OK RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 64058050 Date 5/26/12 Initials RaT Region (A B (C) D)

Site ____________ Location 5.1 mi E of Exit 42 on 302 St

Q_{100} = 3350 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 3350 (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 = 143 ft. Flow angle at bridge = 30 ° Abut. Skew = 0 ° Effective Skew = 30 °

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 = 123.8 ft* $q_2 = Q_2/W_2$ = 27.1 ft²/s

Bridge Vel, V_2 = 3.7 ft/s Final $y_2 = q_2/V_2$ = 7.3 ft Δh = 0.3 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 7.6 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. = 0-1.5 ft 12.8

Low Steel Elev. = 9.0 ft 3.8

n (Channel) = ~~0.04~~ 0.035 9.0

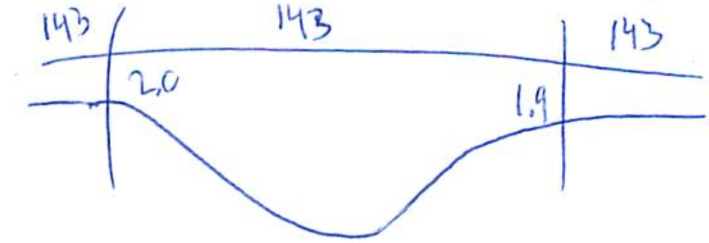
n (LOB) = 0.035

n (ROB) = 0.035

Pier Width = 1.85 ft

Pier Length = 1.85 ft

Piers for 100 yr = 4 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 143 ft

Width of left overbank flow at approach, W_{lob} = 143 ft Average left overbank flow depth, y_{lob} = 2.0 ft

Width of right overbank flow at approach, W_{rob} = 143 ft Average right overbank flow depth, y_{rob} = 1.9 ft

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

x = 3.82 From Figure 9 W_2 (effective) = 116.4 ft y_{cs} = 4.4 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 = 0.24 Using pier width a on Figure 11, ξ = 7.5 Pier scour y_{ps} = 6.1 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 2.0 ft right abutment, y_{aRT} = 1.9 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} = 8.2 and ψ_{RT} = 7.9

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 8.2 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 7.9 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 64058050 Date 5/26/12 Initials RaL Region (A B (C) D)

Site ______ Location 5.1 mi E of Exit 42 on 302 St

Q_{500} = ~~Q_{500}~~ Q25 5050 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 5037 (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 = 143 ft. Flow angle at bridge = 30 ° Abut. Skew = 0 ° Effective Skew = 30 °

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 = 123.84 ft* $q_2 = Q_2/W_2$ = 40.7 ft^2/s

Bridge Vel, V_2 = 4.5 ft/s Final $y_2 = q_2/V_2$ = 9 ft Δh = 0.4 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 9.4 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. = 5-1.5 ft

Low Steel Elev. = 9.0 ft

n (Channel) = 0.035

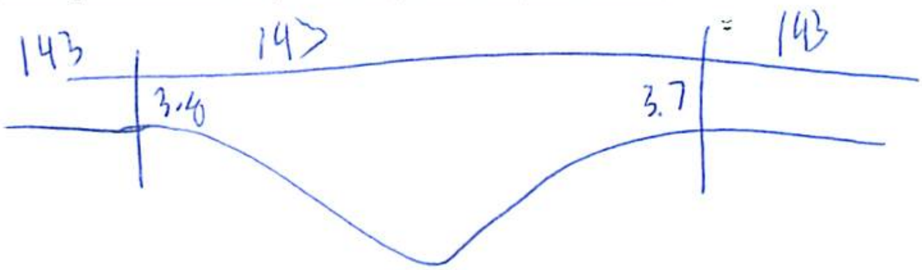
n (LOB) = 0.035

n (ROB) = 0.030

Pier Width = 1.83 ft

Pier Length = 1.85 ft

Piers for 500 yr = 4 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 143 ft

Width of left overbank flow at approach, W_{lob} = 143 ft Average left overbank flow depth, y_{lob} = 3.8 ft

Width of right overbank flow at approach, W_{rob} = 143 ft Average right overbank flow depth, y_{rob} = 3.7 ft

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

x = 7.54 From Figure 9 W_2 (effective) = 116.4 ft y_{cs} = 8.4 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 = 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 = 7.5 Pier scour y_{ps} = 6.2 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 3.8 ft right abutment, y_{aRT} = 3.7 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} = 12.9 and ψ_{RT} = 12.7

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 12.9 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 12.7 ft

Route 302 St Stream East Brule Ck MRM ______ Date 5/26/12 Initials RAT
Bridge Structure No. 64058050 Location 5.1 mi E of Exit 42 on 302 St
GPS coordinates: N 43° 00' [illegible]" W 96° 41' 38.9" taken from: USL abutment X centerline of ⇑ MRM end ______
Datum of coordinates: WGS84 ______ NAD27 X

Drainage area = 65.98 sq. mi.
The average bottom of the main channel was 12.8 ft below top of guardrail at a point 67 ft from left abutment.
Method used to determine flood flows: ____Freq. Anal. ____drainage area ratio X regional regression equations.

MISCELLANEOUS CONSIDERATIONS

Flows	~~Q100~~ Q10 = 3350			~~Q500~~ Q25 = 5050		
Estimated flow passing through bridge	0			5037		
Estimated road overflow & overtopping	0			13		
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	

8/26	
2	945
5	2230
10	3350
25	5050
50	6510
100	8100
500	12300

5/21	
2	945
5	2230
10	3350
25	5050
50	6510
100	8100
500	12300

Riprap at abutments? ____Yes X No ____Marginal
Evidence of past Scour? X Yes ____No ____Don't know 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). main channel
2). pier scour
3). piers
4). left ab
5). left ab
6). right ab
7). right ab
8). right OB
9). main channel
10. left OB

Summary of Results

	~~Q100~~ 10	~~Q500~~ 25
Bridge flow evaluated	3350	5037
Flow depth at left abutment (yaLT), in feet	2.0	3.8
Flow depth at right abutment (yaRT), in feet	1.9	3.7
Contraction scour depth (ycs), in feet	4.4	8.4
Pier scour depth (yps), in feet	6.1	6.2
Left abutment scour depth (yas), in feet	8.2	12.9
Right abutment scour depth (yas), in feet	7.8	12.7
Flow angle of attack	30	30

See Comments/Diagram for justification where required