Latah Bridge Rehabilitation Study - Geometric Considerations for Select Bridge Rehabilitation Alternatives

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DATE:	November 12, 2012
PROJECT NUMBER:	425825

The purpose of this Memorandum is to summarize horizontal and vertical alignment considerations for the Sunset Boulevard corridor as it approaches the Latah Bridge in response to possible implementation of bridge rehabilitation concept alternatives D and E, as defined in the Latah Bridge Rehabilitation Study – Volume 2 study document.

Alternatives D and E have been developed as long-term rehabilitation concepts in that they consider the long term functional requirement needs of the bridge for multiple modes of transportation, while providing structural rehabilitation solutions that maximize the life span of the structure. Alternatives D and E both require widening of the bridge deck, and also will require changes to the east and west approaches and along Sunset Boulevard, to include roadway widening, and horizontal alignment revisions to meet current standards.

Alternatives D and E are described below, along with initial understanding of geometric implications for implementation of these Alternatives. Multiple geometric concepts have not been developed for each Alternative. Assessments of impacts and costs are not included as part of this analysis.

Bridge Rehabilitation Concept Alternative D

Figure 1 illustrates bridge rehabilitation concept Alternative D. This alternative widens the bridge deck to accommodate 4-lanes of traffic, 5-foot bike lanes, and 6-foot sidewalks, along with bridge railing, and traffic railing.



Figure 1: Alternative D – Latah Bridge Roadway Section (4-lanes and bike lanes)

Roadway Sections

In accordance with the City of Spokane "Design Standards"¹, arterial requirements and widths are described in Table 3-A. For principal arterials, the minimum thru lane width is 12-feet, the minimum bike lane width is 5-feet, and the minimum two-way-left-turn lane width is 14-feet.

West of Latah Bridge

West of the Latah Bridge, Sunset Boulevard consists of a 5-lane roadway, with intermittent sections of 6-foot sidewalks behind vertical curb and gutter. Thru travel lanes are 12-feet wide, and the two-way-left-turn lane is 14-feet wide. The approximate curb-curb width of the roadway is 62-feet.

Implementation of Alternative D would add two 5-foot bicycle lanes to the existing roadway section, which would move the curbs and sidewalks out an additional 5-feet. Proposed curb-curb width of the roadway would be 72-feet. Figure 2 illustrates a roadway section concept for west of Latah Bridge.



Figure 2: Alternative D – Sunset Boulevard Roadway Section (West of Bridge) (5-lanes and bike lanes)

East of Latah Bridge

East of the Latah Bridge, between the bridge and the intersection with 4th Avenue, Sunset Boulevard is largely comprised of an underpass configuration with Inland Empire Way. Sunset Boulevard consists primarily of two-lanes (one in each direction). The Sunset Boulevard lanes are located on either side of Inland Empire Way, as it transitions from an underpass and rises to match the grades of Sunset Boulevard, just west of the 4th Avenue intersection. As Sunset Boulevard reaches 4th Avenue, it is comprised of four-lanes, with intermittent sections of 6-foot sidewalks behind vertical curb and gutter. Thru travel lanes are 12-feet wide.

Implementation of Alternative D would require revisions to the Sunset Boulevard/Inland Empire Way underpass to provide for four-lanes on Sunset Boulevard. Two 5-foot bicycle lanes would also be included in these revisions. These roadway section revisions, along with horizontal alignment recommendations (see below), would necessitate replacement of the existing underpass structure. Figure 3 illustrates a roadway section concept for east of Latah Bridge.

¹ "Design Standards," City of Spokane Dept. of Engineering Services, February, 2007.



Figure 3: <u>Alternative D – Sunset Boulevard Roadway Section (East of Bridge)</u> (4-lanes and bike lanes)

It is possible that revisions to the Sunset Boulevard/Inland Empire Way underpass may be accomplished under a separate capital project outside the Latah Bridge rehabilitation. It is important to note that if these revisions are not accomplished, a sub-standard transition from four-lanes to two-lanes would be required, and coupled with the horizontal geometry and underpass configuration, would cause congestion at this location, and would likely introduce additional hazards to the travelling public.

