ok RT

## SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 50l46060 Date 6/25/12 Initials RA Region ( A B C D )

Site _____ Location 1 mi W of Baltic on 250 St

~~$Q_{100}$~~ = low steel by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. X

Bridge discharge ($Q_2$) = 4187 (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 = 63 ft. Flow angle at bridge = 0 ° Abut. Skew = 0 ° Effective Skew = 0 °

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 = 63 ft* $q_2 = Q_2/W_2$ = 66.5 ft²/s

Bridge Vel, $V_2$ = 5.8 ft/s Final $y_2 = q_2/V_2$ = 11.5 ft $\Delta h$ = 0.7 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 12.2 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. = 0-4.0 ft

Low Steel Elev. = 11.5 ft

n (Channel) = 0.035

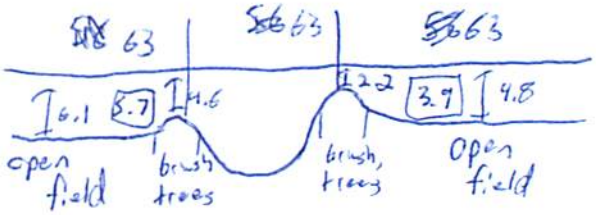
n (LOB) = 0.045 - some trees/brush

n (ROB) = 0.045 east bean field/ditch

Pier Width = 1.65 ft

Pier Length = 1.65 ft

# Piers for 100 yr = 2 ft




### CONTRACTION SCOUR

6.1-4.6

Width of main channel at approach section $W_1$ = ~~63~~ 63 ft

Width of left overbank flow at approach, $W_{lob}$ = ~~63~~ 63 ft Average left overbank flow depth, $y_{lob}$ = ~~BNA~~ 5.7 ft

Width of right overbank flow at approach, $W_{rob}$ = ~~63~~ 63 ft Average right overbank flow depth, $y_{rob}$ = 3.9 ft

PGRM: Contract

Live Bed Contraction Scour (use if bed material is small cobbles or finer) 2.4 2.2-4.8

$x$ = ~~BNA~~ 4.99 From Figure 9 $W_2$ (effective) = 59.7 ft $y_{cs}$ = ~~BNA~~ 5.7 ft 2.6

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

PGRM: CWCSNEW

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 = ~~0.3~~ 0.3 Using pier width a on Figure 11, $\xi$ = 6.9 Pier scour $y_{ps}$ = 5.8 ft

### ABUTMENT SCOUR CALCULATIONS

PGRM: Abutment

Average flow depth blocked by: left abutment, $y_{aLT}$ = 5.7 ft right abutment, $y_{aRT}$ = 3.9 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, $\psi_{LT}$ = 16.3 and $\psi_{RT}$ = 13.1

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 16.3 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 13.1 ft

## SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 50186060 Date 6/25/12 Initials RaT Region ( A B C D )

Site _____ Location 1 m. W of Baltic on 250 St

$Q_{500}$ = 1950 by: drainage area ratio ____ flood freq. anal. ____ regional regression eq. X

Bridge discharge ($Q_2$) = 1950 (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 = 63 ft. Flow angle at bridge = 0 ° Abut. Skew = 0 ° Effective Skew = 0 °

Width ($W_2$) iteration = 63 _____ _____ _____

Avg. flow depth at bridge, $y_2$ iteration = 7.9 _____ _____ _____ _____

Corrected channel width at bridge Section = $W_2$ times cos of flow angle = 63 ft* $q_2 = Q_2/W_2$ = 31 $ft^2/s$

Bridge Vel, $V_2$ = 3.9 ft/s Final $y_2 = q_2/V_2$ = 7.9 ft $\Delta h$ = 0.3 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. = 0-4.0 ft

