LEVEL II SCOUR ANALYSIS FOR BRIDGE 7 (CORITH00020007) on TOWN HIGHWAY 2, crossing COOKVILLE BROOK, CORINTH, VERMONT

Open-File Report 98-553

Prepared in cooperation with

VERMONT AGENCY OF TRANSPORTATION

and

FEDERAL HIGHWAY ADMINISTRATION

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U.S. Department of the Interior
U.S. Geological Survey

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By MICHELLE M. SERRA AND ERICK M. BOEHMLER

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Pembroke, New Hampshire

1998

U.S. DEPARTMENT OF THE INTERIOR
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CONVERSION FACTORS, ABBREVIATIONS, AND VERTICAL DATUM

Multiply	By	To obtain
	Length	
inch (in.)	25.4	millimeter (mm)
foot (ft)	0.3048	meter (m)
mile (mi)	1.609	kilometer (km)
	Slope	
foot per mile (ft/mi)	0.1894	meter per kilometer (m/km)
	Area	
square mile (mi^2)	2.590	square kilometer (km^2)
	Volume	
cubic foot (ft^3)	0.02832	cubic meter (m^3)
	Velocity and Flow	
foot per second (ft/s)	0.3048	meter per second (m/s)
cubic foot per second (ft^3/s)	0.02832	cubic meter per second (m^3/s)
cubic foot per second per square mile [(ft^3/s)/mi^2]	0.01093	cubic meter per second per square kilometer [(m^3/s)/km^2

OTHER ABBREVIATIONS

BF	bank full	LWW	left wingwall
cfs	cubic feet per second	Max	maximum
D_{50}	median diameter of bed material	MC	main channel
DS	downstream	RAB	right abutment
elev.	elevation	RABUT	face of right abutment
f/p	flood plain	RB	right bank
ft^2	square feet	ROB	right overbank
ft/ft	feet per foot	RWW	right wingwall
FEMA	Federal Emergency Management Agency	TH	town highway
FHWA	Federal Highway Administration	UB	under bridge
JCT	junction	US	upstream
LAB	left abutment	USGS	United States Geological Survey
LABUT	face of left abutment	VTAOT	Vermont Agency of Transportation
LB	left bank	WSPRO	water-surface profile model
LOB	left overbank	yr	year

In this report, the words “right” and “left” refer to directions that would be reported by an observer facing downstream.

Sea level: In this report, “sea level” refers to the National Geodetic Vertical Datum of 1929-- a geodetic datum derived from a general adjustment of the first-order level nets of the United States and Canada, formerly called Sea Level Datum of 1929.

In the appendices, the above abbreviations may be combined. For example, USLB would represent upstream left bank.

LEVEL II SCOUR ANALYSIS FOR BRIDGE 7 (CORITH00020007) ON TOWN HIGHWAY 2, CROSSING COOKVILLE BROOK, CORINTH, VERMONT

By **Michelle M. Serra and Erick M. Boehmler**

INTRODUCTION AND SUMMARY OF RESULTS

This report provides the results of a detailed Level II analysis of scour potential at structure CORITH00020007 on Town Highway 2 crossing Cookville Brook, Corinth, Vermont (figures 1–8). A Level II study is a basic engineering analysis of the site, including a quantitative analysis of stream stability and scour (FHWA, 1993). Results of a Level I scour investigation also are included in appendix E of this report. A Level I investigation provides a qualitative geomorphic characterization of the study site. Information on the bridge, gleaned from Vermont Agency of Transportation (VTAOT) files, was compiled prior to conducting Level I and Level II analyses and is found in appendix D.

The site is in the New England Upland section of the New England physiographic province in east central Vermont. The 19.6-mi^2 drainage area is in a predominantly rural and forested basin. In the vicinity of the study site, the surface cover is pasture except for the upstream left bank, which is shrub and brush with a few trees.

In the study area, Cookville Brook is a sinuous channel with a slope of approximately 0.006 ft/ft, an average channel top width of 42 ft and an average bank height of 4 ft. The channel bed material ranges from sand to cobble with a median grain size (D_{50}) of 36.0 mm (0.118 ft). The geomorphic assessment at the time of the Level I and Level II site visit on September 5, 1995, indicated that the reach was laterally unstable, as manifested by cut-banks upstream and downstream of the bridge.

The Town Highway 2 crossing of Cookville Brook is a 50-ft-long, two-lane bridge consisting of one 46-foot concrete tee beam span (Vermont Agency of Transportation, written communication, March 24, 1995). The opening length of the structure parallel to the bridge face is 45.1 ft. The bridge is supported by vertical, concrete abutments. The channel is skewed approximately zero degrees to the opening and the opening-skew-to-roadway is zero degrees.

No scour holes were observed during the site visit on September 5, 1995. The only scour protection measure at the site was type-2 stone fill (less than 36 inches diameter) along the left and right abutments, creating stone-fill embankments. Additional details describing conditions at the site are included in the Level II Summary and appendices D and E.

Scour depths and recommended rock rip-rap sizes were computed using the general guidelines described in Hydraulic Engineering Circular 18 (Richardson and Davis, 1995) for the 100- and 500-year discharges. In addition, the incipient roadway-overtopping discharge was determined and analyzed as another potential worst-case scour scenario. Total scour at a highway crossing is comprised of three components: 1) long-term streambed degradation; 2) contraction scour (due to accelerated flow caused by a reduction in flow area at a bridge) and; 3) local scour (caused by accelerated flow around piers and abutments). Total scour is the sum of the three components. Equations are available to compute depths for contraction and local scour and a summary of the results of these computations follows.

Contraction scour for all modelled flows ranged from 3.5 to 4.1 ft. The worst-case contraction scour occurred at the 500-year discharge. Abutment scour ranged from 5.0 to 8.0 ft for the left abutment and from 6.5 to 7.6 ft for the right abutment. The worst-case abutment scour occurred at the 500-year discharge. Additional information on scour depths and depths to armoring are included in the section titled “Scour Results”. Scoured-streambed elevations, based on the calculated scour depths, are presented in tables 1 and 2. A cross-section of the scour computed at the bridge is presented in figure 8. Scour depths were calculated assuming an infinite depth of erosive material and a homogeneous particle-size distribution.

It is generally accepted that the Froehlich equation (abutment scour) gives “excessively conservative estimates of scour depths” (Richardson and Davis, 1995, p. 46). Usually, computed scour depths are evaluated in combination with other information including (but not limited to) historical performance during flood events, the geomorphic stability assessment, existing scour protection measures, and the results of the hydraulic analyses. Therefore, scour depths adopted by VTAOT may differ from the computed values documented herein.

Plymouth, VT. Quadrangle, 1:24,000, 1966
Photoinspected 1983

NORTH

Figure 1. Location of study area on USGS 1:24,000 scale map.

Figure 2. Location of study area on Vermont Agency of Transportation town highway map.

LEVEL II SUMMARY

Structure Number CORITH00020007 ***Stream*** Cookville Brook

County Orange ***Road*** TH 2 ***District*** 7

Description of Bridge

Bridge length 50 ***ft*** ***Bridge width*** 24.8 ***ft*** ***Max span length*** 46 ***ft***

Alignment of bridge to road (on curve or straight) Curve

Abutment type Vertical, concrete ***Embankment type*** Sloping

Stone fill on abutment? Yes ***Date of inspection*** 9/5/95

Description of stone fill Type-2, along the left and right abutments.

Brief description of piers/abutments The abutments are concrete.

No 0

Is bridge skewed to flood flow according to No ***survey?*** ***Angle***

There are mild channel bends in the far upstream and downstream reaches.

Debris accumulation on bridge at time of Level I or Level II site visit:

	Date of inspection	*Percent of channel blocked horizontally*	*Percent of channel blocked vertically*
	9/5/95	0	0
Level I	9/5/95	0	0
Level II			

Potential for debris Moderate. The upstream banks are well vegetated.

Describe any features near or at the bridge that may affect flow (include observation date) The stone-fill embankments in front of the abutments protrude into the channel, as observed on 9/5/95.

Description of the Geomorphic Setting

General topography The channel is located within a moderate relief valley with a narrow flood plain.

Geomorphic conditions at bridge site: downstream (DS), upstream (US)

Date of inspection 9/5/95

DS left: Steep channel bank to a narrow overbank and steep road embankment

DS right: Steep channel bank to a narrow flood plain

US left: Steep channel bank to a moderately sloped road embankment

US right: Moderately sloped channel bank to a narrow flood plain

Description of the Channel

Average top width 42 ft ***Average depth*** 4 ft

Predominant bed material Gravel/Sand ***Bank material*** Sand/Gravel

[illegible] Perennial and sinuous with alluvial channel boundaries and irregular point bars.

Vegetative co[illegible] 9/5/95

Trees and brush with grass on the overbank

DS left: Shrubs and brush with grass on the overbank

DS right: Shrubs and brush and a few trees

US left: Trees and brush with grass on the overbank

US right:

Do banks appear stable? No [illegible] ***date of observation.***

Cut-banks upstream and downstream of the bridge point to laterally unstable banks.

Describe any obstructions in channel and date of observation.

None as of 9/5/95.

Hydrology

Drainage area 19.6 ***mi***^{2}

Percentage of drainage area in physiographic provinces: (approximate)

Physiographic province/section	***Percent of drainage area***
New England/New England Upland	100

Is drainage area considered rural or urban? Rural ***Describe any significant urbanization***: None

Is there a USGS gage on the stream of interest? No

USGS gage description --

USGS gage number --

Gage drainage area -- ***mi***^{2}

Is there a lake/p [illegible] No

Calculated Discharges

Q100 2,700 ***ft***^{3}***/s*** ***Q500*** 3,680 ***ft***^{3}***/s***

The 100- and 500-year discharges are based on a drainage area relationship [(19.6/20.2)exp 0.67] with flood frequency estimates used in the model for bridge number 5c in Corinth. Bridge number 5c crosses Cookville Brook downstream of this site and has a drainage area of 20.2 square miles. The 100- and 500-year discharges for bridge number 5c are the median values of several empirical methods (Benson, 1962; Johnson and Tasker, 1974; FHWA, 1983; Potter, 1957a&b; Talbot, 1887). Each curve was extended graphically to the 500-year event.

Description of the Water-Surface Profile Model (WSPRO) Analysis

Datum for WSPRO analysis (USGS survey, sea level, VTAOT plans) USGS survey

Datum tie between USGS survey and VTAOT plans None

Description of reference marks used to determine USGS datum. RM1 is a chiseled X on top of the upstream end of the right abutment (elev. 501.57 ft, arbitrary survey datum). RM2 is a chiseled X on top of the downstream end of the left abutment (elev. 501.06 ft, arbitrary survey datum).

Cross-Sections Used in WSPRO Analysis

[1]Cross-section	*Section Reference Distance (SRD) in feet*	*[2]Cross-section development*	*Comments*
EXIT1	-35	1	Exit section
FULLV	0	2	Downstream Full-valley section (Templated from EXIT1)
BRIDG	0	1	Bridge section
RDWAY	16	1	Road Grade section
APTEM	70	1	Approach section as surveyed (Used as a template)
APPRO	77	2	Modelled Approach section (Templated from APTEM)

[1] For location of cross-sections see plan-view sketch included with Level I field form, appendix E.
For more detail on how cross-sections were developed see WSPRO input file.

Data and Assumptions Used in WSPRO Model

Hydraulic analyses of the reach were done by use of the Federal Highway Administration's WSPRO step-backwater computer program (Shearman and others, 1986, and Shearman, 1990). The analyses reported herein reflect conditions existing at the site at the time of the study. Furthermore, in the development of the model it was necessary to assume no accumulation of debris or ice at the site. Results of the hydraulic model are presented in the Bridge Hydraulic Summary, appendix B, and figure 7.

Channel roughness factors (Manning's "n") used in the hydraulic model were estimated using field inspections at each cross section following the general guidelines described by Arcement and Schneider (1989). Final adjustments to the values were made during the modelling of the reach. Channel "n" values for the reach ranged from 0.035 to 0.045, and overbank "n" values ranged from 0.040 to 0.060.

Normal depth at the exit section (EXIT1) was assumed as the starting water surface. This depth was computed by use of the slope-conveyance method outlined in the user's manual for WSPRO (Shearman, 1990). The slope used was 0.0059 ft/ft, which was estimated from contour lines on the topographic map (U.S. Geological Survey, 1981).

The surveyed approach section (APTEM) was moved along the approach channel slope (0.0035 ft/ft) to establish the modelled approach section (APPRO), one bridge length upstream of the upstream face as recommended by Shearman and others (1986). This location provides a consistent method for determining scour variables.

