Appendix D

Improvement Options Report

US 2 - Badrock Canyon Corridor Planning Study

IMPROVEMENT OPTIONS REPORT

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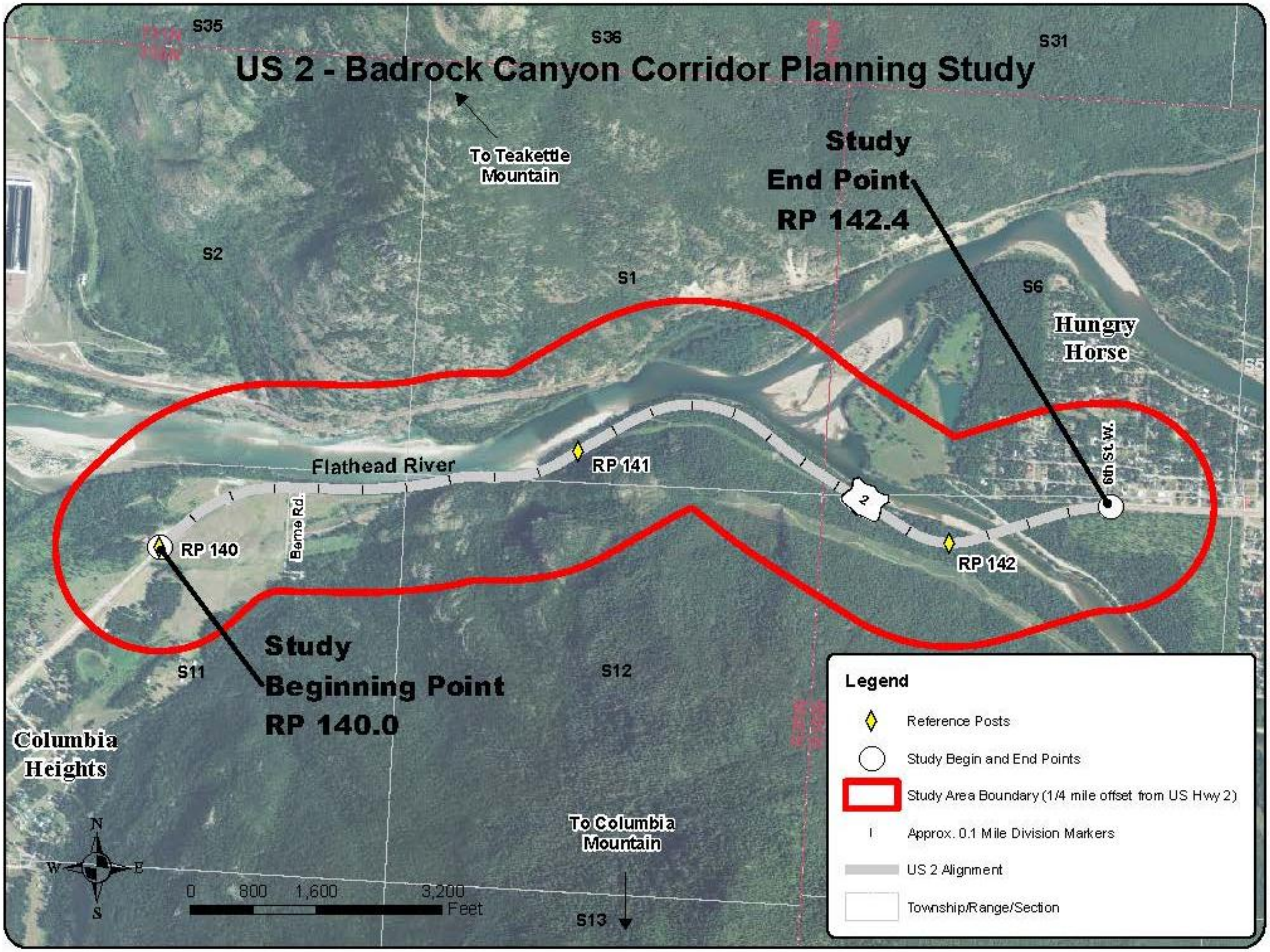
1.0 INTRODUCTION

The US 2-Badrock Canyon Corridor Planning Study area includes 2.4 miles of US Highway 2 beginning at Reference Post (RP) 140.0 and ending at RP 142.4. The study area is located within Sections 6 and 7, Township 30 North, Range 19 West, Montana Meridian and Sections 1, 2, 11 and 12, Township 30 North, Range 20 West, Montana Meridian, within Flathead County. Figure 1-1 illustrates the study area.

Figure 1-1 Study Area



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

1.1 Previous Planning Efforts in US 2 – Badrock Canyon Corridor

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

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

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

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

1.2 Linking Transportation Planning and Environmental Compliance

FHWA guidance on linking transportation planning and environmental analysis notes transportation planning can be used to limit the number of potential solutions evaluated during the National and Montana Environmental Policy Act (NEPA/MEPA) process. A planning study can provide a basis for early screening, allowing exclusive focus on reasonable, feasible alternatives during the NEPA/MEPA process.

This report documents the planning level screening process used in the US 2-Badrock Canyon corridor with the intent of fulfilling future NEPA/MEPA requirements. The report identifies potential improvement options, defines qualitative screening criteria, and presents a planning level evaluation of options in the corridor. The findings and recommendations provided in this report can be used to streamline a future SEIS effort if MDT pursues improvements in the corridor.

1.3 Background

Alternatives identified in the FEIS were used as a starting point for the US 2 – Badrock Canyon Corridor Study. The FEIS initially considered transportation system management (TSM), transit, alternate routes, reconstruction of the existing alignment, tunnel construction, construction of a grade-separated facility, and closing US 2.

The FEIS identified reconstruction of the existing US 2 alignment as the only reasonable alternative. All other alternatives were eliminated from further consideration due to constructability challenges, impracticality, high costs and/or failure to improve conditions in the corridor. The FEIS analyzed several roadway configurations to reconstruct the existing US 2 alignment, including an improved two-lane highway, a two-lane highway with a center left-turn lane, an undivided four-lane highway, and a four-lane highway with a center left-turn lane. A four-lane highway involving rock excavation in Badrock Canyon was recommended throughout the corridor (with a center left-turn lane from Columbia Heights to Berne Road [RP 140.3±]) based on anticipated traffic projections at that time, which indicated four travel lanes would be needed for the highway to operate at an acceptable LOS B in the FEIS design year of 2010.

1.4 Factoring in Corridor Needs and Objectives

Needs and objectives for the US 2 – Badrock Canyon Corridor Planning Study were developed through a review of baseline data provided in the FEIS and Re-evaluation, existing and projected conditions identified through the corridor planning study process, consideration of input from members of the public and resource agencies, and coordination with the study advisory committee, including representatives from the Confederated Salish and Kootenai Tribes (CSKT), Flathead County, City of Columbia Falls, and the canyon community. The corridor planning study team identified a range of potential improvement options to address corridor safety and operational needs and objectives relating to roadway geometry, the South Fork Flathead River Bridge, roadside safety and traffic control devices, drainage conditions, traffic operations, and non-motorized usage in the corridor. The planning team also attempted to identify improvements that would minimize adverse impacts to sensitive resources in the corridor and consider other limiting factors, including utility conflicts, construction feasibility, and funding availability. Needs, objectives, and other considerations are listed below.

<u>Need 1</u>: Improve the safety and operation of the US 2 roadway facility within the study area for all users, where practicable.

Objectives:

1.a Improve roadway elements to meet current MDT design standards.

1.b Provide a South Fork Flathead River Bridge structure that meets current MDT design standards.

1.c Provide appropriate guardrail and signing based on current design guidelines.

1.d Provide appropriate drainage facilities throughout the corridor to minimize water and ice on the roadway.

1.e Provide desirable Level of Service (LOS) through the planning horizon year of 2035.

1.f Provide opportunities for non-motorized usage in the corridor.

<u>Need 2</u>: Minimize adverse impacts from improvements to the environmental, historic, cultural, scenic and recreational characteristics of the corridor.

Objectives:

2.a Minimize adverse impacts to the main stem and South Fork of the Flathead River and fisheries that may result from improvement options.

2.b Minimize adverse impacts to historic, cultural, and archaeological resources that may result from improvement options.

2.c Strive to maintain the scenic nature of the corridor with respect to view sheds and landscape features.

2.d Provide reasonable access to recreational sites in the corridor.

2.e Minimize conflicts with wild animals and facilitate wildlife movement.

Other issues to be considered as part of the screening process:

- Conflicts with utilities
- Construction feasibility
- Availability and feasibility of funding

2.0 DEVELOPMENT OF IMPROVEMENT OPTIONS

2.1 Alignments

The US 2 – Badrock Canyon corridor is physically constrained and includes a number of sensitive environmental and cultural resources. Within the middle portion of the corridor from RP 140.6± to RP 141.2±, US 2 is directly bordered by culturally sensitive rock outcroppings to the south and the Flathead River to the north, which provides critical habitat for bull trout. Narrow shoulders, sharp curves, limited sight distance, roadway drainage and icing issues, and public access to recreational sites create safety concerns within the corridor, while traffic operations are anticipated to decline within the 2035 planning horizon.

The US 2 – Badrock Canyon planning team identified six potential alignments to improve safety and operations for US 2 corridor users while minimizing impacts to environmental and cultural resources to the extent practicable.

Figure 2-1 illustrates potential alignments, with required structures indicated in black. Appendix 1 includes additional alignment figures. The following sections describe potential alignments in more detail.

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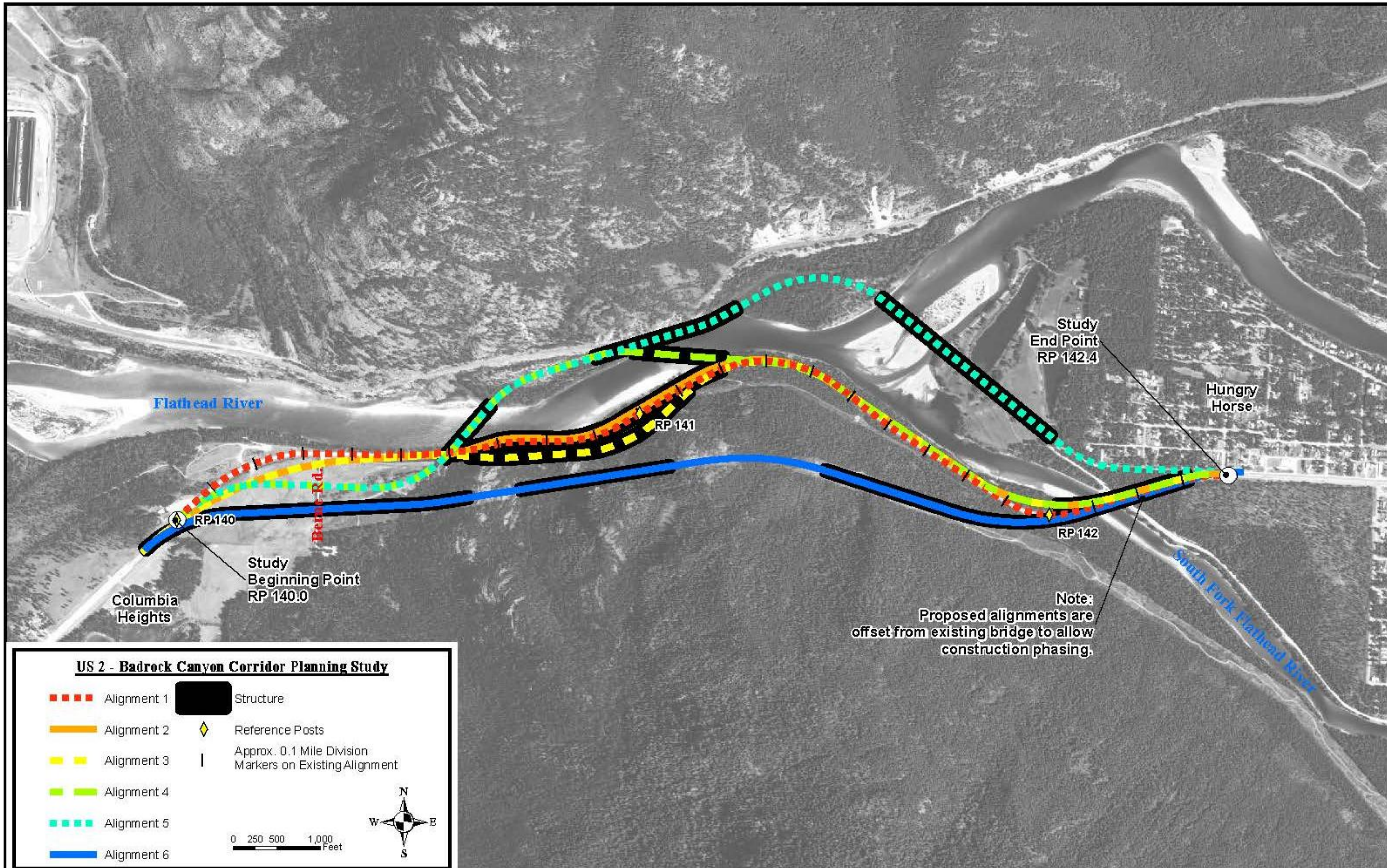
Figure 2-1 Potential Alignments



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2.1.1 Alignment 1 (Existing Alignment)

Alignment 1 would follow the existing US 2 alignment and would involve no modifications to current roadway geometry. Existing horizontal and vertical curves failing to meet current MDT design standards would remain, and the roadway would continue to have two travel lanes with minimal shoulders throughout the corridor. Improvements would be implemented to provide or enhance access management, bicycle/pedestrian facilities, drainage, parking, roadside safety, rockfall prevention, rumble strips, sight distance, traffic control, and wildlife passage. The existing South Fork Flathead River Bridge would be replaced with a new two-lane or four-lane structure due to its classification as functionally obsolete and structurally deficient.

2.1.2 Alignment 2 (Optimized Existing Alignment)

Alignment 2 would generally follow the existing US 2 alignment, although it would include modifications to horizontal/vertical geometry and other roadway elements to meet current MDT design standards where practicable. A new elevated or at-grade structure would be needed in the most constrained portion of the corridor (RP 140.6± to RP 141.2±) to avoid rock excavation. An elevated structure would be constructed above the elevation of the existing US 2 roadway, while an at-grade structure would be constructed at approximately the current roadway elevation. US 2 would be reconstructed as a two-lane facility with shoulders; a combination of two-lane, three-lane, and/or four-lane sections; or a four-lane facility. A new two-lane or four-lane bridge would be constructed to replace the existing South Fork Flathead River Bridge, depending on the lane configuration selected for this alignment.

2.1.3 Alignment 3 (Tunnel Alignment)

Alignment 3 would generally follow the existing US 2 alignment at the western and eastern ends of the corridor (RP 140.0± to RP 140.6± and RP 141.2± to RP 142.4±). It would be reconstructed as a four-lane roadway and would include modifications to horizontal/vertical alignments and other roadway elements to meet current MDT design standards where practicable. A two-lane or four-lane tunnel would extend through the mountain south of US 2 from RP 140.6± to RP 141.2± to bypass the most constrained portion of the corridor. Within this segment, a two-lane tunnel could serve as part of a couplet to accommodate eastbound (EB) volumes with the existing US 2 roadway serving westbound (WB) traffic. For a couplet scenario, a new structure would be needed along the existing US 2 alignment to avoid rock cuts. Alternately, a four-lane tunnel could accommodate EB and WB traffic, and the existing US 2 facility could continue to be maintained as a local roadway to provide access to Berne

Memorial Park (RP 140.9±) and the Flathead River. For both configurations, a new four-lane bridge would be constructed to replace the existing South Fork Flathead River Bridge and tie into the four existing travel lanes in Hungry Horse.

2.1.4 Alignment 4 (Partial Canyon Bypass Alignment)

Alignment 4 would cross to the north side of the main stem of the Flathead River at RP 140.6± and rejoin the existing alignment at RP 141.2±, bypassing the most constrained portion of the existing alignment. Within this segment, the existing US 2 roadway could continue to be maintained as a local roadway to provide access to Berne Memorial Park and the Flathead River. The new four-lane US 2 facility would meet current MDT design standards where practicable. Alignment 4 would include two new four-lane bridges crossing the main stem of the Flathead River, and a new four-lane bridge crossing the South Fork of the Flathead River.

2.1.5 Alignment 5 (Full Canyon Bypass Alignment)

Alignment 5 would cross to the north side of the main stem Flathead River at RP 140.6± and rejoin the existing alignment at the far eastern end of the corridor (RP 142.4±), bypassing the majority of the existing alignment. Within this portion of the corridor, the existing US 2 roadway could continue to be maintained as a local roadway providing access to Berne Memorial Park and the Flathead River. The new four-lane US 2 facility would meet current MDT design standards where practicable. Alignment 5 would include three new four-lane bridges crossing or paralleling the main stem of the Flathead River. The new alignment could tie into the west end of River Junction Road before intersecting the existing US 2 alignment in Hungry Horse.

2.1.6 Alignment 6 (Southern Alignment)

Alignment 6 would depart from the existing alignment at the western end of the corridor (RP 140.0±) to traverse over the mountainous terrain south of US 2, and rejoin the existing alignment at RP 142.4±. Within this portion of the corridor, the existing US 2 roadway could continue to be maintained as a local roadway to provide access to Berne Memorial Park and the Flathead River. The new four-lane US 2 facility would meet current MDT design standards where practicable. Three lengthy elevated structures would be needed to span the steep topography, and a new four-lane bridge would replace the existing South Fork Flathead River Bridge.

2.2 Alignment Screening

A qualitative screening process was developed to evaluate the range of alignments at a pre-NEPA/MEPA planning level. To be considered viable and pass the screening, an alignment must be reasonable and practicable in terms of cost, constructability, level of community support, degree of impacts to sensitive resources, and right-of-way acquisition requirements. Screening criteria and results are described in more detail below.

2.2.1 Cost

Cost is an important consideration at the pre-NEPA/MEPA planning level. An alignment can be screened from further consideration if it would not be feasible due to excessive costs. An estimated cost may be deemed unreasonable if it is substantially greater than costs for other options that meet corridor needs and objectives. Very high cost projects are not practicable or feasible due to difficulties in securing funding.

Estimated costs include at-grade and elevated structures within the most constrained portion of the corridor (RP 140.6± to RP 141.2±), bridges, and various lane configurations, as well as unknown factors at the planning level stage. Cost estimates include two- and four-lane configurations for Alignment 2 and a four-lane configuration for a new US 2 facility (Alignments 3, 4, 5, and 6). A 20 to 50 percent contingency was included for Alignments 1, 2, 4, 5, and 6 to account for unknown factors over the planning horizon. A 30 to 60 percent contingency was assumed for Alignment 3 due to a higher number of unknown factors associated with excavating a tunnel through the mountain south of the existing alignment. Cost estimates reflect anticipated construction costs only, and do not include potential costs associated with right-of-way acquisition, utility relocation, preliminary engineering, or operations and maintenance.

Estimated costs include replacement of the existing South Fork Flathead River Bridge and construction of new bridges, where appropriate. Bridge widths would vary from two to four travel lanes to match lane configurations associated with each alignment. In coordination with MDT's Bridge Bureau, a conservative estimate of $175 per square foot was utilized for reconstruction of the South Fork Flathead River Bridge, bridges associated with Alignments 4 and 5, and elevated structures associated with Alignments 2 and 6. An estimate of $125 per square foot was utilized for construction of a cantilevered deck associated with Alignment 2. Structures could be constructed using methods and structure types commonly used on the highway system in Montana. Substructures typically consist of pile or drilled shaft foundations supporting cast-in-place concrete pile caps, pier walls, or hammerhead caps. Superstructures range from steel plate girders to pre-stressed concrete I-girders supporting cast-in-place concrete deck slabs. Miscellaneous elements supported by and attached to the bridge deck may include sidewalks, vehicle barriers, pedestrian barriers, and steel bridge railing, as appropriate.

Planning level cost estimates for each alignment are presented in Table 2.1. Appendix 2 includes cost estimate tables.

Table 2.1 Planning Level Cost Estimates – Alignments

Alignment	Planning Level Estimate of Costs(1)
Alignment 1 (Existing Alignment)	Spot Improvements: $500 to $6.6M South Fork Flathead River Bridge Reconstruction: $9.7M to $27.3M
Alignment 2 (Optimized Existing Alignment)	US 2 Reconstruction: $35.9M to $177.0M
Alignment 3 (Tunnel Alignment)	US 2 Reconstruction / New Construction: $399.0M to $558.0M
Alignment 4 (Partial Canyon Bypass Alignment)	US 2 Reconstruction / New Construction: $70.1M to $86.4M
Alignment 5 (Full Canyon Bypass Alignment)	US 2 Reconstruction / New Construction: $89.5M to $110.0M
Alignment 6 (Southern Alignment)	US 2 Reconstruction / New Construction: $307.0M to $379.0M

Source: DOWL HKM, 2012.

(1) Estimates for Alignment 1 indicate range of costs for potential spot improvements and reconstruction of the South Fork Flathead River Bridge. Estimates for Alignments 2 through 6 encompass reconstruction or construction of new alignments within the corridor, including replacement of the existing South Fork Flathead River Bridge, where appropriate. Cost ranges reflect various spot improvements, structures, lane configurations, and contingencies. Cost estimates are provided in 2012 dollars and reflect anticipated construction costs only. Costs reflect planning level estimates, and should not be considered an actual cost encompassing all scenarios and circumstances. Estimates do not include potential costs associated with right-of-way acquisition, utility relocation, preliminary engineering, or operations and maintenance. Cost estimate tables are provided in Appendix 2.

Alignment 1 (Existing Alignment)

Spot improvements range in cost from $500 for a new static sign up to $6.6 million for a dedicated bicycle/pedestrian facility. Reconstruction of the South Fork Flathead River Bridge is estimated to cost from $9.7 million to $15.3 million for a two-lane structure and $19.6 to $27.3 million for a four-lane structure.

Alignment 2 (Optimized Existing Alignment)

The planning level cost estimate for Alignment 2 ranges from $35.9 to $177.0 million due to the wide variation in potential structure types and lane configurations. The low end of the cost estimate range represents a two-lane configuration with a two-lane cantilevered structure through the most constrained portion of the corridor (RP 140.6± to RP 141.2±) and replacement of the existing South Fork Flathead River Bridge with a new two-lane bridge. The high end of the cost estimate range represents a four-lane configuration with a four-lane elevated structure in the most constrained portion of the corridor and replacement of the existing South Fork Flathead River Bridge with a new four-lane bridge. Alignment 2 structure types and lane configurations are described in more detail in Chapters 4 and 5.

Alignment 3 (Tunnel Alignment)

Construction of Alignment 3 is estimated to range from $399.0 to $558.0 million. The low end of this cost range represents a couplet configuration from RP 140.6± to RP 141.2±, with a two-lane EB tunnel through the mountain south of US 2 and a two-lane cantilevered structure for WB traffic generally following the existing alignment. The high end of the cost range represents a four-lane tunnel from RP 140.6± to RP 141.2± to bypass the most constrained portion of the corridor.

Alignment 4 (Partial Canyon Bypass Alignment)

Construction of Alignment 4 is estimated to range from $70.1 to $86.4 million. This estimate includes two new four-lane bridges crossing the main stem of the Flathead River and replacement of the existing South Fork Flathead River Bridge with a new four-lane bridge.

Alignment 5 (Full Canyon Bypass Alignment)

The planning level cost estimate for Alignment 5 ranges from $89.5 to $110.0 million. This estimate includes three new four-lane bridges crossing or paralleling the main stem of the Flathead River.

Alignment 6 (Southern Alignment)

Alignment 6 is estimated to range from $307.0 to $379.0 million, which would include construction of three structures traversing over the mountainous terrain south of US 2 and the South Fork of the Flathead River.

Cost Summary

Alignment 1 is expected to be the least costly alignment. Alignments 2, 4, and 5 are expected to range in cost from $35.9 million to $177.0 million, depending on the required number of river crossings, lane configurations, and the types of structures involved in construction or reconstruction of US 2. Alignments 3 and 6 are expected to range in cost from $307.0 to $558.0 million, nearly two to more than three times higher than the next most costly alignment. For this reason, Alignments 3 and 6 are considered not feasible from a cost perspective.

2.2.2 Constructability

Alignment 1 (Existing Alignment)

Alignment 1 would involve constructability challenges associated with replacement of the existing South Fork Flathead River Bridge. Measures to protect water quality while installing bridge piers within and adjacent to the river would be required. Reconstruction of the South Fork Flathead River Bridge may require construction of a second parallel bridge, use of the existing bridge, and/or phased construction to maintain traffic during construction.

Construction of spot improvements in the most constrained portion of the corridor (RP 140.6± to RP 141.2±) may require intermittent lane closures, resulting in challenges for emergency vehicle access.

Alignment 2 (Optimized Existing Alignment)

In addition to South Fork Flathead River Bridge challenges mentioned above for Alignment 1, Alignment 2 would involve construction challenges in the most constrained portion of the corridor. Mobilizing construction equipment, maintaining traffic, and providing adequate emergency vehicle access during construction activities would be a challenge given the physical site constraints.

Construction of a cantilevered or elevated structure would require retaining walls or bridge piers within or adjacent to the Flathead River. Foundation construction may be difficult due to geotechnical soil variance. Measures would need to be taken to reduce the likelihood of soil erosion or failure due to construction loads. Environmental permitting requirements may impose construction timing and/or other restrictions.

AT&T owns and operates a fiber optic cable that generally runs along the south side of US 2. NorthWestern Energy owns and operates a 10-inch diameter high pressure natural gas transmission pipeline that generally runs along the south side of US 2. This is the only natural gas transmission pipeline serving the Flathead Valley area. In some locations where the rock outcroppings encroach upon the roadway, the line may be located directly under the road surface. The exact location and depth of the line in relation to Alignment 2 is not known at this time. The 1995 FEIS disclosed the gas pipeline would be in conflict with proposed highway reconstruction and must be relocated. At a minimum, temporary pipeline relocation during construction activities would have been required for construction of the FEIS preferred alternative. Following roadway reconstruction, the gas transmission pipeline was proposed to be permanently relocated within the highway right-of-way. The 2002 Re-evaluation noted shifting the US 2 alignment to the north to avoid cutting or blasting the rock outcroppings may reduce conflicts with the transmission pipeline and the temporary relocation previously proposed may no longer be required. The Re-evaluation noted the effects of highway reconstruction on the pipeline and the need for relocation cannot be determined until engineering design is completed. The exact location of buried utilities in relation to Alignment 2 and the need for and methods of potential relocation would need to be addressed during project development.

Alignment 3 (Tunnel Alignment)

A tunnel would pose substantial construction challenges. Based on information provided by the MDT Geotechnical Section, rock outcroppings south of US 2 are composed of Precambrian argillite and quartzite. The rock outcroppings exhibit multiple tension cracks, some as wide as two feet running parallel to US 2. Tension cracking along these outcroppings would likely create complications related to tunnel construction. At this planning level stage, no geotechnical engineering was completed to determine the feasibility of excavating the rock in this area to construct a tunnel. Additional geotechnical analysis which could cost up to $2.0 million would be required to determine the feasibility of this option before engineering design could proceed.

Mobilizing roadway construction equipment within the constrained portion of the corridor would be difficult depending on the tunneling method. If a tunnel alignment were pursued, it may be possible to maintain two-lane traffic on the existing US 2 alignment during portions of construction. At times, traffic flow may need to be restricted to one travel lane serving alternating directions of traffic.

Utility conflicts would need to be addressed during project development, as noted in the discussion for Alignment 2.

Alignment 4 (Partial Canyon Bypass Alignment)

Alignment 4 would require construction of two new bridges crossing the main stem of the Flathead River, in addition to replacement of the existing South Fork Flathead River Bridge. Further analysis of subsurface materials would need to be verified to ensure proper design of the bridges. Measures to protect water quality while installing bridge piers within and adjacent to the river may pose constructability challenges. Construction of Alignment 4 would also be complicated by the proximity of the railroad line across the river north of the existing US 2 alignment.

Alignment 5 (Full Canyon Bypass Alignment)

Alignment 5 would involve all of the construction difficulties mentioned above for Alignment 4. New bridge construction would be required, likely through lowland areas with a high water table in some locations, requiring private access road reconstruction and additional private property impacts. Alignment 5 could tie into the west end of River Junction Road, which is currently a low-volume unpaved roadway within a residential area. Connection with River Junction Road could impact local traffic patterns in Hungry Horse.

Alignment 6 (Southern Alignment)

Substantial challenges would be encountered during construction of Alignment 6 due to the mountainous terrain south of the existing US 2 alignment. No geotechnical engineering has been conducted to determine the feasibility of constructing elevated structures over this steep terrain and would need to be verified at the project level.

Alignment 6 would require considerable quantities of embankment material to bring the proposed roadway structure to grade, specifically on the west end of the project. Substantial quantities of material would also need to be excavated and blasted on the top of the mountain to properly grade the new roadway. New bridges would need to be constructed within these areas, adding complications of soil consolidation and settlement. Settlement issues would likely require construction of embankment materials followed by a settling period, typically one construction season. This process would delay the finish date of construction.

The existing South Fork Flathead River Bridge would need to be replaced with a much longer bridge. The new super structure would tower over the existing roadway on the east end of the project and would create a steep longitudinal grade on the structure for a length of over 4,000 feet. The new bridge would incorporate piers over 100 feet high, overlapping the existing highway.

Constructability Summary

Alignments 3 and 6 are not feasible from a constructability standpoint due to potential geotechnical risks associated with blasting and/or tunneling through unstable rock formations and steep terrain south of the existing alignment.

2.2.3 Potentially Impacted Resources

Alignments were identified to minimize impacts to sensitive environmental and cultural resources and adjacent land areas to the extent practicable. Despite these efforts, replacement of the South Fork Flathead River Bridge, reconstruction of the existing US 2 alignment, and/or construction of new alignments would result in unavoidable impacts within the corridor. Potentially impacted resources are listed below.

- Surface water bodies, including the main stem, Middle Fork, and South Fork of the Flathead River
- Wetland areas
- Floodplains
- Federally and state-listed fish and wildlife species and habitat, including critical habitat for bull trout and Canada lynx
- Wildlife movement corridors
- Farmlands
- Vegetation, including federally and state-listed plant species
- Cultural and archaeological resources, including the Badrock Canyon Cultural Landscape
- Recreational resources, including Berne Memorial Park and Fisherman's Rock
- Geologic features
- Water source at Berne Memorial Park
- Section 4(f) sites
- Visual resources

Section 404 of the Clean Water Act requires permitting through the U.S. Army Corps of Engineers (USACE) prior to discharging dredged or fill material into waters of the United States or adjacent wetlands. A Section 404 permit would be needed for all alignments due to anticipated impacts to the Flathead River. Under Section 404(b)(1) guidelines (40 CFR 230.10), USACE may only permit discharges into waters of the United States that represent the least environmentally damaging practicable alternative (LEDPA), provided the alternative meets the project purpose and does not have other significant adverse environmental consequences. To be practicable, an alternative must be available and capable of being implemented after taking into consideration cost, existing technology, and logistics in light of the overall project purpose. Technical and logistical factors include access, transportation needs, utilities, topography, and available construction techniques. During an agency meeting conducted on January 9, 2012, USACE indicated culturally significant rock outcroppings and other Tribal concerns would be considered when identifying the LEDPA for this corridor.

Other environmental permits that would be required for all alignments are listed below. Permitting through the Montana Department of Natural Resources and Conservation (DNRC) is discussed in Section 2.2.4.

- Montana Stream Protection Act (SPA 124 Authorization) administered by Montana Fish, Wildlife & Parks (FWP)
- Montana Floodplain and Floodway Management Act (Floodplain Development Permit) administered by the Flathead County Floodplain Administrator
- Short-term Water Quality Standard for Turbidity (318 Authorization) administered by the Montana Department of Environmental Quality (DEQ)

Alignment 1 (Existing Alignment)

Alignment 1 would result in potential impacts to the South Fork Flathead River, wetlands, fish and wildlife habitat, and vegetation due to reconstruction of the South Fork Flathead River Bridge and construction of spot improvements. Alignment 1 is expected to be the least impactful alignment.

Alignment 2 (Optimized Existing Alignment)

Alignment 2 would result in potential impacts associated with reconstruction and widening of US 2 and reconstruction of the South Fork Flathead River Bridge. In order to avoid rock cuts, the roadway could be widened to the north, resulting in impacts to the South Fork Flathead River, floodplains, wetlands, and fish and wildlife habitat. Impacts to wildlife movement corridors, farmlands, vegetation, the Badrock Cultural Landscape, Berne Memorial Park, Fisherman's Rock, and visual resources may also occur. The degree of impact would depend on the lane configuration selected for this alignment.

Alignment 3 (Tunnel Alignment)

Alignment 3 would result in potential impacts associated with reconstruction and widening of US 2 and reconstruction of the South Fork Flathead River Bridge as described for Alignment 2.

Tunnel construction would impact geologic features south of US 2. Additional study would be needed to determine if tunneling could impact the water source at Berne Memorial Park.

Alignments 4 and 5 (Partial and Full Canyon Bypass Alignments)

Construction of Alignments 4 and 5 would require new bridge crossings, resulting in impacts to the main stem of the Flathead River, floodplains, wetlands, and fish and wildlife habitat. It may be difficult to permit new bridge crossings if there are less environmentally damaging options that meet corridor needs and objectives. In addition to potential impacts associated with reconstruction and widening of the existing US 2 alignment at the eastern and western ends of the corridor, Alignments 4 and 5 would result in impacts to multiple resources along new alignments north of the Flathead River.

Alignment 6 (Southern Alignment)

Alignment 6 would result in potential impacts to the South Fork Flathead River, floodplains, wetlands, and fish and wildlife habitat due to reconstruction of the South Fork Flathead River Bridge. Alignment 6 would impact multiple resources along a new alignment spanning the mountainous terrain south of the existing US 2 alignment. Additional study would be needed to determine if Alignment 6 could impact the water source at Berne Memorial Park.

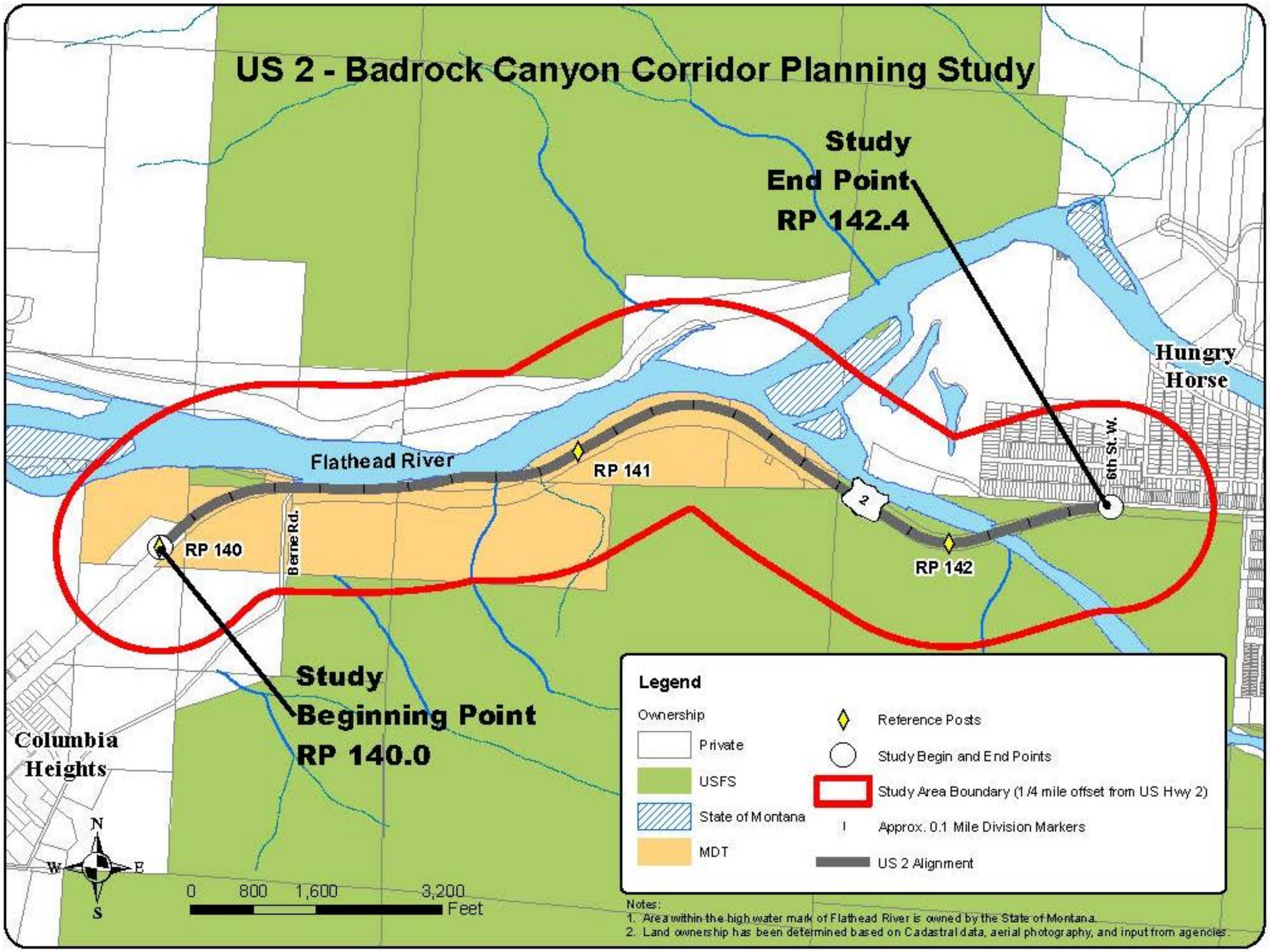
Potentially Impacted Resources Summary

All alignments would result in unavoidable impacts to resources in the corridor. Construction of Alignments 3 and 6 could create a risk of impacting the water source at Berne Memorial Park. Alignments 4 and 5 would require new river crossings, which could result in Flathead River impacts that may be difficult to permit. For these reasons, Alignments 3, 4, 5, and 6 would result in or would create a risk of unreasonable impacts to corridor resources.

2.2.4 Right-of-Way Acquisition / Easements

Following completion of the FEIS, MDT purchased additional right-of-way from RP 140.0± to RP 141.7± adjacent to the existing US 2 facility in anticipation of a future project to widen the roadway. Figure 2-2 illustrates land ownership within the corridor.

Figure 2-2 Land Ownership



The State of Montana holds ownership of the land and minerals located below navigable rivers, streams, and lakes and related acreage as established in the Equal Footing Doctrine and Montana statutes. DNRC administers these lands on behalf of the state. DNRC considers navigable waterways to be those for which it has historical documentation of commercial use. The portions of the main stem and south fork of the Flathead River within the corridor study area are considered navigable. A land use license or easement is required from DNRC for any construction or improvement of a structure within or over a navigable water body.

Alignment 1

No new right-of-way would be needed for spot improvements on the existing US 2 alignment. A DNRC land use license or easement would be required for replacement of the South Fork Flathead River Bridge. A US Forest Service (USFS) easement would be required at the eastern end of the corridor on either side of the South Fork Flathead River Bridge and at the fishing access site near RP 140.2±.

Alignment 2

No new right-of-way would be needed for reconstruction of US 2 along Alignment 2 from RP 140.3± to RP 141.7±. A small amount of right-of-way may need to be acquired from private landowners near RP 140.0±. A USFS easement would be required at the eastern end of the corridor from RP 141.7± to RP 142.4 and possibly near RP 140.2± where roadway widening and modifications to horizontal and vertical elements would extend outside existing MDT rights-of-way onto USFS land. Replacement of the South Fork Flathead River Bridge would require a land use license or easement from DNRC.

Alignment 3

Tunnel construction and widening/modification of the US 2 alignment would generally occur within existing MDT rights-of-way. A USFS easement would be required at the eastern end of the corridor from RP 141.7± to RP 142.4 and possibly near RP 140.2± where roadway widening and modifications to horizontal and vertical elements would extend outside existing MDT rights-of-way. Replacement of the South Fork Flathead River Bridge would require a land use license or easement from DNRC.

Alignment 4

New right-of-way on the north side of the river would need to be acquired from private landowners from RP 140.6± to RP 141.2±. Alignment 4 would be in close proximity to existing railroad rights-of-way on the north side of the river. Coordination with the railroad would be required to avoid impacts to rail operations. New river crossings and replacement of the South Fork Flathead River Bridge would require a land use license or easement from DNRC. A USFS easement would be required at the eastern end of the corridor from RP 141.7± to RP 142.4 where roadway widening and modifications to horizontal and vertical elements would extend outside the existing MDT rights-of-way.

Alignment 5

New right-of-way would need to be acquired from private landowners from RP 140.6± to 142.4±. Coordination with the railroad would be required to avoid impacts to rail operations. New river crossings and replacement of the South Fork Flathead River Bridge would require a land use license or easement from DNRC. Alignment 5 would enter Hungry Horse from the northwest, and may impact buildings and require modifications to existing private access roads.

Alignment 6

A USFS easement would be required from RP 141.1± to RP 142.4 where roadway widening and modifications to horizontal and vertical elements would extend outside the existing MDT rights-of-way. Replacement of the South Fork Flathead River Bridge would require a land use license or easement from DNRC. Coordination with utilities may be required.

Right-of-Way Acquisition / Easements Summary

All alignments would require USFS easements and/or DNRC land use licenses or easements. Alignments 4, 5, and 6 would require unreasonable quantities of new right-of-way from private landowners and coordination with the railroad and utilities.

2.2.5 Community Support

During the Phase I and Phase II corridor planning study efforts, community members and CSKT representatives expressed support for maintaining or generally following the existing alignment (Alignments 1 and 2). Support was expressed for spot improvements, replacement of the South Fork Flathead River Bridge, and roadway reconstruction to improve corridor safety and operations, while minimizing impacts to sensitive environmental and cultural resources. There was some interest in tunnel options and potential alignments to the north and south of the existing US 2 roadway (Alignments 3, 4, 5, and 6), although community members and CSKT representatives were generally less supportive of new alignments.

2.2.6 Screening Summary - Alignments

Alignments 1 and 2 are advanced, with additional discussion in Chapter 3. Based on failure to meet criteria relating to cost, constructability, resource impacts, right-of-way acquisition / easements, and community support, Alignments 3, 4, 5 and 6 are eliminated from further consideration and will not be discussed further in this report. Table 2.2 summarizes the alignment screening. Orange shading indicates failure to pass a screening criterion, with specific failing elements highlighted in black.

Table 2.2 Screening Summary – Alignments

Criteria	Alignment 1 Existing	Alignment 2 Optimized Existing	Alignment 3 Tunnel	Alignment 4 Partial Canyon Bypass	Alignment 5 Full Canyon Bypass	Alignment 6 Southern Alignment
Planning Level Estimate of Costs[1]	*Spot Improvements* $500 to $6.6M *South Fork Flathead River Bridge Reconstruction* $9.7 to $27.3M	*US 2 Reconstruction* $35.9M to $177.0M	*US 2 Reconstruction / New Construction* **$399.0M to $558.0M**	*US 2 Reconstruction / New Construction* $70.1M to $86.4M	*US 2 Reconstruction / New Construction* $89.5M to $110.0M	*US 2 Reconstruction / New Construction* **$307.0M to $379.0M**
Constructability Challenges[2]	• South Fork Flathead River Bridge reconstruction • Traffic delays during construction	• South Fork Flathead River Bridge reconstruction • Mobilization of materials and equipment into constrained area • Traffic delays during construction • Conflicts with utilities	• **Geotechnical risks** • South Fork Flathead River Bridge reconstruction • Mobilization of materials and equipment into constrained area • Traffic delays during construction • Conflicts with utilities	• New river crossings • South Fork Flathead River Bridge reconstruction • Mobilization of materials and equipment into constrained area • Traffic delays during construction	• New river crossings • Mobilization of materials and equipment into constrained area • Traffic delays during construction	• **Steep terrain** • **Geotechnical risks** • South Fork Flathead River Bridge reconstruction • Mobilization of materials and equipment into constrained area • Conflicts with utilities
Potentially Impacted Resources[2]	• Impacts to multiple resources adjacent to existing alignment	• Impacts to multiple resources adjacent to existing alignment	• **Risk of impacts to water source at Berne Memorial Park** • Impacts to multiple resources adjacent to existing alignment	• **New river crossings** • Impacts to multiple resources adjacent to existing alignment • Impacts to multiple resources along new alignment		• **Risk of impacts to water source at Berne Memorial Park** • Impacts to multiple resources adjacent to existing bridge and along new alignment
Right-of-Way (RW) Acquisition / Easements	• DNRC easement at river crossing • USFS easement at RP 140.2± and at eastern end of corridor			• **New RW throughout much of corridor** • **Railroad involvement** • DNRC easements at river crossings • USFS easement at eastern end of corridor	• **New RW throughout majority of corridor** • **Railroad involvement** • DNRC easements at river crossings	• **New RW throughout majority of corridor** • **Utility involvement** • DNRC easement at river crossing • USFS easement at eastern end of corridor
Community Support[3]	More Support	More Support	More Support	**Less Support**	**Less Support**	**Less Support**
Recommendation	**Advance**	**Advance**	**Eliminate from Further Consideration**	**Eliminate from Further Consideration**	**Eliminate from Further Consideration**	**Eliminate from Further Consideration**

Source: DOWL HKM, 2012. Note: Shading indicates failure to meet criteria.

(1) Estimates indicate capital construction costs for spot improvements; reconstruction of existing alignment, including existing South Fork Flathead River Bridge; and/or construction of new alignment. Alignment 1 includes a two-lane configuration (with a two-lane South Fork Flathead River Bridge). Alignment 2 includes two-, three-, and four-lane configurations (with a two- or four-lane South Fork Flathead River Bridge). Alignments 3 through 6 include a four-lane configuration (with a four-lane South Fork Flathead River Bridge, where appropriate). Planning level estimates should not be considered an actual cost encompassing all scenarios and circumstances. Estimates do not include potential costs associated with right-of-way acquisition, utility relocation, preliminary engineering, or operations and maintenance. Cost estimate tables are provided in Appendix 2.

(2) Planning level summary does not provide a comprehensive list of issues. Further analysis would be required during project development.

(3) Indication of community support is based on feedback provided during informational meetings held in Columbia Falls and Hungry Horse and written comments submitted during the study.

3.0 ALIGNMENTS ADVANCED

3.1 Alignment 1

This section identifies potential improvements that could be implemented along the existing US 2 alignment (Alignment 1) before roadway reconstruction throughout the corridor.

3.1.1 Access Management

Berne Memorial Park attracts members of the public and visitors wishing to access picnic areas and the Flathead River. Safety improvements at Berne Memorial Park could include vehicle turn lanes or median treatments to limit turning movements into and out of the park. A median barrier could be constructed at Berne Memorial Park that would only allow EB right-in and right-out movements and eliminate safety issues associated with left-turn movements. Concrete barrier could also be placed adjacent to the Berne Memorial Park parking area to designate a single point of access.

Potential Locations
RP 140.8± to RP 141.0± (South Side of US 2)

Planning Level Cost Estimate
$100,000 to $150,000

Recommended Implementation Timeframe
Short-term

Potentially Impacted Resources and Right-of-Way Requirements
Impacts to Section 4(f) recreational resources may occur. Additional study would be needed to quantify specific impacts.

3.1.2 Bicycle/Pedestrian Facilities

Community members expressed support for improved pedestrian and bicycle access within the study corridor. Currently, the roadway's narrow or non-existent shoulders do not encourage non-motorized use. A bi-directional path could be constructed near or immediately adjacent to the existing roadway, providing a dedicated facility for non-motorized users. The facility could be constructed to the north or south of the existing roadway, although a facility to the south may minimize the need for crossings by providing access to Berne Memorial Park and connecting to existing trail systems. Portions of the dedicated facility could be implemented before roadway reconstruction throughout the corridor. Due to physical constraints including the Flathead River and rock outcroppings, a dedicated facility within the most constrained portion of the corridor would need to be designed and implemented in coordination with roadway reconstruction.

An elevated pedestrian bridge could be constructed to allow access across US 2. The structure would need to incorporate ramps and landings in compliance with the Americans with Disabilities Act (ADA). The required ramp and landing dimensions may be difficult to accommodate given physical constraints within the corridor.

The specific location of a dedicated bicycle/pedestrian facility, the potential need for crossings in the corridor, and compatibility with roadway reconstruction would need to be determined during project development.

Potential Locations
Dedicated Bicycle/Pedestrian Facility: Throughout Corridor (North or South Side of US 2)
Bicycle/Pedestrian Overcrossing: RP 140.8± (North & South Sides of US 2)

Planning Level Cost Estimate
Dedicated Bicycle/Pedestrian Facility: $3.6 million to $6.6 million (entire corridor)
Bicycle/Pedestrian Overcrossing: $1.0 million to $2.5 million per location

Recommended Implementation Timeframe
Mid- to long-term

Potentially Impacted Resources and Right-of-Way Requirements
Impacts to the Flathead River, wetland areas, floodplains, fish and wildlife species and habitat, farmlands, vegetation, Section 4(f) cultural/archaeological resources and recreational resources, geologic features, and visual resources may occur. Additional study would be needed to quantify specific impacts. Environmental permitting would be required.

3.1.3 Drainage

Based on field observations and previous reports, there are a number of drainage issues within the constrained portion of the corridor. Surface water ponding occurs seasonally near Berne Memorial Park due to a flat roadway cross slope, the lack of drainage ditches, and plugged or buried culverts. One of the areas of concern lies east of the park, directly below the east rock overhang. This area frequently collects water from melting ice and snow on the rock ledge, at times creating icy conditions on the roadway below.

Plugged or buried culverts could be replaced to improve drainage conditions in the canyon. New ditches or concrete valley gutters could be constructed adjacent to the edge of pavement on US 2 at the Berne Memorial Park parking lot to maximize the amount of collected surface water. Additional drainage features could also be incorporated along the east rock overhang to remove standing water from the roadway.

Potential Locations
Install Culverts: RP 140.8±, RP 141.1±, RP 141.2±, and RP 142.0± (North & South Sides of US 2)
Re-grade Ditches: RP 140.8±, RP 140.9±, and RP 141.8± (South Side of US 2)
Install Valley Gutter: RP 141.0± (South Side of US 2)

Planning Level Cost Estimate
Install Culverts: $4,000 to $10,000 per location
Re-grade Ditches: $1,000 to $15,000 per location
Install Valley Gutter: $3,000 to $5,000

Recommended Implementation Timeframe
Short-term

Potentially Impacted Resources and Right-of-Way Requirements
None

3.1.4 Parking

The parking area at the existing fishing access site at RP 140.2± could be further developed to provide additional parking opportunities and river access within the corridor. The parking area could be linked to the dedicated bicycle/pedestrian facility discussed above to allow non-motorized users to park their vehicles at the western end of the corridor and walk or bicycle through the corridor. Coordination with USFS would be required.

Potential Location
RP 140.2± (North Side of US 2)

Planning Level Cost Estimate
$400,000 to $500,000

Recommended Implementation Timeframe
Short-term

Potentially Impacted Resources and Right-of-Way Requirements
Impacts to vegetation, Section 4(f) recreational resources, and visual resources may occur. Additional study would be needed to quantify specific impacts.

3.1.5 Roadside Safety

Guardrail issues were observed during the field investigation conducted for this study. W-beam guardrail is the primary guardrail style used in the corridor. Some end treatments were observed with one-way departure terminal sections adjacent to two-lane traffic. These end sections could be updated to standard terminal sections, reducing the severity of possible crashes.

Potential Locations
RP 140.3±, RP 141.9±, and RP 142.3± (North & South Sides of US 2)

Planning Level Cost Estimate
$3,000 to $5,000 per location

Recommended Implementation Timeframe
Short-term

Potentially Impacted Resources and Right-of-Way Requirements
None

3.1.6 Rockfall Prevention

Community members and MDT maintenance personnel have described incidents involving rocks and debris falling onto the roadway from adjacent rock outcroppings. Two possible rockfall prevention options were considered for this study. Additional options could be considered at the project level.

Wire mesh netting could be installed on rock outcroppings south of US 2 at RP 140.7± (west of Berne Memorial Park) and RP 141.1± (east of Berne Memorial Park). The netting would provide protection from rocks and debris that may fall onto the roadway. Alternately, rock bolts could be installed in the areas noted above. Rock bolts could be drilled into the rock outcroppings and backfilled with grout to secure the rock face, reducing the likelihood of falling rocks while minimizing visual impacts. Additional geotechnical investigations may be needed during the project development process to determine the feasibility of these options. Potential cultural or visual mitigation measures are not included in the planning level cost estimate listed below.

Potential Locations
RP 140.7± and RP 141.1± (South Side of US 2)

Planning Level Cost Estimate
$200,000 to $1.0 million per location

Recommended Implementation Timeframe
Short-term

Potentially Impacted Resources and Right-of-Way Requirements
Impacts to Section 4(f) cultural/archaeological resources, geologic features, and visual resources would occur. Additional study would be needed to quantify specific impacts.

3.1.7 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. 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. Continuous application of shoulder and centerline rumble strips is recommended within the US 2 corridor.

Potential Locations
Throughout corridor

Planning Level Cost Estimate
$2,100 to $2,700 per mile

Recommended Implementation Timeframe
Short-term

Potentially Impacted Resources and Right-of-Way Requirements
None

3.1.8 Sight Distance

Trees and shrubs limit sight distance for motorized users in several locations within the corridor. Clearing, grubbing, and tree trimming could improve safety by increasing sight distance around tight horizontal curves.

Potential Locations
RP 140.9±, RP 141.3±, and RP 142.0± (North & South Sides of US 2)

Planning Level Cost Estimate
$9,000 to $30,000 per location

Recommended Implementation Timeframe
Short-term

Potentially Impacted Resources and Right-of-Way Requirements
Impacts to the wetland areas, wildlife species and habitat, vegetation, and visual resources may occur. Additional study would be needed to quantify specific impacts.

3.1.9 South Fork Flathead River Bridge

The South Fork Flathead River Bridge is classified as functionally obsolete and structurally deficient. In the interim period before roadway reconstruction occurs in the corridor, MDT could pursue bridge replacement to provide a safe and functional structure crossing the South Fork of the Flathead River. As supported by future NEPA/MEPA efforts, MDT could initially replace the existing South Fork Flathead River Bridge with a new two-lane bridge. Ultimately, a single four-lane bridge or dual two-lane bridges are recommended to transition into the four existing travel lanes in Hungry Horse and allow flexibility during the design life of the structure. A four-lane bridge (or two two-lane structures) would allow MDT to consider roadway widening within the corridor without the need to replace the bridge(s). A dedicated bicycle/pedestrian facility on the north or south side of the bridge could tie into existing trail systems and a new dedicated non-motorized facility throughout the corridor. Compatibility with other corridor improvements would need to be considered during project development.

Potential Location
RP 142.1±

Planning Level Cost Estimate
$9.7 million to $27.3 million depending on lane configuration

Recommended Implementation Timeframe
Short- to mid-term

Potentially Impacted Resources and Right-of-Way Requirements
Impacts to the Flathead River, wetland areas, floodplains, fish and wildlife species and habitat, farmlands, vegetation, cultural/archaeological resources, recreational resources, and visual resources may occur. Additional study would be needed to quantify specific impacts. Environmental permitting would be required.

3.1.10 Traffic Control

Community members expressed support for additional static warning signs and/or variable message signs (VMS). Static signage could include miscellaneous warning signs such as turning roadway signs and share the road signs installed adjacent to the edge of the travel way or on overhead poles. Overhead static signs could also include warning beacons to further warn travelers. Permanent or temporary VMS could warn motorists of safety concerns, such as falling rocks, icy roads, or accidents and inform motorists of bicycle/pedestrian use in the canyon. Two VMS styles currently utilized on Montana highways include small temporary signs mounted on portable trailers and larger permanent signs on metal poles, both placed adjacent to the roadway. A third VMS style incorporates overhead metal pole structures spanning the roadway. The overhead style is typically used on Interstate or multi-lane facilities, but could be adjusted to fit a narrower roadway. All three VMS systems are capable of being controlled via manual entry or via remote radio connectivity.

Potential Locations

Static sign: RP 140.0±, RP 140.2±, RP 140.4±, RP 140.6±, RP141.0±, RP 141.1±, and RP 142.4± (North & South Sides of US 2)

Variable message sign: RP 140.0±, RP 142.3± (North & South Sides of US 2)

Planning Level Cost Estimate

Static sign: $500 to $1,000 per location

Variable message sign: $20,000 to $250,000 per location

Recommended Implementation Timeframe

Short-term

Potentially Impacted Resources and Right-of-Way Requirements

None

3.1.11 Wildlife Passage

The US 2 corridor lies in proximity to national forest land and the Flathead River. Wildlife species migrate between mountain ranges to the north and south, creating potential safety issues for motorized vehicles. In a written comment submitted to MDT, U.S. Fish and Wildlife Service (USFWS) noted Badrock Canyon is a known wildlife movement area. USFWS requested consideration of measures to facilitate wildlife movement while improving highway safety.

In an effort to reduce animal-vehicle conflicts, wildlife crossing options were evaluated to determine the appropriate type and location within the corridor. Based on known wildlife movements, a crossing would likely provide the greatest benefit at the western end of the corridor (RP 140.0± to RP 140.4±) before the corridor narrows. At-grade, elevated, and below-grade concepts were analyzed. At-grade fencing could be used to direct wildlife to a designated below-grade crossing point. A below-grade crossing would be preferred over an elevated option due to lower anticipated costs and reduced visual impacts. A preliminary analysis of survey data collected for the FEIS effort indicates a wildlife undercrossing could be constructed at the western end of the corridor without altering the current roadway grade. Planning level cost estimates do not reflect roadway grade alterations. This planning level determination would need to be confirmed during the project development phase.

Potential Location
RP 140.2± (North & South Sides of US 2)

Planning Level Cost Estimate
$920,000 to $1.1 million

Recommended Implementation Timeframe
Short- to mid-term

Potentially Impacted Resources and Right-of-Way Requirements
Impacts to floodplains, farmlands, vegetation, and visual resources may occur. Additional study would be needed to quantify specific impacts.

3.2 Alignment 2

3.2.1 Structure Types

Alignment 2 would widen the existing US 2 roadway to meet current MDT design standards where practicable. This would entail, at a minimum, shoulders. Alignment 2 improvements could also include additional travel lanes and a dedicated left-turn bay at Berne Memorial Park. The need for a structure within the most constrained portion of the corridor (140.6± to RP 141.2±) was identified in an effort to accommodate roadway widening while avoiding cutting or blasting the face of rock outcroppings.

Rock cutting/blasting activities are undesirable for several reasons. First, the rock in Badrock Canyon is known to be unstable. The Badrock outcroppings exhibit multiple tension cracks, some as wide as two feet running parallel to US 2. The MDT Geotechnical Section has noted these tension cracks increase the potential for large scale failure if the rock face is cut or blasted.

Secondly, the CSKT consider the entire Badrock Canyon to have special historical and cultural significance, and the canyon cliffs are extremely important to CSKT members. In part due to new information about historical/archaeological and Section 4(f) resources identified after completion of the FEIS, the Re-evaluation found the FEIS did not adequately assess an alignment that would minimize or totally avoid rock excavation near Berne Memorial Park.

Lastly, community members and CSKT representatives have expressed strong support for maintaining the water feature at Berne Memorial Park. In their comments provided to MDT, USACE noted springs are an important aquatic resource in the state of Montana. Additional study would be needed to determine if cutting or blasting the rock would result in impacts to the water source at Berne Memorial Park.

For these reasons, at-grade and elevated structure options were identified to allow roadway widening while avoiding impacts to the canyon rock face. These options are described in more detail below.

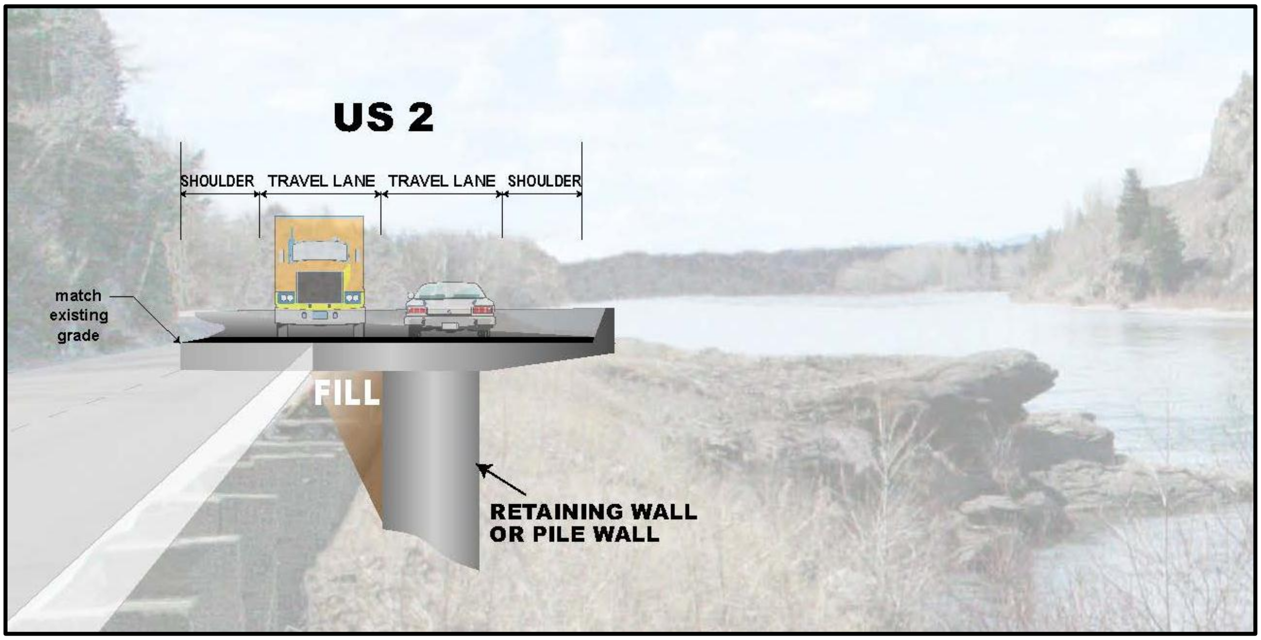
Cantilevered Structure

A cantilevered structure could be used to widen the roadway without impacting the rock outcrops within Badrock Canyon. Roadway widening could occur in the direction of the Flathead River, with the cantilevered structure extending over the water body. The structure would require retaining walls or pile walls within the floodplain to support traffic loads and a thickened reinforced concrete slab serving as the road surface. The roadway would remain at or close to its existing grade. Access to Berne Memorial Park could be maintained, although access to the Flathead River may be restricted where the cantilevered structure would extend over the existing river bank.

A transition from the at-grade roadway typical section to the cantilevered section would be required. The cantilevered section would incorporate concrete barrier rail adjacent to the Flathead River, matching new metal guardrail adjacent to the pavement section.

The cantilevered structure would vary in width depending on the number of travel lanes associated with Alignment 2. An example of a two-lane cantilevered structure is illustrated in Figure 3-1. Figures illustrating additional cantilevered structure variations are included in Appendix 3.

Figure 3-1 Two-Lane Cantilevered Structure



Source: DOWL HKM, 2012.

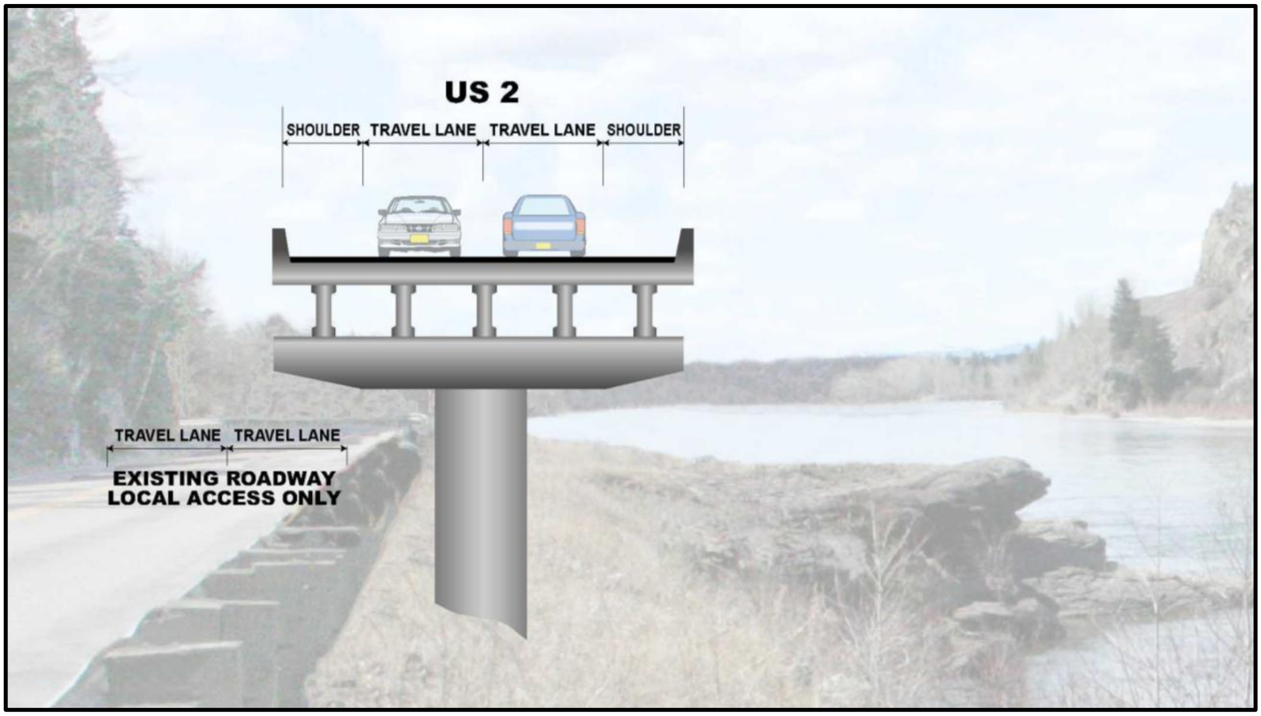
Elevated Structure

An elevated structure could be constructed above the current US 2 roadway grade to avoid impacting the rock outcrops. The elevated structure could be constructed using precast concrete decking sitting atop concrete piers. Piers would be placed north of the existing US 2 roadway within the floodplain. The existing US 2 roadway could remain in place to provide local access to Berne Memorial Park and the Flathead River.

A transition from the at-grade roadway typical section to the elevated section would be required. Retaining walls could be used to raise the paved section and transition to the elevated structure while minimizing the footprint at ground level. The existing roadway profile drops in elevation through the constrained portion of the corridor at the point closest to the Flathead River. This would allow shorter transitions from the existing profile to the finished raised profile of the elevated structure.

The elevated structure would vary in width depending on the number of travel lanes. An example of a two-lane elevated structure is illustrated in Figure 3-2. Figures illustrating additional elevated structure variations are included in Appendix 3.

Figure 3-2 Two-Lane Elevated Structure



Source: DOWL HKM, 2012.

3.2.2 Structure Screening

Cost

Table 3.1 presents planning level cost estimate ranges for cantilevered and elevated structures. Based on guidance provided by the MDT Bridge Bureau, conservative unit costs of $125 and $175 per square foot were assumed for cantilevered and elevated structures, respectively.

Table 3.1 Planning Level Cost Estimates –Structures

Structure Type	Planning Level Estimate of Costs(1)
Cantilevered Structure & Transition Sections	$22.0M to $63.9M
Elevated Structure & Transition Sections	$71.5M to $138.0M

Source: DOWL HKM, 2012.

(1) Cost estimates are provided in 2012 dollars and reflect anticipated construction costs only. Costs reflect planning level estimates, and should not be considered an actual cost encompassing all scenarios and circumstances. Cost estimates do not include potential costs associated with right-of-way acquisition, utility relocation, preliminary engineering, or operations and maintenance. Cost estimate tables are provided in Appendix 2.

The planning level cost estimate for a cantilevered structure and transition sections within the most constrained portion of the corridor (140.6± to RP 141.2±) ranges from $22.0 million for a two-lane structure to $63.9 million for a four-lane structure.

By comparison, an elevated structure and transition sections within the most constrained portion of the corridor (140.6± to RP 141.2±) is estimated to range from $71.5 million for a two-lane structure to $138.0 million for a four-lane structure, two to three times the low and high cost estimates for a cantilevered structure, respectively. For this reason, the cost of an elevated structure is not considered practicable.

Community Support

Community members were somewhat supportive of a cantilevered structure that would maintain access to Berne Memorial Park. Less support was expressed for an elevated structure as it would eliminate direct access to Berne Memorial Park from US 2. Concern was also expressed that an elevated structure would block views of the canyon and create wintertime maintenance difficulties.

Screening Summary – Alignment 2 Structures

Table 3.2 summarizes the structure screening. Orange shading indicates failure to pass a screening criterion. Based on failure to meet criteria relating to cost and community support, elevated structure options are eliminated from further consideration and will not be discussed further in this report. A cantilevered structure is advanced, with additional discussion of potential Alignment 2 options provided later in this chapter.

Table 3.2 Screening Summary –Structures (Alignment 2)

Criteria	Alignment 2	
	Cantilevered Structure (RP 140.6± to RP 141.2±)	Elevated Structure (RP 140.6± to RP 141.2±)
Planning Level Estimate of Costs[(1)]	$22.0M to $63.9M	$71.5M to $138.0M
Community Support[(2)]	More Support	Less Support
Recommendation	Advance	Eliminate from Further Consideration

Source: DOWL HKM, 2012.
Note: Shading indicates failure to meet criteria.
[(1)] Estimates indicate capital construction costs for cantilevered and elevated structures within the most constrained portion of the corridor (RP 140.6± to RP 141.2±). Costs reflect planning level estimates, and should not be considered an actual cost encompassing all scenarios and circumstances. Estimates do not include potential costs associated with right-of-way acquisition, utility relocation, preliminary engineering, or operations and maintenance. Cost ranges include two-lane, three-lane, and four-lane structures and transitions sections only and do not include costs for reconstruction of the entire corridor. Cost estimate tables are provided in Appendix 2.
[(2)] Indication of community support is based on feedback provided during informational meetings held in Columbia Falls and Hungry Horse and written comments submitted during the study.

3.2.3 Lane Configurations

Lane configurations considered for Alignment 2 are presented in the following sections. Configurations include two-lane, three-lane, and four-lane segments.

All options would include shoulders in accordance with current MDT and American Association of State Highway and Transportation (AASHTO) guidelines. Shoulder width has also been shown to affect safety performance. Shoulders allow errant vehicles to correct their path and return to the travel lane without leaving the paved surface. Shoulders provide an opportunity for vehicles to pull over in emergency situations and enable speed limit enforcement by providing locations for law enforcement officers to pull over speeding drivers. A wider top width can also improve sight distance, allowing drivers to detect objects and animals in the roadway.

A dedicated WB left-turn bay at Berne Memorial Park (RP 140.9±) could be incorporated in any of the lane configurations. A left-turn bay would allow upstream traffic to continue without delay and provide an exclusive lane from which to wait for a gap in opposing traffic to safely execute a left turn.

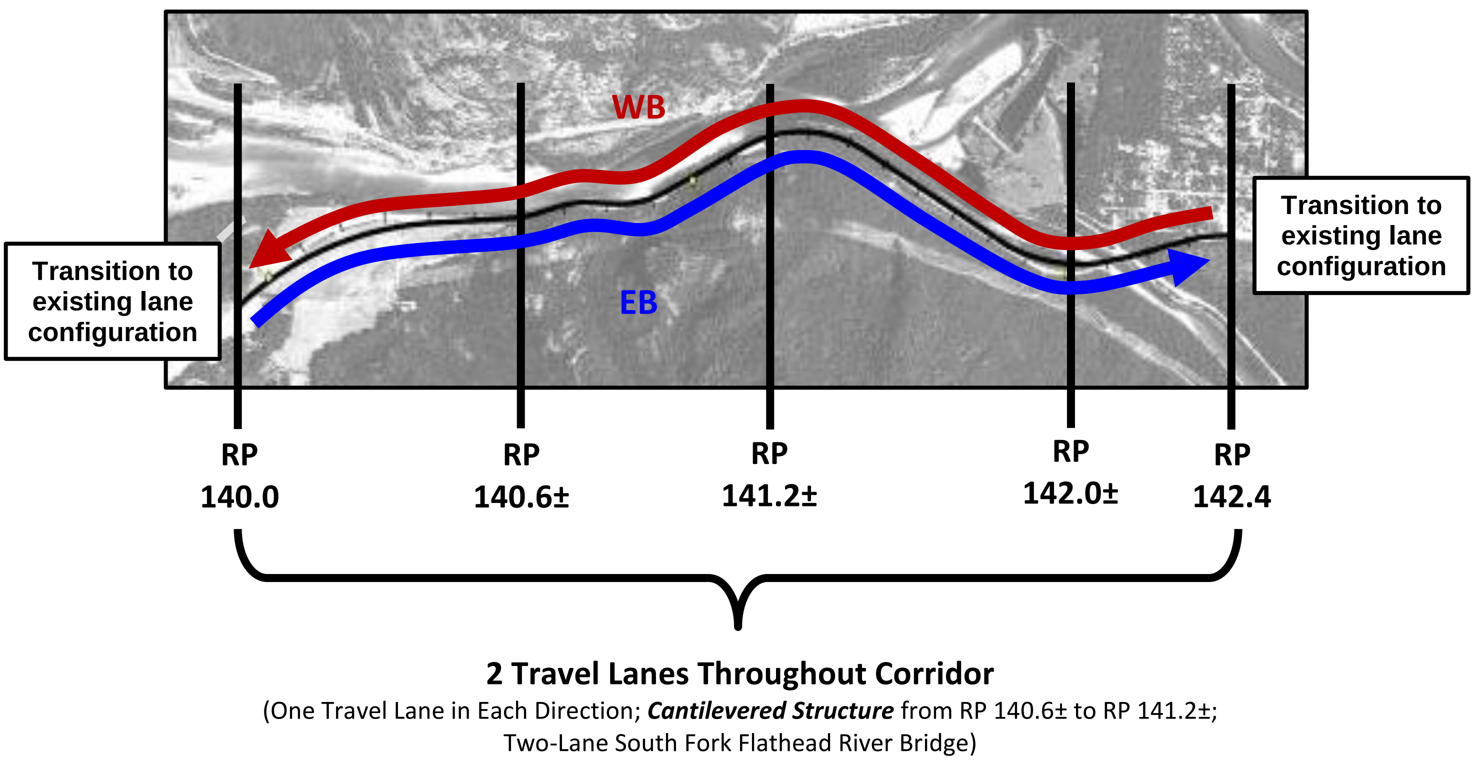
A dedicated bicycle/pedestrian facility could also be incorporated with any of the lane configurations. The facility could be constructed to the north or south of the existing roadway, although a facility to the south may minimize the need for crossings by providing access to Berne Memorial Park and connecting to the existing trail systems.

Appropriate transitions would be needed at both ends of the corridor to tie into existing lane configurations in Columbia Heights and Hungry Horse.

Two-Lane Configuration

The US 2 facility could be reconstructed along Alignment 2 with a single travel lane in each direction through the corridor, as is currently provided. The reconstructed roadway would meet current MDT design standards where practicable, including shoulders throughout the study area and a new two-lane bridge replacing the existing South Fork Flathead River Bridge. Figure 3-3 illustrates a two-lane configuration. Typical section figures are provided in Appendix 3.

Figure 3-3 Two-Lane Configuration

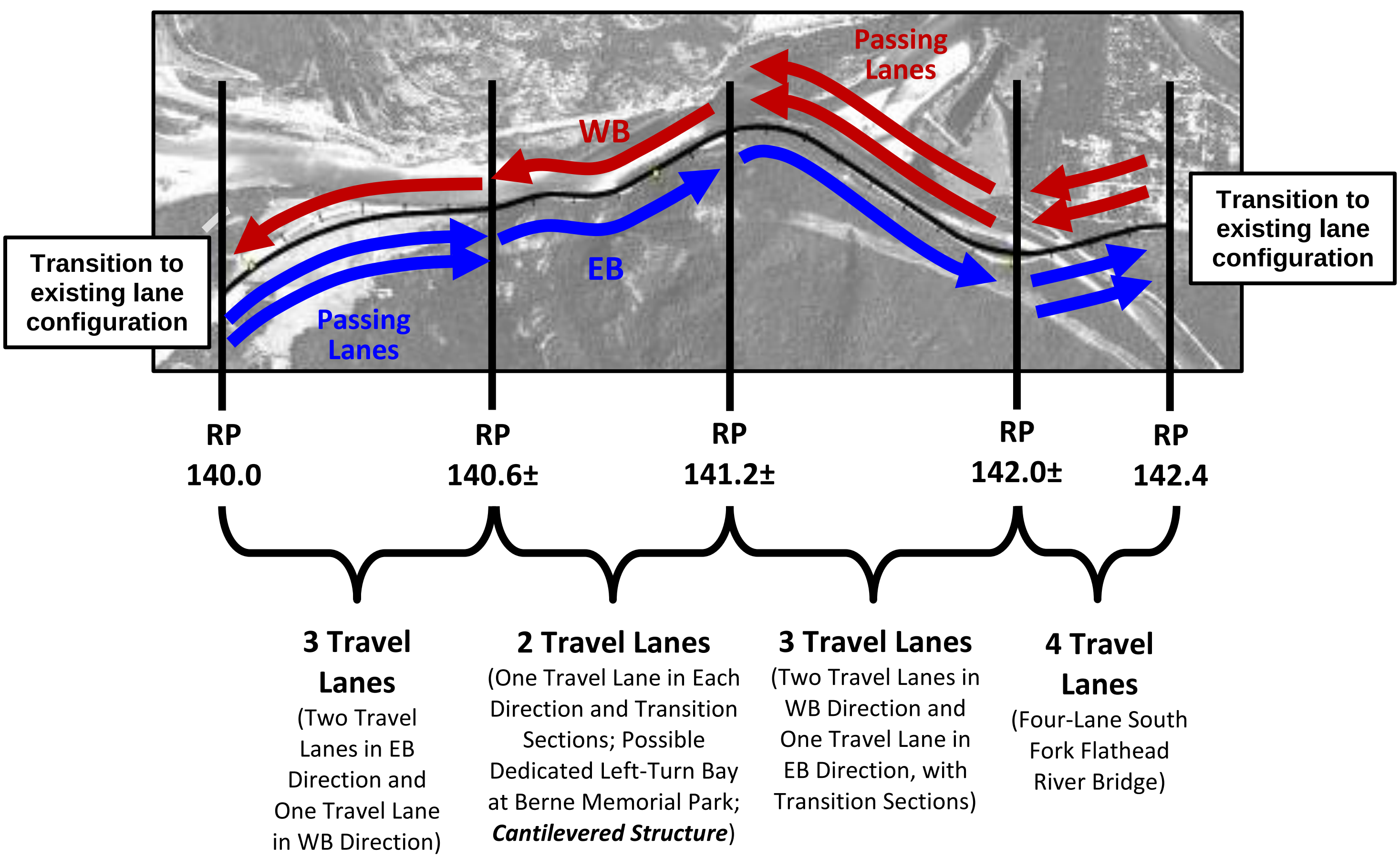


Three-Lane / Two-Lane Configuration with Four-Lane South Fork Flathead River Bridge

A combination of three-lane and two-lane sections was identified to improve passing opportunities while minimizing potential impacts. Passing opportunities (two travel lanes in the same direction) would be provided before traffic enters the most constrained portion of the corridor (RP 140.6± to RP 141.2±). Passing lanes would be provided in the EB direction from RP 140.0 to RP 140.6± and from RP 141.2± to RP 142.0± in the WB direction. A single travel lane would be provided in the opposing direction of travel in these locations. One travel lane in each direction (with transition sections) would be provided to minimize the roadway footprint from RP 140.6± to RP 141.2±.

A new four-lane South Fork Flathead River Bridge would connect to the four existing travel lanes within Hungry Horse. A four-lane bridge would allow MDT to consider further roadway widening within the corridor during the design life of the structure without the need to replace the bridge. Figure 3-4 illustrates the 3-2-3-4 configuration.

Figure 3-4 3-2-3-4 Configuration

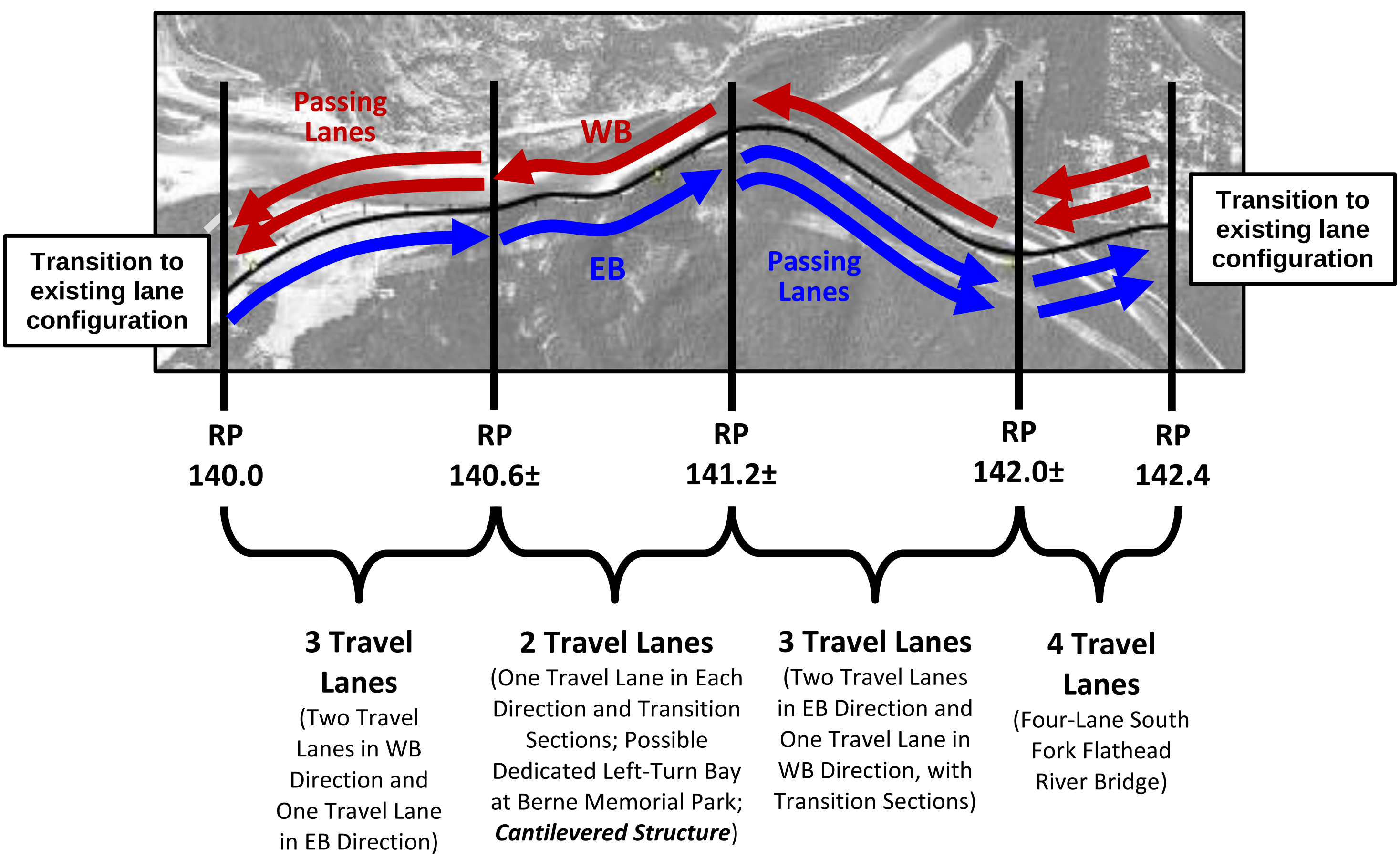


Reverse Three-Lane / Two-Lane Configuration with Four-Lane South Fork Flathead River Bridge

A reverse 3-2-3-4 configuration was identified that would provide passing lanes after traffic volumes exit the most constrained portion of the corridor (RP 140.6± to RP 141.2±). Passing lanes would be provided from RP 140.0 to RP 140.6± in the WB direction and from RP 141.2± to RP 142.0± in the EB direction. All other features of the 3-2-3-4 configuration would remain the same. This configuration would provide passing lanes after (i.e., heading away from) the most constrained portion of the corridor with the intent of potentially providing safer transitions from one-lane to two-lane sections.

As with the 3-2-3-4 configuration, a new four-lane South Fork Flathead River Bridge would be constructed to allow flexibility during the design life of the structure. Figure 3-5 illustrates the reverse 3-2-3-4 configuration.

