Espey, Huston & Associates, Inc.

Level II Bridge Scour Analysis

for Structure 124009700200 on Route SC 97 Crossing Susybole Creek in Chester County, South Carolina

EH&A Project No. 16139.01
EH&A File Number 16139.01 B-4

Prepared in cooperation with

South Carolina Department of Transportation

Columbia, South Carolina
January 1995

LEVEL II BRIDGE SCOUR ANALYSIS

FOR STRUCTURE 124009700200 ON ROUTE SC 97 CROSSING SUSYBOLE CREEK IN CHESTER COUNTY, SOUTH CAROLINA

This report provides the results of the detailed Level II analysis of scour potential at bridge 124009700200 on Route SC 97 crossing Susybole Creek in Chester County, South Carolina. The site is located in the Piedmont physiographic province near Lowrys, South Carolina. The bridge lies at approximately 34° 48' 25" north, 081° 21' 00" west, 6 miles west of Lowrys, South Carolina. The contributing watershed area for this bridge is 19.6 mi^2. The watershed is rural, consisting of forest and farmland. In the vicinity of the bridge, the floodplain consists of woodland and brush.

Susybole Creek transverses the gently rolling topography at an approximate velocity of one foot per second. The area surrounding the bridge is composed predominately of light brush and trees. A residence with a grass lawn and open woodlands is located upstream at the eastern overbank of the bridge. The upstream banks have heavy tree and brush growth. Several trees along the upstream bank have fallen into the creek. A large mound of sand is located in the downstream, western overbank. Several trees have fallen into the creek along the downstream east bank.

The bridge on Route 97 over Susybole Creek is 200 feet long with five 40-foot span lengths, and is skewed 45 degrees to the floodplain. The structure has six bents. Bents 1 and 6 are at the abutments, and bents 2 through 5 consist of four steel H-piles. Along the east overbank at bent 2, erosion is undermining and exposing the pile encasement (refer to photo 5). The pile encasements of bent 4 along the west overbank are also exposed, (refer to photo 6). The piles of bent 3, located in the center of the main channel, have exposed pile encasements (refer to photos 4 and 7). The spill-through abutments are protected by D_{50}= 12 in. riprap that is in good condition. Abutment scour calculations were not performed.

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 to 6.28 feet. The 500-year total scour depth at the downstream face of the bridge ranged from 0 to 4.13 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 124009700200 Stream Susybole Creek
County Chester Route SC 97 District 4

Description of Bridge

Bridge length 200 ft Bridge width 26.9 ft Max span length 40 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 November 14, 1994

Description of riprap D_{50} = 12 inches in good condition

Brief description of piers/pile bents Bents 2 through 5 consist of four steel H-piles.

Is bridge skewed to floodplain according to USGS quad map? Yes Angle 45°

Is bridge located on a bend in channel? Yes If so, describe (mild, moderate, severe)

Moderate with a severe bend immediately downstream

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	November 14, 1994	0	0

Potential for debris Low

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

November 14, 1994. A large sand pile is located in the right overbank downstream.

Description of Floodplain

General topography Gently rolling

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

Date of inspection November 14, 1994

D/S left: Open woods with pasture

D/S right: Wooded with a large sand pile (refer to photo 9)

U/S left: Residential lawn

U/S right: Dense woodland and brush

Description of Channel

Average top width 40 ft Average depth .5 ft

Predominant bed material Sand Bank material Sandy clay

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

Vegetative cover on channel banks near bridge: Date of inspection November 14, 1994

D/S left: Weeds and brush

D/S right: Weeds and brush

U/S left: Weeds and brush

U/S right: Weeds and brush

Do banks appear stable? No If not, describe location and type of instability and date of observation. November 14, 1994. The northeast bank is sloughing causing trees to fall into the creek.

Describe any obstructions in channel and date of observation. None

Hydrology

Drainage area 19.6 mi^2

Percentage of drainage area in physiographic provinces:

Physiographic province	Percent of drainage area
Piedmont	100%

Is drainage area considered rural or urban? Rural *Describe any significant urbanization and potential for development.* Potential for development is low.

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 4876 ft^3/s *Q500* 6850 ft^3/s

Method used to determine discharges Regression equation for 100-year flood discharge (Ref. USGS WRIR 87-4096, "Magnitude and Frequency of Floods in Rural and Urban Basins of North Carolina", Gunter, Mason, and Stamey). SCDOT recommends using the North Carolina regression equations for bridges located in this portion of the state where the South Carolina regression equations do not apply. The 500-year discharge for this site was obtained by plotting the 2- through 100-year North Carolina regression equation results on log-probability paper, and extrapolating to obtain the 500-year discharge.

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 Quad map elevations were decreased by 400 feet to match the bridge plan datum.

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	200	4	Full Valley Section
BRDG	200	1	Bridge Section
ROAD	213	3	Road Section
APPR	426	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 "Armenia, S.C." USGS quad map and from information collected during the field inspection on November 14, 1994. 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 87-4096, "Magnitude and Frequency of Floods in Rural and Urban Basins of North Carolina", Gunter, Mason, and Stamey. SCDOT recommends using the North Carolina regression equations for bridges located in this portion of the state where the South Carolina regression equations do not apply. The 500-year discharge for this site was obtained by plotting the 2- through 100-year North Carolina regression equation results on log-probability paper, and extrapolating to obtain the 500-year discharge. Bridge elevations were estimated from the USGS quad map and the SCDOT bridge plans using field measurements. There is no discharge 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 30.0 ft

Average low steel elevation 27.4 ft

100-year discharge	4876	ft^3/s
Water-surface elevation at D/S bridge face	12.84	ft
Area of flow at D/S bridge face	545	ft^2
Average velocity in bridge opening	8.95	ft/s
Maximum WSPRO tube velocity at bridge	10.58	ft/s

Water-surface elevation at Approach section with bridge	13.99	ft
Water-surface elevation at Approach section without bridge	13.94	ft
Amount of backwater caused by bridge	0.05	ft

500-year discharge	6850	ft^3/s
Water-surface elevation at D/S bridge face	14.45	ft
Area of flow at D/S bridge face	726	ft^2
Average velocity in bridge opening	9.44	ft/s
Maximum WSPRO tube velocity at bridge	11.58	ft/s

Water-surface elevation at Approach section with bridge	15.28	ft
Water-surface elevation at Approach section without bridge	15.39	ft
Amount of backwater caused by bridge	0	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 124009700200 on SC 97 crossing Susybole Creek in Chester County, 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[5] of Highest Pile Tip (feet)	Elevation of Bottom of Scour Hole (feet)	Remaining[4] Embedment (feet)
100-year discharge is 4876 cubic feet per second							
Abutment	0	0	Abutment-Protected	0	N/A	N/A	N/A
2	40	0.37	4.12	4.49	-5.10	3.61	8.71
3	80	0.37	5.92	6.29	-9.1	-0.68	8.42
4	120	0.37	3.50	3.87	-6.4	6.23	12.63
5	160	0	0	0	4.9	15.10	10.20
Abutment	200	0	Abutment-Protected	0	N/A	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.

5 No data was available on the elevation of the pile tips. Pile tip elevations were estimated by subtracting the "pay length" from the elevation of the bottom of the pile caps.

Table 2

Cumulative scour depths at piers/bents for the 500-year discharge at structure 124009700200 on SC 97 crossing Susybole Creek in Chester County, 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 6850 cubic feet per second							
Abutment	0	0	Abutment-Protected	0	N/A	N/A	N/A
2	40	0.21	2.73	2.94	-5.10	5.15	10.25
3	80	0.21	3.92	4.13	-9.1	1.47	10.57
4	120	0.21	2.07	2.28	-6.4	7.81	14.21
5	160	0	0	0	4.9	15.1	10.20
Abutment	200	0	Abutment-Protected	0	N/A	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.

5 No data was available on the elevation of the pile tips. Pile tip elevations were estimated by subtracting the "pay length" from the elevation of the bottom of the pile caps.

