SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 11180085 Date 10-28-11 Initials RT Region (A B C D)

Site _____ Location Spring Creek on 304th Ave

Q_{100} = 10,100 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. ✓

Bridge discharge (Q_2) = 10,100 (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 = 139 ft. Flow angle at bridge = 0 ° Abut. Skew = 0 ° Effective Skew = 0 °

Width (W_2) iteration = 139 _____ _____ _____

Avg. flow depth at bridge, y_2 iteration = 12.0 _____ _____ _____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 139 ft* $q_2 = Q_2/W_2$ = 72.7 ft^2/s

Bridge Vel, V_2 = 6.0 ft/s Final $y_2 = q_2/V_2$ = 12.0 ft Δh = 0.7 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 12.8 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,

channel is trapezoidal and almost manmade?

flow is abutment to abutment at Q_{100}

Water Surface Elev. = ≈ -.7 ft

Low Steel Elev. = 12.4 ft

n (Channel) = .028

n (LOB) = .027 tall grass, ungrazed

n (ROB) = .027

Pier Width = 1.65 ft

Pier Length = 1.65 ft

Piers for 100 yr = 4 ft

very flat floodplain

CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 139 ft

Width of left overbank flow at approach, W_{lob} = 278 ft Average left overbank flow depth, y_{lob} = 4.2 ft

Width of right overbank flow at approach, W_{rob} = 278 ft Average right overbank flow depth, y_{rob} = 4.1 ft

assume 2 bridge widths

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

x = 9.17 From Figure 9 W_2 (effective) = 132.4 ft y_{cs} = 10.1 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 = 0.31 Using pier width a on Figure 11, ξ = 6.9 Pier scour y_{ps} = 5.8 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 4.2 ft right abutment, y_{aRT} = 4.1 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} = 13.6 and ψ_{RT} = 13.4

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 13.6 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 13.4 ft

SCOUR ANALYSIS AND REPORTING FORM

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

Site _____ Location _____

Q_{500} = 21,400 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. ✓

Bridge discharge (Q_2) = 10,700 (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 = 139 ft. Flow angle at bridge = ____° Abut. Skew = ____° Effective Skew = ____°

Width (W_2) iteration = 139 ____ ____ ____

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

Corrected channel width at bridge Section = W_2 times cos of flow angle = 139 ft* $q_2 = Q_2/W_2$ = 77 ft^2/s

Bridge Vel, V_2 = 6.2 ft/s Final $y_2 = q_2/V_2$ = 12.4 ft Δh = 0.8 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 13.2 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,

$Q_{500} > Q_{max\ scour}$

Water Surface Elev. = ≈ -0.7 ft

Low Steel Elev. = 12.4 ft

n (Channel) = .028

n (LOB) = .027

n (ROB) = .027

Pier Width = 1.65 ft

Pier Length = 1.65 ft

Piers for 500 yr = 4 ft

CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 139 ft

Width of left overbank flow at approach, W_{lob} = 278 ft Average left overbank flow depth, y_{lob} = 4.9 ft

Width of right overbank flow at approach, W_{rob} = 278 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 = 11.31 From Figure 9 W_2 (effective) = 132.4 ft y_{cs} = 12.3 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 = 1 Correction factor for flow angle of attack (from Table 1), K2 = 1

Froude # at bridge = 0.31 Using pier width a on Figure 11, ξ = 6.9 Pier scour y_{ps} = 5.8 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 4.9 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} = 14.8 and ψ_{RT} = 14.5

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 14.8 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 14.5 ft

Route 304th Ave Stream Spring Creek MRM _____ Date _____ Initials _____

Bridge Structure No. 11180085 Location ½ S, 2W, ½ S from Herreid

GPS coordinates: N 45° 49.147' taken from: ~~UST~~ USR abutment ✓ centerline of ⇑ MRM end _____

W 100° 6.635' Datum of coordinates: WGS84 ✓ NAD27 _____

Cont.

Drainage area = 584.65 sq. mi.

The average bottom of the main channel was 16.4 ft below top of guardrail at a point 44 ft from ~~left~~ right abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 10,100			Q_{500} = 21,400		
Estimated flow passing through bridge	10,100			10,700		
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			✓			✓

contraction scour pool under bridge
scour visible around piers

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

This site appears to have a manmade chanel in the vicinity of the bridge

photos
structure number
approach section from center of bridge
right ~~left~~ overbank from bridge
left ~~right~~ overbank from bridge
bridge section from Left approach
scour pool under bridge

Summary of Results

	Q100	Q500
Bridge flow evaluated	10,100	10,700
Flow depth at left abutment (yaLT), in feet	4.2	4.9
Flow depth at right abutment (yaRT), in feet	4.1	4.7
Contraction scour depth (ycs), in feet	10.1	12.3
Pier scour depth (yps), in feet	5.8	5.8
R ~~Left~~ abutment scour depth (yas), in feet	13.6	14.8
L ~~Right~~ abutment scour depth (yas), in feet	13.4	14.5
1Flow angle of attack	0	0

See Comments/Diagram for justification where required

Basin Characteristics from Provisional Stream Stats 10-18-11

Total D.A. = 2030 mi^2

N.C. Area (from shapefile) = 1445.35 mi^2

Cont. D.A. = 584.65 mi^2

PII = 0.60

100% Subregion B

Manually Calculated Peaks

Q_{100} = 10,100 cfs

Q_{500} = 21,400 cfs