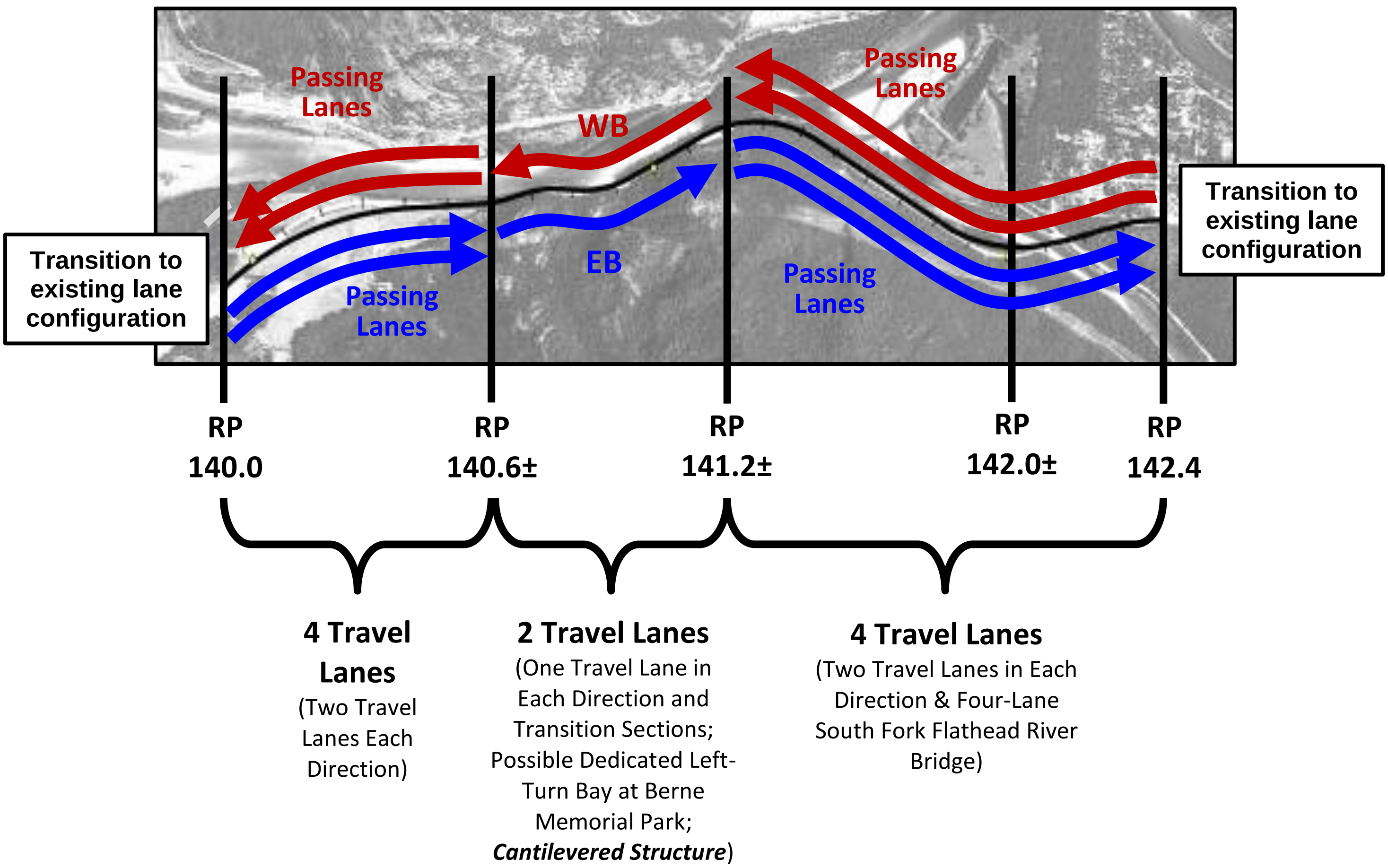
Figure 3-5 Reverse 3-2-3-4 Configuration



Four-Lane / Two-Lane Configuration

A 4-2-4 configuration was identified to improve passing opportunities while minimizing potential resource impacts. A 4-2-4 would provide four travel lanes on the western end (140.0 to 140.6±) and eastern end (RP 141.2± to RP 142.4) of the corridor, while providing two travel lanes through the most constrained portion of the corridor (RP 140.6± to RP 141.2±). A four-lane South Fork Flathead River Bridge would be provided with this configuration. Figure 3-6 illustrates the 4-2-4 configuration.

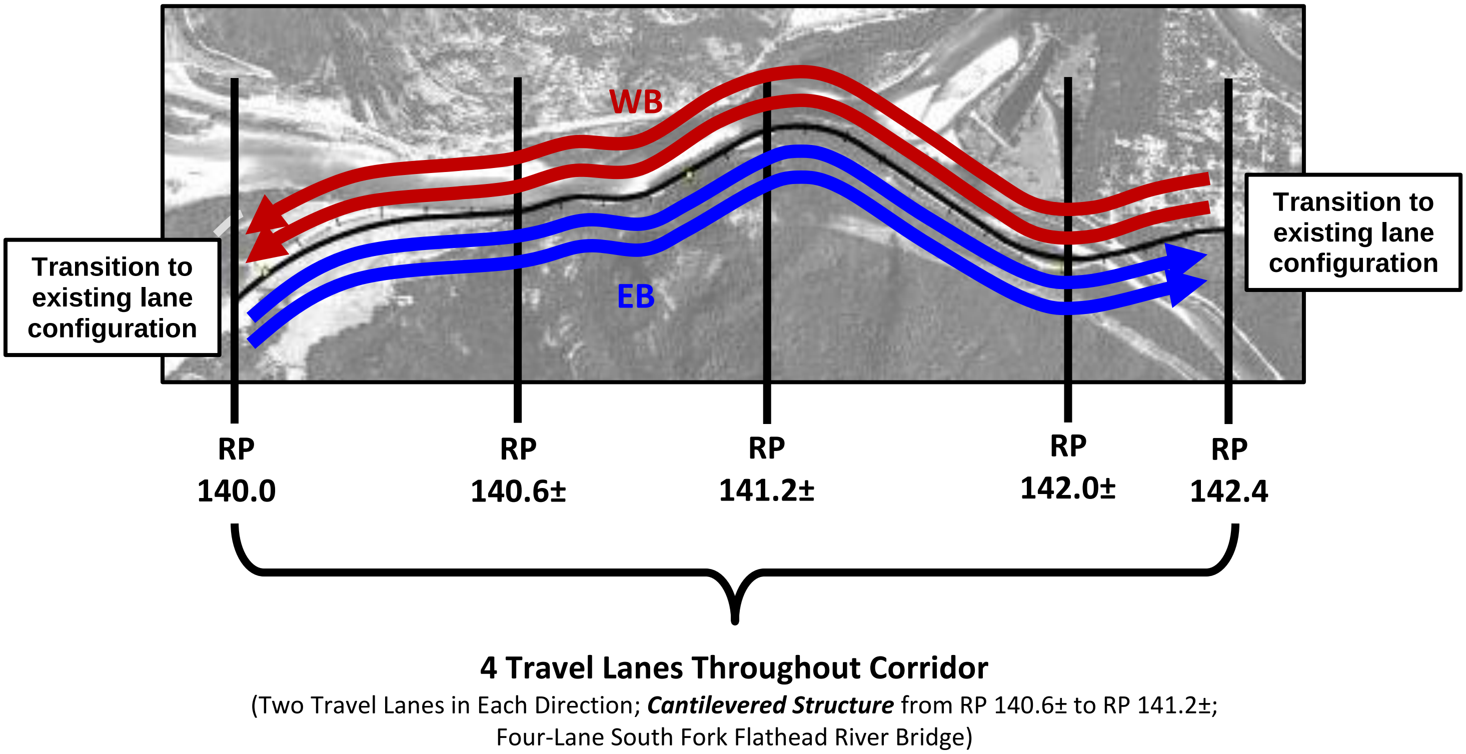
Figure 3-6 4-2-4 Configuration



Four-Lane Configuration

A configuration with four travel lanes throughout the corridor was identified to provide corridor-wide safety and operational improvements. Figure 3-7 illustrates a four-lane configuration.

Figure 3-7 Four-Lane Configuration



3.2.4 Lane Configuration Screening

Cost

Table 3.3 provides planning level cost estimates for each lane configuration. All estimates include a cantilevered structure within the most constrained portion of the corridor (RP 140.6± to RP 141.2±).

Table 3.3 Planning Level Cost Estimates for Alignment 2 Lane Configurations

Configuration[1]	Planning Level Estimate of Costs[2]
Two-Lane Configuration	$35.9M to $59.1M
3-2-3-4 Configuration	$48.0M to $86.8M
Reverse 3-2-3-4 Configuration	$48.0M to $86.8M
4-2-4 Configuration	$57.2M to $90.9M
Four-Lane Configuration	$65.0M to $110.2M

Source: DOWL HKM, 2012.
(1) Cantilevered structure assumed within most constrained portion of corridor (RP 140.6± to RP 141.2±).
(2) Estimates indicate capital construction costs for roadway reconstruction, including replacement of the existing South Fork Flathead River Bridge and construction of a dedicated bicycle/pedestrian facility. Costs reflect planning level estimates, and should not be considered an actual cost encompassing all scenarios and circumstances. Estimates do not include potential costs associated with right-of-way acquisition, utility relocation, preliminary engineering, or operations and maintenance. Cost estimate tables are provided in Appendix 2.

Operations

Traffic conditions on transportation facilities are commonly evaluated using the Level of Service (LOS) concept. The Highway Capacity Manual (HCM) 2010 defines LOS as a classification of performance measured on an A to F scale, with LOS A representing the best operating conditions from the traveler's perspective and LOS F representing the worst. Within the study corridor, US 2 falls under the HCM classification of a Class II two-lane highway. Class II two-lane highways commonly pass through rugged or scenic areas where motorists do not necessarily expect to travel at high speeds. The HCM defines LOS for Class II two-lane highway on the basis of the "percent time-spent-following" (PTSF) concept. PTSF represents the freedom to maneuver and the comfort and convenience of travel. It reflects the average percentage of time that vehicles must travel in platoons behind slower vehicles due to an inability to pass. As more drivers are caught in a platoon behind a slow-moving vehicle, they will desire to make more passing maneuvers. The two major factors affecting PTSF include passing capacity and passing demand. The concept of passing capacity for a two-lane highway reflects that the ability to pass is limited by the opposing traffic flow rate and the distribution of gaps within the opposing flow. The concept of passing demand reflects that the desire or demand to pass increases as the platoon of cars lengthens behind a slow-moving vehicle (i.e., as PTSF increases in a given direction). Both passing capacity and passing demand are related to flow rates. When traffic flow in both directions increases, passing demand increases and passing capacity decreases. The entire study corridor is currently striped as a no passing zone, eliminating passing opportunities and negatively affecting LOS.

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

Table 3.4 presents LOS criteria for Class II two-lane highway segments.

Table 3.4 LOS Criteria for Class II Two-lane Highways

Level of Service	Class II Two-lane Highways PTSF[1] (%)
A	≤40.0
B	>40.0 to 55.0
C	>55.0 to 70.0
D	>70.0 to 85.0
E	>85
F	Demand Exceeds Capacity

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

Highway Capacity Software (HCS) Version 2010 was used to analyze LOS for a Class II two-lane highway in the corridor. Appendix 4 includes HCS analysis worksheets.

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

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

Table 3.5 presents the predicted results of the Class II two-lane highway operational analysis for peak season and adjusted annual average (2035) conditions for an average week (Monday – Sunday). Analysis results assume the entire corridor would remain striped as a no passing zone. Results for morning, evening, and off-peak hours are reported.

Table 3.5 Class II Two-lane Highway Operational Analysis Results (2035)

Analysis Period		Existing 2-Lane Section RP 140.0 to RP 142.4	
		PTSF(1) (%)	LOS
Peak Season	AM Peak Hour EB	84.4	D
	AM Peak Hour WB	71.6	D
	Median Off-Peak Hour EB	81.9	D
	Median Off-Peak Hour WB	77.2	D
	PM Peak Hour EB	75.4	D
	PM Peak Hour WB	89.4	E
Adjusted Annual Average	AM Peak Hour EB	69.8	C
	AM Peak Hour WB	57.8	C
	Median Off-Peak Hour EB	69.1	C
	Median Off-Peak Hour WB	65.1	C
	PM Peak Hour EB	60.0	C
	PM Peak Hour WB	75.5	D

Source: DOWL HKM, 2011.
(1) Percent time-spent-following

The MDT Traffic Engineering Manual identifies the minimum desirable LOS for a principal arterial facility in rolling terrain as LOS B. Using this criterion, the US 2 corridor is predicted to operate at an undesirable LOS C to LOS E by 2035, depending on the hour, direction, and season.

The capacity of a highway corridor is governed by its narrowest cross section. Passing lanes provided at regular intervals in each direction of travel can improve LOS by decreasing PTSF. PTSF is improved by allowing platoons in the direction of the passing lane to disperse through unrestricted passing for the length of the passing lane. Passing lanes can eliminate the formation of long platoons behind a slower-moving vehicle and provide operational benefits for some distance downstream before PTSF returns to its former level (without the passing lane). This is described as the downstream effect. Passing lanes currently exist outside the study area at both ends of the corridor, however their downstream effect is partially negated due to slower speed limits within the communities of Columbia Heights and Hungry Horse.

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.

The HCM defines LOS for multilane highways on the basis of density. Density is defined as 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 3.6 presents LOS criteria for multilane highway segments.

Table 3.6 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.

The following sections discuss predicted operations for each lane configuration. A dedicated WB left-turn bay at Berne Memorial Park (RP 140.9±) could be incorporated with any of the lane configurations. A left-turn bay would provide incremental operational improvements only for WB traffic volumes. Appendix 4 includes HCS analysis worksheets indicating predicted operations with and without a WB left-turn bay at Berne Memorial Park.

Two-Lane Configuration

A two-lane configuration with shoulders in accordance with current MDT design standards would provide no improvement in LOS compared to the existing two-lane configuration. Although shoulders would likely improve safety in the corridor, they would not improve passing conditions, PTSF, or LOS values.

Three-Lane / Two-Lane Configuration with Four-Lane South Fork Flathead River Bridge

Table 3.7 presents the predicted operations of a 3-2-3-4 configuration in 2035. A 3-2-3-4 configuration would improve corridor operations by at least one LOS value in both directions during peak and off-peak hours of the day. The corridor is generally predicted to operate at an acceptable LOS A or B during most times of the year, and narrowly exceed the LOS C threshold in the peak season during the AM peak hour in the EB direction and the PM peak hour in the WB direction by 2035.

A 3-2-3-4 configuration would result in an improvement over the existing two-lane configuration by providing passing lanes in each direction before traffic volumes enter the most constrained portion of the corridor, allowing vehicle queues to disperse. The portion of the corridor from RP 140.0 to RP 142.0± can be assessed as a single segment due to the downstream effect created by the passing lanes in the 3-2-3-4 configuration.

Table 3.7 Projected Operational Analysis Results: 3-2-3-4 Configuration (2035)

Analysis Period		Existing 2-Lane Section RP 140.0 to RP 142.4 PTSF(1) (%)	Existing 2-Lane Section RP 140.0 to RP 142.4 LOS	3-2-3-4 Configuration RP 140.0 to RP 142.0± PTSF(1) (%)	3-2-3-4 Configuration RP 140.0 to RP 142.0± LOS	3-2-3-4 Configuration RP 142.0± to RP 142.4 Density (pc/mi/ln)(2)	3-2-3-4 Configuration RP 142.0± to RP 142.4 LOS
Peak Season	AM Peak Hour EB	84.4	D	57.0	C	8.0	A
	AM Peak Hour WB	71.6	D	45.2	B	5.4	A
	Median Off-Peak Hour EB	81.9	D	54.8	B	7.3	A
	Median Off-Peak Hour WB	77.2	D	48.9	B	6.5	A
	PM Peak Hour EB	75.4	D	49.3	B	6.0	A
	PM Peak Hour WB	89.4	E	58.8	C	10.1	A
Adjusted Annual Average	AM Peak Hour EB	69.8	C	45.0	B	4.0	A
	AM Peak Hour WB	57.8	C	34.5	A	2.7	A
	Median Off-Peak Hour EB	69.1	C	44.5	B	3.6	A
	Median Off-Peak Hour WB	65.1	C	40.8	B	3.2	A
	PM Peak Hour EB	60.0	C	38.0	A	3.1	A
	PM Peak Hour WB	75.5	D	47.6	B	5.1	A

Source: DOWL HKM, 2011.
(1) Percent time-spent-following
(2) pc/mi/ln: passenger cars per mile per lane

<u>Reverse Three-Lane / Two-Lane Configuration with Four-Lane South Fork Flathead River Bridge</u>

Table 3.8 presents the predicted operations of a reverse 3-2-3-4 configuration in 2035. A reverse 3-2-3-4 configuration would improve corridor operations by at least one LOS value where passing locations are provided after traffic volumes leave the most constrained portion of the corridor (RP 140.0 to 140.6± in the WB direction and RP 141.2± to 142.4 in the EB direction). No improvement over the existing two-lane configuration would be provided before (i.e., headed into) or within the canyon. The location of the passing lanes in the reverse 3-2-3-4 configuration creates a downstream effect extending outside the study corridor. The portion of the corridor from RP 140.0 to RP 142.0± is assessed as three separate segments due to the three distinct operational conditions created by the passing lane locations.

Table 3.8 Projected Operational Analysis Results: Reverse 3-2-3-4 Configuration (2035)

Analysis Period		Existing 2-Lane Section		Reverse 3-2-3-4 Configuration							
		RP 140.0 to RP 142.4		RP 140.0 to RP 140.6±		RP 140.6± to RP 141.2±		RP 141.2± to RP 142.0±		RP 142.0± to RP 142.4	
		PTSF(1) (%)	LOS	PTSF(1) (%)	LOS	PTSF(1) (%)	LOS	PTSF(1) (%)	LOS	Density (pc/mi/ln)(2)	LOS
Peak Season	AM Peak Hour EB	84.4	D	84.4	D	84.4	D	52.3	B	8.0	A
	AM Peak Hour WB	71.6	D	43.7	B	71.6	D	71.6	D	5.4	A
	Median Off-Peak Hour EB	81.9	D	81.9	D	81.9	D	50.8	B	7.3	A
	Median Off-Peak Hour WB	77.2	D	47.1	B	77.2	D	77.2	D	6.5	A
	PM Peak Hour EB	75.4	D	75.4	D	75.4	D	46.0	B	6.0	A
	PM Peak Hour WB	89.4	E	55.4	C	89.4	E	89.4	E	10.1	A
Adjusted Annual Average	AM Peak Hour EB	69.8	C	69.8	C	69.8	C	42.6	B	4.0	A
	AM Peak Hour WB	57.8	C	34.7	A	57.8	C	57.8	C	2.7	A
	Median Off-Peak Hour EB	69.1	C	69.1	C	69.1	C	42.2	B	3.6	A
	Median Off-Peak Hour WB	65.1	C	39.7	A	65.1	C	65.1	C	3.2	A
	PM Peak Hour EB	60.0	C	60.0	C	60.0	C	36.0	A	3.1	A
	PM Peak Hour WB	75.5	D	46.1	B	75.5	D	75.5	D	5.1	A

Source: DOWL HKM, 2011.
(1) Percent time-spent-following
(2) pc/mi/ln: passenger cars per mile per lane

Four-Lane / Two-Lane Configuration

Table 3.9 presents the predicted operations of a 4-2-4 configuration in 2035. The four-lane portions at both ends of the corridor would provide substantial operational benefits by giving vehicles an opportunity to pass slower vehicles in both the WB and EB directions. Additionally, a 4-2-4 configuration would provide a downstream effect that would carry throughout the study corridor, resulting in improved LOS within the two-lane section from RP 140.6± to RP 141.2±. The corridor is generally predicted to operate at an acceptable LOS A or B during most times of the year, and narrowly exceed the LOS C threshold in the peak season during the PM peak hour in the WB direction by 2035.

Table 3.9 Projected Operational Analysis Results: 4-2-4 Configuration (2035)

Analysis Period		Existing 2-Lane Section		4-2-4 Configuration			
				RP 140.0 to RP 140.6± & RP 141.2± to RP 142.4		RP 140.6± to RP 141.2±	
		PTSF(1) (%)	LOS	Density (pc/mi/ln)(2)	LOS	PTSF(1) (%)	LOS
Peak Season	AM Peak Hour EB	84.4	D	8.0	A	53.4	B
	AM Peak Hour WB	71.6	D	5.4	A	44.3	B
	Median Off-Peak Hour EB	81.9	D	7.3	A	51.7	B
	Median Off-Peak Hour WB	77.2	D	6.5	A	47.8	B
	PM Peak Hour EB	75.4	D	6.0	A	46.7	B
	PM Peak Hour WB	89.4	E	10.1	A	56.7	C
Adjusted Annual Average	AM Peak Hour EB	69.8	C	4.0	A	43.1	B
	AM Peak Hour WB	57.8	C	2.7	A	35.0	A
	Median Off-Peak Hour EB	69.1	C	3.6	A	42.7	B
	Median Off-Peak Hour WB	65.1	C	3.2	A	40.1	B
	PM Peak Hour EB	60.0	C	3.1	A	36.4	A
	PM Peak Hour WB	75.5	D	5.1	A	46.6	B

Source: DOWL HKM, 2012.
(1) Percent time-spent-following
(2) pc/mi/ln: passenger cars per mile per lane

Four-Lane Configuration

Table 3.10 presents the predicted operations of a four-lane configuration in 2035. Constructing a four-lane highway would provide LOS A throughout the entire corridor within the 2035 planning horizon.

Table 3.10 Projected Operational Analysis Results: Four-Lane Configuration (2035)

Analysis Period		Existing 2-Lane Section		4-Lane Section Throughout Corridor	
		RP 140.0 to RP 142.4		RP 140.0 to RP 142.4	
		PTSF[1] (%)	LOS	Density (pc/mi/ln)[2]	LOS
Peak Season	AM Peak Hour EB	84.4	D	8.0	A
	AM Peak Hour WB	71.6	D	5.4	A
	Median Off-Peak Hour EB	81.9	D	7.3	A
	Median Off-Peak Hour WB	77.2	D	6.5	A
	PM Peak Hour EB	75.4	D	6.0	A
	PM Peak Hour WB	89.4	E	10.1	A
Adjusted Annual Average	AM Peak Hour EB	69.8	C	4.0	A
	AM Peak Hour WB	57.8	C	2.7	A
	Median Off-Peak Hour EB	69.1	C	3.6	A
	Median Off-Peak Hour WB	65.1	C	3.2	A
	PM Peak Hour EB	60.0	C	3.1	A
	PM Peak Hour WB	75.5	D	5.1	A

Source: DOWL HKM, 2012.
[1] Percent time-spent-following
[2] pc/mi/ln: passenger cars per mile per lane

Summary

Table 3.11 presents a summary of operational analysis results for all lane configurations in 2035.

Table 3.11 Summary of Projected Operational Analysis Results (2035)

Analysis Period		2-Lane Configuration[1]	3-2-3-4 Configuration[2]		Reverse 3-2-3-4 Configuration[2]				4-2-4 Configuration[2]		4-Lane Configuration
		RP 140.0 to RP 142.4	RP 140.0 to RP 142.0±	RP 142.0± to RP 142.4	RP 140.0 to RP 140.6±	RP 140.6± to RP 141.2±	RP 141.2± to RP 142.0±	RP 142.0± to RP 142.4	RP 140.0 to RP 140.6± & RP 141.2± to RP 142.4	RP 140.6± to RP 141.2±	RP 140.0 to RP 142.4
Peak Season	AM Peak Hour EB	D	C	A	D	D	B	A	A	B	A
	AM Peak Hour WB	D	B	A	B	D	D	A	A	B	A
	Median Off-Peak Hour EB	D	B	A	D	D	B	A	A	B	A
	Median Off-Peak Hour WB	D	B	A	B	D	D	A	A	B	A
	PM Peak Hour EB	D	B	A	D	D	B	A	A	B	A
	PM Peak Hour WB	E	C	A	C	E	E	A	A	C	A
Adjusted Annual Average	AM Peak Hour EB	C	B	A	C	C	B	A	A	B	A
	AM Peak Hour WB	C	A	A	A	C	C	A	A	A	A
	Median Off-Peak Hour EB	C	B	A	C	C	B	A	A	B	A
	Median Off-Peak Hour WB	C	B	A	A	C	C	A	A	B	A
	PM Peak Hour EB	C	A	A	C	C	A	A	A	A	A
	PM Peak Hour WB	D	B	A	B	D	D	A	A	B	A

Source: DOWL HKM, 2012.

[1] Analysis results for two-lane configuration assume the entire corridor would remain striped as a no passing zone.

[2] For 3-2-3-4, Reverse 3-2-3-4, and 4-2-4 configurations, range of LOS values indicates variance depending on number of lanes within each corridor segment.

Note: LOS values indicate predicted operations without a WB left-turn bay at Berne Memorial Park (RP 140.9±). A left-turn bay would provide marginal operational improvements only for WB traffic volumes. Appendix 4 includes HCS analysis worksheets indicating projected operations with and without a WB left-turn bay at Berne Memorial Park.

Level of Anticipated Impact

A two-lane configuration would provide the smallest footprint and would result in the least impacts throughout the corridor. The 3-2-3-4 and reverse 3-2-3-4 configurations would be more impactful than a two-lane configuration, although the roadway would still be limited to two travel lanes to minimize impacts in the most constrained portion of the corridor. Similarly a 4-2-4 configuration would be slightly more impactful, while still minimizing impacts within the narrowest part of the corridor. A four-lane configuration throughout the corridor would have the widest footprint and would result in the greatest level of impact.

Community Support

Two-Lane Configuration

Community members were supportive of a two-lane configuration throughout the corridor, noting this configuration would result in the fewest impacts and maintain the existing corridor character. Some concerns were expressed that a two-lane configuration with shoulders may not sufficiently improve corridor operations. Other community members noted shoulders would improve safety, and were less concerned with improving corridor operations.

3-2-3-4 and Reverse 3-2-3-4 Configurations

Community members were somewhat supportive of three-lane / two-lane configurations as these could provide operational and safety benefits while minimizing impacts within the most constrained portion of the corridor. Some community members perceived a three-lane / two-lane combination may be an appropriate compromise given the competing environmental, cultural/historical, safety, and operational issues and concerns in the corridor.

4-2-4 and Four-Lane Configurations

Less community support was expressed for a 4-2-4 configuration or a four-lane configuration throughout the corridor. Potential improvements in corridor safety and operations provided by four-lane sections were not perceived to justify the additional impacts to environmental and cultural/historical resources that would result from a wider footprint. Four travel lanes throughout the corridor received the least support.

Screening Summary

Table 3.12 summarizes the lane configuration screening. Orange shading indicates failure to pass a screening criterion. Based on failure to meet criteria relating to cost, operations, anticipated level of impact, and community support, the two-lane, reverse 3-2-3-4, and four-lane configurations are eliminated from further consideration and will not be discussed further in this report. 3-2-3-4 and 4-2-4 lane configurations are advanced.

Table 3.12 Screening Summary – Lane Configurations (Alignment 2)

<table>
<tr><th rowspan="2">Criteria</th><th colspan="5">Alignment 2(1)</th></tr>
<tr><th>2 Lanes Throughout Corridor</th><th>3-2-3-4</th><th>Reverse 3-2-3-4</th><th>4-2-4</th><th>Four Lanes Throughout Corridor</th></tr>
<tr><td>Planning Level Estimate of Costs(2)</td><td>$35.9M to $59.1M</td><td>$48.0M to $86.8M</td><td>$48.0M to $86.8M</td><td>$57.2M to $90.9M</td><td>$64.6M to $110.2M</td></tr>
<tr><td>Operations
Anticipated Level of Service - 2035(3)</td><td>C to E</td><td>A to C(4)</td><td>A to E(5)</td><td>A to C(4)</td><td>A</td></tr>
<tr><td rowspan="2">Level of Anticipated Impact(6)</td><td rowspan="2">Least Impacts</td><td colspan="3">Moderate Impacts</td><td rowspan="2">Most Impacts</td></tr>
<tr><td colspan="2">Less</td><td>More</td></tr>
<tr><td>Community Support(7)</td><td>Most Support</td><td>Some Support</td><td>Some Support</td><td>Some Support</td><td>Least Support</td></tr>
<tr><td>Recommendation</td><td>Eliminate from Further Consideration</td><td>Advance</td><td>Eliminate from Further Consideration</td><td>Advance</td><td>Eliminate from Further Consideration</td></tr>
</table>

Source: DOWL HKM, 2012.
Note: Shading indicates failure to meet criteria.

(1) Cantilevered structure included within the most constrained portion of corridor (RP 140.6± to RP 141.2±).

(2) Estimates indicate capital construction costs for roadway reconstruction, including replacement of the existing South Fork Flathead River Bridge and construction of a dedicated bicycle/pedestrian facility. Costs reflect planning level estimates, and should not be considered an actual cost encompassing all scenarios and circumstances. Estimates do not include potential costs associated with right-of-way acquisition, utility relocation, preliminary engineering, or operations and maintenance. Cost estimate tables are provided in Appendix 2.

(3) LOS ranges reflect values within the AM and PM peak hour and median off-peak hour during peak season and adjusted annual average conditions. Additional detail is provided in Appendix 4.

(4) Configurations narrowly exceed the LOS C threshold during the peak hour of the peak season; LOS A and B are anticipated throughout the rest of the year.

(5) Reverse 3-2-3-4 improves LOS for the direction of travel outside of and heading away from the most constrained portion of the corridor (as indicated by LOS A), but does not improve LOS before or within the most constrained portion of the corridor (as indicated by LOS E).

(6) Level of anticipated impact is based on lane configuration footprint. Further analysis would be required during project development to identify specific impacts.

(7) Indication of community support is based on feedback provided during informational meetings held in Columbia Falls and Hungry Horse and written comments submitted during the study.

4.0 SUMMARY OF RECOMMENDED IMPROVEMENT OPTIONS

The US 2 – Badrock Canyon Corridor Planning Study has confirmed FEIS findings that construction of a grade-separated structure, a tunnel, and new alignments north and south of the existing US 2 alignment are not reasonable options based on cost, constructability, impacts, right-of-way, and community support screening criteria.

The planning study recommends reconstruction of the corridor along Alignment 2 (Optimized Existing Alignment) with either a 3-2-3-4 or 4-2-4 configuration, using a two-lane cantilevered structure within the most constrained portion of the corridor (RP 140.6± to RP 141.2±) and a four-lane South Fork Flathead River Bridge. A two-lane cantilevered structure could be used to avoid rock excavation and minimize the roadway footprint within the narrowest part of the corridor. Shoulders and improved geometry are expected to reduce safety concerns throughout the corridor. A dedicated bicycle/pedestrian facility would improve non-motorized access in the corridor. A four-lane South Fork Flathead River Bridge would provide flexibility during the design life of the structure to allow future roadway widening if necessary through the corridor. The three- or four-lane sections at the eastern and western ends of the corridor would provide passing opportunities and allow vehicle queues to disperse before entering the most constrained area. The corridor is generally predicted to operate at an acceptable LOS A or B during most times of the year, narrowly exceeding the LOS C threshold during the peak hour of the peak season by 2035. Although this planning study confirms FEIS findings that a four-lane configuration is needed to provide LOS B or better at all times of the day and year, a design exception could be considered to balance the need to improve corridor safety and operations with the need to minimize adverse impacts to resources in the corridor.

Full reconstruction of the corridor is recommended for long-term consideration within the 2035 planning horizon. Phasing may be appropriate to allow funding identification for construction of shorter segments within the corridor. Replacement of the existing South Fork Flathead River Bridge with a new four-lane bridge could be pursued first, followed by reconstruction of the western (RP 140.0 to RP 140.6±) and eastern (141.2± to RP 142.0±) ends of the corridor with three-lane sections. The most constrained portion of the corridor (RP 140.6± to RP 141.2±) could be addressed last using a two-lane cantilevered structure.

In the interim period before corridor wide reconstruction (Alignment 2), other short-, mid-, or long-term, options could be implemented along the existing US 2 alignment (Alignment 1) to provide incremental improvements in safety and corridor access. Several Alignment 1 improvements, including parking, rockfall prevention and a new South Fork Flathead River Bridge, are considered stand-alone options that would remain if Alignment 2 reconstruction is pursued at a later date. All other Alignment 1 options may need to be modified or replaced if Alignment 2 roadway reconstruction is pursued. Some of the identified Alignment 1 improvements represent substantial transportation system investments. If Alignment 1 improvements are forwarded from this study, compatibility with future corridor reconstruction should be considered.

Implementation of corridor improvement options is dependent on funding availability and other system priorities. Recommended timeframes for implementation are defined as follows:

- Short-term: Implementation recommended within 1- to 5-year period
- Mid-term: Implementation recommended within 6- to 10-year period
- Long-term: Implementation recommended within 11- to 20-year period

Table 4.1 provides a menu of recommended improvements for consideration in the corridor. Implementation of all options is not anticipated. Selection of some options may preclude implementation of others.

Table 4.1 Menu of Recommended Improvements

Recommended Improvement			Possible Locations	Planning Level Estimate of Costs(4)	Recommended Implementation Timeframe(5)	Potentially Impacted Resources / RW Requirements
Alignment 1 Improvements	Access Management(1)	Install Concrete Barrier	RP 140.8± to RP 141.0± (South Side of US 2)	$100,000 to $150,000	Short-term	No
	Bicycle/ Pedestrian Facilities(1)	Construct Dedicated Bicycle/Pedestrian Facility	Throughout Corridor (North Side of US 2)	$3.6M to $6.6M	Mid-term to long-term	Yes
		Construct Bicycle/Pedestrian Overcrossing	RP 140.8± (North & South Sides of US 2)	$1.0M to $2.5M		Yes
	Drainage(1)	Install Culverts	RP 140.8±; RP 141.1±; RP 141.2±; RP 142.0± (North & South Sides of US 2)	$4,000 to $10,000 per location	Short-term to mid-term	No
		Re-grade Ditches	RP 140.8±; RP 140.9±; RP141.8± (South Side of US 2)	$1,000 to $15,000 per location		No
		Install Valley Gutter	RP 141.0± (South Side of US 2)	$3,000 to $5,000		No
	Parking(2)	Construct Parking Lot	RP 140.2± (North Side of US 2)	$400,000 to $500,000		Yes
	Roadside Safety(1)	Install Guardrail with End Treatments	RP 140.3±; RP 141.9±; RP 142.3±(North & South Sides of US 2)	$3,000 to $5,000 per location		No
	Rockfall Prevention(1)	Install Wire Mesh Stabilization Fence	RP 140.7±; RP 141.1± (South Side of US 2)	$200,000 to $1.0M per location		Yes
	Rumble Strips(1)	Install Shoulder and Centerline Rumble Strips	Throughout Corridor	$2,100 to $2,700 per mile		No
	Sight Distance(1)	Remove Vegetation	RP 140.9±; RP 141.3±; RP 142.0± (North & South Sides of US 2)	$9,000 to $30,000		Yes
	South Fork Flathead River Bridge(2)	Reconstruct South Fork Flathead River Bridge	RP 142.1	$9.7M to $27.3M		Yes
	Traffic Control(1)	Install Static Sign	RP 140.0±; RP 140.2±; RP 140.4±; RP 140.6±; RP 141.0±; RP 141.1±; RP 142.4± (North & South Sides of US 2)	$500 to $1,000 per location		No
		Install Variable Message Sign	RP 140.0±; RP 142.3± (North & South Sides of US 2)	$20,000 to $250,000 per location		No
	Wildlife Passage(1)	Wildlife Undercrossing	RP 140.2± (North & South Sides of US 2)	$920,000 to $1.1M		Yes
Roadway Reconstruction(3) (Alignment 2)		Construct 3-2-3-4 Configuration	Throughout Corridor	$48.0M to $86.8M	Long-term	Yes
		Construct 4-2-4 Configuration	Throughout Corridor	$57.2M to $90.9M	Long-term	Yes

Source: DOWL HKM, 2012. (1)Improvements may need to be modified or replaced if Alignment 2 reconstruction is pursued at a later date.

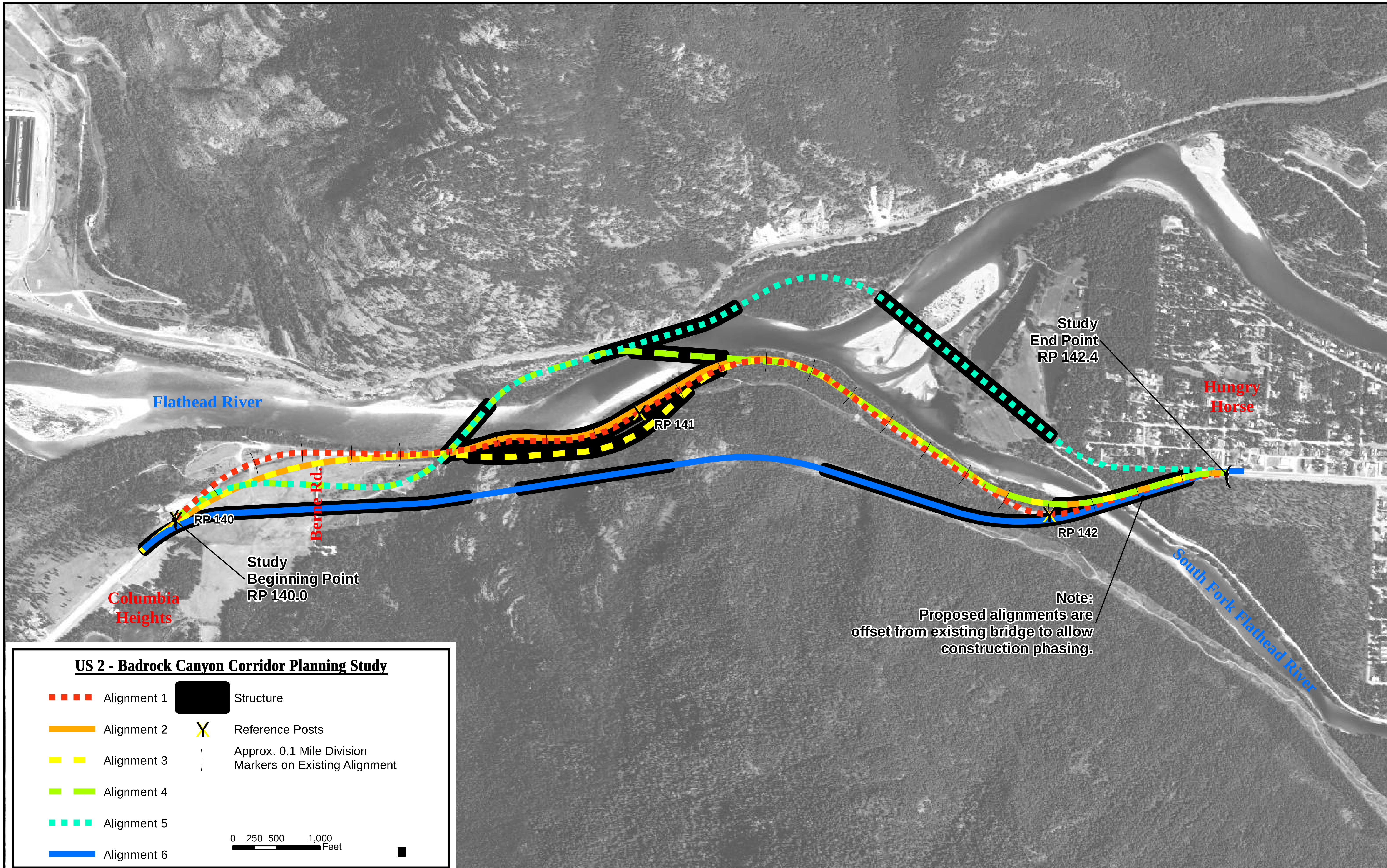
(2) Stand-alone improvements could remain if Alignment 2 reconstruction is pursued at a later date.

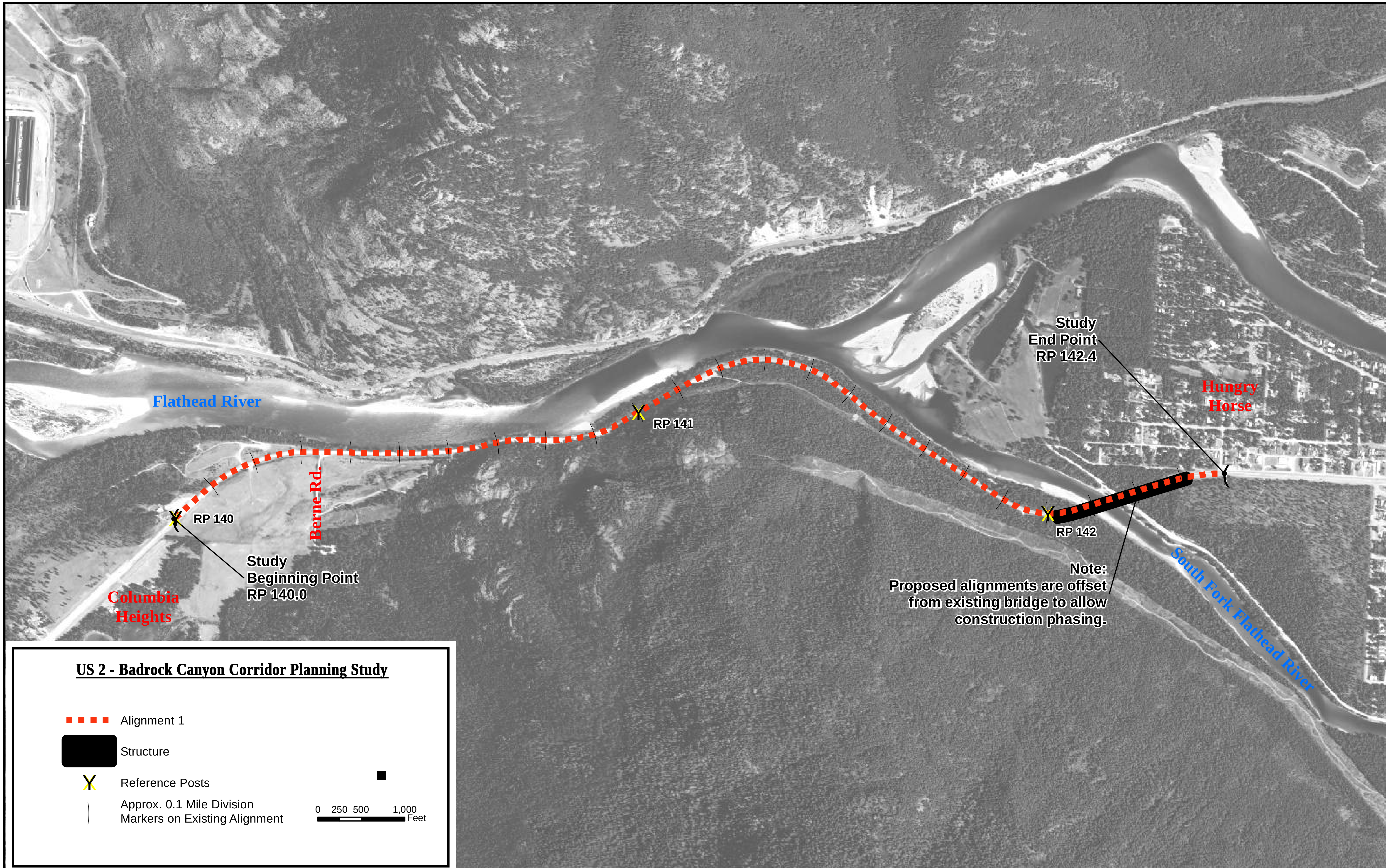
(3) Roadway reconstruction costs include replacement of the existing South Fork Flathead River Bridge with a new four-lane structure. Roadway reconstruction would be less costly if the South Fork Flathead River Bridge is replaced separately as part of an Alignment 1 improvement.

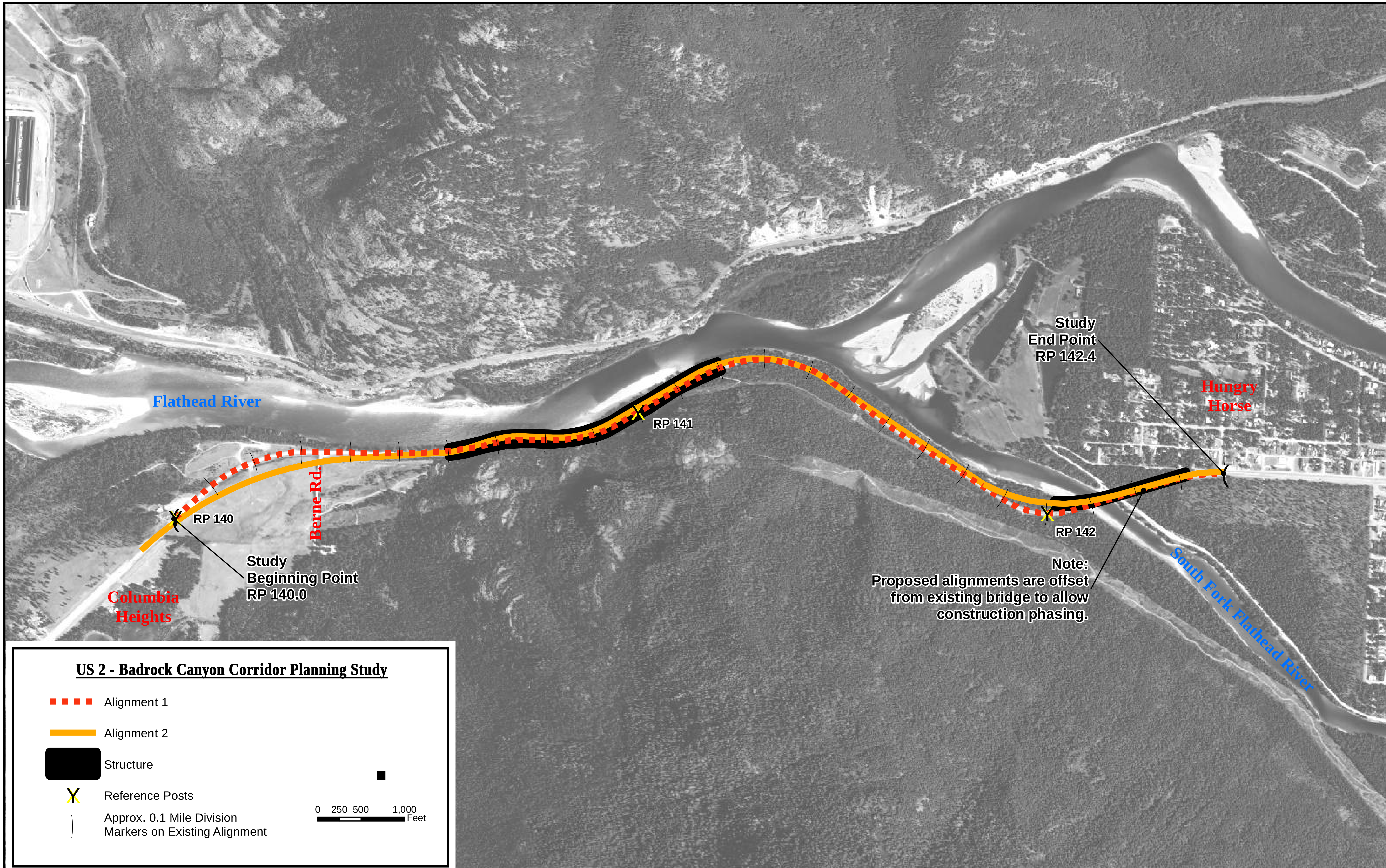
[4] Costs reflect planning level estimates, and should not be considered an actual cost encompassing all scenarios and circumstances. Estimates do not include potential costs associated with right-of-way acquisition, utility relocation, preliminary engineering, or operations and maintenance. Cost estimate tables are provided in Appendix 2.[5] Recommended implementation timeframe does not indicate when projects will be programmed or implemented. Project programming is based on available funding and other system priorities. Short-term: Implementation is recommended within a 1- to 5-year period; Mid-term: Implementation is recommended within a 6- to 10-year period; Long-term: Implementation is recommended within a 11- to 20-year period.

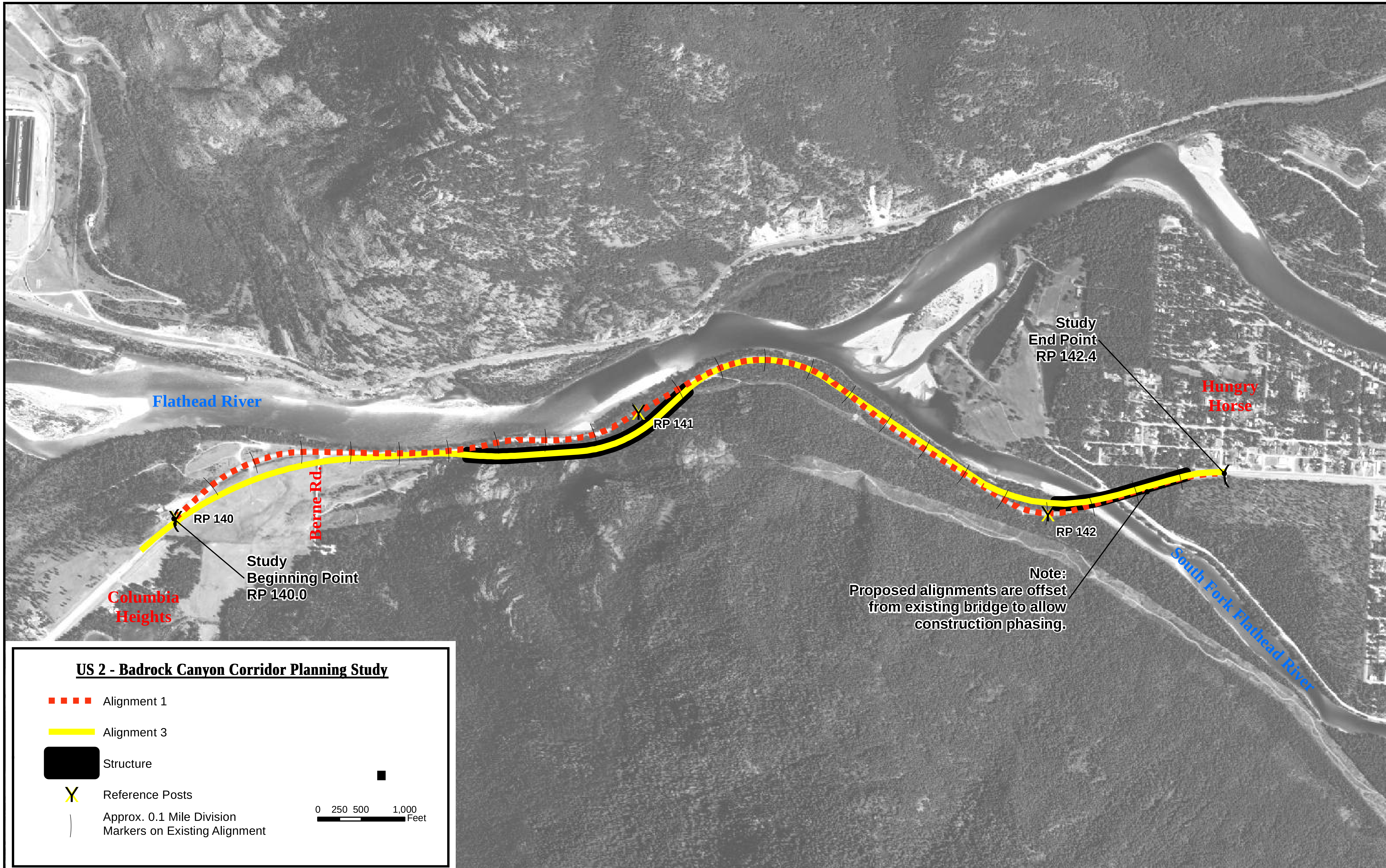
Appendix 1

Alignment Figures

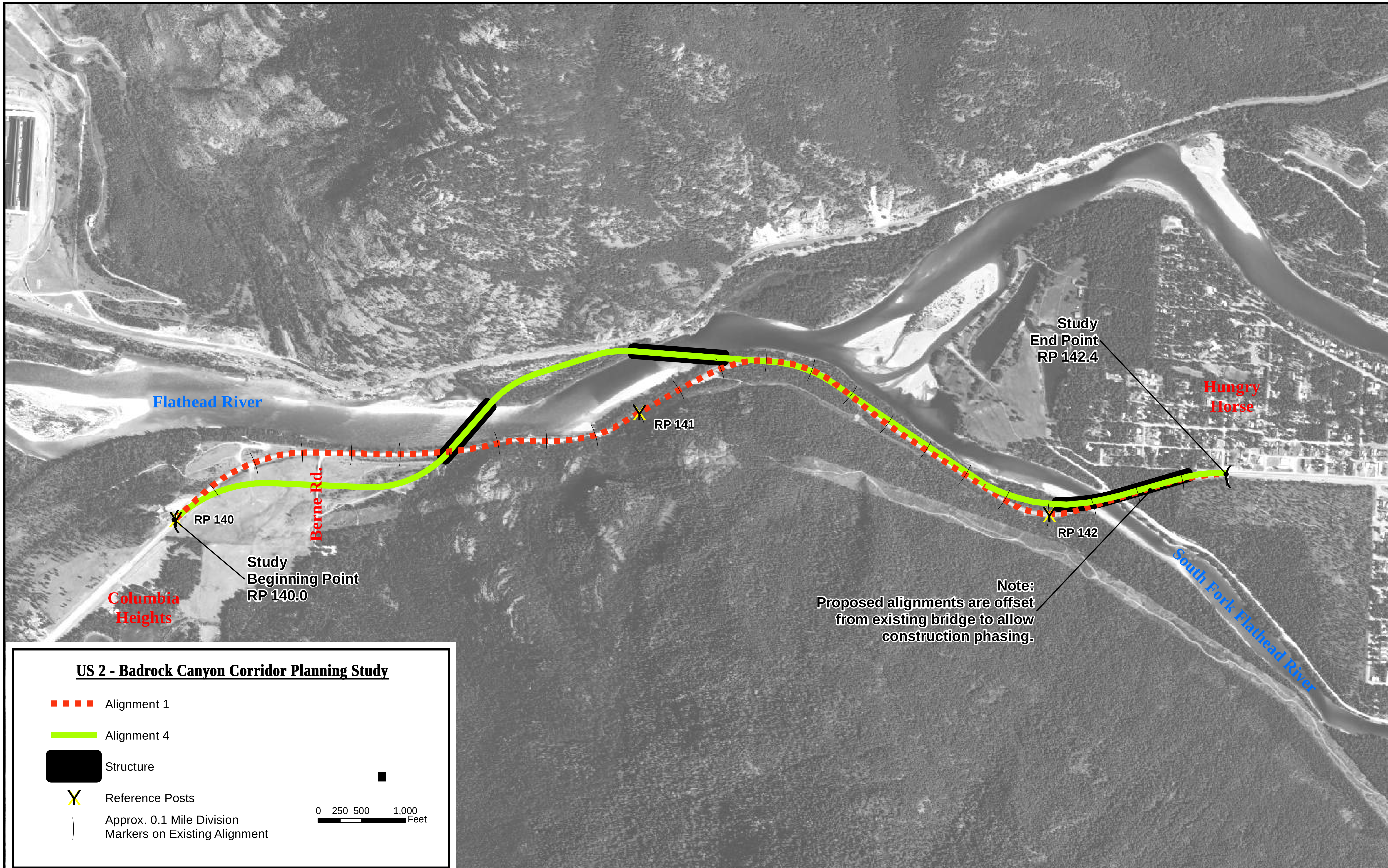

US 2 - Badrock Canyon Corridor Planning Study
Alignment 1
Alignment 2
Alignment 3
Alignment 4
Alignment 5
Alignment 6
Structure
Reference Posts
Approx. 0.1 Mile Division
Markers on Existing Alignment
0 250 500 1,000
Feet
Flathead River
Berne Rd.
Columbia
Heights
Hungry
Horse
South Fork Flathead River
RP 140
RP 141
RP 142
Study
Beginning Point
RP 140.0
Study
End Point
RP 142.4
Note:
Proposed alignments are
offset from existing bridge to allow
construction phasing.


Flathead River
Study
End Point
RP 142.4
Hungry
Horse
RP 141
RP 140
Berne Rd.
RP 142
Study
Beginning Point
RP 140.0
Columbia
Heights
Note:
Proposed alignments are offset
from existing bridge to allow
construction phasing.
South Fork Flathead River
US 2 - Badrock Canyon Corridor Planning Study
Alignment 1
Structure
Reference Posts
Approx. 0.1 Mile Division
Markers on Existing Alignment
0 250 500 1,000
Feet

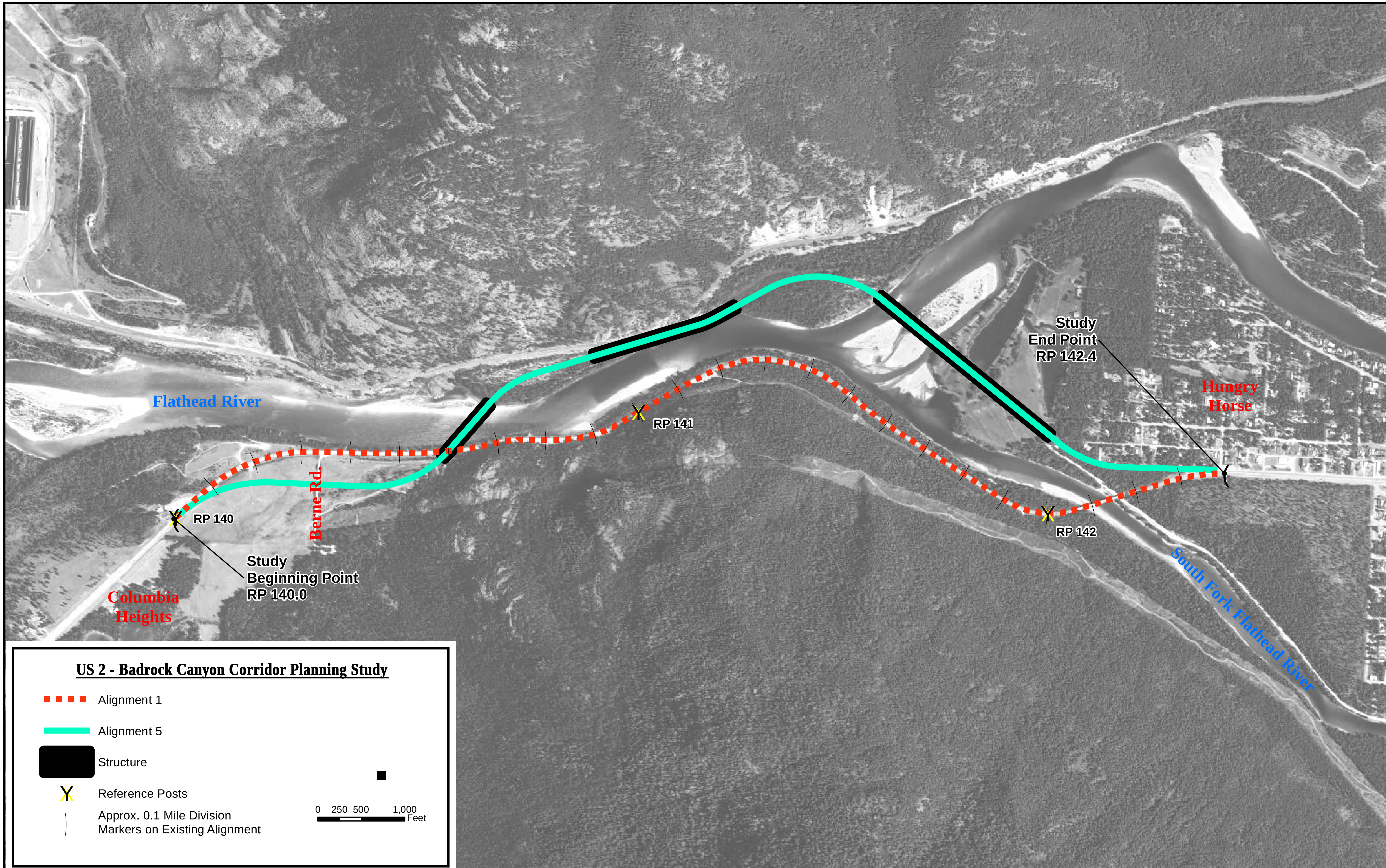

Flathead River
Columbia Heights
Berne Rd.
RP 140
RP 141
RP 142
Study Beginning Point RP 140.0
Study End Point RP 142.4
Hungry Horse
South Fork Flathead River
Note: Proposed alignments are offset from existing bridge to allow construction phasing.
US 2 - Badrock Canyon Corridor Planning Study
Alignment 1
Alignment 2
Structure
Reference Posts
Approx. 0.1 Mile Division Markers on Existing Alignment
0 250 500 1,000
Feet



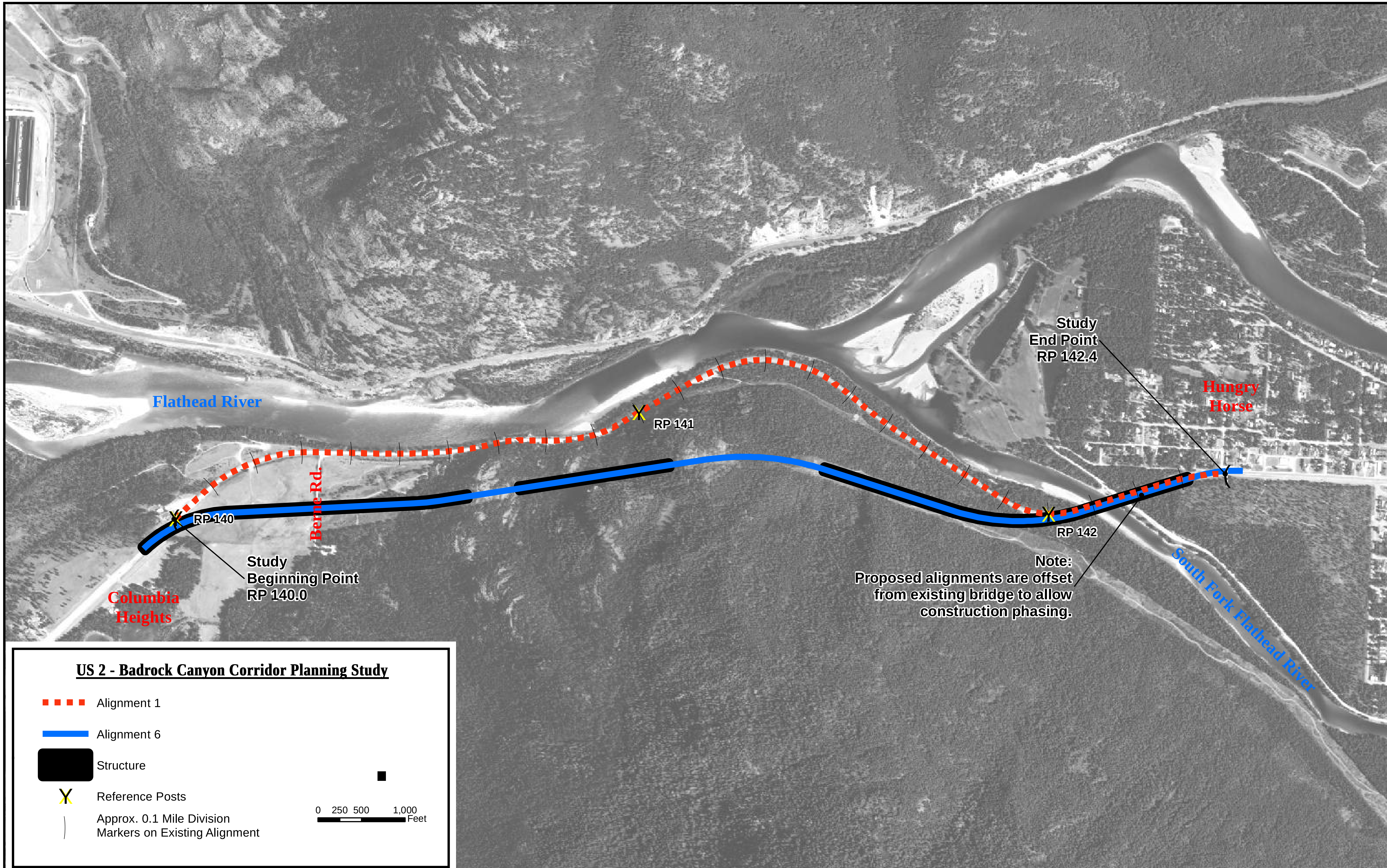
Flathead River
Study
End Point
RP 142.4
Hungry
Horse
RP 141
RP 140
Berne Rd.
RP 142
Study
Beginning Point
RP 140.0
Columbia
Heights
Note:
Proposed alignments are offset
from existing bridge to allow
construction phasing.
South Fork Flathead River
US 2 - Badrock Canyon Corridor Planning Study
Alignment 1
Alignment 3
Structure
Reference Posts
Approx. 0.1 Mile Division
Markers on Existing Alignment
0 250 500 1,000
Feet



Flathead River
Study
End Point
RP 142.4
Hungry
Horse
RP 141
RP 140
Berne Rd.
RP 142
Study
Beginning Point
RP 140.0
Columbia
Heights
Note:
Proposed alignments are offset
from existing bridge to allow
construction phasing.
South Fork Flathead River
US 2 - Badrock Canyon Corridor Planning Study
Alignment 1
Alignment 4
Structure
Reference Posts
Approx. 0.1 Mile Division
Markers on Existing Alignment
0 250 500 1,000
Feet



Flathead River
Study
End Point
RP 142.4
Hungry
Horse
RP 141
RP 140
Berne Rd.
RP 142
Study
Beginning Point
RP 140.0
Columbia
Heights
South Fork Flathead River
US 2 - Badrock Canyon Corridor Planning Study
Alignment 1
Alignment 5
Structure
Reference Posts
Approx. 0.1 Mile Division
Markers on Existing Alignment
0 250 500 1,000
Feet


Flathead River
Berne Rd.
Columbia Heights
Hungry Horse
South Fork Flathead River
RP 140
RP 141
RP 142
Study Beginning Point RP 140.0
Study End Point RP 142.4
Note: Proposed alignments are offset from existing bridge to allow construction phasing.
US 2 - Badrock Canyon Corridor Planning Study
Alignment 1
Alignment 6
Structure
Reference Posts
Approx. 0.1 Mile Division Markers on Existing Alignment
0 250 500 1,000
Feet

Appendix 2

Cost Estimate Spreadsheets

US 2 - BADROCK CANYON CORRIDOR PLANNING STUDY - ALIGNMENT 2
TWO LANES THROUGHOUT CORRIDOR
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-LANE ROAD (FULL RECONSTRUCT)						
EXCAVATION-UNCLASS BORROW	515.00	CUYD	$4.67	$2,405.00		$2,405.00
EMBANKMENT IN PLACE	160.00	CUYD	$6.83	$1,093.00		$1,093.00
CRUSHED AGGREGATE COURSE	345.00	CUYD	$18.79	$6,483.00		$6,483.00
COVER - TYPE 2	445.00	SQYD	$0.51	$227.00		$227.00
DUST PALLIATIVE	1.00	TON		$0.00	$120.00	$120.00
PLANT MIX BIT SURF GR S-3/4 IN	125.00	TON	$25.37	$3,171.00		$3,171.00
ASPHALT CEMENT PG 64 64-28	7.00	TON	$674.59	$4,722.00		$4,722.00
EMULS ASPHALT CRS-2P	1.00	TON	$578.92	$579.00		$579.00
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-LANE ROAD (FULL RECONSTRUCT) SUBTOTAL				$18,805.00		$18,925.00
GUARD RAIL-STEEL/7 FOOT POSTS	500.00	LNFT	$30.20	$15,100.00		$15,100.00
REGRADE APPROACH ROAD CONNECTION	1.00	EACH		$0.00	$10,000.00	$10,000.00
REGRADE APPROACHES	12.00	EACH		$0.00	$1,000.00	$12,000.00
CATEGORY	**LENGTH (STA.)**	**COST PER STATION**			**SUBTOTAL**	
TWO-LANE ROAD (FULL RECONSTRUCT)	112.70	$18,925.00			$2,100,000	
CATEGORY	**LENGTH (FT.)**	**WIDTH (FT.)**	**COST PER SQUARE FOOT [4]**		**SUBTOTAL**	
CANTILEVER CONSTRUCTION (TWO-LANE)	1,850.00	41.50	$125.00		$9,600,000	
	APPROX. QUANTITY	**UNIT**	**UNIT PRICE**			
EXCAVATION-UNCLASS BORROW	11,000.00	CUYD	$4.67		$51,400.00	
EMBANKMENT IN PLACE	2,665.00	CUYD	$6.83		$18,200.00	
RETAINING WALL	28,710.00	SQFT	$50.00		$1,400,000.00	
CANTILEVER CONSTRUCTION (TWO-LANE) SUBTOTAL					$11,100,000.00	
CATEGORY	**LENGTH (FT.)**	**WIDTH (FT.)**	**COST PER SQUARE FOOT [5]**		**SUBTOTAL**	
SOUTH FORK BRIDGE CONSTRUCTION						
STRUCTURE (TWO-LANE)	655.00	43.00	$175.00		$4,900,000	
STRUCTURE COST SUBTOTAL					$16,000,000	
SUBTOTAL 1					$18,100,000	
ADDITIONAL COSTS						
MISCELLANEOUS @ 20% OF SUBTOTAL 1 [6]					20%	$3,600,000
MOBILIZATION @ 18% OF SUBTOTAL 1 [7]					18%	$3,300,000
CONSTRUCTION ENGINEERING @ 15% OF SUBTOTAL 1					15%	$2,700,000
SUBTOTAL 2						$27,700,000
INDIRECT COST (IDC) - CONSTRUCTION @ 9.64% OF SUBTOTAL 2 [8]					9.64%	$2,700,000
CONTINGENCY @ 20% & 50% OF SUBTOTAL 2 [9]					20%	$5,500,000
					50%	$13,900,000
TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [10]					**$35,900,000**	
TOTAL IMPROVEMENT OPTION COST @ 50% CONTINGENCY [10]					**$44,300,000**	

[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 planning level cost for a cantilever deck was estimated at $125 per square foot based on average MDT bridge costs and construction sequencing.
[5] Planning level costs for simple bridge structures range on average between $110 and $175 per square foot. A conservative estimate of $175 per square foot was utilized for this structure.
[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 50 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

US 2 - BADROCK CANYON CORRIDOR PLANNING STUDY - ALIGNMENT 2
TWO LANES THROUGHOUT CORRIDOR WITH DEDICATED BICYCLE/PEDESTRIAN FACILITY
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
TWO-LANE ROAD (FULL RECONSTRUCT)						
EXCAVATION-UNCLASS BORROW	515.00	CUYD	$4.67	$2,405.00		$2,405.00
EMBANKMENT IN PLACE	160.00	CUYD	$6.83	$1,093.00		$1,093.00
CRUSHED AGGREGATE COURSE	345.00	CUYD	$18.79	$6,483.00		$6,483.00
COVER - TYPE 2	445.00	SQYD	$0.51	$227.00		$227.00
DUST PALLIATIVE	1.00	TON		$0.00	$120.00	$120.00
PLANT MIX BIT SURF GR S-3/4 IN	125.00	TON	$25.37	$3,171.00		$3,171.00
ASPHALT CEMENT PG 64 64-28	7.00	TON	$674.59	$4,722.00		$4,722.00
EMULS ASPHALT CRS-2P	1.00	TON	$578.92	$579.00		$579.00
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-LANE ROAD (FULL RECONSTRUCT) SUBTOTAL				$18,805.00		$18,925.00
GUARD RAIL-STEEL/7 FOOT POSTS	500.00	LNFT	$30.20	$15,100.00		$15,100.00
REGRADE APPROACH ROAD CONNECTION	1.00	EACH		$0.00	$10,000.00	$10,000.00
REGRADE APPROACHES	12.00	EACH		$0.00	$1,000.00	$12,000.00
CATEGORY	**LENGTH (STA.)**	**COST PER STATION**			**SUBTOTAL**	
TWO-LANE ROAD (FULL RECONSTRUCT)	111.10	$18,925.00			$2,100,000	
DEDICATED BICYCLE/PEDESTRIAN FACILITY	11.20	$2,767.00			$31,000	
CONCRETE BARRIER RAIL	126.72	$7,060.00			$895,000	
CATEGORY	**LENGTH (FT.)**	**WIDTH (FT.)**	**COST PER SQUARE FOOT [4]**		**SUBTOTAL**	
CANTILEVER CONSTRUCTION (TWO-LANE)	1,975.00	53.50	$125.00		$13,210,000	
	APPROX. QUANTITY	**UNIT**	**UNIT PRICE**			
EXCAVATION-UNCLASS BORROW	14,000.00	CUYD	$4.67		$65,400.00	
EMBANKMENT IN PLACE	7,200.00	CUYD	$6.83		$49,200.00	
RETAINING WALL	30,200.00	SQFT	$50.00		$1,500,000.00	
CANTILEVER CONSTRUCTION (TWO-LANE) SUBTOTAL					$14,800,000.00	
CATEGORY	**LENGTH (FT.)**	**WIDTH (FT.)**	**COST PER SQUARE FOOT [5]**		**SUBTOTAL**	
SOUTH FORK BRIDGE CONSTRUCTION						
STRUCTURE (TWO-LANE)	655.00	55.00	$175.00		$6,300,000	
STRUCTURE COST SUBTOTAL					$21,100,000	
SUBTOTAL 1					$24,200,000	
ADDITIONAL COSTS						
MISCELLANEOUS @ 20% OF SUBTOTAL 1 [6]					20%	$4,800,000
MOBILIZATION @ 18% OF SUBTOTAL 1 [7]					18%	$4,400,000
CONSTRUCTION ENGINEERING @ 15% OF SUBTOTAL 1					15%	$3,600,000
SUBTOTAL 2						$37,000,000
INDIRECT COST (IDC) - CONSTRUCTION @ 9.64% OF SUBTOTAL 2 [8]					9.64%	$3,600,000
CONTINGENCY @ 20% & 50% OF SUBTOTAL 2 [9]					20%	$7,400,000
					50%	$18,500,000
TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [10]					**$48,000,000**	
TOTAL IMPROVEMENT OPTION COST @ 50% CONTINGENCY [10]					**$59,100,000**	

[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 planning level cost for a cantilever deck was estimated at $125 per square foot based on average MDT bridge costs and construction sequencing.
[5] Planning level costs for simple bridge structures range on average between $110 and $175 per square foot. A conservative estimate of $175 per square foot was utilized for this structure.
[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 50 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.

US 2 - BADROCK CANYON CORRIDOR PLANNING STUDY - ALIGNMENT 2
TWO LANES THROUGHOUT CORRIDOR,
ELEVATEDTWO LANE ROADWAY STRUCTURE RP 140.6 - RP 141.2
Planning Level Estimate of Costs

Item Description	Approx. Quantity (Per Station) [1]	Unit	Average Bid Prices [2] Unit Price Dollars	Average Bid Prices Amount Dollars	Adjusted Unit Prices Unit Price Dollars	Adjusted Unit Prices Amount [3] Dollars
TWO-LANE ROAD (FULL RECONSTRUCT)						
EXCAVATION-UNCLASS BORROW	515.00	CUYD	$4.67	$2,405.00		$2,405.00
EMBANKMENT IN PLACE	160.00	CUYD	$6.83	$1,093.00		$1,093.00
CRUSHED AGGREGATE COURSE	345.00	CUYD	$18.79	$6,483.00		$6,483.00
COVER - TYPE 2	445.00	SQYD	$0.51	$227.00		$227.00
DUST PALLIATIVE	1.00	TON		$0.00	$120.00	$120.00
PLANT MIX BIT SURF GR S-3/4 IN	125.00	TON	$25.37	$3,171.00		$3,171.00
ASPHALT CEMENT PG 64 64-28	7.00	TON	$674.59	$4,722.00		$4,722.00
EMULS ASPHALT CRS-2P	1.00	TON	$578.92	$579.00		$579.00
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-LANE ROAD (FULL RECONSTRUCT) SUBTOTAL				$18,805.00		$18,925.00
CATEGORY	**LENGTH (STA.)**		**COST PER STATION**		**SUBTOTAL**	
TWO-LANE ROAD (FULL RECONSTRUCT)	85.11		$18,925.00		$1,600,000	
CATEGORY	**LENGTH (FT.)**	**WIDTH (FT.)**	**COST PER SQUARE FOOT [4]**		**SUBTOTAL**	
ELEVATED STRUCTURE (TWO-LANE)	4,800.00	43.00	$175.00		$36,100,000	
SOUTH FORK BRIDGE CONSTRUCTION						
STRUCTURE (TWO-LANE)	655.00	43.00	$175.00		$4,900,000	
STRUCTURE COST SUBTOTAL					$41,000,000	
				SUBTOTAL 1	$42,600,000	
ADDITIONAL COSTS						
				MISCELLANEOUS @ 20% OF SUBTOTAL 1 [5]	20%	$8,500,000
				MOBILIZATION @ 18% OF SUBTOTAL 1 [6]	18%	$7,700,000
				CONSTRUCTION ENGINEERING @ 15% OF SUBTOTAL 1	15%	$6,400,000
				SUBTOTAL 2		$65,200,000
				INDIRECT COST (IDC) - CONSTRUCTION @ 9.64% OF SUBTOTAL 2 [7]	9.64%	$6,300,000
				CONTINGENCY @ 20% & 50% OF SUBTOTAL 2 [8]	20%	$13,000,000
					50%	$32,600,000
				TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [9]	**$84,500,000**	
				TOTAL IMPROVEMENT OPTION COST @ 50% CONTINGENCY [9]	**$104,100,000**	

[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] Planning level costs for simple bridge structures range on average between $110 and $175 per square foot. A conservative estimate of $175 per square foot was utilized for these structures.
[5] 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.
[6] The Mobilization category includes all costs incurred in assembling and transporting materials to the work site.
[7] 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.
[8] A contingency range of 20 to 50 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.
[9] 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

US 2 - BADROCK CANYON CORRIDOR PLANNING STUDY - ALIGNMENT 2
TWO LANES THROUGHOUT CORRIDOR,
ELEVATEDTWO LANE ROADWAY STRUCTURE RP 140.6 - RP 141.2 WITH DEDICATED
BICYCLE/PEDESTRIAN FACILITY
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
TWO-LANE ROAD (FULL RECONSTRUCT)						
EXCAVATION-UNCLASS BORROW	515.00	CUYD	$4.67	$2,405.00		$2,405.00
EMBANKMENT IN PLACE	160.00	CUYD	$6.83	$1,093.00		$1,093.00
CRUSHED AGGREGATE COURSE	345.00	CUYD	$18.79	$6,483.00		$6,483.00
COVER - TYPE 2	445.00	SQYD	$0.51	$227.00		$227.00
DUST PALLIATIVE	1.00	TON		$0.00	$120.00	$120.00
PLANT MIX BIT SURF GR S-3/4 IN	125.00	TON	$25.37	$3,171.00		$3,171.00
ASPHALT CEMENT PG 64 64-28	7.00	TON	$674.59	$4,722.00		$4,722.00
EMULS ASPHALT CRS-2P	1.00	TON	$578.92	$579.00		$579.00
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-LANE ROAD (FULL RECONSTRUCT) SUBTOTAL				$18,805.00		$18,925.00
CATEGORY	**LENGTH (STA.)**	**COST PER STATION**			**SUBTOTAL**	
TWO-LANE ROAD (FULL RECONSTRUCT)	85.11	$18,925.00			$1,600,000	
DEDICATED BICYCLE/PEDESTRIAN FACILITY	8.40	$2,767.00			$23,200	
CONCRETE BARRIER RAIL	126.72	$7,060.00			$895,000	
CATEGORY	**LENGTH (FT.)**	**WIDTH (FT.)**	**COST PER SQUARE FOOT [4]**		**SUBTOTAL**	
ELEVATED STRUCTURE (TWO-LANE)	4,800.00	43.00	$175.00		$36,100,000	
SOUTH FORK BRIDGE CONSTRUCTION						
STRUCTURE (TWO-LANE)	655.00	55.00	$175.00		$6,300,000	
STRUCTURE COST SUBTOTAL					$42,400,000	
				SUBTOTAL 1	$44,900,000	
			ADDITIONAL COSTS			
				MISCELLANEOUS @ 20% OF SUBTOTAL 1 [5]	20%	$9,000,000
				MOBILIZATION @ 18% OF SUBTOTAL 1 [7]	18%	$8,100,000
				CONSTRUCTION ENGINEERING @ 15% OF SUBTOTAL 1	15%	$6,700,000
				SUBTOTAL 2		$68,700,000
				INDIRECT COST (IDC) - CONSTRUCTION @ 9.64% OF SUBTOTAL 2 [7]	9.64%	$6,600,000
				CONTINGENCY @ 20% & 50% OF SUBTOTAL 2 [8]	20%	$13,700,000
					50%	$34,400,000
				TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [9]	**$89,000,000**	
				TOTAL IMPROVEMENT OPTION COST @ 50% CONTINGENCY [9]	**$109,700,000**	

[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] Planning level costs for simple bridge structures range on average between $110 and $175 per square foot. A conservative estimate of $175 per square foot was utilized for these structures.
[5] 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.
[6] The Mobilization category includes all costs incurred in assembling and transporting materials to the work site.
[7] 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.
[8] A contingency range of 20 to 50 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.
[9] 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

US 2 - BADROCK CANYON CORRIDOR PLANNING STUDY - ALIGNMENT 2
THREE LANES RP 140.0 - RP 140.6, TWO LANES RP 140.6 - RP 141.2,
THREE LANES RP 141.2 - RP 142.0, FOUR LANES RP 142.0 - 142.4
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
THREE-LANE ROAD (FULL RECONSTRUCT)						
EXCAVATION-UNCLASS BORROW	620.00	CUYD	$4.67	$2,895.00		$2,895.00
EMBANKMENT IN PLACE	195.00	CUYD	$6.83	$1,332.00		$1,332.00
CRUSHED AGGREGATE COURSE	425.00	CUYD	$18.79	$7,986.00		$7,986.00
COVER - TYPE 2	600.00	SQYD	$0.51	$306.00		$306.00
DUST PALLIATIVE	2.00	TON		$0.00	$120.00	$240.00
PLANT MIX BIT SURF GR S-3/4 IN	165.00	TON	$25.37	$4,186.00		$4,186.00
ASPHALT CEMENT PG 64 64-28	9.00	TON	$674.59	$6,071.00		$6,071.00
EMULS ASPHALT CRS-2P	2.00	TON	$578.92	$1,158.00		$1,158.00
STRIPING-WHITE EPOXY	1.00	GAL	$61.96	$62.00		$62.00
STRIPING-YELLOW EPOXY	2.00	GAL	$62.79	$126.00		$126.00
THREE-LANE ROAD (FULL RECONSTRUCT) SUBTOTAL				$24,122.00		$24,362.00
GUARD RAIL-STEEL/7 FOOT POSTS	500.00	LNFT	$30.20	$15,100.00		$15,100.00
REGRADE APPROACH ROAD CONNECTION	1.00	EACH		$0.00	$10,000.00	$10,000.00
REGRADE APPROACHES	12.00	EACH		$0.00	$1,000.00	$12,000.00
CATEGORY	**LENGTH (STA.)**	**COST PER STATION**			**SUBTOTAL**	
THREE-LANE ROAD (FULL RECONSTRUCT)	112.70	$24,362.00			$2,700,000	
LANE TRANSITION WEST OF CORRIDOR	20.00	$20,250.00			$410,000	
3 TO 4 LANE TRANSITION WEST OF BRIDGE	5.00	$28,155.00			$140,000	
ROADWAY COST SUBTOTAL					$3,300,000	
CATEGORY	**LENGTH (FT.)**	**WIDTH (FT.)**	**COST PER SQUARE FOOT [4]**		**SUBTOTAL**	
CANTILEVER CONSTRUCTION (TWO-LANE)	1,850.00	41.50	$125.00		$9,600,000	
	APPROX. QUANTITY	**UNIT**	**UNIT PRICE**			
EXCAVATION-UNCLASS BORROW	11,000.00	CUYD	$4.67		$51,000.00	
EMBANKMENT IN PLACE	2,665.00	CUYD	$6.83		$18,200.00	
RETAINING WALL	28,710.00	SQFT	$50.00		$1,400,000.00	
CANTILEVER CONSTRUCTION (TWO-LANE) SUBTOTAL					$11,100,000.00	
CATEGORY	**LENGTH (FT.)**	**WIDTH (FT.)**	**COST PER SQUARE FOOT [5]**		**SUBTOTAL**	
SOUTH FORK BRIDGE CONSTRUCTION						
EB STRUCTURE (TWO-LANE)	655.00	43.00	$175.00		$4,900,000	
WB STRUCTURE (TWO-LANE)	655.00	43.00	$175.00		$4,900,000	
STRUCTURE COST SUBTOTAL					$20,900,000	
				SUBTOTAL 1	$24,200,000	
ADDITIONAL COSTS						
				MISCELLANEOUS @ 20% OF SUBTOTAL 1 [6]	20%	$4,800,000
				MOBILIZATION @ 18% OF SUBTOTAL 1 [7]	18%	$4,400,000
				CONSTRUCTION ENGINEERING @ 15% OF SUBTOTAL 1	15%	$3,600,000
				SUBTOTAL 2		$37,000,000
				INDIRECT COST (IDC) - CONSTRUCTION @ 9.64% OF SUBTOTAL 2 [8]	9.64%	$3,600,000
				CONTINGENCY @ 20% & 50% OF SUBTOTAL 2 [9]	20%	$7,400,000
					50%	$18,500,000
				TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [10]	**$48,000,000**	
				TOTAL IMPROVEMENT OPTION COST @ 50% CONTINGENCY [10]	**$59,100,000**	

[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 planning level cost for a cantilever deck was estimated at $125 per square foot based on average MDT bridge costs and construction sequencing.
[5] Planning level costs for simple bridge structures range on average between $110 and $175 per square foot. A conservative estimate of $175 per square foot was utilized for these structures.
[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 50 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

US 2 - BADROCK CANYON CORRIDOR PLANNING STUDY - ALIGNMENT 2
THREE LANES RP 140.0 - RP 140.6, TWO LANES RP 140.6 - RP 141.2,
THREE LANES RP 141.2 - RP 142.0, FOUR LANES RP 142.0 - 142.4 WITH DEDICATED
BICYCLE/PEDESTRIAN FACILITY
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
THREE-LANE ROAD (FULL RECONSTRUCT)						
EXCAVATION-UNCLASS BORROW	620.00	CUYD	$4.67	$2,895.00		$2,895.00
EMBANKMENT IN PLACE	195.00	CUYD	$6.83	$1,332.00		$1,332.00
CRUSHED AGGREGATE COURSE	425.00	CUYD	$18.79	$7,986.00		$7,986.00
COVER - TYPE 2	600.00	SQYD	$0.51	$306.00		$306.00
DUST PALLIATIVE	2.00	TON		$0.00	$120.00	$240.00
PLANT MIX BIT SURF GR S-3/4 IN	165.00	TON	$25.37	$4,186.00		$4,186.00
ASPHALT CEMENT PG 64 64-28	9.00	TON	$674.59	$6,071.00		$6,071.00
EMULS ASPHALT CRS-2P	2.00	TON	$578.92	$1,158.00		$1,158.00
STRIPING-WHITE EPOXY	1.00	GAL	$61.96	$62.00		$62.00
STRIPING-YELLOW EPOXY	2.00	GAL	$62.79	$126.00		$126.00
THREE-LANE ROAD (FULL RECONSTRUCT) SUBTOTAL				$24,122.00		$24,362.00
GUARD RAIL-STEEL/7 FOOT POSTS	500.00	LNFT	$30.20	$15,100.00		$15,100.00
REGRADE APPROACH ROAD CONNECTION	1.00	EACH		$0.00	$10,000.00	$10,000.00
REGRADE APPROACHES	12.00	EACH		$0.00	$1,000.00	$12,000.00

CATEGORY	LENGTH (STA.)	COST PER STATION	SUBTOTAL
THREE-LANE ROAD (FULL RECONSTRUCT)	111.10	$24,362.00	$2,700,000
LANE TRANSITION WEST OF CORRIDOR	20.00	$20,250.00	$410,000
3 TO 4 LANE TRANSITION WEST OF BRIDGE	5.00	$28,155.00	$140,000
DEDICATED BICYCLE/PEDESTRIAN FACILITY	11.20	$2,767.00	$31,000
CONCRETE BARRIER RAIL	126.72	$7,060.00	$895,000
ROADWAY & DEDICATED BICYCLE/PEDESTRIAN FACILITY COST SUBTOTAL			$4,200,000

CATEGORY	LENGTH (FT.)	WIDTH (FT.)	COST PER SQUARE FOOT [4]	SUBTOTAL
CANTILEVER CONSTRUCTION (TWO-LANE)	1,975.00	53.50	$125.00	$13,210,000
	APPROX. QUANTITY	**UNIT**	**UNIT PRICE**	
EXCAVATION-UNCLASS BORROW	14,000.00	CUYD	$4.67	$65,000.00
EMBANKMENT IN PLACE	7,200.00	CUYD	$6.83	$49,200.00
RETAINING WALL	30,200.00	SQFT	$50.00	$1,500,000.00
CANTILEVER CONSTRUCTION (TWO-LANE) SUBTOTAL				$14,800,000.00

CATEGORY	LENGTH (FT.)	WIDTH (FT.)	COST PER SQUARE FOOT [5]	SUBTOTAL
SOUTH FORK BRIDGE CONSTRUCTION				
EB STRUCTURE (TWO-LANE) [6]	655.00	43.00	$175.00	$4,900,000
WB STRUCTURE (TWO-LANE)	655.00	55.00	$175.00	$6,300,000
STRUCTURE COST SUBTOTAL				$26,000,000
			SUBTOTAL 1	$30,200,000

ADDITIONAL COSTS		
MISCELLANEOUS @ 20% OF SUBTOTAL 1 [7]	20%	$6,000,000
MOBILIZATION @ 18% OF SUBTOTAL 1 [8]	18%	$5,400,000
CONSTRUCTION ENGINEERING @ 15% OF SUBTOTAL 1	15%	$4,500,000
SUBTOTAL 2		$46,100,000
INDIRECT COST (IDC) - CONSTRUCTION @ 9.64% OF SUBTOTAL 2 [9]	9.64%	$4,400,000
CONTINGENCY @ 20% & 50% OF SUBTOTAL 2 [10]	20%	$9,200,000
	50%	$23,100,000
TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [11]	**$59,700,000**	
TOTAL IMPROVEMENT OPTION COST @ 50% CONTINGENCY [11]	**$73,600,000**	

[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] The planning level cost for a cantilever deck was estimated at $125 per square foot based on average MDT bridge costs and construction sequencing.
[5] Planning level costs for simple bridge structures range on average between $110 and $175 per square foot. A conservative estimate of $175 per square foot was utilized for these structures.
[6] Dedicated bicycle/pedestrian facility could be incorporated on either eastbound or westbound bridge structure.
[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 relations.
[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 50 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.

