LEVEL II SCOUR ANALYSIS FOR BRIDGE 8 (STAMVT01000008) on VERMONT HIGHWAY 100, crossing the NORTH BRANCH of the HOOSIC RIVER, STAMFORD, VERMONT

U.S. Geological Survey
Open-File Report 97-215

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

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By MICHAEL A. IVANOFF

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Pembroke, New Hampshire

1997

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

U.S. GEOLOGICAL SURVEY
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Denver, CO 80225-0286

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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 8 (STAMVT01000008) ON VERMONT HIGHWAY 100, CROSSING THE NORTH BRANCH OF THE HOOSIC RIVER, STAMFORD, VERMONT

***By* Michael A. Ivanoff**

INTRODUCTION AND SUMMARY OF RESULTS

This report provides the results of a detailed Level II analysis of scour potential at structure STAMVT01000008 on Vermont Highway 100 crossing the North Branch of the Hoosic River, Stamford, 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). 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 Green Mountain section of the New England physiographic province in southern Vermont. The 6.8-mi^2 drainage area is in a predominantly rural and forested basin. In the vicinity of the study site, the upstream right bank surface cover is short grass and the upstream left bank is a sand/gravel lot while the immediate banks are covered by shrubs and trees. Downstream of the bridge banks are forested.

In the study area, the North Branch of the Hoosic River has an incised, sinuous channel with a slope of approximately 0.02 ft/ft, an average channel top width of 37 ft and an average bank height of 3 ft. The channel bed material is predominantly cobble with a median grain size (D_{50}) of 88.0 mm (0.289 ft). The geomorphic assessment at the time of the Level I and Level II site visit on August 1, 1996, indicated that the reach was laterally unstable.

The Vermont Highway 100 crossing of the North Branch of the Hoosic River is a 39-ft-long, two-lane bridge consisting of one 37-foot steel-beam span (Vermont Agency of Transportation, written communication, November 1, 1995). The bridge is supported by vertical, concrete abutments. The channel is skewed approximately 20 degrees to the opening while the opening-skew-to-roadway is 15 degrees.

A scour hole 2.5 ft deeper than the mean thalweg depth was observed along the upstream end of the right abutment during the Level I assessment. The only scour protection measure at the site was type-3 stone fill (less than 48 inches diameter) at the downstream ends of the left and right abutments extending downstream along the left bank for 13 feet and along the right bank for 16 feet. The plans show stone fill placed at the upstream ends of the abutments. The protection at the upstream end of the right abutment has failed due to stream migration towards the right bank. The protection at the upstream end of the left abutment was not detected due to the sand/gravel pile, for District 1 maintenance, migrating into the channel (Figure 3). 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, 1995). 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 0.6 to 3.0 ft. The worst-case contraction scour occurred at the 500-year discharge. Left abutment scour ranged from 14.4 to 17.8 ft. Right abutment scour ranged from 8.1 to 11.1 ft. 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 others, 1995, p. 47). 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.

Stamford, VT. Quadrangle, 1:24,000, 1954

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 STAMVT01000008 ***Stream*** North Branch of the Hoosic River

County Bennington ***Road*** VT 100 ***District*** 1

Description of Bridge

Bridge length 39 ***ft*** ***Bridge width*** 35 ***ft*** ***Max span length*** 37 ***ft***

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

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

Stone fill on abutment? No ***Date of inspection*** 08/01/96

Description of stone fill Type-3, around the downstream end of both the left and right abutments.

Abutments are concrete. There is a scour hole approximately 2.5 foot deep in front of the upstream end of the right abutment with the top of the footing exposed.

Yes 20

Is bridge skewed to flood flow according to Yes ***survey?*** ***Angle***

The channel makes a moderate turn into the structure impacting the upstream end of the right abutment.

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	08/01/96	0	0
Level II	08/01/96	0	0

Potential for debris Moderate. There is some debris caught on the banks and there are trees leaning over the channel upstream.

Describe any features near or at the bridge that may affect flow (include observation date) A large pile of sand/gravel on the upstream left bank is migrating into the channel as shown in figure 3 as of 08/01/96.

Description of the Geomorphic Setting

General topography The channel is located within a moderate relief valley with narrow flood plain and steep valley walls on both sides.

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

Date of inspection 08/01/96

DS left: Moderately sloped channel bank to a narrow flood plain.

DS right: Moderately sloped channel bank to the valley wall.

US left: Moderately sloped channel bank to a narrow flood plain.

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

Description of the Channel

Average top width 37 ***ft*** ***Average depth*** 3 ***ft***

Predominant bed material Cobbles ***Bank material*** Cobbles

Sinuous with semi-alluvial channel boundaries.

08/01/96

Vegetative co

DS left: Trees and brush

DS right: Trees and brush

US left: Few trees and some brush with trees and brush on the valley wall.

US right: Trees and brush with grass and a few trees on the flood plain

Do banks appear stable? No ***If not, describe location and type of instability and date of observation.***

There are cutbanks on the right bank both upstream and downstream. The stream migration has led to the failure of the stone fill protection shown on the plans at the upstream end of the right abutment.

Describe any obstructions in channel and date of observation.

The assessment of 08/01/96 noted flow conditions are influenced by a pile of sand/gravel on the left bank side of the channel upstream. The material is migrating into the channel and contributes to the bed along the left abutment.

Hydrology

Drainage area 6.8 ***mi²***

Percentage of drainage area in physiographic provinces: (approximate)

Physiographic province/section	***Percent of drainage area***
New England/Green Mountain	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 -- ***mi²***

Is there a lake/p No

Calculated Discharges

Q100 2,470 ***ft³/s*** ***Q500*** 4,120 ***ft³/s***

The 100- and 500-year discharges are based on a drainage area relationship [(6.8/7.2)exp 0.7] with peak discharges for North Branch of the Hoosic River upstream of Basin Brook calculated in the Stamford Flood Insurance Study (Federal Emergency Management Agency January, 1978). The drainage area above Basin Brook is 7.2 square miles. The discharge values are within a range of several empirical methods (Benson, 1962; Johnson and Tasker, 1974; FHWA, 1983; Potter, 1957a&b; Talbot, 1887).

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 The USGS survey datum is equal to the VTAOT plans' datum. Add 0.2 ft to obtain NGVD.

Description of reference marks used to determine USGS datum. RM1 is a VTAOT tablet on top of the left end of the upstream bridge rail (elev. 1287.86 ft, arbitrary survey datum). RM2 is a chiseled X on top of the right end of the downstream roadway curb (elev. 1285.56 ft, arbitrary survey datum).

Cross-Sections Used in WSPRO Analysis

[1]*Cross-section*	*Section Reference Distance (SRD) in feet*	[2]*Cross-section development*	*Comments*
EXITX	-39	1	Exit section
FULLV	0	2	Downstream Full-valley section (Templated from EXITX)
BRIDG	0	1	Bridge section
RDWAY	18	1	Road Grade section
APPRO	71	1	Approach section as surveyed

[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 0.055, and overbank "n" values ranged from 0.039 to 0.065.

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 0.0195 ft/ft which was estimated from the 100-year discharge slope downstream of the bridge in the Flood Insurance Study for Stamford, VT (Federal Emergency Management Agency, January 1978).

The approach section (APPRO) was surveyed at 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.

Bridge Hydraulics Summary

Average bridge embankment elevation 1285.4 ***ft***
Average low steel elevation 1280.5 ***ft***

100-year discharge 2,470 ***ft^3/s***
Water-surface elevation in bridge opening 1280.6 ***ft***
Road overtopping? Yes ***Discharge over road*** 190 ***ft^3/s***
Area of flow in bridge opening 209 ***ft^2***
Average velocity in bridge opening 10.7 ***ft/s***
Maximum WSPRO tube velocity at bridge 12.2 ***ft/s***

Water-surface elevation at Approach section with bridge 1284.7
Water-surface elevation at Approach section without bridge 1281.2
Amount of backwater caused by bridge 3.5 ***ft***

500-year discharge 4,120 ***ft^3/s***
Water-surface elevation in bridge opening 1280.6 ***ft***
Road overtopping? Yes ***Discharge over road*** 1,432 ***ft^3/s***
Area of flow in bridge opening 209 ***ft^2***
Average velocity in bridge opening 12.8 ***ft/s***
Maximum WSPRO tube velocity at bridge 14.4 ***ft/s***

Water-surface elevation at Approach section with bridge 1285.9
Water-surface elevation at Approach section without bridge 1282.8
Amount of backwater caused by bridge 3.1

Incipient overtopping discharge 2,130 ***ft^3/s***
Water-surface elevation in bridge opening 1280.6 ***ft***
Area of flow in bridge opening 209 ***ft^2***
Average velocity in bridge opening 10.0 ***ft/s***
Maximum WSPRO tube velocity at bridge 11.6 ***ft/s***

Water-surface elevation at Approach section with bridge 1283.9
Water-surface elevation at Approach section without bridge 1281.0
Amount of backwater caused by bridge 2.9 ***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, 1995). 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.

The 100-year and incipient road-overflow discharges resulted in unsubmerged orifice flow. The 500-year discharge 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 all discharges was computed by use of the Chang equation (Richardson and others, 1995, p. 145-146). The results of Laursen's clear-water contraction scour equation (Richardson and others, 1995, p. 32, equation 20) for these events were also computed and can be found in appendix F. In this case, the 500-year discharge resulted in the worst case contraction scour with a scour depth of 3.0 ft.

