BILLINGS AREA I-90 CORRIDOR PLANNING STUDY

EXISTING AND PROJECTED CONDITIONS REPORT

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MDT
DEPARTMENT OF TRANSPORTATION

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1.0 INTRODUCTION

This report presents information about existing and projected conditions within the study area for the Billings Area I-90 Corridor Planning Study. The study area includes an approximately 22-mile segment of Interstate 90 (I-90) beginning at the Laurel Interchange (RP 433.8) and ending immediately west of the Pinehills Interchange (RP 455.85). Figure 1-1 illustrates the study area begin and end points and the mainline Interstate segments and interchanges within the corridor. Appendix 1 contains maps illustrating Reference Posts (RPs) and additional details throughout the study corridor.

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 and planned projects in the study corridor, and Chapter 5 provides a summary of issues and concerns in the corridor.

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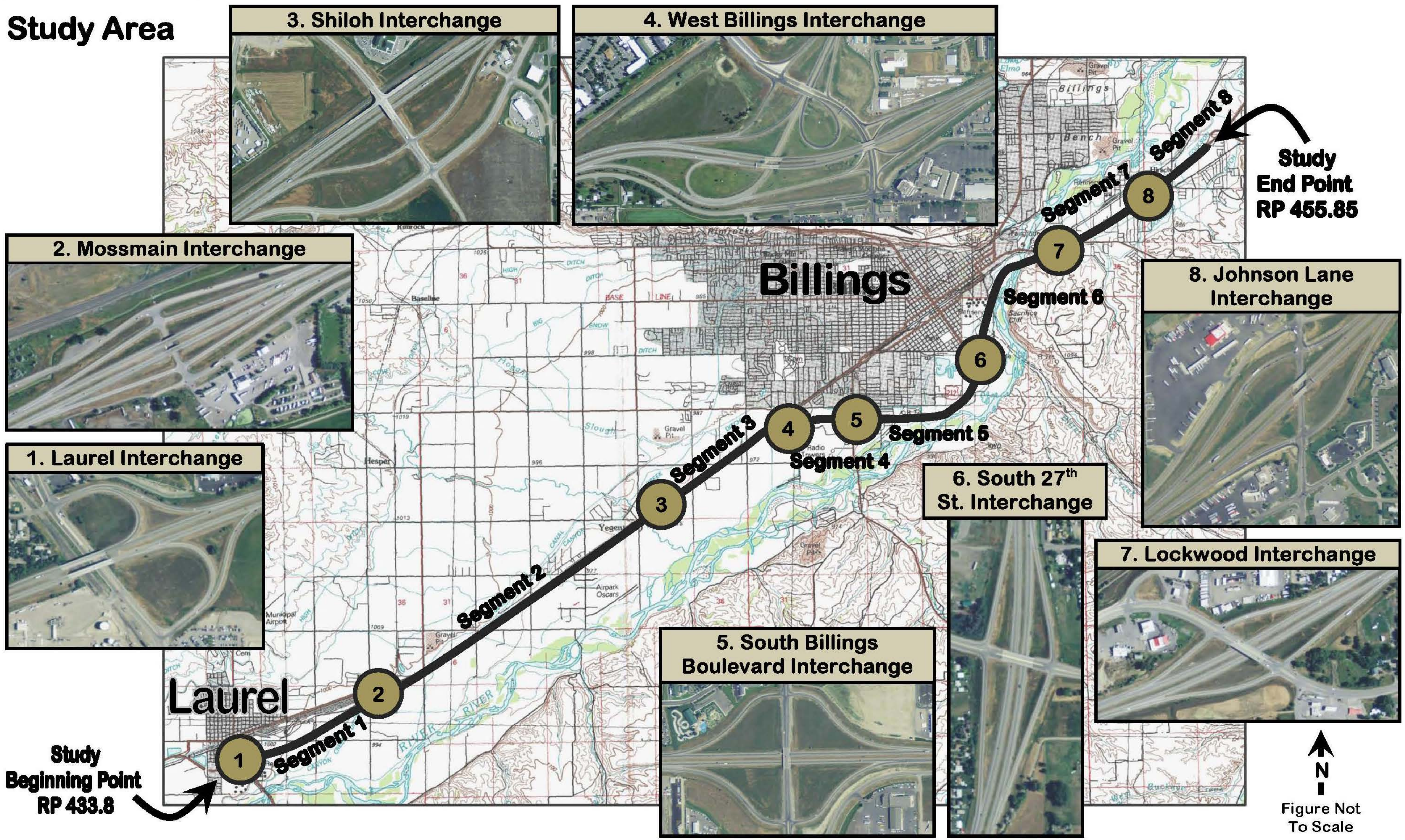
Figure 1-1 Study Area



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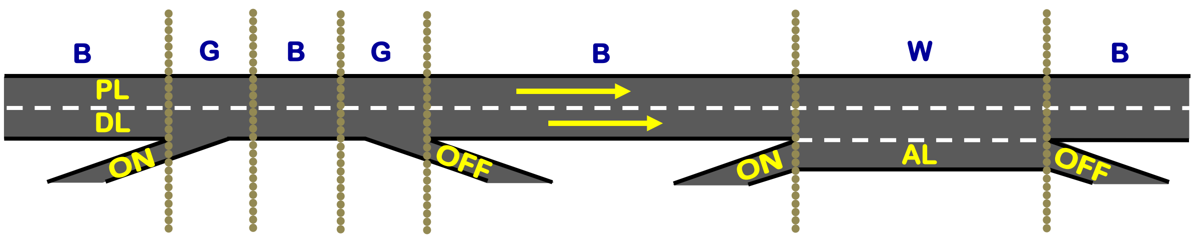
2.0 EXISTING CONDITIONS

2.1 Transportation System Conditions

This section discusses the Interstate transportation system within the study corridor in terms of its existing physical features, geometric characteristics, crash history to date, traffic volumes, and operational characteristics.

Various terms are used throughout this report to describe elements of the Interstate transportation facility. For clarity, these terms are illustrated below in Figure 2-1.

Figure 2-1 Illustration of Freeway Elements



Key

PL:	Passing Lane
DL:	Driving Lane
AL:	Auxiliary Lane
B:	Basic Freeway Segment (also described as Mainline or Interstate Link)
G:	Gore Area (also described as Merge or Diverge Area)
ON:	On-Ramp
OFF:	Off-Ramp
W:	Weaving Segment with Auxiliary Lane between Ramps

Note: Figure 2-1 illustrates two lanes of a four-lane divided Interstate facility. This figure is intended for illustrative purposes only and does not represent any portion of the I-90 study corridor.

This corridor planning study focuses on mainline I-90 elements, including freeway segments and ramp gore areas. Additionally, the study includes an analysis of the Laurel and Mossmain Interchanges in order to supplement analysis conducted for the *Billings I-90 Interchanges Project* report prepared by Short Elliott Hendrickson Inc (March 2006), which assessed the Shiloh, South Billings Boulevard, 27th Street, Lockwood, and Johnson Lane Interchanges. Due to recent improvements, the West Billings Interchange was not included as part of the study.

2.1.1 Physical Features and Characteristics

Physical features and characteristics of the Interstate corridor were determined through field observation and a review of published statistics, documentation, GIS data, and MDT record drawings. A windshield survey of the corridor was conducted in April 2011 to assist in identifying opportunities and constraints within the corridor. Appendix 2 contains a summary memorandum and a photo log documenting conditions observed in the field. Appendix 3 contains a map illustrating physical constraints in the corridor.

Roadway Function

Functional classification is a system that characterizes 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. Interstate 90 (I-90) is functionally classified as a principal arterial and is part of the National Highway System (NHS). The NHS serves as a primary means of moving people, goods, and services throughout the country. Interstate routes connect, as directly as practicable, the principal metropolitan areas, cities, and industrial centers including important routes into, through, and around urban areas; serve the national defense; and, to the greatest extent possible, connect at suitable border points with routes of continental importance in Canada and Mexico. The system is characterized by controlled access,[1] high traffic volumes and speeds, and long-distance trips.

I-90 is the longest Interstate highway in the United States at approximately 3,020 miles. I-90 extends from Seattle, Washington to Boston, Massachusetts. Within the study area, I-90 is intersected by four other NHS routes, including Interstate 94 (I-94), US-212, US-87, and Montana Highway 3. Of special importance is the fact that a portion of I-90 from the South 27th Street Interchange in Billings to the system to system I-90 / I-94 Interchange east of Billings is part of the Camino Real Trade Corridor, identified by the FHWA as an NHS high-priority corridor. I-90 generally runs in an east-west direction and serves as the principal east-west route in the Billings urban area and the surrounding area in Yellowstone County.

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

[1] A controlled access facility restricts all direct access to the facility except through the use of interchange ramps to enhance its primary purpose of providing an unhindered flow of traffic.

Bureau identified 32 bridges within the study area. Of the bridges in the corridor, 10 are functionally obsolete, and four of these are eligible for rehabilitation. 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, but rather that the bridge does not meet current standards for lane widths, shoulder widths, or vertical clearances to serve current traffic demand. Eligibility for federal aid for rehabilitation of a bridge is determined based on the functional or structural status of the bridge and its sufficiency rating. Eligibility ratings for each bridge in the study corridor are provided in Appendix 4.

The twin eastbound (EB) and westbound (WB) I-90 structures over the Yellowstone River are currently classified by MDT as fracture critical. The term "fracture critical" indicates that the bridge does not include redundant supporting elements. This means that if key supporting elements were to fail, the bridge would be in danger of collapse. This does not mean that the bridge is inherently unsafe, but only that there is a lack of redundancy in its design. MDT is currently planning for the replacement of these two structures.

Appendix 4 includes additional data collected by MDT regarding the bridges in the study corridor, including location; sufficiency rating; year built; deck and roadway width; type, design, number, and length of main span(s); total length; vertical clearance; and deficiency rating. A separate analysis of the bridge structure is not included with this study. Appendix 3 contains a map illustrating bridge concerns in the corridor.

Railroad Facilities

A rail line and service spur lines owned and operated by Montana Rail Link generally parallel I-90 to the north over much of the corridor length. Appendix 5 contains maps illustrating the location of railroad crossings in the corridor.

Bicycle and Pedestrian Facilities

There are no dedicated pedestrian or bicycle facilities directly adjacent to the Interstate. Coulson Park, located on Charlene Street north of the NorthWestern Energy plant, includes a walking trail that crosses under the Yellowstone River Bridge at RP 452± in Segment 6 north of the 27th Street Interchange.

Utilities

NorthWestern Energy and Montana Dakota Utilities (MDU) are the two major utility providers in the corridor. According to information provided by MDT, NorthWestern Energy owns, operates, and maintains approximately 380 power poles, 142 overhead transformers, 46 underground padmount transformers, and 3 natural gas lines that are within or pass through the corridor. The Williston Basin Interstate Pipeline Company (a subsidiary of the MDU Resources Group) owns and operates a major natural gas pipeline that travels within the corridor.

Multiple pipelines owned and operated by the Exxon Mobile, Conoco Phillips, and Cenex oil refineries also traverse the corridor. These pipelines generally convey petroleum products, and operate under pressure.

Right-of-Way

Right-of-way boundaries were estimated for the purpose of this study based on a review of cadastral data, available MDT record drawings, and MDT right-of-way plans. Right-of-way boundaries vary throughout the corridor, but generally are 200 to 300 feet wide. Drawings illustrating approximated right-of-way boundaries are included in Appendix 6.

2.1.2 Geometric Characteristics

Mainline Interstate

Design Criteria and Guidelines

Figure 2-2 presents MDT geometric design criteria for freeways (National Highway System – Interstate). Additionally, Chapters 9 and 10 of the MDT Roadway Design Manual (December 2004) and Chapters 25 and 26 of the MDT Traffic Engineering Manual (November 2007) were consulted for guidance regarding mainline Interstate horizontal and vertical alignments.

The design speed within the corridor is 70 mph (level terrain). The posted speed limit along the rural portion of the Interstate corridor (RP 433.8 to RP 442.7) is 75 miles per hour (mph), with a posted truck speed of 65 mph. The posted speed limit for the portion of the corridor within the Billings urban area (RP 442.7 to RP 455.85) is 65 mph for both passenger cars and trucks.

