and Cultural Resources

Cultural and Archaeological Resources

Three known cultural features exist in Badrock Canyon, including the historic Tote Road (24FH583), a pre-contact archaeological site (24FH760), and the Badrock Canyon Cultural Landscape.

The western and eastern termini of the Tote Road are located several hundred feet to the south of the current US 2 alignment; the middle portion of the Tote Road arcs further south on the lower slopes of Columbia Mountain. The Tote Road is considered eligible for listing on the National Register of Historic Places (NRHP).

Site 24FH760 an archaeological site located both north and south of the current roadway and is considered eligible for listing on the NRHP.

The Confederated Salish and Kootenai Tribes (CSKT) consider the entire Badrock Canyon to have special historical and cultural significance. To date, the canyon has not been evaluated for eligibility for listing on the NRHP.

If improvement options are forwarded from the study, impacts to significant cultural and archaeological resources should be avoided or minimized to the greatest extent practicable. Additional archaeological testing would be necessary to establish the nature and significance of materials discovered in proximity to Site 24FH760. Additional assessment may also be needed to determine the canyon's eligibility for listing on the NRHP as a cultural landscape. Consultation with the CSKT and SHPO would be required to identify mitigation measures for any unavoidable impacts to cultural and archaeological resources.

Recreational Resources

The US 2 – Badrock Canyon corridor serves as a gateway to a variety of recreational opportunities. US 2 is the only route accessing the West Glacier entrance to Glacier National Park. Dispersed recreational opportunities on public lands in the study area vicinity include hunting, hiking, fishing, cross country skiing, floating, berry picking, and camping.

In 1953, the Simpson family conveyed a 100-foot-wide strip of land to the State Highway Commission for use as "a roadside park (including use of a part thereof as a Port of Entry station) and for a highway right of way." [2] This area is known as Berne Memorial Park and is used by hikers and picnickers.

Anglers, boaters, and other recreational users access the Flathead River throughout the study area. A designated river access site is located at the west end of the corridor near RP 140.2 on land owned and maintained by USFS. Vehicles can enter the site directly from US 2 to access a parking area and boat ramp. Dispersed access sites are located along the highway corridor, primarily from Berne Memorial Park upstream to the South Fork Flathead River Bridge. A rock outcropping known as Fisherman's Rock is located directly adjacent to the Flathead River north of US 2 and Berne Memorial Park. An unpaved pullout near RP 141.4 provides access from US 2

[2] Following execution of the bargain and sale deed, the Port of Entry station was located west of the canyon closer to Columbia Falls.

to the river. A small frontage road under the South Fork Flathead River Bridge near RP 142.1 also provides river access.

Two USFS trails can be accessed from US 2 in the study area. The trailhead for the Columbia Mountain trail is located at the western end of the study area and may be accessed from US 2 via Berne Road or Monte Vista Drive. A second trail that leads to Fawn Lake can be accessed by a primitive road that joins US 2 near the South Fork Flathead River Bridge.

Impacts to recreational access will be considered during the project development process if improvement options are forwarded from this study.

Section 4(f) Resources

The FEIS evaluated 11 properties located within the general corridor for their eligibility as Section 4(f) resources. Of these, only Berne Memorial Park and the Tote Road were determined eligible for Section 4(f) protection.

Since that time, additional cultural, archaeological, and recreational resources have been identified in the corridor. Known and potential Section 4(f) resources within the study area are listed in Table 2.15. Fisherman's Rock was listed in the FEIS as a feature of Berne Memorial Park and is therefore not listed separately in Table 2.15.

Table 2.15 Known and Potential Section 4(f) Resources within the Study Area

Name	Type of 4(f) Resource
Tote Road	Historic
Archaeological Site (24FH760)	Historic
Other potential archaeological site(s) near Site 24FH760	Historic
Badrock Canyon Cultural Landscape	Historic
Berne Memorial Park	Recreational
Columbia Mountain Trailhead	Recreational
Fawn Lake Trailhead	Recreational

Source: DOWL HKM, 2011.

If improvement options forwarded from this study use Section 4(f) resources, a Section 4(f) evaluation would be needed to demonstrate there are no feasible and prudent alternatives to such use and all possible measures to minimize harm have been incorporated.

Section 6(f) Resources

Based on a review of the Land and Water Conservation Fund (LWCF) list by county published by FWP, there are no LWCF sites located within the study area.

Noise

Badrock Canyon is relatively undeveloped, although there are a number of residential and commercial developments at the western and eastern ends of the study area near Columbia Heights and Hungry Horse. In addition to these developments, Berne Memorial Park may be considered a sensitive noise receptor. If improvement options are forwarded from the study, the noise analysis would need to be updated.

Visual Resources

The western end of the study area is characterized by gently rolling terrain bordered by steep mountains. Teakettle Mountain to the north and Columbia Mountain to the south are dominant visual features. Extending on either side of US 2, grasslands and pasturelands are interspersed with stands of cottonwoods, aspens, and conifers. Moving east into Badrock Canyon, US 2 is bordered by the Flathead River to the north and the lower slopes of Columbia Mountain to the south. Railroad tracks are visible across the river to the north. Steep rock outcroppings serve as the dominant visual element in the Berne Memorial Park vicinity. Thick forest cover extends on both sides of US 2 east of Berne Memorial Park to Hungry Horse and generally obstructs views of the river in this area.

If improvement options are forwarded from this study, further evaluation of the potential effects on visual resources would be conducted and effects would be minimized to the extent practicable.

3.0 PROJECTED CONDITIONS

This section discusses projected conditions for the highway transportation system within the study corridor in terms of anticipated future traffic volumes and operational characteristics.

3.1 Traffic Volumes

3.1.1 Growth Rate

The 1995 FEIS projected traffic volumes for 2010 using regression analysis to evaluate linear relationships between historical AADT volumes recorded at MDT's ATR A-60RP 139.6 . Using 11 years of recorded AADT volumes, the FEIS projected AADT volumes for 1995, 2000, 2005 and 2010. Similarly, the 2002 Re-evaluation also used a regression analysis to develop a best trend line for projecting AADT traffic volumes. The Re-evaluation considered AADT volumes observed at this ATR location from 1982 to 2001 (20 years) in projecting AADT volumes. Table 3.1 presents the FEIS and Re-evaluation projections compared with actual volumes recorded from this ATR location.

Table 3.1 FEIS AADT Traffic Projection compared with Actual AADT Volumes

Data Type		1995	2000	Percent Growth 1995-2000	2005	Percent Growth 2000-2005	2010	Percent Growth 2005-2010
Projections	FEIS	6,010	6,960	15.8%	7,900	13.5%	8,850	12%
	Re-evaluation	NA	NA	NA	7,580	NA	8,425	11.1%
Actual Data	ATR (RP 139.6)	6,305	7,383	17.1%	6,520	-13.2%	6,765	3.8%
Variation from Actual Data	FEIS	4.9% lower	6.1% lower	NA	21.2% higher	NA	30.8% higher	NA
	Re-evaluation	NA	NA	NA	16.3% higher	NA	24.5% higher	NA

Source: MDT, 1995; MDT, 2002; DOWL HKM, 2011.

Both the FEIS and Re-evaluation overestimated the anticipated growth in traffic volumes in the corridor through the year 2010.

For the purposes of this corridor planning study, actual AADT volumes at this ATR location from 1991 to 2010 (20 years) were reviewed.

A compound annual growth rate was identified for historic traffic volumes over the period 1991 through 2010. The general calculation for identifying a compound annual growth rate is shown below, followed by the calculation using data from the years 1991 to 2010 and more recent periods. For comparison purposes, a compound annual growth rate calculated from the FEIS and Re-evaluation traffic projections is also presented.

Compound Annual Growth Rate Calculation Formula

$[(\text{Ending Volume/Starting Volume})^{(1/(\text{Ending Year-Starting Year})}] - 1$ = Compound Annual Growth Rate

Actual Data 1991 – 2010: $[(6{,}765/5{,}116)^{(1/(2010-1991)}] - 1 \approx$ **1.5%**

Actual Data 2000 – 2010: $[(6{,}765/7{,}383)^{(1/(2010-2000)}] - 1 \approx$ **-0.9%**

Actual Data 2005 – 2010: $[(6{,}765/6{,}520)^{(1/(2010-2005)}] - 1 \approx$ **0.7%**

FEIS Projections 1995 – 2010: $[(8{,}850/6{,}010)^{(1/(2010-1995)}] - 1 \approx$ **2.6%**

Re-evaluation Projections 2005 – 2010: $[(8{,}425/7{,}580)^{(1/(2010-2005)}] - 1 \approx$ **2.1%**

Based on historical data over the previous 20 years, a compound annual growth rate of 1.5 % was selected for projecting future volumes for the purposes of this corridor study. This growth rate reflects a compromise between the FEIS and Re-evaluation projections (which are higher than actual data now available) and the low growth rates occurring since 2000.

3.1.2 Projected Volumes

The formula for calculating projected traffic volumes is shown below.

Projected Traffic Volume Calculation Formula

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

Appendix 5 contains future AADT and peak hour volumes calculated using the growth rate formula noted above.

3.1.3 Operational Characteristics

Analysis Results

Table 3.2 presents the results of the operational analysis for projected (2035) conditions.

Table 3.2 Projected Operational Analysis Results (2035)

Time Period		2035	
		PTSF[1] (%)	LOS
Peak Season	AM Peak Hour	84.4	D
	Median Off-Peak Hour	81.9	D
	PM Peak Hour	89.4	E
Adjusted Annual Average	AM Peak Hour	69.8	C
	Median Off-Peak Hour	69.1	C
	PM Peak Hour	75.5	D

Source: DOWL HKM, 2012.
[1] Percent time-spent-following

The MDT Traffic Engineering Manual defines desirable operations for a principal arterial facility in rolling terrain as LOS B. The US 2 corridor is projected to operate at an undesirable LOS C to LOS E, depending on the hour and the season. Appendix 6 contains HCS operational analysis worksheets.

4.0 RECENT PROJECT

The most recently completed major project in proximity to the study corridor was the Columbia Heights-East project, which extended from RP 138.2 to RP 140.0 and was completed in 2004. The project widened US 2 from two travel lanes and narrow shoulders to four 12-foot travel lanes, a 14-foot center turn lane, and two eight-foot shoulders, with a total paved width ranging from 77 to 88 feet.

5.0 SUMMARY OF ISSUES AND CONCERNS

Based on the foregoing review of existing and projected conditions, Table 5.1 presents a summary of potential issues and concerns within the corridor identified by this study. Anticipated impacts to specific resources will be detailed following development of improvement options.

Table 5.1 Summary of Issues and Concerns

Condition		Issue/Concern
Transportation System Conditions	**Physical Features**	<u>Bridges</u> • South Fork Flathead River Bridge is structurally deficient, functionally obsolete, and eligible for replacement <u>Guardrail</u> • Guardrail end sections do not meet current design standards <u>Drainage</u> • During periods of snow melt, water ponds and flows across US 2 <u>Utilities</u> • Multiple utilities are located in close proximity to US 2 alignment, including a high pressure gas pipeline and fiber optics line
	Geometric Conditions	<u>Roadway Width</u> • Nonexistent shoulders along US 2 within the corridor <u>Horizontal Alignment</u> • Nine horizontal curves do not meet current MDT design standards <u>Vertical Alignment</u> • Six vertical curves do not meet current MDT design standards
	Crash History	<u>RP 140.0 to 142.4 (2006 – 2010)</u> • Crash rate is nearly 2.5 times higher than the statewide average for similar facilities • Severity rate is three times higher than the statewide average for similar facilities • Fatal accidents and incidents involving wild animals are concentrated in first half-mile of the corridor from RP 140.0 to 140.5
	Operational Conditions	<u>Existing Conditions</u> • US 2 currently operates from LOS C to LOS D during off-peak and peak hours and seasons <u>Projected Conditions</u> • US 2 is projected to operate from LOS C to LOS E during off-peak and peak hours and seasons

Environmental Conditions

Prime Farmland
- Soils classified as prime farmland if irrigated and farmland of statewide importance are located at the western end of the study corridor

Geologic Hazards
- Fault lines are located to the east and west of the immediate study area
- Bedding and joint structure of the rocks in Badrock Canyon provide a potential for rockfalls

Surface Water
- Within the study corridor, the main stem of Flathead River and the South Fork of the Flathead River are listed in DEQ's 303(d)/305(b) report

Wild and Scenic Rivers
- Within the study corridor, the Middle Fork of the Flathead River is designated as a Recreational River

Groundwater
- Several domestic water sources and two public water systems are located within the study area

Wetlands
- Five wetlands are located within the study area

Hazardous Materials
- A single LUST site is located in the study corridor

Floodplains
- US 2 encroaches into the 100-year floodplain for the Flathead River and a portion of the South Fork of the Flathead River

Fish and Wildlife
- Within Flathead County, three mammals, one fish, and one insect are federally listed as threatened or candidate species
- Four mammal, two bird, four fish, and one invertebrate species of concern are documented within the study area vicinity
- The Great Northern Environmental Stewardship Area (GNESA) group has identified Badrock Canyon as a key conservation area, and several locations within the study corridor are known wildlife crossing points

Vegetation
- Within Flathead County, two plants are federally listed as threatened or candidate species
- Seven plant species of concern are documented in study area vicinity

Cultural and Archaeological Resources
- Three known cultural features, including the historic Tote Road, an archaeological site, and the Badrock Canyon Cultural Landscape occur in the study area

Recreational Resources
- A number of designated and dispersed recreational access sites are located within the US 2 corridor.

Section 4(f) Resources
- Four historic sites and three recreational sites within the study area have been or could potentially be classified as Section 4(f) resources

Noise
- There are residential developments within proximity to the study corridor

Visual Resources
- Scenic qualities of canyon are highly valued

Appendix 1

Field Review Memorandum and Photo Log

MEMORANDUM

Physical Address:
104 East Broadway
Suite G-1
Helena, Montana 59601

Mailing Address:
P.O. Box 1009
Helena, Montana 59624

Phone: (406) 442 - 0370
Fax: (406) 442 - 0377

To: Sheila Ludlow
MDT Project Manager

From: Sarah Nicolai
DOWL HKM Project Manager

Date: December 19, 2011

Subject: Summary of Field Review Conducted on October 26, 2011
US 2 - Badrock Canyon Corridor Planning Study

DOWL HKM conducted a field review of the study corridor on October 26, 2011. This summary lists potential constraints observed in the field during the review, although it should not be considered a comprehensive account of all constraints within the corridor. Constraints are listed progressing west to east from Reference Post (RP) 140.0 to RP 142.4 under each category. RP and Station (Sta.) locations are approximated. Potential constraints were visually inspected; no testing or detailed inspections were conducted.

DOWL HKM visually inspected the following features and constraints.

Culverts & Drainage Features

- Single 18-inch corrugated metal pipe (CMP) running underneath US 2 at RP 140.1 (Sta. 21). Photo 3.
- Two 18-inch CMP culverts running underneath US 2 at RP 140.8 (Sta. 55). Photo 17.
- Drainage issues associated with Berne Memorial Park spring. RP 140.8 (Sta. 56). Photo 19.
- Single 18-inch CMP (approximately sixty percent buried) running underneath US 2 at RP 141.3 (Sta. 73). Photos 28 and 29.
- Roadside drainage issues along south side of US 2 looking west. RP 140.6 (Sta 47). Photos 9.
- Roadside drainage issues along south side of US 2 looking west. RP 140.8 (Sta 56). Photos 19.
- Roadside drainage issues along south side of US 2 looking west. RP 141.3 (Sta 75). Photos 30 and 31.

Wildlife Issues

- Wildlife crossing sign at RP 140.3 (Sta. 29). Photo 6.
- No animal carcasses were observed during the field review.

Utility Lines and Facilities / Access Roads

- Power lines parallel US 2 to the south atop the rock outcroppings over the entire corridor. Photos 5, 9, 24, 39 and 40.
- A narrow unpaved road is connected to a roadside pullout at RP 141.1 (Sta. 75). Road appears to provide access to power lines that run parallel to US 2 to the south.
- A fiber optics line runs parallel to US 2 to the south throughout the corridor. Markers were noted at RP 140.9 (Sta. 57) and RP 141.8 (Sta. 112). Photos 21 and 37.
- A gas transmission line runs parallel to US 2 to the south throughout the corridor. Markers were noted at RP 141.7 (Sta. 111) and RP 141.8 (Sta. 112). Photos 34, 35 and 37.
- Access road on south side of US 2 at RP 141.8 (Sta. 114). Photo 38.
- Substation located on south side of US 2 at RP 141.8 (Sta. 117). Photo 39.

Geologic Features

- Unstable geologic features on the south side of US 2 at RP 140.6 (Sta. 47). Photo 8.
- Culturally significant rock outcroppings on the south side of US 2 begin at 140.6 (Sta. 44) and extend to 141.1 (Sta. 73). Photos 8 to 14 and 23 to 25.

Recreational Features

- National Forest recreational sign located off of US 2. RP 140.1 (Sta. 20). Photo 2.
- National Forest trailhead located off of Berne Road. RP 140.3 (Sta. 29). Photo 7.
- Fisherman's Rock on the north side of US 2 at RP 140.7 (Sta. 54). Photos 14 and 15.
- Roadside pullout located on the south side of US 2. The pullout serves as an entrance to Berne Memorial Park and provides access to a spring. RP 140.6 to 140.7 (Sta. 55 to 63). Photos 18, 19, 20, and 22.
- Roadside pullout located on south side of US 2 at RP 141.3 (Sta. 75). Photos 30 and 31.
- Recreational access to the Flathead River on north side of US 2 at RP 141.7 (Sta. 111). Photo 34.

