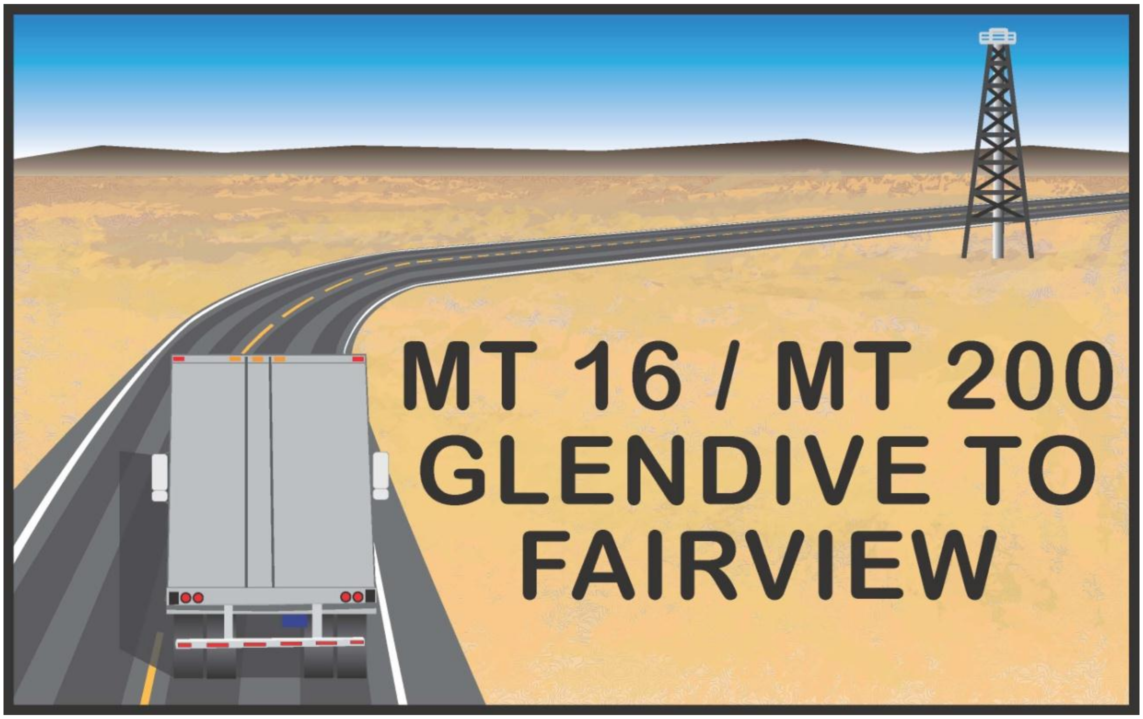

IMPROVEMENT OPTIONS REPORT

PREPARED FOR:

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July 2012

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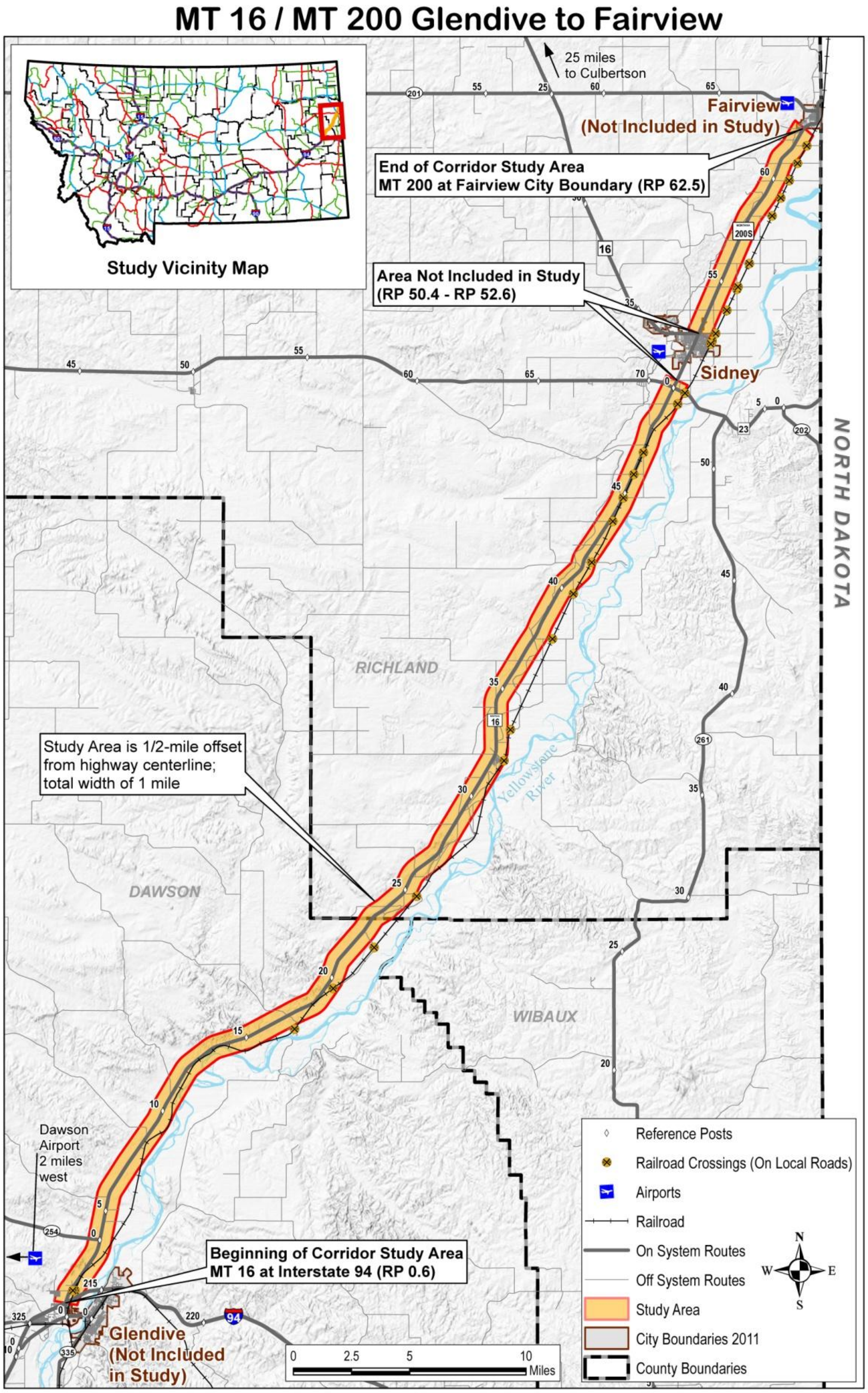
1.0 INTRODUCTION

This report presents improvement options recommended for the MT 16 / MT 200 Glendive to Fairview Corridor Planning Study. The study area includes approximately 59.7 miles of state highway beginning on MT 16 at approximate Reference Post (RP) 0.6 just north of the I-94 Interchange in Glendive and extending northeasterly to the intersection of County Road 123 (RP 50.4) south of Sidney. The study resumes at Sidney's northern city limit boundary (RP 52.6) north of the MT 200 intersection with Holly Street, and extends northeast on MT 200 to the Fairview city limits (RP 62.5). The study excludes areas within the city limits of Glendive, Sidney, and Fairview and extends one-half mile on each side of the highway centerline throughout the corridor. The study area is illustrated in Figure 1-1.

Concurrent with this corridor planning study, MDT conducted a corridor safety audit (CSA) focusing on the portion of MT 16 / MT 200 between I-94 and the North Dakota state line. A CSA is a formal safety performance review of a corridor by a multi-disciplinary team. As part of the CSA, MDT held an audit workshop on February 1 and 2, 2012 to gather input from local, state, and federal officials and to conduct an on-site field review of the corridor. The audit team included representatives from MDT, the City of Sidney, the City of Fairview, Federal Highway Administration (FHWA), and Montana Highway Patrol. The CSA team generated recommendations and countermeasures for roadway segments or intersections demonstrating a history of crashes or an identifiable pattern of crash types. This improvement options report incorporates CSA recommendations for the rural portion of the MT 16 / MT 200 corridor. The CSA report is provided in Appendix 1 of this report.

Figure 1-1 Study Area



Source: MDT, 2012; DOWL HKM, 2012.

2.0 IMPROVEMENT OPTIONS

The corridor planning study team identified improvement options to address corridor safety and operational needs and complement recommendations generated through the CSA process. The team identified safety improvements to improve roadway geometry, reduce conflicts with intersecting roadways, and address head-on and single vehicle run-off the road crashes and unsafe driver behavior. The team identified operational improvements to accommodate existing and future traffic demands through the 2035 planning horizon. Current and anticipated future safety and operational conditions within the MT 16 / MT 200 corridor are described in detail in the existing and projected conditions report prepared for this study.

This report describes general improvement strategies and concepts as well as specific improvement options recommended for the MT 16 / MT 200 corridor. Improvement options are presented alphabetically by category, and proposed follow-up responsibility is listed for each improvement option.

Implementation of improvement options is dependent on available personnel resources, funding availability, right-of-way needs, and other project delivery elements. Recommended timeframes for implementation are defined as follows:

- Immediate: Implementation is currently ongoing or will be initiated in 2012
- Short-term: Implementation is recommended within a 1- to 3-year period
- Mid-term: Implementation is recommended within a 3- to 6-year period
- Long-term: Implementation is recommended within a 6- to 20-year period
- As Needed: Implementation could occur based on observed need throughout the 2035 planning horizon

Planning level cost estimates are listed in 2012 dollars for each improvement option. Cost estimates reflect anticipated construction costs only, and do not include potential costs associated with right-of-way acquisition, utility relocation, preliminary engineering, construction engineering / inspection, or operations and maintenance. Cost ranges are provided in some cases, indicating unknown factors at this planning level stage. Appendix 2 provides detailed cost estimates, including construction material assumptions.

Potentially impacted resources and anticipated permitting / right-of-way requirements are listed for each option. Project level analysis would be needed to quantify resource impacts if improvements are forwarded from this study.

The following sections discuss recommended improvement options and associated planning level cost estimates, implementation timeframes, potentially impacted resources and permitting / right of way requirements, and proposed follow-up responsibilities.

2.1 Access Management

Access management involves controlling ingress and egress to adjacent land parcels while preserving the traffic flow on the surrounding road system to promote safe and efficient use of the transportation network.

Safety and operational benefits of controlling highway access are well documented. As access density (or the number of access points per mile) increases, there is generally a corresponding increase in crashes and travel times. Appropriately managing access within a highway corridor can improve traffic flow and reduce intersection-related crashes. Access management techniques include, but are not limited to:

- **Access / Driveway Spacing**: Increasing the distance between intersecting roadways and driveways improves the flow of traffic and reduces congestion for heavily traveled corridors. Fewer access points spaced further apart allows orderly merging of traffic and presents fewer challenges to drivers. Consolidation of existing driveways and use of frontage road systems can reduce the number of direct access points on a highway facility.
- **Turning Lanes / Median Treatments**: Dedicated left- and right-turn lanes prioritize the flow of through traffic. Two-way left-turn lanes (TWLTL) and nontraversible, raised medians are effective means to regulate access and reduce crashes.

The CSA noted several full movement driveways providing access to private residences are located in the portion of the corridor from Crane to Sidney. Full movement driveways allow unrestricted movements (e.g., right-turn, left-turn, and through movements) to and from the mainline highway. The greatest density of access points in the corridor occurs from Sidney to Fairview. Full movement driveways and intersecting public roadways add conflict points, contribute to crash frequency, present conflicts for pedestrians and bicyclists, and negatively affect travel times.

Recommended Improvement Option

Option 1 Access Management Study

An access management study or a combination of studies is recommended to identify and eliminate duplicative driveways, identify opportunities to combine or realign driveways and approaches, regulate the size and operations of driveways, identify appropriate access for planned future development in the corridor, and identify additional access control or consolidation measures, as appropriate. The study could evaluate access issues within the entire corridor from Glendive to Fairview, with specific focus on full movement driveways in areas with high access density. Access management issues could be addressed through one or multiple studies of varying length and scope.

Proposed Follow-Up Responsibility
MDT

Planning Level Cost Estimate
$50,000 to $300,000, depending on length and scope

Recommended Implementation Timeframe
Short-term

Potentially Impacted Resources and Permitting / Right-of-Way Requirements
None

2.2 Education & Law Enforcement

Unsafe driver behavior was identified as a key concern during the corridor planning and safety audit processes. Community members described speeding, unsafe passing maneuvers, and near-miss crashes occurring frequently in the corridor. Safety concerns related to driver behavior can be mitigated through increased law enforcement presence and educational strategies targeting high risk groups or actions.

Recommended Improvement Options

Option 2.a Public Outreach Campaigns

The CSA recommends enhanced public outreach campaigns to provide additional driver education regarding traffic laws and regulations and appropriate driving behavior in proximity to large vehicles. Additionally, the CSA identified the need for enhanced young driver education due to the number of young driver crashes in this corridor.

Enhanced educational strategies could target passenger vehicles operating unsafely around large trucks, aggressive driving, drowsy driving, distracted driving, speeding, impaired driving, texting / cell phone use, and seat belt use. Public outreach methods could include public service announcements, billboards targeting high risk groups, print advertising, promotion of designated driving programs, expansion of free ride home and taxi services, and enhanced driver's education and / or school-based health curriculum.

The MDT website currently provides information and links to additional resources for educational outreach to young drivers (http://www.mdt.mt.gov/safety/safety-initiatives/young.shtml) and impaired driving education (http://www.mdt.mt.gov/safety/safety-initiatives/drugs-alcohol.shtml). Several public outreach tools are available through the local DUI task force coordinator as well as from MDT, including the Respect the Cage Campaign (http://respectthecage.com/), Buckle Up Montana (http://buckleup.mt.gov/default.shtml), and the MDT Plan 2 Live Website (http://plan2live.mt.gov/). The U.S. Department of Transportation, National Highway Traffic Safety Administration (NHTSA), and the National Safety Council offer online resources at http://www.distraction.gov/ and http://www.nsc.org/SAFETY_ROAD/DISTRACTED_DRIVING/Pages/Public_Education.aspx.

Proposed Follow-Up Responsibility
Dawson and Richland Counties; MDT; Cities of Glendive, Sidney, and Fairview; other local stakeholders

Planning Level Cost Estimate
Various – costs for personnel time, media advertising, curriculum materials, and other public outreach materials were not estimated

Recommended Implementation Timeframe
Short-term

Potentially Impacted Resources and Permitting / Right-of-Way Requirements
None

Option 2.b Increased Enforcement

The CSA identified a need for increased law enforcement patrols along the MT 16 / MT 200 corridor. Law enforcement officials have conducted concentrated enforcement patrols along MT 16 / MT 200 in recent years, although budget and personnel constraints have been identified as limiting factors.

Proposed Follow-Up Responsibility
Montana Highway Patrol (MHP); Dawson and Richland Counties; Cities of Glendive, Sidney, and Fairview

Planning Level Cost Estimate
$65,000 – approximate annual salary for patrol officer; $60,000 – approximate cost for new patrol vehicle[1]

Recommended Implementation Timeframe
Short-term

[1] Source: Rich Rowe, Undersheriff for Dawson County, 2012.

Potentially Impacted Resources and Permitting / Right-of-Way Requirements

None

2.3 Geometry

Horizontal & Vertical Alignment

In general, roadways should be constructed to meet current MDT design standards. Where an existing roadway comes close to meeting current MDT design standards, it may not be cost-effective to reconstruct the roadway to address minor geometric issues unless there are crash concentrations attributable to roadway geometry. Locations within the MT 16 / MT 200 corridor that do not meet current MDT design standards for horizontal or vertical alignment represent minor variations from current standards in terms of maximum grade, superelevation, and K value (or the horizontal distance needed to produce a one percent change in gradient). Crash data does not support reconstruction of these locations as stand-alone projects. They should be addressed at the time of future programmed projects in the corridor.

Intersections

Current MDT design standards note roadways should intersect at or as close to 90° as practical. Skewed intersections are undesirable for several reasons:

- Vehicular turning movements and sight distance are restricted.
- Additional pavement and channelization may be required to accommodate large vehicle turning movements.
- The exposure time for vehicles and pedestrians crossing the main traffic flow is increased.

MDT design guidance notes intersection angles should not exceed 30° from perpendicular at maximum. Intersections with a skew greater than 30° may require geometric improvements, including realignment.

Transitions

The MT 16 / MT 200 roadway within the study area consists of a two-lane roadway throughout the majority of the study corridor, with short stretches of three-lane sections north of Glendive and through Savage, and a four-lane section near Sidney. Typical section transitions should be well delineated, and drivers should be cautioned prior to transition locations. Transition lengths should follow the guidance of the MDT Road Design Manual.

Recommended Improvement Options

Option 3.a Intersection Realignment

A number of intersecting county roads (CRs) within the study corridor are aligned to MT 16 / MT 200 at an angle greater than 30° from perpendicular. Realignment of these intersections is recommended to improve sight distance and accommodate passenger vehicle and large vehicle turning movements. Recommended intersection realignment locations are listed below.

- RP 24.0 (CR 100)
- RP 25.6 (CR 340)
- RP 25.9 (CR 339)
- RP 28.6 (CR 104)
- RP 28.9 (CR 340)
- RP 30.9 (CR 106)
- RP 35.2 (CR 110)
- RP 37.5 (CR 112)
- RP 42.3 (CR 116)
- RP 43.6 (CR 117)
- RP 46.9 (CR 348)
- RP 58.0 (CR 130)

Site specific conditions will dictate the appropriate realignment geometry, depending on constraints and features at each intersection. Appendix 3 contains figures illustrating current alignments.

CR 116 (RP 42.3) is in proximity to a subdivision undergoing approach permitting at the time this report was written. The subdivision is located 1.3 miles north of Crane at approximate RP 41.5. If the proposed development proceeds, it may be appropriate to consider access consolidation at the time of intersection realignment to reduce conflict points within the highway corridor.

Proposed Follow-Up Responsibility
Dawson and Richland Counties, in coordination with MDT

Planning Level Cost Estimate
$39,000 to $310,000 per intersection; see Appendix 2 for detailed cost estimate

Recommended Implementation Timeframe
Short-term to long-term

Potentially Impacted Resources and Permitting / Right-of-Way Requirements
Farmlands, wetlands, floodplains, and surface water bodies may be impacted. Additional study will be needed to quantify specific impacts. New right-of-way and permitting may be required.

Option 3.b Lane Transition

The roadway typical section within and south of the Sidney city limits (RP 50.0 to RP 51.7) consists of four travel lanes and a center left-turn lane. The roadway typical section transitions to two travel lanes south of the MT 16 / MT 23 / MT 200 intersection (RP 50.0). Community members have voiced concerns regarding the transition length in this location. Extending the four lane roadway section further south of the intersection may help alleviate driver confusion.

Proposed Follow-Up Responsibility
MDT

Planning Level Cost Estimate
$460 per lineal ft; see Appendix 2 for detailed cost estimate

Recommended Implementation Timeframe
Short-term to mid-term

Potentially Impacted Resources and Permitting / Right-of-Way Requirements
Farmlands, wetlands, floodplains, and surface water bodies may be impacted. Additional study will be needed to quantify specific impacts. New right-of-way and permitting may be required.

2.4 Passing Opportunities and Capacity Improvements

Level of Service

Six Level of Service (LOS) categories ranging from A to F are used to describe traffic operations for Class I two-lane highways. Class I two-lane highways are major intercity routes, primary connectors of major traffic generators, daily commuter routes, or major links in state or national highway networks where motorists expect to travel at relatively high speeds. These facilities serve mostly long-distance trips or provide connections between facilities that serve long-distance trips.

The Highway Capacity Manual (HCM) defines LOS for Class I two-lane highways on the basis of the percent time-spent-following (PTSF) concept. PTSF represents the freedom to maneuver and the comfort and convenience of travel, reflected by the average percentage of time that vehicles must travel in platoons behind slower vehicles due to an inability to pass. The two major factors affecting PTSF are passing capacity and passing demand. The concept of passing capacity for a two-lane highway reflects that the ability to pass is limited by oncoming vehicles (opposing flow rate) and by the distance between those vehicles (the distribution of gaps in the opposing flow). The concept of passing demand reflects that the demand for passing maneuvers increases as more drivers are caught behind a slow-moving vehicle (i.e., as PTSF increases in a given direction). Both passing capacity and passing demand are related to the number of vehicles using the roadway at a given time (flow rates). Increased traffic flow rates generally result in increased passing demand and decreased passing capacity. Table 2.1 presents LOS criteria for Class I two-lane highways.

Table 2.1 LOS Criteria for Class I Two-Lane Highways

Level of Service	PTSF[1] (%)
A	≤35.0
B	>35.0 to 50.0
C	>50.0 to 65.0
D	>65.0 to 80.0
E	>80
F	Demand Exceeds Capacity

Source: HCM 2010, Exhibit 15-3 Automobile LOS for Two-lane Highways
[1] pc/mi/ln: passenger cars per mile per lane

LOS F occurs when the demand flow rate exceeds the capacity of the roadway to handle the flow. In such cases, PTSF will be above the threshold shown for LOS E, although specific values cannot be determined.

Table 2.2 presents anticipated 2035 conditions for the existing two-lane facility. LOS values represent estimated operational conditions within each specified corridor segment based on available traffic data. Appendix 4 contains HCS operational analysis worksheets.

The MDT Traffic Engineering Manual defines desirable operations for principal and minor arterial facilities in level terrain, such as the MT 16 / MT 200 corridor, as LOS B. Principal arterials provide the highest traffic volumes and the greatest trip lengths of all arterial functional classifications. Minor arterials in rural areas typically provide a mix of interstate and interregional travel service. When compared to principal arterials, minor arterials accommodate shorter trip lengths and typically lower traffic volumes, but provide more access to abutting properties. The MT 16 / MT 200 corridor is projected to operate at LOS C or worse by 2035 throughout the majority of the corridor. Poor LOS for a two-lane highway indicates most vehicles are traveling in closely spaced clusters or platoons, speeds are noticeably curtailed, and passing opportunities are limited to nonexistent.

Table 2.2 Projected Operations (2035)

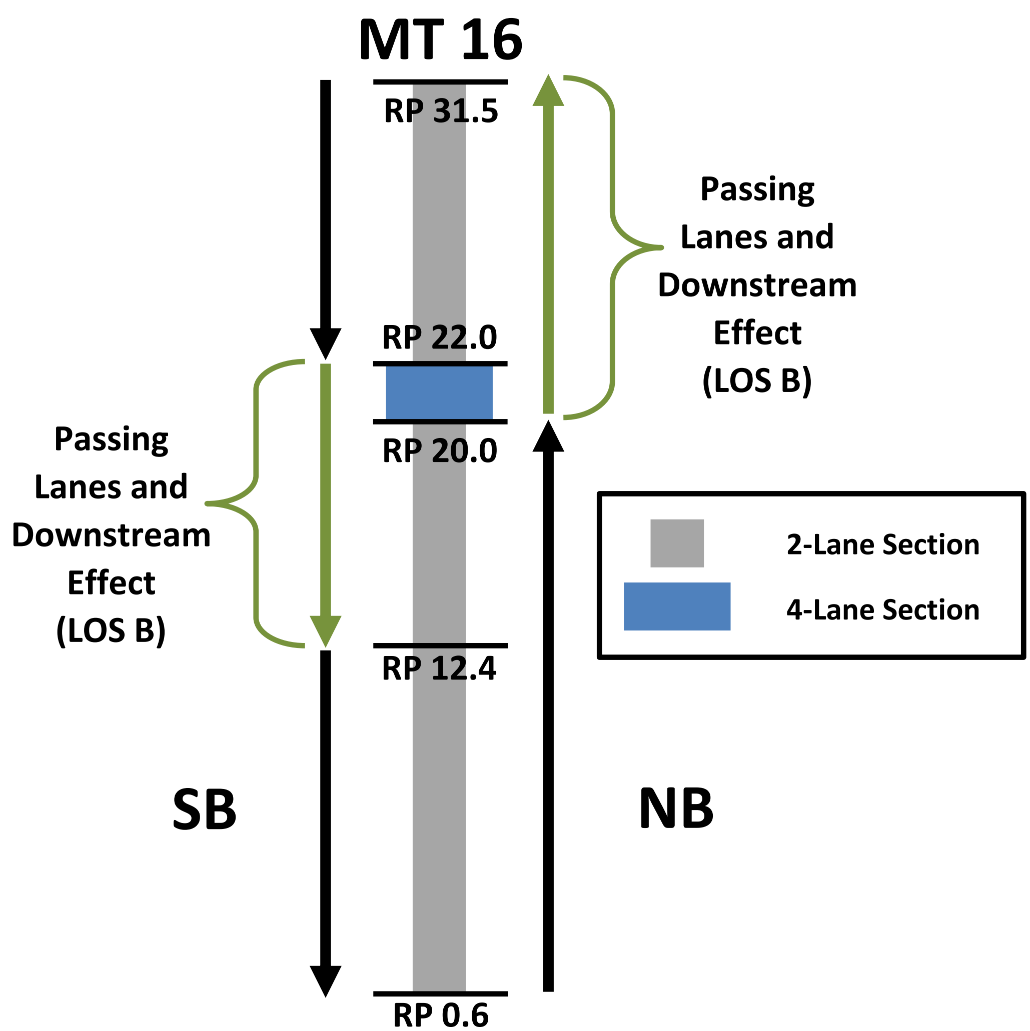
Location[(1)]			2012 2-Lane with Passing Lanes[(2)]		2035 2-Lane with Passing Lanes[(2)]			
					Low Estimate[(3)]		High Estimate[(4)]	
			PTSF[(5)] (%)	LOS	PTSF[(5)] (%)	LOS	PTSF[(5)] (%)	LOS
Corridor Segment	Glendive to Savage	MT 16 NB RP 0.6 to RP 20.0	39.6	B	54.6	C	60.3	C
		MT 16 SB RP 0.6 to RP 12.4	39.5	B	54.9	C	61.7	C
		MT 16 NB RP 20.0 to RP 31.5	26.5	A	39.3	B	47.3	B
		MT 16 SB RP 12.4 to RP 22.0	25.2	A	37.7	B	45.7	B
		MT 16 SB RP 22.0 to RP 31.5	40.1	B	55.3	C	60.1	C
	Savage to Crane	MT 16 NB RP 31.5 to RP 41.5	37.9	B	51.3	C	59.2	C
		MT 16 SB RP 31.5 to RP 41.5	42.5	B	57.3	C	64.7	C
	Crane to Sidney	MT 16 NB RP 41.5 to RP 50.4	38.0	B	52.2	C	59.5	C
		MT 16 SB RP 41.5 to RP 50.4	50.2	C	64.7	C	72.8	D
	Sidney to Fairview	MT 200 EB RP 52.6 to RP 62.5	51.1	C	71.3	D	77.4	D
		MT 200 WB RP 52.6 to RP 62.5	49.3	B	69.2	D	75.9	D

Source: DOWL HKM, 2012.
Note: Shaded gray rows indicate analyzed sections with passing lanes and their associated downstream effect.
(1) NB = Northbound; SB = Southbound; EB = Eastbound; WB = Westbound;
(2) Passing lanes are being constructed as part of the 30 km NE of Glendive – NE project from RP 20.0 to RP 22.0 in the northbound and southbound directions. Project completion is anticipated in August 2012.
(3) Low estimate indicates three years of rapid traffic volume growth, followed by twenty years of historical background growth.
(4) High estimate indicates five years of rapid traffic volume growth, followed by eighteen years of historical background growth.
(5) Percent time-spent-following

A current MDT project (30 km NE of Glendive – NE) to reconstruct portions of the study corridor includes an amendment to the contract (change order) to include passing lanes from approximately RP 20.0 to RP 22.0, which is expected to decrease PTSF and improve LOS over the length of the passing lanes and for some distance downstream before PTSF returns to its former level. *These passing lanes are included in the LOS analysis presented in Table 2.2*, indicated by acceptable LOS B in the northbound segment from RP 20.0 to Savage (RP 31.5) and the southbound segment from RP 12.4 to RP 22.0.

In the northbound direction, two LOS values are reported between Glendive (RP 0.6) and Savage (RP 31.5). The first LOS value represents the single northbound travel lane from RP 0.6 to RP 20.0, and the second LOS value represents two northbound travel lanes including the passing lane and downstream effect from RP 20.0 to Savage (RP 31.5). In the southbound direction, three LOS values are reported between Glendive (RP 0.6) and Savage (RP 31.5). The first LOS values represents the single southbound travel lane from Glendive (RP 0.6) to RP 12.4, the second value represents two southbound travel lanes including the passing lane and downstream effect from RP 12.4 to RP 22.0, and the third value represents the single southbound travel lane from RP 22.0 to Savage (RP 31.5). Figure 2-1 illustrates these conditions.

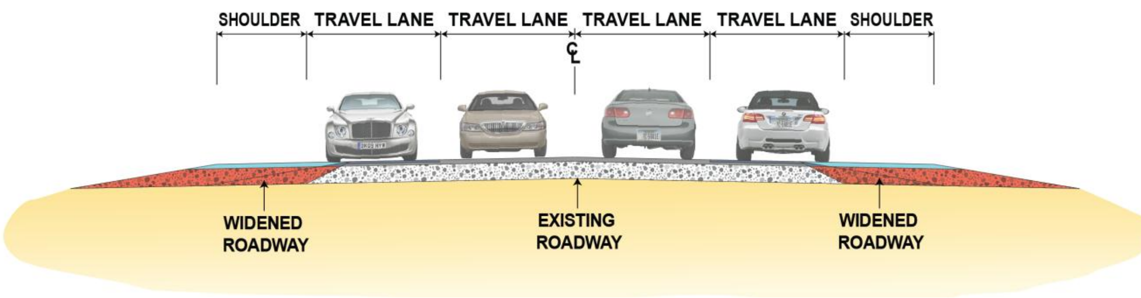
Figure 2-1 Passing Lanes and Downstream Effect



Passing Opportunities

Passing lanes provided at regular intervals in each direction of travel can improve highway operations. Although passing lanes do not increase the capacity of a two-lane highway, they can improve LOS by decreasing PTSF. PTSF is improved by allowing platoons in the direction of the passing lane to disperse through unrestricting passing for the length of the passing lane. Periodic provision of passing lanes can eliminate the formation of long platoons behind a single slow-moving vehicle. Passing lanes may be provided intermittently or at fixed intervals for each direction of travel. They may also be provided for both directions of travel at the same location resulting in a short section of four-lane undivided highway as shown in Figure 2-2. This typical section assumes roadway widening (shown in red) on both sides of the existing MT 16 / MT 200 roadway (shown in white) to achieve the required road width.

Figure 2-2 Passing Lane Typical Section (Both Directions)



Alternatively, for passing lanes within road segments characterized by high access densities, additional widening may be necessary for construction of a center TWLTL as shown in Figure 2-3.

Figure 2-3 Passing Lane Typical Section (Both Directions with Center TWLTL)

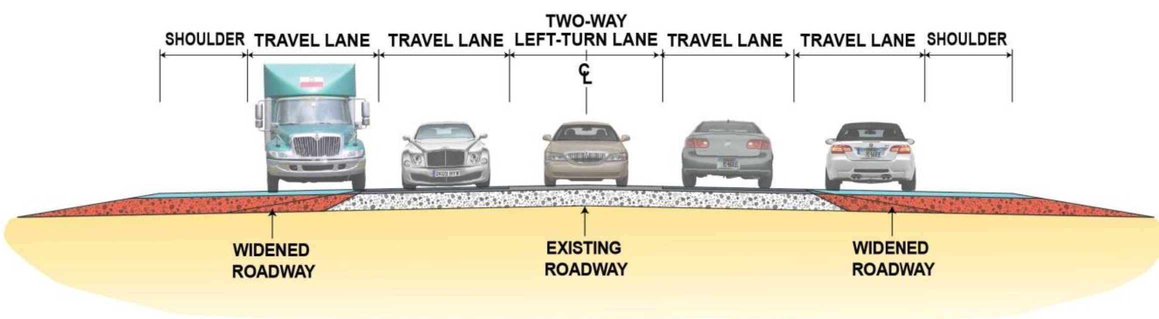


Table 2.3 presents the downstream roadway length affected by passing lanes on highways with varying traffic volumes. Passing lanes constructed on highways with lower traffic volumes result in longer downstream affected lengths. This is due primarily to fewer vehicles downstream of the passing lane resulting in fewer following situations.

Table 2.3 Downstream Length of Roadway Affected by Passing Lanes

Directional Demand Flow Rate[1] (passenger cars per hour)	Downstream Length of Affected Roadway (miles)
≤200	13.0
300	11.6
400	8.1
500	7.3
600	6.5
700	5.7
800	5.0
900	4.3
≥1,000	3.6

Source: HCM 2010, Exhibit 15-23 Downstream Length of Roadway Affected by Passing Lanes on Directional Segments in Level and Rolling Terrain.
[1] Directional Demand Flow Rate is the traffic volume flow rate of a highway in one direction. The relative high percentage of large vehicles within the MT 16 / MT 200 corridor traffic stream would likely reduce the downstream length of affected roadway associated with the corresponding directional demand flow rates.
Note: Interpolation to the nearest 0.1 is recommended.

The location and length of passing lanes should be determined in the context of corridor-specific constraints. Appendix 5 illustrates known constraints in the MT 16 / MT 200 corridor that may influence identification of appropriate passing lane locations. Known constraints include utilities, bridges, culverts / siphons, wetlands and surface water bodies, and intersecting roadways.

In addition to passing lanes, passing opportunities may be increased by providing frequent passing zones. Passing zones are indicated by dashed yellow centerlines. Passing zones may be delineated in one or both directions of travel. Passing zones should only be provided in locations with sufficient passing sight distance based on current MDT design standards for the appropriate design speed of the roadway. Passing sight distance is the minimum sight distance required to safely begin and complete a passing maneuver under the assumed conditions of the highway. Community members noted no-passing zones at intersecting roadways divide longer passing segments and hinder passing in the corridor. Passing opportunities are also limited by the frequency of oncoming vehicles (opposing flow rate), including large vehicles.

Capacity

Another method to improve LOS in the corridor is to provide additional capacity by widening the facility from a two-lane highway to a four-lane highway with two travel lanes in each direction. Multilane highways may be divided by various median types, may be undivided with only a centerline separating the direction of flow, or may have a center two-way left-turn lane (TWLTL). The TWLTL concept is described in more detail in Section 2.9.

The HCM defines LOS for multilane highways on the basis of density. Density describes the proximity to other vehicles and is related to the freedom to maneuver within the traffic stream (or the number of passenger cars per mile per lane). Table 2.4 presents LOS criteria for multilane highway segments.

Table 2.4 LOS Criteria for Multilane Highways

Level of Service	Density (pc/mi/ln)[1]
A	>0 to 11.0
B	>11.0 to 18.0
C	>18.0 to 26.0
D	>26 to 35
E	>35 to 45
F	Demand Exceeds Capacity

Source: HCM 2010, Exhibit 14-4 Automobile LOS for Multilane Highway Segments.
[1] pc/mi/ln: passenger cars per mile per lane

LOS F occurs when the demand flow rate exceeds capacity. In such cases, density values will be above the threshold shown for LOS E, although specific values cannot be determined.

Constructing a four-lane highway would provide LOS A throughout the entire corridor within the 2035 planning horizon.

Recommended Improvement Options

Option 4.a Passing Lanes

Passing lanes are recommended at regular intervals throughout the corridor. Further study will be needed to determine appropriate locations for passing lanes based on corridor geometry and constraints. Highest priority should be given from Sidney to Fairview due to anticipated poor operating conditions (LOS D by 2035). Crane to Sidney is anticipated to reach LOS C and D by 2035 and should be a secondary priority, followed by the remainder of the corridor. Concurrent with this corridor study, MDT is utilizing Interactive Highway Safety Design Model (IHSDM) software to identify appropriate passing lane locations.

Proposed Follow-Up Responsibility
MDT

Planning Level Cost Estimate
$1.8 to $2.0 million per mile for undivided four-lane section (passing lanes in both directions); passing lane construction has been assumed at locations within the corridor characterized by relatively flat terrain. A 5-foot embankment height (vertical distance from roadway shoulder to bottom of embankment) has been assumed. See Appendix 2 for detailed cost estimate. Additional costs may be associated with construction in steep terrain.

Recommended Implementation Timeframe
Immediate (30 km NE of Glendive - NE project) to long-term

Potentially Impacted Resources and Permitting Requirements
Farmlands, wetlands, floodplains, and surface water bodies may be impacted. Additional study will be needed to quantify specific impacts. Permitting may be required. Roadside ditches, culverts, and other potential conveyance or retention features would need to be considered where appropriate during project development.

Right-of-Way Requirements
New right-of-way may be required. Standard right-of-way limits for arterial facilities are 80 feet from the centerline of the roadway to the right-of-way line or 10 feet beyond the construction limits, whichever is greater. Right-of-way acquisition will likely be required for construction within segments of steep terrain (RP 12 to16 and RP 26.5 to 28), as well as the segment of the corridor between Sidney and Fairview (RP 52.6 to 62.4). Approximately 20 to 50 ft of right-of-way acquisition is anticipated throughout this segment.

Constructability Challenges
Passing lane construction may not be cost-effective within certain segments of the corridor due to physical constraints including the adjacent rail facility, the Yellowstone River, and steep terrain.

Option 4.b Engineering Study to Evaluate Passing Zones

An engineering study is recommended to evaluate corridor passing zones and determine if removal of no-passing zones at low-volume intersecting roadways is appropriate.

Proposed Follow-Up Responsibility
MDT

Planning Level Cost Estimate
NA – MDT to conduct study as part of current program

Recommended Implementation Timeframe
Short-term

Potentially Impacted Resources and Permitting / Right-of-Way Requirements
None

Option 4.c Four-Lane Highway

Widening the MT 16 / MT 200 corridor from a two-lane highway to a four-lane highway is recommended for further consideration as a potential long-term option to provide additional capacity in the corridor. This improvement may be considered within the 2035 planning horizon if regularly-spaced passing lanes cannot provide desirable LOS in the corridor. The north end of the corridor from Sidney to Fairview (RP 52.6 to 62.4) would be a higher priority based on anticipated LOS D in 2035.

Proposed Follow-Up Responsibility
MDT

Planning Level Cost Estimate
$152.8 million to $164.5 million (undivided four-lane section throughout the corridor); $2.6 to $2.8 million (per mile); an average embankment fill quantity of 8 feet (below subgrade) and an average excavation quantity of 2 feet (below subgrade) is assumed throughout the corridor. See Appendix 2 for detailed cost estimate.

Recommended Implementation Timeframe
Long-term

Potentially Impacted Resources and Permitting / Right-of-Way Requirements
Farmlands, wetlands, floodplains, and surface water bodies may be impacted. Additional study will be needed to quantify specific impacts. New right-of-way and permitting may be required. Roadside ditches, culverts, and other potential conveyance or retention features would need to be considered where appropriate during project development. Any potential bridge replacement would require identification of appropriate bridge deck drainage during project development.

2.5 Pavement Preservation

Timely maintenance can extend the life of a pavement surface and minimize long-term maintenance costs. The MDT maintenance program maintains asphalt pavements in a manner that provides a safe roadway, preserves and extends the state's investment, maintains the functional condition, and delays future deterioration by providing the appropriate treatment at the right time. For corridors with increasing traffic volumes, pavement maintenance schedules may need to be altered, and in some cases expedited, to achieve typical maintenance goals.

Recommended Improvement Option

Option 5.a Pavement Preservation

A mill and overlay or another form of surfacing rehabilitation is recommended for the MT 16 / MT 200 corridor at the appropriate time within the maintenance schedule based on projected future traffic volumes and the percentage of large vehicles in the traffic stream. Milling is a process used to remove surface irregularities and deteriorated pavements. Milling is typically performed prior to a surface overlay project and helps to ensure a smooth transition from an existing surface to the new pavement. Based on a preliminary pavement analysis of the MT 16 / MT 200 corridor assuming increasing future traffic volumes and continued high percentages of large vehicles in the traffic stream (see Appendix 6), a 3-inch overlay is recommended for MT 16 and a 6-inch overlay is recommended for MT 200 at the appropriate time within the maintenance schedule. Recommended pavement thicknesses are based on an estimated structural number accounting for projected AADT and the percentage of heavy trucks in the traffic stream.

Proposed Follow-Up Responsibility
MDT

Planning Level Cost Estimate
$59.0 million to $63.6 million (entire corridor); $1 million (per mile); see Appendix 2 for detailed cost estimate

Recommended Implementation Timeframe
As needed, depending on future pavement condition

Potentially Impacted Resources and Permitting / Right-of-Way Requirements
None

2.6 Public Transportation

Public transportation can provide a reduction in the number of single occupant vehicles on the roadway and reduce congestion under favorable ridership conditions. The density of residential developments; roadway congestion levels; and the type, frequency, and accessibility of public transportation services are factors influencing ridership in a highway corridor.

Richland County Transportation offers on-call bus service on weekdays for Sidney, Savage, and Fairview with pick-up and drop-off locations arranged on an individual basis. Dawson County Transit also provides weekday on-call bus service within the Dawson County Urban Transportation District in Glendive.

Recommended Improvement Option

Option 6 Transit Study and Park & Ride Facilities

The CSA recommends investigating the feasibility of constructing park and ride facilities in Glendive and Fairview to alleviate traffic congestion in the corridor. A park and ride facility may also be appropriate in Sidney. Park and ride facilities are parking lots that allow people to leave their vehicles and transfer to public transport for the rest of their trip. Park and ride facilities may be used to facilitate connections with public transportation services, as well as informal ride-sharing networks and employer-sponsored transportation. A transit study could be conducted to identify potential ridership and evaluate potential expansion of existing public transportation services.

Proposed Follow-Up Responsibility
Dawson and Richland Counties; MDT; Cities of Glendive, Sidney, and Fairview; other local stakeholders

Planning Level Cost Estimate
$30,000 – transit study; $300,000 per park and ride facility (actual cost will vary depending on size and amenities)

Recommended Implementation Timeframe
Mid-term to long -term

Potentially Impacted Resources and Permitting / Right-of-Way Requirements
Transit Study: None

Park and Ride Facilities: New right-of-way may be required. Appropriate location should be identified to avoid impacts to resources.

2.7 Roadside Safety

The safest roadside is flat and free of obstructions or steep slopes. The MDT Road Design Manual specifies an offset distance from the edge of the travel way (ETW) to be free of any obstructions. The ETW is delineated by the white pavement marking located on the right-hand side of the travel lane. This offset distance, known as the “clear zone,” includes the roadway shoulder and is defined based on design speed, Average Annual Daily Traffic (AADT), the slope and offset of cut / fill sections from the ETW.

Roadside ditches can present a hazard if an errant vehicle cannot easily travel its slopes, regain control, and return to the travel way. An errant vehicle leaving the roadway may not be able to safely negotiate a critical slope (also called a non-traversable slope. Depending on encroachment conditions, a vehicle on a critical slope may overturn. For most embankment heights, fill slopes steeper than 3:1 are considered critical. A non-recoverable slope can be safely traversed, although an errant vehicle may not be able to return to the roadway. Slopes greater than or equal to 3:1 and less than 4:1 are considered traversable but non-recoverable.

When steep side slopes occur adjacent to a roadway, the hazardous condition ideally should be eliminated by providing slopes and dimensions specified in current MDT design criteria. Oftentimes, this is not practical due to economic, environmental, or drainage conditions. If steep side slopes cannot be flattened due to these reasons, it may be necessary to shield the hazard with a roadway barrier such as guardrail, depending on the fill section height.

Recommended Improvement Option

Option 7 Roadside Safety Improvements

An overhead sign post north of the MT 16 / MT 200 / Holly Street intersection (RP 52.6) is located within the clear zone. Relocation of the sign post outside the clear zone is recommended.

Additionally, based on field review and CSA recommendations, slope flattening or barrier warrants should be considered in the fourteen (14) locations noted below.

- RP 1.1 (East Side)
- RP 1.8 (West Side)
- RP 2.4 (East Side)
- RP 3.0 (East Side)
- RP 7.0 (East & West Sides)
- RP 8.5 (East & West Sides)
- RP 11.8 (East & West Sides)
- RP 12.7 (West Side)
- RP 14.2 (West Side)
- RP 14.4 (West Side)
- RP 16.3 (West Side)
- RP 17.4 (East Side)
- RP 28.5 (East Side)
- RP 29.7 (East & West Sides)

Site specific conditions will dictate the degree of flattening or the appropriate barrier dimensions and placement at each location, depending on which roadside safety method is selected.

Proposed Follow-Up Responsibility
MDT

Planning Level Cost Estimate
$40,000 (overhead sign relocation); $30 per lineal foot (guardrail); $60 per lineal foot (slope flattening average; cost will vary depending on fill height)

Recommended Implementation Timeframe
Short-term to mid-term

Potentially Impacted Resources and Permitting / Right-of-Way Requirements
Few, if any, impacts are anticipated as a result of relocating the overhead sign or installing roadside barriers as these improvements can generally be performed within the existing right-of-way.

Farmlands, wetlands, floodplains, and surface water bodies may be impacted as a result of slope flattening, depending on the need to extend beyond existing right-of-way limits. Additional study will be needed to quantify specific impacts. New right-of-way and permitting may be required. Roadside ditches, culverts, and other potential conveyance or retention features would need to be considered where appropriate during project development.

2.8 Speed

Community members have expressed concern regarding the speed differential between large vehicles and passenger vehicles in the corridor. The daytime posted speed limit within the corridor is primarily 70 mph for passenger vehicles and 60 mph for trucks, with short sections of reduced speed zones (45 to 55 mph) near the boundaries of Sidney and Fairview and through the community of Savage. Speed limits for highways within the state are set by the Montana Legislature and are detailed in the Montana Code Annotated (MCA) § 61-8-303.

The Transportation Commission has the authority to set special speed zones. In response to written requests from local governments, MDT will conduct an engineering and traffic investigation called a spot speed study to measure speeds at specific locations. As part of this process, MDT examines physical roadway characteristics, crash data, and traffic data, including the speed at which the majority of traffic is moving. MDT may recommend a special speed zone if the operating character of the roadway deviates from normal conditions addressed by general statutory speed regulation. MDT will prepare a report detailing its findings and recommendations and will submit the report for consideration by the Transportation Commission. If the Transportation Commission determines that a speed limit is greater or less than is reasonable and safe for the roadway under current operational and environmental conditions, it may set a special speed limit for the corridor.

Recommended Improvement Option

Option 8 Speed Study

A speed study is recommended to assess the differential in speed between passenger vehicles and large vehicles and identify appropriate speed limits for all vehicles in the corridor.

Proposed Follow-Up Responsibility
MDT

Planning Level Cost Estimate
NA – MDT to conduct study as part of current program

Recommended Implementation Timeframe
Short-term

Potentially Impacted Resources and Permitting / Right-of-Way Requirements
None

2.9 Traffic Control Devices and Safety / Warning Features

Traffic Control Devices / Pavement Markings

Traffic control devices are used to promote highway safety and efficiency through the orderly movement of all road users. Traffic control devices notify drivers of regulations and provide warning and guidance to promote efficient operation and minimize crash occurrences.

Traffic signals aim to balance the traffic handling capacity of intersections, as well as reduce the frequency of certain types of crashes. An engineering and traffic study of an intersection's physical characteristics and traffic conditions is necessary to determine if a traffic signal is warranted in a particular location. Signal warrants consider traffic volumes, crash history, proximity to schools, pedestrian usage, and other local needs.

Warning signs may be used to inform drivers in advance of upcoming intersections and lane transitions. Flashing warning beacons can supplement warning or regulatory signs or markers. For example, where a minor side street intersects a highway, a circular yellow flashing indication is sometimes installed prior to the intersection on the minor roadway with an enhanced intersection warning sign and a supplemental name plaque on the major roadway. The need for warning beacons and warning signs is determined on a case-by-case basis.

Appropriately maintained retroreflective signs and pavement markings can improve highway safety and prevent roadway departure crashes by making signs and markings appear brighter and easier to see and read. Retroreflective properties of traffic control devices deteriorate over time and require regular maintenance to comply with the Manual on Uniform Traffic Control Devices (MUTCD).

Rumble Strips

Application of shoulder and centerline rumble strips on two-lane highways has been shown to reduce the incidence and severity of roadway departure crashes, including head-on, opposite direction sideswipe, and SVROR crashes.

Shoulder and centerline rumble strips commonly consist of parallel grooves cut into the roadway. Shoulder and centerline rumble strips in combination with appropriate pavement markings can alert drowsy, inattentive, or impaired drivers who unintentionally stray across the roadway centerline or off the edge of the roadway. The audible sound and physical vibration alert drivers, improving driver reaction and increasing the likelihood for a safe return to the travel lane. Centerline rumble strips can also assist drivers in identifying lane delineations during low visibility conditions.

A number of states have used centerline rumble strips in passing zones with no clear indication that centerline rumble strips inhibit passing behavior. In corridors carrying high percentages of large vehicles, it is important to consider the warning properties and appropriate placement of rumble strips. Typical recommendations for rumble strip length, width, and depth should not be reduced given the muffling effect of large vehicle tires. Additionally, potential for off-tracking should be considered when centerline rumble strips are used in curvilinear segments. Off-tracking refers to the wide path of a large vehicle's wheels when turning a corner.

Centerline rumble strips are a cost-effective measure to reduce the incidence and severity of crossover crashes. These benefits often outweigh the disadvantages of increased noise and maintenance requirements. Spot application of centerline rumble strips is not as effective in reducing crossover crashes due to the difficultly in determining where a driver may become inattentive.

Overhead Lighting

Overhead lighting can improve visibility for drivers and other roadway users and provide a safe and comfortable environment for the nighttime driver. Providing overhead lighting for all highways facilities is not practical or cost effective. It is generally MDT practice to only provide overhead highway lighting where justified based on engineering judgment and the criteria, recommendations, and principals presented in the AASHTO publication Roadway Lighting Design Guide.

The MDT Traffic Engineering Manual recommends consideration of overhead lighting in locations with high vehicle-to-vehicle interactions, including roadways with numerous driveways, substantial commercial or residential development, and a high percentage of large vehicles. Community members suggested extending overhead lighting outside city limits in the corridor to improve visibility in these locations.

Recommended Improvement Options

<u>Option 9.a Traffic Signals</u>

Installation of flashing beacons with supplemental warning signage or traffic signals should be considered on a case-by-case basis within the 2035 planning horizon if future crash trends indicate intersection-related clusters within the corridor that could be correctable through beacon installation / signage or intersection signalization. The following intersections were identified as potential signal locations due to reported crashes in their approximate vicinity within the 2006 to 2010 period:

Full Signalization

- RP 50.0
  (MT 16 / MT 23 / MT 200)

Enhanced Intersection Warning (Beacon / Signage)

- RP 50.4 (MT 16 / MT 200 / CR 123)
- RP 53.7 (MT 200 / CR 126)
- RP 58.0 (MT 200 / CR 130)
- RP 60.7 (MT 200 / CR 132)
- RP 61.7 (MT 200 / CR 133)

Proposed Follow-Up Responsibility
MDT

Planning Level Cost Estimate
$500 per new sign; $30,000 per flashing beacon; $300,000 per signal

Recommended Implementation Timeframe
As Needed

Potentially Impacted Resources and Permitting / Right-of-Way Requirements
None

Option 9.b Signing and Striping

MT 16 transitions from two travel lanes to one lane approximately 300 feet south of the MT 16 / MT 200 intersection (RP 50.0) in the southbound direction. Similarly, MT 200 transitions from two lanes to one lane north of the MT 16 / MT 200 / Holly Street intersection (RP 52.6) in the southbound direction. Through the safety audit and corridor planning study processes, community members voiced concerns regarding inadequate lane reduction warning (signage / pavement markings) in these locations.

Advance warning signs and modified striping should be considered to clearly indicate upcoming lane transitions. Additionally, a signing and striping inventory is recommended to identify the need for maintenance or replacement of existing signs.

Proposed Follow-Up Responsibility
MDT

Planning Level Cost Estimate
$500 per new sign; $26 per ft^2 per replacement sign; $50 per station (striping)

Recommended Implementation Timeframe
Immediate to short-term

Potentially Impacted Resources and Permitting / Right-of-Way Requirements
None

Option 9.c Shoulder and Centerline Rumble Strips

Continuous application of shoulder and centerline rumble strips is recommended within the MT 16 / MT 200 corridor with gaps only at major intersecting roadways. SF 119-Glendive Rumble Strips is a safety project to install shoulder and centerline rumble strips on MT 16 from approximately RP 1.5 to approximately RP 49.9 and MT 200 from Sidney to Fairview. The anticipated project start date is fall 2012.

Proposed Follow-Up Responsibility
MDT

Planning Level Cost Estimate
$2,100 per mile; $700 per strip

Recommended Implementation Timeframe
Immediate

Potentially Impacted Resources and Permitting / Right-of-Way Requirements
None

Option 9.d Overhead Lighting

Extension of existing overhead lighting is recommended for further consideration in areas immediately outside the city limits of Sidney and Fairview due to high number of access points and the high percentage of large vehicles in the traffic stream.

Proposed Follow-Up Responsibility
MDT

Planning Level Cost Estimate
$13,000 per overhead lighting fixture (average); see Appendix 2 for detailed cost estimate

Recommended Implementation Timeframe
Short-term to mid-term

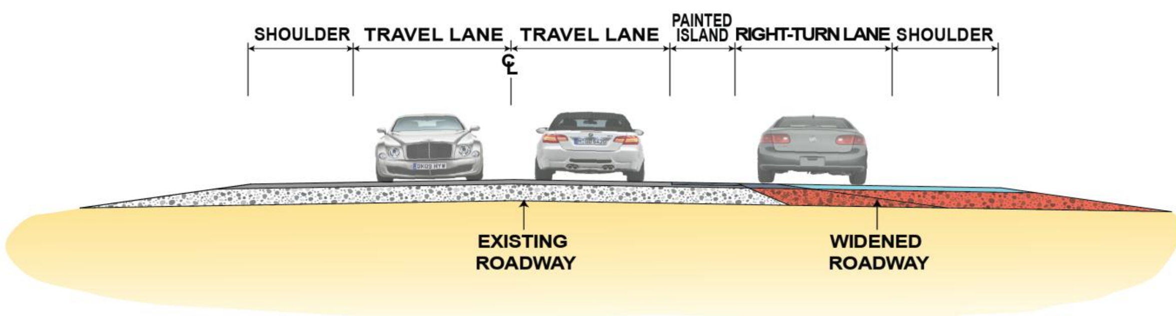
Potentially Impacted Resources and Permitting / Right-of-Way Requirements
None

2.10 Turn Lanes

Intersection turn lanes are desirable in appropriate locations on two-lane highways to reduce delays to through vehicles caused by turning vehicles and to reduce turning accidents. Separate right- and left-turn lanes may be provided, as appropriate, to remove turning vehicles from the through traffic stream.

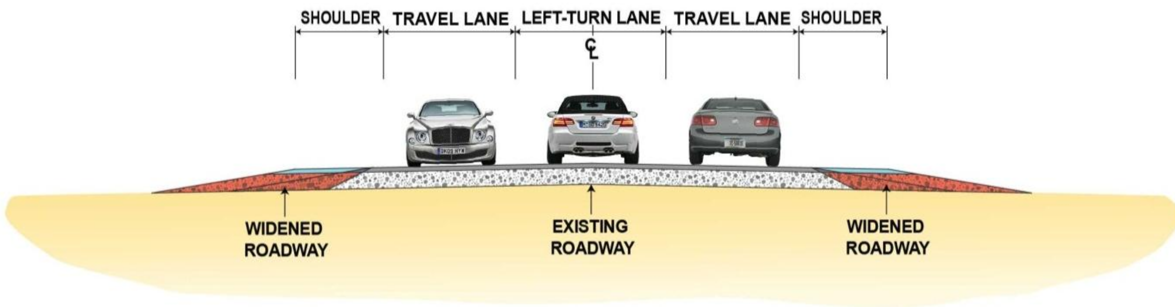
Exclusive right-turn lanes may be appropriate at unsignalized intersections on two-lane highways where the ratio of right-turning vehicles to the total design hour volume exceeds the threshold specified in the MDT Road Design Manual or at any intersection where a crash trend involves right-turning vehicles. Side-street visibility can be inhibited by right-turn lanes due to moving sight obstructions created by decelerating vehicles in the turn lane. Proper placement of the side-street stop bar and turn lane lateral placement can maintain visibility. A right-turn lane typical section is provided in Figure 2-4. This typical section assumes widening (shown in red) in one direction adjacent to the existing MT 16 / MT 200 roadway (shown in white) to achieve the required road width.

Figure 2-4 Right-Turn Lane Typical Section



Left-turn lanes provide a protected location for turning vehicles to wait for an acceptable gap in the opposing traffic stream. This reduces the potential for collisions from the rear and may encourage left-turning vehicles to wait for an adequate gap in opposing traffic before turning. Left-turn lanes have also been shown to reduce delay to through vehicles in locations with high opposing volumes. Exclusive left-turn lanes may be appropriate at unsignalized intersections on two-lane highways that meet MDT guidelines for opposing volumes, advancing volumes, and percentage of left-turn movements or where a crash trend involves left-turning vehicles. TWLTLs are used to accommodate a continuous left-turn demand and reduce delay and accidents. TWLTLs may be considered in locations where there are a high number of approaches per mile and high AADT volumes (greater than 5,000 vehicles per day for two-lane roadways). The left-turn lane typical section shown in Figure 2-5 assumes widening (shown in red) on both sides of the existing MT 16 / MT 200 roadway (shown in white) to achieve the required road width.