Figure 2-2 Design Criteria for Freeways

	Design Element		Manual Section	Rural	Urban
Design Controls	Design Forecast Year (Geometrics)		8.4	20 Years	20 Years
Design Controls	*Design Speed	Level	8.3	70 mph	50 mph
Design Controls	*Design Speed	Rolling	8.3	60 mph	50 mph
Design Controls	*Design Speed	Mountainous	8.3	50 mph	50 mph
Design Controls	Level of Service		8.4	B	B
Roadway Elements	*Travel Lane Width		11.2	4 @ 12'	4 @ 12'
Roadway Elements	*Shoulder Width	Outside Shoulder	11.2	10' (1)	10' (1)
Roadway Elements	*Shoulder Width	Inside Shoulder	11.2	4' (2)	4' (2)
Roadway Elements	Cross Slope	*Travel Lane	11.2	2%	2%
Roadway Elements	Cross Slope	Shoulder	11.2	2% (3)	2% (3)
Roadway Elements	Median Width	Level	11.3	Minimum: 36'	Desirable: **36'** Minimum: 16' (4)
Roadway Elements	Median Width	Rolling	11.3	Minimum: 36'	Desirable: **36'** Minimum: 16' (4)
Roadway Elements	Median Width	Mountainous	11.3	Minimum: 16' (4)	Desirable: **36'** Minimum: 16' (4)
Earth Cut Sections	Ditch	Inslope	11.4	6:1 (Width: 6')	6:1 (Width: 6')
Earth Cut Sections	Ditch	Width	11.4	10' Min.	10'
Earth Cut Sections	Ditch	Slope	11.4	20:1 towards back slope	20:1 towards back slope
Earth Cut Sections	Back Slope; Cut Depth at Slope Stake (5)	0' - 5'	11.4	5:1	5:1
Earth Cut Sections	Back Slope; Cut Depth at Slope Stake (5)	5' - 10'	11.4	Level/Rolling: 4:1; Mountainous: 3:1	3:1
Earth Cut Sections	Back Slope; Cut Depth at Slope Stake (5)	10' - 15'	11.4	Level/Rolling: 3:1; Mountainous: 2:1	2:1
Earth Cut Sections	Back Slope; Cut Depth at Slope Stake (5)	> 15'	11.4	Level/Rolling: 2:1; Mountainous: 1.5:1	1.5:1
Earth Fill Slopes	Fill Height at Slope Stake (6)	0' - 10'	11.4	6:1	6:1
Earth Fill Slopes	Fill Height at Slope Stake (6)	10' - 20'	11.4	4:1	4:1
Earth Fill Slopes	Fill Height at Slope Stake (6)	20' - 30'	11.4	3:1	3:1
Earth Fill Slopes	Fill Height at Slope Stake (6)	> 30'	11.4	2:1	2:1

	Design Element		Manual Section	Rural 50 mph	Rural 60 mph	Rural 70 mph	Urban 50 mph
Alignment Elements	DESIGN SPEED		N/A	50 mph	60 mph	70 mph	50 mph
Alignment Elements	*Stopping Sight Distance		8.6	425'	570'	730'	425'
Alignment Elements	*Minimum Radius (e = 8.0%)		9.2	760'	1200'	1820'	760'
Alignment Elements	*Superelevation Rate (7)		9.3	e_{max} = 8.0%			e_{max} = 8.0%
Alignment Elements	*Vertical Curvature (K-value)	Crest	10.5	84	151	247	84
Alignment Elements	*Vertical Curvature (K-value)	Sag	10.5	96	136	181	96
Alignment Elements	*Maximum Grade	Level	10.3	3%			5%
Alignment Elements	*Maximum Grade	Rolling	10.3	4%			5%
Alignment Elements	*Maximum Grade	Mountainous	10.3	5% (8)			5%
Alignment Elements	*Minimum Vertical Clearance (9)		10.6	17.0'			17.0'

*** Controlling design criteria (see Section 8.8).**

Source: MDT Road Design Manual, Chapter 12, page 12(4), Figure 12-2, "Geometric Design Criteria for Freeways (National Highway System – Interstate) U.S. Customary," December 2004.

Roadway Width

I-90 is a four-lane divided highway, generally consisting of two separate two-lane roadbeds, although the area between the West Billings Interchange and the South Billings Boulevard Interchange (RP 446.3 to RP 446.8) includes a third auxiliary lane in each direction. Table 2.1 provides information on the mainline Interstate width and surface thickness throughout the corridor, based on the current MDT Road Log.

Table 2.1 Mainline Interstate Width and Surface Thickness

EB Lanes			
Location (Reference Post)	Top Thickness (inches)	Bottom Thickness (inches)	Top Width (feet)
433.0 to 434.1	7.2	17.4	37
434.1 to 446.0	7.2	24.0	37
446.0 to 446.4	7.2	30.0	37
446.4 to 446.8	7.2	30.0	45
446.8 to 447.2	7.2	30.0	37
447.2 to 449.7	7.2	24.0	37
449.7 to 453.3	7.2	24.0	38
453.3 to 456.3	7.8	24.0	38
456.3 to 456.6	4.2	24.0	38
WB Lanes			
Location (Reference Post)	Top Thickness (inches)	Bottom Thickness (inches)	Top Width (feet)
433.0 to 433.8	7.2	22.0	37
433.8 to 445.9	7.2	24.0	37
445.9 to 446.3	7.2	30.0	37
446.3 to 446.7	7.2	30.0	45
446.7 to 447.2	7.2	30.0	37
447.2 to 449.6	7.2	24.0	37
449.6 to 453.2	7.2	24.0	38
453.2 to 455.9	7.8	24.0	38
455.9 to 456.8	4.2	24.0	38

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, and sight distance. For a design speed of 70 mph, the MDT Road Design Manual recommends a minimum curve radius of 1,820 feet (ft), a minimum stopping sight distance of 730 ft, and a minimum curve length of 1,050 ft (which is applicable only for curves with deflection angles of five degrees or less).[2] Based on these criteria, all horizontal curves within the corridor meet current design standards for curve radius and stopping sight distance. Seven horizontal curves with deflection angles less than five degrees do not meet the current design standard for minimum curve length, although this criterion is only recommended to improve the aesthetics of the highway even if not necessary for engineering reasons. Superelevation information was not available for the corridor and therefore was not assessed. Table 2.2 presents horizontal alignment data for the Interstate mainline.

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 (or the horizontal distance needed to produce a one percent change in gradient). Table 2.3 presents vertical alignment information for the Interstate mainline. As noted below, eight vertical curves fail to meet current design standards. Appendix 3 contains a map illustrating vertical curve concerns in the corridor.

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

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Table 2.2 Interstate Mainline 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. Sight Distance (730 ft)	Meet Min. Radius (1820 ft)	Curve Pass/Fail	Comments
434.44	28+50	SIMPLE	448	5,730	4° 28' 60"	70	11.6	YES	YES	**PASS**	Alignment meets design requirements, but does not meet aesthetic requirements for curve length.
435.04	60+27	SIMPLE	1,252	5,730	12° 31' 00"	70	11.6	YES	YES	**PASS**	
436.77	151+27	SIMPLE	503	11,460	2° 31' 00"	70	5.8	YES	YES	**PASS**	Alignment meets design requirements, but does not meet aesthetic requirements for curve length.
437.85	208+67	SPIRAL	791	3,800	8° 31' 45"	70	17.5	YES	YES	**PASS**	
438.10	221+69	SIMPLE	137	5,700	1° 22' 31"	70	11.7	YES	YES	**PASS**	
439.16	277+64	SIMPLE	61	5,700	0° 36' 58"	70	11.7	YES	YES	**PASS**	
439.60	300+81	SIMPLE	28	5,700	0° 16' 36"	70	11.7	YES	YES	**PASS**	Alignment meets design requirements, but does not meet aesthetic requirements for curve length.
442.17	436+72	SIMPLE	798	11,500	3° 58' 32"	70	5.8	YES	YES	**PASS**	
442.45	451+58	SIMPLE	791	11,500	3° 56' 29"	70	5.8	YES	YES	**PASS**	
445.64	619+87	SPIRAL	1,939	2,100	43° 05' 18"	70	31.6	YES	YES	**PASS**	
446.07	642+33	SPIRAL	1,832	2,410	34° 59' 14"	70	27.6	YES	YES	**PASS**	
446.54	667+45	SPIRAL	1,366	2,200	26° 12' 32"	70	30.2	YES	YES	**PASS**	
449.55	826+11	SIMPLE	9,965	6,360	89° 46' 28"	70	10.5	YES	YES	**PASS**	
450.49	875+68	SIMPLE	1,740	5,700	17° 29' 19"	70	11.7	YES	YES	**PASS**	
451.75	942+59	SPIRAL	3,037	2,900	53° 46' 20"	70	22.9	YES	YES	**PASS**	
452.79	997+24	SIMPLE	1,090	5,700	10° 57' 32"	70	11.7	YES	YES	**PASS**	
454.00	1061+13	SIMPLE	537	5,700	5° 23' 42"	70	11.7	YES	YES	**PASS**	
454.38	1081+45	SIMPLE	1,205	5,700	12° 06' 50"	70	11.7	YES	YES	**PASS**	
455.11	1119+80	SIMPLE	1,181	11,500	5° 53' 03"	70	5.8	YES	YES	**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(4).

(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.

Table 2.3 Interstate Mainline Vertical Alignment Analysis

Curve PI[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 (247/181)	Meet Max. Grade (3%)	Meet Min. Curve Length[4] (210'/1000')	Curve Pass/Fail	Comments
434.01	8+50	CREST	1,500	237	3.164%	-3.164%	70	**NO**	**NO**	YES	**FAIL**	LAUREL INTERCHANGE BRIDGE
434.15	13+00	SAG	500	161	-3.164%	-0.050%	70	**NO**	**NO**	NO	**FAIL**	LAUREL INTERCHANGE BRIDGE
434.68	41+00	CREST	800	3,540	-0.050%	-0.276%	70	YES	YES	NO	**PASS**	
435.15	66+00	SAG	110	780	-0.276%	-0.135%	70	YES	YES	NO	**PASS**	
435.58	88+75	CREST	800	4,734	-0.135%	-0.304%	70	YES	YES	NO	**PASS**	
436.03	112+50	SAG	800	4,969	-0.304%	-0.143%	70	YES	YES	NO	**PASS**	
436.37	130+50	CREST	800	4,000	-0.143%	-0.343%	70	YES	YES	NO	**PASS**	
436.84	155+00	NA	NA	NA	-0.343%	-0.209%	70	NA	YES	NA	**PASS**	
437.28	178+50	SAG	450	140	-0.209%	3.000%	70	**NO**	YES	NO	**FAIL**	MOSSMAIN INTERCHANGE BRIDGE
437.49	189+50	CREST	1,450	242	3.000%	-3.000%	70	**NO**	YES	YES	**FAIL**	MOSSMAIN INTERCHANGE BRIDGE
437.69	200+25	SAG	450	168	-3.000%	-0.321%	70	**NO**	YES	NO	**FAIL**	MOSSMAIN INTERCHANGE BRIDGE
438.08	220+50	NA	NA	NA	-0.321%	-0.251%	70	NA	YES	NA	**PASS**	
438.64	250+50	NA	NA	NA	-0.251%	-0.368%	70	NA	YES	NA	**PASS**	
438.48	241+80	CREST	1,312	20,185	-0.212%	-0.277%	70	YES	YES	YES	**PASS**	USED 1998 METRIC PLANS
438.79	258+37	CREST	984	7,569	-0.277%	-0.407%	70	YES	YES	NO	**PASS**	USED 1998 METRIC PLANS