DOWL HKM

US 2 - BADROCK CANYON CORRIDOR PLANNING STUDY - ALIGNMENT 2
THREE LANES FROM RP140.0 - 142.0, FOUR LANES RP 142.0 - 142.4 WITH TURN BAY AT BERNE PARK
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
THREE-LANE ROAD (FULL RECONSTRUCT)						
EXCAVATION-UNCLASS BORROW	620.00	CUYD	$4.67	$2,895.00		$2,895.00
EMBANKMENT IN PLACE	195.00	CUYD	$6.83	$1,332.00		$1,332.00
CRUSHED AGGREGATE COURSE	425.00	CUYD	$18.79	$7,986.00		$7,986.00
COVER - TYPE 2	600.00	SQYD	$0.51	$306.00		$306.00
DUST PALLIATIVE	2.00	TON		$0.00	$120.00	$240.00
PLANT MIX BIT SURF GR S-3/4 IN	165.00	TON	$25.37	$4,186.00		$4,186.00
ASPHALT CEMENT PG 64 64-28	9.00	TON	$674.59	$6,071.00		$6,071.00
EMULS ASPHALT CRS-2P	2.00	TON	$578.92	$1,158.00		$1,158.00
STRIPING-WHITE EPOXY	1.00	GAL	$61.96	$62.00		$62.00
STRIPING-YELLOW EPOXY	2.00	GAL	$62.79	$126.00		$126.00
THREE-LANE ROAD (FULL RECONSTRUCT) SUBTOTAL				$24,122.00		$24,362.00
GUARD RAIL-STEEL/7 FOOT POSTS	500.00	LNFT	$30.20	$15,100.00		$15,100.00
REGRADE APPROACH ROAD CONNECTION	1.00	EACH		$0.00	$10,000.00	$10,000.00
REGRADE APPROACHES	12.00	EACH		$0.00	$1,000.00	$12,000.00
CATEGORY	**LENGTH (STA.)**	**COST PER STATION**			**SUBTOTAL**	
THREE-LANE ROAD (FULL RECONSTRUCT)	111.73	$24,362.00			$2,700,000	
LANE TRANSITION WEST OF CORRIDOR	20.00	$20,250.00			$410,000	
3 TO 4 LANE TRANSITION WEST OF BRIDGE	5.00	$28,155.00			$140,000	
ROADWAY COST SUBTOTAL					$3,300,000	
CATEGORY	**LENGTH (FT.)**	**WIDTH (FT.)**	**COST PER SQUARE FOOT [4]**		**SUBTOTAL**	
CANTILEVER CONSTRUCTION (THREE-LANE)	1,975.00	55.50	$125.00		$13,700,000	
	APPROX. QUANTITY	**UNIT**	**UNIT PRICE**			
EXCAVATION-UNCLASS BORROW	15,000.00	CUYD	$4.67		$70,100.00	
EMBANKMENT IN PLACE	7,860.00	CUYD	$6.83		$53,700.00	
RETAINING WALL	30,555.00	SQFT	$50.00		$1,500,000.00	
CANTILEVER CONSTRUCTION (THREE-LANE) SUBTOTAL					$15,300,000.00	
CATEGORY	**LENGTH (FT.)**	**WIDTH (FT.)**	**COST PER SQUARE FOOT [5]**		**SUBTOTAL**	
SOUTH FORK BRIDGE CONSTRUCTION						
EB STRUCTURE (TWO-LANE)	655.00	43.00	$175.00		$4,900,000	
WB STRUCTURE (TWO-LANE)	655.00	43.00	$175.00		$4,900,000	
STRUCTURE COST SUBTOTAL					$25,100,000	
SUBTOTAL 1					$28,400,000	
ADDITIONAL COSTS						
MISCELLANEOUS @ 20% OF SUBTOTAL 1 [6]					20%	$5,700,000
MOBILIZATION @ 18% OF SUBTOTAL 1 [7]					18%	$5,100,000
CONSTRUCTION ENGINEERING @ 15% OF SUBTOTAL 1					15%	$4,300,000
SUBTOTAL 2						$43,500,000
INDIRECT COST (IDC) - CONSTRUCTION @ 9.64% OF SUBTOTAL 2 [8]					9.64%	$4,200,000
CONTINGENCY @ 20% & 50% OF SUBTOTAL 2 [9]					20%	$8,700,000
					50%	$21,800,000
TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [10]					**$56,400,000**	
TOTAL IMPROVEMENT OPTION COST @ 50% CONTINGENCY [10]					**$69,500,000**	

[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] The planning level cost for a cantilever deck was estimated at $125 per square foot based on average MDT bridge costs and construction sequencing.
[5] Planning level costs for simple bridge structures range on average between $110 and $175 per square foot. A conservative estimate of $175 per square foot was utilized for these structures.
[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 50 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

US 2 - BADROCK CANYON CORRIDOR PLANNING STUDY - ALIGNMENT 2
THREE LANES FROM RP140.0 - 142.0, FOUR LANES RP 142.0 - 142.4 WITH TURN BAY AT BERNE PARK & WITH DEDICATED BICYCLE/PEDESTRIAN FACILITY
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
THREE-LANE ROAD (FULL RECONSTRUCT)						
EXCAVATION-UNCLASS BORROW	620.00	CUYD	$4.67	$2,895.00		$2,895.00
EMBANKMENT IN PLACE	195.00	CUYD	$6.83	$1,332.00		$1,332.00
CRUSHED AGGREGATE COURSE	425.00	CUYD	$18.79	$7,986.00		$7,986.00
COVER - TYPE 2	600.00	SQYD	$0.51	$306.00		$306.00
DUST PALLIATIVE	2.00	TON		$0.00	$120.00	$240.00
PLANT MIX BIT SURF GR S-3/4 IN	165.00	TON	$25.37	$4,186.00		$4,186.00
ASPHALT CEMENT PG 64 64-28	9.00	TON	$674.59	$6,071.00		$6,071.00
EMULS ASPHALT CRS-2P	2.00	TON	$578.92	$1,158.00		$1,158.00
STRIPING-WHITE EPOXY	1.00	GAL	$61.96	$62.00		$62.00
STRIPING-YELLOW EPOXY	2.00	GAL	$62.79	$126.00		$126.00
THREE-LANE ROAD (FULL RECONSTRUCT) SUBTOTAL				$24,122.00		$24,362.00
GUARD RAIL-STEEL/7 FOOT POSTS	500.00	LNFT	$30.20	$15,100.00		$15,100.00
REGRADE APPROACH ROAD CONNECTION	1.00	EACH		$0.00	$10,000.00	$10,000.00
REGRADE APPROACHES	12.00	EACH		$0.00	$1,000.00	$12,000.00
CATEGORY	**LENGTH (STA.)**	**COST PER STATION**			**SUBTOTAL**	
THREE-LANE ROAD (FULL RECONSTRUCT)	110.13	$24,362.00			$2,700,000	
LANE TRANSITION WEST OF CORRIDOR	20.00	$20,250.00			$410,000	
3 TO 4 LANE TRANSITION WEST OF BRIDGE	5.00	$28,155.00			$140,000	
DEDICATED BICYCLE/PEDESTRIAN FACILITY	11.00	$2,767.00			$30,400	
CONCRETE BARRIER RAIL	126.72	$7,060.00			$895,000	
ROADWAY & DEDICATED BICYCLE/PEDESTRIAN FACILITY COST SUBTOTAL					$4,200,000	
CATEGORY	**LENGTH (FT.)**	**WIDTH (FT.)**	**COST PER SQUARE FOOT [4]**		**SUBTOTAL**	
CANTILEVER CONSTRUCTION (THREE-LANE)	2,180.00	67.50	$125.00		$18,390,000	
	APPROX. QUANTITY	**UNIT**	**UNIT PRICE**			
EXCAVATION-UNCLASS BORROW	18,500.00	CUYD	$4.67		$86,400.00	
EMBANKMENT IN PLACE	14,200.00	CUYD	$6.83		$97,000.00	
RETAINING WALL	31,900.00	SQFT	$50.00		$1,600,000.00	
CANTILEVER CONSTRUCTION (THREE-LANE) SUBTOTAL					$20,200,000.00	
CATEGORY	**LENGTH (FT.)**	**WIDTH (FT.)**	**COST PER SQUARE FOOT [5]**		**SUBTOTAL**	
SOUTH FORK BRIDGE CONSTRUCTION						
EB STRUCTURE (TWO-LANE) [6]	655.00	55.00	$175.00		$6,300,000	
WB STRUCTURE (TWO-LANE)	655.00	43.00	$175.00		$4,900,000	
STRUCTURE COST SUBTOTAL					$31,400,000	
				SUBTOTAL 1	$35,600,000	
		ADDITIONAL COSTS				
				MISCELLANEOUS @ 20% OF SUBTOTAL 1 [7]	20%	$7,100,000
				MOBILIZATION @ 18% OF SUBTOTAL 1 [8]	18%	$6,400,000
				CONSTRUCTION ENGINEERING @ 15% OF SUBTOTAL 1	15%	$5,300,000
				SUBTOTAL 2		$54,400,000
				INDIRECT COST (IDC) - CONSTRUCTION @ 9.64% OF SUBTOTAL 2 [9]	9.64%	$5,200,000
				CONTINGENCY @ 20% & 50% OF SUBTOTAL 2 [10]	20%	$10,900,000
					50%	$27,200,000
				TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [11]	**$70,500,000**	
				TOTAL IMPROVEMENT OPTION COST @ 50% CONTINGENCY [11]	**$86,800,000**	

[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 planning level cost for a cantilever deck was estimated at $125 per square foot based on average MDT bridge costs and construction sequencing.
[5] Planning level costs for simple bridge structures range on average between $110 and $175 per square foot. A conservative estimate of $175 per square foot was utilized for these structures.
[6] Dedicated bicycle/pedestrian facility could be incorporated on either eastbound or westbound bridge structure.
[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 relations.
[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 50 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.

DOWL HKM

US 2 - BADROCK CANYON CORRIDOR PLANNING STUDY - ALIGNMENT 2
FOUR LANES RP 140.0 - RP 140.6, THREE LANES RP 140.6 - RP 141.2,
FOUR LANES RP 141.2 - RP 142.4
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
FOUR-LANE ROAD (FULL RECONSTRUCT)						
EXCAVATION-UNCLASS BORROW	690.00	CUYD	$4.67	$3,222.00		$3,222.00
EMBANKMENT IN PLACE	220.00	CUYD	$6.83	$1,503.00		$1,503.00
CRUSHED AGGREGATE COURSE	485.00	CUYD	$18.79	$9,113.00		$9,113.00
COVER - TYPE 2	715.00	SQYD	$0.51	$365.00		$365.00
DUST PALLIATIVE	2.00	TON		$0.00	$120.00	$240.00
PLANT MIX BIT SURF GR S-3/4 IN	195.00	TON	$25.37	$4,947.00		$4,947.00
ASPHALT CEMENT PG 64 64-28	11.00	TON	$674.59	$7,420.00		$7,420.00
EMULS ASPHALT CRS-2P	2.00	TON	$578.92	$1,158.00		$1,158.00
STRIPING-WHITE EPOXY	2.00	GAL	$61.96	$124.00		$124.00
STRIPING-YELLOW EPOXY	1.00	GAL	$62.79	$63.00		$63.00
FOUR-LANE ROAD (FULL RECONSTRUCT) SUBTOTAL				$27,915.00		$28,155.00
GUARD RAIL-STEEL/7 FOOT POSTS	500.00	LNFT	$30.20	$15,100.00		$15,100.00
REGRADE APPROACH ROAD CONNECTION	1.00	EACH		$0.00	$10,000.00	$10,000.00
REGRADE APPROACHES	12.00	EACH		$0.00	$1,000.00	$12,000.00

CATEGORY	LENGTH (STA.)	COST PER STATION	SUBTOTAL
FOUR-LANE ROAD (FULL RECONSTRUCT)	110.05	$28,155.00	$3,100,000
LANE TRANSITION WEST OF CORRIDOR	20.00	$21,600.00	$430,000
LANE TRANSITION EAST END OF CORRIDOR	8.00	$26,250.00	$210,000
ROADWAY COST SUBTOTAL			$3,700,000

CATEGORY	LENGTH (FT.)	WIDTH (FT.)	COST PER SQUARE FOOT [4]	SUBTOTAL
CANTILEVER CONSTRUCTION (THREE-LANE)	1,975.00	55.50	$125.00	$13,700,000
	APPROX. QUANTITY	**UNIT**	**UNIT PRICE**	
EXCAVATION-UNCLASS BORROW	15,000.00	CUYD	$4.67	$70,100.00
EMBANKMENT IN PLACE	7,860.00	CUYD	$6.83	$53,700.00
RETAINING WALL	30,555.00	SQFT	$50.00	$1,500,000.00
CANTILEVER CONSTRUCTION (THREE-LANE) SUBTOTAL				$15,300,000.00
CATEGORY	**LENGTH (FT.)**	**WIDTH (FT.)**	**COST PER SQUARE FOOT [5]**	**SUBTOTAL**
SOUTH FORK BRIDGE CONSTRUCTION				
EB STRUCTURE (TWO-LANE)	655.00	43.00	$175.00	$4,900,000
WB STRUCTURE (TWO-LANE)	655.00	43.00	$175.00	$4,900,000
STRUCTURE COST SUBTOTAL				$25,100,000
			SUBTOTAL 1	$28,800,000

ADDITIONAL COSTS		
MISCELLANEOUS @ 20% OF SUBTOTAL 1 [6]	20%	$5,800,000
MOBILIZATION @ 18% OF SUBTOTAL 1 [7]	18%	$5,200,000
CONSTRUCTION ENGINEERING @ 15% OF SUBTOTAL 1	15%	$4,300,000
SUBTOTAL 2		$44,100,000
INDIRECT COST (IDC) - CONSTRUCTION @ 9.64% OF SUBTOTAL 2 [8]	9.64%	$4,300,000
CONTINGENCY @ 20% & 50% OF SUBTOTAL 2 [9]	20%	$8,800,000
	50%	$22,100,000
TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [10]		**$57,200,000**
TOTAL IMPROVEMENT OPTION COST @ 50% CONTINGENCY [10]		**$70,500,000**

[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] The planning level cost for a cantilever deck was estimated at $125 per square foot based on average MDT bridge costs and construction sequencing.
[5] Planning level costs for simple bridge structures range on average between $110 and $175 per square foot. A conservative estimate of $175 per square foot was utilized for these structures.
[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 50 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

US 2 - BADROCK CANYON CORRIDOR PLANNING STUDY - ALIGNMENT 2
FOUR LANES RP 140.0 - RP 140.6, THREE LANES RP 140.6 - RP 141.2,
FOUR LANES RP 141.2 - RP 142.4 WITH DEDICATED BICYCLE/PEDESTRIAN FACILITY
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
FOUR-LANE ROAD (FULL RECONSTRUCT)						
EXCAVATION-UNCLASS BORROW	690.00	CUYD	$4.67	$3,222.00		$3,222.00
EMBANKMENT IN PLACE	220.00	CUYD	$6.83	$1,503.00		$1,503.00
CRUSHED AGGREGATE COURSE	485.00	CUYD	$18.79	$9,113.00		$9,113.00
COVER - TYPE 2	715.00	SQYD	$0.51	$365.00		$365.00
DUST PALLIATIVE	2.00	TON		$0.00	$120.00	$240.00
PLANT MIX BIT SURF GR S-3/4 IN	195.00	TON	$25.37	$4,947.00		$4,947.00
ASPHALT CEMENT PG 64 64-28	11.00	TON	$674.59	$7,420.00		$7,420.00
EMULS ASPHALT CRS-2P	2.00	TON	$578.92	$1,158.00		$1,158.00
STRIPING-WHITE EPOXY	2.00	GAL	$61.96	$124.00		$124.00
STRIPING-YELLOW EPOXY	1.00	GAL	$62.79	$63.00		$63.00
FOUR-LANE ROAD (FULL RECONSTRUCT) SUBTOTAL				$27,915.00		$28,155.00
GUARD RAIL-STEEL/7 FOOT POSTS	500.00	LNFT	$30.20	$15,100.00		$15,100.00
REGRADE APPROACH ROAD CONNECTION	1.00	EACH		$0.00	$10,000.00	$10,000.00
REGRADE APPROACHES	12.00	EACH		$0.00	$1,000.00	$12,000.00
CATEGORY	**LENGTH (STA.)**	**COST PER STATION**			**SUBTOTAL**	
FOUR-LANE ROAD (FULL RECONSTRUCT)	110.13	$28,155.00			$3,100,000	
LANE TRANSITION WEST OF CORRIDOR	20.00	$21,600.00			$430,000	
LANE TRANSITION EAST END OF CORRIDOR	8.00	$26,250.00			$210,000	
DEDICATED BICYCLE/PEDESTRIAN FACILITY	11.00	$2,767.00			$30,400	
CONCRETE BARRIER RAIL	126.72	$7,060.00			$895,000	
ROADWAY & DEDICATED BICYCLE/PEDESTRIAN FACILITY COST SUBTOTAL					$4,700,000	
CATEGORY	**LENGTH (FT.)**	**WIDTH (FT.)**	**COST PER SQUARE FOOT [4]**		**SUBTOTAL**	
CANTILEVER CONSTRUCTION (THREE-LANE)	2,180.00	67.50	$125.00		$18,400,000	
	APPROX. QUANTITY	**UNIT**	**UNIT PRICE**			
EXCAVATION-UNCLASS BORROW	18,500.00	CUYD	$4.67		$86,400.00	
EMBANKMENT IN PLACE	14,200.00	CUYD	$6.83		$97,000.00	
RETAINING WALL	31,900.00	SQFT	$50.00		$1,600,000.00	
CANTILEVER CONSTRUCTION (THREE-LANE) SUBTOTAL					$20,200,000.00	
CATEGORY	**LENGTH (FT.)**	**WIDTH (FT.)**	**COST PER SQUARE FOOT [5]**		**SUBTOTAL**	
SOUTH FORK BRIDGE CONSTRUCTION						
EB STRUCTURE (TWO-LANE) [6]	655.00	55.00	$175.00		$6,300,000	
WB STRUCTURE (TWO-LANE)	655.00	43.00	$175.00		$4,900,000	
STRUCTURE COST SUBTOTAL					$31,400,000	
SUBTOTAL 1					$36,100,000	
ADDITIONAL COSTS						
MISCELLANEOUS @ 20% OF SUBTOTAL 1 [7]					20%	$7,200,000
MOBILIZATION @ 18% OF SUBTOTAL 1 [8]					18%	$6,500,000
CONSTRUCTION ENGINEERING @ 15% OF SUBTOTAL 1					15%	$5,400,000
SUBTOTAL 2						$55,200,000
INDIRECT COST (IDC) - CONSTRUCTION @ 9.64% OF SUBTOTAL 2 [9]					9.64%	$5,300,000
CONTINGENCY @ 20% & 50% OF SUBTOTAL 2 [10]					20%	$11,000,000
					50%	$27,600,000
TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [11]					**$71,500,000**	
TOTAL IMPROVEMENT OPTION COST @ 50% CONTINGENCY [11]					**$88,100,000**	

[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 planning level cost for a cantilever deck was estimated at $125 per square foot based on average MDT bridge costs and construction sequencing.
[5] Planning level costs for simple bridge structures range on average between $110 and $175 per square foot. A conservative estimate of $175 per square foot was utilized for these structures.
[6] Dedicated bicycle/pedestrian facility could be incorporated on either eastbound or westbound bridge structure.
[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 relations.
[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 50 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.

US 2 - BADROCK CANYON CORRIDOR PLANNING STUDY - ALIGNMENT 2
FOUR LANES WITH CENTER MEDIAN RP 140.0 - RP 140.6, THREE LANES RP 140.6 - RP 141.2, FOUR LANES WITH CENTER MEDIAN RP 141.2 - RP 142.4
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
FOUR-LANE ROAD (FULL RECONSTRUCT)						
EXCAVATION-UNCLASS BORROW	765.00	CUYD	$4.67	$3,573.00		$3,573.00
EMBANKMENT IN PLACE	240.00	CUYD	$6.83	$1,639.00		$1,639.00
CRUSHED AGGREGATE COURSE	545.00	CUYD	$18.79	$10,241.00		$10,241.00
COVER - TYPE 2	825.00	SQYD	$0.51	$421.00		$421.00
DUST PALLIATIVE	2.00	TON		$0.00	$120.00	$240.00
PLANT MIX BIT SURF GR S-3/4 IN	220.00	TON	$25.37	$5,581.00		$5,581.00
ASPHALT CEMENT PG 64 64-28	12.00	TON	$674.59	$8,095.00		$8,095.00
EMULS ASPHALT CRS-2P	2.00	TON	$578.92	$1,158.00		$1,158.00
CONCRETE BARRIER RAIL	10.00	EACH	$706.02	$7,060.00		$7,060.00
STRIPING-WHITE EPOXY	2.00	GAL	$61.96	$124.00		$124.00
STRIPING-YELLOW EPOXY	2.00	GAL	$62.79	$126.00		$126.00
FOUR-LANE ROAD (FULL RECONSTRUCT) SUBTOTAL				$38,018.00		$38,258.00
GUARD RAIL-STEEL/7 FOOT POSTS	500.00	LNFT	$30.20	$15,100.00		$15,100.00
REGRADE APPROACH ROAD CONNECTION	1.00	EACH		$0.00	$10,000.00	$10,000.00
REGRADE APPROACHES	12.00	EACH		$0.00	$1,000.00	$12,000.00
CATEGORY	**LENGTH (STA.)**	**COST PER STATION**			**SUBTOTAL**	
FOUR-LANE ROAD (FULL RECONSTRUCT)	109.33	$38,258.00			$4,200,000	
LANE TRANSITION WEST OF CORRIDOR	20.00	$21,600.00			$430,000	
LANE TRANSITION EAST END OF CORRIDOR	8.00	$26,250.00			$210,000	
ROADWAY COST SUBTOTAL					$4,800,000	
CATEGORY	**LENGTH (FT.)**	**WIDTH (FT.)**	**COST PER SQUARE FOOT [4]**		**SUBTOTAL**	
CANTILEVER CONSTRUCTION (THREE-LANE)	1,975.00	55.50	$125.00		$13,700,000	
	APPROX. QUANTITY	**UNIT**	**UNIT PRICE**			
EXCAVATION-UNCLASS BORROW	15,000.00	CUYD	$4.67		$70,100.00	
EMBANKMENT IN PLACE	7,860.00	CUYD	$6.83		$53,700.00	
RETAINING WALL	30,555.00	SQFT	$50.00		$1,500,000.00	
CANTILEVER CONSTRUCTION (THREE-LANE) SUBTOTAL					$15,300,000.00	
CATEGORY	**LENGTH (FT.)**	**WIDTH (FT.)**	**COST PER SQUARE FOOT [5]**		**SUBTOTAL**	
SOUTH FORK BRIDGE CONSTRUCTION						
EB STRUCTURE (TWO-LANE)	655.00	43.00	$175.00		$4,900,000	
WB STRUCTURE (TWO-LANE)	655.00	43.00	$175.00		$4,900,000	
STRUCTURE COST SUBTOTAL					$25,100,000	
				SUBTOTAL 1	$29,900,000	
		ADDITIONAL COSTS				
				MISCELLANEOUS @ 20% OF SUBTOTAL 1 [6]	20%	$6,000,000
				MOBILIZATION @ 18% OF SUBTOTAL 1 [7]	18%	$5,400,000
				CONSTRUCTION ENGINEERING @ 15% OF SUBTOTAL 1	15%	$4,500,000
				SUBTOTAL 2		$45,800,000
				INDIRECT COST (IDC) - CONSTRUCTION @ 9.64% OF SUBTOTAL 2 [8]	9.64%	$4,400,000
				CONTINGENCY @ 20% & 50% OF SUBTOTAL 2 [9]	20%	$9,200,000
					50%	$22,900,000
				TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [10]	**$59,400,000**	
				TOTAL IMPROVEMENT OPTION COST @ 50% CONTINGENCY [10]	**$73,100,000**	

[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 planning level cost for a cantilever deck was estimated at $125 per square foot based on average MDT bridge costs and construction sequencing.
[5] Planning level costs for simple bridge structures range on average between $110 and $175 per square foot. A conservative estimate of $175 per square foot was utilized for these structures.
[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 50 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.

US 2 - BADROCK CANYON CORRIDOR PLANNING STUDY - ALIGNMENT 2
FOUR LANES WITH CENTER MEDIAN RP 140.0 - RP 140.6, THREE LANES RP 140.6 - RP 141.2, FOUR LANES WITH CENTER MEDIAN RP 141.2 - RP 142.4 WITH DEDICATED BICYCLE/PEDESTRIAN FACILITY
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
FOUR-LANE ROAD (FULL RECONSTRUCT)						
EXCAVATION-UNCLASS BORROW	765.00	CUYD	$4.67	$3,573.00		$3,573.00
EMBANKMENT IN PLACE	240.00	CUYD	$6.83	$1,639.00		$1,639.00
CRUSHED AGGREGATE COURSE	545.00	CUYD	$18.79	$10,241.00		$10,241.00
COVER - TYPE 2	825.00	SQYD	$0.51	$421.00		$421.00
DUST PALLIATIVE	2.00	TON		$0.00	$120.00	$240.00
PLANT MIX BIT SURF GR S-3/4 IN	220.00	TON	$25.37	$5,581.00		$5,581.00
ASPHALT CEMENT PG 64 64-28	12.00	TON	$674.59	$8,095.00		$8,095.00
EMULS ASPHALT CRS-2P	2.00	TON	$578.92	$1,158.00		$1,158.00
CONCRETE BARRIER RAIL	10.00	EACH	$706.02	$7,060.00		$7,060.00
STRIPING-WHITE EPOXY	2.00	GAL	$61.96	$124.00		$124.00
STRIPING-YELLOW EPOXY	2.00	GAL	$62.79	$126.00		$126.00
FOUR-LANE ROAD (FULL RECONSTRUCT) SUBTOTAL				$38,018.00		$38,258.00
GUARD RAIL-STEEL/7 FOOT POSTS	500.00	LNFT	$30.20	$15,100.00		$15,100.00
REGRADE APPROACH ROAD CONNECTION	1.00	EACH		$0.00	$10,000.00	$10,000.00
REGRADE APPROACHES	12.00	EACH		$0.00	$1,000.00	$12,000.00
CATEGORY	**LENGTH (STA.)**	**COST PER STATION**			**SUBTOTAL**	
FOUR-LANE ROAD (FULL RECONSTRUCT)	110.13	$38,258.00			$4,200,000	
LANE TRANSITION WEST OF CORRIDOR	20.00	$21,600.00			$430,000	
LANE TRANSITION EAST END OF CORRIDOR	8.00	$26,250.00			$210,000	
DEDICATED BICYCLE/PEDESTRIAN FACILITY	11.00	$2,767.00			$30,400	
CONCRETE BARRIER RAIL	126.72	$7,060.00			$895,000	
ROADWAY & DEDICATED BICYCLE/PEDESTRIAN FACILITY COST SUBTOTAL					$5,800,000	
CATEGORY	**LENGTH (FT.)**	**WIDTH (FT.)**	**COST PER SQUARE FOOT [4]**		**SUBTOTAL**	
CANTILEVER CONSTRUCTION (THREE-LANE)	2,180.00	67.50	$125.00		$18,400,000	
	APPROX. QUANTITY	**UNIT**	**UNIT PRICE**			
EXCAVATION-UNCLASS BORROW	18,500.00	CUYD	$4.67		$86,400.00	
EMBANKMENT IN PLACE	14,200.00	CUYD	$6.83		$97,000.00	
RETAINING WALL	31,900.00	SQFT	$50.00		$1,600,000.00	
CANTILEVER CONSTRUCTION (THREE-LANE) SUBTOTAL					$20,200,000.00	
CATEGORY	**LENGTH (FT.)**	**WIDTH (FT.)**	**COST PER SQUARE FOOT [5]**		**SUBTOTAL**	
SOUTH FORK BRIDGE CONSTRUCTION						
EB STRUCTURE (TWO-LANE) [6]	655.00	55.00	$175.00		$6,300,000	
WB STRUCTURE (TWO-LANE)	655.00	43.00	$175.00		$4,900,000	
STRUCTURE COST SUBTOTAL					$31,400,000	
SUBTOTAL 1					$37,200,000	
ADDITIONAL COSTS						
MISCELLANEOUS @ 20% OF SUBTOTAL 1 [7]					20%	$7,400,000
MOBILIZATION @ 18% OF SUBTOTAL 1 [8]					18%	$6,700,000
CONSTRUCTION ENGINEERING @ 15% OF SUBTOTAL 1					15%	$5,600,000
SUBTOTAL 2						$56,900,000
INDIRECT COST (IDC) - CONSTRUCTION @ 9.64% OF SUBTOTAL 2 [9]					9.64%	$5,500,000
CONTINGENCY @ 20% & 50% OF SUBTOTAL 2 [10]					20%	$11,400,000
					50%	$28,500,000
TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [11]					**$73,800,000**	
TOTAL IMPROVEMENT OPTION COST @ 50% CONTINGENCY [11]					**$90,900,000**	

[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 planning level cost for a cantilever deck was estimated at $125 per square foot based on average MDT bridge costs and construction sequencing.
[5] Planning level costs for simple bridge structures range on average between $110 and $175 per square foot. A conservative estimate of $175 per square foot was utilized for these structures.
[6] Dedicated bicycle/pedestrian facility could be incorporated on either eastbound or westbound bridge structure.
[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 relations.
[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 50 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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US 2 - BADROCK CANYON CORRIDOR PLANNING STUDY - ALIGNMENT 2
FOUR LANES THROUGHOUT CORRIDOR
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
FOUR-LANE ROAD (FULL RECONSTRUCT)						
EXCAVATION-UNCLASS BORROW	690.00	CUYD	$4.67	$3,222.00		$3,222.00
EMBANKMENT IN PLACE	220.00	CUYD	$6.83	$1,503.00		$1,503.00
CRUSHED AGGREGATE COURSE	485.00	CUYD	$18.79	$9,113.00		$9,113.00
COVER - TYPE 2	715.00	SQYD	$0.51	$365.00		$365.00
DUST PALLIATIVE	2.00	TON		$0.00	$120.00	$240.00
PLANT MIX BIT SURF GR S-3/4 IN	195.00	TON	$25.37	$4,947.00		$4,947.00
ASPHALT CEMENT PG 64 64-28	11.00	TON	$674.59	$7,420.00		$7,420.00
EMULS ASPHALT CRS-2P	2.00	TON	$578.92	$1,158.00		$1,158.00
STRIPING-WHITE EPOXY	2.00	GAL	$61.96	$124.00		$124.00
STRIPING-YELLOW EPOXY	1.00	GAL	$62.79	$63.00		$63.00
FOUR-LANE ROAD (FULL RECONSTRUCT) SUBTOTAL				$27,915.00		$28,155.00
GUARD RAIL-STEEL/7 FOOT POSTS	500.00	LNFT	$30.20	$15,100.00		$15,100.00
REGRADE APPROACH ROAD CONNECTION	1.00	EACH		$0.00	$10,000.00	$10,000.00
REGRADE APPROACHES	12.00	EACH		$0.00	$1,000.00	$12,000.00
CATEGORY	**LENGTH (STA.)**		**COST PER STATION**		**SUBTOTAL**	
FOUR-LANE ROAD (FULL RECONSTRUCT)	110.05		$28,155.00		$3,100,000	
LANE TRANSITION WEST OF CORRIDOR	20.00		$21,600.00		$430,000	
LANE TRANSITION EAST END OF CORRIDOR	8.00		$26,250.00		$210,000	
ROADWAY COST SUBTOTAL					$3,700,000	
CATEGORY	**LENGTH (FT.)**	**WIDTH (FT.)**	**COST PER SQUARE FOOT [4]**		**SUBTOTAL**	
CANTILEVER CONSTRUCTION (FOUR-LANE)	2,115.00	65.00	$125.00		$17,200,000	
	APPROX. QUANTITY	**UNIT**	**UNIT PRICE**			
EXCAVATION-UNCLASS BORROW	18,000.00	CUYD	$4.67		$84,060.00	
EMBANKMENT IN PLACE	13,980.00	CUYD	$6.83		$95,500.00	
RETAINING WALL	31,590.00	SQFT	$50.00		$1,600,000.00	
CANTILEVER CONSTRUCTION (FOUR-LANE) SUBTOTAL					$19,000,000.00	
CATEGORY	**LENGTH (FT.)**	**WIDTH (FT.)**	**COST PER SQUARE FOOT [5]**		**SUBTOTAL**	
SOUTH FORK BRIDGE CONSTRUCTION						
EB STRUCTURE (TWO-LANE)	655.00	43.00	$175.00		$4,900,000	
WB STRUCTURE (TWO-LANE)	655.00	43.00	$175.00		$4,900,000	
STRUCTURE COST SUBTOTAL					$28,800,000	
SUBTOTAL 1					$32,500,000	
ADDITIONAL COSTS						
MISCELLANEOUS @ 20% OF SUBTOTAL 1 [6]					20%	$6,500,000
MOBILIZATION @ 18% OF SUBTOTAL 1 [7]					18%	$5,900,000
CONSTRUCTION ENGINEERING @ 15% OF SUBTOTAL 1					15%	$4,900,000
SUBTOTAL 2						$49,800,000
INDIRECT COST (IDC) - CONSTRUCTION @ 9.64% OF SUBTOTAL 2 [8]					9.64%	$4,800,000
CONTINGENCY @ 20% & 50% OF SUBTOTAL 2 [9]					20%	$10,000,000
					50%	$24,900,000
TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [10]					**$64,600,000**	
TOTAL IMPROVEMENT OPTION COST @ 50% CONTINGENCY [10]					**$79,500,000**	

[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] The planning level cost for a cantilever deck was estimated at $125 per square foot based on average MDT bridge costs and construction sequencing.
[5] Planning level costs for simple bridge structures range on average between $110 and $175 per square foot. A conservative estimate of $175 per square foot was utilized for these structures.
[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 50 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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US 2 - BADROCK CANYON CORRIDOR PLANNING STUDY - ALIGNMENT 2
FOUR LANES THROUGHOUT CORRIDOR WITH DEDICATED BICYCLE/PEDESTRIAN FACILITY
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
FOUR-LANE ROAD (FULL RECONSTRUCT)						
EXCAVATION-UNCLASS BORROW	690.00	CUYD	$4.67	$3,222.00		$3,222.00
EMBANKMENT IN PLACE	220.00	CUYD	$6.83	$1,503.00		$1,503.00
CRUSHED AGGREGATE COURSE	485.00	CUYD	$18.79	$9,113.00		$9,113.00
COVER - TYPE 2	715.00	SQYD	$0.51	$365.00		$365.00
DUST PALLIATIVE	2.00	TON		$0.00	$120.00	$240.00
PLANT MIX BIT SURF GR S-3/4 IN	195.00	TON	$25.37	$4,947.00		$4,947.00
ASPHALT CEMENT PG 64 64-28	11.00	TON	$674.59	$7,420.00		$7,420.00
EMULS ASPHALT CRS-2P	2.00	TON	$578.92	$1,158.00		$1,158.00
STRIPING-WHITE EPOXY	2.00	GAL	$61.96	$124.00		$124.00
STRIPING-YELLOW EPOXY	1.00	GAL	$62.79	$63.00		$63.00
FOUR-LANE ROAD (FULL RECONSTRUCT) SUBTOTAL				$27,915.00		$28,155.00
GUARD RAIL-STEEL/7 FOOT POSTS	500.00	LNFT	$30.20	$15,100.00		$15,100.00
REGRADE APPROACH ROAD CONNECTION	1.00	EACH		$0.00	$10,000.00	$10,000.00
REGRADE APPROACHES	12.00	EACH		$0.00	$1,000.00	$12,000.00
CATEGORY	**LENGTH (STA.)**	**COST PER STATION**			**SUBTOTAL**	
FOUR-LANE ROAD (FULL RECONSTRUCT)	117.05	$28,155.00			$3,300,000	
LANE TRANSITION WEST OF CORRIDOR	20.00	$21,600.00			$430,000	
LANE TRANSITION EAST END OF CORRIDOR	8.00	$26,250.00			$210,000	
DEDICATED BICYCLE/PEDESTRIAN FACILITY	11.50	$2,767.00			$31,800	
CONCRETE BARRIER RAIL	126.72	$7,060.00			$895,000	
ROADWAY & DEDICATED BICYCLE/PEDESTRIAN FACILITY COST SUBTOTAL					$4,900,000	
CATEGORY	**LENGTH (FT.)**	**WIDTH (FT.)**	**COST PER SQUARE FOOT [4]**		**SUBTOTAL**	
CANTILEVER CONSTRUCTION (FOUR-LANE)	2,510.00	77.00	$125.00		$24,200,000	
	APPROX. QUANTITY	**UNIT**	**UNIT PRICE**			
EXCAVATION-UNCLASS BORROW	22,000.00	CUYD	$4.67		$102,740.00	
EMBANKMENT IN PLACE	21,500.00	CUYD	$6.83		$146,800.00	
RETAINING WALL	36,500.00	SQFT	$50.00		$1,800,000.00	
CANTILEVER CONSTRUCTION (FOUR-LANE) SUBTOTAL					$26,200,000.00	
CATEGORY	**LENGTH (FT.)**	**WIDTH (FT.)**	**COST PER SQUARE FOOT [5]**		**SUBTOTAL**	
SOUTH FORK BRIDGE CONSTRUCTION						
EB STRUCTURE (TWO-LANE) [6]	655.00	55.00	$175.00		$6,300,000	
WB STRUCTURE (TWO-LANE)	655.00	43.00	$175.00		$4,900,000	
STRUCTURE COST SUBTOTAL					$37,400,000	
				SUBTOTAL 1	$42,300,000	
ADDITIONAL COSTS						
				MISCELLANEOUS @ 20% OF SUBTOTAL 1 [7]	20%	$8,500,000
				MOBILIZATION @ 18% OF SUBTOTAL 1 [8]	18%	$7,600,000
				CONSTRUCTION ENGINEERING @ 15% OF SUBTOTAL 1	15%	$6,300,000
				SUBTOTAL 2		$64,700,000
				INDIRECT COST (IDC) - CONSTRUCTION @ 9.64% OF SUBTOTAL 2 [9]	9.64%	$6,200,000
				CONTINGENCY @ 20% & 50% OF SUBTOTAL 2 [10]	20%	$12,900,000
					50%	$32,400,000
				TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [11]	**$83,800,000**	
				TOTAL IMPROVEMENT OPTION COST @ 50% CONTINGENCY [11]	**$103,300,000**	

[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 planning level cost for a cantilever deck was estimated at $125 per square foot based on average MDT bridge costs and construction sequencing.
[5] Planning level costs for simple bridge structures range on average between $110 and $175 per square foot. A conservative estimate of $175 per square foot was utilized for these structures.
[6] Dedicated bicycle/pedestrian facility could be incorporated on either eastbound or westbound bridge structure.
[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 relations.
[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 50 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.

US 2 - BADROCK CANYON CORRIDOR PLANNING STUDY - ALIGNMENT 2
FOUR LANES THROUGHOUT CORRIDOR,
ELEVATED FOUR LANE ROADWAY STRUCTURE RP 140.6 - RP 141.2
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
FOUR-LANE ROAD (FULL RECONSTRUCT)						
EXCAVATION-UNCLASS BORROW	690.00	CUYD	$4.67	$3,222.00		$3,222.00
EMBANKMENT IN PLACE	220.00	CUYD	$6.83	$1,503.00		$1,503.00
CRUSHED AGGREGATE COURSE	485.00	CUYD	$18.79	$9,113.00		$9,113.00
COVER - TYPE 2	715.00	SQYD	$0.51	$365.00		$365.00
DUST PALLIATIVE	2.00	TON		$0.00	$120.00	$240.00
PLANT MIX BIT SURF GR S-3/4 IN	195.00	TON	$25.37	$4,947.00		$4,947.00
ASPHALT CEMENT PG 64 64-28	11.00	TON	$674.59	$7,420.00		$7,420.00
EMULS ASPHALT CRS-2P	2.00	TON	$578.92	$1,158.00		$1,158.00
STRIPING-WHITE EPOXY	2.00	GAL	$61.96	$124.00		$124.00
STRIPING-YELLOW EPOXY	1.00	GAL	$62.79	$63.00		$63.00
FOUR-LANE ROAD (FULL RECONSTRUCT) SUBTOTAL				$27,915.00		$28,155.00

CATEGORY	LENGTH (STA.)	COST PER STATION	SUBTOTAL
FOUR-LANE ROAD (FULL RECONSTRUCT)	85.11	$28,155.00	$2,400,000
LANE TRANSITION WEST OF CORRIDOR	20.00	$21,600.00	$430,000
LANE TRANSITION EAST END OF CORRIDOR	8.00	$26,250.00	$210,000
ROADWAY COST SUBTOTAL			$3,000,000

CATEGORY	LENGTH (FT.)	WIDTH (FT.)	COST PER SQUARE FOOT [4]	SUBTOTAL
ELEVATED STRUCTURE (FOUR-LANE)	4,800.00	67.00	$175.00	$56,300,000
SOUTH FORK BRIDGE CONSTRUCTION				
EB STRUCTURE (TWO-LANE)	655.00	43.00	$175.00	$4,900,000
WB STRUCTURE (TWO-LANE)	655.00	43.00	$175.00	$4,900,000
STRUCTURE COST SUBTOTAL				$66,100,000
SUBTOTAL 1				$69,100,000

ADDITIONAL COSTS		
MISCELLANEOUS @ 20% OF SUBTOTAL 1 [5]	20%	$13,800,000
MOBILIZATION @ 18% OF SUBTOTAL 1 [6]	18%	$12,400,000
CONSTRUCTION ENGINEERING @ 15% OF SUBTOTAL 1	15%	$10,400,000
SUBTOTAL 2		$106,000,000
INDIRECT COST (IDC) - CONSTRUCTION @ 9.64% OF SUBTOTAL 2 [7]	9.64%	$10,200,000
CONTINGENCY @ 20% & 50% OF SUBTOTAL 2 [8]	20%	$21,200,000
	50%	$53,000,000
TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [9]		**$137,000,000**
TOTAL IMPROVEMENT OPTION COST @ 50% CONTINGENCY [9]		**$169,000,000**

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[3] Cost estimates are provided in 2012 dollars. All dollar amounts are rounded for planning purposes.
[4] Planning level costs for simple bridge structures range on average between $110 and $175 per square foot. A conservative estimate of $175 per square foot was utilized for these structures.
[5] 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.
[6] The Mobilization category includes all costs incurred in assembling and transporting materials to the work site.
[7] 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.
[8] A contingency range of 20 to 50 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.
[9] 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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US 2 - BADROCK CANYON CORRIDOR PLANNING STUDY - ALIGNMENT 2
FOUR LANES THROUGHOUT CORRIDOR,
ELEVATED FOUR LANE ROADWAY STRUCTURE RP 140.6 - RP 141.2 WITH DEDICATED BICYCLE/PEDESTRIAN FACILITY
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
FOUR-LANE ROAD (FULL RECONSTRUCT)						
EXCAVATION-UNCLASS BORROW	690.00	CUYD	$4.67	$3,222.00		$3,222.00
EMBANKMENT IN PLACE	220.00	CUYD	$6.83	$1,503.00		$1,503.00
CRUSHED AGGREGATE COURSE	485.00	CUYD	$18.79	$9,113.00		$9,113.00
COVER - TYPE 2	715.00	SQYD	$0.51	$365.00		$365.00
DUST PALLIATIVE	2.00	TON		$0.00	$120.00	$240.00
PLANT MIX BIT SURF GR S-3/4 IN	195.00	TON	$25.37	$4,947.00		$4,947.00
ASPHALT CEMENT PG 64 64-28	11.00	TON	$674.59	$7,420.00		$7,420.00
EMULS ASPHALT CRS-2P	2.00	TON	$578.92	$1,158.00		$1,158.00
STRIPING-WHITE EPOXY	2.00	GAL	$61.96	$124.00		$124.00
STRIPING-YELLOW EPOXY	1.00	GAL	$62.79	$63.00		$63.00
FOUR-LANE ROAD (FULL RECONSTRUCT) SUBTOTAL				$27,915.00		$28,155.00

CATEGORY	LENGTH (STA.)	COST PER STATION	SUBTOTAL
FOUR-LANE ROAD (FULL RECONSTRUCT)	85.11	$28,155.00	$2,400,000
LANE TRANSITION WEST OF CORRIDOR	20.00	$21,600.00	$430,000
LANE TRANSITION EAST END OF CORRIDOR	8.00	$26,250.00	$210,000
DEDICATED BICYCLE/PEDESTRIAN FACILITY	8.40	$2,767.00	$23,200
CONCRETE BARRIER RAIL	126.72	$7,060.00	$895,000
ROADWAY & DEDICATED BICYCLE/PEDESTRIAN FACILITY COST SUBTOTAL			$4,000,000

CATEGORY	LENGTH (FT.)	WIDTH (FT.)	COST PER SQUARE FOOT [4]	SUBTOTAL	
ELEVATED STRUCTURE (FOUR-LANE)	4,800.00	67.00	$175.00	$56,300,000	
SOUTH FORK BRIDGE CONSTRUCTION					
EB STRUCTURE (TWO-LANE) [5]	655.00	55.00	$175.00	$6,300,000	
WB STRUCTURE (TWO-LANE)	655.00	43.00	$175.00	$4,900,000	
STRUCTURE COST SUBTOTAL				$67,500,000	
			SUBTOTAL 1	$71,500,000	
ADDITIONAL COSTS					
			MISCELLANEOUS @ 20% OF SUBTOTAL 1 [6]	20%	$14,300,000
			MOBILIZATION @ 18% OF SUBTOTAL 1 [7]	18%	$12,900,000
			CONSTRUCTION ENGINEERING @ 15% OF SUBTOTAL 1	15%	$10,700,000
			SUBTOTAL 2		$109,000,000
			INDIRECT COST (IDC) - CONSTRUCTION @ 9.64% OF SUBTOTAL 2 [8]	9.64%	$10,500,000
			CONTINGENCY @ 20% & 50% OF SUBTOTAL 2 [9]	20%	$21,800,000
				50%	$54,500,000
			TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [10]	**$141,000,000**	
			TOTAL IMPROVEMENT OPTION COST @ 50% CONTINGENCY [10]	**$174,000,000**	

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[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] Planning level costs for simple bridge structures range on average between $110 and $175 per square foot. A conservative estimate of $175 per square foot was utilized for these structures.
[5] Dedicated bicycle/pedestrian facility could be incorporated on either eastbound or westbound bridge structure.
[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 50 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.

US 2 - BADROCK CANYON CORRIDOR PLANNING STUDY - ALIGNMENT 2
FOUR LANES THROUGHOUT CORRIDOR,
CANTILIVER AND RAISED ROADWAY STRUCTURE RP 140.0 - RP 141.2
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
FOUR-LANE ROAD (FULL RECONSTRUCT)						
EXCAVATION-UNCLASS BORROW	690.00	CUYD	$4.67	$3,222.00		$3,222.00
EMBANKMENT IN PLACE	220.00	CUYD	$6.83	$1,503.00		$1,503.00
CRUSHED AGGREGATE COURSE	485.00	CUYD	$18.79	$9,113.00		$9,113.00
COVER - TYPE 2	715.00	SQYD	$0.51	$365.00		$365.00
DUST PALLIATIVE	2.00	TON		$0.00	$120.00	$240.00
PLANT MIX BIT SURF GR S-3/4 IN	195.00	TON	$25.37	$4,947.00		$4,947.00
ASPHALT CEMENT PG 64 64-28	11.00	TON	$674.59	$7,420.00		$7,420.00
EMULS ASPHALT CRS-2P	2.00	TON	$578.92	$1,158.00		$1,158.00
STRIPING-WHITE EPOXY	2.00	GAL	$61.96	$124.00		$124.00
STRIPING-YELLOW EPOXY	1.00	GAL	$62.79	$63.00		$63.00
TWO-LANE ROAD (FULL RECONSTRUCT) SUBTOTAL				$27,915.00		$28,155.00
CATEGORY	**LENGTH (STA.)**	**COST PER STATION**			**SUBTOTAL**	
TWO-LANE ROAD (FULL RECONSTRUCT)	104.59	$28,155.00			$2,900,000	
LANE TRANSITION WEST OF CORRIDOR	20.00	$21,600.00			$430,000	
LANE TRANSITION EAST END OF CORRIDOR	8.00	$26,250.00			$210,000	
ROADWAY COST SUBTOTAL					$3,500,000	
CATEGORY	**LENGTH (FT.)**	**WIDTH (FT.)**	**COST PER SQUARE FOOT**		**SUBTOTAL**	
ELEVATED STRUCTURE (TWO-LANE) [4]	4,800.00	39.00	$175.00		$32,800,000	
CANTILEVER CONSTRUCTION (TWO-LANE) [5]	1,850.00	37.50	$125.00		$8,700,000	
	APPROX. QUANTITY	**UNIT**	**UNIT PRICE**			
EXCAVATION-UNCLASS BORROW	11,000.00	CUYD	$4.67		$51,400.00	
EMBANKMENT IN PLACE	2,665.00	CUYD	$6.83		$18,200.00	
RETAINING WALL	28,710.00	SQFT	$50.00		$1,400,000.00	
CANTILEVER CONSTRUCTION (TWO-LANE) SUBTOTAL					$10,200,000.00	
CATEGORY	**LENGTH (FT.)**	**WIDTH (FT.)**	**COST PER SQUARE FOOT** [4]		**SUBTOTAL**	
SOUTH FORK BRIDGE CONSTRUCTION						
EB STRUCTURE (TWO-LANE)	655.00	43.00	$175.00		$4,900,000	
WB STRUCTURE (TWO-LANE)	655.00	43.00	$175.00		$4,900,000	
STRUCTURE COST SUBTOTAL					$52,800,000	
SUBTOTAL 1					$56,300,000	
ADDITIONAL COSTS						
MISCELLANEOUS @ 20% OF SUBTOTAL 1 [6]					20%	$11,300,000
MOBILIZATION @ 18% OF SUBTOTAL 1 [7]					18%	$10,100,000
CONSTRUCTION ENGINEERING @ 15% OF SUBTOTAL 1					15%	$8,400,000
SUBTOTAL 2						$86,100,000
INDIRECT COST (IDC) - CONSTRUCTION @ 9.64% OF SUBTOTAL 2 [8]					9.64%	$8,300,000
CONTINGENCY @ 20% & 50% OF SUBTOTAL 2 [9]					20%	$17,200,000
					50%	$43,100,000
TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [10]					**$112,000,000**	
TOTAL IMPROVEMENT OPTION COST @ 50% CONTINGENCY [10]					**$138,000,000**	

[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] Planning level costs for simple bridge structures range on average between $110 and $175 per square foot. A conservative estimate of $175 per square foot was utilized for these structures.
[5] The planning level cost for a cantilever deck was estimated at $125 per square foot based on average MDT bridge costs.
[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 50 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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US 2 - BADROCK CANYON CORRIDOR PLANNING STUDY - ALIGNMENT 2
FOUR LANES THROUGHOUT CORRIDOR,
CANTILIVER AND RAISED ROADWAY STRUCTURE RP 140.0 - RP 141.2 WITH DEDICATED BICYCLE/PEDESTRIAN FACILITY
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
FOUR-LANE ROAD (FULL RECONSTRUCT)						
EXCAVATION-UNCLASS BORROW	690.00	CUYD	$4.67	$3,222.00		$3,222.00
EMBANKMENT IN PLACE	220.00	CUYD	$6.83	$1,503.00		$1,503.00
CRUSHED AGGREGATE COURSE	485.00	CUYD	$18.79	$9,113.00		$9,113.00
COVER - TYPE 2	715.00	SQYD	$0.51	$365.00		$365.00
DUST PALLIATIVE	2.00	TON		$0.00	$120.00	$240.00
PLANT MIX BIT SURF GR S-3/4 IN	195.00	TON	$25.37	$4,947.00		$4,947.00
ASPHALT CEMENT PG 64 64-28	11.00	TON	$674.59	$7,420.00		$7,420.00
EMULS ASPHALT CRS-2P	2.00	TON	$578.92	$1,158.00		$1,158.00
STRIPING-WHITE EPOXY	2.00	GAL	$61.96	$124.00		$124.00
STRIPING-YELLOW EPOXY	1.00	GAL	$62.79	$63.00		$63.00
TWO-LANE ROAD (FULL RECONSTRUCT) SUBTOTAL				$27,915.00		$28,155.00
CATEGORY	**LENGTH (STA.)**	**COST PER STATION**			**SUBTOTAL**	
TWO-LANE ROAD (FULL RECONSTRUCT)	104.59	$28,155.00			$2,900,000	
LANE TRANSITION WEST OF CORRIDOR	20.00	$21,600.00			$430,000	
LANE TRANSITION EAST END OF CORRIDOR	8.00	$26,250.00			$210,000	
DEDICATED BICYCLE/PEDESTRIAN FACILITY	8.40	$2,767.00			$23,200	
CONCRETE BARRIER RAIL	126.72	$7,060.00			$895,000	
ROADWAY & DEDICATED BICYCLE/PEDESTRIAN FACILITY COST SUBTOTAL					$4,500,000	
CATEGORY	**LENGTH (FT.)**	**WIDTH (FT.)**	**COST PER SQUARE FOOT**		**SUBTOTAL**	
ELEVATED STRUCTURE (TWO-LANE) [4]	4,800.00	39.00	$175.00		$32,800,000	
CANTILEVER CONSTRUCTION (TWO-LANE) [5]	1,850.00	37.50	$125.00		$8,700,000	
	APPROX. QUANTITY	**UNIT**	**UNIT PRICE**			
EXCAVATION-UNCLASS BORROW	11,000.00	CUYD	$4.67		$51,400.00	
EMBANKMENT IN PLACE	2,665.00	CUYD	$6.83		$18,200.00	
RETAINING WALL	28,710.00	SQFT	$50.00		$1,400,000.00	
CANTILEVER CONSTRUCTION (TWO-LANE) SUBTOTAL					$10,200,000.00	
CATEGORY	**LENGTH (FT.)**	**WIDTH (FT.)**	**COST PER SQUARE FOOT [4]**		**SUBTOTAL**	
SOUTH FORK BRIDGE CONSTRUCTION						
EB STRUCTURE (TWO-LANE) [6]	655.00	55.00	$175.00		$6,300,000	
WB STRUCTURE (TWO-LANE)	655.00	43.00	$175.00		$4,900,000	
STRUCTURE COST SUBTOTAL					$54,200,000	
SUBTOTAL 1					$58,700,000	
ADDITIONAL COSTS						
MISCELLANEOUS @ 20% OF SUBTOTAL 1 [7]					20%	$11,700,000
MOBILIZATION @ 18% OF SUBTOTAL 1 [8]					18%	$10,600,000
CONSTRUCTION ENGINEERING @ 15% OF SUBTOTAL 1					15%	$8,800,000
SUBTOTAL 2						$89,800,000
INDIRECT COST (IDC) - CONSTRUCTION @ 9.64% OF SUBTOTAL 2 [9]					9.64%	$8,700,000
CONTINGENCY @ 20% & 50% OF SUBTOTAL 2 [10]					20%	$18,000,000
					50%	$44,900,000
TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [11]					**$117,000,000**	
TOTAL IMPROVEMENT OPTION COST @ 50% CONTINGENCY [11]					**$143,000,000**	

[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] Planning level costs for simple bridge structures range on average between $110 and $175 per square foot. A conservative estimate of $175 per square foot was utilized for these structures.
[5] The planning level cost for a cantilever deck was estimated at $125 per square foot based on average MDT bridge costs.
[6] Dedicated bicycle/pedestrian facility could be incorporated on either eastbound or westbound bridge structure.
[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 relations.
[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 50 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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US 2 - BADROCK CANYON CORRIDOR PLANNING STUDY - ALIGNMENT 2
FOUR LANES WITH CENTER MEDIAN THROUGHOUT CORRIDOR
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
FOUR-LANE ROAD (FULL RECONSTRUCT)						
EXCAVATION-UNCLASS BORROW	765.00	CUYD	$4.67	$3,573.00		$3,573.00
EMBANKMENT IN PLACE	240.00	CUYD	$6.83	$1,639.00		$1,639.00
CRUSHED AGGREGATE COURSE	545.00	CUYD	$18.79	$10,241.00		$10,241.00
COVER - TYPE 2	825.00	SQYD	$0.51	$421.00		$421.00
DUST PALLIATIVE	2.00	TON		$0.00	$120.00	$240.00
PLANT MIX BIT SURF GR S-3/4 IN	220.00	TON	$25.37	$5,581.00		$5,581.00
ASPHALT CEMENT PG 64 64-28	12.00	TON	$674.59	$8,095.00		$8,095.00
EMULS ASPHALT CRS-2P	2.00	TON	$578.92	$1,158.00		$1,158.00
CONCRETE BARRIER RAIL	10.00	EACH	$706.02	$7,060.00		$7,060.00
STRIPING-WHITE EPOXY	2.00	GAL	$61.96	$124.00		$124.00
STRIPING-YELLOW EPOXY	2.00	GAL	$62.79	$126.00		$126.00
FOUR-LANE ROAD (FULL RECONSTRUCT) SUBTOTAL				$38,018.00		$38,258.00
GUARD RAIL-STEEL/7 FOOT POSTS	500.00	LNFT	$30.20	$15,100.00		$15,100.00
REGRADE APPROACH ROAD CONNECTION	1.00	EACH		$0.00	$10,000.00	$10,000.00
REGRADE APPROACHES	12.00	EACH		$0.00	$1,000.00	$12,000.00
CATEGORY	**LENGTH (STA.)**	**COST PER STATION**			**SUBTOTAL**	
FOUR-LANE ROAD (FULL RECONSTRUCT)	109.33	$38,258.00			$4,200,000	
LANE TRANSITION WEST OF CORRIDOR	20.00	$21,600.00			$430,000	
LANE TRANSITION EAST END OF CORRIDOR	8.00	$26,250.00			$210,000	
ROADWAY COST SUBTOTAL					$4,800,000	
CATEGORY	**LENGTH (FT.)**	**WIDTH (FT.)**	**COST PER SQUARE FOOT [4]**		**SUBTOTAL**	
CANTILEVER CONSTRUCTION (FOUR-LANE)	2,210.00	75.50	$125.00		$20,900,000	
	APPROX. QUANTITY	**UNIT**	**UNIT PRICE**			
EXCAVATION-UNCLASS BORROW	20,000.00	CUYD	$4.67		$93,400.00	
EMBANKMENT IN PLACE	18,955.00	CUYD	$6.83		$129,000.00	
RETAINING WALL	32,310.00	SQFT	$50.00		$1,600,000.00	
CANTILEVER CONSTRUCTION (FOUR-LANE) SUBTOTAL					$22,700,000.00	
CATEGORY	**LENGTH (FT.)**	**WIDTH (FT.)**	**COST PER SQUARE FOOT [5]**		**SUBTOTAL**	
SOUTH FORK BRIDGE CONSTRUCTION						
EB STRUCTURE (TWO-LANE)	655.00	43.00	$175.00		$4,900,000	
WB STRUCTURE (TWO-LANE)	655.00	43.00	$175.00		$4,900,000	
STRUCTURE COST SUBTOTAL					$32,500,000	
				SUBTOTAL 1	$37,300,000	
		ADDITIONAL COSTS				
				MISCELLANEOUS @ 20% OF SUBTOTAL 1 [6]	20%	$7,500,000
				MOBILIZATION @ 18% OF SUBTOTAL 1 [7]	18%	$6,700,000
				CONSTRUCTION ENGINEERING @ 15% OF SUBTOTAL 1	15%	$5,600,000
				SUBTOTAL 2		$57,100,000
				INDIRECT COST (IDC) - CONSTRUCTION @ 9.64% OF SUBTOTAL 2 [8]	9.64%	$5,500,000
				CONTINGENCY @ 20% & 50% OF SUBTOTAL 2 [9]	20%	$11,400,000
					50%	$28,600,000
				TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [10]	**$74,000,000**	
				TOTAL IMPROVEMENT OPTION COST @ 50% CONTINGENCY [10]	**$91,200,000**	

[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] The planning level cost for a cantilever deck was estimated at $125 per square foot based on average MDT bridge costs and construction sequencing.
[5] Planning level costs for simple bridge structures range on average between $110 and $175 per square foot. A conservative estimate of $175 per square foot was utilized for these structures.
[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 50 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

US 2 - BADROCK CANYON CORRIDOR PLANNING STUDY - ALIGNMENT 2
FOUR LANES WITH CENTER MEDIAN THROUGHOUT CORRIDOR WITH DEDICATED BICYCLE/PEDESTRIAN FACILITY
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
FOUR-LANE ROAD (FULL RECONSTRUCT)						
EXCAVATION-UNCLASS BORROW	765.00	CUYD	$4.67	$3,573.00		$3,573.00
EMBANKMENT IN PLACE	240.00	CUYD	$6.83	$1,639.00		$1,639.00
CRUSHED AGGREGATE COURSE	545.00	CUYD	$18.79	$10,241.00		$10,241.00
COVER - TYPE 2	825.00	SQYD	$0.51	$421.00		$421.00
DUST PALLIATIVE	2.00	TON		$0.00	$120.00	$240.00
PLANT MIX BIT SURF GR S-3/4 IN	220.00	TON	$25.37	$5,581.00		$5,581.00
ASPHALT CEMENT PG 64 64-28	12.00	TON	$674.59	$8,095.00		$8,095.00
EMULS ASPHALT CRS-2P	2.00	TON	$578.92	$1,158.00		$1,158.00
CONCRETE BARRIER RAIL	10.00	EACH	$706.02	$7,060.00		$7,060.00
STRIPING-WHITE EPOXY	2.00	GAL	$61.96	$124.00		$124.00
STRIPING-YELLOW EPOXY	2.00	GAL	$62.79	$126.00		$126.00
FOUR-LANE ROAD (FULL RECONSTRUCT) SUBTOTAL				$38,018.00		$38,258.00
GUARD RAIL-STEEL/7 FOOT POSTS	500.00	LNFT	$30.20	$15,100.00		$15,100.00
REGRADE APPROACH ROAD CONNECTION	1.00	EACH		$0.00	$10,000.00	$10,000.00
REGRADE APPROACHES	12.00	EACH		$0.00	$1,000.00	$12,000.00
CATEGORY	**LENGTH (STA.)**	**COST PER STATION**			**SUBTOTAL**	
FOUR-LANE ROAD (FULL RECONSTRUCT)	107.58	$38,258.00			$4,100,000	
LANE TRANSITION WEST OF CORRIDOR	20.00	$21,600.00			$430,000	
LANE TRANSITION EAST END OF CORRIDOR	8.00	$26,250.00			$210,000	
DEDICATED BICYCLE/PEDESTRIAN FACILITY	10.83	$2,767.00			$30,000	
CONCRETE BARRIER RAIL	126.72	$7,060.00			$895,000	
ROADWAY & DEDICATED BICYCLE/PEDESTRIAN FACILITY COST SUBTOTAL					$5,700,000	
CATEGORY	**LENGTH (FT.)**	**WIDTH (FT.)**	**COST PER SQUARE FOOT [4]**		**SUBTOTAL**	
CANTILEVER CONSTRUCTION (FOUR-LANE)	2,385.00	87.50	$125.00		$26,100,000	
	APPROX. QUANTITY	**UNIT**	**UNIT PRICE**			
EXCAVATION-UNCLASS BORROW	22,000.00	CUYD	$4.67		$102,740.00	
EMBANKMENT IN PLACE	23,500.00	CUYD	$6.83		$161,000.00	
RETAINING WALL	35,000.00	SQFT	$50.00		$1,800,000.00	
CANTILEVER CONSTRUCTION (FOUR-LANE) SUBTOTAL					$28,200,000.00	
CATEGORY	**LENGTH (FT.)**	**WIDTH (FT.)**	**COST PER SQUARE FOOT [5]**		**SUBTOTAL**	
SOUTH FORK BRIDGE CONSTRUCTION						
EB STRUCTURE (TWO-LANE) [6]	655.00	55.00	$175.00		$6,300,000	
WB STRUCTURE (TWO-LANE)	655.00	43.00	$175.00		$4,900,000	
STRUCTURE COST SUBTOTAL					$39,400,000	
				SUBTOTAL 1	$45,100,000	
ADDITIONAL COSTS						
				MISCELLANEOUS @ 20% OF SUBTOTAL 1 [7]	20%	$9,000,000
				MOBILIZATION @ 18% OF SUBTOTAL 1 [8]	18%	$8,100,000
				CONSTRUCTION ENGINEERING @ 15% OF SUBTOTAL 1	15%	$6,800,000
				SUBTOTAL 2		$69,000,000
				INDIRECT COST (IDC) - CONSTRUCTION @ 9.64% OF SUBTOTAL 2 [9]	9.64%	$6,700,000
				CONTINGENCY @ 20% & 50% OF SUBTOTAL 2 [10]	20%	$13,800,000
					50%	$34,500,000
				TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [11]	**$89,500,000**	
				TOTAL IMPROVEMENT OPTION COST @ 50% CONTINGENCY [11]	**$110,200,000**	

[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] The planning level cost for a cantilever deck was estimated at $125 per square foot based on average MDT bridge costs and construction sequencing.
[5] Planning level costs for simple bridge structures range on average between $110 and $175 per square foot. A conservative estimate of $175 per square foot was utilized for these structures.
[6] Dedicated bicycle/pedestrian facility could be incorporated on either eastbound or westbound bridge structure.
[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 relations.
[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 50 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.

DOWL HKM

US 2 - BADROCK CANYON CORRIDOR PLANNING STUDY - ALIGNMENT 2
FOUR LANES THROUGHOUT CORRIDOR WITH CENTER MEDIAN, ELEVATED FOUR LANE ROADWAY STRUCTURE WITH NO CENTER MEDIAN RP 140.6 - RP 141.2
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
FOUR-LANE ROAD (FULL RECONSTRUCT)						
EXCAVATION-UNCLASS BORROW	765.00	CUYD	$4.67	$3,573.00		$3,573.00
EMBANKMENT IN PLACE	240.00	CUYD	$6.83	$1,639.00		$1,639.00
CRUSHED AGGREGATE COURSE	545.00	CUYD	$18.79	$10,241.00		$10,241.00
COVER - TYPE 2	825.00	SQYD	$0.51	$421.00		$421.00
DUST PALLIATIVE	2.00	TON		$0.00	$120.00	$240.00
PLANT MIX BIT SURF GR S-3/4 IN	220.00	TON	$25.37	$5,581.00		$5,581.00
ASPHALT CEMENT PG 64 64-28	12.00	TON	$674.59	$8,095.00		$8,095.00
EMULS ASPHALT CRS-2P	2.00	TON	$578.92	$1,158.00		$1,158.00
CONCRETE BARRIER RAIL	10.00	EACH	$706.02	$7,060.00		$7,060.00
STRIPING-WHITE EPOXY	2.00	GAL	$61.96	$124.00		$124.00
STRIPING-YELLOW EPOXY	2.00	GAL	$62.79	$126.00		$126.00
FOUR-LANE ROAD (FULL RECONSTRUCT) SUBTOTAL				$38,018.00		$38,258.00
CATEGORY	**LENGTH (STA.)**		**COST PER STATION**		**SUBTOTAL**	
FOUR-LANE ROAD (FULL RECONSTRUCT)	85.11		$38,258.00		$3,300,000	
LANE TRANSITION WEST OF CORRIDOR	20.00		$21,600.00		$430,000	
LANE TRANSITION EAST END OF CORRIDOR	8.00		$26,250.00		$210,000	
ROADWAY COST SUBTOTAL					$3,900,000	
CATEGORY	**LENGTH (FT.)**	**WIDTH (FT.)**	**COST PER SQUARE FOOT [4]**		**SUBTOTAL**	
RAISED STRUCTURE (FOUR-LANE)	4,800.00	67.00	$175.00		$56,300,000	
SOUTH FORK BRIDGE CONSTRUCTION						
EB STRUCTURE (TWO-LANE)	655.00	43.00	$175.00		$4,900,000	
WB STRUCTURE (TWO-LANE)	655.00	43.00	$175.00		$4,900,000	
STRUCTURE COST SUBTOTAL					$66,100,000	
SUBTOTAL 1					$70,000,000	
ADDITIONAL COSTS						
MISCELLANEOUS @ 20% OF SUBTOTAL 1 [5]					20%	$14,000,000
MOBILIZATION @ 18% OF SUBTOTAL 1 [6]					18%	$12,600,000
CONSTRUCTION ENGINEERING @ 15% OF SUBTOTAL 1					15%	$10,500,000
SUBTOTAL 2						$107,000,000
INDIRECT COST (IDC) - CONSTRUCTION @ 9.64% OF SUBTOTAL 2 [7]					9.64%	$10,300,000
CONTINGENCY @ 20% & 50% OF SUBTOTAL 2 [8]					20%	$21,400,000
					50%	$53,500,000
TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [9]					**$139,000,000**	
TOTAL IMPROVEMENT OPTION COST @ 50% CONTINGENCY [9]					**$171,000,000**	

[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] Planning level costs for simple bridge structures range on average between $110 and $175 per square foot. A conservative estimate of $175 per square foot was utilized for these structures.
[5] 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.
[6] The Mobilization category includes all costs incurred in assembling and transporting materials to the work site.
[7] 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.
[8] A contingency range of 20 to 50 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.
[9] 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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US 2 - BADROCK CANYON CORRIDOR PLANNING STUDY - ALIGNMENT 2
FOUR LANES THROUGHOUT CORRIDOR WITH CENTER MEDIAN, ELEVATED FOUR LANE ROADWAY STRUCTURE WITH NO CENTER MEDIAN RP 140.6 - RP 141.2 WITH DEDICATED BICYCLE/PEDESTRIAN FACILITY
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
FOUR-LANE ROAD (FULL RECONSTRUCT)						
EXCAVATION-UNCLASS BORROW	765.00	CUYD	$4.67	$3,573.00		$3,573.00
EMBANKMENT IN PLACE	240.00	CUYD	$6.83	$1,639.00		$1,639.00
CRUSHED AGGREGATE COURSE	545.00	CUYD	$18.79	$10,241.00		$10,241.00
COVER - TYPE 2	825.00	SQYD	$0.51	$421.00		$421.00
DUST PALLIATIVE	2.00	TON		$0.00	$120.00	$240.00
PLANT MIX BIT SURF GR S-3/4 IN	220.00	TON	$25.37	$5,581.00		$5,581.00
ASPHALT CEMENT PG 64 64-28	12.00	TON	$674.59	$8,095.00		$8,095.00
EMULS ASPHALT CRS-2P	2.00	TON	$578.92	$1,158.00		$1,158.00
CONCRETE BARRIER RAIL	10.00	EACH	$706.02	$7,060.00		$7,060.00
STRIPING-WHITE EPOXY	2.00	GAL	$61.96	$124.00		$124.00
STRIPING-YELLOW EPOXY	2.00	GAL	$62.79	$126.00		$126.00
FOUR-LANE ROAD (FULL RECONSTRUCT) SUBTOTAL				$38,018.00		$38,258.00

CATEGORY	LENGTH (STA.)	COST PER STATION	SUBTOTAL
FOUR-LANE ROAD (FULL RECONSTRUCT)	85.11	$38,258.00	$3,300,000
LANE TRANSITION WEST OF CORRIDOR	20.00	$21,600.00	$430,000
LANE TRANSITION EAST END OF CORRIDOR	8.00	$26,250.00	$210,000
DEDICATED BICYCLE/PEDESTRIAN FACILITY	8.40	$2,767.00	$23,200
CONCRETE BARRIER RAIL	126.72	$7,060.00	$895,000
ROADWAY & DEDICATED BICYCLE/PEDESTRIAN FACILITY COST SUBTOTAL			$4,900,000

CATEGORY	LENGTH (FT.)	WIDTH (FT.)	COST PER SQUARE FOOT [4]	SUBTOTAL
RAISED STRUCTURE (FOUR-LANE)	4,800.00	67.00	$175.00	$56,300,000
SOUTH FORK BRIDGE CONSTRUCTION				
EB STRUCTURE (TWO-LANE) [5]	655.00	55.00	$175.00	$6,300,000
WB STRUCTURE (TWO-LANE)	655.00	43.00	$175.00	$4,900,000
STRUCTURE COST SUBTOTAL				$67,500,000
			SUBTOTAL 1	$72,400,000

ADDITIONAL COSTS		
MISCELLANEOUS @ 20% OF SUBTOTAL 1 [6]	20%	$14,500,000
MOBILIZATION @ 18% OF SUBTOTAL 1 [7]	18%	$13,000,000
CONSTRUCTION ENGINEERING @ 15% OF SUBTOTAL 1	15%	$10,900,000
SUBTOTAL 2		$111,000,000
INDIRECT COST (IDC) - CONSTRUCTION @ 9.64% OF SUBTOTAL 2 [8]	9.64%	$10,700,000
CONTINGENCY @ 20% & 50% OF SUBTOTAL 2 [9]	20%	$22,200,000
	50%	$55,500,000
TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [10]		**$144,000,000**
TOTAL IMPROVEMENT OPTION COST @ 50% CONTINGENCY [10]		**$177,000,000**

[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] Planning level costs for simple bridge structures range on average between $110 and $175 per square foot. A conservative estimate of $175 per square foot was utilized for these structures.
[5] Dedicated bicycle/pedestrian facility could be incorporated on either eastbound or westbound bridge structure.
[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 50 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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US 2 - BADROCK CANYON CORRIDOR PLANNING STUDY - ALIGNMENT 2
FOUR LANES THROUGHOUT CORRIDOR WITH TURN BAY AT BERNE PARK
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
FOUR-LANE ROAD (FULL RECONSTRUCT)						
EXCAVATION-UNCLASS BORROW	795.00	CUYD	$4.67	$3,713.00		$3,713.00
EMBANKMENT IN PLACE	250.00	CUYD	$6.83	$1,708.00		$1,708.00
CRUSHED AGGREGATE COURSE	570.00	CUYD	$18.79	$10,710.00		$10,710.00
COVER - TYPE 2	870.00	SQYD	$0.51	$444.00		$444.00
DUST PALLIATIVE	2.00	TON		$0.00	$120.00	$240.00
PLANT MIX BIT SURF GR S-3/4 IN	235.00	TON	$25.37	$5,962.00		$5,962.00
ASPHALT CEMENT PG 64 64-28	13.00	TON	$674.59	$8,770.00		$8,770.00
EMULS ASPHALT CRS-2P	2.00	TON	$578.92	$1,158.00		$1,158.00
STRIPING-WHITE EPOXY	2.00	GAL	$61.96	$124.00		$124.00
STRIPING-YELLOW EPOXY	3.00	GAL	$62.79	$188.00		$188.00
FOUR-LANE ROAD (FULL RECONSTRUCT) SUBTOTAL				$32,777.00		$33,017.00
GUARD RAIL-STEEL/7 FOOT POSTS	500.00	LNFT	$30.20	$15,100.00		$15,100.00
REGRADE APPROACH ROAD CONNECTION	1.00	EACH		$0.00	$10,000.00	$10,000.00
REGRADE APPROACHES	12.00	EACH		$0.00	$1,000.00	$12,000.00

CATEGORY	LENGTH (STA.)	COST PER STATION	SUBTOTAL
FOUR-LANE ROAD (FULL RECONSTRUCT)	109.33	$33,017.00	$3,600,000
LANE TRANSITION WEST OF CORRIDOR	20.00	$21,600.00	$430,000
LANE TRANSITION EAST END OF CORRIDOR	8.00	$26,250.00	$210,000
ROADWAY COST SUBTOTAL			$4,200,000

CATEGORY	LENGTH (FT.)	WIDTH (FT.)	COST PER SQUARE FOOT [4]	SUBTOTAL
CANTILEVER CONSTRUCTION (FOUR-LANE)	2,210.00	75.50	$125.00	$20,900,000
	APPROX. QUANTITY	**UNIT**	**UNIT PRICE**	
EXCAVATION-UNCLASS BORROW	20,000.00	CUYD	$4.67	$93,400.00
EMBANKMENT IN PLACE	18,955.00	CUYD	$6.83	$129,000.00
RETAINING WALL	32,310.00	SQFT	$50.00	$1,600,000.00
CANTILEVER CONSTRUCTION (FOUR-LANE) SUBTOTAL				$22,700,000.00

CATEGORY	LENGTH (FT.)	WIDTH (FT.)	COST PER SQUARE FOOT [5]	SUBTOTAL
SOUTH FORK BRIDGE CONSTRUCTION				
EB STRUCTURE (TWO-LANE)	655.00	43.00	$175.00	$4,900,000
WB STRUCTURE (TWO-LANE)	655.00	43.00	$175.00	$4,900,000
STRUCTURE COST SUBTOTAL				$32,500,000
			SUBTOTAL 1	$36,700,000

ADDITIONAL COSTS		
MISCELLANEOUS @ 20% OF SUBTOTAL 1 [6]	20%	$7,300,000
MOBILIZATION @ 18% OF SUBTOTAL 1 [7]	18%	$6,600,000
CONSTRUCTION ENGINEERING @ 15% OF SUBTOTAL 1	15%	$5,500,000
SUBTOTAL 2		$56,100,000
INDIRECT COST (IDC) - CONSTRUCTION @ 9.64% OF SUBTOTAL 2 [8]	9.64%	$5,400,000
CONTINGENCY @ 20% & 50% OF SUBTOTAL 2 [9]	20%	$11,200,000
	50%	$28,100,000
TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [10]		**$72,700,000**
TOTAL IMPROVEMENT OPTION COST @ 50% CONTINGENCY [10]		**$89,600,000**

[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] The planning level cost for a cantilever deck was estimated at $125 per square foot based on average MDT bridge costs and construction sequencing.
[5] Planning level costs for simple bridge structures range on average between $110 and $175 per square foot. A conservative estimate of $175 per square foot was utilized for these structures.
[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 50 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.

