S-51 Emergency Bridge Replacement over Black Mingo Creek

HYDRAULIC STUDY FOR THE REPLACEMENT OF THE S-51 BRIDGE OVER BLACK MINGO CREEK

FINAL

Williamsburg County, South Carolina
February 2016

INFRASTRUCTURE CONSULTING AND ENGINEERING
COLUMBIA, SC

HYDRAULIC STUDY
FOR THE REPLACEMENT OF
THE S-51 BRIDGE
OVER BLACK MINGO CREEK

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February 2016

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The South Carolina Department of Transportation

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Introduction

The project consists of the replacement of the S-51 (Battery Park Road) Bridge over Black Mingo Creek in Williamsburg County, South Carolina, under an emergency replacement process. During the recent record storm event of October 2015 one of the bridges interior spans collapsed. This was caused by heavy scouring around the interior bents due to record high flows through the bridge. This bridge will be replaced on the existing alignment with an offsite detour during construction. This emergency replacement project is being reviewed for impact on the FEMA 100 year flooding elevation as well as for the anticipated scour on the proposed bridge resulting from the 100 year and 500 year storms. SCDOT requirements also include providing 2 feet of freeboard from the bridge low chord to the design high water elevation. Because S-51 is a secondary road (major collector), the design high water elevation is based on the 25 year storm.

The focus of the hydraulic study is to ensure that the proposed design will have no significant adverse upstream or downstream impact on 100-year and lower frequency flood elevations, the backwater created by the proposed bridge versus the natural condition meets SCDOT requirements, and the proposed design will meet established standards for scour analysis.

Project Description

This project is located in Williamsburg County where S-51 (Battery Park Road) crosses over Black Mingo Creek. The closest intersection is at S-51 (Battery Park Road) with Harvest Road. The project site is approximately 2600 ft south of the Harvest Road intersection. The upstream watershed contributing drainage area through this crossing is approximately 107 square miles. The project location is shown in Figures 1A and 1B.

Figure 1A. Project Location Map – Overview

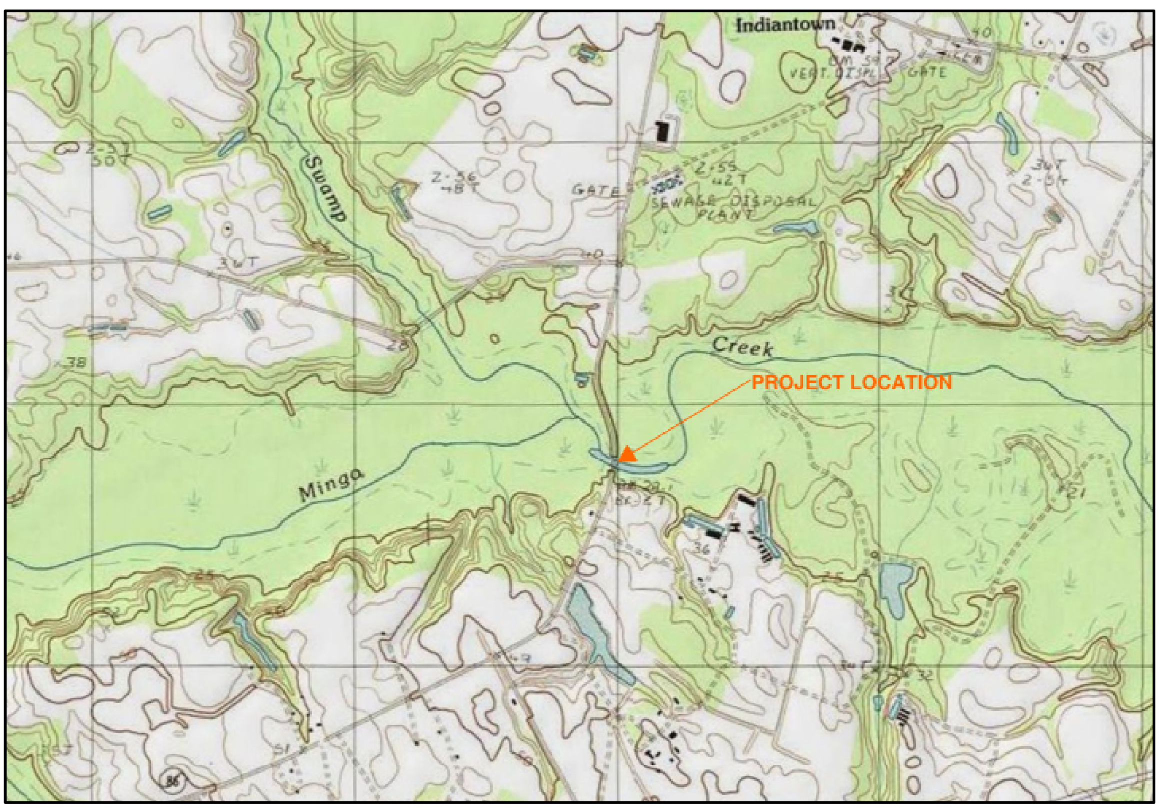


Figure 1B. Project Location Map - Detailed

The existing bridge has an out to out width of 28.2 feet, is 135 feet long with a low chord elevation of 25.37 based on the received survey information. The proposed bridge will have an out to out width of 36 feet, will be 164 feet long with a hydraulic opening of 160.5 feet and a low chord elevation of 25.37. The proposed bridge will have a minimum of 70 feet span over the main channel. The bridge site and surrounding areas were modeled for the natural conditions, existing conditions, and proposed conditions.

The bridge is not skewed for the existing or proposed conditions. The channel skew directly beneath the bridge is minimal (less than 15 degrees) so the overall flood flow is considered when determining the skew angle. The flood flow within the limits of the study is at a 90 degree skew.

The project is located within a Special Flood Hazard Area Zone AE approximate study area. The project site is located on FEMA Map Panel 45089C0305D dated November 16, 2012. Figure 2 shows the published FIRM for this project site for the area. Boggy Swamp A converges with Black Mingo Creek approximately 850' upstream from the project site.

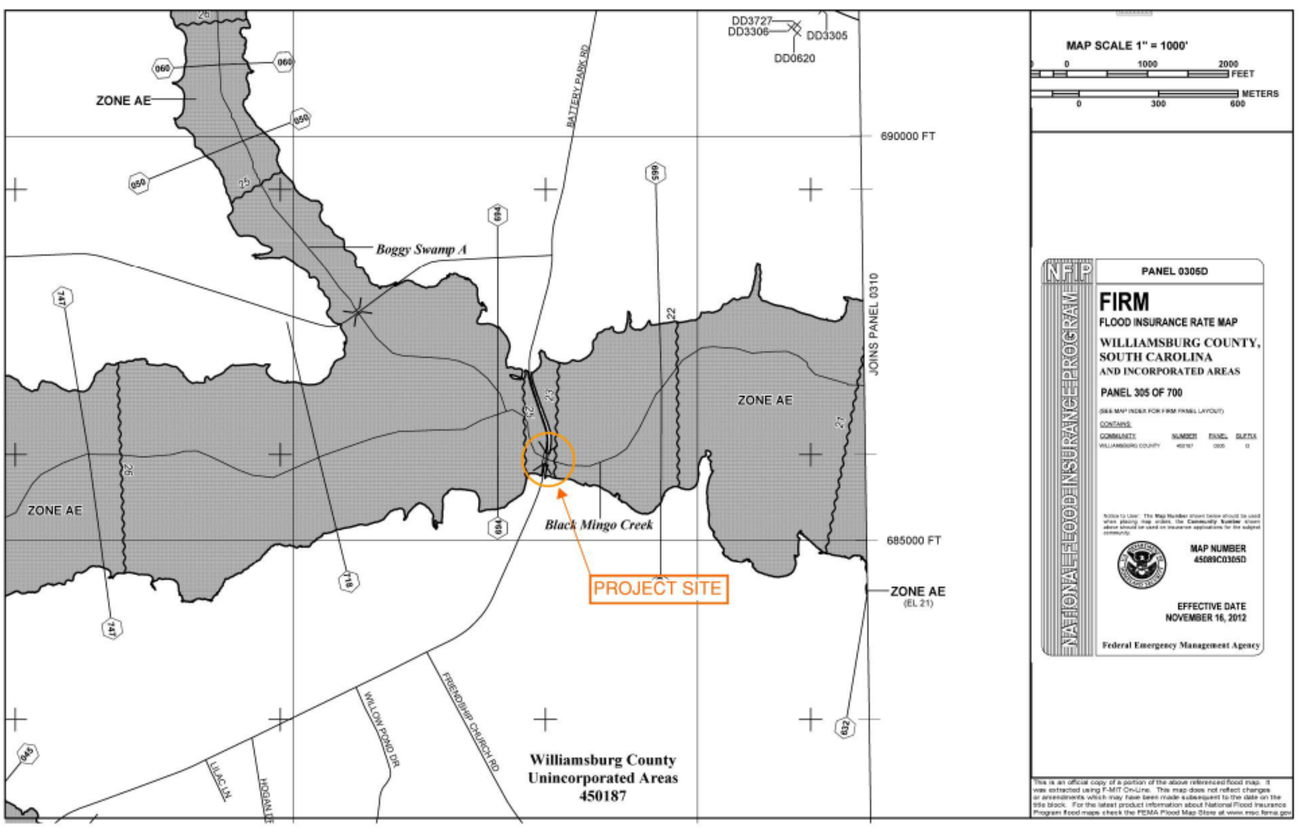


Figure 2. FEMA Firm Map Panel 305 of 700

Vertical Datum

The vertical datum used for this project is NAVD 88; horizontal datum is NAD 83. Existing bridge plans are NGVD 29. The conversion is listed below.

NAVD88 = NGVD29-0.971 ft

Soils Information

A preliminary geotechnical report was compiled by F&ME Consultants based on findings by S&ME in November 2015. This report included two borings to a depth of 100 feet below the existing embankment to verify sub-surface conditions as well as 2 cone penetrometer soundings. In general, the subsurface investigation indicated three main strata. The first stratum encountered consists of fill material predominantly sandy material with some fines content. This material extended approximately seven (7) to nine (9) feet below ground surface. Beneath the fill material was a layer of alluvial soil material. These alluvial soils were classified as peat (OH) at the northern end and silty sand (SM) at the southern end. The alluvial soils were approximately six (6) feet thick to ten (10) feet thick. The third and last material was a Pee Dee Formation soils layer classified as stiff to hard clay (CL), medium dense to very dense silty sand (SM), and very dense sand with silt (SP-SM). The Pee Dee Formation material extended to drilling termination depths of 100 feet in each boring.

Hydrologic Analysis

There were no past or current stream gages found to exist on Black Mingo Creek. The discharges that were used to evaluate the project site were obtained using the USGS Methods for Estimating the Magnitude and Frequency of Floods for Urban and Small, Rural Streams in Georgia, South Carolina, and North Carolina, 2011, by Toby D. Feaster, Anthony J. Gotvald, and J. Curtis Weaver, with 100 percent being in Region 4. The calculated flow information can be found in Appendix A.

The delineated watershed showing an upstream Watershed Drainage Area equal to 107 sq. mi., at river station 68462, is shown in Figure 3, a more detailed map can be found in Appendix B. The USGS 100-yr flow was found to be consistent with the 100-yr flow that FEMA published in the FIS date November 16, 2012. Since the FEMA 100-yr flow was nearly identical to the calculated 100-yr discharge from the USGS Regression method (< 5% increase), the higher FEMA discharge was used for the analysis.

All other profiles used values calculated from the USGS regression method. Discharges for the other flow change locations (not at the bridge) were calculated by using the 100 year peak flow information provided in the FIS and adjusting the drainage area until the USGS Regression output nearly matched this value. These values were only used in the 'SCDOT Multi' steady flow data file and all output from NSS can be seen in Appendix A. The discharges at the site are shown in Table 1 below:

Table 1. *Summary of Peak Flows at S-51 Bridge over Black Mingo Creek*

Return Period Storm	USGS Rural Regression Flows River STA 68462	FIS Limited Detailed Flood Hazard Data (11/16/2012)	Design Discharges Used for Analysis
2-Year	1250	-	1250
5-Year	2300	-	-
10-Year	3100	-	3100
25-Year	4160	-	4160
50-Year	5090	-	5090
100-Year	6080	6349	6349
200-Year	6980	-	-
500-Year	8350	-	8350

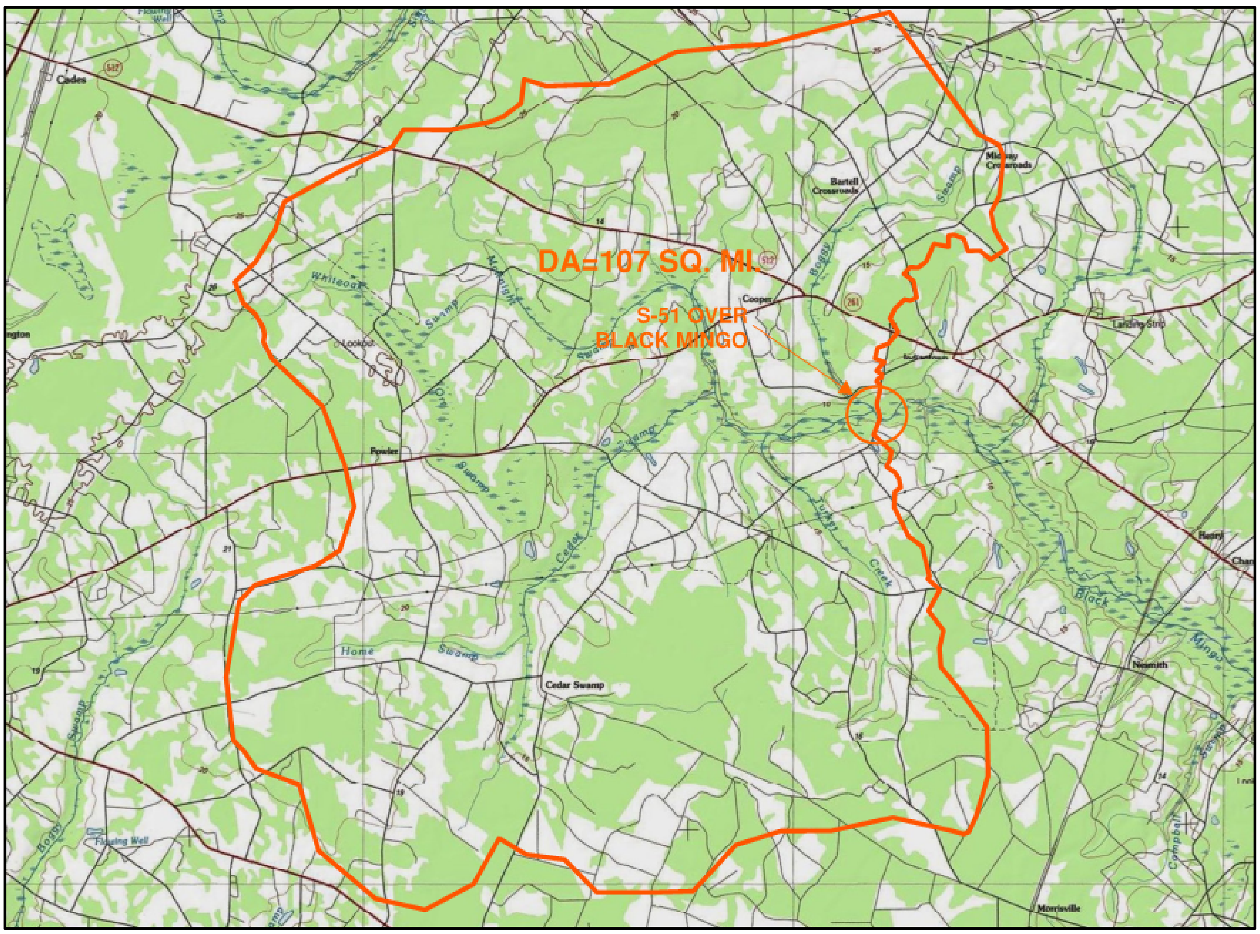


Figure 3. *Drainage Area Map*

Hydraulic Analysis (FEMA)

HEC-RAS, Version 4.1.0 was used for bridge hydraulic analysis. Since this site is in a FEMA Zone AE; five models were prepared to evaluate the bridges:

- *Effective Model*- The effective model was received from FEMA by request from Infrastructure Consulting & Engineering in an electronic format on December 21, 2015. The original model was created in HEC-RAS (Version 3.1.3). Output was compared to the published data.
- *Duplicate Effective Model*- The Duplicate Effective model merely consisted of running the Effective model in HEC-RAS Version 4.1.0. The purpose of this model is to duplicate the output generated in the effective model. Any differences found can be directly attributed to the newer version of HEC-RAS.
- *Corrected Effective Model*-The Corrected Effective model included any changes to the Duplicate Effective model based on recent survey, field review, and any available as-built bridge and roadway plans.
- *Revised Effective Model*-In the revised effective model the proposed conditions were modeled including the proposed roadway and proposed bridge.

Cross Section Geometry

The cross sections were cut using GIS from Williamsburg County 2008 LiDAR and supplemented with field surveys from SCDOT and Construction Support Services, Inc. (CSS). This field survey was obtained from CSS in January 2016 after the storm event of October 2015. This caused the survey data to show large scour areas. The cross sections directly upstream and downstream of the bridge represented this post scour channel. These cross sections were used for the edited models with the exception of the natural model. The cross section location map can be seen below in Figure 4.

Manning's Roughness Coefficients

Channel and overbank Manning's n values from the FIS were confirmed to match values obtained from field observations and aerial photography. A visual inspection of the overbank areas confirmed that they consist of heavy vegetation, primarily of medium to large size Cypress trees. A Manning's n value of 0.05 was used to represent the stream channel. A Manning's n value of 0.15 was used for the overbank areas. These values remain unchanged from FEMA Effective model.

Downstream Boundary Condition / Sensitivity Analysis

The normal depth method was used as the boundary condition for the model. The downstream slope of the stream was obtained from the FEMA model and verified using the USGS Quadrangle maps.

A sensitivity analysis was not completed because the reach in the FEMA model was used to model the proposed S-51 Bridge, which is located in the center of the model (approximately 12.0 miles upstream from the downstream boundary of the model).

Effective Model

The following steps were taken with the Effective HEC-RAS Model:

- Received from FEMA on December 21, 2015.
- FEMA output from HEC-RAS version 3.1.3

Duplicate Effective Model

The following steps were taken to create the Duplicate Effective HEC-RAS Model:

- Effective model copied to create DEM.
- Run in HEC-RAS version 4.1.0 and output compared to Effective Model.

Corrected Effective Model

The following steps were taken to create the Corrected Effective HEC-RAS Model:

- Duplicate Effective model copied to create CEM.
- FEMA cross sections 68519 and 68393 were updated using SCDNR LiDAR for Williamsburg County (2008). Cross sections were cut using ArcGIS.
- Field survey points were used to adjust the LiDAR cross sections within the channel proximity of the bridge site. The survey data represents the post scour channel caused by recent October flood event.
- The 100 year discharge in the Steady Flow Data were verified to match that found in the FIS.
- Reach boundary condition was input using normal depth with a Slope of 0.0001 ft/ft. This did not change from the DEM but was verified from Quad map and LiDAR contours.
- FEMA Manning's n-values were verified via field observations and aerial imagery, they were left unchanged from the DEM.
- Top of bank locations were updated for cross sections 68519 and 68393.
- Used survey to adjust bridge alignment over creek and adjusted ineffective flows in sections 68519 and 68393.
- Ineffective flows were added to sections 69444 and 67923.
- Adjusted existing bridge geometry including:
    - Existing bridge length 135' from survey
    - Bridge width changed to 28.2' measured from survey
    - Distance to US section changed to 47.75
    - US & DS embankments changed to 2:1 side slopes
    - Low chord adjusted to 25.37 per survey
    - Bridge pier stationing updated to 8 piers @ 15' spacing
    - Drag coefficient changed to 1.20 for circular piers
    - Adjusted Manning's n-values for DS internal bridge section (entire area under bridge changed 0.05) and adjusted point data for US internal bridge section
    - Road profile updated in Deck/Roadway Editor

    - Removed sloped abutments since vertical abutments were observed in the field
- Bridge Modeling Approach: For Low and High Flow Methods, the highest energy answer was used.

Revised Effective Model

The following steps were taken to create the Revised Effective HEC-RAS Model:

- Corrected Effective model copied to create REM.
- The existing bridge was updated to represent the proposed bridge along the same alignment.
- Bridge location over channel adjusted according to proposed layout
- Ineffective flows updated for sections 69444, 68519, 68393, and 67923.
- Adjusted bridge geometry to match proposed design, this includes:
    - Bridge length adjusted to 164’, hydraulic opening changed to 160.4’
    - Bridge width out to out changed to 36.0’
    - Distance to US section changed to 43.85’
    - Low chord remained at 25.37
    - Bridge pier stationing updated to 2 piers @ span configuration of 37.5’-70.0’-56.5’, piers will be 18” PSC Square piles
    - Drag coefficient changed to 2.00 for square nose piers
    - Added 2:1 sloped spill through abutments
    - Proposed road profile updated in Deck/Roadway Editor.

Hydraulic Analysis (SCDOT)

Three additional models were prepared for the SCDOT analysis:

- *Existing Model* – This model consists of the CEM geometry run with the USGS Regression discharges.
- *Proposed Model* – This model consists of the REM geometry run with the USGS Regression discharges.
- *Natural Model* – In this model, the existing conditions, without the existing S-51 roadway and current S-51 Bridge, were modeled and run with the USGS Regression discharges.

Existing SCDOT Model (Corrected Effective)

The following changes were made to create the Existing SCDOT Model:

- Corrected Effective geometry used to create Existing plan.
- USGS calculated discharges were used to run profiles for the 2-yr, 10-yr, 25-yr, 50-yr, & 500-yr events.
- FEMA discharges were used to run the 100-yr profile.

Proposed SCDOT Model (Revised Effective)

The following changes were made to create the Proposed SCDOT Model:

- Revised Effective geometry used to create the Proposed SCDOT plan.
- USGS calculated discharges were used to run profiles for the 2-yr, 10-yr, 25-yr, 50-yr, & 500-yr events.
- FEMA discharges were used to run the 100-yr profile.

Natural SCDOT Model

The following changes were made to create the Natural SCDOT Model:

- Corrected Effective geometry used to create Natural plan.
- Bridge at River Station 68462 removed.
- Surveyed scour hole at the bridge, caused by October 2015 flood event, was removed. SCDNR LiDAR for Williamsburg county dated 2008 was used to cut the sections everywhere outside the TOB. The channel from the Effective model was used for the pre-scour channel geometry. This was verified to nearly match the depth of the channel cross section shown on the existing Roadway plans.
- Ineffective flows in sections 69444, 68519, 68393, and 67923 were removed.
- Expansion and Contraction coefficients adjusted to 0.1 and 0.3 for sections 69444, 68519, and 68393.
- USGS calculated discharges were used to run profiles for the 2-yr, 10-yr, 25-yr, 50-yr, & 500-yr events.

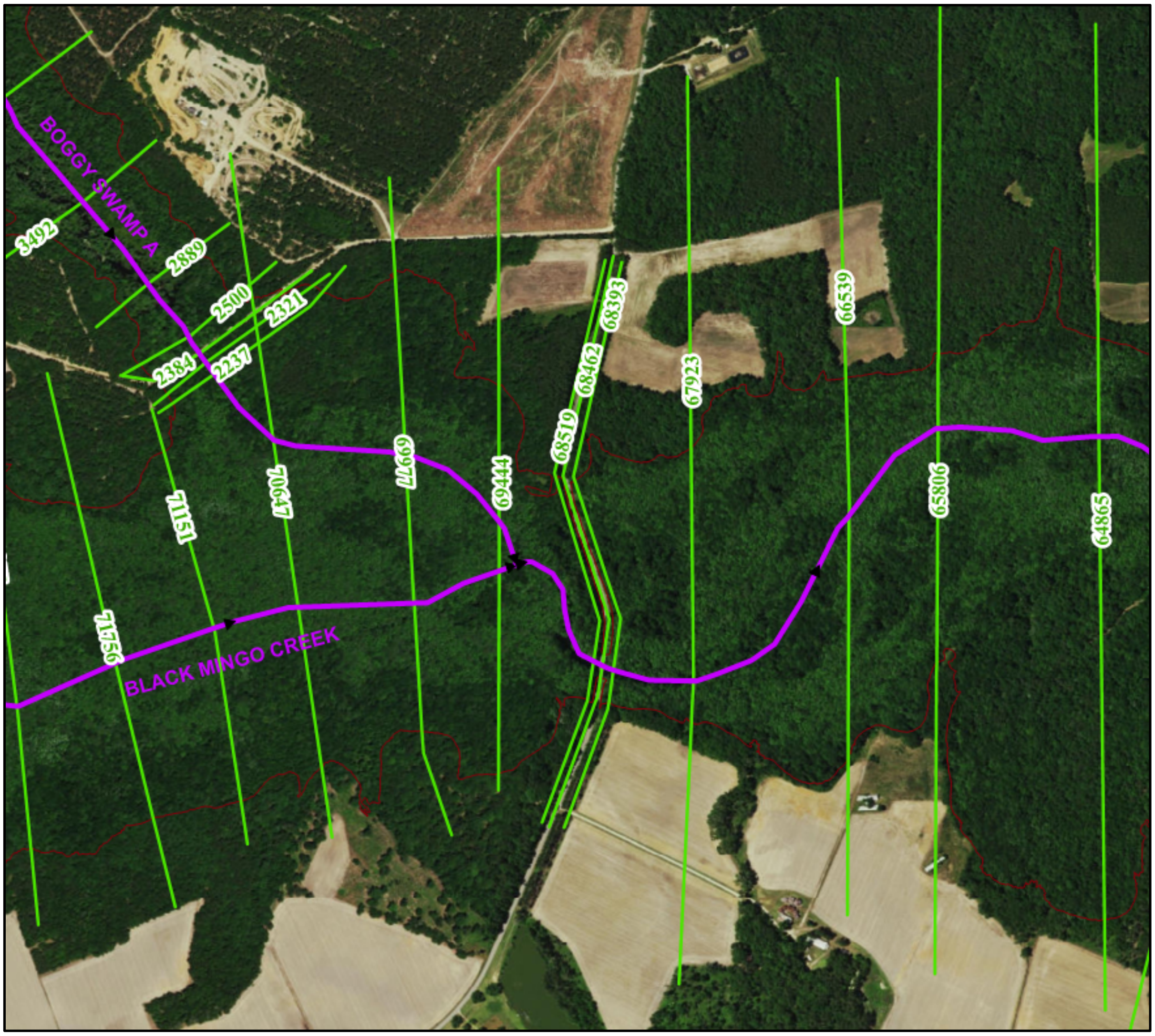


__Figure 4.__ Cross Section Location Map near Bridge

Table 2. *FEMA Effective, Duplicate Effective, Corrected Effective, and Revised Models*

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev
				(cfs)	(ft)	(ft)
Reach-1	73210	100-year	DEM	5677.00	14.86	25.91
Reach-1	73210	100-year	CEM	5677.00	14.86	25.02
Reach-1	73210	100-year	REM	5677.00	14.86	24.97
Reach-1	72377	100-year	DEM	5677.00	14.38	25.83
Reach-1	72377	100-year	CEM	5677.00	14.38	24.90
Reach-1	72377	100-year	REM	5677.00	14.38	24.85
Reach-1	71756	100-year	DEM	5677.00	14.17	25.76
Reach-1	71756	100-year	CEM	5677.00	14.17	24.78
Reach-1	71756	100-year	REM	5677.00	14.17	24.73
Reach-1	71151	100-year	DEM	5677.00	14.45	25.68
Reach-1	71151	100-year	CEM	5677.00	14.45	24.65
Reach-1	71151	100-year	REM	5677.00	14.45	24.59
Reach-1	70647	100-year	DEM	5677.00	13.96	25.60
Reach-1	70647	100-year	CEM	5677.00	13.96	24.52
Reach-1	70647	100-year	REM	5677.00	13.96	24.45
Reach-1	69977	100-year	DEM	5677.00	13.60	25.46
Reach-1	69977	100-year	CEM	5677.00	13.60	24.29
Reach-1	69977	100-year	REM	5677.00	13.60	24.21
Reach-1	69444	100-year	DEM	5677.00	13.57	25.41
Reach-1	69444	100-year	CEM	5677.00	13.57	24.12
Reach-1	69444	100-year	REM	5677.00	13.57	24.04
Reach-1	68519	100-year	DEM	6349.00	13.72	24.36
Reach-1	68519	100-year	CEM	6349.00	3.82	23.64
Reach-1	68519	100-year	REM	6349.00	3.82	23.56
Reach-1	68462			Bridge		
Reach-1	68393	100-year	DEM	6349.00	13.47	22.74
Reach-1	68393	100-year	CEM	6349.00	7.03	23.32
Reach-1	68393	100-year	REM	6349.00	7.03	23.32
Reach-1	67923	100-year	DEM	6349.00	12.68	22.69
Reach-1	67923	100-year	CEM	6349.00	12.68	22.83
Reach-1	67923	100-year	REM	6349.00	12.68	22.83
Reach-1	66539	100-year	DEM	6349.00	12.54	22.15
Reach-1	66539	100-year	CEM	6349.00	12.54	22.15
Reach-1	66539	100-year	REM	6349.00	12.54	22.15
Reach-1	65806	100-year	DEM	6349.00	12.36	21.82
Reach-1	65806	100-year	CEM	6349.00	12.36	21.82
Reach-1	65806	100-year	REM	6349.00	12.36	21.82

More detailed output from the HEC-RAS models can be seen in the appendices. Appendix D shows the profiles of the two conditions. Appendix E contains the detailed cross sections used for the models. Appendix F has more detailed tables of the output obtained from HEC-RAS for both of the conditions. When comparing the Corrected Effective model to the Revised model, there were no increases in the water surface elevations.

Table 3. *SCDOT Natural and Proposed Conditions Models (25, and 100 year storm)*

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev
				(cfs)	(ft)	(ft)
Reach-1	70647	25	EX SCDOT	3880.00	13.96	23.04
Reach-1	70647	25	PROP SCDOT	3880.00	13.96	22.99
Reach-1	70647	25	NAT	3880.00	13.96	22.92
Reach-1	70647	100 FEMA	EX SCDOT	5677.00	13.96	24.51
Reach-1	70647	100 FEMA	PROP SCDOT	5677.00	13.96	24.45
Reach-1	70647	100 FEMA	NAT	5677.00	13.96	24.10
Reach-1	69977	25	EX SCDOT	3880.00	13.60	22.80
Reach-1	69977	25	PROP SCDOT	3880.00	13.60	22.74
Reach-1	69977	25	NAT	3880.00	13.60	22.65
Reach-1	69977	100 FEMA	EX SCDOT	5677.00	13.60	24.28
Reach-1	69977	100 FEMA	PROP SCDOT	5677.00	13.60	24.21
Reach-1	69977	100 FEMA	NAT	5677.00	13.60	23.81
Reach-1	69444	25	EX SCDOT	3880.00	13.57	22.62
Reach-1	69444	25	PROP SCDOT	3880.00	13.57	22.55
Reach-1	69444	25	NAT	3880.00	13.57	22.52
Reach-1	69444	100 FEMA	EX SCDOT	5677.00	13.57	24.11
Reach-1	69444	100 FEMA	PROP SCDOT	5677.00	13.57	24.04
Reach-1	69444	100 FEMA	NAT	5677.00	13.57	23.67
Reach-1	68519	25	EX SCDOT	4160.00	3.82	22.28
Reach-1	68519	25	PROP SCDOT	4160.00	3.82	22.21
Reach-1	68519	25	NAT	4160.00	13.72	21.95
Reach-1	68519	100 FEMA	EX SCDOT	6349.00	3.82	23.64
Reach-1	68519	100 FEMA	PROP SCDOT	6349.00	3.82	23.56
Reach-1	68519	100 FEMA	NAT	6349.00	13.72	23.10
Reach-1	68462			Bridge		
Reach-1	68393	25	EX SCDOT	4160.00	7.03	22.07
Reach-1	68393	25	PROP SCDOT	4160.00	7.03	22.07
Reach-1	68393	25	NAT	4160.00	13.47	21.80
Reach-1	68393	100 FEMA	EX SCDOT	6349.00	7.03	23.31
Reach-1	68393	100 FEMA	PROP SCDOT	6349.00	7.03	23.31
Reach-1	68393	100 FEMA	NAT	6349.00	13.47	22.96
Reach-1	67923	25	EX SCDOT	4160.00	12.68	21.68
Reach-1	67923	25	PROP SCDOT	4160.00	12.68	21.68
Reach-1	67923	25	NAT	4160.00	12.68	21.54
Reach-1	67923	100 FEMA	EX SCDOT	6349.00	12.68	22.82
Reach-1	67923	100 FEMA	PROP SCDOT	6349.00	12.68	22.82
Reach-1	67923	100 FEMA	NAT	6349.00	12.68	22.68
Reach-1	66539	25	EX SCDOT	4160.00	12.54	21.05
Reach-1	66539	25	PROP SCDOT	4160.00	12.54	21.05
Reach-1	66539	25	NAT	4160.00	12.54	21.05
Reach-1	66539	100 FEMA	EX SCDOT	6349.00	12.54	22.13
Reach-1	66539	100 FEMA	PROP SCDOT	6349.00	12.54	22.13
Reach-1	66539	100 FEMA	NAT	6349.00	12.54	22.13

As can be seen by the tables and figures comparing site conditions in the natural state as well as with the existing and proposed bridges, the proposed bridge construction does not increase the 25-year or 100-year flooding elevation.

Conclusion

As shown above, the proposed bridge replacement is in conformance with the SCDOT Requirements for Hydraulic Studies May 2009. The bridge replacement does not increase the backwater of the Natural 100-year storm event more than 1 foot at any cross section and 2 foot of freeboard is obtained above the 25 year Design water surface elevation.

The results show a no rise to the BFE; therefore a “No Impact” Certification will be required. When comparing the Corrected Effective model to the Revised Effective model there is no change in the 100-year profile, rounded to the nearest 0.1 foot for any cross section outside the Department’s right of way.

Scour Analysis

The effects of scour resulting from the 100-and 500-year flood events were determined. Per the SCDOT’s “Requirements for Hydraulic Design Studies”, May 2009, scour analysis for riverine bridges was performed utilizing the USGS envelope curves and HEC-RAS version 4.1.0, using HEC-18 (5th Ed.) methodology with hydraulic results from the HEC-RAS model.

Calculations used in the USGS curves are limited to the 100-year event. Due to this constraint, the HEC-18 method was used to give a ratio between the 100-year and 500-year values. This result was then multiplied by the USGS curve 100-year value resulting in an estimate for the 500-year scour depth.

Although the depth of each type of scour (contraction, pier, and abutment) varied among the methodologies the total scour from the USGS curves and HEC-18 Spreadsheet produced similar results, with the exception of the USGS curves producing nearly twice the amount of channel contraction scour. After performing both calculations, a combination of the USGS curve methodology and the HEC-18 methodology were selected.

The USGS curves predicted more contraction scour than HEC-18 live-bed and Clearwater equations. To determine contraction scour, the USGS curves rely on approach top width, embankment lengths, and channel width at the bridge to calculate a geometric contraction ratio, but this ratio does not account for channel depth. The post flood event survey showed no significant change to the approach width, the embankment lengths, or the channel top width beneath the bridge, but did show a substantial change in the depth of the channel when comparing to the channel cross-section from the existing roadway plans. Based on this, it was determined that HEC-18 would give more accurate representation of channel contraction scour on the post-flood event channel. Thus we recommend the use of HEC-18 for Live Bed Contraction Channel Scour; rather than the Curves. This is further verified by the comparison of the Asbuilt Plan Stream bed elevation of 14.0 and the post storm event bed elevation of 4.0. This confirms that channel contraction scour has already occurred. Since this is live-bed conditions and may not indicate the maximum depth of the scour caused during the flood event, a conservative approach will be taken and the estimated HEC-18 contraction scour values will be added to the existing scour hole. Appendix G includes the soil borings and particle sizes (D50 and D95) used in the HEC-18 scour calculations.

For pier scour, USGS curves produced slightly smaller results than the CSU equations from HEC-18. Due to the cohesive soil, a 1:1 slope was used to plot each of the scour holes. A top width (*TW*) of 4 times the scour depth plus the pier width was used when plotting the scour profile.

$$TW = 4\, y_s + b,$$

where

TW	is the top width of the pier-scour holes, in feet;
y_s	is the pier-scour depth, in feet; and
b	is the pier width, in feet.

$$TW = 4 * (4.21) + 1.67' = 18.51' \text{ (100 YR)}$$

$$TW = 4 * (4.63) + 1.67' = 20.19' \text{ (500 YR)}$$

The bridge was modeled with spill-through abutments. Although HEC-18 calculated a greater depth of abutment scour, the drainage area was within range of the USGS curve data, which provides a more accurate and less conservative estimate of the actual abutment scour values. Riprap will be placed on all bridge end fills to a depth of 2.0’ below the ground line and extend 2.0’ above the design high-water level to reduce the likelihood of abutment scour occurring, per SCDOT standard applications.

Partially weathered rock (PWR) was not found at the site. Hard rock was found at depths below the predicted scour plot. Therefore, the scour depths shown in the table below are anticipated to stop above the hard rock. Per boring log B-3, at Interior Bent 3, a rock like layer was encountered at an approximate elevation of 0.5’. After discussion with the Geotechnical engineer, it was determined that this layer acted similar to rock and that the erodibility index could be applied to determine if there were any further scour at this layer (See the Geotechnical Report for further details). The erodibility index indicated no further scour beyond this layer. Although the scour values, shown in Table 4 below, indicate the full depth of the calculated scour, the scour plot on the bridge plan and profile will stop the scour line where this dense layer is encountered in the proximity of interior bent 3.

The estimated 100-year and 500-year scour depths for the contraction, piers, and abutment can be found below in Table 4. Scour calculations are provided in Appendix G, and data was interpreted onto the bridge plan and profile.

Table 4. *Scour Results Summary Table*

BENT #	BRIDGE PLAN STATION	HEC-RAS STATION	SCOUR SUMMARY TABLE							
			CONTR		PIER		ABUTMENT		TOTAL	
			100-yr	500-yr	100-yr	500-yr	100-yr	500-yr	100-yr	500-yr
1	67+61.00	L.ABUT	0.00	0.00	N/A	N/A	15.15	19.70	15.15	19.70
2-3	67+98.50 68+68.50	BENT 2 BENT 3	7.35	9.71	4.21	4.63	N/A	N/A	11.56	14.34
4	69+25.00	R.ABUT	0.00	0.00	N/A	N/A	4.29	5.58	4.29	5.58

*FROM HEC-18 EQUATIONS

*FROM USGS ENVELOPE CURVES

Appendix A
Hydrologic Information

Figures in Appendix

NSS Rural Regression
National Streamflow Statistics Program
Version 6.1
Based on Techniques and Methods Book 4-A6
Equations from database C:\Program Files (x86)\NSS\data\NSS_v6_2015-10-13.mdb
Updated by KGR 10/2/2015 11:54:26 AM added ASPECT

Site: Black Mingo Creek @ S-51, South_Carolina
User:
Date: Wednesday, December 09, 2015 07:23 PM

Equations for South_Carolina developed using English units

Rural Estimate: Rural 1
Basin Drainage Area: 107 square miles AT BRIDGE SITE
1 Region

Region: Peak_Southeast_US_over_1_sqmi_2009_5043 (Gotvald, A.J., Feaster, T.D., and Weaver, J.C., 2009, Magnitude and Frequency of Rural Floods in the Southeastern United States, 2006: Volume 1, Georgia: U.S. Geological Survey Scientific Investigations Report 2009-5043, 120 p.)
Drainage_Area = 107 square miles
Percent_Area_in_Region_1 = 0 percent
Percent_Area_in_Region_2 = 0 percent
Percent_Area_in_Region_3 = 0 percent
Percent_Area_in_Region_4 = 100 percent
Percent_Area_in_Region_5 = 0 percent
Crippen & Bue Region 2

Results for: Rural 1

Equations used:
PK2 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0220*PCTREG1+0.0204*PCTREG2+0.0141*PCTREG3+0.0178*PCTREG4+0.0196*PCTREG5)*DRNAREA^(0.649+0.00130*PCTREG2+0.00109*PCTREG3)
PK5 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0247*PCTREG1+0.0232*PCTREG2+0.0165*PCTREG3+0.0209*PCTREG4+0.0230*PCTREG5)*DRNAREA^(0.627+0.00122*PCTREG2+0.00117*PCTREG3)
PK10 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0260*PCTREG1+0.0246*PCTREG2+0.0177*PCTREG3+0.0224*PCTREG4+0.0247*PCTREG5)*DRNAREA^(0.617+0.00119*PCTREG2+0.00123*PCTREG3)
PK25 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0273*PCTREG1+0.0260*PCTREG2+0.0189*PCTREG3+0.0239*PCTREG4+0.0265*PCTREG5)*DRNAREA^(0.606+0.00118*PCTREG2+0.00130*PCTREG3)
PK50 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0282*PCTREG1+0.0268*PCTREG2+0.0196*PCTREG3+0.0249*PCTREG4+0.0276*PCTREG5)*DRNAREA^(0.600+0.00118*PCTREG2+0.00135*PCTREG3)
PK100 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0289*PCTREG1+0.0276*PCTREG2+0.0202*PCTREG3+0.0258*PCTREG4+0.0286*PCTREG5)*DRNAREA^(0.594+0.00119*PCTREG2+0.00139*PCTREG3)
PK200 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0295*PCTREG1+0.0282*PCTREG2+0.0208*PCTREG3+0.0265*PCTREG4+0.0295*PCTREG5)*DRNAREA^(0.589+0.00120*PCTREG2+0.00144*PCTREG3)
PK500 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0303*PCTREG1+0.0290*PCTREG2+0.0214*PCTREG3+0.0274*PCTREG4+0.0306*PCTREG5)*DRNAREA^(0.583+0.00121*PCTREG2+0.

00149*PCTREG3)

Statistic	Value, ft3/s	Pred. Intervals Low	High	Prediction Error, %
PK2	1250	719	2160	35
PK5	2300	1330	3960	34
PK10	3100	1770	5420	35
PK25	4160	2290	7530	38
PK50	5090	2720	9520	40
PK100	6080	3140	11800	42
PK200	6980	3480	14000	44
PK500	8350	3970	17600	48

maximum: 88100 (for C&B region 2)

National Streamflow Statistics Program
Version 6.1
Based on Techniques and Methods Book 4-A6
Equations from database C:\Program Files (x86)\NSS\data\NSS_v6_2015-10-13.mdb
Updated by KGR 10/2/2015 11:54:26 AM added ASPECT

Site: unnamed, South_Carolina
User:
Date: Thursday, January 14, 2016 02:40 PM

Equations for South_Carolina developed using English units

Rural Estimate: Rural 1
Basin Drainage Area: 147 square miles
1 Region

AT RIVER STA 38116

Region: Peak_Southeast_US_over_1_sqmi_2009_5043 (Gotvald, A.J., Feaster, T.D., and Weaver, J.C., 2009, Magnitude and Frequency of Rural Floods in the Southeastern United States, 2006: Volume 1, Georgia: U.S. Geological Survey Scientific Investigations Report 2009-5043, 120 p.)
Drainage_Area = 147 square miles
Percent_Area_in_Region_1 = 0 percent
Percent_Area_in_Region_2 = 0 percent
Percent_Area_in_Region_3 = 0 percent
Percent_Area_in_Region_4 = 100 percent
Percent_Area_in_Region_5 = 0 percent
Crippen & Bue Region 2

Results for: Rural 1

Equations used:
PK2 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0220*PCTREG1+0.0204*PCTREG2+0.0141*PCTREG3+0.0178*PCTREG4+0.0196*PCTREG5)*DRNAREA^(0.649+0.00130*PCTREG2+0.00109*PCTREG3)
PK5 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0247*PCTREG1+0.0232*PCTREG2+0.0165*PCTREG3+0.0209*PCTREG4+0.0230*PCTREG5)*DRNAREA^(0.627+0.00122*PCTREG2+0.00117*PCTREG3)
PK10 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0260*PCTREG1+0.0246*PCTREG2+0.0177*PCTREG3+0.0224*PCTREG4+0.0247*PCTREG5)*DRNAREA^(0.617+0.00119*PCTREG2+0.00123*PCTREG3)
PK25 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0273*PCTREG1+0.0260*PCTREG2+0.0189*PCTREG3+0.0239*PCTREG4+0.0265*PCTREG5)*DRNAREA^(0.606+0.00118*PCTREG2+0.00130*PCTREG3)
PK50 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0282*PCTREG1+0.0268*PCTREG2+0.0196*PCTREG3+0.0249*PCTREG4+0.0276*PCTREG5)*DRNAREA^(0.600+0.00118*PCTREG2+0.00135*PCTREG3)
PK100 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0289*PCTREG1+0.0276*PCTREG2+0.0202*PCTREG3+0.0258*PCTREG4+0.0286*PCTREG5)*DRNAREA^(0.594+0.00119*PCTREG2+0.00139*PCTREG3)
PK200 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0295*PCTREG1+0.0282*PCTREG2+0.0208*PCTREG3+0.0265*PCTREG4+0.0295*PCTREG5)*DRNAREA^(0.589+0.00120*PCTREG2+0.00144*PCTREG3)
PK500 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0303*PCTREG1+0.0290*PCTREG2+0.0214*PCTREG3+0.0274*PCTREG4+0.0306*PCTREG5)*DRNAREA^(0.583+0.00121*PCTREG2+0.

River STA 38116

00149*PCTREG3)

Statistic	Value, ft3/s	Pred. Intervals Low	High	Prediction Error, %
PK2	1540	886	2670	35
PK5	2810	1630	4840	34
PK10	3780	2160	6610	35
PK25	5050	2790	9160	38
PK50	6170	3300	11500	40
PK100	7370	3810	14300	42
PK200	8440	4210	16900	44
PK500	10100	4790	21200	48

maximum: 102000 (for C&B region 2)

National Streamflow Statistics Program
Version 6.1
Based on Techniques and Methods Book 4-A6
Equations from database C:\Program Files (x86)\NSS\data\NSS_v6_2015-10-13.mdb
Updated by KGR 10/2/2015 11:54:26 AM added ASPECT

Site: unnamed, South_Carolina
User:
Date: Thursday, January 14, 2016 02:39 PM

Equations for South_Carolina developed using English units

Rural Estimate: Rural 1
Basin Drainage Area: 140 square miles AT RIVER STA 47130
1 Region

Region: Peak_Southeast_US_over_1_sqmi_2009_5043 (Gotvald, A.J., Feaster, T.D., and Weaver, J.C., 2009, Magnitude and Frequency of Rural Floods in the Southeastern United States, 2006: Volume 1, Georgia: U.S. Geological Survey Scientific Investigations Report 2009-5043, 120 p.)
Drainage_Area = 140 square miles
Percent_Area_in_Region_1 = 0 percent
Percent_Area_in_Region_2 = 0 percent
Percent_Area_in_Region_3 = 0 percent
Percent_Area_in_Region_4 = 100 percent
Percent_Area_in_Region_5 = 0 percent
Crippen & Bue Region 2

Results for: Rural 1

Equations used:
PK2 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0220*PCTREG1+0.0204*PCTREG2+0.0141*PCTREG3+0.0178*PCTREG4+0.0196*PCTREG5)*DRNAREA^(0.649+0.00130*PCTREG2+0.00109*PCTREG3)
PK5 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0247*PCTREG1+0.0232*PCTREG2+0.0165*PCTREG3+0.0209*PCTREG4+0.0230*PCTREG5)*DRNAREA^(0.627+0.00122*PCTREG2+0.00117*PCTREG3)
PK10 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0260*PCTREG1+0.0246*PCTREG2+0.0177*PCTREG3+0.0224*PCTREG4+0.0247*PCTREG5)*DRNAREA^(0.617+0.00119*PCTREG2+0.00123*PCTREG3)
PK25 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0273*PCTREG1+0.0260*PCTREG2+0.0189*PCTREG3+0.0239*PCTREG4+0.0265*PCTREG5)*DRNAREA^(0.606+0.00118*PCTREG2+0.00130*PCTREG3)
PK50 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0282*PCTREG1+0.0268*PCTREG2+0.0196*PCTREG3+0.0249*PCTREG4+0.0276*PCTREG5)*DRNAREA^(0.600+0.00118*PCTREG2+0.00135*PCTREG3)
PK100 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0289*PCTREG1+0.0276*PCTREG2+0.0202*PCTREG3+0.0258*PCTREG4+0.0286*PCTREG5)*DRNAREA^(0.594+0.00119*PCTREG2+0.00139*PCTREG3)
PK200 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0295*PCTREG1+0.0282*PCTREG2+0.0208*PCTREG3+0.0265*PCTREG4+0.0295*PCTREG5)*DRNAREA^(0.589+0.00120*PCTREG2+0.00144*PCTREG3)
PK500 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0303*PCTREG1+0.0290*PCTREG2+0.0214*PCTREG3+0.0274*PCTREG4+0.0306*PCTREG5)*DRNAREA^(0.583+0.00121*PCTREG2+0.