Bridge Hydraulics Summary

Average bridge embankment elevation 503.5 ***ft***
Average low steel elevation 497.6 ***ft***

100-year discharge 2,700 ***ft^3/s***
Water-surface elevation in bridge opening 497.8 ***ft***
Road overtopping? Yes ***Discharge over road*** 438 ***ft^3/s***
Area of flow in bridge opening 189 ***ft^2***
Average velocity in bridge opening 12.0 ***ft/s***
Maximum WSPRO tube velocity at bridge 14.7 ***ft/s***

Water-surface elevation at Approach section with bridge 502.0
Water-surface elevation at Approach section without bridge 499.0
Amount of backwater caused by bridge 3.0 ***ft***

500-year discharge 3,680 ***ft^3/s***
Water-surface elevation in bridge opening 497.8 ***ft***
Road overtopping? Yes ***Discharge over road*** 1,305 ***ft^3/s***
Area of flow in bridge opening 189 ***ft^2***
Average velocity in bridge opening 12.5 ***ft/s***
Maximum WSPRO tube velocity at bridge 15.3 ***ft/s***

Water-surface elevation at Approach section with bridge 502.8
Water-surface elevation at Approach section without bridge 499.4
Amount of backwater caused by bridge 3.4 ***ft***

Incipient overtopping discharge 2,130 ***ft^3/s***
Water-surface elevation in bridge opening 497.8 ***ft***
Area of flow in bridge opening 189 ***ft^2***
Average velocity in bridge opening 11.3 ***ft/s***
Maximum WSPRO tube velocity at bridge 13.8 ***ft/s***

Water-surface elevation at Approach section with bridge 501.2
Water-surface elevation at Approach section without bridge 498.7
Amount of backwater caused by bridge 2.5 ***ft***

Scour Analysis Summary

Special Conditions or Assumptions Made in Scour Analysis

Scour depths were computed using the general guidelines described in Hydraulic Engineering Circular 18 (Richardson and Davis, 1995). Scour depths were calculated assuming an infinite depth of erosive material and a homogeneous particle-size distribution. The results of the scour analyses for the 100- and 500-year discharges are presented in tables 1 and 2 and the scour depths are shown graphically in figure 8.

At this site, the 100-year, 500-year, and incipient roadway-overtopping discharges resulted in submerged orifice flow. Contraction scour at bridges with orifice flow is best estimated by use of the Chang pressure-flow scour equation (oral communication, J. Sterling Jones, October 4, 1996). Thus, contraction scour for these discharges was computed by use of the Chang equation (Richardson and Davis, 1995, p. 145-146).

For comparison, contraction scour was also computed by use of the Laursen clear-water contraction scour equation (Richardson and Davis, 1995, p. 32, equation 20) and the Umbrell pressure-flow equation (Richardson and Davis, 1995, p. 144). Results from these computations are presented in appendix F.

Abutment scour for the left abutment was computed by use of the Froehlich equation (Richardson and Davis, 1995, p. 48, equation 28). Variables for the Froehlich equation include the Froude number of the flow approaching the embankments, the length of the embankment blocking flow, and the depth of flow approaching the embankment less any roadway overtopping.

Scour at the right abutment was computed by use of the HIRE equation (Richardson and Davis, 1995, p. 49, equation 29) because the HIRE equation is recommended when the length to depth ratio of the embankment blocking flow exceeds 25. The variables used by the HIRE abutment-scour equation are defined the same as those defined for the Froehlich abutment-scour equation.

Because the influence of scour processes on the stone-fill embankment material is uncertain, the scour depth at the vertical concrete abutment walls is unknown. Therefore, the total scour depths were applied for the entire stone-fill embankment area below the elevation at the toe of each embankment, as shown in figure 8.

Scour Results

Contraction scour:	*100-year discharge*	*500-year discharge*	*Incipient overtopping discharge*
		(Scour depths in feet)	
Main channel			
Live-bed scour	--	--	--
Clear-water scour	3.9	4.1	3.5
Depth to armoring	N/A	N/A	N/A
Left overbank	--	--	--
Right overbank	--	--	--

Local scour:			
Abutment scour			
Left abutment	6.6	8.0	5.0
Right abutment	6.8	7.6	6.5
Pier scour			
Pier 1	--	--	--
Pier 2	--	--	--
Pier 3	--	--	--

Riprap Sizing

	100-year discharge	*500-year discharge*	*Incipient overtopping discharge*
		(D_{50} in feet)	
Abutments:			
Left abutment	1.6	1.6	1.7
Right abutment	1.6	1.6	1.7
Piers:			
Pier 1	--	--	--
Pier 2	--	--	--

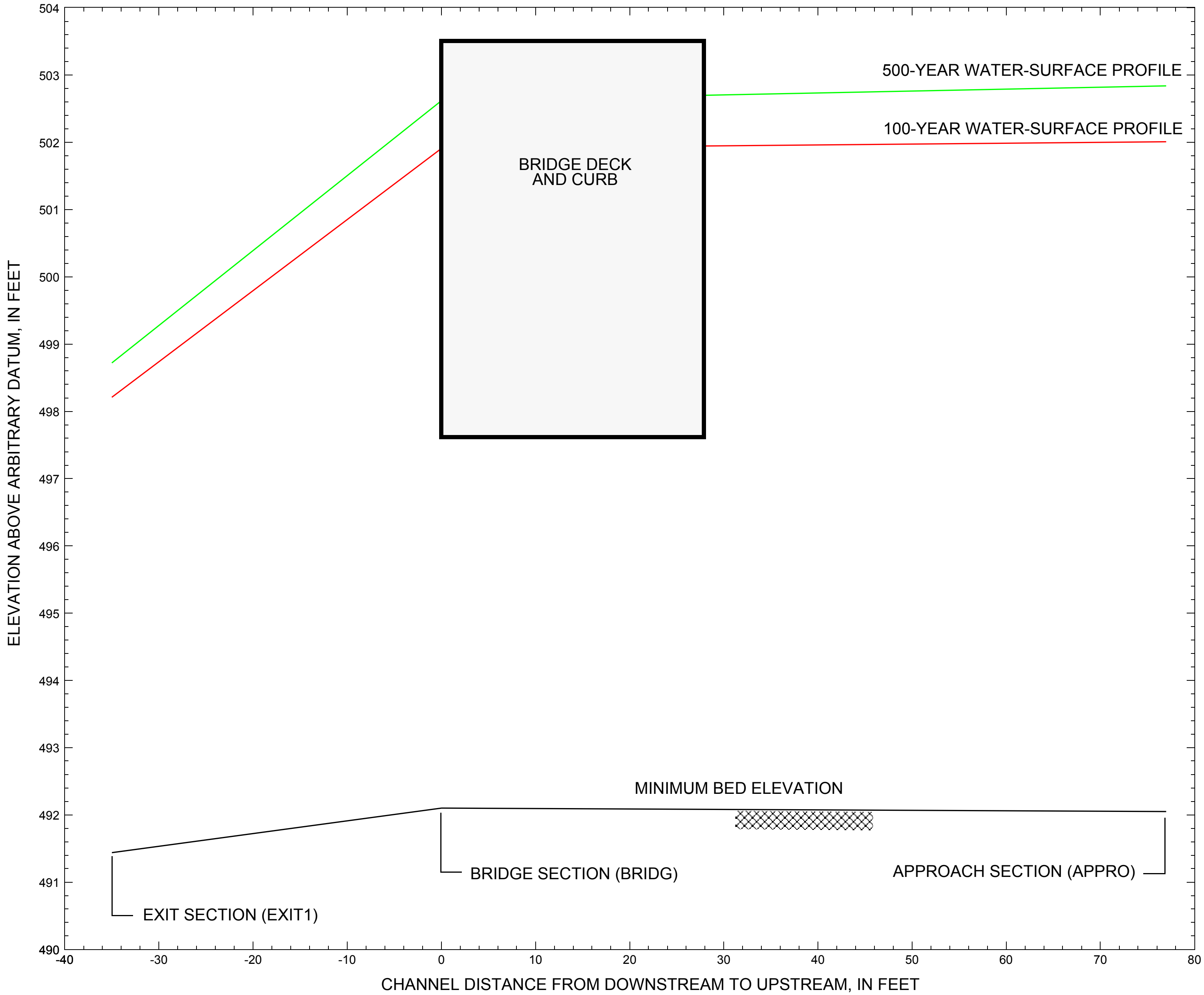

Figure 7. Water-surface profiles for the 100- and 500-year discharges at structure CORITH00020007 on Town Highway 2, crossing Cookville Brook, Corinth, Vermont.

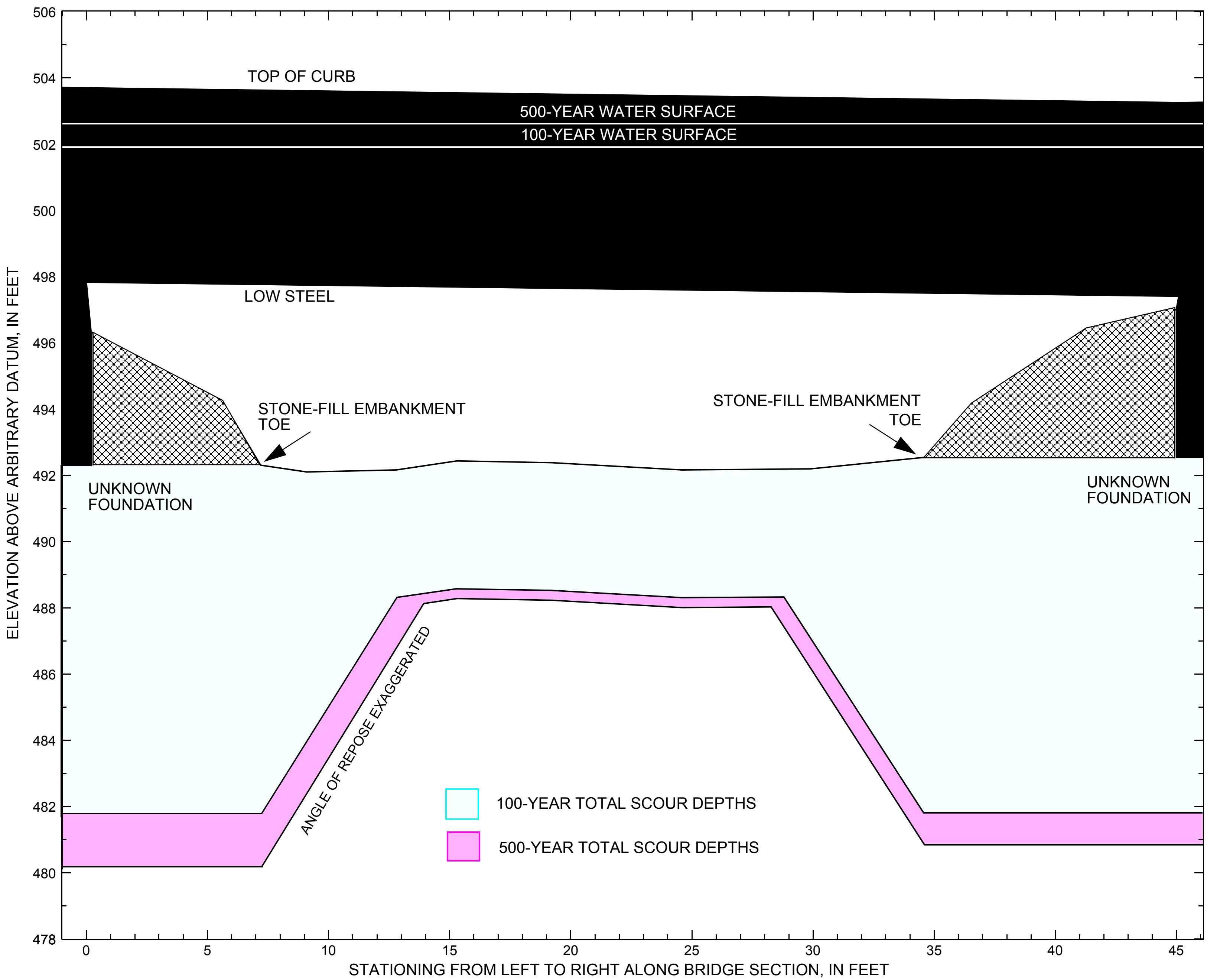

Figure 8. Scour elevations for the 100- and 500-year discharges at structure CORITH00020007 on Town Highway 2, crossing Cookville Brook, Corinth, Vermont.

Table 1. Remaining footing/pile depth at abutments for the 100-year discharge at structure CORITH00020007 on Town Highway 2, crossing Cookville Brook, Corinth, Vermont.

