ok RJ

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 07088110 Date 7/27/12 Initials RA Region (A B C D) 6

Site _____ Location ~1.1 mi W of Highway 281 on 11th St.

Q_{max} = Q_{10} 3050 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = Q_{10} 3050 (should be Q_{100} 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 = 163 ft. Flow angle at bridge = 90° Abut. Skew = 0 ° Effective Skew = 60 °

Width (W_2) iteration = _____ _____ _____ _____

Avg. flow depth at bridge, y_2 iteration = _____ _____ _____ _____

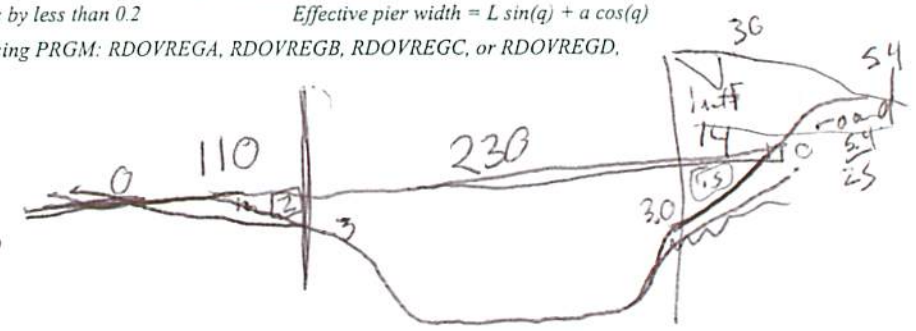
Corrected channel width at bridge Section = W_2 times cos of flow angle = 81.5 ft* $q_2 = Q_2/W_2$ = 37.4 ft²/s

Bridge Vel, V_2 = 3 ft/s Final $y_2 = q_2/V_2$ = 12.3 ft Δh = 12.5-12.3 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 12.5 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. = 2 ft 15.9 -3.7 15.2

Low Steel Elev. = 15.2 ft

n (Channel) = 0.035

n (LOB) = 0.035

n (ROB) = ~~0.035 0.030~~ 0.040

Pier Width = 1.3 ft

Pier Length = 31 ft

Piers for 100 yr = 3 ft

CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 230 ft

Width of left overbank flow at approach, W_{lob} = 110 ft Average left overbank flow depth, y_{lob} = 3.62 ft

Width of right overbank flow at approach, W_{rob} = 14 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 = 25.44 From Figure 9 W_2 (effective) = 77.6 ft y_{cs} = 20.6 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

PGRM: Pier

PIER SCOUR CALCULATIONS

L/a ratio = 23.95 Correction factor for flow angle of attack (from Table 1), K2 = 4.6

Froude # at bridge = 0.15 Using pier width a on Figure 11, ξ = 5.8 Pier scour y_{ps} = 20.1 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 2 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} = 8.2 and ψ_{RT} = 6.3

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 8.2 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 6.3 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 07648110 Date 7/22/17 Initials NAL Region (A B C D)

Site _____ Location ~1.1 mi W of Highway 281 on 111th St.

Q_{500} = Q25 6830 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 4536 (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 = 163 ft. Flow angle at bridge = 60 ° Abut. Skew = 0 ° Effective Skew = 60 °

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 = 81.5 ft* $q_2 = Q_2/W_2$ = 55.7 ft^2/s

Bridge Vel, V_2 = 3.7 ft/s Final $y_2 = q_2/V_2$ = 15.2 ft Δh = 0.3 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 15.5 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. = 2 ft

Low Steel Elev. = 15.2 ft

n (Channel) = 0.035

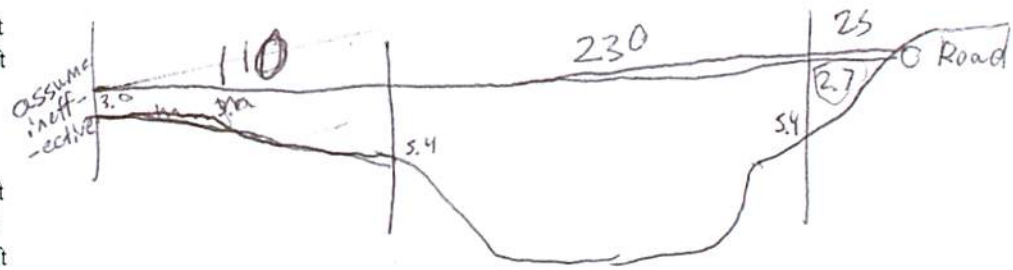
n (LOB) = 0.035

n (ROB) = 0.040

Pier Width = 1.3 ft

Pier Length = 31 ft

Piers for 500 yr = 3 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 230 ft

Width of left overbank flow at approach, W_{lob} = 110 ft Average left overbank flow depth, y_{lob} = 4.6 ft

Width of right overbank flow at approach, W_{rob} = 25 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 = ~~40.02~~ 33.58 From Figure 9 W_2 (effective) = ~~66.6~~ 77.4 ft y_{cs} = ~~28.5~~ ft 25

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

PGRM: CWCSNEW

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 = 23.85 Correction factor for flow angle of attack (from Table 1), K2 = 4.6

Froude # at bridge = 0.17 Using pier width a on Figure 11, ξ = 5.8 Pier scour y_{ps} = 20.4 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 4.6 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} = 14.3 and ψ_{RT} = 11

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 14.3 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 11 ft

98.54327
45.77883
45° 46' 43".788
98° 32' 35".772

Route _____ Stream Elm River MRM _____ Date 7/27/17 Initials RaT

Bridge Structure No. 43,811 Location _____

GPS coordinates: N 45° 46' [illegible] taken from: USL abutment X centerline of ⇑ MRM end _____

W 96° 32' [illegible] Datum of coordinates: WGS84 X NAD27 ____

Drainage area = 996.5 36,011 sq. mi. 18.9

The average bottom of the main channel was [illegible] ft below top of guardrail at a point 118 61 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	$Q_{100} = Q_{10}$ 3050			$Q_{500} = Q_{25}$ 6830		
Estimated flow passing through bridge	3050			4536		
Estimated road overflow & overtopping	0			2294		
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	

7/17

2	259
5	1370
10	3050
25	6830
50	11100
100	16800
500	36900

Riprap at abutments? ____Yes ____No X Marginal ~~only~~ left abutment 100% covered by riprop. Right abutment - marginal.

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

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 ____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

Comments, Diagrams & orientation of digital photos

1). left OB 11). main channel

2). main channel

3). right OB.

4-5). pier

6). right abutment

7-9). left abutment

10). right abutment

Note: overbank profile taken ~247 ft from center of bridge

Summary of Results

	~~Q100~~ Q_{10}	~~Q500~~ Q_{25}
Bridge flow evaluated	3050	4536
Flow depth at left abutment (yaLT), in feet	2	4.6
Flow depth at right abutment (yaRT), in feet	1.5	2.7
Contraction scour depth (ycs), in feet	20.6	~~29.5~~ 25
Pier scour depth (yps), in feet	20.1	20.4
Left abutment scour depth (yas), in feet	8.2	14.3
Right abutment scour depth (yas), in feet	6.3	11
1Flow angle of attack	60	60

See Comments/Diagram for justification where required