Curve PI[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 (247/181)	Meet Max. Grade (3%)	Meet Min. Curve Length[4] (210'/1000')	Curve Pass/Fail	Comments
439.18	278+55	SAG	1,312	9,791	-0.407%	-0.273%	70	YES	YES	YES	**PASS**	USED 1998 METRIC PLANS
439.63	302+50	CREST	800	2,105	0.000%	-0.380%	70	YES	YES	NO	**PASS**	SKIPPED VC AT 279+50 DUE TO 1998 PLANS
440.07	325+50	SAG	380	145	-0.380%	2.246%	70	**NO**	YES	NO	**FAIL**	S. 56 ST. BRIDGE APPROACH
440.25	335+50	CREST	1,600	331	2.246%	-2.593%	70	YES	YES	YES	**PASS**	
440.46	346+50	SAG	600	238	-2.593%	-0.070%	70	YES	YES	NO	**PASS**	
441.30	390+50	SAG	800	3,810	-0.070%	0.140%	70	YES	YES	NO	**PASS**	
441.86	420+50	NA	NA	NA	0.140%	0.057%	70	NA	YES	NA	**PASS**	
442.43	450+50	CREST	800	2,305	0.057%	-0.290%	70	YES	YES	NO	**PASS**	
443.00	480+50	NA	NA	NA	-0.290%	0.137%	70	NA	YES	NA	**PASS**	
443.57	510+50	NA	NA	NA	0.137%	-0.090%	70	NA	YES	NA	**PASS**	
444.14	540+50	NA	NA	NA	-0.090%	-0.200%	70	NA	YES	NA	**PASS**	
444.71	570+50	NA	NA	NA	-0.200%	-0.343%	70	NA	YES	NA	**PASS**	
445.14	593+50	NA	NA	NA	-0.343%	-0.163%	70	NA	YES	NA	**PASS**	
445.83	629+65	SAG	500	158	-0.163%	3.000%	70	**NO**	YES	NO	**FAIL**	WEST BILLINGS INTERCHANGE BRIDGE
446.04	640+70	CREST	1,700	283	3.000%	-3.000%	70	YES	YES	YES	**PASS**	
446.29	654+25	SAG	500	208	-3.000%	-0.600%	70	YES	YES	NO	**PASS**	
446.77	679+50	SAG	300	938	-0.600%	-0.280%	70	YES	YES	NO	**PASS**	
447.36	710+50	CREST	400	3,636	-0.280%	-0.390%	70	YES	YES	NO	**PASS**	
447.24	704+50	NA	NA	NA	-0.390%	-0.200%	70	NA	YES	NA	**PASS**	
447.79	733+50	CREST	300	1,000	-0.200%	-0.500%	70	YES	YES	NO	**PASS**	
448.11	750+50	SAG	300	811	-0.500%	-0.130%	70	YES	YES	NO	**PASS**	
448.70	781+50	NA	NA	NA	-0.130%	-0.240%	70	NA	YES	NA	**PASS**	
449.59	828+50	NA	NA	NA	-0.240%	-0.220%	70	NA	YES	NA	**PASS**	
450.30	866+10	SAG	750	233	-0.220%	3.000%	70	YES	YES	NO	**PASS**	
450.53	877+90	CREST	1,600	267	3.000%	-3.000%	70	YES	YES	YES	**PASS**	
450.80	892+40	SAG	800	287	-3.000%	-0.210%	70	YES	YES	NO	**PASS**	
451.61	934+90	SAG	600	1,463	-0.210%	0.200%	70	YES	YES	NO	**PASS**	
451.93	952+00	SAG	800	444	0.200%	2.000%	70	YES	YES	NO	**PASS**	
453.00	1008+50	CREST	1,100	220	2.000%	-3.000%	70	**NO**	YES	YES	**FAIL**	LOCKWOOD INTERCHANGE BRIDGE
453.10	1013+90	SAG	800	250	-3.000%	0.200%	70	YES	YES	NO	**PASS**	
453.78	1049+60	NA	NA	NA	0.200%	-0.322%	70	NA	YES	NA	**PASS**	
454.23	1073+60	SAG	800	1,770	-0.322%	0.130%	70	YES	YES	NO	**PASS**	
454.52	1088+60	CREST	800	1,831	0.130%	-0.307%	70	YES	YES	NO	**PASS**	
454.75	1100+60	SAG	800	809	-0.307%	0.682%	70	YES	YES	NO	**PASS**	
455.11	1119+60	CREST	800	2,974	0.682%	0.413%	70	YES	YES	NO	**PASS**	
455.31	1130+60	CREST	800	332	0.413%	-2.000%	70	YES	YES	NO	**PASS**	
455.54	1142+60	SAG	800	462	-2.000%	-0.269%	70	YES	YES	NO	**PASS**	
456.09	1171+60	SAG	800	469	-0.269%	1.436%	70	YES	YES	NO	**PASS**	
456.54	1195+45	CREST	1,250	750	1.436%	-0.230%	70	YES	YES	YES	**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(4).
[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] Minimum curve length is recommended for aesthetic reasons (see MDT Road Design Manual pages 10.5(3) and 10.5(7)).
NA indicates locations with no vertical curve (vertical grade only).

Ramp Gore Areas

Design Criteria and Guidelines

Chapter 9 of the MDT Road Design Manual (December 2004) and Chapter 29 of the MDT Traffic Engineering Manual (November 2007) were consulted for guidance regarding exit and entrance ramp and mainline freeway junctions.

Horizontal and Vertical Alignment

A geometric analysis of the Shiloh, South Billings Boulevard, 27th Street, Lockwood, and Johnson Lane Interchange ramp intersections was conducted as part of the *Billings I-90 Interchanges Project* report prepared by Short Elliott Hendrickson Inc (March 2006). A number of geometric deficiencies were noted for the five interchanges studied. Results and recommendations presented in that report are still considered viable and have not been revisited by this study. Appendix 7 includes excerpts from the 2006 report referencing the results of this analysis.

An assessment of the Laurel and Mossmain Interchange ramp gore areas was conducted as part of the Billings Area I-90 Corridor Planning Study to determine if merge/diverge angles and acceleration and deceleration lengths at entrance and exit ramps meet current design standards. Additionally, vertical elements were assessed, including consideration of grade, vertical curve length, vertical curve type (either a sag curve or a crest curve), and K value (or the horizontal distance needed to produce a one percent change in gradient). Deviations from current standards are noted below. Appendix 3 contains a map illustrating vertical and horizontal concerns at the Laurel and Mossmain interchanges.

Laurel Interchange

- Based on record drawings, the WB and EB on-ramps do not provide sufficient acceleration length or gap length. Recommended acceleration length is based on the highway design speed and the design speed of the entrance curve (variable depending on geometry of interchange). The entry curves at the Laurel Interchange located just before the acceleration ramps vary from 300 ft to 450 ft, safely allowing a design speed of 35 mph. Based on this entry curve design speed, the recommended acceleration length is 1,230 ft. In its current geometric configuration as a partial cloverleaf interchange, the ramp acceleration lengths are less than 400 ft. As such, the lack of acceleration distance and tight horizontal geometry do not allow a vehicle to enter the freeway at recommended speeds.

- The WB and EB off-ramps provide sufficient sight distance, but do not provide adequate deceleration distance. Recommended deceleration length is based on the highway design speed and the design speed of the exit geometry (variable depending on the interchange). The minimum length for a highway design speed of 70 mph and a 50 mph exit speed is 340 ft; the current deceleration lengths are less than 250 ft. Additionally, the recommended radius for a 50 mph exit speed is 760 ft; current exit radii vary from 460 ft to 600 ft.

- The WB on-ramp and EB off-ramp do not meet the minimum K value for a ramp design speed of 50 mph.

Mossmain Interchange

- The WB and EB on-ramps are shorter than recommended. In its current configuration as a diamond interchange with frontage roads, the acceleration ramp lengths are approximately 1,185 ft. Assuming that vehicles turn onto the acceleration ramp from the crossroads at an initial speed of 15mph, acceleration ramp lengths are recommended at 1,560 ft to enter a 70 mph design speed road. Even at initial speeds of 30 mph, the acceleration ramp would be recommended at 1,230 ft.

- The WB and EB off-ramps meet sight distance and deceleration length recommendations.

- There are no vertical alignment deficiencies.

Tables 2.4 and 2.5 present additional information regarding horizontal and vertical alignment for the Laurel and Mossmain Interchange ramps. Due to recent improvements, a geometric analysis was not conducted for the West Billings Interchange.

Table 2.4 Horizontal Alignment Analysis for Laurel and Mossmain Interchanges

Interchange	Ramp Description	Radius (ft)	Design Speed for Curve Radius (mph)	Taper	L_D[1] (ft)	L_A[2] (ft)	Meet Min. Taper[3]	Meet Min. L_A[4]	Meet Min. L_D[5]	Meet Min. Entry Radii[6]
Laurel Interchange	WB ON-RAMP	304	30@ 8%	6°25'11"	-	33	NO	NO	-	NO
		175	Too Low[7]							
		300	30 @ 8%							
	WB OFF-RAMP	603	30 @ 6%	3°41'30"	227	-	YES	-	NO	-
		404	30 @ 7%							
	EB ON-RAMP	500	30 @ 7%	0°56'38"	-	366	YES	NO	-	NO
		441	30 @ 7%							
	EB OFF-RAMP	460	30 @ 7%	4°41'29"	174	-	YES	-	NO	-
		250	30 @ 8%							
		353	30 @ 8%							
Mossmain Interchange	WB ON-RAMP	1763	30@ 3%	0°49'06"	-	462	YES	NO	-	YES
	WB OFF-RAMP	7639	50 @ 2%	3°59'33"	198	-	YES	-	Unknown[8]	-
	EB ON-RAMP	1910	30 @ 3%	0°49'06"	-	464	YES	NO	-	YES
	EB OFF-RAMP	7639	50 @ 2%	4°00'00"	153	-	YES	-	Unknown[8]	-

Source: MDT, 2011; DOWL HKM, 2011; MDT record drawings; MDT Road Design Manual (RDM), page 9.3(3); MDT Traffic Engineering Manual (TEM) pages 29.5(5), 29.5(12), 29.5(14), 29.5(18).

(1) L_D is Deceleration Length and only applies to off-ramps.

(2) L_A is Acceleration Length and only applies to on-ramps.

(3) Entry taper can vary from 2° to 5° (TEM page 29.5(1)); exit taper can vary from 1:50 to 1:70 (TEM page 29.5(14)).

(4) L_A is based on initial vehicle speed (or the design speed of the last entry curve which varies depending on curve radius) and the final speed (or the design speed of the roadway being entered, which in this case is I-90 at 70 mph). The TEM page 29.5(18) provides the minimum distance that is required for a vehicle transitioning from the initial speed to the final speed.

(5) L_D is based on initial vehicle speed (in this case, the design speed of I-90 at 70 mph) and the speed that is allowed by the first geometrically controlling feature (usually the first radius as determined in the RDM). The TEM page 29.5(5) provides the minimum distance that is required for a vehicle transitioning from the initial speed to the final speed.

(6) As shown in the TEM page 29.5(14), the minimum entry radius is 1000'. This only applies to on-ramps which incorporate entry curves.

(7) In this location, the horizontal radius is so tight that it does not meet any design speed as shown in the RDM page 9.3(3). The curve is insufficient for 30 mph design speed.

(8) Will meet L_D requirement if superelevation is 3%; not enough information.

Table 2.5 Vertical Alignment Analysis for Laurel and Mossmain Interchanges

Interchange	Ramp Description	PVI[1] (Station)	Curve Type[2]	Curve Length (ft)	K Value[3]	Grade Back	Grade Ahead	Design Speed (mph)	Meet Min. K Value (84/96 for crest/sag)	Meet Max. Grade (3-5%)	Comments
Laurel Interchange	WB ON-RAMP	13+29	SAG	200	44	-4.550%	0.000%	50	**NO**	YES	Would meet K value at Lower Range ramp design speed (35 mph)
	WB OFF-RAMP	NA	NA	NA	NA	-0.737%	-0.737%	50	NA	YES	
	EB ON-RAMP	NA	NA	NA	NA	-0.640%	-0.640%	50	NA	YES	
	EB OFF-RAMP	14+45	SAG	200	55	-3.636%	0.000%	50	**NO**	YES	Would meet K value at Lower Range ramp design speed (35 mph)
Mossmain Interchange	WB ON-RAMP	29+39	SAG	200	248	-0.806%	0.000%	50	YES	YES	
	WB OFF-RAMP	33+39	SAG	200	144	0.100%	1.490%	50	YES	YES	
	EB ON-RAMP	27+00	SAG	200	147	0.100%	1.460%	50	YES	YES	
	EB OFF-RAMP	23+50	SAG	200	165	-1.353%	-0.140%	50	YES	YES	

Source: MDT, 2011; DOWL HKM, 2011; MDT record drawings; MDT Road Design Manual, pages 10.5(1), 10.5(2), 10.5(5), 10.5(6); MDT Traffic Engineering Manual pages 29.6(1), 29.6(10).

(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).

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

NA indicates locations with no vertical curve (vertical grade only).

Ramps Intersections

Design Criteria and Guidelines

Chapter 13 of the MDT Road Design Manual (September 2007) and Chapter 28 of the MDT Traffic Engineering Manual (November 2007) were consulted for guidance and design criteria regarding signalized and non-signalized intersections. Additionally, the American Association of State Highway and Transportation Officials (AASHTO) Roadway Lighting Design Guide (October 2005) was consulted for guidance and design criteria regarding lighting for freeways.

Horizontal and Vertical Intersection Configuration

A geometric analysis of the Shiloh, South Billings Boulevard, 27th Street, Lockwood, and Johnson Lane Interchange ramp intersections was conducted as part of the *Billings I-90 Interchanges Project* report prepared by Short Elliott Hendrickson Inc (March 2006). A number of geometric deficiencies were noted at the intersections for the five interchanges studied. Results and recommendations presented in that report are still considered viable and have not been revisited by this study. Appendix 7 includes excerpts from the 2006 report referencing the results of this analysis.

