OK [initials]

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 50202018 Date 6/26/12 Initials R.a.T Region (A B (C) D)

Site ________ Location W 3rd St in Dell Rapids just W of Hwy 115

~~Q_{100}~~ = Q_{10} 872 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 872 (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 = 47 ft. Flow angle at bridge = ~~35~~ 45° Abut. Skew = 40 ° Effective Skew = 5 °

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 = 46.82 ft* $q_2 = Q_2/W_2$ = 18.6 ft^2/s

Bridge Vel, V_2 = 3.1 ft/s Final $y_2 = q_2/V_2$ = 6.1 ft Δh = 0.2 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 6.3 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. = 0-0.2 ft

Low Steel Elev. = 7.4 ft

n (Channel) = 0.040 -smooth & uniform rock cut.

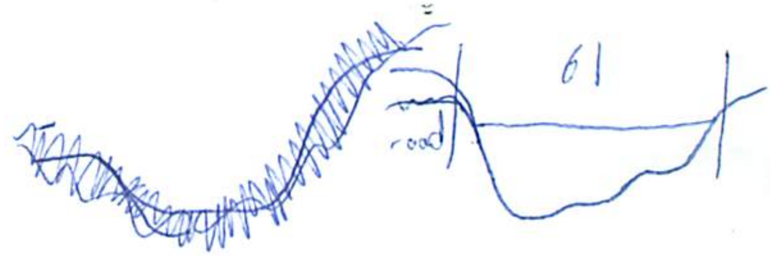
n (LOB) = 0.016 asphalt

n (ROB) = 0.030

Pier Width = 0 ft

Pier Length = 0 ft

\# Piers for 100 yr = 0 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 61 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 = 1.91 From Figure 9 W_2 (effective) = 46.8 ft y_{cs} = 2.4 ft -see notes

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

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

ABUTMENT SCOUR CALCULATIONS

-see notes

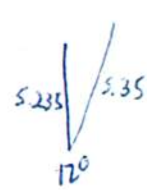
PGRM: Abutment

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. 50202018 Date 6/26/12 Initials [illegible] Region (A B (C) D)

Site ________ Location W 3rd St in Dell Rapids just W of Hwy 115

Q_{500} = Q_{25} 1340 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. x

Bridge discharge (Q_2) = 1287 (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 = 47 ft. Flow angle at bridge = 45 ° Abut. Skew = 40 ° Effective Skew = 5 °

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 = 46.82 ft* $q_2 = Q_2/W_2$ = 28.6 ft²/s

Bridge Vel, V_2 = 3.8 ft/s Final $y_2 = q_2/V_2$ = 7.6 ft Δh = 0.3 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 7.8 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. = 0-0.2 ft

Low Steel Elev. = 7.4 ft

n (Channel) = 0.040

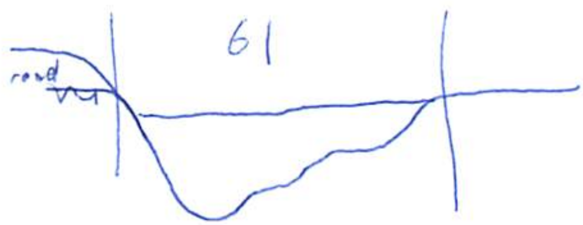
n (LOB) = 0.016

n (ROB) = 0.030

Pier Width = 0 ft

Pier Length = 0 ft

Piers for 500 yr = 0 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 61 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 = 2.36 From Figure 9 W_2 (effective) = 46.8 ft y_{cs} = 2.9 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, $V_1 = Q_{500}/(y_1W_1)$ = ________ 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 = ________ Correction factor for flow angle of attack (from Table 1), K2 = ________

Froude # at bridge = ________ Using pier width a on Figure 11, ξ = ________ Pier scour y_{ps} = ________ 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° 43' 9.552"
43° 49' 21.648"

96.71932
43.82268

Route W 3rd St Stream ______ MRM ______ Date 6/26/12 Initials RaJ

Bridge Structure No. 50202018 Location W 3rd St in Dell Rapids just W of HWY 115

GPS coordinates: N 43° 49' 22.1'' W 96° 43' 9.8'' taken from: USL abutment X centerline of ⇑ MRM end ______

Datum of coordinates: WGS84 X NAD27 ______

Drainage area = 10.12 sq. mi.

10.12

The average bottom of the main channel was 13 ft below top of guardrail at a point 35 ft from left abutment.

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

6/19

8/25

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = Q_{10} 872			Q_{500} = Q_{25} 1340		
Estimated flow passing through bridge	872			1287		
Estimated road overflow & overtopping	0			63		
Consideration	Yes	No	Possibly	Yes	No	Possibly
Chance of overtopping		X		X		
Chance of Pressure flow		X		X		
Armored appearance to channel		X	X?		X	X?
Lateral instability of channel		X			X	

2	226
5	567
10	872
25	1340
50	1740
100	2170
500	3290

Riprap at abutments? ____Yes ____No X Marginal mostly gravel sized rose quartz on right abutment

Evidence of past Scour? ____Yes X No X Don't know - doesn't appear anything can be easily eroded

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____	Sand____	Gravel____	Cobbles____	Boulders____
Size range, in mm	<0.062	0.062-2.00	2.00-64	64-250	>250

see picture 9 - bed is basically one slant slab of rose quartz (bedrock)

Comments, Diagrams & orientation of digital photos

1). right OB
2). main
3). left OB
4). right abutment scour
5-6). right abutment
7-8). left abutment
9). bed material
10). main channel

Summary of Results

	Q100 Q_{10}	Q500 Q_{25}
Bridge flow evaluated	872	1287
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	2.4	2.9
Pier scour depth (yps), in feet	N/A	N/A
Left abutment scour depth (yas), in feet	0	0
Right abutment scour depth (yas), in feet	0	0
1Flow angle of attack	5	5

Notes Bridge bed was a single flat sheet of rose quartz with little other material erosion would likely be less.

Note: abutment walls are sloped

120

See Comments/Diagram for justification where required