OK RT

18153030 from Loomis 0.6N, 4.2E, James River,

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. ~~18169000~~ Date 6/9/11 Initials RAT Region (A B (C) D)

Site ______ Location from Riverside, 2.6 N, 2 W, James River

Q_{100} = ~~28100~~ 40300 by: drainage area ratio ~~___~~ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 40300 (should be Q_{100} 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

Bridge Width = 262 ft. Flow angle at bridge = 30 ° Abut. Skew = 0 ° Effective Skew = 30 °

Width (W_2) iteration = 226.9 217 187.93 ~~210~~ 190.53

Avg. flow depth at bridge, y_2 iteration = 18.9 20.7 20.8 190.53

Corrected channel width at bridge Section = W_2 times cos of flow angle = ~~226.90~~ ft* $q_2 = Q_2/W_2$ = 211.5 ft²/s

Bridge Vel, V_2 = 10.3 ft/s Final $y_2 = q_2/V_2$ = 20.5 ft Δh = 2.2 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 22.7 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. = 40 ft

Low Steel Elev. = ~~24.3~~ 22.8 ft ~~bot~~ - see last page

n (Channel) = 0.030 32.7

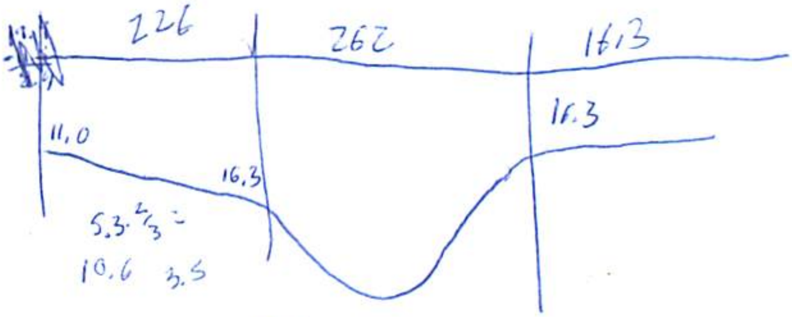
n (LOB) = 0.025 -5.4

n (ROB) = 0.030 24.3

Pier Width = 3.0 ft 9.6

Pier Length = 3.0 ft

\# Piers for 100 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

228
-9.7
13.1

Width of main channel at approach section W_1 = 262 ft

Width of left overbank flow at approach, W_{lob} = 262 ft Average left overbank flow depth, y_{lob} = 14.3 ft

Width of right overbank flow at approach, W_{rob} = 262 ft Average right overbank flow depth, y_{rob} = 16.2 ft

3.2 + 13.1

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

x = ~~___~~ From Figure 9 W_2 (effective) = 184.5 ft y_{cs} = 31.6 ft

95.8

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, $V_c = 11.52 y_1^{1/6} D_{50}^{1/3}$ = ______ 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 = 0.4 Using pier width a on Figure 11, ξ = 10.7 Pier scour y_{ps} = 9.3 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 14.3 ft right abutment, y_{aRT} = 16.2 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} = 24.9 and ψ_{RT} = 22.5

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 24.9 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 22.5 ft

16169030 from Loomis 0.6 N 4.2 E, James River

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. ~~18169060~~ Date 6/4/12 Initials RJ Region (A B (C) D)

Site Q_{50} = 68600 Location ~~from Riverside, 2.6 N, 5.2 W~~

~~Q_{500} = 155400~~ 69100 by: drainage area ratio ~~1.0~~ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = ~~67996~~ 59366 (should be Q_{500} unless there is a relief bridge, road overflow, or bridge overtopping)

65948 62469

Analytical Procedure for Estimating Hydraulic Variables Needed to Apply Method

Bridge Width = 262 ft. Flow angle at bridge = 30 ° Abut. Skew = 0 ° Effective Skew = 30 °

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 = 226.9 ft* $q_2 = Q_2/W_2$ = 282.4 ~~[illegible]~~ ft^2/s 261.7

Bridge Vel, V_2 = ~~12.2~~ 11.5 ft/s Final $y_2 = q_2/V_2$ = ~~24.3~~ 22.8 ft Δh = ~~3.1~~ 2.7 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = ~~27.4~~ 25.5 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,

