OK RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 64010112 Date 5/27/17 Initials cat Region (A B C D)

Site _____ Location 0.3mi E & 2.1 mi S of Ex. 38 on 471 Ave 308 st 309 st

Q_{100} = 12400 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = 12400 (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 = 123 ft. Flow angle at bridge = 15 ° Abut. Skew = 20 ° Effective Skew = 35 °

Width (W_2) iteration = _____ _____ _____ _____

Avg. flow depth at bridge, y_2 iteration = _____ _____ _____ 122.53

Corrected channel width at bridge Section = W_2 times cos of flow angle = 118.81 ft* $q_2 = Q_2/W_2$ = 101.2 ft²/s

Bridge Vel, V_2 = 7.1 ft/s Final $y_2 = q_2/V_2$ = 14.2 ft Δh = 1.0 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 15.2 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

Low Steel Elev. = 14.7 ft

n (Channel) = 0.050

n (LOB) = 0.035

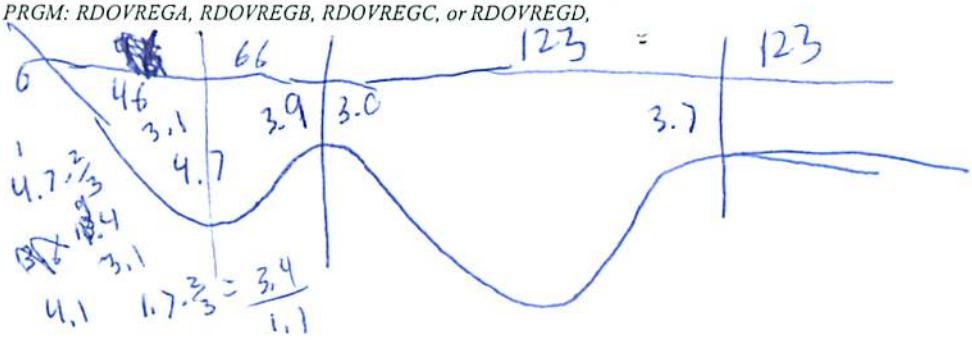
n (ROB) = 0.030

Pier Width = 2.65 ft

Pier Length = 2.65 ft

Piers for 100 yr = 2 ft

19
20.65
-5.95
14.70



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 123 ft 66+46

Width of left overbank flow at approach, W_{lob} = 112 ft Average left overbank flow depth, y_{lob} = 3.5 ft

Width of right overbank flow at approach, W_{rob} = 123 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 = 5.07 From Figure 9 W_2 (effective) = 117.2 ft y_{cs} = 5.8 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

PGRM: Pier

PIER SCOUR CALCULATIONS

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

Froude # at bridge = 0.33 Using pier width a on Figure 11, ξ = 9.9 Pier scour y_{ps} = 8.4 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 3.5 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} = 12.4 and ψ_{RT} = 12.7

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 12.4 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 12.7 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 64010112 Date 5/27/12 Initials 5/27/12 Region (A B C D)

Site _____ Location 0.3 mi E & 2.1 mi S of Exit 38 on 471 Ave

Q_{500} = 19900 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = ~~17918~~ 13314 (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 = 123 ft. Flow angle at bridge = 15 ° Abut. Skew = 20 ° Effective Skew = 85 °

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 = ~~122.53~~ 120.57 ft* $q_2 = Q_2/W_2$ = 108.7 ft^2/s

Bridge Vel, V_2 = 7.41 ft/s Final $y_2 = q_2/V_2$ = 14.7 ft Δh = 1.11 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 15.8 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. = 0-1.6 ft

