Espey, Huston & Associates, Inc.

Level II Bridge Scour Analysis

for Structure 134010200500 on Route SC 102 Crossing Wallace Prong Creek in Chesterfield County, South Carolina

EH&A Project No. 16221.01
EH&A File Number 16221.01 B-2

Prepared in cooperation with

South Carolina Department of Transportation

Columbia, South Carolina
March 1995

LEVEL II BRIDGE SCOUR ANALYSIS

FOR STRUCTURE 134010200500 ON ROUTE SC 102 CROSSING WALLACE PRONG CREEK IN CHESTERFIELD COUNTY, SOUTH CAROLINA

This report provides the results of the detailed Level II analysis of scour potential at bridge 134010200500 on Route SC 102 crossing Wallace Prong Creek in Chesterfield County, South Carolina. The site is located in the Upper Coastal Plain physiographic province near Chesterfield, South Carolina. The bridge lies approximately 34° 39' 15" North, 080° 04' 33" West, 3 miles south of Chesterfield, South Carolina. The contributing watershed area for this bridge is 15.85 mi^2. The watershed is rural, consisting of forest and farmland. In the vicinity of the bridge the floodplain consists of woodland, brush and marsh.

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 and dense vegetation within the main channel and the floodplain. The accumulation of debris downstream of the bridge may be the result of beaver activity. Beaver activity is very prevalent and recent cuttings were observed.

The bridge structure is 101 feet in length with four equal 25-foot spans. The bridge is supported by five bents each consisting of five timber piles with cross bracing. The spill-through abutments are protected by D_{50} = 10 inch riprap. Some erosion was observed on the banks due to surface water runoff. Abutment scour was not performed for this bridge.

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 2.71 feet. The 500-year total scour depth at the downstream face of the bridge ranged from 0.00 to 3.16 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 134010200500 Stream Wallace Prong Creek
County Chesterfield Route SC 102 District 4

Description of Bridge

Bridge length 101 ft Bridge width 27.5 ft Max span length 25.0 ft

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

Abutment type Spill-through Embankment type Sloping

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

Description of riprap D_{50} = 10 inch riprap in good condition. Some is missing around the abutments with some evidence of erosion from surface runoff.

Brief description of piers/pile bents Three interior bents each bent consists of five 1.3-foot timber piles with cross bracing.

Is bridge skewed to floodplain according to USGS quad map? No Angle

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 High potential due to possible beaver activity.

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

January 9, 1995. The accumulation of debris downstream of the bridge may be the result of the beaver activity.

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 30 *ft* *Average depth* 4 *ft*

Predominant bed material Silty sand *Bank material* Silty sand

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

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

D/S left: Very dense brush and weeds

D/S right: Very dense brush and weeds

U/S left: Very dense brush and weeds

U/S right: Very 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. January 9, 1995. The accumulation of debris downstream of the bridge may be due to beaver activity.

Hydrology

Drainage area 15.85 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 781 ft^3/s Q500 1109 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 Bowman).

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 match 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	101	4	Full Valley Section
BRDG	101	1	Bridge Section
ROAD	Not used	3	Road Section
APPR	230	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 Bowman. Bridge elevations were estimated from the USGS quad map and the SCDOT bridge plans using field measurements. There are no high water marks known to calibrate the model. The cross section data is coded left to right facing downstream.

Bridge Hydraulics

Average embankment elevation 154.3 ft

Average low steel elevation 152.3 ft

100-year discharge	781	ft^3/s
Water-surface elevation at D/S bridge face	146.51	ft
Area of flow at D/S bridge face	261	ft^2
Average velocity in bridge opening	3.00	ft/s
Maximum WSPRO tube velocity at bridge	4.37	ft/s

Water-surface elevation at Approach section with bridge	146.74	ft
Water-surface elevation at Approach section without bridge	146.72	ft
Amount of backwater caused by bridge	0.02	ft

500-year discharge	1109	ft^3/s
Water-surface elevation at D/S bridge face	147.27	ft
Area of flow at D/S bridge face	317	ft^2
Average velocity in bridge opening	3.49	ft/s
Maximum WSPRO tube velocity at bridge	4.80	ft/s

Water-surface elevation at Approach section with bridge	147.53	ft
Water-surface elevation at Approach section without bridge	147.49	ft
Amount of backwater caused by bridge	0.04	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 134010200500 on SC 102 crossing Wallace 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 781 cubic feet per second							
Abutment	0	0.00	Abutment-Protected	0.00	122.80	N/A	N/A
2	25	0.16	1.70	1.86	121.69	140.54	18.85
3	50	0.16	2.55	2.71	121.08	139.49	18.41
4	75	0.16	1.58	1.74	120.47	141.06	20.59
Abutment	100	0.00	Abutment-Protected	0.00	117.86	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 134010200500 on SC 102 crossing Wallace Prong Creek in Chesterfield, South Carolina.