An assessment of the Laurel and Mossmain Interchange ramp intersections was conducted as part of the Billings Area I-90 Corridor Planning Study to identify issues with intersection configuration, sight distance, and vertical clearance. A summary of this analysis is provided below. Figure 2-3 illustrates the location of ramp intersections at the Laurel and Mossmain interchanges.

Figure 2-3 Intersections at Laurel and Mossmain Interchanges

Laurel Interchange Ramp Intersections

The Laurel Interchange includes two intersections. The northern intersection (L1) is signal controlled and the southern intersection (L2) is stop-controlled. Geometric analysis of these intersections was conducted based on review of record drawings and aerial photography.

- Intersection radii are configured adequately to handle turning movements for a WB-62 vehicle (i.e., a semitrailer vehicle with a wheelbase of 62 feet).
- Both intersections have sufficient sight distance for a 40 to 45 mph design speed. Due to the current configuration and length of the WB off-ramp to the signalized intersection (L1), stopping sight distance may be impaired during certain peak hour volume queues or during a train preemption of the signal phasing.
- There are no vertical clearance issues at either of the intersections.

Mossmain Interchange Ramp Intersections

This interchange incorporates four intersections (M1, M2, M3, and M4). All intersections are stop-controlled. Geometric analysis of these intersections was conducted based on review of record drawings and aerial photography.

- Intersection radii are configured adequately to handle turning movements for a WB-62 vehicle.
- Intersection M4 (Magelssen Road / S. Frontage Road / Interchange Crossroad) is currently stop-controlled on the south leg and the west leg, allowing for free movements between the east leg and the north leg. This configuration requires a free-flowing movement to occur at 90-degrees, which could be a hindrance to some drivers. However, all intersections have sufficient sight distance.
- The Interstate bridge over the interchange crossroad has a maximum vertical clearance of 14’-8.”

2.1.3 Safety Analysis

Mainline Interstate

In March 2011, MDT provided crash data for the portion of the I-90 corridor from RP 433.0 to RP 457.0. The portion of I-90 from RP 433.0 to RP 442.3 is defined as rural Interstate by MDT.

The remainder of the corridor (RP 442.3 to RP 457.0) is classified as urban Interstate as this section is generally located within the urban limits of Billings[3].

As presented in Table 2.6, the crash rate and severity rate for the rural and urban portions of the I-90 corridor are lower than statewide averages for similar facilities.

Table 2.6 Crash History Comparison (Statewide Average vs. I-90 Corridor)

Criteria	Rural		Urban	
	Statewide Average for Rural Interstate (2006 – 2010)	I-90 Corridor RP 433.0 – 442.3 (2006 – 2010)	Statewide Average for Urban Interstate (2006 – 2010)	I-90 Corridor RP 442.3 – 457.0 (2006 – 2010)
Crash Rate (All Vehicles)	0.92	0.89	1.18	0.96
Severity Index (All Vehicles)	1.86	1.81	1.79	1.90
Severity Rate (All Vehicles)	1.70	1.61	2.11	1.82

Source: MDT, 2011.

MDT's 2010 Comprehensive Highway Safety Plan Annual Update identified the portion of I-90 from RP 426.9 to RP 445.5 as a Rural High Crash Severity Corridor.

Crash and severity rates were calculated by corridor segment using Traffic by Section (TBS) data (see Table 2.7). Over the analysis period, Segment 4 (West Billings Interchange to South Billings Boulevard Interchange) had a higher crash rate and severity rate compared to the statewide average rates for similar facilities; the rates for all other segments fell below the statewide average values.

[3] Note: Urban areas are defined by the US Census Bureau as cities with a population greater than 5,000.

Table 2.7 Crash Rate and Severity Rate Comparison (Statewide Average and I-90 Corridor vs. I-90 Corridor Segments, 2006 – 2010)

		Segment[1]	Crash Rate: Statewide Average (I-90 Corridor Average)[2]	Crash Rate: I-90 Segment[1]	Severity Rate: Statewide Average (I-90 Corridor Average)[2]	Severity Rate: I-90 Segment[1]
Rural	1	**Laurel to Mossmain** (RP 434.0 to RP 437.5)	0.92 (0.89)	0.90	1.70 (1.61)	1.53
	2	**Mossmain to Shiloh** (RP 437.5 to RP 442.2)		0.69		1.37
Urban	3	**Shiloh to West Billings** (RP 442.2 to RP 446.0)	1.18 (0.96)	0.70	2.11 (1.82)	1.38
	4	**West Billings to South Billings Boulevard** (RP 446.0 to RP 447.2)		2.86		6.13
	5	**South Billings Boulevard to 27th Street** (RP 447.2 to RP 450.1)		0.61		1.08
	6	**27th Street to Lockwood** (RP 450.1 to RP 452.9)		1.13		1.93
	7	**Lockwood to Johnson Lane** (RP 452.9 to 455.3)		0.58		1.08
	8	**Johnson Lane to Pinehills** (RP 455.3 to 456.6)		0.72		1.31

Source: MDT, 2011; DOWL HKM, 2011.

Note: For the purpose of crash and severity rate calculations, AADT values were calculated using average of 2006 through 2009 TBS volumes weighted according to TBS segment length. 2010 TBS volumes were not available at the time of the analysis; accordingly, the 2009 volume was used twice in crash and severity rate calculations.

Shaded cell indicates segment exceeding statewide average and corridor-wide rates.

(1) For the crash and severity rate analysis, segments were defined using TBS limits; segment limits for crash/severity rate calculations do not exactly match segment definitions used in the remainder of the study.

(2) As defined by MDT in rural and urban rate calculation, rural portion of corridor extends from RP 433.0 to RP 442.3; urban portion of corridor extends from RP 442.3 to RP 457.0.

In addition to crash rate and severity rate, the crash analysis also examined crash frequency (or the number of crashes occurring over a specified time period). The average number of crashes within a half-mile stretch of the corridor over the five-year analysis period was 18.9. The half-mile stretch from RP 446.0 to RP 446.5 located in Segment 4 had the highest number of crashes as compared to all other half-mile stretches in the corridor. This half-mile stretch is also located in the segment with the highest crash rate and severity rate in the corridor, and was therefore analyzed to identify trends in types of accidents and contributing factors.

A total of 106 crashes were reported over the half-mile stretch from RP 446.0 to RP 446.5 located between the EB on-ramps and WB off-ramps at the West Billings Interchange. The majority of crashes in this half-mile stretch (58 of 106, or 55%) were classified as rear-end collisions. The West Billings Interchange has five merge/diverge locations, which adds to the complexity of the weaving and merging patterns that occur over this half-mile stretch and may influence the number of crashes in this location.

Based on recorded characteristics, most crashes in the half-mile stretch from RP 446.0 to RP 446.5 generally were incidents involving two vehicles that occurred on the roadway during dry, clear, daylight conditions in or near an intersection or interchange.

Over the five-year analysis period, a total of 43 crashes within the study corridor involved wild animals (approximately two per mile or nine per year). Crashes involving wild animals were distributed relatively evenly throughout the corridor, ranging from zero to four crashes per half-mile stretch. No single location had a substantially higher concentration of crashes involving wild animals as compared to the corridor overall.

Additional details regarding the crash analysis conducted for this study are contained in Appendix 8.

Ramp Intersections

A safety analysis of the Shiloh, South Billings Boulevard, 27th Street, Lockwood, and Johnson Lane Interchanges was conducted as part of the *2006 Billings I-90 Interchanges Project* report. Safety deficiencies were noted at the Shiloh and Lockwood Interchanges. Appendix 7 includes excerpts from the 2006 report referencing the results of this analysis.

An assessment of the Laurel and Mossmain Interchanges was conducted as part of the Billings Area I-90 Corridor Planning Study to supplement the *2006 Billings I-90 Interchanges Project* report. To avoid duplication of the mainline Interstate analysis, crashes coded as occurring on the I-90 mainline were not assessed for this exercise.

Laurel Interchange Analysis

Rear-end collisions occurred most frequently (five out of 13, or 38% of all crashes). The WB off-ramp terminus and the WB on-ramp entrance is a signalized intersection. The relatively high number of right angle and left turn crashes may indicate that signal phasing modifications or other mitigation measures may be needed at this intersection.

Mossmain Interchange Analysis

Only one crash was reported at the four Mossmain Interchange ramp intersections; all other crashes occurring near the Mossmain Interchange during the analysis period were coded as occurring on the I-90 mainline. Accordingly, no trends were identified at these intersections.

Lighting

A lighting analysis of the Shiloh, South Billings Boulevard, 27th Street, Lockwood, and Johnson Lane Interchange ramp intersections was conducted as part of the *Billings I-90 Interchanges Project* report prepared by Short Elliott Hendrickson Inc (March 2006). A number of lighting deficiencies were noted at the intersections for the five interchanges studied. Results and recommendations presented in that report are still considered viable and have not been revisited by this study. Appendix 7 includes excerpts from the 2006 report referencing the results of this analysis.

A lighting assessment of the Laurel and Mossmain Interchanges was conducted as part of the Billings Area I-90 Corridor Planning Study according to MDT and AASHTO guidelines. MDT and AASHTO classify lighting at interchanges as Partial Interchange Lighting (PIL) or Complete Interchange Lighting (CIL). PIL is defined as a lighting system that provides illumination only of decision making areas of roadways including acceleration and deceleration lanes, ramp terminals, crossroads at frontage road or ramp intersections, and other areas of nighttime hazard. CIL provides relatively uniform lighting on all main lanes and direct connections, and complete interchange lighting of all interchanges within the section.

The Laurel Interchange currently has PIL; CIL conditions are not met due to lack of lighting along the WB on-ramp and EB off-ramp. Although the Mossmain Interchange has lighting along the mainline Interstate and at one location at the WB off-ramp gore, it does not fully meet the PIL criteria.

MDT and AASHTO have defined warranting conditions for PIL and CIL based on ADT volumes for ramps, freeway through lanes, and crossroads in rural, suburban, and urban conditions, as well as the ratio of night to day crash rate within the interchange area and proximity to commercial or industrial development. According to the MDT and AASHTO criteria, PIL is warranted where the total current ADT freeway through traffic lanes exceeds 10,000 for rural conditions, where the total current ADT ramp traffic exceeds 1,000 for rural conditions, or where the ratio of night to day crash rate within the interchange area is at least

1.25 times the statewide average for all unlighted similar sections. CIL is warranted where the total current ADT ramp traffic entering and leaving the freeway within the interchange area exceeds 5,000 for rural conditions or where the ratio of night to day crash rate within the interchange area is at least 1.5 times the statewide average for all unlighted similar sections.

Based upon the ramp volume criterion, CIL is currently warranted for the Laurel and Mossmain interchanges. As noted in Chapter 13 of the MDT Road Design Manual (November 2007), CIL is generally not justified nor provided by MDT. Table 2.8 summarizes the analysis for the Laurel and Mossmain Interchanges.

Table 2.8 Lighting Analysis for Laurel and Mossmain Interchanges

Interchange	Type	Existing Interchange Lighting Type	Ramp Volumes[1] (2010)		Mainline Volumes[2] (2010)		Existing Night-to-Day Accident Ratio [3]	Deficiencies
			Total Entering & Exiting Volume (veh/day)	Volumes Meet MDT CIL Volume Criteria?	Total Mainline Through Volume (veh/day)	Volumes Meet MDT PIL Volume Criteria?		
Laurel	Rural	PIL	17,239	Yes	9,037	No	0.24	Meets ramp volume criteria for CIL
Mossmain	Rural	*	7,341	Yes	20,332	Yes	0.33	Meets ramp volume criteria for CIL and mainline volume criteria for PIL

Source: DOWL HKM, 2011; Chapter 13 of the MDT Road Design Manual (November 2007); AASHTO Roadway Lighting Design Guide (October 2005).
CIL = Complete Interchange Lighting; PIL = Partial Interchange Lighting Interchange Lighting
(1) Total volume merging and diverging at the interchange (EB and WB).
(2) Total volume between the interchange merge and diverge locations (EB and WB).
(3) Only accidents within interchange area (ramps, terminals and between terminals) were included in this calculation.
* The Mossmain Interchange does not fully meet PIL criteria.
Note: Crossroad volumes were not evaluated.

2.1.4 Traffic Volumes

Mainline Interstate and Ramp Gore Areas

I-90 is traveled heavily year-round. The primary users of this route are local residents, commuters, commercial truck drivers, recreational users accessing the Yellowstone River, and tourists traveling to Yellowstone National Park and other regional attractions. The vehicle mix includes automobiles, light trucks, delivery vans, intercity passenger buses, school buses, tractor trailers, and semi-trucks.

