LEVEL II SCOUR ANALYSIS FOR BRIDGE 42 (NEWFTH00350042) on TOWN HIGHWAY 35, crossing STRATTON HILL BROOK, NEWFANE, VERMONT

Open-File Report 98-404

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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LEVEL II SCOUR ANALYSIS FOR BRIDGE 42 (NEWFTH00350042) on TOWN HIGHWAY 35, crossing STRATTON HILL BROOK, NEWFANE, VERMONT

By EMILY C. WILD and MICHAEL A. IVANOFF

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Pembroke, New Hampshire

1998

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

U.S. GEOLOGICAL SURVEY
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Box 25286
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	Max	maximum
D_{50}	median diameter of bed material	MC	main channel
DS	downstream	RAB	right abutment
elev.	elevation	RABUT	face of right abutment
f/p	flood plain	RB	right bank
ft^2	square feet	ROB	right overbank
ft/ft	feet per foot	RWW	right wingwall
FEMA	Federal Emergency Management Agency	TH	town highway
FHWA	Federal Highway Administration	UB	under bridge
JCT	junction	US	upstream
LAB	left abutment	USGS	United States Geological Survey
LABUT	face of left abutment	VTAOT	Vermont Agency of Transportation
LB	left bank	WSPRO	water-surface profile model
LOB	left overbank	yr	year

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

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

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

LEVEL II SCOUR ANALYSIS FOR BRIDGE 42 (NEWFTH00350042) ON TOWN HIGHWAY 35, CROSSING STRATTON HILL BROOK, NEWFANE, VERMONT

By **Emily C. Wild and Michael A. Ivanoff**

INTRODUCTION AND SUMMARY OF RESULTS

This report provides the results of a detailed Level II analysis of scour potential at structure NEWFTH00350042 on Town Highway 35 crossing Stratton Hill Brook, Newfane, Vermont (figures 1–8). A Level II study is a basic engineering analysis of the site, including a quantitative analysis of stream stability and scour (FHWA, 1993). Results of a Level I scour investigation also are included in appendix E of this report. A Level I investigation provides a qualitative geomorphic characterization of the study site. Information on the bridge, gleaned from Vermont Agency of Transportation (VTAOT) files, was compiled prior to conducting Level I and Level II analyses and is found in appendix D.

The site is in the New England Upland section of the New England physiographic province in southeastern Vermont. The 1.16-mi^2 drainage area is in a predominantly rural and forested basin. In the vicinity of the study site, the surface cover is forested.

In the study area, Stratton Hill Brook has an incised, striaght channel with a slope of approximately 0.1 ft/ft, an average channel top width of 36 ft and an average bank height of 8 ft. The channel bed material ranges from gravel to boulders with a median grain size (D_{50}) of 121 mm (0.396 ft). The geomorphic assessment at the time of the Level I and Level II site visit on August 20, 1996, indicated that the reach was stable.

The Town Highway 34 crossing of Stratton Hill Brook is a 34-ft-long, one-lane bridge consisting of a 32-foot steel-beam span (Vermont Agency of Transportation, written communication, April 6, 1995). The opening length of the structure parallel to the bridge face is 30.8 ft. The bridge is supported by vertical, concrete abutments with upstream wingwalls. The channel is skewed approximately 20 degrees to the opening while the computed opening-skew-to-roadway is 15 degrees.

During the Level I assessment, it was observed that the right abutment footing was exposed 1.5 feet. The only scour protection measure at the site was type-1 stone fill (less than 12 inches diameter) along the downstream left bank. Additional details describing conditions at the site are included in the Level II Summary and appendices D and E.

Scour depths and recommended rock rip-rap sizes were computed using the general guidelines described in Hydraulic Engineering Circular 18 (Richardson and Davis, 1995) for the 100- and 500-year discharges. 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. Abutment scour ranged from 2.3 to 3.3 ft. The worst-case abutment scour occurred at the 500-year discharge. Additional information on scour depths and depths to armoring are included in the section titled “Scour Results”. Scoured-streambed elevations, based on the calculated scour depths, are presented in tables 1 and 2. A cross-section of the scour computed at the bridge is presented in figure 8. Scour depths were calculated assuming an infinite depth of erosive material and a homogeneous particle-size distribution.

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

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

NORTH

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

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

LEVEL II SUMMARY

Structure Number NEWFTH00350042 ***Stream*** Stratton Hill Brook

County Windham ***Road*** TH 35 ***District*** 2

Description of Bridge

Bridge length 34 ***ft*** ***Bridge width*** 15.5 ***ft*** ***Max span length*** 32 ***ft***

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

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

Stone fill on abutment? No ***Date of inspection*** 8/20/96

Description of stone fill Type-1, along the downstream left bank.

Brief description of piers/abutments Abutments and wingwalls are concrete. The right abutment footing is exposed 1.5 ft at the downstream end.

Is bridge skewed to flood flow according to Level I survey? Yes ***Angle*** 20

Is bridge located on a bend in channel? If so, describe (mild, moderate, severe) No

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	8/20/96	0	0
Level II	8/20/96	0	0

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

Describe any features near or at the bridge that may affect flow (include observation date) No features were observed, 8/20/96.

Description of the Geomorphic Setting

General topography The channel is located within a moderately sloped valley.

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

Date of inspection 8/20/96

DS left: Steep channel bank with a moderately sloped overbank.

DS right: Steep channel bank with a moderately sloped overbank.

US left: Steep channel bank with a moderately sloped overbank.

US right: Steep channel bank with a moderately sloped overbank.

Description of the Channel

Average top width 36 ft

Average depth 8 ft

Predominant bed material Cobbles/Boulders

Bank material Cobbles/Boulders

Sinuous but stable with non-alluvial channel boundaries.

8/20/96

Vegetative co Trees and brush.

DS left: Trees and brush with Town Highway 35 adjacent to the channel bank.

DS right: Trees and brush with Town Highway 35 adjacent to the channel bank.

US left: Trees and brush.

US right:

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

No obstructions were observed, 8/20/96.

Describe any obstructions in channel and date of observation.

Hydrology

Drainage area 1.16 ***mi²***

Percentage of drainage area in physiographic provinces: (approximate)

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

Is drainage area considered rural or urban? Rural ***Describe any significant urbanization***:

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 440 ***ft³/s*** ***Q500*** 680 ***ft³/s***

The 100-year and 500-year discharges are the median values taken from the range defined by several empirical flood frequency curves (Benson, 1962; Johnson and Tasker, 1974; FHWA, 1983; Potter, 1957a&b; Talbot, 1887). Each curve was extended graphically to the 500-year event.

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

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

Datum tie between USGS survey and VTAOT plans None

Description of reference marks used to determine USGS datum. RM1 is a chiseled X on top of the upstream right wingwall (elev. 499.56 ft, arbitrary survey datum). RM2 is a chiseled X on top of the upstream end of the left abutment (elev. 501.05 ft, arbitrary survey datum).

Cross-Sections Used in WSPRO Analysis

[1]*Cross-section*	*Section Reference Distance (SRD) in feet*	[2]*Cross-section development*	*Comments*
EXIT1	-33	1	Exit section
DSBRG	0	1	Downstream bridge section and road grade section
USBRG	17	1	Upstream bridge section and road grade section
APPR1	40	2	Modelled Approach section (Templated from APTEM)
APTEM	49	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 0.075 to 0.080, and overbank "n" values ranged from 0.055 to 0.065.

Critical depth at the exit section (EXIT1) was assumed as the starting water surface. Normal depth was computed by use of the slope-conveyance method outlined in the user's manual for WSPRO (Shearman, 1990) which resulted in a supercritical solution, but within 0.3 feet of critical depth. The slope used was 0.0950 ft/ft, which was calculated from thalweg points surveyed downstream of the bridge.

