LEVEL II SCOUR ANALYSIS FOR BRIDGE 6 (STAMVT01000006) on VERMONT HIGHWAY 100, crossing the NORTH BRANCH OF THE HOOSIC RIVER, STAMFORD, VERMONT

U.S. Geological Survey
Open-File Report 97-216

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

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By ROBERT H. FLYNN

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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 6 (STAMVT01000006) ON VERMONT HIGHWAY 100, CROSSING THE NORTH BRANCH OF THE HOOSIC RIVER, STAMFORD, VERMONT

By **Robert H. Flynn**

INTRODUCTION AND SUMMARY OF RESULTS

This report provides the results of a detailed Level II analysis of scour potential at structure STAMVT01000006 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 8.61-mi^2 drainage area is in a predominantly rural and forested basin. In the vicinity of the study site, the surface cover is grass with forest along the immediate banks throughout the reach.

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 44 ft and an average bank height of 4 ft. The channel bed material ranges from sand to boulder with a median grain size (D_{50}) of 97.4 mm (0.320 ft). The geomorphic assessment at the time of the Level I and Level II site visit on July 31, 1996, indicated that the reach was stable.

The Vermont Highway 100 crossing of the North Branch of the Hoosic River is a 99-ft-long, two-lane bridge consisting of one 97-foot steel-beam span (Vermont Agency of Transportation, written communication, September 28, 1995). The bridge is supported by vertical, concrete abutments with wingwalls. The channel is skewed approximately 60 degrees to the opening and the opening-skew-to-roadway is also 60 degrees.

The scour protection measures at the site included type-1 stone fill (less than 12 inches diameter) along the downstream left bank. Type-2 (less than 36 inches diameter) stone fill was found along the upstream left bank and the downsteam right bank. 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 0.7 to 2.1 ft. The worst-case contraction scour occurred at the 500-year discharge. Abutment scour ranged from 18.8 to 19.7 ft along the right abutment and from 2.8 to 6.8 ft along the left abutment. The worst-case abutment scour occurred at the 500-year discharge. Additional information on scour depths and depths to armoring are included in the section titled “Scour Results”. Scoured-streambed elevations, based on the calculated scour depths, are presented in tables 1 and 2. A cross-section of the scour computed at the bridge is presented in figure 8. Scour depths were calculated assuming an infinite depth of erosive material and a homogeneous particle-size distribution.

It is generally accepted that the Froehlich equation (abutment scour) gives “excessively conservative estimates of scour depths” (Richardson and 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 STAMVT01000006 ***Stream*** North Branch Hoosic River

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

Description of Bridge

Bridge length 99 ***ft*** ***Bridge width*** 35.2 ***ft*** ***Max span length*** 97 ***ft***

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

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

Stone fill on abutment? No ***Date of inspection*** 7/31/96

Description of stone fill Type-1 stone fill was found along the downstream left bank. Type-2 stone fill was found along the upstream left bank and downstream right bank.

Abutments are concrete.

Y 60

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

There is a mild channel bend in the upstream reach.

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	7/31/96	0	0
Level II	7/31/96	0	0

Potential for debris High. There are large boulders (3 to 6 ft in diameter), scarred trees along the banks and downed trees in the channel upstream.

Describe any features near or at the bridge that may affect flow (include observation date) Boulders and downed trees upstream may affect flow.

Description of the Geomorphic Setting

General topography The channel is located within a wide, flat to slightly irregular flood plain in a moderate relief valley setting.

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

Date of inspection 7/31/96

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

DS right: Moderately sloped channel bank to a wide flood plain.

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

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

Description of the Channel

Average top width 44 *ft* ***Average depth*** 4 *ft*

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

Sinuous with semi-alluvial channel boundaries and a wide flood plain.

7/31/96

Vegetative co Grass with forest along immediate banks.

DS left: Grass with forest along immediate banks.

DS right: Grass with forest along immediate banks.

US left: Grass with forest along immediate banks.

US right:

Do banks appear stable? No ***If not, describe location and type of instability and date of observation.*** The upstream banks are scalloped and eroded with cut banks and exposed tree roots evident along both banks . The downstream banks are also scalloped and have exposed tree roots. 7/31/96

Describe any obstructions in channel and date of observation. The assessment of 7/31/96 noted downed trees along both upstream banks and among large boulders (3 ft to 6 ft diameter) upstream.

Hydrology

Drainage area 8.61 ***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 2,930 ***ft³/s*** ***Q500*** 4,890 ***ft³/s***

The 100- and 500-year discharges are based on a drainage area relationship [(8.6/8.8)exp 0.75] with the North Branch of the Hoosic River upstream of the Sumner Brook confluence which has flood frequency estimates available from a Federal Emergency Management Agency flood insurance study for the town Stamford (Federal Emergency Management Agency, 1978) . The drainage area above upstream of the Sumner Brook confluence is 8.8 square miles. (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 Add 717.8 ft to USGS arbitrary survey datum to obtain VTAOT plans datum (NGVD).

Description of reference marks used to determine USGS datum. RM1 is a VTAOT survey disk on top of the right end of the downstream bridge rail (elev. 501.30 ft, arbitrary survey datum). RM2 is a chiseled X on top of the curb at the upstream end of the left abutment (elev. 500.87ft, arbitrary survey datum).

Cross-Sections Used in WSPRO Analysis

[1]*Cross-section*	*Section Reference Distance (SRD) in feet*	[2]*Cross-section development*	*Comments*
EXITX	-98	1	Exit section
FULLV	0	2	Downstream Full-valley section (Templated from EXITX)
BRIDG	0	1	Bridge section
RDWAY	34	1	Road Grade section
APPRO	115	2	Modelled Approach section (Templated from APTEM)
APTEM	186	1	Approach section as surveyed (Used as a template)

[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 0.050 to 0.060, and overbank "n" values ranged from 0.055 to 0.090.

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 0.016 ft/ft which was determined from the 100-year water surface profile slope in the flood insurance study for the town of Stamford (Federal Emergency Management Agency, 1978)

The surveyed approach section (APTEM) was moved along the approach channel slope (0.010 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.

Bridge Hydraulics Summary

Average bridge embankment elevation 499.4 ***ft***
Average low steel elevation 494.3 ***ft***

100-year discharge 2,930 ***ft^3/s***
Water-surface elevation in bridge opening 495.0 ***ft***
Road overtopping? Y ***Discharge over road*** 27 ***ft^3/s***
Area of flow in bridge opening 268 ***ft^2***
Average velocity in bridge opening 10.8 ***ft/s***
Maximum WSPRO tube velocity at bridge 12.3 ***ft/s***

Water-surface elevation at Approach section with bridge 498.9
Water-surface elevation at Approach section without bridge 497.8
Amount of backwater caused by bridge 1.1 ***ft***

500-year discharge 4,890 ***ft^3/s***
Water-surface elevation in bridge opening 495.0 ***ft***
Road overtopping? Y ***Discharge over road*** 1,595 ***ft^3/s***
Area of flow in bridge opening 268 ***ft^2***
Average velocity in bridge opening 12.3 ***ft/s***
Maximum WSPRO tube velocity at bridge 13.9 ***ft/s***

Water-surface elevation at Approach section with bridge 501.7
Water-surface elevation at Approach section without bridge 500.0
Amount of backwater caused by bridge 1.7 ***ft***

Incipient overtopping discharge 2,830 ***ft^3/s***
Water-surface elevation in bridge opening 495.0 ***ft***
Area of flow in bridge opening 268 ***ft^2***
Average velocity in bridge opening 10.6 ***ft/s***
Maximum WSPRO tube velocity at bridge 12.0 ***ft/s***

Water-surface elevation at Approach section with bridge 498.7
Water-surface elevation at Approach section without bridge 497.6
Amount of backwater caused by bridge 1.1 ***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.

All modeled discharges resulted in submerged orifice flow. Contraction scour at bridges with orifice flow is best estimated by use of the Chang pressure-flow scour equation (oral communication, J. Sterling Jones, October 4, 1996). Thus, the Chang equation (Richardson and others, 1995, pp. 145-146) was applied to compute the contraction scour for these discharges. The results of Laursen's clear-water contraction scour equation (Richardson and others, 1995, p. 32, equation 20) were also computed and can be found in appendix F. The 500-year discharge model resulted in the worst case contraction scour with a scour depth of 2.1 ft. The computed depths to streambed armoring suggest armoring will not limit the depth of contraction scour.

