U.S. DEPARTMENT OF THE INTERIOR

U.S. GEOLOGICAL SURVEY

LEVEL II BRIDGE SCOUR ANALYSIS FOR STRUCTURE 124009700800 ON ROUTE SC 97, CROSSING ROCKY CREEK IN CHESTER COUNTY, SOUTH CAROLINA

By Andy W. Caldwell and Michael G. Zalants

Prepared in cooperation with the
SOUTH CAROLINA DEPARTMENT
OF TRANSPORTATION

Columbia, South Carolina

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UNIT ABBREVIATIONS

cubic foot per second	ft^3/s
feet per second	ft/s
foot	ft
mile	mi
millimeter	mm
square foot	ft^2
square mile	mi^2

OTHER ABBREVIATIONS

downstream	D/S
upstream	U/S
flood plain	f/p
median diameter of bed material	D_{50}
Water-Surface Profile computation model	WSPRO
South Carolina Department of Transportation	SCDOT

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

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

Level II bridge scour analysis for structure 124009700800 on Route SC 97, crossing Rocky Creek in Chester County, South Carolina

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This report provides the results of the detailed Level II analysis of scour potential at structure 124009700800 on Route SC 97, crossing Rocky Creek in Chester County, South Carolina (figure 1 in pocket; figures 4-7). The site is located in the Piedmont physiographic province near the town of Great Falls in the southern part of Chester County. The drainage area for the site is 126 mi^2, and is a predominantly rural drainage basin with little development in recent years. In the vicinity of the study site, the land is covered by moderately thick hardwoods and with an old clear-cut area on the upstream left flood plain.

In the study area, Rocky Creek has a meandering channel with a slope of approximately 0.0019 ft/ft (10.0 ft/mi), an average channel top width of 104 ft and an average channel depth of 12.9 ft. The predominant channel bed material is sand (D_{50} is 1.4 mm) and the channel banks consist of a silty sand (D_{50} is 0.32 mm). In general, the banks have moderate woody vegetative cover and were noted to be relatively stable at the time of the Level I and Level II site visits, July 19, 1990 and September 27 and 28, 1993, respectively.

The Route SC 97 crossing of Rocky Creek is a 413-ft-long, two-lane bridge consisting of one 70-ft and six 53- to 62-ft concrete arch spans, supported by steel and concrete bents with concrete arch abutments. The left and right abutments are not protected by riprap. In this report, the words "right" and "left" refer to directions that would be reported by an observer facing downstream. Additional details describing conditions at the site are included in the Scour Report Summary.

Scour depths were computed using engineering judgement and the general guidelines described in Hydraulic Engineering Circular 18 (Richardson and others, 1993) and the Transportation Research Board Draft Paper, "Evaluating scour at bridges using WSPRO" (Arneson and others, 1992). Scour depths were calculated assuming an infinite depth of erosive material and a homogeneous particle-size distribution. The results of the scour analysis are presented in tables 1 through 5 and a graph of the scour depths is shown on figure 2.

Scour depth calculations indicate that pile tip exposure will occur at bents 1 and 2 for the 100- and 500-year discharges. Scour caused by the 100-year discharge will undermine bents 1 and 2 by 7.6 and 0.5 ft, respectively. Scour caused by the 500-year discharge will undermine bents 1 and 2 by 13.5 and 6.5 ft, respectively.

It should be noted that the SCDOT bridge plan borings (docket number 12.328) show subsurface rock and gravel deposits that could affect the scour depths shown in this study. For more information, see the SCDOT bridge plans in the pocket at the back of the report.

Table 1. *--Remaining pile/footing penetration at piers/bents for the 100-year discharge at structure 124009700800 on Route SC 97, crossing Rocky Creek in Chester County, South Carolina*

Pier/bent [1] number	Station from [2] left end of bridge (feet)	Pile tip/ [3] footing elevation, SCDOT datum (feet)	Pile tip/ footing elevation, USGS datum (feet)	Ground elevation at pier/bent, USGS datum (feet)	Total [4] scour depth (feet)	Elevation of scour, USGS datum (feet)	Remaining [5] pile/footing penetration (feet)
100-year discharge is 16,900 cubic feet per second							
6	53	213.2	62.2	82.7	13.6	69.1	6.9
5	109	208.4	57.4	81.1	13.8	67.3	9.9
4	170	208.2	57.2	74.5	10.4	64.1	6.9
3	240	212.5	61.5	78.4	10.4	68.0	6.5
2	302	220.0	69.0	83.0	14.5	68.5	-0.5
1	360	220.4	69.4	76.9	15.1	61.8	-7.6

[1] Pier/bent number corresponds to the South Carolina Department of Transportation (SCDOT) bridge plans.

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

[3] Pile tip/footing elevations obtained from the SCDOT bridge plans. The maximum elevation at each pier/bent for the widened structure is used. No elevation data was received for the arch piers from the SCDOT.

[4] Total scour depth is the sum of the contraction and pier/bent scour depths.

[5] A negative number signifies undermining of pile tip/footing.

NOTE: The SCDOT bridge plan borings (docket number 12.328) show subsurface rock and gravel deposits that could reduce the scour depths shown in the above table. For more information, see the SCDOT plans in report pocket.

Table 2. *--Remaining pile/footing penetration at piers/bents for the 500-year discharge at structure 124009700800 on Route SC 97, crossing Rocky Creek in Chester County, South Carolina*

Pier/bent [1] number	Station from[2] left end of bridge (feet)	Pile tip/ [3] footing elevation, SCDOT datum (feet)	Pile tip/ footing elevation, USGS datum (feet)	Ground elevation at pier/bent, USGS datum (feet)	Total [4] scour depth (feet)	Elevation of scour, USGS datum (feet)	Remaining[5] pile/footing penetration (feet)
500-year discharge is 24,400 cubic feet per second							
6	53	213.2	62.2	82.7	19.6	63.1	0.9
5	109	208.4	57.4	81.1	19.8	61.3	3.9
4	170	208.2	57.2	74.5	11.5	63.0	5.8
3	240	212.5	61.5	78.4	11.5	66.9	5.4
2	302	220.0	69.0	83.0	20.5	62.5	-6.5
1	360	220.4	69.4	76.9	21.0	55.9	-13.5

[1] Pier/bent number corresponds to the South Carolina Department of Transportation (SCDOT) bridge plans.

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

[3] Pile tip/footing elevations obtained from the SCDOT bridge plans. The maximum elevation at each pier/bent for the widened structure is used. No elevation data was received for the arch piers from the SCDOT.

[4] Total scour depth is the sum of the contraction and pier/bent scour depths.

[5] A negative number signifies undermining of pile tip/footing.

NOTE: The SCDOT bridge plan borings (docket number 12.328) show subsurface rock and gravel deposits that could reduce the scour depths shown in the above table. For more information, see the SCDOT plans in report pocket.

Table 3. --*Cumulative scour depths at piers/bents for the 100-year discharge at structure 124009700800 on Route SC 97, crossing Rocky Creek in Chester County, South Carolina*

Pier/bent [1] number	Station from [2] left end of bridge (feet)	Contraction scour depth (feet)	Pier/bent scour depth **without** debris (feet)	Total [3] scour depth **without** debris (feet)
100-year discharge is 16,900 cubic feet per second				
6	53	6.0	7.6	13.6
5	109	6.0	7.8	13.8
4	170	0[4]	10.4	10.4
3	240	0[4]	10.4	10.4
2	302	7.0	7.5	14.5
1	360	7.0	8.1	15.1

[1] Pier/bent number corresponds to the South Carolina Department of Transportation (SCDOT) bridge plans.

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

[3] Total scour depth is the sum of the contraction and pier/bent scour depths.

[4] The calculated contraction scour is a negative value, but was set equal to zero to reflect a more reasonable estimate of scour during peak flood conditions.

NOTE: The SCDOT bridge plan borings (docket number 12.328) show subsurface rock and gravel deposits that could reduce the scour depths shown in the above table. For more information, see the SCDOT plans in report pocket.

NOTE: The pier and contraction scour equations used in this scour analysis were those recommended in Hydraulic Engineering Circular 18 (Richardson and others, 1993). Scour depths were calculated assuming an infinite depth of erosive material and a homogeneous particle-size distribution.

Table 4. --*Cumulative scour depths at piers/bents for the 500-year discharge at structure 124009700800 on Route SC 97, crossing Rocky Creek in Chester County, South Carolina*

Pier/bent [1] number	Station from [2] left end of bridge (feet)	Contraction scour depth (feet)	Pier/bent scour depth **without** debris (feet)	Total [3] scour depth **without** debris (feet)
500-year discharge is 24,400 cubic feet per second				
6	53	10.7	8.9	19.6
5	109	10.7	9.1	19.8
4	170	0[4]	11.5	11.5
3	240	0[4]	11.5	11.5
2	302	11.5	9.0	20.5
1	360	11.5	9.5	21.0

[1] Pier/bent number corresponds to the South Carolina Department of Transportation (SCDOT) bridge plans.

