DUP ok-RaT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 07200234 Date 10-10-12 Initials RFT Region (A B C (D))

Site ____________ Location 12340 396th Ave (near Columbia), Elm River

Q_{100} (Q_{50}) = 13200 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 13200 (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 = 211 ft. Flow angle at bridge = 0 ° Abut. Skew = 0 ° Effective Skew = 0 °

Width (W_2) iteration = 211 177 182 180

Avg. flow depth at bridge, y_2 iteration = 16.2 17.8 17.5 17.6

Corrected channel width at bridge Section = W_2 times cos of flow angle = 180 ft* $q_2 = Q_2/W_2$ = 73.3 ft^2/s

Bridge Vel, V_2 = 4.2 ft/s Final $y_2 = q_2/V_2$ = 17.6 ft Δh = 0.3 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 17.9 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. = 2.1 ft

Low Steel Elev. = 19.3 @ table

n (Channel) = .035

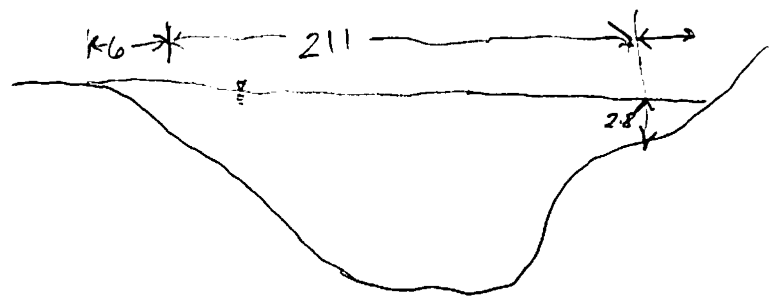
n (LOB) = .035

n (ROB) = .045

Pier Width = 2.2 ft

Pier Length = 2.33 ft

\# Piers for 100 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 211 ft

Width of left overbank flow at approach, W_{lob} = 6 ft Average left overbank flow depth, y_{lob} = 0.3 ft

Width of right overbank flow at approach, W_{rob} = 15 ft Average right overbank flow depth, y_{rob} = 1.4 ft

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

x = 3.63 From Figure 9 W_2 (effective) = 175.6 ft y_{cs} = 4.2 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, $Vc = 11.52 y_1^{1/6} D_{50}^{1/3}$ = ________ 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 = 1.06 Correction factor for flow angle of attack (from Table 1), K2 = 1

Froude # at bridge = 0.18 Using pier width a on Figure 11, ξ = 8.6 Pier scour y_{ps} = 6.6 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 0.3 ft right abutment, y_{aRT} = 1.4 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} = 1.4 and ψ_{RT} = 5.9

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 1.4 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 5.9 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 07200234 Date ________ Initials ________ Region (A B C (D))

Site ________ Location ________

Q_{500} (100) = 20100 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 20100 (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 = 211 ft. Flow angle at bridge = 0 ° Abut. Skew = 0 ° Effective Skew = 0 °

Width (W_2) iteration = 211 ____ ____ ____

Avg. flow depth at bridge, y_2 iteration = 20.2 ____ ____ ____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 211 ft* $q_2 = Q_2/W_2$ = 95.3 ft^2/s

Bridge Vel, V_2 = 4.7 ft/s Final $y_2 = q_2/V_2$ = 20.2 ft Δh = 0.4 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 20.7 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 $y_2 \approx 20.7$

Water Surface Elev. = 2.1 ft

Low Steel Elev. = 19.3 ft @ tape

n (Channel) = .035

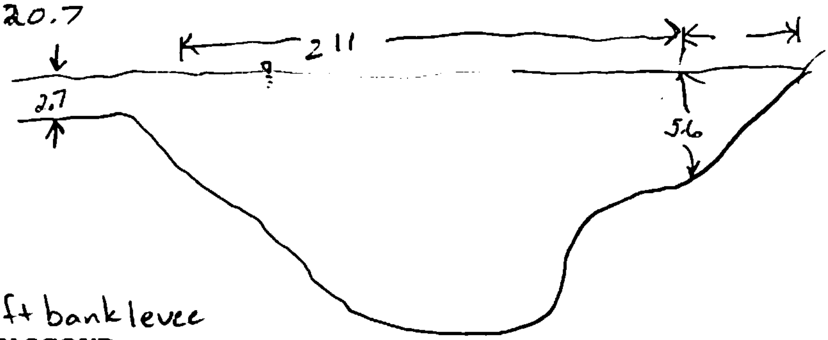
n (LOB) = .035

n (ROB) = .045

Pier Width = 2.2 ft

Pier Length = 2.33 ft

Piers for 500 yr = 2 ft



assume ineffective flow behind left bank levee

CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 211 ft

Width of left overbank flow at approach, W_{lob} = 18 ft Average left overbank flow depth, y_{lob} = 2.7 ft

Width of right overbank flow at approach, W_{rob} = 30 ft Average right overbank flow depth, y_{rob} = 2.8 ft

<u>Live Bed Contraction Scour</u> (use if bed material is small cobbles or finer)

x = 0.58 From Figure 9 W_2 (effective) = 206.6 ft y_{cs} = 1 ft

PGRM: CWCSNEW

<u>Clear Water Contraction Scour</u> (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, $V_c = 11.52 y_1^{1/6} D_{50}^{1/3}$ = ________ 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}, χ = 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 = 1.06 Correction factor for flow angle of attack (from Table 1), K2 = 1

Froude # at bridge = 0.18 Using pier width a on Figure 11, ξ = 8.6 Pier scour y_{ps} = 6.7 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 2.7 ft right abutment, y_{aRT} = 2.8 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 and ψ_{RT} = 11.2

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 11 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 11.2 ft

Route 396 Ave Stream Elm River MRM________ Date ____________ Initials________

Bridge Structure No. 07200234 Location ______________________

GPS coordinates: N 45° 35.927' taken from: USL abutment ✓ centerline of ⇑ MRM end ______

W98° 18.665' Datum of coordinates: WGS84 ✓ NAD27____

Drainage area = 1253.07 sq. mi.

The average bottom of the main channel was 24.6 ft below top of guardrail at a point 79 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	Q50= 13200			Q100= 20100		
Estimated flow passing through bridge	13200			20100		
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 ✓ No ____Marginal

Evidence of past Scour? ____Yes ____No ✓ Don't know possible contraction / pier scour

Debris Potential? ✓ High ____Med ____Low debris jam on left side pier

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 / levee from road
ROB from road
left abut. and debris jam

right abut from left
bridge section from left approach

Summary of Results

	Q50	Q100
Bridge flow evaluated	13200	20100
Flow depth at left abutment (yaLT), in feet	0.3	2.7
Flow depth at right abutment (yaRT), in feet	1.4	2.8
Contraction scour depth (ycs), in feet	4.2	* 1
Pier scour depth (yps), in feet	6.6	6.7
Left abutment scour depth (yas), in feet	1.4	11.0
Right abutment scour depth (yas), in feet	5.9	11.2
1Flow angle of attack	0°	0°

See Comments/Diagram for justification where required

* contraction scour decreased as flow increased because the increase in stage caused a relatively large increase in wetted width at the bridge. Equation "thinks" there is more room for flow then.