OK-RAT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 05093181 Date 10-15-12 Initials RFT Region (A B (C) D)

Site _____ Location 3.5 mi N, 4.6 mi W Springfield on 309 St

Q_{100} = 6760 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 6760 (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 = 172 ft. Flow angle at bridge = 7 ° Abut. Skew = 0 ° Effective Skew = 7 °

Width (W_2) iteration = 101 134 127 130

Avg. flow depth at bridge, y_2 iteration = 11.6 10.1 10.3 10.2

Corrected channel width at bridge Section = W_2 times cos of flow angle = 129.03 ft* $q_2 = Q_2/W_2$ = 52.4 ft^2/s

Bridge Vel, V_2 = 5.1 ft/s Final $y_2 = q_2/V_2$ = 10.2 ft Δh = 0.5 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 10.7 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.

somewhat incised. Appears to be impounded (beaver dam?) but is only a couple feet deep.

Water Surface Elev. = ____ ft

Low Steel Elev. = 15.7 ft

n (Channel) = .035

n (LOB) = .033 pasture

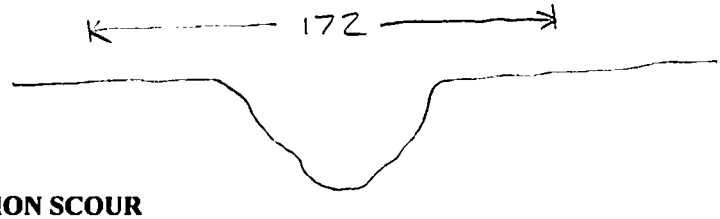
n (ROB) = .030 alfalfa

Pier Width = 2.3 ft

Pier Length = 2.3 ft

Piers for 100 yr = 2 ft

moved approach section further upstream to avoid old channel on left and trib on rt.



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 172 ft

Width of left overbank flow at approach, W_{lob} = 172 ft Average left overbank flow depth, y_{lob} = 5.6 ft

Width of right overbank flow at approach, W_{rob} = 172 ft Average right overbank flow depth, y_{rob} = 4.1 ft

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

x = 12.91 From Figure 9 W_2 (effective) = 124.4 ft y_{cs} = 13.9 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, $V_1 = Q_{100}/(y_1 W_1)$ = ____ 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 = 1 Correction factor for flow angle of attack (from Table 1), K2 = 1

Froude # at bridge = 0.28 Using pier width a on Figure 11, ξ = 8.9 Pier scour y_{ps} = 7.4 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 5.6 ft right abutment, y_{aRT} = 4.1 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} = 16.1 and ψ_{RT} = 13.4

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 16.1 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 13.4 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 05093181 Date _____ Initials _____ Region (A B C D)

Site _____ Location _____

Q_{500} = 14200 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = 14200 (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 = 172 ft. Flow angle at bridge = 7 ° Abut. Skew = 0 ° Effective Skew = 7 °

Width (W_2) iteration = 172 165 167 _____

Avg. flow depth at bridge, y_2 iteration = 12.9 13.1 13.1 _____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 165.76 ft* $q_2 = Q_2/W_2$ = 85.7 ft^2/s

Bridge Vel, V_2 = 6.6 ft/s Final $y_2 = q_2/V_2$ = 13.1 ft Δh = 0.9 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 13.9 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. = _____ ft

Low Steel Elev. = 157 ft

n (Channel) = .035

n (LOB) = .033

n (ROB) = .030

Pier Width = 2.3 ft

Pier Length = 2.3 ft

Piers for 500 yr = 2 ft

CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 172 ft

Width of left overbank flow at approach, W_{lob} = 172 ft Average left overbank flow depth, y_{lob} = 8.8 ft

Width of right overbank flow at approach, W_{rob} = 172 ft Average right overbank flow depth, y_{rob} = 7.3 ft

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

x = 14.2 From Figure 9 W_2 (effective) = 161.2 ft y_{cs} = 14.6 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, $V_1 = Q_{500}/(y_1 W_1)$ = _____ 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 = 1 Correction factor for flow angle of attack (from Table 1), K2 = 1

Froude # at bridge = 0.32 Using pier width a on Figure 11, ξ = 8.9 Pier scour y_{ps} = 7.5 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 8.8 ft right abutment, y_{aRT} = 7.3 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} = 20.4 and ψ_{RT} = 19.1

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 20.4 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 19.1 ft

Route 309 St Stream Emanuel Ck MRM _____ Date _____ Initials _____

Bridge Structure No. 05093181 Location 3.5 mi W, 4.6 N Springfield on 309 St

GPS coordinates: N 42° 54.451 taken from: USL abutment ✓ centerline of ⇑ MRM end _____

W 97° 58.865 Datum of coordinates: WGS84 ✓ NAD27 _____

Drainage area = 160.54 sq. mi.

The average bottom of the main channel was 21.2 ft below top of guardrail at a point 46 ft from left abutment.

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

9-6-12

2	168
5	703
10	1430
25	2950
50	4600
100	6760
500	14200

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 6760			Q_{500} = 14200		
Estimated flow passing through bridge	6760			14200		
Estimated road overflow & overtopping	0			0		
Consideration	Yes	No	Possibly	Yes	No	Possibly
Chance of overtopping		✓			✓	
Chance of Pressure flow		✓			✓	
Armored appearance to channel		✓			✓	
Lateral instability of channel			✓			✓

Riprap at abutments? ____Yes ____No X Marginal a little field stone near very top of abutments

Evidence of past Scour? X Yes ____No ____Don't know left abutment & left pier set

Debris Potential? ____High X Med ____Low some trees, but only 2 pier sets

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

Riprap	____Yes	✓No	____Don't know	____NA
Spur Dike	____Yes	____No	____Don't know	✓NA
Other _____	____Yes	____No	____Don't know	✓NA

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

Material	Silt/Clay ✓	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

Str. no

bridge section

LOB

ROB

rt. abut.

left abut.

left abut. scour/erosion under bridge

approach from bridge

natural topography rises toward roadbed and may help guide flow toward bridge opening, thus may partially mitigate abutment & contraction scour.

Summary of Results

	Q100	Q500
Bridge flow evaluated	6760	14200
Flow depth at left abutment (yaLT), in feet	5.6	8.8
Flow depth at right abutment (yaRT), in feet	4.1	7.3
Contraction scour depth (ycs), in feet	13.9	14.6
Pier scour depth (yps), in feet	7.4	7.5
Left abutment scour depth (yas), in feet	16.1	20.4
Right abutment scour depth (yas), in feet	13.4	19.1
Flow angle of attack	7°	7°

See Comments/Diagram for justification where required