OK RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 06112080 Date 5-17-12 Initials CW/RAT Region (A B (C) D)

Site ______ Location 204 St, 0.5mi S & 0.3mi W of Bruce – Brookings Co

Q_{100} = Q25 = 10900 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. ✓

Bridge discharge (Q_2) = 10900 (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 = 235 ft. 234.11 Flow angle at bridge = 5 ° Abut. Skew = 0 ° 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 = 234.11 ft* 0.5 $q_2 = Q_2/W_2$ = 46.6 ft^2/s

Bridge Vel, V_2 = 4.8 ft/s Final $y_2 = q_2/V_2$ = 9.6 ft Δh = 0.5 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 10.1 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. = 1.6 ft

Low Steel Elev. = ____ ft 10.9

n (Channel) = 0.040

n (LOB) = 0.035

n (ROB) = 0.035

Pier Width = 2.4 ft

Pier Length = 2.4 ft

\# Piers for 100 yr = 3 ft

CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 235 ft

Width of left overbank flow at approach, W_{lob} = 235 ft Average left overbank flow depth, y_{lob} = 3.9 ft

Width of right overbank flow at approach, W_{rob} = 235 ft Average right overbank flow depth, y_{rob} = 3.9 ft

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

x = 5.2 From Figure 9 W_2 (effective) = 226.9 ft y_{cs} = 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, $V_1 = Q_{100}/(y_1 W_1)$ = ______ ft/s

Critical approach velocity, $V_c = 11.17 y_1^{1/6} D_{50}^{1/3}$ = ______ 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 = 0.27 Using pier width a on Figure 11, ξ = 9.2 Pier scour y_{ps} = 7.6 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 3.9 ft right abutment, y_{aRT} = 3.9 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} = 13.1 and ψ_{RT} = 13.1

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 13.1 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 13.1 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 06112080 Date ________ Initials ________ Region (A B (C) D)

Site ________ Location 204 St, 0.5 mi S & 0.3 mi W of Bruce

Q_{500} (50) = ~~3100~~ ~~3100~~ 14700 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. ✓

Bridge discharge (Q_2) = ~~[illegible]~~ 13975 (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 = 235 ft. Flow angle at bridge = 5 ° Abut. Skew = 0 ° 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 = 234.11 ft* $q_2 = Q_2/W_2$ = ~~[illegible]~~ 59.7 ft^2/s

Bridge Vel, V_2 = ~~[illegible]~~ 5.5 ft/s Final $y_2 = q_2/V_2$ = ~~[illegible]~~ 10.9 ft Δh = 0.6 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = ~~[illegible]~~ 11.5 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. = 1.6 ft

Low Steel Elev. = ~~[illegible]~~ ~~13.6~~ ft 10.9

n (Channel) = 0.046

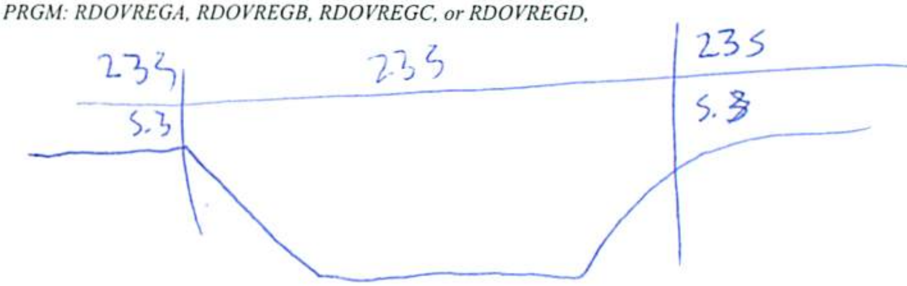
n (LOB) = 0.035

n (ROB) = 0.033

Pier Width = 2.4 ft

Pier Length = 2.4 ft

\# Piers for 500 yr = 3 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 235 ft

Width of left overbank flow at approach, W_{lob} = 235 ft Average left overbank flow depth, y_{lob} = 5.3 ft

Width of right overbank flow at approach, W_{rob} = 235 ft Average right overbank flow depth, y_{rob} = 5.3 ft

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

x = 7.9 From Figure 9 W_2 (effective) = 226.9 ft y_{cs} = 8.7 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

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 = 9.2 Pier scour y_{ps} = 7.7 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 5.3 ft right abutment, y_{aRT} = 5.3 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} = 15.6 and ψ_{RT} = 15.6

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 15.6 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 15.6 ft

Route 204 St Stream Big Sioux River MRM ________ Date ____________ Initials ________

Bridge Structure No. 06112080 Location 204 St, 0.5mi S & 0.3mi W of Bruce

GPS coordinates: N44° 25' 40.3" W 96° 54' 13.7" taken from: USL abutment _____ centerline of ⇑ MRM end ______

Datum of coordinates: WGS84 _____ NAD27 _____

Drainage area = 1561 sq. mi.

The average bottom of the main channel was ~~15~~ 16.6 ft below top of guardrail at a point ~~85~~ 85 ft from left abutment.

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

5/15 ~~8/22~~

2	1610
5	4240
10	6780
25	10900
50	14700
100	19000
500	31100

MISCELLANEOUS CONSIDERATIONS

Flows	~~Q100~~ = Q_{25} = 10900			Q_{500} = 14700		
Estimated flow passing through bridge	10900			13975		
Estimated road overflow & overtopping	0			725		
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? X Yes ____No ____Marginal

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

Debris Potential? ____High ____Med X Low

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

Riprap ____Yes ____No X 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

2273 str. no.
2274 bridge from ~~left~~ right approach
2275 left abut from right approach
2276 left abut.
2277 right abut.
2278 bridge section from left ditch

Summary of Results

	~~Q100~~ Q_{25}	~~Q500~~ 50
Bridge flow evaluated	10900	13975
Flow depth at left abutment (yaLT), in feet	3.9	5.3
Flow depth at right abutment (yaRT), in feet	3.9	5.3
Contraction scour depth (ycs), in feet	~~7~~6	~~[illegible]~~ 8.7
Pier scour depth (yps), in feet	7.6	7.7
Left abutment scour depth (yas), in feet	13.1	15.6
Right abutment scour depth (yas), in feet	13.1	15.6
1Flow angle of attack	5	5

See Comments/Diagram for justification where required