OK-RAT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 41280298 Date 9-20-12 Initials RTT Region (Ⓐ B C D)

Site ______ Location 0.1 mi E of Roberts Drav

Q_{100} = 992 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. ✓

Bridge discharge (Q_2) = 992 (should be Q_{100} unless there is a relief bridge, road overflow, or bridge overtopping)

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

Analytical Procedure for Estimating Hydraulic Variables Needed to Apply Method

Bridge Width = 50 ft. Flow angle at bridge = 0 ° Abut. Skew = 0 ° Effective Skew = 0 °

Width (W_2) iteration = 34 40 39 ____

Avg. flow depth at bridge, y_2 iteration = 4.6 4.2 4.2 ____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 39 ft* $q_2 = Q_2/W_2$ = 25.4 ft^2/s

Bridge Vel, V_2 = 6.0 ft/s Final $y_2 = q_2/V_2$ = 4.2 ft Δh = 0.7 ft

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

Low Steel Elev. = 5.6 ft

n (Channel) = .040

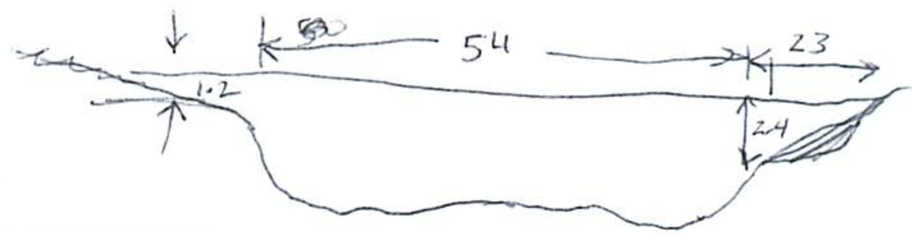
n (LOB) = .035

n (ROB) = .060

Pier Width = NA ft

Pier Length = NA ft

Piers for 100 yr = 0 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 54 ft

Width of left overbank flow at approach, W_{lob} = 40 ft Average left overbank flow depth, y_{lob} = 1.2 ft

Width of right overbank flow at approach, W_{rob} = 23 ft Average right overbank flow depth, y_{rob} = 1.2 ft

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

x = ____ From Figure 9 W_2 (effective) = ____ ft y_{cs} = ____ ft

PGRM: CWCSNEW

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

Estimated bed material D_{50} = 0.4 ft Average approach velocity, $V_1 = Q_{100}/(y_1 W_1)$ = 1.7 ft/s

Critical approach velocity, $Vc = 11.17 y_1^{1/6} D_{50}^{1/3}$ = 10.76 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.

$D_{c50} = 0.0006(q_2/y_1^{7/6})^3$ = .035 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} = 0 ft

PIER SCOUR CALCULATIONS

PGRM: Pier

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

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

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 1.2 ft right abutment, y_{aRT} = 1.2 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} = 5.1

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 5.1 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 5.1 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 41280298 Date ______ Initials ______ Region ((A) B C D)

Site ______ Location 0.1 mi E of Roberts Draw

Q_{500} = 2360 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. ✓

Bridge discharge (Q_2) = 2360 (should be Q_{500} unless there is a relief bridge, road overflow, or bridge overtopping)

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

Analytical Procedure for Estimating Hydraulic Variables Needed to Apply Method

Bridge Width = 50 ft. Flow angle at bridge = 0 ° Abut. Skew = 0 ° Effective Skew = 0 °

Width (W_2) iteration = 50 ____ ____ ____

Avg. flow depth at bridge, y_2 iteration = 5.9 ____ ____ ____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 50 ft* $q_2 = Q_2/W_2$ = 47.2 ft^2/s

Bridge Vel, V_2 = 7.9 ft/s Final $y_2 = q_2/V_2$ = 5.9 ft Δh = 1.3 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 7.2 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. = ____ ft

