OK RJ

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 05102160 Date 6/10/12 Initials RaT Region (A B C D)

Site _____ Location 307 St, 3.8 mi W of HW 37

Q_{100} = 6260 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 6260 (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 = 147 ft. Flow angle at bridge = 5 ° Abut. Skew = 0 ° Effective Skew = 5 °

Width (W_2) iteration = 146.44 ~~96 95.63~~ ~~116 115.54~~ ~~104 105.6~~ ~~110 109.56~~ 109 ~~108.59~~

Avg. flow depth at bridge, y_2 iteration = 9.2 11.4 ~~10.4~~ 10.9 11.2 ~~10.8~~

Corrected channel width at bridge Section = W_2 times cos of flow angle = 111.57 ft* $q_2 = Q_2/W_2$ = 56.1 ft²/s

Bridge Vel, V_2 = 5.3 ft/s Final $y_2 = q_2/V_2$ = 10.6 ft Δh = 0.5 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 11.1 ft

W_2	y_2
146.44	~~10.8~~ 9.2
~~112.57~~	~~10.4~~
115.56	10.4
109.58	10.7
111.57	10.6

** 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. = 0 ft

Low Steel Elev. = 16.1 ft

n (Channel) = 0.040

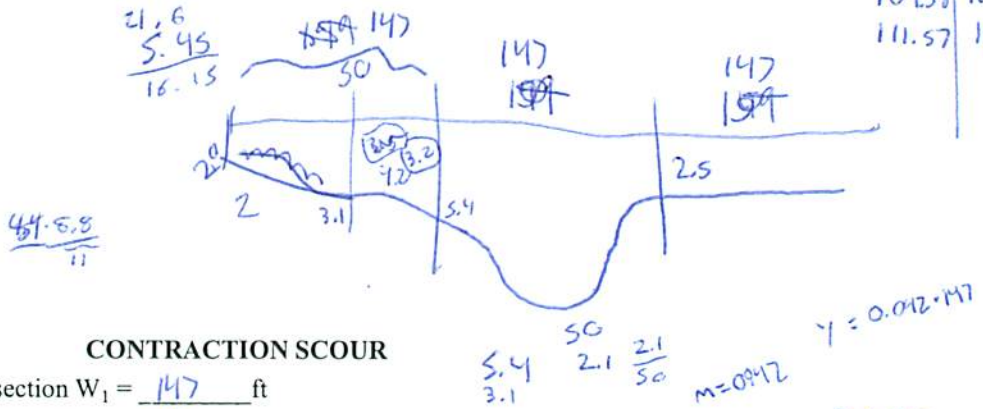
n (LOB) = 0.030

n (ROB) = 0.030

Pier Width = 2.8 ft

Pier Length = 2.8 ft

Piers for 100 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 147 ft

Width of left overbank flow at approach, W_{lob} = 147 ft Average left overbank flow depth, y_{lob} = ~~3.5~~ 3.2 ft

Width of right overbank flow at approach, W_{rob} = 147 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 = 8.59 From Figure 9 W_2 (effective) = 106 ft y_{cs} = 9.5 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 = 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 = 10.2 Pier scour y_{ps} = 8.5 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 3.2 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} = 11.9 and ψ_{RT} = 10.2

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 11.9 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 10.2 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 05102160 Date 6/19/12 Initials RaT Region (A B C D)

Site _____ Location 307 St, 3.8 mi W of #HWY 37

Q_{500} = 13100 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 13100 (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 = 147 ft. Flow angle at bridge = 5 ° Abut. Skew = 0 ° Effective Skew = 5 °

Width (W_2) iteration = 146.44 (140) 139.47 ~~146.44~~ (144) 143.45

Avg. flow depth at bridge, y_2 iteration = 13.3 13.7 ~~13.4~~ 13.5

Corrected channel width at bridge Section = W_2 times cos of flow angle = 143.45 ft* $q_2 = Q_2/W_2$ = 91.3 ft^2/s

Bridge Vel, V_2 = 6.8 ft/s Final $y_2 = q_2/V_2$ = 13.5 ft Δh = 0.9 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 14.4 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 ft

