OK RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 5806 4260 Date 6/9/10 Initials CW Region (A B (C) D)

Site ________ Location from South edge Redfield, 2.7 W

Q_{100} = 16800 by: drainage area ratio ✓ flood freq. anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = 16800 (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 = 177 ft. Flow angle at bridge = 20 ° Abut. Skew = 0 ° Effective Skew = 20°

Width (W_2) iteration = 177 153 161 159

Avg. flow depth at bridge, y_2 iteration = 14.2 15.2 14.9 15.0

Corrected channel width at bridge Section = W_2 times cos of flow angle = 149.41 ft* $q_2 = Q_2/W_2$ = 112.4 ft^2/s

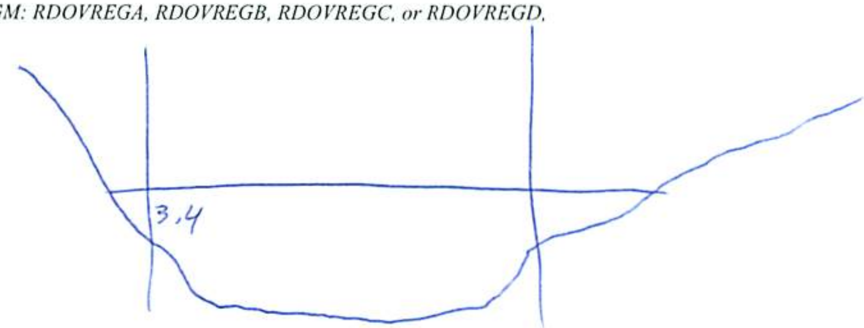
Bridge Vel, V_2 = 7.5 ft/s Final $y_2 = q_2/V_2$ = 15. ft Δh = 1.2 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 16.1 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. = 21.2 ft
n (Channel) = 0.033
n (LOB) = 0.040
n (ROB) = 0.040
Pier Width = 2.5 ft
Pier Length = 2.5 ft
Piers for 100 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 230 ft

Width of left overbank flow at approach, W_{lob} = 6 ft Average left overbank flow depth, y_{lob} = ~~3.4~~ 1.7 ft

Width of right overbank flow at approach, W_{rob} = 93 ft Average right overbank flow depth, y_{rob} = ~~5.1~~ ~~2.5~~ ft 2.6

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

x = 9.96 From Figure 9 W_2 (effective) = 144.4 ft y_{cs} = 10.9 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, $V_c = 11.52 y_1^{1/6} D_{50}^{1/3}$ = ______ 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 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 = 9.5 Pier scour y_{ps} = 3.1 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 1.7 ft right abutment, y_{aRT} = 2.6 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} = 7.0 and ψ_{RT} = 10.6

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 7.0 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 10.6 ft

28.40
1.65
24.75
3.60
21.15

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 58064260 Date 6/9/10 Initials CW Region (A B (C) D)

Site ______ Location from South edge Redfield, 2.7 W

Q_{500} = 33900 by: drainage area ratio ✓ flood freq. anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = 33900 (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 = 177 ft. Flow angle at bridge = 20 ° Abut. Skew = 0 ° Effective Skew = 20 °

Width (W_2) iteration = 177 177 ____ ____

Avg. flow depth at bridge, y_2 iteration = 20.1 20.1 ____ ____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 166.33 ft* $q_2 = Q_2/W_2$ = 203.8 ft²/s

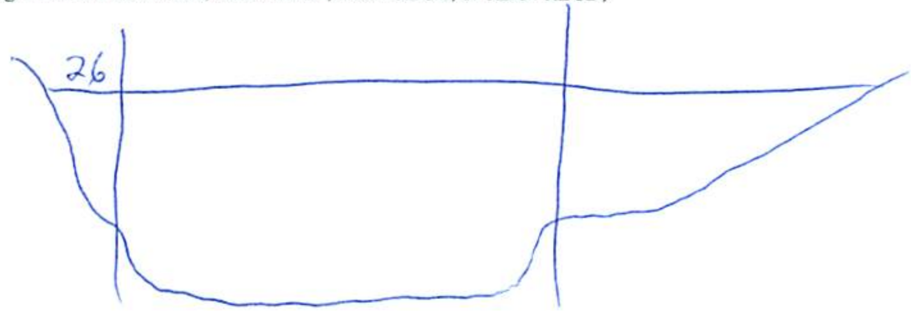
Bridge Vel, V_2 = 10.1 ft/s Final $y_2 = q_2/V_2$ = 20.1 ft Δh = 2.1 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 22.2 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. = 21.2 ft
n (Channel) = 0.033
n (LOB) = 0.040
n (ROB) = 0.040
Pier Width = 2.5 ft
Pier Length = 2.5 ft
\# Piers for 500 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 230 ft

Width of left overbank flow at approach, W_{lob} = 26 ft Average left overbank flow depth, y_{lob} = 3.0 ft (6.1)

Width of right overbank flow at approach, W_{rob} = 142 ft Average right overbank flow depth, y_{rob} = 4.4 ft (8.4)

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

x = 10.64 From Figure 9 W_2 (effective) = 161.3 ft y_{cs} = 11.6 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, $Vc = 11.52 y_1^{1/6} D_{50}^{1/3}$ = ____ 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 Correction factor for flow angle of attack (from Table 1), K2 = 1

Froude # at bridge = 0.4 Using pier width a on Figure 11, ξ = 9.5 Pier scour y_{ps} = 8.3 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 3.0 ft right abutment, y_{aRT} = 4.4 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} = 11.5 and ψ_{RT} = 14.0

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 11.5 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 14.0 ft

Route 174 St Stream Turtle Creek MRM ______ Date 6/9/10 Initials Ch

Bridge Structure No. 58064260 Location from South edge Redfield 2.7 W

GPS coordinates: N 44°51'53.9" W 98°34'41.4" taken from: USL abutment X centerline of ⇑ MRM end ______

Datum of coordinates: WGS84 X NAD27 ______

Drainage area = 1403.48 sq. mi.

The average bottom of the main channel was 28 ft below top of guardrail at a point 47 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} =	16800		Q_{500} =	33900	
Estimated flow passing through bridge		16800			33900	
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 ____No X Marginal

Evidence of past Scour? X Yes ____No ____Don't know

Debris Potential? ____High ____Med X 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

1653 - ID
54 - US
55 - US RB
56 - US LB
57 - erosion @ L. Abut
58 - Piers
59 - L. Abut
60 - R. Abut
61 - asphalt erosion?
62 - "
63 - L. Abut
64 - R. Abut
65 - App RB
66 - App XS LB
67 - US Face Bridge
68 - ? on RB US
69 - US Face Bridge

Summary of Results

	Q100	Q500
Bridge flow evaluated	16800	33900
Flow depth at left abutment (yaLT), in feet	1.7	3.0
Flow depth at right abutment (yaRT), in feet	2.6	4.4
Contraction scour depth (ycs), in feet	10.9	11.6
Pier scour depth (yps), in feet	8.1	8.3
Left abutment scour depth (yas), in feet	7.0	11.5
Right abutment scour depth (yas), in feet	10.6	14.0
1Flow angle of attack	20	2

See Comments/Diagram for justification where required