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

Scour at the left abutment 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. 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	1.0	2.1	0.7
Depth to armoring	8.5 16.8	7.5	--
Left overbank	--	--	--
Right overbank	--	--	3.3 6.8

Local scour:	100-yr discharge	500-yr discharge	Incipient overtopping discharge
Abutment scour	2.8 18.8	19.7	18.8
Left abutment	---	---	---
Right abutment			
Pier scour	--	--	--
Pier 1	--	--	--
Pier 2	2.2	2.3	2.2
Pier 3			

Riprap Sizing

	100-yr discharge	500-yr discharge	Incipient overtopping discharge
		(D_{50} in feet)	
Abutments:	2.2	2.3	2.2
Left abutment	--	--	--
Right abutment	--	--	--
Piers:	--	--	--
Pier 1			
Pier 2			

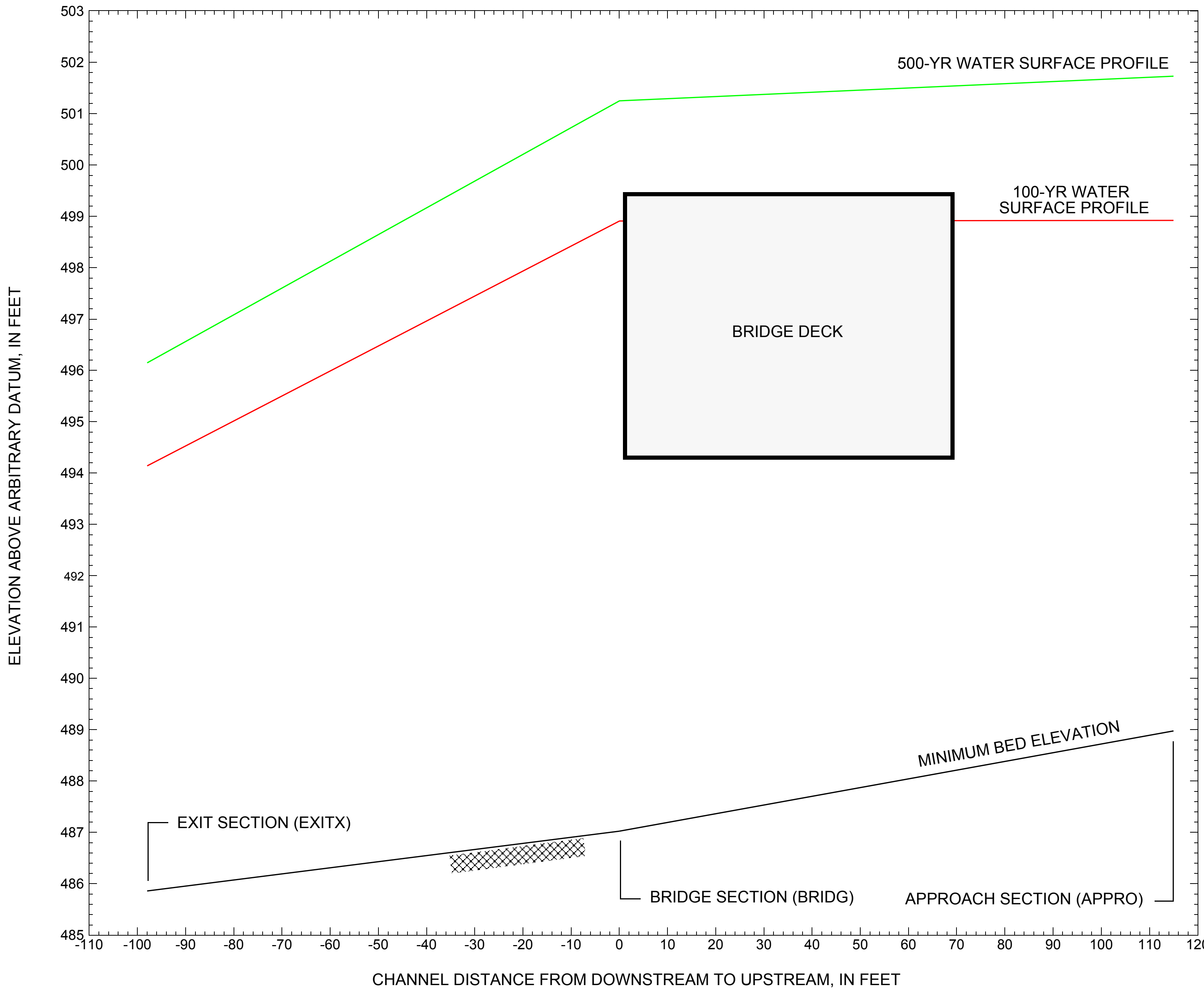

Figure 7. Water-surface profiles for the 100- and 500-yr discharges at structure STAMVT01000006 on Vermont Highway 100, crossing North Branch of the Hoosic River, Stamford, Vermont.

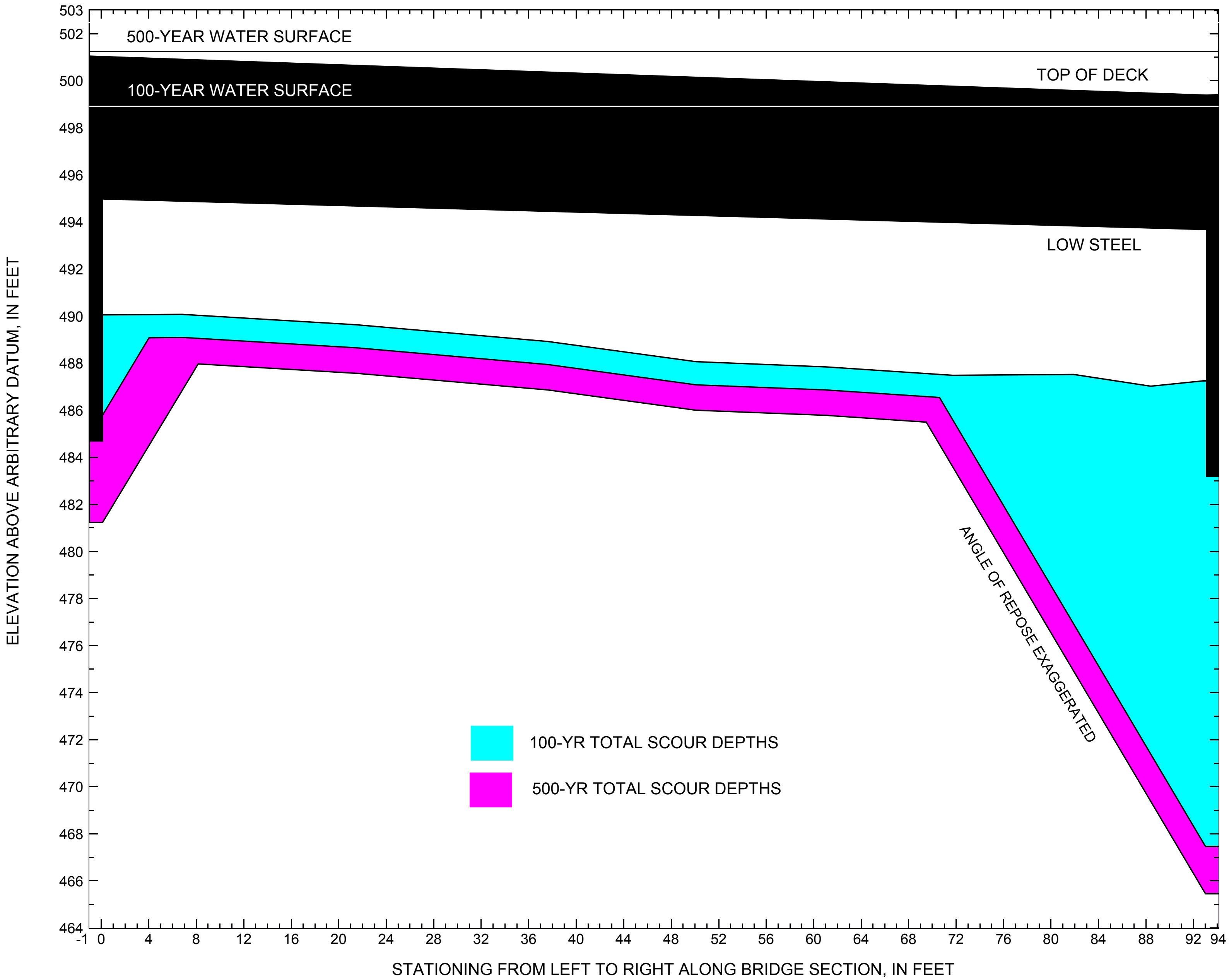

Figure 8. Scour elevations for the 100-yr and 500-yr discharges at structure STAMVT01000006 on Vermont Highway 100, crossing North Branch of the Hoosic River, Stamford, Vermont.

Table 1. Remaining footing/pile depth at abutments for the 100-year discharge at structure STAMVT01000006 on Vermont Highway 100, crossing 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 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 2,930 cubic-feet per second											
Left abutment	0.0	1212.4	495.0	484.7	490.1	1.0	3.3	--	4.3	485.8	1.1
Right abutment	93.1	1211.3	493.7	483.2	487.3	1.0	18.8	--	19.8	467.5	-15.7

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 STAMVT01000006 on Vermont Highway 100, crossing 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 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 4,890 cubic-feet per second											
Left abutment	0.0	1212.4	495.0	484.7	490.1	2.1	6.8	--	8.9	481.2	-3.5
Right abutment	93.1	1211.3	493.7	483.2	487.3	2.1	19.7	--	21.8	465.5	-17.7