US 2 - BADROCK CANYON CORRIDOR PLANNING STUDY - ALIGNMENT 2
FOUR LANES THROUGHOUT CORRIDOR WITH TURN BAY AT BERNE PARK & WITH DEDICATED BICYCLE/PEDESTRIAN FACILITY
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
FOUR-LANE ROAD (FULL RECONSTRUCT)						
EXCAVATION-UNCLASS BORROW	795.00	CUYD	$4.67	$3,713.00		$3,713.00
EMBANKMENT IN PLACE	250.00	CUYD	$6.83	$1,708.00		$1,708.00
CRUSHED AGGREGATE COURSE	570.00	CUYD	$18.79	$10,710.00		$10,710.00
COVER - TYPE 2	870.00	SQYD	$0.51	$444.00		$444.00
DUST PALLIATIVE	2.00	TON		$0.00	$120.00	$240.00
PLANT MIX BIT SURF GR S-3/4 IN	235.00	TON	$25.37	$5,962.00		$5,962.00
ASPHALT CEMENT PG 64 64-28	13.00	TON	$674.59	$8,770.00		$8,770.00
EMULS ASPHALT CRS-2P	2.00	TON	$578.92	$1,158.00		$1,158.00
STRIPING-WHITE EPOXY	2.00	GAL	$61.96	$124.00		$124.00
STRIPING-YELLOW EPOXY	3.00	GAL	$62.79	$188.00		$188.00
FOUR-LANE ROAD (FULL RECONSTRUCT) SUBTOTAL				$32,777.00		$33,017.00
GUARD RAIL-STEEL/7 FOOT POSTS	500.00	LNFT	$30.20	$15,100.00		$15,100.00
REGRADE APPROACH ROAD CONNECTION	1.00	EACH		$0.00	$10,000.00	$10,000.00
REGRADE APPROACHES	12.00	EACH		$0.00	$1,000.00	$12,000.00
CATEGORY	**LENGTH (STA.)**	**COST PER STATION**			**SUBTOTAL**	
FOUR-LANE ROAD (FULL RECONSTRUCT)	117.05	$33,017.00			$3,900,000	
LANE TRANSITION WEST OF CORRIDOR	20.00	$21,600.00			$430,000	
LANE TRANSITION EAST END OF CORRIDOR	8.00	$26,250.00			$210,000	
DEDICATED BICYCLE/PEDESTRIAN FACILITY	11.50	$2,767.00			$31,800	
CONCRETE BARRIER RAIL	126.72	$7,060.00			$895,000	
ROADWAY & DEDICATED BICYCLE/PEDESTRIAN FACILITY COST SUBTOTAL					$5,500,000	
CATEGORY	**LENGTH (FT.)**	**WIDTH (FT.)**	**COST PER SQUARE FOOT [4]**		**SUBTOTAL**	
CANTILEVER CONSTRUCTION (FOUR-LANE)	2,510.00	77.00	$125.00		$24,200,000	
	APPROX. QUANTITY	**UNIT**	**UNIT PRICE**			
EXCAVATION-UNCLASS BORROW	22,000.00	CUYD	$4.67		$102,700.00	
EMBANKMENT IN PLACE	21,500.00	CUYD	$6.83		$147,000.00	
RETAINING WALL	36,500.00	SQFT	$50.00		$1,800,000.00	
CANTILEVER CONSTRUCTION (FOUR-LANE) SUBTOTAL					$26,200,000.00	
CATEGORY	**LENGTH (FT.)**	**WIDTH (FT.)**	**COST PER SQUARE FOOT [5]**		**SUBTOTAL**	
SOUTH FORK BRIDGE CONSTRUCTION						
EB STRUCTURE (TWO-LANE) [6]	655.00	55.00	$175.00		$6,300,000	
WB STRUCTURE (TWO-LANE)	655.00	43.00	$175.00		$4,900,000	
STRUCTURE COST SUBTOTAL					$37,400,000	
SUBTOTAL 1					$42,900,000	
ADDITIONAL COSTS						
MISCELLANEOUS @ 20% OF SUBTOTAL 1 [7]					20%	$8,600,000
MOBILIZATION @ 18% OF SUBTOTAL 1 [8]					18%	$7,700,000
CONSTRUCTION ENGINEERING @ 15% OF SUBTOTAL 1					15%	$6,400,000
SUBTOTAL 2						$65,600,000
INDIRECT COST (IDC) - CONSTRUCTION @ 9.64% OF SUBTOTAL 2 [9]					9.64%	$6,300,000
CONTINGENCY @ 20% & 50% OF SUBTOTAL 2 [10]					20%	$13,100,000
					50%	$32,800,000
TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [11]					**$85,000,000**	
TOTAL IMPROVEMENT OPTION COST @ 50% CONTINGENCY [11]					**$104,700,000**	

[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 planning level cost for a cantilever deck was estimated at $125 per square foot based on average MDT bridge costs and construction sequencing.
[5] Planning level costs for simple bridge structures range on average between $110 and $175 per square foot. A conservative estimate of $175 per square foot was utilized for these structures.
[6] Dedicated bicycle/pedestrian facility could be incorporated on either eastbound or westbound bridge structure.
[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 relations.
[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 50 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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US 2 - BADROCK CANYON CORRIDOR PLANNING STUDY - ALIGNMENT 3
FOUR LANES THROUGHOUT CORRIDOR,
FOUR LANE TUNNEL RP 140.6 - RP 141.1
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
FOUR-LANE ROAD (FULL RECONSTRUCT)						
EXCAVATION-UNCLASS BORROW	690.00	CUYD	$4.67	$3,222.00		$3,222.00
EMBANKMENT IN PLACE	220.00	CUYD	$6.83	$1,503.00		$1,503.00
CRUSHED AGGREGATE COURSE	485.00	CUYD	$18.79	$9,113.00		$9,113.00
COVER - TYPE 2	715.00	SQYD	$0.51	$365.00		$365.00
DUST PALLIATIVE	2.00	TON		$0.00	$120.00	$240.00
PLANT MIX BIT SURF GR S-3/4 IN	195.00	TON	$25.37	$4,947.00		$4,947.00
ASPHALT CEMENT PG 64 64-28	11.00	TON	$674.59	$7,420.00		$7,420.00
EMULS ASPHALT CRS-2P	2.00	TON	$578.92	$1,158.00		$1,158.00
STRIPING-WHITE EPOXY	2.00	GAL	$61.96	$124.00		$124.00
STRIPING-YELLOW EPOXY	1.00	GAL	$62.79	$63.00		$63.00
FOUR-LANE ROAD (FULL RECONSTRUCT) SUBTOTAL				$27,915.00		$28,155.00
GUARD RAIL-STEEL/7 FOOT POSTS	850.00	LNFT	$30.20	$25,670.00		$25,670.00
REGRADE APPROACH ROAD CONNECTION	3.00	EACH		$0.00	$10,000.00	$30,000.00
ADDITIONAL EXCAVATION-UNCLASSIFIED	10,500.00	CUYD	$4.27	$44,835.00		$44,835.00
REGRADE APPROACHES	12.00	EACH		$0.00	$1,000.00	$12,000.00
CATEGORY	**LENGTH (STA.)**	**COST PER STATION**			**SUBTOTAL**	
FOUR-LANE ROAD (FULL RECONSTRUCT)	104.59	$28,155.00			$2,900,000	
LANE TRANSITION WEST OF CORRIDOR	20.00	$21,600.00			$430,000	
LANE TRANSITION EAST END OF CORRIDOR	8.00	$26,250.00			$210,000	
TUNNEL CONSTRUCTION (FOUR-LANE) [4]	27.47	$7,300,000.00			$201,000,000	
ROADWAY COST SUBTOTAL					$205,000,000	
CATEGORY	**LENGTH (FT.)**	**WIDTH (FT.)**	**COST PER SQUARE FOOT** [5]		**SUBTOTAL**	
SOUTH FORK BRIDGE CONSTRUCTION						
EB STRUCTURE (TWO-LANE)	655.00	43.00	$175.00		$4,900,000	
WB STRUCTURE (TWO-LANE)	655.00	43.00	$175.00		$4,900,000	
STRUCTURE COST SUBTOTAL					$9,800,000	
				SUBTOTAL 1	$215,000,000	
ADDITIONAL COSTS						
				MISCELLANEOUS @ 20% OF SUBTOTAL 1 [6]	20%	$43,000,000
				MOBILIZATION @ 18% OF SUBTOTAL 1 [7]	18%	$38,700,000
				CONSTRUCTION ENGINEERING @ 15% OF SUBTOTAL 1	15%	$32,300,000
				SUBTOTAL 2		$329,000,000
				INDIRECT COST (IDC) - CONSTRUCTION @ 9.64% OF SUBTOTAL 2 [8]	9.64%	$31,700,000
				CONTINGENCY @ 30% & 60% OF SUBTOTAL 2 [9]	30%	$98,700,000
					60%	$197,000,000
				TOTAL IMPROVEMENT OPTION COST @ 30% CONTINGENCY [10]	**$459,000,000**	
				TOTAL IMPROVEMENT OPTION COST @ 60% CONTINGENCY [10]	**$558,000,000**	

[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] Unit cost provided by MDT Geotechnical Division.
[5] Planning level costs for simple bridge structures range on average between $110 and $175 per square foot. A conservative estimate of $175 per square foot was utilized for these structures.
[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 30 to 60 percent was used due to the high degree of unknown factors involved in rock excavation and uncertainties 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.

US 2 - BADROCK CANYON CORRIDOR PLANNING STUDY - ALIGNMENT 3
FOUR LANES THROUGHOUT CORRIDOR,
TWO LANE TUNNEL AND TWO LANE CANTILEVER RP 140.6 - RP 141.1
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
FOUR-LANE ROAD (FULL RECONSTRUCT)						
EXCAVATION-UNCLASS BORROW	690.00	CUYD	$4.67	$3,222.00		$3,222.00
EMBANKMENT IN PLACE	220.00	CUYD	$6.83	$1,503.00		$1,503.00
CRUSHED AGGREGATE COURSE	485.00	CUYD	$18.79	$9,113.00		$9,113.00
COVER - TYPE 2	715.00	SQYD	$0.51	$365.00		$365.00
DUST PALLIATIVE	2.00	TON		$0.00	$120.00	$240.00
PLANT MIX BIT SURF GR S-3/4 IN	195.00	TON	$25.37	$4,947.00		$4,947.00
ASPHALT CEMENT PG 64 64-28	11.00	TON	$674.59	$7,420.00		$7,420.00
EMULS ASPHALT CRS-2P	2.00	TON	$578.92	$1,158.00		$1,158.00
STRIPING-WHITE EPOXY	2.00	GAL	$61.96	$124.00		$124.00
STRIPING-YELLOW EPOXY	1.00	GAL	$62.79	$63.00		$63.00
FOUR-LANE ROAD (FULL RECONSTRUCT) SUBTOTAL				$27,915.00		$28,155.00
GUARD RAIL-STEEL/7 FOOT POSTS	850.00	LNFT	$30.20	$25,670.00		$25,670.00
REGRADE APPROACH ROAD CONNECTION	3.00	EACH		$0.00	$10,000.00	$30,000.00
ADDITIONAL EXCAVATION-UNCLASSIFIED	7,000.00	CUYD	$4.27	$29,890.00		$29,890.00
REGRADE APPROACHES	12.00	EACH		$0.00	$1,000.00	$12,000.00
CATEGORY	**LENGTH (STA.)**	**COST PER STATION**			**SUBTOTAL**	
FOUR-LANE ROAD (FULL RECONSTRUCT)	104.59	$28,155.00			$2,900,000	
LANE TRANSITION WEST OF CORRIDOR	20.00	$21,600.00			$430,000	
LANE TRANSITION EAST END OF CORRIDOR	8.00	$26,250.00			$210,000	
TUNNEL CONSTRUCTION (TWO-LANE) [4]	27.47	$5,500,000.00			$151,000,000	
ROADWAY COST SUBTOTAL					$155,000,000	
CATEGORY	**LENGTH (FT.)**	**WIDTH (FT.)**	**COST PER SQUARE FOOT** [5]		**SUBTOTAL**	
CANTILEVER CONSTRUCTION (TWO-LANE)	1,850.00	41.50	$125.00		$9,600,000	
	APPROX. QUANTITY	**UNIT**	**UNIT PRICE**			
EXCAVATION-UNCLASS BORROW	11,000.00	CUYD	$4.67		$51,400.00	
EMBANKMENT IN PLACE	2,665.00	CUYD	$6.83		$18,200.00	
RETAINING WALL	28,710.00	SQFT	$50.00		$1,400,000.00	
CANTILEVER CONSTRUCTION (TWO-LANE) SUBTOTAL					$11,100,000.00	
CATEGORY	**LENGTH (FT.)**	**WIDTH (FT.)**	**COST PER SQUARE FOOT** [6]		**SUBTOTAL**	
SOUTH FORK BRIDGE CONSTRUCTION						
EB STRUCTURE (TWO-LANE)	655.00	43.00	$175.00		$4,900,000	
WB STRUCTURE (TWO-LANE)	655.00	43.00	$175.00		$4,900,000	
STRUCTURE COST SUBTOTAL					$20,900,000	
SUBTOTAL 1					$187,000,000	
ADDITIONAL COSTS						
MISCELLANEOUS @ 20% OF SUBTOTAL 1 [7]					20%	$37,400,000
MOBILIZATION @ 18% OF SUBTOTAL 1 [8]					18%	$33,700,000
CONSTRUCTION ENGINEERING @ 15% OF SUBTOTAL 1					15%	$28,100,000
SUBTOTAL 2						$286,000,000
INDIRECT COST (IDC) - CONSTRUCTION @ 9.64% OF SUBTOTAL 2 [9]					9.64%	$27,600,000
CONTINGENCY @ 30% & 60% OF SUBTOTAL 2 [10]					30%	$85,800,000
					60%	$172,000,000
TOTAL IMPROVEMENT OPTION COST @ 30% CONTINGENCY [11]					**$399,000,000**	
TOTAL IMPROVEMENT OPTION COST @ 60% CONTINGENCY [11]					**$486,000,000**	

[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] Unit cost provided by MDT Geotechnical Division.
[5] The planning level cost for a cantilever deck was estimated at $125 per square foot based on average MDT bridge costs.
[6] Planning level costs for simple bridge structures range on average between $110 and $175 per square foot. A conservative estimate of $175 per square foot was utilized for these structures.
[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 relations.
[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 30 to 60 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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US 2 - BADROCK CANYON CORRIDOR PLANNING STUDY - ALIGNMENT 4
FOUR LANES THROUGHOUT CORRIDOR
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
FOUR-LANE ROAD (FULL RECONSTRUCT)						
EXCAVATION-UNCLASS BORROW	690.00	CUYD	$4.67	$3,222.00		$3,222.00
EMBANKMENT IN PLACE	220.00	CUYD	$6.83	$1,503.00		$1,503.00
CRUSHED AGGREGATE COURSE	485.00	CUYD	$18.79	$9,113.00		$9,113.00
COVER - TYPE 2	715.00	SQYD	$0.51	$365.00		$365.00
DUST PALLIATIVE	2.00	TON		$0.00	$120.00	$240.00
PLANT MIX BIT SURF GR S-3/4 IN	195.00	TON	$25.37	$4,947.00		$4,947.00
ASPHALT CEMENT PG 64 64-28	11.00	TON	$674.59	$7,420.00		$7,420.00
EMULS ASPHALT CRS-2P	2.00	TON	$578.92	$1,158.00		$1,158.00
STRIPING-WHITE EPOXY	2.00	GAL	$61.96	$124.00		$124.00
STRIPING-YELLOW EPOXY	1.00	GAL	$62.79	$63.00		$63.00
FOUR-LANE ROAD (FULL RECONSTRUCT) SUBTOTAL				$27,915.00		$28,155.00
GUARD RAIL-STEEL/7 FOOT POSTS	800.00	LNFT	$30.20	$24,160.00		$24,160.00
REGRADE APPROACH ROAD CONNECTION	3.00	EACH		$0.00	$10,000.00	$30,000.00
PAVEMENT REMOVAL	1,700.00	CUYD		$0.00	$3.00	$5,100.00
ADDITIONAL EXCAVATION-UNCLASSIFIED	8,000.00	CUYD	$4.27	$34,160.00		$34,160.00
REGRADE APPROACHES	6.00	EACH		$0.00	$1,000.00	$6,000.00
CATEGORY	**LENGTH (STA.)**	**COST PER STATION**			**SUBTOTAL**	
FOUR-LANE ROAD (FULL RECONSTRUCT)	109.93	$28,155.00			$3,100,000	
LANE TRANSITION WEST OF CORRIDOR	20.00	$21,600.00			$430,000	
LANE TRANSITION EAST END OF CORRIDOR	8.00	$26,250.00			$210,000	
ROADWAY COST SUBTOTAL					$3,700,000	
CATEGORY	**LENGTH (FT.)**	**WIDTH (FT.)**	**COST PER SQUARE FOOT [4]**		**SUBTOTAL**	
BRIDGE CONSTRUCTION						
WEST STRUCTURE (FOUR-LANE)	800.00	67.00	$175.00		$9,400,000	
MIDDLE STRUCTURE (FOUR-LANE)	1,050.00	67.00	$175.00		$12,300,000	
SOUTH FORK BRIDGE STRUCTURE EB (TWO-LANE)	655.00	43.00	$175.00		$4,900,000	
SOUTH FORK BRIDGE STRUCTURE WB (TWO-LANE)	655.00	43.00	$175.00		$4,900,000	
STRUCTURE COST SUBTOTAL					$31,500,000	
				SUBTOTAL 1	$35,300,000	
ADDITIONAL COSTS						
				MISCELLANEOUS @ 20% OF SUBTOTAL 1 [5]	20%	$7,100,000
				MOBILIZATION @ 18% OF SUBTOTAL 1 [7]	18%	$6,400,000
				CONSTRUCTION ENGINEERING @ 15% OF SUBTOTAL 1	15%	$5,300,000
				SUBTOTAL 2		$54,100,000
				INDIRECT COST (IDC) - CONSTRUCTION @ 9.64% OF SUBTOTAL 2 [7]	9.64%	$5,200,000
				CONTINGENCY @ 20% & 50% OF SUBTOTAL 2 [9]	20%	$10,800,000
					50%	$27,100,000
				TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [10]	**$70,100,000**	
				TOTAL IMPROVEMENT OPTION COST @ 50% CONTINGENCY [10]	**$86,400,000**	

[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] Planning level costs for simple bridge structures range on average between $110 and $175 per square foot. A conservative estimate of $175 per square foot was utilized for these structures.
[5] 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.
[6] The Mobilization category includes all costs incurred in assembling and transporting materials to the work site.
[7] 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.
[8] A contingency range of 20 to 50 percent was used due to the high degree of unknown factors involved in rock excavation and uncertainties over the planning horizon, as well as the substantial amount of items not accounted for in this planning level cost estimate.
[9] 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.

US 2 - BADROCK CANYON CORRIDOR PLANNING STUDY - ALIGNMENT 5
FOUR LANES THROUGHOUT CORRIDOR
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
FOUR-LANE ROAD (FULL RECONSTRUCT)						
EXCAVATION-UNCLASS BORROW	690.00	CUYD	$4.67	$3,222.00		$3,222.00
EMBANKMENT IN PLACE	220.00	CUYD	$6.83	$1,503.00		$1,503.00
CRUSHED AGGREGATE COURSE	485.00	CUYD	$18.79	$9,113.00		$9,113.00
COVER - TYPE 2	715.00	SQYD	$0.51	$365.00		$365.00
DUST PALLIATIVE	2.00	TON		$0.00	$120.00	$240.00
PLANT MIX BIT SURF GR S-3/4 IN	195.00	TON	$25.37	$4,947.00		$4,947.00
ASPHALT CEMENT PG 64 64-28	11.00	TON	$674.59	$7,420.00		$7,420.00
EMULS ASPHALT CRS-2P	2.00	TON	$578.92	$1,158.00		$1,158.00
STRIPING-WHITE EPOXY	2.00	GAL	$61.96	$124.00		$124.00
STRIPING-YELLOW EPOXY	1.00	GAL	$62.79	$63.00		$63.00
FOUR-LANE ROAD (FULL RECONSTRUCT) SUBTOTAL				$27,915.00		$28,155.00
GUARD RAIL-STEEL/7 FOOT POSTS	800.00	LNFT	$30.20	$24,160.00		$24,160.00
REGRADE APPROACH ROAD CONNECTION	3.00	EACH		$0.00	$10,000.00	$30,000.00
PAVEMENT REMOVAL	1,700.00	CUYD		$0.00	$3.00	$5,100.00
RELOCATE PRIVATE ROAD	1.00	LS		$0.00	$20,000.00	$20,000.00
ADDITIONAL EXCAVATION-UNCLASSIFIED	8,000.00	CUYD	$4.27	$34,160.00		$34,160.00
REGRADE APPROACHES	6.00	EACH		$0.00	$1,000.00	$6,000.00
CATEGORY	**LENGTH (STA.)**	**COST PER STATION**			**SUBTOTAL**	
FOUR-LANE ROAD (FULL RECONSTRUCT)	99.25	$28,155.00			$2,800,000	
LANE TRANSITION WEST OF CORRIDOR	20.00	$21,600.00			$430,000	
LANE TRANSITION EAST END OF CORRIDOR	8.00	$26,250.00			$210,000	
ROADWAY COST SUBTOTAL					$3,400,000	
CATEGORY	**LENGTH (FT.)**	**WIDTH (FT.)**	**COST PER SQUARE FOOT [4]**		**SUBTOTAL**	
BRIDGE CONSTRUCTION (FOUR-LANE)						
WEST STRUCTURE	800.00	67.00	$175.00		$9,400,000	
MIDDLE STRUCTURE	1,729.00	67.00	$175.00		$20,300,000	
EAST STRUCTURE	1,012.00	67.00	$175.00		$11,900,000	
STRUCTURE COST SUBTOTAL					$41,600,000	
SUBTOTAL 1					$45,100,000	
ADDITIONAL COSTS						
MISCELLANEOUS @ 20% OF SUBTOTAL 1 [5]					20%	$9,000,000
MOBILIZATION @ 18% OF SUBTOTAL 1 [7]					18%	$8,100,000
CONSTRUCTION ENGINEERING @ 15% OF SUBTOTAL 1					15%	$6,800,000
SUBTOTAL 2						$69,000,000
INDIRECT COST (IDC) - CONSTRUCTION @ 9.64% OF SUBTOTAL 2 [7]					9.64%	$6,700,000
CONTINGENCY @ 20% & 50% OF SUBTOTAL 2 [9]					20%	$13,800,000
					50%	$34,500,000
TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [10]					**$89,500,000**	
TOTAL IMPROVEMENT OPTION COST @ 50% CONTINGENCY [10]					**$110,000,000**	

[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] Planning level costs for simple bridge structures range on average between $110 and $175 per square foot. A conservative estimate of $175 per square foot was utilized for these structures.
[5] 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.
[6] The Mobilization category includes all costs incurred in assembling and transporting materials to the work site.
[7] 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.
[8] A contingency range of 20 to 50 percent was used due to the high degree of unknown factors involved in rock excavation and uncertainties over the planning horizon, as well as the substantial amount of items not accounted for in this planning level cost estimate.
[9] 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.

US 2 - BADROCK CANYON CORRIDOR PLANNING STUDY - ALIGNMENT 6
FOUR LANES THROUGHOUT CORRIDOR
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
FOUR-LANE ROAD (FULL CONSTRUCT)						
EXCAVATION-UNCLASS BORROW	690.00	CUYD	$4.67	$3,222.00		$3,222.00
EMBANKMENT IN PLACE	220.00	CUYD	$6.83	$1,503.00		$1,503.00
CRUSHED AGGREGATE COURSE	485.00	CUYD	$18.79	$9,113.00		$9,113.00
COVER - TYPE 2	715.00	SQYD	$0.51	$365.00		$365.00
DUST PALLIATIVE	2.00	TON		$0.00	$120.00	$240.00
PLANT MIX BIT SURF GR S-3/4 IN	195.00	TON	$25.37	$4,947.00		$4,947.00
ASPHALT CEMENT PG 64 64-28	11.00	TON	$674.59	$7,420.00		$7,420.00
EMULS ASPHALT CRS-2P	2.00	TON	$578.92	$1,158.00		$1,158.00
STRIPING-WHITE EPOXY	2.00	GAL	$61.96	$124.00		$124.00
STRIPING-YELLOW EPOXY	1.00	GAL	$62.79	$63.00		$63.00
FOUR-LANE ROAD (FULL CONSTRUCT) SUBTOTAL				$27,915.00		$28,155.00
TWO-LANE US 2 REALIGNMENT (FULL RECONSTRUCT)						
EXCAVATION-UNCLASS BORROW	515.00	CUYD	$4.67	$2,405.00		$2,405.00
EMBANKMENT IN PLACE	160.00	CUYD	$6.83	$1,093.00		$1,093.00
CRUSHED AGGREGATE COURSE	345.00	CUYD	$18.79	$6,483.00		$6,483.00
COVER - TYPE 2	445.00	SQYD	$0.51	$227.00		$227.00
DUST PALLIATIVE	1.00	TON		$0.00	$120.00	$120.00
PLANT MIX BIT SURF GR S-3/4 IN	125.00	TON	$25.37	$3,171.00		$3,171.00
ASPHALT CEMENT PG 64 64-28	7.00	TON	$674.59	$4,722.00		$4,722.00
EMULS ASPHALT CRS-2P	1.00	TON	$578.92	$579.00		$579.00
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-LANE ROAD (FULL RECONSTRUCT) SUBTOTAL				$18,805.00		$18,925
ADDITIONAL EXCAVATION-UNCLASSIFIED	348,000.00	CUYD	$4.27	$1,485,960.00		$1,485,960.00
EMBANKMENT IN PLACE	5,144,000.00	CUYD	$6.83	$35,133,520.00		$35,133,520.00
GUARD RAIL-STEEL/7 FOOT POSTS	4,800.00	LNFT	$30.20	$144,960.00		$144,960.00
REINFORCED CONCRETE RETAINING WALL	9,200.00	SQFT	$25.00	$230,000.00	$50.00	$460,000.00
REGRADE APPROACH ROAD CONNECTION	1.00	EACH		$0.00	$10,000.00	$10,000.00
CATEGORY	**LENGTH (STA.)**	**COST PER STATION**			**SUBTOTAL**	
FOUR-LANE ROAD (FULL CONSTRUCT)	31.54	$28,155.00			$890,000	
LANE TRANSITION WEST OF CORRIDOR	20.00	$21,600.00			$430,000	
LANE TRANSITION EAST END OF CORRIDOR	8.00	$26,250.00			$210,000	
TWO-LANE US 2 REALIGNMENT (FULL RECONSTRUCT)	9.00	$18,925.00			$170,000	
ROADWAY COST SUBTOTAL					$1,700,000	
CATEGORY	**LENGTH (FT.)**	**WIDTH (FT.)**	**COST PER SQUARE FOOT [4]**		**SUBTOTAL**	
BRIDGE CONSTRUCTION						
WEST STRUCTURE (FOUR-LANE)	3830.00	67.00	$175.00		$44,900,000	
MIDDLE STRUCTURE (FOUR-LANE)	1,744.00	67.00	$175.00		$20,400,000	
EAST STRUCTURE (FOUR-LANE)	4303.00	67.00	$175.00		$50,500,000	
STRUCTURE COST SUBTOTAL					$116,000,000	
SUBTOTAL 1					$155,000,000	
ADDITIONAL COSTS						
MISCELLANEOUS @ 20% OF SUBTOTAL 1 [5]					20%	$31,000,000
MOBILIZATION @ 18% OF SUBTOTAL 1 [7]					18%	$27,900,000
CONSTRUCTION ENGINEERING @ 15% OF SUBTOTAL 1					15%	$23,300,000
SUBTOTAL 2						$237,000,000
INDIRECT COST (IDC) - CONSTRUCTION @ 9.64% OF SUBTOTAL 2 [7]					9.64%	$22,800,000
CONTINGENCY @ 20% & 50% OF SUBTOTAL 2 [9]					20%	$47,400,000
					50%	$119,000,000
TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [10]					**$307,000,000**	
TOTAL IMPROVEMENT OPTION COST @ 50% CONTINGENCY [10]					**$379,000,000**	

[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] Planning level costs for simple bridge structures range on average between $110 and $175 per square foot. A conservative estimate of $175 per square foot was utilized for these structures.
[5] 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.
[6] The Mobilization category includes all costs incurred in assembling and transporting materials to the work site.
[7] 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.
[8] A contingency range of 20 to 50 percent was used due to the high degree of unknown factors involved in rock excavation and uncertainties over the planning horizon, as well as the substantial amount of items not accounted for in this planning level cost estimate.
[9] 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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US 2 - BADROCK CANYON CORRIDOR PLANNING STUDY - CANTILEVER CONSTRUCTION (TWO LANES) RP 140.6 - RP 141.2
Planning Level Estimate of Costs

Cantilever Construction (Two-Lane)	Length (FT.)	Width (FT.)	Cost Per Square Foot [1]	Subtotal	
CANTILEVER CONSTRUCTION (TWO-LANE)	1,850.00	41.50	$125.00	$9,600,000	
	APPROX. QUANTITY	**UNIT**	**UNIT PRICE**		
EXCAVATION-UNCLASS BORROW	11,000.00	CUYD	$4.67	$51,400.00	
EMBANKMENT IN PLACE	2,665.00	CUYD	$6.83	$18,200.00	
RETAINING WALL	28,710.00	SQFT	$50.00	$1,400,000.00	
CANTILEVER CONSTRUCTION (TWO-LANE) SUBTOTAL				$11,100,000.00	
STRUCTURE COST SUBTOTAL				$11,100,000	
			SUBTOTAL 1	$11,100,000	
ADDITIONAL COSTS					
			MISCELLANEOUS @ 20% OF SUBTOTAL 1 [2]	20%	$2,200,000
			MOBILIZATION @ 18% OF SUBTOTAL 1 [3]	18%	$2,000,000
			CONSTRUCTION ENGINEERING @ 15% OF SUBTOTAL 1	15%	$1,700,000
			SUBTOTAL 2		$17,000,000
			INDIRECT COST (IDC) - CONSTRUCTION @ 9.64% OF SUBTOTAL 2 [4]	9.64%	$1,600,000
			CONTINGENCY @ 20% & 50% OF SUBTOTAL 2 [5]	20%	$3,400,000
				50%	$8,500,000
			TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [6]	**$22,000,000**	
			TOTAL IMPROVEMENT OPTION COST @ 50% CONTINGENCY [6]	**$27,100,000**	

[1] The planning level cost for a cantilever deck was estimated at $125 per square foot based on average MDT bridge costs and construction sequencing.
[2] 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.
[3] The Mobilization category includes all costs incurred in assembling and transporting materials to the work site.
[4] 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.
[5] A contingency range of 20 to 50 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.
[6] 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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US 2 - BADROCK CANYON CORRIDOR PLANNING STUDY - CANTILEVER CONSTRUCTION (TWO LANES) RP 140.6 - RP 141.2 WITH DEDICATED BICYCLE/PEDESTRIAN FACILITY
Planning Level Estimate of Costs

Cantilever Construction (Two-Lane)	Length (FT.)	Width (FT.)	Cost Per Square Foot [1]	Subtotal	
CANTILEVER CONSTRUCTION (TWO-LANE)	1,975.00	53.50	$125.00	$13,200,000	
	APPROX. QUANTITY	**UNIT**	**UNIT PRICE**		
EXCAVATION-UNCLASS BORROW	14,000.00	CUYD	$4.67	$65,400.00	
EMBANKMENT IN PLACE	7,200.00	CUYD	$6.83	$49,200.00	
RETAINING WALL	30,200.00	SQFT	$50.00	$1,500,000.00	
CANTILEVER CONSTRUCTION (TWO-LANE) SUBTOTAL				$14,800,000.00	
STRUCTURE COST SUBTOTAL				$14,800,000	
			SUBTOTAL 1	$14,800,000	
ADDITIONAL COSTS					
			MISCELLANEOUS @ 20% OF SUBTOTAL 1 [2]	20%	$3,000,000
			MOBILIZATION @ 18% OF SUBTOTAL 1 [3]	18%	$2,700,000
			CONSTRUCTION ENGINEERING @ 15% OF SUBTOTAL 1	15%	$2,200,000
			SUBTOTAL 2		$22,700,000
			INDIRECT COST (IDC) - CONSTRUCTION @ 9.64% OF SUBTOTAL 2 [4]	9.64%	$2,200,000
			CONTINGENCY @ 20% & 50% OF SUBTOTAL 2 [5]	20%	$4,500,000
				50%	$11,400,000
			TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [6]	**$29,400,000**	
			TOTAL IMPROVEMENT OPTION COST @ 50% CONTINGENCY [6]	**$36,300,000**	

[1] The planning level cost for a cantilever deck was estimated at $125 per square foot based on average MDT bridge costs and construction sequencing.
[2] 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.
[3] The Mobilization category includes all costs incurred in assembling and transporting materials to the work site.
[4] 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.
[5] A contingency range of 20 to 50 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.
[6] 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.

US 2 - BADROCK CANYON CORRIDOR PLANNING STUDY - CANTILEVER CONSTRUCTION (FOUR LANES WITH MEDIAN) RP 140.6 - RP 141.2
Planning Level Estimate of Costs

Cantilever Construction (Four-Lane)	Length (FT.)	Width (FT.)	Cost Per Square Foot [1]	Subtotal	
CANTILEVER CONSTRUCTION (FOUR-LANE)	2,210.00	75.50	$125.00	$20,900,000	
	APPROX. QUANTITY	**UNIT**	**UNIT PRICE**		
EXCAVATION-UNCLASS BORROW	20,000.00	CUYD	$4.67	$93,400.00	
EMBANKMENT IN PLACE	18,955.00	CUYD	$6.83	$129,000.00	
RETAINING WALL	32,310.00	SQFT	$50.00	$1,600,000.00	
CANTILEVER CONSTRUCTION (FOUR-LANE) SUBTOTAL				$22,700,000.00	
STRUCTURE COST SUBTOTAL				$22,700,000	
			SUBTOTAL 1	$22,700,000	
ADDITIONAL COSTS					
			MISCELLANEOUS @ 20% OF SUBTOTAL 1 [2]	20%	$4,500,000
			MOBILIZATION @ 18% OF SUBTOTAL 1 [3]	18%	$4,100,000
			CONSTRUCTION ENGINEERING @ 15% OF SUBTOTAL 1	15%	$3,400,000
			SUBTOTAL 2		$34,700,000
			INDIRECT COST (IDC) - CONSTRUCTION @ 9.64% OF SUBTOTAL 2 [4]	9.64%	$3,300,000
			CONTINGENCY @ 20% & 50% OF SUBTOTAL 2 [5]	20%	$6,900,000
				50%	$17,400,000
			TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [6]	**$44,900,000**	
			TOTAL IMPROVEMENT OPTION COST @ 50% CONTINGENCY [6]	**$55,400,000**	

[1] The planning level cost for a cantilever deck was estimated at $125 per square foot based on average MDT bridge costs and construction sequencing.
[2] 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.
[3] The Mobilization category includes all costs incurred in assembling and transporting materials to the work site.
[4] 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.
[5] A contingency range of 20 to 50 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.
[6] 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.

US 2 - BADROCK CANYON CORRIDOR PLANNING STUDY - CANTILEVER CONSTRUCTION (FOUR LANES WITH MEDIAN) RP 140.6 - RP 141.2 WITH DEDICATED BICYCLE/PEDESTRIAN FACILITY
Planning Level Estimate of Costs

Cantilever Construction (Four-Lane)	Length (FT.)	Width (FT.)	Cost Per Square Foot [1]	Subtotal	
CANTILEVER CONSTRUCTION (FOUR-LANE)	2,510.00	77.00	$125.00	$24,200,000	
	APPROX. QUANTITY	**UNIT**	**UNIT PRICE**		
EXCAVATION-UNCLASS BORROW	22,000.00	CUYD	$4.67	$102,700.00	
EMBANKMENT IN PLACE	21,500.00	CUYD	$6.83	$147,000.00	
RETAINING WALL	36,500.00	SQFT	$50.00	$1,800,000.00	
CANTILEVER CONSTRUCTION (FOUR-LANE) SUBTOTAL				$26,200,000.00	
STRUCTURE COST SUBTOTAL				$26,200,000	
			SUBTOTAL 1	$26,200,000	
ADDITIONAL COSTS					
			MISCELLANEOUS @ 20% OF SUBTOTAL 1 [2]	20%	$5,200,000
			MOBILIZATION @ 18% OF SUBTOTAL 1 [3]	18%	$4,700,000
			CONSTRUCTION ENGINEERING @ 15% OF SUBTOTAL 1	15%	$3,900,000
			SUBTOTAL 2		$40,000,000
			INDIRECT COST (IDC) - CONSTRUCTION @ 9.64% OF SUBTOTAL 2 [4]	9.64%	$3,900,000
			CONTINGENCY @ 20% & 50% OF SUBTOTAL 2 [5]	20%	$8,000,000
				50%	$20,000,000
			TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [6]	**$51,900,000**	
			TOTAL IMPROVEMENT OPTION COST @ 50% CONTINGENCY [6]	**$63,900,000**	

[1] The planning level cost for a cantilever deck was estimated at $125 per square foot based on average MDT bridge costs and construction sequencing.
[2] 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.
[3] The Mobilization category includes all costs incurred in assembling and transporting materials to the work site.
[4] 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.
[5] A contingency range of 20 to 50 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.
[6] 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.

US 2 - BADROCK CANYON CORRIDOR PLANNING STUDY -
ELEVATED TWO LANE ROADWAY STRUCTURE RP 140.6 - RP 141.2
Planning Level Estimate of Costs

Elevated Structure (Two-Lane)	Length (FT.)	Width (FT.)	Cost Per Square Foot [1]	Subtotal	
ELEVATED STRUCTURE (TWO-LANE)	4,800.00	43.00	$175.00	$36,120,000	
STRUCTURE COST SUBTOTAL				$36,100,000	
			SUBTOTAL 1	$36,100,000	
ADDITIONAL COSTS					
			MISCELLANEOUS @ 20% OF SUBTOTAL 1 [2]	20%	$7,200,000
			MOBILIZATION @ 18% OF SUBTOTAL 1 [3]	18%	$6,500,000
			CONSTRUCTION ENGINEERING @ 15% OF SUBTOTAL 1	15%	$5,400,000
			SUBTOTAL 2		$55,200,000
			INDIRECT COST (IDC) - CONSTRUCTION @ 9.64% OF SUBTOTAL 2 [4]	9.64%	$5,300,000
			CONTINGENCY @ 20% & 50% OF SUBTOTAL 2 [5]	20%	$11,000,000
				50%	$27,600,000
			TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [6]	**$71,500,000**	
			TOTAL IMPROVEMENT OPTION COST @ 50% CONTINGENCY [6]	**$88,100,000**	

[1] Planning level costs for simple bridge structures range on average between $110 and $175 per square foot. A conservative estimate of $175 per square foot was utilized for these structures.
[2] 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.
[3] The Mobilization category includes all costs incurred in assembling and transporting materials to the work site.
[4] 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.
[5] A contingency range of 20 to 50 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.
[6] 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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US 2 - BADROCK CANYON CORRIDOR PLANNING STUDY -
ELEVATED FOUR LANE ROADWAY STRUCTURE RP 140.6 - RP 141.2
Planning Level Estimate of Costs

Elevated Structure (Four-Lane)	Length (FT.)	Width (FT.)	Cost Per Square Foot [1]	Subtotal	
ELEVATED STRUCTURE (FOUR-LANE)	4,800.00	67.00	$175.00	$56,300,000	
STRUCTURE COST SUBTOTAL				$56,300,000	
SUBTOTAL 1				$56,300,000	
ADDITIONAL COSTS					
MISCELLANEOUS @ 20% OF SUBTOTAL 1 [2]				20%	$11,300,000
MOBILIZATION @ 18% OF SUBTOTAL 1 [3]				18%	$10,100,000
CONSTRUCTION ENGINEERING @ 15% OF SUBTOTAL 1				15%	$8,400,000
SUBTOTAL 2					$86,100,000
INDIRECT COST (IDC) - CONSTRUCTION @ 9.64% OF SUBTOTAL 2 [4]				9.64%	$8,300,000
CONTINGENCY @ 20% & 50% OF SUBTOTAL 2 [5]				20%	$17,200,000
				50%	$43,100,000
TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [6]				**$112,000,000**	
TOTAL IMPROVEMENT OPTION COST @ 50% CONTINGENCY [6]				**$138,000,000**	

[1] Planning level costs for simple bridge structures range on average between $110 and $175 per square foot. A conservative estimate of $175 per square foot was utilized for these structures.
[2] 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.
[3] The Mobilization category includes all costs incurred in assembling and transporting materials to the work site.
[4] 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.
[5] A contingency range of 20 to 50 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.
[6] 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.

US 2 - BADROCK CANYON CORRIDOR PLANNING STUDY - RECONSTRUCTION OF SOUTH FORK BRIDGE (TWO LANE)
Planning Level Estimate of Costs

South Fork Bridge Construction	Length (FT.)	Width (FT.)	Cost Per Square Foot [1]	Subtotal	
STRUCTURE (TWO-LANE)	655.00	43.00	$175.00	$4,900,000	
STRUCTURE COST SUBTOTAL				$4,900,000	
			SUBTOTAL 1	$4,900,000	
		ADDITIONAL COSTS			
			MISCELLANEOUS @ 20% OF SUBTOTAL 1 [2]	20%	$1,000,000
			MOBILIZATION @ 18% OF SUBTOTAL 1 [3]	18%	$900,000
			CONSTRUCTION ENGINEERING @ 15% OF SUBTOTAL 1	15%	$700,000
			SUBTOTAL 2		$7,500,000
			INDIRECT COST (IDC) - CONSTRUCTION @ 9.64% OF SUBTOTAL 2 [4]	9.64%	$700,000
			CONTINGENCY @ 20% & 50% OF SUBTOTAL 2 [5]	20%	$1,500,000
				50%	$3,800,000
			TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [6]	**$9,700,000**	
			TOTAL IMPROVEMENT OPTION COST @ 50% CONTINGENCY [6]	**$12,000,000**	

[1] Planning level costs for simple bridge structures range on average between $110 and $175 per square foot. A conservative estimate of $175 per square foot was utilized for this structure.
[2] 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.
[3] The Mobilization category includes all costs incurred in assembling and transporting materials to the work site.
[4] 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.
[5] A contingency range of 20 to 50 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.
[6] 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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US 2 - BADROCK CANYON CORRIDOR PLANNING STUDY - RECONSTRUCTION OF SOUTH FORK BRIDGE (TWO LANE) WITH DEDICATED BICYCLE/PEDESTRIAN FACILITY
Planning Level Estimate of Costs

South Fork Bridge Construction	Length (FT.)	Width (FT.)	Cost Per Square Foot [1]	Subtotal	
STRUCTURE (TWO-LANE)	655.00	55.00	$175.00	$6,300,000	
STRUCTURE COST SUBTOTAL				$6,300,000	
			SUBTOTAL 1	$6,300,000	
		ADDITIONAL COSTS			
			MISCELLANEOUS @ 20% OF SUBTOTAL 1 [2]	20%	$1,300,000
			MOBILIZATION @ 18% OF SUBTOTAL 1 [3]	18%	$1,100,000
			CONSTRUCTION ENGINEERING @ 15% OF SUBTOTAL 1	15%	$900,000
			SUBTOTAL 2		$9,600,000
			INDIRECT COST (IDC) - CONSTRUCTION @ 9.64% OF SUBTOTAL 2 [4]	9.64%	$900,000
			CONTINGENCY @ 20% & 50% OF SUBTOTAL 2 [5]	20%	$1,900,000
				50%	$4,800,000
			TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [6]	**$12,400,000**	
			TOTAL IMPROVEMENT OPTION COST @ 50% CONTINGENCY [6]	**$15,300,000**	

[1] Planning level costs for simple bridge structures range on average between $110 and $175 per square foot. A conservative estimate of $175 per square foot was utilized for this structure.
[2] 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.
[3] The Mobilization category includes all costs incurred in assembling and transporting materials to the work site.
[4] 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.
[5] A contingency range of 20 to 50 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.
[6] 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.

US 2 - BADROCK CANYON CORRIDOR PLANNING STUDY - RECONSTRUCTION OF SOUTH FORK BRIDGE (FOUR LANE)
Planning Level Estimate of Costs

South Fork Bridge Construction	Length (FT.)	Width (FT.)	Cost Per Square Foot [1]	Subtotal	
EB STRUCTURE (TWO-LANE)	655.00	43.00	$175.00	$4,900,000	
WB STRUCTURE (TWO-LANE)	655.00	43.00	$175.00	$4,900,000	
STRUCTURE COST SUBTOTAL				$9,800,000	
			SUBTOTAL 1	$9,800,000	
		ADDITIONAL COSTS			
			MISCELLANEOUS @ 20% OF SUBTOTAL 1 [2]	20%	$2,000,000
			MOBILIZATION @ 18% OF SUBTOTAL 1 [3]	18%	$1,800,000
			CONSTRUCTION ENGINEERING @ 15% OF SUBTOTAL 1	15%	$1,500,000
			SUBTOTAL 2		$15,100,000
			INDIRECT COST (IDC) - CONSTRUCTION @ 9.64% OF SUBTOTAL 2 [4]	9.64%	$1,500,000
			CONTINGENCY @ 20% & 50% OF SUBTOTAL 2 [5]	20%	$3,000,000
				50%	$7,600,000
			TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [6]	**$19,600,000**	
			TOTAL IMPROVEMENT OPTION COST @ 50% CONTINGENCY [6]	**$24,200,000**	

[1] Planning level costs for simple bridge structures range on average between $110 and $175 per square foot. A conservative estimate of $175 per square foot was utilized for this structure.
[2] 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.
[3] The Mobilization category includes all costs incurred in assembling and transporting materials to the work site.
[4] 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.
[5] A contingency range of 20 to 50 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.
[6] 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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US 2 - BADROCK CANYON CORRIDOR PLANNING STUDY - RECONSTRUCTION OF SOUTH FORK BRIDGE (FOUR LANE) WITH DEDICATED BICYCLE/PEDESTRIAN FACILITY
Planning Level Estimate of Costs

South Fork Bridge Construction	Length (FT.)	Width (FT.)	Cost Per Square Foot [1]	Subtotal	
EB STRUCTURE (TWO-LANE) [2]	655.00	55.00	$175.00	$6,300,000	
WB STRUCTURE (TWO-LANE)	655.00	43.00	$175.00	$4,900,000	
STRUCTURE COST SUBTOTAL				$11,200,000	
			SUBTOTAL 1	$11,200,000	
		ADDITIONAL COSTS			
			MISCELLANEOUS @ 20% OF SUBTOTAL 1 [3]	20%	$2,200,000
			MOBILIZATION @ 18% OF SUBTOTAL 1 [4]	18%	$2,000,000
			CONSTRUCTION ENGINEERING @ 15% OF SUBTOTAL 1	15%	$1,700,000
			SUBTOTAL 2		$17,100,000
			INDIRECT COST (IDC) - CONSTRUCTION @ 9.64% OF SUBTOTAL 2 [5]	9.64%	$1,600,000
			CONTINGENCY @ 20% & 50% OF SUBTOTAL 2 [6]	20%	$3,400,000
				50%	$8,600,000
			TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [7]	**$22,100,000**	
			TOTAL IMPROVEMENT OPTION COST @ 50% CONTINGENCY [7]	**$27,300,000**	

[1] Planning level costs for simple bridge structures range on average between $110 and $175 per square foot. A conservative estimate of $175 per square foot was utilized for this structure.
[2] Dedicated bicycle/pedestrian facility could be incorporated on either eastbound or westbound bridge structure.
[3] 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.
[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 50 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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US 2 - BADROCK CANYON CORRIDOR PLANNING STUDY - BICYCLE/PEDESTRIAN OVERCROSSING

Planning Level Estimate of Costs [1]

Item Description	Approx. Quantity	Unit	Unit Price	Amount	Unit Price	Amount [2]
			Dollars	Dollars	Dollars	Dollars
ELEVATED CAST IN PLACE CONCRETE RAMP	600.00	LNFT	$325.00	$195,000.00		$195,000.00
PICKETED STEEL HAND RAILS	1,200.00	LNFT	$184.00	$220,800.00		$220,800.00
RAMP PIERS AND FOUNDATION	1.00	LS			$47,000.00	$47,000.00
CATEGORY	**LENGTH (FT.)**	**WIDTH (FT.)**	**COST PER SQUARE FOOT [3]**		**SUBTOTAL**	
BICYCLE/PEDESTRIAN OVERCROSSING						
STRUCTURE	50.00	12.00	$150.00		$90,000	
STRUCTURE COST SUBTOTAL					$90,000	
				SUBTOTAL 1	$550,000	
			ADDITIONAL COSTS			
				MISCELLANEOUS @ 20% OF SUBTOTAL 1 [4]	20%	$110,000
				MOBILIZATION @ 10% OF SUBTOTAL 1 [5]	10%	$60,000
				CONSTRUCTION ENGINEERING @ 15% OF SUBTOTAL 1	15%	$80,000
				SUBTOTAL 2		$800,000
				INDIRECT COST (IDC) - CONSTRUCTION @ 9.64% OF SUBTOTAL 2 [6]	9.64%	$80,000
				CONTINGENCY @ 20% SUBTOTAL 2 [7]	20%	$160,000
				TOTAL IMPROVEMENT OPTION COST (LOW RANGE ESTIMATE @ 20% CONTINGENCY) [8]	**$1,000,000**	
				TOTAL IMPROVEMENT OPTION COST (UPPER RANGE ESTIMATE) [8, 9]	**$2,500,000**	

[1] Location of the bicycle/pedestrian overcrossing is assumed at Berne Park with existing two-lane configuration.
[2] Cost estimates are provided in 2012 dollars. All dollar amounts are rounded for planning purposes.
[3] Planning level costs for simple bridge structures range on average between $110 and $175 per square foot. A conservative estimate of $150 per square foot was utilized for this structure.
[4] 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.
[5] The Mobilization category includes all costs incurred in assembling and transporting materials to the work site.
[6] 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.
[7] A contingency of 20 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.
[8] 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.
[9] Upper range planning level cost estimate attempts to account for miscellaneous aesthetic amenities, other optional features, and potential mitigation elements not included in the low range estimate. For comparison purposes, the Pablo, MT pedestrian overcrossing was constructed to span the multilane US 93 facility at a cost of approximately $3.0 million for construction engineering and construction. The upper range planning level cost estimate for the US 2 – Badrock Canyon Corridor pedestrian overcrossing is less than $3.0 million due to the narrower width of US 2 compared to US 93.

US 2 - BADROCK CANYON CORRIDOR PLANNING STUDY - DEDICATED BICYCLE/PEDESTRIAN FACILITY

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
BICYCLE/PEDESTRIAN FACILITY (FULL CONSTRUCT)						
EXCAVATION-UNCLASS BORROW	150.00	CUYD	$4.67	$701.00		$701.00
EMBANKMENT IN PLACE	50.00	CUYD	$6.83	$342.00		$342.00
CRUSHED AGGREGATE COURSE	31.00	CUYD	$18.79	$582.00		$582.00
DUST PALLIATIVE	0.30	TON		$0.00	$120.00	$36.00
PLANT MIX BIT SURF GR S-3/4 IN	17.00	TON	$25.37	$431.00		$431.00
ASPHALT CEMENT PG 64 64-28	1.00	TON	$674.59	$675.00		$675.00
BICYCLE/PEDESTRIAN FACILITY (FULL CONSTRUCT) SUBTOTAL				$2,731.00		$2,767.00
EMBANKMENT IN PLACE	3,200.00	CUYD	$6.83	$21,856.00		$21,856.00
BICYCLE RAILING	3,500.00	LNFT	$60.00	$210,000.00	$60.00	$210,000.00
REINFORCED CONCRETE RETAINING WALL	27,680.00	SQFT	$25.00	$692,000.00	$50.00	$1,384,000.00
CATEGORY	**LENGTH (STA.)**	**COST PER STATION**			**SUBTOTAL**	
CONCRETE BARRIER RAIL	126.72	$7,060.00			$895,000	
DEDICATED BICYCLE/PEDESTRIAN FACILITY	116.00	$2,767.00			$320,000	
				SUBTOTAL 1	$2,800,000	
		ADDITIONAL COSTS				
				MISCELLANEOUS @ 20% OF SUBTOTAL 1 [4]	20%	$560,000
				MOBILIZATION @ 10% OF SUBTOTAL 1 [7]	10%	$280,000
				CONSTRUCTION ENGINEERING @ 15% OF SUBTOTAL 1	15%	$420,000
				SUBTOTAL 2		$4,100,000
				INDIRECT COST (IDC) - CONSTRUCTION @ 9.64% OF SUBTOTAL 2 [6]	9.64%	$400,000
				CONTINGENCY @ 20% & 50% OF SUBTOTAL 2 [7]	20%	$820,000
					50%	$2,050,000
				TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [8]	**$5,300,000**	
				TOTAL IMPROVEMENT OPTION COST @ 50% CONTINGENCY [8]	**$6,600,000**	

[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] 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.
[5] The Mobilization category includes all costs incurred in assembling and transporting materials to the work site.
[6] 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.
[7] A contingency range of 20 to 50 percent was used due to the high degree of unknown factors involved in rock excavation and uncertainties over the planning horizon, as well as the substantial amount of items not accounted for in this planning level cost estimate.
[8] 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

US 2 - BADROCK CANYON CORRIDOR PLANNING STUDY - PARKING LOT
Planning Level Estimate of Costs

Item Description	Approx. Quantity	Unit	Unit Price	Amount	Unit Price	Amount [1]
			Dollars	Dollars	Dollars	Dollars
PARKING LOT						
PAVEMENT SURFACE	30,193.00	SQFT	$2.25	$67,934.00		$67,934.00
CURB AND GUTTER	1,015.00	LNFT	$17.00	$17,255.00		$17,255.00
PAVEMENT MARKINGS	40.00	GAL	$12.00	$480.00		$480.00
AMENITIES [2]	1.00	LS	$0.00	$0.00	$50,000.00	$50,000.00
DRAINAGE SYSTEM	1.00	LS	$0.00	$0.00	$60,000.00	$60,000.00
PARKING LOT SUBTOTAL				$85,669.00		$195,669.00
				SUBTOTAL 1	$200,000	
ADDITIONAL COSTS						
				MISCELLANEOUS @ 20% OF SUBTOTAL 1 [3]	20%	$40,000
				MOBILIZATION @ 18% OF SUBTOTAL 1 [4]	18%	$36,000
				CONSTRUCTION ENGINEERING @ 15% OF SUBTOTAL 1	15%	$30,000
				SUBTOTAL 2		$310,000
				INDIRECT COST (IDC) - CONSTRUCTION @ 9.64% OF SUBTOTAL 2 [5]	9.64%	$29,900
				CONTINGENCY @ 20% & 50% OF SUBTOTAL 2 [6]	20%	$62,000
					50%	$155,000
				TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [7]	**$400,000**	
				TOTAL IMPROVEMENT OPTION COST @ 50% CONTINGENCY [7]	**$500,000**	

[1] Cost estimates are provided in 2012 dollars. All dollar amounts are rounded for planning purposes.
[2] Amenity features may provide or enhance existing landscaping, fencing, lighting, benches or picnic areas, and bathrooms.
[3] 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.
[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 50 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.

DOWL HKM

US 2 - BADROCK CANYON CORRIDOR PLANNING STUDY - WILDLIFE UNDERCROSSING
Planning Level Estimate of Costs

Item Description	Approx. Quantity	Unit	Unit Price	Amount	Unit Price	Amount [1]
			Dollars	Dollars	Dollars	Dollars
RENFORCED CONCRETE BOX (22 FEET BY 12 FEET)	170.00	LNFT	$2,500.00	$425,000.00		$425,000.00
ADDITIONAL EXCAVATION-UNCLASSIFIED	4,700.00	CUYD	$4.27	$20,069.00		$20,069.00
WILDLIFE EXIT RAMPS (JUMP OUTS)	4.00	EACH	$7,500.00	$30,000.00		$30,000.00
WILDLIFE FENCING	6,000.00	SQFT	$2.50	$15,000.00		$15,000.00
SUBTOTAL 1					$490,000	
ADDITIONAL COSTS						
MISCELLANEOUS @ 20% OF SUBTOTAL 1 [2]					20%	$100,000
MOBILIZATION @ 10% OF SUBTOTAL 1 [3]					10%	$49,000
CONSTRUCTION ENGINEERING @ 15% OF SUBTOTAL 1					15%	$74,000
SUBTOTAL 2						$710,000
INDIRECT COST (IDC) - CONSTRUCTION @ 9.64% OF SUBTOTAL 2 [4]					9.64%	$68,000
CONTINGENCY @ 20% & 50% OF SUBTOTAL 2 [5]					20%	$140,000
					50%	$360,000
TOTAL IMPROVEMENT OPTION COST @ 20% CONTINGENCY [6]					$920,000	
TOTAL IMPROVEMENT OPTION COST @ 50% CONTINGENCY [6]					$1,100,000	

[1] Cost estimates are provided in 2012 dollars. All dollar amounts are rounded for planning purposes.
[2] 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.
[3] The Mobilization category includes all costs incurred in assembling and transporting materials to the work site.
[4] 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.
[5] A contingency range of 20 to 50 percent was used due to the high degree of unknown factors involved in rock excavation and uncertainties over the planning horizon, as well as the substantial amount of items not accounted for in this planning level cost estimate.
[6] 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.

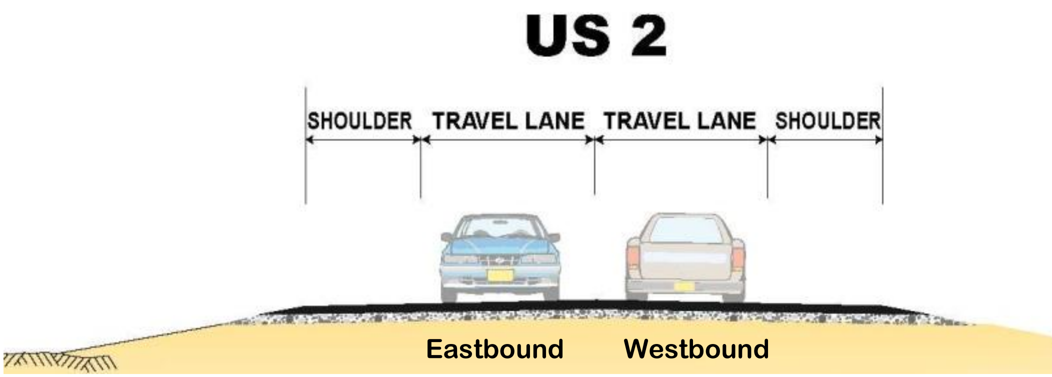
Appendix 3

Typical Sections and Spot Improvements

RANGE OF POTENTIAL TYPICAL SECTIONS CONSIDERED

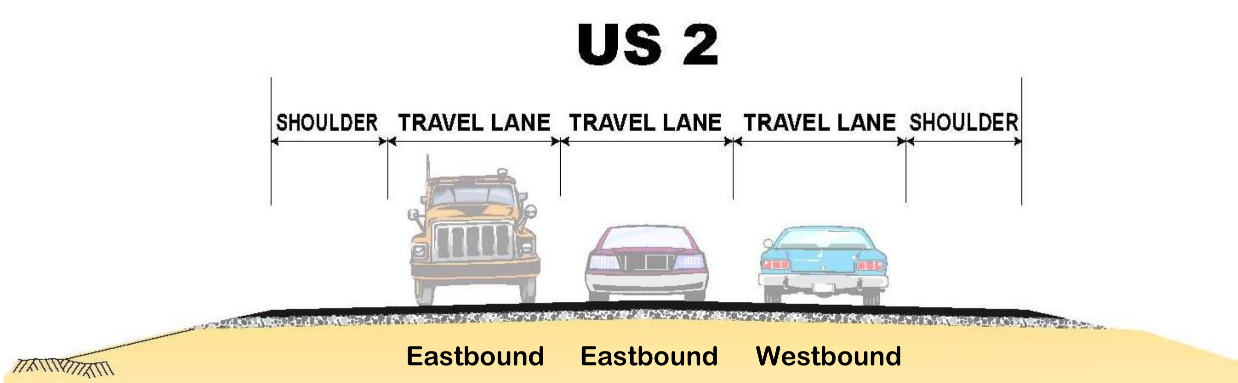
Typical Section 1: Two-Lane

(RP 140.0 to 140.6± and RP 141.2± to RP 142.4)



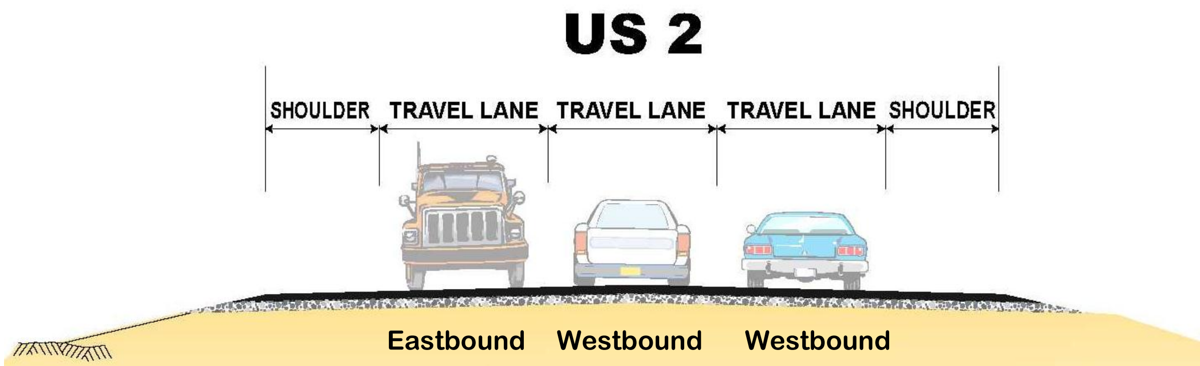
Typical Section 2: Three-Lane

(3-2-3-4 Configuration from RP 140.0 to 140.6± and Reverse 3-2-3-4 Configuration from RP 141.2± to RP 142.0±)



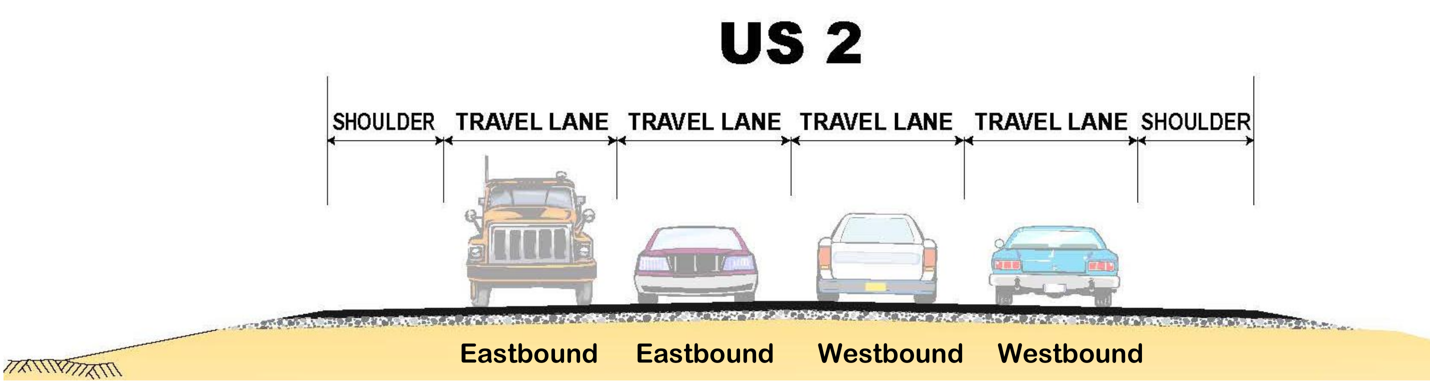
Typical Section 3: Reverse Three-Lane

(Reverse 3-2-3-4 Configuration from RP 140.0 to 140.6± and 3-2-3-4 Configuration from RP 141.2± to RP 142.0±)



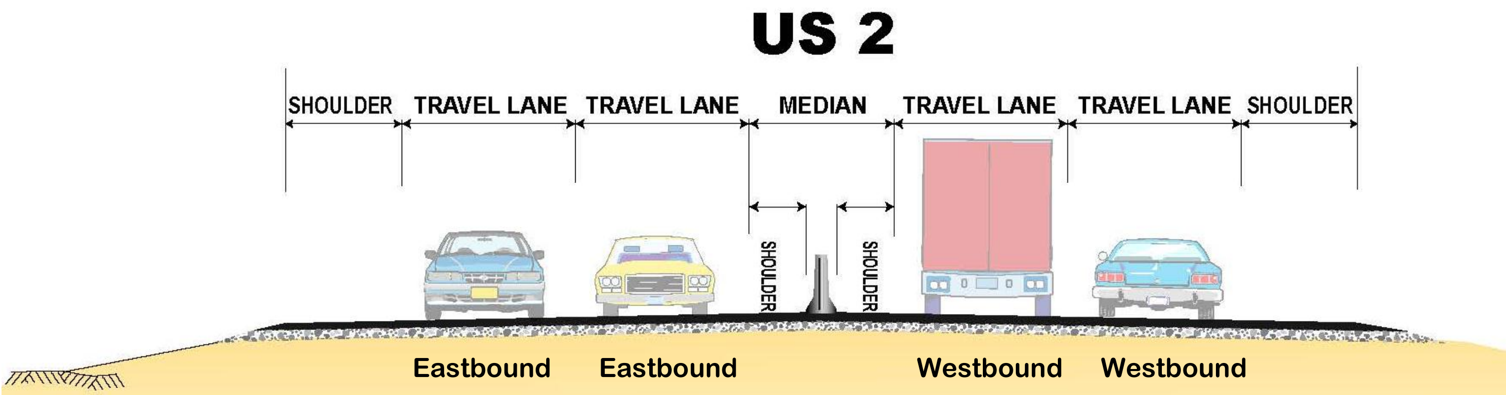
Typical Section 4: Four-lane

(RP 140.0 to 140.6± and RP 141.2± to RP 142.4)



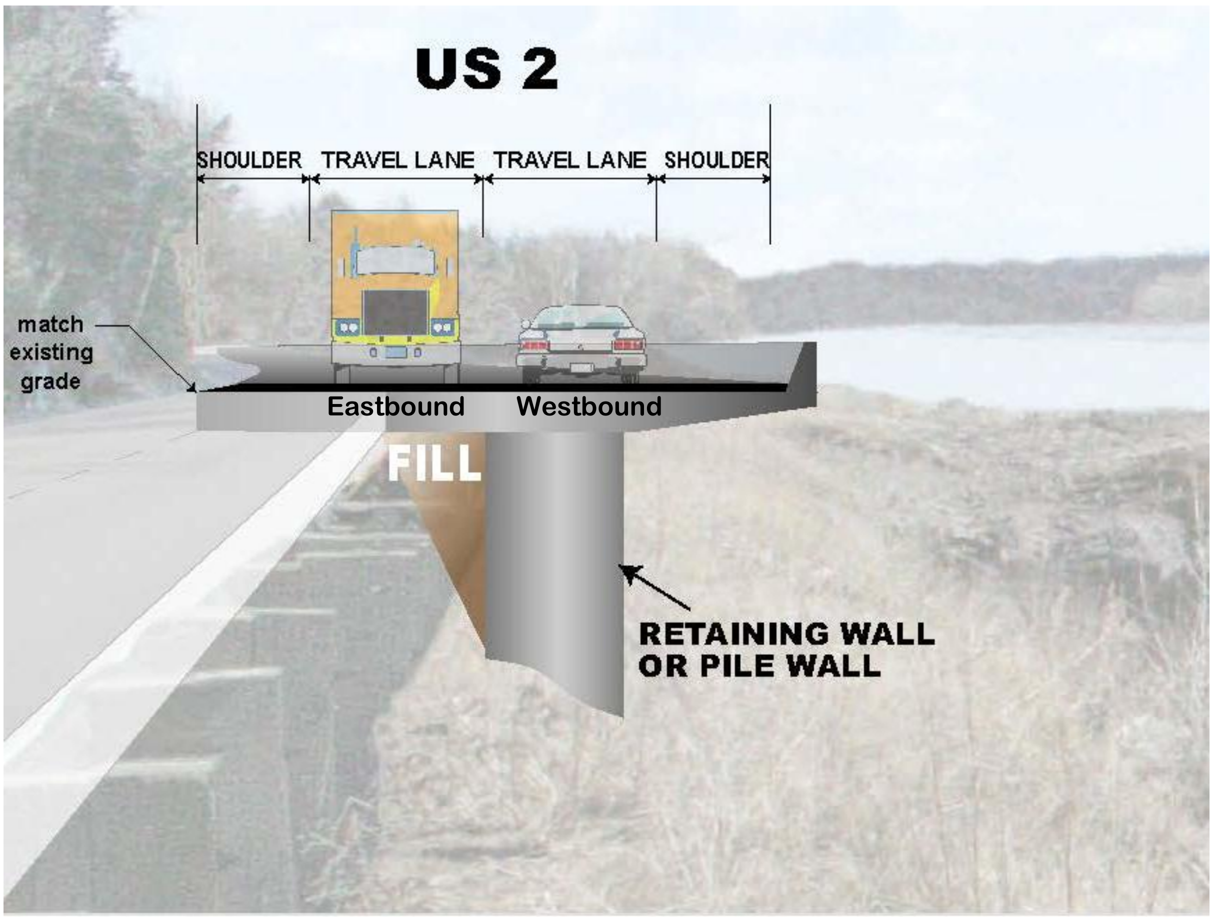
Typical Section 5: Four-lane with Center Median

(RP 140.0 to 140.6± and RP 141.2± to RP 142.4)



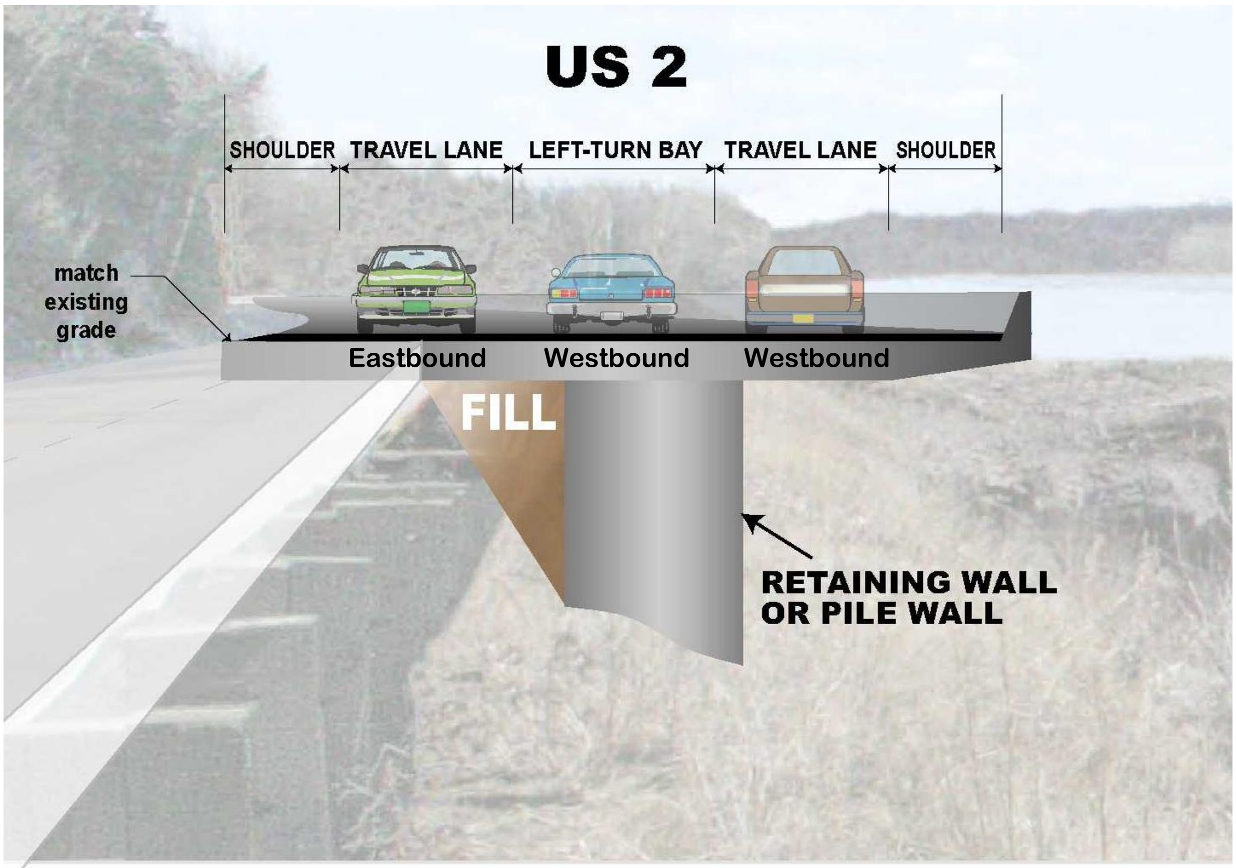
Typical Section 6: Two-Lane Cantilevered Structure

(RP 140.6± to RP 141.2±)



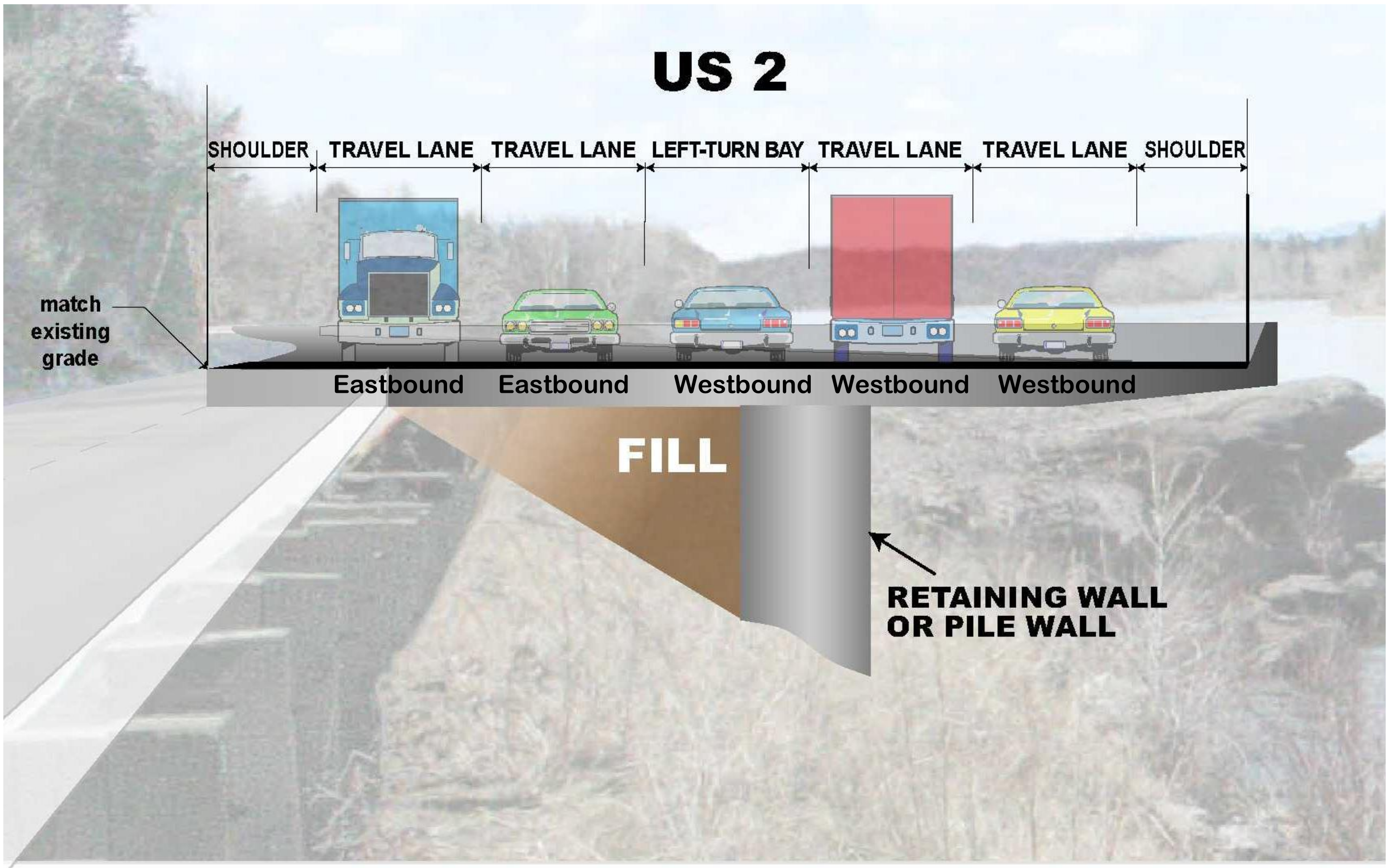
Typical Section 7: Two-Lane Cantilevered Structure with Left-Turn Bay at Berne Park

(RP 140.9±)



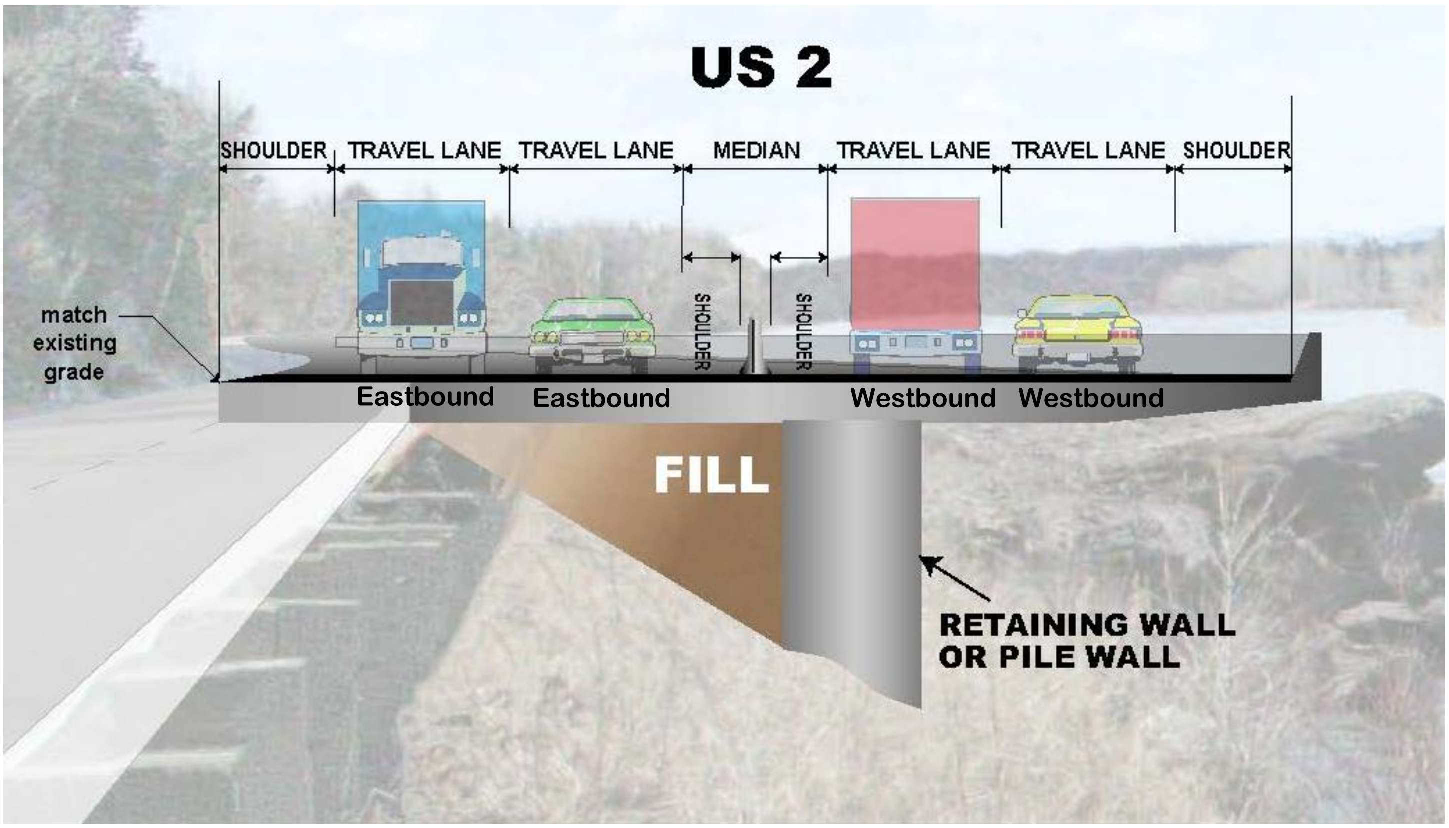
Typical Section 8: Four-Lane Cantilevered Structure with Left-Turn Bay at Berne Park

(RP 140.9±)



Typical Section 9: Four-Lane Cantilevered Structure with Median

(RP 140.6± to RP 141.2±)

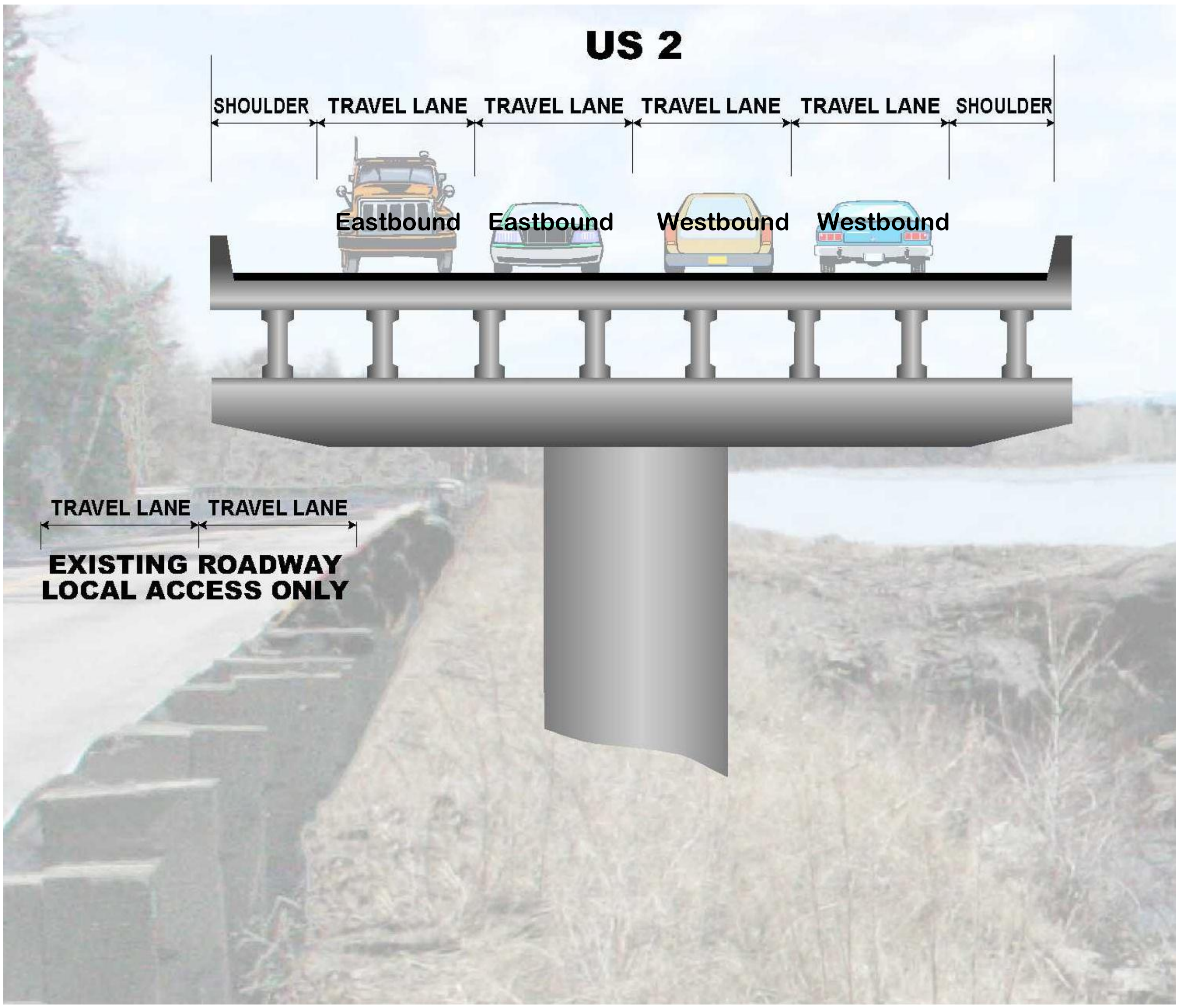


Typical Section 10: Two-Lane Elevated Structure

(RP 140.6± to RP 141.2±)

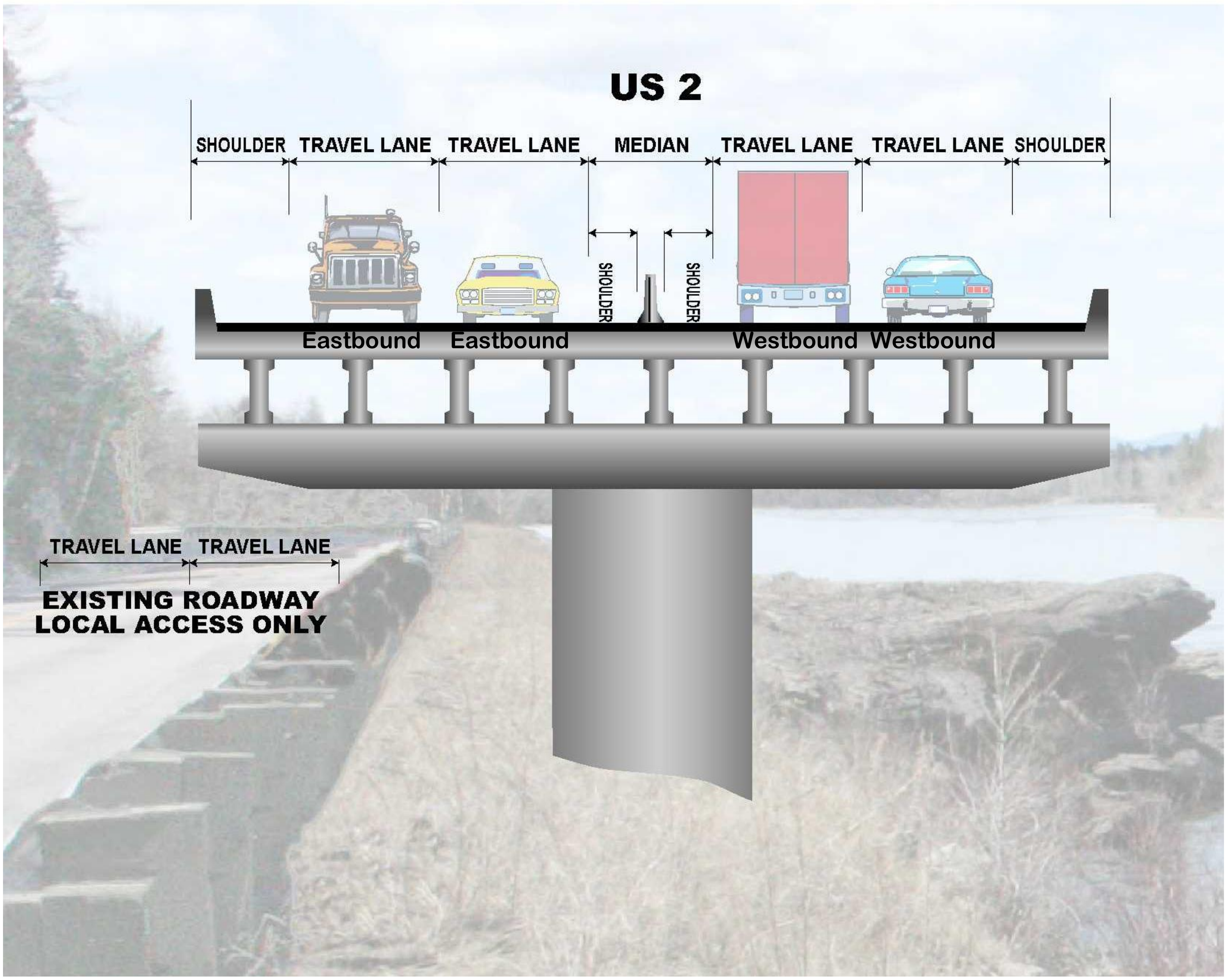
Typical Section 11: Four-Lane Elevated Structure

