OK RT

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SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 39054040 Date 7/24/12 Initials RAT Region (A B (C) D)

Site ________ Location Just east of Bancroft on 200 St

Q_{100} = Q_{50} 1620 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 1620 (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 = 35 ft. Flow angle at bridge = 10 ° Abut. Skew = 0 ° Effective Skew = 10 °

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 = 34.47 ft* $q_2 = Q_2/W_2$ = 47 ft²/s

Bridge Vel, V_2 = 4.9 ft/s Final $y_2 = q_2/V_2$ = 9.7 ft Δh = 0.5 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 10.2 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. = 3.1 ft (channel dry)

Low Steel Elev. = 10.6 ft

n (Channel) = 0.035 ~~0.045~~

n (LOB) = 0.030 ~~0.030~~

n (ROB) = 0.030 ~~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 = 66 ft

Width of left overbank flow at approach, W_{lob} = 35 ft Average left overbank flow depth, y_{lob} = 2.7 ft

Width of right overbank flow at approach, W_{rob} = 35 ft Average right overbank flow depth, y_{rob} = 2.7 ft

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

x = 11.97 From Figure 9 W_2 (effective) = 34.5 ft y_{cs} = 13 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

PIER SCOUR CALCULATIONS

PGRM: Pier

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} = 2.7 ft right abutment, y_{aRT} = 2.7 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 and ψ_{RT} = 11

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 16.4 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 16.4 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 39054040 Date 7/24/12 Initials PoT Region (A B (C) D)

Site ______ Location Just E of Bancroft on 200 St

Q_{500} = Q_{100} 2180 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 1731 (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 = 35 ft. Flow angle at bridge = 10 ° Abut. Skew = 0 ° Effective Skew = 10 °

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 = 34.47 ft* $q_2 = Q_2/W_2$ = 50.2 ft^2/s

Bridge Vel, V_2 = 5 ft/s Final $y_2 = q_2/V_2$ = 10 ft Δh = 0.5 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 10.5 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. = 3.1 ft

Low Steel Elev. = 10 ft

n (Channel) = ~~grass~~ 0.035

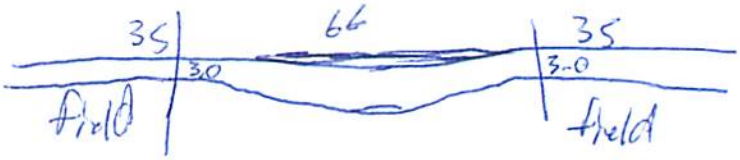
n (LOB) = 0.030

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 = 66 ft

Width of left overbank flow at approach, W_{lob} = 35 ft Average left overbank flow depth, y_{lob} = 3.0 ft

Width of right overbank flow at approach, W_{rob} = 35 ft Average right overbank flow depth, y_{rob} = 3.0 ft

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

x = 12.69 From Figure 9 W_2 (effective) = 34.5 ft y_{cs} = 13.7 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

PIER SCOUR CALCULATIONS

PGRM: Pier

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} = 3.0 ft right abutment, y_{aRT} = 3.0 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} = 11.5 and ψ_{RT} = 11.5

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 17.2 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 17.2 ft

44° 29' 3.696''
97° 44' 39.3468''

97.744263
44.48436

Route 200 St Stream Redstone Ck MRM ________ Date 7/24/12 Initials Pat

Bridge Structure No. 39054040 Location Just E of Bancroft on 200 St

GPS coordinates: N 44° 29' 3.9" / W 97° 44' 39.9" taken from: USL abutment X centerline of ⇑ MRM end ______

Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 39.23 sq. mi.

The average bottom of the main channel was 14.4 ft below top of guardrail at a point 12 ft from left abutment.

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

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2	232
5	738
10	1300
25	2340
50	3340
100	4570
500	8330

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = Q_{50} 1620			~~Q_{500}~~ = Q_{100} 2180		
Estimated flow passing through bridge	1620			1731		
Estimated road overflow & overtopping	0			449		
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	

7/3

2	126
5	384
10	662
25	1150
50	1620
100	2180
500	3550

Riprap at abutments? ____Yes X No ____Marginal

Evidence of past Scour? X Yes ____No ____Don't know — 4ft of elevation drop under bridge - contraction. abutments submerged

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 X Don't know ____NA — wood beam at bottom of abutments

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_{50}	~~Q500~~ Q_{100}
Bridge flow evaluated	1620	1731
Flow depth at left abutment (yaLT), in feet	2.7	3.0
Flow depth at right abutment (yaRT), in feet	2.7	3.0
Contraction scour depth (ycs), in feet	13.0	13.7
Pier scour depth (yps), in feet	NA	N/A
Left abutment scour depth (yas), in feet	16.4	17.2
Right abutment scour depth (yas), in feet	16.4	17.2
1Flow angle of attack	10	10

See Comments/Diagram for justification where required