LEVEL II SCOUR ANALYSIS FOR BRIDGE 57 (BRIDTH00650057) on TOWN HIGHWAY 65, crossing BROAD BROOK, BRIDGEWATER, VERMONT

U.S. Geological Survey
Open-File Report 96-232

Prepared in cooperation with
VERMONT AGENCY OF TRANSPORTATION
and
FEDERAL HIGHWAY ADMINISTRATION

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By JOSEPH D. AYOTTE and SCOTT A. OLSON

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Pembroke, New Hampshire

1996

U.S. DEPARTMENT OF THE INTERIOR
BRUCE BABBITT, Secretary

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

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 57 (BRIDTH00650057) ON TOWN HIGHWAY 65, CROSSING BROAD BROOK, BRIDGEWATER, VERMONT

By Joseph D. Ayotte and Scott A. Olson

INTRODUCTION

This report provides the results of a detailed Level II analysis of scour potential at structure BRIDTH00650057 on Town Highway 65 crossing Broad Brook, Bridgewater, 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 (U.S. Department of Transportation, 1993). A Level I study is included in Appendix E of this report. A Level I study provides a qualitative geomorphic characterization of the study site. Information on the bridge, available from VTAOT files, was compiled prior to conducting Level I and Level II analyses and can be found in Appendix D.

The site is in the Green Mountain physiographic province of central Vermont in the town of Bridgewater. The 26.9-mi^2 drainage area is in a predominantly rural and forested basin. In the vicinity of the study site, the US left bank is forested; DS left bank is shrub and brushland; US right bank is lawn and the DS right bank has very little vegetation and is largely coincident with the Ottauquechee River.

In the study area, Broad Brook has an incised channel with a slope of approximately 0.0067 ft/ft, an average channel top width of 60 ft and an average channel depth of 3 ft. The predominant channel bed material is gravel (D_{50} is 46.2 mm or 0.151 ft). The geomorphic assessment at the time of the Level I and Level II site visit on October 25, 1994, indicated that the reach was stable.

The Town Highway 65 crossing of Broad Brook is a 47-ft-long, one-lane bridge consisting of one 44-ft steel-beam span with a timber deck, supported by vertical concrete abutments with wingwalls on the upstream and downstream sides (Vermont Agency of Transportation, written commun., August, 1994). The US right wingwall and road approach is protected by stone fill. The US and DS right wingwalls and the right abutment are reported as having 1.0 to 1.5 ft of scour at the time of the Level one assessment on 10/25/94. Erosion from road wash affects all road approach embankments. Broad Brook flows into the Ottauquechee River approximately 30 ft downstream of the bridge. The channel approach to the bridge is straight with the bridge skewed 20 degrees to flow and the opening skew-to-roadway is 0 degrees. Additional details describing conditions at the site are included in the Level II Summary and Appendices D and E.

Scour depths and rock rip-rap sizes were computed using the general guidelines described in Hydraulic Engineering Circular 18 (Richardson and others, 1993).
Total scour at a highway crossing is comprised of three components: 1) long-term aggradation or degradation; 2) contraction scour (due to reduction in flow area caused by 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 scour depths for contraction and local scour and a summary of the results follows.

Contraction scour for all modelled flows ranged from 0.4 ft to 1.5 ft and the worst-case contraction scour occurred at the incipient overtopping discharge. Abutment scour ranged from 6.0 ft to 14.6 ft and the worst-case abutment scour occurred at the 100-year discharge. Scour depths and depths to armoring are summarized on p. 14 in the section titled "Scour Results". Scour elevations, based on the calculated depths are presented in tables 1 and 2; a graph of the scour elevations is presented in figure 8 Scour depths were calculated assuming an infinite depth of erosive material and a homogeneous particle-size distribution.

For all scour presented in this report, "the scour depths adopted [by VTAOT] may differ from the equation values based on engineering judgement" (Richardson and others, 1993, p. 21, 27). It is generally accepted that the Froehlich equation (abutment scour) gives "excessively conservative estimates of scour depths" (Richardson and others, 1993, p. 48). Many factors, including historical performance during flood events, the geomorphic assessment, and the results of the hydraulic analyses, must be considered to properly assess the validity of abutment scour results.

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 BRIDTH00650057 ***Stream*** Broad Brook

County Windsor ***Road*** TH034 ***District*** 04

Description of Bridge

Bridge length 47 ***ft*** ***Bridge width*** 14.8 ***ft*** ***Max span length*** 44 ***ft***

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

Abutment type Vertical ***Embankment type*** Sloping

Stone fill on abutment? No ***Date of inspection*** 10/25/94

Description of stone fill Type-2, around the upstream end of the upstream right wingwall is slumped.

Brief description of piers/abutments Abutments and wingwalls are concrete. The right abutment footing is exposed with 1 to 1.5 ft of scour reported.

Is bridge skewed to flood flow according to N ***survey?*** Y ***Angle*** 20

The bridge is located approximately 30 ft from confluence with the Ottauquechee River

.

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***
Level I	10/25/94	0	0
Level II	10/25/94	--	--

Potential for debris Low.

Describe any features near or at the bridge that may affect flow (include observation date) None reported on 10/25/94.

Description of the Geomorphic Setting

General topography The bridge is on the valley flat at the mouth of Broad Bk. approx. 30 ft from the confluence with the Ottauquechee R.

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

Date of inspection 10/25/94

DS left: widening flood plain into Ottauquechee R. valley

DS right: widening flood plain into Ottauquechee R. valley

US left: narrow flood plain to valley wall

US right: narrow flood plain to valley wall

Description of the Channel

Average top width 60 ***ft*** ***Average depth*** 3.3 ***ft***

Predominant bed material gravel ***Bank material*** gravel

Narrow, incised channel with only slight sinuosity.

Vegetative co 10/25/94

shrub and brush

DS left: Ottauquechee R. valley flood plain

DS right: forest

US left: sloping lawn

US right:

Do banks appear stable? Y ***If not, describe location and type of instability and date of observation.***

10/25/94--Both the DS banks are reported to have light fluvial erosion and only the right bank US is reported to have light fluvial erosion.

Describe any obstructions in channel and date of observation. 10/25/94--None.

Hydrology

Drainage area 26.9 ***mi²***

Percentage of drainage area in physiographic provinces: (approximate)

Physiographic province	***Percent of drainage area***
Green Mountain	100

Is drainage area considered rural or urban? Rural ***Describe any significant urbanization***: None. Area is mostly forested drainage.

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

USGS gage description

USGS gage number

Gage drainage area ***mi²***

Is there a lake/p No

Calculated Discharges

Q100 6,000 ***ft³/s*** ***Q500*** 7,800 ***ft³/s***

Q100 was taken from VTAOT files. Q500 was determined by extrapolating data from empirical methods (Potter, 1957a; Potter, 1957b; Johnson and Tasker, 1974; Federal Highway Administration, 1983).