Figure 2-5 Left-Turn Lane Typical Section



Recommended Improvement Options

Option 10.a Proposed Left- and Right-Turn Lanes

The CSA recommends consideration of center two-way left-turn lanes in appropriate locations from Sidney to Fairview to reduce the number of intersection-related collisions in this area, consideration of a northbound right-turn lane at the intersection of MT 16 / CR 110 (RP 35.3), and a left-turn lane at the intersection of MT 16 / CR 126 (RP 53.7).

Community members also requested consideration of a left-turn lane at the intersection of MT 16 / CR 110, right- and / or left-turn lanes within Crane (RP 41.4 to RP 41.9), a southbound right-turn lane at the intersection of MT 16 / MT 23 / MT 200 (RP 50.0), and right- and / or left-turn lanes at the intersections of MT 16 / CR 551 (RP 17.0) and MT 16 / CR 128 (RP 55.8).

Consideration of guidelines is recommended in these locations to determine appropriate turn-lane applications.

Proposed Follow-Up Responsibility
MDT

Planning Level Cost Estimate
Warrants: NA; Turn Lanes: $160,000 to $250,000 per turn lane; see Appendix 2 for detailed cost estimate

Recommended Implementation Timeframe
Warrants: short-term; Turn Lanes: short-term to mid-term

Potentially Impacted Resources and Permitting Requirements
Warrants: None

Turn Lanes: Farmlands, wetlands, floodplains, and surface water bodies may be impacted. Additional study will be needed to quantify specific impacts. New right-of-way and permitting may be required.

Right-of-Way Requirements

Right-of-way requirements will vary based on the potential turn lane location. Anticipated right-of-way acquisition needs are detailed in Table 2.5.

Table 2.5 Right-of-Way Requirements for Turn Lanes

Intersection/ Location (RP)	Existing ROW	Site Characteristics	Anticipated ROW Acquisition
CR 551 (RP 17.0)	West: 100' East: 100'	Intersection is located at the top of a vertical crest curve; tall roadway embankment	Dependent on fill height and roadside safety treatment
CR 110 (RP 35.3)	West: 80' East: 70'	Flat terrain bordered by farmland	None
Town of Crane (RP 41.4 – 41.9)	West: 80' East 60-80'	Flat terrain bordered by farmland and residences	0 to 20 feet
MT16 / MT 23 / MT 200 (RP 50.0)	West: 80' East: 60'	Flat terrain bordered by farmland	20 feet
CR 126 (RP 53.7)	West: 60-100' East: ~70'	Flat terrain bordered by farmland and a residence	20 to 40 feet
CR 128 (RP 55.8)	West: 70' East: 60"	Flat terrain bordered by farmland (LT) and residences (RT)	20 to 30 feet

Option 10.b Existing Turn Lane Reconstruction

The CSA recommends reconstruction of the existing northbound right-turn lane at the intersection of MT 200 / CR 126 (RP 53.7) to provide moving sight distance.

Proposed Follow-Up Responsibility

MDT

Planning Level Cost Estimate

$130,000 to $140,000; see Appendix 2 for detailed cost estimate

Recommended Implementation Timeframe

Short-term to mid-term

Potentially Impacted Resources and Permitting / Right-of-Way Requirements

Farmlands, wetlands, floodplains, and surface water bodies may be impacted. Additional study will be needed to quantify specific impacts. New right-of-way and permitting may be required.

3.0 OTHER PLANNING EFFORTS AND PROJECTS

Recent and ongoing planning efforts and projects in the study area vicinity are described below.

Sidney Truck Route Study

This 2009 study was initiated by the City of Sidney, in cooperation with MDT, to determine the need for and feasibility of a Sidney truck route. The study determined a truck route east of Sidney would have the greatest potential to attract truck traffic currently traveling north / south along Central Avenue. Feedback from local and regional trucking operations and several local residents and business owners confirmed they favored an eastern route.

Culbertson Corridor Planning Study (ongoing) – The Culbertson area has experienced similar growth in traffic volumes along US 2 and MT 16 as is being experienced along the MT 16 / MT 200 corridor. The Culbertson Corridor Planning Study is primarily focused on truck traffic on US 2 and MT 16 which intersect in Culbertson. The Study is anticipated to be completed by the end of 2012.

MT 200 / CR 129 Intersection Signing involved installation of signing at the intersection of MT 200 and CR 129 from approximately RP 56.9 to approximately RP 57.2. The project was completed in 2012.

30 km NE of Glendive – NE involves reconstruction of MT 16 from approximately RP 18.6 to approximately RP 28.9. Centerline rumble strips will be installed throughout the reconstructed segment. An amendment to this project includes northbound and southbound passing lanes on MT 16 from approximately RP 20.0 to RP 22.0. The project began in April 2011 and completion is estimated in August 2012.

Sidney – Southwest is a major rehabilitation project from approximately RP 49.8 to RP 52.6 consisting of a mill, overlay, and seal and cover. This project included lane configuration modifications within Sidney from four lanes to three lanes and signal installation at the 7th Street / Central Ave. and Holly Street / Central Ave. intersections. An amendment to this project involved installing protected left-turn phases in the NB and SB directions at the Holly Street / Central Avenue intersection, in the NB direction at the 2nd Street N / Central Avenue intersection, and in the SB direction at the 14th Street / Central Avenue intersection. The project was let in February 2011.

Slide Repair – NE of Glendive / MT11-1 is a slide repair project from approximately RP 13.0 to approximately RP 13.5. The project began in July 2012 and includes removing the slide area extending to the roadway shoulder.

Fairview Intersection Improvements is an intersection improvement project extending from approximately RP 63.1 to approximately RP 63.8. The project includes installation of a traffic signal on MT 200 at 6th Street, construction of a pedestrian crossing on Western Avenue, installation of a high intensity rapid flashing beacon, and geometric improvements and installation of all-way STOP control at the MT 200 / Secondary 201 intersection to better accommodate truck turning movements. The project began in May 2012.

SF 119 – Glendive Rumble Strips is a safety project to install shoulder and centerline rumble strips on MT 16 from approximately RP 1.5 to approximately RP 49.9 and MT 200 from Sidney to Fairview. The project will also install shoulder rumble strips on several other roadways outside the study area limits. The anticipated project start date is fall 2012.

4.0 SUMMARY OF RECOMMENDED IMPROVEMENT OPTIONS

Figure 4-1 and Table 4.1 summarize recommended improvement options within the study corridor.

Improvements are categorized in Table 4.1 according to their recommended timeframe for implementation, as follows:

- Immediate: Implementation is currently ongoing or will be initiated in 2012
- Short-term: Implementation is recommended within a 1- to 3-year period
- Mid-term: Implementation is recommended within a 3- to 6-year period
- Long-term: Implementation is recommended within a 6- to 20-year period
- As Needed: Implementation should occur based on observed need throughout the 2035 planning horizon

Planning level cost estimates are listed in Table 4.1 in 2012 dollars for each improvement option. Cost estimates reflect anticipated construction costs only, and do not include potential costs associated with right-of-way acquisition, utility relocation, preliminary engineering, construction engineering / inspection, or operations and maintenance. Cost ranges are provided in some cases, indicating unknown factors at this planning level stage. Appendix 2 includes detailed cost estimates, including construction material assumptions.

Potentially impacted resources and anticipated permitting / right-of-way requirements are listed in Table 4.1 for each option. Project level analysis will be needed to identify specific resource locations and quantify resource impacts if improvements are forwarded from this study.

Corridor safety and operational concerns will be best addressed through combined implementation of education, enforcement, and engineering solutions. Improvement options may be implemented at the local level, through MDT maintenance programs, or the MDT project development process as funding allows. Improvement option implementation is dependent on available personnel resources, funding availability, right-of-way needs, and other project delivery elements.

Figure 4-1 Recommended Improvement Options

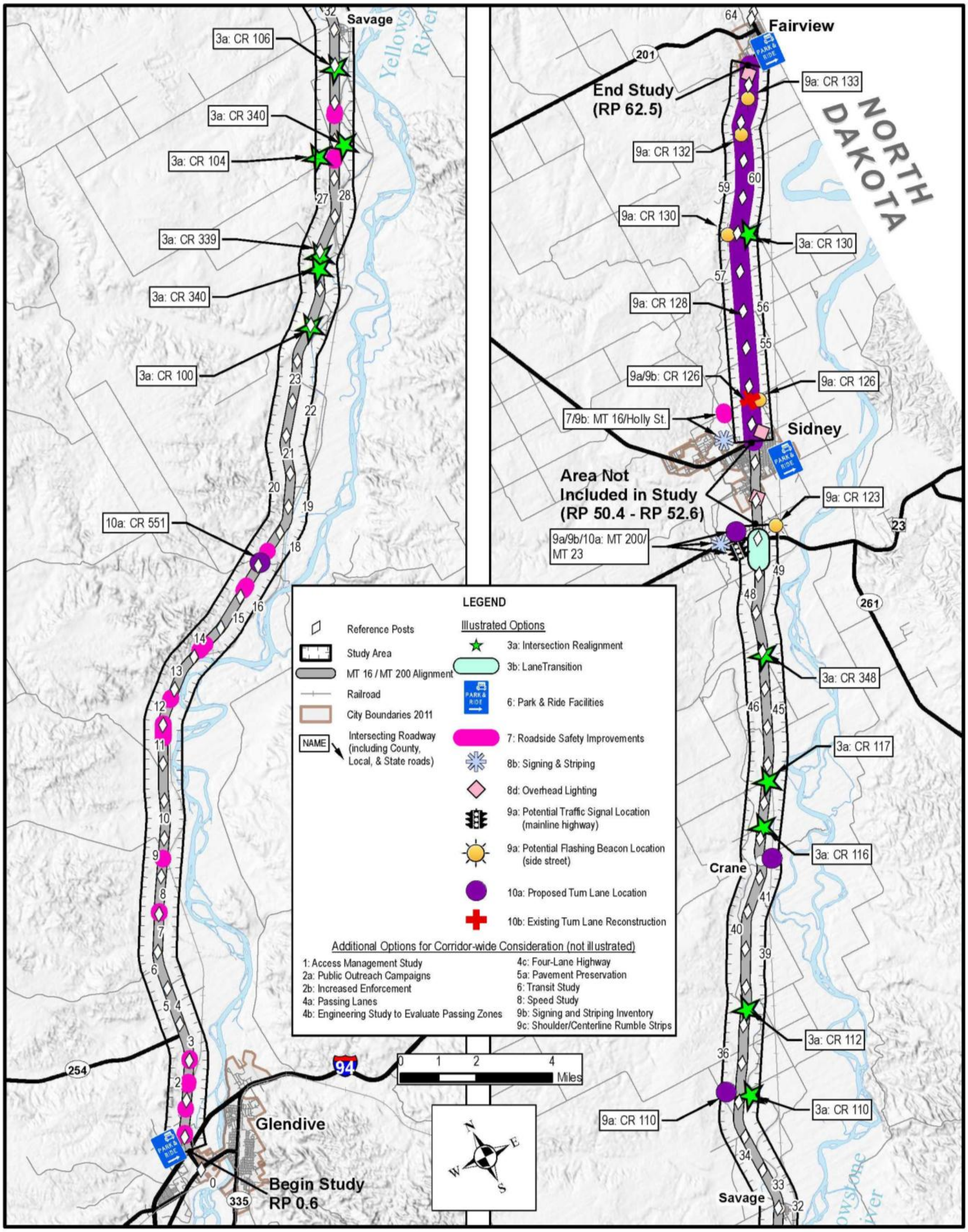


Table 4.1 Recommended Improvement Options

Option Category	Option ID	Option Description	Potential Locations (1)	Recommended in MDT Corridor Safety Audit (High Priority)	Proposed Follow-Up Responsibility	Planning Level Cost Estimate (2)	Recommended Implementation Timeframe (3)	Potentially Impacted Resources and Anticipated ROW / Permitting Requirements
Access Management	**Option 1**	Access Management Study	Corridor-wide	✓	MDT	$50,000 to $300,000	Short-term	No
Education and Enforcement	**Option 2.a**	Public Outreach Campaigns	Corridor-wide	✓	Dawson and Richland Counties; MDT; Cities of Glendive, Sidney, and Fairview; other local stakeholders	Various (4)	Short-term	No
	Option 2.b	Increased Enforcement	Corridor-wide	✓	MHP; Dawson and Richland Counties; Cities of Glendive, Sidney, and Fairview	$65,000 – patrol officer (5) $60,000 – patrol vehicle (5)	Short-term	No
Geometry	**Option 3.a**	Intersection Realignment	RP 24.0 (CR 100) RP 25.6 (CR 340) RP 25.9 (CR 339) RP 28.6 (CR 104) RP 28.9 (CR 340) RP 30.9 (CR 106) RP 35.2 (CR 110) RP 37.5 (CR 112) RP 42.3 (CR 116) RP 43.6 (CR 117) RP 46.9 (CR 348) RP 58.0 (CR 130)		Dawson and Richland Counties, in coordination with MDT	$39,000 to $310,000 per intersection	Short-term to long-term	Yes
	Option 3.b	Lane Transition	RP 50.0 (South of MT16 / MT 23 / MT 200 Intersection)	✓	MDT	$460 per lineal ft	Short-term to mid-term	Yes

Recommended Improvement Options			Potential Locations[1]	Recommended in MDT Corridor Safety Audit (High Priority)	Proposed Follow-Up Responsibility	Planning Level Cost Estimate[2]	Recommended Implementation Timeframe[3]	Potentially Impacted Resources and Anticipated ROW / Permitting Requirements
Option Category	**Option ID**	**Option Description**						
Passing Opportunities and Capacity Improvements	**Option 4.a**	Passing Lanes	Corridor-wide	✓	MDT	$1.8 to $2.0 million per mile (includes four-lane section with passing lane in both directions)	Immediate to long-term	Yes
	Option 4.b	Engineering Study to Evaluate Passing Zones	Corridor-wide		MDT	NA[6]	Short-term	No
	Option 4.c	Four-Lane Highway	Corridor-wide		MDT	$153 to $165 million (entire corridor) $2.6 to $2.8 million (per mile)	Long-term	Yes
Pavement Preservation	**Option 5.a**	Pavement Preservation	Corridor-wide		MDT	$59 to $64 million (entire corridor) $1 million (per mile)	As needed	No
Public Transportation	**Option 6**	Transit Study and Park & Ride Facilities	Corridor-wide	✓	Dawson and Richland Counties, MDT; Cities of Glendive, Sidney, and Fairview; Other local stakeholders	$30,000 (transit study) $290,000 (per park and ride facility)	Mid-term to long-term	Transit Study: No Park & Ride Facilities: Potentially Yes

Recommended Improvement Options			Potential Locations[1]	Recommended in MDT Corridor Safety Audit (High Priority)	Proposed Follow-Up Responsibility	Planning Level Cost Estimate[2]	Recommended Implementation Timeframe[3]	Potentially Impacted Resources and Anticipated ROW / Permitting Requirements
Option Category	**Option ID**	**Option Description**						
Roadside Safety	**Option 7**	Roadside Safety Improvements	RP 1.1 (East Side) RP 1.8 (West Side) RP 2.4 (East Side) RP 3.0 (East Side) RP 7.0 (East & West Sides) RP 8.5 (East & West Sides) RP 11.8 (East & West Sides) RP 12.7 (West Side) RP 14.2 (West Side) RP 14.4 (West Side) RP 16.3 (West Side) RP 17.4 (East Side) RP 28.5 (East Side) RP 29.7 (East & West Sides) RP 52.6 (West Side)	✓	MDT	$40,000 (overhead sign relocation) $30 per lineal ft (guardrail) $60 per lineal ft (slope flattening average; cost will vary depending on fill height)	Short-term to mid-term	Overhead sign relocation: No Guardrail: No Slope flattening: Yes
Speed	**Option 8**	Speed Study	Corridor-wide	✓	MDT	NA[7]	Short-term	No
Traffic Control Devices and Safety / Warning Features	**Option 9.a**	Traffic Signals	Full Signalization RP 50.0 (MT 16 / MT 23 / MT 200) Enhanced Intersection Warning RP 50.4 (MT 16 / MT 200 / CR 123) RP 53.7 (MT 200 / CR 126) RP 58.0 (MT 200 / CR 130) RP 60.7 (MT 200 / CR 132) RP 61.7 (MT 200 / CR 133)	✓	MDT	$500 (new sign) $30,000 per flashing beacon $300,000 per signal	As needed	No
	Option 9.b	Signing and Striping	Inventory: Corridor-wide RP 50.0 (MT16 / MT 23 / MT 200) RP 52.6 (MT 16 / MT 200 / Holly St.)	✓	MDT	Inventory: NA[7] $500 (new sign) $26 per ft^2 (replacement sign) $50 per station (striping)	Immediate to mid-term	No
	Option 9.c	Shoulder / Centerline Rumble Strips	Corridor-wide	✓	MDT	$2,100 per mile $700 per strip	Short-term	No
	Option 9.d	Overhead Lighting	North and south of Sidney and south of Fairview		MDT	$13,000 per fixture (average)	Short-term to mid-term	No

Recommended Improvement Options			Potential Locations[1]	Recommended in MDT Corridor Safety Audit (High Priority)	Proposed Follow-Up Responsibility	Planning Level Cost Estimate[2]	Recommended Implementation Timeframe[3]	Potentially Impacted Resources and Anticipated ROW / Permitting Requirements
Option Category	**Option ID**	**Option Description**						
Turn Lanes	**Option 10.a**	Proposed Left- and Right-Turn Lanes	Sidney to Fairview (RP 52.6 to 62.5) Crane (RP 41.4 to 41.9) RP 17.0 (MT 16 / CR 551) RP 35.3 (MT 16 / CR 110) RP 50.0 (MT 16 / MT 23 / MT 200) RP 53.7 (MT 16 / CR 126) RP 55.8 (MT 16 / CR 128)	✓	MDT	Warrants: NA[6] Turn Lanes: $160,000 to $250,000 per turn lane	Warrants: Short-term Turn lanes: Short-term to mid-term	Warrants: No Turn Lanes: Yes
	Option 10.b	Existing Turn Lane Reconstruction	RP 53.7 (CR 126)	✓	MDT	$130,000 to $140,000	Short-term to mid-term	Yes

(1) The term corridor-wide is used to indicate consideration throughout the study area, as appropriate. Specific locations may be identified at the project level.

(2) Planning level cost estimates are provided in 2012 dollars and are rounded for planning purposes. Cost estimates reflect construction costs only based on planning level estimates, and should not be considered an actual cost or encompassing all scenarios and circumstances. Cost estimate ranges are provided in some cases due to the high degree of unknown factors over the planning horizon, as well as the substantial amount of items not accounted for in this planning level cost estimate. Costs associated with right-of-way acquisition, utility relocation, preliminary engineering, construction engineering / inspection, and operations / maintenance are not included. Detailed cost estimates are provided in Appendix 2.

(3) The recommended implementation timeframe does not indicate when projects will be programmed or implemented. Project programming is based on available funding and other system priorities. Timeframes are defined as follows - Immediate: Implementation is currently ongoing or will be initiated in 2012; Short-term: Implementation is recommended within a 1- to 3-year period; Mid-term: Implementation is recommended within a 3- to 6-year period; Long-term: Implementation is recommended within a 6- to 20-year period; As needed: Implementation should occur based on observed need throughout the planning horizon.

(4) Public outreach campaigns would involve costs for personnel time, media advertising, curriculum materials, and other public outreach materials, which were not estimated.

(5) Source: Rich Rowe, Undersheriff for Dawson County (2012).

(6) Costs would be absorbed as part of current MDT program.

5.0 REFERENCES

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Appendix 1

Corridor Safety Audit Report

MT 16/MT 200 Corridor Safety Audit
Glendive to the North Dakota State Line
Glendive & Fairview Montana

February 1 & 2,2012

CHAPTER 4

CHAPTER 5

APPENDIX A

TABLES

FIGURES

ACRONYMS / ABBREVIATIONS

AADT	Average Annual Daily Traffic
CHSP	Comprehensive Highway Safety Plan
CSA	Corridor Safety Audit
MDT	Montana Department of Transportation
MPH	Miles per Hour
MHP	Montana Highway Patrol
MV	Motor Vehicle
OD	Opposite Direction
RP	Reference Post
SD	Same Direction
TWLTL	Two-Way Left-Turn Lane
VPH	Vehicles per Hour
NHTSA	National Highway Traffic Safety Administration

The Corridor Safety Audit program is part of the Highway Safety Improvement Program and is covered by Section 409, UC Code 23, which states:

"Notwithstanding any other provision of law, reports, surveys, schedules, lists, or data compiled or collected for any purpose directly relating to paragraph (1) or subsection (c) (1) (D), or published by the Secretary in accordance with paragraph (3), shall not be subject to discovery or admitted into evidence in a Federal or State court proceeding or considered for other purposes in any action for damages arising from any occurrence at a location identified or addressed in such reports, surveys, schedules, lists or other data."

EXECUTIVE SUMMARY

Photo 1: An audit workshop was held February 1st to 2nd, 2012.

PURPOSE / PROCESS

The MT 16/MT 200 Corridor Safety Audit (CSA) was conducted to assess the safe operation of the roadway and to improve safety for all road users. The study area for this CSA focused on approximately 64 miles of MT 16/MT 200 between Interstate 94 and the North Dakota Stateline.

The Glendive District Office requested the completion of the CSA on the MT 16/MT 200. This request was based on the occurrence of several recent crashes within the corridor that resulted in serious injuries and/or fatalities.

A CSA is a formal safety performance review of a corridor by a multi-disciplinary team. The CSA is conducted to evaluate the roadway characteristics as well as the behavioral characteristics of drivers within a corridor. The CSA process generates recommendations and countermeasures to address roadway segments or intersections which demonstrate a history of crashes, or address an identifiable pattern of crash types. Recommendations include short, mid and long-term improvements to address identified issues.

As part of the development of this CSA report, an audit workshop was held February 1st to 2nd, 2012. The purpose of the workshop was to gather input from local, state, and federal officials and to conduct an on-site field review of the corridor. A multi-disciplinary approach to transportation safety was used for the audit workshop. An audit team was assembled with representatives invited from the "Four E's" of transportation safety: Education, Enforcement, Engineering, and Emergency Medical Services. The audit team consisted of representatives from the following entities:

- Montana Department of Transportation
- City of Sidney
- City of Fairview
- Federal Highway Administration
- Local Media
- Montana Highway Patrol

Identified Safety Concerns

MDT personnel analyzed crash data for the 5-year period from July 1st, 2006 to June 30th, 2011. The crash data was analyzed for the study area from reference post 0.00 (MT 16 & Towne Street) to the North Dakota Stateline at reference post 64.181.

According to the MDT crash database, there were 624 crashes reported within the study area during this time period. Reportable crashes are defined as those with a fatality, an injury, or property damage only with at least $1,000 of damage. Trends and contributing factors for the crashes, along with characteristics of the drivers and vehicles involved, were analyzed from information provided in the crash reports.

Based on the crash data analysis and the audit workshop, including input from local officials and law enforcement, a number of crash trends and areas of concern were discussed within the study area including:

- Corridor and Area Wide Safety Concerns:
    - Commercial vehicle speed differential (which may contribute to large vehicle queues and aggressive passing maneuvers).
    - High occurrence of large vehicle involved crashes.
    - High occurrence of crashes with unbelted occupants.
    - High occurrence of crashes involving vehicles with out-of-state registration.
    - Crashes involving fatigued and/or impaired drivers.
    - Potential delays in emergency response times due to rail crossings.
    - Concern for how the existing transportation network will handle the projected growth in the area.
    - Need for increased law enforcement presence.

- Site Specific Safety Concerns:
    - Delineation on the southernmost curve in Fairview is not to current standards.
    - Increased driveway/intersection related crashes between Sidney and Fairview.
    - Moving sight distance concerns at the intersection of County Road 126.
    - Potential conflict with thru and right turning vehicles at the intersection Holly St/Central Ave Intersection in Sidney.
    - Potential left-turning conflicts and operational issues at the signalized intersections in Sidney.
    - Minimal guidance to drivers approaching the intersection of MT 16/MT 23/MT 200. Concern was also expressed regarding the speed limit through this area. The southbound lane drop was also mentioned as a concern.

Recommended Safety Enhancements

Corridor safety improvement recommendations were identified based on the MT 16/MT 200 corridor safety audit workshop and crash analysis. The recommendations are both behavioral and engineering focused and are intended to mitigate safety trends and concerns identified during the audit process.

A number of engineering based recommendations were made to address safety concerns throughout the corridor. What defines an engineering recommendation is quite broad and can consist of anything from engineering studies to reconstruction projects.

Three engineering studies are recommended to occur immediately: 1) a corridor wide speed zone study; 2) evaluation of left turn phasing and overall signal operations at the signalized intersections in Sidney; and 3) evaluation of passing zones throughout the corridor. The speed zone study recommendation is to assess the concern expressed regarding the differential in speed between the commercial vehicles and passenger vehicles resulting in large queues of vehicles. Speed limits cannot be modified without a detailed data collection and analysis effort through the speed zone study process. The evaluation of left-turn phasing at signalized intersections is to address concerns of insufficient gaps in the traffic stream, for left-turning vehicles. The passing zone evaluation is recommended to determine if additional passing opportunities at appropriate locations are justified given the volume of traffic and safety concerns identified.

In addition to the engineering studies, additional engineering recommendations include updated signs, evaluation a two-way left-turn lane (TWLTL) between Sidney and Fairview, continuous centerline rumble strips and other improvements. Some of the engineering recommendations will require considerable advanced planning, while others can likely be implemented through normal maintenance operations. In any case, those improvements that are recommended to occur immediately or in the short-term should be considered the highest priorities when selecting mitigation strategies for implementation.

Education and enforcement are behavioral tools that are also relevant when discussing ways to mitigate safety concerns. Behavioral recommendations can consist of enhanced traffic safety education targeting high risk groups or actions, or increased enforcement activities among other things. Although the majority of the recommendations in this report revolve around engineering or infrastructure improvements, there is an opportunity to enhance current educational efforts. These enhancements would primarily be targeted to younger drivers, safely operating around large vehicles, and reducing impaired, fatigued and aggressive driving.

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Chapter 1

INTRODUCTION

A CSA is a formal safety performance examination of a corridor by a multi-disciplinary team.

PURPOSE

The purpose of the MT16/MT 200 Corridor Safety Audit (CSA) was to utilize a nontraditional approach to address safety concerns through an intensive and collaborative forum. A CSA is a formal safety performance examination of a corridor by a multi-disciplinary team. CSA's can be used on any size corridor, from a rural environment to and urban environment and large volume roadways. The CSA is conducted to evaluate the corridor and generate recommendations and countermeasures for roadway segments or intersections which demonstrate a history of crashes or an identifiable pattern of crash types. Recommendations include short, mid and long-term improvements to address identified issues. Because the CSA process considers local needs and conditions, recommendations can be implemented incrementally as time and resources permit. Implementation and funding responsibility for recommendations identified in the CSA can fall to local governments, law enforcement agencies, MDT, and community organizations among others.

OBJECTIVES

The main objective of the MT 16/MT 200 Corridor Safety Audit CSA is to assess the safe operation of the roadway and to improve safety for all road users. This objective must be balanced with maintaining thru-traffic mobility and providing a reasonable amount of access to adjacent land. Some of the major benefits of the CSA include:

- Proactive measure and is not solely dependent on crash data;
- Identifies both behavioral and engineering safety improvements for all agencies and jurisdictions to pursue;
- Considers the safety of all users;
- Adaptable to local needs and conditions; and
- Recommendations can be implemented as time and resources permit.

Audit Team

The audit team was assembled based on input from MDT and the City of Sidney and the City of Fairview. Invitations were distributed to identified team members to participate in the audit workshop. Personal contact was made via telephone to each of the invited team members after the invitations were distributed. The audit team composition is shown in **Table 1.** A copy of the sign in sheet from the Audit meeting is included in Appendix A.

The following individuals were invited to participate in the in the audit workshop but were unable to attend.

- Danielle Murphy (State Highway Traffic Safety Office)
- Eric Belford (MDT Motor Carrier Services), an alternate from MCS was in attendance
- Frank DiFonzo (Sidney Chief of Police)
- Russ Huotari (Richland County Public Works Director)
- Susan Quandt (Fairview Chief of Police)
- Joe Sharbano (Dawson County Road Supervisor)

Name	Organization	Title
Shane Mintz	Montana Department of Transportation (Glendive)	District Administrator
Jim Frank	Montana Department of Transportation (Glendive)	District Preconstruction Engineer
Keith Bithell	Montana Department of Transportation (Glendive)	District Traffic Engineer
Kraig McLeod	Montana Department of Transportation (Helena)	Safety Engineer
Carol Strizich	Montana Department of Transportation (Helena)	Transportation Planner
Jonathan Floyd	Montana Department of Transportation (Helena)	Civil Engineering Specialist
Stan Brelin	Montana Department of Transportation (Helena)	Traffic Engineer
Tom Roberts	Montana Department of Transportation (Miles City)	Maintenance Chief
Kent Shepherd	Montana Department of Transportation (Glendive)	Glendive Maintenance
Kevin Gower	Montana Department of Transportation (Wolf Point)	Maintenance Chief
Butch Sansaver	Montana Department of Transportation (Wolf Point)	Wolf Point Maintenance
Marcee Allen	Federal Highway Administration	Safety Engineer
Bret Smelser	City of Sidney	Mayor
Jeff Heinz	City of Sidney	Public Works
Debra Gilbert	City Council	Council Member
Bryan Cummins	City of Fairview	Mayor
Glenn Quinnell	Montana Highway Patrol	Sergeant
Nyle Obergfell	Montana Highway Patrol	Trooper
Linda Switzer	Montana Department of Transportation (MCS)	Motor Carrier Services Enforcement Officer
Scott Pfahler	DOWL HKM (Helena)	Consultant
David Stoner	DOWL HKM (Helena)	Consultant
Louisa Barber	Sidney Herald Newspaper	Reporter
Carol Lambert	Transportation Commission	Commissioner

Table 1: Audit Team Members

PROCESS

Montana's *Comprehensive Highway Safety Plan* (CHSP) identifies rural high crash severity corridors based on severity rate and number of fatalities and incapacitating injuries per mile. A strategy to improve the safety of these corridors is to conduct a formal and independent performance review by a multi-disciplinary team. Crash trends are analyzed and improvement recommendations are identified based on the review.

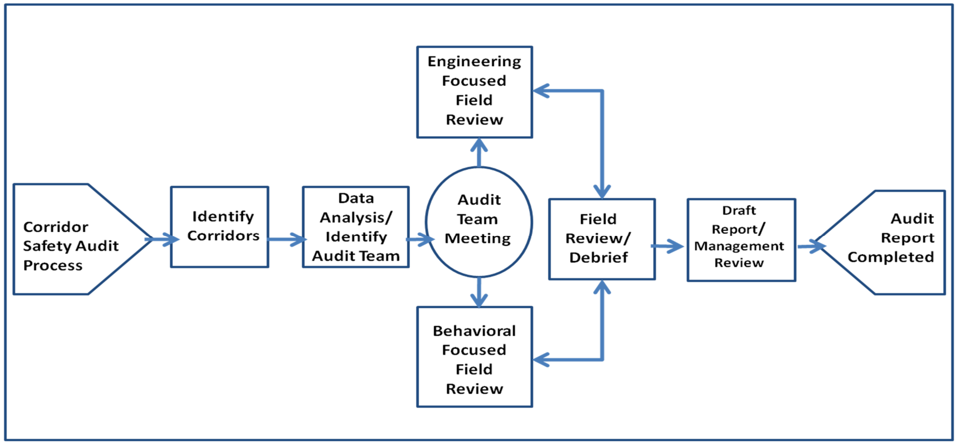

Figure 1: Corridor Safety Audit Process

The MT 16/MT 200 corridor is not currently listed as a high crash severity corridor in the CHSP. The CSA was completed based on a December 2011 request from the MDT Glendive District. The District's request was based on the occurrence of several recent crashes within the corridor that resulted in serious injuries and/or fatalities.

The CSA process involves coordination with local officials, emergency services personnel, and law enforcement to conduct an "audit workshop". For the MT 16/MT 200 CSA, the audit workshop spanned two days in February, 2012 (Wednesday, February 1st and Thursday, February 2nd). Prior to the audit workshop, staff from MDT's Traffic and Safety Section, State Highway Traffic Safety Bureau and Statewide and Urban Planning conducted a comprehensive review and analysis of 5 years of crash data for the MT 16/MT 200 corridor to identify crash trends specific to the corridor.

The following events were held as part of the audit workshop:

- **Office Review:** On February 1st, the audit team met at 9:00 AM at the Sidney City Hall located at 115 2nd Street SE. Between 9:00 and 12:00 PM, MDT presented a summary of the data analysis and reviewed corridor characteristics with the audit team. This included an evaluation of both behavioral and engineering trends that were relevant to the corridor. After the presentation, the team had an open discussion about concerns and experiences in the corridor.

- **Field review:** A portion of the audit team participated in a field visit of the corridor between 1:00 and 4:30 PM on February 1st. During that time, the audit team travelled the full length of the corridor in each direction. Additionally, during the office review it was determined that the four primary points for on-site review were from reference post 0 to 4, reference post 12 to 28, reference post 49 to 51 and reference post 53 to 63. The team also reviewed the corridor between 5:00 and 7:30 PM to observe dark, nighttime conditions during the peak evening travel hours. The nighttime review occurred the evening of January 31, 2012.

- **Audit Debrief:** On February 2nd, the audit team reconvened at the Glendive District office between 8:00 and 11:00 AM to debrief from the previous day. A discussion was held on the findings of the field review, and the perceived problems and potential strategies for improvements.

Chapter 2

CORRIDOR CHARACTERISTICS

CORRIDOR DESCRIPTION

The MT 16/MT 200 corridor is functionally classified as a principle arterial from Glendive to North of Sidney and as a minor arterial from just north of Sidney to the North Dakota Stateline. MT 16 is designated as National Highway System Route 20 (N-20) from Glendive to Sidney. MT 16 transitions into MT 200 from Sidney to North Dakota Stateline and is designated as State Primary Route 20 (P-20). The study area for this CSA focused on approximately 64 miles of MT 16/MT 200 between Interstate 94 and the North Dakota Stateline. The study area is shown in **Figure 2**.

The MT 16/MT 200 corridor consists primarily of two 12 foot travel lanes in each direction and 8 foot shoulders for a majority of the corridor. The roadway is generally rural in nature, however through the communities of Sidney and Fairview, the roadway is more typical of an urban/suburban environment. The speed limit along the MT 16/MT 200 corridor is posted at 70 mph for cars and 65 mph for trucks for the majority of the corridor, except through the City of Savage, City of Sidney and the City of Fairview. The speed limit through Savage is posted at 55 mph. The speed limit as you approach the cities of Fairview and Sidney gradually step down from 70 mph to 25 mph and gradually increasing as you leave the urban areas.

Table 2: Background AADT on MT 16/MT 200

	AADT	
Year	Total	Commercial
2007	4,441	415
2008	4,745	415
2009	4,368	430
2010	2,953*	430
2011	6,828#	1,004

***2010 AADT values were incomplete as not all segments were counted**

 # Preliminary for 2011

ROADWAY USERS AND TRAFFIC VOLUMES

MT 16/MT 200 serves as a vital corridor link and acts as a gateway to the Bakken Oil Fields in North Dakota. Primary users of the roadway consist of local residents, commuters from Montana and northwestern North Dakota for the Bakken Oil Industry, and seasonal sugar beet/agricultural traffic. The average annual daily traffic (AADT) for the study area ranges from approximately 4,400 vehicles per day (vpd) in 2007 to approximately 6,800 vpd in 2011 for all vehicles. Similarly, the average annual daily traffic for commercial motor vehicles ranges from 400 vehicles per day (vpd) to 1,000 vehicles per day (vpd). **Table 2** shows the most recent five years of AADT data for the corridor.

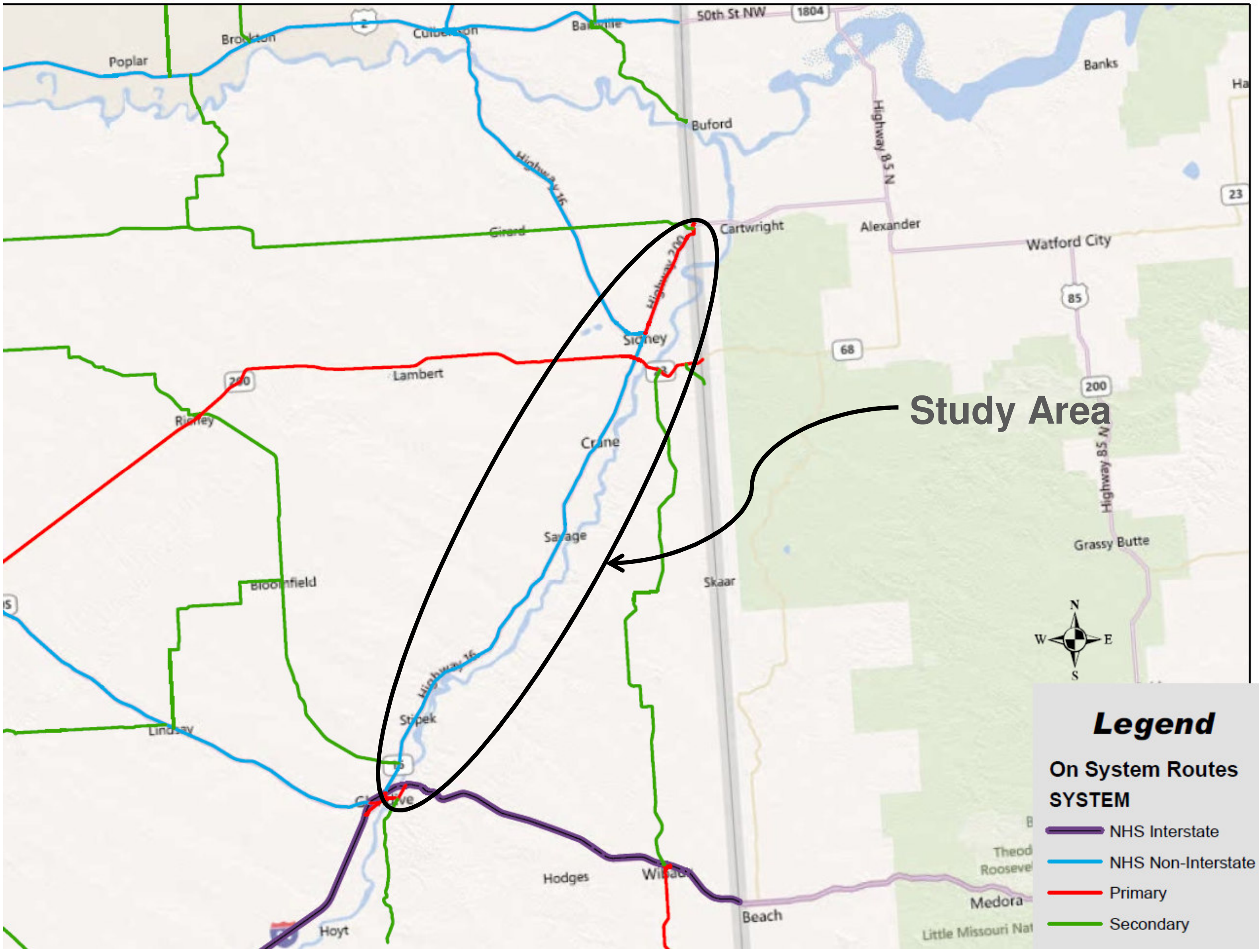

Figure 2: Study Area Map

Chapter 3

Problem Identification

Crash Data Analysis

MDT personnel analyzed crash data for the five-year period from July 1st, 2006 to June 30th, 2011. The crash data was analyzed for the entire study area as shown previously in **Figure 2**.

According to the MDT crash database, there were 624 crashes reported within the study area during this time period. Reportable crashes are defined as those with a fatality, an injury, or property damage only with at least $1,000 of damage. Based on the information provided in the crash reports, trends and contributing factors for the crashes, along with characteristics of the drivers and vehicles involved, are presented in the following sections. A location map of the reported crashes is shown in **Figure 3**.

The crash reports are a summation of information provided by responding officers. Note that some of the information contained in the reports may be subjective and/or incomplete. The information and analysis provided in this section is a summary of the data as contained in the crash reports.

Crash data was analyzed for:

1) The entire corridor from Glendive (RP 0.0) to the North Dakota Stateline (RP 64.181)
2) Urban and rural crashes
   a. The rural portions of the corridor from Glendive (RP 0) to Sidney (RP 51.325) and from Sidney (RP 52.627) to Fairview (RP62.540).
   b. The urban portions of the corridor through the town of Sidney (RP 51.326 to RP 52.626) and town of Fairview (RP 62.541to RP63.894). Please note neither Sidney or Fairview are classified as urban areas (having a population greater than 5,000); however, this report refers to the areas within Sidney and Fairview as the "urban" limits.

It should be noted that several projects or behavioral efforts were completed along the corridor during the crash data analysis period. These recently completed or ongoing projects will likely have a positive impact on several of the safety concerns identified during the audit. A summary of the recent projects is provided at the end of this chapter.

CRASH LOCATION MAP

GLENDIVE TO THE NORTH DAKOTA STATELINE

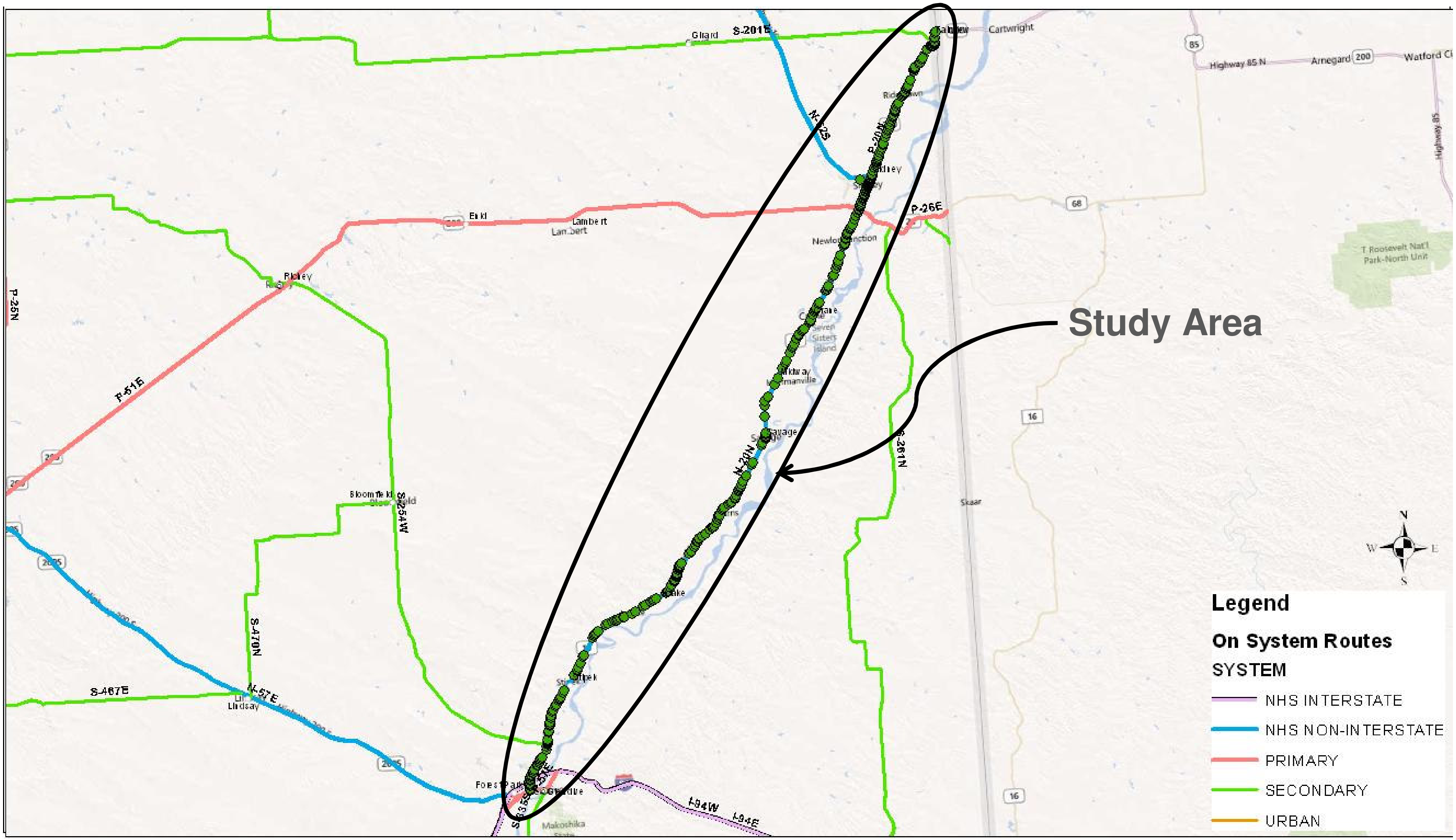

Figure 3: Crash Locations Map

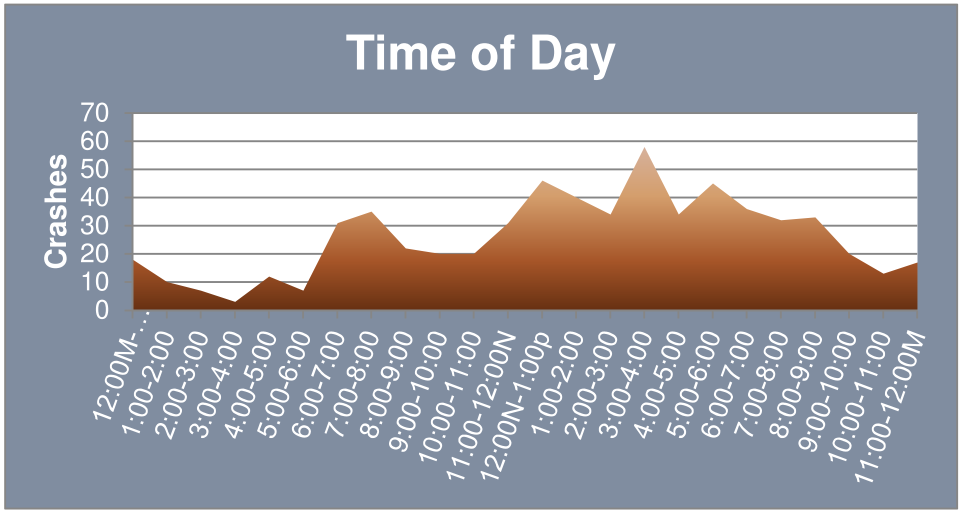

Figure 4: Crash Statistics for Time of Day

CRASH PERIOD

Crash data for the corridor was evaluated based on the period of time when the crash occurred. With regards to time of day, spikes in the number of crashes occur during the peak hours. Thirty-five crashes were reported between 7:00 AM and 8:00 AM. During the noon peak hour, (11:00 AM to 1:00 PM) 77 crashes occurred. Between 3:00 PM and 7:00 PM, 173 of the 624 reported crashes, almost 28%, were reported.

The majority of crashes occurred during weekdays which, when combined, account for over 75% of the corridor total. The most common day was Friday, with 132 reported crashes. The fewest number of crashes occurred on Saturday's when 69 crashes were reported.

The most common months for crashes were October, November, December and January which had 62, 68, 83 and 81 reported crashes, respectively. The first snowstorms often occur in the month of October, which can lead to an increase in weather related crashes. Traffic volumes commonly increase during the month of December due to holiday related activity, especially in areas with retail businesses. March and August had the fewest crashes, with 31 and 34 reported crashes, respectively.

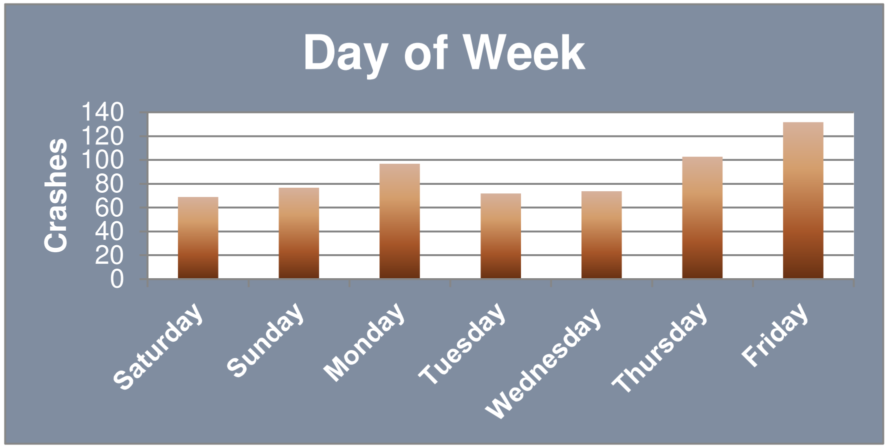

Figure 5: Crash Statistics for Day of the Week

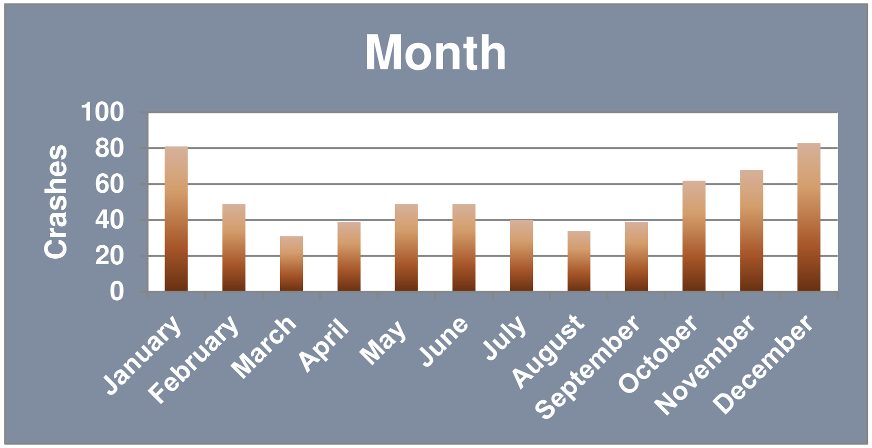

Figure 6: Crash Statistics for Month

Environmental Factors

Crash data was reviewed to see if any trends exist related to environmental factors such as weather, roadway surfacing, and light conditions. Of the 624 crashes in the study period, 53 crashes occurred under snow or blowing snow conditions with another 22 crashes occurring during rain. When combined, approximately 14.2% of crashes occurred during inclement weather conditions. Weather conditions do not appear to be a major contributor to vehicle crashes.

Approximately 64% (400) of crashes occurred while road surfacing was dry, 52 crashes occurred on wet road surfacing, 63 with snow or slush present, and 100 on icy surfacing. Based on the crash data analysis, road surfacing condition does not appear to be a major contributing factor to crashes along the corridor.

Almost 61% (380) of crashes occurred during the daylight, 55 crashes were reported as under dark-lighted conditions, while 158 were under dark not lit conditions.

Table 3: Crash Statistics for Environmental Factors

Weather Condition	Number of crashes	% Total	% Total-Statewide
FOG, SMOG, SMOKE	2	0.3%	1.0%
SLEET, HAIL, FREEZING RAIN, DRIZZLE	12	1.9%	1.2%
BLOWING SNOW	22	3.5%	2.9%
CROSSWINDS	7	1.1%	1.0%
CLEAR	397	63.6%	49.0%
CLOUDY	129	20.7%	32.3%
RAIN	22	3.5%	3.8%
SNOW	31	5.0%	8.7%
UNKNOWN	2	0.3%	0.2%

Roadway Surface	Number of crashes	% Total	% Total-Statewide
DRY	400	64.1%	62.3%
WET	52	8.3%	9.0%
SNOW OR SLUSH	63	10.1%	10.7%
ICE	100	16.1%	14.5%
SAND, MUD, DIRT, OIL	1	0.2%	0.5%
DEBRIS	0	0.0%	0.0%
LOOSE GRAVEL	6	0.1%	2.3%
OTHER	0	0.0%	0.1%
NOT STATED	2	0.3%	0.5%

Light Condition	Number of crashes	% Total	% Total-Statewide
DAYLIGHT	380	60.9%	65.4%
DARK NOT LIT	158	25.3%	20.6%
DARK-LIGHTED	55	8.8%	9.3%
DAWN	14	2.2%	1.7%
DUSK	16	2.6%	2.3%
UNKNOWN	1	0.2%	0.8%

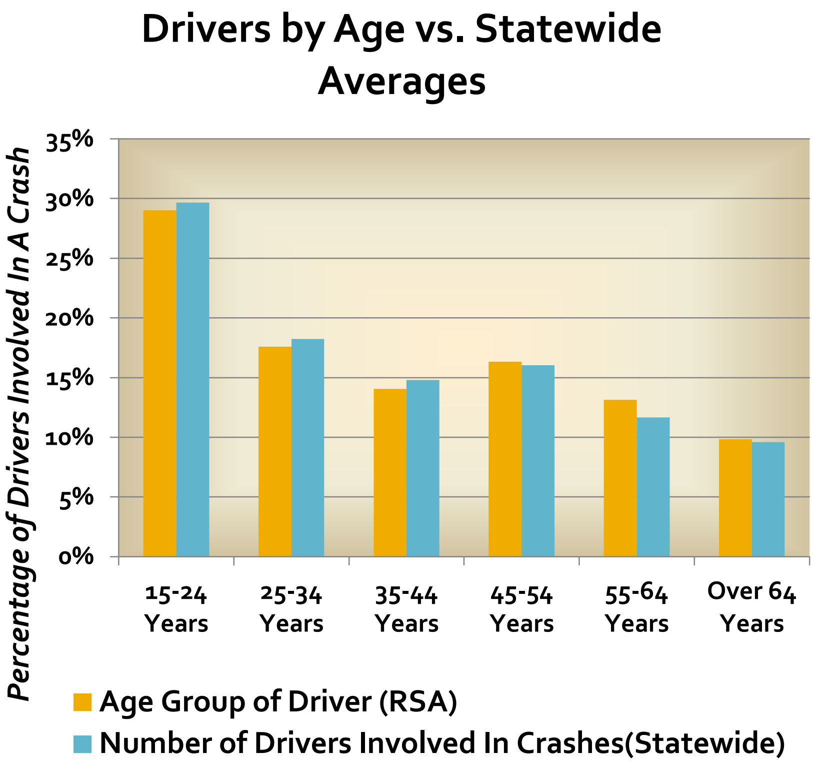

Figure 7: Crash Statistics for Driver Age

Driver Details

When a driver's age is known, the drivers with the highest percent involvement in crashes are 15-24 years old, followed by the 25-34 year old age group. Drivers between the ages of 15 and 24 account for almost 30% of crashes within the study area. Younger drivers are commonly involved in a high percentage of crashes throughout Montana due to their lack of experience behind the wheel. As shown in **Figure 7** the age group of drivers involved in crashes within the CSA is very similar to statewide data; however, young driver and older driver crashes are an emphasis area within the current Comprehensive Highway Safety Plan and were considered during the Audit workshop.

Contributing Circumstances

An analysis of contributing circumstances in crashes shows an identifiable trend of crashes resulting from driver error. Over 49% of contributing circumstances were related to driver error. Careless driving, inattentive driving, failing to yield and too fast for conditions were the three highest contributing circumstances, respectively. Alcohol / drugs were contributing circumstances in 2.8% of crashes.

Contributing Circumstance	Number of crashes	% Total
INATTENTIVE DRIVING	144	16.51%
CARELESS DRIVING	67	7.68%
FAILED TO YIELD	44	5.05%
TOO FAST FOR CONDITIONS	39	4.47%
FOLLOWED TOO CLOSELY	25	2.87%
ALCOHOL / DRUGS	24	2.75%
IMPROPER MANEUVER	23	2.63%

Table 4: Crash Statistics for Most Frequent Contributing Circumstances

Crash Type and Severity

Crash type and severity are important elements to evaluate when looking at corridor safety. Trends in crash type and severity can help identify safety issues and concerns within the corridor. To aid in the analysis, the corridor was broken into areas that exhibited either rural or urban characteristics.

Corridor Wide

The most common collision type along the corridor is wild animal crashes, accounting for 21% of all crashes. Wild animal crashes are generally dispersed throughout the corridor with a slight concentration between RP 0 to RP 6. Rear end crashes are the second most common at almost 17% of crashes throughout the corridor, particularly at the major intersections in Sidney and Fairview. Right angle crashes are the third most common at almost 12% of crashes. Over 51% of crashes involved two or more vehicles. The majority of single vehicle crashes occurred within the rural portions of the corridor.

Almost 78% (487 crashes), resulted in no injuries being reported. Three fatal injury crashes occurred during the analysis period. Nineteen crashes resulted in incapacitating injuries, defined as an injury, other than a fatality, which prevents the injured person from walking, driving or normally continuing the activities they were capable of performing before the injury. Only 60% of drivers involved in injury crashes had proper belt usage, which is similar to statewide belt usage.

