

LEVEL II BRIDGE SCOUR ANALYSIS REPORT  
OF  
STRUCTURE NO. 18-4-0165-0-08-00  
SC ROUTE-165 OVER  
DORCHESTER CREEK  
IN  
DORCHESTER COUNTY, SOUTH CAROLINA



FEBRUARY, 1995

Prepared for:



SOUTH CAROLINA DEPARTMENT OF TRANSPORTATION  
COLUMBIA, SOUTH CAROLINA

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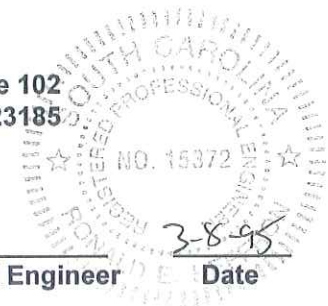
3-7-95  
Date

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Date



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**SUMMARY REPORT**  
**LEVEL II BRIDGE SCOUR ANALYSIS**  
**STRUCTURE NO. 18-4-0165-0-08-00**  
**SC-165 OVER DORCHESTER CREEK**  
**DORCHESTER COUNTY, SOUTH CAROLINA**

**1.1 Introduction**

This report presents the results of a Level II analysis of scour potential at Structure No. 18-4-0165-0-08-00, SC-165 over Dorchester Creek in Dorchester County, South Carolina. This work was authorized by Supplemental Agreement No. 4701-94 of Contract No. 747 (CEI Job No. 1844).

**1.2 Description of the Site and Bridge**

The site is located in the Lower Coastal Plain physiographic province near the town of Stallville in Dorchester County. Dorchester Creek also known as Sawmill Branch is a tributary of the Ashley River which continues on to the coast near Charleston, South Carolina. Figure 1 shows the topography in the vicinity of the bridge and Photographs 1 through 6 show typical views of the bridge and upstream and downstream conditions.

The State Route 165 crossing of Dorchester Creek consists of a single 118-foot long, two-lane bridge. The bridge consists of four 22-foot long concrete spans and one 30-foot span, supported by prestressed concrete pile bents with spill-through abutments. The left and right abutments are unprotected and signs of erosion are present. Additional details describing conditions at the site are included in Section 2.0 of this report.

**1.3 Hydraulics**

The drainage area for the site is 19.2 mi<sup>2</sup>. Land use is predominantly rural with some encroaching development. Figure 2 shows a map of the tributary drainage area. In the vicinity of the study site, the land is covered by moderate to dense woods, consisting primarily of deciduous trees.

In the study area, Dorchester Creek has a straight well-defined and relatively uniform, swampy channel with a slope of approximately 0.00083 ft/ft (4.38 ft/mi). Average channel top width is 55 feet (at the bridge) and average channel depth is 6.0 feet (at the bridge). The channel is well defined both upstream and downstream of the bridge and signs of channel straightening are apparent. Moderate tree coverage is found in the surrounding area. The predominant channel bed material is fine clayey sand with some silt. The channel banks consist primarily of clayey sand. In general, the banks have

a heavy vegetative cover and were noted to be relatively stable at the time of the site visit.

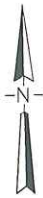
#### **1.4 Scour Analysis**

The scour analysis was made using engineering judgement and the general guidelines described in Hydraulic Engineering Circular No. 18 (Richardson and others, Second edition-1993) and the Transportation Research Board draft paper, "Evaluating Scour at Bridges Using WSPRO" (Arneson and others, 1992). Scour calculations were made assuming an infinite depth of erosive material and a homogeneous particle size distribution.

The results of the scour analysis are presented in Tables 1 and 2 and graphs of the scour depths are presented in Figures 5 and 6. The maximum total scour depths predicted for the 100-year and 500-year discharges are 11.5 and 14.2 feet, respectively.

#### **1.5 Conclusions and Recommendations**

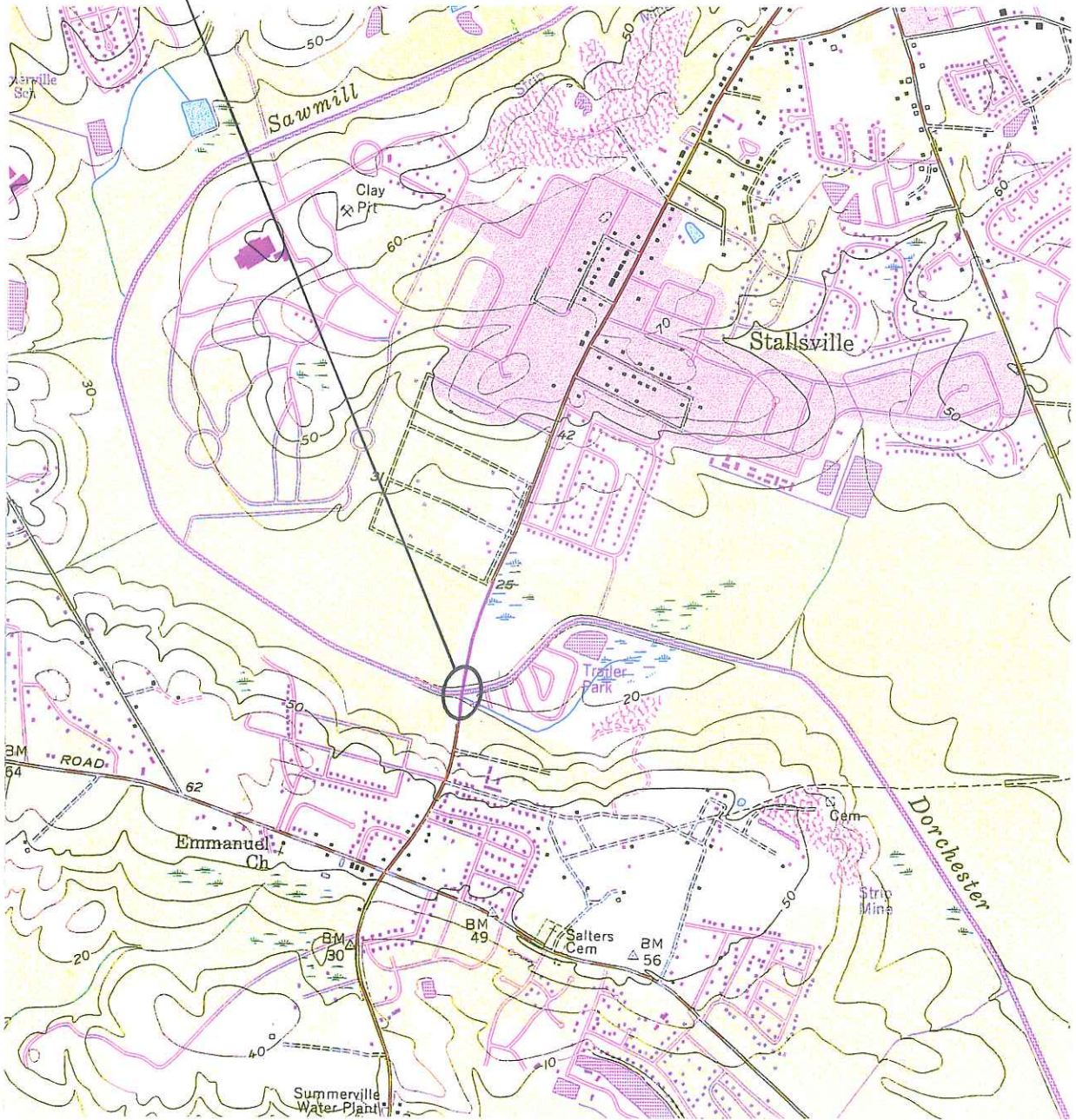
The predicted scour depths for both the 100-year and 500-year discharges exceed the depth of embedment of the piles. Therefore, it is recommended that appropriate countermeasures be designed and installed at this site to protect the substructure from these erosive forces. In addition, riprap which has eroded from the abutment embankments should be restored.



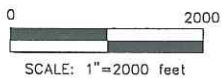
STRUCTURE NO. 18-4-0165-0-08-00  
 SC-165 OVER DORCHESTER CREEK



DORCHESTER COUNTY



GRAPHIC SCALE



COLLINS ENGINEERS, INC.

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FEBRUARY, 1995

SOUTH CAROLINA  
 DEPARTMENT OF TRANSPORTATION

STR. NO. 18-4-0165-0-08-00  
 SC-165 OVER DORCHESTER CREEK

TOPOGRAPHY AT  
 BRIDGE VICINITY

FIG. NO.