Low Steel Elev. = 14.7 ft

n (Channel) = 0.050

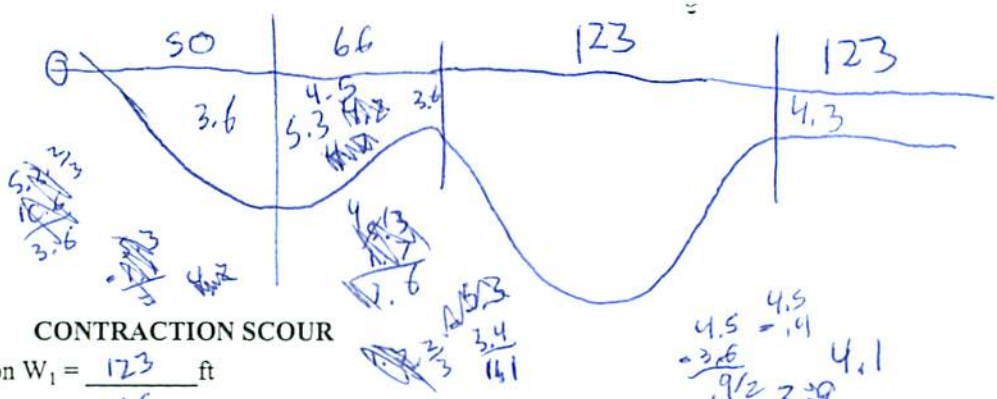
n (LOB) = 0.035

n (ROB) = 0.030

Pier Width = 2.66 ft

Pier Length = 2.65 ft

Piers for 500 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 123 ft

Width of left overbank flow at approach, W_{lob} = 116 ft Average left overbank flow depth, y_{lob} = _____ ft

Width of right overbank flow at approach, W_{rob} = 123 ft Average right overbank flow depth, y_{rob} = ~~3.77~~ 4.3 ft

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

x = 6.29 From Figure 9 W_2 (effective) = 117.2 ft y_{cs} = 7.1 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, $V_1 = Q_{500}/(y_1W_1)$ = _____ 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 = 0.34 Using pier width a on Figure 11, ξ = 9.9 Pier scour y_{ps} = 8.4 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 4.1 ft right abutment, y_{aRT} = 4.3 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} = 13.4 and ψ_{RT} = 13.8

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 13.4 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 13.8 ft

Route 471 Ave Stream Brule Ck MRM _____ Date 5/27/12 Initials RaT

Bridge Structure No. 64016112 Location 0.3 mi E & 2.1 mi S of Exit 38 on 471 Ave

GPS coordinates: N 42° 55' 19.8" taken from: USL abutment X centerline of ⇑ MRM end _____

W 96° 47' 07.9" Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 149.13 sq. mi.

The average bottom of the main channel was 20.65 ft below top of guardrail at a point 37 ft from left abutment.

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

5/24
~~8/26~~

2	1440
5	3380
10	5080
25	7680
50	9930
100	12400
500	18900

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 12400			Q_{500} = 18900		
Estimated flow passing through bridge	~~12400~~			13314		
Estimated road overflow & overtopping	0			5586		
Consideration	Yes	No	Possibly	Yes	No	Possibly
Chance of overtopping		X		X		~~X~~
Chance of Pressure flow	X		~~X~~	X		
Armored appearance to channel		X			X	
Lateral instability of channel		X			X	

Riprap at abutments? ____Yes ____No X Marginal some on right ab one big chunk of the old bridge on the left ab.

Evidence of past Scour? X Yes ____No ____Don't know

Debris Potential? ____High ____Med X Low pier contraction

5/21

2	102
5	324
10	561
25	973
50	1360
100	1810
500	3080

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

19). right OB

1). main channel
2). damage
3). damage
4). damage
5). right ab.
6). piers
7). left ab
8). piers
9). right ab
10). debris
11). pier ~~extra~~ scour
12). left ab
13). left ab
14). left OB
15). right OB
16). main channel
17). left OB
18). main channel

Summary of Results

	Q100	Q500
Bridge flow evaluated	12400	13314
Flow depth at left abutment (yaLT), in feet	3.5	4.1
Flow depth at right abutment (yaRT), in feet	3.7	4.3
Contraction scour depth (ycs), in feet	5.8	7.1
Pier scour depth (yps), in feet	8.4	8.4
Left abutment scour depth (yas), in feet	~~8~~ 12.4	13.4
Right abutment scour depth (yas), in feet	12.7	13.8
1Flow angle of attack	5	5

See Comments/Diagram for justification where required