Oak Creek

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 16582080 Date 8/9/11 Initials [illegible] Region (A (B) C D)

Site ______ Location 1 mi N + 0.2 mi E of McLaughlin on IRR 108 St

Q_{100} = 6390 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. ✓

Bridge discharge (Q_2) = 6390 (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 = 158 ft. Flow angle at bridge = 0 ° Abut. Skew = 0 ° Effective Skew = 0 °

Width (W_2) iteration = 158 84 93 88 89

Avg. flow depth at bridge, y_2 iteration = 7.5 10.5 9.9 10.2 10.2

Corrected channel width at bridge Section = W_2 times cos of flow angle = 89 ft* $q_2 = Q_2/W_2$ = 71.8 ft²/s

Bridge Vel, V_2 = 7.1 ft/s Final $y_2 = q_2/V_2$ = 10.2 ft Δh = 1.0 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 11.2 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) = 0.035

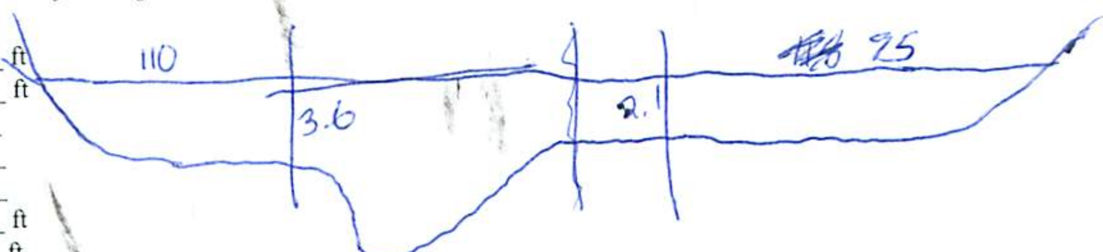
n (LOB) = 0.050

n (ROB) = 0.050

Pier Width = 3.0 ft

Pier Length = 3.0 ft

Piers for 100 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 160 ft

Width of left overbank flow at approach, W_{lob} = 110 ft Average left overbank flow depth, y_{lob} = 2.7 ft

Width of right overbank flow at approach, W_{rob} = ~~[illegible]~~ ft 95 Average right overbank flow depth, y_{rob} = ~~[illegible]~~ ft 1.5

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

x = 11.68 From Figure 9 W_2 (effective) = 83 ft y_{cs} = 12.7 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, $V_1 = Q_{100}/(y_1W_1)$ = ______ 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 $D_{50} >= D_{c50}$, $\chi = 0.0$

Otherwise, $\chi = 0.122y_1[q_2/(D_{50}^{1/3}y_1^{7/6})]^{6/7} - y_1$ = ______ From Figure 10, y_{cs} = ______ 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 = 0.39 Using pier width a on Figure 11, ξ = 10.7 Pier scour y_{ps} = 9.3 ft

3.60 / 0.75 / 1800 / 2520 / 2700

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 2.7 ft right abutment, y_{aRT} = 1.5 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} = 11.0 and ψ_{RT} = 6.3

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 11.0 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 6.3 ft

3.6 / 5.4 / 9.5

16.4 / 11.2 / 5.4 2.9 45.1 / 2.9 3.1 2.10 / .75 / 10.50 5.9 / 2.1 / 60

3 / 9.50 / 0.75 / 4750 / 6650 / 7.1250 2.10 / 0.75 / 1050 / 1470 / 14950

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 16582080 Date 8/9/11 Initials CW Region (A (B) C D)

Site ______ Location 1 mi N + 0.2 E of McLaughlin on IRR 108 St

Q_{500} = 16600 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. ✓

Bridge discharge (Q_2) = 16600 (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 = 158 ft. Flow angle at bridge = 0 ° Abut. Skew = 0 ° Effective Skew = 0 °

Width (W_2) iteration = 158 100 116 110 110

Avg. flow depth at bridge, y_2 iteration = 12.4 15.8 14.5 15.0 15.0

Corrected channel width at bridge Section = W_2 times cos of flow angle = 110 ft* $q_2 = Q_2/W_2$ = 150.9 ft^2/s

