KINGS RIVER BRIDGE
WATERWAY DESIGN HYDRAULICS MEMO

To: Reuben Johnson, WFLHD Project Manager
From: Carolyn Sourek, WFLHD Hydraulics Engineer
Date: July 19, 2016
Project: AK DOT 135(6) – Glenn Highway: Kings River Bridge

Background
The Alaska Department of Transportation & Public Facilities (AKDOT&PF), in conjunction with the Western Federal Lands Highway Division, is developing roadway improvements on 26 miles of the Glenn Highway east of Palmer, Matanuska-Susitna Borough, Alaska. The road improvements for the Glenn Highway Project: MP 66.5 – 92 include restoring, resurfacing, and rehabilitating the existing roadway, stream bank stabilization, bridge construction, and installation and repair of major drainage crossings.

The section of the Glenn Highway Project which includes replacement of the bridge near MP 66.5 (Latitude 61°43'55.90"N, Longitude 148°44'59.16"W NAD27), is designated Kings River Bridge. Currently, the proposed bridge centerline alignment is shifted 50 feet upstream of the existing structure centerline to allow for public roadway access on the existing structure during construction. The roadway improvements in this section include approximately 2000 feet of roadway realignment to accommodate the bridge shift. A project map is provided as Figure 1 in the attachments. AKDOT will continue to maintain the bridge and roadway. WFLHD is designing the bridge and roadway per Federal Highways Administration (FHWA) and AKDOT guidelines. Recommendations for the initial waterway width, skew angle, minimum bridge low chord elevation, and abutment type are presented.

Recommendations

- Minimum low chord elevation (project datum calculated from AK83-4) 570 feet (to match the existing highway bridge low chord), provides 3 feet minimum clearance from peak 100 year storm water surface elevation (563 feet)
- Waterway width 155 feet, at channel elevation 552 feet
- Spill through abutment with side slopes 1V:2.5H
- Angle between bridge centerline and channel (at bankfull flow) centerline 90 degrees
- Offset left (looking downstream) bridge end 125-135 feet south from existing left bridge end
- Grade waterway elevation to 552 feet
- Offset from existing highway bridge 50 foot minimum upstream, to approximate location of historic truss bridge
- Match skew angle of existing piers, 90 degrees to the bridge centerline
Memo to: Reuben Johnson, WFLHD Project Manager  
July 19, 2016

- Abutment protection riprap Class VI (FP 14) or Class III (AKDOT), 5 feet thick

**Site Description**

Kings River is an alluvial tributary of the Matanuska River, which is a major contributing stream of the Knik Arm, ultimately flowing into the Cook Inlet. Kings River appears to be fed by snowmelt primarily, with a drainage basin of 150 square miles. The Kings River confluence with Matanuska River is less than 500 feet downstream of the proposed bridge.

The streambed material is well graded, with sand, gravels, rounded cobbles, and the occasional small boulder. It appears to transport easily during flood events. This system appears to be aggrading. Upstream of the bridge, the channel is dredged, with material stockpiled into makeshift berms to control lateral migration as well as define the main channel. There is currently an existing 115 foot long spur dike upstream of the south abutment as well as riprap lined roadway embankment. This rock is Class VI (FP 14), or Class 3 (AKDOT). Past inspection reports (1971, 1975, and 1981) and maintenance reports (2012) indicate that the riprap spur dike and abutment protection on the south bank have required replacement several times after larger storm events. An existing conditions map is provided as Figure 2. Image gradations processed by Hydraulic Toolbox v4.2 for streambed material and riprap, are provided in the attachments.

Kings River is a braided river. Lateral migration is active and the south bank upstream of the crossing actively erodes during higher flows. Ordinary high water, or approximate bankfull width, is 75 feet, per survey, at the proposed bridge site. Depth is approximately 4 feet during ordinary high water.

Kings River produces large woody debris. One foot diameter logs and larger were observed in the stream channel and deposited on gravel bar created by primary and secondary channels upstream of the bridge.

**Hydrology**

Peak streamflow predictions were calculated from the USGS Scientific Report 2016-5024 Regression Tool. This stream is not gaged and no gage data is available. Peak flows are provided in the Bridge Hydraulics Summary in the attachments.