Abutment scour was computed by use of the HIRE equation (Richardson and others, 1995, p. 49, equation 29) because the HIRE equation is recommended when the length to depth ratio of the embankment blocking flow exceeds 25. Variables for the HIRE 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 Results

Contraction scour:	*100-yr discharge*	*500-yr discharge*	*Incipient overtopping discharge*
		(Scour depths in feet)	
Main channel			
Live-bed scour	--	--	--
Clear-water scour	1.1	3.0	0.6
Depth to armoring	6.2	17.1	4.9
Left overbank	--	--	--
Right overbank	--	--	--
Local scour:			
Abutment scour			
Left abutment	15.8	17.8	14.4
Right abutment	9.4	11.1	8.1
Pier scour			
Pier 1	--	--	--
Pier 2	--	--	--
Pier 3	--	--	--

Riprap Sizing

	100-yr discharge	*500-yr discharge*	*Incipient overtopping discharge*
		(D_{50} in feet)	
Abutments:			
Left abutment	2.3	2.6	2.0
Right abutment	2.3	2.6	2.0
Piers:			
Pier 1	--	--	--
Pier 2	--	--	--

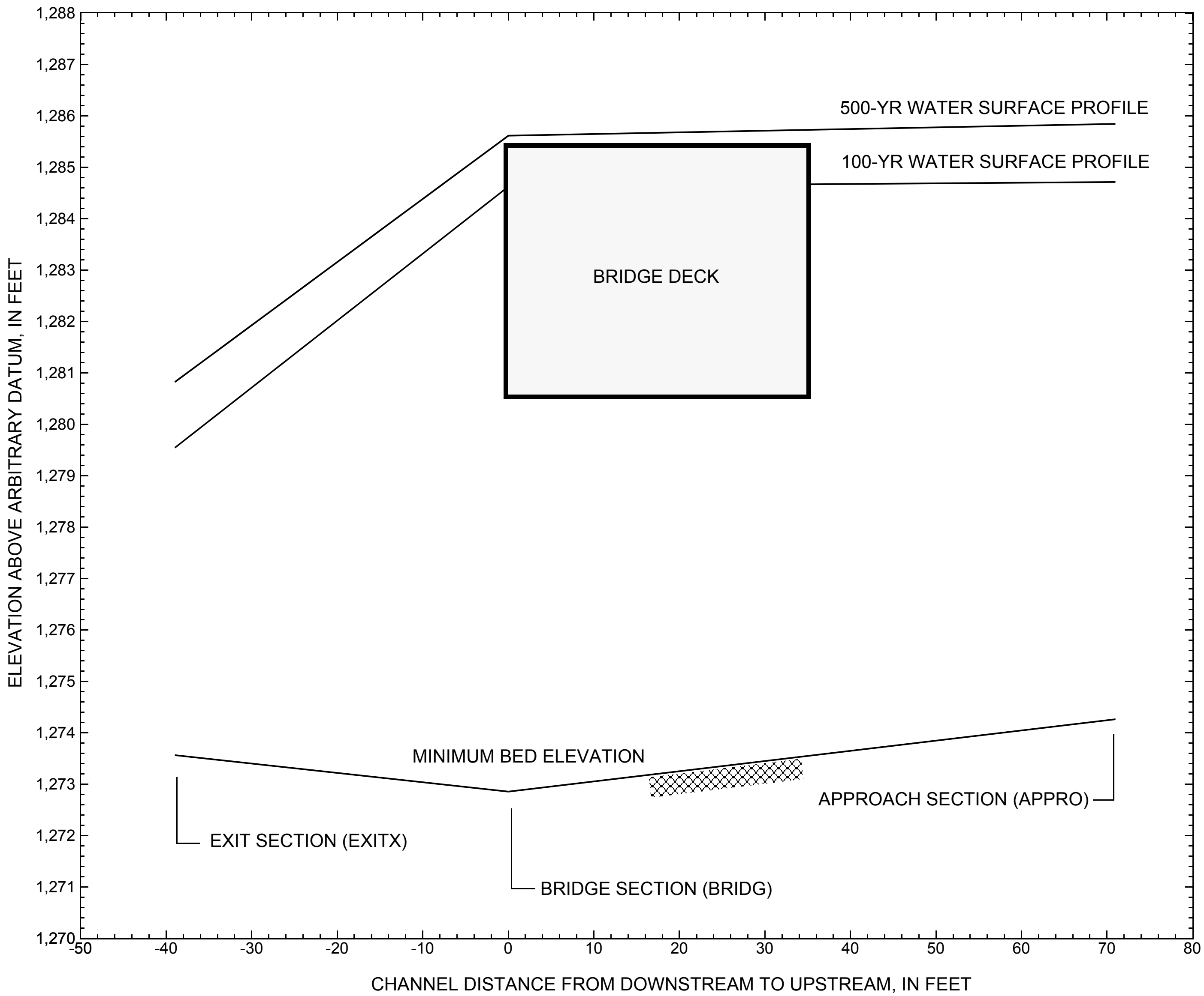

Figure 7. Water-surface profiles for the 100- and 500-yr discharges at structure STAMVT01000008 on Vermont Highway 100, crossing the North Branch of the Hoosic River, Stamford, Vermont.

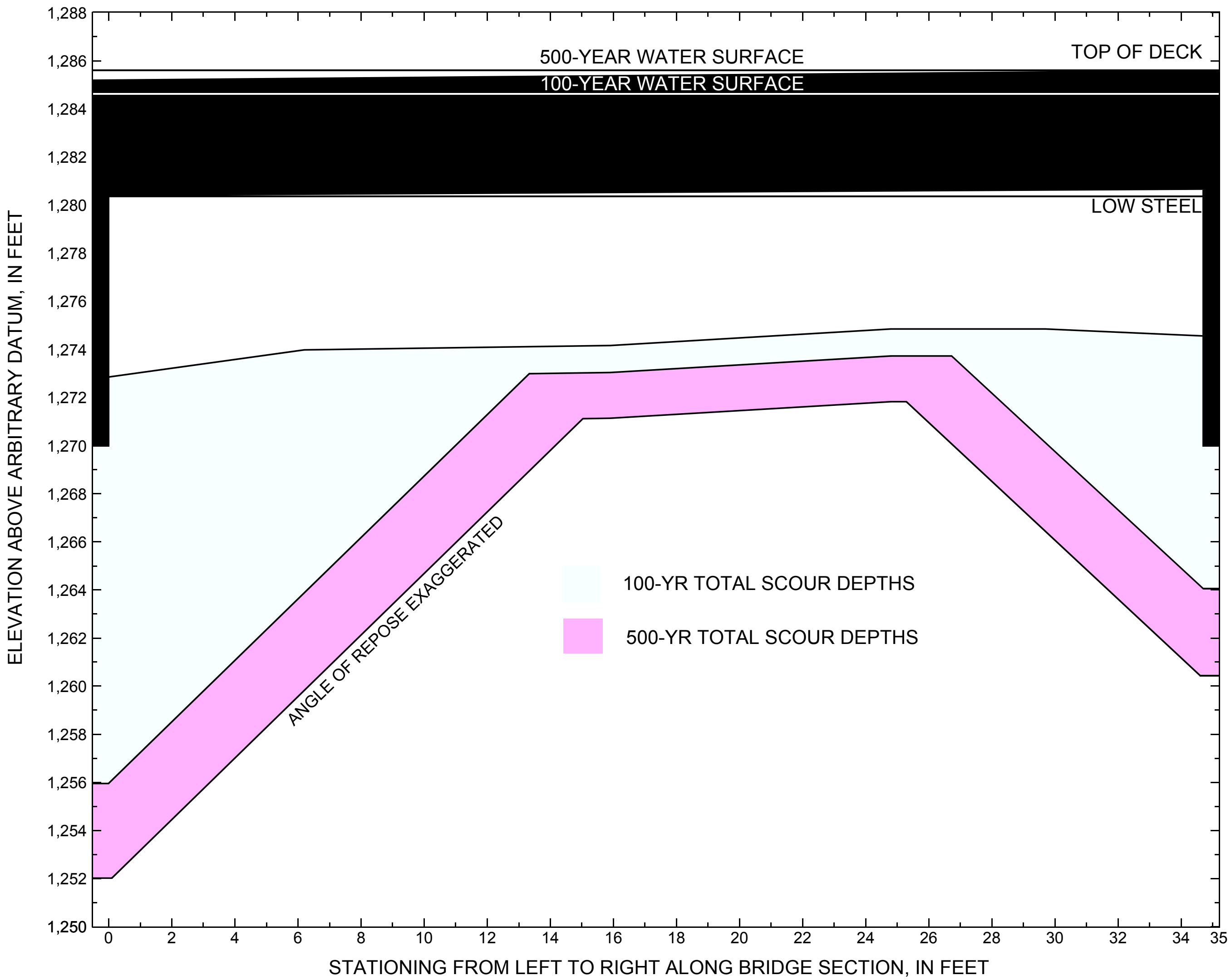

Figure 8. Scour elevations for the 100-yr and 500-yr discharges at structure STAMVT01000008 on Vermont Highway 100, crossing the North Branch of the Hoosic River, Stamford, Vermont.