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's TransCAD model was used to generate existing (2010) AADT values for each freeway link and ramp gore area in the corridor. A validation process was conducted to confirm AADT segment volumes generated by the TransCAD model. Model volumes were compared to field counts collected in April 2011, Traffic Count Program (TCP) data, Traffic by Section (TBS) data, and Automatic Traffic Recorder (ATR) data. The model was calibrated in select locations to more closely reflect available count data. Raw field count data printouts are contained in Appendix 9. Appendix 10 provides volumes considered in the model validation process.

Peak Hour Mainline Traffic Volumes

Data from the April 2011 field count collection effort was used to identify the worst case peak hour of the day (defined as the four consecutive 15-minute periods with the highest volumes over the three-day count period) and the peak hour percent of ADT. Peak hour mainline traffic volumes for 2010 were calculated from the AADT generated by the TransCAD model using the field count percent of ADT. Appendix 10 presents peak hour volumes for mainline links and gore areas in the corridor.

Ramp Intersections

Peak Hour Volumes

Peak hour 15-minute turning movement counts were collected by MDT at the two Laurel ramp intersections on April 12, 2011 and at the four Mossmain ramp intersections on April 13, 2011. Raw turning movement count data printouts are contained in Appendix 9.

The peak counts were adjusted to reflect daily and monthly traffic variations as developed and reported by MDT. The worst case peak hour of the day for study intersections was calculated from the observed field data and the consecutive 15-minute counts.

Data from the field count collection effort was also used to identify the peak hour percent of the Average Daily Traffic (ADT). For the purposes of this study, ADT was estimated by assuming the observed PM peak hour is approximately 10% of the ADT. This relationship of the peak hour to the ADT is consistent with 24-hour data collected along the Interstate corridor by MDT. Appendix 10 presents peak hour volumes for the Laurel and Mossmain ramp intersections.

2.1.5 Operational Characteristics

Mainline Interstate

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. For mainline Interstate operations, the HCM defines LOS on the basis of density. Factors affecting mainline LOS include free flow travel speed, percentage of trucks and buses within the travel stream, driver population factor, peak hour factor, the number of travel lanes, and terrain. LOS for freeway segments is generally a measure of the degree of congestion on a roadway and applies to a specific time period, usually 15 minutes. For a mainline, 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.

Basic freeway segments are the portions of a freeway outside the influence area of any on-ramp or off-ramp. Table 2.9 presents LOS density criteria for basic mainline freeway segments.

Table 2.9 LOS Criteria for Basic Freeway Segments

Level of Service	Density (pc/mi/ln)[1]
A	≤11.0
B	>11.0 to 18.0
C	>18.0 to 26.0
D	>26.0 to 35.0
E	>35.0 to 45.0
F	>45.0 or any component with a vd/c[2] ratio >1.00

Source: HCM 2010, Exhibit 10-7 LOS Criteria for Freeway Facilities.
(1) pc/mi/ln: passenger cars per mile per lane
(2) A Demand Flow Rate (vd/c) > 1.00 indicates that demand exceeds available capacity.

Freeway weaving segments are the portions of a freeway where an on-ramp is closely followed by an off-ramp and entering or exiting traffic must make at least one lane change to enter or exit the freeway. Table 2.10 presents LOS density criteria for mainline weaving segments.

Table 2.10 LOS Criteria for Weaving Segments

Level of Service	Density (pc/mi/ln)[1]
A	0 to 10.0
B	>10.0 to 20.0
C	>20.0 to 28.0
D	>28.0 to 35.0
E	>35.0
F	Demand exceeds capacity[2]

Source: HCM 2010, Exhibit 12-10 LOS Criteria for Weaving Segments.
[1] pc/mi/ln: passenger cars per mile per lane
[2] Level of service for weaving segments is generally based on density, although in this case LOS is defined as F when the demand volume exceeds available capacity.

Highway Capacity Software (HCS) Version 2010 was used to analyze LOS for basic and weaving Interstate links throughout the corridor. Appendix 10 provides a list of input values used for the operational analysis. Appendix 11 contains the operational analysis worksheets for each analysis location.

Analysis Results

Table 2.11 presents the results of the mainline Interstate operational analysis for existing (2010) conditions. Appendix 12 contains figures illustrating these results.

Table 2.11 Mainline Interstate Operational Analysis Results

Analysis Location		2010 Peak Hour EB Density (pc/mi/ln)(1)	2010 Peak Hour EB LOS	2010 Peak Hour WB Density (pc/mi/ln)(1)	2010 Peak Hour WB LOS
	Laurel Under	3.4	A	3.8	A
1	Laurel to Mossmain	10.3	A	10.3	A
	Mossmain Under	11.6	B	7.7	A
2	Mossmain to Shiloh	12.3	B	12.2	B
	Shiloh Under	10.0	A	9.5	A
3	Shiloh to West Billings	12.6	B	12.3	B
	West Billings Over	3.6	A	5.5	A
	West Billings Over Part 2(2)	4.0	A	NA	NA
4	West Billings to South Billings Boulevard(3)	8.8	A	9.6	A
	South Billings Boulevard Under	8.2	A	9.0	A
5	South Billings Boulevard to 27th Street	11.1	B	10.0	A
	27th Street Under	9.2	A	7.6	A
6	27th Street to Lockwood	13.6	B	11.4	B
	Lockwood Under	10.9	A	8.5	A
7	Lockwood to Johnson Lane	10.3	A	11.7	B
	Johnson Lane Under	8.9	A	5.7	A
8	Johnson Lane to Pinehills	9.3	A	6.6	A

Source: DOWL HKM, 2011.
(1) pc/mi/ln: passenger cars per mile per lane
(2) EB only; no corresponding WB link
(3) Location was analyzed as mainline weaving segment; all other locations analyzed as basic freeway segments.
The terms “Under” and “Over” are used to describe the portion of the mainline Interstate above or below the interchange between on-ramps and off-ramps.

The MDT Traffic Engineering Manual and MDT Road Design Manual define acceptable operations for urban and rural freeway facilities as LOS B. Using this criterion, all freeway segments within the study area are currently operating acceptably. LOS worksheets for these segments are provided in Appendix 11.

Ramp Gore Areas

Methodology

Ramp gore areas (also called freeway merge and diverge segments) are the portions of a freeway where traffic enters or exits without having to change lanes to enter or leave a through traffic lane. As with mainline operations, six LOS categories ranging from A to F are used to describe traffic operations for ramps, with A representing the best conditions and F representing the worst. To reflect driver perceptions regarding the operations of ramps and transitional facilities between freeways and intersecting arterials, the density ranges for corresponding levels of service for ramps is broader than that for freeway segments. Table 2.12 presents LOS criteria for ramp gore areas.

Table 2.12 LOS Criteria for Ramp Gore Areas

Level of Service	Density (pc/mi/ln) [1]	Comments
A	≤10.0	Unrestricted operations
B	>10.0 to 20.0	Merging and diverging maneuvers noticeable to drivers
C	>20.0 to 28.0	Influence area speeds begin to decline
D	>28.0 to 35.0	Influence area turbulence becomes intrusive
E	>35.0	Turbulence felt by virtually all drivers
F	Demand exceeds capacity	Ramp and freeway queues form

Source: HCM 2010, Exhibit 13-2 LOS Criteria for Freeway Merge and Diverge Segments
[1] pc/mi/ln: passenger cars per mile per lane

HCS was used to analyze LOS for ramp gore areas throughout the corridor. Appendix 10 provides a list of input values used for the operational analysis. Appendix 11 contains operational analysis worksheets for each analysis location.

Analysis Results

Table 2.13 presents the results of the ramp gore area operational analysis for existing (2010) conditions. Appendix 12 contains figures illustrating these results.

Table 2.13 Ramp Gore Area Operational Analysis Results

Interchange	Ramp Gore	2010 EB		2010 WB	
		Density (pc/mi/ln)(1)	LOS	Density (pc/mi/ln)(1)	LOS
Laurel	On-Ramp	12.4	B	4.0	A
	Off-Ramp	6.4	A	6.9	A
Mossmain	On-Ramp	15.4	B	12.4	B
	Off-Ramp	17.4	B	11.9	B
Shiloh	On-Ramp	13.6	B	15.1	B
	Off-Ramp	15.6	B	14.1	B
West Billings	On-Ramp	7.3	A	14.8	B
	Off-Ramp	7.8	A	NA	NA
	On-Ramp at Mullowney	NA	NA	NA	NA
South Billings Boulevard	On-Ramp	11.0	B	NA	NA
	Off-Ramp	NA	NA	14.1	B
27th Street	On-Ramp	14.6	B	12.1	B
	Off-Ramp	13.9	B	11.9	B
Lockwood	On-Ramp	13.4	B	14.3	B
	Off-Ramp	15.9	B	13.6	B
Johnson Lane	On-Ramp	11.3	B	14.4	B
	Off-Ramp	13.3	B	9.6	A

Source: DOWL HKM, 2011.
(1) pc/mi/ln: passenger cars per mile per lane

The MDT Traffic Engineering Manual and MDT Road Design Manual define acceptable operations for urban and rural freeway facilities as LOS B. Using this criterion as the threshold value, all freeway gore areas within the study area are currently operating acceptably.

For comparison purposes, operational analysis results from the *2006 Billings I-90 Interchanges Project* report are contained in Appendix 7. In some cases, the results reported in Table 2.13 show poorer operating conditions in 2010 than the *2006 Billings I-90 Interchanges Project* report lists for 2023 conditions. Results from the 2006 report could not be replicated due to unknown input values.

Ramp Intersections

Methodology

Intersection capacity and LOS analyses were completed using procedures outlined in the most current version of the Highway Capacity Manual 2010 for both signalized and unsignalized intersections. Analysis was based on HCM calculations for vehicle delay, capacity, and LOS calculations. In accordance with HCM procedures, LOS was determined by estimating the average vehicular delay of the intersections and the intersection movements. For intersections, six LOS categories ranging from A to F are used to describe traffic operations, with LOS A representing no delay and LOS F represent substantial delay. Delay times for each of these categories differ depending on the type of intersection control. LOS delay criteria for signalized intersections are higher than those reported for unsignalized intersections. This difference, as explained in the HCM, accounts for the greater variability in delay associated with each intersection control type as well as different driver expectations associated with each intersection control type. Drivers expect greater delays to be associated with signalized intersections as compared to unsignalized intersections because the perception is that signalized intersections are designed to carry higher traffic volumes and create more delay than would otherwise be expected at an unsignalized intersection.   Table 2.14 presents delay times for each category, as defined by the HCM. Factors affecting mainline LOS include average travel speed, percent time delay, intersection delay, capacity utilization, and maximum density.

Table 2.14 Intersection LOS Criteria

LOS	Average Control Delay (seconds per vehicle)	
	Two-Way Stop-Controlled Intersections	Signalized Intersections
A	0 to 10.0	≤10.0
B	>10.0 to 15.0	>10.0 to 20.0
C	>15.0 to 25.0	>20.0 to 35.0
D	>25.0 to 35.0	>35.0 to 55.0
E	>35.0 to 50.0	>55.0 to 80.0
F	>50.0	>80.0

Source: HCM 2010, Exhibit 18-4 Level of Service Criteria for Signalized Intersections and 19-1 Level of Service Criteria for Two-Way Stop-Controlled (TWSC) Intersections.

For this corridor study, ramp intersections for the Laurel Interchange and the Mossmain Interchange were evaluated, as these intersections were not included in the 2006 SEH report. The

SEH report reviewed operational characteristics of the remaining interchange intersections within the corridor area, and the analysis and conclusions documented in that report are still considered valid. The West Billings Interchange is not included in either the SEH report or this document, as the interchange was recently reconstructed.

Currently, the northern intersection at the Laurel Interchange serving WB traffic (L1) is operating as a signalized intersection. All other intersections at the Laurel Interchange (L2) and the Mossmain Interchange (M1, M2, M3, and M4) are stop-controlled on the minor legs. Refer to Figure 2-3 for an illustration of intersection locations.

Analysis Results

Tables 2.15 and 2.16 present the results of the ramp intersection operational analysis for existing (2010) conditions. Appendix 12 contains figures illustrating these results.

Table 2.15 Operational Analysis Results for Signalized Intersection

Intersection		Control Type	Intersection Approach	Turning Movement	2010 Peak Hour Delay (s/veh)	2010 Peak Hour Volume to Capacity Ratio	2010 Peak Hour LOS
L1	**S. 4th Street / WB I-90 Ramps / US 212**	Signalized	EB Approach (S. 4th Street)	EB Left / Through / Right	6.7	NA	A
			WB Approach (WB I-90 Ramps)	WB Left	9.5		A
				WB Through / Right	7.7		A
			NB Approach (US 212)	NB Left	7.9		A
				NB Through & Through / Right	8.6		A
			SB Approach (US 212)	SB Left	8.4		A
				SB Through & Through / Right	9.8		A
			Intersection		**8.9**	**0.52**	**A**

Source: DOWL HKM, 2011.
Shaded cells indicate average control delay and intersection volume to capacity (v/c) ratio for the intersection (all approaches).