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 stam006.wsp
T2        Hydraulic analysis for structure STAMVT01000006   Date: 06-JAN-97
T3        Vermont Highway 100 over the No. Branch of the Hoosic River, Stamford, VT .RHF
*
J1         * * 0.002
J3         6 29 30 552 553 551 5 16 17 13 3 * 15 14 23 21 11 12 4 7 3
*
Q           2930.0   4890.0   2830.0
SK           0.016    0.016    0.016
*
XS   EXITX   -98           0.
GR         -522.9, 514.43   -470.3, 504.27   -302.8, 499.60   -153.0, 499.07
GR            0.0, 497.41     45.2, 489.75     49.5, 487.82     54.2, 487.07
GR           57.1, 486.52     62.9, 486.19     67.6, 486.05     70.4, 485.86
GR           74.6, 486.12     76.7, 487.05     84.4, 492.77     89.6, 495.65
GR          112.2, 497.43    217.7, 499.07    259.0, 508.21
*
N           0.09         0.057      0.09
SA                   0.0       89.6
*
XS   FULLV      0  * * *   0.019
*
*             SRD     LSEL    XSSKEW
BR   BRIDG     0    494.33      60.0
GR            0.0, 494.98      1.3, 490.05      6.8, 490.07     21.5, 489.63
GR           37.6, 488.92     50.1, 488.06     61.0, 487.84     71.7, 487.48
GR           81.9, 487.52     88.4, 487.02     92.8, 487.25     93.1, 487.97
GR           93.1, 493.68     0.0, 494.98
*
*        BRTYPE  BRWDTH
CD          1      68.5
N           0.050
*
*            SRD    EMBWID   IPAVE
XR   RDWAY     34      35.2     1
GR         -563.8, 511.03   -148.4, 502.71      0.0, 500.31      0.1, 501.03
GR           31.9, 500.79     60.7, 500.42    122.9, 499.64    141.3, 499.39
GR          141.4, 498.44    159.1, 498.42    220.3, 504.74
*
XT   APTEM    186
GR         -536.5, 512.67   -496.9, 511.03   -245.2, 504.04   -140.3, 500.87
GR          -89.1, 499.14      0.0, 498.09     30.3, 495.22     42.9, 490.91
GR           45.9, 490.17     52.4, 489.69     55.9, 489.71     60.8, 489.91
GR           67.5, 490.76     75.2, 491.76     78.6, 495.33    139.8, 497.21
GR          192.6, 515.81
*
AS   APPRO    115 * * * 0.010
GT
N           0.055         0.060        0.055
SA                  30.3         78.6
*
HP 1 BRIDG 494.98 1 494.98
HP 2 BRIDG 494.98 * * 2901
HP 1 APPRO 498.92 1 498.92
HP 2 APPRO 498.92 * * 2930
HP 2 RDWAY 498.91 * * 27
*
HP 1 BRIDG 494.98 1 494.98
HP 2 BRIDG 494.98 * * 3297
HP 1 APPRO 501.73 1 501.73
HP 2 APPRO 501.73 * * 4890
HP 2 RDWAY 501.25 * * 1595
```

APPENDIX B:

WSPRO OUTPUT FILE

WSPRO OUTPUT FILE

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WSPRO         FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
V090192            MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS

        U.S. Geological Survey WSPRO Input File stam006.wsp
        Hydraulic analysis for structure STAMVT01000006   Date: 06-JAN-97
        Vermont Highway 100 over the No. Branch of the Hoosic River, Stamford, VT
           *** RUN DATE & TIME: 02-11-97  07:50
    CROSS-SECTION PROPERTIES:  ISEQ =  3;  SECID = BRIDG;  SRD =       0.

     WSEL  SA#     AREA        K   TOPW   WETP  ALPH    LEW    REW     QCR
             1     268.  15031.     0.   104.                            0.
   494.98          268.  15031.     0.   104.  1.00     0.    93.      0.

    VELOCITY DISTRIBUTION:  ISEQ =  3;  SECID = BRIDG;  SRD =       0.
         WSEL     LEW     REW    AREA        K        Q    VEL
       494.98     0.0    93.1   268.1   15031.    2901.  10.82

X STA.         0.0        8.7       14.8       20.5       26.1       31.1
  A(I)            19.6       14.8       14.2       14.3       13.3
  V(I)            7.41       9.77      10.23      10.13      10.88

X STA.        31.1       36.1       40.8       45.1       49.2       53.1
  A(I)            13.5       13.0       12.6       12.3       12.2
  V(I)           10.77      11.18      11.48      11.79      11.84

X STA.        53.1       56.9       60.8       64.5       68.2       71.9
  A(I)            12.0       12.0       11.8       11.9       11.9
  V(I)           12.10      12.05      12.25      12.17      12.20

X STA.        71.9       75.6       79.4       83.3       87.3       93.1
  A(I)            11.9       12.2       12.4       13.1       19.0
  V(I)           12.15      11.93      11.74      11.08       7.63


    CROSS-SECTION PROPERTIES:  ISEQ =  5;  SECID = APPRO;  SRD =     115.
     WSEL  SA#     AREA        K   TOPW   WETP  ALPH    LEW    REW     QCR
             1     184.   6164.   134.   134.                         1225.
             2     403.  39874.    48.    51.                         6614.
             3     214.  12383.    68.    69.                         2152.
   498.92          801.  58420.   250.   253.  1.41  -104.   147.   6850.

    VELOCITY DISTRIBUTION:  ISEQ =  5;  SECID = APPRO;  SRD =     115.
         WSEL     LEW     REW    AREA        K        Q    VEL
       498.92  -103.6   146.7   801.4   58420.    2930.   3.66

X STA.      -103.6        9.0       29.0       36.8       41.3       44.7
  A(I)           111.6       66.9       41.5       32.9       29.6
  V(I)            1.31       2.19       3.53       4.45       4.96

X STA.        44.7       47.6       50.4       53.0       55.7       58.3
  A(I)            27.7       26.8       26.4       26.2       26.1
  V(I)            5.29       5.47       5.54       5.58       5.61

X STA.        58.3       61.0       63.8       66.8       70.2       73.8
  A(I)            26.1       27.1       27.4       29.1       30.0
  V(I)            5.61       5.41       5.35       5.03       4.88

X STA.        73.8       81.1       91.8      104.4      119.7      146.7
  A(I)            42.5       43.5       46.6       50.2       63.0
  V(I)            3.45       3.37       3.14       2.92       2.33


    VELOCITY DISTRIBUTION:  ISEQ =  4;  SECID = RDWAY;  SRD =      34.
         WSEL     LEW     REW    AREA        K        Q    VEL
       498.91   141.4   163.8     9.7      90.      27.   2.79

X STA.       141.4      142.6      143.5      144.5      145.5      146.4
  A(I)             0.6        0.5        0.5        0.5        0.4
  V(I)            2.41       2.97       2.94       3.00       3.01

X STA.       146.4      147.3      148.3      149.2      150.1      151.1
  A(I)             0.5        0.4        0.4        0.4        0.4
  V(I)            2.98       3.04       3.01       3.04       3.03

X STA.       151.1      152.0      152.9      153.9      154.8      155.8
  A(I)             0.4        0.4        0.5        0.5        0.5
  V(I)            3.02       3.01       2.97       2.99       2.92

X STA.       155.8      156.7      157.7      158.7      159.9      163.8
  A(I)             0.5        0.5        0.5        0.6        0.8
  V(I)            2.93       2.82       2.73       2.42       1.68
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        U.S. Geological Survey WSPRO Input File stam006.wsp
        Hydraulic analysis for structure STAMVT01000006   Date: 06-JAN-97
        Vermont Highway 100 over the No. Branch of the Hoosic River, Stamford, VT
     CROSS-SECTION PROPERTIES:  ISEQ =  3;  SECID = BRIDG;  SRD =       0.

     WSEL  SA#     AREA        K   TOPW   WETP  ALPH    LEW    REW     QCR
             1     268.   15031.     0.   104.                           0.
   494.98          268.   15031.     0.   104.  1.00     0.    93.      0.

    VELOCITY DISTRIBUTION:  ISEQ =  3;  SECID = BRIDG;  SRD =       0.
         WSEL     LEW     REW    AREA        K        Q    VEL
       494.98     0.0    93.1   268.1   15031.    3297.  12.30

X STA.        0.0        8.7       14.8       20.5       26.1       31.1
  A(I)            19.6       14.8       14.2       14.3       13.3
  V(I)            8.42      11.10      11.62      11.52      12.36

X STA.       31.1       36.1       40.8       45.1       49.2       53.1
  A(I)            13.5       13.0       12.6       12.3       12.2
  V(I)           12.24      12.71      13.04      13.40      13.46

X STA.       53.1       56.9       60.8       64.5       68.2       71.9
  A(I)            12.0       12.0       11.8       11.9       11.9
  V(I)           13.75      13.70      13.92      13.84      13.87

X STA.       71.9       75.6       79.4       83.3       87.3       93.1
  A(I)            11.9       12.2       12.4       13.1       19.0
  V(I)           13.81      13.55      13.34      12.59       8.67


    CROSS-SECTION PROPERTIES:  ISEQ =  5;  SECID = APPRO;  SRD =     115.

     WSEL  SA#     AREA        K   TOPW   WETP  ALPH    LEW    REW     QCR
             1     682.   38914.   223.   223.                        6768.
             2     539.   64660.    48.    51.                       10219.
             3     416.   34768.    76.    77.                        5530.
   501.73         1637.  138342.   347.   350.  1.32  -192.   155.  17595.

    VELOCITY DISTRIBUTION:  ISEQ =  5;  SECID = APPRO;  SRD =     115.