Horizontal Alignment

In accordance with the City of Spokane "Design Standards", horizontal geometry considerations shall be in accordance with low volume urban street criteria as described in AASHTO "A Policy on Geometric Design for Highways and Streets²." This standard suggests a minimum horizontal curve radius of 490-feet for 40mph design speed.

Refer to Exhibit 1 for a conceptual horizontal layout of Alternative D.

West of Latah Bridge

No horizontal curve radius changes are required between the west bridge approach and the intersection with Government Way. Existing radii exceed the minimum standard.

East of Latah Bridge

East of the bridge, horizontal geometry improvements are recommended to accommodate the revisions to the Sunset Boulevard/Inland Empire Way underpass and provide for minimum standard radii. Exhibit 1 illustrates how 490-foot minimum standard radii would improve horizontal geometry. Entering sight distance from Coeur d'Alene Street would be significantly improved by implementing standard horizontal geometry on Sunset Boulevard.

It is recommended that the intersection of Hemlock St. and Sunset Boulevard be eliminated due to the intersections proximity to the Coeur d'Alene St./Sunset Boulevard intersection, the challenging skew angle of the intersection, coupled with the sight distance challenges at this location.

Vertical Alignment

In accordance with the City of Spokane "Design Standards", maximum longitudinal roadway grades shall be at least 0.8 percent, and at most 8 percent. Vertical curves are required when the algebraic difference in roadway grades exceeds one percent. Minimum vertical curve length for sag or crest curves is three times the design speed, or 120-feet. The

 $^{^2}$ "A Policy on Geometric Design for Highways and Streets," AASHTO, Fourth Edition, 2001.

existing conditions appear to exceed this standard. As a result, no changes to vertical alignment are suggested at this time.

Bridge Rehabilitation Concept – Alternative E

Figure 2 illustrates bridge rehabilitation concept Alternative E. This alternative widens the bridge deck to accommodate 4-lanes of traffic, shared-use bicycle lanes, and 6-foot sidewalks, along with bridge railing, and traffic railing. Further, the inside travel lanes are intended to be shared with light rail vehicles, as they may be implemented at some point in the future.



Figure 4:Alternative E - Latah Bridge Roadway Section(Future light rail, 4-lanes and shared-use lanes)

Roadway Sections

In accordance with the City of Spokane "Design Standards", arterial requirements and widths are described in Table 3-A. For principal arterials, the minimum thru lane width is 12-feet, the minimum shared-use bicycle lane is 15-feet, and the minimum two-way-left-turn lane width is 14-feet.

Tri-Met "Design Criteria"³ for Light Rail Transit (LRT) were used in this analysis, as a practical, regional standard. Clearance standards are presented in Chapter 22. Minimum track to track centerline separation on tangents is 12-feet, and 14-feet minimum is recommended. On curves, clearance envelopes must be calculated for the vehicles to ensure that vehicle space is clear of obstructions.

West of Latah Bridge

West of the Latah Bridge, Sunset Boulevard consists of a 5-lane roadway, with intermittent sections of 6-foot sidewalks behind vertical curb and gutter. Thru travel lanes are 12-feet wide, and the two-way-left-turn lane is 14-feet wide. The approximate curb-curb width of the roadway is 62-feet.

³ "Design Criteria," Tri-Met, Revision 10.0, January, 2010

West of Latah Bridge, LRT is best accommodated by locating the tracks on a raised concrete median along the center of the Sunset Boulevard corridor. As such, vehicular traffic must transition from the shared LRT/travel lanes on the Latah Bridge to become adjacent to the raised LRT median. Figure 5 illustrates a recommended roadway section for west of the Latah Bridge.



Figure 5: Alternative E – Sunset Boulevard Roadway Section (West of Bridge) (Future light rail, 4-lanes and shared-use lanes)

East of Latah Bridge

East of the Latah Bridge, due to the complex nature of the Inland Empire Way underpass, LRT is best accommodated by allowing the Sunset Boulevard corridor to occupy the center of the existing right of way, and transition the grade separated access ramps to Inland Empire Way to the outside of the Sunset Boulevard travel lanes. This significant reconfiguration of the underpass minimizes conflicts between LRT vehicles and motorized traffic, and improves operations. Figure 6 illustrates the reconfiguration of the Inland Empire Way underpass. Note that LRT vehicles continue to share the inside travel lane with motorized vehicles thru the underpass, and would eventually transition to have all vehicular lanes outside a raised concrete LRT median, similar to the scenario described for West of the Latah Bridge.



