U.S. DEPARTMENT OF THE INTERIOR

U.S. GEOLOGICAL SURVEY

LEVEL II BRIDGE SCOUR ANALYSIS FOR STRUCTURE 134000900400 ON ROUTE SC 9, CROSSING THOMPSON CREEK IN CHESTERFIELD COUNTY, SOUTH CAROLINA

By J. Mike Sullivan and Stephen T. Benedict

Prepared in cooperation with the
SOUTH CAROLINA DEPARTMENT
OF TRANSPORTATION

Columbia, South Carolina

1994

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}
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 134000900400 on Route SC 9, crossing Thompson Creek in Chesterfield County, South Carolina

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This report provides the results of the detailed Level II analysis of scour potential at structure 134000900400 on Route SC 9, crossing Thompson Creek in Chesterfield County, South Carolina (figure 1 in pocket; figures 4-9). The site is located in the upper Coastal Plain, near the town of Chesterfield, in the northeastern part of Chesterfield County. The drainage area for the site is 148 mi^2, and is a predominately rural drainage basin with little development in recent years. Approximately 17 percent of the basin falls within the upper Coastal Plain, 47 percent within the South Carolina Piedmont and 36 percent within the North Carolina Piedmont physiographic provinces. In the vicinity of the study site, the land is covered by moderately thick hardwoods on the right floodplain and row crops on the left floodplain with some woods near the channel.

In the study area, Thompson Creek has a meandering channel with a slope of approximately 0.0008 ft/ft (4.2 ft/mi), an average channel top width of 75 ft and an average channel depth of 11 ft. The predominant channel bed material is sand (D_{50} is 1.5 mm) and the channel banks consist of a silty clayey sand (D_{50} is 0.25 mm). In general, the banks were noted to have moderate woody vegetative cover with roots exposed by heavy fluvial erosion and some mass wasting at impact points at the time of the Level I and Level II site visits, September 4, 1990 and September 8, 1992, respectively.

The Route SC 9 crossing of Thompson Creek is a 500-ft-long, two-lane bridge consisting of twenty 25-ft concrete spans, supported by concrete bents with spillthrough abutments. The left abutment is protected by riprap but the right abutment was noted having heavy erosion during the Level I site visit. 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 presented in figure 2.

Table 1. *--Remaining pile/footing penetration at piers/bents for the 100-year discharge at structure 134000900400 on Route SC 9, crossing Thompson Creek in Chesterfield County, South Carolina*

Pier/bent [1] number	Station from [2] left end of bridge (feet)	Pile tip/ footing elevation, SCDOT datum (feet)	Pile tip/ footing elevation, USGS datum (feet)	Ground elevation at pier/bent, USGS datum (feet)	Total [3] scour depth (feet)	Elevation of scour, USGS datum (feet)	Remaining [4] pile/footing penetration (feet)
100-year discharge is 12,200 cubic feet per second							
2 20	475	138.9	82.7	89.8	5.6	84.2	1.5
3 19	450	131.5	75.3	77.6	10.1 [5]	67.5	-7.8
4 18	425	130.1	73.9	79.3	10.1 [5]	69.2	-4.7
5 17	400	129.7	73.5	79.5	10.1 [5]	69.4	-4.1
6 16	375	129.2	73.0	80.9	10.1 [5]	70.8	-2.2
7 15	350	129.3	73.1	85.1	10.1 [5]	75.0	1.9
8 14	325	129.5	73.3	87.3	13.2	74.1	0.8
9 13	300	129.8	73.6	88.8	13.0	75.8	2.2
10 12	275	130.0	73.8	89.6	12.8	76.8	3.0
11 11	250	130.0	73.8	89.6	12.8	76.8	3.0
12 10	225	130.0	73.8	88.7	13.0	75.7	1.9
13 9	200	130.0	73.8	89.2	12.9	76.3	2.5
14 8	175	130.0	73.8	88.1	13.1	75.0	1.2
15 7	150	130.1	73.9	87.8	13.1	74.7	0.8
16 6	125	130.6	74.4	87.5	13.2	74.3	-0.1
17 5	100	130.4	74.2	85.8	13.4	72.4	-1.8
18 4	75	130.4	74.2	87.0	13.2	73.8	-0.4
19 3	50	130.8	74.6	86.4	13.3	73.1	-1.5
20 2	25	131.8	75.6	87.7	13.2	74.5	-1.1

[1] Pier/bent number corresponds to South Carolina Department of Transportation 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] A negative number signifies undermining of pile tip/footing.

[5] 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 show subsurface rock that could reduce the scour depths shown in the above table. For more information see SCDOT plans in report pocket.
NOTE: Complete pile tip/footing elevations were not available from SCDOT. For more information, see scour assumptions in this report.

Table 2. *--Remaining pile/footing penetration at piers/bents for the 500-year discharge at structure 134000900400 on Route SC 9, crossing Thompson Creek in Chesterfield County, South Carolina*

Pier/bent [1] number	Station from [2] left end of bridge (feet)	Pile tip/ footing elevation, SCDOT datum (feet)	Pile tip/ footing elevation, USGS datum (feet)	Ground elevation at pier/bent, USGS datum (feet)	Total [3] scour depth (feet)	Elevation of scour, USGS datum (feet)	Remaining [4] pile/footing penetration (feet)
500-year discharge is 18,400 cubic feet per second							
2	475	138.9	82.7	89.8	6.6	83.2	0.5
3	450	131.5	75.3	77.6	10.8 [5]	66.8	-8.5
4	425	130.1	73.9	79.3	10.8 [5]	68.5	-5.4
5	400	129.7	73.5	79.5	10.8 [5]	68.7	-4.8
6	375	129.2	73.0	80.9	10.8 [5]	70.1	-2.9
7	350	129.3	73.1	85.1	10.8 [5]	74.3	1.2
8	325	129.5	73.3	87.3	18.6	68.7	-4.6
9	300	129.8	73.6	88.8	18.4	70.4	-3.2
10	275	130.0	73.8	89.6	18.3	71.3	-2.5
11	250	130.0	73.8	89.6	18.3	71.3	-2.5
12	225	130.0	73.8	88.7	18.4	70.3	-3.5
13	200	130.0	73.8	89.2	18.3	70.9	-2.9
14	175	130.0	73.8	88.1	18.5	69.6	-4.2
15	150	130.1	73.9	87.8	18.5	69.3	-4.6
16	125	130.6	74.4	87.5	18.6	68.9	-5.5
17	100	130.4	74.2	85.8	18.8	67.0	-7.2
18	75	130.4	74.2	87.0	18.6	68.4	-5.8
19	50	130.8	74.6	86.4	18.7	67.7	-6.9
20	25	131.8	75.6	87.7	18.6	69.1	-6.5

[1] Pier/bent number corresponds to South Carolina Department of Transportation 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] A negative number signifies undermining of pile tip/footing.

[5] 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 show subsurface rock that could reduce the scour depths shown in the above table. For more information see SCDOT plans in report pocket.
NOTE: Complete pile tip/footing elevations were not available from SCDOT. For more information, see scour assumptions in this report.

Table 3. --*Cumulative scour depths at piers/bents for the 100-year discharge at structure 134000900400 on Route SC 9, crossing Thompson Creek in Chesterfield 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 12,200 cubic feet per second				
2 ٢٠	475	0.0	5.6	5.6
3 ١٩	450	0.0 [4]	10.1	10.1
4 ١٨	425	0.0 [4]	10.1	10.1
5 ١٧	400	0.0 [4]	10.1	10.1
6 ١٦	375	0.0 [4]	10.1	10.1
7 ١٥	350	0.0 [4]	10.1	10.1
8 ١٤	325	5.6	7.6	13.2
9 ١٣	300	5.6	7.4	13.0
10 ١٢	275	5.6	7.2	12.8
11 ١١	250	5.6	7.2	12.8
12 ١٠	225	5.6	7.4	13.0
13 ٩	200	5.6	7.3	12.9
14 ٨	175	5.6	7.5	13.1
15 ٧	150	5.6	7.5	13.1
16 ٦	125	5.6	7.6	13.2
17 ٥	100	5.6	7.8	13.4
18 ٤	75	5.6	7.6	13.2
19 ٣	50	5.6	7.7	13.3
20 ٢	25	5.6	7.6	13.2

[1] Pier/bent number corresponds to South Carolina Department of Transportation 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 show subsurface rock that could reduce the scour depths shown in the above table. For more information see 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 134000900400 on Route SC 9, crossing Thompson Creek in Chesterfield 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 18,400 cubic feet per second				
2	475	0.0	6.6	6.6
3	450	0.0 [4]	10.8	10.8
4	425	0.0 [4]	10.8	10.8
5	400	0.0 [4]	10.8	10.8
6	375	0.0 [4]	10.8	10.8
7	350	0.0 [4]	10.8	10.8
8	325	10.0	8.6	18.6
9	300	10.0	8.4	18.4
10	275	10.0	8.3	18.3
11	250	10.0	8.3	18.3
12	225	10.0	8.4	18.4
13	200	10.0	8.3	18.3
14	175	10.0	8.5	18.5
15	150	10.0	8.5	18.5
16	125	10.0	8.6	18.6
17	100	10.0	8.8	18.8
18	75	10.0	8.6	18.6
19	50	10.0	8.7	18.7
20	25	10.0	8.6	18.6

[1] Pier/bent number corresponds to South Carolina Department of Transportation 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 show subsurface rock that could reduce the scour depths shown in the table above. For more information see 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 134000900400 on Route SC 9, crossing Thompson Creek in Chesterfield 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	12,200	0.0[3]	15.9
500-year	18,400	0.0[3]	20.5

[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.

[3] Scour was not computed for the left abutment because of adequate riprap protection.

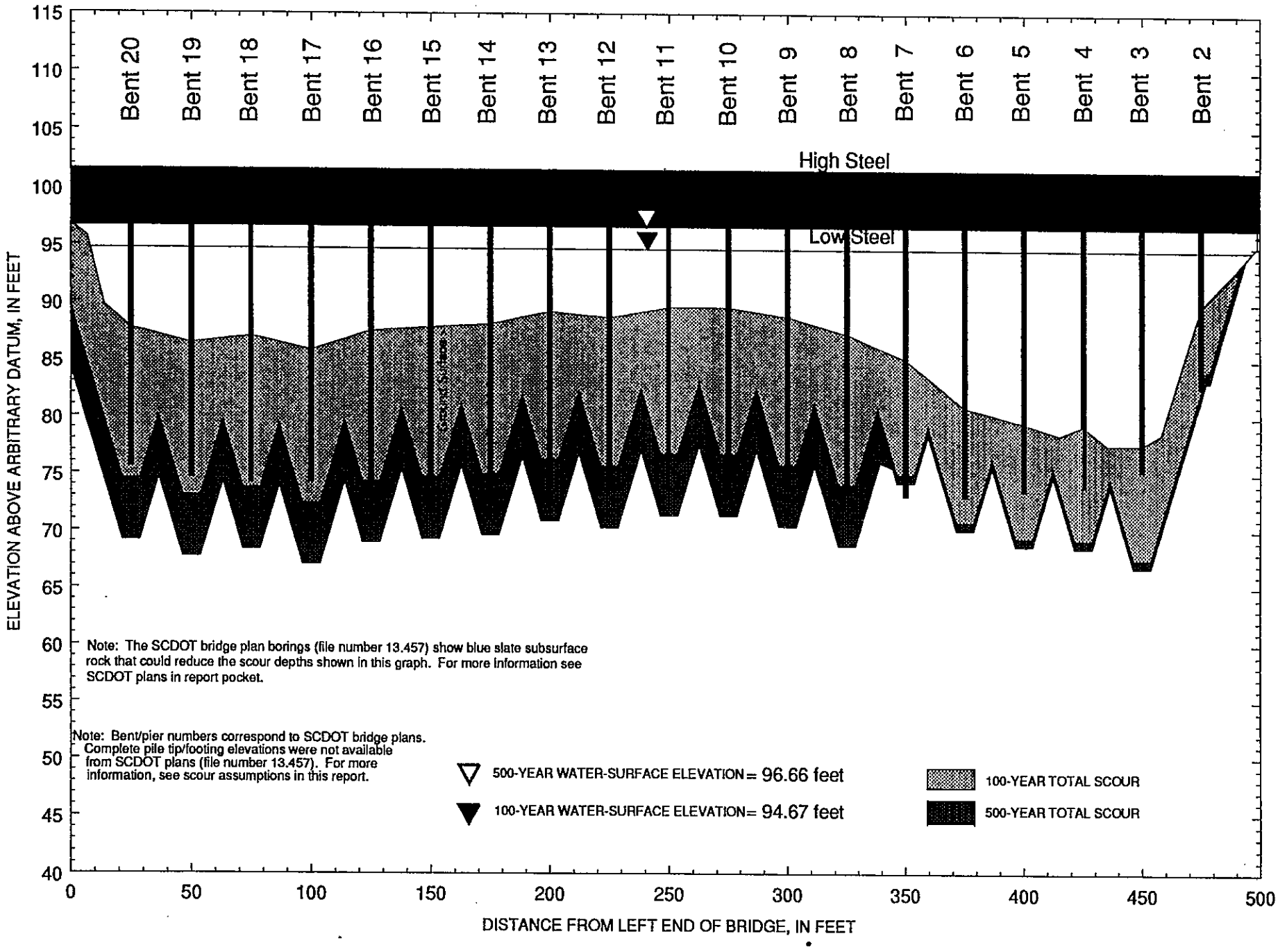

Figure 2.--Total scour depths for the 100- and 500- year discharges at structure 134000900400 on Route S.C. 9, crossing Thompson Creek in Chesterfield County, South Carolina.

