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SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 52457406 Date 11/5/10 Initials CW Region (A B C D)

Site _____ Location 0.7 S intersection with old Folsum Rd, on Spring Creek Rd

Q_{100} = 1720 by: drainage area ratio ✓ flood freq. anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = 1720 (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 = 140 ft. Flow angle at bridge = 50 ° Abut. Skew = 0 ° Effective Skew = 50 °

Width (W_2) iteration = 140 90 25 ____ 70 88 96

Avg. flow depth at bridge, y_2 iteration = 3.6 1.3 9.3 5.3 4.7 4.5

Corrected channel width at bridge Section = W_2 times cos of flow angle = 61.71 ft* $q_2 = Q_2/W_2$ = 27.9 ft²/s

Bridge Vel, V_2 = 6.3 ft/s Final $y_2 = q_2/V_2$ = 4.5 ft Δh = 0.8 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 5.3 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. = — ft

Low Steel Elev. = 10.8 ft

n (Channel) = 0.040

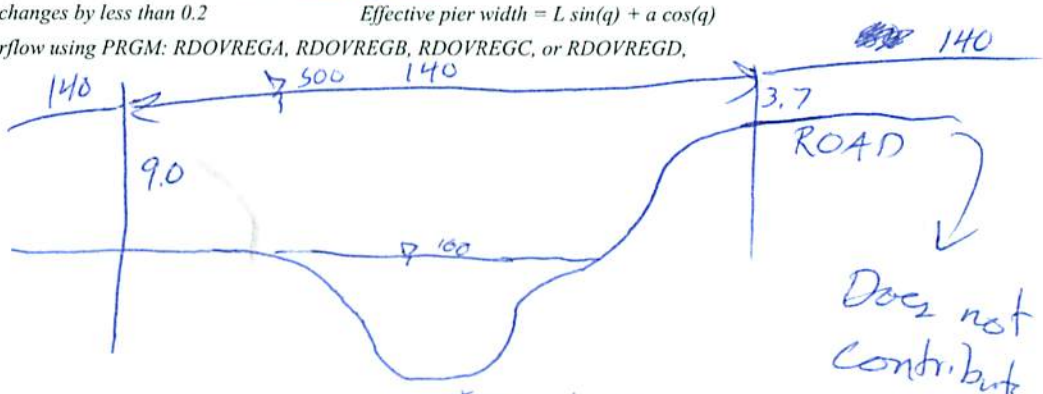
n (LOB) = 0.055

n (ROB) = 0.055

Pier Width = 1.67 ft

Pier Length = 1.67 ft

Piers for 100 yr = 4 ft



Does not contribute

*Drew diagrams on wrong page

CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 140 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} = 0 ft Average right overbank flow depth, y_{rob} = 0.0 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) Z = 0

Estimated bed material D_{50} = 0.30 ft Average approach velocity, $V_1 = Q_{100}/(y_1 W_1)$ = 2.32 ft/s

Critical approach velocity, $Vc = 11.52 y_1^{1/6} D_{50}^{1/3}$ = 9.87 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.

$D_{c50} = 0.0006(q_2/y_1^{7/6})^3$ = 0.038 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} = 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 = 0.52 Using pier width a on Figure 11, ξ = 7.6 Pier scour y_{ps} = 6.3 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 0.0 ft right abutment, y_{aRT} = 0.0 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} = 0.0 and ψ_{RT} = 0.0

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 0.0 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 0.0 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 52457406 Date 11/5/10 Initials CW Region (A B C D)

Site _____ Location 0.7 S intersection dd Folsom Rd on Spring Creek Rd

Q_{500} = 27800 by: drainage area ratio ✓ flood freq. anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = 12630 (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 = 140 ft. Flow angle at bridge = 50 ° Abut. Skew = 0 ° Effective Skew = 50 °

Width (W_2) iteration = 140 _____ _____ _____

Avg. flow depth at bridge, y_2 iteration = 16.6 > 10.4 RD overflow W_2 = 89.99

Corrected channel width at bridge Section = W_2 times cos of flow angle = 89.99 ft* $q_2 = Q_2/W_2$ = 140.3 ft²/s