Table 2.16 Operational Analysis Results for Stop-Controlled Intersections

Intersection		Control Type	Intersection Approach	Turning Movement	2010 Peak Hour Delay (s/veh)	2010 Peak Hour LOS
L2	I-90 EB Ramps / US 212	Stop	WB Approach (EB I-90 Ramps)	WB Left	-	-
				WB Right	14.1	B
		Yield	NB Approach (US 212)	NB Through	-	-
				NB Through / Right	-	-
		Uncontrolled	SB Approach (US 212)	SB Left	9.1	A
				SB Through	-	-
				SB Through	-	-
M1	E. Main Street / S. 72nd Street West / Interchange Crossroad	Stop	EB Approach (E. Main Street)	EB Through / Right	18.0	C
		Stop	WB Approach (S. 72nd Street West)	WB Left / Through	226.9	F
		Uncontrolled	NB Approach (Interchange Crossroad)	NB Left / Right	8.0	A
M2	I-90 WB Ramps / Interchange Crossroad	Stop	WB Approach (WB I-90 Off-Ramp)	WB Left / Through / Right	19.3	C
		Uncontrolled	NB Approach (Interchange Crossroad)	NB Left / Through	4.0	A
		Uncontrolled	SB Approach (Interchange Crossroad)	SB Through / Right	-	-
M3	I-90 EB Ramps / Interchange Crossroad	Stop	EB Approach (EB I-90 Off-Ramp)	EB Left / Through / Right	11.7	B
		Uncontrolled	NB Approach (Interchange Crossroad)	NB Through / Right	-	-
		Uncontrolled	SB Approach (Interchange Crossroad)	SB Left / Through	4.1	A
M4	Magelssen Road / S. Frontage Road / Interchange Crossroad	Stop	EB Approach (Magelssen Road)	EB Left / Through / Right	-	-
		Uncontrolled	WB Approach (S. Frontage Road)	WB Left / Through / Right	5.7	A
		Stop	NB Approach (Driveway)	NB Left / Through / Right	11.2	B
		Uncontrolled	SB Approach (Interchange Crossroad)	SB Left / Through / Right	-	-

Source: DOWL HKM, 2011.
Dash (-) indicates no conflicting movements (i.e., no delay).
Shaded cells indicate worst approach.

The Billings Urban Area Long-Range Transportation Plan (2009 Update) notes that the Billings Urban Area has set a goal of achieving and maintaining LOS C on all major roadways through 2035. Based on the HCM analyses, the Laurel Interchange intersections are currently operating with sufficient capacity and with acceptable intersection delay.

The Mossmain Interchange intersections are currently experiencing poor operating characteristics in their existing configuration. Specifically, the northern intersection of E. Main Street / S. 72nd Street West / Interchange Crossroad (M1) is currently operating at LOS F as a result of stop delay due to the large volume of NB left and EB right movements. Similarly, the intersection of the I-90 WB Ramps / Interchange Crossroad (M2) is experiencing LOS C as a result of the delay associated with entering the free-flowing movements of NB and SB traffic. Appendix 11 contains operational analysis worksheets for each analysis location.

2.2 Land Use, Economic, and Demographic Conditions

2.2.1 Land Use and Development

Zoning maps indicate that land adjacent to I-90 within the study corridor has been zoned for multiple uses, including heavy industrial, light industrial, entryway light industrial, highway commercial, community commercial, single family residential, multi-family residential, manufactured home residential, planned unit development, public use, and agricultural uses. The main land uses adjacent to the Interstate are industrial, commercial, and agricultural. Appendix 1 contains maps illustrating cadastral data for the corridor. Zoning maps are included in Appendix 13.

Based on discussions with the City-County Transportation Planner, undeveloped areas near the Lockwood Interchange, South Billings Boulevard Interchange, and the Shiloh Interchange are zoned for commercial development and are expected to further develop over the study planning horizon. Given the current zoning of undeveloped land, there is ample development capacity in the corridor.[4]

At the time of the 2009 Transportation Plan Update[5], projections showed that the number of dwelling units was expected to increase over the period 2002 to 2035 by 47.2% in the South

[4] Communication with Scott Walker, Transportation Planner, April 14, 2011.
[5] The 2009 Transportation Plan Update utilized the TransCAD traffic model for the Billings Urban Area, which is maintained by MDT in cooperation with the Billings City-County Planning Department and incorporates City of Billings and Yellowstone County land use forecasts. The Billings Area I-90 Corridor Planning Study also utilized the MDT TransCAD model and incorporated updated (2010) population and employment data.

Hills area, which feeds into the South Billings Boulevard Interchange. Over this same time period, the number of dwelling units was expected to increase by 466.0% in the Shiloh Northwest area, and 108.0% in the Shiloh West area, which both feed into the Shiloh Interchange.[6] Based on discussions with the City-County Transportation Planner, applications for building permits in Billings have been somewhat flat in recent years, including commercial retail and larger residential tract development.[7]

2.2.2 Economic and Demographic Conditions

The Billings area is a regional economic hub due to its size and relatively central location in relation to smaller communities in eastern Montana and northern Wyoming. The Billings airport, rail, and trucking facilities support regional commerce. Billings also offers extensive medical services and retail outlets. These factors have contributed to the steady growth of the region over the past 40 years, as illustrated by increases in population and per capita income over the 1970 to 2010 period.

Table 2.17 presents historic population data for the State of Montana, Yellowstone County, and the City of Billings. Over the 40-year period from 1970 to 2010, Yellowstone County and the City of Billings grew by a greater percentage (approximately 70 percent) compared to the state as a whole (approximately 42 percent).

Table 2.17 Historic Population

Year	State of Montana	Yellowstone County	City of Billings
1970	694,409	87,367	61,581
1980	786,690	108,035	66,824
1990	799,065	113,419	81,151
2000	902,195	129,352	89,847
2010	989,415	147,972	104,170
Change (1970-2010)	295,006 (42.4%)	60,605 (69.4%)	42,589 (69.2%)

Source: U.S. Census Bureau, Census of Population, 1970, 1980, 1990, 2000, and 2010.

[6] Billings Urban Area Long-Range Transportation Plan – 2009 Update, Table 3.5, Billings Urban Area Projected Dwelling Unit Distribution.

[7] Communication with Scott Walker, Transportation Planner, April 14, 2011.

Table 2.18 presents historic per capita income data for Yellowstone County and the City of Billings. Income figures are provided for the year listed and are not adjusted for inflation. Over the 40-year period from 1970 to 2010, both areas experienced similar growth in per capita income.

Table 2.18 Per Capita Income

Year	Yellowstone County Per Capita Income(1)	Billings Metropolitan Statistical Area Per Capita Income(1)
1970	$3,869	$3,829
1980	$10,470	$10,322
1990	$17,354	$17,192
2000	$26,827	$26,684
2009(2)	$39,412	$39,212

Source: U.S. Bureau of Economic Analysis, 2011.
(1) Per capita income provided in dollars for year listed; not adjusted for inflation.
(2) 2010 per capita income data not yet available from U.S. Bureau of Economic Analysis.

Table 2.19 presents age distribution data for the State of Montana, Yellowstone County, and the City of Billings. Generally, age groups in Yellowstone County and the City of Billings are of similar size to the state as a whole.

Table 2.19 Age Distribution (2010)

Age Groups	State of Montana		Yellowstone County		City of Billings	
	Number	Percent	Number	Percent	Number	Percent
Under 18 Years	223,563	22.6%	35,040	23.7%	23,547	22.6%
18 to 24 Years	94,611	9.6%	13,249	9.0%	10,252	9.8%
25 to 34 Years	122,864	12.4%	20,067	13.6%	15,318	14.7%
35 to 44 Years	112,945	11.4%	17,789	12.0%	12,025	11.5%
45 to 54 Years	149,832	15.1%	22,223	15.0%	14,799	14.2%
55 to 64 Years	138,858	14.0%	18,736	12.7%	12,623	12.1%
65 to 74 Years	80,742	8.2%	10,742	7.3%	7,508	7.2%
75 Years and Over	66,000	6.7%	10,126	6.8%	8,098	7.8%
Total Population	**989,415**	**100%**	**147,972**	**100%**	**104,170**	**100%**

Source: U.S. Census Bureau, 2010.

As presented in Table 2.20, the majority of the population in Montana, Yellowstone County, and the City of Billings is classified as white by the US Census Bureau. Racial composition in Yellowstone County and the City of Billings is generally similar to that of the state as a whole.

Table 2.20 Racial Composition (2010)

Racial Groups	State of Montana		Yellowstone County		City of Billings	
	Number	Percent	Number	Percent	Number	Percent
White	884,961	89.4%	134,228	90.7%	93,313	89.6%
Black of African American	4,027	0.4%	935	0.6%	828	0.8%
American Indian and Alaska Native	62,555	6.3%	5,881	4.0%	4,619	4.4%
Asian	6,253	0.6%	939	0.6%	778	0.7%
Native Hawaiian and Other Pacific Islander	668	0.1%	114	0.1%	93	0.1%
Some Other Race	5,975	0.6%	1,763	1.2%	1,467	1.4%
Two or More Races	24,976	2.5%	4,112	2.8%	3,072	2.9%
Total Population	**989,415**	**100%**	**147,972**	**100%**	**104,170**	**100%**

Source: U.S. Census Bureau, 2010.

2.3 Environmental and Physical Setting

An Environmental Scan Report was prepared in support of the Billings Area I-90 Corridor Planning Study in order to identify environmental resource constraints and opportunities within the study corridor. Information was gathered from previously-published documents, websites, GIS data, and a windshield survey conducted on April 15, 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 and important farmlands according to Section 4201 of the Farmland Protection Policy Act (FPPA) of 1981 (Title 7 United States Code, Chapter 73, Sections 4201-4209). If a project is 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.

Surface Water

The study corridor lies within the Yellowstone River Valley, specifically the Upper Yellowstone-Lake Basin (HUC: 10070004) and Upper Yellowstone-Pompeys Pillar (HUC: 10070007). The Yellowstone River, Canyon Creek, Hogan's Slough, the BBWA Canal, and several minor irrigation ditches cross I-90 within the study area.

The Upper Yellowstone and Middle Yellowstone watersheds are listed in the Montana Department of Environmental Quality's (DEQ's) 2010 Integrated 303(d)/305(b) Water Quality Report for Montana. The single listed water body is the Yellowstone River from the City of Laurel Public Water System (PWS) to the Huntley Diversion Dam. Total Maximum Daily Loads (TMDLs) have not yet been written for the Yellowstone River in the study corridor. When TMDLs are prepared for the Yellowstone River and implementation plans are in place, any construction activities would have to comply with the requirements set forth in the plan.

If an individual project is forwarded from this study, impacts to surface water resources should be avoided and minimized to the extent practicable.

Irrigation Facilities

Irrigation facilities exist in Yellowstone County adjacent to the study corridor. Maps illustrating these facilities are contained in Appendix 14. Impacts to irrigation facilities should be avoided to the greatest extent practicable. Impacted irrigation canals and ditches would need to be relocated in consultation with ditch owners to minimize impacts to farming operations.

Any potential impacts to irrigation facilities would need to be examined to determine if the irrigation facilities are considered Waters of the U.S. and subject to jurisdiction by the U.S. Army Corps of Engineers (USACE).

Stormwater

Under DEQ's Montana Pollutant Discharge Elimination System (MPDES) program, the City of Billings and MDT are co-permittees for the portion of the Billings Urbanized Area within the Billings city limits through the Small Municipal Separate Storm Sewer System (MS4) program; Yellowstone County and MDT are co-permittees for the portion of the Billings Urbanized Area outside the Billings city limits. Receiving waters for the Billings MS4 include the Billings Bench Water Association (BBWA) Canal, Canyon Creek Ditch, Canyon Creek, Suburban Ditch, Grey Eagle Ditch, Yellowstone River, Shiloh Drain, Alkali Creek, City/County Drain, Yegen Drain, Holling Drain, Blue Creek, Tributary to Blue Creek, Five Mile Creek, Coulson Ditch, Lockwood Ditch, Dry Creek, and Tributary to Dry Creek. If an individual project is forwarded from this study, impacts to the stormwater system should be avoided or minimized to the extent practicable.