Low Steel Elev. = 5.6 ft

n (Channel) = .040

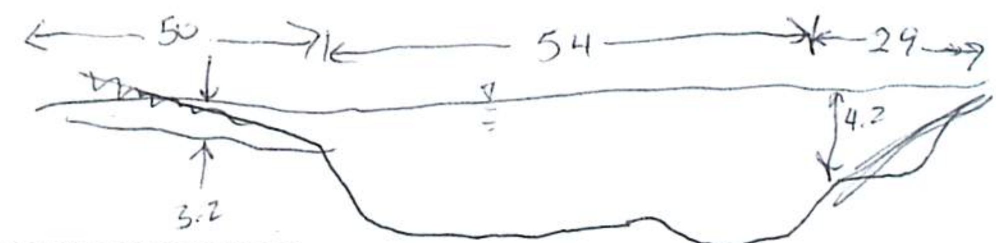
n (LOB) = .035

n (ROB) = .060

Pier Width = NA ft

Pier Length = NA ft

\# Piers for 500 yr = 0 ft



PGRM: Contract

CONTRACTION SCOUR

Width of main channel at approach section W_1 = 54 ft

Width of left overbank flow at approach, W_{lob} = 50 ft Average left overbank flow depth, y_{lob} = 3.2 ft

Width of right overbank flow at approach, W_{rob} = 29 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 = ____ From Figure 9 W_2 (effective) = ____ ft y_{cs} = ____ ft

PGRM: CWCSNEW

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

Estimated bed material D_{50} = 0.4 ft Average approach velocity, $V_1 = Q_{500}/(y_1W_1)$ = 2.46 ft/s

Critical approach velocity, $Vc = 11.17y_1^{1/6}D_{50}^{1/3}$ = 11.44 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.

$D_{c50} = 0.0006(q_2/y_1^{7/6})^3$ = .063 ft If $D_{50} >= D_{c50}$, χ = (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} = 0 ft

PGRM: Pie

PIER SCOUR CALCULATIONS

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

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

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 3.2 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} = 11.9 and ψ_{RT} = 8.6

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 11.9 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 8.6 ft

Route Nemo Rd Stream Estes Ck MRM ____ Date ____ Initials ____

Bridge Structure No. 41280298 Location 0.1 mi E of Roberts Draw

GPS coordinates: N 44° 10.366' taken from: USL abutment ____ centerline of ⇑ MRM end ____

W 103° 29.587' Datum of coordinates: WGS84 ____ NAD27 ____

Drainage area = 6.02 sq. mi.

The average bottom of the main channel was 11.8 ft below top of guardrail at a point 18 ft from left abutment.

Method used to determine flood flows: ____ Freq. Anal. ____ drainage area ratio ✓ regional regression equations.

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 992			Q_{500} = 2360		
Estimated flow passing through bridge	992			2360		
Estimated road overflow & overtopping	0			0		
Consideration	Yes	No	Possibly	Yes	No	Possibly
Chance of overtopping		✓			✓	
Chance of Pressure flow		✓		✓		
Armored appearance to channel		✓			✓	
Lateral instability of channel		✓			✓	

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2	29.2
5	97.5
10	191
25	391
50	645
100	992
500	2360

Riprap at abutments? X Yes ____ No ____ Marginal bridge is totally lined with riprap

Evidence of past Scour? ____ Yes ✓ No ____ Don't know assume CWCS

Debris Potential? ____ High ✓ Med ____ Low trees, but no piers

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

Riprap X Yes ____ No ____ Don't know ____ NA

Spur Dike ____ Yes ____ No ____ Don't know ✓ NA

Other ________________ ____ Yes ____ No ____ Don't know ✓ NA

Bed Material Classification Based on Median Particle Size (D_{50})

Material	Silt/Clay____	Sand____	Gravel____	Cobbles X	Boulders____
Size range, in mm	<0.062	0.062-2.00	2.00-64	64-250	>250

Comments, Diagrams & orientation of digital photos

Str. no.
approach
LOB
ROB
Bridge from approach
under bridge

Summary of Results

	Q100	Q500
Bridge flow evaluated	992	2360
Flow depth at left abutment (yaLT), in feet	1.2	3.2
Flow depth at right abutment (yaRT), in feet	1.2	2.1
Contraction scour depth (ycs), in feet	0	0
Pier scour depth (yps), in feet	NA	NA
Left abutment scour depth (yas), in feet	5.1	11.9
Right abutment scour depth (yas), in feet	5.1	8.6
1Flow angle of attack	0°	0°

See Comments/Diagram for justification where required