The surveyed approach section (APTEM) was moved along the approach channel slope (0.1034 ft/ft) to establish the modelled approach section (APPR1), 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.

For all modelled flows, the bridge was not a significant constriction in the channel. The WSPRO bridge routines failed to find a solution which balanced the total discharge and energy at the APPRO section with the sum of the discharges and energy over the roadway and through the bridge opening. Therefore, the bridge was ignored, and the channel at the bridge was combined with the roadway cross-section to represent a full valley cross section at the bridge location.

Bridge Hydraulics Summary

Average bridge embankment elevation 500.6 ***ft***
Average low steel elevation 498.3 ***ft***

100-year discharge 440 ***ft^3/s***
Water-surface elevation in bridge opening 493.4 ***ft***
Road overtopping? No ***Discharge over road*** -- ***ft^3/s***
Area of flow in bridge opening 53 ***ft^2***
Average velocity in bridge opening 8.3 ***ft/s***
Maximum WSPRO tube velocity at bridge 10.9 ***ft/s***

Water-surface elevation at Approach section with bridge N/A
Water-surface elevation at Approach section without bridge 496.6
Amount of backwater caused by bridge N/A ***ft***

500-year discharge 680 ***ft^3/s***
Water-surface elevation in bridge opening 494.3 ***ft***
Road overtopping? No ***Discharge over road*** -- ***ft^3/s***
Area of flow in bridge opening 69 ***ft^2***
Average velocity in bridge opening 9.8 ***ft/s***
Maximum WSPRO tube velocity at bridge 12.9 ***ft/s***

Water-surface elevation at Approach section with bridge N/A
Water-surface elevation at Approach section without bridge 497.5
Amount of backwater caused by bridge N/A ***ft***

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

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

Scour Analysis Summary

Special Conditions or Assumptions Made in Scour Analysis

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

Contraction scour for the 100-year and 500-year discharges was computed by use of the Laursen clear-water contraction scour equation (Richardson and Davis, 1995, p. 32, equation 20). Variables for the Laursen clear-water contraction scour equation include the discharge through the bridge, the width of the channel at the bridge, and the median grain size of the channel bed material.

Abutment scour was computed by use of the Froehlich equation (Richardson and Davis, 1995, p. 48, equation 28). Variables for the Froehlich equation include the Froude number of the flow approaching the embankments, the length of the embankment blocking flow, and the depth of flow approaching the embankment less any roadway overtopping. For this case, the embankments do not block flow. Therefore, the depth of flow at each abutment was assumed to be the depth of abutment scour.

Because the influence of scour processes on the embankment material is uncertain, the scour depth at the vertical left abutment wall is unknown. Therefore, the total scour depth shown in figure 8 for the left abutment was applied for the entire embankment below the elevation at the toe of the embankment.

Scour Results

Contraction scour:	100-year discharge	500-year discharge	Incipient overtopping discharge
	(Scour depths in feet)		
Main channel			
Live-bed scour	--	--	--
Clear-water scour	0.0	0.0	--
Depth to armoring	4.5	7.0	--
Left overbank	--	--	--
Right overbank	--	--	--
Local scour:			
Abutment scour			
Left abutment	2.4	3.3	--
Right abutment	2.3	3.2	--
Pier scour			
Pier 1	--	--	--
Pier 2	--	--	--
Pier 3	--	--	--

Riprap Sizing

	100-year discharge	500-year discharge (D_{50} in feet)	Incipient overtopping discharge
Abutments:			
Left abutment	1.2	1.5	--
Right abutment	1.2	1.5	--
Piers:			
Pier 1	--	--	--
Pier 2	--	--	--

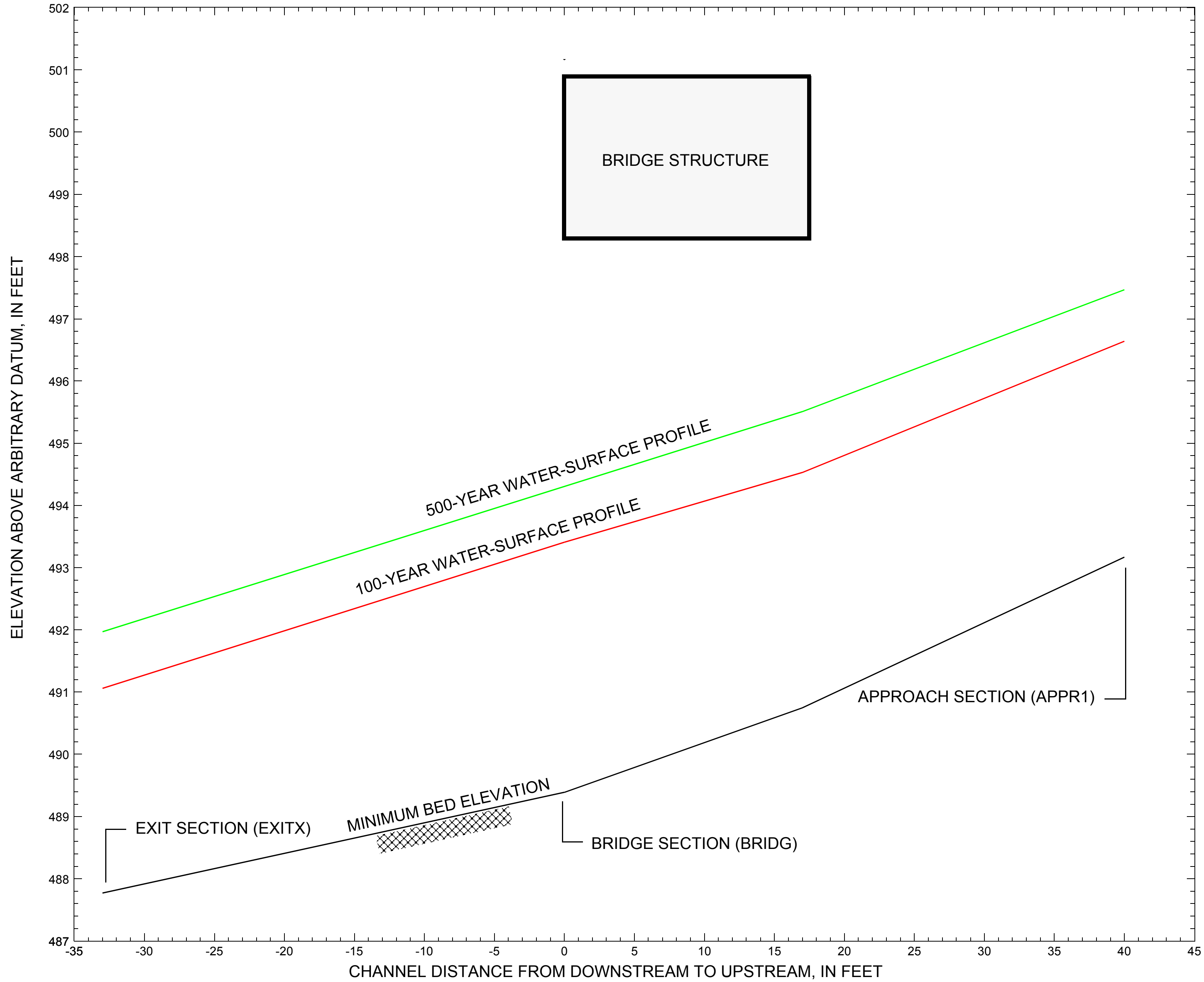

Figure 7. Water-surface profiles for the 100- and 500-year discharges at structure NEWFTH00350042 on Town Highway 35, crossing Stratton Hill Brook, Newfane, Vermont.

