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SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. Z103 0282 Date 9-17-12 Initials RFT 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)

151-8 = 143

Analytical Procedure for Estimating Hydraulic Variables Needed to Apply Method

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

Bridge Width = ~~151~~ 143 ft. Flow angle at bridge = 18 ° Abut. Skew = 0 ° Effective Skew = 18 °

Width (W_2) iteration = 136 117 123 120

Avg. flow depth at bridge, y_2 iteration = 8.7 9.7 9.4 9.6

Corrected channel width at bridge Section = W_2 times cos of flow angle = 114.13 ft* $q_2 = Q_2/W_2$ = 64.1 ft²/s

Bridge Vel, V_2 = 6.7 ft/s Final $y_2 = q_2/V_2$ = 9.6 ft Δh = 0.9 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 10.5 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,

ROB width estimated -trees

Water Surface Elev. = dry ft

Low Steel Elev. = 15.4 ft

n (Channel) = 0.040

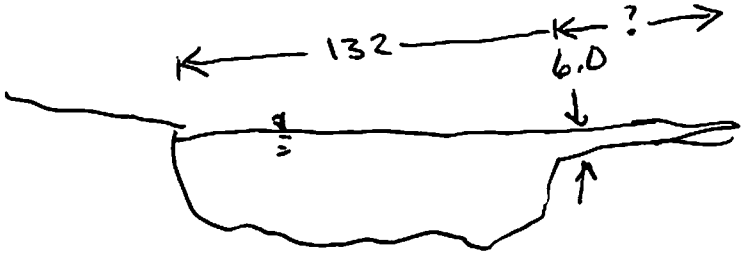
n (LOB) = 0.030

n (ROB) = 0.060

Pier Width = 2.0 ft

Pier Length = 2.0 ft

Piers for 100 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 132 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} = 50 ft Average right overbank flow depth, y_{rob} = 3 ft

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

x = 2.48 From Figure 9 W_2 (effective) = 110.1 ft y_{cs} = 3.0 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, $V_1 = Q_{100}/(y_1 W_1)$ = _____ 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 = 0.38 Using pier width a on Figure 11, ξ = 8 Pier scour y_{ps} = 6.9 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 0 ft right abutment, y_{aRT} = 3 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} = 0 and ψ_{RT} = 11.5

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 0 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 11.5 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 21030282 Date _____ Initials _____ Region (A (B) C D)

Site _____ Location _____

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)

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

Analytical Procedure for Estimating Hydraulic Variables Needed to Apply Method

143 → 151

Bridge Width = 151 ft. Flow angle at bridge = 18 ° Abut. Skew = 0 ° Effective Skew = 18 °

Width (W_2) iteration = 136 134 136 _____

Avg. flow depth at bridge, y_2 iteration = 11.4 11.8 11.7 _____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 129.34 ft* $q_2 = Q_2/W_2$ = 94.3 ft²/s

Bridge Vel, V_2 = 8.0 ft/s Final $y_2 = q_2/V_2$ = 11.7 ft Δh = 1.3 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 13.0 ft

ROB width estimated - trees

** 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. = dry ft

Low Steel Elev. = 15.4 ft

n (Channel) = .04

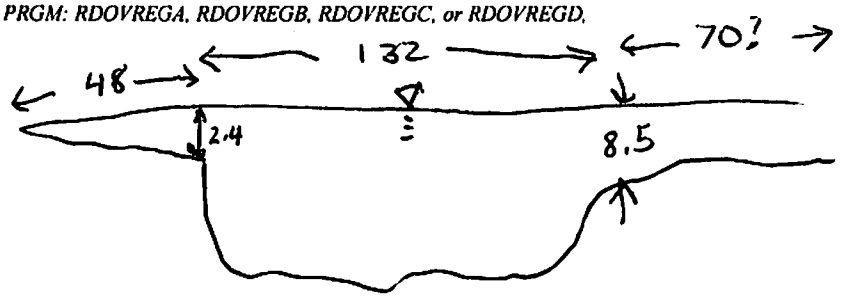
n (LOB) = .03

n (ROB) = .06

Pier Width = 2.0 ft

Pier Length = 2.0 ft

Piers for 500 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 132 ft

Width of left overbank flow at approach, W_{lob} = 48 ft Average left overbank flow depth, y_{lob} = 1.2 ft

Width of right overbank flow at approach, W_{rob} = 70 ft Average right overbank flow depth, y_{rob} = 4.3 ft

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

x = 1.58 From Figure 9 W_2 (effective) = 125.3 ft y_{cs} = 2.1 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, $V_1 = Q_{500}/(y_1 W_1)$ = _____ 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

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} = 1.2 ft right abutment, y_{aRT} = 4.3 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} = 5.1 and ψ_{RT} = 13.8

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 5.1 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 13.8 ft

Route FAS 6247 Stream Bear Creek MRM _____ Date _____ Initials _____

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

GPS coordinates: N 45° 3.859' taken from: USL abutment X centerline of ⇑ MRM end _____

W 101° 26.671' Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 186.71 sq. mi.

The average bottom of the main channel was 20.6 ft below top of guardrail at a point 61 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 7310			Q_{500} = 12200		
Estimated flow passing through bridge	7310			12200		
Estimated road overflow & overtopping	–			–		
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 scour visible under bridge at both abutments and at piers

Evidence of past Scour? ✓Yes ____No ____Don't know

Debris Potential? X High ____Med ____Low lots of trees/brush in ROB

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

there is a cobble bar in the channel, but mainly very fine soils

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

Str. no.
approach from bridge
LOB from bridge
ROB from LOB
rt abut. from LOB
left abut from under bridge
rt abut from under bridge
pier/contraction scour in channel under bridge

Summary of Results

	Q100	Q500
Bridge flow evaluated	7310	12200
Flow depth at left abutment (yaLT), in feet	0	1.2
Flow depth at right abutment (yaRT), in feet	3.0	4.3
Contraction scour depth (ycs), in feet	3.0	2.1
Pier scour depth (yps), in feet	6.9	7.0
Left abutment scour depth (yas), in feet	0	5.1
Right abutment scour depth (yas), in feet	11.5	13.8
Flow angle of attack	18°	18°

See Comments/Diagram for justification where required