Espey, Huston & Associates, Inc.

Level II Bridge Scour Analysis

for Structure 137007900100 on Route S 79 Crossing North Prong Creek in Chesterfield County, South Carolina

EH&A Project No. 16221.01
EH&A File Number 16221.01 B-3

Prepared in cooperation with

South Carolina Department of Transportation

Columbia, South Carolina
March 1995

LEVEL II BRIDGE SCOUR ANALYSIS

FOR STRUCTURE 137007900100 ON ROUTE S 79 CROSSING NORTH PRONG CREEK IN CHESTERFIELD COUNTY, SOUTH CAROLINA

This report provides the results of the detailed Level II analysis of scour potential at bridge 137007900100 on Route S 79 crossing North Prong Creek in Chesterfield County, South Carolina. The site is located in the Upper Coastal Plain physiographic province at approximately 34° 40' 19" North, 080° 02' 36" West, 3 miles south of Chesterfield, South Carolina. The contributing watershed area for this bridge is 20.7 mi^2. The watershed is rural, consisting of forest and farmland. In the vicinity of the bridge the floodplain consists of woodland and brush.

The bridge site is rural with dense forest and extremely dense undergrowth. The topography is gentle rolling to flat ground with a wide marshy floodplain with dense vegetation on the banks and the floodplain. The base flow velocity was estimated at 0.5 feet per second.

The bridge structure is 120 feet in length with four 30 foot spans. The bridge is supported by three interior bents each consisting of six concrete piles. The vertical abutments are not protected by riprap. The bridge deck is on a 0.00% grade. The channel banks are protected by D_{50} = 10 inch riprap that is in poor condition.

Scour calculations were performed using engineering judgement and according to the FHWA Hydraulic Engineering Circular No. 18, (Revised April 1993). The calculations were performed assuming a uniform fine-sand streambed particle with a D_{50} of 0.12 mm. The 100-year total scour depth at the downstream face of the bridge ranged from 0.00 to 6.46 feet. The 500-year total scour depth at the downstream face of the bridge ranged from 0.00 to 8.15 feet. It is assumed that scour activity will be arrested at the solid rock line.

This study was conducted using limited available data. Stream surveys and geotechnical assessments were not available. For hydraulic modeling purposes, stream cross sections were estimated using measurements taken at the downstream face of the bridge, combined with contour data from the USGS quad map and field observations. Scour computations are dependent upon, and sensitive to, cross-sectional geometry. A sand grain size was assumed for scour calculations. For these reasons, the results of this study should be considered approximate.

SCOUR REPORT SUMMARY

Structure Number 137007900100 Stream North Prong Creek
County Chesterfield Route S 79 District 4

Description of Bridge

Bridge length 120.0 ft Bridge width 37.5 ft Max span length 30.0 ft

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

Abutment type Vertical Embankment type Sloping

Riprap on abutment? Yes Date of inspection January 9, 1995

Description of riprap D_{50} = 10 inches. Riprap at channel banks is in poor condition providing very little protection at the stream banks. The abutments are not protected.

Brief description of piers/pile bents There are three interior bents each consisting of six concrete piles 16" square.

Is bridge skewed to floodplain according to USGS quad map? Yes Angle 20°

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

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			
Level II	January 9, 1995	0	0

Potential for debris The potential for debris accumulation is low.

Describe any features near or at the bridge that may affect flow (include observation date).

Description of Floodplain

General topography Gently rolling

Floodplain conditions at bridge site; downstream (D/S), upstream (U/S)

Date of inspection January 9, 1995

D/S left: Dense forest with thick underbrush marshy terrain

D/S right: Dense forest with thick underbrush marshy terrain

U/S left: Dense forest with thick underbrush marshy terrain

U/S right: Dense forest with thick underbrush marshy terrain

Description of Channel

Average top width 57 *ft* *Average depth* 5 *ft*

Predominant bed material Silty sand *Bank material* Silty sand

Stream type (straight, meandering, braided, swampy, channelized) Straight

Vegetative cover on channel banks near bridge: *Date of inspection* January 9, 1995

D/S left: Dense brush and weeds

D/S right: Dense brush and weeds

U/S left: Dense brush and weeds

U/S right: Dense brush and weeds

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

Describe any obstructions in channel and date of observation.

Hydrology

Drainage area 20.7 mi^2

Percentage of drainage area in physiographic provinces:

Physiographic province	Percent of drainage area
Upper Coastal Plain	100%

Is drainage area considered rural or urban? Rural *Describe any significant urbanization and potential for development.* No significant urbanization and low potential for development.

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

USGS gage description _____

USGS gage number _____

Gage drainage area _____ mi^2

Is there a lake/pond that will significantly affect hydrology/hydraulics? No

If so, describe _____

Calculated Discharges

Q100 938 ft^3/s *Q500* 1322 ft^3/s

Method used to determine discharges Regression equations for 100- and 500-year flood discharges (Ref. USGS WRIR 91-4157, "Techniques for Estimating Magnitude and Frequency of Floods in South Carolina, 1988", Guimaraes and Bohman).

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

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

Datum tie, if available SCDOT bridge plans appear to have the same datum as the USGS quad map.

Briefly describe the survey used to develop WSPRO model. No survey was available. The stream cross section at the downstream face of the bridge was measured during the inspection. This cross section was then combined with data from the USGS quad map to produce other cross sections. Field observations were used to supplement and modify the sections.

Cross-Sections Used in WSPRO Analysis

Cross-section ID[1]	Section Reference Distance (SRD) in feet	How cross-section was developed[2]	Comments
EXIT	000	2,3	Exit Section
FULL	120	4	Full Valley Section
BRDG	120	1	Bridge Section
ROAD	Not used	3	Road Section
APPR	276	2,3	Approach Section

[1] 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 based on topographic map; 4) synthesized by combining channel survey data and topographic contours; and 5) other

Starting water-surface elevation for WSPRO analysis (place ✓ on the appropriate line):

✓ *used slope/conveyance and confirmed by testing for convergence when reasonably possible*

__ *used known water-surface elevations. Describe* _____

Describe any special assumptions or considerations made in developing WSPRO model.

No survey was available. Cross section information was taken from the "Chesterfield, S.C." USGS quad map and from information collected during the field inspection on January 9, 1995. Elevations given are approximate. Manning's roughness coefficients were estimated from field observations. The 100- and 500-year discharges were obtained using procedures described in USGS WRIR 91-4157, "Techniques for Estimating Magnitude and Frequency of Floods in South Carolina, 1988", Guimaraes and Bohman. Bridge elevations were estimated from the USGS quad map and the SCDOT bridge plans using field measurements. There is no data associated with high water marks available for model calibration. The cross section data is coded left to right facing downstream.

Bridge Hydraulics

Average embankment elevation 133.1 ft

Average low steel elevation 131.5 ft

100-year discharge	938	ft^3/s
Water-surface elevation at D/S bridge face	127.13	ft
Area of flow at D/S bridge face	260	ft^2
Average velocity in bridge opening	3.61	ft/s
Maximum WSPRO tube velocity at bridge	4.65	ft/s

Water-surface elevation at Approach section with bridge	127.37	ft
Water-surface elevation at Approach section without bridge	127.33	ft
Amount of backwater caused by bridge	0.04	ft

500-year discharge	1322	ft^3/s
Water-surface elevation at D/S bridge face	128.09	ft
Area of flow at D/S bridge face	330	ft^2
Average velocity in bridge opening	4.01	ft/s
Maximum WSPRO tube velocity at bridge	5.25	ft/s

Water-surface elevation at Approach section with bridge	128.34	ft
Water-surface elevation at Approach section without bridge	128.29	ft
Amount of backwater caused by bridge	0.05	ft

Scour

Describe any special assumptions or considerations made in bridge scour analysis.

Scour calculations were performed using engineering judgement according to FHWA Hydraulic Circular No. 18, "Evaluating Scour at Bridges" (Richardson et al., 1993). Because gradation information is unavailable for this site, the streambed was assumed to be comprised of fine sand having a D_{50} of 0.12 mm. It was further assumed that the streambed is composed of homogeneous, erosive fine sand down to the solid rock line, at which elevation all scour would be arrested. The results of the scour analysis are summarized in Tables 1 and 2 on the following pages.

Table 1

Cumulative scour depths at piers/bents for the 100-year discharge at structure 137007900100 on S 79 crossing North Prong Creek in Chesterfield, South Carolina.

