OK RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 68156182 Date 5/29/12 Initials RaL Region (A B (C) D)

Site ____________ Location 0.1 mi W of int of 443 Ave & 309 St

Q_{100} = 105000 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 105000 (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 = 431 ft. Flow angle at bridge = 0 ° Abut. Skew = 0 ° Effective Skew = 0 °

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 = 431 ft* $q_2 = Q_2/W_2$ = 243.6 ft^2/s

Bridge Vel, V_2 = 11.1 ft/s Final $y_2 = q_2/V_2$ = 22 ft Δh = 2.5 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 24.5 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.

Water Surface Elev. = Unk -culvert footing 27 ft
30.48
25.9
24.9

Low Steel Elev. = 24.9 ft

n (Channel) = 0.035

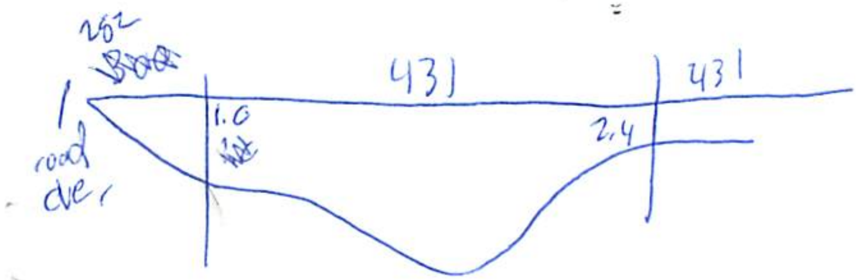
n (LOB) = 0.050

n (ROB) = 0.045

Pier Width = 2.0 ft

Pier Length = 2.25 ft

Piers for 100 yr = 4 ft



CONTRACTION SCOUR

PGRM: Contract

1.5·2/3 3.6

Width of main channel at approach section W_1 = 431 ft

Width of left overbank flow at approach, W_{lob} = 262 ft Average left overbank flow depth, y_{lob} = 1.0 ft

Width of right overbank flow at approach, W_{rob} = 431 ft Average right overbank flow depth, y_{rob} = 2.4 ft

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

x = 0.92 From Figure 9 W_2 (effective) = 423 ft y_{cs} = 1.4 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, $V_1 = Q_{100}/(y_1W_1)$ = ____ 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 = 1.125 Correction factor for flow angle of attack (from Table 1), K2 = 1.0

Froude # at bridge = 0.42 Using pier width a on Figure 11, ξ = 8 Pier scour y_{ps} = 7 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 1.0 ft right abutment, y_{aRT} = 2.4 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} = 4.3 and ψ_{RT} = 9.8

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 4.3 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 9.8 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 68156182 Date 5/29/12 Initials RaL Region (A B C D) 6

Site _____ Location 0.1 mi W of int of 443 Ave & 309 St

Q_{500} = 256000 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 134574 (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 = 481 ft. Flow angle at bridge = 0 ° Abut. Skew = 0 ° Effective Skew = 0 °

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 = 431 ft* $q_2 = Q_2/W_2$ = 312.2 ft^2/s

Bridge Vel, V_2 = 12.5 ft/s Final $y_2 = q_2/V_2$ = 24.9 ft Δh = 3.2 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 28.1 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. = Unknown ft - current too low

Low Steel Elev. = 24.9 ft

n (Channel) = 0.035

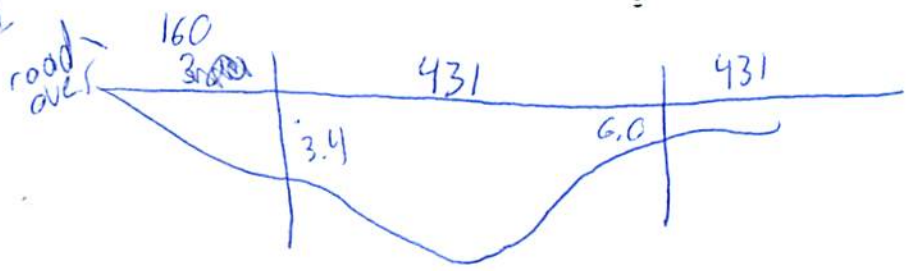
n (LOB) = 0.050

n (ROB) = 0.045

Pier Width = 2.0 ft

Pier Length = 2.25 ft

Piers for 500 yr = 4 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 431 ft 5.1 · 2/3 = 10.2/3 = 3.4

Width of left overbank flow at approach, W_{lob} = 160 ft Average left overbank flow depth, y_{lob} = 3.4 ft

Width of right overbank flow at approach, W_{rob} = 431 ft Average right overbank flow depth, y_{rob} = 6.0 ft

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

x = 2.45 From Figure 9 W_2 (effective) = 423 ft y_{cs} = 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, $V_1 = Q_{500}/(y_1 W_1)$ = _____ 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 = 1.125 Correction factor for flow angle of attack (from Table 1), K2 = 1

Froude # at bridge = 0.44 Using pier width a on Figure 11, ξ = 8 Pier scour y_{ps} = 7.1 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 3.4 ft right abutment, y_{aRT} = 6.0 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} = 12.2 and ψ_{RT} = 16.8

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 12.2 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 16.8 ft

Route 309 St Stream James River MRM ________ Date 5/29/12 Initials RnT

Bridge Structure No. 68156182 Location 0.1 mi W of int of 443 Ave & 309 St

GPS coordinates: N 42° 54' 27.3" W 97° 19' 36.2" taken from: USL abutment X centerline of ⇑ MRM end ______

Datum of coordinates: WGS84 X NAD27 ______

Drainage area = 19072.53 sq. mi.

The average bottom of the main channel was 30.4 ft below top of guardrail at a point 187 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} =	105000		Q_{500} =	256000	
Estimated flow passing through bridge		105000			134574	
Estimated road overflow & overtopping		0			121426	
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	

5/22.

2	976
5	6290
10	15300
25	38000
50	65500
100	105000
500	256000

Riprap at abutments? X Yes ____No ____Marginal

Evidence of past Scour? X Yes ____No ____Don't know contraction, pier.

Debris Potential? X High X Med ____Low

Does scour countermeasure(s) appear to have been designed?

Riprap X Yes ____No ____Don't know ____NA cose grade

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 X	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). left abutment damage
3) left abutment
4). left abutment
5-7) debris
8). piers
9). pier scour
10-11) main channel @ bridge entrance
12-13) left channel approach
13). downstream left channel
14-16) right abutment
17). right OB
18). main channel
19) left OB
20) left OB

Summary of Results

	Q100	Q500
Bridge flow evaluated	105000	134574
Flow depth at left abutment (yaLT), in feet	1.0	3.4
Flow depth at right abutment (yaRT), in feet	2.4	6.0
Contraction scour depth (ycs), in feet	1.4	3
Pier scour depth (yps), in feet	7	7.1
Left abutment scour depth (yas), in feet	4.3	12.2
Right abutment scour depth (yas), in feet	9.8	16.8
1Flow angle of attack	0	0

See Comments/Diagram for justification where required