OK RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 51050041 Date 7/25/12 Initials RLT Region (A B C D)

Site _____ Location 1.5mi W + 1.1mi S from Exit 21 on 471 Ave

Q_{100} = Gs 404 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 404 (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 = 37 ft. Flow angle at bridge = 25 ° Abut. Skew = 0 ° Effective Skew = 25 °

Width (W_2) iteration = _____ _____ _____ _____

Avg. flow depth at bridge, y_2 iteration = _____ _____ _____ 33.53

Corrected channel width at bridge Section = W_2 times cos of flow angle = 36.44 ft* $q_2 = Q_2/W_2$ = 11 ft^2/s (12)

Bridge Vel, V_2 = 2.4 (2.5) ft/s Final $y_2 = q_2/V_2$ = 4.9 ft Δh = 0.1 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = ~~4.5~~ 5.0 ft

right 4.9 3.1 left 5.0

* 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. = dry ft

Low Steel Elev. = 5.0 ft

n (Channel) = 0.045

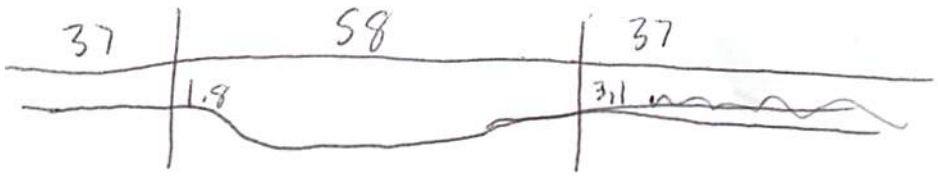
n (LOB) = 0.035

n (ROB) = 0.035

Pier Width = 1.35 ft

Pier Length = 6.65 ft

Piers for 100 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 58 ft

Width of left overbank flow at approach, W_{lob} = 37 ft Average left overbank flow depth, y_{lob} = 3.1 ft

Width of right overbank flow at approach, W_{rob} = 37 ft Average right overbank flow depth, y_{rob} = 1.8 ft

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

x = 9.62 From Figure 9 W_2 (effective) = 30.8 ft y_{cs} = 10.6 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, $V_1 = Q_{100}/(y_1 W_1)$ = _____ 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

PGRM: Pier

PIER SCOUR CALCULATIONS

L/a ratio = 5

Correction factor for flow angle of attack (from Table 1), K2 = 2.2

Froude # at bridge = ~~0.250~~ 0.20

Using pier width a on Figure 11, ξ = ~~5~~ 6 Pier scour y_{ps} = ~~10.5~~ ~~9.5~~ ft 10.3

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 3.1 ft right abutment, y_{aRT} = 1.8 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} = 11.7 and ψ_{RT} = 7.4

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 21.3 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = ~~13.5~~ ~~13.5~~ ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 51050041 Date 7/25/17 Initials LaT Region (A B C D)

Site _____ Location 1.5 W & 1.1 S from Exit 121 on 471 Ave

Q_{500} = Q10 630 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = ~~457~~ 430 (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

Bridge Width = 37 ft. Flow angle at bridge = 25 ° Abut. Skew = 0 ° Effective Skew = 25 °

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 = 33.53 ft* $q_2 = Q_2/W_2$ = ~~17.6~~ 12.5 ft^2/s

Bridge Vel, V_2 = 2.5 ft/s Final $y_2 = q_2/V_2$ = 5 ft Δh = 0.1 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 5.1 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,

PGRM: "RegionA", "RegionB", "RegionC", or "RegionD"

Water Surface Elev. = 601 ft

Low Steel Elev. = 5.0 ft

n (Channel) = 0.048

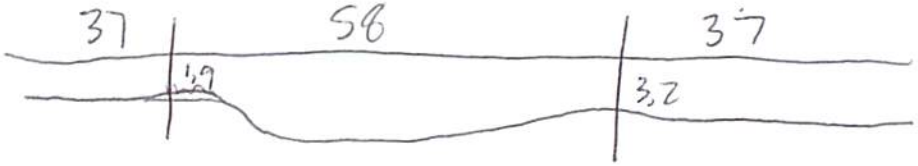
n (LOB) = 0.035

n (ROB) = 0.035

Pier Width = 1.35 ft

Pier Length = ~~8.65~~ ft

Piers for 500 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 58 ft

Width of left overbank flow at approach, W_{lob} = 37 ft Average left overbank flow depth, y_{lob} = 3.2 ft

Width of right overbank flow at approach, W_{rob} = 37 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 = ~~0.59~~ 9.97 From Figure 9 W_2 (effective) = ~~33.3~~ 30.8 ft y_{cs} = ~~9.9~~ 10.9 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

PGRM: Pier

PIER SCOUR CALCULATIONS

L/a ratio = 5 Correction factor for flow angle of attack (from Table 1), K2 = 2.2

Froude # at bridge = 0.2 Using pier width a on Figure 11, ξ = 6 Pier scour y_{ps} = 10.3 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 3.2 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} = 11.9 and ψ_{RT} = 7.8

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 21.6 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 14.2 ft

44° 8' 12.588"
96° 47' 9.768"

96.78683
44.13683

Route 471 Alt Stream _____ MRM _____ Date 7/23/12 Initials RaT

Bridge Structure No. 5105004 Location 1.5 W & 1.5 S of Exit 121 on 471 Alt

GPS coordinates: N 46° 08' 12.41" W 96° 47' 20.21" taken from: USL abutment X centerline of ⇑ MRM end _____

Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 8.38 sq. mi.

The average bottom of the main channel was 9.4 ft below top of guardrail at a point 23 ft from left abutment.

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

6/20
8/25

2	156
5	404
10	630
25	981
50	1280
100	1610
500	2460

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = Qs 404			Q_{500} = Q10 630		
Estimated flow passing through bridge	404			~~420~~		
Estimated road overflow & overtopping	0			~~216~~		
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? ____Yes X No ____Don't know

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). right abutment
7-8). left abutment
9-10). main channel

Summary of Results

	~~Q100~~ Qs	~~Q500~~ Q10
Bridge flow evaluated	404	630
Flow depth at left abutment (yaLT), in feet	3.1	3.2
Flow depth at right abutment (yaRT), in feet	1.8	1.9
Contraction scour depth (ycs), in feet	10.6	10.9
Pier scour depth (yps), in feet	10.3	10.3
Left abutment scour depth (yas), in feet	~~21.3~~	21.6
Right abutment scour depth (yas), in feet	13.5	14.2
1Flow angle of attack	25	25

See Comments/Diagram for justification where required