1

2/27/95 GAF

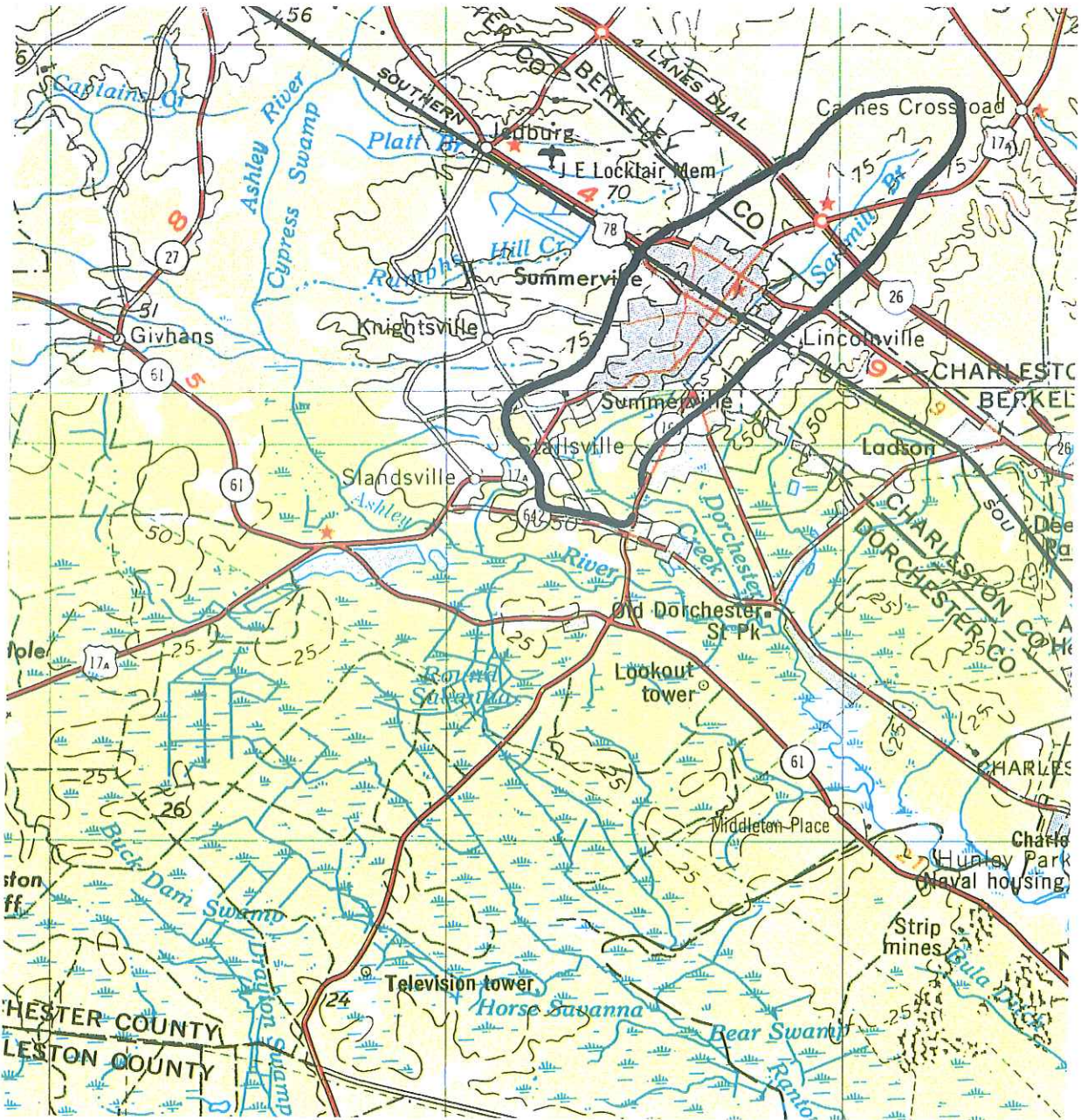


SC-165 OVER DORCHESTER CREEK

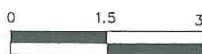
DRAINAGE AREA = 19.2 MI<sup>2</sup>



DORCHESTER COUNTY



GRAPHIC SCALE



SCALE: 1"=3 miles



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TRIBUTARY  
DRAINAGE AREA

FIG. NO.

2

## UNIT ABBREVIATIONS

cubic foot per second	ft <sup>3</sup> /s
feet per second	ft/s
foot	ft
mile	mi
millimeter	mm
square foot	ft <sup>2</sup>
square mile	mi <sup>2</sup>

## OTHER ABBREVIATIONS

downstream	D/S
upstream	U/S
northbound lane	NBL
southbound lane	SBL
eastbound lane	EBL
westbound lane	WBL
flood plain	f/p
median diameter of bed material	D <sub>50</sub>
South Carolina Department of Transp.	SC DOT

---

In this report, "right" and "left" refer to directions facing downstream.

## 2.0 DETAILS OF SCOUR ANALYSIS

Structure Number(s) 18-4-0165-0-08-00 Stream Dorchester Creek  
County Dorchester Route SC-165 District \_\_\_\_\_

### 2.1 Description of Bridge(s):

Bridge Length 118 ft Bridge Width 44.0 ft Max. Span Length 30 ft

Alignment of Bridge to Road (on curve or straight) straight

Abutment Type spill through Embankment Type sloping

Riprap on Abutment no Date of Site Visit 1-5-95

Description of Riprap Original bridge plans called for riprap along the abutments but there is no sign of riprap at the site and abutments are currently unprotected.

Brief Description of Piers/Pile Bents Six sets of bents - each bent has nine 16-inch square prestressed concrete piles. Each bent has a 2.5-foot wide by 2.5-foot high concrete cap.

Is Bridge Skewed to Flood Plain According to USGS Topo Map? yes Angle 20

Is Bridge Located on a Bend in the Channel? no If so, describe (mild, moderate, severe)

#### Debris Accumulation on Bridge at Time of Site Visit:

Date of Site Visit	Percent of Channel Blocked Horizontally	Percent of Channel Blocked Vertically
1-5-95	<5%	<5%

Potential for Debris Moderate potential for debris due to likelihood of high flow in heavily wooded, vegetated swampy flood plain.

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

None

## 2.2 Description of Flood Plain:

**General Topography** Generally flat, swampy flood plain upstream and downstream. Some localized rises present, as well as swamp drains.

### Flood Plain Conditions at Bridge Site: Downstream (D/S), Upstream (U/S)

**Date of Site Visit** 1-5-95

**D/S Left:** Heavily wooded with some trees and dense brush

**D/S Right:** Heavily wooded with mature trees and dense brush

**U/S Left:** Heavily wooded with mature trees and brush

**D/S Right:** Heavily wooded with mature trees and brush

## 2.3 Description of Channel:

**Average Top Width** 55 ft (at bridge) **Average Depth** 6.0 ft

**Predominant Bed Material** fine clayey sand **Bank Material** clayey sand

**Stream Type (straight, meandering, braided, swampy, channelized)** straight, swampy

**Vegetative Cover on Channel Banks Near Bridge:** **Date of Site Visit** 1-5-95

**D/S Left:** Grassy embankments with light vegetation mostly bushes and some trees.

**D/S Right:** Grassy embankments with small trees and moderate vegetation.

**U/S Left:** Grassy embankments with medium and mature deciduous trees.

**U/S Right:** Grassy embankments, with a timber retaining wall and heavy trees.

**Do Banks Appear Stable?** Yes **If not, Describe Location and Type of Instability**

**and Date of Observation** Embankments are very uniform both upstream and downstream. A timber retaining wall is located on the upstream right side where the slope is eroding

**Describe any Obstructions and Date of Observation** None

## Consultant Scour Study Check List

County Dorchester Crossing Dorchester Ck.  
 Road/Route SC165  
 Consultant Ayres

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

Check List	Correct	Incorrect	Comments
County	✓		
Structure #	✓		
Stream Name	✓		
Physiographic Province	✓		
Description of Location	✓		
Bridge Length and Width	✓		
Max Span Length	✓		
# of Spans	✓		
D50	✓		
Skew	✓		
Q100		✓	Use FIS FEMA Study 01
Q500		✓	
Discharge Method and applicability		✓	Used FIS study and assumed Rural
WSPRO Cross section Locations	✓		
WSPRO Setup		✓	Used incorrect values for H <sub>p</sub> and H <sub>p2</sub> cards
Inputs for scour against WSPRO			
Equations for Scour	✓		