Geometric Features

- Steep side slopes transition into the Flathead River at RP 140.3 (Sta. 30) to RP 140.7 (Sta. 60). Photos 9 to 11.
- Horizontal and vertical curves at RP 141.2 (Sta. 70) and RP 141.3 (sta. 77 to 82). Photos 27, 32, and 33.

Bridges

- Remnants of what appears to be a former bridge across the Flathead River. RP 141.7 (Sta. 111). Photo 36.
- Existing bridge over the South Fork of the Flathead River. Built in 1938 with a bridge deck 26 feet wide. RP 142.1 (Sta. 125). Photos 40 and 41.

Other Features

- Railroad running parallel to US 2 on the north side of the Flathead River. RP 141.1 (Sta. 67). Photo 26.

PHOTO LOG

PREPARED FOR:

MONTANA
MDT
DEPARTMENT OF TRANSPORTATION

PREPARED BY:

DOWL HKM

104 East Broadway, Suite G-1
P.O. Box 1009
Helena, Montana 59624
(406) 442-0370

December 2011

The photos contained within this photo log illustrate potential constraints observed in the field during a field review conducted on October 26, 2011. Photos are numbered in chronological order progressing west to east. Reference Post (RP) and Station (Sta.) locations are approximated. This photo log does not provide a comprehensive account of all constraints within the corridor. Potential constraints were visually inspected; no testing or detailed inspections were conducted.

Photo 1. Looking east on the north side of US 2 at a recreational access point. RP 140.1 (Sta. 20).

Photo 2. National Forest recreational sign located off of US 2. RP 140.1 (Sta. 20).

Photo 3. Single 18-inch corrugated metal pipe (CMP) on south side of US 2 at RP 140.1 (Sta. 21).

Photo 4. Open pasture south of US 2. RP 140.1 (Sta. 20).

Photo 5. Power lines parallel US 2 to the south atop the rock outcroppings over the entire corridor. RP 140.1 (Sta. 20).

Photo 6. Wildlife crossing sign located on north side of US 2. RP 140.3 (Sta. 29).

Photo 7. National Forest trailhead sign located off of Berne Road. RP 140.3 (Sta. 29).

Photo 8. Unstable geologic features south of US 2. Potential for falling rock. RP 140.6 (Sta. 47).

Photo 9. Looking east on the north side of US 2. Snow and ice on outcroppings to the south of US 2 may cause drainage issues. RP 140.6 (Sta. 47).

Photo 10. West outcropping along the south side of US 2, steep slope adjacent to river on the north side, and sharp horizontal curve. RP 140.7 (Sta. 50).

Photo 11. Steep slope adjacent to river on the north side of US 2. RP 140.7 (Sta. 50).

Photo 12. Icing on west outcropping on south side of US 2. RP 140.7 (Sta. 50).

Photo 13. Spring dedication sign on south side of US 2. RP 140.7 (Sta. 50).


Photo 14. Looking west on the north side of US 2 at Fisherman's rock. RP 140.7 (Sta. 54).

Photo 15. Looking north on the north side of US 2 at Fisherman's rock. RP 140.7 (Sta. 54).

Photo 16. Looking north on the south side of US 2 at foundation for former rest area. RP 140.7 (Sta. 54).

Photo 17. Two 18-inch CMP culverts south of US 2. RP 140.8 (Sta. 55).

Photo 18. South of US 2 looking at the Berne Memorial Park spring. RP 140.8 (Sta. 56).

Photo 19. Drainage issues associated with Berne Memorial Park spring. RP 140.8 (Sta. 56).

Photo 20. South of US 2 looking at original water fountain at Berne Memorial Park. Fountain is no longer in use. RP 140.8 (Sta. 56).

Photo 21. Fiber optic marker at east pullout. RP 140.9 (Sta. 57).

Photo 22. Badrock Canyon historical point sign on south side of US 2. RP 140.9 (Sta. 57).

Photo 23. Reference Post 141 marker and east outcropping. RP 141.0 (Sta. 65).

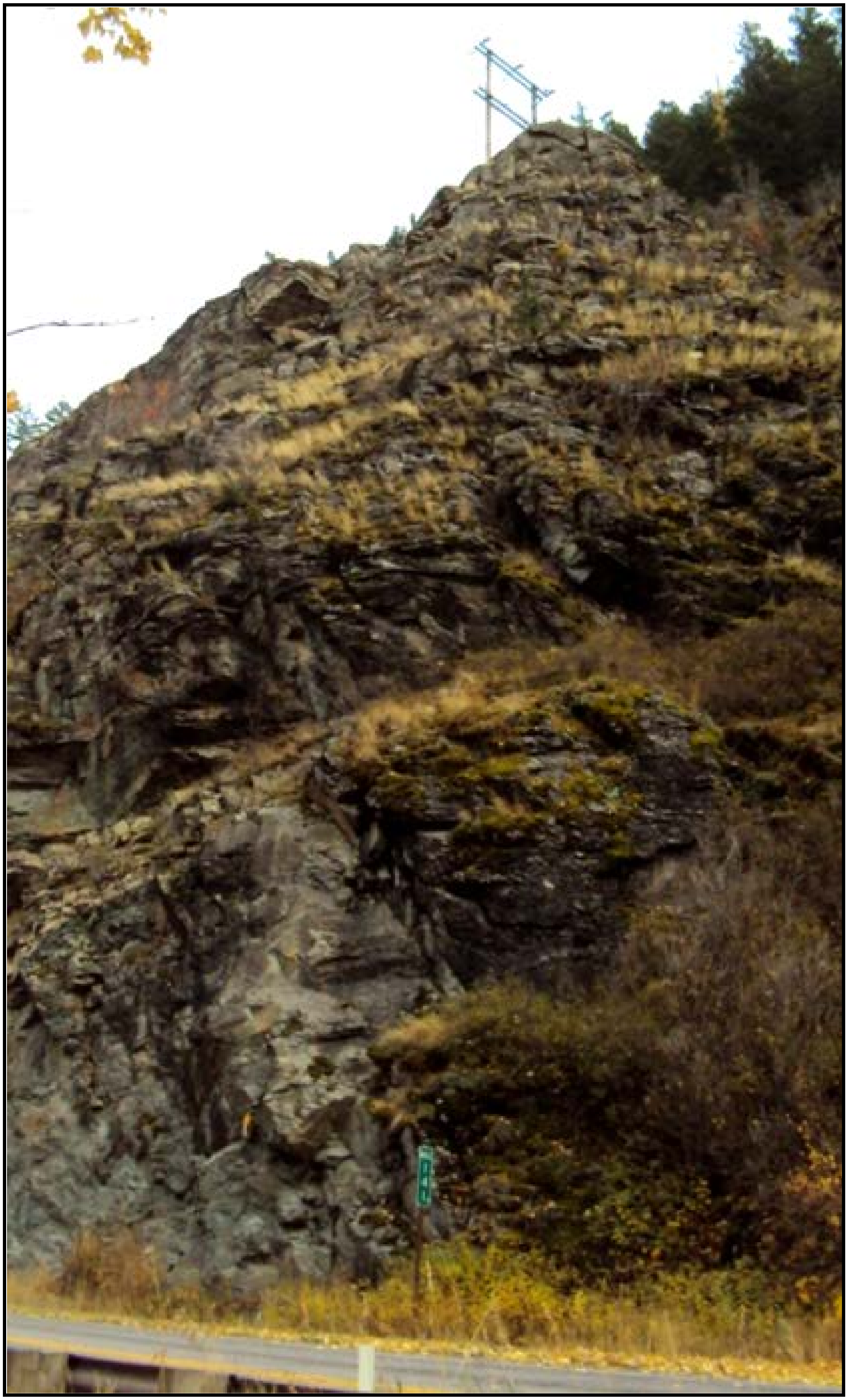


Photo 24. Reference Post 141 marker, power lines overhead, and east outcropping. Potential for falling rock. RP 141.0 (Sta. 65).

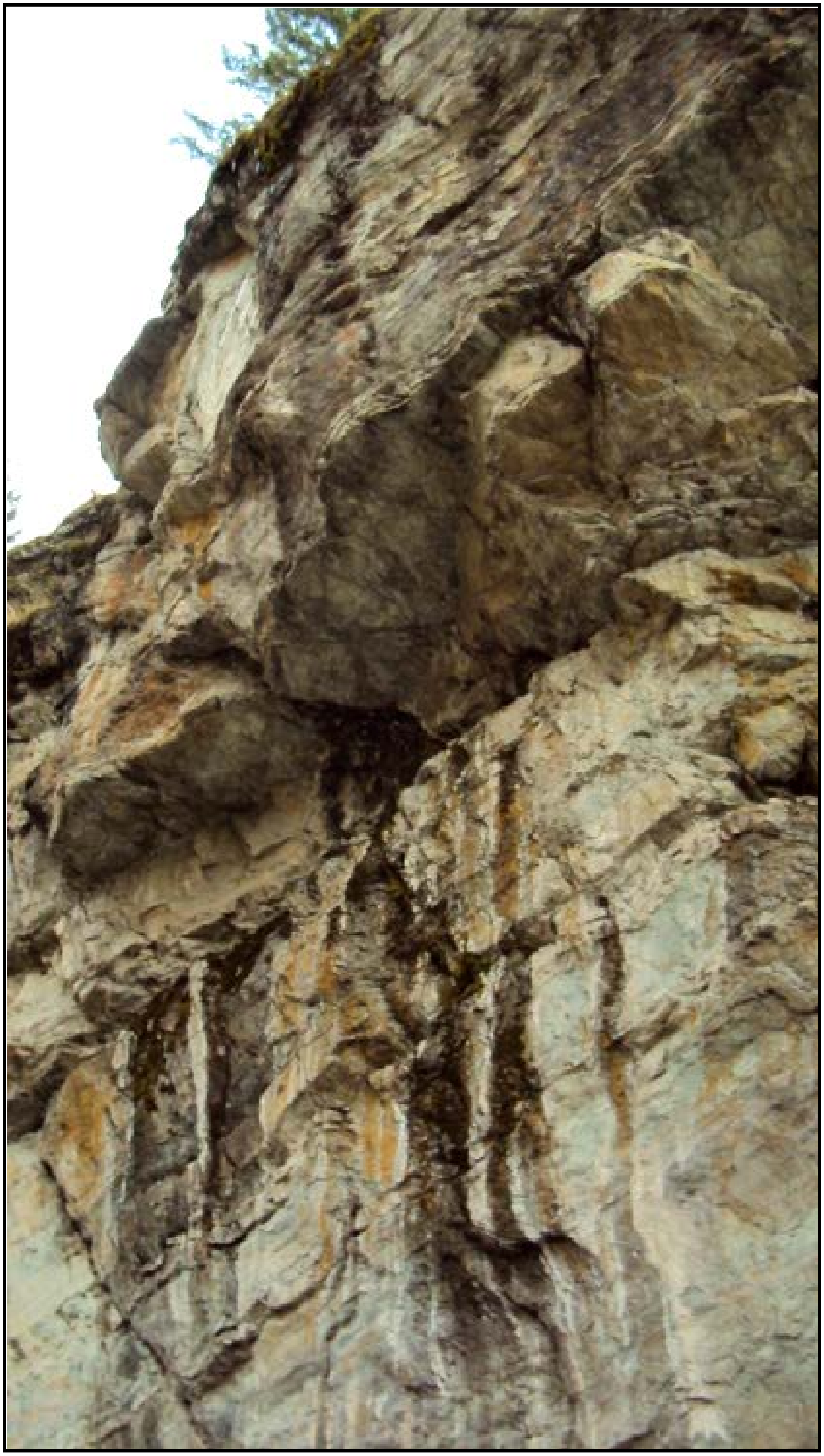


Photo 25. Evidence of water flow at east outcropping on the south side of US 2. Potential for falling rock. RP 141.1 (Sta. 67).

Photo 26. Looking north on the north side of US 2 at a freight train running parallel to US 2 from across the Flathead River (north side). RP 141.1 (Sta. 67).

Photo 27. Looking east at a horizontal and vertical curve and a 45 mph warning sign. RP 141.2 (Sta. 70).


Photo 28. Single 18-inch CMP (approximately sixty percent buried) on the north side of US 2. RP 141.3 (Sta. 73).

Photo 29. Single 18-inch CMP (approximately sixty percent buried) with minimal cover beneath roadbed on the south side of US 2. RP 141.3 (Sta. 73).

Photo 30. Looking northwest on the south side of US 2 at the east pullout. Roadside drainage issues are visible alongside the south side of the road. RP 141.3 (Sta. 75).

Photo 31. Roadside drainage issues along south side of US 2 looking west at the east pullout. RP 141.3 (Sta. 75).

Photo 32. Horizontal curve and extended snow reflectors. RP 141.3 (Sta. 77).

Photo 33. Looking west on the south side of US 2 at a horizontal and vertical curve. RP 141.3 (Sta. 82).

Photo 34. Looking north on the north side of US 2 at a recreational access point and the Flathead River. The red pole is a gas utility marker. RP 141.7 (Sta. 111).

Photo 35. Natural gas pipeline marker on north side of US 2 off of boat access road to the river. RP 141.7 (Sta. 111).

Photo 36. Looking north at a former bridge crossing. The concrete foundation of the former bridge can be seen. RP 141.7 (Sta. 111).

Photo 37. Fiber optics line and natural gas pipeline utility markers. RP 141.8 (Sta. 112).

Photo 38. Looking south west on the south side of US 2 at a utility access road. RP 141.8 (Sta. 114).

Photo 39. Substation located on south side of US 2. RP 141.8 (Sta.117).

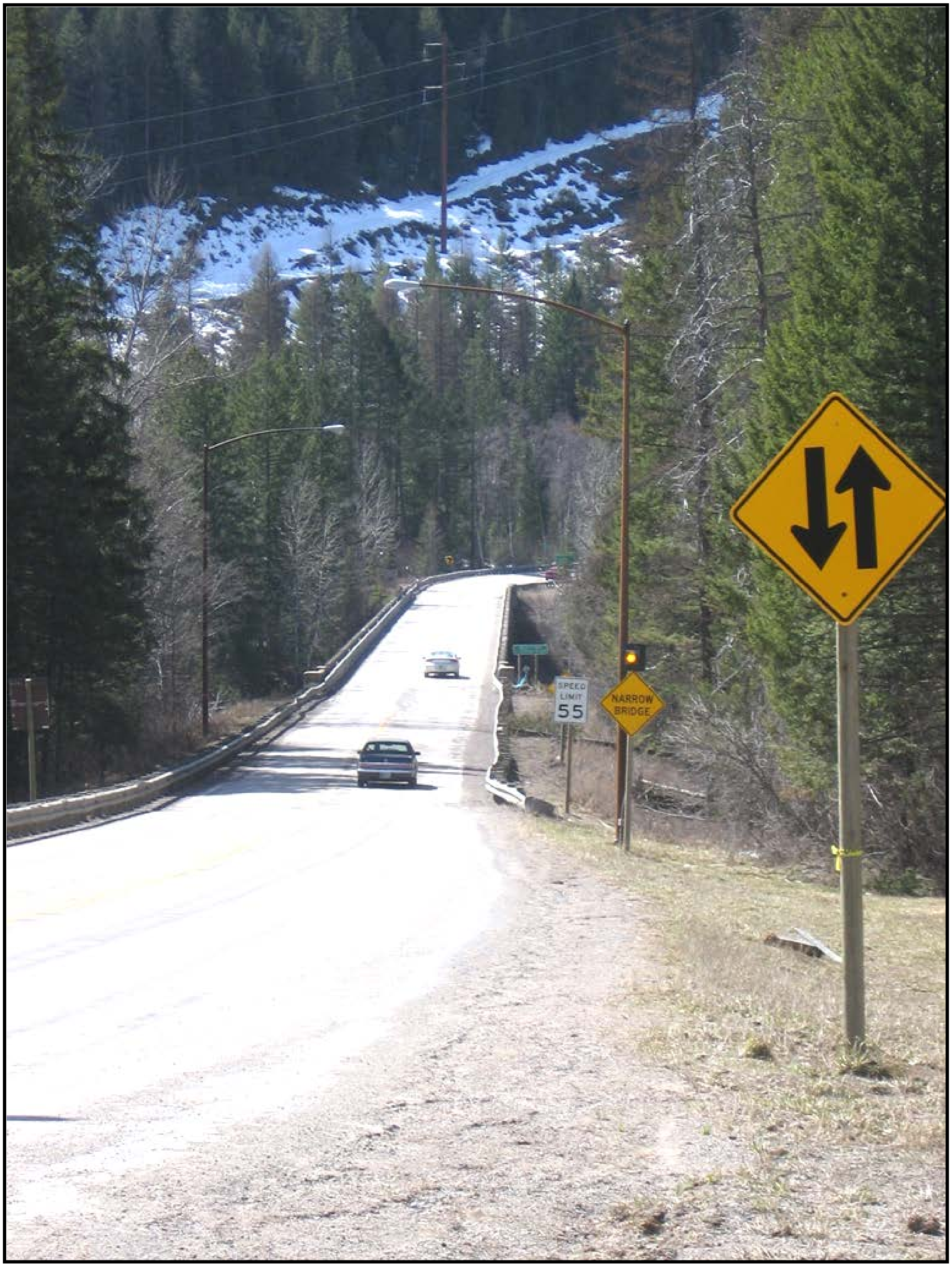


Photo 40. Looking west at the narrow bridge deck over the South Fork of the Flathead River. RP 142.0 (Sta. 120).