PROJECT 16139.01

DETERMINING THE FLOOD DISCHARGES FOR VARIOUS RECURRENCE INTERVALS IN THE BLUE RIDGE-PIEDMONT HYDROLOGIC AREA OF NORTH CAROLINA

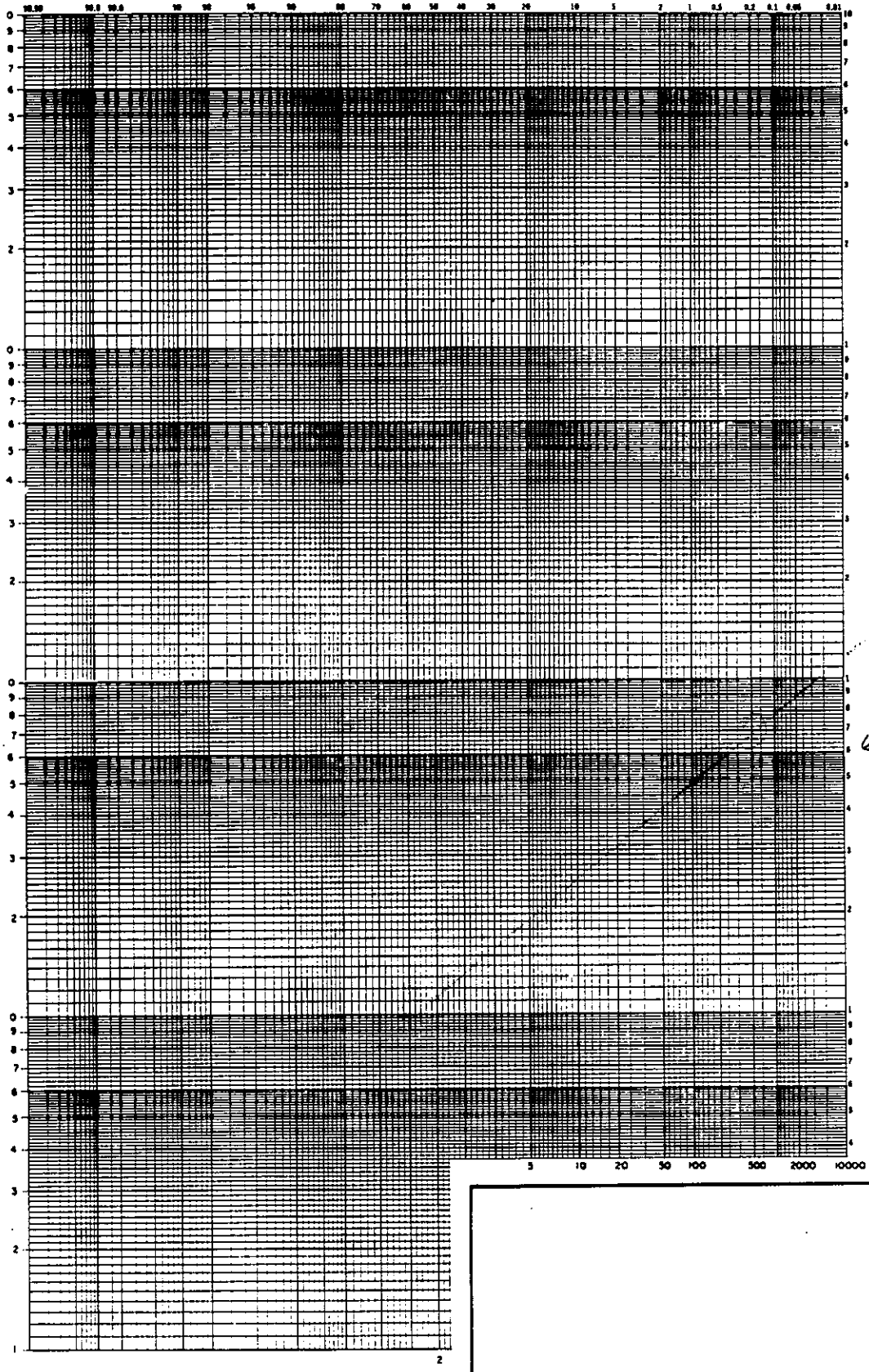
BRIDGE NUMBER 4 SUSYBOLE CREEK

AREA IN SQUARE FEET = 547158955.0

AREA IN SQUARE MILES = 19.6

	DISCHARGE (CFS)	RECURRENCE INTERVAL (YEAR)
Q2 = 144*(AREA)^0.691	Q2 = 1126	2
Q5 = 248*(AREA)^0.670	Q5 = 1822	5
Q10 = 334*(AREA)^0.665	Q10 = 2418	10
Q25 = 467*(AREA)^0.655	Q25 = 3282	25
Q50 = 581*(AREA)^0.650	Q50 = 4023	50
Q100 = 719*(AREA)^0.643	Q100 = 4876	100
EXTRAPOLATION:	Q500 = 6850	500

EXCEEDENCE PER HUNDRED YEARS



ALBUQUERQUE DISTRICT, CORPS OF ENGINEERS

WSPRO INPUT

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T2        ROUTE 97 OVER THE SUSYBOLE CREEK
T3        EH&A FILE NO. 16139.01 B-4
*         CHESTER CO., SOUTH CAROLINA
*         FILE NAME: 16139W04.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          4876    6850
SK        .00235  .00235
*         ************************************************************
*         CROSS SECTION INFORMATION WAS TAKEN FROM THE USGS QUAD
*         SHEET "ARMENIA S.C." AND FROM INFORMATION COLLECTED DURING
*         THE FIELD INSPECTION ON NOVEMBER 14, 1994.  ELEVATIONS
*         GIVEN ARE APPROXIMATE.  MANNINGS COEFFICIENTS WERE
*         ESTIMATED FROM FIELD OBSERVATIONS.  THIS BRIDGE FALLS
*         IN THE REGION WHERE S.C. REGIONAL REGRESSION EQUATIONS DO
*         NOT APPLY.  SCDOT SUGGESTED USING THE N.C. REGIONAL
*         REGRESSION EQUATIONS FOR THIS AREA.  THE 100-YEAR DISCHARGE
*         WAS CALCULATED USING THE N.C. EQUATIONS.  THE 500-YEAR
*         DISCHARGE WAS OBTAINED BY PLOTTING THE 2- THROUGH 100-YEAR
*         DISCHARGES ON LOG-PROBABILITY PAPER, AND EXTRAPOLATING TO
*         OBTAIN THE 500-YEAR DISCHARGE.  BRIDGE STRUCTURAL
*         ELEVATIONS WERE TAKEN FROM BRIDGE DRAWINGS PROVIDED BY
*         SCDOT.  QUAD SHEET ELEVATION WERE REDUCED BY 400 FEET TO
*         MATCH THE BRIDGE ELEVATIONS.  THERE ARE NO HIGH WATER
*         MARKS KNOWN TO CALIBRATE THE MODEL.  THE CROSS SECTION
*         DATA IS CODED LEFT TO RIGHT FACING DOWNSTREAM.  THE FLOW
*         APPROACHING THE BRIDGE IS AT A 45 DEGREE ANGLE TO THE
*         BRIDGE, HOWEVER, THE CROSS SECTION DATA WAS MEASURED AT
*         THE DOWNSTREAM FACE OF THE BRIDGE WHERE THE CREEK BENDS
*         AND EXITS THE BRIDGE SECTION AT A ZERO DEGREE ANGLE.
*         THEREFORE A ZERO SKEW WAS APPLIED TO EACH OF THE SECTIONS.
*         ************************************************************
XS     EXIT  000 00
GR          1550,30.0 1600,20.0 1890,14.6
GR          2040,14.6 2041,8.1
GR          2042,7.6 2050,5.7 2060,6.1 2067,6.9
GR          2076,5.5 2082,5.1 2084,5.0
GR          2116,5.5 2136,5.5 2171,30.0 2200,30.0
GR          2225,15.0 3100,20.0 3200,30.0
N           .15      .080      .035      .045      .15
SA             1740      2040      2136      2225
*         ************************************************************
XS     FULL  200 00
GR          1800,30.0 1850,20.0 1900,20.0 2040,15.1 2041,8.6
GR          2042,8.1 2050,6.2 2060,6.6 2067,7.4 2076,6.0
GR          2082,5.6 2084,5.5 2116,6.0 2122,10.1 2124,10.8
GR          2353,20.0 2428,30.0
N           .15      .080      .035      .15
SA             1850      2040      2124
*         ************************************************************
BR     BRDG  200 27.4 00
GR          2001,28.6 2004,26.1 2017,21.3 2024,18.5 2040,15.1
GR          2041,8.6 2042,8.1 2050,6.2 2060,6.6 2067,7.4
GR          2076,6.0 2082,5.6 2084,5.5 2116,6.0 2122,10.1
GR          2124,10.8 2139,12.8 2157,13.8 2162,15.1 2167,15.7
GR          2183,16.3 2201,26.1 2001,28.6
N           .040      .035      .040
SA               2040      2124
CD          3   26.9   2   30.0
PW 1        5.6,1 7.6,1 7.6,2 8.1,2 8.1,3 9.1,2 9.1,4
PW 1        10.1,4 10.1,6 12.6,6 12.6,4 15.1,3 16.1,5 16.1,4
PW 1        24.1,8 24.1,11 26.6,11 26.6,8 27.1,8 27.1,4 27.4,4
*         ************************************************************
AS     APPR  426 00
GR          1650,30.0 1850,20.0 2040,15.6 2041,9.1
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WSPRO INPUT (Cont.)