00149*PCTREG3)

Statistic	Value, ft3/s	Pred. Intervals Low	High	Prediction Error, %
PK2	1490	858	2580	35
PK5	2730	1580	4690	34
PK10	3670	2090	6420	35
PK25	4900	2710	8890	38
PK50	5990	3200	11200	40
PK100	7160	3700	13900	42
PK200	8200	4090	16400	44
PK500	9800	4660	20600	48

maximum: 100000 (for C&B region 2)

```
National Streamflow Statistics Program
Version 6.1
Based on Techniques and Methods Book 4-A6
Equations from database C:\Program Files (x86)\NSS\data\NSS_v6_2015-10-13.mdb
Updated by KGR 10/2/2015 11:54:26 AM added ASPECT

Site: unnamed, South_Carolina
User:
Date: Thursday, January 14, 2016 02:38 PM

Equations for South_Carolina developed using English units

Rural Estimate: Rural 1
   Basin Drainage Area: 136 square miles
   1 Region
```

AT RIVER STA 56571

```
   Region: Peak_Southeast_US_over_1_sqmi_2009_5043 (Gotvald, A.J., Feaster, T.D.,
and Weaver, J.C., 2009, Magnitude and Frequency of Rural Floods in the Southeastern
United States, 2006: Volume 1, Georgia: U.S. Geological Survey Scientific
Investigations Report 2009-5043, 120 p.)
      Drainage_Area = 136 square miles
      Percent_Area_in_Region_1 = 0 percent
      Percent_Area_in_Region_2 = 0 percent
      Percent_Area_in_Region_3 = 0 percent
      Percent_Area_in_Region_4 = 100 percent
      Percent_Area_in_Region_5 = 0 percent
   Crippen & Bue Region 2


Results for:  Rural 1

Equations used:
PK2 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0220*PCTREG1+0.0204*PCT
REG2+0.0141*PCTREG3+0.0178*PCTREG4+0.0196*PCTREG5)*DRNAREA^(0.649+0.00130*PCTREG2+0.
00109*PCTREG3)
PK5 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0247*PCTREG1+0.0232*PCT
REG2+0.0165*PCTREG3+0.0209*PCTREG4+0.0230*PCTREG5)*DRNAREA^(0.627+0.00122*PCTREG2+0.
00117*PCTREG3)
PK10 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0260*PCTREG1+0.0246*PCT
REG2+0.0177*PCTREG3+0.0224*PCTREG4+0.0247*PCTREG5)*DRNAREA^(0.617+0.00119*PCTREG2+0.
00123*PCTREG3)
PK25 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0273*PCTREG1+0.0260*PCT
REG2+0.0189*PCTREG3+0.0239*PCTREG4+0.0265*PCTREG5)*DRNAREA^(0.606+0.00118*PCTREG2+0.
00130*PCTREG3)
PK50 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0282*PCTREG1+0.0268*PCT
REG2+0.0196*PCTREG3+0.0249*PCTREG4+0.0276*PCTREG5)*DRNAREA^(0.600+0.00118*PCTREG2+0.
00135*PCTREG3)
PK100 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0289*PCTREG1+0.0276*PCT
REG2+0.0202*PCTREG3+0.0258*PCTREG4+0.0286*PCTREG5)*DRNAREA^(0.594+0.00119*PCTREG2+0.
00139*PCTREG3)
PK200 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0295*PCTREG1+0.0282*PCT
REG2+0.0208*PCTREG3+0.0265*PCTREG4+0.0295*PCTREG5)*DRNAREA^(0.589+0.00120*PCTREG2+0.
00144*PCTREG3)
PK500 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0303*PCTREG1+0.0290*PCT
REG2+0.0214*PCTREG3+0.0274*PCTREG4+0.0306*PCTREG5)*DRNAREA^(0.583+0.00121*PCTREG2+0.
```

River STA 56571

00149*PCTREG3)

Statistic	Value, ft3/s	Pred. Intervals Low	High	Prediction Error, %
PK2	1460	842	2530	35
PK5	2680	1560	4610	34
PK10	3600	2060	6300	35
PK25	4820	2660	8740	38
PK50	5890	3150	11000	40
PK100	7040	3640	13600	42
PK200	8070	4020	16200	44
PK500	9640	4580	20300	48

maximum: 98600 (for C&B region 2)

```
National Streamflow Statistics Program
Version 6.1
Based on Techniques and Methods Book 4-A6
Equations from database C:\Program Files (x86)\NSS\data\NSS_v6_2015-10-13.mdb
Updated by KGR 10/2/2015 11:54:26 AM added ASPECT

Site: unnamed, South_Carolina
User:
Date: Thursday, January 14, 2016 02:33 PM

Equations for South_Carolina developed using English units

Rural Estimate: Rural 1
   Basin Drainage Area: 95 square miles
   1 Region
```

AT RIVER STA 77881

```
   Region: Peak_Southeast_US_over_1_sqmi_2009_5043 (Gotvald, A.J., Feaster, T.D.,
and Weaver, J.C., 2009, Magnitude and Frequency of Rural Floods in the Southeastern
United States, 2006: Volume 1, Georgia: U.S. Geological Survey Scientific
Investigations Report 2009-5043, 120 p.)
      Drainage_Area = 95 square miles
      Percent_Area_in_Region_1 = 0 percent
      Percent_Area_in_Region_2 = 0 percent
      Percent_Area_in_Region_3 = 0 percent
      Percent_Area_in_Region_4 = 100 percent
      Percent_Area_in_Region_5 = 0 percent
   Crippen & Bue Region 2


Results for:  Rural 1

Equations used:
PK2 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0220*PCTREG1+0.0204*PCT
REG2+0.0141*PCTREG3+0.0178*PCTREG4+0.0196*PCTREG5)*DRNAREA^(0.649+0.00130*PCTREG2+0.
00109*PCTREG3)
PK5 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0247*PCTREG1+0.0232*PCT
REG2+0.0165*PCTREG3+0.0209*PCTREG4+0.0230*PCTREG5)*DRNAREA^(0.627+0.00122*PCTREG2+0.
00117*PCTREG3)
PK10 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0260*PCTREG1+0.0246*PCT
REG2+0.0177*PCTREG3+0.0224*PCTREG4+0.0247*PCTREG5)*DRNAREA^(0.617+0.00119*PCTREG2+0.
00123*PCTREG3)
PK25 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0273*PCTREG1+0.0260*PCT
REG2+0.0189*PCTREG3+0.0239*PCTREG4+0.0265*PCTREG5)*DRNAREA^(0.606+0.00118*PCTREG2+0.
00130*PCTREG3)
PK50 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0282*PCTREG1+0.0268*PCT
REG2+0.0196*PCTREG3+0.0249*PCTREG4+0.0276*PCTREG5)*DRNAREA^(0.600+0.00118*PCTREG2+0.
00135*PCTREG3)
PK100 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0289*PCTREG1+0.0276*PCT
REG2+0.0202*PCTREG3+0.0258*PCTREG4+0.0286*PCTREG5)*DRNAREA^(0.594+0.00119*PCTREG2+0.
00139*PCTREG3)
PK200 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0295*PCTREG1+0.0282*PCT
REG2+0.0208*PCTREG3+0.0265*PCTREG4+0.0295*PCTREG5)*DRNAREA^(0.589+0.00120*PCTREG2+0.
00144*PCTREG3)
PK500 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0303*PCTREG1+0.0290*PCT
REG2+0.0214*PCTREG3+0.0274*PCTREG4+0.0306*PCTREG5)*DRNAREA^(0.583+0.00121*PCTREG2+0.
```

00149*PCTREG3)

Statistic	Value, ft3/s	Pred. Intervals Low	High	Prediction Error, %
PK2	1160	667	2010	35
PK5	2140	1240	3680	34
PK10	2890	1650	5050	35
PK25	3880	2140	7030	38
PK50	4750	2540	8890	40
PK100	5690	2940	11000	42
PK200	6530	3260	13100	44
PK500	7820	3720	16400	48

maximum: 83500 (for C&B region 2)

National Streamflow Statistics Program
Version 6.1
Based on Techniques and Methods Book 4-A6
Equations from database C:\Program Files (x86)\NSS\data\NSS_v6_2015-10-13.mdb
Updated by KGR 10/2/2015 11:54:26 AM added ASPECT

Site: unnamed, South_Carolina
User:
Date: Thursday, January 14, 2016 02:49 PM

Equations for South_Carolina developed using English units

Rural Estimate: Rural 1
Basin Drainage Area: 78 square miles AT RIVER STA 80916
1 Region

Region: Peak_Southeast_US_over_1_sqmi_2009_5043 (Gotvald, A.J., Feaster, T.D., and Weaver, J.C., 2009, Magnitude and Frequency of Rural Floods in the Southeastern United States, 2006: Volume 1, Georgia: U.S. Geological Survey Scientific Investigations Report 2009-5043, 120 p.)
Drainage_Area = 78 square miles
Percent_Area_in_Region_1 = 0 percent
Percent_Area_in_Region_2 = 0 percent
Percent_Area_in_Region_3 = 0 percent
Percent_Area_in_Region_4 = 100 percent
Percent_Area_in_Region_5 = 0 percent
Crippen & Bue Region 2

Results for: Rural 1

Equations used:
PK2 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0220*PCTREG1+0.0204*PCTREG2+0.0141*PCTREG3+0.0178*PCTREG4+0.0196*PCTREG5)*DRNAREA^(0.649+0.00130*PCTREG2+0.00109*PCTREG3)
PK5 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0247*PCTREG1+0.0232*PCTREG2+0.0165*PCTREG3+0.0209*PCTREG4+0.0230*PCTREG5)*DRNAREA^(0.627+0.00122*PCTREG2+0.00117*PCTREG3)
PK10 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0260*PCTREG1+0.0246*PCTREG2+0.0177*PCTREG3+0.0224*PCTREG4+0.0247*PCTREG5)*DRNAREA^(0.617+0.00119*PCTREG2+0.00123*PCTREG3)
PK25 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0273*PCTREG1+0.0260*PCTREG2+0.0189*PCTREG3+0.0239*PCTREG4+0.0265*PCTREG5)*DRNAREA^(0.606+0.00118*PCTREG2+0.00130*PCTREG3)
PK50 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0282*PCTREG1+0.0268*PCTREG2+0.0196*PCTREG3+0.0249*PCTREG4+0.0276*PCTREG5)*DRNAREA^(0.600+0.00118*PCTREG2+0.00135*PCTREG3)
PK100 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0289*PCTREG1+0.0276*PCTREG2+0.0202*PCTREG3+0.0258*PCTREG4+0.0286*PCTREG5)*DRNAREA^(0.594+0.00119*PCTREG2+0.00139*PCTREG3)
PK200 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0295*PCTREG1+0.0282*PCTREG2+0.0208*PCTREG3+0.0265*PCTREG4+0.0295*PCTREG5)*DRNAREA^(0.589+0.00120*PCTREG2+0.00144*PCTREG3)
PK500 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0303*PCTREG1+0.0290*PCTREG2+0.0214*PCTREG3+0.0274*PCTREG4+0.0306*PCTREG5)*DRNAREA^(0.583+0.00121*PCTREG2+0.

00149*PCTREG3)

Statistic	Value, ft3/s	Pred. Intervals Low	High	Prediction Error, %
PK2	1020	587	1770	35
PK5	1890	1100	3250	34
PK10	2560	1460	4470	35
PK25	3440	1900	6240	38
PK50	4220	2250	7900	40
PK100	5060	2610	9790	42
PK200	5810	2900	11700	44
PK500	6970	3310	14700	48

maximum: 76000 (for C&B region 2)

```
National Streamflow Statistics Program
Version 6.1
Based on Techniques and Methods Book 4-A6
Equations from database C:\Program Files (x86)\NSS\data\NSS_v6_2015-10-13.mdb
Updated by KGR 10/2/2015 11:54:26 AM added ASPECT

Site: unnamed, South_Carolina
User:
Date: Thursday, January 14, 2016 02:48 PM

Equations for South_Carolina developed using English units

Rural Estimate: Rural 1
   Basin Drainage Area: 73 square miles
   1 Region
```

AT RIVER STA 83828

```
   Region: Peak_Southeast_US_over_1_sqmi_2009_5043 (Gotvald, A.J., Feaster, T.D.,
and Weaver, J.C., 2009, Magnitude and Frequency of Rural Floods in the Southeastern
United States, 2006: Volume 1, Georgia: U.S. Geological Survey Scientific
Investigations Report 2009-5043, 120 p.)
      Drainage_Area = 73 square miles
      Percent_Area_in_Region_1 = 0 percent
      Percent_Area_in_Region_2 = 0 percent
      Percent_Area_in_Region_3 = 0 percent
      Percent_Area_in_Region_4 = 100 percent
      Percent_Area_in_Region_5 = 0 percent
   Crippen & Bue Region 2


Results for:  Rural 1

Equations used:
PK2 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0220*PCTREG1+0.0204*PCT
REG2+0.0141*PCTREG3+0.0178*PCTREG4+0.0196*PCTREG5)*DRNAREA^(0.649+0.00130*PCTREG2+0.
00109*PCTREG3)
PK5 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0247*PCTREG1+0.0232*PCT
REG2+0.0165*PCTREG3+0.0209*PCTREG4+0.0230*PCTREG5)*DRNAREA^(0.627+0.00122*PCTREG2+0.
00117*PCTREG3)
PK10 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0260*PCTREG1+0.0246*PCT
REG2+0.0177*PCTREG3+0.0224*PCTREG4+0.0247*PCTREG5)*DRNAREA^(0.617+0.00119*PCTREG2+0.
00123*PCTREG3)
PK25 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0273*PCTREG1+0.0260*PCT
REG2+0.0189*PCTREG3+0.0239*PCTREG4+0.0265*PCTREG5)*DRNAREA^(0.606+0.00118*PCTREG2+0.
00130*PCTREG3)
PK50 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0282*PCTREG1+0.0268*PCT
REG2+0.0196*PCTREG3+0.0249*PCTREG4+0.0276*PCTREG5)*DRNAREA^(0.600+0.00118*PCTREG2+0.
00135*PCTREG3)
PK100 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0289*PCTREG1+0.0276*PCT
REG2+0.0202*PCTREG3+0.0258*PCTREG4+0.0286*PCTREG5)*DRNAREA^(0.594+0.00119*PCTREG2+0.
00139*PCTREG3)
PK200 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0295*PCTREG1+0.0282*PCT
REG2+0.0208*PCTREG3+0.0265*PCTREG4+0.0295*PCTREG5)*DRNAREA^(0.589+0.00120*PCTREG2+0.
00144*PCTREG3)
PK500 =
(round(PCTREG1+PCTREG2+PCTREG3+PCTREG4+PCTREG5,0)=100)*10^(0.0303*PCTREG1+0.0290*PCT
REG2+0.0214*PCTREG3+0.0274*PCTREG4+0.0306*PCTREG5)*DRNAREA^(0.583+0.00121*PCTREG2+0.
```

00149*PCTREG3)

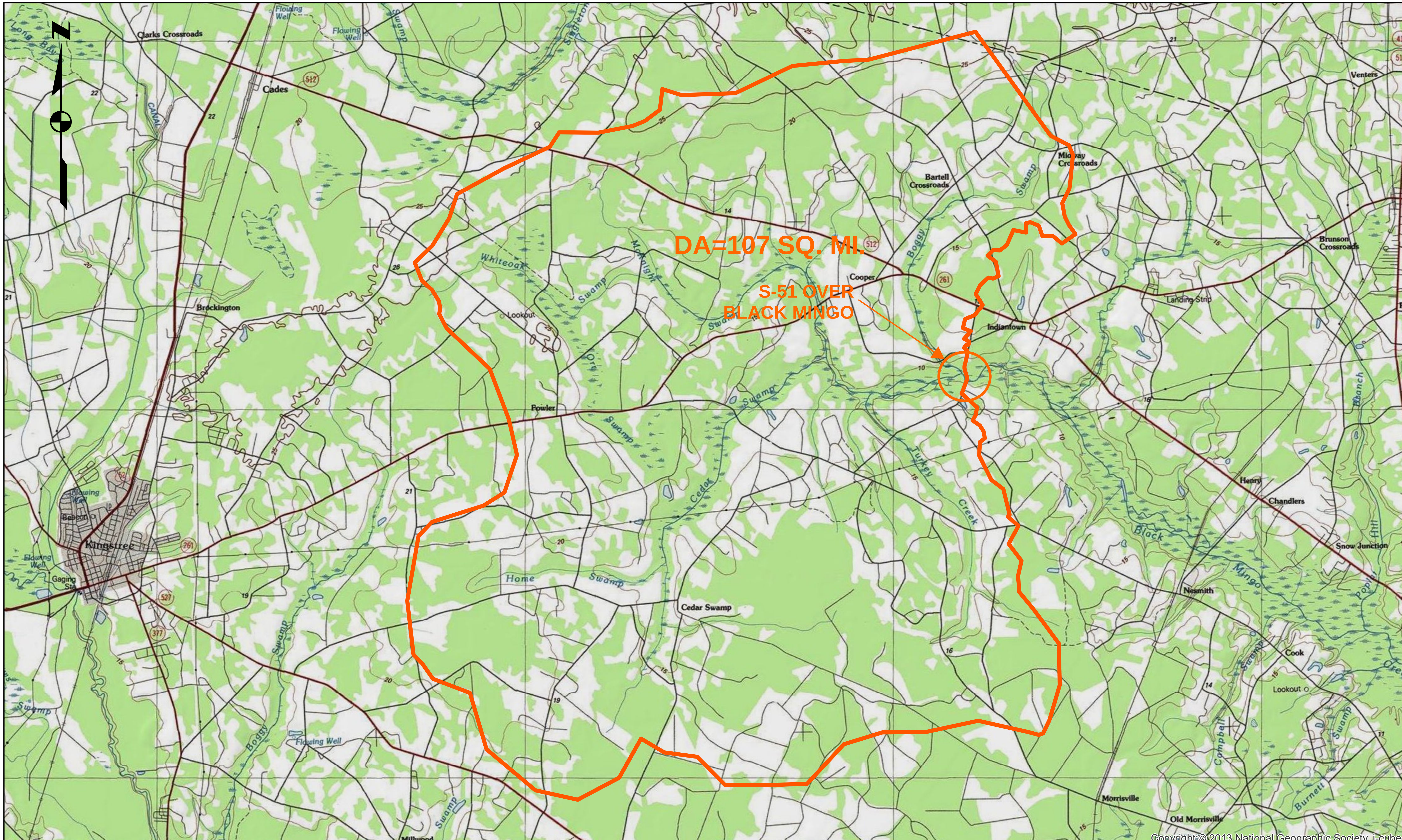
Statistic	Value, ft3/s	Pred. Intervals Low	High	Prediction Error, %
PK2	976	562	1690	35
PK5	1810	1050	3120	34
PK10	2450	1400	4290	35
PK25	3310	1820	5990	38
PK50	4060	2170	7590	40
PK100	4860	2510	9410	42
PK200	5590	2790	11200	44
PK500	6700	3190	14100	48

maximum: 73600 (for C&B region 2)

TABLE 4—Limited Detailed Flood Hazard Data			
Cross Section[1]	Stream Station[2]	Flood Discharge (cfs)	1% Annual Chance Water-Surface Elevation (feet NAVD 88)
BLACK MINGO CREEK (continued)			
494	49436	7,039	17.7
501	50100	7,039	17.8
506	50627	7,039	17.87
513	51345	7,039	17.97
520	51975	7,039	18.04
527	52673	7,039	18.14
533	53325	7,039	18.29
541	54059	7,039	18.51
548	54764	7,039	18.69
553	55309	7,039	18.81
560	55973	7,039	19.01
566	56571	7,039	19.24
573	57277	6,349	19.47
578	57785	6,349	19.61
584	58402	6,349	19.77
591	59074	6,349	19.94
601	60141	6,349	20.19
613	61288	6,349	20.43
623	62288	6,349	20.65
632	63165	6,349	20.86
639	63935	6,349	21.05
649	64865	6,349	21.37
658	65806	6,349	21.82
665	66539	6,349	22.15
679	67923	6,349	22.69
684	68393	6,349	22.74
685	68519	6,349	24.36
694	69444	5,677	25.41
700	69977	5,677	25.46
706	70647	5,677	25.6
712	71151	5,677	25.68
718	71756	5,677	25.76
724	72377	5,677	25.83
732	73210	5,677	25.91
740	74035	5,677	25.97
747	74728	5,677	26.04
756	75575	5,677	26.13
764	76387	5,677	26.27
772	77191	5,677	26.46
779	77881	5,677	26.63
785	78506	5,058	26.76
791	79092	5,058	26.83

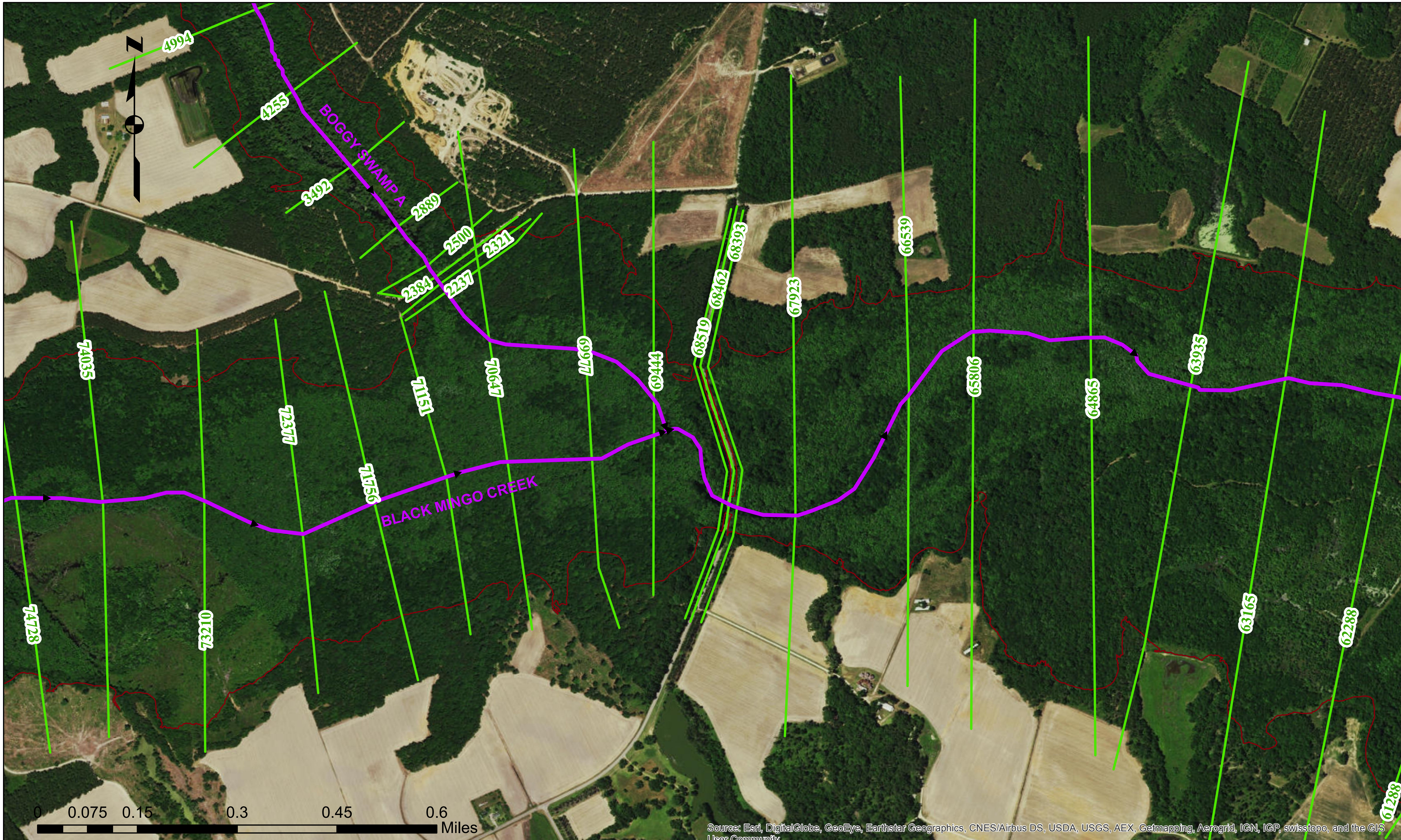
Appendix B
Detailed Drainage Area Map

Drainage Area Map S-51 (Battery Park Rd) over Black Mingo



0 0.5 1 2 3 4
Miles

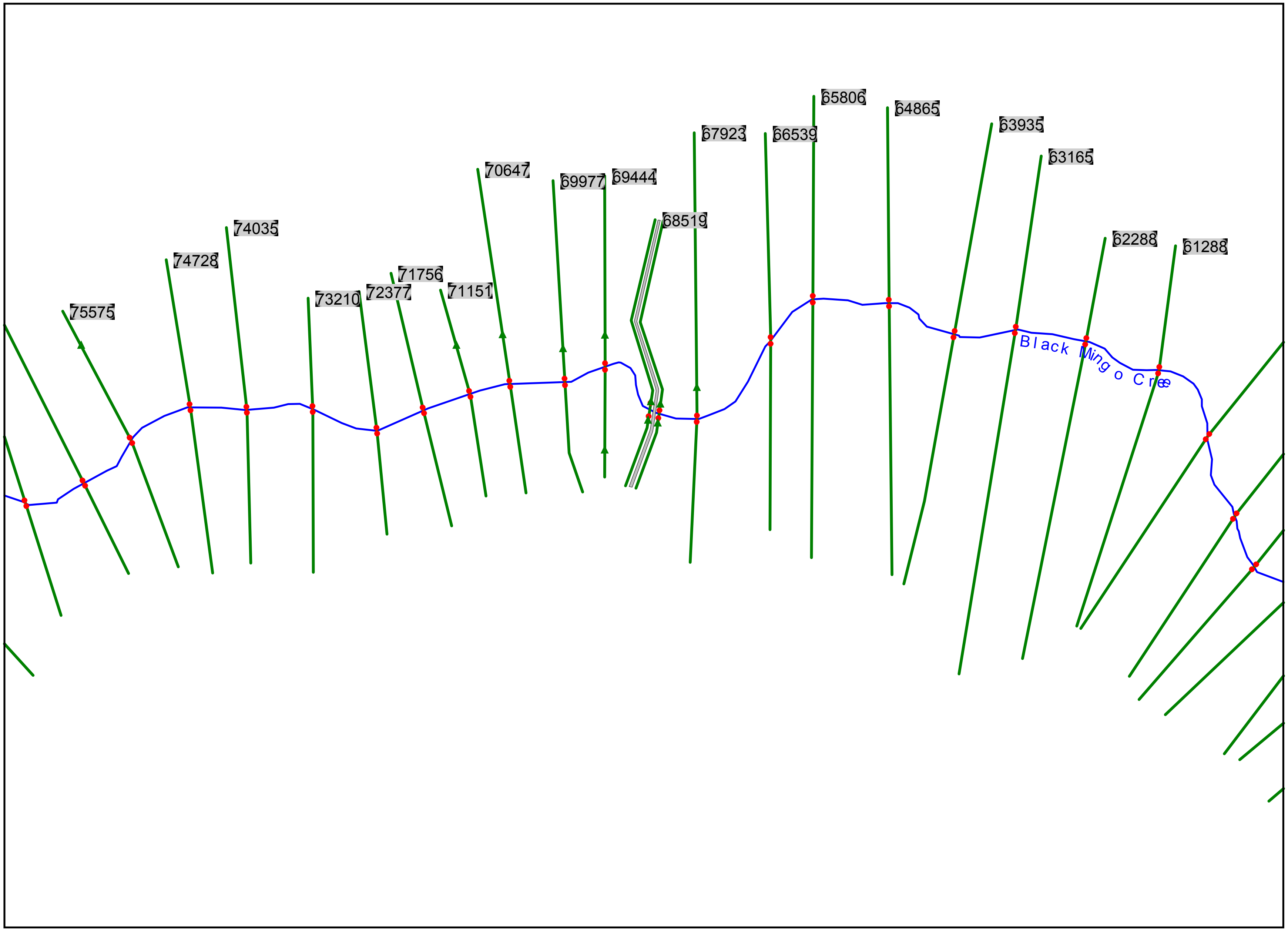
Appendix C
Detail Cross Section Maps



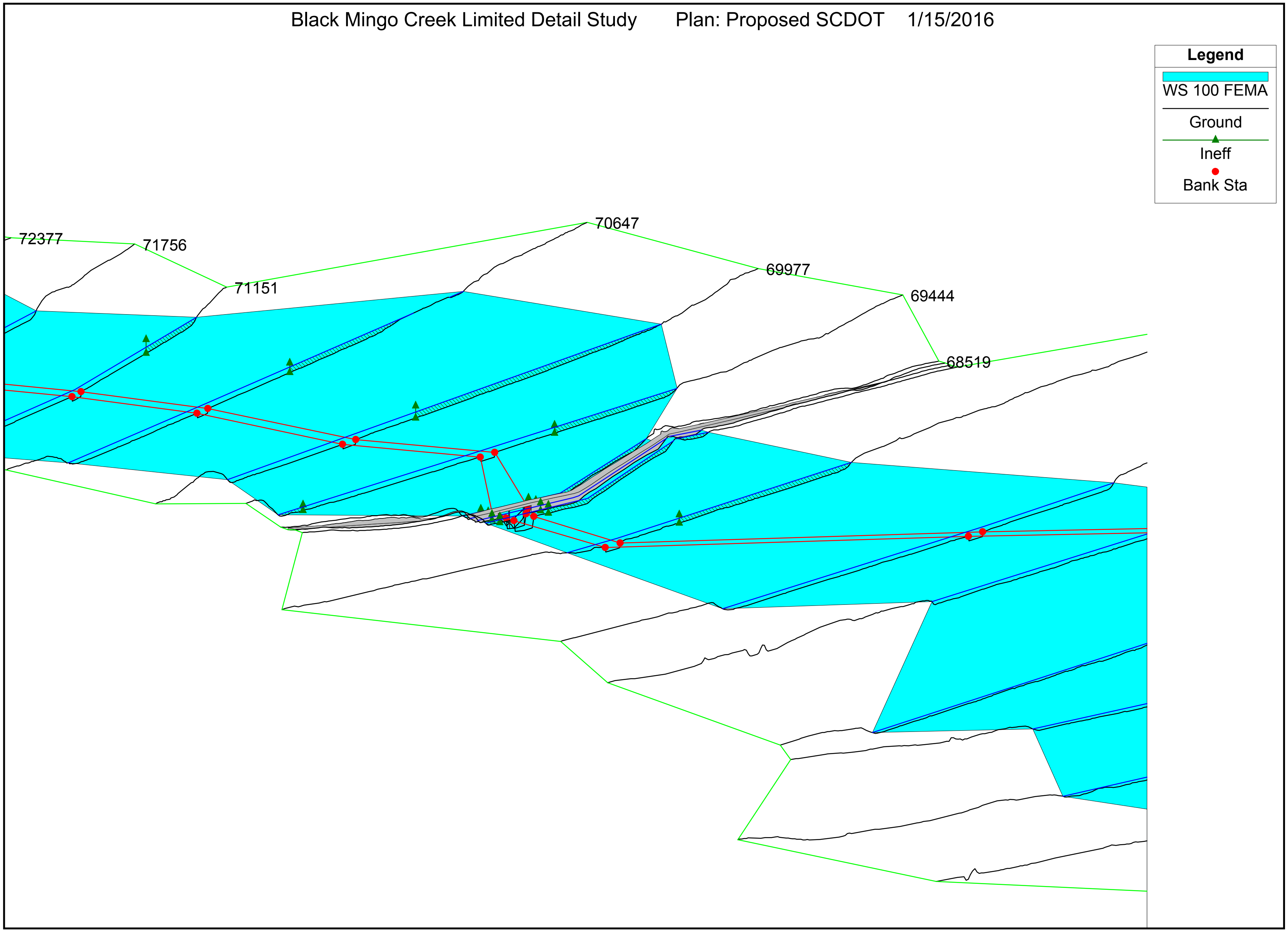
N
BOGGY SWAMP A
BLACK MINGO CREEK
4994
4255
3492
2889
2500
2321
2384
2237
74035
74728
73210
72377
71756
71151
70647
69977
69444
68519
68462
68393
67923
66539
65806
64865
63935
63165
62288
61288
0
0.075
0.15
0.3
0.45
0.6
Miles
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

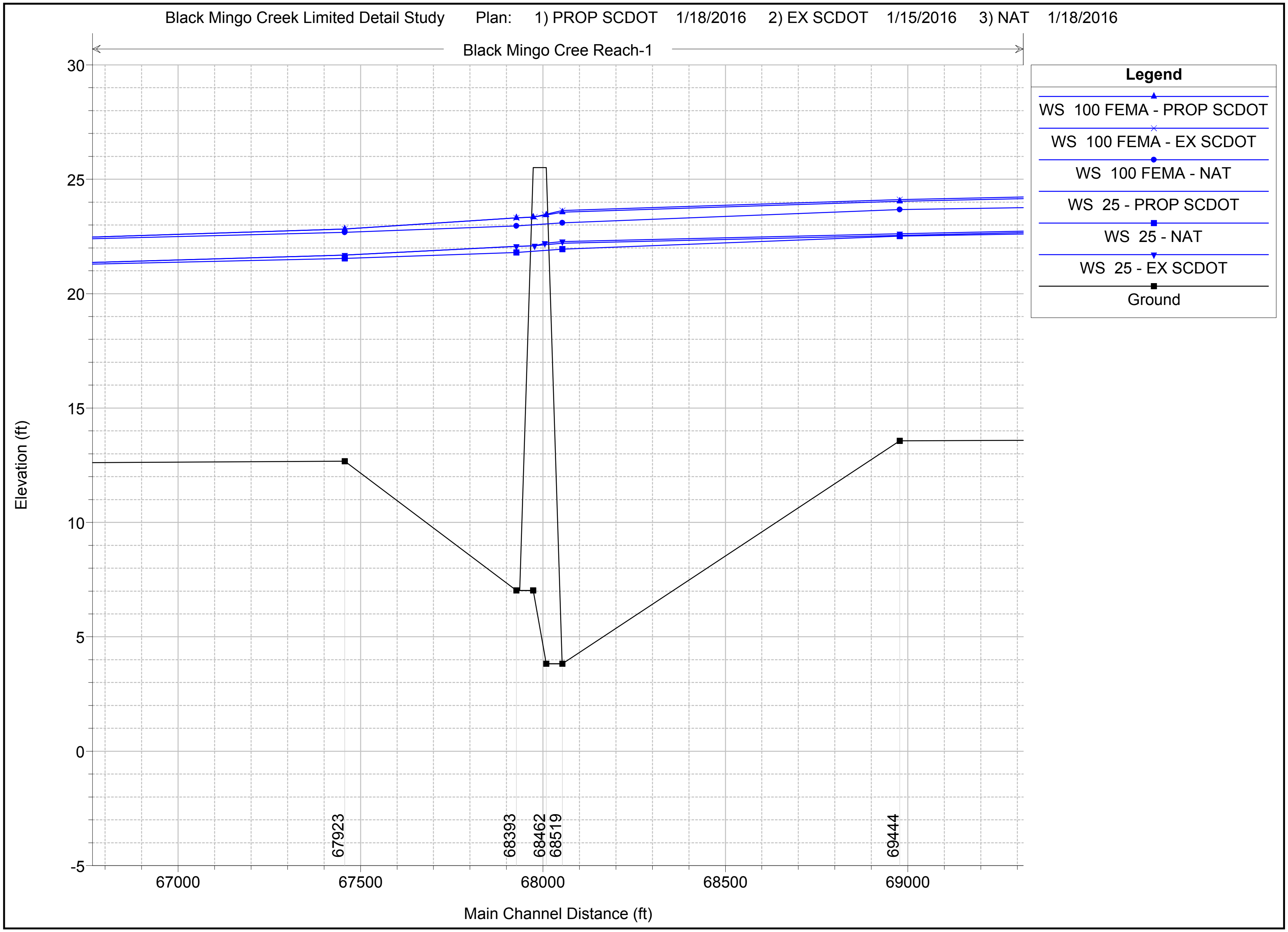
Appendix D
HEC-RAS Output – Profiles

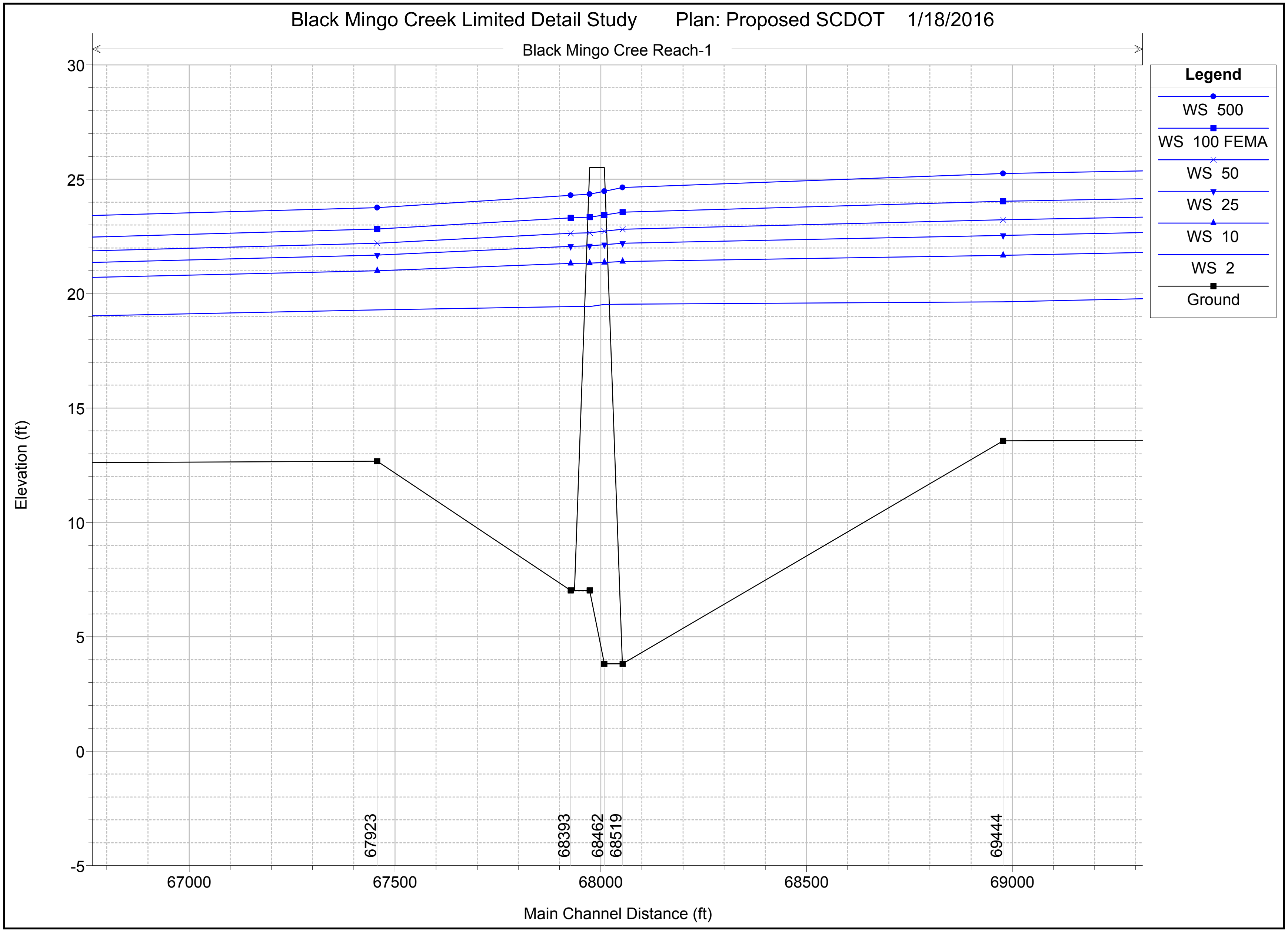
Figures in Appendix



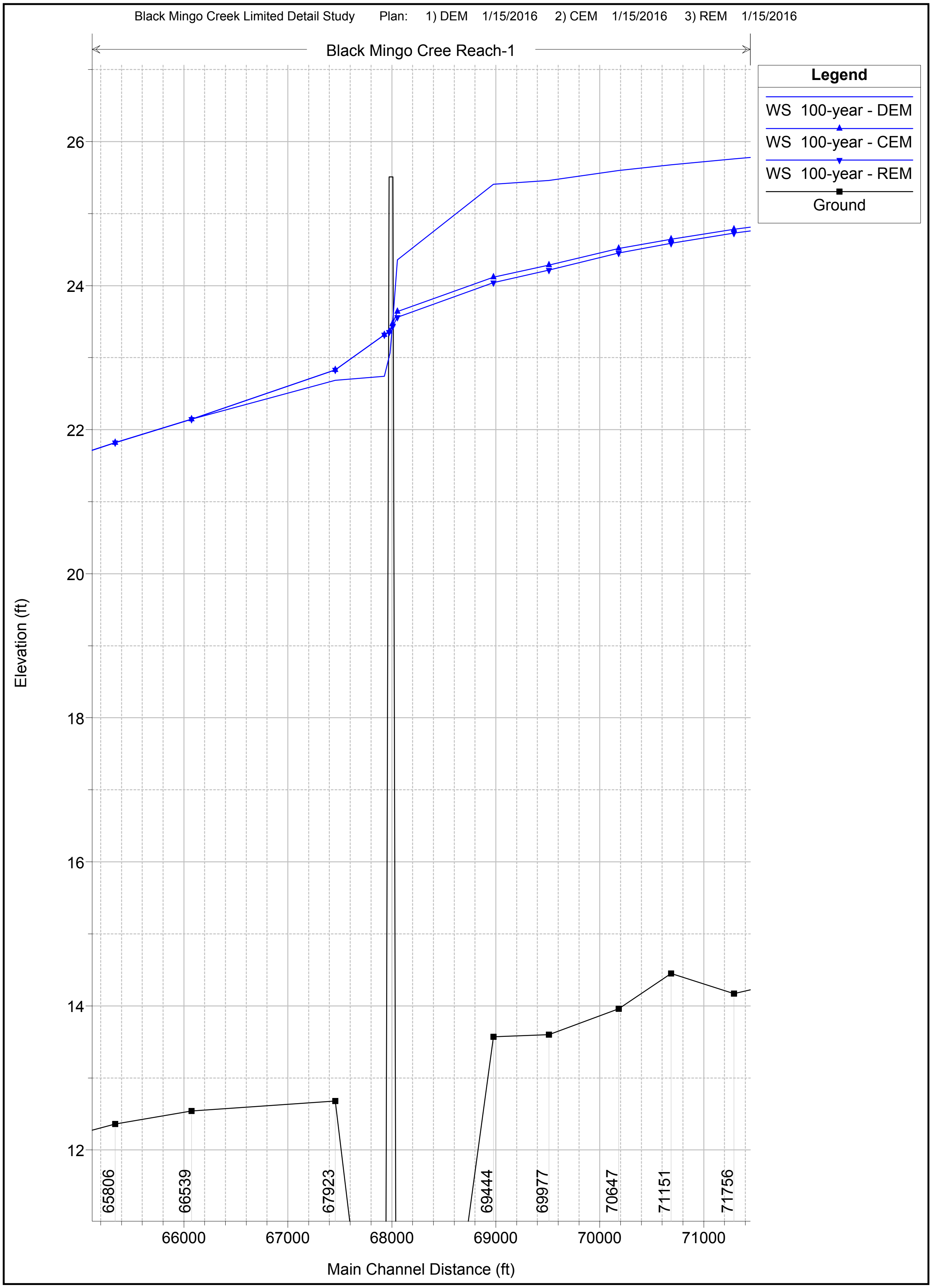
75575
74728
74035
73210
72377
71756
71151
70647
69977
69444
68519
67923
66539
65806
64865
63935
63165
62288
61288
Black Mingo Cree


Black Mingo Creek Limited Detail Study Plan: Proposed SCDOT 1/15/2016
Legend
WS 100 FEMA
Ground
Ineff
Bank Sta
72377
71756
71151
70647
69977
69444
68519


Black Mingo Creek Limited Detail Study Plan: 1) PROP SCDOT 1/18/2016 2) EX SCDOT 1/15/2016 3) NAT 1/18/2016
Black Mingo Cree Reach-1
Legend
WS 100 FEMA - PROP SCDOT
WS 100 FEMA - EX SCDOT
WS 100 FEMA - NAT
WS 25 - PROP SCDOT
WS 25 - NAT
WS 25 - EX SCDOT
Ground
Elevation (ft)
30
25
20
15
10
5
0
-5
67923
68393
68462
68519
69444
67000
67500
68000
68500
69000
Main Channel Distance (ft)



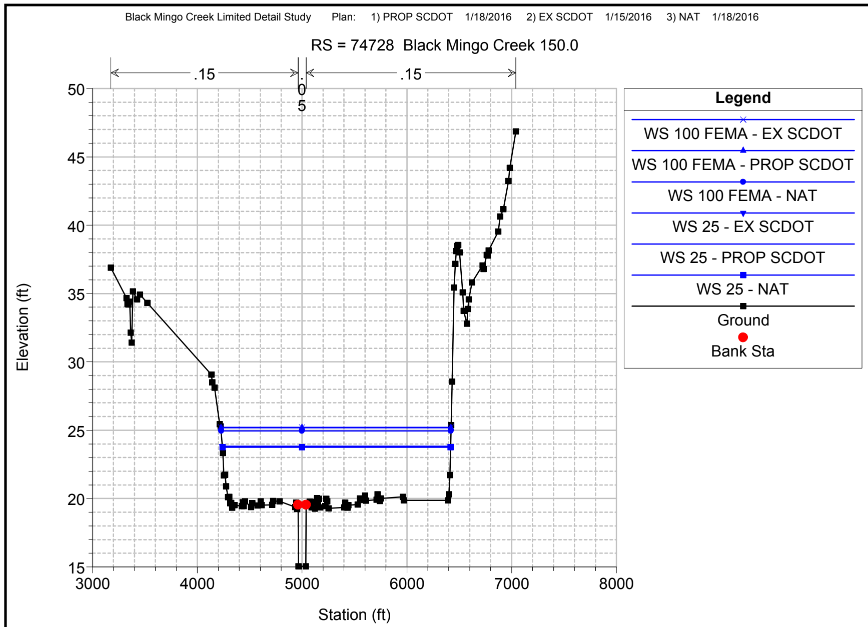
Black Mingo Creek Limited Detail Study Plan: Proposed SCDOT 1/18/2016
Black Mingo Cree Reach-1
Legend
WS 500
WS 100 FEMA
WS 50
WS 25
WS 10
WS 2
Ground
Elevation (ft)
30
25
20
15
10
5
0
-5
67923
68393
68462
68519
69444
67000
67500
68000
68500
69000
Main Channel Distance (ft)



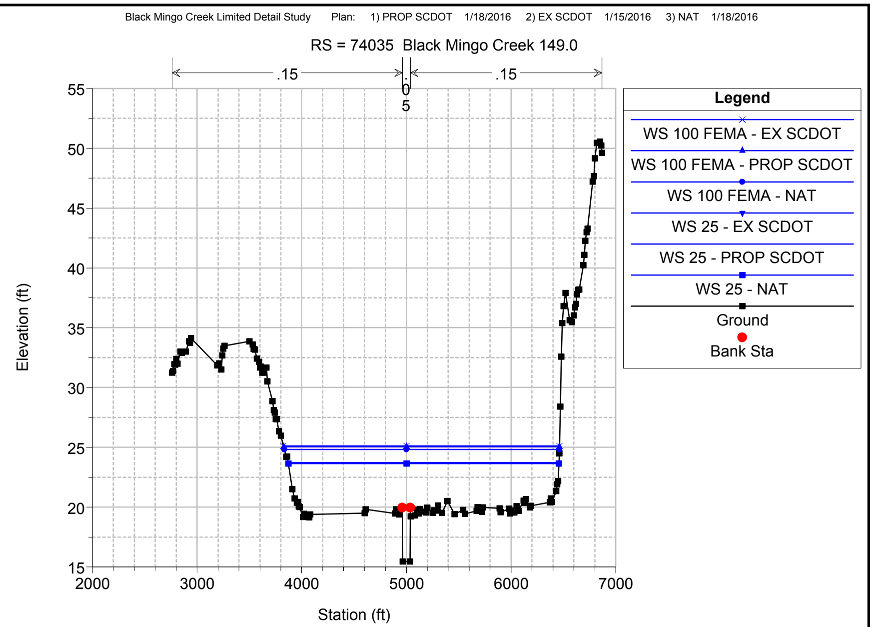
Black Mingo Creek Limited Detail Study Plan: 1) DEM 1/15/2016 2) CEM 1/15/2016 3) REM 1/15/2016
Black Mingo Cree Reach-1
Legend
WS 100-year - DEM
WS 100-year - CEM
WS 100-year - REM
Ground
Elevation (ft)
26
24
22
20
18
16
14
12
65806
66539
67923
69444
69977
70647
71151
71756
66000
67000
68000
69000
70000
71000
Main Channel Distance (ft)