Photo 41. Looking east under the bridge over the South Fork of the Flathead River that is showing signs of corrosion. RP 142.1 (Sta. 129).

Appendix 2

Bridge Inspection Report,
Plan Sheets, and Detail Drawings

Montana Department of Transportation

INITIAL ASSESSMENT FORM FOR STRUCTURE :

P00001142+02631

Location : HUNGRY HORSE Structure Name: none

General Location Data

District Code, Number, Location : **01 Dist 1 MISSOULA**

Division Code, Location : **12 KALISPELL**

County Code, Location : **029 FLATHEAD**

City Code, Location : **00000 RURAL AREA**

Kind fo Hwy Code, Description : **2 2 U.S. Numbered Hwy**

Signed Route Number : **00002**

Str Owner Code, Description : **1 State Highway Agency**

Maintained by Code, Description : **1 State Highway Agency**

Intersecting Feature : **SO. FORK FLATHEAD RIVER**

Kilometer Post, Mile Post : **228.95 km 142.26**

Structure on the State Highway System : **X**

Latitude : **48°23'04"**

Structure on the National Highway System : **X**

Longitude : **114°04'43"**

Str Meet or Exceed NBIS Bridge Length : **X**

Construction Data

Construction Project Number : **F 257 F**

Construction Station Number : **111+37.00**

Construction Drawing Number : **1921**

Construction Year : **1938**

Reconstruction Year :

Traffic Data

Current ADT : **6,480** ADT Count Year : **2009** Percent Trucks : **2 %**

Structure Loading, Rating and Posting Data

Loading Data :

Design Loading :		**2 M 13.5 (H 15)**
Inventory Load, Design :	**21.7 mton**	**2 AS Allowable Stress**
Operating Load, Design :	**32.6 mton**	**2 AS Allowable Stress**
Posting :		**5 At/Above Legal Loads**

Rating Data :	Operating	Inventory	Posting
Truck 1 Type 3 :			
Truck 2 Type 3-S3 :			
Truck 3 Type 3-3 :	**62**		

Structure, Roadway and Clearance Data

Structure Deck, Roadway and Span Data :

Structure Length : **180.44 m**

Deck Area : **1,601.00 m sq**

Deck Roadway Width : **7.92 m**

Approach Roadway Width : **9.75 m**

Median Code, Description : **0 No median**

Structure Vertical and Horizontal Clearance Data :

Vertical Clearance Over the Structure : **99.99 m**

Reference Feature for Vertical Clearance : **N Feature not hwy or RR**

Vertical Clearance Under the Structure : **0.00 m**

Reference Feature for Lateral Underclearance : **N Feature not hwy or RR**

Minimum Lateral Under Clearance Right : **0.00 m**

Minimum Lateral Under Clearance Left : **0.00 m**

Span Data

Main Span

Number Spans : **5**

Material Type Code, Description : **4 Steel continuous**

Span Design Code, Description : **3 Girder and Floorbeam System**

Deck

Deck Structure Type : **1 Concrete Cast-in-Place**

Deck Surfacing Type : **6 Bituminous**

Deck Protection Type : **0 None**

Deck Membrain Type : **0 None**

Approach Span

Number of Spans : **2**

Material Type Code, Description : **1 Concrete**

Span Design Code, Description : **4 Tee Beam**

(52) Out-to-Out Width : **8.87 m**

(50A) Curb Width : **0.00 m**

(50B) Curb Width : **0.00 m**

Skew Angle : **45°**

Structure Vertical and Horizontal Clearance Data Inventory Route :

Over / Under Direction Name	Inventory Route	South, West or Bi-directional Travel			North or East Travel		
		Direction	Vertical	Horizontal	Direction	Vertical	Horizontal
Route On Structure	P00001	Both	99.99 m	7.92 m	N/A		

Montana Department of Transportation

INITIAL ASSESSMENT FORM FOR STRUCTURE :

P00001142+02631

Continue

Inspection Data

Sufficiency Rating : **27.6**
Health Index : **87.84**
Structure Status :**Struc Def - Elg Repl**

Inspection Due Date : 05 October 2012
(91) Inspection Fequency (months) : **24**
Next Fracture Critical Due Date : **05 Oct 2012**
Fracture Critical Detail : **1 or 2 Stl-girder systms**

NBI Inspection Data

(90) Date of Last Inspection : 05 October 2010

Last Inspected By : Donald Rasmussen - 96

(90) Inspection Date :

Inspected By :

(58) Deck Rating :	7	(68) Deck Geometry :	3	(36C) Approach Rail Rating :	1	(62) Culvert Rating :	N
(59) Superstructure Rating :	4	(67) Structure Rating :	4	(36A) Bridge Rail Rating :	1	(61) Channel Rating :	8
(60) Substructure Rating :	6	(69) Under Clearance :	N	(36B) Transition Rating :	0	(71) Waterway Adequacy :	8
(72) App Rdwy Align :	6	(41) Posting Status :	A	(36D) End Rail Rating :	0	(113) Scour Critical :	5

Unrepaired Spalls : 2 m sq

Deck Surfacing Depth : 0.50 in

Inspection Hours

Crew Hours for inspection :	26
Helper Hours :	-1
Special Crew Hours :	-1
Special Equipment Hours :	-1

Snooper Required : **Y**

Snooper Hours for inspection :	4
Flagger Hours :	8

Inspection Work Candidates

Candidate ID	Date Requested	Status	Priority	Effected Structure Unit	Scope of Work	Action	Covered Condition States
D11-FY2009-000047	**02 December 2008**	**Approved**	**Medium**	All Spans	Bridge	Remove	
Remove trees interfering with the snooper inspection, especially on the right side on the west bank; see photo, and anywhere else needed. Approved. DRC							
D11-FY2009-000048	**02 December 2008**	**Not Approved**	**High**	M Main	334 Metal Rail Coated	Rehab Elem	
Replace missing blockouts on the right side near the east end. Repair collision damage and broken posts west of the bridge.							

Montana Department of Transportation

INITIAL ASSESSMENT FORM FOR STRUCTURE :

P00001142+02631

Continue

Element Inspection Data

* * * * * * * * * * Span : **Main-0 - Spans 2 thru 6** * * * * * * * * * *

Element Description

Smart Flag	Scale Factor	Env	Quantity	Units	Insp Each	Pct Stat 1	Pct Stat 2	Pct Stat 3	Pct Stat 4	Pct Stat 5
Element 13 - Unp Conc Deck/AC Ovl										
	1	4	1352	sq.m.	X	0	100	0	0	0
						%	%	%	%	%

Previous Inspection Notes :

10/05/2010 - No significant changes noted. Deck is still state 2. MZKZ

11/18/2009 - Deck edges continue to deteriorate. There is at least one spall in eastbound traffic lane at B7 expansion joint. See pic. No other changes noted. QECW

08/29/2008 - Changed quantity from 1471 m2 to 1352 m2. 8.87 x (180.44 - (2 x 14))=1352 m2. 14m is approach span length. Asphalt overlay is over half gone in the west bound lane and about a quarter missing on the east bound lane. Numerous areas of edge of deck spalling with exposed both mats of deck rebar and at least two pieces of edge of deck rebar hanging down over the river. No obvious spalling between the curbs. CZJZ

Inspection Notes:

Smart Flag	Scale Factor	Env	Quantity	Units	Insp Each	Pct Stat 1	Pct Stat 2	Pct Stat 3	Pct Stat 4	Pct Stat 5
Element 107 - Paint Stl Opn Girder										
	1	4	331	m.		70	10	10	10	0
						%	%	%	%	%

Previous Inspection Notes :

10/05/2010 - No significant changes noted. Changed quantity back to 331 because the original change was made by mistake. MZKZ

11/18/2009 - Cracks previously detected at P4 left appear unchanged. Slight swelling of bottom flanges between bottom flange and cover plate under some of the joints. Heavier pack rust and swelling between bottom flange and the gusset over the bearings. No significant changes noted. Changed quantity from 331 to 305. QECW

08/29/2008 - Areas of freckled rust throughout with heavier rust under all the joints. Small areas of minor section loss on the web of the right girder at B3. Slight swelling on the flanges, mostly on the bottom flanges between the bottom flange and the cover plates under some of the joints; see fracture critical report for more detail. Heavier pack rust and swelling between the bottom flange and the gusset over the bearings. Some pack rust and swelling between the bearing stiffener plates. Lots of pack rust on one gusset on the right girder in mid span 3 under a joint. No changes noted on previous small cracks found at the welds on the riveted bottom flange sections where the girder bends vertically (planned bend) each side of the bearing mostly at B4. See photos. No rivets were missing or obviously failed from pack rust. CZJZ

Inspection Notes:

Smart Flag	Scale Factor	Env	Quantity	Units	Insp Each	Pct Stat 1	Pct Stat 2	Pct Stat 3	Pct Stat 4	Pct Stat 5
Element 152 - Paint Stl Floor Beam										
	1	4	837	m.		75	5	10	10	0
						%	%	%	%	%

Previous Inspection Notes :

10/05/2010 - These is some section loss in the top flanges of the floor beams under joints but the top flange is embedded in the concrete deck and it is not measureable. I do not think it is severe enough yet to warrant structural analysis. MZKZ

11/18/2009 - No significant changes noted. QECW

08/29/2008 - Heavy rust with some corrosion and section loss under the joints at B2, B3, spans 3 and 4 and B7. The remainder and the majority of the floorbeams that are not under joints are in good shape with a little rust mostly on the flanges. See photos. CZJZ

Inspection Notes:

Montana Department of Transportation

INITIAL ASSESSMENT FORM FOR STRUCTURE :

P00001142+02631
Continue

********** Span : Main-0 - Spans 2 thru 6 (cont.) **********

Element Description

Smart Flag	Scale Factor	Env	Quantity	Units	Insp Each	Pct Stat 1	Pct Stat 2	Pct Stat 3	Pct Stat 4	Pct Stat 5

Element 210 - R/Conc Pier Wall B3 - B6

Smart Flag	Scale Factor	Env	Quantity	Units	Insp Each	Pct Stat 1	Pct Stat 2	Pct Stat 3	Pct Stat 4	Pct Stat 5
	1	4	50	m.		100	0	0	0	
						%	%	%	%	%

Previous Inspection Notes :

10/05/2010 - No significant changes noted. MZKZ
11/18/2009 - No significant changes noted. QECW
08/29/2008 - No changes noted. No spalls or scour noted. Four skewed pier walls. Quantity of 50 would be correct. CZJZ

Inspection Notes:

Element 215 - R/Conc Abutment B2 and B7

Smart Flag	Scale Factor	Env	Quantity	Units	Insp Each	Pct Stat 1	Pct Stat 2	Pct Stat 3	Pct Stat 4	Pct Stat 5
	1	4	26	m.		100	0	0	0	
						%	%	%	%	%

Previous Inspection Notes :

10/05/2010 - No significant changes noted. MZKZ
11/18/2009 - No significant changes noted. QECW
08/29/2008 - The only side visible is on the sides facing the main spans. No problems or changes noted. CZJZ

Inspection Notes:

Element 234 - R/Conc Cap   B3 - B6

Smart Flag	Scale Factor	Env	Quantity	Units	Insp Each	Pct Stat 1	Pct Stat 2	Pct Stat 3	Pct Stat 4	Pct Stat 5
	1	4	50	m.		95	0	5	0	
						%	%	%	%	%

Previous Inspection Notes :

10/05/2010 - No significznt changes noted. MZKZ
11/18/2009 - No significant changes noted. QECW
08/29/2008 - One six inch spall with exposed rebar under the left girder at B4. No other changes noted. Changed quantity from 35 to 50 to agree with 9-16-05 calculations for element 210 - pier wall. CZJZ

Inspection Notes:

Element 304 - Open Expansion Joint

Smart Flag	Scale Factor	Env	Quantity	Units	Insp Each	Pct Stat 1	Pct Stat 2	Pct Stat 3	Pct Stat 4	Pct Stat 5
	1	4	70	m.		80	20	0		
						%	%	%	%	%

Previous Inspection Notes :

10/05/2010 - No significant changes noted. MZKZ
11/18/2009 - No significant changes noted. QECW
08/29/2008 - Quantity: Use curb to curb. Skewed - 1 ea. at B2 and B7. 2x7.9/cos 45 = 22.3m. 6 non-skewed - 6x7.9=47.4 22.3 47.4 = 69.7m Changed quantity from 25 to 70. Except at B2 and B7, the joint openings were measured from none to 3/8 inch. Joint openings at B2 and B7 are larger. None have seals. Lots of corrosion on the floorbeams and x frames under these leaking joints. No changes noted with the joints. CZJZ

Inspection Notes:

Montana Department of Transportation

INITIAL ASSESSMENT FORM FOR STRUCTURE :

P00001142+02631

Continue

********** Span : **Main-0 - Spans 2 thru 6 (cont.)** **********

Smart Flag	Scale Factor	Env	Quantity	Units	Insp Each	Pct Stat 1	Pct Stat 2	Pct Stat 3	Pct Stat 4	Pct Stat 5
Element 305 - Assm Jt w/o Seal										
	1	3	25	m.		80	20	0		
						%	%	%	%	%

Previous Inspection Notes :

10/05/2010 - No significant changes noted. MZKZ

11/18/2009 - No significant changes noted. QECW

08/29/2008 - Quantity = 2x8.87/cos45 = 25. Changed quantity from 34 to 25. No changes noted. Rusting and corrosion below the joints. CZJZ

08/22/2007 - Sliding plate joints are mostly filled with asphalt. Some spalling and delamination along joint edges. (Joints are visible for inspection, they have asphalt in them, but not over the top of the joints.) NVJZ

09/16/2005 - No changes from last inspection. No other problems with the joints noted. CZLZ

08/19/2003 - Sliding plate joints are mostly filled with asphalt and loose material. Need cleaned. Rusting and corrosion underneath. UZJZ

10/10/2001 - Sliding plate joints at P-3 & P-6 skewed to CL. Asphalt material partially plugging joint(s). Some rusting and corrosion, with some minor spalliing in overhangs. JJEA

09/27/1999 - The sliding plate joints at P-3 and P-4 have been paved over with cracks in asphalt surface. The underside shows some spalling, corrosion and rusting. NJBX

09/22/1997 - B-3 and B-6 - sliding plates UJGS

10/01/1994 - None REFI

Inspection Notes:

Smart Flag	Scale Factor	Env	Quantity	Units	Insp Each	Pct Stat 1	Pct Stat 2	Pct Stat 3	Pct Stat 4	Pct Stat 5
Element 311 - Moveable Bearing B3, B5 and B6										
	1	4	10	ea.		40	60	0		
						%	%	%	%	%

Previous Inspection Notes :

10/05/2010 - No significant changes noted. MZKZ

11/18/2009 - No significant changes noted. QECW

08/29/2008 - 4 ea. at B3 and B6 and 2 at B5. The bearings at B5 have the most paint with very little paint left at B3 and B6. A small amount of gravel on some of the bearings. No other problems noted. CZJZ

Inspection Notes:

Smart Flag	Scale Factor	Env	Quantity	Units	Insp Each	Pct Stat 1	Pct Stat 2	Pct Stat 3	Pct Stat 4	Pct Stat 5
Element 313 - Fixed Bearing B2, B4 and B7										
	1	4	6	ea.		35	65	0		
						%	%	%	%	%

Previous Inspection Notes :

10/05/2010 - No significant changes noted. MZKZ

11/18/2009 - No significant changes noted. QECW

08/29/2008 - The paint at B4 is in pretty good shape with the bearings at B2 and B7 have heavy rust with almost no paint left. No other problems noted. CZJZ

Inspection Notes:

Montana Department of Transportation

INITIAL ASSESSMENT FORM FOR STRUCTURE :

P00001142+02631

Continue

* * * * * * * * * * Span : **Main-0 - Spans 2 thru 6** **(cont.)** * * * * * * * * * *

Element Description

Smart Flag	Scale Factor	Env	Quantity	Units	Insp Each	Pct Stat 1	Pct Stat 2	Pct Stat 3	Pct Stat 4	Pct Stat 5
Element 334 - Metal Rail Coated										
	1	3	305	m.		95	0	5	0	0
						%	%	%	%	%

Previous Inspection Notes :

10/05/2010 - No significant changes noted. MZKZ

11/18/2009 - No significant changes noted. QECW

08/29/2008 - Quantity = 2(180.44 -28) = 304.88m Changed quantity from 332 to 305. Put 5 percent in state 3 for missing blockouts behind the right rail near B7. No other problems noted. CZJZ

08/22/2007 - No significant changes noted. NVJZ

09/16/2005 - Deck rail is concrete rail and posts behind a large w beam steel rail. There is collision damage to the rail only at the approach to bent 1 left. The last 3 section of bridge rail near bent 8 right side is steel. No other problems noted. (109.398 * 2 = 218.796) CZLZ

08/19/2003 - Rail shows minor collision damage. No problems noted. UZJZ

10/10/2001 - Triple W-beam metal rail shows some minor collision type damage throughout. Old style BAS - Not To Std.. Approach rail shows some collision damage. Terminals OK. JJEA

09/27/1999 - Some minor plow type damage to rail. Some minor corrosion and rusting. NJBX

09/22/1997 - None UJGS

10/01/1994 - None REFI

Inspection Notes:

