

DESIGN ANALYSIS EXAMPLE

DESIGN ANALYSIS NO.

Analysis Title

SR #, US # or I-# Project Title

MP TO MP

XL-####

PIN-#####

Month Year

WASHINGTON STATE DEPARTMENT OF TRANSPORTATION

Region

Name, PE

Project Engineer

Design Analysis Recommended for Approval:

Date _____

By _____

Engineering Manager

Design Analysis Recommended for Approval:

Date _____

By _____, P.E.

Assistant State Design Engineer for Region

Design Analysis Approval:

Date _____

By _____

FHWA/if applicable



**Washington State
Department of Transportation**

	6	Y	N	Rolling	Rural-Minor Arterial	29% (SR 6)	Design Speed = 60mph (Existing) Posted Speed = 55mph Target Speed = 55mph
Project Information	Begin MP	End MP	Sub-Program		County	Funding Sources	
	26.44	26.97	P-2 Structures		Lewis	P-2 Sub-Program	
	Current ADT or DHV	Within City?	Access Class				
	SR-6 (2010) - 1,300 ADT SR-6 (2033) - 2,460 ADT	No	Managed Access				
Brief Project Description	This SR 6 Rock Creek Bridge Replacement project is a P-2 Structures project. The purpose of the SR 6 Rock Creek Bridge Replacement Project is to replace the functionally obsolete and low sufficiency rated structure. The project includes changing the horizontal alignment and the vertical profile of SR-6 to accommodate the new bridge. The project includes relocating the intersection of SR 6 and McCormick Creek Road for the longer new bridge.						
Important or related documents	Vicinity Map Project Layout Sight Distance Options Sheet (Appendix A)						

Context, Background, History

There is flexibility in the content that can be provided here. This section should include a description of existing conditions. It can also include any background and history that is useful in understanding the issue or decision. Include the information that led to choosing the performance metrics that were used to compare options.

SR 6 is a two lane highway with eleven foot wide lanes. The outside shoulders vary between two and eight feet in width, except for on bridges where the shoulder widths are one foot.

In the last 5 years (2010 - 2015) there have been no fatal or serious injury crashes and there have not been more crashes than other similar intersections.

The existing vertical alignment within the project is relatively flat. The existing profile grades vary from 0.1 percent to 2 percent. The existing horizontal alignment (west to east) consists of a tangent section, a short curve before the bridge (409 ft. radius), tangent across the bridge and another curve (955 ft. radius) after the bridge followed by a long tangent.

The existing available Intersection Sight Distance (ISD) at the SR 6/McCormick Creek Road intersection is approximately 340 feet. ISD to the east is limited by the cut slope on the north side of the highway (see Exhibit A). The intersection angle is currently 30.4°.

Construction is currently scheduled to begin in 2013. The project is expected to be operationally complete in 2015.

Performance Evaluation Methodology

Making performance-based decisions relies on choosing performance metrics and setting performance targets, and using the metrics and targets to compare options. Describe the methodology (including metrics and targets) that will be used to compare the performance of options. At a minimum, describe the metrics and targets will be used to evaluate the safety performance and mobility (traffic operations) performance of the options.

BOD Baseline Need(s)

The SR 6 Rock Creek Bridge is functionally obsolete. This need is not used for comparing alternatives because all the alternatives would have a neutral score for this need.

Metric and Target: Functional crossing of Rock Creek

Needs used to evaluate alternatives in this Design Analysis

Reduce risk of fatal and all injury Intersection Sight Distance (ISD) Related Crashes per year.

Metric: fatal and all injury crashes per year

Target: 0 Intersection Sight Distance (ISD) related fatal or injury crashes per year

Minimize affect to land owners (60' of existing R/W)

Metric: Acres of Disturbance

Target: Minimize affect to land owners

Minimize added disturbance of environmentally sensitive areas (wetlands and riparian habitat)

Metric: Acres of disturbed environmentally sensitive areas

Target: Minimum Acres of Disturbance

The SR 6/McCormick Creek Road intersection has 340 feet of Intersection Sight Distance (ISD) for vehicles entering SR 6 looking east at westbound. ISD to the east is limited by the cut slope on the north side of the highway (see Exhibit A).

Metric: Feet of intersection sight distance

Target: Up to 1,015 feet (WB-50 turning Left)

Options Analysis

ATTACH the option EVALUATION MATRIX: Refer to the evaluation matrix, and describe the performance metrics and targets that were used (as shown on the evaluation matrix), and the reasoning for choosing them. Explain how any "weighting" of criteria led to choosing the preferred option.

