OK RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 52692290 Date 8/11/11 Initials CW Region (A (B) C D)

Site ____________ Location 2.2 mi E of Exit 84 on HWY 1416

Q_{100} = 827 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. ✓

Bridge discharge (Q_2) = 827 (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 = 33 ft. Flow angle at bridge = 30 ° Abut. Skew = 0 ° Effective Skew = 30 °

Width (W_2) iteration = 33

Avg. flow depth at bridge, y_2 iteration = 6.3 Vert wall

Corrected channel width at bridge Section = W_2 times cos of flow angle = 28.58 ft* $q_2 = Q_2/W_2$ = 28.9 ft^2/s

Bridge Vel, V_2 = 4.6 ft/s Final $y_2 = q_2/V_2$ = 6.3 ft Δh = 0.4 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 6.7 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. = 7.7 ft

n (Channel) = [illegible] 0.045

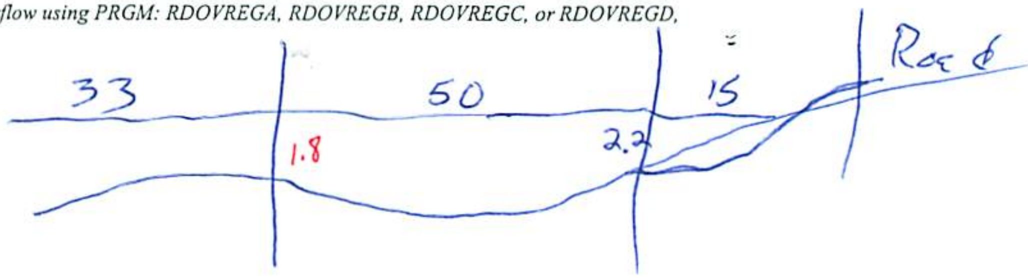
n (LOB) = 0.035

n (ROB) = 0.035

Pier Width = [illegible] 2.1 ft

Pier Length = 2.1 ft

\# Piers for 100 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 50 ft

Width of left overbank flow at approach, W_{lob} = [illegible] ft 33 Average left overbank flow depth, y_{lob} = [illegible] 1.8 ft

Width of right overbank flow at approach, W_{rob} = 15 ft Average right overbank flow depth, y_{rob} = 1.1 ft 2.2/2

~~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} = 0.5 ft Average approach velocity, $V_1 = Q_{100}/(y_1 W_1)$ = 1.26 ft/s

Critical approach velocity, $Vc = 11.17 y_1^{1/6} D_{50}^{1/3}$ = 12.17 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.

$D_{c50} = 0.0006(q_2/y_1^{7/6})^3$ = 0.019 ft If $D_{50} >= D_{c50}$, $\chi = 0.0$

Otherwise, $\chi = 0.122 y_1[q_2/(D_{50}^{1/3} y_1^{7/6})]^{6/7} - y_1$ = 0.0 From Figure 10, y_{cs} = 0.0 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 = 0.32 Using pier width a on Figure 11, ξ = 8.3 Pier scour y_{ps} = 7.0 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 1.8 ft right abutment, y_{aRT} = 1.1 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} = 7.4 and ψ_{RT} = 4.7

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 11.1 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 7.0 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 5269229O Date 8/11/11 Initials CW Region (A (B) C D)

Site ______ Location 2.2 mi E of Exit 84 on HWY 14K

Q_{500} = 1430 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. ✓

Bridge discharge (Q_2) = ~~[illegible]~~ 1097 (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 = 33 ft. Flow angle at bridge = 30 ° Abut. Skew = 0 ° Effective Skew = 30 °

Width (W_2) iteration = 33 ______ ______

Avg. flow depth at bridge, y_2 iteration = 6.4 > LS ______ ______

Corrected channel width at bridge Section = W_2 times cos of flow angle = 28.58 ft* $q_2 = Q_2/W_2$ = ~~38.58~~ 38.4 ft²/s

