OK RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 33410024 Date 7/10/12 Initials RJ Region (A B C D)

Site ~~33410024~~ Location 1 mi S of Harrold on 321 Ave

~~Q_{100}~~ = ~~350~~ 2860 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 2860 (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 = 62 ft. Flow angle at bridge = 20 ° Abut. Skew = 0 ° Effective Skew = 20 °

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 = 58.26 ft* $q_2 = Q_2/W_2$ = 49.1 ft^2/s

Bridge Vel, V_2 = 5 ft/s Final $y_2 = q_2/V_2$ = 9.9 ft Δh = 0.5 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 10.4 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. = 0 ft

Low Steel Elev. = 10.7 ft

n (Channel) = 0.045

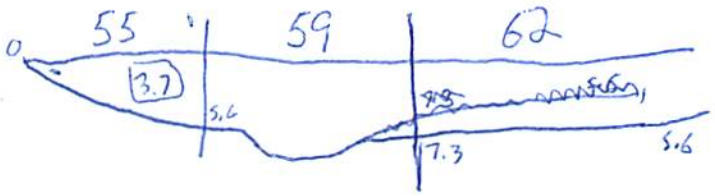
n (LOB) = 0.0.35

n (ROB) = 0.035

Pier Width = 2.3 ft

Pier Length = 1 ft

Piers for 100 yr = 1 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = ~~55~~ 59 ft 5.6 7.3 14.2 3.7

Width of left overbank flow at approach, W_{lob} = 55 ft Average left overbank flow depth, y_{lob} = 3.7 ft

Width of right overbank flow at approach, W_{rob} = ~~55~~ 62 ft Average right overbank flow depth, y_{rob} = ~~8.5~~ 6.2 ft 7.3 ~5.6

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

x = 9.17 From Figure 9 W_2 (effective) = 56 ft y_{cs} = 10.1 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 = ~~E~~0.434

Froude # at bridge = 0.25

Correction factor for flow angle of attack (from Table 1), K2 = 1

Using pier width a on Figure 11, ξ = ~~4.9~~ 8.9 Pier scour y_{ps} = ~~4~~ 7.4 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 3.7 ft right abutment, y_{aRT} = 6.2 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} = 12.7 and ψ_{RT} = 17.2

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 19 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 25.6 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 33410024 Date 7/10/12 Initials RaT Region (A B C D)

Site _____ Location 1 mi S of Harrold on 321 Ave

Q_{500} = Q100 4160 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 3045 (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 = 62 ft. Flow angle at bridge = 20 ° Abut. Skew = 0 ° Effective Skew = 20 °

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 = 58.26 ft* $q_2 = Q_2/W_2$ = 52.3 ft^2/s

Bridge Vel, V_2 = 5.1 ft/s Final $y_2 = q_2/V_2$ = 10.2 ft Δh = 0.5 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 10.7 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. = 0 ft

Low Steel Elev. = 10.2 ft

n (Channel) = 0.045

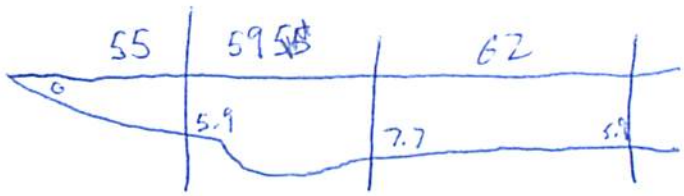
n (LOB) = 0.035

n (ROB) = 0.035

Pier Width = 2.3 ft

Pier Length = 1 ft

Piers for 500 yr = 4 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 59 ft

Width of left overbank flow at approach, W_{lob} = 55 ft Average left overbank flow depth, y_{lob} = 3.9 ft

Width of right overbank flow at approach, W_{rob} = 62 ft Average right overbank flow depth, y_{rob} = 6.5 ft

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

x = 9.74 From Figure 9 W_2 (effective) = 56 ft y_{cs} = 10.7 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

PIER SCOUR CALCULATIONS

PGRM: Pier

L/a ratio = 0.434 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 = 8.9 Pier scour y_{ps} = 7.4 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 3.9 ft right abutment, y_{aRT} = 6.5 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} = 13.1 and ψ_{RT} = 17.7

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 19.5 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 26.4 ft

99.74473

44.50962

99° 44' 41.0748"

44° 30' 25.0632"

Route 321 Ave Stream South Medicine Ck MRM _____ Date 7/10/18 Initials RJ

Bridge Structure No. 33410024 Location 1 mi S of Harrold on 321 Ave

GPS coordinates: N 44° 30' 24.71" W 99° 44' 40.91" taken from: USL abutment X centerline of ⇑ MRM end _____

Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 105.53 sq. mi. 14.7

The average bottom of the main channel was ~~13.4~~ ft below top of guardrail at a point ~~38~~ 30 ft from left abutment.

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

7/2
~~8/24~~

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = ~~Q100~~ Q50 2860			Q_{500} = ~~Q500~~ Q100 4160		
Estimated flow passing through bridge	2860			3045		
Estimated road overflow & overtopping	0			1115		
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	

2	101
5	441
10	903
25	1850
50	2860
100	4160
500	8430

Riprap at abutments? ____Yes __X__No ____Marginal

Evidence of past Scour? __X__Yes ____No ____Don't know some 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). left OB
2). main channel
3). right OB
4). pier
5-6). left abutment
7-8). right abutment

TL main channel

~~Notes~~

Summary of Results

	~~Q100~~ Q50	~~Q500~~ Q100
Bridge flow evaluated	2860	3045
Flow depth at left abutment (yaLT), in feet	3.7	3.9
Flow depth at right abutment (yaRT), in feet	6.2	6.5
Contraction scour depth (ycs), in feet	10.1	10.7
Pier scour depth (yps), in feet	~~4~~ 7.4	2.4
Left abutment scour depth (yas), in feet	19	19.5
Right abutment scour depth (yas), in feet	25.6	26.4
1Flow angle of attack	20	20

See Comments/Diagram for justification where required