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 Add 1 ft to USGS datum to obtain VTAOT datum.

Description of reference marks used to determine USGS datum. RM1 is the center of chiseled X on the DS right abutment (elev. 499.99 feet, arbitrary survey datum). RM2 is the center of chiseled X on the US left abutment (elev. 500.07 feet, arbitrary survey datum).

Cross-Sections Used in WSPRO Analysis

[1]*Cross-section*	*Section Reference Distance (SRD) in feet*	[2]*Cross-section development*	*Comments*
EXITX	-21	1	Exit section
FULLV	0	2	Downstream full valley section (templated from EXITX)
BRIDG	0	1	Bridge opening
RDWAY	8	1	Roadway section
APTEM	80	1	Surveyed approach section used as a template.
APPRO	57	2	Modeled 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 analysis 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, Jr. 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 0.080, and overbank "n" values ranged from 0.035 to 0.037.

Normal depth at the exit section (EXITX) 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 0.0067 ft/ft which was estimated from the Plymouth VT. 1:24,000 scale topographic map (U.S. Geological Survey, 1966) in the vicinity of the bridge site. The field surveyed exit section was located between the DS bridge face and the confluence with the Ottauquechee River, approx. 30 ft downstream. The model was run assuming no backwater from the Ottauquechee River and assuming 'normal depth' in the exit section.

The surveyed approach section (APTEM) was moved along the approach channel slope (0.019 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 approach also provides a consistent method for determining scour variables.

The flow at modelled discharges was assumed to align with the abutments and therefore skew was not applied to the bridge (BRIDG) cross section.

The incipient overtopping discharge was determined to be 2,244 ft^3/s.

Bridge Hydraulics Summary

Average bridge embankment elevation 500.1 *ft*
Average low steel elevation 497.4 *ft*

100-year discharge 6,000 ft^3/s
Water-surface elevation in bridge opening 497.5 *ft*
Road overtopping? Y *Discharge over road* 3278 ft^3/s
Area of flow in bridge opening 310 ft^2
Average velocity in bridge opening 8.9 *ft/s*
Maximum WSPRO tube velocity at bridge 10.0 *ft/s*

Water-surface elevation at Approach section with bridge 500.6 *ft*
Water-surface elevation at Approach section without bridge 498.7 *ft*
Amount of backwater caused by bridge 1.9 *ft*

500-year discharge 7,800 ft^3/s
Water-surface elevation in bridge opening 497.5 *ft*
Road overtopping? Y *Discharge over road* 5171 ft^3/s
Area of flow in bridge opening 310 ft^2
Average velocity in bridge opening 8.7 *ft/s*
Maximum WSPRO tube velocity at bridge 9.8 *ft/s*

Water-surface elevation at Approach section with bridge 501.0 *ft*
Water-surface elevation at Approach section without bridge 499.2 *ft*
Amount of backwater caused by bridge 1.8 *ft*

Incipient overtopping discharge 2,244 ft^3/s
Water-surface elevation in bridge opening 494.5 *ft*
Area of flow in bridge opening 188 ft^2
Average velocity in bridge opening 11.9 *ft/s*
Maximum WSPRO tube velocity at bridge 13.9 *ft/s*

Water-surface elevation at Approach section with bridge 496.8 *ft*
Water-surface elevation at Approach section without bridge 495.4 *ft*
Amount of backwater caused by bridge 1.4 *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 others, 1993). Scour depths were calculated assuming an infinite depth of erosive material and a homogeneous particle-size distribution. The results of the scour analysis are presented in tables 1 and 2 and a graph of the scour depths is presented in figure 8.

Contraction scour was computed by use of the clear-water contraction scour equation (Richardson and others, 1993, p. 35, equation 18) for the incipient road-overflow discharges. Contraction scour was computed by use of Chang pressure-flow scour equation (Richardson and others, 1995, p. 145-146) for the 100-year and 500-year discharges, where orifice flow was at the bridge. Contraction scour at bridges with orifice flow is best estimated by use of Chang pressure-flow scour equation (oral communication, J. Sterling Jones, October 4, 1996). The results of Laursen's clear-water contraction scour equation (Richardson and others, 1993, p. 35, equation 18) for the 100-year and 500-year discharges were also computed and can be found in appendix F. For contraction scour computations, the average depth in the contracted section (AREA/TOPWIDTH) is subtracted from the depth of flow computed by the scour equation (Y2) to determine the actual amount of scour. In this case, the incipient road-overflow model resulted in the worst case contraction scour with a scour depth of 1.5 ft. However, it was not the worst case total scour.

Abutment scour for the right abutment at all modelled discharges was computed by use of the Froehlich equation (Richardson and others, 1993, p. 49, equation 24). The Froehlich equation gives "excessively conservative estimates of scour depths" (Richardson and others, 1993, p. 48). 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 left abutment for all discharges was computed by use of the HIRE equation (Richardson and others, 1993, p. 50, equation 25) 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.

Scour Results

Contraction scour:	*100-yr discharge*	*500-yr discharge*	*Incipient overtopping discharge*
		(Scour depths in feet)	
Main channel			
Live-bed scour	--	--	--
Clear-water scour	0.6	0.4	1.5
Depth to armoring	3.2	2.7	1.4
Left overbank	--	--	--
Right overbank	--	--	--

Local scour:			
Abutment scour			
Left abutment	10.9	13.2	6.0
Right abutment	14.6	13.4	7.7
Pier scour			
Pier 1	--	--	--
Pier 2	--	--	--
Pier 3	--	--	--

Rock Riprap Sizing

	100-yr discharge	*500-yr discharge*	*Incipient overtopping discharge*
		(D_{50} in feet)	
Abutments:			
Left abutment	1.5	1.5	1.8
Right abutment	1.5	1.5	1.8
Piers:			
Pier 1	--	--	--
Pier 2	--	--	--