[VTAOT, Vermont Agency of Transportation; --, no data]

Description	Station[1]	VTAOT minimum low-chord elevation (feet)	Surveyed minimum low-chord elevation[2] (feet)	Bottom of footing/pile elevation[2] (feet)	Channel elevation at abutment/ pier[2] (feet)	Contraction scour depth (feet)	Abutment scour depth (feet)	Pier scour depth (feet)	Depth of total scour (feet)	Elevation of scour[2] (feet)	Remaining footing/pile depth (feet)
100-year discharge is 2,700 cubic-feet per second											
Left abutment	0.0	--	497.8	--	496.3	--	--	--	--	--	--
Left embankment toe	7.2	--	--	--	492.3	3.9	6.6	--	10.5	481.8	--
Right embankment toe	34.6	--	--	--	492.5	3.9	6.8	--	10.7	481.8	--
Right abutment	45.1	--	497.4	--	497.0	--	--	--	--	--	--

1.Measured along the face of the most constricting side of the bridge.
2.Arbitrary datum for this study.

Table 2. Remaining footing/pile depth at abutments for the 500-year discharge at structure CORITH00020007 on Town Highway 2, crossing Cookville Brook, Corinth, Vermont.

[VTAOT, Vermont Agency of Transportation; --, no data]

Description	Station[1]	VTAOT minimum low-chord elevation (feet)	Surveyed minimum low-chord elevation[2] (feet)	Bottom of footing/pile elevation[2] (feet)	Channel elevation at abutment/ pier[2] (feet)	Contraction scour depth (feet)	Abutment scour depth (feet)	Pier scour depth (feet)	Depth of total scour (feet)	Elevation of scour[2] (feet)	Remaining footing/pile depth (feet)
500-year discharge is 3,680 cubic-feet per second											
Left abutment	0.0	--	497.8	--	496.3	--	--	--	--	--	--
Left embankment toe	7.2	--	--	--	492.3	4.1	8.0	--	12.1	480.2	--
Right embankment toe	34.6	--	--	--	492.5	4.1	7.6	--	11.7	480.8	--
Right abutment	45.1	--	497.4	--	497.0	--	--	--	--	--	--

1.Measured along the face of the most constricting side of the bridge.
2.Arbitrary datum for this study.

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APPENDIX A:

WSPRO INPUT FILE

WSPRO INPUT FILE

```
T1        U.S. Geological Survey WSPRO Input File cori007.wsp
T2        Hydraulic analysis for structure corith00020007   Date: 31-JUL-97
T3        hydraulic analysis of bridge 7 in corinth over cookville brook
*
J1         * * 0.0020
J3         6 29 30 552 553 551 5 16 17 13 3 * 15 14 23 21 11 12 4 7 3
*
Q           2700.0   3680.0   2130.0
SK          0.0059   0.0059   0.0059
*
XS   EXIT1    -35           0.
GR         -246.0, 519.76   -172.2, 511.89   -162.2, 503.95   -153.9, 504.91
GR         -122.8, 504.53    -84.2, 502.82    -63.2, 496.72     -5.7, 496.66
GR            0.0, 494.31      1.9, 492.64      5.0, 492.14      9.6, 491.60
GR           14.9, 491.44     21.2, 491.74     29.2, 491.93     33.5, 492.19
GR           35.4, 494.14     37.8, 496.35    214.6, 497.91    275.1, 501.54
GR          305.5, 502.36    362.1, 505.68
*
N           0.050        0.045        0.040
SA                  -5.7         37.8
*
XS   FULLV      0  * * *   0.0093
*
*             SRD     LSEL    XSSKEW
BR   BRIDG     0    497.61       0.0
GR            0.0, 497.83      0.2, 496.32      5.6, 494.26      7.2, 492.30
GR            9.1, 492.10     12.8, 492.16     15.3, 492.43     19.2, 492.38
GR           24.6, 492.16     29.9, 492.19     34.6, 492.54     36.5, 494.09
GR           41.3, 496.44     45.0, 497.00     45.1, 497.40      0.0, 497.83
*
*         BRTYPE  BRWDTH
CD          1      32.0
N           0.035
*
*             SRD    EMBWID   IPAVE
XR   RDWAY     16      24.8     1
GR         -156.6, 510.46   -151.2, 509.73   -139.6, 502.79   -113.3, 504.00
GR          -59.3, 503.15     -2.0, 501.99     -1.9, 502.85     -0.2, 502.80
GR            0.0, 503.70     20.3, 503.60     45.1, 503.25     45.3, 502.36
GR           47.0, 502.32     47.2, 501.43     79.9, 501.26    165.7, 501.15
GR          227.6, 501.18    281.5, 506.07
*
XT   APTEM     70           0.
GR         -110.9, 512.62    -89.8, 502.94    -86.9, 503.20    -74.1, 503.90
GR          -51.9, 502.93    -47.9, 500.23     -4.3, 498.11      0.0, 495.81
GR            5.4, 492.67     11.6, 492.12     16.6, 492.65     20.2, 492.71
GR           23.5, 492.55     28.5, 492.03     30.2, 492.65     35.6, 494.65
GR           47.7, 495.64    121.6, 498.12    202.2, 497.73    226.2, 500.66
GR          259.2, 500.84    273.7, 506.42
*
AS   APPRO     77  * * * 0.0035
GT
N           0.060        0.045        0.050
SA                  -4.3         35.6
*
HP 1 BRIDG  497.83 1 497.83
HP 2 BRIDG  497.83 * * 2264
HP 2 RDWAY  501.91 * *  438
HP 1 APPRO  502.01 1 502.01
HP 2 APPRO  502.01 * * 2700
*
HP 1 BRIDG  497.83 1 497.83
HP 2 BRIDG  497.83 * * 2368
HP 2 RDWAY  502.62 * * 1305
```

APPENDIX B:

WSPRO OUTPUT FILE

WSPRO OUTPUT FILE

```
       U.S. Geological Survey WSPRO Input File cori007.wsp
       Hydraulic analysis for structure corith00020007   Date: 31-JUL-97
       hydraulic analysis of bridge 7 in corinth over cookville brook
          *** RUN DATE & TIME: 06-22-98  07:58

   CROSS-SECTION PROPERTIES:  ISEQ =  3;  SECID = BRIDG;  SRD =       0.

    WSEL  SA#     AREA        K   TOPW   WETP  ALPH    LEW    REW     QCR
            1     189.   12785.     0.    94.                            0.
  497.83          189.   12785.     0.    94.  1.00     0.    45.      0.

   VELOCITY DISTRIBUTION:  ISEQ =  3;  SECID = BRIDG;  SRD =       0.

        WSEL     LEW     REW    AREA        K        Q    VEL
      497.83     0.0    45.1   189.0   12785.    2264.  11.98

X STA.        0.0        6.8        8.3        9.7       11.1       12.5
  A(I)            19.0        8.2        7.8        7.7        7.9
  V(I)            5.95      13.80      14.59      14.61      14.41

X STA.       12.5       14.0       15.5       17.0       18.6       20.1
  A(I)             8.0        8.1        8.2        8.1        8.1
  V(I)           14.15      14.04      13.82      13.96      13.93

X STA.       20.1       21.6       23.1       24.5       26.0       27.4
  A(I)             7.9        8.0        7.8        8.0        7.7
  V(I)           14.35      14.23      14.44      14.18      14.66

X STA.       27.4       28.9       30.4       31.9       33.5       45.1
  A(I)             7.9        8.0        8.0        8.0       26.6
  V(I)           14.25      14.24      14.18      14.12       4.25

   VELOCITY DISTRIBUTION:  ISEQ =  4;  SECID = RDWAY;  SRD =      16.

        WSEL     LEW     REW    AREA        K        Q    VEL
      501.91    47.1   235.6   128.0    3680.     438.   3.42

X STA.       47.1       62.9       74.9       85.2       95.1      104.6
  A(I)             8.2        7.1        6.7        6.5        6.5
  V(I)            2.67       3.08       3.29       3.35       3.39

X STA.      104.6      113.8      122.9      131.6      140.1      148.3
  A(I)             6.3        6.3        6.2        6.1        6.0
  V(I)            3.46       3.47       3.53       3.58       3.64

X STA.      148.3      156.3      164.3      172.2      180.1      188.2
  A(I)             6.0        6.0        5.9        6.0        6.1
  V(I)            3.67       3.62       3.68       3.64       3.59

X STA.      188.2      196.3      204.4      212.5      221.0      235.6
  A(I)             6.0        6.0        5.9        6.3        7.8
  V(I)            3.63       3.63       3.69       3.50       2.81

   CROSS-SECTION PROPERTIES:  ISEQ =  5;  SECID = APPRO;  SRD =      77.

    WSEL  SA#     AREA        K   TOPW   WETP  ALPH    LEW    REW     QCR
            1     125.    5980.    46.    47.                         1167.
            2     345.   46634.    40.    42.                         5761.
            3     897.   66776.   227.   227.                        10124.
  502.01         1367.  119390.   313.   316.  1.36   -51.   262.  13927.

   VELOCITY DISTRIBUTION:  ISEQ =  5;  SECID = APPRO;  SRD =      77.

        WSEL     LEW     REW    AREA        K        Q    VEL
      502.01   -50.5   262.2  1367.0  119390.    2700.   1.98

X STA.      -50.5       -3.9        5.5        9.8       13.8       18.1
  A(I)           126.7       62.9       40.4       39.8       39.9
  V(I)            1.07       2.14       3.34       3.39       3.38

X STA.       18.1       22.5       26.7       31.0       37.2       45.8
  A(I)            41.3       39.9       41.7       49.4       58.4
  V(I)            3.27       3.38       3.24       2.73       2.31

X STA.       45.8       54.3       64.7       76.0       89.3      105.1
  A(I)            53.8       61.6       63.4       68.6       73.8
  V(I)            2.51       2.19       2.13       1.97       1.83

X STA.      105.1      125.7      147.0      166.9      186.1      262.2
  A(I)            84.3       84.1       80.2       79.3      177.4
  V(I)            1.60       1.61       1.68       1.70       0.76
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       U.S. Geological Survey WSPRO Input File cori007.wsp
       Hydraulic analysis for structure corith00020007   Date: 31-JUL-97
       hydraulic analysis of bridge 7 in corinth over cookville brook
          *** RUN DATE & TIME: 06-22-98  07:58

   CROSS-SECTION PROPERTIES:  ISEQ =  3;  SECID = BRIDG;  SRD =       0.

    WSEL  SA#     AREA        K   TOPW   WETP  ALPH    LEW    REW     QCR
            1     189.  12785.     0.    94.                            0.
  497.83          189.  12785.     0.    94.  1.00     0.    45.       0.

   VELOCITY DISTRIBUTION:  ISEQ =  3;  SECID = BRIDG;  SRD =       0.

        WSEL     LEW     REW    AREA        K        Q    VEL
      497.83     0.0    45.1   189.0   12785.    2368.  12.53

X STA.        0.0        6.8        8.3        9.7       11.1       12.5
  A(I)            19.0        8.2        7.8        7.7        7.9
  V(I)            6.23      14.43      15.26      15.28      15.07

X STA.       12.5       14.0       15.5       17.0       18.6       20.1
  A(I)             8.0        8.1        8.2        8.1        8.1
  V(I)           14.80      14.69      14.45      14.61      14.57

X STA.       20.1       21.6       23.1       24.5       26.0       27.4
  A(I)             7.9        8.0        7.8        8.0        7.7
  V(I)           15.01      14.88      15.11      14.83      15.34

X STA.       27.4       28.9       30.4       31.9       33.5       45.1
  A(I)             7.9        8.0        8.0        8.0       26.6
  V(I)           14.90      14.89      14.83      14.77       4.45

   VELOCITY DISTRIBUTION:  ISEQ =  4;  SECID = RDWAY;  SRD =      16.

        WSEL     LEW     REW    AREA        K        Q    VEL
      502.62   -33.1   243.5   275.0   12100.    1305.   4.74

X STA.      -33.1       57.6       68.4       78.6       88.3       97.8
  A(I)            23.1       13.7       13.6       13.1       13.1
  V(I)            2.82       4.78       4.79       4.97       4.99

X STA.       97.8      107.1      116.5      125.6      134.5      143.5
  A(I)            12.9       13.2       12.8       12.8       12.9
  V(I)            5.05       4.95       5.08       5.10       5.06

X STA.      143.5      152.3      161.0      169.6      178.2      186.9
  A(I)            12.7       12.8       12.5       12.7       12.6
  V(I)            5.16       5.12       5.21       5.13       5.17

X STA.      186.9      195.6      204.4      213.1      222.0      243.5
  A(I)            12.8       12.8       12.6       12.8       19.5
  V(I)            5.12       5.10       5.18       5.08       3.35

   CROSS-SECTION PROPERTIES:  ISEQ =  5;  SECID = APPRO;  SRD =      77.

    WSEL  SA#     AREA        K   TOPW   WETP  ALPH    LEW    REW     QCR
            1     164.   9194.    47.    48.                         1729.
            2     378.  54327.    40.    42.                         6609.
            3    1086.  91218.   229.   229.                        13423.
  502.84         1628. 154739.   316.   320.  1.28   -52.   264.   18511.

   VELOCITY DISTRIBUTION:  ISEQ =  5;  SECID = APPRO;  SRD =      77.

        WSEL     LEW     REW    AREA        K        Q    VEL
      502.84   -51.7   264.3  1627.9  154739.    3680.   2.26

X STA.      -51.7       -9.3        4.7        9.6       14.3       19.1
  A(I)           140.8       87.5       50.0       49.8       49.0
  V(I)            1.31       2.10       3.68       3.70       3.76

X STA.       19.1       23.9       28.6       34.1       42.9       52.6
  A(I)            49.3       49.7       53.8       70.0       69.9
  V(I)            3.73       3.70       3.42       2.63       2.63

X STA.       52.6       62.2       73.7       86.8      101.8      119.6
  A(I)            65.5       75.0       79.6       84.1       90.0
  V(I)            2.81       2.45       2.31       2.19       2.04

X STA.      119.6      140.1      159.2      177.8      195.7      264.3
  A(I)            97.1       92.6       91.5       89.6      193.2
  V(I)            1.89       1.99       2.01       2.05       0.95
```

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      U.S. Geological Survey WSPRO Input File cori007.wsp
      Hydraulic analysis for structure corith00020007   Date: 31-JUL-97
      hydraulic analysis of bridge 7 in corinth over cookville brook
         *** RUN DATE & TIME: 06-22-98  07:58

  CROSS-SECTION PROPERTIES:  ISEQ =  3;  SECID = BRIDG;  SRD =       0.