Smart Flag	Scale Factor	Env	Quantity	Units	Insp Each	Pct Stat 1	Pct Stat 2	Pct Stat 3	Pct Stat 4	Pct Stat 5
Element 356 - Sup Steel Fat SmFlag										
X	1	1	1	ea.	X	0	100	0		
						%	%	%	%	%

Previous Inspection Notes :

10/05/2010 - No changes noted. MZKZ

11/18/2009 - No changes noted in cracks on the bottom flange of the left girder just before and after P4. QECW

08/29/2008 - No changes noted in the cracks in the bottom flange welds two feet back and two feet ahead of the center of bearing of the left girder. CZJZ

08/22/2007 - Significant corrosion and pack rust with advanced section loss under joint locations. Lighter rust scattered throughout. No significant changes noted. NVJZ

09/16/2005 - Significant corrosion, pack rust and lighter rust throughout with specific locations of more severe conditions. Several locations of section loss. No significant changes noted. CZLZ

08/19/2003 - Significant corrosion, pack rust, and rust throughout with specific locations of more severe conditions. Several locations of section loss. No significant changes noted. UZJZ

10/10/2001 - Heavy corrosion along bottom of bottom flanges of floorbeam at P-3 Lt. & Rt., also along inside webs along length of joint and bottom flanges. Several locations of heavy corrosion and rusting with severs section loss of skewed vertical cross braces at joint locations. All floorbeams at double guard angle joints show corrosion rusting and section loss. JJEA

09/27/1999 - None NJBX

09/22/1997 - _ UJGS

Inspection Notes:

INITIAL ASSESSMENT FORM FOR STRUCTURE :

P00001142+02631
Continue

* * * * * * * * * * Span : **Main-0 - Spans 2 thru 6 (cont.)** * * * * * * * * * *

Element Description

Smart Flag	Scale Factor	Env	Quantity	Units	Insp Each	Pct Stat 1	Pct Stat 2	Pct Stat 3	Pct Stat 4	Pct Stat 5
Element 357 - Sup Pack Rust SmFlag										
X	1	1	1	ea.	X	0	100	0	0	
						%	%	%	%	%

Previous Inspection Notes :

10/05/2010 - No significant changes noted.	MZKZ
11/18/2009 - All pack rust noted in August 2009 inspection appears unchanged.	QECW
08/29/2008 - Pack rust between bearing stiffener plates under the sliding plate joints at B3 and B6. Slight swelling from pack rust in the bottom flanges of both girders in mid span 3; at the bottom flange of the left girder under the first joint AOL of B4; at the bottom flanges of both girders and the top flange of the left girder under the first joint AOL of B5 and in the bottom flange at the very end of the cover plate of the right girder at the second joint AOL of B4. A larger amount of swelling between the bottom flanges and the gusset plates over the bearings. All rivets are holding. Severe swelling at one gusset in span 3 on the right side.	CZJZ
08/22/2007 - Areas of severe pack rust under joint locations. No significant changes noted.	NVJZ
09/16/2005 - Areas of severe pack rust. No significant changes noted.	CZLZ
08/19/2003 - Areas of severe pack rust - no significant changes noted.	UZJZ
10/10/2001 - Pack rust spreading double angle stiffeners Lt. & Rt. at P-3 at sliding plate joint. Pack rust at crest of all girders all spans. Numerous locations of small areas of pack rust. No significant changes noted.	JJEA
09/27/1999 - None	NJBX
09/22/1997 - _	UJGS

Inspection Notes:

Smart Flag	Scale Factor	Env	Quantity	Units	Insp Each	Pct Stat 1	Pct Stat 2	Pct Stat 3	Pct Stat 4	Pct Stat 5
Element 363 - Sup Sect Loss SmFlag										
X	1	4	1	ea.	X	0	100	0	0	
						%	%	%	%	%

Previous Inspection Notes :

10/05/2010 - Element 181 - Vertical Cross Frames was deleted this inspection per memo from Mike Murphy dated 5-10-10. Floorbeams section loss is not quite bad enough to warrant structural analysis.	MZKZ
11/18/2009 - No significant changes noted.	QECW
08/29/2008 - Section loss has put element 181 x-frames in state 4 and 5 and element 152 - floorbeams into state 4. An analysis has not been done.	CZJZ

Inspection Notes:

* * * * * * * * * * Span : **Appr-2 - Tower Spans** * * * * * * * * * *

Element Description

Smart Flag	Scale Factor	Env	Quantity	Units	Insp Each	Pct Stat 1	Pct Stat 2	Pct Stat 3	Pct Stat 4	Pct Stat 5
Element 63 - Unp Top Flang/AC Ovl Tower Spans 1 and 7										
	1	4	248	sq.m.	X	100	0	0	0	0
						%	%	%	%	%

Previous Inspection Notes :

10/05/2010 - No significant changes noted.	MZKZ

Inspection Notes:

INITIAL ASSESSMENT FORM FOR STRUCTURE :

P00001142+02631

Continue

* * * * * * * * * * Span : **Appr-2 - Tower Spans (cont.)** * * * * * * * * * *

Smart Flag	Scale Factor	Env	Quantity	Units	Insp Each	Pct Stat 1	Pct Stat 2	Pct Stat 3	Pct Stat 4	Pct Stat 5
Element 110 - R/Conc Open Girder Tower spans 1 and 7										
	1	3	70	m.		100	0	0	0	
						%	%	%	%	%

Previous Inspection Notes :

10/05/2010 - No significant changes noted.	MZKZ
09/16/2005 - No problems noted with the concrete at the tower spans. (5 * 14.02 = 70.10) changed 02/17/2006 Please confirm - Nate.	CZLZ
08/19/2003 - None	UZJZ
10/10/2001 - None	JJEA
09/27/1999 - Don't believe this element exists. THESE ELEMENTS DO EXIST BUT ARE ONLY ACCESSIBLE VIA DOORS THROUGH THE BACKWALLS AT BENTS 1 & 8.	NJBX
09/22/1997 - None	UJGS
10/01/1994 - None	REFI

Inspection Notes:

Smart Flag	Scale Factor	Env	Quantity	Units	Insp Each	Pct Stat 1	Pct Stat 2	Pct Stat 3	Pct Stat 4	Pct Stat 5
Element 334 - Metal Rail Coated Tower spans 1 and 7										
	1	4	56	m.		100	0	0	0	0
						%	%	%	%	%

Previous Inspection Notes :

10/05/2010 - No changes noted.	MZKZ

Inspection Notes:

INITIAL ASSESSMENT FORM FOR STRUCTURE :

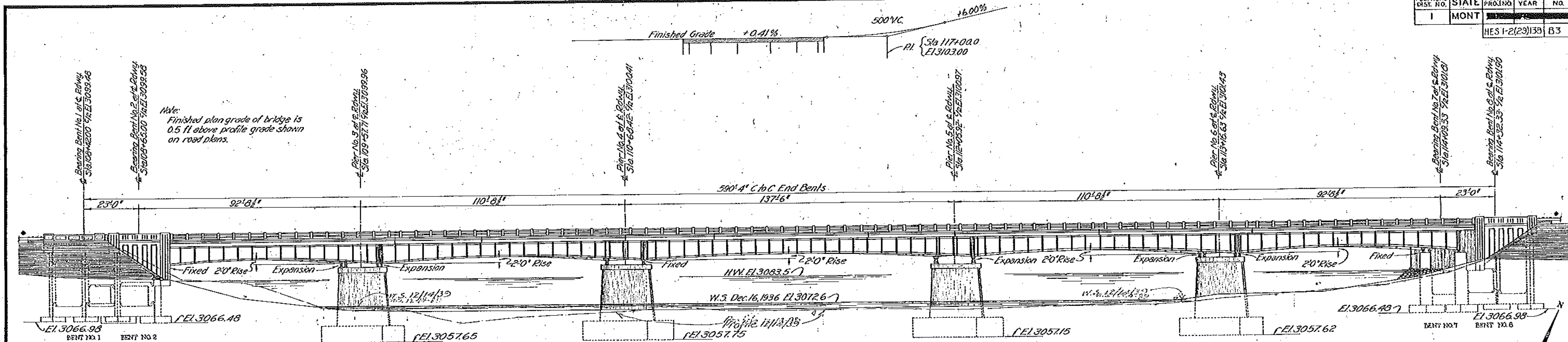
P00001142+02631

Continue

General Inspection Notes

10/05/2010 - None	MZKZ
11/18/2009 - None	QECW
08/29/2008 - Transition rail near B8 on the left does not have double guardrail. The end of the guardrail west of B1 on the right has broken posts from severe collision damage. Less severe collision damage to the guardrail west of B1 on the left. The guardrail on the right 40 feet west from B1 has broken posts.Deleted 4 concrete columns - element 205 as they are integral with the abutment. Snooper driver had 4 hours not including driving time and traffic control had 1.5 hours.	CZJZ
08/22/2007 - None	NVJZ
09/16/2005 - None	CZLZ
08/19/2003 - None	UZJZ
10/10/2001 - None	JJEA
09/27/1999 - It's this inspectors opinion that this structure has no approach spans and that the "tower spans" are not tower spans but backwalls and wingwalls only because there is no indication from the roadway behavior, as seen in other structures. Other bridges show cracks in the approach asphalt at the beginning of the tower span and at the beginning of the main span. This bridge does not exhibit this characteristic.	NJBX
09/22/1997 - None	UJGS
10/01/1994 - Sufficiency Rating Calculation Accepted by ops$u5963 at 3/10/97 11:19:12 Sufficiency Rating Calculation Accepted by OPS$U9004 at 2/19/97 12:33:34	REFI
10/01/1992 - Updated with tape 1994	NB94
01/01/1990 - Updated with tape 1992	NB92
04/01/1987 - Updated with tape 1989	NB89
09/01/1984 - Updated with tape 1987	NB87
10/01/1982 - Updated with tape 1984	NB84
07/01/1980 - Updated with tape 1983	NB83
03/01/1979 - Updated with tape 1980	NB80

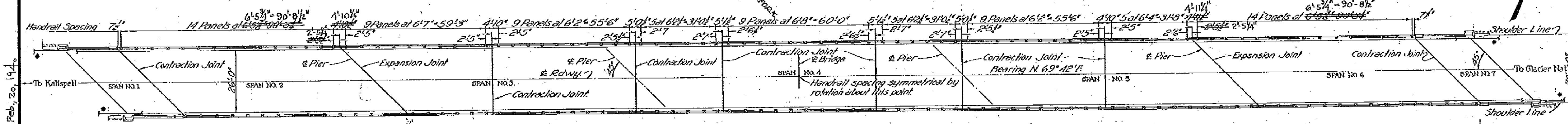
FED. ROAD DIST. NO.	STATE	FED. AID PROJ. NO.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
1	MONT	[redacted]			
		HES 1-2(29)138		B3	



ELEVATION

Note: Elevations shown for bottoms of footings are approximate only. Final elevations shall be determined by the engineer.

Ice-Light
Drift-Considerable
Scour-Slight
Subsoil-See note below.



PLAN

♦ THIS CONTRACT HES I-2(29)38
New Curb Tapers & Thrie Beam Guard Rail added. Thrie Beam Guard Rail blocked out & made continuous w/Approach rail. See Dwg. No. 14158 & 14159.

SPECIFICATIONS:- Montana State Highway Commission Standard Specifications for Road and Bridge Construction, revised April, 1935; Design Specifications for Highway Structures, revised July, 1935; and Special Provisions shall govern unless otherwise noted.

LIVE LOAD:- Standard H-15 loading.

CONCRETE:- All concrete of superstructure, and as noted on details of bents shall be class "D". All other concrete shall be class "A" unless otherwise noted.

Chamfer all exposed edges of concrete 1½ inches and fillet all entrant angles 1½ inches unless otherwise noted.

REINFORCING STEEL:- All reinforcing bars shall be of intermediate grade billet steel. They shall be of approved deformed section unless otherwise noted.

Slab bars shall be supported on steel chairs placed sufficiently close together to maintain bars in proper position. All other bars shall be supported on steel chairs or precast concrete blocks. The unit price bid for reinforcing steel shall include the cost of furnishing and placing chairs, precast blocks and all other materials used to fasten reinforcing steel in place.

Splicing of main reinforcing bars shall not be permitted except as shown on the plans.

Bends in reinforcing bars shall be made to a radius of not less than four diameters of the bar. Hooks shall conform to the dimensions shown in the following sketches.

3d = Inside Radius   45°   3d = Inside Radius   d = Diameter of bar

REINFORCING COVERING:- Minimum covering from surface of concrete to face of any reinforcing bar shall be not less than 2 inches except in slabs, where the minimum covering shall be 1 inch. In footings and piers the minimum covering shall be 3 inches.

CONSTRUCTION JOINTS:- Construction joints shall be made only at locations shown on the plans or as approved by the engineer. Adequate keys shall be provided at all construction joints as noted on the plans or determined by the engineer.

MASTIC JOINT MATERIAL:- All mastic material shall be "Carey Elastite" or an approved equal. Cost of furnishing and placing mastic material shall be included in the unit price bid for class "D" concrete.

FINISHING:- Attention is directed particularly to the requirements of paragraph 26.5(m)(2) of the Standard Specifications for the finishing of concrete floor slab.

GENERAL NOTES

STRUCTURAL STEEL:- For requirements governing structural steels and their fabrication, see the Standard Specifications. To avoid oversight, these requirements shall be clearly noted on the shop drawings.

Structural steel shall receive one shop coat and two field coats of paint, on all surfaces not in contact with concrete, except as noted in paragraph 33.8 of the Standard Specifications.

Shop Coat:- Lead paint as described in Section 53 of the Standard Specifications.
First Field Coat:- Primer coat for aluminum paint as described in Section 54 of the Standard Specifications.
Second Field Coat:- Aluminum paint as described in Section 54 of the Standard Specifications.

PLACING OF CONCRETE:- In addition to the requirements of placing concrete as set forth in the Standard Specifications for Road and Bridge Construction, the contractor shall provide suitable vibratory tampers which shall operate at a speed of not less than 3200 blows per minute. These tampers shall be used in the placing and compacting of all concrete except that which is placed under water and in handrails and curbs when poured as separate units.

The engineer shall determine the allowable slump which in no case shall exceed 4 in. for class "D" concrete or limits set up in the Standard Specifications for other classes of concrete.

CONCRETE CURB & HANDRAIL:- The price bid for concrete curb and handrail shall be payment for curbs and handrails complete in place, except for reinforcing bars therein, which shall be paid for as reinforcing steel.

SOILS AND FOUNDATION MATERIALS:- Borings were taken by the Montana State Highway Commission approximately 650 ft upstream from the final bridge site and sand, gravel and boulders of varying degrees of compactness or cementation were encountered for a depth of 36 feet.

The State Highway Commission does not guarantee that the materials which will be actually encountered in the course of excavation for the structure will be the same as encountered where the borings were taken, neither does the State assume any responsibility for any variation or misinterpretation of the classes of materials.

No claim or adjustment in the unit price bid for excavation shall be made if the materials found in the course of excavation do not agree with those shown as found at the site where borings were taken.

STRUCTURE EXCAVATION:- Only the excavation below elevation 3064.65 for pier No. 3, elevation 3065.75 for pier No. 4, elevation 3065.15 for pier No. 5, elevation 3064.62 for pier No. 6, elevation 3069.25 for bents No. 1 and No. 2 and elevation 3069.25 for bents No. 7 and No. 8 need be restricted to the area inside the coffer dams.

All boulders taken out of holes in excavating for piers or bents shall be placed back around pier or bent from which they were taken in such a manner as to provide the best protection against scour.

Excavation for bents shall be paid for under item No. 7 and excavation for piers shall be paid for under item No. 8.