Low Steel Elev. = 16.1 ft

n (Channel) = 0.040

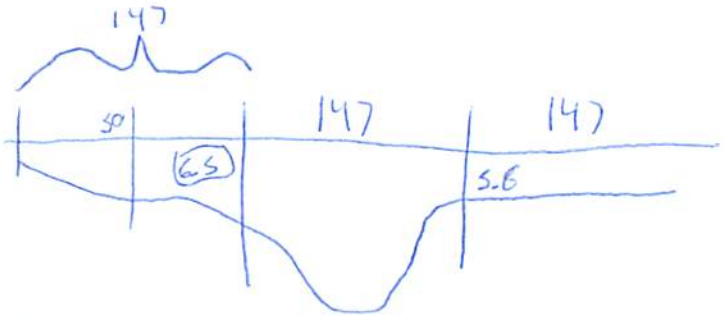
n (LOB) = 0.030

n (ROB) = 0.030

Pier Width = 2.8 ft

Pier Length = 2.8 ft

Piers for 500 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 147 ft

Width of left overbank flow at approach, W_{lob} = 147 ft Average left overbank flow depth, y_{lob} = 6.5 ft

Width of right overbank flow at approach, W_{rob} = 147 ft Average right overbank flow depth, y_{rob} = 5.8 ft

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

x = 10.89 From Figure 9 W_2 (effective) = 137.9 ft y_{cs} = 11.9 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, $V_1 = Q_{500}/(y_1 W_1)$ = _____ 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} = 1 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 = 0.33 Using pier width a on Figure 11, ξ = 10.2 Pier scour y_{ps} = 8.7 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 6.5 ft right abutment, y_{aRT} = 5.8 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} = 17.7 and ψ_{RT} = 16.5

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 17.7 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 16.5 ft

97° 57' 58.214"
42° 56' 15.864

97.96617
42.93774

Route 307 St Stream Emanuel St MRM _____ Date 6/10/12 Initials RaT

Bridge Structure No. 05102160 Location 307 St, 3.8 mi W of Hwy 37

GPS coordinates: N 42° 56' 16.0" taken from: USL abutment X centerline of ⇑ MRM end _____

W 97° 57' 56.0" Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 141.36 sq. mi.

The average bottom of the main channel was 21.6 ft below top of guardrail at a point 97 ft from left abutment.

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

6/4
~~8/22~~

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 6260			Q_{500} = 13100		
Estimated flow passing through bridge	6260			13100		
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	

2	~~1600~~ 659
5	660
10	1340
25	2750
50	4260
100	6260
500	13100

Riprap at abutments? ____Yes ____No __X__Marginal ~~Some riprap~~ heavy abutment some pier contraction

Evidence of past Scour? __X__Yes ____No ____Don't know

Debris Potential? ____High __X__Med ____Low -appears some one chopped down a tree and disposed into the channel

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

Riprap ____Yes ____No __X__Don't know ____NA ~~appears~~ Riprap is placed into scour hole on downstream right abutment but nowhere else

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

Note: 05102160 drains into 05093181 yet 05102160 flow values are higher, in streamstats.

Comments, Diagrams & orientation of digital photos

1). debris
2). left OB
3). ~~right~~ OB main channel
4). right OB
5) piers
6). left Abutment
7). right Abutment

8). debris
9). pier scour
10). right abutment
11-13) left abutment (scour)
14-15). right abutment (scour)
16-17). main channel

Summary of Results

	Q100	Q500
Bridge flow evaluated	6260	13100
Flow depth at left abutment (yaLT), in feet	3.2	6.5
Flow depth at right abutment (yaRT), in feet	2.5	5.5
Contraction scour depth (ycs), in feet	9.5	11.9
Pier scour depth (yps), in feet	8.5	8.7
Left abutment scour depth (yas), in feet	11.9	17.7
Right abutment scour depth (yas), in feet	10.2	16.5
1Flow angle of attack	5	5

See Comments/Diagram for justification where required