OK RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 43153192 Date 8/17/11 Initials GW Region (A B C D)

Site _____ Location 0.1 mi N of Presho on Co Hwy 22, straight of Main St

Q_{100} = 7650 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. ✓

Bridge discharge (Q_2) = 7650 (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 = 150 ft. Flow angle at bridge = 0 ° Abut. Skew = 0 ° Effective Skew = 0 °

Width (W_2) iteration = 150 134 138 ____

Avg. flow depth at bridge, y_2 iteration = 4.5 9.0 4.9 ____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 138 ft* $q_2 = Q_2/W_2$ = 55.4 ft^2/s

Bridge Vel, V_2 = 6.3 ft/s Final $y_2 = q_2/V_2$ = 8.9 ft Δh = 0.8 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 9.7 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. = _____ ft

Low Steel Elev. = _____ ft

n (Channel) = 0.080

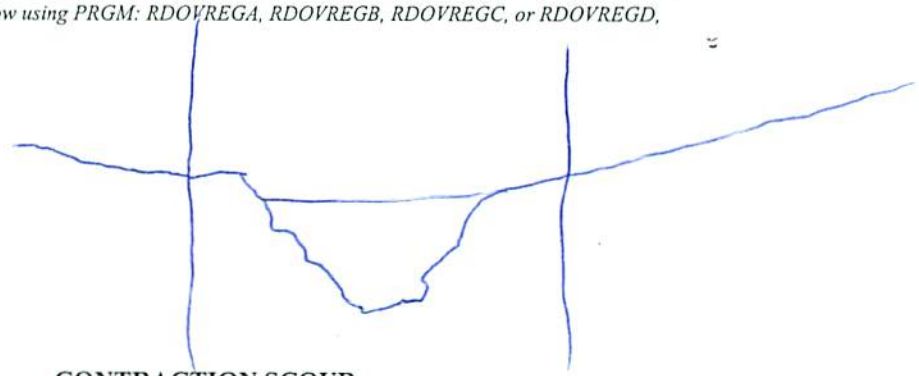
n (LOB) = 0.060

n (ROB) = 0.040

Pier Width = 1.65 ft

Pier Length = 1.65 ft

Piers for 100 yr = 4 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 150 ft

Width of left overbank flow at approach, W_{lob} = 0 ft Average left overbank flow depth, y_{lob} = 0.0 ft

Width of right overbank flow at approach, W_{rob} = 0 ft Average right overbank flow depth, y_{rob} = 0.0 ft

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

x = 1.37 From Figure 9 W_2 (effective) = 131.4 ft y_{cs} = 1.9 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

PGRM: Pier

PIER SCOUR CALCULATIONS

L/a ratio = 1.0 Correction factor for flow angle of attack (from Table 1), K2 = 1.0

Froude # at bridge = 0.37 Using pier width a on Figure 11, ξ = 6.9 Pier scour y_{ps} = 5.9 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 0.0 ft right abutment, y_{aRT} = 0.0 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} = 0.0 and ψ_{RT} = 0.0

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 0.0 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 0.0 ft

12.3 13
9.7
9.6

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 43153192 Date 8/17/11 Initials CLV Region (A B C D)

Site _____ Location 0.1 mi N of Presho on Co HWY 22, just off Main St.

Q_{500} = 12700 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. ✓

Bridge discharge (Q_2) = 12700 (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

Bridge Width = 150 ft. Flow angle at bridge = 0 ° Abut. Skew = 0 ° Effective Skew = 0 °

Width (W_2) iteration = 150 _____ _____ _____

Avg. flow depth at bridge, y_2 iteration = 11.1 _____ _____ _____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 150 ft* $q_2 = Q_2/W_2$ = 84.7 ft^2/s

Bridge Vel, V_2 = 7.6 ft/s Final $y_2 = q_2/V_2$ = 11.1 ft Δh = 1.2 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 12.3 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,

