OK RT

52317313

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. ~~52320313~~ Date 9/30/10 Initials CW Region (A B C D)

Site _____ Location on Thunderhead Falls Rd, upstream from powerhouse Gulch

Q_{100} = 860 by: drainage area ratio ✓ flood freq. anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = 860 (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 = 45 ft. Flow angle at bridge = 30 ° Abut. Skew = 30 ° Effective Skew = 0 °

Width (W_2) iteration = 45 Vert. Abut ____

Avg. flow depth at bridge, y_2 iteration = 3.6 ____ ____ ____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 45 ft* $q_2 = Q_2/W_2$ = 19.1 ft^2/s

Bridge Vel, V_2 = 5.3 ft/s Final $y_2 = q_2/V_2$ = 3.6 ft Δh = 0.6 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. = — ft

Low Steel Elev. = — ft

n (Channel) = 0.040

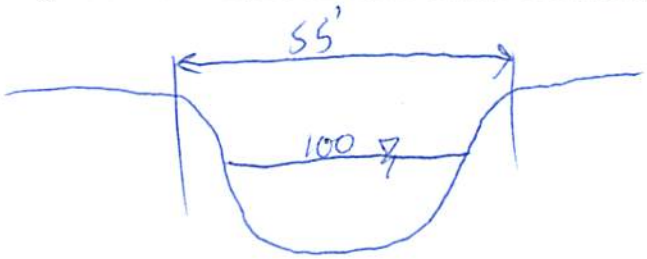
n (LOB) = 0.035

n (ROB) = 0.035

Pier Width = — ft

Pier Length = — ft

Piers for 100 yr = 0 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = ~~50~~ ft 55

Width of left overbank flow at approach, W_{lob} = 0 ft Average left overbank flow depth, y_{lob} = 0 ft

Width of right overbank flow at approach, W_{rob} = 0 ft Average right overbank flow depth, y_{rob} = 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) 2:0

Estimated bed material D_{50} = 0.30 ft Average approach velocity, $V_1 = Q_{100}/(y_1 W_1)$ = 3.72 ft/s

Critical approach velocity, $Vc = 11.52 y_1^{1/6} D_{50}^{1/3}$ = 9.5 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.

$D_{c50} = 0.0006(q_2/y_1^{7/6})^3$ = 0.0275 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} = 0.0 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} = 0 ft right abutment, y_{aRT} = 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 and ψ_{RT} = 0

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 0 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 0 ft

52317313

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. ~~52320313~~ Date 9/30/10 Initials CW Region (A B C D)

Site _____ Location on Thunderhead Falls Rd, Upstream from Powerhouse Gulch

Q_{500} = 1280 by: drainage area ratio ✓ flood freq. anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = 1280 (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 = 45 ft. Flow angle at bridge = 30 ° Abut. Skew = 30 ° Effective Skew = 0 °

Width (W_2) iteration = 45 Vert. Abut ____

Avg. flow depth at bridge, y_2 iteration = 4.5 ____ ____ ____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 45 ft* $q_2 = Q_2/W_2$ = 28.4 ft^2/s

Bridge Vel, V_2 = 6.3 ft/s Final $y_2 = q_2/V_2$ = 4.5 ft Δh = 0.8 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 5.3 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. = ~ ft

n (Channel) = 0.040

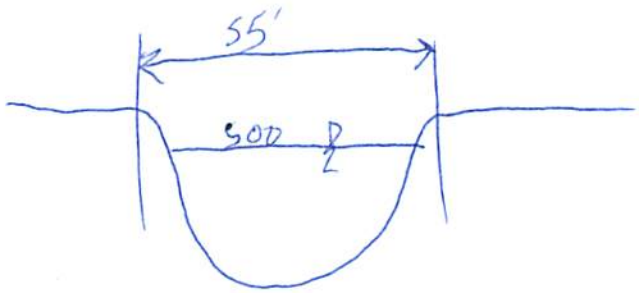
n (LOB) = 0.035

n (ROB) = 0.035

Pier Width = ~ ft

Pier Length = ~ ft

Piers for 500 yr = ~ 0 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 55 ft

Width of left overbank flow at approach, W_{lob} = 0 ft Average left overbank flow depth, y_{lob} = 0 ft

Width of right overbank flow at approach, W_{rob} = 0 ft Average right overbank flow depth, y_{rob} = 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} = 0.30 ft Average approach velocity, $V_1 = Q_{500}/(y_1 W_1)$ = 4.39 ft/s

Critical approach velocity, $Vc = 11.52 y_1^{1/6} D_{50}^{1/3}$ = 7.87 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.

$D_{c50} = 0.0006(q_2/y_1^{7/6})^3$ = 0.04 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} = 0.0 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} = 0 ft right abutment, y_{aRT} = 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 and ψ_{RT} = 0

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 0 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 0 ft

Thunderhead Falls

Route Road Stream Rapid Creek MRM _____ Date 9/30/10 Initials [redacted] CL

Bridge Structure No. ~~5232031~~ 5231313 Location on Thunderhead Falls Rd, upstream from Powerhouse Gulch

GPS coordinates: N 44° 03' 44.2" taken from: USL abutment X centerline of ⇑ MRM end _____

W 103° 25' 04.6" Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 337.74 sq. mi.

The average bottom of the main channel was 12.6 ft below top of guardrail at a point 21 ft from left abutment.

Method used to determine flood flows: ____Freq. Anal. ✓ drainage area ratio ____regional regression equations.

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 860			Q_{500} = 1280		
Estimated flow passing through bridge		860			1280	
Estimated road overflow & overtopping						
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

Debris Potential? X High ____Med ____Low

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

Riprap ____Yes ____No ____Don't know X 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

1281 - Bridge ID
82 - US from bridge
83 - US RB
84 - US LB
85 - US Face of Bridge
86 - Approach XS RB
87 - Approach XS LB
88 - R. Abut
89 - L. Abut
90. - R. Abut

Summary of Results

	Q100	Q500
Bridge flow evaluated	860	1280
Flow depth at left abutment (yaLT), in feet	0.0	0.0
Flow depth at right abutment (yaRT), in feet	0.0	0.0
Contraction scour depth (ycs), in feet	0.0	0.0
Pier scour depth (yps), in feet	~~0.0~~ NA	~~0.0~~ NA
Left abutment scour depth (yas), in feet	0.0	0.0
Right abutment scour depth (yas), in feet	0.0	0.0
1Flow angle of attack	0°	0°

See Comments/Diagram for justification where required