LEVEL II SCOUR ANALYSIS FOR BRIDGE 11 (STAMVT01000011) on STATE ROUTE 100, crossing CRAZY JOHN STREAM, STAMFORD, VERMONT

Open-File Report 97-824

Prepared in cooperation with

VERMONT AGENCY OF TRANSPORTATION

and

FEDERAL HIGHWAY ADMINISTRATION

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

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By MICHAEL A. IVANOFF AND JAMES R. DEGNAN

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Pembroke, New Hampshire

1997

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

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

OTHER ABBREVIATIONS

BF	bank full	MC	main channel
cfs	cubic feet per second	NGVD	National Geodetic Vertical Datum
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
LWW	left wingwall		

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 11 (STAMVT01000011) ON STATE ROUTE 100, CROSSING CRAZY JOHN STREAM, STAMFORD, VERMONT

By **Michael A. Ivanoff and James R. Degnan**

INTRODUCTION AND SUMMARY OF RESULTS

This report provides the results of a detailed Level II analysis of scour potential at structure STAMVT01000011 on State Route 100 crossing Crazy John Stream, 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 2.28-mi^2 drainage area is in a predominantly rural and forested basin. In the vicinity of the study site, the surface cover is pasture upstream of the bridge while the immediate banks have dense woody vegetation. Just downstream of the bridge, Crazy John Stream enters on the right bank of the North Branch Hoosic River. The downstream right bank of the North Branch Hoosic River is covered by shrubs and brush. The left bank of the North Branch Hoosic River is forested.

In the study area, Crazy John Stream has an incised, sinuous channel with a slope of approximately 0.03 ft/ft, an average channel top width of 45 ft and an average bank height of 7 ft. The channel bed material ranges from sand to cobbles with a median grain size (D_{50}) of 65.6 mm (0.215 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 stable.

The State Route 100 crossing of Crazy John Stream is a 28-ft-long, two-lane bridge consisting of one 25-foot concrete slab span (Vermont Agency of Transportation, written communication, September 28, 1995). The opening length of the structure parallel to the bridge face is 24.1 ft. The bridge is supported by vertical, concrete abutments with wingwalls. The channel is skewed approximately 40 degrees to the opening while the calculated opening-skew-to-roadway is 35 degrees.

A scour hole 1.25 ft deeper than the mean thalweg depth was observed along the upstream end of the right abutment during the Level I assessment. There also was channel scour 2 ft deeper than the mean thalweg depth in the North Branch Hoosic River at the confluence with Crazy John Stream. The only scour protection measure at the site was type-2 stone fill (less than 36 inches diameter) at the upstream end of the upstream left wingwall, along the entire base length of the upstream right wingwall and the downstream wingwalls, the upstream banks, and the downstream right bank of the North Branch Hoosic River. Additional details describing conditions at the site are included in the Level II Summary and Appendices D and E.

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

Contraction scour for all modelled flows was zero ft. Left abutment scour ranged from 6.0 to 8.4 ft. The worst-case left abutment scour occurred at the 500-year discharge. The worst-case right abutment scour occurred at the incipient roadway-overtopping 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 STAMVT01000011 ***Stream*** Crazy John Stream

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

Description of Bridge

Bridge length 28 ***ft*** ***Bridge width*** 36.5 ***ft*** ***Max span length*** 25 ***ft***

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

Abutment type Vertical, concrete ***Embankment type*** None

Stone fill on abutment? No ***Date of inspection*** 8/1/96

Description of stone fill Type-2, around the upstream end of the upstream left wingwall, along the entire base length of the upstream right wingwall, and along the entire base length of the downstream left and right wingwalls.

Brief description of piers/abutments Abutments and wingwalls are concrete. There is a 1.25 ft deep scour hole in front of the upstream end of the right abutment.

Is bridge skewed to flood flow according to Y ***survey?*** Yes ***Angle*** 40

There is a mild channel bend in the upstream reach. The scour hole has developed in the location where the flow impacts 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	8/1/96	0	0
Level II	8/1/96	0	0

Potential for debris Moderate. There are trees leaning over the channel upstream.

Describe any features near or at the bridge that may affect flow (include observation date) Just downstream of the bridge, Crazy John Stream enters on the right bank of the North Branch Hoosic River as noted on 8/1/96.

Description of the Geomorphic Setting

General topography The channel is located in a moderate relief valley with a flat to slightly irregular, narrow flood plain.

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

Date of inspection 8/1/96

DS left: Steep channel bank to a narrow flood plain.

DS right: Steep channel bank to a narrow flood plain.

US left: Steep channel bank to a narrow flood plain.

US right: Steep channel bank to a narrow flood plain.

Description of the Channel

Average top width 45 ***ft*** ***Average depth*** 7 ***ft***

Predominant bed material Gravel / Cobbles ***Bank material*** Gravel/Cobbles

Perennial, sinuous, and stable stream with non-alluvial channel boundaries and a narrow flood plain.

8/1/96

Vegetative co

North Branch Hoosic River with trees and brush on the left bank.

DS left: North Branch Hoosic River with a few trees and brush on the right bank.

DS right: A few trees with short grass and brush on the overbank.

US left: A few trees with short grass and brush on the overbank.

US right:

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

The assessment of 8/1/96 noted a side bar along the left abutment under the bridge.

Describe any obstructions in channel and date of observation.

Hydrology

Drainage area 2.28 ***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***: -

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 630 ***ft³/s*** ***Q500*** 850 ***ft³/s***

The 100- and 500-year discharges are based on a flood frequency curve developed by use of discharges from the VTAOT database for this site. A drainage area relationship [(5.18/2.28)^0.67] was used to determine the combined discharge for the North Branch Hoosic River and Crazy John Stream. The drainage area adjusted discharge values are within a range of several flood frequency curves based on 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 Add 872.3 ft to the USGS arbitrary survey datum to obtain VTAOT plans' datum. Add 1.5 ft to VTAOT plans' datum to obtain NGVD 29.

Description of reference marks used to determine USGS datum. RM1 is a VT Highway Dept. brass tablet on the top of the downstream end of the right abutment (elev. 499.36 ft, arbitrary survey datum). RM2 is a chiseled X on top of the upstream end of the left abutment (elev. 500.44 ft, arbitrary survey datum). RM16 is a VT Highway Dept. brass tablet on the top of the upstream left guardrail post on the downstream bridge over the North Branch

Hoosic River (elev. 1368.62 ft, NGVD 1929).

Cross-Sections Used in WSPRO Analysis

[1]*Cross-section*	*Section Reference Distance (SRD) in feet*	[2]*Cross-section development*	*Comments*
EXITX	-42	1	Exit section on North Branch Hoosic River
EXIT2	-22	2	Exit section (Templated from the Approach section)
FULLV	0	2	Downstream Full-valley section (Templated from EXIT2)
BRIDG	0	1	Bridge section
RDWAY	22	1	Road Grade section
APPRO	63	1	Approach section

[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.

[2] Cross-section development: (1) survey at SRD, (2) shift of survey data to SRD, (3) modification of survey data, (4) composite bridge section, (5) other.

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 0.045 to 0.060, and overbank "n" values ranged from 0.030 to 0.040.

Normal depth at the exit section (EXITX) in the North Branch Hoosic River, 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 0.0294 ft/ft, which was determined from the 100-year water surface profile slope downstream of the confluence in the Flood Insurance Study for Stamford, VT (U.S. Department of Housing and Urban Development, 1978). The combined discharges for the North Branch Hoosic River and Crazy John Stream were used to determine the starting water surface. The exit section for Crazy John Stream (EXIT2) was templated from the surveyed approach section based on a slope of 0.027 ft/ft between the approach section and the North Branch Hoosic River.

The approach section (APPRO) was surveyed one bridge length upstream of the upstream face as recommended by Shearman and others (1986). This location provides a consistent method for determining scour variables.

Bridge Hydraulics Summary

Average bridge embankment elevation 500.7 ***ft***
Average low steel elevation 498.2 ***ft***

100-year discharge 630 ***ft³/s***
Water-surface elevation in bridge opening 496.3 ***ft***
Road overtopping? No ***Discharge over road*** -- ***ft³/s***
Area of flow in bridge opening 78 ***ft²***
Average velocity in bridge opening 8.1 ***ft/s***
Maximum WSPRO tube velocity at bridge 9.9 ***ft/s***

Water-surface elevation at Approach section with bridge 497.8
Water-surface elevation at Approach section without bridge 497.4
Amount of backwater caused by bridge 0.4 ***ft***

500-year discharge 850 ***ft³/s***
Water-surface elevation in bridge opening 498.5 ***ft***
Road overtopping? Yes ***Discharge over road*** 22 ***ft³/s***
Area of flow in bridge opening 116 ***ft²***
Average velocity in bridge opening 7.1 ***ft/s***
Maximum WSPRO tube velocity at bridge 8.4 ***ft/s***

Water-surface elevation at Approach section with bridge 499.4
Water-surface elevation at Approach section without bridge 498.2
Amount of backwater caused by bridge 1.2 ***ft***

Incipient overtopping discharge 740 ***ft³/s***
Water-surface elevation in bridge opening 496.7 ***ft***
Area of flow in bridge opening 87 ***ft²***
Average velocity in bridge opening 8.5 ***ft/s***
Maximum WSPRO tube velocity at bridge 10.4 ***ft/s***

Water-surface elevation at Approach section with bridge 498.3
Water-surface elevation at Approach section without bridge 497.8
Amount of backwater caused by bridge 0.5 ***ft***

Scour Analysis Summary

Special Conditions or Assumptions Made in Scour Analysis

Scour depths were computed using the general guidelines described in Hydraulic Engineering Circular 18 (Richardson and others, 1995). Scour depths were calculated assuming an infinite depth of erosive material and a homogeneous particle-size distribution.