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GR          2042,8.6 2050,6.7 2060,7.1 2067,7.9 2076,6.5
GR          2082,5.6 2084,6.0 2116,6.5 2122,10.6 2124,11.3
GR          2164,41.0
N           .030      .15      .035      .15
SA               1950      2040      2124
*          ************************************************************
HP 1  APPR 13.99 * 13.99
HP 1  BRDG 12.84 * 12.84
HP 2  APPR 13.99 * 13.99 4876
HP 2  BRDG 12.84 * 12.84 4876
*
HP 1  APPR 15.28 * 15.28
HP 1  BRDG 14.45 * 14.45
HP 2  APPR 15.28 * 15.28 6850
HP 2  BRDG 14.45 * 14.45 6850
EX
ER
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WSPRO OUTPUT

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

           *** RUN DATE & TIME: 12-30-94  08:51

   T2        ROUTE 97 OVER THE SUSYBOLE CREEK
   T3        EH&A FILE NO. 16139.01 B-4
   *         CHESTER CO., SOUTH CAROLINA
   *         FILE NAME: 16139W04.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          4876    6850
 *** Q-DATA FOR SEC-ID, ISEQ =            1
   SK        .00235  .00235
   *         ************************************************************
   *         CROSS SECTION INFORMATION WAS TAKEN FROM THE USGS QUAD
   *         SHEET "ARMENIA S.C." AND FROM INFORMATION COLLECTED DURING
   *         THE FIELD INSPECTION ON NOVEMBER 14, 1994.  ELEVATIONS
   *         GIVEN ARE APPROXIMATE.  MANNINGS COEFFICIENTS WERE
   *         ESTIMATED FROM FIELD OBSERVATIONS.  THIS BRIDGE FALLS
   *         IN THE REGION WHERE S.C. REGIONAL REGRESSION EQUATIONS DO
   *         NOT APPLY.  SCDOT SUGGESTED USING THE N.C. REGIONAL
   *         REGRESSION EQUATIONS FOR THIS AREA.  THE 100-YEAR DISCHARGE
   *         WAS CALCULATED USING THE N.C. EQUATIONS.  THE 500-YEAR
   *         DISCHARGE WAS OBTAINED BY PLOTTING THE 2- THROUGH 100-YEAR
   *         DISCHARGES ON LOG-PROBABILITY PAPER, AND EXTRAPOLATING TO
   *         OBTAIN THE 500-YEAR DISCHARGE.  BRIDGE STRUCTURAL
   *         ELEVATIONS WERE TAKEN FROM BRIDGE DRAWINGS PROVIDED BY
   *         SCDOT.  QUAD SHEET ELEVATION WERE REDUCED BY 400 FEET TO
   *         MATCH THE BRIDGE ELEVATIONS.  THERE ARE NO HIGH WATER
   *         MARKS KNOWN TO CALIBRATE THE MODEL.  THE CROSS SECTION
   *         DATA IS CODED LEFT TO RIGHT FACING DOWNSTREAM.  THE FLOW
   *         APPROACHING THE BRIDGE IS AT A 45 DEGREE ANGLE TO THE
   *         BRIDGE, HOWEVER, THE CROSS SECTION DATA WAS MEASURED AT
   *         THE DOWNSTREAM FACE OF THE BRIDGE WHERE THE CREEK BENDS
   *         AND EXITS THE BRIDGE SECTION AT A ZERO DEGREE ANGLE.
   *         THEREFORE A ZERO SKEW WAS APPLIED TO EACH OF THE SECTIONS.
   *         ************************************************************
1
 WSPRO         FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
 P060188           MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS


        ROUTE 97 OVER THE SUSYBOLE CREEK
        EH&A FILE NO. 16139.01 B-4
           *** RUN DATE & TIME: 12-30-94  08:51

 *** START PROCESSING CROSS SECTION - " EXIT"
   XS   EXIT  000 00
   GR         1550,30.0 1600,20.0 1890,14.6
   GR         2040,14.6 2041,8.1
   GR         2042,7.6 2050,5.7 2060,6.1 2067,6.9
   GR         2076,5.5 2082,5.1 2084,5.0
   GR         2116,5.5 2136,5.5 2171,30.0 2200,30.0
   GR         2225,15.0 3100,20.0 3200,30.0
   N          .15      .080      .035      .045      .15
   SA             1740      2040      2136      2225
   *         ************************************************************
```

WSPRO OUTPUT (Cont.)

```
*** 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 =  19):
       X      Y          X      Y          X      Y          X      Y
   1550.0   30.00    1600.0   20.00    1890.0   14.60    2040.0   14.60
   2041.0    8.10    2042.0    7.60    2050.0    5.70    2060.0    6.10
   2067.0    6.90    2076.0    5.50    2082.0    5.10    2084.0    5.00
   2116.0    5.50    2136.0    5.50    2171.0   30.00    2200.0   30.00
   2225.0   15.00    3100.0   20.00    3200.0   30.00

 X-Y MAX-MIN POINTS:
     XMIN       Y          X    YMIN       XMAX       Y          X    YMAX
   1550.0   30.00    2084.0    5.00    3200.0   30.00    1550.0   30.00

SUBAREA BREAKPOINTS (NSA =  5):
       1740.    2040.    2136.    2225.

ROUGHNESS COEFFICIENTS (NSA =  5):
         .150     .080     .035     .045     .150
1
WSPRO          FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
P060188            MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS


        ROUTE 97 OVER THE SUSYBOLE CREEK
        EH&A FILE NO. 16139.01 B-4
           *** RUN DATE & TIME: 12-30-94  08:51

*** START PROCESSING CROSS SECTION - " FULL"
  XS   FULL  200 00
  GR         1800,30.0 1850,20.0 1900,20.0 2040,15.1 2041,8.6
  GR         2042,8.1 2050,6.2 2060,6.6 2067,7.4 2076,6.0
  GR         2082,5.6 2084,5.5 2116,6.0 2122,10.1 2124,10.8
  GR         2353,20.0 2428,30.0
  N          .15     .080      .035      .15
  SA            1850      2040      2124
  *         ************************************************************

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

--- DATA SUMMARY FOR SECID " FULL" AT SRD =    200.  ERR-CODE =      0

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

X-Y COORDINATE PAIRS  (NGP =  17):
       X      Y          X      Y          X      Y          X      Y
   1800.0   30.00    1850.0   20.00    1900.0   20.00    2040.0   15.10
   2041.0    8.60    2042.0    8.10    2050.0    6.20    2060.0    6.60
   2067.0    7.40    2076.0    6.00    2082.0    5.60    2084.0    5.50
   2116.0    6.00    2122.0   10.10    2124.0   10.80    2353.0   20.00
   2428.0   30.00

 X-Y MAX-MIN POINTS:
     XMIN       Y          X    YMIN       XMAX       Y          X    YMAX
   1800.0   30.00    2084.0    5.50    2428.0   30.00    1800.0   30.00

SUBAREA BREAKPOINTS (NSA =  4):
       1850.    2040.    2124.