REFERENCES	
DWG. NO.	DESCRIPTION
1922	Tower Spans No. 1 & No. 7
1923	" " " " " "
1924	Piers No. 3, 4, 5 & 6
1925	Floor System and Shoes
1926	Special Floor Details
1927	Floor Plan & Bracing Details
1928	Girder details Spans No. 2 & 6
1929	" " " No. 3, 4 & 5
1930	" " " " " " "
1931	" " " " " " "
1932	" " " " " " "
1800	Standard Bronze Tablet

DESIGNED BY	VPM	May 1937
DRAWN BY	J. McD.	7-26-37
TRACED BY	J. McD.	7-29-37
CHECKED BY	V.P.M.	8-12-37
REVISED BY	POH	9-8-86
REVISED BY		

Construction Change: Made by HL Feb., 20, 1940

STATE OF MONTANA
STATE HIGHWAY COMMISSION

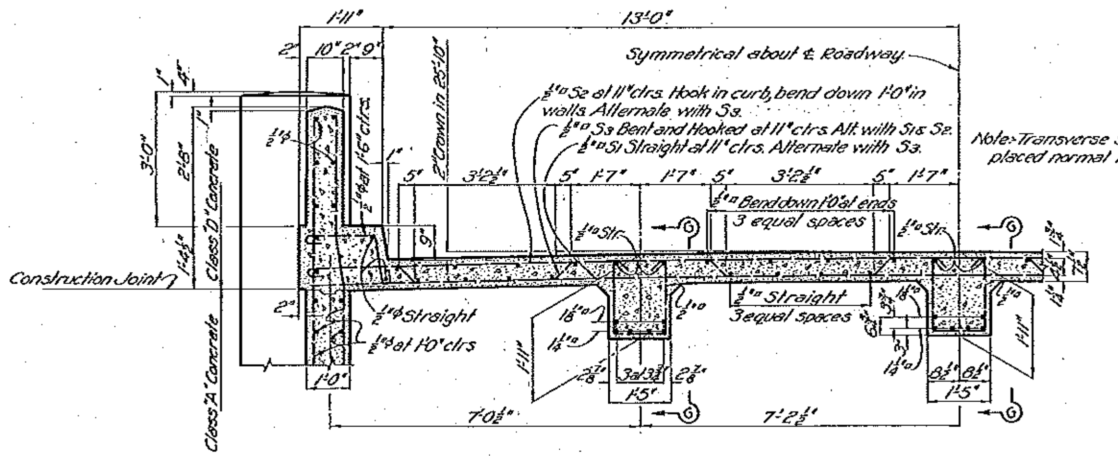
BRIDGE OVER SOUTH FORK OF FLATHEAD RIVER
NEAR CORAM
FED. AID PROJ. NO. 257 F
FLATHEAD COUNTY

GENERAL LAYOUT
Scale: 1" = 20'-0"

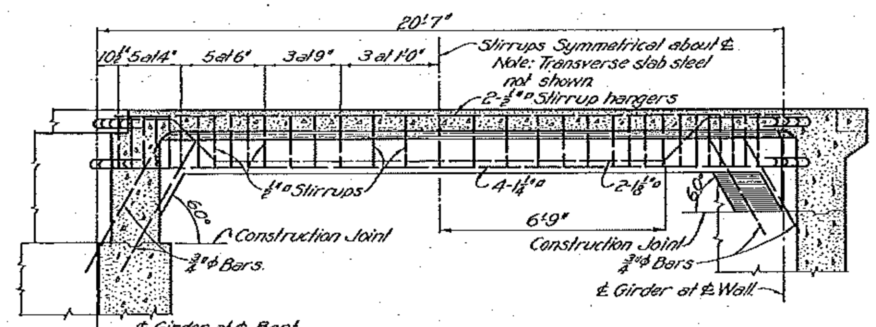
APPROVED BY B. J. Ornburn
BRIDGE DESIGNING ENGINEER

FILE NO. 795   DRAWING NO. 1921

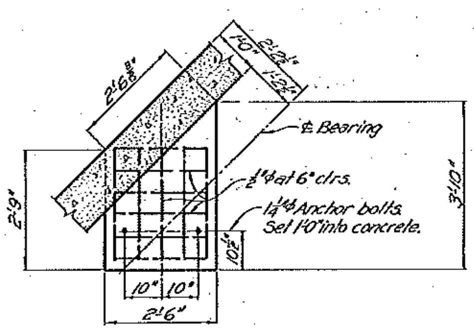
FED. ROAD DIST. NO.	STATE	FED. AID PROJ. NO.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
1	MONT.	257-F		3	13



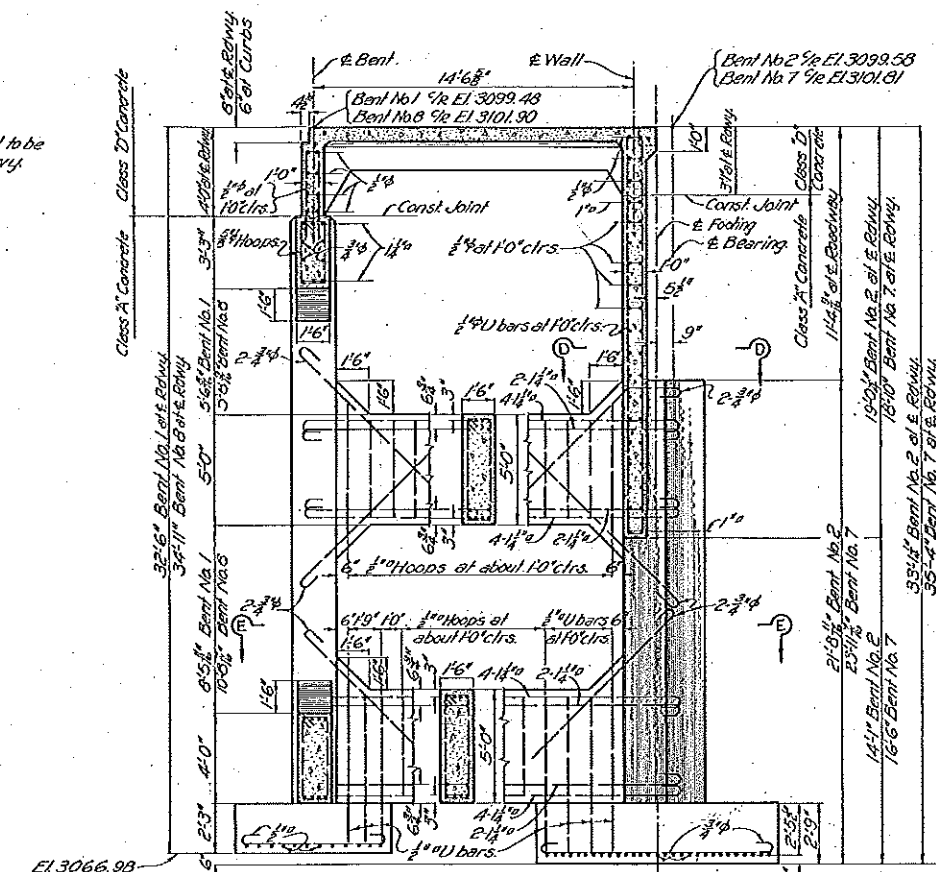
HALF SECTION-NORMAL TO ℄ ROADWAY
Scale: ½"=1'0"



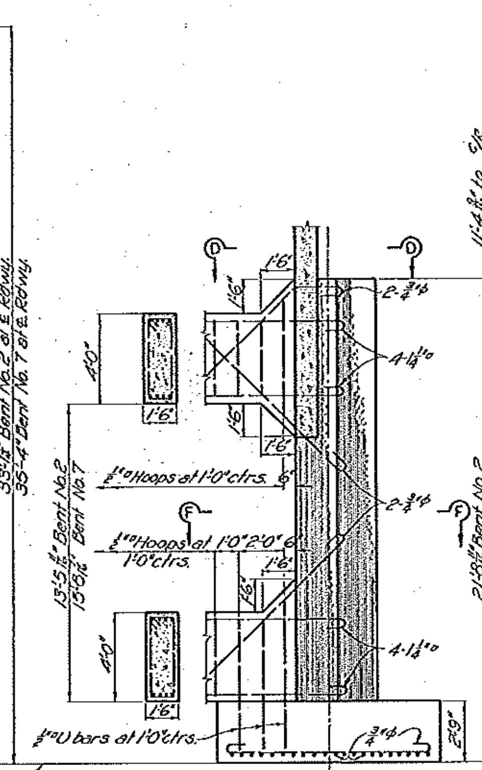
SECTION G-G
Scale: ⅜"=1'0"



SECTION D-D
Scale: ½"=1'0"

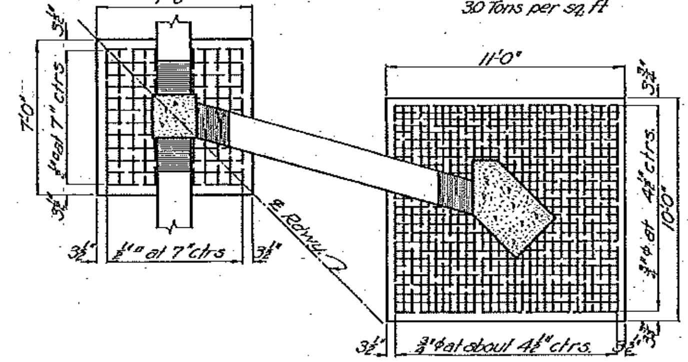


SECTION B-B
See Dwg. No. 1922

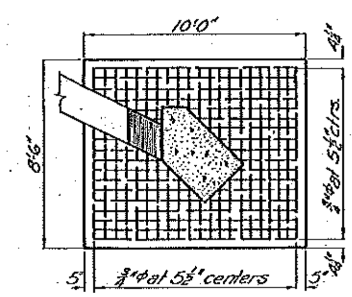


PART SECTION C-C
See Dwg. No. 1922

Maximum foundation pressure 30 Tons per sq. ft.



SECTION E-E



SECTION F-F

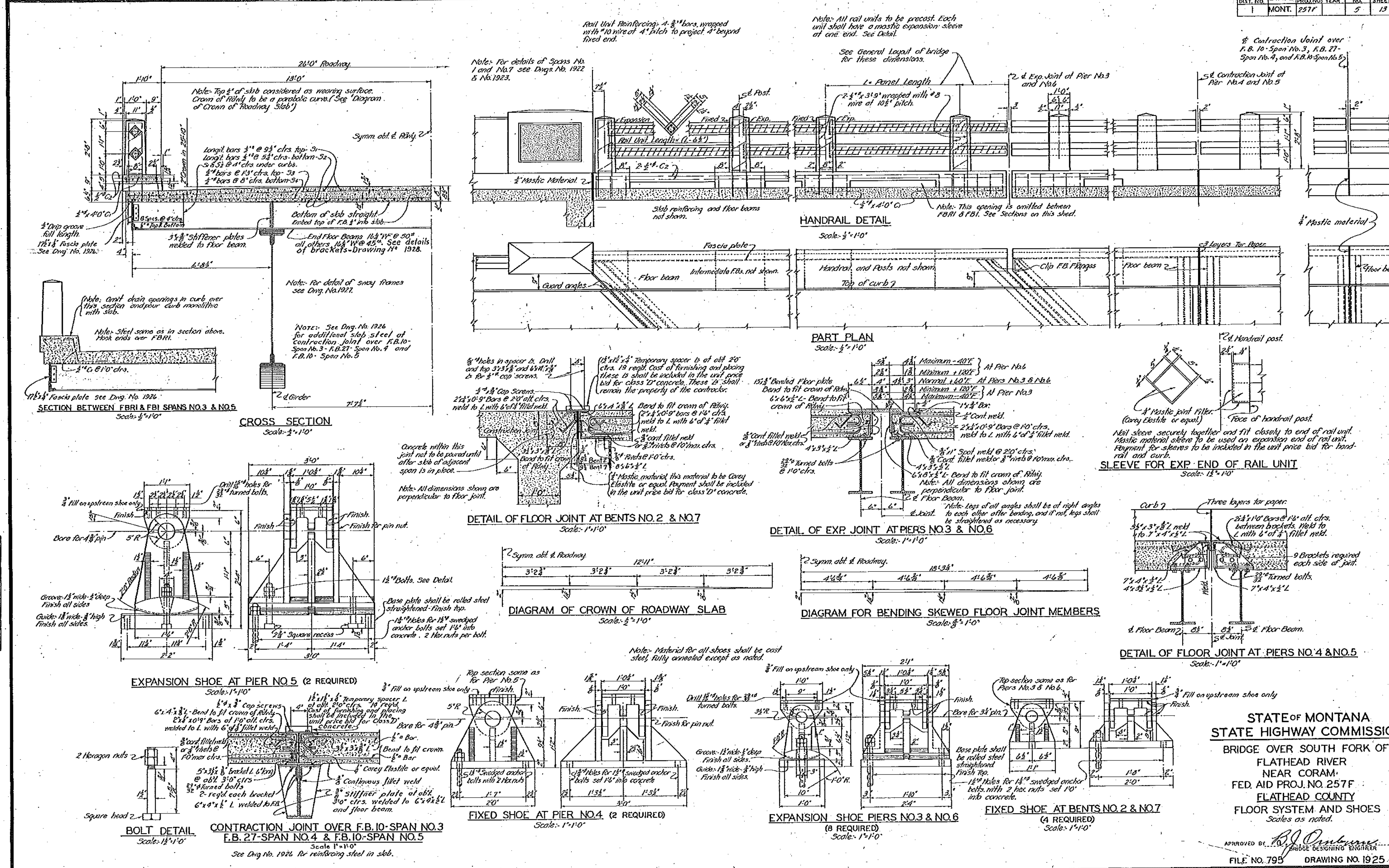
DESIGNED BY A.W.d.	June 1937
DRAWN BY	6-19-37
TRACED BY J.M.Q.	6-23-37
CHECKED BY	6-23-37
REVISED BY	
REVISED BY	

STATE OF MONTANA
STATE HIGHWAY COMMISSION
BRIDGE OVER SOUTH FORK OF
FLATHEAD RIVER
NEAR CORAM
FED. AID PROJ. NO. 257-F
FLATHEAD COUNTY
TOWER SPANS NO. 1 & NO. 7
Scale: ¼"=1'0" unless otherwise noted.

APPROVED BY B. J. Ornburn
BRIDGE DESIGNING ENGINEER

FILE NO. 795 DRAWING NO. 1923

FED. ROAD DIST. NO.	STATE	FED. AID PROJ. NO.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
1	MONT.	257F		5	13



DESIGNED BY	V.R.M.	13 May 1937
DRAWN BY	J.A.M.	6-10-37
TRACED BY	T.C.R.	6-14-37
CHECKED BY	V.R.M.	8-12-37
REVISED BY		
REVISED BY		

STATE OF MONTANA
STATE HIGHWAY COMMISSION

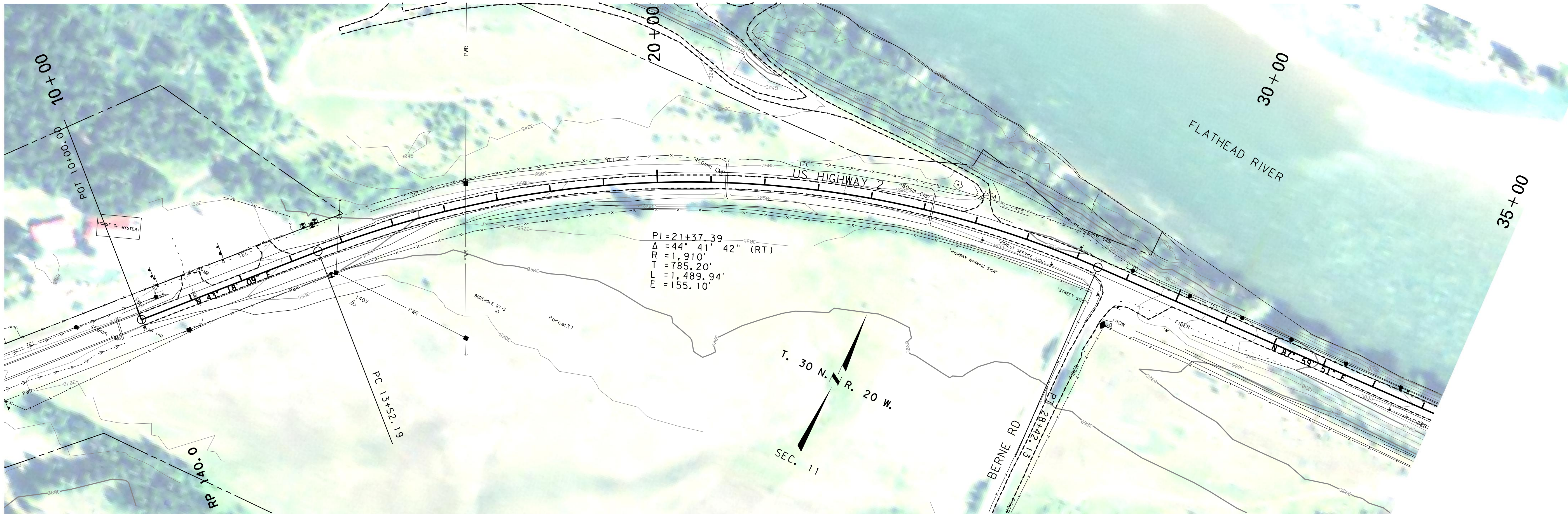
BRIDGE OVER SOUTH FORK OF
FLATHEAD RIVER
NEAR CORAM
FED. AID PROJ. NO. 257F
FLATHEAD COUNTY
FLOOR SYSTEM AND SHOES
Scales as noted.