Guidance in other publications (if applicable):

Design Manual Section 1310.09 (July 2010), says;

Provide a clear sight triangle for a P vehicle at all intersections. In addition, provide a clear sight triangle for the SU vehicle for rural highway conditions. If there is significant combination truck traffic, use the WB-50 or WB-67 rather than the SU. In areas where SU or WB vehicles are minimal and right of way restrictions limit sight triangle clearing, only the P vehicle sight distance needs to be provided.

The following required ISD's were calculated using DM Exhibit 1310-27a (July 2010):

The required ISD for a WB-50 is 1,015 feet for left turn movements and 927 feet for right turn movements.

The required ISD for a Single-unit trucks (SU) or Buses (BUS) is 838 feet for left turn movements and 750 feet for right turn movements.

The required ISD for a P vehicle is 662 feet for left turn movements and 574 feet for right turn movements.

Safety Performance Evaluation:

In the last 5 years (2010 - 2015) there have been no fatal or serious injury crashes and there have been less crashes than other similar intersections.

Discussion of Alternatives Considered

ATTACH the option EVALUATION MATRIX: Refer to the evaluation matrix, and describe the performance metrics and targets that were used (as shown on the evaluation matrix), and the reasoning for choosing them. Explain how any "weighting" of criteria led to choosing the preferred option.

Operational Performance Evaluation of each Alternative:

Alternative 1: Provide full design standard ISD for a WB-50 design vehicle (Logging Truck): 1015 feet of ISD.

This alternative would require a major cut and wall into the hillside, most likely requiring some controlled blasting. The soil nail wall would be approximately 67 feet tall at its highest point and up to 780 feet long. To allow for a clear sight line, the open area between the wall and SR 6 would be approximately 85 feet wide.

Advantages

- Assuming that a longer sight distance reduces the risk of ISD related crashes up to a ISD of 1,015 feet, this alternative and alternative 4 would have the least number of Intersection sight distance related crashes.
- Provides full Intersection Sight Distance (1015 feet) for a WB-50 vehicle approaching the intersection westbound.
- Exceeds the needed stopping sight distance (570 feet at 60 mph) for vehicles on SR 6 if a truck pulls out in front of them from McCormick Creek Road.

Disadvantages

- Requires approximately four times more excavation than Alternative #3.
- Requires a soil nail wall approximately four times larger than that in Alternative #3.
- Larger project footprint than Alternatives #2 & #3
 - 31,000 Square Feet of more R/W needed
 - 42,000 Square Feet of disturbance to environmentally sensitive area
- Construction costs approximately 4 times higher than Alternative #3. The high cost, combined with other items for the bridge replacement project would exceed project budget.

Estimated Cost:

Roadway Excavation: 51,000 CY
~\$12/CY = \$612,000
Approx. Soil Nail Wall Area: 28,226 SF
~\$100/SF = \$2.82 Million
TOTAL: \$3.43 Million

Alternative 2: Provide full design standard ISD for a SU design vehicle: 838 feet of ISD.

This alternative would require a major cut and wall into the hillside, most likely requiring some controlled blasting. The soil nail wall would be approximately 50 feet tall at its highest point and up to 570 feet long. To allow for a clear sight line, the open area between the wall and SR 6 would be approximately 55 feet wide.

Advantages:

- Assuming that a longer sight distance reduces ISD related crashes up to a ISD of 1,015 feet, this alternative would have more Intersection sight distance related crashes than alternative 1 or alternative 4 but would have less crashes than alternative 3.
- Provides full ISD for an SU vehicle (838 feet), approximately 2.5 times the ISD currently available at the intersection for a SU vehicle approaching the intersection westbound
- Requires approximately half the excavation of Alternative #1.
- Soil nail wall size approximately 40% less than Alternative #1.
- Project Cost approximately 40% lower than Alternative #1.
- Utilizes smaller project footprint than Alternative #1.
- Exceeds stopping sight distance (570 feet at 60 mph) for vehicles on SR 6 if a truck pulls out in front of them from McCormick Creek Road.

Disadvantages:

- Requires two times more excavation than Alternative #3
- Construction costs over two times higher than Alternative #3. The high cost, combined with other items for the bridge replacement project would exceed project budget.
- Requires a larger project footprint than Alternative #3
- Does not provide the full ISD for left-turning or right-turning WB-50 vehicles from McCormick Creek Road onto SR 6.

