OK-RAT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 48298103 Date 10-12-12 Initials RFT Region (A (B) C D)

Site ______ Location 1.8 mi E of HWY 83 on 254 St

Q_{100} = 41100 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. ✓

Bridge discharge (Q_2) = 41100 (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 = 362 ft. Flow angle at bridge = 20 ° Abut. Skew = 0 ° Effective Skew = 20 °

Width (W_2) iteration = 362 ____ ____ ____

Avg. flow depth at bridge, y_2 iteration = 13.4 ____ ____ ____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 340.17 ft* $q_2 = Q_2/W_2$ = 120.8 ft^2/s

Bridge Vel, V_2 = 9.0 ft/s Final $y_2 = q_2/V_2$ = 13.4 ft Δh = 1.7 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 15.0 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. = 0.3 ft

Low Steel Elev. = 14.8 ft

n (Channel) = .035 mostly smooth + sandy, trees on edges

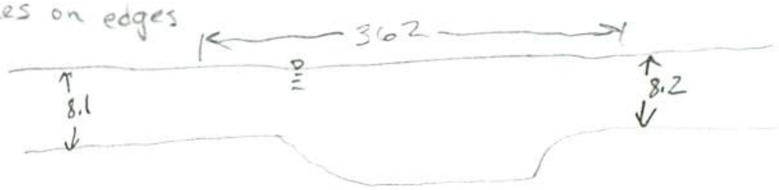
n (LOB) = .065

n (ROB) = .065 } woods + brush

Pier Width = 3.0 ft

Pier Length = 28 ft

\# Piers for 100 yr = 4 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 362 ft

Width of left overbank flow at approach, W_{lob} = 362 ft Average left overbank flow depth, y_{lob} = 8.1 ft

Width of right overbank flow at approach, W_{rob} = 362 ft Average right overbank flow depth, y_{rob} = 8.2 ft

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

x = 7.99 From Figure 9 W_2 (effective) = 328.2 ft y_{cs} = 8.8 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, $Vc = 11.17y_1^{1/6}D_{50}^{1/3}$ = ____ 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 = 9.33 Correction factor for flow angle of attack (from Table 1), K2 = 2.4

Froude # at bridge = 0.43 Using pier width a on Figure 11, ξ = 10.7 Pier scour y_{ps} = 22.6 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 8.1 ft right abutment, y_{aRT} = 8.2 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} = 19.8 and ψ_{RT} = 19.9

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 19.8 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 19.9 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 48298103 Date ________ Initials ________ Region (A (B) C D)

Site ________________ Location 1.8 mi E of Hwy 83 on 254 St

Q_{500} = 105000 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. ✓

Bridge discharge (Q_2) = 76376 (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 = 362 ft. Flow angle at bridge = 20 ° Abut. Skew = 0 ° Effective Skew = 20 °

Width (W_2) iteration = 362 ____ ____ ____

Avg. flow depth at bridge, y_2 iteration = 18.5 ____ ____ ____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 340.17 ft* $q_2 = Q_2/W_2$ = 224.5 ft^2/s

Bridge Vel, V_2 = 12.1 ft/s Final $y_2 = q_2/V_2$ = 18.5 ft Δh = 3.0 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 21.5 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.

road overflow will occur at $y_2 \approx 18.5$

Water Surface Elev. = 0.3 ft

Low Steel Elev. = 14.8 ft

n (Channel) = .035

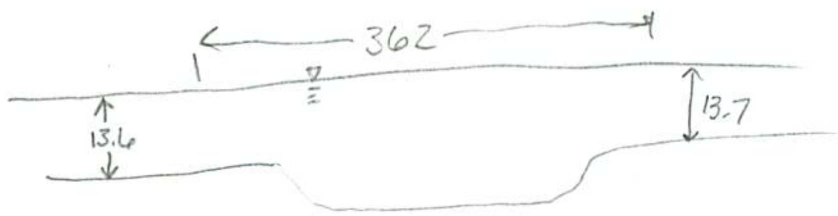
n (LOB) = .065

n (ROB) = .065

Pier Width = 3.0 ft

Pier Length = 28 ft

\# Piers for 500 yr = 4 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 362 ft

Width of left overbank flow at approach, W_{lob} = 362 ft Average left overbank flow depth, y_{lob} = 13.6 ft

Width of right overbank flow at approach, W_{rob} = 362 ft Average right overbank flow depth, y_{rob} = 13.7 ft

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

x = 14.19 From Figure 9 W_2 (effective) = 328.2 ft y_{cs} = 14.6 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, $Vc = 11.17 y_1^{1/6} D_{50}^{1/3}$ = ________ 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 = 9.33 Correction factor for flow angle of attack (from Table 1), K2 = 2.4

Froude # at bridge = 0.5 Using pier width a on Figure 11, ξ = 10.7 Pier scour y_{ps} = 23.1 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 13.6 ft right abutment, y_{aRT} = 13.7 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} = 24.3 and ψ_{RT} = 24.4

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 24.3 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 24.4 ft

Route Co HWY 11 Stream Little White River MRM ________ Date ____________ Initials ________

Bridge Structure No. 44298103 Location 1.8 mi E of HWY 83 on 254 St

GPS coordinates: N 43° 43.133' taken from: USL abutment ✓ centerline of ⇑ MRM end ______

W 100° 39.238' Datum of coordinates: WGS84 ✓ NAD27 ______

Drainage area = 1570.14 sq. mi.

The average bottom of the main channel was 20.8 ft below top of guardrail at a point 123 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 41100			Q_{500} = 105000		
Estimated flow passing through bridge	41100			76376		
Estimated road overflow & overtopping	0			28624		
Consideration	Yes	No	Possibly	Yes	No	Possibly
Chance of overtopping		✓		✓		
Chance of Pressure flow		✓		✓		
Armored appearance to channel		✓			✓	
Lateral instability of channel			✓			✓

Pk calc'd 8/8 (8/12)

2	1190
5	3980
10	7800
25	16000
50	26206
100	41100
500	105000

Riprap at abutments? X Yes ____No ____Marginal

Evidence of past Scour? ____Yes ____No ____Don't know

Debris Potential? X High ____Med ____Low lots of timber upstream

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

Riprap ✓ Yes ____No ____Don't know ____NA

Spur Dike on left & rt with riprap ✓ Yes ____No ____Don't know ____NA

Other ____________ ____Yes ____No ____Don't know ✓ NA

Bed Material Classification Based on Median Particle Size (D_{50})

Material	Silt/Clay____	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

str. no.
bridge from rt. approach
LOB
ROB

rt. abut.
rt. spur dike
left abut.
left spur dike

Spur dikes will probably mitigate some of the estimated abutment scour

Summary of Results

	Q100	Q500 max scour
Bridge flow evaluated	41100	76376
Flow depth at left abutment (yaLT), in feet	8.1	13.6
Flow depth at right abutment (yaRT), in feet	8.2	13.7
Contraction scour depth (ycs), in feet	8.8	14.6
Pier scour depth (yps), in feet	22.6	23.1
Left abutment scour depth (yas), in feet	19.8	24.3
Right abutment scour depth (yas), in feet	19.9	24.4
1Flow angle of attack	20°	20°

See Comments/Diagram for justification where required