SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. **06170149** Date **8/18/10** Initials **CW** Region (A B **C** D)

Site _____ Location **0.1 mi N intersection Hwy 14 and Medary Ave near Brookings**

Q_{100} = **3850** by: drainage area **✓** flood frequency anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = **3331** (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

(left margin, rotated: PGRM: "RegionA", "RegionB", "RegionC", or "RegionD")

Bridge Width = **65** ft. Flow angle at bridge = **0** ° Abut. Skew = **0** ° Effective Skew = **0** °

Width (W_2) iteration = **65** _____ _____

Avg. flow depth at bridge, y_2 iteration = **10.9** _____ _____

Corrected channel width at bridge Section = W_2 times cos of flow angle = **65** ft* $q_2 = Q_2/W_2$ = **51.2** ft²/s

Bridge Vel, V_2 = **5.1** ft/s Final $y_2 = q_2/V_2$ = **10.1** ft Δh = **0.5** ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = **10.6** 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,

$Y_2 > LS \rightarrow RD$ overflow

Water Surface Elev. = ____ ft
Low Steel Elev. = **10.1** ft
n (Channel) = **0.080**
n (LOB) = **0.080**
n (ROB) = ~~0.080~~ **0.033**
Pier Width = **2.0** ft
Pier Length = **2.0** ft
Piers for 100 yr = **2** ft

Water will top dike

CONTRACTION SCOUR

(left margin, rotated: PGRM: Contract)

Width of main channel at approach section W_1 = **70** ft

Width of left overbank flow at approach, W_{lob} = **65** ft Average left overbank flow depth, y_{lob} = **6.1** ft

Width of right overbank flow at approach, W_{rob} = **65** ft Average right overbank flow depth, y_{rob} = **5.6** ft

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

x = **15.51** From Figure 9 W_2 (effective) = **61** ft y_{cs} = **15.3** ft

Clear Water Contraction Scour (use if bed material is larger than small cobbles)

(left margin, rotated: PGRM: CWCSNEW)

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

Critical approach velocity, $V_c = 11.52 y_1^{1/6} D_{50}^{1/3}$ = _____ 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

(left margin, rotated: PGRM: Pier)

L/a ratio = **1.0**

Froude # at bridge = **0.28**

Correction factor for flow angle of attack (from Table 1), K2 = **1.0**

Using pier width a on Figure 11, ξ = **8** Pier scour y_{ps} = **6.6** ft

ABUTMENT SCOUR CALCULATIONS

(left margin, rotated: PGRM: Abutment)

Average flow depth blocked by: left abutment, y_{aLT} = **6.1** ft right abutment, y_{aRT} = **5.6** 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** and ψ_{RT} = **16.1**

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = **17** ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = **16.1** ft

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. __0617O149__ Date __8/18/10__ Initials __CW__ Region (A B (C) D)

Site _____ Location __0.1 mi N intersection Hwy 14 and Medary Ave near Brookings__

Q_{500} = __6010__ by: drainage area __✓__ flood frequency anal. ____ regional regression eq. ____

Bridge discharge (Q_2) = __3331__ (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 = __65__ ft. Flow angle at bridge = __0__ ° Abut. Skew = __0__ ° Effective Skew = __0__ °

Width (W_2) iteration = __65__ _____ _____ _____

Avg. flow depth at bridge, y_2 iteration = __13.6__ _____ _____ _____

Corrected channel width at bridge Section = W_2 times cos of flow angle = __65__ ft* $q_2 = Q_2/W_2$ = __51.2__ ft²/s

Bridge Vel, V_2 = __5.1__ ft/s Final $y_2 = q_2/V_2$ = __10.1__ ft Δh = __0.5__ ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = __10.6__ 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. = __10.1__ ft
n (Channel) = __0.090__
n (LOB) = __0.080__
n (ROB) = __0.033__
Pier Width = __2.0__ ft
Pier Length = __2.0__ ft
Piers for 500 yr = __2__ ft

$y_2 > LS \rightarrow$ Road overflow

CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section W_1 = __70__ ft

Width of left overbank flow at approach, W_{lob} = __65__ ft Average left overbank flow depth, y_{lob} = __6.1__ ft

