OK RJ

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 52322365 Date 10/21/10 Initials CW Region ((A) B C D)

Site ____________ Location First bridge downstream from Balsa Gulch Rd.

Q_{100} = 3020 by: drainage area ratio ✓ flood freq. anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = 3020 (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 = 96 ft. Flow angle at bridge = 50 ° Abut. Skew = 45 ° Effective Skew = 5 °

Width (W_2) iteration = 96 60 63 ____

Avg. flow depth at bridge, y_2 iteration = 4.4 6.2 6.0 ____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 62.76 ft* $q_2 = Q_2/W_2$ = 48.1 ft²/s

Bridge Vel, V_2 = 4.0 ft/s Final $y_2 = q_2/V_2$ = 6.0 ft Δh = 1.3 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 7.3 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. = — ft

Low Steel Elev. = 11.0 ft

n (Channel) = 0.050

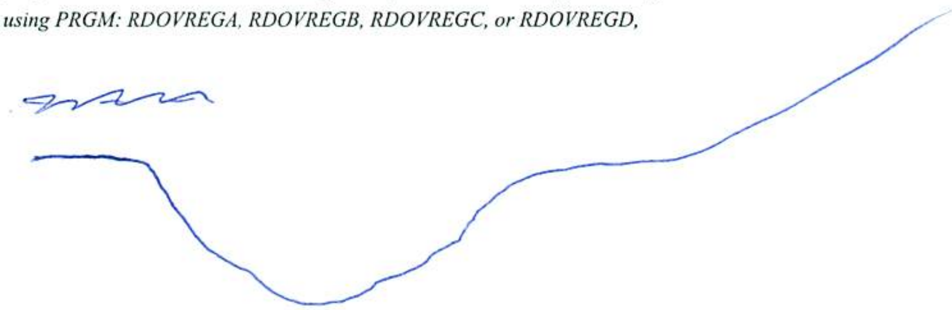
n (LOB) = 0.045

n (ROB) = 0.045

Pier Width = 2.0 ft

Pier Length = 2.0 ft

\# Piers for 100 yr = 2 ft



PGRM: Contract

CONTRACTION SCOUR

Width of main channel at approach section W_1 = 100 ft

Width of left overbank flow at approach, W_{lob} = 0.0 ft Average left overbank flow depth, y_{lob} = 0.0 ft

Width of right overbank flow at approach, W_{rob} = ~~[illegible]~~ ft 0 Average right overbank flow depth, y_{rob} = 0.0 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) Z = 0

Estimated bed material D_{50} = 0.4 ft Average approach velocity, $V_1 = Q_{100}/(y_1W_1)$ = 4.14 ft/s

Critical approach velocity, $Vc = 11.52y_1^{1/6}D_{50}^{1/3}$ = 11.46 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.

$D_{c50} = 0.0006(q_2/y_1^{7/6})^3$ = 0.0635 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} = 0.0 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 = 0.58 Using pier width a on Figure 11, ξ = 8 Pier scour y_{ps} = 7.3 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 0.0 ft right abutment, y_{aRT} = 0.0 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} = 0.0 and ψ_{RT} = 0.0

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 0.0 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 0.0 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 52322365 Date 10/21/10 Initials CW Region (A B C D) [A circled]

Site ______ Location First Bridge downstream from Balsar Gulch Rd

Q_{500} = 22500 by: drainage area ratio ✓ flood freq. anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = ~~13787~~ 13878 (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 = 96 ft. Flow angle at bridge = 50 ° Abut. Skew = 45 ° Effective Skew = 5 °

Width (W_2) iteration = 96 RD Overflow ~~[illegible]~~ ~~[illegible]~~ 96 cos 5° = 95.63'

Avg. flow depth at bridge, y_2 iteration = ______ ______ ______ ______

Corrected channel width at bridge Section = W_2 times cos of flow angle = 95.63 ft* $q_2 = Q_2/W_2$ = 145.1 ft^2/s

Bridge Vel, V_2 = 13.2 ft/s Final $y_2 = q_2/V_2$ = 11.0 ft Δh = 3.6 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 14.6 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,

But LOVB Flow wont contribute b/c on road.