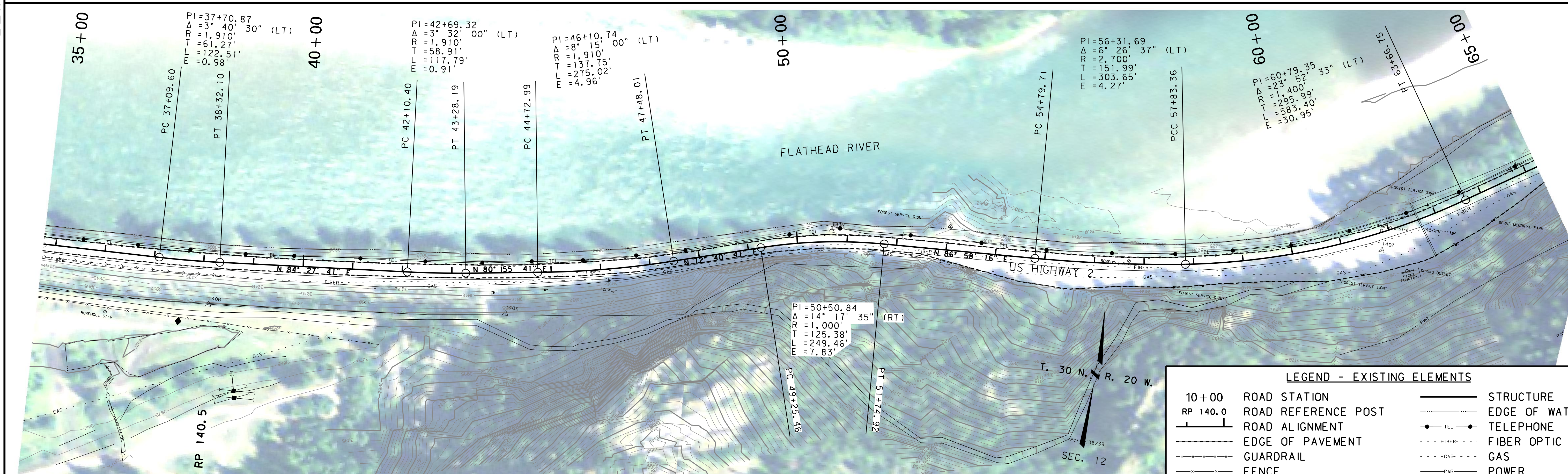
APPROVED BY B.J. Ornburn
BRIDGE DESIGNING ENGINEER

FILE NO. 795 DRAWING NO. 1925

Appendix 3

Plan Sheets for
Existing US 2 Alignment





LEGEND - EXISTING ELEMENTS

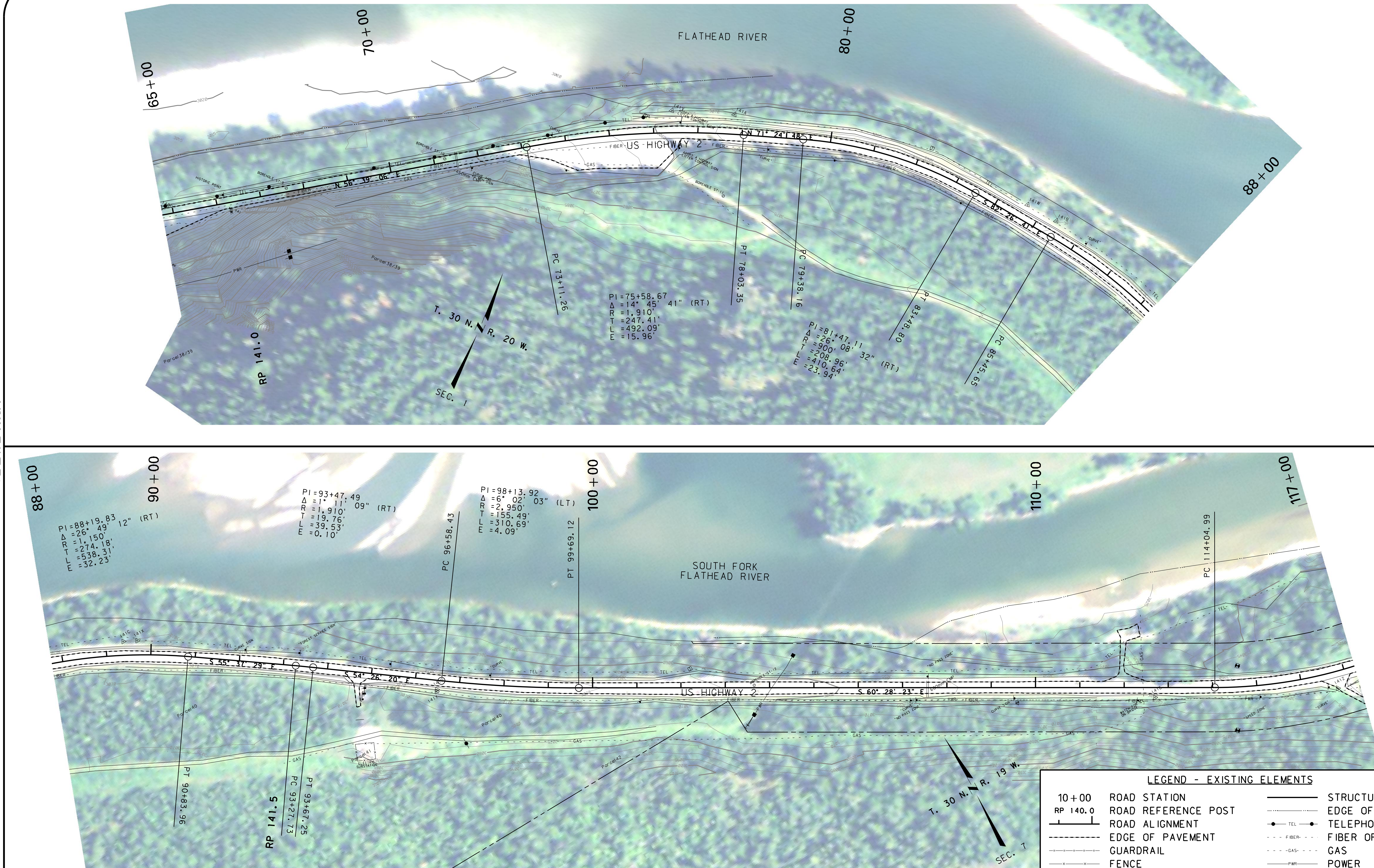
10+00	ROAD STATION		STRUCTURE
RP 140.0	ROAD REFERENCE POST		EDGE OF WATER
	ROAD ALIGNMENT	TEL	TELEPHONE
	EDGE OF PAVEMENT	FIBER	FIBER OPTIC
	GUARDRAIL	GAS	GAS
	FENCE	PWR	POWER
	RIGHT-OF-WAY		

NOTE:
EXISTING MDT RIGHT-OF-WAY IS APPROXIMATE. MDT ROW EXTENDS TO HIGH WATER MARK WHERE APPLICABLE.

SCALE 1"=200'

SHEET 1 OF 3

DOWL HKM



DOWL HKM

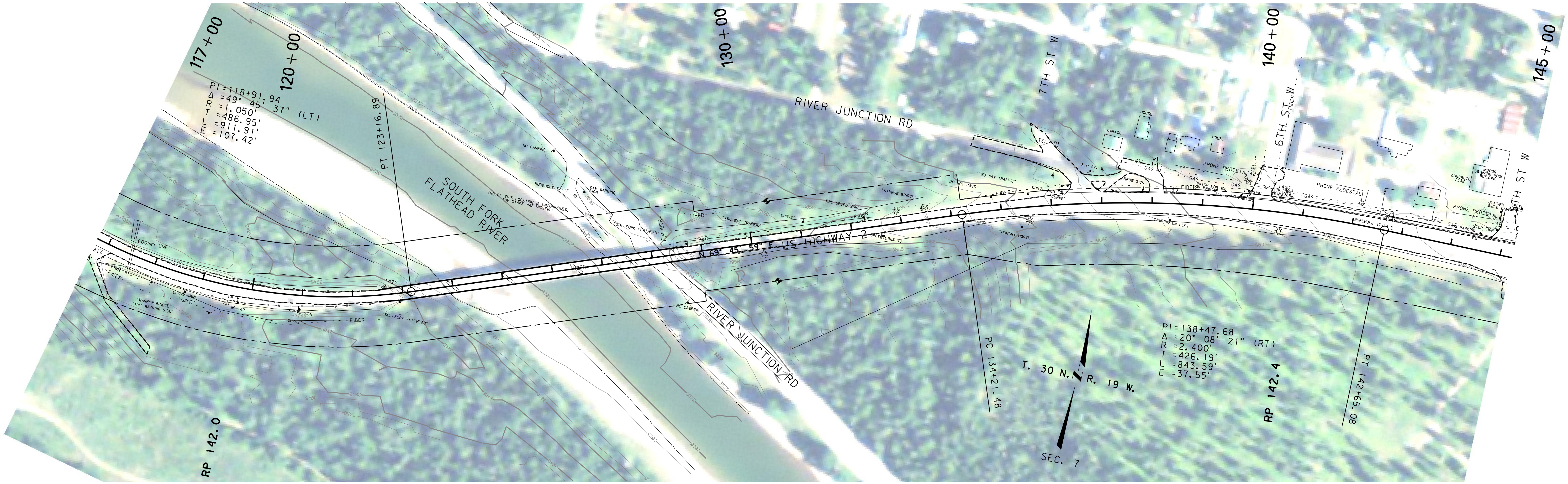
LEGEND - EXISTING ELEMENTS

10+00	ROAD STATION		STRUCTURE
RP 140.0	ROAD REFERENCE POST		EDGE OF WATER
	ROAD ALIGNMENT	TEL	TELEPHONE
	EDGE OF PAVEMENT	FIBER	FIBER OPTIC
	GUARDRAIL	GAS	GAS
	FENCE	PWR	POWER
	RIGHT-OF-WAY		

NOTE:
EXISTING MDT RIGHT-OF-WAY IS APPROXIMATE. MDT ROW EXTENDS TO HIGH WATER MARK WHERE APPLICABLE.

SCALE 1"=200'

DOWL HKM



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NOTE:
EXISTING MDT RIGHT-OF-WAY IS APPROXIMATE. MDT ROW EXTENDS TO HIGH WATER MARK WHERE APPLICABLE.

LEGEND - EXISTING ELEMENTS

10+00	ROAD STATION		STRUCTURE
RP 140.0	ROAD REFERENCE POST		EDGE OF WATER
	ROAD ALIGNMENT	TEL	TELEPHONE
	EDGE OF PAVEMENT	FIBER	FIBER OPTIC
	GUARDRAIL	GAS	GAS
	FENCE	PWR	POWER
	RIGHT-OF-WAY		

SCALE 1"=200'

Appendix 4

Crash Statistics

Table 1 Crashes By Year

2006	2007	2008	2009	2010
17	17	16	16	11

Source: MDT, 2011.

Table 2 Crashes By Day of Week

Sun	Mon	Tue	Wed	Thu	Fri	Sat
8	9	8	10	15	10	17

Source: MDT, 2011.

Table 3 Crashes By Month

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
11	6	7	4	3	4	8	8	4	6	6	10

Source: MDT, 2011.

Table 4 Crashes By Light Conditions

Dark Not Lit	Dark - Lighted	Daylight	Dawn	Dusk
27	4	40	2	4

Source: MDT, 2011.

Table 5 Crashes By Road Conditions

Wet	Ice	Dry	Snow or Slush
6	19	35	17

Source: MDT, 2011.

Table 6 Crashes By Weather Conditions

Sleet	Cloudy	Clear	Snow	Blowing Snow	Unknown
1	23	30	18	4	1

Source: MDT, 2011.

Table 7 Crashes By Type

Other	Rear End	Head On	Sideswipe
56	8	8	3

Source: MDT, 2011.

Table 8 Contributing Circumstances[1]

Other (Person)	Exceeded Speed Limit	Rain Snow	Wrong Side / Way	Slushy	Inattentive Driving	Careless Driving	Alcohol	Other (Road)
1	1	1	2	2	6	7	10	13
Other (Vehicle)	**Drugs**	**Obstruction**	**Wet**	**Followed Too Closely**	**Other (Driver)**	**Other (Environment)**	**Icy**	**Too Fast For Conditions**
1	1	1	1	3	3	7	11	17

Source: MDT, 2011.

[1] Crashes may involve multiple contributing circumstances; sum of contributing circumstances does not equal total number of crashes.

Table 9 Crashes By Vehicle Type

Vehicle Type	Number of Crashes[1]
Passenger Car	21
Compact Car	11
Van	1
Pickup	12
Mini Van	4
SUV	17
Mid-Size Wagon	2
Small Wagon	2
Mid-Size Car	8
Motorcycle	5
STD Pickup	12
Motorhome	1
Truck/Tractor	2
Large Car	1
Unknown	1
Small Pickup	4

Source: MDT, 2011.
[1] Crashes may involve multiple vehicles; sum of vehicle types does not equal total number of crashes.

Table 10 Number of Crashes By Severity

Crash Severity	2006	2007	2008	2009	2010	Five-Year Total[1]
Fatality	1	0	4	0	0	5
Injury	14	13	8	6	4	45
Property Damage Only	11	9	9	12	9	50

Source: MDT, 2011.
[1] Crashes may involve multiple fatalities, injuries, and property damage occurrences; sum of these occurrences does not equal total number of crashes.

Appendix 5

Historic and Projected Traffic Volumes

Table 1 Historic AADT Volumes at MDT ATR A-60 at RP 139.6 (1991-2010)

Year	AADT
1991	5,116
1992	5,720
1993	5,881
1994	6,146
1995	6,305
1996	6,135
1997	6,295
1998	6,448
1999	6,448
2000	7,383
2001	6,494
2002	6,629
2003	NA(1)
2004	NA(1)
2005	6,520
2006	6,550
2007	6,676
2008	6,454
2009	6,459
2010	6,765

Source: MDT, 1991-2010; DOWL HKM, 2011.
(1) Traffic volume data was not recorded.

Table 2 ATR A-60 Average Daily & Annual Average Daily Volumes (2010, Average for Entire Week)

Month	Average Day
January	3,750
February	4,260
March	4,456
April	4,976
May	6,462
June	9,063
July	13,036
August	12,100
September	8,598
October	5,898
November	4,709
December	3,872
Annual Average	6,765

Source: MDT, 2010; DOWL HKM, 2011.

Table 3 Projected Traffic Volumes (2012 – 2035)

Year	AADT	Peak Season[1]			Adjusted Annual Average[1]		
		AM Peak Hour	Median Off-Peak Hour	PM Peak Hour	AM Peak Hour	Median Off-Peak Hour	PM Peak Hour
2011	6,866	905	923	1,097	454	459	550
2012	6,969	918	936	1,113	461	466	559
2013	7,074	932	950	1,130	467	473	567
2014	7,180	946	965	1,147	474	480	576
2015	7,288	960	979	1,164	482	488	584
2016	7,397	975	994	1,181	489	495	593
2017	7,508	989	1,009	1,199	496	502	602
2018	7,621	1,004	1,024	1,217	504	510	611
2019	7,735	1,019	1,039	1,235	511	518	620
2020	7,851	1,035	1,055	1,254	519	525	629
2021	7,969	1,050	1,071	1,273	527	533	639
2022	8,088	1,066	1,087	1,292	535	541	648
2023	8,210	1,082	1,103	1,311	543	549	658
2024	8,333	1,098	1,120	1,331	551	558	668
2025	8,458	1,115	1,136	1,351	559	566	678
2026	8,585	1,131	1,153	1,371	567	574	688
2027	8,713	1,148	1,171	1,392	576	583	699
2028	8,844	1,165	1,188	1,413	584	592	709
2029	8,977	1,183	1,206	1,434	593	601	720
2030	9,111	1,201	1,224	1,455	602	610	730
2031	9,248	1,219	1,243	1,477	611	619	741
2032	9,387	1,237	1,261	1,499	620	628	753
2033	9,528	1,256	1,280	1,522	630	638	764
2034	9,671	1,274	1,299	1,545	639	647	775
2035	9,816	1,293	1,319	1,568	649	657	787

Source: MDT, 2012; DOWL HKM, 2012.

(1) Volumes include eastbound and westbound traffic.