ROUGHNESS COEFFICIENTS (NSA =  4):
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WSPRO OUTPUT (Cont.)

```
         .150    .080    .035    .150
1
 WSPRO          FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
 P060188            MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS


        ROUTE 97 OVER THE SUSYBOLE CREEK
        EH&A FILE NO. 16139.01 B-4
           *** RUN DATE & TIME: 12-30-94  08:51

*** START PROCESSING CROSS SECTION - " BRDG"
  BR   BRDG  200 27.4 00
  GR         2001,28.6 2004,26.1 2017,21.3 2024,18.5 2040,15.1
  GR         2041,8.6 2042,8.1 2050,6.2 2060,6.6 2067,7.4
  GR         2076,6.0 2082,5.6 2084,5.5 2116,6.0 2122,10.1
  GR         2124,10.8 2139,12.8 2157,13.8 2162,15.1 2167,15.7
  GR         2183,16.3 2201,26.1 2001,28.6
  N          .040      .035      .040
  SA              2040      2124
  CD         3   26.9   2   30.0
  PW 1       5.6,1 7.6,1 7.6,2 8.1,2 8.1,3 9.1,2 9.1,4
  PW 1       10.1,4 10.1,6 12.6,6 12.6,4 15.1,3 16.1,5 16.1,4
  PW 1       24.1,8 24.1,11 26.6,11 26.6,8 27.1,8 27.1,4 27.4,4
  *         ************************************************************

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

--- DATA SUMMARY FOR SECID " BRDG" AT SRD =    200.  ERR-CODE =      0

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

X-Y COORDINATE PAIRS  (NGP =  23):
       X      Y         X      Y         X      Y         X      Y
   2001.0   28.60    2004.0   26.10    2017.0   21.30    2024.0   18.50
   2040.0   15.10    2041.0    8.60    2042.0    8.10    2050.0    6.20
   2060.0    6.60    2067.0    7.40    2076.0    6.00    2082.0    5.60
   2084.0    5.50    2116.0    6.00    2122.0   10.10    2124.0   10.80
   2139.0   12.80    2157.0   13.80    2162.0   15.10    2167.0   15.70
   2183.0   16.30    2201.0   26.10    2001.0   28.60

 X-Y MAX-MIN POINTS:
     XMIN       Y         X    YMIN      XMAX       Y         X    YMAX
   2001.0   28.60    2084.0    5.50    2201.0   26.10    2001.0   28.60

SUBAREA BREAKPOINTS (NSA =  3):
       2040.   2124.

ROUGHNESS COEFFICIENTS (NSA =  3):
         .040    .035    .040

BRIDGE PARAMETERS:
 BRTYPE  BRWDTH     LSEL  USERCD  EMBSS   EMBELV  ABSLPL  ABSLPR
    3      26.9    27.40 *******   2.00    30.00 ******* *******

PIER DATA:  NPW = 21    PPCD = 1.
     PELV  PWDTH      PELV  PWDTH      PELV  PWDTH      PELV  PWDTH
      5.60   1.0       7.60   1.0       7.60   2.0       8.10   2.0
      8.10   3.0       9.10   2.0       9.10   4.0      10.10   4.0
     10.10   6.0      12.60   6.0      12.60   4.0      15.10   3.0
     16.10   5.0      16.10   4.0      24.10   8.0      24.10  11.0
     26.60  11.0      26.60   8.0      27.10   8.0      27.10   4.0
     27.40   4.0
1
 WSPRO          FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
 P060188            MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS
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WSPRO OUTPUT (Cont.)

```
        ROUTE 97 OVER THE SUSYBOLE CREEK
        EH&A FILE NO. 16139.01 B-4
           *** RUN DATE & TIME: 12-30-94  08:51

*** START PROCESSING CROSS SECTION - " APPR"
  AS    APPR  426 00
  GR          1650,30.0 1850,20.0 2040,15.6 2041,9.1
  GR          2042,8.6 2050,6.7 2060,7.1 2067,7.9 2076,6.5
  GR          2082,5.6 2084,6.0 2116,6.5 2122,10.6 2124,11.3
  GR          2164,41.0
  N           .030      .15      .035      .15
  SA               1950     2040      2124
  *         ************************************************************
  HP 1  APPR 13.99 * 13.99

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

--- DATA SUMMARY FOR SECID " APPR" AT SRD =    426.  ERR-CODE =      0

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

X-Y COORDINATE PAIRS  (NGP =  15):
       X      Y         X      Y         X      Y         X      Y
   1650.0   30.00    1850.0   20.00    2040.0   15.60    2041.0    9.10
   2042.0    8.60    2050.0    6.70    2060.0    7.10    2067.0    7.90
   2076.0    6.50    2082.0    5.60    2084.0    6.00    2116.0    6.50
   2122.0   10.60    2124.0   11.30    2164.0   41.00

 X-Y MAX-MIN POINTS:
     XMIN       Y         X    YMIN      XMAX       Y         X    YMAX
   1650.0   30.00    2082.0    5.60    2164.0   41.00    2164.0   41.00

SUBAREA BREAKPOINTS (NSA =  4):
       1950.   2040.   2124.

ROUGHNESS COEFFICIENTS (NSA =  4):
         .030    .150    .035    .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 97 OVER THE SUSYBOLE CREEK
        EH&A FILE NO. 16139.01 B-4
           *** RUN DATE & TIME: 12-30-94  08:51
    CROSS-SECTION PROPERTIES:  ISEQ =  4;  SECID =  APPR;  SRD =     426.

     WSEL  SA#     AREA        K   TOPW   WETP  ALPH    LEW    REW     QCR
              3     586.   86912.    84.    90.                      8786.
              4       5.      51.     4.     5.                        32.
    13.99           590.   86963.    87.    94.  1.01  2040.  2128.   8645.
1
  HP 1  BRDG 12.84 * 12.84
1
WSPRO         FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
P060188           MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS


        ROUTE 97 OVER THE SUSYBOLE CREEK
        EH&A FILE NO. 16139.01 B-4
           *** RUN DATE & TIME: 12-30-94  08:51
    CROSS-SECTION PROPERTIES:  ISEQ =  3;  SECID =  BRDG;  SRD =     200.
```

WSPRO OUTPUT (Cont.)

```
     WSEL  SA#      AREA         K    TOPW    WETP  ALPH     LEW     REW      QCR
                2     529.   73822.    84.     89.                             7552.
                3      16.     576.    16.     16.                               88.
    12.84           545.   74397.    99.    105.  1.04  2040.   2140.    7111.
1
  HP 2  APPR 13.99 * 13.99 4876
1
 WSPRO         FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
 P060188          MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS


        ROUTE 97 OVER THE SUSYBOLE CREEK
        EH&A FILE NO. 16139.01 B-4
           *** RUN DATE & TIME: 12-30-94  08:51


    VELOCITY DISTRIBUTION:  ISEQ =  4;  SECID =  APPR;  SRD =     426.

         WSEL     LEW     REW    AREA        K        Q    VEL
        13.99  2040.2  2127.6   590.4   86963.    4876.   8.26

 X STA.      2040.2     2049.6     2053.3     2057.2     2061.4     2065.9
   A(I)            54.8       26.7       27.7       28.8       29.3
   V(I)            4.45       9.15       8.80       8.47       8.31

 X STA.      2065.9     2070.7     2074.7     2078.3     2081.5     2084.6
   A(I)            30.5       28.0       26.8       26.3       25.0
   V(I)            8.00       8.72       9.10       9.28       9.75

 X STA.      2084.6     2087.8     2091.2     2094.5     2097.9     2101.3
   A(I)            25.8       26.4       26.2       26.9       26.4
   V(I)            9.46       9.22       9.32       9.08       9.24

 X STA.      2101.3     2104.7     2108.2     2111.7     2115.3     2127.6
   A(I)            26.0       26.8       26.6       27.1       48.5
   V(I)            9.36       9.09       9.18       8.98       5.03
1
  HP 2  BRDG 12.84 * 12.84 4876
1
 WSPRO         FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
 P060188          MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS


        ROUTE 97 OVER THE SUSYBOLE CREEK
        EH&A FILE NO. 16139.01 B-4
           *** RUN DATE & TIME: 12-30-94  08:51


    VELOCITY DISTRIBUTION:  ISEQ =  3;  SECID =  BRDG;  SRD =     200.

         WSEL     LEW     REW    AREA        K        Q    VEL
        12.84  2040.3  2139.7   544.8   74397.    4876.   8.95

 X STA.      2040.3     2049.4     2053.2     2057.1     2061.3     2065.9
   A(I)            47.5       24.6       25.6       25.8       27.0
   V(I)            5.13       9.89       9.54       9.44       9.04

 X STA.      2065.9     2070.8     2074.9     2078.4     2081.8     2084.9
   A(I)            27.9       26.0       24.3       23.9       23.1
   V(I)            8.73       9.39      10.04      10.19      10.58

 X STA.      2084.9     2088.2     2091.5     2094.8     2098.1     2101.5
   A(I)            23.6       24.2       23.9       23.5       23.8
   V(I)           10.34      10.09      10.20      10.36      10.23

 X STA.      2101.5     2104.9     2108.4     2111.9     2115.4     2139.7
```

WSPRO OUTPUT (Cont.)

```
   A(I)            24.2       24.3       24.1       24.6       53.0
   V(I)           10.09      10.03      10.14       9.92       4.60
1   .
   *
   HP 1  APPR 15.28 * 15.28
1
 WSPRO         FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
 P060188           MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS


        ROUTE 97 OVER THE SUSYBOLE CREEK
        EH&A FILE NO. 16139.01 B-4
           *** RUN DATE & TIME: 12-30-94  08:51
    CROSS-SECTION PROPERTIES:  ISEQ =  4;  SECID =  APPR;  SRD =     426.