   WSEL  SA#     AREA        K   TOPW   WETP  ALPH    LEW    REW     QCR
           1     189.  12785.     0.    94.                            0.
 497.83          189.  12785.     0.    94.  1.00     0.    45.       0.

  VELOCITY DISTRIBUTION:  ISEQ =  3;  SECID = BRIDG;  SRD =       0.

       WSEL     LEW     REW    AREA        K        Q    VEL
     497.83     0.0    45.1   189.0   12785.    2130.  11.27

X STA.        0.0        6.8        8.3        9.7       11.1       12.5
  A(I)           19.0        8.2        7.8        7.7        7.9
  V(I)           5.60      12.98      13.73      13.74      13.56

X STA.       12.5       14.0       15.5       17.0       18.6       20.1
  A(I)            8.0        8.1        8.2        8.1        8.1
  V(I)          13.31      13.21      13.00      13.14      13.11

X STA.       20.1       21.6       23.1       24.5       26.0       27.4
  A(I)            7.9        8.0        7.8        8.0        7.7
  V(I)          13.50      13.38      13.59      13.34      13.80

X STA.       27.4       28.9       30.4       31.9       33.5       45.1
  A(I)            7.9        8.0        8.0        8.0       26.6
  V(I)          13.40      13.40      13.34      13.28       4.00

  CROSS-SECTION PROPERTIES:  ISEQ =  5;  SECID = APPRO;  SRD =      77.

   WSEL  SA#     AREA        K   TOPW   WETP  ALPH    LEW    REW     QCR
           1      88.   3379.    45.    45.                          694.
           2     312.  39502.    40.    42.                         4961.
           3     712.  45750.   224.   225.                         7194.
 501.19         1112.  88631.   309.   312.  1.47   -49.   260.    9881.

  VELOCITY DISTRIBUTION:  ISEQ =  5;  SECID = APPRO;  SRD =      77.

       WSEL     LEW     REW    AREA        K        Q    VEL
     501.19   -49.3   260.0  1112.0   88631.    2130.   1.92

X STA.      -49.3        0.8        6.3        9.9       13.4       17.0
  A(I)          110.2       40.7       31.3       31.4       31.6
  V(I)           0.97       2.62       3.40       3.39       3.37

X STA.       17.0       20.9       24.6       28.2       32.1       37.9
  A(I)           32.5       32.0       31.6       33.3       40.5
  V(I)           3.27       3.32       3.37       3.20       2.63

X STA.       37.9       45.3       54.1       63.8       74.7       87.5
  A(I)           44.1       48.4       49.9       52.4       56.3
  V(I)           2.41       2.20       2.13       2.03       1.89

X STA.       87.5      103.3      126.1      149.6      171.6      260.0
  A(I)           62.2       74.8       73.6       70.9      164.2
  V(I)           1.71       1.42       1.45       1.50       0.65
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        U.S. Geological Survey WSPRO Input File cori007.wsp
        Hydraulic analysis for structure corith00020007   Date: 31-JUL-97
        hydraulic analysis of bridge 7 in corinth over cookville brook
           *** RUN DATE & TIME: 06-22-98  07:58

 XSID:CODE   SRDL    LEW     AREA   VHD    HF     EGL    CRWS       Q    WSEL
       SRD   FLEN    REW        K  ALPH    HO     ERR     FR#     VEL

EXIT1:XS   ******   -68.     526.  0.67 *****  498.88  498.08   2700.  498.21
      -35. ******   220.   35141.  1.64 ***** *******    0.86    5.14

 ===125 FR# EXCEEDS FNTEST AT SECID "FULLV":  TRIALS CONTINUED.
              FNTEST,FR#,WSEL,CRWS =  0.80     1.01     498.36     498.41
 ===110 WSEL NOT FOUND AT SECID "FULLV":  REDUCED DELTAY.
                   WSLIM1,WSLIM2,DELTAY =   497.71     520.09     0.50
 ===115 WSEL NOT FOUND AT SECID "FULLV":  USED WSMIN = CRWS.
                   WSLIM1,WSLIM2,CRWS =   497.71     520.09     498.41
 ===130 CRITICAL WATER-SURFACE ELEVATION  A _ S _ S _ U _ M _ E _ D  !!!!!
              ENERGY EQUATION  N_O_T  B_A_L_A_N_C_E_D  AT SECID "FULLV"
                   WSBEG,WSEND,CRWS =   498.41     520.09     498.41

FULLV:FV      35.   -68.     490.  0.79 *****  499.20  498.41   2700.  498.41
        0.    35.   217.   32424.  1.67 ***** *******    0.96    5.51
         <<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>

APPRO:AS      77.   -22.     526.  0.67  0.49  499.67 *******   2700.  499.00
       77.    77.   212.   35228.  1.63  0.00   -0.02    0.77    5.13
         <<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>

 ===255 ATTEMPTING FLOW CLASS 3 (6) SOLUTION.
                       WS3N,LSEL =   498.41     497.61

            <<<<<RESULTS REFLECTING THE CONSTRICTED FLOW FOLLOW>>>>>

 XSID:CODE   SRDL    LEW     AREA   VHD    HF     EGL    CRWS       Q    WSEL
       SRD   FLEN    REW        K  ALPH    HO     ERR     FR#     VEL

BRIDG:BR      35.     0.     189.  2.23 *****  500.06  497.47   2264.  497.83
        0. ******    45.   12785.  1.00 ***** *******    1.03   11.98

     TYPE PPCD FLOW      C    P/A    LSEL   BLEN   XLAB   XRAB
       1. ****   6.  0.800  0.000  497.61 ****** ****** ******

    XSID:CODE    SRD   FLEN    HF   VHD     EGL     ERR       Q    WSEL
   RDWAY:RG      16.    52.  0.03  0.08  502.07    0.00    438.  501.91

            Q   WLEN    LEW    REW  DMAX  DAVG  VMAX  VAVG  HAVG  CAVG
   LT:     0.     3.    -5.    -2.   0.1   0.0   2.1   8.6   0.2   3.0
   RT:   438.   189.    47.   236.   0.8   0.7   4.2   3.4   0.8   3.0

 XSID:CODE   SRDL    LEW     AREA   VHD    HF     EGL    CRWS       Q    WSEL
       SRD   FLEN    REW        K  ALPH    HO     ERR     FR#     VEL

APPRO:AS      45.   -51.    1367.  0.08  0.20  502.09  498.70   2700.  502.01
       77.    50.   262.  119382.  1.36  0.00    0.00    0.19    1.98

       M(G)   M(K)       KQ   XLKQ   XRKQ    OTEL
     ****** ****** ******** ****** ****** ********

                     <<<<<END OF BRIDGE COMPUTATIONS>>>>>

  FIRST USER DEFINED TABLE.

    XSID:CODE    SRD    LEW    REW       Q        K     AREA     VEL    WSEL
   EXIT1:XS     -35.   -68.   220.   2700.   35141.     526.    5.14  498.21
   FULLV:FV       0.   -68.   217.   2700.   32424.     490.    5.51  498.41
   BRIDG:BR       0.     0.    45.   2264.   12785.     189.   11.98  497.83
   RDWAY:RG      16.*******     0.    438.       0.*********    1.00  501.91
   APPRO:AS      77.   -51.   262.   2700.  119382.    1367.    1.98  502.01

    XSID:CODE   XLKQ   XRKQ        KQ
   APPRO:AS  ***********************

 SECOND USER DEFINED TABLE.

    XSID:CODE     CRWS      FR#    YMIN    YMAX     HF     HO  VHD      EGL     WSEL
   EXIT1:XS     498.08     0.86  491.44  519.76************  0.67  498.88  498.21
   FULLV:FV     498.41     0.96  491.77  520.09************  0.79  499.20  498.41
   BRIDG:BR     497.47     1.03  492.10  497.83************  2.23  500.06  497.83
   RDWAY:RG  ***************  501.15  510.46   0.03******  0.08  502.07  501.91
   APPRO:AS     498.70     0.19  492.05  512.64   0.20   0.00  0.08  502.09  502.01
```

```
        U.S. Geological Survey WSPRO Input File cori007.wsp
        Hydraulic analysis for structure corith00020007   Date: 31-JUL-97
        hydraulic analysis of bridge 7 in corinth over cookville brook
           *** RUN DATE & TIME: 06-22-98  07:58

 XSID:CODE   SRDL    LEW     AREA   VHD    HF     EGL    CRWS       Q    WSEL
       SRD   FLEN    REW        K  ALPH    HO     ERR     FR#     VEL

EXIT1:XS   ******   -70.     676.  0.69 *****  499.42  498.50   3680.  498.72
      -35. ******   228.   47869.  1.51 ***** *******    0.78    5.44

 ===125 FR# EXCEEDS FNTEST AT SECID "FULLV":  TRIALS CONTINUED.
             FNTEST,FR#,WSEL,CRWS =  0.80    0.88     498.89     498.83
 ===110 WSEL NOT FOUND AT SECID "FULLV":  REDUCED DELTAY.
                  WSLIM1,WSLIM2,DELTAY =   498.22     520.09    0.50
 ===115 WSEL NOT FOUND AT SECID "FULLV":  USED WSMIN = CRWS.
                  WSLIM1,WSLIM2,CRWS =   498.22     520.09     498.83

FULLV:FV      35.   -70.     629.  0.82  0.23  499.71  498.83   3680.  498.89
        0.    35.   225.   43640.  1.55  0.07    0.00    0.88    5.85
         <<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>

 ===125 FR# EXCEEDS FNTEST AT SECID "APPRO":  TRIALS CONTINUED.
             FNTEST,FR#,WSEL,CRWS =  0.80    0.81     499.43     499.17
 ===110 WSEL NOT FOUND AT SECID "APPRO":  REDUCED DELTAY.
                  WSLIM1,WSLIM2,DELTAY =   498.39     512.64    0.50
 ===115 WSEL NOT FOUND AT SECID "APPRO":  USED WSMIN = CRWS.
                  WSLIM1,WSLIM2,CRWS =   498.39     512.64     499.17

APPRO:AS      77.   -31.     629.  0.83  0.54  500.27  499.17   3680.  499.43
       77.    77.   216.   43960.  1.57  0.00    0.01    0.81    5.85
         <<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>

 ===255 ATTEMPTING FLOW CLASS 3 (6) SOLUTION.
                       WS3N,LSEL =   498.89     497.61

            <<<<<RESULTS REFLECTING THE CONSTRICTED FLOW FOLLOW>>>>>

 XSID:CODE   SRDL    LEW     AREA   VHD    HF     EGL    CRWS       Q    WSEL
       SRD   FLEN    REW        K  ALPH    HO     ERR     FR#     VEL

BRIDG:BR      35.     0.     189.  2.44 *****  500.27  497.50   2368.  497.83
        0. ******    45.   12785.  1.00 ***** *******    1.08   12.53

     TYPE PPCD FLOW      C    P/A    LSEL   BLEN   XLAB   XRAB
       1. ****   6.  0.800  0.000  497.61 ****** ****** ******

    XSID:CODE    SRD   FLEN    HF   VHD     EGL     ERR       Q    WSEL
   RDWAY:RG      16.    52.  0.03  0.10  502.91    0.00   1305.  502.62

            Q   WLEN    LEW    REW  DMAX  DAVG  VMAX  VAVG  HAVG  CAVG
   LT:     44.    31.   -33.    -2.   0.6   0.3   3.5   4.6   0.6   3.0
   RT:   1261.   198.    45.   243.   1.5   1.3   5.9   4.8   1.6   3.1

 XSID:CODE   SRDL    LEW     AREA   VHD    HF     EGL    CRWS       Q    WSEL
       SRD   FLEN    REW        K  ALPH    HO     ERR     FR#     VEL

APPRO:AS      45.   -52.    1627.  0.10  0.24  502.94  499.17   3680.  502.84
       77.    52.   264.  154647.  1.28  0.00    0.00    0.20    2.26

       M(G)   M(K)       KQ   XLKQ   XRKQ    OTEL
     ****** ****** ******** ****** ****** ********

                     <<<<<END OF BRIDGE COMPUTATIONS>>>>>

  FIRST USER DEFINED TABLE.