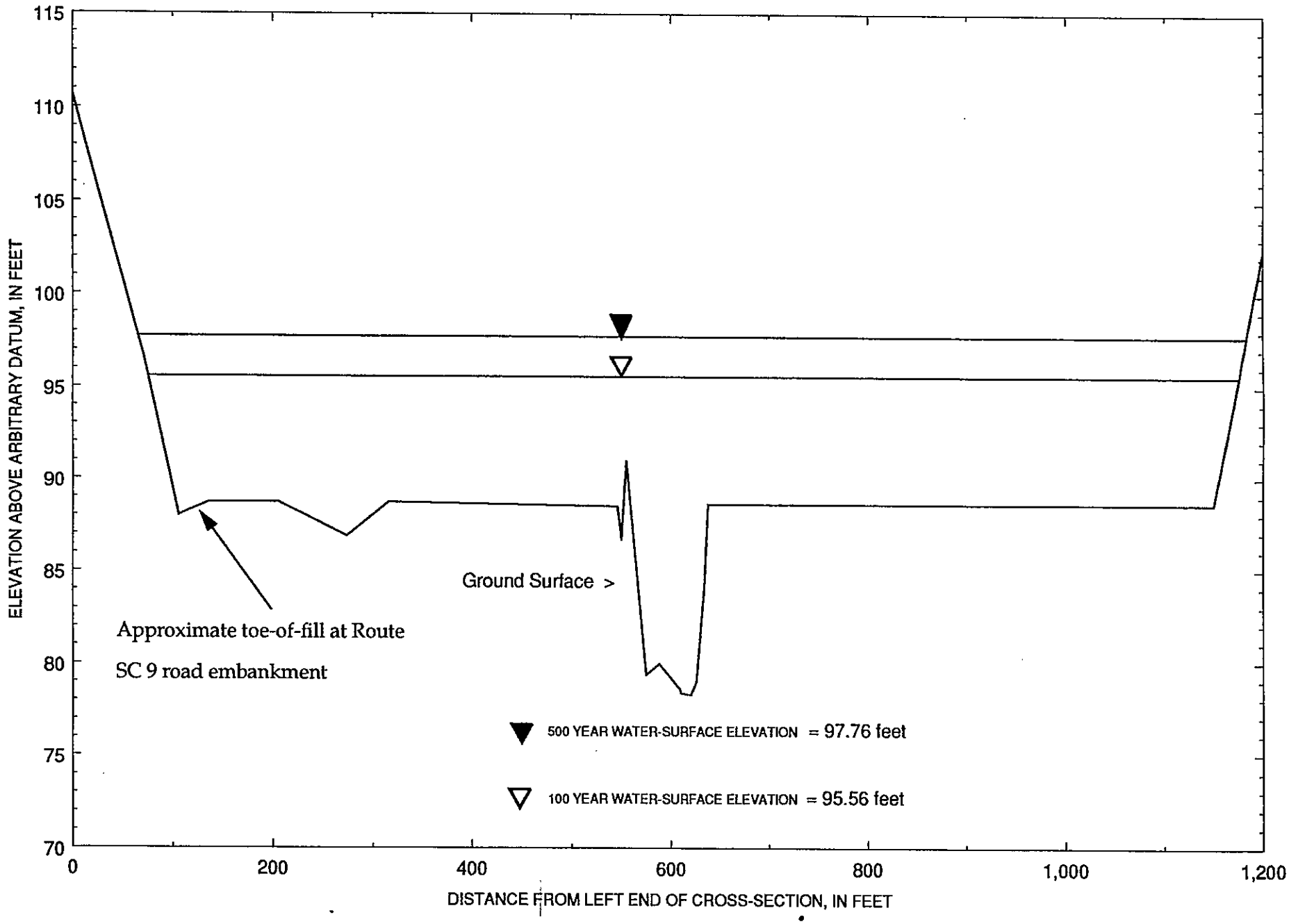

Figure 3.--Approach cross section at structure 134000900400 on Route SC 9, crossing Thompson Creek in Chesterfield County, South Carolina.

Figure 4.--Structure 134000900400 on Route SC 9, crossing Thompson Creek in Chesterfield County, South Carolina as viewed from the upstream left bank (September 4, 1990).

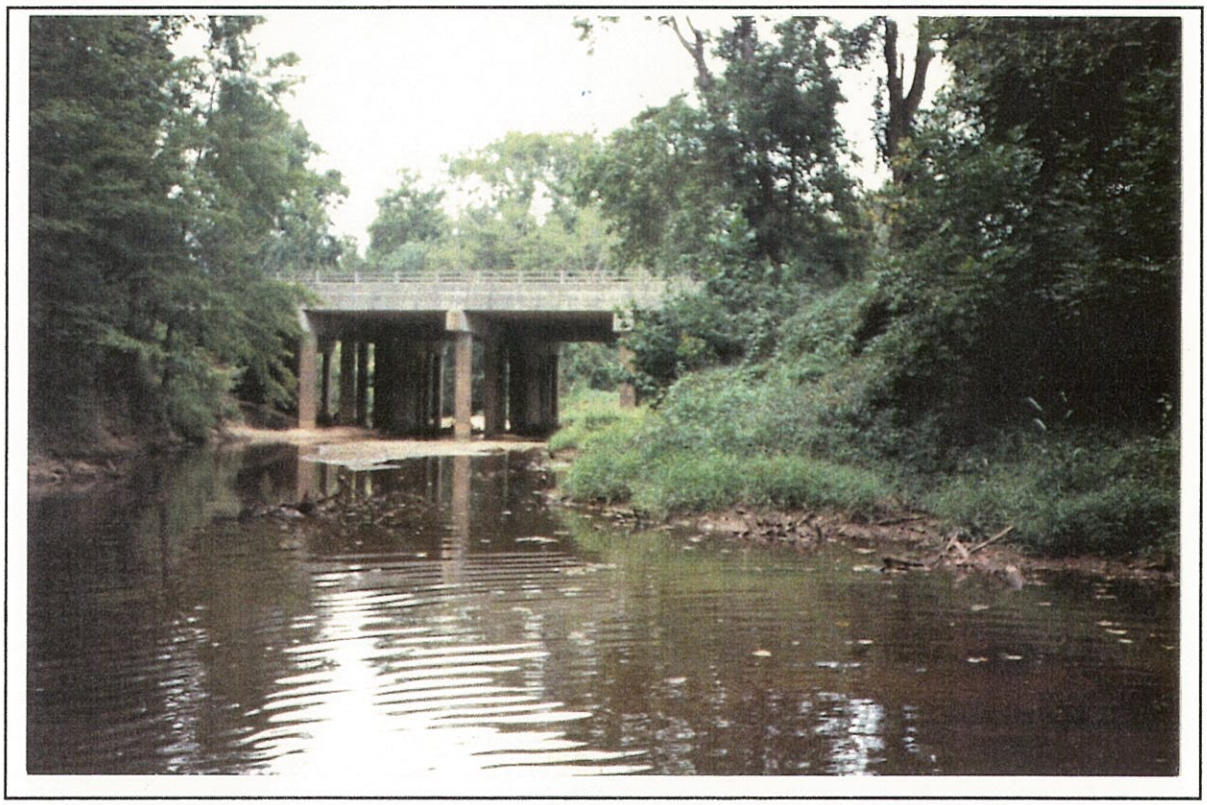

Figure 5.--Structure 134000900400 on Route SC 9, crossing Thompson Creek in Chesterfield County, South Carolina as viewed from the downstream channel (September 4, 1990).

Figure 6.--Approach channel, about 353 feet upstream of structure 134000900400 on Route SC 9, crossing Thompson Creek in Chesterfield County, South Carolina facing upstream (September 8, 1992).

Figure 7.--Exit channel, about 235 feet downstream of structure 134000900400 on Route SC 9, crossing Thompson Creek in Chesterfield County, South Carolina facing downstream (September 8, 1990).

Figure 8.--Severe erosion of the right abutment of structure 134000900400 on Route SC 9, crossing Thompson Creek in Chesterfield County, South Carolina (September 4, 1990).

Figure 9.--Downstream channel as viewed from under structure 134000900400 on Route SC 9, crossing Thompson Creek in Chesterfield County, South Carolina (September 4, 1990).

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SCOUR REPORT SUMMARY

Structure Number 134000900400 *Stream* Thompson Creek

County Chesterfield *Road* SC 9 *District* 4

Description of Bridge

Bridge length 500 *ft* *Bridge width* 76 *ft* *Max span length* 25 *ft*

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

Abutment type spillthrough *Embankment type* sloping

Riprap on abutment? yes *Date of inspection* 9-4-1990

Description of riprap 18-24 inch granite covers the left abutment and is in good condition. 18-24 inch granite covers only the upstream half of the right abutment. The middle portion of the right abutment has no protection and severe erosion is occurring.

Brief description of piers/pile bents There are 19 sets of concrete bents and piles are described in the U/S to D/S direction. Bents 10-20 have two 1.35 ft square piles, two 2.1 ft square piers, and seven 1.35 ft square piles. Bents 5-9 have two 1.35 ft square piles, two 2.0 ft square piers, two 1.35 ft square piles, and two 2.0 ft square piers. Bents 2-4 are similar to bents 5-9 except the space between the interior piers is solid concrete.

Is bridge skewed to flood plain according to USGS topo map? yes *Angle* 20

Is bridge located on a bend in channel? yes *If so, describe (mild, moderate, severe)* From the Level I Form, the bend directly at the bridge appears to be mild to moderate due to a left bank impact point at the bridge. There is a severe bend 100 ft upstream.

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	9-4-1990	0	0
Level II	9-8-1992	---	---

Potential for debris Low to moderate: there are signs of some woody debris in the upstream and downstream channel.

Describe any features near or at the bridge that may affect flow (include observation date). Some point bars are noted under the bridge as described on the Level I Scour Form dated 9-4-1990.

Description of Flood Plain

General topography The USGS topo map shows a flat floodplain around the channel that extends several hundred feet before rising sharply.

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

Date of inspection 9-8-1992

D/S left: Sparse to moderately thick hardwoods near banks; cornfield on left f/p

D/S right: Moderate hardwood cover on and near banks as well as on the f/p

U/S left: Moderate hardwood cover on and near banks; cornfield on left f/p

U/S right: Moderate hardwood cover on and near banks as well as on the f/p

Description of Channel

Average top width 75 *ft* *Average depth* 11.0 *ft*

Predominant bed material sand *Bank material* sand/silt

Stream type (straight, meandering, braided, swampy, channelized) meandering; topo map shows large bends near bridge; channel shifts left to right in the floodplain

Vegetative cover on channel banks near bridge: Date of inspection 9-4-1990/9-8-1992

D/S left: moderate to high cover: mostly medium trees with some underbrush

D/S right: moderate to high cover: mostly medium trees with some underbrush

U/S left: moderate to high cover: mostly medium trees with some underbrush

U/S right: moderate to high cover: mostly medium trees with some underbrush

Do banks appear stable? yes *If not, describe location and type of instability and date of observation.* Overall, banks appear stable upstream and downstream of the bridge; although, they have somewhat steep slopes and appear to have moderate to heavy fluvial erosion. Localized mass wasting was noted on the right bank at the bridge and just downstream of the bridge. These conditions were noted on the Level I Form on 9-4-1990 and from the Level II pictures.

Describe any obstructions in channel and date of observation. None

Hydrology

Drainage area 148 mi^2

Percentage of drainage area in physiographic provinces:

Physiographic province	*Percent of drainage area*
upper Coastal Plain	17.35
S.C. Piedmont	47.17
N.C. Piedmont	35.48

Is drainage area considered rural or urban? rural *Describe any significant urbanization and potential for development.* There is a slight potential for development due to the proximity of the town of Chesterfield to the site. Otherwise, the drainage area encompasses a predominately rural area.