NATIONAL BRIDGE INVENTORY AND APPRAISAL

```

***** IDENTIFICATION ***** STRUCTURE INVENTORY AND APPRAISAL *****
(1) STATE NAME - SOUTH CAROLINA # 000184016500800 CODE 454
(8) STRUCTURE NUMBER # 000184016500800
(5) INVENTORY ROUTE (ON/UNDER) - ON = 131001650
(2) STATE HIGHWAY DEPARTMENT DISTRICT
(3) COUNTY CODE 18 (4) PLACE CODE 0
(6) FEATURES INTERSECTED - DORCHESTER CREEK
(7) FACILITY CARRIED - SC 165
(9) LOCATION - 3.2MI SW SWMR,VL
(11) MILEPOINT 10.840
(16) LATITUDE 32 DEGREES 58 MINUTES 24.00 SECONDS
(17) LONGITUDE 80 DEGREES 11 MINUTES 54.00 SECONDS
(98) BORDER BRIDGE STATE CODE %SHARE %
(99) BORDER BRIDGE STRUCTURE NO. #
***** STRUCTURE TYPE AND MATERIAL *****
(43) STRUCTURE TYPE MAIN: MATERIAL - CONCRETE CODE 101
TYPE - SLAB
(44) STRUCTURE TYPE APPR: MATERIAL - OTHER CODE 000
TYPE - OTHER
(45) NUMBER OF SPANS IN MAIN UNIT CODE 5
(46) NUMBER OF APPROACH SPANS
(107) DECK STRUCTURE TYPE - CONCRETE CAST-IN-PL CODE 1
(108) WEARING SURFACE / PROTECTIVE SYSTEM:
A) TYPE OF WEARING SURFACE - CONCRETE CODE 1
B) TYPE OF MEMBRANE - UNKNOWN CODE 8
C) TYPE OF DECK PROTECTION - UNKNOWN CODE 8
***** AGE AND SERVICE *****
(27) YEAR BUILT 1973
(106) YEAR RECONSTRUCTED
(42) TYPE OF SERVICE ON - HIGHWAY CODE 15
UNDER - WATERWAY
(28) LANES: ON STRUCTURE 2 UNDER STRUCTURE
(29) AVERAGE DAILY TRAFFIC 15800
(30) YEAR OF ADT 1999 03 %
(19) BYPASS, DETOUR LENGTH (109) TRUCK ADT 2 MI
***** GEOMETRIC DATA *****
(48) LENGTH OF MAXIMUM SPAN 30 FT
(49) STRUCTURE LENGTH 118 FT
(50) CURB OR SIDEWALK: LEFT FT RIGHT FT
(51) BRIDGE ROADWAY WIDTH CURB TO CURB 44.0 FT
(52) DECK WIDTH OUT TO OUT 45.5 FT
(32) APPROACH ROADWAY WIDTH (W/SHOULDERS) 40 FT
(33) BRIDGE MEDIAN - NO MEDIAN CODE 0
(34) SKEW DEG (35) STRUCTURE FLARED NO
(10) INVENTORY ROUTE MIN VERT CLEAR 99 FT 99 IN
(47) INVENTORY ROUTE TOTAL HORIZ CLEAR 44.0 FT
(53) MIN VERT CLEAR OVER BRIDGE ROADWAY 99 FT 99 IN
(54) MIN VERT UNDERCLEAR REF - OTHER FT IN
(55) MIN LAT UNDERCLEAR RT REF - OTHER 99.9 FT
(56) MIN LAT UNDERCLEAR LT FT
***** CLASSIFICATION *****
(112) NBIS BRIDGE LENGTH -
(104) HIGHWAY SYSTEM -
(26) FUNCTIONAL CLASS -
(100) STRAIGHT HIGHWAY - NOT STRAIGHT HWY 16
(101) PARALLEL STRUCTURE - NONE EXIST 0
(102) DIRECTION OF TRAFFIC - 2-WAY TRAFFIC N
(103) TEMPORARY STRUCTURE - NOT TEMPORARY 2
(110) DESIGNATED NATIONAL NETWORK - NOT PART 0
(20) TOLL - ON FREE ROAD 3
(21) MAINTAIN - STATE HIGHWAY AGENCY 1
(22) OWNER - SCDOT 1
(37) HISTORICAL SIGNIFICANCE - NOT ELIGIBLE 5
***** CONDITION *****
(58) DECK 7
(59) SUPERSTRUCTURE 7
(60) SUBSTRUCTURE 7
(61) CHANNEL & CHANNEL PROTECTION 8
(62) CULVERTS N
***** LOAD RATING AND POSTING *****
(31) DESIGN LOAD - HS-20 5
(64) OPERATING RATING - HS 5
(66) INVENTORY RATING - HS 41
(70) BRIDGE POSTING - NO POSTING REQUIRED 5
(41) STRUCTURE OPEN, POSTED OR CLOSED - DESCRIPTION - OPEN - NO RESTRICTIONS A
***** APPRAISAL *****
(67) STRUCTURE EVALUATION CODE 7
(68) DECK GEOMETRY 6
(69) UNDERCLEARANCES, VERTICAL & HORIZONTAL N
(71) WATERWAY ADEQUACY 8
(72) APPROACH ROADWAY ALIGNMENT 6
(36) TRAFFIC SAFETY FEATURES 0111
(113) SCOUR CRITICAL BRIDGES 3
***** PROPOSED IMPROVEMENTS *****
(75) TYPE OF WORK - CODE
(76) LENGTH OF STRUCTURE IMPROVEMENT 000118 FT
(94) BRIDGE IMPROVEMENT COST $ 99,000
(95) ROADWAY IMPROVEMENT COSTS $ 9,000
(96) TOTAL PROJECT COST $ 149,000
(97) YEAR OF IMPROVEMENT COST ESTIMATE 2019
(114) FUTURE ADT 021646
(115) YEAR OF FUTURE ADT 2019

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***** NAVIGATION DATA *****
(38) NAVIGATION CONTROL - NO NAV. CONTROL      CODE 0
(111) PIER PROTECTION - N/A                    CODE
(39) NAVIGATION VERTICAL CLEARANCE            FT
(116) VERT-LIFT BRIDGE NAV MIN VERT CLEAR    FT
(40) NAVIGATION HORIZONTAL CLEARANCE          FT

SIA.TXT

***** INSPECTIONS *****
(90) INSPECTION DATE 04/00 (91) FREQUENCY 24 MO
(92) CRITICAL FEATURE INSPECTION:           (93) CRT DATE
A) FRACTURE CRIT DETAIL - NO -             MO A) /
B) UNDERWATER INSP - NO -                 MO B) /
C) OTHER SPECIAL INSP - NO -               MO C) /

```



## 2.5 Description of the Water Surface Profile (WSPRO) Model:

Datum for WSPRO Analysis (USGS Survey, Sea Level, SC DOT USGS Survey)

Datum Tie, if available No ties available in vicinity of site.

Briefly Describe the Survey Data Used to Develop WSPRO The bridge opening was surveyed at the time of the site visit. The Exit, Full Valley and Approach Sections were developed by synthesizing the bridge opening survey. The original roadway plans and the topographic contours from 7.5-minute topographic maps of the bridge vicinity.

### Cross-Sections Used in WSPRO Analysis

Cross-Section ID*	Section Reference Distance (SRD), ft	How Cross-Section was Developed**	Comments
EXIT	-118	4	Exit Section
FULV	0	4	Full Valley Section
BRDG	0	1	D/S Bridge Section
ROAD	22	4	Roadway Section
USAPR	162	4	Approach Section

\* For location of cross-sections, see topographic map (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

**Starting Water Surface Elevation for WSPRO Analysis (place x on appropriate line):**

  x   used slope/conveyance and confirmed by testing for convergence when reasonably possible.

       used known water surface elevation. Describe \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**Describe any Special Assumptions or Considerations Made in Developing WSPRO Model**

The 100 and 500 year discharge at SC-165 was assumed to be the same as the discharge at Dorchester Road. The drainage area at Dorchester Road is 20.4 square miles, and at SC-165 is 19.2 square miles. Despite the difference, the discharge has been assumed to be the same at the two sites and the difference in drainage area considered insignificant.

## 2.6 Bridge Hydraulics:

Average Embankment Elevation	<u>24.5</u>	ft
Average Low Steel Elevation	<u>25.2</u>	ft

100-Year Discharge	<u>2890</u>	ft <sup>3</sup> /s
Water Surface Elevation at D/S Bridge Face	<u>21.15</u>	ft
Area of Flow at D/S Bridge Face	<u>413</u>	ft <sup>2</sup>
Average Velocity in Bridge Opening	<u>7.00</u>	ft/s
Maximum WSPRO Tube Velocity at Bridge	<u>9.05</u>	ft/s
Water Surface Elevation at Approach Section With Bridge	<u>21.90</u>	ft
Water Surface Elevation at Approach Section Without Bridge	<u>21.46</u>	ft
Amount of Backwater Caused by Bridge	<u>.44</u>	ft

500-Year Discharge	<u>4460</u>	ft <sup>3</sup> /s
Water Surface Elevation at D/S Bridge Face	<u>22.89</u>	ft
Area of Flow at D/S Bridge Face	<u>554</u>	ft <sup>2</sup>
Average Velocity in Bridge Opening	<u>8.05</u>	ft/s
Maximum WSPRO Tube Velocity at Bridge	<u>10.66</u>	ft/s
Water Surface Elevation at Approach Section With Bridge	<u>24.17</u>	ft
Water Surface Elevation at Approach Section Without Bridge	<u>23.24</u>	ft
Amount of Backwater Caused by Bridge	<u>.93</u>	ft

## 2.7 Scour Computations

### Describe any Special Assumptions or Considerations Made in Bridge Scour Analysis

The scour analysis was made using engineering judgement and the general guidelines described in Hydraulic Engineering Circular No. 18, "Evaluating Scour at Bridges (Richardson and others, Second Edition-1993)", and the Transportation Research Board Draft Paper, "Evaluating Scour at Bridges Using WSPRO" (Arneson and others, 1992). Scour calculations were made assuming an infinite depth of erosive material and a homogeneous particle-size distribution. The results of the scour analysis are presented in Tables 1 and 2 and graphs of the scour depths are presented in Figures 5 and 6.