    XSID:CODE    SRD    LEW    REW       Q        K     AREA     VEL    WSEL
   EXIT1:XS     -35.   -70.   228.   3680.   47869.     676.    5.44  498.72
   FULLV:FV       0.   -70.   225.   3680.   43640.     629.    5.85  498.89
   BRIDG:BR       0.     0.    45.   2368.   12785.     189.   12.53  497.83
   RDWAY:RG      16.*******    44.   1305.******************    1.00  502.62
   APPRO:AS      77.   -52.   264.   3680.  154647.    1627.    2.26  502.84

    XSID:CODE   XLKQ   XRKQ       KQ
   APPRO:AS  ***********************

 SECOND USER DEFINED TABLE.

    XSID:CODE     CRWS     FR#    YMIN    YMAX     HF    HO  VHD      EGL    WSEL
   EXIT1:XS    498.50    0.78  491.44  519.76************  0.69  499.42  498.72
   FULLV:FV    498.83    0.88  491.77  520.09  0.23  0.07  0.82  499.71  498.89
   BRIDG:BR    497.50    1.08  492.10  497.83************  2.44  500.27  497.83
   RDWAY:RG  ***************  501.15  510.46  0.03******  0.10  502.91  502.62
   APPRO:AS    499.17    0.20  492.05  512.64  0.24  0.00  0.10  502.94  502.84
```

WSPRO OUTPUT FILE (continued)

```
        U.S. Geological Survey WSPRO Input File cori007.wsp
        Hydraulic analysis for structure corith00020007   Date: 31-JUL-97
        hydraulic analysis of bridge 7 in corinth over cookville brook
           *** RUN DATE & TIME: 06-22-98  07:58

 XSID:CODE   SRDL    LEW     AREA   VHD    HF     EGL    CRWS       Q    WSEL
       SRD   FLEN    REW        K  ALPH    HO     ERR     FR#     VEL

EXIT1:XS   ******   -67.     421.  0.67 *****  498.52  497.66   2130.  497.84
      -35. ******   207.   27713.  1.70 ***** *******    0.94    5.06

 ===125 FR# EXCEEDS FNTEST AT SECID "FULLV":  TRIALS CONTINUED.
            FNTEST,FR#,WSEL,CRWS =  0.80    1.07     497.98     497.99
 ===110 WSEL NOT FOUND AT SECID "FULLV":  REDUCED DELTAY.
                 WSLIM1,WSLIM2,DELTAY =   497.34     520.09    0.50
 ===115 WSEL NOT FOUND AT SECID "FULLV":  USED WSMIN = CRWS.
                 WSLIM1,WSLIM2,CRWS =   497.34     520.09     497.99

FULLV:FV      35.   -66.     374.  0.84  0.23  498.82  497.99   2130.  497.99
        0.    35.   186.   24822.  1.66  0.08    0.00    1.06    5.70
         <<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>

APPRO:AS      77.   -17.     462.  0.55  0.47  499.28 *******   2130.  498.73
       77.    77.   210.   30225.  1.68  0.00   -0.01    0.74    4.61
         <<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>

 ===255 ATTEMPTING FLOW CLASS 3 (6) SOLUTION.
                      WS3N,LSEL =   497.99     497.61

            <<<<<RESULTS REFLECTING THE CONSTRICTED FLOW FOLLOW>>>>>

 XSID:CODE   SRDL    LEW     AREA   VHD    HF     EGL    CRWS       Q    WSEL
       SRD   FLEN    REW        K  ALPH    HO     ERR     FR#     VEL

BRIDG:BR      35.     0.     189.  1.98 *****  499.81  497.43   2134.  497.83
        0. ******    45.   12785.  1.00 ***** *******    0.97   11.29

     TYPE PPCD FLOW      C    P/A    LSEL   BLEN   XLAB   XRAB
       1. ****   3.  0.800  0.000  497.61 ****** ****** ******

    XSID:CODE    SRD   FLEN    HF   VHD     EGL     ERR       Q    WSEL
   RDWAY:RG      16.        <<<<<EMBANKMENT IS NOT OVERTOPPED>>>>>

 XSID:CODE   SRDL    LEW     AREA   VHD    HF     EGL    CRWS       Q    WSEL
       SRD   FLEN    REW        K  ALPH    HO     ERR     FR#     VEL

APPRO:AS      45.   -49.    1113.  0.08  0.20  501.28  497.72   2130.  501.19
       77.    49.   260.   88742.  1.47  0.00    0.00    0.22    1.91

       M(G)   M(K)       KQ   XLKQ   XRKQ    OTEL
     ****** ****** ******** ****** ******   501.16

                     <<<<<END OF BRIDGE COMPUTATIONS>>>>>

  FIRST USER DEFINED TABLE.

    XSID:CODE     SRD    LEW    REW       Q        K      AREA     VEL    WSEL
   EXIT1:XS      -35.   -67.   207.   2130.   27713.      421.    5.06  497.84
   FULLV:FV        0.   -66.   186.   2130.   24822.      374.    5.70  497.99
   BRIDG:BR        0.     0.    45.   2134.   12785.      189.   11.29  497.83
   RDWAY:RG       16.**************      0.       0.        0.    1.00********
   APPRO:AS       77.   -49.   260.   2130.   88742.     1113.    1.91  501.19

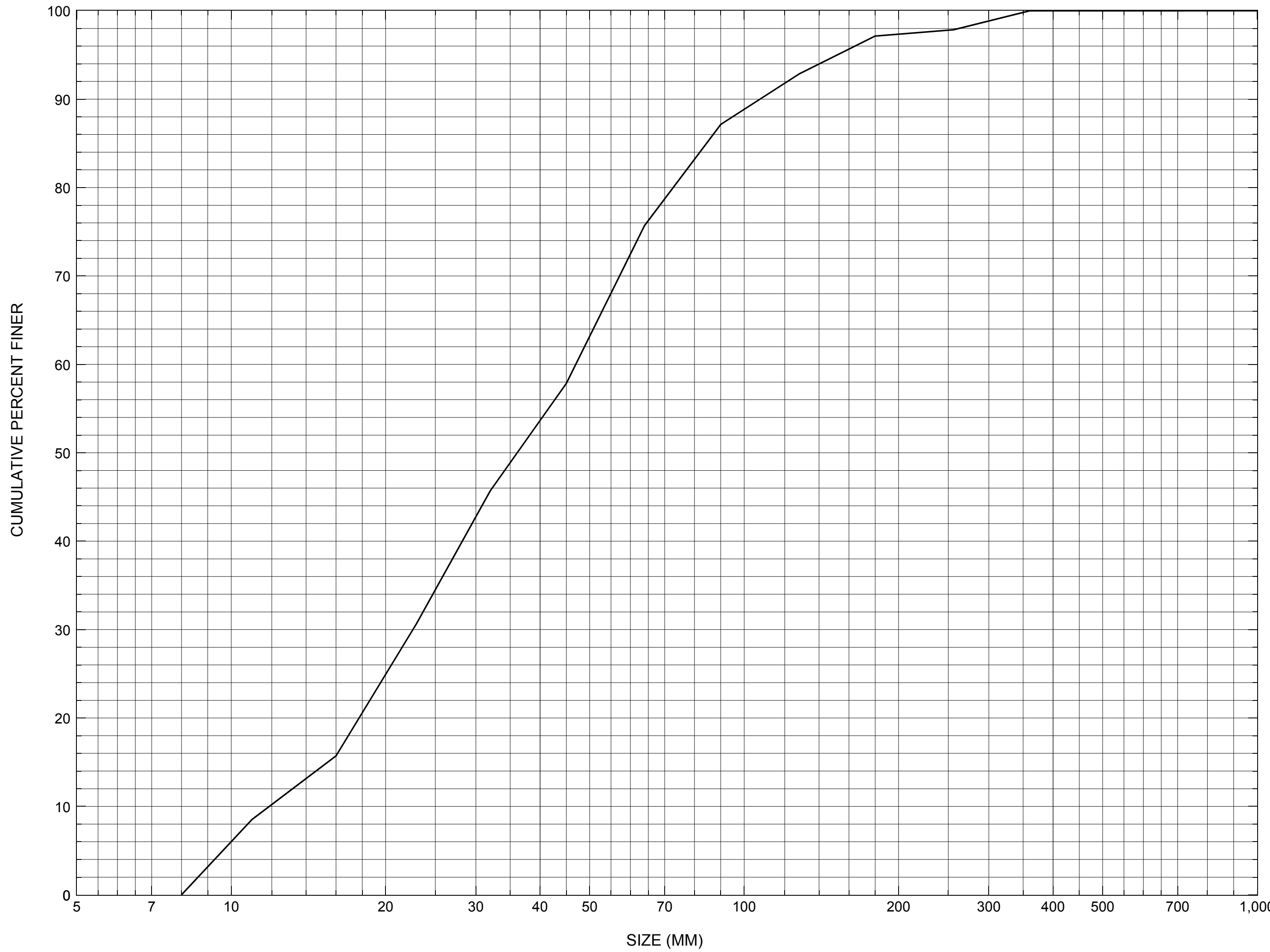
    XSID:CODE   XLKQ   XRKQ       KQ
   APPRO:AS  ***********************

 SECOND USER DEFINED TABLE.

