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SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 26230091 Date 8/14/12 Initials RaT Region (A B (C) D)

Site ______ Location 1 mi S, 1 mi E of Twin Brooks on 472 Ave

Q_{100} = 604 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 804 (should be Q_{100} 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 = 27 ft. Flow angle at bridge = 5 ° Abut. Skew = 0 ° Effective Skew = 5 °

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 = 26.9 ft* $q_2 = Q_2/W_2$ = 29.9 ft^2/s

Bridge Vel, V_2 = 3.9 ft/s Final $y_2 = q_2/V_2$ = 7.7 ft Δh = 0.3 ft

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

56 38

46

Water Surface Elev. = dry ft

Low Steel Elev. = 7.9 ft

n (Channel) = 0.040

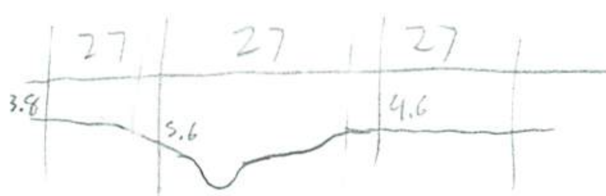
n (LOB) = 0.035

n (ROB) = 0.035

Pier Width = 0 ft

Pier Length = 0 ft

Piers for 100 yr = 0 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 27 ft

Width of left overbank flow at approach, W_{lob} = 27 ft Average left overbank flow depth, y_{lob} = 5.0 ft

Width of right overbank flow at approach, W_{rob} = 27 ft Average right overbank flow depth, y_{rob} = 4.6 ft

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

x = 7.87 From Figure 9 W_2 (effective) = 26.9 ft y_{cs} = 8.7 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 = ______ 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

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 5.0 ft right abutment, y_{aRT} = 4.6 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 and ψ_{RT} = 14.3

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 27.3 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 26.0 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 26230091 Date 8/14/12 Initials RaT Region (A B (C) D)

Site ______ Location 1 mi S, 1 mi E of Twin Brooks on 472 Ave

Q_{500} = 1260 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. X

Bridge discharge (Q_2) = 821 (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 = 27 ft. Flow angle at bridge = 5 ° Abut. Skew = 0 ° Effective Skew = 5 °

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 = 26.9 ft* $q_2 = Q_2/W_2$ = 30.5 ft^2/s

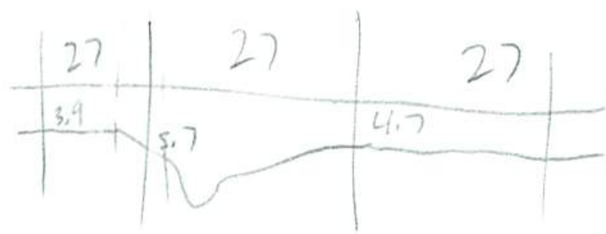
Bridge Vel, V_2 = 3.9 ft/s Final $y_2 = q_2/V_2$ = 7.8 ft Δh = 0.3 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 8.1 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. = dry ft
Low Steel Elev. = 7.8 ft
n (Channel) = 0.040
n (LOB) = 0.035
n (ROB) = 0.035
Pier Width = 0 ft
Pier Length = 0 ft
Piers for 500 yr = 0 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 27 ft

Width of left overbank flow at approach, W_{lob} = 27 ft Average left overbank flow depth, y_{lob} = 5.1 ft

Width of right overbank flow at approach, W_{rob} = 27 ft Average right overbank flow depth, y_{rob} = 4.7 ft

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

x = 8.08 From Figure 9 W_2 (effective) = 26.9 ft y_{cs} = 8.9 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, $V_1 = Q_{500}/(y_1 W_1)$ = ______ 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 = ______ 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

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 5.1 ft right abutment, y_{aRT} = 4.7 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} = 14.5

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 27.6 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 26.3 ft

45° 11' 29".94
96° 45', 42".66

96.76183
45.19165

Route 472 Ave Stream ______________ MRM ________ Date 8/4/12 Initials RaT

Bridge Structure No. 26230091 Location 1 mi S, 1 mi E of Twin Brooks on 472 Ave

GPS coordinates: N 45° 11' 30.3" taken from: USL abutment X centerline of ⇑ MRM end ______

W 96° 45' 43.7" Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 6.57 sq. mi.

The average bottom of the main channel was 11.8 ft below top of guardrail at a point 21 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 804			Q_{500} = 1260		
Estimated flow passing through bridge	804			821		
Estimated road overflow & overtopping	0			439		
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	

7/3

8/23

2	63.2
5	178
10	290
25	471
50	629
100	804
500	1260

Riprap at abutments? _____Yes _____No X Marginal see pictures

Evidence of past Scour? X Yes _____No _____Don't know minor, contraction

Debris Potential? _____High _____Med X Low

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

Riprap _____Yes X No _____Don't know _____NA

Spur Dike _____Yes X No _____Don't know _____NA

Other ________________ _____Yes X 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

1). left OB

2). main channel

3). right OB

4-5). right abutment

6-7). left abutment

8). main channel

Summary of Results

	Q100	Q500
Bridge flow evaluated	804	821
Flow depth at left abutment (yaLT), in feet	5.0	5.1
Flow depth at right abutment (yaRT), in feet	4.6	4.7
Contraction scour depth (ycs), in feet	8.7	8.9
Pier scour depth (yps), in feet	N/A	N/A
Left abutment scour depth (yas), in feet	27.3	27.6
Right abutment scour depth (yas), in feet	26.0	26.3
1Flow angle of attack	5	5

See Comments/Diagram for justification where required