Table 1. Remaining footing/pile depth at abutments for the 100-year discharge at structure STAMVT01000008 on Vermont Highway 100, crossing the North Branch of the Hoosic River, Stamford, Vermont.
[VTAOT, Vermont Agency of Transportation; --,no data]

Description	Station[1]	VTAOT bridge seat elevation (feet)	Surveyed minimum bridge seat 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 2,470 cubic-feet per second											
Left abutment	0.0	1280.2	1280.1	1270	1272.8	1.1	15.8	--	16.9	1255.9	-14.1
Right abutment	34.7	1280.5	1280.4	1270	1274.6	1.1	9.4	--	10.5	1264.1	-5.9

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 STAMVT01000008 on Vermont Highway 100, crossing the North Branch of the Hoosic River, Stamford, Vermont.
[VTAOT, Vermont Agency of Transportation; --, no data]

Description	Station[1]	VTAOT bridge seat elevation (feet)	Surveyed minimum bridge seat 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 4,120 cubic-feet per second											
Left abutment	0.0	1280.2	1280.1	1270	1272.8	3.0	17.8	--	20.8	1252.0	-18.0
Right abutment	34.7	1280.5	1280.4	1270	1274.6	3.0	11.1	--	14.1	1260.5	-9.5

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, 1954, Stamford, Vermont 7.5 Minute Series quadrangle map: U.S. Geological Survey Topographic Maps, Scale 1:24,000.

APPENDIX A:

WSPRO INPUT FILE

WSPRO INPUT FILE

```
T1        U.S. Geological Survey WSPRO Input File stam008.wsp
T2        Hydraulic analysis for structure STAMVT01000008   Date: 09-JAN-97
T3        Bridge # 8 over North Branch of the Hoosic R. Stamford, VT by MAI
*
J3         6 29 30 552 553 551 5 16 17 13 3 * 15 14 23 21 11 12 4 7 3
*
Q           2470.0   4120.0  2130.0
SK          0.0195   0.0195  0.0195
*
XS   EXITX    -39
GR          -82.2,1284.07    -35.8,1280.99     -8.0,1276.10      0.0,1274.46
GR            5.5,1273.56     14.5,1273.61     22.1,1273.88     30.7,1274.45
GR           32.6,1276.57     78.7,1279.71    125.0,1283.85    146.0,1293.69
N           0.065        0.055
SA                 -35.8
*
XS   FULLV      0  * * *   0.0088
*
*              SRD     LSEL    XSSKEW
BR   BRIDG      0   1280.50      15.0
GR            0.0,1280.37      0.0,1272.85      6.2,1273.98     15.9,1274.16
GR           24.8,1274.85     29.7,1274.85     34.7,1274.56     34.7,1280.63
GR            0.0,1280.37
*         BRTYPE  BRWDTH
CD           1      36.1
N           0.035
*
*              SRD    EMBWID   IPAVE
XR   RDWAY     18      35.0     1
GR         -288.0,1295.47   -240.8,1285.32   -115.8,1284.07    -20.1,1284.11
GR          -19.9,1284.97      0.0,1285.19     34.8,1285.59     54.0,1285.71
GR           54.1,1284.56    219.4,1288.29    253.3,1298.45
*
AS   APPRO     71
GR         -288.0,1295.47   -240.8,1285.32   -230.7,1281.04   -178.5,1280.23
GR           -3.2,1279.90      0.0,1278.50      5.4,1276.99     12.0,1275.11
GR           19.2,1274.72     23.8,1274.28     28.9,1274.26     35.1,1275.19
GR           39.4,1279.96    116.4,1283.25    219.4,1288.29    253.3,1298.45
N           0.041        0.055        0.039
SA                  -3.2         39.4
*
HP 1 BRIDG   1280.63 1 1280.63
HP 2 BRIDG   1280.63 * * 2240
HP 2 RDWAY   1284.62 * * 190
HP 1 APPRO   1284.71 1 1284.71
HP 2 APPRO   1284.71 * * 2470
*
HP 1 BRIDG   1280.63 1 1280.63
HP 2 BRIDG   1280.63 * * 2684
HP 2 RDWAY   1285.61 * * 1432
HP 1 APPRO   1285.87 1 1285.87
HP 2 APPRO   1285.87 * * 4120
*
HP 1 BRIDG   1280.63 1 1280.63
HP 2 BRIDG   1280.63 * * 2130
HP 1 APPRO   1283.87 1 1283.87
HP 2 APPRO   1283.87 * * 2130
```

APPENDIX B:

WSPRO OUTPUT FILE

WSPRO OUTPUT FILE

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        U.S. Geological Survey WSPRO Input File stam008.wsp
        Hydraulic analysis for structure STAMVT01000008   Date: 09-JAN-97
        Bridge # 8 over North Branch of the Hoosic R. Stamford, VT by MAI
           *** RUN DATE & TIME: 02-07-97  13:00
    CROSS-SECTION PROPERTIES:  ISEQ =  3;  SECID = BRIDG;  SRD =       0.

     WSEL  SA#     AREA        K   TOPW   WETP  ALPH    LEW    REW     QCR
             1     209.  16762.     0.    81.                           0.
  1280.63          209.  16762.     0.    81.  1.00     0.    35.      0.

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

         WSEL     LEW     REW    AREA        K        Q    VEL
      1280.63     0.0    34.7   208.9   16762.    2240.  10.72

X STA.         0.0        2.3        3.9        5.4        7.0        8.5
  A(I)            16.4       10.5        9.9        9.9        9.3
  V(I)            6.81      10.65      11.33      11.30      12.10

X STA.         8.5       10.0       11.6       13.0       14.6       16.1
  A(I)             9.6        9.3        9.2        9.4        9.3
  V(I)           11.72      11.98      12.21      11.95      11.99

X STA.        16.1       17.6       19.2       20.9       22.6       24.4
  A(I)             9.3        9.5        9.6        9.9       10.0
  V(I)           12.01      11.84      11.70      11.34      11.24

X STA.        24.4       26.2       28.1       30.0       31.9       34.7
  A(I)            10.0       10.3       10.5       11.1       15.9
  V(I)           11.19      10.84      10.66      10.05       7.02

    VELOCITY DISTRIBUTION:  ISEQ =  4;  SECID = RDWAY;  SRD =      18.

         WSEL     LEW     REW    AREA        K        Q    VEL
      1284.62  -170.8    56.8    66.0     879.     190.   2.88

X STA.      -170.8     -135.0     -124.5     -117.1     -110.9     -105.0
  A(I)             6.4        4.3        3.7        3.4        3.2
  V(I)            1.48       2.20       2.59       2.79       2.92

X STA.      -105.0      -99.2      -93.3      -87.6      -82.0      -76.4
  A(I)             3.2        3.2        3.1        3.0        3.0
  V(I)            3.00       2.98       3.10       3.15       3.16

X STA.       -76.4      -70.7      -65.1      -59.4      -53.7      -48.0
  A(I)             3.0        3.0        3.0        3.0        3.0
  V(I)            3.17       3.18       3.16       3.20       3.15

X STA.       -48.0      -42.2      -36.5      -31.4      -26.3       56.8
  A(I)             3.0        3.0        2.6        2.6        3.3
  V(I)            3.19       3.18       3.62       3.64       2.89

    CROSS-SECTION PROPERTIES:  ISEQ =  5;  SECID = APPRO;  SRD =      71.

     WSEL  SA#     AREA        K   TOPW   WETP  ALPH    LEW    REW     QCR
             1    1043.  101796.   236.   237.                      12436.
             2     376.   41531.    43.    46.                       6332.
             3     261.   18060.   107.   107.                       2313.
  1284.71         1679.  161387.   386.   389.  1.05  -239.   146.  19415.

    VELOCITY DISTRIBUTION:  ISEQ =  5;  SECID = APPRO;  SRD =      71.

         WSEL     LEW     REW    AREA        K        Q    VEL
      1284.71  -239.4   146.2  1679.5  161387.    2470.   1.47

X STA.      -239.4     -208.4     -187.5     -168.7     -150.5     -132.6
  A(I)           101.5       87.4       83.5       82.1       81.6
  V(I)            1.22       1.41       1.48       1.50       1.51

X STA.      -132.6     -114.7      -97.3      -80.1      -63.2      -46.2
  A(I)            82.0       80.3       79.9       79.5       80.0
  V(I)            1.51       1.54       1.55       1.55       1.54

X STA.       -46.2      -29.6      -13.1        3.1       12.2       18.8
  A(I)            78.6       79.1       85.6       76.4       64.7
  V(I)            1.57       1.56       1.44       1.62       1.91

X STA.        18.8       25.3       31.6       44.0       68.1      146.2
  A(I)            65.8       66.1       85.8       97.4      142.3
  V(I)            1.88       1.87       1.44       1.27       0.87
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        U.S. Geological Survey WSPRO Input File stam008.wsp
        Hydraulic analysis for structure STAMVT01000008   Date: 09-JAN-97
        Bridge # 8 over North Branch of the Hoosic R. Stamford, VT by MAI
           *** RUN DATE & TIME: 02-07-97  13:00
    CROSS-SECTION PROPERTIES:  ISEQ =  3;  SECID = BRIDG;  SRD =       0.

     WSEL  SA#     AREA        K   TOPW   WETP  ALPH    LEW    REW     QCR
             1     209.  16762.     0.    81.                            0.
  1280.63          209.  16762.     0.    81.  1.00     0.    35.      0.

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

         WSEL     LEW     REW    AREA        K        Q    VEL
      1280.63     0.0    34.7   208.9   16762.    2684.  12.85

X STA.         0.0        2.3        3.9        5.4        7.0        8.5
  A(I)            16.4       10.5        9.9        9.9        9.3
  V(I)            8.16      12.77      13.57      13.54      14.50

X STA.         8.5       10.0       11.6       13.0       14.6       16.1
  A(I)             9.6        9.3        9.2        9.4        9.3
  V(I)           14.05      14.36      14.63      14.32      14.36

X STA.        16.1       17.6       19.2       20.9       22.6       24.4
  A(I)             9.3        9.5        9.6        9.9       10.0
  V(I)           14.38      14.19      14.02      13.58      13.47

X STA.        24.4       26.2       28.1       30.0       31.9       34.7
  A(I)            10.0       10.3       10.5       11.1       15.9
  V(I)           13.40      12.98      12.77      12.05       8.41

    VELOCITY DISTRIBUTION:  ISEQ =  4;  SECID = RDWAY;  SRD =      18.

