OK RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 62229220 Date 8/16/11 Initials CW Region (A B C D)

Site _____ Location 5.4 mi N + 2.9 mi E of Winner on 272 St

Q_{100} = 4610 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. ✓

Bridge discharge (Q_2) = 4610 (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 = 116 ft. Flow angle at bridge = 0 ° Abut. Skew = 0 ° Effective Skew = 0 °

Width (W_2) iteration = 116 96 90 ____

Avg. flow depth at bridge, y_2 iteration = 7.4 8.6 8.5 ____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 90 ft* $q_2 = Q_2/W_2$ = 51.2 ft^2/s

Bridge Vel, V_2 = 6.0 ft/s Final $y_2 = q_2/V_2$ = 8.5 ft Δh = 0.7 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 9.2 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. = _____ ft

Low Steel Elev. = _____ ft

n (Channel) = 0.040

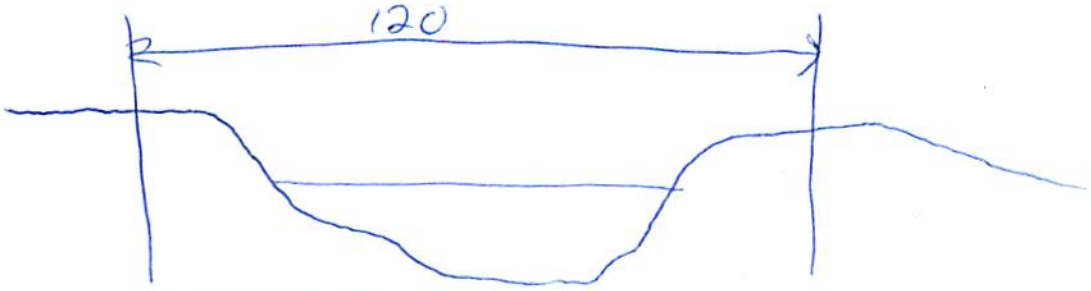
n (LOB) = 0.035

n (ROB) = 0.045

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 = 120 ft

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

Width of right overbank flow at approach, W_{rob} = ~~116~~ 0.0 ft Average right overbank flow depth, y_{rob} = ~~1.4~~ 0.0 ft

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

x = 3.64 From Figure 9 W_2 (effective) = 96 ft y_{cs} = 4.3 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 = 0.36 Using pier width a on Figure 11, ξ = 4.0 Pier scour y_{ps} = 6.9 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

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 69229220 Date 8/16/11 Initials CW Region (A (B) C D)

Site _____ Location 5.4 N + 2.9 E of Winner on 272 St

Q_{500} = 7730 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. ✓

Bridge discharge (Q_2) = 7730 (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 = 116 ft. 116 Flow angle at bridge = 0 ° Abut. Skew = 0 ° Effective Skew = 0 °

Width (W_2) iteration = ~~9.8~~ 116

Avg. flow depth at bridge, y_2 iteration = 9.8 Vert Wall

Corrected channel width at bridge Section = W_2 times cos of flow angle = 116 ft* $q_2 = Q_2/W_2$ = 66.6 ft^2/s

Bridge Vel, V_2 = 6.8 ft/s Final $y_2 = q_2/V_2$ = 9.8 ft Δh = 1.0 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 10.7 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) = 0.040

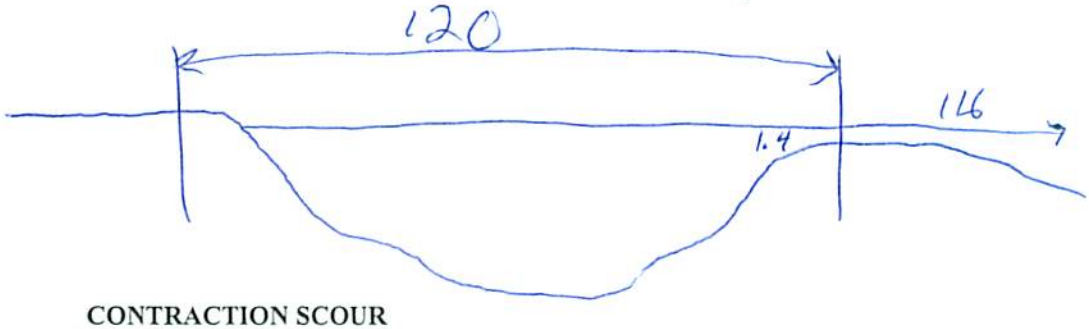
n (LOB) = 0.035

n (ROB) = 0.045

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 = 120 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} = 116 ft Average right overbank flow depth, y_{rob} = 1.4 ft

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

x = 1.1 From Figure 9 W_2 (effective) = 112 ft y_{cs} = 1.6 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 $D_{50} >= D_{c50}$, $\chi = 0.0$

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

Froude # at bridge = 0.38 Using pier width a on Figure 11, ξ = 8.0 Pier scour y_{ps} = 6.9 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 0.0 ft right abutment, y_{aRT} = 1.4 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} = 5.9

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 0.0 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 5.9 ft

Route 272 St Stream Thunder Ck MRM _____ Date 8/16/11 Initials CW

Bridge Structure No. 6222920 Location 5.4 mi N + 2.9 mi E of Wainwright on 272 St

GPS coordinates: N 43° 27' 31.2" W 99° 47' 37.9" taken from: USL abutment X centerline of ⇑ MRM end _____

Datum of coordinates: WGS84 X NAD27 ____

Drainage area = 82.7 sq. mi.

The average bottom of the main channel was 16.4 ft below top of guardrail at a point 63 ft from left abutment.

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

PK calc'd 8/4

2	308
5	930
10	1610
25	2660
50	3540
100	4610
500	7730

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 4610			Q_{500} = 7730		
Estimated flow passing through bridge		4610			7730	
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	

Riprap at abutments? ____Yes X No ____Marginal

Evidence of past Scour? X Yes ____No ____Don't know At approach XS + in ditch

Debris Potential? ____High X Med ____Low Log jam

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 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

1941 - ID
42 - US
43 - US RB
44 - US LB
45 - L. Abut
46 - R. Abut.
47 - US Face

Summary of Results

	Q100	Q500
Bridge flow evaluated	4610	7730
Flow depth at left abutment (yaLT), in feet	0	0
Flow depth at right abutment (yaRT), in feet	0	1.4
Contraction scour depth (ycs), in feet	4.3	1.6
Pier scour depth (yps), in feet	6.7	6.9
Left abutment scour depth (yas), in feet	0	0
Right abutment scour depth (yas), in feet	0	5.9
1Flow angle of attack	0°	0°

See Comments/Diagram for justification where required