Pier/bent Number[1]	Distance[2] from left end of bridge (feet)	Contraction scour depth (feet)	Local scour depth without debris (feet)	Total scour[3] depth without debris (feet)	Elevation of Highest Pile Tip (feet)	Elevation of Bottom of Scour Hole (feet)	Remaining[4] Embedment (feet)
100-year discharge is 938 cubic feet per second							
Abutment	0	N/A	Abutment-Protected	N/A	99.61	N/A	N/A
4	30	0.00	0.00	0.00	99.61	N/A	N/A
3	60	0.98	4.92	5.90	99.61	115.50	15.89
2	90	0.98	5.48	6.46	99.61	113.44	13.83
Abutment	120	N/A	Abutment-Protected	N/A	99.61	N/A	N/A

[1] Piers/bent number corresponds to South Carolina Department of Transportation bridge plans.

[2] Distances are determined from left to right looking downstream.

[3] Total scour depth is the sum of the contraction and local scour depths.

[4] Elevation of bottom of scour hole minus elevation of highest pile tip. A negative number indicates computed scour is below the bottom of the pile tip.

Table 2

Cumulative scour depths at piers/bents for the 500-year discharge at structure 137007900100 on S 79 crossing North Prong Creek in Chesterfield, South Carolina.

Pier/bent Number[1]	Distance[2] from left end of bridge (feet)	Contraction scour depth (feet)	Local scour depth without debris (feet)	Total scour[3] depth without debris (feet)	Elevation of Highest Pile Tip (feet)	Elevation of Bottom of Scour Hole (feet)	Remaining[4] Embedment (feet)
500-year discharge is 1322 cubic feet per second							
Abutment	0	N/A	Abutment-Protected	N/A	99.61	N/A	N/A
4	30	0.05	2.66	2.71	99.61	124.49	24.88
3	60	2.34	5.46	7.80	99.61	113.60	13.99
2	90	2.34	5.81	8.15	99.61	111.75	12.14
Abutment	120	N/A	Abutment-Protected	N/A	99.61	N/A	N/A

[1] Piers/bent number corresponds to South Carolina Department of Transportation bridge plans.

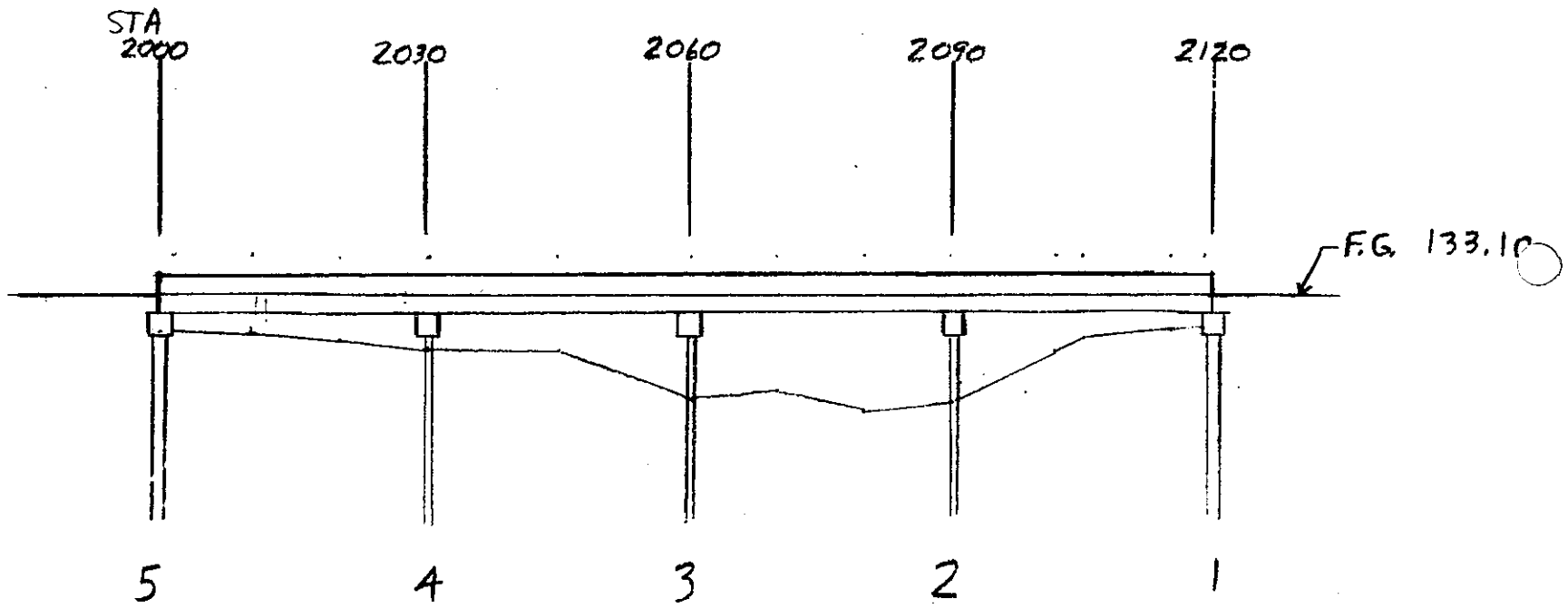
[2] Distances are determined from left to right looking downstream.

[3] Total scour depth is the sum of the contraction and local scour depths.

[4] Elevation of bottom of scour hole minus elevation of highest pile tip. A negative number indicates computed scour is below the bottom of the pile tip.