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

[3] Total scour depth is the sum of the contraction and pier/bent scour depths.

[4] The calculated contraction scour is a negative value, but was set equal to zero to reflect a more reasonable estimate of scour during peak flood conditions.

NOTE: The SCDOT bridge plan borings (docket number 12.328) show subsurface rock and gravel deposits that could reduce the scour depths shown in the above table. For more information, see the SCDOT plans in report pocket.

NOTE: The pier and contraction scour equations used in this scour analysis were those recommended in Hydraulic Engineering Circular 18 (Richardson and others, 1993). Scour depths were calculated assuming an infinite depth of erosive material and a homogeneous particle-size distribution.

Table 5. --*Abutment scour depths for the 100- and 500-year discharges at structure 124009700800 on Route SC 97, crossing Rocky Creek in Chester County, South Carolina*

Recurrence interval for discharge	Discharge (cubic feet per second)	Depth of scour[1, 2] at left abutment (feet)	Depth of scour[1, 2] at right abutment (feet)
100-year	16,900	7.6	12.5
500-year	24,400	14.7	18.2

[1] Abutment scour depths were calculated using the Froehlich (1989) live-bed abutment scour equation, assuming no abutment protection.

[2] The words "right" and "left" refer to directions that would be reported by an observer facing downstream.

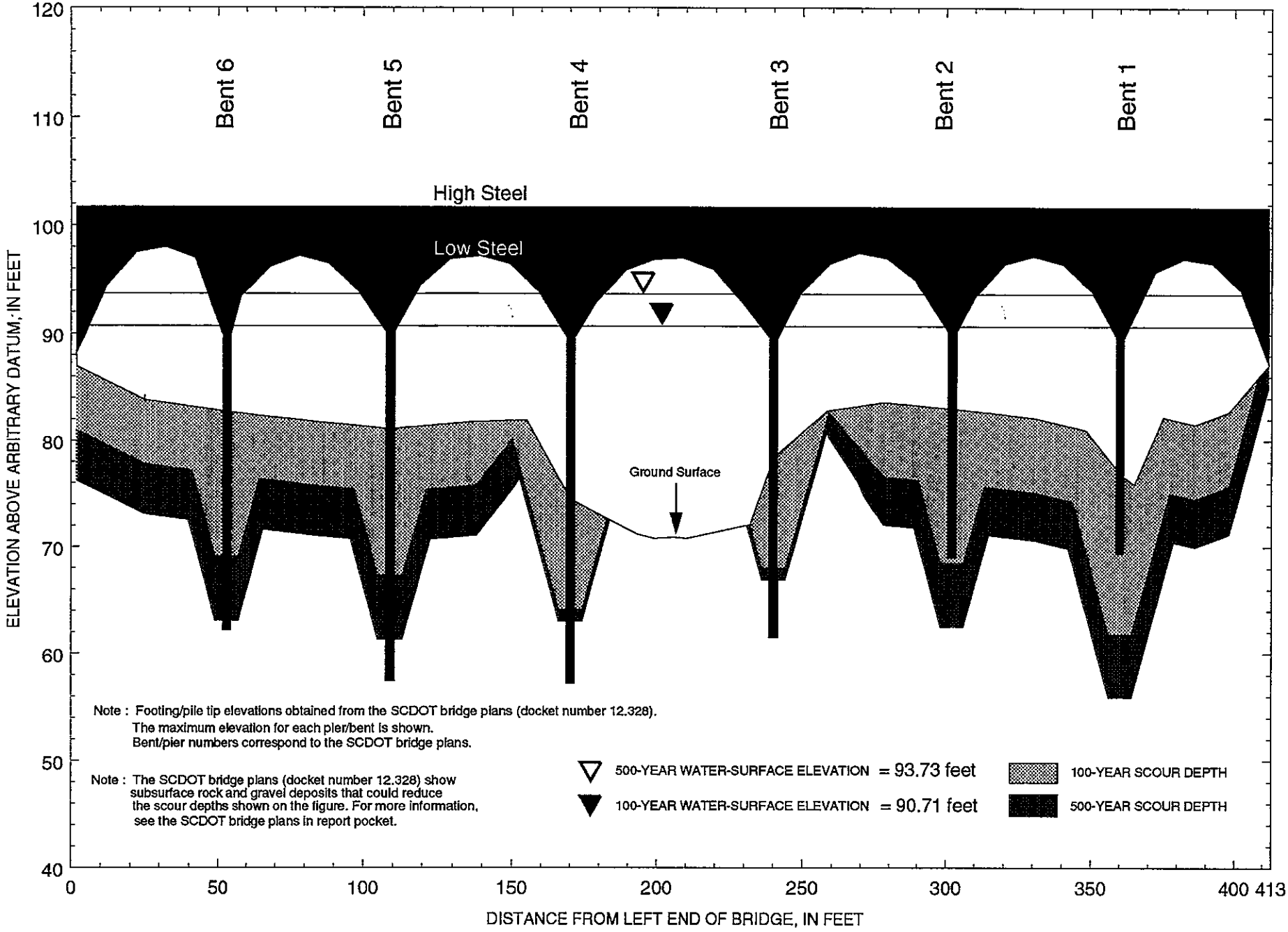

Figure 2.--Total scour depths for the 100- and 500-year discharges at structure 124009700800 on Route SC 97, crossing Rocky Creek in Chester County, South Carolina.

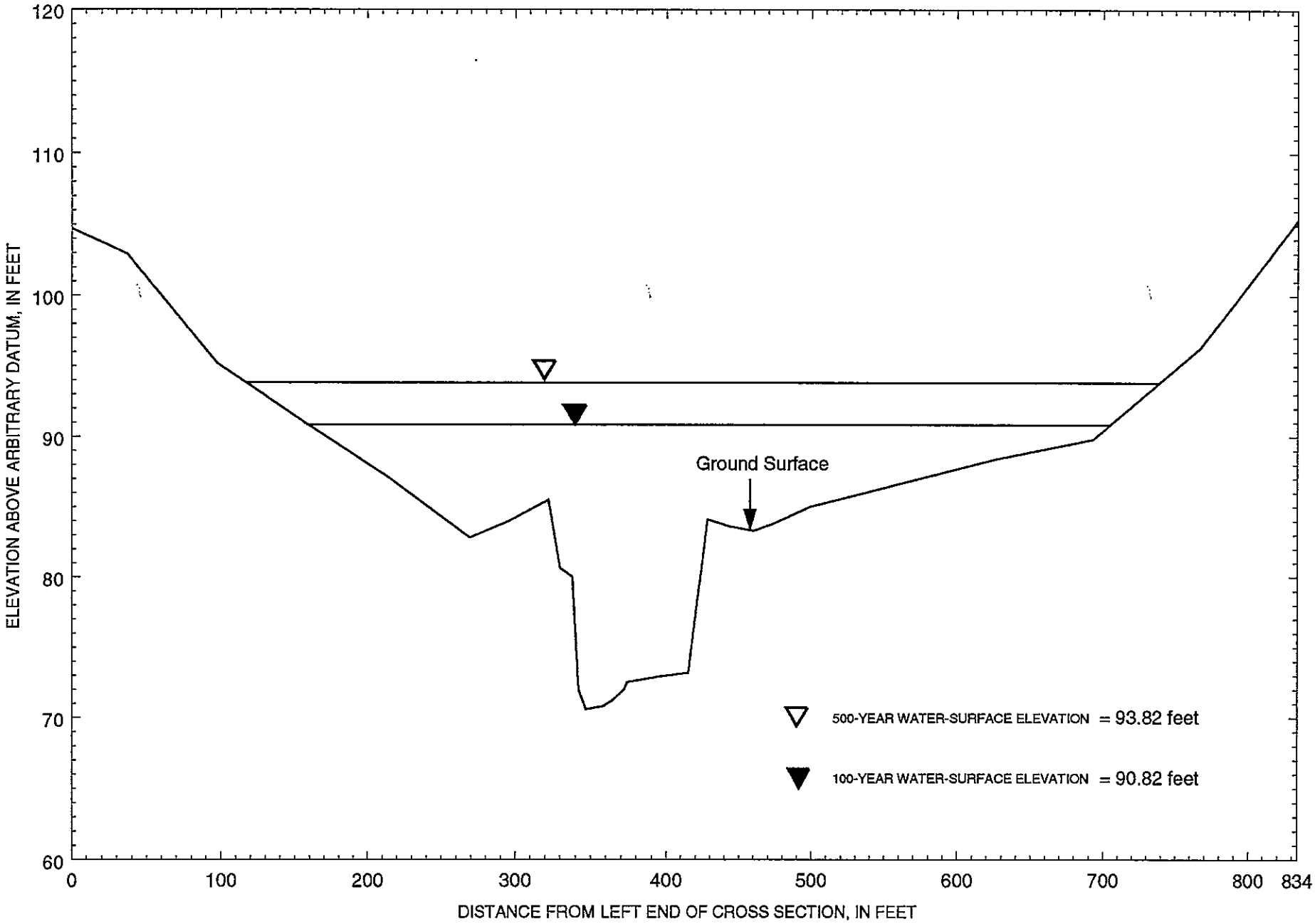

Figure 3.--Approach cross section at structure 124009700800 on Route SC 97, crossing Rocky Creek in Chester County, South Carolina.

