OK-RAT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 64148058 Date 10-16-12 Initials RFT Region (A B (C) D)

Site _____ Location 0.4 mi S and 5.8 mi E Alcester on 302 St

Q_{100} = 25 .1860-2780 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. ✓

Bridge discharge (Q_2) = 2780 (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 = 54 ft. Flow angle at bridge = 20 ° Abut. Skew = 0 ° Effective Skew = 20 °

Width (W_2) iteration = 54 _____ _____ _____

Avg. flow depth at bridge, y_2 iteration = ~~8.5~~ 10.4 _____ _____ _____

Corrected channel width at bridge Section = W_2 times cos of flow angle = ~~50.74~~ 54.8 ft $q_2 = Q_2/W_2$ = ~~36.7~~ ft²/s

Bridge Vel, V_2 = ~~4.3~~ 5.2 ft/s Final $y_2 = q_2/V_2$ = ~~8.5~~ 10.4 ft Δh = ~~0.4~~ 0.6 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = ~~8.9~~ 11.0 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. = _____ ft

Low Steel Elev. = 7.8 ft

n (Channel) = .035

n (LOB) = .030

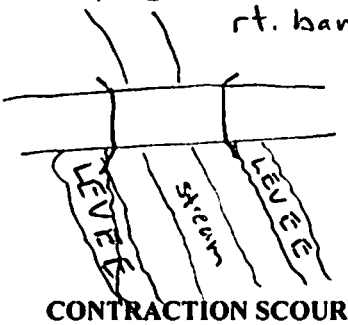
n (ROB) = .050

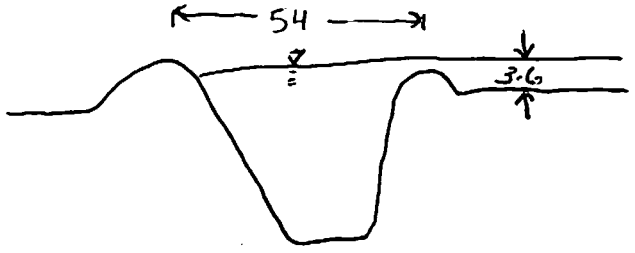
Pier Width = NA ft

Pier Length = NA ft

Piers for 100 yr = 0 ft

left bank levee is higher than road; no LOB flow
rt. bank levee is not as high as left





CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 54 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} = 54 ft Average right overbank flow depth, y_{rob} = 3.6 ft

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

x = 2.83 From Figure 9 W_2 (effective) = 50.8 ft y_{cs} = 3.4 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, $Vc = 11.17 y_1^{1/6} D_{50}^{1/3}$ = _____ 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: Pier

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

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

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 0 ft right abutment, y_{aRT} = 3.6 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 left and ψ_{RT} = 12.6 rt

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 0 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 12.6 ft

although there is no left overbank flow, there will probably still be left abutment scour because of flow angle

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 64148058 Date _____ Initials _____ Region (A B C D)

Site _____ Location _____

Q_{500} = ~~2750~~ 3550 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. ✓

Bridge discharge (Q_2) = 2919 (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 = 54 ft. Flow angle at bridge = 20 ° Abut. Skew = 0 ° Effective Skew = 20 °

Width (W_2) iteration = 54 _____ _____ _____

Avg. flow depth at bridge, y_2 iteration = 10.7 _____ _____ _____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 50.74 ft* $q_2 = Q_2/W_2$ = 57.5 ft^2/s

Bridge Vel, V_2 = 5.4 ft/s Final $y_2 = q_2/V_2$ = 10.7 ft Δh = 0.6 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 11.3 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.

road overflow will begin at $y_2 \approx 10.7$ assume this is also $Q_{max\ scour}$

Water Surface Elev. = _____ ft

Low Steel Elev. = 7.8 ft

n (Channel) = .035

n (LOB) = .030

n (ROB) = .030

Pier Width = NA ft

Pier Length = NA ft

Piers for 500 yr = 0 ft

CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 54 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} = 54 ft Average right overbank flow depth, y_{rob} = 3.9 ft

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

x = 3.11 From Figure 9 W_2 (effective) = 50.7 ft y_{cs} = 3.7 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

PGRM: Pier

PIER SCOUR CALCULATIONS

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

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

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 0 ft right abutment, y_{aRT} = 3.9 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 left and ψ_{RT} = 13.1 rt

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 0 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 13.1 ft

Route 302 St Stream Green Creek MRM _____ Date _____ Initials _____

Bridge Structure No. 64148058 Location 0.4 S and 5.8 mi E Alcester on 302 St

GPS coordinates: N 43° 00.027' W 96° 31.006' taken from: USL abutment ✓ centerline of ⇑ MRM end _____

Datum of coordinates: WGS84 ✓ NAD27 _____

Drainage area = 16.41 sq. mi.

The average bottom of the main channel was 13 ft below top of guardrail at a point 10 ft from left abutment.

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

9-26-12

MISCELLANEOUS CONSIDERATIONS

Flows	$Q_{\cancel{100}}^{25}$ = 2780			$Q_{\cancel{500}}^{50}$ = 3550		
Estimated flow passing through bridge	2780			Qmax scour = 2919		
Estimated road overflow & overtopping	0			631		
Consideration	Yes	No	Possibly	Yes	No	Possibly
Chance of overtopping			✓	✓		
Chance of Pressure flow	✓			✓		
Armored appearance to channel		✓			✓	
Lateral instability of channel		✓			✓	

Pk	Q
2	537
5	1250
10	1860
25	2780
50	3550
100	4370
500	6480

Riprap at abutments? ____Yes ✓No ____Marginal

Evidence of past Scour? ✓Yes ____No ____Don't know left abut mostly eroded (no longer spill-through)

Debris Potential? ____High ____Med ✓Low

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

Riprap	____Yes	____No	____Don't know	✓NA
Spur Dike	____Yes	____No	____Don't know	✓NA
Other levees	____Yes	____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

Str. no
approach from bridge
left levee + overbank from road
rt levee + overbank from road
bridge from approach

left abut. (eroded)
~~rt. abut.~~

Summary of Results

	Q100 25	Q500 max scour
Bridge flow evaluated	2780	2919
Flow depth at left abutment (yaLT), in feet	0	0
Flow depth at right abutment (yaRT), in feet	3.6	3.9
Contraction scour depth (ycs), in feet	3.4	3.7
Pier scour depth (yps), in feet	NA	NA
Left abutment scour depth (yas), in feet	0*	0*
Right abutment scour depth (yas), in feet	12.6	13.1
1Flow angle of attack	20°	20°

* see note bottom of p. 1

See Comments/Diagram for justification where required