ok RT

SCOUR ANALYSIS AND REPORTING FORM RFT/cw/RaT

Bridge Structure No. 03160251 Date 5-15-12 Initials ~~5-15~~ Region (A B C D)

Site _____ Location 5.9 mi N of Alpena on 392 Ave

Q2 Q_{100} = 202 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. ✓

Bridge discharge (Q_2) = 202 (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 = 120 ft. Flow angle at bridge = ~~45~~ 55 Abut. Skew = 0 ° Effective Skew = ~~45~~ 55 °

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 = 68.83 ft* $q_2 = Q_2/W_2$ = 2.9 ft^2/s

Bridge Vel, V_2 = 1.2 ft/s Final $y_2 = q_2/V_2$ = 2.4 ft Δh = 0 ft

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

** NOTE: repeat above calculations until y_2 changes by less by 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. = 2.6 ft

Low Steel Elev. = 4.1 ft

n (Channel) = 0.075

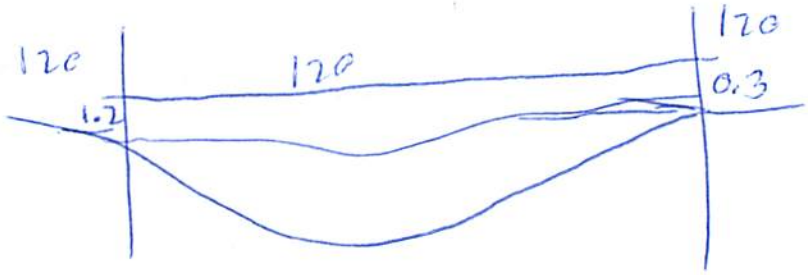
n (LOB) = 0.05

n (ROB) = 0.08

Pier Width = 1.0 ft

Pier Length = 24 ft

Piers for 100 yr = 9 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 120 ft 1.2+

Width of left overbank flow at approach, W_{lob} = 120 ft Average left overbank flow depth, y_{lob} = 1.2 ft

Width of right overbank flow at approach, W_{rob} = 120 ft Average right overbank flow depth, y_{rob} = 0.3 0.3+ ft

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

x = 3.98 From Figure 9 W_2 (effective) = 59.8 ft y_{cs} = 4.6 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, $V_1 = Q_{100}/(y_1W_1)$ = _____ 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 = 24 Correction factor for flow angle of attack (from Table 1), K2 = 4.4

Froude # at bridge = 0.14 Using pier width a on Figure 11, ξ = ~~4.9~~ 4.9 Pier scour y_{ps} = 15.9 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 1.2 ft right abutment, y_{aRT} = 0.3 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} = 5.1 and ψ_{RT} = 1.4

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 9.2 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 2.6 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 03160251 Date _____ Initials _____ Region (A B C D)

Site _____ Location 5.9 mi N of Alpena on 392 Ave

Q5 Q_{500} = 932 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. ✓

Bridge discharge (Q_2) = 540 (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 = 120 ft. Flow angle at bridge = 55 ° Abut. Skew = 0 ° Effective Skew = 55 °

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 = 68.53 ft* $q_2 = Q_2/W_2$ = 8.4 ft^2/s

Bridge Vel, V_2 = 2.1 ft/s Final $y_2 = q_2/V_2$ = 4.1 ft Δh = 0.1 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 4.2 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. = 2.8 ft

Low Steel Elev. = 4.1 ft

n (Channel) = 0.075

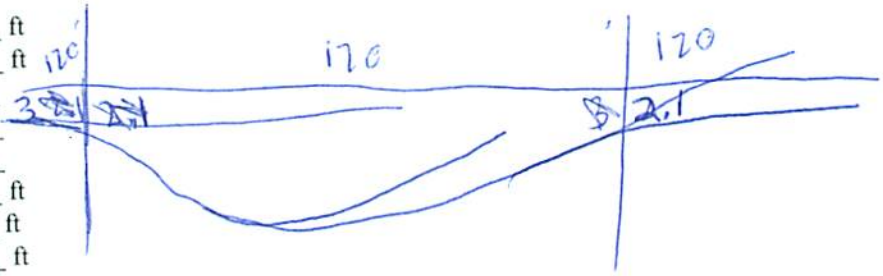
n (LOB) = 0.080

n (ROB) = 0.080

Pier Width = 1.0 ft

Pier Length = 25 ft

Piers for 500 yr = 9 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 120 ft

Width of left overbank flow at approach, W_{lob} = 120 ft Average left overbank flow depth, y_{lob} = 3 ft

Width of right overbank flow at approach, W_{rob} = 120 ft Average right overbank flow depth, y_{rob} = 2.1 ft

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

x = ~~18.34~~ 11.22 From Figure 9 W_2 (effective) = ~~40.6~~ 59.8 ft y_{cs} = ~~16.9~~ 12.2 ft

Clear Water Contraction Scour (use if bed material is larger than small cobbles)

PGRM: CWCSNEW

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 = 24 Correction factor for flow angle of attack (from Table 1), K2 = 4.41

Froude # at bridge = 0.18 Using pier width a on Figure 11, ξ = 4.9 Pier scour y_{ps} = 16.6 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 3 ft right abutment, y_{aRT} = 2.1 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} = 11.5 and ψ_{RT} = 8.6

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 20.7 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 15.7 ft

Route 392 Ave Stream Cain Ck MRM _____ Date _____ Initials _____

Bridge Structure No. Q3160251 Location 5.9 mile N of Alpena on 392 Ave

GPS coordinates: N 44° 16' 03.6" W 94° 22' 36.0" taken from: USL abutment ____ centerline of ⇑ MRM end ____

Datum of coordinates: WGS84 ____ NAD27 ____

Drainage area = 347.4 sq. mi.

The average bottom of the main channel was 9.0 ft below top of guardrail at a point 15 ft from left abutment.

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

5/14

~~5/22~~

Pk 2	202
5	932
10	1970
25	4210
50	~~6670~~
100	9930
500	21300

6660

MISCELLANEOUS CONSIDERATIONS

Flows	~~Q_{100}~~ Q_2 = 202			Q_{500} = ~~Q_5~~ 932		
Estimated flow passing through bridge	202			580		
Estimated road overflow & overtopping				352		
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 possible at upstream right abutment

Debris Potential? ____High __X__ Med ____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

2228 Structure no.

2229 approach from bridge

2230 bridge from left ditch

2231 left abut. from left ditch

2232 spalling on pier

2233 crack / scour at rt. abutment

Summary of Results

	~~Q100~~ 2	~~Q500~~ 5
Bridge flow evaluated	202	580
Flow depth at left abutment (yaLT), in feet	1.2	3
Flow depth at right abutment (yaRT), in feet	0.3	2.1
Contraction scour depth (ycs), in feet	4.6	12.2
Pier scour depth (yps), in feet	15.9	16.6
Left abutment scour depth (yas), in feet	9.2	20.9
Right abutment scour depth (yas), in feet	2.6	15.7
1Flow angle of attack	55°	55°

See Comments/Diagram for justification where required