(RP 140.6± to RP 141.2±)



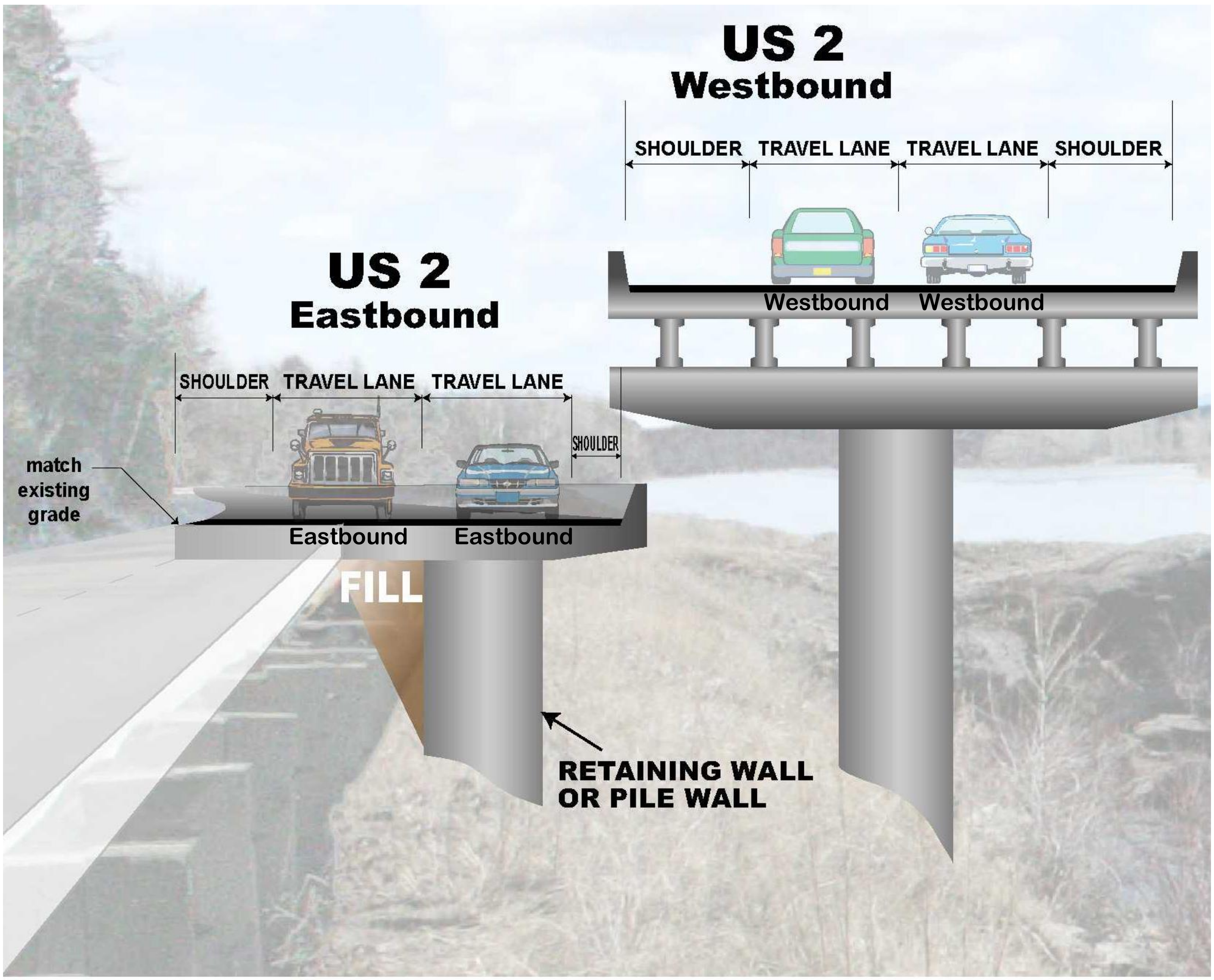
Typical Section 12: Four-Lane Elevated Structure with Median

(RP 140.6± to RP 141.2±)



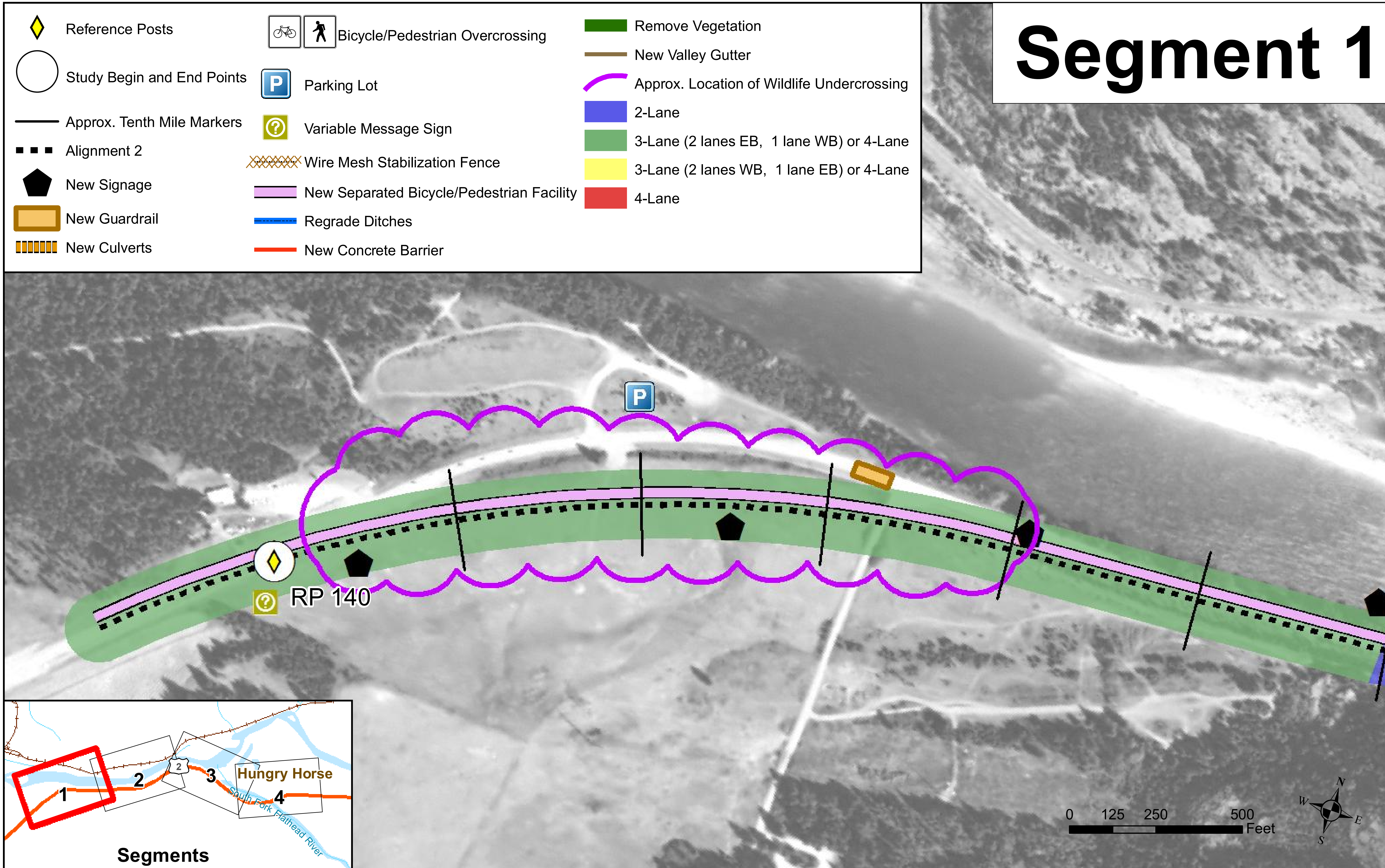
Typical Section 13: Four-Lane Elevated Structure / Cantilevered Structure Combination

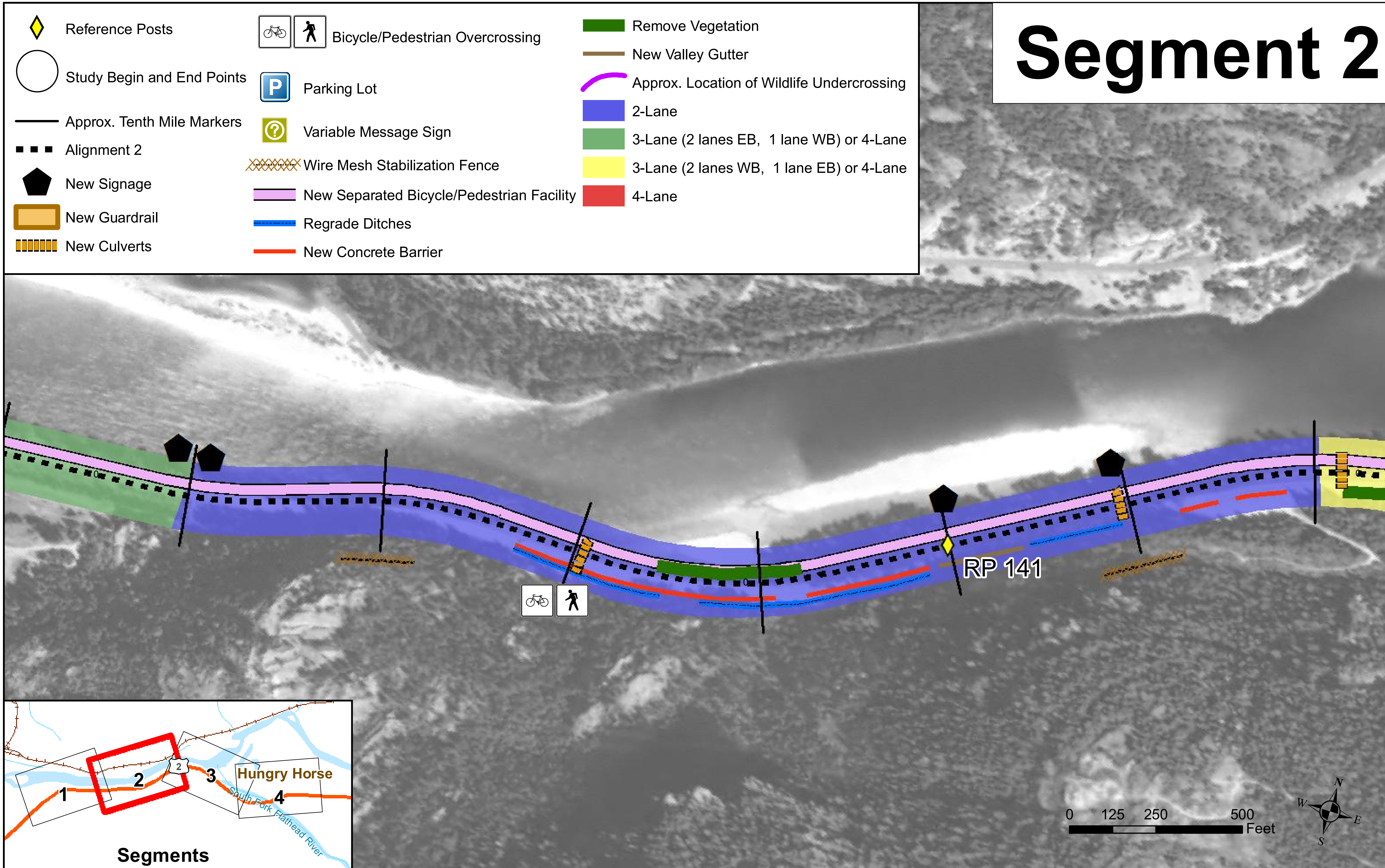
(RP 140.6± to RP 141.2±)



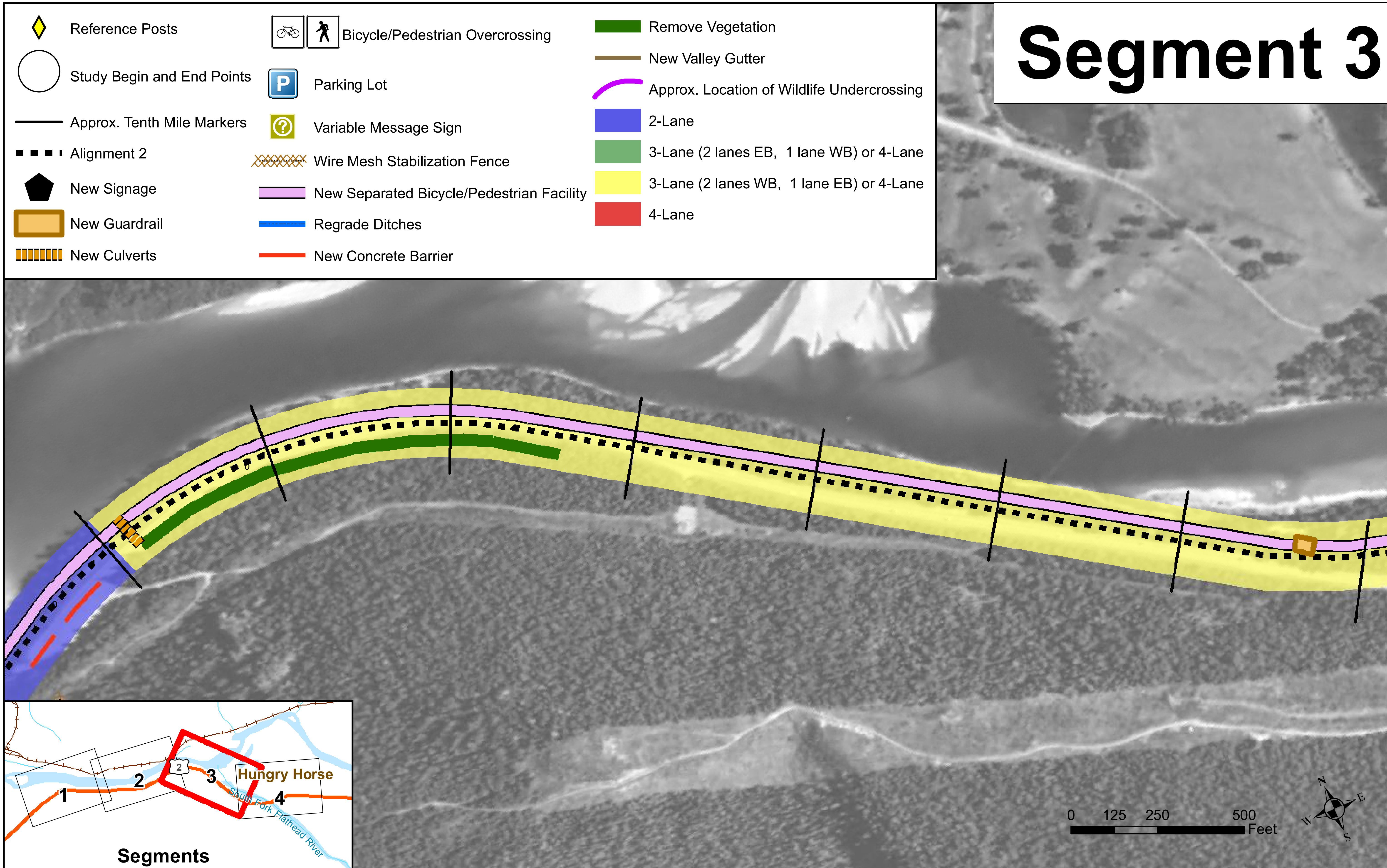
Separated Bicycle / Pedestrian Facility

(Throughout Corridor)


Segment 1
Reference Posts
Study Begin and End Points
Approx. Tenth Mile Markers
Alignment 2
New Signage
New Guardrail
New Culverts
Bicycle/Pedestrian Overcrossing
Parking Lot
Variable Message Sign
Wire Mesh Stabilization Fence
New Separated Bicycle/Pedestrian Facility
Regrade Ditches
New Concrete Barrier
Remove Vegetation
New Valley Gutter
Approx. Location of Wildlife Undercrossing
2-Lane
3-Lane (2 lanes EB, 1 lane WB) or 4-Lane
3-Lane (2 lanes WB, 1 lane EB) or 4-Lane
4-Lane
P
RP 140
1
2
3
4
Hungry Horse
South Fork Flathead River
Segments
0 125 250 500
Feet
N
E
S
W

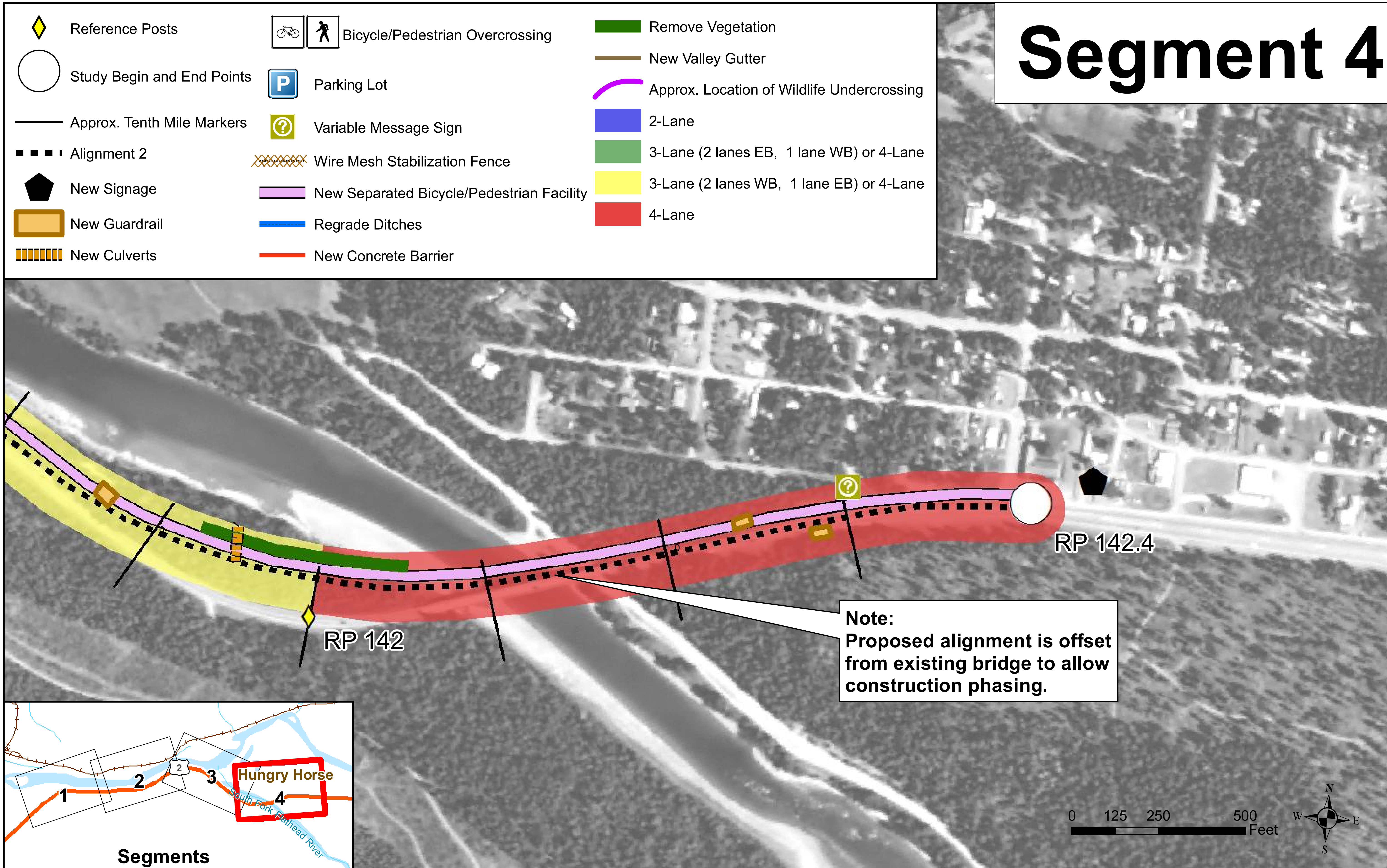

Segment 2
Reference Posts
Study Begin and End Points
Approx. Tenth Mile Markers
Alignment 2
New Signage
New Guardrail
New Culverts
Bicycle/Pedestrian Overcrossing
Parking Lot
Variable Message Sign
Wire Mesh Stabilization Fence
New Separated Bicycle/Pedestrian Facility
Regrade Ditches
New Concrete Barrier
Remove Vegetation
New Valley Gutter
Approx. Location of Wildlife Undercrossing
2-Lane
3-Lane (2 lanes EB, 1 lane WB) or 4-Lane
3-Lane (2 lanes WB, 1 lane EB) or 4-Lane
4-Lane
RP 141
0 125 250 500
Feet
N
E
S
W
1
2
3
4
Hungry Horse
South Fork Flathead River
Segments

Segment 3



Reference Posts
Study Begin and End Points
Approx. Tenth Mile Markers
Alignment 2
New Signage
New Guardrail
New Culverts
Bicycle/Pedestrian Overcrossing
Parking Lot
Variable Message Sign
Wire Mesh Stabilization Fence
New Separated Bicycle/Pedestrian Facility
Regrade Ditches
New Concrete Barrier
Remove Vegetation
New Valley Gutter
Approx. Location of Wildlife Undercrossing
2-Lane
3-Lane (2 lanes EB, 1 lane WB) or 4-Lane
3-Lane (2 lanes WB, 1 lane EB) or 4-Lane
4-Lane
0 125 250 500 Feet
N E S W
1
2
3
4
Hungry Horse
South Fork Flathead River
Segments

Segment 4



Reference Posts
Study Begin and End Points
Approx. Tenth Mile Markers
Alignment 2
New Signage
New Guardrail
New Culverts
Bicycle/Pedestrian Overcrossing
Parking Lot
Variable Message Sign
Wire Mesh Stabilization Fence
New Separated Bicycle/Pedestrian Facility
Regrade Ditches
New Concrete Barrier
Remove Vegetation
New Valley Gutter
Approx. Location of Wildlife Undercrossing
2-Lane
3-Lane (2 lanes EB, 1 lane WB) or 4-Lane
3-Lane (2 lanes WB, 1 lane EB) or 4-Lane
4-Lane
RP 142
RP 142.4
Note:
Proposed alignment is offset from existing bridge to allow construction phasing.
Hungry Horse
1
2
3
4
South Fork Flathead River
Segments
0
125
250
500
Feet
N
S
E
W

Appendix 4

Operational
Analysis Worksheets

Appendix 4

Operational Analysis Worksheets

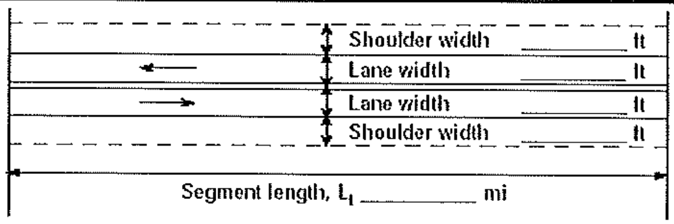
Existing Peak Season

DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

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

Project Description: *US 2 - Badrock Canyon Corridor P®*

Input Data



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

Terrain ☐ Level ☑ Rolling

Analysis direction vol., V_d	*553veh/h*
Opposing direction vol., V_o	*351veh/h*
Shoulder width ft	*1.0*
Lane Width ft	*12.0*
Segment Length mi	*2.4*
Grade Length mi	Up/down
Peak-hour factor, PHF	*0.92*
No-passing zone	*100%*
% Trucks and Buses, P_T	*6 %*
% Recreational vehicles, P_R	*4%*
Access points *mi*	*3/mi*

Average Travel Speed

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

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
		Base free-flow speed[4], BFFS	*60.0 mi/h*
Mean speed of sample[3], S_{FM}		Adj. for lane and shoulder width,[4] f_{LS} (Exhibit 15-7)	*4.2 mi/h*
Total demand flow rate, both directions, *v*		Adj. for access points[4], f_A (Exhibit 15-8)	*0.8 mi/h*
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Free-flow speed, FFS ($FSS=BFFS-f_{LS}-f_A$)	*55.0 mi/h*
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	*2.6 mi/h*	Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	*43.9 mi/h*
		Percent free flow speed, PFFS	*79.8 %*

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*	*1.6*
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	*1.0*	*1.0*
Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*1.000*	*0.965*
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	*0.97*	*0.89*
Directional flow rate[2], v_i(pc/h) $v_i=V_i/(PHF*f_{HV,PTSF}*f_{g,PTSF})$	*620*	*444*
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	*56.8*	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	*34.5*	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	*76.9*	

Level of Service and Other Performance Measures

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

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

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

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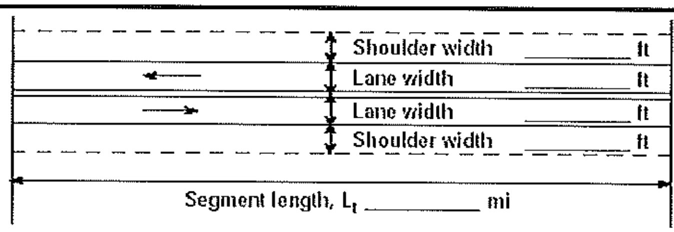
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

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

Project Description: *US 2 - Badrock Canyon 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	*0.84*
No-passing zone	*100%*
% Trucks and Buses , P_T	*6 %*
% Recreational vehicles, P_R	*4%*
Access points *mi*	*3/mi*
Analysis direction vol., V_d	*351veh/h*
Opposing direction vol., V_o	*553veh/h*
Shoulder width ft	*1.0*
Lane Width ft	*12.0*
Segment Length mi	*2.4*

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	*2.0*	*1.6*
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	*1.1*	*1.1*
Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.940*	*0.962*
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	*0.91*	*0.98*
Demand flow rate[2], v_i (pc/h) $v_i=V_i/(PHF* f_{g,ATS} * f_{HV,ATS})$	*488*	*698*

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
Mean speed of sample[3], S_{FM}		Base free-flow speed[4], BFFS	*62.0 mi/h*
Total demand flow rate, both directions, *v*		Adj. for lane and shoulder width,[4] f_{LS} (Exhibit 15-7)	*4.2 mi/h*
Free-flow speed, $FFS=S_{FM}+0.00776(v/ f_{HV,ATS})$		Adj. for access points[4], f_A (Exhibit 15-8)	*0.8 mi/h*
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	*1.7 mi/h*	Free-flow speed, FFS $(FSS=BFFS-f_{LS}-f_A)$	*57.0 mi/h*
		Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS} + v_{o,ATS}) - f_{np,ATS}$	*46.2 mi/h*
		Percent free flow speed, PFFS	*80.9 %*

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T(Exhibit 15-18 or 15-19)	*1.4*	*1.0*
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	*1.0*	*1.0*
Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.977*	*1.000*
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	*0.91*	*0.98*
Directional flow rate[2], v_i(pc/h) $v_i=V_i/(PHF*f_{HV,PTSF}* f_{g,PTSF})$	*470*	*672*
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	*51.4*	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	*32.7*	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}*(v_{d,PTSF} / v_{d,PTSF} + v_{o,PTSF})$	*64.9*	

Level of Service and Other Performance Measures

Level of service, LOS (Exhibit 15-3)	*C*
Volume to capacity ratio, *v/c*	*0.28*

Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h	*1603*
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	*1666*
Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only)	*80.9*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*417.9*
Effective width, Wv (Eq. 15-29) ft	*13.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*5.58*
Bicycle level of service (Exhibit 15-4)	*F*
Notes	
1. Note that the adjustment factor for level terrain is 1.00,as level terrain is one of the base conditions. For the purpose of grade adjustment, specific downgrade segments are treated as level terrain. 2. If v_i(v_d or v_o) >=1,700 pc/h, terminate analysis--the LOS is F. 3. For the analysis direction only and for v>200 veh/h. 4. For the analysis direction only 5. Exhibit 15-20 provides coefficients a and b for Equation 15-10. 6. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.	

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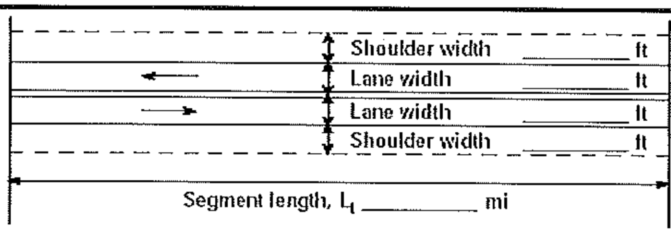
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

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

Project Description: *US 2 - Badrock Canyon Corridor Planning Study*

Input Data



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

Terrain ☐ Level ☑ Rolling

Analysis direction vol., V_d	*493veh/h*	
Opposing direction vol., V_o	*430veh/h*	
Shoulder width ft	*1.0*	
Lane Width ft	*12.0*	
Segment Length mi	*2.4*	
Grade Length mi		Up/down
Peak-hour factor, PHF	*0.91*	
No-passing zone	*100%*	
% Trucks and Buses, P_T	*6 %*	
% Recreational vehicles, P_R	*4%*	
Access points *mi*	*3/mi*	

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	*1.8*	*1.9*
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	*1.1*	*1.1*
Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.951*	*0.945*
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	*0.96*	*0.94*
Demand flow rate[2], v_i (pc/h) $v_i=V_i/(PHF*f_{g,ATS}*f_{HV,ATS})$	*593*	*532*

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
		Base free-flow speed[4], BFFS	*61.0 mi/h*
Mean speed of sample[3], S_{FM}		Adj. for lane and shoulder width,[4] f_{LS} (Exhibit 15-7)	*4.2 mi/h*
Total demand flow rate, both directions, *v*		Adj. for access points[4], f_A (Exhibit 15-8)	*0.8 mi/h*
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Free-flow speed, FFS $(FSS=BFFS-f_{LS}-f_A)$	*56.0 mi/h*
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	*2.3 mi/h*	Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	*45.0 mi/h*
		Percent free flow speed, PFFS	*80.3 %*

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-18 or 15-19)	*1.2*	*1.4*
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	*1.0*	*1.0*
Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.988*	*0.977*
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	*0.96*	*0.94*
Directional flow rate[2], v_i (pc/h) $v_i=V_i/(PHF*f_{HV,PTSF}*f_{g,PTSF})$	*571*	*515*
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	*55.5*	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	*36.9*	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	*74.9*	

Level of Service and Other Performance Measures

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

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

Notes

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

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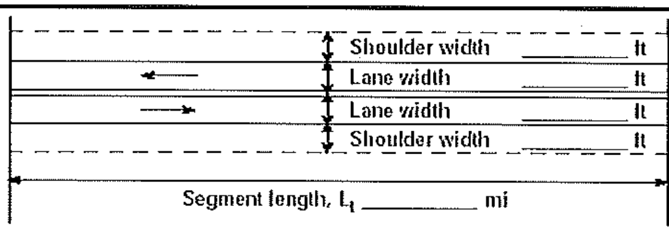
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

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

Project Description: US 2 - Badrock Canyon Corridor Planning Study

Input Data



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

Terrain ☐ Level ☑ Rolling

Analysis direction vol., V_d	430veh/h
Opposing direction vol., V_o	493veh/h
Shoulder width ft	1.0
Lane Width ft	12.0
Segment Length mi	2.4
Grade Length mi Up/down	
Peak-hour factor, PHF	0.89
No-passing zone	100%
% Trucks and Buses , P_T	6 %
% Recreational vehicles, P_R	4%
Access points *mi*	3/mi

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	1.8	1.7
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	1.1	1.1
Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	0.951	0.956
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	0.94	0.96
Demand flow rate[2], v_i (pc/h) $v_i=V_i/(PHF^* f_{g,ATS} * f_{HV,ATS})$	540	604

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
Mean speed of sample[3], S_{FM}		Base free-flow speed[4], BFFS	61.0 mi/h
Total demand flow rate, both directions, *v*		Adj. for lane and shoulder width,[4] f_{LS}(Exhibit 15-7)	4.2 mi/h
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Adj. for access points[4], f_A (Exhibit 15-8)	0.8 mi/h
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	1.9 mi/h	Free-flow speed, FFS $(FSS=BFFS-f_{LS}-f_A)$	56.0 mi/h
		Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	45.3 mi/h
		Percent free flow speed, PFFS	80.8 %

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T(Exhibit 15-18 or 15-19)	1.4	1.2
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	1.0	1.0
Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	0.977	0.988
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	0.95	0.97
Directional flow rate[2], v_i(pc/h) $v_i=V_i/(PHF^*f_{HV,PTSF}{}^* f_{g,PTSF})$	521	578
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	53.6	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	36.5	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}{}^*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	70.9	

Level of Service and Other Performance Measures

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

Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h	*1576*
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	*1629*
Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only)	*80.8*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*483.1*
Effective width, Wv (Eq. 15-29) ft	*13.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*5.65*
Bicycle level of service (Exhibit 15-4)	*F*
Notes	

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

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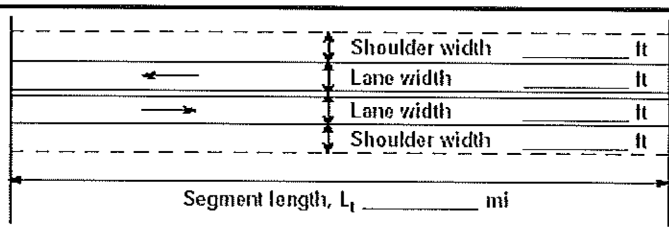
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

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

Project Description: *US 2 - Badrock Canyon 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	*410veh/h*
Opposing direction vol., V_o	*687veh/h*
Shoulder width ft	*1.0*
Lane Width ft	*12.0*
Segment Length mi	*2.4*
Peak-hour factor, PHF	*0.88*
No-passing zone	*100%*
% Trucks and Buses , P_T	*6 %*
% Recreational vehicles, P_R	*4%*
Access points *mi*	*3/mi*

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	*1.9*	*1.4*
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	*1.1*	*1.1*
Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.945*	*0.973*
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	*0.93*	*0.99*
Demand flow rate[2], v_i (pc/h) $v_i=V_i/(PHF*f_{g,ATS}*f_{HV,ATS})$	*530*	*810*

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
Mean speed of sample[3], S_{FM}		Base free-flow speed[4], BFFS	*61.0 mi/h*
Total demand flow rate, both directions, v		Adj. for lane and shoulder width,[4] f_{LS}(Exhibit 15-7)	*4.2 mi/h*
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Adj. for access points[4], f_A (Exhibit 15-8)	*0.8 mi/h*
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	*1.4 mi/h*	Free-flow speed, FFS $(FSS=BFFS-f_{LS}-f_A)$	*56.0 mi/h*
		Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	*44.3 mi/h*
		Percent free flow speed, PFFS	*79.0 %*

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T(Exhibit 15-18 or 15-19)	*1.4*	*1.0*
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	*1.0*	*1.0*
Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.977*	*1.000*
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	*0.94*	*1.00*
Directional flow rate[2], v_i(pc/h) $v_i=V_i/(PHF*f_{HV,PTSF}*f_{g,PTSF})$	*508*	*781*
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	*55.5*	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	*28.5*	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	*66.7*	

Level of Service and Other Performance Measures

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

Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h	*1638*
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	*1700*
Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only)	*79.0*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*465.9*
Effective width, Wv (Eq. 15-29) ft	*13.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*5.63*
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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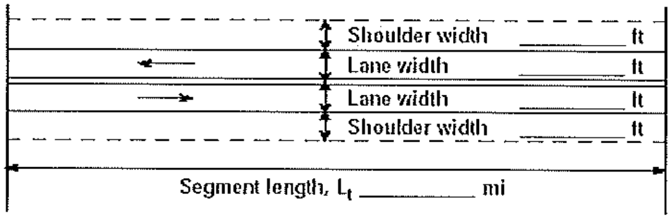
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

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

Project Description: US 2 - Badrock Canyon 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	687veh/h
Opposing direction vol., V_o	410veh/h
Shoulder width ft	1.0
Lane Width ft	12.0
Segment Length mi	2.4
Peak-hour factor, PHF	0.91
No-passing zone	100%
% Trucks and Buses , P_T	6 %
% Recreational vehicles, P_R	4%
Access points *mi*	3/mi

Average Travel Speed

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

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
Mean speed of sample[3], S_{FM}		Base free-flow speed[4], BFFS	63.0 mi/h
Total demand flow rate, both directions, v		Adj. for lane and shoulder width,[4] f_{LS}(Exhibit 15-7)	4.2 mi/h
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Adj. for access points[4], f_A (Exhibit 15-8)	0.8 mi/h
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	2.6 mi/h	Free-flow speed, FFS $(FSS=BFFS-f_{LS}-f_A)$	58.0 mi/h
		Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	45.3 mi/h
		Percent free flow speed, PFFS	78.1 %

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	1.4
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	1.0	1.0
Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	1.000	0.977
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	1.00	0.93
Directional flow rate[2], v_i(pc/h) $v_i=V_i/(PHF^*f_{HV,PTSF}^* f_{g,PTSF})$	755	496
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	64.5	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	29.4	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF} *(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	82.2	

Level of Service and Other Performance Measures

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

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

Notes

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

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Appendix 4

Operational Analysis Worksheets

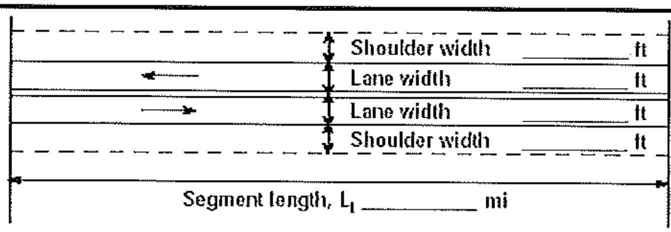
Existing Adjusted Annual Average

DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

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

Project Description: *US 2 - Badrock Canyon Corridor Planning Study*

Input Data



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

Terrain Level ☐ Rolling ☑

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

Average Travel Speed

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

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
Mean speed of sample[3], S_{FM}		Base free-flow speed[4], BFFS	*60.0 mi/h*
Total demand flow rate, both directions, *v*		Adj. for lane and shoulder width,[4] f_{LS}(Exhibit 15-7)	*4.2 mi/h*
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Adj. for access points[4], f_A (Exhibit 15-8)	*0.8 mi/h*
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	*3.6 mi/h*	Free-flow speed, FFS (FSS=BFFS-f_{LS}-f_A)	*55.0 mi/h*
		Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	*46.3 mi/h*
		Percent free flow speed, PFFS	*84.0 %*

Percent Time-Spent-Following

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

Level of Service and Other Performance Measures

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

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

Notes

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

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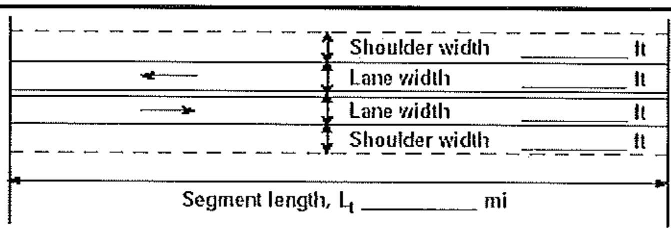
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

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

Project Description: *US 2 - Badrock Canyon Corridor Planning Study*

Input Data



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

Terrain ☐ Level ☑ Rolling

Analysis direction vol., V_d	*175veh/h*
Opposing direction vol., V_o	*279veh/h*
Shoulder width ft	*1.0*
Lane Width ft	*12.0*
Segment Length mi	*2.4*
Grade Length mi	Up/down
Peak-hour factor, PHF	*0.84*
No-passing zone	*100%*
% Trucks and Buses, P_T	*6 %*
% Recreational vehicles, P_R	*4%*
Access points *mi*	*3/mi*

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	*2.3*	*2.1*
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	*1.1*	*1.1*
Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.924*	*0.935*
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	*0.76*	*0.85*
Demand flow rate[2], v_i (pc/h) $v_i=V_i/(PHF*f_{g,ATS}*f_{HV,ATS})$	*297*	*418*

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
Mean speed of sample[3], S_{FM}		Base free-flow speed[4], BFFS	*62.0 mi/h*
Total demand flow rate, both directions, v		Adj. for lane and shoulder width,[4] f_{LS} (Exhibit 15-7)	*4.2 mi/h*
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Adj. for access points[4], f_A (Exhibit 15-8)	*0.8 mi/h*
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	*3.1 mi/h*	Free-flow speed, FFS $(FSS=BFFS-f_{LS}-f_A)$	*57.0 mi/h*
		Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	*48.4 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)	*1.7*	*1.6*
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	*1.0*	*1.0*
Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.960*	*0.965*
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	*0.80*	*0.87*
Directional flow rate[2], v_i(pc/h) $v_i=V_i/(PHF*f_{HV,PTSF}*f_{g,PTSF})$	*271*	*396*
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	*32.3*	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	*49.1*	
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)	*B*
Volume to capacity ratio, v/c	*0.18*

Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h	1438
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	1477
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	208.3
Effective width, Wv (Eq. 15-29) ft	13.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	5.23
Bicycle level of service (Exhibit 15-4)	E
Notes	

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

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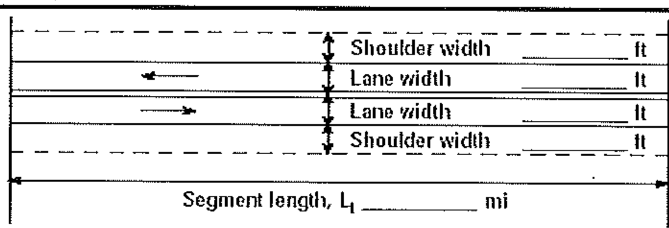
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

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

Project Description: *US 2 - Badrock Canyon Corridor Planning Study*

Input Data



Analysis direction vol., V_d	*246veh/h*	☐ Class I highway ☑ Class II highway ☐ Class III highway	
Opposing direction vol., V_o	*214veh/h*	Terrain ☐ Level ☑ Rolling	
Shoulder width ft	*1.0*	Grade Length mi Up/down	
Lane Width ft	*12.0*	Peak-hour factor, PHF	*0.91*
Segment Length mi	*2.4*	No-passing zone	*100%*
		% Trucks and Buses , P_T	*6 %*
		% Recreational vehicles, P_R	*4%*
		Access points *mi*	*3/mi*

Average Travel Speed

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

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
		Base free-flow speed[4], BFFS	*61.0 mi/h*
Mean speed of sample[3], S_{FM}		Adj. for lane and shoulder width,[4] f_{LS} (Exhibit 15-7)	*4.2 mi/h*
Total demand flow rate, both directions, *v*		Adj. for access points[4], f_A (Exhibit 15-8)	*0.8 mi/h*
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Free-flow speed, FFS $(FSS=BFFS-f_{LS}-f_A)$	*56.0 mi/h*
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	*3.4 mi/h*	Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	*47.3 mi/h*
		Percent free flow speed, PFFS	*84.4 %*

Percent Time-Spent-Following

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

Level of Service and Other Performance Measures

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

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

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

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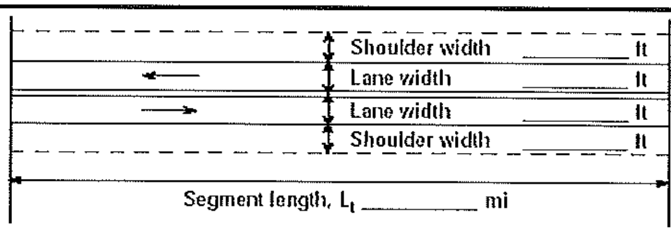
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

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

Project Description: *US 2 - Badrock Canyon Corridor Planning Study*

Input Data



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

Terrain ☐ Level ☑ Rolling

Analysis direction vol., V_d	*214veh/h*
Opposing direction vol., V_o	*246veh/h*
Shoulder width ft	*1.0*
Lane Width ft	*12.0*
Segment Length mi	*2.4*
Grade Length mi	Up/down
Peak-hour factor, PHF	*0.89*
No-passing zone	*100%*
% Trucks and Buses , P_T	*6 %*
% Recreational vehicles, P_R	*4%*
Access points *mi*	*3/mi*

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	*2.2*	*2.1*
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	*1.1*	*1.1*
Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.929*	*0.935*
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	*0.78*	*0.81*
Demand flow rate[2], v_i (pc/h) $v_i=V_i/(PHF^* f_{g,ATS} * f_{HV,ATS})$	*332*	*365*

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
Mean speed of sample[3], S_{FM}		Base free-flow speed[4], BFFS	*61.0 mi/h*
Total demand flow rate, both directions, *v*		Adj. for lane and shoulder width,[4] f_{LS}(Exhibit 15-7)	*4.2 mi/h*
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Adj. for access points[4], f_A (Exhibit 15-8)	*0.8 mi/h*
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	*3.2 mi/h*	Free-flow speed, FFS $(FSS=BFFS-f_{LS}-f_A)$	*56.0 mi/h*
		Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	*47.4 mi/h*
		Percent free flow speed, PFFS	*84.6 %*

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T(Exhibit 15-18 or 15-19)	*1.7*	*1.7*
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	*1.0*	*1.0*
Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.960*	*0.960*
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	*0.82*	*0.84*
Directional flow rate[2], v_i(pc/h) $v_i=V_i/(PHF^*f_{HV,PTSF}{}^* f_{g,PTSF})$	*306*	*343*
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	*34.7*	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	*53.3*	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}{}^*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	*59.8*	

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	*1367*
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	*1428*
Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only)	*84.6*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*240.4*
Effective width, Wv (Eq. 15-29) ft	*13.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*5.30*
Bicycle level of service (Exhibit 15-4)	*E*
Notes	

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

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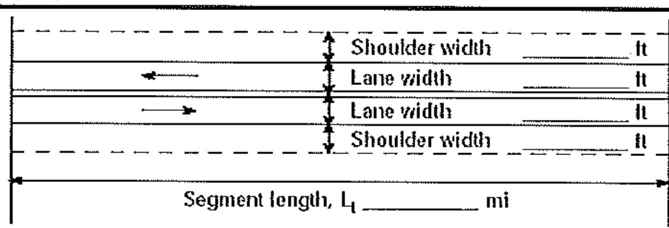
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

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

Project Description: *US 2 - Badrock Canyon Corridor Planning Study*

Input Data



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

Terrain ☐ Level ☑ Rolling

Analysis direction vol., V_d	*207*veh/h
Opposing direction vol., V_o	*343*veh/h
Shoulder width ft	*1.0*
Lane Width ft	*12.0*
Segment Length mi	*2.4*
Grade Length mi	Up/down
Peak-hour factor, PHF	*0.88*
No-passing zone	*100%*
% Trucks and Buses , P_T	*6* %
% Recreational vehicles, P_R	*4%*
Access points *mi*	*3*/mi

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	*2.2*	*2.0*
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	*1.1*	*1.1*
Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.929*	*0.940*
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	*0.78*	*0.89*
Demand flow rate[2], v_i (pc/h) $v_i=V_i/(PHF^* f_{g,ATS} * f_{HV,ATS})$	*325*	*466*

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
Mean speed of sample[3], S_{FM}		Base free-flow speed[4], BFFS	*61.0 mi/h*
Total demand flow rate, both directions, *v*		Adj. for lane and shoulder width,[4] f_{LS}(Exhibit 15-7)	*4.2 mi/h*
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Adj. for access points[4], f_A (Exhibit 15-8)	*0.8 mi/h*
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	*2.7 mi/h*	Free-flow speed, FFS $(FSS=BFFS-f_{LS}-f_A)$	*56.0 mi/h*
		Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	*47.2 mi/h*
		Percent free flow speed, PFFS	*84.3 %*

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T(Exhibit 15-18 or 15-19)	*1.7*	*1.6*
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	*1.0*	*1.0*
Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.960*	*0.965*
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	*0.82*	*0.89*
Directional flow rate[2], v_i(pc/h) $v_i=V_i/(PHF^*f_{HV,PTSF}*f_{g,PTSF})$	*299*	*454*
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	*35.9*	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	*43.0*	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	*53.0*	

Level of Service and Other Performance Measures

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

Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h	*1494*
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	*1544*
Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only)	*84.3*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*235.2*
Effective width, Wv (Eq. 15-29) ft	*13.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*5.29*
Bicycle level of service (Exhibit 15-4)	*E*
Notes	

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

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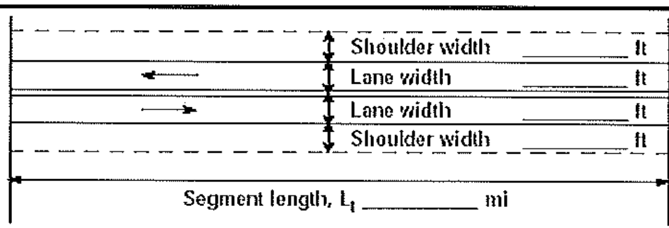
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

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

Project Description: *US 2 - Badrock Canyon 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	*343*veh/h
Opposing direction vol., V_o	*207*veh/h
Shoulder width ft	*1.0*
Lane Width ft	*12.0*
Segment Length mi	*2.4*
Peak-hour factor, PHF	*0.91*
No-passing zone	*100%*
% Trucks and Buses , P_T	*6 %*
% Recreational vehicles, P_R	*4%*
Access points *mi*	*3*/mi

Average Travel Speed

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

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
Mean speed of sample[3], S_{FM}		Base free-flow speed[4], BFFS	*63.0 mi/h*
Total demand flow rate, both directions, *v*		Adj. for lane and shoulder width,[4] f_{LS}(Exhibit 15-7)	*4.2 mi/h*
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Adj. for access points[4], f_A (Exhibit 15-8)	*0.8 mi/h*
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	*3.8 mi/h*	Free-flow speed, FFS $(FSS=BFFS-f_{LS}-f_A)$	*58.0 mi/h*
		Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	*48.3 mi/h*
		Percent free flow speed, PFFS	*83.2 %*

Percent Time-Spent-Following

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

Level of Service and Other Performance Measures

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

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

Notes

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

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Appendix 4

Operational
Analysis Worksheets

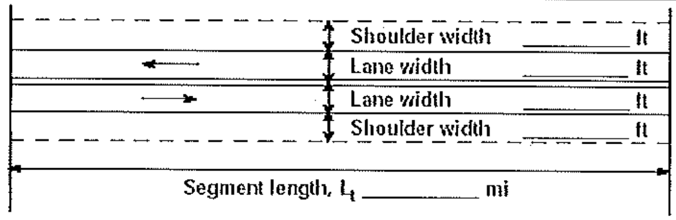
2035 Two-Lane Peak Season

DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

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

Project Description: *US 2 - Badrock Canyon Corridor Planning Study*

Input Data



Analysis direction vol., V_d	*791veh/h*
Opposing direction vol., V_o	*502veh/h*
Shoulder width ft	*1.0*
Lane Width ft	*12.0*
Segment Length mi	*2.4*

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

Terrain ☐ Level ☑ Rolling

Grade Length mi	Up/down
Peak-hour factor, PHF	*0.93*
No-passing zone	*100%*
% Trucks and Buses , P_T	*6 %*
% Recreational vehicles, P_R	*4%*
Access points *mi*	*3/mi*

Average Travel Speed

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

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
		Base free-flow speed[4], BFFS	*60.0 mi/h*
		Adj. for lane and shoulder width,[4] f_{LS} (Exhibit 15-7)	*4.2 mi/h*
Mean speed of sample[3], S_{FM}		Adj. for access points[4], f_A (Exhibit 15-8)	*0.8 mi/h*
Total demand flow rate, both directions, *v*		Free-flow speed, FFS (FSS=BFFS-f_{LS}-f_A)	*55.0 mi/h*
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	*41.8 mi/h*
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	*1.9 mi/h*	Percent free flow speed, PFFS	*75.9 %*

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T(Exhibit 15-18 or 15-19)	*1.0*	*1.2*
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	*1.0*	*1.0*
Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*1.000*	*0.988*
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	*1.00*	*0.96*
Directional flow rate[2], v_i(pc/h) $v_i=V_i/(PHF*f_{HV,PTSF}*f_{g,PTSF})$	*851*	*569*
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	*68.6*	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	*26.4*	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	*84.4*	

Level of Service and Other Performance Measures

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

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

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

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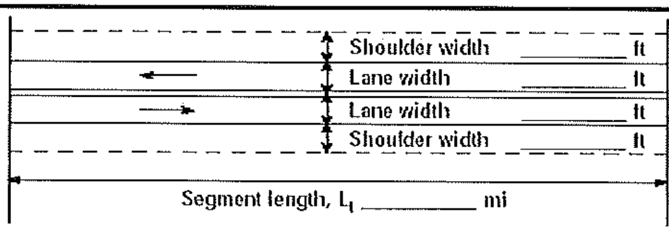
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

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

Project Description: *US 2 - Badrock Canyon 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	*100%*
% Trucks and Buses , P_T	*6 %*
% Recreational vehicles, P_R	*4%*
Access points *mi*	*3/mi*
Analysis direction vol., V_d	*502veh/h*
Opposing direction vol., V_o	*791veh/h*
Shoulder width ft	*1.0*
Lane Width ft	*12.0*
Segment Length mi	*2.4*

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	*1.7*	*1.3*
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	*1.1*	*1.1*
Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.956*	*0.978*
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	*0.97*	*1.00*
Demand flow rate[2], v_i (pc/h) $v_i=V_i/(PHF*f_{g,ATS}*f_{HV,ATS})$	*622*	*930*

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
Mean speed of sample[3], S_{FM}		Base free-flow speed[4], BFFS	*60.0 mi/h*
Total demand flow rate, both directions, v		Adj. for lane and shoulder width,[4] f_{LS} (Exhibit 15-7)	*4.2 mi/h*
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Adj. for access points[4], f_A (Exhibit 15-8)	*0.8 mi/h*
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	*1.2 mi/h*	Free-flow speed, FFS $(FSS=BFFS-f_{LS}-f_A)$	*55.0 mi/h*
		Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	*41.8 mi/h*
		Percent free flow speed, PFFS	*75.9 %*

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T(Exhibit 15-18 or 15-19)	*1.2*	*1.0*
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	*1.0*	*1.0*
Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.988*	*1.000*
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	*0.97*	*1.00*
Directional flow rate[2], v_i(pc/h) $v_i=V_i/(PHF*f_{HV,PTSF}*f_{g,PTSF})$	*602*	*909*
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	*61.7*	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	*24.9*	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	*71.6*	

Level of Service and Other Performance Measures

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

Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h	*1663*
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	*1700*
Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only)	*75.9*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*577.0*
Effective width, Wv (Eq. 15-29) ft	*13.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*5.74*
Bicycle level of service (Exhibit 15-4)	*F*
Notes	

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

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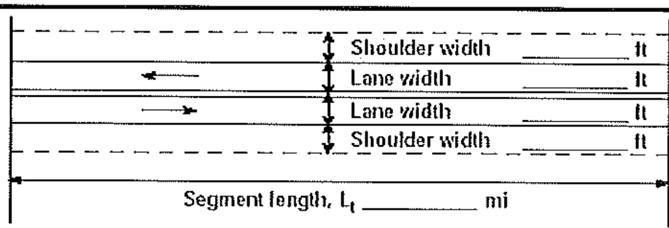
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

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

Project Description: *US 2 - Badrock Canyon Corridor Planning Study*

Input Data



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

Terrain ☐ Level ☑ Rolling

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

Average Travel Speed

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

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
Mean speed of sample[3], S_{FM}		Base free-flow speed[4], BFFS	*61.0 mi/h*
Total demand flow rate, both directions, v		Adj. for lane and shoulder width,[4] f_{LS}(Exhibit 15-7)	*4.2 mi/h*
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Adj. for access points[4], f_A (Exhibit 15-8)	*0.8 mi/h*
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	*1.6 mi/h*	Free-flow speed, FFS $(FSS=BFFS-f_{LS}-f_A)$	*56.0 mi/h*
		Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	*42.6 mi/h*
		Percent free flow speed, PFFS	*76.0 %*

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T(Exhibit 15-18 or 15-19)	*1.0*	*1.0*
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	*1.0*	*1.0*
Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*1.000*	*1.000*
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	*1.00*	*0.99*
Directional flow rate[2], v_i(pc/h) $v_i=V_i/(PHF^* f_{HV,PTSF} {}^* f_{g,PTSF})$	*774*	*682*
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	*67.4*	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	*27.2*	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF} {}^*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	*81.9*	

Level of Service and Other Performance Measures

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

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

Notes

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

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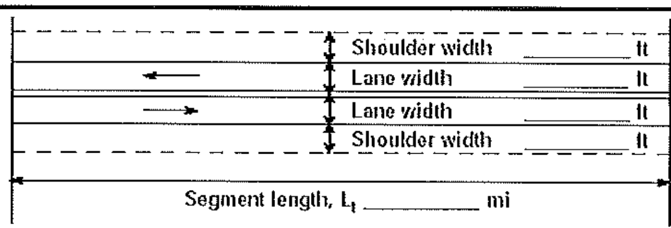
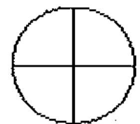
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

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

Project Description: *US 2 - Badrock Canyon Corridor Planning Study*

Input Data





Show North Arrow

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

Terrain ☐ Level ☑ Rolling

Grade Length mi Up/down

Analysis direction vol., V_d	*614*veh/h
Opposing direction vol., V_o	*704*veh/h
Shoulder width ft	*1.0*
Lane Width ft	*12.0*
Segment Length mi	*2.4*
Peak-hour factor, PHF	*0.89*
No-passing zone	*100%*
% Trucks and Buses , P_T	*6 %*
% Recreational vehicles, P_R	*4%*
Access points *mi*	*3/mi*

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	*1.6*	*1.4*
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	*1.1*	*1.1*
Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.962*	*0.973*
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	*0.98*	*0.99*
Demand flow rate[2], v_i (pc/h) $v_i=V_i/(PHF*f_{g,ATS}*f_{HV,ATS})$	*732*	*821*

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
Mean speed of sample[3], S_{FM}		Base free-flow speed[4], BFFS	*61.0 mi/h*
Total demand flow rate, both directions, *v*		Adj. for lane and shoulder width,[4] f_{LS}(Exhibit 15-7)	*4.2 mi/h*
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Adj. for access points[4], f_A (Exhibit 15-8)	*0.8 mi/h*
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	*1.4 mi/h*	Free-flow speed, FFS $(FSS=BFFS-f_{LS}-f_A)$	*56.0 mi/h*
		Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	*42.6 mi/h*
		Percent free flow speed, PFFS	*76.1 %*

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*	*1.0*
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)	*0.99*	*1.00*
Directional flow rate[2], v_i(pc/h) $v_i=V_i/(PHF*f_{HV,PTSF}*f_{g,PTSF})$	*697*	*791*
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	*64.7*	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	*26.7*	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	*77.2*	

Level of Service and Other Performance Measures

Level of service, LOS (Exhibit 15-3)	*D*
Volume to capacity ratio, *v/c*	*0.41*

Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h	*1638*
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	*1700*
Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only)	*76.1*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*689.9*
Effective width, Wv (Eq. 15-29) ft	*13.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*5.83*
Bicycle level of service (Exhibit 15-4)	*F*
Notes	

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

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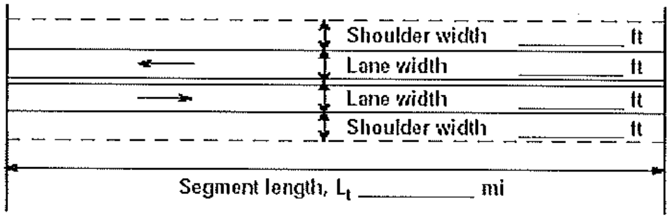
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

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

Project Description: *US 2 - Badrock Canyon Corridor Planning Study*

Input Data



Analysis direction vol., V_d	586veh/h
Opposing direction vol., V_o	981veh/h
Shoulder width ft	1.0
Lane Width ft	12.0
Segment Length mi	2.4

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

Terrain ☐ Level ☑ Rolling

Grade Length mi	Up/down
Peak-hour factor, PHF	0.89
No-passing zone	100%
% Trucks and Buses , P_T	6 %
% Recreational vehicles, P_R	4%
Access points *mi*	3/mi

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	1.6	1.3
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	1.1	1.1
Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	0.962	0.978
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	0.98	1.00
Demand flow rate[2], v_i(pc/h) $v_i=V_i/(PHF*f_{g,ATS}*f_{HV,ATS})$	698	1127

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
Mean speed of sample[3], S_{FM}		Base free-flow speed[4], BFFS	62.0 mi/h
Total demand flow rate, both directions, v		Adj. for lane and shoulder width,[4] f_{LS}(Exhibit 15-7)	4.2 mi/h
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Adj. for access points[4], f_A (Exhibit 15-8)	0.8 mi/h
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	1.1 mi/h	Free-flow speed, FFS $(FSS=BFFS-f_{LS}-f_A)$	57.0 mi/h
		Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	41.8 mi/h
		Percent free flow speed, PFFS	73.3 %

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)	0.98	1.00
Directional flow rate[2], v_i(pc/h) $v_i=V_i/(PHF*f_{HV,PTSF}*f_{g,PTSF})$	672	1102
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	67.8	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	20.1	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	75.4	

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	*1663*
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	*1700*
Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only)	*73.3*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*658.4*
Effective width, Wv (Eq. 15-29) ft	*13.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*5.81*
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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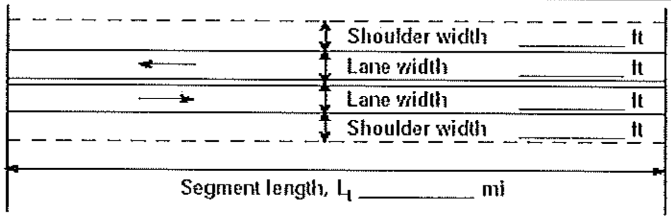
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

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

Project Description: *US 2 - Badrock Canyon Corridor Planning Study*

Input Data



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

Terrain ☐ Level ☑ Rolling

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

Average Travel Speed

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

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
		Base free-flow speed[4], BFFS	*60.0 mi/h*
Mean speed of sample[3], S_{FM}		Adj. for lane and shoulder width,[4] f_{LS}(Exhibit 15-7)	*4.2 mi/h*
Total demand flow rate, both directions, v		Adj. for access points[4], f_A (Exhibit 15-8)	*0.8 mi/h*
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Free-flow speed, FFS $(FSS=BFFS-f_{LS}-f_A)$	*55.0 mi/h*
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	*1.7 mi/h*	Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	*39.4 mi/h*
		Percent free flow speed, PFFS	*71.7 %*

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

Level of Service and Other Performance Measures

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

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

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

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Appendix 4

Operational Analysis Worksheets

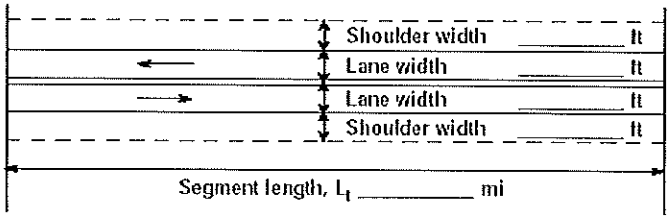
2035 Two-Lane Adjusted Annual Average

DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

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

Project Description: *US 2 - Badrock Canyon Corridor Planning Study*

Input Data



Analysis direction vol., V_d	398veh/h
Opposing direction vol., V_o	250veh/h
Shoulder width ft	1.0
Lane Width ft	12.0
Segment Length mi	2.4

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

Terrain	☐ Level ☑ Rolling
Grade Length mi	Up/down
Peak-hour factor, PHF	0.93
No-passing zone	100%
% Trucks and Buses , P_T	6 %
% Recreational vehicles, P_R	4%
Access points *mi*	3/mi

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	1.9	2.2
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	1.1	1.1
Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	0.945	0.929
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	0.91	0.81
Demand flow rate[2], v_i(pc/h) $v_i=V_i/(PHF*f_{g,ATS}*f_{HV,ATS})$	498	357

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
Mean speed of sample[3], S_{FM}		Base free-flow speed[4], BFFS	60.0 mi/h
Total demand flow rate, both directions, v		Adj. for lane and shoulder width,[4] f_{LS}(Exhibit 15-7)	4.2 mi/h
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Adj. for access points[4], f_A (Exhibit 15-8)	0.8 mi/h
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	3.1 mi/h	Free-flow speed, FFS $(FSS=BFFS-f_{LS}-f_A)$	55.0 mi/h
		Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	45.3 mi/h
		Percent free flow speed, PFFS	82.3 %

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T(Exhibit 15-18 or 15-19)	1.4	1.7
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	1.0	1.0
Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	0.977	0.960
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	0.92	0.83
Directional flow rate[2], v_i(pc/h) $v_i=V_i/(PHF*f_{HV,PTSF}*f_{g,PTSF})$	476	337
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	46.3	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	40.2	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	69.8	

Level of Service and Other Performance Measures

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

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

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

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DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

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

Project Description: *US 2 - Badrock Canyon 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

Grade Length mi	Up/down
Peak-hour factor, PHF	*0.87*
No-passing zone	*100%*
% Trucks and Buses , P_T	*6 %*
% Recreational vehicles, P_R	*4%*
Access points *mi*	*3/mi*

Analysis direction vol., V_d	*250veh/h*
Opposing direction vol., V_o	*398veh/h*
Shoulder width ft	*1.0*
Lane Width ft	*12.0*
Segment Length mi	*2.4*

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	*2.1*	*1.9*
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	*1.1*	*1.1*
Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.935*	*0.945*
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	*0.82*	*0.93*
Demand flow rate[2], v_i (pc/h) $v_i=V_i/(PHF*f_{g,ATS}*f_{HV,ATS})$	*375*	*521*

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
Mean speed of sample[3], S_{FM}		Base free-flow speed[4], BFFS	*60.0 mi/h*
Total demand flow rate, both directions, *v*		Adj. for lane and shoulder width,[4] f_{LS}(Exhibit 15-7)	*4.2 mi/h*
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Adj. for access points[4], f_A (Exhibit 15-8)	*0.8 mi/h*
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	*2.3 mi/h*	Free-flow speed, FFS $(FSS=BFFS-f_{LS}-f_A)$	*55.0 mi/h*
		Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	*45.8 mi/h*
		Percent free flow speed, PFFS	*83.3 %*

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T(Exhibit 15-18 or 15-19)	*1.7*	*1.4*
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	*1.0*	*1.0*
Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.960*	*0.977*
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	*0.84*	*0.93*
Directional flow rate[2], v_i(pc/h) $v_i=V_i/(PHF*f_{HV,PTSF}*f_{g,PTSF})$	*356*	*504*
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	*41.6*	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	*39.1*	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	*57.8*	

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	*1536*
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	*1613*
Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only)	*83.3*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*287.4*
Effective width, Wv (Eq. 15-29) ft	*13.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*5.39*
Bicycle level of service (Exhibit 15-4)	*E*
Notes	

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

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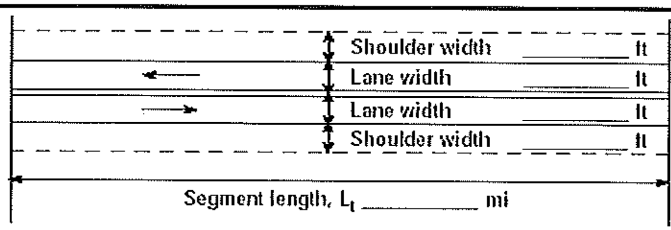
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

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

Project Description: *US 2 - Badrock Canyon Corridor Planning Study*

Input Data



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

Terrain ☐ Level ☑ Rolling

Analysis direction vol., V_d	*351veh/h*
Opposing direction vol., V_o	*306veh/h*
Shoulder width ft	*1.0*
Lane Width ft	*12.0*
Segment Length mi	*2.4*
Grade Length mi Up/down	
Peak-hour factor, PHF	*0.91*
No-passing zone	*100%*
% Trucks and Buses , P_T	*6 %*
% Recreational vehicles, P_R	*4%*
Access points *mi*	*3/mi*

Average Travel Speed

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

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
Mean speed of sample[3], S_{FM}		Base free-flow speed[4], BFFS	*61.0 mi/h*
Total demand flow rate, both directions, *v*		Adj. for lane and shoulder width,[4] f_{LS}(Exhibit 15-7)	*4.2 mi/h*
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Adj. for access points[4], f_A (Exhibit 15-8)	*0.8 mi/h*
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	*2.9 mi/h*	Free-flow speed, FFS $(FSS=BFFS-f_{LS}-f_A)$	*56.0 mi/h*
		Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	*46.3 mi/h*
		Percent free flow speed, PFFS	*82.6 %*

Percent Time-Spent-Following

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

Level of Service and Other Performance Measures

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

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

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

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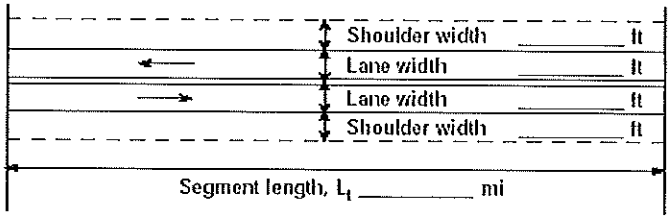
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

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

Project Description: *US 2 - Badrock Canyon Corridor Planning Study*

Input Data



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

Terrain ☐ Level ☑ Rolling

Analysis direction vol., V_d	306veh/h
Opposing direction vol., V_o	351veh/h
Shoulder width ft	1.0
Lane Width ft	12.0
Segment Length mi	2.4
Grade Length mi	Up/down
Peak-hour factor, PHF	0.89
No-passing zone	100%
% Trucks and Buses , P_T	6 %
% Recreational vehicles, P_R	4%
Access points *mi*	3/mi

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	2.1	2.0
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	1.1	1.1
Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	0.935	0.940
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	0.86	0.90
Demand flow rate[2], v_i (pc/h) $v_i=V_i/(PHF*f_{g,ATS}*f_{HV,ATS})$	428	466

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
Mean speed of sample[3], S_{FM}		Base free-flow speed[4], BFFS	61.0 mi/h
Total demand flow rate, both directions, v		Adj. for lane and shoulder width,[4] f_{LS}(Exhibit 15-7)	4.2 mi/h
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Adj. for access points[4], f_A (Exhibit 15-8)	0.8 mi/h
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	2.7 mi/h	Free-flow speed, FFS $(FSS=BFFS-f_{LS}-f_A)$	56.0 mi/h
		Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	46.4 mi/h
		Percent free flow speed, PFFS	82.9 %

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T(Exhibit 15-18 or 15-19)	1.6	1.6
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	1.0	1.0
Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	0.965	0.965
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	0.87	0.90
Directional flow rate[2], v_i(pc/h) $v_i=V_i/(PHF*f_{HV,PTSF}*f_{g,PTSF})$	409	454
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	44.7	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	43.0	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	65.1	

Level of Service and Other Performance Measures

Level of service, LOS (Exhibit 15-3)	C
Volume to capacity ratio, *v/c*	0.26

Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h	*1494*
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	*1544*
Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only)	*82.9*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*343.8*
Effective width, Wv (Eq. 15-29) ft	*13.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*5.48*
Bicycle level of service (Exhibit 15-4)	*E*
Notes	

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

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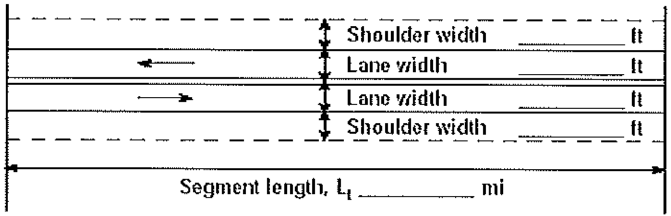
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

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

Project Description: *US 2 - Badrock Canyon Corridor Planning Study*

Input Data



Class I highway ☑ Class II highway Class III highway

Terrain Level ☑ Rolling

Analysis direction vol., V_d	296veh/h
Opposing direction vol., V_o	491veh/h
Shoulder width ft	1.0
Lane Width ft	12.0
Segment Length mi	2.4
Grade Length mi	Up/down
Peak-hour factor, PHF	0.89
No-passing zone	100%
% Trucks and Buses , P_T	6 %
% Recreational vehicles, P_R	4%
Access points *mi*	3/mi

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	2.1	1.7
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	1.1	1.1
Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	0.935	0.956
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	0.85	0.96
Demand flow rate[2], v_i(pc/h) $v_i=V_i/(PHF*f_{g,ATS}*f_{HV,ATS})$	418	601

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
Mean speed of sample[3], S_{FM}		Base free-flow speed[4], BFFS	62.0 mi/h
Total demand flow rate, both directions, *v*		Adj. for lane and shoulder width,[4] f_{LS}(Exhibit 15-7)	4.2 mi/h
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Adj. for access points[4], f_A (Exhibit 15-8)	0.8 mi/h
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	1.9 mi/h	Free-flow speed, FFS (FSS=BFFS-f_{LS}-f_A)	57.0 mi/h
		Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	47.2 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)	1.6	1.2
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	1.0	1.0
Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	0.965	0.988
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	0.87	0.97
Directional flow rate[2], v_i(pc/h) $v_i=V_i/(PHF*f_{HV,PTSF}*f_{g,PTSF})$	396	576
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	45.3	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	36.0	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	60.0	

Level of Service and Other Performance Measures

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

Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h	*1576*
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	*1629*
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	*332.6*
Effective width, Wv (Eq. 15-29) ft	*13.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*5.46*
Bicycle level of service (Exhibit 15-4)	*E*
Notes	

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

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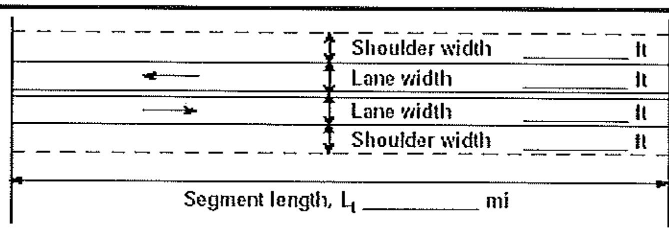
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

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

Project Description: *US 2 - Badrock Canyon Corridor Planning Study*

Input Data



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

Terrain ☐ Level ☑ Rolling

Analysis direction vol., V_d	*491veh/h*
Opposing direction vol., V_o	*296veh/h*
Shoulder width ft	*1.0*
Lane Width ft	*12.0*
Segment Length mi	*2.4*
Grade Length mi	Up/down
Peak-hour factor, PHF	*0.91*
No-passing zone	*100%*
% Trucks and Buses , P_T	*6 %*
% Recreational vehicles, P_R	*4%*
Access points *mi*	*3/mi*

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	*1.8*	*2.1*
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	*1.1*	*1.1*
Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.951*	*0.935*
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	*0.96*	*0.85*
Demand flow rate[2], v_i (pc/h) $v_i=V_i/(PHF^* f_{g,ATS} * f_{HV,ATS})$	*591*	*409*

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
		Base free-flow speed[4], BFFS	*60.0 mi/h*
Mean speed of sample[3], S_{FM}		Adj. for lane and shoulder width,[4] f_{LS}(Exhibit 15-7)	*4.2 mi/h*
Total demand flow rate, both directions, *v*		Adj. for access points[4], f_A (Exhibit 15-8)	*0.8 mi/h*
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Free-flow speed, FFS ($FSS=BFFS-f_{LS}-f_A$)	*55.0 mi/h*
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	*2.8 mi/h*	Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	*44.5 mi/h*
		Percent free flow speed, PFFS	*80.9 %*

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T(Exhibit 15-18 or 15-19)	*1.2*	*1.6*
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	*1.0*	*1.0*
Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.988*	*0.965*
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	*0.96*	*0.86*
Directional flow rate[2], v_i(pc/h) $v_i=V_i/(PHF^*f_{HV,PTSF}*f_{g,PTSF})$	*569*	*392*
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	*54.1*	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	*36.2*	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	*75.5*	

Level of Service and Other Performance Measures

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

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

Notes

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

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Appendix 4

Operational
Analysis Worksheets

2035 3-2-3-4 Peak Season
Three-Lane RP 140.0 – RP 140.6
Two-Lane RP 140.6 – RP 141.2
Three-Lane RP 141.2 – 142.0

2

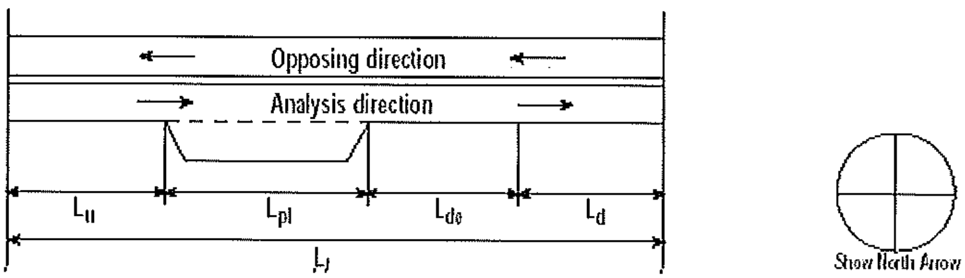
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET WITH PASSING LANE WORKSHEET

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

Project Description: US 2 Badrock Canyon Corridor PlafÅ

Input Data

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



Shoulder width (ft)	1.0
Lane Width (ft)	12.0
Segment Length (mi)	2.4
Total length of analysis segment, L_t	2.4
Length of two-lane highway upstream of the passing lane, L_u	0.0
Length of passing lane including tapers , L_{pl}	0.6
Average travel speed, ATS_d (from Directional Two-Lane Highway Segment Worksheet)	41.8
Percent time-spent-following, $PTSF_d$ (from Directional Two-Lane Highway Segment Worksheet)	84.4
Level of service[1], LOS_d (from Directional Two-Lane Highway Segment Worksheet)	D
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 $L_d=L_t-(L_u+L_{pl}+L_{de})$	0.10
Adj. factor for the effect of passing lane on average speed, f_{pl} (Exhibit 15-28)	1.11
Average travel speed including passing lane[2], $ATS_{pl} = (ATS_d * L_t) / (L_u+L_d+(L_{pl}/f_{pl})+(2L_{de}/(1+f_{pl,ATS})))$	44.5
Percent free flow speed including passing lane, $PFFS_{pl} = (ATS_{pl}/ FFS)$	80.9
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)	4.64
Length of two-lane highway downstream of effective length of the passing lane for percent-time-following, $L_d = L_t-(L_u+L_{pl}+L_{de})$	-2.84
Adj. factor for the effect of passing lane on percent time-spent-following,	

$f_{pl,PTSF}$(Exhibit 15-26)	*0.62*
Percent time-spent-following including passing lane[3], $PTSF_{pl}$(%) $PTSF_{pl}= PTSF_d[L_u+L_d+f_{pl,PTSF}L_{pl}+((1+f_{pl,PTSF})/2)L_{de}]/L_t$	*57.0*
Level of Service and Other Performance Measures[4]	
Level of service including passing lane LOS_{pl} (Exhibit 15-3)	*C*
Peak 15-min total travel time, TT_{15}(veh-h) $TT_{15}= VMT_{15}/ATS_{pl}$	*11.5*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*850.5*
Effective width, W_v (Eq. 15-29) ft	*13.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*5.94*
Bicycle level of service (Exhibit 15-4)	*F*
Notes	
1. 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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2

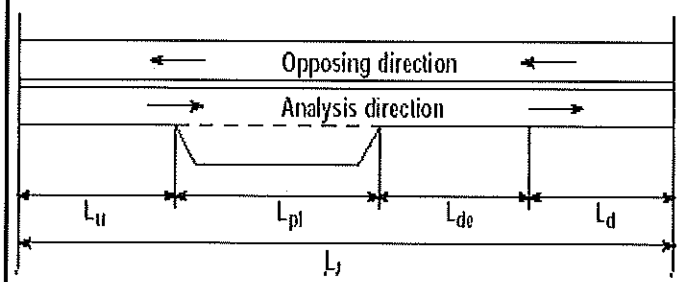
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET WITH PASSING LANE WORKSHEET

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

Project Description: US 2 Badrock Canyon Corridor PlanÝ

Input Data

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



Shoulder width (ft)	1.0
Lane Width (ft)	12.0
Segment Length (mi)	2.4
Total length of analysis segment, L_t	2.4
Length of two-lane highway upstream of the passing lane, L_u	0.0
Length of passing lane including tapers , L_{pl}	1.1
Average travel speed, ATS_d (from Directional Two-Lane Highway Segment Worksheet)	41.8
Percent time-spent-following, $PTSF_d$ (from Directional Two-Lane Highway Segment Worksheet)	71.6
Level of service[1], LOS_d (from Directional Two-Lane Highway Segment Worksheet)	D
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 $L_d=L_t-(L_u+L_{pl}+L_{de})$	-0.40
Adj. factor for the effect of passing lane on average speed, f_{pl} (Exhibit 15-28)	1.11
Average travel speed including passing lane[2], $ATS_{pl} = (ATS_d * L_t) / (L_u+L_d+(L_{pl}/f_{pl})+ (2L_{de}/(1+f_{pl,ATS})))$	45.4
Percent free flow speed including passing lane, $PFFS_{pl} = (ATS_{pl}/ FFS)$	82.5
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)	6.48
Length of two-lane highway downstream of effective length of the passing lane for percent-time-following, $L_d =L_t-(L_u+ L_{pl}+ L_{de})$	-5.18
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], $PTSF_{pl}$(%) $PTSF_{pl}= PTSF_d[L_u+L_d+f_{pl,PTSF}L_{pl}+((1+f_{pl,PTSF})/2)L_{de}]/L_t$	45.2
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) $TT_{15}= VMT_{15}/ATS_{pl}$	7.6
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	577.0
Effective width, W_v (Eq. 15-29) ft	13.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	5.74
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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2

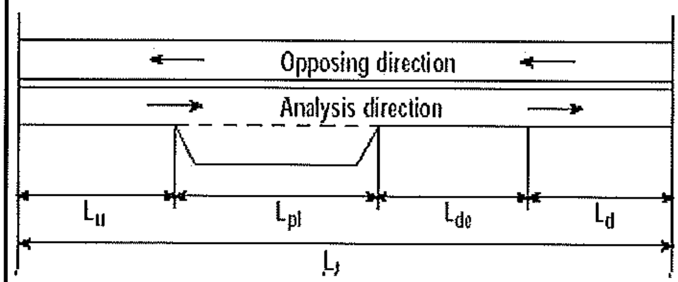
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET WITH PASSING LANE WORKSHEET

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

Project Description: US 2 Badrock Canyon Corridor PlaW

Input Data

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



Shoulder width (ft)	1.0
Lane Width (ft)	12.0
Segment Length (mi)	2.4
Total length of analysis segment, L_t	2.4
Length of two-lane highway upstream of the passing lane, L_u	0.0
Length of passing lane including tapers , L_{pl}	0.6
Average travel speed, ATS_d (from Directional Two-Lane Highway Segment Worksheet)	42.6
Percent time-spent-following, $PTSF_d$ (from Directional Two-Lane Highway Segment Worksheet)	81.9
Level of service[1], LOS_d (from Directional Two-Lane Highway Segment Worksheet)	D
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 $L_d=L_t-(L_u+L_{pl}+L_{de})$	0.10
Adj. factor for the effect of passing lane on average speed, f_{pl} (Exhibit 15-28)	1.11
Average travel speed including passing lane[2], $ATS_{pl} = (ATS_d * L_t) / (L_u+L_d+(L_{pl}/f_{pl})+ (2L_{de}/(1+f_{pl,ATS})))$	45.4
Percent free flow speed including passing lane, $PFFS_{pl} = (ATS_{pl} / FFS)$	81.0
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)	5.18
Length of two-lane highway downstream of effective length of the passing lane for percent-time-following, $L_d =L_t-(L_u+ L_{pl}+ L_{de})$	-3.38
Adj. factor for the effect of passing lane on percent time-spent-following,	

$f_{pl,PTSF}$(Exhibit 15-26)	0.62
Percent time-spent-following including passing lane[3], $PTSF_{pl}$(%) $PTSF_{pl}= PTSF_d[L_u+L_d+f_{pl,PTSF}L_{pl}+((1+f_{pl,PTSF})/2)L_{de}]/L_t$	54.8
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) $TT_{15}= VMT_{15}/ATS_{pl}$	10.2
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	773.6
Effective width, W_v (Eq. 15-29) ft	13.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	5.89
Bicycle level of service (Exhibit 15-4)	F
Notes	
1. 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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2