Figure 6: <u>Alternative E – Sunset Boulevard Roadway Section (East of Bridge)</u> (Future light rail, 4-lanes and shared-use lanes)

Horizontal Alignment

In accordance with the City of Spokane "Design Standards", horizontal geometry considerations shall be in accordance with low volume urban street criteria as described in

AASHTO "A Policy on Geometric Design for Highways and Streets." This standard suggests a minimum horizontal curve radius of 490-feet for 40mph design speed.

Tri-Met "Design Criteria" for Light Rail Transit (LRT) were used in this analysis, as a practical, regional standard. Track geometry and trackwork standards are presented in Chapter 3. Minimum horizontal curve radii for 40 mph design speed is based on degree of curvature, and in no case shall be less than 82-feet. Spiral curve transitions are required, and superelevation of the tracks will also be required if the curve radius is below 11,000-feet. Minimum tangent length between curved sections is 100-feet or 3 times the design speed (120').

Refer to Exhibit 2 for a conceptual horizontal layout of Alternative E.

West of Latah Bridge

No horizontal curve radius changes are required between the west bridge approach and the intersection with Government Way. Existing radii exceed the minimum AASHTO roadway standard and will accommodate LRT at 40mph operating speeds.

East of Latah Bridge

East of the bridge, horizontal geometry improvements are recommended and feasible to accomplish with the reconfiguration of the Inland Empire Way underpass. Exhibit 2 illustrates how horizontal curves that exceed the minimum may be accommodated. Entering sight distance from Coeur d'Alene Street would be substantially improved by implementing standard horizontal geometry on Sunset Boulevard.

It is recommended that the intersection of Hemlock St. and Sunset Boulevard be eliminated due to the proximity to the Coeur d'Alene St./Sunset Boulevard intersection, the challenging skew angle of the intersection, coupled with the sight distance challenges at this location.

Vertical Alignment

In accordance with the City of Spokane "Design Standards", maximum longitudinal roadway grades shall be at least 0.8 percent, and at most 8 percent. Vertical curves are required when the algebraic difference in roadway grades exceeds one percent. Minimum vertical curve length for sag or crest curves is three times the design speed, or 120-feet.

Tri-Met "Design Criteria" for Light Rail Transit (LRT) were used in this analysis, as a practical, regional standard. Track geometry and trackwork standards are presented in Chapter 3. Maximum longitudinal grades for LRT vehicles on mainline tracks should not exceed 5%, with an absolute maximum of 7%. Minimum length vertical curves are based on design speed. For design speeds in excess of 35 mph, the minimum vertical curve length is based on the following formula L=70*(G_1 - G_2).

No changes to vertical alignment are suggested at this time. The existing Sunset Boulevard vertical geometry appears to exceed minimum standards. Maximum LRT grades may be reached west of the Sunset Boulevard/Government Way intersection, where grades appear (from GIS data) to exceed 5% in places.

Conclusions

This limited analysis suggests only two of a number of possible options for addressing geometric challenges on Sunset Boulevard associated with potential implementation of alternatives that widen the Latah Bridge. In order to accommodate four lanes of vehicular traffic, non-motorized facilities, and possibly light rail, a number of geometric challenges must be addressed immediately east and west of the Latah Bridge. In particular, east of Latah Bridge, the Sunset Boulevard/Inland Empire Way underpass presents unique geometric challenges that may require significant reconfiguration.

In order to gain a complete understanding of the range of feasible alternatives for addressing these roadway corridor geometric issues, it is recommended that a more detailed evaluation of the east end roadway approach alternatives should be performed prior to selecting the preferred alternative for the final deck configuration on the Latah Bridge. This approach will allow the City to understand how bridge and roadway solutions are interlinked, possible phased approach opportunities, and how best package project(s) to pursue funding.