         WSEL     LEW     REW    AREA        K        Q    VEL
      1285.61  -242.1   100.6   303.0    7137.    1432.   4.73

X STA.      -242.1     -192.9     -170.9     -155.1     -142.1     -131.2
  A(I)            25.5       19.4       16.8       15.8       14.5
  V(I)            2.80       3.70       4.25       4.54       4.94

X STA.      -131.2     -121.9     -113.1     -104.9      -96.7      -88.5
  A(I)            13.4       13.3       12.7       12.6       12.5
  V(I)            5.35       5.40       5.63       5.71       5.72

X STA.       -88.5      -80.5      -72.4      -64.6      -56.6      -48.7
  A(I)            12.3       12.2       11.9       12.1       12.0
  V(I)            5.84       5.85       6.00       5.92       5.96

X STA.       -48.7      -40.9      -32.6      -23.1       57.0      100.6
  A(I)            11.8       12.5       14.2       26.0       21.4
  V(I)            6.07       5.72       5.04       2.75       3.34

    CROSS-SECTION PROPERTIES:  ISEQ =  5;  SECID = APPRO;  SRD =      71.

     WSEL  SA#     AREA        K   TOPW   WETP  ALPH    LEW    REW     QCR
             1    1319.  148785.   240.   241.                       17536.
             2     425.   51029.    43.    46.                        7621.
             3     399.   32022.   131.   131.                        3952.
  1285.87         2142.  231837.   413.   417.  1.04  -243.   170.  27082.

    VELOCITY DISTRIBUTION:  ISEQ =  5;  SECID = APPRO;  SRD =      71.

         WSEL     LEW     REW    AREA        K        Q    VEL
      1285.87  -243.4   169.9  2142.4  231837.    4120.   1.92

X STA.      -243.4     -210.1     -189.5     -171.0     -153.0     -135.3
  A(I)           130.5      109.6      103.6      101.8      101.0
  V(I)            1.58       1.88       1.99       2.02       2.04

X STA.      -135.3     -118.0     -100.7      -83.7      -66.6      -50.0
  A(I)            99.4       99.6       98.8       99.8       97.2
  V(I)            2.07       2.07       2.08       2.06       2.12

X STA.       -50.0      -33.3      -16.7        0.2       11.5       19.7
  A(I)            98.4       98.9      103.1      101.9       89.5
  V(I)            2.09       2.08       2.00       2.02       2.30

X STA.        19.7       27.2       35.2       54.4       82.3      169.9
  A(I)            86.6       89.8      118.2      130.4      184.3
  V(I)            2.38       2.29       1.74       1.58       1.12
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WSPRO OUTPUT FILE (continued)

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        U.S. Geological Survey WSPRO Input File stam008.wsp
        Hydraulic analysis for structure STAMVT01000008   Date: 09-JAN-97
        Bridge # 8 over North Branch of the Hoosic R. Stamford, VT by MAI
           *** RUN DATE & TIME: 02-07-97  13:00
    CROSS-SECTION PROPERTIES:  ISEQ =  3;  SECID = BRIDG;  SRD =       0.

     WSEL  SA#     AREA        K   TOPW   WETP  ALPH    LEW    REW     QCR
             1     209.   16762.     0.    81.                          0.
  1280.63          209.   16762.     0.    81.  1.00     0.    35.      0.

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

         WSEL     LEW     REW    AREA        K        Q    VEL
      1280.63     0.0    34.7   208.9   16762.    2130.  10.19

X STA.         0.0        2.3        3.9        5.4        7.0        8.5
  A(I)            16.4       10.5        9.9        9.9        9.3
  V(I)            6.48      10.13      10.77      10.75      11.51

X STA.         8.5       10.0       11.6       13.0       14.6       16.1
  A(I)             9.6        9.3        9.2        9.4        9.3
  V(I)           11.15      11.40      11.61      11.37      11.40

X STA.        16.1       17.6       19.2       20.9       22.6       24.4
  A(I)             9.3        9.5        9.6        9.9       10.0
  V(I)           11.42      11.26      11.12      10.78      10.69

X STA.        24.4       26.2       28.1       30.0       31.9       34.7
  A(I)            10.0       10.3       10.5       11.1       15.9
  V(I)           10.64      10.30      10.14       9.56       6.68

    CROSS-SECTION PROPERTIES:  ISEQ =  5;  SECID = APPRO;  SRD =      71.

     WSEL  SA#     AREA        K   TOPW   WETP  ALPH    LEW    REW     QCR
             1     845.   72173.   234.   235.                       9114.
             2     340.   35151.    43.    46.                       5449.
             3     178.   10768.    90.    90.                       1427.
  1283.87         1364.  118092.   366.   370.  1.06  -237.   129.  14480.

    VELOCITY DISTRIBUTION:  ISEQ =  5;  SECID = APPRO;  SRD =      71.

         WSEL     LEW     REW    AREA        K        Q    VEL
      1283.87  -237.4   129.1  1363.6  118092.    2130.   1.56

X STA.      -237.4     -205.8     -183.8     -164.7     -146.2     -127.6
  A(I)            84.7       74.5       69.4       68.1       69.3
  V(I)            1.26       1.43       1.53       1.56       1.54

X STA.      -127.6     -109.5      -91.6      -74.4      -57.3      -40.2
  A(I)            67.9       67.7       66.0       65.8       66.3
  V(I)            1.57       1.57       1.61       1.62       1.61

X STA.       -40.2      -23.5       -6.8        6.8       13.5       19.3
  A(I)            65.4       65.9       72.1       55.0       52.3
  V(I)            1.63       1.62       1.48       1.94       2.04

X STA.        19.3       24.6       29.8       36.3       57.7      129.1
  A(I)            50.0       49.8       57.1       82.1      114.1
  V(I)            2.13       2.14       1.87       1.30       0.93
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        U.S. Geological Survey WSPRO Input File stam008.wsp
        Hydraulic analysis for structure STAMVT01000008   Date: 09-JAN-97
        Bridge # 8 over North Branch of the Hoosic R. Stamford, VT by MAI
           *** RUN DATE & TIME: 02-07-97  13:00

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

EXITX:XS   ******   -28.     315.  0.96 ***** 1280.50 1278.98   2470. 1279.54
      -39. ******    76.   17676.  1.00 ***** *******    0.79    7.85

FULLV:FV      39.   -31.     371.  0.69  0.61 1281.09 *******   2470. 1280.41
        0.    39.    83.   21978.  1.00  0.00   -0.02    0.65    6.66
         <<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>

 ===125 FR# EXCEEDS FNTEST AT SECID "APPRO":  TRIALS CONTINUED.
              FNTEST,FR#,WSEL,CRWS =  0.80    0.86    1281.23    1281.14

 ===110 WSEL NOT FOUND AT SECID "APPRO":  REDUCED DELTAY.
                   WSLIM1,WSLIM2,DELTAY =  1279.91    1298.45    0.50

 ===115 WSEL NOT FOUND AT SECID "APPRO":  USED WSMIN = CRWS.
                   WSLIM1,WSLIM2,CRWS =  1279.91    1298.45    1281.14

APPRO:AS      71.  -231.     476.  0.60  0.73 1281.81 1281.14   2470. 1281.21
       71.    71.    69.   26904.  1.44  0.00   -0.01    0.87    5.18
         <<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>

 ===220 FLOW CLASS 1 (4) SOLUTION INDICATES POSSIBLE PRESSURE FLOW.
           WS3,WSIU,WS1,LSEL =  1279.80    1283.11    1283.26    1280.50

 ===245 ATTEMPTING 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      39.     0.     209.  1.79 ***** 1282.42 1279.46   2240. 1280.63
        0. ******    35.   16762.  1.00 ***** *******    0.77   10.72

     TYPE PPCD FLOW      C    P/A    LSEL   BLEN   XLAB   XRAB
       1. ****    5.  0.500  0.000 1280.50 ****** ****** ******

    XSID:CODE    SRD   FLEN    HF   VHD     EGL     ERR       Q    WSEL
   RDWAY:RG      18.    36.  0.01  0.04 1284.73   -0.02    190. 1284.62

             Q   WLEN    LEW    REW  DMAX  DAVG  VMAX  VAVG  HAVG  CAVG
   LT:    190.   151.  -171.   -20.   0.6   0.4   3.4   2.9   0.5   3.1
   RT:      0.     3.    54.    57.   0.1   0.0   1.7   5.0   0.1   2.9

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

APPRO:AS      35.  -239.    1678.  0.04  0.09 1284.74 1281.14   2470. 1284.71
       71.    45.   146.  161225.  1.05  0.55   -0.02    0.13    1.47

  FIRST USER DEFINED TABLE.

    XSID:CODE    SRD    LEW    REW       Q         K     AREA     VEL    WSEL
   EXITX:XS     -39.   -28.    76.   2470.   17676.     315.    7.85 1279.54
   FULLV:FV       0.   -31.    83.   2470.   21978.     371.    6.66 1280.41
   BRIDG:BR       0.     0.    35.   2240.   16762.     209.   10.72 1280.63
   RDWAY:RG      18.*******   190.    190.*********       0.    1.00 1284.62
   APPRO:AS      71.  -239.   146.   2470.  161225.    1678.    1.47 1284.71

 SECOND USER DEFINED TABLE.

