OK RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 22220089 Date 6/11/12 Initials RaT Region (A B C D)

Site _____ Location 3 mi N, 4 mi E of Armour on 396 Ave

Q_{100} = Q50 951 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 951 (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 = 24 ft. Flow angle at bridge = 0 ° Abut. Skew = 0 ° Effective Skew = 0 °

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 = 24 ft* $q_2 = Q_2/W_2$ = 39.4 ft^2/s

Bridge Vel, V_2 = 3.9 ft/s Final $y_2 = q_2/V_2$ = 7.5 ft Δh = 0.3 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 8.1 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. = 0 ft

Low Steel Elev. = 8.0 ft

n (Channel) = 0.040

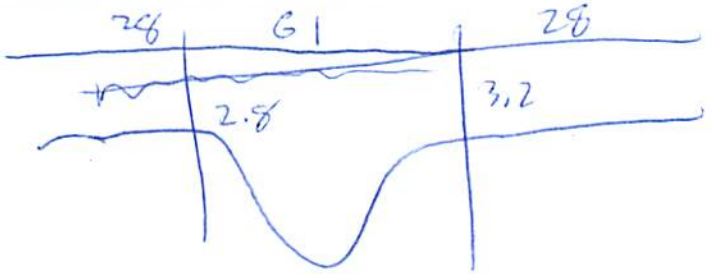
n (LOB) = 0.030 } recently updated

n (ROB) = 0.030 } hwy

Pier Width = 0 ft

Pier Length = 0 ft

Piers for 100 yr = 0 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = ~~56~~ 61 ft

Width of left overbank flow at approach, W_{lob} = 24 ft Average left overbank flow depth, y_{lob} = 2.8 ft

Width of right overbank flow at approach, W_{rob} = 26 ft Average right overbank flow depth, y_{rob} = 3.2 ft

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

x = 13.65 From Figure 9 W_2 (effective) = 28 ft y_{cs} = 14.3 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 = _____ 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} = 2.9 ft right abutment, y_{aRT} = 3.2 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} = 11.2 and ψ_{RT} = 11.9

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 16.7 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 17.7 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 22220089 Date 6/11/12 Initials KAT Region (A B C D)

Site _____ Location 3mi N, 4mi E of Armour on 396 Ave

Q_{500} = 9100 1190 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 900 (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 = 29 ft. Flow angle at bridge = 0 ° Abut. Skew = 0 ° Effective Skew = 0 °

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 = 29 ft* $q_2 = Q_2/W_2$ = 32.1 ft^2/s

Bridge Vel, V_2 = 4 ft/s Final $y_2 = q_2/V_2$ = 8 ft Δh = 0.3 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 8.3 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,

Water Surface Elev. = 0 ft

Low Steel Elev. = 9 ft

n (Channel) = 0.040

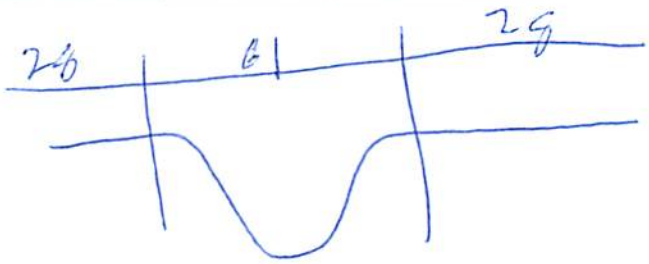
n (LOB) = 0.030

n (ROB) = 0.030

Pier Width = — ft

Pier Length = — ft

Piers for 500 yr = — ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 29 X 61 ft

Width of left overbank flow at approach, W_{lob} = 25 ft Average left overbank flow depth, y_{lob} = 3.0 ft

Width of right overbank flow at approach, W_{rob} = 28 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 = 14.31 From Figure 9 W_2 (effective) = 28 ft y_{cs} = 14.6 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, $V_1 = Q_{500}/(y_1W_1)$ = _____ 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 = _____ 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} = 3.0 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} = 11.5 and ψ_{RT} = 12.2

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 17.2 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 18.2 ft

96.2695
43.37089

95° 16' 10.236"
43° 22' 15.204"

Route 396 Ave Stream _____ MRM _____ Date 6/11/12 Initials RAT

Bridge Structure No. 22220089 Location 3mi N, 4mi E of Armour on 396 Ave

GPS coordinates: N 43° 22' 14.71" W 98° 16' 10.1" taken from: USL abutment X centerline of ↑ MRM end _____

Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 10.64 sq. mi.

The average bottom of the main channel was 13.0 ft below top of guardrail at a point 23 ft from left abutment.

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

6/4
8/23

MISCELLANEOUS CONSIDERATIONS

Flows	$Q_{\cancel{100}\ 50}$ = 851			$Q_{\cancel{500}\ 100}$ = 1190		
Estimated flow passing through bridge	851			900		
Estimated road overflow & overtopping	0			290		
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~~	~~49.8~~ 49.7
5	169
10	311
25	~~581~~ 580
50	~~852~~ 851
100	1190
500	2260

Riprap at abutments? ____Yes ____No X Marginal along bottom under bridge.

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

Debris Potential? ____High ____Med X Low

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

Riprap X Yes ____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 OB
2). main channel
3). left OB
4). right abutment
5). left abutment
6). right abutment
7). left abutment
8). main channel

Summary of Results

	~~Q100~~ Q50	~~Q500~~ Q100
Bridge flow evaluated	851	900
Flow depth at left abutment (yaLT), in feet	2.9	3.0
Flow depth at right abutment (yaRT), in feet	3.2	3.4
Contraction scour depth (ycs), in feet	14.3	14.6
Pier scour depth (yps), in feet	NA	NA
Left abutment scour depth (yas), in feet	16.7	17.2
Right abutment scour depth (yas), in feet	17.7	18.2
1Flow angle of attack	0	0

See Comments/Diagram for justification where required