Appendix E
HEC-RAS Output – Cross-Sections

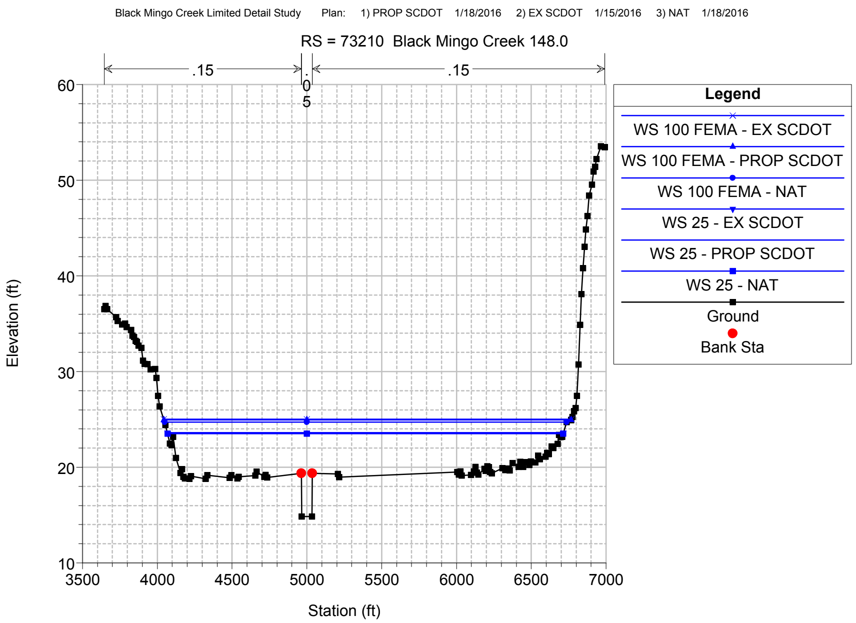
Figures in Appendix



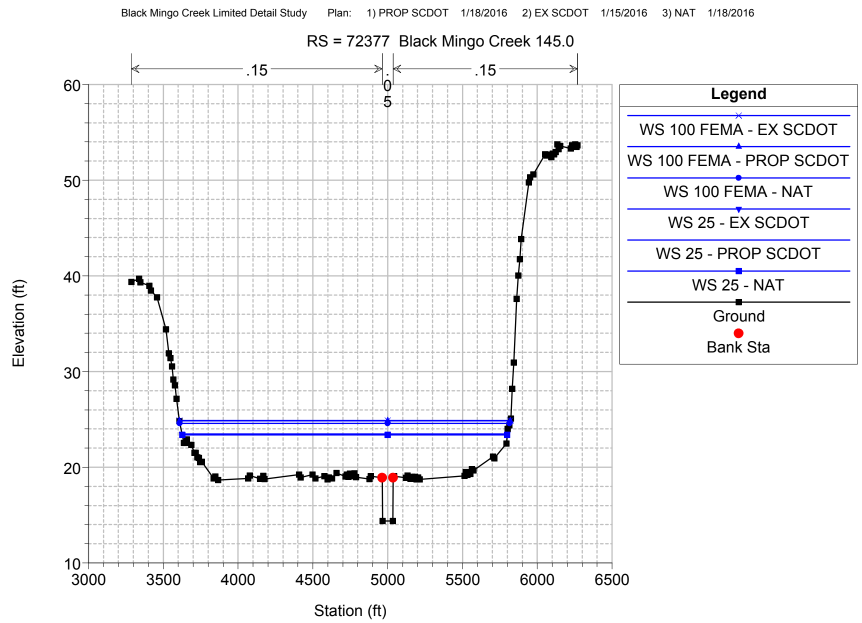
Black Mingo Creek Limited Detail Study Plan: 1) PROP SCDOT 1/18/2016 2) EX SCDOT 1/15/2016 3) NAT 1/18/2016
RS = 74728 Black Mingo Creek 150.0
.15
.05
.15
Legend
WS 100 FEMA - EX SCDOT
WS 100 FEMA - PROP SCDOT
WS 100 FEMA - NAT
WS 25 - EX SCDOT
WS 25 - PROP SCDOT
WS 25 - NAT
Ground
Bank Sta
Elevation (ft)
Station (ft)



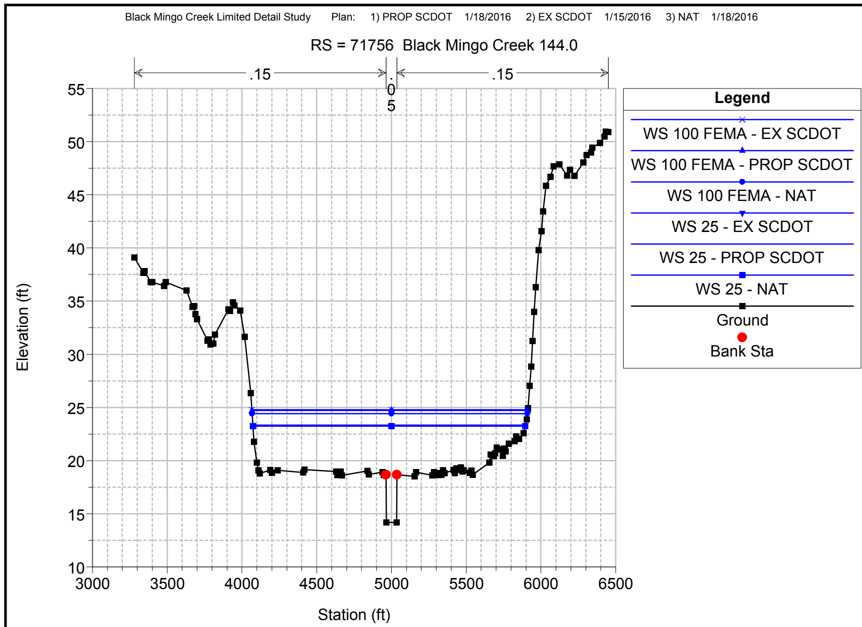
Black Mingo Creek Limited Detail Study Plan: 1) PROP SCDOT 1/18/2016 2) EX SCDOT 1/15/2016 3) NAT 1/18/2016
RS = 74035 Black Mingo Creek 149.0
.15
.05
.15
Legend
WS 100 FEMA - EX SCDOT
WS 100 FEMA - PROP SCDOT
WS 100 FEMA - NAT
WS 25 - EX SCDOT
WS 25 - PROP SCDOT
WS 25 - NAT
Ground
Bank Sta
Elevation (ft)
Station (ft)

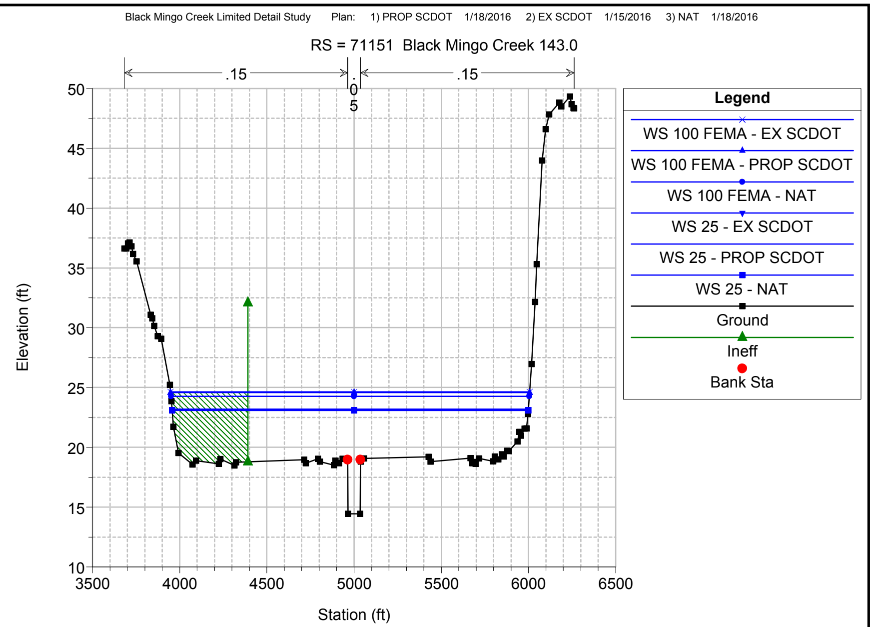


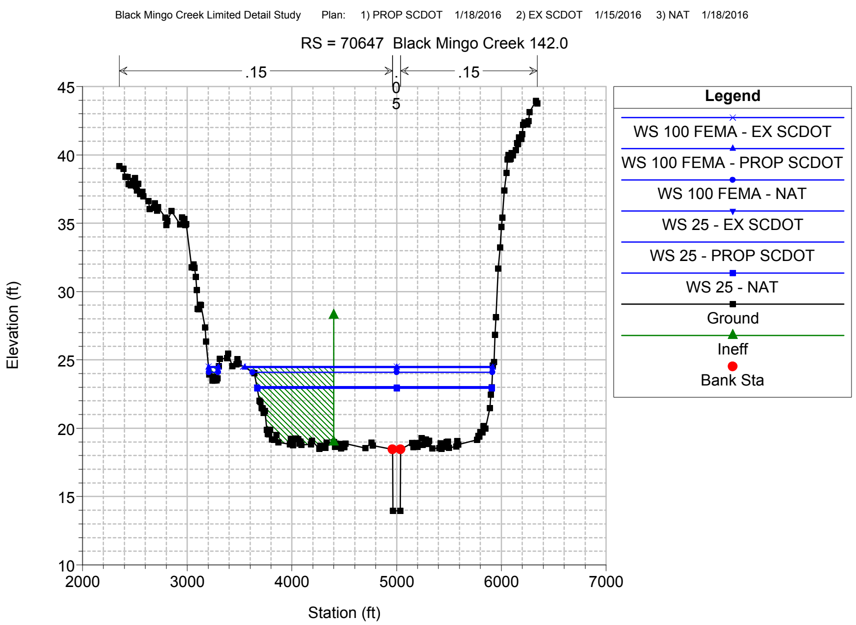
Black Mingo Creek Limited Detail Study Plan: 1) PROP SCDOT 1/18/2016 2) EX SCDOT 1/15/2016 3) NAT 1/18/2016
RS = 73210 Black Mingo Creek 148.0
.15
.05
.15
Legend
WS 100 FEMA - EX SCDOT
WS 100 FEMA - PROP SCDOT
WS 100 FEMA - NAT
WS 25 - EX SCDOT
WS 25 - PROP SCDOT
WS 25 - NAT
Ground
Bank Sta
Elevation (ft)
Station (ft)

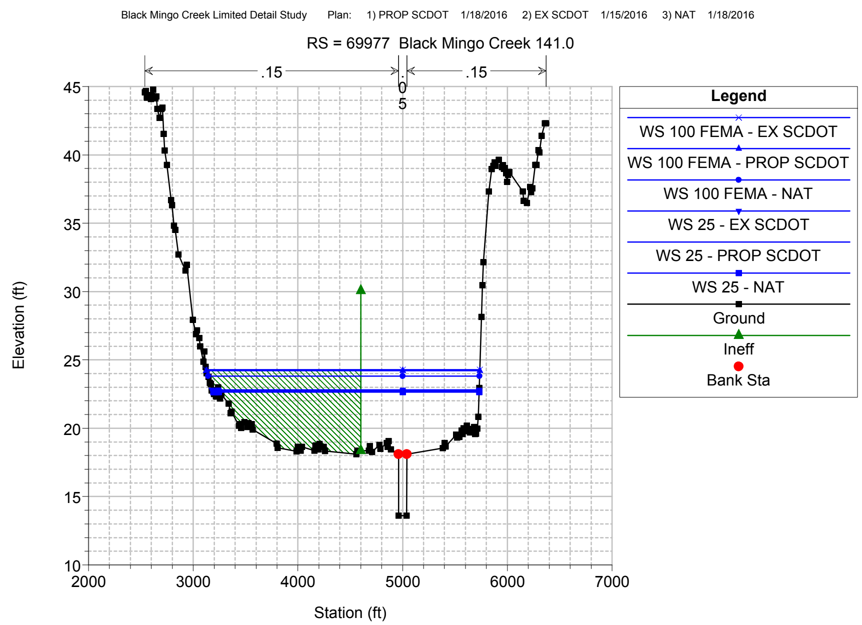


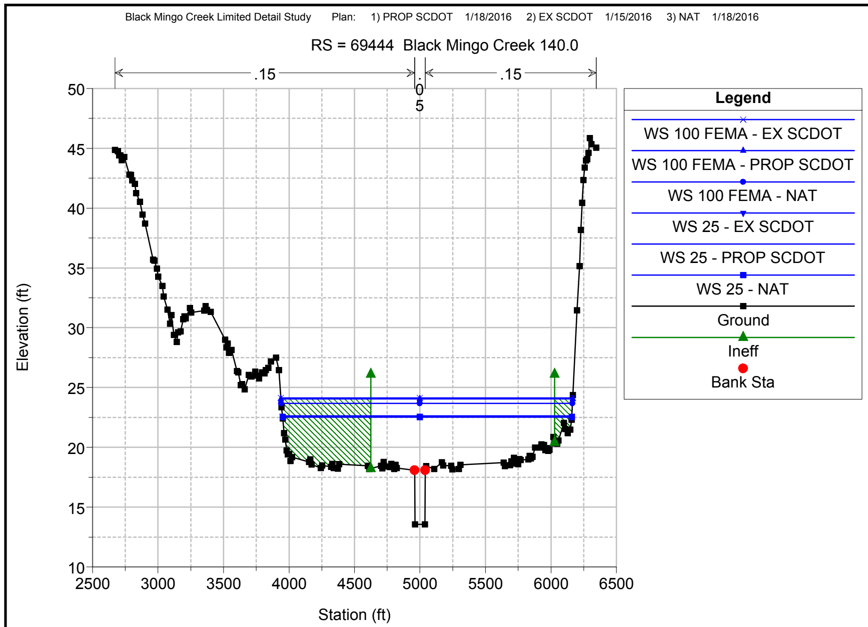
Black Mingo Creek Limited Detail Study Plan: 1) PROP SCDOT 1/18/2016 2) EX SCDOT 1/15/2016 3) NAT 1/18/2016
RS = 72377 Black Mingo Creek 145.0
.15
.05
.15
Legend
WS 100 FEMA - EX SCDOT
WS 100 FEMA - PROP SCDOT
WS 100 FEMA - NAT
WS 25 - EX SCDOT
WS 25 - PROP SCDOT
WS 25 - NAT
Ground
Bank Sta
Elevation (ft)
Station (ft)

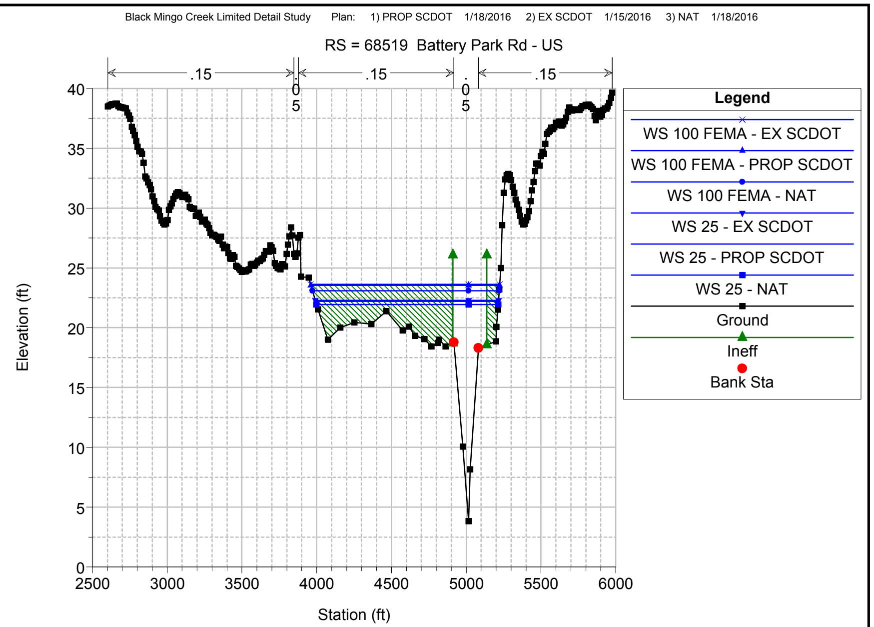

Black Mingo Creek Limited Detail Study Plan: 1) PROP SCDOT 1/18/2016 2) EX SCDOT 1/15/2016 3) NAT 1/18/2016
RS = 71756 Black Mingo Creek 144.0
.15
.05
.15
Elevation (ft)
Station (ft)
Legend
WS 100 FEMA - EX SCDOT
WS 100 FEMA - PROP SCDOT
WS 100 FEMA - NAT
WS 25 - EX SCDOT
WS 25 - PROP SCDOT
WS 25 - NAT
Ground
Bank Sta

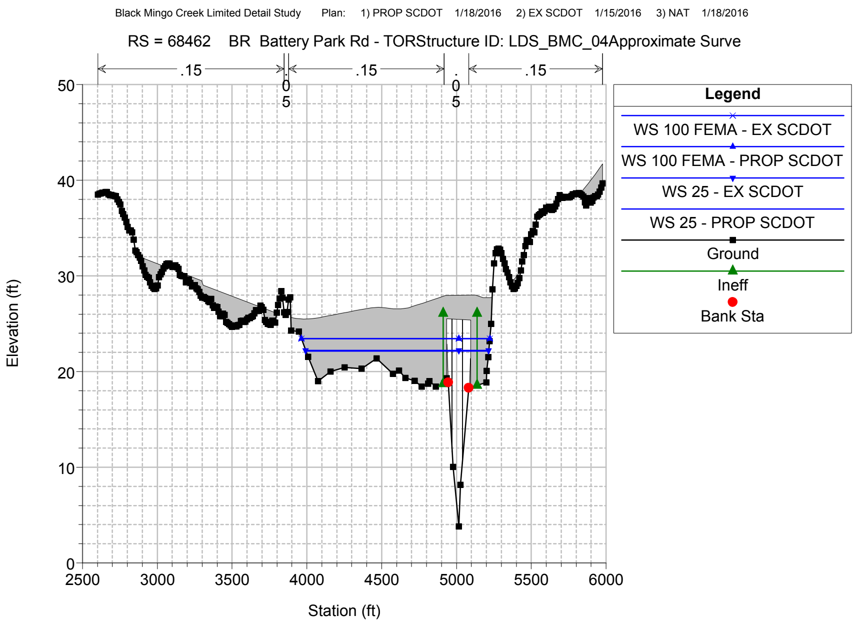

Black Mingo Creek Limited Detail Study Plan: 1) PROP SCDOT 1/18/2016 2) EX SCDOT 1/15/2016 3) NAT 1/18/2016
RS = 71151 Black Mingo Creek 143.0
.15
.05
.15
Elevation (ft)
Station (ft)
Legend
WS 100 FEMA - EX SCDOT
WS 100 FEMA - PROP SCDOT
WS 100 FEMA - NAT
WS 25 - EX SCDOT
WS 25 - PROP SCDOT
WS 25 - NAT
Ground
Ineff
Bank Sta

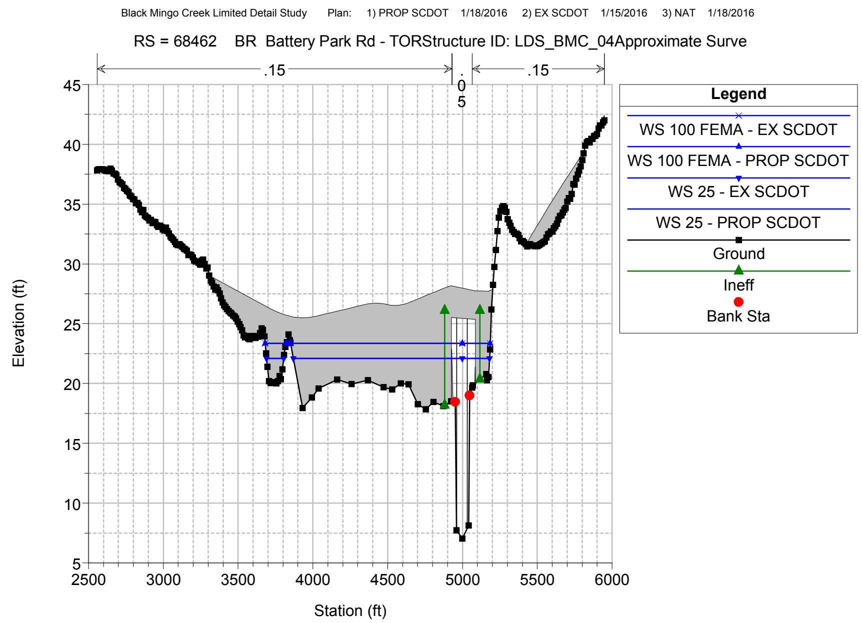

Black Mingo Creek Limited Detail Study Plan: 1) PROP SCDOT 1/18/2016 2) EX SCDOT 1/15/2016 3) NAT 1/18/2016
RS = 70647 Black Mingo Creek 142.0
.15
.05
.15
Elevation (ft)
Station (ft)
Legend
WS 100 FEMA - EX SCDOT
WS 100 FEMA - PROP SCDOT
WS 100 FEMA - NAT
WS 25 - EX SCDOT
WS 25 - PROP SCDOT
WS 25 - NAT
Ground
Ineff
Bank Sta

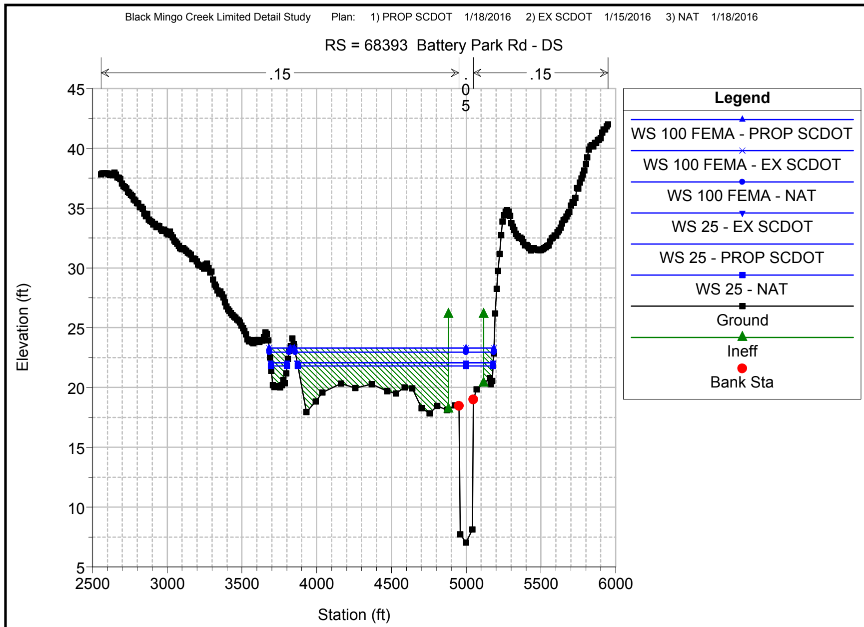

Black Mingo Creek Limited Detail Study Plan: 1) PROP SCDOT 1/18/2016 2) EX SCDOT 1/15/2016 3) NAT 1/18/2016
RS = 69977 Black Mingo Creek 141.0
.15
.05
.15
Elevation (ft)
Station (ft)
Legend
WS 100 FEMA - EX SCDOT
WS 100 FEMA - PROP SCDOT
WS 100 FEMA - NAT
WS 25 - EX SCDOT
WS 25 - PROP SCDOT
WS 25 - NAT
Ground
Ineff
Bank Sta

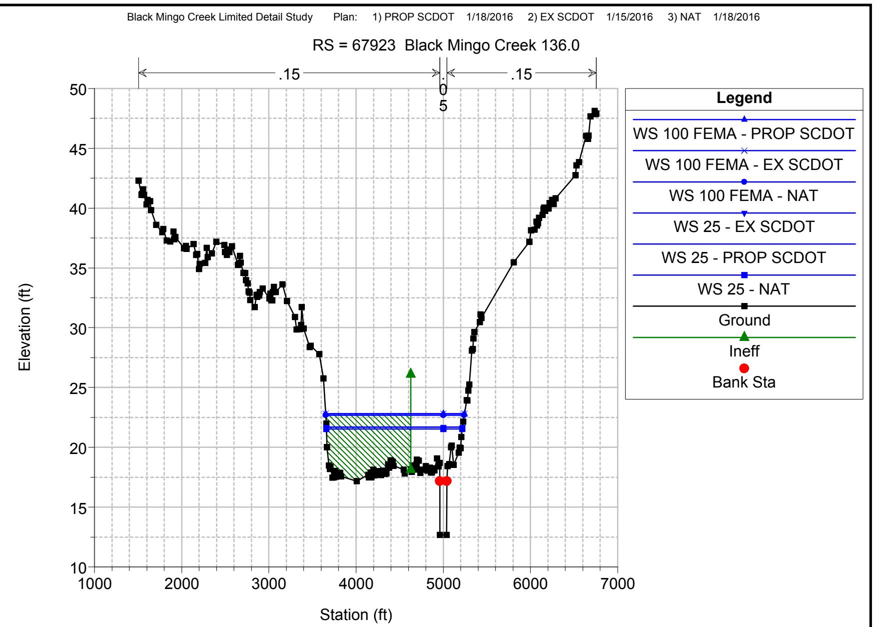

Black Mingo Creek Limited Detail Study Plan: 1) PROP SCDOT 1/18/2016 2) EX SCDOT 1/15/2016 3) NAT 1/18/2016
RS = 69444 Black Mingo Creek 140.0
.15
.05
.15
Legend
WS 100 FEMA - EX SCDOT
WS 100 FEMA - PROP SCDOT
WS 100 FEMA - NAT
WS 25 - EX SCDOT
WS 25 - PROP SCDOT
WS 25 - NAT
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)

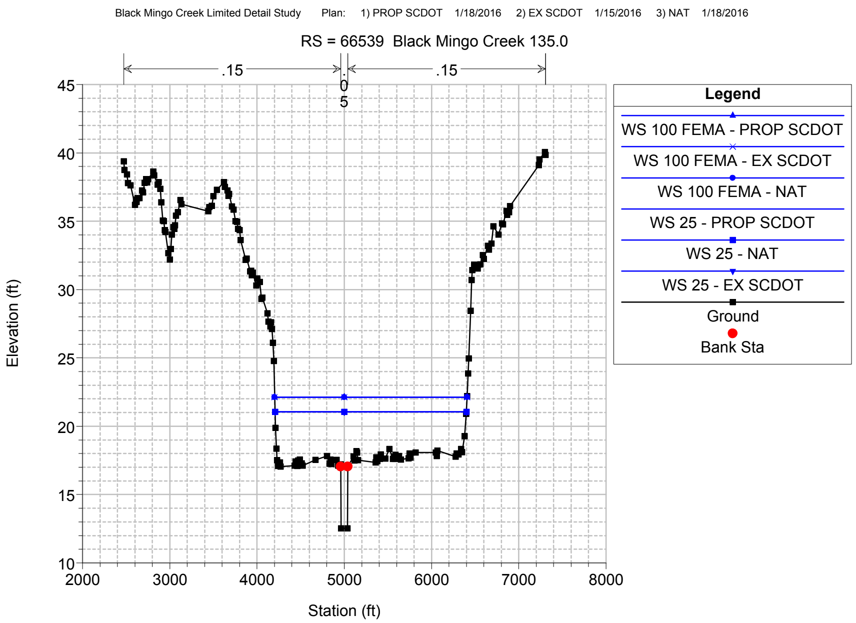

Black Mingo Creek Limited Detail Study Plan: 1) PROP SCDOT 1/18/2016 2) EX SCDOT 1/15/2016 3) NAT 1/18/2016
RS = 68519 Battery Park Rd - US
.15
.05
.15
.05
.15
Legend
WS 100 FEMA - EX SCDOT
WS 100 FEMA - PROP SCDOT
WS 100 FEMA - NAT
WS 25 - EX SCDOT
WS 25 - PROP SCDOT
WS 25 - NAT
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Black Mingo Creek Limited Detail Study Plan: 1) PROP SCDOT 1/18/2016 2) EX SCDOT 1/15/2016 3) NAT 1/18/2016
RS = 68462 BR Battery Park Rd - TORStructure ID: LDS_BMC_04Approximate Surve
.15
.05
.15
.05
.15
Legend
WS 100 FEMA - EX SCDOT
WS 100 FEMA - PROP SCDOT
WS 25 - EX SCDOT
WS 25 - PROP SCDOT
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Black Mingo Creek Limited Detail Study Plan: 1) PROP SCDOT 1/18/2016 2) EX SCDOT 1/15/2016 3) NAT 1/18/2016
RS = 68462 BR Battery Park Rd - TORStructure ID: LDS_BMC_04Approximate Surve
.15
.05
.15
Legend
WS 100 FEMA - EX SCDOT
WS 100 FEMA - PROP SCDOT
WS 25 - EX SCDOT
WS 25 - PROP SCDOT
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Black Mingo Creek Limited Detail Study Plan: 1) PROP SCDOT 1/18/2016 2) EX SCDOT 1/15/2016 3) NAT 1/18/2016
RS = 68393 Battery Park Rd - DS
.15
.05
.15
Legend
WS 100 FEMA - PROP SCDOT
WS 100 FEMA - EX SCDOT
WS 100 FEMA - NAT
WS 25 - EX SCDOT
WS 25 - PROP SCDOT
WS 25 - NAT
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Black Mingo Creek Limited Detail Study Plan: 1) PROP SCDOT 1/18/2016 2) EX SCDOT 1/15/2016 3) NAT 1/18/2016
RS = 67923 Black Mingo Creek 136.0
.15
.05
.15
Legend
WS 100 FEMA - PROP SCDOT
WS 100 FEMA - EX SCDOT
WS 100 FEMA - NAT
WS 25 - EX SCDOT
WS 25 - PROP SCDOT
WS 25 - NAT
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Black Mingo Creek Limited Detail Study Plan: 1) PROP SCDOT 1/18/2016 2) EX SCDOT 1/15/2016 3) NAT 1/18/2016
RS = 66539 Black Mingo Creek 135.0
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.05
.15
Legend
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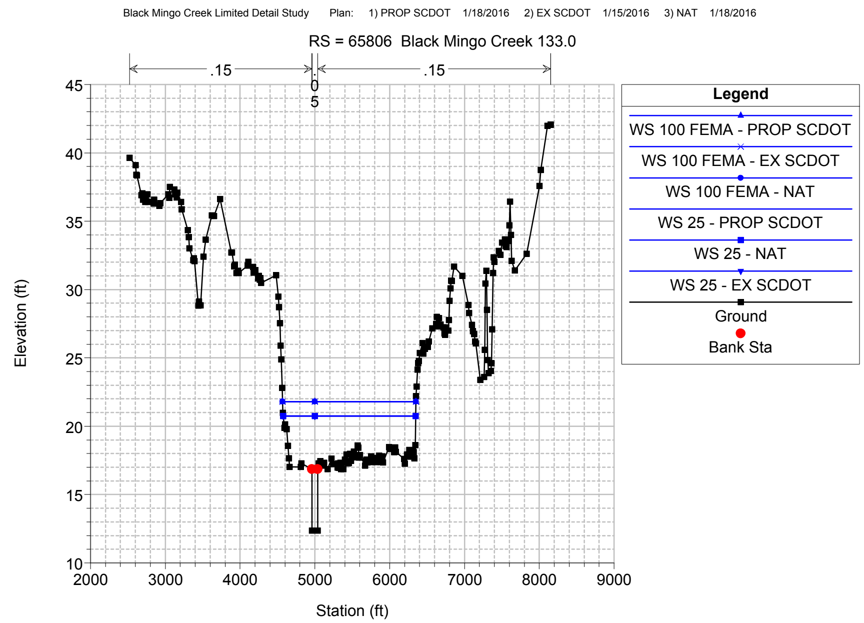
WS 100 FEMA - EX SCDOT
WS 100 FEMA - NAT
WS 25 - PROP SCDOT
WS 25 - NAT
WS 25 - EX SCDOT
Ground
Bank Sta
Elevation (ft)
Station (ft)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.05
.15
Legend
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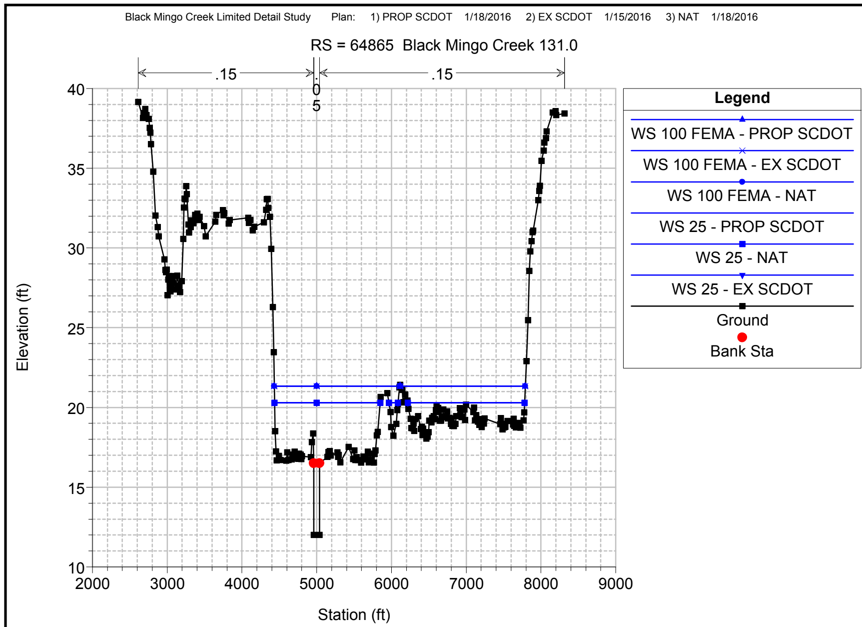
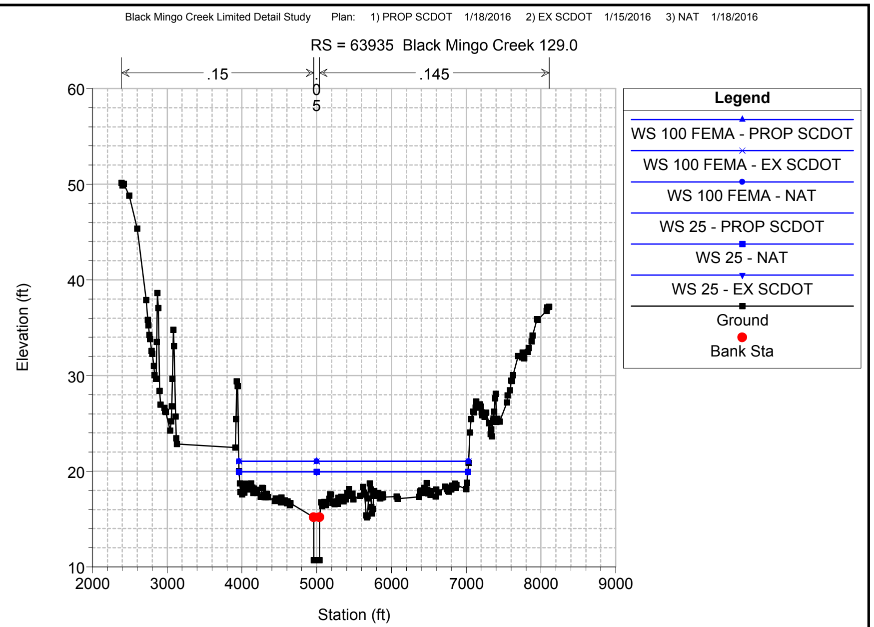
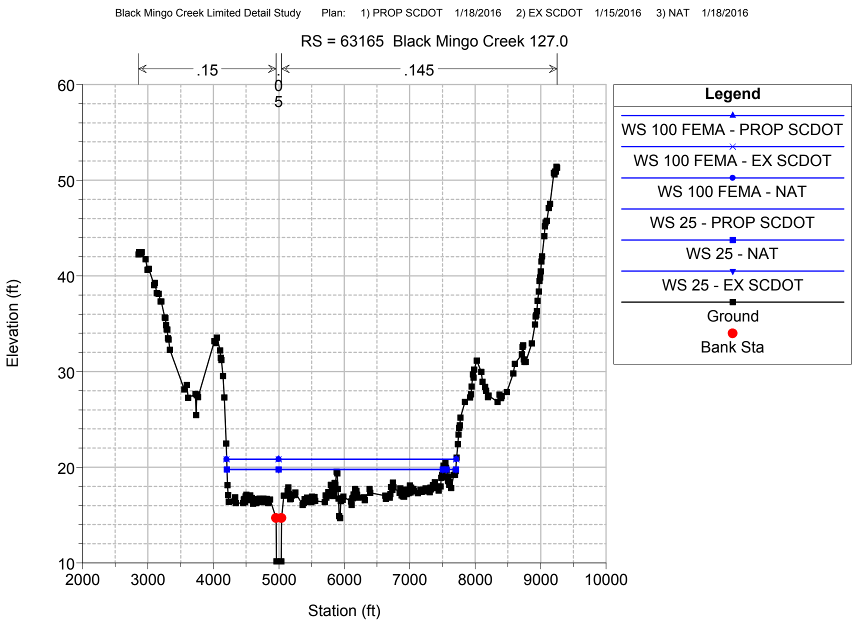
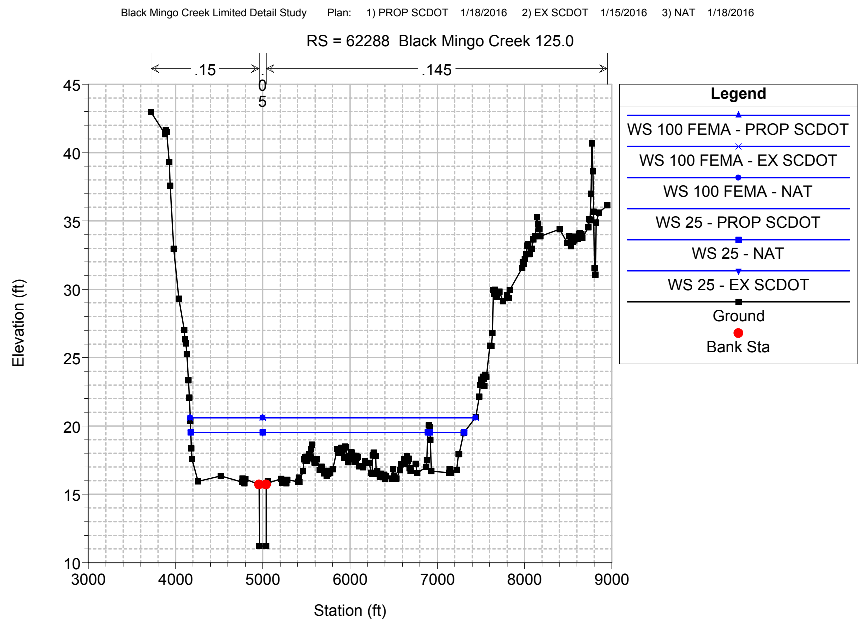
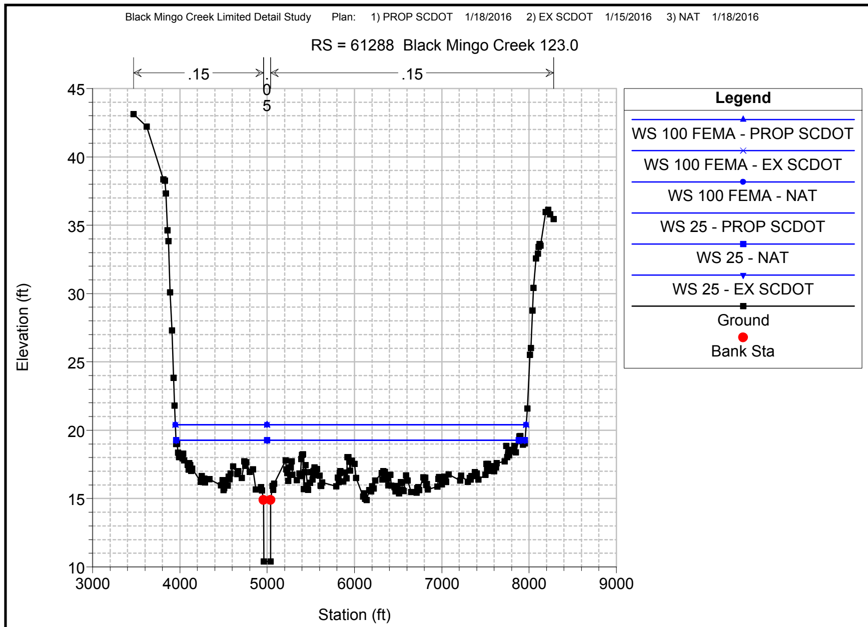
WS 100 FEMA - EX SCDOT
WS 100 FEMA - NAT
WS 25 - PROP SCDOT
WS 25 - NAT
WS 25 - EX SCDOT
Ground
Bank Sta
Elevation (ft)
Station (ft)

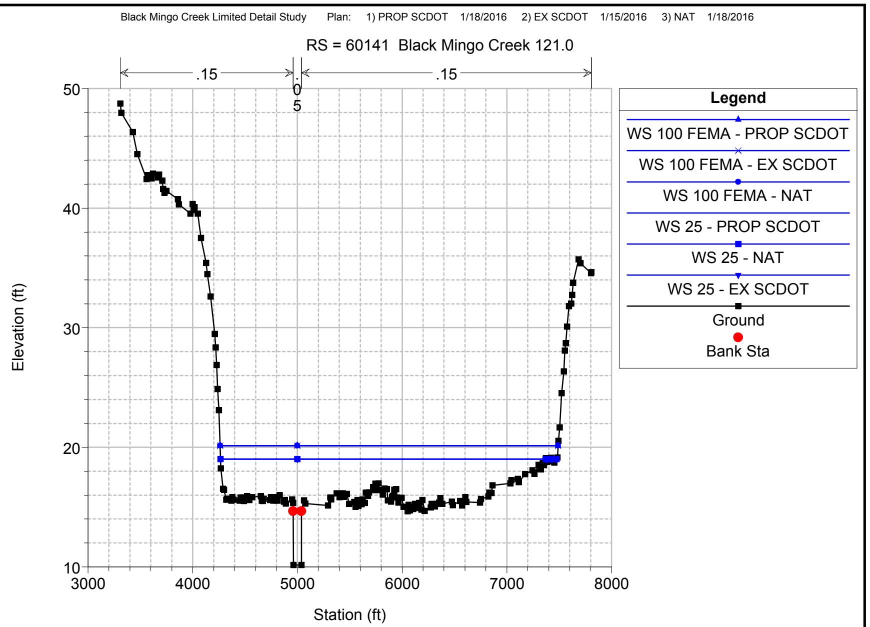

Black Mingo Creek Limited Detail Study Plan: 1) PROP SCDOT 1/18/2016 2) EX SCDOT 1/15/2016 3) NAT 1/18/2016
RS = 64865 Black Mingo Creek 131.0
.15
.15
Legend
WS 100 FEMA - PROP SCDOT
WS 100 FEMA - EX SCDOT
WS 100 FEMA - NAT
WS 25 - PROP SCDOT
WS 25 - NAT
WS 25 - EX SCDOT
Ground
Bank Sta
Elevation (ft)
Station (ft)

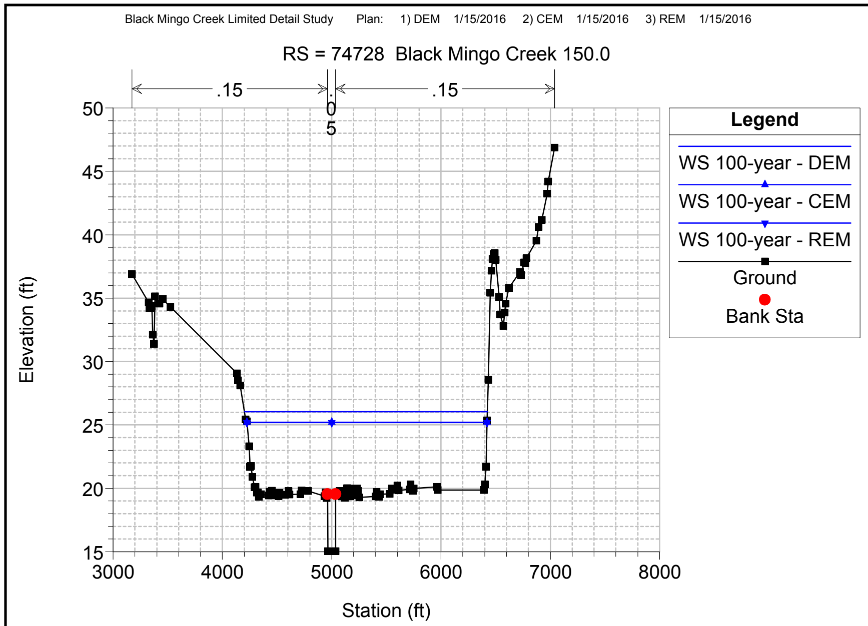

Black Mingo Creek Limited Detail Study Plan: 1) PROP SCDOT 1/18/2016 2) EX SCDOT 1/15/2016 3) NAT 1/18/2016
RS = 63935 Black Mingo Creek 129.0
.15
.145
Legend
WS 100 FEMA - PROP SCDOT
WS 100 FEMA - EX SCDOT
WS 100 FEMA - NAT
WS 25 - PROP SCDOT
WS 25 - NAT
WS 25 - EX SCDOT
Ground
Bank Sta
Elevation (ft)
Station (ft)

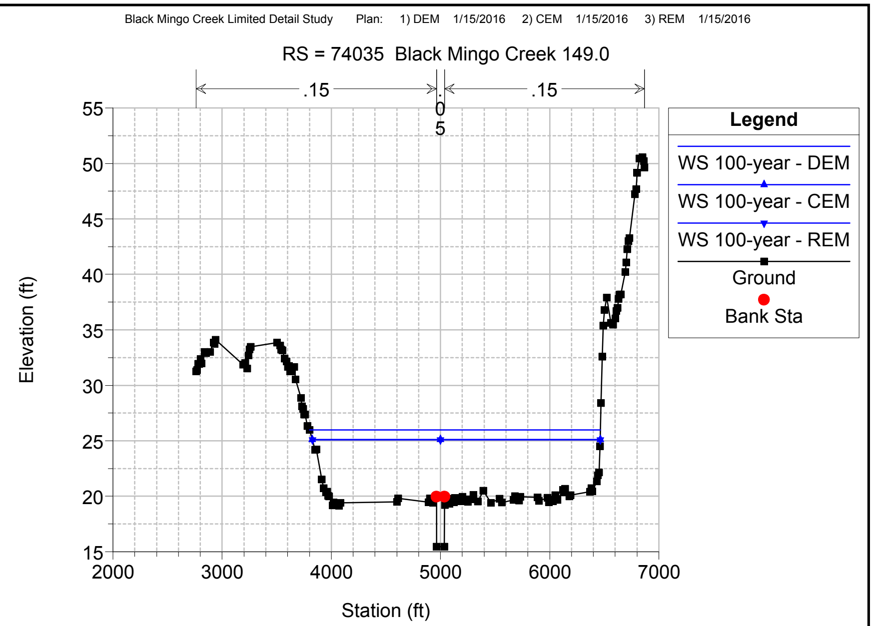

Black Mingo Creek Limited Detail Study Plan: 1) PROP SCDOT 1/18/2016 2) EX SCDOT 1/15/2016 3) NAT 1/18/2016
RS = 63165 Black Mingo Creek 127.0
.15
.145
Legend
WS 100 FEMA - PROP SCDOT
WS 100 FEMA - EX SCDOT
WS 100 FEMA - NAT
WS 25 - PROP SCDOT
WS 25 - NAT
WS 25 - EX SCDOT
Ground
Bank Sta
Elevation (ft)
Station (ft)

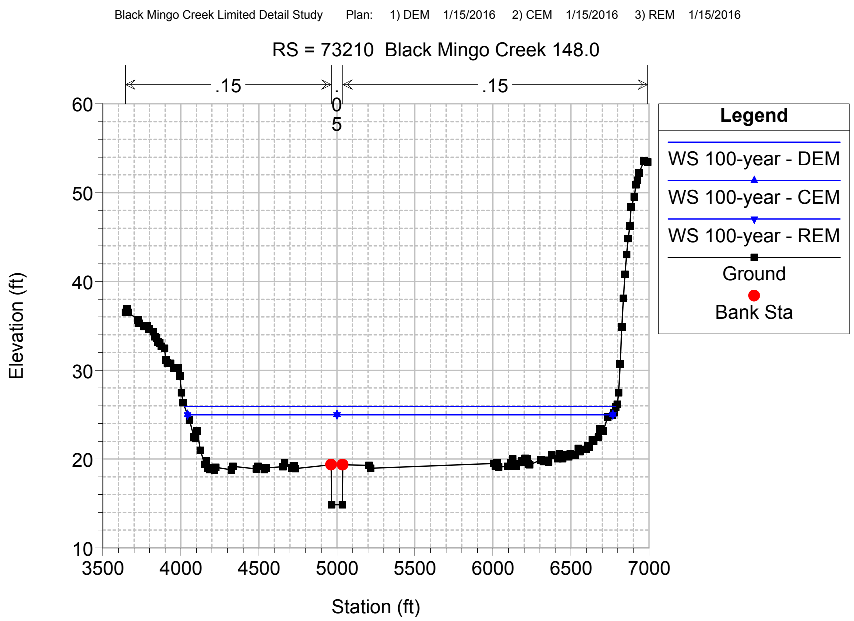

Black Mingo Creek Limited Detail Study Plan: 1) PROP SCDOT 1/18/2016 2) EX SCDOT 1/15/2016 3) NAT 1/18/2016
RS = 62288 Black Mingo Creek 125.0
.15
.145
Legend
WS 100 FEMA - PROP SCDOT
WS 100 FEMA - EX SCDOT
WS 100 FEMA - NAT
WS 25 - PROP SCDOT
WS 25 - NAT
WS 25 - EX SCDOT
Ground
Bank Sta
Elevation (ft)
Station (ft)