Water Surface Elev. = — ft

Low Steel Elev. = 11.0 ft

n (Channel) = 0.050

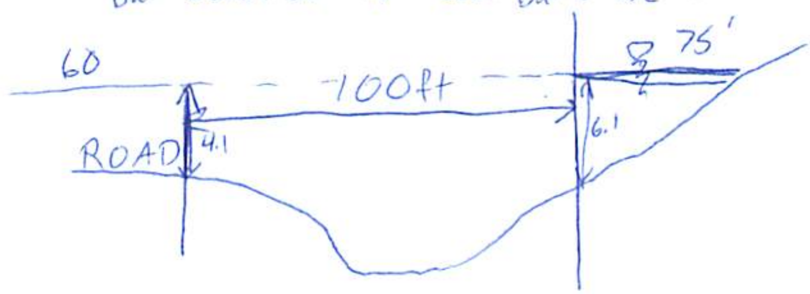
n (LOB) = 0.045

n (ROB) = 0.045

Pier Width = 2.0 ft

Pier Length = 7.0 ft

\# Piers for 500 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 100 ft

Width of left overbank flow at approach, W_{lob} = 60 ft Average left overbank flow depth, y_{lob} = 4.1 ft

Width of right overbank flow at approach, W_{rob} = 75 ft Average right overbank flow depth, y_{rob} = 3.1 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) z = 0

Estimated bed material D_{50} = 0.4 ft Average approach velocity, $V_1 = Q_{500}/(y_1 W_1)$ = ~~9.51~~ ft/s 5.43

Critical approach velocity, $Vc = 11.52 y_1^{1/6} D_{50}^{1/3}$ = 12.47 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.

$D_{c50} = 0.0006(q_2/y_1^{7/6})^3$ = 0.154 ft If $D_{50} >= D_{c50}$, χ = 0.0 [circled]

Otherwise, $\chi = 0.122 y_1 [q_2/(D_{50}^{1/3} y_1^{7/6})]^{6/7} - y_1$ = — 0 From Figure 10, y_{cs} = 0.0 ft

PIER SCOUR CALCULATIONS

PGRM: Pie

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

Froude # at bridge = 0.7 Using pier width a on Figure 11, ξ = 8 Pier scour y_{ps} = 7.6 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 0.0 ft right abutment, y_{aRT} = 3.1 ft

Shape coefficient K_1= 1.00 for vertical-wall, 0.82 for vertical-wall with wingwalls, 0.55 for spill-through [circled]

Using values for y_{aLT} and y_{aRT} on figure 12, ψ_{LT} = 0.0 and ψ_{RT} = 11.7

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 0.0 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 11.7 ft

Route Sheridan Lake Road Stream Spring Creek MRM ____ Date 10/21/10 Initials CW

Bridge Structure No. 52322365 Location First bridge downstream from Balsar Gulch Rd

GPS coordinates: N43°59' 19.2" W103° 25' 03.6" taken from: USL abutment X centerline of ⇑ MRM end ____

Datum of coordinates: WGS84 X NAD27 ____

Drainage area = 151.51 sq. mi.

The average bottom of the main channel was 15.1 ft below top of guardrail at a point 50 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 3020			Q_{500} = 22500		
Estimated flow passing through bridge	3020			13878		
Estimated road overflow & overtopping	3020			4622		
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 ____ No X Marginal Looks like rock was just dumped

Evidence of past Scour? ____ Yes X No ____ Don't know

Debris Potential? X High ____ Med ____ Low

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

Riprap ____ Yes X 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})

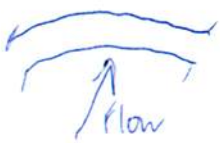
Material	Silt/Clay ____	Sand ____	Gravel ____	Cobbles X	Boulders ____
Size range, in mm	<0.062	0.062-2.00	2.00-64	64-250	>250

Comments, Diagrams & orientation of digital photos

Prescribed burns in area
US Face bridge is curved

For 500 yr event 10rB
Flow won't contribute
b/c on road already

1370 - ID
71 - US
72 - RB US
73 - LB US
74 - R. Abut
75 - AP. XS to Right
76 - AP. XS to Left
77 - L. Abut
78 - US Face Bridge



Summary of Results

	Q100	Q500
Bridge flow evaluated	3020	13878
Flow depth at left abutment (yaLT), in feet	0.0	0.0
Flow depth at right abutment (yaRT), in feet	0.0	3.1
Contraction scour depth (ycs), in feet	0.0	0.0
Pier scour depth (yps), in feet	7.3	7.6
Left abutment scour depth (yas), in feet	0.0	0.0
Right abutment scour depth (yas), in feet	0.0	11.7
1Flow angle of attack	5°	5°

See Comments/Diagram for justification where required