OK RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 44005080 Date 6/18/12 Initials RG Region (A B (C) D)

Site ______ Location NW corner of Spencer on 252 St

Q_{100} = Q_5 = Q2 1488 Q5 609 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 609 (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 = 34 ft. Flow angle at bridge = 40° 30 Abut. Skew = 0 ° Effective Skew = 40 30 °

Width (W_2) iteration = ____ ____ ____ ____

Avg. flow depth at bridge, y_2 iteration = ____ ____ ____ 26.05

Corrected channel width at bridge Section = W_2 times cos of flow angle = 29.47 ft* $q_2 = Q_2/W_2$ = 20.7 ft²/s

Bridge Vel, V_2 = 3.2 ft/s Final $y_2 = q_2/V_2$ = 6.4 ft Δh = 0.2 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 6.6 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. = 3.5 ft

Low Steel Elev. = 7.4 ft 11.9 6.2

n (Channel) = 0.035

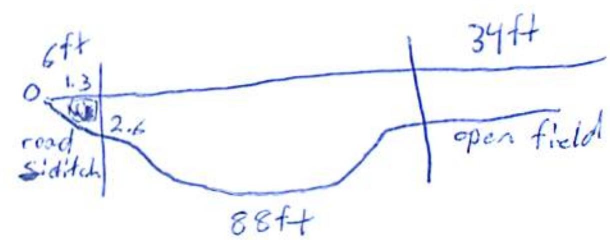
n (LOB) = 0.035

n (ROB) = 0.030

Pier Width = 2.5 ft

Pier Length = 2.5 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} = 6 ft 2.7 · 2/3 5.4 2.2/2 Average left overbank flow depth, y_{lob} = 1.3 ft

Width of right overbank flow at approach, W_{rob} = 34 ft Average right overbank flow depth, y_{rob} = 1.1 ft

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

x = 17.81 From Figure 9 W_2 (effective) = 24.4 ft y_{cs} = 16.5 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, $V_c = 11.17y_1^{1/6}D_{50}^{1/3}$ = ______ 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 = 0.22 Using pier width a on Figure 11, ξ = 9.5 Pier scour y_{ps} = 7.6 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 1.3 ft right abutment, y_{aRT} = 1.1 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} = 5.5 and ψ_{RT} = 4.7

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 9.9 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 8.5 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 44005080 Date 6/18/12 Initials RAL Region (A B C D)

Site _____ Location NW corner of Spencer on 252 St

Q_{500} = 640 6889 1226 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = 6889 6091 (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 = 34 ft. Flow angle at bridge = 30 ° Abut. Skew = 0 ° Effective Skew = 30 °

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 = 29.44 ft* $q_2 = Q_2/W_2$ = 27.5 ft^2/s

Bridge Vel, V_2 = 3.7 ft/s Final $y_2 = q_2/V_2$ = 7.4 ft Δh = 0.3 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 7.7 ft

** NOTE: repeat above calculations until y_2 changes by less than 0.2* *Effective pier width = L sin(a) + a cos(a)*

If y_2 is above LS, then account for Road Overflow using PRGM: RDOVREGA, RDOVREGB, RDOVREGC, or RDOVREGD,

Water Surface Elev. = 3.5 ft

Low Steel Elev. = 7.4 ft

n (Channel) = 0.035

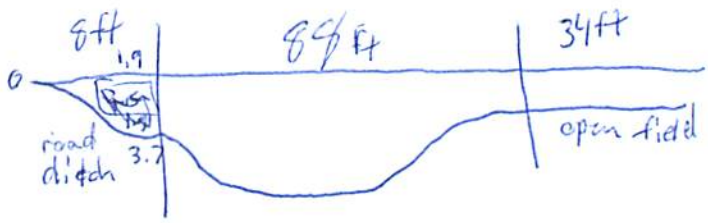
n (LOB) = 0.035

n (ROB) = 0.030

Pier Width = 2.5 ft

Pier Length = 2.5 ft

Piers for 500 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 34 ft

$3.7 \cdot \frac{2}{3} = \frac{7.4}{3} = 2.5$

Width of left overbank flow at approach, W_{lob} = 8 ft Average left overbank flow depth, y_{lob} = 1.9 ft

Width of right overbank flow at approach, W_{rob} = 34 ft Average right overbank flow depth, y_{rob} = 0.2 ft

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

x = 2.182 From Figure 9 W_2 (effective) = 24.4 ft y_{cs} = 18.7 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

PGRM: Pier

PIER SCOUR CALCULATIONS

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

Froude # at bridge = 0.24 Using pier width a on Figure 11, ξ = 9.5 Pier scour y_{ps} = 7.7 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 1.7 ft right abutment, y_{aRT} = 2.2 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} = 7 and ψ_{RT} = 9

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 12.8 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 16.4 ft

97° 35' 48.81
43 43' 51.84

~~97.9611~~
~~43.7310~~

97.596893
43.731079

Route 252 St Stream Wolf Ck MRM _____ Date 6/19/12 Initials RAT

Bridge Structure No. 44005080 Location NW corner of Spencer on 252 St

GPS coordinates: N 43° 43' 31.9"
W 97° 35' 48.9"

taken from: USL abutment X centerline of ⇑ MRM end _____

Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 122.33 sq. mi.

122.33

The average bottom of the main channel was 11.9 ft below top of guardrail at a point 25 ft from left abutment.

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

6118
~~8/24~~

2	148
5	609
10	1230
25	2510
50	3880
100	5680
500	11800

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = Q_5 ~~1878~~ 609			Q_{500} = Q_{10} 1230		
Estimated flow passing through bridge		~~1878~~ 609			~~1878~~ 609	
Estimated road overflow & overtopping		0			421	
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 lots of riprap at water height but not much higher

Evidence of past Scour? X Yes ____No ____Don't know pier, abutment & contraction

Debris Potential? ____High ____Med X Low

Abutment is scouring along outside abutments upstream and downstream see pictures

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	____No	X Don't know	____NA

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

Material	Silt/Clay X	Sand ____	Gravel ____	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
4-5). left abutment
6). piers, - has round/~~thick~~ thicker base than appears in picture
7-8). right abutment
9). main channel
10-12). abutment scour

Notes: Fair amount of large cobbles and/or boulders appear to be under the bridge. Consider using clear water contraction however channel is very very dirty and walking through also ~~picks~~ loosens alot of silt.

Q_2 is lower than current surface level

Summary of Results

	Q100 5	Q500 10
Bridge flow evaluated	609	809
Flow depth at left abutment (yaLT), in feet	1.3	1.9
Flow depth at right abutment (yaRT), in feet	1.1	~~2.7~~ 2.2
Contraction scour depth (ycs), in feet	16.5	18.7
Pier scour depth (yps), in feet	7.6	7.7
Left abutment scour depth (yas), in feet	9.9	12.9
Right abutment scour depth (yas), in feet	8.5	16.4
1Flow angle of attack	30	30

See Comments/Diagram for justification where required