Wetlands

The study area encompasses portions of the Yellowstone River and several other drainages with associated wetland areas. If an individual project is forwarded from this study, formal wetland delineations would need to be conducted according to standard USACE procedures. Jurisdictional wetland determinations would also need to be conducted during the project development process.

Wetland impacts should be avoided to the greatest extent practicable. All unavoidable wetland impacts would be mitigated as required by the USACE and in accordance with Federal Highway Administration (FHWA) and MDT policies and Executive Order (EO) 11990.

Floodplains

Within the study corridor, I-90 encroaches into the 100-year floodplain for the Yellowstone River delineated by the Federal Emergency Management Agency (FEMA). FEMA is in the process of updating its floodplain mapping within the study corridor. If an individual project is forwarded from the study, coordination with Yellowstone County should be conducted during the project development process to obtain floodplain mapping and permits as necessary.

Hazardous Materials

According to the Montana Natural Resource Information System (NRIS) database, there are 16 leaking underground storage tank (LUST) sites within the I-90 study corridor. The majority of these sites consist of active and former commercial gasoline stations and truck stops. Additionally, there are seven sites identified in the DEQ Site Response Section database accessed via NRIS and two active refinery sites in the corridor that have ongoing U.S. Environmental Protection Agency (USEPA) Resource Conservation and Recovery Act (RCRA) investigations and corrective actions. I-90 crosses through the Lockwood Solvent Site, a federal NPL Superfund site. Portions of the solvent plume originated from the Beall Trailer, Inc. facility and extend under I-90 from the Lockwood Interchange to the east approximately one mile.

Petroleum pipelines enter the Billings area from several directions and are connected to three active refineries, including the Cenex Laurel Refinery, the Conoco-Phillips Refinery, and the Exxon-Mobil Refinery. The lines in close proximity to I-90 generally follow the BNSF Railway corridor. NRIS data indicate a 12-inch petroleum liquid pipeline crosses under I-90 at the Laurel Interchange and another 12-inch petroleum liquid line crosses under I-90 approximately 5 miles east of Laurel. Although not identified on NRIS, a third line of unknown diameter crosses under

I-90 at the Lockwood Interchange. Appendix 15 contains a map illustrating hazardous materials sites within the corridor.

Further evaluation may be needed at specific sites to determine the exact location of facilities of concern or petroleum pipelines and if soil or groundwater contamination could be encountered during construction. This may include reviewing DEQ files and conducting a subsurface investigation to determine the extent of soil and groundwater contamination.

Air Quality

Portions of the study corridor are located within the Billings carbon monoxide (CO) designated re-attainment area (2002). Similarly the corridor traverses the former sulfur dioxide (SO_2) area of concern, which is no longer legally designated as a nonattainment area. If an individual project is forwarded from the study, an air quality analysis may be required.

2.3.2 Biological Resources

Fish and Wildlife

Threatened and Endangered Wildlife Species

There are five endangered, threatened, proposed, or candidate animal species listed for Yellowstone County, including the candidate Sprague's pipit, the candidate greater sage grouse, the proposed mountain plover, the endangered whooping crane, and the endangered black-footed ferret. No endangered, threatened, proposed, or candidate animal species are located within the study corridor. If an individual project is forwarded from the study, an 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

There are two mammal, four bird, five reptile, one amphibian, and two fish species of concern documented by the Montana Natural Heritage Program (MNHP) within three miles of the study area as of October 2010. If an individual project is forwarded from this study, on-site surveys will need to be completed during the project development process.

Vegetation

Native vegetation in the study area generally consists of wetland and riparian areas along waterways and sagebrush/grasslands in the upland areas. The remaining vegetation consists of cultivated crop land.

Threatened and Endangered Plant Species

There are no endangered, threatened, proposed, or candidate plant species listed for Yellowstone County, and none are currently expected to occur in the study area. If an individual project is 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

No plant species of concern have been documented within three miles of the study area. If an individual project is 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 will need to be completed during the project development process to determine any potential impacts to listed plant species of concern.

Noxious Weeds

If an individual project is forwarded from the study, the study area will need to be surveyed for noxious weeds during the project development process.

2.3.3 Social and Cultural Resources

Environmental Justice

Minority and low-income persons likely live within the study corridor. If a project is forwarded from the study, Environmental Justice will need to be further evaluated during the project development process.

Cultural and Archaeological Resources

A windshield survey of the proposed survey area revealed at least eleven historic or potentially historic sites located within 300 feet of the existing I-90 alignment. Six of the sites have not been previously recorded and their National Register of Historic Places (NRHP) status would need to be determined during the project development process. There are also several historic-age residences north of the Interstate between the South Billings Boulevard and 27th Street Interchanges. If improvements are proposed in this area, impacts to historic sites will need to be identified. With the exception of the Coulson Townsite, the study corridor is substantially developed and there is a low likelihood of finding any intact archaeological sites within the corridor. Appendix 15 contains a map illustrating historic sites within the corridor.

Federally-funded projects forwarded from the study would require a cultural resource survey of the Area of Potential Effect (APE) as specified in Section 106 of the National Historic Preservation Act (NHPA) (36 CFR 800). Impacts to significant cultural and archaeological resources should be avoided or minimized to the greatest extent practicable.

Section 4(f) Resources

Based on field observation, GIS review of public park lands, and review of the NRHP list for Yellowstone County, there are nineteen sites that could potentially be classified as Section 4(f) resources within the study area, including 11 historic sites and eight recreational sites. If an individual project is forwarded from this study, a Section 4(f) evaluation would need to be completed for any Section 4(f) resource impacted by the project. Appendix 15 contains a map illustrating Section 4(f) resources within the corridor.

Section 6(f) Resources

Two parks were identified as possible 6(f) resources within the study area. These include Ponderosa Park (RP 447.8±) and Coulson Park (RP 451.5±). If an individual project is forwarded from this study, impacts to Section 6(f) resources would need to be documented. Appendix 15 contains a map illustrating Section 6(f) resources within the corridor.

Noise

There are a number of residential developments within proximity to the study corridor. If an individual project is forwarded from the study, a noise analysis may be needed to evaluate noise impacts resulting from the addition of driving lanes in proximity to noise receptors.

3.0 PROJECTED CONDITIONS

3.1 Transportation System Conditions

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

3.1.1 Traffic Volumes

Mainline Interstate and Ramp Gore Areas

Annual Average Daily Traffic Volumes

Projected (2035) AADT volumes were calculated from the 2010 model output values using growth rates provided by MDT's TransCAD model. For planning purposes, MDT typically uses growth rates in the range from 1.0 to 3.5 percent. Model growth rates from 0.0 to 0.99 percent were rounded up to 1.0 percent for the purposes of this study. It was determined that model growth rates above 3.5 percent were appropriate given the relatively low volumes and the future development capacity in the five specific ramp locations where these rates occurred.

Appendix 10 presents AADT volumes and growth rates for mainline links and gore areas that were used for this corridor study.

Peak Hour Mainline Traffic Volumes

Data from the April 2011 field count collection effort was used to identify the worst case peak hour of the day (defined as the four consecutive 15-minute periods with the highest volumes over the three-day count period) and the peak hour percent of ADT. Peak hour mainline traffic volumes for 2035 were calculated from the AADT generated by the TransCAD model using the field count percent of ADT. Appendix 10 presents peak hour volumes for mainline links and gore areas in the corridor.

Ramp Intersections

Peak Hour Volumes

Growth rates provided by MDT's TransCAD model were applied to adjusted peak hour volumes from the April 2011 field count data for each intersection leg in order to calculate projected 2035 volumes. Appendix 10 presents peak hour volumes for the Laurel and Mossmain ramp intersections.

3.1.2 Operational Characteristics

Operational characteristics of the mainline Interstate, ramp gore areas, and ramp intersections were assessed using the same methodology outlined previously. Please refer to Section 2.1.5 for a detailed description.

Mainline Interstate

Analysis Results

Table 3.1 presents the results of the mainline Interstate operational analysis for projected (2035) conditions. Appendix 12 contains figures illustrating these results.

Table 3.1 Mainline Interstate Operational Analysis Results

Analysis Location		2035 Peak Hour EB		2035 Peak Hour WB	
		Density (pc/mi/ln)(1)	LOS	Density (pc/mi/ln)(1)	LOS
	Laurel Under	6.0	A	7.0	A
1	Laurel to Mossmain	13.9	B	13.9	B
	Mossmain Under	14.9	B	10.0	A
2	Mossmain to Shiloh	16.6	B	16.5	B
	Shiloh Under	12.9	B	12.1	B
3	Shiloh to West Billings	21.6	C	20.4	C
	West Billings Over	7.9	A	10.9	A
	West Billings Over Part 2(2)	8.8	A	NA	NA
4	West Billings to South Billings Boulevard(3)	15.5	B	17.3	B
	South Billings Boulevard Under	12.7	B	16.2	B
5	South Billings Boulevard to 27th Street	19.7	C	17.7	B
	27th Street Under	16.2	B	12.2	B
6	27th Street to Lockwood	25.4	C	18.0	B
	Lockwood Under	17.2	B	14.0	B
7	Lockwood to Johnson Lane	17.1	B	20.3	C
	Johnson Lane Under	14.2	B	8.8	A
8	Johnson Lane to Pinehills	15.3	B	10.1	A

Source: DOWL HKM, 2011.
(1) pc/mi/ln: passenger cars per mile per lane
(2) EB only; no corresponding WB link
(3) Location was analyzed as mainline weaving segment; all other locations analyzed as basic freeway segments.
Shaded cells indicate unacceptable operations (defined as LOS C or worse).
The terms "Under" and "Over" are used to describe the portion of the mainline Interstate above or below the interchange between on-ramps and off-ramps.

The MDT Traffic Engineering Manual and MDT Road Design Manual define acceptable operations for urban and rural freeway facilities as LOS B. Using this criterion, several freeway segments within the study area were identified as operating at an unacceptable level, reaching LOS C (with vehicle densities above 18 and 20 pc/mi/ln for basic freeway and weaving segments, respectively) by the study horizon year. Segments that are projected to operate at an unacceptable level include the Shiloh to West Billings, South Billings Boulevard to 27th Street and the 27th Street to Lockwood EB segments and the Shiloh to West Billings and Lockwood to Johnson Lane WB segments.

It should be noted that the WB segment from 27th Street to Lockwood is predicted to experience a density of 18 pc/mi/ln in 2035, which is just at the demarcation between LOS B and LOS C. The WB segment from South Billings Boulevard to 27th Street is predicted to experience a density of 17.7 pc/mi/ln in 2035, which is just above the demarcation between LOS B and LOS C. Coupled with the segments on either side that are predicted to fall below LOS B, the WB segments between Shiloh and Johnson Lane could be considered together.

LOS worksheets for these segments are provided in Appendix 11.

Sensitivity Analysis

HCS was used to conduct a sensitivity analysis to determine the year when operations could be expected to shift from LOS B to LOS C. Expected average annual growth rates developed through the MDT TransCAD model were used to predict volumes for intermediate years through straight-line growth. Table 3.2 presents the results of the sensitivity analysis for mainline Interstate segments.

Table 3.2 Mainline Interstate Sensitivity Analysis

Analysis Location		Deficiency Year	
		EB	WB
3	Shiloh to West Billings	2028	2030
5	South Billings Boulevard to 27th Street	2032	-
6	27th Street to Lockwood	2023	-
7	Lockwood to Johnson Lane	-	2031

Source: DOWL HKM, 2011.
Note: The South Billings Boulevard to 27th Street and 27th Street to Lockwood WB segments are projected to reach LOS C by 2036.

Ramp Gore Areas

Analysis Results

Table 3.3 presents the results of the ramp gore area operational analysis for projected (2035) conditions. Appendix 12 contains figures illustrating these results.

Table 3.3 Ramp Gore Area Operational Analysis Results

Interchange	Ramp Gore	2035 EB		2035 WB	
		Density (pc/mi/ln)(1)	LOS	Density (pc/mi/ln)(1)	LOS
Laurel	On-Ramp	17.7	B	7.9	A
	Off-Ramp	9.8	A	11.0	B
Mossmain	On-Ramp	20.5	C	16.2	B
	Off-Ramp	21.6	C	14.9	B
Shiloh	On-Ramp	25.4	C	20.1	C
	Off-Ramp	19.3	B	17.5	B
West Billings	On-Ramp	12.6	B	23.4	C
	Off-Ramp	13.4	B/F	NA	NA
	On-Ramp at Mullowney	NA	NA	NA	NA
South Billings Boulevard	On-Ramp	21.5	C	NA	NA
	Off-Ramp	NA	NA	23.2	C
27th Street	On-Ramp	23.7	C	19.1	B
	Off-Ramp	22.4	C	17.8	B
Lockwood	On-Ramp	21.7	C	21.8	C
	Off-Ramp	23.4	C	20.7	C
Johnson Lane	On-Ramp	17.9	B	23.8	C
	Off-Ramp	19.7	B	13.3	B

Source: DOWL HKM, 2011.
(1) pc/mi/ln: passenger cars per mile per lane
Shaded cells indicate unacceptable operations (defined as LOS C or worse).