Contraction scour for the 100-year and incipient roadway-overtopping discharges was computed by use of the Laursen clear-water contraction scour equation (Richardson and others, 1995, p. 32, equation 20). At this site, the 500-year discharge resulted in unsubmerged 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 this discharge was computed by use of the Chang equation (Richardson and others, 1995, p. 145-146). The results of the scour analysis for the 100-year and 500-year discharges are presented in Tables 1 and 2 and a graph of the scour depths is presented in Figure 8. The computed depths to streambed armoring suggest armoring will not limit the depth of contraction scour. The results of the contraction scour computations was zero ft.

For comparison, contraction scour for the 500-year discharge was also computed by use of the Laursen clear-water contraction scour equation (Richardson and others, 1995, p. 32, equation 20) and the Umbrell pressure-flow equation (Richardson and others, 1995, p. 144) and presented in Appendix F. Furthermore, for the 500-year discharge, contraction scour was computed by substituting an estimate for the depth of flow at the downstream bridge face in the contraction scour equations. Results with respect to this substitution are provided in Appendix F.

Abutment scour 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. The results of the scour analysis for the 100-year and 500-year discharges are presented in Tables 1 and 2 and a graph of the scour depths is presented in Figure 8.

Scour Results

Contraction scour:	100-yr discharge	500-yr discharge	Incipient overtopping discharge
	(Scour depths in feet)		
Main channel			
Live-bed scour	--	--	--
Clear-water scour	0.0	0.0	0.0
Depth to armoring	2.3	1.3	2.8
Left overbank	--	--	--
Right overbank	--	--	--
Local scour:			
Abutment scour			
Left abutment	6.4	8.4	7.3
Right abutment	6.0	6.2	6.7
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	1.3	1.2	1.4
Right abutment	1.3	1.2	1.4
Piers:			
Pier 1	--	--	--
Pier 2	--	--	--

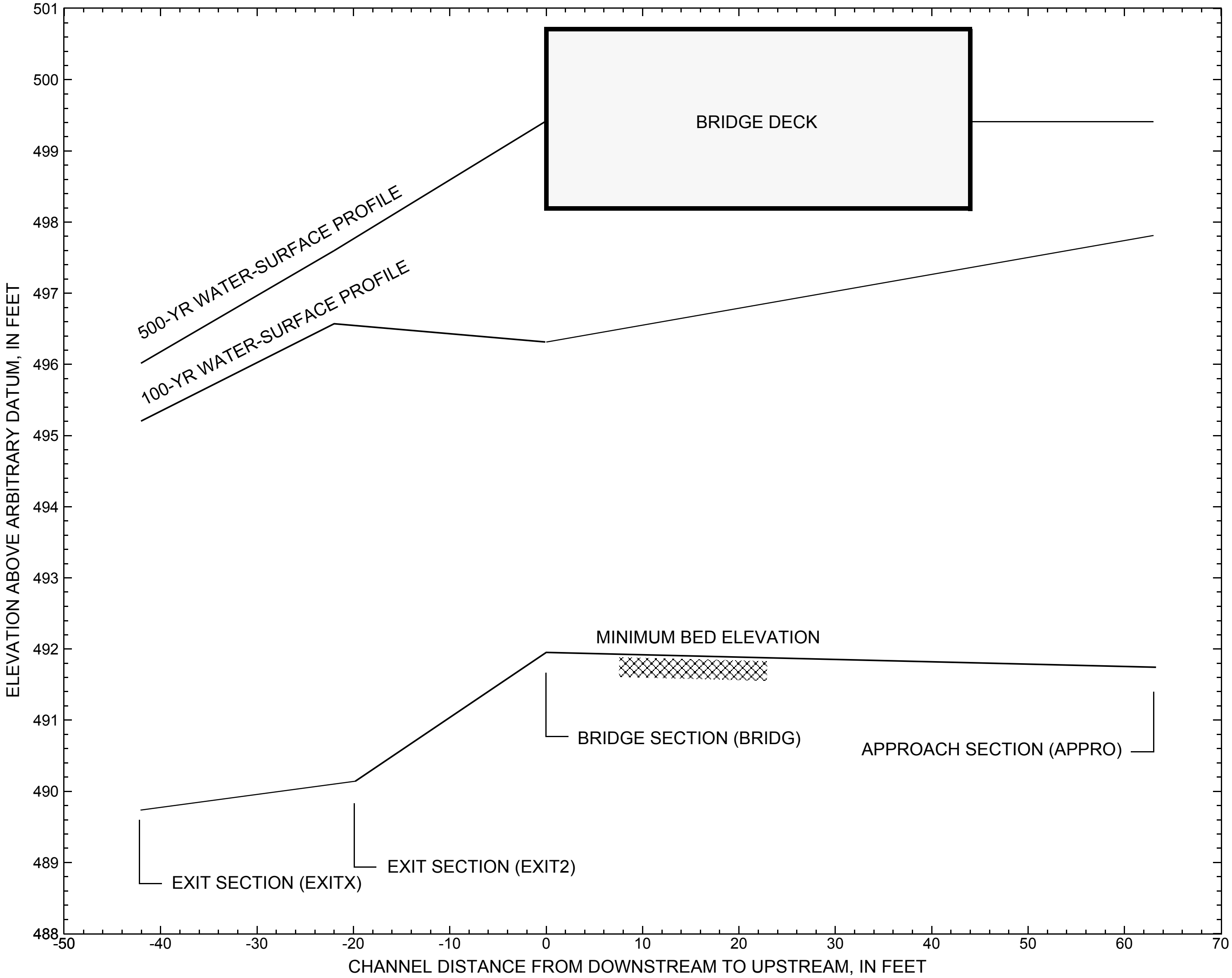

Figure 7. Water-surface profiles for the 100- and 500-yr discharges at structure STAMVT01000011 on State Route 100, crossing Crazy John Stream, Stamford, Vermont.

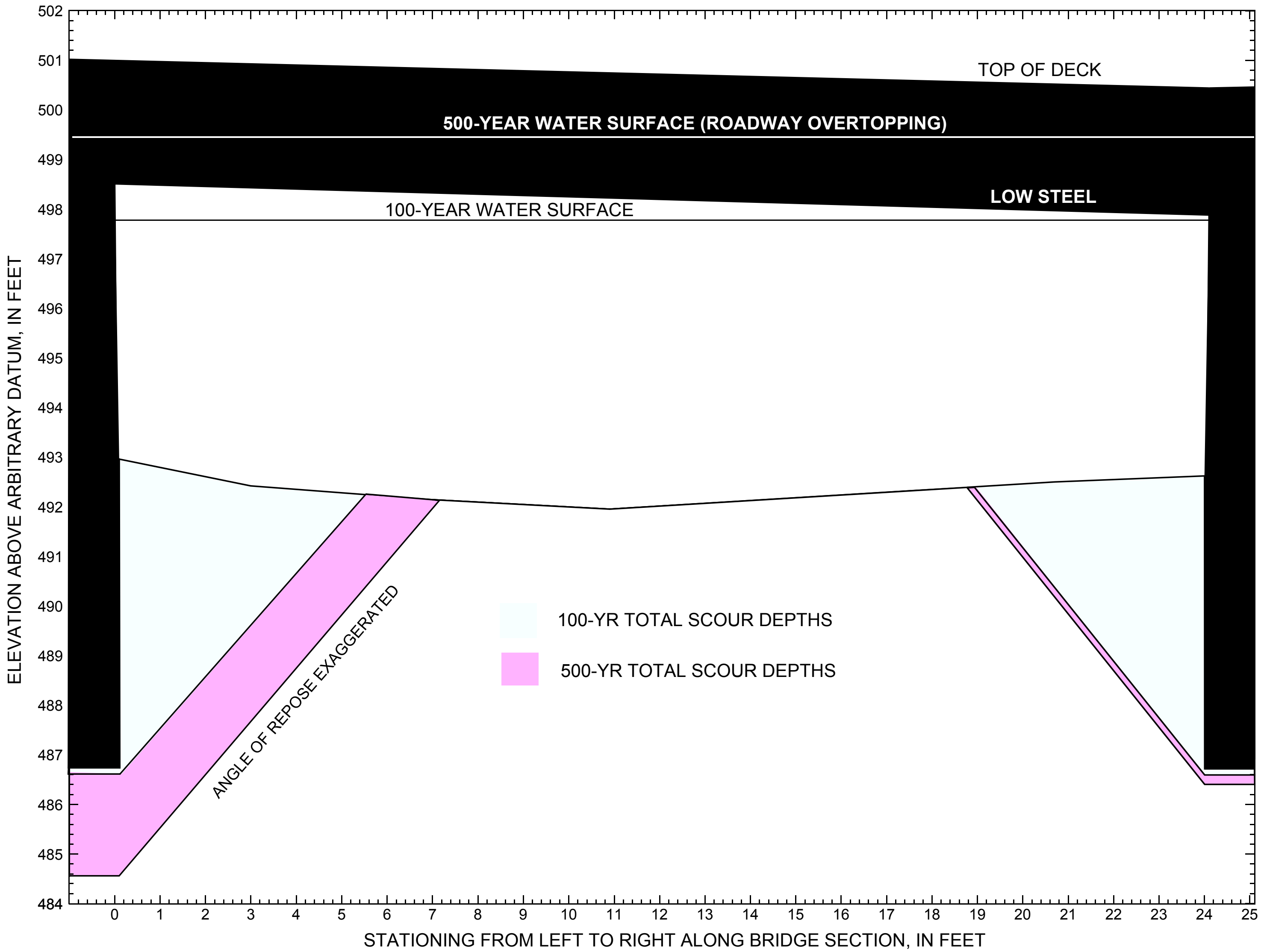

Figure 8. Scour elevations for the 100-yr and 500-yr discharges at structure STAMVT01000011 on State Route 100, crossing Crazy John Stream, Stamford, Vermont.

