Rapid Creek OK TCT

SCOUR ANALYSIS AND REPORTING FORM 11/20/10 + 12/2/10

Bridge Structure No. 52391311 Date ~~11/13/10~~ Initials CW Region (A B C D)

Site _____ Location 32nd St over Rapid Creek

Q_{100} = 4690 by: drainage area ratio ✓ flood freq. anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = 4690 (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 = ~~115~~ 112 ft. Flow angle at bridge = 40 ° Abut. Skew = 20 ° Effective Skew = 20 °

Width (W_2) iteration = ~~115~~ 112

Avg. flow depth at bridge, y_2 iteration = 5.4 5.8 vert Abut

Corrected channel width at bridge Section = W_2 times cos of flow angle = 105.25 ft* $q_2 = Q_2/W_2$ = 44.6 ft²/s

Bridge Vel, V_2 = 7.7 ft/s Final $y_2 = q_2/V_2$ = 5.8 ft Δh = 1.2 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 7.0 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. = 7.0 ft

n (Channel) = 0.045

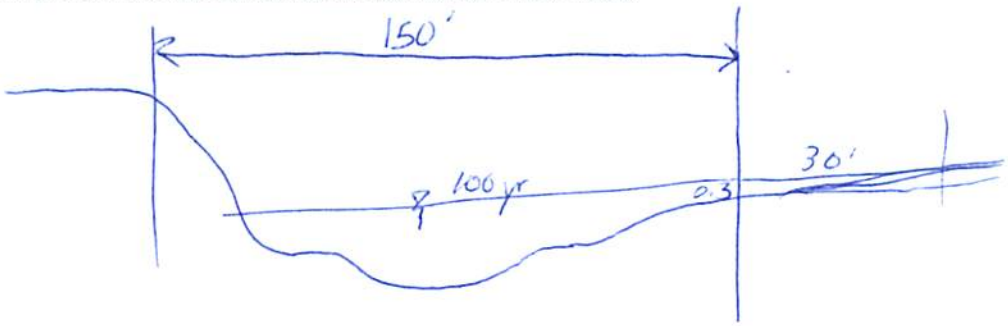
n (LOB) = 0.040

n (ROB) = 0.040

Pier Width = 2.0 ft

Pier Length = 2.0 ft

Piers for 100 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = ~~140~~ ft 150

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} = 30 ft Average right overbank flow depth, y_{rob} = 0.3 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} = 0.4 ft Average approach velocity, $V_1 = Q_{100}/(y_1 W_1)$ = ~~4.47~~ 3.72 ft/s

Critical approach velocity, $Vc = 11.52 y_1^{1/6} D_{50}^{1/3}$ = 11.38 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.

$D_{c50} = 0.0006(q_2/y_1^{7/6})^3$ = 0.0587 ft If $D_{50} >= D_{c50}$, χ = 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} = 0.0 ft

PIER SCOUR CALCULATIONS

PGRM: Pier

L/a ratio = 1.0 Correction factor for flow angle of attack (from Table 1), K2 = 1.0

Froude # at bridge = 0.56 Using pier width a on Figure 11, ξ = 8 Pier scour y_{ps} = 7.3 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 0.0 ft right abutment, y_{aRT} = 0.3 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} = 1.4

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 0.0 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = ~~1.4~~ 2.6 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 52391311 Date ~~11/13/10~~ Initials CW Region (A B C D)

Site _____ Location 32nd St over Rapid Creek

Q_{500} = 17800 by: drainage area ratio ✓ flood freq. anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = ~~7127~~ 6697 (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 = 112 ft. Flow angle at bridge = 40 ° Abut. Skew = 20 ° Effective Skew = 20 °

Width (W_2) iteration = 112

Avg. flow depth at bridge, y_2 iteration = RD Overflow 63.6

Corrected channel width at bridge Section = W_2 times cos of flow angle = ~~105.25~~ ft* $q_2 = Q_2/W_2$ = ~~67.7~~ ft^2/s

Bridge Vel, V_2 = ~~9.3~~ ft/s 9.1 Final $y_2 = q_2/V_2$ = ~~7.2~~ ft 7.0 Δh = ~~1.8~~ ft 1.7