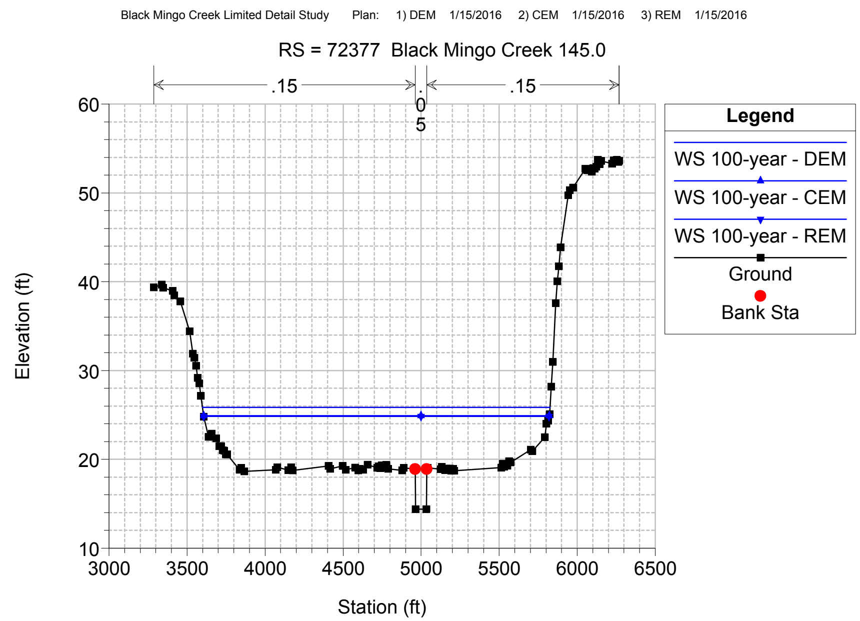

Black Mingo Creek Limited Detail Study Plan: 1) PROP SCDOT 1/18/2016 2) EX SCDOT 1/15/2016 3) NAT 1/18/2016
RS = 61288 Black Mingo Creek 123.0
.15
.05
.15
Legend
WS 100 FEMA - PROP SCDOT
WS 100 FEMA - EX SCDOT
WS 100 FEMA - NAT
WS 25 - PROP SCDOT
WS 25 - NAT
WS 25 - EX SCDOT
Ground
Bank Sta
Elevation (ft)
Station (ft)


Black Mingo Creek Limited Detail Study Plan: 1) PROP SCDOT 1/18/2016 2) EX SCDOT 1/15/2016 3) NAT 1/18/2016
RS = 60141 Black Mingo Creek 121.0
.15
.05
.15
Legend
WS 100 FEMA - PROP SCDOT
WS 100 FEMA - EX SCDOT
WS 100 FEMA - NAT
WS 25 - PROP SCDOT
WS 25 - NAT
WS 25 - EX SCDOT
Ground
Bank Sta
Elevation (ft)
Station (ft)


Black Mingo Creek Limited Detail Study Plan: 1) DEM 1/15/2016 2) CEM 1/15/2016 3) REM 1/15/2016
RS = 74728 Black Mingo Creek 150.0
.15
.15
0
5
Elevation (ft)
Station (ft)
Legend
WS 100-year - DEM
WS 100-year - CEM
WS 100-year - REM
Ground
Bank Sta


Black Mingo Creek Limited Detail Study Plan: 1) DEM 1/15/2016 2) CEM 1/15/2016 3) REM 1/15/2016
RS = 74035 Black Mingo Creek 149.0
.15
.15
0
5
Elevation (ft)
Station (ft)
Legend
WS 100-year - DEM
WS 100-year - CEM
WS 100-year - REM
Ground
Bank Sta


Black Mingo Creek Limited Detail Study Plan: 1) DEM 1/15/2016 2) CEM 1/15/2016 3) REM 1/15/2016
RS = 73210 Black Mingo Creek 148.0
.15
.15
0
5
Elevation (ft)
Station (ft)
Legend
WS 100-year - DEM
WS 100-year - CEM
WS 100-year - REM
Ground
Bank Sta


Black Mingo Creek Limited Detail Study Plan: 1) DEM 1/15/2016 2) CEM 1/15/2016 3) REM 1/15/2016
RS = 72377 Black Mingo Creek 145.0
.15
.15
0
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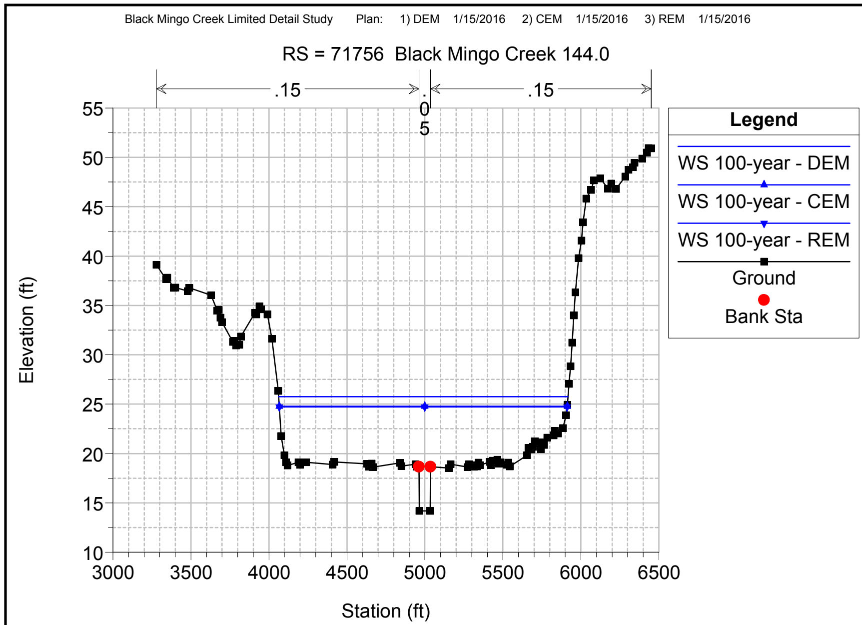
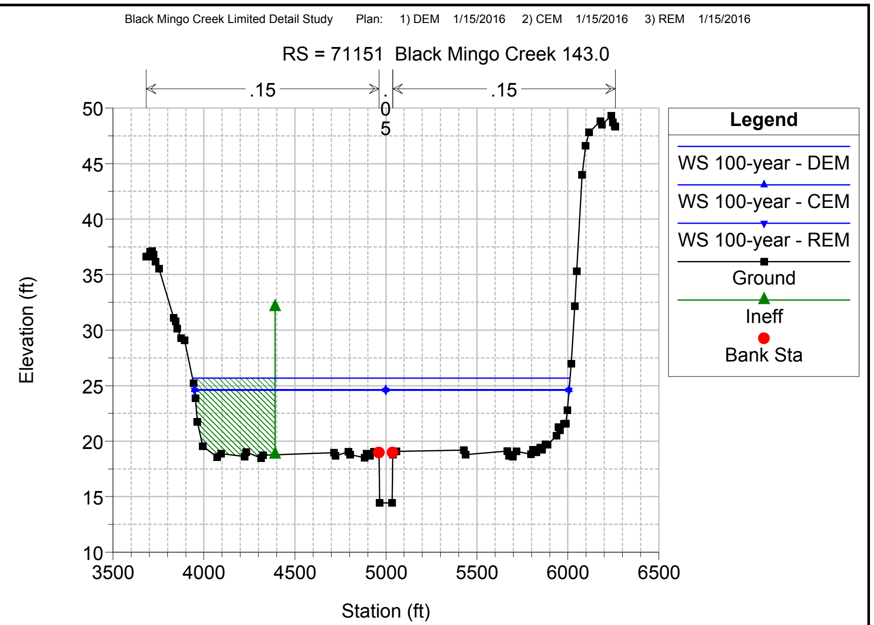
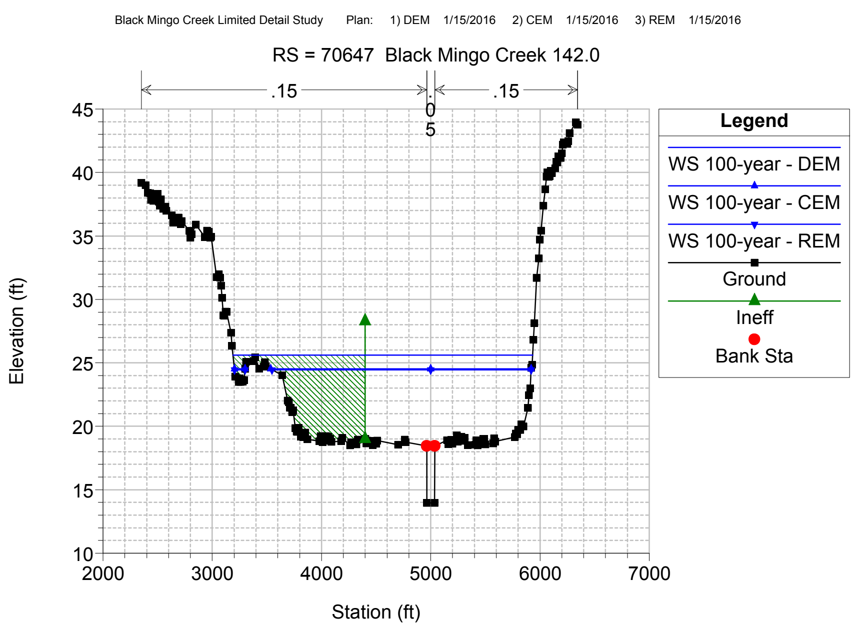
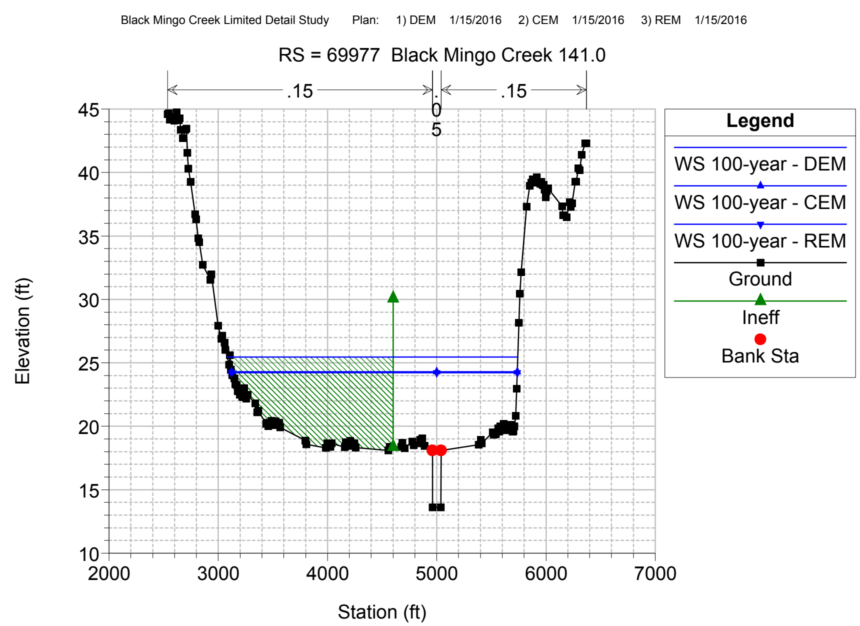
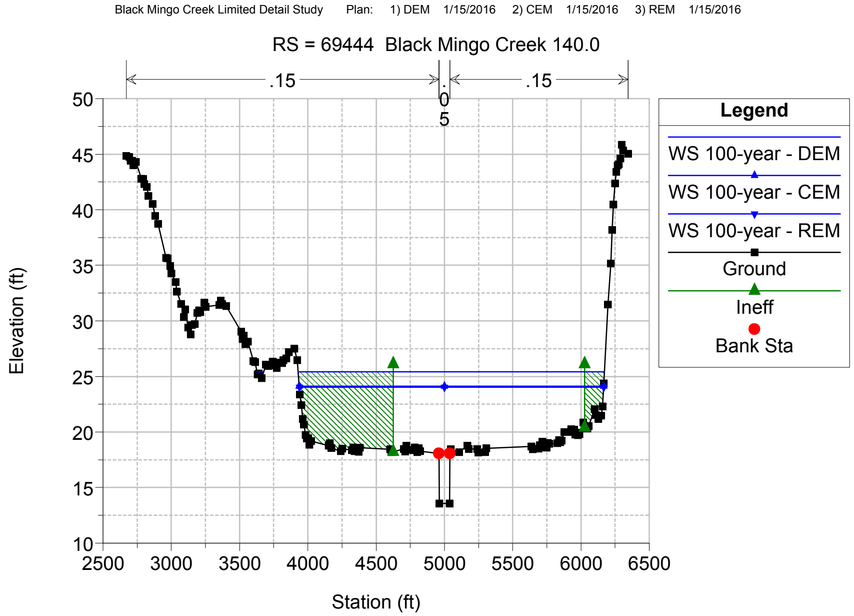
Elevation (ft)
Station (ft)
Legend
WS 100-year - DEM
WS 100-year - CEM
WS 100-year - REM
Ground
Bank Sta


Black Mingo Creek Limited Detail Study Plan: 1) DEM 1/15/2016 2) CEM 1/15/2016 3) REM 1/15/2016
RS = 71756 Black Mingo Creek 144.0
.15
.15
Elevation (ft)
Station (ft)
Legend
WS 100-year - DEM
WS 100-year - CEM
WS 100-year - REM
Ground
Bank Sta

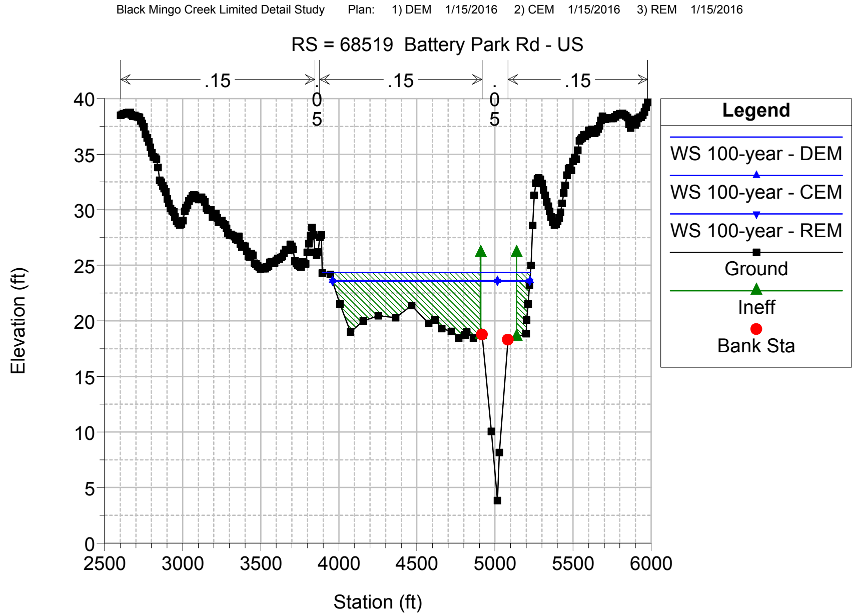

Black Mingo Creek Limited Detail Study Plan: 1) DEM 1/15/2016 2) CEM 1/15/2016 3) REM 1/15/2016
RS = 71151 Black Mingo Creek 143.0
.15
.15
Elevation (ft)
Station (ft)
Legend
WS 100-year - DEM
WS 100-year - CEM
WS 100-year - REM
Ground
Ineff
Bank Sta


Black Mingo Creek Limited Detail Study Plan: 1) DEM 1/15/2016 2) CEM 1/15/2016 3) REM 1/15/2016
RS = 70647 Black Mingo Creek 142.0
.15
.15
Elevation (ft)
Station (ft)
Legend
WS 100-year - DEM
WS 100-year - CEM
WS 100-year - REM
Ground
Ineff
Bank Sta

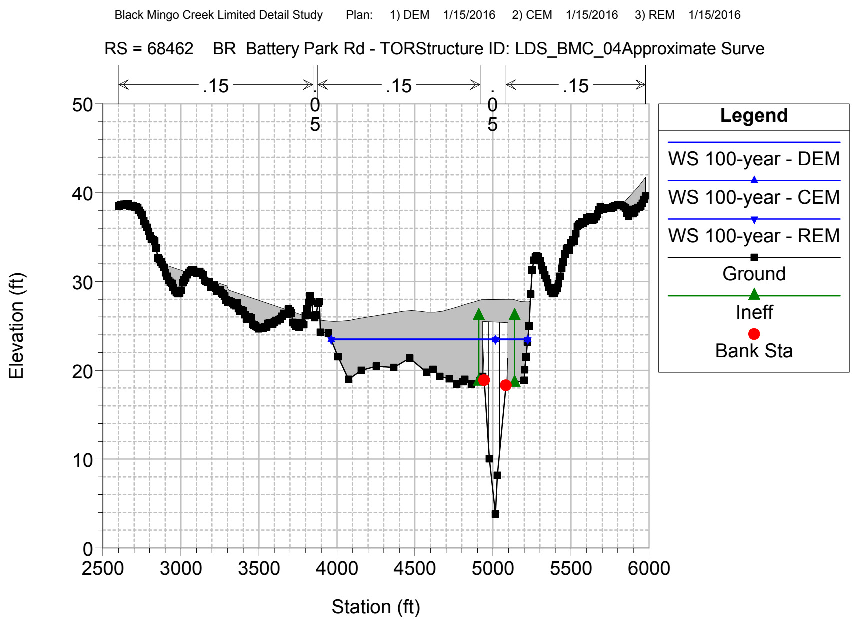

Black Mingo Creek Limited Detail Study Plan: 1) DEM 1/15/2016 2) CEM 1/15/2016 3) REM 1/15/2016
RS = 69977 Black Mingo Creek 141.0
.15
.15
Elevation (ft)
Station (ft)
Legend
WS 100-year - DEM
WS 100-year - CEM
WS 100-year - REM
Ground
Ineff
Bank Sta



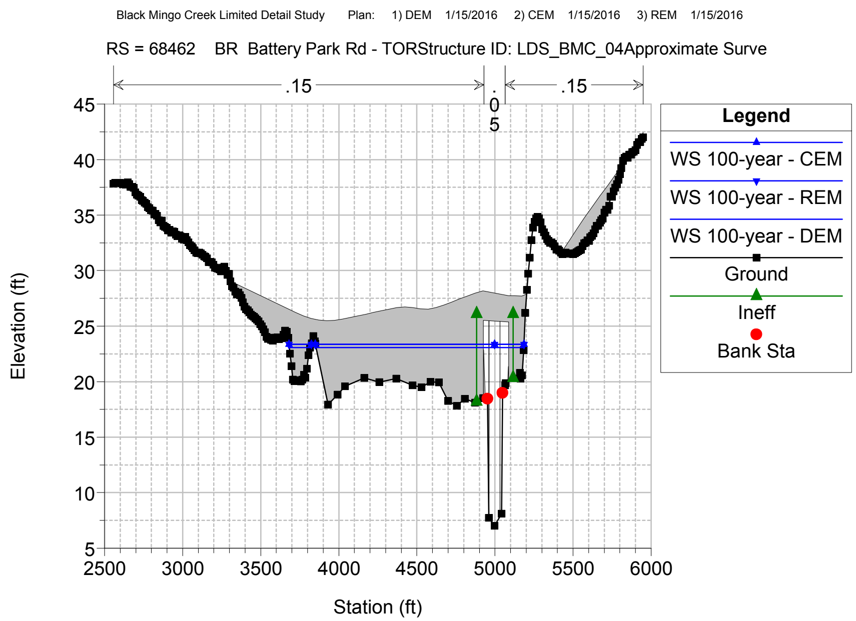
Black Mingo Creek Limited Detail Study Plan: 1) DEM 1/15/2016 2) CEM 1/15/2016 3) REM 1/15/2016
RS = 69444 Black Mingo Creek 140.0
Legend
WS 100-year - DEM
WS 100-year - CEM
WS 100-year - REM
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)



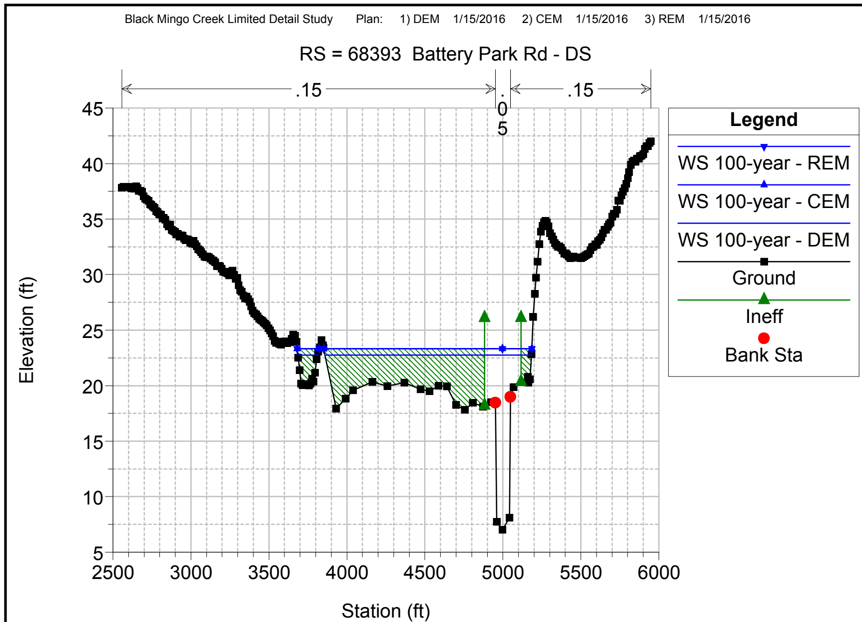
Black Mingo Creek Limited Detail Study Plan: 1) DEM 1/15/2016 2) CEM 1/15/2016 3) REM 1/15/2016
RS = 68519 Battery Park Rd - US
Legend
WS 100-year - DEM
WS 100-year - CEM
WS 100-year - REM
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)



Black Mingo Creek Limited Detail Study Plan: 1) DEM 1/15/2016 2) CEM 1/15/2016 3) REM 1/15/2016
RS = 68462 BR Battery Park Rd - TORStructure ID: LDS_BMC_04Approximate Surve
Legend
WS 100-year - DEM
WS 100-year - CEM
WS 100-year - REM
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)



Black Mingo Creek Limited Detail Study Plan: 1) DEM 1/15/2016 2) CEM 1/15/2016 3) REM 1/15/2016
RS = 68462 BR Battery Park Rd - TORStructure ID: LDS_BMC_04Approximate Surve
Legend
WS 100-year - CEM
WS 100-year - REM
WS 100-year - DEM
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Black Mingo Creek Limited Detail Study Plan: 1) DEM 1/15/2016 2) CEM 1/15/2016 3) REM 1/15/2016
RS = 68393 Battery Park Rd - DS
.15
.05
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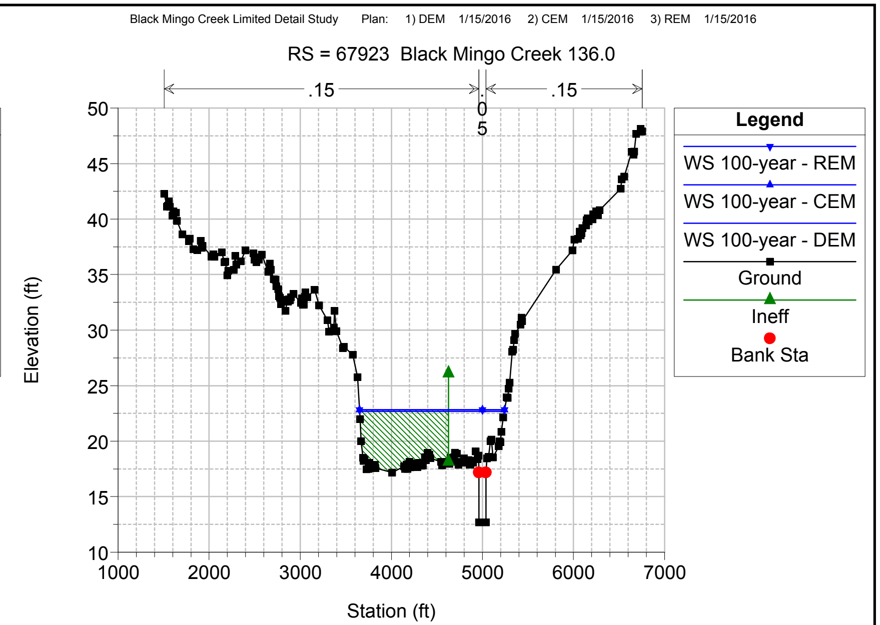
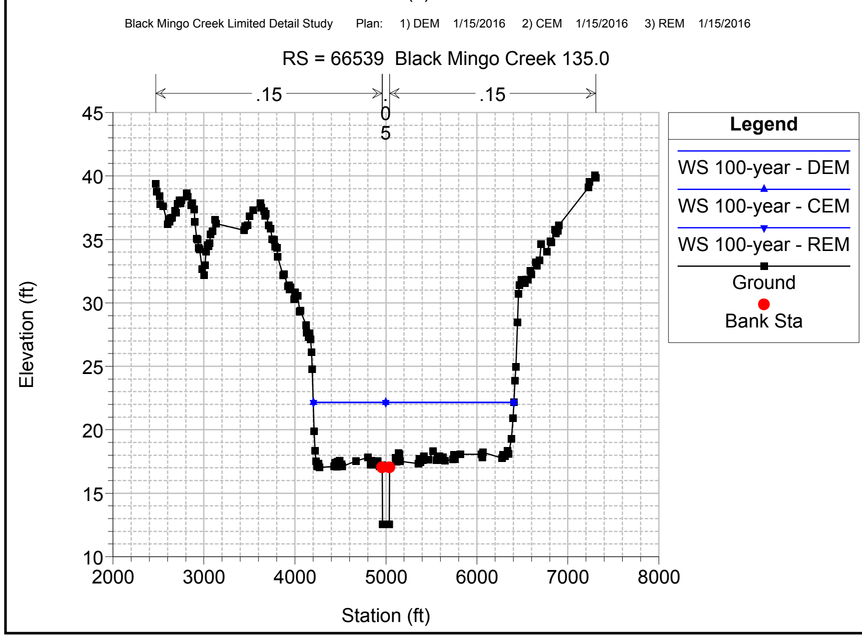
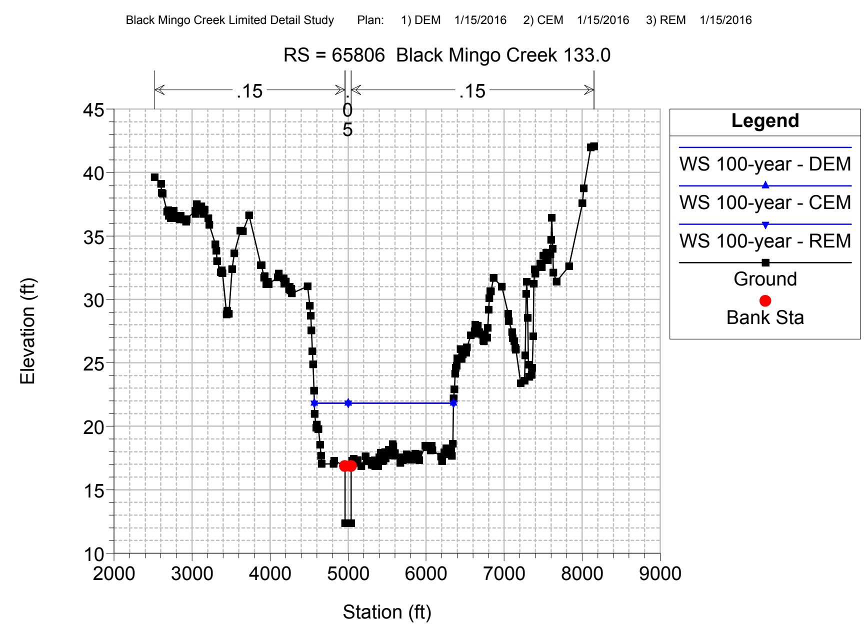
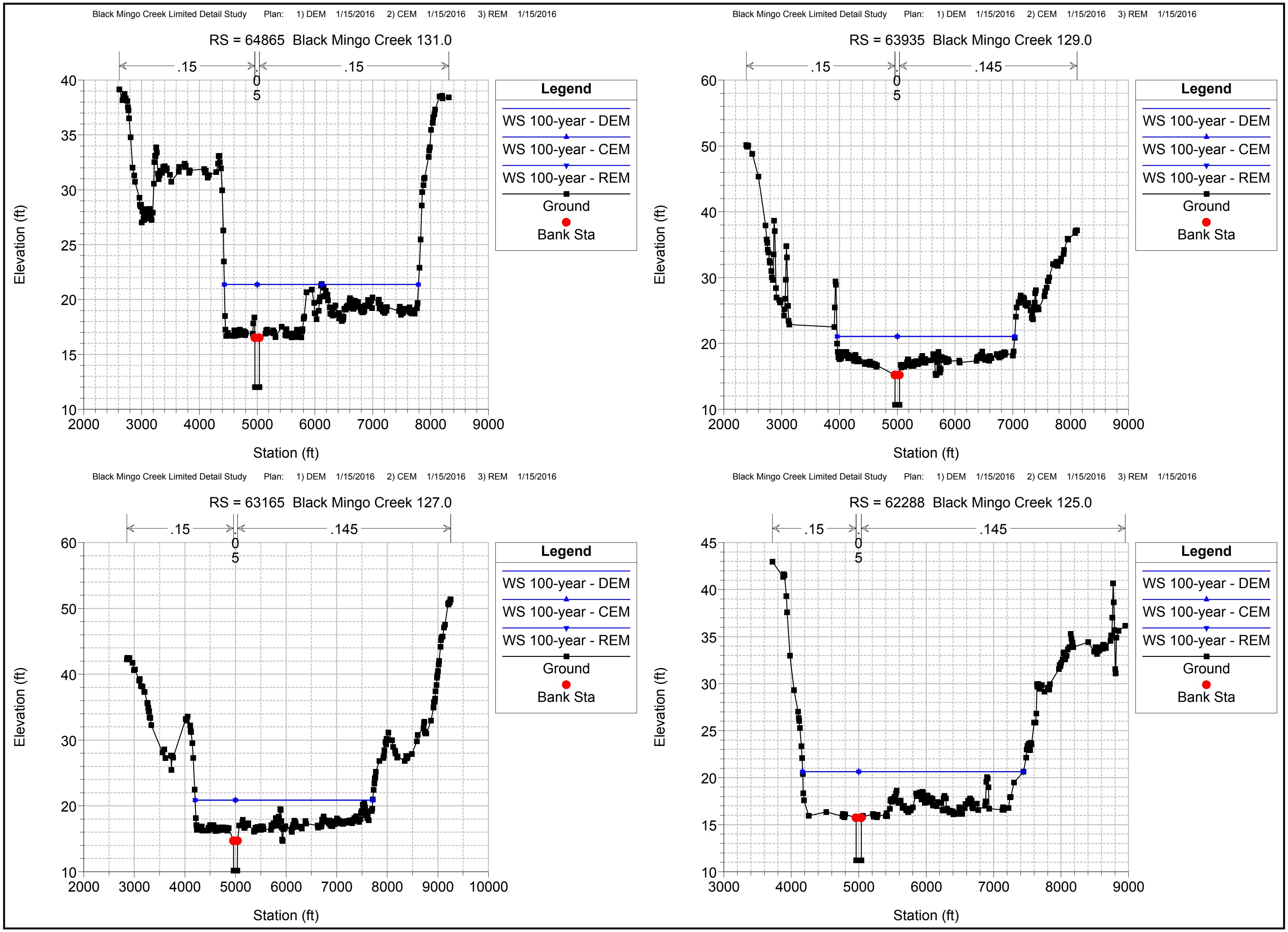
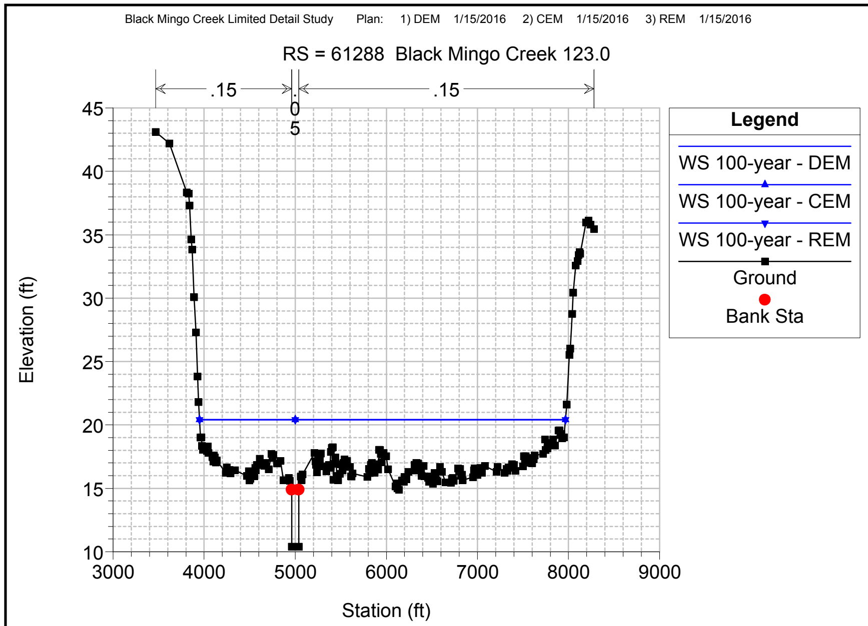
Legend
WS 100-year - REM
WS 100-year - CEM
WS 100-year - DEM
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Black Mingo Creek Limited Detail Study Plan: 1) DEM 1/15/2016 2) CEM 1/15/2016 3) REM 1/15/2016
RS = 67923 Black Mingo Creek 136.0
.15
.05
.15
Legend
WS 100-year - REM
WS 100-year - CEM
WS 100-year - DEM
Ground
Ineff
Bank Sta
Elevation (ft)
Station (ft)


Black Mingo Creek Limited Detail Study Plan: 1) DEM 1/15/2016 2) CEM 1/15/2016 3) REM 1/15/2016
RS = 66539 Black Mingo Creek 135.0
.15
.05
.15
Legend
WS 100-year - DEM
WS 100-year - CEM
WS 100-year - REM
Ground
Bank Sta
Elevation (ft)
Station (ft)


Black Mingo Creek Limited Detail Study Plan: 1) DEM 1/15/2016 2) CEM 1/15/2016 3) REM 1/15/2016
RS = 65806 Black Mingo Creek 133.0
.15
.05
.15
Legend
WS 100-year - DEM
WS 100-year - CEM
WS 100-year - REM
Ground
Bank Sta
Elevation (ft)
Station (ft)


Black Mingo Creek Limited Detail Study Plan: 1) DEM 1/15/2016 2) CEM 1/15/2016 3) REM 1/15/2016
RS = 64865 Black Mingo Creek 131.0
.15
0
5
.15
Legend
WS 100-year - DEM
WS 100-year - CEM
WS 100-year - REM
Ground
Bank Sta
Elevation (ft)
Station (ft)
Black Mingo Creek Limited Detail Study Plan: 1) DEM 1/15/2016 2) CEM 1/15/2016 3) REM 1/15/2016
RS = 63935 Black Mingo Creek 129.0
.15
0
5
.145
Legend
WS 100-year - DEM
WS 100-year - CEM
WS 100-year - REM
Ground
Bank Sta
Elevation (ft)
Station (ft)
Black Mingo Creek Limited Detail Study Plan: 1) DEM 1/15/2016 2) CEM 1/15/2016 3) REM 1/15/2016
RS = 63165 Black Mingo Creek 127.0
.15
0
5
.145
Legend
WS 100-year - DEM
WS 100-year - CEM
WS 100-year - REM
Ground
Bank Sta
Elevation (ft)
Station (ft)
Black Mingo Creek Limited Detail Study Plan: 1) DEM 1/15/2016 2) CEM 1/15/2016 3) REM 1/15/2016
RS = 62288 Black Mingo Creek 125.0
.15
0
5
.145
Legend
WS 100-year - DEM
WS 100-year - CEM
WS 100-year - REM
Ground
Bank Sta
Elevation (ft)
Station (ft)


Black Mingo Creek Limited Detail Study Plan: 1) DEM 1/15/2016 2) CEM 1/15/2016 3) REM 1/15/2016
RS = 61288 Black Mingo Creek 123.0
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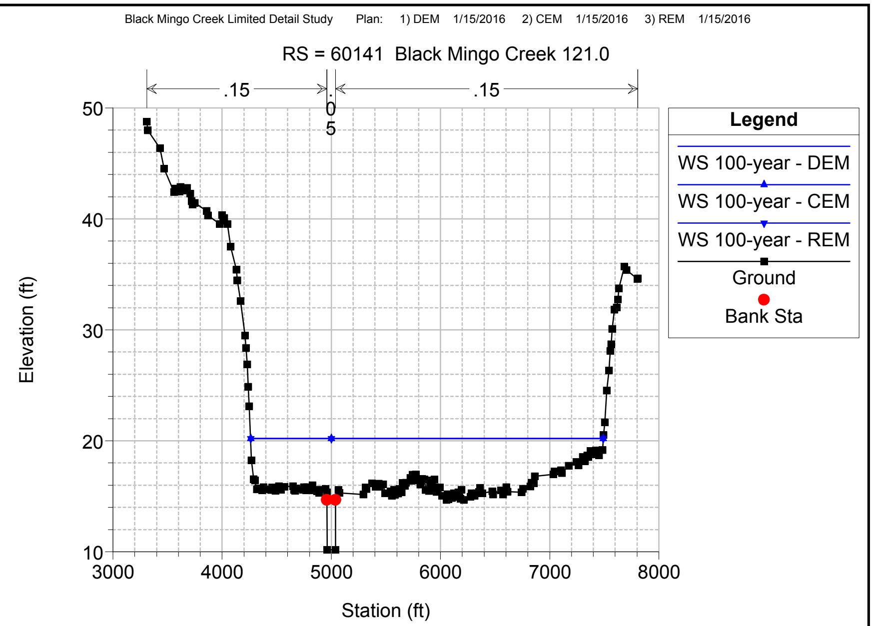
.05
.15
Legend
WS 100-year - DEM
WS 100-year - CEM
WS 100-year - REM
Ground
Bank Sta
Elevation (ft)
Station (ft)


Black Mingo Creek Limited Detail Study Plan: 1) DEM 1/15/2016 2) CEM 1/15/2016 3) REM 1/15/2016
RS = 60141 Black Mingo Creek 121.0
.15
.05
.15
Legend
WS 100-year - DEM
WS 100-year - CEM
WS 100-year - REM
Ground
Bank Sta
Elevation (ft)
Station (ft)

Appendix F
HEC-RAS Output – Tables

Tables in Appendix

HEC-RAS Locations: User Defined Profile: 2

River	Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
					(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Black Mingo Cree	Reach-1	71151	2	PROP SCDOT	1160.00	14.45	20.28	16.49	20.31	0.000371	1.74	2301.15	1942.11	0.13
Black Mingo Cree	Reach-1	71151	2	EX SCDOT	1160.00	14.45	20.33	16.49	20.36	0.000348	1.69	2378.44	1945.94	0.12
Black Mingo Cree	Reach-1	71151	2	NAT	1160.00	14.45	20.46	16.49	20.49	0.000295	1.58	2578.52	1955.83	0.12
Black Mingo Cree	Reach-1	70647	2	PROP SCDOT	1160.00	13.96	20.10	16.00	20.13	0.000341	1.73	2226.85	2086.71	0.12
Black Mingo Cree	Reach-1	70647	2	EX SCDOT	1160.00	13.96	20.17	16.00	20.19	0.000316	1.67	2318.08	2097.30	0.12
Black Mingo Cree	Reach-1	70647	2	NAT	1160.00	13.96	20.32	16.00	20.35	0.000264	1.56	2546.02	2104.31	0.11
Black Mingo Cree	Reach-1	69977	2	PROP SCDOT	1160.00	13.60	19.85	15.54	19.89	0.000379	1.85	1632.91	2058.33	0.13
Black Mingo Cree	Reach-1	69977	2	EX SCDOT	1160.00	13.60	19.93	15.54	19.97	0.000349	1.79	1719.92	2110.57	0.13
Black Mingo Cree	Reach-1	69977	2	NAT	1160.00	13.60	20.13	15.54	20.16	0.000289	1.67	1934.48	2166.40	0.12
Black Mingo Cree	Reach-1	69444	2	PROP SCDOT	1160.00	13.57	19.65		19.69	0.000394	1.85	1791.55	1884.11	0.13
Black Mingo Cree	Reach-1	69444	2	EX SCDOT	1160.00	13.57	19.75		19.78	0.000351	1.77	1917.68	1895.72	0.13
Black Mingo Cree	Reach-1	69444	2	NAT	1160.00	13.57	20.01		20.03	0.000201	1.38	3147.22	1981.35	0.10
Black Mingo Cree	Reach-1	68519	2	PROP SCDOT	1250.00	3.82	19.54	9.28	19.55	0.000067	0.95	1369.87	612.03	0.06
Black Mingo Cree	Reach-1	68519	2	EX SCDOT	1250.00	3.82	19.65	9.28	19.66	0.000064	0.94	1372.23	630.05	0.06
Black Mingo Cree	Reach-1	68519	2	NAT	1250.00	13.72	19.53		19.64	0.001082	2.84	796.32	610.51	0.22
Black Mingo Cree	Reach-1	68462			Bridge									
Black Mingo Cree	Reach-1	68393	2	PROP SCDOT	1250.00	7.03	19.43		19.45	0.000073	1.17	1139.44	521.36	0.06
Black Mingo Cree	Reach-1	68393	2	EX SCDOT	1250.00	7.03	19.43	9.42	19.45	0.000073	1.17	1137.00	521.38	0.06
Black Mingo Cree	Reach-1	68393	2	NAT	1250.00	13.47	19.41		19.51	0.000961	2.72	835.82	518.11	0.21
Black Mingo Cree	Reach-1	67923	2	PROP SCDOT	1250.00	12.68	19.29		19.36	0.000529	2.27	883.53	1454.44	0.16
Black Mingo Cree	Reach-1	67923	2	EX SCDOT	1250.00	12.68	19.29		19.36	0.000529	2.27	882.41	1454.44	0.16
Black Mingo Cree	Reach-1	67923	2	NAT	1250.00	12.68	19.21		19.24	0.000331	1.78	2161.48	1446.42	0.12
Black Mingo Cree	Reach-1	66539	2	PROP SCDOT	1250.00	12.54	18.78		18.81	0.000302	1.65	2824.30	2146.69	0.12
Black Mingo Cree	Reach-1	66539	2	EX SCDOT	1250.00	12.54	18.78		18.81	0.000302	1.65	2824.30	2146.69	0.12
Black Mingo Cree	Reach-1	66539	2	NAT	1250.00	12.54	18.78		18.81	0.000302	1.65	2824.30	2146.69	0.12
Black Mingo Cree	Reach-1	65806	2	PROP SCDOT	1250.00	12.36	18.51		18.55	0.000409	1.90	2092.22	1689.47	0.14
Black Mingo Cree	Reach-1	65806	2	EX SCDOT	1250.00	12.36	18.51		18.55	0.000409	1.90	2092.22	1689.47	0.14
Black Mingo Cree	Reach-1	65806	2	NAT	1250.00	12.36	18.51		18.55	0.000409	1.90	2092.22	1689.47	0.14
Black Mingo Cree	Reach-1	64865	2	PROP SCDOT	1250.00	12.00	18.12		18.16	0.000409	1.90	1998.97	1358.16	0.14
Black Mingo Cree	Reach-1	64865	2	EX SCDOT	1250.00	12.00	18.12		18.16	0.000409	1.90	1998.97	1358.16	0.14
Black Mingo Cree	Reach-1	64865	2	NAT	1250.00	12.00	18.12		18.16	0.000409	1.90	1998.97	1358.16	0.14

HEC-RAS Locations: User Defined Profile: 10

River	Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
					(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Black Mingo Cree	Reach-1	71151	10	PROP SCDOT	2890.00	14.45	22.28	18.19	22.30	0.000298	1.90	5437.77	2032.46	0.12
Black Mingo Cree	Reach-1	71151	10	EX SCDOT	2890.00	14.45	22.33	18.19	22.35	0.000285	1.87	5528.72	2033.19	0.12
Black Mingo Cree	Reach-1	71151	10	NAT	2890.00	14.45	22.33	18.19	22.36	0.000285	1.87	5530.46	2033.20	0.12
Black Mingo Cree	Reach-1	70647	10	PROP SCDOT	2890.00	13.96	22.12	17.70	22.15	0.000296	1.95	5213.14	2207.80	0.12
Black Mingo Cree	Reach-1	70647	10	EX SCDOT	2890.00	13.96	22.19	17.70	22.21	0.000282	1.92	5308.76	2210.04	0.12
Black Mingo Cree	Reach-1	70647	10	NAT	2890.00	13.96	22.19	17.70	22.21	0.000282	1.92	5310.57	2210.08	0.12
Black Mingo Cree	Reach-1	69977	10	PROP SCDOT	2890.00	13.60	21.87	17.15	21.91	0.000409	2.33	3888.25	2396.04	0.14
Black Mingo Cree	Reach-1	69977	10	EX SCDOT	2890.00	13.60	21.95	17.15	21.99	0.000387	2.28	3974.99	2404.56	0.14
Black Mingo Cree	Reach-1	69977	10	NAT	2890.00	13.60	21.95	17.15	21.99	0.000387	2.28	3976.63	2404.72	0.14
Black Mingo Cree	Reach-1	69444	10	PROP SCDOT	2890.00	13.57	21.67		21.71	0.000358	2.14	4566.93	2174.75	0.13
Black Mingo Cree	Reach-1	69444	10	EX SCDOT	2890.00	13.57	21.76		21.80	0.000334	2.09	4669.98	2180.70	0.13
Black Mingo Cree	Reach-1	69444	10	NAT	2890.00	13.57	21.82		21.84	0.000197	1.61	6950.10	2184.81	0.10
Black Mingo Cree	Reach-1	68519	10	PROP SCDOT	3100.00	3.82	21.41	11.56	21.46	0.000198	1.89	1796.40	1200.44	0.11
Black Mingo Cree	Reach-1	68519	10	EX SCDOT	3100.00	3.82	21.51	11.56	21.56	0.000194	1.88	1759.02	1203.68	0.11
Black Mingo Cree	Reach-1	68519	10	NAT	3100.00	13.72	21.27		21.43	0.001357	3.87	2387.31	1179.63	0.26
Black Mingo Cree	Reach-1	68462			Bridge									
Black Mingo Cree	Reach-1	68393	10	PROP SCDOT	3100.00	7.03	21.32		21.41	0.000253	2.42	1548.45	1397.43	0.12
Black Mingo Cree	Reach-1	68393	10	EX SCDOT	3100.00	7.03	21.32	11.01	21.41	0.000254	2.42	1518.42	1397.45	0.12
Black Mingo Cree	Reach-1	68393	10	NAT	3100.00	13.47	21.11		21.26	0.001263	3.77	2655.33	1389.80	0.25
Black Mingo Cree	Reach-1	67923	10	PROP SCDOT	3100.00	12.68	21.00		21.17	0.001031	3.71	1840.24	1547.34	0.23
Black Mingo Cree	Reach-1	67923	10	EX SCDOT	3100.00	12.68	21.00		21.17	0.001032	3.71	1837.42	1547.34	0.23
Black Mingo Cree	Reach-1	67923	10	NAT	3100.00	12.68	20.87		20.92	0.000411	2.32	4678.12	1544.70	0.14
Black Mingo Cree	Reach-1	66539	10	PROP SCDOT	3100.00	12.54	20.41		20.43	0.000297	1.92	6354.93	2182.60	0.12
Black Mingo Cree	Reach-1	66539	10	EX SCDOT	3100.00	12.54	20.41		20.43	0.000297	1.92	6354.93	2182.60	0.12
Black Mingo Cree	Reach-1	66539	10	NAT	3100.00	12.54	20.41		20.43	0.000297	1.92	6354.93	2182.60	0.12
Black Mingo Cree	Reach-1	65806	10	PROP SCDOT	3100.00	12.36	20.12		20.16	0.000452	2.34	4863.75	1757.07	0.15
Black Mingo Cree	Reach-1	65806	10	EX SCDOT	3100.00	12.36	20.12		20.16	0.000452	2.34	4863.75	1757.07	0.15
Black Mingo Cree	Reach-1	65806	10	NAT	3100.00	12.36	20.12		20.16	0.000452	2.34	4863.75	1757.07	0.15
Black Mingo Cree	Reach-1	64865	10	PROP SCDOT	3100.00	12.00	19.68		19.72	0.000490	2.42	5011.52	2761.86	0.16
Black Mingo Cree	Reach-1	64865	10	EX SCDOT	3100.00	12.00	19.68		19.72	0.000490	2.42	5011.52	2761.86	0.16
Black Mingo Cree	Reach-1	64865	10	NAT	3100.00	12.00	19.68		19.72	0.000490	2.42	5011.52	2761.86	0.16

