Rock Creek

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 31059020 Date 10/7/11 Initials ~~MM~~ CA Region (A B C D)

Site _____ Location ~2 mi S & 3mi E of Farwell on 246 St

Q_{100} = 3720 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. ✓

Bridge discharge (Q_2) = 2914 (should be Q_{100} unless there is a relief bridge, road overflow, or bridge overtopping)

Q10

Analytical Procedure for Estimating Hydraulic Variables Needed to Apply Method

PGRM: "RegionA", "RegionB", "RegionC", or "RegionD"

Bridge Width = 40 ft. Flow angle at bridge = 4 ° Abut. Skew = 0 ° Effective Skew = 4 °

Width (W_2) iteration = 40

Avg. flow depth at bridge, y_2 iteration = 13.7 > 12.1 → RD Overflow

Corrected channel width at bridge Section = W_2 times cos of flow angle = 39.61 ft* $q_2 = Q_2/W_2$ = 73.6 ft²/s

Bridge Vel, V_2 = 6.1 ft/s Final $y_2 = q_2/V_2$ = 12.1 ft Δh = 0.8 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 12.9 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. = 12.1 ft

n (Channel) = 0.040

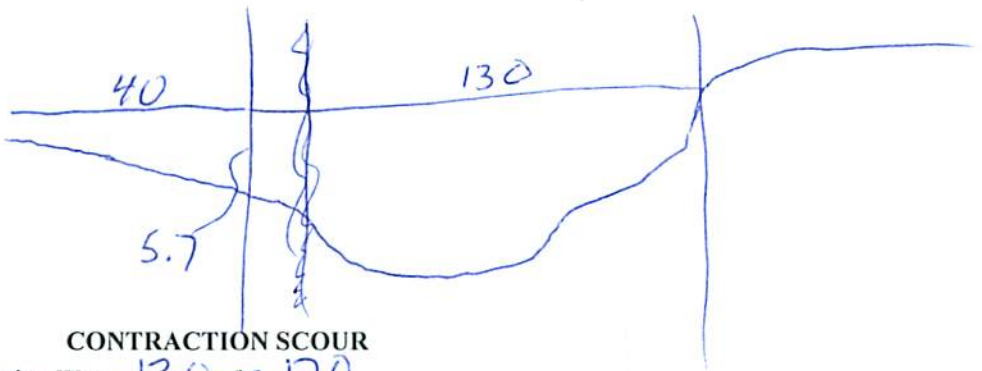
n (LOB) = 0.033

n (ROB) = 0.045

Pier Width = ~~———~~ ft

Pier Length = ~~———~~ ft

Piers for 100 yr = 0 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = ~~130~~ 120 ft

Width of left overbank flow at approach, W_{lob} = 40 ft Average left overbank flow depth, y_{lob} = 5.7 ft

Width of right overbank flow at approach, W_{rob} = 0.0 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 = ~~33.49~~ 30.23 From Figure 9 W_2 (effective) = 39.6 ft y_{cs} = ~~24.9~~ 23.2 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} = 5.7 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} = 16.3 and ψ_{RT} = 0.0

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 24.3 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 0.0 ft

- 12.9

- 12.9 - 5.7

- 12.9 - 6.3 = 6.6

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 31059020 Date 10/7/14 Initials CW Region (A B C D)

Site _____ Location ~2 mi S & 3 mi E of Farwell on 214 St

Q_{500} = 2080 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. ✓

Bridge discharge (Q_2) = 2080 (should be Q_{500} unless there is a relief bridge, road overflow, or bridge overtopping)

Q5

Analytical Procedure for Estimating Hydraulic Variables Needed to Apply Method

PGRM: "RegionA", "RegionB", "RegionC", or "RegionD"

Bridge Width = 40 ft. Flow angle at bridge = 8 ° Abut. Skew = 0 ° Effective Skew = 8 °