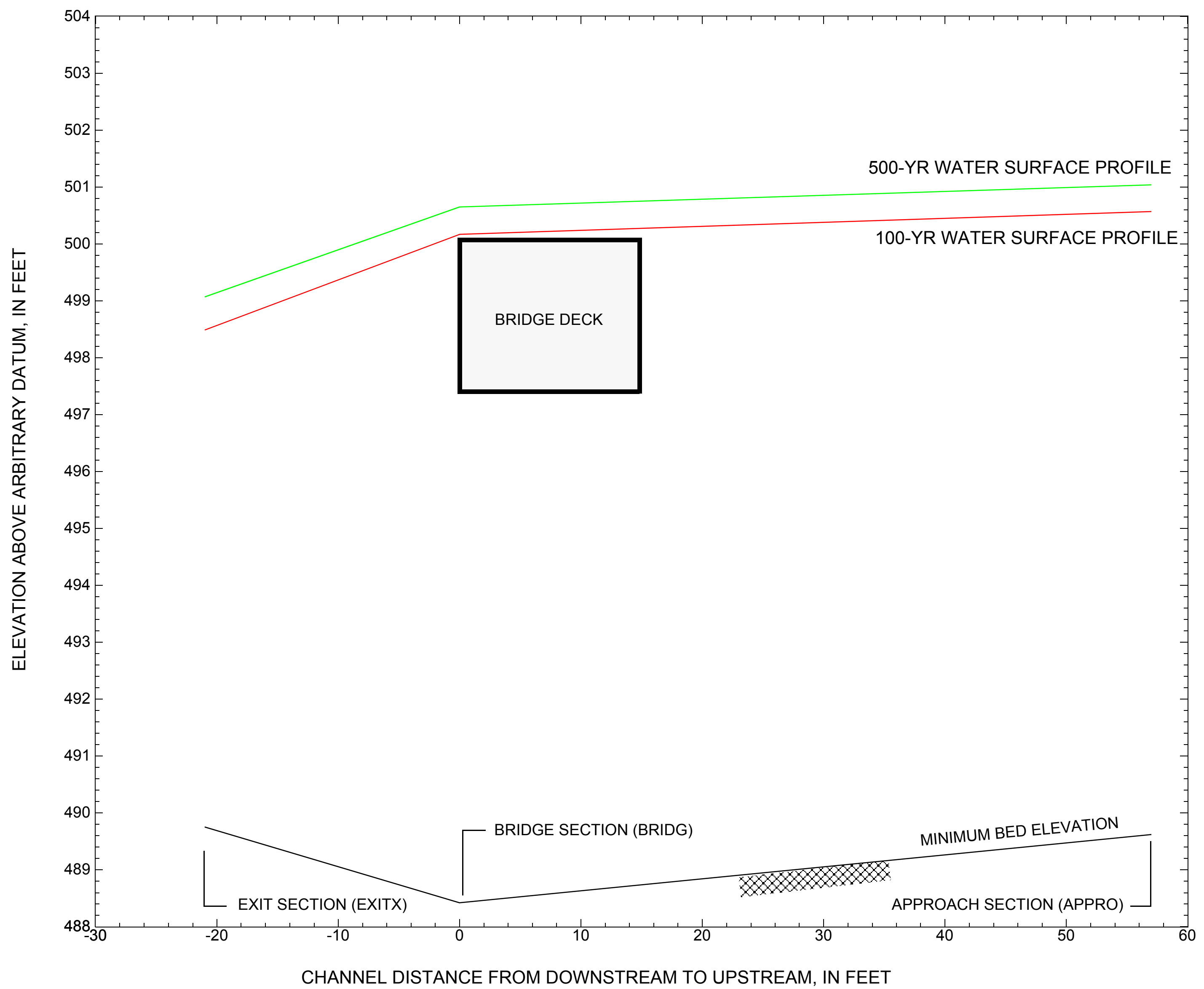

Figure 7. Water-surface profiles for the 100- and 500-yr discharges at structure BRIDTH00650057 on town highway 65, crossing Broad Brook, Bridgewater, Vermont.

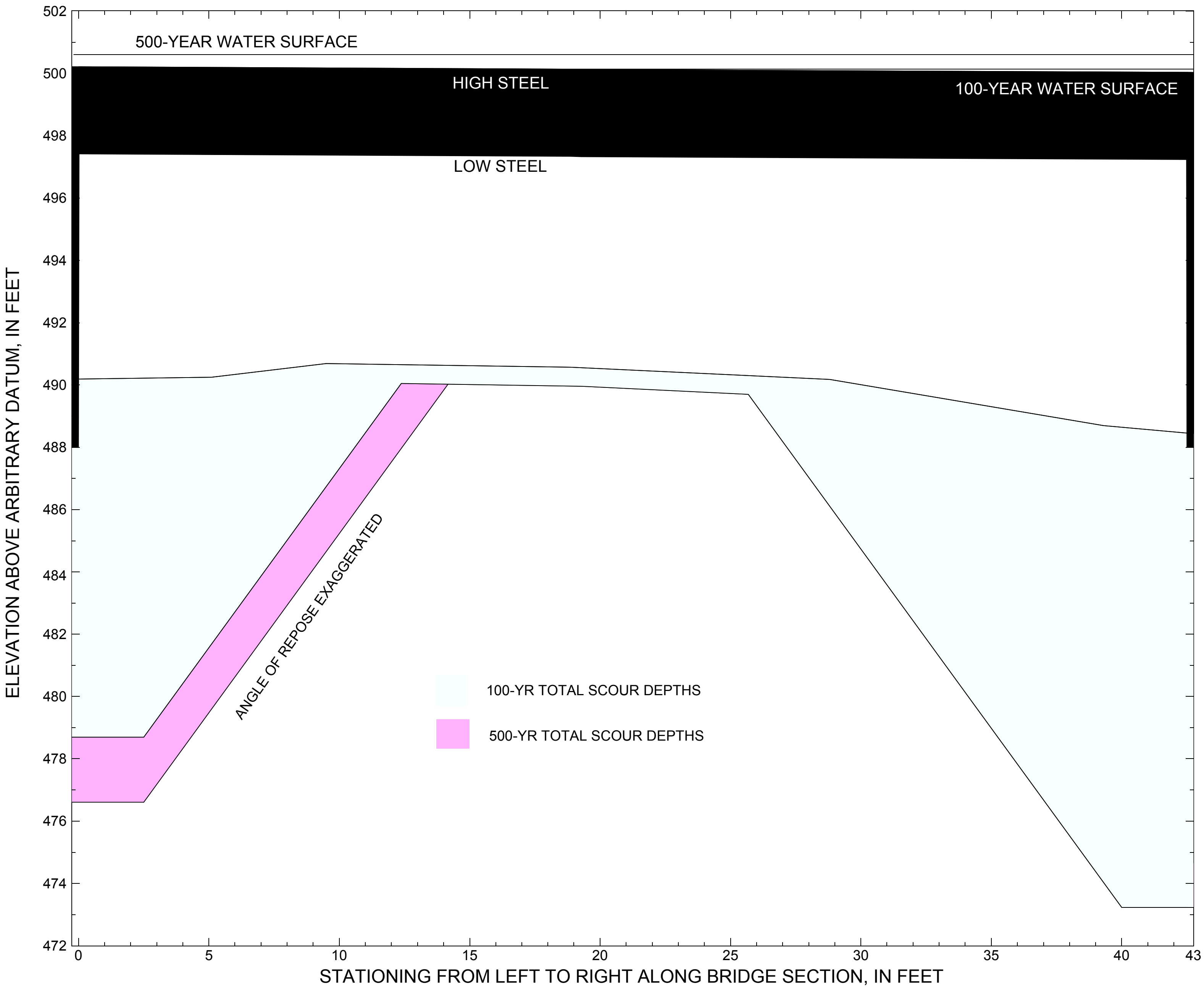

Figure 8. Scour elevations for the 100-yr and 500-yr discharges at structure BRIDTH00650057 on town highway 65, crossing Broad Brook, Bridgewater, Vermont.