Collision Type	Number of crashes	% Total
WILD ANIMAL	131	21.0%
REAR END	105	16.8%
FIXED OBJECT	95	15.2%
RIGHT ANGLE	74	11.9%
SIDESWIPE SD	71	11.4%
OVERTURN	49	7.9%
LEFT TURN OD	21	3.4%
PARKED MV	18	2.9%
SIDESWIPE OD	15	2.4%
HEAD ON	9	1.4%
PEDESTRIAN	6	1.0%
LEFT TURN SD	4	0.6%
RIGHT TURN SD	3	0.5%
RIGHT TURN OD	0	0.0%

Table 5: Corridor Wide Crash Statistics for Collision Type

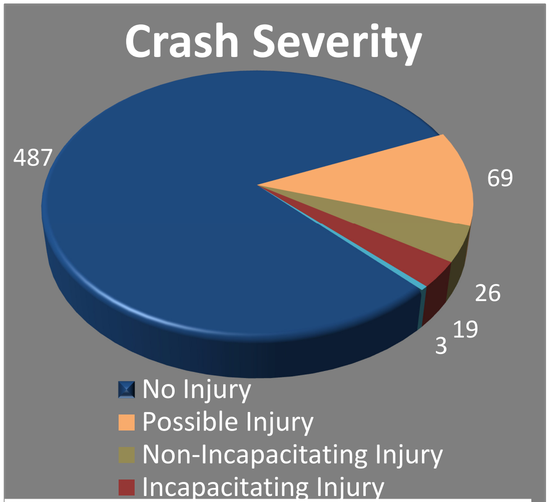

Figure 9: Corridor Wide Crash Statistics for Severity

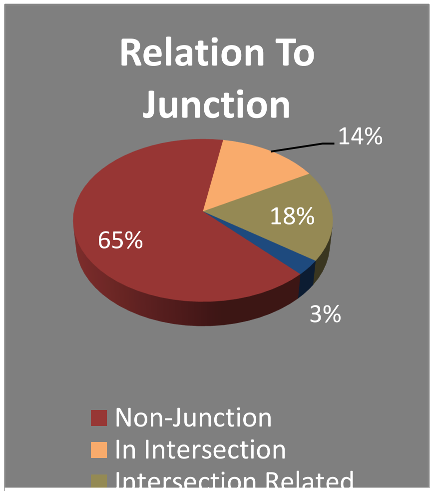

Figure 8: Corridor Wide Crash Statistics for Relation to Junction

RURAL PORTIONS

Over 56% of the total crashes (353 out of 624) occurred in the rural portions of the corridor. Single vehicle running off the road (SVROR) crashes accounted for over 35% of all crashes within the rural portions of the corridor.

The most common collision type for the rural portions of the corridor is a collision with a wild animal, accounting for 37% of all rural crashes. Fixed object crashes are the third most common, accounting for 21% of all rural crashes. A fixed object crash can include collision with a ditch, embankment, sign post, guardrail face and/or guardrail end, etc. Roll over crashes are the fourth most common at 13% of rural crashes, especially from reference point 12 to reference point 28. Rear end crashes are the fifth most common at almost 7% of rural crashes, most of which occurred at county road and private driveway approaches.

Over 75% (265 crashes) resulted in no injuries being reported; however, all three of the fatal crashes occurred within the rural portions of the corridor as well as 63% of the injury crashes.

A discussion of relevant projects in the area which may address some of these crash trends is included at the end of this chapter.

Crash or Collision Type	Number of crashes	% Total (Rural)
WILD ANIMAL	130	36.8%
SINGLE VECHILE RUN OFF ROAD	125	35.4%
FIXED OBJECT	75	21.2%
ROLL OVER	47	13.3%
REAR END	23	6.5%
RIGHT ANGLE	20	5.7%
SIDESWIPE SD	18	5.1%
SIDESWIPE OD	9	2.5%
NOT FIXED OBJECT OR DEBRIS	9	2.5%
HEAD-ON	6	1.7%
LOST CONTROL	4	1.1%
DOMESTIC ANIMAL	3	0.8%
LEFT TURN OD	2	0.6%
JACKKNIFE	2	0.6%
PARKED VEHICLE	2	0.6%
LEFT TURN SD	1	0.3%
PEDESTRIAN	1	0.3%
RIGHT TURN SD	0	0.0%

Table 6: Rural Crash Statistics for Collision Type

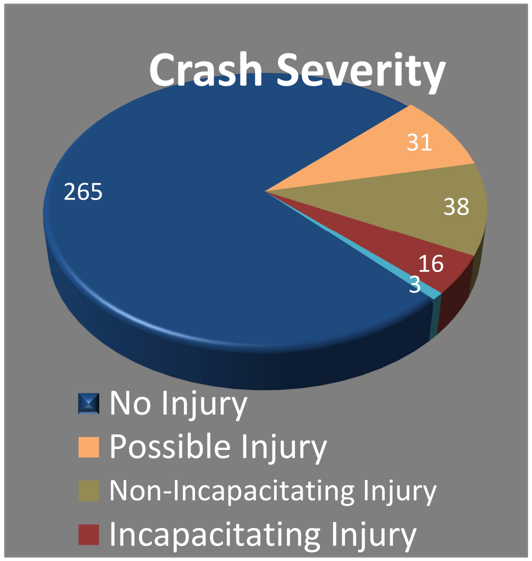

Figure 11: Rural Crash Statistics for Severity

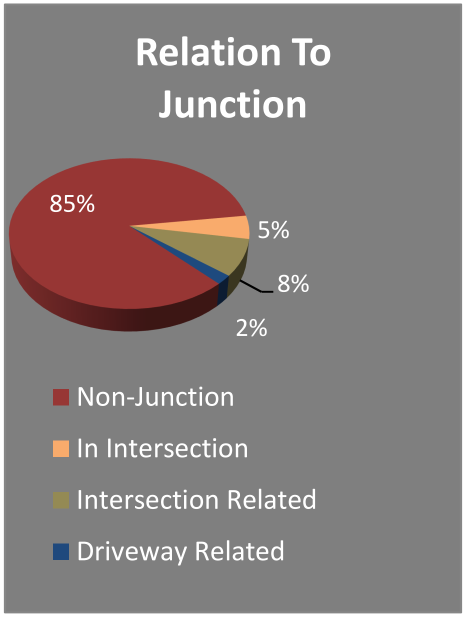

Figure 10: Rural Crash Statistics for Relation to Junction

Urban Portions

Approximately 44% of the total crashes (271 out of 624) occurred in the urban portions of the corridor. The most common collision type for the urban portions of the corridor is a rear end collision, accounting for 29% of all urban crashes. Right angle crashes are the second most common at 20% of urban crashes. Sideswipe same direction crashes are the third most common at almost 20% of urban crashes. All three of these crash types are representative of an urban/suburban area.

Over 81% (222 crashes) resulted in no injuries being reported. There were no fatal crashes within the urban portions and 37% of the injury crashes occurred in the urban areas.

A discussion of relevant projects in the area which may address some of these crash trends is included at the end of this chapter.

Collision Type	Number of crashes	% Total (Urban)
REAR END	79	29.2%
RIGHT ANGLE	55	20.3%
SIDESWIPE SD	53	19.6%
FIXED OBJECT	26	9.6%
LEFT TURN OD	19	7.0%
PARKED VEHICLE	16	5.9%
SIDESWIPE OD	6	2.2%
PEDESTRIAN	5	1.8%
ROLL OVER	4	1.5%
LEFT TURN SD	3	1.1%
NOT FIXED OBJECT OR DEBRIS	3	1.1%
HEAD-ON	3	1.1%
RIGHT TURN SD	1	0.4%
JACKKNIFE	1	0.4%
WILD ANIMAL	1	0.4%
LOST CONTROL	0	0.0%
DOMESTIC ANIMAL	0	0.0%

Table 7: Urban Crash Statistics for Collision Type

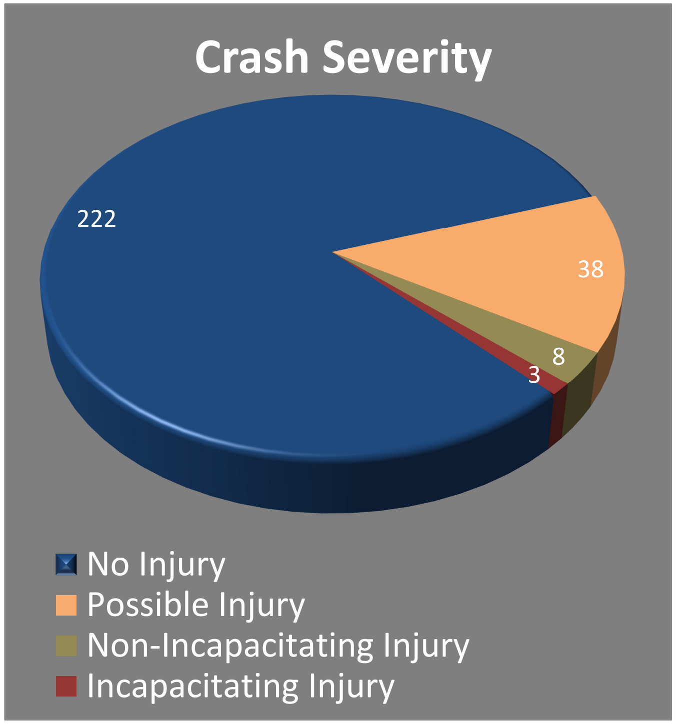

Figure 13: Urban Crash Statistics for Severity

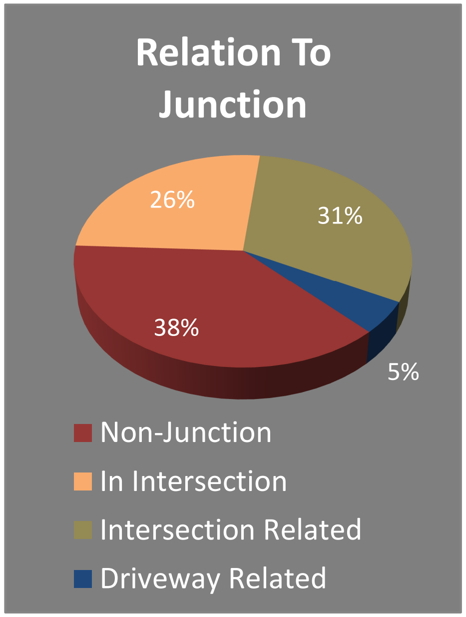

Figure 12: Urban Crash Statistics for Relation to Junction

Crash Trends

A number of crash trends and specific areas of interest were identified within the study area. The following sections detail the crash characteristics for both the rural and urban portions of the corridor. A discussion of relevant projects in the area which may address some of these crash trends is included at the end of this chapter.

Rural Portion

There were four main areas of interest along the rural portion of the corridor; Reference post 0 to reference post 4, reference post 12 to reference post 28, reference post 49 to reference post 51.3 and reference post 53 to reference post 63, respectively. These areas are highlighted in gold in **Figure 14** below. The crash trends identified at each segment are summarized in more detail below.

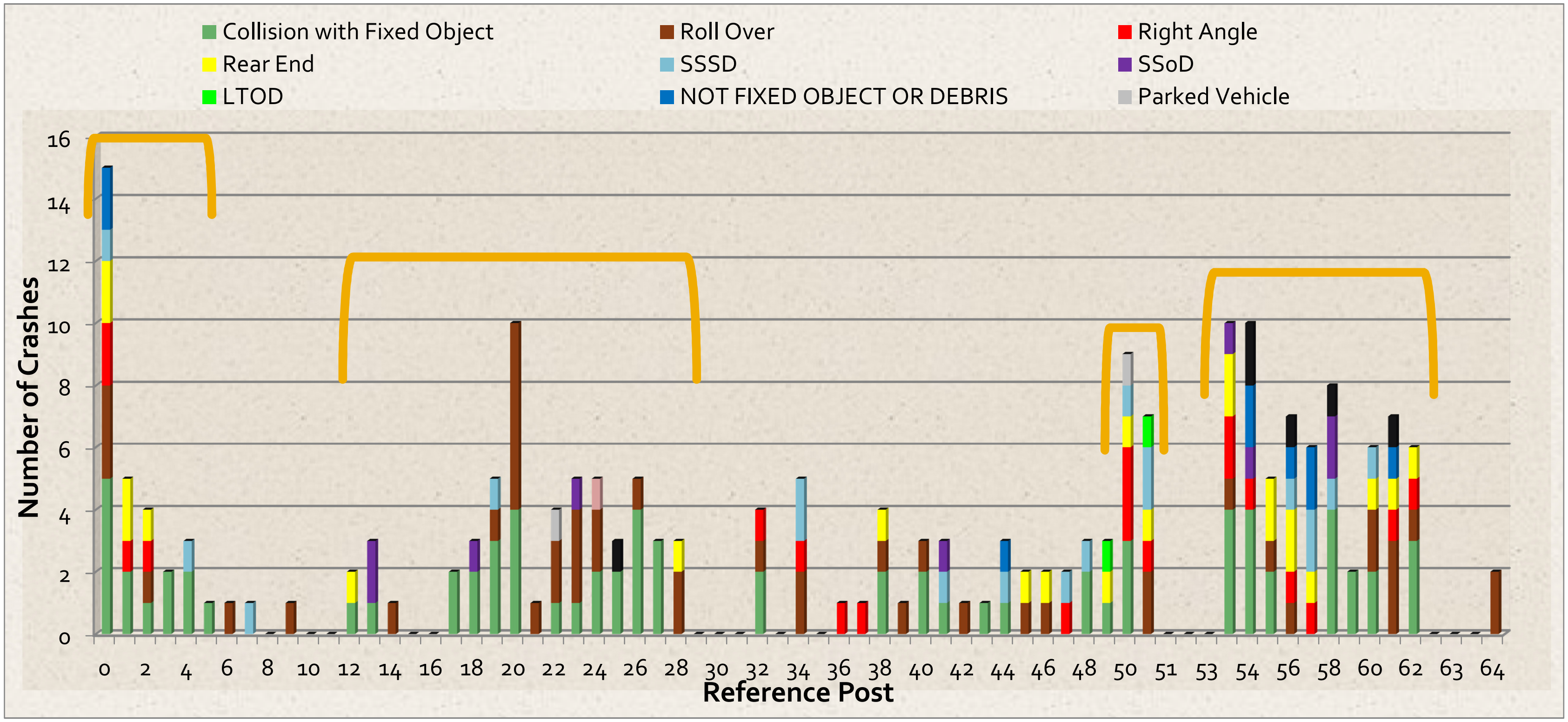

Figure 14: Areas of Interest Along Corridor

Reference Post 0 To Reference Post 4

The main collision types for this segment are fixed object and wild animal. There were a total of 58 crashes resulting in 7 injury crashes (1 incapacitating injury, 2 non-incapacitating injury and 4 possible injury) and 51 property damage only.

Reference Post 12 To Reference Post 28

The main collision types for this segment are fixed object, wild animal and roll over. There were a total of 87 crashes resulting in a fatal crash, 24 injury crashes (6 incapacitating injury, 10 non-incapacitating injury and 8 possible injury) and 62 property damage only.

Reference Post 49 To Reference Post 51.3

The main collision types for this segment are right angle, sideswipe and wild animal. There were a total of 27 crashes resulting in a fatal crash, 6 injury crashes (1 incapacitating injury, 3 non-incapacitating injury and 2 possible injury) and 21 property damage only.

Reference Post 53 To Reference Post 63

The main collision types for this segment are fixed object, rear end, right angle, roll over and head on. There were a total of 73 crashes resulting in a fatal crash, 30 injury crashes (5 incapacitating injury, 16 non-incapacitating injury and 9 possible injury) and 42 property damage only.

Urban Portion - Sidney

Generally, most of the crashes occurring within the Sidney portion of the corridor were intersection or intersection related. There are multiple intersections along the corridor, as a result, only those with a fatal or incapacitating injury crash are summarized in the section below. Other sections of the urban areas were reviewed by the Audit Team; however, crash data is only presented in this report for the intersections which experienced severe crashes.

Central Avenue / 14th street SW/SE Intersection

The intersection of Central Avenue and 14th Street SW/ SE is currently a signalized intersection with two lanes in each direction along Central Avenue and one lane in each direction along 14th Street SW/SE.

At this location, a total of 22 crashes occurred during the five year analysis period. As the table below demonstrates the main collision type is right angle and rear end collisions. No major trends were identified related to crash type at this intersection.

Central & 14TH ST SW/SE					
Collision Type		**Severity**			
Right Angle	5	Incapacitating Injury Crash	1		
Left Turn Right Angle	4	Non-Incapacitating Injury Crash	1		
Opposing Left Turn	1	Possible Injury Crash	4		
Rear End	8	Property Damage Only Crashes	16		
Sideswipe Same direction	2				
Jackknife	1				
Fixed Object	1				
Road Condition		**Weather Condition**		**Light Condition**	
Dry	12	Clear	12	Daylight	19
Wet	2	Cloudy	8	Dark-Lighted	3
Snow or Slush	2	Blowing Sand, Soil, Dirt, Snow	2		
Ice	5				
Sand, Mud, Dirt or Oil	1				

Table 8: Central & 14th ST SW /SE Intersection Summary

Central avenue & 7th Street SW/SE Intersection

The Central Avenue and 7th Street SW/SE intersection is a two-way STOP controlled intersection for 7th Street SW/SE. Central Avenue has two lanes in each direction and 7th Street SW/ SE has one travel lane in each direction at this location. A total of 18 crashes occurred at this location during the study period. The most common type of crash was left turn right angle collisions which accounted for 6 of the reported crashes. There were 4 reported right angle crashes and 3 rear end crashes. The majority of crashes resulted in property damage only. One pedestrian crash occurred at this intersection.

In general, this intersection experiences similar crash types as the entire corridor. No major trends were identified related to crash type at this intersection. The Sidney-Southwest project which has been recently constructed changed the lane configuration from a 4-lane to a 3-lane and installed a traffic signal at this intersection. It is anticipated that these improvements will address some of the crashes at this intersection.

Central & 7TH ST SW/SE					
Collision Type		**Severity**		**Pedestrian Related**	
Right Angle	4	Incapacitating Injury Crash	1	Rear End	1
Left Turn Right Angle	6	Possible Injury Crash	1		
Rear End	3	Property Damage Only Crashes	16		
Sideswipe Same direction	1				
Loss of Control	1				
Fixed Object	3				
Road Condition		**Weather Condition**		**Light Condition**	
Dry	10	Clear	12	Daylight	14
Wet	1	Cloudy	4	Dark-Lighted	3
Snow or Slush	1	Blowing Sand, Soil, Dirt, Snow	1	Dusk	1
Ice	6	Snow	1		

Table 9: Central & 7th ST SW/SE Intersection Summary

Central avenue & 2nd street SW/SE Intersection

The intersection of Central Avenue and 2nd Street SW/SE is currently a signalized intersection. Central Avenue has two travel lanes in each direction and one travel lane in each direction along 2nd Street SW/SE. This cluster of crashes was identified between RP 52.280 and RP 52.332.

Twenty-two crashes were reported at this location during the analysis period. Of the 22 crashes, 9 were rear end and 8 were right angle collision types. The majority of the crashes at this intersection also resulted in property damage only. No major trends were identified related to crash type at this location. As previously mentioned the Sidney-Southwest project changed the lane configuration from a 4-lane to a 3-lane configuration and the crashes at the intersection are prior to the project being completed.

Central & 2ND ST SW/SE					
Collision Type		**Severity**		**Pedestrian Related**	
Right Angle	4	Incapacitating Injury Crash	1	Left Turn-Pedestrian	1
Left Turn Right Angle	4	Possible Injury Crash	3		
Rear End	9	Property Damage Only Crashes	18		
Sideswipe Same direction	1				
Parked Vehicles	3				
Road Condition		**Weather Condition**		**Light Condition**	
Dry	5	Clear	14	Daylight	15
Wet	8	Cloudy	4	Dark-Lighted	5
Ice	8	Rain	2	Dusk	2
Unknown	1	Snow	2		

Table 10: Central & 2nd ST SW/SE Intersection Summary

MT 16/MT 23 & MT 200 INTERSECTION

Crashes that occurred between RP 49.00 and RP 50.999 were considered part of the MT 16/MT 23 and MT 200 intersection cluster. Eight crashes were reported at this location. Two crashes were rear ends, three were left turn right angle crash types.

There was a right angle crash that resulted in one fatality and one non-incapacitating injury. A breakdown of the crash experience is listed below. No major trends were identified related to crash type at this location.

Sidney - MT 16/MT 23/MT 200					
Collision Type		**Severity**			
Right Angle	1	Fatal Crash	1		
Left Turn Right Angle	3	Non-Incapacitating Injury Crash	1		
Rear End	2	Property Damage Only Crashes	6		
Loss of Control	1				
Fixed Object	1				
Road Condition		**Weather Condition**		**Light Condition**	
Dry	6	Clear	5	Daylight	6
Ice	2	Cloudy	1	Dark-Lighted	1
		Snow	1	Dark-Not Lighted	1
		Fog, Smog, Smoke	1		

Table 11: MT 16/MT23/MT200 Intersection Summary

URBAN PORTION - FAIRVIEW

Through the Town of Fairview the majority (16) of the crashes were midblock crashes. Of these crashes, 3 crashes at the 90-degree turn immediately south of Town, 6 crashes involved a collision with a parked motor vehicle, and 2 vehicles struck a light pole.

Also, there were a total of seven crashes occurring at intersections, three of which occurred at the intersection of MT 200 and S-201/ 1st Street. Under project STPP 20-2(28)63, UPN 7832, Fairview Intersection Improvements, a traffic signal will be installed at the intersection of MT 200 (Ellery Avenue) and 6th Street, modify curb radii at the intersection of MT 200 (Ellery Avenue) and S-201 (1st street) to accommodate trucks in addition to adding ALL WAY STOP control with an overhead flasher, relocation of existing school crosswalk at the intersection of MT 200 (9th Street) and Pleasant Avenue to the east at the intersection of MT 200 (9th Street) and Western Avenue. A High Intensity Rapid Flashing Beacon will also be installed at the crossing. Additionally, new ADA ramps will be installed at all three intersections. The anticipated letting for this project is May 2012.

Audit Workshop

An audit workshop was held February 2nd and 3rd, 2012 for the MT 16/MT 200 corridor. The purpose of the audit was to gather input from local, state, and federal officials and to conduct an on-site field review of the corridor. Input from officials with familiarity and experience in the corridor provides detailed knowledge of local conditions and issues related to corridor safety that may or may not be apparent in the crash data. The on-site field review provided an opportunity to look at physical issues along the corridor.

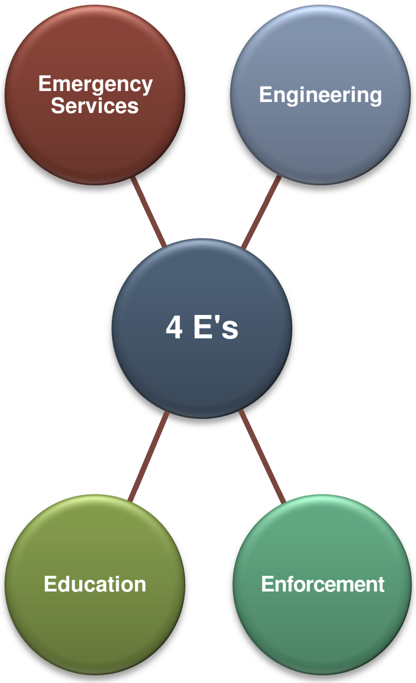

Figure 15: 4 E's of Transportation Safety

Process

A multi-disciplinary approach to transportation safety was used for the audit workshop. An audit team was assembled with representatives from the "Four E's" of transportation safety: Education, Enforcement, Engineering, and Emergency Services. The audit team consisted of representatives from the following agencies / departments:

- Montana Department of Transportation
  - Planning
  - Traffic and Safety
  - Glendive District Personnel
  - Motor Carrier Services
- City of Sidney & Fairview
  - Public Works
  - Council Members
  - Mayors
- Montana Highway Patrol
- Federal Highway Administration

An office meeting was held from 9:00 AM to 12:00 PM on February 1st, 2012. The meeting discussed corridor crash data and solicited input from the audit team. An on-site field audit was conducted with the team following the meeting. An additional nighttime field review was completed by a portion of the Audit Team on the evening of January 31, 2012. A debriefing meeting was held the following day (February 2nd) at 8:00 AM at the Glendive District Office. Results and observations from the field audit were discussed during the debriefing meeting with audit team members and the Glendive District Transportation Commissioner.

Observations/Discussion Summary

This section provides a brief summary of the observations and discussions of the Audit Team. Several comments and observations were made regarding the overall transportation system in the area. Although outside the limits and scope of this road safety audit they are documented in this report for future consideration.

General Comments:

- **Rail Crossing Hinder Emergency Response Time:** Concern was expressed regarding trains blocking the at grade rail crossings in Sidney and Fairview for significant portions of time hindering local access and emergency response times. No at grade crossings exist within the limits of this CSA.
- **Overall Concern With Projected Growth In The Area & Impacts To Current Transportation Network:** Concern over the impacts oil development is having on the overall transportation system. Some of the issues discussed were an increase in traffic volumes, percentage of commercial motor vehicle crashes, etc.
- **Truck Routes:** The development of an alternate truck route in Sidney to minimize the commercial motor vehicle traffic on MT 16/ MT 200. The Sidney Corridor Study includes a conceptual route.

Corridor wide:

- **Commercial Vehicle Speed Differential:** Concern was expressed regarding the difference in traveling speeds of commercial motor vehicles and all other road users.
- **Increased Enforcement:** Law enforcement officials acknowledged that there is a need for increased patrols along the MT 16/MT 200 corridor. Lack of resources (budget and personnel) was expressed as a hindrance. The law enforcement officials did mention they have conducted concentrated enforcement patrols along MT 16/ MT 200 in the recent years.
- **Head-On and Single Vehicle Run Off the Road Crashes (SVROR):** Head on crashes and SVROR crashes were discussed. Fatigue, aggressive driving and impaired driving are all contributors to this crash issue. The group supported the installation of continuous centerline rumble strips along the entire length of the MT 16/ MT 200 corridor to address head-on and single vehicle off the road crashes.
- **Land Use:** Current land use along the corridor is mostly farming and agricultural use. It was suggested that the vehicle mix is heavily influenced by sugar beet season as well as the oil development in North Dakota.

Rural Portions:

- **Speeds:** Speeds were expressed as a concern throughout the corridor primarily focused around commercial vehicle/passenger car speed differential and aggressive driving, etc.
- **Passing Lanes:** Given the increase in volume concern was expressed regarding perceived lack of passing opportunities along the corridor.
- **Intersection Crashes:** Numerous intersections and approaches exist in the rural portions of the corridor. It was suggested improvements be evaluated in the area between Sidney and Fairview to minimize these conflicts. Additional measures (limited access control, turn bays, etc.) were also discussed for evaluation at appropriate locations as discussed in the following sections.

Urban portions:

- **Intersection of Holly Street & Central Avenue:** The southbound right turn lane drop was noted by the Team for trapping southbound vehicles going thru the intersection.
- **Town of Sidney and Fairview:** Travel speeds of vehicles entering the communities were discussed. Most notably, the intersection of MT 16/MT 200/ MT 23, south of Sidney, provides minimal guidance to drivers approaching the intersection. Concern was raised that actual speeds may exceed the posted speed limits especially as passenger cars attempt to pass commercial vehicles using the 4-lane section thru the community of Fairview.

Identifiable Trends / Areas of Concern

A number of crash trends and areas of concern were identified within the study area. These crash trends and areas of concern were a result of the review of vehicle crash data, the corridor audit, field review, and discussions with local officials. In addition to these specific locations, several corridor wide behavioral issues and concerns were identified including impaired driving, aggressive or fatigued driving and lack of seatbelt use. The following crash trends and areas of concern were identified:

- Reference Post 0 to Reference Post 4
  - Wild Animal Crashes
  - Fixed Object Crashes
- Reference Post 12 to Reference Post 28
  - Wild Animal Crashes
  - Fixed Object Crashes
  - Roll Over Crashes
- Reference Post 49 to Reference Post 51.3
  - Right angle Crashes
  - Sideswipe Crashes
  - Wild Animal Crashes
- Reference Post 53 to Reference Post 63
  - Fixed object Crashes
  - Right Angle Crashes
  - Rear End Crashes
  - Roll Over Crashes
  - Head-On Crashes
- Sidney Area (Reference Post 51.326 to Reference Post 52.626)
  - Right Angle Crashes
  - Rear End Crashes
  - Sideswipe Crashes
- Fairview Area (Reference Post 62.541 to Reference Post 63.894)
  - Midblock Crashes
  - Intersection Crashes

RELEVANT PROJECTS IN THE AREA

Several projects are ongoing, planned or have been recently completed within the study period. These projects may mitigate, at least in part, several of the issues identified by the Audit Team and discussed in Chapter 3. Additionally, several of the recommendations developed by the Audit Team are being considered for inclusion in the projects:

- Reconstruction project began in April 2011, from reference point 18.6 to reference point 28.9. *This project will likely mitigate many of the crash trends observed in this area. The addition of passing lanes will be included within certain sections of this project. Centerline rumble strip will be installed with this project.*
- Major rehabilitation project consisting of a mill, overlay and seal & cover let in February 2011, from reference post 49.99 to reference post 52.566. This project also changed the lane configuration in Sidney from a 4-Lane to a 3-lane and signalized two additional intersections 7th Street & Central Avenue and Holly Street & Central Avenue.
- Fairview intersection improvements project consists of installing a traffic signal, High Intensity Rapid Flashing Beacon, Geometric improvements along with all-way STOP control for the intersection of MT 200 and S-201. *This project will likely mitigate many of the crash trends observed in this area.*
- Proposed safety project to install shoulder and centerline rumble strips from reference post 1.45 to reference post 49.88. *This project was being developed prior to the initiation of the Safety Audit; however, as a result of the Audit the project scope will be expanded to include centerline rumble strips, at appropriate locations, throughout the length of the corridor.*
- Intersection signing for the intersection of MT 200 and CR 129, reference point 56.9, was installed by MDT maintenance forces in 2012. The intersection signing was implemented to address an identified crash trend at the intersection.
- Corridor wide MHP roving patrol, DUI task force and MCS special activities in the area. These activities have been and could be further implemented to address some of the behavioral issues along the corridor.
- MDT will be installing protected left turn phases in the NB and SB directions at Holly & Central, in the NB direction at 2nd N & Central and in the SB direction at 14th & Central. The signing for the southbound right turn only lane at the intersection of Holy & Central will also be improved.

Chapter 4

RECOMMENDATIONS

IMPROVEMENT STRATEGIES

Corridor safety improvement recommendations were identified based on the MT 16/MT 200 corridor safety review and crash analysis. The recommendations are intended to mitigate safety concerns identified along the study corridor. Both behavioral and engineering recommendations were made to help address the identified trends and areas of concern.

A suggested implementation timeframe was developed for each recommendation. Immediate, short-term (1 – 3 years), mid-term (3 – 6 years), and long term (> 6 years) implementation timeframes were considered. Given fiscal constraints, recommendations may have to be developed individually or in small groups. Depending on the funding source, a “Benefit-to-Cost Analysis” may be required before implementation to ensure that the benefits of the recommendation outweigh the project cost.

Discussions were held during the audit workshop which related to the context of the corridor and its relation to overall travel patterns within the region. Some members of the audit team expressed a desire for major changes to the roadway such as the addition of an alternate truck route and/or constructing a bypass around Sidney. Although collectively these measures may be a strategy to mitigate some safety issues, they are outside the scope of planning for this CSA, which specifically strives to tie mitigation strategies to definable crash trends based on crash data analysis.

BEHAVIORAL RECOMMENDATIONS

Educational and enforcement tools are relevant when discussing ways to mitigate safety concerns. Although the majority of the recommendations in this report revolve around engineering or infrastructure improvements, there is an opportunity to enhance educational efforts. These enhancements would primarily be targeted to younger drivers, safely operating around large vehicles, and reducing impaired, fatigued and aggressive driving. **Table 12** provides a list of behavioral recommendations for the corridor.

Educational opportunities targeted at younger drivers could be delivered through school based health programs and/or new driver education programs. The targeted messaging to younger drivers should be geared towards distracted driving, seat belts, speeding, and making informed decisions on the pitfalls of impaired driving. Numerous resources are available to assist instructors in this regard. One resource for gathering informational materials to assist in the educational outreach to younger drivers can be found on MDT’s website at the following location:

- http://www.mdt.mt.gov/safety/safety-initiatives/young.shtml

Relative to impaired driving education, informational material can be found by contacting the local DUI Task Force Coordinators:

Mary Friesz

433-2207; mfriesz@richland.org

1201 W Holly St

Sidney, MT 59270

or

Rich Rowe

377-5291; richrowe@midrivers.com

440 Colorado Blvd

Glendive, MT 59330

Or by visiting following web link:

- http://www.mdt.mt.gov/safety/safety-initiatives/drugs-alcohol.shtml

Table 12: Behavioral Recommendations

ID	Recommendation	Description	Proposed Follow-Up Responsibility	Implementation Timeframe
1	Increase impaired driving education	Expanding public outreach and educational efforts to target impaired drivers is desirable and can consist of public service announcements, billboards targeting high risk groups, print advertising, promoting designated driving programs, and expanding free ride home and taxi services. Both Dawson and Richland Counties have local DUI Task Force Coordinators who can support this effort. The MDT Plan 2 Live Website provides several resources. http://plan2live.mt.gov/	MDT, City of Sidney, City of Fairview, DUI Task Force Coordinators and other stakeholders	Short-term
2	Young Driver education	School based education and incentive programs could be enhanced via existing driver's education and/or school based health curriculum to address these safety areas with younger drivers. Additional instruction to new, young drivers pertaining to various transportation safety topics such as impaired driving, texting/cell phone use, seat belt use, etc. could be beneficial to help curb the observed trends of younger driver collisions. Several national resources are available at: http://www.distraction.gov/ and	City of Sidney, City of Fairview	Short-term

		http://www.nsc.org/SAFETY_ROAD/DISTRACTED_DRIVING/Pages/Public_Education.aspx		
3	Public Outreach/Education Campaigns	Media messaging and enhanced educational efforts will help address the transportation safety, specifically targeting areas identified as concerns in this corridor such as inattentive driving, distracted driving, fatigued driving, seatbelt use, aggressive driving and operating safely around large vehicles. Several public outreach tools are available, including the Respect The Cage Campaign and the MDT Plan 2 Live Website. Local public service announcements and billboards could also be pursued.	City of Sidney, City of Fairview, law enforcement, MDT, and Local stakeholders	Short-term
4	Increased Enforcement	Law enforcement officials acknowledged that there is a need for increased patrols along the MT 16/MT 200 corridor; however, budget and manpower issues limit the amount of time spent on the corridor. The Law enforcement officials did mention they have conducted concentrated enforcement patrols along MT 16/ MT 200 in the recent years.	MHP, City of Sidney, City of Fairview.	Short-term
5	Provide Public Transportation	To alleviate some of the traffic congestion investigate the feasibility of constructing a park and ride facility at both ends of the corridor.	MDT, City of Sidney, City of Fairview and Local Stakeholders	Long-term

Engineering Recommendations

A number of engineering based recommendations were made to address safety concerns throughout the corridor. What defines an engineering recommendation is quite broad and can consist of anything from engineering studies to reconstruction projects. **Table 13** provides a list of the engineering recommendations developed for the corridor.

Some of the engineering recommendations will require considerable advance planning, while others can likely be implemented through normal maintenance operations. In any case, those recommendations that are identified to occur immediately or in the short-term should be considered the highest priorities when selecting mitigation strategies for implementation.

Table 13: Engineering Recommendations

ID	Recommendation	Description	Proposed Follow-Up Responsibility	Implementation Timeframe
CORRIDOR WIDE				
6	Continuous Centerline Rumble Strips	The placement of continuous centerline rumble strips for the rural portions of the corridor may mitigate some of the head on and SVROR crashes. The centerline rumble strip design would be similar to North Dakota.	MDT	Short-term
7	Passing Lanes	Evaluate the addition of passing lanes to facilitate more passing opportunities along the corridor. MDT is in the process of determining if passing lanes are warranted. Funding for appropriate projects will also need to be identified.	MDT Traffic Bureau & Glendive District	Mid-term & Long-term
8	Develop Access Management Plan	Several "full movement" driveways to private residences are located from Sidney to Crane. These add conflict points, contribute to crash frequency, and present conflicts for pedestrians and bicyclists. Developing an access management plan may be desirable to identify and eliminate duplicative driveways, and to regulate the size and operations of the driveway.	MDT Glendive District	Mid-Term
RURAL SEGMENTS				
9	Speed Study	Perform a speed study throughout the rural portions of the corridor. If a speed study is conducted, it may provide justification for making modification to the existing statutory speed limit and eliminating the speed differential between the commercial and passenger vehicles.	MDT Traffic Bureau	Short-term

ID	Recommendation	Description	Proposed Follow-Up Responsibility	Implementation Timeframe
10	Two-Way Left-Turn Lane	Investigate the feasibility and need of installing a Two-Way-Left-Turn Lane (TWLTL) at appropriate locations from Sidney to Fairview Montana. The center TWLTL could potentially help reduce the number of intersection related collisions within this area. This may entail going to a 5-lane section in these sections or the TWLTL could be used for passing under the current conditions.	MDT Traffic Bureau & Glendive District	Long-Term
11	Intersection of MT 200 and CR 126 (RP 53.7)	Reconstruct northbound right turn lane at the intersection to provide moving sight distance at the intersection. Evaluate the need for a NB left-turn lane.	Glendive District	Mid-term
12	Intersection of MT 16 and CR 110 (RP 35.2)	Evaluate the need for a northbound right-turn lane at the intersection.	MDT Traffic Bureau & Glendive District	Mid-term
13	Guardrail Warrants	Evaluate the fill slopes on the east side of the roadway at reference point 28.5 and reference point 29.7 to determine if guardrail is warranted.	MDT Road Design	Mid-term
URBAN SEGMENTS				
14	Intersection of MT 16/ MT 200 /MT 23	Evaluate the need for additional signing and/or other improvements at the intersection, specifically for southbound traffic. Including this intersection in the overall speed study is also recommended.	MDT Traffic Bureau & Glendive District	Short-term
15	Intersection of Holly Street & Central Avenue	The audit team noted the SB right turn lane drop may create a lane trap. Additional signing and/or pavement markings may be needed to provide sufficient warning to drivers.	MDT Traffic Bureau & Glendive District	Mid-term
16	Sidney Intersections	MDT is currently investigating the need for a protected left-turn phase at key intersections through Sidney.	MDT Traffic Bureau	Short-term
17	Town of Fairview	Installation of dynamic message signs at the north and south end of Fairview, Montana to provide feedback to drivers as they enter Fairview.	MDT Glendive District and Town of Fairview.	Short-term
18	Town of Fairview	The installation of larger and adequately spaced chevrons throughout the curve south of town	MDT Glendive District and Town of Fairview	Short-term

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Chapter 5

Conclusion

Implementation and Next Steps

This CSA was developed to generate potential improvement recommendations and counter measures for the segments or intersections of MT 16/MT 200 corridor between Glendive and the North Dakota Stateline that demonstrate a history of, or potential for, motor vehicle crashes. The safety recommendations identified during the audit and documented in this report are aimed at improving the safety of the study area. Many of the strategies identified can be implemented through routine maintenance, while others will require more substantial project development. The full impact of the improvement strategies will be realized when they are combined. Time and budget constraints will ultimately dictate the implementation schedule.

Engineering strategies alone will not eliminate the traffic safety issues identified along the study corridor. Education, with support from a targeted enforcement campaign, is an effective approach for addressing the driver behaviors that lead to crashes.

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Appendix A

- Sign-in sheets
- Audit Presentation

Corridor Safety Audit; Glendive to North Dakota State Line
February 1, 2012

Name	Organization	Phone Number
Kraig McLeod	MDT - Traffic & Safety Bureau	444-6256
JONATHAN FLOYD	MDT - TRAFFIC & SAETY BUREAU	444-0094
MARCEE ALLEN	FHWA	441-3909
Shane Mintz	MDT - Glendive	345-8212
KEITH BITHELL	MDT - GLENDIVE	345-8215
Tom Roberts	MDT - Miles City	233-3622
KENT SHEPHERD	MDT - MAINTENANCE	345-8253
JIM FRANK	MDT - GLENDIVE	345-8214
Scott Pfahler	DOWL HKM - Helena	442-0370
David Stoner	DOWL HKM - Helena	
BRYAN CUMMINS	MAYOR TOWN OF FAIRVIEW	406-480-3682 406-742-5227
LOUISA BARBER	Sidney Herald	433-2403
Nyle Obergfell	MHP	406-939-4015
GLENN QUINNETT	MHP	406-939-3996
Debra Gilbert	City Council	406-433-3721-(W)
Kevin Gower	MDT - Wolf Point	406-653-6709
Butch SANSAVER	MDT - Wolf Point	406-653-6712
BRET SMELSER	MAYOR of SIDNEY	406-433-2809
Stan Brelin	MDT Traffic - Helena	406-444-6135

Carol Strizich — MDT - Planning

Linda ? — MCS

Jeff Heinz — Sidney Public Works

Corridor Safety Audit; Glendive to North Dakota State Line
February 2, 2012

Name	Organization	Phone Number
JONATHAN M. FLOYD	MDT - TRAFFIC & SAFETY BUREAU	444-0094
MARCEE ALLEN	FHWA	441-3909
Stan Brelin	MDT. Traffic	444-6135
Carol Strizich	MDT- Planning	444-9240
Kraig McLeod	MDT- Traffic & Safety Bureau	444-6256
KEITH BITHELL	MDT TRAFFIC GLENDIVE	345-8215
Kevin Gower	MDT. WolF Point Maint	653-6709
Butch SANSAVER	MDT. WolfPoint Maint	406-653-6712
Tom Roberts	MDT- MilesCity maint	406-233-3622
KENT SHEPHERD	MDT - MAINT	406-345-8253
Shane Mintz	MDT- Glendive	345-8212
CAROL LAMBERT	DIST 4 Commissioner	436-2001

MT 16/MT 200 – Glendive to the ND State Line

Corridor Safety Audit (CSA)
February 1 & 2, 2012

Agenda:

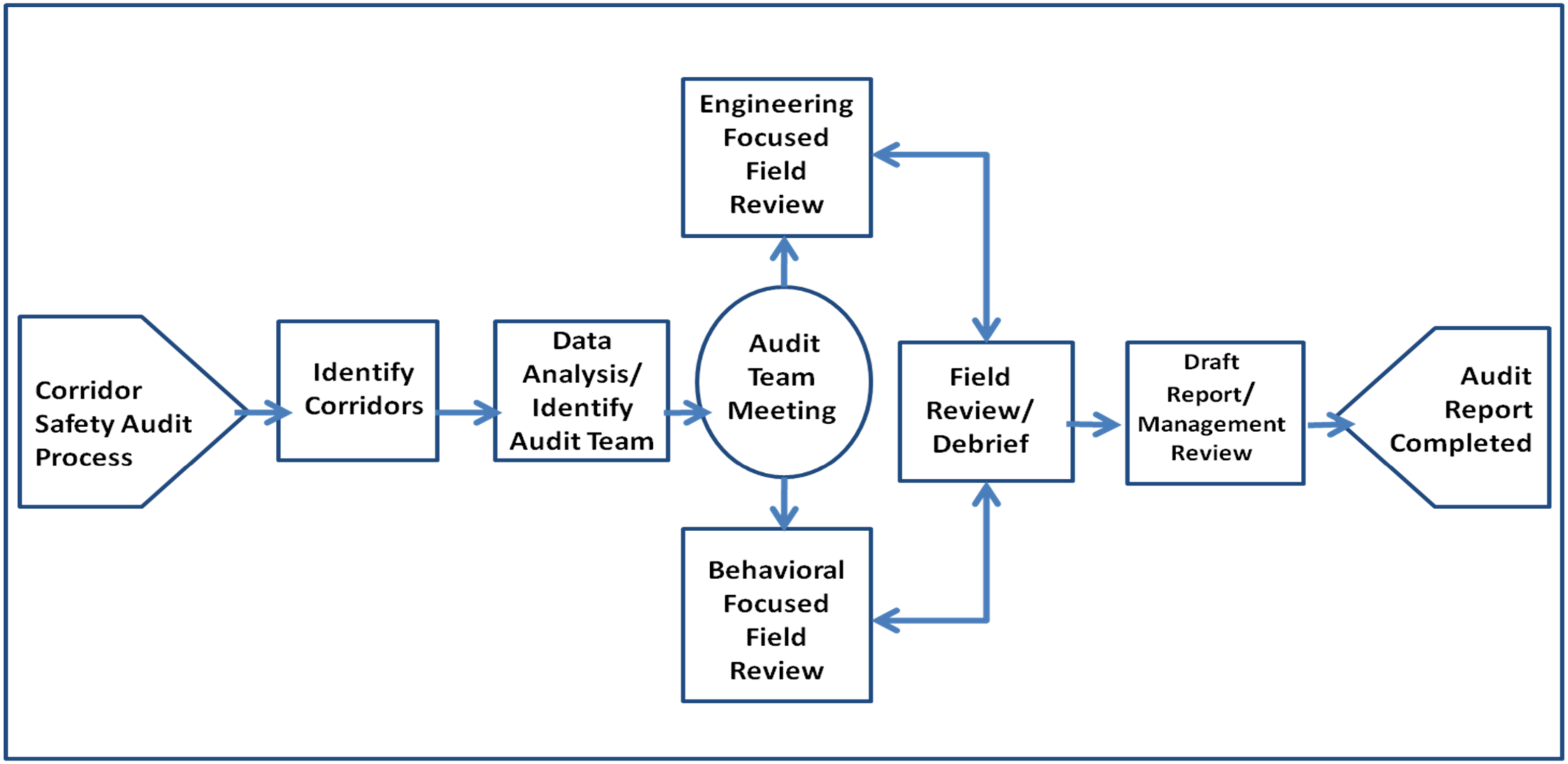
- Introductions
- Meeting schedule – 2 Day Event
- Review of corridor crash data
  - Urban and Rural
- Open discussion/Audit Team input
- Field review:
  - Day 1 - Sidney Area
  - Day 2 – Glendive to Sidney

Be Thinking About……

- ✓ Specific safety issues
- ✓ Local safety initiatives
- ✓ Roadway infrastructure
- ✓ Transportation operations
- ✓ Enforcement
- ✓ Emergency response
- ✓ Your experience in the corridor

What is the process for a CSA?

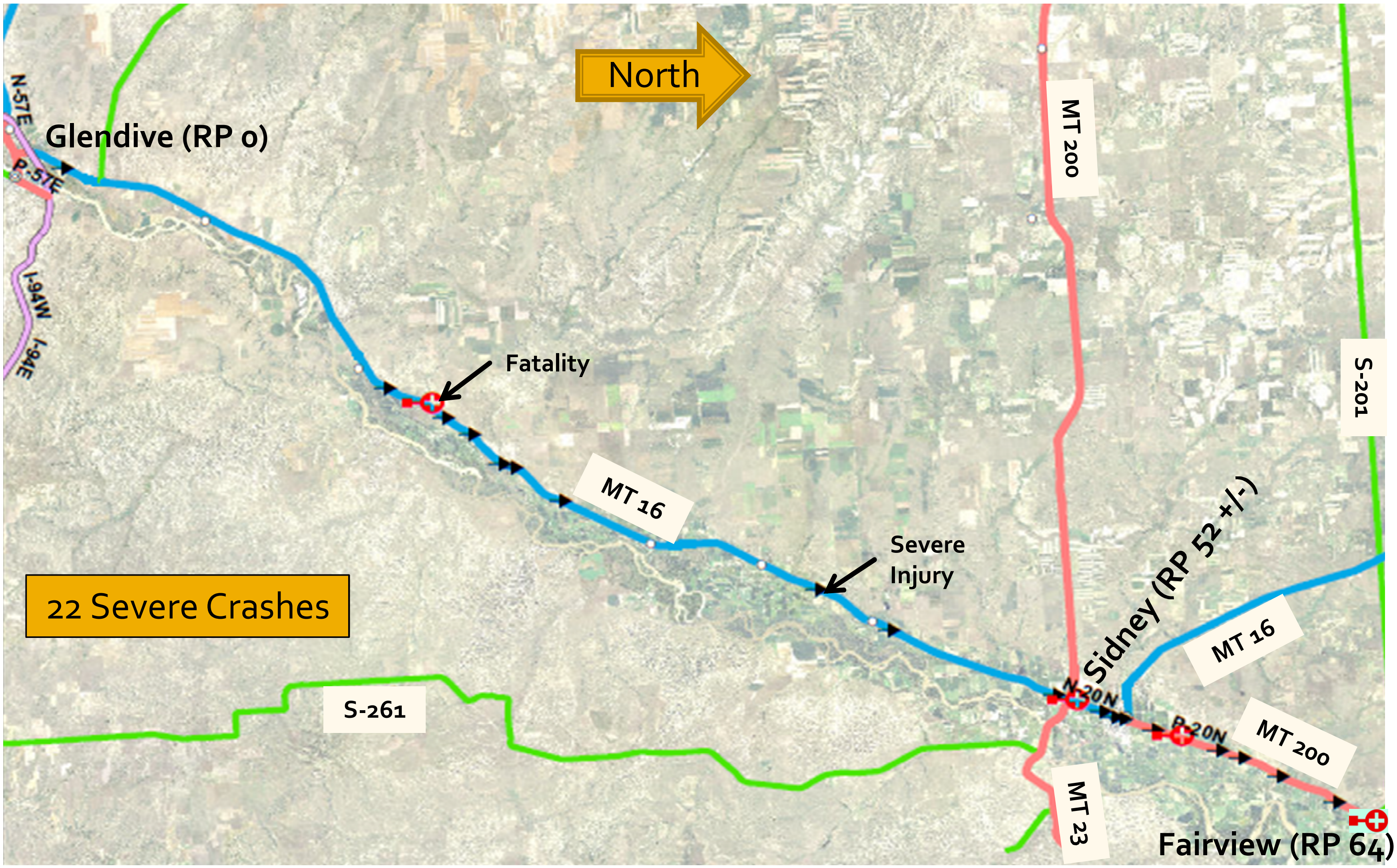
Corridor Safety Audits



Crash Data - General

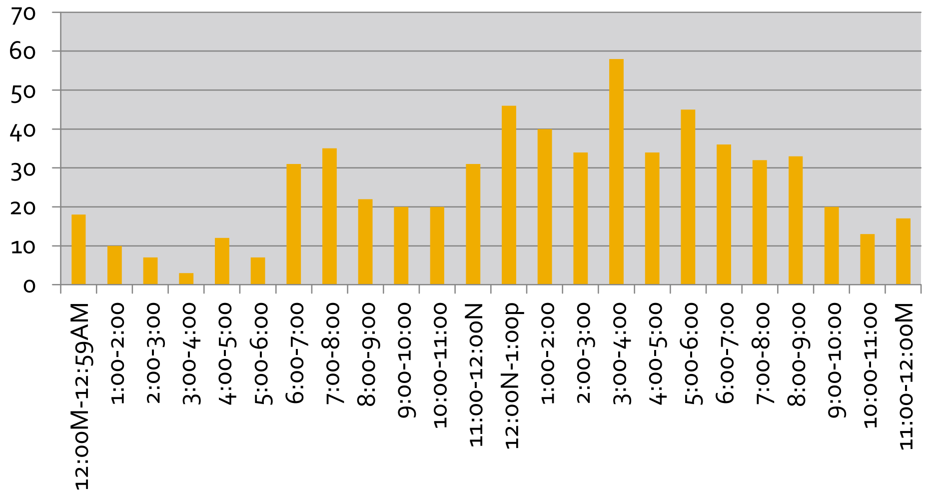
- Based on five-year period of analysis (July 1, 2006 to June 30, 2011).
- Crash data for 64.1 mile corridor (MT16 & MT 200) between Glendive and the North Dakota State Line.
- Total of 624 crashes in the analysis period.

Location Map – MT 16/MT 200

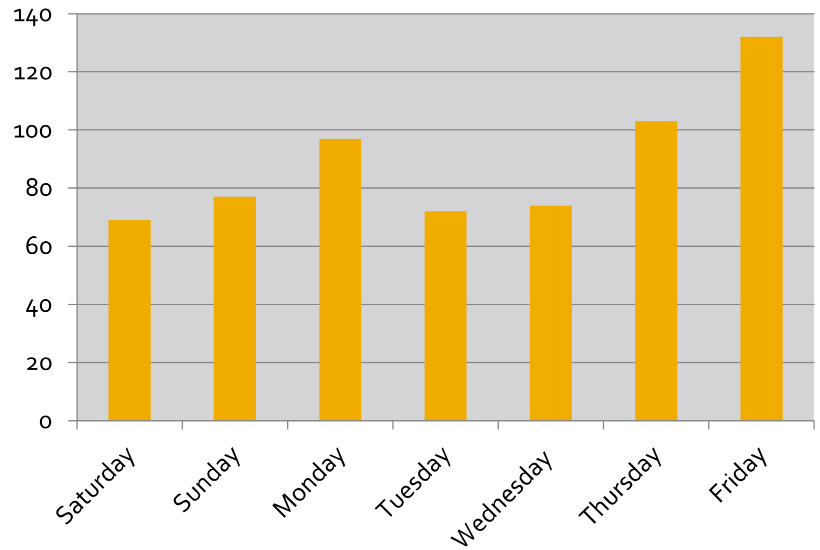


Crash Data – General Time

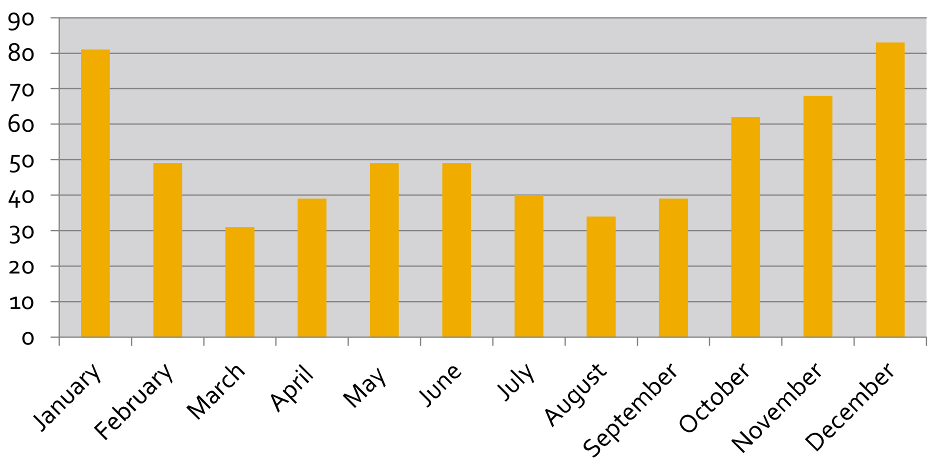
Crashes By Time of Day



Crashes By Day of Week

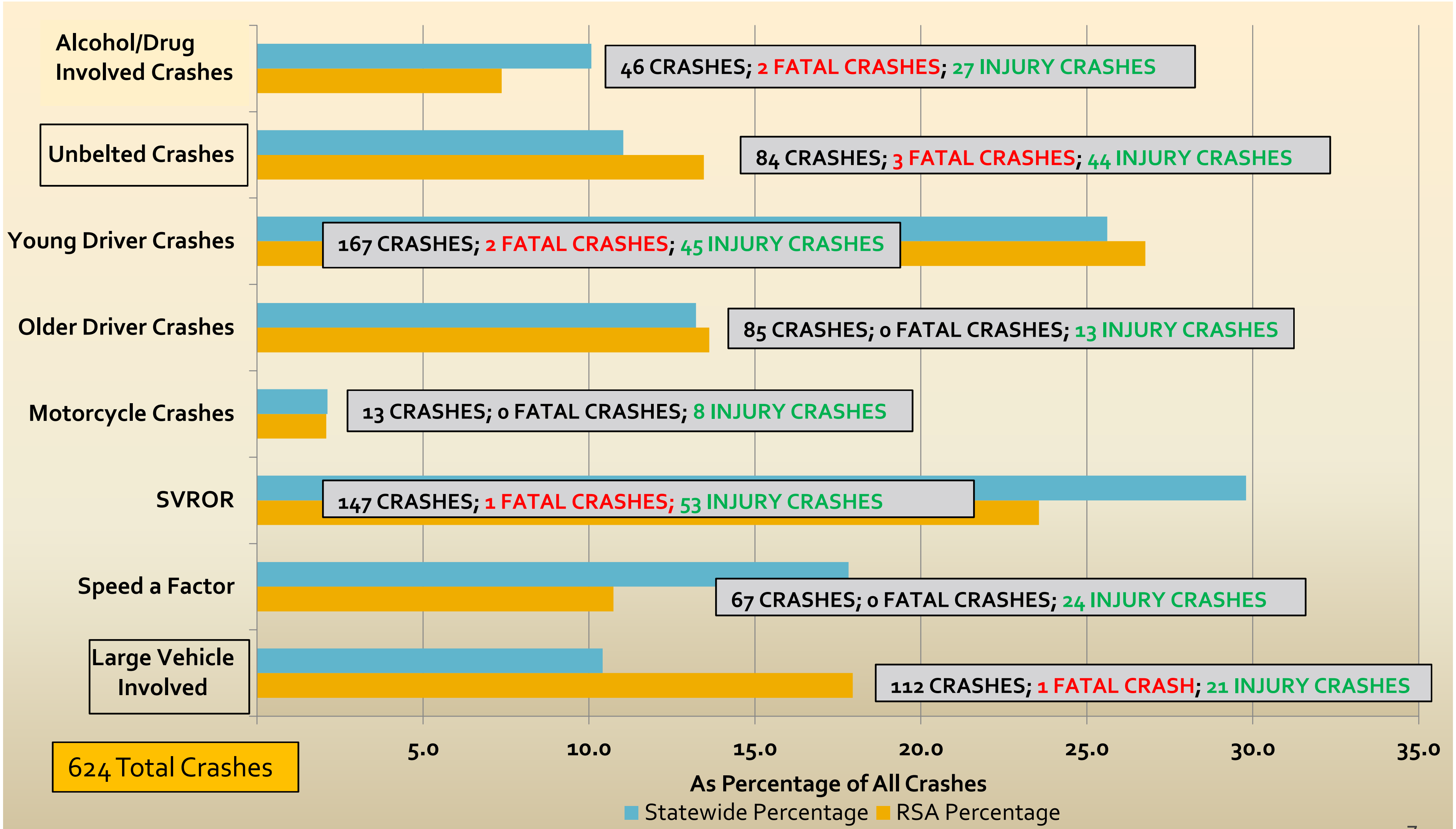


Crashes By Month

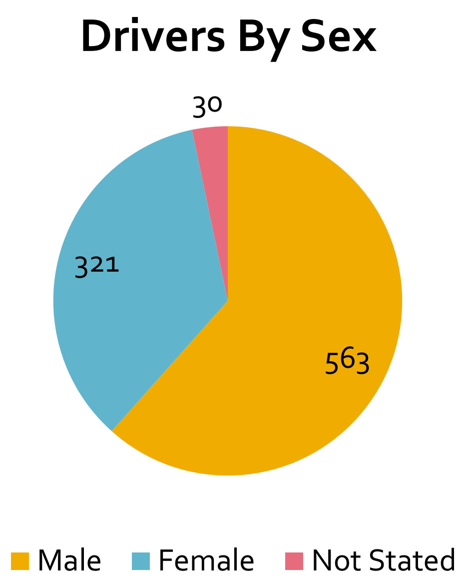


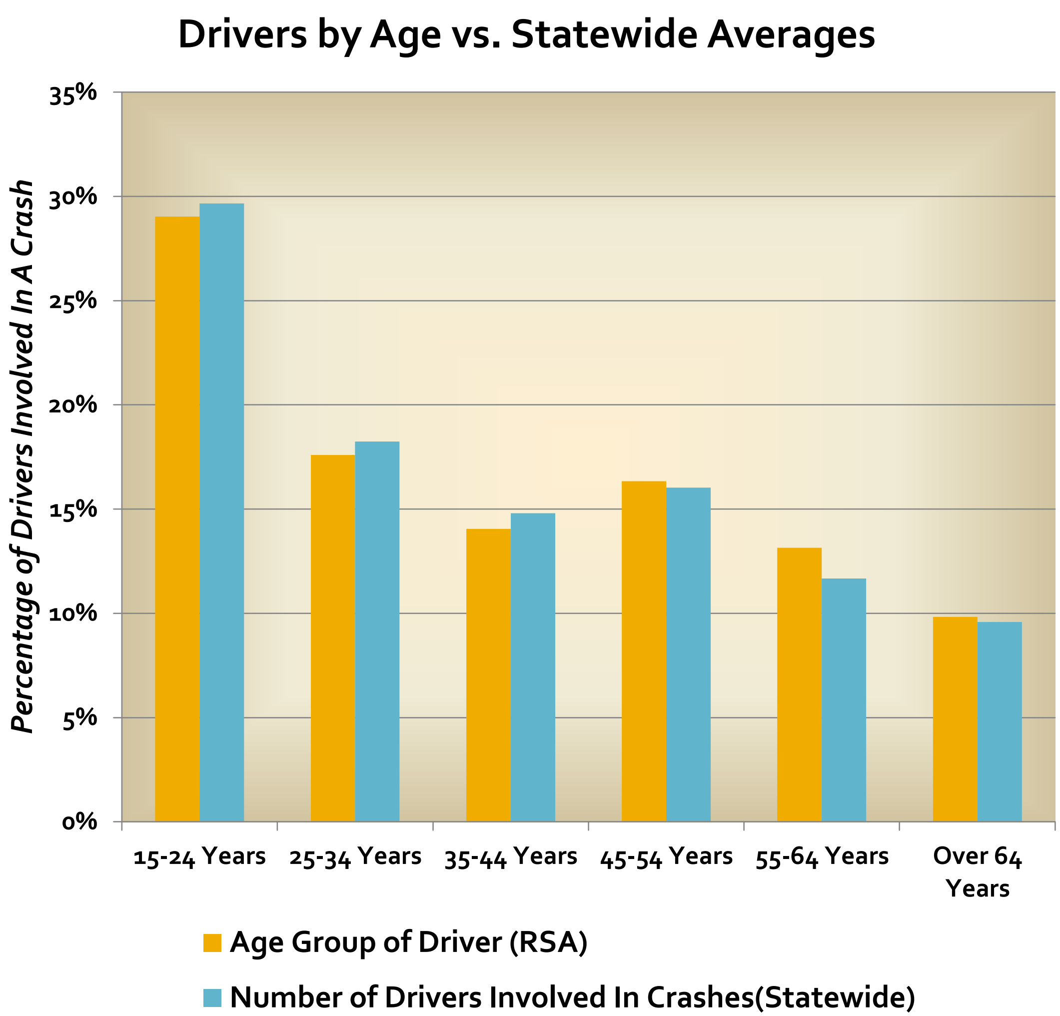
- Spike during afternoon and evening rush.
- November, December, January crashes.
- Friday crashes.

