OK RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 14112090 Date 5/25/12 Initials RaT Region (A B (C) D)

Site ____________ Location 46320 306 St, Vermillion River

Q_{100} = ~~19500~~ Q0 8870 by: drainage area ratio ~~____~~ flood freq. anal. _____ regional regression eq. X

Bridge discharge (Q_2) = 8870 (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 = 154 ft. Flow angle at bridge = 0 ° Abut. Skew = 0 ° Effective Skew = 0 °

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 = 154 ft* $q_2 = Q_2/W_2$ = 57.6 ft^2/s

Bridge Vel, V_2 = 5.4 ft/s Final $y_2 = q_2/V_2$ = 10.7 ft Δh = 0.6 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 11.3 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. = 0-1.5 ft 16.0

Low Steel Elev. = 14.1 ft 3.9

n (Channel) = 0.075

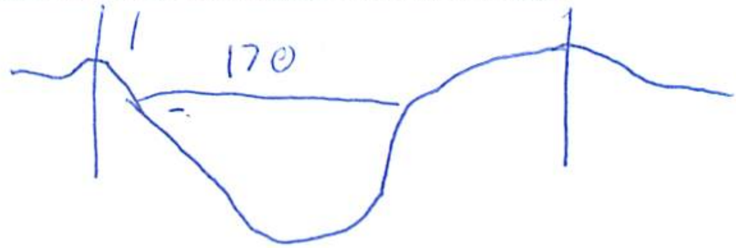
n (LOB) = 0.035

n (ROB) = 0.030

Pier Width = 1.9 ft

Pier Length = 1.9 ft

\# Piers for 100 yr = 4 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = ~~154~~ 170 ft

Width of left overbank flow at approach, W_{lob} = 0 ft Average left overbank flow depth, y_{lob} = 0 ft

Width of right overbank flow at approach, W_{rob} = 0 ft Average right overbank flow depth, y_{rob} = 0 ft

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

x = 1.82 From Figure 9 W_2 (effective) = 146.4 ft y_{cs} = 2.3 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, $Vc = 11.52 y_1^{1/6} D_{50}^{1/3}$ = ________ 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 = 0.29 Using pier width a on Figure 11, ξ = 7.7 Pier scour y_{ps} = 6.4 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 0 ft right abutment, y_{aRT} = 0 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} = 0 and ψ_{RT} = 0

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 0 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 0 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 14112090 Date 5/28/12 Initials KaT Region (A B (C) D)

Site ____________ Location 46320 306 St

Q_{500} ~~25~~ = ~~34000~~ 16400 by: drainage area ratio ~~WW~~ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 15394 (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 = 154 ft. Flow angle at bridge = 0 ° Abut. Skew = 0 ° Effective Skew = 0 °

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 = 154 ft* $q_2 = Q_2/W_2$ = 100 ft^2/s

Bridge Vel, V_2 = 7.1 ft/s Final $y_2 = q_2/V_2$ = 14.1 ft Δh = 1 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 15.1 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 0-1.5ft ft

Low Steel Elev. = 14.1 ft

n (Channel) = 0.075

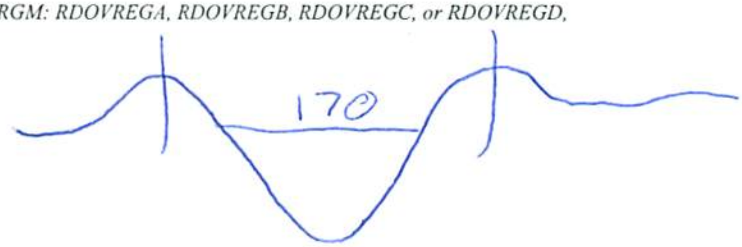
n (LOB) = 0.085

n (ROB) = 0.030

Pier Width = 1.9 ft

Pier Length = 1.9 ft

Piers for 500 yr = 4 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 170 ft

Width of left overbank flow at approach, W_{lob} = 0 ft Average left overbank flow depth, y_{lob} = 0 ft

Width of right overbank flow at approach, W_{rob} = 0 ft Average right overbank flow depth, y_{rob} = 0 ft

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

x = 2.43 From Figure 9 W_2 (effective) = 146.4 ft y_{cs} = 3 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

PIER SCOUR CALCULATIONS

PGRM: Pie

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 = 7.7 Pier scour y_{ps} = 6.5 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 0 ft right abutment, y_{aRT} = 0 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} = 0 and ψ_{RT} = 0

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 0 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 0 ft

96,947066
42.953533

Route 306 St Stream Vermillion River MRM ______ Date 5/28/12 Initials RaT

Bridge Structure No. 14112090 Location 46320 306 St

GPS coordinates: N42° 57' 12.8" W96° 56' 49.4" taken from: USL abutment X centerline of ⇑ MRM end ______

Datum of coordinates: WGS84 X NAD27 ______

Drainage area = 1665.99 sq. mi.

The average bottom of the main channel was 16.0 ft below top of guardrail at a point 58 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = ~~19500~~ Q_{10} 8870			Q_{500} = ~~[illegible]~~ Q_{25} 16400		
Estimated flow passing through bridge	8870			15394		
Estimated road overflow & overtopping	0			1006		
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	

5/27

2	11.9	1750
5	27.8	5050
10	43.6	8870
25	~~69.8~~	16,400
50	99	24300
100	~~122~~	34600
500	205	7~~8~~0600

Riprap at abutments? X Yes ____No ____Marginal - less than half way up.

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

Debris Potential? X High ____Med ____Low - bridge entrances is blocked by a fallen trees.

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) right abut
3). right abut
4). debris
5). piers
6) . right OB
7). main channel
8). left OB
9). main channel
10). left ab
11). left ab.

Summary of Results

	~~Q100~~ Q_{10}	~~Q500~~ Q_{25}
Bridge flow evaluated	8870	15394
Flow depth at left abutment (yaLT), in feet	0	0
Flow depth at right abutment (yaRT), in feet	0	0
Contraction scour depth (ycs), in feet	2.3	3
Pier scour depth (yps), in feet	6.4	6.5
Left abutment scour depth (yas), in feet	0	0
Right abutment scour depth (yas), in feet	0	0
1Flow angle of attack	0	0

See Comments/Diagram for justification where required