Width of right overbank flow at approach, W_{rob} = __65__ ft Average right overbank flow depth, y_{rob} = __5.6__ ft

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

x = __15.51__ From Figure 9 W_2 (effective) = __61__ ft y_{cs} = __15.3__ 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, $V_c = 11.52 y_1^{1/6} D_{50}^{1/3}$ = _____ 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: Pie

L/a ratio = __1.0__ Correction factor for flow angle of attack (from Table 1), K2 = __1.0__

Froude # at bridge = __0.28__ Using pier width a on Figure 11, ξ = __8__ Pier scour y_{ps} = __6.6__ ft

ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, y_{aLT} = __6.1__ ft right abutment, y_{aRT} = __5.6__ 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__ and ψ_{RT} = __16.1__

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = __17__ ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = __16.1__ ft

471st Ave/

Route __Medary Ave__ Stream __E. Branch Sixmile Cr.__ MRM _____ Date __8/18/10__ Initials __Ch__

Bridge Structure No. __06170149__ Location __0.1 mi N intersection Hwy 14 and Medary Ave near__

GPS coordinates: __N 44° 19' 37.3"__ taken from: USL abutment __X__ centerline of ↑ MRM end _____ → __Brookings__

__W 096° 47' 17.5"__ Datum of coordinates: WGS84 __X__ NAD27 _____

Drainage area = __64.25__ sq. mi.

The average bottom of the main channel was __13.5__ ft below top of guardrail at a point __21__ ft from left abutment.

Method used to determine flood flows: _____ Freq. Anal. __✓__ drainage area adjustment _____ regional regression equations.

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 3850			Q_{500} = 6010		
Estimated flow passing through bridge	3331			3331		
Estimated road overflow & overtopping	519			2679		
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   _Small round cobbles on abut._

Evidence of past Scour?   _____ Yes __X__ No _____ Don't know

Debris Potential?   __X__ High _____ Med _____ Low

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

Riprap   _____ Yes __X__ No _____ Don't know _____ NA

Spur Dike   __X__ Yes _____ No _____ Don't know _____ NA **?**

Other _____   _____ Yes _____ No _____ Don't know __X__ 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

140 - Bridge #   46 - " "
41 - US   47 - Right Abut.
42 - US RB
43 - US LB
44 - US Left Abut
45 - Under bridge looking
     DS & to right

~75' Spur dike   Approach XS   Flow
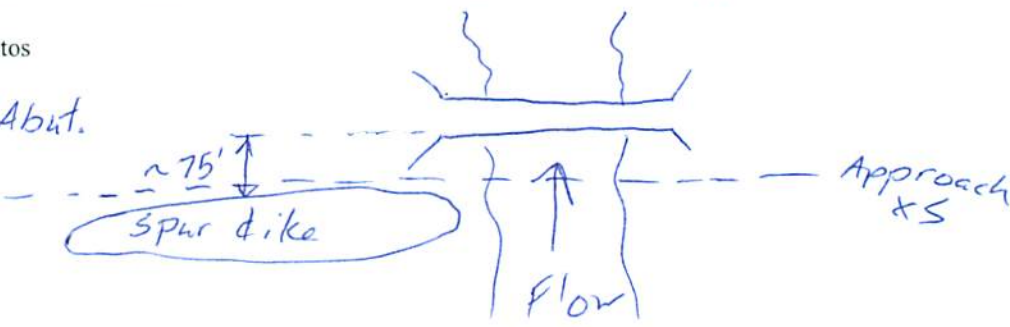
Summary of Results

	Q100	Q500
Bridge flow evaluated	3331	3331
Flow depth at left abutment (yaLT), in feet	6.1	6.1
Flow depth at right abutment (yaRT), in feet	5.6	5.6
Contraction scour depth (ycs), in feet	15.3	15.3
Pier scour depth (yps), in feet	6.6	6.6
Left abutment scour depth (yas), in feet	17.0	17.0
Right abutment scour depth (yas), in feet	16.1	16.1
1Flow angle of attack	0	0

See Comments/Diagram for justification where required