SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 65170185 Date 10-28 Initials RT Region (A B (C) D)

Site ____________ Location Swan creek 0.5 S Akaska

Q_{100} = 9970 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. ✓

Bridge discharge (Q_2) = 9970 (should be Q_{100} unless there is a relief bridge, road overflow, or bridge overtopping)

Analytical Procedure for Estimating Hydraulic Variables Needed to Apply Method

PGRM: "RegionA", "RegionB", "RegionC", or "RegionD"

Bridge Width = 104 ft. Flow angle at bridge = 0 ° Abut. Skew = 0 ° Effective Skew = 0 °

Width (W_2) iteration = 104 ____ ____ ____

Avg. flow depth at bridge, y_2 iteration = 13.8 ____ ____ ____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 104 ft* $q_2 = Q_2/W_2$ = 95.9 ft^2/s

Bridge Vel, V_2 = 6.9 ft/s Final $y_2 = q_2/V_2$ = 13.8 ft Δh = 1 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 14.8 ft

** NOTE: repeat above calculations until y_2 changes by less than 0.2* *Effective pier width = L sin(q) + a cos(q)*

If y_2 is above LS, then account for Road Overflow using PRGM: RDOVREGA, RDOVREGB, RDOVREGC, or RDOVREGD,

bridge flows abutment to abutment at Q_{100}

Water Surface Elev. ≈ -3.1 ft

Low Steel Elev. = 16.5 ft

n (Channel) = .032 some trees/brush and dead timber in high flow channel

n (LOB) = .027 grazed pasture

n (ROB) = .029 pasture with trees, not grazed

Pier Width = 2.25 ft

Pier Length = 2.25 ft

\# Piers for 100 yr = 2 ft

the bridge may be the low point in the roadway. possibly lower point over road in Akaska

CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 104 ft

Width of left overbank flow at approach, W_{lob} = 208 ft — 2x bridge opening Average left overbank flow depth, y_{lob} = 1.8 ft

Width of right overbank flow at approach, W_{rob} = 94 ft (to trees) Average right overbank flow depth, y_{rob} = 2.8 ft

right overbank grass is higher, trees will minimize right overbank flow

Live Bed Contraction Scour (use if bed material is small cobbles or finer)

x = 2.73 From Figure 9 W_2 (effective) = 99.5 ft y_{cs} = 3.3 ft

PGRM: CWCSNEW

Clear Water Contraction Scour (use if bed material is larger than small cobbles)

N/A

Estimated bed material D_{50} = ____ ft Average approach velocity, $V_1 = Q_{100}/(y_1 W_1)$ = ____ ft/s

Critical approach velocity, $Vc = 11.17 y_1^{1/6} D_{50}^{1/3}$ = ____ ft/s

If $V_1 < V_c$ and $D_{50} >= 0.2$ ft, use clear water equation below, otherwise use live bed scour equation above.

$D_{c50} = 0.0006(q_2/y_1^{7/6})^3$ = ____ ft If $D_{50} >= D_{c50}$, $\chi = 0.0$

Otherwise, $\chi = 0.122 y_1 [q_2/(D_{50}^{1/3} y_1^{7/6})]^{6/7} - y_1$ = ____ From Figure 10, y_{cs} = ____ ft

PIER SCOUR CALCULATIONS

PGRM: Pier

L/a ratio = 1 Correction factor for flow angle of attack (from Table 1), K2 = 1

Froude # at bridge = 0.33 Using pier width a on Figure 11, ξ = 8.8 Pier scour y_{ps} = 7.4 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 1.8 ft right abutment, y_{aRT} = 2.8 ft

Shape coefficient K_1= 1.00 for vertical-wall, 0.82 for vertical-wall with wingwalls, (0.55) for spill-through

Using values for y_{aLT} and y_{aRT} on figure 12, ψ_{LT} = 7.4 and ψ_{RT} = 11.2

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 7.4 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 11.2 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. ________ Date ________ Initials ________ Region (A B (C) D)

Site ________ Location ________

20.8 / 3.2 / 17.6

Q_{500} = 21,200 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. ✓

Bridge discharge (Q_2) = 16,200 (should be Q_{500} unless there is a relief bridge, road overflow, or bridge overtopping)

PGRM: "RegionA", "RegionB", "RegionC", or "RegionD"

Analytical Procedure for Estimating Hydraulic Variables Needed to Apply Method

Bridge Width = 104 ft. Flow angle at bridge = 0 ° Abut. Skew = 0 ° Effective Skew = 0 °

Width (W_2) iteration = 104 ____ ____ ____

Avg. flow depth at bridge, y_2 iteration = 17.6 ____ ____ ____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 104 ft* $q_2 = Q_2/W_2$ = 155.8 ft^2/s

Bridge Vel, V_2 = 8.9 ft/s Final $y_2 = q_2/V_2$ = 17.6 ft Δh = 1.6 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 19.2 ft

** NOTE: repeat above calculations until y_2 changes by less than 0.2* *Effective pier width = L sin(q) + a cos(q)*

If y_2 is above LS, then account for Road Overflow using PRGM: RDOVREGA, RDOVREGB, RDOVREGC, or RDOVREGD,

