5th

OK by RFT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 52312433 Date 9/2/12 Initials DaT Region (A B C D)

Site _____ Location 0.6 mi W of Keystone on Old Hill City Rd

Q_{100} = 1250 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 1250 (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 = 44 ft. Flow angle at bridge = 25 ° Abut. Skew = 30 ° Effective Skew = 5 °

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 = 43.63 ft* $q_2 = Q_2/W_2$ = 28.5 ft²/s

Bridge Vel, V_2 = 6.3 ft/s Final $y_2 = q_2/V_2$ = 4.5 ft Δh = 0.8 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 5.3 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. = 5.5 ft

n (Channel) = 0.040

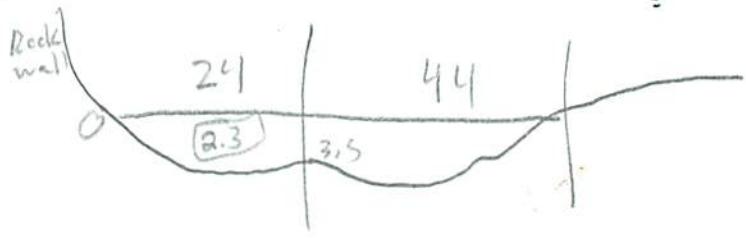
n (LOB) = 0.030

n (ROB) = 0.045

Pier Width = X ft

Pier Length = X ft

Piers for 100 yr = X ft



CONTRACTION SCOUR

2.3, 3.5, 7/3 = 7.0

Width of main channel at approach section W_1 = 44 ft

Width of left overbank flow at approach, W_{lob} = 24 ft Average left overbank flow depth, y_{lob} = 2.3 ft

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

PGRM: Contract

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

x = 0.98 From Figure 9 W_2 (effective) = 43.8 ft y_{cs} = 1.4 ft

Clear Water Contraction Scour (use if bed material is larger than small cobbles)

PGRM: CWCSNEW

Estimated bed material D_{50} = 0.2 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 = _____ 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

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 2.3 ft right abutment, y_{aRT} = 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} = 9.4 and ψ_{RT} = 0

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 17.1 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 0 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 52312433 Date 9/2/12 Initials RAL Region (A B C D)

Site _____ Location 0.6 mi W of Keystone on Old Hill City Rd

Q_{500} = 2900 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 1796 (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 = 44 ft. Flow angle at bridge = 25 ° Abut. Skew = 38 ° Effective Skew = 5 °

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 = 43.83 ft* $q_2 = Q_2/W_2$ = 41 ft^2/s

Bridge Vel, V_2 = 7.5 ft/s Final $y_2 = q_2/V_2$ = 5.5 ft Δh = 1.1 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 6.6 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. = 5.5 ft

n (Channel) = 0.035

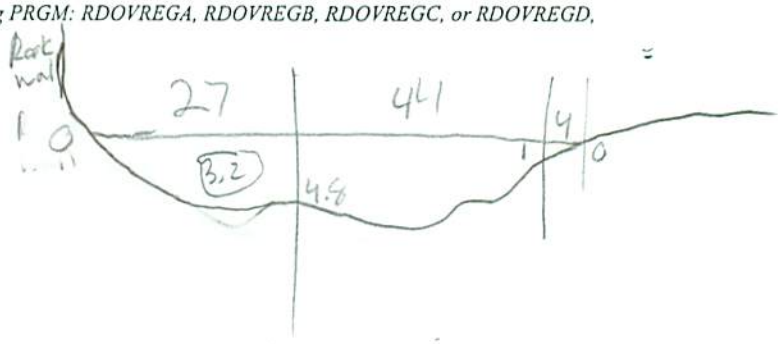
n (LOB) = 0.030

n (ROB) = 0.045

Pier Width = X ft

Pier Length = X ft

Piers for 500 yr = X ft



CONTRACTION SCOUR

PGRM: Contract

4.6 · 2/3 = 9.6

Width of main channel at approach section W_1 = 44 ft

Width of left overbank flow at approach, W_{lob} = 27 ft Average left overbank flow depth, y_{lob} = 3.2 ft

Width of right overbank flow at approach, W_{rob} = 4 ft Average right overbank flow depth, y_{rob} = 0.5 ft

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

x = 1.45 From Figure 9 W_2 (effective) = 43.6 ft y_{cs} = 1.9 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 = _____ 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

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 3.2 ft right abutment, y_{aRT} = 0.5 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} = 11.9 and ψ_{RT} = 2.3

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 21.6 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 4.2 ft

43° 53' 35.652"
103° 26' 8.7"

103.43575
43.89407

old hill city rd

Route Old Hill City Rd Stream Battle CK MRM _____ Date 9/27/12 Initials DgT

Bridge Structure No. 5231243 Location 0.6 mi W of Keystone on Old Hill City Rd

GPS coordinates: N 43° 53' 38.41" taken from: USL abutment X centerline of ⇑ MRM end _____

W 103° 26' 8.51" Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 13.43 sq. mi.

The average bottom of the main channel was 9.9 ft below top of guardrail at a point 121 ft from left abutment.

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

7/3

2	41.4
5	82
10	253
25	506
50	823
100	1250
500	2900

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 1250			Q_{500} = 2900		
Estimated flow passing through bridge		1250			1796	
Estimated road overflow & overtopping		0			1104	
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? X Yes ____No ____Don't know Some left abutment

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 X	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

1). left OB
2). main channel
3). right OB
4-5). right abutment
6-7). left abutment
8). bed materia
9). main channel

Summary of Results

	Q100	Q500
Bridge flow evaluated	1250	1796
Flow depth at left abutment (yaLT), in feet	2.3	3.2
Flow depth at right abutment (yaRT), in feet	0	0.5
Contraction scour depth (ycs), in feet	1.4	1.9
Pier scour depth (yps), in feet	X	X
Left abutment scour depth (yas), in feet	17.1	21.6
Right abutment scour depth (yas), in feet	0	4.2
1Flow angle of attack	5	5

See Comments/Diagram for justification where required