Bridge Vel, V_2 = 10.1 ft/s Final $y_2 = q_2/V_2$ = 15.0 ft Δh = 2.1 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 17.1 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) = 0.035

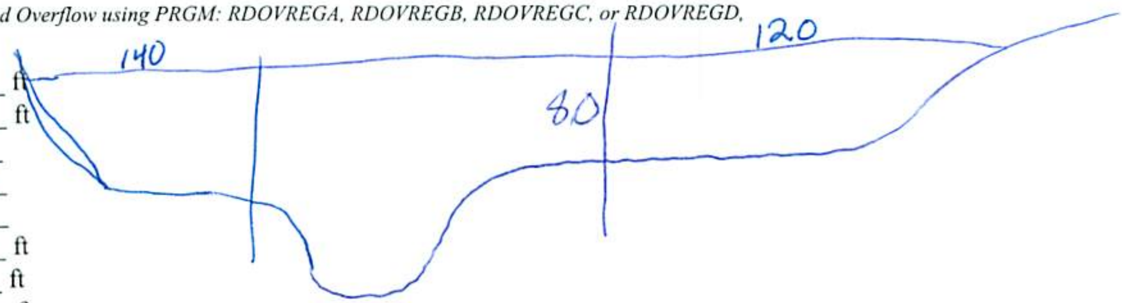
n (LOB) = 0.050

n (ROB) = 0.050

Pier Width = 3.0 ft

Pier Length = 3.0 ft

\# Piers for 500 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 160 ft

Width of left overbank flow at approach, W_{lob} = ~~[illegible]~~ ft 140 Average left overbank flow depth, y_{lob} = 7.1 ft

Width of right overbank flow at approach, W_{rob} = 120 ft Average right overbank flow depth, y_{rob} = 6.0 ft

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

x = 15.34 From Figure 9 W_2 (effective) = 104 ft y_{cs} = 15.2 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, $V_1 = Q_{500}/(y_1 W_1)$ = ______ 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 = 0.46 Using pier width a on Figure 11, ξ = 10.7 Pier scour y_{ps} = 9.5 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 7.1 ft right abutment, y_{aRT} = 6.0 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} = 14.8 and ψ_{RT} = 16.8

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 14.8 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 16.8 ft

8.00
0.75
4000
6000
6000

Route IRR 108 St Stream Oak Ck MRM ________ Date 8/9/11 Initials CEZ

Bridge Structure No. 16582080 Location 1 mi N ~~&~~ + 0.2 mi E of McLaughlin on IRR 108 St

GPS coordinates: N 45° 49' 58.9" W 100° 48' 26.4" taken from: USL abutment X centerline of ⇑ MRM end ______

Datum of coordinates: WGS84 X NAD27 ______

Drainage area = 146.70 sq. mi.

The average bottom of the main channel was 30 ft below top of guardrail at a point 44 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 6390			Q_{500} = 16600		
Estimated flow passing through bridge	6390			16600		
Estimated road overflow & overtopping	~~[illegible]~~			—		
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	

Peaks Calc'd on 8/4

Pk	Q
2	426
5	1300
10	2250
25	3610
50	4920
100	6390
500	16600

Riprap at abutments? ____Yes ____No X 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 ____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 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

Very tall vegetation → lot's of estimating b/c poor visibility

1430 - ID
31 - US
32 - US RB
33 - US LB
34 - R. Abut
35 - App XS LB
36 - App XS RB
37 - Bridge US
38 - L. Abut

Summary of Results

	Q100	Q500
Bridge flow evaluated	6390	16600
Flow depth at left abutment (yaLT), in feet	2.7	7.1
Flow depth at right abutment (yaRT), in feet	1.5	6.0
Contraction scour depth (ycs), in feet	12.7	15.2
Pier scour depth (yps), in feet	9.3	9.5
Left abutment scour depth (yas), in feet	11.0	18.8
Right abutment scour depth (yas), in feet	6.3	16.8
1Flow angle of attack	0	0

See Comments/Diagram for justification where required