Crash Data – General



Crash Data – Driver Details





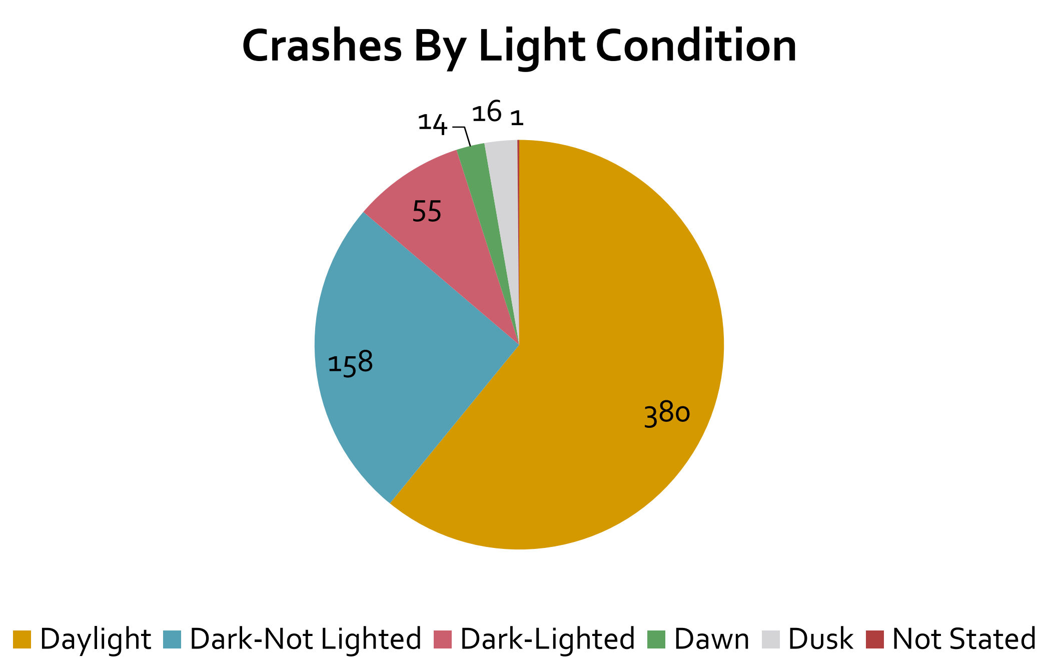
- Similar to statewide data.

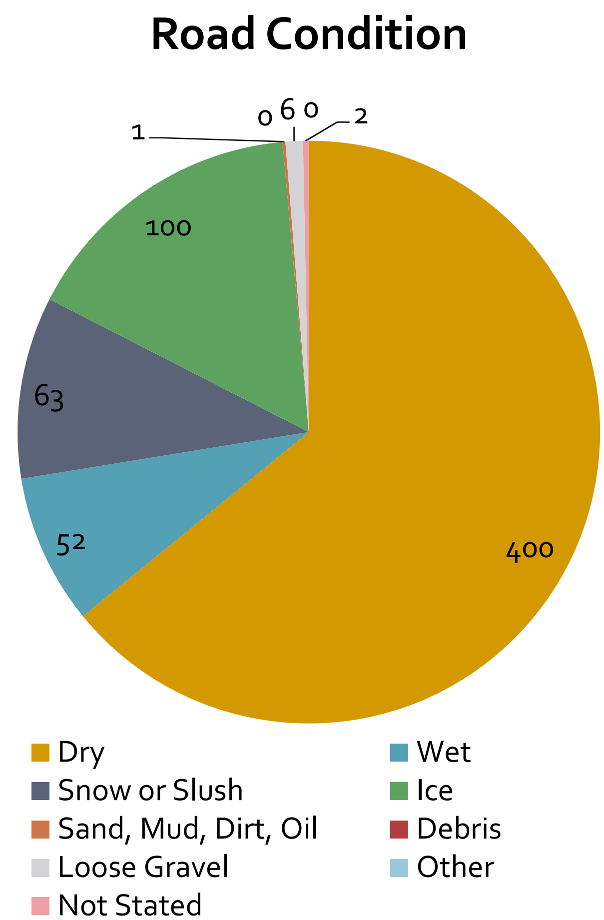
Crash Data – Driver Details

Main Contributing Circumstances Involving Driver	Number of Occurrences
Inattentive Driving	144
Careless Driving	67
Failed to Yield Right of Way	44
Too Fast for Conditions	39
Followed to Closely	25
Disregarded Traffic Signs	19

- 238 (24.5% of the crashes) vehicles involved in crashes were out-of-state registration. (14% higher than the statewide average)
- Inattentive + Careless Driving were most prevalent driver related contributing circumstances.

Crash Data – Environmental Details

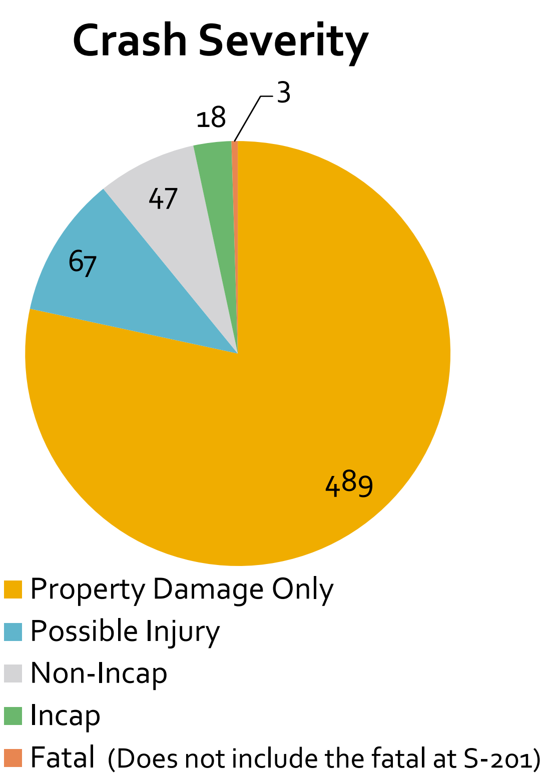




Main Contributing Circumstances Involving Environment	Number of Occurrences
OTHER*(ENVIRONMENT)	65
RAIN, SNOW	13
SUN GLARE	5
BLOWING SAND, SOIL, DIRT	3

624 Total Crashes

Crash Data –Type and Severity

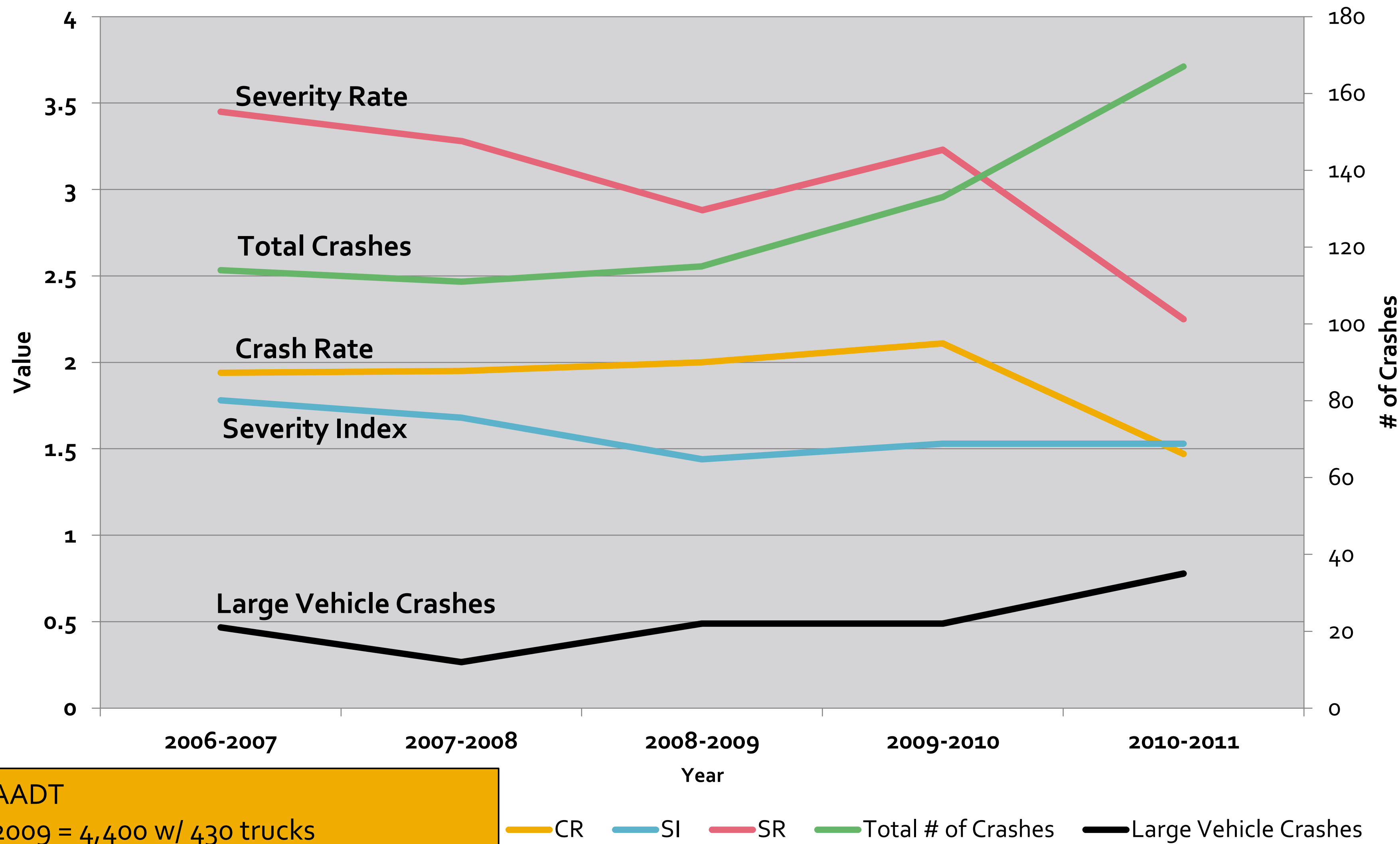


Highway System	Study Segment
NINHS	Glendive - Sidney
Primary	Sidney to ND

Crash and Severity Rates (2006-2010)	NINHS/Primary Study Area	Statewide Average for NINHS/Primary Roadways
All Vehicles Crash Rate	2.17/1.44	1.04/1.18
All Vehicles Severity Index	1.51/1.82	2.09/2.29
All Vehicles Severity Rate	3.28/2.62	2.18/2.71

Corridor Crash Characteristics (2006-2011)	Number of Crashes	Percent of Total
Single Vehicle	300	48.1%
Multiple Vehicle	324	51.9%
Alcohol/Drug Related	46	7.4%
Wildlife Related	131	46.9%
Ice, Snow or Slush Road Conditions	163	26.1%

Crash Data – Corridor Rates



AADT
2009 = 4,400 w/ 430 trucks
Preliminary 2011 = 6,800 w/ 1,000 trucks

Crash Data –Type and Severity

Collision Type (**Injury Crashes Only**)	Total **Injury** Crashes	Rural **Injury** Crashes	Urban **Injury** Crashes	Rural **Fatal** Crashes	Urban **Fatal** Crashes
Roll Over	30	27	2	1	0
Collision w/ Fixed Object	25	25	0	0	0
Head On	8	5	2	1	0
Right Angle	29	7	21	1	0
Left Turn Opposite Direction	7	3	4	0	0
Left Turn Same Direction	1	0	1	0	0
Sideswipe Opposite Direction	4	4	0	0	0
Sideswipe Same Direction	5	2	3	0	0
Pedestrian	4	0	4	0	0
Rear End	18	7	11	0	0
Loss of Control	1	1	0	0	0
Domestic Animal	1	1	0	0	0
Parked Vehicle	1	0	1	0	0
Wild Animal	2	2	0	0	0
Totals	**136**	**84**	**49**	**3**	**0**

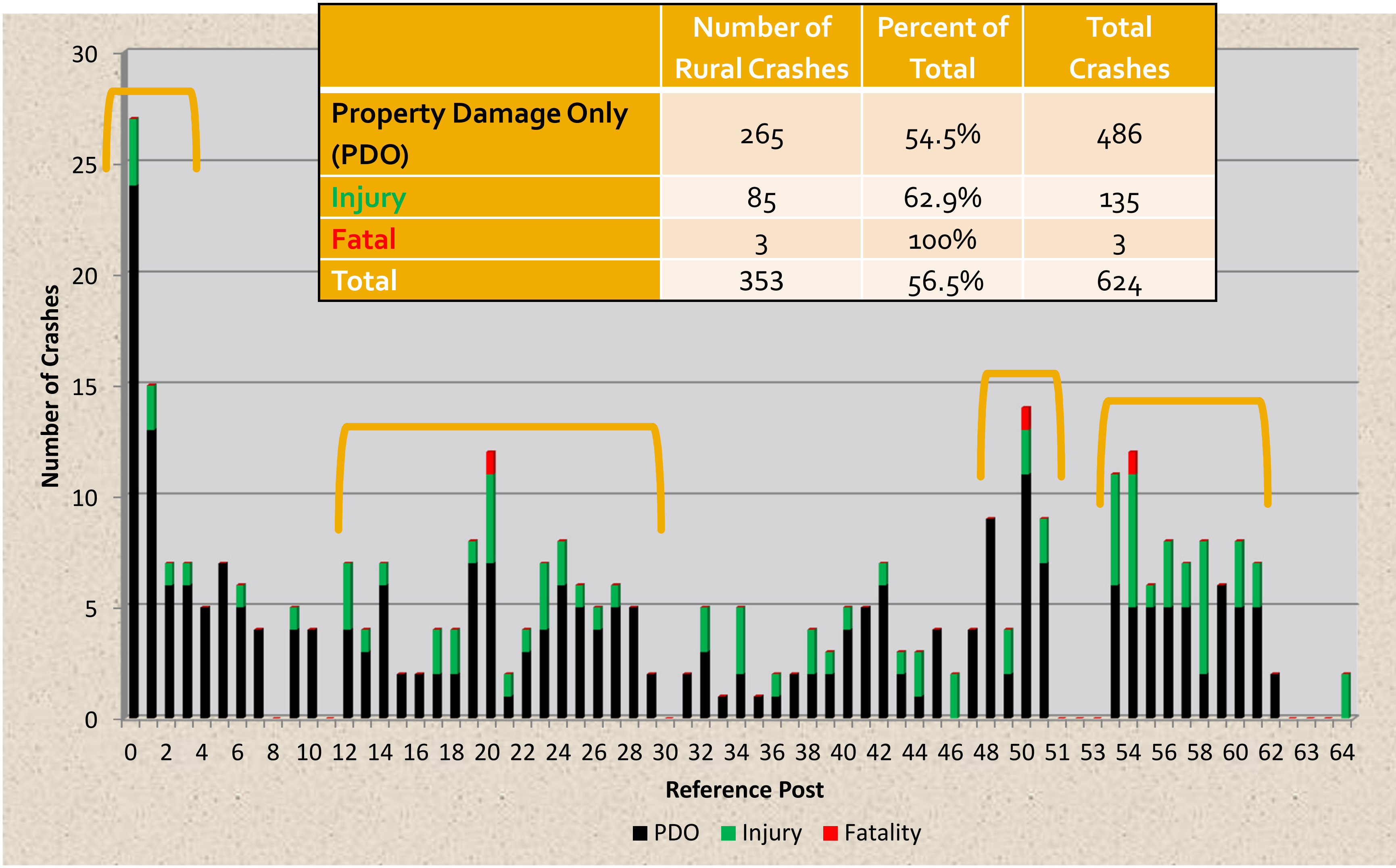
Crash Data – Injuries by Belt Use

Injuries By Belt Used	Number of Occupants	RSA Percentage	Statewide Percentage
None/Improper Use	52	29%	22%
Proper Use	107	60%	61%
Non-Motorist	6	3%	4%
Helmet	1	1%	2%
Unknown	13	7%	11%
Total	179		

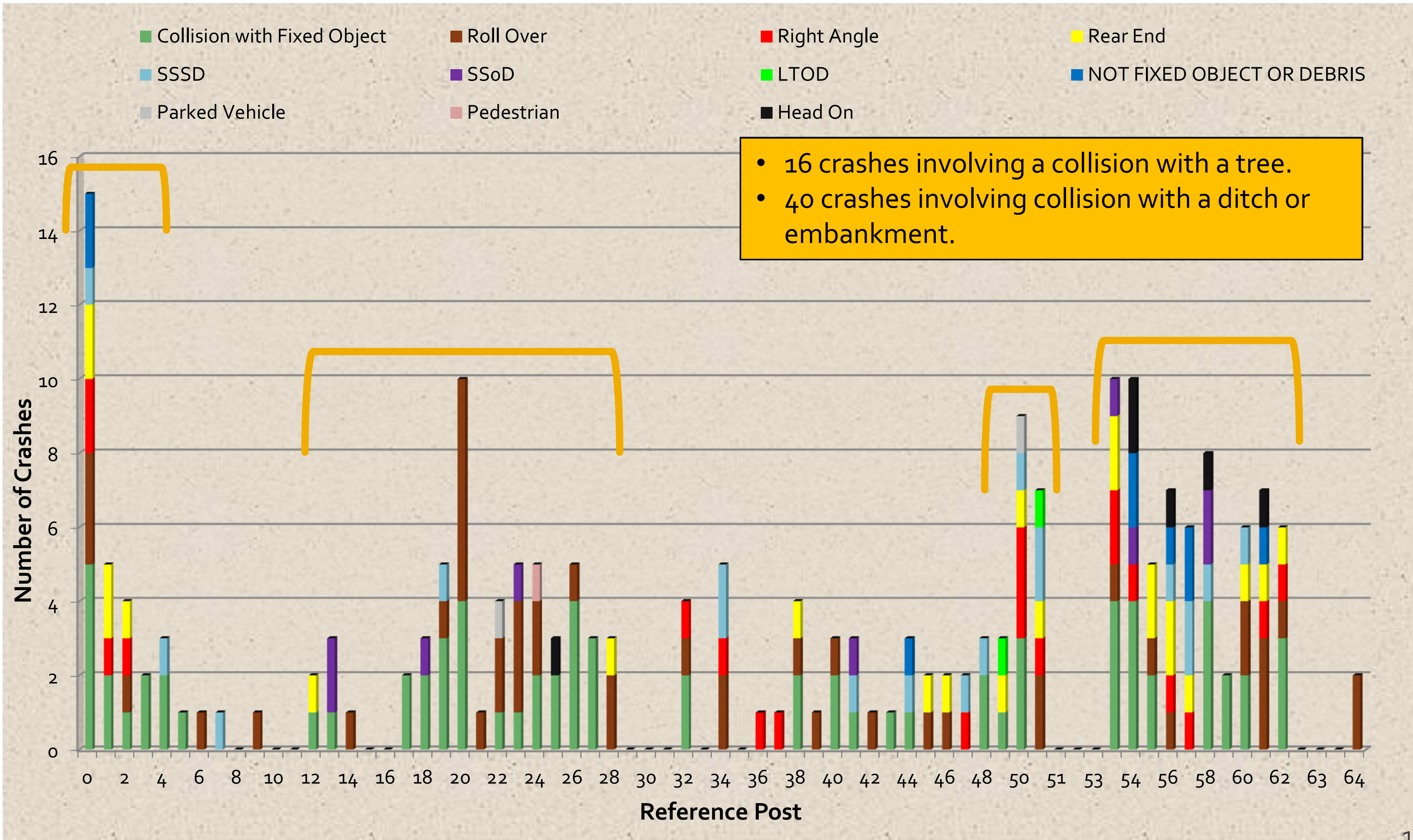
- Slightly higher unbelted percentage.
- Remainder are consistent with statewide data.

Rural Crash Data – Crash Severity

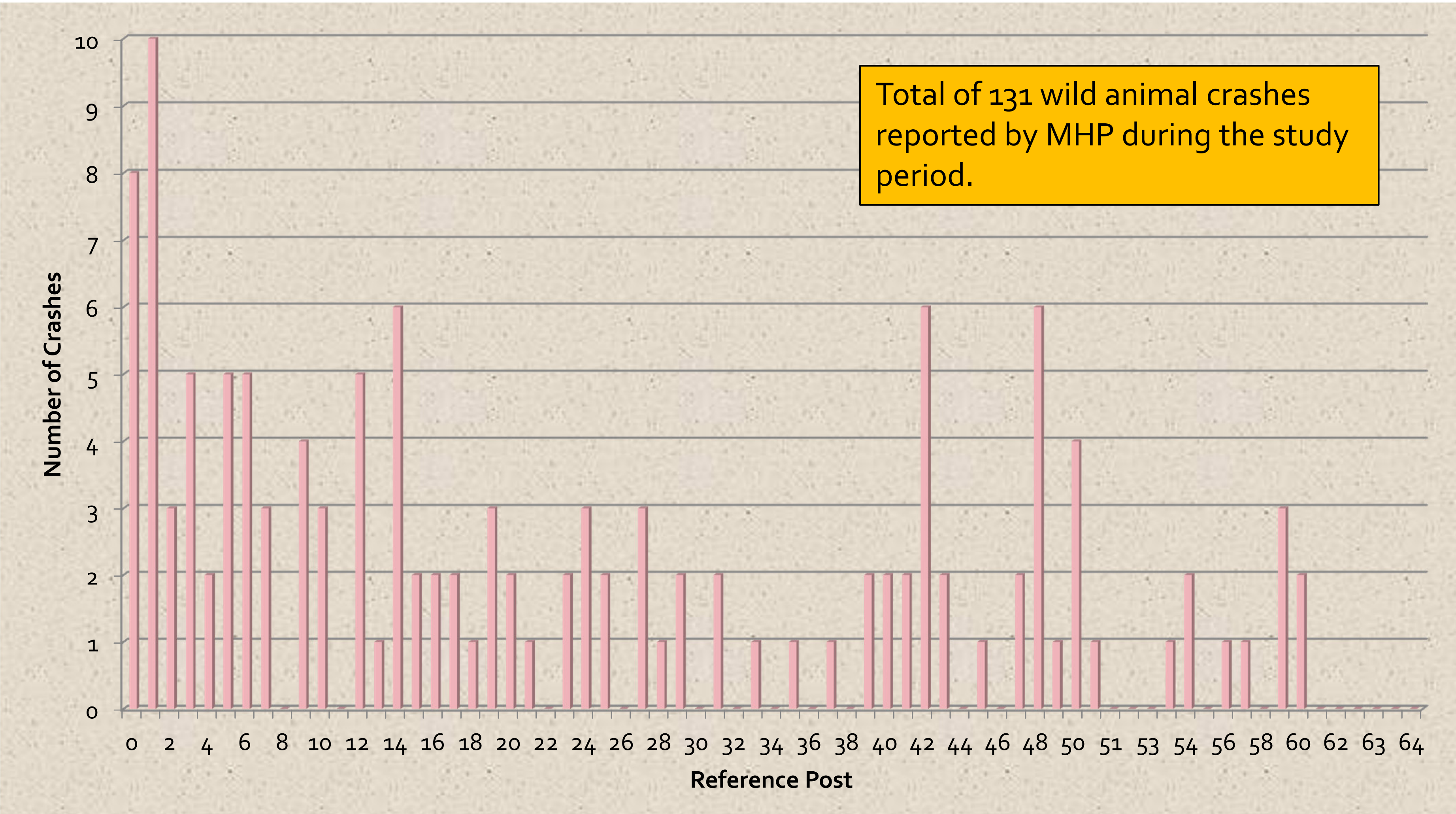
	Number of Rural Crashes	Percent of Total	Total Crashes
Property Damage Only (PDO)	265	54.5%	486
Injury	85	62.9%	135
Fatal	3	100%	3
Total	353	56.5%	624



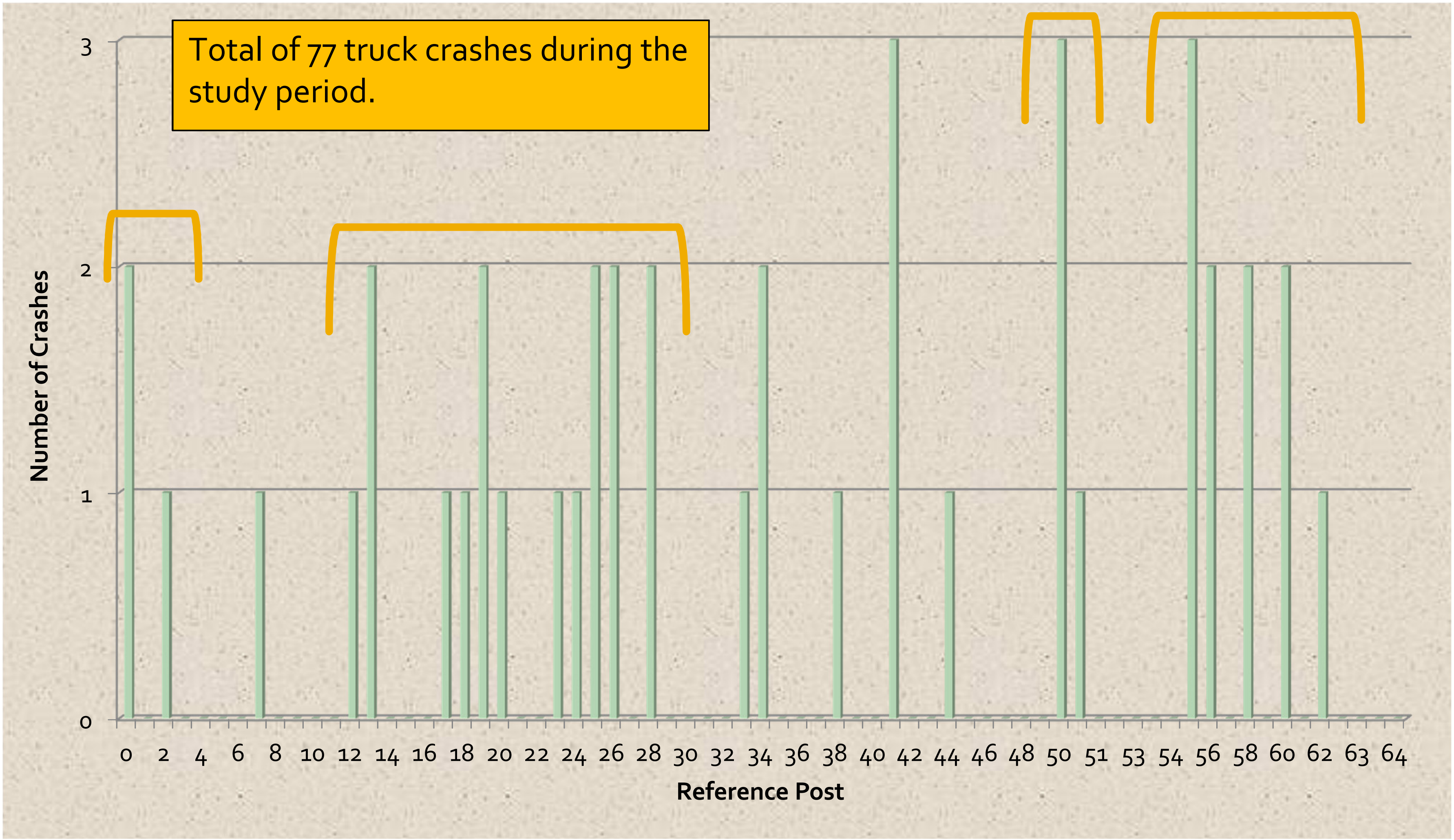
Rural Crash Data – Primary First Harmful/Most Harmful Event



Rural Crash Data –Wild Animal



Rural Crash Data – Truck Crashes



Rural Crash Data - Summary

- 100% of fatal crashes
- 63% of injury crashes
- 92% of roll overs
- 55% of truck crashes
- 67% of head-on crashes

Crash Data – Sidney

- 248 crashes occurred in Sidney. 81% were property damage only.

- 37 truck crashes occurred within Sidney.
  - 6 occurred at the intersection of Central Avenue & 14th St SW/SE
  - 11 SSSD w/ trucks (4-lane to 3-lane project addressed this crash trend)

Crash Data – Sidney

- 178 of the crashes were right angle (50), rear end (76) or side swipe same direction (52).

- 121 of the crashes were intersection related.
  - Crashes were generally dispersed throughout the city with no significant concentration.

Crash Data – Sidney

- Central & 14th Street SW/SE
  - 22 crashes; 9- right angle & 8-rear end.
- Central & 7th Street SW/SE
  - 18 crashes; 10- right angle & 3 rear end.
- Central & 2nd Street SW/SE
  - 22 crashes; 8- right angle & 9-rear end.

Crash Data – Fairview

- Seven crashes occurred at intersections.
  - 3 crashes at MT 200 and S-201/1st St including 1 fatal crash.
- 16 midblock crashes
  - 3 crashes occurred at the 90° curve
  - 6 crashes involving a collision with a parked motor vehicle
  - 2 vehicles striking a light pole

Relevant Projects in the Area

- **Reconstruction began in April of 2011, from ~RP 18.6 to ~RP 28.9.**
- Major rehabilitation project consisting of a mill, overlay and seal & cover let in February 2011, from ~RP 49.99 to ~RP 52.566.
- Slide repair northeast of Glendive project to be let in March 2012, from ~RP 13.0 to ~RP 13.5.
- Fairview intersection improvements project to be let in March of 2012, from ~RP 63.1 to ~RP 63.8.
- Proposed safety project to install shoulder and centerline rumble strips from ~RP 1.45 to ~RP 49.88.
- Intersection signing will be installed by MDT maintenance forces in 2012 for the intersection of MT 200 & CR 129, from ~RP 56.9 to ~RP 57.2.

Questions & Discussion

COMMON TRANSPORTATION SAFETY ISSUES

LOCAL SAFETY INITIATIVES
- Designated pedestrian/bicycle routes
- Speed zone requests
- Local programs (MADD, etc.)

PLANNING INITIATIVES
- Local planning/development
- Area roadway projects
- Standards
- Planning approvals & process
- Funding

ROAD DESIGN & OPERATION
- Traffic weaving and passing maneuvers
- Adjacent land use character
- Lane configuration
- Access density/access control
- Shoulder/clear zone
- Guardrail
- Horizontal alignment
- Sight distance
- Lighting/night time visibility
- Pavement condition
- Bridges
- Vertical alignment
- Traffic control

EMERGENCY RESPONSE
- Response time
- Proximity of EMS & hospitals
- Roadway cross-section available for emergency vehicles
- Dispatching & communication

SAFETY ISSUES
- High speed
- Traffic mix (i.e. trucks, tourists, commuters)
- Speed differential
- Driver training
- Blowing snow
- Wildlife
- Visibility

ENFORCEMENT
- Speeding
- Drunk driving
- Seat belt
- Illegal operations
- Frequency/visibility of enforcement

MAINTENANCE ISSUES
- Frequency of maintenance
- Drainage and icing
- Snow storage

Issues/Concerns Discussed:

- Commercial vehicle speed differential.
- Rail crossing's hinder emergency response time.
- Overall concern expressed for the growth projected in the area and how the transportation system will handle it.

Possible Solutions – Behavioral Based:

- Provide tools to local officials to address driver behavior issues:
  - MDT Plan 2 Live Website.
  - Support Buckle Up coalition coordinator.
  - Respect the Cage during upcoming community event or North Dakota event.

- Evaluate if NHTSA funding is available for additional enforcement.
- Provide stationary "enforcement" car.
- Increase enforcement within the corridor. Follow-up with Butler on prioritizing this corridor.

Possible Solutions - Engineering

- Larger chevrons at the curve in Fairview.
- Continuous centerline rumble strips, similar to ND.
- Widen roadway and provide passing lanes within the limits of the current reconstruction project.
- Holly/Central signing/pavement marking for SB right turn lane drop.

Possible Solutions - Engineering

- MT16 & MT 200 /MT 23 – Additional guide signs to delineate lanes.
  - Evaluate extending 4-lane section south of intersection and reducing speed.
- Evaluate need for passing lanes within the corridor.
  - Implement projects as needs and funding are identified. Passing lane projects within the corridor.
- Speed zone study south of Sidney & through Crane.

Possible Solutions - Engineering

- Evaluate Two Way Left Turn Lane (TWLTL) – Sidney to Fairview.
- Evaluate addition of left turn phase on Sidney signals (on the docket).
- Continue evaluation and implementation of truck routes at appropriate locations.

Possible Solutions - Engineering

- Evaluate/implement limited access control from Sidney to Crane.
- Reconstruct right turn lane to include shoulders and provide moving sight distance at the right turn lane at CR 126 north of Sidney .
- Evaluate need for NB right turn lane at RP 35.2 +/-.

Possible Solutions - Engineering

- Evaluate fill slopes (guardrail warrants) at RP 29.7 & 28.5 on east side of roadway.
- Dynamic speed message signs at the north/south end of Fairview (solar powered??).

Appendix 2

Cost Estimate Spreadsheets

DOWL HKM

Option 3.a - RP 24.0 (COUNTY RD 100) INTERSECTION REALIGNMENT
Planning Level Estimate of Costs

Item Description	Approx. Quantity (Per Station) [1]	Unit	Average Bid Prices [2]		Adjusted Unit Prices	
			Unit Price	Amount	Unit Price	Amount [3]
			Dollars	Dollars	Dollars	Dollars
COUNTY RD 100 (RP 24.0)						
SURFACING AGGREGATE [4]	51	CUYD	$30.00	$1,530.00		$1,530.00
CRUSHED AGGREGATE COURSE [4]	100	CUYD	$18.79	$1,879.00		$1,879.00
EMBANKMENT IN PLACE [5]	325	CUYD	$6.83	$2,220.00		$2,220.00
COUNTY RD 100 (RP 24.0) SUBTOTAL				$5,543.00		$5,629

CATEGORY	LENGTH (STA.)	COST PER STATION	
COUNTY RD 100 (RP 24.0)	23.35	5,629.00	$130,000
ROADWAY OBLITERATION	23.34	357.93	$8,400
SUBTOTAL 1			$138,400

ADDITIONAL COSTS		
MISCELLANEOUS @ 20% OF SUBTOTAL 1 [6]	20%	$28,000
MOBILIZATION @ 10% OF SUBTOTAL 1 [7]	10%	$14,000
SUBTOTAL 2		$180,000
INDIRECT COST (IDC) - CONSTRUCTION @ 9.64% OF SUBTOTAL 2 [8]	9.64%	$17,000
CONTINGENCY @ 20% & 30% OF SUBTOTAL 2 [9]	20%	$36,000
	30%	$54,000
TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [10]	$230,000	
TOTAL IMPROVEMENT OPTION COST @ 30% CONTINGENCY [10]	$250,000	

[1] One station is equal to 100 feet.
[2] Average MDT bid prices provided for the period January 2011 to December 2011.
[3] Cost estimates are provided in 2012 dollars. All dollar amounts are rounded for planning purposes.
[4] Typical section includes 0.5 ft of top course surfacing aggregate and 0.75 ft of crushed aggregate course.
[5] 3 ft average fill depth (edge of shoulder to bottom of embankment) with a 25% shrink factor is assumed throughout the corridor.
[6] The Miscellaneous category is estimated at 20 percent due to unknown factors including but not limited to excavation, embankment, topsoil, guardrail, BMPs, utilities, traffic control, noxious weeds, slope treatments, ditch or channel excavation, incidental pavement transitional areas, temporary striping, temporary water pollution/erosion control measures and public relations.
[7] The Mobilization category includes all costs incurred in assembling and transporting materials to the work site.
[8] Indirect costs are costs not directly associated with the construction of a project, but incurred during the construction processes. IDC percentage is subject to change.
[9] A contingency range of 20 to 30 percent was used due to the high degree of unknown factors over the planning horizon, as well as the substantial amount of items not accounted for in this planning level cost estimate.
[10] The Total Improvement Option Cost reflects an estimate of potential construction costs based on planning level estimates, and should not be considered an actual cost or encompassing all scenarios and circumstances.

DOWL HKM

Option 3.a - RP 25.6 (COUNTY RD 340) INTERSECTION REALIGNMENT
Planning Level Estimate of Costs

Item Description	Approx. Quantity (Per Station) [1]	Unit	Average Bid Prices [2]		Adjusted Unit Prices	
			Unit Price	Amount	Unit Price	Amount [3]
			Dollars	Dollars	Dollars	Dollars
COUNTY RD 340 (RP 25.6)						
SURFACING AGGREGATE [4]	51	CUYD	$30.00	$1,530.00		$1,530.00
CRUSHED AGGREGATE COURSE [4]	100	CUYD	$18.79	$1,879.00		$1,879.00
EMBANKMENT IN PLACE [5]	325	CUYD	$6.83	$2,220.00		$2,220.00
COUNTY RD 340 (RP 25.6) SUBTOTAL				$5,543.00		$5,629
CATEGORY	LENGTH (STA.)	COST PER STATION				
COUNTY RD 340 (RP 25.6)	6.55	5,629.00			$37,000	
ROADWAY OBLITERATION	9.22	357.93			$3,300	
SUBTOTAL 1					$40,300	
ADDITIONAL COSTS						
MISCELLANEOUS @ 20% OF SUBTOTAL 1 [6]					20%	$8,100
MOBILIZATION @ 10% OF SUBTOTAL 1 [7]					10%	$4,000
SUBTOTAL 2						$50,000
INDIRECT COST (IDC) - CONSTRUCTION @ 9.64% OF SUBTOTAL 2 [8]					9.64%	$4,800
CONTINGENCY @ 20% & 30% OF SUBTOTAL 2 [9]					20%	$10,000
					30%	$15,000
TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [10]					$65,000	
TOTAL IMPROVEMENT OPTION COST @ 30% CONTINGENCY [10]					$70,000	

[1] One station is equal to 100 feet.
[2] Average MDT bid prices provided for the period January 2011 to December 2011.
[3] Cost estimates are provided in 2012 dollars. All dollar amounts are rounded for planning purposes.
[4] Typical section includes 0.5 ft of top course surfacing aggregate and 0.75 ft of crushed aggregate course.
[5] 3 ft average fill depth (edge of shoulder to bottom of embankment) with a 25% shrink factor is assumed throughout the corridor.
[6] The Miscellaneous category is estimated at 20 percent due to unknown factors including but not limited to excavation, embankment, topsoil, guardrail, BMPs, utilities, traffic control, noxious weeds, slope treatments, ditch or channel excavation, incidental pavement transitional areas, temporary striping, temporary water pollution/erosion control measures and public relations.
[7] The Mobilization category includes all costs incurred in assembling and transporting materials to the work site.
[8] Indirect costs are costs not directly associated with the construction of a project, but incurred during the construction processes. IDC percentage is subject to change.
[9] A contingency range of 20 to 30 percent was used due to the high degree of unknown factors over the planning horizon, as well as the substantial amount of items not accounted for in this planning level cost estimate.
[10] The Total Improvement Option Cost reflects an estimate of potential construction costs based on planning level estimates, and should not be considered an actual cost or encompassing all scenarios and circumstances.

DOWL HKM

Option 3.a - RP 25.9 (COUNTY RD 339) INTERSECTION REALIGNMENT
Planning Level Estimate of Costs

Item Description	Approx. Quantity (Per Station) [1]	Unit	Average Bid Prices [2]		Adjusted Unit Prices	
			Unit Price	Amount	Unit Price	Amount [3]
			Dollars	Dollars	Dollars	Dollars
COUNTY RD 339 (RP 25.9)						
SURFACING AGGREGATE [4]	51	CUYD	$30.00	$1,530.00		$1,530.00
CRUSHED AGGREGATE COURSE [4]	100	CUYD	$18.79	$1,879.00		$1,879.00
EMBANKMENT IN PLACE [5]	325	CUYD	$6.83	$2,220.00		$2,220.00
COUNTY RD 339 (RP 25.9) SUBTOTAL				$5,543.00		$5,629
CATEGORY	LENGTH (STA.)	COST PER STATION				
COUNTY RD 339 (RP 25.9)	16.78	5,629.00			$94,000	
ROADWAY OBLITERATION	15.29	357.93			$5,500	
SUBTOTAL 1					$99,500	
ADDITIONAL COSTS						
MISCELLANEOUS @ 20% OF SUBTOTAL 1 [6]					20%	$20,000
MOBILIZATION @ 10% OF SUBTOTAL 1 [7]					10%	$10,000
SUBTOTAL 2						$130,000
INDIRECT COST (IDC) - CONSTRUCTION @ 9.64% OF SUBTOTAL 2 [8]					9.64%	$13,000
CONTINGENCY @ 20% & 30% OF SUBTOTAL 2 [9]					20%	$26,000
					30%	$39,000
TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [10]					$170,000	
TOTAL IMPROVEMENT OPTION COST @ 30% CONTINGENCY [10]					$180,000	

[1] One station is equal to 100 feet.
[2] Average MDT bid prices provided for the period January 2011 to December 2011.
[3] Cost estimates are provided in 2012 dollars. All dollar amounts are rounded for planning purposes.
[4] Typical section includes 0.5 ft of top course surfacing aggregate and 0.75 ft of crushed aggregate course.
[5] 3 ft average fill depth (edge of shoulder to bottom of embankment) with a 25% shrink factor is assumed throughout the corridor.
[6] The Miscellaneous category is estimated at 20 percent due to unknown factors including but not limited to excavation, embankment, topsoil, guardrail, BMPs, utilities, traffic control, noxious weeds, slope treatments, ditch or channel excavation, incidental pavement transitional areas, temporary striping, temporary water pollution/erosion control measures and public relations.
[7] The Mobilization category includes all costs incurred in assembling and transporting materials to the work site.
[8] Indirect costs are costs not directly associated with the construction of a project, but incurred during the construction processes. IDC percentage is subject to change.
[9] A contingency range of 20 to 30 percent was used due to the high degree of unknown factors over the planning horizon, as well as the substantial amount of items not accounted for in this planning level cost estimate.
[10] The Total Improvement Option Cost reflects an estimate of potential construction costs based on planning level estimates, and should not be considered an actual cost or encompassing all scenarios and circumstances.

Option 3.a - RP 28.6 (COUNTY RD 104) INTERSECTION REALIGNMENT
Planning Level Estimate of Costs

Item Description	Approx. Quantity (Per Station) [1]	Unit	Average Bid Prices [2]		Adjusted Unit Prices	
			Unit Price	Amount	Unit Price	Amount [3]
			Dollars	Dollars	Dollars	Dollars
COUNTY RD 104 (RP 28.6)						
SURFACING AGGREGATE [4]	51	CUYD	$30.00	$1,530.00		$1,530.00
CRUSHED AGGREGATE COURSE [4]	100	CUYD	$18.79	$1,879.00		$1,879.00
EMBANKMENT IN PLACE [5]	325	CUYD	$6.83	$2,220.00		$2,220.00
COUNTY RD 104 (RP 28.6) SUBTOTAL				$5,543.00		$5,629
CATEGORY	LENGTH (STA.)	COST PER STATION				
COUNTY RD 104 (RP 28.6)	13.41	5,629.00			$75,000	
ROADWAY OBLITERATION	10.92	357.93			$4,000	
SUBTOTAL 1					$79,000	
ADDITIONAL COSTS						
MISCELLANEOUS @ 20% OF SUBTOTAL 1 [6]					20%	$16,000
MOBILIZATION @ 10% OF SUBTOTAL 1 [7]					10%	$7,900
SUBTOTAL 2						$100,000
INDIRECT COST (IDC) - CONSTRUCTION @ 9.64% OF SUBTOTAL 2 [8]					9.64%	$10,000
CONTINGENCY @ 20% & 30% OF SUBTOTAL 2 [9]					20%	$20,000
					30%	$30,000
TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [10]					$130,000	
TOTAL IMPROVEMENT OPTION COST @ 30% CONTINGENCY [10]					$140,000	

[1] One station is equal to 100 feet.
[2] Average MDT bid prices provided for the period January 2011 to December 2011.
[3] Cost estimates are provided in 2012 dollars. All dollar amounts are rounded for planning purposes.
[4] Typical section includes 0.5 ft of top course surfacing aggregate and 0.75 ft of crushed aggregate course.
[5] 3 ft average fill depth (edge of shoulder to bottom of embankment) with a 25% shrink factor is assumed throughout the corridor.
[6] The Miscellaneous category is estimated at 20 percent due to unknown factors including but not limited to excavation, embankment, topsoil, guardrail, BMPs, utilities, traffic control, noxious weeds, slope treatments, ditch or channel excavation, incidental pavement transitional areas, temporary striping, temporary water pollution/erosion control measures and public relations.
[7] The Mobilization category includes all costs incurred in assembling and transporting materials to the work site.
[8] Indirect costs are costs not directly associated with the construction of a project, but incurred during the construction processes. IDC percentage is subject to change.
[9] A contingency range of 20 to 30 percent was used due to the high degree of unknown factors over the planning horizon, as well as the substantial amount of items not accounted for in this planning level cost estimate.
[10] The Total Improvement Option Cost reflects an estimate of potential construction costs based on planning level estimates, and should not be considered an actual cost or encompassing all scenarios and circumstances.

Option 3.a - RP 28.9 (COUNTY RD 340) INTERSECTION REALIGNMENT
Planning Level Estimate of Costs

Item Description	Approx. Quantity (Per Station) [1]	Unit	Average Bid Prices [2]		Adjusted Unit Prices	
			Unit Price	Amount	Unit Price	Amount [3]
			Dollars	Dollars	Dollars	Dollars
COUNTY RD 340 (RP 28.9)						
SURFACING AGGREGATE [4]	51	CUYD	$30.00	$1,530.00		$1,530.00
CRUSHED AGGREGATE COURSE [4]	100	CUYD	$18.79	$1,879.00		$1,879.00
EMBANKMENT IN PLACE [5]	325	CUYD	$6.83	$2,220.00		$2,220.00
COUNTY RD 340 (RP 28.9) SUBTOTAL				$5,543.00		$5,629
CATEGORY	LENGTH (STA.)	COST PER STATION				
COUNTY RD 340 (RP 28.9)	28.55	5,629.00			$160,000	
ROADWAY OBLITERATION	21.49	357.93			$7,700	
SUBTOTAL 1					$167,700	
ADDITIONAL COSTS						
MISCELLANEOUS @ 20% OF SUBTOTAL 1 [6]					20%	$34,000
MOBILIZATION @ 10% OF SUBTOTAL 1 [7]					10%	$17,000
SUBTOTAL 2						$220,000
INDIRECT COST (IDC) - CONSTRUCTION @ 9.64% OF SUBTOTAL 2 [8]					9.64%	$21,000
CONTINGENCY @ 20% & 30% OF SUBTOTAL 2 [9]					20%	$44,000
					30%	$66,000
TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [10]					$290,000	
TOTAL IMPROVEMENT OPTION COST @ 30% CONTINGENCY [10]					$310,000	

[1] One station is equal to 100 feet.
[2] Average MDT bid prices provided for the period January 2011 to December 2011.
[3] Cost estimates are provided in 2012 dollars. All dollar amounts are rounded for planning purposes.
[4] Typical section includes 0.5 ft of top course surfacing aggregate and 0.75 ft of crushed aggregate course.
[5] 3 ft average fill depth (edge of shoulder to bottom of embankment) with a 25% shrink factor is assumed throughout the corridor.
[6] The Miscellaneous category is estimated at 20 percent due to unknown factors including but not limited to excavation, embankment, topsoil, guardrail, BMPs, utilities, traffic control, noxious weeds, slope treatments, ditch or channel excavation, incidental pavement transitional areas, temporary striping, temporary water pollution/erosion control measures and public relations.
[7] The Mobilization category includes all costs incurred in assembling and transporting materials to the work site.
[8] Indirect costs are costs not directly associated with the construction of a project, but incurred during the construction processes. IDC percentage is subject to change.
[9] A contingency range of 20 to 30 percent was used due to the high degree of unknown factors over the planning horizon, as well as the substantial amount of items not accounted for in this planning level cost estimate.
[10] The Total Improvement Option Cost reflects an estimate of potential construction costs based on planning level estimates, and should not be considered an actual cost or encompassing all scenarios and circumstances.

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Option 3.a - RP 30.9 (COUNTY RD 106) INTERSECTION REALIGNMENT
Planning Level Estimate of Costs

Item Description	Approx. Quantity (Per Station) [1]	Unit	Average Bid Prices [2]		Adjusted Unit Prices	
			Unit Price	Amount	Unit Price	Amount [3]
			Dollars	Dollars	Dollars	Dollars
COUNTY RD 106 (RP 30.9)						
SURFACING AGGREGATE [4]	51	CUYD	$30.00	$1,530.00		$1,530.00
CRUSHED AGGREGATE COURSE [4]	100	CUYD	$18.79	$1,879.00		$1,879.00
EMBANKMENT IN PLACE [5]	325	CUYD	$6.83	$2,220.00		$2,220.00
COUNTY RD 106 (RP 30.9) SUBTOTAL				$5,543.00		$5,629

CATEGORY	LENGTH (STA.)	COST PER STATION	
COUNTY RD 106 (RP 30.9)	6.78	5,629.00	$38,000
ROADWAY OBLITERATION	7.45	357.93	$2,700
		SUBTOTAL 1	$40,700

ADDITIONAL COSTS		
MISCELLANEOUS @ 20% OF SUBTOTAL 1 [6]	20%	$8,100
MOBILIZATION @ 10% OF SUBTOTAL 1 [7]	10%	$4,100
SUBTOTAL 2		$50,000
INDIRECT COST (IDC) - CONSTRUCTION @ 9.64% OF SUBTOTAL 2 [8]	9.64%	$4,800
CONTINGENCY @ 20% & 30% OF SUBTOTAL 2 [9]	20%	$10,000
	30%	$15,000
TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [10]	$65,000	
TOTAL IMPROVEMENT OPTION COST @ 30% CONTINGENCY [10]	$70,000	

[1] One station is equal to 100 feet.
[2] Average MDT bid prices provided for the period January 2011 to December 2011.
[3] Cost estimates are provided in 2012 dollars. All dollar amounts are rounded for planning purposes.
[4] Typical section includes 0.5 ft of top course surfacing aggregate and 0.75 ft of crushed aggregate course.
[5] 3 ft average fill depth (edge of shoulder to bottom of embankment) with a 25% shrink factor is assumed throughout the corridor.
[6] The Miscellaneous category is estimated at 20 percent due to unknown factors including but not limited to excavation, embankment, topsoil, guardrail, BMPs, utilities, traffic control, noxious weeds, slope treatments, ditch or channel excavation, incidental pavement transitional areas, temporary striping, temporary water pollution/erosion control measures and public relations.
[7] The Mobilization category includes all costs incurred in assembling and transporting materials to the work site.
[8] Indirect costs are costs not directly associated with the construction of a project, but incurred during the construction processes. IDC percentage is subject to change.
[9] A contingency range of 20 to 30 percent was used due to the high degree of unknown factors over the planning horizon, as well as the substantial amount of items not accounted for in this planning level cost estimate.
[10] The Total Improvement Option Cost reflects an estimate of potential construction costs based on planning level estimates, and should not be considered an actual cost or encompassing all scenarios and circumstances.

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Option 3.a - RP 35.2 (COUNTY RD 110) INTERSECTION REALIGNMENT
Planning Level Estimate of Costs

Item Description	Approx. Quantity (Per Station) [1]	Unit	Average Bid Prices [2]		Adjusted Unit Prices	
			Unit Price	Amount	Unit Price	Amount [3]
			Dollars	Dollars	Dollars	Dollars
COUNTY RD 110 (RP 35.2)						
SURFACING AGGREGATE [4]	51	CUYD	$30.00	$1,530.00		$1,530.00
CRUSHED AGGREGATE COURSE [4]	100	CUYD	$18.79	$1,879.00		$1,879.00
EMBANKMENT IN PLACE [5]	325	CUYD	$6.83	$2,220.00		$2,220.00
COUNTY RD 110 (RP 35.2) SUBTOTAL				$5,543.00		$5,629
CATEGORY	LENGTH (STA.)	COST PER STATION				
COUNTY RD 110 (RP 35.2)	14.32	5,629.00			$81,000	
ROADWAY OBLITERATION	13.10	357.93			$4,700	
SUBTOTAL 1					$85,700	
ADDITIONAL COSTS						
MISCELLANEOUS @ 20% OF SUBTOTAL 1 [6]					20%	$17,000
MOBILIZATION @ 10% OF SUBTOTAL 1 [7]					10%	$8,600
SUBTOTAL 2						$110,000
INDIRECT COST (IDC) - CONSTRUCTION @ 9.64% OF SUBTOTAL 2 [8]					9.64%	$11,000
CONTINGENCY @ 20% & 30% OF SUBTOTAL 2 [9]					20%	$22,000
					30%	$33,000
TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [10]					$140,000	
TOTAL IMPROVEMENT OPTION COST @ 30% CONTINGENCY [10]					$150,000	

[1] One station is equal to 100 feet.
[2] Average MDT bid prices provided for the period January 2011 to December 2011.
[3] Cost estimates are provided in 2012 dollars. All dollar amounts are rounded for planning purposes.
[4] Typical section includes 0.5 ft of top course surfacing aggregate and 0.75 ft of crushed aggregate course.
[5] 3 ft average fill depth (edge of shoulder to bottom of embankment) with a 25% shrink factor is assumed throughout the corridor.
[6] The Miscellaneous category is estimated at 20 percent due to unknown factors including but not limited to excavation, embankment, topsoil, guardrail, BMPs, utilities, traffic control, noxious weeds, slope treatments, ditch or channel excavation, incidental pavement transitional areas, temporary striping, temporary water pollution/erosion control measures and public relations.
[7] The Mobilization category includes all costs incurred in assembling and transporting materials to the work site.
[8] Indirect costs are costs not directly associated with the construction of a project, but incurred during the construction processes. IDC percentage is subject to change.
[9] A contingency range of 20 to 30 percent was used due to the high degree of unknown factors over the planning horizon, as well as the substantial amount of items not accounted for in this planning level cost estimate.
[10] The Total Improvement Option Cost reflects an estimate of potential construction costs based on planning level estimates, and should not be considered an actual cost or encompassing all scenarios and circumstances.