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 12,200 ft^3/s *Q500* 18,400 ft^3/s

Method used to determine discharges The discharges were determined using the appropriate USGS regional regression equations and weighting the results by the drainage area. Regression equations for North Carolina were taken from Water-Resources Investigations Report 87-4096 and the equations for South Carolina were taken from Water-Resources Investigations Report 91-4157.

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 56.2 feet to USGS field survey to obtain SCDOT bridge plans datum (file number 13.457)

Description of reference marks used to determine USGS datum. RM 1 is a chiseled square in the upstream, right headwall and has an arbitrary elevation of 100.00 feet. RM 2 is a chiseled in the downstream, left headwall and its elevation was determined to be 100.08 feet based on a survey loop using standard levels.

Cross-Sections Used in WSPRO Analysis

*Cross-section ID	*Section Reference Distance (SRD) in feet*	**How cross-section was developed*	*Comments*
SYNC	-4400	4	Synthesized X-section
SYNB	-4000	4	Synthesized X-section
SYNA	-1900	4	Synthesized X-section
T70	-1500	3	Synthesized X-section
EXIT	-500	2	Exit Section
FULV	0	2	Full Valley Section
BRID2	0	1	D/S Face of Bridge
APPR	576	2	Approach 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.

Cross sections SYNC, SYNB and SYNA were synthesized, based on the Exit Section channel survey and assuming an average top of bank and flood plain elevation of 88.0 feet. (The average flood plain elevation was determined by comparing the channel surveys and the flood plain data from the SCDOT road plans.) The cross sections were extended on a flat grade from the top of banks to the edges of the floodplain with the use of the USGS topographic map. By comparing the flood plain data from the SCDOT plans with the USGS topographic map, the 150 foot contour represented the boundary of the flat area of the floodplain. The end of the cross sections were then extended up on the same slope as the contours. The elevations at each cross section were then shifted to the appropriate section reference distance using the channel slope.

Cross section T70 was synthesized by using the Exit Section data and shifting the channel location 800 feet to the left. This was done to model the shift of the channel from the right flood plain at the Exit Section towards the left flood plain at cross-section T70 as shown on the USGS topographic map.

The Exit and Full Valley Sections were synthesized using the Exit Section channel survey in conjunction with the SCDOT road plans (File Number 323-A & Ext.), for determining floodplain stations and elevations. The Exit Section channel was surveyed at 235 feet downstream of the downstream face of the bridge.

The downstream face of bridge was determined to be the most constrictive section at the bridge, and therefore, was used in the WSPRO analysis. The bridge skew of 20 degrees was determined by taking a weighted average of three different angles of flow approaching the bridge. (See WSPRO Input File for a more detailed explanation). Because of the large number of piles, several piles were combined in the 'PW' card to accommodate the maximum number of allowable entries. Also, the bridge geometry was subdivided into the left overbank and channel to allow hydraulic variables computations for the scour analysis.

An approach channel section was surveyed 277 feet upstream of the upstream face of the bridge. The flood plain geometry for the Approach Section was determined by using the SCDOT road plans to determine an average flood plain elevation and the USGS topographic map to determine the limits of the flood plain. It should be noted that the left end of the

Approach Section is constricted by the road embankment and is reflected in the cross-section geometry.

The starting water-surface elevation for the model was determined by using slope/ conveyance methodology. To confirm that this method is appropriate, the 100- and 500- year water-surface profiles were tested for convergence by lowering the starting water-surface elevation by one foot. For each profile, the change in elevation at the Exit Section was only 0.1 foot and therefore, it was concluded that slope/conveyance was appropriate.

Bridge Hydraulics

Average embankment elevation 99.6 *ft*

Average low steel elevation 96.7 *ft*

100-year discharge 12,200 ft^3/s

Water-surface elevation at D/S bridge face 94.67 *ft*

Area of flow at D/S bridge face 3,874 ft^2

Average velocity in bridge opening 3.15 *ft/s*

Maximum WSPRO tube velocity at bridge 4.96 *ft/s*

Water-surface elevation at Approach section with bridge 95.56 *ft*

Water-surface elevation at Approach section without bridge 94.98 *ft*

Amount of backwater caused by bridge 0.58 *ft*

500-year discharge 18,400 ft^3/s

Water-surface elevation at D/S bridge face 96.66 *ft*

Area of flow at D/S bridge face 4,795 ft^2

Average velocity in bridge opening 3.84 *ft/s*

Maximum WSPRO tube velocity at bridge 5.63 *ft/s*

Water-surface elevation at Approach section with bridge 97.76 *ft*

Water-surface elevation at Approach section without bridge 97.00 *ft*

Amount of backwater caused by bridge 0.76 *ft*

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 4 and a graph of the scour depths is shown in figure 2.

The most constricted bridge face cross section (downstream face of bridge) at the SC 9 crossing of Thompson Creek was used for the WSPRO and scour analysis. A comparison of the upstream and downstream bridge face cross sections for the SC 9 bridge showed that the geometry for both cross sections was very similar. Therefore, the most constricted bridge face cross section was representative of the hydraulic and scour conditions at the bridge.

It should be noted that in the most constricted bridge face cross section (downstream face of bridge), bents 7 through 3 were determined to be in the channel and therefore local pier scour for these bents was determined using the maximum depth of flow within the channel and 90 percent of the maximum WSPRO tube velocity at the bridge. Also, the pier width of all 19 bents varies from 1.35 foot piles on the widened portion of the bridge to 2.1 foot piers at the original structure. To assure a conservative estimate of the scour, a pier width of 2.1 feet was used at all bents.

Abutment scour was only computed for the right end of the bridge because of only partial protection of the upstream half of the abutment. The left abutment was not analyzed because it is fully protected by 18 to 24 inch granite riprap.

The left overbank was analyzed for clear-water contraction scour and the main channel was analyzed for live-bed contraction scour. The calculations showed that a small amount of aggradation (0.7 and 0.2 feet for the 100- and 500- year discharges, respectively) rather that degradation would occur in the channel. However, to assure a reasonable estimate of the scour, the channel contraction scour was assumed to be 0.0 feet and is reflected in tables 1 through 4 and figure 2.

It should be noted that the SCDOT bridge plan borings (file number 13.457) show subsurface rock 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 SC 9 bridge has been widened twice and that there is no footing information available for the original structure. The following information was provided by SCDOT plans (file number 13.457) for the SC 9 crossing of Thompson Creek: the pile tip/footing elevations for the widening of the structure in 1974 and average pile tip/ footing bottom elevations for the widening of the structure in 1963. Upon recommendation by officials at the SCDOT, the highest elevation obtained from the above information at each bent was used in figure 2 and tables 1 and 2.

Because footing elevations for the original structure were not available from the SCDOT, no consideration was given to analyzing the footings for pier scour with exposed footings.

WSPRO INPUT FILE

```
T1        Structure Number: 134000900400                (500 ft Bridge)
T2        Thompson Creek at SC 9                        File: thompson.sc9
T3        Chesterfield County, South Carolina           STB 10/93
*
*          Q100       Q500
Q         12200       18400
SK        .0008       .0008
*
*         For the development of synthesized cross-sections SYNC through
*         SYNA, several assumptions were made.  First, all channel data
*         were based on the EXIT section survey, assuming an average top
*         of bank and floodplain elevation of approximately 88.0 ft at
*         this section.  The channel data were then shifted by the channel
*         slope to the point of interest.  Next, while examining the
*         USGS topo map, contour 150 was determined to be the approximate
*         edge of the flat area of the floodplain before the land begins
*         to rise sharply.  Therefore, each synthesized cross-section was
*         extended on a flat grade from the top of the banks to contour
*         150 as measured on the USGS topo map.  Finally, the synthesized
*         cross-sections were extended by the slope of the contour beyond
*         the flat edge of the floodplain.
*
*         The data for SYNC was synthesized using the channel data at the
*         EXIT section and each end of the cross-section was extended using
*         the USGS topo map.
*
XS   SYNC   -4400  * * * 0.0008
GR             0  94.7   110  84.7  1230  84.7  1273  84.7  1287  75.1
GR          1296  74.8  1306  75.2  1317  74.1  1329  75.2  1335  84.7
GR          1345  84.7  1745  84.7  2095  94.7
N            0.13          0.056         0.15
SA                 1287          1335
*
*         The data for SYNB was synthesized using the channel data at the
*         EXIT section and each end of the cross-section was extended using
*         the USGS topo map.
*
XS   SYNB   -4000  * * * 0.0008
GR             0  95.0
GR           200  85.0  1030  85.0  1103  85.0  1117  75.4  1126  75.1
GR          1136  75.5  1147  74.4  1159  75.5  1165  85.0  1195  85.0
GR          1370  85.0  1870  95.0
N            0.13          0.056         0.15
SA                 1103          1165
FL           500   1103    400   1165   270
*
*         The data for SYNA was synthesized using the channel data at the
*         EXIT section and each end of the cross-section was extended using
*         the USGS topo map.
*
XS   SYNA   -1900  * * * 0.0008
GR             0  96.7    50  86.7   150  86.7   193  86.7   207  77.1
GR           216  76.8   226  77.2   237  76.1   249  77.2   255  86.7
GR           305  86.7   555  86.7  1255  86.7  1355  96.7
N            0.13          0.056         0.15
SA                  193          255
FL          1350   193   2100   255   2300
*
```

```
*          Template T70 represents a cross-section at 1500 ft D/S.
*          This section was synthesized from the EXIT survey data in
*          which the main channel data was shifted 800 ft to the left.
*          This shift was determined from the USGS topo map.
*
XT   TMP70    -235  0.0008
GR              0   110.7      71    96.7     106    88.0     136    88.7
GR            206    88.7     274    86.9     316    88.7     546    88.5
GR            576    87.4     583    89.2     597    78.4     606    78.1
GR            616    78.5     627    77.4     639    78.5     645    88.4
GR           1450    88.4    1464    92.8    1470    93.8    1489    95.8
GR           1500    96.9    1505    97.5    1605   107.5
*
XS   T70     -1500  * * *  0.0008
GT
N             0.13          0.056        0.15
SA                   583          645
*
*          Survey data for the EXIT Section at 235 ft D/S of Bridge face.
*          Distance is determined from survey data.
*          Floodplain points for the EXIT Section were determined from SCDHPT
*          road plans.  Channel data were determined from USGS survey.
*
XT   SURV1    -235    0.0008
GR              0   110.7      71    96.7     106    88.0     136    88.7
GR            206    88.7     274    86.9     316    88.7     546    88.5
GR            576    87.4     616    88.9     756    86.9     851    88.4
GR           1093    86.3    1226    87.7    1316    86.7    1383    89.2
GR           1397    78.4    1406    78.1    1416    78.5    1427    77.4
GR           1439    78.5    1445    88.4    1450    89.4    1464    92.8
GR           1470    93.8    1489    95.8    1500    96.9    1505    97.5
GR           1605   107.5
*
XS   EXIT      -500  * * *  0.0008
GT
N             0.13          0.056        0.15
SA                   1383         1445
FL            900    1385    1040    1445    900
*
XS   FULV        0  * * *  0.0008
GT
*
*          D/S Face of Bridge
*
*          A skew of 20 degrees was determined for the bridge in the following
*          manner.  Flow through the bridge come through the left overbank at
*          an angle of 30 degrees toward the right bank, flow comes straight
*          through the bridge at the channel section (0 degrees) and flow comes
*          through the right side of the bridge at an angle of 26 degrees
*          toward the left bank.  A weighted average was then taken of the
*          three areas to determine the average skew.  Since the right side
*          is smaller than the main channel and left overbank areas its weight
*          will only carry half of the other two.  In other words:
*          (26 x 0.5) + (0 x 0.25) + (30 x 0.25) = 20.5 degrees or 20 degrees.
*
```

```
BR    BRID2       0     96.7       20
GR                0     96.7        1     96.7      1.1     96.7        7     95.7
GR               14     89.7       25     87.7       50     86.4       75     87.0
GR              100     85.8      125     87.5      150     87.8      175     88.1
GR              200     89.2      225     88.7      250     89.6      275     89.6
GR              300     88.8      325     87.3      350     85.1      375     80.9
GR              400     79.5      415     78.5      425     79.3      435     77.6
GR              450     77.6      458     78.6      475     89.8      484     91.8
GR              490     93.1    498.9     95.1      499     96.7      500     96.7
GR                0     96.7
N             0.056            0.056
SA                    375
*
*         Several piles were combined in order to accommodate the maximum
*         number of piles allowable in the PW card.
*
PW 1          77.6    1.4   79.3    1.4   79.3    2.8   79.5    2.8   79.5    4.2
PW            80.9    4.2   80.9    5.6   85.1    5.6   85.1    7.0   85.8    7.0
PW            85.8    8.4   86.4    8.4   86.4    9.8   87.0    9.8   87.0   16.8
PW            87.7   16.8   88.1   16.8   88.1   18.2   88.7   18.2   88.7   21.0
PW            89.2   21.0   89.2   22.4   89.6   22.4   89.6   26.6   96.7   26.6
CD               3     76      2   99.6
*
*         Survey data for the APPROACH Section at 277 ft U/S of Bridge face.
*         Distance is determined from survey data.  The channel section was
*         determined from USGS field survey and the floodplain points were
*         synthesized by drawing an Approach section on the USGS topo map
*         and manually finding the stations and elevations.  The approach
*         section was drawn at an angle of about 45 degrees (perpendicular
*         to the floodplain).  Since the section was synthesized in this
*         manner, no skew angle was needed for the Approach section for the
*         WSPRO run.
*
XT    SURV2     353    0.0008
GR                0     110.7       71     96.7      106     88.0      136     88.7
GR              206      88.7      274     86.9      316     88.7      546     88.5
GR              550      86.7      555     91.0      566     84.6      575     79.4
GR              588      80.0      609     78.6      610     78.4      620     78.3
GR              626      79.0      634     84.1      638     88.6     1150     88.6
GR             1200     102.4
*
AS    APPR       576
BP               205
GT
N              0.15            0.056            0.15
SA                      555                    638
*
HP 1 BRID2     94.67     0     94.67     12200
HP 2 BRID2     94.73     0     94.73     12200
HP 1 APPR      95.56     0     95.56     12200
HP 2 APPR      95.56     0     95.56     12200
HP 1 BRID2     96.66     0     96.66     18400
HP 2 BRID2     96.73     0     96.73     18400
HP 1 APPR      97.76     0     97.76     18400
HP 2 APPR      97.76     0     97.76     18400
*
EX
ER
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WSPRO OUTPUT

