OK RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 42087200 Date 10-12-10 Initials RRL Region (A B C D)

Site _____ Location From I-29 Exit 56, 2.2 E

Q_{100} = 2100 by: drainage area ratio ✓ flood freq. anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = 2100 (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 = 78 ft. Flow angle at bridge = 8 ° Abut. Skew = 0 ° Effective Skew = 8 °

Width (W_2) iteration = 71 72 73 ____

Avg. flow depth at bridge, y_2 iteration = 7.4 7.7 7.6 ____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 72.29 ft* $q_2 = Q_2/W_2$ = 29 ft^2/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, $y_1 = \Delta h + y_2$ = 7.9 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. = 1.5 ft

Low Steel Elev. = ____ ft

n (Channel) = 0.035

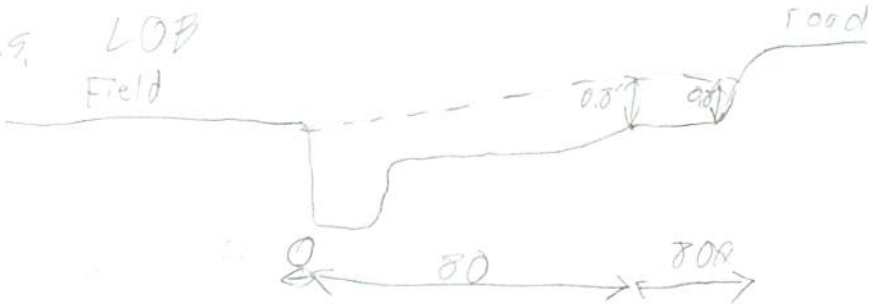
n (LOB) = 0.037

n (ROB) = 0.037

Pier Width = 2 ft

Pier Length = 2 ft

Piers for 100 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 80 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} = 80 ft Average right overbank flow depth, y_{rob} = 0.8 ft

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

x = 1.55 From Figure 9 W_2 (effective) = 68.3 ft y_{cs} = 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, $V_1 = Q_{100}/(y_1W_1)$ = ____ 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 Correction factor for flow angle of attack (from Table 1), K2 = 1

Froude # at bridge = 0.24 Using pier width a on Figure 11, ξ = 8 Pier scour y_{ps} = 6.5 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 0 ft right abutment, y_{aRT} = 0.8 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} = 3.5

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 0 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 3.5 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 42087200 Date 10-12-10 Initials RAL Region (A B C D)

Site _____ Location From I-29 Exit 56, 2.2 E

Q_{500} = 4570 by: drainage area ratio ✓ flood freq. anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = 4570 (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 = 73 ft. Flow angle at bridge = 8 ° Abut. Skew = 0 ° Effective Skew = 8 °

Width (W_2) iteration = 73 _____ _____ _____

Avg. flow depth at bridge, y_2 iteration = 10.9 _____ _____ _____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 77.24 ft* $q_2 = Q_2/W_2$ = 59.2 ft^2/s

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

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 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. = 1.5 ft

Low Steel Elev. = 11.0 ft

n (Channel) = 0.035

n (LOB) = 0.037

n (ROB) = 0.037

Pier Width = 2 ft

Pier Length = 2 ft

Piers for 500 yr = 2 ft

CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 80 ft

Width of left overbank flow at approach, W_{lob} = 80 ft Average left overbank flow depth, y_{lob} = 3.2 ft

Width of right overbank flow at approach, W_{rob} = 80 ft Average right overbank flow depth, y_{rob} = 4.3 ft

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

x = 4.78 From Figure 9 W_2 (effective) = 73.2 ft y_{cs} = 5.5 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, $Vc = 11.52 y_1^{1/6} D_{50}^{1/3}$ = _____ 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

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 = 8 Pier scour y_{ps} = 6.6 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 3.2 ft right abutment, y_{aRT} = 4.3 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} = 11.9 and ψ_{RT} = 13.8

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 11.9 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 13.8 ft

Route 288 St Stream Saddle Creek MRM _____ Date 10-12-10 Initials KRL

Bridge Structure No. 42087200 Location From I-29 Exit 56, 2.2 E

GPS coordinates: N 43° 12.854' W 96° 45.165' taken from: USL abutment ✓ centerline of ⇑ MRM end _____

Datum of coordinates: WGS84 ____ NAD27 ____

Drainage area = 13.86 sq. mi.

The average bottom of the main channel was 15.7 ft below top of guardrail at a point 28 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 2100			Q_{500} = 4570		
Estimated flow passing through bridge	2100			4570		
Estimated road overflow & overtopping	0			0		
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? ____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 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

1-Bridge Deck
2-Upstream
3-Downstream
4-Left Overbank
5-Right Overbank
6-Left Abutment
7-Right Abutment
8-Piers

Notes: Severe scour at Abutments, No rip-rap at all present.

Summary of Results

	Q100	Q500
Bridge flow evaluated	2100	4570
Flow depth at left abutment (yaLT), in feet	0	3.2
Flow depth at right abutment (yaRT), in feet	0.8	4.3
Contraction scour depth (ycs), in feet	2	5.5
Pier scour depth (yps), in feet	6.5	6.6
Left abutment scour depth (yas), in feet	0	11.9
Right abutment scour depth (yas), in feet	3.5	13.8
1Flow angle of attack	8	8

See Comments/Diagram for justification where required