SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 54144100 Date 10-28 Initials RT Region (A B (C) D)

Site _____ Location from Gettysburg 5W, 6N, 2.5W

Q_{100} = 2750 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. ✓

Bridge discharge (Q_2) = 2750 (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

Bridge Width = 100 ft. Flow angle at bridge = 10 ° Abut. Skew = 0 ° Effective Skew = 10 °

Width (W_2) iteration = 98.5 86.6 88.6 _____

Avg. flow depth at bridge, y_2 iteration = 7.5 8.0 7.9 _____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 88.6 ft* $q_2 = Q_2/W_2$ = 31 ft^2/s

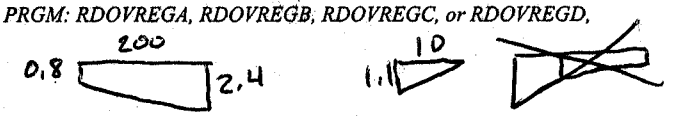
Bridge Vel, V_2 = 3.9 ft/s Final $y_2 = q_2/V_2$ = 7.9 ft Δh = 0.3 ft

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,

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



Water Surface Elev. = -0.4 ft

Low Steel Elev. = 13.2 ft

n (Channel) = .027

n (LOB) = .027

n (ROB) = .027

Pier Width = 0.85 ft

Pier Length = 0.85 ft

Piers for 100 yr = 2 ft

} medium grass, smooth channel, trapezoidal manmade channel near bridge?

steel I-beam piers, 8 piers per set plus 2 diagonals approx. 4.5 feet between verticals

CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 110 ft

Width of left overbank flow at approach, W_{lob} = 200 ft = 2x bridge opening Average left overbank flow depth, y_{lob} = 1.6 ft

Width of right overbank flow at approach, W_{rob} = 10 ft Average right overbank flow depth, y_{rob} = 0.55 ft

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

x = 3.43 From Figure 9 W_2 (effective) = 86.9 ft y_{cs} = 4 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, $V_1 = Q_{100}/(y_1W_1)$ = _____ ft/s

Critical approach velocity, $Vc = 11.17y_1^{1/6}D_{50}^{1/3}$ = _____ 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 = .24 Using pier width a on Figure 11, ξ = 4.1 Pier scour y_{ps} = 3.3 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 1.6 ft right abutment, y_{aRT} = .55 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} = 6.6 and ψ_{RT} = 2.5

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 6.6 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 2.5 ft

SCOUR ANALYSIS AND REPORTING FORM

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

Site _____ Location _____

Q_{500} = 5420 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. ✓

Bridge discharge (Q_2) = 5420 (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 = 100 ft. Flow angle at bridge = 10 ° Abut. Skew = 0 ° Effective Skew = 10 °

Width (W_2) iteration = 100

Avg. flow depth at bridge, y_2 iteration = 10.5

Corrected channel width at bridge Section = W_2 times cos of flow angle = 98.5 ft* $q_2 = Q_2/W_2$ = 55 ft^2/s

Bridge Vel, V_2 = 5.3 ft/s Final $y_2 = q_2/V_2$ = 10.5 ft Δh = 0.6 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 11.0 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,

Water Surface Elev. = 10.4 ft

Low Steel Elev. = 13.2 ft

n (Channel) = .027

n (LOB) = .027

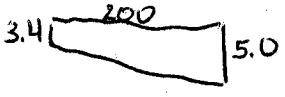
n (ROB) = .027

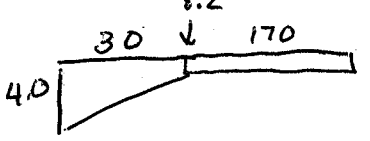
Pier Width = 0.85 ft

Pier Length = 0.85 ft

Piers for 500 yr = 2 ft

bridge flows abutment to abutment at Q_{500}, but will probably not reach low steel





34

PGRM: Contract

CONTRACTION SCOUR

Width of main channel at approach section W_1 = 110 ft

Width of left overbank flow at approach, W_{lob} = 200 ft Average left overbank flow depth, y_{lob} = 4.2 ft

Width of right overbank flow at approach, W_{rob} = 200 ft Average right overbank flow depth, y_{rob} = 0.48 ft

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

x = 6.19 From Figure 9 W_2 (effective) = 96.8 ft y_{cs} = 6.9 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, $Vc = 11.17y_1^{1/6}D_{50}^{1/3}$ = _____ 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

PGRM: Pier

PIER SCOUR CALCULATIONS

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

Froude # at bridge = .29 Using pier width a on Figure 11, ξ = 4.1 Pier scour y_{ps} = 3.4 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 4.2 ft right abutment, y_{aRT} = .48 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} = 13.6 and ψ_{RT} = 2.2

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 13.6 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 2.2 ft

Route 158 St Stream Little Cheyenne MRM _____ Date 10-28 Initials RT

Bridge Structure No. 54144100 Location from Gettysburg, SW, 6N, 2.5W

GPS coordinates: 45° 6.058' taken from: USL abutment ✓ centerline of ⇑ MRM end _____

100° 6.791' Datum of coordinates: WGS84 ✓ NAD27 _____

Drainage area = 62.9 sq. mi.

The average bottom of the main channel was 17.4 ft below top of guardrail at a point 20 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 2750			Q_{500} = 5420		
Estimated flow passing through bridge	2750			5420		
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		✓			✓	

Riprap at abutments? ____Yes ✓No ____Marginal

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

Debris Potential? ____High ____Med ✓Low

scour pool under bridge abutments appear to be eroded underbridge on both sides, but OK where vegetated

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____	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

abutment scour may be mitigated by shaped channel and smooth transition to bridge opening

photos
Structure number
approach from bridge
LOB from bridge
ROB from bridge
Bridge from low flow channel @ approach
scour pool under bridge / pier config.

Summary of Results

	Q100	Q500
Bridge flow evaluated	2750	5420
Flow depth at left abutment (yaLT), in feet	1.6	4.2
Flow depth at right abutment (yaRT), in feet	0.55	0.48 (area weighted)
Contraction scour depth (ycs), in feet	4.0	6.9
Pier scour depth (yps), in feet	3.3	3.4
Left abutment scour depth (yas), in feet	~~7.6~~ 6.6	13.6
Right abutment scour depth (yas), in feet	2.5	2.2
1Flow angle of attack	10°	10°

See Comments/Diagram for justification where required

Basin Characteristics from Provisional Stream Stats 10-17-11

Cont. D.A. = 62.9

PIT = 0.68

100% Subregion B

Manually calculated Peaks

$Q_{100} = 2750$ cfs

$Q_{500} = 5420$ cfs