Soil borings provided on the bridge drawings (and confirmed by field observation) indicate a fine sand throughout. Using sieve analysis data from the bridge plans,  $D_{50}$  was determined to be 0.15 mm.

Upstream velocities in the channel at the Approach Section are high, indicative of live-bed scour. Using Neill's equation from HEC-18 for determining the velocity associated with initiation of motion, a velocity over 1.16 feet per second is required for live-bed scour. For this report, live-bed scour will be assumed. Scour depths were computed for the 100-year and 500-year discharges. Contraction scour computations were made based upon Case 1 conditions (overbank flow on floodplain being forced back to the main channel by the approaches to the bridge). The local scour computations were made assuming a 20 degree skew angle, nine square piles per bent and no debris. Abutment scour was considered likely due to the lack of protection and signs of erosion already at the abutments.

Hydrologic calculations were based on the reported 100-and 500-year discharges at Dorchester Road, Sawmill Branch from the Flood Insurance Study of Dorchester County, South Carolina-Unincorporated Areas. Revised April 15, 1994 by the Federal Emergency Management Agency. Note that the bridge plans used a 50-year discharge of 2150 cfs.

Figure 3 provides a graph of the most constricted bridge face (D/S Bridge Face) used in the WSPRO analysis and scour calculations. Figure 4 is a graph of the Approach Section used in the WSPRO analysis.

**Table 1**  
 Cumulative scour depths at piers/bents for the 100-year discharge at  
 Structure No. 18-4-0165-0-08-00  
 SC-165 Over Dorchester Creek, Dorchester County, South Carolina

Pier/Bent <sup>1</sup> Number	Station from <sup>2</sup> Left End of Bridge (ft)	Contraction Scour Depth (ft)	Pier/Bent Scour Depth (ft)	Total Scour <sup>3</sup> Depth (ft)	Remaining Embedment Depth (ft)
<b>100-Year Discharge is 2,890cfs</b>					
2	22	1.1	5.4	6.5	7.7
3	44	1.1	9.7	10.8	0.0
4	74	1.1	10.4	11.5	0.0

- 1 Pier/bent number corresponds to SC DOT 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.

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

**Table 2**  
 Cumulative scour depths at piers/bents for the 500-year discharge at  
 Structure No. 18-4-0165-0-08-00  
 SC-165 Over Dorchester Creek, Dorchester County, South Carolina

Pier/Bent <sup>1</sup> Number	Station from <sup>2</sup> Left End of Bridge (ft)	Contraction Scour Depth (ft)	Pier/Bent Scour Depth (ft)	Total Scour <sup>3</sup> Depth (ft)	Remaining Embedment Depth (ft)
<b>500-Year Discharge is 2,645 cfs</b>					
2	22	2.8	6.0	8.8	5.4
3	44	2.8	10.9	13.7	0.0
4	74	2.8	11.4	14.2	0.0

- 1 Pier/bent number corresponds to SC DOT 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.

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

# SC-165 Over Dorchester Creek Downstream Bridge Face

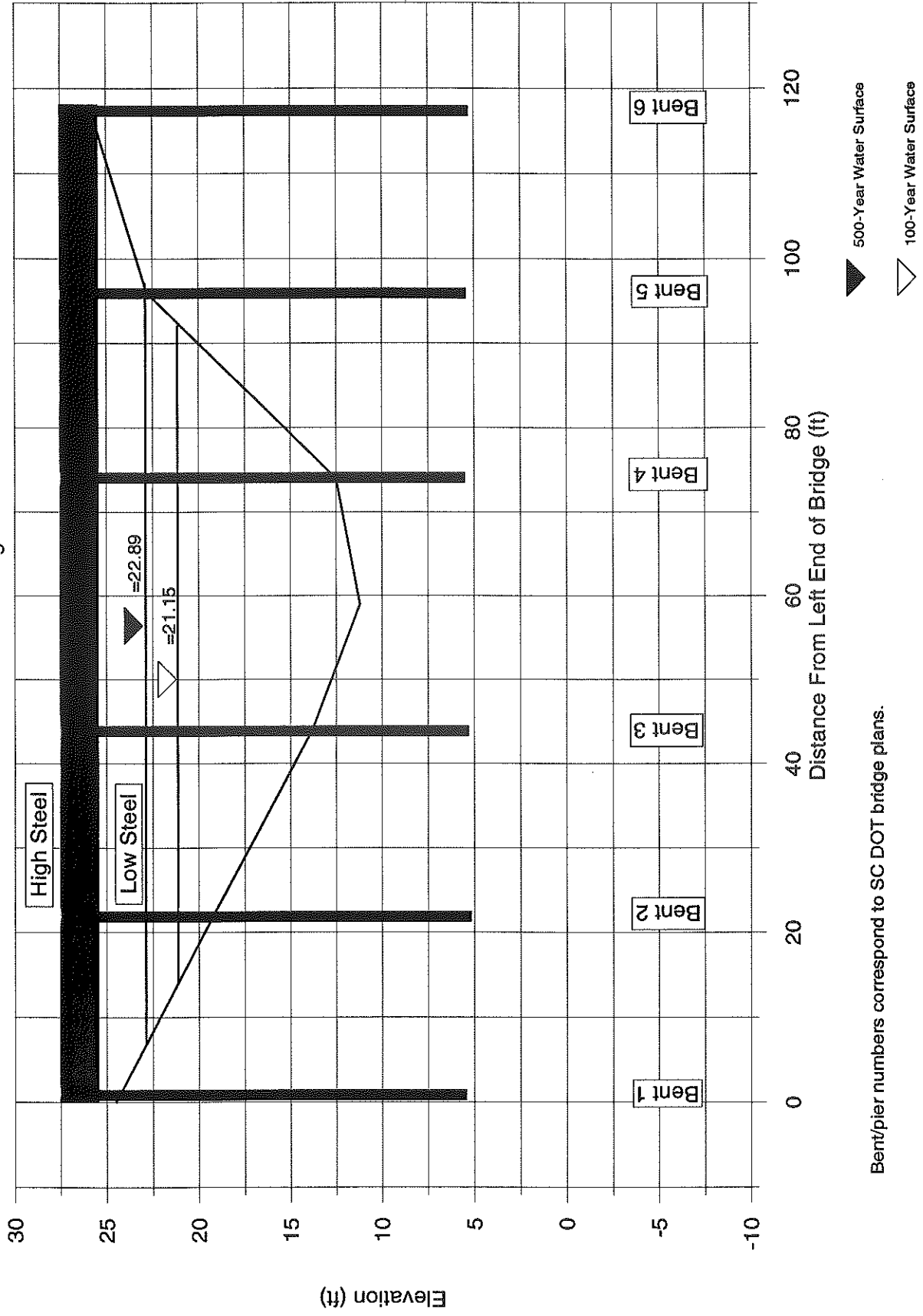


Figure 3. Downstream bridge face input to the WSPRO model.

