OK RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 21030282 Date 7/11/12 Initials RAT Region (A (B) C D)

Site _____ Location in Bear Creek on FAS 6247

Q_{100} = 7310 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 7310 (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 = 141 ft. Flow angle at bridge = 20 ° Abut. Skew = 0 ° Effective Skew = 20 °

Width (W_2) iteration = _____ _____ _____ _____

Avg. flow depth at bridge, y_2 iteration = _____ _____ _____ _____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 132.5 ft* $q_2 = Q_2/W_2$ = 55.2 ft^2/s

Bridge Vel, V_2 = 6.2 ft/s Final $y_2 = q_2/V_2$ = 8.8 ft Δh = 0.8 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 9.6 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. = 0 ft

Low Steel Elev. = 15.0 ft

n (Channel) = ~~0.040~~ 0.035 5.3

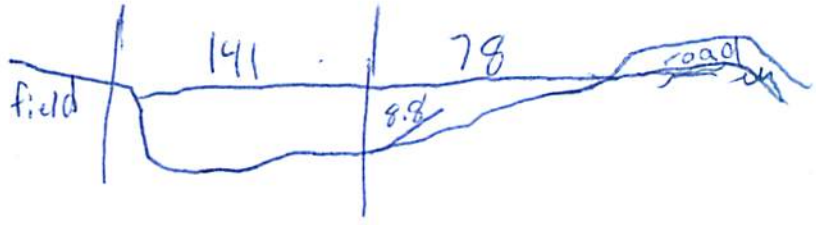
n (LOB) = 0.030

n (ROB) = 0.060

Pier Width = 2 ft

Pier Length = 2 ft

Piers for 100 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 141 ft

Width of left overbank flow at approach, W_{lob} = 0 ft Average left overbank flow depth, y_{lob} = 0 ft

Width of right overbank flow at approach, W_{rob} = ~~63~~ 74 ft Average right overbank flow depth, y_{rob} = 8.8 ft

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

x = 3.97 From Figure 9 W_2 (effective) = 128.5 ft y_{cs} = 4.5 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, $V_1 = Q_{100}/(y_1W_1)$ = _____ 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 $D_{50} >= D_{c50}$, $\chi = 0.0$

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

PGRM: Pier

PIER SCOUR CALCULATIONS

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 Pier scour y_{ps} = 6.9 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 0 ft right abutment, y_{aRT} = 8.8 ft

Shape coefficient K_1= 1.00 for vertical-wall, 0.82 for vertical-wall with wingwalls, 20.4 0.55 for spill-through

Using values for y_{aLT} and y_{aRT} on figure 12, ψ_{LT} = 0 and ψ_{RT} = ~~0.0~~

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 0 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 20.4 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 21036282 Date 7/11/12 Initials RaJ Region (A B C D)

Site _____ Location in Beat Creek on FAS 6247

Q_{500} = 12200 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 12200 (should be Q_{500} 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 = 141 ft. Flow angle at bridge = 20 ° Abut. Skew = 0 ° Effective Skew = 20 °

Width (W_2) iteration = _____ _____ _____ _____

Avg. flow depth at bridge, y_2 iteration = _____ _____ _____ _____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 132.5 ft* $q_2 = Q_2/W_2$ = 92.1 ft^2/s

Bridge Vel, V_2 = 8 ft/s Final $y_2 = q_2/V_2$ = 11.6 ft Δh = 1.3 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 12.9 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. = 0 ft

Low Steel Elev. = 15.0 ft

n (Channel) = 0.035

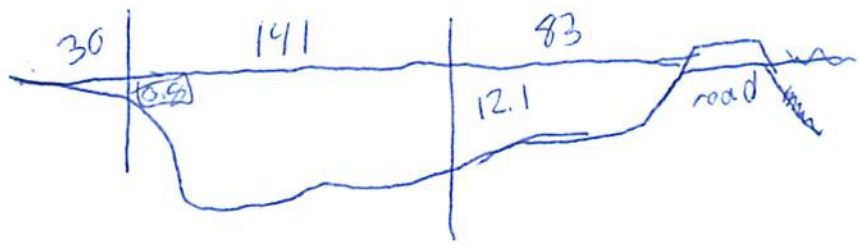
n (LOB) = 0.030

n (ROB) = 0.060

Pier Width = 2 ft

Pier Length = 2 ft

Piers for 500 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 141 ft

Width of left overbank flow at approach, W_{lob} = 30 ft Average left overbank flow depth, y_{lob} = 0.8 ft

Width of right overbank flow at approach, W_{rob} = 30 83 ft Average right overbank flow depth, y_{rob} = ~~12~~ 12.1 ft

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

x = 5.66 From Figure 9 W_2 (effective) = 128.5 ft y_{cs} = 6.41 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 $D_{50} >= D_{c50}$, $\chi = 0.0$

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

PGRM: Pier

PIER SCOUR CALCULATIONS

L/a ratio = 1

Correction factor for flow angle of attack (from Table 1), K2 = 1

Froude # at bridge = 0.41

Using pier width a on Figure 11, ξ = 8 Pier scour y_{ps} = 7 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 0.8 ft right abutment, y_{aRT} = 12.1 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} = 3.5 and ψ_{RT} = 23.1

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 3.5 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 23.1 ft

Route FAS 6247 Stream Bear CK MRM _____ Date 7/11/12 Initials RAT

Bridge Structure No. 21030282 Location in Bear Creek on FAS 6247

GPS coordinates: N 45° 3' 51.0" W 101° 26' 41.2" taken from: USL abutment X centerline of ⇑ MRM end _____

Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 186.71 sq. mi.

The average bottom of the main channel was 20.3 ft below top of guardrail at a point 56 ft from left abutment.

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

7/2
~~8/23~~

2	490
5	1490
10	2580
25	4140
50	5630
100	7310
500	12200

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 7310			Q_{500} = 12200		
Estimated flow passing through bridge		7310			12200	
Estimated road overflow & overtopping		0			0	
Consideration	Yes	No	Possibly	Yes	No	Possibly
Chance of overtopping		X			X	
Chance of Pressure flow		X			X	
Armored appearance to channel		X			X	
Lateral instability of channel		X			X	

Riprap at abutments? ____Yes ____No X Marginal only on right abutment, mostly small cobbles

Evidence of past Scour? X Yes ____No ____Don't know contraction & some abutment

Debris Potential? ____High ____Med X Low

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

Riprap	____Yes	X No	____Don't know	____NA
Spur Dike	____Yes	X No	____Don't know	____NA
Other_____	X Yes	____No	____Don't know	____NA

- appears some dirt has been placed on right abutment after scour

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

Material	Silt/Clay X	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

1). left OB
2). main channel
3). right OB
4-5). left abutment
6). pier
7). right abutment
8). abutment scour (right)
9). right abutment
10). main channel

Note: Right OB brush is too thick for an accurate measurement

Summary of Results

	Q100	Q500
Bridge flow evaluated	7310	12200
Flow depth at left abutment (yaLT), in feet	0	0.9
Flow depth at right abutment (yaRT), in feet	8.8	12.1
Contraction scour depth (ycs), in feet	4.5	6.4
Pier scour depth (yps), in feet	6.9	7
Left abutment scour depth (yas), in feet	0	~~3.0~~ 3.5
Right abutment scour depth (yas), in feet	20.4	23.1
1Flow angle of attack	0	0

See Comments/Diagram for justification where required