OK RJ

## SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 51129200 Date 7/26/12 Initials RaJ Region ( A B (C) D )

Site ____________ Location 1 mi E of Trent on 240 St

$Q_{100}$ = Q10 1310 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge ($Q_2$) = 1310 (should be $Q_{100}$ unless there is a relief bridge, road overflow, or bridge overtopping)

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

### Analytical Procedure for Estimating Hydraulic Variables Needed to Apply Method

Bridge Width = 41 ft. Flow angle at bridge = 20 ° Abut. Skew = 0 ° Effective Skew = 20 °

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 = 38.53 ft* $q_2 = Q_2/W_2$ = 34 $ft^2/s$

Bridge Vel, $V_2$ = 4.1 ft/s Final $y_2 = q_2/V_2$ = 8.2 ft $\Delta h$ = 0.3 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 8.6 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.*

11.4
8.6
2.8

5.0
2.8
2.2

Water Surface Elev. = 2.0 ft

Low Steel Elev. = 8.6 ft

n (Channel) = 0.045

n (LOB) = 0.030

n (ROB) = ~~0.035~~ 0.040

Pier Width = 0 ft

Pier Length = 0 ft

\# Piers for 100 yr = 0 ft


### CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section $W_1$ = 41 ft

Width of left overbank flow at approach, $W_{lob}$ = 0 ft Average left overbank flow depth, $y_{lob}$ = 0 ft

Width of right overbank flow at approach, $W_{rob}$ = 41 ft Average right overbank flow depth, $y_{rob}$ = 2.2 ft

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

$x$ = 1.61 From Figure 9 $W_2$ (effective) = 38.5 ft $y_{cs}$ = 2.1 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, $\xi$ = ________ Pier scour $y_{ps}$ = ________ ft

### ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, $y_{aLT}$ = 0 ft right abutment, $y_{aRT}$ = 2.2 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, $\psi_{LT}$ = 0 and $\psi_{RT}$ = 9

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 0 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 16.4 ft

16.4

## SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 51129200 Date 7/26/12 Initials RAT Region ( A B (C) D )

Site ______ Location 1 mi E of Trent on 240 S/

$Q_{500}$ = Q25 2020 by: drainage area ratio____ flood freq. anal. ____ regional regression eq. X

Bridge discharge ($Q_2$) = 1431 (should be $Q_{500}$ unless there is a relief bridge, road overflow, or bridge overtopping)

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

### Analytical Procedure for Estimating Hydraulic Variables Needed to Apply Method

Bridge Width = 41 ft. Flow angle at bridge = 20 ° Abut. Skew = 0 ° Effective Skew = 20 °

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 = 38.53 ft* $q_2 = Q_2/W_2$ = 37.1 ft²/s

Bridge Vel, $V_2$ = 4.3 ft/s Final $y_2 = q_2/V_2$ = 8.6 ft $\Delta h$ = 0.4 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 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. = 2.0 ft
Low Steel Elev. = 6.6 ft
n (Channel) = 0.045
n (LOB) = 0.030
n (ROB) = ~~0.035~~ 0.040
Pier Width = 0 ft
Pier Length = 0 ft
\# Piers for 500 yr = 0 ft


PGRM: Contract

### CONTRACTION SCOUR

Width of main channel at approach section $W_1$ = 41 ft

Width of left overbank flow at approach, $W_{lob}$ = 0 ft Average left overbank flow depth, $y_{lob}$ = 0 ft

Width of right overbank flow at approach, $W_{rob}$ = 41 ft Average right overbank flow depth, $y_{rob}$ = 2.6 ft

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

$x$ = 1.94 From Figure 9 $W_2$ (effective) = 38.5 ft $y_{cs}$ = 2.5 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, $V_1 = Q_{500}/(y_1W_1)$ = ______ 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

PGRM: Pie

### 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, $\xi$ = ______ Pier scour $y_{ps}$ = ______ ft

PGRM: Abutment

### ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, $y_{aLT}$ = 0 ft right abutment, $y_{aRT}$ = 2.6 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, $\psi_{LT}$ = 0 and $\psi_{RT}$ = 10.6

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 0 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 19.3 ft

43° 54′ 21.6″
96° 37′ 40.″188

96.627183
43.906

Route 240 St Stream Brookfield Ck MRM ______ Date 7/24/12 Initials RnT

Bridge Structure No. 51129200 Location 1 mi E of Trent on 240 St

GPS coordinates: N 43° 54' 21.7" W 96° 37' 40.0" taken from: USL abutment X centerline of ⇑ MRM end ______

Datum of coordinates: WGS84 X NAD27 ____

Drainage area = 22.6 sq. mi.

The average bottom of the main channel was 14.1 ft below top of guardrail at a point 30 ft from left abutment.

Method used to determine flood flows: ____ Freq. Anal. ____ drainage area ratio X regional regression equations.

## MISCELLANEOUS CONSIDERATIONS

| Flows | $Q_{100}$ = ~~Q~~ Q10 | 1310 | | $Q_{500}$ = Q25 | 2020 | |
|---|---|---|---|---|---|---|
| Estimated flow passing through bridge | | 1310 | | | 1431 | |
| Estimated road overflow & overtopping | | 0 | | | 589 | |
| 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 | |

6/29 8/25

| | |
|---|---|
| 2 | 342 |
| 5 | 854 |
| 10 | 1310 |
| 25 | 2020 |
| 50 | 2640 |
| 100 | 3300 |
| 500 | 5030 |

Riprap at abutments? ____ Yes ____ No X Marginal - corn husks on abutment areas. exposed outside some abutment. Underwater...

Evidence of past Scour? X Yes ____ No ____ Don't know

Debris Potential? ____ High ____ Med X Low

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

| | | | | |
|---|---|---|---|---|
| Riprap | ____ Yes | X No | ____ Don't know | ____ NA |
| Spur Dike | ____ Yes | X No | ____ Don't know | ____ NA |
| Other ________ | ____ Yes | X 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 |

Note: overbank profile taken 77ft from left abutment

Comments, Diagrams & orientation of digital photos

1). left OB
2). main channel
3). right OB
4). right abutment
5). left abutment
6). main channel

Summary of Results

| | ~~Q100~~ Q10 | ~~Q500~~ Q25 |
|---|---|---|
| Bridge flow evaluated | 1310 | 1431 |
| Flow depth at left abutment (yaLT), in feet | 0 | 0 |
| Flow depth at right abutment (yaRT), in feet | 2.2 | 2.6 |
| Contraction scour depth (ycs), in feet | 2.1 | 2.5 |
| Pier scour depth (yps), in feet | N/A | N/A |
| Left abutment scour depth (yas), in feet | 0 | 0 |
| Right abutment scour depth (yas), in feet | 16.4 | 19.3 |
| 1Flow angle of attack | 20 | 20 |

See Comments/Diagram for justification where required