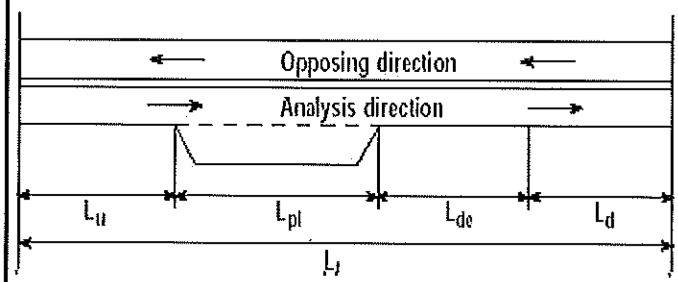
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET WITH PASSING LANE WORKSHEET

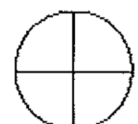
General Information		**Site Information**	
Analyst	*David Stoner*	Highway of Travel	*US 2*
Agency or Company	*DOWL HKM*	From/To	*Columbia F to Hungry H WB*
Date Performed	*11/15/2011*	Jurisdiction	*Flathead County*
Analysis Time Period	*Median Off-Peak*	Analysis Year	*2035*

Project Description: *US 2 Badrock Canyon Corridor Plat*

Input Data

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





Show North Arrow

Shoulder width (ft)	*1.0*
Lane Width (ft)	*12.0*
Segment Length (mi)	*2.4*
Total length of analysis segment, L_t	*2.4*
Length of two-lane highway upstream of the passing lane, L_u	*0.0*
Length of passing lane including tapers , L_{pl}	*1.1*
Average travel speed, ATS_d (from Directional Two-Lane Highway Segment Worksheet)	*42.7*
Percent time-spent-following, $PTSF_d$ (from Directional Two-Lane Highway Segment Worksheet)	*77.2*
Level of service[1], LOS_d (from Directional Two-Lane Highway Segment Worksheet)	*D*
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 $L_d = L_t - (L_u + L_{pl} + L_{de})$	*-0.40*
Adj. factor for the effect of passing lane on average speed, f_{pl} (Exhibit 15-28)	*1.11*
Average travel speed including passing lane[2], $ATS_{pl} = (ATS_d * L_t) / (L_u + L_d + (L_{pl}/f_{pl}) + (2L_{de}/(1+f_{pl,ATS})))$	*46.5*
Percent free flow speed including passing lane, $PFFS_{pl} = (ATS_{pl}/ FFS)$	*82.9*
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)	*5.79*
Length of two-lane highway downstream of effective length of the passing lane for percent-time-following, $L_d = L_t - (L_u + L_{pl} + L_{de})$	*-4.49*
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], $PTSF_{pl}$(%) $PTSF_{pl}= PTSF_d[L_u+L_d+f_{pl,PTSF}L_{pl}+((1+f_{pl,PTSF})/2)L_{de}]/L_t$	*48.9*
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) $TT_{15}= VMT_{15}/ATS_{pl}$	*8.8*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*682.2*
Effective width, W_v (Eq. 15-29) ft	*13.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*5.83*
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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2

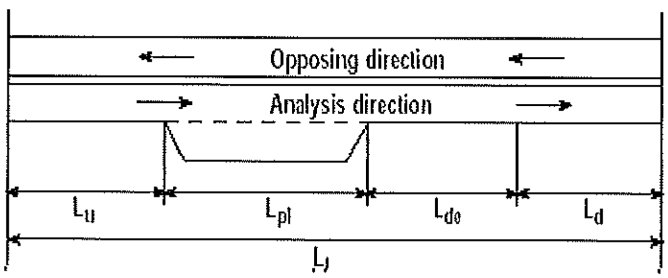
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET WITH PASSING LANE WORKSHEET

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

Project Description: US 2 Badrock Canyon Corridor Pla/

Input Data

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



Shoulder width (ft)	1.0
Lane Width (ft)	12.0
Segment Length (mi)	2.4
Total length of analysis segment, L_t	2.4
Length of two-lane highway upstream of the passing lane, L_u	0.0
Length of passing lane including tapers , L_{pl}	0.6
Average travel speed, ATS_d (from Directional Two-Lane Highway Segment Worksheet)	41.8
Percent time-spent-following, $PTSF_d$ (from Directional Two-Lane Highway Segment Worksheet)	75.4
Level of service[1], LOS_d (from Directional Two-Lane Highway Segment Worksheet)	D
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 $L_d = L_t - (L_u + L_{pl} + L_{de})$	0.10
Adj. factor for the effect of passing lane on average speed, f_{pl} (Exhibit 15-28)	1.11
Average travel speed including passing lane[2], $ATS_{pl} = (ATS_d * L_t) / (L_u + L_d + (L_{pl}/f_{pl}) + (2L_{de}/(1+f_{pl,ATS})))$	44.6
Percent free flow speed including passing lane, $PFFS_{pl} = (ATS_{pl}/ FFS)$	78.1
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)	5.92
Length of two-lane highway downstream of effective length of the passing lane for percent-time-following, $L_d = L_t - (L_u + L_{pl} + L_{de})$	-4.12
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], $PTSF_{pl}$(%) $PTSF_{pl}= PTSF_d[L_u+L_d+f_{pl,PTSF}L_{pl}+((1+f_{pl,PTSF})/2)L_{de}]/L_t$	*49.3*
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) $TT_{15}= VMT_{15}/ATS_{pl}$	*8.9*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*658.4*
Effective width, W_v (Eq. 15-29) ft	*13.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*5.81*
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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2

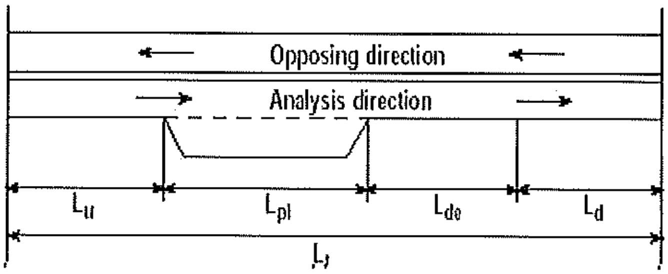
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET WITH PASSING LANE WORKSHEET

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

Project Description: US 2 Badrock Canyon Corridor Pla±PB

Input Data

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



Shoulder width (ft)	1.0
Lane Width (ft)	12.0
Segment Length (mi)	2.4
Total length of analysis segment, L_t	2.4
Length of two-lane highway upstream of the passing lane, L_u	0.0
Length of passing lane including tapers , L_{pl}	1.1
Average travel speed, ATS_d (from Directional Two-Lane Highway Segment Worksheet)	39.4
Percent time-spent-following, $PTSF_d$ (from Directional Two-Lane Highway Segment Worksheet)	89.4
Level of service[1], LOS_d (from Directional Two-Lane Highway Segment Worksheet)	E
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 $L_d=L_t-(L_u+L_{pl}+L_{de})$	-0.40
Adj. factor for the effect of passing lane on average speed, f_{pl} (Exhibit 15-28)	1.11
Average travel speed including passing lane[2], $ATS_{pl} = (ATS_d * L_t) / (L_u+L_d+(L_{pl}/f_{pl})+ (2L_{de}/(1+f_{pl,ATS})))$	42.9
Percent free flow speed including passing lane, $PFFS_{pl} = (ATS_{pl}/ FFS)$	77.9
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)	3.60
Length of two-lane highway downstream of effective length of the passing lane for percent-time-following, $L_d = L_t-(L_u+ L_{pl}+ L_{de})$	-2.30
Adj. factor for the effect of passing lane on percent time-spent-following,	

$f_{pl,PTSF}$(Exhibit 15-26)	0.62
Percent time-spent-following including passing lane[3], $PTSF_{pl}$(%) $PTSF_{pl}= PTSF_d[L_u+L_d+f_{pl,PTSF}L_{pl}+((1+f_{pl,PTSF})/2)L_{de}]/L_t$	58.8
Level of Service and Other Performance Measures[4]	
Level of service including passing lane LOS_{pl} (Exhibit 15-3)	C
Peak 15-min total travel time, TT_{15}(veh-h) $TT_{15}= VMT_{15}/ATS_{pl}$	15.1
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	1078.0
Effective width, W_v (Eq. 15-29) ft	13.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	6.06
Bicycle level of service (Exhibit 15-4)	F
Notes	
1. 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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Appendix 4

Operational Analysis Worksheets

2035 3-2-3-4 Four-Lane Peak Season
RP 142.0 – RP 142.4

Direction 1 = Eastbound
Direction 2 = Westbound

MULTILANE HIGHWAYS WORKSHEET(Direction 1)

General Information

Analyst	David Stoner
Agency or Company	DOWL HKM
Date Performed	4/30/2012
Analysis Time Period	AM Peak

Site Information

Highway/Direction to Travel	US 2
From/To	Columbia Falls to Hungry Horse
Jurisdiction	Flathead County
Analysis Year	2035

Project Description US 2 Badrock Canyon Corridor Planning Study

☐ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	791	Peak-Hour Factor, PHF	0.93
AADT(veh/h)		%Trucks and Buses, P_T	6
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Rolling
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	2.0
E_T	2.5	f_{HV}	0.885

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)	480
Speed, S (mi/h)	60.0
D (pc/mi/ln)	8.0
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	*425.3*
Effective width, W_v (Eq. 15-29) ft	*24.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*3.55*
Bicycle level of service (Exhibit 15-4)	*D*

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MULTILANE HIGHWAYS WORKSHEET(Direction 2)

General Information

Analyst	David Stoner
Agency or Company	DOWL HKM
Date Performed	4/30/2012
Analysis Time Period	AM Peak

Site Information

Highway/Direction to Travel	US 2
From/To	Columbia Falls to Hungry Horse
Jurisdiction	Flathead County
Analysis Year	2035

Project Description US 2 Badrock Canyon Corridor Planning Study

☐ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	502	Peak-Hour Factor, PHF	0.87
AADT(veh/h)		%Trucks and Buses, P_T	6
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Rolling
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	2.0
E_T	2.5	f_{HV}	0.885

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)	326
Speed, S (mi/h)	60.0
D (pc/mi/ln)	5.4
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	288.5
Effective width, W_v (Eq. 15-29) ft	24.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	3.36
Bicycle level of service (Exhibit 15-4)	C

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MULTILANE HIGHWAYS WORKSHEET(Direction 1)

General Information		Site Information	
Analyst	David Stoner	Highway/Direction to Travel	US 2
Agency or Company	DOWL HKM	From/To	Columbia Falls to Hungry Horse
Date Performed	4/30/2012	Jurisdiction	Flathead County
Analysis Time Period	Median Off Peak Peak	Analysis Year	2035

Project Description US 2 Badrock Canyon Corridor Planning Study

☐ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	704	Peak-Hour Factor, PHF	0.91
AADT(veh/h)		%Trucks and Buses, P_T	6
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Rolling
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	2.0
E_T	2.5	f_{HV}	0.885

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)	61.0	FFS (mi/h)	61.0
Base Free-Flow Speed, BFFS			

Operations		Design	
Operational (LOS)		Design (N)	
Flow Rate, v_p (pc/h/ln)	437	Required Number of Lanes, N	
Speed, S (mi/h)	60.0	Flow Rate, v_p (pc/h)	
D (pc/mi/ln)	7.3	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	386.8
Effective width, W_v (Eq. 15-29) ft	24.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	3.51
Bicycle level of service (Exhibit 15-4)	D

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MULTILANE HIGHWAYS WORKSHEET(Direction 2)

General Information

Analyst	David Stoner
Agency or Company	DOWL HKM
Date Performed	4/30/2012
Analysis Time Period	Median Off Peak Peak

Site Information

Highway/Direction to Travel	US 2
From/To	Columbia Falls to Hungry Horse
Jurisdiction	Flathead County
Analysis Year	2035

Project Description US 2 Badrock Canyon Corridor Planning Study

☐ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	614	Peak-Hour Factor, PHF	0.89
AADT(veh/h)		%Trucks and Buses, P_T	6
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Rolling
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	2.0
E_T	2.5	f_{HV}	0.885

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)	61.0
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)	61.0

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	389
Speed, S (mi/h)	60.0
D (pc/mi/ln)	6.5
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	344.9
Effective width, W_v (Eq. 15-29) ft	24.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	3.45
Bicycle level of service (Exhibit 15-4)	C

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MULTILANE HIGHWAYS WORKSHEET(Direction 1)

General Information

Analyst	David Stoner
Agency or Company	DOWL HKM
Date Performed	4/30/2012
Analysis Time Period	PM Peak

Site Information

Highway/Direction to Travel	US 2
From/To	Columbia Falls to Hungry Horse
Jurisdiction	Flathead County
Analysis Year	2035

Project Description US 2 Badrock Canyon Corridor Planning Study

☐ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	586	Peak-Hour Factor, PHF	0.89
AADT(veh/h)		%Trucks and Buses, P_T	6
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Rolling
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	2.0
E_T	2.5	f_{HV}	0.885

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)	62.0
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)	62.0

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	372
Speed, S (mi/h)	60.0
D (pc/mi/ln)	6.2
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	329.2
Effective width, W_v (Eq. 15-29) ft	24.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	3.42
Bicycle level of service (Exhibit 15-4)	C

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MULTILANE HIGHWAYS WORKSHEET(Direction 2)

[x]

General Information

Analyst	David Stoner
Agency or Company	DOWL HKM
Date Performed	4/30/2012
Analysis Time Period	PM Peak

Site Information

Highway/Direction to Travel	US 2
From/To	Columbia Falls to Hungry Horse
Jurisdiction	Flathead County
Analysis Year	2035

Project Description US 2 Badrock Canyon Corridor Planning Study

☐ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	981	Peak-Hour Factor, PHF	0.91
AADT(veh/h)		%Trucks and Buses, P_T	6
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Rolling
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	2.0
E_T	2.5	f_{HV}	0.885

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)	609
Speed, S (mi/h)	60.0
D (pc/mi/ln)	10.1
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	539.0
Effective width, W_v (Eq. 15-29) ft	24.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	3.67
Bicycle level of service (Exhibit 15-4)	D

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Appendix 4

Operational
Analysis Worksheets

2035 3-2-3-4 Adjusted Annual Average
Three-Lane RP 140.0 – RP 140.6
Two-Lane RP 140.6 – RP 141.2
Three-Lane RP 141.2 – 142.0

2

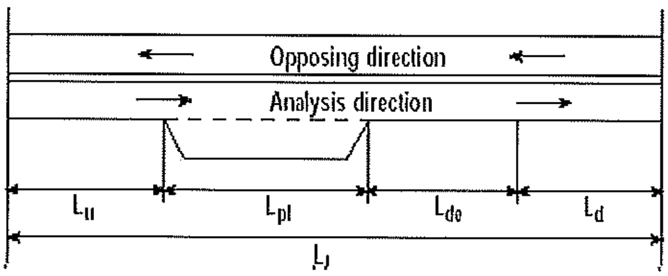
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET WITH PASSING LANE WORKSHEET

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

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

Input Data

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



Shoulder width (ft)	1.0
Lane Width (ft)	12.0
Segment Length (mi)	2.4
Total length of analysis segment, L_t	2.4
Length of two-lane highway upstream of the passing lane, L_u	0.0
Length of passing lane including tapers , L_{pl}	0.6
Average travel speed, ATS_d (from Directional Two-Lane Highway Segment Worksheet)	45.3
Percent time-spent-following, $PTSF_d$ (from Directional Two-Lane Highway Segment Worksheet)	69.8
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 $L_d=L_t-(L_u+L_{pl}+L_{de})$	0.10
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], $ATS_{pl} = (ATS_d * L_t) / (L_u+L_d+(L_{pl}/f_{pl})+ (2L_{de}/(1+f_{pl,ATS})))$	48.0
Percent free flow speed including passing lane, $PFFS_{pl} = (ATS_{pl}/ FFS)$	87.3
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)	7.49
Length of two-lane highway downstream of effective length of the passing lane for percent-time-following, $L_d=L_t-(L_u+L_{pl}+L_{de})$	-5.69
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	45.0
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}	5.3
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	428.0
Effective width, W_v (Eq. 15-29) ft	13.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	5.59
Bicycle level of service (Exhibit 15-4)	F
Notes	

1. 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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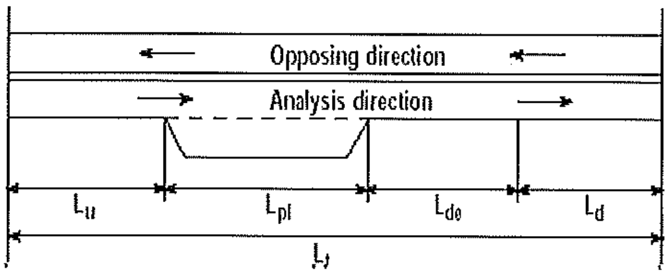
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET WITH PASSING LANE WORKSHEET

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

Project Description: US 2 Badrock Canyon Corridor Plan

Input Data

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



Shoulder width (ft)	1.0
Lane Width (ft)	12.0
Segment Length (mi)	2.4
Total length of analysis segment, L_t	2.4
Length of two-lane highway upstream of the passing lane, L_u	0.0
Length of passing lane including tapers , L_{pl}	1.1
Average travel speed, ATS_d (from Directional Two-Lane Highway Segment Worksheet)	45.8
Percent time-spent-following, $PTSF_d$ (from Directional Two-Lane Highway Segment Worksheet)	57.8
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 $L_d=L_t-(L_u+L_{pl}+L_{de})$	-0.40
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], $ATS_{pl} = (ATS_d * L_t) / (L_u+L_d+(L_{pl}/f_{pl})+ (2L_{de}/(1+f_{pl,ATS})))$	49.5
Percent free flow speed including passing lane, $PFFS_{pl} = (ATS_{pl}/ FFS)$	89.8
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)	9.64
Length of two-lane highway downstream of effective length of the passing lane for percent-time-following, $L_d =L_t-(L_u+ L_{pl}+ L_{de})$	-8.34
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], $PTSF_{pl}$(%) $PTSF_{pl}= PTSF_d[L_u+L_d+f_{pl,PTSF}L_{pl}+((1+f_{pl,PTSF})/2)L_{de}]/L_t$	*35.5*
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) $TT_{15}= VMT_{15}/ATS_{pl}$	*3.5*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*287.4*
Effective width, W_v (Eq. 15-29) ft	*13.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*5.39*
Bicycle level of service (Exhibit 15-4)	*E*
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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2

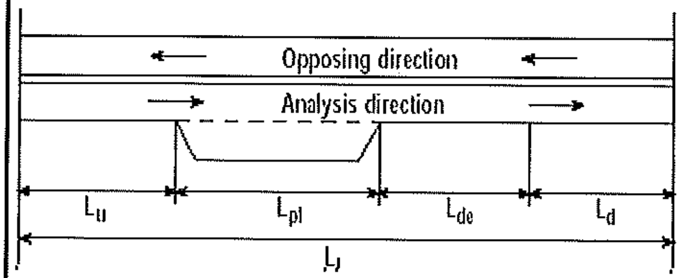
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET WITH PASSING LANE WORKSHEET

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

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

Input Data

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



Shoulder width (ft)	*1.0*
Lane Width (ft)	*12.0*
Segment Length (mi)	*2.4*
Total length of analysis segment, L_t	*2.4*
Length of two-lane highway upstream of the passing lane, L_u	*0.0*
Length of passing lane including tapers , L_{pl}	*0.6*
Average travel speed, ATS_d (from Directional Two-Lane Highway Segment Worksheet)	*46.3*
Percent time-spent-following, $PTSF_d$ (from Directional Two-Lane Highway Segment Worksheet)	*69.1*
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 $L_d=L_t-(L_u+L_{pl}+L_{de})$	*0.10*
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], $ATS_{pl} = (ATS_d * L_t) / (L_u+L_d+(L_{pl}/f_{pl})+ (2L_{de}/(1+f_{pl,ATS})))$	*49.1*
Percent free flow speed including passing lane, $PFFS_{pl} = (ATS_{pl}/ FFS)$	*87.5*
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)	*7.71*
Length of two-lane highway downstream of effective length of the passing lane for percent-time-following, $L_d =L_t-(L_u+ L_{pl}+ L_{de})$	*-5.91*
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], $PTSF_{pl}$(%) $PTSF_{pl}= PTSF_d[L_u+L_d+f_{pl,PTSF}L_{pl}+((1+f_{pl,PTSF})/2)L_{de}]/L_t$	44.5
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) $TT_{15}= VMT_{15}/ATS_{pl}$	4.7
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	385.7
Effective width, W_v (Eq. 15-29) ft	13.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	5.54
Bicycle level of service (Exhibit 15-4)	F
Notes	
1. 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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2

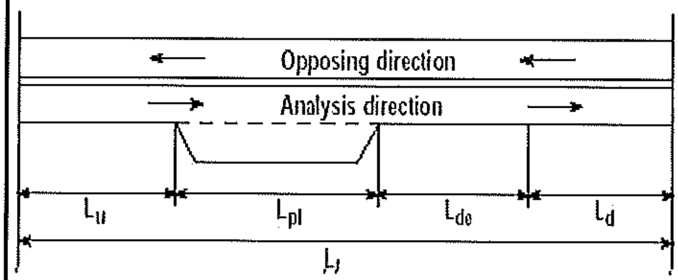
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET WITH PASSING LANE WORKSHEET

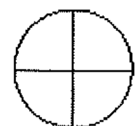
General Information		Site Information	
Analyst	*David Stoner*	Highway of Travel	*US 2*
Agency or Company	*DOWL HKM*	From/To	*Columbia F to Hungry H WB*
Date Performed	*11/15/2011*	Jurisdiction	*Flathead County*
Analysis Time Period	*Median Off-Peak*	Analysis Year	*2035*

Project Description: *US 2 Badrock Canyon Corridor Pla¼¼¥B*

Input Data

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





Show North Arrow

Shoulder width (ft)	*1.0*
Lane Width (ft)	*12.0*
Segment Length (mi)	*2.4*
Total length of analysis segment, L_t	*2.4*
Length of two-lane highway upstream of the passing lane, L_u	*0.0*
Length of passing lane including tapers , L_{pl}	*1.1*
Average travel speed, ATS_d (from Directional Two-Lane Highway Segment Worksheet)	*46.4*
Percent time-spent-following, $PTSF_d$ (from Directional Two-Lane Highway Segment Worksheet)	*65.1*
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 $L_d=L_t-(L_u+L_{pl}+L_{de})$	*-0.40*
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], $ATS_{pl} = (ATS_d * L_t) / (L_u+L_d+(L_{pl}/f_{pl})+ (2L_{de}/(1+f_{pl,ATS})))$	*50.1*
Percent free flow speed including passing lane, $PFFS_{pl} = (ATS_{pl}/ FFS)$	*89.4*
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)	*8.03*
Length of two-lane highway downstream of effective length of the passing lane for percent-time-following, $L_d =L_t-(L_u+ L_{pl}+ L_{de})$	*-6.73*
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], $PTSF_{pl}$(%) $PTSF_{pl}= PTSF_d[L_u+L_d+f_{pl,PTSF}L_{pl}+((1+f_{pl,PTSF})/2)L_{de}]/L_t$	40.8
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) $TT_{15}= VMT_{15}/ATS_{pl}$	4.1
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	343.8
Effective width, W_v (Eq. 15-29) ft	13.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	5.48
Bicycle level of service (Exhibit 15-4)	E
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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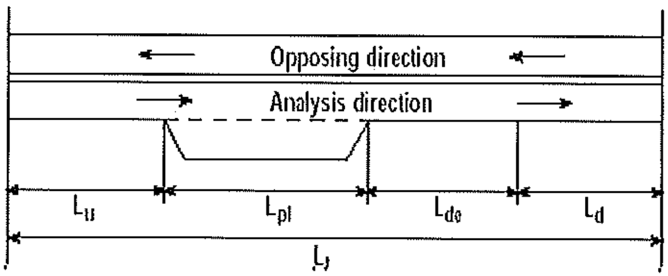
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET WITH PASSING LANE WORKSHEET

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

Project Description: *US 2 Badrock Canyon Corridor PlaÝ{¥B*

Input Data

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



Shoulder width (ft)	*1.0*
Lane Width (ft)	*12.0*
Segment Length (mi)	*2.4*
Total length of analysis segment, L_t	*2.4*
Length of two-lane highway upstream of the passing lane, L_u	*0.0*
Length of passing lane including tapers , L_{pl}	*0.6*
Average travel speed, ATS_d (from Directional Two-Lane Highway Segment Worksheet)	*47.2*
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 $L_d=L_t-(L_u+L_{pl}+L_{de})$	*0.10*
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], $ATS_{pl} = (ATS_d * L_t) / (L_u+L_d+(L_{pl}/f_{pl})+(2L_{de}/(1+f_{pl,ATS})))$	*50.0*
Percent free flow speed including passing lane, $PFFS_{pl} = (ATS_{pl}/FFS)$	*87.7*
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)	*8.24*
Length of two-lane highway downstream of effective length of the passing lane for percent-time-following, $L_d=L_t-(L_u+L_{pl}+L_{de})$	*-6.44*
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], $PTSF_{pl}$(%) $PTSF_{pl}= PTSF_d[L_u+L_d+f_{pl,PTSF}L_{pl}+((1+f_{pl,PTSF})/2)L_{de}]/L_t$	38.0
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) $TT_{15}= VMT_{15}/ATS_{pl}$	4.0
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	332.6
Effective width, W_v (Eq. 15-29) ft	13.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	5.46
Bicycle level of service (Exhibit 15-4)	E
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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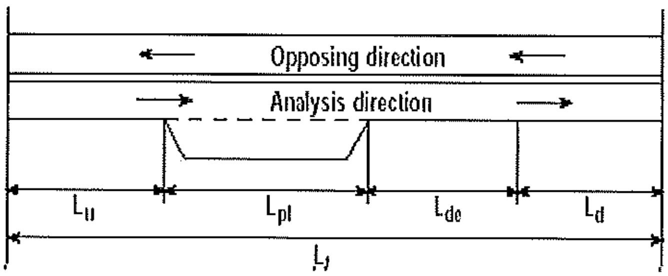
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET WITH PASSING LANE WORKSHEET

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

Project Description: US 2 Badrock Canyon Corridor Plac¾¡B

Input Data

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



Shoulder width (ft)	1.0
Lane Width (ft)	12.0
Segment Length (mi)	2.4
Total length of analysis segment, L_t	2.4
Length of two-lane highway upstream of the passing lane, L_u	0.0
Length of passing lane including tapers , L_{pl}	1.1
Average travel speed, ATS_d (from Directional Two-Lane Highway Segment Worksheet)	44.5
Percent time-spent-following, $PTSF_d$ (from Directional Two-Lane Highway Segment Worksheet)	75.5
Level of service[1], LOS_d (from Directional Two-Lane Highway Segment Worksheet)	D
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 $L_d=L_t-(L_u+L_{pl}+L_{de})$	-0.40
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], $ATS_{pl} = (ATS_d * L_t) / (L_u+L_d+(L_{pl}/f_{pl})+ (2L_{de}/(1+f_{pl,ATS})))$	48.0
Percent free flow speed including passing lane, $PFFS_{pl} = (ATS_{pl}/ FFS)$	87.3
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)	6.75
Length of two-lane highway downstream of effective length of the passing lane for percent-time-following, $L_d=L_t-(L_u+ L_{pl}+ L_{de})$	-5.45
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], $PTSF_{pl}$(%) $PTSF_{pl}= PTSF_d[L_u+L_d+f_{pl,PTSF}L_{pl}+((1+f_{pl,PTSF})/2)L_{de}]/L_t$	*47.6*
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) $TT_{15}= VMT_{15}/ATS_{pl}$	*6.7*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*539.6*
Effective width, W_v (Eq. 15-29) ft	*13.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*5.71*
Bicycle level of service (Exhibit 15-4)	*F*
Notes	
1. 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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Appendix 4

Operational
Analysis Worksheets

2035 3-2-3-4 Four-Lane Adjusted Annual Average
RP 142.0 – RP 142.4

Direction 1 = Eastbound
Direction 2 = Westbound

MULTILANE HIGHWAYS WORKSHEET(Direction 1)

General Information		Site Information	
Analyst	David Stoner	Highway/Direction to Travel	US 2
Agency or Company	DOWL HKM	From/To	Columbia Falls to Hungry Horse
Date Performed	4/30/2012	Jurisdiction	Flathead County
Analysis Time Period	AM Peak	Analysis Year	2035

Project Description US 2 Badrock Canyon Corridor Planning Study

☐ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	398	Peak-Hour Factor, PHF	0.93
AADT(veh/h)		%Trucks and Buses, P_T	6
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Rolling
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	2.0
E_T	2.5	f_{HV}	0.885

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)	241	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	214.0
Effective width, W_v (Eq. 15-29) ft	24.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	3.21
Bicycle level of service (Exhibit 15-4)	C

MULTILANE HIGHWAYS WORKSHEET(Direction 2)

[X]

General Information

Analyst	David Stoner
Agency or Company	DOWL HKM
Date Performed	4/30/2012
Analysis Time Period	AM Peak

Site Information

Highway/Direction to Travel	US 2
From/To	Columbia Falls to Hungry Horse
Jurisdiction	Flathead County
Analysis Year	2035

Project Description US 2 Badrock Canyon Corridor Planning Study

☐ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	250	Peak-Hour Factor, PHF	0.87
AADT(veh/h)		%Trucks and Buses, P_T	6
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Rolling
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	2.0
E_T	2.5	f_{HV}	0.885

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	*143.7*
Effective width, W_v (Eq. 15-29) ft	*24.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*3.00*
Bicycle level of service (Exhibit 15-4)	*C*

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MULTILANE HIGHWAYS WORKSHEET(Direction 1)

[x]

General Information

Analyst	David Stoner
Agency or Company	DOWL HKM
Date Performed	4/30/2012
Analysis Time Period	Median Off-Peak

Site Information

Highway/Direction to Travel	US 2
From/To	Columbia Falls to Hungry Horse
Jurisdiction	Flathead County
Analysis Year	2035

Project Description US 2 Badrock Canyon Corridor Planning Study

☐ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	351	Peak-Hour Factor, PHF	0.91
AADT(veh/h)		%Trucks and Buses, P_T	6
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Rolling
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	2.0
E_T	2.5	f_{HV}	0.885

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)	61.0
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)	61.0

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	217
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	*192.9*
Effective width, W_v (Eq. 15-29) ft	*24.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*3.15*
Bicycle level of service (Exhibit 15-4)	*C*

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MULTILANE HIGHWAYS WORKSHEET(Direction 2)

General Information

Analyst	David Stoner
Agency or Company	DOWL HKM
Date Performed	4/30/2012
Analysis Time Period	Median Off-Peak

Site Information

Highway/Direction to Travel	US 2
From/To	Columbia Falls to Hungry Horse
Jurisdiction	Flathead County
Analysis Year	2035

Project Description US 2 Badrock Canyon Corridor Planning Study

☐ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	306	Peak-Hour Factor, PHF	0.89
AADT(veh/h)		%Trucks and Buses, P_T	6
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Rolling
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	2.0
E_T	2.5	f_{HV}	0.885

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)	61.0
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)	61.0

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	194
Speed, S (mi/h)	60.0
D (pc/mi/ln)	3.2
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	171.9
Effective width, W_v (Eq. 15-29) ft	24.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	3.09
Bicycle level of service (Exhibit 15-4)	C

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MULTILANE HIGHWAYS WORKSHEET(Direction 1)

[X]

General Information

Analyst	David Stoner
Agency or Company	DOWL HKM
Date Performed	4/30/2012
Analysis Time Period	PM Peak

Site Information

Highway/Direction to Travel	US 2
From/To	Columbia Falls to Hungry Horse
Jurisdiction	Flathead County
Analysis Year	2035

Project Description US 2 Badrock Canyon Corridor Planning Study

☐ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	296	Peak-Hour Factor, PHF	0.89
AADT(veh/h)		%Trucks and Buses, P_T	6
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Rolling
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	2.0
E_T	2.5	f_{HV}	0.885

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)	62.0
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)	62.0

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	187
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	166.3
Effective width, W_v (Eq. 15-29) ft	24.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	3.08
Bicycle level of service (Exhibit 15-4)	C

MULTILANE HIGHWAYS WORKSHEET(Direction 2)

[x]

General Information

Analyst	David Stoner
Agency or Company	DOWL HKM
Date Performed	4/30/2012
Analysis Time Period	PM Peak

Site Information

Highway/Direction to Travel	US 2
From/To	Columbia Falls to Hungry Horse
Jurisdiction	Flathead County
Analysis Year	2035

Project Description US 2 Badrock Canyon Corridor Planning Study

☐ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	491	Peak-Hour Factor, PHF	0.91
AADT(veh/h)		%Trucks and Buses, P_T	6
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Rolling
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	2.0
E_T	2.5	f_{HV}	0.885

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)	304
Speed, S (mi/h)	60.0
D (pc/mi/ln)	5.1
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	269.8
Effective width, W_v (Eq. 15-29) ft	24.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	3.32
Bicycle level of service (Exhibit 15-4)	C

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Appendix 4

Operational Analysis Worksheets

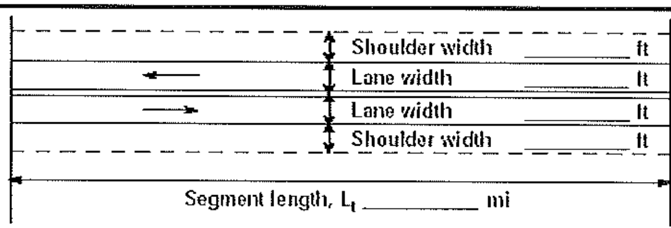
2035 Reverse 3-2-3-4 Peak Season
Three-Lane RP 140.0 – RP 140.6
One-Lane Eastbound
Two-Lane Westbound

DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

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

Project Description: *US 2 Badrock Canyon Corridor PlafÅ*

Input Data



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

Terrain ☐ Level ☑ Rolling

Analysis direction vol., V_d	791veh/h
Opposing direction vol., V_o	502veh/h
Shoulder width ft	1.0
Lane Width ft	12.0
Segment Length mi	0.6
Grade Length mi	Up/down
Peak-hour factor, PHF	0.93
No-passing zone	100%
% Trucks and Buses , P_T	6 %
% Recreational vehicles, P_R	4%
Access points *mi*	3/mi

Average Travel Speed

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

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
Mean speed of sample[3], S_{FM}		Base free-flow speed[4], BFFS	60.0 mi/h
Total demand flow rate, both directions, v		Adj. for lane and shoulder width,[4] f_{LS}(Exhibit 15-7)	4.2 mi/h
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Adj. for access points[4], f_A (Exhibit 15-8)	0.8 mi/h
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	1.9 mi/h	Free-flow speed, FFS $(FSS=BFFS-f_{LS}-f_A)$	55.0 mi/h
		Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	41.8 mi/h
		Percent free flow speed, PFFS	75.9 %

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T(Exhibit 15-18 or 15-19)	1.0	1.2
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	1.0	1.0
Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	1.000	0.988
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	1.00	0.96
Directional flow rate[2], v_i(pc/h) $v_i=V_i/(PHF*f_{HV,PTSF}*f_{g,PTSF})$	851	569
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	68.6	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	26.4	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	84.4	

Level of Service and Other Performance Measures

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

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

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

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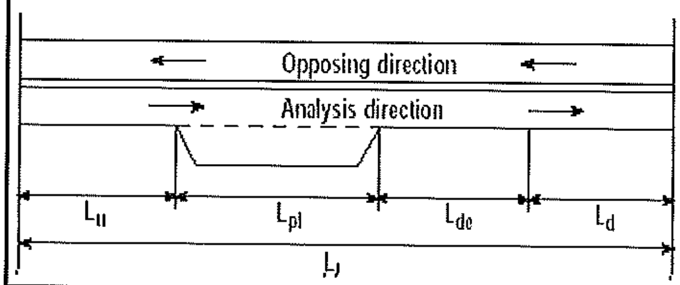
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET WITH PASSING LANE WORKSHEET

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

Project Description: *US 2 Badrock Canyon Corridor PlanÝ*

Input Data

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



Shoulder width (ft)	*1.0*
Lane Width (ft)	*12.0*
Segment Length (mi)	*0.6*
Total length of analysis segment, L_t	*0.6*
Length of two-lane highway upstream of the passing lane, L_u	*0.0*
Length of passing lane including tapers , L_{pl}	*0.6*
Average travel speed, ATS_d (from Directional Two-Lane Highway Segment Worksheet)	*41.8*
Percent time-spent-following, $PTSF_d$ (from Directional Two-Lane Highway Segment Worksheet)	*71.6*
Level of service[1], LOS_d (from Directional Two-Lane Highway Segment Worksheet)	*D*
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 $L_d=L_t-(L_u+L_{pl}+L_{de})$	*-1.70*
Adj. factor for the effect of passing lane on average speed, f_{pl} (Exhibit 15-28)	*1.11*
Average travel speed including passing lane[2], $ATS_{pl} = (ATS_d * L_t) / (L_u+L_d+(L_{pl}/f_{pl})+ (2L_{de}/(1+f_{pl,ATS})))$	*46.4*
Percent free flow speed including passing lane, $PFFS_{pl} = (ATS_{pl}/ FFS)$	*84.3*
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)	*6.48*
Length of two-lane highway downstream of effective length of the passing lane for percent-time-following, $L_d=L_t-(L_u+L_{pl}+L_{de})$	*-6.48*
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], $PTSF_{pl}$(%) $PTSF_{pl} = PTSF_d[L_u+L_d+f_{pl,PTSF}L_{pl}+((1+f_{pl,PTSF})/2)L_{de}]/L_t$	43.7
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) $TT_{15} = VMT_{15}/ATS_{pl}$	1.9
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	577.0
Effective width, W_v (Eq. 15-29) ft	13.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	5.74
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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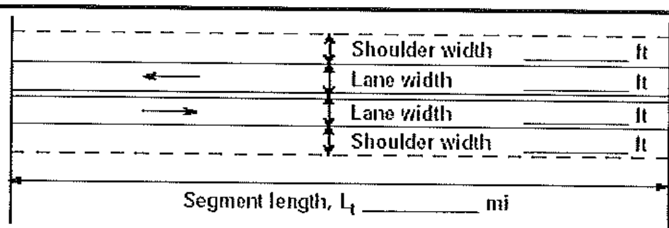
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

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

Project Description: US 2 Badrock Canyon Corridor PlaW

Input Data



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

Terrain ☐ Level ☑ Rolling

Analysis direction vol., V_d	704veh/h
Opposing direction vol., V_o	614veh/h
Shoulder width ft	1.0
Lane Width ft	12.0
Segment Length mi	0.6
Grade Length mi	Up/down
Peak-hour factor, PHF	0.91
No-passing zone	100%
% Trucks and Buses , P_T	6 %
% Recreational vehicles, P_R	4%
Access points *mi*	3/mi

Average Travel Speed

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

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
Mean speed of sample[3], S_{FM}		Base free-flow speed[4], BFFS	61.0 mi/h
Total demand flow rate, both directions, v		Adj. for lane and shoulder width,[4] f_{LS}(Exhibit 15-7)	4.2 mi/h
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Adj. for access points[4], f_A (Exhibit 15-8)	0.8 mi/h
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	1.6 mi/h	Free-flow speed, FFS $(FSS=BFFS-f_{LS}-f_A)$	56.0 mi/h
		Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	42.6 mi/h
		Percent free flow speed, PFFS	76.0 %

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T(Exhibit 15-18 or 15-19)	1.0	1.0
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	1.0	1.0
Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	1.000	1.000
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	1.00	0.99
Directional flow rate[2], v_i(pc/h) $v_i=V_i/(PHF*f_{HV,PTSF}*f_{g,PTSF})$	774	682
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	67.4	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	27.2	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	81.9	

Level of Service and Other Performance Measures

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

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

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

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2

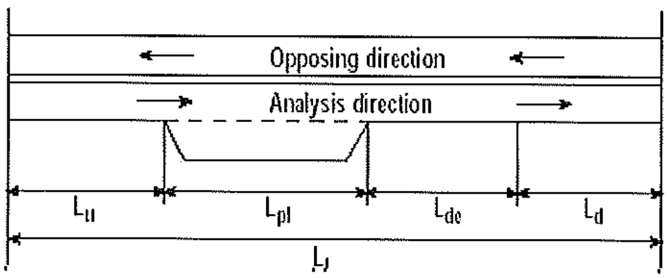
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET WITH PASSING LANE WORKSHEET

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

Project Description: *US 2 Badrock Canyon Corridor Plat*

Input Data

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



Shoulder width (ft)	*1.0*
Lane Width (ft)	*12.0*
Segment Length (mi)	*0.6*
Total length of analysis segment, L_t	*0.6*
Length of two-lane highway upstream of the passing lane, L_u	*0.0*
Length of passing lane including tapers , L_{pl}	*0.6*
Average travel speed, ATS_d (from Directional Two-Lane Highway Segment Worksheet)	*42.7*
Percent time-spent-following, $PTSF_d$ (from Directional Two-Lane Highway Segment Worksheet)	*77.2*
Level of service[1], LOS_d (from Directional Two-Lane Highway Segment Worksheet)	*D*
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 $L_d=L_t-(L_u+L_{pl}+L_{de})$	*-1.70*
Adj. factor for the effect of passing lane on average speed, f_{pl} (Exhibit 15-28)	*1.11*
Average travel speed including passing lane[2], $ATS_{pl} = (ATS_d * L_t) / (L_u+L_d+(L_{pl}/f_{pl})+ (2L_{de}/(1+f_{pl,ATS})))$	*47.4*
Percent free flow speed including passing lane, $PFFS_{pl} = (ATS_{pl}/ FFS)$	*84.7*
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)	*5.79*
Length of two-lane highway downstream of effective length of the passing lane for percent-time-following, $L_d =L_t-(L_u+ L_{pl}+ L_{de})$	*-5.79*
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], $PTSF_{pl}$(%) $PTSF_{pl}= PTSF_d[L_u+L_d+f_{pl,PTSF}L_{pl}+((1+f_{pl,PTSF})/2)L_{de}]/L_t$	47.1
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) $TT_{15}= VMT_{15}/ATS_{pl}$	2.1
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	682.2
Effective width, W_v (Eq. 15-29) ft	13.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	5.83
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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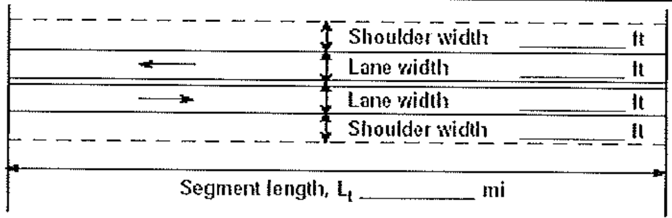
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

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

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

Input Data



Analysis direction vol., V_d *586veh/h*
Opposing direction vol., V_o *981veh/h*
Shoulder width ft *1.0*
Lane Width ft *12.0*
Segment Length mi *0.6*

☐ Class I highway ☑ Class II highway ☐ Class III highway
Terrain ☐ Level ☑ Rolling
Grade Length mi Up/down
Peak-hour factor, PHF *0.89*
No-passing zone *100%*
% Trucks and Buses, P_T *6 %*
% Recreational vehicles, P_R *4%*
Access points *mi* *3/mi*

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	1.6	1.3
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	1.1	1.1
Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	0.962	0.978
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	0.98	1.00
Demand flow rate[2], v_i (pc/h) $v_i=V_i/(PHF * f_{g,ATS} * f_{HV,ATS})$	698	1127

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
Mean speed of sample[3], S_{FM}		Base free-flow speed[4], BFFS	62.0 mi/h
Total demand flow rate, both directions, v		Adj. for lane and shoulder width,[4] f_{LS} (Exhibit 15-7)	4.2 mi/h
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Adj. for access points[4], f_A (Exhibit 15-8)	0.8 mi/h
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	1.1 mi/h	Free-flow speed, FFS $(FSS=BFFS-f_{LS}-f_A)$	57.0 mi/h
		Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	41.8 mi/h
		Percent free flow speed, PFFS	73.3 %

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)	0.98	1.00
Directional flow rate[2], v_i (pc/h) $v_i=V_i/(PHF*f_{HV,PTSF}*f_{g,PTSF})$	672	1102
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	67.8	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	20.1	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	75.4	

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	*1663*
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	*1700*
Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only)	*73.3*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*658.4*
Effective width, Wv (Eq. 15-29) ft	*13.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*5.81*
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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2

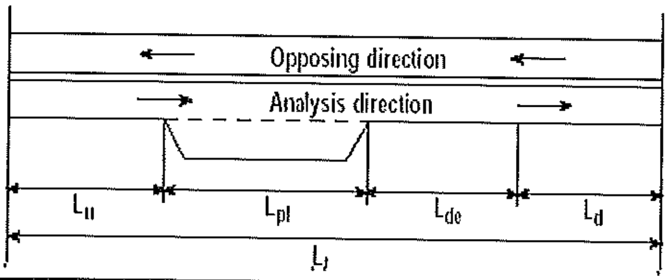
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET WITH PASSING LANE WORKSHEET

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

Project Description: US 2 Badrock Canyon Corridor Pla±PB

Input Data

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



Shoulder width (ft)	1.0
Lane Width (ft)	12.0
Segment Length (mi)	0.6
Total length of analysis segment, L_t	0.6
Length of two-lane highway upstream of the passing lane, L_u	0.0
Length of passing lane including tapers, L_{pl}	0.6
Average travel speed, ATS_d (from Directional Two-Lane Highway Segment Worksheet)	39.4
Percent time-spent-following, $PTSF_d$ (from Directional Two-Lane Highway Segment Worksheet)	89.4
Level of service[1], LOS_d (from Directional Two-Lane Highway Segment Worksheet)	E
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 $L_d=L_t-(L_u+L_{pl}+L_{de})$	-1.70
Adj. factor for the effect of passing lane on average speed, f_{pl} (Exhibit 15-28)	1.11
Average travel speed including passing lane[2], $ATS_{pl} = (ATS_d * L_t) / (L_u+L_d+(L_{pl}/f_{pl})+ (2L_{de}/(1+f_{pl,ATS})))$	43.8
Percent free flow speed including passing lane, $PFFS_{pl} = (ATS_{pl}/ FFS)$	79.5
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)	3.60
Length of two-lane highway downstream of effective length of the passing lane for percent-time-following, $L_d = L_t-(L_u+ L_{pl}+ L_{de})$	-3.60
Adj. factor for the effect of passing lane on percent time-spent-following,	

$f_{pl,PTSF}$(Exhibit 15-26)	0.62
Percent time-spent-following including passing lane[3], $PTSF_{pl}$(%) $PTSF_{pl} = PTSF_d[L_u + L_d + f_{pl,PTSF} L_{pl} + ((1+f_{pl,PTSF})/2)L_{de}]/L_t$	55.4
Level of Service and Other Performance Measures[4]	
Level of service including passing lane LOS_{pl} (Exhibit 15-3)	C
Peak 15-min total travel time, TT_{15}(veh-h) $TT_{15} = VMT_{15}/ATS_{pl}$	3.7
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	1078.0
Effective width, W_v (Eq. 15-29) ft	13.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	6.06
Bicycle level of service (Exhibit 15-4)	F
Notes	

1. 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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Appendix 4

Operational
Analysis Worksheets

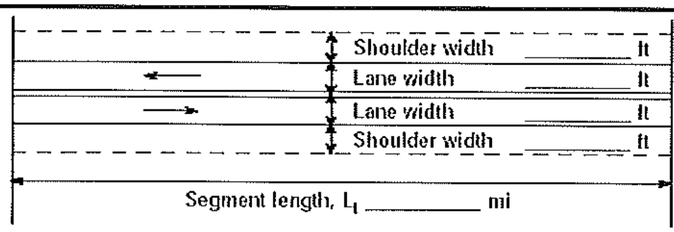
2035 Reverse 3-2-3-4 Peak Season
Two-Lane RP 140.6 – RP 141.2
One-Lane Eastbound
One-Lane Westbound

DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

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

Project Description: *US 2 Badrock Canyon Corridor PlafÂ*

Input Data



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

Terrain ☐ Level ☑ Rolling

Grade Length mi	Up/down
Peak-hour factor, PHF	*0.93*
No-passing zone	*100%*
% Trucks and Buses, P_T	*6 %*
% Recreational vehicles, P_R	*4%*
Access points *mi*	*3/mi*
Analysis direction vol., V_d	*791veh/h*
Opposing direction vol., V_o	*502veh/h*
Shoulder width ft	*1.0*
Lane Width ft	*12.0*
Segment Length mi	*0.6*

Average Travel Speed

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

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
		Base free-flow speed[4], BFFS	*60.0 mi/h*
		Adj. for lane and shoulder width,[4] f_{LS} (Exhibit 15-7)	*4.2 mi/h*
Mean speed of sample[3], S_{FM}		Adj. for access points[4], f_A (Exhibit 15-8)	*0.8 mi/h*
Total demand flow rate, both directions, v		Free-flow speed, FFS (FSS=BFFS-f_{LS}-f_A)	*55.0 mi/h*
Free-flow speed, FFS=S_{FM}+0.00776(v/ $f_{HV,ATS}$)		Average travel speed, ATS_d=FFS-0.00776($v_{d,ATS}$ + $v_{o,ATS}$) - $f_{np,ATS}$	*41.8 mi/h*
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	*1.9 mi/h*	Percent free flow speed, PFFS	*75.9 %*

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T(Exhibit 15-18 or 15-19)	*1.0*	*1.2*
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	*1.0*	*1.0*
Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*1.000*	*0.988*
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	*1.00*	*0.96*
Directional flow rate[2], v_i(pc/h) $v_i=V_i/(PHF*f_{HV,PTSF}*f_{g,PTSF})$	*851*	*569*
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	*68.6*	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	*26.4*	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	*84.4*	

Level of Service and Other Performance Measures

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

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

Notes

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

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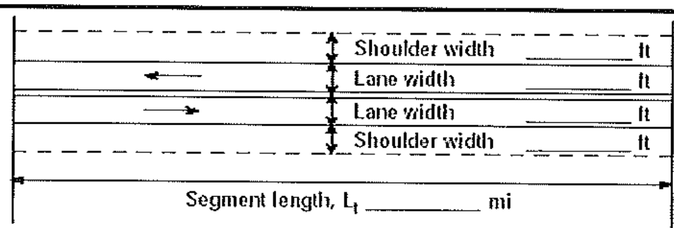
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

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

Project Description: *US 2 Badrock Canyon Corridor PlanÝ*

Input Data



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

Terrain ☐ Level ☑ Rolling

Analysis direction vol., V_d	*502veh/h*
Opposing direction vol., V_o	*791veh/h*
Shoulder width ft	*1.0*
Lane Width ft	*12.0*
Segment Length mi	*0.6*
Grade Length mi	Up/down
Peak-hour factor, PHF	*0.87*
No-passing zone	*100%*
% Trucks and Buses , P_T	*6 %*
% Recreational vehicles, P_R	*4%*
Access points *mi*	*3/mi*

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	*1.7*	*1.3*
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	*1.1*	*1.1*
Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.956*	*0.978*
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	*0.97*	*1.00*
Demand flow rate[2], v_i (pc/h) $v_i=V_i/(PHF*f_{g,ATS}*f_{HV,ATS})$	*622*	*930*

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
		Base free-flow speed[4], BFFS	*60.0 mi/h*
Mean speed of sample[3], S_{FM}		Adj. for lane and shoulder width,[4] f_{LS}(Exhibit 15-7)	*4.2 mi/h*
Total demand flow rate, both directions, *v*		Adj. for access points[4], f_A (Exhibit 15-8)	*0.8 mi/h*
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Free-flow speed, FFS $(FSS=BFFS-f_{LS}-f_A)$	*55.0 mi/h*
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	*1.2 mi/h*	Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	*41.8 mi/h*
		Percent free flow speed, PFFS	*75.9 %*

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T(Exhibit 15-18 or 15-19)	*1.2*	*1.0*
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	*1.0*	*1.0*
Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.988*	*1.000*
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	*0.97*	*1.00*
Directional flow rate[2], v_i(pc/h) $v_i=V_i/(PHF*f_{HV,PTSF}*f_{g,PTSF})$	*602*	*909*
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	*61.7*	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	*24.9*	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	*71.6*	

Level of Service and Other Performance Measures

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

Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h	*1663*
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	*1700*
Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only)	*75.9*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*577.0*
Effective width, Wv (Eq. 15-29) ft	*13.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*5.74*
Bicycle level of service (Exhibit 15-4)	*F*

Notes

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

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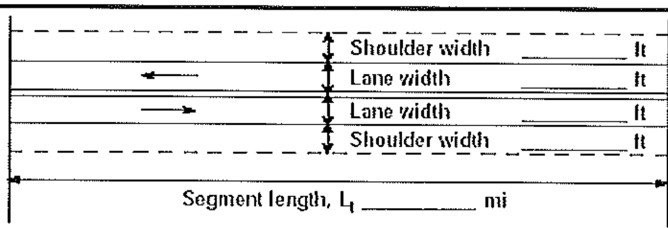
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

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

Project Description: *US 2 Badrock Canyon Corridor PlaW*

Input Data



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

Terrain ☐ Level ☑ Rolling

Analysis direction vol., V_d	*704veh/h*
Opposing direction vol., V_o	*614veh/h*
Shoulder width ft	*1.0*
Lane Width ft	*12.0*
Segment Length mi	*0.6*
Grade Length mi	Up/down
Peak-hour factor, PHF	*0.91*
No-passing zone	*100%*
% Trucks and Buses , P_T	*6 %*
% Recreational vehicles, P_R	*4%*
Access points *mi*	*3/mi*

Average Travel Speed

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

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
Mean speed of sample[3], S_{FM}		Base free-flow speed[4], BFFS	*61.0 mi/h*
Total demand flow rate, both directions, *v*		Adj. for lane and shoulder width,[4] f_{LS}(Exhibit 15-7)	*4.2 mi/h*
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Adj. for access points[4], f_A (Exhibit 15-8)	*0.8 mi/h*
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	*1.6 mi/h*	Free-flow speed, FFS (FSS=BFFS-f_{LS}-f_A)	*56.0 mi/h*
		Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	*42.6 mi/h*
		Percent free flow speed, PFFS	*76.0 %*

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T(Exhibit 15-18 or 15-19)	*1.0*	*1.0*
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	*1.0*	*1.0*
Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*1.000*	*1.000*
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	*1.00*	*0.99*
Directional flow rate[2], v_i(pc/h) $v_i=V_i/(PHF^*f_{HV,PTSF}{}^* f_{g,PTSF})$	*774*	*682*
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	*67.4*	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	*27.2*	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}{}^*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	*81.9*	

Level of Service and Other Performance Measures

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

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

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

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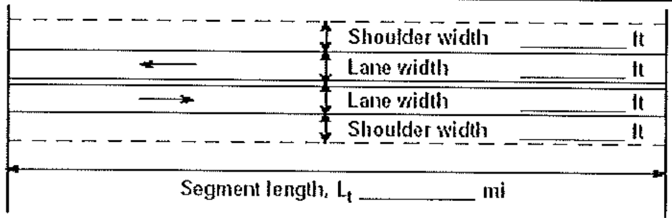
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

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

Project Description: US 2 Badrock Canyon Corridor Plat

Input Data



Analysis direction vol., V_d	614veh/h
Opposing direction vol., V_o	704veh/h
Shoulder width ft	1.0
Lane Width ft	12.0
Segment Length mi	0.6

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

Terrain: Level ☐ Rolling ☑

Grade Length mi	Up/down
Peak-hour factor, PHF	0.90
No-passing zone	100%
% Trucks and Buses, P_T	6 %
% Recreational vehicles, P_R	4%
Access points *mi*	3/mi

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	1.6	1.4
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	1.1	1.1
Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	0.962	0.973
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	0.98	0.99
Demand flow rate[2], v_i (pc/h) $v_i=V_i/(PHF^* f_{g,ATS} * f_{HV,ATS})$	724	812

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
Mean speed of sample[3], S_{FM}		Base free-flow speed[4], BFFS	61.0 mi/h
Total demand flow rate, both directions, *v*		Adj. for lane and shoulder width,[4] f_{LS}(Exhibit 15-7)	4.2 mi/h
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Adj. for access points[4], f_A (Exhibit 15-8)	0.8 mi/h
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	1.4 mi/h	Free-flow speed, FFS $(FSS=BFFS-f_{LS}-f_A)$	56.0 mi/h
		Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	42.7 mi/h
		Percent free flow speed, PFFS	76.3 %

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)	0.99	1.00
Directional flow rate[2], v_i(pc/h) $v_i=V_i/(PHF^*f_{HV,PTSF}{}^* f_{g,PTSF})$	689	782
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	64.6	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	27.0	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}{}^*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	77.2	

Level of Service and Other Performance Measures

Level of service, LOS (Exhibit 15-3)	D
Volume to capacity ratio, *v/c*	0.41

Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h	*1638*
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	*1700*
Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only)	*76.3*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*682.2*
Effective width, Wv (Eq. 15-29) ft	*13.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*5.83*
Bicycle level of service (Exhibit 15-4)	*F*

Notes

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

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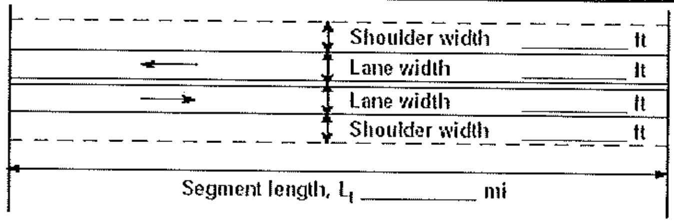
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

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

Project Description: US 2 Badrock Canyon Corridor Pla/

Input Data



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

Terrain ☐ Level ☑ Rolling

Grade Length mi	Up/down
Peak-hour factor, PHF	0.89
No-passing zone	100%
% Trucks and Buses , P_T	6 %
% Recreational vehicles, P_R	4%
Access points *mi*	3/mi

Analysis direction vol., V_d	586veh/h
Opposing direction vol., V_o	981veh/h
Shoulder width ft	1.0
Lane Width ft	12.0
Segment Length mi	0.6

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	1.6	1.3
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	1.1	1.1
Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	0.962	0.978
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	0.98	1.00
Demand flow rate[2], v_i (pc/h) $v_i=V_i/(PHF*f_{g,ATS}*f_{HV,ATS})$	698	1127

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
		Base free-flow speed[4], BFFS	62.0 mi/h
Mean speed of sample[3], S_{FM}		Adj. for lane and shoulder width,[4] f_{LS}(Exhibit 15-7)	4.2 mi/h
Total demand flow rate, both directions, *v*		Adj. for access points[4], f_A (Exhibit 15-8)	0.8 mi/h
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Free-flow speed, FFS $(FSS=BFFS-f_{LS}-f_A)$	57.0 mi/h
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	1.1 mi/h	Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	41.8 mi/h
		Percent free flow speed, PFFS	73.3 %

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)	0.98	1.00
Directional flow rate[2], v_i(pc/h) $v_i=V_i/(PHF*f_{HV,PTSF}*f_{g,PTSF})$	672	1102
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	67.8	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	20.1	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	75.4	

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	*1663*
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	*1700*
Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only)	*73.3*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*658.4*
Effective width, Wv (Eq. 15-29) ft	*13.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*5.81*
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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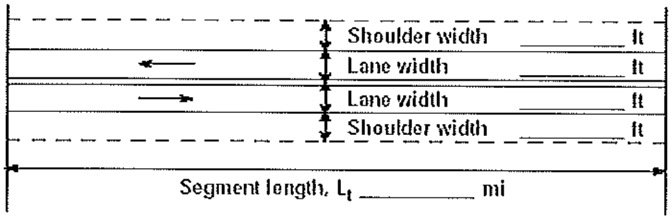
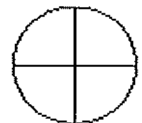
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

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

Project Description: *US 2 Badrock Canyon Corridor Pla±PB*

Input Data





Show North Arrow

Analysis direction vol., V_d	*981veh/h*	☐ Class I highway ☑ Class II highway ☐ Class III highway	
Opposing direction vol., V_o	*586veh/h*	Terrain ☐ Level ☑ Rolling	
Shoulder width ft	*1.0*	Grade Length mi Up/down	
Lane Width ft	*12.0*	Peak-hour factor, PHF	*0.91*
Segment Length mi	*0.6*	No-passing zone	*100%*
		% Trucks and Buses, P_T	*6 %*
		% Recreational vehicles, P_R	*4%*
		Access points *mi*	*3/mi*

Average Travel Speed

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

Free-Flow Speed from Field Measurement		**Estimated Free-Flow Speed**	
		Base free-flow speed[4], BFFS	*60.0 mi/h*
		Adj. for lane and shoulder width,[4] f_{LS}(Exhibit 15-7)	*4.2 mi/h*
Mean speed of sample[3], S_{FM}		Adj. for access points[4], f_A (Exhibit 15-8)	*0.8 mi/h*
Total demand flow rate, both directions, *v*		Free-flow speed, FFS (FSS=BFFS-f_{LS}-f_A)	*55.0 mi/h*
Free-flow speed, FFS=S_{FM}+0.00776($v/f_{HV,ATS}$)		Average travel speed, ATS_d=FFS-0.00776($v_{d,ATS}+v_{o,ATS}$) - $f_{np,ATS}$	*39.4 mi/h*
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	*1.7 mi/h*	Percent free flow speed, PFFS	*71.7 %*

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

Level of Service and Other Performance Measures

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

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

Notes

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

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Appendix 4

Operational Analysis Worksheets

2035 Reverse 3-2-3-4 Peak Season
Three-Lane RP 141.2 – RP 142.0
Two-Lane Eastbound
One-Lane Westbound

2

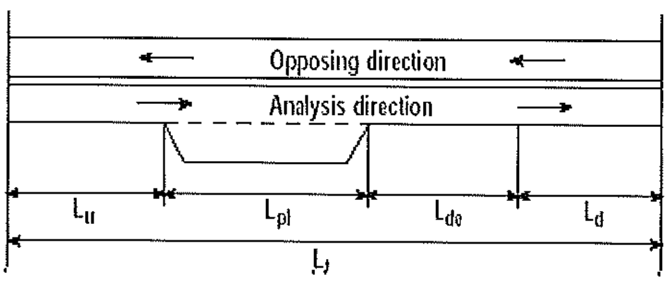
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET WITH PASSING LANE WORKSHEET

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

Project Description: *US 2 Badrock Canyon Corridor PlafÁ*

Input Data

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



Shoulder width (ft)	*1.0*
Lane Width (ft)	*12.0*
Segment Length (mi)	*1.1*
Total length of analysis segment, L_t	*1.1*
Length of two-lane highway upstream of the passing lane, L_u	*0.0*
Length of passing lane including tapers , L_{pl}	*1.1*
Average travel speed, ATS_d (from Directional Two-Lane Highway Segment Worksheet)	*41.8*
Percent time-spent-following, $PTSF_d$ (from Directional Two-Lane Highway Segment Worksheet)	*84.4*
Level of service[1], LOS_d (from Directional Two-Lane Highway Segment Worksheet)	*D*
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 $L_d=L_t-(L_u+L_{pl}+L_{de})$	*-1.70*
Adj. factor for the effect of passing lane on average speed, f_{pl} (Exhibit 15-28)	*1.11*
Average travel speed including passing lane[2], $ATS_{pl} = (ATS_d * L_t) / (L_u+L_d+(L_{pl}/f_{pl})+ (2L_{de}/(1+f_{pl,ATS})))$	*46.4*
Percent free flow speed including passing lane, $PFFS_{pl} = (ATS_{pl}/ FFS)$	*84.2*
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)	*4.64*
Length of two-lane highway downstream of effective length of the passing lane for percent-time-following, $L_d = L_t-(L_u+ L_{pl}+ L_{de})$	*-4.64*
Adj. factor for the effect of passing lane on percent time-spent-following,	

$f_{pl,PTSF}$(Exhibit 15-26)	0.62
Percent time-spent-following including passing lane[3], $PTSF_{pl}$(%) $PTSF_{pl}= PTSF_d[L_u+L_d+f_{pl,PTSF}L_{pl}+((1+f_{pl,PTSF})/2)L_{de}]/L_t$	52.3
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) $TT_{15}= VMT_{15}/ATS_{pl}$	5.0
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	850.5
Effective width, W_v (Eq. 15-29) ft	13.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	5.94
Bicycle level of service (Exhibit 15-4)	F
Notes	
1. 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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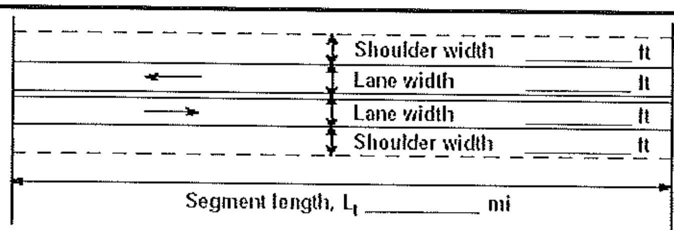
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

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

Project Description: US 2 Badrock Canyon Corridor PlanÝ

Input Data



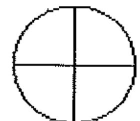
Analysis direction vol., V_d 502veh/h

Opposing direction vol., V_o 791veh/h

Shoulder width ft 1.0

Lane Width ft 12.0

Segment Length mi 1.1



Show North Arrow

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

Terrain ☐ Level ☑ Rolling

Grade Length mi Up/down

Peak-hour factor, PHF 0.87

No-passing zone 100%

% Trucks and Buses , P_T 6 %

% Recreational vehicles, P_R 4%

Access points *mi* 3/mi

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	1.7	1.3
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	1.1	1.1
Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	0.956	0.978
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	0.97	1.00
Demand flow rate[2], v_i (pc/h) $v_i=V_i/(PHF*f_{g,ATS}*f_{HV,ATS})$	622	930

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
		Base free-flow speed[4], BFFS	60.0 mi/h
Mean speed of sample[3], S_{FM}		Adj. for lane and shoulder width,[4] f_{LS} (Exhibit 15-7)	4.2 mi/h
Total demand flow rate, both directions, *v*		Adj. for access points[4], f_A (Exhibit 15-8)	0.8 mi/h
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Free-flow speed, FFS $(FSS=BFFS-f_{LS}-f_A)$	55.0 mi/h
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	1.2 mi/h	Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	41.8 mi/h
		Percent free flow speed, PFFS	75.9 %

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T(Exhibit 15-18 or 15-19)	1.2	1.0
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	1.0	1.0
Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	0.988	1.000
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	0.97	1.00
Directional flow rate[2], v_i(pc/h) $v_i=V_i/(PHF*f_{HV,PTSF}*f_{g,PTSF})$	602	909
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	61.7	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	24.9	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	71.6	

Level of Service and Other Performance Measures

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

Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h	*1663*
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	*1700*
Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only)	*75.9*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*577.0*
Effective width, Wv (Eq. 15-29) ft	*13.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*5.74*
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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2

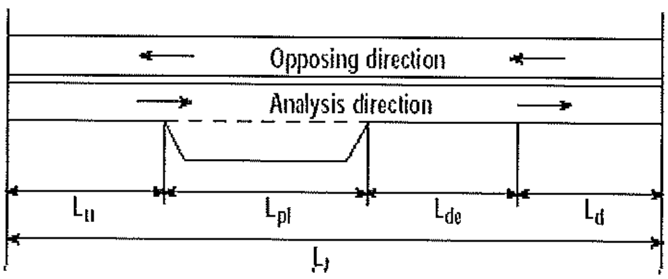
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET WITH PASSING LANE WORKSHEET

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

Project Description: *US 2 Badrock Canyon Corridor PlaW*

Input Data

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



Shoulder width (ft)	*1.0*
Lane Width (ft)	*12.0*
Segment Length (mi)	*1.1*
Total length of analysis segment, L_t	*1.1*
Length of two-lane highway upstream of the passing lane, L_u	*0.0*
Length of passing lane including tapers, L_{pl}	*1.1*
Average travel speed, ATS_d (from Directional Two-Lane Highway Segment Worksheet)	*42.6*
Percent time-spent-following, $PTSF_d$ (from Directional Two-Lane Highway Segment Worksheet)	*81.9*
Level of service[1], LOS_d (from Directional Two-Lane Highway Segment Worksheet)	*D*
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 $L_d=L_t-(L_u+L_{pl}+L_{de})$	*-1.70*
Adj. factor for the effect of passing lane on average speed, f_{pl} (Exhibit 15-28)	*1.11*
Average travel speed including passing lane[2], $ATS_{pl} = (ATS_d * L_t) / (L_u+L_d+(L_{pl}/f_{pl})+ (2L_{de}/(1+f_{pl,ATS})))$	*47.3*
Percent free flow speed including passing lane, $PFFS_{pl} = (ATS_{pl}/ FFS)$	*84.4*
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)	*5.18*
Length of two-lane highway downstream of effective length of the passing lane for percent-time-following, $L_d=L_t-(L_u+L_{pl}+L_{de})$	*-5.18*
Adj. factor for the effect of passing lane on percent time-spent-following,	

$f_{pl,PTSF}$(Exhibit 15-26)	0.62
Percent time-spent-following including passing lane[3], $PTSF_{pl}$(%) $PTSF_{pl}= PTSF_d[L_u+L_d+f_{pl,PTSF}L_{pl}+((1+f_{pl,PTSF})/2)L_{de}]/L_t$	50.8
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) $TT_{15}= VMT_{15}/ATS_{pl}$	4.5
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	773.6
Effective width, W_v (Eq. 15-29) ft	13.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	5.89
Bicycle level of service (Exhibit 15-4)	F
Notes	
1. 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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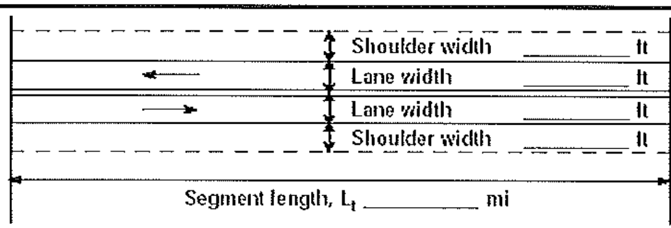
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

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

Project Description: US 2 Badrock Canyon Corridor Plat

Input Data



Class I highway ☑ Class II highway Class III highway

Terrain Level ☑ Rolling

Analysis direction vol., V_d	614veh/h
Opposing direction vol., V_o	704veh/h
Shoulder width ft	1.0
Lane Width ft	12.0
Segment Length mi	1.1
Grade Length mi	Up/down
Peak-hour factor, PHF	0.90
No-passing zone	100%
% Trucks and Buses , P_T	6 %
% Recreational vehicles, P_R	4%
Access points mi	3/mi

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	1.6	1.4
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	1.1	1.1
Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	0.962	0.973
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	0.98	0.99
Demand flow rate[2], v_i (pc/h) $v_i=V_i/(PHF*f_{g,ATS}*f_{HV,ATS})$	724	812

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
Mean speed of sample[3], S_{FM}		Base free-flow speed[4], BFFS	61.0 mi/h
Total demand flow rate, both directions, v		Adj. for lane and shoulder width,[4] f_{LS}(Exhibit 15-7)	4.2 mi/h
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Adj. for access points[4], f_A (Exhibit 15-8)	0.8 mi/h
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	1.4 mi/h	Free-flow speed, FFS $(FSS=BFFS-f_{LS}-f_A)$	56.0 mi/h
		Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	42.7 mi/h
		Percent free flow speed, PFFS	76.3 %

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)	0.99	1.00
Directional flow rate[2], v_i(pc/h) $v_i=V_i/(PHF*f_{HV,PTSF}*f_{g,PTSF})$	689	782
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	64.6	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	27.0	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	77.2	

Level of Service and Other Performance Measures

Level of service, LOS (Exhibit 15-3)	D
Volume to capacity ratio, v/c	0.41

Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h	*1638*
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	*1700*
Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only)	*76.3*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*682.2*
Effective width, Wv (Eq. 15-29) ft	*13.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*5.83*
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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2

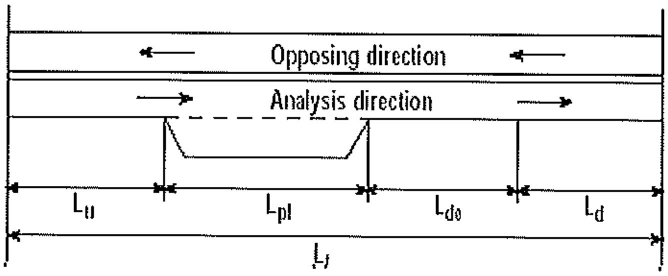
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET WITH PASSING LANE WORKSHEET

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

Project Description: US 2 Badrock Canyon Corridor Pla/

Input Data

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



Shoulder width (ft)	1.0
Lane Width (ft)	12.0
Segment Length (mi)	1.1
Total length of analysis segment, L_t	1.1
Length of two-lane highway upstream of the passing lane, L_u	0.0
Length of passing lane including tapers , L_{pl}	1.1
Average travel speed, ATS_d (from Directional Two-Lane Highway Segment Worksheet)	41.8
Percent time-spent-following, $PTSF_d$ (from Directional Two-Lane Highway Segment Worksheet)	75.4
Level of service[1], LOS_d (from Directional Two-Lane Highway Segment Worksheet)	D
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 $L_d=L_t-(L_u+L_{pl}+L_{de})$	-1.70
Adj. factor for the effect of passing lane on average speed, f_{pl} (Exhibit 15-28)	1.11
Average travel speed including passing lane[2], $ATS_{pl} = (ATS_d * L_t) / (L_u+L_d+(L_{pl}/f_{pl})+ (2L_{de}/(1+f_{pl,ATS})))$	46.4
Percent free flow speed including passing lane, $PFFS_{pl} = (ATS_{pl}/ FFS)$	81.3
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)	5.92
Length of two-lane highway downstream of effective length of the passing lane for percent-time-following, $L_d =L_t-(L_u+ L_{pl}+ L_{de})$	-5.92
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], $PTSF_{pl}$(%) $PTSF_{pl}= PTSF_d[L_u+L_d+f_{pl,PTSF}L_{pl}+((1+f_{pl,PTSF})/2)L_{de}]/L_t$	46.0
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) $TT_{15}= VMT_{15}/ATS_{pl}$	3.9
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	658.4
Effective width, W_v (Eq. 15-29) ft	13.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	5.81
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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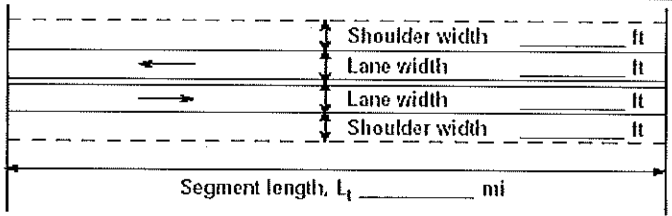
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

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

Project Description: *US 2 Badrock Canyon Corridor Pla±PB*

Input Data



Analysis direction vol., V_d	*981veh/h*
Opposing direction vol., V_o	*586veh/h*
Shoulder width ft	*1.0*
Lane Width ft	*12.0*
Segment Length mi	*1.1*

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

Terrain ☐ Level ☑ Rolling

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

Average Travel Speed

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

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
Mean speed of sample[3], S_{FM}		Base free-flow speed[4], BFFS	*60.0 mi/h*
Total demand flow rate, both directions, *v*		Adj. for lane and shoulder width,[4] f_{LS} (Exhibit 15-7)	*4.2 mi/h*
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Adj. for access points[4], f_A (Exhibit 15-8)	*0.8 mi/h*
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	*1.7 mi/h*	Free-flow speed, FFS $(FSS=BFFS-f_{LS}-f_A)$	*55.0 mi/h*
		Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	*39.4 mi/h*
		Percent free flow speed, PFFS	*71.7 %*

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

Level of Service and Other Performance Measures

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

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

Notes

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

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Appendix 4

Operational
Analysis Worksheets

2035 Reverse 3-2-3-4 Four-Lane Peak Season
RP 142.0 – RP 142.4

Direction 1 = Eastbound
Direction 2 = Westbound

MULTILANE HIGHWAYS WORKSHEET(Direction 1)

General Information		Site Information	
Analyst	David Stoner	Highway/Direction to Travel	US 2
Agency or Company	DOWL HKM	From/To	Columbia Falls to Hungry Horse
Date Performed	4/30/2012	Jurisdiction	Flathead County
Analysis Time Period	AM Peak	Analysis Year	2035

Project Description US 2 Badrock Canyon Corridor Planning Study

☐ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	791	Peak-Hour Factor, PHF	0.93
AADT(veh/h)		%Trucks and Buses, P_T	6
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Rolling
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	2.0
E_T	2.5	f_{HV}	0.885

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)	480	Required Number of Lanes, N	
Speed, S (mi/h)	60.0	Flow Rate, v_p (pc/h)	
D (pc/mi/ln)	8.0	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	425.3
Effective width, W_v (Eq. 15-29) ft	24.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	3.55
Bicycle level of service (Exhibit 15-4)	D

MULTILANE HIGHWAYS WORKSHEET(Direction 2)

General Information

Analyst	David Stoner
Agency or Company	DOWL HKM
Date Performed	4/30/2012
Analysis Time Period	AM Peak

Site Information

Highway/Direction to Travel	US 2
From/To	Columbia Falls to Hungry Horse
Jurisdiction	Flathead County
Analysis Year	2035

Project Description US 2 Badrock Canyon Corridor Planning Study

☐ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	502	Peak-Hour Factor, PHF	0.87
AADT(veh/h)		%Trucks and Buses, P_T	6
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Rolling
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	2.0
E_T	2.5	f_{HV}	0.885

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)	326
Speed, S (mi/h)	60.0
D (pc/mi/ln)	5.4
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	288.5
Effective width, W_v (Eq. 15-29) ft	24.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	3.36
Bicycle level of service (Exhibit 15-4)	C

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MULTILANE HIGHWAYS WORKSHEET(Direction 1)

[x]

General Information

Analyst	David Stoner
Agency or Company	DOWL HKM
Date Performed	4/30/2012
Analysis Time Period	Median Off Peak Peak

Site Information

Highway/Direction to Travel	US 2
From/To	Columbia Falls to Hungry Horse
Jurisdiction	Flathead County
Analysis Year	2035

Project Description US 2 Badrock Canyon Corridor Planning Study

☐ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	704	Peak-Hour Factor, PHF	0.91
AADT(veh/h)		%Trucks and Buses, P_T	6
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Rolling
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	2.0
E_T	2.5	f_{HV}	0.885

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)	61.0
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)	61.0

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	437
Speed, S (mi/h)	60.0
D (pc/mi/ln)	7.3
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	386.8
Effective width, W_v (Eq. 15-29) ft	24.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	3.51
Bicycle level of service (Exhibit 15-4)	D

MULTILANE HIGHWAYS WORKSHEET(Direction 2)

General Information

Analyst	David Stoner
Agency or Company	DOWL HKM
Date Performed	4/30/2012
Analysis Time Period	Median Off Peak Peak

Site Information

Highway/Direction to Travel	US 2
From/To	Columbia Falls to Hungry Horse
Jurisdiction	Flathead County
Analysis Year	2035

Project Description US 2 Badrock Canyon Corridor Planning Study

☐ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	614	Peak-Hour Factor, PHF	0.89
AADT(veh/h)		%Trucks and Buses, P_T	6
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Rolling
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	2.0
E_T	2.5	f_{HV}	0.885

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)	61.0
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)	61.0

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	389
Speed, S (mi/h)	60.0
D (pc/mi/ln)	6.5
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	344.9
Effective width, W_v (Eq. 15-29) ft	24.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	3.45
Bicycle level of service (Exhibit 15-4)	C

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MULTILANE HIGHWAYS WORKSHEET(Direction 1)

General Information

Analyst	David Stoner
Agency or Company	DOWL HKM
Date Performed	4/30/2012
Analysis Time Period	PM Peak

Site Information

Highway/Direction to Travel	US 2
From/To	Columbia Falls to Hungry Horse
Jurisdiction	Flathead County
Analysis Year	2035

Project Description US 2 Badrock Canyon Corridor Planning Study

☐ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	586	Peak-Hour Factor, PHF	0.89
AADT(veh/h)		%Trucks and Buses, P_T	6
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Rolling
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	2.0
E_T	2.5	f_{HV}	0.885

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)	62.0
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)	62.0

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	372
Speed, S (mi/h)	60.0
D (pc/mi/ln)	6.2
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	329.2
Effective width, W_v (Eq. 15-29) ft	24.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	3.42
Bicycle level of service (Exhibit 15-4)	C

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MULTILANE HIGHWAYS WORKSHEET(Direction 2)

General Information

Analyst	David Stoner
Agency or Company	DOWL HKM
Date Performed	4/30/2012
Analysis Time Period	PM Peak

Site Information

Highway/Direction to Travel	US 2
From/To	Columbia Falls to Hungry Horse
Jurisdiction	Flathead County
Analysis Year	2035

Project Description US 2 Badrock Canyon Corridor Planning Study

☐ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	981	Peak-Hour Factor, PHF	0.91
AADT(veh/h)		%Trucks and Buses, P_T	6
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Rolling
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	2.0
E_T	2.5	f_{HV}	0.885

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)	609
Speed, S (mi/h)	60.0
D (pc/mi/ln)	10.1
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	539.0
Effective width, W_v (Eq. 15-29) ft	24.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	3.67
Bicycle level of service (Exhibit 15-4)	D

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Appendix 4

Operational
Analysis Worksheets

2035 Reverse 3-2-3-4 Adjusted Annual Average
Three-Lane RP 140.0 – RP 140.6
One-Lane Eastbound
Two-Lane Westbound

2

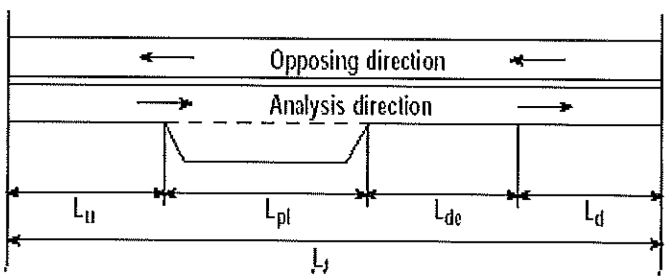
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET WITH PASSING LANE WORKSHEET

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

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

Input Data

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



Shoulder width (ft)	*1.0*
Lane Width (ft)	*12.0*
Segment Length (mi)	*1.1*
Total length of analysis segment, L_t	*1.1*
Length of two-lane highway upstream of the passing lane, L_u	*0.0*
Length of passing lane including tapers, L_{pl}	*1.1*
Average travel speed, ATS_d (from Directional Two-Lane Highway Segment Worksheet)	*45.3*
Percent time-spent-following, $PTSF_d$ (from Directional Two-Lane Highway Segment Worksheet)	*69.8*
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 $L_d = L_t - (L_u + L_{pl} + L_{de})$	*-1.70*
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], $ATS_{pl} = (ATS_d * L_t) / (L_u + L_d + (L_{pl}/f_{pl}) + (2L_{de}/(1+f_{pl,ATS})))$	*49.9*
Percent free flow speed including passing lane, $PFFS_{pl} = (ATS_{pl} / FFS)$	*90.6*
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)	*7.49*
Length of two-lane highway downstream of effective length of the passing lane for percent-time-following, $L_d = L_t - (L_u + L_{pl} + L_{de})$	*-7.49*
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], $PTSF_{pl}$(%) $PTSF_{pl}= PTSF_d[L_u+L_d+f_{pl,PTSF}L_{pl}+((1+f_{pl,PTSF})/2)L_{de}]/L_t$	42.6
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) $TT_{15}= VMT_{15}/ATS_{pl}$	2.4
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	428.0
Effective width, W_v (Eq. 15-29) ft	13.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	5.59
Bicycle level of service (Exhibit 15-4)	F
Notes	
1. 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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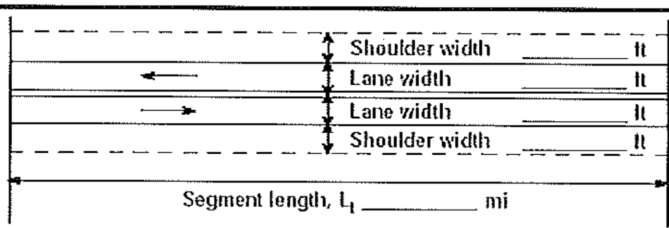
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

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

Project Description: US 2 Badrock Canyon Corridor Plan

Input Data



Class I highway ☑ Class II highway Class III highway

Terrain ☐ Level ☑ Rolling

Analysis direction vol., V_d	250veh/h
Opposing direction vol., V_o	398veh/h
Shoulder width ft	1.0
Lane Width ft	12.0
Segment Length mi	1.1
Grade Length mi	Up/down
Peak-hour factor, PHF	0.87
No-passing zone	100%
% Trucks and Buses , P_T	6 %
% Recreational vehicles, P_R	4%
Access points *mi*	3/mi

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	2.1	1.9
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	1.1	1.1
Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	0.935	0.945
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	0.82	0.93
Demand flow rate[2], v_i (pc/h) $v_i=V_i/(PHF^* f_{g,ATS} * f_{HV,ATS})$	375	521

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
		Base free-flow speed[4], BFFS	60.0 mi/h
Mean speed of sample[3], S_{FM}		Adj. for lane and shoulder width,[4] f_{LS}(Exhibit 15-7)	4.2 mi/h
Total demand flow rate, both directions, v		Adj. for access points[4], f_A (Exhibit 15-8)	0.8 mi/h
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Free-flow speed, FFS $(FSS=BFFS-f_{LS}-f_A)$	55.0 mi/h
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	2.3 mi/h	Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	45.8 mi/h
		Percent free flow speed, PFFS	83.3 %