Table 1. Remaining footing/pile depth at abutments for the 100-year discharge at structure STAMVT01000011 on State Route 100, crossing Crazy John Stream, Stamford, Vermont.

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

Description	Station[1]	VTAOT minimum low-chord elevation (feet)	Surveyed minimum low-chord elevation[2] (feet)	Bottom of footing/pile elevation[2] (feet)	Channel elevation at abutment/ pier[2] (feet)	Contraction scour depth (feet)	Abutment scour depth (feet)	Pier scour depth (feet)	Depth of total scour (feet)	Elevation of scour[2] (feet)	Remaining footing/pile depth (feet)
100-yr. discharge is 630 cubic-feet per second											
Left abutment	0.0	--	498.5	486.7	493.0	0.0	6.4	--	6.4	486.6	-0.1
Right abutment	24.1	--	497.9	486.7	492.6	0.0	6.0	--	6.0	486.6	-0.1

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 STAMVT01000011 on State Route 100, crossing Crazy John Stream, Stamford, Vermont.

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

Description	Station[1]	VTAOT minimum low-chord elevation (feet)	Surveyed minimum low-chord elevation[2] (feet)	Bottom of footing/pile elevation[2] (feet)	Channel elevation at abutment/ pier[2] (feet)	Contraction scour depth (feet)	Abutment scour depth (feet)	Pier scour depth (feet)	Depth of total scour (feet)	Elevation of scour[2] (feet)	Remaining footing/pile depth (feet)
500-yr. discharge is 850 cubic-feet per second											
Left abutment	0.0	--	498.5	486.7	493.0	0.0	8.4	--	8.4	484.6	-2.1
Right abutment	24.1	--	497.9	486.7	492.6	0.0	6.2	--	6.2	486.4	-0.3

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 stam011.wsp
T2        Hydraulic analysis for structure STAMVT01000011   Date: 21-JAN-97
T3        Bridge # 11 over Crazy John Stream in 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           1090.0   1470.0  1280.0
SK          0.0294   0.0294  0.0294
*
XS   EXITX    -42
GR         -24.9, 505.16    -11.3, 496.99      0.0, 491.29      1.3, 490.23
GR           5.6, 489.73      9.9, 490.05     15.1, 491.30     16.9, 490.82
GR          18.4, 491.27     27.3, 496.28     34.0, 499.55     78.9, 498.61
GR         152.5, 498.42    211.5, 500.42    376.7, 503.09
N          0.060        0.040
SA                 34.0
*
XS   EXIT2     -20
GR        -304.4, 506.15   -110.3, 501.78    -12.0, 498.29     -5.9, 494.43
GR           0.0, 493.59      6.8, 492.53     10.5, 491.73     13.6, 490.99
GR          17.2, 491.01     19.9, 490.15     20.6, 491.78     32.8, 497.81
GR          79.2, 497.38    116.7, 500.93    174.0, 504.44    260.9, 506.89
N          0.030        0.060        0.040
SA               -12.0          32.8
*
Q           630.0    850.0   740.0
*
XS   FULLV      0  * * *   0.027
*
*             SRD     LSEL    XSSKEW
BR   BRIDG     0    498.2       35.0
GR           0.0, 498.51      0.0, 492.96      3.0, 492.42      7.0, 492.14
GR          10.9, 491.95     16.1, 492.24     20.7, 492.50     24.0, 492.62
GR          24.1, 497.88      0.0, 498.51
*
*         BRTYPE  BRWDTH        WWANGL    WWWID
CD          1      51.3 * *     37.7     11.0
N          0.045
*
*             SRD    EMBWID   IPAVE
XR   RDWAY     22      36.5     1
GR        -319.7, 507.94   -177.8, 504.83      0.0, 501.00     19.8, 500.44
GR          41.5, 499.87     79.2, 498.86    116.7, 502.51
*   78.9, 498.61    152.5, 498.42    211.5, 500.42    376.7, 503.09
*
AS   APPRO     63
GR        -304.4, 507.73   -110.3, 503.36    -12.0, 499.87     -5.9, 496.01
GR           0.0, 495.17      6.8, 494.11     10.5, 493.31     13.6, 492.57
GR          17.2, 492.59     19.9, 491.73     20.6, 493.36     32.8, 499.39
GR          79.2, 498.96    116.7, 502.51    174.0, 506.02    260.9, 508.47
N          0.030        0.060        0.040
SA               -12.0          32.8
*
HP 1 BRIDG   496.25 1 496.25
HP 2 BRIDG   496.25 * * 630
HP 1 APPRO   497.77 1 497.77
HP 2 APPRO   497.77 * * 630
*
HP 1 BRIDG   498.51 1 498.51
HP 2 BRIDG   498.51 * * 824
HP 1 BRIDG   497.66 1 497.66
HP 2 RDWAY   499.40 * * 22
```

APPENDIX B:

WSPRO OUTPUT FILE

WSPRO OUTPUT FILE

```
         U.S. Geological Survey WSPRO Input File stam011.wsp
         Hydraulic analysis for structure STAMVT01000011   Date: 21-JAN-97
         Bridge # 11 over Crazy John Stream in Stamford, VT  By MAI
            *** RUN DATE & TIME: 12-04-97  10:30
     CROSS-SECTION PROPERTIES:  ISEQ =  4;  SECID = BRIDG;  SRD =       0.

      WSEL  SA#     AREA        K   TOPW   WETP  ALPH    LEW    REW     QCR
              1      78.    5234.    20.    27.                         873.
    496.25           78.    5234.    20.    27.  1.00     0.    24.    873.


     VELOCITY DISTRIBUTION:  ISEQ =  4;  SECID = BRIDG;  SRD =       0.

          WSEL     LEW     REW    AREA        K        Q    VEL
        496.25     0.0    24.1    77.6    5234.     630.   8.12

 X STA.         0.0         2.4         3.8         5.0         6.1         7.1
   A(I)               6.9         4.4         3.8         3.5         3.5
   V(I)              4.56        7.18        8.20        8.97        9.08

 X STA.         7.1         8.1         9.1        10.0        10.9        11.8
   A(I)               3.4         3.3         3.2         3.2         3.2
   V(I)              9.29        9.53        9.74        9.75        9.77

 X STA.        11.8        12.8        13.7        14.7        15.7        16.8
   A(I)               3.2         3.3         3.3         3.3         3.5
   V(I)              9.85        9.67        9.50        9.52        9.10

 X STA.        16.8        17.8        19.0        20.3        21.7        24.1
   A(I)               3.5         3.7         3.9         4.4         7.1
   V(I)              9.06        8.43        8.08        7.23        4.45

     CROSS-SECTION PROPERTIES:  ISEQ =  6;  SECID = APPRO;  SRD =      63.

      WSEL  SA#     AREA        K   TOPW   WETP  ALPH    LEW    REW     QCR
              2     124.    6391.    38.    41.                        1264.
    497.77          124.    6391.    38.    41.  1.00    -9.    30.   1264.


     VELOCITY DISTRIBUTION:  ISEQ =  6;  SECID = APPRO;  SRD =      63.

          WSEL     LEW     REW    AREA        K        Q    VEL
        497.77    -8.7    29.5   123.8    6391.     630.   5.09

 X STA.        -8.7        -2.0         1.1         3.4         5.4         7.1
   A(I)              10.3         7.8         7.0         6.5         6.1
   V(I)              3.05        4.03        4.52        4.84        5.19

 X STA.         7.1         8.6         9.9        11.1        12.2        13.2
   A(I)               5.8         5.5         5.2         5.1         5.0
   V(I)              5.43        5.69        6.04        6.21        6.28

 X STA.        13.2        14.1        15.0        16.0        16.9        17.9
   A(I)               4.8         4.8         4.9         4.8         5.1
   V(I)              6.54        6.52        6.45        6.50        6.15

 X STA.        17.9        18.8        19.7        21.1        23.0        29.5
   A(I)               5.1         5.4         7.0         6.9        10.5
   V(I)              6.15        5.85        4.53        4.54        3.00
```

```
        U.S. Geological Survey WSPRO Input File stam011.wsp
        Hydraulic analysis for structure STAMVT01000011   Date: 21-JAN-97
        Bridge # 11 over Crazy John Stream in Stamford, VT  By MAI
           *** RUN DATE & TIME: 12-04-97  10:30
    CROSS-SECTION PROPERTIES:  ISEQ =  4;  SECID = BRIDG;  SRD =       0.

