OK RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 52419299 Date 4/4/11 Initials CW Region ([✓ A] B C D)

Site ______ Location East Boulevard over Rapid Creek

Q_{100} = 4800 by: drainage area ratio ✓ flood freq. anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = 4800 (should be Q_{100} 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 = 210 ft. Flow angle at bridge = 5 ° Abut. Skew = 0 ° Effective Skew = 5 °

Width (W_2) iteration = 210 163 163 ____

Avg. flow depth at bridge, y_2 iteration = 4.0 4.6 4.6 ____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 162.38 ft* $q_2 = Q_2/W_2$ = 29.6 ft²/s

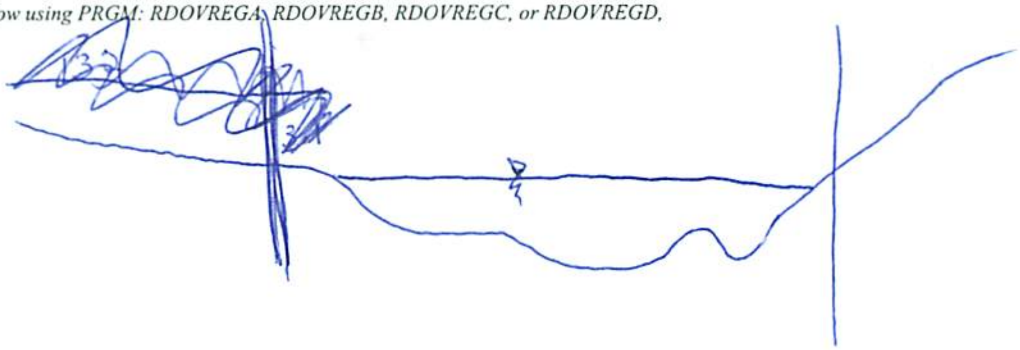
Bridge Vel, V_2 = 6.4 ft/s Final $y_2 = q_2/V_2$ = 4.6 ft Δh = 0.8 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 5.4 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. = ____ ft
Low Steel Elev. = ~~0.035~~ ft
n (Channel) = 0.040
n (LOB) = 0.035
n (ROB) = 0.035
Pier Width = 1.25 ft
Pier Length = 80 ft
\# Piers for 100 yr = 3 ft



PGRM: Contract

CONTRACTION SCOUR

Width of main channel at approach section W_1 = 210 ft

Width of left overbank flow at approach, W_{lob} = ~~132~~ ft 0 Average left overbank flow depth, y_{lob} = ~~1.55~~ ft 0.0

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 = ______ 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) Z = 0 ~~2=2.34~~

Estimated bed material D_{50} = 0.2 ft Average approach velocity, $V_1 = Q_{100}/(y_1 W_1)$ = 4.23 ft/s

Critical approach velocity, $Vc = 11.52 y_1^{1/6} D_{50}^{1/3}$ = 8.65 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.

$D_{c50} = 0.0006(q_2/y_1^{7/6})^3$ = 0.0425 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} = 0.0 ft

PGRM: Pier

PIER SCOUR CALCULATIONS

L/a ratio = 64 Correction factor for flow angle of attack (from Table 1), K2 = 1.5

Froude # at bridge = 0.53 Using pier width a on Figure 11, ξ = 5.6 Pier scour y_{ps} = 7.7 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

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

1.55
2)3.1
2
1.1

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 52419299 Date 4/4/11 Initials Ch Region ([✓ A] B C D)

Site ______ Location East Boulevard over Rapid Creek

Q_{500} = 18100 by: drainage area ratio ✓ flood freq. anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = 18100 (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 = 210 ft. Flow angle at bridge = 5 ° Abut. Skew = 0 ° Effective Skew = 5 °

Width (W_2) iteration = 210 190 201 200

Avg. flow depth at bridge, y_2 iteration = 8.3 8.8 8.5 8.5

Corrected channel width at bridge Section = W_2 times cos of flow angle = 199.24 ft* $q_2 = Q_2/W_2$ = 90.8 ft^2/s

