OK-RAT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 56110046 Date 9-27-12 Initials RFT Region (A B C D)

Site _____ Location 22455 405th Ave, 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)

Analytical Procedure for Estimating Hydraulic Variables Needed to Apply Method

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

Bridge Width = 220 ft. Flow angle at bridge = 30 ° Abut. Skew = 30 ° Effective Skew = 0 °

Width (W_2) iteration = 186 212 220 _____

Avg. flow depth at bridge, y_2 iteration = 18 16.9 16.6 _____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 190.53 ft* $q_2 = Q_2/W_2$ = 138.6 ft^2/s

Bridge Vel, V_2 = 8.3 ft/s Final $y_2 = q_2/V_2$ = 16.6 ft Δh = 1.4 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 18.0 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.

waters will reach low steel at Q_{100}

Water Surface Elev. = ≈20.0 ft

Low Steel Elev. = 15.3 ft (at location of avg. channel bottom)

n (Channel) = .023 mostly smooth + straight

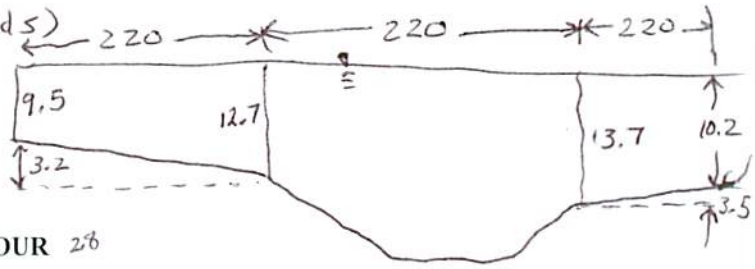
n (LOB) = .025 (bare field w/ few weeds)

n (ROB) = .030 taller weeds

Pier Width = 3 ft

Pier Length = 3 ft

Piers for 100 yr = 2 ft



CONTRACTION SCOUR 256

PGRM: Contract

Width of main channel at approach section W_1 = 220 ft

Width of left overbank flow at approach, W_{lob} = 220 ft Average left overbank flow depth, y_{lob} = 11.1 ft

Width of right overbank flow at approach, W_{rob} = 220 ft Average right overbank flow depth, y_{rob} = 11.95 ft

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

x = 20.59 From Figure 9 W_2 (effective) = 184.5 ft y_{cs} = 18.0 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 Correction factor for flow angle of attack (from Table 1), K2 = 1

Froude # at bridge = 0.36 Using pier width a on Figure 11, ξ = 10.7 Pier scour y_{ps} = 9.2 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 11.1 ft right abutment, y_{aRT} = 11.95 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} = 22.2 and ψ_{RT} = 23.0

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 22.2 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 23.0 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 56110046 Date _____ Initials _____ Region (A B C D)

Site _____ Location 22455 405th Ave

Q_{500} = 45300 by: drainage area ratio ____ flood freq. anal. ✓ regional regression eq. ____

Bridge discharge (Q_2) = 34248 (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 = 220 ft. Flow angle at bridge = 30 ° Abut. Skew = 30 ° Effective Skew = 0 °

Width (W_2) iteration = 220 _____ _____ _____

Avg. flow depth at bridge, y_2 iteration = 18.9 _____ _____ _____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 190.53 ft* $q_2 = Q_2/W_2$ = 179.8 ft^2/s

Bridge Vel, V_2 = 9.5 ft/s Final $y_2 = q_2/V_2$ = 18.9 ft Δh = 1.9 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 20.8 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 $y_2 \approx 18.9$ Assume this coincides with $Q_{max\ scour} \approx 34248$ cfs

Water Surface Elev. = ≈0.0 ft

Low Steel Elev. = 15.3 ft

n (Channel) = .023

n (LOB) = .025

n (ROB) = .030

Pier Width = 3 ft

Pier Length = 3 ft

Piers for 500 yr = 2 ft

CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 220 ft

Width of left overbank flow at approach, W_{lob} = 220 ft Average left overbank flow depth, y_{lob} = 13.9 ft

Width of right overbank flow at approach, W_{rob} = 220 ft Average right overbank flow depth, y_{rob} = 14.75 ft

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

x = 26.37 From Figure 9 W_2 (effective) = 184.5 ft y_{cs} = 21.1 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, $V_1 = Q_{500}/(y_1 W_1)$ = _____ 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

PGRM: Pier

PIER SCOUR CALCULATIONS

L/a ratio = 1 Correction factor for flow angle of attack (from Table 1), K2 = 1

Froude # at bridge = 0.39 Using pier width a on Figure 11, ξ = 10.7 Pier scour y_{ps} = 9.3 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 13.9 ft right abutment, y_{aRT} = 14.75 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} = 24.6 and ψ_{RT} = 25.3

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 24.6 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 25.3 ft

Route 405 Ave Stream James River MRM _____ Date _____ Initials _____

Bridge Structure No. 56110046 Location 22455 405th Ave

GPS coordinates: N 44° 7.993' taken from: USL abutment ✓ centerline of ⇑ MRM end _____

W 98° 6.646' Datum of coordinates: WGS84 ✓ NAD27 _____

Drainage area = 14882.87 sq. mi. 14622.39

The average bottom of the main channel was 22.9 ft below top of guardrail at a point 37 ft from left abutment.

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

streamstats ↓ 7/3

2	1160
5	6580
10	18100
25	37100
50	63200
100	100000
500	244000

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 26400			Q_{500} = 45300		
Estimated flow passing through bridge	26400			34248		
Estimated road overflow & overtopping				11052		
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 ____No ____Marginal fieldstone + boulders

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

Debris Potential? ____High ✓Med ____Low

Does scour countermeasure(s) appear to have been designed?

Riprap ____Yes ____No ✓Don't know ____NA possibly,

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 from bridge
ROB from bridge
Bridge from ROB

left abut.
rt. abut.
concrete poured on rt abut
flood debris on pier caps

Summary of Results

	Q100	Q500 max Scour
Bridge flow evaluated	26400	34248
Flow depth at left abutment (yaLT), in feet	11.1	13.9
Flow depth at right abutment (yaRT), in feet	11.95	14.75
Contraction scour depth (ycs), in feet	18.0	21.1
Pier scour depth (yps), in feet	9.2	9.3
Left abutment scour depth (yas), in feet	22.2	24.6
Right abutment scour depth (yas), in feet	23.0	25.3
1Flow angle of attack	30° (0° eff)	30° (0° eff)

See Comments/Diagram for justification where required