NW Lawrence Co.

41238044

Whitewood Creek Valley Rd

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. ~~42138044~~ Date 7/12/11 Initials CW Region (A B C D) — A circled

Site 06436190 Location 0.3 SW Lawrence - Meade County Line on Whitewood Valley Rd

Q_{100} = 9260 by: drainage area ratio____ flood freq. anal. ✓ regional regression eq. ____

Bridge discharge (Q_2) = 9260 (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 = 117 ft. Flow angle at bridge = 10 ° Abut. Skew = 0 ° Effective Skew = 10°

Width (W_2) iteration = 117 98 109 104

Avg. flow depth at bridge, y_2 iteration = 8.0 8.8 8.3 8.5

Corrected channel width at bridge Section = W_2 times cos of flow angle = 102.42 ft* $q_2 = Q_2/W_2$ = 90.4 ft²/s

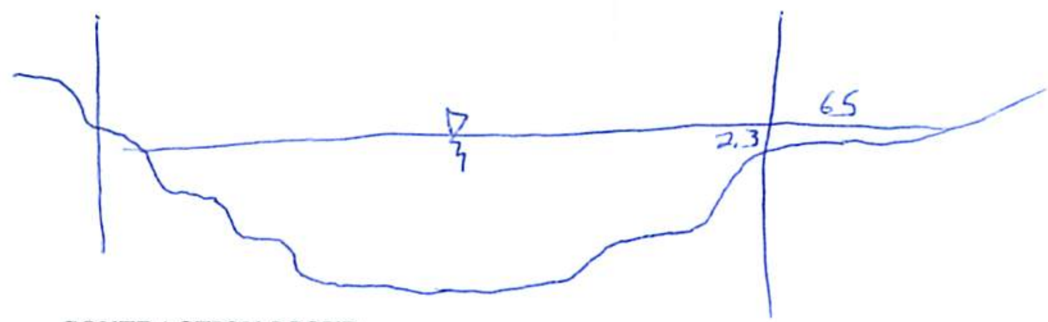
Bridge Vel, V_2 = 10.7 ft/s Final $y_2 = q_2/V_2$ = 8.5 ft Δh = 2.3 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 10.8 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.

Water Surface Elev. = ____ ft
Low Steel Elev. = 13.0 ft
n (Channel) = 0.045
n (LOB) = 0.080
n (ROB) = 0.070
Pier Width = 2.35 ft
Pier Length = 2.35 ft
\# Piers for 100 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 125 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} = 65 ft Average right overbank flow depth, y_{rob} = 1.2 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} = 0.2 ft Average approach velocity, $V_1 = Q_{100}/(y_1W_1)$ = 4.51 ft/s

Critical approach velocity, $Vc = 11.52y_1^{1/6}D_{50}^{1/3}$ = 9.71 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.

$D_{c50} = 0.0006(q_2/y_1^{7/6})^3$ = 0.107 ft If $D_{50} >= D_{c50}$, $\chi = 0.0$

Otherwise, $\chi = 0.122y_1[q_2/(D_{50}^{1/3}y_1^{7/6})]^{6/7} - y_1$ = 0 From Figure 10, y_{cs} = 0 ft

PIER SCOUR CALCULATIONS

PGRM: Pier

L/a ratio = 1.0 Correction factor for flow angle of attack (from Table 1), K2 = 1.0

Froude # at bridge = 0.65 Using pier width a on Figure 11, ξ = 9.1 Pier scour y_{ps} = 8.5 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 0 ft right abutment, y_{aRT} = 1.2 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} = 5.1

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 0 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 5.1 ft

5.1
3.9
0.7
9.7

2.3

4.8
2|9.7
8.7

23981916
22674
1326

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 42138044 Date 7/12/11 Initials CW Region (A B C D)

Site 06436190 Location 0.3 SW Lawrence-Meade Co. Line on Whitewood Valley Rd

Q_{500} = 23900 by: drainage area ratio ____ flood freq. anal. ✓ regional regression eq. ____

Bridge discharge (Q_2) = 22674 (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 = 117 ft. Flow angle at bridge = 10° Abut. Skew = 0 ° Effective Skew = 10 °

Width (W_2) iteration = 117

Avg. flow depth at bridge, y_2 iteration = 13.4 >13.0

Corrected channel width at bridge Section = W_2 times cos of flow angle = 115.2 ft* $q_2 = Q_2/W_2$ = 196.8 ft^2/s

Bridge Vel, V_2 = 15.1 ft/s Final $y_2 = q_2/V_2$ = 13.0 ft Δh = 4.7 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 17.7 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,