Table 1. Remaining footing/pile depth at abutments for the 100-year discharge at structure BRIDTH00650057 on Town Highway 65, crossing Broad Brook, Bridgewater, Vermont.

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

Description	Station[1]	VTAOT plans' bridge seat elevation (feet)	Surveyed minimum low-chord elevation[2] (feet)	Bottom of footing 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-yr. discharge is 6,000 cubic-feet per second											
Left abutment	0.0	497.7	497.5	488	490.2	0.6	10.9	--	11.5	478.7	-9
Right abutment	42.5	498.0	497.2	488	488.4	0.6	14.6	--	15.2	473.2	-15

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 BRIDTH00650057 on Town Highway 65, crossing Broad Brook, Bridgewater, Vermont.

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

Description	Station[1]	VTAOT plans' bridge seat elevation (feet)	Surveyed minimum low-chord elevation[2] (feet)	Bottom of footing 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-yr. discharge is 7,800 cubic-feet per second											
Left abutment	0.0	497.7	497.5	488	490.2	0.4	13.2	--	13.6	476.6	-11
Right abutment	42.5	498.0	497.2	488	488.4	0.4	13.4	--	13.8	474.6	-13

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

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U.S. Geological Survey, 1966, Plymouth, Vermont 7.5 Minute Series quadrangle map: U.S. Geological Survey Topographic Maps, Photoinspected 1983, Scale 1:24,000.

APPENDIX A:

WSPRO INPUT FILE

WSPRO INPUT FILE

```
T1        U.S. GEOLOGICAL SURVEY WSPRO INPUT FILE brid057.wsp
T2        CREATED ON 22-SEP-95 FOR BRIDGE BRIDTH00650057 USING FILE brid057.dca
T3        HYDRAULIC ANALYSIS OF BRID057     SAO
*
J3         6 29 30 552 553 551 5 16 17 13 3 * 15 14 23 21 11 12 4 7 3
*
Q          6000 7800 2244
SK         .0067 .0067 .0067
*          exit modelled w/ ds-most slope of 0.0067
*
XS   EXITX  -21
*           (SRD is where x-c was orig. surveyed)
GR         -265.6, 505.     -256.6, 499.93   -223.8, 499.43    -54.9, 496.39
GR          -22.1, 493.65     -0.4, 492.28      0.0, 490.51      4.1, 489.75
GR           12.8, 490.30     27.1, 489.86     29.3, 489.83     33.3, 489.98
GR           42.0, 489.97     45.6, 490.71     57.2, 492.87     83.0, 498.19
GR          135.6, 496.92    183.7, 496.51    226.7, 499.19    226.7, 505.
N            0.080       0.037
SA                 -0.4
*
XS   FULLV   0 * * * -0.03
*             (from avg thalweg slope between exit and bridge; note: neg. slope)
*
BR   BRIDG   0 497.4
*            (orig. surveyed at SRD=14.5 which is the US face; data are shifted to
*              the DS face without correction for slope--assumed same elevation of
*              data points)
GR            0.0, 497.51      0.0, 490.18      5.1, 490.25      9.5, 490.69
GR           19.3, 490.56     28.8, 490.18     39.3, 488.70     42.5, 488.42
GR           42.5, 497.19      0.0, 497.51
N            0.035
CD           1 28.5 * * 45 8.5
*
XR   RDWAY   8 14.5 2
GR         -265.6, 505.     -265.6, 499.93   -156.2, 500.35    -56.2, 500.02
GR            0.0, 500.28     45.0, 499.99     84.3, 498.99    136.9, 496.92
GR          185.0, 496.51    228.0, 499.19    228.0, 505.
BP          0
*
XT   APTEM    80
*           (SRD is where x-c was orig. surveyed, 65.5, + 14.5 for deck width)
GR         -265.6, 505.     -256.6, 499.93   -223.8, 499.72    -54.9, 496.68
GR          -47.9, 495.66    -14.1, 496.19     -5.2, 492.42      0.0, 490.99
GR            2.4, 490.56      9.1, 490.06     20.4, 490.35     31.3, 490.23
GR           36.4, 490.89     48.6, 494.75     68.2, 496.74     94.0, 498.59
GR          103.4, 501.93    122.9, 506.02
*
AS   APPRO    57
*             (SRD is one bridge length plus deck width; GT correction is for
*              23 ft over a slope of 0.01911, which is the thalweg slope between
*              the approach x-c and the US bridge face x-c)
GT           -0.44
```

```
N            0.035     0.060     0.037      0.045
SA                -54.9      -14.1    48.6
BP           0
*
HP 1 BRIDG    497.51 1 497.51
HP 2 BRIDG    497.51 * * 2756
HP 2 RDWAY    500.17 * * 3278
HP 1 APPRO    500.57 1 500.57
HP 2 APPRO    500.57 * * 6000
*
HP 1 BRIDG    497.51 1 497.51
HP 2 BRIDG    497.51 * * 2700
HP 2 RDWAY    500.65 * * 5171
HP 1 APPRO    501.04 1 501.04
HP 2 APPRO    501.04 * * 7800
*
HP 1 BRIDG    494.49 1 494.49
HP 2 BRIDG    494.49 * * 2244
HP 1 APPRO    496.75 1 496.75
HP 2 APPRO    496.75 * * 2244
*
EX
ER
```

APPENDIX B:

WSPRO OUTPUT FILE

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

      WSEL  SA#     AREA        K   TOPW   WETP  ALPH    LEW    REW     QCR
              1     310.   27836.     0.   101.                          0.
    497.51          310.   27836.     0.   101.  1.00     0.    43.      0.
1
     VELOCITY DISTRIBUTION:  ISEQ =  3;  SECID = BRIDG;  SRD =       0.

          WSEL     LEW     REW    AREA        K        Q    VEL
        497.51     0.0    42.5   310.1   27836.    2756.   8.89

 X STA.         0.0        3.2        5.4        7.6        9.8       12.0
   A(I)            23.3       16.0       15.3       15.0       15.0
   V(I)            5.92       8.62       9.01       9.21       9.16

 X STA.        12.0       14.2       16.3       18.5       20.6       22.7
   A(I)            14.7       14.7       14.6       14.7       14.3
   V(I)            9.35       9.37       9.47       9.40       9.61

 X STA.        22.7       24.8       26.8       28.8       30.8       32.6
   A(I)            14.5       14.2       14.2       14.1       14.0
   V(I)            9.51       9.72       9.71       9.74       9.88

 X STA.        32.6       34.4       36.2       37.9       39.8       42.5
   A(I)            13.8       14.3       14.2       15.8       23.4
   V(I)            9.98       9.63       9.73       8.72       5.88
1
     VELOCITY DISTRIBUTION:  ISEQ =  4;  SECID = RDWAY;  SRD =       8.