    XSID:CODE    CRWS     FR#    YMIN    YMAX    HF    HO  VHD      EGL    WSEL
   EXITX:XS   1278.98    0.79 1273.56 1293.69************  0.96 1280.50 1279.54
   FULLV:FV  ********    0.65 1273.90 1294.03  0.61  0.00  0.69 1281.09 1280.41
   BRIDG:BR   1279.46    0.77 1272.85 1280.63************  1.79 1282.42 1280.63
   RDWAY:RG  *************** 1284.07 1298.45  0.01******  0.04 1284.73 1284.62
   APPRO:AS   1281.14    0.13 1274.26 1298.45  0.09  0.55  0.04 1284.74 1284.71
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        U.S. Geological Survey WSPRO Input File stam008.wsp
        Hydraulic analysis for structure STAMVT01000008   Date: 09-JAN-97
        Bridge # 8 over North Branch of the Hoosic R. Stamford, VT by MAI
           *** RUN DATE & TIME: 02-07-97  13:00

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

EXITX:XS   ******   -35.     462.  1.24 ***** 1282.06 1280.28   4120. 1280.82
      -39. ******    91.   29492.  1.00 ***** *******    0.82    8.92

FULLV:FV      39.   -42.     541.  0.90  0.61 1282.67 *******   4120. 1281.76
        0.    39.    98.   36776.  1.00  0.00    0.00    0.68    7.61
          <<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>

 ===135 CONVEYANCE RATIO OUTSIDE OF RECOMMENDED LIMITS.
                             "APPRO"     KRATIO =  1.98

APPRO:AS      71.  -235.     986.  0.30  0.45 1283.10 *******   4120. 1282.80
       71.    71.   106.   72945.  1.11  0.00   -0.01    0.46    4.18
          <<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>

 ===255 ATTEMPTING FLOW CLASS 3 (6) SOLUTION.
                        WS3N,LSEL =  1281.76    1280.50

             <<<<<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      39.     0.     209.  2.57 ***** 1283.20 1280.10   2684. 1280.63
        0. ******    35.   16762.  1.00 ***** *******    0.92   12.84

     TYPE PPCD FLOW      C    P/A    LSEL   BLEN   XLAB   XRAB
       1. ****   6.  0.800  0.000 1280.50 ****** ****** ******

    XSID:CODE    SRD   FLEN    HF   VHD     EGL     ERR       Q    WSEL
   RDWAY:RG      18.    36.  0.01  0.06 1285.92    0.00   1432. 1285.61

            Q   WLEN    LEW    REW  DMAX  DAVG  VMAX  VAVG  HAVG  CAVG
   LT:   1306.   258.  -242.    16.   1.5   1.1   5.5   4.7   1.4   3.1
   RT:    126.    69.    16.   101.   1.1   0.4   3.9   4.7   0.7   3.1

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

APPRO:AS      35.  -243.    2142.  0.06  0.16 1285.93 1281.72   4120. 1285.87
       71.    55.   170.  231829.  1.04  0.55    0.00    0.15    1.92

  FIRST USER DEFINED TABLE.

    XSID:CODE    SRD    LEW    REW       Q        K     AREA     VEL    WSEL
   EXITX:XS     -39.   -35.    91.   4120.   29492.     462.    8.92 1280.82
   FULLV:FV       0.   -42.    98.   4120.   36776.     541.    7.61 1281.76
   BRIDG:BR       0.     0.    35.   2684.   16762.     209.   12.84 1280.63
   RDWAY:RG      18.******* 1306.   1432.******************    1.00 1285.61
   APPRO:AS      71.  -243.   170.   4120.  231829.    2142.    1.92 1285.87

 SECOND USER DEFINED TABLE.

    XSID:CODE    CRWS     FR#    YMIN    YMAX    HF    HO  VHD     EGL    WSEL
   EXITX:XS   1280.28    0.82 1273.56 1293.69************  1.24 1282.06 1280.82
   FULLV:FV  ********    0.68 1273.90 1294.03  0.61  0.00  0.90 1282.67 1281.76
   BRIDG:BR   1280.10    0.92 1272.85 1280.63************  2.57 1283.20 1280.63
   RDWAY:RG  **************** 1284.07 1298.45  0.01******  0.06 1285.92 1285.61
   APPRO:AS   1281.72    0.15 1274.26 1298.45  0.16  0.55  0.06 1285.93 1285.87
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        U.S. Geological Survey WSPRO Input File stam008.wsp
        Hydraulic analysis for structure STAMVT01000008   Date: 09-JAN-97
        Bridge # 8 over North Branch of the Hoosic R. Stamford, VT by MAI
           *** RUN DATE & TIME: 02-07-97  13:00

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

EXITX:XS   ******   -26.     280.  0.90 ***** 1280.10 1278.64   2130. 1279.20
      -39. ******    71.   15242.  1.00 ***** *******    0.79    7.61

FULLV:FV      39.   -29.     334.  0.63  0.61 1280.70 *******   2130. 1280.07
        0.    39.    79.   19107.  1.00  0.00    0.00    0.64    6.37
         <<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>

 ===125 FR# EXCEEDS FNTEST AT SECID "APPRO":  TRIALS CONTINUED.
              FNTEST,FR#,WSEL,CRWS =  0.80    1.10    1280.84    1280.96

 ===110 WSEL NOT FOUND AT SECID "APPRO":  REDUCED DELTAY.
                   WSLIM1,WSLIM2,DELTAY =  1279.57    1298.45    0.50

 ===115 WSEL NOT FOUND AT SECID "APPRO":  USED WSMIN = CRWS.
                   WSLIM1,WSLIM2,CRWS =  1279.57    1298.45    1280.96

 ===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 "APPRO"
                   WSBEG,WSEND,CRWS =  1280.96    1298.45    1280.96

APPRO:AS      71.  -225.     401.  0.66 ***** 1281.62 1280.96   2130. 1280.96
       71.    71.    63.   22106.  1.51 ***** *******    0.98    5.31
         <<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>

 ===220 FLOW CLASS 1 (4) SOLUTION INDICATES POSSIBLE PRESSURE FLOW.
           WS3,WSIU,WS1,LSEL =  1279.27    1282.22    1282.41    1280.50

 ===245 ATTEMPTING 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      39.     0.     209.  1.56 ***** 1282.19 1279.21   2089. 1280.63
        0. ******    35.   16762.  1.00 ***** *******    0.72   10.00

     TYPE PPCD FLOW      C    P/A    LSEL   BLEN   XLAB   XRAB
       1. ****   2.  0.496  0.000 1280.50 ****** ****** ******

    XSID:CODE    SRD   FLEN    HF   VHD     EGL      ERR       Q    WSEL
   RDWAY:RG      18.        <<<<<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      35.  -237.    1362.  0.04  0.10 1283.91 1280.96   2130. 1283.87
       71.    43.   129.  117889.  1.06  0.55   -0.02    0.15    1.56

  FIRST USER DEFINED TABLE.

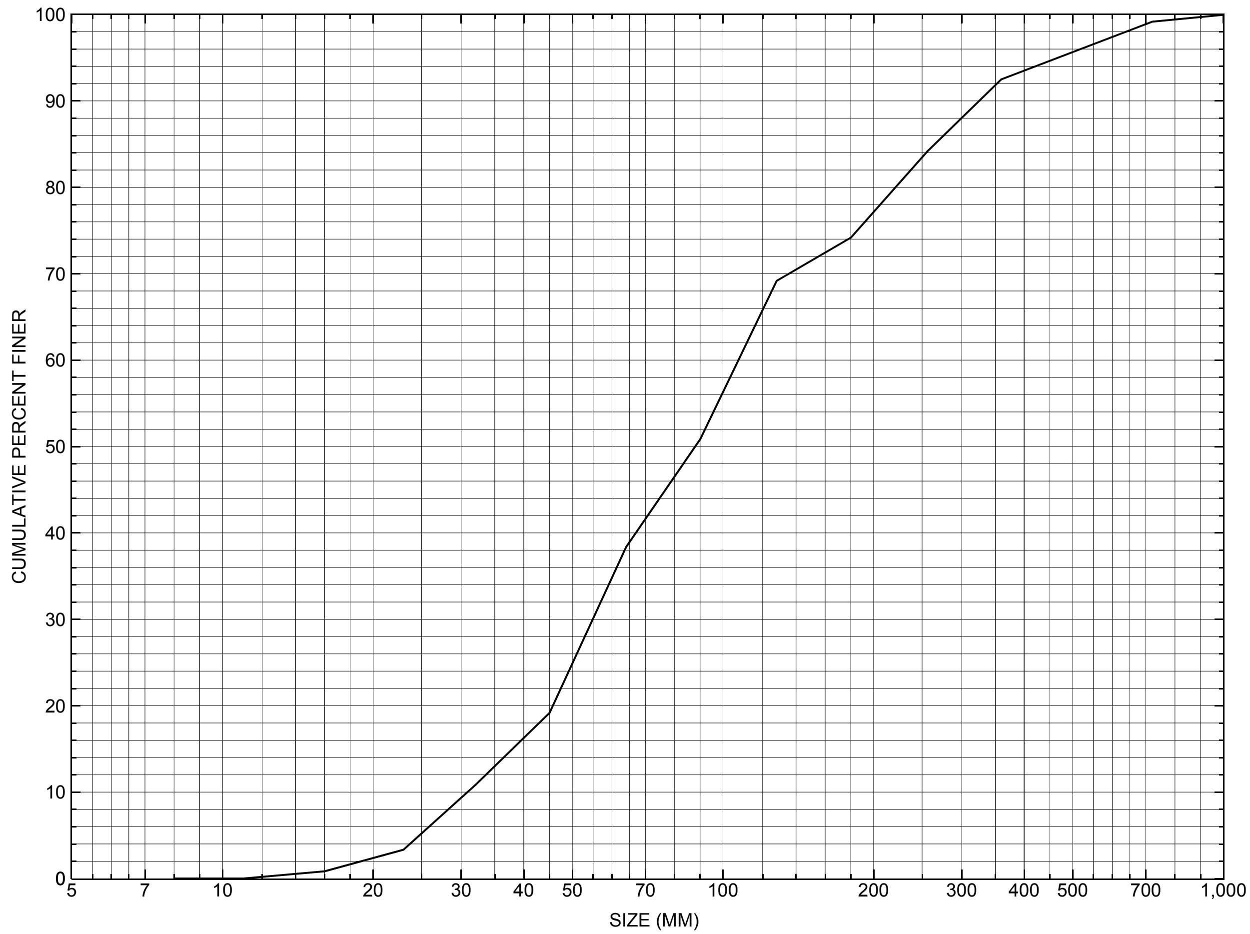
    XSID:CODE    SRD    LEW    REW       Q        K     AREA     VEL    WSEL
   EXITX:XS     -39.   -26.    71.   2130.   15242.     280.    7.61 1279.20
   FULLV:FV       0.   -29.    79.   2130.   19107.     334.    6.37 1280.07
   BRIDG:BR       0.     0.    35.   2089.   16762.     209.   10.00 1280.63
   RDWAY:RG      18.**************      0.*****************     1.00********
   APPRO:AS      71.  -237.   129.   2130.  117889.    1362.    1.56 1283.87