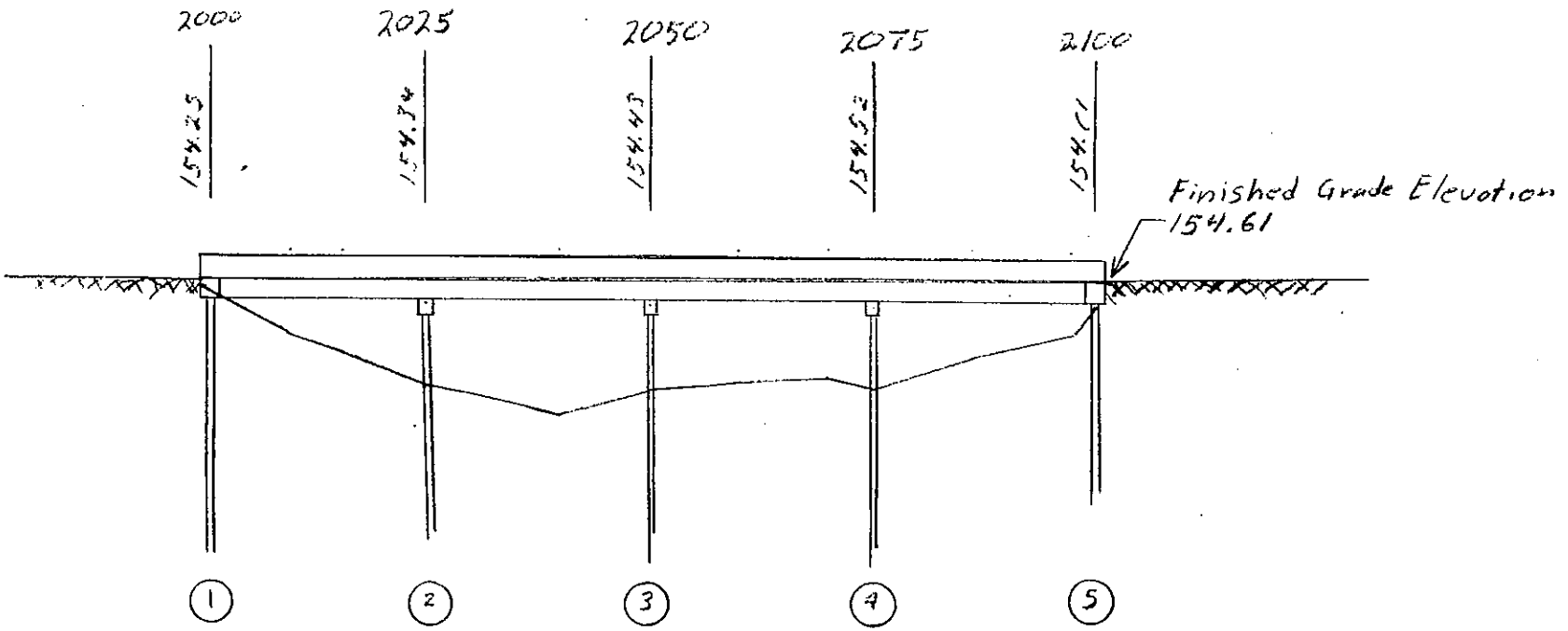
Pier/bent Number[1]	Distance[2] from left end of bridge (feet)	Contraction scour depth (feet)	Local scour depth without debris (feet)	Total scour[3] depth without debris (feet)	Elevation of Highest Pile Tip (feet)	Elevation of Bottom of Scour Hole (feet)	Remaining[4] Embedment (feet)
500-year discharge is 1109 cubic feet per second							
Abutment	0	0.00	Abutment-Protected	0.00	122.80	N/A	N/A
2	25	0.36	2.75	3.11	121.69	139.28	17.59
3	50	0.36	2.80	3.16	121.08	139.04	17.96
4	75	0.36	2.43	2.79	120.47	140.01	19.54
Abutment	100	0.00	Abutment-Protected	0.00	117.86	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.



Route SC-102 over
Wallace Prong Creek
EH&A File No. 16221.01 B-2

——— Measured on January 9, 1995

The cross section at the time of construction is unknown.

Scale: 1" = 20'

```
T2        ROUTE SC 102 OVER WALLACE PRONG CREEK
T3        EH&A FILE NO. 16221.01 B-2
*         CHESTERFIELD CO., SOUTH CAROLINA
*         FILE NAME: 16221W02.DAT
*         ************************************************************
J1         .02 .01 .01 .95
J3        5 3 13 15 23 430 446 448 * 5 17 29 30 6 16 555 * 7 14 3 11
*         ************************************************************
*          Q100   Q500
Q          781    1109
SK        .0018  .0018
*         ************************************************************
*         CROSS SECTION INFORMATION WAS TAKEN FROM THE USGS QUAD
*         SHEET "CHESTERFIELD 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 WHICH MATCHED THE QUAD
*         SHEET.  THERE ARE NO HIGH WATER MARKS KNOWN TO CALIBRATE
*         THE MODEL.  THE CROSS SECTION DATA IS CODED LEFT TO RIGHT
*         FACING DOWNSTREAM.
*         ************************************************************
XS     EXIT  000 00
GR          1500,150.0 2016,146.0 2025,142.3 2040,139.6 2050,142.0
GR          2060,143.0 2070,143.9 2075,142.6 2086,146.0
GR          2550,150.0
N           .15    .15    .05    .15    .15
SA             2000   2016   2086   2101
*         ************************************************************
XS     FULL 101  00
GR          1500,150.0 2016,146.2 2025,142.4 2040,139.8 2050,142.2
GR          2060,143.2 2070,144.1 2075,142.8 2086,146.2
GR          2550,150.0
N           .15    .15    .045    .15    .15
SA             2000   2016    2086   2101
*         ************************************************************
BR     BRDG 101  152.3  00
GR          2002,152.0 2010,148.1 2016,146.2 2025,142.4 2040,139.8
GR          2050,142.2 2060,143.2 2070,144.1 2075,142.8 2086,146.2
GR          2097,148.7 2100,151.8 2100,152.4 2002,152.0
N           .045    .035    .045
SA             2016    2086
CD          3  30  2 154.25
PW 1        142.2,1.3 142.4,1.3 142.4,4.3 142.8,4.3 142.8,5.6
PW 1        148.5,5.6 148.5,3.9 152.3,3.9
*         ************************************************************
AS     APPR  230  00
GR          1500,150.0 2016,146.4 2025,142.6 2040,140.0 2050,142.4
GR          2060,143.4 2070,144.3 2075,143.0 2086,146.4
GR          2550,150.0
N           .15    .15    .05    .15    .15
SA             2000   2016   2086   2101
*         ************************************************************
HP 1  APPR 146.74 * 146.74
HP 1  BRDG 146.51 * 146.51
HP 2  APPR 146.74 * 146.74   781
HP 2  BRDG 146.51 * 146.51   781
*
HP 1  APPR 147.53 * 147.53
HP 1  BRDG 147.27 * 147.27
HP 2  APPR 147.53 * 147.53  1109
HP 2  BRDG 147.27 * 147.27  1109
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: 03-06-95  16:14

  T2        ROUTE SC 102 OVER WALLACE PRONG CREEK
  T3        EH&A FILE NO. 16221.01 B-2
  *         CHESTERFIELD CO., SOUTH CAROLINA
  *         FILE NAME: 16221W02.DAT
  *         ************************************************************
  J1         .02 .01 .01 .95

J1 RECORD PARAMETERS:
DELTAY =  .02   YTOL =  .01   QTOL =  .01   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          781    1109
*** Q-DATA FOR SEC-ID, ISEQ =            1
  SK        .0018  .0018
  *         ************************************************************
  *         CROSS SECTION INFORMATION WAS TAKEN FROM THE USGS QUAD
  *         SHEET "CHESTERFIELD 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 WHICH MATCHED THE QUAD
  *         SHEET.  THERE ARE NO HIGH WATER MARKS KNOWN TO CALIBRATE
  *         THE MODEL.  THE 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 SC 102 OVER WALLACE PRONG CREEK
        EH&A FILE NO. 16221.01 B-2
           *** RUN DATE & TIME: 03-06-95  16:14

*** START PROCESSING CROSS SECTION - " EXIT"
  XS   EXIT  000 00
  GR         1500,150.0 2016,146.0 2025,142.3 2040,139.6 2050,142.0
  GR         2060,143.0 2070,143.9 2075,142.6 2086,146.0
  GR         2550,150.0
  N          .15    .15    .05    .15    .15
  SA            2000   2016   2086   2101
  *         ************************************************************

*** 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
       .0         0. *********        .50        .00

X-Y COORDINATE PAIRS  (NGP =  10):
       X      Y          X      Y          X      Y          X      Y
   1500.0  150.00    2016.0  146.00    2025.0  142.30    2040.0  139.60
   2050.0  142.00    2060.0  143.00    2070.0  143.90    2075.0  142.60
   2086.0  146.00    2550.0  150.00

 X-Y MAX-MIN POINTS:
     XMIN       Y          X    YMIN       XMAX       Y          X    YMAX
   1500.0  150.00    2040.0  139.60    2550.0  150.00    1500.0  150.00

SUBAREA BREAKPOINTS (NSA =  5):
       2000.   2016.   2086.   2101.

ROUGHNESS COEFFICIENTS (NSA =  5):
         .150    .150    .050    .150    .150
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ROUTE SC 102 OVER WALLACE PRONG CREEK
EH&A FILE NO. 16221.01 B-2
*** RUN DATE & TIME: 03-06-95 16:14