Figure 4.--Structure 124009700800 on Route SC 97, crossing Rocky Creek in Chester County, South Carolina as viewed from upstream (July 19, 1990).

Figure 5.--Upstream channel as viewed from structure 124009700800 on Route SC 97, crossing Rocky Creek in Chester County, South Carolina (July 19, 1990).

Figure 6.--Structure 124009700800 on Route SC 97, crossing Rocky Creek in Chester County, South Carolina as viewed from downstream (July 19, 1990).

Figure 7.--Downstream channel as viewed from structure 124009700800 on Route SC 97, crossing Rocky Creek in Chester County, South Carolina (July 19, 1990).

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U.S. Geological Survey, Interagency Advisory Committee on Water Data, 1982, Guidelines for determining flood flow frequency, Bulletin 17B of the Hydrology Subcommittee, 190 p.

SCOUR REPORT SUMMARY

Structure Number 124009700800 *Stream* Rocky Creek

County Chester *Road* SC 97 *District* 4

Description of Bridge

Bridge length 413 *ft* *Bridge width* 31 *ft* *Max span length* 70 *ft*

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

Abutment type vertical *Embankment type* sloping

Riprap on abutment? no *Date of inspection* 7-19-1990

Description of riprap No riprap was placed at the toe of the concrete arch abutments.

Brief description of piers/pile bents Six interior concrete arch piers support the original structure; these interior piers have been widened with two 1.0 ft by 1.0 ft steel H-piles at the downstream end of the bridge.

Is bridge skewed to flood plain according to USGS topo map? yes *Angle* 8

Is bridge located on a bend in channel? no *If so, describe (mild, moderate, severe)* The channel is fairly straight through the bridge but begins a mild bend at approximately 150 ft 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	7-19-1990	0	0
Level II	9-27-1993	----	----

Potential for debris Moderate: High velocities could transport debris from flood plain.

Describe any features near or at the bridge that may affect flow (include observation date). None observed

Description of Flood Plain

General topography Typical Piedmont topography with rolling hills and a relatively narrow flood plain.

Flood-plain conditions at bridge site: downstream (D/S), upstream (U/S)

Date of inspection 9-27-1993

D/S left: Moderately thick hardwoods

D/S right: Moderately thick hardwoods

U/S left: Old clear cut area with potential for rapid growth of the young vegetation

U/S right: Moderately thick hardwoods

Description of Channel

Average top width 104 *ft* *Average depth* 12.9 *ft*

Predominant bed material sand *Bank material* silty sand

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

Vegetative cover on channel banks near bridge: *Date of inspection* 9-27-1993

D/S left: Moderately thick woody vegetation

D/S right: Moderately thick woody vegetation

U/S left: Light woody vegetation

U/S right: Moderately thick woody vegetation

Do banks appear stable? yes *If not, describe location and type of instability and date of observation.* Overall, the banks appear stable with some localized bank failure noted on the downstream left bank at the impact point during the Level I inspection on 7-19-1990.

Describe any obstructions in channel and date of observation. None observed

Hydrology

Drainage area 126 mi^2

Percentage of drainage area in physiographic provinces:

Physiographic province	*Percent of drainage area*
Piedmont (high-flow area)	100

Is drainage area considered rural or urban? rural *Describe any significant urbanization and potential for development.* There is no significant urbanization and little potential for development in the Rocky Creek drainage basin.

Is there a USGS gage on the stream of interest? yes

USGS gage description Rocky Creek at Great Falls, SC

USGS gage number 02147500

Gage drainage area 194 mi^2

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

If so, describe

Calculated Discharges

Q100 16,900 ft^3/s *Q500* 24,400 ft^3/s

Method used to determine discharges Because the basin is in the high-flow region of S.C., the 100- and 500-year discharges were determined by using the N.C rural regression equations and methods described in USGS Bulletin 17B. The rural regression discharges were then weighted with the gage data by methods described on pages 18 through 20 of WRIR 87-4096 (Gunter, Mason, and Stamey, 1987).

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

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

Datum tie between USGS survey and SCDOT plans Add 151.0 ft to the USGS survey to obtain the SCDOT plan's datum (docket number 12.328).

Description of reference marks used to determine USGS datum. RM 1 is a chiseled square on the upstream left headwall of the Route SC 97 bridge with a surveyed elevation of 99.94 ft. RM 2 is a chiseled square on the downstream right headwall of the Route SC 97 bridge with an assumed elevation of 100.00 ft.

Cross Sections Used in WSPRO Analysis

**Cross section ID*	*Section Reference Distance (SRD) in feet*	***How cross section was developed*	*Comments*
EXIT	-413	2	Exit cross section
FULV	0	2	Full valley cross section
BRIDG	0	1	Upstream bridge face
APPR	444	2	Approach cross section

* For location of cross sections see topographic map included with report (figure 1). For more detail on how cross sections were developed see WSPRO input file.

** 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 5) other

Description of data and assumptions used in developing WSPRO model.

Rocky Creek has a relatively uniform flood plain width in the study area, with no downstream natural or man-made contractions of flow that cause significant backwater at the Route SC 97 crossing. Therefore, it was assumed that slope-conveyance methodology would be adequate for estimating the starting water-surface elevation for the water-surface profile computations.

For this study, the WSPRO model requires, as a minimum, an exit section one bridge width downstream of the bridge, a full-valley section at the downstream face of the bridge, the bridge section, and an approach section one bridge width upstream of the bridge. Cross sections at the upstream and downstream faces of the bridge were directly surveyed and the more constricted (upstream) bridge face was used in the WSPRO model. The section reference distance (SRD) at the downstream face of the bridge was set to zero. Surveys of the exit and approach channels (located at 544 ft downstream of the upstream bridge face and 330 ft upstream of the upstream bridge face, respectively) were superimposed on the flood plain survey taken along the upstream toe-of-fill of Route SC 97. These cross sections were shifted by the channel slope to the appropriate SRD to represent the exit, full-valley, and approach cross sections required by the WSPRO model.

Bridge Hydraulics

Average embankment elevation 99.7 *ft*

Average low steel elevation 97.0 *ft*

100-year discharge 16,900 ft^3/s

Water-surface elevation at D/S bridge face 90.71 *ft*

Area of flow at D/S bridge face 4,162 ft^2

Average velocity in bridge opening 4.06 *ft/s*

Maximum WSPRO tube velocity at bridge 6.49 *ft/s*

Water-surface elevation at Approach section with bridge 90.82 *ft*

Water-surface elevation at Approach section without bridge 90.84 *ft*

Amount of backwater caused by bridge 0* *ft*

500-year discharge 24,400 ft^3/s

Water-surface elevation at D/S bridge face 93.73 *ft*

Area of flow at D/S bridge face 5,128 ft^2

Average velocity in bridge opening 4.76 *ft/s*

Maximum WSPRO tube velocity at bridge 7.86 *ft/s*

Water-surface elevation at Approach section with bridge 93.82 *ft*

Water-surface elevation at Approach section without bridge 93.80 *ft*

Amount of backwater caused by bridge 0.02 *ft*

*Backwater for the 100- year discharge is -0.02 ft. Because negative backwater is unlikely, it was set to zero.

Scour

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

Scour depths were computed using engineering judgement and the general guidelines described in Hydraulic Engineering Circular 18 (Richardson and others, 1993) and the Transportation Research Board Draft Paper, "Evaluating scour at bridges using WSPRO" (Arneson and others, 1992). Scour depths were calculated assuming an infinite depth of erosive material and a homogeneous particle-size distribution. The results of the scour analysis are presented in tables 1 through 5 and a graph of the scour depths is shown on figure 2.

The local pier scour was determined using the Colorado State University pier scour equation (Richardson and others, 1993). Bents 5 and 6 are located on the left overbank and were analyzed using the maximum left overbank WSPRO tube velocity and the depth of flow at each bent. Bents 1 and 2 are located on the right overbank and were analyzed using the maximum right overbank WSPRO tube velocity and the depth of flow at each bent. Bents 3 and 4 are located in the channel and were analyzed using 90 percent of the maximum WSPRO tube velocity and the maximum depth within the channel at the bridge. The maximum depth within the channel was used to account for possible changes in the thalweg during a flood event.

The left and right overbanks at the bridge were analyzed for contraction scour using Laursen's clear-water contraction scour equation (Richardson and others, 1993). The channel contraction scour was analyzed using Laursen's modified live-bed contraction scour equation (Richardson and others, 1993).