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = ~~8.8~~ ft 8.7

** 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. = 7.0 ft

n (Channel) = 0.045

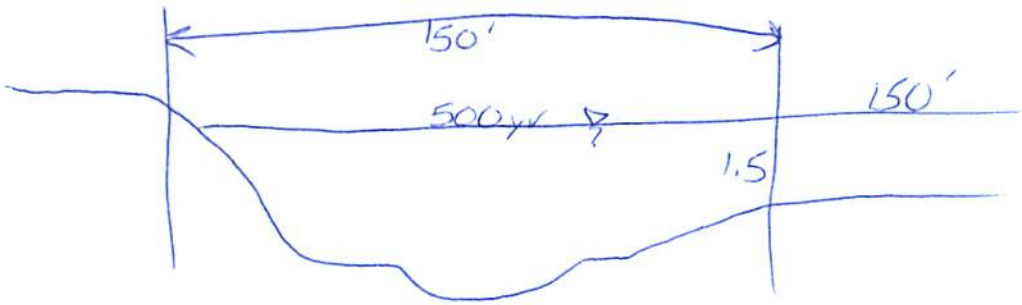
n (LOB) = 0.040

n (ROB) = 0.046

Pier Width = 2.0 ft

Pier Length = 2.0 ft

Piers for 500 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 150 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} = 150 ft Average right overbank flow depth, y_{rob} = 1.5 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} = 0.4 ft Average approach velocity, $V_1 = Q_{500}/(y_1 W_1)$ = ~~5.28~~ ft/s ~~5.13~~ 2.57

Critical approach velocity, $Vc = 11.52 y_1^{1/6} D_{50}^{1/3}$ = ~~11.87~~ ft/s 11.8

If $V_1 < V_c$ and $D_{50} >= 0.2$ ft, use clear water equation below, otherwise use live bed scour equation above.

$D_{c50} = 0.0006(q_2/y_1^{7/6})^3$ = ~~0.0851~~ ft 0.795 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} = 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 = 0.61 Using pier width a on Figure 11, ξ = 8 Pier scour y_{ps} = 7.4 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 0.0 ft right abutment, y_{aRT} = 1.5 ft

Shape coefficient K_1= 1.00 for vertical-wall, 0.82 for vertical-wall with wingwalls, ~~0.55~~ 0.55 for spill-through

Using values for y_{aLT} and y_{aRT} on figure 12, ψ_{LT} = 0.0 and ψ_{RT} = ~~6.3~~ 11.4

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 0.0 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = ~~6.3~~ ft

Route 32nd St Stream Rapid Creek MRM _____ Date 11/20/10 Initials CR

Bridge Structure No. 52391311 Location 32nd St over Rapid Creek

GPS coordinates: N 44° 04' [illegible] 3.5" W 103° 16' 17.0" taken from: USL abutment_____ centerline of ⇑ MRM end _____

Datum of coordinates: WGS84_____ NAD27_____

Drainage area = 405.75 sq. mi.

The average bottom of the main channel was 11.6 ft below top of guardrail at a point 150 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 4690			Q_{500} = 17800		
Estimated flow passing through bridge	4690			~~7127~~ 6697		
Estimated road overflow & overtopping				~~10673~~ 11103		
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? _____Yes X No _____Don't know

Debris Potential? X High _____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_____	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

Photos - 2 Days

11/20/10
1488 - 1D
89 - US
90 - US RB
91 - US LB

12/2/10
92 - APP XS looking @ LB
93 - APP XS looking @ RB
94 - US Face Bridge
95 - L. Abut.
96 - R. Abut.

Summary of Results

	Q100	Q500
Bridge flow evaluated	4690	7127
Flow depth at left abutment (yaLT), in feet	0.0	0.0
Flow depth at right abutment (yaRT), in feet	0.3	1.5
Contraction scour depth (ycs), in feet	0.0	0.0
Pier scour depth (yps), in feet	7.3	7.4
Left abutment scour depth (yas), in feet	0.0	0.0
Right abutment scour depth (yas), in feet	~~1.4~~ 2.6	~~6.5~~ 11.4
1Flow angle of attack	20°	20°

See Comments/Diagram for justification where required

CR