          WSEL     LEW     REW    AREA        K        Q    VEL
        500.17  -265.6   228.0   425.0   25853.    3278.   7.71

 X STA.      -265.6       98.3      113.9      124.2      132.0      138.5
   A(I)            63.0       31.7       26.3       22.5       20.7
   V(I)            2.60       5.17       6.23       7.28       7.90

 X STA.       138.5      144.4      149.8      155.1      160.1      164.7
   A(I)            19.5       18.0       17.7       17.1       16.2
   V(I)            8.39       9.11       9.25       9.60      10.10

 X STA.       164.7      169.3      173.7      178.0      182.2      186.5
   A(I)            16.0       15.7       15.2       15.3       15.4
   V(I)           10.21      10.42      10.77      10.69      10.61

 X STA.       186.5      191.0      196.3      202.5      211.2      228.0
   A(I)            15.5       16.5       17.1       20.0       25.3
   V(I)           10.60       9.91       9.58       8.18       6.49
1
     CROSS-SECTION PROPERTIES:  ISEQ =  5;  SECID = APPRO;  SRD =      57.

      WSEL  SA#     AREA        K   TOPW   WETP  ALPH    LEW    REW     QCR
              1     515.   40594.   204.   204.                       4641.
              2     206.   15007.    41.    41.                       2622.
              3     596.  105982.    63.    64.                      10439.
              4     198.   15790.    52.    53.                       2184.
    500.57         1514.  177373.   359.   362.  1.55  -259.   101.  14156.
1
1     VELOCITY DISTRIBUTION:  ISEQ =  5;  SECID = APPRO;  SRD =      57.

          WSEL     LEW     REW    AREA        K        Q    VEL
        500.57  -258.5   100.8  1514.5  177373.    6000.   3.96

 X STA.      -258.5     -162.5     -119.7      -90.6      -66.6      -44.2
   A(I)           152.8      118.9       99.6       93.9      102.7
   V(I)            1.96       2.52       3.01       3.20       2.92

 X STA.       -44.2      -21.1       -6.2       -0.3        4.4        8.7
   A(I)           118.3       85.4       54.1       47.7       46.6
   V(I)            2.54       3.51       5.55       6.28       6.43

 X STA.         8.7       12.9       17.1       21.4       25.6       29.9
   A(I)            46.0       45.5       45.6       45.2       46.3
   V(I)            6.53       6.59       6.58       6.63       6.47

 X STA.        29.9       34.3       39.4       46.5       61.2      100.8
   A(I)            46.9       49.8       57.0       85.1      126.8
```

```
   V(I)            6.40       6.02       5.26       3.52       2.37
1
   *
     CROSS-SECTION PROPERTIES:  ISEQ =  3;  SECID = BRIDG;  SRD =       0.

      WSEL  SA#     AREA        K   TOPW   WETP  ALPH    LEW    REW     QCR
              1     310.   27836.     0.   101.                          0.
    497.51          310.   27836.     0.   101.  1.00     0.    43.      0.
1
     VELOCITY DISTRIBUTION:  ISEQ =  3;  SECID = BRIDG;  SRD =       0.

          WSEL     LEW     REW    AREA        K        Q    VEL
        497.51     0.0    42.5   310.1   27836.    2700.   8.71

 X STA.        0.0        3.2        5.4        7.6        9.8       12.0
   A(I)            23.3       16.0       15.3       15.0       15.0
   V(I)            5.80       8.44       8.83       9.02       8.98

 X STA.       12.0       14.2       16.3       18.5       20.6       22.7
   A(I)            14.7       14.7       14.6       14.7       14.3
   V(I)            9.16       9.17       9.28       9.21       9.41

 X STA.       22.7       24.8       26.8       28.8       30.8       32.6
   A(I)            14.5       14.2       14.2       14.1       14.0
   V(I)            9.32       9.53       9.51       9.54       9.68

 X STA.       32.6       34.4       36.2       37.9       39.8       42.5
   A(I)            13.8       14.3       14.2       15.8       23.4
   V(I)            9.78       9.44       9.53       8.55       5.76
1
     VELOCITY DISTRIBUTION:  ISEQ =  4;  SECID = RDWAY;  SRD =       8.

          WSEL     LEW     REW    AREA        K        Q    VEL
        500.65  -265.6   228.0   650.6   37619.    5171.   7.95

 X STA.     -265.6       39.8       88.4      106.1      118.2      127.3
   A(I)           150.2       56.0       38.5       33.2       29.1
   V(I)            1.72       4.62       6.72       7.78       8.89

 X STA.      127.3      134.9      141.6      147.8      153.7      159.3
   A(I)            26.7       24.9       23.6       22.4       22.0
   V(I)            9.68      10.39      10.94      11.52      11.74

 X STA.      159.3      164.7      170.0      175.0      180.1      184.9
   A(I)            21.4       21.0       20.3       20.5       19.7
   V(I)           12.07      12.31      12.72      12.61      13.10

 X STA.      184.9      190.0      195.7      202.9      211.9      228.0
   A(I)            20.6       20.8       23.2       24.8       31.6
   V(I)           12.57      12.45      11.14      10.42       8.19
1
     CROSS-SECTION PROPERTIES:  ISEQ =  5;  SECID = APPRO;  SRD =      57.

      WSEL  SA#     AREA        K   TOPW   WETP  ALPH    LEW    REW     QCR
              1     610.   53803.   204.   205.                       5985.
              2     225.   17410.    41.    41.                       2997.
              3     626.  114852.    63.    64.                      11223.
              4     223.   18901.    54.    54.                       2576.
    501.04         1684.  204965.   361.   364.  1.49  -259.   102.  16894.
1
     VELOCITY DISTRIBUTION:  ISEQ =  5;  SECID = APPRO;  SRD =      57.

          WSEL     LEW     REW    AREA        K        Q    VEL
        501.04  -259.4   102.1  1683.9  204965.    7800.   4.63

 X STA.     -259.4     -176.3     -134.8     -105.0      -80.6      -59.5
   A(I)           160.4      123.8      108.3      100.5       95.6
   V(I)            2.43       3.15       3.60       3.88       4.08

 X STA.      -59.5      -37.3      -13.3       -3.8        1.8        6.6
   A(I)           119.8      131.2       72.1       57.1       53.0
   V(I)            3.26       2.97       5.41       6.83       7.36

 X STA.        6.6       11.1       15.6       20.2       24.7       29.4
   A(I)            51.4       51.2       51.2       50.7       51.9
   V(I)            7.59       7.62       7.61       7.70       7.52
```

```
 X STA.        29.4       34.1       39.3       46.9       63.3      102.1
   A(I)             52.7       54.6       64.0       99.9      134.6
   V(I)             7.40       7.15       6.09       3.90       2.90
1
   *
     CROSS-SECTION PROPERTIES:  ISEQ =  3;  SECID = BRIDG;  SRD =       0.