Water Surface Elev. = -3.1 ft

Low Steel Elev. = 16.5 ft

n (Channel) = .032

n (LOB) = .027

n (ROB) = .029

Pier Width = 2.25 ft

Pier Length = 2.25 ft

\# Piers for 500 yr = 2 ft

Qmax scour < Q500

Qmax scour ≈ 16,200 cfs ≈ 17.6'

CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 104 ft

Width of left overbank flow at approach, W_{lob} = 208 ft Average left overbank flow depth, y_{lob} = 5.0 ft

Width of right overbank flow at approach, W_{rob} = 94 ft (← to trees) Average right overbank flow depth, y_{rob} = ~~7.6~~ 5.9 ft

Live Bed Contraction Scour (use if bed material is small cobbles or finer)

x = 8.72 From Figure 9 W_2 (effective) = 99.5 ft y_{cs} = 9.6 ft

PGRM: CWCSNEW

Clear Water Contraction Scour (use if bed material is larger than small cobbles)

Estimated bed material D_{50} = ____ ft Average approach velocity, $V_1 = Q_{500}/(y_1W_1)$ = ____ ft/s

Critical approach velocity, $Vc = 11.17y_1^{1/6}D_{50}^{1/3}$ = ____ ft/s

If $V_1 < V_c$ and D_{50} >= 0.2 ft, use clear water equation below, otherwise use live bed scour equation above.

$D_{c50} = 0.0006(q_2/y_1^{7/6})^3$ = ____ ft If $D_{50} >= D_{c50}$, χ = 0.0

Otherwise, $\chi = 0.122y_1[q_2/(D_{50}^{1/3}y_1^{7/6})]^{6/7} - y_1$ = ____ From Figure 10, y_{cs} = ____ ft

N/A

PIER SCOUR CALCULATIONS

PGRM: Pier

L/a ratio = 1 Correction factor for flow angle of attack (from Table 1), K2 = 1

Froude # at bridge = 0.37 Using pier width a on Figure 11, ξ = 8.8 Pier scour y_{ps} = 7.6 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 5.0 ft right abutment, y_{aRT} = ~~7.6~~ 5.9 ft

Shape coefficient K_1= 1.00 for vertical-wall, 0.82 for vertical-wall with wingwalls, (0.55) for spill-through

Using values for y_{aLT} and y_{aRT} on figure 12, ψ_{LT} = ~~20~~ 15 and ψ_{RT} = 16.6

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 15 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 16.6 ft

Route 303 Ave Stream Swan Creek MRM ________ Date ____________ Initials ________

Bridge Structure No. 65170185 Location 0.5 mi S. Akaska

GPS coordinates: 45° 19.614' taken from: USL abutment ✓ centerline of ⇑ MRM end ______

100° 7.233' Datum of coordinates: WGS84 ✓ NAD27 _____

cont.

Drainage area = ~~52.4~~ 521.32 sq. mi.

The average bottom of the main channel was 20.8 ft below top of guardrail at a point 39 ft from left abutment.

Method used to determine flood flows: ____Freq. Anal. ____drainage area ratio ✓ regional regression equations.

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 9970			Q_{500} = 21,200		
Estimated flow passing through bridge	9970			16,200		
Estimated road overflow & overtopping	0			5000		
Consideration	Yes	No	Possibly	Yes	No	Possibly
Chance of overtopping		✓		✓		
Chance of Pressure flow		✓		✓		
Armored appearance to channel		✓			✓	
Lateral instability of channel			✓			✓

Riprap at abutments? _____Yes ✓ No _____Marginal

Evidence of past Scour? ✓ Yes _____No _____Don't know

Debris Potential? _____High ✓ Med _____Low

there appears to be a contraction scour pool below bridge. Possibly some minor pier scour.

Does scour countermeasure(s) appear to have been designed?

Riprap	_____Yes	_____No	_____Don't know	✓ NA
Spur Dike	_____Yes	_____No	_____Don't know	✓ NA
Other ________________	_____Yes	_____No	_____Don't know	✓ NA

Bed Material Classification Based on Median Particle Size (D_{50})

Material	Silt/Clay ✓	Sand_____	Gravel_____	Cobbles_____	Boulders_____
Size range, in mm	<0.062	0.062-2.00	2.00-64	64-250	>250

Comments, Diagrams & orientation of digital photos

right abutment scour will probably be less than estimate because trees will slow overbank flow and create an ineffective flow area

photos
structure number
approach from bridge center
left overbank from bridge
right overbank from bridge
bridge opening from left approach
scour pool underneath bridge

Summary of Results

	Q100	Q500
Bridge flow evaluated	9970	16,200
Flow depth at left abutment (yaLT), in feet	1.8	5.0
Flow depth at right abutment (yaRT), in feet	2.8	5.9
Contraction scour depth (ycs), in feet	3.3	9.6
Pier scour depth (yps), in feet	7.4	7.6
Left abutment scour depth (yas), in feet	7.4	15
Right abutment scour depth (yas), in feet	11.2	16.6
1Flow angle of attack	0	0

See Comments/Diagram for justification where required

Basin characteristics from
Provisional StreamStats 10-17-11

Cont. D.A. = ~~32.37~~ 521.32 mi^2 (544 - 22.68)

PII = 0.65

100% Subregion B

Manually calculated peaks

Q_{100} = ~~1760 cfs~~ 9970 cfs

Q_{500} = ~~3370 cfs~~ 21,200 cfs