 SECOND USER DEFINED TABLE.

    XSID:CODE    CRWS     FR#    YMIN    YMAX    HF    HO  VHD      EGL    WSEL
   EXITX:XS   1278.64    0.79 1273.56 1293.69************  0.90 1280.10 1279.20
   FULLV:FV  ********    0.64 1273.90 1294.03  0.61  0.00  0.63 1280.70 1280.07
   BRIDG:BR   1279.21    0.72 1272.85 1280.63************  1.56 1282.19 1280.63
   RDWAY:RG  *************** 1284.07 1298.45************  0.02 1285.01********
   APPRO:AS   1280.96    0.15 1274.26 1298.45  0.10  0.55  0.04 1283.91 1283.87
```

APPENDIX C:

BED-MATERIAL PARTICAL-SIZE DISTRIBUTION



Appendix C. Bed material particle-size distribution for a pebble count in the channel approach of structure STAMVT01000008, in Stamford, Vermont.

APPENDIX D:

HISTORICAL DATA FORM

United States Geological Survey
Bridge Historical Data Collection and Processing Form

Structure Number STAMVT01000008

General Location Descriptive

Data collected by *(First Initial, Full last name)* L. Medalie

Date *(MM/DD/YY)* 11 / 01 / 95

Highway District Number *(I - 2; nn)* 01

County *(FIPS county code; I - 3; nnn)* 003

Town *(FIPS place code; I - 4; nnnnn)* 69775

Mile marker *(I - 11; nnn.nnn)* 003520

Waterway *(I - 6)* NO. BR. HOOSIC RIVER

Road Name *(I - 7)*: -

Route Number VT 100

Vicinity *(I - 9)* 3.6 MI N MA STATE LINE

Topographic Map Stamford

Hydrologic Unit Code: -

Latitude *(I - 16; nnnn.n)* 42469

Longitude *(i - 17; nnnnn.n)* 73026

Select Federal Inventory Codes

FHWA Structure Number *(I - 8)* 20010200080214

Maintenance responsibility *(I - 21; nn)* 01

Maximum span length *(I - 48; nnnn)* 0037

Year built *(I - 27; YYYY)* 1963

Structure length *(I - 49; nnnnnn)* 000039

Average daily traffic, ADT *(I - 29; nnnnnn)* 001225

Deck Width *(I - 52; nn.n)* 350

Year of ADT *(I - 30; YY)* 92

Channel & Protection *(I - 61; n)* 6

Opening skew to Roadway *(I - 34; nn)* 15

Waterway adequacy *(I - 71; n)* 3

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

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

Structure type *(I - 43; nnn)* 302

Year Reconstructed *(I - 106)* 0000

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

Clear span (*nnn.n ft*) 33.7

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

Vertical clearance from streambed (*nnn.n ft*) 6

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

Waterway of full opening (*nnn.n ft*^{2}) 202

Comments:

Clear span of 28 ft and vertical clearance of 7 ft, are from the hydraulics report. According to the structural inspection report dated 8/24/93, structure is a single span rolled beam bridge. The channel takes a moderate turn into the structure and is straight leaving it. Flow is currently along the downstream side of left abutment and along the right abutment. There is some minor scour at the downstream end of left abutment and along the right abutment but no undermining. Some minor stream bank erosion, US and DS, is noted. Bridge seat at the right abutment has considerable debris, particularly along facia lines. Heavy cracks and scaling under weep holes at right abutment. General scour noted at mid-channel.

Bridge Hydrologic Data

Is there hydrologic data available? __Y__ *if No, type ctrl-n h* VTAOT Drainage area (*mi²*): __6.7__

Terrain character: __Mostly forested and mountainous__

Stream character & type:

Streambed material: ____

Discharge Data (*cfs*): $Q_{2.33}$ __700__ Q_{10} __1200__ Q_{25} __1700__

Q_{50} __2100__ Q_{100} __2450__ 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*): __.7__%

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*)	4	5.8	7.5	9	10.5
Velocity (*ft / sec*)					

Long term stream bed changes:

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

Relief Elevation (*ft*): ____ Discharge over roadway at Q_{100} (*ft³/ sec*): ____

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

Upstream distance (*miles*): ____ Town: __Stamford__ Year Built: ____

Highway No. : __VT100__ Structure No. : __9__ Structure Type: ____

Clear span (*ft*): ____ Clear Height (*ft*): ____ Full Waterway (*ft²*): ____

Downstream distance (*miles*): ___________ Town: **Stamford** Year Built: ______

Highway No. : **VT100** Structure No. : **6** Structure Type: ______________________

Clear span (*ft*): _____ Clear Height (*ft*): ______ Full Waterway (ft^2): _______

Comments:

Hydraulic summary states that it appears that the existing 33.7 ft x 6 ft bridge is inadequate vertically. It was noted that raising the bottom of beams 2 ft would yield a clearance at Q 50 (design flow) of 0.5 ft.

USGS Watershed Data

Watershed Hydrographic Data

Drainage area *(DA)* **6.79** mi^2 Lake and pond area **0.035** mi^2

Watershed storage *(ST)* **0.5** %

Bridge site elevation **1320** ft Headwater elevation **2970** ft

Main channel length **3.16** mi

10% channel length elevation **1320** ft 85% channel length elevation **2240** ft

Main channel slope *(S)* **388.2** 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? Y *If no, type ctrl-n pl* Date issued for construction *(MM / YYYY):* ___ / ______

Project Number ________________________ Minimum channel bed elevation: 1274

Low superstructure elevation: USLAB 1280.24 DSLAB 1280.18 USRAB 1280.56 DSRAB 1280.50

Benchmark location description:

BM #23, chiseled square on south west concrete wingwall, elevation 1283.62 ft (this is on a bridge approximately 80 ft to the southeast of bridge 8).
Disc on new bridge, upstream left corner, elev. 1287.86 ft.

Reference Point (*MSL, Arbitrary, Other*): Unknown Datum (*NAD27, NAD83, Other*): -

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

If 1: Footing Thickness 2 Footing bottom elevation: 1270

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? Y *If no, type ctrl-n bi* Number of borings taken: 5

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

Briefly describe material at foundation bottom elevation or around piles:

Boulders and roots at left abutment
Roots, sand and gravel at right abutment

Comments:

The low superstructure elevations are the bridge seat elevations from the bridge plans.

Cross-sectional Data

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

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

Comments: **The station and elevation measurements are in feet.**

Station	419	443	454	-	-	-	-	-	-	-	-
Feature	LAB	-	RAB	-	-	-	-	-	-	-	-
Low cord elevation	1279.7	1279.9	1280.1	-	-	-	-	-	-	-	-
Bed elevation	1273.7	1271.5	1273.6	-	-	-	-	-	-	-	-
Low cord to bed length	6	8.4	6.5	-	-	-	-	-	-	-	-

Station	-	-	-	-	-	-	-	-	-	-	-
Feature	-	-	-	-	-	-	-	-	-	-	-
Low cord elevation	-	-	-	-	-	-	-	-	-	-	-
Bed elevation	-	-	-	-	-	-	-	-	-	-	-
Low cord to bed length	-	-	-	-	-	-	-	-	-	-	-

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

Comments: **Orientation of the cross sections is inconsistent with any cross section data surveyed for this study and is not comparable. Data was not retrieved.**

Station	-	-	-	-	-	-	-	-	-	-	-
Feature	-	-	-	-	-	-	-	-	-	-	-
Low cord elevation	-	-	-	-	-	-	-	-	-	-	-
Bed elevation	-	-	-	-	-	-	-	-	-	-	-
Low cord to bed length	-	-	-	-	-	-	-	-	-	-	-

Station	-	-	-	-	-	-	-	-	-	-	-
Feature	-	-	-	-	-	-	-	-	-	-	-
Low cord elevation	-	-	-	-	-	-	-	-	-	-	-
Bed elevation	-	-	-	-	-	-	-	-	-	-	-
Low cord to bed length	-	-	-	-	-	-	-	-	-	-	-

APPENDIX E:

LEVEL I DATA FORM

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

Qa/Qc Check by: **RB** Date: **10/09/96**

Computerized by: **RB** Date: **10/11/96**

