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SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 560940010 Date 9-28-12 Initials RFT Region (A B C D)

Site _____ Location 40345 221 St, James River

Q_{100} = 26400 by: drainage area ratio ✓ flood freq. anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = 26400 (should be Q_{100} unless there is a relief bridge, road overflow, or bridge overtopping)

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Analytical Procedure for Estimating Hydraulic Variables Needed to Apply Method

PGRM: "RegionA", "RegionB", "RegionC", or "RegionD"

Bridge Width = 330 ft. Flow angle at bridge = 0 ° Abut. Skew = 0 ° Effective Skew = 0 °

Width (W_2) iteration = 330 272 291 278 280

Avg. flow depth at bridge, y_2 iteration = 12.6 13.9 13.4 13.7 13.7

Corrected channel width at bridge Section = W_2 times cos of flow angle = 280 ft* $q_2 = Q_2/W_2$ = 94.3 ft^2/s

Bridge Vel, V_2 = 6.9 ft/s Final $y_2 = q_2/V_2$ = 13.7 ft Δh = 1.0 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 14.7 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.

road overflow will begin at $y_2 \approx$ 18.3 ft

Water Surface Elev. = ≈0.0 ft

Low Steel Elev. = 19 ft at location chosen for avg. channel bottom

n (Channel) = .03

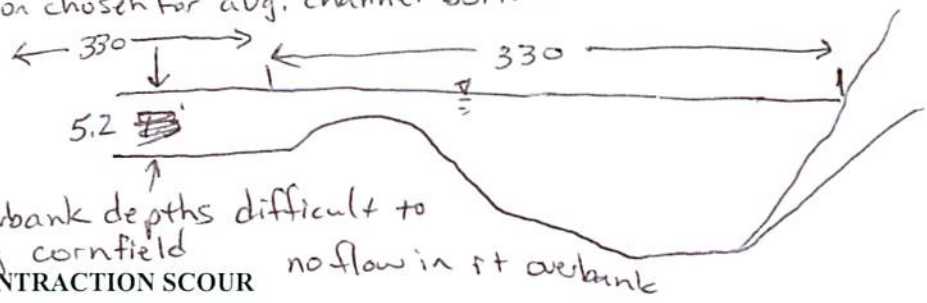
n (LOB) = .04

n (ROB) = .029

Pier Width = 2.25 ft

Pier Length = 3.75 ft

Piers for 100 yr = 3 ft



left overbank depths difficult to estimate because of standing cornfield

no flow in ft overbank

CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 330 ft

Width of left overbank flow at approach, W_{lob} = 330 ft Average left overbank flow depth, y_{lob} = 5.2 ft

Width of right overbank flow at approach, W_{rob} = 0 ft Average right overbank flow depth, y_{rob} = 0 ft

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

x = 5.41 From Figure 9 W_2 (effective) = 273.3 ft y_{cs} = 6.1 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, $Vc = 11.52 y_1^{1/6} D_{50}^{1/3}$ = _____ 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 = 1.667 Correction factor for flow angle of attack (from Table 1), K2 = 1

Froude # at bridge = 0.33 Using pier width a on Figure 11, ξ = 8.8 Pier scour y_{ps} = 7.4 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 5.2 ft right abutment, y_{aRT} = 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} = 15.4 and ψ_{RT} = 0

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 15.4 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 0 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 560094010 Date _____ Initials _____ Region (A B C D)

Site _____ Location 40345 221 St

Q_{500} = 45200 by: drainage area ratio ✓ flood freq. anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = 45200 (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 = 330 ft. Flow angle at bridge = 0 ° Abut. Skew = 0 ° Effective Skew = 0 °

Width (W_2) iteration = 305 301 _____ _____

Avg. flow depth at bridge, y_2 iteration = 17.2 17.3 _____ _____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 301 ft* $q_2 = Q_2/W_2$ = 150.2 ft^2/s

Bridge Vel, V_2 = 8.7 ft/s Final $y_2 = q_2/V_2$ = 17.3 ft Δh = 1.5 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 18.8 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,

road overflow will occur at $y_2 \approx 18.3$, which ~~is bridge~~ has top width of water at bridge of $W_2 \approx 305$

Water Surface Elev. = ≈0.0 ft

Low Steel Elev. = 19 ft at avg bolt

n (Channel) = .030 mostly smooth, but some rocks

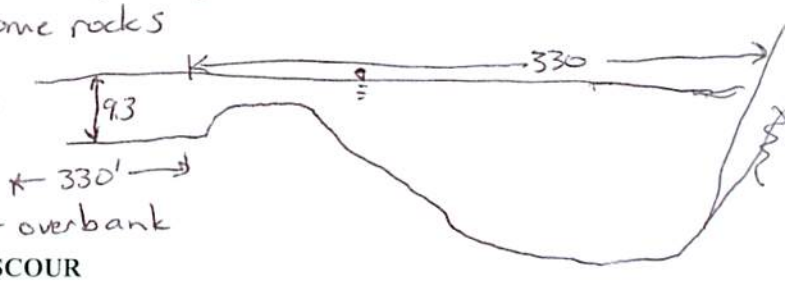
n (LOB) = .040 cornfield

n (ROB) = .029 ungrazed pasture

Pier Width = 2.25 ft

Pier Length = 3.75 ft

Piers for 500 yr = 3 ft



no flow in right overbank

CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 330 ft

Width of left overbank flow at approach, W_{lob} = 330 ft Average left overbank flow depth, y_{lob} = 9.3 ft

Width of right overbank flow at approach, W_{rob} = 0 ft Average right overbank flow depth, y_{rob} = 0 ft

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

x = 6.98 From Figure 9 W_2 (effective) = 296.5 ft y_{cs} = 7.8 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 = 1.667 Correction factor for flow angle of attack (from Table 1), K2 = 1

Froude # at bridge = 0.37 Using pier width a on Figure 11, ξ = 8.8 Pier scour y_{ps} = 7.5 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 9.3 ft right abutment, y_{aRT} = 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} = 20.8 and ψ_{RT} = 0

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 20.8 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 0 ft

Route 221 St Stream James River MRM _____ Date _____ Initials _____

Bridge Structure No. 56094010 Location 40345 221 St

GPS coordinates: N 44° 11.065' taken from: USL abutment ✓ centerline of ⇑ MRM end _____

W 98° 8.524' Datum of coordinates: WGS84 ✓ NAD27 _____

Drainage area = 14872.99 sq. mi. 14622.36

The average bottom of the main channel was 24.5 ft below top of guardrail at a point 56 ft from left abutment.

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

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2	1160
5	6520
10	15400
25	37100
50	63200
100	100000
500	244000

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 26400			Q_{500} = 45200		
Estimated flow passing through bridge	26400			45200		
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 X No ____Marginal Some field stone present, but it may be native material, not placed.

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

Debris Potential? ____High ____Med 1 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

Structure no.
approach from bridge
LOB from bridge
ROB from LOB approach
bridge from approach
left abut.
right abut.
local erosion on left abut.

Summary of Results

	Q100	Q500
Bridge flow evaluated	26400	45200
Flow depth at left abutment (yaLT), in feet	5.2	9.3
Flow depth at right abutment (yaRT), in feet	0	0
Contraction scour depth (ycs), in feet	6.1	7.8
Pier scour depth (yps), in feet	7.4	7.5
Left abutment scour depth (yas), in feet	15.4	20.8
Right abutment scour depth (yas), in feet	0	0
1Flow angle of attack	0°	0°

See Comments/Diagram for justification where required