         WSEL     LEW     REW    AREA        K        Q    VEL
       501.73  -192.3   154.6  1637.0  138342.    4890.   2.99

X STA.     -192.3      -82.6      -47.4      -18.1        6.2       22.6
  A(I)           187.2      126.2      116.2      105.2       94.0
  V(I)            1.31       1.94       2.10       2.32       2.60

X STA.       22.6       33.9       40.7       45.6       49.9       54.0
  A(I)            80.9       65.0       56.6       53.3       52.8
  V(I)            3.02       3.76       4.32       4.59       4.63

X STA.       54.0       58.1       62.3       66.7       71.7       78.9
  A(I)            51.5       52.4       53.8       56.9       70.4
  V(I)            4.75       4.67       4.54       4.29       3.47

X STA.       78.9       89.4      100.7      113.1      127.1      154.6
  A(I)            72.8       74.6       77.8       81.6      107.5
  V(I)            3.36       3.28       3.14       3.00       2.27


    VELOCITY DISTRIBUTION:  ISEQ =  4;  SECID = RDWAY;  SRD =      34.
         WSEL     LEW     REW    AREA        K        Q    VEL
       501.25   -58.1   186.5   253.5    5391.    1595.   6.29

X STA.      -58.1       -0.4       46.9       64.7       77.2       87.2
  A(I)            26.9       19.6       13.7       12.0       10.9
  V(I)            2.96       4.07       5.84       6.66       7.30

X STA.       87.2       97.8      107.8      116.6      124.3      131.3
  A(I)            13.1       13.5       13.0       12.2       11.8
  V(I)            6.07       5.91       6.12       6.56       6.79

X STA.      131.3      137.7      142.9      146.1      149.3      152.4
  A(I)            11.2       11.2        8.9        9.1        8.8
  V(I)            7.12       7.15       8.94       8.76       9.02

X STA.      152.4      155.7      159.0      162.9      168.2      186.5
  A(I)             9.1        9.5       10.1       11.5       17.3
  V(I)            8.73       8.40       7.91       6.91       4.60
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        U.S. Geological Survey WSPRO Input File stam006.wsp
        Hydraulic analysis for structure STAMVT01000006   Date: 06-JAN-97
        Vermont Highway 100 over the No. Branch of the Hoosic River, Stamford, VT

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

     WSEL  SA#     AREA        K   TOPW   WETP  ALPH    LEW    REW     QCR
             1     268.   15031.     0.   104.                          0.
   494.98          268.   15031.     0.   104.  1.00     0.    93.      0.

    VELOCITY DISTRIBUTION:  ISEQ =  3;  SECID = BRIDG;  SRD =       0.
         WSEL     LEW     REW    AREA        K        Q    VEL
       494.98     0.0    93.1   268.1   15031.    2830.  10.56

X STA.         0.0        8.7       14.8       20.5       26.1       31.1
  A(I)            19.6       14.8       14.2       14.3       13.3
  V(I)            7.22       9.53       9.98       9.89      10.61

X STA.        31.1       36.1       40.8       45.1       49.2       53.1
  A(I)            13.5       13.0       12.6       12.3       12.2
  V(I)           10.51      10.91      11.20      11.50      11.55

X STA.        53.1       56.9       60.8       64.5       68.2       71.9
  A(I)            12.0       12.0       11.8       11.9       11.9
  V(I)           11.80      11.76      11.95      11.88      11.91

X STA.        71.9       75.6       79.4       83.3       87.3       93.1
  A(I)            11.9       12.2       12.4       13.1       19.0
  V(I)           11.86      11.63      11.45      10.80       7.44


    CROSS-SECTION PROPERTIES:  ISEQ =  5;  SECID = APPRO;  SRD =     115.

     WSEL  SA#     AREA        K   TOPW   WETP  ALPH    LEW    REW     QCR
             1     149.    4515.   126.   126.                        920.
             2     390.   37748.    48.    51.                       6295.
             3     196.   10756.    67.    68.                       1893.
   498.65          735.   53019.   242.   245.  1.41   -96.   146.   6121.

    VELOCITY DISTRIBUTION:  ISEQ =  5;  SECID = APPRO;  SRD =     115.
         WSEL     LEW     REW    AREA        K        Q    VEL
       498.65   -95.6   145.9   735.0   53019.    2830.   3.85

X STA.       -95.6       17.5       32.9       38.7       42.5       45.6
  A(I)           103.9       57.0       34.9       29.6       26.6
  V(I)            1.36       2.48       4.06       4.78       5.32

X STA.        45.6       48.3       50.9       53.5       56.0       58.5
  A(I)            25.2       24.8       24.4       24.2       24.0
  V(I)            5.63       5.71       5.80       5.85       5.89

X STA.        58.5       61.0       63.7       66.7       69.7       73.2
  A(I)            24.5       24.6       26.2       26.2       27.9
  V(I)            5.77       5.74       5.40       5.39       5.07

X STA.        73.2       79.1       89.8      102.6      118.6      145.9
  A(I)            37.2       41.5       44.5       48.7       59.1
  V(I)            3.80       3.41       3.18       2.91       2.39
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        U.S. Geological Survey WSPRO Input File stam006.wsp
        Hydraulic analysis for structure STAMVT01000006   Date: 06-JAN-97
        Vermont Highway 100 over the No. Branch of the Hoosic River, Stamford, VT
           *** RUN DATE & TIME: 02-11-97  07:50

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

EXITX:XS   ******    19.     323.  1.28 *****  495.42  493.00   2930.  494.14
      -98. ******    87.   23144.  1.00 ***** *******    0.73    9.08

FULLV:FV      98.    21.     307.  1.42  1.68  497.18 *******   2930.  495.76
        0.    98.    86.   21697.  1.00  0.07    0.02    0.78    9.55
         <<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>
 ===135 CONVEYANCE RATIO OUTSIDE OF RECOMMENDED LIMITS.
                             "APPRO"     KRATIO =  1.78

APPRO:AS     115.   -32.     544.  0.60  1.18  498.35 *******   2930.  497.75
      115.   115.   143.   38713.  1.33  0.00    0.00    0.62    5.38
         <<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>
 ===255 ATTEMPTING FLOW CLASS 3 (6) SOLUTION.
                        WS3N,LSEL =    495.76     494.33

            <<<<<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      98.     0.     268.  1.82 *****  496.80  493.51   2901.  494.98
        0. ******    93.   15031.  1.00 ***** *******    1.12   10.82

     TYPE PPCD FLOW      C    P/A    LSEL   BLEN   XLAB   XRAB
       1. ****   6.  0.800  0.000  494.33 ****** ****** ******

    XSID:CODE    SRD   FLEN    HF   VHD     EGL     ERR       Q   WSEL
   RDWAY:RG      34.    80.  0.20  0.29  499.01    0.00     27.  498.91

            Q   WLEN    LEW    REW  DMAX  DAVG  VMAX  VAVG  HAVG  CAVG
   LT:     0.   279.  -226.    53.   4.0   2.3   8.8   8.8   3.5   3.1
   RT:    27.    23.   141.   164.   0.5   0.4   3.3   2.7   0.5   3.1

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

APPRO:AS      47.  -104.     801.  0.29  0.61  499.21  495.94   2930.  498.92
      115.    63.   147.   58377.  1.41  0.00    0.00    0.43    3.66

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

                     <<<<<END OF BRIDGE COMPUTATIONS>>>>>
WSPRO         FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
V090192             MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS

        U.S. Geological Survey WSPRO Input File stam006.wsp
        Hydraulic analysis for structure STAMVT01000006   Date: 06-JAN-97
        Vermont Highway 100 over the No. Branch of the Hoosic River, Stamford, VT
           *** RUN DATE & TIME: 02-11-97  07:50
  FIRST USER DEFINED TABLE.

    XSID:CODE    SRD    LEW    REW       Q        K     AREA     VEL   WSEL
   EXITX:XS     -98.    19.    87.   2930.   23144.     323.    9.08  494.14
   FULLV:FV       0.    21.    86.   2930.   21697.     307.    9.55  495.76
   BRIDG:BR       0.     0.    93.   2901.   15031.     268.   10.82  494.98
   RDWAY:RG      34.*******     0.     27.       0.*********    1.00  498.91
   APPRO:AS     115.  -104.   147.   2930.   58377.     801.    3.66  498.92

    XSID:CODE   XLKQ   XRKQ       KQ
   APPRO:AS  ***********************
1
WSPRO         FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
V090192             MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS

        U.S. Geological Survey WSPRO Input File stam006.wsp
        Hydraulic analysis for structure STAMVT01000006   Date: 06-JAN-97
        Vermont Highway 100 over the No. Branch of the Hoosic River, Stamford, VT
           *** RUN DATE & TIME: 02-11-97  07:50
 SECOND USER DEFINED TABLE.

    XSID:CODE    CRWS     FR#    YMIN    YMAX    HF    HO   VHD     EGL    WSEL
   EXITX:XS    493.00    0.73  485.86  514.43************  1.28  495.42  494.14
   FULLV:FV  ********    0.78  487.72  516.29  1.68  0.07  1.42  497.18  495.76
