Indian Creek

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 10262330 Date 10/28/11 Initials Cw Region (A (B) C D)

Site ______ Location ~4.7 mi E & 1 mi N of Newell on Schmele Rd

Q_{100} = 10600 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. ✓

Bridge discharge (Q_2) = 10600 (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 = 98 ft. Flow angle at bridge = 5 ° Abut. Skew = 0 ° Effective Skew = 5 °

Width (W_2) iteration = 98 ~~75~~ 65 73 68 70

Avg. flow depth at bridge, y_2 iteration = 12.6 ~~14.5~~ 15.7 14.7 15.3 15.1

Corrected channel width at bridge Section = W_2 times cos of flow angle = 69.73 ft* $q_2 = Q_2/W_2$ = 152 ft^2/s

Bridge Vel, V_2 = 10.1 ft/s Final $y_2 = q_2/V_2$ = 15.1 ft Δh = 2.1 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 17.2 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. = 22.5 ft

n (Channel) = 0.035

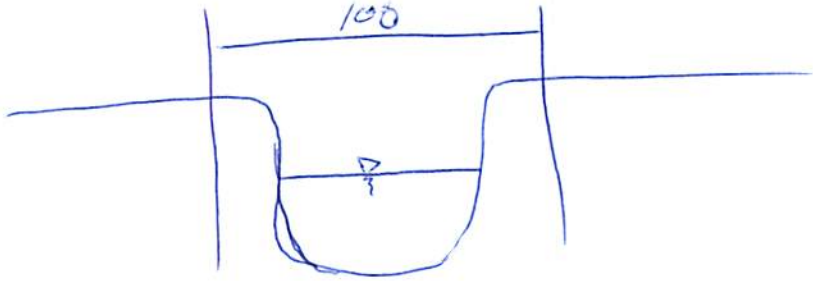
n (LOB) = 0.033

n (ROB) = 0.033

Pier Width = 1.0 ft

Pier Length = 0.4/25 ft

Piers for 100 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 100 ft

Width of left overbank flow at approach, W_{lob} = 0 ft Average left overbank flow depth, y_{lob} = 0.0 ft

Width of right overbank flow at approach, W_{rob} = 0 ft Average right overbank flow depth, y_{rob} = 0.0 ft

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

x = 9.19 From Figure 9 W_2 (effective) = 67.7 ft y_{cs} = 9.1 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, $V_1 = Q_{100}/(y_1 W_1)$ = ______ ft/s

Critical approach velocity, $V_c = 11.17 y_1^{1/6} D_{50}^{1/3}$ = ______ 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 = 25 Correction factor for flow angle of attack (from Table 1), K2 = 1.5

Froude # at bridge = 0.46 Using pier width a on Figure 11, ξ = 4.9 Pier scour y_{ps} = 6.5 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 0.0 ft right abutment, y_{aRT} = 0.0 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} = 0.0 and ψ_{RT} = 0.0

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 0.0 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 0.0 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 10262330 Date 10/28/11 Initials CW Region (A (B) C D)

Site ______ Location ~4.7 mi W & 1 mi N of Newell on Schmele Rd

Q_{500} = 17500 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. ✓

Bridge discharge (Q_2) = 17500 (should be Q_{500} unless there is a relief bridge, road overflow, or bridge overtopping)

PGRM: "RegionA", "RegionB", "RegionC", or "RegionD"

Analytical Procedure for Estimating Hydraulic Variables Needed to Apply Method

Bridge Width = 98 ft. Flow angle at bridge = 5 ° Abut. Skew = 0 ° Effective Skew = 5 °

Width (W_2) iteration = 98 75 80 80

Avg. flow depth at bridge, y_2 iteration = 16.4 [illegible] 18.9 18.3

Corrected channel width at bridge Section = W_2 times cos of flow angle = 79.7 ft* $q_2 = Q_2/W_2$ = 219.6 ft²/s

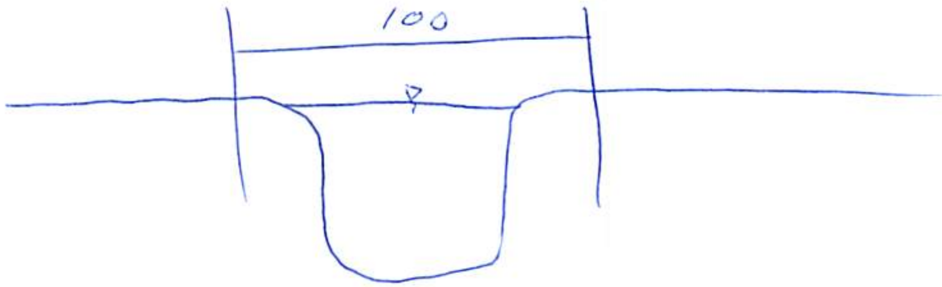
Bridge Vel, V_2 = 12.0 ft/s Final $y_2 = q_2/V_2$ = 18.3 ft Δh = 3.0 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 21.3 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. = 22.5 ft
n (Channel) = 0.035
n (LOB) = 0.033
n (ROB) = 0.033
Pier Width = 1 ft
Pier Length = 0.4/25 ft
Piers for 500 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 100 ft

Width of left overbank flow at approach, W_{lob} = 0 ft Average left overbank flow depth, y_{lob} = 0.0 ft

Width of right overbank flow at approach, W_{rob} = 0 ft Average right overbank flow depth, y_{rob} = 0.0 ft

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

x = 6.11 From Figure 9 W_2 (effective) = 77.7 ft y_{cs} = 6.9 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, $V_1 = Q_{500}/(y_1 W_1)$ = ______ ft/s

Critical approach velocity, $V_c = 11.17 y_1^{1/6} D_{50}^{1/3}$ = ______ 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: Pie

L/a ratio = 25 Correction factor for flow angle of attack (from Table 1), K2 = 1.5

Froude # at bridge = 0.49 Using pier width a on Figure 11, ξ = 4.9 Pier scour y_{ps} = 6.6 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 0.0 ft right abutment, y_{aRT} = 0.0 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} = 0.0 and ψ_{RT} = 0.0

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 0.0 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 0.0 ft

Route Schmele Rd Stream Indian Ck MRM ______ Date 10/28/11 Initials CW

Bridge Structure No. 10262330 Location ~4.7 mi W & 1 mi N of Newell on Schmele Rd

GPS coordinates: N44° 44' 04.0" taken from: USL abutment X centerline of ⇑ MRM end ______

W103° 31' 11.6" Datum of coordinates: WGS84 X NAD27 ______

Drainage area = 360.26 sq. mi.

The average bottom of the main channel was 27.4 ft below top of guardrail at a point 40 ft from left abutment.

Method used to determine flood flows: ____Freq. Anal. ____drainage area ratio ✓ regional regression equations.

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 10600			Q_{500} = 17500		
Estimated flow passing through bridge	10600			17500		
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 Degradation

Debris Potential? ____High X 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 X	Sand X	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

10/4/11

2	713
5	2180
10	3780
25	6040
50	8200
100	10600
500	17500

* Channel is extremely incised

Photos
2146 - ID
47 - Sign on bridge
48 - US
49 - US RB
50 - US LB
51 - L. Abut
52 - R. Abut
53 - Pier Config
54 - Piers
55 - Piers
56 - US Face
57 - LB App XS
58 - RB App XS
59 - Debris on bridge

Summary of Results

	Q100	Q500
Bridge flow evaluated	10600	17500
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	9.1	6.9
Pier scour depth (yps), in feet	6.5	6.6
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