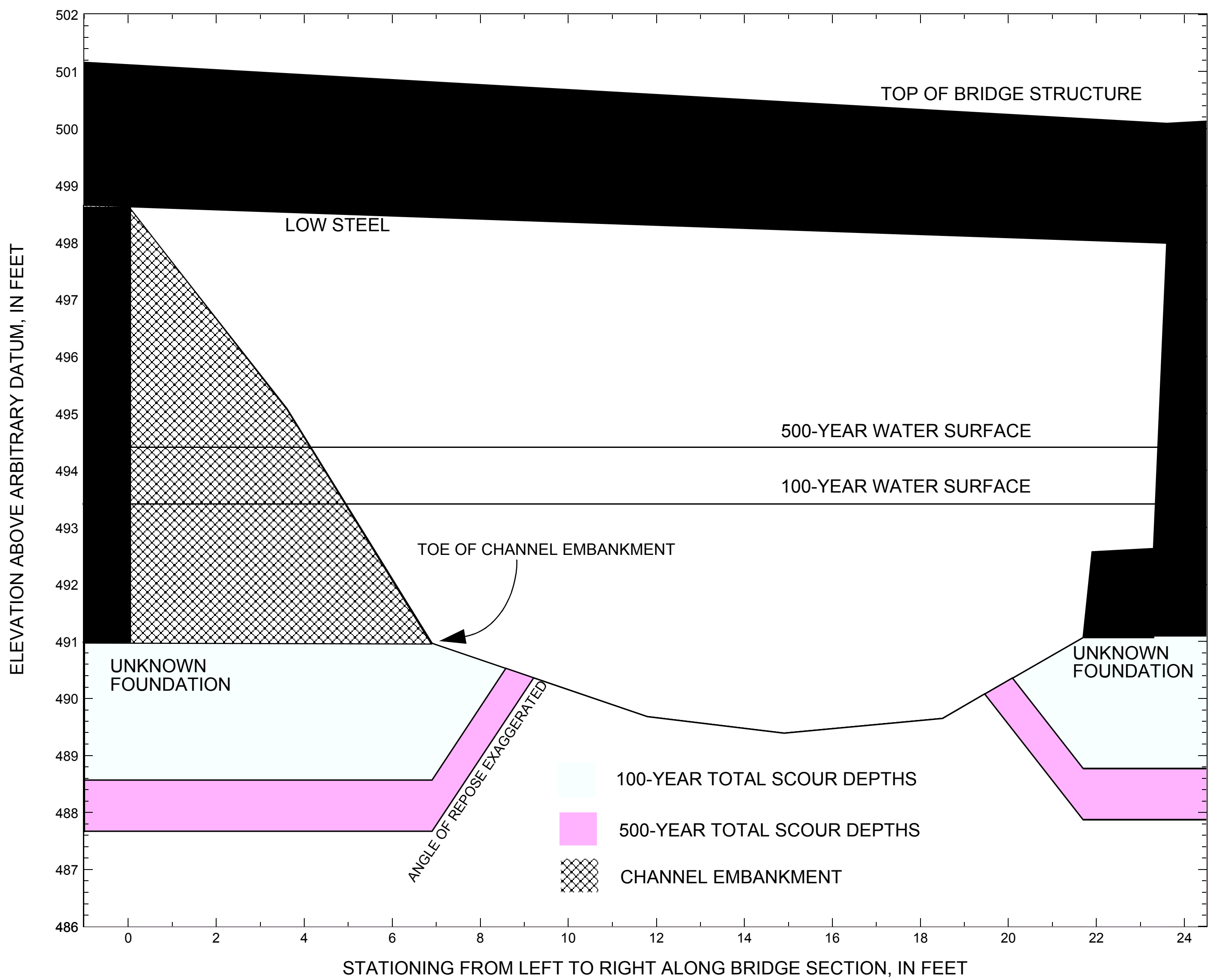

Figure 8. Scour elevations for the 100- and 500-year discharges at structure NEWFTH00350042 on Town Highway 35, crossing Stratton Hill Brook, Newfane, Vermont.

Table 1. Remaining footing/pile depth at abutments for the 100-year discharge at structure NEWFTH00350042 on Town Highway 35, crossing Stratton Hill Brook, Newfane, Vermont.

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

Description	Station[1]	VTAOT minimum low-chord elevation (feet)	Surveyed minimum low-chord elevation[2] (feet)	Bottom of footing/pile elevation[2] (feet)	Channel elevation at abutment/ pier[2] (feet)	Contraction scour depth (feet)	Abutment scour depth (feet)	Pier scour depth (feet)	Depth of total scour (feet)	Elevation of scour[2] (feet)	Remaining footing/pile depth (feet)
100-year. discharge is 440 cubic-feet per second											
Left abutment	0.0	--	498.6	--	--	--	--	--	--	488.6	--
Channel embankment toe	6.9	--	--	--	491.0	0.0	2.4	--	2.4	488.6	--
Right abutment	23.6	--	498.0	--	491.1	0.0	2.3	--	2.3	488.8	--

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 NEWFTH00350042 on Town Highway 35, crossing Stratton Hill Brook, Newfane, Vermont.

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

Description	Station[1]	VTAOT minimum low-chord elevation (feet)	Surveyed minimum low-chord elevation[2] (feet)	Bottom of footing/pile elevation[2] (feet)	Channel elevation at abutment/ pier[2] (feet)	Contraction scour depth (feet)	Abutment scour depth (feet)	Pier scour depth (feet)	Depth of total scour (feet)	Elevation of scour[2] (feet)	Remaining footing/pile depth (feet)
500-year. discharge is 680 cubic-feet per second											
Left abutment	0.0	--	498.6	--	--	--	--	--	3.3	487.7	--
Channel embankment toe	6.9	--	--	--	491.0	0.0	3.3	--	3.3	487.7	
Right abutment	23.6	--	498.0	--	491.1	0.0	3.2	--	3.2	487.9	--

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, 1984, Newfane, Vermont 7.5 Minute Series quadrangle map: U.S. Geological Survey Topographic Maps, Scale 1:25,000.

APPENDIX A:

WSPRO INPUT FILE

WSPRO INPUT FILE

```
T1        U.S. Geological Survey WSPRO Input File  newf042.other.wsp
T2        Hydraulic analysis for structure NEWFTH00350042   Date: 02-JAN-98
T3        Town Highway 35, Stratton Hill Brook, Newfane, Vermont          ECW
*
J3         6 29 30 552 553 551 5 16 17 13 3 * 15 14 23 21 11 12 4 7 3
*
Q            440.0    680.0
SK          0.0950   0.0950
*
XS   EXIT1    -33           0.
GR          -26.2, 511.96    -16.7, 504.10     -7.9, 503.17      0.0, 499.95
GR           13.8, 488.58     17.1, 488.07     19.2, 487.77     22.7, 487.89
GR           25.8, 487.80     27.1, 487.88     30.9, 492.92     36.0, 495.06
GR           54.9, 497.58     71.1, 497.12     74.8, 496.04     79.2, 496.56
GR          105.5, 507.93
*
N           0.065        0.080        0.065
SA                  0.0         30.9
*
*
XS   DSBRG     0   15
GR          -83.7, 515.79    -49.7, 504.52     -0.1, 501.12      0.0, 498.63
GR            3.6, 495.09      6.9, 490.97     11.8, 489.68     14.9, 489.39
GR           18.5, 489.65     21.7, 491.07     21.9, 492.57     23.3, 492.63
GR           23.6, 497.99     30.8, 500.09     37.0, 499.91     50.1, 499.44
GR           68.9, 500.13     87.6, 504.65    110.9, 508.61
*
N           0.055         0.075         0.055
SA                  0.0           23.7
*
XS   USBRG     17  15
GR          -83.7, 515.79    -49.7, 504.52      0.0, 501.12      0.1, 499.11
GR            0.5, 497.79     10.0, 493.61     18.8, 491.21     21.0, 490.75
GR           22.5, 491.19     29.2, 492.41     29.5, 493.23     30.0, 493.23
GR           30.1, 500.09     30.8, 500.09     37.0, 499.91     50.1, 499.44
GR           68.9, 500.13     87.6, 504.65    110.9, 508.61
*
N            0.055         0.080         0.055
SA                  0.0           30.1
*
XT   APTEM     49           0.
GR          -78.9, 512.88    -63.8, 506.53     -5.8, 502.34      0.0, 499.62
GR            5.8, 495.26     11.8, 494.59     14.1, 494.10     17.0, 494.58
GR           22.4, 495.78     26.6, 500.12     34.2, 502.98     54.0, 503.16
GR           58.6, 508.38
*
XS   APPR1     40 * * * 0.1034
GT
N           0.055        0.080        0.055
SA                 -5.8        34.2
*
*
HP 1 DSBRG 493.41 1 493.41
HP 2 DSBRG 493.41 * * 440
HP 1 APPR1 496.64 1 496.64
HP 2 APPR1 496.64 * * 440
*
```