   BRIDG:BR    493.51    1.12  487.02  494.98************  1.82  496.80  494.98
   RDWAY:RG  ****************  498.42  511.03  0.20******  0.29  499.01  498.91
   APPRO:AS    495.94    0.43  488.98  515.10  0.61  0.00  0.29  499.21  498.92
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WSPRO OUTPUT FILE (continued)

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WSPRO         FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
V090192             MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS

        U.S. Geological Survey WSPRO Input File stam006.wsp
        Hydraulic analysis for structure STAMVT01000006   Date: 06-JAN-97
        Vermont Highway 100 over the No. Branch of the Hoosic River, Stamford, VT
           *** RUN DATE & TIME: 02-11-97  07:50

 XSID:CODE   SRDL    LEW     AREA   VHD    HF     EGL    CRWS       Q    WSEL
       SRD   FLEN    REW        K  ALPH    HO     ERR     FR#     VEL
EXITX:XS   ******     7.     476.  1.65 *****  497.80  494.95   4890.  496.15
      -98. ******    96.   38656.  1.01 ***** *******    0.78   10.28

 ===125 FR# EXCEEDS FNTEST AT SECID "FULLV":  TRIALS CONTINUED.
              FNTEST,FR#,WSEL,CRWS =  0.80     0.82     497.76      496.81
 ===110 WSEL NOT FOUND AT SECID "FULLV":  REDUCED DELTAY.
                   WSLIM1,WSLIM2,DELTAY =   495.65     516.29    0.50
 ===115 WSEL NOT FOUND AT SECID "FULLV":  USED WSMIN = CRWS.
                   WSLIM1,WSLIM2,CRWS =   495.65     516.29     496.81

FULLV:FV      98.     9.     453.  1.82  1.68  499.56  496.81   4890.  497.74
        0.    98.    93.   36167.  1.00  0.08    0.00    0.82   10.81
         <<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>
 ===135 CONVEYANCE RATIO OUTSIDE OF RECOMMENDED LIMITS.
                               "APPRO"     KRATIO =  2.35

APPRO:AS     115.  -137.    1100.  0.42  0.90  500.45 *******   4890.  500.03
      115.   115.   150.   84818.  1.37  0.00    0.00    0.47    4.45
         <<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>
 ===255 ATTEMPTING FLOW CLASS 3 (6) SOLUTION.
                       WS3N,LSEL =   497.74     494.33

            <<<<<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      98.     0.     268.  2.35 *****  497.33  493.80   3297.  494.98
        0. ******    93.   15031.  1.00 ***** *******    1.28   12.30

     TYPE PPCD FLOW      C     P/A    LSEL   BLEN   XLAB   XRAB
       1. ****    6.  0.800  0.000  494.33 ****** ****** ******

    XSID:CODE    SRD   FLEN    HF   VHD     EGL     ERR       Q    WSEL
   RDWAY:RG      34.    80.  0.10  0.18  501.81    0.00   1595.  501.25

            Q   WLEN    LEW    REW  DMAX  DAVG  VMAX  VAVG  HAVG  CAVG
   LT:    347.   111.   -58.    53.   0.9   0.5   4.6   6.9   1.0   3.0
   RT:   1248.   133.    53.   186.   2.8   1.5   6.7   6.2   2.1   3.1

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

APPRO:AS      47.  -192.    1636.  0.18  0.50  501.91  497.39   4890.  501.73
      115.    62.   155.  138244.  1.32  0.00    0.00    0.28    2.99

       M(G)   M(K)       KQ   XLKQ   XRKQ     OTEL
     ****** ****** ******** ****** ****** ********
                         <<<<<END OF BRIDGE COMPUTATIONS>>>>>
WSPRO         FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
V090192             MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS

        U.S. Geological Survey WSPRO Input File stam006.wsp
        Hydraulic analysis for structure STAMVT01000006   Date: 06-JAN-97
        Vermont Highway 100 over the No. Branch of the Hoosic River, Stamford, VT
           *** RUN DATE & TIME: 02-11-97  07:50
  FIRST USER DEFINED TABLE.

    XSID:CODE    SRD    LEW    REW       Q        K     AREA     VEL    WSEL
   EXITX:XS     -98.     7.    96.   4890.   38656.     476.   10.28  496.15
   FULLV:FV       0.     9.    93.   4890.   36167.     453.   10.81  497.74
   BRIDG:BR       0.     0.    93.   3297.   15031.     268.   12.30  494.98
   RDWAY:RG      34.*******   347.   1595.       0.*********    1.00  501.25
   APPRO:AS     115.  -192.   155.   4890.  138244.    1636.    2.99  501.73

        U.S. Geological Survey WSPRO Input File stam006.wsp
        Hydraulic analysis for structure STAMVT01000006   Date: 06-JAN-97
        Vermont Highway 100 over the No. Branch of the Hoosic River, Stamford, VT
           *** RUN DATE & TIME: 02-11-97  07:50
 SECOND USER DEFINED TABLE.

    XSID:CODE     CRWS     FR#    YMIN    YMAX     HF     HO  VHD      EGL    WSEL
   EXITX:XS     494.95    0.78  485.86  514.43************  1.65  497.80  496.15
   FULLV:FV     496.81    0.82  487.72  516.29  1.68  0.08  1.82  499.56  497.74
   BRIDG:BR     493.80    1.28  487.02  494.98************  2.35  497.33  494.98
   RDWAY:RG   ****************  498.42  511.03  0.10******  0.18  501.81  501.25
   APPRO:AS     497.39    0.28  488.98  515.10  0.50  0.00  0.18  501.91  501.73
```

```
 WSPRO         FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
 V090192             MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS

         U.S. Geological Survey WSPRO Input File stam006.wsp
         Hydraulic analysis for structure STAMVT01000006   Date: 06-JAN-97
         Vermont Highway 100 over the No. Branch of the Hoosic River, Stamford, VT
            *** RUN DATE & TIME: 02-11-97  07:50

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

 EXITX:XS   ******    20.     314.  1.26 *****  495.27  492.85   2830.  494.01
       -98. ******    87.   22355.  1.00 ***** *******    0.73    9.01

 FULLV:FV      98.    22.     298.  1.41  1.68  497.03 *******   2830.  495.62
         0.    98.    86.   20849.  1.00  0.07    0.00    0.78    9.51
          <<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>
  ===135 CONVEYANCE RATIO OUTSIDE OF RECOMMENDED LIMITS.
                               "APPRO"     KRATIO =  1.77

 APPRO:AS     115.   -20.     521.  0.60  1.20  498.22 *******   2830.  497.62
       115.   115.   143.   36962.  1.32  0.00    0.00    0.61    5.43
          <<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>
  ===255 ATTEMPTING FLOW CLASS 3 (6) SOLUTION.
                          WS3N,LSEL =   495.62     494.33

             <<<<<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      98.     0.     268.  1.74 *****  496.72  493.43   2833.  494.98
         0. ******    93.   15031.  1.00 ***** *******    1.10   10.57

      TYPE PPCD FLOW      C    P/A    LSEL   BLEN   XLAB   XRAB
        1. ****   3.  0.800  0.000  494.33 ****** ****** ******

     XSID:CODE    SRD   FLEN    HF   VHD     EGL     ERR       Q    WSEL
    RDWAY:RG      34.        <<<<<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      47.   -96.     734.  0.33  0.64  498.97  495.78   2830.  498.65
       115.    64.   146.   52961.  1.41  0.00    0.00    0.46    3.85

        M(G)   M(K)       KQ   XLKQ   XRKQ    OTEL
      ****** ****** ******** ****** ******   498.42

                      <<<<<END OF BRIDGE COMPUTATIONS>>>>>
1
 WSPRO         FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
 V090192             MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS

         U.S. Geological Survey WSPRO Input File stam006.wsp
         Hydraulic analysis for structure STAMVT01000006   Date: 06-JAN-97
         Vermont Highway 100 over the No. Branch of the Hoosic River, Stamford, VT
            *** RUN DATE & TIME: 02-11-97  07:50
   FIRST USER DEFINED TABLE.

     XSID:CODE    SRD    LEW    REW       Q        K     AREA     VEL    WSEL
    EXITX:XS     -98.    20.    87.   2830.   22355.     314.    9.01  494.01
    FULLV:FV       0.    22.    86.   2830.   20849.     298.    9.51  495.62
    BRIDG:BR       0.     0.    93.   2833.   15031.     268.   10.57  494.98
    RDWAY:RG      34.**************      0.       0.       0.    1.00********
    APPRO:AS     115.   -96.   146.   2830.   52961.     734.    3.85  498.65

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

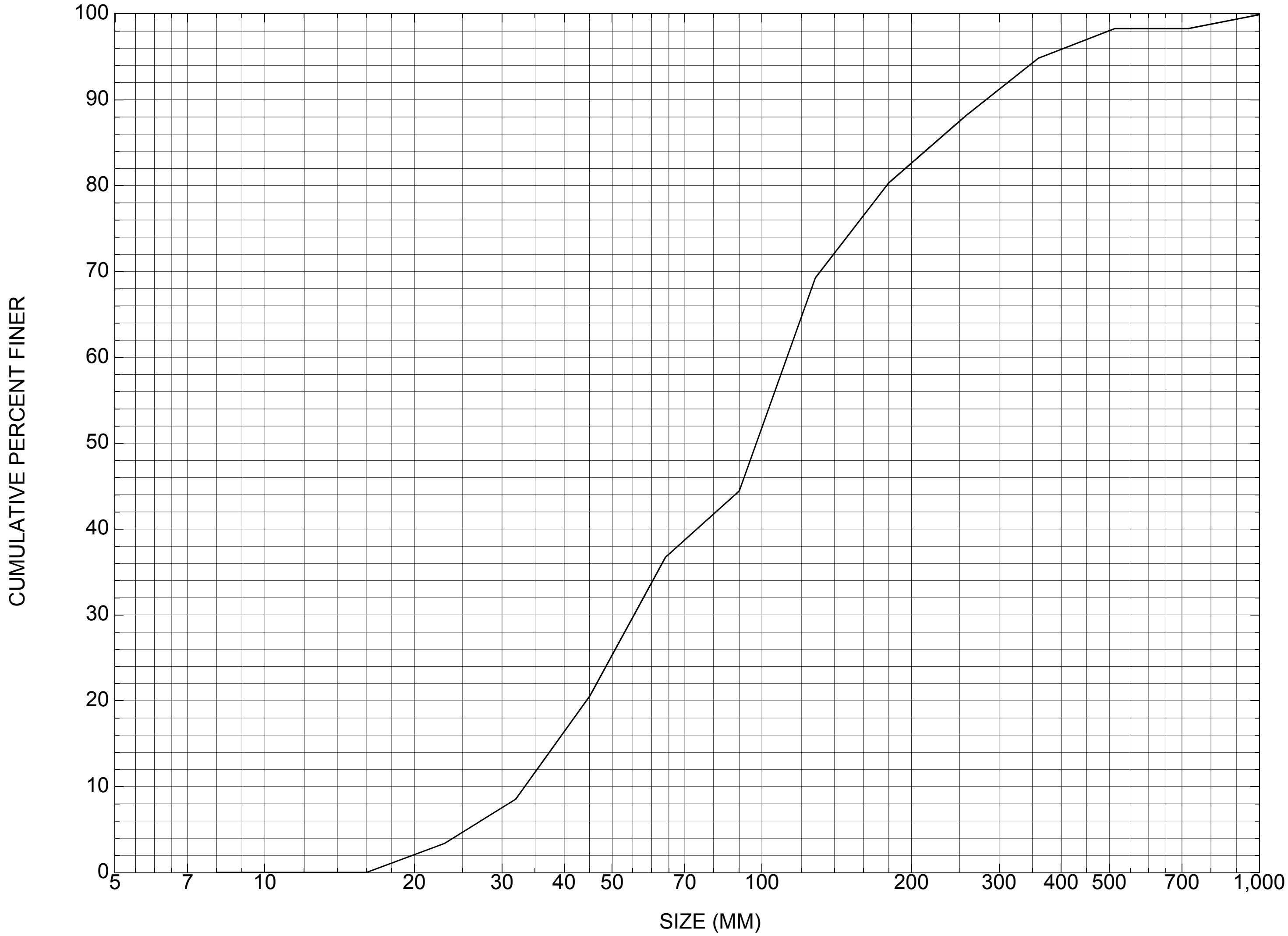
         U.S. Geological Survey WSPRO Input File stam006.wsp
         Hydraulic analysis for structure STAMVT01000006   Date: 06-JAN-97
         Vermont Highway 100 over the No. Branch of the Hoosic River, Stamford, VT
            *** RUN DATE & TIME: 02-11-97  07:50
  SECOND USER DEFINED TABLE.

     XSID:CODE    CRWS     FR#    YMIN    YMAX    HF    HO   VHD      EGL    WSEL
    EXITX:XS    492.85    0.73  485.86  514.43************  1.26  495.27  494.01
    FULLV:FV  ********    0.78  487.72  516.29  1.68  0.07  1.41  497.03  495.62
    BRIDG:BR    493.43    1.10  487.02  494.98************  1.74  496.72  494.98
    RDWAY:RG  ****************  498.42  511.03************  0.33  498.75********
    APPRO:AS    495.78    0.46  488.98  515.10  0.64  0.00  0.33  498.97  498.65
   ER

1  NORMAL  END  OF  WSPRO  EXECUTION.
```