Reviewd by: **MAI** Date: **02/14/97**

Structure Number **STAMVT01000008**

A. General Location Descriptive

1. Data collected by *(First Initial, Full last name)* **M. IVANOFF** Date *(MM/DD/YY)* **08** / **01** / 19**96**

2. Highway District Number **01** Mile marker **003520**

County **BENNINGTON 003** Town **STAMFORD 69775**

Waterway *(I - 6)* **N. BRANCH HOOSIC RIVER** Road Name **VT 100**

Route Number **VT 100** Hydrologic Unit Code: **-**

3. Descriptive comments:

Located 3.6 miles north of the Massachusetts state line. There is a 2 ft. wide by 1 ft. high culvert along the left road approach draining the sand and gravel yard. The culvert is 15 ft. below the road surface.

B. Bridge Deck Observations

4. Surface cover... LBUS **2** RBUS **5** LBDS **6** RBDS **6** Overall **6**
*(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 **2** 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 **39** *(feet)* Span length **37** *(feet)* Bridge width **35** *(feet)*

Road approach to bridge:

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

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

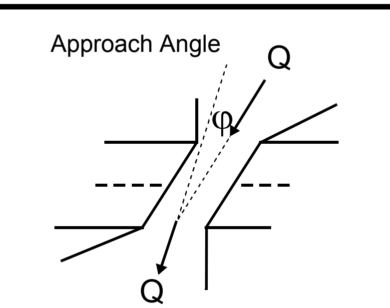
10. Embankment slope (*run / rise in feet / foot*):
US left **0.0:1** US right **0.0:1**

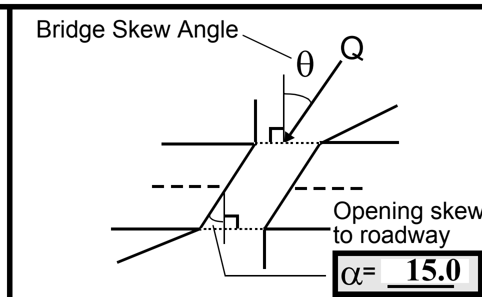
	Protection		13.Erosion	14.Severity
	11.Type	12.Cond.		
LBUS	0	-	0	-
RBUS	0	-	2	3
RBDS	0	-	0	-
LBDS	0	-	0	-

*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: **5** 16. Bridge skew: **20**





17. Channel impact zone 1: Exist? **Y** *(Y or N)*

Where? **RB** *(LB, RB)* Severity **2**

Range? **58** feet **US** *(US, UB, DS)* to **10** feet **UB**

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**

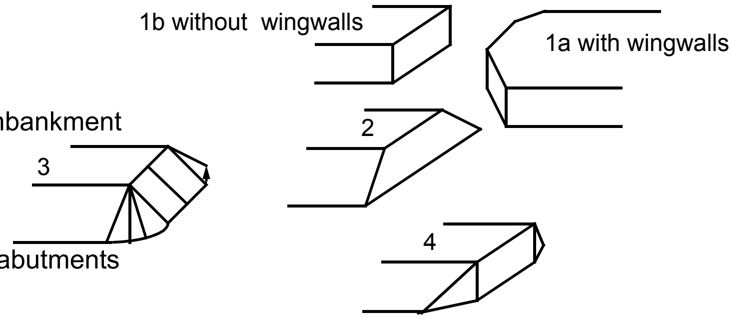
1a- Vertical abutments with wingwalls

1b- Vertical abutments without wingwalls

2- Vertical abutments and wingwalls, sloping embankment
Wingwalls perpendicular 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 US right bank has trees and brush along the bank with cut grass, some trees and a few houses on the overbank. The US left bank is the District 1 maintenance building and gravel and sand lot. There is some brush along the channel and on the bank behind the building. The DS banks are forested.

7. Values are from the VTAOT files. Measured values are the same.

14. The right bank US pavement is being undermined under the roadway shoulder.

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
36.5	**2.0**			**5.0**	**1**	**4**	**43**	**43**	**1**	**1**

23. Bank width **15.0** 24. Channel width **45.0** 25. Thalweg depth **34.0** 29. Bed Material **345**

30 .Bank protection type: LB **0** RB **0** 31. 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*

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

29. The bed material is gravel, cobble and some boulders.
From 180 ft. to 238 ft. US there is an old bridge abutment on the left bank. There is 3 ft. of water flowing along its base length from the US left wingwall to the DS left wingwall. The average thalweg is 0.5 ft.

33. Point/Side bar present? **Y** (Y or N. if N type ctrl-n pb) 34. Mid-bar distance: **54** 35. Mid-bar width: **15**

36. Point bar extent: **89** feet **US** (US, UB) to **0** feet **DS** (US, UB, DS) positioned **0** %LB to **50** %RB

37. Material: **34**

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

This is a gravel and cobble side bar with some interstitial sand. An additional point bar exists from 180 ft. to 340 ft. US along the right bank. Mid-bar is at 300 ft. with a width of 30 ft. It is composed of cobble and gravel and is positioned from 40% LB to 100% RB.

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

41. Mid-bank distance: **57** 42. Cut bank extent: **0** feet **US** (US, UB) to **103** 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.):

-

45. Is channel scour present? **Y** (Y or if N type ctrl-n cs) 46. Mid-scour distance: **0**

47. Scour dimensions: Length **18** Width **8** Depth : **2.5** Position **80** %LB to **100** %RB

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

Average thalweg depth is 0.5 ft. Scour begins along the US end of the right abutment to 8 ft. under the bridge. The stream has meandered at the bridge face and is impacting the upstream end of the right abutment. Another scour hole is found at the base of the right bank cut bank. It is 20 ft. long, 5 ft. wide and 1.5 ft. deep. It is positioned from 90% LB to 100% RB.

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):

A small perennial stream enters the left bank 270 ft upstream.

D. Under Bridge Channel Assessment

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

56. Height (BF) LB	56. Height (BF) RB	57 Angle (BF) LB	57 Angle (BF) RB	61. Material (BF) LB	61. Material (BF) RB	62. Erosion (BF) LB	62. Erosion (BF) RB
23.0		**1.0**		**2**	**7**	**7**	**0**

58. Bank width (BF) **-** 59. Channel width (Amb) **-** 60. Thalweg depth (Amb) **90.0** 63. Bed Material **0**

*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.):

345

63. Bed material consists of gravel, cobble and some boulders.

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

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

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

70. Debris and Ice Comments:

1

Trees are leaning into the channel US with some debris along the banks. The channel makes a moderate turn into the structure.

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**	**15**	**90**			**2**	**2**	**33.5**

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.):

2.5

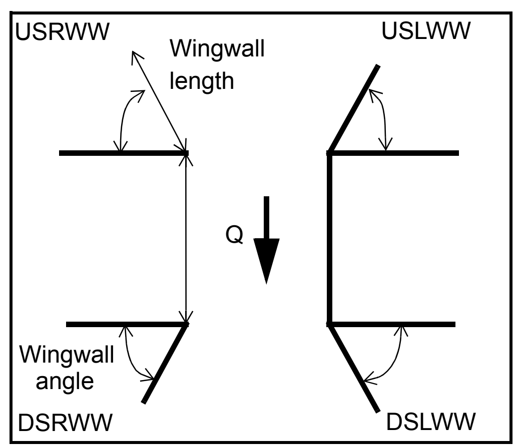
0.1

1

The right abutment US end is impacted by stream flow with the surface of the footing exposed. Flow is from the US end of the right abutment to the DS end of the left abutment. There is also a side bar along the left abutment that begins US. The side bar consist of sand and small gravel similar to the material on the upstream left flood plain (District 1 maintenance lot).

80. **Wingwalls**:

	Exist?	Material?	Scour Condition?	Scour depth?	Exposure depth?	81. Angle?	Length?
USLWW:						**33.5**	
USRWW:	**N**		**-**		**-**	**0.5**	
DSLWW:	**-**		**-**		**N**	**36.0**	
DSRWW:	**-**		**-**		**-**	**36.0**	



*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**	**-**	**-**	**-**	**-**	**-**	**3**	**3**
Extent	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**-**

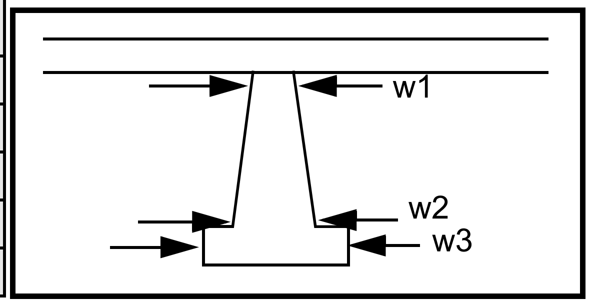
*Bank / Bridge protection types: **0**- absent; **1**- < 12 inches; **2**- < 36 inches; **3**- < 48 inches; **4**- < 60 inches; **5**- wall / artificial levee*
*Bank / Bridge protection conditions: **1**- good; **2**- slumped; **3**- eroded; **4**- failed*
*Protection extent: **1**- entire base length; **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? __Pr__ *(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)	otec-	side	abut	alon	*LFP, LTB, LB, MCL, MCM, MCR, RB, RTB, RFP*
87. Type	tion	walls	ment	g the	***1**- Solid pier, **2**- column, **3**- bent*
88. Material	men-	neatl	) and	bank	***1**- Wood; **2**- concrete; **3**- metal; **4**- stone*
89. Shape	tione	y	exte	.	***1**- Round; **2**- Square; **3**- Pointed*
90. Inclined?	d for	place	ndin		*Y- yes; N- no*
91. Attack ∠ (BF)	both	d	g to		
92. Pushed	abut	(like	the		*LB or RB*
93. Length (feet)	-	-	-	-	
94. # of piles	ment	a	edge		
95. Cross-members	s is	spill	of		***0**- none; **1**- laterals; **2**- diagonals; **3**- both*