```
*** START PROCESSING CROSS SECTION - " FULL"
  XS   FULL 101  00
  GR         1500,150.0 2016,146.2 2025,142.4 2040,139.8 2050,142.2
  GR         2060,143.2 2070,144.1 2075,142.8 2086,146.2
  GR         2550,150.0
  N          .15    .15    .045    .15    .15
  SA            2000   2016    2086   2101
  *         ************************************************************

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

--- DATA SUMMARY FOR SECID " FULL" AT SRD =    101.  ERR-CODE =      0

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

X-Y COORDINATE PAIRS  (NGP =  10):
       X      Y         X      Y         X      Y         X      Y
   1500.0  150.00    2016.0  146.20    2025.0  142.40    2040.0  139.80
   2050.0  142.20    2060.0  143.20    2070.0  144.10    2075.0  142.80
   2086.0  146.20    2550.0  150.00

 X-Y MAX-MIN POINTS:
     XMIN       Y         X    YMIN      XMAX       Y         X    YMAX
   1500.0  150.00    2040.0  139.80    2550.0  150.00    1500.0  150.00

SUBAREA BREAKPOINTS (NSA =  5):
       2000.   2016.   2086.   2101.

ROUGHNESS COEFFICIENTS (NSA =  5):
         .150    .150    .045    .150    .150
```


ROUTE SC 102 OVER WALLACE PRONG CREEK
EH&A FILE NO. 16221.01 B-2
*** RUN DATE & TIME: 03-06-95 16:14

```
*** START PROCESSING CROSS SECTION - " BRDG"
  BR   BRDG 101  152.3  00
  GR         2002,152.0 2010,148.1 2016,146.2 2025,142.4 2040,139.8
  GR         2050,142.2 2060,143.2 2070,144.1 2075,142.8 2086,146.2
  GR         2097,148.7 2100,151.8 2100,152.4 2002,152.0
  N          .045    .035    .045
  SA             2016    2086
  CD         3  30  2 154.25
  PW 1       142.2,1.3 142.4,1.3 142.4,4.3 142.8,4.3 142.8,5.6
  PW 1       148.5,5.6 148.5,3.9 152.3,3.9
  *         ************************************************************

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

--- DATA SUMMARY FOR SECID " BRDG" AT SRD =    101.  ERR-CODE =      0

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

X-Y COORDINATE PAIRS  (NGP =  14):
       X      Y         X      Y         X      Y         X      Y
   2002.0  152.00    2010.0  148.10    2016.0  146.20    2025.0  142.40
   2040.0  139.80    2050.0  142.20    2060.0  143.20    2070.0  144.10
   2075.0  142.80    2086.0  146.20    2097.0  148.70    2100.0  151.80
   2100.0  152.40    2002.0  152.00
```

```
 X-Y MAX-MIN POINTS:
     XMIN       Y         X    YMIN      XMAX       Y         X    YMAX
   2002.0  152.00    2040.0  139.80    2100.0  151.80    2100.0  152.40

 SUBAREA BREAKPOINTS (NSA =  3):
        2016.   2086.