APPENDIX C:

BED-MATERIAL PARTICAL-SIZE DISTRIBUTION



Appendix C. Bed material particle-size distribution for a pebble count in the channel approach of structure STAMVT01000006, in Stamford, Vermont.

APPENDIX D:

HISTORICAL DATA FORM

United States Geological Survey
Bridge Historical Data Collection and Processing Form

Structure Number STAMVT01000006

General Location Descriptive

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

Date *(MM/DD/YY)* 09 / 28 / 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)* 002850

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

Road Name *(I - 7):* -

Route Number VT100

Vicinity *(I - 9)* 2.8 MI N MA STATE LINE

Topographic Map Stamford

Hydrologic Unit Code: -

Latitude *(I - 16; nnnn.n)* 42464

Longitude *(i - 17; nnnnn.n)* 73031

Select Federal Inventory Codes

FHWA Structure Number *(I - 8)* 20010200060214

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

Maximum span length *(I - 48; nnnn)* 0097

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

Structure length *(I - 49; nnnnnn)* 000099

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

Deck Width *(I - 52; nn.n)* 352

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

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

Opening skew to Roadway *(I - 34; nn)* 60

Waterway adequacy *(I - 71; n)* 5

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*) 45

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

Vertical clearance from streambed (*nnn.n ft*) 7.3

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

Waterway of full opening (*nnn.n* ft^2) 328.5

Comments:

According to the structural inspection report dated 8/23/93, structure is a single span rolled beam bridge. Channel is straight through the structure; flow is toward Labut side of channel. Some minor scour noted along Rabut but no undermining. Some minor stream bank erosion at US Labut. A buildup of stone and gravel along Rabut side of channel on US end of structure is noted. Stem of Rabut has some minor stain ing, cracking, and scaling down along the flow line. Stem of Labut has some cracking with leakage at the fascias. Remainder of the stem has some minor cracking, staining, and scaling along the flow line. Labut wings have some minor cracking with leakage. Footings not exposed.

Bridge Hydrologic Data

Is there hydrologic data available? Y *if No, type ctrl-n h* VTAOT Drainage area *(mi²)*: 8.8

Terrain character: -

Stream character & type: -

Streambed material: -

Discharge Data *(cfs)*: $Q_{2.33}$ 880 Q_{10} 1470 Q_{25} 2110

Q_{50} 2610 Q_{100} 2980 Q_{500} -

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

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

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

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

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

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

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

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

Water Surface Elevation Estimates for Existing Structure:

Peak discharge frequency	$Q_{2.33}$	Q_{10}	Q_{25}	Q_{50}	Q_{100}
Water surface elevation (*ft*)	1212.6	1213.6	1214.1	1214.5	1215.2
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: 1963

Highway No. : VT100 Structure No. : 8 Structure Type: CONC. WF BEAM ST.

Clear span (*ft*): 34.8 Clear Height (*ft*): 6 Full Waterway (*ft²*): 208.8

Downstream distance (*miles*): - Town: Stamford Year Built: 1939

Highway No. : TH 1 Structure No. : 7 Structure Type: I-BEAM, STRINGER

Clear span (*ft*): 43 Clear Height (*ft*): 8 Full Waterway (ft^2): 344

Comments:

Water surface elevations above based on channel bottom elevation 1207.2' at approach. Data from FEMA study. Design flow Q50. Recommendation from study that the existing bridge appears inadequate hydraulically. New structure with at least 50' clear span and minimum clear height of 8' is recommended.

USGS Watershed Data

Watershed Hydrographic Data

Drainage area *(DA)* 8.61 mi^2 Lake and pond area 0.35 mi^2

Watershed storage *(ST)* 0.4 %

Bridge site elevation 1217 ft Headwater elevation 2970 ft

Main channel length 3.98 mi

10% channel length elevation 1200 ft 85% channel length elevation 2230 ft

Main channel slope *(S)* 345.1 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: ________

Low superstructure elevation: USLAB 1213.69 DSLAB 1212.41 USRAB 1211.98 DSRAB _______

Benchmark location description:

1211.30

New bridge disc elev. 1219.10 on downstream right corner post end.

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

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

If 1: Footing Thickness 1______ Footing bottom elevation: 2______

If 2: Pile Type: 12__ (*1-Wood; 2-Steel or metal; 3-Concrete*) Approximate pile driven length: 01______

If 3: Footing bottom elevation: ______

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

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

Briefly describe material at foundation bottom elevation or around piles:

5

3

Rabut foundation in refusal (bedrock?)

Labut foundation in hard sand and gravel

Comments:

Right footing bottom elev = 1201'; left footing bottom elev = 1202.5'.

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

Cross-sectional Data

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

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

Comments: **Y**
FEMA

Station	**Sta-**	**mea-**		**6.6**	**7**	**5**	**5.5**	**-**	**-**	**-**	**-**
Feature	**tion**	**sure-**	**175**	**179**	**235**	**276**	**7**	**-**	**-**	**-**	**-**
Low cord elevation	**and**	**ments**	**LAB**	**-**	**-**	**RAB**	**-**	**-**	**-**	**-**	**-**
Bed elevation	**eleva-**	**are in**	**1213.6**	**1213.5**	**1213**	**1212.**	**-**	**-**	**-**	**-**	**-**
Low cord to bed length	**tion**	**feet.**	**1207**	**1206.5**	**1208**	**5120**	**-**	**-**	**-**	**-**	**-**
Station	-	-	-	-	-	-	-	-	-	-	-
Feature	-	-	-	-	-	-	-	-	-	-	-
Low cord elevation	-	-	-	-	-	-	-	-	-	-	-
Bed elevation	-	-	-	-	-	-	-	-	-	-	-
Low cord to bed length	-	-	-	-	-	-	-	-	-	-	-

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

Comments: -
-

Station	**-**	**-**	**OT**	**vatio**	**toco**	**VTA**	**data**	**-**	**-**	**-**	**-**
Feature	**-**	**-**	**Brid**	**ns**	**pies**	**OT**	**is**	**-**	**-**	**-**	**-**
Low cord elevation	**-**	**-**	**ge**	**are**	**of**	**cross**	**avail**	**-**	**-**	**-**	**-**
Bed elevation	**-**	**-**	**seat**	**on**	**plan**	**-sec-**	**able.**	**-**	**-**	**-**	**-**
Low cord to bed length	**-**	**VTA**	**ele-**	**pho-**	**s.**	**tion**	**-**	**-**	**-**	**-**	**-**
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: **10/07/96**
Computerized by: **RB** Date: **10/09/96**
Reviewd by: **RF** Date: **02/13/97**