     WSEL  SA#     AREA        K   TOPW   WETP  ALPH    LEW    REW     QCR
             1     116.    6699.     0.    50.                           0.
   498.51          116.    6699.     0.    50.  1.00     0.    24.      0.

    VELOCITY DISTRIBUTION:  ISEQ =  4;  SECID = BRIDG;  SRD =       0.

         WSEL     LEW     REW    AREA        K        Q    VEL
       498.51     0.0    24.1   116.0    6699.     824.   7.11

 X STA.         0.0        2.1        3.4        4.6        5.6        6.6
   A(I)            9.9        6.3        5.7        5.3        5.1
   V(I)           4.15       6.53       7.25       7.73       8.02

 X STA.         6.6        7.7        8.6        9.6       10.6       11.6
   A(I)            5.2        5.0        5.0        4.9        4.9
   V(I)           7.99       8.18       8.26       8.33       8.33

 X STA.        11.6       12.5       13.5       14.6       15.6       16.7
   A(I)            4.9        5.0        5.1        5.2        5.2
   V(I)           8.38       8.23       8.09       7.95       7.90

 X STA.        16.7       17.9       19.1       20.4       21.8       24.1
   A(I)            5.5        5.4        5.9        6.4        9.8
   V(I)           7.53       7.60       6.94       6.41       4.19

    CROSS-SECTION PROPERTIES:  ISEQ =  4;  SECID = BRIDG;  SRD =       0.

     WSEL  SA#     AREA        K   TOPW   WETP  ALPH    LEW    REW     QCR
             1     105.    8113.    20.    29.                        1374.
   497.64          105.    8113.    20.    29.  1.00     0.    24.   1374.

    VELOCITY DISTRIBUTION:  ISEQ =  5;  SECID = RDWAY;  SRD =      22.

         WSEL     LEW     REW    AREA        K        Q    VEL
       499.40    59.0    84.7     6.9     108.      22.   3.17

 X STA.        59.0       66.4       68.6       70.2       71.5       72.5
   A(I)            0.7        0.5        0.4        0.4        0.4
   V(I)           1.51       2.18       2.47       2.87       3.05

 X STA.        72.5       73.4       74.2       74.9       75.6       76.2
   A(I)            0.3        0.3        0.3        0.3        0.3
   V(I)           3.28       3.41       3.67       3.82       3.92

 X STA.        76.2       76.8       77.4       77.9       78.4       78.9
   A(I)            0.3        0.3        0.3        0.3        0.3
   V(I)           4.01       4.13       4.27       4.25       4.31

 X STA.        78.9       79.4       79.9       80.6       81.5       84.7
   A(I)            0.3        0.3        0.3        0.3        0.5
   V(I)           4.19       4.03       3.67       3.28       2.16

    CROSS-SECTION PROPERTIES:  ISEQ =  6;  SECID = APPRO;  SRD =      63.

     WSEL  SA#     AREA        K   TOPW   WETP  ALPH    LEW    REW     QCR
             2     191.   11896.    44.    48.                        2253.
             3      11.     158.    51.    51.                          31.
   499.40          202.   12053.    95.    99.  1.08   -11.    84.   1610.

    VELOCITY DISTRIBUTION:  ISEQ =  6;  SECID = APPRO;  SRD =      63.

         WSEL     LEW     REW    AREA        K        Q    VEL
       499.40   -11.3    83.8   202.3   12053.     850.   4.20

 X STA.       -11.3       -3.9       -1.0        1.5        3.5        5.4
   A(I)           16.1       11.5       10.4        9.6        9.2
   V(I)           2.64       3.70       4.10       4.43       4.63

 X STA.         5.4        7.1        8.6       10.0       11.3       12.5
   A(I)            8.7        8.5        8.2        8.0        7.8
   V(I)           4.88       5.01       5.16       5.34       5.42

 X STA.        12.5       13.7       14.8       15.9       17.1       18.2
   A(I)            7.6        7.7        7.5        8.0        8.0
   V(I)           5.60       5.51       5.65       5.34       5.29

 X STA.        18.2       19.3       20.8       22.7       25.4       83.8
   A(I)            8.2       10.4        9.9       11.8       25.2
   V(I)           5.20       4.08       4.27       3.61       1.68
```

```
        U.S. Geological Survey WSPRO Input File stam011.wsp
        Hydraulic analysis for structure STAMVT01000011   Date: 21-JAN-97
        Bridge # 11 over Crazy John Stream in Stamford, VT  By MAI
           *** RUN DATE & TIME: 12-04-97  10:30
    CROSS-SECTION PROPERTIES:  ISEQ =  4;  SECID = BRIDG;  SRD =       0.

     WSEL  SA#     AREA        K   TOPW   WETP  ALPH    LEW    REW     QCR
             1      87.    6214.    20.    28.                       1041.
   496.74           87.    6214.    20.    28.  1.00     0.    24.   1041.



    VELOCITY DISTRIBUTION:  ISEQ =  4;  SECID = BRIDG;  SRD =       0.

         WSEL     LEW     REW    AREA        K        Q    VEL
       496.74     0.0    24.1    87.2    6214.     740.   8.48

X STA.         0.0        2.5        3.8        5.0        6.1        7.2
  A(I)             8.0        4.8        4.3        4.1        3.9
  V(I)            4.60       7.70       8.57       8.94       9.60

X STA.         7.2        8.1        9.1       10.0       10.9       11.9
  A(I)             3.8        3.7        3.6        3.6        3.6
  V(I)            9.85      10.11      10.35      10.37      10.39

X STA.        11.9       12.8       13.7       14.7       15.7       16.7
  A(I)             3.6        3.6        3.7        3.7        3.8
  V(I)           10.20      10.32       9.96       9.98       9.74

X STA.        16.7       17.8       19.0       20.2       21.6       24.1
  A(I)             3.9        4.2        4.4        4.9        8.2
  V(I)            9.51       8.83       8.44       7.54       4.53


    CROSS-SECTION PROPERTIES:  ISEQ =  6;  SECID = APPRO;  SRD =      63.

     WSEL  SA#     AREA        K   TOPW   WETP  ALPH    LEW    REW     QCR
             2     145.    8059.    40.    44.                       1568.
   498.32          145.    8059.    40.    44.  1.00   -10.    31.   1568.



    VELOCITY DISTRIBUTION:  ISEQ =  6;  SECID = APPRO;  SRD =      63.

         WSEL     LEW     REW    AREA        K        Q    VEL
       498.32    -9.6    30.6   145.3    8059.     740.   5.09

X STA.        -9.6       -2.7        0.2        2.6        4.6        6.4
  A(I)            12.3        8.7        8.2        7.4        7.1
  V(I)            3.02       4.27       4.54       4.99       5.22

X STA.         6.4        7.9        9.3       10.6       11.8       12.8
  A(I)             6.7        6.4        6.2        6.0        5.9
  V(I)            5.51       5.75       6.01       6.19       6.26

X STA.        12.8       13.9       14.8       15.8       16.8       17.9
  A(I)             5.8        5.6        5.8        5.7        5.9
  V(I)            6.43       6.55       6.38       6.44       6.25