HEC-RAS Locations: User Defined Profile: 25

River	Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
					(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Black Mingo Cree	Reach-1	71151	25	PROP SCDOT	3880.00	14.45	23.14	19.84	23.16	0.000283	1.99	6826.09	2042.42	0.12
Black Mingo Cree	Reach-1	71151	25	EX SCDOT	3880.00	14.45	23.19	19.84	23.21	0.000274	1.97	6899.04	2042.85	0.12
Black Mingo Cree	Reach-1	71151	25	NAT	3880.00	14.45	23.07	19.84	23.10	0.000296	2.03	6717.60	2041.78	0.12
Black Mingo Cree	Reach-1	70647	25	PROP SCDOT	3880.00	13.96	22.99	19.59	23.02	0.000288	2.06	6519.29	2242.86	0.12
Black Mingo Cree	Reach-1	70647	25	EX SCDOT	3880.00	13.96	23.04	19.59	23.07	0.000279	2.04	6594.74	2244.42	0.12
Black Mingo Cree	Reach-1	70647	25	NAT	3880.00	13.96	22.92	19.59	22.94	0.000303	2.10	6406.60	2239.65	0.12
Black Mingo Cree	Reach-1	69977	25	PROP SCDOT	3880.00	13.60	22.74	17.91	22.79	0.000412	2.50	4871.56	2532.29	0.15
Black Mingo Cree	Reach-1	69977	25	EX SCDOT	3880.00	13.60	22.80	17.91	22.84	0.000397	2.46	4937.84	2548.29	0.14
Black Mingo Cree	Reach-1	69977	25	NAT	3880.00	13.60	22.65	17.91	22.70	0.000435	2.55	4771.69	2520.68	0.15
Black Mingo Cree	Reach-1	69444	25	PROP SCDOT	3880.00	13.57	22.55		22.58	0.000342	2.25	5795.71	2208.54	0.13
Black Mingo Cree	Reach-1	69444	25	EX SCDOT	3880.00	13.57	22.62		22.65	0.000329	2.21	5850.57	2209.56	0.13
Black Mingo Cree	Reach-1	69444	25	NAT	3880.00	13.57	22.52		22.54	0.000209	1.75	8481.20	2208.08	0.10
Black Mingo Cree	Reach-1	68519	25	PROP SCDOT	4160.00	3.82	22.21	12.48	22.29	0.000272	2.33	1978.04	1223.91	0.13
Black Mingo Cree	Reach-1	68519	25	EX SCDOT	4160.00	3.82	22.28	12.48	22.36	0.000270	2.33	1919.22	1225.92	0.13
Black Mingo Cree	Reach-1	68519	25	NAT	4160.00	13.72	21.95		22.11	0.001383	4.16	3200.24	1216.43	0.27
Black Mingo Cree	Reach-1	68462			Bridge									
Black Mingo Cree	Reach-1	68393	25	PROP SCDOT	4160.00	7.03	22.07		22.21	0.000369	3.03	1724.54	1424.72	0.14
Black Mingo Cree	Reach-1	68393	25	EX SCDOT	4160.00	7.03	22.07	11.76	22.21	0.000372	3.04	1676.48	1424.72	0.14
Black Mingo Cree	Reach-1	68393	25	NAT	4160.00	13.47	21.80		21.94	0.001202	3.92	3619.17	1414.96	0.25
Black Mingo Cree	Reach-1	67923	25	PROP SCDOT	4160.00	12.68	21.68		21.89	0.001245	4.30	2239.72	1561.28	0.25
Black Mingo Cree	Reach-1	67923	25	EX SCDOT	4160.00	12.68	21.68		21.89	0.001247	4.30	2236.21	1561.28	0.25
Black Mingo Cree	Reach-1	67923	25	NAT	4160.00	12.68	21.54		21.59	0.000446	2.54	5713.27	1558.41	0.15
Black Mingo Cree	Reach-1	66539	25	PROP SCDOT	4160.00	12.54	21.05		21.07	0.000311	2.07	7750.29	2192.43	0.13
Black Mingo Cree	Reach-1	66539	25	EX SCDOT	4160.00	12.54	21.05		21.07	0.000311	2.07	7750.29	2192.43	0.13
Black Mingo Cree	Reach-1	66539	25	NAT	4160.00	12.54	21.05		21.07	0.000311	2.07	7750.29	2192.43	0.13
Black Mingo Cree	Reach-1	65806	25	PROP SCDOT	4160.00	12.36	20.74		20.79	0.000486	2.56	5957.22	1771.62	0.16
Black Mingo Cree	Reach-1	65806	25	EX SCDOT	4160.00	12.36	20.74		20.79	0.000486	2.56	5957.22	1771.62	0.16
Black Mingo Cree	Reach-1	65806	25	NAT	4160.00	12.36	20.74		20.79	0.000486	2.56	5957.22	1771.62	0.16
Black Mingo Cree	Reach-1	64865	25	PROP SCDOT	4160.00	12.00	20.29		20.33	0.000486	2.54	6822.33	3096.04	0.16
Black Mingo Cree	Reach-1	64865	25	EX SCDOT	4160.00	12.00	20.29		20.33	0.000486	2.54	6822.33	3096.04	0.16
Black Mingo Cree	Reach-1	64865	25	NAT	4160.00	12.00	20.29		20.33	0.000486	2.54	6822.33	3096.04	0.16

HEC-RAS Locations: User Defined   Profile: 50

River	Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
					(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Black Mingo Cree	Reach-1	71151	50	PROP SCDOT	4750.00	14.45	23.81	20.08	23.84	0.000276	2.07	7909.20	2048.79	0.12
Black Mingo Cree	Reach-1	71151	50	EX SCDOT	4750.00	14.45	23.85	20.08	23.88	0.000269	2.05	7974.01	2049.17	0.12
Black Mingo Cree	Reach-1	71151	50	NAT	4750.00	14.45	23.64	20.08	23.66	0.000307	2.16	7622.45	2047.11	0.13
Black Mingo Cree	Reach-1	70647	50	PROP SCDOT	4750.00	13.96	23.67	19.86	23.69	0.000284	2.15	7539.78	2319.35	0.12
Black Mingo Cree	Reach-1	70647	50	EX SCDOT	4750.00	13.96	23.71	19.86	23.74	0.000277	2.13	7606.04	2327.51	0.12
Black Mingo Cree	Reach-1	70647	50	NAT	4750.00	13.96	23.47	19.86	23.50	0.000319	2.25	7244.22	2257.85	0.13
Black Mingo Cree	Reach-1	69977	50	PROP SCDOT	4750.00	13.60	23.42	19.45	23.46	0.000415	2.63	5635.61	2578.70	0.15
Black Mingo Cree	Reach-1	69977	50	EX SCDOT	4750.00	13.60	23.47	19.45	23.51	0.000403	2.60	5692.86	2580.02	0.15
Black Mingo Cree	Reach-1	69977	50	NAT	4750.00	13.60	23.19	19.45	23.24	0.000472	2.76	5376.46	2564.78	0.16
Black Mingo Cree	Reach-1	69444	50	PROP SCDOT	4750.00	13.57	23.23		23.26	0.000335	2.34	6744.89	2219.01	0.13
Black Mingo Cree	Reach-1	69444	50	EX SCDOT	4750.00	13.57	23.28		23.32	0.000327	2.32	6773.38	2219.87	0.13
Black Mingo Cree	Reach-1	69444	50	NAT	4750.00	13.57	23.05		23.07	0.000217	1.86	9650.96	2216.26	0.11
Black Mingo Cree	Reach-1	68519	50	PROP SCDOT	5090.00	3.82	22.82	13.14	22.93	0.000335	2.69	2117.91	1241.55	0.14
Black Mingo Cree	Reach-1	68519	50	EX SCDOT	5090.00	3.82	22.88	13.16	22.99	0.000334	2.70	2044.10	1243.18	0.14
Black Mingo Cree	Reach-1	68519	50	NAT	5090.00	13.72	22.47		22.63	0.001370	4.33	3838.77	1231.43	0.27
Black Mingo Cree	Reach-1	68462			Bridge									
Black Mingo Cree	Reach-1	68393	50	PROP SCDOT	5090.00	7.03	22.64		22.82	0.000473	3.53	1858.36	1446.87	0.16
Black Mingo Cree	Reach-1	68393	50	EX SCDOT	5090.00	7.03	22.64	12.37	22.82	0.000478	3.54	1796.51	1446.85	0.17
Black Mingo Cree	Reach-1	68393	50	NAT	5090.00	13.47	22.33		22.46	0.001165	4.03	4371.28	1434.21	0.25
Black Mingo Cree	Reach-1	67923	50	PROP SCDOT	5090.00	12.68	22.20		22.45	0.001404	4.74	2550.82	1573.00	0.27
Black Mingo Cree	Reach-1	67923	50	EX SCDOT	5090.00	12.68	22.20		22.45	0.001406	4.74	2546.77	1573.01	0.27
Black Mingo Cree	Reach-1	67923	50	NAT	5090.00	12.68	22.06		22.11	0.000470	2.71	6519.60	1569.24	0.16
Black Mingo Cree	Reach-1	66539	50	PROP SCDOT	5090.00	12.54	21.54		21.57	0.000322	2.18	8837.61	2198.32	0.13
Black Mingo Cree	Reach-1	66539	50	EX SCDOT	5090.00	12.54	21.54		21.57	0.000322	2.18	8837.61	2198.32	0.13
Black Mingo Cree	Reach-1	66539	50	NAT	5090.00	12.54	21.54		21.57	0.000322	2.18	8837.61	2198.32	0.13
Black Mingo Cree	Reach-1	65806	50	PROP SCDOT	5090.00	12.36	21.23		21.27	0.000506	2.71	6816.92	1778.64	0.16
Black Mingo Cree	Reach-1	65806	50	EX SCDOT	5090.00	12.36	21.23		21.27	0.000506	2.71	6816.92	1778.64	0.16
Black Mingo Cree	Reach-1	65806	50	NAT	5090.00	12.36	21.23		21.27	0.000506	2.71	6816.92	1778.64	0.16
Black Mingo Cree	Reach-1	64865	50	PROP SCDOT	5090.00	12.00	20.77		20.81	0.000474	2.61	8352.48	3244.06	0.16
Black Mingo Cree	Reach-1	64865	50	EX SCDOT	5090.00	12.00	20.77		20.81	0.000474	2.61	8352.48	3244.06	0.16
Black Mingo Cree	Reach-1	64865	50	NAT	5090.00	12.00	20.77		20.81	0.000474	2.61	8352.48	3244.06	0.16

HEC-RAS Locations: User Defined Profile: 100 FEMA

River	Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
					(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Black Mingo Cree	Reach-1	71151	100 FEMA	PROP SCDOT	5677.00	14.45	24.58	20.29	24.61	0.000255	2.10	9152.21	2057.99	0.12
Black Mingo Cree	Reach-1	71151	100 FEMA	EX SCDOT	5677.00	14.45	24.64	20.29	24.66	0.000247	2.07	9246.97	2058.70	0.12
Black Mingo Cree	Reach-1	71151	100 FEMA	NAT	5677.00	14.45	24.26	20.29	24.28	0.000304	2.24	8628.28	2054.06	0.13
Black Mingo Cree	Reach-1	70647	100 FEMA	PROP SCDOT	5677.00	13.96	24.45	20.08	24.47	0.000265	2.19	8723.17	2465.29	0.12
Black Mingo Cree	Reach-1	70647	100 FEMA	EX SCDOT	5677.00	13.96	24.51	20.08	24.54	0.000256	2.16	8818.64	2480.65	0.12
Black Mingo Cree	Reach-1	70647	100 FEMA	NAT	5677.00	13.96	24.10	20.08	24.13	0.000319	2.35	8189.87	2379.40	0.13
Black Mingo Cree	Reach-1	69977	100 FEMA	PROP SCDOT	5677.00	13.60	24.21	19.82	24.26	0.000390	2.69	6539.21	2613.80	0.15
Black Mingo Cree	Reach-1	69977	100 FEMA	EX SCDOT	5677.00	13.60	24.28	19.82	24.33	0.000377	2.65	6619.64	2615.61	0.14
Black Mingo Cree	Reach-1	69977	100 FEMA	NAT	5677.00	13.60	23.81	19.82	23.87	0.000479	2.90	6081.18	2591.12	0.16
Black Mingo Cree	Reach-1	69444	100 FEMA	PROP SCDOT	5677.00	13.57	24.04		24.07	0.000305	2.36	7883.10	2228.73	0.13
Black Mingo Cree	Reach-1	69444	100 FEMA	EX SCDOT	5677.00	13.57	24.11		24.15	0.000296	2.33	7925.52	2229.59	0.13
Black Mingo Cree	Reach-1	69444	100 FEMA	NAT	5677.00	13.57	23.67		23.69	0.000209	1.90	11040.81	2224.62	0.11
Black Mingo Cree	Reach-1	68519	100 FEMA	PROP SCDOT	6349.00	3.82	23.56	13.95	23.71	0.000417	3.13	2286.27	1262.68	0.16
Black Mingo Cree	Reach-1	68519	100 FEMA	EX SCDOT	6349.00	3.82	23.64	13.96	23.79	0.000416	3.14	2202.15	1264.91	0.16
Black Mingo Cree	Reach-1	68519	100 FEMA	NAT	6349.00	13.72	23.10		23.26	0.001362	4.54	4617.76	1249.48	0.27
Black Mingo Cree	Reach-1	68462			Bridge									
Black Mingo Cree	Reach-1	68393	100 FEMA	PROP SCDOT	6349.00	7.03	23.31		23.57	0.000617	4.15	2017.18	1476.86	0.19
Black Mingo Cree	Reach-1	68393	100 FEMA	EX SCDOT	6349.00	7.03	23.31	13.13	23.57	0.000626	4.18	1938.82	1476.77	0.19
Black Mingo Cree	Reach-1	68393	100 FEMA	NAT	6349.00	13.47	22.96		23.09	0.001136	4.18	5287.58	1460.04	0.25
Black Mingo Cree	Reach-1	67923	100 FEMA	PROP SCDOT	6349.00	12.68	22.82		23.11	0.001596	5.27	2929.80	1591.75	0.29
Black Mingo Cree	Reach-1	67923	100 FEMA	EX SCDOT	6349.00	12.68	22.82		23.11	0.001598	5.28	2925.10	1591.74	0.29
Black Mingo Cree	Reach-1	67923	100 FEMA	NAT	6349.00	12.68	22.68		22.73	0.000500	2.92	7496.61	1587.35	0.16
Black Mingo Cree	Reach-1	66539	100 FEMA	PROP SCDOT	6349.00	12.54	22.13		22.16	0.000336	2.33	10142.58	2205.37	0.13
Black Mingo Cree	Reach-1	66539	100 FEMA	EX SCDOT	6349.00	12.54	22.13		22.16	0.000336	2.33	10142.58	2205.37	0.13
Black Mingo Cree	Reach-1	66539	100 FEMA	NAT	6349.00	12.54	22.13		22.16	0.000336	2.33	10142.58	2205.37	0.13
Black Mingo Cree	Reach-1	65806	100 FEMA	PROP SCDOT	6349.00	12.36	21.81		21.85	0.000531	2.90	7847.36	1783.44	0.17
Black Mingo Cree	Reach-1	65806	100 FEMA	EX SCDOT	6349.00	12.36	21.81		21.85	0.000531	2.90	7847.36	1783.44	0.17
Black Mingo Cree	Reach-1	65806	100 FEMA	NAT	6349.00	12.36	21.81		21.85	0.000531	2.90	7847.36	1783.44	0.17
Black Mingo Cree	Reach-1	64865	100 FEMA	PROP SCDOT	6349.00	12.00	21.35		21.38	0.000463	2.69	10260.55	3348.67	0.16
Black Mingo Cree	Reach-1	64865	100 FEMA	EX SCDOT	6349.00	12.00	21.35		21.38	0.000463	2.69	10260.55	3348.67	0.16
Black Mingo Cree	Reach-1	64865	100 FEMA	NAT	6349.00	12.00	21.35		21.38	0.000463	2.69	10260.55	3348.67	0.16

HEC-RAS Locations: User Defined Profile: 500

River	Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
					(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Black Mingo Cree	Reach-1	71151	500	PROP SCDOT	7820.00	14.45	25.83	20.69	25.86	0.000263	2.31	11177.11	2076.58	0.12
Black Mingo Cree	Reach-1	71151	500	EX SCDOT	7820.00	14.45	25.93	20.69	25.95	0.000252	2.27	11328.05	2078.24	0.12
Black Mingo Cree	Reach-1	71151	500	NAT	7820.00	14.45	25.30	20.69	25.33	0.000337	2.52	10311.28	2067.06	0.14
Black Mingo Cree	Reach-1	70647	500	PROP SCDOT	7820.00	13.96	25.69	20.51	25.72	0.000279	2.42	10625.48	2744.87	0.13
Black Mingo Cree	Reach-1	70647	500	EX SCDOT	7820.00	13.96	25.79	20.51	25.82	0.000267	2.38	10777.20	2746.60	0.12
Black Mingo Cree	Reach-1	70647	500	NAT	7820.00	13.96	25.12	20.51	25.15	0.000362	2.67	9743.64	2696.68	0.14
Black Mingo Cree	Reach-1	69977	500	PROP SCDOT	7820.00	13.60	25.44	20.48	25.49	0.000422	3.01	7935.45	2655.67	0.15
Black Mingo Cree	Reach-1	69977	500	EX SCDOT	7820.00	13.60	25.55	20.48	25.60	0.000403	2.96	8061.15	2661.44	0.15
Black Mingo Cree	Reach-1	69977	500	NAT	7820.00	13.60	24.78	20.48	24.85	0.000564	3.35	7186.77	2624.49	0.18
Black Mingo Cree	Reach-1	69444	500	PROP SCDOT	7820.00	13.57	25.25		25.29	0.000324	2.61	9585.93	2279.67	0.14
Black Mingo Cree	Reach-1	69444	500	EX SCDOT	7820.00	13.57	25.37		25.41	0.000311	2.58	9663.86	2289.27	0.13
Black Mingo Cree	Reach-1	69444	500	NAT	7820.00	13.57	24.63		24.65	0.000234	2.14	13174.72	2235.27	0.11
Black Mingo Cree	Reach-1	68519	500	PROP SCDOT	8350.00	3.82	24.65	15.07	24.86	0.000533	3.75	2534.25	1335.95	0.18
Black Mingo Cree	Reach-1	68519	500	EX SCDOT	8350.00	3.82	24.77	15.04	24.98	0.000528	3.76	2437.60	1370.86	0.18
Black Mingo Cree	Reach-1	68519	500	NAT	8350.00	13.72	24.04		24.20	0.001308	4.77	5807.51	1276.35	0.27
Black Mingo Cree	Reach-1	68462			Bridge									
Black Mingo Cree	Reach-1	68393	500	PROP SCDOT	8350.00	7.03	24.30		24.67	0.000836	5.04	2249.15	1636.95	0.22
Black Mingo Cree	Reach-1	68393	500	EX SCDOT	8350.00	7.03	24.30	14.24	24.68	0.000851	5.09	2147.83	1637.07	0.22
Black Mingo Cree	Reach-1	68393	500	NAT	8350.00	13.47	23.91		24.04	0.001066	4.34	6704.77	1561.65	0.25
Black Mingo Cree	Reach-1	67923	500	PROP SCDOT	8350.00	12.68	23.76		24.10	0.001795	5.93	3514.94	1619.89	0.32
Black Mingo Cree	Reach-1	67923	500	EX SCDOT	8350.00	12.68	23.76		24.10	0.001798	5.94	3509.24	1619.88	0.32
Black Mingo Cree	Reach-1	67923	500	NAT	8350.00	12.68	23.63		23.68	0.000516	3.16	9015.80	1615.96	0.17
Black Mingo Cree	Reach-1	66539	500	PROP SCDOT	8350.00	12.54	23.08		23.11	0.000333	2.47	12230.30	2214.98	0.13
Black Mingo Cree	Reach-1	66539	500	EX SCDOT	8350.00	12.54	23.08		23.11	0.000333	2.47	12230.30	2214.98	0.13
Black Mingo Cree	Reach-1	66539	500	NAT	8350.00	12.54	23.08		23.11	0.000333	2.47	12230.30	2214.98	0.13
Black Mingo Cree	Reach-1	65806	500	PROP SCDOT	8350.00	12.36	22.75		22.80	0.000524	3.07	9540.94	1797.63	0.17
Black Mingo Cree	Reach-1	65806	500	EX SCDOT	8350.00	12.36	22.75		22.80	0.000524	3.07	9540.94	1797.63	0.17
Black Mingo Cree	Reach-1	65806	500	NAT	8350.00	12.36	22.75		22.80	0.000524	3.07	9540.94	1797.63	0.17
Black Mingo Cree	Reach-1	64865	500	PROP SCDOT	8350.00	12.00	22.35		22.38	0.000383	2.62	13625.26	3372.14	0.14
Black Mingo Cree	Reach-1	64865	500	EX SCDOT	8350.00	12.00	22.35		22.38	0.000383	2.62	13625.26	3372.14	0.14
Black Mingo Cree	Reach-1	64865	500	NAT	8350.00	12.00	22.35		22.38	0.000383	2.62	13625.26	3372.14	0.14

HEC-RAS Locations: User Defined Profile: 100-year

River	Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
					(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Black Mingo Cree	Reach-1	71151	100-year	DEM	5677.00	14.45	25.68	20.29	25.69	0.000149	1.72	10919.79	2073.75	0.09
Black Mingo Cree	Reach-1	71151	100-year	CEM	5677.00	14.45	24.65	20.29	24.67	0.000247	2.07	9252.11	2058.73	0.12
Black Mingo Cree	Reach-1	71151	100-year	REM	5677.00	14.45	24.59	20.29	24.61	0.000254	2.10	9157.34	2058.02	0.12
Black Mingo Cree	Reach-1	70647	100-year	DEM	5677.00	13.96	25.60	20.08	25.61	0.000153	1.79	10478.27	2743.20	0.09
Black Mingo Cree	Reach-1	70647	100-year	CEM	5677.00	13.96	24.52	20.08	24.54	0.000256	2.16	8823.81	2481.48	0.12
Black Mingo Cree	Reach-1	70647	100-year	REM	5677.00	13.96	24.45	20.08	24.48	0.000264	2.19	8728.33	2466.12	0.12
Black Mingo Cree	Reach-1	69977	100-year	DEM	5677.00	13.60	25.46	19.82	25.49	0.000220	2.18	7963.39	2656.96	0.11
Black Mingo Cree	Reach-1	69977	100-year	CEM	5677.00	13.60	24.29	19.82	24.33	0.000376	2.65	6623.98	2615.71	0.14
Black Mingo Cree	Reach-1	69977	100-year	REM	5677.00	13.60	24.21	19.82	24.26	0.000389	2.68	6543.58	2613.90	0.15
Black Mingo Cree	Reach-1	69444	100-year	DEM	5677.00	13.57	25.41	19.68	25.41	0.000085	1.35	14911.69	2291.24	0.07
Black Mingo Cree	Reach-1	69444	100-year	CEM	5677.00	13.57	24.12		24.15	0.000295	2.33	7931.27	2229.63	0.13
Black Mingo Cree	Reach-1	69444	100-year	REM	5677.00	13.57	24.04		24.07	0.000305	2.35	7888.99	2228.78	0.13
Black Mingo Cree	Reach-1	68519	100-year	DEM	6349.00	13.72	24.36	20.47	24.99	0.002597	6.87	1375.01	1278.78	0.38
Black Mingo Cree	Reach-1	68519	100-year	CEM	6349.00	3.82	23.64	13.99	23.79	0.000415	3.14	2203.16	1265.05	0.16
Black Mingo Cree	Reach-1	68519	100-year	REM	6349.00	3.82	23.56	13.99	23.71	0.000417	3.13	2287.39	1262.82	0.16
Black Mingo Cree	Reach-1	68462			Bridge									
Black Mingo Cree	Reach-1	68393	100-year	DEM	6349.00	13.47	22.74	20.34	23.75	0.004835	8.49	1049.14	1467.43	0.51
Black Mingo Cree	Reach-1	68393	100-year	CEM	6349.00	7.03	23.32	13.13	23.57	0.000625	4.18	1939.91	1477.03	0.19
Black Mingo Cree	Reach-1	68393	100-year	REM	6349.00	7.03	23.32		23.57	0.000617	4.15	2018.40	1477.13	0.19
Black Mingo Cree	Reach-1	67923	100-year	DEM	6349.00	12.68	22.69		22.74	0.000497	2.92	7509.92	1587.61	0.16
Black Mingo Cree	Reach-1	67923	100-year	CEM	6349.00	12.68	22.83		23.12	0.001593	5.27	2929.34	1591.95	0.29
Black Mingo Cree	Reach-1	67923	100-year	REM	6349.00	12.68	22.83		23.12	0.001590	5.27	2934.05	1591.95	0.29
Black Mingo Cree	Reach-1	66539	100-year	DEM	6349.00	12.54	22.15		22.17	0.000333	2.32	10168.71	2205.51	0.13
Black Mingo Cree	Reach-1	66539	100-year	CEM	6349.00	12.54	22.15		22.17	0.000333	2.32	10168.71	2205.51	0.13
Black Mingo Cree	Reach-1	66539	100-year	REM	6349.00	12.54	22.15		22.17	0.000333	2.32	10168.71	2205.51	0.13
Black Mingo Cree	Reach-1	65806	100-year	DEM	6349.00	12.36	21.82		21.87	0.000526	2.89	7873.41	1783.56	0.17
Black Mingo Cree	Reach-1	65806	100-year	CEM	6349.00	12.36	21.82		21.87	0.000526	2.89	7873.41	1783.56	0.17
Black Mingo Cree	Reach-1	65806	100-year	REM	6349.00	12.36	21.82		21.87	0.000526	2.89	7873.41	1783.56	0.17
Black Mingo Cree	Reach-1	64865	100-year	DEM	6349.00	12.00	21.37		21.40	0.000456	2.67	10330.61	3352.30	0.15
Black Mingo Cree	Reach-1	64865	100-year	CEM	6349.00	12.00	21.37		21.40	0.000456	2.67	10330.61	3352.30	0.15
Black Mingo Cree	Reach-1	64865	100-year	REM	6349.00	12.00	21.37		21.40	0.000456	2.67	10330.61	3352.30	0.15

Plan: EX SCDOT Black Mingo Cree Reach-1 RS: 68462 Profile: 25

E.G. US. (ft)	22.36	Element	Inside BR US	Inside BR DS
W.S. US. (ft)	22.28	E.G. Elev (ft)	22.34	22.24
Q Total (cfs)	4160.00	W.S. Elev (ft)	22.21	22.09
Q Bridge (cfs)	4160.00	Crit W.S. (ft)	12.70	11.97
Q Weir (cfs)		Max Chl Dpth (ft)	18.39	15.06
Weir Sta Lft (ft)		Vel Total (ft/s)	2.95	3.07
Weir Sta Rgt (ft)		Flow Area (sq ft)	1410.23	1353.67
Weir Submerg		Froude # Chl	0.12	0.14
Weir Max Depth (ft)		Specif Force (cu ft)	9380.95	9324.93
Min El Weir Flow (ft)	26.11	Hydr Depth (ft)	11.10	10.66
Min El Prs (ft)	25.51	W.P. Total (ft)	321.45	325.01
Delta EG (ft)	0.15	Conv. Total (cfs)	112416.2	106371.0
Delta WS (ft)	0.21	Top Width (ft)	127.00	127.00
BR Open Area (sq ft)	1779.56	Frctn Loss (ft)		
BR Open Vel (ft/s)	3.07	C & E Loss (ft)		
Coef of Q		Shear Total (lb/sq ft)	0.38	0.40
Br Sel Method	Momentum	Power Total (lb/ft s)	2603.50	2557.00

Plan: EX SCDOT Black Mingo Cree Reach-1 RS: 68462 Profile: 100 FEMA

E.G. US. (ft)	23.79	Element	Inside BR US	Inside BR DS
W.S. US. (ft)	23.64	E.G. Elev (ft)	23.71	23.64
Q Total (cfs)	6349.00	W.S. Elev (ft)	23.46	23.36
Q Bridge (cfs)	6349.00	Crit W.S. (ft)	14.31	13.40
Q Weir (cfs)		Max Chl Dpth (ft)	19.64	16.33
Weir Sta Lft (ft)		Vel Total (ft/s)	4.05	4.19
Weir Sta Rgt (ft)		Flow Area (sq ft)	1569.57	1515.12
Weir Submerg		Froude # Chl	0.16	0.18
Weir Max Depth (ft)		Specif Force (cu ft)	11666.58	11578.21
Min El Weir Flow (ft)	26.11	Hydr Depth (ft)	12.36	11.93
Min El Prs (ft)	25.51	W.P. Total (ft)	341.53	345.35
Delta EG (ft)	0.22	Conv. Total (cfs)	128938.6	122380.3
Delta WS (ft)	0.32	Top Width (ft)	127.00	127.00
BR Open Area (sq ft)	1779.56	Frctn Loss (ft)	0.07	0.06
BR Open Vel (ft/s)	4.19	C & E Loss (ft)	0.01	0.01
Coef of Q		Shear Total (lb/sq ft)	0.70	0.74
Br Sel Method	Energy only	Power Total (lb/ft s)	2603.50	2557.00

Plan: PROP SCDOT   Black Mingo Cree   Reach-1 RS: 68462   Profile: 25

E.G. US. (ft)	22.29	Element	Inside BR US	Inside BR DS
W.S. US. (ft)	22.21	E.G. Elev (ft)	22.26	22.23
Q Total (cfs)	4160.00	W.S. Elev (ft)	22.14	22.09
Q Bridge (cfs)	4160.00	Crit W.S. (ft)	12.48	11.86
Q Weir (cfs)		Max Chl Dpth (ft)	18.32	15.06
Weir Sta Lft (ft)		Vel Total (ft/s)	2.71	2.90
Weir Sta Rgt (ft)		Flow Area (sq ft)	1532.36	1433.05
Weir Submerg		Froude # Chl	0.15	0.15
Weir Max Depth (ft)		Specif Force (cu ft)	9847.45	9657.66
Min El Weir Flow (ft)	26.11	Hydr Depth (ft)	9.95	9.31
Min El Prs (ft)	25.51	W.P. Total (ft)	203.58	224.71
Delta EG (ft)	0.08	Conv. Total (cfs)	180511.9	157731.7
Delta WS (ft)	0.14	Top Width (ft)	154.04	153.85
BR Open Area (sq ft)	1958.78	Frctn Loss (ft)	0.02	0.02
BR Open Vel (ft/s)	2.90	C & E Loss (ft)	0.01	0.00
Coef of Q		Shear Total (lb/sq ft)	0.25	0.28
Br Sel Method	Energy only	Power Total (lb/ft s)	2603.50	2557.00

Plan: PROP SCDOT   Black Mingo Cree   Reach-1 RS: 68462   Profile: 100 FEMA

E.G. US. (ft)	23.71	Element	Inside BR US	Inside BR DS
W.S. US. (ft)	23.56	E.G. Elev (ft)	23.66	23.61
Q Total (cfs)	6349.00	W.S. Elev (ft)	23.44	23.35
Q Bridge (cfs)	6349.00	Crit W.S. (ft)	14.08	13.26
Q Weir (cfs)		Max Chl Dpth (ft)	19.62	16.32
Weir Sta Lft (ft)		Vel Total (ft/s)	3.66	3.90
Weir Sta Rgt (ft)		Flow Area (sq ft)	1734.55	1629.33
Weir Submerg		Froude # Chl	0.19	0.19
Weir Max Depth (ft)		Specif Force (cu ft)	12346.85	11996.97
Min El Weir Flow (ft)	26.11	Hydr Depth (ft)	11.01	10.34
Min El Prs (ft)	25.51	W.P. Total (ft)	214.26	235.31
Delta EG (ft)	0.14	Conv. Total (cfs)	214085.1	184176.8
Delta WS (ft)	0.24	Top Width (ft)	157.50	157.50
BR Open Area (sq ft)	1958.78	Frctn Loss (ft)	0.04	0.04
BR Open Vel (ft/s)	3.90	C & E Loss (ft)	0.01	0.00
Coef of Q		Shear Total (lb/sq ft)	0.44	0.51
Br Sel Method	Energy only	Power Total (lb/ft s)	2603.50	2557.00

Plan: CEM   Black Mingo Cree   Reach-1 RS: 68462   Profile: 100-year

E.G. US. (ft)	23.79	Element	Inside BR US	Inside BR DS
W.S. US. (ft)	23.64	E.G. Elev (ft)	23.72	23.64
Q Total (cfs)	6349.00	W.S. Elev (ft)	23.47	23.36
Q Bridge (cfs)	6349.00	Crit W.S. (ft)	14.31	13.40
Q Weir (cfs)		Max Chl Dpth (ft)	19.65	16.33
Weir Sta Lft (ft)		Vel Total (ft/s)	4.04	4.19
Weir Sta Rgt (ft)		Flow Area (sq ft)	1570.20	1515.76
Weir Submerg		Froude # Chl	0.16	0.18
Weir Max Depth (ft)		Specif Force (cu ft)	11674.06	11585.57
Min El Weir Flow (ft)	26.11	Hydr Depth (ft)	12.36	11.94
Min El Prs (ft)	25.51	W.P. Total (ft)	341.61	345.43
Delta EG (ft)	0.22	Conv. Total (cfs)	129005.0	122446.0
Delta WS (ft)	0.32	Top Width (ft)	127.00	127.00
BR Open Area (sq ft)	1779.56	Frctn Loss (ft)	0.07	0.06
BR Open Vel (ft/s)	4.19	C & E Loss (ft)	0.01	0.01
Coef of Q		Shear Total (lb/sq ft)	0.70	0.74
Br Sel Method	Energy only	Power Total (lb/ft s)	2603.50	2557.00

Plan: REM Black Mingo Cree Reach-1 RS: 68462 Profile: 100-year

E.G. US. (ft)	23.71	Element	Inside BR US	Inside BR DS
W.S. US. (ft)	23.56	E.G. Elev (ft)	23.66	23.61
Q Total (cfs)	6349.00	W.S. Elev (ft)	23.44	23.35
Q Bridge (cfs)	6349.00	Crit W.S. (ft)	14.08	13.26
Q Weir (cfs)		Max Chl Dpth (ft)	19.62	16.32
Weir Sta Lft (ft)		Vel Total (ft/s)	3.66	3.89
Weir Sta Rgt (ft)		Flow Area (sq ft)	1735.34	1630.14
Weir Submerg		Froude # Chl	0.19	0.19
Weir Max Depth (ft)		Specif Force (cu ft)	12355.20	12004.94
Min El Weir Flow (ft)	26.11	Hydr Depth (ft)	11.02	10.35
Min El Prs (ft)	25.51	W.P. Total (ft)	214.29	235.34
Delta EG (ft)	0.14	Conv. Total (cfs)	214218.9	184289.1
Delta WS (ft)	0.24	Top Width (ft)	157.50	157.50
BR Open Area (sq ft)	1958.78	Frctn Loss (ft)	0.04	0.04
BR Open Vel (ft/s)	3.89	C & E Loss (ft)	0.01	0.00
Coef of Q		Shear Total (lb/sq ft)	0.44	0.51
Br Sel Method	Energy only	Power Total (lb/ft s)	2603.50	2557.00

Appendix G
Scour and Soils Information

Site Information

1

(Fill in gray shaded cells - leave blank if data not available)

Bridge Number:	0004570005100100	**Stream:**	Black Mingo Creek	**Date of Analysis:**	01/29/16
County:	Williamsburg	**Road:**	S-45-51		
Physiographic Region (for scour):	Coastal Plain	**Multiple Bridge?**	No	**Bridge Length:**	164 ft
		Relief Bridge?	No		
Latitude:	334238 DMS	**Swampy, Poorly Defined Channel?**	No	**Drainage Area:**	107 sq mi
Longitude:	793433 DMS				

SCDOT PLAN DATA

(Be sure to check for tie equalities)

Data Available?	Yes
Quality of Plan Data:	Good

SCDOT Road Plan number:	P029461	
Use HWM or average flood-plain flow depth for WSEL?**	High Water	
WSEL on SCDOT datum:	23.56	ft
LEW station at unconstricted cross section from plans (if no data, leave cell empty):	3961	ft
REW station at unconstricted cross section from plans (if no data, leave cell empty):	5224	ft
Unconstricted cross-section topwidth from plans:	1263	ft

LEW station at bridge:	4934.5	ft
REW station at bridge:	5095	ft
Left abutment toe station:	4944.5	ft
Right abutment toe station:	5087	ft
LTB station at bridge (if relief bridge or swampy, poorly defined channel, leave cell empty):	4944.5	ft
RTB station at bridge (if relief bridge or swampy, poorly defined channel, leave cell empty):	5082.5	ft
Channel topwidth (plans):	138	ft
Distance from toe to toe (plans):	143	ft
Left embankment length (plans):	984	ft
Right embankment length (plans):	137	ft
M(g) (plans):	0.87	

CHECK (Single bridge data):

Do embankment lengths and toe-to-toe distance equal unconstricted cross-section topwidth?	Yes

CHECK (Multiple bridge data):

Does sum of embankment and bridge lengths equal approach flood-plain topwidth?	N/A

**NOTE: Average flood-plain flow depth in Coastal Plain and Piedmont is approximately 7 ft.

TOPOGRAPHIC MAP DATA

Data Available?	Yes
Quality of Map Data:	Good

Does topo indicate wide, flat floodplain?	Yes	
Does topo indicate severe meander just upstream?	No	
Bridge length as provided by SCDOT (verify with topo map if possible):	164	ft
Approach flood-plain topwidth (topo map):**	1200	ft
Left embankment length (topo map):	1000	ft
Right embankment length (topo map):	135	ft
M(g) (topo map):	0.86	

CHECK (Single bridge data):

Does sum of embankment and bridge lengths equal approach flood-plain topwidth?	No

CHECK (Multiple bridge data):

Does sum of embankment and bridge lengths equal approach flood-plain topwidth?	N/A

**NOTE: The approach cross section should be located approximately 1 bridge-width upstream of the bridge of interest.
The HWM from the SCDOT plans or the average flood-plain flow depth should be used to approximate the flood-plain topwidth.

FEMA/Other MAP DATA

If "Other Map," describe:

Data Available?	Yes
Quality of Map Data:	Good

Bridge length as provided by SCDOT (verify with FEMA/Other map if possible):	164	ft
Approach flood-plain topwidth (FEMA/Other map):**	1200	ft
Left embankment length (FEMA/Other map):	1050	ft
Right embankment length (FEMA/Other map):	150	ft
M(g) (FEMA/Other map):	0.86	

CHECK (Single bridge data):

Does sum of embankment and bridge lengths equal approach flood-plain topwidth?	No

CHECK (Multiple bridge data):

Does sum of embankment and bridge lengths equal approach flood-plain topwidth?	N/A

**NOTE: The approach cross section should be located approximately 1 bridge-width upstream of the bridge of interest.
The inundated areas on the FEMA/Other map should be used to approximate the flood-plain topwidth.

Comparison of Geometric-Contraction Ratios [M(g)]

	M(g) Value	Quality of Source Data
M(g) from road plans:	0.87	Good
M(g) from topographic map:	0.86	Good
M(g) from FEMA/Other map:	0.86	Good
USE M(g):	0.86	

Select Source for M(g)

Source Used:	Topo Map

NOTE: The "USE M(g)" value is automatically selected, but can be overridden by typing in another value.
If the originally selected value of M(g) is overridden, justification should be provided in the comments below.

NOTE: The details associated with the topographic and FEMA/Other maps will often be limited, causing discrepancies in the estimate of M(g).
Bridge plans are based on an actual survey and should be given strong consideration in the selection of the final M(g).
As a general rule, the selected M(g) and embankment lengths should come from the same data source.

Comparison of Embankment Lengths

Select Source for Embankment Length

Source Used:	Topo Map

	Left		Right	
	Embankment Length (ft)	Quality of Source Data	Embankment Length (ft)	Quality of Source Data
Embankment length from road plans:	984	Good	137	Good
Embankment length from topographic map:	1000	Good	135	Good
Embankment length from FEMA/Other map:	1050	Good	150	Good
USE embankment length:	1000 ft		135 ft	

CHECK:

Is this a relief or swampy bridge with a poorly defined channel and a bridge length less than or equal to 240 ft? If so, use the maximum embankment length from the selected "Source Used" for left and right embankment length.	**No**

NOTE: The "USE embankment length" value is automatically selected, but can be overridden by typing in another value.
If the originally selected value of embankment length is overridden, justification should be provided in the comments below.

NOTE: The details associated with the topographic and FEMA/Other maps will often be limited, causing discrepancies in the estimate of embankment length.
Bridge plans are based on an actual survey and should be given strong consideration in the selection of the final embankment lengths.
As a general rule, the selected M(g) and embankment lengths should come from the same data source.

Select Source for Overbank Width

Source Used:	SCDOT Plans

Comparison of Overbank Widths underneath Bridge

	Left Overbank Width (Left abutment toe to left top of bank)**	Right Overbank Width (Right top of bank to right abutment toe)**
Overbank width (SCDOT plans):	0 ft	4.5 ft
Overbank width (Consultant report):	ft	ft
USE overbank width:	0 ft	4.5 ft

NOTE: The overbank width information is compared with the topwidth of the abutment-scour hole to determine how much of the overbank width will be covered by the abutment-scour hole and how much will remain for overbank scour.
** If the site is a relief bridge or has a swampy, poorly defined channel, then the overbank width will be determined by splitting the toe-to-toe width between the left and right overbanks.

COMMENTS:

1	The South Carolina bridge-scour envelope curves were developed from a limited sample of field data and it is possible that scour could exceed the envelope curves in some cases. Additionally, the envelope curves do not necessarily reflect scour resulting from extreme floods such as the 500-year (0.2-percent chance) flood; nor do they account for adverse field conditions such as scour created by debris. These and other limitations should be kept in mind when using the envelope curves to assess scour potential.
2	
3	
4	
5	
6	

Multiple Bridge Data

(Fill in gray shaded cells. Other cells are selected/calculated automatically.)

Bridge Number:	0004570005100100	**Stream:**	Black Mingo Creek	**Date of Analysis:**	01/29/16
County:	Williamsburg	**Road:**	S-45-51		
				Bridge Length:	164 ft
Physiographic Region:	Coastal Plain	**Multiple Bridge?**	No	**Drainage Area:**	107 sq mi
		Relief Bridge?	No		
Latitude:	334238 DMS	**Swampy, Poorly Defined Channel?**	No		
Longitude:	793433 DMS				

ENTIRE APPROACH SECTION

SCDOT Road Plans

Sufficient data available for multiple bridge assessment? (select value):		
SCDOT Road Plan number:		
Total number of bridges at multiple bridge crossing (maximum value is 7):		
Bridge # from left to right looking D/S for bridge of interest (Column 1 in Table):		
Approach LEW station from plans:		ft
Approach REW station from plans:		ft
Flood-plain topwidth from plans (SCDOT plans):	N/A	ft

Select method to estimate embankment length and M(g)

Method Used: Weighted

Topo Map

Sufficient data available for multiple bridge assessment? (select value):		
Approach LEW station from topo map (assume to be zero):		ft
Approach REW station from topo map:		ft
Approach flood-plain topwidth (topo):	N/A	ft

FEMA/Other Map

Sufficient data available for multiple bridge assessment? (select value):		
Approach LEW station from FEMA/Other map (assume to be zero):		ft
Approach REW station from FEMA/Other map:		ft
Approach flood-plain topwidth (FEMA/Other map):	N/A	ft

NOTE: If sufficient data are not available to define all of the variables for a given data source (plans or maps) then leave cells for that particular data source blank, with the exception of the first cell that identifies if sufficient data is available.

SCDOT Road Plans **(Note: bridges are entered from left to right looking downstream)**

			Weighted by Bridge Length			Worst Case using full left and right embankment lengths between bridges			Average of two methods			Selected Values		
Bridge # Left to Right looking D/S	Left End Bridge Station on Approach (ft)	Bridge Length (ft)	Slice M(g)	Left Embankment Length (ft)	Right Embankment Length (ft)	Slice M(g)	Left Embankment Length (ft)	Right Embankment Length (ft)	Slice M(g)	Left Embankment Length (ft)	Right Embankment Length (ft)	Slice M(g)	Left Embankment Length (ft)	Right Embankment Length (ft)
1														
Does sum of embankment and bridge lengths equal approach flood-plain topwidth?			N/A			N/A			Selected Values for Bridge #:			No Data	No Data	No Data

2

Topo Map (Note: bridges are entered from left to right looking downstream)

			Weighted by Bridge Length			Worst Case using full left and right embankment lengths between bridges			Average of two methods			Selected Values		
Bridge # Left to Right looking D/S	Left End Bridge Station on Approach (ft)	Bridge Length (ft)	Slice M(g)	Left Embankment Length (ft)	Right Embankment Length (ft)	Slice M(g)	Left Embankment Length (ft)	Right Embankment Length (ft)	Slice M(g)	Left Embankment Length (ft)	Right Embankment Length (ft)	Slice M(g)	Left Embankment Length (ft)	Right Embankment Length (ft)
1														
Does sum of embankment and bridge lengths equal approach flood-plain topwidth?			N/A			N/A			Selected Values for Bridge #:			No Data	No Data	No Data

FEMA/Other Map (Note: bridges are entered from left to right looking downstream)

			Weighted by Bridge Length			Worst Case using full left and right embankment lengths between bridges			Average of two methods			Selected Values		
Bridge # Left to Right looking D/S	Left End Bridge Station on Approach (ft)	Bridge Length (ft)	Slice M(g)	Left Embankment Length (ft)	Right Embankment Length (ft)	Slice M(g)	Left Embankment Length (ft)	Right Embankment Length (ft)	Slice M(g)	Left Embankment Length (ft)	Right Embankment Length (ft)	Slice M(g)	Left Embankment Length (ft)	Right Embankment Length (ft)
1														
Does sum of embankment and bridge lengths equal approach flood-plain topwidth?			N/A			N/A			Selected Values for Bridge #:			No Data	No Data	No Data

COMMENTS:

1 The South Carolina bridge-scour envelope curves were developed from a limited sample of field data and it is possible that scour could exceed the envelope curves in some cases. Additionally, the envelope curves do not necessarily reflect scour resulting from extreme floods such as the 500-year (0.2-percent chance) flood; nor do they account for adverse field conditions such as scour created by debris. These and other limitations should be kept in mind when using the envelope curves to assess scour potential.

2 In the absence of a numeric model, the estimate of the geometric-contraction ratios and embankment lengths for multiple bridges makes simplifying assumptions using three methods: the weighted, worst case, and average methods. The weighted method estimates embankment length by prorating by bridge length. The worst case method assumes the entire embankment between bridges will apply to each bridge. The average method takes a simple average between the previous methods. Details of the equations used in the computations can be found in the worksheet cells. The user makes a final selection of the method to be used. Because these methods are approximate, judgment must be used in selection of final values.

3

Clear-Water Abutment-Scour Estimate

1

(Fill in gray shaded cells. Other cells are selected/calculated automatically.)

Bridge Number:	00045700005100100	**Stream:**	Black Mingo Creek	**Date of Analysis:**	01/29/16
County:	Williamsburg	**Road:**	S-45-51		
Physiographic Region:	Coastal Plain	**Multiple Bridge?**	No	**Bridge Length:**	164 ft
		Relief Bridge?	No		
Latitude:	334238 **DMS**	**Swampy, Poorly Defined Channel?**	No	**Drainage Area:**	107 sq mi
Longitude:	793433 **DMS**				

Drainage Area Check -- Original Curve (Benedict, 2003): DA IN RANGE

Drainage Area Check -- Modified Curve (Benedict and Caldwell, 2012): DA IN RANGE

Comparison of Geometric-Contraction Ratios [M(g)]

	M(g) Value	Quality of Source Data
M(g) from road plans:	0.87	Good
M(g) from topographic map:	0.86	Good
M(g) from FEMA/Other map:	0.86	Good
USE M(g): (from "Site Info" Sheet)	0.86	

M(g) range check -- Original Curve (Benedict, 2003): (from "EQUATIONS" Sheet) OK

M(g) range check -- Modified Curve (Benedict and Caldwell, 2012): (from "EQUATIONS" Sheet) OK

NOTE: The "USE M(g)" value is automatically pulled from the Site Info Sheet, but can be overridden by typing in another value. If the originally selected value of M(g) is overridden, justification should be provided in the comments below.