Estimated Cost:

Excavation: 26,000 CY
~\$12/CY = \$312,000
Approx. Wall Area: 16,868 SF
~\$100/SF = \$1.69 Million
TOTAL: \$2.00 Million

Alternative 3: Provide full design standard ISD for a Passenger design vehicle: 662 feet of ISD.

This alternative would require a moderate cut and wall into the hillside, possibly requiring some controlled blasting. The

soil nail wall would be approximately 31 feet tall at its highest point and up to 440 feet long. To allow for a clear sight line, the open area between the wall and SR 6 would be approximately 25 feet wide.

Advantages:

- Provides full design level ISD criteria for a P vehicle (662 feet) for a P vehicle approaching the intersection westbound.
- Minimizes excavation required (~1/4 of the excavation of Alternative #1, ~1/2 of Alternative #2).
- Minimizes soil nail wall size required (~1/4 of Alternative #1, ~1/2 of Alternative #2).
- Utilizes smaller project footprint than Alternatives #1 & 2.
- Less construction delay to the traveling public than Alternatives #1 & 2.
- Exceeds stopping sight distance (570 feet at 60 mph) for vehicles on SR 6 if a truck pulls out in front of them from McCormick Creek Road.

Disadvantages:

- Assuming that a longer sight distance reduces ISD related crashes up to a ISD of 1,015 feet, this alternative would have more Intersection sight distance related crashes than the other alternatives.
- Does not provide the full ISD for left-turning or right-turning WB-50 vehicles from McCormick Creek Road onto SR 6.
- Construction costs are less than the other alternatives.
- Does not meet ISD guidelines for the selected WB-50 Design vehicle.

Estimated Cost:

Excavation: 13,400 CY
~\$12/CY = \$161,000
Approx. Wall Area: 7,332 SF
~\$100/SF = \$730,000
TOTAL: \$0.89 Million

Alternative 4: Relocate the McCormick Creek Road intersection to the west of bridge 6/102. (See Exhibit B)

Advantages:

- Provides full ISD for a WB-50 vehicle (1015 feet) for a WB-50 vehicle approaching the intersection westbound.
- Avoids major cuts in hillside.

Disadvantages:

- Requires a new permanent structure for McCormick Creek Road over McCormick Creek for Lewis County.
- Fill in the floodplain.
- Requires more Category II Wetland mitigation than other alternatives
- Increased probability of Historic/Cultural Resource impacts.
- Erosion and scour prevention costs are higher than with other alternatives.
- Dewatering costs during construction are higher than with other alternatives.
- Stormwater flow control cost could be higher than with other alternatives because of more new impervious surface area.
- Exceeds stopping sight distance (570 feet at 60 mph) for vehicles on SR 6 if a truck pulls out in front of them from McCormick Creek Road.

- No cost estimate was generated for this alternative. It was decided by SW Region management to not pursue this alternative because of the 72,000 Square Feet of disturbance to the National Register of Historic Places (NRNP).

Recommendations

Succinctly state why the preferred option was chosen. The decision should be performance-based, and should be stated in terms of performance trade-offs and associated mitigation measures.

The Preferred alternative #3 - provides 662 feet of ISD by excavating approximately 13,400 C.Y. of soil and rock and constructing a 440 LF soil nail wall to meet full design level ISD criteria for a P vehicle.

- Relationship to existing condition -
 - There has not been a fatal or severe injury crash related to this intersection for over 13 years and the recommended alternative will provide 662 feet of ISD, which is nearly double the 340 feet ISD currently available at the intersection.
 - There have been no ISD related crashes, of any severity, in the last 5 years, and that is with almost half of the sight distance available for the existing condition.
- Engineering Judgment -
 - The ISD provided by alternative #3 exceeds the Stopping Sight Distance (SSD) (570 feet at 60 mph). If a SU or combination truck were to pull onto SR 6 in front of a westbound vehicle that was not visible because of the cut slope ISD obstruction, the westbound vehicle has ample opportunity to avoid a collision because the required SSD is available.
 - For existing intersections, the DM allows reduction of the setback for ISD from 18 feet to 10 feet. Because this is a new intersection, this provision doesn't apply to this situation, however, when vehicles creep up to the edge of traveled way, about 700 feet of sight distance would be available with this alternative.
- Other considerations -
 - Alternatives #1 & #2 have construction costs which, combined with other project costs, would exceed the budget currently available for this project.
 - Alternative #3 produces a smaller project footprint than the other alternatives, which minimizes environmental impact. A smaller footprint helps with environmental compliance during construction by minimizing the area of exposure of erodible soil to rainfall.
 - Alternative #3 takes less time to construct and therefore minimizes impact to the traveling public.
 - Alternative #3 produces less waste material than Alternatives #1 & #2. It also would have the lowest amount of potential controlled blasting, which would reduce potential impacts to neighboring properties and wildlife.