    XSID:CODE     CRWS     FR#    YMIN    YMAX    HF     HO   VHD      EGL    WSEL
   EXIT1:XS     497.66    0.94  491.44  519.76************  0.67  498.52  497.84
   FULLV:FV     497.99    1.06  491.77  520.09  0.23  0.08  0.84  498.82  497.99
   BRIDG:BR     497.43    0.97  492.10  497.83************  1.98  499.81  497.83
   RDWAY:RG  ***************  501.15  510.46************  0.08  501.25********
   APPRO:AS     497.72    0.22  492.05  512.64  0.20  0.00  0.08  501.28  501.19
```

APPENDIX C:

BED-MATERIAL PARTICLE-SIZE DISTRIBUTION



Appendix C. Bed material particle-size distribution for a pebble count in the channel approach of structure CORITH00020007, in Corinth, Vermont.

APPENDIX D:

HISTORICAL DATA FORM

United States Geological Survey
Bridge Historical Data Collection and Processing Form

Structure Number CORITH00020007

General Location Descriptive

Data collected by *(First Initial, Full last name)* E. BOEHMLER

Date *(MM/DD/YY)* 03 / 24 / 95

Highway District Number *(I - 2; nn)* 07

County *(FIPS county code; I - 3; nnn)* 017

Town *(FIPS place code; I - 4; nnnnn)* 15700

Mile marker *(I - 11; nnn.nnn)* 000000

Waterway *(I - 6)* COOKVILLE BROOK

Road Name *(I - 7):* -

Route Number TH002

Vicinity *(I - 9)* 0.1 MI JCT TH 2 + TH 4

Topographic Map West Topsham

Hydrologic Unit Code: 01080103

Latitude *(I - 16; nnnn.n)* 44011

Longitude *(i - 17; nnnnn.n)* 72160

Select Federal Inventory Codes

FHWA Structure Number *(I - 8)* 10090500070905

Maintenance responsibility *(I - 21; nn)* 03

Maximum span length *(I - 48; nnnn)* 0046

Year built *(I - 27; YYYY)* 1940

Structure length *(I - 49; nnnnnn)* 000050

Average daily traffic, ADT *(I - 29; nnnnnn)* 000550

Deck Width *(I - 52; nn.n)* 248

Year of ADT *(I - 30; YY)* 91

Channel & Protection *(I - 61; n)* 7

Opening skew to Roadway *(I - 34; nn)* 00

Waterway adequacy *(I - 71; n)* 7

Operational status *(I - 41; X)* A

Underwater Inspection Frequency *(I - 92B; XYY)* N

Structure type *(I - 43; nnn)* 104

Year Reconstructed *(I - 106)* 0000

Approach span structure type *(I - 44; nnn)* 000

Clear span (*nnn.n ft*) -

Number of spans *(I - 45; nnn)* 001

Vertical clearance from streambed (*nnn.n ft*) 006.0

Number of approach spans *(I - 46; nnnn)* 0000

Waterway of full opening (*nnn.n ft*^{2}) -

Comments:

The structural inspection report of 6/29/93 indicates the structure is a concrete T-beam type bridge with an asphalt roadway surface. The abutments are concrete, with minor cracks and spalls reported. Overall, the substructure is in good condition with no footings exposed, undermined, or settled. There is boulder fill placed in front of the abutments and around their ends. A few of the boulders are noted on the banks upstream and downstream of the bridge. Channel scour is noted as normal. Point bars and debris accumulation problems are reported as minor. Some small areas of bank erosion are evident.

Bridge Hydrologic Data

Is there hydrologic data available? N *if No, type ctrl-n h* VTAOT Drainage area *(mi^2)*: -

Terrain character: -

Stream character & type: -

Streambed material: -

Discharge Data *(cfs)*: $Q_{2.33}$ - Q_{10} - Q_{25} -
Q_{50} - Q_{100} - Q_{500} -

Record flood date *(MM / DD / YY)*: - / / Water surface elevation *(ft)*: -

Estimated Discharge *(cfs)*: - Velocity at Q - *(ft/s)*: -

Ice conditions *(Heavy, Moderate, Light)* : - Debris *(Heavy, Moderate, Light)*: -

The stage increases to maximum highwater elevation (*Rapidly, Not rapidly*): -

The stream response is (*Flashy, Not flashy*): -

Describe any significant site conditions upstream or downstream that may influence the stream's stage: -

Watershed storage area (*in percent*): -%

The watershed storage area is: - (*1-mainly at the headwaters; 2- uniformly distributed; 3-immediatly upstream oi the site*)

Water Surface Elevation Estimates for Existing Structure:

Peak discharge frequency	$Q_{2.33}$	Q_{10}	Q_{25}	Q_{50}	Q_{100}
Water surface elevation (*ft*)	-	-	-	-	-
Velocity (*ft / sec*)	-	-	-	-	-

Long term stream bed changes: -

Is the roadway overtopped below the Q_{100}? (*Yes, No, Unknown*): U Frequency: -

Relief Elevation (*ft*): - Discharge over roadway at Q_{100} (*ft^3/ sec*): -

Are there other structures nearby? (*Yes, No, Unknown*): U *If No or Unknown, type ctrl-n os*

Upstream distance (*miles*): - Town: - Year Built: -

Highway No. : - Structure No. : - Structure Type: -

Clear span (*ft*): - Clear Height (*ft*): - Full Waterway (*ft^2*): -

Downstream distance (*miles*): - Town: - Year Built: -

Highway No. : - Structure No. : - Structure Type: -

Clear span (*ft*): - Clear Height (*ft*): - Full Waterway (ft^2): -

Comments:

-

USGS Watershed Data

Watershed Hydrographic Data

Drainage area *(DA)* **19.62** mi^2 Lake/pond/swamp area **0.37** mi^2

Watershed storage *(ST)* **1.9** %

Bridge site elevation **820** ft Headwater elevation **2267** ft

Main channel length **10.6** mi

10% channel length elevation **890** ft 85% channel length elevation **1810** ft

Main channel slope *(S)* **115.72** ft / mi

Watershed Precipitation Data

Average site precipitation - in Average headwater precipitation - in

Maximum 2yr-24hr precipitation event *(I24,2)* - in

Average seasonal snowfall *(Sn)* - ft

Bridge Plan Data

Are plans available? N *If no, type ctrl-n pl* Date issued for construction *(MM / YYYY)*: - / -

Project Number -

Minimum channel bed elevation: -

Low superstructure elevation: USLAB - DSLAB - USRAB - DSRAB -

Benchmark location description:

NO BENCHMARK INFORMATION

Reference Point (*MSL, Arbitrary, Other*): -

Datum (*NAD27, NAD83, Other*): -

Foundation Type: 4 (*1-Spreadfooting; 2-Pile; 3- Gravity; 4-Unknown*)

If 1: Footing Thickness - Footing bottom elevation: -

If 2: Pile Type: - (*1-Wood; 2-Steel or metal; 3-Concrete*) Approximate pile driven length: -

If 3: Footing bottom elevation: -

Is boring information available? N *If no, type ctrl-n bi* Number of borings taken: -

Foundation Material Type: 3 (*1-regolith, 2-bedrock, 3-unknown*)

Briefly describe material at foundation bottom elevation or around piles:

NO FOUNDATION MATERIAL INFORMATION

Comments:

NO PLANS

Cross-sectional Data

Is cross-sectional data available? Y *If no, type ctrl-n xs*

Source (*FEMA, VTAOT, Other*)? VTAOT

Comments: **This cross section is the upstream face. The low chord to bed length data is from the sketch attached to a bridge inspection report dated 6/29/93. The low chord elevations are those for this report.**

Station	0	11	23	34	45	-	-	-	-	-	-
Feature	LAB	-	-	-	RAB	-	-	-	-	-	-
Low chord elevation	497.8	497.7	497.6	497.5	497.4	-	-	-	-	-	-
Bed elevation	495.3	490.8	491.1	491.5	495.7	-	-	-	-	-	-
Low chord to bed	2.5	6.9	6.5	6.0	1.7	-	-	-	-	-	-

Station	-	-	-	-	-	-	-	-	-	-	-
Feature	-	-	-	-	-	-	-	-	-	-	-
Low chord elevation	-	-	-	-	-	-	-	-	-	-	-
Bed elevation	-	-	-	-	-	-	-	-	-	-	-
Low chord to bed	-	-	-	-	-	-	-	-	-	-	-

Source (*FEMA, VTAOT, Other*)? -

Comments: -

Station	-	-	-	-	-	-	-	-	-	-	-
Feature	-	-	-	-	-	-	-	-	-	-	-
Low chord elevation	-	-	-	-	-	-	-	-	-	-	-
Bed elevation	-	-	-	-	-	-	-	-	-	-	-
Low chord to bed	-	-	-	-	-	-	-	-	-	-	-

Station	-	-	-	-	-	-	-	-	-	-	-
Feature	-	-	-	-	-	-	-	-	-	-	-
Low chord elevation	-	-	-	-	-	-	-	-	-	-	-
Bed elevation	-	-	-	-	-	-	-	-	-	-	-
Low chord to bed	-	-	-	-	-	-	-	-	-	-	-

APPENDIX E:

LEVEL I DATA FORM

U. S. Geological Survey
Bridge Field Data Collection and Processing Form

Qa/Qc Check by: **EW** Date: **2/22/96**
Computerized by: **EW** Date: **2/22/96**
Reviewd by: **RB** Date: **6/12/98**

Structure Number **CORITH00020007**

A. General Location Descriptive

1. Data collected by *(First Initial, Full last name)* **E. BOEHMLER** Date *(MM/DD/YY)* **09** / **05** / 19**95**

2. Highway District Number **07** Mile marker **-**
County **ORANGE 017** Town **CORINTH 15700**
Waterway *(I - 6)* **COOKVILLE BROOK** Road Name **-**
Route Number **TH02** Hydrologic Unit Code: **01080103**

3. Descriptive comments:
The bridge is located about 100 ft from the intersection of TH02 and TH04.

B. Bridge Deck Observations

4. Surface cover... LBUS **5** RBUS **4** LBDS **4** RBDS **4** Overall **4**
*(2b us,ds,lb,rb: **1**- Urban; **2**- Suburban; **3**- Row crops; **4**- Pasture; **5**- Shrub- and brushland; **6**- Forest; **7**- Wetland)*

5. Ambient water surface... US **1** UB **1** DS **2** *(**1**- pool; **2**- riffle)*

6. Bridge structure type **1** *(**1**- single span; **2**- multiple span; **3**- single arch; **4**- multiple arch; **5**- cylindrical culvert; **6**- box culvert; or **7**- other)*

7. Bridge length **50.0** *(feet)* Span length **46.0** *(feet)* Bridge width **24.8** *(feet)*

Road approach to bridge:

8. LB **2** RB **0** *(**0** even, **1**- lower, **2**- higher)*

9. LB **1** RB **1** *(**1**- Paved, **2**- Not paved)*

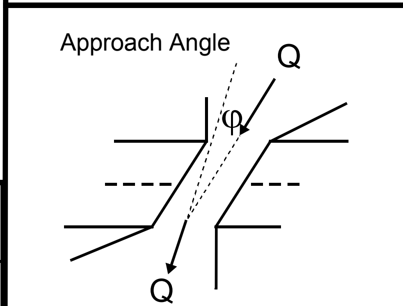
10. Embankment slope (*run / rise in feet / foot*):
US left **--** US right **--**

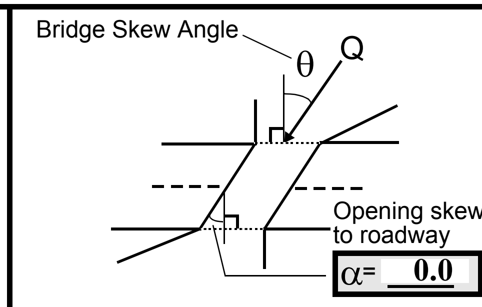
	Protection		13.Erosion	14.Severity
	11.Type	12.Cond.		
LBUS	0	-	2	1
RBUS	0	-	0	0
RBDS	0	-	2	1
LBDS	0	-	0	0

*Bank protection types: **0**- none; **1**- < 12 inches; **2**- < 36 inches; **3**- < 48 inches; **4**- < 60 inches; **5**- wall / artificial levee*
*Bank protection conditions: **1**- good; **2**- slumped; **3**- eroded; **4**- failed*
*Erosion: **0** - none; **1**- channel erosion; **2**- road wash; **3**- both; **4**- other*
*Erosion Severity: **0** - none; **1**- slight; **2**- moderate; **3**- severe*

Channel approach to bridge (BF):

15. Angle of approach: **0** 16. Bridge skew: **0**





α= **0.0**

17. Channel impact zone 1: Exist? **Y** *(Y or N)*
Where? **LB** *(LB, RB)* Severity **1**
Range? **185** feet **US** *(US, UB, DS)* to **90** feet **US**

Channel impact zone 2: Exist? **N** *(Y or N)*
Where? **-** *(LB, RB)* Severity **-**
Range? **-** feet **-** *(US, UB, DS)* to **-** feet **-**

*Impact Severity: **0**- none to very slight; **1**- Slight; **2**- Moderate; **3**- Severe*

18. Bridge Type: **1b/3**

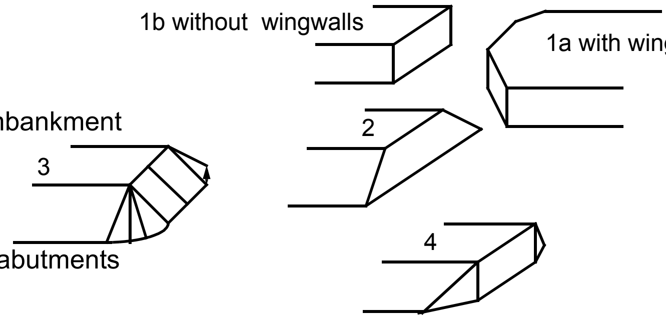
1a- Vertical abutments with wingwalls

1b- Vertical abutments without wingwalls

2- Vertical abutments and wingwalls, sloping embankment
Wingwalls parallel to abut. face

3- Spill through abutments

4- Sloping embankment, vertical wingwalls and abutments
Wingwall angle less than 90°.



19. Bridge Deck Comments (surface cover variations, measured bridge and span lengths, bridge type variations, approach overflow width, etc.)

#4- The surface cover on the LBUS is shrub and brush with a few trees in the section between the channel and TH04. Further left bankward of TH04, there is a very narrow strip of trees, then pasture on the hill. The LBDS, RBUS, and RBDS are all pasture with some small trees, brush and shrubs on the immediate banks.
#7- The bridge dimensions measured are the same as the values indicated in the VTAOT Historical Data Form (appendix D).
#18- The abutments are type 1b with large boulders/stone fill placed in front of them.

C. Upstream Channel Assessment

20. SRD	21. Bank height (BF) LB	21. Bank height (BF) RB	22. Bank angle (BF) LB	22. Bank angle (BF) RB	26. % Veg. cover (BF) LB	26. % Veg. cover (BF) RB	27. Bank material (BF) LB	27. Bank material (BF) RB	28. Bank erosion (BF) LB	28. Bank erosion (BF) RB
45.0	**5.5**			**2.0**		**1**	**2**	**234**	**234**	**2**

23. Bank width **30.0** 24. Channel width **20.0** 25. Thalweg depth **40.5** 29. Bed Material **1**

30 .Bank protection type: LB **342** RB **0** 31. Bank protection condition: LB **0** RB **-**

SRD - Section ref. dist. to US face *% Vegetation (Veg) cover: **1**- 0 to 25%; **2**- 26 to 50%; **3**- 51 to 75%; **4**- 76 to 100%*
*Bed and bank Material: **0**- organics; **1**- silt / clay, < 1/16mm; **2**- sand, 1/16 - 2mm; **3**- gravel, 2 - 64mm; **4**- cobble, 64 - 256mm; **5**- boulder, > 256mm; **6**- bedrock; **7**- manmade*
*Bank Erosion: **0**- not evident; **1**- light fluvial; **2**- moderate fluvial; **3**- heavy fluvial / mass wasting*
*Bank protection types: **0**- absent; **1**- < 12 inches; **2**- < 36 inches; **3**- < 48 inches; **4**- < 60 inches; **5**- wall / artificial levee*
*Bank protection conditions: **1**- good; **2**- slumped; **3**- eroded; **4**- failed*

32. Comments (bank material variation, minor inflows, protection extent, etc.):

-

The US channel bends slightly to the right. A long point bar extends through the entire observed US reach on the RB. Moderate bank cutting erosion exists intermittenly on both upstream banks.

33. Point/Side bar present? **Y** *(Y or N. if N type ctrl-n pb)* 34. Mid-bar distance: **85** 35. Mid-bar width: **18**

36. Point bar extent: **165** feet **US** *(US, UB)* to **25** feet **US** *(US, UB, DS)* positioned **25** %LB to **100** %RB

37. Material: **32**

38. Point or side bar comments (Circle Point or Side; Note additional bars, material variation, status, etc.):

The point bar is mainly gravel (fine to medium) and sand with some coarse gravel to cobbles. About 5% of the bar area is vegetated with grass and weeds only on the highest points.

