OK RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 05187100 Date 6/10/12 Initials RGT Region (A B [✓ C] D)

Site ______ Location 301 St, ~2mi N, 2.7mi E Tyndall - Bon Homme Co

Q_{100} = 1740 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 1740 (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 = 49 ft. Flow angle at bridge = 5 ° Abut. Skew = 0 ° 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 = 48.81 ft* $q_2 = Q_2/W_2$ = 35.6 ft²/s

Bridge Vel, V_2 = 4.2 ft/s Final $y_2 = q_2/V_2$ = 8.4 ft Δh = 0.4 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 8.8 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. = 6 ft

Low Steel Elev. = 8.55 ft

n (Channel) = 0.040

n (LOB) = ~~0.035~~ 0.030

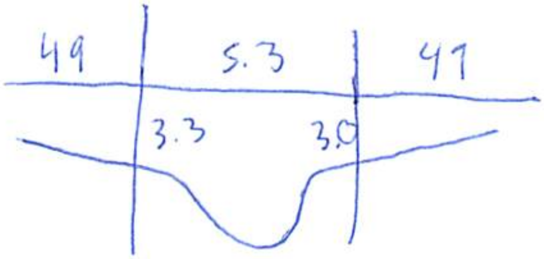
n (ROB) = 0.030

Pier Width = 1.11 ft

Pier Length = 1.11 ft

Piers for 100 yr = 1 ft

3.5/π



1,3.⅔ 2.6

3.7·2.4 0.9

CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = ~~49~~ 53 ft

Width of left overbank flow at approach, W_{lob} = 49 ft Average left overbank flow depth, y_{lob} = 3.3 ft

Width of right overbank flow at approach, W_{rob} = 49 ft Average right overbank flow depth, y_{rob} = 3.0 ft

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

x = 5.33 From Figure 9 W_2 (effective) = 47.7 ft y_{cs} = 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, $V_1 = Q_{100}/(y_1W_1)$ = ____ 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

PIER SCOUR CALCULATIONS

PGRM: Pier

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

Froude # at bridge = 0.26 Using pier width a on Figure 11, ξ = 5.2 Pier scour y_{ps} = 4.2 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 3.3 ft right abutment, y_{aRT} = 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} = 12 and ψ_{RT} = 11.5

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 18 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 17.2 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 05187100 Date 6/10/12 Initials RAS Region (A B [✓ C] D)

Site ________ Location 301 st, ~2 mi N, 2.7 mi E Tyndall - Bon Homme

Q_{500} = 3380 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = ~~1240~~ 1792 (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 = 49 ft. Flow angle at bridge = 5 ° Abut. Skew = 0 ° 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 = 48.81 ft* $q_2 = Q_2/W_2$ = 36.7 ft²/s

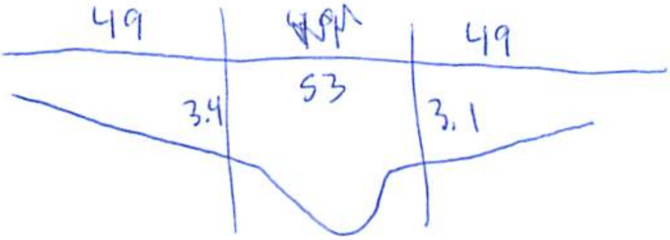
Bridge Vel, V_2 = 4.3 ft/s Final $y_2 = q_2/V_2$ = 8.6 ft Δh = 0.4 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 8.9 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. = 0 ft
Low Steel Elev. = 8.55 ft
n (Channel) = 0.040
n (LOB) = 0.030
n (ROB) = 0.030
Pier Width = 1.11 ft
Pier Length = 1.11 ft
Piers for 500 yr = 1 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 53 ft

Width of left overbank flow at approach, W_{lob} = 49 ft Average left overbank flow depth, y_{lob} = 3.4 ft

Width of right overbank flow at approach, W_{rob} = 49 ft Average right overbank flow depth, y_{rob} = 3.1 ft

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

x = 5.54 From Figure 9 W_2 (effective) = 47.7 ft y_{cs} = 6.3 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, $V_1 = Q_{500}/(y_1 W_1)$ = ____ ft/s

Critical approach velocity, $V_c = 11.17 y_1^{1/6} D_{50}^{1/3}$ = ____ 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: Pie

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

Froude # at bridge = 0.26 Using pier width a on Figure 11, ξ = 5.2 Pier scour y_{ps} = 4.3 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 3.4 ft right abutment, y_{aRT} = 3.1 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} = ~~3.4~~ 12.2 and ψ_{RT} = 11.7

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 18.2 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 17.4 ft

97.79847
43.0251

Route 301 St Stream Snatch Ck MRM ____ Date 6/10/12 Initials Rat

Bridge Structure No. 05187100 Location 2 mi N, 2.7 mi E of Tyndall

GPS coordinates: N 43° 1' 30.6" taken from: USL abutment X centerline of ⇑ MRM end ____

W 97° 47' 54.4" Datum of coordinates: WGS84 X NAD27 ____

Drainage area = 17.85 sq. mi.

The average bottom of the main channel was 12.4 ft below top of guardrail at a point 36 ft from left abutment.

Method used to determine flood flows: ____ Freq. Anal. ____ drainage area ratio X regional regression equations.

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 1740			Q_{500} = 3380		
Estimated flow passing through bridge	1740			1792		
Estimated road overflow & overtopping	0			1588		
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	

8/22

2	67.4
5	234
10	~~437~~ 438
25	~~830~~ 831
50	1230
100	1740
500	3380

6/4

2	67.5
5	234
10	438
25	831
50	1230
100	1740
500	3380

Riprap at abutments? X Yes ____ No ____ Marginal

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?

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). left OB
2). main channel
3). right OB
4). piers
5-6). left abutment
7-9). right abutment (damaged)

Note: channel is dry

10). main channel

Summary of Results

	Q100	Q500
Bridge flow evaluated	1740	1792
Flow depth at left abutment (yaLT), in feet	3.3	3.4
Flow depth at right abutment (yaRT), in feet	3	3.1
Contraction scour depth (ycs), in feet	6	6.3
Pier scour depth (yps), in feet	4.2	4.3
Left abutment scour depth (yas), in feet	18	18.2
Right abutment scour depth (yas), in feet	17.2	17.4
1Flow angle of attack	5	5

See Comments/Diagram for justification where required