OK RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 63235230 Date 5/24/12 Initials rat Region (A B C D)

Site _____ Location 3.5 mi N & 1 mi E of Centerville on 291 St

Q_{100} = ~~Q50~~ 20200 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 20200 (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 = 212 ft. Flow angle at bridge = 95 ° Abut. Skew = 30 ° Effective Skew = ~~90~~ 85 °

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 = 211.19 ft* $q_2 = Q_2/W_2$ = 95.6 ft^2/s

Bridge Vel, V_2 = 6.9 ft/s Final $y_2 = q_2/V_2$ = 13.9 ft Δh = 1 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 14.8 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. = 0-3.0 ft

Low Steel Elev. = 16.3 ft

n (Channel) = 0.030

n (LOB) = ~~0.045~~ 0.090

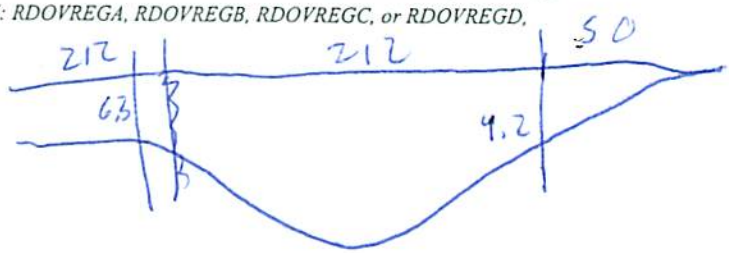
n (ROB) = ~~0.040~~ 0.045

Pier Width = 2.7 ft

Pier Length = 2.7 ft

Piers for 100 yr = 4 ft

20.5 − 4.2 = 16.3



scour table ↓ past

CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 212 ft

Width of left overbank flow at approach, W_{lob} = 212 ft Average left overbank flow depth, y_{lob} = 6.3 ft

Width of right overbank flow at approach, W_{rob} = 50 ft Average right overbank flow depth, y_{rob} = ~~6.3~~ 4.2 ft

6.3 − 3/3 = 12.6/3 = 4.2

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

x = ~~3.46~~ 2.42 From Figure 9 W_2 (effective) = 200.4 ft y_{cs} = ~~4.7~~ 3.0 ft

Clear Water Contraction Scour (use if bed material is larger than small cobbles)

PGRM: CWCSNEW

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 = 0.33 Using pier width a on Figure 11, ξ = 1.0 Pier scour y_{ps} = 8.5 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 6.3 ft right abutment, y_{aRT} = 4.2 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} = 17.3 and ψ_{RT} = 13.6

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 17.3 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 13.6 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 63235230 Date 5/24/17 Initials RAT Region (A B C D)

Site _____ Location 3.5 mi N & 1 mi E of Centerville on 291 st

Q_{500} 0450 24500 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = 24294 (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 = 212 ft. Flow angle at bridge = 30 ° Abut. Skew = -25 ° Effective Skew = 5 °

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 = 211.19 ft* $q_2 = Q_2/W_2$ = 133.6 ft^2/s

Bridge Vel, V_2 = 8.2 ft/s Final $y_2 = q_2/V_2$ = 16.3 ft Δh = 1.4 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 17.7 ft

* *NOTE: repeat above calculations until y_2 changes by less by 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. = 0-3.0 ft

Low Steel Elev. = 16.3 ft

n (Channel) = 0.030

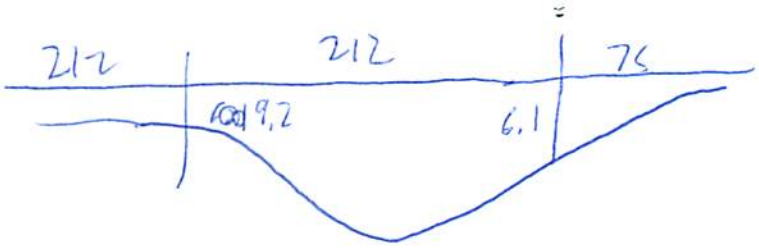
n (LOB) = 0.090

n (ROB) = 0.045

Pier Width = 2.7 ft

Pier Length = 2.7 ft

Piers for 500 yr = 4 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 212 ft

Width of left overbank flow at approach, W_{lob} = 212 ft Average left overbank flow depth, y_{lob} = 9.2 ft

Width of right overbank flow at approach, W_{rob} = 75 ft Average right overbank flow depth, y_{rob} = 6.1 ft

9.2 - 2/3 = 15.4

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

x = 3.57 From Figure 9 W_2 (effective) = 204 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, $V_1 = Q_{500}/(y_1W_1)$ = _____ 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} = 1 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 = 0.36 Using pier width a on Figure 11, ξ = 1.0 Pier scour y_{ps} = 8.6 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 9.2 ft right abutment, y_{aRT} = 6.1 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} = 20.7 and ψ_{RT} = 17

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 20.7 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 17 ft

Route 291 St Stream Vermillion River MRM _____ Date 5/24/12 Initials Rat

Bridge Structure No. 63235230 Location 3.5 mi N & 1mi E of Centerville on 291 St

GPS coordinates: N 43° 10' 15" W 96° 51' 54.5" taken from: USL abutment X centerline of ⇑ MRM end _____

Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 1251.15 sq. mi.

The average bottom of the main channel was 20.5 ft below top of guardrail at a point 55 ft from left abutment.

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

5/22

2	1540
5	4380
10	7600
25	13800
50	20200
100	28500
500	56600

MISCELLANEOUS CONSIDERATIONS

Flows	~~Q50~~ Q100 = 20200			~~Q100~~ Q500 = 28500		
Estimated flow passing through bridge	20200			28224		
Estimated road overflow & overtopping	0			~~28224~~ 276		
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? X Yes ____No ____Marginal

Evidence of past Scour? X Yes ____No ____Don't know pier / contract

Debris Potential? ____High ____Med ____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). main channel
2). U.S. ab
3). R. ab.
4). Piers
5). Pier scour
6). left ab
7) runoff
8). runoff
9)) runoff
10). main ~~channel~~ channel
11). left ~~channel~~ ab
12). runoff
13). left channel
14) right ab
15) right ab

Note: left and right overbank ~~are~~ heavily covered in shrubs/trees, most up to my chest. I was unable to get ~~proper measurements~~ into a position for proper measurements so I estimated the best I could

Summary of Results

	~~Q100~~ Q200	~~Q500~~ Q500
Bridge flow evaluated	20200	28224
Flow depth at left abutment (yaLT), in feet	6.3	9.2
Flow depth at right abutment (yaRT), in feet	4.2	6.1
Contraction scour depth (ycs), in feet	~~6.3~~ ~~4.1~~ 3.0	4.5
Pier scour depth (yps), in feet	~~11~~ 8.5	8.6
Left abutment scour depth (yas), in feet	17.3	20.7
Right abutment scour depth (yas), in feet	13.6	17
1Flow angle of attack	5	5

See Comments/Diagram for justification where required