OK RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 34202069 Date 6/7/12 Initials RaT Region (A B C D)

Site _____ Location 1 mi W of HWY 44 on 424 Ave

Q_{100} = 659 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 659 (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 = 150 ft. Flow angle at bridge = 10 ° Abut. Skew = 0 ° Effective Skew = 10 °

Width (W_2) iteration = _____ _____ _____ _____

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

Corrected channel width at bridge Section = W_2 times cos of flow angle = 147.72 ft* $q_2 = Q_2/W_2$ = 5.8 ft^2/s

Bridge Vel, V_2 = 1.7 ft/s Final $y_2 = q_2/V_2$ = 3.4 ft Δh = 0.1 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 3.5 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.

Water Surface Elev. = 7.4 ft

Low Steel Elev. = 6.4 ft

n (Channel) = 0.033

n (LOB) = 0.030

n (ROB) = 0.030

Pier Width = 1.65 ft

Pier Length = 21 ft

Piers for 100 yr = 3 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} = 0 150 ft Average left overbank flow depth, y_{lob} = 0.60 ft

Width of right overbank flow at approach, W_{rob} = 180 0 ft Average right overbank flow depth, y_{rob} = 0.60 ft

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

x = 0.18 From Figure 9 W_2 (effective) = 142.8 ft y_{cs} = 0.3 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

PGRM: Pier

PIER SCOUR CALCULATIONS

L/a ratio = 12.73

Froude # at bridge = 0.16

Correction factor for flow angle of attack (from Table 1), K2 = 2

Using pier width a on Figure 11, ξ = 6.9 Pier scour y_{ps} = 10.5 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 0.6 ft right abutment, y_{aRT} = 0.6 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} = 2.7 and ψ_{RT} = 2.7

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 4.9 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 4.9 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 34202069 Date 6/7/12 Initials RJ Region (A B C D)

Site _____ Location 1 mi W of HWY 44 on 424 Ave

Q_{500} = 1600 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 1600 (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 = 150 ft. Flow angle at bridge = 10 ° Abut. Skew = 0 ° Effective Skew = 10 °

Width (W_2) iteration = _____ _____ _____ _____

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

Corrected channel width at bridge Section = W_2 times cos of flow angle = 147.72 ft* $q_2 = Q_2/W_2$ = 10.8 ft^2/s

Bridge Vel, V_2 = 2.3 ft/s Final $y_2 = q_2/V_2$ = 4.6 ft Δh = 0.1 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 4.8 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. = 2.4 ft

Low Steel Elev. = 9.41 ft

n (Channel) = 0.033

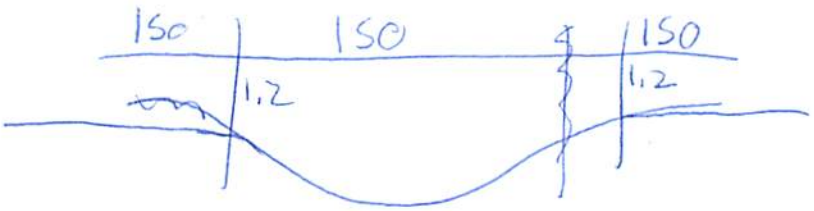
n (LOB) = 0.03

n (ROB) = 0.03

Pier Width = 1.65 ft

Pier Length = 21 ft

Piers for 500 yr = 3 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} = 150 ft Average left overbank flow depth, y_{lob} = 1.2 ft

Width of right overbank flow at approach, W_{rob} = 150 ft Average right overbank flow depth, y_{rob} = 1.2 ft

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

x = 1.34 From Figure 9 W_2 (effective) = 142.8 ft y_{cs} = 1.8 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, $V_1 = Q_{500}/(y_1W_1)$ = _____ 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

PGRM: Pier

PIER SCOUR CALCULATIONS

L/a ratio = 12.73 Correction factor for flow angle of attack (from Table 1), K2 = 2

Froude # at bridge = 0.19 Using pier width a on Figure 11, ξ = 6.9 Pier scour y_{ps} = 10.7 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 1.2 ft right abutment, y_{aRT} = 1.2 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} = 5.1 and ψ_{RT} = 5.1

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 9.2 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 9.2 ft

97° 42' 57.2"
43° 24' 5.904"

97.71589
43.40164

Route 424 Ave Stream _____ MRM _____ Date 6/7/12 Initials RaT

Bridge Structure No. 34202069 Location 1 m. W of Hwy 44 on 424 Ave

GPS coordinates: N 43° 24' 4.91" taken from: USL abutment X centerline of ↑ MRM end _____

W 97° 42' 55.71" Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 5.9 sq. mi.

The average bottom of the main channel was 1366 ft below top of guardrail at a point 87 ft from left abutment.

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

5/24
8/24

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 859			Q_{500} = 1600		
Estimated flow passing through bridge		859			1600	
Estimated road overflow & overtopping		0			0	
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	

2	41.3
5	131
10	236
25	429
50	621
100	859
500	1600

Riprap at abutments? ____Yes X No ____Marginal

Evidence of past Scour? X Yes ____No ____Don't know abutment pier contraction

Debris Potential? ____High ____Med X Low

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

Riprap ____Yes X No ____Don't know ____NA

Spur Dike ____Yes X No ____Don't know ____NA

Other _____ ____Yes X 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

1). right abutment scour
2). right abutment damage
3). left abutment scour (downstream)
4). main channel
5-6) left abutment
7-8) right abutment
9). piers
10). main channel
11). left OB
12). right OB

Note: high water mark is equivalent with ½ from Q500

Summary of Results

	Q100	Q500
Bridge flow evaluated	859	1600
Flow depth at left abutment (yaLT), in feet	0	1.2
Flow depth at right abutment (yaRT), in feet	0	1.2
Contraction scour depth (ycs), in feet	0.3	1.5
Pier scour depth (yps), in feet	10.5	10.7
Left abutment scour depth (yas), in feet	4.9	9.2
Right abutment scour depth (yas), in feet	4.9	9.2
1Flow angle of attack	10	10

See Comments/Diagram for justification where required