X STA.        17.9       18.9       19.9       21.5       23.5       30.6
  A(I)             6.2        6.4        8.3        8.4       12.4
  V(I)            5.97       5.82       4.47       4.40       2.98
```

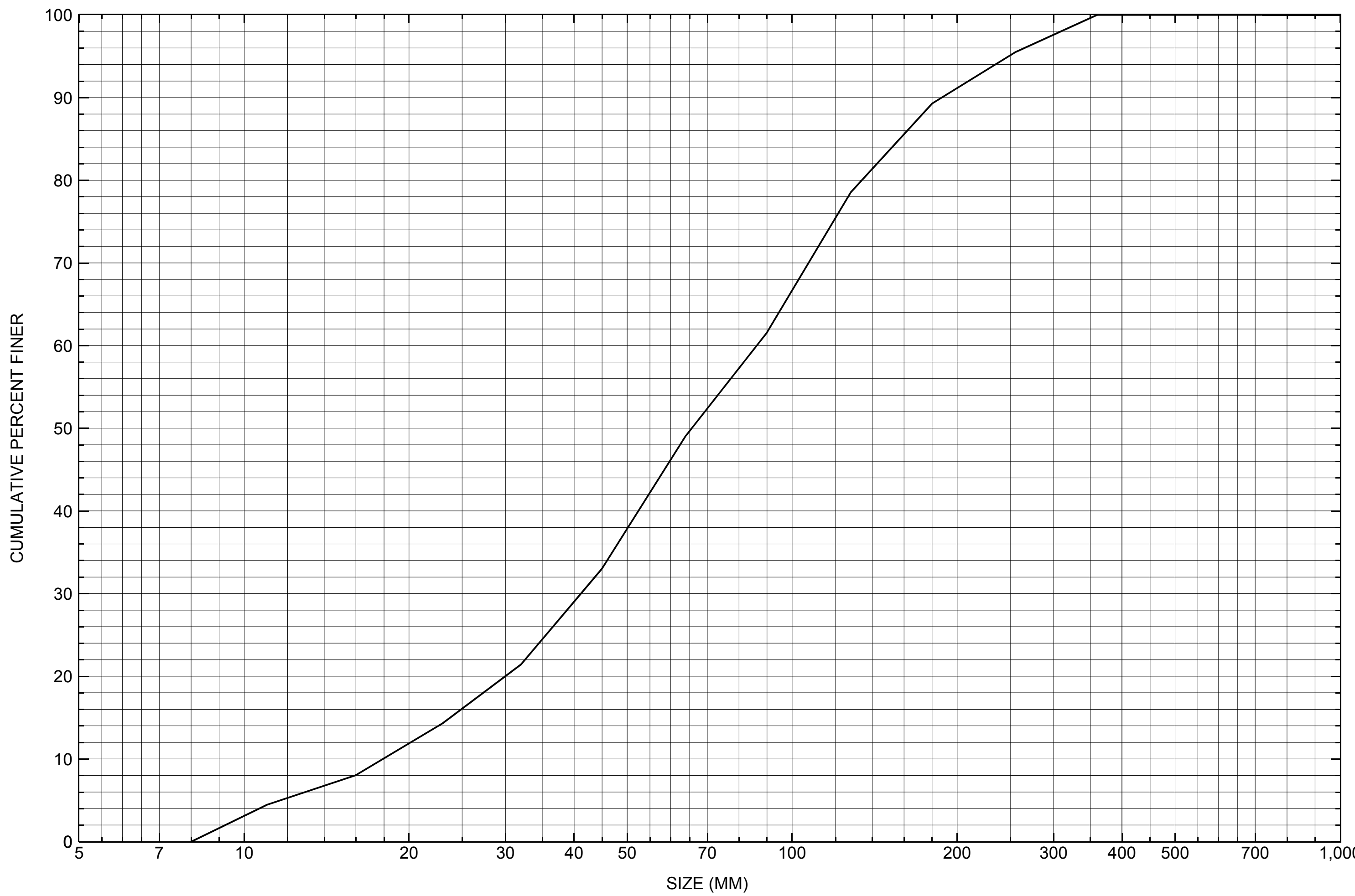
```
        U.S. Geological Survey WSPRO Input File stam011.wsp
        Hydraulic analysis for structure STAMVT01000011   Date: 21-JAN-97
        Bridge # 11 over Crazy John Stream in Stamford, VT  By MAI
           *** RUN DATE & TIME: 12-04-97  10:30

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

EXITX:XS   ******    -8.     116.  1.36 *****  496.54  494.84   1090.  495.18
      -42. ******    25.    6355.  1.00 ***** *******    0.88    9.37

EXIT2:XS      22.    -9.     138.  0.32  0.34  496.88 *******    630.  496.56
      -20.    22.    30.    7477.  1.00  0.00    0.00    0.43    4.57

FULLV:FV      20.    -9.     122.  0.42  0.17  497.09 *******    630.  496.67
        0.    20.    29.    6224.  1.00  0.05   -0.01    0.51    5.18
         <<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>

APPRO:AS      63.    -8.     109.  0.52  0.76  497.90 *******    630.  497.38
       63.    63.    29.    5313.  1.00  0.05    0.00    0.59    5.78
         <<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>

            <<<<<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      20.     0.      78.  1.02  0.20  497.28  495.47    630.  496.25
        0.    20.    24.    5243.  1.00  0.20    0.00    0.72    8.11

     TYPE PPCD FLOW      C    P/A    LSEL   BLEN   XLAB   XRAB
       1. ****   1.  1.000 ******  498.20 ****** ****** ******

    XSID:CODE     SRD   FLEN    HF   VHD     EGL     ERR       Q    WSEL
   RDWAY:RG      22.        <<<<<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      12.    -9.     124.  0.40  0.16  498.17  496.38    630.  497.77
       63.    13.    30.    6382.  1.00  0.74    0.01    0.50    5.10

       M(G)   M(K)       KQ   XLKQ   XRKQ    OTEL
      0.346  0.041    6088.     2.    26.   497.51

  FIRST USER DEFINED TABLE.

    XSID:CODE     SRD    LEW    REW       Q        K      AREA     VEL    WSEL
   EXITX:XS     -42.    -8.    25.   1090.    6355.     116.    9.37  495.18
   EXIT2:XS     -20.    -9.    30.    630.    7477.     138.    4.57  496.56
   FULLV:FV       0.    -9.    29.    630.    6224.     122.    5.18  496.67
   BRIDG:BR       0.     0.    24.    630.    5243.      78.    8.11  496.25
   RDWAY:RG      22.**************       0.******************    1.00********
   APPRO:AS      63.    -9.    30.    630.    6382.     124.    5.10  497.77

    XSID:CODE   XLKQ   XRKQ       KQ
   APPRO:AS       2.    26.    6088.

 SECOND USER DEFINED TABLE.

    XSID:CODE     CRWS     FR#    YMIN    YMAX    HF    HO   VHD      EGL    WSEL
   EXITX:XS     494.84    0.88  489.73  505.16************  1.36  496.54  495.18
   EXIT2:XS   ********    0.43  490.15  506.89  0.34  0.00  0.32  496.88  496.56
   FULLV:FV   ********    0.51  490.69  507.43  0.17  0.05  0.42  497.09  496.67
   BRIDG:BR     495.47    0.72  491.95  498.51  0.20  0.20  1.02  497.28  496.25
   RDWAY:RG   ****************  498.86  507.94**********************************
   APPRO:AS     496.38    0.50  491.73  508.47  0.16  0.74  0.40  498.17  497.77
```

```
       U.S. Geological Survey WSPRO Input File stam011.wsp
       Hydraulic analysis for structure STAMVT01000011   Date: 21-JAN-97
       Bridge # 11 over Crazy John Stream in Stamford, VT  By MAI
          *** RUN DATE & TIME: 12-04-97  10:30

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

EXITX:XS   ******    -9.     145.  1.61 *****  497.60  495.67   1470.  495.99
      -42. ******    27.    8571.  1.00 ***** *******    0.90   10.17

EXIT2:XS      22.   -11.     182.  0.35  0.32  497.92 *******    850.  497.57
      -20.    22.    81.   10953.  1.02  0.00    0.00    0.50    4.67

FULLV:FV      20.   -10.     161.  0.43  0.14  498.09 *******    850.  497.66
        0.    20.    31.    9325.  1.00  0.04   -0.01    0.47    5.28
        <<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>

APPRO:AS      63.    -9.     142.  0.56  0.63  498.79 *******    850.  498.23
       63.    63.    30.    7773.  1.00  0.06    0.00    0.56    6.00
        <<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>

 ===220 FLOW CLASS 1 (4) SOLUTION INDICATES POSSIBLE PRESSURE FLOW.
          WS3,WSIU,WS1,LSEL =   497.14     498.73     498.86     498.20

 ===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      20.     0.     116.  0.78 *****  499.29  496.11    824.  498.51
        0. ******    24.    6699.  1.00 ***** *******    0.57    7.10

     TYPE PPCD FLOW      C    P/A    LSEL   BLEN   XLAB   XRAB
       1. ****   5.  0.455 ******  498.20 ****** ****** ******

    XSID:CODE    SRD   FLEN    HF   VHD     EGL     ERR       Q    WSEL
   RDWAY:RG      22.    27.  0.13  0.30  499.57    0.00     22.  499.40

            Q   WLEN    LEW    REW  DMAX  DAVG  VMAX  VAVG  HAVG  CAVG
   LT:     0.    86.   -74.    12.   1.9   0.9   6.0   7.2   1.7   3.1
   RT:    22.    26.    59.    85.   0.5   0.3   3.0   3.2   0.4   3.0

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

APPRO:AS      12.   -11.     203.  0.30  0.11  499.70  496.93    850.  499.40
       63.    13.    84.   12072.  1.08  0.74    0.00    0.53    4.20

  FIRST USER DEFINED TABLE.

    XSID:CODE    SRD    LEW    REW       Q        K     AREA     VEL    WSEL
   EXITX:XS     -42.    -9.    27.   1470.    8571.     145.   10.17  495.99
   EXIT2:XS     -20.   -11.    81.    850.   10953.     182.    4.67  497.57
   FULLV:FV       0.   -10.    31.    850.    9325.     161.    5.28  497.66
   BRIDG:BR       0.     0.    24.    824.    6699.     116.    7.10  498.51
   RDWAY:RG      22.*******     0.     22.       0.       0.    1.00  499.40
   APPRO:AS      63.   -11.    84.    850.   12072.     203.    4.20  499.40

 SECOND USER DEFINED TABLE.