96. Scour Condition	alon	thro	the		***0**- not evident; **1**- evident (comment); **2**- footing exposed; **3**- piling exposed; **4**- undermined footing; **5**- settled; **6**- failed*
97. Scour depth	g the	ugh	wate		
98. Exposure depth	DS	type	r		

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

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 (Amb) -   Thalweg depth (Amb) -   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.):
-
-
-
-
-
-
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-
-
-
-
-
-

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 NO (US, UB, DS) positioned PI %LB to ER %RB

Material: S

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

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 4 feet 4 (US, UB, DS)

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

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

43
1
1
345

Is channel scour present? 3 (Y or if N type ctrl-n cs) Mid-scour distance: 3

Scour dimensions: Length 1 Width 1 Depth: The Positioned ban %LB to k %RB

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

material consists of cobble and gravel. The bed material is gravel, cobble and boulders. The left bank protection extends from 13 ft. DS to the DS bridge face. The right bank protection extends from 0 ft. DS to 10 ft. DS. The bank protection also acts as abutment protection.

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

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

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

Confluence comments (eg. confluence name):

F. Geomorphic Channel Assessment

107. Stage of reach evolution _____

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)*:

N

-

NO DROP STRUCTURE

Y

12

13

2

UB

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: STAMVT01000008 Town: Stamford
Road Number: VT 100 County: Bennington
Stream: North Branch Hoosic River

Initials MAI Date: 02/07/97 Checked: RHF

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	2470	4120	2130
Main Channel Area, ft2	376	425	340
Left overbank area, ft2	1043	1319	845
Right overbank area, ft2	261	399	178
Top width main channel, ft	43	43	43
Top width L overbank, ft	236	240	234
Top width R overbank, ft	107	131	90
D50 of channel, ft	0.289	0.289	0.289
D50 left overbank, ft	--	--	--
D50 right overbank, ft	--	--	--
y1, average depth, MC, ft	8.7	9.9	7.9
y1, average depth, LOB, ft	4.4	5.5	3.6
y1, average depth, ROB, ft	2.4	3.0	2.0
Total conveyance, approach	161387	231837	118092
Conveyance, main channel	41531	51029	35151
Conveyance, LOB	101796	148785	72173
Conveyance, ROB	18060	32022	10768
Percent discrepancy, conveyance	0.0000	0.0004	0.0000
Qm, discharge, MC, cfs	635.6	906.8	634.0
Ql, discharge, LOB, cfs	1558.0	2644.1	1301.8
Qr, discharge, ROB, cfs	276.4	569.1	194.2
Vm, mean velocity MC, ft/s	1.7	2.1	1.9
Vl, mean velocity, LOB, ft/s	1.5	2.0	1.5
Vr, mean velocity, ROB, ft/s	1.1	1.4	1.1
Vc-m, crit. velocity, MC, ft/s	10.6	10.9	10.5
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

ARMORING

D90	1.066	1.066	1.066
D95	1.538	1.538	1.538
Critical grain size,Dc, ft	0.6363	0.9136	0.5754
Decimal-percent coarser than Dc	0.237	0.138	0.262
Depth to armoring,ft	6.15	17.12	4.86

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)

Approach Section	Q100	Q500	Qother
Main channel Area, ft2	376	425	340
Main channel width, ft	43	43	43
y1, main channel depth, ft	8.74	9.88	7.91
Bridge Section			
(Q) total discharge, cfs	2470	4120	2130
(Q) discharge thru bridge, cfs	2240	2684	2130
Main channel conveyance	16762	16762	16762
Total conveyance	16762	16762	16762
Q2, bridge MC discharge,cfs	2240	2684	2130
Main channel area, ft2	209	209	209
Main channel width (skewed), ft	33.5	33.5	33.5
Cum. width of piers in MC, ft	0.0	0.0	0.0
W, adjusted width, ft	33.5	33.5	33.5
y_bridge (avg. depth at br.), ft	6.24	6.24	6.24
Dm, median (1.25*D50), ft	0.361	0.361	0.361
y2, depth in contraction,ft	6.07	7.09	5.82
ys, scour depth (y2-ybridge), ft	-0.16	0.86	-0.42

Pressure Flow Scour (contraction scour for orifice flow conditions)

Hb+Ys=Cq*qbr/Vc   Cq=1/Cf*Cc   Cf=1.5*Fr^0.43 (<=1)
Chang Equation   Cc=SQRT[0.10(Hb/(ya-w)-0.56)]+0.79 (<=1)
(Richarson and others, 1995, p. 145-146)

	Q100	Q500	OtherQ
Q, total, cfs	2470	4120	2130
Q, thru bridge, cfs	2240	2684	2130
Total Conveyance, bridge	16762	16762	16762
Main channel(MC) conveyance, bridge	16762	16762	16762
Q, thru bridge MC, cfs	2240	2684	2130
Vc, critical velocity, ft/s	10.64	10.86	10.46
Vc, critical velocity, m/s	3.24	3.31	3.19
Main channel width (skewed), ft	33.5	33.5	33.5
Cum. width of piers in MC, ft	0.0	0.0	0.0
W, adjusted width, ft	33.5	33.5	33.5
qbr, unit discharge, ft2/s	66.9	80.1	63.6
qbr, unit discharge, m2/s	6.2	7.4	5.9
Area of full opening, ft2	208.9	208.9	208.9
Hb, depth of full opening, ft	6.24	6.24	6.24
Hb, depth of full opening, m	1.90	1.90	1.90
Fr, Froude number, bridge MC	0.77	0.92	0.72

Cf, Fr correction factor (<=1.0)	1.00	1.00	1.00
Elevation of Low Steel, ft	1280.5	1280.5	1280.5
Elevation of Bed, ft	1274.26	1274.26	1274.26
Elevation of Approach, ft	1284.71	1285.87	1283.87
Friction loss, approach, ft	0.09	0.16	0.1
Elevation of WS immediately US, ft	1284.62	1285.71	1283.77
ya, depth immediately US, ft	10.36	11.45	9.51
ya, depth immediately US, m	3.16	3.49	2.90
Mean elevation of deck, ft	1285.39	1285.39	1285.39
w, depth of overflow, ft (>=0)	0.00	0.32	0.00
Cc, vert contrac correction (<=1.0)	0.85	0.80	0.89
Ys, depth of scour, ft	1.12	3.02	0.61

Comparison of Chang and Laursen results (for unsubmerged orifice flow)

y2, from Laursen's equation, ft	6.07	7.09	5.82
Full valley WSEL, ft	1280.41	0	1280.07
Full valley depth, ft	6.14	0	5.80
Ys, depth of scour (y2-yfullv), ft	-0.0730	N/A	0.01058

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	2470	4120	2130	2470	4120	2130
a', abut.length blocking flow, ft	240	244	238	112.1	135.8	95
Ae, area of blocked flow ft2	1004.1	1082.1	870.2	307.3	416.4	215.5
Qe, discharge blocked abut.,cfs	--	--	1336	--	--	249
(If using Qtotal_overbank to obtain Ve, leave Qe blank and enter Ve and Fr manually)						
Ve, (Qe/Ae), ft/s	1.49	2.00	1.54	1.12	1.45	1.16
ya, depth of f/p flow, ft	4.18	4.43	3.66	2.74	3.07	2.27
--Coeff., K1, for abut. type (1.0, verti.; 0.82, verti. w/ wingwall; 0.55, spillthru)						
K1	1	1	1	1	1	1
--Angle (theta) of embankment (<90 if abut. points DS; >90 if abut. points US)						
theta	105	105	105	75	75	75
K2	1.02	1.02	1.02	0.98	0.98	0.98
Fr, froude number f/p flow	0.124	0.150	0.141	0.119	0.141	0.135
ys, scour depth, ft	19.65	22.52	19.13	10.93	13.57	9.66

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)	240	244	238	112.1	135.8	95
y1 (depth f/p flow, ft)	4.18	4.43	3.66	2.74	3.07	2.27
a'/y1	57.36	55.02	65.09	40.89	44.29	41.88
Skew correction (p. 49, fig. 16)	1.03	1.03	1.03	0.95	0.95	0.95
Froude no. f/p flow	0.12	0.15	0.14	0.12	0.14	0.14
Ys w/ corr. factor K1/0.55:						
vertical	15.78	17.81	14.41	9.39	11.10	8.10
vertical w/ ww's	12.94	14.61	11.81	7.70	9.10	6.64
spill-through	8.68	9.80	7.92	5.16	6.10	4.45

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	Qother	Q100	Q500	Qother
Fr, Froude Number	0.77	0.92	0.72	0.77	0.92	0.72
(Fr from the characteristic V and y in contracted section--mc, bridge section)						
y, depth of flow in bridge, ft	6.24	6.24	6.24	6.24	6.24	6.24
Median Stone Diameter for riprap at:	left abutment			right abutment, ft		
Fr<=0.8 (vertical abut.)	2.29	ERR	2.00	2.29	ERR	2.00
fr>0.8 (vertical abut.)	ERR	2.55	ERR	ERR	2.55	ERR