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T(Exhibit 15-18 or 15-19)	1.7	1.4
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	1.0	1.0
Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	0.960	0.977
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	0.84	0.93
Directional flow rate[2], v_i(pc/h) $v_i=V_i/(PHF^*f_{HV,PTSF}{}^* f_{g,PTSF})$	356	504
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	41.6	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	39.1	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}{}^*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	57.8	

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	*1536*
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	*1613*
Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only)	*83.3*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*287.4*
Effective width, Wv (Eq. 15-29) ft	*13.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*5.39*
Bicycle level of service (Exhibit 15-4)	*E*
Notes	

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

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2

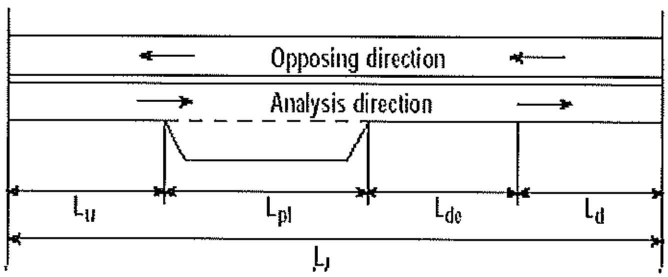
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET WITH PASSING LANE WORKSHEET

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

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

Input Data

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



Shoulder width (ft)	*1.0*
Lane Width (ft)	*12.0*
Segment Length (mi)	*1.1*
Total length of analysis segment, L_t	*1.1*
Length of two-lane highway upstream of the passing lane, L_u	*0.0*
Length of passing lane including tapers , L_{pl}	*1.1*
Average travel speed, ATS_d (from Directional Two-Lane Highway Segment Worksheet)	*46.3*
Percent time-spent-following, $PTSF_d$ (from Directional Two-Lane Highway Segment Worksheet)	*69.1*
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 $L_d=L_t-(L_u+L_{pl}+L_{de})$	*-1.70*
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], $ATS_{pl} = (ATS_d * L_t) / (L_u+L_d+(L_{pl}/f_{pl})+ (2L_{de}/(1+f_{pl,ATS})))$	*50.9*
Percent free flow speed including passing lane, $PFFS_{pl} = (ATS_{pl}/ FFS)$	*90.9*
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)	*7.71*
Length of two-lane highway downstream of effective length of the passing lane for percent-time-following, $L_d =L_t-(L_u+ L_{pl}+ L_{de})$	*-7.71*
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], $PTSF_{pl}$(%) $PTSF_{pl}= PTSF_d[L_u+L_d+f_{pl,PTSF}L_{pl}+((1+f_{pl,PTSF})/2)L_{de}]/L_t$	42.2
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) $TT_{15}= VMT_{15}/ATS_{pl}$	2.1
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	385.7
Effective width, W_v (Eq. 15-29) ft	13.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	5.54
Bicycle level of service (Exhibit 15-4)	F
Notes	
1. 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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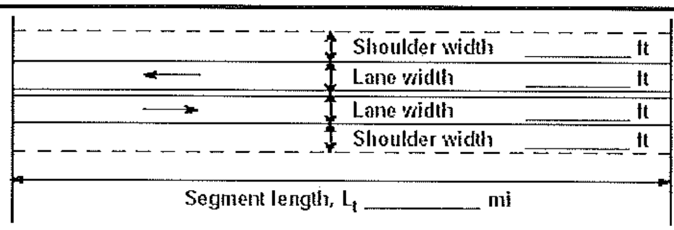
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

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

Project Description: *US 2 Badrock Canyon Corridor Pla¼¼¥B*

Input Data



Class I highway ☑ Class II highway Class III highway

Terrain Level ☑ Rolling

Analysis direction vol., V_d	306veh/h
Opposing direction vol., V_o	351veh/h
Shoulder width ft	1.0
Lane Width ft	12.0
Segment Length mi	1.1
Grade Length mi	Up/down
Peak-hour factor, PHF	0.89
No-passing zone	100%
% Trucks and Buses , P_T	6 %
% Recreational vehicles, P_R	4%
Access points *mi*	3/mi

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	2.1	2.0
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	1.1	1.1
Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	0.935	0.940
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	0.86	0.90
Demand flow rate[2], v_i (pc/h) $v_i=V_i/(PHF^* f_{g,ATS} * f_{HV,ATS})$	428	466

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
Mean speed of sample[3], S_{FM}		Base free-flow speed[4], BFFS	61.0 mi/h
Total demand flow rate, both directions, v		Adj. for lane and shoulder width,[4] f_{LS}(Exhibit 15-7)	4.2 mi/h
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Adj. for access points[4], f_A (Exhibit 15-8)	0.8 mi/h
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	2.7 mi/h	Free-flow speed, FFS $(FSS=BFFS-f_{LS}-f_A)$	56.0 mi/h
		Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	46.4 mi/h
		Percent free flow speed, PFFS	82.9 %

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T(Exhibit 15-18 or 15-19)	1.6	1.6
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	1.0	1.0
Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	0.965	0.965
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	0.87	0.90
Directional flow rate[2], v_i(pc/h) $v_i=V_i/(PHF^*f_{HV,PTSF}^* f_{g,PTSF})$	409	454
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	44.7	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	43.0	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}{}^*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	65.1	

Level of Service and Other Performance Measures

Level of service, LOS (Exhibit 15-3)	C
Volume to capacity ratio, *v/c*	0.26

Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h	*1494*
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	*1544*
Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only)	*82.9*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*343.8*
Effective width, Wv (Eq. 15-29) ft	*13.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*5.48*
Bicycle level of service (Exhibit 15-4)	*E*
Notes	

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

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2

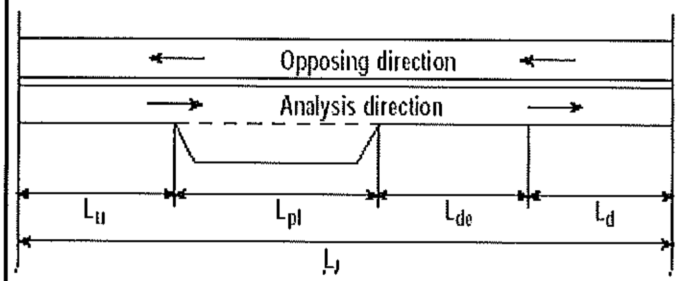
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET WITH PASSING LANE WORKSHEET

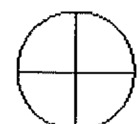
General Information		Site Information	
Analyst	*David Stoner*	Highway of Travel	*US 2*
Agency or Company	*DOWL HKM*	From/To	*Columbia F to Hungry H EB*
Date Performed	*11/15/2011*	Jurisdiction	*Flathead County*
Analysis Time Period	*PM Peak*	Analysis Year	*2035*

Project Description: *US 2 Badrock Canyon Corridor PlaÝ{¥B*

Input Data

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





Shoulder width (ft)	*1.0*
Lane Width (ft)	*12.0*
Segment Length (mi)	*1.1*
Total length of analysis segment, L_t	*1.1*
Length of two-lane highway upstream of the passing lane, L_u	*0.0*
Length of passing lane including tapers , L_{pl}	*1.1*
Average travel speed, ATS_d (from Directional Two-Lane Highway Segment Worksheet)	*47.2*
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 $L_d=L_t-(L_u+L_{pl}+L_{de})$	*-1.70*
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], $ATS_{pl} = (ATS_d * L_t) / (L_u+L_d+(L_{pl}/f_{pl})+ (2L_{de}/(1+f_{pl,ATS})))$	*51.9*
Percent free flow speed including passing lane, $PFFS_{pl} = (ATS_{pl}/ FFS)$	*91.0*
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)	*8.24*
Length of two-lane highway downstream of effective length of the passing lane for percent-time-following, $L_d=L_t-(L_u+L_{pl}+L_{de})$	*-8.24*
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], $PTSF_{pl}$(%) $PTSF_{pl}= PTSF_d[L_u+L_d+f_{pl,PTSF}L_{pl}+((1+f_{pl,PTSF})/2)L_{de}]/L_t$	*36.0*
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) $TT_{15}= VMT_{15}/ATS_{pl}$	*1.8*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*332.6*
Effective width, W_v (Eq. 15-29) ft	*13.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*5.46*
Bicycle level of service (Exhibit 15-4)	*E*
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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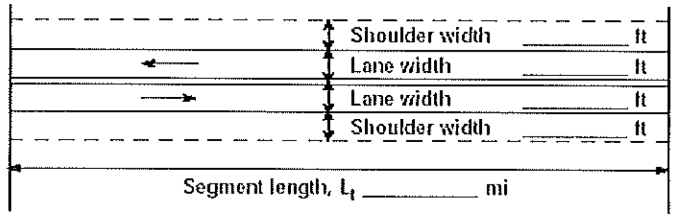
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

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

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

Input Data



Analysis direction vol., V_d	*491*veh/h	Class I highway ☐ / Class II highway ☑ / Class III highway ☐	
Opposing direction vol., V_o	*296*veh/h	Terrain: Level ☐ / Rolling ☑	
Shoulder width ft	*1.0*	Grade Length mi Up/down	
Lane Width ft	*12.0*	Peak-hour factor, PHF	*0.91*
Segment Length mi	*1.1*	No-passing zone	*100%*
		% Trucks and Buses , P_T	*6 %*
		% Recreational vehicles, P_R	*4%*
		Access points *mi*	*3/mi*

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	*1.8*	*2.1*
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	*1.1*	*1.1*
Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.951*	*0.935*
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	*0.96*	*0.85*
Demand flow rate[2], v_i (pc/h) $v_i=V_i/(PHF*f_{g,ATS}*f_{HV,ATS})$	*591*	*409*

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
Mean speed of sample[3], S_{FM}		Base free-flow speed[4], BFFS	*60.0 mi/h*
Total demand flow rate, both directions, v		Adj. for lane and shoulder width,[4] f_{LS}(Exhibit 15-7)	*4.2 mi/h*
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Adj. for access points[4], f_A (Exhibit 15-8)	*0.8 mi/h*
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	*2.8 mi/h*	Free-flow speed, FFS $(FSS=BFFS-f_{LS}-f_A)$	*55.0 mi/h*
		Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	*44.5 mi/h*
		Percent free flow speed, PFFS	*80.9 %*

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T(Exhibit 15-18 or 15-19)	*1.2*	*1.6*
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	*1.0*	*1.0*
Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.988*	*0.965*
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	*0.96*	*0.86*
Directional flow rate[2], v_i(pc/h) $v_i=V_i/(PHF*f_{HV,PTSF}*f_{g,PTSF})$	*569*	*392*
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	*54.1*	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	*36.2*	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	*75.5*	

Level of Service and Other Performance Measures

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

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

Notes

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

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Appendix 4

Operational
Analysis Worksheets

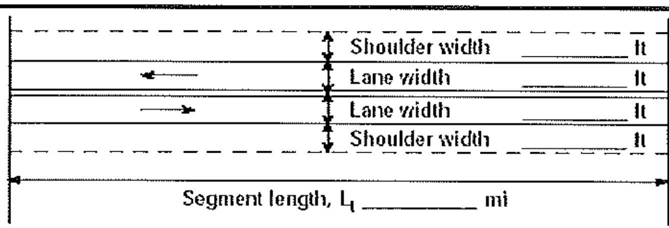
2035 Reverse 3-2-3-4 Adjusted Annual Average
Two-Lane RP 140.6 – RP 141.2
One-Lane Eastbound
One-Lane Westbound

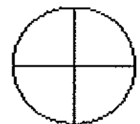
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

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

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

Input Data





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

Terrain ☐ Level ☑ Rolling

Grade Length mi	Up/down
Peak-hour factor, PHF	0.93
No-passing zone	100%
% Trucks and Buses , P_T	6 %
% Recreational vehicles, P_R	4%
Access points *mi*	3/mi
Analysis direction vol., V_d	398veh/h
Opposing direction vol., V_o	250veh/h
Shoulder width ft	1.0
Lane Width ft	12.0
Segment Length mi	0.6

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	1.9	2.2
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	1.1	1.1
Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	0.945	0.929
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	0.91	0.81
Demand flow rate[2], v_i (pc/h) $v_i=V_i/(PHF^* f_{g,ATS} {}^* f_{HV,ATS})$	498	357

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
Mean speed of sample[3], S_{FM}		Base free-flow speed[4], BFFS	60.0 mi/h
Total demand flow rate, both directions, *v*		Adj. for lane and shoulder width,[4] f_{LS}(Exhibit 15-7)	4.2 mi/h
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Adj. for access points[4], f_A (Exhibit 15-8)	0.8 mi/h
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	3.1 mi/h	Free-flow speed, FFS $(FSS=BFFS-f_{LS}-f_A)$	55.0 mi/h
		Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	45.3 mi/h
		Percent free flow speed, PFFS	82.3 %

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T(Exhibit 15-18 or 15-19)	1.4	1.7
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	1.0	1.0
Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	0.977	0.960
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	0.92	0.83
Directional flow rate[2], v_i(pc/h) $v_i=V_i/(PHF^*f_{HV,PTSF}{}^* f_{g,PTSF})$	476	337
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	46.3	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	40.2	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}{}^*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	69.8	

Level of Service and Other Performance Measures

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

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

Notes

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

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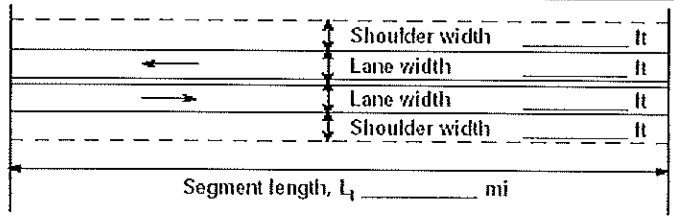
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

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

Project Description: *US 2 Badrock Canyon Corridor Plan*

Input Data



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

Terrain ☐ Level ☑ Rolling

Analysis direction vol., V_d	*250veh/h*
Opposing direction vol., V_o	*398veh/h*
Shoulder width ft	*1.0*
Lane Width ft	*12.0*
Segment Length mi	*0.6*
Grade Length mi	Up/down
Peak-hour factor, PHF	*0.87*
No-passing zone	*100%*
% Trucks and Buses , P_T	*6 %*
% Recreational vehicles, P_R	*4%*
Access points *mi*	*3/mi*

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	*2.1*	*1.9*
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	*1.1*	*1.1*
Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.935*	*0.945*
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	*0.82*	*0.93*
Demand flow rate[2], v_i (pc/h) $v_i=V_i/(PHF*f_{g,ATS}*f_{HV,ATS})$	*375*	*521*

Free-Flow Speed from Field Measurement		**Estimated Free-Flow Speed**	
		Base free-flow speed[4], BFFS	*60.0 mi/h*
Mean speed of sample[3], S_{FM}		Adj. for lane and shoulder width,[4] f_{LS} (Exhibit 15-7)	*4.2 mi/h*
Total demand flow rate, both directions, *v*		Adj. for access points[4], f_A (Exhibit 15-8)	*0.8 mi/h*
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Free-flow speed, FFS ($FSS=BFFS-f_{LS}-f_A$)	*55.0 mi/h*
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	*2.3 mi/h*	Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	*45.8 mi/h*
		Percent free flow speed, PFFS	*83.3 %*

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-18 or 15-19)	*1.7*	*1.4*
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	*1.0*	*1.0*
Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.960*	*0.977*
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	*0.84*	*0.93*
Directional flow rate[2], v_i (pc/h) $v_i=V_i/(PHF*f_{HV,PTSF}*f_{g,PTSF})$	*356*	*504*
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	*41.6*	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	*39.1*	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	*57.8*	

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	*1536*
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	*1613*
Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only)	*83.3*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*287.4*
Effective width, Wv (Eq. 15-29) ft	*13.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*5.39*
Bicycle level of service (Exhibit 15-4)	*E*
Notes	

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

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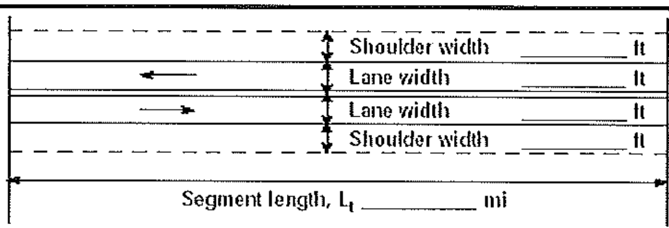
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

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

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

Input Data



Analysis direction vol., V_d	351veh/h
Opposing direction vol., V_o	306veh/h
Shoulder width ft	1.0
Lane Width ft	12.0
Segment Length mi	0.6

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

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

Average Travel Speed

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

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
Mean speed of sample[3], S_{FM}		Base free-flow speed[4], BFFS	61.0 mi/h
Total demand flow rate, both directions, v		Adj. for lane and shoulder width,[4] f_{LS}(Exhibit 15-7)	4.2 mi/h
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Adj. for access points[4], f_A (Exhibit 15-8)	0.8 mi/h
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	2.9 mi/h	Free-flow speed, FFS $(FSS=BFFS-f_{LS}-f_A)$	56.0 mi/h
		Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	46.3 mi/h
		Percent free flow speed, PFFS	82.6 %

Percent Time-Spent-Following

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

Level of Service and Other Performance Measures

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

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

Notes

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

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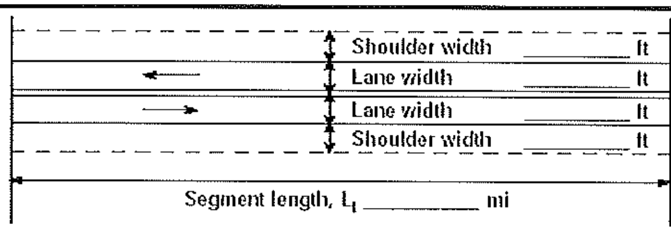
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

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

Project Description: *US 2 Badrock Canyon Corridor Pla¼¼¥B*

Input Data



Analysis direction vol., V_d	*306veh/h*
Opposing direction vol., V_o	*351veh/h*
Shoulder width ft	*1.0*
Lane Width ft	*12.0*
Segment Length mi	*0.6*

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

Terrain ☐ Level ☑ Rolling

Grade Length mi	Up/down
Peak-hour factor, PHF	*0.89*
No-passing zone	*100%*
% Trucks and Buses , P_T	*6 %*
% Recreational vehicles, P_R	*4%*
Access points *mi*	*3/mi*

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	*2.1*	*2.0*
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	*1.1*	*1.1*
Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.935*	*0.940*
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	*0.86*	*0.90*
Demand flow rate[2], v_i (pc/h) $v_i=V_i/(PHF * f_{g,ATS} * f_{HV,ATS})$	*428*	*466*

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
Mean speed of sample[3], S_{FM}		Base free-flow speed[4], BFFS	*61.0 mi/h*
Total demand flow rate, both directions, v		Adj. for lane and shoulder width,[4] f_{LS} (Exhibit 15-7)	*4.2 mi/h*
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Adj. for access points[4], f_A (Exhibit 15-8)	*0.8 mi/h*
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	*2.7 mi/h*	Free-flow speed, FFS $(FSS=BFFS-f_{LS}-f_A)$	*56.0 mi/h*
		Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	*46.4 mi/h*
		Percent free flow speed, PFFS	*82.9 %*

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-18 or 15-19)	*1.6*	*1.6*
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	*1.0*	*1.0*
Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	*0.965*	*0.965*
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	*0.87*	*0.90*
Directional flow rate[2], v_i(pc/h) $v_i=V_i/(PHF*f_{HV,PTSF}*f_{g,PTSF})$	*409*	*454*
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	*44.7*	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	*43.0*	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	*65.1*	

Level of Service and Other Performance Measures

Level of service, LOS (Exhibit 15-3)	*C*
Volume to capacity ratio, *v/c*	*0.26*

Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h	*1494*
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	*1544*
Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only)	*82.9*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*343.8*
Effective width, Wv (Eq. 15-29) ft	*13.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*5.48*
Bicycle level of service (Exhibit 15-4)	*E*
Notes	

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

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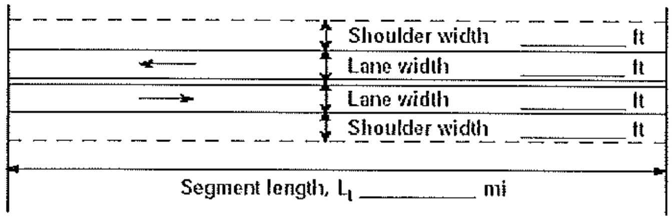
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

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

Project Description: US 2 Badrock Canyon Corridor PlaÝ(¥B

Input Data



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

Terrain ☐ Level ☑ Rolling

Grade Length mi Up/down

Peak-hour factor, PHF 0.89

No-passing zone 100%

% Trucks and Buses , P_T 6 %

% Recreational vehicles, P_R 4%

Access points *mi* 3/mi

Analysis direction vol., V_d 296veh/h

Opposing direction vol., V_o 491veh/h

Shoulder width ft 1.0

Lane Width ft 12.0

Segment Length mi 0.6

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	2.1	1.7
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	1.1	1.1
Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	0.935	0.956
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	0.85	0.96
Demand flow rate[2], v_i (pc/h) $v_i=V_i/(PHF^* f_{g,ATS}{}^* f_{HV,ATS})$	418	601

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
Mean speed of sample[3], S_{FM}		Base free-flow speed[4], BFFS	62.0 mi/h
Total demand flow rate, both directions, v		Adj. for lane and shoulder width,[4] f_{LS}(Exhibit 15-7)	4.2 mi/h
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Adj. for access points[4], f_A (Exhibit 15-8)	0.8 mi/h
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	1.9 mi/h	Free-flow speed, FFS ($FSS=BFFS-f_{LS}-f_A$)	57.0 mi/h
		Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	47.2 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)	1.6	1.2
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	1.0	1.0
Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	0.965	0.988
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	0.87	0.97
Directional flow rate[2], v_i(pc/h) $v_i=V_i/(PHF^*f_{HV,PTSF}{}^* f_{g,PTSF})$	396	576
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	45.3	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	36.0	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}{}^*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	60.0	

Level of Service and Other Performance Measures

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

Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h	*1576*
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	*1629*
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	*332.6*
Effective width, Wv (Eq. 15-29) ft	*13.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*5.46*
Bicycle level of service (Exhibit 15-4)	*E*
Notes	

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

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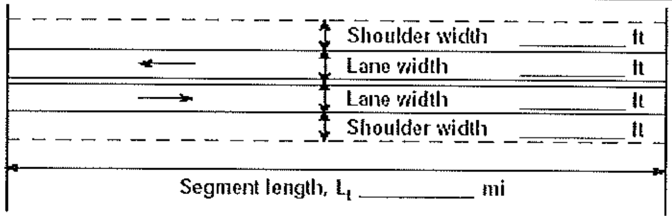
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

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

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

Input Data



Class I highway ☑ Class II highway Class III highway

Terrain Level ☑ Rolling

Analysis direction vol., V_d	*491*veh/h
Opposing direction vol., V_o	*296*veh/h
Shoulder width ft	*1.0*
Lane Width ft	*12.0*
Segment Length mi	*0.6*
Grade Length mi Up/down	
Peak-hour factor, PHF	*0.91*
No-passing zone	*100%*
% Trucks and Buses , P_T	*6 %*
% Recreational vehicles, P_R	*4%*
Access points *mi*	*3*/mi

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	*1.8*	*2.1*
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	*1.1*	*1.1*
Heavy-vehicle adjustment factor, $f_{HV,ATS}$=1/ (1+ $P_T(E_T$-1)+$P_R(E_R$-1))	*0.951*	*0.935*
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	*0.96*	*0.85*
Demand flow rate[2], v_i(pc/h) $v_i=V_i$ / (PHF* $f_{g,ATS}$ * $f_{HV,ATS}$)	*591*	*409*

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
Mean speed of sample[3], S_{FM}		Base free-flow speed[4], BFFS	*60.0 mi/h*
Total demand flow rate, both directions, *v*		Adj. for lane and shoulder width,[4] f_{LS}(Exhibit 15-7)	*4.2 mi/h*
Free-flow speed, FFS=S_{FM}+0.00776(*v*/ $f_{HV,ATS}$)		Adj. for access points[4], f_A (Exhibit 15-8)	*0.8 mi/h*
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	*2.8 mi/h*	Free-flow speed, FFS (FSS=BFFS-f_{LS}-f_A)	*55.0 mi/h*
		Average travel speed, ATS_d=FFS-0.00776($v_{d,ATS}$ + $v_{o,ATS}$) - $f_{np,ATS}$	*44.5 mi/h*
		Percent free flow speed, PFFS	*80.9 %*

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T(Exhibit 15-18 or 15-19)	*1.2*	*1.6*
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	*1.0*	*1.0*
Heavy-vehicle adjustment factor, f_{HV}=1/ (1+ $P_T(E_T$-1)+$P_R(E_R$-1))	*0.988*	*0.965*
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	*0.96*	*0.86*
Directional flow rate[2], v_i(pc/h) $v_i=V_i$/(PHF*$f_{HV,PTSF}$* $f_{g,PTSF}$)	*569*	*392*
Base percent time-spent-following[4], $BPTSF_d$(%)=100(1-$e^{av_d^b}$)	*54.1*	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	*36.2*	
Percent time-spent-following, $PTSF_d$(%)=$BPTSF_d$+$f_{np,PTSF}$ *($v_{d,PTSF}$ / $v_{d,PTSF}$ + $v_{o,PTSF}$)	*75.5*	

Level of Service and Other Performance Measures

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

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

Notes

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

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Appendix 4

Operational
Analysis Worksheets

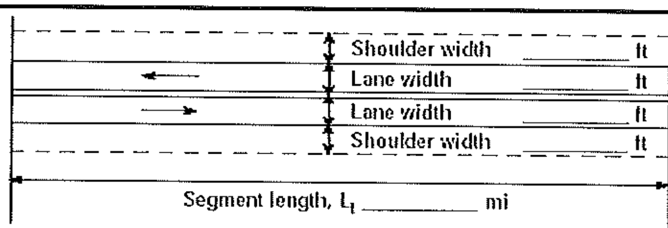
2035 Reverse 3-2-3-4 Adjusted Annual Average
Three-Lane RP 141.2 – RP 142.0
Two-Lane Eastbound
One-Lane Westbound

DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

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

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

Input Data



Analysis direction vol., V_d	398veh/h
Opposing direction vol., V_o	250veh/h
Shoulder width ft	1.0
Lane Width ft	12.0
Segment Length mi	0.6

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

Terrain	☐ Level	☑ Rolling
Grade Length mi	Up/down	
Peak-hour factor, PHF	0.93	
No-passing zone	100%	
% Trucks and Buses , P_T	6 %	
% Recreational vehicles, P_R	4%	
Access points *mi*	3/mi	

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	1.9	2.2
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	1.1	1.1
Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	0.945	0.929
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	0.91	0.81
Demand flow rate[2], v_i (pc/h) $v_i=V_i/(PHF*f_{g,ATS}*f_{HV,ATS})$	498	357

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
		Base free-flow speed[4], BFFS	60.0 mi/h
Mean speed of sample[3], S_{FM}		Adj. for lane and shoulder width,[4] f_{LS} (Exhibit 15-7)	4.2 mi/h
Total demand flow rate, both directions, v		Adj. for access points[4], f_A (Exhibit 15-8)	0.8 mi/h
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Free-flow speed, FFS ($FSS=BFFS-f_{LS}-f_A$)	55.0 mi/h
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	3.1 mi/h	Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	45.3 mi/h
		Percent free flow speed, PFFS	82.3 %

Percent Time-Spent-Following

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-18 or 15-19)	1.4	1.7
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	1.0	1.0
Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	0.977	0.960
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	0.92	0.83
Directional flow rate[2], v_i(pc/h) $v_i=V_i/(PHF*f_{HV,PTSF}*f_{g,PTSF})$	476	337
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	46.3	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	40.2	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	69.8	

Level of Service and Other Performance Measures

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

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

Notes

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

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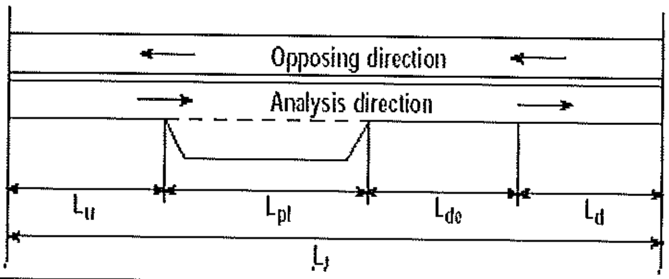
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET WITH PASSING LANE WORKSHEET

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

Project Description: *US 2 Badrock Canyon Corridor Plan*

Input Data

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



Shoulder width (ft)	*1.0*
Lane Width (ft)	*12.0*
Segment Length (mi)	*0.6*
Total length of analysis segment, L_t	*0.6*
Length of two-lane highway upstream of the passing lane, L_u	*0.0*
Length of passing lane including tapers , L_{pl}	*0.6*
Average travel speed, ATS_d (from Directional Two-Lane Highway Segment Worksheet)	*45.8*
Percent time-spent-following, $PTSF_d$ (from Directional Two-Lane Highway Segment Worksheet)	*57.8*
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 $L_d=L_t-(L_u+L_{pl}+L_{de})$	*-1.70*
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], $ATS_{pl} = (ATS_d * L_t) / (L_u+L_d+(L_{pl}/f_{pl})+ (2L_{de}/(1+f_{pl,ATS})))$	*50.4*
Percent free flow speed including passing lane, $PFFS_{pl} = (ATS_{pl}/ FFS)$	*91.6*
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)	*9.64*
Length of two-lane highway downstream of effective length of the passing lane for percent-time-following, $L_d = L_t-(L_u+ L_{pl}+ L_{de})$	*-9.64*
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], $PTSF_{pl}$(%) $PTSF_{pl}= PTSF_d[L_u+L_d+f_{pl,PTSF}L_{pl}+((1+f_{pl,PTSF})/2)L_{de}]/L_t$	34.7
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) $TT_{15}= VMT_{15}/ATS_{pl}$	0.9
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	287.4
Effective width, W_v (Eq. 15-29) ft	13.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	5.39
Bicycle level of service (Exhibit 15-4)	E
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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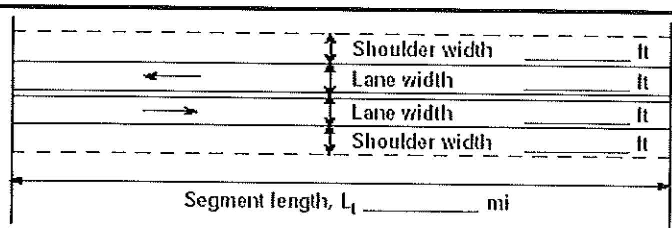
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

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

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

Input Data



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

Terrain ☐ Level ☑ Rolling

Analysis direction vol., V_d	*351veh/h*
Opposing direction vol., V_o	*306veh/h*
Shoulder width ft	*1.0*
Lane Width ft	*12.0*
Segment Length mi	*0.6*
Grade Length mi Up/down	
Peak-hour factor, PHF	*0.91*
No-passing zone	*100%*
% Trucks and Buses , P_T	*6 %*
% Recreational vehicles, P_R	*4%*
Access points *mi*	*3/mi*

Average Travel Speed

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

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
		Base free-flow speed[4], BFFS	*61.0 mi/h*
Mean speed of sample[3], S_{FM}		Adj. for lane and shoulder width,[4] f_{LS} (Exhibit 15-7)	*4.2 mi/h*
Total demand flow rate, both directions, *v*		Adj. for access points[4], f_A (Exhibit 15-8)	*0.8 mi/h*
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Free-flow speed, FFS $(FSS=BFFS-f_{LS}-f_A)$	*56.0 mi/h*
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	*2.9 mi/h*	Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	*46.3 mi/h*
		Percent free flow speed, PFFS	*82.6 %*

Percent Time-Spent-Following

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

Level of Service and Other Performance Measures

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

Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h	*0*
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	*1477*
Percent Free-Flow Speed $PFFS_d$(Equation 15-11 - Class III only)	*82.6*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*385.7*
Effective width, Wv (Eq. 15-29) ft	*13.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*5.54*
Bicycle level of service (Exhibit 15-4)	*F*
Notes	
1. Note that the adjustment factor for level terrain is 1.00,as level terrain is one of the base conditions. For the purpose of grade adjustment, specific downgrade segments are treated as level terrain. 2. If v_i(v_d or v_o) >=1,700 pc/h, terminate analysis--the LOS is F. 3. For the analysis direction only and for v>200 veh/h. 4. For the analysis direction only 5. Exhibit 15-20 provides coefficients a and b for Equation 15-10. 6. Use alternative Exhibit 15-14 if some trucks operate at crawl speeds on a specific downgrade.	

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2

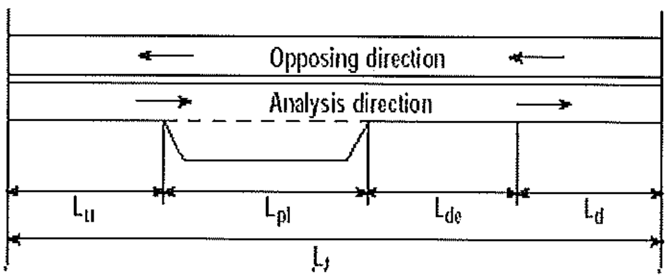
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET WITH PASSING LANE WORKSHEET

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

Project Description: *US 2 Badrock Canyon Corridor Pla¼¼¥B*

Input Data

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



Shoulder width (ft)	*1.0*
Lane Width (ft)	*12.0*
Segment Length (mi)	*0.6*
Total length of analysis segment, L_t	*0.6*
Length of two-lane highway upstream of the passing lane, L_u	*0.0*
Length of passing lane including tapers , L_{pl}	*0.6*
Average travel speed, ATS_d (from Directional Two-Lane Highway Segment Worksheet)	*46.4*
Percent time-spent-following, $PTSF_d$ (from Directional Two-Lane Highway Segment Worksheet)	*65.1*
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 $L_d=L_t-(L_u+L_{pl}+L_{de})$	*-1.70*
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], $ATS_{pl} = (ATS_d * L_t) / (L_u+L_d+(L_{pl}/f_{pl})+ (2L_{de}/(1+f_{pl,ATS})))$	*51.1*
Percent free flow speed including passing lane, $PFFS_{pl} = (ATS_{pl}/ FFS)$	*91.2*
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)	*8.03*
Length of two-lane highway downstream of effective length of the passing lane for percent-time-following, $L_d = L_t-(L_u+ L_{pl}+ L_{de})$	*-8.03*
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], $PTSF_{pl}$(%) $PTSF_{pl}= PTSF_d[L_u+L_d+f_{pl,PTSF}L_{pl}+((1+f_{pl,PTSF})/2)L_{de}]/L_t$	*39.7*
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) $TT_{15}= VMT_{15}/ATS_{pl}$	*1.0*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*343.8*
Effective width, W_v (Eq. 15-29) ft	*13.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*5.48*
Bicycle level of service (Exhibit 15-4)	*E*
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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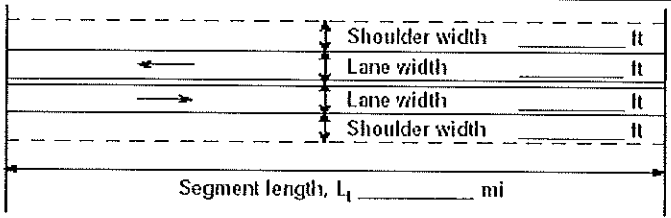
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET

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

Project Description: US 2 Badrock Canyon Corridor PlaŸ{¥B

Input Data



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

Terrain ☐ Level ☑ Rolling

Analysis direction vol., V_d	296veh/h
Opposing direction vol., V_o	491veh/h
Shoulder width ft	1.0
Lane Width ft	12.0
Segment Length mi	0.6
Grade Length mi	Up/down
Peak-hour factor, PHF	0.89
No-passing zone	100%
% Trucks and Buses , P_T	6 %
% Recreational vehicles, P_R	4%
Access points *mi*	3/mi

Average Travel Speed

	Analysis Direction (d)	Opposing Direction (o)
Passenger-car equivalents for trucks, E_T (Exhibit 15-11 or 15-12)	2.1	1.7
Passenger-car equivalents for RVs, E_R (Exhibit 15-11 or 15-13)	1.1	1.1
Heavy-vehicle adjustment factor, $f_{HV,ATS}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	0.935	0.956
Grade adjustment factor[1], $f_{g,ATS}$ (Exhibit 15-9)	0.85	0.96
Demand flow rate[2], v_i(pc/h) $v_i=V_i/(PHF*f_{g,ATS}*f_{HV,ATS})$	418	601

Free-Flow Speed from Field Measurement		Estimated Free-Flow Speed	
		Base free-flow speed[4], BFFS	62.0 mi/h
Mean speed of sample[3], S_{FM}		Adj. for lane and shoulder width,[4] f_{LS}(Exhibit 15-7)	4.2 mi/h
Total demand flow rate, both directions, v		Adj. for access points[4], f_A (Exhibit 15-8)	0.8 mi/h
Free-flow speed, $FFS=S_{FM}+0.00776(v/f_{HV,ATS})$		Free-flow speed, FFS $(FSS=BFFS-f_{LS}-f_A)$	57.0 mi/h
Adj. for no-passing zones, $f_{np,ATS}$ (Exhibit 15-15)	1.9 mi/h	Average travel speed, $ATS_d=FFS-0.00776(v_{d,ATS}+v_{o,ATS})-f_{np,ATS}$	47.2 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)	1.6	1.2
Passenger-car equivalents for RVs, E_R (Exhibit 15-18 or 15-19)	1.0	1.0
Heavy-vehicle adjustment factor, $f_{HV}=1/(1+P_T(E_T-1)+P_R(E_R-1))$	0.965	0.988
Grade adjustment factor[1], $f_{g,PTSF}$ (Exhibit 15-16 or Ex 15-17)	0.87	0.97
Directional flow rate[2], v_i(pc/h) $v_i=V_i/(PHF*f_{HV,PTSF}*f_{g,PTSF})$	396	576
Base percent time-spent-following[4], $BPTSF_d(\%)=100(1-e^{av_d^b})$	45.3	
Adj. for no-passing zone, $f_{np,PTSF}$ (Exhibit 15-21)	36.0	
Percent time-spent-following, $PTSF_d(\%)=BPTSF_d+f_{np,PTSF}*(v_{d,PTSF}/v_{d,PTSF}+v_{o,PTSF})$	60.0	

Level of Service and Other Performance Measures

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

Capacity, $C_{d,ATS}$ (Equation 15-12) pc/h	*1576*
Capacity, $C_{d,PTSF}$ (Equation 15-13) pc/h	*1629*
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	*332.6*
Effective width, Wv (Eq. 15-29) ft	*13.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*5.46*
Bicycle level of service (Exhibit 15-4)	*E*
Notes	

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

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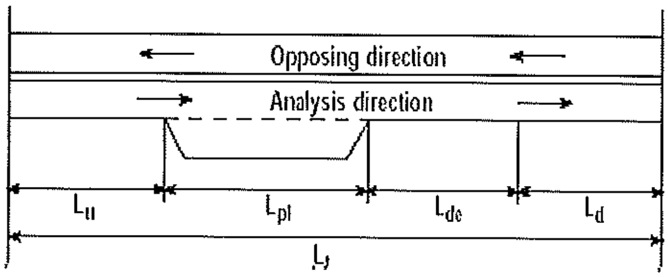
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET WITH PASSING LANE WORKSHEET

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

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

Input Data

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



Shoulder width (ft)	*1.0*
Lane Width (ft)	*12.0*
Segment Length (mi)	*0.6*
Total length of analysis segment, L_t	*0.6*
Length of two-lane highway upstream of the passing lane, L_u	*0.0*
Length of passing lane including tapers , L_{pl}	*0.6*
Average travel speed, ATS_d (from Directional Two-Lane Highway Segment Worksheet)	*44.5*
Percent time-spent-following, $PTSF_d$ (from Directional Two-Lane Highway Segment Worksheet)	*75.5*
Level of service[1], LOS_d (from Directional Two-Lane Highway Segment Worksheet)	*D*
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 $L_d = L_t - (L_u + L_{pl} + L_{de})$	*-1.70*
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], $ATS_{pl} = (ATS_d * L_t) / (L_u + L_d + (L_{pl}/f_{pl}) + (2L_{de}/(1+f_{pl,ATS})))$	*49.0*
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)	*6.75*
Length of two-lane highway downstream of effective length of the passing lane for percent-time-following, $L_d = L_t - (L_u + L_{pl} + L_{de})$	*-6.75*
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], $PTSF_{pl}$(%) $PTSF_{pl}= PTSF_d[L_u+L_d+f_{pl,PTSF}L_{pl}+((1+f_{pl,PTSF})/2)L_{de}]/L_t$	46.1
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) $TT_{15}= VMT_{15}/ATS_{pl}$	1.7
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	539.6
Effective width, W_v (Eq. 15-29) ft	13.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	5.71
Bicycle level of service (Exhibit 15-4)	F
Notes	
1. 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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Appendix 4

Operational
Analysis Worksheets

2035 Reverse 3-2-3-4 Four-Lane Adjusted Annual Average

RP 142.0 – RP 142.4

Direction 1 = Eastbound

Direction 2 = Westbound

MULTILANE HIGHWAYS WORKSHEET(Direction 1)

General Information		Site Information	
Analyst	David Stoner	Highway/Direction to Travel	US 2
Agency or Company	DOWL HKM	From/To	Columbia Falls to Hungry Horse
Date Performed	4/30/2012	Jurisdiction	Flathead County
Analysis Time Period	AM Peak	Analysis Year	2035

Project Description US 2 Badrock Canyon Corridor Planning Study

☐ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	398	Peak-Hour Factor, PHF	0.93
AADT(veh/h)		%Trucks and Buses, P_T	6
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Rolling
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	2.0
E_T	2.5	f_{HV}	0.885

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)	241	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	*214.0*
Effective width, W_v (Eq. 15-29) ft	*24.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*3.21*
Bicycle level of service (Exhibit 15-4)	*C*

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MULTILANE HIGHWAYS WORKSHEET(Direction 2)

[X]

General Information

Analyst	David Stoner
Agency or Company	DOWL HKM
Date Performed	4/30/2012
Analysis Time Period	AM Peak

Site Information

Highway/Direction to Travel	US 2
From/To	Columbia Falls to Hungry Horse
Jurisdiction	Flathead County
Analysis Year	2035

Project Description US 2 Badrock Canyon Corridor Planning Study

☐ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	250	Peak-Hour Factor, PHF	0.87
AADT(veh/h)		%Trucks and Buses, P_T	6
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Rolling
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	2.0
E_T	2.5	f_{HV}	0.885

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	*143.7*
Effective width, W_v (Eq. 15-29) ft	*24.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*3.00*
Bicycle level of service (Exhibit 15-4)	*C*

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MULTILANE HIGHWAYS WORKSHEET(Direction 1)

[X]

General Information

Analyst	David Stoner
Agency or Company	DOWL HKM
Date Performed	4/30/2012
Analysis Time Period	Median Off-Peak

Site Information

Highway/Direction to Travel	US 2
From/To	Columbia Falls to Hungry Horse
Jurisdiction	Flathead County
Analysis Year	2035

Project Description US 2 Badrock Canyon Corridor Planning Study

☐ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	351	Peak-Hour Factor, PHF	0.91
AADT(veh/h)		%Trucks and Buses, P_T	6
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Rolling
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	2.0
E_T	2.5	f_{HV}	0.885

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)	61.0
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)	61.0

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	217
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	192.9
Effective width, W_v (Eq. 15-29) ft	24.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	3.15
Bicycle level of service (Exhibit 15-4)	C

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MULTILANE HIGHWAYS WORKSHEET(Direction 2)

General Information

Analyst	David Stoner
Agency or Company	DOWL HKM
Date Performed	4/30/2012
Analysis Time Period	Median Off-Peak

Site Information

Highway/Direction to Travel	US 2
From/To	Columbia Falls to Hungry Horse
Jurisdiction	Flathead County
Analysis Year	2035

Project Description US 2 Badrock Canyon Corridor Planning Study

☐ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	306	Peak-Hour Factor, PHF	0.89
AADT(veh/h)		%Trucks and Buses, P_T	6
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Rolling
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	2.0
E_T	2.5	f_{HV}	0.885

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)	61.0
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)	61.0

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	194
Speed, S (mi/h)	60.0
D (pc/mi/ln)	3.2
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	171.9
Effective width, W_v (Eq. 15-29) ft	24.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	3.09
Bicycle level of service (Exhibit 15-4)	C

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MULTILANE HIGHWAYS WORKSHEET(Direction 1)

General Information

Analyst	David Stoner
Agency or Company	DOWL HKM
Date Performed	4/30/2012
Analysis Time Period	PM Peak

Site Information

Highway/Direction to Travel	US 2
From/To	Columbia Falls to Hungry Horse
Jurisdiction	Flathead County
Analysis Year	2035

Project Description US 2 Badrock Canyon Corridor Planning Study

☐ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	296	Peak-Hour Factor, PHF	0.89
AADT(veh/h)		%Trucks and Buses, P_T	6
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Rolling
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	2.0
E_T	2.5	f_{HV}	0.885

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)	62.0
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)	62.0

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	187
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	*166.3*
Effective width, W_v (Eq. 15-29) ft	*24.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*3.08*
Bicycle level of service (Exhibit 15-4)	*C*

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MULTILANE HIGHWAYS WORKSHEET(Direction 2)

General Information

Analyst	David Stoner
Agency or Company	DOWL HKM
Date Performed	4/30/2012
Analysis Time Period	PM Peak

Site Information

Highway/Direction to Travel	US 2
From/To	Columbia Falls to Hungry Horse
Jurisdiction	Flathead County
Analysis Year	2035

Project Description US 2 Badrock Canyon Corridor Planning Study

Oper.(LOS) Des. (N) Plan. (vp)

Flow Inputs

Volume, V (veh/h)	491	Peak-Hour Factor, PHF	0.91
AADT(veh/h)		%Trucks and Buses, P_T	6
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Rolling
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	2.0
E_T	2.5	f_{HV}	0.885

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)	304
Speed, S (mi/h)	60.0
D (pc/mi/ln)	5.1
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	269.8
Effective width, W_v (Eq. 15-29) ft	24.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	3.32
Bicycle level of service (Exhibit 15-4)	C

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Appendix 4

Operational Analysis Worksheets

2035 Three-Lane Peak Season

2

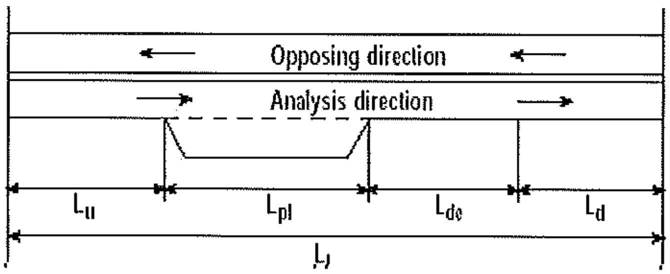
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET WITH PASSING LANE WORKSHEET

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

Project Description: *US 2 Badrock Canyon Corridor Pla=â*

Input Data

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



Shoulder width (ft)	*1.0*
Lane Width (ft)	*12.0*
Segment Length (mi)	*2.4*
Total length of analysis segment, L_t	*2.4*
Length of two-lane highway upstream of the passing lane, L_u	*0.0*
Length of passing lane including tapers , L_{pl}	*0.6*
Average travel speed, ATS_d (from Directional Two-Lane Highway Segment Worksheet)	*41.8*
Percent time-spent-following, $PTSF_d$ (from Directional Two-Lane Highway Segment Worksheet)	*84.6*
Level of service[1], LOS_d (from Directional Two-Lane Highway Segment Worksheet)	*D*
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 $L_d = L_t - (L_u + L_{pl} + L_{de})$	*0.10*
Adj. factor for the effect of passing lane on average speed, f_{pl} (Exhibit 15-28)	*1.11*
Average travel speed including passing lane[2], $ATS_{pl} = (ATS_d * L_t) / (L_u + L_d + (L_{pl}/f_{pl}) + (2L_{de}/(1+f_{pl,ATS})))$	*44.6*
Percent free flow speed including passing lane, $PFFS_{pl} = (ATS_{pl} / FFS)$	*80.9*
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)	*4.64*
Length of two-lane highway downstream of effective length of the passing lane for percent-time-following, $L_d = L_t - (L_u + L_{pl} + L_{de})$	*-2.84*
Adj. factor for the effect of passing lane on percent time-spent-following,	

$f_{pl,PTSF}$(Exhibit 15-26)	0.62
Percent time-spent-following including passing lane[3], $PTSF_{pl}$(%) $PTSF_{pl}= PTSF_d[L_u+L_d+f_{pl,PTSF}L_{pl}+((1+f_{pl,PTSF})/2)L_{de}]/L_t$	57.1
Level of Service and Other Performance Measures[4]	
Level of service including passing lane LOS_{pl} (Exhibit 15-3)	C
Peak 15-min total travel time, TT_{15}(veh-h) $TT_{15}= VMT_{15}/ATS_{pl}$	11.4
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	850.5
Effective width, W_v (Eq. 15-29) ft	13.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	5.94
Bicycle level of service (Exhibit 15-4)	F
Notes	

1. 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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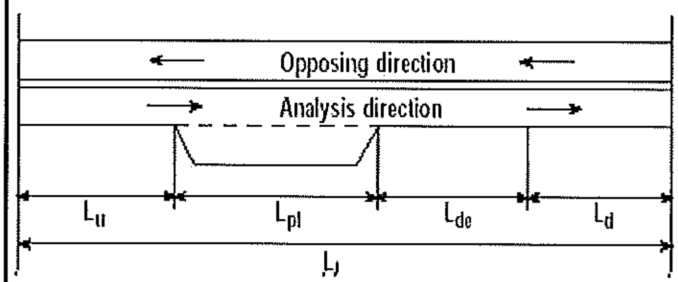
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET WITH PASSING LANE WORKSHEET

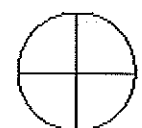
General Information		Site Information	
Analyst	*David Stoner*	Highway of Travel	*US 2*
Agency or Company	*DOWL HKM*	From/To	*Columbia F to Hungry H WB*
Date Performed	*11/15/2011*	Jurisdiction	*Flathead County*
Analysis Time Period	*AM Peak*	Analysis Year	*2035*

Project Description: *US 2 Badrock Canyon Corridor Pla 4*

Input Data

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





Shoulder width (ft)	*1.0*
Lane Width (ft)	*12.0*
Segment Length (mi)	*2.4*
Total length of analysis segment, L_t	*2.4*
Length of two-lane highway upstream of the passing lane, L_u	*0.0*
Length of passing lane including tapers , L_{pl}	*1.1*
Average travel speed, ATS_d (from Directional Two-Lane Highway Segment Worksheet)	*41.9*
Percent time-spent-following, $PTSF_d$ (from Directional Two-Lane Highway Segment Worksheet)	*70.5*
Level of service[1], LOS_d (from Directional Two-Lane Highway Segment Worksheet)	*D*
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 $L_d=L_t-(L_u+L_{pl}+L_{de})$	*-0.40*
Adj. factor for the effect of passing lane on average speed, f_{pl} (Exhibit 15-28)	*1.11*
Average travel speed including passing lane[2], $ATS_{pl} = (ATS_d * L_t) / (L_u+L_d+(L_{pl}/f_{pl})+ (2L_{de}/(1+f_{pl,ATS})))$	*45.5*
Percent free flow speed including passing lane, $PFFS_{pl} = (ATS_{pl}/ FFS)$	*82.7*
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)	*6.63*
Length of two-lane highway downstream of effective length of the passing lane for percent-time-following, $L_d=L_t-(L_u+L_{pl}+L_{de})$	*-5.33*
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], $PTSF_{pl}$(%) $PTSF_{pl}= PTSF_d[L_u+L_d+f_{pl,PTSF}L_{pl}+((1+f_{pl,PTSF})/2)L_{de}]/L_t$	44.5
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) $TT_{15}= VMT_{15}/ATS_{pl}$	7.4
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	559.8
Effective width, W_v (Eq. 15-29) ft	13.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	5.73
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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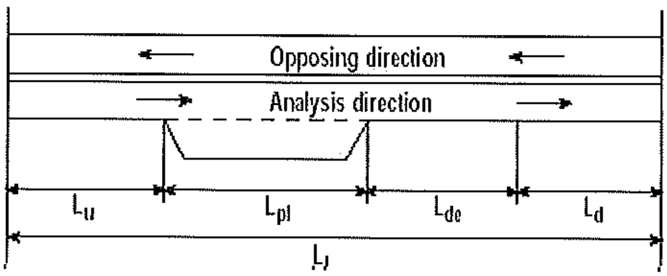
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET WITH PASSING LANE WORKSHEET

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

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

Input Data

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



Shoulder width (ft)	*1.0*
Lane Width (ft)	*12.0*
Segment Length (mi)	*2.4*
Total length of analysis segment, L_t	*2.4*
Length of two-lane highway upstream of the passing lane, L_u	*0.0*
Length of passing lane including tapers , L_{pl}	*0.6*
Average travel speed, ATS_d (from Directional Two-Lane Highway Segment Worksheet)	*42.7*
Percent time-spent-following, $PTSF_d$ (from Directional Two-Lane Highway Segment Worksheet)	*81.6*
Level of service[1], LOS_d (from Directional Two-Lane Highway Segment Worksheet)	*D*
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 $L_d=L_t-(L_u+L_{pl}+L_{de})$	*0.10*
Adj. factor for the effect of passing lane on average speed, f_{pl} (Exhibit 15-28)	*1.11*
Average travel speed including passing lane[2], $ATS_{pl} = (ATS_d * L_t) / (L_u+L_d+(L_{pl}/f_{pl})+ (2L_{de}/(1+f_{pl,ATS})))$	*45.5*
Percent free flow speed including passing lane, $PFFS_{pl} = (ATS_{pl}/ FFS)$	*81.2*
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)	*5.18*
Length of two-lane highway downstream of effective length of the passing lane for percent-time-following, $L_d =L_t-(L_u+ L_{pl}+ L_{de})$	*-3.38*
Adj. factor for the effect of passing lane on percent time-spent-following,	

$f_{pl,PTSF}$(Exhibit 15-26)	*0.62*
Percent time-spent-following including passing lane[3], $PTSF_{pl}$(%) $PTSF_{pl}= PTSF_d[L_u+L_d+f_{pl,PTSF}L_{pl}+((1+f_{pl,PTSF})/2)L_{de}]/L_t$	*54.6*
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) $TT_{15}= VMT_{15}/ATS_{pl}$	*10.2*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*773.6*
Effective width, W_v (Eq. 15-29) ft	*13.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*5.89*
Bicycle level of service (Exhibit 15-4)	*F*

Notes

1. 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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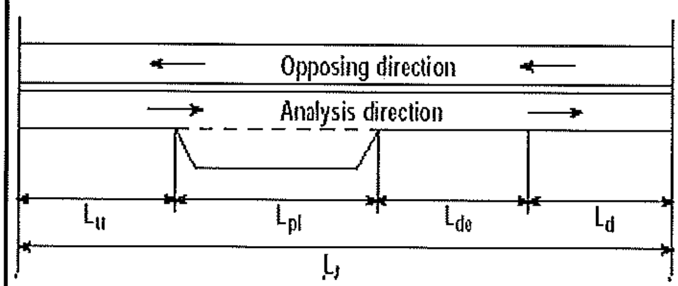
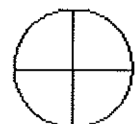
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET WITH PASSING LANE WORKSHEET			
General Information		***Site Information***	
Analyst	*David Stoner*	Highway of Travel	*US 2*
Agency or Company	*DOWL HKM*	From/To	*Columbia F to Hungry H WB*
Date Performed	*11/15/2011*	Jurisdiction	*Flathead County*
Analysis Time Period	*Median Off-Peak*	Analysis Year	*2035*
Project Description: *US 2 Badrock Canyon Corridor Plag$*			
Input Data			

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





Show North Arrow

Shoulder width (ft)	*1.0*
Lane Width (ft)	*12.0*
Segment Length (mi)	*2.4*
Total length of analysis segment, L_t	*2.4*
Length of two-lane highway upstream of the passing lane, L_u	*0.0*
Length of passing lane including tapers , L_{pl}	*1.1*
Average travel speed, ATS_d (from Directional Two-Lane Highway Segment Worksheet)	*42.9*
Percent time-spent-following, $PTSF_d$ (from Directional Two-Lane Highway Segment Worksheet)	*76.6*
Level of service[1], LOS_d (from Directional Two-Lane Highway Segment Worksheet)	*D*
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 $L_d=L_t-(L_u+L_{pl}+L_{de})$	*-0.40*
Adj. factor for the effect of passing lane on average speed, f_{pl} (Exhibit 15-28)	*1.11*
Average travel speed including passing lane[2], $ATS_{pl} = (ATS_d * L_t) / (L_u+L_d+(L_{pl}/f_{pl})+ (2L_{de}/(1+f_{pl,ATS})))$	*46.6*
Percent free flow speed including passing lane, $PFFS_{pl} = (ATS_{pl}/ FFS)$	*83.2*
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)	*5.89*
Length of two-lane highway downstream of effective length of the passing lane for percent-time-following, $L_d =L_t-(L_u+ L_{pl}+ L_{de})$	*-4.59*
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], $PTSF_{pl}$(%) $PTSF_{pl}= PTSF_d[L_u+L_d+f_{pl,PTSF}L_{pl}+((1+f_{pl,PTSF})/2)L_{de}]/L_t$	*48.5*
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) $TT_{15}= VMT_{15}/ATS_{pl}$	*8.5*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*662.2*
Effective width, W_v (Eq. 15-29) ft	*13.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*5.81*
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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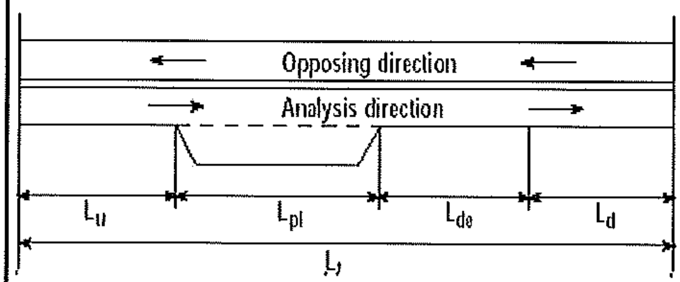
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET WITH PASSING LANE WORKSHEET

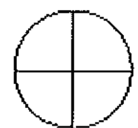
General Information		Site Information	
Analyst	David Stoner	Highway of Travel	US 2
Agency or Company	DOWL HKM	From/To	Columbia F to Hungry H EB
Date Performed	11/15/2011	Jurisdiction	Flathead County
Analysis Time Period	PM Peak	Analysis Year	2035

Project Description: US 2 Badrock Canyon Corridor Pla2j

Input Data

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





Shoulder width (ft)	1.0
Lane Width (ft)	12.0
Segment Length (mi)	2.4
Total length of analysis segment, L_t	2.4
Length of two-lane highway upstream of the passing lane, L_u	0.0
Length of passing lane including tapers , L_{pl}	0.6
Average travel speed, ATS_d (from Directional Two-Lane Highway Segment Worksheet)	42.1
Percent time-spent-following, $PTSF_d$ (from Directional Two-Lane Highway Segment Worksheet)	75.4
Level of service[1], LOS_d (from Directional Two-Lane Highway Segment Worksheet)	D
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 $L_d=L_t-(L_u+L_{pl}+L_{de})$	0.10
Adj. factor for the effect of passing lane on average speed, f_{pl} (Exhibit 15-28)	1.11
Average travel speed including passing lane[2], $ATS_{pl} = (ATS_d * L_t) / (L_u+L_d+(L_{pl}/f_{pl})+ (2L_{de}/(1+f_{pl,ATS})))$	44.8
Percent free flow speed including passing lane, $PFFS_{pl} = (ATS_{pl}/ FFS)$	78.6
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)	5.92
Length of two-lane highway downstream of effective length of the passing lane for percent-time-following, $L_d=L_t-(L_u+L_{pl}+L_{de})$	-4.12
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], $PTSF_{pl}$(%) $PTSF_{pl}= PTSF_d[L_u+L_d+f_{pl,PTSF}L_{pl}+((1+f_{pl,PTSF})/2)L_{de}]/L_t$	49.3
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) $TT_{15}= VMT_{15}/ATS_{pl}$	8.8
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	658.4
Effective width, W_v (Eq. 15-29) ft	13.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	5.81
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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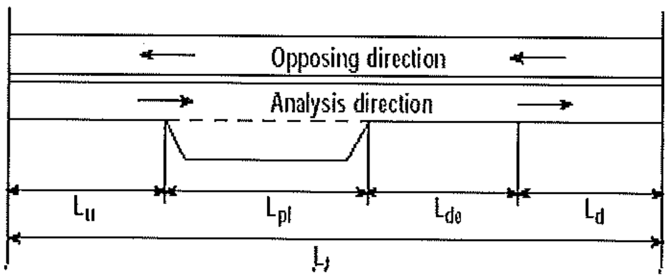
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET WITH PASSING LANE WORKSHEET

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

Project Description: US 2 Badrock Canyon Corridor Pla¥7B

Input Data

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



Shoulder width (ft)	1.0
Lane Width (ft)	12.0
Segment Length (mi)	2.4
Total length of analysis segment, L_t	2.4
Length of two-lane highway upstream of the passing lane, L_u	0.0
Length of passing lane including tapers , L_{pl}	1.1
Average travel speed, ATS_d (from Directional Two-Lane Highway Segment Worksheet)	39.7
Percent time-spent-following, $PTSF_d$ (from Directional Two-Lane Highway Segment Worksheet)	88.9
Level of service[1], LOS_d (from Directional Two-Lane Highway Segment Worksheet)	E
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 $L_d=L_t-(L_u+L_{pl}+L_{de})$	-0.40
Adj. factor for the effect of passing lane on average speed, f_{pl} (Exhibit 15-28)	1.11
Average travel speed including passing lane[2], $ATS_{pl} = (ATS_d * L_t) / (L_u+L_d+(L_{pl}/f_{pl})+ (2L_{de}/(1+f_{pl,ATS})))$	43.1
Percent free flow speed including passing lane, $PFFS_{pl} = (ATS_{pl}/ FFS)$	78.4
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)	3.60
Length of two-lane highway downstream of effective length of the passing lane for percent-time-following, $L_d=L_t-(L_u+L_{pl}+L_{de})$	-2.30
Adj. factor for the effect of passing lane on percent time-spent-following,	

$f_{pl,PTSF}$(Exhibit 15-26)	0.62
Percent time-spent-following including passing lane[3], $PTSF_{pl}$(%) $PTSF_{pl}= PTSF_d[L_u+L_d+f_{pl,PTSF}L_{pl}+((1+f_{pl,PTSF})/2)L_{de}]/L_t$	58.4
Level of Service and Other Performance Measures[4]	
Level of service including passing lane LOS_{pl} (Exhibit 15-3)	C
Peak 15-min total travel time, TT_{15}(veh-h) $TT_{15}= VMT_{15}/ATS_{pl}$	14.6
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	1046.2
Effective width, W_v (Eq. 15-29) ft	13.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	6.04
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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Appendix 4

Operational
Analysis Worksheets

2035 Three-Lane Adjusted Annual Average

2

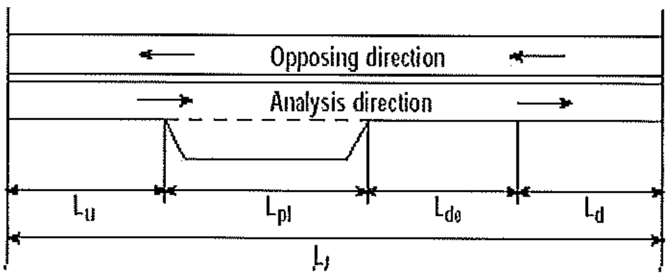
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET WITH PASSING LANE WORKSHEET

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

Project Description: US 2 Badrock Canyon Corridor Plaò²¤B

Input Data

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



Shoulder width (ft)	1.0
Lane Width (ft)	12.0
Segment Length (mi)	2.4
Total length of analysis segment, L_t	2.4
Length of two-lane highway upstream of the passing lane, L_u	0.0
Length of passing lane including tapers , L_{pl}	0.6
Average travel speed, ATS_d (from Directional Two-Lane Highway Segment Worksheet)	45.3
Percent time-spent-following, $PTSF_d$ (from Directional Two-Lane Highway Segment Worksheet)	70.4
Level of service[1], LOS_d (from Directional Two-Lane Highway Segment Worksheet)	D
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 $L_d=L_t-(L_u+L_{pl}+L_{de})$	0.10
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], $ATS_{pl} = (ATS_d * L_t) / (L_u+L_d+(L_{pl}/f_{pl})+ (2L_{de}/(1+f_{pl,ATS})))$	48.0
Percent free flow speed including passing lane, $PFFS_{pl} = (ATS_{pl}/ FFS)$	87.3
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)	7.49
Length of two-lane highway downstream of effective length of the passing lane for percent-time-following, $L_d=L_t-(L_u+L_{pl}+L_{de})$	-5.69
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], $PTSF_{pl}$(%) $PTSF_{pl}= PTSF_d[L_u+L_d+f_{pl,PTSF}L_{pl}+((1+f_{pl,PTSF})/2)L_{de}]/L_t$	45.4
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) $TT_{15}= VMT_{15}/ATS_{pl}$	5.3
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	428.0
Effective width, W_v (Eq. 15-29) ft	13.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	5.59
Bicycle level of service (Exhibit 15-4)	F
Notes	

1. 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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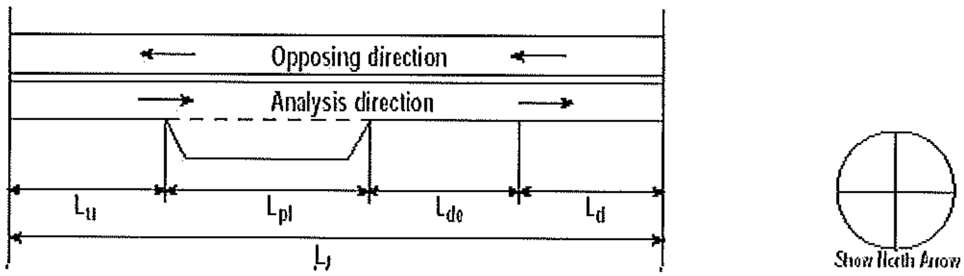
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET WITH PASSING LANE WORKSHEET

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

Project Description: US 2 Badrock Canyon Corridor Pla?ªB

Input Data

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



Shoulder width (ft)	1.0
Lane Width (ft)	12.0
Segment Length (mi)	2.4
Total length of analysis segment, L_t	2.4
Length of two-lane highway upstream of the passing lane, L_u	0.0
Length of passing lane including tapers , L_{pl}	1.1
Average travel speed, ATS_d (from Directional Two-Lane Highway Segment Worksheet)	45.9
Percent time-spent-following, $PTSF_d$ (from Directional Two-Lane Highway Segment Worksheet)	56.6
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 $L_d=L_t-(L_u+L_{pl}+L_{de})$	-0.40
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], $ATS_{pl} = (ATS_d * L_t) / (L_u+L_d+(L_{pl}/f_{pl})+ (2L_{de}/(1+f_{pl,ATS})))$	49.5
Percent free flow speed including passing lane, $PFFS_{pl} = (ATS_{pl}/ FFS)$	89.9
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)	9.99
Length of two-lane highway downstream of effective length of the passing lane for percent-time-following, $L_d = L_t-(L_u+ L_{pl}+ L_{de})$	-8.69
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], $PTSF_{pl}$(%) $PTSF_{pl}= PTSF_d[L_u+L_d+f_{pl,PTSF}L_{pl}+((1+f_{pl,PTSF})/2)L_{de}]/L_t$	*34.8*
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) $TT_{15}= VMT_{15}/ATS_{pl}$	*3.4*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*279.3*
Effective width, W_v (Eq. 15-29) ft	*13.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*5.37*
Bicycle level of service (Exhibit 15-4)	*E*
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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2

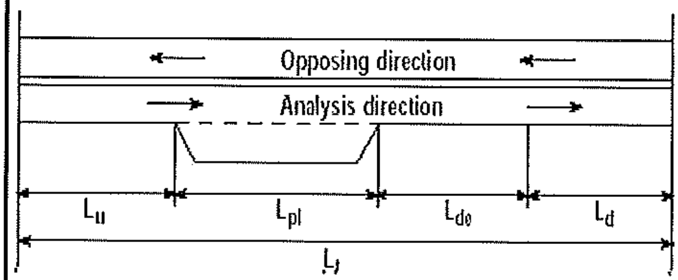
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET WITH PASSING LANE WORKSHEET

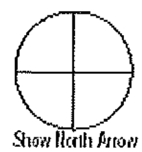
General Information		Site Information	
Analyst	David Stoner	Highway of Travel	US 2
Agency or Company	DOWL HKM	From/To	Columbia F to Hungry H EB
Date Performed	11/15/2011	Jurisdiction	Flathead County
Analysis Time Period	Median Off-Peak	Analysis Year	2035

Project Description: US 2 Badrock Canyon Corridor Pla×A¥B

Input Data

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





Shoulder width (ft)	1.0
Lane Width (ft)	12.0
Segment Length (mi)	2.4
Total length of analysis segment, L_t	2.4
Length of two-lane highway upstream of the passing lane, L_u	0.0
Length of passing lane including tapers , L_{pl}	0.6
Average travel speed, ATS_d (from Directional Two-Lane Highway Segment Worksheet)	46.3
Percent time-spent-following, $PTSF_d$ (from Directional Two-Lane Highway Segment Worksheet)	69.5
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 $L_d=L_t-(L_u+L_{pl}+L_{de})$	0.10
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], $ATS_{pl} = (ATS_d * L_t) / (L_u+L_d+(L_{pl}/f_{pl})+ (2L_{de}/(1+f_{pl,ATS})))$	49.1
Percent free flow speed including passing lane, $PFFS_{pl} = (ATS_{pl}/ FFS)$	87.6
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)	7.71
Length of two-lane highway downstream of effective length of the passing lane for percent-time-following, $L_d =L_t-(L_u+ L_{pl}+ L_{de})$	-5.91
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], $PTSF_{pl}$(%) $PTSF_{pl} = PTSF_d[L_u + L_d + f_{pl,PTSF} L_{pl} + ((1+f_{pl,PTSF})/2)L_{de}]/L_t$	*44.8*
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) $TT_{15} = VMT_{15}/ATS_{pl}$	*4.7*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*385.7*
Effective width, W_v (Eq. 15-29) ft	*13.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*5.54*
Bicycle level of service (Exhibit 15-4)	*F*
Notes	
1. 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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2

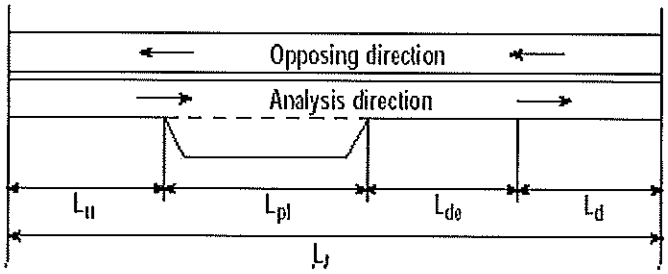
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET WITH PASSING LANE WORKSHEET

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

Project Description: US 2 Badrock Canyon Corridor Plaqõ¥B

Input Data

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



Shoulder width (ft)	1.0
Lane Width (ft)	12.0
Segment Length (mi)	2.4
Total length of analysis segment, L_t	2.4
Length of two-lane highway upstream of the passing lane, L_u	0.0
Length of passing lane including tapers, L_{pl}	1.1
Average travel speed, ATS_d (from Directional Two-Lane Highway Segment Worksheet)	46.5
Percent time-spent-following, $PTSF_d$ (from Directional Two-Lane Highway Segment Worksheet)	63.9
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 $L_d=L_t-(L_u+L_{pl}+L_{de})$	-0.40
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], $ATS_{pl} = (ATS_d * L_t) / (L_u+L_d+(L_{pl}/f_{pl})+ (2L_{de}/(1+f_{pl,ATS})))$	50.2
Percent free flow speed including passing lane, $PFFS_{pl} = (ATS_{pl}/ FFS)$	89.5
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)	8.20
Length of two-lane highway downstream of effective length of the passing lane for percent-time-following, $L_d = L_t-(L_u+ L_{pl}+ L_{de})$	-6.90
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], $PTSF_{pl}$(%) $PTSF_{pl}= PTSF_d[L_u+L_d+f_{pl,PTSF}L_{pl}+((1+f_{pl,PTSF})/2)L_{de}]/L_t$	39.4
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) $TT_{15}= VMT_{15}/ATS_{pl}$	4.0
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	333.7
Effective width, W_v (Eq. 15-29) ft	13.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	5.47
Bicycle level of service (Exhibit 15-4)	E

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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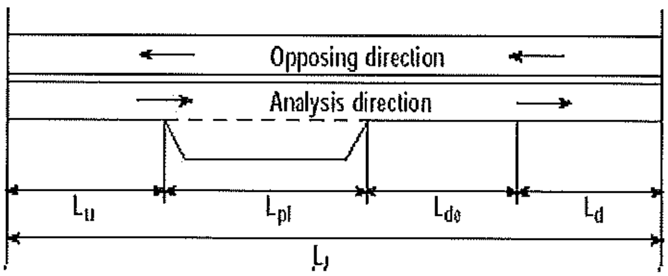
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET WITH PASSING LANE WORKSHEET

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

Project Description: *US 2 Badrock Canyon Corridor Pla*

Input Data

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



Shoulder width (ft)	*1.0*
Lane Width (ft)	*12.0*
Segment Length (mi)	*2.4*
Total length of analysis segment, L_t	*2.4*
Length of two-lane highway upstream of the passing lane, L_u	*0.0*
Length of passing lane including tapers , L_{pl}	*0.6*
Average travel speed, ATS_d (from Directional Two-Lane Highway Segment Worksheet)	*47.2*
Percent time-spent-following, $PTSF_d$ (from Directional Two-Lane Highway Segment Worksheet)	*60.2*
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 $L_d=L_t-(L_u+L_{pl}+L_{de})$	*0.10*
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], $ATS_{pl} = (ATS_d * L_t) / (L_u+L_d+(L_{pl}/f_{pl})+ (2L_{de}/(1+f_{pl,ATS})))$	*50.1*
Percent free flow speed including passing lane, $PFFS_{pl} = (ATS_{pl}/ FFS)$	*87.7*
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)	*8.24*
Length of two-lane highway downstream of effective length of the passing lane for percent-time-following, $L_d=L_t-(L_u+L_{pl}+L_{de})$	*-6.44*
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], $PTSF_{pl}$(%) $PTSF_{pl}= PTSF_d[L_u+L_d+f_{pl,PTSF}L_{pl}+((1+f_{pl,PTSF})/2)L_{de}]/L_t$	38.1
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) $TT_{15}= VMT_{15}/ATS_{pl}$	4.0
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	332.6
Effective width, W_v (Eq. 15-29) ft	13.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	5.46
Bicycle level of service (Exhibit 15-4)	E
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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2

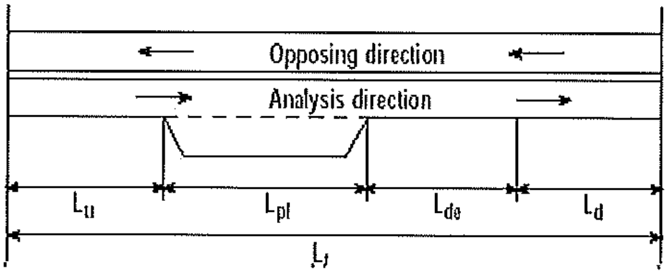
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET WITH PASSING LANE WORKSHEET

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

Project Description: US 2 Badrock Canyon Corridor Play¢B

Input Data

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



Shoulder width (ft)	1.0
Lane Width (ft)	12.0
Segment Length (mi)	2.4
Total length of analysis segment, L_t	2.4
Length of two-lane highway upstream of the passing lane, L_u	0.0
Length of passing lane including tapers, L_{pl}	1.1
Average travel speed, ATS_d (from Directional Two-Lane Highway Segment Worksheet)	44.6
Percent time-spent-following, $PTSF_d$ (from Directional Two-Lane Highway Segment Worksheet)	74.6
Level of service[1], LOS_d (from Directional Two-Lane Highway Segment Worksheet)	D
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 $L_d=L_t-(L_u+L_{pl}+L_{de})$	-0.40
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], $ATS_{pl} = (ATS_d * L_t) / (L_u+L_d+(L_{pl}/f_{pl})+(2L_{de}/(1+f_{pl,ATS})))$	48.1
Percent free flow speed including passing lane, $PFFS_{pl} = (ATS_{pl}/FFS)$	87.4
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)	6.89
Length of two-lane highway downstream of effective length of the passing lane for percent-time-following, $L_d=L_t-(L_u+L_{pl}+L_{de})$	-5.59
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], $PTSF_{pl}$(%) $PTSF_{pl}= PTSF_d[L_u+L_d+f_{pl,PTSF}L_{pl}+((1+f_{pl,PTSF})/2)L_{de}]/L_t$	47.0
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) $TT_{15}= VMT_{15}/ATS_{pl}$	6.5
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	523.1
Effective width, W_v (Eq. 15-29) ft	13.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	5.69
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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Appendix 4

Operational
Analysis Worksheets

2035 4-2-4 Peak Season
Four-Lane RP 140.0 – RP 140.6
Two-Lane RP 140.6 – RP 141.2
Four-Lane RP 141.2 – 142.4

Direction 1 = Eastbound
Direction 2 = Westbound

MULTILANE HIGHWAYS WORKSHEET(Direction 1)

[X]

General Information

Analyst	David Stoner
Agency or Company	DOWL HKM
Date Performed	4/30/2012
Analysis Time Period	AM Peak

Site Information

Highway/Direction to Travel	US 2
From/To	Columbia Falls to Hungry Horse
Jurisdiction	Flathead County
Analysis Year	2035

Project Description US 2 Badrock Canyon Corridor Planning Study

☐ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	791	Peak-Hour Factor, PHF	0.93
AADT(veh/h)		%Trucks and Buses, P_T	6
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Rolling
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	2.0
E_T	2.5	f_{HV}	0.885

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)	480
Speed, S (mi/h)	60.0
D (pc/mi/ln)	8.0
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	425.3
Effective width, W_v (Eq. 15-29) ft	24.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	3.55
Bicycle level of service (Exhibit 15-4)	D

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MULTILANE HIGHWAYS WORKSHEET(Direction 2)

[X]

General Information

Analyst	David Stoner
Agency or Company	DOWL HKM
Date Performed	4/30/2012
Analysis Time Period	AM Peak

Site Information

Highway/Direction to Travel	US 2
From/To	Columbia Falls to Hungry Horse
Jurisdiction	Flathead County
Analysis Year	2035

Project Description US 2 Badrock Canyon Corridor Planning Study

☐ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	502	Peak-Hour Factor, PHF	0.87
AADT(veh/h)		%Trucks and Buses, P_T	6
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Rolling
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	2.0
E_T	2.5	f_{HV}	0.885

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)	326
Speed, S (mi/h)	60.0
D (pc/mi/ln)	5.4
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	288.5
Effective width, W_v (Eq. 15-29) ft	24.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	3.36
Bicycle level of service (Exhibit 15-4)	C

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MULTILANE HIGHWAYS WORKSHEET(Direction 1)

General Information

Analyst	David Stoner
Agency or Company	DOWL HKM
Date Performed	4/30/2012
Analysis Time Period	Median Off Peak Peak

Site Information

Highway/Direction to Travel	US 2
From/To	Columbia Falls to Hungry Horse
Jurisdiction	Flathead County
Analysis Year	2035

Project Description US 2 Badrock Canyon Corridor Planning Study

☐ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	704	Peak-Hour Factor, PHF	0.91
AADT(veh/h)		%Trucks and Buses, P_T	6
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Rolling
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	2.0
E_T	2.5	f_{HV}	0.885

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)	61.0
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)	61.0

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	437
Speed, S (mi/h)	60.0
D (pc/mi/ln)	7.3
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	386.8
Effective width, W_v (Eq. 15-29) ft	24.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	3.51
Bicycle level of service (Exhibit 15-4)	D

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MULTILANE HIGHWAYS WORKSHEET(Direction 2)

[X]

General Information

Analyst	David Stoner
Agency or Company	DOWL HKM
Date Performed	4/30/2012
Analysis Time Period	Median Off Peak Peak

Site Information

Highway/Direction to Travel	US 2
From/To	Columbia Falls to Hungry Horse
Jurisdiction	Flathead County
Analysis Year	2035

Project Description US 2 Badrock Canyon Corridor Planning Study

☐ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	614	Peak-Hour Factor, PHF	0.89
AADT(veh/h)		%Trucks and Buses, P_T	6
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Rolling
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	2.0
E_T	2.5	f_{HV}	0.885

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)	61.0
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)	61.0

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	389
Speed, S (mi/h)	60.0
D (pc/mi/ln)	6.5
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	344.9
Effective width, W_v (Eq. 15-29) ft	24.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	3.45
Bicycle level of service (Exhibit 15-4)	C

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MULTILANE HIGHWAYS WORKSHEET(Direction 1)

General Information

Analyst	David Stoner
Agency or Company	DOWL HKM
Date Performed	4/30/2012
Analysis Time Period	PM Peak

Site Information

Highway/Direction to Travel	US 2
From/To	Columbia Falls to Hungry Horse
Jurisdiction	Flathead County
Analysis Year	2035

Project Description US 2 Badrock Canyon Corridor Planning Study

☐ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	586	Peak-Hour Factor, PHF	0.89
AADT(veh/h)		%Trucks and Buses, P_T	6
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Rolling
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	2.0
E_T	2.5	f_{HV}	0.885

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)	62.0
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)	62.0

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	372
Speed, S (mi/h)	60.0
D (pc/mi/ln)	6.2
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	329.2
Effective width, W_v (Eq. 15-29) ft	24.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	3.42
Bicycle level of service (Exhibit 15-4)	C

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MULTILANE HIGHWAYS WORKSHEET(Direction 2)

General Information

Analyst	David Stoner
Agency or Company	DOWL HKM
Date Performed	4/30/2012
Analysis Time Period	PM Peak

Site Information

Highway/Direction to Travel	US 2
From/To	Columbia Falls to Hungry Horse
Jurisdiction	Flathead County
Analysis Year	2035

Project Description US 2 Badrock Canyon Corridor Planning Study

☐ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	981	Peak-Hour Factor, PHF	0.91
AADT(veh/h)		%Trucks and Buses, P_T	6
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Rolling
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	2.0
E_T	2.5	f_{HV}	0.885

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)	609
Speed, S (mi/h)	60.0
D (pc/mi/ln)	10.1
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	539.0
Effective width, W_v (Eq. 15-29) ft	24.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	3.67
Bicycle level of service (Exhibit 15-4)	D

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2

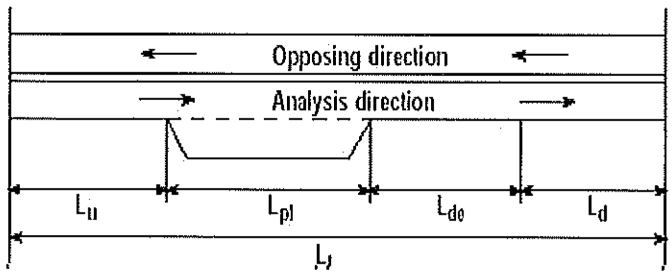
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET WITH PASSING LANE WORKSHEET

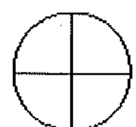
General Information		Site Information	
Analyst	*David Stoner*	Highway of Travel	*US 2*
Agency or Company	*DOWL HKM*	From/To	*Columbia F to Hungry H EB*
Date Performed	*11/15/2011*	Jurisdiction	*Flathead County*
Analysis Time Period	*AM Peak*	Analysis Year	*2035*

Project Description: *US 2 Badrock Canyon Corridor PlafÁ*

Input Data

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





Show North Arrow

Shoulder width (ft)	*1.0*
Lane Width (ft)	*12.0*
Segment Length (mi)	*1.2*
Total length of analysis segment, L_t	*1.2*
Length of two-lane highway upstream of the passing lane, L_u	*0.0*
Length of passing lane including tapers , L_{pl}	*0.6*
Average travel speed, ATS_d (from Directional Two-Lane Highway Segment Worksheet)	*41.8*
Percent time-spent-following, $PTSF_d$ (from Directional Two-Lane Highway Segment Worksheet)	*84.4*
Level of service[1], LOS_d (from Directional Two-Lane Highway Segment Worksheet)	*D*
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 $L_d=L_t-(L_u+L_{pl}+L_{de})$	*-1.10*
Adj. factor for the effect of passing lane on average speed, f_{pl} (Exhibit 15-28)	*1.11*
Average travel speed including passing lane[2], $ATS_{pl} = (ATS_d * L_t) / (L_u+L_d+(L_{pl}/f_{pl})+ (2L_{de}/(1+f_{pl,ATS})))$	*46.0*
Percent free flow speed including passing lane, $PFFS_{pl} = (ATS_{pl}/ FFS)$	*83.5*
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)	*4.64*
Length of two-lane highway downstream of effective length of the passing lane for percent-time-following, $L_d = L_t-(L_u+ L_{pl}+ L_{de})$	*-4.04*
Adj. factor for the effect of passing lane on percent time-spent-following,	

