OK RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 52344276 Date 11/20/10 Initials CW Region (A B C D)

Site _____ Location 0.5 S int. Nemo Rd & Schmitz Trail on Nemo Rd

Q_{100} = 3160 by: drainage area ratio ✓ flood freq. anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = 3160 (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 = 108 ft. Flow angle at bridge = 25 ° Abut. Skew = 25 ° Effective Skew = 0 °

Width (W_2) iteration = 108 92 86 ____

Avg. flow depth at bridge, y_2 iteration = 4.6 5.3 5.2 ____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 86 ft* $q_2 = Q_2/W_2$ = 36.7 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. = 0 ft

Low Steel Elev. = 11.5 ft

n (Channel) = 0.034

n (LOB) = 0.040

n (ROB) = 0.050

Pier Width = 0.83 ft

Pier Length = 0.55 ft

Piers for 100 yr = 2 ft

CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = ~~120~~ 108 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 = _____ 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=0

Estimated bed material D_{50} = 0.3 ft Average approach velocity, $V_1 = Q_{100}/(y_1W_1)$ = 4.72 ft/s

Critical approach velocity, $Vc = 11.52y_1^{1/6}D_{50}^{1/3}$ = 10.14 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.

$D_{c50} = 0.0006(q_2/y_1^{7/6})^3$ = 0.049977 ft If $D_{50} >= D_{c50}$, χ = 0.0

Otherwise, $\chi = 0.122y_1[q_2/(D_{50}^{1/3}y_1^{7/6})]^{6/7} - y_1$ = ~~0.0~~ From Figure 10, y_{cs} = 0.0 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 = 0.55 Using pier width a on Figure 11, ξ = ~~4.1~~ 4.0 Pier scour y_{ps} = 3.7 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. 52344276 Date 11/26/10 Initials CL Region (A B C D)

Site _____ Location Q55 int. Nemo Rd & Schmitz Trail on Nemo Rd

Q_{500} = 19400 by: drainage area ratio ✓ flood freq. anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = 16997 (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 = 104 ft. Flow angle at bridge = 25 ° Abut. Skew = 25 ° Effective Skew = 0 °

Width (W_2) iteration = 108

Avg. flow depth at bridge, y_2 iteration = 12.4 → RD overflow

Corrected channel width at bridge Section = W_2 times cos of flow angle = 108 ft* $q_2 = Q_2/W_2$ = 157.4 ft^2/s

Bridge Vel, V_2 = 13.7 ft/s Final $y_2 = q_2/V_2$ = 11.5 ft Δh = 3.9 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 15.4 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. = 0 ft

Low Steel Elev. = 11.5 ft

n (Channel) = 0.036

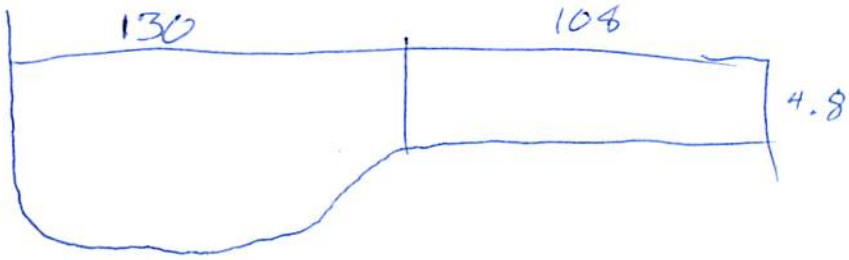
n (LOB) = ~~0.080~~ 0.040

n (ROB) = 0.050

Pier Width = 0.83 ft

Pier Length = 0.85 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} = 0 ft Average left overbank flow depth, y_{lob} = 0 ft

Width of right overbank flow at approach, W_{rob} = 108 ft Average right overbank flow depth, y_{rob} = 4.8 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=0

Estimated bed material D_{50} = 0.3 ft Average approach velocity, $V_1 = Q_{500}/(y_1W_1)$ = ~~4.49~~ 4.64 ft/s

Critical approach velocity, $Vc = 11.52y_1^{1/6}D_{50}^{1/3}$ = 11.79 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.

$D_{c50} = 0.0006(q_2/y_1^{7/6})^3$ = 0.1632 ft If $D_{50} >= D_{c50}$, χ = 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} = 0.0 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 = 0.71 Using pier width a on Figure 11, ξ = 4 Pier scour y_{ps} = 3.8 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 0 ft right abutment, y_{aRT} = 4.4 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} = 14.7

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 0 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 14.7 ft

Route Nemo Rd Stream Boxelder Creek MRM _____ Date 11/20/10 Initials CW

Bridge Structure No. 52344276 Location 0.5 S jct Nemo Rd & Schmitz Trail on Nemo Rd

GPS coordinates: N 44° 07' 01.7" W 103° 21' 51.3" taken from: USL abutment X centerline of ⇑ MRM end _____

Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 115.75 sq. mi.

The average bottom of the main channel was 16.0 ft below top of guardrail at a point 30 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 3160			Q_{500} = 19400		
Estimated flow passing through bridge	3160			16997		
Estimated road overflow & overtopping				2403		
Consideration	Yes	No	Possibly	Yes	No	Possibly
Chance of overtopping		X		X		
Chance of Pressure flow		X		X		X
Armored appearance to channel		X			X	
Lateral instability of channel		X			X	

Riprap at abutments? ____Yes ____No X Marginal

Evidence of past Scour? X Yes ____No ____Don't know footing exposed on pier

Debris Potential? X High ____Med ____Low

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

Riprap X Yes ____No ____Don't know ____NA Gabian basket w/ round rocks

Spur Dike ____Yes X No ____Don't know X NA

Other _____ ____Yes X 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

Bed consists of medium cobbles to small boulders.

1182 - Bridge #
43 - us from bridge
44 - R. Bank us
45 - LB us
46 - Bridge from us XS
47 - bed material
48 - Gabian baskets
89 - R. Abut
90 - L. Abut
91 - Down stream
92 - exposed footings

Summary of Results

	Q100	Q500
Bridge flow evaluated	3160	16997
Flow depth at left abutment (yaLT), in feet	0.0	0.0
Flow depth at right abutment (yaRT), in feet	0.0	4.3
Contraction scour depth (ycs), in feet	0.0	0.0
Pier scour depth (yps), in feet	3.7	3.8
Left abutment scour depth (yas), in feet	0.0	0.0
Right abutment scour depth (yas), in feet	0.0	14.7
1Flow angle of attack	~~25°~~ 0°	~~25~~ 0°

See Comments/Diagram for justification where required