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## SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 39353040 Date 5-17-12 Initials CW/RaT Region ( A B [✓ C] D )

Site ______ Location 2.1 mi E of Badger on 200 St

Qmax scour

$Q_{100}$ = ~~55.7~~ 1500 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. ____

Bridge discharge ($Q_2$) = ~~55.7~~ 1500 (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 = 55 ft. Flow angle at bridge = 25 ° Abut. Skew = 0 ° Effective Skew = 25 °

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 = 49.85 ft* $q_2 = Q_2/W_2$ = ~~[illegible]~~ 30.1 $ft^2/s$

Bridge Vel, $V_2$ = ~~0.7~~ 3.9 ft/s Final $y_2 = q_2/V_2$ = ~~45~~ 7.7 ft $\Delta h$ = 0.3 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = ~~[illegible]~~ 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. = 0.2 ft

Low Steel Elev. = 8 ft

n (Channel) = 0.033

n (LOB) = 0.035

n (ROB) = 0.033

Pier Width = ~~[illegible]~~ 1.6 ft

Pier Length = 1.6 ft

\# Piers for 100 yr = 2 ft

~~[illegible]~~ Stream Stats seems wrong as there are high water marks above 1.5. Used crest of road

### CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section $W_1$ = 110 ft

Width of left overbank flow at approach, $W_{lob}$ = 55 ft Average left overbank flow depth, $y_{lob}$ = 8.4 ft

Width of right overbank flow at approach, $W_{rob}$ = 55 ft 5.1-1.7+ Average right overbank flow depth, $y_{rob}$ = 9.~~[illegible]~~ ft

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

$x$ = ~~65.75~~ 31.74 From Figure 9 $W_2$ (effective) = 46.7 ft $y_{cs}$ = ~~11.2~~ 24 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, $V_c = 11.17y_1^{1/6}D_{50}^{1/3}$ = ______ 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 = 0.23 Using pier width a on Figure 11, $\xi$ = 6.7 Pier scour $y_{ps}$ = 5.5 ft

### ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, $y_{aLT}$ = 8.4 ft right abutment, $y_{aRT}$ = 9.2 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, $\psi_{LT}$ = 20.1 and $\psi_{RT}$ = ~~8~~ 20.7

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 36.5 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 37.7 ft

4.4

5.1

1.7

3.4

## SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 34353040 Date ________ Initials ______ Region ( A B [✓ C] D )

Site ________ Location 2.1 mi E of Badger on 200 St

$Q_{500}$ = 82.3 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. ____

Bridge discharge ($Q_2$) = 82.3 (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 = 55 ft. Flow angle at bridge = 25 ° Abut. Skew = 0 ° Effective Skew = 25 °

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 = 49.85 ft* $q_2 = Q_2/W_2$ = 1.7 $ft^2/s$

Bridge Vel, $V_2$ = 0.9 ft/s Final $y_2 = q_2/V_2$ = 1.8 ft $\Delta h$ = 0 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 1.8 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. = 0.4 ft
Low Steel Elev. = 8 ft
n (Channel) = 0.033
n (LOB) = 0.035
n (ROB) = 0.033
Pier Width = 1.6 ft
Pier Length = 1.6 ft
\# Piers for 500 yr = 2 ft

### 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, $V_1 = Q_{500}/(y_1 W_1)$ = ____ 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: Pie

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

Froude # at bridge = ____ Using pier width a on Figure 11, $\xi$ = ____ 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, $\psi_{LT}$ = ____ and $\psi_{RT}$ = ____

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 200 St Stream ____________ MRM ________ Date ____________ Initials ________

Bridge Structure No. 39353040 Location 2.1 mi E of Badger on 200 St

GPS coordinates: N 44° 29' 06.9'' taken from: USL abutment ____ centerline of ⇑ MRM end ______

W 97° 04' 35.7'' Datum of coordinates: WGS84 ____ NAD27 ____

Drainage area = 50.4 sq. mi.

The average bottom of the main channel was 11.3 ft below top of guardrail at a point 15 ft from left abutment.

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

## MISCELLANEOUS CONSIDERATIONS

Crest of Road 5/17

| | | |
|---|---|---|
| 2 | 4.61 |
| 5 | 13.6 |
| 10 | 21.8 |
| 25 | 34.4 |
| 50 | 44.7 |
| 100 | 55.7 |
| 500 | 82.3 |

| Flows | ~~$Q_{100}$~~ = Qmax scour<br>1500 | | | $Q_{500}$ = | | |
|---|---|---|---|---|---|---|
| Estimated flow passing through bridge | 1500 | | | | | |
| Estimated road overflow & overtopping | 0 | | | | | |
| Consideration | Yes | No | Possibly | Yes | No | Possibly |
| Chance of overtopping | X | | | | | |
| Chance of Pressure flow | X | | | | | |
| Armored appearance to channel | | X | | | | |
| Lateral instability of channel | | X | | | | |

Riprap at abutments? ____Yes [✓ No] ____Marginal

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

Debris Potential? ____High ____Med [✓ Low]

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

2302 Str. no.
2303 approach from bridge
2304 ROB from bridge
2305 LOB from bridge
2306 erosion at abutment toe under bridge
2307 erosion at abutment toe under bridge
2308 bridge section from left abutment
2309 bridge section from ROB

Summary of Results

| | ~~Q100~~ Q max scour | Q500 |
|---|---|---|
| Bridge flow evaluated | | |
| Flow depth at left abutment (yaLT), in feet | 8.4 | |
| Flow depth at right abutment (yaRT), in feet | 9.2 | |
| Contraction scour depth (ycs), in feet | ~~11.2~~ 24 | |
| Pier scour depth (yps), in feet | 5.5 | |
| Left abutment scour depth (yas), in feet | 36.5 | |
| Right abutment scour depth (yas), in feet | 37.7 | |
| 1Flow angle of attack | 25° | |

See Comments/Diagram for justification where required