GUIDANCE:

Original Curve (Benedict, 2003)

Limits: 1) For Piedmont sites the maximum M(g) =0.82, but 0.86 could be justified with caution.
2) For Coastal Plain sites the maximum M(g) =0.98, but use caution when greater than 0.9.
3) Drainage area should fall within range of measured data and caution should be used as drainage area approaches limits of data.

Refer to USGS Report WRIR 03-4064 (Benedict, 2003) for additional guidance.

Modified Curve (Benedict and Caldwell, 2012)

Limits: 1) For Piedmont sites the maximum M(g) =0.85.
2) For Coastal Plain sites the maximum M(g) =0.9.
3) Drainage area should fall within the range of measured data and caution should be used as drainage area approaches limits of data.

Refer to USGS Report SIR 2012-5029 (Benedict and Caldwell, 2012) for additional guidance.

Comparison of Embankment Lengths

	Left: Embankment Length (ft)	Left: Quality of Source Data	Right: Embankment Length (ft)	Right: Quality of Source Data
Embankment length from road plans:	984	Good	137	Good
Embankment length from topographic map:	1000	Good	135	Good
Embankment length from FEMA/Other map:	1050	Good	150	Good
USE embankment length (*from Site Info Sheet*):	**1000**		**135**	

	Left	Right
Embankment length range check -- Original Curve (Benedict, 2003) (from "EQUATIONS" Sheet):	**OK**	**OK**
Embankment length range check -- Modified Curve (Benedict and Caldwell, 2012) (from "EQUATIONS" Sheet):	**OUTSIDE RANGE**	**OK**

NOTE: The "USE embankment length" value is automatically pulled from the Site Info Sheet, but can be overridden by typing in another value. If the originally selected value of embankment length is overridden, justification should be provided in the comments below.

CHECK:

Is this a relief or swampy bridge with a length less than or equal to 240 ft? If so, use the maximum embankment length from the selected "Source Used" (see "Site Info" Sheet) for left and right embankment lengths.	**No**

GUIDANCE:

Original Curve (Benedict, 2003)

Limits: 1) If the bridge is a relief or swampy bridge with a length of 240 ft or less, the longest embankment length for the left or right embankments should be used at both abutments.
2) For Piedmont sites the maximum embankment length = 950 ft.
3) For Coastal Plain sites the maximum embankment length = 7,440 ft, but most of the data is for lengths of about 2,000 ft or less. Caution must be used when values exceed 2,000 ft.
4) Drainage area should fall within the range of measured data and caution should be used as drainage area approaches limits of data.

Refer to USGS Report WRIR 03-4064 (Benedict, 2003) for additional guidance.

Modified Curve (Benedict and Caldwell, 2012)

Limits: 1) If the bridge is a relief or swampy bridge with a length of 240 ft or less, the longest embankment length for the left or right embankments should be used at both abutments.
2) For Piedmont and Coastal Plain sites, the maximum embankment length = 500 ft.
3) Drainage area should fall within the range of measured data and caution should be used as drainage area approaches limits of data.

Refer to USGS Report SIR 2012-5029 (Benedict and Caldwell, 2012) for additional guidance.

Clear-Water Abutment-Scour Depths from Envelope Curves

Original Curve (Benedict, 2003)

	Left Abutment		Right Abutment	
Abutment-scour depth by embankment length:	15.2	ft	4.6	ft
Abutment-scour depth by geometric-contraction ratio M(g):	16.3	ft	16.3	ft
Selected abutment-scour depth:	**15.2**	ft	**4.6**	ft

Modified Curve (Benedict and Caldwell, 2012)

	Left Abutment		Right Abutment	
Abutment-scour depth by embankment-length category:	N/A	ft	6.4	ft
Abutment-scour depth by interpolation:	N/A	ft	4.3	ft
Selected abutment-scour depth:	**N/A**	ft	**4.3**	ft
Final selected abutment-scour depth:	**15.2**	ft	**4.3**	ft

NOTE: The "Selected abutment-scour depth" value for the original (Benedict, 2003) and modified (Benedict and Caldwell, 2012) envelope curves, as well as the "Final selected abutment-scour depth," is automatically selected based on the guidance listed below, but can be overridden by typing in another value. If the originally selected value of abutment-scour depth is overridden, justification should be provided in the comments below.

GUIDANCE: (Spreadsheet should follow below rules, but need to verify.)

Original Curve (Benedict, 2003)

1) If the bridge is a relief or swampy bridge with a length of 240 ft or less, the scour depth determined by embankment length for the left and right abutments should be based on the longest embankment length.
NOTE: The "Use embankment length" from above should reflect the maximum embankment length from the left or right embankment if the bridge meets the criteria in item 1. Check to verify.
2) For single bridge use smaller of 2 original envelope curves (embankment length or M(g) curves).
3) For multiple bridge in Piedmont, use M(g) envelope curve.
4) For multiple bridge in Coastal Plain, for embankment length < 426 ft use M(g) envelope curve.
5) For multiple bridge in Coastal Plain, for embankment length >= 426 ft use smallest of 2 envelope curves.
6) If the M(g) and (or) embankment lengths are near the limits or beyond the range of the envelope data a caution or warning message, respectively, will appear in the "M(g) range check" and (or) "Embankment length range check" cells above. For these cases judgment must be used to assess the best estimate of clear-water abutment scour.

Refer to USGS Report WRIR 03-4064 (Benedict, 2003) for additional guidance.

Modified Curve (Benedict and Caldwell, 2012)

1) If the bridge is a relief or swampy bridge with a length of 240 ft or less, the scour depth determined by embankment length for the left and right abutments should be based on the longest embankment length.
NOTE: The "Use embankment length" from above should reflect the maximum embankment length from the left or right embankment if the bridge meets the criteria in item 1. Check to verify.
2) Use for single bridges only. Use original curve (Benedict, 2003) for multiple bridges.
3) If the estimate of scour using the original envelope curves is less than that using the modified curve, then use the scour depth associated with the original curve.
4) If the M(g) and (or) embankment lengths are near the limits or beyond the range of the envelope data a caution or warning message, respectively, will appear in the "M(g) range check" and (or) "Embankment length range check" cells above. For these cases judgment must be used to assess the best estimate of clear-water abutment scour.

Refer to USGS Report SIR 2012-5029 (Benedict and Caldwell, 2012) for additional guidance.

Scour-Hole Topwidths

	Left Abutment		Right Abutment	
Use Abutment Scour-Hole Topwidth Curve (select from 1 or 2 below):	1		1	
Abutment scour-hole topwidth:	70.0	ft	63.3	ft
Is scour depth outside range of graph?	No		No	

(1) Any length bridge with a well defined channel or any bridge longer than 240 feet
(2) Flood-plain relief or swampy bridge with length of 240 ft or less

**NOTE: The "Abutment scour-hole topwidth" is automatically calculated, but can be overridden by typing in another value.
The scour-hole topwidth equations coded in the spreadsheet limit the abutment-scour depth to 25 feet, which is beyond the range of the original graphs. The cell below the scour-hole topwidth will indicate if the abutment-scour depth exceeds the graph range and judgment must be used with regard to utilizing the estimated value.**

Refer to USGS Report WRIR 03-4064 (Benedict, 2003) for additional guidance.

COMMENTS:

1	The South Carolina bridge-scour envelope curves were developed from a limited sample of field data and it is possible that scour could exceed the envelope curves in some cases. Additionally, the envelope curves do not necessarily reflect scour resulting from extreme floods such as the 500-year (0.2-percent chance) flood; nor do they account for adverse field conditions such as scour created by debris. These and other limitations should be kept in mind when using the envelope curves to assess scour potential.
2	
3	
4	
5	

Clear-Water Overbank-Contraction Scour Estimate

1

(Fill in gray shaded cells. Other cells are selected/calculated automatically.)

Bridge Number:	0004570005100100	**Stream:**	Black Mingo Creek	**Date of Analysis:**	01/29/16
County:	Williamsburg	**Road:**	S-45-51		
				Bridge Length:	164 ft
Physiographic Region:	Coastal Plain	**Multiple Bridge?**	No		
		Relief Bridge?	No	**Drainage Area:**	107 sq mi
Latitude:	334238 DMS	**Swampy, Poorly Defined Channel?**	No		
Longitude:	793433 DMS			**Drainage Area Check:**	DA IN RANGE

Comparison of Geometric-Contraction Ratios [M(g)]

	M(g) Value	Quality of Source Data
M(g) from road plans:	0.87	Good
M(g) from topographic map:	0.86	Good
M(g) from FEMA/Other map:	0.86	Good
USE M(g): (from "Site Info" Sheet)	0.86	
M(g) range check: (from "EQUATIONS" Sheet)	CAUTION	

NOTES:

If the geometric-contraction ratio is greater than 0.95 message is **OUTSIDE RANGE**.
If the geometric-contraction ratio is between 0 and 0.85 message is **OK**.
If the geometric-contraction ratio is between 0.85 and 0.95 message is **CAUTION**.

NOTE: The "USE M(g)" value is automatically pulled from the Site Info Sheet, but can be overridden by typing in another value.
If the originally selected value of M(g) is overridden, justification should be provided in the comments below.

GUIDANCE:

1) For the Piedmont data the maximum M(g) for clear-water overbank contraction scour was 0.85.
2) For the Coastal Plain data the maximum M(g) for clear-water overbank contraction scour was 0.95 with data sparse for M(g) greater than 0.9.
3) Caution must be used when M(g) nears or exceeds the upper limits of the data and the "M(g) range check" cell above should be used to help evaluate the final selection of M(g).

Refer to USGS Report SIR 2005-5289 (Benedict and Caldwell, 2006) for additional guidance.

Clear-Water Overbank Contraction-Scour Depths from Envelope Curves

	Left Overbank	Right Overbank
Clear-water overbank-contraction-scour depth from envelope curve:	4.8 ft	4.8 ft
Selected clear-water overbank-contraction-scour depth:	4.8 ft	4.8 ft

NOTE: The "Selected clear-water overbank-contraction-scour depth" value is automatically selected, but can be overridden by typing in another value
If the originally selected value of overbank-contraction-scour depth is overridden, justification should be provided in the comments below

GUIDANCE:

1) If the M(g) is near the limits or beyond the range of the envelope data a caution or warning message, respectively, will appear in the "M(g) range check" cell above.
For these cases judgment must be used to assess the best estimate of clear-water overbank-contraction scour.

Refer to USGS Report SIR 2005-5289 (Benedict and Caldwell, 2006) for additional guidance.

COMMENTS:

1 The South Carolina bridge-scour envelope curves were developed from a limited sample of field data and it is possible that scour could exceed the envelope curves in some cases. Additionally, the envelope curves do not necessarily reflect scour resulting from extreme floods such as the 500-year (0.2-percent chance) flood; nor do they account for adverse field conditions such as scour created by debris. These and other limitations should be kept in mind when using the envelope curves to assess scour potential.

2

3

Live-Bed Channel Contraction Scour Estimate

1

(Fill in gray shaded cells. Other cells are selected/calculated automatically.)

Bridge Number:	0004570005100100	**Stream:**	Black Mingo Creek	**Date of Analysis:**	01/29/16
County:	Williamsburg	**Road:**	S-45-51		
Physiographic Region:	Coastal Plain	**Multiple Bridge?**	No	**Bridge Length:**	164 ft
		Relief Bridge?	No	**Drainage Area:**	107 sq mi
Latitude:	334238 DMS	**Swampy, Poorly Defined Channel?**	No		
Longitude:	793433 DMS				

Drainage Area Check -- Original Curve (Benedict and Caldwell, 2009): DA IN RANGE

Drainage Area Check -- Modified Curve (Benedict and Caldwell, 2012): DA IN RANGE

Comparison of Geometric-Contraction Ratios [M(g)]

	M(g) Value	Quality of Source Data
M(g) from road plans:	0.87	Good
M(g) from topographic map:	0.86	Good
M(g) from FEMA/Other map:	0.86	Good
USE M(g): (from "Site Info" Sheet)	0.86	

M(g) range check -- Original Curve (Benedict and Caldwell, 2009) (M(g) <=0.82): OUTSIDE RANGE
M(g) range check -- Modified Curve (Benedict and Caldwell, 2012) (M(g) <=0.90): OK

NOTE: The "USE M(g)" value is automatically pulled from the Site Info Sheet, but can be overridden by typing in another value.
If the originally selected value of M(g) is overridden, justification should be provided in the comments below.

GUIDANCE:

Original Curve (Benedict and Caldwell, 2009)

Limits: 1) For Piedmont and Coastal Plain sites the maximum M(g) =0.82.
2) Limited clear-water scour data suggests that it may be appropriate to extend the live-bed curve beyond a value of 0.82; however caution and judgment must be used.
3) Drainage area should fall within range of the measured data and caution should be used as drainage area approaches limits of data.
4) Because of uncertainty associated with the live-bed contraction-scour data, caution and judgment must be used in the final estimate of live-bed contraction scour.

Refer to USGS Report SIR 2009-5099 (Benedict and Caldwell, 2009) for additional guidance.

Modified Curve (Benedict and Caldwell, 2012)

Limits: 1) For Piedmont and Coastal Plain sites the maximum M(g) =0.9.
2) Drainage area should be 200 square miles or less.
3) Because of uncertainty associated with the live-bed contraction-scour data, caution and judgment must be used in the final estimate of live-bed contraction scour.

Refer to USGS Report SIR 2012-5029 (Benedict and Caldwell, 2012) for additional guidance.

Live-Bed Channel Contraction-Scour Depths from Envelope Curves

	Scour Depth
Original Curve (Benedict and Caldwell, 2009)	
Live-bed contraction-scour depth:	19.5 ft
Modified Curve (Benedict and Caldwell, 2012)	
Live-bed contraction-scour depth:	15.8 ft
Selected live-bed contraction-scour depth:	15.8 ft

NOTE: The "Selected live-bed contraction-scour depth" value is automatically selected based on the guidance listed below,
but can be overridden by typing in another value.
If the originally selected value of live-bed contraction-scour depth is overridden, justification should be provided in the comments below.

GUIDANCE:

1) If drainage area is 200 square miles or less, then use the live-bed contraction-scour estimate based on the modified envelope curve (Benedict and Caldwell, 2012).
Otherwise, use the estimate based on the original envelope curve (Benedict and Caldwell, 2009).
2) If site is a relief bridge or is swampy with a poorly defined channel, it will be assumed that live-bed contraction scour will not occur and the scour depths in the above cells will be set to "N/A."

Refer to USGS Report SIR 2009-5099 (Benedict and Caldwell, 2009) and SIR 2012-5029 (Benedict and Caldwell, 2012) for additional guidance.

COMMENTS:

1	The South Carolina bridge-scour envelope curves were developed from a limited sample of field data and it is possible that scour could exceed the envelope curves in some cases. Additionally, the envelope curves do not necessarily reflect scour resulting from extreme floods such as the 500-year (0.2-percent chance) flood; nor do they account for adverse field conditions such as scour created by debris. These and other limitations should be kept in mind when using the envelope curves to assess scour potential.
2	
3	

Pier Scour Estimate

1

(Fill in gray shaded cells. Other cells are selected/calculated automatically.)

Bridge Number:	0004570005100100	**Stream:**	Black Mingo Creek	**Date of Analysis:**	01/29/16
County:	Williamsburg	**Road:**	S-45-51		
Physiographic Region:	Coastal Plain	**Multiple Bridge?**	No	**Bridge Length:**	164 ft
		Relief Bridge?	No	**Drainage Area:**	107 sq mi
Latitude:	334238 DMS	**Swampy, Poorly Defined Channel?**	No		
Longitude:	793433 DMS				

NOTE: See cell comments for additional guidance.

GUIDANCE:

Pier Scour Computations

- If a pier or bent falls anywhere on the overbank, pier scour will be computed for both the abutment and overbank regions.
- If there are piers or bents of varying geometries on the same overbank, use the worst case pier geometry in both the abutment and overbank areas.
- When a pier is on the floodplain, but near the channel bank, the user must decide if the pier should be considered to be a channel pier or not; in addition to the proximity of the pier to the bank, the user should consider other factors such as bends that may increase potential for scour.

Refer to USGS Reports SIR 2009-5099 (Benedict and Caldwell, 2009) and SIR 2005-5289 (Benedict and Caldwell, 2006) for additional guidance.

	Left Abutment	Left Overbank	Channel	Right Overbank	Right Abutment
Location of pier	LABUT	LOB	CH	ROB	RABUT
Type of pier or bent **(choose from list)**	No Pier or Bent	No Pier or Bent	No Pier or Bent	No Pier or Bent	No Pier or Bent
Envelope curve used **(choose from list)**	Automatic Calculation	Automatic Calculation	Automatic Calculation	Automatic Calculation	Automatic Calculation
Pier width (feet)			1.5		
Pier length (feet) **(should not be less than pier width)**			10.5		
Angle of attack (degrees) **(should not exceed 90)**			0		
Multiple column pier or bent? **(choose from list)**			Yes		
Estimate of minimum spacing between columns (feet)			3.75		
Column spacing to width ratio **(should be between 2 and 10)**	N/A	N/A	2.5	N/A	N/A
Skew coefficient (single pier - HEC-18)	N/A	N/A	1.00	N/A	N/A
Skew coefficient (multiple column - Melville and Coleman, 2000) **(should be between 1 and 1.4)**	N/A	N/A	1.12	N/A	N/A
Skew coefficient (selected value)	N/A	N/A	1.12	N/A	N/A
Envelope curve used in pier scour estimate	N/A	N/A	2.5b	N/A	N/A
Pier scour from envelope (feet) (no adjustment)	0.00	0.00	3.75	0.00	0.00
Pier scour adjusted for skew (feet)	0.00	0.00	4.21	0.00	0.00

COMMENTS:

1 The South Carolina bridge-scour envelope curves were developed from a limited sample of field data and it is possible that scour could exceed the envelope curves in some cases. Additionally, the envelope curves do not necessarily reflect scour resulting from extreme floods such as the 500-year (0.2-percent chance) flood; nor do they account for adverse field conditions such as scour created by debris. These and other limitations should be kept in mind when using the envelope curves to assess scour potential.

2

3

4

Scour Analysis
Using USGS Bridge-Scour Envelope Curves

Pile Penetration Table

(Fill in gray shaded cells. Other cells are selected/calculated automatically.)

Bridge Number:	0004570005100100	**Stream:**	Black Mingo Creek	**Date of Analysis:**	01/29/16
County:	Williamsburg	**Road:**	S-45-51		
				Bridge Length:	164 ft
Physiographic Region:	Coastal Plain	**Multiple Bridge?**	No		
		Relief Bridge?	No	**Drainage Area:**	107 sq mi
Latitude:	334238 **DMS**	**Swampy, Poorly Defined Channel?**	No		
Longitude:	793433 **DMS**				

NOTE: Bents are listed from left to right looking downstream

GUIDANCE FOR LEFT AND RIGHT ABUTMENT SCOUR:

1) Do not include clear-water overbank scour depth in abutment-scour area.
2) If site is in the Piedmont region and the abutment-scour depth is less than or equal to 5 feet then add pier-scour depth for determining total scour.
3) If the pier in the abutment area is a multiple column bent/pier with minimal skew or a solid, long pier with no skew, and the pier width is less than or equal to 2.3 ft, then do not add pier scour to total scour. (NOTE: The exception to this guidance is for sites in the Piedmont with abutment-scour depths less than or equal to 5 ft as noted in item 2 above.)
4) The spreadsheet assumes that abutment scour will always occur at the left and right abutments. The spreadsheet will automatically make an initial determination regarding the inclusion of pier scour in the total scour estimate. The user should review this initial determination and if appropriate override the automated value by typing "Yes" or "No" (case sensitive) in the "Use pier scour?" column. If the pier is skewed, the user should apply judgment to determine if pier scour should be included in the total scour estimate, especially for long solid piers where a pier skew can cause large scour depths.
5) If the site is a relief or swampy bridge that is 240 ft or less, the abutment-scour depth will be applicable from toe-to-toe; if the relief or swampy bridge is greater than 240 ft, the abutment scour-hole depths will be limited to the abutment scour-hole topwidths and the clear-water overbank contraction scour will be applied to the remaining overbank area. The spreadsheet will automatically determine if there is any overbank area on which overbank contraction scour will occur.

Refer to USGS Report WRIR 03-4064 (Benedict, 2003) for additional guidance.

GUIDANCE FOR LEFT AND RIGHT OVERBANK CONTRACTION SCOUR:

1) If the abutment-scour hole topwidth is greater than the overbank width then it will be assumed that the abutment-scour depth will cover the entire overbank area and there will be no clear-water overbank scour applied to the bridge overbank. However, if the abutment-scour hole topwidth is less than the overbank width then it will be assumed that clear-water overbank scour occurs in the overbank area not affected by the abutment scour hole.
2) The spreadsheet will automatically determine if clear-water overbank scour should be applied or not.
3) If clear-water overbank scour is determined to be applicable to the overbank area, then the spreadsheet will automatically apply the calculated pier scour to the overbank as well.

Refer to USGS Report SIR 2005-5289 (Benedict and Caldwell, 2006) for additional guidance.

GUIDANCE FOR LIVE-BED CHANNEL SCOUR:

1) If the main channel is well defined and considered to be live-bed in nature, it will be assumed that the live-bed contraction scour and channel pier scour will be included in the estimate for total scour in the main channel. The spreadsheet will automatically determine if these scour components are to be included in the estimate of total scour in the main channel.
2) Live-bed contraction scour will not be applied to a relief bridge or to a bridge with a swampy, poorly defined channel; at such bridges, it will be assumed that clear-water scour conditions prevail and the procedures for applying clear-water abutment and contraction scour, as noted previously, will be used. The spreadsheet will automatically determine if live-bed scour should or should not be applied to the channel.

Refer to USGS Report SIR 2009-5099 (Benedict and Caldwell, 2009) for additional guidance.

GENERAL GUIDANCE:

1) Drainage area should fall within the range of measured data and caution should be used as drainage area approaches limits of the data or exceeds the data range.
2) If the M(g) and (or) embankment lengths are near the limits or beyond the range of the envelope data caution should be used.
3) User should review automatically determined values to assure that selected values are reasonable.

	Pier location	Use clear-water abutment scour?	Clear-water abutment scour from USGS curves (feet)	Use clear-water overbank contraction scour?	Clear-water overbank contraction scour from USGS curves (feet)	Use live-bed channel contraction scour?	Live-bed channel contraction scour from USGS curves (feet)	Use pier scour?	Pier scour (feet)	Total scour at bent (feet)	Computed embedment of pile from consultant (feet)	Remaining pile penetration (feet)	Embedment below thalweg from consultant (feet)	Remaining pile penetration (at thalweg) (feet)
Left Abutment	LABUT	Yes	15.15	No	0.00	No	0.00	No	0.00	15.15		-15.15		-15.15
Left Overbank	LOB	No	0.00	No	0.00	No	0.00	No	0.00	N/A		N/A		N/A
Channel	CH	No	0.00	No	0.00	Yes	15.77	Yes	4.21	19.98		-19.98		-19.98
Right Overbank	ROB	No	0.00	No	0.00	No	0.00	No	0.00	N/A		N/A		N/A
Right Abutment	RABUT	Yes	4.29	No	0.00	No	0.00	No	0.00	4.29		-4.29		-4.29

COMMENTS:

1	The South Carolina bridge-scour envelope curves were developed from a limited sample of field data and it is possible that scour could exceed the envelope curves in some cases. Additionally, the envelope curves do not necessarily reflect scour resulting from extreme floods such as the 500-year (0.2-percent chance) flood; nor do they account for adverse field conditions such as scour created by debris. These and other limitations should be kept in mind when using the envelope curves to assess scour potential.
2	
3	
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Scour Analysis
Using USGS Bridge-Scour Envelope Curves

Pile Penetration Table

(Fill in gray shaded cells. Other cells are selected/calculated automatically.)

Bridge Number:	0004570005100100	**Stream:**	Black Mingo Creek	**Date of Analysis:**	01/29/16
County:	Williamsburg	**Road:**	S-45-51		
				Bridge Length:	164 ft
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		Relief Bridge?	No	**Drainage Area:**	107 sq mi
Latitude:	334238 **DMS**	**Swampy, Poorly Defined Channel?**	No		
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NOTE: Bents are listed from left to right looking downstream

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3) If clear-water overbank scour is determined to be applicable to the overbank area, then the spreadsheet will automatically apply the calculated pier scour to the overbank as well.

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1) If the main channel is well defined and considered to be live-bed in nature, it will be assumed that the live-bed contraction scour and channel pier scour will be included in the estimate for total scour in the main channel. The spreadsheet will automatically determine if these scour components are to be included in the estimate of total scour in the main channel.
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3) User should review automatically determined values to assure that selected values are reasonable.

	Pier location	Use clear-water abutment scour?	Clear-water abutment scour from USGS curves (feet)	Use clear-water overbank contraction scour?	Clear-water overbank contraction scour from USGS curves (feet)	Use live-bed channel contraction scour?	Live-bed channel contraction scour from USGS curves (feet)	Use pier scour?	Pier scour (feet)	Total scour at bent (feet)	Computed embedment of pile from consultant (feet)	Remaining pile penetration (feet)	Embedment below thalweg from consultant (feet)	Remaining pile penetration (at thalweg) (feet)
Left Abutment	LABUT	Yes	19.70	No	0.00	No	0.00	No	0.00	19.70		-19.70		-19.70
Left Overbank	LOB	No	0.00	No	0.00	No	0.00	No	0.00	N/A		N/A		N/A
Channel	CH	No	0.00	No	0.00	Yes	20.50	Yes	4.63	25.13		-25.13		-25.13
Right Overbank	ROB	No	0.00	No	0.00	No	0.00	No	0.00	N/A		N/A		N/A
Right Abutment	RABUT	Yes	5.58	No	0.00	No	0.00	No	0.00	5.58		-5.58		-5.58

COMMENTS:

1	The South Carolina bridge-scour envelope curves were developed from a limited sample of field data and it is possible that scour could exceed the envelope curves in some cases. Additionally, the envelope curves do not necessarily reflect scour resulting from extreme floods such as the 500-year (0.2-percent chance) flood; nor do they account for adverse field conditions such as scour created by debris. These and other limitations should be kept in mind when using the envelope curves to assess scour potential.
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100 YR Scour Results HEC-RAS

Contraction Scour

		Left	Channel	Right
Input Data				
	Average Depth (ft):	5.74	10.34	5.20
	Approach Velocity (ft/s):	0.55	2.36	0.52
	Br Average Depth (ft):	2.17	12.33	3.89
	BR Opening Flow (cfs):	29.15	6289.01	30.84
	BR Top WD (ft):	10.00	135.00	12.50
	Grain Size D50 (mm):	0.20	0.20	0.20
	Approach Flow (cfs):	1067.84	1940.02	2669.14
	Approach Top WD (ft):	335.20	79.60	987.20
	K1 Coefficient:	0.690	0.690	0.690
Results				
	Scour Depth Ys (ft):	0.20	7.35	0.00
	Critical Velocity (ft/s):	1.30	1.44	1.28
	Equation:	Clear	Live	Clear

Pier Scour

All piers have the same scour depth

Input Data		
	Pier Shape:	Square nose
	Pier Width (ft):	1.50
	Grain Size D50 (mm):	0.20000
	Depth Upstream (ft):	11.92
	Velocity Upstream (ft/s):	3.13
	K1 Nose Shape:	1.10
	Pier Angle:	5.00
	Pier Length (ft):	10.50
	K2 Angle Coef:	1.36
	K3 Bed Cond Coef:	1.10
	Grain Size D90 (mm):	0.73000
	K4 Armouring Coef:	1.00
Results		
	Scour Depth Ys (ft):	4.64
	Froude #:	0.16
	Equation:	CSU equation

Abutment Scour

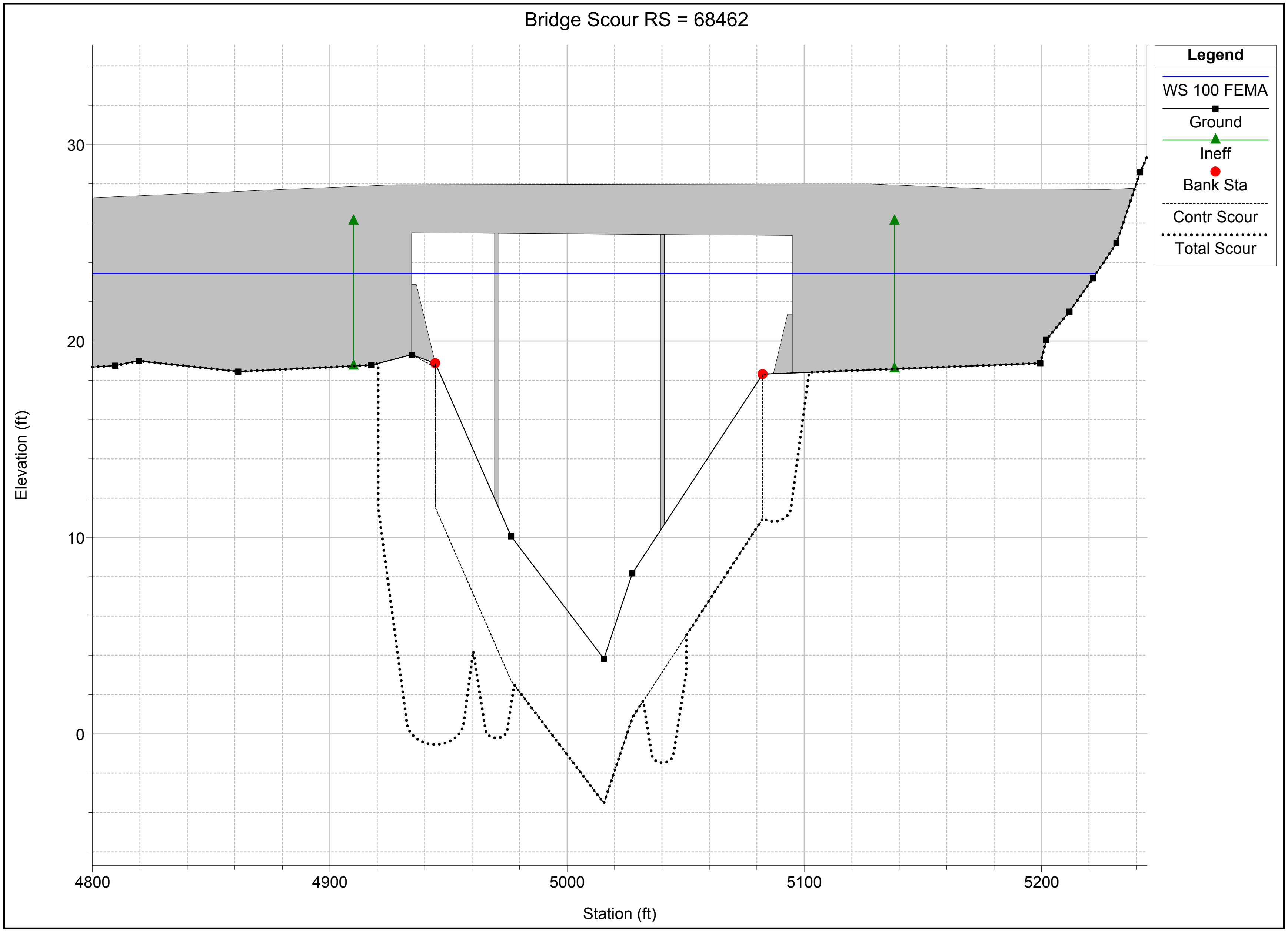
		Left	Right
Input Data			
	Station at Toe (ft):	4944.50	5086.92
	Toe Sta at appr (ft):	4960.20	5044.22
	Abutment Length (ft):	335.20	987.20
	Depth at Toe (ft):	4.69	5.23
	K1 Shape Coef:	0.55 - Spill-through abutment	
	Degree of Skew (degrees):	95.00	85.00
	K2 Skew Coef:	1.01	0.99
	Projected Length L' (ft):	333.92	983.44
	Avg Depth Obstructed Ya (ft):	5.74	5.20
	Flow Obstructed Qe (cfs):	1067.84	2669.14
	Area Obstructed Ae (sq ft):	1924.10	5135.61
Results			
	Scour Depth Ys (ft):	12.07	7.51
	Froude #:	0.25	0.05

Equation:	HIRE	HIRE

Combined Scour Depths

Pier Scour + Contraction Scour (ft):		
	Channel:	11.98
Left abutment scour + contraction scour (ft):	19.41	
Right abutment scour + contraction scour (ft):	7.51	

100 YR Scour Results HEC-RAS



500 YR Scour Results HEC-RAS

Contraction Scour

		Left	Channel	Right
Input Data				
	Average Depth (ft):	6.95	11.56	6.42
	Approach Velocity (ft/s):	0.65	2.61	0.62
	Br Average Depth (ft):	3.20	13.36	4.92
	BR Opening Flow (cfs):	61.21	8237.97	50.82
	BR Top WD (ft):	10.00	135.00	12.50
	Grain Size D50 (mm):	0.20	0.20	0.20
	Approach Flow (cfs):	1514.67	2404.64	3900.68
	Approach Top WD (ft):	335.20	79.60	987.20
	K1 Coefficient:	0.690	0.690	0.690
Results				
	Scour Depth Ys (ft):	1.28	9.71	0.00
	Critical Velocity (ft/s):	1.34	1.46	1.33
	Equation:	Clear	Live	Clear

Pier Scour

All piers have the same scour depth

Input Data		
	Pier Shape:	Square nose
	Pier Width (ft):	1.50
	Grain Size D50 (mm):	0.20000
	Depth Upstream (ft):	13.00
	Velocity Upstream (ft/s):	3.75
	K1 Nose Shape:	1.10
	Pier Angle:	5.00
	Pier Length (ft):	10.50
	K2 Angle Coef:	1.36
	K3 Bed Cond Coef:	1.10
	Grain Size D90 (mm):	0.73000
	K4 Armouring Coef:	1.00
Results		
	Scour Depth Ys (ft):	5.07
	Froude #:	0.18
	Equation:	CSU equation

Abutment Scour

		Left	Right
Input Data			
	Station at Toe (ft):	4944.50	5086.92
	Toe Sta at appr (ft):	4960.20	5044.22
	Abutment Length (ft):	335.20	987.20
	Depth at Toe (ft):	5.78	6.31
	K1 Shape Coef:	0.55 - Spill-through abutment	
	Degree of Skew (degrees):	95.00	85.00
	K2 Skew Coef:	1.01	0.99
	Projected Length L' (ft):	333.92	983.44
	Avg Depth Obstructed Ya (ft):	6.95	6.42
	Flow Obstructed Qe (cfs):	1514.67	3900.68
	Area Obstructed Ae (sq ft):	2331.23	6334.63
Results			
	Scour Depth Ys (ft):	15.25	9.54
	Froude #:	0.27	0.05

Equation:	HIRE	HIRE

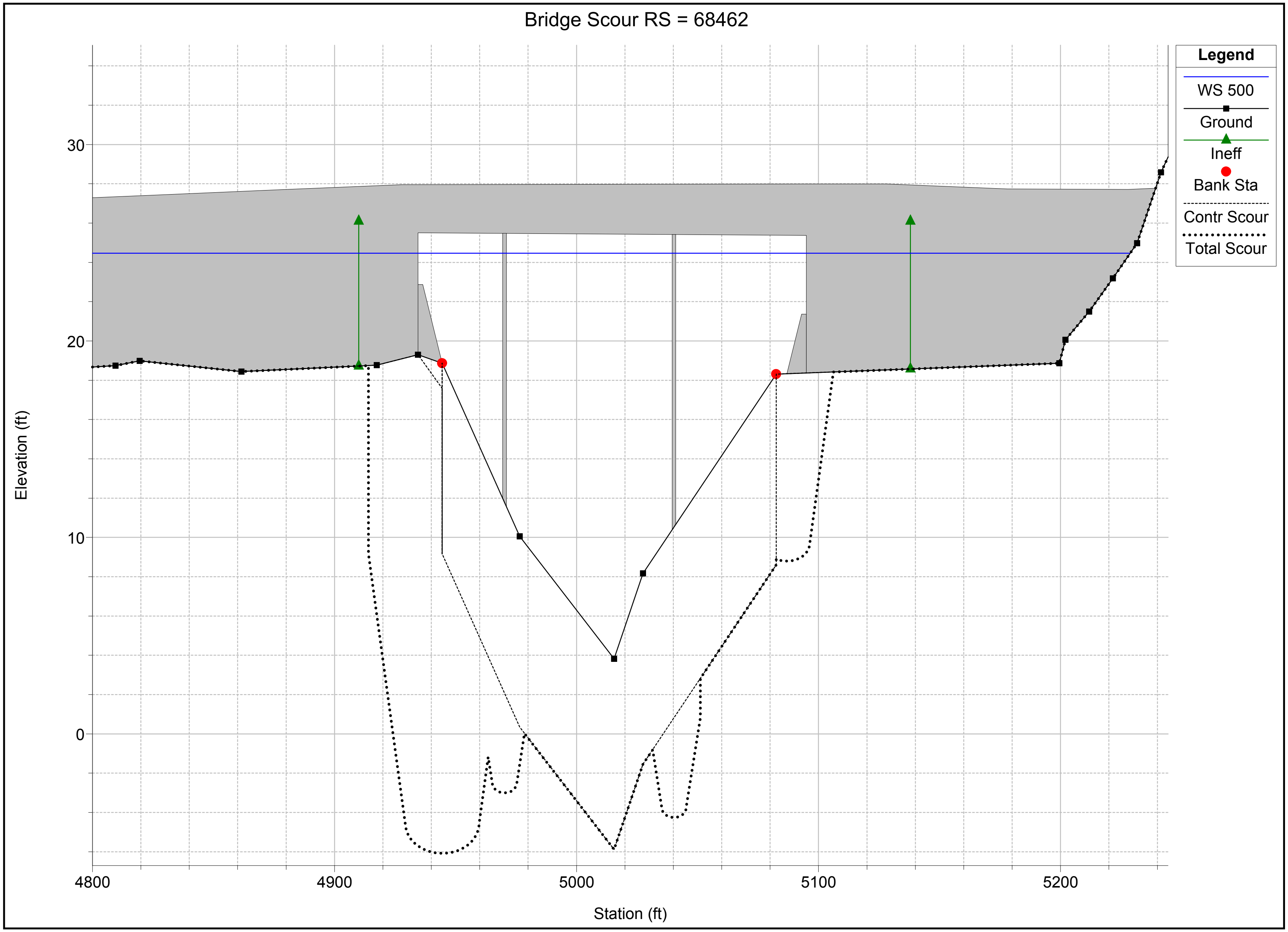
Combined Scour Depths

Pier Scour + Contraction Scour (ft):

	Channel:	14.77

Left abutment scour + contraction scour (ft):	24.95
Right abutment scour + contraction scour (ft):	9.54

500 YR Scour Results HEC-RAS



Project:	Emergency Bridge Pkg 4
Location:	Black Mingo Creek S-51
Computed:	RDS **Date:** 2/15/16
Checked:	**Date:**

INFRASTRUCTURE CONSULTING & ENGINEERING

PIER SCOUR DEPTH BY ERODIBILITY INDEX METHOD

Reference HEC 18, 5th Edition, Ch.7, Section 7.13

Channel Bents			Rock Erosive Characteristics						100 YEAR FLOOD					500 YEAR FLOOD				
Boring	Elev (m)	Ys (m)	Ms	Kb	Kd	Js	K	Pc (KW/m^2)	Ys/b (m)	P/Pa	Pa (KW/m^2)	P (KW/m^2)	Scour (y/n)	Ys/b (m)	P/Pa	Pa (KW/m^2)	P (KW/m^2)	Scour (y/n)
Riverbed Level	2.15	0.00																
Top Of PWR	0.64	1.51	0.87	1.00	0.05	1.02	0.04	0.10	2.96	1.02	0.01	0.01	no	2.96	1.02	0.02	0.02	no

Gamma = 9800 N/m^3
Rho = 1000 kg/m^3

Water Surface Elevation 100 YR=	7.12	m	Approach Depth 100 YR (y)=	4.97	m	Section 68519
Water Surface Elevation 500 YR=	7.42	m	Approach Depth 500 YR (y)=	5.27	m	Section 68519
Slope of EGL (Sf) =	0.000305	(m/m)				
Pier W (b) =	0.51	m				

$$K = (M_s)(K_b)(K_d)(J_s)$$

where:

- K = Erodibility Index
- M_s = Intact rock mass strength parameter
- K_b = Block size parameter
- K_d = Shear strength parameter
- J_s = Relative orientation parameter

$$\tau = K_b \gamma R S_f$$

* Use the local approach depth upstream of the pier instead of the hydraulic radius and assume Kb=1 if the stream is relatively straight in the bridge reach

where:

- τ = Design shear stress, lb/ft^2 (N/m^2)
- K_b = Bend coefficient (dimensionless)
- γ = Unit weight of water, lb/ft^3
- R = Hydraulic radius (area divided by wetted perimeter), ft (m)
- S_f = Slope of the energy grade line, ft/ft (m/m)

$$P_c = K^{0.75}$$

where:

- K = Erodibility Index
- P_c = Critical stream power necessary to initiate scour, KW/m^2

$$P_a = 7.853\rho\left(\frac{\tau}{\rho}\right)^{3/2}$$

where:

- P_a = Stream power of approach flow, W/m^2
- ρ = Mass density of water, 1000 kg/m^3
- τ = Bed shear stress of approach flow, N/m^2 or Pa

$$\frac{P}{P_a} = 8.42\, e^{-0.712\left(\frac{y_s}{b}\right)}$$

where:

- P = Stream power at the bottom of the scour hole, W/m^2
- P_a = Stream power of the approach flow near the stream bed, W/m^2
- y_s = Depth of scour hole, m
- b = Pier width perpendicular to the flow direction, m

PRELIMINARY GEOTECHNICAL ENGINEERING REPORT

S-51 Emergency Bridge Replacement over Black Mingo Creek Williamsburg County, South Carolina

For

INFRASTRUCTURE CONSULTING & ENGINEERING

By

F&ME

CONSULTANTS

Geotechnical / Environmental / Materials
3112 Devine Street
Columbia, South Carolina 29205
Tel. (803) 254-4540 • Fax. (803) 254-4542

December 21, 2015

SCDOT Project ID: P029461
F&ME File No.: G5556.02

1.0 PROJECT DESCRIPTION

The bridge project is located on S-51 (Battery Park Road) over Black Mingo Creek in Williamsburg County, South Carolina. A site location plan is presented in Section 1 of the Appendix. It is our understanding that the project will include the demolition/removal of the existing bridge structure and the replacement with a new bridge structure on the existing roadway alignment. We understand that the increase in vertical grade of the replacement bridge relative to the existing grade is approximately two (2) feet. The preliminary replacement bridge superstructure design is a three (3) span arrangement of 37'-6", 70'-0", and 56'-6".

The planned foundation elements for the replacement bridge are steel HP14x73 piles at the end bents and composite 20" square, pre-stressed concrete piles at the interior bents. The piles will develop the required driving resistance in both skin friction and end bearing in moderately dense coastal plain soils. Specific geometry of the foundation elements will be provided in the final bridge geotechnical engineering report.

As specified in the project's Request for Proposals (RFP), the Roadway structure Operation Classification (ROC) is II and the bridge Operational Classification is II. The specified ROC applies to bridge embankments only. As defined in the RFP, the "bridge embankment" is the longitudinal length of embankment where mitigation is required to meet the global performance objectives of the bridge system or 50 feet, whichever is greater. As described in the following sections, the roadway embankments located within 50 feet of the proposed bridge ends will be referred to as the "bridge embankments".

The preliminary subsurface investigation was performed by S&ME, Inc. at the request of the SCDOT to aid in the development of the project's RFP. The preliminary subsurface investigation consisted of two (2) soil test borings and two (2) cone penetrometer soundings performed near each end of the existing bridge. Where applicable, F&ME will supplement the performed preliminary subsurface investigation with additional subsurface tests during the final subsurface investigation to comply with the subsurface investigation requirements of the GDM and/or the RFP.

Since the same geotechnical data has been used for the preliminary bridge and roadway geotechnical design, we have combined the preliminary bridge and roadway geotechnical reports into one submittal, presented herein.

The preliminary bridge and roadway embankment analyses and development of preliminary design recommendations were performed in accordance with the 2010 GDM v1.1 and the 2012 AASHTO LRFD Bridge Design Specifications, 6th Ed. with the 2013 interim revisions.

2.0 PRELIMINARY SUBSURFACE INVESTIGATION

The preliminary subsurface investigation was performed by S&ME at the request of the SCDOT. The SCDOT subsequently provided the resulting data with the project's RFP.

On November 25, 2015, two (2) soil test borings (designated as STB-1 and STB-4) were performed. One soil test boring was performed near each end bent location of the existing bridge. The borings were advanced using a CME-45D drill rig. Rotary wash drilling techniques were utilized to maintain a stable borehole. Standard split-spoon samples (SPT-tests) were continuously obtained in the top ten (10) feet. Following the continuous sampling, SPT's were obtained at regular, five (5) foot intervals throughout the remaining depths of the soil test borings. All borings were advanced to a depth of 100 feet below the top of the existing embankment. During standard penetration testing (SPT) of the encountered soils, an automatic hammer system was used. The energy ratio of the hammer system was measured as 81%.

On November 25, 2015, two (2) cone penetrometer soundings (designated as CPT-2 and CPT-3) were performed. CPT-2 was performed in the general vicinity of STB-1, and CPT-3 was performed in the general vicinity of STB-4. The CPT equipment was advanced utilizing a truck mounted rig. The CPT's were advanced to depths were the maximum reaction force was observed and were subsequently terminated. The CPT's were extended to an approximate depth of twenty-three (23) feet below existing grade from the top of the existing embankment in each sounding.

Additional geotechnical field data, including an MASW test, will be collected during the final subsurface investigation. The combination of data collected during the preliminary and final subsurface investigations will comply with the GDM and/or RFP requirements.

Locations of the preliminary borings and soundings were provided in the subsurface investigation data provided by SCDOT. Utilizing this information, F&ME has determined the station and offset relative to the planned S-51 alignment. The locations of the preliminary tests are provided in the following table.

Test Boring Location Schedule					
Boring I.D.	Test Hole Locale	Station (S-51)	Offset from CL (ft)	Boring Elevation (ft-MSL)	Test Depth (ft)
STB-1	North EB	67+49	1.7-RT	26.3	100.00
CPT-2	North EB	67+41	5.5-LT	26.2	23.4
CPT-3	South EB	69+27	4.1-RT	26.6	23.6
STB-4	South EB	69+15	4.7-LT	26.5	100.0

We have provided a Testing Location Plan in Section 2 of Appendix A.

3.0 PRELIMINARY LABORATORY TESTING PROGRAM

The preliminary laboratory test program consisted of natural moisture content, grain size analysis, Atterberg limits, and organic content tests. The results from the preliminary laboratory testing are provided in Appendix B.

Additional laboratory testing will be performed by F&ME on soil and rock samples collected during the final subsurface investigation. The results of this testing will be provided in the final geotechnical report(s).

4.0 SUBSURFACE CONDITIONS

The below soil descriptions, strata depths, and consistencies are generalized and were interpreted by F&ME based on the subsurface conditions as encountered in the preliminary soil test borings and CPT soundings. We have included the soil testing logs in Appendix B for detailed descriptions of the encountered soil conditions. As with any geologic formation, the depth and thickness of the soil strata will vary across the site. Although the test borings/soundings designate strata changes at specific depths in the description of the soil stratigraphy on the soil testing logs, transitions between soil strata are generally gradual. Therefore, the outlined subsurface profile shown on the soil testing logs should only be considered general on-site soil conditions and should not be utilized as an absolute indicator.

4.1 General Site Geology

The site is located in the Lower Coastal Plain physiographical province of South Carolina. The Lower Coastal Plain is a gently seaward dipping surface containing six terraces, which represent sedimentary sequences formed during eustatic sea level transgression or regression and/or tectonic uplift or subsidence over geologic time. The geology underlying the bridge site is described in general terms.

The near surface geology at the site includes recent alluvial sediments, which in turn are underlain by Pleistocene age sediments. Underlying these sediments unconformably in the vicinity are sediments of the Paleocene aged Rhems Formation (where not eroded away) and then the Cretaceous aged PeeDee Formation. The sediments in the area consist of fluvial, beach, backbarrier, estuarine, and continental shelf deposits. Due to uplift and subsequent erosion, sediments from the Pliocene through the Eocene are not present in the area.

4.2 Soil Stratigraphy

The soil test borings performed during the preliminary subsurface investigation indicate three (3) main strata:

1. Existing embankment fill (SM);
2. Alluvium (PT, SM);
3. Pee Dee Formation (SM, CL, SP-SM)

The soil tests were performed from the top of the existing roadway embankment near the existing bridge ends. The soil test borings initially encountered fill material that is comprised of a silty sand material. SPT N-values in this material ranged between one (1) and twenty-one (21) blows per foot (bpf). This material extended approximately seven (7) to nine (9) feet below the top of the existing embankment.

Beneath the fill material, a layer of low density/consistency alluvial soil material was encountered. At the northern end of the existing bridge, the alluvium was classified as peat (OH). At the southern end of the existing bridge, the alluvium was classified as silty sand (SM) and sand with silt (SP-SM). N-values in these alluvial soils ranged from two (2) to eight (8) bpf. The alluvial soils varied in thickness from six (6) feet to ten (10) feet.