The live-bed contraction scour equation indicates the deposition of sediment in the channel at the bridge during the 100- and 500-year floods. (See negative scour values determined in scour calculations included at the end of the report). However, it seems unreasonable to expect sediment deposition at the bridge during peak flood conditions. Therefore, the negative scour values were set equal to zero as reflected in tables 1 through 4 and figure 2.

The abutments are not protected by riprap, therefore abutment scour was calculated using the Froehlich (1989) live-bed abutment scour equation.

It should be noted that the SCDOT bridge plan borings (docket number 12.328) show subsurface rock and gravel deposits that could affect the scour depths shown in this study. For more information, see the SCDOT bridge plans in the pocket at the back of the report.

It should also be noted that the old arch piers for the original structure could possibly have footings and/or pile groups. However, there was no information available from the SCDOT for these original substructures.

WSPRO INPUT FILE

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T1          Structure #124009700800                (413 ft. bridge)
T2          Rocky Creek at SC 97              file: rocky.sc97
T3          Chester County, South Carolina      AWC   September 1994
*
*
*
*           Q100       Q500
Q           16900      24400
SK          .0019     .0019
*
*
*
*           Survey data for the EXIT cross section was taken at
*           the U/S toe-of-fill. The channel survey for the EXIT
*           cross section was taken at 544 ft D/S of U/S bridge
*           face and then superimposed onto the toe-of-fill survey
*           of the flood plain. The distance is determined from the
*           Level II survey of 9-27-1993.
*
XT   SURV1   0    .0019
GR             0  103.9   37  102.1   97  94.4   159  90.0   214  86.3
GR           269  82.1   327  83.4   335  80.4   344  73.6   360  72.1
GR           373  71.5   385  71.3   402  71.5   416  72.0   425  77.2
GR           430  83.1   464  83.5   627  87.6   693  89.0   767  95.5
GR           834  104.6
*
XS   EXIT    -413
GT
N           0.15   0.045   0.15
SA              327     430
PX
*
XS   FULV    0
GT
PX
*
*
*           U/S Face of Bridge
*
BR   BRIDG    0  97.0  8
GR            1.9  88.2    2  86.9    25  83.8    53  82.7    82  81.8
GR            109  81.1   138  81.8   155  81.9   170  74.5   193  71.2
GR            199  70.8   206  70.9   210  70.8   215  71.1   232  72.1
GR            240  78.4   258  82.8   278  83.6   302  83.0   331  82.1
GR            348  81.0   360  76.9   365  75.9   375  82.2   386  81.5
GR            398  82.7   411.9  87.1   412  87.2   402  94.1
GR            392  96.6   382  97.0   372  95.8   361  89.5   359  89.5
GR            350  94.0   340  96.5   330  97.2   320  96.5   310  93.5
GR            303  90.0   301  90.0   289  95.0   279  97.0   269  97.5
GR            259  96.5   249  93.8   241  89.5   239  89.5   229  93.0
GR            219  96.0   209  97.0   199  96.9   189  95.9   179  93.0
GR            171  89.5   169  89.5   159  93.9   149  96.5   139  97.2
GR            129  96.9   119  94.5   110  90.0   108  90.0    98  94.0
GR            88  96.5    78  97.2    68  96.2    58  93.5    54  89.5
GR            52  89.5    42  97.0    32  98.0    22  97.5    12  94.5
GR            1.9  88.2
N           0.05   0.045   0.05
SA              155     258
```

```
CD            2  31  2  99.7
PW 1          74.5  3.25   76.9  3.25   76.9  6.5   78.4  6.5   78.4  9.75
PW            81.1  9.75   81.1  13.0   82.7  13.0   82.7  16.25   83.0  16.25
PW            83.0  19.5   89.5  19.5   89.5  6.5   90.0  6.5   90.0  0
PX
*
*
*           Data for the APPROACH cross section was obtained by superimposing
*           a survey of the U/S channel section at 330 ft U/S of the
*           U/S bridge face on the U/S toe-of-fill flood plain survey
*           of 9-28-1993.
*
*
XT   SURV2   0  .0019
GR             0  103.9   37  102.1   97  94.4   159  90.0   214  86.3
GR           269  82.0   296  83.2   322  84.7   330  79.8   338  79.2
GR           342  71.2   347  69.8   358  70.0   364  70.4   372  71.2
GR           374  71.7   394  72.1   415  72.4   428  83.3   443  82.8
GR           460  82.5   474  83.0   499  84.2   627  87.6   693  89.0
GR           767  95.5   834  104.6
*
AS   APPR    444
GT
N            0.15   0.045   0.15
SA               322     428
BP           167
PX
*
*
*
*
HP 1 BRIDG   90.71  0  90.71
HP 2 BRIDG   90.76  0  90.76  16900
HP 1 APPR    90.82  0  90.82
HP 2 APPR    90.82  0  90.82  16900
HP 1 BRIDG   93.73  0  93.73
HP 2 BRIDG   93.79  0  93.79  24400
HP 1 APPR    93.82  0  93.82
HP 2 APPR    93.82  0  93.82  24400
*
EX
ER
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WSPRO OUTPUT

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WSPRO          FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
V042094            MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS

          Structure #124009700800                (413 ft. bridge)
          Rocky Creek at SC 97                file: rocky.sc97
          Chester County, South Carolina       AWC   September 1994
           *** RUN DATE & TIME: 10-04-94  07:40
    CROSS-SECTION PROPERTIES:  ISEQ =  3;  SECID = BRIDG;  SRD =        0.

     WSEL  SA#      AREA          K   TOPW   WETP  ALPH     LEW     REW       QCR
           1        1223     136439    138    169                          20688
           2        1637     304549     87    123                          40303
           3        1302     148114    136    175                          22871
    90.71           4162     589102    361    466  1.20       2     412     73265


WSPRO          FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
V042094            MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS

          Structure #124009700800                (413 ft. bridge)
          Rocky Creek at SC 97                file: rocky.sc97
          Chester County, South Carolina       AWC   September 1994
           *** RUN DATE & TIME: 10-04-94  07:40


    VELOCITY DISTRIBUTION:  ISEQ =  3;  SECID = BRIDG;  SRD =        0.

        WSEL      LEW      REW     AREA        K         Q     VEL
       90.76      1.9    412.0   4180.1   591613.    16900.    4.04

X STA.          1.9       52.8       83.8      112.3      137.7      162.0
  A(I)            322.7      259.6      261.5      233.8      226.2
  V(I)             2.62       3.26       3.23       3.61       3.74

X STA.        162.0      176.4      184.7      191.9      198.7      205.3
  A(I)            212.9      145.2      136.0      133.0      130.2
  V(I)             3.97       5.82       6.21       6.35       6.49

X STA.        205.3      212.0      218.8      226.1      234.6      259.6
  A(I)            130.8      133.2      139.2      154.6      265.0
  V(I)             6.46       6.34       6.07       5.46       3.19

X STA.        259.6      294.4      329.3      353.6      373.3      412.0
  A(I)            256.7      275.7      229.1      247.0      287.7
  V(I)             3.29       3.06       3.69       3.42       2.94
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WSPRO OUTPUT --Continued

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WSPRO          FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
V042094            MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS

          Structure #124009700800              (413 ft. bridge)
          Rocky Creek at SC 97              file: rocky.sc97
          Chester County, South Carolina       AWC   September 1994
           *** RUN DATE & TIME: 10-04-94  07:40
    CROSS-SECTION PROPERTIES:  ISEQ =  4;  SECID = APPR ;  SRD =     444.

     WSEL  SA#      AREA         K   TOPW   WETP  ALPH    LEW    REW      QCR
             1       777     21849    163    163                        9632
             2      1723    343655    106    117                       39436
             3      1127     28576    276    276                       12918
    90.82           3627    394080    545    556  2.94    159    704    30949


WSPRO          FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
V042094            MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS

          Structure #124009700800              (413 ft. bridge)
          Rocky Creek at SC 97              file: rocky.sc97
          Chester County, South Carolina       AWC   September 1994
           *** RUN DATE & TIME: 10-04-94  07:40


    VELOCITY DISTRIBUTION:  ISEQ =  4;  SECID = APPR ;  SRD =     444.