# SC-165 Over Dorchester Creek Upstream Approach Section

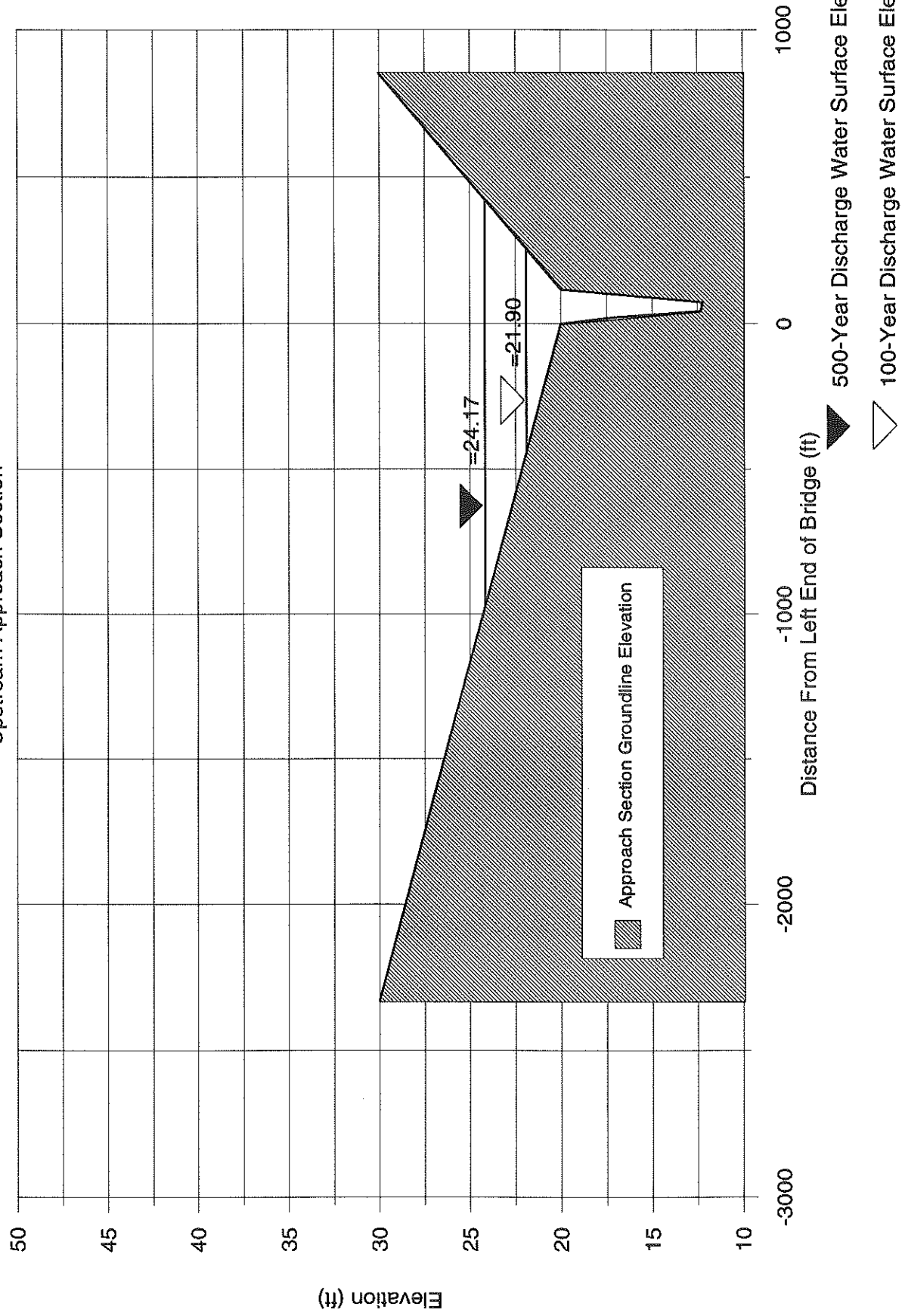
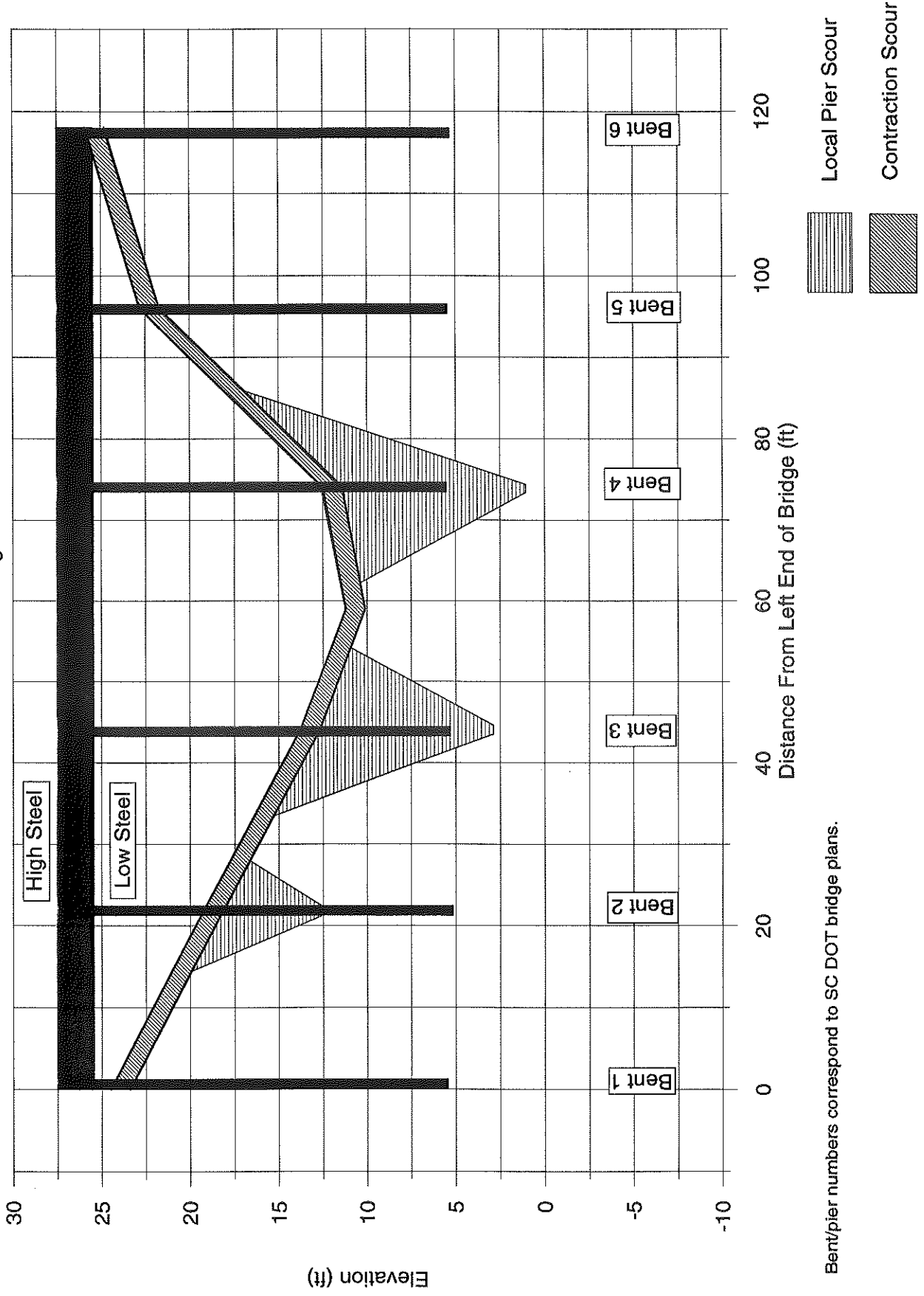


Figure 4. Approach cross-section input to the WSPRO model.

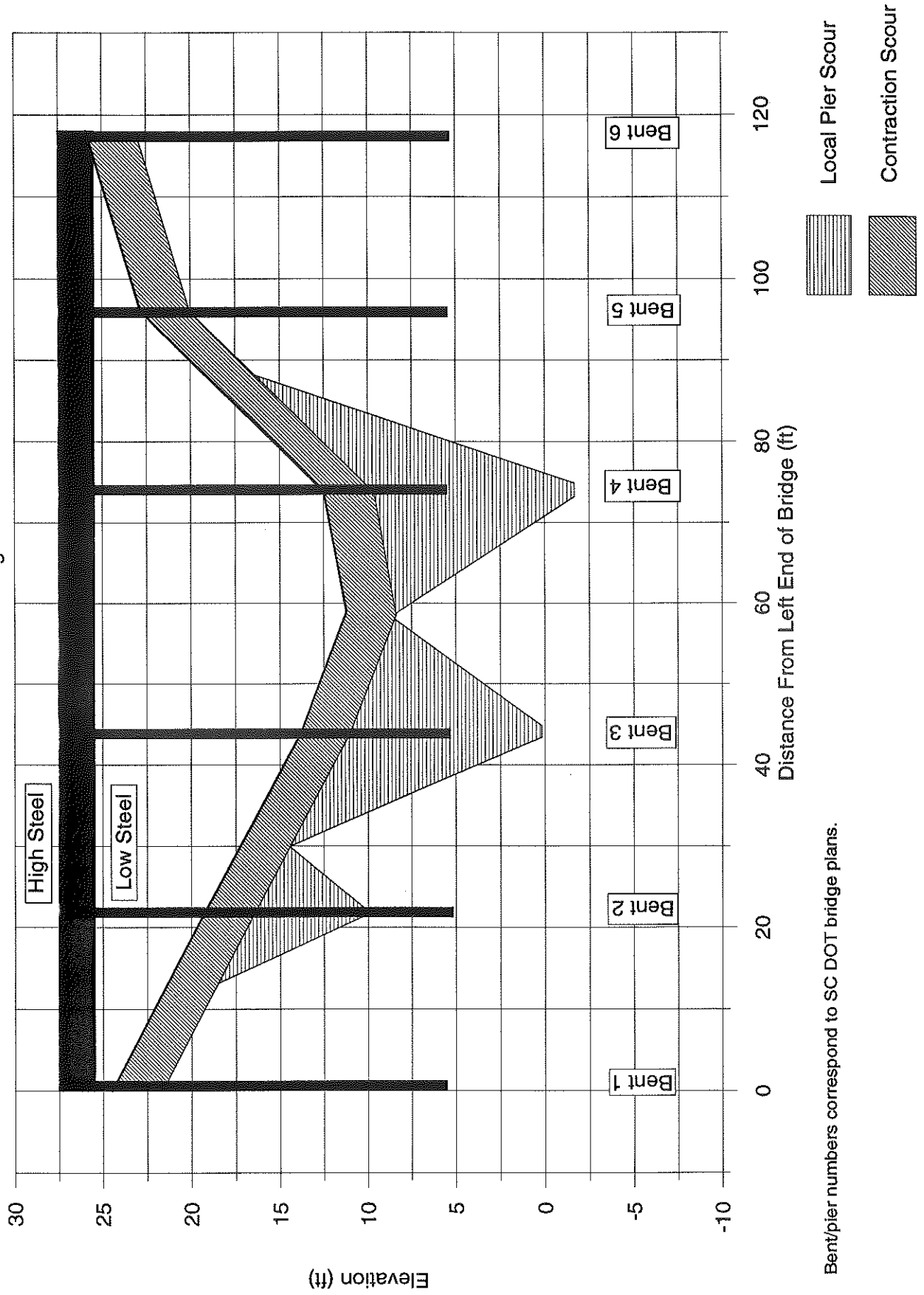
SC-165 Over Dorchester Creek  
Downstream Bridge Face



Bent/pier numbers correspond to SC DOT bridge plans.