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

 BRIDGE PARAMETERS:
  BRTYPE  BRWDTH     LSEL  USERCD  EMBSS   EMBELV  ABSLPL  ABSLPR
     3      30.0   152.30 *******   2.00   154.25 ******* *******

 PIER DATA:  NPW =  8    PPCD = 1.
      PELV  PWDTH      PELV  PWDTH      PELV  PWDTH      PELV  PWDTH
    142.20   1.3     142.40   1.3     142.40   4.3     142.80   4.3
    142.80   5.6     148.50   5.6     148.50   3.9     152.30   3.9
1
 WSPRO          FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
 P060188            MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS


         ROUTE SC 102 OVER WALLACE PRONG CREEK
         EH&A FILE NO. 16221.01 B-2
            *** RUN DATE & TIME: 03-06-95  16:14

 *** START PROCESSING CROSS SECTION - " APPR"
   AS   APPR  230  00
   GR          1500,150.0 2016,146.4 2025,142.6 2040,140.0 2050,142.4
   GR          2060,143.4 2070,144.3 2075,143.0 2086,146.4
   GR          2550,150.0
   N           .15    .15    .05    .15    .15
   SA             2000   2016   2086   2101
   *          ************************************************************
   HP 1  APPR 146.74 * 146.74

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

 --- DATA SUMMARY FOR SECID " APPR" AT SRD =    230.  ERR-CODE =      0

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

 X-Y COORDINATE PAIRS  (NGP =  10):
        X      Y          X      Y          X      Y          X      Y
    1500.0  150.00    2016.0  146.40    2025.0  142.60    2040.0  140.00
    2050.0  142.40    2060.0  143.40    2070.0  144.30    2075.0  143.00
    2086.0  146.40    2550.0  150.00

  X-Y MAX-MIN POINTS:
     XMIN       Y         X    YMIN      XMAX       Y         X    YMAX
   1500.0  150.00    2040.0  140.00    2550.0  150.00    1500.0  150.00

 SUBAREA BREAKPOINTS (NSA =  5):
        2000.   2016.   2086.   2101.

 ROUGHNESS COEFFICIENTS (NSA =  5):
          .150    .150    .050    .150    .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 SC 102 OVER WALLACE PRONG CREEK
         EH&A FILE NO. 16221.01 B-2
            *** RUN DATE & TIME: 03-06-95  16:14
     CROSS-SECTION PROPERTIES:  ISEQ =  4;  SECID =  APPR;  SRD =     230.

      WSEL  SA#      AREA        K   TOPW   WETP  ALPH    LEW     REW      QCR
              1       4.       9.    33.    33.                          7.
```

```
             2       5.      20.    16.    16.                          14.
             3     262.   18504.    70.    72.                        2882.
             4       4.      18.    15.    15.                          13.
             5       3.       7.    29.    29.                           6.
   146.74          278.   18558.   163.   165.  1.11  2000.  2130.   1956.
1
  HP 1  BRDG 146.51 * 146.51
1
 WSPRO         FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
 P060188           MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS


        ROUTE SC 102 OVER WALLACE PRONG CREEK
        EH&A FILE NO. 16221.01 B-2
           *** RUN DATE & TIME: 03-06-95  16:14
    CROSS-SECTION PROPERTIES:  ISEQ =  3;  SECID =  BRDG;  SRD =     101.

     WSEL  SA#     AREA        K   TOPW   WETP  ALPH    LEW    REW     QCR
             1       0.       1.    1.     1.                          0.
             2     260.   26083.   70.    72.                        2848.
             3       0.       2.    1.     1.                          0.
   146.51          261.   26086.   72.    74.  1.00  2015.  2087.   2804.
1
  HP 2  APPR 146.74 * 146.74   781
1
 WSPRO         FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
 P060188           MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS


        ROUTE SC 102 OVER WALLACE PRONG CREEK
        EH&A FILE NO. 16221.01 B-2
           *** RUN DATE & TIME: 03-06-95  16:14


    VELOCITY DISTRIBUTION:  ISEQ =  4;  SECID =  APPR;  SRD =     230.

        WSEL     LEW     REW    AREA        K        Q    VEL
      146.74  2000.0  2129.8   278.1    18558.     781.   2.81

X STA.      2000.0     2025.8     2028.3     2030.6     2032.7     2034.5
  A(I)             27.9       11.6       11.3       10.7       10.6
  V(I)             1.40       3.37       3.46       3.65       3.69

X STA.      2034.5     2036.3     2038.0     2039.6     2041.1     2042.7
  A(I)             10.6       10.2       10.6       10.3        9.7
  V(I)             3.69       3.81       3.69       3.80       4.01

X STA.      2042.7     2044.2     2046.1     2048.3     2050.9     2053.9
  A(I)              9.1       10.3       11.0       11.8       12.2
  V(I)             4.28       3.81       3.56       3.32       3.20

X STA.      2053.9     2057.3     2061.5     2067.3     2073.8     2129.8
  A(I)             13.0       14.3       17.0       18.3       34.1
  V(I)             3.01       2.74       2.30       2.14       1.15
1
  HP 2  BRDG 146.51 * 146.51   781
1
 WSPRO         FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
 P060188           MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS


        ROUTE SC 102 OVER WALLACE PRONG CREEK
        EH&A FILE NO. 16221.01 B-2
           *** RUN DATE & TIME: 03-06-95  16:14


    VELOCITY DISTRIBUTION:  ISEQ =  3;  SECID =  BRDG;  SRD =     101.

        WSEL     LEW     REW    AREA        K        Q    VEL
      146.51  2015.0  2087.4   260.6    26086.     781.   3.00

X STA.      2015.0     2025.9     2028.4     2030.7     2032.7     2034.6
  A(I)             23.9       11.1       11.2       10.8       10.4
  V(I)             1.63       3.51       3.50       3.60       3.75
```

```
 X STA.      2034.6     2036.3     2038.0     2039.5     2041.1     2042.6
   A(I)            10.2       10.3       10.2       10.5        9.4
   V(I)            3.81       3.80       3.84       3.70       4.16

 X STA.      2042.6     2044.2     2046.0     2048.1     2050.7     2053.7
   A(I)             8.9       10.1       10.8       11.5       12.0
   V(I)            4.37       3.88       3.63       3.38       3.26

 X STA.      2053.7     2057.0     2061.2     2066.8     2073.6     2087.4
   A(I)            12.7       14.3       16.4       18.4       27.4
   V(I)            3.07       2.73       2.38       2.12       1.43
1
   *
   HP 1  APPR 147.53 * 147.53
1
 WSPRO          FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
 P060188            MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS


         ROUTE SC 102 OVER WALLACE PRONG CREEK
         EH&A FILE NO. 16221.01 B-2
            *** RUN DATE & TIME: 03-06-95  16:14
     CROSS-SECTION PROPERTIES:  ISEQ =  4;  SECID =  APPR;  SRD =     230.