APPENDIX B:

WSPRO OUTPUT FILE

```
        U.S. Geological Survey WSPRO Input File  newf042.other.wsp
        Hydraulic analysis for structure NEWFTH00350042   Date: 02-JAN-98
        Town Highway 35, Stratton Hill Brook, Newfane, Vermont          ECW
           *** RUN DATE & TIME: 02-06-98  16:41
    CROSS-SECTION PROPERTIES:  ISEQ =  2;  SECID = DSBRG;  SRD =       0.

     WSEL  SA#     AREA        K   TOPW   WETP  ALPH    LEW    REW     QCR
             2      53.    1912.    18.    22.                         518.
   493.41           53.    1912.    18.    22.  1.00     5.    23.    518.

    VELOCITY DISTRIBUTION:  ISEQ =  2;  SECID = DSBRG;  SRD =       0.

         WSEL     LEW     REW    AREA        K        Q    VEL
       493.41     4.9    23.3    52.9    1912.     440.   8.32

X STA.        4.9        8.5        9.3       10.1       10.8       11.4
  A(I)            6.4        2.3        2.3        2.2        2.2
  V(I)           3.42       9.48       9.52       9.84      10.22

X STA.       11.4       12.0       12.6       13.1       13.7       14.3
  A(I)            2.2        2.1        2.1        2.1        2.1
  V(I)          10.16      10.48      10.47      10.45      10.31

X STA.       14.3       14.8       15.3       15.9       16.4       17.0
  A(I)            2.1        2.1        2.1        2.0        2.1
  V(I)          10.67      10.62      10.60      10.78      10.68

X STA.       17.0       17.5       18.1       18.6       19.3       23.3
  A(I)            2.0        2.1        2.0        2.2        8.1
  V(I)          10.86      10.57      10.74       9.90       2.71

    CROSS-SECTION PROPERTIES:  ISEQ =  4;  SECID = APPR1;  SRD =      40.

     WSEL  SA#     AREA        K   TOPW   WETP  ALPH    LEW    REW     QCR
             2      51.    1589.    21.    23.                         442.
   496.64           51.    1589.    21.    23.  1.00     3.    24.    442.

    VELOCITY DISTRIBUTION:  ISEQ =  4;  SECID = APPR1;  SRD =      40.

         WSEL     LEW     REW    AREA        K        Q    VEL
       496.64     2.7    24.1    50.7    1589.     440.   8.68

X STA.        2.7        6.8        7.8        8.6        9.5       10.3
  A(I)            5.9        2.3        2.3        2.2        2.2
  V(I)           3.71       9.40       9.63       9.86       9.98

X STA.       10.3       11.0       11.8       12.5       13.1       13.7
  A(I)            2.2        2.2        2.1        2.1        2.0
  V(I)          10.21      10.16      10.48      10.53      10.75

X STA.       13.7       14.3       14.9       15.5       16.2       16.9
  A(I)            2.1        2.0        2.1        2.1        2.1
  V(I)          10.70      10.87      10.70      10.51      10.57

X STA.       16.9       17.6       18.4       19.3       20.4       24.1
  A(I)            2.1        2.2        2.3        2.4        5.7
  V(I)          10.28       9.86       9.54       9.00       3.87
```