Measured January 9, 1995

Route S-79 over
North Prong Creek
Chesterfield, S.C.
EH&A File No. 16221.01 B-3



Looking Downstream

```
T2        ROUTE 79 OVER NORTH PRONG CREEK
T3        EH&A FILE NO. 16221.01 B-3
*         CHESTERFIELD CO., SOUTH CAROLINA
*         FILE NAME: 16221W03.DAT
*         ************************************************************
J1         .5  *  *  .95
J3        5 3 13 15 23 430 446 448 * 5 17 29 30 6 16 555 * 7 14 3 11
*         ************************************************************
*          Q100    Q500
Q          938     1322
SK        .0009   .0009
*         ************************************************************
*         CROSS SECTION INFORMATION WAS TAKEN FROM THE USGS QUAD
*         SHEET "CHESTERFILED S.C." AND FROM INFORMATION COLLECTED
*         DURING THE FIELD INSPECTION ON JANUARY 9, 1995.  ELEVATIONS
*         GIVEN ARE APPROXIMATE.  MANNINGS COEFFICIENTS WERE
*         ESTIMATED FROM FIELD OBSERVATIONS.  THE 100- AND 500-YEAR
*         DISCHARGES WERE CALCULATED USING REGRESSION EQUATIONS.
*         BRIDGE STRUCTURAL ELEVATIONS WERE TAKEN FROM BRIDGE
*         DRAWINGS PROVIDED BY SCDOT.  THERE ARE NO HIGH WATER MARKS
*         KNOWN TO CALIBRATE THE MODEL.  CROSS SECTION DATA IS CODED
*         LEFT TO RIGHT FACING DOWNSTREAM.
*         ************************************************************
XS   EXIT  000  20
GR         1600,130.0 2045,126.7 2060,121.2 2070,122.2
GR         2080,119.6 2090,119.7 2102,126.6 2520,130.0
N          .15    .12    .035    .12    .15
SA            2000   2045    2103    2120
*         ************************************************************
XS   FULL  120  20
GR         1750,130.0 2045,126.9 2060,121.4 2070,122.4
GR         2080,119.8 2090,119.9 2102,126.8 2270,130.0
N          .15     .12    .035    .12    .15
SA            2000   2045     2103   2120
*         ************************************************************
BR   BRDG  120  131.5  20
GR         2001,131.5 2001,129.2 2010,128.9 2020,128.4 2030,127.2
GR         2045,126.9 2060,121.4 2070,122.4 2080,119.8 2090,119.9
GR         2102,126.8 2105,128.3 2115,129.2 2119,129.4 2119,131.5
GR         2001,131.5
N          .045     .035      .045
SA              2045      2103
CD         2  37.5  2  133.1
PW 1       119.9,1.33 121.4,1.33 121.4,2.66 127.2,2.66 127.2,3.99
PW 1       131.5,3.99
*         ************************************************************
AS   APPR  276  20
GR         1750,130.0 2045,127.0 2060,121.5 2070,122.5
GR         2080,119.9 2090,120.0 2102,126.9 2320,130.0
N          .15    .12    .040    .12    .15
SA            2000   2045    2103   2120
*         ************************************************************
HP 1 APPR  127.37 * 127.37
HP 1 BRDG  127.13 * 127.13
HP 2 APPR  127.37 * 127.37  938
HP 2 BRDG  127.13 * 127.13  938
*
HP 1 APPR  128.34 * 128.34
HP 1 BRDG  128.09 * 128.09
HP 2 APPR  128.34 * 128.34 1322
HP 2 BRDG  128.09 * 128.09 1322
EX
ER
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1
 WSPRO          FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
 P060188             MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS

            *** RUN DATE & TIME: 03-20-95  08:26

   T2         ROUTE 79 OVER NORTH PRONG CREEK
   T3         EH&A FILE NO. 16221.01 B-3
   *          CHESTERFIELD CO., SOUTH CAROLINA
   *          FILE NAME: 16221W03.DAT
   *          ************************************************************
   J1          .5  *  *  .95

 J1 RECORD PARAMETERS:
 DELTAY =  .50   YTOL =  .02   QTOL =  .02   FNTEST =  .95   IHFNOJ = -1

   J3         5 3 13 15 23 430 446 448 * 5 17 29 30 6 16 555 * 7 14 3 11
   *          ************************************************************
   *           Q100    Q500
   Q           938     1322
 *** Q-DATA FOR SEC-ID, ISEQ =            1
   SK         .0009   .0009
   *          ************************************************************
   *          CROSS SECTION INFORMATION WAS TAKEN FROM THE USGS QUAD
   *          SHEET "CHESTERFILED S.C." AND FROM INFORMATION COLLECTED
   *          DURING THE FIELD INSPECTION ON JANUARY 9, 1995.  ELEVATIONS
   *          GIVEN ARE APPROXIMATE.  MANNINGS COEFFICIENTS WERE
   *          ESTIMATED FROM FIELD OBSERVATIONS.  THE 100- AND 500-YEAR
   *          DISCHARGES WERE CALCULATED USING REGRESSION EQUATIONS.
   *          BRIDGE STRUCTURAL ELEVATIONS WERE TAKEN FROM BRIDGE
   *          DRAWINGS PROVIDED BY SCDOT.  THERE ARE NO HIGH WATER MARKS
   *          KNOWN TO CALIBRATE THE MODEL.  CROSS SECTION DATA IS CODED
   *          LEFT TO RIGHT FACING DOWNSTREAM.
   *          ************************************************************
1
 WSPRO          FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
 P060188             MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS


         ROUTE 79 OVER NORTH PRONG CREEK
         EH&A FILE NO. 16221.01 B-3
            *** RUN DATE & TIME: 03-20-95  08:26

 *** START PROCESSING CROSS SECTION - "EXIT "
   XS  EXIT  000  20
   GR          1600,130.0 2045,126.7 2060,121.2 2070,122.2
   GR          2080,119.6 2090,119.7 2102,126.6 2520,130.0
   N           .15    .12    .035    .12    .15
   SA             2000   2045    2103    2120
   *          ************************************************************

 *** FINISH PROCESSING CROSS SECTION - "EXIT "
 *** CROSS SECTION "EXIT " WRITTEN TO DISK, RECORD NO. =  1

 --- DATA SUMMARY FOR SECID "EXIT " AT SRD =      0.  ERR-CODE =      0

      SKEW      IHFNO     VSLOPE         EK         CK
      20.0         0. *********       .50        .00

 X-Y COORDINATE PAIRS  (NGP =   8):
        X      Y          X      Y          X      Y          X      Y
    1600.0  130.00    2045.0  126.70    2060.0  121.20    2070.0  122.20
    2080.0  119.60    2090.0  119.70    2102.0  126.60    2520.0  130.00

  X-Y MAX-MIN POINTS:
      XMIN       Y          X    YMIN       XMAX       Y          X    YMAX
    1600.0  130.00    2080.0  119.60    2520.0  130.00    1600.0  130.00

 SUBAREA BREAKPOINTS (NSA =  5):
        2000.   2045.   2103.   2120.

 ROUGHNESS COEFFICIENTS (NSA =  5):
          .150    .120    .035    .120    .150
1
 WSPRO          FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
 P060188             MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS
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        ROUTE 79 OVER NORTH PRONG CREEK
        EH&A FILE NO. 16221.01 B-3
           *** RUN DATE & TIME: 03-20-95  08:26

*** START PROCESSING CROSS SECTION - "FULL "
  XS  FULL  120  20
  GR         1750,130.0 2045,126.9 2060,121.4 2070,122.4
  GR         2080,119.8 2090,119.9 2102,126.8 2270,130.0
  N          .15     .12    .035    .12    .15
  SA            2000   2045     2103   2120
  *         ************************************************************

*** FINISH PROCESSING CROSS SECTION - "FULL "
*** CROSS SECTION "FULL " WRITTEN TO DISK, RECORD NO. =  2

--- DATA SUMMARY FOR SECID "FULL " AT SRD =    120.  ERR-CODE =      0

     SKEW      IHFNO     VSLOPE         EK         CK
     20.0        0. *********        .50        .00

X-Y COORDINATE PAIRS  (NGP =   8):
       X       Y          X       Y          X       Y          X       Y
   1750.0  130.00    2045.0  126.90    2060.0  121.40    2070.0  122.40
   2080.0  119.80    2090.0  119.90    2102.0  126.80    2270.0  130.00

 X-Y MAX-MIN POINTS:
     XMIN       Y          X    YMIN      XMAX       Y          X    YMAX
   1750.0  130.00    2080.0  119.80    2270.0  130.00    1750.0  130.00

SUBAREA BREAKPOINTS (NSA =  5):
       2000.   2045.   2103.   2120.

ROUGHNESS COEFFICIENTS (NSA =  5):
         .150    .120    .035    .120    .150
1
WSPRO          FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
P060188            MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS


        ROUTE 79 OVER NORTH PRONG CREEK
        EH&A FILE NO. 16221.01 B-3
           *** RUN DATE & TIME: 03-20-95  08:26

*** START PROCESSING CROSS SECTION - "BRDG "
  BR  BRDG  120  131.5  20
  GR         2001,131.5 2001,129.2 2010,128.9 2020,128.4 2030,127.2
  GR         2045,126.9 2060,121.4 2070,122.4 2080,119.8 2090,119.9
  GR         2102,126.8 2105,128.3 2115,129.2 2119,129.4 2119,131.5
  GR         2001,131.5
  N          .045     .035     .045
  SA             2045     2103
  CD         2  37.5  2  133.1
  PW 1       119.9,1.33 121.4,1.33 121.4,2.66 127.2,2.66 127.2,3.99
  PW 1       131.5,3.99
  *         ************************************************************

*** FINISH PROCESSING CROSS SECTION - "BRDG "
*** CROSS SECTION "BRDG " WRITTEN TO DISK, RECORD NO. =  3

--- DATA SUMMARY FOR SECID "BRDG " AT SRD =    120.  ERR-CODE =      0

     SKEW      IHFNO     VSLOPE         EK         CK
     20.0        0. *********        .50        .00

X-Y COORDINATE PAIRS  (NGP =  16):
       X       Y          X       Y          X       Y          X       Y
   2001.0  131.50    2001.0  129.20    2010.0  128.90    2020.0  128.40
   2030.0  127.20    2045.0  126.90    2060.0  121.40    2070.0  122.40
   2080.0  119.80    2090.0  119.90    2102.0  126.80    2105.0  128.30
   2115.0  129.20    2119.0  129.40    2119.0  131.50    2001.0  131.50

 X-Y MAX-MIN POINTS:
     XMIN       Y          X    YMIN      XMAX       Y          X    YMAX
   2001.0  131.50    2080.0  119.80    2119.0  129.40    2001.0  131.50
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 SUBAREA BREAKPOINTS (NSA =  3):
        2045.   2103.

 ROUGHNESS COEFFICIENTS (NSA =  3):
          .045    .035    .045

 BRIDGE PARAMETERS:
  BRTYPE  BRWDTH     LSEL  USERCD  EMBSS   EMBELV    YABLT    YABRT
     2      37.5   131.50 *******   2.00   133.10 ******** ********

 PIER DATA:  NPW =  6    PPCD = 1.
      PELV  PWDTH      PELV  PWDTH      PELV  PWDTH      PELV  PWDTH
     119.90   1.3     121.40   1.3     121.40   2.7     127.20   2.7
     127.20   4.0     131.50   4.0
1
 WSPRO         FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
 P060188           MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS


         ROUTE 79 OVER NORTH PRONG CREEK
         EH&A FILE NO. 16221.01 B-3
            *** RUN DATE & TIME: 03-20-95  08:26

 *** START PROCESSING CROSS SECTION - "APPR "
   AS  APPR  276  20
   GR          1750,130.0 2045,127.0 2060,121.5 2070,122.5
   GR          2080,119.9 2090,120.0 2102,126.9 2320,130.0
   N           .15    .12    .040    .12    .15
   SA             2000   2045    2103   2120
   *          ************************************************************
   HP 1 APPR  127.37 * 127.37

 *** FINISH PROCESSING CROSS SECTION - "APPR "
 *** CROSS SECTION "APPR " WRITTEN TO DISK, RECORD NO. =  4

 --- DATA SUMMARY FOR SECID "APPR " AT SRD =    276.  ERR-CODE =      0

      SKEW      IHFNO    VSLOPE        EK        CK
      20.0         0. *********       .50       .00

 X-Y COORDINATE PAIRS  (NGP =   8):
        X      Y         X      Y         X      Y         X      Y
    1750.0  130.00    2045.0  127.00    2060.0  121.50    2070.0  122.50
    2080.0  119.90    2090.0  120.00    2102.0  126.90    2320.0  130.00

  X-Y MAX-MIN POINTS:
     XMIN       Y         X    YMIN      XMAX       Y         X    YMAX
    1750.0  130.00    2080.0  119.90    2320.0  130.00    1750.0  130.00

 SUBAREA BREAKPOINTS (NSA =  5):
        2000.   2045.   2103.   2120.

 ROUGHNESS COEFFICIENTS (NSA =  5):
          .150    .120    .040    .120    .150

 BRIDGE PROJECTION DATA:  XREFLT  XREFRT  FDSTLT  FDSTRT
                         ******* ******* ******* *******
1
 WSPRO         FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
 P060188           MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS


         ROUTE 79 OVER NORTH PRONG CREEK
         EH&A FILE NO. 16221.01 B-3
            *** RUN DATE & TIME: 03-20-95  08:26
     CROSS-SECTION PROPERTIES:  ISEQ =  4;  SECID = APPR ;  SRD =     276.

      WSEL  SA#     AREA        K   TOPW   WETP  ALPH    LEW     REW      QCR
              2       6.       25.    34.    34.                          15.
              3     267.    27521.    55.    58.                        3349.
              4       5.       32.    16.    16.                          18.
              5       2.        3.    14.    14.                           3.
    127.37          280.    27582.   119.   122.  1.09  2009.   2135.    2332.
1
   HP 1 BRDG  127.13 * 127.13
```