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Option 3.a - RP 37.5 (COUNTY RD 112) INTERSECTION REALIGNMENT
Planning Level Estimate of Costs

Item Description	Approx. Quantity (Per Station) [1]	Unit	Average Bid Prices [2]		Adjusted Unit Prices	
			Unit Price	Amount	Unit Price	Amount [3]
			Dollars	Dollars	Dollars	Dollars
COUNTY RD 112 (RP 37.5)						
SURFACING AGGREGATE [4]	51	CUYD	$30.00	$1,530.00		$1,530.00
CRUSHED AGGREGATE COURSE [4]	100	CUYD	$18.79	$1,879.00		$1,879.00
EMBANKMENT IN PLACE [5]	325	CUYD	$6.83	$2,220.00		$2,220.00
COUNTY RD 112 (RP 37.5) SUBTOTAL				$5,543.00		$5,629
CATEGORY	LENGTH (STA.)	COST PER STATION				
COUNTY RD 112 (RP 37.5)	5.31	5,629.00			$30,000	
ROADWAY OBLITERATION	5.09	357.93			$1,800	
SUBTOTAL 1					$31,800	
ADDITIONAL COSTS						
MISCELLANEOUS @ 20% OF SUBTOTAL 1 [6]					20%	$6,400
MOBILIZATION @ 10% OF SUBTOTAL 1 [7]					10%	$3,200
SUBTOTAL 2						$40,000
INDIRECT COST (IDC) - CONSTRUCTION @ 9.64% OF SUBTOTAL 2 [8]					9.64%	$3,900
CONTINGENCY @ 20% & 30% OF SUBTOTAL 2 [9]					20%	$8,000
					30%	$12,000
TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [10]					$52,000	
TOTAL IMPROVEMENT OPTION COST @ 30% CONTINGENCY [10]					$56,000	

[1] One station is equal to 100 feet.
[2] Average MDT bid prices provided for the period January 2011 to December 2011.
[3] Cost estimates are provided in 2012 dollars. All dollar amounts are rounded for planning purposes.
[4] Typical section includes 0.5 ft of top course surfacing aggregate and 0.75 ft of crushed aggregate course.
[5] 3 ft average fill depth (edge of shoulder to bottom of embankment) with a 25% shrink factor is assumed throughout the corridor.
[6] The Miscellaneous category is estimated at 20 percent due to unknown factors including but not limited to excavation, embankment, topsoil, guardrail, BMPs, utilities, traffic control, noxious weeds, slope treatments, ditch or channel excavation, incidental pavement transitional areas, temporary striping, temporary water pollution/erosion control measures and public relations.
[7] The Mobilization category includes all costs incurred in assembling and transporting materials to the work site.
[8] Indirect costs are costs not directly associated with the construction of a project, but incurred during the construction processes. IDC percentage is subject to change.
[9] A contingency range of 20 to 30 percent was used due to the high degree of unknown factors over the planning horizon, as well as the substantial amount of items not accounted for in this planning level cost estimate.
[10] The Total Improvement Option Cost reflects an estimate of potential construction costs based on planning level estimates, and should not be considered an actual cost or encompassing all scenarios and circumstances.

Option 3.a - RP 42.3 (COUNTY RD 116) INTERSECTION REALIGNMENT
Planning Level Estimate of Costs

Item Description	Approx. Quantity (Per Station) [1]	Unit	Average Bid Prices [2]		Adjusted Unit Prices	
			Unit Price	Amount	Unit Price	Amount [3]
			Dollars	Dollars	Dollars	Dollars
COUNTY RD 116 (RP 42.3)						
SURFACING AGGREGATE [4]	51	CUYD	$30.00	$1,530.00		$1,530.00
CRUSHED AGGREGATE COURSE [4]	100	CUYD	$18.79	$1,879.00		$1,879.00
EMBANKMENT IN PLACE [5]	325	CUYD	$6.83	$2,220.00		$2,220.00
COUNTY RD 116 (RP 42.3) SUBTOTAL				$5,543.00		$5,629
CATEGORY	LENGTH (STA.)	COST PER STATION				
COUNTY RD 116 (RP 42.3)	16.52	5,629.00			$93,000	
ROADWAY OBLITERATION	14.82	357.93			$5,300	
SUBTOTAL 1					$98,300	
ADDITIONAL COSTS						
MISCELLANEOUS @ 20% OF SUBTOTAL 1 [6]					20%	$20,000
MOBILIZATION @ 10% OF SUBTOTAL 1 [7]					10%	$10,000
SUBTOTAL 2						$130,000
INDIRECT COST (IDC) - CONSTRUCTION @ 9.64% OF SUBTOTAL 2 [8]					9.64%	$13,000
CONTINGENCY @ 20% & 30% OF SUBTOTAL 2 [9]					20%	$26,000
					30%	$39,000
TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [10]					$170,000	
TOTAL IMPROVEMENT OPTION COST @ 30% CONTINGENCY [10]					$180,000	

[1] One station is equal to 100 feet.
[2] Average MDT bid prices provided for the period January 2011 to December 2011.
[3] Cost estimates are provided in 2012 dollars. All dollar amounts are rounded for planning purposes.
[4] Typical section includes 0.5 ft of top course surfacing aggregate and 0.75 ft of crushed aggregate course.
[5] 3 ft average fill depth (edge of shoulder to bottom of embankment) with a 25% shrink factor is assumed throughout the corridor.
[6] The Miscellaneous category is estimated at 20 percent due to unknown factors including but not limited to excavation, embankment, topsoil, guardrail, BMPs, utilities, traffic control, noxious weeds, slope treatments, ditch or channel excavation, incidental pavement transitional areas, temporary striping, temporary water pollution/erosion control measures and public relations.
[7] The Mobilization category includes all costs incurred in assembling and transporting materials to the work site.
[8] Indirect costs are costs not directly associated with the construction of a project, but incurred during the construction processes. IDC percentage is subject to change.
[9] A contingency range of 20 to 30 percent was used due to the high degree of unknown factors over the planning horizon, as well as the substantial amount of items not accounted for in this planning level cost estimate.
[10] The Total Improvement Option Cost reflects an estimate of potential construction costs based on planning level estimates, and should not be considered an actual cost or encompassing all scenarios and circumstances.

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Option 3.a - RP 43.6 (COUNTY RD 117) INTERSECTION REALIGNMENT
Planning Level Estimate of Costs

Item Description	Approx. Quantity (Per Station) [1]	Unit	Average Bid Prices [2]		Adjusted Unit Prices	
			Unit Price	Amount	Unit Price	Amount [3]
			Dollars	Dollars	Dollars	Dollars
COUNTY RD 117 (RP 43.6)						
SURFACING AGGREGATE [4]	51	CUYD	$30.00	$1,530.00		$1,530.00
CRUSHED AGGREGATE COURSE [4]	100	CUYD	$18.79	$1,879.00		$1,879.00
EMBANKMENT IN PLACE [5]	325	CUYD	$6.83	$2,220.00		$2,220.00
COUNTY RD 117 (RP 43.6) SUBTOTAL				$5,543.00		$5,629
CATEGORY	LENGTH (STA.)	COST PER STATION				
COUNTY RD 117 (RP 43.6)	17.72	5,629.00			$100,000	
ROADWAY OBLITERATION	15.61	357.93			$5,600	
SUBTOTAL 1					$105,600	
ADDITIONAL COSTS						
MISCELLANEOUS @ 20% OF SUBTOTAL 1 [6]					20%	$21,000
MOBILIZATION @ 10% OF SUBTOTAL 1 [7]					10%	$11,000
SUBTOTAL 2						$140,000
INDIRECT COST (IDC) - CONSTRUCTION @ 9.64% OF SUBTOTAL 2 [8]					9.64%	$13,000
CONTINGENCY @ 20% & 30% OF SUBTOTAL 2 [9]					20%	$28,000
					30%	$42,000
TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [10]					$180,000	
TOTAL IMPROVEMENT OPTION COST @ 30% CONTINGENCY [10]					$200,000	

[1] One station is equal to 100 feet.
[2] Average MDT bid prices provided for the period January 2011 to December 2011.
[3] Cost estimates are provided in 2012 dollars. All dollar amounts are rounded for planning purposes.
[4] Typical section includes 0.5 ft of top course surfacing aggregate and 0.75 ft of crushed aggregate course.
[5] 3 ft average fill depth (edge of shoulder to bottom of embankment) with a 25% shrink factor is assumed throughout the corridor.
[6] The Miscellaneous category is estimated at 20 percent due to unknown factors including but not limited to excavation, embankment, topsoil, guardrail, BMPs, utilities, traffic control, noxious weeds, slope treatments, ditch or channel excavation, incidental pavement transitional areas, temporary striping, temporary water pollution/erosion control measures and public relations.
[7] The Mobilization category includes all costs incurred in assembling and transporting materials to the work site.
[8] Indirect costs are costs not directly associated with the construction of a project, but incurred during the construction processes. IDC percentage is subject to change.
[9] A contingency range of 20 to 30 percent was used due to the high degree of unknown factors over the planning horizon, as well as the substantial amount of items not accounted for in this planning level cost estimate.
[10] The Total Improvement Option Cost reflects an estimate of potential construction costs based on planning level estimates, and should not be considered an actual cost or encompassing all scenarios and circumstances.

Option 3.a - RP 46.9 (COUNTY RD 348) INTERSECTION REALIGNMENT
Planning Level Estimate of Costs

Item Description	Approx. Quantity (Per Station) [1]	Unit	Average Bid Prices [2]		Adjusted Unit Prices	
			Unit Price Dollars	Amount Dollars	Unit Price Dollars	Amount [3] Dollars
COUNTY RD 348 (RP 46.9)						
SURFACING AGGREGATE [4]	51	CUYD	$30.00	$1,530.00		$1,530.00
CRUSHED AGGREGATE COURSE [4]	100	CUYD	$18.79	$1,879.00		$1,879.00
EMBANKMENT IN PLACE [5]	325	CUYD	$6.83	$2,220.00		$2,220.00
COUNTY RD 348 (RP 46.9) SUBTOTAL				$5,543.00		$5,629
CATEGORY	LENGTH (STA.)	COST PER STATION				
COUNTY RD 348 (RP 46.9)	7.67	5,629.00			$43,000	
ROADWAY OBLITERATION	14.00	357.93			$5,000	
SUBTOTAL 1					$48,000	
ADDITIONAL COSTS						
MISCELLANEOUS @ 20% OF SUBTOTAL 1 [6]					20%	$10,000
MOBILIZATION @ 10% OF SUBTOTAL 1 [7]					10%	$4,800
SUBTOTAL 2						$60,000
INDIRECT COST (IDC) - CONSTRUCTION @ 9.64% OF SUBTOTAL 2 [8]					9.64%	$5,800
CONTINGENCY @ 20% & 30% OF SUBTOTAL 2 [9]					20%	$12,000
					30%	$18,000
TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [10]					$78,000	
TOTAL IMPROVEMENT OPTION COST @ 30% CONTINGENCY [10]					$84,000	

[1] One station is equal to 100 feet.
[2] Average MDT bid prices provided for the period January 2011 to December 2011.
[3] Cost estimates are provided in 2012 dollars. All dollar amounts are rounded for planning purposes.
[4] Typical section includes 0.5 ft of top course surfacing aggregate and 0.75 ft of crushed aggregate course.
[5] 3 ft average fill depth (edge of shoulder to bottom of embankment) with a 25% shrink factor is assumed throughout the corridor.
[6] The Miscellaneous category is estimated at 20 percent due to unknown factors including but not limited to excavation, embankment, topsoil, guardrail, BMPs, utilities, traffic control, noxious weeds, slope treatments, ditch or channel excavation, incidental pavement transitional areas, temporary striping, temporary water pollution/erosion control measures and public relations.
[7] The Mobilization category includes all costs incurred in assembling and transporting materials to the work site.
[8] Indirect costs are costs not directly associated with the construction of a project, but incurred during the construction processes. IDC percentage is subject to change.
[9] A contingency range of 20 to 30 percent was used due to the high degree of unknown factors over the planning horizon, as well as the substantial amount of items not accounted for in this planning level cost estimate.
[10] The Total Improvement Option Cost reflects an estimate of potential construction costs based on planning level estimates, and should not be considered an actual cost or encompassing all scenarios and circumstances.

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Option 3.a - RP 58.0 (COUNTY RD 130) INTERSECTION REALIGNMENT
Planning Level Estimate of Costs

Item Description	Approx. Quantity (Per Station) [1]	Unit	Average Bid Prices [2]		Adjusted Unit Prices	
			Unit Price	Amount	Unit Price	Amount [3]
			Dollars	Dollars	Dollars	Dollars
COUNTY RD 130 (RP 58.0)						
SURFACING AGGREGATE [4]	51	CUYD	$30.00	$1,530.00		$1,530.00
CRUSHED AGGREGATE COURSE [4]	100	CUYD	$18.79	$1,879.00		$1,879.00
EMBANKMENT IN PLACE [5]	325	CUYD	$6.83	$2,220.00		$2,220.00
COUNTY RD 130 (RP 58.0) SUBTOTAL				$5,543.00		$5,629
CATEGORY	LENGTH (STA.)	COST PER STATION				
COUNTY RD 130 (RP 58.0)	4.45	5,629.00			$25,000	
ROADWAY OBLITERATION	4.60	357.93			$1,600	
SUBTOTAL 1					$26,600	
ADDITIONAL COSTS						
MISCELLANEOUS @ 20% OF SUBTOTAL 1 [6]					20%	$5,300
MOBILIZATION @ 10% OF SUBTOTAL 1 [7]					10%	$2,700
SUBTOTAL 2						$30,000
INDIRECT COST (IDC) - CONSTRUCTION @ 9.64% OF SUBTOTAL 2 [8]					9.64%	$2,900
CONTINGENCY @ 20% & 30% OF SUBTOTAL 2 [9]					20%	$6,000
					30%	$9,000
TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [10]					$39,000	
TOTAL IMPROVEMENT OPTION COST @ 30% CONTINGENCY [10]					$42,000	

[1] One station is equal to 100 feet.
[2] Average MDT bid prices provided for the period January 2011 to December 2011.
[3] Cost estimates are provided in 2012 dollars. All dollar amounts are rounded for planning purposes.
[4] Typical section includes 0.5 ft of top course surfacing aggregate and 0.75 ft of crushed aggregate course.
[5] 3 ft average fill depth (edge of shoulder to bottom of embankment) with a 25% shrink factor is assumed throughout the corridor.
[6] The Miscellaneous category is estimated at 20 percent due to unknown factors including but not limited to excavation, embankment, topsoil, guardrail, BMPs, utilities, traffic control, noxious weeds, slope treatments, ditch or channel excavation, incidental pavement transitional areas, temporary striping, temporary water pollution/erosion control measures and public relations.
[7] The Mobilization category includes all costs incurred in assembling and transporting materials to the work site.
[8] Indirect costs are costs not directly associated with the construction of a project, but incurred during the construction processes. IDC percentage is subject to change.
[9] A contingency range of 20 to 30 percent was used due to the high degree of unknown factors over the planning horizon, as well as the substantial amount of items not accounted for in this planning level cost estimate.
[10] The Total Improvement Option Cost reflects an estimate of potential construction costs based on planning level estimates, and should not be considered an actual cost or encompassing all scenarios and circumstances.

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Option 3.b - 4-LANE TO 2-LANE HIGHWAY TRANSITION
Planning Level Estimate of Costs

Item Description	Approx. Quantity (Per Station) [1]	Unit	Average Bid Prices [2]		Adjusted Unit Prices	
			Unit Price	Amount	Unit Price	Amount [3]
			Dollars	Dollars	Dollars	Dollars
4-LANE TO 2-LANE HIGHWAY TRANSITION						
COLD MILL	800.00	SQYD	$1.29	$1,032.00		$1,032.00
EXCAVATION-UNCLASS BORROW [4]	286.00	CUYD	$4.67	$1,336.00		$1,336.00
EMBANKMENT IN PLACE [5]	1,430.00	CUYD	$6.83	$9,767.00		$9,767.00
CRUSHED AGGREGATE COURSE [6]	57.60	CUYD	$18.79	$1,082.00		$1,082.00
SPECIAL BORROW - NEAT LINE [6]	318.20	CUYD	$15.41	$4,903.00		$4,903.00
COVER - TYPE 2	444.00	SQYD	$0.51	$226.00		$226.00
DUST PALLIATIVE	0.52	TON		$0.00	$120.00	$62.00
PLANT MIX BIT SURF GR S-3/4 IN [6]	117.60	TON	$25.37	$2,984.00		$2,984.00
ASPHALT CEMENT PG 64 64-28	6.35	TON	$674.59	$4,284.00		$4,284.00
EMULS ASPHALT CRS-2P	0.79	TON	$578.92	$457.00		$457.00
STRIPING-WHITE EPOXY	1.00	GAL	$61.96	$62.00		$62.00
STRIPING-YELLOW EPOXY	1.00	GAL	$62.79	$63.00		$63.00
TRANSITION COST PER STATION						$26,258
SUBTOTAL 1					$26,258	
ADDITIONAL COSTS						
MISCELLANEOUS @ 20% OF SUBTOTAL 1 [12]					20%	$5,300
MOBILIZATION @ 10% OF SUBTOTAL 1 [13]					10%	$2,600
SUBTOTAL 2						$34,000
INDIRECT COST (IDC) - CONSTRUCTION @ 9.64% OF SUBTOTAL 2 [14]					9.64%	$3,300
CONTINGENCY @ 20% & 30% OF SUBTOTAL 2 [15]					20%	$6,800
					30%	$10,200
TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [16]					$44,000	
TOTAL IMPROVEMENT OPTION COST @ 30% CONTINGENCY [16]					$48,000	

[1] One station is equal to 100 feet.
[2] Average MDT bid prices provided for the period January 2011 to December 2011.
[3] Cost estimates are provided in 2012 dollars. All dollar amounts are rounded for planning purposes.
[4] 5 ft average cut depth (below subgrade) is assumed throughout the corridor.
[5] 8 ft average fill depth (below subgrade) with a 25% shrink factor is assumed throughout the corridor.
[6] Typical section includes 0.5 ft of PMBS, 0.5 ft of crushed aggregate course, and 2 ft of special borrow.
[7] Typical section includes 0.54 ft of PMBS, 1 ft of crushed aggregate course, and 2 ft of special borrow.
[8] Deck width only includes required width for expansion.
[9] Average bridge cost includes reconstruction of abutments and intermediate substructure.
[10] Complete culvert replacement is assumed.
[11] 24" culvert diameter & 90 ft length is assumed for all culverts not classified as bridges.
[12] The Miscellaneous category is estimated at 20 percent due to unknown factors including but not limited to excavation, embankment, topsoil, guardrail, BMPs, utilities, traffic control, noxious weeds, slope treatments, ditch or channel excavation, incidental pavement transitional areas, temporary striping, temporary water pollution/erosion control measures and public relations.
[13] The Mobilization category includes all costs incurred in assembling and transporting materials to the work site.
[14] Indirect costs are costs not directly associated with the construction of a project, but incurred during the construction processes. IDC percentage is subject to change.
[15] A contingency range of 20 to 30 percent was used due to the high degree of unknown factors over the planning horizon, as well as the substantial amount of items not accounted for in this planning level cost estimate.
[16] The Total Improvement Option Cost reflects an estimate of potential construction costs based on planning level estimates, and should not be considered an actual cost or encompassing all scenarios and circumstances.

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Option 4.a - TWO-WAY PASSING LANE EXPANSION
Planning Level Estimate of Costs

Item Description	Approx. Quantity (Per Station) [1]	Unit	Average Bid Prices [2]		Adjusted Unit Prices	
			Unit Price	Amount	Unit Price	Amount [3]
			Dollars	Dollars	Dollars	Dollars
TWO-WAY PASSING LANE EXPANSION (4-LANE)						
COLD MILL	800.00	SQYD	$1.29	$1,032.00		$1,032.00
EXCAVATION-UNCLASS BORROW [4]	187.70	CUYD	$4.67	$877.00		$877.00
EMBANKMENT IN PLACE [5]	137.13	CUYD	$6.83	$937.00		$937.00
CRUSHED AGGREGATE COURSE [6]	193.90	CUYD	$18.79	$3,643.00		$3,643.00
SPECIAL BORROW - NEAT LINE [6]	337.00	CUYD	$15.41	$5,193.00		$5,193.00
COVER - TYPE 2	444.00	SQYD	$0.51	$226.00		$226.00
DUST PALLIATIVE	0.52	TON		$0.00	$120.00	$62.00
PLANT MIX BIT SURF GR S-3/4 IN [6]	121.90	TON	$25.37	$3,093.00		$3,093.00
ASPHALT CEMENT PG 64 64-28	6.58	TON	$674.59	$4,439.00		$4,439.00
EMULS ASPHALT CRS-2P	0.79	TON	$578.92	$457.00		$457.00
STRIPING-WHITE EPOXY	1.00	GAL	$61.96	$62.00		$62.00
STRIPING-YELLOW EPOXY	1.00	GAL	$62.79	$63.00		$63.00
TWO-WAY PASSING LANE EXPANSION (4-LANE) SUBTOTAL				$18,990.00		$20,084

CATEGORY	LENGTH (STA.)	COST PER STATION	SUBTOTAL 1
TWO-WAY PASSING LANE EXPANSION (4-LANE)	52.80	20,084.00	$1,100,000

ADDITIONAL COSTS		
MISCELLANEOUS @ 20% OF SUBTOTAL 1 [7]	20%	$220,000
MOBILIZATION @ 10% OF SUBTOTAL 1 [8]	10%	$110,000
SUBTOTAL 2		$1,400,000
INDIRECT COST (IDC) - CONSTRUCTION @ 9.64% OF SUBTOTAL 2 [9]	9.64%	$130,000
CONTINGENCY @ 20% & 30% OF SUBTOTAL 2 [10]	20%	$280,000
	30%	$420,000
TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [11]	$1,800,000	
TOTAL IMPROVEMENT OPTION COST @ 30% CONTINGENCY [11]	$2,000,000	

[1] One station is equal to 100 feet.
[2] Average MDT bid prices provided for the period January 2011 to December 2011.
[3] Cost estimates are provided in 2012 dollars. All dollar amounts are rounded for planning purposes.
[4] Excavation only assumed where crushed aggregate course expansion will replace existing embankment.
[5] Typical section includes 0.52 ft of plant mix bituminous surface, 0.75 ft of crushed aggregate course, and 2 ft of special borrow.
[6] 5 ft average fill depth (edge of shoulder to bottom of embankment) with a 25% shrink factor is assumed throughout the corridor.
[7] The Miscellaneous category is estimated at 20 percent due to unknown factors including but not limited to excavation, embankment, topsoil, guardrail, BMPs, utilities, traffic control, noxious weeds, slope treatments, ditch or channel excavation, incidental pavement transitional areas, temporary striping, temporary water pollution/erosion control measures and public relation
[8] The Mobilization category includes all costs incurred in assembling and transporting materials to the work site.
[9] Indirect costs are costs not directly associated with the construction of a project, but incurred during the construction processes. IDC percentage is subject to change.
[10] A contingency range of 20 to 30 percent was used due to the high degree of unknown factors over the planning horizon, as well as the substantial amount of items not accounted for in this planning level cost estimate.
[11] The Total Improvement Option Cost reflects an estimate of potential construction costs based on planning level estimates, and should not be considered an actual cost or encompassing all scenarios and circumstances.

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Option 4.c - FOUR-LANE EXPANSION
Planning Level Estimate of Costs

Item Description	Approx. Quantity (Per Station) [1]	Unit	Average Bid Prices [2]		Adjusted Unit Prices	
			Unit Price	Amount	Unit Price	Amount [3]
			Dollars	Dollars	Dollars	Dollars
TWO-WAY PASSING LANE EXPANSION (4-LANE)						
MT 16						
COLD MILL	800.00	SQYD	$1.29	$1,032.00		$1,032.00
EXCAVATION-UNCLASS BORROW [4]	286.00	CUYD	$4.67	$1,336.00		$1,336.00
EMBANKMENT IN PLACE [5]	1,430.00	CUYD	$6.83	$9,767.00		$9,767.00
CRUSHED AGGREGATE COURSE [6]	57.60	CUYD	$18.79	$1,082.00		$1,082.00
SPECIAL BORROW - NEAT LINE [6]	318.20	CUYD	$15.41	$4,903.00		$4,903.00
COVER - TYPE 2	444.00	SQYD	$0.51	$226.00		$226.00
DUST PALLIATIVE	0.52	TON		$0.00	$120.00	$62.00
PLANT MIX BIT SURF GR S-3/4 IN [6]	117.60	TON	$25.37	$2,984.00		$2,984.00
ASPHALT CEMENT PG 64 64-28	6.35	TON	$674.59	$4,284.00		$4,284.00
EMULS ASPHALT CRS-2P	0.79	TON	$578.92	$457.00		$457.00
STRIPING-WHITE EPOXY	1.00	GAL	$61.96	$62.00		$62.00
STRIPING-YELLOW EPOXY	1.00	GAL	$62.79	$63.00		$63.00
MT 16 SUBTOTAL				$26,196.00		$26,258
MT 200						
COLD MILL	800.00	SQYD	$1.29	$1,032.00		$1,032.00
EXCAVATION-UNCLASS BORROW [4]	715.00	CUYD	$4.67	$3,339.00		$3,339.00
EMBANKMENT IN PLACE [5]	1,430.00	CUYD	$6.83	$9,767.00		$9,767.00
CRUSHED AGGREGATE COURSE [7]	125.50	CUYD	$18.79	$2,358.00		$2,358.00
SPECIAL BORROW - NEAT LINE [7]	356.20	CUYD	$15.41	$5,489.00		$5,489.00
COVER - TYPE 2	444.00	SQYD	$0.51	$226.00		$226.00
DUST PALLIATIVE	0.52	TON		$0.00	$120.00	$62.00
PLANT MIX BIT SURF GR S-3/4 IN [7]	126.20	TON	$25.37	$3,202.00		$3,202.00
ASPHALT CEMENT PG 64 64-28	6.81	TON	$674.59	$4,594.00		$4,594.00
EMULS ASPHALT CRS-2P	0.79	TON	$578.92	$457.00		$457.00
STRIPING-WHITE EPOXY	1.00	GAL	$61.96	$62.00		$62.00
STRIPING-YELLOW EPOXY	1.00	GAL	$62.79	$63.00		$63.00
MT 200 SUBTOTAL				$30,589.00		$30,651

CATEGORY	LENGTH (STA.)	COST PER STATION	SUBTOTAL
MT 16 FOUR LANE EXPANSION	2629.44	26,258.00	$69,044,000
MT 200 FOUR LANE EXPANSION	522.72	30,651.00	$16,022,000

CATEGORY	LENGTH (FT.)	WIDTH (FT.) [8]	COST PER FT/FT^2 [9]	SUBTOTAL
BRIDGE/CULVERT CONSTRUCTION				
DEER CREEK	112.0	24.00	$125.00	$336,000
THREE MILE CREEK [10]	106.6		$1,371.60	$146,213
LOWER 7 MILE CREEK	132.0	24.00	$125.00	$396,000
MORGAN CREEK	122.0	24.00	$125.00	$366,000
THIRTEEN MILE CREEK	332.0	24.00	$160.00	$1,274,880
BURNS CREEK	195.6	24.00	$125.00	$586,800
GARDEN COULEE / STOCKPASS [10]	147.5		$740.00	$109,150
USBR MAIN CANAL	95.0	24.00	$125.00	$285,000
DUNLAP CREEK	122.0	24.00	$125.00	$366,000
USBR MAIN CANAL	75.0	24.00	$125.00	$225,000
USBR MAIN CANAL	94.0	24.00	$125.00	$282,000
CRANE CREEK [10]	127.0		$1,600.00	$203,200
FOX CREEK	183.0	24.00	$125.00	$549,000
FIRST HAY CREEK	109.5	24.00	$125.00	$328,500
SECOND HAY CREEK [10]	127.0		$442.50	$56,198
ALL OTHER CULVERTS [11]				$188,000
BRIDGE COST SUBTOTAL				$5,509,940
			SUBTOTAL 1	$90,600,000

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Option 4.c - FOUR-LANE EXPANSION
Planning Level Estimate of Costs

Item Description	Approx. Quantity (Per Station) [1]	Unit	Average Bid Prices [2]		Adjusted Unit Prices	
			Unit Price	Amount	Unit Price	Amount [3]
			Dollars	Dollars	Dollars	Dollars
ADDITIONAL COSTS						
MISCELLANEOUS @ 20% OF SUBTOTAL 1 [12]					20%	$18,100,000
MOBILIZATION @ 10% OF SUBTOTAL 1 [13]					10%	$9,100,000
SUBTOTAL 2						$117,800,000
INDIRECT COST (IDC) - CONSTRUCTION @ 9.64% OF SUBTOTAL 2 [14]					9.64%	$11,400,000
CONTINGENCY @ 20% & 30% OF SUBTOTAL 2 [15]					20%	$23,600,000
					30%	$35,300,000
TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [16]					$152,800,000	
TOTAL IMPROVEMENT OPTION COST @ 30% CONTINGENCY [16]					$164,500,000	

[1] One station is equal to 100 feet.
[2] Average MDT bid prices provided for the period January 2011 to December 2011.
[3] Cost estimates are provided in 2012 dollars. All dollar amounts are rounded for planning purposes.
[4] 5 ft average cut depth (below subgrade) is assumed throughout the corridor.
[5] 8 ft average fill depth (below subgrade) with a 25% shrink factor is assumed throughout the corridor.
[6] Typical section includes 0.5 ft of PMBS, 0.5 ft of crushed aggregate course, and 2 ft of special borrow.
[7] Typical section includes 0.54 ft of PMBS, 1 ft of crushed aggregate course, and 2 ft of special borrow.
[8] Deck width only includes required width for expansion.
[9] Average bridge cost includes reconstruction of abutments and intermediate substructure.
[10] Complete culvert replacement is assumed.
[11] 24" culvert diameter & 90 ft length is assumed for all culverts not classified as bridges.
[12] The Miscellaneous category is estimated at 20 percent due to unknown factors including but not limited to excavation, embankment, topsoil, guardrail, BMPs, utilities, traffic control, noxious weeds, slope treatments, ditch or channel excavation, incidental pavement transitional areas, temporary striping, temporary water pollution/erosion control measures and public relation
[13] The Mobilization category includes all costs incurred in assembling and transporting materials to the work site.
[14] Indirect costs are costs not directly associated with the construction of a project, but incurred during the construction processes. IDC percentage is subject to change.
[15] A contingency range of 20 to 30 percent was used due to the high degree of unknown factors over the planning horizon, as well as the substantial amount of items not accounted for in this planning level cost estimate.
[16] The Total Improvement Option Cost reflects an estimate of potential construction costs based on planning level estimates, and should not be considered an actual cost or encompassing all scenarios and circumstances.

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Option 5.a - MILL & OVERLAY
Planning Level Estimate of Costs

Item Description	Approx. Quantity (Per Station) [1]	Unit	Average Bid Prices [2]		Adjusted Unit Prices	
			Unit Price	Amount	Unit Price	Amount [3]
			Dollars	Dollars	Dollars	Dollars
MILL & OVERLAY						
MT 16						
COLD MILL	4,000.00	SQYD	$1.29	$5,160.00		$5,160.00
COVER - TYPE 2	444.00	SQYD	$0.51	$226.00		$226.00
PLANT MIX BIT SURF GR S-3/4 IN [4]	71.40	TON	$25.37	$1,811.00		$1,811.00
ASPHALT CEMENT PG 64 64-28	3.86	TON	$674.59	$2,604.00		$2,604.00
EMULS ASPHALT CRS-2P	0.79	TON	$578.92	$457.00		$457.00
STRIPING-WHITE EPOXY	1.00	GAL	$61.96	$62.00		$62.00
STRIPING-YELLOW EPOXY	1.00	GAL	$62.79	$63.00		$63.00
MT 16 SUBTOTAL				$10,383.00		$10,383
MT 200						
COLD MILL	4,000.00	SQYD	$1.29	$5,160.00		$5,160.00
COVER - TYPE 2	444.00	SQYD	$0.51	$226.00		$226.00
PLANT MIX BIT SURF GR S-3/4 IN [5]	142.80	TON	$25.37	$3,623.00		$3,623.00
ASPHALT CEMENT PG 64 64-28	7.71	TON	$674.59	$5,201.00		$5,201.00
EMULS ASPHALT CRS-2P	0.79	TON	$578.92	$457.00		$457.00
STRIPING-WHITE EPOXY	1.00	GAL	$61.96	$62.00		$62.00
STRIPING-YELLOW EPOXY	1.00	GAL	$62.79	$63.00		$63.00
MT 200 SUBTOTAL				$14,792.00		$14,792
CATEGORY	LENGTH (STA.)	COST PER STATION			SUBTOTAL	
MT 16 MILL & OVERLAY	2629.44	10,383.00			$27,300,000	
MT 200 MILL & OVERLAY	522.72	14,792.00			$7,700,000	
SUBTOTAL 1					$35,000,000	
ADDITIONAL COSTS						
MISCELLANEOUS @ 20% OF SUBTOTAL 1 [6]					20%	$7,000,000
MOBILIZATION @ 10% OF SUBTOTAL 1 [7]					10%	$3,500,000
SUBTOTAL 2						$45,500,000
INDIRECT COST (IDC) - CONSTRUCTION @ 9.64% OF SUBTOTAL 2 [8]					9.64%	$4,400,000
CONTINGENCY @ 20% & 30% OF SUBTOTAL 2 [9]					20%	$9,100,000
					30%	$13,700,000
TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [10]					$59,000,000	
TOTAL IMPROVEMENT OPTION COST @ 30% CONTINGENCY [10]					$63,600,000	

[1] One station is equal to 100 feet.
[2] Average MDT bid prices provided for the period January 2011 to December 2011.
[3] Cost estimates are provided in 2012 dollars. All dollar amounts are rounded for planning purposes.
[4] A 3-inch overlay is recommended for the MT 16 corridor.
[5] A 6-inch overlay is recommended for the MT 200 corridor.
[6] The Miscellaneous category is estimated at 20 percent due to unknown factors including but not limited to excavation, embankment, topsoil, guardrail, BMPs, utilities, traffic control, noxious weeds, slope treatments, ditch or channel excavation, incidental pavement transitional areas, temporary striping, temporary water pollution/erosion control measures and public relation
[7] The Mobilization category includes all costs incurred in assembling and transporting materials to the work site.
[8] Indirect costs are costs not directly associated with the construction of a project, but incurred during the construction processes. IDC percentage is subject to change.
[9] A contingency range of 20 to 30 percent was used due to the high degree of unknown factors over the planning horizon, as well as the substantial amount of items not accounted for in this planning level cost estimate.
[10] The Total Improvement Option Cost reflects an estimate of potential construction costs based on planning level estimates, and should not be considered an actual cost or encompassing all scenarios and circumstances.

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Option 6 - PARK & RIDE FACILITY
Planning Level Estimate of Costs

Item Description	Approx. Quantity	Unit	Average Bid Prices [2]		Adjusted Unit Prices	
			Unit Price	Amount	Unit Price	Amount [3]
			Dollars	Dollars	Dollars	Dollars
PARK & RIDE FACILITY[1]						
EXCAVATION-UNCLASS BORROW [4]	474.07	CUYD	$4.67	$2,214.00		$2,214.00
EMBANKMENT IN PLACE [5]	1,185.19	CUYD	$6.83	$8,095.00		$8,095.00
CRUSHED AGGREGATE COURSE [6]	237.04	CUYD	$18.79	$4,454.00		$4,454.00
COVER - TYPE 2	1,422.20	SQYD	$0.51	$725.00		$725.00
DUST PALLIATIVE	2.30	TON		$0.00	$120.00	$276.00
PLANT MIX BIT SURF GR S-3/4 IN [6]	266.52	TON	$25.37	$6,762.00		$6,762.00
ASPHALT CEMENT PG 64 64-28	14.39	TON	$674.59	$9,707.00		$9,707.00
EMULS ASPHALT CRS-2P	2.54	TON	$578.92	$1,470.00		$1,470.00
STRIPING-WHITE EPOXY	1.00	GAL	$61.96	$62.00		$62.00
0.1 ACRE LOT	1.00	LS	$20,000.00	$20,000.00		$20,000.00
CONCRETE CURB & GUTTER	480.00	LF	$17.04	$8,179.00		$8,179.00
TYPE B CURB INLET	2.00	EA	$2,304.81	$4,610.00		$4,610.00
RCP IRR 18" CLASS 2	100.00	LF	$47.19	$4,719.00		$4,719.00
COVERED PEDESTRIAN SHELTER	1.00	LS	$55,000.00	$55,000.00		$55,000.00
LANDSCAPING/SPRINKLERS	1.00	LS	$8,000.00	$8,000.00		$8,000.00
LIGHTING/SIGNING	1.00	LS	$10,000.00	$10,000.00		$10,000.00
BICYCLE RACKS	3.00	EA	$450.00	$1,350.00		$1,350.00
BICYCLE LOCKERS	15.00	EA	$1,000.00	$15,000.00		$15,000.00
PARK & RIDE FACILITY SUBTOTAL 1					$160,623.00	
MISCELLANEOUS @ 20% OF SUBTOTAL 1 [7]					20%	$32,000
MOBILIZATION @ 10% OF SUBTOTAL 1 [8]					10%	$16,000
SUBTOTAL 2						$210,000
INDIRECT COST (IDC) - CONSTRUCTION @ 9.64% OF SUBTOTAL 2 [9]					9.64%	$20,000
CONTINGENCY @ 20% & 30% OF SUBTOTAL 2 [10]					20%	$42,000
					30%	$63,000
TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [11]					$270,000	
TOTAL IMPROVEMENT OPTION COST @ 30% CONTINGENCY [11]					$290,000	

[1] Assumed facility is 0.1 acre lot with 80 ft x 160 ft parking lot providing ~35 parking spaces.
[2] Average MDT bid prices provided for the period January 2011 to December 2011.
[3] Cost estimates are provided in 2012 dollars. All dollar amounts are rounded for planning purposes.
[4] 1 ft average excavation depth.
[5] 2 ft average fill depth with a 25% shrink factor.
[6] Assumed material thicknesses: 0.3 ft of PMBS and 0.50 ft of crushed aggregate course.
[7] The Miscellaneous category is estimated at 20 percent due to unknown factors including but not limited to excavation, embankment, topsoil, BMPs, utilities, traffic control, noxious weeds, slope treatments, ditch or channel excavation, incidental pavement transitional areas, temporary striping, temporary water pollution/erosion control measures and public relation
[8] The Mobilization category includes all costs incurred in assembling and transporting materials to the work site.
[9] Indirect costs are costs not directly associated with the construction of a project, but incurred during the construction processes. IDC percentage is subject to change.
[10] A contingency range of 20 to 30 percent was used due to the high degree of unknown factors over the planning horizon, as well as the substantial amount of items not accounted for in this planning level cost estimate.
[11] The Total Improvement Option Cost reflects an estimate of potential construction costs based on planning level estimates, and should not be considered an actual cost or encompassing all scenarios and circumstances.

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Option 7 - OVERHEAD SIGN RELOCATION
Planning Level Estimate of Costs

Item Description	Approx. Quantity	Unit	Average Bid Prices [1]		Adjusted Unit Prices	
			Unit Price	Amount	Unit Price	Amount [2]
			Dollars	Dollars	Dollars	Dollars
OVERHEAD SIGN RELOCATION						
REMOVE OVERHEAD SIGN STRUCTURE	1.00	EA	$1,210.00	$1,210.00		$1,210.00
FOUNDATION CONCRETE	2.50	CUYD	$942.53	$2,356.00		$2,356.00
SIGNS-ALUM REFL SHEET IX	35.00	SQFT	$41.48	$1,452.00		$1,452.00
OVERHEAD STR/METAL-CANTILEVER	1.00	EA	$20,650.62	$20,651.00		$20,651.00
REINFORCING STEEL	176.00	LB	$1.15	$202.00		$202.00
OVERHEAD SIGN RELOCATION SUBTOTAL 1					$25,871.00	
MISCELLANEOUS @ 20% OF SUBTOTAL 1 [3]					20%	$5,000
MOBILIZATION @ 10% OF SUBTOTAL 1 [4]					10%	$3,000
SUBTOTAL 2						$30,000
INDIRECT COST (IDC) - CONSTRUCTION @ 9.64% OF SUBTOTAL 2 [5]					9.64%	$3,000
CONTINGENCY @ 20% & 30% OF SUBTOTAL 2 [6]					20%	$6,000
					30%	$9,000
TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [7]					$40,000	
TOTAL IMPROVEMENT OPTION COST @ 30% CONTINGENCY [7]					$40,000	

[1] Average MDT bid prices provided for the period January 2011 to December 2011.
[2] Cost estimates are provided in 2012 dollars. All dollar amounts are rounded for planning purposes.
[3] The Miscellaneous category is estimated at 20 percent due to unknown factors including but not limited to excavation, embankment, topsoil, BMPs, utilities, traffic control, noxious weeds, slope treatments, ditch or channel excavation, incidental pavement transitional areas, temporary striping, temporary water pollution/erosion control measures and public relation
[4] The Mobilization category includes all costs incurred in assembling and transporting materials to the work site.
[5] Indirect costs are costs not directly associated with the construction of a project, but incurred during the construction processes. IDC percentage is subject to change.
[6] A contingency range of 20 to 30 percent was used due to the high degree of unknown factors over the planning horizon, as well as the substantial amount of items not accounted for in this planning level cost estimate.
[7] The Total Improvement Option Cost reflects an estimate of potential construction costs based on planning level estimates, and should not be considered an actual cost or encompassing all scenarios and circumstances.

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Option 9.b - RESTRIPING
Planning Level Estimate of Costs

Item Description	Approx. Quantity (Per Station) [1]	Unit	Average Bid Prices [2]		Adjusted Unit Prices	
			Unit Price	Amount	Unit Price	Amount [3]
			Dollars	Dollars	Dollars	Dollars
CORRIDOR RESTRIPING						
STRIPING-WHITE EPOXY	0.40	GAL	$58.34	$23.00		$23.00
STRIPING-YELLOW EPOXY	0.40	GAL	$58.99	$24.00		$24.00
CORRIDOR RESTRIPING SUBTOTAL				$47.00		$47
CATEGORY	LENGTH (STA.)	COST PER STATION			SUBTOTAL 1	
CORRIDOR RESTRIPING	3152.10	47.00			$150,000	
ADDITIONAL COSTS						
MOBILIZATION @ 10% OF SUBTOTAL 1 [4]					10%	$15,000
SUBTOTAL 2						$170,000
INDIRECT COST (IDC) - CONSTRUCTION @ 9.64% OF SUBTOTAL 2 [5]					9.64%	$16,000
CONTINGENCY @ 20% & 30% OF SUBTOTAL 2 [6]					20%	$34,000
					30%	$51,000
TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [7]					$220,000	
TOTAL IMPROVEMENT OPTION COST @ 30% CONTINGENCY [7]					$240,000	

[1] One station is equal to 100 feet.
[2] Average MDT bid prices provided for the period January 2011 to December 2011.
[3] Cost estimates are provided in 2012 dollars. All dollar amounts are rounded for planning purposes.
[4] The Mobilization category includes all costs incurred in assembling and transporting materials to the work site.
[5] Indirect costs are costs not directly associated with the construction of a project, but incurred during the construction processes. IDC percentage is subject to change.
[6] A contingency range of 20 to 30 percent was used due to the high degree of unknown factors over the planning horizon, as well as the substantial amount of items not accounted for in this planning level cost estimate.
[7] The Total Improvement Option Cost reflects an estimate of potential construction costs based on planning level estimates, and should not be considered an actual cost or encompassing all scenarios and circumstances.

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Option 9.d - OVERHEAD LIGHTING
Planning Level Estimate of Costs

Item Description	Approx. Quantity	Unit	Average Bid Prices [1]		Adjusted Unit Prices	
			Unit Price	Amount	Unit Price	Amount [2]
			Dollars	Dollars	Dollars	Dollars
LUMINAIRES (200' SPACING)						
CONCRETE-CLASS DD	4.16	CUYD	$903.00	$3,756.48		$3,800
CONDUIT-PLASTIC 2 IN	1,600.00	LNFT	$15.81	$25,296.00		$25,300
PULL BOX-CONCRETE TYPE 2	1.00	EACH	$459.29	$459.29		$500
CONDUCTER-COPPER AWG8-600V	3,200.00	LNFT	$0.73	$2,336.00		$2,300
CONDUCTER-COPPER AWG10-600V	1,600.00	LNFT	$0.65	$1,040.00		$1,000
LUMINAIRE ASSEMBLY-400 W S.V.	8.00	EACH	$433.14	$3,465.12		$3,500
STANDARD-STL TYPE 10-A-500-6	8.00	EACH	$1,960.70	$15,685.60		$15,700
SERV ASSEMB-100 AMP	1.00	EACH	$2,179.63	$2,179.63		$2,200
COST FOR 8 LIGHTS					$54,300	
AVG COST PER LIGHT					$6,787.50	
ADDITIONAL COSTS						
MISCELLANEOUS @ 20% OF AVERAGE [3]					20%	$1,400
MOBILIZATION @ 10% OF SUBTOTAL 1 [4]					10%	$700
SUBTOTAL 2						$8,900
INDIRECT COST (IDC) - CONSTRUCTION @ 9.64% OF SUBTOTAL 2 [5]					9.64%	$900
CONTINGENCY @ 20% & 30% OF SUBTOTAL 2 [6]					20%	$1,800
					30%	$2,700
TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [7]					$12,000	
TOTAL IMPROVEMENT OPTION COST @ 30% CONTINGENCY [7]					$13,000	

[1] Average MDT bid prices provided for the period January 2011 to December 2011.
[2] Cost estimates are provided in 2012 dollars. All dollar amounts are rounded for planning purposes.
[3] The Miscellaneous category is estimated at 20 percent due to unknown factors including but not limited to excavation, embankment, topsoil, guardrail, BMPs, utilities, lighting, traffic control, noxious weeds, slope treatments, ditch or channel excavation, incidental pavement transitional areas, temporary striping, temporary water pollution/erosion control measures and public relations.
[4] The Mobilization category includes all costs incurred in assembling and transporting materials to the work site.
[5] Indirect costs are costs not directly associated with the construction of a project, but incurred during the construction processes. IDC percentage is subject to change.
[6] A contingency range of 20 to 30 percent was used due to the high degree of unknown factors over the planning horizon, as well as the substantial amount of items not accounted for in this planning level cost estimate.
[7] The Total Improvement Option Cost reflects an estimate of potential construction costs based on planning level estimates, and should not be considered an actual cost or encompassing all scenarios and circumstances.

Option 10.a - LEFT TURN LANE
Planning Level Estimate of Costs

Item Description	Approx. Quantity (Per Station) [1]	Unit	Average Bid Prices [2]		Adjusted Unit Prices	
			Unit Price Dollars	Amount Dollars	Unit Price Dollars	Amount [3] Dollars
LEFT TURN LANE						
COLD MILL	0.00	SQYD	$1.29	$0.00		$0.00
EXCAVATION-UNCLASS BORROW [4]	187.70	CUYD	$4.67	$877.00		$877.00
EMBANKMENT IN PLACE [5]	77.10	CUYD	$6.83	$527.00		$527.00
CRUSHED AGGREGATE COURSE [6]	62.50	CUYD	$18.79	$1,174.00		$1,174.00
SPECIAL BORROW - NEAT LINE [6]	263.10	CUYD	$15.41	$4,054.00		$4,054.00
COVER - TYPE 2	156.00	SQYD	$0.51	$80.00		$80.00
DUST PALLIATIVE	0.34	TON		$0.00	$120.00	$41.00
PLANT MIX BIT SURF GR S-3/4 IN [6]	61.30	TON	$25.37	$1,555.00		$1,555.00
ASPHALT CEMENT PG 64 64-28	3.31	TON	$674.59	$2,233.00		$2,233.00
EMULS ASPHALT CRS-2P	0.28	TON	$578.92	$162.00		$162.00
STRIPING-WHITE EPOXY	1.00	GAL	$61.96	$62.00		$62.00
STRIPING-YELLOW EPOXY	1.00	GAL	$62.79	$63.00		$63.00
LEFT TURN LANE SUBTOTAL				$10,787.00		$10,828
CATEGORY	LENGTH (STA.)	COST PER STATION			SUBTOTAL 1	
LEFT TURN LANE	13.23	10,828.00			$140,000	
ADDITIONAL COSTS						
MISCELLANEOUS @ 20% OF SUBTOTAL 1 [7]					20%	$28,000
MOBILIZATION @ 10% OF SUBTOTAL 1 [8]					10%	$14,000
SUBTOTAL 2						$180,000
INDIRECT COST (IDC) - CONSTRUCTION @ 9.64% OF SUBTOTAL 2 [9]					9.64%	$17,000
CONTINGENCY @ 20% & 30% OF SUBTOTAL 2 [10]					20%	$36,000
					30%	$54,000
TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [11]					$230,000	
TOTAL IMPROVEMENT OPTION COST @ 30% CONTINGENCY [11]					$250,000	

[1] One station is equal to 100 feet.
[2] Average MDT bid prices provided for the period January 2011 to December 2011.
[3] Cost estimates are provided in 2012 dollars. All dollar amounts are rounded for planning purposes.
[4] Excavation only assumed where CAC expansion will replace existing embankment.
[5] 5 ft average fill depth (edge of shoulder to bottom of embankment) with a 25% shrink factor is assumed throughout the corridor.
[6] Typical section includes 0.52 ft of PMBS, 0.75 ft of crushed aggregate course, and 2 ft of special borrow.
[7] The Miscellaneous category is estimated at 20 percent due to unknown factors including but not limited to excavation, embankment, topsoil, guardrail, BMPs, utilities, traffic control, noxious weeds, slope treatments, ditch or channel excavation, incidental pavement transitional areas, temporary striping, temporary water pollution/erosion control measures and public relation
[8] The Mobilization category includes all costs incurred in assembling and transporting materials to the work site.
[9] Indirect costs are costs not directly associated with the construction of a project, but incurred during the construction processes. IDC percentage is subject to change.
[10] A contingency range of 20 to 30 percent was used due to the high degree of unknown factors over the planning horizon, as well as the substantial amount of items not accounted for in this planning level cost estimate.
[11] The Total Improvement Option Cost reflects an estimate of potential construction costs based on planning level estimates, and should not be considered an actual cost or encompassing all scenarios and circumstances.

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Option 10.a - RIGHT TURN LANE
Planning Level Estimate of Costs

Item Description	Approx. Quantity (Per Station) [1]	Unit	Average Bid Prices [2] Unit Price Dollars	Average Bid Prices [2] Amount Dollars	Adjusted Unit Prices Unit Price Dollars	Adjusted Unit Prices Amount [3] Dollars
RIGHT TURN LANE						
COLD MILL	800.00	SQYD	$1.29	$1,032.00		$1,032.00
EXCAVATION-UNCLASS BORROW [4]	93.90	CUYD	$4.67	$439.00		$439.00
EMBANKMENT IN PLACE [5]	100.60	CUYD	$6.83	$687.00		$687.00
CRUSHED AGGREGATE COURSE [6]	59.00	CUYD	$18.79	$1,109.00		$1,109.00
SPECIAL BORROW - NEAT LINE [6]	205.63	CUYD	$15.41	$3,169.00		$3,169.00
COVER - TYPE 2	189.00	SQYD	$0.51	$96.00		$96.00
DUST PALLIATIVE	0.35	TON		$0.00	$120.00	$42.00
PLANT MIX BIT SURF GR S-3/4 IN [6]	79.50	TON	$25.37	$2,017.00		$2,017.00
ASPHALT CEMENT PG 64 64-28	4.29	TON	$674.59	$2,894.00		$2,894.00
EMULS ASPHALT CRS-2P	0.34	TON	$578.92	$197.00		$197.00
STRIPING-WHITE EPOXY	1.00	GAL	$61.96	$62.00		$62.00
STRIPING-YELLOW EPOXY	1.00	GAL	$62.79	$63.00		$63.00
RIGHT TURN LANE SUBTOTAL				$10,733.00		$10,775
CATEGORY	LENGTH (STA.)	COST PER STATION			SUBTOTAL 1	
RIGHT TURN LANE	8.73	10,775.00			$94,000	
ADDITIONAL COSTS						
MISCELLANEOUS @ 20% OF SUBTOTAL 1 [7]					20%	$19,000
MOBILIZATION @ 10% OF SUBTOTAL 1 [8]					10%	$9,400
SUBTOTAL 2						$120,000
INDIRECT COST (IDC) - CONSTRUCTION @ 9.64% OF SUBTOTAL 2 [9]					9.64%	$12,000
CONTINGENCY @ 20% & 30% OF SUBTOTAL 2 [10]					20%	$24,000
					30%	$36,000
TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [11]					$160,000	
TOTAL IMPROVEMENT OPTION COST @ 30% CONTINGENCY [11]					$170,000	

[1] One station is equal to 100 feet.
[2] Average MDT bid prices provided for the period January 2011 to December 2011.
[3] Cost estimates are provided in 2012 dollars. All dollar amounts are rounded for planning purposes.
[4] Excavation only assumed where CAC expansion will replace existing embankment.
[5] 5 ft average fill depth (edge of shoulder to bottom of embankment) with a 25% shrink factor is assumed throughout the corridor.
[6] Typical section includes 0.52 ft of PMBS, 0.75 ft of crushed aggregate course, and 2 ft of special borrow.
[7] The Miscellaneous category is estimated at 20 percent due to unknown factors including but not limited to excavation, embankment, topsoil, guardrail, BMPs, utilities, traffic control, noxious weeds, slope treatments, ditch or channel excavation, incidental pavement transitional areas, temporary striping, temporary water pollution/erosion control measures and public relation
[8] The Mobilization category includes all costs incurred in assembling and transporting materials to the work site.
[9] Indirect costs are costs not directly associated with the construction of a project, but incurred during the construction processes. IDC percentage is subject to change.
[10] A contingency range of 20 to 30 percent was used due to the high degree of unknown factors over the planning horizon, as well as the substantial amount of items not accounted for in this planning level cost estimate.
[11] The Total Improvement Option Cost reflects an estimate of potential construction costs based on planning level estimates, and should not be considered an actual cost or encompassing all scenarios and circumstances.