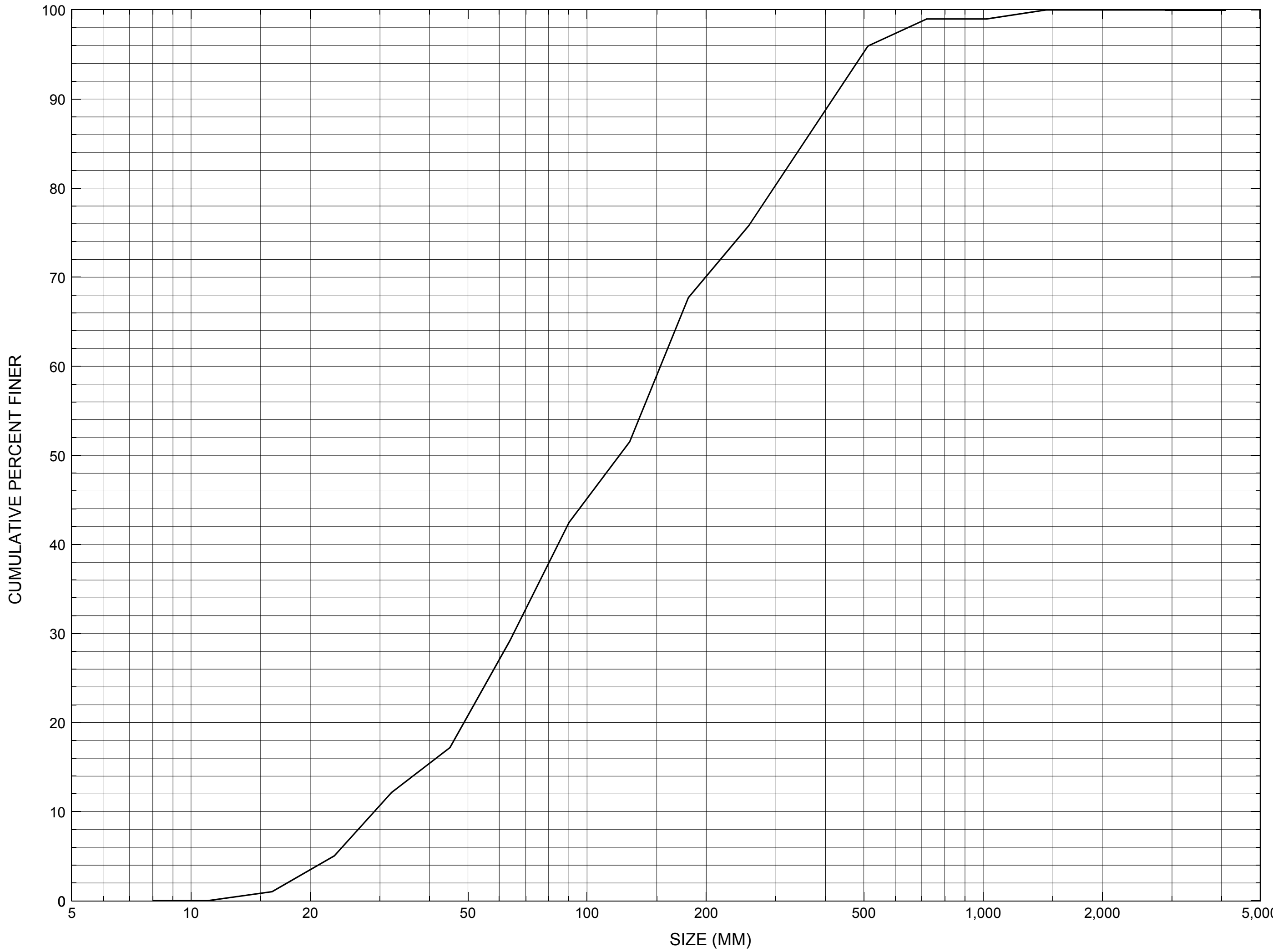
```
        U.S. Geological Survey WSPRO Input File  newf042.other.wsp
        Hydraulic analysis for structure NEWFTH00350042   Date: 02-JAN-98
        Town Highway 35, Stratton Hill Brook, Newfane, Vermont          ECW
           *** RUN DATE & TIME: 02-06-98  16:41
    CROSS-SECTION PROPERTIES:  ISEQ =  2;  SECID = DSBRG;  SRD =       0.

     WSEL  SA#     AREA        K   TOPW   WETP  ALPH    LEW     REW     QCR
             2      69.    2819.    19.    24.                         759.
   494.31           69.    2819.    19.    24.  1.00     4.     23.    759.

    VELOCITY DISTRIBUTION:  ISEQ =  2;  SECID = DSBRG;  SRD =       0.

         WSEL     LEW     REW    AREA        K        Q    VEL
       494.31     4.2    23.4    69.2    2819.     680.   9.83

X STA.        4.2        8.3        9.1        9.9       10.5       11.2
  A(I)             9.0        3.0        2.9        2.8        2.8
  V(I)            3.77      11.39      11.53      12.28      12.15

X STA.       11.2       11.8       12.4       13.0       13.6       14.2
  A(I)             2.8        2.7        2.7        2.7        2.8
  V(I)           12.14      12.49      12.50      12.50      12.36

X STA.       14.2       14.8       15.4       15.9       16.5       17.1
  A(I)             2.7        2.7        2.6        2.7        2.7
  V(I)           12.58      12.52      12.92      12.83      12.69

X STA.       17.1       17.6       18.2       18.8       19.5       23.4
  A(I)             2.6        2.6        2.7        2.9       10.7
  V(I)           12.88      12.92      12.40      11.80       3.17

    CROSS-SECTION PROPERTIES:  ISEQ =  4;  SECID = APPR1;  SRD =      40.

     WSEL  SA#     AREA        K   TOPW   WETP  ALPH    LEW     REW     QCR
             2      69.    2494.    23.    26.                         677.
   497.47           69.    2494.    23.    26.  1.00     2.     25.    677.

    VELOCITY DISTRIBUTION:  ISEQ =  4;  SECID = APPR1;  SRD =      40.

         WSEL     LEW     REW    AREA        K        Q    VEL
       497.47     1.6    24.9    69.2    2494.     680.   9.82

X STA.        1.6        6.5        7.4        8.3        9.2       10.0
  A(I)             8.8        3.0        3.1        2.9        3.0
  V(I)            3.87      11.23      11.14      11.71      11.51

X STA.       10.0       10.8       11.6       12.3       13.0       13.7
  A(I)             2.9        2.9        2.8        2.9        2.8
  V(I)           11.75      11.82      12.11      11.84      12.15

X STA.       13.7       14.3       15.0       15.7       16.4       17.1
  A(I)             2.8        2.8        2.8        2.8        2.9
  V(I)           12.17      12.34      12.10      12.07      11.91

X STA.       17.1       17.9       18.8       19.7       20.7       24.9
  A(I)             2.9        3.0        3.0        3.1        8.2
  V(I)           11.85      11.33      11.21      10.80       4.16
```

```
        U.S. Geological Survey WSPRO Input File  newf042.other.wsp
        Hydraulic analysis for structure NEWFTH00350042   Date: 02-JAN-98
        Town Highway 35, Stratton Hill Brook, Newfane, Vermont          ECW
           *** RUN DATE & TIME: 02-06-98  16:41

 ===015 WSI IN WRONG FLOW REGIME AT SECID "EXIT1":  USED WSI = CRWS.
                           WSI,CRWS =   490.89     491.06

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

EXIT1:XS   ******    11.      49.  1.28 *****  492.33  491.06    440.  491.06
      -33. ******    29.    1570.  1.00 ***** *******    0.99    9.06

 ===125 FR# EXCEEDS FNTEST AT SECID "DSBRG":  TRIALS CONTINUED.
              FNTEST,FR#,WSEL,CRWS =  0.80    0.86     493.40     493.09

 ===110 WSEL NOT FOUND AT SECID "DSBRG":  REDUCED DELTAY.
                   WSLIM1,WSLIM2,DELTAY =   490.56     515.79    0.50

 ===115 WSEL NOT FOUND AT SECID "DSBRG":  USED WSMIN = CRWS.
                   WSLIM1,WSLIM2,CRWS =   490.56     515.79     493.09

DSBRG:XS      33.     5.      53.  1.08  2.13  494.49  493.09    440.  493.41
        0.    33.    23.    1908.  1.00  0.00    0.02    0.85    8.33

 ===125 FR# EXCEEDS FNTEST AT SECID "USBRG":  TRIALS CONTINUED.
              FNTEST,FR#,WSEL,CRWS =  0.80    1.03     494.48     494.53

 ===110 WSEL NOT FOUND AT SECID "USBRG":  REDUCED DELTAY.
                   WSLIM1,WSLIM2,DELTAY =   492.91     515.79    0.50

 ===115 WSEL NOT FOUND AT SECID "USBRG":  USED WSMIN = CRWS.
                   WSLIM1,WSLIM2,CRWS =   492.91     515.79     494.53

 ===130 CRITICAL WATER-SURFACE ELEVATION  A _ S _ S _ U _ M _ E _ D  !!!!!
              ENERGY EQUATION  N_O_T  B_A_L_A_N_C_E_D  AT SECID "USBRG"
                   WSBEG,WSEND,CRWS =   494.53     515.79     494.53

USBRG:XS      17.     8.      50.  1.19 *****  495.71  494.53    440.  494.53
       17.    17.    30.    1540.  1.00 ***** *******    1.00    8.73

 ===120 YTOL NOT SATISFIED AT SECID "APPR1":  TRIALS CONTINUED.
                        YTOL,WSLIM1,WSLIM2 =  0.02     494.03     495.03

 ===125 FR# EXCEEDS FNTEST AT SECID "APPR1":  TRIALS CONTINUED.
              FNTEST,FR#,WSEL,CRWS =  0.80    1.10     496.48     496.64

 ===110 WSEL NOT FOUND AT SECID "APPR1":  REDUCED DELTAY.
                   WSLIM1,WSLIM2,DELTAY =   494.03     511.95    0.50

 ===115 WSEL NOT FOUND AT SECID "APPR1":  USED WSMIN = CRWS.
                   WSLIM1,WSLIM2,CRWS =   494.03     511.95     496.64

 ===130 CRITICAL WATER-SURFACE ELEVATION  A _ S _ S _ U _ M _ E _ D  !!!!!
              ENERGY EQUATION  N_O_T  B_A_L_A_N_C_E_D  AT SECID "APPR1"
                   WSBEG,WSEND,CRWS =   496.64     511.95     496.64

APPR1:XS      23.     3.      51.  1.17 *****  497.81  496.64    440.  496.64
       40.    23.    24.    1588.  1.00 ***** *******    1.00    8.69

  FIRST USER DEFINED TABLE.

   XSID:CODE    SRD    LEW    REW       Q        K     AREA     VEL    WSEL
  EXIT1:XS     -33.    11.    29.    440.    1570.      49.    9.06  491.06
  DSBRG:XS       0.     5.    23.    440.    1908.      53.    8.33  493.41
  USBRG:XS      17.     8.    30.    440.    1540.      50.    8.73  494.53
  APPR1:XS      40.     3.    24.    440.    1588.      51.    8.69  496.64

 SECOND USER DEFINED TABLE.

   XSID:CODE    CRWS     FR#    YMIN    YMAX    HF    HO  VHD      EGL    WSEL
  EXIT1:XS    491.06    0.99  487.77  511.96************  1.28  492.33  491.06
  DSBRG:XS    493.09    0.85  489.39  515.79  2.13  0.00  1.08  494.49  493.41
  USBRG:XS    494.53    1.00  490.75  515.79************  1.19  495.71  494.53
  APPR1:XS    496.64    1.00  493.17  511.95************  1.17  497.81  496.64
```

```
        U.S. Geological Survey WSPRO Input File  newf042.other.wsp
        Hydraulic analysis for structure NEWFTH00350042   Date: 02-JAN-98
        Town Highway 35, Stratton Hill Brook, Newfane, Vermont          ECW
           *** RUN DATE & TIME: 02-06-98  16:41

 ===015 WSI IN WRONG FLOW REGIME AT SECID "EXIT1":  USED WSI = CRWS.
                           WSI,CRWS =   491.73     491.97

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

EXIT1:XS   ******    10.      67.  1.63 *****  493.60  491.97    680.  491.97
      -33. ******    30.    2456.  1.00 ***** *******    1.00   10.22

 ===125 FR# EXCEEDS FNTEST AT SECID "DSBRG":  TRIALS CONTINUED.
             FNTEST,FR#,WSEL,CRWS =  0.80    0.89     494.31     494.02

 ===110 WSEL NOT FOUND AT SECID "DSBRG":  REDUCED DELTAY.
                  WSLIM1,WSLIM2,DELTAY =   491.47     515.79    0.50

 ===115 WSEL NOT FOUND AT SECID "DSBRG":  USED WSMIN = CRWS.
                  WSLIM1,WSLIM2,CRWS =   491.47     515.79     494.02

DSBRG:XS      33.     4.      69.  1.51  2.21  495.81  494.02    680.  494.31
        0.    33.    23.    2814.  1.00  0.00    0.00    0.90    9.84

 ===125 FR# EXCEEDS FNTEST AT SECID "USBRG":  TRIALS CONTINUED.
             FNTEST,FR#,WSEL,CRWS =  0.80    0.93     495.55     495.39

 ===110 WSEL NOT FOUND AT SECID "USBRG":  REDUCED DELTAY.
                  WSLIM1,WSLIM2,DELTAY =   493.81     515.79    0.50

 ===115 WSEL NOT FOUND AT SECID "USBRG":  USED WSMIN = CRWS.
                  WSLIM1,WSLIM2,CRWS =   493.81     515.79     495.39

USBRG:XS      17.     6.      73.  1.37  1.08  496.88  495.39    680.  495.51
       17.    17.    30.    2588.  1.00  0.00   -0.01    0.94    9.38

 ===125 FR# EXCEEDS FNTEST AT SECID "APPR1":  TRIALS CONTINUED.
             FNTEST,FR#,WSEL,CRWS =  0.80    1.15     497.18     497.47

 ===110 WSEL NOT FOUND AT SECID "APPR1":  REDUCED DELTAY.
                  WSLIM1,WSLIM2,DELTAY =   495.01     511.95    0.50

 ===115 WSEL NOT FOUND AT SECID "APPR1":  USED WSMIN = CRWS.
                  WSLIM1,WSLIM2,CRWS =   495.01     511.95     497.47

 ===130 CRITICAL WATER-SURFACE ELEVATION  A _ S _ S _ U _ M _ E _ D  !!!!!
             ENERGY EQUATION  N_O_T  B_A_L_A_N_C_E_D  AT SECID "APPR1"
                  WSBEG,WSEND,CRWS =   497.47     511.95     497.47

APPR1:XS      23.     2.      69.  1.50 *****  498.97  497.47    680.  497.47
       40.    23.    25.    2499.  1.00 ***** *******    1.00    9.81

  FIRST USER DEFINED TABLE.

   XSID:CODE    SRD    LEW    REW       Q        K     AREA     VEL    WSEL
   EXIT1:XS    -33.    10.    30.    680.    2456.      67.   10.22  491.97
   DSBRG:XS      0.     4.    23.    680.    2814.      69.    9.84  494.31
   USBRG:XS     17.     6.    30.    680.    2588.      73.    9.38  495.51
   APPR1:XS     40.     2.    25.    680.    2499.      69.    9.81  497.47

 SECOND USER DEFINED TABLE.

    XSID:CODE    CRWS     FR#    YMIN    YMAX    HF    HO  VHD      EGL    WSEL
   EXIT1:XS    491.97    1.00  487.77  511.96************  1.63  493.60  491.97
   DSBRG:XS    494.02    0.90  489.39  515.79  2.21  0.00  1.51  495.81  494.31
   USBRG:XS    495.39    0.94  490.75  515.79  1.08  0.00  1.37  496.88  495.51
   APPR1:XS    497.47    1.00  493.17  511.95************  1.50  498.97  497.47
```