      WSEL  SA#     AREA        K   TOPW   WETP  ALPH    LEW    REW     QCR
              1     189.   18693.    43.    53.                        2253.
    494.49          189.   18693.    43.    53.  1.00     0.    43.   2253.
1
     VELOCITY DISTRIBUTION:  ISEQ =  3;  SECID = BRIDG;  SRD =       0.

          WSEL     LEW     REW    AREA        K        Q    VEL
        494.49     0.0    42.5   188.5   18693.    2244.  11.90

 X STA.         0.0        3.4        5.8        8.1       10.5       12.9
   A(I)             14.6       10.0        9.4        9.5        9.2
   V(I)             7.69      11.24      11.99      11.87      12.19

 X STA.        12.9       15.3       17.6       19.9       22.1       24.2
   A(I)              9.2        8.9        8.9        8.9        8.6
   V(I)            12.22      12.57      12.60      12.57      13.09

 X STA.        24.2       26.3       28.3       30.2       32.0       33.6
   A(I)              8.6        8.5        8.4        8.1        8.1
   V(I)            12.99      13.14      13.32      13.77      13.90

 X STA.        33.6       35.2       36.7       38.3       39.9       42.5
   A(I)              8.1        8.1        8.5        9.5       15.3
   V(I)            13.82      13.90      13.17      11.75       7.32
1
     CROSS-SECTION PROPERTIES:  ISEQ =  5;  SECID = APPRO;  SRD =      57.

      WSEL  SA#     AREA        K   TOPW   WETP  ALPH    LEW    REW     QCR
              1       7.     124.    28.    28.                          21.
              2      50.    1415.    41.    41.                         313.
              3     357.   45041.    63.    64.                        4833.
              4      30.    1077.    26.    26.                         181.
    496.75          444.   47657.   158.   160.  1.31   -83.    74.   3692.
1
     VELOCITY DISTRIBUTION:  ISEQ =  5;  SECID = APPRO;  SRD =      57.

          WSEL     LEW     REW    AREA        K        Q    VEL
        496.75   -83.2    74.5   443.8   47657.    2244.   5.06

 X STA.       -83.2       -8.1       -2.7        0.8        3.7        6.3
   A(I)             70.8       24.6       20.9       18.9       17.9
   V(I)             1.58       4.55       5.36       5.95       6.26

 X STA.         6.3        8.7       11.1       13.5       15.9       18.3
   A(I)             17.1       17.0       16.6       16.8       16.7
   V(I)             6.57       6.61       6.77       6.67       6.73

 X STA.        18.3       20.7       23.2       25.6       28.1       30.4
   A(I)             16.7       16.7       16.9       16.9       16.4
   V(I)             6.72       6.73       6.62       6.65       6.82

 X STA.        30.4       33.0       35.7       39.0       43.8       74.5
   A(I)             17.4       18.3       19.3       22.6       45.3
   V(I)             6.47       6.12       5.80       4.97       2.48
1
 +++ BEGINNING PROFILE CALCULATIONS --   3
  XSID:CODE   SRDL    LEW     AREA   VHD    HF     EGL    CRWS       Q    WSEL
        SRD   FLEN    REW        K  ALPH    HO     ERR     FR#     VEL

 EXITX:XS   ******  -172.    1064.  0.71 *****  499.20  497.64   6000.  498.49
      -21. ******   215.   73250.  1.43 ***** *******    0.72    5.64

  ===135 CONVEYANCE RATIO OUTSIDE OF RECOMMENDED LIMITS.
                              "FULLV"     KRATIO =  1.58

 FULLV:FV      21.  -230.    1505.  0.38  0.09  499.28 *******   6000.  498.90
        0.     21.   227.  115983.  1.52  0.00   -0.01    0.48    3.99
          <<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>
```

WSPRO OUTPUT FILE (continued)

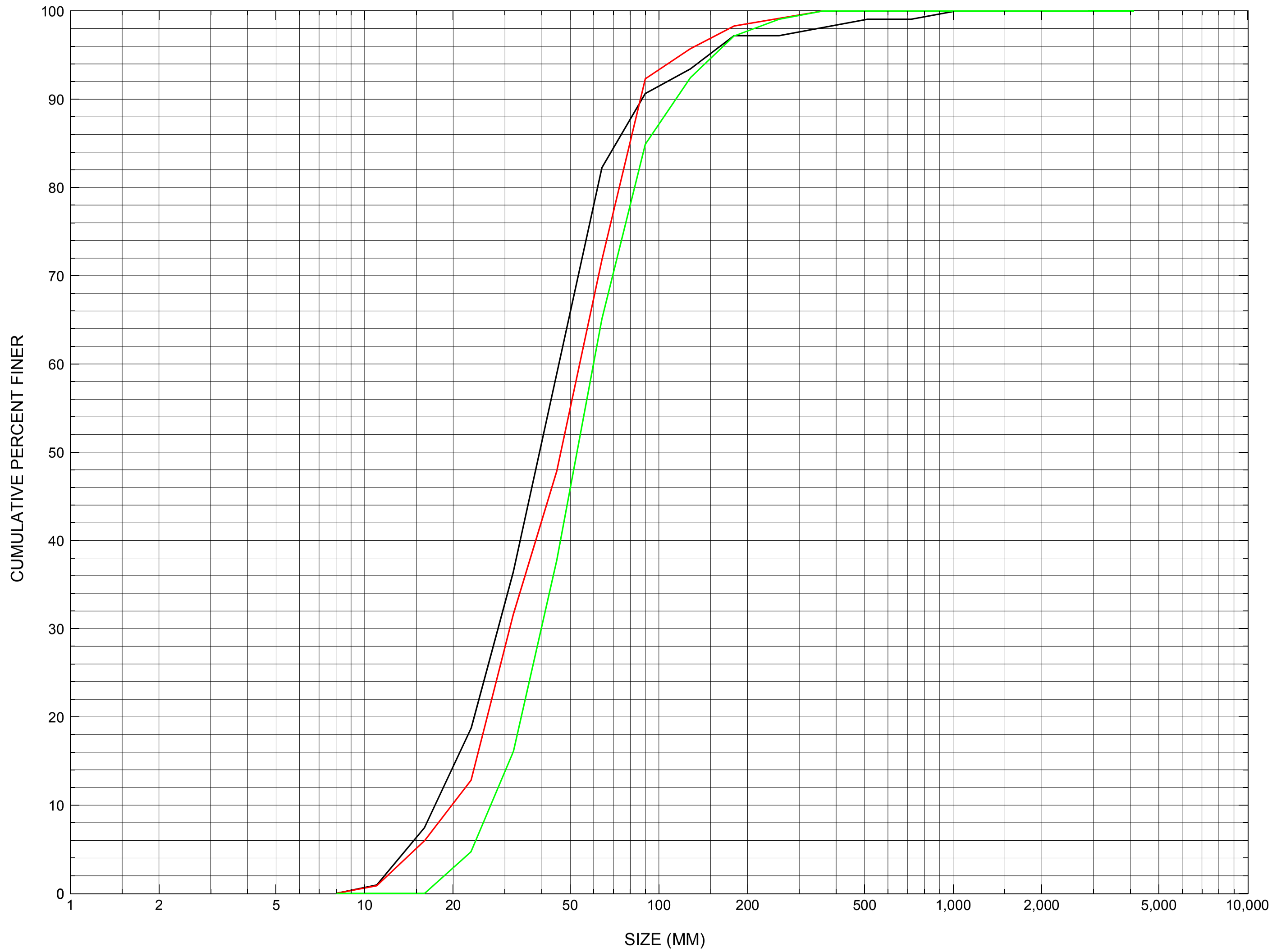
```
 ===125 FR# EXCEEDS FNTEST AT SECID “APPRO”:  TRIALS CONTINUED.
             FNTEST,FR#,WSEL,CRWS =  0.80    0.89     498.65     498.22

