Wolf Creek

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 44010185 Date 10/9/11 Initials CG Region (A B (C) D)

Site _____ Location 2mi E & 1.3mi S of Emery on 431 Ave

Q_{100} = 7200 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. ✓

Bridge discharge (Q_2) = 7200 (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 = 173 ft. Flow angle at bridge = 18 ° Abut. Skew = 0 ° Effective Skew = 18 °

Width (W_2) iteration = 173 160 165 ____

Avg. flow depth at bridge, y_2 iteration = 9.3 9.7 9.6 ____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 156.92 ft* $q_2 = Q_2/W_2$ = 45.9 ft^2/s

Bridge Vel, V_2 = 4.4 ft/s Final $y_2 = q_2/V_2$ = 9.6 ft Δh = 0.5 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 10.0 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. = 13.1 ft

n (Channel) = 0.045

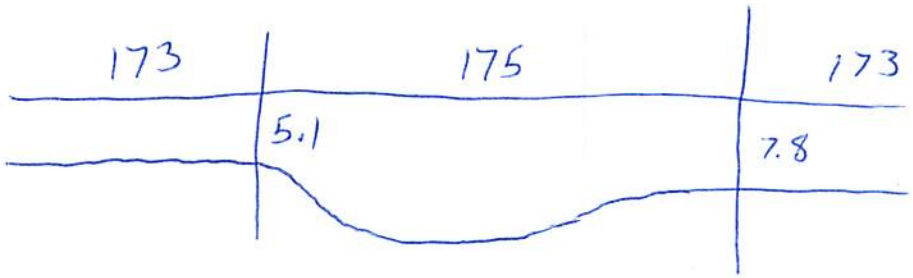
n (LOB) = 0.033

n (ROB) = 0.035

Pier Width = 1.80 ft

Pier Length = 1.83 ft

Piers for 100 yr = 4 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 175 ft

Width of left overbank flow at approach, W_{lob} = 173 ft Average left overbank flow depth, y_{lob} = 5.1 ft

Width of right overbank flow at approach, W_{rob} = 173 ft Average right overbank flow depth, y_{rob} = 7.8 ft

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

x = 16.64 From Figure 9 W_2 (effective) = 149.7 ft y_{cs} = 15.9 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 $D_{50} >= D_{c50}$, $\chi = 0.0$

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 = 1.0 Correction factor for flow angle of attack (from Table 1), K2 = 1.0

Froude # at bridge = 0.27 Using pier width a on Figure 11, ξ = 7.4 Pier scour y_{ps} = 6.1 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 5.1 ft right abutment, y_{aRT} = 7.8 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} = 15.2 and ψ_{RT} = 19.6

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 15.2 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 19.6 ft

17.4
4.3
13.1

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 44010185 Date 10/9/11 Initials CW Region (A B C D)

Site _____ Location 2 mi E & 1.3 mi S of Emery on 431 Ave

Q_{500} = 15200 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. ✓

Bridge discharge (Q_2) = 14194 (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 = 173 ft. Flow angle at bridge = 14 ° Abut. Skew = 0 ° Effective Skew = 18 °

Width (W_2) iteration = 173 _____ _____ _____

Avg. flow depth at bridge, y_2 iteration = 13.6 → RD overflow _____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 16453 ft* $q_2 = Q_2/W_2$ = 86.3 ft^2/s

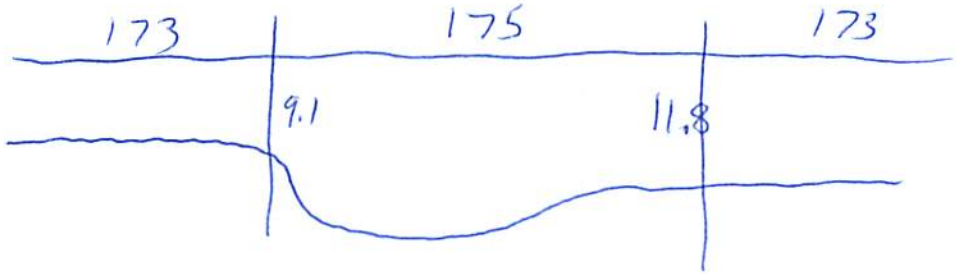
Bridge Vel, V_2 = 6.6 ft/s Final $y_2 = q_2/V_2$ = 13.1 ft Δh = 0.9 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 14.0 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. = 13.1 ft
n (Channel) = 0.045
n (LOB) = 0.033
n (ROB) = 0.035
Pier Width = 1.90 ft
Pier Length = 1.83 ft
Piers for 500 yr = 4 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 175 ft

Width of left overbank flow at approach, W_{lob} = 173 ft Average left overbank flow depth, y_{lob} = 9.1 ft

Width of right overbank flow at approach, W_{rob} = 173 ft Average right overbank flow depth, y_{rob} = 11.8 ft

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

x = 26.7 From Figure 9 W_2 (effective) = 157.3 ft y_{cs} = 21.3 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 $D_{50} >= D_{c50}$, 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} = _____ ft

PGRM: Pier

PIER SCOUR CALCULATIONS

L/a ratio = 1.0 Correction factor for flow angle of attack (from Table 1), K2 = 1.0

Froude # at bridge = 0.32 Using pier width a on Figure 11, ξ = 7.4 Pier scour y_{ps} = 6.2 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 9.1 ft right abutment, y_{aRT} = 11.8 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} = 20.6 and ψ_{RT} = 22.8

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 20.6 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 22.8 ft

Route 431 Ave Stream Wolf Ck MRM _____ Date 10/9/11 Initials Cw

Bridge Structure No. 44010185 Location 2 mi E & 1.3 mi S of Emery on 431 Ave

GPS coordinates: N43° 34' 53.7" taken from: USL abutment X centerline of ⇑ MRM end _____

W 97° 35' 13.6" Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 179.82 sq. mi.

The average bottom of the main channel was 17.4 ft below top of guardrail at a point 62 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 7200			Q_{500} = 15200		
Estimated flow passing through bridge	7200			14194		
Estimated road overflow & overtopping				1006		
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? X Yes ____No ____Marginal

Evidence of past Scour? ____Yes X No ____Don't know erosion us of bridge → cattle in stream

Debris Potential? ____High ____Med X Low

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

Riprap	X Yes	____No	____Don't know	____NA
Spur Dike	____Yes	____No	____Don't know	X NA
Other _____	____Yes	____No	____Don't know	X 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

10/4/11

2	174
5	737
10	1510
25	3130
50	4480
100	7200
500	15200

Photos

2067 - 10

64 - US

69 - USRB

70 - USLB

71 - US Face

72 - L. Abut

73 - R. Abut

Summary of Results

	Q100	Q500
Bridge flow evaluated	7200	14194
Flow depth at left abutment (yaLT), in feet	5.1	9.1
Flow depth at right abutment (yaRT), in feet	7.8	11.8
Contraction scour depth (ycs), in feet	15.9	21.3
Pier scour depth (yps), in feet	6.1	6.2
Left abutment scour depth (yas), in feet	15.2	20.6
Right abutment scour depth (yas), in feet	19.6	22.3
1Flow angle of attack	18	18

See Comments/Diagram for justification where required