APPENDIX C:

BED-MATERIAL PARTICLE-SIZE DISTRIBUTION



Appendix C. Bed material particle-size distribution for a pebble count in the channel approach of structure NEWFTH00350042, in Newfane, Vermont.

APPENDIX D:

HISTORICAL DATA FORM

United States Geological Survey
Bridge Historical Data Collection and Processing Form

Structure Number NEWFTH00350042

General Location Descriptive

Data collected by *(First Initial, Full last name)* M. IVANOFF

Date *(MM/DD/YY)* 04 / 06 / 95

Highway District Number *(I - 2; nn)* 02

County *(FIPS county code; I - 3; nnn)* 025

Town *(FIPS place code; I - 4; nnnnn)* 48400

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

Waterway *(I - 6)* STRATTON HILL BROOK

Road Name *(I - 7):* -

Route Number TH035

Vicinity *(I - 9)* 0.15 MI TO JCT W CL2 TH2

Topographic Map Newfane

Hydrologic Unit Code: 01080107

Latitude *(I - 16; nnnn.n)* 42564

Longitude *(i - 17; nnnnn.n)* 72435

Select Federal Inventory Codes

FHWA Structure Number *(I - 8)* 10131200421312

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

Maximum span length *(I - 48; nnnn)* 0032

Year built *(I - 27; YYYY)* 1939

Structure length *(I - 49; nnnnnn)* 000034

Average daily traffic, ADT *(I - 29; nnnnnn)* 000030

Deck Width *(I - 52; nn.n)* 155

Year of ADT *(I - 30; YY)* 90

Channel & Protection *(I - 61; n)* 5

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

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

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

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*) -

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

Vertical clearance from streambed (*nnn.n ft*) 006.8

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

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

Comments:

The structural inspection report of 07/27/94 indicates the structure is a steel beam type bridge with a timber deck. The abutments appear to be concrete faced laid up stone. They have some areas of minor spalling noted. There is a newer concrete subfooting poured along the bottom of the right abutment. The waterway has a fairly straight alignment through the skewed structure. The streambed consists of stone and boulder material with some gravel deposits. The stone fill protection consists of natural stone and boulder material.

Bridge Hydrologic Data

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

Terrain character: -

Stream character & type: -

Streambed material: -

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

Q_{50} - Q_{100} - Q_{500} -

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

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

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

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

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

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

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

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

Water Surface Elevation Estimates for Existing Structure:

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

Long term stream bed changes: -

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

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

-

USGS Watershed Data

Watershed Hydrographic Data

Drainage area *(DA)* **1.16** mi^2

Lake/pond/swamp area **0** mi^2

Watershed storage *(ST)* **0** %

Bridge site elevation **886** ft

Headwater elevation **1864** ft

Main channel length **1.98** mi

10% channel length elevation **866** ft

85% channel length elevation **1654** ft

Main channel slope *(S)* **530.51** ft / mi

Watershed Precipitation Data

Average site precipitation - in

Average headwater precipitation - in

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

Average seasonal snowfall *(Sn)* - ft

Bridge Plan Data

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

Project Number - Minimum channel bed elevation: -

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

Benchmark location description:
NO BENCHMARK INFORMATION

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

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

If 1: Footing Thickness ____ Footing bottom elevation: ____

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

If 3: Footing bottom elevation: ____

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

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

Briefly describe material at foundation bottom elevation or around piles:
NO FOUNDATION MATERIAL INFORMATION

Comments:
NO PLANS.