**Hydraulics**

Survey data collected in 2014 by M. Rucinski, LSIT, and in 2015 by R&M Consultants, was combined by WFLHD. The combined basemap was converted to the Glenn Highway project datum, from AK83-4. Orthographic photographs were also obtained from the USGS Alaska Science Center. They were collected as part of the Geomorphology and Bank Erosion of the Matanuska River, Southcentral Alaska study, Scientific Investigations Report 2011-5214. A comparison of these photographs at the project site is provided in the attachments.

It is expected that backwater from the Matanuska River does not influence Kings River, even though their confluence is within 500 feet. The Matanuska is highly braided and its main channel changes location within the braid plain often. When on the west bank, the Kings River confluence is much greater than 500 feet. Cross sections were taken from combined survey and input into HEC-RAS to determine 100 and 500 year water surface elevations. Ordinary high water (OHW) marks were collected in the 2015 survey. The 2 year storm water surface elevation through the bridge was approximately 560 feet, approximately 4 feet higher than the OHW elevation.

Thalweg elevation was determined to be 552 feet. Water surface modeling was performed using the Hec-Ras ver. 5.0. Output report and data is available in the attachments. A floodplain elevation for Kings
River of 558 feet was determined from survey data.

**Lateral Migration**

The Kings River actively migrates during higher flows, contributing large woody debris and sediment to the channel and downstream reaches. As part of the Matanuska Bank Erosion study performed by USGS, a historic braid plain was delineated. This braid plain is consistent with channel lateral migration in the past 100 years. The braid plain fans out within 800 feet of its confluence with the Matanuska. At the bridge, the braid plain is approximately 800 feet; while upstream it is closer to 500 feet wide. Spur dikes will be necessary to control channel migration.

**Scour**

Scientific Investigations Report 2004-5066 Summary and Comparison of Multiphase Streambed Scour Analysis at Selected Bridge Site in Alaska, prepared by USGS in cooperation with AKDOT, provides modeling results for a scour analysis performed at the existing Kings River highway bridge. These results will be compared to hydraulic modeling and analysis done in response to this project. The contraction scour depth of 0.0 feet was the same for 100 and 500 year events per USGS SIR 2004-5066. This indicates that there is no contraction and the waterway width is hydraulically adequate. A pier scour depth of 7.2 feet was the same for 100 and 500 year events per USGS SIR 2004-5006.

Attachments: Bridge Hydraulics Summary – Partially Complete
Site Visit Photos
Figure 1 – Project Map
Figure 2 – Existing Conditions Map
Figure 3 – Proposed Conditions Map
Figure 4 – Orthographic Photo Comparison
Gradation Data
Gaged Peak Streamflows – USGS
HEC RAS Report Output

Cc: Sven Leon, WFLHD Hydraulics Team Lead
Benn Oltmann, WFLHD Structures
Kevin Harrison, WFLHD Design
Matthew Hinshaw, WFLHD Design
Doug Anderson, WFLHD Engineering Geologist
Brian Collins, WFLHD Geotechnical
Stephen Morrow, WFLHD Environmental
Larry Goble, WFLHD Survey
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**BRIDGE HYDRAULICS & SCOUR ANALYSIS SUMMARY**

To: Reuben Johnson, WFLHD Project Manager  
By: Carolyn Sourek, PE

Project: AK DOT 135(6)  
Bridge: Kings River  
Date: 7/19/2016

**BRIDGE STRUCTURE SUMMARY**

<table>
<thead>
<tr>
<th>Low Chord Elevation</th>
<th>570.0 feet (project datum from AK83-4)</th>
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<tbody>
<tr>
<td>Minimum Design Freeboard</td>
<td>3.0 feet above ex hwy bridge low chord</td>
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<tr>
<td>Stream Bottom Elevation</td>
<td>552.0 feet</td>
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<td>Clearance to Stream Bot.</td>
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<td>Waterway Width</td>
<td>180 feet</td>
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<td>Skew</td>
<td>90 degrees relative to stream</td>
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<td>Bridge/Stream CL Sta</td>
<td>Bridge Start</td>
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<tr>
<td>Abutment Type</td>
<td>Spill-through, one pier at Sta. XX+XX (135 ft spans)</td>
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**HYDRAULIC & HYDROLOGIC SUMMARY**