1
WSPRO FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
P060188 MODEL FOR WATER-SURFACE PROFILE COMPUTATIONS

ROUTE 79 OVER NORTH PRONG CREEK
EH&A FILE NO. 16221.01 B-3
*** RUN DATE & TIME: 03-20-95 08:26

CROSS-SECTION PROPERTIES: ISEQ = 3; SECID = BRDG ; SRD = 120.

WSEL	SA#	AREA	K	TOPW	WETP	ALPH	LEW	REW	QCR
	1	1.	10.	11.	11.				2.
	2	259.	30011.	54.	58.				3212.
127.13		260.	30020.	65.	68.	1.01	2034.	2103.	2942.

1
HP 2 APPR 127.37 * 127.37 938
1
WSPRO FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
P060188 MODEL FOR WATER-SURFACE PROFILE COMPUTATIONS

ROUTE 79 OVER NORTH PRONG CREEK
EH&A FILE NO. 16221.01 B-3
*** RUN DATE & TIME: 03-20-95 08:26

VELOCITY DISTRIBUTION: ISEQ = 4; SECID = APPR ; SRD = 276.

WSEL	LEW	REW	AREA	K	Q	VEL
127.37	2008.6	2135.1	280.0	27582.	938.	3.35

X STA.	2008.6	2057.8	2060.2	2062.4	2064.7	2067.2
A(I)		39.0	12.6	11.7	11.8	12.3
V(I)		1.20	3.73	4.00	3.97	3.82
X STA.	2067.2	2069.8	2072.5	2074.6	2076.5	2078.2
A(I)		12.6	12.7	12.0	11.2	10.6
V(I)		3.73	3.70	3.92	4.19	4.43
X STA.	2078.2	2079.8	2081.3	2082.9	2084.3	2085.9
A(I)		10.8	10.8	10.7	10.4	10.7
V(I)		4.35	4.34	4.38	4.50	4.39
X STA.	2085.9	2087.4	2088.9	2090.4	2092.3	2135.1
A(I)		10.5	10.4	10.5	11.6	37.0
V(I)		4.47	4.49	4.45	4.04	1.27

1
HP 2 BRDG 127.13 * 127.13 938
1
WSPRO FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
P060188 MODEL FOR WATER-SURFACE PROFILE COMPUTATIONS

ROUTE 79 OVER NORTH PRONG CREEK
EH&A FILE NO. 16221.01 B-3
*** RUN DATE & TIME: 03-20-95 08:26

VELOCITY DISTRIBUTION: ISEQ = 3; SECID = BRDG ; SRD = 120.

WSEL	LEW	REW	AREA	K	Q	VEL
127.13	2033.5	2102.7	260.2	30020.	938.	3.61

X STA.	2033.5	2058.2	2060.5	2062.7	2065.0	2067.4
A(I)		33.9	12.1	11.3	11.6	11.7
V(I)		1.38	3.88	4.17	4.03	4.00
X STA.	2067.4	2070.1	2072.7	2074.8	2076.7	2078.3
A(I)		12.4	12.2	11.5	10.7	10.1
V(I)		3.79	3.85	4.08	4.37	4.62
X STA.	2078.3	2079.8	2081.4	2082.9	2084.3	2085.9
A(I)		10.5	10.5	10.4	10.1	10.3
V(I)		4.49	4.48	4.52	4.65	4.54

```
 X STA.      2085.9     2087.3     2088.8     2090.3     2092.2     2102.7
   A(I)             10.2       10.1       10.2       11.3       29.2
   V(I)             4.62       4.64       4.59       4.15       1.61
1
   *
   HP 1 APPR  128.34 * 128.34
1
 WSPRO          FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
 P060188            MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS


         ROUTE 79 OVER NORTH PRONG CREEK
         EH&A FILE NO. 16221.01 B-3
            *** RUN DATE & TIME: 03-20-95  08:26
     CROSS-SECTION PROPERTIES:  ISEQ =  4;  SECID = APPR ;  SRD =     276.

      WSEL  SA#     AREA        K   TOPW   WETP  ALPH    LEW    REW     QCR
             1      36.     207.    82.    82.                         136.
             2      47.     626.    42.    42.                         281.
             3     320.   37198.    55.    58.                        4393.
             4      21.     309.    16.    16.                         135.
             5      46.     324.    78.    78.                         202.
    128.34          470.   38665.   273.   276.  1.92  2000.  2203.   2523.
1
   HP 1 BRDG  128.09 * 128.09
1
 WSPRO          FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
 P060188            MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS


         ROUTE 79 OVER NORTH PRONG CREEK
         EH&A FILE NO. 16221.01 B-3
            *** RUN DATE & TIME: 03-20-95  08:26
     CROSS-SECTION PROPERTIES:  ISEQ =  3;  SECID = BRDG ;  SRD =     120.

      WSEL  SA#     AREA        K   TOPW   WETP  ALPH    LEW    REW     QCR
             1      18.     524.    21.    21.                          93.
             2     311.   40608.    55.    58.                        4221.
             3       1.      10.     1.     2.                           2.
    128.09          330.   41141.    77.    81.  1.08  2023.  2105.   3724.
1
   HP 2 APPR  128.34 * 128.34 1322
1
 WSPRO          FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
 P060188            MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS


         ROUTE 79 OVER NORTH PRONG CREEK
         EH&A FILE NO. 16221.01 B-3
            *** RUN DATE & TIME: 03-20-95  08:26


     VELOCITY DISTRIBUTION:  ISEQ =  4;  SECID = APPR ;  SRD =     276.

         WSEL     LEW     REW    AREA        K        Q    VEL
       128.34  2000.0  2203.3   469.8   38665.    1322.   2.81

 X STA.      2000.0     2054.5     2058.0     2060.6     2062.9     2065.4
   A(I)             74.5       18.2       15.6       14.7       15.0
   V(I)              .89       3.64       4.23       4.50       4.40

 X STA.      2065.4     2068.1     2070.9     2073.5     2075.7     2077.7
   A(I)             15.6       16.0       15.3       14.4       14.6
   V(I)             4.23       4.14       4.32       4.59       4.53

 X STA.      2077.7     2079.6     2081.3     2083.0     2084.8     2086.5
   A(I)             14.7       13.5       13.5       13.5       13.5
   V(I)             4.51       4.91       4.89       4.91       4.91

 X STA.      2086.5     2088.1     2089.8     2091.8     2094.5     2203.3
   A(I)             13.1       13.4       14.7       16.5       93.8
   V(I)             5.04       4.94       4.51       4.01        .70
1
   HP 2 BRDG  128.09 * 128.09 1322
```

```
1
 WSPRO          FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
 P060188             MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS


         ROUTE 79 OVER NORTH PRONG CREEK
         EH&A FILE NO. 16221.01 B-3
            *** RUN DATE & TIME: 03-20-95  08:26


     VELOCITY DISTRIBUTION:  ISEQ =  3;  SECID = BRDG ;  SRD =     120.

          WSEL     LEW     REW    AREA        K        Q    VEL
        128.09  2022.6  2104.6   329.6   41141.    1322.   4.01

 X STA.      2022.6     2055.4     2058.6     2060.9     2063.2     2065.6
   A(I)            48.0       16.8       14.0       14.2       14.1
   V(I)            1.38       3.94       4.72       4.64       4.69

 X STA.      2065.6     2068.2     2071.0     2073.5     2075.6     2077.5
   A(I)            14.6       15.4       14.6       13.7       13.0
   V(I)            4.51       4.29       4.53       4.83       5.09

 X STA.      2077.5     2079.3     2080.9     2082.6     2084.2     2085.8
   A(I)            13.2       13.0       12.7       12.6       12.6
   V(I)            5.02       5.10       5.22       5.24       5.24

 X STA.      2085.8     2087.5     2089.1     2090.8     2093.0     2104.6
   A(I)            12.6       12.6       13.0       14.5       34.4
   V(I)            5.23       5.25       5.07       4.55       1.92
1
   EX

 +++ BEGINNING PROFILE CALCULATIONS --   2
1
 WSPRO          FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
 P060188             MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS


         ROUTE 79 OVER NORTH PRONG CREEK
         EH&A FILE NO. 16221.01 B-3
            *** RUN DATE & TIME: 03-20-95  08:26

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

 EXIT :XS   ******  2000.     284.   .19 *****  127.24  123.70    938.  127.04
         0. ******  2157.   31258.  1.14 ***** *******     .45    3.30

 FULL :FV      120.  2021.     266.   .20   .11  127.35 *******    938.  127.15
       120.    120.  2120.   30221.  1.04   .00     .00     .38    3.53
          <<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>

 APPR :AS      156.  2013.     275.   .19   .17  127.52 *******    938.  127.33
       276.    156.  2132.   27178.  1.08   .00     .00     .40    3.41
          <<<<<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

 BRDG :BR      120.  2034.     260.   .23   .12  127.36  124.08    938.  127.13
       120.    120.  2103.   30020.  1.16   .00     .00     .34    3.61

      TYPE PPCD FLOW      C     P/A    LSEL   BLEN   XLAB   XRAB
        2.   1.   1.   .930    .066  131.50 ****** ****** ******

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

 APPR :AS      119.  2009.     280.   .19   .14  127.56  124.00    938.  127.37
       276.    119.  2135.   27570.  1.09   .06     .00     .40    3.35

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