Bridge Vel, V_2 = 10.7 ft/s Final $y_2 = q_2/V_2$ = 8.5 ft Δh = 2.3 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 10.9 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. = ____ ft

n (Channel) = 0.040

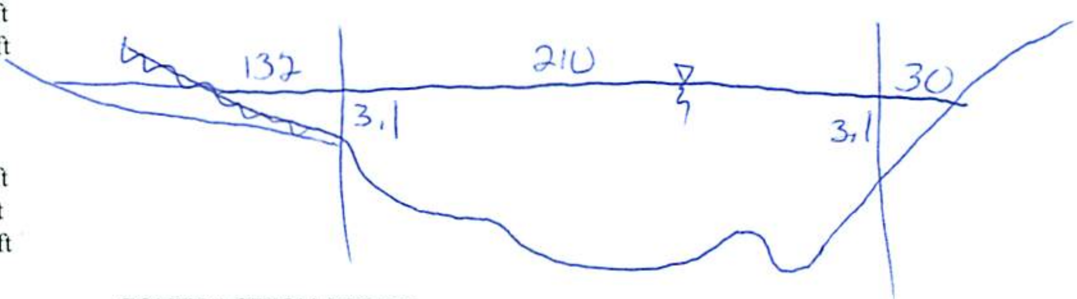
n (LOB) = 0.035

n (ROB) = 0.035

Pier Width = 1.25 ft

Pier Length = 86 ft

\# Piers for 500 yr = 3 ft



PGRM: Contract

CONTRACTION SCOUR

Width of main channel at approach section W_1 = 210 ft

Width of left overbank flow at approach, W_{lob} = 132 ft Average left overbank flow depth, y_{lob} = 1.55 ft

Width of right overbank flow at approach, W_{rob} = 30 ft Average right overbank flow depth, y_{rob} = 1.55 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) Z=0

Estimated bed material D_{50} = 0.2 ft Average approach velocity, $V_1 = Q_{500}/(y_1 W_1)$ = 4.46 ~~7.41~~ ft/s ~~Z=2.346~~

Critical approach velocity, $Vc = 11.52 y_1^{1/6} D_{50}^{1/3}$ = 9.73 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.

$D_{c50} = 0.0006(q_2/y_1^{7/6})^3$ = 0.1051 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} = 0.0 ft

PGRM: Pie

PIER SCOUR CALCULATIONS

L/a ratio = 64

Correction factor for flow angle of attack (from Table 1), K2 = 1.5

Froude # at bridge = 0.65

Using pier width a on Figure 11, ξ = 5.6 Pier scour y_{ps} = 7.9 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 1.55 ft right abutment, y_{aRT} = 1.55 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} = 6.4 and ψ_{RT} = 6.4

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 6.4 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 6.4 ft

Route East Boulevard Stream Rapid Creek MRM ________ Date 4/4/11 Initials CL

Bridge Structure No. 52419299 Location East Boulevard over Rapid Creek

GPS coordinates: N 44° 04' 58.1" taken from: USL abutment X centerline of ⇑ MRM end ______

W 103° 12' 52.9" Datum of coordinates: WGS84 X NAD27 ______

Drainage area = 419.57 sq. mi.

The average bottom of the main channel was 19.0 ft below top of guardrail at a point 86.0 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} =	4800		Q_{500} =	18100	
Estimated flow passing through bridge		4800			18100	
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 _____No X Marginal L-Yes R-No

Evidence of past Scour? X Yes _____No _____Don't know

Debris Potential? X High _____Med _____Low

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

Riprap X Yes _____No _____Don't know _____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 X	Cobbles_____	Boulders_____
Size range, in mm	<0.062	0.062-2.00	2.00-64	64-250	>250

Comments, Diagrams & orientation of digital photos

Photos

1546 - ID
47 - US
48 - RBUS
49 - LBUS
50 - ID

51 - ~~R. Abut~~ L. Abut
52 - ~~R. Abut~~ L. Abut
53 - ~~#~~ R. Abut
54 - US Face bridge
55 - R. Abut

56 - Gate @ R. Abut
57 - New channel on RB
58 - US face bridge
59 - US face bridge

Summary of Results

	Q100	Q500
Bridge flow evaluated	4800	18100
Flow depth at left abutment (yaLT), in feet	0.0	1.55
Flow depth at right abutment (yaRT), in feet	0.0	1.55
Contraction scour depth (ycs), in feet	0.0	0.0
Pier scour depth (yps), in feet	7.7	7.9
Left abutment scour depth (yas), in feet	0.0	~~1.55~~ 6.4
Right abutment scour depth (yas), in feet	0.0	~~1.55~~ 6.4
1Flow angle of attack	5	5

See Comments/Diagram for justification where required