Dup. ok-RJT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 27089250 Date 10-12-12 Initials RFT Region (A (B) C D)

Site _____ Location 3mi S & 3mi W of Burke on 294 St

Q_{100} = 7210 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. ✓

Bridge discharge (Q_2) = 7210 (should be Q_{100} unless there is a relief bridge, road overflow, or bridge overtopping)

44 62 126

Analytical Procedure for Estimating Hydraulic Variables Needed to Apply Method

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

Bridge Width = 140 ft. Flow angle at bridge = 5 ° Abut. Skew = 0 ° Effective Skew = 5 °

Width (W_2) iteration = 140 116 126 120 123 122

Avg. flow depth at bridge, y_2 iteration = 8.5 9.4 9.0 9.3 9.1 9.2

Corrected channel width at bridge Section = W_2 times cos of flow angle = 121.54 ft* $q_2 = Q_2/W_2$ = 59.3 ft²/s

Bridge Vel, V_2 = 6.5 ft/s Final $y_2 = q_2/V_2$ = 9.2 ft Δh = 0.9 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 10.0 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.

y_2 10.6 is abut. to abut.

Water Surface Elev. = dry ft

Low Steel Elev. = 14.3 ft

n (Channel) = .090 incised (low flow)

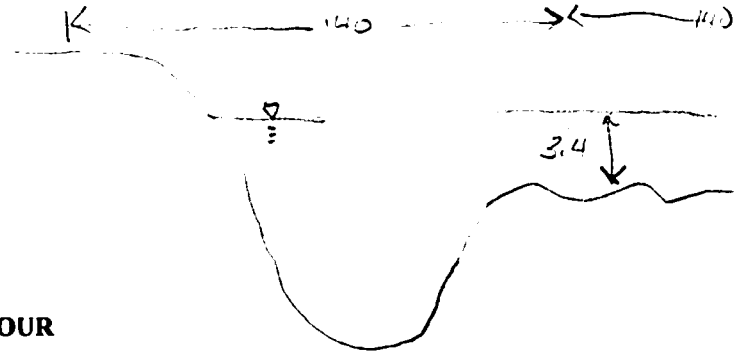
n (LOB) = .090

n (ROB) = .095

Pier Width = 1.67 ft

Pier Length = 1.67 ft

Piers for 100 yr = 4 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 140 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} = 140 ft Average right overbank flow depth, y_{rob} = 3.4 ft

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

x = 4.1 From Figure 9 W_2 (effective) = 114.9 ft y_{cs} = 4.7 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, $V_1 = Q_{100}/(y_1 W_1)$ = _____ 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 = 1 Correction factor for flow angle of attack (from Table 1), K2 = 1

Froude # at bridge = 0.38 Using pier width a on Figure 11, ξ = 7 Pier scour y_{ps} = 6.0 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 0 ft right abutment, y_{aRT} = 3.4 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} = 12.2

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 0 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 12.2 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 27089250 Date _____ Initials _____ Region (A (B) C D)

Site _____ Location _____

Q_{500} = 12000 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. ✓

Bridge discharge (Q_2) = 12000 (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 = 140 ft. Flow angle at bridge = 5 ° Abut. Skew = 0 ° Effective Skew = 5 °

Width (W_2) iteration = 140 _____ _____ _____

Avg. flow depth at bridge, y_2 iteration = 11.2 _____ _____ _____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 139.47 ft* $q_2 = Q_2/W_2$ = 86 ft^2/s

Bridge Vel, V_2 = 7.7 ft/s Final $y_2 = q_2/V_2$ = 11.2 ft Δh = 1.2 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 12.4 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. = dry ft

Low Steel Elev. = 14.3 ft

n (Channel) = .090

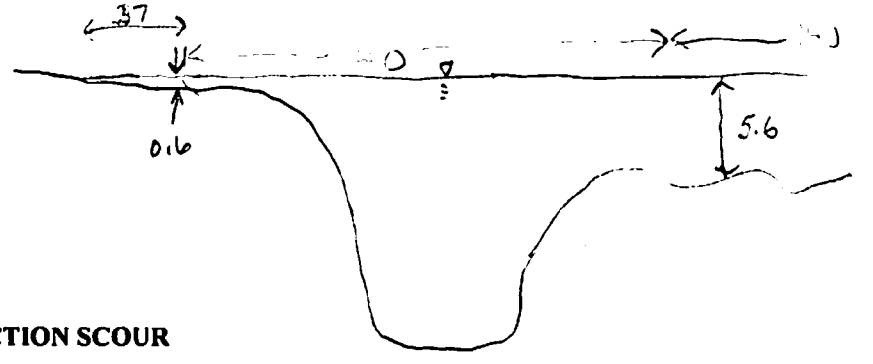
n (LOB) = .090

n (ROB) = .095

Pier Width = 1.67 ft

Pier Length = 1.67 ft

Piers for 500 yr = 4 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 140 ft

Width of left overbank flow at approach, W_{lob} = 37 ft Average left overbank flow depth, y_{lob} = 0.3 ft

Width of right overbank flow at approach, W_{rob} = 140 ft Average right overbank flow depth, y_{rob} = 5.6 ft

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

x = 3.97 From Figure 9 W_2 (effective) = 132.8 ft y_{cs} = 4.6 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: Pier

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

Froude # at bridge = 0.41 Using pier width a on Figure 11, ξ = 7 Pier scour y_{ps} = 6.1 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 0.3 ft right abutment, y_{aRT} = 5.6 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} = 1.4 and ψ_{RT} = 16.1

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 1.4 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 16.1 ft

Route 294 St Stream Ponca Creek MRM _____ Date _____ Initials _____

Bridge Structure No. 27089250 Location 3mi. S + 3mi W of Burke on 294 St

GPS coordinates: N 43° 8.416' taken from: USL abutment ✓ centerline of ⇑ MRM end _____

W 99° 21.293' Datum of coordinates: WGS84 ✓ NAD27 _____

Drainage area = 215.4 sq. mi.

The average bottom of the main channel was 18.2 ft below top of guardrail at a point 61 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 7210			Q_{500} = 12000		
Estimated flow passing through bridge	7210			12000		
Estimated road overflow & overtopping	0			0		
Consideration	Yes	No	Possibly	Yes	No	Possibly
Chance of overtopping		✓			✓	
Chance of Pressure flow		✓			✓	
Armored appearance to channel		✓			✓	
Lateral instability of channel		✓			✓	

Riprap at abutments? ____Yes ____No X Marginal

Evidence of past Scour? ____Yes ____No ____Don't know abutment, contraction

Debris Potential? ✓High ____Med ____Low

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

Riprap concrete rubble	____Yes	X No	____Don't know	____NA
Spur Dike	____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 (fine) 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 approach

LOB from ROB

ROB

right abut. rubble on rt.

left abut. rubble on left

approach from bridge

Summary of Results

	Q100	Q500
Bridge flow evaluated	7210	12000
Flow depth at left abutment (yaLT), in feet	0	0.3
Flow depth at right abutment (yaRT), in feet	3.4	5.6
Contraction scour depth (ycs), in feet	4.7	4.6
Pier scour depth (yps), in feet	6.0	6.1
Left abutment scour depth (yas), in feet	0	1.4
Right abutment scour depth (yas), in feet	12.2	16.1
Flow angle of attack	5°	5°

See Comments/Diagram for justification where required