39. Is a cut-bank present? **Y** *(Y or if N type ctrl-n cb)* 40. Where? **LB** *(LB or RB)*

41. Mid-bank distance: **125** 42. Cut bank extent: **185** feet **US** *(US, UB)* to **50** feet **US** *(US, UB, DS)*

43. Bank damage: **1** *(**1**- eroded and/or creep; **2**- slip failure; **3**- block failure)*

44. Cut bank comments (eg. additional cut banks, protection condition, etc.):

The cut-bank extent is more severe in the range of 180 US to 125 US, where the impact zone is present. The cut-bank erosion is minor as the channel straightens out toward the bridge.

45. Is channel scour present? **N** *(Y or if N type ctrl-n cs)* 46. Mid-scour distance: **-**

47. Scour dimensions: Length **-** Width **-** Depth : **-** Position **-** %LB to **-** %RB

48. Scour comments (eg. additional scour areas, local scouring process, etc.):

NO CHANNEL SCOUR

49. Are there major confluences? **N** *(Y or if N type ctrl-n mc)* 50. How many? **-**

51. Confluence 1: Distance **-** 52. Enters on **-** *(LB or RB)* 53. Type **-** *(**1**- perennial; **2**- ephemeral)*

Confluence 2: Distance **-** Enters on **-** *(LB or RB)* Type **-** *(**1**- perennial; **2**- ephemeral)*

54. Confluence comments (eg. confluence name):

NO MAJOR CONFLUENCES

D. Under Bridge Channel Assessment

55. Channel restraint (BF)? LB **2** RB ______ *(**1**- natural bank; **2**- abutment; **3**- artificial levee)*

56. Height (BF)		57 Angle (BF)		61. Material (BF)		62. Erosion (BF)	
LB	RB	LB	RB	LB	RB	LB	RB
25.0		**0.5**		**2**	**7**	**7**	**-**

58. Bank width (BF) **-** 59. Channel width **-** 60. Thalweg depth **90.0** 63. Bed Material **-**

*Bed and bank Material: **0**- organics; **1**- silt / clay, < 1/16mm; **2**- sand, 1/16 - 2mm; **3**- gravel, 2 - 64mm; **4**- cobble, 64 - 256mm; **5**- boulder, > 256mm; **6**- bedrock; **7**- manmade*

*Bank Erosion: **0**- not evident; **1**- light fluvial; **2**- moderate fluvial; **3**- heavy fluvial / mass wasting*

64. Comments (bank material variation, minor inflows, protection extent, etc.):

324

The channel under the bridge is straight and nearly symmetrical compared to upstream, where the thalweg runs along the left side of the channel.

65. **Debris and Ice** Is there debris accumulation? ____ *(Y or N)* 66. Where? **N** ____ *(1- Upstream; 2- At bridge; 3- Both)*

67. Debris Potential **-** ____ *(1- Low; 2- Moderate; 3- High)* 68. Capture Efficiency **2** ____ *(1- Low; 2- Moderate; 3- High)*

69. Is there evidence of ice build-up? **1** ___ *(Y or N)* Ice Blockage Potential **N** ____ *(1- Low; 2- Moderate; 3- High)*

70. Debris and Ice Comments:

1

The channel is slightly sinuous to straight. There is some minor bank cutting. Tree density along the banks upstream increases beyond 100 feet upstream of bridge. Debris and ice will flow through the straight channel.

Abutments	71. Attack ∠(BF)	72. Slope ∠ (Qmax)	73. Toe loc. (BF)	74. Scour Condition	75. Scour depth	76. Exposure depth	77. Material	78. Length
LABUT		0	90	2	0	0	0	90.0
RABUT	1	0	90			2	0	45.0

Pushed: LB or RB *Toe Location (Loc.): 0- even, 1- set back, 2- protrudes*
Scour cond.: 0- not evident; 1- evident (comment); 2- footing exposed; 3-undermined footing; 4- piling exposed; 5- settled; 6- failed
Materials: *1*- Concrete; *2*- Stone masonry or drywall; *3*- steel or metal; *4*- wood

79. Abutment comments (eg. undermined penetration, unusual scour processes, debris, etc.):

0

0

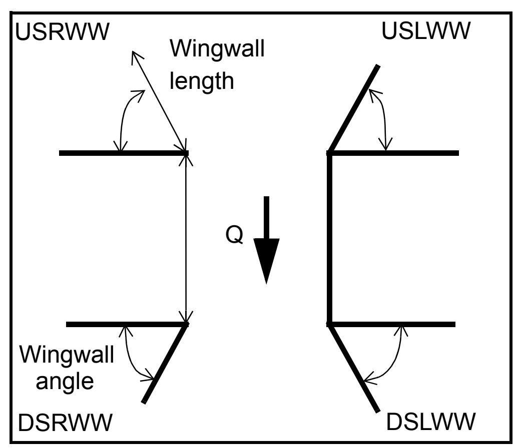
1

The abutments are concrete vertical walls with stone-fill slopes. The stone fill protrudes into the channel at the upstream end of the right abutment and the downstream end of the left abutment.

80. **Wingwalls**:

	Exist?	Material?	Scour Condition?	Scour depth?	Exposure depth?	81. Angle?	Length?
USLWW:						45.0	
USRWW:	N		-		-	0.5	
DSLWW:	-		-		N	31.5	
DSRWW:	-		-		-	32.0	

Wingwall materials: 1- Concrete; 2- Stone masonry or drywall; 3- steel or metal; 4- wood



82. **Bank / Bridge Protection**:

Location	USLWW	USRWW	LABUT	RABUT	LB	RB	DSLWW	DSRWW
Type	-	-	N	-	-	-	1	1
Condition	N	-	-	-	-	-	1	1
Extent	-	-	-	-	-	2	2	-

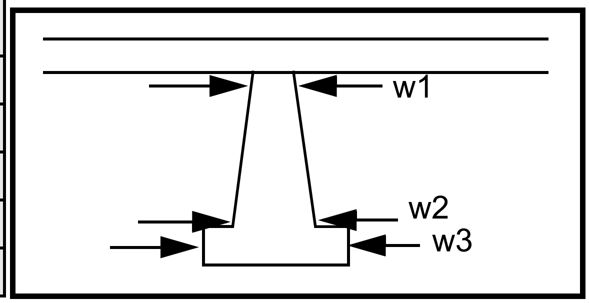
Bank / Bridge protection types: 0- absent; 1- < 12 inches; 2- < 36 inches; 3- < 48 inches; 4- < 60 inches; 5- wall / artificial levee
Bank / Bridge protection conditions: 1- good; 2- slumped; 3- eroded; 4- failed
Protection extent: 1- entire base length; 2- US end; 3- DS end; 4- other

83. Wingwall and protection comments (eg. undermined penetration, unusual scour processes, etc.):
-
-
-
-
-
-
-
-
-
-
-

Piers:

84. Are there piers? Th (Y or if N type ctrl-n pr)

85. Pier no.	width (w) feet			elevation (e) feet		
	w1	w2	w3	e@w1	e@w2	e@w3
Pier 1	-	-	-	-	-	-
Pier 2	-	-	-	-	-	-
Pier 3	-	-	-	-	-	-
Pier 4	-	-	-	-	-	-



Level 1 Pier Descr.	1	2	3	4	
86. Location (BF)	ere are	on the	each	chord.	*LFP, LTB, LB, MCL, MCM, MCR, RB, RTB, RFP*
87. Type	no	abut	abut	The	***1**- Solid pier, **2**- column, **3**- bent*
88. Material	wing	ment	ment	stone	***1**- Wood; **2**- concrete; **3**- metal; **4**- stone*
89. Shape	walls	s is	con-	fill	***1**- Round; **2**- Square; **3**- Pointed*
90. Inclined?	at	in	crete	on	*Y- yes; N- no*
91. Attack ∠ (BF)	this	good	wall	the	
92. Pushed	brid	con-	abou	right	*LB or RB*
93. Length (feet)	-	-	-	-	
94. # of piles	ge.	ditio	t 2	abut	
95. Cross-members		n	feet	ment	***0**- none; **1**- laterals; **2**- diagonals; **3**- both*
96. Scour Condition	Pro-	and	belo	wall	***0**- not evident; **1**- evident (comment); **2**- footing exposed; **3**- piling exposed; **4**- undermined footing; **5**- settled; **6**- failed*
97. Scour depth	tec-	inter	w	is	
98. Exposure depth	tion	sects	low	topp	

99. Pier comments (eg. undermined penetration, protection and protection extent, unusual scour processes, etc.):

ed with a layer of sand no more than 0.5 feet thick.

N

-

E. Downstream Channel Assessment

100.

SRD	Bank height (BF) LB	Bank height (BF) RB	Bank angle (BF) LB	Bank angle (BF) RB	% Veg. cover (BF) LB	% Veg. cover (BF) RB	Bank material (BF) LB	Bank material (BF) RB	Bank erosion (BF) LB	Bank erosion (BF) RB
-	-			-	-	-	-	-	-	-

Bank width (BF) - Channel width - Thalweg depth - Bed Material -

Bank protection type (Qmax): LB - RB - Bank protection condition: LB - RB -

SRD - Section ref. dist. to US face *% Vegetation (Veg) cover: **1**- 0 to 25%; **2**- 26 to 50%; **3**- 51 to 75%; **4**- 76 to 100%*
*Bed and bank Material: **0**- organics; **1**- silt / clay, < 1/16mm; **2**- sand, 1/16 - 2mm; **3**- gravel, 2 - 64mm; **4**- cobble, 64 - 256mm; **5**- boulder, > 256mm; **6**- bedrock; **7**- manmade*
*Bank Erosion: **0**- not evident; **1**- light fluvial; **2**- moderate fluvial; **3**- heavy fluvial / mass wasting*
*Bank protection types: **0**- absent; **1**- < 12 inches; **2**- < 36 inches; **3**- < 48 inches; **4**- < 60 inches; **5**- wall / artificial levee*
*Bank protection conditions: **1**- good; **2**- slumped; **3**- eroded; **4**- failed*

Comments (eg. bank material variation, minor inflows, protection extent, etc.):

-
-
-
-
-
-
-
-
-
-
-
-
-
-
-

101. Is a drop structure present? - *(Y or N, if N type ctrl-n ds)* 102. Distance: - feet

103. Drop: - feet 104. Structure material: - *(**1**- steel sheet pile; **2**- wood pile; **3**- concrete; **4**- other)*

105. Drop structure comments (eg. downstream scour depth):

-
-
-
-
-
-

106. Point/Side bar present? - (Y or N. if N type ctrl-n pb) Mid-bar distance: - Mid-bar width: -

Point bar extent: - feet - (US, UB, DS) to - feet - (US, UB, DS) positioned - %LB to - %RB

Material: -

Point or side bar comments (Circle Point or Side; note additional bars, material variation, status, etc.):

-
-
-
NO PIERS

Is a cut-bank present? ____ (Y or if N type ctrl-n cb) Where? ____ (LB or RB) Mid-bank distance: ____

Cut bank extent: ____ feet ____ (US, UB, DS) to ____ feet ____ (US, UB, DS)

Bank damage: ____ (**1**- eroded and/or creep; **2**- slip failure; **3**- block failure)

Cut bank comments (eg. additional cut banks, protection condition, etc.):

1
1
23

Is channel scour present? **23** (Y or if N type ctrl-n cs) Mid-scour distance: **1**

Scour dimensions: Length **1** Width **32** Depth: **0** Positioned **0** %LB to **-** %RB

Scour comments (eg. additional scour areas, local scouring process, etc.):

-
The channel continues to be straight downstream to nearly 175 feet, where the next bend in the channel occurs. The bed material is nearly all gravel and sand with no cobbles or boulders. The banks are unprotected. Erosion between the downstream bridge face and 100 feet downstream is light fluvial. Beyond 100

Are there major confluences? **fee** (Y or if N type ctrl-n mc) How many? **t**

Confluence 1: Distance **down** Enters on **stre** (LB or RB) Type **am,** (**1**- perennial; **2**- ephemeral)

Confluence 2: Distance **ero-** Enters on **sion** (LB or RB) Type **is** (**1**- perennial; **2**- ephemeral)

Confluence comments (eg. confluence name):

moderate to heavy on both sides, in the region of the left bank side bar. There is a mid-channel bar extending from 7 feet UB to 20 feet DS. It is composed of gravel with some sand and is not vegetated. It is positioned

F. Geomorphic Channel Assessment

107. Stage of reach evolution **10**

1- Constructed
2- Stable
3- Aggraded
4- Degraded
5- Laterally unstable
6- Vertically and laterally unstable

108. Evolution comments *(Channel evolution not considering bridge effects; See HEC-20, Figure 1 for geomorphic descriptors)*:

% LB to 50% RB and is 10 feet wide near 7 feet DS from the bridge. In the range of 7 feet UB to 50 feet DS, the channel is in a state of transition.

N

-

NO DROP STRUCTURE

109. G. Plan View Sketch

point bar (pb)	debris	flow (Q)	stone wall
cut-bank (cb)	rip rap or stone fill	cross-section	other wall
scour hole		ambient channel	

APPENDIX F:

SCOUR COMPUTATIONS

SCOUR COMPUTATIONS

Structure Number: CORITH00020007 Town: Corinth
Road Number: TH2 County: Orange
Stream: Cookville Brook

Initials MS Date: 08/19/97 Checked: RLB

Analysis of contraction scour, live-bed or clear water?

Critical Velocity of Bed Material (converted to English units)
Vc=11.21*y1^0.1667*D50^0.33 with Ss=2.65
(Richardson and others, 1995, p. 28, eq. 16)

Approach Section Characteristic	100 yr	500 yr	other Q
Total discharge, cfs	2700	3680	2130
Main Channel Area, ft2	345	378	312
Left overbank area, ft2	125	164	88
Right overbank area, ft2	897	1086	712
Top width main channel, ft	40	40	40
Top width L overbank, ft	46	47	45
Top width R overbank, ft	227	229	224
D50 of channel, ft	0.118	0.118	0.118
D50 left overbank, ft	--	--	--
D50 right overbank, ft	--	--	--
y1, average depth, MC, ft	8.6	9.5	7.8
y1, average depth, LOB, ft	2.7	3.5	2.0
y1, average depth, ROB, ft	4.0	4.7	3.2
Total conveyance, approach	119390	154739	88631
Conveyance, main channel	46634	54327	39502
Conveyance, LOB	5980	9194	3379
Conveyance, ROB	66776	91218	45750
Percent discrepancy, conveyance	0.0000	0.0000	0.0000
Qm, discharge, MC, cfs	1054.6	1292.0	949.3
Ql, discharge, LOB, cfs	135.2	218.7	81.2
Qr, discharge, ROB, cfs	1510.1	2169.3	1099.5
Vm, mean velocity MC, ft/s	3.1	3.4	3.0
Vl, mean velocity, LOB, ft/s	1.1	1.3	0.9
Vr, mean velocity, ROB, ft/s	1.7	2.0	1.5
Vc-m, crit. velocity, MC, ft/s	7.9	8.0	7.7
Vc-l, crit. velocity, LOB, ft/s	ERR	ERR	ERR
Vc-r, crit. velocity, ROB, ft/s	ERR	ERR	ERR

Results

Live-bed(1) or Clear-Water(0) Contraction Scour?			
Main Channel	0	0	0
Left Overbank	N/A	N/A	N/A
Right Overbank	N/A	N/A	N/A

Pressure Flow Scour (contraction scour for orifice flow conditions)

Chang pressure flow equation Hb+Ys=Cq*qbr/Vc

Cq=1/Cf*Cc Cf=1.5*Fr^0.43 (<=1) Cc=SQRT[0.10(Hb/(ya-w)-0.56)]+0.79 (<=1)

Umbrell pressure flow equation

(Hb+Ys)/ya=1.1021*[(1-w/ya)*(Va/Vc)]^0.6031

(Richardson and other, 1995, p. 144-146)

	Q100	Q500	OtherQ
Q, total, cfs	2700	3680	2130
Q, thru bridge MC, cfs	2264	2368	2130
Vc, critical velocity, ft/s	7.87	7.99	7.74
Va, velocity MC approach, ft/s	3.06	3.42	3.04
Main channel width (normal), ft	45.1	45.1	45.1
Cum. width of piers in MC, ft	0.0	0.0	0.0
W, adjusted width, ft	45.1	45.1	45.1
qbr, unit discharge, ft2/s	50.2	52.5	47.2
Area of full opening, ft2	189.0	189.0	189.0
Hb, depth of full opening, ft	4.19	4.19	4.19
Fr, Froude number, bridge MC	1.03	1.08	0.97
Cf, Fr correction factor (<=1.0)	1.00	1.00	1.00
**Area at downstream face, ft2	N/A	N/A	N/A
**Hb, depth at downstream face, ft	N/A	N/A	N/A
**Fr, Froude number at DS face	ERR	ERR	ERR
**Cf, for downstream face (<=1.0)	N/A	N/A	N/A
Elevation of Low Steel, ft	497.61	497.61	497.61
Elevation of Bed, ft	493.42	493.42	493.42
Elevation of Approach, ft	502.01	502.84	501.19
Friction loss, approach, ft	0.21	0.24	0.2
Elevation of WS immediately US, ft	501.80	502.60	500.99
ya, depth immediately US, ft	8.38	9.18	7.57
Mean elevation of deck, ft	501.7	501.7	501.7
w, depth of overflow, ft (>=0)	0.10	0.90	0.00
Cc, vert contrac correction (<=1.0)	0.79	0.79	0.79
**Cc, for downstream face (<=1.0)	ERR	ERR	ERR
Ys, scour w/Chang equation, ft	**3.88**	**4.12**	**3.53**
Ys, scour w/Umbrell equation, ft	0.99	1.50	0.56

Clear Water Contraction Scour in MAIN CHANNEL

