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SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 52395305 Date 12/2/10 Initials cw Region (A B C D)

Site _____ Location Sheridan Lake Rd over Rapid Creek

Q_{100} = 4710 by: drainage area ratio ✓ flood freq. anal. _____ regional regression eq. ____

Bridge discharge (Q_2) = 3959 (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 = 107 ft. Flow angle at bridge = 15 ° Abut. Skew = 15 ° Effective Skew = 6 °

Width (W_2) iteration = 107 _____ _____ _____

Avg. flow depth at bridge, y_2 iteration = 5.7 → RD Overflow _____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 107 ft* $q_2 = Q_2/W_2$ = 37 ft^2/s

Bridge Vel, V_2 = 7.1 ft/s Final $y_2 = q_2/V_2$ = 5.2 ft Δh = 1.0 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 6.2 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. = 5.2 ft

n (Channel) = 0.033

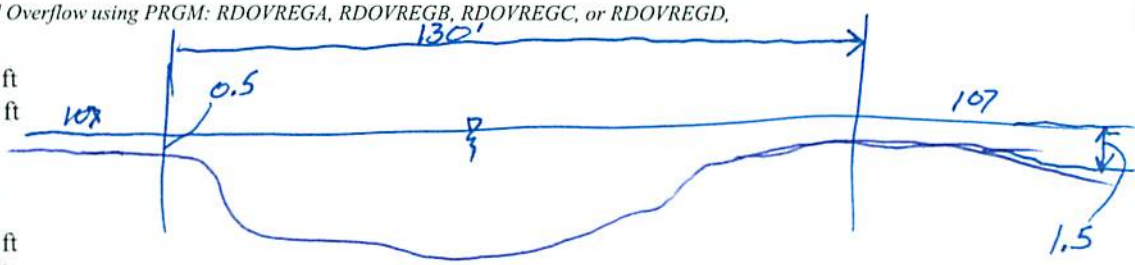
n (LOB) = 0.045

n (ROB) = 0.045

Pier Width = 2.0 ft

Pier Length = 2.0 ft

Piers for 100 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 130 ft ignored wood fence

Width of left overbank flow at approach, W_{lob} = 107 ft Average left overbank flow depth, y_{lob} = 0.5 ft

Width of right overbank flow at approach, W_{rob} = 107 ft Average right overbank flow depth, y_{rob} = 1.5 ft

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

x = _____ From Figure 9 W_2 (effective) = _____ ft y_{cs} = _____ ft

PGRM: CWCSNEW

Clear Water Contraction Scour (use if bed material is larger than small cobbles) ~~z = 1.037~~ 0 1.86

Estimated bed material D_{50} = 0.2 ft Average approach velocity, $V_1 = Q_{100}/(y_1 W_1)$ = ~~4.97~~ ft/s

Critical approach velocity, $Vc = 11.52 y_1^{1/6} D_{50}^{1/3}$ = 8.85 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.

$D_{c50} = 0.0006(q_2/y_1^{7/6})^3$ = 0.0512 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} = 0.0 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 = 0.55 Using pier width a on Figure 11, ξ = 8 Pier scour y_{ps} = 7.3 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 0.5 ft right abutment, y_{aRT} = 1.5 ft

Shape coefficient K_1= (1.00 for vertical-wall, 0.82 for vertical-wall with wingwalls, ~~0.55~~ cw for spill-through

Using values for y_{aLT} and y_{aRT} on figure 12, ψ_{LT} = 2.3 and ψ_{RT} = 6.3

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = ~~2.3~~ 4.2 ft cw Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = ~~6.3~~ 11.4 ft cw

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 52395305 Date 12/2/10 Initials CW Region (A B C D)

Site _____ Location Sheridan Lake Rd over Rapid Creek

Q_{500} = 17700 by: drainage area ratio ✓ flood freq. anal. _____ regional regression eq. _____

Bridge discharge (Q_2) = 3959 (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 = 107 ft. Flow angle at bridge = 15 ° Abut. Skew = 15 ° Effective Skew = 0 °

Width (W_2) iteration = 107 _____ _____ _____

Avg. flow depth at bridge, y_2 iteration = 11.8 → RD Overflow _____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 107 ft* $q_2 = Q_2/W_2$ = 37 ft^2/s

Bridge Vel, V_2 = 7.1 ft/s Final $y_2 = q_2/V_2$ = 5.2 ft Δh = 1.0 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 6.2 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. = 5.2 ft

n (Channel) = 0.033

n (LOB) = 0.045

n (ROB) = 0.045

Pier Width = 2.0 ft

Pier Length = 2.0 ft

Piers for 500 yr = 2 ft

CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 130 ft

Width of left overbank flow at approach, W_{lob} = 107 ft Average left overbank flow depth, y_{lob} = 0.5 ft

Width of right overbank flow at approach, W_{rob} = 107 ft Average right overbank flow depth, y_{rob} = 1.5 ft

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

x = _____ From Figure 9 W_2 (effective) = _____ ft y_{cs} = _____ ft

PGRM: CWCSNEW

Clear Water Contraction Scour (use if bed material is larger than small cobbles) 2 ~~1.037~~ 0 1.86

Estimated bed material D_{50} = 0.2 ft Average approach velocity, $V_1 = Q_{500}/(y_1 W_1)$ = ~~4.91~~ ft/s

Critical approach velocity, $Vc = 11.52 y_1^{1/6} D_{50}^{1/3}$ = 8.85 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.

$D_{c50} = 0.0006(q_2/y_1^{7/6})^3$ = 0.0512 ft If $D_{50} >= D_{c50}$, χ = 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} = 0.0 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 = 0.55 Using pier width a on Figure 11, ξ = 8 Pier scour y_{ps} = 7.3 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 0.5 ft right abutment, y_{aRT} = ~~0.5~~ 1.5 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} = 2.3 and ψ_{RT} = 6.3

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = ~~2.3~~ 4.2 ft CW Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = ~~6.3~~ 11.4 ft CW

Route Sheridan Lake Rd Stream Rapid Creek MRM _____ Date 12/2/10 Initials CW

Bridge Structure No. 52395305 Location Sheridan Lake Rd over Rapid Creek

GPS coordinates: N 44°04'29.9" W 103° 15'44.2" taken from: USL abutment X centerline of ⇈ MRM end _____

Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 407.62 sq. mi. 9.6

The average bottom of the main channel was ~~9.0~~ ft below top of guardrail at a point ~~54~~ 56 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 4710			Q_{500} = 17700		
Estimated flow passing through bridge	3959			3959		
Estimated road overflow & overtopping	751			13741		
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

Debris Potential? X High ____Med ____Low

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

Comments, Diagrams & orientation of digital photos

Photos

1497-ID
98- US
99- US RB
1500- US LB

01- Scour under L. Abut
02- L. Abut
03- R. Abut
04- US Face Bridge
05- US Face Bridge

Summary of Results

	Q100	Q500
Bridge flow evaluated	3959	~~0.5~~ 3959
Flow depth at left abutment (yaLT), in feet	0.5	~~1.5~~ 0.5
Flow depth at right abutment (yaRT), in feet	1.5	1.5
Contraction scour depth (ycs), in feet	0.0	0.0
Pier scour depth (yps), in feet	7.3	7.3
Left abutment scour depth (yas), in feet	CW ~~2.3~~ 4.2	CW ~~2.3~~ 4.2
Right abutment scour depth (yas), in feet	CW ~~6.3~~ 11.4	CW ~~6.3~~ 11.4
1Flow angle of attack	0°	0°

See Comments/Diagram for justification where required