     WSEL  SA#      AREA        K   TOPW   WETP  ALPH    LEW    REW     QCR
             3      694.   114184.   84.    91.                       11316.
             4       11.      145.    5.     7.                          85.
    15.28            704.   114329.   89.    98.  1.03  2040.  2129.  11076.
1
   HP 1  BRDG 14.45 * 14.45
1
 WSPRO         FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
 P060188           MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS


        ROUTE 97 OVER THE SUSYBOLE CREEK
        EH&A FILE NO. 16139.01 B-4
           *** RUN DATE & TIME: 12-30-94  08:51
    CROSS-SECTION PROPERTIES:  ISEQ =  3;  SECID =  BRDG;  SRD =     200.

     WSEL  SA#      AREA        K   TOPW   WETP  ALPH    LEW    REW     QCR
             2      664.   106486.   84.    91.                       10601.
             3       61.     3268.   36.    36.                         457.
    14.45            725.   109754.  119.   127.  1.09  2040.  2160.   9701.
1
   HP 2  APPR 15.28 * 15.28 6850
1
 WSPRO         FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
 P060188           MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS


        ROUTE 97 OVER THE SUSYBOLE CREEK
        EH&A FILE NO. 16139.01 B-4
           *** RUN DATE & TIME: 12-30-94  08:51


    VELOCITY DISTRIBUTION:  ISEQ =  4;  SECID =  APPR;  SRD =     426.

        WSEL     LEW     REW    AREA        K        Q    VEL
       15.28  2040.0  2129.4   704.4  114329.   6850.   9.72

X STA.      2040.0     2049.8     2053.6     2057.5     2061.6     2066.1
  A(I)          68.8       32.5       32.5       33.0       35.0
  V(I)          4.97      10.55      10.55      10.38       9.78

X STA.      2066.1     2070.7     2074.7     2078.3     2081.5     2084.7
  A(I)          35.5       32.5       31.9       30.6       30.0
  V(I)          9.65      10.54      10.72      11.19      11.43

X STA.      2084.7     2088.0     2091.4     2094.8     2098.3     2101.8
  A(I)          30.5       31.3       31.0       31.9       31.3
  V(I)         11.22      10.93      11.04      10.74      10.93

X STA.      2101.8     2105.2     2108.8     2112.4     2115.9     2129.4
  A(I)          31.0       31.9       31.6       31.2       60.3
  V(I)         11.06      10.72      10.83      10.99       5.68
```

WSPRO OUTPUT (Cont.)

```
1
  HP 2  BRDG 14.45 * 14.45 6850
1
 WSPRO         FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
 P060188           MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS


         ROUTE 97 OVER THE SUSYBOLE CREEK
         EH&A FILE NO. 16139.01 B-4
            *** RUN DATE & TIME: 12-30-94  08:51


     VELOCITY DISTRIBUTION:  ISEQ =  3;  SECID =  BRDG;  SRD =     200.

          WSEL     LEW     REW    AREA        K        Q    VEL
         14.45  2040.1  2159.5   725.3  109754.    6850.   9.44

 X STA.      2040.1     2049.9     2053.7     2057.7     2062.0     2066.6
   A(I)          66.4       30.9       32.2       33.5       34.2
   V(I)          5.16      11.07      10.65      10.24      10.02

 X STA.      2066.6     2071.3     2075.3     2078.9     2082.5     2085.8
   A(I)          34.1       32.8       30.5       30.9       29.6
   V(I)         10.04      10.45      11.21      11.08      11.58

 X STA.      2085.8     2089.2     2092.7     2096.2     2099.7     2103.3
   A(I)          30.2       31.0       30.7       30.9       30.8
   V(I)         11.33      11.05      11.16      11.08      11.11

 X STA.      2103.3     2106.9     2110.5     2114.1     2118.6     2159.5
   A(I)          31.3       30.6       31.1       35.6       88.0
   V(I)         10.95      11.21      11.02       9.61       3.89
1
  EX

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


         ROUTE 97 OVER THE SUSYBOLE CREEK
         EH&A FILE NO. 16139.01 B-4
            *** RUN DATE & TIME: 12-30-94  08:51

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

  EXIT:XS   ******  2040.      693.   .80  *****   13.40    10.01    4876.   12.60
         0. ******  2146.   100548.  1.04  ***** *******      .49     7.03

  FULL:FV     200.  2040.      602.  1.23   .61    14.22 *******    4876.   13.00
       200.   200.  2179.    77412.  1.20   .21      .00      .75     8.10
          <<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>

  APPR:AS     226.  2040.      586.  1.09   .81    15.03 *******    4876.   13.94
       426.   226.  2128.    85873.  1.01   .00      .00      .57     8.33
          <<<<<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     200.  2040.      545.  1.25   .64    14.09    11.33    4876.   12.84
       200.   200.  2140.    74390.  1.00   .05      .00      .67     8.95
```

WSPRO OUTPUT (Cont.)

```
     TYPE PPCD FLOW      C     P/A    LSEL   BLEN   XLAB   XRAB
       3.   1.   1.  1.000    .047   27.40 ****** ****** ******

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

 APPR:AS     199.  2040.      591.  1.08    .73   15.07   11.70    4876.   13.99
      426.   199.  2128.    87025.  1.01    .25     .01     .56    8.25

      M(G)   M(K)       KQ   XLKQ   XRKQ    OTEL
      .000   .000    86909.  2040.  2139.   13.37

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


        ROUTE 97 OVER THE SUSYBOLE CREEK
        EH&A FILE NO. 16139.01 B-4
           *** RUN DATE & TIME: 12-30-94  08:51
   FIRST USER DEFINED TABLE.

     XSID:CODE       Q    WSEL     VEL    CRWS    YMIN
     EXIT:XS      4876.   12.60    7.03   10.01    5.00
     FULL:FV      4876.   13.00    8.10********    5.50
     BRDG:BR      4876.   12.84    8.95   11.33    5.50
     APPR:AS      4876.   13.99    8.25   11.70    5.60
1
 WSPRO         FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
 P060188           MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS


        ROUTE 97 OVER THE SUSYBOLE CREEK
        EH&A FILE NO. 16139.01 B-4
           *** RUN DATE & TIME: 12-30-94  08:51
   SECOND USER DEFINED TABLE.

     XSID:CODE       Q     AREA    LEW    REW    SRD        K
     EXIT:XS      4876.     693.  2040.  2146.     0.   100548.
     FULL:FV      4876.     602.  2040.  2179.   200.    77412.
     BRDG:BR      4876.     545.  2040.  2140.   200.    74390.
     APPR:AS      4876.     591.  2040.  2128.   426.    87025.

     XSID:CODE     OTEL
     APPR:AS      13.37
1
 WSPRO         FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
 P060188           MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS


        ROUTE 97 OVER THE SUSYBOLE CREEK
        EH&A FILE NO. 16139.01 B-4
           *** RUN DATE & TIME: 12-30-94  08:51
   THIRD USER DEFINED TABLE.

     XSID:CODE      EGL      FR#    WSEL     HF
     EXIT:XS      13.40      .49   12.60******
     FULL:FV      14.22      .75   13.00    .61
     BRDG:BR      14.09      .67   12.84    .64
     APPR:AS      15.07      .56   13.99    .73
1
 WSPRO         FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
 P060188           MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS


        ROUTE 97 OVER THE SUSYBOLE CREEK
        EH&A FILE NO. 16139.01 B-4
```

WSPRO OUTPUT (Cont.)

```
          *** RUN DATE & TIME: 12-30-94  08:51

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

 EXIT:XS   ******  2040.      862.  1.03 *****   15.20   11.09   6850.   14.18
        0. ******  2148.   141239.  1.05 ***** *******     .51    7.95

 FULL:FV     200.  2040.      845.  1.51   .60   16.04 *******   6850.   14.53
      200.   200.  2217.   110928.  1.48   .24     .00     .79    8.11
          <<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>

 APPR:AS     226.  2040.      714.  1.47   .82   16.86 *******   6850.   15.39
      426.   226.  2130.   116766.  1.03   .00     .00     .61    9.59
          <<<<<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     200.  2040.      726.  1.39   .60   15.84   12.76   6850.   14.45
      200.   200.  2160.   109825.  1.00   .02    -.02     .68    9.44

     TYPE PPCD FLOW      C     P/A    LSEL   BLEN   XLAB   XRAB
       3.   1.   1.  1.000    .043   27.40 ****** ****** ******

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

 APPR:AS     199.  2040.      704.  1.51   .74   16.79   12.92   6850.   15.28
      426.   199.  2129.   114293.  1.03   .22     .01     .62    9.73

       M(G)   M(K)       KQ   XLKQ   XRKQ    OTEL
       .000   .000  114176.  2039.  2158.    14.56

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


        ROUTE 97 OVER THE SUSYBOLE CREEK
        EH&A FILE NO. 16139.01 B-4
           *** RUN DATE & TIME: 12-30-94  08:51
  FIRST USER DEFINED TABLE.