Structure Number **STAMVT01000006**

A. General Location Descriptive

1. Data collected by *(First Initial, Full last name)* **R. FLYNN** Date *(MM/DD/YY)* **07** / **31** / 19**96**

2. Highway District Number **01** Mile marker **002850**
County **003** Town **69775**
Waterway *(I - 6)* **N. BRANCH HOOSIC RIVER** Road Name **VT 100**
Route Number **VT 100** Hydrologic Unit Code: **-**

3. Descriptive comments:
Located 2.8 miles north of the Massachusetts state line.

B. Bridge Deck Observations

4. Surface cover... LBUS **6** RBUS **6** LBDS **4** 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 **1** UB **2** 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 **99** *(feet)* Span length **97** *(feet)* Bridge width **35.2** *(feet)*

Road approach to bridge:

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

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

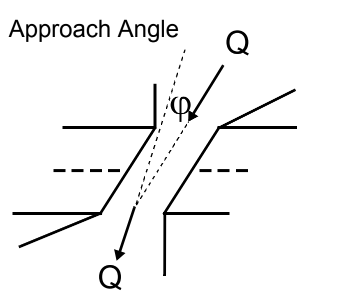
10. Embankment slope (*run / rise in feet / foot*):
US left **0.0:1** US right **0.0:1**

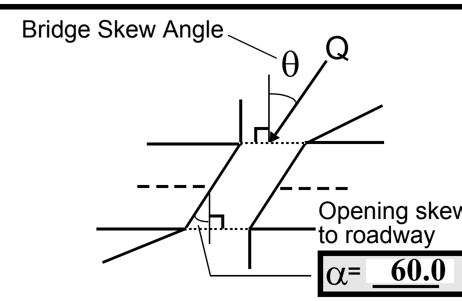
	Protection		13.Erosion	14.Severity
	11.Type	12.Cond.		
LBUS	0	-	2	2
RBUS	0	-	2	1
RBDS	0	-	2	2
LBDS	0	-	0	0

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

Channel approach to bridge (BF):

15. Angle of approach: **5** 16. Bridge skew: **60**





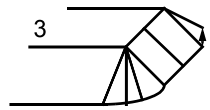
17. Channel impact zone 1: Exist? **Y** *(Y or N)*
Where? **RB** *(LB, RB)* Severity **2**
Range? **0** feet **US** *(US, UB, DS)* to **20** feet **DS**

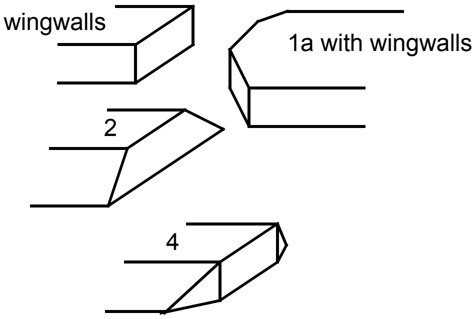
Channel impact zone 2: Exist? **N** *(Y or N)*
Where? **-** *(LB, RB)* Severity **-**
Range? **-** feet **-** *(US, UB, DS)* to **-** feet **-**

*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. There is a house and driveway on the right bank US, but the immediate bank is a high forested hill. The left bank US is forested along the bank then it is mowed grass along VT 100. The left bank DS is a lawn with a house and barn and trees along the immediate bank. The right bank DS is forested along the bank and road embankment for VT 100.
7. Values are from the VT AOT files. Measured bridge length is 101 ft., bridge span is 91 ft., and the bridge width is 34.5 ft.
18. The sides of the abutments are parallel to VT 100.

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
118.0	**4.5**			**3.5**	**2**	**3**	**420**	**420**	**2**	**2**

23. Bank width **20.0** 24. Channel width **45.0** 25. Thalweg depth **48.5** 29. Bed Material **452**

30 .Bank protection type: LB **2** RB **0** 31. Bank protection condition: LB **3** 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.):
28. Both banks are scalloped and have exposed tree roots.
30. Bank protection extends from the end of the US left abutment to 150 ft. US.
There is a cobble and boulder island from 150 ft. US to 200+ ft. US. It is positioned 20% LB to 75% RB.

33. Point/Side bar present? Y (Y or N. if N type ctrl-n pb) 34. Mid-bar distance: 75 35. Mid-bar width: 10

36. Point bar extent: 100 feet US (US, UB) to 48 feet US (US, UB, DS) positioned 100 %LB to 80 %RB

37. Material: 4523

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

An additional point bar is evident on the right bank from 85 ft. US to 150 ft. US. Mid-bar width is 10 ft. and it is positioned from 20% LB to 0% RB. It is comprised of cobbles, boulders, sand and gravel. This point bar is below the cut bank. The bank has eroded and slumped to form the point bar.

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: 110 42. Cut bank extent: 80 feet US (US, UB) to 130 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.):

Another cut bank is along the left bank from 110 ft. US to 200 ft. US. It is eroded and there are roots exposed.

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

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

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

NO CHANNEL SCOUR

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

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

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

54. Confluence comments (eg. confluence name):

NO MAJOR CONFLUENCES

D. Under Bridge Channel Assessment

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

56. Height (BF) 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
32.5		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.):

425

63. The stream bed is primarily cobble. The channel has a steep gradient US with a large amount of cobbles and boulders in the streambed and along the banks.

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 **3**____ *(1- Low; 2- Moderate; 3- High)*

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

70. Debris and Ice Comments:

2

There are scarred and downed trees US and along the banks, also there are large boulders, 3 ft. to 6 ft. in diameter, along the banks US and DS. High flow ice is evident by scarred trees US and a 6 ft. log wedged between the I beams and the right abutment about 6 ft. above the stream bed.

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**	**-**	**-**	**90.0**
RABUT	**1**	**5**	**90**			**2**	**0**	**45.5**

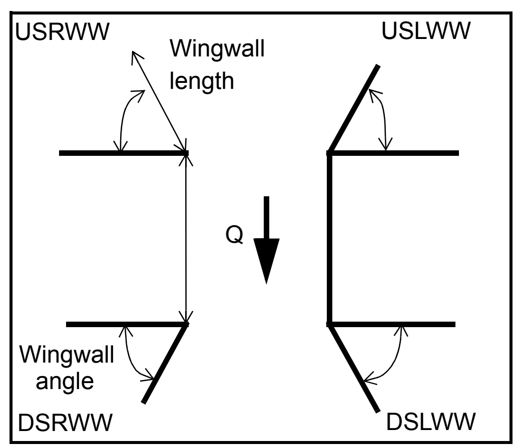
Pushed: LB or RB *Toe Location (Loc.): 0- even, 1- set back, 2- protrudes*
Scour cond.: 0- not evident; 1- evident (comment); 2- footing exposed; 3-undermined footing; 4- piling exposed; 5- settled; 6- failed
Materials: *1*- Concrete; *2*- Stone masonry or drywall; *3*- steel or metal; *4*- wood

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

-
-
1
-

80. **Wingwalls**:

	Exist?	Material?	Scour Condition?	Scour depth?	Exposure depth?	81. Angle?	Length?
USLWW:						**45.5**	
USRWW:	**N**		**-**		**-**	**1.0**	
DSLWW:	**-**		**-**		**N**	**68.0**	
DSRWW:	**-**		**-**		**-**	**68.5**	



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**	**-**	**-**	**-**	**-**	**-**
Condition	**N**	**-**	**-**	**-**	**-**	**--**	**-**	**-**
Extent	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

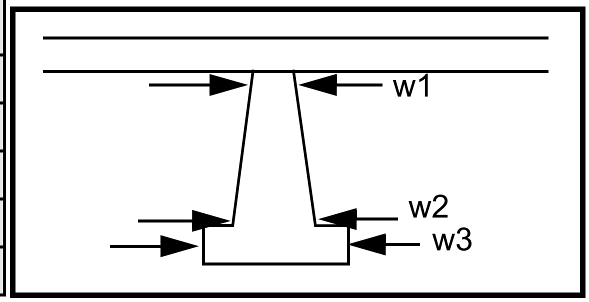
Bank / Bridge protection types: 0- absent; 1- < 12 inches; 2- < 36 inches; 3- < 48 inches; 4- < 60 inches; 5- wall / artificial levee
Bank / Bridge protection conditions: 1- good; 2- slumped; 3- eroded; 4- failed
Protection extent: 1- entire base length; 2- US end; 3- DS end; 4- other

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

Piers:

84. Are there piers? _-____ *(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)		-	-	-	*LFP, LTB, LB, MCL, MCM, MCR, RB, RTB, RFP*
87. Type		-	-	-	***1**- Solid pier, **2**- column, **3**- bent*
88. Material		-	-	-	***1**- Wood; **2**- concrete; **3**- metal; **4**- stone*
89. Shape		-	-	-	***1**- Round; **2**- Square; **3**- Pointed*
90. Inclined?		-	-	-	*Y- yes; N- no*
91. Attack ∠ (BF)		-	-	-	
92. Pushed		-	-	-	*LB or RB*
93. Length (feet)	-	-	-	-	
94. # of piles		-	-	-	
95. Cross-members		-	-	-	***0**- none; **1**- laterals; **2**- diagonals; **3**- both*
96. Scour Condition		-	-	-	***0**- not evident; **1**- evident (comment); **2**- footing exposed; **3**- piling exposed; **4**- undermined footing; **5**- settled; **6**- failed*
97. Scour depth	**N**	-	-	-	
98. Exposure depth	-	-	-	-	

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

-
-
-
-
-
-
-
-
-
-

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
-	-			-	-	NO	PIE	RS		

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.):

2
2
420
4520
2
2
452
1
2
3
3
Bank protection along both banks extends beyond 200 ft. DS but the banks are eroding due to high flows and ice conditions. Bank erosion is evident by scalloped banks and exposed tree roots.