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Option 10.b - RIGHT TURN LANE RECONSTRUCTION
Planning Level Estimate of Costs

Item Description	Approx. Quantity (Per Station) [1]	Unit	Average Bid Prices [2]		Adjusted Unit Prices	
			Unit Price	Amount	Unit Price	Amount [3]
			Dollars	Dollars	Dollars	Dollars
RIGHT TURN LANE RECONSTRUCTION						
COLD MILL	800.00	SQYD	$1.29	$1,032.00		$1,032.00
EXCAVATION-UNCLASS BORROW [4]	110.00	CUYD	$4.67	$514.00		$514.00
EMBANKMENT IN PLACE [5]	39.00	CUYD	$6.83	$266.00		$266.00
CRUSHED AGGREGATE COURSE [6]	51.60	CUYD	$18.79	$970.00		$970.00
SPECIAL BORROW - NEAT LINE [6]	155.90	CUYD	$15.41	$2,402.00		$2,402.00
COVER - TYPE 2	100.00	SQYD	$0.51	$51.00		$51.00
DUST PALLIATIVE	0.21	TON		$0.00	$120.00	$25.00
PLANT MIX BIT SURF GR S-3/4 IN [6]	57.20	TON	$25.37	$1,451.00		$1,451.00
ASPHALT CEMENT PG 64 64-28	3.09	TON	$674.59	$2,084.00		$2,084.00
EMULS ASPHALT CRS-2P	0.18	TON	$578.92	$104.00		$104.00
STRIPING-WHITE EPOXY	1.00	GAL	$61.96	$62.00		$62.00
STRIPING-YELLOW EPOXY	1.00	GAL	$62.79	$63.00		$63.00
RIGHT TURN LANE RECONSTRUCTION SUBTOTAL				$7,967.00		$9,024
CATEGORY	LENGTH (STA.)	COST PER STATION			SUBTOTAL 1	
RIGHT TURN LANE RECONSTRUCTION	8.73	9,024.00			$79,000	
ADDITIONAL COSTS						
MISCELLANEOUS @ 20% OF SUBTOTAL 1 [7]					20%	$16,000
MOBILIZATION @ 10% OF SUBTOTAL 1 [8]					10%	$7,900
SUBTOTAL 2						$100,000
INDIRECT COST (IDC) - CONSTRUCTION @ 9.64% OF SUBTOTAL 2 [9]					9.64%	$10,000
CONTINGENCY @ 20% & 30% OF SUBTOTAL 2 [10]					20%	$20,000
					30%	$30,000
TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [11]					$130,000	
TOTAL IMPROVEMENT OPTION COST @ 30% CONTINGENCY [11]					$140,000	

[1] One station is equal to 100 feet.
[2] Average MDT bid prices provided for the period January 2011 to December 2011.
[3] Cost estimates are provided in 2012 dollars. All dollar amounts are rounded for planning purposes.
[4] Excavation only assumed where CAC expansion will replace existing embankment.
[5] 5 ft average fill depth (edge of shoulder to bottom of embankment) with a 25% shrink factor is assumed throughout the corridor.
[6] Typical section includes 0.52 ft of PMBS, 0.75 ft of crushed aggregate course, and 2 ft of special borrow.
[7] The Miscellaneous category is estimated at 20 percent due to unknown factors including but not limited to excavation, embankment, topsoil, guardrail, BMPs, utilities, traffic control, noxious weeds, slope treatments, ditch or channel excavation, incidental pavement transitional areas, temporary striping, temporary water pollution/erosion control measures and public relation
[8] The Mobilization category includes all costs incurred in assembling and transporting materials to the work site.
[9] Indirect costs are costs not directly associated with the construction of a project, but incurred during the construction processes. IDC percentage is subject to change.
[10] A contingency range of 20 to 30 percent was used due to the high degree of unknown factors over the planning horizon, as well as the substantial amount of items not accounted for in this planning level cost estimate.
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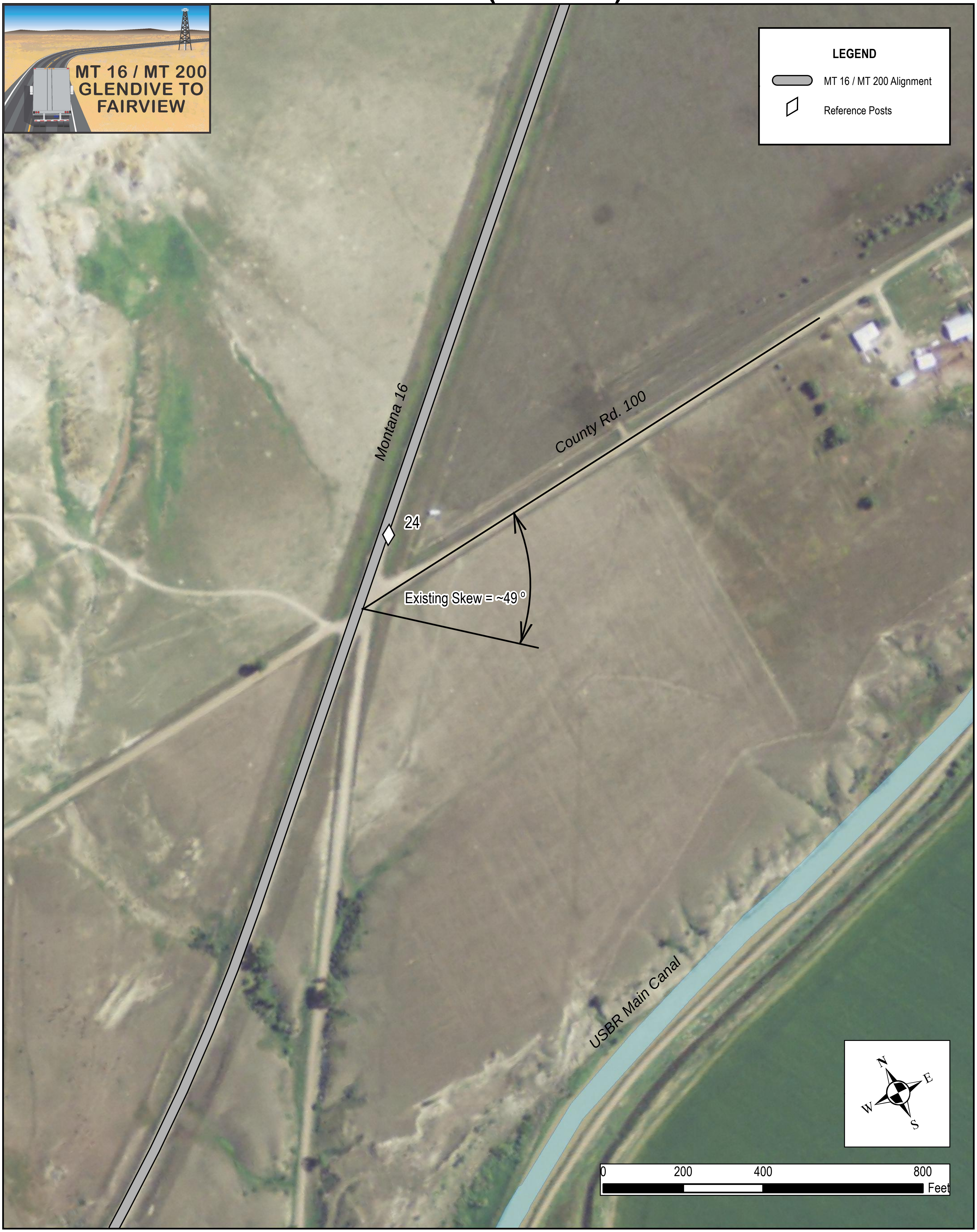
Appendix 3

Roadway Intersection Figures

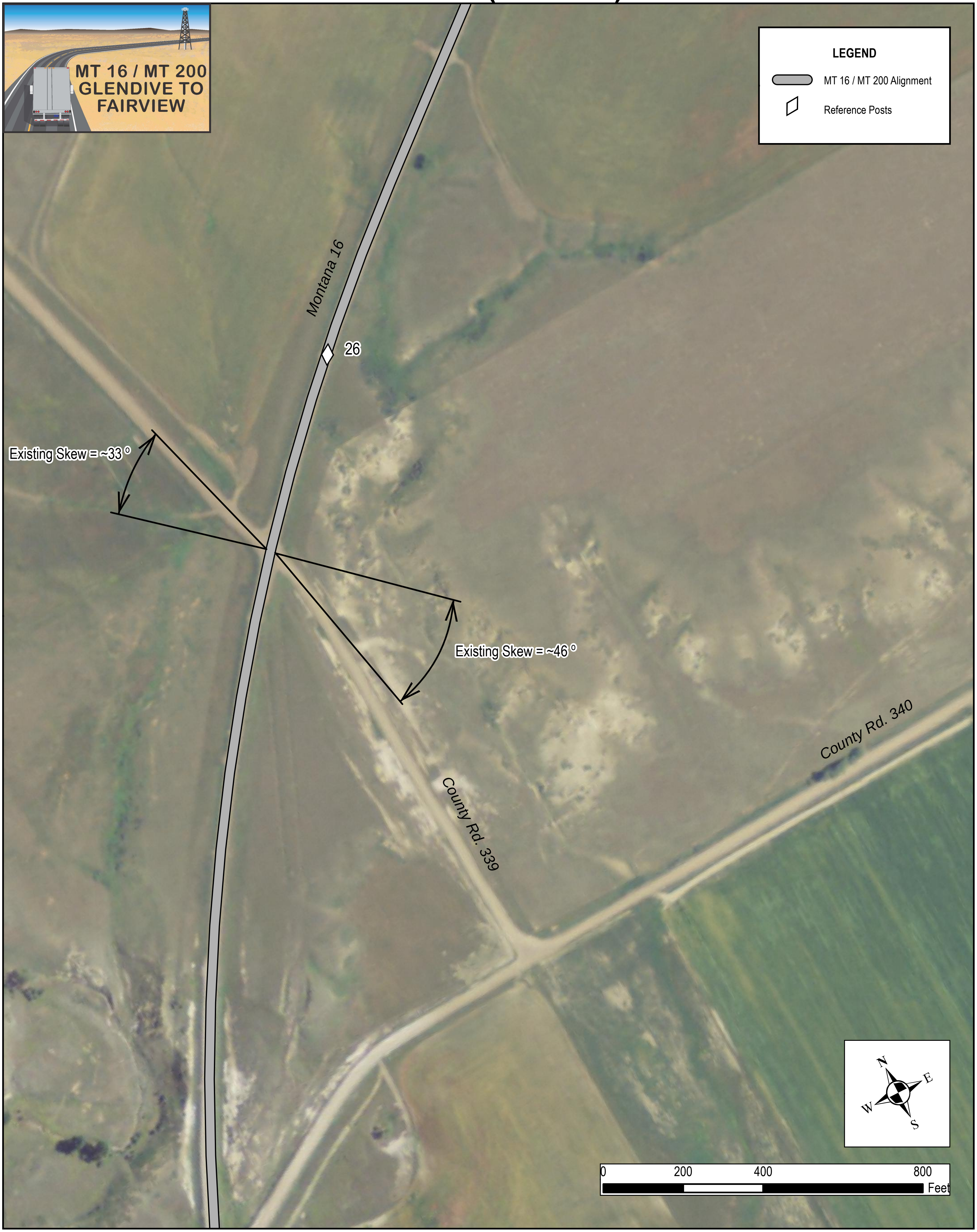
RP 24.0 (CR 100)


MT 16 / MT 200
GLENDIVE TO
FAIRVIEW
LEGEND
MT 16 / MT 200 Alignment
Reference Posts
Montana 16
County Rd. 100
24
Existing Skew = ~49 °
USBR Main Canal
N
E
S
W
0
200
400
800
Feet

RP 25.6 (CR 340)


MT 16 / MT 200
GLENDIVE TO
FAIRVIEW
LEGEND
MT 16 / MT 200 Alignment
Reference Posts
Montana 16
County Rd. 340
Existing Skew = ~52 °
N
E
W
S
0
200
400
800
Feet

RP 25.9 (CR 339)

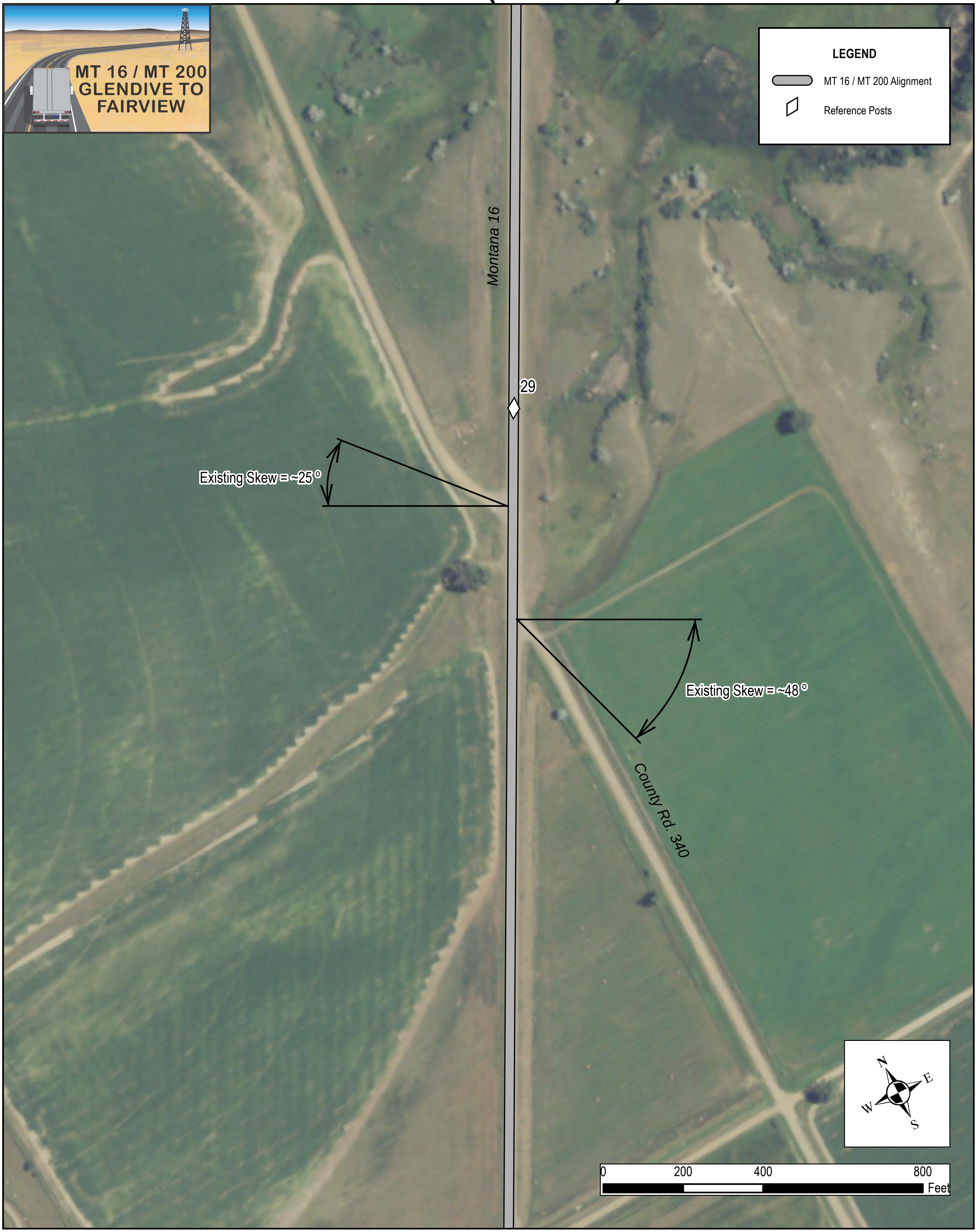


MT 16 / MT 200
GLENDIVE TO
FAIRVIEW
LEGEND
MT 16 / MT 200 Alignment
Reference Posts
Montana 16
26
Existing Skew = ~33 °
Existing Skew = ~46 °
County Rd. 339
County Rd. 340
N
E
W
S
0
200
400
800
Feet

RP 28.6 (CR 104)


MT 16 / MT 200
GLENDIVE TO
FAIRVIEW
LEGEND
MT 16 / MT 200 Alignment
Reference Posts
Montana 16
County Rd. 104
County Rd. 340
Existing Skew = ~31 °
N
E
W
S
0
200
400
800
Feet

RP 28.9 (CR 340)



MT 16 / MT 200
GLENDIVE TO
FAIRVIEW
LEGEND
MT 16 / MT 200 Alignment
Reference Posts
Montana 16
29
Existing Skew = ~25°
Existing Skew = ~48°
County Rd. 340
N
E
W
S
0
200
400
800
Feet

RP 30.9 (CR 106)


MT 16 / MT 200
GLENDIVE TO
FAIRVIEW
LEGEND
MT 16 / MT 200 Alignment
Reference Posts
31
Existing Skew = ~30 °
County Rd. 106
Montana 16
N
E
S
W
0
200
400
800
Feet

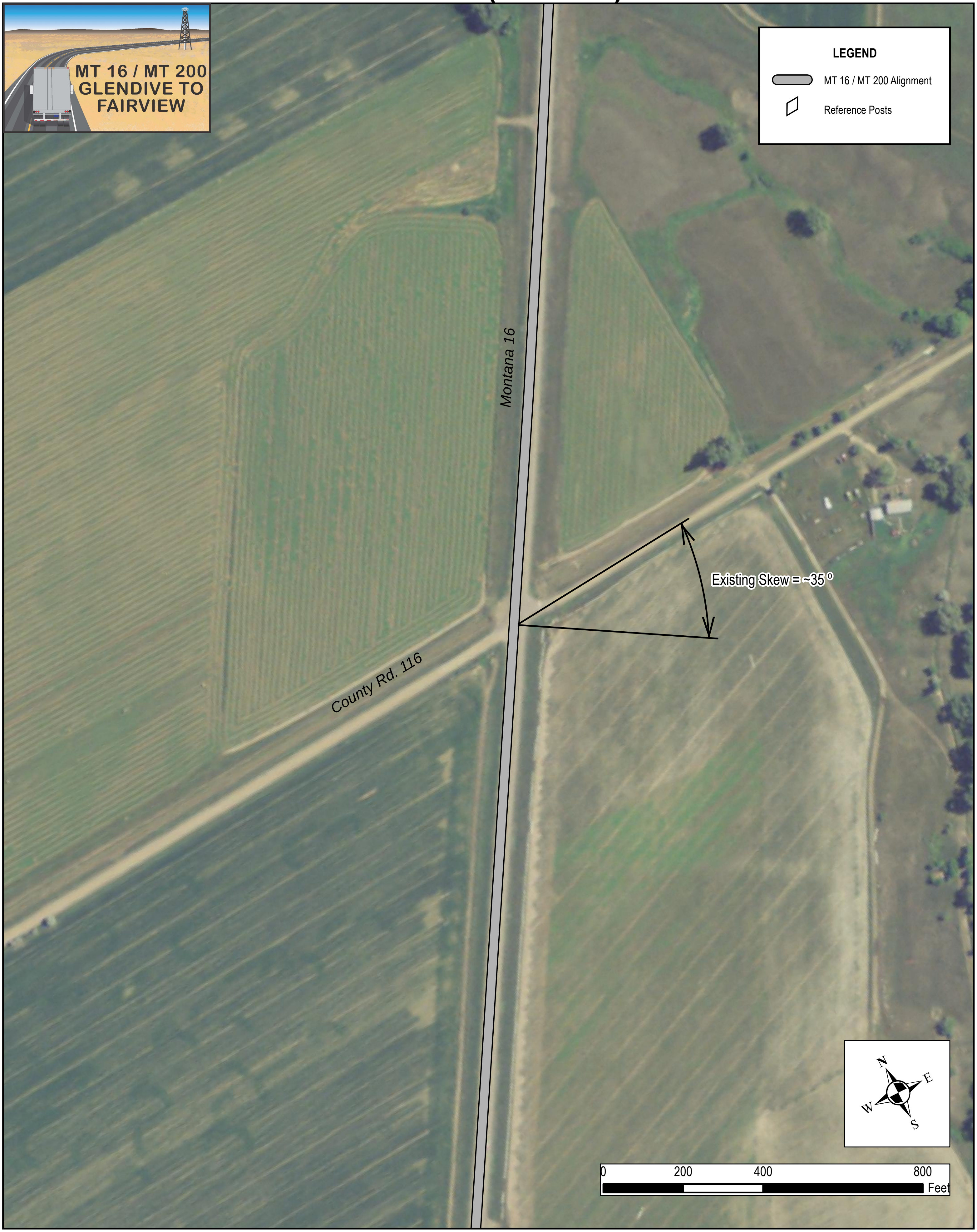
RP 35.2 (CR 110)

MT 16 / MT 200
GLENDIVE TO
FAIRVIEW
LEGEND
MT 16 / MT 200 Alignment
Reference Posts
Montana 16
County Rd. 110
Existing Skew = ~31 °
35
N
E
W
S
0
200
400
800
Feet

RP 37.5 (CR 112)

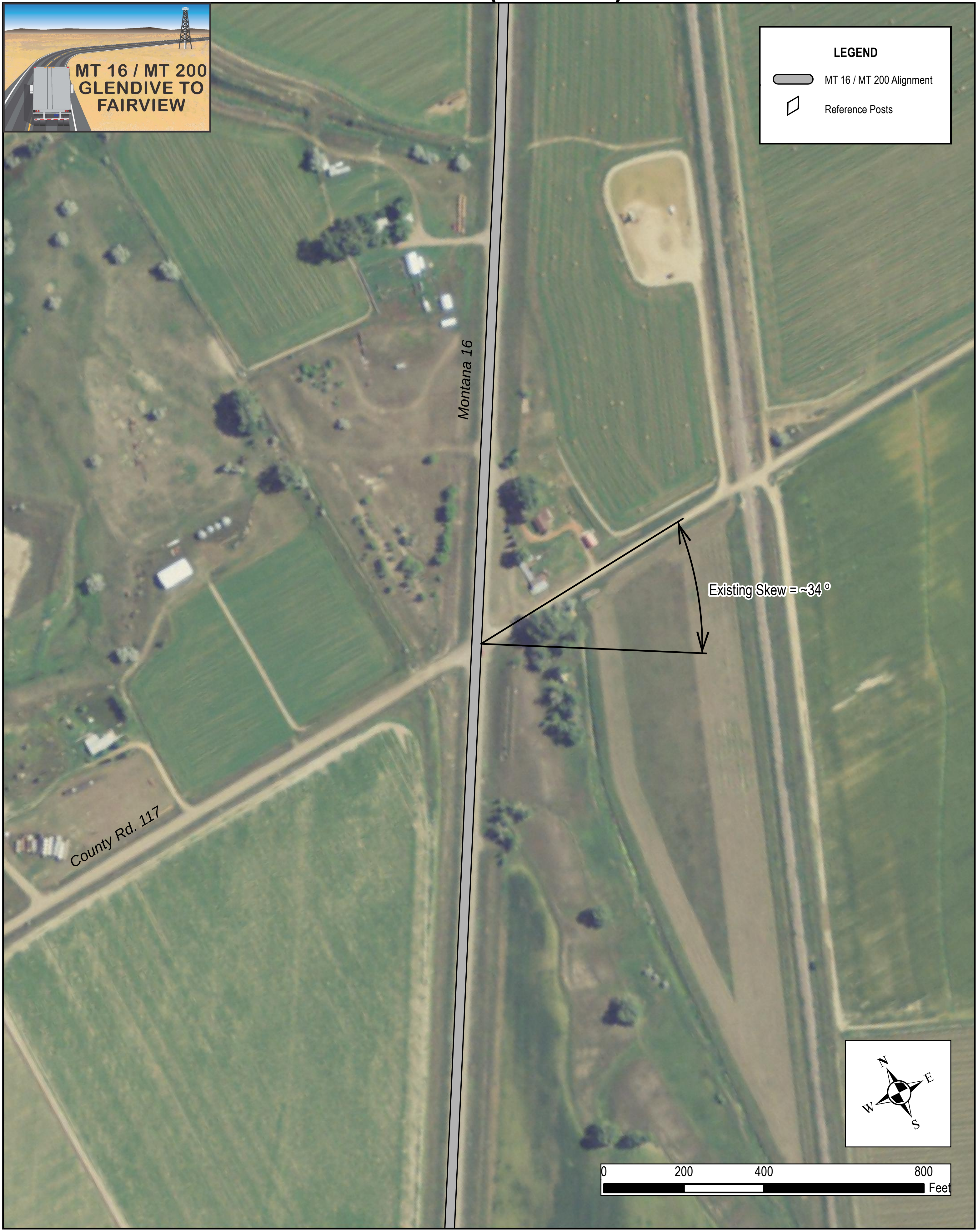

MT 16 / MT 200
GLENDIVE TO
FAIRVIEW
LEGEND
MT 16 / MT 200 Alignment
Reference Posts
USBR Main Canal
County Rd. 112
Existing Skew = ~34 °
Montana 16
N
E
S
W
0
200
400
800
Feet

RP 42.3 (CR 116)



MT 16 / MT 200
GLENDIVE TO
FAIRVIEW
LEGEND
MT 16 / MT 200 Alignment
Reference Posts
Montana 16
County Rd. 116
Existing Skew = ~35 °
N
E
S
W
0
200
400
800
Feet

RP 43.6 (CR 117)



MT 16 / MT 200
GLENDIVE TO
FAIRVIEW
LEGEND
MT 16 / MT 200 Alignment
Reference Posts
Montana 16
Existing Skew = ~34 °
County Rd. 117
N
E
W
S
0
200
400
800
Feet

RP 46.9 (CR 348)


MT 16 / MT 200
GLENDIVE TO
FAIRVIEW
LEGEND
MT 16 / MT 200 Alignment
Reference Posts
Railroad
47
Existing Skew = ~45°
Montana 16
County Rd. 348
N
E
W
S
0
200
400
800
Feet

RP 58.0 (CR 130)

MT 16 / MT 200
GLENDIVE TO
FAIRVIEW
LEGEND
MT 16 / MT 200 Alignment
Reference Posts
Montana 200
County Rd. 130
Existing Skew = ~31 °
58
N
E
W
S
0
200
400
800
Feet

Appendix 4

Operational Analysis Worksheets

Appendix 4

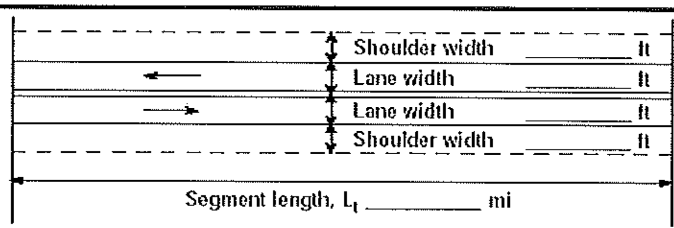
Existing Two-Lane Highway 2012

DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

General Information		Site Information	
Analyst	*David Stoner*	Highway / Direction of Travel	*MT 16*
Agency or Company	*DOWL HKM*	From/To	*RP 0.6 to 20.0 NB*
Date Performed	*4/17/2012*	Jurisdiction	*Dawson/Richland County*
Analysis Time Period	*Peak Hour*	Analysis Year	*2012*

Project Description: *MT 16 / MT 200 Glendive to Fairview Corridor Planning Study*

Input Data



Analysis direction vol., V_d *135*veh/h

Opposing direction vol., V_o *139*veh/h

Shoulder width ft *8.0*
Lane Width ft *12.0*
Segment Length mi *19.4*

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

Terrain ☑ Level ☐ Rolling

Grade Length mi Up/down

Peak-hour factor, PHF *0.81*

No-passing zone *27%*

% Trucks and Buses , P_T *27 %*

% Recreational vehicles, P_R *4%*

Access points *mi* *5*/mi

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	*1.6*	*1.6*
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	*1.0*	*1.0*
Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.861*	*0.861*
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	*1.00*	*1.00*
Demand flow rate[2], v_i (pc/h) $v_i=V_i/(PHF*f_{g,ATS}*f_{HV,ATS})$	*194*	*199*

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
		Base free-flow speed[4], BFFS	*65.0 mi/h*
Mean speed of sample[3], S_{FM}		Adj. for lane and shoulder width,[4] f_{LS} (Exhibit 15-7)	*0.0 mi/h*
Total demand flow rate, both directions, *v*		Adj. for access points[4], f_A (Exhibit 15-8)	*1.3 mi/h*
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Free-flow speed, FFS ($FSS=BFFS-f_{LS}-f_A$)	*63.8 mi/h*
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	*2.5 mi/h*	Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	*58.2 mi/h*
		Percent free flow speed, PFFS	*91.3 %*

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-18 or 15-19)	*1.1*	*1.1*
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	*1.0*	*1.0*
Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.974*	*0.974*
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	*1.00*	*1.00*
Directional flow rate[2], v_i (pc/h) $v_i=V_i/(PHF*f_{HV,PTSF}*f_{g,PTSF})$	*171*	*176*
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	*18.8*	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	*42.2*	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	*39.6*	

Level of Service and Other Performance Measures

Level of service, LOS (Exhibit 15-3)	*B*
Volume to capacity ratio, *v/c*	*0.13*

Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h	*1464*
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	*1655*
Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only)	*91.3*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*166.7*
Effective width, Wv (Eq. 15-29) ft	*34.50*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*11.34*
Bicycle level of service (Exhibit 15-4)	*F*

Notes

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

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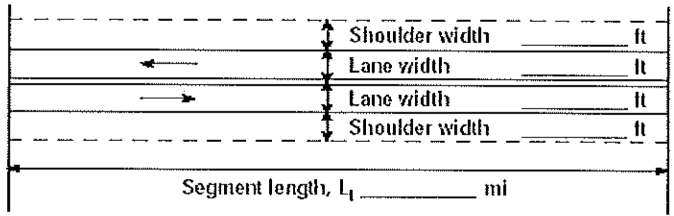
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

General Information		Site Information	
Analyst	*David Stoner*	Highway / Direction of Travel	*MT 16*
Agency or Company	*DOWL HKM*	From/To	*RP 0.6 to RP 12.4 SB*
Date Performed	*4/17/2012*	Jurisdiction	*Dawson/Richland County*
Analysis Time Period	*Peak Hour*	Analysis Year	*2012*

Project Description: *MT 16 / MT 200 Glendive to Fairview Corridor Planning Study*

Input Data



Analysis direction vol., V_d	*139veh/h*
Opposing direction vol., V_o	*135veh/h*
Shoulder width ft	*8.0*
Lane Width ft	*12.0*
Segment Length mi	*11.8*

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

Terrain ☑ Level ☐ Rolling

Grade Length mi	Up/down
Peak-hour factor, PHF	*0.78*
No-passing zone	*20%*
% Trucks and Buses , P_T	*29 %*
% Recreational vehicles, P_R	*4%*
Access points *mi*	*7/mi*

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	*1.6*	*1.6*
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	*1.0*	*1.0*
Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.852*	*0.852*
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	*1.00*	*1.00*
Demand flow rate[2], v_i (pc/h) $v_i=V_i/(PHF^* f_{g,ATS} * f_{HV,ATS})$	*209*	*203*

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
		Base free-flow speed[4], BFFS	*65.0 mi/h*
		Adj. for lane and shoulder width,[4] f_{LS}(Exhibit 15-7)	*0.0 mi/h*
Mean speed of sample[3], S_{FM}		Adj. for access points[4], f_A (Exhibit 15-8)	*1.8 mi/h*
Total demand flow rate, both directions, *v*		Free-flow speed, FFS (FSS=BFFS-f_{LS}-f_A)	*63.3 mi/h*
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	*58.0 mi/h*
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	*2.1 mi/h*	Percent free flow speed, PFFS	*91.6 %*

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T(Exhibit 15-18 or 15-19)	*1.1*	*1.1*
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	*1.0*	*1.0*
Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.972*	*0.972*
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	*1.00*	*1.00*
Directional flow rate[2], v_i(pc/h) $v_i=V_i/(PHF^*f_{HV,PTSF}{}^* f_{g,PTSF})$	*183*	*178*
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	*20.0*	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	*38.4*	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}{}^*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	*39.5*	

Level of Service and Other Performance Measures

Level of service, LOS (Exhibit 15-3)	*B*
Volume to capacity ratio, *v/c*	*0.14*

Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h	*1448*
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	*1652*
Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only)	*91.6*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*178.2*
Effective width, Wv (Eq. 15-29) ft	*34.10*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*13.06*
Bicycle level of service (Exhibit 15-4)	*F*
Notes	

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

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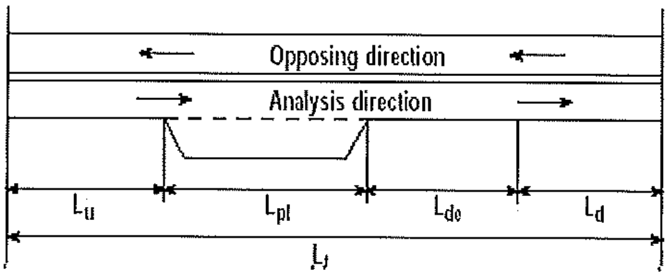
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET WITH PASSING LANE WORKSHEET

General Information		*Site Information*	
Analyst	*David Stoner*	Highway of Travel	*MT 16*
Agency or Company	*DOWL HKM*	From/To	*RP 20.0 to Savage NB*
Date Performed	*4/17/2012*	Jurisdiction	*Dawson/Richland County*
Analysis Time Period	*Peak Hour*	Analysis Year	*2012*

Project Description: *MT 16 / MT 200 Glendive to Fairview Corridor Planning Study*

Input Data

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



Shoulder width (ft)	*8.0*
Lane Width (ft)	*12.0*
Segment Length (mi)	*11.5*
Total length of analysis segment, L_t	*11.5*
Length of two-lane highway upstream of the passing lane, L_u	*0.0*
Length of passing lane including tapers , L_{pl}	*1.9*
Average travel speed, ATS_d (from Directional Two-Lane Highway Segment Worksheet)	*58.6*
Percent time-spent-following, $PTSF_d$ (from Directional Two-Lane Highway Segment Worksheet)	*37.3*
Level of service[1], LOS_d (from Directional Two-Lane Highway Segment Worksheet)	*B*
Average Travel Speed	
Length of the downstream highway segment within the effective length of passing lane for average travel speed, L_{de} (Exhibit 15-23)	*1.70*
Length of two-lane highway downstream of effective length of the passing lane for avg travel speed, L_d $L_d = L_t - (L_u + L_{pl} + L_{de})$	*7.90*
Adj. factor for the effect of passing lane on average speed, f_{pl} (Exhibit 15-28)	*1.08*
Average travel speed including passing lane[2], $ATS_{pl} = (ATS_d * L_t) / (L_u + L_d + (L_{pl}/f_{pl}) + (2L_{de}/(1+f_{pl,ATS})))$	*59.7*
Percent free flow speed including passing lane, $PFFS_{pl} = (ATS_{pl}/ FFS)$	*93.6*
Percent Time-Spent-Following	
Length of the downstream highway segment within the effective length of passing lane for percent time-spent-following, L_{de} (Exhibit 15-23)	*13.00*
Length of two-lane highway downstream of effective length of the passing lane for percent-time-following, $L_d = L_t - (L_u + L_{pl} + L_{de})$	*-3.40*
Adj. factor for the effect of passing lane on percent time-spent-following, $f_{pl,PTSF}$ (Exhibit 15-26)	*0.58*

Percent time-spent-following including passing lane[3], $PTSF_{pl}$(%) $PTSF_{pl} = PTSF_d[L_u + L_d + f_{pl,PTSF} L_{pl} + ((1+f_{pl,PTSF})/2)L_{de}]/L_t$	26.5
Level of Service and Other Performance Measures[4]	
Level of service including passing lane LOS_{pl} (Exhibit 15-3)	A
Peak 15-min total travel time, TT_{15}(veh-h) $TT_{15} = VMT_{15}/ATS_{pl}$	8.0
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	166.7
Effective width, W_v (Eq. 15-29) ft	34.50
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	11.34
Bicycle level of service (Exhibit 15-4)	F
Notes	
1. If LOS_d=F, passing lane analysis cannot be performed. 2. If L_d <0, use alternative Equation 15-18. 3. If L_d<0, use alternative Equation 15-16. 4. v/c, VMT_{15} and VMT_{60} are calculated on Directional Two-Lane Highway Segment Worksheet.	

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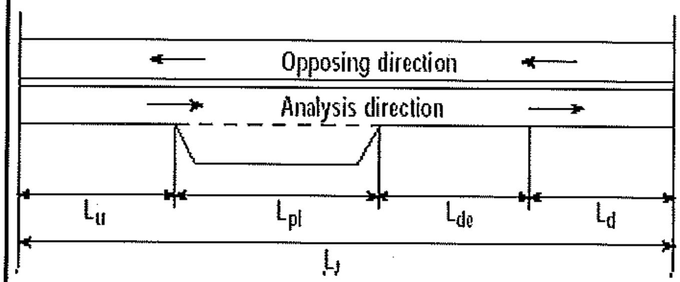
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET WITH PASSING LANE WORKSHEET

General Information		Site Information	
Analyst	*David Stoner*	Highway of Travel	*MT 16*
Agency or Company	*DOWL HKM*	From/To	*RP 12.4 to RP 22.0 SB*
Date Performed	*4/17/2012*	Jurisdiction	*Dawson/Richland County*
Analysis Time Period	*Peak Hour*	Analysis Year	*2012*

Project Description: *MT 16 / MT 200 Glendive to Fairview Corridor Planning Study*

Input Data

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



Shoulder width (ft)	*8.0*
Lane Width (ft)	*12.0*
Segment Length (mi)	*9.6*
Total length of analysis segment, L_t	*9.6*
Length of two-lane highway upstream of the passing lane, L_u	*0.0*
Length of passing lane including tapers , L_{pl}	*1.9*
Average travel speed, ATS_d (from Directional Two-Lane Highway Segment Worksheet)	*59.1*
Percent time-spent-following, $PTSF_d$ (from Directional Two-Lane Highway Segment Worksheet)	*37.1*
Level of service[1], LOS_d (from Directional Two-Lane Highway Segment Worksheet)	*B*
Average Travel Speed	
Length of the downstream highway segment within the effective length of passing lane for average travel speed, L_{de} (Exhibit 15-23)	*1.70*
Length of two-lane highway downstream of effective length of the passing lane for avg travel speed, L_d $L_d=L_t-(L_u+L_{pl}+L_{de})$	*6.00*
Adj. factor for the effect of passing lane on average speed, f_{pl} (Exhibit 15-28)	*1.09*
Average travel speed including passing lane[2], $ATS_{pl} = (ATS_d * L_t) / (L_u+L_d+(L_{pl}/f_{pl})+ (2L_{de}/(1+f_{pl,ATS})))$	*60.6*
Percent free flow speed including passing lane, $PFFS_{pl} = (ATS_{pl}/ FFS)$	*93.9*
Percent Time-Spent-Following	
Length of the downstream highway segment within the effective length of passing lane for percent time-spent-following, L_{de} (Exhibit 15-23)	*13.00*
Length of two-lane highway downstream of effective length of the passing lane for percent-time-following, $L_d=L_t-(L_u+L_{pl}+L_{de})$	*-5.30*
Adj. factor for the effect of passing lane on percent time-spent-following, $f_{pl,PTSF}$(Exhibit 15-26)	*0.58*

Percent time-spent-following including passing lane[3], $PTSF_{pl}$(%) $PTSF_{pl}= PTSF_d[L_u+L_d+f_{pl,PTSF}L_{pl}+((1+f_{pl,PTSF})/2)L_{de}]/L_t$	25.2
Level of Service and Other Performance Measures[4]	
Level of service including passing lane LOS_{pl} (Exhibit 15-3)	A
Peak 15-min total travel time, TT_{15}(veh-h) $TT_{15}= VMT_{15}/ATS_{pl}$	7.1
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	178.2
Effective width, W_v (Eq. 15-29) ft	34.10
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	13.06
Bicycle level of service (Exhibit 15-4)	F
Notes	

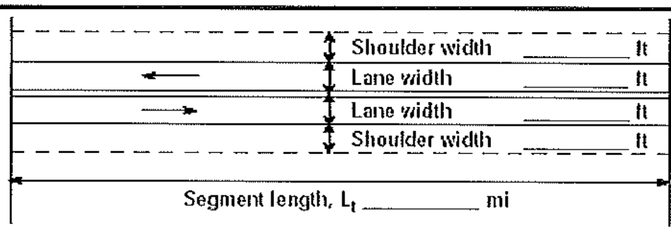
1. If LOS_d=F, passing lane analysis cannot be performed.
2. If L_d <0, use alternative Equation 15-18.
3. If L_d<0, use alternative Equation 15-16.
4. v/c, VMT_{15} and VMT_{60} are calculated on Directional Two-Lane Highway Segment Worksheet.

DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

General Information		Site Information	
Analyst	*David Stoner*	Highway / Direction of Travel	*MT 16*
Agency or Company	*DOWL HKM*	From/To	*RP 22.0 to Savage SB*
Date Performed	*4/17/2012*	Jurisdiction	*Dawson/Richland County*
Analysis Time Period	*Peak Hour*	Analysis Year	*2012*

Project Description: *MT 16 / MT 200 Glendive to Fairview Corridor Planning Study*

Input Data



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

Terrain ☑ Level ☐ Rolling

Analysis direction vol., V_d	*139veh/h*
Opposing direction vol., V_o	*135veh/h*
Shoulder width ft	*8.0*
Lane Width ft	*12.0*
Segment Length mi	*9.5*
Grade Length mi	Up/down
Peak-hour factor, PHF	*0.78*
No-passing zone	*22%*
% Trucks and Buses, P_T	*29 %*
% Recreational vehicles, P_R	*4%*
Access points *mi*	*5/mi*

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	*1.6*	*1.6*
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	*1.0*	*1.0*
Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.852*	*0.852*
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	*1.00*	*1.00*
Demand flow rate[2], v_i(pc/h) $v_i=V_i/(PHF*f_{g,ATS}*f_{HV,ATS})$	*209*	*203*

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
Mean speed of sample[3], S_{FM}		Base free-flow speed[4], BFFS	*65.0 mi/h*
Total demand flow rate, both directions, v		Adj. for lane and shoulder width,[4] f_{LS}(Exhibit 15-7)	*0.0 mi/h*
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Adj. for access points[4], f_A (Exhibit 15-8)	*1.3 mi/h*
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	*2.2 mi/h*	Free-flow speed, FFS ($FSS=BFFS-f_{LS}-f_A$)	*63.8 mi/h*
		Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	*58.3 mi/h*
		Percent free flow speed, PFFS	*91.5 %*

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T(Exhibit 15-18 or 15-19)	*1.1*	*1.1*
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	*1.0*	*1.0*
Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.972*	*0.972*
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	*1.00*	*1.00*
Directional flow rate[2], v_i(pc/h) $v_i=V_i/(PHF*f_{HV,PTSF}*f_{g,PTSF})$	*183*	*178*
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	*20.0*	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	*39.7*	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	*40.1*	

Level of Service and Other Performance Measures

Level of service, LOS (Exhibit 15-3)	*B*
Volume to capacity ratio, *v/c*	*0.14*

Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h	*1448*
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	*1652*
Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only)	*91.5*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*178.2*
Effective width, Wv (Eq. 15-29) ft	*34.10*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*13.06*
Bicycle level of service (Exhibit 15-4)	*F*
Notes	

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

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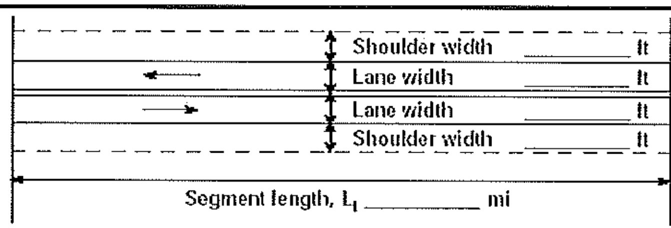
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

General Information		Site Information	
Analyst	*David Stoner*	Highway / Direction of Travel	*MT 16*
Agency or Company	*DOWL HKM*	From/To	*Savage to Crane NB*
Date Performed	*4/17/2012*	Jurisdiction	*Dawson/Richland County*
Analysis Time Period	*Peak Hour*	Analysis Year	*2012*

Project Description: *MT 16 / MT 200 Glendive to Fairview Corridor Planning Study*

Input Data



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

Terrain ☑ Level ☐ Rolling

Grade Length mi Up/down

Peak-hour factor, PHF *0.87*

No-passing zone *31%*

% Trucks and Buses , P_T *23 %*

% Recreational vehicles, P_R *4%*

Access points *mi* *11/mi*

Analysis direction vol., V_d *141*veh/h

Opposing direction vol., V_o *171*veh/h

Shoulder width ft *8.0*

Lane Width ft *12.0*

Segment Length mi *10.0*

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	*1.7*	*1.5*
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	*1.0*	*1.0*
Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.861*	*0.897*
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	*1.00*	*1.00*
Demand flow rate[2], v_i (pc/h) $v_i=V_i/(PHF*f_{g,ATS}*f_{HV,ATS})$	*188*	*219*

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
Mean speed of sample[3], S_{FM}		Base free-flow speed[4], BFFS	*69.0 mi/h*
Total demand flow rate, both directions, v		Adj. for lane and shoulder width,[4] f_{LS} (Exhibit 15-7)	*0.0 mi/h*
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Adj. for access points[4], f_A (Exhibit 15-8)	*2.8 mi/h*
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	*2.7 mi/h*	Free-flow speed, FFS $(FSS=BFFS-f_{LS}-f_A)$	*66.3 mi/h*
		Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	*60.4 mi/h*
		Percent free flow speed, PFFS	*91.1 %*

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T(Exhibit 15-18 or 15-19)	*1.1*	*1.1*
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	*1.0*	*1.0*
Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.978*	*0.978*
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	*1.00*	*1.00*
Directional flow rate[2], v_i(pc/h) $v_i=V_i/(PHF*f_{HV,PTSF}*f_{g,PTSF})$	*166*	*201*
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	*18.3*	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	*43.4*	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	*37.9*	

Level of Service and Other Performance Measures

Level of service, LOS (Exhibit 15-3)	*B*
Volume to capacity ratio, *v/c*	*0.12*

Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h	*1525*
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	*1662*
Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only)	*91.1*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*162.1*
Effective width, Wv (Eq. 15-29) ft	*33.90*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*8.67*
Bicycle level of service (Exhibit 15-4)	*F*

Notes

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

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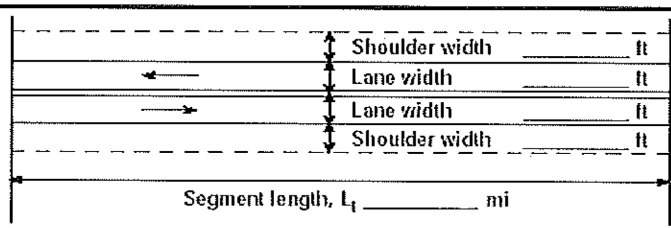
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

General Information		Site Information	
Analyst	David Stoner	Highway / Direction of Travel	MT 16
Agency or Company	DOWL HKM	From/To	Savage to Crane SB
Date Performed	4/17/2012	Jurisdiction	Dawson/Richland County
Analysis Time Period	Peak Hour	Analysis Year	2012

Project Description: *MT 16 / MT 200 Glendive to Fairview Corridor Planning Study*

Input Data



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

Terrain ☑ Level ☐ Rolling

Analysis direction vol., V_d	171veh/h
Opposing direction vol., V_o	141veh/h
Shoulder width ft	8.0
Lane Width ft	12.0
Segment Length mi	10.0
Grade Length mi Up/down	
Peak-hour factor, PHF	0.84
No-passing zone	19%
% Trucks and Buses , P_T	25 %
% Recreational vehicles, P_R	4%
Access points *mi*	11/mi

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	1.5	1.6
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	1.0	1.0
Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	0.889	0.870
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	1.00	1.00
Demand flow rate[2], v_i (pc/h) $v_i=V_i/(PHF^* f_{g,ATS} * f_{HV,ATS})$	229	193

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
Mean speed of sample[3], S_{FM}		Base free-flow speed[4], BFFS	66.0 mi/h
Total demand flow rate, both directions, v		Adj. for lane and shoulder width,[4] f_{LS} (Exhibit 15-7)	0.0 mi/h
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Adj. for access points[4], f_A (Exhibit 15-8)	2.8 mi/h
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	2.0 mi/h	Free-flow speed, FFS $(FSS=BFFS-f_{LS}-f_A)$	63.3 mi/h
		Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	58.0 mi/h
		Percent free flow speed, PFFS	91.6 %

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-18 or 15-19)	1.1	1.1
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	1.0	1.0
Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	0.976	0.976
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	1.00	1.00
Directional flow rate[2], v_i(pc/h) $v_i=V_i/(PHF^* f_{HV,PTSF} * f_{g,PTSF})$	209	172
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	22.4	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	36.7	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF} *(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	42.5	

Level of Service and Other Performance Measures

Level of service, LOS (Exhibit 15-3)	B
Volume to capacity ratio, *v/c*	0.15

Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h	*1479*
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	*1659*
Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only)	*91.6*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*203.6*
Effective width, Wv (Eq. 15-29) ft	*28.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*12.00*
Bicycle level of service (Exhibit 15-4)	*F*
Notes	

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

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DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

General Information		Site Information	
Analyst	*David Stoner*	Highway / Direction of Travel	*MT 16*
Agency or Company	*DOWL HKM*	From/To	*Crane to Sidney NB*
Date Performed	*4/17/2012*	Jurisdiction	*Dawson/Richland County*
Analysis Time Period	*Peak Hour*	Analysis Year	*2012*

Project Description: *MT 16 / MT 200 Glendive to Fairview Corridor Planning Study*

Input Data

Shoulder width ____ ft
Lane width ____ ft
Lane width ____ ft
Shoulder width ____ ft
Segment length, L_t ____ mi

Show North Arrow

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

Terrain ☑ Level ☐ Rolling

Analysis direction vol., V_d	*151veh/h*
Opposing direction vol., V_o	*232veh/h*
Shoulder width ft	*8.0*
Lane Width ft	*12.0*
Segment Length mi	*8.9*
Grade Length mi Up/down	
Peak-hour factor, PHF	*0.80*
No-passing zone	*24%*
% Trucks and Buses, P_T	*19 %*
% Recreational vehicles, P_R	*4%*
Access points *mi*	*12/mi*

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	*1.5*	*1.4*
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	*1.0*	*1.0*
Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.913*	*0.929*
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	*1.00*	*1.00*
Demand flow rate[2], v_i (pc/h) $v_i=V_i/(PHF*f_{g,ATS}*f_{HV,ATS})$	*207*	*312*

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
Mean speed of sample[3], S_{FM}		Base free-flow speed[4], BFFS	*65.0 mi/h*
Total demand flow rate, both directions, *v*		Adj. for lane and shoulder width,[4] f_{LS} (Exhibit 15-7)	*0.0 mi/h*
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Adj. for access points[4], f_A (Exhibit 15-8)	*3.0 mi/h*
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	*1.9 mi/h*	Free-flow speed, FFS (FSS=BFFS-f_{LS}-f_A)	*62.0 mi/h*
		Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	*56.1 mi/h*
		Percent free flow speed, PFFS	*90.5 %*

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T(Exhibit 15-18 or 15-19)	*1.1*	*1.1*
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	*1.0*	*1.0*
Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.981*	*0.981*
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	*1.00*	*1.00*
Directional flow rate[2], v_i(pc/h) $v_i=V_i/(PHF*f_{HV,PTSF}*f_{g,PTSF})$	*192*	*296*
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	*23.2*	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	*37.7*	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	*38.0*	

Level of Service and Other Performance Measures

Level of service, LOS (Exhibit 15-3)	*B*
Volume to capacity ratio, *v/c*	*0.13*

Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h	*1579*
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	*1668*
Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only)	*90.5*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*188.8*
Effective width, Wv (Eq. 15-29) ft	*32.90*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*6.55*
Bicycle level of service (Exhibit 15-4)	*F*
Notes	

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

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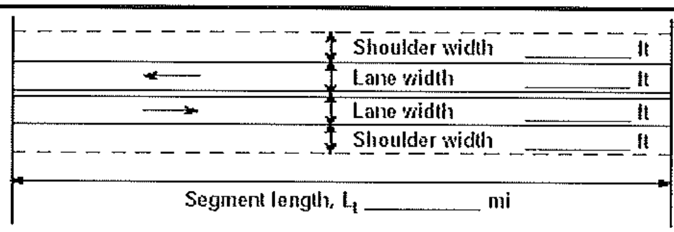
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

General Information		Site Information	
Analyst	*David Stoner*	Highway / Direction of Travel	*MT 16*
Agency or Company	*DOWL HKM*	From/To	*Crane to Sidney SB*
Date Performed	*4/17/2012*	Jurisdiction	*Dawson/Richland County*
Analysis Time Period	*Peak Hour*	Analysis Year	*2012*

Project Description: *MT 16 / MT 200 Glendive to Fairview Corridor Planning Study*

Input Data



Analysis direction vol., V_d *232veh/h*
Opposing direction vol., V_o *151veh/h*
Shoulder width ft *8.0*
Lane Width ft *12.0*
Segment Length mi *8.9*

☑ Class I highway ☐ Class II highway ☐ Class III highway
Terrain ☑ Level ☐ Rolling
Grade Length mi Up/down
Peak-hour factor, PHF *0.87*
No-passing zone *22%*
% Trucks and Buses , P_T *19 %*
% Recreational vehicles, P_R *4%*
Access points *mi* *12/mi*

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	*1.4*	*1.6*
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	*1.0*	*1.0*
Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.929*	*0.898*
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	*1.00*	*1.00*
Demand flow rate[2], v_i (pc/h) $v_i=V_i/(PHF*f_{g,ATS}*f_{HV,ATS})$	*287*	*193*

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
Mean speed of sample[3], S_{FM}		Base free-flow speed[4], BFFS	*69.0 mi/h*
Total demand flow rate, both directions, *v*		Adj. for lane and shoulder width,[4] f_{LS}(Exhibit 15-7)	*0.0 mi/h*
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Adj. for access points[4], f_A (Exhibit 15-8)	*3.0 mi/h*
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	*2.2 mi/h*	Free-flow speed, FFS $(FSS=BFFS-f_{LS}-f_A)$	*66.0 mi/h*
		Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	*60.0 mi/h*
		Percent free flow speed, PFFS	*91.0 %*

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T(Exhibit 15-18 or 15-19)	*1.1*	*1.1*
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	*1.0*	*1.0*
Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.981*	*0.981*
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	*1.00*	*1.00*
Directional flow rate[2], v_i(pc/h) $v_i=V_i/(PHF*f_{HV,PTSF}*f_{g,PTSF})$	*272*	*177*
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	*27.9*	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	*36.8*	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	*50.2*	

Level of Service and Other Performance Measures

Level of service, LOS (Exhibit 15-3)	C
Volume to capacity ratio, *v/c*	*0.19*

Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h	*1527*
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	*1668*
Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only)	*91.0*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*266.7*
Effective width, Wv (Eq. 15-29) ft	*28.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*8.22*
Bicycle level of service (Exhibit 15-4)	*F*

Notes

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

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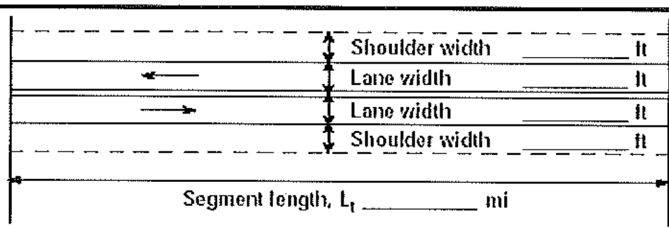
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

General Information		Site Information	
Analyst	David Stoner	Highway / Direction of Travel	MT 200
Agency or Company	DOWL HKM	From/To	Sidney to Fairview EB
Date Performed	4/17/2012	Jurisdiction	Dawson/Richland County
Analysis Time Period	Peak Hour	Analysis Year	2012

Project Description: *MT 16 / MT 200 Glendive to Fairview Corridor Planning Study*

Input Data



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

Terrain ☑ Level ☐ Rolling

Analysis direction vol., V_d	257veh/h
Opposing direction vol., V_o	254veh/h
Shoulder width ft	8.0
Lane Width ft	12.0
Segment Length mi	9.9
Grade Length mi Up/down	
Peak-hour factor, PHF	0.83
No-passing zone	17%
% Trucks and Buses , P_T	17 %
% Recreational vehicles, P_R	4%
Access points *mi*	16/mi

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	1.4	1.4
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	1.0	1.0
Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	0.936	0.936
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	1.00	1.00
Demand flow rate[2], v_i (pc/h) $v_i=V_i/(PHF*f_{g,ATS}*f_{HV,ATS})$	331	327

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
Mean speed of sample[3], S_{FM}		Base free-flow speed[4], BFFS	69.0 mi/h
Total demand flow rate, both directions, v		Adj. for lane and shoulder width,[4] f_{LS}(Exhibit 15-7)	0.0 mi/h
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Adj. for access points[4], f_A (Exhibit 15-8)	4.0 mi/h
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	1.8 mi/h	Free-flow speed, FFS $(FSS=BFFS-f_{LS}-f_A)$	65.0 mi/h
		Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	58.1 mi/h
		Percent free flow speed, PFFS	89.3 %

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T(Exhibit 15-18 or 15-19)	1.1	1.1
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	1.0	1.0
Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	0.983	0.983
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	1.00	1.00
Directional flow rate[2], v_i(pc/h) $v_i=V_i/(PHF*f_{HV,PTSF}*f_{g,PTSF})$	315	311
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	33.8	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	34.3	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	51.1	

Level of Service and Other Performance Measures

Level of service, LOS (Exhibit 15-3)	C
Volume to capacity ratio, *v/c*	0.21

Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h	*1591*
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	*1672*
Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only)	*89.3*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*309.6*
Effective width, Wv (Eq. 15-29) ft	*28.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*7.15*
Bicycle level of service (Exhibit 15-4)	*F*
Notes	

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

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DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

General Information

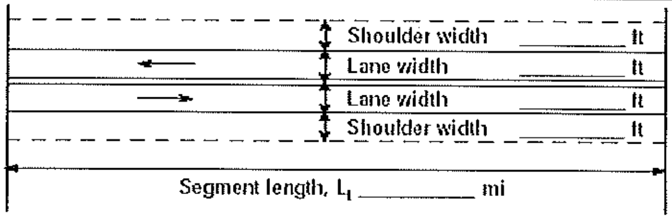
Analyst	*David Stoner*
Agency or Company	*DOWL HKM*
Date Performed	*4/17/2012*
Analysis Time Period	*Peak Hour*

Site Information

Highway / Direction of Travel	*MT 200*
From/To	*Sidney to Fairview WB*
Jurisdiction	*Dawson/Richland County*
Analysis Year	*2012*

Project Description: *MT 16 / MT 200 Glendive to Fairview Corridor Planning Study*

Input Data



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

Terrain ☑ Level ☐ Rolling

Grade Length mi	Up/down
Peak-hour factor, PHF	*0.86*
No-passing zone	*15%*
% Trucks and Buses, P_T	*25 %*
% Recreational vehicles, P_R	*4%*
Access points *mi*	*16/mi*

Analysis direction vol., V_d	*254veh/h*
Opposing direction vol., V_o	*257veh/h*
Shoulder width ft	*8.0*
Lane Width ft	*12.0*
Segment Length mi	*9.9*

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	*1.4*	*1.4*
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	*1.0*	*1.0*
Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.909*	*0.909*
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	*1.00*	*1.00*
Demand flow rate[2], v_i (pc/h) $v_i=V_i/(PHF*f_{g,ATS}*f_{HV,ATS})$	*325*	*329*

Free-Flow Speed from Field Measurement

Mean speed of sample[3], S_{FM}	
Total demand flow rate, both directions, v	
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$	
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	*1.7 mi/h*