```
        .411   .000   27625.  2033.  2103.   127.23

                    <<<<<END OF BRIDGE COMPUTATIONS>>>>>
1
 WSPRO          FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
 P060188            MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS


         ROUTE 79 OVER NORTH PRONG CREEK
         EH&A FILE NO. 16221.01 B-3
            *** RUN DATE & TIME: 03-20-95  08:26
   FIRST USER DEFINED TABLE.

     XSID:CODE       Q    WSEL     VEL    CRWS    YMIN
    EXIT :XS       938.  127.04    3.30  123.70  119.60
    FULL :FV       938.  127.15    3.53******** 119.80
    BRDG :BR       938.  127.13    3.61  124.08  119.80
    APPR :AS       938.  127.37    3.35  124.00  119.90
1
 WSPRO          FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
 P060188            MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS


         ROUTE 79 OVER NORTH PRONG CREEK
         EH&A FILE NO. 16221.01 B-3
            *** RUN DATE & TIME: 03-20-95  08:26
  SECOND USER DEFINED TABLE.

     XSID:CODE       Q     AREA    LEW    REW    SRD        K
    EXIT :XS       938.     284.  2000.  2157.     0.   31258.
    FULL :FV       938.     266.  2021.  2120.   120.   30221.
    BRDG :BR       938.     260.  2034.  2103.   120.   30020.
    APPR :AS       938.     280.  2009.  2135.   276.   27570.

     XSID:CODE    OTEL
    APPR :AS    127.23
1
 WSPRO          FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
 P060188            MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS


         ROUTE 79 OVER NORTH PRONG CREEK
         EH&A FILE NO. 16221.01 B-3
            *** RUN DATE & TIME: 03-20-95  08:26
   THIRD USER DEFINED TABLE.

     XSID:CODE     EGL     FR#    WSEL    HF
    EXIT :XS    127.24     .45  127.04******
    FULL :FV    127.35     .38  127.15   .11
    BRDG :BR    127.36     .34  127.13   .12
    APPR :AS    127.56     .40  127.37   .14
1
 WSPRO          FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
 P060188            MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS


         ROUTE 79 OVER NORTH PRONG CREEK
         EH&A FILE NO. 16221.01 B-3
            *** RUN DATE & TIME: 03-20-95  08:26

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

EXIT :XS    ******  2000.     537.   .23 *****  128.24  124.39   1322.  128.00
        0. ******  2274.   44044.  2.49 ***** *******     .58    2.46

FULL :FV      120.  2000.     418.   .26   .11  128.36 *******   1322.  128.10
      120.    120.  2170.   41863.  1.66   .01     .00     .53    3.17
         <<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>

APPR :AS      156.  2000.     457.   .24   .17  128.54 *******   1322.  128.29
      276.    156.  2200.   38046.  1.87   .00     .00     .53    2.89
         <<<<<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	
BRDG :BR	120.	2023.	330.	.29	.13	128.38	124.80	1322.	128.09
120.	120.	2105.	41163.	1.14	.01	.00	.37	4.01	

TYPE	PPCD	FLOW	C	P/A	LSEL	BLEN	XLAB	XRAB
2.	1.	1.	.935	.064	131.50	******	******	******

XSID:CODE	SRDL	LEW	AREA	VHD	HF	EGL	CRWS	Q	WSEL
SRD	FLEN	REW	K	ALPH	HO	ERR	FR#	VEL	
APPR :AS	119.	2000.	471.	.24	.14	128.58	124.69	1322.	128.34
276.	120.	2204.	38710.	1.93	.06	.00	.52	2.81	

M(G)	M(K)	KQ	XLKQ	XRKQ	OTEL
.589	.028	37633.	2023.	2105.	128.21

<<<<<END OF BRIDGE COMPUTATIONS>>>>>

1
WSPRO FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
P060188 MODEL FOR WATER-SURFACE PROFILE COMPUTATIONS

ROUTE 79 OVER NORTH PRONG CREEK
EH&A FILE NO. 16221.01 B-3
*** RUN DATE & TIME: 03-20-95 08:26

FIRST USER DEFINED TABLE.

XSID:CODE	Q	WSEL	VEL	CRWS	YMIN
EXIT :XS	1322.	128.00	2.46	124.39	119.60
FULL :FV	1322.	128.10	3.17********		119.80
BRDG :BR	1322.	128.09	4.01	124.80	119.80
APPR :AS	1322.	128.34	2.81	124.69	119.90

1
WSPRO FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
P060188 MODEL FOR WATER-SURFACE PROFILE COMPUTATIONS

ROUTE 79 OVER NORTH PRONG CREEK
EH&A FILE NO. 16221.01 B-3
*** RUN DATE & TIME: 03-20-95 08:26

SECOND USER DEFINED TABLE.

XSID:CODE	Q	AREA	LEW	REW	SRD	K
EXIT :XS	1322.	537.	2000.	2274.	0.	44044.
FULL :FV	1322.	418.	2000.	2170.	120.	41863.
BRDG :BR	1322.	330.	2023.	2105.	120.	41163.
APPR :AS	1322.	471.	2000.	2204.	276.	38710.

XSID:CODE	OTEL
APPR :AS	128.21

1
WSPRO FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
P060188 MODEL FOR WATER-SURFACE PROFILE COMPUTATIONS

ROUTE 79 OVER NORTH PRONG CREEK
EH&A FILE NO. 16221.01 B-3
*** RUN DATE & TIME: 03-20-95 08:26

THIRD USER DEFINED TABLE.

XSID:CODE	EGL	FR#	WSEL	HF
EXIT :XS	128.24	.58	128.00******	
FULL :FV	128.36	.53	128.10	.11
BRDG :BR	128.38	.37	128.09	.13
APPR :AS	128.58	.52	128.34	.14

ER

1 NORMAL END OF WSPRO EXECUTION.

SCDOT BRIDGE SCOUR
Saved As: 16221A03.WQ1
JOB NO. 16221.01 B-3
BRIDGE NO. 137007900100
BY/CHK: RAS/GG

ESPEY, HUSTON & ASSOC., INC
460 McLAWS CIRCLE, SUITE 150
WILLIAMSBURG, VA 23185

STORM EVENT (YR): 100

DETERMINATION OF CRITICAL SCOUR VELOCITY

(A) INPUT

VARIABLES	DESCRIPTION	VALUE
MAIN CHANNEL:		
Ssm	SPECIFIC GRAVITY OF MAIN CHANNEL BED MATERIAL	2.65
D50m	MEAN DIAM. OF MAIN CHANNEL BED MATERAIL (mm)	0.12
AREAm	APPR. MAIN CHANNEL AREA (ft)^2	278
TOPW	APPR. MAIN CHANNEL TOP WIDTH (ft)	105
Ym	APPR. MAIN CHANNEL AVG. DEPTH = AREAm/TOPW	2.65
HFa	APPR. HEAD LOSS DUE TO FRICTION	0.17
DIST	DISTANCE FROM BRIDGE TO APPR.	156
Sf	AVG. UNCONSTRICTED ENERGY SLOPE = HFa/DIST	0.00109
Km	APPR. MAIN CHANNEL CONVEYANCE	27579
Vm	APPR. MAIN CHANNEL AVG. VELOCITY (fps)	3.27
	Vm = (Km*(Sf)^.5)/AREAm	

LEFT OVERBANK:

DUE TO THE GEOMETRY OF THE BRIDGE OPENING THE ENTIRE BRIDGE OPENING IS TREATED AS MAIN CHANNEL.