```
y2 = (Q2^2/(131*Dm^(2/3)*W2^2))^(3/7)    Converted to English Units
ys=y2-y_bridge
(Richardson and others, 1995, p. 32, eq. 20, 20a)
```

Bridge Section	Q100	Q500	Other Q
(Q) total discharge, cfs	2700	3680	2130
(Q) discharge thru bridge, cfs	2264	2368	2130
Main channel conveyance	12785	12785	12785
Total conveyance	12785	12785	12785
Q2, bridge MC discharge,cfs	2264	2368	2130
Main channel area, ft2	189	189	189
Main channel width (normal), ft	45.1	45.1	45.1
Cum. width of piers in MC, ft	0.0	0.0	0.0
W, adjusted width, ft	45.1	45.1	45.1
y_bridge (avg. depth at br.), ft	4.19	4.19	4.19
Dm, median (1.25*D50), ft	0.1475	0.1475	0.1475
y2, depth in contraction,ft	6.14	6.38	5.82
ys, scour depth (y2-ybridge), ft	1.94	2.19	1.63

Armoring

```
Dc=[(1.94*V^2)/(5.75*log(12.27*y/D90))^2]/[0.03*(165-62.4)]
Depth to Armoring=3*(1/Pc-1)
(Federal Highway Administration, 1993)
```

Downstream bridge face property	100-yr	500-yr	Other Q
Q, discharge thru bridge MC, cfs	2264	2368	2130
Main channel area (DS), ft2	189	189	189
Main channel width (normal), ft	45.1	45.1	45.1
Cum. width of piers, ft	0.0	0.0	0.0
Adj. main channel width, ft	45.1	45.1	45.1
D90, ft	0.3521	0.3521	0.3521
D95, ft	0.4980	0.4980	0.4980
Dc, critical grain size, ft	0.5839	0.6393	0.5168
Pc, Decimal percent coarser than Dc	0.030	0.027	0.045

Depth to armoring, ft	N/A	N/A	N/A

Abutment Scour

Froehlich's Abutment Scour
Ys/Y1 = 2.27*K1*K2*(a'/Y1)^0.43*Fr1^0.61+1
(Richardson and others, 1995, p. 48, eq. 28)

	Left Abutment			Right Abutment		
Characteristic	100 yr Q	500 yr Q	Other Q	100 yr Q	500 yr Q	Other Q
(Qt), total discharge, cfs	2700	3680	2130	2700	3680	2130
a', abut.length blocking flow, ft	50.5	51.7	49.3	217.1	219.2	214.9
Ae, area of blocked flow ft2	152.8	190.5	108.44	693.74	757.17	653.89
Qe, discharge blocked abut.,cfs	191.01	--	104.8	--	--	961.38
(If using Qtotal_overbank to obtain Ve, leave Qe blank and enter Ve and Fr manually)						
Ve, (Qe/Ae), ft/s	1.25	1.54	0.97	1.64	1.96	1.47
ya, depth of f/p flow, ft	3.03	3.68	2.20	3.20	3.45	3.04
--Coeff., K1, for abut. type (1.0, verti.; 0.82, verti. w/ wingwall; 0.55, spillthru)						
K1	0.55	0.55	0.55	0.55	0.55	0.55
--Angle (theta) of embankment (<90 if abut. points DS; >90 if abut. points US)						
theta	90	90	90	90	90	90
K2	1.00	1.00	1.00	1.00	1.00	1.00
Fr, froude number f/p flow	0.127	0.138	0.115	0.147	0.161	0.149
ys, scour depth, ft	**6.62**	**7.96**	**4.99**	10.80	11.89	10.45

HIRE equation (a'/ya > 25)
ys = 4*Fr^0.33*y1*K/0.55
(Richardson and others, 1995, p. 49, eq. 29)

a'(abut length blocked, ft)	50.5	51.7	49.3	217.1	219.2	214.9
y1 (depth f/p flow, ft)	3.03	3.68	2.20	3.20	3.45	3.04
a'/y1	16.69	14.03	22.41	67.94	63.46	70.63
Skew correction (p. 49, fig. 16)	1.00	1.00	1.00	1.00	1.00	1.00
Froude no. f/p flow	0.13	0.14	0.11	0.15	0.16	0.15
Ys w/ corr. factor K1/0.55:						
vertical	ERR	ERR	ERR	12.34	13.75	11.79
vertical w/ ww's	ERR	ERR	ERR	10.12	11.27	9.67
spill-through	ERR	ERR	ERR	**6.79**	**7.56**	**6.49**

Abutment riprap Sizing

Isbash Relationship
D50=y*K*Fr^2/(Ss-1) and D50=y*K*(Fr^2)^0.14/(Ss-1)
(Richardson and others, 1995, p112, eq. 81,82)

Characteristic	Q100	Q500	Other Q	Q100	Q500	Other Q
Fr, Froude Number	1.03	1.08	0.97	1.03	1.08	0.97
y, depth of flow in bridge, ft	4.19	4.19	4.19	4.19	4.19	4.19
Median Stone Diameter for riprap at:	left abutment			right abutment, ft		
Fr<=0.8 (vertical abut.)	ERR	ERR	ERR	ERR	ERR	ERR
Fr>0.8 (vertical abut.)	1.77	1.79	1.74	1.77	1.79	1.74
Fr<=0.8 (spillthrough abut.)	ERR	ERR	ERR	ERR	ERR	ERR
Fr>0.8 (spillthrough abut.)	1.56	1.58	1.54	1.56	1.58	1.54