SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 07095100 Date 10-11-11 Initials RT Region (A B C D)

Site _____ Location 3S, 1W from Frederick

Q_{100} = 11,300 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. ✓

Bridge discharge (Q_2) = 2600 (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 = 100 ft. Flow angle at bridge = 16 ° Abut. Skew = 30 ° Effective Skew = 16 °

Width (W_2) iteration = 96.1 _____ _____ _____

Avg. flow depth at bridge, y_2 iteration = 10.4 _____ _____ _____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 96.1 ft* $q_2 = Q_2/W_2$ = 27 ft^2/s

Bridge Vel, V_2 = 2.6 ft/s Final $y_2 = q_2/V_2$ = 10.4 ft Δh = 0.1 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 10.5 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. = 0.4 ft

Low Steel Elev. = 10.2 ft

n (Channel) = .027

n (LOB) = .028

n (ROB) = .029

Pier Width = 1.35 ft

Pier Length = 1.35 ft

Piers for 100 yr = 2 ft

This location has a left bank higher than the bridge, so left abutment scour will be close to zero. low spot in road west of bridge. Bridge was overtopped at west end this spring/summer. Local land owner said there is road overflow every spring. Assume Qmax scour occurs at point road overflow begins = 10.2 ft ≈ Q = 2600

CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 100 ft

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

Width of right overbank flow at approach, W_{rob} = 200 ft Average right overbank flow depth, y_{rob} = 3.1 ft

2 limited because of road overflow

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

x = 3.48 From Figure 9 W_2 (effective) = 93.4 ft y_{cs} = 4.1 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, $Vc = 11.17 y_1^{1/6} D_{50}^{1/3}$ = _____ 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 = 0.14 Using pier width a on Figure 11, ξ = 6 Pier scour y_{ps} = 4.4 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 0 ft right abutment, y_{aRT} = 3.1 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} = 0 and ψ_{RT} = 11.7

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 0 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 11.7 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 07095100 Date _____ Initials _____ Region (A B C D)

Site _____ Location _____

Q_{500} = 24,200 by: drainage area ratio _____ flood freq. anal. _____ regional regression eq. _____

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

Width (W_2) iteration = _____ _____ _____ _____

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

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

Bridge Vel, V_2 = _____ ft/s Final $y_2 = q_2/V_2$ = _____ ft Δh = _____ ft

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

Water Surface Elev. = _____ ft

Low Steel Elev. = _____ ft

n (Channel) = _____

n (LOB) = _____

n (ROB) = _____

Pier Width = _____ ft

Pier Length = _____ ft

Piers for 500 yr = _____ ft

$Q_{max\ scour} < Q_{100}$

see top sheet

CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = _____ ft

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

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

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

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

PGRM: Pier

PIER SCOUR CALCULATIONS

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

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

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

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

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

Route 110 ST Stream Maple River MRM _____ Date _____ Initials _____

Bridge Structure No. 07095100 Location 3S, 1W from Frederick

GPS coordinates: N 45° 47.588' taken from: USL abutment ✓ centerline of ⇑ MRM end _____

W 98° 31.695' Datum of coordinates: WGS84 ✓ NAD27 _____

Drainage area = 527.51 (cont.) sq. mi.

The average bottom of the main channel was 14.8 ft below top of guardrail at a point 38 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 11,300			Q_{500} = 24,200		
Estimated flow passing through bridge	2,600					
Estimated road overflow & overtopping	8,700					
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

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

low spot in road approx. feet west of bridge

Photos
Structure number
bridge from approach
right overbank at approach
right abutment under bridge
left abutment under bridge
approach from bridge

Summary of Results

	Q100	Q500
Bridge flow evaluated	2600	
Flow depth at left abutment (yaLT), in feet	0	
Flow depth at right abutment (yaRT), in feet	3.1	
Contraction scour depth (ycs), in feet	4.1	
Pier scour depth (yps), in feet	4.4	
Left abutment scour depth (yas), in feet	0	
Right abutment scour depth (yas), in feet	11.7	
1Flow angle of attack	16°	

See Comments/Diagram for justification where required

Basin Characteristics from Provisional StreamStats 10-7-11

Cont. D.A. = 527.51

PII = 0.76

100% Subregion B

Manually Calculated Peaks

Q_{100} = 11,300 cfs

Q_{500} = 24,200 cfs