RIGHT OVERBANK:

DUE TO THE GEOMETRY OF THE BRIDGE OPENING THE ENTIRE BRIDGE OPENING IS TREATED AS MAIN CHANNEL.

SCDOT BRIDGE SCOUR
Saved As: 16221A03.WQ1
JOB NO. 16221.01 B-3
BRIDGE NO. 137007900100
BY/CHK: RAS/GG

ESPEY, HUSTON & ASSOC., INC
460 McLAWS CIRCLE, SUITE 150
WILLIAMSBURG, VA 23185

STORM EVENT (YR): 100

(1) MAIN CHANNEL CRITICAL VELOCITY (Vcm):
NEILL'S EQ;
Vcm=1.58*((Ssm-1)*g*D50m)^1/2*(Ym/D50m)^1/6
Vcm= 0.99 fps

(2) LEFT OVERBANK CRITICAL VELOCITY (Vci):

INCLUDED IN MAIN CHANNEL

(3) RIGHT OVERBANK CRITICAL VELOCITY (Vcr):

INCLUDED IN MAIN CHANNEL

NOTES: LIVE-BED SCOUR WILL BE COMPUTED FOR THE MAIN CHANNEL.

SCDOT BRIDGE SCOUR
Saved As: 16221A03.WQ1
JOB NO. 16221.01 B-3
BRIDGE NO. 137007900100
BY/CHK: RAS/GG

ESPEY, HUSTON & ASSOC., INC
460 McLAWS CIRCLE, SUITE 150
WILLIAMSBURG, VA 23185

STORM EVENT (YR): 100

SCOUR CALCULATIONS

I. LIVE BED CONTRACTION SCOUR

(A) INPUT FROM WSPRO

VARIABLE	DESCRIPTION	VALUE
Q	TOTAL DISCHARGE(cfs) APPROACH	938
Q	TOTAL DISCHARGE(cfs) BRIDGE	938
Ktot(APP)	APP. TOTAL CONVEYANCE	27579
Ktot(BR)	BR. TOTAL CONVEYANCE	30020
Sf	AVG. UNCONSTRICTED ENERGY SLOPE	0.00109
MAIN CHANNEL:		
Km(APP)	APP. MAIN CHANNEL CONVEYANCE	27579
W1m(APP)	APP. MAIN CHANNEL WIDTH(ft)	105
Am(APP)	APP. MAIN CHANNEL AREA	278
TOPWm(APP)	APP. MAIN CHANNEL TOP WIDTH(ft)	105
Y1m(APP)	AVG. DEPTH IN UPSTR MAIN CHANNEL(ft)	2.65
WETPm(APP)	APP. MAIN CHANNEL WETTED PERIM.(ft)	108
Km(BR)	BR. MAIN CHANNEL CONVEYANCE	30020
W2m(BR)	BR. MAIN CHANNEL WIDTH MINUS PIER WIDTHS(ft)	66.5
LEFT OVERBANK:		

DUE TO THE GEOMETRY OF THE BRIDGE OPENING THE ENTIRE BRIDGE OPENING IS TREATED AS MAIN CHANNEL

RIGHT OVERBANK:

DUE TO THE GEOMETRY OF THE BRIDGE OPENING THE ENTIRE BRIDGE OPENING IS TREATED AS MAIN CHANNEL

SCDOT BRIDGE SCOUR
Saved As: 16221A03.WQ1
JOB NO. 16221.01 B-3
BRIDGE NO. 137007900100
BY/CHK: RAS/GG

ESPEY, HUSTON & ASSOC., INC
460 McLAWS CIRCLE, SUITE 150
WILLIAMSBURG, VA 23185

STORM EVENT (YR): 100

(B) CALCULATIONS (CONTRACTION SCOUR)

1. MAIN CHANNEL CONTRACTION SCOUR (Ysm):

(a) APP. MAIN CHAN. HYD. RADIUS (Rm):

Rm=Am(APP)/WETPm(APP)
Rm= 2.57 ft

(b) AVG. MAIN CHANNEL SHEAR STRESS (SHEARm):
Ywater=UNIT WT. OF WATER(62.4 lb/cf)

SHEARm=Ywater*Rm*Sf
SHEARm= 0.18 lb/sf

(c) SHEAR VELOCITY IN APP. MAIN CHANNEL (Vm*):
p=DENSITY OF WATER(1.94 slugs/cf)

Vm*=(SHEARm/p)^.5
Vm*= 0.30 fps

(d) MAIN CHANNEL BED MATL. D50m:

D50m= 0.12 mm
D50m= 0.00039 ft

(e) FALL VELOCITY (wm):
FROM FIG. 3, PAGE 34

wm= 0.03 fps

(f) EXPONENT (K1):
FROM TBL. ON PAGE 33

Vm*/wm= 10.01
K1= 0.69

(g) DISCHARGE IN MAIN CHANNEL OF APP (Q1m):

Q1m=Q*(Km(APP)/Ktot(APP))
Q1m= 938 cfs

(h) DISCHARGE IN MAIN CHANNEL OF BR (Q2m):

Q2m=Q*(Km(BR)/Ktot(BR))
Q2m= 938 cfs

(i) LAURSEN'S LIVE BED EQUATION:
Y2m/Y1m=(Q2m/Q1m)^6/7*(W1m/W2m)^K1
Y2m= 3.63 ft

(j) MAIN CONTRACTION SCOUR DEPTH (Ysm):
Ysm=Y2m-Y1m
Ysm= 0.98 ft

SCDOT BRIDGE SCOUR
Saved As: 16221A03.WQ1
JOB NO. 16221.01 B-3
BRIDGE NO. 137007900100
BY/CHK: RAS/GG

ESPEY, HUSTON & ASSOC., INC
460 McLAWS CIRCLE, SUITE 150
WILLIAMSBURG, VA 23185

STORM EVENT (YR): 100

III. LOCAL SCOUR AT PIERS

(A) INPUT FROM WSPRO

VARIABLE		DESCRIPTION	VALUE
PIER #2:	WSPRO STA	2090	
A2		AREA OF CONVEYANCE TUBE AT PIER #2 (sf)	10.2
V2		VELOCITY IN CONVEYANCE TUBE AT PIER #2 (fps)	4.59
TOPW2		TOPWIDTH OF CONVEYANCE TUBE AT PIER #2 (ft)	1.5
Y2		MEAN DEPTH OF CONVEYANCE TUBE AT PIER #2 (ft)	6.80
PIER #3:	WSPRO STA	2060	
A3		AREA OF CONVEYANCE TUBE AT PIER #3 (sf)	12.1
V3		VELOCITY IN CONVEYANCE TUBE AT PIER #3 (fps)	3.88
TOPW3		TOPWIDTH OF CONVEYANCE TUBE AT PIER #3 (ft)	2.3
Y3		MEAN DEPTH OF CONVEYANCE TUBE AT PIER #3 (ft)	5.26
PIER #4:	WPSRO STA	2030	

WATER SURFACE DOES NOT REACH PIER #4; THEREFORE, NO LOCAL SCOUR WILL OCCUR AT THIS PIER.