The MDT Traffic Engineering Manual and MDT Road Design Manual define acceptable operations for urban and rural freeway facilities as LOS B. Using this criterion as the threshold value, 17 freeway gore areas within the study area were identified as operating at an unacceptable level by the study horizon year. These include on-ramps at the Mossmain (EB), Shiloh (EB and WB), West Billings (WB), South Billings Boulevard (EB), 27th Street (EB), Lockwood (EB and WB), and Johnson Lane (WB) Interchanges and off-ramps at the Mossmain (EB), West Billings (EB), South Billings Boulevard (WB), 27th Street (EB), and Lockwood (EB and WB) Interchanges. It should also be noted that the Shiloh EB off-ramp, the 27th Street WB on-ramp, and the Johnson Lane EB off-ramp are predicted to experience densities of 19.3, 19.1, and 19.7, respectively, which are just below the demarcation between LOS B and LOS C.

Generally, unacceptable operation for freeway merge and diverge segments is defined as vehicle densities above 20 pc/mi/ln. At the West Billings EB off-ramp in 2035, a density of 13.4 pc/mi/ln would normally indicate operation at LOS B. The capacity for a single-lane ramp cannot exceed 2,200 vehicles per hour, whereas the volume of vehicles in the peak hour in this location was calculated to be 2,405. Accordingly, because the ramp volume is projected to exceed available capacity, the gore area is projected to operate at LOS F, despite the relatively low density value.

Sensitivity Analysis

HCS was used to conduct a sensitivity analysis to determine the year when operations could be expected to shift from LOS B to LOS C. Expected average annual growth rates developed through the MDT TransCAD model were used to predict volumes for intermediate years through straight-line growth. Table 3.4 presents the results of the sensitivity analysis for ramp gore areas.

Table 3.4 Ramp Gore Area Sensitivity Analysis

Interchange	Ramp Gore	Deficiency Year	
		EB	WB
Mossmain	On-Ramp	2033	-
	Off-Ramp	2027	-
Shiloh	On-Ramp	2027	2035
West Billings	On-Ramp	-	2027
	Off-Ramp	2028	-
	On-Ramp at Mullowney	-	-
South Billings Boulevard	On-Ramp	2034	-
	Off-Ramp	-	2028
27th Street	On-Ramp	2027	-
	Off-Ramp	2030	-
Lockwood	On-Ramp	2031	2031
	Off-Ramp	2026	2034
Johnson Lane	On-Ramp	-	2027

Source: DOWL HKM, 2011.

Ramp Intersections

Analysis Results

Tables 3.5 and 3.6 present the results of the ramp intersection operational analysis for projected (2035) conditions. Appendix 12 contains figures illustrating these results.

Table 3.5 Operational Analysis Results for Signalized Intersection

Intersection		Control Type	Intersection Approach	Turning Movement	2035 Peak Hour Delay (s/veh)	2035 Peak Hour Volume to Capacity Ratio	2035 Peak Hour LOS
L1	S. 4th Street / WB I-90 Ramps / US 212	Signalized	EB Approach (S. 4th Street)	EB Left / Through / Right	7.4	NA	A
			WB Approach (WB I-90 Ramps)	WB Left	10.9		B
				WB Through / Right	8.7		A
			NB Approach (US 212)	NB Left	8.3		A
				NB Through & Through / Right	8.9		A
			SB Approach (US 212)	SB Left	8.8		A
				SB Through & Through / Right	10.8		B
			Intersection		**9.8**	**0.57**	**A**

Source: DOWL HKM, 2011.
Shaded cells indicate average control delay and intersection volume to capacity (v/c) ratio for the intersection (all approaches).

Table 3.6 Operational Analysis Results for Stop-Controlled Intersections

Intersection		Control Type	Intersection Approach	Turning Movement	2035 Peak Hour	
					Delay (s/veh)	LOS
L2	I-90 EB Ramps / US 212	Stop	WB Approach (EB I-90 Ramps)	WB Left	-	-
				WB Right	17.8	C
		Yield	NB Approach (US 212)	NB Through	-	-
				NB Through / Right	-	-
		Uncontrolled	SB Approach (US 212)	SB Left	9.7	A
				SB Through	-	-
				SB Through	-	-
M1	E. Main Street / S. 72^{nd} Street West / Interchange Crossroad	Stop	EB Approach (E. Main Street)	EB Through / Right	528.7	F
		Stop	WB Approach (S. 72^{nd} Street West)	WB Left / Through	Overflow	F
		Uncontrolled	NB Approach (Interchange Crossroad)	NB Left / Right	9.2	A
M2	I-90 WB Ramps / Interchange Crossroad	Stop	WB Approach (WB I-90 Off-Ramp)	WB Left / Through / Right	241.1	F
		Uncontrolled	NB Approach (Interchange Crossroad)	NB Left / Through	5.3	A
		Uncontrolled	SB Approach (Interchange Crossroad)	SB Through / Right	-	-
M3	I-90 EB Ramps / Interchange Crossroad	Stop	EB Approach (EB I-90 Off-Ramp)	EB Left / Through / Right	42.0	E
		Uncontrolled	NB Approach (Interchange Crossroad)	NB Through / Right	-	-
		Uncontrolled	SB Approach (Interchange Crossroad)	SB Left / Through	5.3	A
M4	Magelssen Road / S. Frontage Road / Interchange Crossroad	Stop	EB Approach (Magelssen Road)	EB Left / Through / Right	-	-
		Uncontrolled	WB Approach (S. Frontage Road)	WB Left / Through / Right	6.3	A
		Stop	NB Approach (Driveway)	NB Left / Through / Right	25.5	D
		Uncontrolled	SB Approach (Interchange Crossroad)	SB Left / Through / Right	-	-

Source: DOWL HKM, 2011.
Dash (-) indicates no conflicting movements (i.e., no delay).
Shaded cells indicate worst approach.

The Billings Urban Area Long-Range Transportation Plan (2009 Update) notes that the Billings Urban Area has set a goal of achieving and maintaining LOS C on all major roadways through 2035. Based on the HCM analyses, the signalized intersection (L1) at the Laurel Interchange can be expected to operate under a satisfactory LOS through the design year, based on appropriate adjustments to the signal timing at this intersection. The southern unsignalized intersection (L2) serving EB traffic falls to LOS C by the planning horizon year, and may benefit from the installation of a signal to improve the LOS to B or better.

By year 2035, all intersections at the Mossmain interchange are expected to reach failing LOS, with intersection M1 experiencing a higher demand than can be served during within the peak hour. Furthermore, delays reported for intersection M2 could experience queues beyond the ability of the ramp to store the vehicles.

Appendix 11 contains operational analysis worksheets for each analysis location.

Sensitivity Analysis

The two intersections at the Laurel Interchange are projected to operate within acceptable range over the planning horizon. Accordingly, a sensitivity analysis was not conducted for these intersections.

Intersection M1 is currently experiencing a failing LOS. Because the four intersections at the Mossmain Interchange are closely spaced, they operate as a system. Any improvements to intersection M1 would likely require improvements to the adjacent intersections simultaneously due to their close proximity. Accordingly, a sensitivity analysis was not conducted for the Mossmain ramp intersections because it can be assumed that this system of intersections as a whole is currently failing.

4.0 RECENT AND PLANNED PROJECTS

The most recently completed major project affecting the study corridor was the Shiloh Road project, completed in 2010. This project reconstructed Shiloh Road to a five-lane urban principal arterial, improving access opportunities to I-90 at the Shiloh Interchange. A parallel project by MDT installed intersection improvements at Zoo Drive and Gabel Road between the Shiloh Road corridor and the Interstate corridor.

Other recent and planned projects include the following:

Pinehills Interchange Southeast consisted of thin over-lay repaving. The project began at RP 456.6 and ended at RP 463.0, affecting 6.5 miles of Interstate adjacent to the eastern border of the corridor study. The project was completed in 2011.

Mossmain Interchange-East is a 23.60 mile roadway and roadside safety improvement project that involved median slope flattening and median cable guardrail. This project begins at RP 437.4 and continues to RP 461.0 on I-90. The portion of the project within the boundaries of the corridor study is approximately 19.20 miles. The project was completed in 2011.

2002-Safety Improvements-Billings is a 1.5 mile roadway and roadside safety improvement project that involved widening the EB Lockwood Interchange off-ramp to two lanes. This project begins at RP 451.7 and continues to RP 453.2 on I-90. The portion of the project within the boundaries of the corridor study is approximately 1.50 miles.

Park City Interchange - East involved a mill and overlay, replacement of the weigh-in-motion sensors at the Mossmain Scale at RP 438.7±, and a seal and cover from RP 426.6 to 446.0.

The *Billings Bypass* project will prepare an Environmental Impact Statement (EIS) for a new arterial roadway connection between I-90 and Old Hwy 312 in the northeast portion of the Billings urban area. The proposed project involves a new crossing of the Yellowstone River, and will connect intersecting roadways through at-grade intersections. The Bypass project is expected to connect to the Interstate corridor at either the Pinehills Interchange or at the Johnson Lane Interchange. Either alternative will require reconstruction of the connecting interchange. The EIS is expected to be completed in late 2012 with a Record of Decision (ROD) expected in early 2013.

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 (e.g., bridges, bicycle and pedestrian facilities, utilities, etc.) will be detailed following development of improvement options. Deficiencies identified in the *Billings I-90 Interchanges Project* report (2006) are contained in Appendix 7.

Table 5.1 Summary of Issues and Concerns

Condition		Issue / Concern
Transportation System Conditions	**Physical Features**	Bridges • 10 bridges are functionally obsolete; of these, four are eligible for rehabilitation • One set of twin bridges is fracture critical
	Geometric Conditions	Mainline Links • Eight non-standard vertical curves within the corridor Laurel and Mossmain Interchange Ramps • Insufficient acceleration lengths at Laurel and Mossmain Interchanges • Insufficient deceleration lengths at Laurel Interchange • Failure to meet minimum K value at Laurel WB on-ramp and EB off-ramp Laurel and Mossmain Interchange Ramp Intersections • The Interstate bridge over the Mossmain Interchange crossroad has a maximum vertical clearance of 14' - 8".
	Safety Conditions	Segment 4 (West Billings to South Billings Boulevard, RP 446.0 to RP 447.2) Crash rate and severity rate are approximately 1.7 and 2.2 times higher than the statewide average for similar facilities. Half-mile stretch from RP 446.0 to RP 446.5 exhibits high frequency of crashes. Laurel and Mossmain Interchange Ramp Intersections • Lighting at the Laurel and Mossmain Interchanges is insufficient according to recommended guidelines
	Operational Conditions	Mainline Links • LOS C is projected by 2035 in five locations Laurel and Mossmain Interchange Ramp Gore Areas • LOS C is projected by 2035 in 15 locations Laurel and Mossmain Interchange Ramp Intersections • LOS D or worse is projected by 2035 in four locations

Condition	Issue / Concern
Environmental Conditions	Prime Farmland • Prime and important farmlands are located in study corridor Surface Water • Portion of Yellowstone River within study area is listed in the DEQ 2010 Integrated 303(d)/305(b) Water Quality Report for Montana. Irrigation Facilities • A number of irrigation facilities are located within the corridor Stormwater • Receiving waters for the Billings MS4 are located within the study corridor Wetlands • Study area includes portions of the Yellowstone River and other drainages with associated wetland areas Floodplains • I-90 encroaches into the 100-year floodplain for the Yellowstone River Hazardous Materials • Hazardous sites in the corridor include 16 LUST sites, three refineries, three petroleum pipelines, one NPL Superfund site, and seven sites identified in the DEQ Site Response Section Floodplains • I-90 encroaches into the 100-year floodplain for the Yellowstone River Fish and Wildlife • Two mammal, four bird, five reptile, one amphibian, and two fish species of concern are documented within three miles of the study area Cultural and Archaeological Resources • At least eleven historic or potentially historic sites are located within 300 feet of the existing I-90 alignment. Section 4(f) and 6(f) Resources • Nineteen sites could potentially be classified as Section 4(f) resources within the study area, including 11 historic sites and eight recreational sites. • Two parks were identified as possible 6(f) resources within the study area. Noise • There are residential developments within proximity to the study corridor