OK RJ

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 12510279 Date 6/10/12 Initials LGJ Region (A B (C) D)

Site ________ Location 0.9 mi N of Wagner on 395 Ave

Q_{100} = Q_{50} 7510 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 7510 (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 = 167 ft. Flow angle at bridge = 0 ° Abut. Skew = 0 ° Effective Skew = 0 ° see last page

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 = 167 ft* $q_2 = Q_2/W_2$ = 45 ft^2/s

Bridge Vel, V_2 = 4.8 ft/s Final $y_2 = q_2/V_2$ = 9.5 ft Δh = 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. = 2.4 ft 14.9 −5.1 9.8

Low Steel Elev. = 9.8 ft

n (Channel) = 0.045

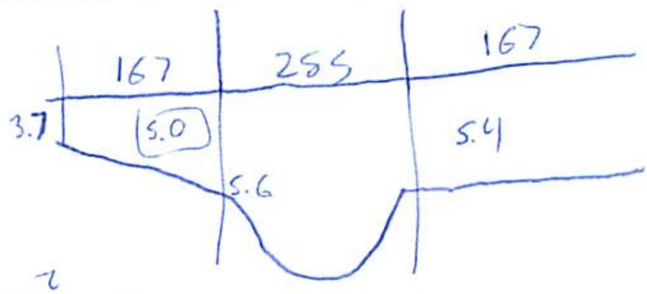
n (LOB) = 0.035

n (ROB) = 0.035

Pier Width = 2.05 ft

Pier Length = 2.25 ft

\# Piers for 100 yr = 2 ft



$160^2+6^2=333^2$ 1.3 5.6−241 5.6 3.7 5.4 241 m=0.0224 0.0224·167

CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 285 ft

Width of left overbank flow at approach, W_{lob} = 167 ft Average left overbank flow depth, y_{lob} = 5.0 ft

Width of right overbank flow at approach, W_{rob} = 167 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 = 16.35 From Figure 9 W_2 (effective) = 162.9 ft y_{cs} = 15.7 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, $V_1 = Q_{100}/(y_1W_1)$ = ________ 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 = 1.10 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 = 8.1 Pier scour y_{ps} = 6.7 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 5.0 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 and ψ_{RT} = 15.7

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 15 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 15.7 ft

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

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 12510279 Date 8/11/12 Initials RAL Region (A B (C) D)

Site ______ Location 0.9 mi N of Wagner on 395 Ave

Q_{500} = Q100 ~~4455~~ 11200 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 8056 (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 = 167 ft. Flow angle at bridge = 0 ° Abut. Skew = 0 ° Effective Skew = 0 °

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 = 167 ft* $q_2 = Q_2/W_2$ = 46.2 ft²/s

Bridge Vel, V_2 = 4.9 ft/s Final $y_2 = q_2/V_2$ = 9.8 ft Δh = 0.5 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 10.3 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. = 2.4 ft

Low Steel Elev. = 9.8 ft

n (Channel) = 0.045

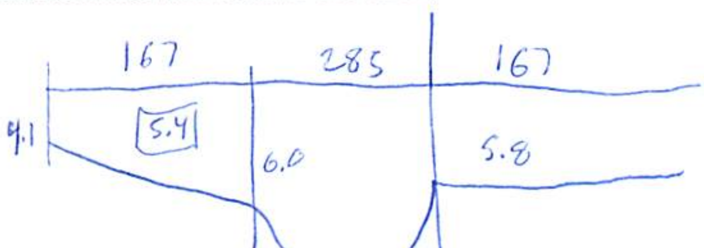
n (LOB) = 0.035

n (ROB) = 0.035

Pier Width = 2.05 ft

Pier Length = 2.25 ft

\# Piers for 500 yr = 2 ft



PGRM: Contract

CONTRACTION SCOUR

Width of main channel at approach section W_1 = 285 ft

Width of left overbank flow at approach, W_{lob} = 167 ft Average left overbank flow depth, y_{lob} = 5.4 ft

Width of right overbank flow at approach, W_{rob} = 167 ft Average right overbank flow depth, y_{rob} = 5.8 ft

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

x = 17.56 From Figure 9 W_2 (effective) = 162.9 ft y_{cs} = 16.4 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 = 1.10 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 = 8.1 Pier scour y_{ps} = 6.7 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 5.4 ft right abutment, y_{aRT} = 5.8 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} = 15.7 and ψ_{RT} = ~~16.5~~ 16.5

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 15.7 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 16.5 ft

98.28807
43.09787

Route 395 Ave Stream Choteau Ck MRM ______ Date 6/10/12 Initials FAL

Bridge Structure No. 12510279 Location 0.9 mi N of Wagner on 395 Ave

GPS coordinates: N 43° 5' 52.7" W 98° 17' 17.5" taken from: USL abutment X centerline of ⥣ MRM end ______

Datum of coordinates: WGS84 X NAD27 ______

Drainage area = 382.48 sq. mi.

The average bottom of the main channel was 14.9 ft below top of guardrail at a point 105 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	~~Q100~~ = Q50 7510			~~Q500~~ = Q100 11200		
Estimated flow passing through bridge	7510			8056		
Estimated road overflow & overtopping	0			3144		
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	

8/23

2	230
5	1050
10	2210
25	4740
50	7520
100	11200
500	24300

Riprap at abutments? X Yes ____No ____Marginal Riprap on surrounding walking bridge lacking in scoured area (see pictures) - major abutment scour

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

Debris Potential? ____High ____Med X Low

5/4/12

2	230
5	1050
10	2210
25	4730
50	7510
100	11200
500	24300

Does scour countermeasure(s) appear to have been designed?

Riprap X Yes ____No ____Don't know ____NA Rose quartz

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) two bridges
2). Right OB
3-4). main channel
5). Left OB
6-7) right Abutment
8-9) left abutment
10-11) piers
12-13) right abutment (scour)
14-15) left abutment scour)
16-17) main Channel

Note: There is a pedestrian bridge infront of the upstream road bridge. The ped. bridge has a lot of riprap and likely in my opinion straightens the flow angle to 0°. The bridge would ~~also~~ likely reduce a further abutment scour under the road bridge.

Summary of Results

	~~Q100~~ Q50	~~Q500~~ Q100
Bridge flow evaluated	7510	8056
Flow depth at left abutment (yaLT), in feet	5.0	5.4
Flow depth at right abutment (yaRT), in feet	5.4	5.8
Contraction scour depth (ycs), in feet	15.7	16.4
Pier scour depth (yps), in feet	6.7	6.7
Left abutment scour depth (yas), in feet	15	15.7
Right abutment scour depth (yas), in feet	15.7	16.5
1Flow angle of attack	0	0

See Comments/Diagram for justification where required