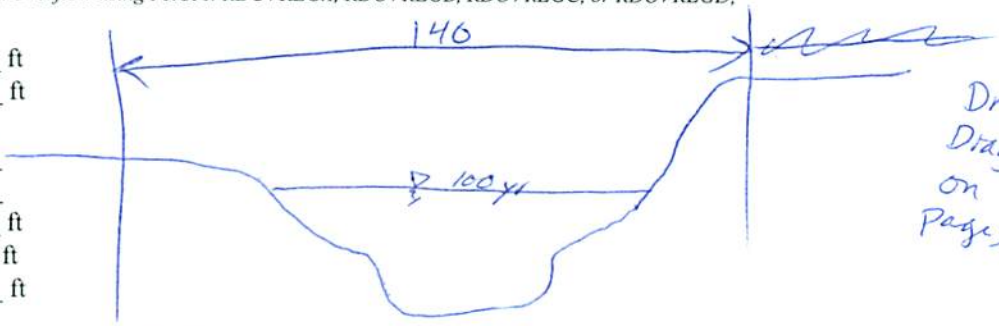
Bridge Vel, V_2 = 13.0 ft/s Final $y_2 = q_2/V_2$ = 10.8 ft Δh = 3.5 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 14.3 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. = — ft
Low Steel Elev. = 10.4 ft
n (Channel) = 0.040
n (LOB) = 0.055
n (ROB) = 0.055
Pier Width = 1.67 ft
Pier Length = 1.67 ft
Piers for 500 yr = 4 ft



Drew Diagrams on wrong Pages

CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 140 ft

Width of left overbank flow at approach, W_{lob} = 140 ft Average left overbank flow depth, y_{lob} = 9.0 ft

Width of right overbank flow at approach, W_{rob} = 0 ft Average right overbank flow depth, y_{rob} = 0.0 ft

Does not contribute to the

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) 2 = 0

Estimated bed material D_{50} = 0.3 ft Average approach velocity, $V_1 = Q_{500}/(y_1 W_1)$ = 6.3+ 3.15 ft/s

Critical approach velocity, $Vc = 11.52 y_1^{1/6} D_{50}^{1/3}$ = 11.65 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.

$D_{c50} = 0.0006(q_2/y_1^{7/6})^3$ = 0.149 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} = 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 = 0.7 Using pier width a on Figure 11, ξ = 7.0 Pier scour y_{ps} = 6.6 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 9.0 ft right abutment, y_{aRT} = 0 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} = 20.6 and ψ_{RT} = 0.0

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 20.6 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 0.0 ft

Route Spring Creek Road Stream Spring Creek MRM _____ Date 11/5/10 Initials CW

Bridge Structure No. 52457406 Location 0.7 S intersection Old Folsum Rd to Spring Creek Rd.

GPS coordinates: N43°55'59.4" W103°08'37.8" taken from: USL abutment X centerline of ⇑ MRM end _____

Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 214.23 sq. mi.

The average bottom of the main channel was 14.0 ft below top of guardrail at a point 70 ft from left abutment.

Method used to determine flood flows: ____Freq. Anal. ✓ drainage area ratio ____regional regression equations.

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 1720			Q_{500} = 27800		
Estimated flow passing through bridge	1726			12630		
Estimated road overflow & overtopping	—			15170		
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? ____Yes X No ____Marginal

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

Debris Potential? X High ____Med ____Low

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

Riprap ____Yes ____No ____Don't know X NA

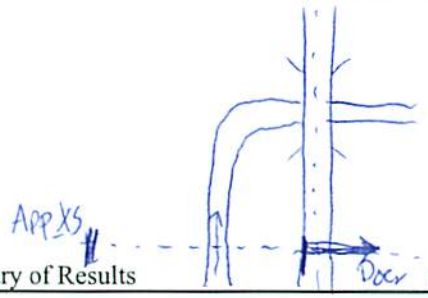
Spur Dike ____Yes ____No ____Don't know X NA

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



Photos:
1463 – Bridge D
1464 – US
1455 – US RB
56 – US LB
57 – R. Abut
58 – L. Abut
59 – US Face Bridge
60 – "
61 – "
62 – US

Summary of Results

	Q100	Q500
Bridge flow evaluated	1720	12630
Flow depth at left abutment (yaLT), in feet	0.0	9.0
Flow depth at right abutment (yaRT), in feet	0.0	0.0
Contraction scour depth (ycs), in feet	0.0	0.0
Pier scour depth (yps), in feet	~~6.3~~ 6.3	~~6.6~~ 6.6
Left abutment scour depth (yas), in feet	0.0	20.6
Right abutment scour depth (yas), in feet	0.0	0.0
1Flow angle of attack	50°	50°

See Comments/Diagram for justification where required