Bridge Vel, V_2 = 5.3 ft/s Final $y_2 = q_2/V_2$ = 7.3 ft Δh = 0.6 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 7.9 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. = 7.3 ft

n (Channel) = 0.045

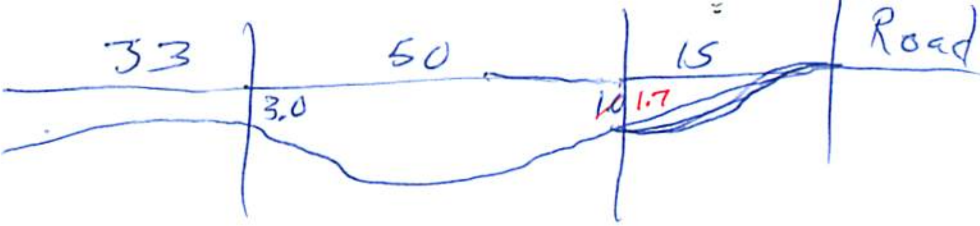
n (LOB) = 0.035

n (ROB) = 0.035

Pier Width = 2.1 ft

Pier Length = 2.1 ft

\# Piers for 500 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 50 ft

Width of left overbank flow at approach, W_{lob} = 33 ft Average left overbank flow depth, y_{lob} = 3.0 ft

Width of right overbank flow at approach, W_{rob} = 15 ft Average right overbank flow depth, y_{rob} = ~~1.0~~ ft ~~0.5~~ 1.7

1 ÷ 2 = 0.5

~~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} = 0.5 ft 2=0 Average approach velocity, $V_1 = Q_{500}/(y_1 W_1)$ = ~~1.42~~ 1.35 ft/s

Critical approach velocity, $Vc = 11.17 y_1^{1/6} D_{50}^{1/3}$ = 12.51 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.

$D_{c50} = 0.0006(q_2/y_1^{7/6})^3$ = ~~0.024~~ ft .021 If $D_{50} >= D_{c50}$, $\chi = 0.0$

Otherwise, $\chi = 0.122 y_1 [q_2/(D_{50}^{1/3} y_1^{7/6})]^{6/7} - y_1$ = 0.0 From Figure 10, y_{cs} = 0.0 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 = 0.35 Using pier width a on Figure 11, ξ = 8.3 Pier scour y_{ps} = 7.1 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 3.0 ft right abutment, y_{aRT} = ~~0.5~~ 1.7 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} = 11.5 and ψ_{RT} = ~~2.3~~ 7

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 17.2 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = ~~3.4~~ 10.5 ft

Route HWY 1416 Stream ____________ MRM ________ Date 8/11/11 Initials CG
Bridge Structure No. 52692290 Location 2.2 mi E of Exit 84 on HWY 1416
GPS coordinates: N 44° 05' 46.5" W 102° 39' 53.3" taken from: USL abutment X centerline of ⇑ MRM end ______
Datum of coordinates: WGS84 X NAD27 ______

Drainage area = 3.97 sq. mi.

The average bottom of the main channel was 11.6 ft below top of guardrail at a point 8 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 827			Q_{500} = 1430		
Estimated flow passing through bridge	827			1097		
Estimated road overflow & overtopping	—			333		
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	

PK calc'd 8/8

PK	
2	54.8
5	161
10	278
25	456
50	628
100	827
500	1430

Riprap at abutments? X Yes ____ No ____ Marginal
Evidence of past Scour? ____ Yes X No ____ Don't know
Debris Potential? ____ High X Med ____ 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 ____	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

1899 - IP
00 - US
01 - US RB
02 - US LB
03 - R. Abut
04 - L. Abut
06 - US Face

Summary of Results

	Q100	Q500
Bridge flow evaluated	827	1097
Flow depth at left abutment (yaLT), in feet	1.8	3.0
Flow depth at right abutment (yaRT), in feet	1.1	~~0.5~~ 1.7
Contraction scour depth (ycs), in feet	0.0	0.0
Pier scour depth (yps), in feet	7.0	7.1
Left abutment scour depth (yas), in feet	11.1	17.2
Right abutment scour depth (yas), in feet	7.0	~~3.4~~ 10.5
1Flow angle of attack	30	30

See Comments/Diagram for justification where required

1430
1097
333