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

Water Surface Elev. = 1.0-4.0 ft

Low Steel Elev. = ~~24.5~~ 22.8 ft

n (Channel) = .030

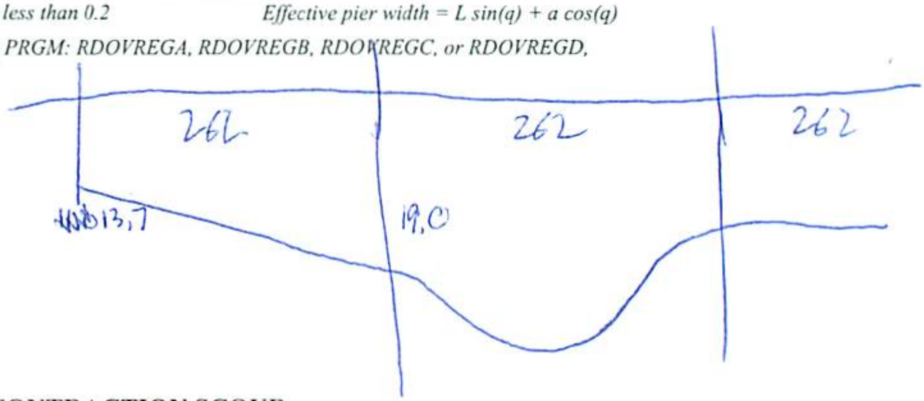
n (LOB) = 0.025

n (ROB) = 0.030

Pier Width = 3.0 ft

Pier Length = 3.0 ft

Piers for 500 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 262 ft

Width of left overbank flow at approach, W_{lob} = 262 ft Average left overbank flow depth, y_{lob} = 2.7 17.2 ft

Width of right overbank flow at approach, W_{rob} = 262 ft Average right overbank flow depth, y_{rob} = 19.0 ft

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

x = 42.09 From Figure 9 W_2 (effective) = 220.9 ft y_{cs} = 29.6 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, $Vc = 11.52y_1^{1/6}D_{50}^{1/3}$ = ____________ 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

PIER SCOUR CALCULATIONS

PGRM: Pier

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

Froude # at bridge = 0.42 Using pier width a on Figure 11, ξ = 10.7 Pier scour y_{ps} = 9.4 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 17.2 ft right abutment, y_{aRT} = 19.6 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} = 27.3 and ψ_{RT} = 28.8

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 27.3 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 28.8 ft

97.96767
43,76103

Route 250 St Stream James River MRM ______ Date 6/4/12 Initials Kal

Bridge Structure No. 18169060 Location from Riverside, 2.6 N, 2 W

GPS coordinates: N 43° 48' 16.4" W 98° 01' 21.5" taken from: USL abutment X centerline of ⇑ MRM end ______

Datum of coordinates: WGS84 X NAD27 ______

Drainage area = 16039.90 sq. mi. 16049.92

The average bottom of the main channel was 32.7 ft below top of guardrail at a point 170 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	~~Q100~~ = Q_{25} ~~28400~~ 40300			~~Q500~~ = Q_{50} ~~55400~~ 68600		
Estimated flow passing through bridge	40300			59386		
Estimated road overflow & overtopping	0			9214		
Consideration	Yes	No	Possibly	Yes	No	Possibly
Chance of overtopping	X			X		X
Chance of Pressure flow		X	X	X		
Armored appearance to channel		X			X	
Lateral instability of channel		X			X	

~~5130~~

2	~~1320~~
5	~~7210~~
10	~~16900~~
25	~~40700~~
50	~~69400~~
100	~~111000~~
500	~~270000~~

2	1310
5	7140
10	16800
25	40300
50	68600
100	109000
500	270000

Riprap at abutments? ____Yes X No X Marginal — mostly along right abutment

Evidence of past Scour? X Yes ____No ____Don't know — abutment contraction

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). main channel
2). low steel
3). piers
4). right abutment
5). left abutment
6). left abutment
7). right abutment
8). abutment scour
9). left OB
10-11). right OB
12-13). main channel

Note: road height is lower than Y_1 for Q_{25}, Q_{50} on left overbank

Note: bridge is ~~slanted~~, sloped and low steel is not uniform. calculated low steel by using a tape measure 34 ft from left abutment and ~~setto~~ subtracting from average channel depth. Further inspection shows 24.3 for highs using a hand level, 22.8 seems more accurate.

Summary of Results

	~~Q100~~ Q_{25}	~~Q500~~ Q_{50}
Bridge flow evaluated	40300	59386
Flow depth at left abutment (yaLT), in feet	14.3	17.2
Flow depth at right abutment (yaRT), in feet	16.2	19.0
Contraction scour depth (ycs), in feet	31.6	29.6
Pier scour depth (yps), in feet	9.3	9.4
Left abutment scour depth (yas), in feet	~~25.1~~ 24.9	27.3
Right abutment scour depth (yas), in feet	~~26.1~~ 26.5	28.8
1Flow angle of attack	30	30

See Comments/Diagram for justification where required