    XSID:CODE       Q    WSEL     VEL    CRWS    YMIN
    EXIT:XS      6850.   14.18    7.95   11.09    5.00
    FULL:FV      6850.   14.53    8.11********    5.50
    BRDG:BR      6850.   14.45    9.44   12.76    5.50
    APPR:AS      6850.   15.28    9.73   12.92    5.60
1
 WSPRO         FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
 P060188          MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS


        ROUTE 97 OVER THE SUSYBOLE CREEK
        EH&A FILE NO. 16139.01 B-4
           *** RUN DATE & TIME: 12-30-94  08:51
 SECOND USER DEFINED TABLE.

    XSID:CODE       Q     AREA    LEW    REW    SRD        K
    EXIT:XS      6850.     862.  2040.  2148.     0.  141239.
    FULL:FV      6850.     845.  2040.  2217.   200.  110928.
    BRDG:BR      6850.     726.  2040.  2160.   200.  109825.
    APPR:AS      6850.     704.  2040.  2129.   426.  114293.
```

WSPRO OUTPUT (Cont.)

```
    XSID:CODE    OTEL
    APPR:AS     14.56
1
 WSPRO          FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
 P060188           MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS


        ROUTE 97 OVER THE SUSYBOLE CREEK
        EH&A FILE NO. 16139.01 B-4
           *** RUN DATE & TIME: 12-30-94  08:51
  THIRD USER DEFINED TABLE.

    XSID:CODE     EGL      FR#    WSEL     HF
    EXIT:XS     15.20      .51   14.18******
    FULL:FV     16.04      .79   14.53    .60
    BRDG:BR     15.84      .68   14.45    .60
    APPR:AS     16.79      .62   15.28    .74
  ER