ABUTMENT	WSPRO STA	2000

SCDOT BRIDGE SCOUR
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JOB NO. 16221.01 B-3
BRIDGE NO. 137007900100
BY/CHK: RAS/GG

ESPEY, HUSTON & ASSOC., INC
460 McLAWS CIRCLE, SUITE 150
WILLIAMSBURG, VA 23185

STORM EVENT (YR): 100

(B) CALCULATIONS (LOCAL SCOUR AT PIERS)

1. SCOUR DEPTH AT PIER #2 (Ys#2):

(a) a=PIER WIDTH (ft)=		1.33
(b) FROUDE NO.=FR2=V2/(g*Y2)^.5=	0.31	
(c) K1=PIER NOSE SHAPE CORR. FACTOR (FIG7, TBL2,PG40)=		1.0
(d) K2=ANGLE OF ATTACK CORR. FACTOR (TBL3, PG40)=		1.75
(e) K3=BED CONDITION CORR. FACTOR (TBL1, PG39)=		1.1

(f) CSU EQ. FOR PIER SCOUR;
Ys#2=Y2*2*K1*K2*K3*(a/Y2)^.65*FR2^.43
Ys#2= 5.48 ft

2. SCOUR DEPTH AT PIER #3 (Ys#3):

(a) a=PIER WIDTH (ft)=		1.33
(b) FROUDE NO.=FR3=V3/(g*Y3)^.5=	0.30	
(c) K1=PIER NOSE SHAPE CORR. FACTOR (FIG7, TBL2,PG40)=		1.0
(d) K2=ANGLE OF ATTACK CORR. FACTOR (TBL3, PG40)=		1.75
(e) K3=BED CONDITION CORR. FACTOR (TBL1, PG39)=		1.1

(f) CSU EQ. FOR PIER SCOUR;
Ys#3=Y3*2*K1*K2*K3*(a/Y3)^.65*FR3^.43
Ys#3= 4.92 ft

3. SCOUR DEPTH AT PIER #4 (Ys#4):

WATER SURFACE DOES NOT REACH PIER #4; THEREFORE, NO LOCAL SCOUR WILL OCCUR AT THIS PIER.

SCDOT BRIDGE SCOUR
Saved As: 16221A03.WQ1
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BRIDGE NO. 137007900100
BY/CHK: RAS/GG

ESPEY, HUSTON & ASSOC., INC
460 McLAWS CIRCLE, SUITE 150
WILLIAMSBURG, VA 23185

STORM EVENT (YR): 100

IV. ABUTMENT SCOUR:

THE WATER DOES NOT REACH THE ABUTMENTS
NO SCOUR CALCULATIONS PERFORMED

SCDOT BRIDGE SCOUR
Saved As: 16221B03.WQ1
JOB NO. 16221.01 B-3
BRIDGE NO. 137007900100
BY/CHK: RAS/GG

ESPEY, HUSTON & ASSOC., INC
460 McLAWS CIRCLE, SUITE 150
WILLIAMSBURG, VA 23185

STORM EVENT (YR): 500

DETERMINATION OF CRITICAL SCOUR VELOCITY

(A) INPUT

VARIABLES	DESCRIPTION	VALUE
MAIN CHANNEL:		
Ssm	SPECIFIC GRAVITY OF MAIN CHANNEL BED MATERIAL	2.65
D50m	MEAN DIAM. OF MAIN CHANNEL BED MATERAIL (mm)	0.12
AREAm	APPR. MAIN CHANNEL AREA (ft)^2	388
TOPW	APPR. MAIN CHANNEL TOP WIDTH (ft)	113
Ym	APPR. MAIN CHANNEL AVG. DEPTH = AREAm/TOPW	3.43
HFa	APPR. HEAD LOSS DUE TO FRICTION	0.17
DIST	DISTANCE FROM BRIDGE TO APPR.	156
Sf	AVG. UNCONSTRICTED ENERGY SLOPE = HFa/DIST	0.00109
Km	APPR. MAIN CHANNEL CONVEYANCE	38134
Vm	APPR. MAIN CHANNEL AVG. VELOCITY (fps)	3.24
	Vm = (Km*(Sf)^.5)/AREAm	
LEFT OVERBANK:		
Ssl	SPECIFIC GRAVITY OF LT. OVERBANK BED MATERIAL	2.65
D50l	MEAN DIAM. OF LT. OVERBANK BED MATL. (mm)	0.12
AREAl	LEFT OVERBANK AREA (ft)^2	36
TOPW	LEFT OVERBANK TOP WIDTH (ft)	82
Yl	APPR. LEFT OVERBANK AVG. DEPTH (ft)	0.44
Kl	LEFT OVERBANK CONVEYANCE	207
Vl	APPR. LEFT OVERBANK AVG. VELOCITY (fps)	0.19
	Vl = (Kl*(Sf)^.5)/AREAl	

RIGHT OVERBANK:

THERE IS NO FLOW IN THE RIGHT OVERBANK AT THE BRIDGE

SCDOT BRIDGE SCOUR
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460 McLAWS CIRCLE, SUITE 150
WILLIAMSBURG, VA 23185

STORM EVENT (YR): 500

(1) MAIN CHANNEL CRITICAL VELOCITY (Vcm):
NEILL'S EQ;
Vcm=1.58*((Ssm-1)*g*D50m)^1/2*(Ym/D50m)^1/6
Vcm= 1.04 fps

(2) LEFT OVERBANK CRITICAL VELOCITY (Vcl):
NEILL'S EQ;
Vcl=1.58*((Ssl-1)*g*D50l)^1/2*(Yl/D50l)^1/6
Vcl= 0.74 fps

(3) RIGHT OVERBANK CRITICAL VELOCITY (Vcr):

THERE IS NO FLOW IN THE RIGHT OVERBANK AT THE BRIDGE

NOTES: LIVE-BED SCOUR WILL BE COMPUTED FOR THE MAIN CHANNEL.
CLEAR-WATER SCOUR WILL BE COMPUTED FOR THE LEFT OVERBANK.

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BRIDGE NO. 137007900100
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ESPEY, HUSTON & ASSOC., INC
460 McLAWS CIRCLE, SUITE 150
WILLIAMSBURG, VA 23185

STORM EVENT (YR): 500

SCOUR CALCULATIONS

I. LIVE BED CONTRACTION SCOUR

(A) INPUT FROM WSPRO

VARIABLE	DESCRIPTION	VALUE
Q	TOTAL DISCHARGE(cfs) APPROACH	1322
Q	TOTAL DISCHARGE(cfs) BRIDGE	1322
Ktot(APP)	APP. TOTAL CONVEYANCE	38665
Ktot(BR)	BR. TOTAL CONVEYANCE	41141
Sf	AVG. UNCONSTRICTED ENERGY SLOPE	0.00109
MAIN CHANNEL:		
Km(APP)	APP. MAIN CHANNEL CONVEYANCE	38134
W1m(APP)	APP. MAIN CHANNEL WIDTH(ft)	113
Am(APP)	APP. MAIN CHANNEL AREA	388
TOPWm(APP)	APP. MAIN CHANNEL TOP WIDTH(ft)	113
Y1m(APP)	AVG. DEPTH IN UPSTR MAIN CHANNEL(ft)	3.43
WETPm(APP)	APP. MAIN CHANNEL WETTED PERIM.(ft)	116
Km(BR)	BR. MAIN CHANNEL CONVEYANCE	40618
W2m(BR)	BR. MAIN CHANNEL WIDTH MINUS PIER WIDTHS(ft)	53.3

RIGHT OVERBANK:

THERE IS NO FLOW IN THE RIGHT OVERBANK AT THE BRIDGE

SCDOT BRIDGE SCOUR
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BRIDGE NO. 137007900100
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WILLIAMSBURG, VA 23185

STORM EVENT (YR): 500

(B) CALCULATIONS (CONTRACTION SCOUR)

1. MAIN CHANNEL CONTRACTION SCOUR (Ysm):

(a) APP. MAIN CHAN. HYD. RADIUS (Rm):

Rm=Am(APP)/WETPm(APP)
Rm= 3.34 ft

(b) AVG. MAIN CHANNEL SHEAR STRESS (SHEARm):
Ywater=UNIT WT. OF WATER(62.4 lb/cf)

SHEARm=Ywater*Rm*Sf
SHEARm= 0.23 lb/sf

(c) SHEAR VELOCITY IN APP. MAIN CHANNEL (Vm*):
p=DENSITY OF WATER(1.94 slugs/cf)

Vm*=(SHEARm/p)^.5
Vm*= 0.34 fps

(d) MAIN CHANNEL BED MATL. D50m:

D50m= 0.12 mm
D50m= 0.00039 ft

(e) FALL VELOCITY (wm):
FROM FIG. 3, PAGE 34

wm= 0.03 fps

(f) EXPONENT (K1):
FROM TBL. ON PAGE 33

Vm*/wm= 11.41
K1= 0.69

(g) DISCHARGE IN MAIN CHANNEL OF APP (Q1m):

Q1m=Q*(Km(APP)/Ktot(APP))
Q1m= 1304 cfs

(h) DISCHARGE IN MAIN CHANNEL OF BR (Q2m):

Q2m=Q*(Km(BR)/Ktot(BR))
Q2m= 1305 cfs

(i) LAURSEN'S LIVE BED EQUATION:
Y2m/Y1m=(Q2m/Q1m)^6/7*(W1m/W2m)^K1
Y2m= 5.77 ft

(j) MAIN CONTRACTION SCOUR DEPTH (Ysm):
Ysm=Y2m-Y1m
Ysm= 2.34 ft

SCDOT BRIDGE SCOUR
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STORM EVENT (YR): 500

II. CLEAR-WATER CONTRACTION SCOUR

(A) INPUT FROM WSPRO

VARIABLE	DESCRIPTION	VALUE
Q	TOTAL DISCHARGE INPUT THRU BRIDGE (cfs)	1322
Ktot	TOTAL CONVEYANCE AT BRIDGE	41141

LEFT OVERBANK:

