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SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 61390096 Date 10-12-12 Initials RFT Region (A (B) C D)

Site ________ Location 2.5 W + 1.4 N of Hidden Timber on 150 Oil St or Hidden Timber Rd

Q_{100} = 1920 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. ✓

Bridge discharge (Q_2) = 1920 (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 = 93 ft. Flow angle at bridge = 0 ° Abut. Skew = 0 ° Effective Skew = 0 °

Width (W_2) iteration = 93 ____ ____ ____

Avg. flow depth at bridge, y_2 iteration = 5.3 ____ ____ ____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 93 ft* $q_2 = Q_2/W_2$ = 20.6 ft^2/s

Bridge Vel, V_2 = 3.9 ft/s Final $y_2 = q_2/V_2$ = 5.3 ft Δh = 0.3 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 5.6 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.

Water Surface Elev. = ____ ft

Low Steel Elev. = 7.9 ft

n (Channel) = .035

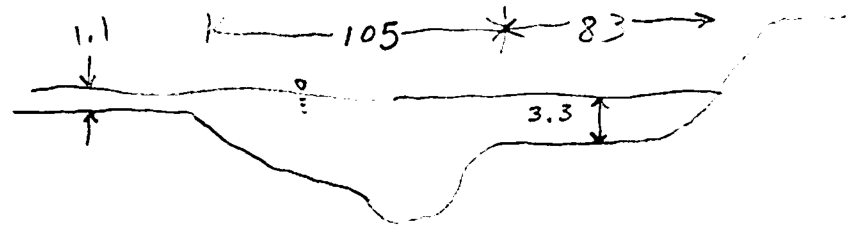
n (LOB) = .035

n (ROB) = .035

Pier Width = 1.67 ft

Pier Length = 1.67 ft

\# Piers for 100 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 105 ft

Width of left overbank flow at approach, W_{lob} = 93 ft Average left overbank flow depth, y_{lob} = 1.1 ft

Width of right overbank flow at approach, W_{rob} = 83 ft Average right overbank flow depth, y_{rob} = 3.3 ft

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

x = 3.49 From Figure 9 W_2 (effective) = 89.7 ft y_{cs} = 4.1 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, $V_c = 11.17 y_1^{1/6} D_{50}^{1/3}$ = ____ 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 $D_{50} >= D_{c50}$, 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} = ____ ft

PIER SCOUR CALCULATIONS

PGRM: Pier

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

Froude # at bridge = 0.3 Using pier width a on Figure 11, ξ = 7 Pier scour y_{ps} = 5.8 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 1.1 ft right abutment, y_{aRT} = 3.3 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} = 4.7 and ψ_{RT} = 12

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 4.7 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 12 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 61390096 Date ______ Initials ______ Region (A (B) C D)

Site ______ Location ______

Q_{500} = 3370 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. ✓

Bridge discharge (Q_2) = 3370 (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 = 93 ft. Flow angle at bridge = 0 ° Abut. Skew = 0 ° Effective Skew = 0 °

Width (W_2) iteration = 93 ____ ____ ____

Avg. flow depth at bridge, y_2 iteration = 7.1 ____ ____ ____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 93 ft* $q_2 = Q_2/W_2$ = 36.2 ft^2/s

Bridge Vel, V_2 = 5.1 ft/s Final $y_2 = q_2/V_2$ = 7.1 ft Δh = 0.5 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 7.6 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,

Water Surface Elev. = ____ ft

Low Steel Elev. = 7.9 ft

n (Channel) = .035

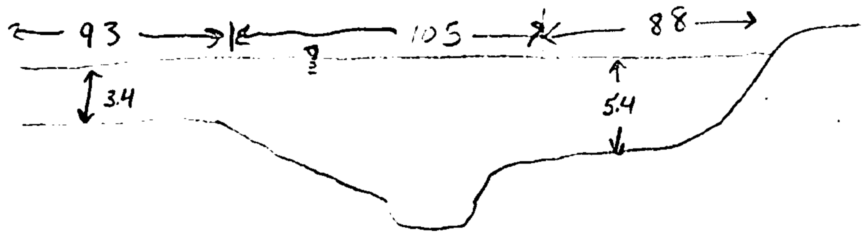
n (LOB) = .035

n (ROB) = .035

Pier Width = 1.67 ft

Pier Length = 1.67 ft

\# Piers for 500 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 105 ft

Width of left overbank flow at approach, W_{lob} = 93 ft Average left overbank flow depth, y_{lob} = 3.4 ft

Width of right overbank flow at approach, W_{rob} = 88 ft Average right overbank flow depth, y_{rob} = 5.4 ft

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

x = 1.58 From Figure 9 W_2 (effective) = 89.7 ft y_{cs} = 2.4 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, $V_c = 11.17y_1^{1/6}D_{50}^{1/3}$ = ____ 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

PIER SCOUR CALCULATIONS

PGRM: Pie

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

Froude # at bridge = 0.34 Using pier width a on Figure 11, ξ = 7 Pier scour y_{ps} = 5.9 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 3.4 ft right abutment, y_{aRT} = 5.4 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} = 12.2 and ψ_{RT} = 15.7

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 12.2 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 15.7 ft

Route Hidden Timber Rd Stream Antelope Creek MRM________ Date____________ Initials__________

Bridge Structure No. 61390096 Location 2.5 W + 1.4 N of Hidden Timber on 150 O'l St

GPS coordinates: N 43° 15.119' taken from: USL abutment ✓ centerline of ⇑ MRM end _____

W 100° 28.294 Datum of coordinates: WGS84 ✓ NAD27_____

Drainage area = 167 sq. mi.

The average bottom of the main channel was 12 ft below top of guardrail at a point 45 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 1920			Q_{500} = 3370		
Estimated flow passing through bridge	1920			3370		
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		✓			✓	

Riprap at abutments? _____Yes ✓ No _____Marginal

Evidence of past Scour? ✓ Yes _____No _____Don't know left abut. + pier

Debris Potential? _____High _____Med ✓ Low

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

Riprap _____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____	fine Sand X	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

Str. no.
bridge from approach
LOB
ROB
right abut.
left abut
approach from bridge
pier scour remnant

Summary of Results

	Q100	Q500
Bridge flow evaluated	1920	3370
Flow depth at left abutment (yaLT), in feet	1.1	3.4
Flow depth at right abutment (yaRT), in feet	3.3	5.4
Contraction scour depth (ycs), in feet	4.1	8.4
Pier scour depth (yps), in feet	5.8	5.9
Left abutment scour depth (yas), in feet	4.7	12.2
Right abutment scour depth (yas), in feet	12.0	15.7
1Flow angle of attack	0°	0°

See Comments/Diagram for justification where required