         WSEL     LEW     REW    AREA         K        Q    VEL
        90.82   159.4   704.1  3627.1  394080.   16900.   4.66

X STA.      159.4      309.3      336.9      345.5      350.2      354.7
  A(I)          704.9      206.2      137.4       95.2       89.5
  V(I)           1.20       4.10       6.15       8.88       9.44

X STA.      354.7      359.1      363.5      368.0      372.5      377.4
  A(I)           88.7       87.5       86.1       86.4       88.9
  V(I)           9.52       9.66       9.81       9.78       9.50

X STA.      377.4      382.2      387.1      392.0      397.1      402.2
  A(I)           87.9       87.5       88.0       90.5       91.3
  V(I)           9.61       9.66       9.60       9.33       9.26

X STA.      402.2      407.3      412.7      419.6      466.7      704.1
  A(I)           91.1       94.9      112.8      363.3      848.9
  V(I)           9.27       8.90       7.49       2.33       1.00
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WSPRO OUTPUT --Continued

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WSPRO          FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
V042094            MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS

          Structure #124009700800              (413 ft. bridge)
          Rocky Creek at SC 97              file: rocky.sc97
          Chester County, South Carolina       AWC   September 1994
           *** RUN DATE & TIME: 10-04-94  07:40
    CROSS-SECTION PROPERTIES:  ISEQ =  3;  SECID = BRIDG;  SRD =        0.

     WSEL  SA#      AREA          K   TOPW   WETP  ALPH     LEW     REW       QCR
             1      1601     191443    112    199                          34368
             2      1857     322909     58    154                          59625
             3      1669     199780    107    207                          37427
    93.73           5127     714132    277    561  1.11       2     412    118912
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WSPRO          FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
V042094            MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS

          Structure #124009700800              (413 ft. bridge)
          Rocky Creek at SC 97              file: rocky.sc97
          Chester County, South Carolina       AWC   September 1994
           *** RUN DATE & TIME: 10-04-94  07:40


    VELOCITY DISTRIBUTION:  ISEQ =  3;  SECID = BRIDG;  SRD =        0.

        WSEL      LEW      REW      AREA         K         Q      VEL
       93.79      1.9    412.0    5143.7   715845.    24400.    4.74

X STA.          1.9       41.6       74.9       95.8      126.6      147.5
  A(I)        338.0      340.2      249.7      341.8      249.7
  V(I)         3.61       3.59       4.89       3.57       4.89

X STA.        147.5      169.2      183.5      191.3      198.3      205.3
  A(I)        283.2      256.3      169.7      157.6      159.3
  V(I)         4:31       4.76       7.19       7.74       7.66

X STA.        205.3      212.2      219.5      227.7      250.7      272.8
  A(I)        155.3      163.2      179.7      338.2      243.1
  V(I)         7.86       7.47       6.79       3.61       5.02

X STA.        272.8      312.0      334.1      355.2      378.1      412.0
  A(I)        371.3      250.9      263.7      307.9      325.0
  V(I)         3.29       4.86       4.63       3.96       3.75
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WSPRO OUTPUT --Continued

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WSPRO          FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
V042094            MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS

          Structure #124009700800              (413 ft. bridge)
          Rocky Creek at SC 97              file: rocky.sc97
          Chester County, South Carolina       AWC   September 1994
           *** RUN DATE & TIME: 10-04-94  07:40
    CROSS-SECTION PROPERTIES:  ISEQ =  4;  SECID = APPR ;  SRD =      444.

     WSEL  SA#      AREA          K   TOPW   WETP  ALPH     LEW     REW       QCR
             1      1328      45790    205    205                          19186
             2      2041     455708    106    117                          50839
             3      2006      69138    310    311                          28954
    93.82            5376     570637    621    633  3.55     117     738     47610


WSPRO          FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
V042094            MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS

          Structure #124009700800              (413 ft. bridge)
          Rocky Creek at SC 97              file: rocky.sc97
          Chester County, South Carolina       AWC   September 1994
           *** RUN DATE & TIME: 10-04-94  07:40


    VELOCITY DISTRIBUTION:  ISEQ =  4;  SECID = APPR ;  SRD =      444.

         WSEL     LEW     REW    AREA        K        Q    VEL
        93.82   117.1   738.3  5376.1  570637.    24400.   4.54

X STA.       117.1      278.5      329.8      342.2      347.9      353.1
  A(I)           915.9      495.2      186.0      128.9      119.5
  V(I)            1.33       2.46       6.56       9.47      10.21

X STA.       353.1      358.1      363.1      368.1      373.3      378.7
  A(I)           115.2      113.8      112.2      114.4      114.5
  V(I)           10.59      10.72      10.88      10.67      10.65

X STA.       378.7      384.1      389.6      395.1      400.7      406.5
  A(I)           115.3      114.7      115.4      116.4      119.3
  V(I)           10.58      10.64      10.57      10.48      10.23

X STA.       406.5      412.4      419.8      454.9      536.0      738.3
  A(I)           122.4      142.4      379.3      737.5      997.9
  V(I)            9.97       8.56       3.22       1.65       1.22
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WSPRO OUTPUT --Continued

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WSPRO          FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
V042094            MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS

          Structure #124009700800              (413 ft. bridge)
          Rocky Creek at SC 97              file: rocky.sc97
          Chester County, South Carolina       AWC   September 1994
           *** RUN DATE & TIME: 10-04-94  07:40

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

EXIT :XS    ******     160      3544  1.06  *****    90.20    82.58    16900    89.13
      -412  ******     703    387380  3.01  *****  *******     0.57     4.77

FULV :FV       413     160      3556  1.06   0.78    91.00  *******    16900    89.94
         0     413     704    388606  3.01   0.00     0.02     0.57     4.75
        <<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>

APPR :AS       444     159      3637  0.99   0.83    91.83  *******    16900    90.84
       444     444     704    395057  2.95   0.00     0.00     0.54     4.65
        <<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>

          <<<<<RESULTS REFLECTING THE CONSTRICTED FLOW FOLLOW>>>>>

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

BRIDG:BR       413       2      4162  0.26   0.77    90.97    84.79    16900    90.71
         0     413     412    589026  1.02   0.00     0.00     0.21     4.06

     TYPE PPCD FLOW      C     P/A     LSEL   BLEN   XLAB   XRAB
       2.   1.   1.  0.992   0.048    97.00 ****** ****** ******

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

APPR :AS       413     159      3630  0.99   0.79    91.82    83.82    16900    90.82
       444     432     704    394321  2.95   0.05     0.00     0.55     4.66

       M(G)    M(K)       KQ    XLKQ    XRKQ    OTEL
      0.248   0.000  394682.    174.    584.    90.07
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WSPRO OUTPUT --Continued

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WSPRO          FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
V042094            MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS

          Structure #124009700800              (413 ft. bridge)
          Rocky Creek at SC 97              file: rocky.sc97
          Chester County, South Carolina       AWC   September 1994
           *** RUN DATE & TIME: 10-04-94  07:40

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

EXIT :XS    ******      118       5263    1.22  *****    93.32     85.76    24400     92.09
      -412  ******      737     559572    3.65  *****  *******      0.54     4.64

FULV :FV       413      118       5277    1.22   0.78    94.12  *******    24400     92.90
         0     413      737     561070    3.66   0.00     0.02      0.53     4.62
        <<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>

APPR :AS       444      117       5366    1.14   0.83    94.95  *******    24400     93.80
       444     444      738     569569    3.55   0.00     0.00      0.51     4.55
        <<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>

           <<<<<RESULTS REFLECTING THE CONSTRICTED FLOW FOLLOW>>>>>

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

BRIDG:BR       413        2       5128    0.36   0.78    94.10     86.16    24400     93.73
         0     413      412     714266    1.03   0.00     0.00      0.24     4.76

     TYPE PPCD FLOW       C      P/A     LSEL    BLEN    XLAB    XRAB
       2.    1.    1.  0.984    0.039    97.00  ******  ******  ******

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

APPR :AS       413      117       5373    1.14   0.79    94.95     87.15    24400     93.82
       444     426      738     570344    3.55   0.06     0.00      0.51     4.54

