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SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 63218262 Date 5/24/12 Initials RaT Region (A B C D)

Site _____ Location NW edge of Centerville

Q_{100} = 29800 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = 29800 (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 = 244 ft. Flow angle at bridge = 10 ° Abut. Skew = 0 ° Effective Skew = 10 °

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 = 240.29 ft* $q_2 = Q_2/W_2$ = 119.9 ft^2/s

Bridge Vel, V_2 = 7.8 ft/s Final $y_2 = q_2/V_2$ = 15.4 ft Δh = 1.2 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 16.7 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. = 0-3.0 ft 1.2 23/15 -5.8 17.2

Low Steel Elev. = ~~17~~ 17.7 ft

n (Channel) = 0.0.50

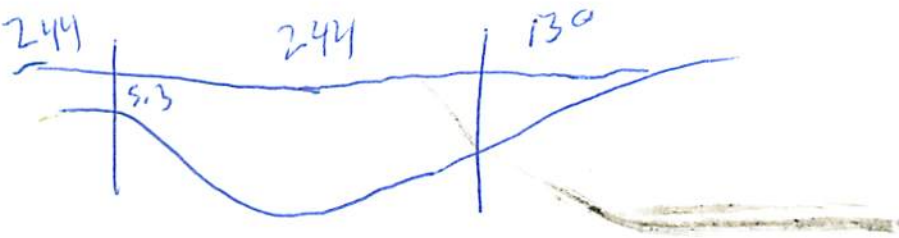
n (LOB) = ~~0.60~~ 0.05c

n (ROB) = 0.0.80

Pier Width = 1.3 ft

Pier Length = 1.3 ft

Piers for 100 yr = 5 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 244 ft

Width of left overbank flow at approach, W_{lob} = 244 ft Average left overbank flow depth, y_{lob} = 5.3 ft

Width of right overbank flow at approach, W_{rob} = 130 ft Average right overbank flow depth, y_{rob} = ~~5~~ 3.5 ft

5.3 3/3 10.6/3 c

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

x = 3.73 From Figure 9 W_2 (effective) = 233.8 ft y_{cs} = 4.4 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, $V_1 = Q_{100}/(y_1 W_1)$ = _____ 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 = 0.35 Using pier width a on Figure 11, ξ = 5.5 Pier scour y_{ps} = 5 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 5.3 ft right abutment, y_{aRT} = 3.5 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} = 15.6 and ψ_{RT} = 12.4

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 15.6 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 12.4 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 63219262 Date 5/24/12 Initials RaT Region (A B C D)

Site _____ Location NW edge of Centerville

Q_{500} = 57500 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = 37876 (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 = 244 ft. Flow angle at bridge = 16 ° Abut. Skew = 0 ° Effective Skew = 10 °

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 = 240.29 ft* $q_2 = Q_2/W_2$ = 157.6 ft²/s

Bridge Vel, V_2 = 6.9 ft/s Final $y_2 = q_2/V_2$ = 17.7 ft Δh = 1.6 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 19.3 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. = 0-3.0 ft

Low Steel Elev. = 17.7 ft

n (Channel) = 0.050

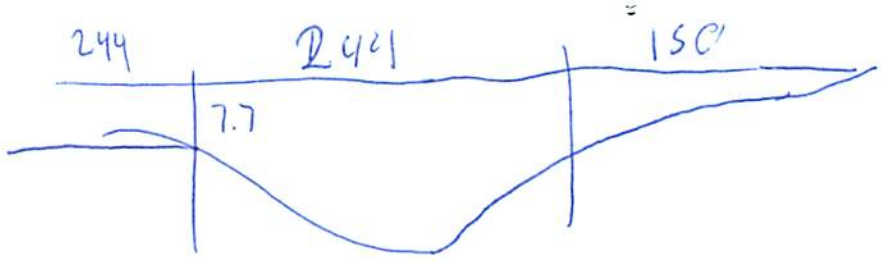
n (LOB) = 0.060

n (ROB) = 0.080

Pier Width = 1.3 ft

Pier Length = 1.3 ft

Piers for 500 yr = ~~15~~ ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 244 ft

Width of left overbank flow at approach, W_{lob} = 244 ft Average left overbank flow depth, y_{lob} = 7.7 ft

Width of right overbank flow at approach, W_{rob} = 150 ft Average right overbank flow depth, y_{rob} = 5.1 ft

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

x = ~~4.79~~ 6.04 From Figure 9 W_2 (effective) = ~~239~~ 233.8 ft y_{cs} = ~~5.5~~ 6.8 ft

$7.7^{2/3}$ 15.4 / 3

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: CWCSNEW

PIER SCOUR CALCULATIONS

PGRM: Pier

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

Froude # at bridge = 0.37 Using pier width a on Figure 11, ξ = 5.8 Pier scour y_{ps} = 5 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 2.7 ft right abutment, y_{aRT} = 5.1 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} = 19.5 and ψ_{RT} = 15.2

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 19.5 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 15.2 ft

Route County Rd Stream Vermillion River MRM _____ Date 5/24/12 Initials RAJ

Bridge Structure No. 6321 8262 Location NW edge of Centerville

GPS coordinates: N 43° 07' 23.2" W 96° 57' 55.1" taken from: USL abutment _____ centerline of ⇑ MRM end _____

Datum of coordinates: WGS84 _____ NAD27 _____

Drainage area = 1756.86 sq. mi.

The average bottom of the main channel was 23.5 ft below top of guardrail at a point 103 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 28800			Q_{500} = 57500		
Estimated flow passing through bridge	28800			37876		
Estimated road overflow & overtopping	0			19625		
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	

5/21

2	1540
5	4400
10	7650
25	13900
50	20400
100	28800
500	57500

Riprap at abutments? X Yes ____No ____Marginal

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

Debris Potential? ____High X Med ____Low

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

Riprap	X Yes	X No	____Don't know	____NA
Spur Dike	____Yes	X No	____Don't know	____NA
Other _____	____Yes	X No	____Don't know	____NA

rose quartz

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

Material	Silt/Clay	Sand	Gravel	Cobbles	Boulders
	X	X			
Size range, in mm	<0.062	0.062-2.00	2.00-64	64-250	>250

Comments, Diagrams & orientation of digital photos

1). Main channel
2). piers
3). ~~drop~~ debris
4). left ab.
5). R. ob.
6). Right Ob.
7). Main channel
8). Pier scour
9) R. ab.
10) R. ab
11). left Ob.

Summary of Results

	Q100	Q500
Bridge flow evaluated	28800	37876
Flow depth at left abutment (yaLT), in feet	5.3	7.7
Flow depth at right abutment (yaRT), in feet	3.5	5.1
Contraction scour depth (ycs), in feet	4.4	~~5.5~~ 6.8
Pier scour depth (yps), in feet	5	5
Left abutment scour depth (yas), in feet	15.6	19.5
Right abutment scour depth (yas), in feet	12.4	15.2
1Flow angle of attack	10	10

See Comments/Diagram for justification where required