OK RT

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 52824300 Date 4/20/11 Initials CW Region (A (B) C D)

Site 06423500 Location 2.2 NE Wasta on Old Wasta Road

Q_{100} = 43800 by: drainage area ratio____ flood freq. anal. ✓ regional regression eq. ____

Bridge discharge (Q_2) = 43800 (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 = 1000 ft. Flow angle at bridge = 20 ° Abut. Skew = 0 ° Effective Skew = 20 °

Width (W_2) iteration = 1000 959 ______ ______

Avg. flow depth at bridge, y_2 iteration = 8.1 8.3 ______ ______

Corrected channel width at bridge Section = W_2 times cos of flow angle = 901.17 ft* $q_2 = Q_2/W_2$ = 48.6 ft^2/s

Bridge Vel, V_2 = 5.9 ft/s Final $y_2 = q_2/V_2$ = 8.3 ft Δh = 0.7 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 9.0 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 = ~~4.65~~ 4.5 ft

Pier Length = ~~23.5~~ 4.5 ft

\# Piers for 100 yr = ______ ft

Level 1.5 not well suited to this site. Analysis not completed. Bridge too long.

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, $V_1 = Q_{100}/(y_1 W_1)$ = ______ ft/s

Critical approach velocity, $Vc = 11.52 y_1^{1/6} D_{50}^{1/3}$ = ______ 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: Pier

L/a ratio = 1.0 Correction factor for flow angle of attack (from Table 1), K2 = 1.0

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

SCOUR ANALYSIS AND REPORTING FORM

Bridge Structure No. 52824300 Date 4/20/11 Initials CW Region (A (B) C D)

Site ______ Location 2.2 NE Wasta on Old Wasta Road

Q_{500} = 53400 by: drainage area ratio____ flood freq. anal. ✓ regional regression eq. ____

Bridge discharge (Q_2) = 53400 (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 = 1000 ft. Flow angle at bridge = 20 ° Abut. Skew = 0 ° Effective Skew = 20 °

Width (W_2) iteration = 1000 978

Avg. flow depth at bridge, y_2 iteration = 9.0 9.1

Corrected channel width at bridge Section = W_2 times cos of flow angle = 919.02 ft* $q_2 = Q_2/W_2$ = 58.1 ft^2/s

Bridge Vel, V_2 = 6.4 ft/s Final $y_2 = q_2/V_2$ = 9.1 ft Δh = 0.8 ft

Average main channel depth at approach section, $y_1 = \Delta h + y_2$ = 9.9 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. = ______ ft
Low Steel Elev. = ______ ft
n (Channel) = ______
n (LOB) = ______
n (ROB) = ______
Pier Width = 4.5 ft
Pier Length = 4.5 ft
Piers for 500 yr = ______ ft

Level 1.5 not well suited to this site — Bridge too long. Analysis not completed

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, $Vc = 11.52 y_1^{1/6} D_{50}^{1/3}$ = ______ 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: Pier

L/a ratio = 1.0 Correction factor for flow angle of attack (from Table 1), K2 = 1.0

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 Old Wasta Road Stream Cheyenne River MRM________ Date 4/20/11 Initials CL

Bridge Structure No. 52824300 Location 2.2 NE Wasta on old Wasta Road

GPS coordinates: N 44° 04' 51.1" W 102° 24' 07.8" taken from: USL abutment X centerline of ⇑ MRM end ______

Datum of coordinates: WGS84 X NAD27____

Drainage area = 12720.18 sq. mi. 23.9

The average bottom of the main channel was ~~24.0~~ ft below top of guardrail at a point 459 ft from left abutment.

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

MISCELLANEOUS CONSIDERATIONS

Flows	Q_{100} = 43800			Q_{500} = 53400		
Estimated flow passing through bridge						
Estimated road overflow & overtopping						
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

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

Summary of Results

	Q100	Q500
Bridge flow evaluated		
Flow depth at left abutment (yaLT), in feet		
Flow depth at right abutment (yaRT), in feet		
Contraction scour depth (ycs), in feet		
Pier scour depth (yps), in feet		
Left abutment scour depth (yas), in feet		
Right abutment scour depth (yas), in feet		
1Flow angle of attack		

See Comments/Diagram for justification where required