Figure 5. Plot of Scour Depths for the 100-Year Discharge

SC-165 Over Dorchester Creek  
Downstream Bridge Face



Bent/pier numbers correspond to SC DOT bridge plans.

Figure 6. Plot of Scour Depths for the 500-Year Discharge

## APPENDIX A

### List of Photographs

- |              |  |
|--------------|--|
| Photograph 1 | Upstream face of bridge looking southeast.   |
| Photograph 2 | View of downstream channel looking southeast.  |
| Photograph 3 | View of upstream channel looking northwest.  |
| Photograph 4 | View of upstream fascia looking north.   |
| Photograph 5 | View of eroded left abutment looking northeast.  |
| Photograph 6 | View of timber retaining wall located just downstream of the bridge on the left side of the channel. |



**Photograph 1**

Upstream face of bridge looking southeast.



**Photograph 2**

View of downstream channel looking southeast.



**Photograph 3**

View of upstream channel looking northwest.



**Photograph 4**

View of upstream fascia looking north.



**Photograph 5**

View of eroded left abutment looking northeast.



**Photograph 6**

View of timber retaining wall located just downstream of the bridge on the left side of the channel.

## APPENDIX B

### WSPRO Input and Selected Output Files

# WSPRO INPUT

\*F

T1 SOUTH CAROLINA PHASE II SCOUR ANALYSIS

T2 BRIDGE SC-165 OVER DORCHESTER CREEK

T3 DORCHESTER COUNTY, SOUTH CAROLINA

\* Q100 Q500

Q 2890 4460

\* 18.5 23.5

SK .00083 .00083

XS EXIT -118

GR -2328,30 0,20 22,17.1 44,12.3 59,11.2 74,12.2 118,20 850 30

N .175 .035 .175

SA 22 96

XS FULLV 0

GR -2328,30 0,20 22,17.1 44,12.3 59,11.2 74,12.2 118,20 850,30

BR BRDG 0,25.5,20,.5,.3

GR 0,24.5 22,19.2 44,13.8 59,11.2 74,12.5 96,22.8 118,25.9 0,24.5

CD 3 44 3 24.5

PW 1 12.5,1.3 13.8,2.6 19.2,3.9 22.5,5.2 22.5,12.5 25.2,12.5

XR ROAD 22,44,1,\*,0

GR -2328,30 0,27 118,27 822,30

AS USAPR 162

GR -2328,30 0,20 22,17.1 44,12.3 74,12.2 118,20 850,30

HP 2 BRDG 20.89,\*,\*,2890

HP 1 BRDG 20.89,1,20.89

HP 2 USAPR 21.71,\*,\*,2890

HP 1 USAPR 21.71,1,21.71

\*

\*

HP 2 BRDG 22.71,\*,\*,4460

HP 1 BRDG 22.71,1,22.71

HP 2 USAPR 24.05,\*,\*,4460

HP 1 USAPR 24.05,1,24.05

\*

EX

ER

## WSPRO OUTPUT

1

WSPRO                    FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY  
 P060188                MODEL FOR WATER-SURFACE PROFILE COMPUTATIONS  
                               (Input modified to free format by GKY&A 01/92)

SOUTH CAROLINA PHASE II SCOUR ANALYSIS  
 BRIDGE SC-165 OVER DORCHESTER CREEK  
 DORCHESTER COUNTY, SOUTH CAROLINA

\*\*\* RUN DATE & TIME: 03-01-95 08:06

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

	WSEL	LEW	REW	AREA	K	Q	VEL	
	20.89	15.0	91.9	412.7	56806.	2890.	7.00	
X STA.	15.0		36.3	40.3	43.5	46.2		48.6
A(I)		51.9		21.5	19.5	18.5		17.2
V(I)		2.78		6.72	7.42	7.79		8.40
X STA.	48.6		50.9	52.9	55.0	56.8		58.7
A(I)		17.3		16.5	16.7	16.2		16.3
V(I)		8.34		8.78	8.67	8.92		8.89
X STA.	58.7		60.5	62.3	64.1	66.0		67.9
A(I)		16.3		16.1	16.0	16.2		16.5
V(I)		8.86		9.00	9.04	8.90		8.74
X STA.	67.9		69.9	71.9	74.0	76.5		91.9
A(I)		16.0		16.4	16.7	18.4		52.6
V(I)		9.05		8.83	8.67	7.85		2.75

1

HP 1 BRDG 20.89,1,20.89

1

WSPRO                    FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY  
 P060188                MODEL FOR WATER-SURFACE PROFILE COMPUTATIONS  
                               (Input modified to free format by GKY&A 01/92)

SOUTH CAROLINA PHASE II SCOUR ANALYSIS  
 BRIDGE SC-165 OVER DORCHESTER CREEK  
 DORCHESTER COUNTY, SOUTH CAROLINA

\*\*\* RUN DATE & TIME: 03-01-95 08:06

CROSS-SECTION PROPERTIES: ISEQ = 3; SECID = BRDG ; SRD = 0.

WSEL	SA#	AREA	K	TOPW	WETP	ALPH	LEW	REW	QCR
	1	6.	41.	7.	7.				29.
	2	407.	56765.	66.	69.				5750.
20.89		413.	56806.	72.	75.	1.03	15.	92.	5525.

1

HP 2 USAPR 21.71,\*,\*,2890

1

WSPRO FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY  
 P060188 MODEL FOR WATER-SURFACE PROFILE COMPUTATIONS  
 (Input modified to free format by GKY&A 01/92)

SOUTH CAROLINA PHASE II SCOUR ANALYSIS  
 BRIDGE SC-165 OVER DORCHESTER CREEK  
 DORCHESTER COUNTY, SOUTH CAROLINA

\*\*\* RUN DATE & TIME: 03-01-95 08:06

VELOCITY DISTRIBUTION: ISEQ = 5; SECID = USAPR; SRD = 162.

	WSEL	LEW	REW	AREA	K	Q	VEL
	21.71	-398.1	243.2	1201.8	108840.	2890.	2.40
X STA.		-398.1	26.1	32.7	37.4	41.1	44.4
A(I)			430.6	40.7	35.3	31.3	29.7
V(I)			.34	3.55	4.09	4.62	4.87
X STA.		44.4	47.5	50.5	53.6	56.6	59.6
A(I)			29.2	28.6	28.9	28.6	28.6
V(I)			4.95	5.05	5.00	5.06	5.05
X STA.		59.6	62.7	65.8	68.8	71.8	74.8
A(I)			29.0	29.1	28.4	28.9	28.7
V(I)			4.98	4.97	5.08	5.00	5.03
X STA.		74.8	78.2	81.8	86.1	91.4	243.2
A(I)			30.2	30.7	33.7	35.9	215.5
V(I)			4.79	4.70	4.29	4.03	.67

1

HP 1 USAPR 21.71,1,21.71

1

WSPRO FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY  
 P060188 MODEL FOR WATER-SURFACE PROFILE COMPUTATIONS  
 (Input modified to free format by GKY&A 01/92)

SOUTH CAROLINA PHASE II SCOUR ANALYSIS  
 BRIDGE SC-165 OVER DORCHESTER CREEK  
 DORCHESTER COUNTY, SOUTH CAROLINA

\*\*\* RUN DATE & TIME: 03-01-95 08:06  
 CROSS-SECTION PROPERTIES: ISEQ = 5; SECID = USAPR; SRD = 162.

WSEL	SA#	AREA	K	TOPW	WETP	ALPH	LEW	REW	QCR
	1	410.	3432.	420.	420.				2297.
	2	604.	103534.	74.	75.				9800.
	3	188.	1874.	147.	148.				1201.
21.71		1202.	108840.	641.	643.	3.40	-398.	243.	5060.