      WSEL  SA#      AREA         K    TOPW   WETP  ALPH    LEW     REW      QCR
              1       74.      471.    146.   146.                          301.
              2       17.      179.     16.    16.                          101.
              3      318.    25452.     70.    72.                         3840.
              4       16.      167.     15.    15.                           94.
              5       66.      418.    131.   131.                          267.
    147.53            491.    26687.    378.   380.  2.08  2000.   2232.   2207.
1
   HP 1  BRDG 147.27 * 147.27
1
 WSPRO          FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
 P060188            MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS


         ROUTE SC 102 OVER WALLACE PRONG CREEK
         EH&A FILE NO. 16221.01 B-2
            *** RUN DATE & TIME: 03-06-95  16:14
     CROSS-SECTION PROPERTIES:  ISEQ =  3;  SECID =  BRDG;  SRD =     101.

      WSEL  SA#      AREA         K    TOPW   WETP  ALPH    LEW     REW      QCR
              1        2.       38.      3.     4.                            8.
              2      313.    35562.     70.    72.                         3764.
              3        3.       54.      5.     5.                           10.
    147.27            318.    35654.     78.    80.  1.02  2013.   2091.   3602.
1
   HP 2  APPR 147.53 * 147.53  1109
1
 WSPRO          FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
 P060188            MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS


         ROUTE SC 102 OVER WALLACE PRONG CREEK
         EH&A FILE NO. 16221.01 B-2
            *** RUN DATE & TIME: 03-06-95  16:14


     VELOCITY DISTRIBUTION:  ISEQ =  4;  SECID =  APPR;  SRD =     230.

         WSEL     LEW      REW     AREA         K        Q    VEL
       147.53  2000.0   2231.6    491.5    26687.    1109.   2.26

 X STA.      2000.0     2023.3     2026.6     2029.3     2031.8     2034.0
   A(I)            36.6       16.2       14.6       14.3       13.9
   V(I)            1.52       3.42       3.80       3.87       3.98

 X STA.      2034.0     2036.0     2037.9     2039.8     2041.6     2043.8
   A(I)            13.6       13.4       13.5       13.5       15.2
   V(I)            4.09       4.12       4.12       4.11       3.64

 X STA.      2043.8     2046.1     2048.6     2051.5     2054.8     2058.6
```

```
  A(I)            14.7       14.2       15.3       15.7       16.7
  V(I)            3.78       3.90       3.62       3.52       3.32

 X STA.      2058.6     2063.1     2068.9     2074.3     2079.0     2231.6
  A(I)            18.3       20.7       20.2       18.6       97.7
  V(I)            3.02       2.67       2.74       2.98        .57
1
  HP 2  BRDG 147.27 * 147.27  1109
1
 WSPRO         FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
 P060188           MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS


        ROUTE SC 102 OVER WALLACE PRONG CREEK
        EH&A FILE NO. 16221.01 B-2
           *** RUN DATE & TIME: 03-06-95  16:14


    VELOCITY DISTRIBUTION:  ISEQ =  3;  SECID =  BRDG;  SRD =     101.

         WSEL     LEW      REW     AREA        K        Q     VEL
       147.27  2012.6   2090.7    317.8   35654.    1109.    3.49

 X STA.      2012.6     2024.9     2027.7     2030.2     2032.5     2034.5
  A(I)            28.1       14.4       13.6       13.6       12.8
  V(I)            1.98       3.85       4.06       4.08       4.34

 X STA.      2034.5     2036.4     2038.2     2039.9     2041.7     2043.4
  A(I)            12.6       12.8       12.6       12.8       12.1
  V(I)            4.39       4.34       4.40       4.32       4.59

 X STA.      2043.4     2045.2     2047.4     2050.0     2052.9     2056.2
  A(I)            11.6       12.9       14.1       14.2       15.2
  V(I)            4.80       4.29       3.92       3.90       3.65

 X STA.      2056.2     2060.2     2064.8     2070.8     2075.3     2090.7
  A(I)            16.6       18.0       20.3       17.7       31.7
  V(I)            3.33       3.08       2.74       3.13       1.75
1
  EX

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


        ROUTE SC 102 OVER WALLACE PRONG CREEK
        EH&A FILE NO. 16221.01 B-2
           *** RUN DATE & TIME: 03-06-95  16:14

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

 EXIT:XS    ******  2000.     275.   .14 *****  146.48  143.91    781.  146.34
        0. ******  2125.   18396.  1.10 ***** *******     .39    2.84

 FULL:FV      101.  2000.     272.   .14   .16  146.65 *******    781.  146.51
      101.    101.  2124.   20305.  1.09   .00     .01     .39    2.87
          <<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>

 APPR:AS      129.  2000.     275.   .14   .21  146.86 *******    781.  146.72
      230.    129.  2127.   18367.  1.10   .00     .00     .40    2.84
          <<<<<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      101.  2015.     261.   .14   .18  146.66  144.20    781.  146.51
      101.    101.  2087.   26131.  1.03   .00     .00     .28    2.99