        M(G)    M(K)        KQ    XLKQ    XRKQ     OTEL
       0.339   0.016   561255.    175.    585.     93.06
```

PIER SCOUR COMPUTATIONS
FOR
ROCKY CREEK AT SC 97 IN CHESTER COUNTY (413 FT BRIDGE)
Q100 = 16,900 CFS AWC 10-4-1994

HYDRAULIC VARIABLES USED IN CSU EQUATION

PIER NUMBER	6	5	4	3	2	1
PIER STATION (FT)	53	109	170	240	302	360
LOCATION OF PIER	LFP	LFP	MCL	MCR	RFP	RFP
Y1: DEPTH (FT)	8.0	9.7	20.0	20.0	7.8	13.9
V1: VEL. (FPS)	3.7	3.7	5.8	5.8	3.7	3.7
a: PIER WIDTH (FT)	3.3	3.3	3.3	3.3	3.3	3.3
L: PIER LENGTH (FT)	22.0	22.0	22.0	22.0	22.0	22.0
PIER SHAPE	1	1	1	1	1	1
ATTACK ANGLE	8	8	8	8	8	8
K1 (SHAPE COEF.)	1.00	1.00	1.00	1.00	1.00	1.00
K2 (ANGLE COEF.)	1.45	1.45	1.45	1.45	1.45	1.45
FROUDE NO.	0.23	0.21	0.23	0.23	0.23	0.17

COMPUTED SCOUR DEPTHS USING CSU EQUATION

SCOUR DEPTH (FT)	6.91	7.09	9.47	9.47	6.84	7.40
MAX SCOUR DEPTH (FT)	7.61	7.80	10.42	10.42	7.53	8.14

"MAX SCOUR DEPTH" includes an additional 10 percent of the computed CSU scour depth as recommended in HEC 18

CONTRACTION SCOUR COMPUTATIONS
FOR
ROCKY CREEK AT SC 97 IN CHESTER COUNTY (413 FT BRIDGE)
Q100 = 16,900 CFS AWC 10-4-1994

==========

LIVE-BED SCOUR COMPUTATIONS

	MAIN CHANNEL	CONTRACTED SECTION
DISCHARGE (CFS)	14738.	8737.
BOTTOM WIDTH (FT)	106.0	95.5
MANNINGS n	0.045	0.045
AVERAGE DEPTH (FT)	19.9	

ENERGY SLOPE	0.00200
D50 (FT)	0.0046
FALL VELOCITY (FPS)	0.65
K1 COEF.	0.64
K2 COEF.	0.21

COMPUTED DEPTH AT CONTRACTED SECTION (FT)	=	13.6
DEPTH AT MAIN CHANNEL (FT)	=	19.9
DEPTH OF CONTRACTION SCOUR (FT)	=	-6.3

LEFT OVERBANK IN BRIDGE OPENING
CLEAR-WATER CONTRACTION SCOUR COMPUTATIONS

DISCHARGE IN CONTRACTED SECTION (CFS)	=	3914.
WIDTH OF CONTRACTED SECTION (FT)	=	152.0
MEDIAN GRAIN SIZE (FT)	=	0.0013
COMPUTED DEPTH OF CONTRACTED SECTION (FT)	=	13.9
AVERAGE FLOOD PLAIN DEPTH (FT)	=	7.8
DEPTH OF CONTRACTION SCOUR (FT)	=	6.0

RIGHT OVERBANK IN BRIDGE OPENING
CLEAR-WATER CONTRACTION SCOUR COMPUTATIONS

DISCHARGE IN CONTRACTED SECTION (CFS)	=	4249.
WIDTH OF CONTRACTED SECTION (FT)	=	152.0
MEDIAN GRAIN SIZE (FT)	=	0.0013
COMPUTED DEPTH OF CONTRACTED SECTION (FT)	=	14.9
AVERAGE FLOOD PLAIN DEPTH (FT)	=	7.8
DEPTH OF CONTRACTION SCOUR (FT)	=	7.0

ABUTMENT SCOUR COMPUTATIONS
FOR
ROCKY CREEK AT SC 97 IN CHESTER COUNTY (413 FT BRIDGE)
Q100 = 16,900 CFS AWC 10-4-1994

==========

LEFT ABUTMENT
SCOUR COMPUTATIONS

ABUTMENT TYPE	1 -VERTICAL WALL
DISCHARGE BLOCKED BY ABUTMENT (CFS)	60.
AREA BLOCKED BY ABUTMENT (SQ FT)	50.0
DEPTH OF FLOW AT ABUTMENT (FT)	3.9
LENGTH OF ABUT. 90 DEG. TO FLOW (FT)	11.0
ABUTMENT SKEW (DEG)	-8
AJUSTED ABUTMENT LENGTH (FT)	13.0
AVERAGE F/P VELOCITY U/S OF ABUT. (FPS)	1.2
FROUDE NUMBER	0.108
K1 COEF.	1.0
K2 COEF.	1.0

DESIGN DEPTH OF SCOUR (FROELICH EQUATION, 1989) (FT) = 7.6

RIGHT ABUTMENT
SCOUR COMPUTATIONS

ABUTMENT TYPE	1 -VERTICAL WALL
DISCHARGE BLOCKED BY ABUTMENT (CFS)	442.
AREA BLOCKED BY ABUTMENT (SQ FT)	444.0
DEPTH OF FLOW AT ABUTMENT (FT)	3.7
LENGTH OF ABUT. 90 DEG. TO FLOW (FT)	124.0
ABUTMENT SKEW (DEG)	8
AJUSTED ABUTMENT LENGTH (FT)	121.3
AVERAGE F/P VELOCITY U/S OF ABUT. (FPS)	1.0
FROUDE NUMBER	0.092
K1 COEF.	1.0
K2 COEF.	1.0

DESIGN DEPTH OF SCOUR (FROELICH EQUATION, 1989) (FT) = 12.5

PIER SCOUR COMPUTATIONS
FOR
ROCKY CREEK AT SC 97 IN CHESTER COUNTY (413 FT BRIDGE)
Q500 = 24,400 CFS AWC 10-4-1994

HYDRAULIC VARIABLES USED IN CSU EQUATION

PIER NUMBER	6	5	4	3	2	1
PIER STATION (FT)	53	109	170	240	302	360
LOCATION OF PIER	LFP	LFP	MCL	MCR	RFP	RFP
Y1: DEPTH (FT)	11.1	12.7	23.0	23.0	10.8	16.9
V1: VEL. (FPS)	4.9	4.9	7.1	7.1	5.0	5.0
a: PIER WIDTH (FT)	3.3	3.3	3.3	3.3	3.3	3.3
L: PIER LENGTH (FT)	22.0	22.0	22.0	22.0	22.0	22.0
PIER SHAPE	1	1	1	1	1	1
ATTACK ANGLE	8	8	8	8	8	8
K1 (SHAPE COEF.)	1.00	1.00	1.00	1.00	1.00	1.00
K2 (ANGLE COEF.)	1.45	1.45	1.45	1.45	1.45	1.45
FROUDE NO.	0.26	0.24	0.26	0.26	0.27	0.22

COMPUTED SCOUR DEPTHS USING CSU EQUATION

SCOUR DEPTH (FT)	8.11	8.25	10.48	10.48	8.17	8.68
MAX SCOUR DEPTH (FT)	8.92	9.08	11.53	11.53	8.98	9.54

"MAX SCOUR DEPTH" includes an additional 10 percent of the computed CSU scour depth as recommended in HEC 18

CONTRACTION SCOUR COMPUTATIONS
FOR
ROCKY CREEK AT SC 97 IN CHESTER COUNTY (413 FT BRIDGE)
Q500 = 24,400 CFS AWC 10-4-1994

LIVE-BED SCOUR COMPUTATIONS

	MAIN CHANNEL	CONTRACTED SECTION
DISCHARGE (CFS)	19486.	11033.
BOTTOM WIDTH (FT)	106.0	95.5
MANNINGS n	0.045	0.045
AVERAGE DEPTH (FT)	22.9	

ENERGY SLOPE	0.00200
D50 (FT)	0.0046
FALL VELOCITY (FPS)	0.65
K1 COEF.	0.64
K2 COEF.	0.21

COMPUTED DEPTH AT CONTRACTED SECTION (FT)	=	15.1
DEPTH AT MAIN CHANNEL (FT)	=	22.9
DEPTH OF CONTRACTION SCOUR (FT)	=	-7.9

LEFT OVERBANK IN BRIDGE OPENING
CLEAR-WATER CONTRACTION SCOUR COMPUTATIONS

DISCHARGE IN CONTRACTED SECTION (CFS)	=	6541.
WIDTH OF CONTRACTED SECTION (FT)	=	152.0
MEDIAN GRAIN SIZE (FT)	=	0.0013
COMPUTED DEPTH OF CONTRACTED SECTION (FT)	=	21.5
AVERAGE FLOOD PLAIN DEPTH (FT)	=	10.8
DEPTH OF CONTRACTION SCOUR (FT)	=	10.7

RIGHT OVERBANK IN BRIDGE OPENING
CLEAR-WATER CONTRACTION SCOUR COMPUTATIONS

DISCHARGE IN CONTRACTED SECTION (CFS)	=	6826.
WIDTH OF CONTRACTED SECTION (FT)	=	152.0