```
WSPRO          FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
V060188            MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS

        Structure Number: 134000900400                    (500 ft Bridge)
        Thompson Creek at SC 9                            File: thompson.sc9
        Chesterfield County, South Carolina               STB 10/93
           *** RUN DATE & TIME: 03-29-94  13:30

    CROSS-SECTION PROPERTIES:  ISEQ =  7;  SECID = BRID2;  SRD =       0.

     WSEL  SA#      AREA         K    TOPW    WETP  ALPH     LEW     REW      QCR
             1     2429.   236213.    345.    348.                          36583.
             2     1444.   202871.    115.    119.                          29090.
    94.67          3873.   439085.    459.    467.  1.11      8.    497.   60704.
```

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WSPRO          FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
V060188            MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS

        Structure Number: 134000900400                    (500 ft Bridge)
        Thompson Creek at SC 9                            File: thompson.sc9
        Chesterfield County, South Carolina               STB 10/93
           *** RUN DATE & TIME: 03-29-94  13:30


    VELOCITY DISTRIBUTION:  ISEQ =  7;  SECID = BRID2;  SRD =       0.

         WSEL      LEW      REW     AREA         K         Q     VEL
        94.73      8.1    497.3   3900.5   443726.    12200.    3.13

X STA.          8.1        49.9        76.9       102.7       132.3       167.6
  A(I)            255.5       203.4       204.3       216.9       230.1
  V(I)             2.39        3.00        2.99        2.81        2.65

X STA.        167.6       212.2       266.8       320.1       347.7       364.2
  A(I)            253.7       283.3       292.7       213.2       165.5
  V(I)             2.40        2.15        2.08        2.86        3.69

X STA.        364.2       377.3       387.8       397.7       407.1       416.0
  A(I)            160.7       140.5       138.5       135.7       133.7
  V(I)             3.79        4.34        4.40        4.50        4.56

X STA.        416.0       424.7       433.7       441.6       449.2       497.3
  A(I)            129.9       135.9       126.3       122.9       358.0
  V(I)             4.70        4.49        4.83        4.96        1.70
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WSPRO          FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
V060188            MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS

        Structure Number: 134000900400                  (500 ft Bridge)
        Thompson Creek at SC 9                          File: thompson.sc9
        Chesterfield County, South Carolina             STB 10/93
           *** RUN DATE & TIME: 03-29-94  13:30

    CROSS-SECTION PROPERTIES:  ISEQ =  8;  SECID = APPR ;  SRD =     576.

     WSEL  SA#      AREA         K    TOPW   WETP  ALPH     LEW     REW      QCR
             1    3246.   115029.   479.   482.                             47960.
             2    1180.   174839.    83.    90.                             25240.
             3    3555.   124456.   537.   537.                             51936.
    95.56         7981.   414324.  1098.  1109.  3.70     76.  1175.      63428.
```

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WSPRO          FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
V060188            MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS

        Structure Number: 134000900400                  (500 ft Bridge)
        Thompson Creek at SC 9                          File: thompson.sc9
        Chesterfield County, South Carolina             STB 10/93
           *** RUN DATE & TIME: 03-29-94  13:30


    VELOCITY DISTRIBUTION:  ISEQ =  8;  SECID = APPR ;  SRD =     576.

          WSEL      LEW      REW     AREA         K         Q     VEL
         95.56     76.3   1174.6   7981.1   414324.   12200.    1.53

X STA.        76.3      183.2      261.9      336.4      423.8      507.6
  A(I)       636.0      566.8      556.0      588.6      571.2
  V(I)        0.96       1.08       1.10       1.04       1.07

X STA.       507.6      570.0      578.9      587.1      595.1      602.6
  A(I)       458.2      135.1      127.4      125.2      121.5
  V(I)        1.33       4.51       4.79       4.87       5.02

X STA.       602.6      610.0      617.2      624.3      637.1      725.1
  A(I)       122.8      121.9      120.3      168.0      597.5
  V(I)        4.97       5.00       5.07       3.63       1.02

X STA.       725.1      809.0      896.1      982.0     1067.3     1174.6
  A(I)       568.4      590.7      582.9      578.6      643.9
  V(I)        1.07       1.03       1.05       1.05       0.95
```

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WSPRO          FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
V060188            MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS

        Structure Number: 134000900400                    (500 ft Bridge)
        Thompson Creek at SC 9                           File: thompson.sc9
        Chesterfield County, South Carolina              STB 10/93
           *** RUN DATE & TIME: 03-29-94  13:30

    CROSS-SECTION PROPERTIES:  ISEQ =  7;  SECID = BRID2;  SRD =       0.

     WSEL  SA#      AREA         K    TOPW   WETP  ALPH     LEW     REW      QCR
             1    3119.   353681.    351.   354.                          52745.
             2    1676.   255035.    117.   122.                          36057.
    96.66         4794.   608716.    468.   477.  1.07      1.    499.   84386.
```

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WSPRO          FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
V060188            MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS

        Structure Number: 134000900400                    (500 ft Bridge)
        Thompson Creek at SC 9                           File: thompson.sc9
        Chesterfield County, South Carolina              STB 10/93
           *** RUN DATE & TIME: 03-29-94  13:30

    VELOCITY DISTRIBUTION:  ISEQ =  7;  SECID = BRID2;  SRD =       0.

         WSEL      LEW      REW     AREA         K         Q     VEL
        96.73      0.0    500.0   4813.2   387855.    18400.    3.82

X STA.          0.0        49.0        75.9       101.5       128.5       160.3
  A(I)          329.1       252.9       248.7       251.2       268.0
  V(I)           2.80        3.64        3.70        3.66        3.43

X STA.        160.3       195.7       237.5       286.1       325.2       348.6
  A(I)          277.7       304.3       328.9       305.1       230.2
  V(I)           3.31        3.02        2.80        3.02        4.00

X STA.        348.6       366.1       380.2       391.6       402.6       412.8
  A(I)          211.3       203.2       176.0       175.4       171.2
  V(I)           4.35        4.53        5.23        5.25        5.37

X STA.        412.8       423.0       432.9       442.0       451.2       500.0
  A(I)          171.4       166.5       163.3       165.3       413.4
  V(I)           5.37        5.52        5.63        5.56        2.23
```

WSPRO OUTPUT --Continued

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WSPRO          FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
V060188             MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS

        Structure Number: 134000900400                    (500 ft Bridge)
        Thompson Creek at SC 9                           File: thompson.sc9
        Chesterfield County, South Carolina              STB 10/93
           *** RUN DATE & TIME: 03-29-94  13:30

    CROSS-SECTION PROPERTIES:  ISEQ =  8;  SECID = APPR ;  SRD =     576.

     WSEL  SA#      AREA         K    TOPW    WETP  ALPH     LEW     REW      QCR
             1     4309.   181949.    488.    492.                          72625.
             2     1362.   222229.     83.     90.                          31321.
             3     4745.   199272.    545.    546.                          79475.
    97.76         10416.   603450.   1116.   1127.  3.25     67.   1183.  100115.
```

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WSPRO          FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
V060188             MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS

        Structure Number: 134000900400                    (500 ft Bridge)
        Thompson Creek at SC 9                           File: thompson.sc9
        Chesterfield County, South Carolina              STB 10/93
           *** RUN DATE & TIME: 03-29-94  13:30


    VELOCITY DISTRIBUTION:  ISEQ =  8;  SECID = APPR ;  SRD =     576.

         WSEL      LEW      REW     AREA         K         Q     VEL
        97.76     66.5  1182.5 10416.2  603450.   18400.   1.77

X STA.        66.5      175.5      250.6      316.7      397.2      474.4
  A(I)           812.9      693.8      659.4      718.0      693.4
  V(I)            1.13       1.33       1.40       1.28       1.33

X STA.       474.4      550.8      575.3      584.6      594.1      603.0
  A(I)           696.0      288.1      167.4      168.6      163.2
  V(I)            1.32       3.19       5.50       5.46       5.64

X STA.       603.0      611.6      620.0      629.2      685.7      763.4
  A(I)           162.8      160.7      169.8      545.8      697.7
  V(I)            5.65       5.73       5.42       1.69       1.32

X STA.       763.4      841.7      921.3      998.5     1076.1     1182.5
  A(I)           703.5      714.6      693.8      697.2      809.5
  V(I)            1.31       1.29       1.33       1.32       1.14
```

WSPRO OUTPUT --Continued

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+++ BEGINNING PROFILE CALCULATIONS --   2


WSPRO          FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
V060188             MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS

        Structure Number: 134000900400                  (500 ft Bridge)
        Thompson Creek at SC 9                          File: thompson.sc9
        Chesterfield County, South Carolina             STB 10/93
           *** RUN DATE & TIME: 03-29-94  13:30

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

SYNC :XS    ******     48.     10409.    0.08   *****    90.39     86.95   12200.     90.31
    -4400.  ******   1941.    431204.    3.76   *****  *******      0.17     1.17

SYNB :XS       400.     86.      8314.    0.13    0.41    90.83  *******   12200.     90.70
    -4000.     435.   1655.    364902.    3.89    0.02     0.00      0.22     1.47

SYNA :XS      2100.     19.      8394.    0.13    2.28    93.12  *******   12200.     92.99
    -1900.    2141.   1318.    383520.    3.85    0.00     0.02      0.20     1.45

T70  :XS       400.     80.      8769.    0.11    0.39    93.51  *******   12200.     93.40
    -1500.     400.   1476.    399452.    3.64    0.00     0.00      0.19     1.39

EXIT :XS      1000.     80.      9468.    0.07    0.74    94.26  *******   12200.     94.19
     -500.     939.   1476.    470148.    2.78    0.00     0.00      0.15     1.29

FULV :FV       500.     80.      9388.    0.07    0.34    94.60  *******   12200.     94.53
        0.     500.   1475.    464319.    2.80    0.00     0.00      0.15     1.30
          <<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>

APPR :AS       576.     79.      7349.    0.17    0.50    95.15  *******   12200.     94.98
      576.     576.   1172.    370000.    3.86    0.05     0.00      0.22     1.66
          <<<<<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

BRID2:BR       500.      8.      3874.    0.25    0.57    94.92     88.71   12200.     94.67
        0.     500.    497.    439200.    1.59    0.09     0.00      0.24     3.15

     TYPE PPCD FLOW       C      P/A     LSEL    BLEN    XLAB    XRAB
        3.   1.    1.   0.792   0.060    96.70  ******  ******  ******

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

APPR :AS       500.     76.      7985.    0.13    0.72    95.70     90.85   12200.     95.56
      576.     551.   1175.    414595.    3.70    0.06     0.01      0.19     1.53

       M(G)    M(K)        KQ    XLKQ    XRKQ     OTEL
      0.554   0.332   276708.    245.    734.     95.13

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

WSPRO OUTPUT --Continued