1

\*  
\*

HP 2 BRDG 22.71,\*,\*,4460

1

WSPRO FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY  
 P060188 MODEL FOR WATER-SURFACE PROFILE COMPUTATIONS  
 (Input modified to free format by GKY&A 01/92)

SOUTH CAROLINA PHASE II SCOUR ANALYSIS  
 BRIDGE SC-165 OVER DORCHESTER CREEK  
 DORCHESTER COUNTY, SOUTH CAROLINA

\*\*\* RUN DATE & TIME: 03-01-95 08:06

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

	WSEL	LEW	REW	AREA	K	Q	VEL
	22.71	7.4	95.8	554.0	85079.	4460.	8.05
X STA.		7.4	31.6	36.6	40.4	43.5	46.3
A(I)		66.4	30.5	27.0	24.6	23.2	
V(I)		3.36	7.31	8.26	9.05	9.61	
X STA.		46.3	48.8	51.2	53.5	55.7	57.8
A(I)		22.9	22.2	22.5	21.8	21.9	
V(I)		9.73	10.04	9.92	10.21	10.18	
X STA.		57.8	59.7	61.7	63.7	65.7	67.8
A(I)		21.1	21.0	20.9	21.3	21.2	
V(I)		10.56	10.63	10.66	10.48	10.52	
X STA.		67.8	70.0	72.1	74.4	77.1	95.8
A(I)		21.5	20.9	21.9	24.0	77.1	
V(I)		10.39	10.66	10.19	9.29	2.89	

1

HP 1 BRDG 22.71,1,22.71

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WSPRO FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY  
 P060188 MODEL FOR WATER-SURFACE PROFILE COMPUTATIONS  
 (Input modified to free format by GKY&A 01/92)

SOUTH CAROLINA PHASE II SCOUR ANALYSIS  
 BRIDGE SC-165 OVER DORCHESTER CREEK  
 DORCHESTER COUNTY, SOUTH CAROLINA

\*\*\* RUN DATE & TIME: 03-01-95 08:06  
 CROSS-SECTION PROPERTIES: ISEQ = 3; SECID = BRDG ; SRD = 0.

WSEL	SA#	AREA	K	TOPW	WETP	ALPH	LEW	REW	QCR
	1	24.	291.	14.	14.				181.
	2	530.	84788.	69.	73.				8313.
22.71		554.	85079.	83.	87.	1.08	7.	96.	7808.

1

HP 2 USAPR 24.05,\*,\*,4460

1

WSPRO FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY  
 P060188 MODEL FOR WATER-SURFACE PROFILE COMPUTATIONS  
 (Input modified to free format by GKY&A 01/92)

SOUTH CAROLINA PHASE II SCOUR ANALYSIS  
 BRIDGE SC-165 OVER DORCHESTER CREEK  
 DORCHESTER COUNTY, SOUTH CAROLINA

\*\*\* RUN DATE & TIME: 03-01-95 08:06

VELOCITY DISTRIBUTION: ISEQ = 5; SECID = USAPR; SRD = 162.

	WSEL	LEW	REW	AREA	K	Q	VEL
	24.05	-942.8	414.5	3540.1	196798.	4460.	1.26
X STA.	-942.8	-216.8	-67.3		23.1	30.9	36.5
A(I)		1132.3	514.0		391.9	63.0	53.2
V(I)		.20	.43		.57	3.54	4.19
X STA.	36.5	41.1	45.0		48.9	52.7	56.5
A(I)		48.0	45.8		45.3	44.8	44.8
V(I)		4.65	4.87		4.93	4.98	4.97
X STA.	56.5	60.3	64.1		67.9	71.7	75.5
A(I)		45.1	45.1		44.1	44.9	45.6
V(I)		4.95	4.94		5.05	4.97	4.89
X STA.	75.5	79.7	84.4		89.9	99.8	414.5
A(I)		46.7	48.8		52.1	81.5	703.1
V(I)		4.77	4.57		4.28	2.74	.32

1

HP 1 USAPR 24.05,1,24.05

1

WSPRO FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY  
 P060188 MODEL FOR WATER-SURFACE PROFILE COMPUTATIONS  
 (Input modified to free format by GKY&A 01/92)

SOUTH CAROLINA PHASE II SCOUR ANALYSIS  
 BRIDGE SC-165 OVER DORCHESTER CREEK  
 DORCHESTER COUNTY, SOUTH CAROLINA

\*\*\* RUN DATE & TIME: 03-01-95 08:06

CROSS-SECTION PROPERTIES: ISEQ = 5; SECID = USAPR; SRD = 162.

WSEL	SA#	AREA	K	TOPW	WETP	ALPH	LEW	REW	QCR
	1	2030.	28381.	965.	965.				16712.
	2	777.	157561.	74.	75.				14301.
	3	732.	10855.	318.	319.				6302.
24.05		3540.	196798.	1357.	1359.	10.65	-943.	414.	9940.

1

\*  
EX

+++ BEGINNING PROFILE CALCULATIONS -- 2

1

WSPRO FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY  
P060188 MODEL FOR WATER-SURFACE PROFILE COMPUTATIONS  
(Input modified to free format by GKY&A 01/92)

SOUTH CAROLINA PHASE II SCOUR ANALYSIS  
BRIDGE SC-165 OVER DORCHESTER CREEK  
DORCHESTER COUNTY, SOUTH CAROLINA

\*\*\* RUN DATE & TIME: 03-01-95 08:06

XSID:CODE	SRDL	LEW	AREA	VHD	HF	EGL	CRWS	Q	WSEL
SRD	FLEN	REW	K	ALPH	HO	ERR	FR#	VEL	
EXIT :XS	*****	-282.	935.	.35	*****	21.56	16.94	2890.	21.21
-118.	*****	207.	100225.	2.37	*****	*****	.61	3.09	

XSID:CODE	SRDL	LEW	AREA	VHD	HF	EGL	CRWS	Q	WSEL
SRD	FLEN	REW	K	ALPH	HO	ERR	FR#	VEL	
FULLLV:FV	118.	-310.	996.	.34	.10	21.67	*****	2890.	21.33
0.	118.	215.	103220.	2.57	.00	.01	.60	2.90	

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

XSID:CODE	SRDL	LEW	AREA	VHD	HF	EGL	CRWS	Q	WSEL
SRD	FLEN	REW	K	ALPH	HO	ERR	FR#	VEL	
USAPR:AS	162.	-340.	1051.	.34	.13	21.80	*****	2890.	21.46
162.	162.	225.	102188.	2.87	.00	.00	.60	2.75	

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

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

XSID:CODE	SRDL	LEW	AREA	VHD	HF	EGL	CRWS	Q	WSEL
SRD	FLEN	REW	K	ALPH	HO	ERR	FR#	VEL	
BRDG :BR	118.	14.	432.	.77	.16	21.92	18.55	2890.	21.15
0.	118.	92.	60513.	1.10	.19	.00	.51	6.70	

TYPE	PPCD	FLOW	C	P/A	LSEL	BLEN	XLAB	XRAB
3.	1.	1.	.953	.066	25.50	*****	*****	*****

XSID:CODE	SRD	FLEN	HF	VHD	EGL	ERR	Q	WSEL
ROAD :RG	22.							

<<<<EMBANKMENT IS NOT OVERTOPPED>>>>

XSID:CODE	SRDL	LEW	AREA	VHD	HF	EGL	CRWS	Q	WSEL
SRD	FLEN	REW	K	ALPH	HO	ERR	FR#	VEL	
USAPR:AS	118.	-443.	1331.	.28	.15	22.19	17.17	2890.	21.90
162.	127.	257.	114284.	3.87	.12	.01	.55	2.17	

M(G) M(K) KQ XLKQ XRKQ OTEL  
 .859 .066 106421. 15. 94. 21.83

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

1

WSPRO FEDERAL HIGHWAY ADMINISTRATION - U. S. GEOLOGICAL SURVEY  
 P060188 MODEL FOR WATER-SURFACE PROFILE COMPUTATIONS  
 (Input modified to free format by GKY&A 01/92)

SOUTH CAROLINA PHASE II SCOUR ANALYSIS  
 BRIDGE SC-165 OVER DORCHESTER CREEK  
 DORCHESTER COUNTY, SOUTH CAROLINA

\*\*\* RUN DATE & TIME: 03-01-95 08:06

XSID:CODE	SRDL	LEW	AREA	VHD	HF	EGL	CRWS	Q	WSEL
SRD	FLEN	REW	K	ALPH	HO	ERR	FR#	VEL	
EXIT :XS	*****	-691.	2266.	.42	*****	23.38	18.19	4460.	22.97
-118.	*****	335.	154697.	6.92	*****	*****	.61	1.97	

XSID:CODE	SRDL	LEW	AREA	VHD	HF	EGL	CRWS	Q	WSEL
SRD	FLEN	REW	K	ALPH	HO	ERR	FR#	VEL	
FULLV:FV	118.	-721.	2401.	.39	.09	23.49	*****	4460.	23.10
0.	118.	345.	159729.	7.34	.00	.01	.59	1.86	

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

XSID:CODE	SRDL	LEW	AREA	VHD	HF	EGL	CRWS	Q	WSEL
SRD	FLEN	REW	K	ALPH	HO	ERR	FR#	VEL	
USAPR:AS	162.	-755.	2544.	.38	.13	23.62	*****	4460.	23.24
162.	162.	355.	160614.	7.96	.00	.00	.58	1.75	

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

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

XSID:CODE	SRDL	LEW	AREA	VHD	HF	EGL	CRWS	Q	WSEL
SRD	FLEN	REW	K	ALPH	HO	ERR	FR#	VEL	
BRDG :BR	118.	7.	569.	1.27	.17	24.15	20.14	4460.	22.89
0.	118.	97.	88263.	1.33	.60	.00	.61	7.84	

TYPE	PPCD	FLOW	C	P/A	LSEL	BLEN	XLAB	XRAB
3.	1.	1.	.869	.070	25.50	*****	*****	*****

XSID:CODE	SRD	FLEN	HF	VHD	EGL	ERR	Q	WSEL
ROAD :RG	22.							