     TYPE PPCD FLOW      C     P/A    LSEL   BLEN   XLAB   XRAB
       3.    1.   1.   .987   .087  152.30 ****** ****** ******
```

XSID:CODE	SRDL	LEW	AREA	VHD	HF	EGL	CRWS	Q	WSEL
SRD	FLEN	REW	K	ALPH	HO	ERR	FR#	VEL	
APPR:AS	99.	2000.	278.	.14	.18	146.87	144.30	781.	146.74
230.	100.	2129.	18533.	1.11	.04	.00	.40	2.81	

M(G)	M(K)	KQ	XLKQ	XRKQ	OTEL
.430	.003	18518.	2015.	2087.	146.56

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

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

ROUTE SC 102 OVER WALLACE PRONG CREEK
EH&A FILE NO. 16221.01 B-2
*** RUN DATE & TIME: 03-06-95 16:14

FIRST USER DEFINED TABLE.

XSID:CODE	Q	WSEL	VEL	CRWS	YMIN
EXIT:XS	781.	146.34	2.84	143.91	139.60
FULL:FV	781.	146.51	2.87********		139.80
BRDG:BR	781.	146.51	2.99	144.20	139.80
APPR:AS	781.	146.74	2.81	144.30	140.00

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

ROUTE SC 102 OVER WALLACE PRONG CREEK
EH&A FILE NO. 16221.01 B-2
*** RUN DATE & TIME: 03-06-95 16:14

SECOND USER DEFINED TABLE.

XSID:CODE	Q	AREA	LEW	REW	SRD	K
EXIT:XS	781.	275.	2000.	2125.	0.	18396.
FULL:FV	781.	272.	2000.	2124.	101.	20305.
BRDG:BR	781.	261.	2015.	2087.	101.	26131.
APPR:AS	781.	278.	2000.	2129.	230.	18533.

XSID:CODE	OTEL
APPR:AS	146.56

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

ROUTE SC 102 OVER WALLACE PRONG CREEK
EH&A FILE NO. 16221.01 B-2
*** RUN DATE & TIME: 03-06-95 16:14

THIRD USER DEFINED TABLE.

XSID:CODE	EGL	FR#	WSEL	HF
EXIT:XS	146.48	.39	146.34******	
FULL:FV	146.65	.39	146.51	.16
BRDG:BR	146.66	.28	146.51	.18
APPR:AS	146.87	.40	146.74	.18

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

ROUTE SC 102 OVER WALLACE PRONG CREEK
EH&A FILE NO. 16221.01 B-2
*** RUN DATE & TIME: 03-06-95 16:14

XSID:CODE	SRDL	LEW	AREA	VHD	HF	EGL	CRWS	Q	WSEL
SRD	FLEN	REW	K	ALPH	HO	ERR	FR#	VEL	
EXIT:XS	******	2000.	465.	.17	*****	147.28	144.40	1109.	147.11
0.	******	2214.	26129.	1.93	*****	*******	.50	2.39	
FULL:FV	101.	2000.	463.	.17	.17	147.45	*******	1109.	147.28
101.	101.	2217.	28753.	1.95	.00	.01	.51	2.39	

```
        <<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>

 APPR:AS     129.  2000.     475.   .17   .21  147.66 *******   1109.  147.49
      230.   129.  2226.   26156.  2.00   .00    -.01     .51    2.33
        <<<<<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     101.  2013.      317.   .20   .19  147.47  144.73   1109.  147.27
      101.   101.  2091.    35604.  1.07   .01     .00     .32    3.49

     TYPE PPCD FLOW      C     P/A    LSEL   BLEN   XLAB   XRAB
        3.   1.   1.   .968    .085  152.30 ****** ****** ******

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

 APPR:AS      99.  2000.      491.   .16   .18  147.69  144.79   1109.  147.53
      230.   101.  2231.    26658.  2.07   .04     .00     .50    2.26

       M(G)   M(K)       KQ   XLKQ   XRKQ    OTEL
       .654   .043   25567.  2013.  2091.   147.36

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


        ROUTE SC 102 OVER WALLACE PRONG CREEK
        EH&A FILE NO. 16221.01 B-2
           *** RUN DATE & TIME: 03-06-95  16:14
   FIRST USER DEFINED TABLE.

     XSID:CODE       Q    WSEL     VEL    CRWS    YMIN
     EXIT:XS      1109.  147.11    2.39  144.40  139.60
     FULL:FV      1109.  147.28    2.39******** 139.80
     BRDG:BR      1109.  147.27    3.49  144.73  139.80
     APPR:AS      1109.  147.53    2.26  144.79  140.00
1
 WSPRO          FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
 P060188           MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS


        ROUTE SC 102 OVER WALLACE PRONG CREEK
        EH&A FILE NO. 16221.01 B-2
           *** RUN DATE & TIME: 03-06-95  16:14
   SECOND USER DEFINED TABLE.

     XSID:CODE       Q     AREA    LEW    REW    SRD        K
     EXIT:XS      1109.     465.  2000.  2214.     0.   26129.
     FULL:FV      1109.     463.  2000.  2217.   101.   28753.
     BRDG:BR      1109.     317.  2013.  2091.   101.   35604.
     APPR:AS      1109.     491.  2000.  2231.   230.   26658.

     XSID:CODE     OTEL
     APPR:AS     147.36
1
 WSPRO          FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
 P060188           MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS


        ROUTE SC 102 OVER WALLACE PRONG CREEK
        EH&A FILE NO. 16221.01 B-2
           *** RUN DATE & TIME: 03-06-95  16:14
   THIRD USER DEFINED TABLE.