1  NORMAL  END  OF  WSPRO  EXECUTION.
```

SCDOT BRIDGE SCOUR
Saved As: 16139A04.WQ1
JOB NO. 16139.01 B-4
BRIDGE NO. 124009700200
BY/CHK: ABS/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	586
TOPW	APPR. MAIN CHANNEL TOP WIDTH (ft)	84
Ym	APPR. MAIN CHANNEL AVG. DEPTH = AREAm/TOPW	6.98
HFa	APPR. HEAD LOSS DUE TO FRICTION	0.81
DIST	DISTANCE FROM BRIDGE TO APPR.	226
Sf	AVG. UNCONSTRICTED ENERGY SLOPE = HFa/DIST	0.00358
Km	APPR. MAIN CHANNEL CONVEYANCE	86912
Vm	APPR. MAIN CHANNEL AVG. VELOCITY (fps) Vm = (Km*(Sf)^.5)/AREAm	8.88

LEFT OVERBANK:

THERE IS NO FLOW IN THE LEFT OVERBANK.

RIGHT OVERBANK:

INSIGNIFICANT FLOW IN RIGHT OVERBANK, FLOW IS IGNORED

SCDOT BRIDGE SCOUR
Saved As: 16139A04.WQ1
JOB NO. 16139.01 B-4
BRIDGE NO. 124009700200
BY/CHK: ABS/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= 1.17 fps

(2) LEFT OVERBANK CRITICAL VELOCITY (Vcl):

THERE IS NO FLOW IN THE LEFT OVERBANK.

(3) RIGHT OVERBANK CRITICAL VELOCITY (Vcr):

INSIGNIFICANT FLOW IN RIGHT OVERBANK, FLOW IS IGNORED

NOTES: LIVE-BED SCOUR WILL BE COMPUTED FOR THE MAIN CHANNEL.
THERE IS NO FLOW IN THE LEFT OVERBANK.
INSIGNIFICANT FLOW IN RIGHT OVERBANK, FLOW IS IGNORED

SCDOT BRIDGE SCOUR
Saved As: 16139A04.WQ1
JOB NO. 16139.01 B-4
BRIDGE NO. 124009700200
BY/CHK: ABS/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	4876
Q	TOTAL DISCHARGE(cfs) BRIDGE	4876
Ktot(APP)	APP. TOTAL CONVEYANCE	86912
Ktot(BR)	BR. TOTAL CONVEYANCE	73822
Sf	AVG. UNCONSTRICTED ENERGY SLOPE	0.00358
MAIN CHANNEL:		
Km(APP)	APP. MAIN CHANNEL CONVEYANCE	86912
W1m(APP)	APP. MAIN CHANNEL WIDTH(ft)	84
Am(APP)	APP. MAIN CHANNEL AREA	586
TOPWm(APP)	APP. MAIN CHANNEL TOP WIDTH(ft)	84
Y1m(APP)	AVG. DEPTH IN UPSTR MAIN CHANNEL(ft)	6.98
WETPm(APP)	APP. MAIN CHANNEL WETTED PERIM.(ft)	90
Km(BR)	BR. MAIN CHANNEL CONVEYANCE	73822
W2m(BR)	BR. MAIN CHANNEL WIDTH MINUS PIER WIDTHS(ft)	78
LEFT OVERBANK:		

THERE IS NO FLOW IN THE LEFT OVERBANK.

RIGHT OVERBANK:

INSIGNIFICANT FLOW IN RIGHT OVERBANK, FLOW IS IGNORED

SCDOT BRIDGE SCOUR
Saved As: 16139A04.WQ1
JOB NO. 16139.01 B-4
BRIDGE NO. 124009700200
BY/CHK: ABS/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= 6.51 ft

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

SHEARm=Ywater*Rm*Sf
SHEARm= 1.46 lb/sf

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

Vm*=(SHEARm/p)^.5
Vm*= 0.87 fps

(d) MAIN CHANNEL BED MATL. D50m:

D50m= 0.12 mm
D50m= 0.0004 ft

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

wm= 0.03 fps

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

Vm*/wm= 28.88
K1= 0.69

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

Q1m=Q*(Km(APP)/Ktot(APP))
Q1m= 4876 cfs

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

Q2m=Q*(Km(BR)/Ktot(BR))
Q2m= 4876 cfs

(i) LAURSEN'S LIVE BED EQUATION:
Y2m/Y1m=(Q2m/Q1m)^6/7*(W1m/W2m)^K1
Y2m= 7.34 ft

(j) MAIN CONTRACTION SCOUR DEPTH (Ysm):
Ysm=Y2m-Y1m
Ysm= 0.37 ft

SCDOT BRIDGE SCOUR
Saved As: 16139A04.WQ1
JOB NO. 16139.01 B-4
BRIDGE NO. 124009700200
BY/CHK: ABS/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	2042	
A2		AREA OF CONVEYANCE TUBE AT PIER #2 (sf)	47.5
V2		VELOCITY IN CONVEYANCE TUBE AT PIER #2 (fps)	5.13
TOPW2		TOPWIDTH OF CONVEYANCE TUBE AT PIER #2 (ft)	9.3
Y2		MEAN DEPTH OF CONVEYANCE TUBE AT PIER #2 (ft)	5.11
PIER #3:	WSPRO STA	2082	
A3		AREA OF CONVEYANCE TUBE AT PIER #3 (sf)	23.1
V3		VELOCITY IN CONVEYANCE TUBE AT PIER #3 (fps)	10.58
TOPW3		TOPWIDTH OF CONVEYANCE TUBE AT PIER #3 (ft)	3.1
Y3		MEAN DEPTH OF CONVEYANCE TUBE AT PIER #3 (ft)	7.45
PIER #4:	WPSRO STA	2122	
A4		AREA OF CONVEYANCE TUBE AT PIER #4 (sf)	53
V4		VELOCITY IN CONVEYANCE TUBE AT PIER #4 (fps)	4.6
TOPW4		TOPWIDTH OF CONVEYANCE TUBE AT PIER #4 (ft)	24.3
Y4		MEAN DEPTH OF CONVEYANCE TUBE AT PIER #4 (ft)	2.18
PIER #5:	WSPRO STA	2162	

THE FLOW DOES NOT REACH PIER #5.

SCDOT BRIDGE SCOUR
Saved As: 16139A04.WQ1
JOB NO. 16139.01 B-4
BRIDGE NO. 124009700200
BY/CHK: ABS/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)= 2
(b) FROUDE NO.=FR2=V2/(g*Y2)^.5= 0.40
(c) K1=PIER NOSE SHAPE CORR. FACTOR (FIG7, TBL2,PG40)= 1
(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= 4.12 ft

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

(a) a=PIER WIDTH (ft)= 2
(b) FROUDE NO.=FR3=V3/(g*Y3)^.5= 0.68
(c) K1=PIER NOSE SHAPE CORR. FACTOR (FIG7, TBL2,PG40)= 1
(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= 5.92 ft

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

(a) a=PIER WIDTH (ft)= 2
(b) FROUDE NO.=FR4=V4/(g*Y4)^.5= 0.55
(c) K1=PIER NOSE SHAPE CORR. FACTOR (FIG7, TBL2,PG40)= 1
(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= 3.50 ft

SCDOT BRIDGE SCOUR
Saved As: 16139A04.WQ1
JOB NO. 16139.01 B-4
BRIDGE NO. 124009700200
BY/CHK: ABS/GG

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

STORM EVENT (YR): 100

IV. ABUTMENT SCOUR:

THE FLOW DOES NOT REACH THE ABUTMENTS.
NO ABUTMENT SCOUR CALCULATIONS ARE PERFORMED.

SCDOT BRIDGE SCOUR
Saved As: 16139B04.WQ1
JOB NO. 16139.01 B-4
BRIDGE NO. 124009700200
BY/CHK: ABS/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	694
TOPW	APPR. MAIN CHANNEL TOP WIDTH (ft)	84
Ym	APPR. MAIN CHANNEL AVG. DEPTH = AREAm/TOPW	8.26
HFa	APPR. HEAD LOSS DUE TO FRICTION	0.82
DIST	DISTANCE FROM BRIDGE TO APPR.	226
Sf	AVG. UNCONSTRICTED ENERGY SLOPE = HFa/DIST	0.00363
Km	APPR. MAIN CHANNEL CONVEYANCE	114184
Vm	APPR. MAIN CHANNEL AVG. VELOCITY (fps)	9.91
	Vm = (Km*(Sf)^.5)/AREAm	

LEFT OVERBANK:

THERE IS NO FLOW IN THE LEFT OVERBANK.

RIGHT OVERBANK:

Ssr	SPECIFIC GRAVITY OF RT.OVERBANK BED MATERIAL	2.65
D50r	MEAN DIAM. OF RT. OVERBANK BED MATL. (mm)	0.12
AREAr	RIGHT OVERBANK AREA (ft)^2	11
TOPW	RIGHT OVERBANK TOP WIDTH (ft)	5
Yr	APPR. RIGHT OVERBANK AVG. DEPTH (ft)	2.20
Kr	RIGHT OVERBANK CONVEYANCE	145
Vr	APPR. RIGHT OVERBANK AVG. VELOCITY (fps)	0.79

SCDOT BRIDGE SCOUR
Saved As: 16139B04.WQ1
JOB NO. 16139.01 B-4
BRIDGE NO. 124009700200
BY/CHK: ABS/GG

ESPEY, HUSTON & ASSOC., INC
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= 1.20 fps

(2) LEFT OVERBANK CRITICAL VELOCITY (Vcl):

THERE IS NO FLOW IN THE LEFT OVERBANK.

(3) RIGHT OVERBANK CRITICAL VELOCITY (Vcr):
NEILL'S EQ;
Vcr=1.58*((Ssr-1)*g*D50r)^1/2*(Yr/D50r)^1/6
Vcr= 0.96 fps

NOTES: LIVE-BED SCOUR WILL BE COMPUTED FOR THE MAIN CHANNEL.
THERE IS NO FLOW IN THE LEFT OVERBANK.
CLEAR-WATER SCOUR WILL BE COMPUTED FOR THE RIGHT OVERBANK.

