OK RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 40210072 Date 7/25/12 Initials RAJ Region (A B C D)

Site _____ Location 1 mi E of Rutland on 463 Ave

Q_{100} = 5260 by: drainage area ratio____ flood freq. anal. _____ regional regression eq. X

Bridge discharge (Q_2) = ~~5260~~ 5260 (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 = 105 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 = 103.4 ft* $q_2 = Q_2/W_2$ = 50.9 ft^2/s

Bridge Vel, V_2 = 5.1 ft/s Final $y_2 = q_2/V_2$ = 10.1 ft Δh = 0.5 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 10.6 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. = 07.5 ft

Low Steel Elev. = 10.3 ft

n (Channel) = 0.045

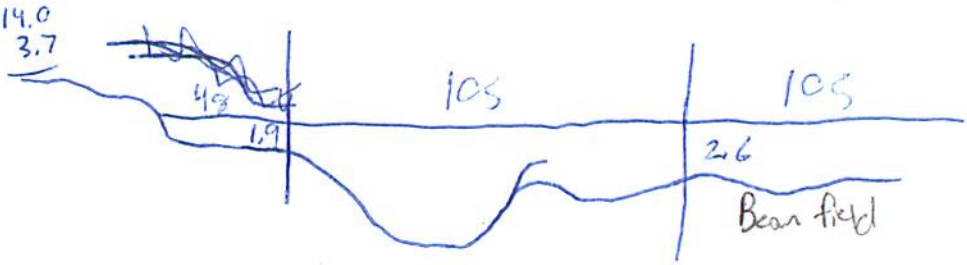
n (LOB) = ~~0.035~~ 0.035

n (ROB) = 0.040

Pier Width = 1.65 ft

Pier Length = 1.65 ft

Piers for 100 yr = 4 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 105 ft

Width of left overbank flow at approach, W_{lob} = 48 ft Average left overbank flow depth, y_{lob} = 1.9 ft

Width of right overbank flow at approach, W_{rob} = ~~NP~~ 105 ft Average right overbank flow depth, y_{rob} = 2.6 ft

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

x = ~~2.1~~ 2.53 From Figure 9 W_2 (effective) = 96.8 ft y_{cs} = ~~3.3~~ 3.1 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 = 0.28 Using pier width a on Figure 11, ξ = 6.9 Pier scour y_{ps} = 5.7 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 1.9 ft right abutment, y_{aRT} = 2.6 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} = 7.8 and ψ_{RT} = 10.6

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 7.8 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 10.6 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 40210072 Date 7/25/12 Initials LaT Region (A B C D)

Site _____ Location 1 mi E of Rutland on 463 Ave

Q_{500} = 5280 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = 5511 (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 = 105 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 = 103.4 ft* $q_2 = Q_2/W_2$ = 53.3 ft^2/s

Bridge Vel, V_2 = 5.2 ft/s Final $y_2 = q_2/V_2$ = 10.3 ft Δh = 0.5 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 10.8 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. = 01.5 ft

Low Steel Elev. = 10.3 ft

n (Channel) = 0.045

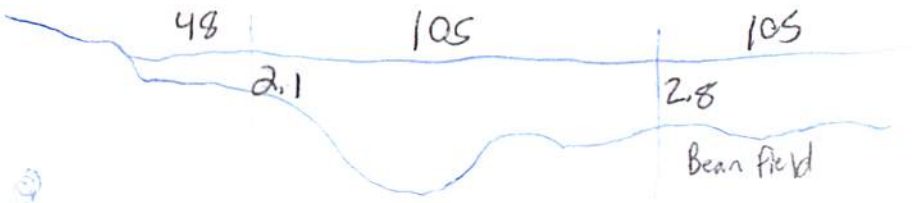
n (LOB) = 0.055

n (ROB) = 0.040

Pier Width = 1.65 ft

Pier Length = 1.65 ft

Piers for 500 yr = 4 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 105 ft

Width of left overbank flow at approach, W_{lob} = 49 ft Average left overbank flow depth, y_{lob} = 2.1 ft

Width of right overbank flow at approach, W_{rob} = 105 ft Average right overbank flow depth, y_{rob} = 2.5 ft

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

x = 2.75 From Figure 9 W_2 (effective) = 96.8 ft y_{cs} = 3.3 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, $V_1 = Q_{500}/(y_1W_1)$ = _____ 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 = 1 Correction factor for flow angle of attack (from Table 1), K2 = 1

Froude # at bridge = 0.29 Using pier width a on Figure 11, ξ = 6.9 Pier scour y_{ps} = 5.7 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 2.1 ft right abutment, y_{aRT} = 2.8 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} = 8.6 and ψ_{RT} = 11.2

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 8.6 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 11.2 ft

44° 5' 33.612"
96° 56' 57.264"

96.99926
44.09267

Route 463 Ave Stream Battle Clk MRM _____ Date ~~7/25/12~~ 8/24/12 Initials RJ

Bridge Structure No. 40210072 Location 1 mi E of Rutland on 463 Ave

GPS coordinates: N 44° 5' 33.6" W 96° 56' 57.5" taken from: USL abutment X centerline of ⇑ MRM end _____

Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 95.4 sq. mi.

The average bottom of the main channel was 14.0 ft below top of guardrail at a point 63 ft from left abutment.

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

6/20
~~8/24~~

2	485
5	1260
10	1980
25	3130
50	4140
100	5260
500	8280

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 5260			Q_{500} = 8250		
Estimated flow passing through bridge	5260			5511		
Estimated road overflow & overtopping	0			769		
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 minor pier/contraction & heavy abutment, esp. right abut.

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). pier
5). right abutment
6) left abutment
7). left abutment
8), pier scour
9-10). right abutment
11), main channel

Note: had to estimate right OB as I did not want to destroy farmer's crop.

Summary of Results

	Q100	Q500
Bridge flow evaluated	5260	5511
Flow depth at left abutment (yaLT), in feet	1.9	2.1
Flow depth at right abutment (yaRT), in feet	2.6	2.8
Contraction scour depth (ycs), in feet	~~3.3~~ 3.1	3.3
Pier scour depth (yps), in feet	5.7	5.7
Left abutment scour depth (yas), in feet	7.8	8.6
Right abutment scour depth (yas), in feet	10.6	11.2
1Flow angle of attack	10	10

See Comments/Diagram for justification where required