    XSID:CODE    CRWS     FR#    YMIN    YMAX    HF    HO  VHD     EGL    WSEL
   EXITX:XS    495.67    0.90  489.73  505.16************  1.61  497.60  495.99
   EXIT2:XS  ********    0.50  490.15  506.89  0.32  0.00  0.35  497.92  497.57
   FULLV:FV  ********    0.47  490.69  507.43  0.14  0.04  0.43  498.09  497.66
   BRIDG:BR    496.11    0.57  491.95  498.51************  0.78  499.29  498.51
   RDWAY:RG  ****************  498.86  507.94  0.13******  0.30  499.57  499.40
   APPRO:AS    496.93    0.53  491.73  508.47  0.11  0.74  0.30  499.70  499.40
```

```
        U.S. Geological Survey WSPRO Input File stam011.wsp
        Hydraulic analysis for structure STAMVT01000011   Date: 21-JAN-97
        Bridge # 11 over Crazy John Stream in Stamford, VT  By MAI
           *** RUN DATE & TIME: 12-04-97  10:30

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

EXITX:XS   ******    -9.     131.  1.49 *****  497.09  495.27   1280.  495.60
      -42. ******    26.    7465.  1.00 ***** *******    0.89    9.79

EXIT2:XS      22.   -10.     160.  0.33  0.32  497.43 *******    740.  497.10
      -20.    22.    31.    9258.  1.00  0.00    0.02    0.41    4.62

FULLV:FV      20.    -9.     142.  0.42  0.15  497.62 *******    740.  497.20
        0.    20.    30.    7809.  1.00  0.04   -0.01    0.49    5.21
         <<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>

APPRO:AS      63.    -9.     126.  0.54  0.67  498.36 *******    740.  497.83
       63.    63.    30.    6553.  1.00  0.06    0.01    0.57    5.88
         <<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>

            <<<<<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      20.     0.      87.  1.12  0.19  497.86  495.84    740.  496.74
        0.    20.    24.    6206.  1.00  0.23    0.00    0.71    8.49

     TYPE PPCD FLOW      C    P/A    LSEL   BLEN   XLAB   XRAB
       1. ****   1.  1.000 ******  498.20 ****** ****** ******

    XSID:CODE     SRD   FLEN    HF   VHD     EGL     ERR       Q    WSEL
   RDWAY:RG      22.        <<<<<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      12.   -10.     145.  0.40  0.14  498.73  496.66    740.  498.32
       63.    13.    31.    8067.  1.00  0.73    0.01    0.47    5.09

       M(G)   M(K)       KQ   XLKQ   XRKQ    OTEL
      0.373  0.061    7550.     1.    25.  498.10

   FIRST USER DEFINED TABLE.

    XSID:CODE     SRD    LEW     REW       Q        K      AREA     VEL    WSEL
   EXITX:XS      -42.    -9.     26.   1280.    7465.     131.     9.79  495.60
   EXIT2:XS      -20.   -10.     31.    740.    9258.     160.     4.62  497.10
   FULLV:FV        0.    -9.     30.    740.    7809.     142.     5.21  497.20
   BRIDG:BR        0.     0.     24.    740.    6206.      87.     8.49  496.74
   RDWAY:RG       22.**************      0.*****************     1.00********
   APPRO:AS       63.   -10.     31.    740.    8067.     145.     5.09  498.32

    XSID:CODE   XLKQ   XRKQ       KQ
   APPRO:AS       1.    25.    7550.

  SECOND USER DEFINED TABLE.