Width (W_2) iteration = 40

Avg. flow depth at bridge, y_2 iteration = 10.2 → Vert Wall

Corrected channel width at bridge Section = W_2 times cos of flow angle = 39.61 ft* $q_2 = Q_2/W_2$ = 52.5 ft^2/s

Bridge Vel, V_2 = 5.1 ft/s Final $y_2 = q_2/V_2$ = 10.2 ft Δh = 0.5 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. = 12.1 ft

n (Channel) = 0.040

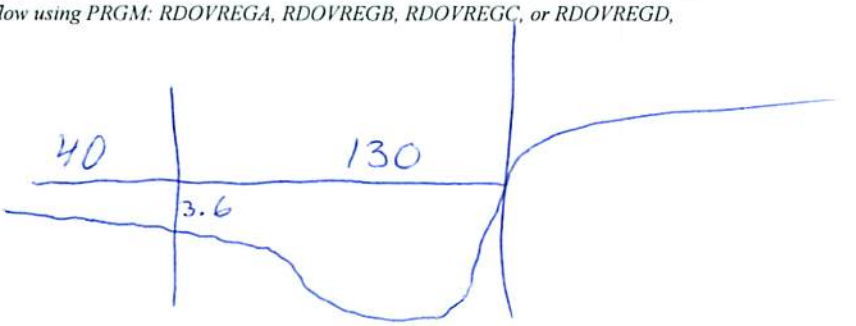
n (LOB) = 0.033

n (ROB) = 0.045

Pier Width = — ft

Pier Length = — ft

Piers for 500 yr = 0 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = ~~130~~ 120 ft

Width of left overbank flow at approach, W_{lob} = 40 ft Average left overbank flow depth, y_{lob} = 3.6 ft

Width of right overbank flow at approach, W_{rob} = 0.0 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 = ~~26.76~~ 24.05 From Figure 9 W_2 (effective) = ~~39.6~~ 39.6 ft y_{cs} = ~~21.3~~ 19.9 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, $Vc = 11.17 y_1^{1/6} D_{50}^{1/3}$ = ____ 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 = ____ 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} = 3.6 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} = 12.6 and ψ_{RT} = 0.0

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 18.7 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 0.0 ft

Route 246 St Stream Rock C/L MRM _____ Date 10/7/11 Initials CL

Bridge Structure No. 31059020 Location ~2 mi S & 3 mi E of Farwell on 246 St

GPS coordinates: N43°49'07.7" W97°51'02.3" taken from: USL abutment X centerline of ⇑ MRM end _____

Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 225.84 sq. mi.

The average bottom of the main channel was 16.5 ft below top of guardrail at a point 6.0 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	~~Q100~~ Q10 = 3720			~~Q500~~ Q5 = 2080		
Estimated flow passing through bridge	2914			2080		
Estimated road overflow & overtopping	806					
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? ____Yes X No ~~X~~ Don't know slightly @ banks → not bad

Debris Potential? ____High ____Med X 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 X	Sand X	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

10/3/11

2	652
5	2080
10	3720
25	6830
50	9970
100	13900
500	26500

- For Q10, overflow would flow over the road to East of bridge @ ht. 6.6 on tape
- Channel is incised

Photos

2025 - 1D

29 - 4S

30 - 4S RB

31 - 4S LB

32 - US Face

33 - Low pt in Rd

34 - LB App XS

35 - RB App XS

Summary of Results

- Scour values may be too high

	~~Q100~~ 10	~~Q500~~ 5
Bridge flow evaluated	2914	2080
Flow depth at left abutment (yaLT), in feet	5.1	3.6
Flow depth at right abutment (yaRT), in feet	0.0	0.0
Contraction scour depth (ycs), in feet	23.2	19.9
Pier scour depth (yps), in feet	____	____
Left abutment scour depth (yas), in feet	24.3	15.7
Right abutment scour depth (yas), in feet	0.0	0.0
1Flow angle of attack	5	5

See Comments/Diagram for justification where required