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 **N** feet **-** *(US, UB, DS)* positioned **NO** %LB to **DR** %RB

Material: **OP**

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

STRUCTURE

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

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

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

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

-
-
-
-

Is channel scour present? **NO** *(Y or if N type ctrl-n cs)* Mid-scour distance: **POIN**

Scour dimensions: Length **T** Width **BAR** Depth: **S** Positioned ____ %LB to ____ %RB

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

N
-
-

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 **NO** Enters on **CU** *(LB or RB)* Type **T** *(**1**- perennial; **2**- ephemeral)*

Confluence comments (eg. confluence name):

BANKS

F. Geomorphic Channel Assessment

107. Stage of reach evolution _____

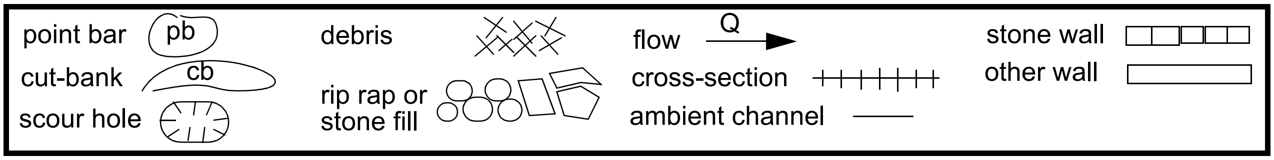
1- Constructed
2- Stable
3- Aggraded
4- Degraded
5- Laterally unstable
6- Vertically and laterally unstable

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

N
-
-
-
-
-
-
NO CHANNEL SCOUR

N

109. G. Plan View Sketch



APPENDIX F:

SCOUR COMPUTATIONS

SCOUR COMPUTATIONS

Structure Number: STAMVT01000006 Town: Stamford
Road Number: Vermont Highway 100 County: Bennington
Stream: No. Branch of Hoosic River

Initials RF Date: 2/06/97 Checked: SAO

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	2930	4890	2830
Main Channel Area, ft2	403	539	390
Left overbank area, ft2	184	682	149
Right overbank area, ft2	214	416	196
Top width main channel, ft	48	48	48
Top width L overbank, ft	134	223	126
Top width R overbank, ft	68	76	67
D50 of channel, ft	0.3195	0.3195	0.3195
D50 left overbank, ft	--	--	--
D50 right overbank, ft	--	--	--
y1, average depth, MC, ft	8.4	11.2	8.1
y1, average depth, LOB, ft	1.4	3.1	1.2
y1, average depth, ROB, ft	3.1	5.5	2.9
Total conveyance, approach	58420	138342	53019
Conveyance, main channel	39874	64660	37748
Conveyance, LOB	6164	38914	4515
Conveyance, ROB	12383	34768	10756
Percent discrepancy, conveyance	-0.0017	0.0000	0.0000
Qm, discharge, MC, cfs	1999.8	2285.5	2014.9
Ql, discharge, LOB, cfs	309.1	1375.5	241.0
Qr, discharge, ROB, cfs	621.1	1229.0	574.1
Vm, mean velocity MC, ft/s	5.0	4.2	5.2
Vl, mean velocity, LOB, ft/s	1.7	2.0	1.6
Vr, mean velocity, ROB, ft/s	2.9	3.0	2.9
Vc-m, crit. velocity, MC, ft/s	10.9	11.5	10.9
Vc-l, crit. velocity, LOB, ft/s	ERR	ERR	ERR
Vc-r, crit. velocity, ROB, ft/s	ERR	ERR	ERR

Results

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

ARMORING

D90	0.9264	0.9264	0.9264

D95	1.1968	1.1968	1.1968
Critical grain size,Dc, ft	0.6299	0.8136	0.5994
Decimal-percent coarser than Dc	0.1825	0.1266	0.1933
Depth to armoring,ft	8.46	16.84	7.50

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	403	539	390
Main channel width, ft	48	48	48
y1, main channel depth, ft	8.40	11.23	8.13

Bridge Section			
(Q) total discharge, cfs	2930	4890	2830
(Q) discharge thru bridge, cfs	2901	3297	2830
Main channel conveyance	15031	15031	15031
Total conveyance	15031	15031	15031
Q2, bridge MC discharge,cfs	2901	3297	2830
Main channel area, ft2	268	268	268
Main channel width (skewed), ft	46.55	46.55	46.55
Cum. width of piers in MC, ft	0.0	0.0	0.0
W, adjusted width, ft	46.55	46.55	46.55
y_bridge (avg. depth at br.), ft	5.76	5.76	5.76
Dm, median (1.25*D50), ft	0.399375	0.399375	0.399375
y2, depth in contraction,ft	5.56	6.20	5.44
ys, scour depth (y2-ybridge), ft	-0.20	0.44	-0.32

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	2930	4890	2830
Q, thru bridge, cfs	2901	3297	2830
Total Conveyance, bridge	15031	15031	15031
Main channel(MC) conveyance, bridge	15031	15031	15031
Q, thru bridge MC, cfs	2901	3297	2830
Vc, critical velocity, ft/s	10.93	11.47	10.87
Vc, critical velocity, m/s	3.33	3.50	3.31
Main channel width (skewed), ft	46.55	46.55	46.55
Cum. width of piers in MC, ft	0.0	0.0	0.0
W, adjusted width, ft	46.55	46.55	46.55
qbr, unit discharge, ft2/s	62.3	70.8	60.8
qbr, unit discharge, m2/s	5.8	6.6	5.6
Area of full opening, ft2	268.1	268.1	268.1

Hb, depth of full opening, ft	5.76	5.76	5.76
Hb, depth of full opening, m	1.76	1.76	1.76
Fr, Froude number, bridge MC	0.79	0.90	0.78
Cf, Fr correction factor (<=1.0)	1.00	1.00	1.00
Elevation of Low Steel, ft	494.33	494.33	494.33
Elevation of Bed, ft	488.57	488.57	488.57
Elevation of Approach, ft	498.92	501.73	498.65
Friction loss, approach, ft	0.61	0.50	0.64
Elevation of WS immediately US, ft	498.31	501.23	498.01
ya, depth immediately US, ft	9.74	12.66	9.44
ya, depth immediately US, m	2.97	3.86	2.88
Mean elevation of deck, ft	500.215	500.215	500.215
w, depth of overflow, ft (>=0)	0.00	1.01	0.00
Cc, vert contrac correction (<=1.0)	0.85	0.79	0.86
Ys, depth of scour, ft	0.98	2.06	0.74

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	2930	4890	2830	2930	4890	2830
a', abut.length blocking flow, ft	126.9	215.6	118.9	76.9	84.8	76.1
Ae, area of blocked flow ft2	159.43	596.7	125.37	269.5	376.7	258.1
Qe, discharge blocked abut.,cfs	251.25	--	194.79	--	--	844.96
(If using Qtotal_overbank to obtain Ve, leave Qe blank and enter Ve and Fr manually)						
Ve, (Qe/Ae), ft/s	1.58	1.95	1.55	3.21	3.08	3.27
ya, depth of f/p flow, ft	1.26	2.77	1.05	3.50	4.44	3.39
--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	30	30	30	150	150	150
K2	0.87	0.87	0.87	1.07	1.07	1.07
Fr, froude number f/p flow	0.248	0.201	0.267	0.297	0.222	0.313
ys, scour depth, ft	8.94	16.09	8.12	18.80	19.73	18.83

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)	126.9	215.6	118.9	76.9	84.8	76.1
y1 (depth f/p flow, ft)	1.26	2.77	1.05	3.50	4.44	3.39
a'/y1	101.01	77.90	112.76	21.94	19.09	22.44
Skew correction (p. 49, fig. 16)	0.57	0.57	0.57	1.13	1.13	1.13
Froude no. f/p flow	0.25	0.20	0.27	0.30	0.22	0.31
Ys w/ corr. factor K1/0.55:						
vertical	3.29	6.76	2.83	ERR	ERR	ERR
vertical w/ ww's	2.69	5.54	2.32	ERR	ERR	ERR
spill-through	1.81	3.72	1.55	ERR	ERR	ERR

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	0.79	0.90	0.78	0.79	0.90	0.78
(Fr from the characteristic V and y in contracted section--mc, bridge section)						
y, depth of flow in bridge, ft	5.76	5.76	5.76	5.76	5.76	5.76
Median Stone Diameter for riprap at:	left abutment			right abutment, ft		
Fr<=0.8 (vertical abut.)	2.22	ERR	2.17	2.22	ERR	2.17
Fr>0.8 (vertical abut.)	ERR	2.34	ERR	ERR	2.34	ERR
Fr<=0.8 (spillthrough abut.)	1.94	ERR	1.89	1.94	ERR	1.89
Fr>0.8 (spillthrough abut.)	ERR	2.07	ERR	ERR	2.07	ERR