Estimated Free-Flow Speed

Base free-flow speed[4], BFFS	*66.0 mi/h*
Adj. for lane and shoulder width,[4] f_{LS} (Exhibit 15-7)	*0.0 mi/h*
Adj. for access points[4], f_A (Exhibit 15-8)	*4.0 mi/h*
Free-flow speed, FFS $(FSS=BFFS-f_{LS}-f_A)$	*62.0 mi/h*
Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	*55.3 mi/h*
Percent free flow speed, PFFS	*89.1 %*

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-18 or 15-19)	*1.1*	*1.1*
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	*1.0*	*1.0*
Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.976*	*0.976*
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	*1.00*	*1.00*
Directional flow rate[2], v_i(pc/h) $v_i=V_i/(PHF*f_{HV,PTSF}*f_{g,PTSF})$	*303*	*306*
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	*33.2*	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	*32.4*	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	*49.3*	

Level of Service and Other Performance Measures

Level of service, LOS (Exhibit 15-3)	*B*
Volume to capacity ratio, *v/c*	*0.21*

Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h	1545
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	1659
Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only)	89.1
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	295.3
Effective width, Wv (Eq. 15-29) ft	28.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	12.19
Bicycle level of service (Exhibit 15-4)	F

Notes

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

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Appendix 4

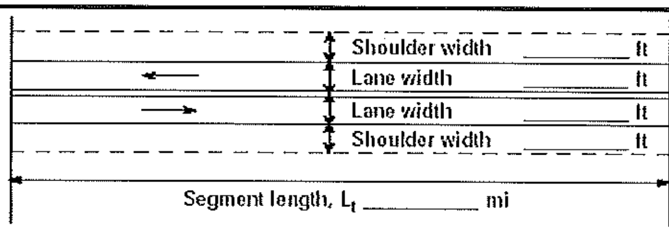
Projected Two-Lane Highway 2035 – Low Condition

DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

General Information		Site Information	
Analyst	David Stoner	Highway / Direction of Travel	MT 16
Agency or Company	DOWL HKM	From/To	RP 0.6 to 20.0 NB
Date Performed	4/17/2012	Jurisdiction	Dawson/Richland County
Analysis Time Period	Peak Hour	Analysis Year	2035 Low

Project Description: *MT 16 / MT 200 Glendive to Fairview Corridor Planning Study*

Input Data



[x] Class I highway [ ] Class II highway [ ] Class III highway

Terrain [x] Level [ ] Rolling

Analysis direction vol., V_d	242veh/h
Opposing direction vol., V_o	249veh/h
Shoulder width ft	8.0
Lane Width ft	12.0
Segment Length mi	19.4
Grade Length mi Up/down	
Peak-hour factor, PHF	0.81
No-passing zone	27%
% Trucks and Buses , P_T	27 %
% Recreational vehicles, P_R	4%
Access points *mi*	5/mi

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	1.4	1.4
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	1.0	1.0
Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	0.903	0.903
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	1.00	1.00
Demand flow rate[2], v_i (pc/h) $v_i=V_i/(PHF^* f_{g,ATS} * f_{HV,ATS})$	331	340

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
Mean speed of sample[3], S_{FM}		Base free-flow speed[4], BFFS	65.0 mi/h
Total demand flow rate, both directions, v		Adj. for lane and shoulder width,[4] f_{LS} (Exhibit 15-7)	0.0 mi/h
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Adj. for access points[4], f_A (Exhibit 15-8)	1.3 mi/h
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	2.0 mi/h	Free-flow speed, FFS $(FSS=BFFS-f_{LS}-f_A)$	63.8 mi/h
		Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	56.5 mi/h
		Percent free flow speed, PFFS	88.7 %

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T(Exhibit 15-18 or 15-19)	1.1	1.1
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	1.0	1.0
Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	0.974	0.974
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	1.00	1.00
Directional flow rate[2], v_i(pc/h) $v_i=V_i/(PHF^*f_{HV,PTSF}^* f_{g,PTSF})$	307	316
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	34.5	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	40.7	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	54.6	

Level of Service and Other Performance Measures

Level of service, LOS (Exhibit 15-3)	C
Volume to capacity ratio, *v/c*	0.22

Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h	*1535*
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	*1655*
Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only)	*88.7*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*298.8*
Effective width, Wv (Eq. 15-29) ft	*28.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*13.66*
Bicycle level of service (Exhibit 15-4)	*F*

Notes

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

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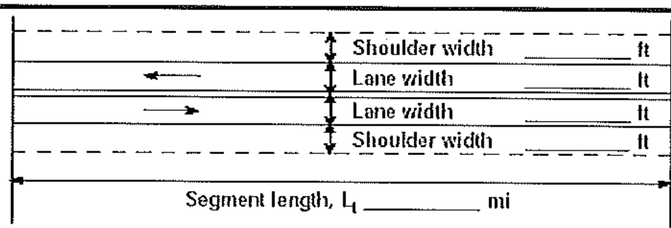
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

General Information		Site Information	
Analyst	*David Stoner*	Highway / Direction of Travel	*MT 16*
Agency or Company	*DOWL HKM*	From/To	*RP 0.6 to RP 12.4 SB*
Date Performed	*4/17/2012*	Jurisdiction	*Dawson/Richland County*
Analysis Time Period	*Peak Hour*	Analysis Year	*2035 Low*

Project Description: *MT 16 / MT 200 Glendive to Fairview Corridor Planning Study*

Input Data



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

Terrain ☑ Level ☐ Rolling

Grade Length mi	Up/down
Peak-hour factor, PHF	*0.78*
No-passing zone	*20%*
% Trucks and Buses, P_T	*29 %*
% Recreational vehicles, P_R	*4%*
Access points *mi*	*7/mi*

Analysis direction vol., V_d	*249veh/h*
Opposing direction vol., V_o	*242veh/h*
Shoulder width ft	*8.0*
Lane Width ft	*12.0*
Segment Length mi	*11.8*

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	*1.4*	*1.4*
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	*1.0*	*1.0*
Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.896*	*0.896*
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	*1.00*	*1.00*
Demand flow rate[2], v_i (pc/h) $v_i=V_i/(PHF*f_{g,ATS}*f_{HV,ATS})$	*356*	*346*

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
Mean speed of sample[3], S_{FM}		Base free-flow speed[4], BFFS	*65.0 mi/h*
Total demand flow rate, both directions, v		Adj. for lane and shoulder width,[4] f_{LS} (Exhibit 15-7)	*0.0 mi/h*
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Adj. for access points[4], f_A (Exhibit 15-8)	*1.8 mi/h*
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	*1.7 mi/h*	Free-flow speed, FFS (FSS=BFFS-f_{LS}-f_A)	*63.3 mi/h*
		Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	*56.1 mi/h*
		Percent free flow speed, PFFS	*88.7 %*

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T(Exhibit 15-18 or 15-19)	*1.1*	*1.1*
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	*1.0*	*1.0*
Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.972*	*0.972*
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	*1.00*	*1.00*
Directional flow rate[2], v_i(pc/h) $v_i=V_i/(PHF*f_{HV,PTSF}*f_{g,PTSF})$	*328*	*319*
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	*36.1*	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	*37.0*	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	*54.9*	

Level of Service and Other Performance Measures

Level of service, LOS (Exhibit 15-3)	*C*
Volume to capacity ratio, *v/c*	*0.23*

Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h	*1523*
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	*1652*
Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only)	*88.7*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*319.2*
Effective width, Wv (Eq. 15-29) ft	*28.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*15.25*
Bicycle level of service (Exhibit 15-4)	*F*
Notes	

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

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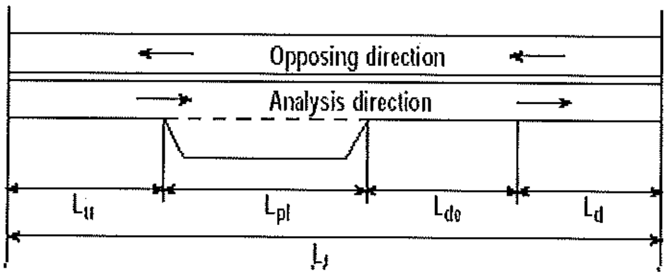
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET WITH PASSING LANE WORKSHEET

General Information		Site Information	
Analyst	David Stoner	Highway of Travel	MT 16
Agency or Company	DOWL HKM	From/To	RP 20.0 to Savage NB
Date Performed	4/17/2012	Jurisdiction	Dawson/Richland County
Analysis Time Period	Peak Hour	Analysis Year	2035 Low

Project Description: MT 16 / MT 200 Glendive to Fairview Corridor Planning Study

Input Data

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



Shoulder width (ft)	8.0
Lane Width (ft)	12.0
Segment Length (mi)	11.5
Total length of analysis segment, L_t	11.5
Length of two-lane highway upstream of the passing lane, L_u	0.0
Length of passing lane including tapers , L_{pl}	1.9
Average travel speed, ATS_d (from Directional Two-Lane Highway Segment Worksheet)	56.8
Percent time-spent-following, $PTSF_d$ (from Directional Two-Lane Highway Segment Worksheet)	53.0
Level of service[1], LOS_d (from Directional Two-Lane Highway Segment Worksheet)	C
Average Travel Speed	
Length of the downstream highway segment within the effective length of passing lane for average travel speed, L_{de} (Exhibit 15-23)	1.70
Length of two-lane highway downstream of effective length of the passing lane for avg travel speed, L_d $L_d=L_t-(L_u+L_{pl}+L_{de})$	7.90
Adj. factor for the effect of passing lane on average speed, f_{pl} (Exhibit 15-28)	1.10
Average travel speed including passing lane[2], $ATS_{pl} = (ATS_d * L_t) / (L_u+L_d+(L_{pl}/f_{pl})+ (2L_{de}/(1+f_{pl,ATS})))$	58.1
Percent free flow speed including passing lane, $PFFS_{pl} = (ATS_{pl}/ FFS)$	91.1
Percent Time-Spent-Following	
Length of the downstream highway segment within the effective length of passing lane for percent time-spent-following, L_{de} (Exhibit 15-23)	11.36
Length of two-lane highway downstream of effective length of the passing lane for percent-time-following, $L_d =L_t-(L_u+ L_{pl}+ L_{de})$	-1.76
Adj. factor for the effect of passing lane on percent time-spent-following, $f_{pl,PTSF}$(Exhibit 15-26)	0.60

Percent time-spent-following including passing lane[3], $PTSF_{pl}$(%) $PTSF_{pl} = PTSF_d[L_u + L_d + f_{pl,PTSF} L_{pl} + ((1+f_{pl,PTSF})/2) L_{de}]/L_t$	*39.3*
Level of Service and Other Performance Measures[4]	
Level of service including passing lane LOS_{pl} (Exhibit 15-3)	*B*
Peak 15-min total travel time, TT_{15}(veh-h) $TT_{15} = VMT_{15}/ATS_{pl}$	*14.8*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*298.8*
Effective width, W_v (Eq. 15-29) ft	*28.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*13.66*
Bicycle level of service (Exhibit 15-4)	*F*
Notes	

1. If LOS_d=F, passing lane analysis cannot be performed.
2. If L_d <0, use alternative Equation 15-18.
3. If L_d<0, use alternative Equation 15-16.
4. v/c, VMT_{15} and VMT_{60} are calculated on Directional Two-Lane Highway Segment Worksheet.

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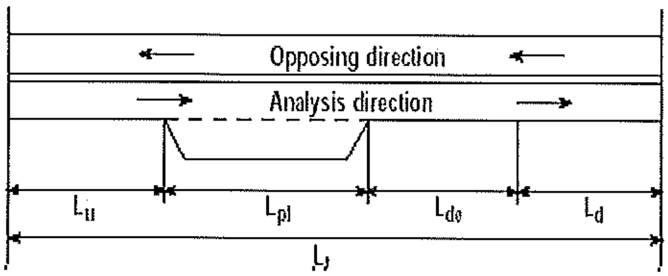
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET WITH PASSING LANE WORKSHEET

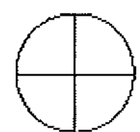
General Information		Site Information	
Analyst	*David Stoner*	Highway of Travel	*MT 16*
Agency or Company	*DOWL HKM*	From/To	*RP 12.4 to RP 22.0 SB*
Date Performed	*4/17/2012*	Jurisdiction	*Dawson/Richland County*
Analysis Time Period	*Peak Hour*	Analysis Year	*2035 Low*

Project Description: *MT 16 / MT 200 Glendive to Fairview Corridor Planning Study*

Input Data

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





Shoulder width (ft)	*8.0*
Lane Width (ft)	*12.0*
Segment Length (mi)	*9.6*
Total length of analysis segment, L_t	*9.6*
Length of two-lane highway upstream of the passing lane, L_u	*0.0*
Length of passing lane including tapers , L_{pl}	*1.9*
Average travel speed, ATS_d (from Directional Two-Lane Highway Segment Worksheet)	*57.3*
Percent time-spent-following, $PTSF_d$ (from Directional Two-Lane Highway Segment Worksheet)	*52.7*
Level of service[1], LOS_d (from Directional Two-Lane Highway Segment Worksheet)	*C*
Average Travel Speed	
Length of the downstream highway segment within the effective length of passing lane for average travel speed, L_{de} (Exhibit 15-23)	*1.70*
Length of two-lane highway downstream of effective length of the passing lane for avg travel speed, L_d $L_d = L_t-(L_u+L_{pl}+L_{de})$	*6.00*
Adj. factor for the effect of passing lane on average speed, f_{pl} (Exhibit 15-28)	*1.10*
Average travel speed including passing lane[2], $ATS_{pl} = (ATS_d * L_t) / (L_u+L_d+(L_{pl}/f_{pl})+ (2L_{de}/(1+f_{pl,ATS})))$	*58.9*
Percent free flow speed including passing lane, $PFFS_{pl} = (ATS_{pl}/ FFS)$	*91.3*
Percent Time-Spent-Following	
Length of the downstream highway segment within the effective length of passing lane for percent time-spent-following, L_{de} (Exhibit 15-23)	*10.62*
Length of two-lane highway downstream of effective length of the passing lane for percent-time-following, $L_d = L_t-(L_u+ L_{pl}+ L_{de})$	*-2.92*
Adj. factor for the effect of passing lane on percent time-spent-following, $f_{pl,PTSF}$(Exhibit 15-26)	*0.60*

Percent time-spent-following including passing lane[3], $PTSF_{pl}$(%) $PTSF_{pl}= PTSF_d[L_u+L_d+f_{pl,PTSF}L_{pl}+((1+f_{pl,PTSF})/2)L_{de}]/L_t$	*37.7*
Level of Service and Other Performance Measures[4]	
Level of service including passing lane LOS_{pl} (Exhibit 15-3)	*B*
Peak 15-min total travel time, TT_{15}(veh-h) $TT_{15}= VMT_{15}/ATS_{pl}$	*13.0*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*319.2*
Effective width, W_v (Eq. 15-29) ft	*28.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*15.25*
Bicycle level of service (Exhibit 15-4)	*F*
Notes	
1. If LOS_d=F, passing lane analysis cannot be performed.	
2. If L_d <0, use alternative Equation 15-18.	
3. If L_d<0, use alternative Equation 15-16.	
4. v/c, VMT_{15} and VMT_{60} are calculated on Directional Two-Lane Highway Segment Worksheet.	

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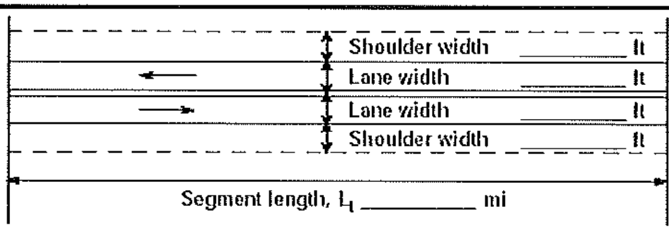
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

General Information		Site Information	
Analyst	*David Stoner*	Highway / Direction of Travel	*MT 16*
Agency or Company	*DOWL HKM*	From/To	*RP 22.0 to Savage SB*
Date Performed	*4/17/2012*	Jurisdiction	*Dawson/Richland County*
Analysis Time Period	*Peak Hour*	Analysis Year	*2035 Low*

Project Description: *MT 16 / MT 200 Glendive to Fairview Corridor Planning Study*

Input Data



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

Terrain ☑ Level ☐ Rolling

Grade Length mi	Up/down
Peak-hour factor, PHF	*0.78*
No-passing zone	*22%*
% Trucks and Buses, P_T	*29 %*
% Recreational vehicles, P_R	*4%*
Access points *mi*	*5/mi*
Analysis direction vol., V_d	*249veh/h*
Opposing direction vol., V_o	*242veh/h*
Shoulder width ft	*8.0*
Lane Width ft	*12.0*
Segment Length mi	*9.5*

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	*1.4*	*1.4*
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	*1.0*	*1.0*
Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.896*	*0.896*
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	*1.00*	*1.00*
Demand flow rate[2], v_i (pc/h) $v_i=V_i/(PHF^* f_{g,ATS} * f_{HV,ATS})$	*356*	*346*

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
		Base free-flow speed[4], BFFS	*65.0 mi/h*
Mean speed of sample[3], S_{FM}		Adj. for lane and shoulder width,[4] f_{LS}(Exhibit 15-7)	*0.0 mi/h*
Total demand flow rate, both directions, v		Adj. for access points[4], f_A (Exhibit 15-8)	*1.3 mi/h*
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Free-flow speed, FFS ($FSS=BFFS-f_{LS}-f_A$)	*63.8 mi/h*
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	*1.8 mi/h*	Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	*56.5 mi/h*
		Percent free flow speed, PFFS	*88.7 %*

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T(Exhibit 15-18 or 15-19)	*1.1*	*1.1*
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	*1.0*	*1.0*
Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.972*	*0.972*
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	*1.00*	*1.00*
Directional flow rate[2], v_i(pc/h) $v_i=V_i/(PHF^*f_{HV,PTSF}^* f_{g,PTSF})$	*328*	*319*
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	*36.1*	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	*37.9*	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	*55.3*	

Level of Service and Other Performance Measures

Level of service, LOS (Exhibit 15-3)	*C*
Volume to capacity ratio, *v/c*	*0.23*

Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h	*1523*
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	*1652*
Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only)	*88.7*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*319.2*
Effective width, Wv (Eq. 15-29) ft	*28.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*15.25*
Bicycle level of service (Exhibit 15-4)	*F*

Notes

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

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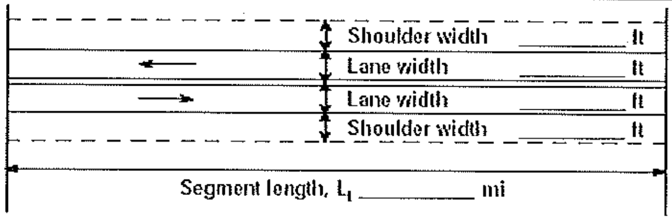
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

General Information		Site Information	
Analyst	David Stoner	Highway / Direction of Travel	MT 16
Agency or Company	DOWL HKM	From/To	Savage to Crane NB
Date Performed	4/17/2012	Jurisdiction	Dawson/Richland County
Analysis Time Period	Peak Hour	Analysis Year	2035 - Low

Project Description: *MT 16 / MT 200 Glendive to Fairview Corridor Planning Study*

Input Data



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

Terrain ☑ Level ☐ Rolling

Analysis direction vol., V_d	253veh/h
Opposing direction vol., V_o	307veh/h
Shoulder width ft	8.0
Lane Width ft	12.0
Segment Length mi	10.0
Grade Length mi	Up/down
Peak-hour factor, PHF	0.87
No-passing zone	31%
% Trucks and Buses , P_T	23 %
% Recreational vehicles, P_R	4%
Access points *mi*	11/mi

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	1.4	1.3
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	1.0	1.0
Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	0.916	0.935
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	1.00	1.00
Demand flow rate[2], v_i (pc/h) $v_i=V_i/(PHF*f_{g,ATS}*f_{HV,ATS})$	317	377

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
		Base free-flow speed[4], BFFS	69.0 mi/h
Mean speed of sample[3], S_{FM}		Adj. for lane and shoulder width,[4] f_{LS} (Exhibit 15-7)	0.0 mi/h
Total demand flow rate, both directions, v		Adj. for access points[4], f_A (Exhibit 15-8)	2.8 mi/h
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Free-flow speed, FFS ($FSS=BFFS-f_{LS}-f_A$)	66.3 mi/h
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	2.1 mi/h	Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	58.8 mi/h
		Percent free flow speed, PFFS	88.7 %

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T(Exhibit 15-18 or 15-19)	1.1	1.1
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	1.0	1.0
Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	0.978	0.978
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	1.00	1.00
Directional flow rate[2], v_i(pc/h) $v_i=V_i/(PHF*f_{HV,PTSF}*f_{g,PTSF})$	297	361
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	33.3	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	39.9	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	51.3	

Level of Service and Other Performance Measures

Level of service, LOS (Exhibit 15-3)	C
Volume to capacity ratio, *v/c*	0.20

Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h	*1590*
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	*1662*
Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only)	*88.7*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*290.8*
Effective width, Wv (Eq. 15-29) ft	*28.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*10.79*
Bicycle level of service (Exhibit 15-4)	*F*

Notes

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

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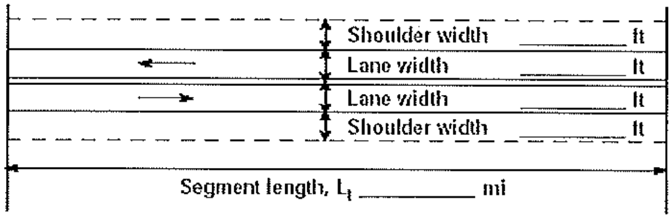
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

General Information		Site Information	
Analyst	David Stoner	Highway / Direction of Travel	MT 16
Agency or Company	DOWL HKM	From/To	Savage to Crane SB
Date Performed	4/17/2012	Jurisdiction	Dawson/Richland County
Analysis Time Period	Peak Hour	Analysis Year	2035 - Low

Project Description: MT 16 / MT 200 Glendive to Fairview Corridor Planning Study

Input Data



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

Terrain ☑ Level ☐ Rolling

Analysis direction vol., V_d	307veh/h
Opposing direction vol., V_o	253veh/h
Shoulder width ft	8.0
Lane Width ft	12.0
Segment Length mi	10.0

Grade Length mi Up/down	
Peak-hour factor, PHF	0.84
No-passing zone	19%
% Trucks and Buses , P_T	25 %
% Recreational vehicles, P_R	4%
Access points *mi*	11/mi

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	1.3	1.4
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	1.0	1.0
Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	0.930	0.909
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	1.00	1.00
Demand flow rate[2], v_i(pc/h) $v_i=V_i/(PHF*f_{g,ATS}*f_{HV,ATS})$	393	331

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
Mean speed of sample[3], S_{FM}		Base free-flow speed[4], BFFS	66.0 mi/h
Total demand flow rate, both directions, *v*		Adj. for lane and shoulder width,[4] f_{LS}(Exhibit 15-7)	0.0 mi/h
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Adj. for access points[4], f_A (Exhibit 15-8)	2.8 mi/h
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	1.7 mi/h	Free-flow speed, FFS $(FSS=BFFS-f_{LS}-f_A)$	63.3 mi/h
		Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	55.9 mi/h
		Percent free flow speed, PFFS	88.4 %

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T(Exhibit 15-18 or 15-19)	1.1	1.1
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	1.0	1.0
Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	0.976	0.976
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	1.00	1.00
Directional flow rate[2], v_i(pc/h) $v_i=V_i/(PHF*f_{HV,PTSF}*f_{g,PTSF})$	375	309
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	38.7	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	33.9	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	57.3	

Level of Service and Other Performance Measures

Level of service, LOS (Exhibit 15-3)	C
Volume to capacity ratio, *v/c*	0.25

Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h	*1545*
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	*1659*
Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only)	*88.4*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*365.5*
Effective width, Wv (Eq. 15-29) ft	*28.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*12.29*
Bicycle level of service (Exhibit 15-4)	*F*

Notes

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

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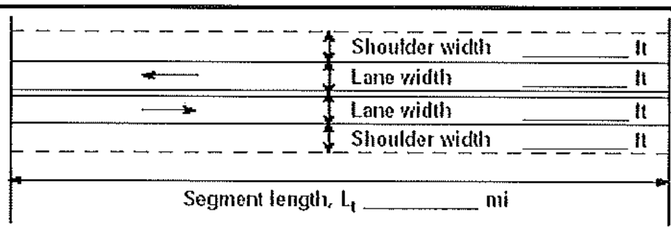
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

General Information		Site Information	
Analyst	*David Stoner*	Highway / Direction of Travel	*MT 16*
Agency or Company	*DOWL HKM*	From/To	*Crane to Sidney NB*
Date Performed	*4/17/2012*	Jurisdiction	*Dawson/Richland County*
Analysis Time Period	*Peak Hour*	Analysis Year	*2035 - Low*

Project Description: *MT 16 / MT 200 Glendive to Fairview Corridor Planning Study*

Input Data



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

Terrain ☑ Level ☐ Rolling

Grade Length mi Up/down

Analysis direction vol., V_d	*271*veh/h
Opposing direction vol., V_o	*416*veh/h
Shoulder width ft	*8.0*
Lane Width ft	*12.0*
Segment Length mi	*8.9*
Peak-hour factor, PHF	*0.80*
No-passing zone	*24%*
% Trucks and Buses , P_T	*19 %*
% Recreational vehicles, P_R	*4%*
Access points *mi*	*12*/mi

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	*1.4*	*1.2*
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	*1.0*	*1.0*
Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.929*	*0.963*
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	*1.00*	*1.00*
Demand flow rate[2], v_i (pc/h) $v_i=V_i/(PHF*f_{g,ATS}*f_{HV,ATS})$	*365*	*540*

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
Mean speed of sample[3], S_{FM}		Base free-flow speed[4], BFFS	*65.0 mi/h*
Total demand flow rate, both directions, v		Adj. for lane and shoulder width,[4] f_{LS} (Exhibit 15-7)	*0.0 mi/h*
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Adj. for access points[4], f_A (Exhibit 15-8)	*3.0 mi/h*
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	*1.4 mi/h*	Free-flow speed, FFS ($FSS=BFFS-f_{LS}-f_A$)	*62.0 mi/h*
		Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	*53.6 mi/h*
		Percent free flow speed, PFFS	*86.5 %*

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-18 or 15-19)	*1.1*	*1.0*
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	*1.0*	*1.0*
Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.981*	*1.000*
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	*1.00*	*1.00*
Directional flow rate[2], v_i(pc/h) $v_i=V_i/(PHF*f_{HV,PTSF}*f_{g,PTSF})$	*345*	*520*
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	*41.1*	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	*27.9*	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	*52.2*	

Level of Service and Other Performance Measures

Level of service, LOS (Exhibit 15-3)	*C*
Volume to capacity ratio, *v/c*	*0.22*

Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h	1637
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	1700
Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only)	86.5
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	338.8
Effective width, Wv (Eq. 15-29) ft	28.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	8.34
Bicycle level of service (Exhibit 15-4)	F
Notes	

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

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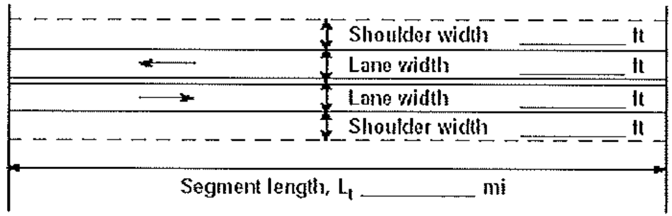
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

General Information		Site Information	
Analyst	*David Stoner*	Highway / Direction of Travel	*MT 16*
Agency or Company	*DOWL HKM*	From/To	*Crane to Sidney SB*
Date Performed	*4/17/2012*	Jurisdiction	*Dawson/Richland County*
Analysis Time Period	*Peak Hour*	Analysis Year	*2035 - Low*

Project Description: *MT 16 / MT 200 Glendive to Fairview Corridor Planning Study*

Input Data



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

Terrain ☑ Level ☐ Rolling

Analysis direction vol., V_d	*416*veh/h	Grade Length mi	Up/down
Opposing direction vol., V_o	*271*veh/h	Peak-hour factor, PHF	*0.87*
Shoulder width ft	*8.0*	No-passing zone	*22%*
Lane Width ft	*12.0*	% Trucks and Buses , P_T	*19 %*
Segment Length mi	*8.9*	% Recreational vehicles, P_R	*4%*
		Access points *mi*	*12*/mi

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	*1.2*	*1.4*
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	*1.0*	*1.0*
Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.963*	*0.929*
Grade adjustment factor¹, $f_{g,ATS}$ (Exhibit 15-9)	*1.00*	*1.00*
Demand flow rate², v_i (pc/h) $v_i=V_i/(PHF*f_{g,ATS}*f_{HV,ATS})$	*497*	*335*

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
Mean speed of sample³, S_{FM}		Base free-flow speed⁴, BFFS	*69.0 mi/h*
Total demand flow rate, both directions, v		Adj. for lane and shoulder width,⁴ f_{LS} (Exhibit 15-7)	*0.0 mi/h*
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Adj. for access points⁴, f_A (Exhibit 15-8)	*3.0 mi/h*
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	*1.9 mi/h*	Free-flow speed, FFS $(FSS=BFFS-f_{LS}-f_A)$	*66.0 mi/h*
		Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	*57.7 mi/h*
		Percent free flow speed, PFFS	*87.4 %*

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T(Exhibit 15-18 or 15-19)	*1.0*	*1.1*
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	*1.0*	*1.0*
Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*1.000*	*0.981*
Grade adjustment factor¹, $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	*1.00*	*1.00*
Directional flow rate², v_i(pc/h) $v_i=V_i/(PHF*f_{HV,PTSF}*f_{g,PTSF})$	*478*	*317*
Base percent time-spent-following⁴, $BPTSF_d(\%)=100(1-e^{av_d^b})$	*47.4*	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	*28.7*	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	*64.7*	

Level of Service and Other Performance Measures

Level of service, LOS (Exhibit 15-3)	*C*
Volume to capacity ratio, *v/c*	*0.31*

Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h	1579
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	1668
Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only)	87.4
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	478.2
Effective width, Wv (Eq. 15-29) ft	28.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	8.51
Bicycle level of service (Exhibit 15-4)	F

Notes

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

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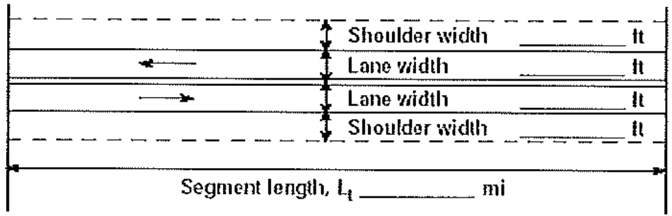
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

General Information		Site Information	
Analyst	*David Stoner*	Highway / Direction of Travel	*MT 200*
Agency or Company	*DOWL HKM*	From/To	*Sidney to Fairview EB*
Date Performed	*4/17/2012*	Jurisdiction	*Dawson/Richland County*
Analysis Time Period	*Peak Hour*	Analysis Year	*2035 - Low*

Project Description: *MT 16 / MT 200 Glendive to Fairview Corridor Planning Study*

Input Data



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

Terrain ☑ Level ☐ Rolling

Analysis direction vol., V_d	*529veh/h*
Opposing direction vol., V_o	*523veh/h*
Shoulder width ft	*8.0*
Lane Width ft	*12.0*
Segment Length mi	*9.9*
Grade Length mi Up/down	
Peak-hour factor, PHF	*0.83*
No-passing zone	*17%*
% Trucks and Buses , P_T	*17 %*
% Recreational vehicles, P_R	*4%*
Access points *mi*	*16/mi*

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	*1.1*	*1.1*
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	*1.0*	*1.0*
Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.983*	*0.983*
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	*1.00*	*1.00*
Demand flow rate[2], v_i (pc/h) $v_i=V_i/(PHF^* f_{g,ATS} * f_{HV,ATS})$	*648*	*641*

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
Mean speed of sample[3], S_{FM}		Base free-flow speed[4], BFFS	*69.0 mi/h*
Total demand flow rate, both directions, *v*		Adj. for lane and shoulder width,[4] f_{LS}(Exhibit 15-7)	*0.0 mi/h*
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Adj. for access points[4], f_A (Exhibit 15-8)	*4.0 mi/h*
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	*1.3 mi/h*	Free-flow speed, FFS $(FSS=BFFS-f_{LS}-f_A)$	*65.0 mi/h*
		Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	*53.7 mi/h*
		Percent free flow speed, PFFS	*82.7 %*

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T(Exhibit 15-18 or 15-19)	*1.0*	*1.0*
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	*1.0*	*1.0*
Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*1.000*	*1.000*
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	*1.00*	*1.00*
Directional flow rate[2], v_i(pc/h) $v_i=V_i/(PHF^* f_{HV,PTSF} * f_{g,PTSF})$	*637*	*630*
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	*60.4*	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	*21.6*	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	*71.3*	

Level of Service and Other Performance Measures

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

Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h	*1671*
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	*1700*
Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only)	*82.7*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*637.3*
Effective width, Wv (Eq. 15-29) ft	*28.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*7.52*
Bicycle level of service (Exhibit 15-4)	*F*
Notes	

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

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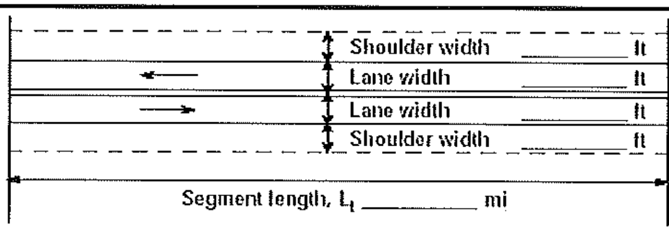
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

General Information		Site Information	
Analyst	*David Stoner*	Highway / Direction of Travel	*MT 200*
Agency or Company	*DOWL HKM*	From/To	*Sidney to Fairview WB*
Date Performed	*4/17/2012*	Jurisdiction	*Dawson/Richland County*
Analysis Time Period	*Peak Hour*	Analysis Year	*2035 - Low*

Project Description: *MT 16 / MT 200 Glendive to Fairview Corridor Planning Study*

Input Data



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

Terrain ☑ Level ☐ Rolling

Grade Length mi Up/down

Analysis direction vol., V_d	*523veh/h*
Opposing direction vol., V_o	*529veh/h*
Shoulder width ft	*8.0*
Lane Width ft	*12.0*
Segment Length mi	*9.9*
Peak-hour factor, PHF	*0.86*
No-passing zone	*15%*
% Trucks and Buses , P_T	*25 %*
% Recreational vehicles, P_R	*4%*
Access points *mi*	*16/mi*

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	*1.1*	*1.1*
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	*1.0*	*1.0*
Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.976*	*0.976*
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	*1.00*	*1.00*
Demand flow rate[2], v_i (pc/h) $v_i=V_i/(PHF*f_{g,ATS}*f_{HV,ATS})$	*623*	*630*

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
Mean speed of sample[3], S_{FM}		Base free-flow speed[4], BFFS	*66.0 mi/h*
Total demand flow rate, both directions, *v*		Adj. for lane and shoulder width,[4] f_{LS}(Exhibit 15-7)	*0.0 mi/h*
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Adj. for access points[4], f_A (Exhibit 15-8)	*4.0 mi/h*
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	*1.1 mi/h*	Free-flow speed, FFS $(FSS=BFFS-f_{LS}-f_A)$	*62.0 mi/h*
		Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	*51.1 mi/h*
		Percent free flow speed, PFFS	*82.5 %*

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T(Exhibit 15-18 or 15-19)	*1.0*	*1.0*
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	*1.0*	*1.0*
Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*1.000*	*1.000*
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	*1.00*	*1.00*
Directional flow rate[2], v_i(pc/h) $v_i=V_i/(PHF*f_{HV,PTSF}*f_{g,PTSF})$	*608*	*615*
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	*58.6*	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	*21.4*	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	*69.2*	

Level of Service and Other Performance Measures

Level of service, LOS (Exhibit 15-3)	*D*
Volume to capacity ratio, *v/c*	*0.38*

Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h	*1659*
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	*1700*
Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only)	*82.5*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*608.1*
Effective width, Wv (Eq. 15-29) ft	*28.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*12.55*
Bicycle level of service (Exhibit 15-4)	*F*
Notes	

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

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Appendix 4

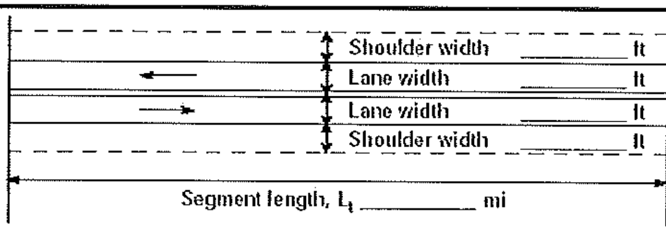
Projected Two-Lane Highway 2035 – High Condition

DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

General Information		Site Information	
Analyst	David Stoner	Highway / Direction of Travel	MT 16
Agency or Company	DOWL HKM	From/To	RP 0.6 to 20.0 NB
Date Performed	4/17/2012	Jurisdiction	Dawson/Richland County
Analysis Time Period	Peak Hour	Analysis Year	2035 High

Project Description: MT 16 / MT 200 Glendive to Fairview Corridor Planning Study

Input Data



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

Terrain ☑ Level ☐ Rolling

Analysis direction vol., V_d	321veh/h
Opposing direction vol., V_o	331veh/h
Shoulder width ft	8.0
Lane Width ft	12.0
Segment Length mi	19.4
Grade Length mi Up/down	
Peak-hour factor, PHF	0.81
No-passing zone	27%
% Trucks and Buses , P_T	27 %
% Recreational vehicles, P_R	4%
Access points *mi*	5/mi

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	1.3	1.3
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	1.0	1.0
Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	0.925	0.925
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	1.00	1.00
Demand flow rate[2], v_i (pc/h) $v_i=V_i/(PHF^* f_{g,ATS} * f_{HV,ATS})$	428	442

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
Mean speed of sample[3], S_{FM}		Base free-flow speed[4], BFFS	65.0 mi/h
Total demand flow rate, both directions, *v*		Adj. for lane and shoulder width,[4] f_{LS}(Exhibit 15-7)	0.0 mi/h
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Adj. for access points[4], f_A (Exhibit 15-8)	1.3 mi/h
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	1.7 mi/h	Free-flow speed, FFS $(FSS=BFFS-f_{LS}-f_A)$	63.8 mi/h
		Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	55.3 mi/h
		Percent free flow speed, PFFS	86.7 %

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T(Exhibit 15-18 or 15-19)	1.1	1.0
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	1.0	1.0
Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	0.974	1.000
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	1.00	1.00
Directional flow rate[2], v_i(pc/h) $v_i=V_i/(PHF^*f_{HV,PTSF}*f_{g,PTSF})$	407	409
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	42.7	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	35.3	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	60.3	

Level of Service and Other Performance Measures

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

Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h	*1573*
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	*1700*
Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only)	*86.7*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*396.3*
Effective width, Wv (Eq. 15-29) ft	*28.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*13.81*
Bicycle level of service (Exhibit 15-4)	*F*
Notes	
1. Note that the adjustment factor for level terrain is 1.00,as level terrain is one of the base conditions. For the purpose of grade adjustment, specific downgrade segments are treated as level terrain. 2. If v_i(v_d or v_o) >=1,700 pc/h, terminate analysis--the LOS is F. 3. For the analysis direction only and for v>200 veh/h. 4. For the analysis direction only 5. Exhibit 15-20 provides coefficients a and b for Equation 15-10. 6. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.	

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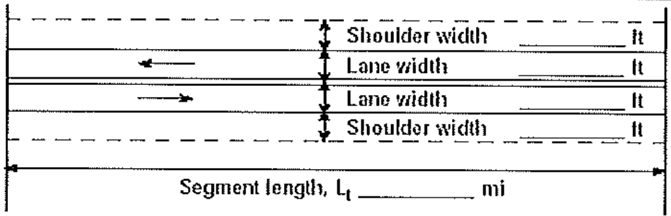
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

General Information		Site Information	
Analyst	David Stoner	Highway / Direction of Travel	MT 16
Agency or Company	DOWL HKM	From/To	RP 0.6 to RP 12.4 SB
Date Performed	4/17/2012	Jurisdiction	Dawson/Richland County
Analysis Time Period	Peak Hour	Analysis Year	2035 High

Project Description: *MT 16 / MT 200 Glendive to Fairview Corridor Planning Study*

Input Data



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

Terrain ☑ Level ☐ Rolling

Grade Length mi	Up/down
Peak-hour factor, PHF	0.78
No-passing zone	20%
% Trucks and Buses , P_T	29 %
% Recreational vehicles, P_R	4%
Access points *mi*	7/mi

Analysis direction vol., V_d	331veh/h
Opposing direction vol., V_o	321veh/h
Shoulder width ft	8.0
Lane Width ft	12.0
Segment Length mi	11.8

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	1.3	1.3
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	1.0	1.0
Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	0.920	0.920
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	1.00	1.00
Demand flow rate[2], v_i (pc/h) $v_i=V_i/(PHF*f_{g,ATS}*f_{HV,ATS})$	461	447

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
		Base free-flow speed[4], BFFS	65.0 mi/h
Mean speed of sample[3], S_{FM}		Adj. for lane and shoulder width,[4] f_{LS} (Exhibit 15-7)	0.0 mi/h
Total demand flow rate, both directions, *v*		Adj. for access points[4], f_A (Exhibit 15-8)	1.8 mi/h
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Free-flow speed, FFS $(FSS=BFFS-f_{LS}-f_A)$	63.3 mi/h
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	1.5 mi/h	Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	54.7 mi/h
		Percent free flow speed, PFFS	86.5 %

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T(Exhibit 15-18 or 15-19)	1.0	1.0
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	1.0	1.0
Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	1.000	1.000
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	1.00	1.00
Directional flow rate[2], v_i(pc/h) $v_i=V_i/(PHF*f_{HV,PTSF}*f_{g,PTSF})$	424	412
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	45.2	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	32.6	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	61.7	

Level of Service and Other Performance Measures

Level of service, LOS (Exhibit 15-3)	C
Volume to capacity ratio, *v/c*	0.29

Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h	*1564*
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	*1700*
Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only)	*86.5*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*424.4*
Effective width, Wv (Eq. 15-29) ft	*28.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*15.39*
Bicycle level of service (Exhibit 15-4)	*F*
Notes	
1. Note that the adjustment factor for level terrain is 1.00,as level terrain is one of the base conditions. For the purpose of grade adjustment, specific downgrade segments are treated as level terrain. 2. If v_i(v_d or v_o) >=1,700 pc/h, terminate analysis--the LOS is F. 3. For the analysis direction only and for v>200 veh/h. 4. For the analysis direction only 5. Exhibit 15-20 provides coefficients a and b for Equation 15-10. 6. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.	

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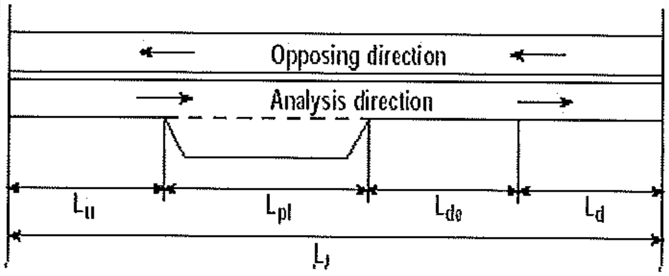
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET WITH PASSING LANE WORKSHEET

General Information		Site Information	
Analyst	*David Stoner*	Highway of Travel	*MT 16*
Agency or Company	*DOWL HKM*	From/To	*RP 20.0 to Savage NB*
Date Performed	*4/17/2012*	Jurisdiction	*Dawson/Richland County*
Analysis Time Period	*Peak Hour*	Analysis Year	*2035 High*

Project Description: *MT 16 / MT 200 Glendive to Fairview Corridor Planning Study*

Input Data

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



Shoulder width (ft)	*8.0*
Lane Width (ft)	*12.0*
Segment Length (mi)	*11.5*
Total length of analysis segment, L_t	*11.5*
Length of two-lane highway upstream of the passing lane, L_u	*0.0*
Length of passing lane including tapers , L_{pl}	*1.9*
Average travel speed, ATS_d (from Directional Two-Lane Highway Segment Worksheet)	*55.5*
Percent time-spent-following, $PTSF_d$ (from Directional Two-Lane Highway Segment Worksheet)	*59.2*
Level of service[1], LOS_d (from Directional Two-Lane Highway Segment Worksheet)	*C*
Average Travel Speed	
Length of the downstream highway segment within the effective length of passing lane for average travel speed, L_{de} (Exhibit 15-23)	*1.70*
Length of two-lane highway downstream of effective length of the passing lane for avg travel speed, L_d $L_d=L_t-(L_u+L_{pl}+L_{de})$	*7.90*
Adj. factor for the effect of passing lane on average speed, f_{pl} (Exhibit 15-28)	*1.10*
Average travel speed including passing lane[2], $ATS_{pl} = (ATS_d * L_t) / (L_u+L_d+(L_{pl}/f_{pl})+ (2L_{de}/(1+f_{pl,ATS})))$	*56.7*
Percent free flow speed including passing lane, $PFFS_{pl} = (ATS_{pl}/ FFS)$	*89.0*
Percent Time-Spent-Following	
Length of the downstream highway segment within the effective length of passing lane for percent time-spent-following, L_{de} (Exhibit 15-23)	*8.04*
Length of two-lane highway downstream of effective length of the passing lane for percent-time-following, $L_d =L_t-(L_u+ L_{pl}+ L_{de})$	*1.56*
Adj. factor for the effect of passing lane on percent time-spent-following, $f_{pl,PTSF}$(Exhibit 15-26)	*0.61*

Percent time-spent-following including passing lane[3], $PTSF_{pl}$(%) $PTSF_{pl}= PTSF_d[L_u+L_d+f_{pl,PTSF}L_{pl}+((1+f_{pl,PTSF})/2)L_{de}]/L_t$	47.3
Level of Service and Other Performance Measures[4]	
Level of service including passing lane LOS_{pl} (Exhibit 15-3)	B
Peak 15-min total travel time, TT_{15}(veh-h) $TT_{15}= VMT_{15}/ATS_{pl}$	20.1
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	396.3
Effective width, W_v (Eq. 15-29) ft	28.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	13.81
Bicycle level of service (Exhibit 15-4)	F
Notes	

1. If LOS_d=F, passing lane analysis cannot be performed.
2. If L_d <0, use alternative Equation 15-18.
3. If L_d<0, use alternative Equation 15-16.
4. v/c, VMT_{15} and VMT_{60} are calculated on Directional Two-Lane Highway Segment Worksheet.

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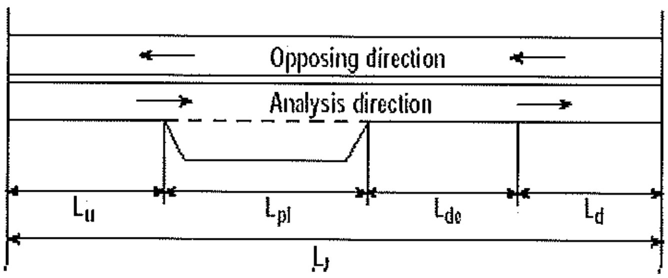
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET WITH PASSING LANE WORKSHEET

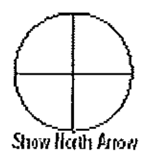
General Information		Site Information	
Analyst	*David Stoner*	Highway of Travel	*MT 16*
Agency or Company	*DOWL HKM*	From/To	*RP 12.4 to RP 22.0 SB*
Date Performed	*4/17/2012*	Jurisdiction	*Dawson/Richland County*
Analysis Time Period	*Peak Hour*	Analysis Year	*2035 High*

Project Description: *MT 16 / MT 200 Glendive to Fairview Corridor Planning Study*

Input Data

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





Shoulder width (ft)	*8.0*
Lane Width (ft)	*12.0*
Segment Length (mi)	*9.6*
Total length of analysis segment, L_t	*9.6*
Length of two-lane highway upstream of the passing lane, L_u	*0.0*
Length of passing lane including tapers , L_{pl}	*1.9*
Average travel speed, ATS_d (from Directional Two-Lane Highway Segment Worksheet)	*55.9*
Percent time-spent-following, $PTSF_d$ (from Directional Two-Lane Highway Segment Worksheet)	*60.0*
Level of service[1], LOS_d (from Directional Two-Lane Highway Segment Worksheet)	*C*
Average Travel Speed	
Length of the downstream highway segment within the effective length of passing lane for average travel speed, L_{de} (Exhibit 15-23)	*1.70*
Length of two-lane highway downstream of effective length of the passing lane for avg travel speed, L_d $L_d=L_t-(L_u+L_{pl}+L_{de})$	*6.00*
Adj. factor for the effect of passing lane on average speed, f_{pl} (Exhibit 15-28)	*1.10*
Average travel speed including passing lane[2], $ATS_{pl} = (ATS_d * L_t) / (L_u+L_d+(L_{pl}/f_{pl})+ (2L_{de}/(1+f_{pl,ATS})))$	*57.4*
Percent free flow speed including passing lane, $PFFS_{pl} = (ATS_{pl}/ FFS)$	*89.1*
Percent Time-Spent-Following	
Length of the downstream highway segment within the effective length of passing lane for percent time-spent-following, L_{de} (Exhibit 15-23)	*7.91*
Length of two-lane highway downstream of effective length of the passing lane for percent-time-following, $L_d =L_t-(L_u+ L_{pl}+ L_{de})$	*-0.21*
Adj. factor for the effect of passing lane on percent time-spent-following, $f_{pl,PTSF}$(Exhibit 15-26)	*0.61*

Percent time-spent-following including passing lane[3], $PTSF_{pl}$(%) $PTSF_{pl}= PTSF_d[L_u+L_d+f_{pl,PTSF}L_{pl}+((1+f_{pl,PTSF})/2)L_{de}]/L_t$	45.7
Level of Service and Other Performance Measures[4]	
Level of service including passing lane LOS_{pl} (Exhibit 15-3)	B
Peak 15-min total travel time, TT_{15}(veh-h) $TT_{15}= VMT_{15}/ATS_{pl}$	17.7
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	424.4
Effective width, W_v (Eq. 15-29) ft	28.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	15.39
Bicycle level of service (Exhibit 15-4)	F
Notes	
1. If LOS_d=F, passing lane analysis cannot be performed. 2. If L_d <0, use alternative Equation 15-18. 3. If L_d<0, use alternative Equation 15-16. 4. v/c, VMT_{15} and VMT_{60} are calculated on Directional Two-Lane Highway Segment Worksheet.	

