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SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 63139120 Date 10-16-12 Initials RFT Region (A B C D) [C circled]

Site ______ Location 2.1 mi W Hwy 19 on 280 St

Q_{100} = 1040 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. ✓

Bridge discharge (Q_2) = 1040 (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 = 0 ° Abut. Skew = 0 ° Effective Skew = 0 °

Width (W_2) iteration = 33

Avg. flow depth at bridge, y_2 iteration = 7.9

Corrected channel width at bridge Section = W_2 times cos of flow angle = 33 ft* $q_2 = Q_2/W_2$ = 31.5 ft²/s

Bridge Vel, V_2 = 4.0 ft/s Final $y_2 = q_2/V_2$ = 7.9 ft Δh = 0.3 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 8.2 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.

low flow channel angles west, but this happens more than 1 bridge width upstream

Water Surface Elev. = dry ft road overflow begins when $y_2 \approx$ 7.9 ft

Low Steel Elev. = 5.2 ft

n (Channel) = .030 smooth, tall veg.

n (LOB) = .035 } cornfields

n (ROB) = .035

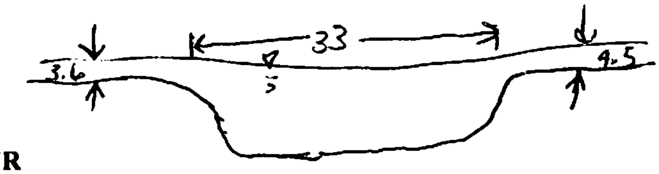
Pier Width = 1.35 ft

Pier Length = 1.35 ft

\# Piers for 100 yr = 2 ft

$Q_{100} \approx Q_{max\ scour}$

approach section is fenceline



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 33 ft

Width of left overbank flow at approach, W_{lob} = 33 ft* Average left overbank flow depth, y_{lob} = 3.6 ft

Width of right overbank flow at approach, W_{rob} = 33 ft Average right overbank flow depth, y_{rob} = 4.5 ft

a field approach on left side helps guide flow to bridge and reduces overbank depth

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

x = 5.49 From Figure 9 W_2 (effective) = 30.3 ft y_{cs} = 6.2 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, $V_1 = Q_{100}/(y_1 W_1)$ = ______ 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 $D_{50} >= D_{c50}$, $\chi = 0.0$

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 = 0.25 Using pier width a on Figure 11, ξ = 6 Pier scour y_{ps} = 4.8 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 3.6 ft right abutment, y_{aRT} = 4.5 ft

Shape coefficient K_1= 1.00 for vertical-wall, (0.82 for vertical-wall with wingwalls) [circled], 0.55 for spill-through

Using values for y_{aLT} and y_{aRT} on figure 12, ψ_{LT} = 12.6 and ψ_{RT} = 14.1

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 18.7 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 21.1 ft

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SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 63139120 Date ______ Initials ______ Region (A B (C) D)

Site ______ Location ______

Q_{500} = ______ by: drainage area ratio ______ flood freq. anal. ______ regional regression eq. X

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

Width (W_2) iteration = ______ ______ ______ ______

Avg. flow depth at bridge, y_2 iteration = ______ ______ ______ ______

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

Bridge Vel, V_2 = ______ ft/s Final $y_2 = q_2/V_2$ = ______ ft Δh = ______ ft

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

Low Steel Elev. = 5.2 ft

$Q_{max scour} \approx Q_{100}$ see page 1

n (Channel) = ______

n (LOB) = ______

n (ROB) = ______

Pier Width = ______ ft

Pier Length = ______ ft

\# Piers for 500 yr = ______ ft

CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = ______ ft

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

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

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: Pie

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} = ______ ft right abutment, y_{aRT} = ______ 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} = ______ and ψ_{RT} = ______

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

Route 280 St Stream ____________ MRM ________ Date ________ Initials ________

Bridge Structure No. 63139120 Location 2.1 W Hwy 19 on 280 St

GPS coordinates N43° 19.776' taken from: USL abutment ✓ centerline of ⇑ MRM end ____

W97° 7.469' Datum of coordinates: WGS84 ✓ NAD27 ____

Drainage area = 7.23 sq. mi.

The average bottom of the main channel was 9.3 ft below top of guardrail at a point 14 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 1040 = Qmax scour			Q_{500} =		
Estimated flow passing through bridge	1040 ?					
Estimated road overflow & overtopping	0 ?					
Consideration	Yes	No	Possibly	Yes	No	Possibly
Chance of overtopping	✓					
Chance of Pressure flow	✓					
Armored appearance to channel		✓				
Lateral instability of channel		✓				

9-26-12

Pk	Q
2	49.8
5	157
10	283
25	517
50	752
100	1040
500	1970

Riprap at abutments? ____Yes ✓ No ____Marginal

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

str. no.
approach from bridge
LOB/field approach
ROB
bridge from approach

left abut.
rt. abut.
old pier scour hole

Summary of Results

	Q100 =	Qmax scour ~~Q500~~
Bridge flow evaluated	1040	
Flow depth at left abutment (yaLT), in feet	3.6	
Flow depth at right abutment (yaRT), in feet	4.5	
Contraction scour depth (ycs), in feet	6.2	
Pier scour depth (yps), in feet	4.8	
Left abutment scour depth (yas), in feet	18.7	
Right abutment scour depth (yas), in feet	21.1	
1Flow angle of attack	0°	

See Comments/Diagram for justification where required