Kl	LEFT OVERBANK CONVEYANCE AT BRIDGE	524
Ql	FLOW IN LEFT OVERBANK THRU BRIDGE (cfs)	16.8
D50l	MEDIAN GRAIN SIZE OF LEFT OVERBANK (ft)	0.0004
Wl	DIST. FROM LEFT BANK TO TOE OF LEFT ABT. (ft)	45
Al	AREA OF LEFT OVERBANK AT APPR. (sf)	36
TOPWl	TOPWIDTH OF LEFT OVERBANK AT APP. (ft)	82
Y1m	FLOW DEPTH IN LEFT OVERBANK AT APP. (ft)	0.44

SCDOT BRIDGE SCOUR
Saved As: 16221B03.WQ1
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BRIDGE NO. 137007900100
BY/CHK: RAS/GG

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WILLIAMSBURG, VA 23185

STORM EVENT (YR): 500

2. CLEAR WATER CONTRACTION SCOUR FOR LEFT OVERBANK (Ysl):

(a) EFFECTIVE MEAN DIAMETER OF LEFT OVERBANK BED MATL. (Dml):

Dml= 0.000492 ft

(b) Y2l=((Ql^2)/(120*Dml^(2/3)*Wl^(2)))^3/7

Y2l= 0.49 ft

(c) Ysl=Y2l-Y1l

Ysl= 0.05 ft

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STORM EVENT (YR): 500

III. LOCAL SCOUR AT PIERS

(A) INPUT FROM WSPRO

VARIABLE		DESCRIPTION	VALUE
PIER #2:	WSPRO STA	2090	
A2		AREA OF CONVEYANCE TUBE AT PIER #2 (sf)	13
V2		VELOCITY IN CONVEYANCE TUBE AT PIER #2 (fps)	5.07
TOPW2		TOPWIDTH OF CONVEYANCE TUBE AT PIER #2 (ft)	1.7
Y2		MEAN DEPTH OF CONVEYANCE TUBE AT PIER #2 (ft)	7.65
PIER #3:	WSPRO STA	2060	
A3		AREA OF CONVEYANCE TUBE AT PIER #3 (sf)	14
V3		VELOCITY IN CONVEYANCE TUBE AT PIER #3 (fps)	4.72
TOPW3		TOPWIDTH OF CONVEYANCE TUBE AT PIER #3 (ft)	2.3
Y3		MEAN DEPTH OF CONVEYANCE TUBE AT PIER #3 (ft)	6.09
PIER #4:	WPSRO STA	2030	
A4		AREA OF CONVEYANCE TUBE AT PIER #4 (sf)	48
V4		VELOCITY IN CONVEYANCE TUBE AT PIER #4 (fps)	1.38
TOPW4		TOPWIDTH OF CONVEYANCE TUBE AT PIER #4 (ft)	32.8
Y4		MEAN DEPTH OF CONVEYANCE TUBE AT PIER #4 (ft)	1.46

SCDOT BRIDGE SCOUR
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BY/CHK: RAS/GG

ESPEY, HUSTON & ASSOC., INC
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WILLIAMSBURG, VA 23185

STORM EVENT (YR): 500

(B) CALCULATIONS (LOCAL SCOUR AT PIERS)

1. SCOUR DEPTH AT PIER #2 (Ys#2):

(a) a=PIER WIDTH (ft)=		1.33
(b) FROUDE NO.=FR2=V2/(g*Y2)^.5=	0.32	
(c) K1=PIER NOSE SHAPE CORR. FACTOR (FIG7, TBL2,PG40)=		1.0
(d) K2=ANGLE OF ATTACK CORR. FACTOR (TBL3, PG40)=		1.75
(e) K3=BED CONDITION CORR. FACTOR (TBL1, PG39)=		1.1

(f) CSU EQ. FOR PIER SCOUR;
Ys#2=Y2*2*K1*K2*K3*(a/Y2)^.65*FR2^.43
Ys#2= 5.81 ft

2. SCOUR DEPTH AT PIER #3 (Ys#3):

(a) a=PIER WIDTH (ft)=		1.33
(b) FROUDE NO.=FR3=V3/(g*Y3)^.5=	0.34	
(c) K1=PIER NOSE SHAPE CORR. FACTOR (FIG7, TBL2,PG40)=		1.0
(d) K2=ANGLE OF ATTACK CORR. FACTOR (TBL3, PG40)=		1.75
(e) K3=BED CONDITION CORR. FACTOR (TBL1, PG39)=		1.1

(f) CSU EQ. FOR PIER SCOUR;
Ys#3=Y3*2*K1*K2*K3*(a/Y3)^.65*FR3^.43
Ys#3= 5.46 ft

3. SCOUR DEPTH AT PIER #4 (Ys#4):

(a) a=PIER WIDTH (ft)=		1.33
(b) FROUDE NO.=FR4=V4/(g*Y4)^.5=	0.20	
(c) K1=PIER NOSE SHAPE CORR. FACTOR (FIG7, TBL2,PG40)=		1.0
(d) K2=ANGLE OF ATTACK CORR. FACTOR (TBL3, PG40)=		1.75
(e) K3=BED CONDITION CORR. FACTOR (TBL1, PG39)=		1.1

(f) CSU EQ. FOR PIER SCOUR;
Ys#4=Y4*2*K1*K2*K3*(a/Y4)^.65*FR4^.43
Ys#4= 2.66 ft

SCDOT BRIDGE SCOUR
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BY/CHK: RAS/GG

ESPEY, HUSTON & ASSOC., INC
460 McLAWS CIRCLE, SUITE 150
WILLIAMSBURG, VA 23185

STORM EVENT (YR): 500

IV. ABUTMENT SCOUR :

FLOW THE WATER DOES NOT REACH THE ABUTMENTS
NO SCOUR CALCULATIONS PERFORMED

Photo 1- *View looking east along Route S79. Downstream is to the right.*

Photo 2- *View looking west along Route S 79. Downstream is to the left.*

Photo 3- *View looking south (downstream) at bent 4. Note the minor scour hole in the background at the third pile from the right.*

Photo 4- *View of east abutment. The abutment is not protected by riprap. Erosion is occurring from roadway runoff.*

Photo 5- *View of west abutment and bent 2. Riprap is placed along the channel banks. No riprap was noted at the abutment.*

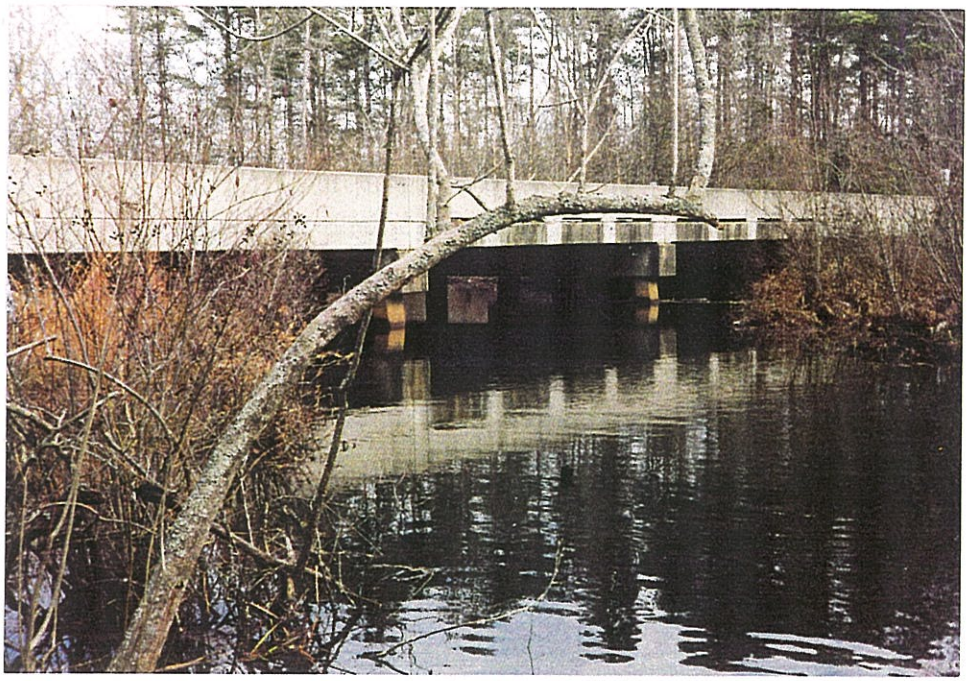

Photo 6- *View looking north at upstream face of the bridge.*

Photo 7- *View looking south (downstream). Abandoned bridge piles are in the center of the photo.*

Photo 8- *View of North Prong Creek upstream of the bridge.*