     XSID:CODE      EGL      FR#     WSEL     HF
     EXIT:XS     147.28      .50  147.11******
     FULL:FV     147.45      .51  147.28    .17
     BRDG:BR     147.47      .32  147.27    .19
     APPR:AS     147.69      .50  147.53    .18
   ER
```

1 NORMAL END OF WSPRO EXECUTION.

SCDOT BRIDGE SCOUR
Saved As: 16221A02.WQ1
JOB NO. 16221.01 B-2
BRIDGE NO. 134010200500
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	262
TOPW	APPR. MAIN CHANNEL TOP WIDTH (ft)	70
Ym	APPR. MAIN CHANNEL AVG. DEPTH = AREAm/TOPW	3.74
HFa	APPR. HEAD LOSS DUE TO FRICTION	0.21
DIST	DISTANCE FROM BRIDGE TO APPR.	129
Sf	AVG. UNCONSTRICTED ENERGY SLOPE = HFa/DIST	0.00163
Km	APPR. MAIN CHANNEL CONVEYANCE	18504
Vm	APPR. MAIN CHANNEL AVG. VELOCITY (fps)	2.85
	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: 16221A02.WQ1
JOB NO. 16221.01 B-2
BRIDGE NO. 134010200500
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= 1.05 fps

(2) LEFT OVERBANK CRITICAL VELOCITY (Vcl):

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: 16221A02.WQ1
JOB NO. 16221.01 B-2
BRIDGE NO. 134010200500
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	781
Q	TOTAL DISCHARGE(cfs) BRIDGE	781
Ktot(APP)	APP. TOTAL CONVEYANCE	18558
Ktot(BR)	BR. TOTAL CONVEYANCE	26086
Sf	AVG. UNCONSTRICTED ENERGY SLOPE	0.00163
MAIN CHANNEL:		
Km(APP)	APP. MAIN CHANNEL CONVEYANCE	18504
W1m(APP)	APP. MAIN CHANNEL WIDTH(ft)	70
Am(APP)	APP. MAIN CHANNEL AREA	262
TOPWm(APP)	APP. MAIN CHANNEL TOP WIDTH(ft)	70
Y1m(APP)	AVG. DEPTH IN UPSTR MAIN CHANNEL(ft)	3.74
WETPm(APP)	APP. MAIN CHANNEL WETTED PERIM.(ft)	72
Km(BR)	BR. MAIN CHANNEL CONVEYANCE	26083
W2m(BR)	BR. MAIN CHANNEL WIDTH MINUS PIER WIDTHS(ft)	66.1
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: 16221A02.WQ1
JOB NO. 16221.01 B-2
BRIDGE NO. 134010200500
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= 3.64 ft

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

SHEARm=Ywater*Rm*Sf
SHEARm= 0.37 lb/sf

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

Vm*=(SHEARm/p)^.5
Vm*= 0.44 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= 14.55
K1= 0.69

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

Q1m=Q*(Km(APP)/Ktot(APP))
Q1m= 779 cfs

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

Q2m=Q*(Km(BR)/Ktot(BR))
Q2m= 781 cfs

(i) LAURSEN'S LIVE BED EQUATION:
Y2m/Y1m=(Q2m/Q1m)^6/7*(W1m/W2m)^K1
Y2m= 3.90 ft

(j) MAIN CONTRACTION SCOUR DEPTH (Ysm):
Ysm=Y2m-Y1m
Ysm= 0.16 ft

SCDOT BRIDGE SCOUR
Saved As: 16221A02.WQ1
JOB NO. 16221.01 B-2
BRIDGE NO. 134010200500
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	2025	
A2		AREA OF CONVEYANCE TUBE AT PIER #2 (sf)	23.9
V2		VELOCITY IN CONVEYANCE TUBE AT PIER #2 (fps)	1.63
TOPW2		TOPWIDTH OF CONVEYANCE TUBE AT PIER #2 (ft)	10.9
Y2		MEAN DEPTH OF CONVEYANCE TUBE AT PIER #2 (ft)	2.19
PIER #3:	WSPRO STA	2050	
A3		AREA OF CONVEYANCE TUBE AT PIER #3 (sf)	11.5
V3		VELOCITY IN CONVEYANCE TUBE AT PIER #3 (fps)	3.38
TOPW3		TOPWIDTH OF CONVEYANCE TUBE AT PIER #3 (ft)	2.6
Y3		MEAN DEPTH OF CONVEYANCE TUBE AT PIER #3 (ft)	4.42
PIER #4:	WPSRO STA	2075	
A4		AREA OF CONVEYANCE TUBE AT PIER #4 (sf)	27.4
V4		VELOCITY IN CONVEYANCE TUBE AT PIER #4 (fps)	1.43
TOPW4		TOPWIDTH OF CONVEYANCE TUBE AT PIER #4 (ft)	13.8
Y4		MEAN DEPTH OF CONVEYANCE TUBE AT PIER #4 (ft)	1.99

SCDOT BRIDGE SCOUR
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BY/CHK: RAS/GG

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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)=		1.3
(b) FROUDE NO.=FR2=V2/(g*Y2)^.5=	0.19	
(c) K1=PIER NOSE SHAPE CORR. FACTOR (FIG7, TBL2,PG40)=		1.0
(d) K2=ANGLE OF ATTACK CORR. FACTOR (TBL3, PG40)=		1.0
(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= 1.70 ft

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

(a) a=PIER WIDTH (ft)=		1.3
(b) FROUDE NO.=FR3=V3/(g*Y3)^.5=	0.28	
(c) K1=PIER NOSE SHAPE CORR. FACTOR (FIG7, TBL2,PG40)=		1.0
(d) K2=ANGLE OF ATTACK CORR. FACTOR (TBL3, PG40)=		1.0
(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= 2.55 ft

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

(a) a=PIER WIDTH (ft)=		1.3
(b) FROUDE NO.=FR4=V4/(g*Y4)^.5=	0.18	
(c) K1=PIER NOSE SHAPE CORR. FACTOR (FIG7, TBL2,PG40)=		1.0
(d) K2=ANGLE OF ATTACK CORR. FACTOR (TBL3, PG40)=		1.0
(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= 1.58 ft

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460 McLAWS CIRCLE, SUITE 150
WILLIAMSBURG, VA 23185

STORM EVENT (YR): 100

IV. ABUTMENT SCOUR :

PROTECTED BY RIPRAP
NO SCOUR CALCULATIONS PERFORMED

SCDOT BRIDGE SCOUR
Saved As: 16221B02.WQ1
JOB NO. 16221.01 B-2
BRIDGE NO. 134010200500
