OK RJ

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 42020144 Date 5/25/12 Initials RaJ Region (A B (C) D)

Site ______ Location 3.4 mi S of Lennox on 466 Ave

Q_{100} = Q_{25} = 2760 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 2760 (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 = 74 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 = 64.08 ft* $q_2 = Q_2/W_2$ = 43.1 ft^2/s

Bridge Vel, V_2 = 4.7 ft/s Final $y_2 = q_2/V_2$ = 9.3 ft Δh = 0.4 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 9.7 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. = 10.5 ft

n (Channel) = 0.050

n (LOB) = 0.030

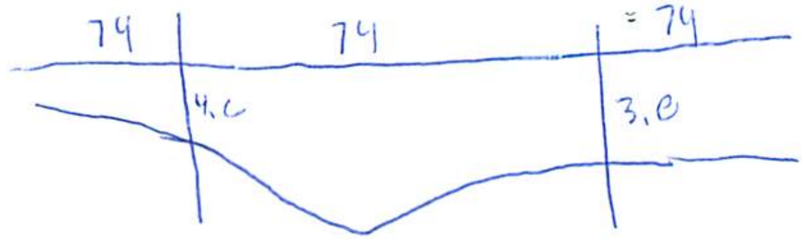
n (ROB) = 0.030

Pier Width = 1.7 ft

Pier Length = 1.7 ft

\# Piers for 100 yr = 4 ft

3
14.4
-3.9
10.5



CONTRACTION SCOUR

PGRM: Contract

5.3 = 3.9 + 1.3/3
-1.4 = 9.6

Width of main channel at approach section W_1 = 74 ft

Width of left overbank flow at approach, W_{lob} = 74 ft Average left overbank flow depth, y_{lob} = 4.6 ft

Width of right overbank flow at approach, W_{rob} = 74 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 = 8.22 From Figure 9 W_2 (effective) = 57.3 ft y_{cs} = 9.1 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, $V_c = 11.17y_1^{1/6}D_{50}^{1/3}$ = ____ 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 = 0.27 Using pier width a on Figure 11, ξ = 7 Pier scour y_{ps} = 5.8 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 4.6 ft right abutment, y_{aRT} = 3.0 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} = 14.5 and ψ_{RT} = 11.5

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 14.3 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 11.5 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 42020144 Date 5/25/12 Initials RAL Region (A B (C) D)

Site ______ Location 3.4 mi S of Lennox on 466 Ave

Q_{500} = Q_{50} 3770 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 3549 (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 = 74 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 = 64.08 ft* $q_2 = Q_2/W_2$ = 55.1 ft^2/s

Bridge Vel, V_2 = 5.3 ft/s Final $y_2 = q_2/V_2$ = 10.5 ft Δh = 0.6 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 11.1 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. = 10.5 ft

n (Channel) = 0.030

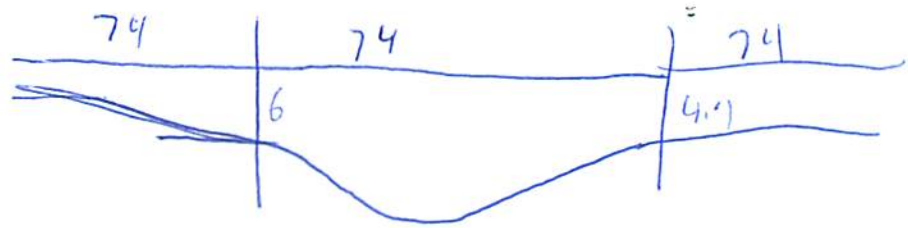
n (LOB) = 0.030

n (ROB) = 0.030

Pier Width = 1.7 ft

Pier Length = 1.7 ft

\# Piers for 500 yr = 4 ft



CONTRACTION SCOUR

PGRM: Contract

1 · 2/3 = 0.7

5.3

Width of main channel at approach section W_1 = 74 ft

Width of left overbank flow at approach, W_{lob} = 74 ft Average left overbank flow depth, y_{lob} = 6 ft

Width of right overbank flow at approach, W_{rob} = 74 ft Average right overbank flow depth, y_{rob} = 4.4 ft

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

x = 11.45 From Figure 9 W_2 (effective) = 57.3 ft y_{cs} = 12.5 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: Pier

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 = 7 Pier scour y_{ps} = 5.4 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 6 ft right abutment, y_{aRT} = 4.4 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} = 16.8 and ψ_{RT} = 14

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 16.8 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 14 ft

Route 466 Ave Stream Long Ck MRM ______ Date 5/25/12 Initials RAL

Bridge Structure No. 42020144 Location 3.4 mi S of Lennox on 466 Ave

GPS coordinates: N 43° 17' 46" W 96° 53' 9.54 taken from: USL abutment X centerline of ⇑ MRM end ______

Datum of coordinates: WGS84 X NAD27 ______

Drainage area = 53.55 sq. mi.

The average bottom of the main channel was 14.4 ft below top of guardrail at a point 35 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	Q~~100~~25=	2760		Q~~500~~50=	3770	
Estimated flow passing through bridge		2760			3549	
Estimated road overflow & overtopping		0			221	
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	

8/24

2	779
5	2050
10	3300
25	5430
50	7420
100	9780
500	16800

5/22

2	403
5	1050
10	1690
25	2760
50	3770
100	4950
500	8460

Riprap at abutments? X Yes ____No ____Marginal

Evidence of past Scour? X Yes ____No ____Don't know piers/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 X	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). piers
3. debris
4). pier scour
5). Lab
6. Rab
7). R. ob
8). main channel
9). LOB

Summary of Results

	Q~~100~~ 25	Q~~500~~ 50
Bridge flow evaluated	2760	3549
Flow depth at left abutment (yaLT), in feet	4.6	~~4.6~~ 6
Flow depth at right abutment (yaRT), in feet	3.0	~~3.0~~ 4.4
Contraction scour depth (ycs), in feet	9.1	12.5
Pier scour depth (yps), in feet	5.8	5.8
Left abutment scour depth (yas), in feet	14.3	16.5
Right abutment scour depth (yas), in feet	11.5	14
1Flow angle of attack	30	30

See Comments/Diagram for justification where required