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SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 12510206 Date 6/11/12 Initials RaT Region (A B C D)

Site _____ Location 9.1 mi N of Wagner on 395 Ave

$Q_{\frac{50}{100}}$ = 6100 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. 1

Bridge discharge (Q_2) = 6100 (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 = 138 ft. Flow angle at bridge = ~~15~~ 20° Abut. Skew = 30° ° Effective Skew = ~~18~~ 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 = 135.9 ft* $q_2 = Q_2/W_2$ = 44.9 ft²/s

Bridge Vel, V_2 = 4.7 ft/s Final $y_2 = q_2/V_2$ = 9.5 ft Δh = ~~0~~ 0.5 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 9.9 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. = ~~12-3~~ 14.2 ft

Low Steel Elev. = 10.5 ft ~~-3.7~~

n (Channel) = ~~0.035~~ 0.040

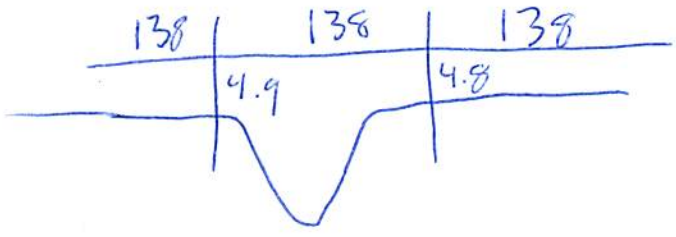
n (LOB) = 0.035

n (ROB) = 0.035

Pier Width = 1.8 ft

Pier Length = 1.8 ft

Piers for 100 yr = 4 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 138 ft

Width of left overbank flow at approach, W_{lob} = 134 ft Average left overbank flow depth, y_{lob} = 4.9 ft

Width of right overbank flow at approach, W_{rob} = 130 ft Average right overbank flow depth, y_{rob} = 4.8 ft

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

x = 8.1 From Figure 9 W_2 (effective) = 128.7 ft y_{cs} = 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, $V_1 = Q_{100}/(y_1 W_1)$ = _____ 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 $D_{50} >= D_{c50}$, χ = 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 = 0.7 Using pier width a on Figure 11, ξ = 7.4 Pier scour y_{ps} = 6 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 4.9 ft right abutment, y_{aRT} = 4.8 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} = 14.8 and ψ_{RT} = 14.7

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 14.8 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 14.7 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 12510206 Date 6/11/12 Initials RAT Region (A B C D)

Site _____ Location 8.1 mi N of Wagner on 395 Ave

Q_{500} = 9060 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 7527 (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 = 136 ft. Flow angle at bridge = 20 ° Abut. Skew = 30 ° 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 = 135.9 ft* $q_2 = Q_2/W_2$ = 55.4 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,

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

Water Surface Elev. = 2-3 ft

Low Steel Elev. = 10.5 ft

n (Channel) = 0.040

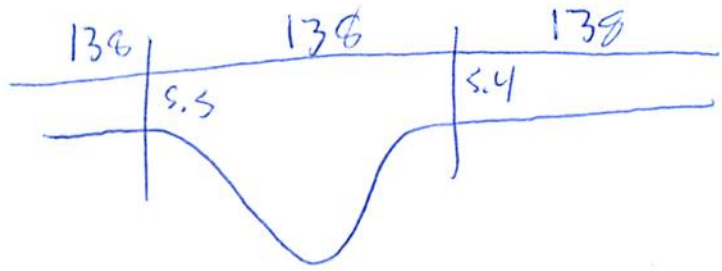
n (LOB) = 0.035

n (ROB) = 0.035

Pier Width = 1.9 ft

Pier Length = 1.5 ft

Piers for 500 yr = 4 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 136 ft

Width of left overbank flow at approach, W_{lob} = 136 ft Average left overbank flow depth, y_{lob} = 5.5 ft

Width of right overbank flow at approach, W_{rob} = 138 ft Average right overbank flow depth, y_{rob} = 5.4 ft

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

x = 9.12 From Figure 9 W_2 (effective) = 128.7 ft y_{cs} = 10 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 = 7.4 Pier scour y_{ps} = 6.1 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 5.5 ft right abutment, y_{aRT} = 5.4 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} = 15.9 and ψ_{RT} = 15.7

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 15.9 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 15.7 ft

Route 395 Alt Stream Chotean Ck MRM _____ Date 6/11/12 Initials KaT

Bridge Structure No. 12510206 Location 8.1 mi N of Wagner on 395 Alt

GPS coordinates: N 43° 12' 7.0" W 98° 17' 15.4" taken from: USL abutment X centerline of ⇑ MRM end _____

Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 271.66 sq. mi.

The average bottom of the main channel was 14.2 ft below top of guardrail at a point 92 ft from left abutment.

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

~~8~~ 6/4
8/23

2	199
5	881
10	1840
25	3870
50	6100
100	9060
500	19300

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = Q_{50} 6100			Q_{500} = Q_{10^0} 9060		
Estimated flow passing through bridge	6100			~~7300~~ 7527		
Estimated road overflow & overtopping	0			~~1677~~ 1533		
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 pier contraction left abutment

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). right OB
2). main channel
3). left OB
4). pier
5). pier scour
6). right abutment
7). left abutment
8). right abutment
9). left abutment (scour
10). main channel

Summary of Results

	~~Q100~~ Q_{50}	~~Q500~~ Q_{10^0}
Bridge flow evaluated	6100	7527
Flow depth at left abutment (yaLT), in feet	4.9	5.5
Flow depth at right abutment (yaRT), in feet	4.8	5.4
Contraction scour depth (ycs), in feet	9	10
Pier scour depth (yps), in feet	6	6.1
Left abutment scour depth (yas), in feet	14.8	15.9
Right abutment scour depth (yas), in feet	14.7	15.7
1Flow angle of attack	10	10

See Comments/Diagram for justification where required