SCDOT BRIDGE SCOUR
Saved As: 16139B04.WQ1
JOB NO. 16139.01 B-4
BRIDGE NO. 124009700200
BY/CHK: ABS/GG

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	6850
Q	TOTAL DISCHARGE(cfs) BRIDGE	6850
Ktot(APP)	APP. TOTAL CONVEYANCE	114184
Ktot(BR)	BR. TOTAL CONVEYANCE	109754
Sf	AVG. UNCONSTRICTED ENERGY SLOPE	0.00363
MAIN CHANNEL:		
Km(APP)	APP. MAIN CHANNEL CONVEYANCE	114184
W1m(APP)	APP. MAIN CHANNEL WIDTH(ft)	84
Am(APP)	APP. MAIN CHANNEL AREA	694
TOPWm(APP)	APP. MAIN CHANNEL TOP WIDTH(ft)	84
Y1m(APP)	AVG. DEPTH IN UPSTR MAIN CHANNEL(ft)	8.26
WETPm(APP)	APP. MAIN CHANNEL WETTED PERIM.(ft)	91
Km(BR)	BR. MAIN CHANNEL CONVEYANCE	106486
W2m(BR)	BR. MAIN CHANNEL WIDTH MINUS PIER WIDTHS(ft)	78

SCDOT BRIDGE SCOUR
Saved As: 16139B04.WQ1
JOB NO. 16139.01 B-4
BRIDGE NO. 124009700200
BY/CHK: ABS/GG

ESPEY, HUSTON & ASSOC., INC
460 McLAWS CIRCLE, SUITE 150
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= 7.63 ft

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

SHEARm=Ywater*Rm*Sf
SHEARm= 1.73 lb/sf

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

Vm*=(SHEARm/p)^.5
Vm*= 0.94 fps

(d) MAIN CHANNEL BED MATL. D50m:

D50m= 0.12 mm
D50m= 0.0004 ft

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

wm= 0.03 fps

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

Vm*/wm= 31.45
K1= 0.69

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

Q1m=Q*(Km(APP)/Ktot(APP))
Q1m= 6850 cfs

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

Q2m=Q*(Km(BR)/Ktot(BR))
Q2m= 6646 cfs

(i) LAURSEN'S LIVE BED EQUATION:
Y2m/Y1m=(Q2m/Q1m)^6/7*(W1m/W2m)^K1
Y2m= 8.47 ft

(j) MAIN CONTRACTION SCOUR DEPTH (Ysm):
Ysm=Y2m-Y1m
Ysm= 0.21 ft

SCDOT BRIDGE SCOUR
Saved As: 16139B04.WQ1
JOB NO. 16139.01 B-4
BRIDGE NO. 124009700200
BY/CHK: ABS/GG

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

STORM EVENT (YR): 500

II. CLEAR-WATER CONTRACTION SCOUR

(A) INPUT FROM WSPRO

VARIABLE	DESCRIPTION	VALUE
Q	TOTAL DISCHARGE INPUT THRU BRIDGE (cfs)	6850
Ktot	TOTAL CONVEYANCE AT BRIDGE	109754

RIGHT OVERBANK:

Kr	RIGHT OVERBANK CONVEYANCE AT BRIDGE	3268
Qr	FLOW IN RIGHT OVERBANK THRU BRIDGE (cfs)	204
D50r	MEDIAN GRAIN SIZE OF RIGHT OVERBANK (ft)	0.00039
Wr	DIST. FROM RT. BANK TO TOE OF RT. ABT. LESS PIER WIDTHS(ft)	36
Ar	AREA OF RIGHT OVERBANK AT APPR. (sf)	11
TOPWr	TOPWIDTH OF RIGHT OVERBANK AT APP. (ft)	5
Y1r	FLOW DEPTH IN RIGHT OVERBANK AT APP. (ft)	2.20

SCDOT BRIDGE SCOUR
Saved As: 16139B04.WQ1
JOB NO. 16139.01 B-4
BRIDGE NO. 124009700200
BY/CHK: ABS/GG

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

STORM EVENT (YR): 500

(B) CALCULATIONS (CLEAR WATER CONTRACTION SCOUR)

3. CLEAR WATER CONTRACTION SCOUR FOR RIGHT OVERBANK (Ysr):

(a) EFFECTIVE MEAN DIAMETER OF RIGHT OVERBANK BED MATL. (Dmr):

Dmr= 0.000492 ft

(b) Y2r=((Qr^2)/(120*Dmr^(2/3)*Wr^(2)))^3/7

Y2r= 5.01 ft

(c) Ysr=Y2r-Y1r

Ysr= 2.81 ft

SCDOT BRIDGE SCOUR
Saved As: 16139B04.WQ1
JOB NO. 16139.01 B-4
BRIDGE NO. 124009700200
BY/CHK: ABS/GG

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

STORM EVENT (YR): 500

III. LOCAL SCOUR AT PIERS

(A) INPUT FROM WSPRO

VARIABLE		DESCRIPTION	VALUE
PIER #2:	WSPRO STA	2042	
A2		AREA OF CONVEYANCE TUBE AT PIER #2 (sf)	66.4
V2		VELOCITY IN CONVEYANCE TUBE AT PIER #2 (fps)	5.16
TOPW2		TOPWIDTH OF CONVEYANCE TUBE AT PIER #2 (ft)	9.8
Y2		MEAN DEPTH OF CONVEYANCE TUBE AT PIER #2 (ft)	6.78
PIER #3:	WSPRO STA	2082	
A3		AREA OF CONVEYANCE TUBE AT PIER #3 (sf)	30.9
V3		VELOCITY IN CONVEYANCE TUBE AT PIER #3 (fps)	11.08
TOPW3		TOPWIDTH OF CONVEYANCE TUBE AT PIER #3 (ft)	3.6
Y3		MEAN DEPTH OF CONVEYANCE TUBE AT PIER #3 (ft)	8.58
PIER #4:	WPSRO STA	2122	
A4		AREA OF CONVEYANCE TUBE AT PIER #4 (sf)	88
V4		VELOCITY IN CONVEYANCE TUBE AT PIER #4 (fps)	3.89
TOPW4		TOPWIDTH OF CONVEYANCE TUBE AT PIER #4 (ft)	40.9
Y4		MEAN DEPTH OF CONVEYANCE TUBE AT PIER #4 (ft)	2.15
PIER #5:	WSPRO STA	2162	

THE FLOW DOES NOT REACH PIER 5.

SCDOT BRIDGE SCOUR
Saved As: 16139B04.WQ1
JOB NO. 16139.01 B-4
BRIDGE NO. 124009700200
BY/CHK: ABS/GG

ESPEY, HUSTON & ASSOC., INC
460 McLAWS CIRCLE, SUITE 150
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
(b)	FROUDE NO.=FR2=V2/(g*Y2)^.5=	0.35	
(c)	K1=PIER NOSE SHAPE CORR. FACTOR (FIG7, TBL2,PG40)=		1
(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= 2.73 ft

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

(a)	a=PIER WIDTH (ft)=		1
(b)	FROUDE NO.=FR3=V3/(g*Y3)^.5=	0.67	
(c)	K1=PIER NOSE SHAPE CORR. FACTOR (FIG7, TBL2,PG40)=		1
(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= 3.92 ft

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

(a)	a=PIER WIDTH (ft)=		1
(b)	FROUDE NO.=FR4=V4/(g*Y4)^.5=	0.47	
(c)	K1=PIER NOSE SHAPE CORR. FACTOR (FIG7, TBL2,PG40)=		1
(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= 2.07 ft

SCDOT BRIDGE SCOUR
Saved As: 16139B04.WQ1
JOB NO. 16139.01 B-4
BRIDGE NO. 124009700200
BY/CHK: ABS/GG

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

STORM EVENT (YR): 500

IV. ABUTMENT SCOUR:

THE FLOW DOES NOT REACH THE ABUTMENTS.
NO ABUTMENT SCOUR CALCULATIONS ARE PERFORMED.

Photo 1: *View of roadway surface, facing west.*

Photo 2: *Northeast view of residence and east overbank.*

Photo 3: *Downstream view.*

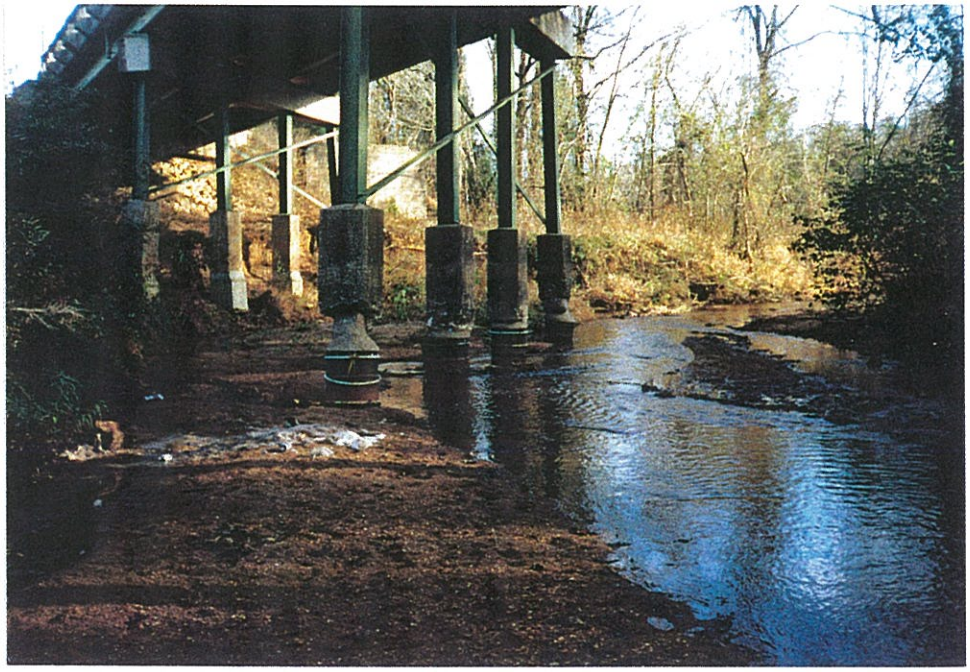

Photo 4: *Downstream view (the piles at bent 3 are in the foreground).*

Photo 5: *View of east bank - note erosion under encasement extensions for the piles of bent 2.*

Photo 6: *View of west bank - piles of bent 4.*

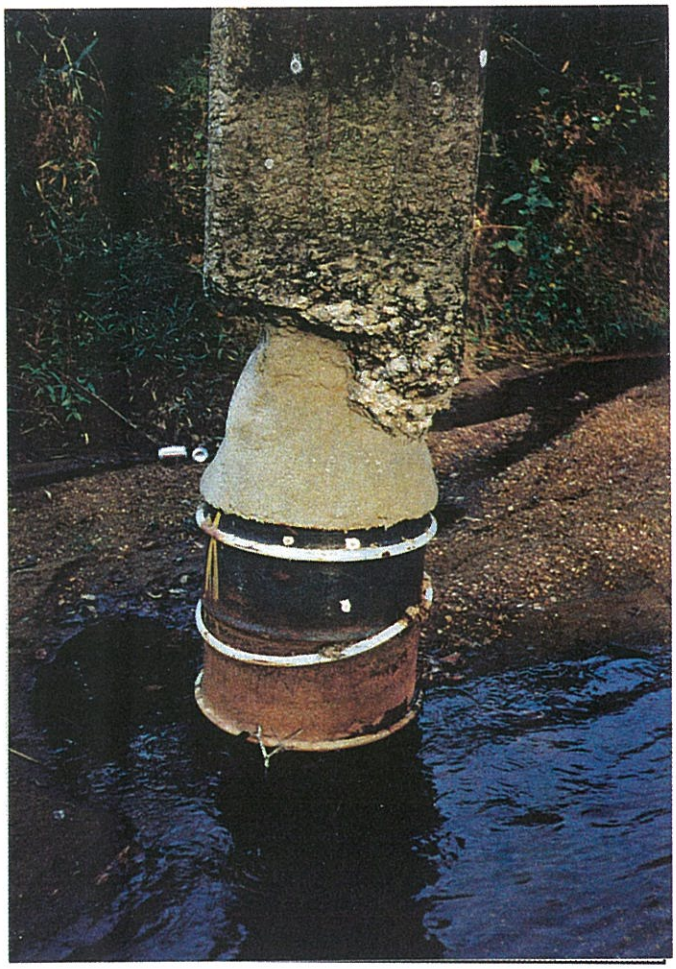

Photo 7: ***Encasement extension.***

Photo 8: *Downstream view facing south.*

Photo 9: *Downstream view at sand pile on west bank.*

Photo 10: *View of west abutment.*

Photo 11: *View eastward from west abutment.*

Consultant Scour Study Check List

County Chester Crossing Susybole Creek
Road/Route SC97
Consultant Espey Huston

Mark whether each item is completed correctly or incorrectly and make a comment as to what needs to be changed.

Check List	Correct	Incorrect	Comments
County	✓		
Structure #	✓		
Stream Name	✓		
Physiographic Province	✓		
Description of Location	✓		
Bridge Length and Width	✓		
Max Span Length	✓		
# of Spans	✓		
D50	✓		.3 from Soil Manual
Skew	✓		
Q100	✓		
Q500	✓		
Discharge Method and applicability	✓		
WSPRO Cross section Locations	✓		
WSPRO Setup	✓		
Equations for Scour	✓		