```
WSPRO          FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY
V060188            MODEL  FOR  WATER-SURFACE  PROFILE  COMPUTATIONS

        Structure Number: 134000900400                    (500 ft Bridge)
        Thompson Creek at SC 9                           File: thompson.sc9
        Chesterfield County, South Carolina              STB 10/93
           *** RUN DATE & TIME: 03-29-94  13:30

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

SYNC :XS    ******     28.    13908.   0.08  *****    92.20    87.64   18400.    92.12
    -4400.  ******   2005.   650084.   2.99  *****  *******     0.15     1.32

SYNB :XS       400.     50.    11271.   0.14   0.42    92.65  *******   18400.    92.51
    -4000.     436.   1745.   544083.   3.29   0.03     0.00     0.20     1.63

SYNA :XS      2100.      9.    10910.   0.14   2.40    95.05  *******   18400.    94.91
    -1900.    2143.   1337.   555902.   3.24   0.00     0.01     0.19     1.69

T70  :XS       400.     72.    11510.   0.12   0.41    95.47  *******   18400.    95.35
    -1500.     400.   1495.   589746.   3.01   0.00     0.00     0.17     1.60

EXIT :XS      1000.     72.    12253.   0.08   0.78    96.25  *******   18400.    96.16
     -500.     932.   1495.   689518.   2.35   0.00     0.00     0.14     1.50

FULV :FV       500.     72.    12196.   0.08   0.36    96.61  *******   18400.    96.52
        0.     500.   1494.   684699.   2.35   0.00     0.00     0.14     1.51
         <<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>

APPR :AS       576.     70.     9572.   0.19   0.53    97.20  *******   18400.    97.00
      576.     576.   1180.   534766.   3.39   0.06     0.00     0.21     1.92
         <<<<<THE ABOVE RESULTS REFLECT "NORMAL" (UNCONSTRICTED) FLOW>>>>>

 ===220 FLOW CLASS 1 (4) SOLUTION INDICATES POSSIBLE PRESSURE FLOW.
          WS3,WSIU,WS1,LSEL =    96.66      96.95      97.76      96.70

 ===245 ATTEMPTING FLOW CLASS 2 (5) SOLUTION.

 ===250 INSUFFICIENT HEAD FOR PRESSURE FLOW.
                       YU/Z,WSIU,WS = 1.04      97.04      97.85

 ===270 REJECTED FLOW CLASS 2 (5) SOLUTION.

          <<<<<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

BRID2:BR       500.      1.     4795.   0.38   0.64    97.04    90.67   18400.    96.66
        0.     500.    499.   608823.   1.64   0.15     0.00     0.27     3.84

     TYPE PPCD FLOW      C     P/A     LSEL    BLEN    XLAB    XRAB
       3.   1.   1.  0.781   0.059    96.70  ******  ******  ******