$f_{pl,PTSF}$(Exhibit 15-26)	*0.62*
Percent time-spent-following including passing lane[3], $PTSF_{pl}$(%) $PTSF_{pl}= PTSF_d[L_u+L_d+f_{pl,PTSF}L_{pl}+((1+f_{pl,PTSF})/2)L_{de}]/L_t$	*53.4*
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) $TT_{15}= VMT_{15}/ATS_{pl}$	*5.5*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*850.5*
Effective width, W_v (Eq. 15-29) ft	*13.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*5.94*
Bicycle level of service (Exhibit 15-4)	*F*
Notes	
1. 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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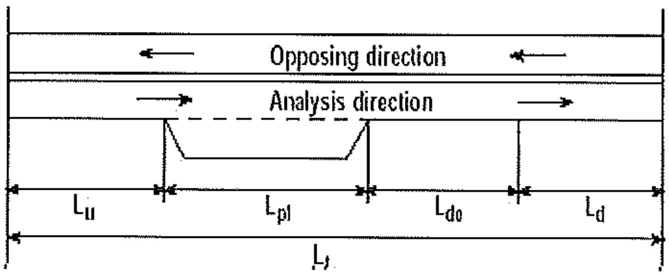
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET WITH PASSING LANE WORKSHEET

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

Project Description: *US 2 Badrock Canyon Corridor PlanÝ*

Input Data

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



Shoulder width (ft)	*1.0*
Lane Width (ft)	*12.0*
Segment Length (mi)	*1.8*
Total length of analysis segment, L_t	*1.8*
Length of two-lane highway upstream of the passing lane, L_u	*0.0*
Length of passing lane including tapers , L_{pl}	*1.1*
Average travel speed, ATS_d (from Directional Two-Lane Highway Segment Worksheet)	*41.8*
Percent time-spent-following, $PTSF_d$ (from Directional Two-Lane Highway Segment Worksheet)	*71.6*
Level of service[1], LOS_d (from Directional Two-Lane Highway Segment Worksheet)	*D*
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 $L_d = L_t - (L_u + L_{pl} + L_{de})$	*-1.00*
Adj. factor for the effect of passing lane on average speed, f_{pl} (Exhibit 15-28)	*1.11*
Average travel speed including passing lane[2], $ATS_{pl} = (ATS_d * L_t) / (L_u + L_d + (L_{pl}/f_{pl}) + (2L_{de}/(1+f_{pl,ATS})))$	*46.0*
Percent free flow speed including passing lane, $PFFS_{pl} = (ATS_{pl} / FFS)$	*83.6*
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)	*6.48*
Length of two-lane highway downstream of effective length of the passing lane for percent-time-following, $L_d = L_t - (L_u + L_{pl} + L_{de})$	*-5.78*
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], $PTSF_{pl}$(%) $PTSF_{pl}= PTSF_d[L_u+L_d+f_{pl,PTSF}L_{pl}+((1+f_{pl,PTSF})/2)L_{de}]/L_t$	44.3
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) $TT_{15}= VMT_{15}/ATS_{pl}$	5.6
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	577.0
Effective width, W_v (Eq. 15-29) ft	13.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	5.74
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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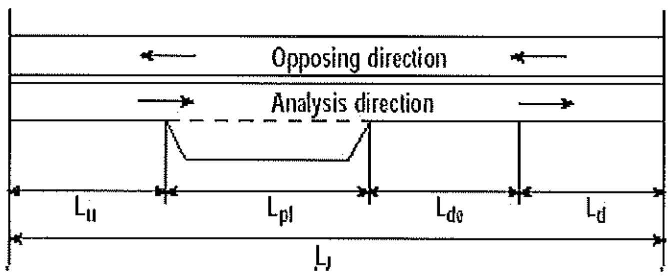
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET WITH PASSING LANE WORKSHEET

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

Project Description: *US 2 Badrock Canyon Corridor PlaW*

Input Data

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



Shoulder width (ft)	*1.0*
Lane Width (ft)	*12.0*
Segment Length (mi)	*1.2*
Total length of analysis segment, L_t	*1.2*
Length of two-lane highway upstream of the passing lane, L_u	*0.0*
Length of passing lane including tapers , L_{pl}	*0.6*
Average travel speed, ATS_d (from Directional Two-Lane Highway Segment Worksheet)	*42.6*
Percent time-spent-following, $PTSF_d$ (from Directional Two-Lane Highway Segment Worksheet)	*81.9*
Level of service[1], LOS_d (from Directional Two-Lane Highway Segment Worksheet)	*D*
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 $L_d=L_t-(L_u+L_{pl}+L_{de})$	*-1.10*
Adj. factor for the effect of passing lane on average speed, f_{pl} (Exhibit 15-28)	*1.11*
Average travel speed including passing lane[2], $ATS_{pl} = (ATS_d * L_t) / (L_u+L_d+(L_{pl}/f_{pl})+(2L_{de}/(1+f_{pl,ATS})))$	*46.9*
Percent free flow speed including passing lane, $PFFS_{pl} = (ATS_{pl}/ FFS)$	*83.6*
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)	*5.18*
Length of two-lane highway downstream of effective length of the passing lane for percent-time-following, $L_d=L_t-(L_u+L_{pl}+L_{de})$	*-4.58*
Adj. factor for the effect of passing lane on percent time-spent-following,	

$f_{pl,PTSF}$(Exhibit 15-26)	0.62
Percent time-spent-following including passing lane[3], $PTSF_{pl}$(%) $PTSF_{pl}= PTSF_d[L_u+L_d+f_{pl,PTSF}L_{pl}+((1+f_{pl,PTSF})/2)L_{de}]/L_t$	51.7
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) $TT_{15}= VMT_{15}/ATS_{pl}$	4.9
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	773.6
Effective width, W_v (Eq. 15-29) ft	13.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	5.89
Bicycle level of service (Exhibit 15-4)	F

Notes

1. 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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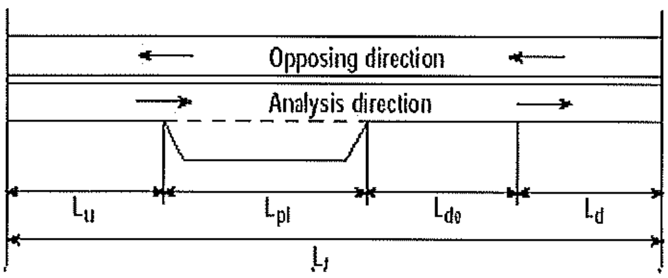
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET WITH PASSING LANE WORKSHEET

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

Project Description: *US 2 Badrock Canyon Corridor Plat*

Input Data

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



Shoulder width (ft)	*1.0*
Lane Width (ft)	*12.0*
Segment Length (mi)	*1.8*
Total length of analysis segment, L_t	*1.8*
Length of two-lane highway upstream of the passing lane, L_u	*0.0*
Length of passing lane including tapers , L_{pl}	*1.1*
Average travel speed, ATS_d (from Directional Two-Lane Highway Segment Worksheet)	*42.7*
Percent time-spent-following, $PTSF_d$ (from Directional Two-Lane Highway Segment Worksheet)	*77.2*
Level of service[1], LOS_d (from Directional Two-Lane Highway Segment Worksheet)	*D*
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 $L_d=L_t-(L_u+L_{pl}+L_{de})$	*-1.00*
Adj. factor for the effect of passing lane on average speed, f_{pl} (Exhibit 15-28)	*1.11*
Average travel speed including passing lane[2], $ATS_{pl} = (ATS_d * L_t) / (L_u+L_d+(L_{pl}/f_{pl})+ (2L_{de}/(1+f_{pl,ATS})))$	*47.1*
Percent free flow speed including passing lane, $PFFS_{pl} = (ATS_{pl}/ FFS)$	*84.0*
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)	*5.79*
Length of two-lane highway downstream of effective length of the passing lane for percent-time-following, $L_d = L_t-(L_u+ L_{pl}+ L_{de})$	*-5.09*
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], $PTSF_{pl}$(%) $PTSF_{pl}= PTSF_d[L_u+L_d+f_{pl,PTSF}L_{pl}+((1+f_{pl,PTSF})/2)L_{de}]/L_t$	47.8
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) $TT_{15}= VMT_{15}/ATS_{pl}$	6.5
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	682.2
Effective width, W_v (Eq. 15-29) ft	13.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	5.83
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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2

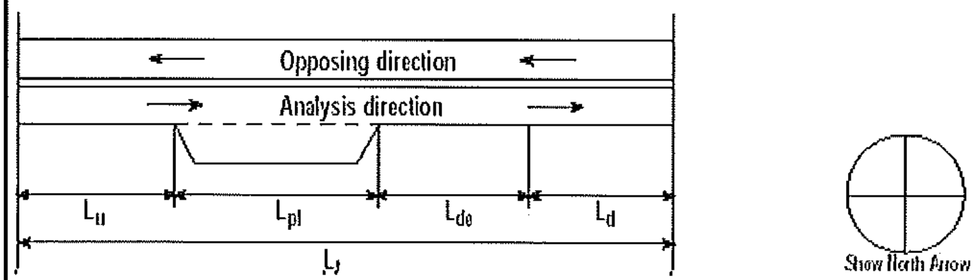
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET WITH PASSING LANE WORKSHEET

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

Project Description: US 2 Badrock Canyon Corridor Pla/

Input Data

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



Shoulder width (ft)	1.0
Lane Width (ft)	12.0
Segment Length (mi)	1.2
Total length of analysis segment, L_t	1.2
Length of two-lane highway upstream of the passing lane, L_u	0.0
Length of passing lane including tapers , L_{pl}	0.6
Average travel speed, ATS_d (from Directional Two-Lane Highway Segment Worksheet)	41.8
Percent time-spent-following, $PTSF_d$ (from Directional Two-Lane Highway Segment Worksheet)	75.4
Level of service[1], LOS_d (from Directional Two-Lane Highway Segment Worksheet)	D
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 $L_d=L_t-(L_u+L_{pl}+L_{de})$	-1.10
Adj. factor for the effect of passing lane on average speed, f_{pl} (Exhibit 15-28)	1.11
Average travel speed including passing lane[2], $ATS_{pl} = (ATS_d{}^* L_t) / (L_u+L_d+(L_{pl}/f_{pl})+ (2L_{de}/(1+f_{pl,ATS})))$	46.0
Percent free flow speed including passing lane, $PFFS_{pl} = (ATS_{pl}/ FFS)$	80.6
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)	5.92
Length of two-lane highway downstream of effective length of the passing lane for percent-time-following, $L_d=L_t-(L_u+L_{pl}+L_{de})$	-5.32
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], $PTSF_{pl}$(%) $PTSF_{pl}= PTSF_d[L_u+L_d+f_{pl,PTSF}L_{pl}+((1+f_{pl,PTSF})/2)L_{de}]/L_t$	46.7
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) $TT_{15}= VMT_{15}/ATS_{pl}$	4.3
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	658.4
Effective width, W_v (Eq. 15-29) ft	13.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	5.81
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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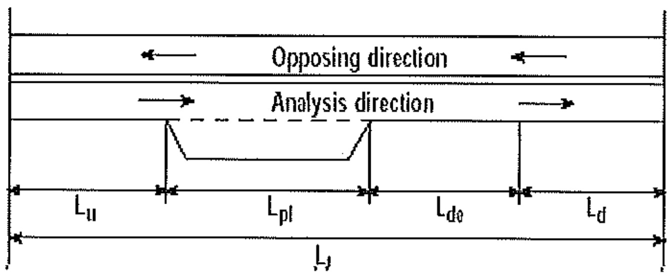
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET WITH PASSING LANE WORKSHEET

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

Project Description: US 2 Badrock Canyon Corridor Pla±PB

Input Data

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



Shoulder width (ft)	1.0
Lane Width (ft)	12.0
Segment Length (mi)	1.8
Total length of analysis segment, L_t	1.8
Length of two-lane highway upstream of the passing lane, L_u	0.0
Length of passing lane including tapers , L_{pl}	1.1
Average travel speed, ATS_d (from Directional Two-Lane Highway Segment Worksheet)	39.4
Percent time-spent-following, $PTSF_d$ (from Directional Two-Lane Highway Segment Worksheet)	89.4
Level of service[1], LOS_d (from Directional Two-Lane Highway Segment Worksheet)	E
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 $L_d=L_t-(L_u+L_{pl}+L_{de})$	-1.00
Adj. factor for the effect of passing lane on average speed, f_{pl} (Exhibit 15-28)	1.11
Average travel speed including passing lane[2], $ATS_{pl} = (ATS_d * L_t) / (L_u+L_d+(L_{pl}/f_{pl})+ (2L_{de}/(1+f_{pl,ATS})))$	43.4
Percent free flow speed including passing lane, $PFFS_{pl} = (ATS_{pl}/ FFS)$	78.9
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)	3.60
Length of two-lane highway downstream of effective length of the passing lane for percent-time-following, $L_d=L_t-(L_u+L_{pl}+L_{de})$	-2.90
Adj. factor for the effect of passing lane on percent time-spent-following,	

$f_{pl,PTSF}$(Exhibit 15-26)	0.62
Percent time-spent-following including passing lane[3], $PTSF_{pl}$(%) $PTSF_{pl} = PTSF_d[L_u + L_d + f_{pl,PTSF} L_{pl} + ((1+f_{pl,PTSF})/2)L_{de}]/L_t$	56.7
Level of Service and Other Performance Measures[4]	
Level of service including passing lane LOS_{pl} (Exhibit 15-3)	C
Peak 15-min total travel time, TT_{15}(veh-h) $TT_{15} = VMT_{15}/ATS_{pl}$	11.2
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	1078.0
Effective width, W_v (Eq. 15-29) ft	13.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	6.06
Bicycle level of service (Exhibit 15-4)	F

Notes

1. 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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Appendix 4

Operational
Analysis Worksheets

2035 4-2-4 Adjusted Annual Average
Four-Lane RP 140.0 – RP 140.6
Two-Lane RP 140.6 – RP 141.2
Four-Lane RP 141.2 – 142.4

Direction 1 = Eastbound
Direction 2 = Westbound

MULTILANE HIGHWAYS WORKSHEET(Direction 1)

[X]

General Information

Analyst	David Stoner
Agency or Company	DOWL HKM
Date Performed	4/30/2012
Analysis Time Period	AM Peak

Site Information

Highway/Direction to Travel	US 2
From/To	Columbia Falls to Hungry Horse
Jurisdiction	Flathead County
Analysis Year	2035

Project Description US 2 Badrock Canyon Corridor Planning Study

☐ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	398	Peak-Hour Factor, PHF	0.93
AADT(veh/h)		%Trucks and Buses, P_T	6
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Rolling
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	2.0
E_T	2.5	f_{HV}	0.885

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)	241
Speed, S (mi/h)	60.0
D (pc/mi/ln)	4.0
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	214.0
Effective width, W_v (Eq. 15-29) ft	24.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	3.21
Bicycle level of service (Exhibit 15-4)	C

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MULTILANE HIGHWAYS WORKSHEET(Direction 2)

General Information

Analyst	David Stoner
Agency or Company	DOWL HKM
Date Performed	4/30/2012
Analysis Time Period	AM Peak

Site Information

Highway/Direction to Travel	US 2
From/To	Columbia Falls to Hungry Horse
Jurisdiction	Flathead County
Analysis Year	2035

Project Description US 2 Badrock Canyon Corridor Planning Study

☐ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	250	Peak-Hour Factor, PHF	0.87
AADT(veh/h)		%Trucks and Buses, P_T	6
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Rolling
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	2.0
E_T	2.5	f_{HV}	0.885

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	143.7
Effective width, W_v (Eq. 15-29) ft	24.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	3.00
Bicycle level of service (Exhibit 15-4)	C

MULTILANE HIGHWAYS WORKSHEET(Direction 1)

General Information

Analyst	David Stoner
Agency or Company	DOWL HKM
Date Performed	4/30/2012
Analysis Time Period	Median Off-Peak

Site Information

Highway/Direction to Travel	US 2
From/To	Columbia Falls to Hungry Horse
Jurisdiction	Flathead County
Analysis Year	2035

Project Description US 2 Badrock Canyon Corridor Planning Study

☐ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	351	Peak-Hour Factor, PHF	0.91
AADT(veh/h)		%Trucks and Buses, P_T	6
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Rolling
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	2.0
E_T	2.5	f_{HV}	0.885

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)	61.0
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)	61.0

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	217
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	192.9
Effective width, W_v (Eq. 15-29) ft	24.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	3.15
Bicycle level of service (Exhibit 15-4)	C

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MULTILANE HIGHWAYS WORKSHEET(Direction 2)

General Information

Analyst	David Stoner
Agency or Company	DOWL HKM
Date Performed	4/30/2012
Analysis Time Period	Median Off-Peak

Site Information

Highway/Direction to Travel	US 2
From/To	Columbia Falls to Hungry Horse
Jurisdiction	Flathead County
Analysis Year	2035

Project Description US 2 Badrock Canyon Corridor Planning Study

☐ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	306	Peak-Hour Factor, PHF	0.89
AADT(veh/h)		%Trucks and Buses, P_T	6
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Rolling
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	2.0
E_T	2.5	f_{HV}	0.885

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)	61.0
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)	61.0

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	194
Speed, S (mi/h)	60.0
D (pc/mi/ln)	3.2
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	171.9
Effective width, W_v (Eq. 15-29) ft	24.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	3.09
Bicycle level of service (Exhibit 15-4)	C

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MULTILANE HIGHWAYS WORKSHEET(Direction 1)

General Information

Analyst	David Stoner
Agency or Company	DOWL HKM
Date Performed	4/30/2012
Analysis Time Period	PM Peak

Site Information

Highway/Direction to Travel	US 2
From/To	Columbia Falls to Hungry Horse
Jurisdiction	Flathead County
Analysis Year	2035

Project Description US 2 Badrock Canyon Corridor Planning Study

☐ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	296	Peak-Hour Factor, PHF	0.89
AADT(veh/h)		%Trucks and Buses, P_T	6
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Rolling
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	2.0
E_T	2.5	f_{HV}	0.885

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)	62.0
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)	62.0

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	187
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	166.3
Effective width, W_v (Eq. 15-29) ft	24.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	3.08
Bicycle level of service (Exhibit 15-4)	C

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MULTILANE HIGHWAYS WORKSHEET(Direction 2)

General Information

Analyst	David Stoner
Agency or Company	DOWL HKM
Date Performed	4/30/2012
Analysis Time Period	PM Peak

Site Information

Highway/Direction to Travel	US 2
From/To	Columbia Falls to Hungry Horse
Jurisdiction	Flathead County
Analysis Year	2035

Project Description US 2 Badrock Canyon Corridor Planning Study

☐ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	491	Peak-Hour Factor, PHF	0.91
AADT(veh/h)		%Trucks and Buses, P_T	6
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Rolling
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	2.0
E_T	2.5	f_{HV}	0.885

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)	304
Speed, S (mi/h)	60.0
D (pc/mi/ln)	5.1
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	269.8
Effective width, W_v (Eq. 15-29) ft	24.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	3.32
Bicycle level of service (Exhibit 15-4)	C

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2

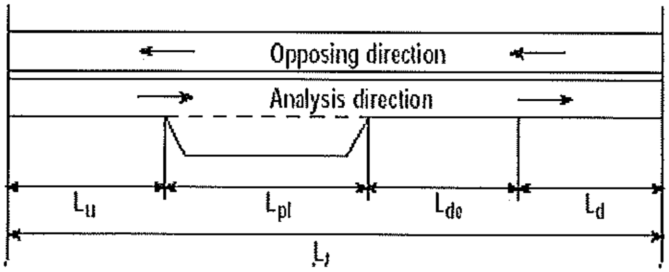
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET WITH PASSING LANE WORKSHEET

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

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

Input Data

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



Shoulder width (ft)	1.0
Lane Width (ft)	12.0
Segment Length (mi)	1.2
Total length of analysis segment, L_t	1.2
Length of two-lane highway upstream of the passing lane, L_u	0.0
Length of passing lane including tapers , L_{pl}	0.6
Average travel speed, ATS_d (from Directional Two-Lane Highway Segment Worksheet)	45.3
Percent time-spent-following, $PTSF_d$ (from Directional Two-Lane Highway Segment Worksheet)	69.8
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 $L_d=L_t-(L_u+L_{pl}+L_{de})$	-1.10
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], $ATS_{pl} = (ATS_d * L_t) / (L_u+L_d+(L_{pl}/f_{pl})+ (2L_{de}/(1+f_{pl,ATS})))$	49.5
Percent free flow speed including passing lane, $PFFS_{pl} = (ATS_{pl}/ FFS)$	89.8
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)	7.49
Length of two-lane highway downstream of effective length of the passing lane for percent-time-following, $L_d =L_t-(L_u+ L_{pl}+ L_{de})$	-6.89
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], $PTSF_{pl}$(%) $PTSF_{pl}= PTSF_d[L_u+L_d+f_{pl,PTSF}L_{pl}+((1+f_{pl,PTSF})/2)L_{de}]/L_t$	43.1
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) $TT_{15}= VMT_{15}/ATS_{pl}$	2.6
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	428.0
Effective width, W_v (Eq. 15-29) ft	13.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	5.59
Bicycle level of service (Exhibit 15-4)	F
Notes	
1. 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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2

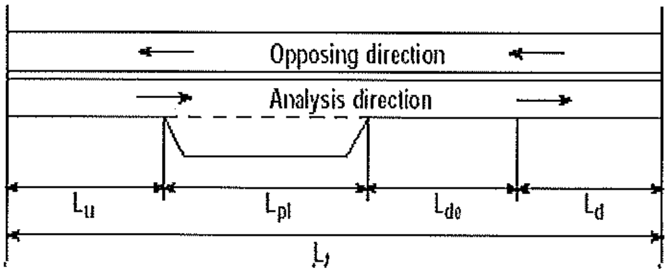
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET WITH PASSING LANE WORKSHEET

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

Project Description: US 2 Badrock Canyon Corridor Plan

Input Data

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



Shoulder width (ft)	1.0
Lane Width (ft)	12.0
Segment Length (mi)	1.8
Total length of analysis segment, L_t	1.8
Length of two-lane highway upstream of the passing lane, L_u	0.0
Length of passing lane including tapers , L_{pl}	1.1
Average travel speed, ATS_d (from Directional Two-Lane Highway Segment Worksheet)	45.8
Percent time-spent-following, $PTSF_d$ (from Directional Two-Lane Highway Segment Worksheet)	57.8
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 $L_d=L_t-(L_u+L_{pl}+L_{de})$	-1.00
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], $ATS_{pl} = (ATS_d * L_t) / (L_u+L_d+(L_{pl}/f_{pl})+ (2L_{de}/(1+f_{pl,ATS})))$	50.0
Percent free flow speed including passing lane, $PFFS_{pl} = (ATS_{pl}/ FFS)$	90.9
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)	9.64
Length of two-lane highway downstream of effective length of the passing lane for percent-time-following, $L_d = L_t-(L_u+ L_{pl}+ L_{de})$	-8.94
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], $PTSF_{pl}$(%) $PTSF_{pl}= PTSF_d[L_u+L_d+f_{pl,PTSF}L_{pl}+((1+f_{pl,PTSF})/2)L_{de}]/L_t$	35.0
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) $TT_{15}= VMT_{15}/ATS_{pl}$	2.6
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	287.4
Effective width, W_v (Eq. 15-29) ft	13.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	5.39
Bicycle level of service (Exhibit 15-4)	E
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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2

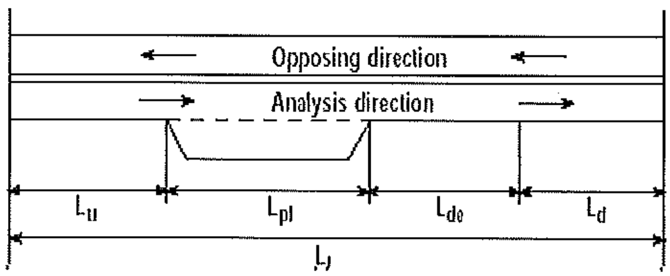
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET WITH PASSING LANE WORKSHEET

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

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

Input Data

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



Shoulder width (ft)	*1.0*
Lane Width (ft)	*12.0*
Segment Length (mi)	*1.2*
Total length of analysis segment, L_t	*1.2*
Length of two-lane highway upstream of the passing lane, L_u	*0.0*
Length of passing lane including tapers , L_{pl}	*0.6*
Average travel speed, ATS_d (from Directional Two-Lane Highway Segment Worksheet)	*46.3*
Percent time-spent-following, $PTSF_d$ (from Directional Two-Lane Highway Segment Worksheet)	*69.1*
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 $L_d=L_t-(L_u+L_{pl}+L_{de})$	*-1.10*
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], $ATS_{pl} = (ATS_d * L_t) / (L_u+L_d+(L_{pl}/f_{pl})+(2L_{de}/(1+f_{pl,ATS})))$	*50.5*
Percent free flow speed including passing lane, $PFFS_{pl} = (ATS_{pl}/FFS)$	*90.1*
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)	*7.71*
Length of two-lane highway downstream of effective length of the passing lane for percent-time-following, $L_d=L_t-(L_u+L_{pl}+L_{de})$	*-7.11*
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], $PTSF_{pl}$(%) $PTSF_{pl}= PTSF_d[L_u+L_d+f_{pl,PTSF}L_{pl}+((1+f_{pl,PTSF})/2)L_{de}]/L_t$	42.7
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) $TT_{15}= VMT_{15}/ATS_{pl}$	2.3
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	385.7
Effective width, W_v (Eq. 15-29) ft	13.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	5.54
Bicycle level of service (Exhibit 15-4)	F
Notes	

1. 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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2

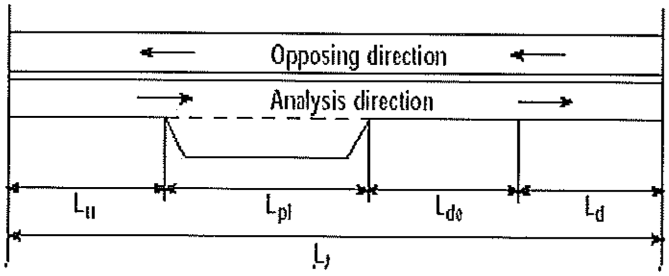
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET WITH PASSING LANE WORKSHEET

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

Project Description: *US 2 Badrock Canyon Corridor Pla¼¼¥B*

Input Data

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



Shoulder width (ft)	*1.0*
Lane Width (ft)	*12.0*
Segment Length (mi)	*1.8*
Total length of analysis segment, L_t	*1.8*
Length of two-lane highway upstream of the passing lane, L_u	*0.0*
Length of passing lane including tapers , L_{pl}	*1.1*
Average travel speed, ATS_d (from Directional Two-Lane Highway Segment Worksheet)	*46.4*
Percent time-spent-following, $PTSF_d$ (from Directional Two-Lane Highway Segment Worksheet)	*65.1*
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 $L_d=L_t-(L_u+L_{pl}+L_{de})$	*-1.00*
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], $ATS_{pl} = (ATS_d * L_t) / (L_u+L_d+(L_{pl}/f_{pl})+ (2L_{de}/(1+f_{pl,ATS})))$	*50.7*
Percent free flow speed including passing lane, $PFFS_{pl} = (ATS_{pl}/ FFS)$	*90.5*
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)	*8.03*
Length of two-lane highway downstream of effective length of the passing lane for percent-time-following, $L_d =L_t-(L_u+ L_{pl}+ L_{de})$	*-7.33*
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], $PTSF_{pl}$(%) $PTSF_{pl}= PTSF_d[L_u+L_d+f_{pl,PTSF}L_{pl}+((1+f_{pl,PTSF})/2)L_{de}]/L_t$	*40.1*
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) $TT_{15}= VMT_{15}/ATS_{pl}$	*3.1*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*343.8*
Effective width, W_v (Eq. 15-29) ft	*13.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*5.48*
Bicycle level of service (Exhibit 15-4)	*E*
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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2

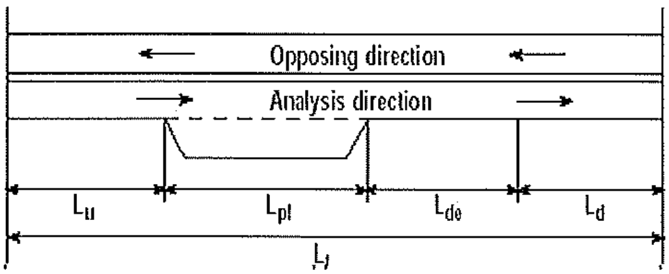
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET WITH PASSING LANE WORKSHEET

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

Project Description: US 2 Badrock Canyon Corridor PlaÝ{¥B

Input Data

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



Shoulder width (ft)	1.0
Lane Width (ft)	12.0
Segment Length (mi)	1.2
Total length of analysis segment, L_t	1.2
Length of two-lane highway upstream of the passing lane, L_u	0.0
Length of passing lane including tapers , L_{pl}	0.6
Average travel speed, ATS_d (from Directional Two-Lane Highway Segment Worksheet)	47.2
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 $L_d=L_t-(L_u+L_{pl}+L_{de})$	-1.10
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], $ATS_{pl} = (ATS_d * L_t) / (L_u+L_d+(L_{pl}/f_{pl})+ (2L_{de}/(1+f_{pl,ATS})))$	51.5
Percent free flow speed including passing lane, $PFFS_{pl} = (ATS_{pl}/ FFS)$	90.3
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)	8.24
Length of two-lane highway downstream of effective length of the passing lane for percent-time-following, $L_d = L_t-(L_u+L_{pl}+L_{de})$	-7.64
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], $PTSF_{pl}$(%) $PTSF_{pl}= PTSF_d[L_u+L_d+f_{pl,PTSF}L_{pl}+((1+f_{pl,PTSF})/2)L_{de}]/L_t$	*36.4*
***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) $TT_{15}= VMT_{15}/ATS_{pl}$	*1.9*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*332.6*
Effective width, W_v (Eq. 15-29) ft	*13.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*5.46*
Bicycle level of service (Exhibit 15-4)	*E*
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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2

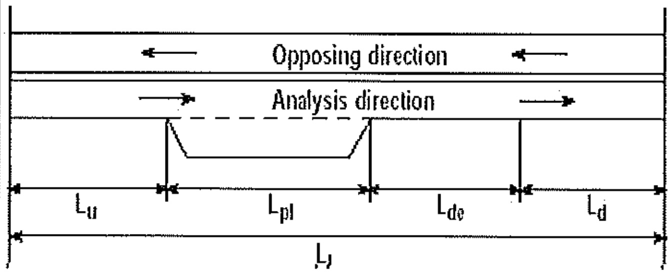
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET WITH PASSING LANE WORKSHEET

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

Project Description: US 2 Badrock Canyon Corridor Plac¾¡B

Input Data

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



Shoulder width (ft)	1.0
Lane Width (ft)	12.0
Segment Length (mi)	1.8
Total length of analysis segment, L_t	1.8
Length of two-lane highway upstream of the passing lane, L_u	0.0
Length of passing lane including tapers , L_{pl}	1.1
Average travel speed, ATS_d (from Directional Two-Lane Highway Segment Worksheet)	44.5
Percent time-spent-following, $PTSF_d$ (from Directional Two-Lane Highway Segment Worksheet)	75.5
Level of service[1], LOS_d (from Directional Two-Lane Highway Segment Worksheet)	D
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 $L_d=L_t-(L_u+L_{pl}+L_{de})$	-1.00
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], $ATS_{pl} = (ATS_d * L_t) / (L_u+L_d+(L_{pl}/f_{pl})+ (2L_{de}/(1+f_{pl,ATS})))$	48.6
Percent free flow speed including passing lane, $PFFS_{pl} = (ATS_{pl}/ FFS)$	88.3
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)	6.75
Length of two-lane highway downstream of effective length of the passing lane for percent-time-following, $L_d = L_t-(L_u+ L_{pl}+ L_{de})$	-6.05
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], $PTSF_{pl}$(%) $PTSF_{pl}= PTSF_d[L_u+L_d+f_{pl,PTSF}L_{pl}+((1+f_{pl,PTSF})/2)L_{de}]/L_t$	*46.6*
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) $TT_{15}= VMT_{15}/ATS_{pl}$	*5.0*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*539.6*
Effective width, W_v (Eq. 15-29) ft	*13.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*5.71*
Bicycle level of service (Exhibit 15-4)	*F*
Notes	
1. 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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Appendix 4

Operational Analysis Worksheets

2035 4-3-4 Peak Season
Four-Lane RP 140.0 – RP 140.6
Three-Lane RP 140.6 – RP 141.2
Four-Lane RP 141.2 – 142.4

Direction 1 = Eastbound
Direction 2 = Westbound

MULTILANE HIGHWAYS WORKSHEET(Direction 1)

[X]

General Information

Analyst	David Stoner
Agency or Company	DOWL HKM
Date Performed	4/30/2012
Analysis Time Period	AM Peak

Site Information

Highway/Direction to Travel	US 2
From/To	Columbia Falls to Hungry Horse
Jurisdiction	Flathead County
Analysis Year	2035

Project Description US 2 Badrock Canyon Corridor Planning Study

☐ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	791	Peak-Hour Factor, PHF	0.93
AADT(veh/h)		%Trucks and Buses, P_T	6
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Rolling
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	2.0
E_T	2.5	f_{HV}	0.885

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)	480
Speed, S (mi/h)	60.0
D (pc/mi/ln)	8.0
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	425.3
Effective width, W_v (Eq. 15-29) ft	24.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	3.55
Bicycle level of service (Exhibit 15-4)	D

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MULTILANE HIGHWAYS WORKSHEET(Direction 2)

[X]

General Information

Analyst	David Stoner
Agency or Company	DOWL HKM
Date Performed	4/30/2012
Analysis Time Period	AM Peak

Site Information

Highway/Direction to Travel	US 2
From/To	Columbia Falls to Hungry Horse
Jurisdiction	Flathead County
Analysis Year	2035

Project Description US 2 Badrock Canyon Corridor Planning Study

☐ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	502	Peak-Hour Factor, PHF	0.87
AADT(veh/h)		%Trucks and Buses, P_T	6
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Rolling
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	2.0
E_T	2.5	f_{HV}	0.885

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)	326
Speed, S (mi/h)	60.0
D (pc/mi/ln)	5.4
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	288.5
Effective width, W_v (Eq. 15-29) ft	24.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	3.36
Bicycle level of service (Exhibit 15-4)	C

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MULTILANE HIGHWAYS WORKSHEET(Direction 1)

General Information

Analyst	David Stoner
Agency or Company	DOWL HKM
Date Performed	4/30/2012
Analysis Time Period	Median Off Peak Peak

Site Information

Highway/Direction to Travel	US 2
From/To	Columbia Falls to Hungry Horse
Jurisdiction	Flathead County
Analysis Year	2035

Project Description US 2 Badrock Canyon Corridor Planning Study

☐ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	704	Peak-Hour Factor, PHF	0.91
AADT(veh/h)		%Trucks and Buses, P_T	6
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Rolling
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	2.0
E_T	2.5	f_{HV}	0.885

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)	61.0
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)	61.0

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	437
Speed, S (mi/h)	60.0
D (pc/mi/ln)	7.3
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	*386.8*
Effective width, W_v (Eq. 15-29) ft	*24.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*3.51*
Bicycle level of service (Exhibit 15-4)	*D*

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MULTILANE HIGHWAYS WORKSHEET(Direction 2)

[x]

General Information

Analyst	David Stoner
Agency or Company	DOWL HKM
Date Performed	4/30/2012
Analysis Time Period	Median Off Peak Peak

Site Information

Highway/Direction to Travel	US 2
From/To	Columbia Falls to Hungry Horse
Jurisdiction	Flathead County
Analysis Year	2035

Project Description US 2 Badrock Canyon Corridor Planning Study

☐ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	614	Peak-Hour Factor, PHF	0.89
AADT(veh/h)		%Trucks and Buses, P_T	6
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Rolling
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	2.0
E_T	2.5	f_{HV}	0.885

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)	61.0
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)	61.0

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	389
Speed, S (mi/h)	60.0
D (pc/mi/ln)	6.5
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	344.9
Effective width, W_v (Eq. 15-29) ft	24.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	3.45
Bicycle level of service (Exhibit 15-4)	C

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MULTILANE HIGHWAYS WORKSHEET(Direction 1)

[x]

General Information

Analyst	David Stoner
Agency or Company	DOWL HKM
Date Performed	4/30/2012
Analysis Time Period	PM Peak

Site Information

Highway/Direction to Travel	US 2
From/To	Columbia Falls to Hungry Horse
Jurisdiction	Flathead County
Analysis Year	2035

Project Description US 2 Badrock Canyon Corridor Planning Study

☐ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	586	Peak-Hour Factor, PHF	0.89
AADT(veh/h)		%Trucks and Buses, P_T	6
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Rolling
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	2.0
E_T	2.5	f_{HV}	0.885

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)	62.0
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)	62.0

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	372
Speed, S (mi/h)	60.0
D (pc/mi/ln)	6.2
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	329.2
Effective width, W_v (Eq. 15-29) ft	24.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	3.42
Bicycle level of service (Exhibit 15-4)	C

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MULTILANE HIGHWAYS WORKSHEET(Direction 2)

General Information

Analyst	David Stoner
Agency or Company	DOWL HKM
Date Performed	4/30/2012
Analysis Time Period	PM Peak

Site Information

Highway/Direction to Travel	US 2
From/To	Columbia Falls to Hungry Horse
Jurisdiction	Flathead County
Analysis Year	2035

Project Description US 2 Badrock Canyon Corridor Planning Study

☐ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	981	Peak-Hour Factor, PHF	0.91
AADT(veh/h)		%Trucks and Buses, P_T	6
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Rolling
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	2.0
E_T	2.5	f_{HV}	0.885

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)	609
Speed, S (mi/h)	60.0
D (pc/mi/ln)	10.1
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	539.0
Effective width, W_v (Eq. 15-29) ft	24.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	3.67
Bicycle level of service (Exhibit 15-4)	D

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2

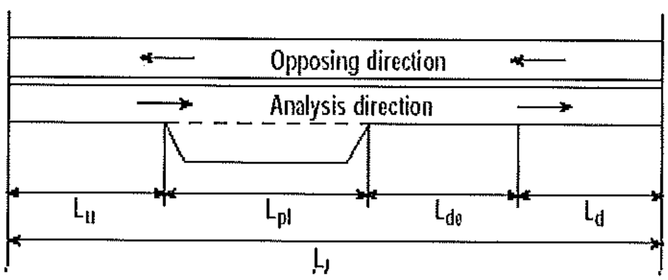
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET WITH PASSING LANE WORKSHEET

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

Project Description: US 2 Badrock Canyon Corridor Pla=â

Input Data

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



Shoulder width (ft)	1.0
Lane Width (ft)	12.0
Segment Length (mi)	1.2
Total length of analysis segment, L_t	1.2
Length of two-lane highway upstream of the passing lane, L_u	0.0
Length of passing lane including tapers , L_{pl}	0.6
Average travel speed, ATS_d (from Directional Two-Lane Highway Segment Worksheet)	41.8
Percent time-spent-following, $PTSF_d$ (from Directional Two-Lane Highway Segment Worksheet)	84.6
Level of service[1], LOS_d (from Directional Two-Lane Highway Segment Worksheet)	D
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 $L_d=L_t-(L_u+L_{pl}+L_{de})$	-1.10
Adj. factor for the effect of passing lane on average speed, f_{pl} (Exhibit 15-28)	1.11
Average travel speed including passing lane[2], $ATS_{pl} = (ATS_d * L_t) / (L_u+L_d+(L_{pl}/f_{pl})+ (2L_{de}/(1+f_{pl,ATS})))$	46.0
Percent free flow speed including passing lane, $PFFS_{pl} = (ATS_{pl}/ FFS)$	83.6
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)	4.64
Length of two-lane highway downstream of effective length of the passing lane for percent-time-following, $L_d =L_t-(L_u+ L_{pl}+ L_{de})$	-4.04
Adj. factor for the effect of passing lane on percent time-spent-following,	

$f_{pl,PTSF}$(Exhibit 15-26)	0.62
Percent time-spent-following including passing lane[3], $PTSF_{pl}$(%) $PTSF_{pl}= PTSF_d[L_u+L_d+f_{pl,PTSF}L_{pl}+((1+f_{pl,PTSF})/2)L_{de}]/L_t$	53.5
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) $TT_{15}= VMT_{15}/ATS_{pl}$	5.5
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	850.5
Effective width, W_v (Eq. 15-29) ft	13.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	5.94
Bicycle level of service (Exhibit 15-4)	F
Notes	
1. 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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2

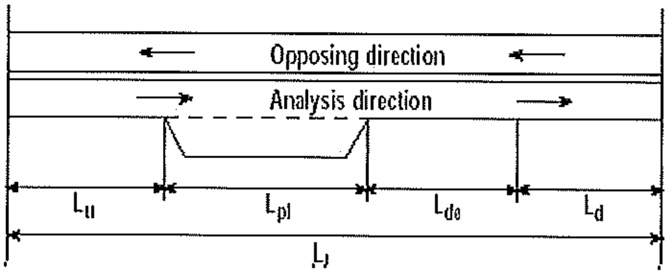
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET WITH PASSING LANE WORKSHEET

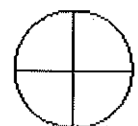
General Information		Site Information	
Analyst	*David Stoner*	Highway of Travel	*US 2*
Agency or Company	*DOWL HKM*	From/To	*Columbia F to Hungry H WB*
Date Performed	*11/15/2011*	Jurisdiction	*Flathead County*
Analysis Time Period	*AM Peak*	Analysis Year	*2035*

Project Description: *US 2 Badrock Canyon Corridor Pla 4*

Input Data

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





Show North Arrow

Shoulder width (ft)	*1.0*
Lane Width (ft)	*12.0*
Segment Length (mi)	*1.8*
Total length of analysis segment, L_t	*1.8*
Length of two-lane highway upstream of the passing lane, L_u	*0.0*
Length of passing lane including tapers , L_{pl}	*1.1*
Average travel speed, ATS_d (from Directional Two-Lane Highway Segment Worksheet)	*41.9*
Percent time-spent-following, $PTSF_d$ (from Directional Two-Lane Highway Segment Worksheet)	*70.5*
Level of service[1], LOS_d (from Directional Two-Lane Highway Segment Worksheet)	*D*
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 $L_d = L_t - (L_u + L_{pl} + L_{de})$	*-1.00*
Adj. factor for the effect of passing lane on average speed, f_{pl} (Exhibit 15-28)	*1.11*
Average travel speed including passing lane[2], $ATS_{pl} = (ATS_d * L_t) / (L_u + L_d + (L_{pl}/f_{pl}) + (2L_{de}/(1+f_{pl,ATS})))$	*46.1*
Percent free flow speed including passing lane, $PFFS_{pl} = (ATS_{pl}/ FFS)$	*83.8*
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)	*6.63*
Length of two-lane highway downstream of effective length of the passing lane for percent-time-following, $L_d = L_t - (L_u + L_{pl} + L_{de})$	*-5.93*
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], $PTSF_{pl}$(%) $PTSF_{pl}= PTSF_d[L_u+L_d+f_{pl,PTSF}L_{pl}+((1+f_{pl,PTSF})/2)L_{de}]/L_t$	43.6
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) $TT_{15}= VMT_{15}/ATS_{pl}$	5.5
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	559.8
Effective width, W_v (Eq. 15-29) ft	13.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	5.73
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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2

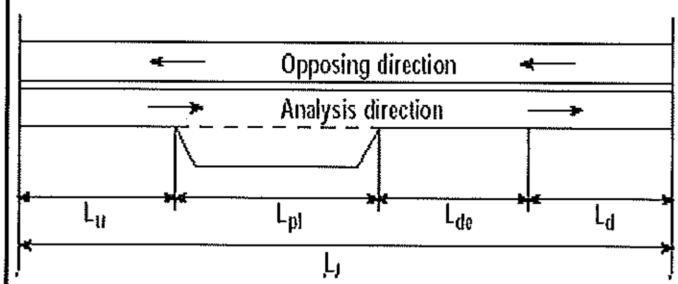
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET WITH PASSING LANE WORKSHEET

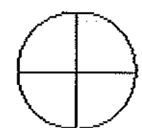
General Information		*Site Information*	
Analyst	*David Stoner*	Highway of Travel	*US 2*
Agency or Company	*DOWL HKM*	From/To	*Columbia F to Hungry H EB*
Date Performed	*11/15/2011*	Jurisdiction	*Flathead County*
Analysis Time Period	*Median Off-Peak*	Analysis Year	*2035*

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

Input Data

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





Show North Arrow

Shoulder width (ft)	*1.0*
Lane Width (ft)	*12.0*
Segment Length (mi)	*1.2*
Total length of analysis segment, L_t	*1.2*
Length of two-lane highway upstream of the passing lane, L_u	*0.0*
Length of passing lane including tapers , L_{pl}	*0.6*
Average travel speed, ATS_d (from Directional Two-Lane Highway Segment Worksheet)	*42.7*
Percent time-spent-following, $PTSF_d$ (from Directional Two-Lane Highway Segment Worksheet)	*81.6*
Level of service[1], LOS_d (from Directional Two-Lane Highway Segment Worksheet)	*D*
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})	*-1.10*
Adj. factor for the effect of passing lane on average speed, f_{pl} (Exhibit 15-28)	*1.11*
Average travel speed including passing lane[2], $ATS_{pl} = (ATS_d * L_t) / (L_u+L_d+(L_{pl}/f_{pl})+ (2L_{de}/(1+f_{pl,ATS})))$	*47.0*
Percent free flow speed including passing lane, $PFFS_{pl} = (ATS_{pl}/ FFS)$	*83.8*
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)	*5.18*
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})	*-4.58*
Adj. factor for the effect of passing lane on percent time-spent-following,	

$f_{pl,PTSF}$(Exhibit 15-26)	0.62
Percent time-spent-following including passing lane[3], $PTSF_{pl}$(%) $PTSF_{pl}= PTSF_d[L_u+L_d+f_{pl,PTSF}L_{pl}+((1+f_{pl,PTSF})/2)L_{de}]/L_t$	51.5
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) $TT_{15}= VMT_{15}/ATS_{pl}$	4.9
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	773.6
Effective width, W_v (Eq. 15-29) ft	13.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	5.89
Bicycle level of service (Exhibit 15-4)	F
Notes	
1. 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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2

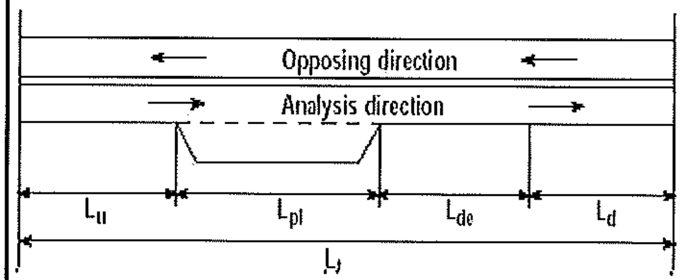
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET WITH PASSING LANE WORKSHEET

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

Project Description: US 2 Badrock Canyon Corridor Plag$

Input Data

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



Shoulder width (ft)	1.0
Lane Width (ft)	12.0
Segment Length (mi)	1.8
Total length of analysis segment, L_t	1.8
Length of two-lane highway upstream of the passing lane, L_u	0.0
Length of passing lane including tapers , L_{pl}	1.1
Average travel speed, ATS_d (from Directional Two-Lane Highway Segment Worksheet)	42.9
Percent time-spent-following, $PTSF_d$ (from Directional Two-Lane Highway Segment Worksheet)	76.6
Level of service[1], LOS_d (from Directional Two-Lane Highway Segment Worksheet)	D
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 $L_d = L_t - (L_u + L_{pl} + L_{de})$	-1.00
Adj. factor for the effect of passing lane on average speed, f_{pl} (Exhibit 15-28)	1.11
Average travel speed including passing lane[2], $ATS_{pl} = (ATS_d * L_t) / (L_u + L_d + (L_{pl}/f_{pl}) + (2L_{de}/(1+f_{pl,ATS})))$	47.3
Percent free flow speed including passing lane, $PFFS_{pl} = (ATS_{pl} / FFS)$	84.3
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)	5.89
Length of two-lane highway downstream of effective length of the passing lane for percent-time-following, $L_d = L_t - (L_u + L_{pl} + L_{de})$	-5.19
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], $PTSF_{pl}$(%) $PTSF_{pl} = PTSF_d[L_u + L_d + f_{pl,PTSF} L_{pl} + ((1+f_{pl,PTSF})/2)L_{de}]/L_t$	47.4
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) $TT_{15} = VMT_{15}/ATS_{pl}$	6.3
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	662.2
Effective width, W_v (Eq. 15-29) ft	13.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	5.81
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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2

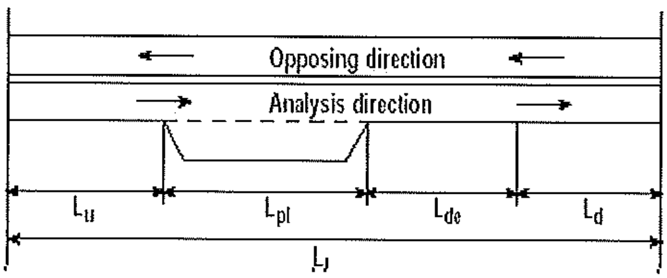
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET WITH PASSING LANE WORKSHEET

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

Project Description: *US 2 Badrock Canyon Corridor Pla2j*

Input Data

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



Shoulder width (ft)	*1.0*
Lane Width (ft)	*12.0*
Segment Length (mi)	*1.2*
Total length of analysis segment, L_t	*1.2*
Length of two-lane highway upstream of the passing lane, L_u	*0.0*
Length of passing lane including tapers, L_{pl}	*0.6*
Average travel speed, ATS_d (from Directional Two-Lane Highway Segment Worksheet)	*42.1*
Percent time-spent-following, $PTSF_d$ (from Directional Two-Lane Highway Segment Worksheet)	*75.4*
Level of service[1], LOS_d (from Directional Two-Lane Highway Segment Worksheet)	*D*
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 $L_d=L_t-(L_u+L_{pl}+L_{de})$	*-1.10*
Adj. factor for the effect of passing lane on average speed, f_{pl} (Exhibit 15-28)	*1.11*
Average travel speed including passing lane[2], $ATS_{pl} = (ATS_d * L_t) / (L_u+L_d+(L_{pl}/f_{pl})+(2L_{de}/(1+f_{pl,ATS})))$	*46.3*
Percent free flow speed including passing lane, $PFFS_{pl} = (ATS_{pl}/FFS)$	*81.1*
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)	*5.92*
Length of two-lane highway downstream of effective length of the passing lane for percent-time-following, $L_d=L_t-(L_u+L_{pl}+L_{de})$	*-5.32*
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], $PTSF_{pl}$(%) $PTSF_{pl}= PTSF_d[L_u+L_d+f_{pl,PTSF}L_{pl}+((1+f_{pl,PTSF})/2)L_{de}]/L_t$	*46.7*
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) $TT_{15}= VMT_{15}/ATS_{pl}$	*4.3*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*658.4*
Effective width, W_v (Eq. 15-29) ft	*13.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*5.81*
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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2

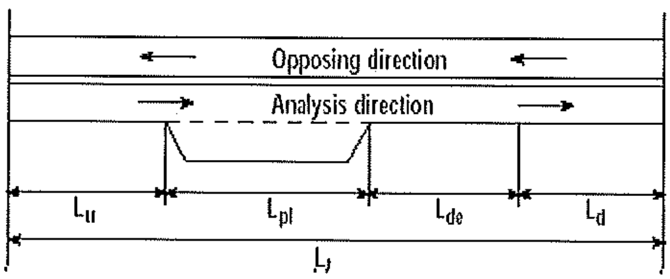
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET WITH PASSING LANE WORKSHEET

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

Project Description: US 2 Badrock Canyon Corridor Pla¥7B

Input Data

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



Shoulder width (ft)	1.0
Lane Width (ft)	12.0
Segment Length (mi)	1.8
Total length of analysis segment, L_t	1.8
Length of two-lane highway upstream of the passing lane, L_u	0.0
Length of passing lane including tapers , L_{pl}	1.1
Average travel speed, ATS_d (from Directional Two-Lane Highway Segment Worksheet)	39.7
Percent time-spent-following, $PTSF_d$ (from Directional Two-Lane Highway Segment Worksheet)	88.9
Level of service[1], LOS_d (from Directional Two-Lane Highway Segment Worksheet)	E
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 $L_d=L_t-(L_u+L_{pl}+L_{de})$	-1.00
Adj. factor for the effect of passing lane on average speed, f_{pl} (Exhibit 15-28)	1.11
Average travel speed including passing lane[2], $ATS_{pl} = (ATS_d * L_t) / (L_u+L_d+(L_{pl}/f_{pl})+ (2L_{de}/(1+f_{pl,ATS})))$	43.7
Percent free flow speed including passing lane, $PFFS_{pl} = (ATS_{pl}/ FFS)$	79.4
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)	3.60
Length of two-lane highway downstream of effective length of the passing lane for percent-time-following, $L_d = L_t-(L_u+ L_{pl}+ L_{de})$	-2.90
Adj. factor for the effect of passing lane on percent time-spent-following,	

$f_{pl,PTSF}$(Exhibit 15-26)	0.62
Percent time-spent-following including passing lane[3], $PTSF_{pl}$(%) $PTSF_{pl}= PTSF_d[L_u+L_d+f_{pl,PTSF}L_{pl}+((1+f_{pl,PTSF})/2)L_{de}]/L_t$	56.4
Level of Service and Other Performance Measures[4]	
Level of service including passing lane LOS_{pl} (Exhibit 15-3)	C
Peak 15-min total travel time, TT_{15}(veh-h) $TT_{15}= VMT_{15}/ATS_{pl}$	10.8
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	1046.2
Effective width, W_v (Eq. 15-29) ft	13.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	6.04
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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Appendix 4

Operational
Analysis Worksheets

2035 4-3-4 Adjusted Annual Average
Four-Lane RP 140.0 – RP 140.6
Three-Lane RP 140.6 – RP 141.2
Four-Lane RP 141.2 – 142.4

Direction 1 = Eastbound
Direction 2 = Westbound

MULTILANE HIGHWAYS WORKSHEET(Direction 1)

General Information

Analyst	David Stoner
Agency or Company	DOWL HKM
Date Performed	4/30/2012
Analysis Time Period	AM Peak

Site Information

Highway/Direction to Travel	US 2
From/To	Columbia Falls to Hungry Horse
Jurisdiction	Flathead County
Analysis Year	2035

Project Description US 2 Badrock Canyon Corridor Planning Study

☐ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	398	Peak-Hour Factor, PHF	0.93
AADT(veh/h)		%Trucks and Buses, P_T	6
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Rolling
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	2.0
E_T	2.5	f_{HV}	0.885

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)	241
Speed, S (mi/h)	60.0
D (pc/mi/ln)	4.0
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	*214.0*
Effective width, W_v (Eq. 15-29) ft	*24.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*3.21*
Bicycle level of service (Exhibit 15-4)	*C*

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MULTILANE HIGHWAYS WORKSHEET(Direction 2)

General Information

Analyst	David Stoner
Agency or Company	DOWL HKM
Date Performed	4/30/2012
Analysis Time Period	AM Peak

Site Information

Highway/Direction to Travel	US 2
From/To	Columbia Falls to Hungry Horse
Jurisdiction	Flathead County
Analysis Year	2035

Project Description US 2 Badrock Canyon Corridor Planning Study

☐ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	250	Peak-Hour Factor, PHF	0.87
AADT(veh/h)		%Trucks and Buses, P_T	6
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Rolling
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	2.0
E_T	2.5	f_{HV}	0.885

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	143.7
Effective width, W_v (Eq. 15-29) ft	24.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	3.00
Bicycle level of service (Exhibit 15-4)	C

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MULTILANE HIGHWAYS WORKSHEET(Direction 1)

General Information

Analyst	David Stoner
Agency or Company	DOWL HKM
Date Performed	4/30/2012
Analysis Time Period	Median Off-Peak

Site Information

Highway/Direction to Travel	US 2
From/To	Columbia Falls to Hungry Horse
Jurisdiction	Flathead County
Analysis Year	2035

Project Description US 2 Badrock Canyon Corridor Planning Study

☐ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	351	Peak-Hour Factor, PHF	0.91
AADT(veh/h)		%Trucks and Buses, P_T	6
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Rolling
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	2.0
E_T	2.5	f_{HV}	0.885

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)	61.0
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)	61.0

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	217
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	*192.9*
Effective width, W_v (Eq. 15-29) ft	*24.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*3.15*
Bicycle level of service (Exhibit 15-4)	*C*

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MULTILANE HIGHWAYS WORKSHEET(Direction 2)

[X]

General Information

Analyst	David Stoner
Agency or Company	DOWL HKM
Date Performed	4/30/2012
Analysis Time Period	Median Off-Peak

Site Information

Highway/Direction to Travel	US 2
From/To	Columbia Falls to Hungry Horse
Jurisdiction	Flathead County
Analysis Year	2035

Project Description US 2 Badrock Canyon Corridor Planning Study

☐ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	306	Peak-Hour Factor, PHF	0.89
AADT(veh/h)		%Trucks and Buses, P_T	6
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Rolling
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	2.0
E_T	2.5	f_{HV}	0.885

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)	61.0
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)	61.0

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	194
Speed, S (mi/h)	60.0
D (pc/mi/ln)	3.2
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	171.9
Effective width, W_v (Eq. 15-29) ft	24.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	3.09
Bicycle level of service (Exhibit 15-4)	C

MULTILANE HIGHWAYS WORKSHEET(Direction 1)

General Information

Analyst	David Stoner
Agency or Company	DOWL HKM
Date Performed	4/30/2012
Analysis Time Period	PM Peak

Site Information

Highway/Direction to Travel	US 2
From/To	Columbia Falls to Hungry Horse
Jurisdiction	Flathead County
Analysis Year	2035

Project Description US 2 Badrock Canyon Corridor Planning Study

☐ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	296	Peak-Hour Factor, PHF	0.89
AADT(veh/h)		%Trucks and Buses, P_T	6
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Rolling
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	2.0
E_T	2.5	f_{HV}	0.885

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)	62.0
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)	62.0

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	187
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	166.3
Effective width, W_v (Eq. 15-29) ft	24.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	3.08
Bicycle level of service (Exhibit 15-4)	C

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MULTILANE HIGHWAYS WORKSHEET(Direction 2)

General Information

Analyst	David Stoner
Agency or Company	DOWL HKM
Date Performed	4/30/2012
Analysis Time Period	PM Peak

Site Information

Highway/Direction to Travel	US 2
From/To	Columbia Falls to Hungry Horse
Jurisdiction	Flathead County
Analysis Year	2035

Project Description US 2 Badrock Canyon Corridor Planning Study

☐ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	491	Peak-Hour Factor, PHF	0.91
AADT(veh/h)		%Trucks and Buses, P_T	6
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Rolling
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	2.0
E_T	2.5	f_{HV}	0.885

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)	304
Speed, S (mi/h)	60.0
D (pc/mi/ln)	5.1
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	*269.8*
Effective width, W_v (Eq. 15-29) ft	*24.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*3.32*
Bicycle level of service (Exhibit 15-4)	*C*

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2

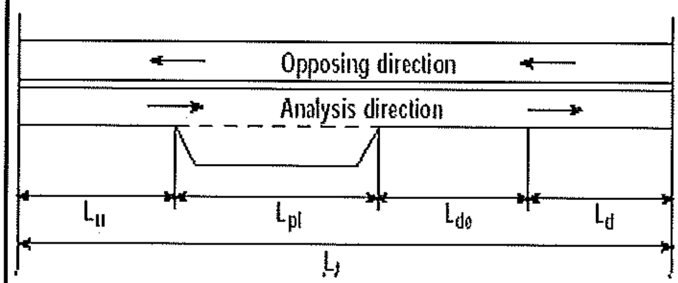
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET WITH PASSING LANE WORKSHEET

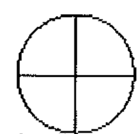
General Information		***Site Information***	
Analyst	*David Stoner*	Highway of Travel	*US 2*
Agency or Company	*DOWL HKM*	From/To	*Columbia F to Hungry H EB*
Date Performed	*11/15/2011*	Jurisdiction	*Flathead County*
Analysis Time Period	*AM Peak*	Analysis Year	*2035*

Project Description: *US 2 Badrock Canyon Corridor Plaô²¤B*

Input Data

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





Shoulder width (ft)	*1.0*
Lane Width (ft)	*12.0*
Segment Length (mi)	*1.2*
Total length of analysis segment, L_t	*1.2*
Length of two-lane highway upstream of the passing lane, L_u	*0.0*
Length of passing lane including tapers , L_{pl}	*0.6*
Average travel speed, ATS_d (from Directional Two-Lane Highway Segment Worksheet)	*45.3*
Percent time-spent-following, $PTSF_d$ (from Directional Two-Lane Highway Segment Worksheet)	*70.4*
Level of service[1], LOS_d (from Directional Two-Lane Highway Segment Worksheet)	*D*
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 $L_d = L_t - (L_u + L_{pl} + L_{de})$	*-1.10*
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], $ATS_{pl} = (ATS_d * L_t) / (L_u + L_d + (L_{pl}/f_{pl}) + (2L_{de}/(1+f_{pl,ATS})))$	*49.5*
Percent free flow speed including passing lane, $PFFS_{pl} = (ATS_{pl}/ FFS)$	*89.9*
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)	*7.49*
Length of two-lane highway downstream of effective length of the passing lane for percent-time-following, $L_d = L_t - (L_u + L_{pl} + L_{de})$	*-6.89*
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], $PTSF_{pl}$(%) $PTSF_{pl}= PTSF_d[L_u+L_d+f_{pl,PTSF}L_{pl}+((1+f_{pl,PTSF})/2)L_{de}]/L_t$	*43.5*
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) $TT_{15}= VMT_{15}/ATS_{pl}$	*2.6*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*428.0*
Effective width, W_v (Eq. 15-29) ft	*13.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*5.59*
Bicycle level of service (Exhibit 15-4)	*F*
Notes	
1. 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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2

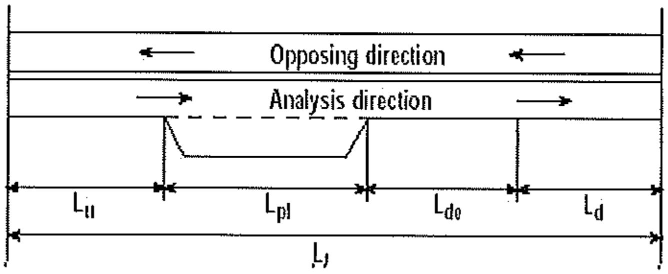
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET WITH PASSING LANE WORKSHEET

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

Project Description: *US 2 Badrock Canyon Corridor Pla?ªB*

Input Data

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



Shoulder width (ft)	*1.0*
Lane Width (ft)	*12.0*
Segment Length (mi)	*1.8*
Total length of analysis segment, L_t	*1.8*
Length of two-lane highway upstream of the passing lane, L_u	*0.0*
Length of passing lane including tapers , L_{pl}	*1.1*
Average travel speed, ATS_d (from Directional Two-Lane Highway Segment Worksheet)	*45.9*
Percent time-spent-following, $PTSF_d$ (from Directional Two-Lane Highway Segment Worksheet)	*56.6*
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 $L_d=L_t-(L_u+L_{pl}+L_{de})$	*-1.00*
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], $ATS_{pl} = (ATS_d * L_t) / (L_u+L_d+(L_{pl}/f_{pl})+ (2L_{de}/(1+f_{pl,ATS})))$	*50.1*
Percent free flow speed including passing lane, $PFFS_{pl} = (ATS_{pl}/ FFS)$	*91.0*
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)	*9.99*
Length of two-lane highway downstream of effective length of the passing lane for percent-time-following, $L_d =L_t-(L_u+ L_{pl}+ L_{de})$	*-9.29*
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], $PTSF_{pl}$(%) $PTSF_{pl}= PTSF_d[L_u+L_d+f_{pl,PTSF}L_{pl}+((1+f_{pl,PTSF})/2)L_{de}]/L_t$	*34.3*
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) $TT_{15}= VMT_{15}/ATS_{pl}$	*2.5*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*279.3*
Effective width, W_v (Eq. 15-29) ft	*13.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*5.37*
Bicycle level of service (Exhibit 15-4)	*E*
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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2

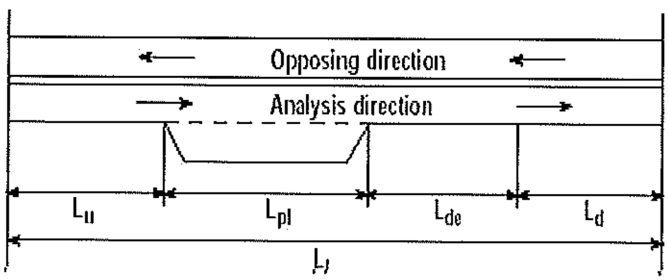
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET WITH PASSING LANE WORKSHEET

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

Project Description: US 2 Badrock Canyon Corridor Pla×A¥B

Input Data

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



Shoulder width (ft)	1.0
Lane Width (ft)	12.0
Segment Length (mi)	1.2
Total length of analysis segment, L_t	1.2
Length of two-lane highway upstream of the passing lane, L_u	0.0
Length of passing lane including tapers , L_{pl}	0.6
Average travel speed, ATS_d (from Directional Two-Lane Highway Segment Worksheet)	46.3
Percent time-spent-following, $PTSF_d$ (from Directional Two-Lane Highway Segment Worksheet)	69.5
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 $L_d=L_t-(L_u+L_{pl}+L_{de})$	-1.10
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], $ATS_{pl} = (ATS_d * L_t) / (L_u+L_d+(L_{pl}/f_{pl})+ (2L_{de}/(1+f_{pl,ATS})))$	50.5
Percent free flow speed including passing lane, $PFFS_{pl} = (ATS_{pl}/ FFS)$	90.2
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)	7.71
Length of two-lane highway downstream of effective length of the passing lane for percent-time-following, $L_d =L_t-(L_u+ L_{pl}+ L_{de})$	-7.11
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], $PTSF_{pl}$(%) $PTSF_{pl}= PTSF_d[L_u+L_d+f_{pl,PTSF}L_{pl}+((1+f_{pl,PTSF})/2)L_{de}]/L_t$	42.9
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) $TT_{15}= VMT_{15}/ATS_{pl}$	2.3
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	385.7
Effective width, W_v (Eq. 15-29) ft	13.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	5.54
Bicycle level of service (Exhibit 15-4)	F
Notes	

1. 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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2

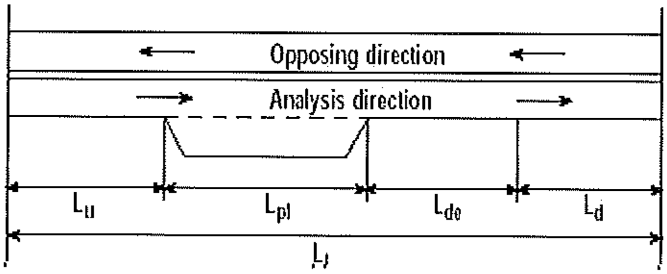
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET WITH PASSING LANE WORKSHEET

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

Project Description: US 2 Badrock Canyon Corridor Plaqõ¥B

Input Data

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



Shoulder width (ft)	1.0
Lane Width (ft)	12.0
Segment Length (mi)	1.8
Total length of analysis segment, L_t	1.8
Length of two-lane highway upstream of the passing lane, L_u	0.0
Length of passing lane including tapers , L_{pl}	1.1
Average travel speed, ATS_d (from Directional Two-Lane Highway Segment Worksheet)	46.5
Percent time-spent-following, $PTSF_d$ (from Directional Two-Lane Highway Segment Worksheet)	63.9
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 $L_d=L_t-(L_u+L_{pl}+L_{de})$	-1.00
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], $ATS_{pl} = (ATS_d * L_t) / (L_u+L_d+(L_{pl}/f_{pl})+ (2L_{de}/(1+f_{pl,ATS})))$	50.8
Percent free flow speed including passing lane, $PFFS_{pl} = (ATS_{pl}/ FFS)$	90.6
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)	8.20
Length of two-lane highway downstream of effective length of the passing lane for percent-time-following, $L_d =L_t-(L_u+ L_{pl}+ L_{de})$	-7.51
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], $PTSF_{pl}$(%) $PTSF_{pl}= PTSF_d[L_u+L_d+f_{pl,PTSF}L_{pl}+((1+f_{pl,PTSF})/2)L_{de}]/L_t$	*38.8*
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) $TT_{15}= VMT_{15}/ATS_{pl}$	*3.0*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*333.7*
Effective width, W_v (Eq. 15-29) ft	*13.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*5.47*
Bicycle level of service (Exhibit 15-4)	*E*
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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2

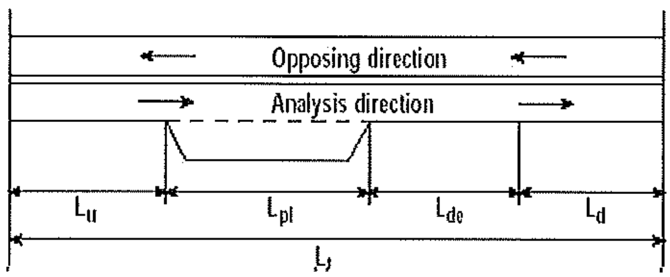
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET WITH PASSING LANE WORKSHEET

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

Project Description: *US 2 Badrock Canyon Corridor Pla*

Input Data

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



Shoulder width (ft)	*1.0*
Lane Width (ft)	*12.0*
Segment Length (mi)	*1.2*
Total length of analysis segment, L_t	*1.2*
Length of two-lane highway upstream of the passing lane, L_u	*0.0*
Length of passing lane including tapers , L_{pl}	*0.6*
Average travel speed, ATS_d (from Directional Two-Lane Highway Segment Worksheet)	*47.2*
Percent time-spent-following, $PTSF_d$ (from Directional Two-Lane Highway Segment Worksheet)	*60.2*
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 $L_d=L_t-(L_u+L_{pl}+L_{de})$	*-1.10*
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], $ATS_{pl} = (ATS_d * L_t) / (L_u+L_d+(L_{pl}/f_{pl})+ (2L_{de}/(1+f_{pl,ATS})))$	*51.5*
Percent free flow speed including passing lane, $PFFS_{pl} = (ATS_{pl}/ FFS)$	*90.3*
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)	*8.24*
Length of two-lane highway downstream of effective length of the passing lane for percent-time-following, $L_d =L_t-(L_u+ L_{pl}+ L_{de})$	*-7.64*
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], $PTSF_{pl}$(%) $PTSF_{pl}= PTSF_d[L_u+L_d+f_{pl,PTSF}L_{pl}+((1+f_{pl,PTSF})/2)L_{de}]/L_t$	*36.6*
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) $TT_{15}= VMT_{15}/ATS_{pl}$	*1.9*
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	*332.6*
Effective width, W_v (Eq. 15-29) ft	*13.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*5.46*
Bicycle level of service (Exhibit 15-4)	*E*
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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2

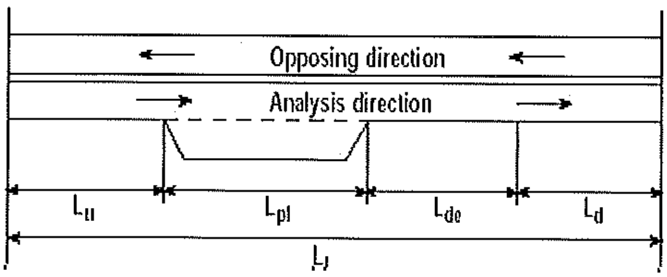
DIRECTIONAL TWO-LANE HIGHWAY SEGMENT WORKSHEET WITH PASSING LANE WORKSHEET

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

Project Description: US 2 Badrock Canyon Corridor Play¢B

Input Data

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



Shoulder width (ft)	1.0
Lane Width (ft)	12.0
Segment Length (mi)	1.8
Total length of analysis segment, L_t	1.8
Length of two-lane highway upstream of the passing lane, L_u	0.0
Length of passing lane including tapers , L_{pl}	1.1
Average travel speed, ATS_d (from Directional Two-Lane Highway Segment Worksheet)	44.6
Percent time-spent-following, $PTSF_d$ (from Directional Two-Lane Highway Segment Worksheet)	74.6
Level of service[1], LOS_d (from Directional Two-Lane Highway Segment Worksheet)	D
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 $L_d=L_t-(L_u+L_{pl}+L_{de})$	-1.00
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], $ATS_{pl} = (ATS_d * L_t) / (L_u+L_d+(L_{pl}/f_{pl})+ (2L_{de}/(1+f_{pl,ATS})))$	48.7
Percent free flow speed including passing lane, $PFFS_{pl} = (ATS_{pl}/ FFS)$	88.5
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)	6.89
Length of two-lane highway downstream of effective length of the passing lane for percent-time-following, $L_d =L_t-(L_u+ L_{pl}+ L_{de})$	-6.19
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], $PTSF_{pl}$(%) $PTSF_{pl} = PTSF_d[L_u + L_d + f_{pl,PTSF}L_{pl} + ((1+f_{pl,PTSF})/2)L_{de}]/L_t$	46.1
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) $TT_{15} = VMT_{15}/ATS_{pl}$	4.8
Bicycle Level of Service	
Directional demand flow rate in outside lane, v_{OL} (Eq. 15-24) veh/h	523.1
Effective width, W_v (Eq. 15-29) ft	13.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	5.69
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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Appendix 4

Operational
Analysis Worksheets

2035 Four-Lane Peak Season

Direction 1 = Eastbound
Direction 2 = Westbound

MULTILANE HIGHWAYS WORKSHEET(Direction 1)

General Information

Analyst	David Stoner
Agency or Company	DOWL HKM
Date Performed	4/30/2012
Analysis Time Period	AM Peak

Site Information

Highway/Direction to Travel	US 2
From/To	Columbia Falls to Hungry Horse
Jurisdiction	Flathead County
Analysis Year	2035

Project Description US 2 Badrock Canyon Corridor Planning Study

Oper.(LOS) Des. (N) Plan. (vp)

Flow Inputs

Volume, V (veh/h)	791	Peak-Hour Factor, PHF	0.93
AADT(veh/h)		%Trucks and Buses, P_T	6
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Rolling
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	2.0
E_T	2.5	f_{HV}	0.885

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)	480
Speed, S (mi/h)	60.0
D (pc/mi/ln)	8.0
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	425.3
Effective width, W_v (Eq. 15-29) ft	24.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	3.55
Bicycle level of service (Exhibit 15-4)	D

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MULTILANE HIGHWAYS WORKSHEET(Direction 2)

[X]

General Information

Analyst	David Stoner
Agency or Company	DOWL HKM
Date Performed	4/30/2012
Analysis Time Period	AM Peak

Site Information

Highway/Direction to Travel	US 2
From/To	Columbia Falls to Hungry Horse
Jurisdiction	Flathead County
Analysis Year	2035

Project Description US 2 Badrock Canyon Corridor Planning Study

☐ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	502	Peak-Hour Factor, PHF	0.87
AADT(veh/h)		%Trucks and Buses, P_T	6
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Rolling
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	2.0
E_T	2.5	f_{HV}	0.885

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)	326
Speed, S (mi/h)	60.0
D (pc/mi/ln)	5.4
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	288.5
Effective width, W_v (Eq. 15-29) ft	24.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	3.36
Bicycle level of service (Exhibit 15-4)	C

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MULTILANE HIGHWAYS WORKSHEET(Direction 1)

General Information

Analyst	David Stoner
Agency or Company	DOWL HKM
Date Performed	4/30/2012
Analysis Time Period	Median Off Peak Peak

Site Information

Highway/Direction to Travel	US 2
From/To	Columbia Falls to Hungry Horse
Jurisdiction	Flathead County
Analysis Year	2035

Project Description US 2 Badrock Canyon Corridor Planning Study

☐ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	704	Peak-Hour Factor, PHF	0.91
AADT(veh/h)		%Trucks and Buses, P_T	6
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Rolling
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	2.0
E_T	2.5	f_{HV}	0.885

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)	61.0
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)	61.0

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	437
Speed, S (mi/h)	60.0
D (pc/mi/ln)	7.3
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	386.8
Effective width, W_v (Eq. 15-29) ft	24.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	3.51
Bicycle level of service (Exhibit 15-4)	D

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MULTILANE HIGHWAYS WORKSHEET(Direction 2)

[X]

General Information

Analyst	David Stoner
Agency or Company	DOWL HKM
Date Performed	4/30/2012
Analysis Time Period	Median Off Peak Peak

Site Information

Highway/Direction to Travel	US 2
From/To	Columbia Falls to Hungry Horse
Jurisdiction	Flathead County
Analysis Year	2035

Project Description US 2 Badrock Canyon Corridor Planning Study

☐ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	614	Peak-Hour Factor, PHF	0.89
AADT(veh/h)		%Trucks and Buses, P_T	6
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Rolling
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	2.0
E_T	2.5	f_{HV}	0.885

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)	61.0
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)	61.0

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	389
Speed, S (mi/h)	60.0
D (pc/mi/ln)	6.5
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	344.9
Effective width, W_v (Eq. 15-29) ft	24.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	3.45
Bicycle level of service (Exhibit 15-4)	C

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MULTILANE HIGHWAYS WORKSHEET(Direction 1)

[x]

General Information

Analyst	David Stoner
Agency or Company	DOWL HKM
Date Performed	4/30/2012
Analysis Time Period	PM Peak

Site Information

Highway/Direction to Travel	US 2
From/To	Columbia Falls to Hungry Horse
Jurisdiction	Flathead County
Analysis Year	2035

Project Description US 2 Badrock Canyon Corridor Planning Study

☐ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	586	Peak-Hour Factor, PHF	0.89
AADT(veh/h)		%Trucks and Buses, P_T	6
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Rolling
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	2.0
E_T	2.5	f_{HV}	0.885

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)	62.0
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)	62.0

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	372
Speed, S (mi/h)	60.0
D (pc/mi/ln)	6.2
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	329.2
Effective width, W_v (Eq. 15-29) ft	24.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	3.42
Bicycle level of service (Exhibit 15-4)	C

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MULTILANE HIGHWAYS WORKSHEET(Direction 2)

General Information

Analyst	David Stoner
Agency or Company	DOWL HKM
Date Performed	4/30/2012
Analysis Time Period	PM Peak

Site Information

Highway/Direction to Travel	US 2
From/To	Columbia Falls to Hungry Horse
Jurisdiction	Flathead County
Analysis Year	2035

Project Description US 2 Badrock Canyon Corridor Planning Study

☐ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	981	Peak-Hour Factor, PHF	0.91
AADT(veh/h)		%Trucks and Buses, P_T	6
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Rolling
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	2.0
E_T	2.5	f_{HV}	0.885

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)	609
Speed, S (mi/h)	60.0
D (pc/mi/ln)	10.1
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	539.0
Effective width, W_v (Eq. 15-29) ft	24.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	3.67
Bicycle level of service (Exhibit 15-4)	D

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Appendix 4

Operational Analysis Worksheets

2035 Four-Lane Adjusted Annual Average

Direction 1 = Eastbound
Direction 2 = Westbound

MULTILANE HIGHWAYS WORKSHEET(Direction 1)

General Information

Analyst	David Stoner
Agency or Company	DOWL HKM
Date Performed	4/30/2012
Analysis Time Period	AM Peak

Site Information

Highway/Direction to Travel	US 2
From/To	Columbia Falls to Hungry Horse
Jurisdiction	Flathead County
Analysis Year	2035

Project Description US 2 Badrock Canyon Corridor Planning Study

☐ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	398	Peak-Hour Factor, PHF	0.93
AADT(veh/h)		%Trucks and Buses, P_T	6
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Rolling
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	2.0
E_T	2.5	f_{HV}	0.885

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)	241
Speed, S (mi/h)	60.0
D (pc/mi/ln)	4.0
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	214.0
Effective width, W_v (Eq. 15-29) ft	24.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	3.21
Bicycle level of service (Exhibit 15-4)	C

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MULTILANE HIGHWAYS WORKSHEET(Direction 2)

[X]

General Information

Analyst	David Stoner
Agency or Company	DOWL HKM
Date Performed	4/30/2012
Analysis Time Period	AM Peak

Site Information

Highway/Direction to Travel	US 2
From/To	Columbia Falls to Hungry Horse
Jurisdiction	Flathead County
Analysis Year	2035

Project Description US 2 Badrock Canyon Corridor Planning Study

☐ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	250	Peak-Hour Factor, PHF	0.87
AADT(veh/h)		%Trucks and Buses, P_T	6
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Rolling
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	2.0
E_T	2.5	f_{HV}	0.885

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	143.7
Effective width, W_v (Eq. 15-29) ft	24.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	3.00
Bicycle level of service (Exhibit 15-4)	C

MULTILANE HIGHWAYS WORKSHEET(Direction 1)

General Information

Analyst	David Stoner
Agency or Company	DOWL HKM
Date Performed	4/30/2012
Analysis Time Period	Median Off-Peak

Site Information

Highway/Direction to Travel	US 2
From/To	Columbia Falls to Hungry Horse
Jurisdiction	Flathead County
Analysis Year	2035

Project Description US 2 Badrock Canyon Corridor Planning Study

☐ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	351	Peak-Hour Factor, PHF	0.91
AADT(veh/h)		%Trucks and Buses, P_T	6
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Rolling
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	2.0
E_T	2.5	f_{HV}	0.885

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)	61.0
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)	61.0

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	217
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	192.9
Effective width, W_v (Eq. 15-29) ft	24.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	3.15
Bicycle level of service (Exhibit 15-4)	C

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MULTILANE HIGHWAYS WORKSHEET(Direction 2)

General Information		Site Information	
Analyst	David Stoner	Highway/Direction to Travel	US 2
Agency or Company	DOWL HKM	From/To	Columbia Falls to Hungry Horse
Date Performed	4/30/2012	Jurisdiction	Flathead County
Analysis Time Period	Median Off-Peak	Analysis Year	2035

Project Description US 2 Badrock Canyon Corridor Planning Study

☐ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	306	Peak-Hour Factor, PHF	0.89
AADT(veh/h)		%Trucks and Buses, P_T	6
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Rolling
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	2.0
E_T	2.5	f_{HV}	0.885

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)	61.0	FFS (mi/h)	61.0
Base Free-Flow Speed, BFFS			

Operations		Design	
Operational (LOS)		Design (N)	
Flow Rate, v_p (pc/h/ln)	194	Required Number of Lanes, N	
Speed, S (mi/h)	60.0	Flow Rate, v_p (pc/h)	
D (pc/mi/ln)	3.2	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	171.9
Effective width, W_v (Eq. 15-29) ft	24.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	3.09
Bicycle level of service (Exhibit 15-4)	C

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MULTILANE HIGHWAYS WORKSHEET(Direction 1)

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General Information

Analyst	David Stoner
Agency or Company	DOWL HKM
Date Performed	4/30/2012
Analysis Time Period	PM Peak

Site Information

Highway/Direction to Travel	US 2
From/To	Columbia Falls to Hungry Horse
Jurisdiction	Flathead County
Analysis Year	2035

Project Description US 2 Badrock Canyon Corridor Planning Study

☐ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	296	Peak-Hour Factor, PHF	0.89
AADT(veh/h)		%Trucks and Buses, P_T	6
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Rolling
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	2.0
E_T	2.5	f_{HV}	0.885

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)	62.0
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)	62.0

Operations

Operational (LOS)

Flow Rate, v_p (pc/h/ln)	187
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	*166.3*
Effective width, W_v (Eq. 15-29) ft	*24.00*
Effective speed factor, S_t (Eq. 15-30)	*4.79*
Bicycle level of service score, BLOS (Eq. 15-31)	*3.08*
Bicycle level of service (Exhibit 15-4)	*C*

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MULTILANE HIGHWAYS WORKSHEET(Direction 2)

General Information

Analyst	David Stoner
Agency or Company	DOWL HKM
Date Performed	4/30/2012
Analysis Time Period	PM Peak

Site Information

Highway/Direction to Travel	US 2
From/To	Columbia Falls to Hungry Horse
Jurisdiction	Flathead County
Analysis Year	2035

Project Description US 2 Badrock Canyon Corridor Planning Study

☐ Oper.(LOS) ☐ Des. (N) ☐ Plan. (vp)

Flow Inputs

Volume, V (veh/h)	491	Peak-Hour Factor, PHF	0.91
AADT(veh/h)		%Trucks and Buses, P_T	6
Peak-Hour Prop of AADT (veh/d)		%RVs, P_R	4
Peak-Hour Direction Prop, D		General Terrain:	Rolling
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	2.0
E_T	2.5	f_{HV}	0.885

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)	304
Speed, S (mi/h)	60.0
D (pc/mi/ln)	5.1
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	269.8
Effective width, W_v (Eq. 15-29) ft	24.00
Effective speed factor, S_t (Eq. 15-30)	4.79
Bicycle level of service score, BLOS (Eq. 15-31)	3.32
Bicycle level of service (Exhibit 15-4)	C

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