OK RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 14109030 Date 5/25/12 Initials rat Region (A B (C) D)

Site ~~11300~~ Q50 Location 46290 300 St, Vermillion River

Q_{100} = ~~11300~~ ~~18500~~ 12000 by: drainage area ratio ~~w~~ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = ~~17000~~ 11300 (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 = 125 ft. Flow angle at bridge = 10 ° Abut. Skew = 0 ° Effective Skew = 10 °

Width (W_2) iteration = 123.1

Avg. flow depth at bridge, y_2 iteration = 16.6

Corrected channel width at bridge Section = W_2 times cos of flow angle = 123.1 ft* $q_2 = Q_2/W_2$ = 91.8 ft²/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, $y_1 = \Delta h + y_2$ = 14.5 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. = 0-4kk ft

Low Steel Elev. = ~~22.1~~ 15.9 ft

n (Channel) = 0.050

n (LOB) = ~~0.060~~ 0.085

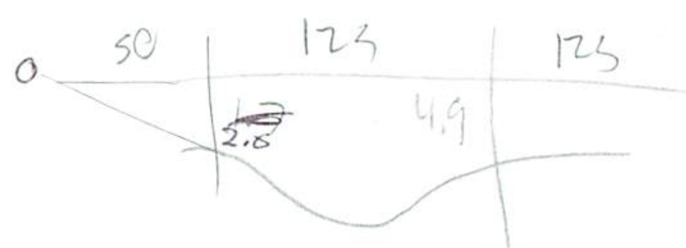
n (ROB) = ~~0.066~~ 0.055

Pier Width = 1.41 ft

Pier Length = 1.41 ft

Piers for 100 yr = 2 ft

20.6
~~26.6~~
4.7
~~22.1~~
15.9



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 125 ft

Width of left overbank flow at approach, W_{lob} = 50 ft Average left overbank flow depth, y_{lob} = 1.3 ft

Width of right overbank flow at approach, W_{rob} = 123 ft Average right overbank flow depth, y_{rob} = 4.9 ft

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

x = 2.88 From Figure 9 W_2 (effective) = 120.3 ft y_{cs} = 3.5 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, $Vc = 11.52y_1^{1/6}D_{50}^{1/3}$ = ____ 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 = 0.33 Using pier width a on Figure 11, ξ = 6.1 Pier scour y_{ps} = 5.2 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 1.3 ft right abutment, y_{aRT} = 4.9 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} = 14.8

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 5.5 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 14.8 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 14109030 Date 5/25/12 Initials RW Region (A B (C) D)

Site ________ Location 46290 300 St

Q_{500} (corrected to Q_{100}) = ~~32300~~ 37100 17000 by: drainage area ratio ~~WW~~ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = ~~30269~~ 15653 (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 = 123.1 ft. Flow angle at bridge = 10 ° Abut. Skew = 0 ° Effective Skew = 10 °

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 = 123.1 ft* $q_2 = Q_2/W_2$ = 127.2 ft^2/s

Bridge Vel, V_2 = 8 ft/s Final $y_2 = q_2/V_2$ = 15.9 ft Δh = 1.3 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 17.2 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. Q-44 ft

Low Steel Elev. = 15.9 ft

n (Channel) = 0.050

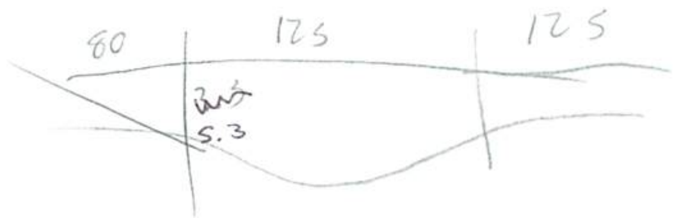
n (LOB) = 0.085

n (ROB) = 0.055

Pier Width = 1.4 ft

Pier Length = 1.4 ft

Piers for 500 yr = 2 ft



PGRM: Contract

CONTRACTION SCOUR

Width of main channel at approach section W_1 = 125 ft

Width of left overbank flow at approach, W_{lob} = 80 ft

Width of right overbank flow at approach, W_{rob} = 125 ft

Average left overbank flow depth, y_{lob} = ~~3.5~~ 2.7 ft (2.6 + 2.7 = 5.3; 5.3 · 1/2 = 10.6)

Average right overbank flow depth, y_{rob} = 7.6 ft (4.9 + 2.7 = 7.6)

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

x = 5.14 From Figure 9 W_2 (effective) = 120.3 ft y_{cs} = 5.8 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, $Vc = 11.52y_1^{1/6}D_{50}^{1/3}$ = ________ 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 = 0.35 Using pier width a on Figure 11, ξ = 6.1 Pier scour y_{ps} = 5.2 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 2.7 ft right abutment, y_{aRT} = 7.6 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 and ψ_{RT} = 19.5

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 11 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 19.5 ft

Route 300 St Stream Vermillion River MRM ______ Date 5/25/12 Initials MaT

Bridge Structure No. 14109030 Location 46290 300 St

GPS coordinates: N 43° 2' 24.8'', W 96 56' 37.1'' taken from: USL abutment X centerline of ⇑ MRM end ______

Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 1536.34 sq. mi.

The average bottom of the main channel was ~~26.8~~ 20.6 ft below top of guardrail at a point ~~59~~ 43 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	~~Q100~~ Q50 =	~~18500~~ 11300		~~Q500~~ Q100 =	~~32300~~ 17000	
Estimated flow passing through bridge		11300			15653	
Estimated road overflow & overtopping		0			1347	
Consideration	Yes	No	Possibly	Yes	No	Possibly
Chance of overtopping		X		X		~~X~~
Chance of Pressure flow		X		X		
Armored appearance to channel		X			X	
Lateral instability of channel		X			X	

5/22

2	332
5	1530
10	3270
25	7080
50	11300
100	17000
500	37100

Riprap at abutments? X Yes ____No ____Marginal

Evidence of past Scour? X Yes ____No ____Don't know pier contract

Debris Potential? ____High X Med ____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). Main channel
2). L. ab
3). Piers
4). LOB
5). Main channel
6). LAB
7). LAB
8). RAB
9). ROB
10. Main channel

Summary of Results

	~~Q100~~ Q50	~~Q500~~ Q100
Bridge flow evaluated	11300	~~134~~ 15653
Flow depth at left abutment (yaLT), in feet	1.3	2.7
Flow depth at right abutment (yaRT), in feet	4.9	7.6
Contraction scour depth (ycs), in feet	3.5	5.8
Pier scour depth (yps), in feet	5.2	5.2 5.2
Left abutment scour depth (yas), in feet	5.5	11
Right abutment scour depth (yas), in feet	14.8	19.5
1Flow angle of attack	10	10

See Comments/Diagram for justification where required