MEDIAN GRAIN SIZE (FT)	=	0.0013
COMPUTED DEPTH OF CONTRACTED SECTION (FT)	=	22.3
AVERAGE FLOOD PLAIN DEPTH (FT)	=	10.8
DEPTH OF CONTRACTION SCOUR (FT)	=	11.5

ABUTMENT SCOUR COMPUTATIONS
FOR
ROCKY CREEK AT SC 97 IN CHESTER COUNTY (413 FT BRIDGE)
Q500 = 24,400 CFS AWC 10-4-1994

==========

LEFT ABUTMENT
SCOUR COMPUTATIONS

ABUTMENT TYPE	1 -VERTICAL WALL
DISCHARGE BLOCKED BY ABUTMENT (CFS)	400.
AREA BLOCKED BY ABUTMENT (SQ FT)	300.0
DEPTH OF FLOW AT ABUTMENT (FT)	6.9
LENGTH OF ABUT. 90 DEG. TO FLOW (FT)	53.0
ABUTMENT SKEW (DEG)	-8
AJUSTED ABUTMENT LENGTH (FT)	43.5
AVERAGE F/P VELOCITY U/S OF ABUT. (FPS)	1.3
FROUDE NUMBER	0.090
K1 COEF.	1.0
K2 COEF.	1.0

DESIGN DEPTH OF SCOUR (FROELICH EQUATION, 1989) (FT) = 14.7

RIGHT ABUTMENT
SCOUR COMPUTATIONS

ABUTMENT TYPE	1 -VERTICAL WALL
DISCHARGE BLOCKED BY ABUTMENT (CFS)	955.
AREA BLOCKED BY ABUTMENT (SQ FT)	781.0
DEPTH OF FLOW AT ABUTMENT (FT)	6.7
LENGTH OF ABUT. 90 DEG. TO FLOW (FT)	158.0
ABUTMENT SKEW (DEG)	8
AJUSTED ABUTMENT LENGTH (FT)	116.7
AVERAGE F/P VELOCITY U/S OF ABUT. (FPS)	1.2
FROUDE NUMBER	0.083
K1 COEF.	1.0
K2 COEF.	1.0

DESIGN DEPTH OF SCOUR (FROELICH EQUATION, 1989) (FT) = 18.2

United States Department of the Interior

GEOLOGICAL SURVEY
Water Resources Division
Stephenson Center, Suite 129
720 Gracern Road
Columbia, SC 29210-7651

October 12, 1994

William H. Hulbert, P.E.
Hydraulic Engineer
South Carolina Department of Transportation
955 Park Street
Columbia, South Carolina 29202

Dear Mr. Hulbert:

We are pleased to transmit to you another report of the Level II Bridge Scour Program titled, "Level II bridge scour analysis for structure 124009700800 on Route SC 97, crossing Rocky Creek in Chester County, South Carolina," by Andy W. Caldwell and Michael G. Zalants. The technical aspects have been reviewed by the South Carolina District Surface-Water Specialist and the report has been approved by the South Carolina Bridge Scour Project Chief.

If you have any questions concerning this report please contact me (750-6101) or Michael G. Zalants (750-6159) and we will be glad to assist you.

Sincerely,

Andy W. Caldwell
Civil Engineer

Enclosure

OCT 1994
RECEIVED
HYDRAULICS

23 1240097008

INDEX OF SHEETS

Sheet No.	Title
1	Title Sheet
2	General Details
3	Details
4	Curb & Gutter
5	Concrete Slope Drains
6	Plans & Profile
7	Plans & Profile
8	Plans & Profile
9	Abutments
10	Bridge
11	Int. Spans
12	Int. Spans
13	Int. Spans
14	Int. Spans
15	Int. Spans

SOUTH CAROLINA
STATE HIGHWAY DEPARTMENT
COLUMBIA

PLAN AND PROFILE OF PROPOSED
STATE HIGHWAY

FEDERAL AID PROJECT NO. F-337(2)
S. C. DOCKET NO. 12328
ROUTE NO. 97
CHESTER COUNTY
WIDENING BRIDGE OVER ROCKY CREEK

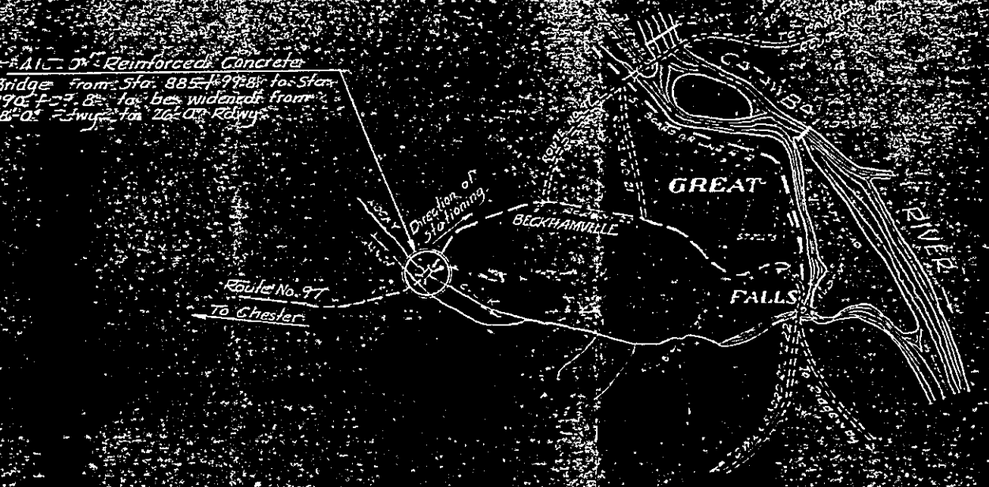
Chester F-337(2) 97

SUMMARY OF ESTIMATED QUANTITIES

Welfare Bridge Excavation	Lump	
Class "A" Concrete	174.5 C.Y.	
Reinforcing Steel	35,885	Lbs.
Steel Superstructure, Including Painting	Necessary	Lbs.
Steel H-Piles (10x42#)	420	Lin. Ft.
Steel H-Piles (12x53#)	410	Lin. Ft.
Waterproofing (2 Mopings Without Protection Course)	241	S.Y.

*Approx. 20% Extra

All of Reinforced Concrete Bridge from Sta. 885+19.98 to Sta. 897+1.37 to be widened from 18'-0" Hwy. to 28'-0" Rdwy.



	0.000 Mi.
	0.077 Mi.
	0.077 Mi.
	0.000 Mi.
	0.077 Mi.

LEGEND
PROPOSED PROJECT
OTHER ROADS

CONVENTIONAL SIGNS
Trolley Poles
Power Poles
Telephone or Telegraph Poles
Mailbox
Trees
Brush
Stumps
Buildings
Bridge
Concrete Box Culvert
Pipe Culvert
Drop Inlet and Culvert
Hub on Center Line

NOTICE

THESE PLANS ARE SUBJECT TO CHANGE WITHOUT NOTICE. OFFICIAL BIDDERS' PLANS ARE ON FILE AT THE OFFICES OF THE S. C. STATE HIGHWAY DEPARTMENT IN COLUMBIA.

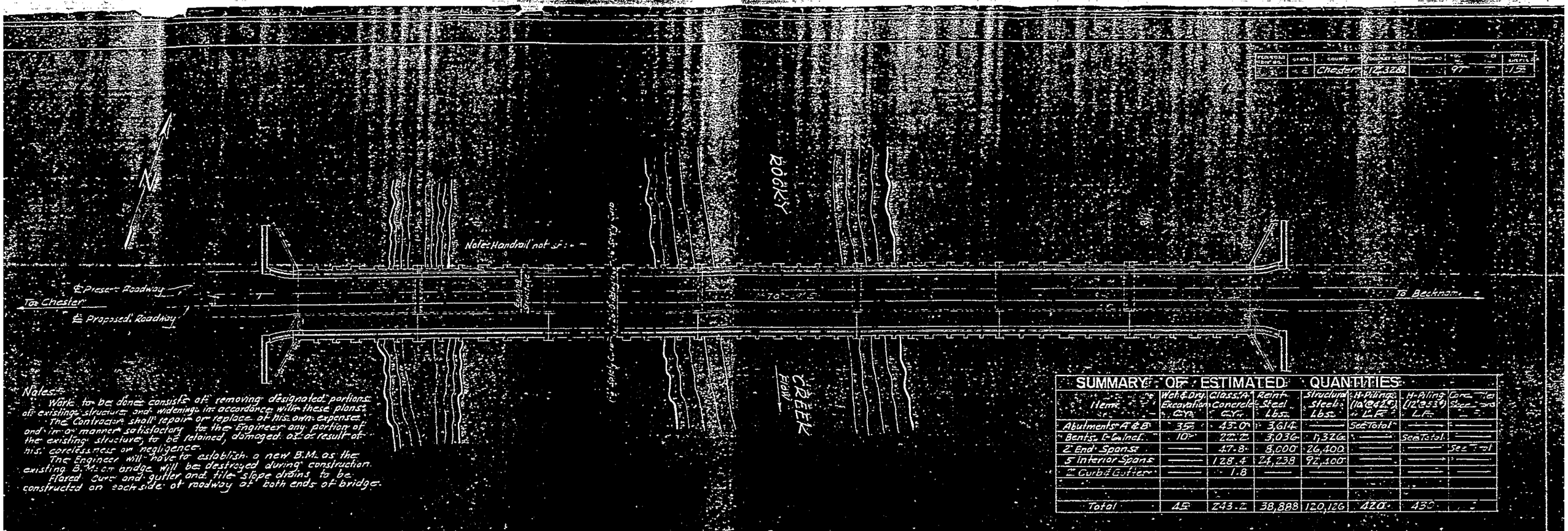
S. C. STATE HIGHWAY DEPARTMENT

APPROVED
S. D. Latimer 4/24/57
STATE HIGHWAY ENGINEER DATE

DEPARTMENT OF COMMERCE
BUREAU OF PUBLIC ROADS
RECOMMENDED FOR APPROVAL
DISTRICT ENGINEER DATE
APPROVED
DIVISION ENGINEER DATE

23 1240097.0080

PROJECT NO.	STATE	COUNTY	ROAD NO.	PROJECT NO.	SHEET NO.	TOTAL SHEETS
	S.C.	Chester	12,328		97	13



Notes:
Work to be done consists of removing designated portions of existing structure and widening in accordance with these plans.
The Contractor shall repair or replace at his own expense and in a manner satisfactory to the Engineer any portion of the existing structures, to be retained, damaged as a result of his carelessness or negligence.
The Engineer will have to establish a new B.M. as the existing B.M. on bridge will be destroyed during construction.
Paved curb and gutter and tile slope drains to be constructed on each side of roadway at both ends of bridge.

SUMMARY OF ESTIMATED QUANTITIES

Item	Wet & Dry Excavation C.Y.	Class A Concrete C.Y.	Reinf. Steel Lbs.	Structural Steel Lbs.	H-Pilings (10"@42.0 lb) L.F.	H-Piling (12"@53.0 lb) L.F.	Core Tile Slope Drains
Abutments A & B	35	43.0	3,614		See Total		
Bents 1 & 2 incl.	10	22.2	3,036	1,326		See Total	
2 End Spans		47.8	8,000	26,400			See Total
5 Interior Spans		128.4	24,238	92,400			
2 Curb & Gutter		1.8					
Total	45	243.2	38,888	120,126	420	430	

