OK RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 11203080 Date 7/12/12 Initials RaT Region (A B C D)

Site _____ Location 0.4mi S & 0.3mi E of Hereid on 108th St

Q_{100} = Qsp 4970 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 4970 (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 = 89 ft. Flow angle at bridge = 15 ° Abut. Skew = 0 ° Effective Skew = 15 °

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 = 85.97 ft* $q_2 = Q_2/W_2$ = 57.8 ft^2/s

Bridge Vel, V_2 = 5.4 ft/s Final $y_2 = q_2/V_2$ = 10.7 ft Δh = 0.6 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 11.3 ft

13.9
11.3
2.6

** 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. = 4.0-7.6 ft 15.6

Low Steel Elev. = 11.6 ft 4.2 11.6 - look low steel from bridge depth

n (Channel) = 0.046

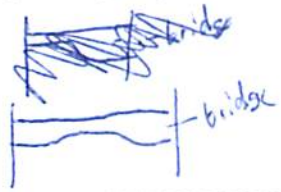
n (LOB) = ~~0.035~~ 0.030

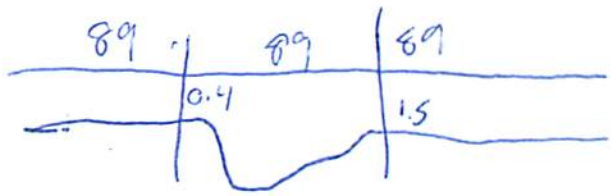
n (ROB) = ~~0.035~~ 0.035

Pier Width = 0.9 ft

Pier Length = 28 ft

Piers for 100 yr = 2 ft





CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 89 ft

Width of left overbank flow at approach, W_{lob} = 89 ft Average left overbank flow depth, y_{lob} = 0.4 ft

Width of right overbank flow at approach, W_{rob} = 89 ft Average right overbank flow depth, y_{rob} = 1.5 ft

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

x = ~~1.18~~ 1.08 From Figure 9 W_2 (effective) = 84.2 ft y_{cs} = ~~1.6~~ 1.5 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, $V_1 = Q_{100}/(y_1W_1)$ = _____ 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 = 31.11 Correction factor for flow angle of attack (from Table 1), K2 = 2.5

Froude # at bridge = ~~0.28~~ 0.29 Using pier width a on Figure 11, ξ = ~~4.2~~ 4.4 Pier scour y_{ps} = ~~1.8~~ 9.1 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 0.4 ft right abutment, y_{aRT} = 1.5 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} = 1.9 and ψ_{RT} = 6.3

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 3.5 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 11.4 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 1120380 Date 7/12/12 Initials KaT Region (A B C D)

Site _____ Location 0.4 mi S & 0.3 mi E of Herrid

Q_{500} = Q500 7370 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 5813 (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 = 89 ft. Flow angle at bridge = 15 ° Abut. Skew = 0 ° Effective Skew = 15 °

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 = 85.97 ft* $q_2 = Q_2/W_2$ = 67.6 ft²/s

Bridge Vel, V_2 = 5.8 ft/s Final $y_2 = q_2/V_2$ = 11.6 ft Δh = 0.7 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 12.3 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. = 4.0-7.6 ft

Low Steel Elev. = 11.6 ft

n (Channel) = 0.040

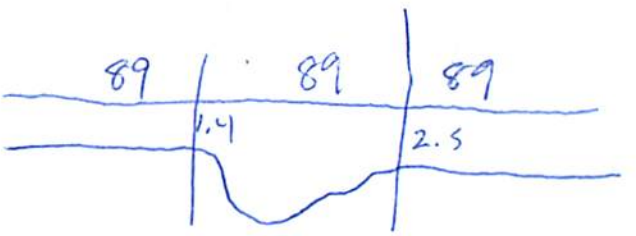
n (LOB) = 0.030

n (ROB) = 0.035

Pier Width = 6.9 ft

Pier Length = 29 ft

Piers for 500 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 89 ft

Width of left overbank flow at approach, W_{lob} = 89 ft Average left overbank flow depth, y_{lob} = 1.4 ft

Width of right overbank flow at approach, W_{rob} = 89 ft Average right overbank flow depth, y_{rob} = 2.5 ft

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

x = 2.21 From Figure 9 W_2 (effective) = 84.2 ft y_{cs} = 2.8 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 = 31.11 Correction factor for flow angle of attack (from Table 1), K2 = 2.5

Froude # at bridge = 0.30 Using pier width a on Figure 11, ξ = 4.4 Pier scour y_{ps} = 9.1 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 1.4 ft right abutment, y_{aRT} = 2.5 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} = 5.9 and ψ_{RT} = 10.2

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 10.6 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 18.6 ft

100° 3' 46.906"
45° 49' 32.458"

100.06303,
45.82569

Route 108th St Stream _____ MRM _____ Date 7/12/12 Initials RaT

Bridge Structure No. 1120308O Location 0.4 mi S + 0.3 mi E of Herried

GPS coordinates: N 45° 49' 32.711 taken from: USL abutment X centerline of ⇑ MRM end _____

W 100° 3' 47.011 Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 353.55 sq. mi.

The average bottom of the main channel was 15.6 ft below top of guardrail at a point 50 ft from left abutment.

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

7/12

2	128
5	664
10	1450
25	3140
50	4970
100	7370
500	15300

MISCELLANEOUS CONSIDERATIONS

Flows	$Q_{\cancel{100}\,50}$ = 4970			$Q_{\cancel{500}\,100}$ = 7370		
Estimated flow passing through bridge	4970			5813		
Estimated road overflow & overtopping	0			1557		
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? ____Yes ____No X Marginal - ~~large~~ dangerous amount of pier

Evidence of past Scour? X Yes ____No ____Don't know - abutment, large amount of left only, right side ~~is~~ untouched

Debris Potential? ____High ____Med X Low

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

Riprap X Yes ____No ____Don't know ____NA - riprap at left abutment is held in place by a wire net

Spur Dike ____Yes X No ____Don't know ____NA

Other cement wall X Yes ____No ____Don't know ____NA - blockade around scoured abutment

-see pictures

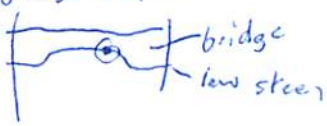
Bed Material Classification Based on Median Particle Size (D_{50})

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 abt
2). main channel
3). right abt
4). left abutment
5). right abutment
6). pier
7). main channel
8). left abutment
9). right abutment
10). left abutment scour

Note: ~~unable~~ unable to get accurate pier width. Took low steel at bridge depth



Summary of Results

	$Q_{\cancel{100}\,50}$	$Q_{\cancel{500}\,100}$
Bridge flow evaluated	4970	5813
Flow depth at left abutment (yaLT), in feet	~~0.5~~ 0.4	1.4
Flow depth at right abutment (yaRT), in feet	~~1.5~~ 1.3	2.5
Contraction scour depth (ycs), in feet	~~1.6~~ 1.5	2.5
Pier scour depth (yps), in feet	9.1	9.1
Left abutment scour depth (yas), in feet	3.5	10.6
Right abutment scour depth (yas), in feet	11.4	15.6
1Flow angle of attack	15	15

See Comments/Diagram for justification where required