ok - RFT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 41163083 Date 9-18-12 Initials RFT Region (A B C D)

Site _____ Location East of Exit 17

Q_{100} = 3010 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. ✓

Bridge discharge (Q_2) = 3010 (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 = 90 ft. Flow angle at bridge = 20 ° Abut. Skew = 0 ° Effective Skew = 20 °

Width (W_2) iteration = 90 _____ _____ _____

Avg. flow depth at bridge, y_2 iteration = 5.1 _____ _____ _____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 84.57 ft* $q_2 = Q_2/W_2$ = 35.6 ft^2/s

Bridge Vel, V_2 = 7.0 ft/s Final $y_2 = q_2/V_2$ = 5.1 ft Δh = 1.0 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 6.1 ft $y_1 > 3.2$ is abut. to abut. flow

* *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. = 9.0 ft

n (Channel) = .040

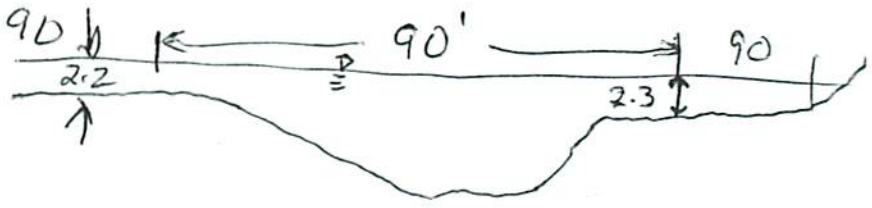
n (LOB) = .035

n (ROB) = ~~.033~~ .035

Pier Width = 1.35 ft

Pier Length = 1.35 ft

Piers for 100 yr = 4 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 90 ft

Width of left overbank flow at approach, W_{lob} = 90 ft Average left overbank flow depth, y_{lob} = 2.2 ft

Width of right overbank flow at approach, W_{rob} = 90 ft Average right overbank flow depth, y_{rob} = 2.3 ft

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

x = 3.84 From Figure 9 W_2 (effective) = 79.2 ft y_{cs} = 4.5 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

PGRM: Pier

PIER SCOUR CALCULATIONS

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

Froude # at bridge = .55 Using pier width a on Figure 11, ξ = 6 Pier scour y_{ps} = 5.4 ft

PGRM: Abutment

ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, y_{aLT} = 2.2 ft right abutment, y_{aRT} = 2.3 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} = 9.0 and ψ_{RT} = 9.4

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 13.5 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 14 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 41163083 Date _____ Initials _____ Region (A B C D)

Site _____ Location E of Exit 17

Q_{500} = 7860 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. ✓

Bridge discharge (Q_2) = 7860 (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 = 90 ft. Flow angle at bridge = 20 ° Abut. Skew = 0 ° Effective Skew = 20 °

Width (W_2) iteration = 90 _____ _____ _____

Avg. flow depth at bridge, y_2 iteration = 8.6 _____ _____ _____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 84.57 ft* $q_2 = Q_2/W_2$ = 92.9 ft^2/s

Bridge Vel, V_2 = 10.8 ft/s Final $y_2 = q_2/V_2$ = 8.6 ft Δh = 2.4 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 11.0 ft

* *NOTE: repeat above calculations until y_2 changes by less than 0.2* *Effective pier width = L sin(a) + a cos(a)*

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. = 9.0 ft

n (Channel) = .040

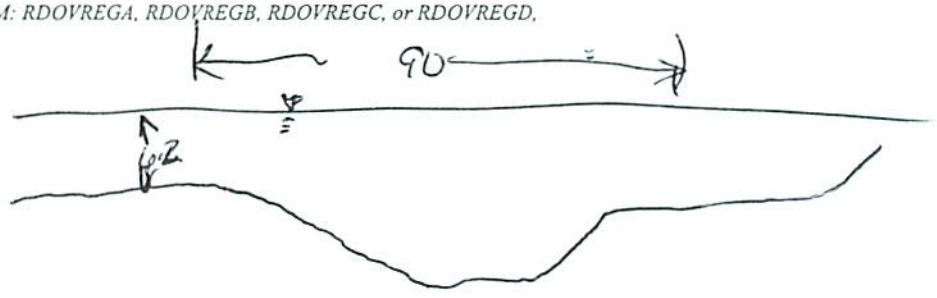
n (LOB) = .035

n (ROB) = .035

Pier Width = 1.35 ft

Pier Length = 1.35 ft

Piers for 500 yr = 4 ft



CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 90 ft

Width of left overbank flow at approach, W_{lob} = 90 ft Average left overbank flow depth, y_{lob} = 6.2 ft

Width of right overbank flow at approach, W_{rob} = 90 ft Average right overbank flow depth, y_{rob} = 6.4 ft

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

x = 12.8 From Figure 9 W_2 (effective) = 79.2 ft y_{cs} = 13.8 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

PIER SCOUR CALCULATIONS

PGRM: Pier

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

Froude # at bridge = .65 Using pier width a on Figure 11, ξ = 6 Pier scour y_{ps} = 5.6 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 6.2 ft right abutment, y_{aRT} = 6.4 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} = 17.2 and ψ_{RT} = 17.5

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 25.4 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 26.1 ft

Route I-90 Service Rd Stream Polo Ck MRM _____ Date _____ Initials _____

Bridge Structure No. 4163083 Location East of Exit 17

GPS coordinates: N 44° 29.022' taken from: USL abutment ✓ centerline of ↑ MRM end _____

W 103° 43.470' Datum of coordinates: WGS84 ✓ NAD27 _____

Drainage area = 19.49 sq. mi.

The average bottom of the main channel was 13.6 ft below top of guardrail at a point 26 ft from left abutment.

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

713

2	64.1
5	241
10	501
25	1070
50	1580
100	3010
500	7860

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 3010			Q_{500} = 7860		
Estimated flow passing through bridge	3010			7860		
Estimated road overflow & overtopping	0			0		
Consideration	Yes	No	Possibly	Yes	No	Possibly
Chance of overtopping		✓			✓	
Chance of Pressure flow		✓			✓	
Armored appearance to channel		✓			✓	
Lateral instability of channel			✓			✓

Riprap at abutments? ____Yes X No ____Marginal

Evidence of past Scour? ____Yes ____No X Don't know possible abutment scour under bridge

Debris Potential? ____High ____Med ✓ Low Did this site used to be flow-through?

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 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

str. no.
approach from bridge
LOB from bridge
ROB from bridge
Bridge from approach

left abut. under bridge
rt. abut. under bridge

Summary of Results

	Q100	Q500
Bridge flow evaluated	3010	7860
Flow depth at left abutment (yaLT), in feet	2.2	6.2
Flow depth at right abutment (yaRT), in feet	2.3	6.4
Contraction scour depth (ycs), in feet	4.5	13.8
Pier scour depth (yps), in feet	5.4	5.4
Left abutment scour depth (yas), in feet	13.5	25.6
Right abutment scour depth (yas), in feet	14.0	26.1
1Flow angle of attack	20°	20°

See Comments/Diagram for justification where required