OK RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 26032070 Date 8-13-10 Initials CW/RT Region (A B (C) D)

Site 06479200 Location 5.1 mi West of I-29 on Exit 201

Q_{100} = 2030 by: drainage area ____ flood frequency anal. ✓ regional regression eq. ____

Bridge discharge (Q_2) = 2030 (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 = 84 ft. Flow angle at bridge = 5 ° Abut. Skew = 0 ° Effective Skew = 5 °

Width (W_2) iteration = 84 76 80 ____

Avg. flow depth at bridge, y_2 iteration = 7.0 7.3 7.1 ____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 79.7 ft* $q_2 = Q_2/W_2$ = 25.5 ft^2/s

Bridge Vel, V_2 = 3.6 ft/s Final $y_2 = q_2/V_2$ = 7.1 ft Δh = 0.3 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 7.4 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. = 4.6 ft

Low Steel Elev. = ____ ft

n (Channel) = .033

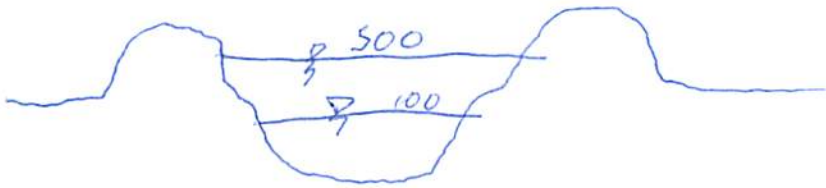
n (LOB) = .033

n (ROB) = .033

Pier Width = 0.45 ft

Pier Length = 0.45 ft

Piers for 100 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 84 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 = 0.57 From Figure 9 W_2 (effective) = 78 ft y_{cs} = 0.9 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, $V_1 = Q_{100}/(y_1 W_1)$ = ____ 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

PGRM: Pier

PIER SCOUR CALCULATIONS

L/a ratio = 1.0 Correction factor for flow angle of attack (from Table 1), K2 = 1.0

Froude # at bridge = 0.24 Using pier width a on Figure 11, ξ = 4.1 Pier scour y_{ps} = 3.3 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

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. 26032070 Date 9/13/10 Initials CW-RT Region (A B C D)

Site 06479200 Location 5.1 mi West of I-29 on Exit 201

Q_{500} = 3530 by: drainage area ____ flood frequency anal. ✓ regional regression eq. ____

Bridge discharge (Q_2) = 3530 (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 = 84 ft. Flow angle at bridge = 5 ° Abut. Skew = 0 ° Effective Skew = 5 °

Width (W_2) iteration = 84 ____ ____ ____

Avg. flow depth at bridge, y_2 iteration = 9.2 ____ ____ ____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 83.68 ft* $q_2 = Q_2/W_2$ = 42.2 ft^2/s

Bridge Vel, V_2 = 4.6 ft/s Final $y_2 = q_2/V_2$ = 9.2 ft Δh = 0.4 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 9.6 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. = 4.6 ft

Low Steel Elev. = ____ ft

n (Channel) = .033

n (LOB) = .033

n (ROB) = .033

Pier Width = 0.65 ft

Pier Length = 0.65 ft

Piers for 500 yr = 2 ft

CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 84 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 = 0.23 From Figure 9 W_2 (effective) = 82 ft y_{cs} = 0.4 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: Pier

L/a ratio = 1.0 Correction factor for flow angle of attack (from Table 1), K2 = 1.0

Froude # at bridge = 0.27 Using pier width a on Figure 11, ξ = 4.1 Pier scour y_{ps} = 3.4 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

Route 149 St Stream Big Sioux River MRM _____ Date 8/13/10 Initials CW/RT

Bridge Structure No. 26032070 Location 5.1 mi West of I-29 @ Exit 201

GPS coordinates: N 45° 13' 28.7" W 97° 09' 32.8" taken from: USL abutment ✓ centerline of ⇑ MRM end _____

Datum of coordinates: WGS84 ✓ NAD27 _____

Drainage area = 55.62 sq. mi.

The average bottom of the main channel was 18.9 ft below top of guardrail at a point 27 ft from left abutment.

Method used to determine flood flows: ✓ Freq. Anal. ____ drainage area adjustment ____ regional regression equations.

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 2030			Q_{500} = 3530		
Estimated flow passing through bridge	2030			3530		
Estimated road overflow & overtopping						
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 X No ____ Marginal

Evidence of past Scour? X Yes ____ No ____ Don't know Pier + sloping abut. washed away

Debris Potential? ____ High ____ Med X Low

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

Riprap	____ Yes	____ No	____ Don't know	X NA
Spur Dike	X Yes	____ No	____ Don't know	____ NA
Other _____	____ Yes	____ No	____ Don't know	X 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

Photos Bridge #

1066 - ~~Site ID~~

1067 - aproach XS from bridge

1068 - R. spur dike

1069 - L. spur dike

1070 - Bridge section from approach

1071 - L. Abut

1072 - R. Abut

Comments, Diagrams & orientation of digital photos

Spur dikes on both sides of upstream side of bridge

Q500 doesn't top dike, would be standing water

Past contraction scour

Summary of Results

	Q100	Q500
Bridge flow evaluated	2030	3530
Flow depth at left abutment (yaLT), in feet	0.0	0.0
Flow depth at right abutment (yaRT), in feet	0.0	0.0
Contraction scour depth (ycs), in feet	0.9	0.4
Pier scour depth (yps), in feet	3.3	3.4
Left abutment scour depth (yas), in feet	0.0	0.0
Right abutment scour depth (yas), in feet	0.0	0.0
1Flow angle of attack	5	5

See Comments/Diagram for justification where required