Dup OK-RAT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 51177030 Date 10-11-12 Initials RFT Region (A B C D)

Site ____________ Location 3.7 mi W of Ward on 223 St

Q_{100} = 3890 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 3890 (should be Q_{100} unless there is a relief bridge, road overflow, or bridge overtopping)

N→S

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

Analytical Procedure for Estimating Hydraulic Variables Needed to Apply Method

Bridge Width = 118 ft. Flow angle at bridge = 10 ° Abut. Skew = 0 ° Effective Skew = 10 °

Width (W_2) iteration = 118 116

Avg. flow depth at bridge, y_2 iteration = 8.2 8.2

Corrected channel width at bridge Section = W_2 times cos of flow angle = 114.24 ft* $q_2 = Q_2/W_2$ = 34.1 ft^2/s

Bridge Vel, V_2 = 4.1 ft/s Final $y_2 = q_2/V_2$ = 8.2 ft Δh = 0.3 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 8.6 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.

moved approach section further upstream to avoid old road bed

Water Surface Elev. = 11.0 ft

Low Steel Elev. = 14.4 ft

n (Channel) = .035

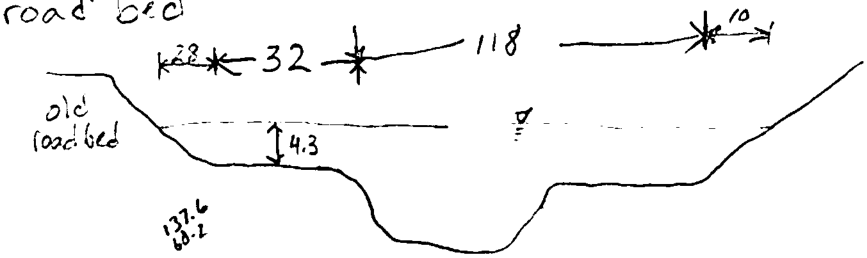
n (LOB) = .030

n (ROB) = .030

Pier Width = 1.69 ft

Pier Length = 1.69 ft

Piers for 100 yr = 4 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 118 ft

Width of left overbank flow at approach, W_{lob} = 60 ft Average left overbank flow depth, y_{lob} = 3.3 ft

Width of right overbank flow at approach, W_{rob} = 10 ft Average right overbank flow depth, y_{rob} = 0.9 ft

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

x = 2 From Figure 9 W_2 (effective) = 107.5 ft y_{cs} = 2.5 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 = 7 Pier scour y_{ps} = 5.7 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 3.3 ft right abutment, y_{aRT} = 0.9 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} = 12 and ψ_{RT} = 3.9

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 12 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 3.9 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 51177030 Date ______ Initials ______ Region (A B (C) D)

Site ______ Location ______

Q_{500} = 5990 by: drainage area ratio ___ flood freq. anal. ___ regional regression eq. X

Bridge discharge (Q_2) = 5990 (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 = 118 ft. Flow angle at bridge = 10 ° Abut. Skew = 0 ° Effective Skew = 10 °

Width (W_2) iteration = 118 ___ ___ ___

Avg. flow depth at bridge, y_2 iteration = 10.1 ___ ___ ___

Corrected channel width at bridge Section = W_2 times cos of flow angle = 116.21 ft* $q_2 = Q_2/W_2$ = 51.5 ft^2/s

Bridge Vel, V_2 = 5.1 ft/s Final $y_2 = q_2/V_2$ = 10.1 ft Δh = 0.5 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 10.7 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.

assume overbank beyond road ccd is ineffective flow

Water Surface Elev. = 1.0 ft

Low Steel Elev. = 14.4 ft

n (Channel) = .035

n (LOB) = .030

n (ROB) = .030

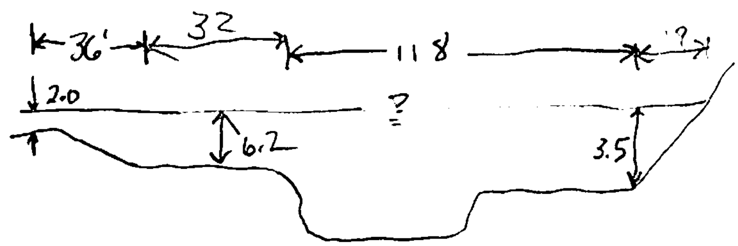
Pier Width = 1.69 ft

Pier Length = 1.69 ft

Piers for 500 yr = 4 ft

198.4

147.6



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 118 ft

Width of left overbank flow at approach, W_{lob} = 68 ft Average left overbank flow depth, y_{lob} = 5.1 ft

Width of right overbank flow at approach, W_{rob} = 19 ft Average right overbank flow depth, y_{rob} = 1.75 ft

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

x = 3.2 From Figure 9 W_2 (effective) = 109.5 ft y_{cs} = 3.8 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, $V_1 = Q_{500}/(y_1W_1)$ = ___ ft/s

Critical approach velocity, $V_c = 11.17y_1^{1/6}D_{50}^{1/3}$ = ___ 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, $\chi = 0.122y_1[q_2/(D_{50}^{1/3}y_1^{7/6})]^{6/7} - y_1$ = ___ 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 = 0.28 Using pier width a on Figure 11, ξ = 7 Pier scour y_{ps} = 5.8 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 5.1 ft right abutment, y_{aRT} = 1.75 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} = 15.2 and ψ_{RT} = 7.2

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 15.2 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 7.2 ft

Route 223 St Stream Spring Creek MRM ________ Date ____________ Initials ________

Bridge Structure No. 51177030 Location 3.7 mi W of Ward on 223rd St

GPS coordinates: N 44° 9.286' W 96° 32.181' taken from: USL abutment ✓ centerline of ⇑ MRM end ______

Datum of coordinates: WGS84 ✓ NAD27 ______

Drainage area = 36.09 sq. mi.

The average bottom of the main channel was 18.3 ft below top of guardrail at a point 39 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 3890			Q_{500} = 5990		
Estimated flow passing through bridge	3890			5990		
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

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

Debris Potential? ____High ____Med X 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 and old roadbed
ROB
Bridge from approach

there is a trashline of grass on a barb wire fence [illegible] indicates a flow between Q_{100} and Q_{500} has recently (this spring or summer) occurred at this site.

left abut. from ditch
rt. abut. from under bridge

old roadbed may help guide LOB flow toward bridge opening

Summary of Results

	Q100	Q500
Bridge flow evaluated	3890	5990
Flow depth at left abutment (yaLT), in feet	3.3	5.1
Flow depth at right abutment (yaRT), in feet	0.9	1.75
Contraction scour depth (ycs), in feet	2.5	3.8
Pier scour depth (yps), in feet	5.7	5.8
Left abutment scour depth (yas), in feet	12	15.2
Right abutment scour depth (yas), in feet	3.9	7.2
1Flow angle of attack	10°	10°

See Comments/Diagram for justification where required