Mitigation Measures

- The new intersection will provide a 90° intersection angle.
- New intersection ahead warning signs.
- New stop sign and stop bar on McCormick Creek Road.

List of Attachments

Evaluation Matrix

Vicinity Map (VM1)

Sight Distance Options (Exhibit A)

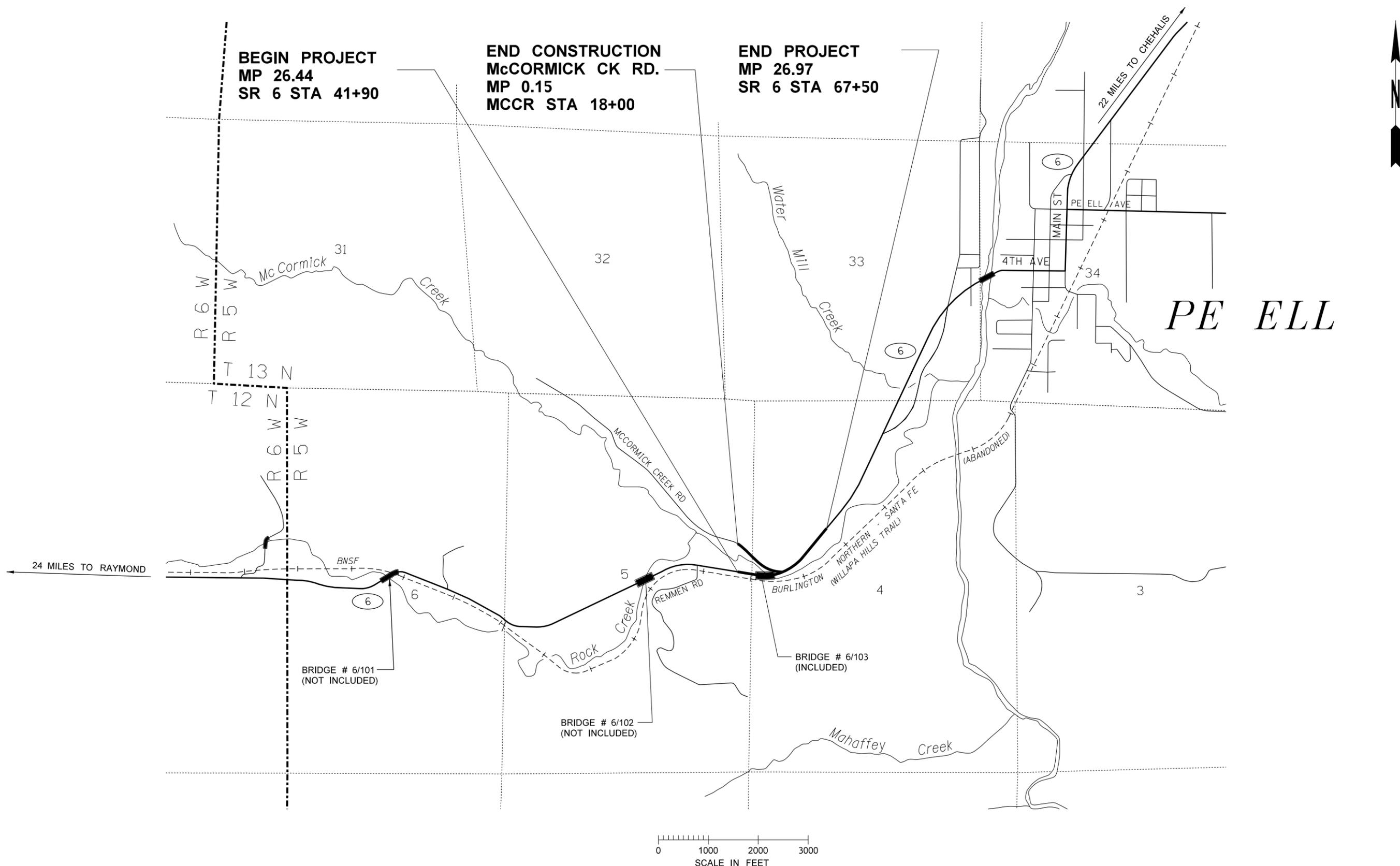
Alternative #4 alignment (Exhibit B)

