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SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 07070289 Date 7/19/12 Initials RaJ Region (A B C D)

Site _____ Location 2 mi E of Richmond on 383 Ave

Q_{100} = Q_{10} 1110 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 1110 (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 = 75 ft. Flow angle at bridge = ~~X~~ °35 Abut. Skew = 0 ° Effective Skew = 35 °

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 = 61.44 ft* $q_2 = Q_2/W_2$ = 18.1 ft^2/s

Bridge Vel, V_2 = 2.2 ft/s Final $y_2 = q_2/V_2$ = 8.4 ft Δh = 0.1 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 8.5 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. = ~~RDWS~~ 2.0-2.5 ft

Low Steel Elev. = 10.9 ft

n (Channel) = 0.048

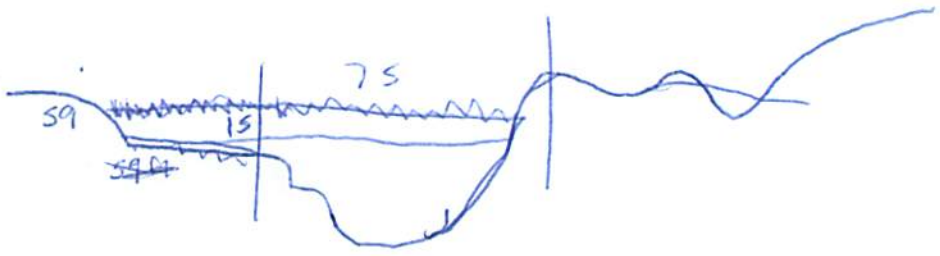
n (LOB) = ~~0.035~~ 0.040

n (ROB) = ~~0.046~~ 0.035

Pier Width = 1.35 ft

Pier Length = 1.35 ft

Piers for 100 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 75 ft

Width of left overbank flow at approach, W_{lob} = 15 ft Average left overbank flow depth, y_{lob} = 0.3 ft

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 = 2.35 From Figure 9 W_2 (effective) = 58.7 ft y_{cs} = 2.9 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, $V_1 = Q_{100}/(y_1W_1)$ = _____ 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

PIER SCOUR CALCULATIONS

PGRM: Pier

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

Froude # at bridge = 0.13 Using pier width a on Figure 11, ξ = 6 Pier scour y_{ps} = 4.7 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 0.3 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} = 1.4 and ψ_{RT} = C

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 1.4 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 0 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 07070289 Date 7/19/12 Initials RAT Region (A B C D)

Site _____ Location 2 mi E of Richmond on 383 Fm

Q_{500} = 925 270 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 1827 (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 = 75 ft. Flow angle at bridge = 35 ° Abut. Skew = 0 ° Effective Skew = 35 °

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 = 61.44 ft* $q_2 = Q_2/W_2$ = 29.7 ft²/s

Bridge Vel, V_2 = 2.7 ft/s Final $y_2 = q_2/V_2$ = 10.9 ft Δh = 0.1 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 11 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. = 20.25 ft

Low Steel Elev. = 10.9 ft

n (Channel) = 0.048

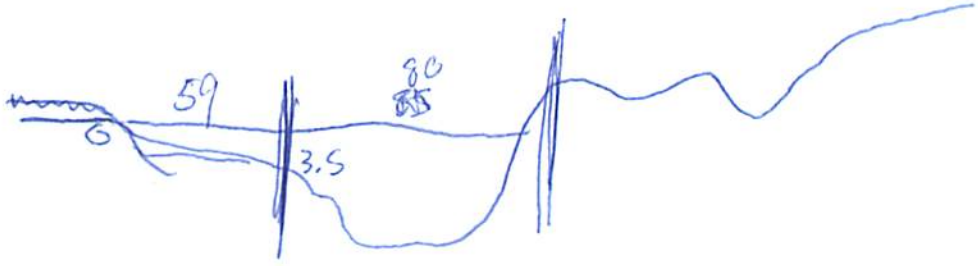
n (LOB) = ~~0.040~~ 0.040

n (ROB) = 0.035

Pier Width = 1.35 ft

Pier Length = 1.35 ft

Piers for 500 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = ~~80~~ 80 ft

Width of left overbank flow at approach, W_{lob} = 59 ft Average left overbank flow depth, y_{lob} = ~~3~~ 3.2 ft

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 = 5.67 From Figure 9 W_2 (effective) = 58.7 ft y_{cs} = 6.4 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 Correction factor for flow angle of attack (from Table 1), K2 = 1

Froude # at bridge = 0.14 Using pier width a on Figure 11, ξ = 6 Pier scour y_{ps} = 4.5 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 3.2 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} = 11.9 and ψ_{RT} = 0

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 11.9 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 0 ft

Route 383 Ave Stream Foot Ck MRM _____ Date 7/19/12 Initials RaT

Bridge Structure No. 07070289 Location 2 mi E of Richmond on 383 Ave

GPS coordinates: N 45° 31' 9.90" taken from: USL abutment X centerline of ↑↓ MRM end _____

W 96° 34' 39.5" Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 150.4 sq. mi. 14.2

The average bottom of the main channel was 12.9 ft below top of guardrail at a point 5825 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = Q10 1110			Q_{500} = Q25 2310		
Estimated flow passing through bridge	1110			1827		
Estimated road overflow & overtopping	0			483		
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	

7/2

2	119
5	535
10	1110
25	2310
50	3590
100	5250
500	10800

Riprap at abutments? X Yes ____No ____Marginal

Evidence of past Scour? X Yes ____No ____Don't know lots of contraction scour 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

9). main channel

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

Summary of Results

	~~Q100~~ Q10	~~Q500~~ Q25
Bridge flow evaluated	1110	1827
Flow depth at left abutment (yaLT), in feet	0.3	3.2
Flow depth at right abutment (yaRT), in feet	0	0
Contraction scour depth (ycs), in feet	2.9	6.4
Pier scour depth (yps), in feet	4.4	4.5
Left abutment scour depth (yas), in feet	1.4	11.9
Right abutment scour depth (yas), in feet	0	0
1Flow angle of attack	35	35

See Comments/Diagram for justification where required