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	313
TOPW	APPR. MAIN CHANNEL TOP WIDTH (ft)	70
Ym	APPR. MAIN CHANNEL AVG. DEPTH = AREAm/TOPW	4.47
HFa	APPR. HEAD LOSS DUE TO FRICTION	0.21
DIST	DISTANCE FROM BRIDGE TO APPR.	129
Sf	AVG. UNCONSTRICTED ENERGY SLOPE = HFa/DIST	0.00163
Km	APPR. MAIN CHANNEL CONVEYANCE	25452
Vm	APPR. MAIN CHANNEL AVG. VELOCITY (fps)	3.28
	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.

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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= 1.08 fps

(2) LEFT OVERBANK CRITICAL VELOCITY (Vcl):

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.

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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	1109
Q	TOTAL DISCHARGE(cfs) BRIDGE	1109
Ktot(APP)	APP. TOTAL CONVEYANCE	26687
Ktot(BR)	BR. TOTAL CONVEYANCE	35654
Sf	AVG. UNCONSTRICTED ENERGY SLOPE	0.00163
MAIN CHANNEL:		
Km(APP)	APP. MAIN CHANNEL CONVEYANCE	25452
W1m(APP)	APP. MAIN CHANNEL WIDTH(ft)	70
Am(APP)	APP. MAIN CHANNEL AREA	313
TOPWm(APP)	APP. MAIN CHANNEL TOP WIDTH(ft)	70
Y1m(APP)	AVG. DEPTH IN UPSTR MAIN CHANNEL(ft)	4.47
WETPm(APP)	APP. MAIN CHANNEL WETTED PERIM.(ft)	72
Km(BR)	BR. MAIN CHANNEL CONVEYANCE	35562
W2m(BR)	BR. MAIN CHANNEL WIDTH MINUS PIER WIDTHS(ft)	66.1
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
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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= 4.35 ft

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

SHEARm=Ywater*Rm*Sf
SHEARm= 0.44 lb/sf

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

Vm*=(SHEARm/p)^.5
Vm*= 0.48 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= 15.90
K1= 0.69

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

Q1m=Q*(Km(APP)/Ktot(APP))
Q1m= 1058 cfs

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

Q2m=Q*(Km(BR)/Ktot(BR))
Q2m= 1106 cfs

(i) LAURSEN'S LIVE BED EQUATION:
Y2m/Y1m=(Q2m/Q1m)^6/7*(W1m/W2m)^K1
Y2m= 4.83 ft

(j) MAIN CONTRACTION SCOUR DEPTH (Ysm):
Ysm=Y2m-Y1m
Ysm= 0.36 ft

SCDOT BRIDGE SCOUR
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STORM EVENT (YR): 500

III. LOCAL SCOUR AT PIERS

(A) INPUT FROM WSPRO

VARIABLE		DESCRIPTION	VALUE
PIER #2:	WSPRO STA	2025	
A2		AREA OF CONVEYANCE TUBE AT PIER #2 (sf)	14.4
V2		VELOCITY IN CONVEYANCE TUBE AT PIER #2 (fps)	3.85
TOPW2		TOPWIDTH OF CONVEYANCE TUBE AT PIER #2 (ft)	2.8
Y2		MEAN DEPTH OF CONVEYANCE TUBE AT PIER #2 (ft)	5.14
PIER #3:	WSPRO STA	2050	
A3		AREA OF CONVEYANCE TUBE AT PIER #3 (sf)	14.1
V3		VELOCITY IN CONVEYANCE TUBE AT PIER #3 (fps)	3.92
TOPW3		TOPWIDTH OF CONVEYANCE TUBE AT PIER #3 (ft)	2.6
Y3		MEAN DEPTH OF CONVEYANCE TUBE AT PIER #3 (ft)	5.42
PIER #4:	WPSRO STA	2075	
A4		AREA OF CONVEYANCE TUBE AT PIER #4 (sf)	17.7
V4		VELOCITY IN CONVEYANCE TUBE AT PIER #4 (fps)	3.13
TOPW4		TOPWIDTH OF CONVEYANCE TUBE AT PIER #4 (ft)	4.5
Y4		MEAN DEPTH OF CONVEYANCE TUBE AT PIER #4 (ft)	3.93

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STORM EVENT (YR): 500

(B) CALCULATIONS (LOCAL SCOUR AT PIERS)

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

(a) a=PIER WIDTH (ft)=		1.3
(b) FROUDE NO.=FR2=V2/(g*Y2)^.5=	0.30	
(c) K1=PIER NOSE SHAPE CORR. FACTOR (FIG7, TBL2,PG40)=		1.0
(d) K2=ANGLE OF ATTACK CORR. FACTOR (TBL3, PG40)=		1.0
(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= 2.75 ft

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

(a) a=PIER WIDTH (ft)=		1.3
(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)=		1.0
(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= 2.80 ft

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

(a) a=PIER WIDTH (ft)=		1.3
(b) FROUDE NO.=FR4=V4/(g*Y4)^.5=	0.28	
(c) K1=PIER NOSE SHAPE CORR. FACTOR (FIG7, TBL2,PG40)=		1.0
(d) K2=ANGLE OF ATTACK CORR. FACTOR (TBL3, PG40)=		1.0
(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= 2.43 ft

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IV. ABUTMENT SCOUR :

PROTECTED BY RIPRAP
NO SCOUR CALCULATIONS PERFORMED

Photo 1- *View looking north on Route SC-102. Downstream is to the right.*

Photo 2- *View looking south on Route SC-102.*

Photo 3- *View of south abutment. Riprap is in good condition. Note erosion under the pile cap due to roadway runoff.*

Photo 4- *View of north abutment and bent 2 looking upstream. Riprap is in good condition.*

Photo 5- *View of bent 3, looking upstream.*

Photo 6- *View of Wallace Prong Creek looking downstream.*

Photo 7- **View of Wallace Prong Creek looking west (upstream).**

Photo 8- **View of Wallace Prong Creek looking downstream.**