Below the alluvium, the Pee Dee formation soils were encountered. The soils comprising the Pee Dee formation at the site were classified as medium dense to very dense silty sand (SM), stiff to hard clay (CL), and very dense sand with silt (SP-SM). N-values in the Pee Dee formation soils ranged from twelve (12) to greater than one hundred (100+) bpf. The Pee Dee formation material extended to drilling termination depths of 100 feet in each boring.

Test No.	NORTH (ft.)	EAST (ft.)	LATITUDE	LONGITUDE	ELEV. (ft. NAVD 88)
STB-1	686095.71	2433140.93	33.710878	-79.575431	26.25
CPT-2	686102.64	2433149.33	33.710896	-79.575403	26.17
CPT-3	685920.66	2433109.09	33.710398	-79.575543	26.55
STB-4	685931.20	2433119.64	33.710426	-79.575508	26.53

Cone Penetration Test (CPT) Sounding Location

Soil Test Boring (STB) Location

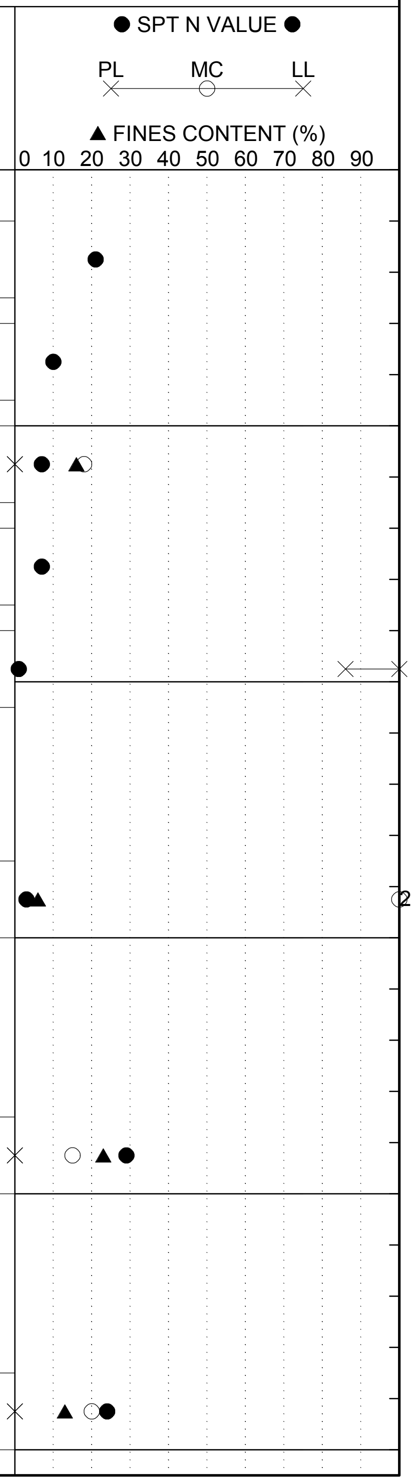
NOTE: Locations as shown is this figure are approximate. Use locations in the table for design.

Project No.: 1413-15-145 Date / Drawn By: December 2015 / DLS Not to Scale	S&ME	**TEST LOCATION PLAN** EBRO Black Mingo Creek S-45-51 (Battery Park Rd) Williamsburg County, South Carolina	Figure: 1

SCDOT Soil Test Log

Project ID:	P029461	**County:**	Williamsburg	**Boring No.:**	STB-1
Site Description:	S-45-51 EBRO Black Mingo Creek			**Route:**	S-45-51
Eng./Geo.:	D. Schoen	**Boring Location:**	N/A	**Offset:**	N/A
Alignment:	Existing				
Elev.:	26.3 ft	**North:**	686095.71	**East:**	2433140.93
Date Started:	11/25/15				
Total Depth:	100 ft	**Soil Depth:**	N/A ft	**Core Depth:**	N/A ft
Date Completed:	11/25/2015				
Bore Hole Diameter (in):	3	**Sampler Configuration**		**Liner Required:**	Y (N)
Liner Used:	Y (N)				
Drill Machine:	CME 45D	**Drill Method:**	Mud Rotary	**Hammer Type:**	Automatic
Energy Ratio:	81%				
Core Size:	N/A	**Driller:**	Carolina Drilling	**Groundwater:**	TOB N/A
24HR	N/A				

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	N Value
	0.0	**ASPHALT** = 11 inches						
	0.9	medium dense, moist, brownish yellow, subangular, silty fine SAND (SM), 10YR 6/6, fill	1.0	SS/1	10	12	9	21
		- - - loose	3.0	SS/2	6	5	5	10
21.3		- - - LL=NP, PL=NP, PI=NP, NMC=17.5, %200=15.8	5.0	SS/3	5	3	4	7
	7.0	loose, moist, dark gray, subangular, low plasticity fines, clayey fine SAND (SC), 2.5Y 4/1, fill	7.0	SS/4	4	4	3	7
16.3	9.0	very loose, moist, very dark gray, high plasticity fines, organic laden silty SAND (SM), 10YR 3/1, trace wood fragments, LL=167, PL=86, PI=81, alluvium	9.0	SS/5	WOR	WOH	1	1
11.3	12.0	soft, wet, very dark gray, PEAT (PT), 10YR 3/1, alluvium - - - NMC=205.0, %200=6.4, OC=26.3	13.5	SS/6	1	1	2	3
6.3	17.0	medium dense, moist, dark greenish gray, subangular, weakly reactive, silty fine SAND (SM), Gley 1 3/5GY, trace moderately cemented lenses, Pee Dee Formation - - - LL=NP, PL=NP, PI=NP, NMC=15.2, %200=22.8	18.5	SS/7	14	19	10	29
1.3		- - - light yellowish brown, 2.5Y 6/4, few gravel, LL=NP, PL=NP, PI=NP, NMC=20.4, %200=13.1	23.5	SS/8	8	13	11	24



LEGEND

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SAMPLER TYPE		DRILLING METHOD	
SS - Split Spoon	NQ - Rock Core, 1-7/8"	HSA - Hollow Stem Auger	RW - Rotary Wash
UD - Undisturbed Sample	CU - Cuttings	CFA - Continuous Flight Augers	RC - Rock Core
AWG - Rock Core, 1-1/8"	CT - Continuous Tube	DC - Driving Casing	

SCDOT Soil Test Log

Project ID:	P029461		**County:**	Williamsburg		**Boring No.:**	STB-1
Site Description:	S-45-51 EBRO Black Mingo Creek					**Route:**	S-45-51
Eng./Geo.:	D. Schoen	**Boring Location:**	N/A	**Offset:**	N/A	**Alignment:**	Existing
Elev.:	26.3 ft	**North:**	686095.71	**East:**	2433140.93	**Date Started:**	11/25/15
Total Depth:	100 ft	**Soil Depth:**	N/A ft	**Core Depth:**	N/A ft	**Date Completed:**	11/25/2015
Bore Hole Diameter (in):	3	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 45D	**Drill Method:**	Mud Rotary	**Hammer Type:**	Automatic	**Energy Ratio:**	81%
Core Size:	N/A	**Driller:**	Carolina Drilling	**Groundwater:**	**TOB** N/A	**24HR**	N/A

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	N Value	● SPT N VALUE ● / PL MC LL / ▲ FINES CONTENT (%) 0 10 20 30 40 50 60 70 80 90
-3.8		- - - very dense, light olive brown, 2.5Y 5/3, 50> material not continuous - discrete lenses less than 6" thick		28.5	SS/9	24	37	50/	50/4.5"	>>
-8.8		- - - recovered pieces of moderately cemented sand		33.5	SS/10	50/0.5"			50/0.5"	>>
-13.8		- - - medium dense, dark greenish gray, weakly reactive, Gley 1 3/10Y		38.5	SS/11	5	6	10	16	
-18.8		- - - not reactive, LL=NP, PL=NP, PI=NP, NMC=32.6, %200=25.0		43.5	SS/12	7	10	14	24	
-23.8				48.5	SS/13	9	13	16	29	

LEGEND

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SAMPLER TYPE		DRILLING METHOD	
SS - Split Spoon	NQ - Rock Core, 1-7/8"	HSA - Hollow Stem Auger	RW - Rotary Wash
UD - Undisturbed Sample	CU - Cuttings	CFA - Continuous Flight Augers	RC - Rock Core
AWG - Rock Core, 1-1/8"	CT - Continuous Tube	DC - Driving Casing	

SCDOT Soil Test Log

Project ID:	P029461	**County:**	Williamsburg	**Boring No.:**	STB-1
Site Description:	S-45-51 EBRO Black Mingo Creek			**Route:**	S-45-51
Eng./Geo.:	D. Schoen	**Boring Location:**	N/A	**Offset:**	N/A
Alignment:	Existing	**Elev.:**	26.3 ft	**North:**	686095.71
East:	2433140.93	**Date Started:**	11/25/15	**Total Depth:**	100 ft
Soil Depth:	N/A ft	**Core Depth:**	N/A ft	**Date Completed:**	11/25/2015
Bore Hole Diameter (in):	3	**Sampler Configuration**		**Liner Required:**	Y (N)
Liner Used:	Y (N)	**Drill Machine:**	CME 45D	**Drill Method:**	Mud Rotary
Hammer Type:	Automatic	**Energy Ratio:**	81%	**Core Size:**	N/A
Driller:	Carolina Drilling	**Groundwater:**	TOB N/A	**24HR**	N/A

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	N Value
	52.0	hard, moist, very dark gray, low plasticity, sandy CLAY (CL), Gley 1 3/N, Pee Dee	53.5	SS/14	31	21	35	56
-28.8								
	57.0	very dense, moist, dark gray, subangular, slightly sility fine SAND (SP-SM), Gley 1 4/N, Pee Dee	58.5	SS/15	50/4.5"			50/4.5"
-33.8								
	62.0	vey stiff, moist, very dark gray, weakly reactive, low plasticity, sandy CLAY (CL), Gley 1 3/N, Pee Dee - - - LL=39, PL=23, PI=16, NMC=27.0, %200=65.6	63.5	SS/16	7	7	9	16
-38.8								
		- - - hard, @ tip of spoon - greenish gray, slightly cemented	68.5	SS/17	50/4.25"			50/4.25"
-43.8								
		- - - stiff, dark gray, Gley 1 3/N	73.5	SS/18	5	5	7	12
-48.8								

● SPT N VALUE ●   PL MC LL   ▲ FINES CONTENT (%)   0 10 20 30 40 50 60 70 80 90

>> (SS/15)   >> (SS/17)

LEGEND

Continued Next Page

SAMPLER TYPE		DRILLING METHOD	
SS - Split Spoon	NQ - Rock Core, 1-7/8"	HSA - Hollow Stem Auger	RW - Rotary Wash
UD - Undisturbed Sample	CU - Cuttings	CFA - Continuous Flight Augers	RC - Rock Core
AWG - Rock Core, 1-1/8"	CT - Continuous Tube	DC - Driving Casing	

SCDOT Soil Test Log

Project ID:	P029461		**County:**	Williamsburg		**Boring No.:**	STB-1
Site Description:	S-45-51 EBRO Black Mingo Creek					**Route:**	S-45-51
Eng./Geo.:	D. Schoen	**Boring Location:**	N/A	**Offset:**	N/A	**Alignment:**	Existing
Elev.:	26.3 ft	**North:**	686095.71	**East:**	2433140.93	**Date Started:**	11/25/15
Total Depth:	100 ft	**Soil Depth:**	N/A ft	**Core Depth:**	N/A ft	**Date Completed:**	11/25/2015
Bore Hole Diameter (in):	3	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 45D	**Drill Method:**	Mud Rotary	**Hammer Type:**	Automatic	**Energy Ratio:**	81%
Core Size:	N/A	**Driller:**	Carolina Drilling	**Groundwater:**	**TOB** N/A	**24HR**	N/A

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	N Value
		- - - very stiff		78.5	SS/19	6	7	10	17
-53.8									
				83.5	SS/20	6	9	14	23
-58.8									
				88.5	SS/21	7	8	10	18
-63.8									
				93.5	SS/22	7	9	11	20
-68.8									
		- - - hard		98.5	SS/23	50/1.5"			50/1.5"
-73.8	100.0	**BORING TERMINATED AT 100 FEET**							

● SPT N VALUE ●

PL MC LL

▲ FINES CONTENT (%)

0 10 20 30 40 50 60 70 80 90

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LEGEND

SAMPLER TYPE		DRILLING METHOD	
SS - Split Spoon	NQ - Rock Core, 1-7/8"	HSA - Hollow Stem Auger	RW - Rotary Wash
UD - Undisturbed Sample	CU - Cuttings	CFA - Continuous Flight Augers	RC - Rock Core
AWG - Rock Core, 1-1/8"	CT - Continuous Tube	DC - Driving Casing	

SCDOT Soil Test Log

Project ID: P029461	**County:** Williamsburg	**Boring No.:** STB-4			
Site Description: S-45-51 EBRO Black Mingo Creek	**Route:** S-45-51				
Eng./Geo.: D. Schoen	**Boring Location:** N/A	**Offset:** N/A	**Alignment:** Existing		
Elev.: 26.5 ft	**North:** 685931.2	**East:** 2433119.64	**Date Started:** 11/25/15		
Total Depth: 100 ft	**Soil Depth:** N/A ft	**Core Depth:** N/A ft	**Date Completed:** 11/25/2015		
Bore Hole Diameter (in): 3	**Sampler Configuration**	**Liner Required:** Y (N)	**Liner Used:** Y (N)		
Drill Machine: CME 45D	**Drill Method:** Mud Rotary	**Hammer Type:** Automatic	**Energy Ratio:** 81%		
Core Size: N/A	**Driller:** Carolina Drilling	**Groundwater:**	**TOB** N/A	**24HR** N/A	

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	N Value
	0.0	**ASPHALT** = 10 inches							
	0.8	medium dense, moist, light brownish yellow, subangular, silty fine SAND (SM), 2.5Y 6/4, fill		1.0	SS/1	6	8	7	15
		- - - loose, brownish yellow, 10YR 6/6		3.0	SS/2	2	3	3	6
21.5		- - - very loose, yellowish brown, 10YR 5/6		5.0	SS/3	1	1 / 12"		1
	7.0	very loose, moist, reddish yellow and strong brown, subangular, low plasticity fines, clayey SAND (SC), 7.5YR 6/6 and 7.5YR 4/6, LL=48, PL=23, PI=25, NMC=29.6, %200=33.8, fill		7.0	SS/4	WOH / 12"		1	1
16.5	9.0	very loose, moist, very dark gray, high plasticity fines, organic laden silty SAND (SM), 10 YR 3/1, trace wood fragments, LL=99, PL=47, PI=52, NMC=67.4, %200=33.1, alluvium		9.0	SS/5	WOH	1	1	2
11.5	12.0	loose, moist, dark grayish brown, subangular, silty fine SAND (SM), 10YR 4/2, alluvium		13.5	SS/6	1	2	6	8
	17.0	loose, moist, dark grayish brown, subangular, slightly silty fine SAND (SP-SM), 10YR 4/2, alluvium		18.5	SS/7	5	3	3	6
6.5	19.5	loose, moist, dark greenish gray, subangular, silty fine SAND (SM), Gley 1 3/5GY, Pee Dee Formation							
1.5		- - - medium dense, light yellowish brown, 2.5Y 6/4		23.5	SS/8	4	8	16	24

● SPT N VALUE ●

PL MC LL

▲ FINES CONTENT (%)

0 10 20 30 40 50 60 70 80 90

Continued Next Page

LEGEND

SAMPLER TYPE		DRILLING METHOD	
SS - Split Spoon	NQ - Rock Core, 1-7/8"	HSA - Hollow Stem Auger	RW - Rotary Wash
UD - Undisturbed Sample	CU - Cuttings	CFA - Continuous Flight Augers	RC - Rock Core
AWG - Rock Core, 1-1/8"	CT - Continuous Tube	DC - Driving Casing	

SCDOT Soil Test Log

Project ID:	P029461	**County:**	Williamsburg	**Boring No.:**	STB-4		
Site Description:	S-45-51 EBRO Black Mingo Creek			**Route:**	S-45-51		
Eng./Geo.:	D. Schoen	**Boring Location:**	N/A	**Offset:**	N/A	**Alignment:**	Existing
Elev.:	26.5 ft	**North:**	685931.2	**East:**	2433119.64	**Date Started:**	11/25/15
Total Depth:	100 ft	**Soil Depth:**	N/A ft	**Core Depth:**	N/A ft	**Date Completed:**	11/25/2015
Bore Hole Diameter (in):	3	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 45D	**Drill Method:**	Mud Rotary	**Hammer Type:**	Automatic	**Energy Ratio:**	81%
Core Size:	N/A	**Driller:**	Carolina Drilling	**Groundwater:**	**TOB** N/A	**24HR**	N/A

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	N Value
-3.5		- - - very dense, light olive brown, 2.5Y 5/3, LL=NP, PL=NP, PI=NP, NMC=30.9, %200=13.9, @ tip of spoon - moderately cemented, 50> material not continuous - discrete lenses less than 6" thick	28.5	SS/9	10	50/4"		50/4"
-8.5	32.0	very dense, moist, light olive brown, subangular, slightly silty fine SAND (SP-SM), 2.5Y 5/3, Pee Dee	33.5	SS/10	13	18	34	52
-13.5	37.0	stiff, moist, very dark gray, weakly reactive, low plasticity, sandy CLAY (CL), Gley 1 3/N, Pee Dee	38.5	SS/11	3	6	6	12
-18.5	42.0	medium dense, dark greenish gray, subangular, not reactive, silty SAND (SM), Gley 1 3/10Y, Pee Dee LL=NP, PL=NP, PI=NP, NMC=32.2, %200=19.5	43.5	SS/12	6	9	13	22
-23.5	47.0	very stiff, moist, very dark gray, weakly reactive, low plasticity, sandy CLAY (CL), Gley 1 3/N, Pee Dee	48.5	SS/13	6	9	9	18

● SPT N VALUE ●
PL MC LL
▲ FINES CONTENT (%)
0 10 20 30 40 50 60 70 80 90
>>

LEGEND

Continued Next Page

SAMPLER TYPE		DRILLING METHOD	
SS - Split Spoon	NQ - Rock Core, 1-7/8"	HSA - Hollow Stem Auger	RW - Rotary Wash
UD - Undisturbed Sample	CU - Cuttings	CFA - Continuous Flight Augers	RC - Rock Core
AWG - Rock Core, 1-1/8"	CT - Continuous Tube	DC - Driving Casing	

SCDOT Soil Test Log

Project ID:	P029461	**County:**	Williamsburg	**Boring No.:**	STB-4		
Site Description:	S-45-51 EBRO Black Mingo Creek	**Route:**	S-45-51				
Eng./Geo.:	D. Schoen	**Boring Location:**	N/A	**Offset:**	N/A	**Alignment:**	Existing
Elev.:	26.5 ft	**North:**	685931.2	**East:**	2433119.64	**Date Started:**	11/25/15
Total Depth:	100 ft	**Soil Depth:**	N/A ft	**Core Depth:**	N/A ft	**Date Completed:**	11/25/2015
Bore Hole Diameter (in):	3	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)
Drill Machine:	CME 45D	**Drill Method:**	Mud Rotary	**Hammer Type:**	Automatic	**Energy Ratio:**	81%
Core Size:	N/A	**Driller:**	Carolina Drilling	**Groundwater:**	**TOB** N/A	**24HR**	N/A

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	N Value
	52.0	medium dense, moist, dark greenish gray, subangular, weakly reactive, silty fine SAND (SM), Gley 1 3/10Y, Pee Dee	53.5	SS/14	6	9	13	22
-28.5								
		- - - not reactive	58.5	SS/15	7	8	12	20
-33.5								
	62.0	very stiff, dark greenish gray, not reactive, low plasticity, sandy CLAY (CL), Gley 1 3/10Y, Pee Dee - - - LL=44, PL=20, PI=24, NMC=23.1, %200=66.1	63.5	SS/16	5	8	20	28
-38.5								
		- - - stiff, weakly reactive	68.5	SS/17	4	5	7	12
-43.5								
		- - - hard	73.5	SS/18	50/4"			50/4"
-48.5								

● SPT N VALUE ● — PL, MC, LL — ▲ FINES CONTENT (%) — 0 10 20 30 40 50 60 70 80 90

>>

LEGEND

Continued Next Page

SAMPLER TYPE		DRILLING METHOD	
SS - Split Spoon	NQ - Rock Core, 1-7/8"	HSA - Hollow Stem Auger	RW - Rotary Wash
UD - Undisturbed Sample	CU - Cuttings	CFA - Continuous Flight Augers	RC - Rock Core
AWG - Rock Core, 1-1/8"	CT - Continuous Tube	DC - Driving Casing	

SCDOT Soil Test Log

Project ID:	P029461		**County:**	Williamsburg		**Boring No.:**	STB-4	
Site Description:	S-45-51 EBRO Black Mingo Creek					**Route:**	S-45-51	
Eng./Geo.:	D. Schoen	**Boring Location:**	N/A	**Offset:**	N/A	**Alignment:**	Existing	
Elev.:	26.5 ft	**North:**	685931.2	**East:**	2433119.64	**Date Started:**	11/25/15	
Total Depth:	100 ft	**Soil Depth:**	N/A ft	**Core Depth:**	N/A ft	**Date Completed:**	11/25/2015	
Bore Hole Diameter (in):	3	**Sampler Configuration**		**Liner Required:**	Y (N)	**Liner Used:**	Y (N)	
Drill Machine:	CME 45D	**Drill Method:**	Mud Rotary	**Hammer Type:**	Automatic	**Energy Ratio:**	81%	
Core Size:	N/A	**Driller:**	Carolina Drilling	**Groundwater:**	**TOB**	N/A	**24HR**	N/A

Elevation (ft)	Depth (ft)	MATERIAL DESCRIPTION	Graphic Log	Sample Depth (ft)	Sample No./Type	1st 6"	2nd 6"	3rd 6"	N Value	● SPT N VALUE ● / PL MC LL / ▲ FINES CONTENT (%) 0 10 20 30 40 50 60 70 80 90
		--- very stiff		78.5	SS/19	6	7	10	17	● 17
-53.5										
		--- hard		83.5	SS/20	5	14	36	50	● 50
-58.5										
		--- LL=43, PL=18, PI=25, NMC=23.2, %200=55.8		88.5	SS/21	7	17	14	31	● 31
-63.5										
		--- very stiff		93.5	SS/22	6	8	9	17	● 17
-68.5										
		--- hard		98.5	SS/23	7	17	50/1"	50/1"	>>●
-73.5	100.0	**BORING TERMINATED AT 100 FEET**								

LEGEND

SAMPLER TYPE		DRILLING METHOD	
SS - Split Spoon	NQ - Rock Core, 1-7/8"	HSA - Hollow Stem Auger	RW - Rotary Wash
UD - Undisturbed Sample	CU - Cuttings	CFA - Continuous Flight Augers	RC - Rock Core
AWG - Rock Core, 1-1/8"	CT - Continuous Tube	DC - Driving Casing	

79° 34' 33" W | 79° 34' 29" W

33° 42' 40" N | 33° 42' 40" N

33° 42' 36" N | 33° 42' 36" N

79° 34' 33" W | 79° 34' 29" W

Map Scale: 1:648 if printed on A portrait (8.5" x 11") sheet.

Meters: 0, 5, 10, 20, 30

Feet: 0, 30, 60, 120, 180

N

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 17N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features

- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Williamsburg County, South Carolina
Survey Area Data: Version 14, Sep 29, 2015

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Nov 28, 2010—Jan 2, 2012

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Williamsburg County, South Carolina (SC089)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
CmB	Chisolm loamy fine sand, 2 to 6 percent slopes	0.0	4.3%
MH	Mouzon and Hobcaw soils, frequently flooded	0.6	66.7%
W	Water	0.3	29.0%
Totals for Area of Interest		**0.9**	**100.0%**

Appendix H
Hydrology Data Sheet

1.5.4 Hydrology Data Sheet for Bridges

MEMORANDUM TO:

Submittal Date: ______________

Supersedes Submittal Date: ______________

RPG ROAD DESIGN TEAM LEADER: ____________________________________

RPG STRUCTURAL ENGINEER: ____________________________________

From: Hydraulic Design Squad / Engineer Infrastructure Consulting & I

Subject: Hydrology Data for Bridge over Black Mingo Creek

County: WILLIAMSBURG **Rd/Rte:** S-51

Structure No: 0004570005100100 4,570,005,100,100 **Const. Pin:** ______________

Bridge Data:

Bridge Length: 164 ft. Bridge Width: 36.00 ft.

Beg. Station: 67+61.00 Ending Station: 69+25.00

Pier/Pile Type: 18" Square PSC Pier/Pipe Width: 1.5 ft.

Skew Angle: 0 °

Bridge Span Configuration: 37.5 ft - 70.0-ft - 56.5-ft

Bridge Span Type: Cored Slab

Min. F.G. Elev.: ____________ ft. Min. Low Steel Elev. 25.37 ft.

Min. Bottom Interior Bent Cap Elev. (For Tidal Bridges Only) N/A ft.

Br. End Fill Slope: 2:1 Riprap Req'd: Yes ☐ No ☐ To Elevation: 24.21 ft.

Comments:

Historic High Water Information:

Elevation of High Water: 26.39 ft. Discharge: (if available) ____________ ft.

Date of occurrence: 10/04/2015 Source of Data: Estimate from Field Review

Page 1 of 2

Design High Water and Backwater Information: (Show high water elevations including backwater on plans)

If 'Secondary Road' provide 25-yr high water elevation including backwater: 22.21 ft.

If 'Primary Road' provide 50-yr high water elevation including backwater: N/A ft.

For all roads provide 100-yr high water elevation including backwater: 23.56 ft.

Hydrology Data for Tidal Bridges: (Only complete this section if tidal flow is the dominant flow) (show on plans)

Mean Higher high tide elevation = ______ ft.

Mean Lower low tide elevation = ______ ft.

10-year tidal surge height = ______ ft. (includes wave height)

100-year stillwater height = ______ ft.

500-year stillwater height = ______ ft.

Maximum vel. within bridge = 100-yr. tidal surge velocity: _____ fps 500-yr. tidal surge velocity: _______ fps

Hydrology Data for Riverine Bridges: (Only complete this section if riverine flow is the dominant flow) (show on plans)

D.A. = 107 sq. mi. (or acres)

Q_{Design} = 4160 cfs

Vel. $_{Design}$ = 2.90 ft./sec.

Design Headwater Elevation = 22.21 ft.

Including 0.26 ft. backwater

Q_{100} = 6349 cfs

Vel_{100} = 3.90 ft/sec

100 Year Headwater Elev. = 23.56 ft.

Including 0.46 ft. backwater

Overtopping Flood:

Q = >8,350 cfs Probability = > 0.20 %

cc: Environmental Engineer ________________________________

Note: Probability may be determined by plotting the 2-, 10-, 25-, 50-, 100-, and 500-year discharges on Gumble paper and reading the probability corresponding to the overtopping discharge. For discharges greater than 500-year, the probability should be stated as less than (<) 0.002.Profiles of the computed scour for the 100-year and 500-year floods should be shown on the bridge plan and profile sheet. The shape of these profiles should be based on the methods described in the HEC-18. A plot of the 100- and 500-year scour lines on a bridge plan and profile sheet must be provided.

Revised 3/16/09

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Appendix I
Hydraulic Design & Risk Assessment Data Forms

1.6.1 Title Sheet

HYDRAULIC DESIGN AND RISK ASSESSMENT FOR

BRIDGE / BRIDGE REPLACEMENT OVER
SPRING LAKE

ROUTE / ROAD NUMBER:	S-45-51
FILE NO.:	
PROJECT NO.:	14-52
PIN:	P029461
COUNTY NAME:	Williamsburg
DATE:	01 / 18 / 2016

PREPARED BY:	Ronnie Smoak
CHECKED BY:	Lauren Warmuth

Hydraulic Design Reference for this study is the :
May 26th
2009

Edition of SCDOT's "Requirements for Hydraulic Design Studies."

(Place stamp and signature in this space)

Signed and Sealed

1.6.2 Comparative Data Sheet

COMPARATIVE DATA

PROJECT DESCRIPTION

County:	WILLIAMSBURG	Rt. / Rd. No.:	S-45-51
Stream:	BLACK MINGO	File No:	
Project No:	14-52	PIN:	P029461
Charge Code:		Road Squad:	
Project Engineer:			

By:	RONNIE SMOAK	Date:	01 18 2016
Checked By:		Date:	

	ROUTE/ROAD NO.'s				
	UPSTREAM SC-261	DOWNSTREAM RR BR			
DISTANCE FROM NEW BR. (mi.)	4.0	5.7			
DRAINAGE AREA (sq. mi.)					
ZONE					
Q_{10} (cfs)					
Q_{25} (cfs)					
Q_{50} (cfs)					
Q_{100} (cfs)					
Q_{500} (cfs)					
BRIDGE LENGTH (ft.)	150				
AVG. FINISHED GRADE (ft.)					
OPENING FURNISHED (sq.ft.)					
VELOCITY (ft./sec)					
HIGHWATER ELEV. (ft.)					
HIGHWATER DATE					
HIGHWATER DEPTH (ft.)					
OBSERVED WATER ELEV. (ft.)					
OBSERVED WATER DATE					
OBSERVED WATER DEPTH (ft.)					
FILE/DOCKET/PROJECT NO.					
DATUM/DATUM TIE					

1.6.3 Site Inspection Form

SITE INSPECTION FORM

PROJECT DESCRIPTION

County: WILLIAMSBURG — Rt. / Rd. No.: S-45-51

Stream: BLACK MINGO — File No:

Project No: — PIN: P029461

By: Infrastructure Consulting & Engineering — Date: 01/18/2016

Note: All references to left and right are looking in the direction of flow.

EXISTING BRIDGE

Length: 135 ft. Width: 28.2 ft. Max. Span Length: 15 ft.

Alignment: Tangent ☑ Curved ☐

Bridge skewed? Yes ☐ No ☑ Angle:

End Abutment Type: VERTICAL

Riprap on Fills? Yes ☐ No ☑ Condition:

Superstructure Type:

Substructure Type: 1' DIAMETER TIMBER PILES WITH CONCRETE CAPS

Utilities Present? Yes ☑ No ☐ Describe: WATER, POWER, TELEPHONE

Debris Accumulations on Bridge: Percent Blocked (Horizontal): 20 %

Percent Blocked (Vertical): 20 %

Hydraulic Problems? Yes ☑ No ☐ Describe: POSSIBLY DUE TO DEBRIS BUILD UP

Draw Sketch of Bridge and Stream Below: (Show north arrow and direction of flow)

1.6.3.1 Site Characteristics Form

SITE CHARACTERISTICS FORM

General Topography VALLEY SURROUNDED BY URBAN DEVELOPMENT

Stream Type (circle one)

Straight   Braided   Anabranched   Meandering

Are channel banks stable?   Yes ☐   No ☑

If No, describe: SEVERAL FALLEN TREES AND DEBRIS ALONG BANKS

Soil Type COARSE SAND

Exposed Rock?   Yes ☐   No ☑

If Yes, give description and location:

Describe potential for debris: HIGH: SEVERAL DOWNED TREES WERE OBSERVED ALONG BANKS AND WITHIN THE STREAM.

Give description and location of any structures or other property that could be damaged by backwater: N/A

Describe any other features that might affect or be affected by the hydraulic performance of the proposed bridge: N/A

1.6.3.2 Manning's "n" Values – for Channels

MANNING'S "n" VALUES – FOR CHANNELS

$$n = [(n_b+n_1+n_2+n_3+n_4)\,m]$$

Channel	**n_b -- *Base n for soil***	**Channel**	**n_1 -- *Degree of Irregularity***
Earth	.020	Smooth	.000
Rock Cut	.025	Minor	.001-.005
Fine Gravel	.024	Moderate	.006-.010
Course Gravel	.028	Severe	.011-.020

	n_2 -- *Variations of Channel Cross Sections*		**n_3 -- *Relative Effect of Obstructions***
Gradual	.000	Negligible	.000-.004
Alternating Occasionally	.001-.005	Minor	.010-.015
Frequently	.010-.015	Appreciable	.020-.030
		Severe	.040-.060

	n_4 -- *Vegetation*		**m -- *Degree of Meandering***
Low	.002-.010	Minor	1.00
Medium	.010-.025	Appreciable	1.15
High	.025-.050	Severe	1.30
Very High	.050-.100		

SITE OBSERVATIONS FOR CHANNELS

Channel Depth	n_b	n_1	n_2	n_3	n_4	m	***Computed n***
	0.024	0.002	0.004	0.004	0.010	1.15	0.0506

1.6.4 Risk Assessment

SOUTH CAROLINA DEPARTMENT OF TRANSPORTATION FLOODPLAIN AND RISK ASSESSMENT
Regulation 23 CFR 650 shall apply to all encroachment and to all actions which affect base floodplains, except for repairs made with emergency funds. (See HEC-17) Note: These studies shall be summarized in the environmental review document prepared pursuant to 23 CFR 771.

Project Description: REPLACEMENT OF COLLAPSED BRIDGE NO. 0004570005100100 OVER S-45-51 (BATTERY PARK RD) TO BE CONDUCTED WITH OFF SITE DETOUR DURING CONSTRUCTION

A. Narrative Describing Purpose and Need for Project:

a. Relevant Project History: THE EXISTING BRIDGE WAS BUILT IN 1986 AND WAS RECONSTRUCTED IN 1994. THE BRIDGE HAD AN OUT TO OUT WIDTH OF 28.2 FEET AND A LENGTH OF 135 FEET.

b. Project Location (attach Location and Project Map): BRIDGE REPLACEMENT ON S-45-51 OVER BLACK MINGO. SEE ATTACHED LOCATION AND PROJECT MAPS.

c. Major Issues and Concerns:

B. Are there any floodplain(s) regulated by FEMA located in the project area?

Yes ☑ **No** ☐

C. Will fill be placed within a 100-year floodplain?

Yes ☑ **No** ☐

Page 1 of 5

D. Will the existing profile grade be raised within the floodplain?

Yes ☑ **No** ☐

E. If applicable, please discuss the practicability of alternatives to any longitudinal encroachments.

N/A

F. Please include a discussion of the following: commensurate with the significance of the risk or environmental impact for all alternatives containing encroachments and those actions which would support base floodplain development:

i. What are the flood-related risks associated with implementation of the action?

THE PROPOSED BRIDGE WILL NOT HAVE A NOTABLE IMPACT ON EXISTING CONDITIONS

ii. What are the impacts on the natural and beneficial floodplain values?

THE PROPOSED BRIDGE WILL NOT HAVE A NOTABLE IMPACT ON EXISTING CONDITIONS

iii. Will the bridge entice people to build in floodplains?

NO INCOMPATIBLE FLOODPLAIN DEVELOPMENT IS EXPECTED

iv. What measures were used to minimize floodplain impacts associated with the action?

FLOODPLAIN IMPACTS WERE MINIMIZED BY REDUCING THE NUMBER OF PIERS IN THE MAIN CHANNEL

v. Were any measures used to restore and preserve the natural and beneficial floodplain values impacted by the action?

A LONGER BRIDGE IS PROPOSED WHICH WILL PRESERVE NATURAL AND BENEFICIAL FLOODPLAIN VALUES

Page 2 of 5

G. Please discuss the practicability of alternatives to any significant encroachments or to support of incompatible floodplain development.

NO SIGNIFICANT ENCROACHMENTS ARE PROPOSED. SINCE THIS PROJECT PROPOSES REPLACEMENT OF THE BRIDGE ALONG THE EXISTING ALIGNMENT, IT IS NOT EXPECTED TO RESULT IN ANY INCOMPATIBLE FLOODPLAIN DEVELOPMENT.

H. List local, state, and federal water resources and floodplain management agencies consulted to determine if the proposed highway action is consistent with existing watershed and floodplain management programs. Describe any information obtained on development and proposed actions in the affected area. Please include agency documentation.

I. BACKWATER DAMAGE FORM

Major flood damage applies to shopping centers, hospitals, industrial facilities, residential areas, schools, farming operations, etc.

1. *Does the maximum flood cause major damage to upstream property?*

Yes - (Go to 2.) No - (Go to 3.)

2. *Would this damage occur if the road were not there?*

Yes - (Go to 3.)

No - (Perform a limited Least Total Expected Cost (LTEC) (HEC-17) analysis to see if the bridge opening should be increased and/or grades raised to minimize the damage potential. Go to II.)

3. *Was this a bridge replacement? If so, was the bridge opening increased enough to increase the discharge passed through the bridge?*

Yes - (Go to 4.) No - (Go to II.)

4. *Does the increased flow cause major damage downstream?*

Yes - (Perform a limited LTEC analysis to determine if the bridge opening should be reduced, the floodway redefined, and flood easements purchased upstream or if flood easements should be purchased downstream. Go to II.)

No - (Go to II)

II. TRAFFIC RELATED LOSSES

1. *Is the overtopping flood greater than the 100-year flood?*

Yes - (Go to III.) No - (Go to 2.)

2. *Does the ADT exceed 50 vehicles per day?*

Yes - (Go to 3.) No - (Go to III.)

3. *Does the duration of road closure in days, multiplied by the difference in length, in miles between the normal route and the detour, exceed 20?*

Yes - (Go to 4.) No - (Go to III.)

4. *Does the annual risk cost for traffic related costs exceed 10% of the estimated annual capital costs?*

Yes - (Perform a limited LTEC analysis to compare the cost to raise the grades and if necessary increase the bridge length with the traffic related costs. Go to III.)

No - (Go to III.)

III. ROADWAY AND/OR STRUCTURE REPAIR COST

1. *Is the overtopping flood less than the 100-year flood?*

Yes - (Go to 2) No - (Go to 3)

Page 4 of 5

2. *Is the overtopping flood less than 0.5 foot over the low point on the roadway and duration no more than 1.0 hour?*

Yes - (Go to 3)

No - (perform a limited LTEC analysis to determine if the grades should be raised and/or the bridge opening increased or that the repair cost for embankment erosion are less significant. Traffic cost should be included in this evaluation.)

3. *Is the proposed bridge or culvert structure subject to potential damage due to debris?*

Yes - (Go to 4) No - (Go to 5)

4. *Perform a limited LTEC analysis to determine if the structure should be modified. (Go to 5.)*

5. *The risk assessment has determined the most economical design for the crossing within the design constraint*s.

Revised 3/16/09

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Appendix J
Level 1 and Level 2 Field Work Forms

LEVEL 1

FIELD ANALYSIS PACKAGE

FOR SCDOT

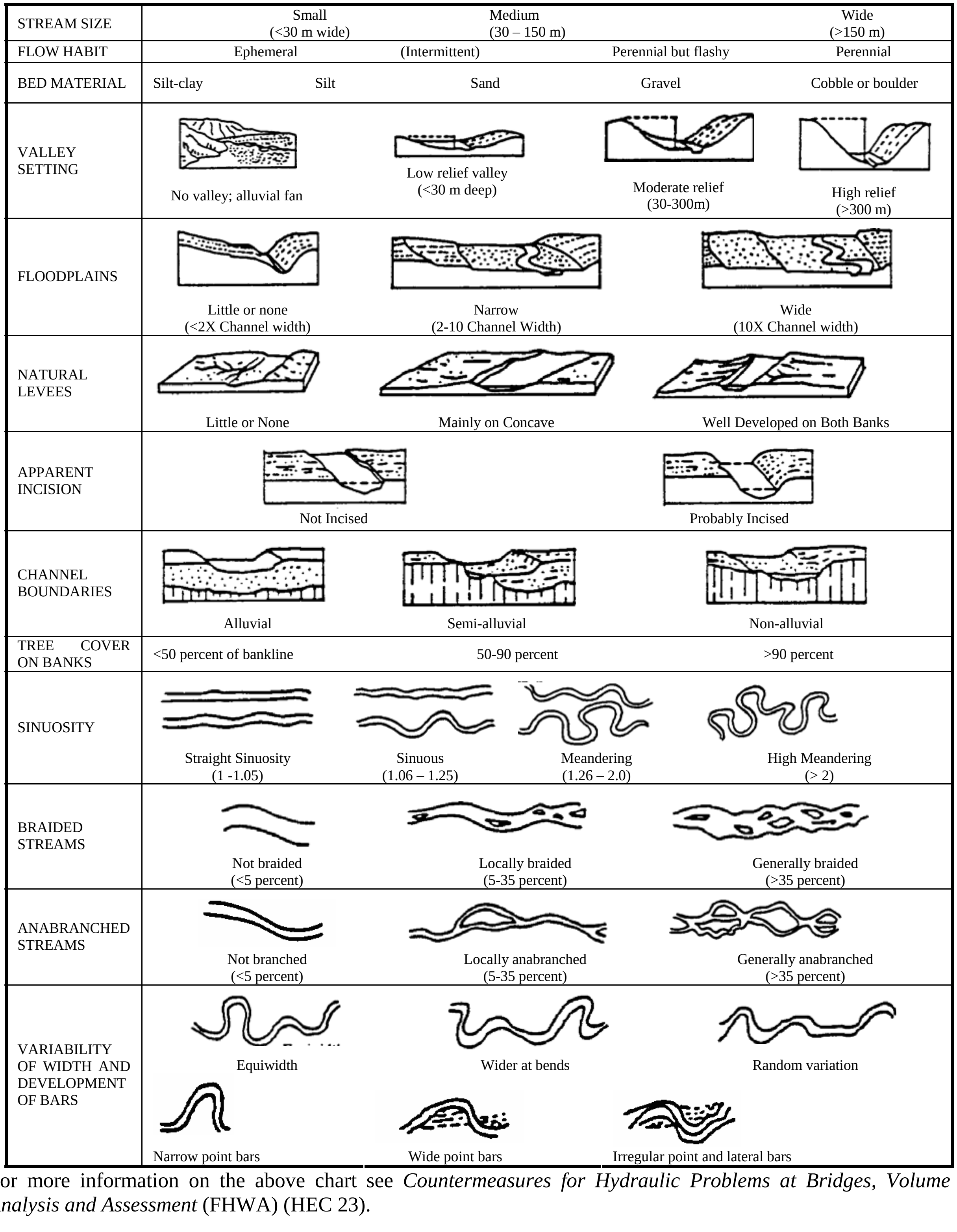
Prepared by: Infrastructure Consulting & Engineering

Project Number:	**15-42**
Stream Name:	**BLACK MINGO CREEK**
Date:	**1/8/16**
Field Crew:	**RDS, MCS**

INDEX

LEVEL 1 – Qualitative and Geomorphic Analysis

Figure 3: Geomorphic Factors Chart



For more information on the above chart see *Countermeasures for Hydraulic Problems at Bridges, Volume 1 Analysis and Assessment* (FHWA) (HEC 23).

LEVEL 1 - Qualitative & Geomorphic Analysis

STEP 1 - Stream Characteristics (Use Fig. 12)

1.) Stream Size

Upstream:

MEDIUM

Downstream:

MEDIUM

2.) Flow Habitat

PERENNIAL

LEVEL 1 - Qualitative & Geomorphic Analysis

STEP 1 - Stream Characteristics (Use Fig. 12) - Continued

3.) Bed Material

Upstream:

SANDY WITH GRAVEL

Downstream:

SANDY WITH GRAVEL

4.) Valley Setting

LOW RELIEF VALLEY

5.) Floodplain

Upstream:

WIDE; MOSTLY WOODS

Downstream:

WIDE; MOSTLY WOODS

CLIENT SCDOT **SUBJECT** ____________________ **Prepared By** RDS **Date** 1/8/16

PROJECT No. 15-42 ______________________________ **Prepared By** ______ **Date** ________

LEVEL 1 - Qualitative & Geomorphic Analysis

STEP 1 - Stream Characteristics (Use Fig. 12) - Continued

6.) Natural Levees

Upstream:

LITTLE OR NONE

Downstream:

LITTLE OR NONE

7.) Apparent Incision

Upstream:

NOT INCISED

Downstream:

NOT INCISED

8.) Channel Boundaries

Upstream:

NONE

Cohesive ?

NO

Downstream:

NONE

Cohesive ?

NO

CLIENT SCDOT SUBJECT ____________ Prepared By RDS Date 1/8/16

PROJECT No. 15-42 Prepared By ______ Date ________

LEVEL 1 - Qualitative & Geomorphic Analysis

STEP 1 - Stream Characteristics (Use Fig. 12) – Continued

9.) Tree Cover on Banks

Upstream:

>90%

Downstream:

>90%

10.) Sinuosity

Upstream:

SINUOUS AT SITE

Downstream:

SINUOUS AT SITE

11.) Braided or Anabranched

Upstream:

NOT

Downstream:

NOT

CLIENT SCDOT **SUBJECT** ____________ **Prepared By** RDS **Date** 1/8/16

PROJECT No. 15-42 ____________ **Prepared By** ______ **Date** ________

LEVEL 1 - Qualitative & Geomorphic Analysis

STEP 1 - Stream Characteristics (Use Fig. 12) – Continued

12.) Variability of Width & Development of Bars

Upstream:			
Channel Non-Veg. Width At Bend	Narrow Ch. Width	Point Bar Unveg. Width	Width of Flowing Water
N/A	N/A	N/A	~150'
Downstream:			
Channel Non-Veg. Width At Bend	**Narrow Ch. Width**	**Point Bar Unveg. Width**	**Width of Flowing Water**
N//A	N/A	N/A	~150'

STEP 2 – Evaluate Land Use Changes

Fire NO

Logging NO

Land Conversion NO

Urbanization

% Impervious Change NO

Vegetation NO

CLIENT SCDOT SUBJECT ____ Prepared By RDS Date 1/8/16

PROJECT No. 15-42 Prepared By ____ Date ____

LEVEL 1 - Qualitative & Geomorphic Analysis

STEP 3 – Assess Overall Stream Stability (Use Fig. 20 & Table 6)

STREAM WAS OBSERVED DURING FLOODLIKE CONDITIONS
STREAM APPEARS STABLE DISPITE THE FLOODING. IT IS STRAIGHT AT THE SITE WITH SOME SLIGHT MEANDERING OVERALL. THE BED MATERIAL IS SANDY WITH GRAVELS AND STONES. THE CHANNEL CONTAINS MANY CYPRUS TREES AND IS IN A SWAMP LIKE ENVIRONMENT. THE CHANNEL BOUNDARIES ARE UNCLEAR DUE TO FLOODING. FLOW WAS SLOW AND APPEARS DEEP AT THE SITE.

STEP 4 – Evaluate Lateral Stability

	Upstream:	Downstream:
Bank Failure	POTENTIAL	POTENTIAL
Bank Slopes	1:3	1:3
Vegetation	YES	YES
Fallen Vegetation Along Banks	MODERATE-HIGH	MODERATE-HIGH
Slump Blocks	NO	NO
Live Vegetation in Flow Bends Near Crossing	NO	NO
Fresh Vertical Faces	NO	NO
Deep Scour Pools at Bank Toes	POSSIBLE	POSSIBLE
Piping	NO	NO
Mass Wasting	NO	NO

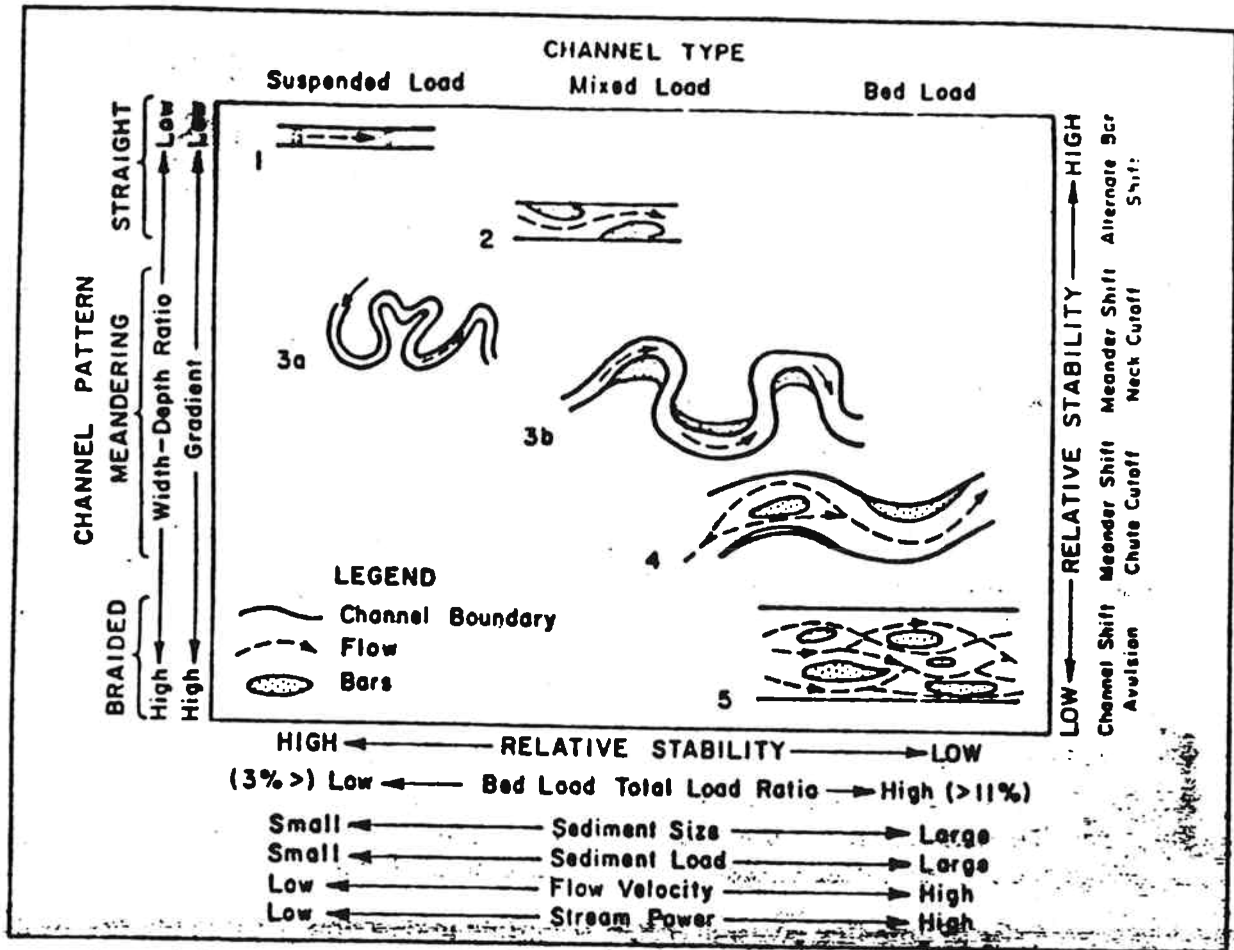


Figure 20. Channel classification and relative stability as hydraulic factors are varied (After [5]).