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

APPR :AS       500.     67.    10417.   0.16   0.81    97.92    91.86   18400.    97.76
      576.     556.   1183.   603510.   3.25   0.07     0.00     0.18     1.77
```

PIER SCOUR COMPUTATIONS
FOR
Q100 Thompson Creek at SC 9 Structure # 134000900400 Chesterfield Co.

HYDRAULIC VARIABLES USED IN CSU EQUATION								
PIER NUMBER	20	19	18	17	16	15	14	13
PIER STATION (FT)	25	50	75	100	125	150	175	200
LOCATION OF PIER	LFP	LFP	LFP	LFP	LFP	LFP	LFP	LFP
Y1: DEPTH (FT)	7.0	8.3	7.7	8.9	7.2	6.9	6.6	5.5
V1: VEL. (FPS)	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
a: PIER WIDTH (FT)	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1
L: PIER LENGTH (FT)	16.4	16.4	16.4	16.4	16.4	16.4	16.4	16.4
PIER SHAPE	1	1	1	1	1	1	1	1
ATTACK ANGLE	20	20	20	20	20	20	20	20
K1 (SHAPE COEF.)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
K2 (ANGLE COEF.)	2.14	2.14	2.14	2.14	2.14	2.14	2.14	2.14
FROUDE NO.	0.20	0.18	0.19	0.18	0.20	0.20	0.21	0.23
COMPUTED SCOUR DEPTHS USING CSU EQUATION								
SCOUR DEPTH (FT)	6.86	7.02	6.95	7.09	6.89	6.85	6.81	6.64
MAX SCOUR DEPTH (FT)	7.55	7.73	7.65	7.80	7.58	7.53	7.49	7.31

HYDRAULIC VARIABLES USED IN CSU EQUATION								
PIER NUMBER	12	11	10	9	8	7	6	5
PIER STATION (FT)	225	250	275	300	325	350	375	400
LOCATION OF PIER	LFP	LFP	LFP	LFP	LFP	LTB	MCL	MCM
Y1: DEPTH (FT)	6.0	5.1	5.1	5.9	7.4	17.1	17.1	17.1
V1: VEL. (FPS)	3.0	3.0	3.0	3.0	3.0	4.5	4.5	4.5
a: PIER WIDTH (FT)	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1
L: PIER LENGTH (FT)	16.4	16.4	16.4	16.4	16.4	16.4	16.4	16.4
PIER SHAPE	1	1	1	1	1	1	1	1
ATTACK ANGLE	20	20	20	20	20	20	20	20
K1 (SHAPE COEF.)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
K2 (ANGLE COEF.)	2.14	2.14	2.14	2.14	2.14	2.14	2.14	2.14
FROUDE NO.	0.22	0.23	0.23	0.22	0.19	0.19	0.19	0.19
COMPUTED SCOUR DEPTHS USING CSU EQUATION								
SCOUR DEPTH (FT)	6.72	6.58	6.58	6.71	6.91	9.18	9.18	9.18
MAX SCOUR DEPTH (FT)	7.39	7.23	7.23	7.38	7.61	10.10	10.10	10.10

HYDRAULIC VARIABLES USED IN CSU EQUATION			
PIER NUMBER	4	3	2
PIER STATION (FT)	425	450	475
LOCATION OF PIER	MCM	MCR	RTB
Y1: DEPTH (FT)	17.1	17.1	4.9
V1: VEL. (FPS)	4.5	4.5	1.7
a: PIER WIDTH (FT)	2.1	2.1	2.1
L: PIER LENGTH (FT)	16.4	16.4	16.4
PIER SHAPE	1	1	1
ATTACK ANGLE	20	20	20
K1 (SHAPE COEF.)	1.00	1.00	1.00
K2 (ANGLE COEF.)	2.14	2.14	2.14
FROUDE NO.	0.19	0.19	0.14
COMPUTED SCOUR DEPTHS USING CSU EQUATION			
SCOUR DEPTH (FT)	9.18	9.18	5.12
MAX SCOUR DEPTH (FT)	10.10	10.10	5.64

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

CONTRACTION SCOUR COMPUTATIONS
FOR
Q100 Thompson Creek at SC 9 Structure # 134000900400 Chesterfield Co.

LIVE-BED SCOUR COMPUTATIONS

	MAIN CHANNEL	CONTRACTED SECTION
DISCHARGE (CFS)	5148.	5637.
BOTTOM WIDTH (FT)	83.0	100.4
MANNINGS n	0.056	0.056
AVERAGE DEPTH (FT)	16.7	

ENERGY SLOPE	0.00140
D50 (FT)	0.0049
FALL VELOCITY (FPS)	0.68
K1 COEF.	0.64
K2 COEF.	0.21

COMPUTED DEPTH AT CONTRACTED SECTION (FT)	=	16.0
DEPTH AT MAIN CHANNEL (FT)	=	16.7
DEPTH OF CONTRACTION SCOUR (FT)	=	-0.7

LEFT OVERBANK IN BRIDGE OPENING
CLEAR-WATER CONTRACTION SCOUR COMPUTATIONS

DISCHARGE IN CONTRACTED SECTION (CFS)	=	6563.
WIDTH OF CONTRACTED SECTION (FT)	=	316.0
MEDIAN GRAIN SIZE (FT)	=	0.0010
COMPUTED DEPTH OF CONTRACTED SECTION (FT)	=	12.4
AVERAGE FLOOD PLAIN DEPTH (FT)	=	6.8
DEPTH OF CONTRACTION SCOUR (FT)	=	5.6

ABUTMENT SCOUR COMPUTATIONS
FOR
Thompson Creek at SC 9 Structure # 134000900400 Chesterfield Co.
100-year scour including the first eight bents JMS 30 MAR 1994

RIGHT ABUTMENT
SCOUR COMPUTATIONS

ABUTMENT TYPE	3 -SPILL THROUGH
DISCHARGE BLOCKED BY ABUTMENT (CFS)	3598.
AREA BLOCKED BY ABUTMENT (SQ FT)	3502.0
DEPTH OF FLOW AT ABUTMENT (FT)	4.9
LENGTH OF ABUT. 90 DEG. TO FLOW (FT)	529.0
ABUTMENT SKEW (DEG)	-20
AJUSTED ABUTMENT LENGTH (FT)	714.7
AVERAGE F/P VELOCITY U/S OF ABUT. (FPS)	1.0
FROUDE NUMBER	0.082
K1 COEF.	0.6
K2 COEF.	1.0

DESIGN DEPTH OF SCOUR (FROELICH EQUATION, 1989) (FT) = 15.9

PIER SCOUR COMPUTATIONS
FOR
Q500 Thompson Creek at SC 9 Structure # 134000900400 Chesterfield Co.

HYDRAULIC VARIABLES USED IN CSU EQUATION								
PIER NUMBER	20	19	18	17	16	15	14	13
PIER STATION (FT)	25	50	75	100	125	150	175	200
LOCATION OF PIER	LFP	LFP	LFP	LFP	LFP	LFP	LFP	LFP
Y1: DEPTH (FT)	9.0	10.3	9.7	10.9	9.2	8.9	8.6	7.5
V1: VEL. (FPS)	3.7	3.7	3.7	3.7	3.7	3.7	3.7	3.7
a: PIER WIDTH (FT)	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1
L: PIER LENGTH (FT)	16.4	16.4	16.4	16.4	16.4	16.4	16.4	16.4
PIER SHAPE	1	1	1	1	1	1	1	1
ATTACK ANGLE	20	20	20	20	20	20	20	20
K1 (SHAPE COEF.)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
K2 (ANGLE COEF.)	2.14	2.14	2.14	2.14	2.14	2.14	2.14	2.14
FROUDE NO.	0.22	0.20	0.21	0.20	0.21	0.22	0.22	0.24
COMPUTED SCOUR DEPTHS USING CSU EQUATION								
SCOUR DEPTH (FT)	7.77	7.91	7.85	7.97	7.79	7.76	7.72	7.58
MAX SCOUR DEPTH (FT)	8.55	8.70	8.63	8.77	8.57	8.53	8.49	8.34

HYDRAULIC VARIABLES USED IN CSU EQUATION								
PIER NUMBER	12	11	10	9	8	7	6	5
PIER STATION (FT)	225	250	275	300	325	350	375	400
LOCATION OF PIER	LFP	LFP	LFP	LFP	LFP	LTB	MCL	MCM
Y1: DEPTH (FT)	8.0	7.1	7.1	7.9	9.4	19.1	19.1	19.1
V1: VEL. (FPS)	3.7	3.7	3.7	3.7	3.7	5.1	5.1	5.1
a: PIER WIDTH (FT)	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1
L: PIER LENGTH (FT)	16.4	16.4	16.4	16.4	16.4	16.4	16.4	16.4
PIER SHAPE	1	1	1	1	1	1	1	1
ATTACK ANGLE	20	20	20	20	20	20	20	20
K1 (SHAPE COEF.)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
K2 (ANGLE COEF.)	2.14	2.14	2.14	2.14	2.14	2.14	2.14	2.14
FROUDE NO.	0.23	0.24	0.24	0.23	0.21	0.20	0.20	0.20
COMPUTED SCOUR DEPTHS USING CSU EQUATION								
SCOUR DEPTH (FT)	7.65	7.53	7.53	7.63	7.82	9.85	9.85	9.85
MAX SCOUR DEPTH (FT)	8.41	8.28	8.28	8.40	8.60	10.83	10.83	10.83

HYDRAULIC VARIABLES USED IN CSU EQUATION			
PIER NUMBER	4	3	2
PIER STATION (FT)	425	450	475
LOCATION OF PIER	MCM	MCR	RTB
Y1: DEPTH (FT)	19.1	19.1	6.9
V1: VEL. (FPS)	5.1	5.1	2.2
a: PIER WIDTH (FT)	2.1	2.1	2.1
L: PIER LENGTH (FT)	16.4	16.4	16.4
PIER SHAPE	1	1	1
ATTACK ANGLE	20	20	20
K1 (SHAPE COEF.)	1.00	1.00	1.00
K2 (ANGLE COEF.)	2.14	2.14	2.14
FROUDE NO.	0.20	0.20	0.15
COMPUTED SCOUR DEPTHS USING CSU EQUATION			
SCOUR DEPTH (FT)	9.85	9.85	6.03
MAX SCOUR DEPTH (FT)	10.83	10.83	6.63

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

CONTRACTION SCOUR COMPUTATIONS
FOR
Q500 Thompson Creek at SC 9 Structure # 134000900400 Chesterfield Co.

LIVE-BED SCOUR COMPUTATIONS

	MAIN CHANNEL	CONTRACTED SECTION
DISCHARGE (CFS)	6776.	7709.
BOTTOM WIDTH (FT)	83.0	100.4
MANNINGS n	0.056	0.056
AVERAGE DEPTH (FT)	18.9	

ENERGY SLOPE	0.00160
D50 (FT)	0.0049
FALL VELOCITY (FPS)	0.68
K1 COEF.	0.64
K2 COEF.	0.21

COMPUTED DEPTH AT CONTRACTED SECTION (FT)	=	18.7
DEPTH AT MAIN CHANNEL (FT)	=	18.9
DEPTH OF CONTRACTION SCOUR (FT)	=	-0.2

LEFT OVERBANK IN BRIDGE OPENING
CLEAR-WATER CONTRACTION SCOUR COMPUTATIONS

DISCHARGE IN CONTRACTED SECTION (CFS)	=	10691.
WIDTH OF CONTRACTED SECTION (FT)	=	316.0
MEDIAN GRAIN SIZE (FT)	=	0.0010
COMPUTED DEPTH OF CONTRACTED SECTION (FT)	=	18.8
AVERAGE FLOOD PLAIN DEPTH (FT)	=	8.8
DEPTH OF CONTRACTION SCOUR (FT)	=	10.0

ABUTMENT SCOUR COMPUTATIONS
FOR
Thompson Creek at SC 9 Structure # 134000900400 Chesterfield Co.
500-year scour including the first eight bents JMS 30 MAR 1994

RIGHT ABUTMENT
SCOUR COMPUTATIONS

ABUTMENT TYPE	3 -SPILL THROUGH
DISCHARGE BLOCKED BY ABUTMENT (CFS)	6166.
AREA BLOCKED BY ABUTMENT (SQ FT)	4700.0
DEPTH OF FLOW AT ABUTMENT (FT)	6.9
LENGTH OF ABUT. 90 DEG. TO FLOW (FT)	537.0
ABUTMENT SKEW (DEG)	-20
AJUSTED ABUTMENT LENGTH (FT)	681.2
AVERAGE F/P VELOCITY U/S OF ABUT. (FPS)	1.3
FROUDE NUMBER	0.088
K1 COEF.	0.6
K2 COEF.	1.0

DESIGN DEPTH OF SCOUR (FROELICH EQUATION, 1989) (FT) = 20.5

SHEET NO.	STATE	COUNTY	FILE NO.
