ok RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 59339327 Date 7/11/12 Initials RT Region (A B C D)

Site _____ Location 1.4 mi SW of Powell ck Rd on Bad River Rd

Q_{100} = Q25, 3020 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 3020 (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 = 43 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 = 40.41 ft* $q_2 = Q_2/W_2$ = 74.7 ft^2/s

Bridge Vel, V_2 = 7.2 ft/s Final $y_2 = q_2/V_2$ = 10.4 ft Δh = 1.1 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 11.4 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. = 11.6 ft

n (Channel) = 0.033

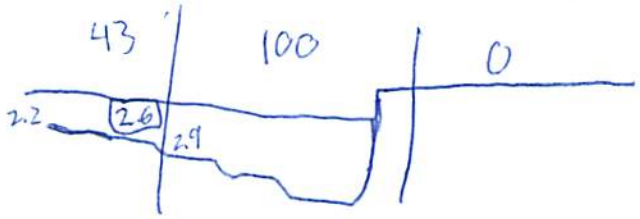
n (LOB) = 0.030

n (ROB) = 0.030

Pier Width = 0 ft

Pier Length = 0 ft

Piers for 100 yr = 0 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 100 ft

Width of left overbank flow at approach, W_{lob} = 43 ft Average left overbank flow depth, y_{lob} = 2.6 ft (2.9 - 2.2)

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

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

x = 17.95 From Figure 9 W_2 (effective) = 40.4 ft y_{cs} = 16.6 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, $V_1 = Q_{100}/(y_1 W_1)$ = _____ 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 = _____ Correction factor for flow angle of attack (from Table 1), K2 = _____

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

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 2.6 ft right abutment, y_{aRT} = 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} = 10.6 and ψ_{RT} = 0

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 19.3 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 0 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 59339327 Date 7/11/12 Initials [illegible] Region (A B C D)

Site _____ Location 1.4 mi SW of Powell Creek Rd on Bad River Rd

Q_{500} = Qsc 4690 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 3861 (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 = 43 ft. Flow angle at bridge = 20 ° Abut. Skew = 0 ° Effective Skew = 20 °

Width (W_2) iteration = _____ _____ _____ _____

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

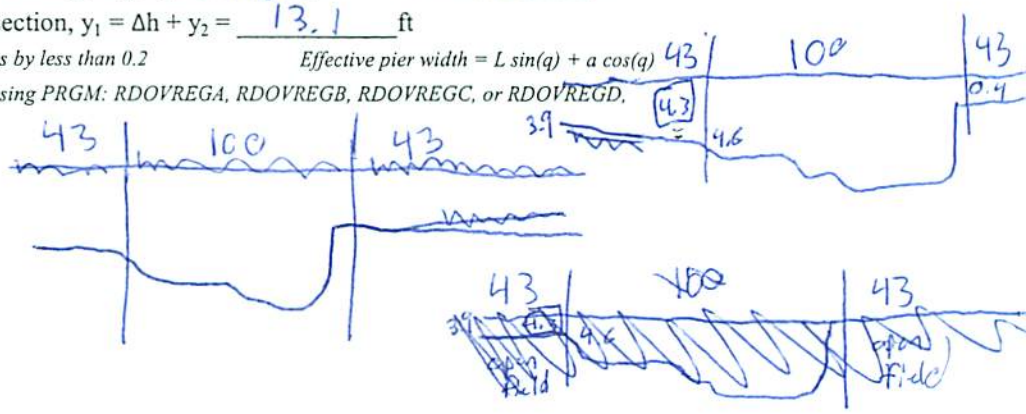
Corrected channel width at bridge Section = W_2 times cos of flow angle = 40.41 ft* $q_2 = Q_2/W_2$ = 95.6 ft²/s

Bridge Vel, V_2 = 8.1 ft/s Final $y_2 = q_2/V_2$ = 11.8 ft Δh = 1.3 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 13.1 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. = 606.1 ft

Low Steel Elev. = 611.2 ft

n (Channel) = 0.033

n (LOB) = 0.030

n (ROB) = 0.030

Pier Width = 0 ft

Pier Length = 0 ft

Piers for 500 yr = 0 ft

CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 100 ft

Width of left overbank flow at approach, W_{lob} = 43 ft Average left overbank flow depth, y_{lob} = 4.3 ft (4.6 − 3.9)

Width of right overbank flow at approach, W_{rob} = 43 ft Average right overbank flow depth, y_{rob} = 0.4 ft

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

x = 21.76 From Figure 9 W_2 (effective) = 40.4 ft y_{cs} = 15.6 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 = _____ Correction factor for flow angle of attack (from Table 1), K2 = _____

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

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 4.3 ft right abutment, y_{aRT} = 0.4 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} = 13.8 and ψ_{RT} = 1.9

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 25.1 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 3.5 ft

Route Bad River Rd Stream Powell Clk MRM _____ Date 7/11/12 Initials RaT

Bridge Structure No. 59339327 Location 1.4 mi SW of Powell Ck Rd on Bad River Rd

GPS coordinates: N 44° 19' 10.2" taken from: USL abutment _____ centerline of ⇑ MRM end _____

W 100° 29' 13.51" Datum of coordinates: WGS84 _____ NAD27 _____

Drainage area = 12.84 sq. mi.

The average bottom of the main channel was 17.9 ft below top of guardrail at a point 21 ft from left abutment.

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

Peak calc'd on 8/8

P/L 2	196
5	736
10	1470
25	3020
50	4690
100	6920
500	15000

7/12

2	195
5	736
10	1470
25	3020
50	4690
100	6910
500	14900

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = Q_{25} 3020			Q_{500} = Q_{50} 4690		
Estimated flow passing through bridge	3020			3861		
Estimated road overflow & overtopping	0			829		
Consideration	Yes	No	Possibly	Yes	No	Possibly
Chance of overtopping		X		X		
Chance of Pressure flow	~~X~~	~~X~~	~~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 contraction + 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 _____ ____Yes __X__No ____Don't know ____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

1). left OB
2). main channel
3). right OB
4-5). right abutment
6-7). left abutment
8). main channel

Summary of Results

	~~Q100~~ Q_{25}	~~Q500~~ Q_{50}
Bridge flow evaluated	~~XX~~ 3020	3861
Flow depth at left abutment (yaLT), in feet	2.6	4.3
Flow depth at right abutment (yaRT), in feet	0	0.4
Contraction scour depth (ycs), in feet	16.6	18.6
Pier scour depth (yps), in feet	N/A	N/A
Left abutment scour depth (yas), in feet	19.3	25.1
Right abutment scour depth (yas), in feet	0	3.5
1Flow angle of attack	20	20

See Comments/Diagram for justification where required