SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 07103440 Date 10-11-11 Initials RT Region (A B C [✓ D])

Site ______ Location 2 S, 0.8 W Warner on 144th Street

Q_{100} = 7960 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. ✓

Bridge discharge (Q_2) = 1700 (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 = 102 ft. Flow angle at bridge = 10 ° Abut. Skew = 0 ° Effective Skew = 10 °

Width (W_2) iteration = 100.5 ____ ____ ____

Avg. flow depth at bridge, y_2 iteration = 8.1 ____ ____ ____

Corrected channel width at bridge Section = W_2 times cos of flow angle = 100.5 ft* $q_2 = Q_2/W_2$ = 16.9 ft^2/s

Bridge Vel, V_2 = 2.1 ft/s Final $y_2 = q_2/V_2$ = 8.1 ft Δh = 0.1 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 8.2 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,

Water Surface Elev. = 1.45 ft

Low Steel Elev. = 9.4 (low end) ft

n (Channel) = .025 smooth mud

n (LOB) = .027 some weeds

n (ROB) = .028 tall grass

Pier Width = 1.25 ft

Pier Length = 1.25 ft

\# Piers for 100 yr = 2 ft

Low spot in road west of bridge. Road overflow will begin before water reaches low steel. Bridge will not pass Q100. Assume Qmaxscour occurs at approximately 8ft ≈ 1700 cfs (this is above ~~B~~ HWM at bridge) It appears that water was over road this past spring

CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = 127 ft limited by road overflow

Width of left overbank flow at approach, W_{lob} = 78 ft Average left overbank flow depth, y_{lob} = 2.6 ft

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

no right overbank at this Q

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

x = 3.86 From Figure 9 W_2 (effective) = 98 ft y_{cs} = 4.5 ft

PGRM: CWCSNEW

Clear Water Contraction Scour (use if bed material is larger than small c[illegible]s)

N/A

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 = 1 Correction factor for flow angle of attack (from Table 1), K2 = 1

Froude # at bridge = 0.13 Using pier width a on Figure 11, ξ = 5.6 Pier scour y_{ps} = 4.2 ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = 2.6 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} = 10.6 and ψ_{RT} = 0

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 10.6 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 0 ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 07103440 Date ________ Initials ________ Region (A B C [✓ D])

Site ____________ Location ____________

Q_{500} = 16,800 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. ✓

Bridge discharge (Q_2) = ____________ (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 = ______ft. Flow angle at bridge = ______° Abut. Skew = ______° Effective Skew = ______°

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 = ______ft* $q_2 = Q_2/W_2$ = ______ft^2/s

Bridge Vel, V_2 = ______ft/s Final $y_2 = q_2/V_2$ = ______ft Δh = ______ft

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

Water Surface Elev. = ______ ft

Low Steel Elev. = ______ ft

n (Channel) = ______

n (LOB) = ______

n (ROB) = ______

Pier Width = ______ ft

Pier Length = ______ ft

\# Piers for 500 yr = ______ ft

$Q_{max\ scour} < Q_{100}$

see top sheet

CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = ______ft

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

Width of right overbank flow at approach, W_{rob} = ______ft Average right overbank flow depth, y_{rob} = ______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)

Estimated bed material D_{50} = ______ ft Average approach velocity, $V_1 = Q_{500}/(y_1W_1)$ = ______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: Pie

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} = ______ft right abutment, y_{aRT} = ______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} = ______ and ψ_{RT} = ______

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

Route 38430 144th St Stream Moccasin Creek MRM____ Date____ Initials____

Bridge Structure No. 07103440 Location 2 S, 0.8 W warner on 144th St

GPS coordinates: N45° 18.011' taken from: USL abutment____ centerline of ⇑ MRM end____
W98° 30.582' Datum of coordinates: WGS84____ NAD27____

Drainage area = 279.81 (cont.) sq. mi.

The average bottom of the main channel was 13.4 ft below top of guardrail at a point 27 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 7960			Q_{500} = 16,800		
Estimated flow passing through bridge	1700			1700		
Estimated road overflow & overtopping	6260					
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 ____No ✓ Marginal

Evidence of past Scour? ✓ Yes ____No ____Don't know

Debris Potential? ____High ____Med ____Low

Qmaxscour occurs at a flow less than Q_{100} See top sheet

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

bridge is sloped, east end higher
low point in road ≈ 330' west
of bridge

Photos
structure number
approach from bridge
bridge from left approach
left overbank
right bank at approach
right abutment under bridge

Summary of Results

	Q100	Q500
Bridge flow evaluated	1700	
Flow depth at left abutment (yaLT), in feet	2.6	
Flow depth at right abutment (yaRT), in feet	0	
Contraction scour depth (ycs), in feet	4.5	
Pier scour depth (yps), in feet	4.2	
Left abutment scour depth (yas), in feet	10.6	
Right abutment scour depth (yas), in feet	0	
1Flow angle of attack	10°	

See Comments/Diagram for justification where required

Basin Characteristics from provisional Stream Stats 10-7-11

Cont. D.A. = 279.81

PII = 0.81

100% Subregion B

Manually Calculated Peaks:

Q_{100} = 7960 cfs

Q_{500} = 16,800 cfs