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

Water Surface Elev. = _____ ft

Low Steel Elev. = _____ ft

n (Channel) = 0.080

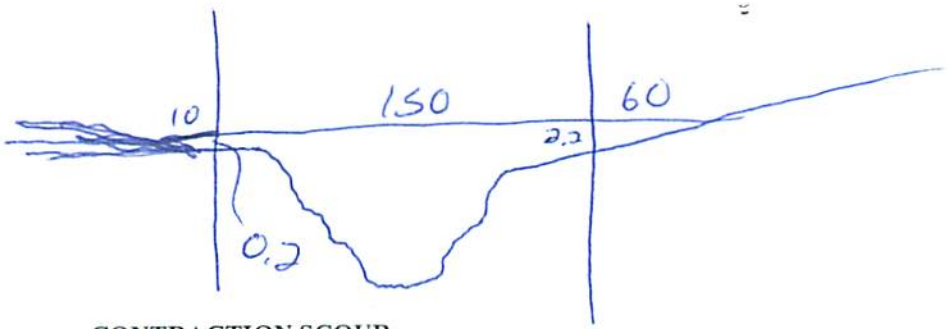
n (LOB) = 0.060

n (ROB) = 0.040

Pier Width = 1.65 ft

Pier Length = 1.65 ft

Piers for 500 yr = 4 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 150 ft

Width of left overbank flow at approach, W_{lob} = 10 ft Average left overbank flow depth, y_{lob} = 0.2 ft

Width of right overbank flow at approach, W_{rob} = 60 ft Average right overbank flow depth, y_{rob} = 1.1 ft

2.2/2 = 1.1

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

x = 0.75 From Figure 9 W_2 (effective) = 143.4 ft y_{cs} = 1.2 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 = 1.0 Correction factor for flow angle of attack (from Table 1), K2 = 1.0

Froude # at bridge = 0.4 Using pier width a on Figure 11, ξ = 6.9 Pier scour y_{ps} = 6.0 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 0.2 ft right abutment, y_{aRT} = 1.1 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} = 1.0 and ψ_{RT} = 4.7

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 1.0 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 4.7 ft

12.3 − 4.9 = 7.4

15.2 − 12.3 = 2.9

5.1 − 2.9 = 2.2

Route County Rd Stream Medicine Ck MRM _____ Date 8/17/16 Initials CL2

Bridge Structure No. 4315392 Location 0.1 mi N of Presho on CO HWY 22, just straight off main St.

GPS coordinates: N43°54'53.3" W100°03'33.8" taken from: USL abutment X centerline of ⇑ MRM end _____

Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 201.52 sq. mi.

The average bottom of the main channel was 15.9 ft below top of guardrail at a point 71 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 7650			Q_{500} = 12700		
Estimated flow passing through bridge		7650			12700	
Estimated road overflow & overtopping						
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

Pk calc'd 8/18

2	512
5	1560
10	2700
25	4330
50	5896
100	7650
500	12700

Riprap at abutments? _____Yes X No _____Marginal

Evidence of past Scour? _____Yes X No _____Don't know

Debris Potential? X High _____Med _____Low

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

Riprap _____Yes _____No _____Don't know X NA

Spur Dike _____Yes _____No _____Don't know X NA

Other _____ _____Yes _____No _____Don't know X NA

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

Material	Silt/Clay_____	Sand_____	Gravel X	Cobbles_____	Boulders_____
Size range, in mm	<0.062	0.062-2.00	2.00-64	64-250	>250

Comments, Diagrams & orientation of digital photos

2003 - ID
04 - US
05 - USRB
06 - USLB
07 - US Face
08 - L. Abut

Summary of Results

	Q100	Q500
Bridge flow evaluated	7650	12700
Flow depth at left abutment (yaLT), in feet	0	0.2
Flow depth at right abutment (yaRT), in feet	0	1.1
Contraction scour depth (ycs), in feet	1.9	1.2
Pier scour depth (yps), in feet	5.9	6.0
Left abutment scour depth (yas), in feet	0	1.0
Right abutment scour depth (yas), in feet	0	4.7
1Flow angle of attack	0°	0°

See Comments/Diagram for justification where required