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SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 29230069 Date 8/17/10 Initials CW Region (A B (C) D)

Site _____ Location 0.9 mi. S Castlewood on 459th Ave.

Q_{100} = 5520 by: drainage area ✓ flood frequency anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = 5520 (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 = 234 ft. Flow angle at bridge = 20 ° Abut. Skew = 0 ° Effective Skew = 20 °

Width (W_2) iteration = 234 200 215 _____

Avg. flow depth at bridge, y_2 iteration = 7.1 7.6 7.4 _____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 202.03 ft* $q_2 = Q_2/W_2$ = 27.3 ft^2/s

Bridge Vel, V_2 = 3.7 ft/s Final $y_2 = q_2/V_2$ = 7.4 ft Δh = 0.3 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 7.7 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. = _____ ft

Low Steel Elev. = 9.5 ft

n (Channel) = 0.045

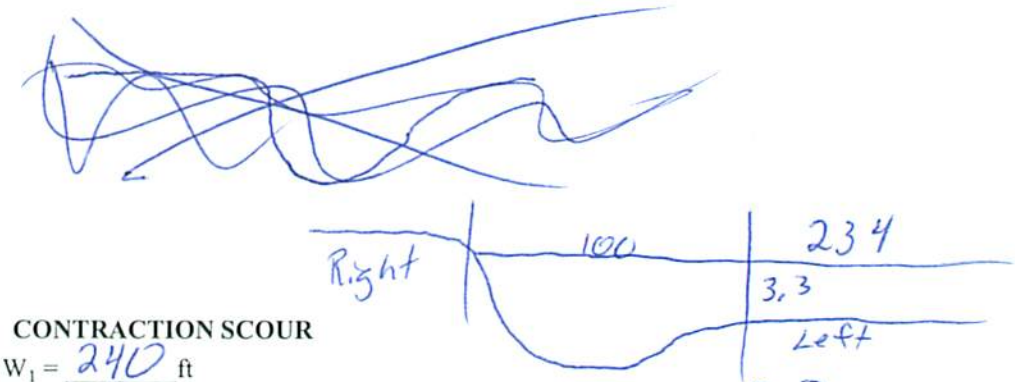
n (LOB) = 0.040

n (ROB) = 0.045

Pier Width = 2.5 ft

Pier Length = 2.5 ft

Piers for 100 yr = 4 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 240 ft

Width of left overbank flow at approach, W_{lob} = 234 ft Average left overbank flow depth, y_{lob} = 3.3 ft

Width of right overbank flow at approach, W_{rob} = ~~231~~ 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 = 4.5 From Figure 9 W_2 (effective) = 192 ft y_{cs} = 5.2 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 = 9.5 Pier scour y_{ps} = 7.7 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 3.3 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} = 12 and ψ_{RT} = 0

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 12 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 0 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 292300609 Date 8/17/10 Initials CW Region (A B C D)

Site _____ Location 0.9 mi S Castlewood on 459th Ave.

Q_{500} = 7840 by: drainage area ✓ flood frequency anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = 7840 (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 = 234 ft. Flow angle at bridge = 20 ° Abut. Skew = 0 ° Effective Skew = 20 °

Width (W_2) iteration = 234 230 ____ ____

Avg. flow depth at bridge, y_2 iteration = 8.4 8.5 ____ ____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 216.13 ft* $q_2 = Q_2/W_2$ = 36.3 ft^2/s

Bridge Vel, V_2 = 4.3 ft/s Final $y_2 = q_2/V_2$ = 8.5 ft Δh = 0.4 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 8.9 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. = ____ ft

Low Steel Elev. = 9.5 ft

n (Channel) = .045

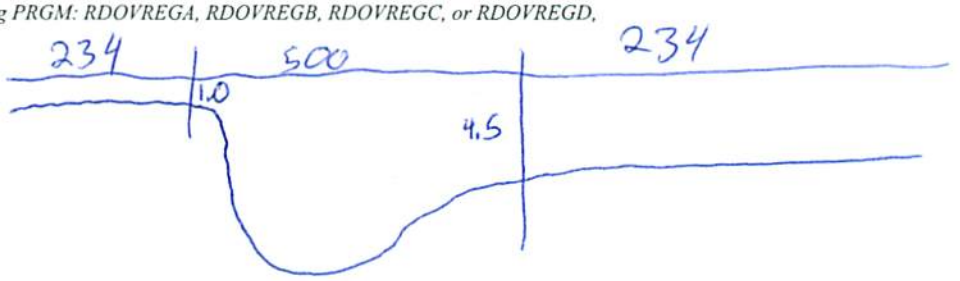
n (LOB) = .040

n (ROB) = .045

Pier Width = 2.5 ft

Pier Length = 2.5 ft

Piers for 500 yr = 4 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 240 ft

Width of left overbank flow at approach, W_{lob} = 234 ft Average left overbank flow depth, y_{lob} = 4.5 ft

Width of right overbank flow at approach, W_{rob} = 234 ft Average right overbank flow depth, y_{rob} = 1.0 ft

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

x = 5.37 From Figure 9 W_2 (effective) = 206.1 ft y_{cs} = 6.1 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: 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 = 0.26 Using pier width a on Figure 11, ξ = 9.5 Pier scour y_{ps} = 7.8 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 4.5 ft right abutment, y_{aRT} = 1.0 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} = 14.1 and ψ_{RT} = 4.3

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 14.1 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 4.3 ft

[illegible] Big Sioux River [illegible] 4/17/10 [illegible]

[illegible] 9 [illegible] S. [illegible]

[illegible]

Route 459th Ave Stream Big Sioux River MRM _____ Date 8/17/10 Initials CW

Bridge Structure No. 292300069 Location 0.9 mi S Castlewood on 459th Ave

GPS coordinates: N44°42'14.5" W097°01'36.7" taken from: USL abutment X centerline of ⇑ MRM end _____

Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 602-56 sq. mi.

The average bottom of the main channel was 15.0 ft below top of guardrail at a point 58 ft from left abutment.

Method used to determine flood flows: ____Freq. Anal. ✓drainage area adjustment ____regional regression equations.

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 5520			Q_{500} = 7840		
Estimated flow passing through bridge	5520			7840		
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? ____Yes X No ____Don't know

Debris Potential? ____High X Med ____Low

Rip Rap may have been overgrown?

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

Riprap ____Yes ____No ____Don't know X NA

Spur Dike ____Yes ____No ____Don't know X 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

Comments, Diagrams & orientation of digital photos

1109 - US
10 - US RB
11 - US LB
12 - US face of Bridge
13 - US face of Bridge
14 - Right. Abut.
15 - L. Abut
16-18 - L. Abut

Summary of Results

	Q100	Q500
Bridge flow evaluated	5520	7840
Flow depth at left abutment (yaLT), in feet	3.3	4.5
Flow depth at right abutment (yaRT), in feet	0.0	1.0
Contraction scour depth (ycs), in feet	5.2	6.1
Pier scour depth (yps), in feet	7.7	7.8
Left abutment scour depth (yas), in feet	12.0	14.1
Right abutment scour depth (yas), in feet	0.0	4.3
1Flow angle of attack	20°	20

See Comments/Diagram for justification where required