<<<<<EMBANKMENT IS NOT OVERTOPPED>>>>>

XSID:CODE	SRDL	LEW	AREA	VHD	HF	EGL	CRWS	Q	WSEL
SRD	FLEN	REW	K	ALPH	HO	ERR	FR#	VEL	
USAPR:AS	118.	-972.	3711.	.25	.15	24.42	18.40	4460.	24.17
162.	139.	424.	202978.	11.05	.11	.01	.43	1.20	

M(G) M(K) KQ XLKQ XRKQ OTEL  
 .917 .194 163242. 7. 97. 24.12

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

ER

1 NORMAL END OF WSPRO EXECUTION.

**APPENDIX C**

**Scour Computations**

**CONTRACTION SCOUR COMPUTATIONS  
FOR  
SC-165 OVER DORCHESTER CREEK  
STRUCTURE NO. 18-4-0165-0-08-00  
DORCHESTER COUNTY, SOUTH CAROLINA**

---

The following computations are made using the HEC-18 equation for Live Bed Contraction Scour:

$$Y_s = Y_2 - Y_1$$

$$Y_2 = \left( \frac{Q_2}{Q_1} \right)^{6/7} \left( \frac{W_1}{W_2} \right)^{k_1} Y_1$$


---

**100-YEAR DISCHARGE  
MAIN CHANNEL  
LIVE-BED CONTRACTION SCOUR COMPUTATIONS**

ENERGY SLOPE	=	0.00083
w FALL VELOCITY	=	0.0035
AVERAGE UPSTREAM CHANNEL DEPTH (FT), Y1	=	8.2
V* SHEAR VELOCITY IN UPSTREAM SECTION	=	0.47
V*/w	=	133.75
k <sub>1</sub> SEE PAGE 33 IN HEC-18	=	0.69
DISCHARGE IN UPSTREAM CHANNEL (CFS), Q1	=	2749
DISCHARGE IN CONTRACTED SECTION (CFS), Q2	=	2890
WIDTH OF UPSTREAM CHANNEL SECTION (FT), W1	=	74
WIDTH OF MAIN CHANNEL CONTRACTED SECTION (FT), W2	=	66
MEDIAN GRAIN SIZE (FT), D50	=	0.00017
COMPUTED WATER DEPTH OF CONTRACTED SECTION (FT), Y	=	9.3
AVERAGE UPSTREAM CHANNEL WATER DEPTH (FT), Y1	=	8.2
AVERAGE SCOUR DEPTH AT CONTRACTED SECTION (FT)	=	1.1

**CONTRACTION SCOUR COMPUTATIONS  
FOR  
SC-165 OVER DORCHESTER CREEK  
STRUCTURE NO. 18-4-0165-0-08-00  
DORCHESTER COUNTY, SOUTH CAROLINA**

---

The following computations are made using the HEC-18 equation for Live Bed Contraction Scour:

$$Y_s = Y_2 - Y_1$$

$$Y_2 = \left( \frac{Q_2}{Q_1} \right)^{6/7} \left( \frac{W_1}{W_2} \right)^{k_1} Y_1$$

---

**500-YEAR DISCHARGE  
MAIN CHANNEL  
LIVE-BED CONTRACTION SCOUR COMPUTATIONS**

ENERGY SLOPE	=	0.00083
w FALL VELOCITY	=	0.0035
AVERAGE UPSTREAM CHANNEL DEPTH (FT), Y1	=	10.5
V• SHEAR VELOCITY IN UPSTREAM SECTION	=	0.53
V*/w	=	151.35
k <sub>1</sub> SEE PAGE 33 IN HEC-18	=	0.69
DISCHARGE IN UPSTREAM CHANNEL (CFS), Q1	=	3571
DISCHARGE IN CONTRACTED SECTION (CFS), Q2	=	4460
WIDTH OF UPSTREAM CHANNEL SECTION (FT), W1	=	74
WIDTH OF MAIN CHANNEL CONTRACTED SECTION (FT), W2	=	69
MEDIAN GRAIN SIZE (FT), D50	=	0.00017
COMPUTED WATER DEPTH OF CONTRACTED SECTION (FT), Y2	=	13.3
AVERAGE UPSTREAM CHANNEL WATER DEPTH (FT), Y1	=	10.5
AVERAGE SCOUR DEPTH AT CONTRACTED SECTION (FT)	=	2.8

**PIER SCOUR COMPUTATIONS  
FOR  
SC-165 OVER DORCHESTER CREEK  
STRUCTURE NO. 18-4-0165-0-08-00  
DORCHESTER COUNTY, SOUTH CAROLINA**

---

The following calculations are made using the HEC-18 equation for Pier Scour

$$Y_s = (2 * K_1 * K_2 * K_3 * (Y_1/a)^{0.35} * Fr^{0.43}) * a$$


---

**SCOUR ANALYSIS FOR Q<sub>100</sub> - CASE 1 (WITHOUT DEBRIS)**

HYDRAULIC VARIABLES USED IN CSU EQUATION

PIER/BENT NUMBER	2	3	4
PIER STATION (FT)	22.00	44.00	74.00
TOP WIDTH (FT)	21.30	2.70	2.10
AREA (FT <sup>2</sup> )	51.90	18.50	16.70
V1: VELOCITY (FPS)	2.78	7.79	8.67
Y1: DEPTH (FT)	2.44	6.85	7.95
ATTACK ANGLE	20.00	20.00	20.00
INDIVIDUAL BENT WIDTH	1.33	1.33	1.33
a: PIER WIDTH (FT)	5.34	5.34	5.34
L: PIER LENGTH (FT)	11.97	11.97	11.97
K1: SHAPE COEFFICIENT	1.00	1.00	1.00
K2: ANGLE COEFFICIENT	1.00	1.00	1.00
K3: BED COND. COEFFICIENT	1.10	1.10	1.10
FROUDE NUMBER	0.31	0.52	0.54
LOCAL SCOUR DEPTH (FT)	5.4	9.7	10.4

**PIER SCOUR COMPUTATIONS  
FOR  
SC-165 OVER DORCHESTER CREEK  
STRUCTURE NO. 18-4-0165-0-08-00  
DORCHESTER COUNTY, SOUTH CAROLINA**

---

The following calculations are made using the HEC-18 equation for Pier Scour:

$$Y_s = (2 \cdot K_1 \cdot K_2 \cdot K_3 \cdot (Y_1/a)^{0.35} \cdot Fr^{0.43}) \cdot a$$


---

**SCOUR ANALYSIS FOR  $Q_{500}$  - CASE 1 (WITHOUT DEBRIS)**

HYDRAULIC VARIABLES USED IN CSU EQUATION

PIER/BENT NUMBER	2	3	4
PIER STATION (FT)	22.00	44.00	74.00
TOP WIDTH (FT)	24.20	2.80	2.30
AREA (FT <sup>2</sup> )	66.40	23.20	21.90
V1: VELOCITY (FPS)	3.36	9.61	10.19
Y1: DEPTH (FT)	2.74	8.29	9.52
ATTACK ANGLE	20.00	20.00	20.00
INDIVIDUAL BENT WIDTH	1.33	1.33	1.33
a: PIER WIDTH (FT)	5.33	5.33	5.33
L: PIER LENGTH (FT)	11.97	11.97	11.97
K1: SHAPE COEFFICIENT	1.00	1.00	1.00
K2: ANGLE COEFFICIENT	1.00	1.00	1.00
K3: BED COND. COEFFICIENT	1.10	1.10	1.10
FROUDE NUMBER	0.36	0.59	0.58
LOCAL SCOUR DEPTH (FT)	6.0	10.9	11.4

## APPENDIX D

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