 ===110 WSEL NOT FOUND AT SECID “APPRO”:  REDUCED DELTAY.
                  WSLIM1,WSLIM2,DELTAY =   498.40     505.58    0.50

 ===115 WSEL NOT FOUND AT SECID “APPRO”:  USED WSMIN = CRWS.
                  WSLIM1,WSLIM2,CRWS =   498.40     505.58     498.22

APPRO:AS      57.  -190.     874.  1.20  0.19  499.88  498.22   6000.  498.67
       57.    57.    95.   93819.  1.64  0.41    0.00    0.89    6.86
         <<<<<THE ABOVE RESULTS REFLECT “NORMAL” (UNCONSTRICTED) FLOW>>>>>

 ===255 ATTEMPTING FLOW CLASS 3 (6) SOLUTION.
                       WS3N,LSEL =   498.90     497.40

            <<<<<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      21.     0.     310.  1.23 *****  498.74  495.14   2756.  497.51
        0. ******    43.   27836.  1.00 ***** *******    0.58    8.89

     TYPE PPCD FLOW      C    P/A    LSEL   BLEN   XLAB   XRAB
       1. ****   6.  0.800  0.000  497.40 ****** ****** ******

    XSID:CODE    SRD   FLEN    HF   VHD     EGL     ERR       Q    WSEL
   RDWAY:RG       8.    43.  0.05  0.38  500.90    0.01   3278.  500.17

            Q   WLEN    LEW    REW  DMAX  DAVG  VMAX  VAVG  HAVG  CAVG
   LT:    302.   145.  -266.    23.   0.2   0.1   3.8  22.6   0.8   2.8
   RT:   2976.   205.    23.   228.   3.7   2.0   7.9   7.2   2.7   3.2

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

APPRO:AS      29.  -259.    1515.  0.38  0.13  500.95  498.22   6000.  500.57
       57.    34.   101.  177411.  1.55  0.00    0.01    0.42    3.96

       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
   EXITX:XS     -21.  -172.   215.   6000.   73250.    1064.    5.64  498.49
   FULLV:FV       0.  -230.   227.   6000.  115983.    1505.    3.99  498.90
   BRIDG:BR       0.     0.    43.   2756.   27836.     310.    8.89  497.51
   RDWAY:RG       8.*******   302.   3278.*****************    2.00  500.17
   APPRO:AS      57.  -259.   101.   6000.  177411.    1515.    3.96  500.57

    XSID:CODE   XLKQ   XRKQ       KQ
   APPRO:AS  **********************
 SECOND USER DEFINED TABLE.

    XSID:CODE    CRWS     FR#    YMIN    YMAX    HF    HO  VHD      EGL    WSEL
   EXITX:XS    497.64    0.72  489.75  505.00************  0.71  499.20  498.49
   FULLV:FV  ********    0.48  489.12  504.37  0.09  0.00  0.38  499.28  498.90
   BRIDG:BR    495.14    0.58  488.42  497.51************  1.23  498.74  497.51
   RDWAY:RG  ****************  496.51  505.00  0.05******  0.38  500.90  500.17
   APPRO:AS    498.22    0.42  489.62  505.58  0.13  0.00  0.38  500.95  500.57
1
 XSID:CODE   SRDL    LEW     AREA   VHD    HF     EGL    CRWS       Q    WSEL
       SRD   FLEN    REW        K  ALPH    HO     ERR     FR#     VEL

EXITX:XS   ******  -204.    1302.  0.82 *****  499.90  498.23   7800.  499.07
      -21. ******   225.   95233.  1.48 ***** *******    0.74    5.99

 ===135 CONVEYANCE RATIO OUTSIDE OF RECOMMENDED LIMITS.
                            “FULLV”     KRATIO =  1.56

FULLV:FV      21.  -257.    1803.  0.46  0.09  499.98 *******   7800.  499.53
        0.    21.   227.  148938.  1.57  0.00    0.00    0.50    4.33
```

```
         <<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>

 ===125 FR# EXCEEDS FNTEST AT SECID "APPRO":  TRIALS CONTINUED.
             FNTEST,FR#,WSEL,CRWS =  0.80    0.94     499.22     499.02

 ===110 WSEL NOT FOUND AT SECID "APPRO":  REDUCED DELTAY.
                  WSLIM1,WSLIM2,DELTAY =   499.03     505.58    0.50

 ===115 WSEL NOT FOUND AT SECID "APPRO":  USED WSMIN = CRWS.
                  WSLIM1,WSLIM2,CRWS =   499.03     505.58     499.02

APPRO:AS      57.  -221.    1040.  1.45  0.21  500.68  499.02   7800.  499.22
       57.    57.    97.  113136.  1.66  0.50   -0.01    0.94    7.50
         <<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>

 ===255 ATTEMPTING FLOW CLASS 3 (6) SOLUTION.
                       WS3N,LSEL =   499.53     497.40

            <<<<<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      21.     0.     310.  1.18 *****  498.69  495.07   2700.  497.51
        0. ******    43.   27836.  1.00 ***** *******    0.57    8.71

     TYPE PPCD FLOW      C    P/A    LSEL   BLEN   XLAB   XRAB
       1. ****   6.  0.800  0.000  497.40 ****** ****** ******

    XSID:CODE    SRD   FLEN    HF   VHD     EGL     ERR       Q   WSEL
   RDWAY:RG       8.    43.  0.06  0.50  501.48    0.01   5171.  500.65

            Q   WLEN    LEW    REW  DMAX  DAVG  VMAX  VAVG  HAVG  CAVG
   LT:   1253.   288.  -266.    23.   0.7   0.5   5.0   8.9   1.3   2.9
   RT:   3918.   205.    23.   228.   4.1   2.5   8.6   7.7   3.3   3.2

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

APPRO:AS      29.  -259.    1684.  0.50  0.17  501.54  499.02   7800.  501.04
       57.    36.   102.  205005.  1.49  0.00    0.01    0.46    4.63

       M(G)   M(K)       KQ   XLKQ   XRKQ    OTEL
     ****** ****** ******** ****** ****** ********
   FIRST USER DEFINED TABLE.