3	S. C.	Chesterfield	13.457 RF-094-2(52)

INDEX OF SHEETS

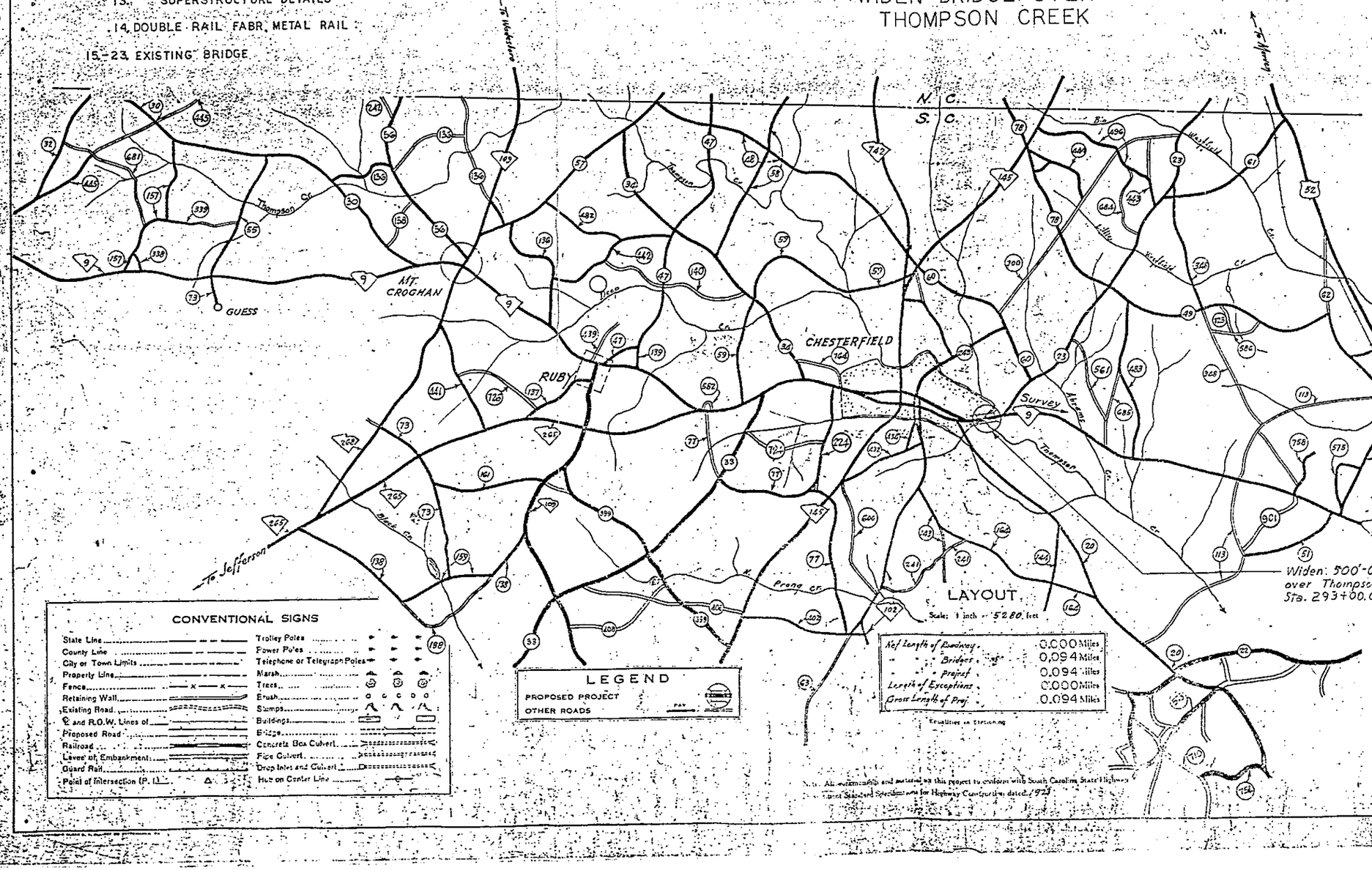
SOUTH CAROLINA
STATE HIGHWAY DEPARTMENT
COLUMBIA

PLAN AND PROFILE OF PROPOSED STATE HIGHWAY

F.A. PROJ. NO. RF-094-2(52)
FILE NO. 13.457
ROUTE NO. S.C. 9
CHESTERFIELD COUNTY
WIDEN BRIDGE OVER
THOMPSON CREEK

SUMMARY OF ESTIMATED QUANTITIES

DRY EXCAVATION	
WET EXCAVATION	
ROCK EXCAVATION	
CONCRETE, CLASS "A"	
REINFORCING STEEL	2
16" SQ. PRESTR. CONC. PILES	
FABRICATED METAL HANDRAIL (ALUM OR STEEL)	



CONVENTIONAL SIGNS

State Line
County Line
City or Town Limits
Property Line
Fence
Retaining Wall
Existing Road
℄ and R.O.W. Lines of
Proposed Road
Railroad
Levee or Embankment
Guard Rail
Point of Intersection (P.I.)
Trolley Poles
Power Pole's
Telephone or Telegraph Poles
Marsh
Trees
Brush
Stumps
Buildings
Bridge
Concrete Box Culvert
Pipe Culvert
Drop Inlet and Culvert
Hub on Center Line

LEGEND

PROPOSED PROJECT
OTHER ROADS

LAYOUT

Scale: 1 inch = 5280 feet

Net Length of Roadway	0.000 Miles
" " " Bridges	0.094 Miles
" " " Project	0.094 Miles
Length of Exceptions	0.000 Miles
Gross Length of Proj.	0.094 Miles

Equalities on Stationing

Note: All materials and material on this project to conform with South Carolina State Highway Current Standard Specifications for Highway Construction dated 1973

APPROVED:
Paul W Cobb
STATE HIGHWAY ENGINEER

DEPARTMENT OF
BUREAU OF PUBL
APPROVED
DISTRICT ENGINEER

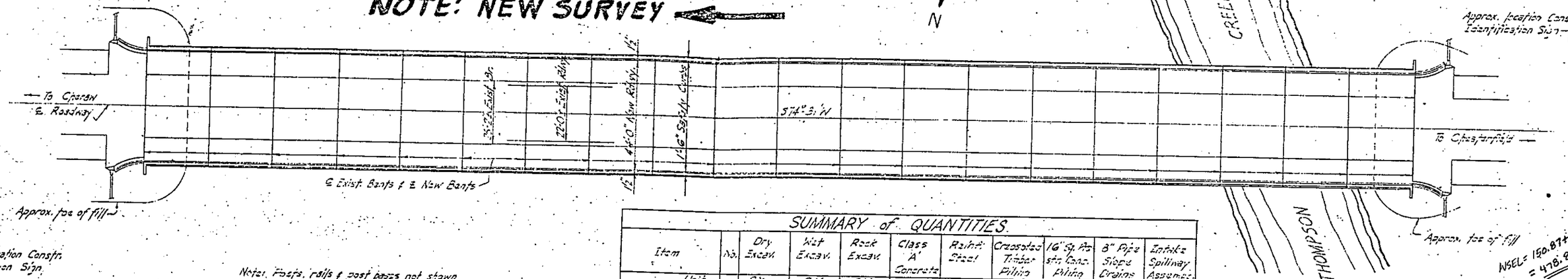
RECOMMENDED BY:
BRIDGE ENGINEER - DESIGN
7-12-74
DATE

Quinn P. Gilc. 4-1-74

FED. RD. DIV. NO.	STATE	COUNTY	FILE NO.	ROUTE NO.	SHEET NO.	TOTAL SHEETS
3	S.C.	CHESTERFIELD	13.457	9	03	29

EXIST. BRIDGE (FOR INFORMATION ONL

NOTE: NEW SURVEY



Approx. location Constr. Identification Sign

Note: Posts, rails & post bases not shown. Drains not shown. For location & details see Sheet No. 12. Field & exam. ends of new slab shall match field & exam. ends of existing beams and slabs.

SUMMARY of QUANTITIES

Item	No.	Dry Excav.	Wet Excav.	Rock Excav.	Class 'A' Concrete	Reinf. Steel	Creosoted Timber Piling	16" Sq. Prestr. Conc. Piling	8" Pipe Slope Drains	Intake Spillway Assemb.
Unit	-	C.Y.	C.Y.	C.Y.	C.Y.	Lbs.	L.F.	L.F.	L.F.	Ea.
End Bents 1 & 5	2	—	—	—	12.2	1,624	240	—	—	—
Int. Bents 2-4	11	—	—	—	65.2	8,451	—	924	—	—
Int. Bents 1+2-3	3	35	393	171	145.5	27,627	—	—	—	—
15' End Spans	2	—	—	—	7.5	14,352	—	—	—	—
25' Int. Spans	18	—	—	—	637.0	127,726	—	—	—	—
Curb & Gutter	2	—	—	—	2.2	153	—	—	64	4
Totals	-	35	393	171	943.2	180,242	240	924	64	4

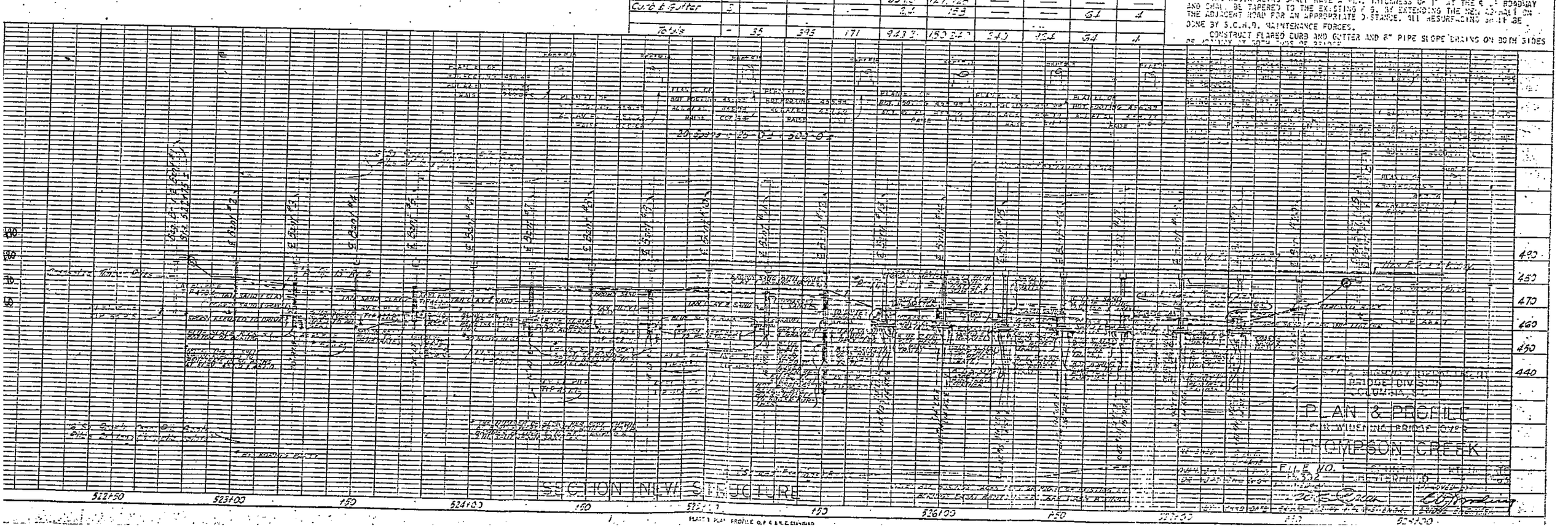
NOTES:

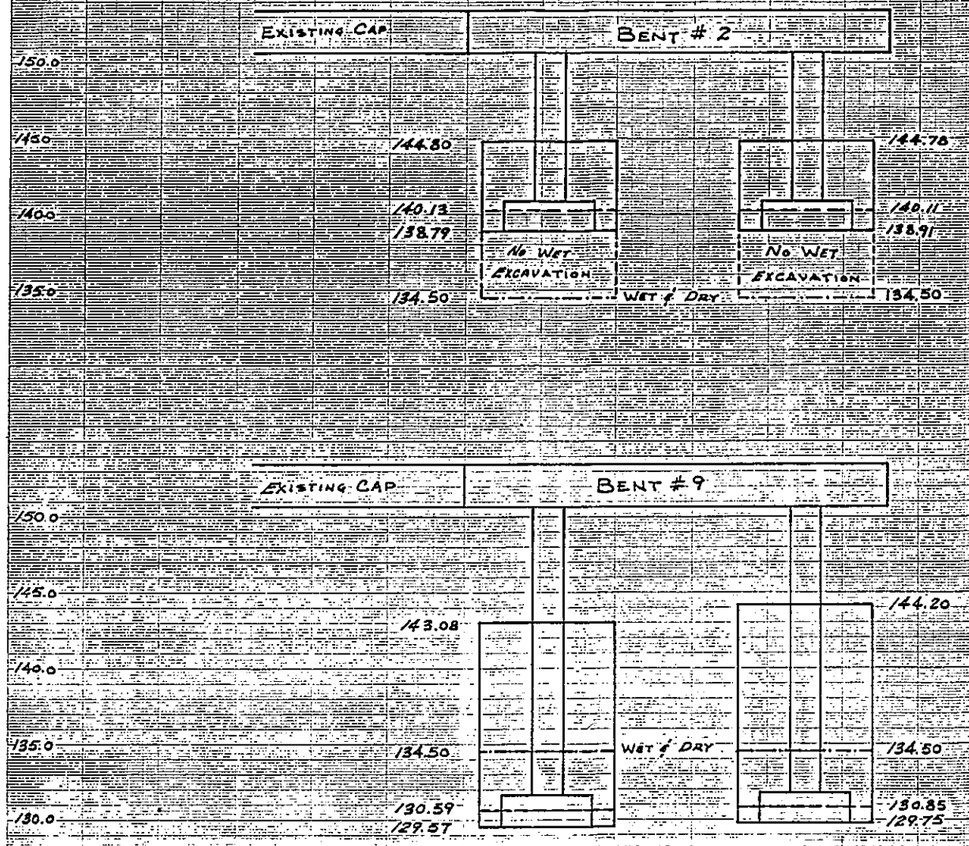
THE RESIDENT ENGINEER SHALL OBTAIN EXISTING F.G. ELEVATIONS AT THE ℄ OF ROADWAY ON THE EXISTING BRIDGE AND ADJACENT ROAD (AT ABOUT 25' INTERVALS FOR ABOUT 100' BACK FROM EACH END OF THE BRIDGE) FOR THE PURPOSE OF ESTABLISHING THE F.G. FOR THE NEW BRIDGE. THE NEW F.G. SHALL BE SET APPROX. 1" ABOVE THE EXISTING F.G.

THE RESURFACING SHALL HAVE A MIN. THICKNESS OF 1" AT THE ℄ OF ROADWAY AND SHALL BE TAPERED TO THE EXISTING F.G. BY EXTENDING THE NEW ASPHALT ON THE ADJACENT ROAD FOR AN APPROPRIATE DISTANCE. ALL RESURFACING SHALL BE DONE BY S.C.H.D. MAINTENANCE FORCES.

CONSTRUCT FLARED CURB AND GUTTER AND 8" PIPE SLOPE DRAINS ON BOTH SIDES AS SHOWN AT BOTH ENDS OF BRIDGE.

WSEL = 150.87 + 328 = 478.87





BENT No.	FTG. No.	ORIG ELEV.	WET & DRY	ROCK ELEV.	EXCAVATION DATA: FINAL ELEV.	DRY EXCAVATION	WET EXCAVATION	ROCK EXCAVATION
2	1	144.80	134.50	140.13	138.79	9'9"x4.67'÷27 = 14.01	No Wet Excavation	9'x9'x1.34÷27 =
2	2	144.78	134.50	140.11	138.91	9'9"x4.47÷27 = 14.01	No Wet Excavation	9'x9'x1.20÷27 =
3	1	134.29	134.50	132.17	131.46	No Dry Excavation		9'x9'x2.12÷27 = 6.36
3	2	133.55	134.50	132.36	131.28	No Dry Excavation		9'x9'x1.19÷27 = 3.57
4	1	135.16	134.50	130.52	129.45	9'x9'x0.66÷27 = 1.98		9'x9'x1.07÷27 =
4	2	134.69	134.50	130.60	129.57	9'x9'x0.19÷27 = 0.57		9'x9'x1.03÷27 =
5	1	136.15	134.50	131.18	129.60	9'x9'x1.65÷27 = 4.95		9'x9'x1.58÷27 =
5	2	136.50	134.50	130.93	129.07	9'x9'x2.00÷27 = 6.00		9'x9'x1.86÷27 =
6	1	138.48	134.50	129.92	128.39	9'x9'x3.98÷27 = 11.94		9'x9'x1.53÷27 =
6	2	141.33	134.50	130.16	128.00	9'x9'x6.83÷27 = 20.49		9'x9'x2.16÷27 =
7	1	143.55	134.50	129.81	128.61	9'x9'x9.05÷27 = 27.15		9'x9'x1.20÷27 =
7	2	144.82	134.50	130.39	129.26	9'x9'x10.32÷27 = 30.96		9'x9'x1.13÷27 =
8	1	143.81	134.50	130.69	129.46	9'x9'x9.31÷27 = 27.93		9'x9'x1.83÷27 =
8	2	144.49	134.50	130.45	129.37	9'x9'x9.99÷27 = 29.97		9'x9'x1.05÷27 =
9	1	143.08	134.50	130.59	129.57	9'x9'x8.58÷27 = 25.74		9'x9'x1.73÷27 =
9	2	144.20	134.50	130.85	129.75	9'x9'x9.70÷27 = 29.10		9'x9'x1.10÷27 =
						TOTAL DRY = 244.80	TOTAL WET = 153.06	TOTAL ROCK =

BENT No.	FTG. No.	PLAN GRADE BOT. CAP	PLAN LENGTH COL. & FTG.	PLAN GRADE FINAL ELEV.	REINFORCING STEEL UNDERRUN DATA: PLAN LENGTH REINF. STEEL	FINAL GRADE BOT. CAP	FINAL LENGTH COL. & FTG.	FINAL GRADE FINAL ELEV.	FINAL LENGTH REINF. STEEL	LBS. REINF. STEEL: BAR CO. NO. BARS WEIGHT BAR STEEL REINFORCING
2	1	150.65	15.00	135.65	15.25	150.65	11.86	138.79	12.11	3.14 x 8 x 2.67 = 67.07
2	2	150.65	15.00	135.65	15.25	150.65	11.74	138.91	11.99	3.26 x 8 x 2.67 = 69.63
3	1	150.65	19.33	131.32	19.58	150.65	19.19	131.46	19.44	0.14 x 8 x 2.67 = 2.99
3	2	150.65	19.33	131.32	19.58	150.65	19.37	131.28	19.62	No Cut OFF
4	1	150.65	20.67	129.98	20.92	150.65	21.20	129.45	21.45	No Cut OFF
4	2	150.65	20.67	129.98	20.92	150.65	21.08	129.57	21.33	No Cut OFF
5	1	150.65	20.67	129.98	20.92	150.65	21.05	129.60	21.30	No Cut OFF
5	2	150.65	20.67	129.98	20.92	150.65	21.58	129.07	21.83	No Cut OFF
6	1	150.65	21.75	128.90	22.00	150.65	22.26	128.39	22.51	No Cut OFF
6	2	150.65	21.75	128.90	22.00	150.65	22.65	128.00	22.90	No Cut OFF
7	1	150.65	21.75	128.90	22.00	150.65	22.04	128.61	22.29	No Cut OFF
7	2	150.65	21.75	128.90	22.00	150.65	21.39	129.26	21.64	0.36 x 8 x 2.67 = 7.69
8	1	150.65	21.75	128.90	22.00	150.65	21.19	129.46	21.44	0.56 x 8 x 2.67 = 11.96
8	2	150.65	21.75	128.90	22.00	150.65	21.28	129.37	21.53	0.47 x 8 x 2.67 = 10.04
9	1	150.65	21.75	128.90	22.00	150.65	21.08	129.57	21.33	0.67 x 8 x 2.67 = 14.31
9	2	150.65	21.75	128.90	22.00	150.65	20.90	129.75	21.15	0.85 x 8 x 2.67 = 18.16
									TOTAL REINFORCING STEEL UNDERRUN =	201.85

Ground Surface Plotted by_____
" " Checked by_____
Template Sections Plotted by_____
" " Checked by_____
Areas by_____
" Checked by_____
Templates Revised by_____
" " Checked by_____
Final Areas by_____
" " Checked by_____
Quantities Transferred & Tanked by_____

K. SPRAGUE — WEIGHT OF HAMMER 2,750 POUNDS — TYPE DIESEL — THOMPSON

DATE 1974	BENT NO.	FOOTING	PILE NO.	DIAM. AT BUTT	DIAM. AT TIP	ORIG. LENGTH	BUILD-UP OR SPLICE	TOTAL LENGTH	LENGTH C.O.	NET LENGTH	ELEV. C.O.	ELEV. OF TIP WHEN PLAN BEARING VALUE IS OBTAINED	ELEV. PILE TIP	ELEV. ORIG. GROUND OR BOTTOM OF FOOTING	PEN. IN GROUND OR BELOW FOOTING	PEN. PER BLOW	FALL OF HAMMER	BEARING VALUE	PAY LENGTH	C.O. 40%	ELEV.
11-22	1		1	16"	14"	20.0	0.00	20.0	10.76	9.24	150.82	141.76	141.52	150.65	9.13	REF.	6'	165T	20.0V		
11-22	1		2	↑	↑	20.0	0.00	20.0	10.85	9.15	150.82	141.67	141.67	150.65	8.98	REF.	6'	165T	20.0V		
11-21	1		3			20.0	0.00	20.0	11.20	8.80	150.82	142.02	142.02	150.65	8.63	REF.	6'	165T	20.0V		
11-22	1		4			20.0	0.00	20.0	12.45	7.55	150.82	143.96	143.47	150.65	7.18	REF.	6'	165T	20.0V	11.5	8.0
11-27	10		1			21.0	0.17	21.17	0.00	21.17	150.82	130.26	129.65	143.83	14.18	REF.	6'	165T	21.17		
11-27	10		2			21.0	0.17	21.17	0.00	21.17	150.82	130.18	129.65	144.17	14.52	REF.	6'	165T	21.17		
11-27	10		3			21.0	0.12	21.12	0.00	21.12	150.82	130.04	129.70	144.20	14.50	REF.	6'	165T	21.12		
11-27	10		4			21.0	0.79	21.79	0.00	21.79	150.82	129.42	129.03	144.29	15.26	REF.	6'	165T	21.79		
11-27	10		5			21.0	0.33	21.33	0.00	21.33	150.82	129.64	129.89	144.56	15.09	REF.	6'	165T	21.33		