    XSID:CODE     CRWS     FR#    YMIN    YMAX    HF    HO   VHD      EGL     WSEL
   EXITX:XS     495.27    0.89  489.73  505.16************  1.49  497.09  495.60
   EXIT2:XS   ********    0.41  490.15  506.89  0.32  0.00  0.33  497.43  497.10
   FULLV:FV   ********    0.49  490.69  507.43  0.15  0.04  0.42  497.62  497.20
   BRIDG:BR     495.84    0.71  491.95  498.51  0.19  0.23  1.12  497.86  496.74
   RDWAY:RG   ****************  498.86  507.94**********************************
   APPRO:AS     496.66    0.47  491.73  508.47  0.14  0.73  0.40  498.73  498.32
```

APPENDIX C:

BED-MATERIAL PARTICLE-SIZE DISTRIBUTION



Appendix C. Bed material particle-size distribution for a pebble count in the channel approach of structure STAMVT01000011, in Stamford, Vermont.

APPENDIX D:

HISTORICAL DATA FORM

United States Geological Survey
Bridge Historical Data Collection and Processing Form

Structure Number STAMVT01000011

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)* 004270

Waterway *(I - 6)* Crazy John Stream

Road Name *(I - 7):* -

Route Number VT 100

Vicinity *(I - 9)* 4.3 miles north of the MA state line

Topographic Map Stamford

Hydrologic Unit Code: -

Latitude *(I - 16; nnnn.n)* 42475

Longitude *(i - 17; nnnnn.n)* 73021

Select Federal Inventory Codes

FHWA Structure Number *(I - 8)* 20010200110214

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

Maximum span length *(I - 48; nnnn)* 0025

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

Structure length *(I - 49; nnnnnn)* 000028

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

Deck Width *(I - 52; nn.n)* 365

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

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

Opening skew to Roadway *(I - 34; nn)* 30

Waterway adequacy *(I - 71; n)* 6

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

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

Structure type *(I - 43; nnn)* 101

Year Reconstructed *(I - 106)* 0000

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

Clear span (*nnn.n ft*) 25

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

Vertical clearance from streambed (*nnn.n ft*) 7.5

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

Waterway of full opening (*nnn.n ft*^{2}) 187.5

Comments:

According to the structural inspection reported dated 8/24/93, the structure is a concrete slab bridge. Both abutments are in good condition, with some minor cracking and scaling along the flow line. Flow in the channel is along the right abutment. Some minor scour is noted along the right abutment, but there is no undermining. There is a gravel and stone buildup along the left abutment under the bridge. There is stone fill along the right bank extending from the US right wingwall. The stream empties into the North Branch Hoosic River 30 ft Downstream.

Bridge Hydrologic Data

Is there hydrologic data available? Y *if No, type ctrl-n h* VTAOT Drainage area *(mi²)*: 2.36

Terrain character: **forested and mountainous**

Stream character & type: -

Streambed material: -

Discharge Data *(cfs)*: $Q_{2.33}$ 200 Q_{10} 370 Q_{25} 470

Q_{50} 550 Q_{100} 630 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: **The confluence with the North Branch of the Hoosic River is just 30 feet downstream of this bridge.**

Watershed storage area (*in percent*): 1 %

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*)	1.9	2.9	3.4	3.8	4.5
Velocity (*ft / sec*)	-	-	-	-	-

Long term stream bed changes: -

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

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

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

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

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

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

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

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

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

Comments:

The headwater elevations are depths at the inlet control. The summary in the hydraulics folder indicates that the existing structure is adequate hydraulically. The design is for a 50-year discharge.
The clear span and waterway opening are based on the summary in the hydraulics file. The 25 ft clear span is based on a 30 degree skew angle. Notes also indicate an unskewed 20 ft clear span, however, plans indicate a 28 ft span.

USGS Watershed Data

Watershed Hydrographic Data

Drainage area *(DA)* **2.28** mi^2 Lake/pond/swamp area **0.003** mi^2

Watershed storage *(ST)* **0.13** %

Bridge site elevation **1280** ft Headwater elevation **2970** ft

Main channel length **2.57** mi

10% channel length elevation **1400** ft 85% channel length elevation **2440** ft

Main channel slope *(S)* **539.56** 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: 1363

Low superstructure elevation: USLAB 1372.76 DSLAB 1372.30 USRAB 1372.14 DSRAB ______

Benchmark location description:

1371.70

No benchmark information in plans, the page appears to be missing from plans.

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

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

If 1: Footing Thickness bitra Footing bottom elevation: ry

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

If 3: Footing bottom elevation: 1359

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

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

Briefly describe material at foundation bottom elevation or around piles:

Y

6

1

According to boring data, the foundation around the right abutment is boulders. Around the left abutment US is sand and gravel, DS is stones and gravel, and at the center of the left abutment is boulders-refusal.

Comments:

The low superstructure elevation is the elevation of the abutment-wingwall top corners from the bridge plans.

Cross-sectional Data

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

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

Comments: **Many bridge and stream cross-sections are with the bridge plans. 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 chord elevation	-	-	-	-	-	-	-	-	-	-	-
Bed elevation	-	-	-	-	-	-	-	-	-	-	-
Low chord-bed	-	-	-	-	-	-	-	-	-	-	-

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

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

Comments: -
-

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

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

APPENDIX E:

LEVEL I DATA FORM

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

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

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

Reviewd by: **MAI** Date: **10/21/97**

Structure Number **STAMVT01000011**

A. General Location Descriptive

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

2. Highway District Number **01** Mile marker **004270**

County **Bennington (003)** Town **Stamford (69775)**

Waterway *(I - 6)* **Crazy John Stream** Road Name **VT 100**

Route Number **VT 100** Hydrologic Unit Code: **02020003**

3. Descriptive comments:

The site is located 4.3 miles north of the Massachusetts state line.

B. Bridge Deck Observations

4. Surface cover... LBUS **4** RBUS **4** LBDS **6** RBDS **5** Overall **5**
*(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 **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 **28** *(feet)* Span length **25** *(feet)* Bridge width **36.5** *(feet)*

Road approach to bridge:

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

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

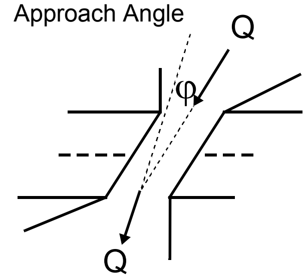
10. Embankment slope (*run / rise in feet / foot*):
US left **--** US right **--**

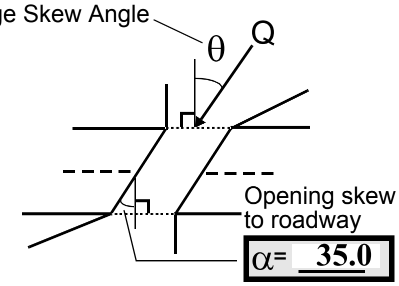
	Protection: 11.Type	Protection: 12.Cond.	13.Erosion	14.Severity
LBUS	0	-	0	0
RBUS	0	-	0	0
RBDS	2	1	3	2
LBDS	2	1	3	2

*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: **30** 16. Bridge skew: **40**





α= **35.0**

17. Channel impact zone 1: Exist? **Y** *(Y or N)*
Where? **RB** *(LB, RB)* Severity **1**
Range? **65** feet **US** *(US, UB, DS)* to **48** feet **US**

Channel impact zone 2: Exist? **Y** *(Y or N)*
Where? **RB** *(LB, RB)* Severity **1**
Range? **25** feet **US** *(US, UB, DS)* to **0** feet **US**

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

18. Bridge Type: **1a**

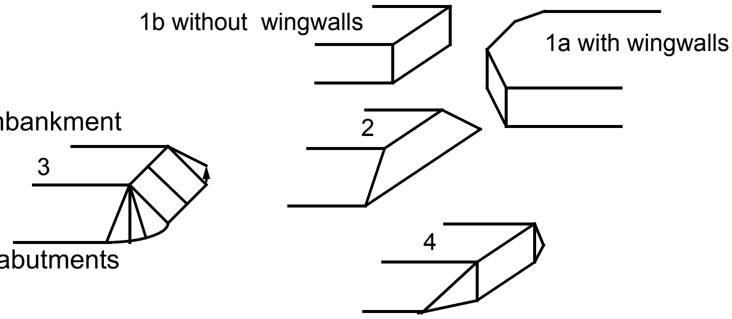
1a- Vertical abutments with wingwalls

1b- Vertical abutments without wingwalls

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

3- Spill through abutments

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



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

4. The immediate banks are all forested.
5. The US half of the water surface under the bridge is pooled.
13. There is road wash erosion behind the DS left wingwall.
11. The DS left road embankment protection also serves as the channel bank protection for the North Branch Hoosic River.
18. The DS wingwall ends are below the bridge low-chord elevation.

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
22.0	**6.0**			**6.0**	**1**	**1**	**432**	**432**	**1**	**2**

23. Bank width **15.0** 24. Channel width **25.0** 25. Thalweg depth **45.0** 29. Bed Material **43**

30 .Bank protection type: LB **2** RB **2** 31. Bank protection condition: LB **1** RB **1**

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.):

26. The vegetation cover beyond two bridge lengths US is between 51% and 75%.
30. The right bank protection extends from 64 ft US to 0 ft US in front of the US right wingwall. The left bank protection extends from 3 ft US to 0 ft US in front of the US left wingwall.
There is a ridge of cobbles, 1 ft high, across the channel 75 ft US that is creating a small pool.
The US measurements were made referencing the right bank.

33. Point/Side bar present? **Y** (Y or N. if N type ctrl-n pb) 34. Mid-bar distance: **120** 35. Mid-bar width: **15**

36. Point bar extent: **140** feet **US** (US, UB) to **92** feet **US** (US, UB, DS) positioned **0** %LB to **75** %RB

37. Material: **43**

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

There is an additional bar extending from 10 ft US to 0 ft DS. The mid bar distance is 0 ft US with a width of 14 ft. It is positioned from 0% LB to 66% 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: **85** 42. Cut bank extent: **150** feet **US** (US, UB) to **64** 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.):

There are many other cut banks US of this one in the anabranching channels.

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

47. Scour dimensions: Length **15** Width **3** Depth : **1.25** Position **90** %LB to **100** %RB

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

The scour depth assumes a 0.75 ft average thalweg.

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
Anabranching occurs on the left bank at 91 ft US and on the right bank at 160 ft.

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
14.0		0.5		2	7	7	-

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

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

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