Appendix 6

Operational
Analysis Worksheets

Appendix 6

Operational
Analysis Worksheets

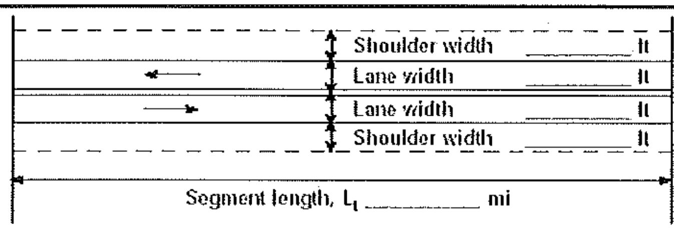
Existing Peak Season

DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

General Information		Site Information	
Analyst	*David Stoner*	Highway / Direction of Travel	*US 2*
Agency or Company	*DOWL HKM*	From/To	*Columbia Falls to Hungry Horse*
Date Performed	*10/27/2011*	Jurisdiction	*Flathead County*
Analysis Time Period	*AM Peak*	Analysis Year	*2011*

Project Description: *US 2 Badrock Canyon Corridor Pla[◄"B*

Input Data



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

Terrain ☐ Level ☑ Rolling

Analysis direction vol., V_d	*279veh/h*
Opposing direction vol., V_o	*175veh/h*
Shoulder width ft	*1.0*
Lane Width ft	*12.0*
Segment Length mi	*2.4*
Grade Length mi	Up/down
Peak-hour factor, PHF	*0.92*
No-passing zone	*100%*
% Trucks and Buses , P_T	*6 %*
% Recreational vehicles, P_R	*4%*
Access points *mi*	*3/mi*

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	*2.1*	*2.3*
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	*1.1*	*1.1*
Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.935*	*0.924*
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	*0.83*	*0.74*
Demand flow rate[2], v_i (pc/h) $v_i=V_i/(PHF^* f_{g,ATS} * f_{HV,ATS})$	*391*	*278*

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
Mean speed of sample[3], S_{FM}		Base free-flow speed[4], BFFS	*60.0 mi/h*
Total demand flow rate, both directions, v		Adj. for lane and shoulder width,[4] f_{LS} (Exhibit 15-7)	*4.2 mi/h*
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Adj. for access points[4], f_A (Exhibit 15-8)	*0.8 mi/h*
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	*3.6 mi/h*	Free-flow speed, FFS (FSS=BFFS-f_{LS}-f_A)	*55.0 mi/h*
		Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	*46.3 mi/h*

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T(Exhibit 15-18 or 15-19)	*1.6*	*1.8*
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	*1.0*	*1.0*
Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.965*	*0.954*
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	*0.85*	*0.79*
Directional flow rate[2], v_i(pc/h) $v_i=V_i/(PHF^* f_{HV,PTSF} * f_{g,PTSF})$	*370*	*252*
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	*37.3*	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	*52.1*	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	*68.3*	

Level of Service and Other Performance Measures

Level of service, LOS (Exhibit 15-3)	*C*
Volume to capacity ratio, *v/c*	*0.27*

Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h	*0*
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	*1354*
Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only)	*84.0*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*303.3*
Effective width, Wv (Eq. 15-29) ft	*13.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*5.42*
Bicycle level of service (Exhibit 15-4)	*E*

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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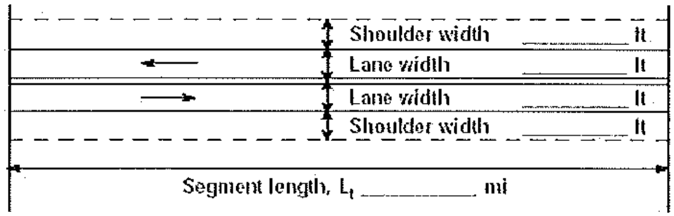
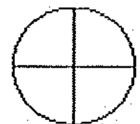
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

General Information		Site Information	
Analyst	*David Stoner*	Highway / Direction of Travel	*US 2*
Agency or Company	*DOWL HKM*	From/To	*Columbia Falls to Hungry Horse*
Date Performed	*10/27/2011*	Jurisdiction	*Flathead County*
Analysis Time Period	*Median Off-Peak*	Analysis Year	*2011*

Project Description: *US 2 Badrock Canyon Corridor PlaWÉ B*

Input Data





Analysis direction vol., V_d	*246veh/h*
Opposing direction vol., V_o	*214veh/h*
Shoulder width ft	*1.0*
Lane Width ft	*12.0*
Segment Length mi	*2.4*

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

Terrain ☐ Level ☑ Rolling

Grade Length	mi	Up/down
Peak-hour factor, PHF		*0.91*
No-passing zone		*100%*
% Trucks and Buses , P_T		*6 %*
% Recreational vehicles, P_R		*4%*
Access points *mi*		*3/mi*

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	*2.2*	*2.2*
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	*1.1*	*1.1*
Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.929*	*0.929*
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	*0.81*	*0.78*
Demand flow rate[2], v_i(pc/h) $v_i=V_i/(PHF^* f_{g,ATS} * f_{HV,ATS})$	*359*	*325*

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
Mean speed of sample[3], S_{FM}		Base free-flow speed[4], BFFS	*61.0 mi/h*
Total demand flow rate, both directions, v		Adj. for lane and shoulder width,[4] f_{LS}(Exhibit 15-7)	*4.2 mi/h*
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Adj. for access points[4], f_A (Exhibit 15-8)	*0.8 mi/h*
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	*3.4 mi/h*	Free-flow speed, FFS $(FSS=BFFS-f_{LS}-f_A)$	*56.0 mi/h*
		Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	*47.3 mi/h*

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T(Exhibit 15-18 or 15-19)	*1.7*	*1.7*
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	*1.0*	*1.0*
Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.960*	*0.960*
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	*0.84*	*0.82*
Directional flow rate[2], v_i(pc/h) $v_i=V_i/(PHF^*f_{HV,PTSF}{}^* f_{g,PTSF})$	*335*	*299*
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	*36.0*	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	*54.1*	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}{}^*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	*64.6*	

Level of Service and Other Performance Measures

Level of service, LOS (Exhibit 15-3)	*C*
Volume to capacity ratio, *v/c*	*0.24*

Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h	*0*
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	*1387*
Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only)	*84.4*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*270.3*
Effective width, Wv (Eq. 15-29) ft	*13.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*5.36*
Bicycle level of service (Exhibit 15-4)	*E*
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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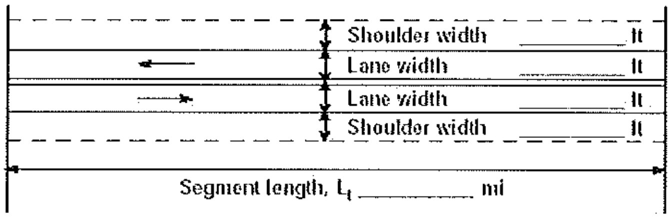
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

General Information		Site Information	
Analyst	*David Stoner*	Highway / Direction of Travel	*US 2*
Agency or Company	*DOWL HKM*	From/To	*Columbia Falls to Hungry Horse*
Date Performed	*10/27/2011*	Jurisdiction	*Flathead County*
Analysis Time Period	*PM Peak*	Analysis Year	*2011*

Project Description: *US 2 Badrock Canyon Corridor Pla*

Input Data



Analysis direction vol., V_d	*343veh/h*	Class I highway ☐ Class II highway ☑ Class III highway ☐	
Opposing direction vol., V_o	*207veh/h*	Terrain ☐ Level ☑ Rolling	
Shoulder width ft	*1.0*	Grade Length mi Up/down	
Lane Width ft	*12.0*	Peak-hour factor, PHF	*0.91*
Segment Length mi	*2.4*	No-passing zone	*100%*
		% Trucks and Buses , P_T	*6 %*
		% Recreational vehicles, P_R	*4%*
		Access points *mi*	*3/mi*

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	*2.0*	*2.2*
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	*1.1*	*1.1*
Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.940*	*0.929*
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	*0.88*	*0.77*
Demand flow rate[2], v_i (pc/h) $v_i=V_i/(PHF^* f_{g,ATS} * f_{HV,ATS})$	*456*	*318*

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
		Base free-flow speed[4], BFFS	*63.0 mi/h*
Mean speed of sample[3], S_{FM}		Adj. for lane and shoulder width,[4] f_{LS}(Exhibit 15-7)	*4.2 mi/h*
Total demand flow rate, both directions, *v*		Adj. for access points[4], f_A (Exhibit 15-8)	*0.8 mi/h*
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Free-flow speed, FFS $(FSS=BFFS-f_{LS}-f_A)$	*58.0 mi/h*
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	*3.8 mi/h*	Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	*48.3 mi/h*

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T(Exhibit 15-18 or 15-19)	*1.6*	*1.7*
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	*1.0*	*1.0*
Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.965*	*0.960*
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	*0.89*	*0.81*
Directional flow rate[2], v_i(pc/h) $v_i=V_i/(PHF^*f_{HV,PTSF}{}^* f_{g,PTSF})$	*439*	*293*
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	*44.2*	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	*44.3*	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}{}^*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	*70.8*	

Level of Service and Other Performance Measures

Level of service, LOS (Exhibit 15-3)	*D*
Volume to capacity ratio, *v/c*	*0.32*

Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h	0
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	1387
Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only)	83.2
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	376.9
Effective width, Wv (Eq. 15-29) ft	13.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	5.53
Bicycle level of service (Exhibit 15-4)	F

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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Appendix 6

Operational
Analysis Worksheets

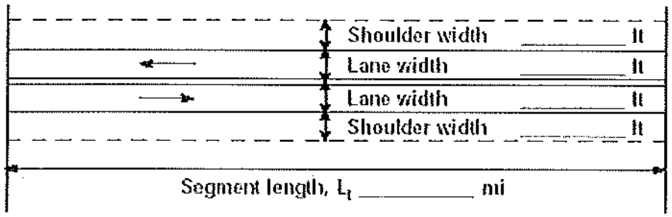
2035 Two-Lane Adjusted Annual Average Season

DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

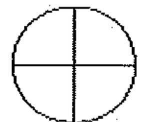
General Information		Site Information	
Analyst	*David Stoner*	Highway / Direction of Travel	*US 2*
Agency or Company	*DOWL HKM*	From/To	*Columbia Falls to Hungry Horse*
Date Performed	*10/27/2011*	Jurisdiction	*Flathead County*
Analysis Time Period	*AM Peak*	Analysis Year	*2011*

Project Description: *US 2 Badrock Canyon Corridor Pla®*

Input Data



Analysis direction vol., V_d *553veh/h*
Opposing direction vol., V_o *351veh/h*
Shoulder width ft *1.0*
Lane Width ft *12.0*
Segment Length mi *2.4*



Show North Arrow

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

Terrain ☐ Level ☑ Rolling

Grade Length mi Up/down

Peak-hour factor, PHF *0.92*

No-passing zone *100%*

% Trucks and Buses , P_T *6 %*

% Recreational vehicles, P_R *4%*

Access points *mi* *3/mi*

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	*1.7*	*2.0*
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	*1.1*	*1.1*
Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.956*	*0.940*
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	*0.97*	*0.89*
Demand flow rate[2], v_i (pc/h) $v_i=V_i/(PHF*f_{g,ATS}*f_{HV,ATS})$	*648*	*456*

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
		Base free-flow speed[4], BFFS	*60.0 mi/h*
Mean speed of sample[3], S_{FM}		Adj. for lane and shoulder width,[4] f_{LS} (Exhibit 15-7)	*4.2 mi/h*
Total demand flow rate, both directions, v		Adj. for access points[4], f_A (Exhibit 15-8)	*0.8 mi/h*
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Free-flow speed, FFS $(FSS=BFFS-f_{LS}-f_A)$	*55.0 mi/h*
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	*2.6 mi/h*	Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	*43.9 mi/h*

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-18 or 15-19)	*1.0*	*1.6*
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*	*0.965*
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	*0.97*	*0.89*
Directional flow rate[2], v_i(pc/h) $v_i=V_i/(PHF*f_{HV,PTSF}*f_{g,PTSF})$	*620*	*444*
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	*56.8*	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	*34.5*	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	*76.9*	

Level of Service and Other Performance Measures

Level of service, LOS (Exhibit 15-3)	*D*
Volume to capacity ratio, *v/c*	*0.40*

Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h	*0*
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	*1544*
Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only)	*79.8*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*601.1*
Effective width, Wv (Eq. 15-29) ft	*13.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*5.76*
Bicycle level of service (Exhibit 15-4)	*F*
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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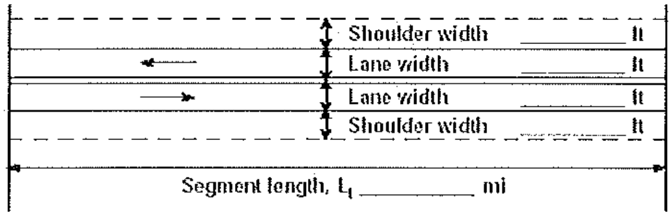
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

General Information		***Site Information***	
Analyst	*David Stoner*	Highway / Direction of Travel	*US 2*
Agency or Company	*DOWL HKM*	From/To	*Columbia Falls to Hungry Horse*
Date Performed	*10/27/2011*	Jurisdiction	*Flathead County*
Analysis Time Period	*Median Off-Peak*	Analysis Year	*2011*

Project Description: *US 2 Badrock Canyon Corridor Plaã¥ B*

Input Data



Analysis direction vol., V_d	*493veh/h*
Opposing direction vol., V_o	*430veh/h*
Shoulder width ft	*1.0*
Lane Width ft	*12.0*
Segment Length mi	*2.4*

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

Terrain ☐ Level ☑ Rolling

Grade Length mi	Up/down
Peak-hour factor, PHF	*0.91*
No-passing zone	*100%*
% Trucks and Buses , P_T	*6 %*
% Recreational vehicles, P_R	*4%*
Access points *mi*	*3/mi*

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	*1.8*	*1.9*
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*	*0.945*
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	*0.96*	*0.94*
Demand flow rate[2], v_i (pc/h) $v_i=V_i$ / (PHF* $f_{g,ATS}$ * $f_{HV,ATS}$)	*593*	*532*

Free-Flow Speed from Field Measurement		**Estimated Free-Flow Speed**	
		Base free-flow speed[4], BFFS	*61.0 mi/h*
Mean speed of sample[3], S_{FM}		Adj. for lane and shoulder width,[4] f_{LS}(Exhibit 15-7)	*4.2 mi/h*
Total demand flow rate, both directions, *v*		Adj. for access points[4], f_A (Exhibit 15-8)	*0.8 mi/h*
Free-flow speed, FFS=S_{FM}+0.00776(*v*/ $f_{HV,ATS}$)		Free-flow speed, FFS (FSS=BFFS-f_{LS}-f_A)	*56.0 mi/h*
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	*2.3 mi/h*	Average travel speed, ATS_d=FFS-0.00776($v_{d,ATS}$ + $v_{o,ATS}$) - $f_{np,ATS}$	*45.0 mi/h*

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T(Exhibit 15-18 or 15-19)	*1.2*	*1.4*
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))	*0.988*	*0.977*
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	*0.96*	*0.94*
Directional flow rate[2], v_i(pc/h) $v_i=V_i$/(PHF*$f_{HV,PTSF}$* $f_{g,PTSF}$)	*571*	*515*
Base percent time-spent-following[4], $BPTSF_d$(%)=100(1-$e^{av_d^b}$)	*55.5*	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	*36.9*	
Percent time-spent-following, $PTSF_d$(%)=$BPTSF_d$+$f_{np,PTSF}$ *($v_{d,PTSF}$ / $v_{d,PTSF}$ + $v_{o,PTSF}$)	*74.9*	

Level of Service and Other Performance Measures

Level of service, LOS (Exhibit 15-3)	*D*
Volume to capacity ratio, *v/c*	*0.35*

Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h	*0*
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	*1613*
Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only)	*80.3*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*541.8*
Effective width, Wv (Eq. 15-29) ft	*13.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*5.71*
Bicycle level of service (Exhibit 15-4)	*F*
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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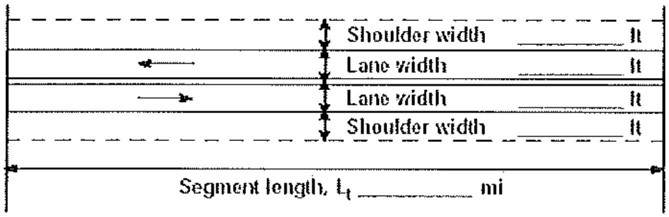
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

General Information		Site Information	
Analyst	David Stoner	Highway / Direction of Travel	US 2
Agency or Company	DOWL HKM	From/To	Columbia Falls to Hungry Horse
Date Performed	10/27/2011	Jurisdiction	Flathead County
Analysis Time Period	PM Peak	Analysis Year	2011

Project Description: US 2 Badrock Canyon Corridor Pla/E+

Input Data



Class I highway ☑ Class II highway Class III highway

Terrain Level ☑ Rolling

Grade Length mi	Up/down
Peak-hour factor, PHF	0.91
No-passing zone	100%
% Trucks and Buses , P_T	6 %
% Recreational vehicles, P_R	4%
Access points mi	3/mi

Analysis direction vol., V_d	687veh/h
Opposing direction vol., V_o	410veh/h
Shoulder width ft	1.0
Lane Width ft	12.0
Segment Length mi	2.4

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	1.5	1.9
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	1.1	1.1
Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	0.967	0.945
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	0.99	0.93
Demand flow rate[2], v_i(pc/h) $v_i=V_i/(PHF^* f_{g,ATS}{}^* f_{HV,ATS})$	789	513

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
		Base free-flow speed[4], BFFS	63.0 mi/h
Mean speed of sample[3], S_{FM}		Adj. for lane and shoulder width,[4] f_{LS}(Exhibit 15-7)	4.2 mi/h
Total demand flow rate, both directions, v		Adj. for access points[4], f_A (Exhibit 15-8)	0.8 mi/h
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Free-flow speed, FFS $(FSS=BFFS-f_{LS}-f_A)$	58.0 mi/h
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	2.6 mi/h	Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	45.3 mi/h

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T(Exhibit 15-18 or 15-19)	1.0	1.4
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	0.977
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	1.00	0.93
Directional flow rate[2], v_i(pc/h) $v_i=V_i/(PHF^* f_{HV,PTSF}{}^* f_{g,PTSF})$	755	496
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	64.5	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	29.4	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}{}^*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	82.2	

Level of Service and Other Performance Measures

Level of service, LOS (Exhibit 15-3)	D
Volume to capacity ratio, v/c	0.47

Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h	*0*
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	*1594*
Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only)	*78.1*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*754.9*
Effective width, Wv (Eq. 15-29) ft	*13.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*5.88*
Bicycle level of service (Exhibit 15-4)	*F*
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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Appendix 6

Operational Analysis Worksheets

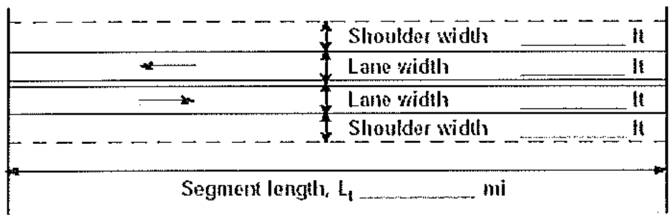
2035 Two-Lane Peak Season

DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

General Information		Site Information	
Analyst	*David Stoner*	Highway / Direction of Travel	*US 2*
Agency or Company	*DOWL HKM*	From/To	*Columbia Falls to Hungry Horse*
Date Performed	*11/15/2011*	Jurisdiction	*Flathead County*
Analysis Time Period	*AM Peak*	Analysis Year	*2035*