Water Surface Elev. = ____ ft

Low Steel Elev. = 13.0 ft

n (Channel) = 0.045

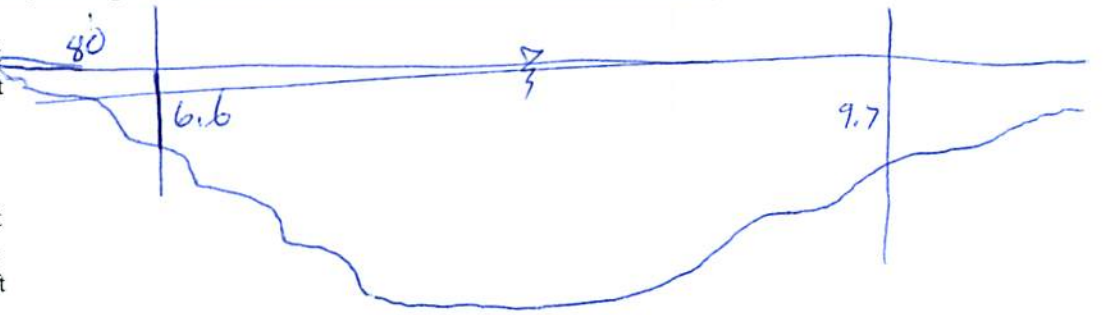
n (LOB) = 0.080

n (ROB) = 0.070

Pier Width = 2.35 ft

Pier Length = 2.35 ft

Piers for 500 yr = 2 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 125 ft

Width of left overbank flow at approach, W_{lob} = ~~117~~ ft 80 Average left overbank flow depth, y_{lob} = 3.3 ft

Width of right overbank flow at approach, W_{rob} = 117 ft Average right overbank flow depth, y_{rob} = 4.9 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} = 0.2 ft Average approach velocity, $V_1 = Q_{500}/(y_1 W_1)$ = 3.98 ft/s

Critical approach velocity, $Vc = 11.52 y_1^{1/6} D_{50}^{1/3}$ = 10.55 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.

$D_{c50} = 0.0006(q_2/y_1^{7/6})^3$ = 0.196 ft If $D_{50} >= D_{c50}$, $\chi = 0.0$

Otherwise, $\chi = 0.122 y_1 [q_2/(D_{50}^{1/3} y_1^{7/6})]^{6/7} - y_1$ = 0 From Figure 10, y_{cs} = 0.0 ft

PIER SCOUR CALCULATIONS

PGRM: Pier

L/a ratio = 1.0 Correction factor for flow angle of attack (from Table 1), K2 = 1.0

Froude # at bridge = 0.74 Using pier width a on Figure 11, ξ = 9.1 Pier scour y_{ps} = 8.7 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 3.3 ft right abutment, y_{aRT} = ~~117~~ 4.9 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} = 12.0 and ψ_{RT} = 14.8

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 12.0 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 14.8 ft

117
125
40
22
3

Whitewood

Route Valley Rd Stream Whitewood Creek MRM _____ Date 7/12/11 Initials CH

Bridge Structure No. 12-273 8044 Location 0.3 SW Lawrence-Meade Co. Line on Whitewood Valley Rd

GPS coordinates: N 44°32'30.6" W 103°34'19.4" taken from: USL abutment X centerline of ⇑ MRM end _____

Datum of coordinates: WGS84 X NAD27 ____

Drainage area = 77.46 sq. mi.

The average bottom of the main channel was 17.0 ft below top of guardrail at a point 56 ft from left abutment.

Method used to determine flood flows: ✓ Freq. Anal. ____drainage area ratio ____regional regression equations.

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 9260			Q_{500} = 23900		
Estimated flow passing through bridge	9260			22674		
Estimated road overflow & overtopping				1326		
Consideration	Yes	No	Possibly	Yes	No	Possibly
Chance of overtopping		X		X		
Chance of Pressure flow		X		X		
Armored appearance to channel		X			X	
Lateral instability of channel		X			X	

Riprap at abutments? X Yes ____No ____Marginal

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

Debris Potential? X High ____Med ____Low

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

Riprap	X Yes	____No	____Don't know	____NA Gabions
Spur Dike	____Yes	____No	____Don't know	X NA
Other _____	____Yes	____No	____Don't know	X NA

Bed Material Classification Based on Median Particle Size (D_{50})

Material	Silt/Clay____	Sand____	Gravel____	Cobbles X	Boulders____
Size range, in mm	<0.062	0.062-2.00	2.00-64	64-250	>250

Comments, Diagrams & orientation of digital photos

A more accurate D50 is needed to verify contraction scour calcs. ⇒ Borderline

Photos

1775-ID
76-US
77-US RB
78-US LB
79-Gabions
80-Gabions

81-R. Abut
82-L. Abut
83-Bank scour RB

Summary of Results

	Q100	Q500
Bridge flow evaluated	9260	22674
Flow depth at left abutment (yaLT), in feet	0.0	3.3
Flow depth at right abutment (yaRT), in feet	1.2	4.9
Contraction scour depth (ycs), in feet	0.0	0.0
Pier scour depth (yps), in feet	8.5	8.7
Left abutment scour depth (yas), in feet	8.0	12.0
Right abutment scour depth (yas), in feet	5.1	14.8
1Flow angle of attack	10	10

See Comments/Diagram for justification where required