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

432
-

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:

2

There are trees leaning over the US channel and erosion along the banks.

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		**-**	**90**	**2**	**0**	**0**	**0**	**90.0**
RABUT	**1**	**5**	**90**			**2**	**1**	**19.5**

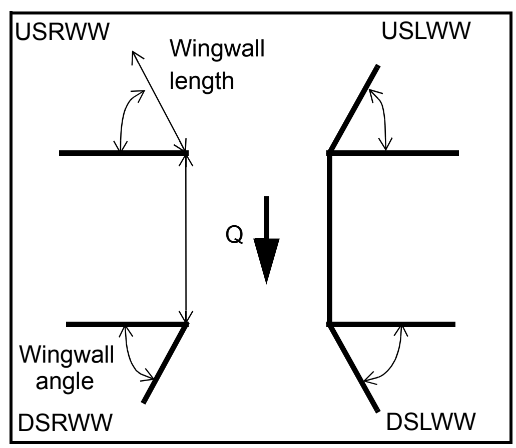
Pushed: LB or RB *Toe Location (Loc.): **0**- even, **1**- set back, **2**- protrudes*
*Scour cond.: **0**- not evident; **1**- evident (comment); **2**- footing exposed; **3**-undermined footing; **4**- piling exposed; **5**- settled; **6**- failed*
Materials: ***1***- Concrete; ***2***- Stone masonry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

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

1.25
0
1
The scour is evident on the US end of the right abutment.

80. Wingwalls:

	Exist?	Material?	Scour Condition?	Scour depth?	Exposure depth?	81. Angle?	Length?
USLWW:						**19.5**	
USRWW:	**Y**		**1**		**0**	**0.5**	
DSLWW:	**0**		**0**		**Y**	**44.0**	
DSRWW:	**1**		**1**		**1.25**	**44.0**	



*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	**0**	**0**	**Y**	**0**	**1**	**1**	**-**	**-**
Condition	**Y**	**0**	**1**	**0**	**2**	**1**	**-**	**-**
Extent	**1**	**0**	**0**	**2**	**2**	**0**	**0**	**-**

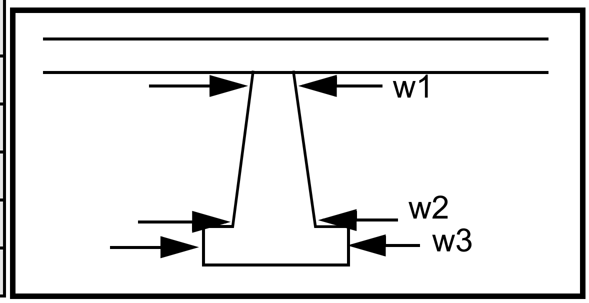
*Bank / Bridge protection types: **0**- absent; **1**- < 12 inches; **2**- < 36 inches; **3**- < 48 inches; **4**- < 60 inches; **5**- wall / artificial levee*
*Bank / Bridge protection conditions: **1**- good; **2**- slumped; **3**- eroded; **4**- failed*
*Protection extent: **1**- entire base length;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

83. Wingwall and protection comments (eg. undermined penetration, unusual scour processes, etc.):
-
-
-
-
-
2
3
1
2
3
1

Piers:

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

85. Pier no.	width (w) feet			elevation (e) feet		
	w1	w2	w3	e@w1	e@w2	e@w3
Pier 1				10.0	17.0	65.0
Pier 2			8.0	12.5	65.0	25.0
Pier 3		-	-	12.0	-	-
Pier 4	-	-	-	-	-	-



Level 1 Pier Descr.	1	2	3	4	
86. Location (BF)	e scour	the		-	*LFP, LTB, LB, MCL, MCM, MCR, RB, RTB, RFP*
87. Type	on	right		-	***1**- Solid pier, **2**- column, **3**- bent*
88. Material	the	abut		-	***1**- Wood; **2**- concrete; **3**- metal; **4**- stone*
89. Shape	US	ment	N	-	***1**- Round; **2**- Square; **3**- Pointed*
90. Inclined?	right	.	-	-	*Y- yes; N- no*
91. Attack ∠ (BF)	wing		-	-	
92. Pushed	wall		-	-	*LB or RB*
93. Length (feet)	-	-	-	-	
94. # of piles	is at		-	-	
95. Cross-members	the		-	-	***0**- none; **1**- laterals; **2**- diagonals; **3**- both*
96. Scour Condition	cor-		-	-	***0**- not evident; **1**- evident (comment); **2**- footing exposed; **3**- piling exposed; **4**- undermined footing; **5**- settled; **6**- failed*
97. Scour depth	ner		-	-	
98. Exposure depth	with		-	-	

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
-	-			-	-	-	-	-	-	-

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

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

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

Comments (eg. bank material variation, minor inflows, protection extent, etc.):
-
-
-
-
-
-
-
NO PIERS

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):
2
1
34
43
2
1

106. Point/Side bar present? 34 *(Y or N. if N type ctrl-n pb)* Mid-bar distance: 0 Mid-bar width: 2

Point bar extent: - feet 1 *(US, UB, DS)* to The feet DS *(US, UB, DS)* positioned rig %LB to ht %RB

Material: ba

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

nk protection extends from 15 ft DS to 470 ft DS along the right bank of the North Branch Hoosic River. There is no protection on the left bank of the North Branch Hoosic River. The next bridge is 470 ft DS on VT 100 over the North Branch Hoosic River.

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

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

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

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

N

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

Scour dimensions: Length DRO Width P Depth: STR Positioned UC %LB to TU %RB

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

RE

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

Confluence 1: Distance Y Enters on 130 *(LB or RB)* Type 12 *(**1**- perennial; **2**- ephemeral)*

Confluence 2: Distance 90 Enters on DS *(LB or RB)* Type 145 *(**1**- perennial; **2**- ephemeral)*

Confluence comments (eg. confluence name):

DS
50

F. Geomorphic Channel Assessment

107. Stage of reach evolution 100

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)*:

43

This side bar is on the North Branch Hoosic River.

Y
LB
30
20
DS
145
DS
1

109. G. Plan View Sketch

- T

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: STAMVT01000011 Town: Stamford
Road Number: State Route 100 County: Bennington
Stream: Crazy John Stream

Initials MAI Date: 09/26/97 Checked: RLB

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

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

Approach Section

Characteristic	100 yr	500 yr	other Q
Total discharge, cfs	630	850	740
Main Channel Area, ft2	124	191	145
Left overbank area, ft2	0	0	0
Right overbank area, ft2	0	11	0
Top width main channel, ft	38	44	40
Top width L overbank, ft	0	0	0
Top width R overbank, ft	0	51	0
D50 of channel, ft	0.2151	0.2151	0.2151
D50 left overbank, ft	--	--	--
D50 right overbank, ft	--	--	--
y1, average depth, MC, ft	3.3	4.3	3.6
y1, average depth, LOB, ft	ERR	ERR	ERR
y1, average depth, ROB, ft	ERR	0.2	ERR
Total conveyance, approach	6391	12053	8059
Conveyance, main channel	6391	11896	8059
Conveyance, LOB	0	0	0
Conveyance, ROB	0	158	0
Percent discrepancy, conveyance	0.0000	-0.0083	0.0000
Qm, discharge, MC, cfs	630.0	838.9	740.0
Ql, discharge, LOB, cfs	0.0	0.0	0.0
Qr, discharge, ROB, cfs	0.0	11.1	0.0
Vm, mean velocity MC, ft/s	5.1	4.4	5.1
Vl, mean velocity, LOB, ft/s	ERR	ERR	ERR
Vr, mean velocity, ROB, ft/s	ERR	1.0	ERR
Vc-m, crit. velocity, MC, ft/s	8.2	8.6	8.3
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

Clear Water Contraction Scour in MAIN CHANNEL

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

Bridge Section	Q100	Q500	Other Q
(Q) total discharge, cfs	630	850	740
(Q) discharge thru bridge, cfs	630	824	740
Main channel conveyance	5234	6699	6214
Total conveyance	5234	6699	6214
Q2, bridge MC discharge,cfs	630	824	740
Main channel area, ft2	78	116	87
Main channel width (normal), ft	19.7	19.7	19.7
Cum. width of piers in MC, ft	0.0	0.0	0.0
W, adjusted width, ft	19.7	19.7	19.7
y_bridge (avg. depth at br.), ft	3.96	5.89	4.42
Dm, median (1.25*D50), ft	0.268875	0.268875	0.268875
y2, depth in contraction,ft	3.51	4.42	4.03
ys, scour depth (y2-ybridge), ft	**-0.45**	-1.47	**-0.39**

Pressure Flow Scour (contraction scour for orifice flow conditions)

Chang pressure flow equation   Hb+Ys=Cq*qbr/Vc
Cq=1/Cf*Cc   Cf=1.5*Fr^0.43 (<=1)   Cc=SQRT[0.10(Hb/(ya-w)-0.56)]+0.79 (<=1)
Umbrell pressure flow equation
(Hb+Ys)/ya=1.1021*[(1-w/ya)*(Va/Vc)]^0.6031
(Richardson and other, 1995, p. 144-146)

	Q100	Q500	OtherQ
Q, total, cfs	630	850	740
Q, thru bridge MC, cfs	630	824	740
Vc, critical velocity, ft/s	8.18	8.58	8.32
Va, velocity MC approach, ft/s	5.08	4.39	5.10
Main channel width (normal), ft	19.7	19.7	19.7
Cum. width of piers in MC, ft	0.0	0.0	0.0
W, adjusted width, ft	19.7	19.7	19.7
qbr, unit discharge, ft2/s	32.0	41.8	37.6
Area of full opening, ft2	78.0	116.0	87.1
Hb, depth of full opening, ft	3.96	5.89	4.42
Fr, Froude number, bridge MC	0	0.57	0.52
Cf, Fr correction factor (<=1.0)	0.00	1.00	1.00
**Area at downstream face, ft2	0	105	0
**Hb, depth at downstream face, ft	0.00	5.33	0.00
**Fr, Froude number at DS face	ERR	0.60	ERR
**Cf, for downstream face (<=1.0)	N/A	1.00	N/A

Elevation of Low Steel, ft	0	498.2	0
Elevation of Bed, ft	-3.96	492.31	-4.42
Elevation of Approach, ft	0	499.4	0
Friction loss, approach, ft	0	0.11	0
Elevation of WS immediately US, ft	0.00	499.29	0.00
ya, depth immediately US, ft	3.96	6.98	4.42
Mean elevation of deck, ft	0	500.72	0
w, depth of overflow, ft (>=0)	0.00	0.00	0.00
Cc, vert contrac correction (<=1.0)	1.00	0.96	1.00
**Cc, for downstream face (<=1.0)	0.79	0.932754	ERR
Ys, scour w/Chang equation, ft	N/A	**-0.80**	N/A
Ys, scour w/Umbrell equation, ft	N/A	-0.75	N/A

**=for UNsubmerged orifice flow using estimated downstream bridge face properties.

**Ys, scour w/Chang equation, ft	N/A	-0.10	N/A
**Ys, scour w/Umbrell equation, ft	ERR	-0.19	ERR

In UNsubmerged orifice flow, an adjusted scour depth using the Laursen equation results and the estimated downstream bridge face properties can also be computed (ys=y2-ybridgeDS)

y2, from Laursen's equation, ft	3.51	4.42	4.03
WSEL at downstream face, ft	--	497.64	--
Depth at downstream face, ft	0.00	5.33	0.00
Ys, depth of scour (Laursen), ft	N/A	-0.91	N/A

Armoring

Dc=[(1.94*V^2)/(5.75*log(12.27*y/D90))^2]/[0.03*(165-62.4)]

Depth to Armoring=3*(1/Pc-1)

(Federal Highway Administration, 1993)

Downstream bridge face property	100-yr	500-yr	Other Q
Q, discharge thru bridge MC, cfs	630	824	740
Main channel area (DS), ft2	78	105	87
Main channel width (normal), ft	19.7	19.7	19.7
Cum. width of piers, ft	0.0	0.0	0.0
Adj. main channel width, ft	19.7	19.7	19.7
D90, ft	0.6148	0.6148	0.6148
D95, ft	0.8149	0.8149	0.8149
Dc, critical grain size, ft	0.3453	0.2858	0.3645
Pc, Decimal percent coarser than Dc	0.309	0.396	0.282
Depth to armoring, ft	**2.32**	**1.31**	**2.78**

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	630	850	740	630	850	740
a', abut.length blocking flow, ft	10.9	13.5	11.8	7.6	61.9	8.7
Ae, area of blocked flow ft2	21.45	41.36	27.83	14.49	34.3	19.12
Qe, discharge blocked abut.,cfs	78.07	142.37	104.83	49.74	--	66.6

(If using Qtotal_overbank to obtain Ve, leave Qe blank and enter Ve and Fr manually)

Ve, (Qe/Ae), ft/s	3.64	3.44	3.77	3.43	2.50	3.48
ya, depth of f/p flow, ft	1.97	3.06	2.36	1.91	0.55	2.20

--Coeff., K1, for abut. type (1.0, verti.; 0.82, verti. w/ wingwall; 0.55, spillthru)

K1	0.82	0.82	0.82	0.82	0.82	0.82

--Angle (theta) of embankment (<90 if abut. points DS; >90 if abut. points US)

theta	55	55	55	125	125	125
K2	0.94	0.94	0.94	1.04	1.04	1.04
Fr, froude number f/p flow	0.457	0.347	0.432	0.438	0.540	0.414
ys, scour depth, ft	**6.42**	**8.37**	**7.29**	**5.96**	**6.17**	**6.70**

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)	10.9	13.5	11.8	7.6	61.9	8.7
y1 (depth f/p flow, ft)	1.97	3.06	2.36	1.91	0.56	2.20
a'/y1	5.54	4.41	5.00	3.99	111.35	3.96
Skew correction (p. 49, fig. 16)	0.87	0.87	0.87	1.08	1.08	1.08
Froude no. f/p flow	0.46	0.35	0.43	0.44	0.54	0.41
Ys w/ corr. factor K1/0.55:						
vertical	ERR	ERR	ERR	ERR	3.56	ERR
vertical w/ ww's	ERR	ERR	ERR	ERR	2.92	ERR
spill-through	ERR	ERR	ERR	ERR	1.96	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	Other Q	Q100	Q500	Other Q
Fr, Froude Number	0.72	0.6	0.71	0.72	0.6	0.71
y, depth of flow in bridge, ft	3.96	5.33	4.42	3.96	5.33	4.42

Median Stone Diameter for riprap at:	left abutment			right abutment, ft		
Fr<=0.8 (vertical abut.)	**1.27**	**1.19**	**1.38**	**1.27**	**1.19**	**1.38**
Fr>0.8 (vertical abut.)	ERR	ERR	ERR	ERR	ERR	ERR