11-28	11		1			21.0	0.00	21.00	0.00	21.00	150.82	130.23	129.82	143.69	13.87	REF.	6'	165T	21.00		
11-28	11		2			21.0	0.00	21.00	0.00	21.00	150.82	130.27	129.82	144.52	14.70	REF.	6'	165T	21.00		
11-28	11		3			21.0	0.00	21.00	0.00	21.00	150.82	130.41	129.82	144.87	15.05	REF.	6'	165T	21.00		
11-28	11		4			21.0	0.00	21.00	0.00	21.00	150.82	130.37	129.82	145.17	15.35	REF.	6'	165T	21.00		
11-28	11		5			21.0	0.00	21.00	0.00	21.00	150.82	130.31	129.82	145.37	15.55	REF.	6'	165T	21.00		
12-2	12		1			21.0	0.00	21.00	0.00	21.00	150.82	130.36	129.82	143.86	14.04	REF.	6'	165T	21.00		
12-2	12		2			21.0	0.00	21.00	0.00	21.00	150.82	130.48	129.82	144.10	14.28	REF.	6'	165T	21.00		
12-2	12		3			21.0	0.00	21.00	0.00	21.00	150.82	130.40	129.82	144.38	14.76	REF.	6'	165T	21.00		
12-2	12		4			21.0	0.00	21.00	0.00	21.00	150.82	130.29	129.82	144.87	15.05	REF.	6'	165T	21.00		
12-2	12		5			21.0	0.00	21.00	0.00	21.00	150.82	130.64	129.82	145.18	15.36	REF.	6'	165T	21.00		
12-3	13		1			21.0	0.00	21.00	0.00	21.00	150.82	129.99	129.82	144.03	14.21	REF.	6'	165T	21.00		
12-3	13		2			21.0	0.00	21.00	0.00	21.00	150.82	130.22	129.82	144.38	14.56	REF.	6'	165T	21.00		
12-3	13		3			21.0	0.00	21.00	0.00	21.00	150.82	130.43	129.82	144.57	14.75	REF.	6'	165T	21.00		
12-3	13		4			21.0	0.00	21.00	0.00	21.00	150.82	130.37	129.82	145.06	15.24	REF.	6'	165T	21.00		
12-3	13		5			21.0	1.20	22.20	0.00	22.20	150.82	128.04	128.62	145.08	16.46	REF.	6'	165T	22.20	0.0	136.2
12-3	14		1			21.0	0.00	21.00	0.00	21.00	150.82	130.14	129.82	143.47	13.65	REF.	6'	165T	21.00		
12-3	14		2			21.0	0.00	21.00	0.00	21.00	150.82	130.18	129.82	144.21	14.39	REF.	6'	165T	21.00		
12-3	14		3			21.0	0.00	21.00	0.00	21.00	150.82	130.21	129.82	144.58	14.76	REF.	6'	165T	21.00		
12-3	14		4			21.0	0.00	21.00	0.00	21.00	150.82	130.31	129.82	144.71	14.89	REF.	6'	165T	21.00		
12-3	14		5			21.0	0.00	21.00	0.00	21.00	150.82	130.33	129.82	145.08	15.26	REF.	6'	165T	21.23		
12-4	15		1			21.0	0.23	21.23	0.00	21.23	150.82	129.83	129.59	143.56	13.97	REF.	6'	165T	21.08		
12-4	15		2			21.0	0.08	21.08	0.00	21.08	150.82	129.92	129.74	143.84	14.10	REF.	6'	165T	21.08		
12-4	15		3			21.0	0.08	21.08	0.00	21.08	150.82	129.84	129.74	143.77	14.03	REF.	6'	165T	21.08		
12-4	15		4			21.0	0.00	21.00	0.17	20.83	150.82	130.52	129.99	144.70	14.71	REF.	6'	165T	21.00		
12-4	15		5			21.0	0.00	21.00	0.25	20.75	150.82	130.36	130.07	144.72	14.65	REF.	6'	165T	21.00		
12-5	16		1			21.0	0.00	21.00	0.58	20.42	150.82	132.73	130.40	142.62	12.22	REF.	6'	165T	21.00		
12-5	16		2			21.0	0.00	21.00	0.25	20.75	150.82	130.29	130.07	143.23	13.16	REF.	6'	165T	21.00		
12-5	16		3			21.0	0.00	21.00	0.67	20.33	150.82	130.72	130.49	143.59	13.10	REF.	6'	165T	21.00		
12-5	16		4			21.0	0.00	21.00	0.83	20.17	150.82	130.94	130.65	144.25	13.60	REF.	6'	165T	21.00	6.0	105
12-5	16		5			21.0	0.00	21.00	0.83	20.17	150.82	130.89	130.65	144.59	13.94	REF.	6'	165T	21.00		
12-6	17		1			21.0	0.00	21.00	0.58	20.42	150.82	132.71	130.40	142.10	11.70	REF.	6'	165T	21.00		
12-6	17		2			21.0	0.00	21.00	0.25	20.75	150.82	130.32	130.07	142.35	12.28	REF.	6'	165T	21.00		
12-6	17		3			21.0	0.00	21.00	0.25	20.75	150.82	130.41	130.07	142.68	12.61	REF.	6'	165T	21.00		
12-6	17		4			21.0	0.00	21.00	0.25	20.75	150.82	130.27	130.07	143.54	13.47	REF.	6'	165T	21.00		
12-6	17		5			21.0	0.00	21.00	0.58	20.42	150.82	130.68	130.40	143.59	13.19	REF.	6'	165T	21.00		
12-9	18		1			21.0	0.00	21.00	0.58	20.42	150.82	130.73	130.40	141.98	11.58	REF.	6'	165T	21.00		
12-9	18		2			21.0	0.00	21.00	0.17	20.83	150.82	130.37	129.98	141.84	11.85	REF.	6'	165T	21.00		
12-9	18		3			21.0	0.17	21.17	0.00	21.17	150.82	130.98	129.65	142.14	12.49	REF.	6'	165T	21.17		
12-9	18		4			21.0	0.00	21.00	0.25	20.75	150.82	130.44	130.07	142.44	12.37	REF.	6'	165T	21.00		
12-9	18		5			21.0	0.17	21.17	0.00	21.17	150.82	129.99	129.65	142.65	13.00	REF.	6'	165T	21.17		
12-10	19		1			21.0	0.00	21.00	0.75	20.25	150.82	131.04	130.57	142.98	12.41	REF.	6'	165T	21.00		
12-10	19		2			21.0	0.00	21.00	1.08	20.00	150.82	131.15	130.82	143.69	12.87	REF.	6'	165T	21.00		
12-10	19		3			21.0	0.00	21.00	0.58	20.42	150.82	130.77	130.40	143.13	12.73	REF.	6'	165T	21.00		
12-10	19		4			21.0	0.00	21.00	0.33	20.67	150.82	130.32	130.15	142.12	12.97	REF.	6'	165T	21.00		
12-10	19		5			21.0	0.17	21.17	0.00	21.17	150.82	129.87	129.65	143.23	13.58	REF.	6'	165T	21.17	4.0	110.5
12-11	20		1			21.0	0.00	21.00	2.00	19.00	150.82	132.16	131.82	144.09	12.27	REF.	6'	165T	21.00		
12-11	20		2			21.0	0.00	21.00	1.42	19.58	150.82	131.61	131.24	144.24	13.00	REF.	6'	165T	21.00		
12-11	20		3			21.0	0.00	21.00	1.33	19.67	150.82	131.57	131.15	144.08	12.93	REF.	6'	165T	21.00		
12-11	20		4			21.0	0.00	21.00	1.33	19.67	150.82	131.49	131.15	143.75	12.60	REF.	6'	165T	21.00	3.5	105
12-11	20		5			21.0	0.00	21.00	1.33	19.67	150.82	131.36	131.15	143.41	12.26	REF.	6'	165T	21.00		
12-12	21		1			21.0	0.00	21.00	2.06	18.94	150.82	132.12	131.88	150.65	18.77	REF.	6'	165T	21.00		
12-12	21		2			21.0	0.00	21.00	3.16	17.84	150.82	133.22	132.98	150.65	17.67	REF.	6'	165T	21.00		
12-12	21		3	↓	↓	21.0	0.00	21.00	2.60	18.40	150.82	132.74	132.82	150.65	17.83	REF.	6'	165T	21.00	2.0	108
12-12	21		4	16"	16"	21.0	0.00	21.00	3.00	18.00	150.82	133.19	132.82	150.65	17.83	REF.	6'	165T	21.00		
TOTAL						1319.00	3.68	1322.68	72.78	1249.90									1322.68		

DATE 1974	BENT NO.	FOOTING	PILE NO.	DIAM. AT BUTT	DIAM. AT TIP	ORIG. LENGTH	BUILD-UP OR SPLICE	TOTAL LENGTH	LENGTH C.O.	NET LENGTH	ELEV. C.O.	ELEV. OF TIP WHEN PLAN BEARING VALUE IS OBTAINED	ELEV. PILE TIP	ELEV. ORIG. GROUND OR BOTTOM OF FOOTING	PEN. IN GROUND OR BELOW FOOTING	PEN. PER BLOW	FALL OF HAMMER	BEARING VALUE

TOTAL

GRAND TOTAL

NOTES CONCERNING ANY UNUSUAL FOUNDATION CONDITIONS

BENT NO.	FOOTING	PILE NO.	REMARKS

NOTES:

PAY LENGTH S
ALLOWANCE FOR
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PILE RECORD

CONSTRUCTION

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

CHESTERFIELD QUADRANGLE
SOUTH CAROLINA—CHESTERFIELD CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)

STUDY AREA

APPR
EXIT
T70
SYNC
SYNA
SYNB

Chesterfield
Claypit
Oakland Ch
Shiloh
Shiloh Ch
Bethesda
Bethesda Ch
Cross Branch Ch
Bay Branch Ch
St James Ch
Peniel Ch
Mount Mary Ch
Dreilla Ch
Lower Macedonia Ch
Teal Chapel
Farmie Cem
Cross Branch Cem
Merriman Millpond
Robeson Millpond
Teal Millpond
Hunts Millpond
Hunts Mill
Sewage Disposal Pond
Edwards Sch
County Cem
County Prison Farm
Sub Sta
Indian Creek
Thompson Creek
Abrams Creek
Reedy Branch
Robeson Branch
Tapert Branch
Mash Branch
Strickland Branch
Cross Branch
Mount Prong
Rocky Prong
Bay Branch
Little Bear Creek
Big Bear Creek
Twitty Creek
Pipeline
Jeep Trail

19 MI. TO U.S. 74
MORVEN, N.C. 10 MI.
RUBY 3.7 MI.
4.6 MI. TO S.C. 109
4953 II NW
(RUBY)
(MIDDENDORF)
4953 II SW
(PATRICK)
4953 II SE
PATRICK (U.S. 1) 4 MI.
CHERAW 7 MI.
BENNETTSVILLE 22 MI.

80°07'30"
80°00'
34°45'
34°37'30"
42'30"
40'
2'30"
5'
2 290 000 FEET
2 270 000 FEET
630 000 FEET
600 000 FEET
3845000m.N.
3832000m.N.
581000m.E.
591000m.E.

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 1968

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 3°68 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

SCALE 1:24 000

CONTOUR INTERVAL 10 FEET
DATUM IS MEAN SEA LEVEL

EXPLANATION

—— EXIT cross section

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
State Route

S.C.
QUADRANGLE LOCATION

CHESTERFIELD, S. C.
N3437.5—W8000/7.5

1968

AMS 4953 II NE—SERIES V846

INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D. C.—1970

Figure 1.--Topography of study area and location of cross sections used in WSPRO analysis for structure 134000900400 on Route SC 9, crossing Thompson Creek in Chesterfield County, South Carolina.