410.0'-c to c of Bridge (measured along existing Rdwy)
70.0'
61.8'
56.2'
51.7'
51.3'
56.3'
℄ Bent No. 1 Sta. 884+61.1
℄ Bent No. 2 Sta. 884+40.7
℄ Abt. No. 3 Sta. 883+98.9
Beg. Br. Sta. 883+98.8
End Br. Sta. 887+07.7
Rg. El. on new ℄ = 250.66
0.00% Grade
H.W. El. 245.5 ± 0.5
Water Level 10-13-53
B.M. #3 - N.W. Corner of guard rail on bridge @ ℄ Sta. 886+00. El. 252.81 (From N.C.H.S. Proj. No. 337-A)
B.M. #2 - Nail in side of 12" 30° Lt. Sta. 892 from ℄ El. 255.
Drive 10" steel H-Piling
Prolile 15' Lt. ℄ of present rdwy.
Prolile 15' Rt. ℄ of present rdwy.

S. C. STATE HIGHWAY DEPARTMENT
COLUMBIA
BRIDGE PLAN & PROFILE
FOR BRIDGE OVER
ROCKY CREEK

Book 1 Pages 1-4

PILE RECORD ON DOCKET NO. 12328

WEIGHT OF HAMMER 3300 FALL 15' TYPE Gravity

BENT NO.	FOOTING	PILE NO.	DATE DRIVEN	DIAMETER BUTT	DIAMETER TIP	PENETRATION	PEN. PER BLOW	BEARING	ELEVATION PILE TIP	ELEVATION CUT-OFF	LENGTH IN PLACE	ORIGINAL LENGTH	LENGTH CUT-OFF	PAY LENGTH	C.O. AT 0.40 OF UNIT PRICE	C.O. AT 0.25 OF UNIT PRICE
6		1V	8-10-54	Shell H-Pile	Virgin @53	19.35	0.250'	39.60	218.15	245.529	32.38	40.00	7.62'	32.38		
6		2V	8-10-54	...	...	22.42	0.250'	39.60	210.58	245.529	34.95	40.00	5.05'	34.95		
Abutment B Rt. Side		3V	8-10-54	...	...	12.89	0.625'	30.46	222.71	248.956	26.25	30.00	3.75'	26.25		
		#2	8-10-54	...	...	13.09	0.625'	30.46	221.91	248.956	27.05	30.00	2.95'	27.05		
		1	8-10-54	Shell H-Pile	Virgin @53	13.71	0.625'	30.46	221.89	246.039	24.15	30.20	5.85'	24.15		
		2	8-10-54	...	...	12.22	0.500'	33.00	222.88	246.039	23.16	30.00	6.84'	23.16		
		#3	8-10-54	...	...	13.83	0.500'	33.00	221.17	246.75	24.30	30.00	5.70'	24.30		
		#4	8-10-54	...	...	12.89	0.500'	33.00	222.61	248.014	19.60	30.00	10.40'	19.60		
Abutment B Lt. Side		1	8-11-54	...	...	11.82	0.625'	30.46	221.70	240.852	19.15	30.00	10.85'	19.15		
Roof																
5		1V	8-11-54	Shell H-Pile	Virgin @53	22.18	0.250'	39.60	208.42	245529	37.11	40.31	3.20'	37.11		
		2V				25.27	0.250'	39.60	205.53	245529	40.00	40.00	00.00'	40.00		
4		1V				21.00	0.125'	44.00'	207.30	245518	38.22	40.37	1.15'	38.22		
		2V				20.24	0.250'	39.60'	208.28	245518	37.28	40.33	3.05'	37.28		
3		1V				19.76	0.125'	44.00	211.18	245518	34.38	35.00	0.62'	34.38		
		2V				17.89	0.250'	39.60	212.52	245518	33.00	35.00	2.00'	33.00		
2		1V				13.67	0.250'	39.60	220.03	245529	25.50	30.00	4.50'	25.50		
		2V				17.47	0.250'	39.60	216.73	245529	28.80	30.00	1.20'	28.80		
1		#5	8-12-54	...	...	3.52	0.250'	39.60	220.38	245.529	25.15	30.00	4.85'	25.15		
		#2V	...	...	...	9.72	0.250'	39.60	215.31	245.529	29.35	30.00	0.65'	29.35		
Abutment A Rt. Side		#1	8-12-54	Shell H-Pile	Virgin @53	18.86	0.625'	30.46	220.18	246.039	25.30	30.00	4.70'	25.20		
		2	...	...	...	18.96	0.625'	30.46	221.34	246.039	24.10	30.00	5.90'	24.10		
		#3	8-12-54	Shell H-Pile	Virgin @53	19.50	0.625'	30.46	222.51	248.956	26.45	30.00	3.55'	26.45		
		#2	...	...	...	18.50	0.625'	30.46	222.51	248.956	26.45	30.00	3.55'	26.45		
		#3	8-12-54	Shell H-Pile	Virgin @53	13.43	0.500'	33.00	221.47	246.175	23.70	30.00	6.30'	23.70		
		#4	8-12-54	...	...	12.49	0.625'	30.46	224.11	248.014	17.90	30.00	12.10'	17.90		
Abutment A Lt. Side		1	8-13-54	...	...	10.57	0.625'	30.46	222.25	240.852	17.90	30.00	12.10'	17.90		
					Totals	H-Piling	10" @ 42 Lbs.				218.96	300.00	80.60	218.96		
					Totals	H-Piling	12" @ 53 Lbs.				502.52	551.01	48.49	502.52		

(28) This pile was driven to refusal on Solid Rock. Cut-off Level.

TOTAL

NOTES CONCERNING ANY UNUSUAL FOUNDATION CONDITIONS

BENT NO.	FOOTINGS	PILE NO.	REMARKS

Driven Piles are shown on Drawing No. 30-4-53 Sheet No. 1 of 1 Sheets. Piles are 20-Penetration Piles.

TOTAL

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

GREAT FALLS QUADRANGLE
SOUTH CAROLINA
7.5 MINUTE SERIES (TOPOGRAPHIC)

STUDY AREA

APPR --->

EXIT --->

Mapped, edited, and published by the Geological Survey

Control by USGS, USC&GS, and South Carolina Geodetic Survey

Topography by photogrammetric methods from aerial photographs taken 1964. Field checked 1969

Polyconic projection. 1927 North American datum
10,000-foot grid based on South Carolina coordinate system, north zone
1000-meter Universal Transverse Mercator grid ticks,
zone 17, shown in blue

Fine red dashed lines indicate selected fence and field lines where generally visible on aerial photographs. This information is unchecked

UTM GRID AND 1969 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

SCALE 1:24 000

CONTOUR INTERVAL 10 FEET
DATUM IS MEAN SEA LEVEL

EXPLANATION

EXIT cross section

S.C.
QUADRANGLE LOCATION

ROAD CLASSIFICATION

Primary highway, all weather, hard surface
Secondary highway, all weather, hard surface
Light-duty road, all weather, improved surface
Unimproved road, fair or dry weather
U. S. Route
State Route

INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D. C.—1971

GREAT FALLS, S. C.
N3430—W8052.5/7.5

1969

AMS 4853 III SW—SERIES V846

Figure 1.--Topography of study area and location of cross sections used in WSPRO analysis for structure 124009700800 on Route SC 97, crossing Rocky Creek in Chester County, South Carolina.