Project Description: *US 2 Badrock Canyon Corridor PlaÛ¬¤B*

Input Data



Analysis direction vol., V_d	*398veh/h*	☐ Class I highway ☑ Class II highway ☐ Class III highway	
Opposing direction vol., V_o	*250veh/h*	Terrain ☐ Level ☑ Rolling	
Shoulder width ft	*1.0*	Grade Length mi Up/down	
Lane Width ft	*12.0*	Peak-hour factor, PHF	*0.93*
Segment Length mi	*2.4*	No-passing zone	*100%*
		% Trucks and Buses, P_T	*6 %*
		% Recreational vehicles, P_R	*4%*
		Access points *mi*	*3/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*	*2.2*
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	*1.1*	*1.1*
Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.945*	*0.929*
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	*0.91*	*0.81*
Demand flow rate[2], v_i (pc/h) $v_i=V_i/(PHF^* f_{g,ATS} {}^* f_{HV,ATS})$	*498*	*357*

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
		Base free-flow speed[4], BFFS	*60.0 mi/h*
Mean speed of sample[3], S_{FM}		Adj. for lane and shoulder width,[4] f_{LS} (Exhibit 15-7)	*4.2 mi/h*
Total demand flow rate, both directions, *v*		Adj. for access points[4], f_A (Exhibit 15-8)	*0.8 mi/h*
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Free-flow speed, FFS ($FSS=BFFS-f_{LS}-f_A$)	*55.0 mi/h*
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	*3.1 mi/h*	Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	*45.3 mi/h*

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T(Exhibit 15-18 or 15-19)	*1.4*	*1.7*
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*	*0.960*
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	*0.92*	*0.83*
Directional flow rate[2], v_i(pc/h) $v_i=V_i/(PHF^* f_{HV,PTSF} {}^* f_{g,PTSF})$	*476*	*337*
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	*46.3*	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	*40.2*	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}{}^*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	*69.8*	

Level of Service and Other Performance Measures

Level of service, LOS (Exhibit 15-3)	*C*
Volume to capacity ratio, *v/c*	*0.33*

Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h	*0*
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	*1428*
Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only)	*82.3*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*428.0*
Effective width, Wv (Eq. 15-29) ft	*13.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*5.59*
Bicycle level of service (Exhibit 15-4)	*F*
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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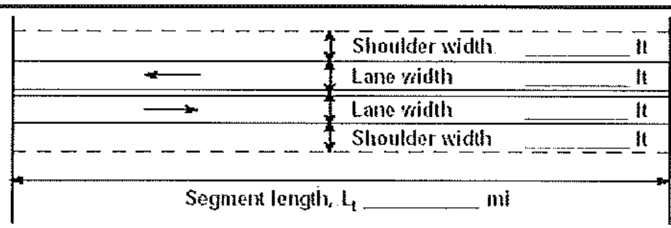
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

General Information		Site Information	
Analyst	*David Stoner*	Highway / Direction of Travel	*US 2*
Agency or Company	*DOWL HKM*	From/To	*Columbia Falls to Hungry Horse*
Date Performed	*11/15/2011*	Jurisdiction	*Flathead County*
Analysis Time Period	*Median Off-Peak*	Analysis Year	*2035*

Project Description: *US 2 Badrock Canyon Corridor Pla¶3¥B*

Input Data



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

Terrain ☐ Level ☑ Rolling

Grade Length mi	Up/down
Peak-hour factor, PHF	*0.91*
No-passing zone	*100%*
% Trucks and Buses, P_T	*6 %*
% Recreational vehicles, P_R	*4%*
Access points *mi*	*3/mi*

Analysis direction vol., V_d	*351veh/h*
Opposing direction vol., V_o	*306veh/h*
Shoulder width ft	*1.0*
Lane Width ft	*12.0*
Segment Length mi	*2.4*

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	*2.0*	*2.1*
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	*1.1*	*1.1*
Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.940*	*0.935*
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	*0.89*	*0.86*
Demand flow rate[2], v_i (pc/h) $v_i=V_i/(PHF*f_{g,ATS}*f_{HV,ATS})$	*461*	*418*

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
Mean speed of sample[3], S_{FM}		Base free-flow speed[4], BFFS	*61.0 mi/h*
Total demand flow rate, both directions, *v*		Adj. for lane and shoulder width,[4] f_{LS}(Exhibit 15-7)	*4.2 mi/h*
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Adj. for access points[4], f_A (Exhibit 15-8)	*0.8 mi/h*
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	*2.9 mi/h*	Free-flow speed, FFS $(FSS=BFFS-f_{LS}-f_A)$	*56.0 mi/h*
		Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	*46.3 mi/h*

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T(Exhibit 15-18 or 15-19)	*1.6*	*1.6*
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	*1.0*	*1.0*
Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.965*	*0.965*
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	*0.89*	*0.87*
Directional flow rate[2], v_i(pc/h) $v_i=V_i/(PHF*f_{HV,PTSF}*f_{g,PTSF})$	*449*	*400*
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	*46.1*	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	*43.4*	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	*69.1*	

Level of Service and Other Performance Measures

Level of service, LOS (Exhibit 15-3)	*C*
Volume to capacity ratio, *v/c*	*0.30*

Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h	0
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	1477
Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only)	82.6
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	385.7
Effective width, Wv (Eq. 15-29) ft	13.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	5.54
Bicycle level of service (Exhibit 15-4)	F

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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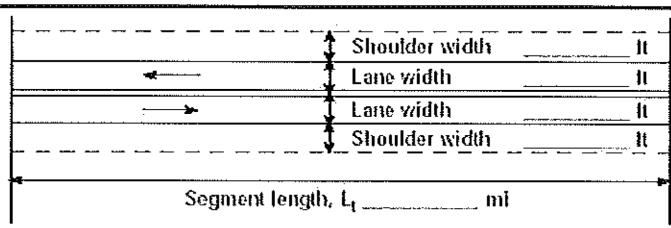
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

General Information		Site Information	
Analyst	*David Stoner*	Highway / Direction of Travel	*US 2*
Agency or Company	*DOWL HKM*	From/To	*Columbia Falls to Hungry Horse*
Date Performed	*11/15/2011*	Jurisdiction	*Flathead County*
Analysis Time Period	*PM Peak*	Analysis Year	*2035*

Project Description: *US 2 Badrock Canyon Corridor Plac¾¡B*

Input Data



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

Terrain ☐ Level ☑ Rolling

Grade Length mi Up/down

Peak-hour factor, PHF *0.91*

No-passing zone *100%*

% Trucks and Buses, P_T *6 %*

% Recreational vehicles, P_R *4%*

Access points *mi* *3/mi*

Analysis direction vol., V_d *491veh/h*

Opposing direction vol., V_o *296veh/h*

Shoulder width ft *1.0*

Lane Width ft *12.0*

Segment Length mi *2.4*

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	*1.8*	*2.1*
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*	*0.935*
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	*0.96*	*0.85*
Demand flow rate[2], v_i(pc/h) v_i=V_i / (PHF* $f_{g,ATS}$ * $f_{HV,ATS}$)	*591*	*409*

Free-Flow Speed from Field Measurement	Estimated Free-Flow Speed	
	Base free-flow speed[4], BFFS	*60.0 mi/h*
Mean speed of sample[3], S_{FM}	Adj. for lane and shoulder width,[4] f_{LS}(Exhibit 15-7)	*4.2 mi/h*
Total demand flow rate, both directions, *v*	Adj. for access points[4], f_A (Exhibit 15-8)	*0.8 mi/h*
Free-flow speed, FFS=S_{FM}+0.00776(*v*/ $f_{HV,ATS}$)	Free-flow speed, FFS (FSS=BFFS-f_{LS}-f_A)	*55.0 mi/h*
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15) *2.8 mi/h*	Average travel speed, ATS_d=FFS-0.00776($v_{d,ATS}$ + $v_{o,ATS}$) - $f_{np,ATS}$	*44.5 mi/h*

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T(Exhibit 15-18 or 15-19)	*1.2*	*1.6*
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))	*0.988*	*0.965*
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	*0.96*	*0.86*
Directional flow rate[2], v_i(pc/h) v_i=V_i/(PHF*$f_{HV,PTSF}$* $f_{g,PTSF}$)	*569*	*392*
Base percent time-spent-following[4], $BPTSF_d$(%)=100(1-$e^{av_d^b}$)	*54.1*	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	*36.2*	
Percent time-spent-following, $PTSF_d$(%)=$BPTSF_d$+$f_{np,PTSF}$ *($v_{d,PTSF}$ / $v_{d,PTSF}$ + $v_{o,PTSF}$)	*75.5*	

Level of Service and Other Performance Measures

Level of service, LOS (Exhibit 15-3)	*D*
Volume to capacity ratio, *v/c*	*0.39*

Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h	*0*
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	*1477*
Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only)	*80.9*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*539.6*
Effective width, Wv (Eq. 15-29) ft	*13.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*5.71*
Bicycle level of service (Exhibit 15-4)	*F*

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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Appendix 6

Operational
Analysis Worksheets

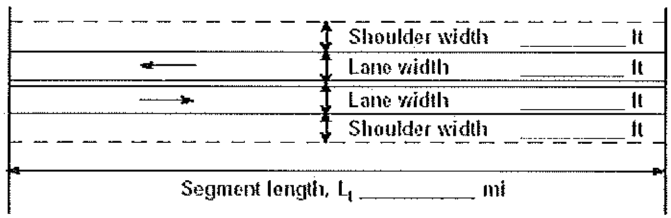
2035 Two-Lane Adjusted Annual Average Season

DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

General Information		*Site Information*	
Analyst	*David Stoner*	Highway / Direction of Travel	*US 2*
Agency or Company	*DOWL HKM*	From/To	*Columbia Falls to Hungry Horse*
Date Performed	*11/15/2011*	Jurisdiction	*Flathead County*
Analysis Time Period	*AM Peak*	Analysis Year .	*2035*

Project Description: *US 2 Badrock Canyon Corridor PlafÂ*

Input Data



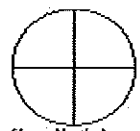
Analysis direction vol., V_d *791veh/h*

Opposing direction vol., V_o *502veh/h*

Shoulder width ft *1.0*

Lane Width ft *12.0*

Segment Length mi *2.4*



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

Terrain ☐ Level ☑ Rolling

Grade Length mi Up/down

Peak-hour factor, PHF *0.93*

No-passing zone *100%*

% Trucks and Buses , P_T *6 %*

% Recreational vehicles, P_R *4%*

Access points *mi* *3/mi*

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	*1.3*	*1.8*
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	*1.1*	*1.1*
Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.978*	*0.951*
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	*1.00*	*0.96*
Demand flow rate[2], v_i (pc/h) $v_i=V_i/(PHF^* f_{g,ATS} * f_{HV,ATS})$	*870*	*591*

Free-Flow Speed from Field Measurement		**Estimated Free-Flow Speed**	
		Base free-flow speed[4], BFFS	*60.0 mi/h*
Mean speed of sample[3], S_{FM}		Adj. for lane and shoulder width,[4] f_{LS}(Exhibit 15-7)	*4.2 mi/h*
Total demand flow rate, both directions, *v*		Adj. for access points[4], f_A (Exhibit 15-8)	*0.8 mi/h*
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Free-flow speed, FFS $(FSS=BFFS-f_{LS}-f_A)$	*55.0 mi/h*
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	*1.9 mi/h*	Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	*41.8 mi/h*

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T(Exhibit 15-18 or 15-19)	*1.0*	*1.2*
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*	*0.988*
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	*1.00*	*0.96*
Directional flow rate[2], v_i(pc/h) $v_i=V_i/(PHF^*f_{HV,PTSF}{}^* f_{g,PTSF})$	*851*	*569*
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	*68.6*	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	*26.4*	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	*84.4*	

Level of Service and Other Performance Measures

Level of service, LOS (Exhibit 15-3)	*D*
Volume to capacity ratio, *v/c*	*0.52*

Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h	*0*
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	*1629*
Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only)	*75.9*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*850.5*
Effective width, Wv (Eq. 15-29) ft	*13.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*5.94*
Bicycle level of service (Exhibit 15-4)	*F*

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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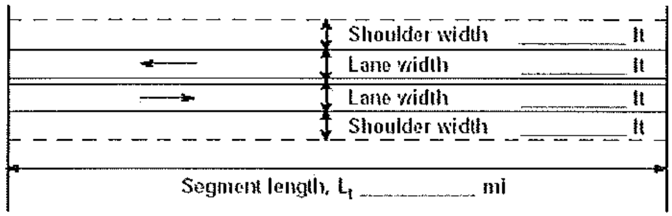
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

General Information		Site Information	
Analyst	*David Stoner*	Highway / Direction of Travel	*US 2*
Agency or Company	*DOWL HKM*	From/To	*Columbia Falls to Hungry Horse*
Date Performed	*11/15/2011*	Jurisdiction	*Flathead County*
Analysis Time Period	*Median Off-Peak*	Analysis Year	*2035*

Project Description: *US 2 Badrock Canyon Corridor PlaW-*

Input Data



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

Terrain ☐ Level ☑ Rolling

Analysis direction vol., V_d	*704veh/h*
Opposing direction vol., V_o	*614veh/h*
Shoulder width ft	*1.0*
Lane Width ft	*12.0*
Segment Length mi	*2.4*
Grade Length mi	Up/down
Peak-hour factor, PHF	*0.91*
No-passing zone	*100%*
% Trucks and Buses , P_T	*6 %*
% Recreational vehicles, P_R	*4%*
Access points *mi*	*3/mi*

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	*1.5*	*1.6*
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	*1.1*	*1.1*
Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.967*	*0.962*
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	*0.99*	*0.98*
Demand flow rate[2], v_i (pc/h) $v_i=V_i/(PHF^* f_{g,ATS}{}^* f_{HV,ATS})$	*808*	*716*

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
		Base free-flow speed[4], BFFS	*61.0 mi/h*
Mean speed of sample[3], S_{FM}		Adj. for lane and shoulder width,[4] f_{LS}(Exhibit 15-7)	*4.2 mi/h*
Total demand flow rate, both directions, *v*		Adj. for access points[4], f_A (Exhibit 15-8)	*0.8 mi/h*
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Free-flow speed, FFS $(FSS=BFFS-f_{LS}-f_A)$	*56.0 mi/h*
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	*1.6 mi/h*	Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	*42.6 mi/h*

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T(Exhibit 15-18 or 15-19)	*1.0*	*1.0*
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*	*0.99*
Directional flow rate[2], v_i(pc/h) $v_i=V_i/(PHF^*f_{HV,PTSF}{}^* f_{g,PTSF})$	*774*	*682*
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	*67.4*	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	*27.2*	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}{}^*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	*81.9*	

Level of Service and Other Performance Measures

Level of service, LOS (Exhibit 15-3)	*D*
Volume to capacity ratio, *v/c*	*0.46*

Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h	*0*
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	*1683*
Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only)	*76.0*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*773.6*
Effective width, Wv (Eq. 15-29) ft	*13.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*5.89*
Bicycle level of service (Exhibit 15-4)	*F*

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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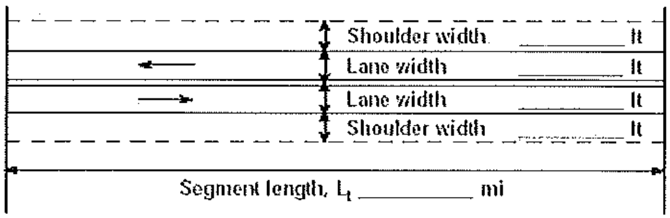
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

General Information		Site Information	
Analyst	David Stoner	Highway / Direction of Travel	US 2
Agency or Company	DOWL HKM	From/To	Columbia Falls to Hungry Horse
Date Performed	11/15/2011	Jurisdiction	Flathead County
Analysis Time Period	PM Peak	Analysis Year	2035

Project Description: US 2 Badrock Canyon Corridor Pla±P B

Input Data



Class I highway ☑ Class II highway Class III highway

Terrain Level ☑ Rolling

Analysis direction vol., V_d	981veh/h
Opposing direction vol., V_o	586veh/h
Shoulder width ft	1.0
Lane Width ft	12.0
Segment Length mi	2.4
Grade Length mi	Up/down
Peak-hour factor, PHF	0.91
No-passing zone	100%
% Trucks and Buses , P_T	6 %
% Recreational vehicles, P_R	4%
Access points mi	3/mi

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	1.3	1.7
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	1.1	1.1
Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	0.978	0.956
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	1.00	0.97
Demand flow rate[2], v_i (pc/h) $v_i=V_i/(PHF^* f_{g,ATS} * f_{HV,ATS})$	1102	694

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
		Base free-flow speed[4], BFFS	60.0 mi/h
Mean speed of sample[3], S_{FM}		Adj. for lane and shoulder width,[4] f_{LS}(Exhibit 15-7)	4.2 mi/h
Total demand flow rate, both directions, v		Adj. for access points[4], f_A (Exhibit 15-8)	0.8 mi/h
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Free-flow speed, FFS $(FSS=BFFS-f_{LS}-f_A)$	55.0 mi/h
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	1.7 mi/h	Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	39.4 mi/h

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T(Exhibit 15-18 or 15-19)	1.0	1.0
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	0.98
Directional flow rate[2], v_i(pc/h) $v_i=V_i/(PHF^*f_{HV,PTSF}{}^* f_{g,PTSF})$	1078	657
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	76.5	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	20.7	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}{}^*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	89.4	

Level of Service and Other Performance Measures

Level of service, LOS (Exhibit 15-3)	E
Volume to capacity ratio, v/c	0.65

Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h	*0*
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	*1666*
Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only)	*71.7*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*1078.0*
Effective width, Wv (Eq. 15-29) ft	*13.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*6.06*
Bicycle level of service (Exhibit 15-4)	*F*

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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