    XSID:CODE    SRD    LEW    REW       Q        K     AREA     VEL    WSEL
   EXITX:XS     -21.  -204.   225.   7800.   95233.    1302.    5.99  499.07
   FULLV:FV       0.  -257.   227.   7800.  148938.    1803.    4.33  499.53
   BRIDG:BR       0.     0.    43.   2700.   27836.     310.    8.71  497.51
   RDWAY:RG       8.******* 1253.   5171.*****************    2.00  500.65
   APPRO:AS      57.  -259.   102.   7800.  205005.    1684.    4.63  501.04

    XSID:CODE   XLKQ   XRKQ       KQ
   APPRO:AS  ***********************
 SECOND USER DEFINED TABLE.

    XSID:CODE    CRWS     FR#    YMIN    YMAX     HF    HO  VHD      EGL    WSEL
   EXITX:XS    498.23    0.74  489.75  505.00************  0.82  499.90  499.07
   FULLV:FV  ********    0.50  489.12  504.37  0.09  0.00  0.46  499.98  499.53
   BRIDG:BR    495.07    0.57  488.42  497.51************  1.18  498.69  497.51
   RDWAY:RG  ****************  496.51  505.00  0.06******  0.50  501.48  500.65
   APPRO:AS    499.02    0.46  489.62  505.58  0.17  0.00  0.50  501.54  501.04
1
 XSID:CODE   SRDL    LEW     AREA   VHD    HF     EGL    CRWS       Q    WSEL
       SRD   FLEN    REW        K  ALPH    HO     ERR     FR#     VEL

EXITX:XS   ******   -37.     316.  0.98 *****  495.83  494.12   2244.  494.86
      -21. ******    67.   27412.  1.24 ***** *******    0.80    7.11
 ===135 CONVEYANCE RATIO OUTSIDE OF RECOMMENDED LIMITS.
                            "FULLV"     KRATIO =  1.53

FULLV:FV      21.   -51.     449.  0.52  0.09  495.93 *******   2244.  495.41
        0.    21.    73.   42040.  1.34  0.00    0.00    0.53    4.99
         <<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>
```

```
 ===135 CONVEYANCE RATIO OUTSIDE OF RECOMMENDED LIMITS.
                           "APPRO"     KRATIO =  0.68

 APPRO:AS      57.   -49.     276.  1.06  0.24  496.42 *******   2244.  495.36
        57.    57.    59.   28733.  1.03  0.27   -0.01    0.79    8.12
          <<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>
 ===215 FLOW CLASS 1 SOLUTION INDICATES POSSIBLE ROAD OVERFLOW.
            WS1,WSSD,WS3,RGMIN =   496.75       0.00     494.49     496.51

 ===260 ATTEMPTING FLOW CLASS 4 SOLUTION.

 ===240 NO DISCHARGE BALANCE IN 15 ITERATIONS.
                    WS,QBO,QRD =   496.70      2217.        27.
 ===280 REJECTED FLOW CLASS 4 SOLUTION.

 ===245 ATTEMPTING FLOW CLASS 2 (5) SOLUTION.

 ===250 INSUFFICIENT HEAD FOR PRESSURE FLOW.
                         YU/Z,WSIU,WS = 1.09     498.05     498.10

 ===270 REJECTED FLOW CLASS 2 (5) SOLUTION.

             <<<<<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      21.     0.     188.  2.20  0.21  496.69  494.45   2244.  494.49
         0.    21.    43.   18688.  1.00  0.33    0.00    1.00   11.91

     TYPE PPCD FLOW      C    P/A    LSEL   BLEN   XLAB   XRAB
       1. ****   1.  1.000 ******  497.40 ****** ****** ******

    XSID:CODE    SRD   FLEN    HF   VHD     EGL     ERR       Q    WSEL
   RDWAY:RG       8.        <<<<<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      29.   -83.     444.  0.52  0.17  497.27  494.37   2244.  496.75
        57.    30.    75.   47692.  1.31  0.41    0.00    0.61    5.05

       M(G)   M(K)       KQ   XLKQ   XRKQ    OTEL
      0.606  0.154   40334.    -5.    38.   496.66
                   <<<<<END OF BRIDGE COMPUTATIONS>>>>>
  FIRST USER DEFINED TABLE.
    XSID:CODE    SRD    LEW    REW       Q        K     AREA     VEL    WSEL
   EXITX:XS     -21.   -37.    67.   2244.   27412.     316.    7.11  494.86
   FULLV:FV       0.   -51.    73.   2244.   42040.     449.    4.99  495.41
   BRIDG:BR       0.     0.    43.   2244.   18688.     188.   11.91  494.49
   RDWAY:RG       8.**************      0.       0.       0.    2.00********
   APPRO:AS      57.   -83.    75.   2244.   47692.     444.    5.05  496.75
    XSID:CODE   XLKQ   XRKQ      KQ
   APPRO:AS      -5.    38.   40334.
 SECOND USER DEFINED TABLE.
    XSID:CODE    CRWS     FR#    YMIN    YMAX    HF    HO  VHD      EGL    WSEL
   EXITX:XS    494.12    0.80  489.75  505.00************  0.98  495.83  494.86
   FULLV:FV  ********    0.53  489.12  504.37  0.09  0.00  0.52  495.93  495.41
   BRIDG:BR    494.45    1.00  488.42  497.51  0.21  0.33  2.20  496.69  494.49
   RDWAY:RG  ****************  496.51  505.00************  0.24  498.31********
   APPRO:AS    494.37    0.61  489.62  505.58  0.17  0.41  0.52  497.27  496.75
  ER

1  NORMAL  END  OF  WSPRO  EXECUTION.
```

APPENDIX C:

BED-MATERIAL PARTICAL-SIZE DISTRIBUTION



Appendix C. Bed material particle-size distributions for three pebble count transects at the approach cross-section for structure BRIDTH00650057, in Bridgewater, Vermont.

APPENDIX D:

HISTORICAL DATA FORM