Cross-sectional Data

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

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

Comments: **The elevation and station measurements are in feet. This cross section was attached to a 7/27/94 bridge inspection report. The elevation coordinate has been made to fit that of this report by the low steel elevations.**

Station	0	8	16	24	31.17	32	-	-	-	-	-
Feature	LAB	-	-	-	-	RAB	-	-	-	-	-
Low chord elevation	499.11	498.85	498.58	498.32	498.08	498.06	-	-	-	-	-
Bed elevation	496.61	492.45	491.58	491.52	492.88	492.86	-	-	-	-	-
Low chord to bed	2.5	6.5	7	6.8	5.2	5.2	-	-	-	-	-

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

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

Comments: -
-

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

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

APPENDIX E:

LEVEL I DATA FORM

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

Qa/Qc Check by: EW Date: 10/30/96
Computerized by: EW Date: 11/1/96
Reviewd by: EW Date: 2/9/98

Structure Number NEWFTH00350042

A. General Location Descriptive

1. Data collected by *(First Initial, Full last name)* M. IVANOFF   Date *(MM/DD/YY)* 08 / 20 / 1996
2. Highway District Number 02   Mile marker 000000
   County WINDHAM (025)   Town NEWFANE (48400)
   Waterway *(I - 6)* STRATTON HILL BROOK   Road Name STRATTON HILL ROAD
   Route Number TH 35   Hydrologic Unit Code: 01080107
3. Descriptive comments:

Bridge 42 is located 0.15 miles from the junction with Town Highway 2.

B. Bridge Deck Observations

4. Surface cover... LBUS 6   RBUS 6   LBDS 6   RBDS 6   Overall 6
*(2b us,ds,lb,rb: **1**- Urban; **2**- Suburban; **3**- Row crops; **4**- Pasture; **5**- Shrub- and brushland; **6**- Forest; **7**- Wetland)*
5. Ambient water surface... US 2   UB 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 34 *(feet)*   Span length 32 *(feet)*   Bridge width 15.5 *(feet)*

Road approach to bridge:

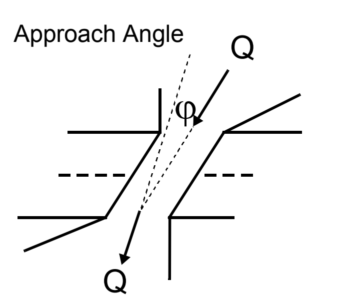
8. LB 2   RB 1   *(**0** even, **1-** lower, **2-** higher)*
9. LB 2   RB 2   *(**1**- Paved, **2**- Not paved)*
10. Embankment slope (*run / rise in feet / foot*):
    US left --   US right --

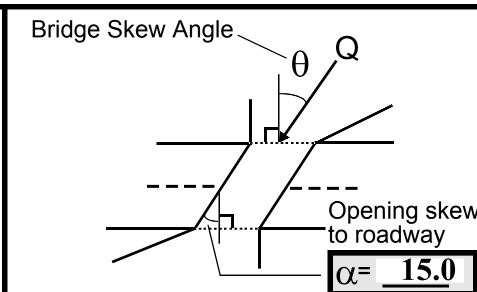
	Protection		13.Erosion	14.Severity
	11.Type	12.Cond.		
LBUS	0	-	0	-
RBUS	0	-	0	-
RBDS	5	1	0	-
LBDS	1	1	0	-

*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: 20   16. Bridge skew: 20



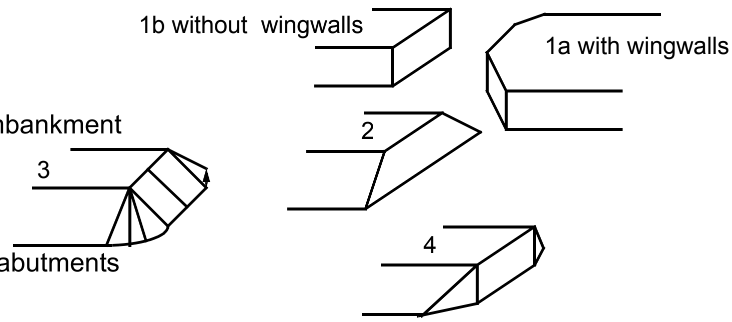


17. Channel impact zone 1:   Exist? Y *(Y or N)*
    Where? RB *(LB, RB)*   Severity 0
    Range? 0 feet US *(US, UB, DS)* to 0 feet DS
    Channel impact zone 2:   Exist? N *(Y or N)*
    Where? ____ *(LB, RB)*   Severity ____
    Range? ____ feet ____ *(US, UB, DS)* to ____ feet ____

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

18. Bridge Type: **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.)

7: Values are from VTAOT database. Site visit measurements where the same as VT AOT values.

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
32.0	7.0			7.0	3	4	54	54	0	0

23. Bank width **30.0** 24. Channel width **30.0** 25. Thalweg depth **40.0** 29. Bed Material **543**

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

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

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

Bedrock extends across channel bed 120 feet upstream.

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

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

37. Material: -

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

NO POINT BARS

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

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

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

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

NO CUT BANKS

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

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

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

NO CHANNEL SCOUR

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

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

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

54. Confluence comments (eg. confluence name):

NO MAJOR CONFLUENCES

D. Under Bridge Channel Assessment

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

56. Height (BF)		57 Angle (BF)		61. Material (BF)		62. Erosion (BF)	
LB	RB	LB	RB	LB	RB	LB	RB
16.5		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.):

543

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? **1** ___ *(Y or N)* Ice Blockage Potential **N** ____ *(1- Low; 2- Moderate; 3- High)*

70. Debris and Ice Comments:

1

Trees overhang the channel and debris exists along the channel 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		**0**	**90**	**0**	**0**	**-**	**-**	**90.0**
RABUT	**1**	**10**	**90**			**2**	**2**	**23.0**

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

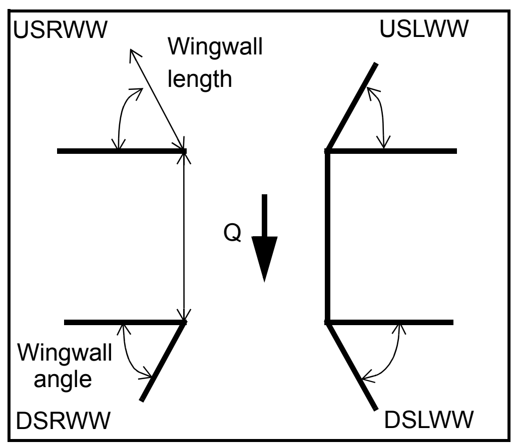
79. Abutment comments (eg. undermined penetration, unusual scour processes, debris, etc.):

0
1.5
1

Historical form notes footing added to base of the right abutment. The right abutment footing maximum exposure is 1.5 feet at the downstream bridge face.