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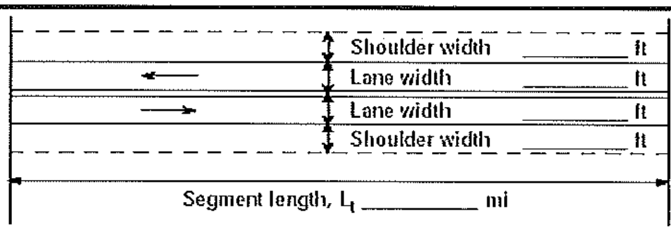
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

General Information		Site Information	
Analyst	*David Stoner*	Highway / Direction of Travel	*MT 16*
Agency or Company	*DOWL HKM*	From/To	*RP 22.0 to Savage SB*
Date Performed	*4/17/2012*	Jurisdiction	*Dawson/Richland County*
Analysis Time Period	*Peak Hour*	Analysis Year	*2035 High*

Project Description: *MT 16 / MT 200 Glendive to Fairview Corridor Planning Study*

Input Data



Analysis direction vol., V_d *321veh/h*

Opposing direction vol., V_o *331veh/h*

Shoulder width ft *8.0*

Lane Width ft *12.0*

Segment Length mi *9.5*

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

Terrain ☑ Level ☐ Rolling

Grade Length mi Up/down

Peak-hour factor, PHF *0.78*

No-passing zone *22%*

% Trucks and Buses , P_T *29 %*

% Recreational vehicles, P_R *4%*

Access points *mi* *5/mi*

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	*1.3*	*1.3*
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	*1.0*	*1.0*
Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.920*	*0.920*
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	*1.00*	*1.00*
Demand flow rate[2], v_i (pc/h) $v_i=V_i/(PHF * f_{g,ATS} * f_{HV,ATS})$	*447*	*461*

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
Mean speed of sample[3], S_{FM}		Base free-flow speed[4], BFFS	*65.0 mi/h*
Total demand flow rate, both directions, v		Adj. for lane and shoulder width,[4] f_{LS}(Exhibit 15-7)	*0.0 mi/h*
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Adj. for access points[4], f_A (Exhibit 15-8)	*1.3 mi/h*
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	*1.5 mi/h*	Free-flow speed, FFS $(FSS=BFFS-f_{LS}-f_A)$	*63.8 mi/h*
		Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	*55.2 mi/h*
		Percent free flow speed, PFFS	*86.5 %*

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T(Exhibit 15-18 or 15-19)	*1.0*	*1.0*
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	*1.0*	*1.0*
Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*1.000*	*1.000*
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	*1.00*	*1.00*
Directional flow rate[2], v_i(pc/h) $v_i=V_i/(PHF*f_{HV,PTSF}*f_{g,PTSF})$	*412*	*424*
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	*43.7*	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	*33.2*	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	*60.1*	

Level of Service and Other Performance Measures

Level of service, LOS (Exhibit 15-3)	*C*
Volume to capacity ratio, *v/c*	*0.29*

Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h	*1564*
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	*1700*
Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only)	*86.5*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*411.5*
Effective width, Wv (Eq. 15-29) ft	*28.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*15.38*
Bicycle level of service (Exhibit 15-4)	*F*
Notes	

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

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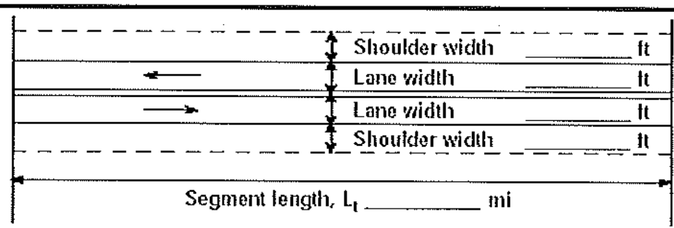
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

General Information		Site Information	
Analyst	*David Stoner*	Highway / Direction of Travel	*MT 16*
Agency or Company	*DOWL HKM*	From/To	*Savage to Crane NB*
Date Performed	*4/17/2012*	Jurisdiction	*Dawson/Richland County*
Analysis Time Period	*Peak Hour*	Analysis Year	*2035 - High*

Project Description: *MT 16 / MT 200 Glendive to Fairview Corridor Planning Study*

Input Data



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

Terrain ☑ Level ☐ Rolling

Analysis direction vol., V_d	*336*veh/h
Opposing direction vol., V_o	*407*veh/h
Shoulder width ft	*8.0*
Lane Width ft	*12.0*
Segment Length mi	*10.0*
Grade Length mi	Up/down
Peak-hour factor, PHF	*0.87*
No-passing zone	*31%*
% Trucks and Buses , P_T	*23 %*
% Recreational vehicles, P_R	*4%*
Access points *mi*	*11*/mi

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	*1.3*	*1.2*
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	*1.0*	*1.0*
Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.935*	*0.956*
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	*1.00*	*1.00*
Demand flow rate[2], v_i (pc/h) $v_i=V_i/(PHF^* f_{g,ATS} * f_{HV,ATS})$	*413*	*489*

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
		Base free-flow speed[4], BFFS	*69.0 mi/h*
Mean speed of sample[3], S_{FM}		Adj. for lane and shoulder width,[4] f_{LS}(Exhibit 15-7)	*0.0 mi/h*
Total demand flow rate, both directions, *v*		Adj. for access points[4], f_A (Exhibit 15-8)	*2.8 mi/h*
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Free-flow speed, FFS $(FSS=BFFS-f_{LS}-f_A)$	*66.3 mi/h*
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	*1.7 mi/h*	Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	*57.5 mi/h*
		Percent free flow speed, PFFS	*86.8 %*

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T(Exhibit 15-18 or 15-19)	*1.1*	*1.0*
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	*1.0*	*1.0*
Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.978*	*1.000*
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	*1.00*	*1.00*
Directional flow rate[2], v_i(pc/h) $v_i=V_i/(PHF^* f_{HV,PTSF} * f_{g,PTSF})$	*395*	*468*
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	*44.1*	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	*33.0*	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF} *(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	*59.2*	

Level of Service and Other Performance Measures

Level of service, LOS (Exhibit 15-3)	*C*
Volume to capacity ratio, *v/c*	*0.25*

Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h	*1625*
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	*1700*
Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only)	*86.8*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*386.2*
Effective width, Wv (Eq. 15-29) ft	*28.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*10.93*
Bicycle level of service (Exhibit 15-4)	*F*
Notes	

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

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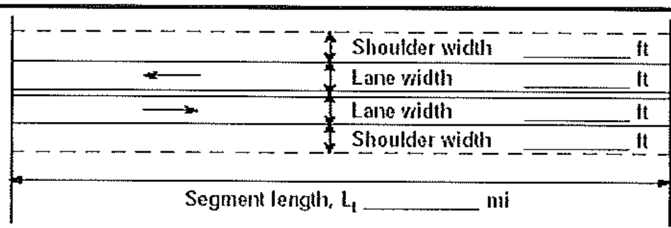
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

General Information		Site Information	
Analyst	*David Stoner*	Highway / Direction of Travel	*MT 16*
Agency or Company	*DOWL HKM*	From/To	*Savage to Crane SB*
Date Performed	*4/17/2012*	Jurisdiction	*Dawson/Richland County*
Analysis Time Period	*Peak Hour*	Analysis Year	*2035 - High*

Project Description: *MT 16 / MT 200 Glendive to Fairview Corridor Planning Study*

Input Data



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

Terrain ☑ Level ☐ Rolling

Analysis direction vol., V_d	*407*veh/h
Opposing direction vol., V_o	*336*veh/h
Shoulder width ft	*8.0*
Lane Width ft	*12.0*
Segment Length mi	*10.0*
Grade Length mi Up/down	
Peak-hour factor, PHF	*0.84*
No-passing zone	*19%*
% Trucks and Buses , P_T	*25* %
% Recreational vehicles, P_R	*4%*
Access points *mi*	*11*/mi

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	*1.2*	*1.3*
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	*1.0*	*1.0*
Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.952*	*0.930*
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	*1.00*	*1.00*
Demand flow rate[2], v_i (pc/h) $v_i=V_i/(PHF*f_{g,ATS}*f_{HV,ATS})$	*509*	*430*

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
Mean speed of sample[3], S_{FM}		Base free-flow speed[4], BFFS	*66.0 mi/h*
Total demand flow rate, both directions, v		Adj. for lane and shoulder width,[4] f_{LS}(Exhibit 15-7)	*0.0 mi/h*
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Adj. for access points[4], f_A (Exhibit 15-8)	*2.8 mi/h*
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	*1.5 mi/h*	Free-flow speed, FFS $(FSS=BFFS-f_{LS}-f_A)$	*63.3 mi/h*
		Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	*54.5 mi/h*
		Percent free flow speed, PFFS	*86.1 %*

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T(Exhibit 15-18 or 15-19)	*1.0*	*1.1*
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	*1.0*	*1.0*
Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*1.000*	*0.976*
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	*1.00*	*1.00*
Directional flow rate[2], v_i(pc/h) $v_i=V_i/(PHF*f_{HV,PTSF}*f_{g,PTSF})$	*485*	*410*
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	*49.3*	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	*28.5*	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	*64.7*	

Level of Service and Other Performance Measures

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

Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h	*1581*
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	*1700*
Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only)	*86.1*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*484.5*
Effective width, Wv (Eq. 15-29) ft	*28.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*12.44*
Bicycle level of service (Exhibit 15-4)	*F*

Notes

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

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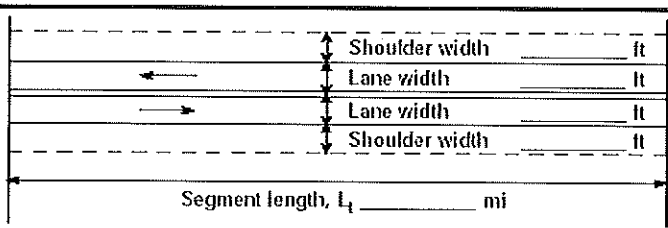
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

General Information		Site Information	
Analyst	David Stoner	Highway / Direction of Travel	MT 16
Agency or Company	DOWL HKM	From/To	Crane to Sidney NB
Date Performed	4/17/2012	Jurisdiction	Dawson/Richland County
Analysis Time Period	Peak Hour	Analysis Year	2035 - High

Project Description: MT 16 / MT 200 Glendive to Fairview Corridor Planning Study

Input Data



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

Terrain ☑ Level ☐ Rolling

Analysis direction vol., V_d	360veh/h
Opposing direction vol., V_o	552veh/h
Shoulder width ft	8.0
Lane Width ft	12.0
Segment Length mi	8.9
Grade Length mi Up/down	
Peak-hour factor, PHF	0.80
No-passing zone	24%
% Trucks and Buses, P_T	19 %
% Recreational vehicles, P_R	4%
Access points mi	12/mi

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	1.3	1.1
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	1.0	1.0
Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	0.946	0.981
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	1.00	1.00
Demand flow rate[2], v_i (pc/h) $v_i=V_i/(PHF*f_{g,ATS}*f_{HV,ATS})$	476	703

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
Mean speed of sample[3], S_{FM}		Base free-flow speed[4], BFFS	65.0 mi/h
Total demand flow rate, both directions, v		Adj. for lane and shoulder width,[4] f_{LS} (Exhibit 15-7)	0.0 mi/h
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Adj. for access points[4], f_A (Exhibit 15-8)	3.0 mi/h
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	1.0 mi/h	Free-flow speed, FFS $(FSS=BFFS-f_{LS}-f_A)$	62.0 mi/h
		Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	51.9 mi/h
		Percent free flow speed, PFFS	83.7 %

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-18 or 15-19)	1.0	1.0
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	1.0	1.0
Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	1.000	1.000
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	1.00	1.00
Directional flow rate[2], v_i(pc/h) $v_i=V_i/(PHF*f_{HV,PTSF}*f_{g,PTSF})$	450	690
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	50.2	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	23.5	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	59.5	

Level of Service and Other Performance Measures

Level of service, LOS (Exhibit 15-3)	C
Volume to capacity ratio, v/c	0.29

Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h	*1668*
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	*1700*
Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only)	*83.7*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*450.0*
Effective width, Wv (Eq. 15-29) ft	*28.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*8.48*
Bicycle level of service (Exhibit 15-4)	*F*
Notes	

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

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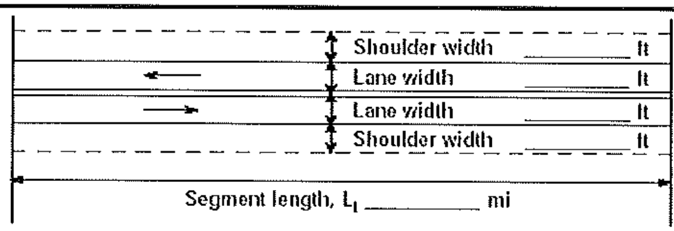
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

General Information		Site Information	
Analyst	*David Stoner*	Highway / Direction of Travel	*MT 16*
Agency or Company	*DOWL HKM*	From/To	*Crane to Sidney SB*
Date Performed	*4/17/2012*	Jurisdiction	*Dawson/Richland County*
Analysis Time Period	*Peak Hour*	Analysis Year	*2035 - High*

Project Description: *MT 16 / MT 200 Glendive to Fairview Corridor Planning Study*

Input Data



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

Terrain ☑ Level ☐ Rolling

Analysis direction vol., V_d	*552veh/h*
Opposing direction vol., V_o	*360veh/h*
Shoulder width ft	*8.0*
Lane Width ft	*12.0*
Segment Length mi	*8.9*
Grade Length mi Up/down	
Peak-hour factor, PHF	*0.87*
No-passing zone	*22%*
% Trucks and Buses , P_T	*19 %*
% Recreational vehicles, P_R	*4%*
Access points *mi*	*12/mi*

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	*1.1*	*1.3*
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	*1.0*	*1.0*
Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.981*	*0.946*
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	*1.00*	*1.00*
Demand flow rate[2], v_i (pc/h) $v_i=V_i/(PHF*f_{g,ATS}*f_{HV,ATS})$	*647*	*437*

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
Mean speed of sample[3], S_{FM}		Base free-flow speed[4], BFFS	*69.0 mi/h*
Total demand flow rate, both directions, *v*		Adj. for lane and shoulder width,[4] f_{LS}(Exhibit 15-7)	*0.0 mi/h*
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Adj. for access points[4], f_A (Exhibit 15-8)	*3.0 mi/h*
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	*1.6 mi/h*	Free-flow speed, FFS $(FSS=BFFS-f_{LS}-f_A)$	*66.0 mi/h*
		Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	*56.0 mi/h*
		Percent free flow speed, PFFS	*84.8 %*

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T(Exhibit 15-18 or 15-19)	*1.0*	*1.0*
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	*1.0*	*1.0*
Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*1.000*	*1.000*
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	*1.00*	*1.00*
Directional flow rate[2], v_i(pc/h) $v_i=V_i/(PHF*f_{HV,PTSF}*f_{g,PTSF})$	*634*	*414*
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	*57.9*	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	*24.6*	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	*72.8*	

Level of Service and Other Performance Measures

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

Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h	*1608*
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	*1700*
Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only)	*84.8*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*634.5*
Effective width, Wv (Eq. 15-29) ft	*28.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*8.66*
Bicycle level of service (Exhibit 15-4)	*F*
Notes	

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

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DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

General Information		Site Information	
Analyst	*David Stoner*	Highway / Direction of Travel	*MT 200*
Agency or Company	*DOWL HKM*	From/To	*Sidney to Fairview EB*
Date Performed	*4/17/2012*	Jurisdiction	*Dawson/Richland County*
Analysis Time Period	*Peak Hour*	Analysis Year	*2035 - High*

Project Description: *MT 16 / MT 200 Glendive to Fairview Corridor Planning Study*

Input Data

Shoulder width ____ ft
Lane width ____ ft
Lane width ____ ft
Shoulder width ____ ft
Segment length, L_t ____ mi

Show North Arrow

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

Terrain ☑ Level ☐ Rolling

Analysis direction vol., V_d	*661*veh/h
Opposing direction vol., V_o	*654*veh/h
Shoulder width ft	*8.0*
Lane Width ft	*12.0*
Segment Length mi	*9.9*
Grade Length mi Up/down	
Peak-hour factor, PHF	*0.83*
No-passing zone	*17%*
% Trucks and Buses , P_T	*17 %*
% Recreational vehicles, P_R	*4%*
Access points *mi*	*16*/mi

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	*1.1*	*1.1*
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	*1.0*	*1.0*
Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.983*	*0.983*
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	*1.00*	*1.00*
Demand flow rate[2], v_i (pc/h) $v_i=V_i/(PHF*f_{g,ATS}*f_{HV,ATS})$	*810*	*802*

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
Mean speed of sample[3], S_{FM}		Base free-flow speed[4], BFFS	*69.0 mi/h*
Total demand flow rate, both directions, *v*		Adj. for lane and shoulder width,[4] f_{LS} (Exhibit 15-7)	*0.0 mi/h*
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Adj. for access points[4], f_A (Exhibit 15-8)	*4.0 mi/h*
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	*0.7 mi/h*	Free-flow speed, FFS (FSS=BFFS-f_{LS}-f_A)	*65.0 mi/h*
		Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	*51.8 mi/h*
		Percent free flow speed, PFFS	*79.7 %*

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-18 or 15-19)	*1.0*	*1.0*
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	*1.0*	*1.0*
Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*1.000*	*1.000*
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	*1.00*	*1.00*
Directional flow rate[2], v_i(pc/h) $v_i=V_i/(PHF*f_{HV,PTSF}*f_{g,PTSF})$	*796*	*788*
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	*68.8*	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	*17.1*	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	*77.4*	

Level of Service and Other Performance Measures

Level of service, LOS (Exhibit 15-3)	*D*
Volume to capacity ratio, *v/c*	*0.48*

Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h	*1671*
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	*1700*
Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only)	*79.7*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*796.4*
Effective width, Wv (Eq. 15-29) ft	*28.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*7.63*
Bicycle level of service (Exhibit 15-4)	*F*

Notes

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

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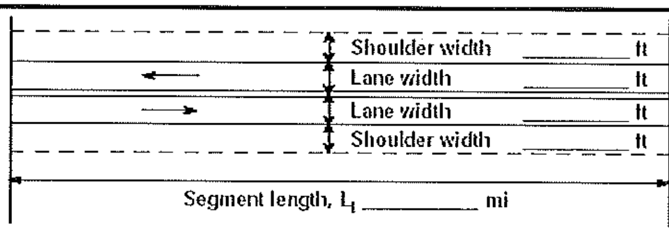
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

General Information		Site Information	
Analyst	*David Stoner*	Highway / Direction of Travel	*MT 200*
Agency or Company	*DOWL HKM*	From/To	*Sidney to Fairview WB*
Date Performed	*4/17/2012*	Jurisdiction	*Dawson/Richland County*
Analysis Time Period	*Peak Hour*	Analysis Year	*2035 - High*

Project Description: *MT 16 / MT 200 Glendive to Fairview Corridor Planning Study*

Input Data



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

Terrain ☑ Level ☐ Rolling

Analysis direction vol., V_d	*654veh/h*
Opposing direction vol., V_o	*661veh/h*
Shoulder width ft	*8.0*
Lane Width ft	*12.0*
Segment Length mi	*9.9*
Grade Length mi	Up/down
Peak-hour factor, PHF	*0.86*
No-passing zone	*15%*
% Trucks and Buses , P_T	*25 %*
% Recreational vehicles, P_R	*4%*
Access points *mi*	*16/mi*

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	*1.1*	*1.1*
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	*1.0*	*1.0*
Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.976*	*0.976*
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	*1.00*	*1.00*
Demand flow rate[2], v_i (pc/h) $v_i=V_i/(PHF*f_{g,ATS}*f_{HV,ATS})$	*779*	*788*

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
		Base free-flow speed[4], BFFS	*66.0 mi/h*
Mean speed of sample[3], S_{FM}		Adj. for lane and shoulder width,[4] f_{LS}(Exhibit 15-7)	*0.0 mi/h*
Total demand flow rate, both directions, v		Adj. for access points[4], f_A (Exhibit 15-8)	*4.0 mi/h*
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Free-flow speed, FFS (FSS=BFFS-f_{LS}-f_A)	*62.0 mi/h*
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	*0.7 mi/h*	Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	*49.2 mi/h*
		Percent free flow speed, PFFS	*79.3 %*

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T(Exhibit 15-18 or 15-19)	*1.0*	*1.0*
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	*1.0*	*1.0*
Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*1.000*	*1.000*
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	*1.00*	*1.00*
Directional flow rate[2], v_i(pc/h) $v_i=V_i/(PHF*f_{HV,PTSF}*f_{g,PTSF})$	*760*	*769*
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	*67.5*	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	*17.0*	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	*75.9*	

Level of Service and Other Performance Measures

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

Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h	*1659*
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	*1700*
Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only)	*79.3*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*760.5*
Effective width, Wv (Eq. 15-29) ft	*28.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*12.67*
Bicycle level of service (Exhibit 15-4)	*F*
Notes	

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

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Appendix 4

Projected Four-Lane Highway 2035 – Low Condition

Direction 1 = Northbound/Eastbound Direction

Direction 2 = Southbound/Westbound Direction

MULTILANE HIGHWAYS WORKSHEET(Direction 1)

General Information

Analyst	David Stoner
Agency or Company	DOWL HKM
Date Performed	5/1/2012
Analysis Time Period	Peak Hour

Site Information

Highway/Direction to Travel	MT 16
From/To	Glendive to Savage
Jurisdiction	Dawson/Richland County
Analysis Year	2035 - Low

Project Description MT 16 / MT 200 Glendive to Fairview Corridor Planning Study

☐ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	242	Peak-Hour Factor, PHF	0.81
AADT(veh/h)		%Trucks and Buses, P_T	25
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	0
Peak-Hour Direction Prop, D		General Terrain:	Level
DDHV (veh/h)		Grade Length (mi)	0.00
Driver Type Adjustment	1.00	Up/Down %	0.00
		Number of Lanes	2

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	f_{HV}	0.889

Speed Inputs

Lane Width, LW (ft)	12.0
Total Lateral Clearance, LC (ft)	12.0
Access Points, A (A/mi)	0
Median Type, M	
FFS (measured)	60.0
Base Free-Flow Speed, BFFS	

Calc Speed Adj and FFS

f_{LW} (mi/h)	
f_{LC} (mi/h)	
f_A (mi/h)	
f_M (mi/h)	
FFS (mi/h)	60.0

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	168
Speed, S (mi/h)	60.0
D (pc/mi/ln)	2.8
LOS	A

Design

Design (N)

Required Number of Lanes, N	
Flow Rate, v_p (pc/h)	
Max Service Flow Rate (pc/h/ln)	
Design LOS	

Bicycle Level of Service

Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*149.4*
Effective width, W_v (Eq. 15-29) ft	*24.00*
Effective speed factor, S_t (Eq. 15-30)	*5.19*
Bicycle level of service score, BLOS (Eq. 15-31)	*13.91*
Bicycle level of service (Exhibit 15-4)	*F*

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MULTILANE HIGHWAYS WORKSHEET(Direction 2)

[X]

General Information

Analyst	David Stoner
Agency or Company	DOWL HKM
Date Performed	5/1/2012
Analysis Time Period	Peak Hour

Site Information

Highway/Direction to Travel	MT 16
From/To	Glendive to Savage
Jurisdiction	Dawson/Richland County
Analysis Year	2035 - Low

Project Description MT 16 / MT 200 Glendive to Fairview Corridor Planning Study

☐ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	249	Peak-Hour Factor, PHF	0.78
AADT(veh/h)		%Trucks and Buses, P_T	25
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	0
Peak-Hour Direction Prop, D		General Terrain:	Level
DDHV (veh/h)		Grade Length (mi)	0.00
Driver Type Adjustment	1.00	Up/Down %	0.00
		Number of Lanes	2

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	f_{HV}	0.889

Speed Inputs

Lane Width, LW (ft)	12.0
Total Lateral Clearance, LC (ft)	12.0
Access Points, A (A/mi)	0
Median Type, M	
FFS (measured)	60.0
Base Free-Flow Speed, BFFS	

Calc Speed Adj and FFS

f_{LW} (mi/h)	
f_{LC} (mi/h)	
f_A (mi/h)	
f_M (mi/h)	
FFS (mi/h)	60.0

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	179
Speed, S (mi/h)	60.0
D (pc/mi/ln)	3.0
LOS	A

Design

Design (N)

Required Number of Lanes, N

Flow Rate, v_p (pc/h)

Max Service Flow Rate (pc/h/ln)

Design LOS

Bicycle Level of Service

Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*159.6*
Effective width, W_v (Eq. 15-29) ft	*24.00*
Effective speed factor, S_t (Eq. 15-30)	*5.19*
Bicycle level of service score, BLOS (Eq. 15-31)	*13.95*
Bicycle level of service (Exhibit 15-4)	*F*

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MULTILANE HIGHWAYS WORKSHEET(Direction 1)

[X]

General Information

Analyst	David Stoner
Agency or Company	DOWL HKM
Date Performed	5/1/2012
Analysis Time Period	Peak Hour

Site Information

Highway/Direction to Travel	MT 16
From/To	Savage to Crane
Jurisdiction	Dawson/Richland County
Analysis Year	2035 - Low

Project Description MT 16 / MT 200 Glendive to Fairview Corridor Planning Study

☐ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	253	Peak-Hour Factor, PHF	0.87
AADT(veh/h)		%Trucks and Buses, P_T	23
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	0
Peak-Hour Direction Prop, D		General Terrain:	Level
DDHV (veh/h)		Grade Length (mi)	0.00
Driver Type Adjustment	1.00	Up/Down %	0.00
		Number of Lanes	2

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	f_{HV}	0.897

Speed Inputs

Lane Width, LW (ft)	12.0
Total Lateral Clearance, LC (ft)	12.0
Access Points, A (A/mi)	0
Median Type, M	
FFS (measured)	60.0
Base Free-Flow Speed, BFFS	

Calc Speed Adj and FFS

f_{LW} (mi/h)	
f_{LC} (mi/h)	
f_A (mi/h)	
f_M (mi/h)	
FFS (mi/h)	60.0

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	162
Speed, S (mi/h)	60.0
D (pc/mi/ln)	2.7
LOS	A

Design

Design (N)

Required Number of Lanes, N	
Flow Rate, v_p (pc/h)	
Max Service Flow Rate (pc/h/ln)	
Design LOS	

Bicycle Level of Service

Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	145.4
Effective width, W_v (Eq. 15-29) ft	24.00
Effective speed factor, S_t (Eq. 15-30)	5.19
Bicycle level of service score, BLOS (Eq. 15-31)	12.39
Bicycle level of service (Exhibit 15-4)	F

MULTILANE HIGHWAYS WORKSHEET(Direction 2)

General Information

Analyst	David Stoner
Agency or Company	DOWL HKM
Date Performed	5/1/2012
Analysis Time Period	Peak Hour

Site Information

Highway/Direction to Travel	MT 16
From/To	Savage to Crane
Jurisdiction	Dawson/Richland County
Analysis Year	2035 - Low

Project Description MT 16 / MT 200 Glendive to Fairview Corridor Planning Study

☐ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	307	Peak-Hour Factor, PHF	0.84
AADT(veh/h)		%Trucks and Buses, P_T	25
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	0
Peak-Hour Direction Prop, D		General Terrain:	Level
DDHV (veh/h)		Grade Length (mi)	0.00
Driver Type Adjustment	1.00	Up/Down %	0.00
		Number of Lanes	2

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	f_{HV}	0.889

Speed Inputs

Lane Width, LW (ft)	12.0
Total Lateral Clearance, LC (ft)	12.0
Access Points, A (A/mi)	0
Median Type, M	
FFS (measured)	60.0
Base Free-Flow Speed, BFFS	

Calc Speed Adj and FFS

f_{LW} (mi/h)	
f_{LC} (mi/h)	
f_A (mi/h)	
f_M (mi/h)	
FFS (mi/h)	60.0

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	205
Speed, S (mi/h)	60.0
D (pc/mi/ln)	3.4
LOS	A

Design

Design (N)

Required Number of Lanes, N	
Flow Rate, v_p (pc/h)	
Max Service Flow Rate (pc/h/ln)	
Design LOS	

Bicycle Level of Service

Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*182.7*
Effective width, W_v (Eq. 15-29) ft	*24.00*
Effective speed factor, S_t (Eq. 15-30)	*5.19*
Bicycle level of service score, BLOS (Eq. 15-31)	*14.02*
Bicycle level of service (Exhibit 15-4)	*F*

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MULTILANE HIGHWAYS WORKSHEET(Direction 1)

General Information

Analyst	David Stoner
Agency or Company	DOWL HKM
Date Performed	5/1/2012
Analysis Time Period	Peak Hour

Site Information

Highway/Direction to Travel	MT 16
From/To	Crane to Sidney
Jurisdiction	Dawson/Richland County
Analysis Year	2035 - Low

Project Description MT 16 / MT 200 Glendive to Fairview Corridor Planning Study

☐ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	271	Peak-Hour Factor, PHF	0.80
AADT(veh/h)		%Trucks and Buses, P_T	19
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	0
Peak-Hour Direction Prop, D		General Terrain:	Level
DDHV (veh/h)		Grade Length (mi)	0.00
Driver Type Adjustment	1.00	Up/Down %	0.00
		Number of Lanes	2

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	f_{HV}	0.913

Speed Inputs

Lane Width, LW (ft)	12.0
Total Lateral Clearance, LC (ft)	12.0
Access Points, A (A/mi)	0
Median Type, M	
FFS (measured)	60.0
Base Free-Flow Speed, BFFS	

Calc Speed Adj and FFS

f_{LW} (mi/h)	
f_{LC} (mi/h)	
f_A (mi/h)	
f_M (mi/h)	
FFS (mi/h)	60.0

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	185
Speed, S (mi/h)	60.0
D (pc/mi/ln)	3.1
LOS	A

Design

Design (N)

Required Number of Lanes, N

Flow Rate, v_p (pc/h)

Max Service Flow Rate (pc/h/ln)

Design LOS

Bicycle Level of Service

Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*169.4*
Effective width, W_v (Eq. 15-29) ft	*24.00*
Effective speed factor, S_t (Eq. 15-30)	*5.19*
Bicycle level of service score, BLOS (Eq. 15-31)	*9.73*
Bicycle level of service (Exhibit 15-4)	*F*

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MULTILANE HIGHWAYS WORKSHEET(Direction 2)

General Information		Site Information	
Analyst	David Stoner	Highway/Direction to Travel	MT 16
Agency or Company	DOWL HKM	From/To	Crane to Sidney
Date Performed	5/1/2012	Jurisdiction	Dawson/Richland County
Analysis Time Period	Peak Hour	Analysis Year	2035 - Low

Project Description MT 16 / MT 200 Glendive to Fairview Corridor Planning Study

☐ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	416	Peak-Hour Factor, PHF	0.87
AADT(veh/h)		%Trucks and Buses, P_T	19
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	0
Peak-Hour Direction Prop, D		General Terrain:	Level
DDHV (veh/h)		Grade Length (mi)	0.00
Driver Type Adjustment	1.00	Up/Down %	0.00
		Number of Lanes	2

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	f_{HV}	0.913

Speed Inputs		Calc Speed Adj and FFS	
Lane Width, LW (ft)	12.0	f_{LW} (mi/h)	
Total Lateral Clearance, LC (ft)	12.0	f_{LC} (mi/h)	
Access Points, A (A/mi)	0	f_A (mi/h)	
Median Type, M		f_M (mi/h)	
FFS (measured)	60.0	FFS (mi/h)	60.0
Base Free-Flow Speed, BFFS			

Operations		Design	
Operational (LOS)		Design (N)	
Flow Rate, v_p (pc/h/ln)	261	Required Number of Lanes, N	
Speed, S (mi/h)	60.0	Flow Rate, v_p (pc/h)	
D (pc/mi/ln)	4.3	Max Service Flow Rate (pc/h/ln)	
LOS	A	Design LOS	

Bicycle Level of Service

Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	239.1
Effective width, W_v (Eq. 15-29) ft	24.00
Effective speed factor, S_t (Eq. 15-30)	5.19
Bicycle level of service score, BLOS (Eq. 15-31)	9.91
Bicycle level of service (Exhibit 15-4)	F

MULTILANE HIGHWAYS WORKSHEET(Direction 1)

General Information

Analyst	David Stoner
Agency or Company	DOWL HKM
Date Performed	5/1/2012
Analysis Time Period	Peak Hour

Site Information

Highway/Direction to Travel	MT 16
From/To	Sidney to Fairview
Jurisdiction	Dawson/Richland County
Analysis Year	2035 - Low

Project Description MT 16 / MT 200 Glendive to Fairview Corridor Planning Study

☐ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	529	Peak-Hour Factor, PHF	0.83
AADT(veh/h)		%Trucks and Buses, P_T	17
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	0
Peak-Hour Direction Prop, D		General Terrain:	Level
DDHV (veh/h)		Grade Length (mi)	0.00
Driver Type Adjustment	1.00	Up/Down %	0.00
		Number of Lanes	2

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	f_{HV}	0.922

Speed Inputs

Lane Width, LW (ft)	12.0
Total Lateral Clearance, LC (ft)	12.0
Access Points, A (A/mi)	0
Median Type, M	
FFS (measured)	60.0
Base Free-Flow Speed, BFFS	

Calc Speed Adj and FFS

f_{LW} (mi/h)	
f_{LC} (mi/h)	
f_A (mi/h)	
f_M (mi/h)	
FFS (mi/h)	60.0

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	345
Speed, S (mi/h)	60.0
D (pc/mi/ln)	5.8
LOS	A

Design

Design (N)

Required Number of Lanes, N	
Flow Rate, v_p (pc/h)	
Max Service Flow Rate (pc/h/ln)	
Design LOS	

Bicycle Level of Service

Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	318.7
Effective width, W_v (Eq. 15-29) ft	24.00
Effective speed factor, S_t (Eq. 15-30)	5.19
Bicycle level of service score, BLOS (Eq. 15-31)	8.82
Bicycle level of service (Exhibit 15-4)	F

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MULTILANE HIGHWAYS WORKSHEET(Direction 2)

[X]

General Information

Analyst	David Stoner
Agency or Company	DOWL HKM
Date Performed	5/1/2012
Analysis Time Period	Peak Hour

Site Information

Highway/Direction to Travel	MT 16
From/To	Sidney to Fairview
Jurisdiction	Dawson/Richland County
Analysis Year	2035 - Low

Project Description MT 16 / MT 200 Glendive to Fairview Corridor Planning Study

☐ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	523	Peak-Hour Factor, PHF	0.86
AADT(veh/h)		%Trucks and Buses, P_T	25
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	0
Peak-Hour Direction Prop, D		General Terrain:	Level
DDHV (veh/h)		Grade Length (mi)	0.00
Driver Type Adjustment	1.00	Up/Down %	0.00
		Number of Lanes	2

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	f_{HV}	0.889

Speed Inputs

Lane Width, LW (ft)	12.0
Total Lateral Clearance, LC (ft)	12.0
Access Points, A (A/mi)	0
Median Type, M	
FFS (measured)	60.0
Base Free-Flow Speed, BFFS	

Calc Speed Adj and FFS

f_{LW} (mi/h)	
f_{LC} (mi/h)	
f_A (mi/h)	
f_M (mi/h)	
FFS (mi/h)	60.0

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	342
Speed, S (mi/h)	60.0
D (pc/mi/ln)	5.7
LOS	A

Design

Design (N)

Required Number of Lanes, N	
Flow Rate, v_p (pc/h)	
Max Service Flow Rate (pc/h/ln)	
Design LOS	

Bicycle Level of Service

Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	304.1
Effective width, W_v (Eq. 15-29) ft	24.00
Effective speed factor, S_t (Eq. 15-30)	5.19
Bicycle level of service score, BLOS (Eq. 15-31)	14.27
Bicycle level of service (Exhibit 15-4)	F

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Appendix 4

Projected Four-Lane Highway 2035 – High Condition

Direction 1 = Northbound/Eastbound Direction

Direction 2 = Southbound/Westbound Direction

MULTILANE HIGHWAYS WORKSHEET(Direction 1)

[X]

General Information

Analyst	David Stoner
Agency or Company	DOWL HKM
Date Performed	5/1/2012
Analysis Time Period	Peak Hour

Site Information

Highway/Direction to Travel	MT 16
From/To	Glendive to Savage
Jurisdiction	Dawson/Richland County
Analysis Year	2035 - High

Project Description MT 16 / MT 200 Glendive to Fairview Corridor Planning Study

☐ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	321	Peak-Hour Factor, PHF	0.81
AADT(veh/h)		%Trucks and Buses, P_T	25
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	0
Peak-Hour Direction Prop, D		General Terrain:	Level
DDHV (veh/h)		Grade Length (mi)	0.00
Driver Type Adjustment	1.00	Up/Down %	0.00
		Number of Lanes	2

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	f_{HV}	0.889

Speed Inputs

Lane Width, LW (ft)	12.0
Total Lateral Clearance, LC (ft)	12.0
Access Points, A (A/mi)	0
Median Type, M	
FFS (measured)	60.0
Base Free-Flow Speed, BFFS	

Calc Speed Adj and FFS

f_{LW} (mi/h)	
f_{LC} (mi/h)	
f_A (mi/h)	
f_M (mi/h)	
FFS (mi/h)	60.0

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	222
Speed, S (mi/h)	60.0
D (pc/mi/ln)	3.7
LOS	A

Design

Design (N)

Required Number of Lanes, N

Flow Rate, v_p (pc/h)

Max Service Flow Rate (pc/h/ln)

Design LOS

Bicycle Level of Service

Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	198.1
Effective width, W_v (Eq. 15-29) ft	24.00
Effective speed factor, S_t (Eq. 15-30)	5.19
Bicycle level of service score, BLOS (Eq. 15-31)	14.06
Bicycle level of service (Exhibit 15-4)	F

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MULTILANE HIGHWAYS WORKSHEET(Direction 2)

[x]

General Information		Site Information	
Analyst	David Stoner	Highway/Direction to Travel	MT 16
Agency or Company	DOWL HKM	From/To	Glendive to Savage
Date Performed	5/1/2012	Jurisdiction	Dawson/Richland County
Analysis Time Period	Peak Hour	Analysis Year	2035 - High

Project Description MT 16 / MT 200 Glendive to Fairview Corridor Planning Study

☐ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	331	Peak-Hour Factor, PHF	0.78
AADT(veh/h)		%Trucks and Buses, P_T	25
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	0
Peak-Hour Direction Prop, D		General Terrain:	Level
DDHV (veh/h)		Grade Length (mi)	0.00
Driver Type Adjustment	1.00	Up/Down %	0.00
		Number of Lanes	2

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	f_{HV}	0.889

Speed Inputs		Calc Speed Adj and FFS	
Lane Width, LW (ft)	12.0	f_{LW} (mi/h)	
Total Lateral Clearance, LC (ft)	12.0	f_{LC} (mi/h)	
Access Points, A (A/mi)	0	f_A (mi/h)	
Median Type, M		f_M (mi/h)	
FFS (measured)	60.0	FFS (mi/h)	60.0
Base Free-Flow Speed, BFFS			

Operations		Design	
Operational (LOS)		Design (N)	
Flow Rate, v_p (pc/h/ln)	238	Required Number of Lanes, N	
Speed, S (mi/h)	60.0	Flow Rate, v_p (pc/h)	
D (pc/mi/ln)	4.0	Max Service Flow Rate (pc/h/ln)	
LOS	A	Design LOS	

Bicycle Level of Service

Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*212.2*
Effective width, W_v (Eq. 15-29) ft	*24.00*
Effective speed factor, S_t (Eq. 15-30)	*5.19*
Bicycle level of service score, BLOS (Eq. 15-31)	*14.09*
Bicycle level of service (Exhibit 15-4)	*F*

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MULTILANE HIGHWAYS WORKSHEET(Direction 1)

General Information

Analyst	David Stoner
Agency or Company	DOWL HKM
Date Performed	5/1/2012
Analysis Time Period	Peak Hour

Site Information

Highway/Direction to Travel	MT 16
From/To	Savage to Crane
Jurisdiction	Dawson/Richland County
Analysis Year	2035 - High

Project Description MT 16 / MT 200 Glendive to Fairview Corridor Planning Study

☐ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	336	Peak-Hour Factor, PHF	0.87
AADT(veh/h)		%Trucks and Buses, P_T	23
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	0
Peak-Hour Direction Prop, D		General Terrain:	Level
DDHV (veh/h)		Grade Length (mi)	0.00
Driver Type Adjustment	1.00	Up/Down %	0.00
		Number of Lanes	2

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	f_{HV}	0.897

Speed Inputs

Lane Width, LW (ft)	12.0
Total Lateral Clearance, LC (ft)	12.0
Access Points, A (A/mi)	0
Median Type, M	
FFS (measured)	60.0
Base Free-Flow Speed, BFFS	

Calc Speed Adj and FFS

f_{LW} (mi/h)	
f_{LC} (mi/h)	
f_A (mi/h)	
f_M (mi/h)	
FFS (mi/h)	60.0

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	215
Speed, S (mi/h)	60.0
D (pc/mi/ln)	3.6
LOS	A

Design

Design (N)

Required Number of Lanes, N

Flow Rate, v_p (pc/h)

Max Service Flow Rate (pc/h/ln)

Design LOS

Bicycle Level of Service

Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	193.1
Effective width, W_v (Eq. 15-29) ft	24.00
Effective speed factor, S_t (Eq. 15-30)	5.19
Bicycle level of service score, BLOS (Eq. 15-31)	12.54
Bicycle level of service (Exhibit 15-4)	F

MULTILANE HIGHWAYS WORKSHEET(Direction 2)

General Information

Analyst	David Stoner
Agency or Company	DOWL HKM
Date Performed	5/1/2012
Analysis Time Period	Peak Hour

Site Information

Highway/Direction to Travel	MT 16
From/To	Savage to Crane
Jurisdiction	Dawson/Richland County
Analysis Year	2035 - High

Project Description MT 16 / MT 200 Glendive to Fairview Corridor Planning Study

☐ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	407	Peak-Hour Factor, PHF	0.84
AADT(veh/h)		%Trucks and Buses, P_T	25
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	0
Peak-Hour Direction Prop, D		General Terrain:	Level
DDHV (veh/h)		Grade Length (mi)	0.00
Driver Type Adjustment	1.00	Up/Down %	0.00
		Number of Lanes	2

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	f_{HV}	0.889

Speed Inputs

Lane Width, LW (ft)	12.0
Total Lateral Clearance, LC (ft)	12.0
Access Points, A (A/mi)	0
Median Type, M	
FFS (measured)	60.0
Base Free-Flow Speed, BFFS	

Calc Speed Adj and FFS

f_{LW} (mi/h)	
f_{LC} (mi/h)	
f_A (mi/h)	
f_M (mi/h)	
FFS (mi/h)	60.0

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	272
Speed, S (mi/h)	60.0
D (pc/mi/ln)	4.5
LOS	A

Design

Design (N)

Required Number of Lanes, N	
Flow Rate, v_p (pc/h)	
Max Service Flow Rate (pc/h/ln)	
Design LOS	

Bicycle Level of Service

Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	242.3
Effective width, W_v (Eq. 15-29) ft	24.00
Effective speed factor, S_t (Eq. 15-30)	5.19
Bicycle level of service score, BLOS (Eq. 15-31)	14.16
Bicycle level of service (Exhibit 15-4)	F

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MULTILANE HIGHWAYS WORKSHEET(Direction 1)

[X]

General Information

Analyst	David Stoner
Agency or Company	DOWL HKM
Date Performed	5/1/2012
Analysis Time Period	Peak Hour

Site Information

Highway/Direction to Travel	MT 16
From/To	Crane to Sidney
Jurisdiction	Dawson/Richland County
Analysis Year	2035 - High

Project Description MT 16 / MT 200 Glendive to Fairview Corridor Planning Study

☐ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	360	Peak-Hour Factor, PHF	0.80
AADT(veh/h)		%Trucks and Buses, P_T	19
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	0
Peak-Hour Direction Prop, D		General Terrain:	Level
DDHV (veh/h)		Grade Length (mi)	0.00
Driver Type Adjustment	1.00	Up/Down %	0.00
		Number of Lanes	2

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	f_{HV}	0.913

Speed Inputs

Lane Width, LW (ft)	12.0
Total Lateral Clearance, LC (ft)	12.0
Access Points, A (A/mi)	0
Median Type, M	
FFS (measured)	60.0
Base Free-Flow Speed, BFFS	

Calc Speed Adj and FFS

f_{LW} (mi/h)	
f_{LC} (mi/h)	
f_A (mi/h)	
f_M (mi/h)	
FFS (mi/h)	60.0

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	246
Speed, S (mi/h)	60.0
D (pc/mi/ln)	4.1
LOS	A

Design

Design (N)

Required Number of Lanes, N	
Flow Rate, v_p (pc/h)	
Max Service Flow Rate (pc/h/ln)	
Design LOS	

Bicycle Level of Service

Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	225.0
Effective width, W_v (Eq. 15-29) ft	24.00
Effective speed factor, S_t (Eq. 15-30)	5.19
Bicycle level of service score, BLOS (Eq. 15-31)	9.88
Bicycle level of service (Exhibit 15-4)	F

MULTILANE HIGHWAYS WORKSHEET(Direction 2)

General Information

Analyst	David Stoner
Agency or Company	DOWL HKM
Date Performed	5/1/2012
Analysis Time Period	Peak Hour

Site Information

Highway/Direction to Travel	MT 16
From/To	Crane to Sidney
Jurisdiction	Dawson/Richland County
Analysis Year	2035 - High

Project Description MT 16 / MT 200 Glendive to Fairview Corridor Planning Study

☐ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	552	Peak-Hour Factor, PHF	0.87
AADT(veh/h)		%Trucks and Buses, P_T	19
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	0
Peak-Hour Direction Prop, D		General Terrain:	Level
DDHV (veh/h)		Grade Length (mi)	0.00
Driver Type Adjustment	1.00	Up/Down %	0.00
		Number of Lanes	2

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	f_{HV}	0.913

Speed Inputs

Lane Width, LW (ft)	12.0
Total Lateral Clearance, LC (ft)	12.0
Access Points, A (A/mi)	0
Median Type, M	
FFS (measured)	60.0
Base Free-Flow Speed, BFFS	

Calc Speed Adj and FFS

f_{LW} (mi/h)	
f_{LC} (mi/h)	
f_A (mi/h)	
f_M (mi/h)	
FFS (mi/h)	60.0

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	347
Speed, S (mi/h)	60.0
D (pc/mi/ln)	5.8
LOS	A

Design

Design (N)

Required Number of Lanes, N	
Flow Rate, v_p (pc/h)	
Max Service Flow Rate (pc/h/ln)	
Design LOS	

Bicycle Level of Service

Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	317.2
Effective width, W_v (Eq. 15-29) ft	24.00
Effective speed factor, S_t (Eq. 15-30)	5.19
Bicycle level of service score, BLOS (Eq. 15-31)	10.05
Bicycle level of service (Exhibit 15-4)	F

MULTILANE HIGHWAYS WORKSHEET(Direction 1)

|x|

General Information

Analyst	David Stoner
Agency or Company	DOWL HKM
Date Performed	5/1/2012
Analysis Time Period	Peak Hour

Site Information

Highway/Direction to Travel	MT 16
From/To	Sidney to Fairview
Jurisdiction	Dawson/Richland County
Analysis Year	2035 - High

Project Description MT 16 / MT 200 Glendive to Fairview Corridor Planning Study

☐ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	661	Peak-Hour Factor, PHF	0.83
AADT(veh/h)		%Trucks and Buses, P_T	17
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	0
Peak-Hour Direction Prop, D		General Terrain:	Level
DDHV (veh/h)		Grade Length (mi)	0.00
Driver Type Adjustment	1.00	Up/Down %	0.00
		Number of Lanes	2

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	f_{HV}	0.922

Speed Inputs

Lane Width, LW (ft)	12.0
Total Lateral Clearance, LC (ft)	12.0
Access Points, A (A/mi)	0
Median Type, M	
FFS (measured)	60.0
Base Free-Flow Speed, BFFS	

Calc Speed Adj and FFS

f_{LW} (mi/h)	
f_{LC} (mi/h)	
f_A (mi/h)	
f_M (mi/h)	
FFS (mi/h)	60.0

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	432
Speed, S (mi/h)	60.0
D (pc/mi/ln)	7.2
LOS	A

Design

Design (N)

Required Number of Lanes, N	
Flow Rate, v_p (pc/h)	
Max Service Flow Rate (pc/h/ln)	
Design LOS	

Bicycle Level of Service

Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	398.2
Effective width, W_v (Eq. 15-29) ft	24.00
Effective speed factor, S_t (Eq. 15-30)	5.19
Bicycle level of service score, BLOS (Eq. 15-31)	8.93
Bicycle level of service (Exhibit 15-4)	F

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MULTILANE HIGHWAYS WORKSHEET(Direction 2)

General Information

Analyst	David Stoner
Agency or Company	DOWL HKM
Date Performed	5/1/2012
Analysis Time Period	Peak Hour

Site Information

Highway/Direction to Travel	MT 16
From/To	Sidney to Fairview
Jurisdiction	Dawson/Richland County
Analysis Year	2035 - High

Project Description MT 16 / MT 200 Glendive to Fairview Corridor Planning Study

☐ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	654	Peak-Hour Factor, PHF	0.86
AADT(veh/h)		%Trucks and Buses, P_T	25
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	0
Peak-Hour Direction Prop, D		General Terrain:	Level
DDHV (veh/h)		Grade Length (mi)	0.00
Driver Type Adjustment	1.00	Up/Down %	0.00
		Number of Lanes	2

Calculate Flow Adjustments

f_p	1.00	E_R	1.2
E_T	1.5	f_{HV}	0.889

Speed Inputs

Lane Width, LW (ft)	12.0
Total Lateral Clearance, LC (ft)	12.0
Access Points, A (A/mi)	0
Median Type, M	
FFS (measured)	60.0
Base Free-Flow Speed, BFFS	

Calc Speed Adj and FFS

f_{LW} (mi/h)	
f_{LC} (mi/h)	
f_A (mi/h)	
f_M (mi/h)	
FFS (mi/h)	60.0

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	427
Speed, S (mi/h)	60.0
D (pc/mi/ln)	7.1
LOS	A

Design

Design (N)

Required Number of Lanes, N

Flow Rate, v_p (pc/h)

Max Service Flow Rate (pc/h/ln)

Design LOS

Bicycle Level of Service

Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*380.2*
Effective width, W_v (Eq. 15-29) ft	*24.00*
Effective speed factor, S_t (Eq. 15-30)	*5.19*
Bicycle level of service score, BLOS (Eq. 15-31)	*14.39*
Bicycle level of service (Exhibit 15-4)	*F*

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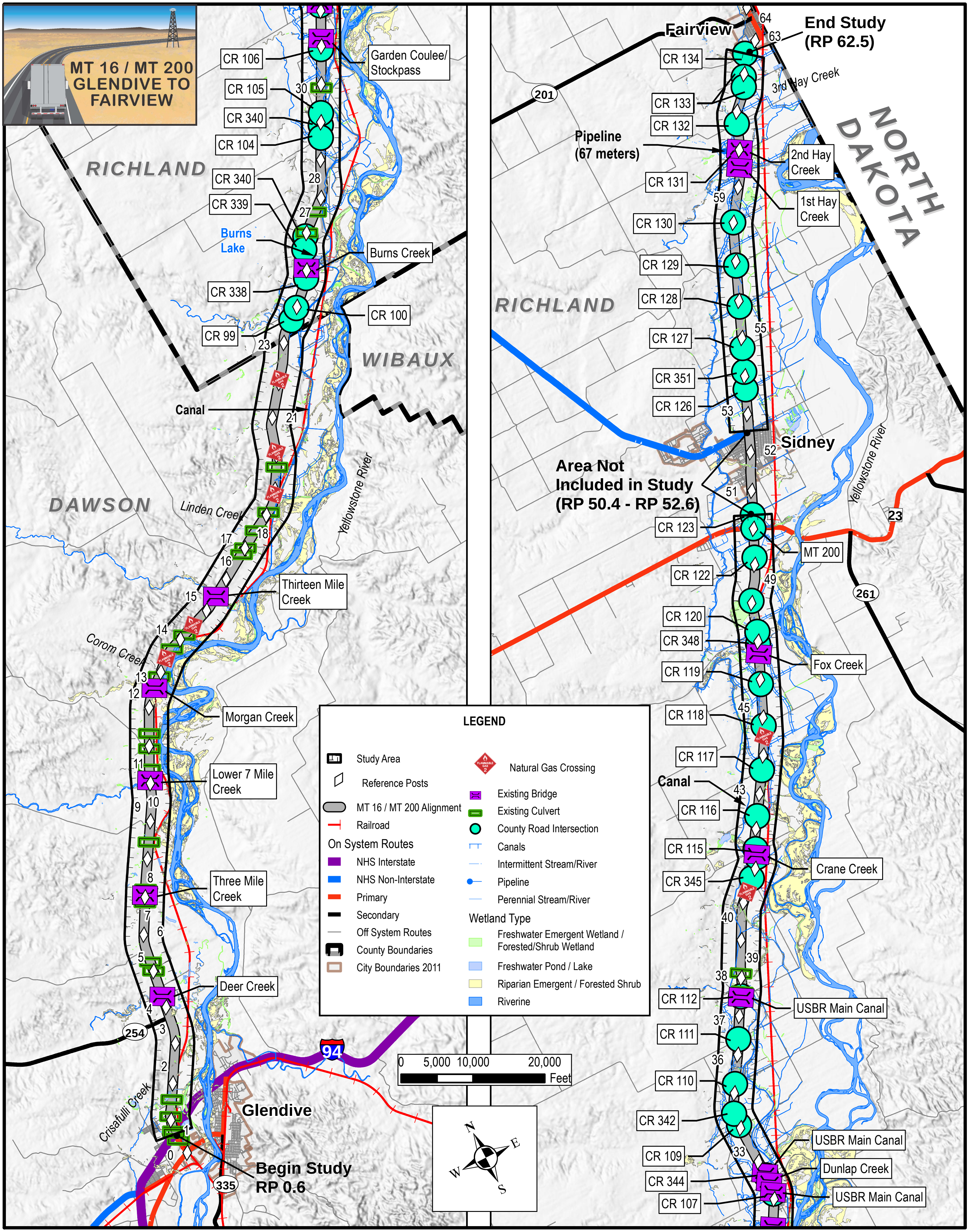
Appendix 5

Corridor Constraints Figure

Corridor Constraints



Appendix 6

Preliminary Pavement Analysis Memorandum

MEMORANDUM

222 North 32nd Street, Suite 700
P.O. Box 31318
Billings, Montana 59107-1318
Phone (406) 656-6399
Fax (406) 656-6398

To: Sarah Nicolai
Planner - DOWL HKM

From: Thomas Grimm, P.E.
Senior Geotechnical Engineer - DOWL HKM

Date: February 21, 2012

Subject: MT16/MT200 Corridor Planning Study
Preliminary Pavement Analysis

DOWL HKM has completed a preliminary pavement analysis for the MT 16/MT 200 Corridor Planning Study. A more detailed pavement analysis and pavement section design will be performed under subsequent project phases.

This pavement analysis focused exclusively on data provided by MDT and cursory field review of representative pavement conditions. Based on the information summarized below, a pavement analysis was performed and preliminary pavement sections are provided.

Scope of Pavement Analysis

DOWL HKM has reviewed pavements, soils, and geotechnical data provided by MDT to assess the existing pavement sections of the MT 16/MT 200 roads. DOWL HKM has not performed materials testing, pavement core sampling, or a comprehensive field review to identify all pavement deficiency locations. This analysis has focused on data provided by MDT and a cursory field review of the existing pavement. Based on the review, DOWL HKM has determined appropriate pavement section alternatives, taking into account the volume of truck traffic and existing pavement conditions.

Location

This study focuses on the portion of MT 16 beginning at approximate Reference Post (RP) 0.6 at the Sidney I-94 Interchange and extends to its intersection with MT 200 just south of Sidney (RP 50.0). The study also includes MT 200 from the Sidney city limit boundary (RP 52.6) just north of its intersection with Holly Street, and extends northeast on MT 200 to the Fairview city limits. The study excludes areas within the city limits of Glendive, Sidney, and Fairview.

Project Understanding

Within the study areas, MT 16 and MT 200 are rural two-lane highways with varying shoulder widths. Truck volumes in the corridor are reflective of the oil-field activity in the region. As a percentage of total traffic volumes, the corridor has some of the highest volumes of commercial trucks in the state, with high growth observed in 2010 and 2011.

Accordingly, this corridor study will address traffic and safety concerns associated with high truck volumes.

Areal Geology

The project alignment is mapped as alluvium, alluvial terrace deposits and sedimentary rock. The alluvial soils consist of clays, silts, sands, and gravels associated with the Yellowstone River drainage. The sedimentary rock is from the Tullock (Tft) Member of the Fort Union Formation. The rock consists mainly of sandstone interbedded with shale and mudstone.

Field Observations and Findings

The pavement was observed to generally be in good condition with slight to minor rutting ¼-inch deep or less. Transverse cracking, less than 1/4 inch wide, was observed at 30 to 60 foot intervals. Stripping, shoulder failure, pumping and subgrade swelling were typically not observed along the alignment.

Five soil survey reports and one geotechnical report were reviewed for this pavement analysis. The reports presented information for the 30 KM NE of Glendive NE, S of Sidney - SW, Glendive - NE, Glendive - NE (2), Savage - Crane, and Sidney - Fairview projects. The reports indicated that the existing pavement sections typically consist of 0.3 feet of asphalt pavement overlying 1.5 feet of crushed base course. The pavement subgrades soils range from A-1 to A-7 soils. Subgrade soils typically consist of A-4 and A-6 soils.

Pavement Analysis

The pavement subgrade soils are anticipated to consist of A-6 soils with an R-value of 5 or less. These soils are considered poor subgrades soils for pavement design, moisture sensitive, and typically have high moisture contents below the existing pavement. Areas requiring sub-excavation should be identified and addressed during the future geotechnical investigation.

Based on traffic data provided by the MDT Traffic Data Collection and Analysis Section, the traffic loading for MT 16 and MT 200 were estimated. Simple Equivalent Single Axial Loads (ESALs) calculations for MT 16 and MT 200 resulted in 5,156,550 (MT 16) and 18,638,503 (MT 200) ESALs. Table 1 summarizes input assumptions and results of the calculations.

Table 1; MT 16/MT200Simple ESAL calc	
Performance period	20yrs
Initial ADT	3130 (MT16) 6080 (MT200)
% heavy trucks	9.3(MT16) 21.8 (MT200)
# lanes design dir.	1
% All truck in dir.	100
% trucks in design dir.	50
Avg. truck factor	1
%Annual truck factor growth	0
%Annual vol. growth	15 (MT16) 30 (MT200)
Estimated ESALs	5,156,550 (MT16) 18,638,503 (MT200)

The existing pavement sections are anticipated to generally consist of 0.3 feet of asphalt pavement over 1.6 feet of crushed base course for both MT 16 and MT 200. The pavement subgrades are assumed to consist of A-6 soils (R-value <5) which represents a poor subgrade condition. Based on the assumed existing pavement section and pavement subgrade conditions, a pavement section design analysis was performed to evaluate the feasibility of pavement overlay and reconstruction alternatives. The inputs and estimated structural number calculated for the MT 16 pavement analysis is presented in Table 2.

Table 2; N-20/MT16 Pavement Analysis	
Flexible Pavement Input	
ESALS (2011-2031)	5156550
Initial Serviceability	4.2
Terminal Serv.	2.5
Reliability	0.9
Std Dev	0.35
Roadbed Res. Mod	6000
Structural No.	4.65

The inputs and estimated structural number calculated for the MT 200 pavement analysis is presented in Table 3.

Table 3; N-20/MT200 Pavement Analysis	
Flexible Pavement Input	
ESALS (2011-2031)	18638503
Initial Serviceability	4.2
Terminal Serv.	2.5
Reliability	0.9
Std Dev	0.35
Roadbed Res. Mod	6000
Structural No.	5.58

Based on the calculated structural numbers for MT 16 and MT 200, pavement section alternatives for pavement overlay and reconstruction were developed. The flexible pavement section thickness and opinion of costs for MT 16 are summarized in Tables 4 through 6.

Table 4; N-20/MT16 Alternative 1 Pavement Overlay to SN=4.65, 3-inch overlay				
	inches	Drainage	SC	
New PMS	3	1	0.41	1.23
Exist PMS	4	1	0.33	1.32
CBC	19.8	0.9	0.12	2.14
				4.68
Cost @ $80/cy PMS placed = $6.67/sy				

PMS, plant mix surfacing; CBC, crushed base course; cy, cubic yard; sy, square yard

Table 5; N-20/MT16 Alternative 2 New Pavement Section to SN=4.65				
	inches	Drainage	SC	
New PMS	6	1	0.41	2.46
CBC	6	0.9	0.14	0.756
Select Fill	24	0.9	0.07	1.512
				4.728
Cost @ $80/cy PMS placed = $13.33/sy Cost @ $18/cy CBC placed = $3.00/sy Cost @ $10/cy Select Fill placed = $6.67/sy Total = $23.00/sy				

PMS, plant mix surfacing; CBC, crushed base course; cy, cubic yard; sy, square yard

Table 6; N-20/MT16 New Pavement Section (CTB) to SN=6.16				
	inches	Drainage	SC	
New PMS	6	1	0.41	2.46
CTB	6	0.9	0.2	1.08
Select	24	0.9	0.07	1.51
				5.05
Cost @ $80/cy PMS placed = $13.33/sy				
Cost @ $18/cy CTB placed = $3.75/sy				
Cost @ $10/cy Select Fill placed = $6.67/sy				
Total = $23.75/sy				

PMS, plant mix surfacing; CTB, cement treated base course; cy, cubic yard; sy, square yard
PMS and CTB limited to minimum section thickness for traffic

The flexible pavement section thickness and opinion of costs for MT 200 are summarized in Tables 7 through 9.

Table 7; N-20/MT200 Pavement Overlay to SN=6.16, 6-inch overlay				
	inches	Drainage	SC	
New PMS	6	1	0.41	2.46
Exist PMS	4	1	0.33	1.32
CBC	19.8	0.9	0.12	2.1384
				5.9184
Cost @ $80/cy PMS placed = $13.33/sy				

PMS, plant mix surfacing; CBC, crushed base course; cy, cubic yard; sy, square yard

Table 8; N-20/MT200 New Pavement Section to SN=6.16				
	inches	Drainage	SC	
New PMS	6.5	1	0.41	2.665
CBC	12	0.9	0.14	1.512
Select	24	0.9	0.07	1.512
				5.689
Cost @ $80/cy PMS placed = $14.44/sy				
Cost @ $18/cy CBC placed = $6.00/sy				
Cost @ $10/cy Select Fill placed = $6.67/sy				
Total = $27.11/sy				

PMS, plant mix surfacing; CBC, crushed base course; cy, cubic yard; sy, square yard

Table 9; N-20/MT200 New Pavement Section (CTB) to SN=6.16				
	inches	Drainage	SC	
New PMS	6	1	0.41	2.46
CTB	9	0.9	0.2	1.62
Select	24	0.9	0.07	1.512
				5.592
Cost @ $80/cy PMS placed = $13.33/sy				
Cost @ $18/cy CTB placed = $5.63/sy				
Cost @ $10/cy Select Fill placed = $6.67/sy				
Total = $25.63/sy				

PMS, plant mix surfacing; CTB, cement treated base course; cy, cubic yard; sy, square yard

A rigid or Portland cement concrete (PCC) section alternative was developed for highways MT16 and MT 200. The rigid section is considered suitable and reasonable for this feasibility level analysis of both highways sections. The rigid section and estimated opinion of cost is summarized in Table 10.

Table 10; N-20/MT200 and N-20/MT16 Portland Cement Concrete Section Alternative	
	inches
PCC	10
CBC	6
Select	18
Cost @ $80/cy PCC placed = $22.22/sy	
Cost @ $18/cy CBC placed = $3.00sy	
Cost @ $10/cy Select Fill placed = $5.00/sy	
Total = $30.22/sy	

PCC, Portland Cement Concrete; CBC, crushed base course; cy, cubic yard; sy, square yard

The pavement section alternatives and costs represent opinions of costs associated with pavement construction only. Unit costs were estimated from 2011 bid tab costs on similar projects. Costs associated with select fill do not reflect any savings that may be attributable to the reuse of material from existing pavement sections.

The above conclusions and recommendations are presented to encourage discussion and consideration toward considering the possible reconstruction and/or plant-mix surfacing overlay of MT 16/MT 200 roads. Additional geotechnical investigations and pavement analyses should be performed during detailed design, and is anticipated to be performed under subsequent project phases.

Attachments: Pavement Analysis