Low Steel Elev. = 11.5 ft

n (Channel) = 0.035

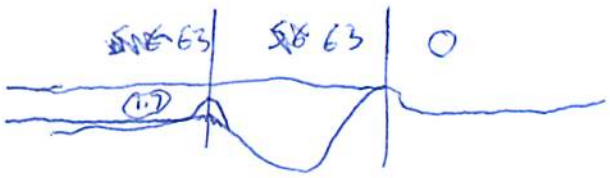
n (LOB) = 0.045

n (ROB) = 0.045

Pier Width = 1.65 ft

Pier Length = 1.65 ft

# Piers for 500 yr = 2 ft




10
11.5
3.9
7.6 0.6-2.1

### CONTRACTION SCOUR

PGRM: Contract

Width of main channel at approach section $W_1$ = 63 ft

Width of left overbank flow at approach, $W_{lob}$ = 63 ft Average left overbank flow depth, $y_{lob}$ = 1.7 ft

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

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

$x$ = 0.94 From Figure 9 $W_2$ (effective) = 59.7 ft $y_{cs}$ = 1.4 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

PGRM: Pier

### PIER SCOUR CALCULATIONS

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

Froude # at bridge = 0.24 Using pier width a on Figure 11, $\xi$ = 6.9 Pier scour $y_{ps}$ = 5.6 ft

PGRM: Abutment

### ABUTMENT SCOUR CALCULATIONS

Average flow depth blocked by: left abutment, $y_{aLT}$ = 1.7 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, $\psi_{LT}$ = 7 and $\psi_{RT}$ = 0

Left abutment scour, $y_{as} = \psi_{LT}(K_1/0.55)$ = 7 ft Right abutment scour $y_{as} = \psi_{RT}(K_1/0.55)$ = 0 ft

96° 45' 40.968"
43° 45" 40.032"

96.7436
43.7611

Route 250 St Stream Diversion Ditch MRM _____ Date 6/25/12 Initials RaT

Bridge Structure No. 50186060 Location 1 mi W of Baltic on 250 St

GPS coordinates: N 43° 45' 39.9" taken from: USL abutment X centerline of ⇑ MRM end _____

W 96° 45' 40.5" Datum of coordinates: WGS84 X NAD27 _____

Drainage area = 3.78 sq. mi.

The average bottom of the main channel was 15.5 ft below top of guardrail at a point 44 ft from left abutment.

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

6/15
~~8/25~~

| | |
|---|---|
| 2 | 137 |
| 5 | 344 |
| 10 | 528 |
| 25 | 809 |
| 50 | 1050 |
| 100 | 1300 |
| 500 | 1950 |

## MISCELLANEOUS CONSIDERATIONS

| Flows | $Q_{100}$ = low steel | | | $Q_{500}$ = 1950 | | |
|---|---|---|---|---|---|---|
| Estimated flow passing through bridge | 41 & 7 | | | 1950 | | |
| Estimated road overflow & overtopping | 0 | | | 0 | | |
| 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? X Yes ____No ____Marginal

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

Debris Potential? ____High ____Med X Low

major abutment scour under concrete (right), some on left too ~~coat~~ major contraction ~0-4 ft water level within a few yards.

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

| | | | | |
|---|---|---|---|---|
| Riprap | X Yes | ____No | ____Don't know | ____NA |
| Spur Dike | ____Yes | X No | ____Don't know | ____NA |
| Other _____ | ____Yes | X No | ____Don't know | ____NA |

loseqhatz spalling into main channel

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

1) left OB
2) main channel
3) right OB
4) pier
5-6) left abutment
7-8) right abutment scour
9-10) right abutment
11) main channel

Summary of Results

| | ~~Q100~~ low steel | Q500 |
|---|---|---|
| Bridge flow evaluated | 41&7 | 1950 |
| Flow depth at left abutment (yaLT), in feet | 5.7 | ~~NA~~ 1.7 |
| Flow depth at right abutment (yaRT), in feet | 3.9 | 0 |
| Contraction scour depth (ycs), in feet | 5.7 | 1.4 |
| Pier scour depth (yps), in feet | 5.8 | 5.6 |
| Left abutment scour depth (yas), in feet | ~~5.8~~ 16.3 | 7 |
| Right abutment scour depth (yas), in feet | ~~13.1~~ 13.1 | 0 |
| 1Flow angle of attack | 0 | 0 |

See Comments/Diagram for justification where required