80. **Wingwalls**:

	Exist?	Material?	Scour Condition?	Scour depth?	Exposure depth?	81. Angle?	Length?
USLWW:						**23.0**	
USRWW:	**Y**		**1**		**0**	**0.5**	
DSLWW:	**-**		**-**		**Y**	**16.5**	
DSRWW:	**1**		**0**		**-**	**18.0**	



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

82. **Bank / Bridge Protection**:

Location	USLWW	USRWW	LABUT	RABUT	LB	RB	DSLWW	DSRWW
Type	**-**	**-**	**N**	**-**	**-**	**-**	**-**	**-**
Condition	**N**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Extent	**-**	**-**	**-**	**0**	**0**	**0**	**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

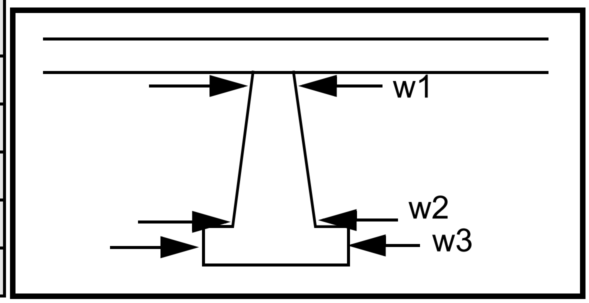
83. Wingwall and protection comments (eg. undermined penetration, unusual scour processes, etc.):

-
-
0
-
-
-
-
-
-
-
-

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		**2.5**	**9.0**	**35.0**	**110.0**	-
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 - 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.):

3
4
54
54
1
0
543
1
0
1
-
Left bank protection extends from the downstream bridge face to 8 feet downstream, and 8 feet (horizontally) into the channel.

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: **Y**

Cut bank extent: **66** feet **8** *(US, UB, DS)* to **46** feet **DS** *(US, UB, DS)*

Bank damage: **100** *(**1**- eroded and/or creep; **2**- slip failure; **3**- block failure)*

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

DS
50
100
43

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

Scour dimensions: Length **and** Width **grav** Depth: **el** Positioned **poi** %LB to **nt** %RB

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

bar.

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

Confluence 1: Distance **65** Enters on **33** *(LB or RB)* Type **DS** *(**1**- perennial; **2**- ephemeral)*

Confluence 2: Distance **80** Enters on **DS** *(LB or RB)* Type **1** *(**1**- perennial; **2**- ephemeral)*

Confluence comments (eg. confluence name):

F. Geomorphic Channel Assessment

107. Stage of reach evolution _____

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

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

N
-
-
-
-
-
-
NO CHANNEL SCOUR

N

109. G. Plan View Sketch

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

APPENDIX F:

SCOUR COMPUTATIONS

SCOUR COMPUTATIONS

Structure Number: NEWFTH00350042 Town: NEWFANE
Road Number: TH 35 County: WINDHAM
Stream: STRATTON HILL BROOK

Initials ECW Date: 1-29-98 Checked: EB

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 Davis, 1995, p. 28, eq. 16)

Approach Section

Characteristic	100 yr	500 yr	other Q
Total discharge, cfs	440	680	0
Main Channel Area, ft2	51	69	0
Left overbank area, ft2	0	0	0
Right overbank area, ft2	0	0	0
Top width main channel, ft	23	23	0
Top width L overbank, ft	0	0	0
Top width R overbank, ft	0	0	0
D50 of channel, ft	0.396	0.396	0
D50 left overbank, ft	--	--	--
D50 right overbank, ft	--	--	--
y1, average depth, MC, ft	2.2	3.0	ERR
y1, average depth, LOB, ft	ERR	ERR	ERR
y1, average depth, ROB, ft	ERR	ERR	ERR
Total conveyance, approach	1589	2494	0
Conveyance, main channel	1589	2494	0
Conveyance, LOB	0	0	0
Conveyance, ROB	0	0	0
Percent discrepancy, conveyance	0.0000	0.0000	ERR
Qm, discharge, MC, cfs	440.0	680.0	ERR
Ql, discharge, LOB, cfs	0.0	0.0	ERR
Qr, discharge, ROB, cfs	0.0	0.0	ERR
Vm, mean velocity MC, ft/s	8.6	9.9	ERR
Vl, mean velocity, LOB, ft/s	ERR	ERR	ERR
Vr, mean velocity, ROB, ft/s	ERR	ERR	ERR
Vc-m, crit. velocity, MC, ft/s	9.4	9.9	N/A
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	N/A
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 Davis, 1995, p. 32, eq. 20, 20a)

Bridge Section	Q100	Q500	Other Q
(Q) total discharge, cfs	440	680	0
(Q) discharge thru bridge, cfs	440	680	0
Main channel conveyance	1912	2819	0
Total conveyance	1912	2819	0
Q2, bridge MC discharge,cfs	440	680	ERR
Main channel area, ft2	53	69	0
Main channel width (normal), ft	17.8	18.5	0.0
Cum. width of piers in MC, ft	0.0	0.0	0.0
W, adjusted width, ft	17.8	18.5	0
y_bridge (avg. depth at br.), ft	2.98	3.73	ERR
Dm, median (1.25*D50), ft	0.495	0.495	0
y2, depth in contraction,ft	2.37	3.32	ERR
ys, scour depth (y2-ybridge), ft	-0.61	-0.41	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	440	680	N/A
Main channel area (DS), ft2	53	69	0
Main channel width (normal), ft	17.8	18.5	0.0
Cum. width of piers, ft	0.0	0.0	0.0
Adj. main channel width, ft	17.8	18.5	0.0
D90, ft	1.3646	1.3646	0.0000
D95, ft	1.6245	1.6245	0.0000
Dc, critical grain size, ft	0.6446	0.7956	ERR
Pc, Decimal percent coarser than Dc	0.303	0.255	0.000
Depth to armoring, ft	4.45	6.98	ERR

Abutment Scour

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

Characteristic	Left Abutment 100 yr Q	500 yr Q	Other Q	Right Abutment 100 yr Q	500 yr Q	Other Q
(Qt), total discharge, cfs	440	680	0	440	680	0
a', abut.length blocking flow, ft	0	0	0	0	0	0
Ae, area of blocked flow ft2	0	0	0	0	0	0
Qe, discharge blocked abut.,cfs	0	0	0	0	0	0
(If using Qtotal_overbank to obtain Ve, leave Qe blank and enter Ve and Fr manually)						
Ve, (Qe/Ae), ft/s	ERR	ERR	ERR	ERR	ERR	ERR
ya, depth of f/p flow, ft	2.44	3.34	ERR	2.34	3.24	ERR
--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	90	90	90	90	90	90
K2	1.00	1.00	1.00	1.00	1.00	1.00
Fr, froude number f/p flow	N/A	N/A	ERR	N/A	N/A	ERR
ys, scour depth, ft	2.44	3.34	N/A	2.34	3.24	N/A

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

a'(abut length blocked, ft)	0	0	0	0	0	0
y1 (depth f/p flow, ft)	ERR	ERR	ERR	ERR	ERR	ERR
a'/y1	ERR	ERR	ERR	ERR	ERR	ERR
Skew correction (p. 49, fig. 16)	1.00	1.00	1.00	1.00	1.00	1.00
Froude no. f/p flow	N/A	N/A	N/A	N/A	N/A	N/A
Ys w/ corr. factor K1/0.55:						
vertical	ERR	ERR	ERR	ERR	ERR	ERR
vertical w/ ww's	ERR	ERR	ERR	ERR	ERR	ERR
spill-through	ERR	ERR	ERR	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 Davis, 1995, p112, eq. 81,82)

Characteristic	Q100	Q500	Other Q	Q100	Q500	Other Q
Fr, Froude Number	0.85	0.9	0	0.85	0.9	0
y, depth of flow in bridge, ft	2.98	3.73	0.00	2.98	3.73	0.00
Median Stone Diameter for riprap at:	left abutment			right abutment, ft		
Fr<=0.8 (vertical abut.)	ERR	ERR	0.00	ERR	ERR	0.00
Fr>0.8 (vertical abut.)	1.19	1.51	ERR	1.19	1.51	ERR