OK RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 20030206 Date 7/30/12 Initials RAT Region (A B (C) D)

Site ____________ Location 0.6 mi So of int of 469 Ar & 186 St.

Q_{100} = 4680 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. Y

Bridge discharge (Q_2) = 4680 (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 = 119 ft. Flow angle at bridge = 10 ° Abut. Skew = 0 ° Effective Skew = 10 °

Width (W_2) iteration = 119 86 90 ____

Avg. flow depth at bridge, y_2 iteration = 8.9 10.5 10.3 ____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 88.63 ft* $q_2 = Q_2/W_2$ = 52.8 ft^2/s

Bridge Vel, V_2 = 5.2 ft/s Final $y_2 = q_2/V_2$ = 10.3 ft Δh = 0.5 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 10.8 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. = 0-0.4 ft (23.1 − 4.1)

Low Steel Elev. = 19.0 ft see notes

n (Channel) = 0.040

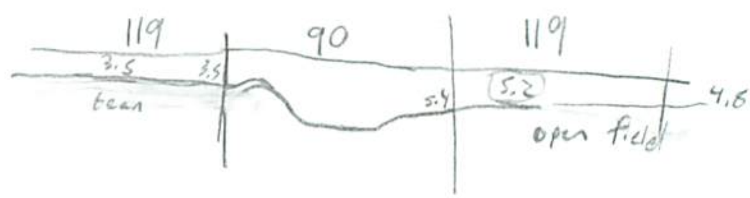
n (LOB) = 0.030

n (ROB) = 0.035

Pier Width = 2 ft

Pier Length = 2 ft

\# Piers for 100 yr = 4 ft



3.5

CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 90 ft

Width of left overbank flow at approach, W_{lob} = 119 ft Average left overbank flow depth, y_{lob} = 5.2 ft (5.4 − 4.8)

Width of right overbank flow at approach, W_{rob} = 119 ft Average right overbank flow depth, y_{rob} = 3.5 ft

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

x = 10.33 From Figure 9 W_2 (effective) = 80.6 ft y_{cs} = 11.3 ft

PGRM: CWCSNEW

Clear Water Contraction Scour (use if bed material is larger than small cobbles) see notes!

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 = 0.29 Using pier width a on Figure 11, ξ = 8 Pier scour y_{ps} = ~~[illegible]~~ 6.3 ft 6.6

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 5.2 ft right abutment, y_{aRT} = 3.5 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} = 15.4 and ψ_{RT} = 12.4

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 15.4 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 12.4 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 20030206 Date 7/30/12 Initials [illegible] Region (A B (C) D)

Site ________ Location 0.6 mi S of int of 469 Av + 186 St

Q_{500} = 7510 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 7510 (should be Q_{500} 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 = 119 ft. Flow angle at bridge = 10 ° Abut. Skew = 0 ° Effective Skew = 10 °

Width (W_2) iteration = 119 92 97 96

Avg. flow depth at bridge, y_2 iteration = 11.3 12.8 12.5 12.6

Corrected channel width at bridge Section = W_2 times cos of flow angle = 94.54 ft* $q_2 = Q_2/W_2$ = 79.4 ft^2/s

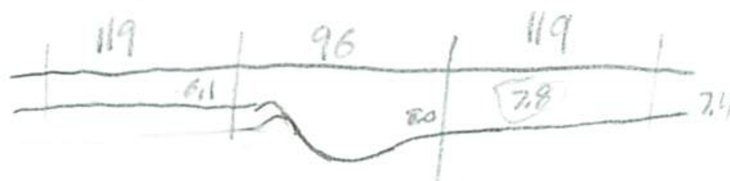
Bridge Vel, V_2 = 6.3 ft/s Final $y_2 = q_2/V_2$ = 12.6 ft Δh = 0.8 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 13.4 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. = 0-0.4 ft
Low Steel Elev. = 19.0 ft
n (Channel) = 0.040
n (LOB) = 0.030
n (ROB) = 0.035
Pier Width = 2 ft
Pier Length = 2 ft
\# Piers for 500 yr = 4 ft



PGRM: Contract

CONTRACTION SCOUR

Width of main channel at approach section W_1 = 96 ft

Width of left overbank flow at approach, W_{lob} = 119 ft Average left overbank flow depth, y_{lob} = 7.8 ft (8.0-7.4)

Width of right overbank flow at approach, W_{rob} = 119 ft Average right overbank flow depth, y_{rob} = 6.1 ft

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

x = 17.11 From Figure 9 W_2 (effective) = 86.5 ft y_{cs} = 16.1 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, $Vc = 11.17y_1^{1/6}D_{50}^{1/3}$ = ______ 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

PGRM: Pie

PIER SCOUR CALCULATIONS

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

Froude # at bridge = 0.31 Using pier width a on Figure 11, ξ = 8 Pier scour y_{ps} = 6.7 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 7.8 ft right abutment, y_{aRT} = 6.1 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} = 19.6 and ψ_{RT} = 17.0

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 19.6 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 17.0 ft

96.82539
44.68029

44° 40' 49.044''
96° 49' 31.4''

Route 469 Ave Stream Hidewood Ck MRM ______ Date 7/30/12 Initials LaJ

Bridge Structure No. 20030206 Location 0.6 mi S of int of 469 Av + 186 St

GPS coordinates: N 44° 40' 48.2" W 96° 49' 32.2" taken from: USL abutment X centerline of ⇑ MRM end ______

Datum of coordinates: WGS84 X NAD27 ______

Drainage area = 135.86 sq. mi.

The average bottom of the main channel was 23.1 ft below top of guardrail at a point 56 ft from left abutment.

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

7/3
8/23

2	384
5	1040
10	1680
25	2710
50	~~3630~~ 3640
100	4680
500	~~7500~~ 7510

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 4680			Q_{500} = 7510		
Estimated flow passing through bridge	4680			7510		
Estimated road overflow & overtopping	0			0		
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? X Yes ____No ____Marginal

Evidence of past Scour? X Yes ____No ____Don't know some contraction, minor abutment

Debris Potential? ____High ____Med X Low

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

Riprap X Yes ____No ____Don't know ____NA - cobble-sized riprap held in place by netted wires.

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 X	Cobbles X	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). pier
5-6). left abutment
7-8). right abutment
9). bed material
10). main channel

Note: bridge on hill slope: took lowest from bridge depth location. Lots of cobbles under bridge. Consider contraction scour.

Summary of Results

	Q100	Q500
Bridge flow evaluated	4680	7510
Flow depth at left abutment (yaLT), in feet	5.2	~~8.9~~ 7.8
Flow depth at right abutment (yaRT), in feet	3.5	6.1
Contraction scour depth (ycs), in feet	11.3	16.1
Pier scour depth (yps), in feet	~~6.3~~ 6.6	6.7
Left abutment scour depth (yas), in feet	15.4	19.6
Right abutment scour depth (yas), in feet	12.4	17.0
1Flow angle of attack	X 10	X 10

See Comments/Diagram for justification where required