Evaluation Matrix - SR 6 /103 Rock Creek Bridge – East Bridge Replacement

Performance Metrics 	Performance Metrics used to Evaluate Alternatives					Cost
Performance Target  	<p>In the last 5 years (2010 - 2015) there have been less crashes than other similar intersections. There is no Crash Modification Factor (CMF) for ISD. It is assumed longer sight distance reduces ISD related crashes up to a ISD of 1,015 feet Reduce risk of fatal and all injury Intersection Sight Distance (ISD) Related Crashes per year. Metric: fatal and all injury crashes per year Target: 0 Intersection Sight Distance (ISD) related fatal or injury crashes per year</p> <p>Minimize affect to land owners (60' of existing R/W) Metric: Acres of Disturbance Target: Minimize</p> <p>Minimize added disturbance of environmentally sensitive areas (wetlands and riparian habitat) Metric: Acres of disturbed environmentally sensitive areas Target: Minimum Acres of Disturbance</p> <p>Minimize added disturbance of environmentally sensitive areas (wetlands and riparian habitat) Metric: Acres of disturbed environmentally sensitive areas Target: Minimum Acres of Disturbance</p>					
1 - Full ISD for a WB-50 turning left - 1015 feet	+ + +	31,000 Sqft.	42,000 Sqft.	1,015 ft.		\$3.4 Million
2 - Full ISD for a SU turning left - 838 feet	+ +	12,500 Sqft.	23,000 Sqft.	838 ft.		\$2.0 Million
3 - Full ISD for Passenger Car turning left - 662 feet	+	1,500 Sqft.	12,000 Sqft.	662 ft.		\$0.89 Million

Score (relative to no-build and related to this Design Analysis):

- + + + Most Benefit
- + + More Benefit
- + Benefit
- o Neutral
- Impact



FILE NAME G:\444307\03-Design\Design\SR 6\SR6 Rock Cr. Bridges\CAD\PS&ESheets\PS_VM.dgn		REGION NO. STATE		FED.AID PROJ.NO.		 Washington State Department of Transportation		SR 6		Plot 4	
TIME 1:53:09 PM	DATE 1/19/2012	10	WASH					ROCK CREEK BRIDGE REPLACEMENT		PLAN REF NO VM1	
PLOTTED BY mittget	DESIGNED BY T. MITTGE	JOB NUMBER						SHEET			
ENTERED BY E. COOPER	CHECKED BY T. GREEN	CONTRACT NO.		LOCATION NO.				OF			
PROJ. ENGR. C. NEWELL	REGIONAL ADM. D. WAGNER	REVISION	DATE	BY		DATE		VICINITY MAP		SHEETS	

SR 6
6/103 ROCK CREEK BRIDGE - EAST BRIDGE REPLACEMENT
PIN # 400612A DEVIATION # 1, EXHIBIT A



PT 19+41.95

WB-50

120' CUT

MCCORMICK CREEK RD.

PT 10+22.24

Alt. #3 - 440' P-Car Soil Nail Wall & Cut Line
P - Car I/S SD 662'

Alt. #2 - 570' SU Soil Nail Wall & Cut Line
SU - VEHICLE I/S SD 838'

Alt. #1 - 780' WB-50 Soil Nail Wall & Cut Line
WB-50 - VEHICLE I/S SD 10115'

P-Car/SU Cut Line

PC 62+48.97

SR 6
6/103 ROCK CREEK BRIDGE - EAST
BRIDGE REPLACEMENT
PIN # 400612A DEVIATION # 1, EXHIBIT B

Possible McCormick Cr Rd
Realignment

MCCORMICK CREEK RD.

POSSIBLE MCCORMICK CREEK RD.
REALIGNMENT DDM #1 ALTERNATIVE #1

ORIGINAL MCCORMICK CREEK RD. ALIGNMENT

REEMEN RD.

BRIDGE #6102

BRIDGE #6103