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<thead>
<tr>
<th>Flood Frequency</th>
<th>Yr</th>
<th>2</th>
<th>10</th>
<th>25</th>
<th>50</th>
<th>100</th>
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<tr>
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<td>50</td>
<td>10</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>0.2</td>
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<tr>
<td>Discharge</td>
<td>cfs</td>
<td>2,660</td>
<td>4,670</td>
<td>5,740</td>
<td>6,540</td>
<td>7,380</td>
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<td>Modeled Water Surface Elevation</td>
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<td>560.5</td>
<td>561.8</td>
<td>562.4</td>
<td>562.8</td>
<td>563.0</td>
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<tr>
<td>Elev</td>
<td>Ft</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
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<tr>
<td>Clearance above WS</td>
<td>Ft</td>
<td>9.5</td>
<td>8.2</td>
<td>7.6</td>
<td>7.2</td>
<td>7.0</td>
<td>6.2</td>
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<td>Design Flow Velocity</td>
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<td>Scour Base Elevation (Channel Thalweg)</td>
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<td>Contraction Scour Depth</td>
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<td>Stream Degradation Depth</td>
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<tr>
<td>Left Abutment Scour Depth</td>
<td>Ft</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Right Abutment Scour Depth</td>
<td>Ft</td>
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<tr>
<td>Total Left Abutment Scour Elevation</td>
<td>Elev</td>
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<tr>
<td>Total Right Abutment Scour Elevation</td>
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<tr>
<td>Pier Scour Depth</td>
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<tr>
<td>Total Pier Scour Elevation</td>
<td>Elev*</td>
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Streambed material grain size (inches)  
D100: 25.1  
D50: 6.29  
D15: 2.44  

**RECOMMENDED SCOUR COUNTERMEASURES**

<table>
<thead>
<tr>
<th>Type</th>
<th>Class VI (FP 14) or Class III (AKDOT)</th>
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<tbody>
<tr>
<td>Top Elevation</td>
<td>569.0</td>
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<tr>
<td>Bottom Elevation</td>
<td>547.0</td>
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<tr>
<td>Thick (Ft)</td>
<td>5</td>
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<tr>
<td>Riprap Design Basis</td>
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* or to bedrock when present.

Glenn Highway (from AK83-4)
### Kings River

#### FOUNDATION SUMMARY

To be completed.

#### GEOTECHNICAL SUMMARY

To be completed.

#### STREAM PLAN & PROFILE STABILITY

To be completed.

ak-dot013506_BridgeHydraulicsSummary.xls
Main channel thalweg contained almost entirely between south abutment and pier. Higher floods utilize additional spans.

Large woody debris on gravel bar separating main channel from secondary channel to the south. Spur dike with Class VI (FP 14) or Class III (AKDOT) riprap has been replaced or repaired several times since the bridge.

Secondary channel utilized during most flows.
Looking upstream from the bridge.

Photo taken during May 2016 site visit. Secondary channel appears to be accepting more flow than in the previous year.

Bank erosion deposits large woody debris. Easily mobilized sediment is dredged from stream channel.

South Roadway Embankment and Berm

Class IV (FP 14) or Class III (AKDOT) roadway embankment protection along south approach roadway. Makeshift berm appears to be made out of fill material.

On Bridge - Looking Upstream

Looking upstream from the bridge. Photo taken during May 2016 site visit. Secondary channel appears to be accepting more flow than in the previous year.
Looking Upstream from Bridge

Looking upstream from the bridge. Small overflow channel to the north of main channel. Flow through North span. Historic bridge abutment can also be seen. Approximate offset distance for proposed bridge.

6/3/2015
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Approximate Project Boundary

Project Site

FIGURE 1
PROJECT MAP – AK DOT 135(6)
GLENN HIGHWAY: KINGS RIVER BRIDGE

Kings River Watershed
Bridge Location
Munuska River
Knik River
Knik Arm
Cook Inlet

0 10 miles
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FIGURE 2
EXISTING CONDITIONS MAP
KINGS RIVER BRIDGE CROSSING

*Aerial dated 2006 provided by USGS on 06/2016. Survey linework provided by AKDOT, performed by R&M Consultants 10/2015 – 12/2015.
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*Aerial dated 2006 provided by USGS on 06/2016. Survey linework provided by AKDOT, performed by R&M Consultants 10/2015 – 12/2015.
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**FIGURE 4**
ORTHOGRAPHIC COMPARISON
KINGS RIVER BRIDGE CROSSING

Edge of channel (2015)
Ordinary High Water (2015)

*Aerials provided by USGS on 06/2016. Survey linework provided by AKDOT, performed by R&M Consultants 10/2015 – 12/2015.*
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