4.5.4 Step 4. Evaluate Lateral Stability

The effects of lateral instability of a stream at a bridge are dependent on the extent of the bank erosion and the design of the bridge. Bank erosion can undermine piers and abutments located outside the channel and erode abutment spill slopes or breach approach fills. Where bank failure is by a rotational slip, lateral pressures on piers located within the slip zone may cause cracks in piers or piling or displacement of pier foundations. Migration of a bend through a bridge opening changes the direction of flow through the opening so that a pier designed and constructed with a round-nose acts as a blunt-nosed, enlarged obstruction in the flow, thus accentuating local and general scour. Also, the development of a point bar on the inside of the migrating bend can increase contraction at the bridge if the outside bank is constrained from eroding. Figure 21 illustrates some of the problems of lateral erosion at bridges.

Table 6. Interpretation of observed data.
(After [27]).

OBSERVED CONDITION	STABLE	UNSTABLE	DEGRADING	AGGRADING
	CHANNEL RESPONSE			
Alluvial Fan \1				
Upstream		X		X
Downstream		X	X	
Dam and Reservoir				
Upstream		X		X
Downstream		X	X	
River Form				
Meandering	X	X	Unknown	Unknown
Straight		X	Unknown	Unknown
Braided		X	Unknown	Unknown
Bank Erosion		X	Unknown	Unknown
Vegetated Banks	X		Unknown	Unknown
Head Cuts		X	X	
Diversion				
Clear water diversion		X		X
Overloaded w/sediment		X	X	
Channel Straightened		X	X	
Deforest Watershed		X		X
Drought Period	X			X
Wet Period		X	X	
Bed Material Size				
Increase		X		X
Decrease		X	Unknown	X

\1The observed condition refers to location of the bridge on the alluvial fan, i.e., on the upstream or downstream portion of the fan.

Bed material transport is directly related to stream power, and relative stability decreases as stream power increases as shown by Figure 20. Stream power is the product of shear stress at the bed and the average velocity in the channel section. Shear stress can be determined from the gross shear stress equation (γ RS) where γ is the specific weight of water, R is the hydraulic radius, and S is the slope of the energy grade line.

CLIENT SCDOT **SUBJECT** ____________________ **Prepared By** RDS **Date** 1/8/16

PROJECT No. 15-42 **Prepared By** ______ **Date** ________

LEVEL 1 - Qualitative & Geomorphic Analysis

STEP 5 – Evaluate Vertical Stability

AGGRADATION / DEGRADATION

	Upstream:	Downstream:
Dams	N/A	N/A
Reservoirs	N/A	N/A
Lakes	N/A	N/A
Stream Bed Mining	POSSIBLE	POSSIBLE
Cutoffs or Chutes	NO	NO
Culvert Inlet	N/A	N/A
Culvert Outlet	N/A	N/A

STEP 6 – Evaluate Debris Potential

Local Maintenance

APPEARS TO HAVE BEEN CLEARED/CLEANED AFTER FLOODING

Observed

SOME TREE DEBRIS/ LOGS ALONG BANK BUT APPEARS TO HAVE BEEN CLEANED. WATER IS VERY DARK SO SCOUR COULDN'T BE DETECTED.

Possibility

MODERATE-HIGH

CLIENT SCDOT **SUBJECT** ____________________ **Prepared By** RDS **Date** 1/8/16

PROJECT No. 15-42 ____________________ **Prepared By** ______ **Date** ________

LEVEL 1 - Qualitative & Geomorphic Analysis

STEP 7 – Evaluate Vertical Stability

CHANNEL MAY HAVE EXPERIENCED SCOUR AT BRIDGE DURING FLOODING

LEVEL 2

FIELD ANALYSIS PACKAGE

FOR SCDOT

Prepared by: Infrastructure Consulting & Engineering

Project Number: **15-42**

Stream Name: **BLACK MINGO CREEK**

Date: **1/8/16**

Field Crew: **RDS, MCS**

INDEX

CLIENT SCDOT **SUBJECT** ______ **Prepared By** RDS **Date** 1/8/16

PROJECT No. 15-42 **Prepared By** ______ **Date** ______

LEVEL 2 – Basic Engineering Analysis

STEP 1 - A. FLOOD HISTORY

1.) **Road & Bridge Plans on File** **YES**

2.) **Specific Flood HW on File** **OLD PLANS-26.2' (1916)**

3.) **Interviews w/ Local Residents**

N/A

4.) **Gage Records**

N/A

5.) **Flood Zone**

ZONE AE- EFFECTIVE NOVEMBER 16, 2012

B. BRIDGE SITE SCOUR HISTORY

C. HYDROLOGY

1.) **Check Drainage Areas**

2.) **Check Land Uses**

3.) **Check on Zoning Maps**

D.) COMPARATIVE DATA SHEETS

CLIENT ____________ SUBJECT ______________________Prepared By ______ Date ______

PROJECT No. _____________________________________ Prepared By ______ Date ______

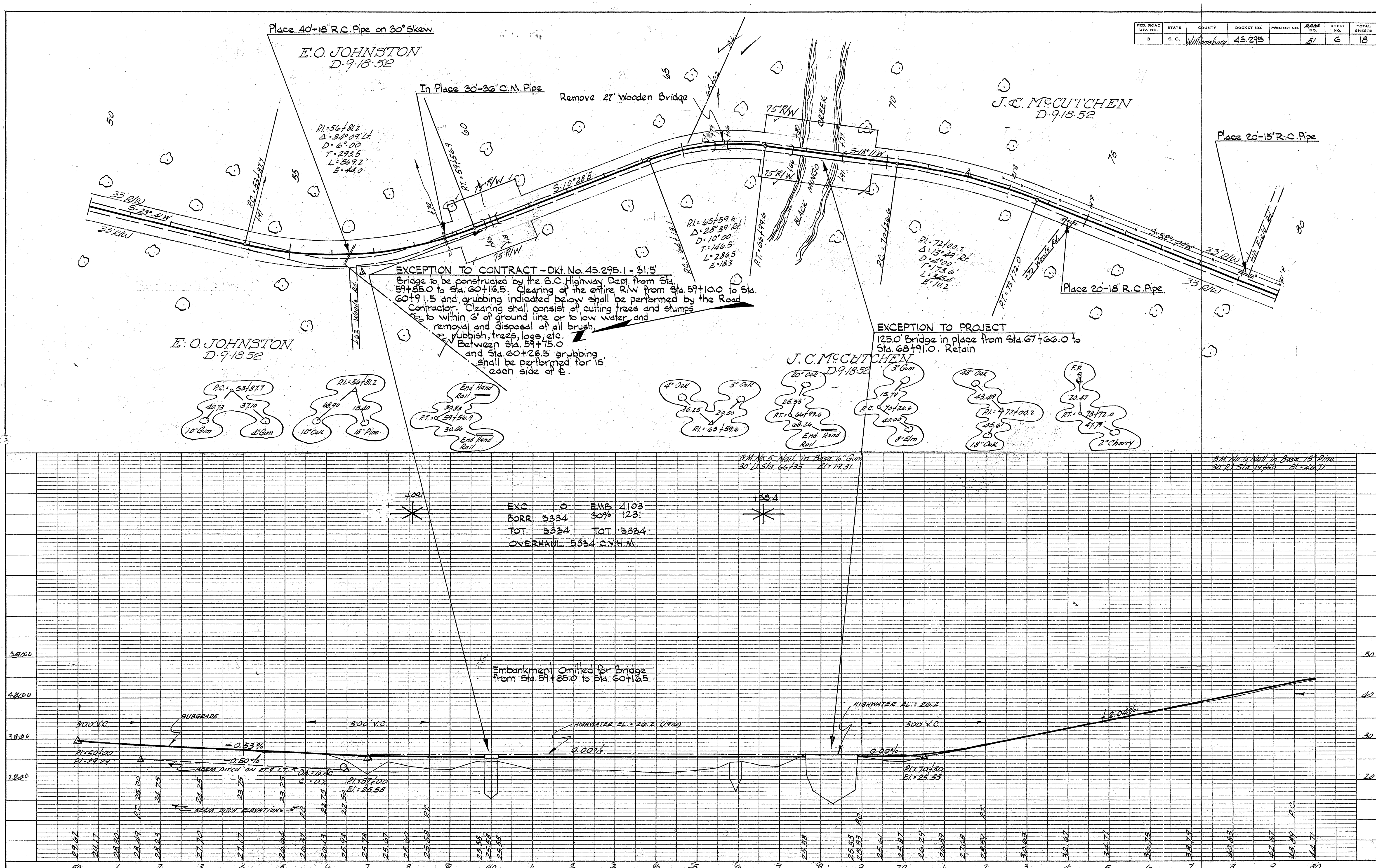
STEP 2 - EVALUATE HYDRAULIC CONDITIONS

- **WATERSHED CHARACTERICTS**
  (Dams, Waterfalls, Beavers, Lakes, Old Bridge, Abutments)

1.) Comparative Bridge Site Sheets

2.) Job Site Inspection Sheet

Appendix K
Existing Bridge Plans



FED. ROAD DIV. NO. 3 | STATE S. C. | COUNTY Williamsburg | DOCKET NO. 45.295 | PROJECT NO. | NO. 51 | SHEET NO. 6 | TOTAL SHEETS 18
Place 40'-18" R.C. Pipe on 30° Skew
E.O. JOHNSTON D-9-18-52
In Place 30'-36" C.M. Pipe
Remove 27' Wooden Bridge
J.C. McCUTCHEN D-9-18-52
Place 20'-15" R.C. Pipe
P.I. = 56+81.2
Δ = 34°09' Lt.
D = 6°00
T = 293.5'
L = 569.2'
E = 44.0
P.I. = 65+59.6
Δ = 28°39' Rt.
D = 10°00
T = 146.5'
L = 286.5'
E = 18.3
P.I. = 72+00.2
Δ = 13°49' Rt.
D = 4°00'
T = 173.6'
L = 345.2'
E = 10.2
S-23°41'W
S-10°28'E
S-18°11'W
S-32°20'W
33' R/W
75' R/W
BLACK MINGO CREEK
Place 20'-18" R.C. Pipe
EXCEPTION TO CONTRACT - Dkt. No. 45.295.1 - 31.5'
Bridge to be constructed by the S.C. Highway Dept. from Sta. 59+85.0 to Sta. 60+16.5. Clearing of the entire R/W from Sta. 59+10.0 to Sta. 60+91.5 and grubbing indicated below shall be performed by the Road Contractor. Clearing shall consist of cutting trees and stumps to within 6" of ground line or to low water and removal and disposal of all brush, rubbish, trees, logs, etc. Between Sta. 59+75.0 and Sta. 60+26.5 grubbing shall be performed for 15' each side of ℄.
EXCEPTION TO PROJECT
125.0' Bridge in place from Sta. 67+66.0 to Sta. 68+91.0. Retain
E. O. JOHNSTON D-9-18-52
J. C. McCUTCHEN D-9-18-52
B.M. No. 5 Nail in Base 6" Gum 30' Lt. Sta. 66+35 El. = 19.31
B.M. No. 6 Nail in Base 15" Pine 30' Rt. Sta. 79+50 El. = 46.71
EXC. 0 EMB. 4103
BORR. 5334 30% 1231
TOT. 5334 TOT. 5334
OVERHAUL 5334 C.Y.H.M.
Embankment Omitted for Bridge from Sta. 59+85.0 to Sta. 60+16.5
HIGHWATER EL. = 26.2 (1916)
HIGHWATER EL. = 26.2
300' V.C.
SUBGRADE
-0.53%
-0.50%
0.00%
+2.04%
BERM DITCH ON RT. & LT.
BERM DITCH ELEVATIONS
P.I. = 50+00 El. = 29.29
P.I. = 57+00 El. = 25.58
P.I. = 70+50 El. = 25.53
DA = 6 Ac.
C = 0.2
PLATE 1 — PLAN — PROFILE
CHARLES BRUNING CO. INC. — NEW YORK

Appendix L
Proposed Construction Drawings

BRIDGE PLANS ID	SHEET NO.
P029461	1

SCDOT
South Carolina Department of Transportation

PROPOSED PLANS FOR

WILLIAMSBURG COUNTY
PROJECT ID P029461
ROAD S-51 (BATTERY PARK ROAD)
REPLACE BRIDGE OVER
BLACK MINGO CREEK

INDEX OF SHEETS

Submit Shop Plans to:

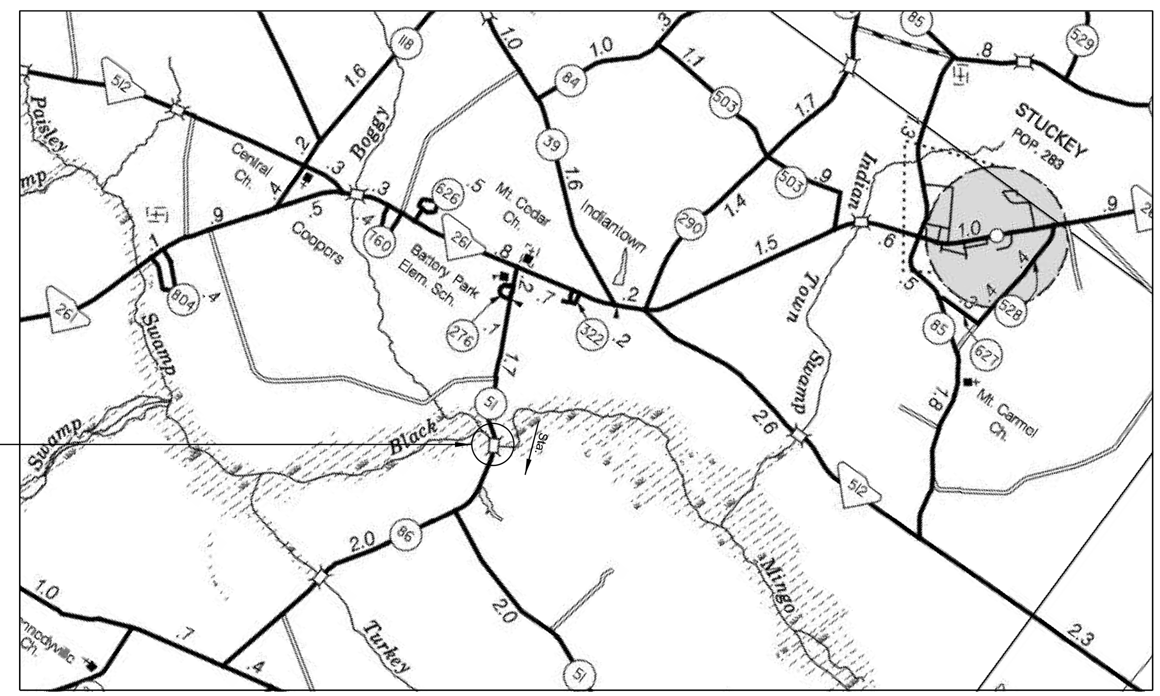
Infrastructure Consulting & Engineering
1021 Briargate Circle
Columbia, SC 29210

Telephone: (803) 822-0333

Approximate Location of Bridge is

Latitude 33° 42' 38" N
Longitude 79° 34' 33" W

SITE LOCATION



-N-

LAYOUT

NET LENGTH OF ROADWAY	0.000	MILES
NET LENGTH OF BRIDGES	0.031	MILES
NET LENGTH OF PROJECT	0.031	MILES
LENGTH OF EXCEPTIONS	0.000	MILES
GROSS LENGTH OF PROJECT	0.031	MILES

95% SUBMITTAL

3 DAYS BEFORE DIGGING IN
SOUTH CAROLINA
CALL 811
SOUTH CAROLINA 811 (SC811)
WWW.SC811.COM
ALL UTILITIES MAY NOT BE A MEMBER OF SC811

ASSET ID 3999

TRAFFIC DATA

2015 ADT 700 V.P.D.

2036 ADT 900 V.P.D.

TRUCKS 7 %

NOTE: EXCEPT AS MAY OTHERWISE BE SPECIFIED ON THE PLANS OR IN THE SPECIAL PROVISIONS, ALL MATERIALS AND WORKMANSHIP ON THIS PROJECT SHALL CONFORM TO THE SOUTH CAROLINA DEPARTMENT OF TRANSPORTATION STANDARD SPECIFICATIONS FOR HIGHWAY CONSTRUCTION (2007 EDITION) AND THE STANDARD DRAWINGS FOR ROAD CONSTRUCTION IN EFFECT AT THE TIME OF THE RELEASE OF THE FINAL RFP.

CONSULTING ENGINEERING FIRM

INFRASTRUCTURE CONSULTING & ENGINEERING

1021 BRIARGATE CIRCLE
COLUMBIA, SC 29210
Telephone: (803) 822-0333

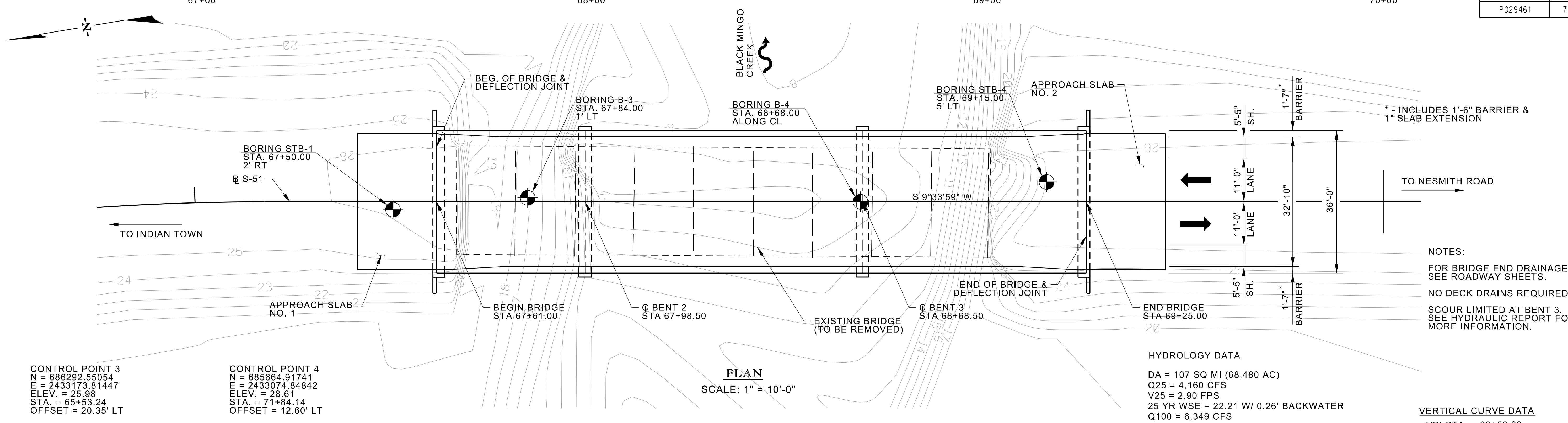
ENGINEER OF RECORD

NOT FOR CONSTRUCTION
SUBJECT TO CHANGE

FOR CONSTRUCTION : ____________ ______
DATE

Z:\Projects\15-42 Emerg Bridge Replace PKG 4\S-51Battery Park Rd\Structures\FINAL PLANS\01_BATTERY PARK _TITLE SHEET.dgn
2/17/2016

BRIDGE PLANS ID	SHEET NO.
P029461	7



PLAN

SCALE: 1" = 10'-0"

CONTROL POINT 3
N = 686292.55054
E = 2433173.81447
ELEV. = 25.98
STA. = 65+53.24
OFFSET = 20.35' LT

CONTROL POINT 4
N = 685664.91741
E = 2433074.84842
ELEV. = 28.61
STA. = 71+84.14
OFFSET = 12.60' LT

NOTES:

FOR BRIDGE END DRAINAGE SEE ROADWAY SHEETS.

NO DECK DRAINS REQUIRED.

SCOUR LIMITED AT BENT 3. SEE HYDRAULIC REPORT FOR MORE INFORMATION.

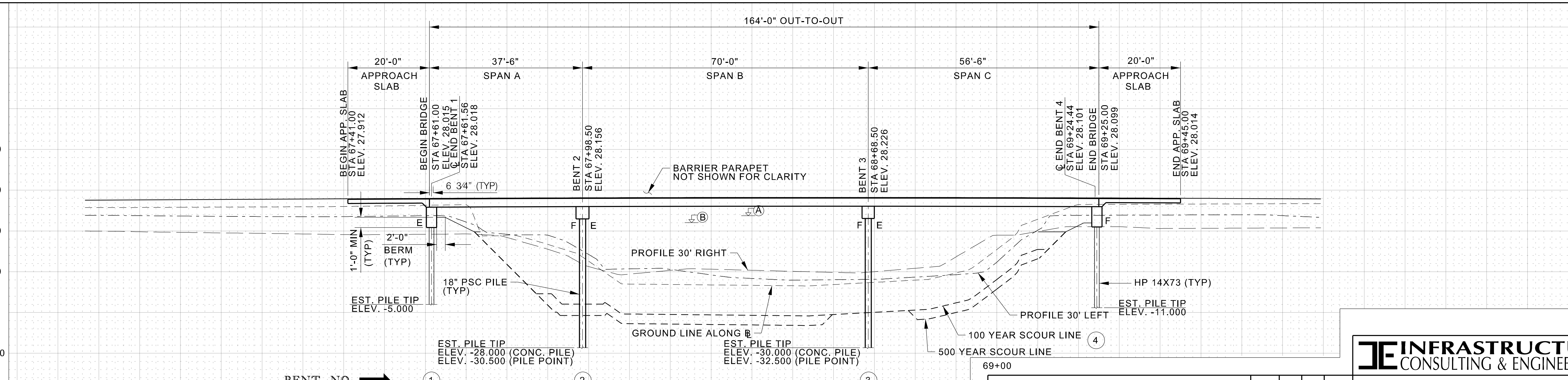
HYDROLOGY DATA

DA = 107 SQ MI (68,480 AC)
Q25 = 4,160 CFS
V25 = 2.90 FPS
25 YR WSE = 22.21 W/ 0.26' BACKWATER
Q100 = 6,349 CFS
V100 = 3.90 FPS
100 YR WSE = 23.56 W/ 0.46' BACKWATER
OVERTOPPING: EXCEEDS 500 YR STORM
Q 500 > 8,350 CFS
PROBABILITY < 0.002

VERTICAL CURVE DATA

VPI STA.= 68+50.00
ELEV. = 28.49
LENGTH = 200'

0.53 % -0.50 %



SECTION ALONG ℄ S-51

SCALE: 1" = 10'-0"

Ⓐ - WSE 100-YR FLOOD EL 23.56
Ⓑ - WSE 25-YR FLOOD EL 22.21

INFRASTRUCTURE CONSULTING & ENGINEERING

SOUTH CAROLINA DEPARTMENT OF TRANSPORTATION

BRIDGE PLAN AND PROFILE

REPLACE S-51 BRIDGE OVER BLACK MINGO CREEK

REV.			
REV.			
REV.			
REVIEWED	R. JAMALUDDIN		
QUAN.	--	--	--
DR.	RAJ	DKY	2/16
DES.	RAJ	DKY	2/16
	BY	CHK.	DATE

COUNTY WILLIAMSBURG ROUTE S-51

Z:\Projects\I5-42 Emerg Bridge Replace PKG 4\S-51Battery Park Rd\Structures\FINAL PLANS\07_BATTERY PARK_BRIDGE PLAN AND PROFILE.dgn
2/17/2016

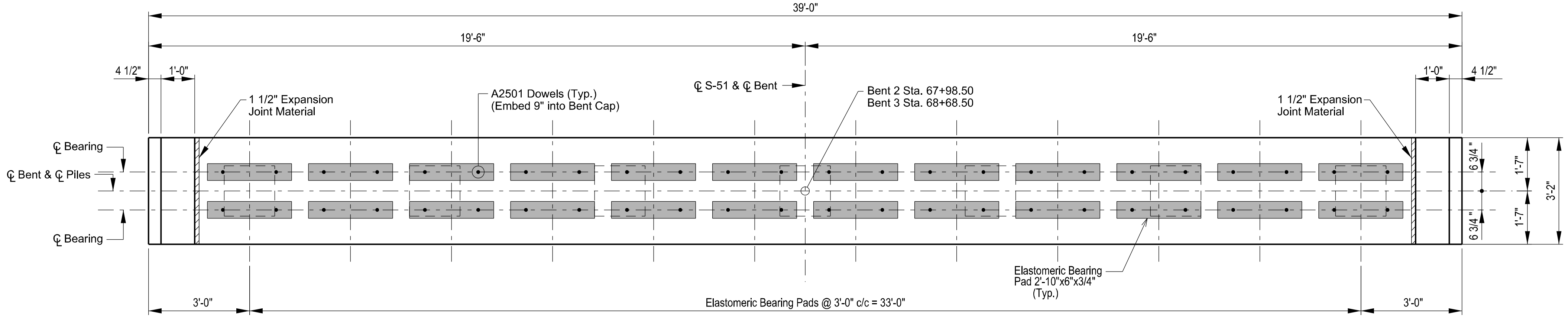
NOTES:

For Interior Bent Details, see Sheet No. 14.

For Sections A-A & B-B, see Sheet No. 14.

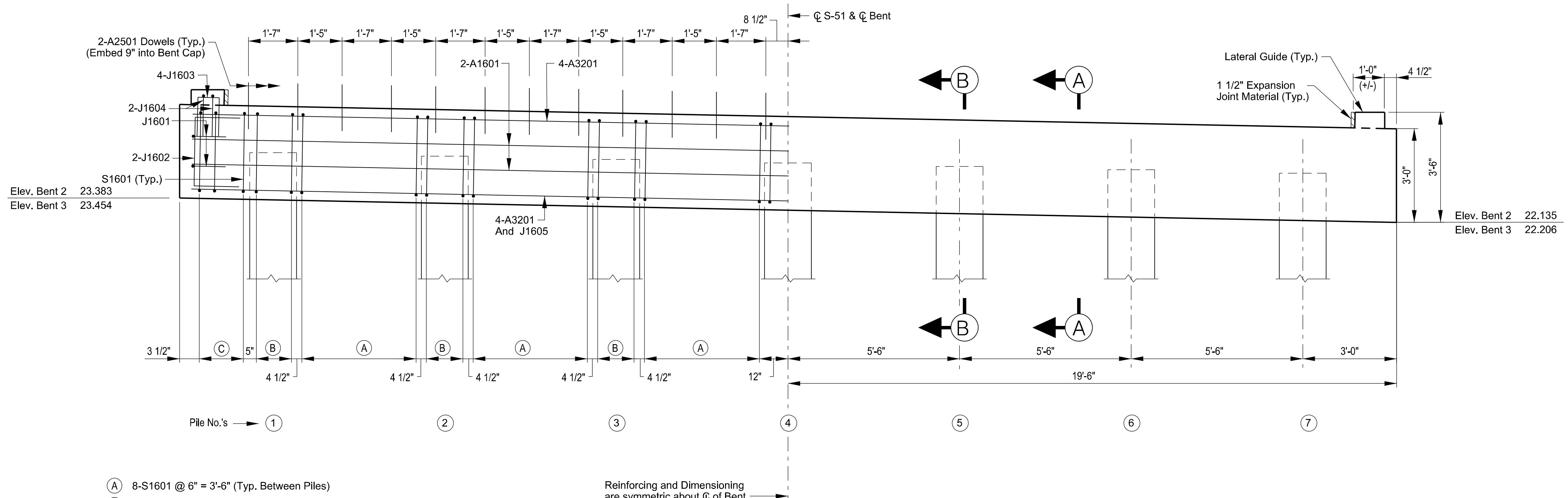
For Elastomeric Bearing Pad Details, see Sheet No. 19.

The Lateral Guides shall be cast after placement of Cored Slabs.



PLAN

Scale: 1/2" = 1'-0"



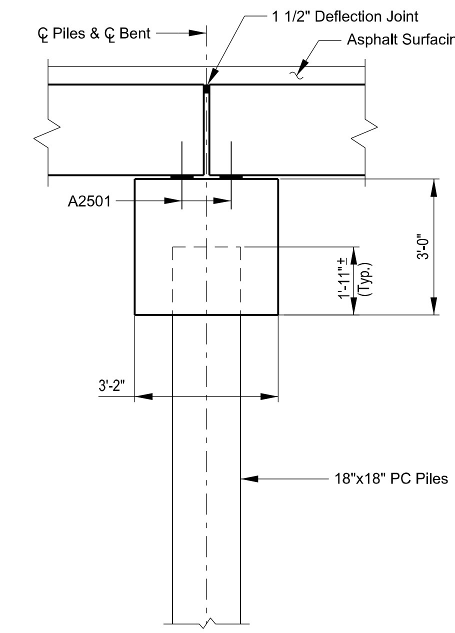
(A) 8-S1601 @ 6" = 3'-6" (Typ. Between Piles)

(B) 4-SB1601 @ 5" = 1'-3" (Typ. At Piles)

(C) 5-S1601 @ 5" = 1'-8"

ELEVATION

Scale: 1/2" = 1'-0"



INTERIOR BENT SECTION

Scale: 1/2" = 1'-0"

PILE CUT-OFF ELEVATIONS		
LOCATION	INTERIOR BENT 2	INTERIOR BENT 3
1	25.204	25.275
2	25.028	25.099
3	24.852	24.923
4	24.676	24.747
5	24.500	24.571
6	24.324	24.395
7	24.148	24.219

INFRASTRUCTURE CONSULTING & ENGINEERING

SOUTH CAROLINA DEPARTMENT OF TRANSPORTATION

INTERIOR BENT 2 AND 3

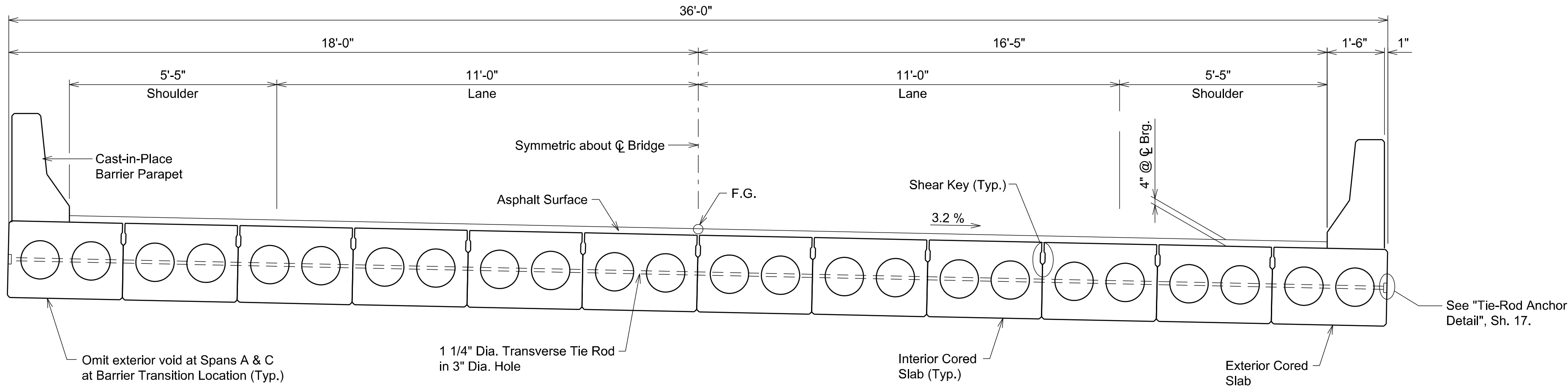
REPLACE S-51 BRIDGE OVER BLACK MINGO CREEK

REV.			
REV.			
REV.			
REVIEWED	R. JAMALUDDIN		
QUAN.			
DR.	RAJ	DKY	2-16
DES.	DKY	RAJ	2-16
	BY	CHK.	DATE

COUNTY: WILLIAMSBURG
ROUTE: S-51

Z:\Projects\15-42 Emerg Bridge Replace PKG 4\S-51Battery Park Rd\Structures\FINAL PLANS\13.BATTERY PARK, INTERIOR BENT 2 AND 3.dgn
2/17/2016

BRIDGE PLANS ID	SHEET NO.
P029461	19



TYPICAL SECTION

Scale: 1/2" = 1'-0"

SUPERSTRUCTURE (BARRIERS)

REINFORCING STEEL SCHEDULE

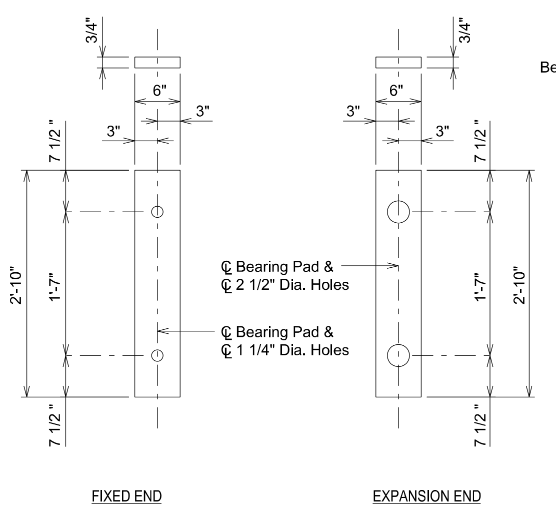
LOCATION	MARK	NO. REQ'D	DIMENSION "a"	"b"	"c"	"d"	"e"	LENGTH
Barrier (Span A)	A1601	14	37'-1"	------	------	------	------	37'-1"
Barrier (Span B)	A1602	28	36'-4"	------	------	------	------	36'-4"
Barrier (Span C)	A1603	14	56'-1"	------	------	------	------	56'-1"
Barrier (Span A)	H1601	46	2'-4"	2'-4"	0'-7 3/8"	------	------	5'-2"
Barrier (Span B)	H1601	142	2'-4"	2'-4"	0'-7 3/8"	------	------	5'-2"
Barrier (Span C)	H1601	84	2'-4"	2'-4"	0'-7 3/8"	------	------	5'-2"
Barrier (Span A)	U1601	2	2'-0"	0'-5"	------	------	------	4'-3"
Barrier (Span C)	U1601	2	2'-0"	0'-5"	------	------	------	4'-3"

QUANTITIES

ITEM	UNIT	Span A	Span B	Span C
Reinforcing Steel for Structures (Bridge)	LB	798	1,826	1,281
Concrete Barrier Parapet	LF	43	140	81
Concrete Barrier Parapet Transition	EA	2	--	2

OVERLAY THICKNESS TABLE

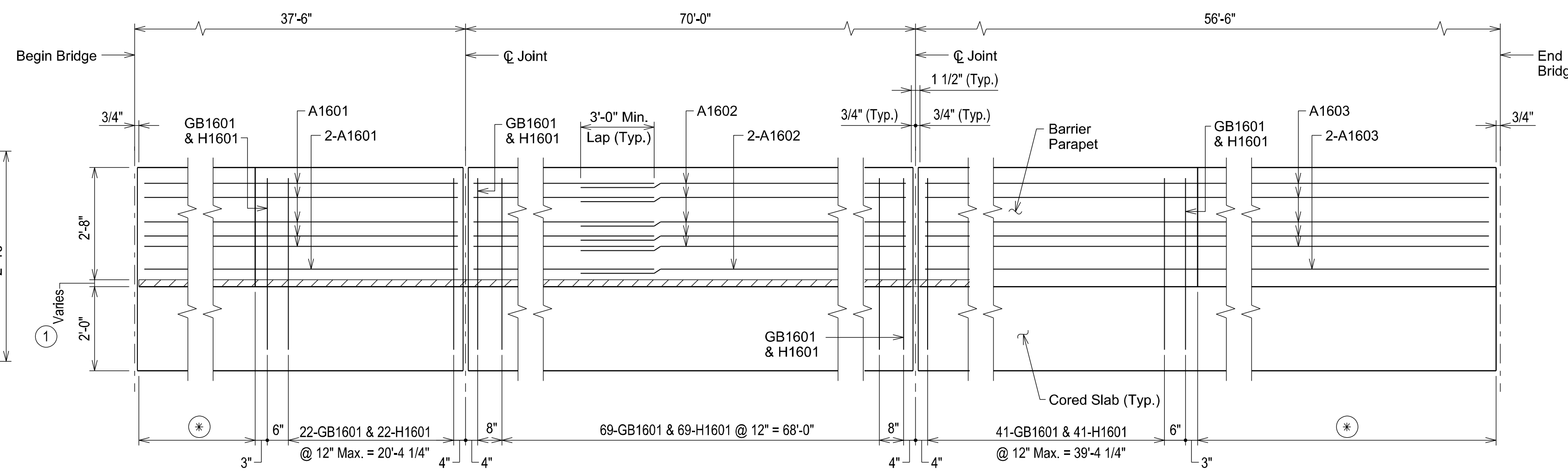
SPAN	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
A	4.0"	3.7"	3.5"	3.3"	3.2"	3.2"	3.2"	3.3"	3.5"	3.7"	4.0"
B	4.0"	3.1"	2.6"	2.3"	2.1"	2.1"	2.1"	2.3"	2.6"	3.1"	4.0"
C	4.0"	3.6"	3.4"	3.3"	3.2"	3.2"	3.2"	3.3"	3.4"	3.6"	4.0"



ELASTOMERIC BEARING DETAIL

(60 Durometer)

No Scale



1 See table above for overlay thickness at left and right gutterline at 10th points of Span A thru C.

BARRIER PARAPET ELEVATION

(Typ. Each Side of Bridge)

Not To Scale

✱ 16' Barrier Transition, for reinforcement and details of barrier transitions, see Sheet No. 3.

NOTES:

See Section 704 of the Standard Specifications and the Special Provisions for additional requirements and information regarding prestressed concrete cored slab units. Submit shop drawings in accordance with the Standard Specifications.

Use prestressing strands that conform to the latest AASHTO M 203 for grade 270 (low relaxation).

Use reinforcing steel that conforms to ASTM A 706 Grade 60.

The tensioning load in all 0.6" Dia. low relaxation strands is 43.9 kips. Do not release the strands until the compressive strength of the concrete has reached f'ci = 5 ksi for Span A and C or f'ci = 6.4 ksi for Span B.

When casting the cored slabs, use a positive hold-down system to prevent the voids from rising or moving sideways. Use a non-corrosive hold-down system that is designed to remain in place until the concrete attains the specified release strength. At least three weeks prior to casting the cored slab units, submit to the RCE, detailed drawings of the proposed hold-down system. Include structural details, locations, and spacing for the proposed hold-down system in the submittal.

Always maintain cored slab units in an upright position. Use lifting devices located within 2'-6" of the ends to lift or handle the cored slab units. Provide a 1" deep recess at the lifting devices. Grout the recesses prior to waterproofing the top surface of the cored slab units. Do not permit the cored slab units to be placed or stored on interior supports causing negative moments.

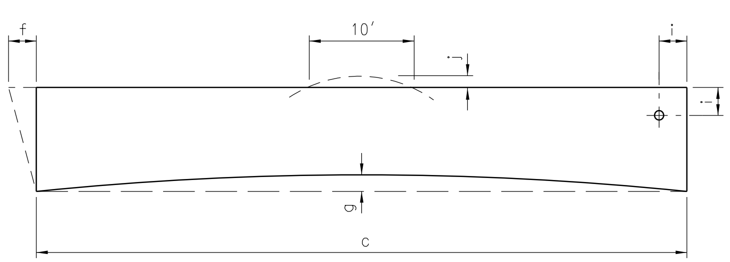
Tie rod assemblies include a 1¼" Dia. rod, two heavy hex nuts, two lockwashers, and two 5" x 5" x ⅝" plate washers. Thread 8" on each end of the tie rods. Provide tie rods and plate washers meeting the requirements of AASHTO M 270, Grade 36. Provide nuts meeting the requirements of ASTM A 563, Grade A. Galvanize tie rods and all hardware in accordance with ASTM A 123, ASTM A 153, or ASTM F 2329 as applicable. Tie rods are to be installed for test fit during fit up of span in casting yard.

Grout all shear keys, dowel holes, and recesses for transverse tie rods after tightening the transverse tie rods. At expansion ends of slab units, fill the dowel holes with cold applied elastic filler to 1½" above the top of dowels and fill the remaining portion with grout. After the grout has cured for a minimum of three days, and has attained the required strength, place the barrier parapet.

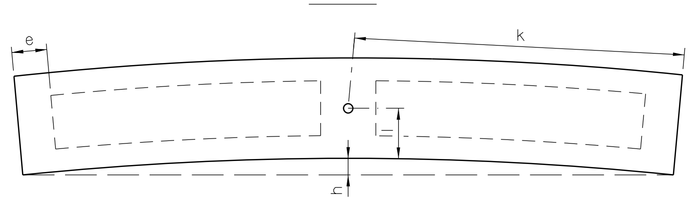
Apply a bridge deck waterproofing system, that complies with the requirements of Section 814 of the Standard Specifications, to the top surface of the cored slab units prior to placing the asphalt wearing surface.

For locations of fixed and expansion bearings, see "Bridge Plan and Profile".

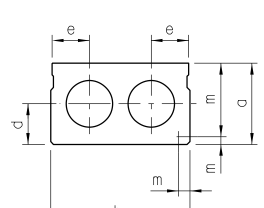
TOLERANCES



PLAN



ELEVATION



CROSS SECTION

a	Depth	+3/8" to -1/8"
b	Width	± 1/4"
c	Length (Length of adjacent cored slab units must be within ± 1/4".)	± 1/8" per 10'
d	Position of Voids: Vertical	± 3/8"
e	Position of Voids: Horizontal	± 3/8"
	Position of Void Ends: Longitudinal	± 1"
f	Square Ends: Deviation from square (horizontal or vertical) or designated skew	± 1/4"
g	Horizontal Alignment: Deviation from a straight line parallel to the center line of member	± 3/8"
h	Camber: Differential between adjacent units	1/4" in 10', 3/4" max.
h	Camber: Differential between high and low members of the same span	3/4" max.
i	Position of Dowel Holes: Deviation from plan position	± 1/4"
	Width: Differential of adjacent spans in the same structure	± 3/4"
	Bearing Area: Deviation from plan surface	± 1/16"
j	Local Smoothness	1/4" in 10'
k	Horizontal Position of holes for Transverse Tie Rods	± 1/2"
l	Vertical Position of holes for Transverse Tie Rods	± 3/8"
m	Position of Strands	± 1/4"

REV.			
REV.			
REV.			
REVIEWED	R. JAMALUDDIN		
QUAN.	RAJ	DKY	2-16
DR.	RAJ	DKY	2-16
DES.	RAJ	DKY	2-16
	BY	CHK.	DATE

INFRASTRUCTURE CONSULTING & ENGINEERING

SOUTH CAROLINA DEPARTMENT OF TRANSPORTATION

SUPERSTRUCTURE DETAILS

REPLACE S-51 BRIDGE OVER BLACK MINGO CREEK

COUNTY: WILLIAMSBURG | ROUTE: S-51

Z:\Projects\I5-42 Emerg Bridge Replace PKG 4\S-51Battery Park Rd\Structures\FINAL PLANS\19_BATTERY PARK_SUPERSTRUCTURE DETAILS.dgn
2/17/2016

SHEET NO	DESCRIPTION	SHEET SUB-TOTALS
1	TITLE SHEET	1
2	SUMMARY OF ESTIMATED QUANTITIES	OMITTED
3	TYPICAL SECTIONS	1
4	RIGHT OF WAY DATA SHEET	1
4A	PROPERTY STRIP MAP	1
5	GENERAL CONSTRUCTION NOTES	1
5A-5B	REFERENCE DATA SHEET	2
6-8	PLAN AND PROFILE SHEET	3
TC1	TRAFFIC CONTROL SHEETS	OMITTED
PM1-PM3	PAVEMENT MARKING & SIGNING PLAN SHEET	3
EC1	EROSION CONTROL DATA SHEET	1
G1-G6	GEOTECHNICAL DETAILS	6
X1-X12	CROSS SECTIONS	12
XP1	CROSS LINE PIPES	1
	TOTAL	33

INDEX OF SHEETS

SCDOT
South Carolina Department of Transportation

SHEET NO.	TOTAL SHEETS
1	33

PROPOSED PLANS FOR WILLIAMSBURG COUNTY PROJECT ID P029461 S-51 BRIDGE REPLACEMENT OVER BLACK MINGO CREEK (BATTERY PARK RD.)

BRIDGE PLANS BOUND UNDER A SEPARATE COVER

Design Reference for these plans is the:

2001

AASHTO "A Policy on Geometric Design of Highways and Streets"

Hydraulic Design Reference for these plans is the:

2009

Edition of SCDOT's "Requirements for Hydraulic Design Studies"

ENVIRONMENTAL PERMIT INFORMATION

USACE PERMIT	X YES	__ NO		
NEPA DOCUMENT	X YES	__ NO		
401 CERTIFICATION	X YES	__ NO		
OCRM CAP	__ YES	X NO		
NAVIGABLE WATERS	__ SC	__ USCG	__ USACE	X N/A

3 DAYS BEFORE DIGGING IN SOUTH CAROLINA

CALL 811

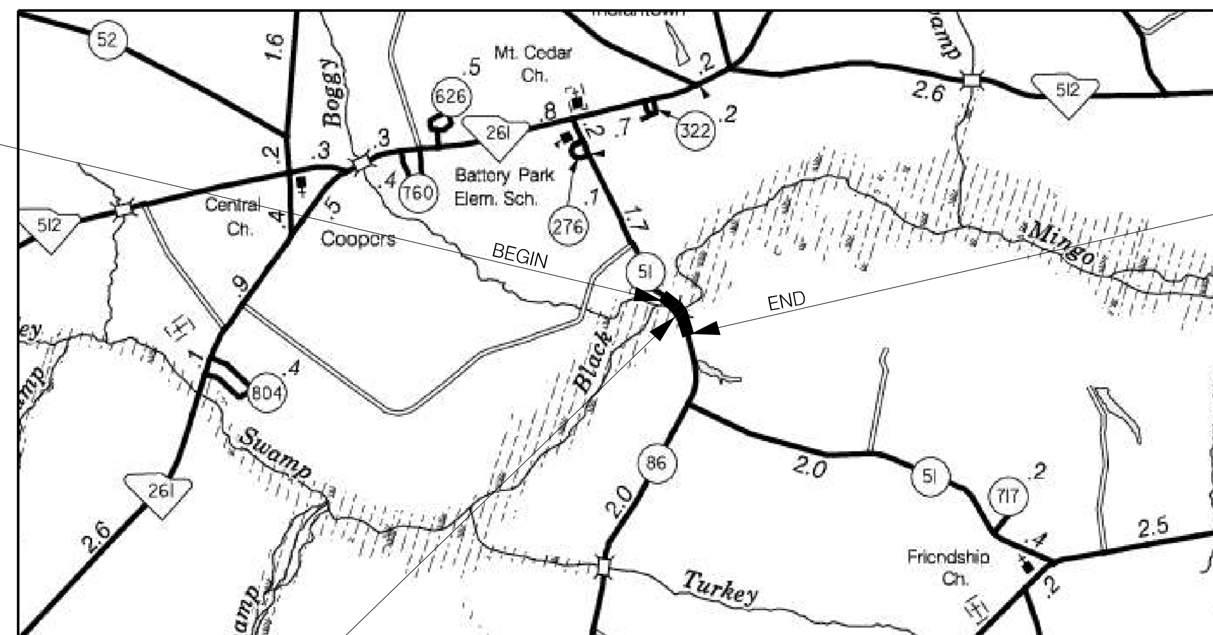
SOUTH CAROLINA 811 (SC811)
WWW.SC811.COM
ALL UTILITIES MAY NOT BE A MEMBER OF SC811

RAILROAD INVOLVEMENT?
YES NO

ESTIMATED TRAFFIC DATA

700	ADT	2015
900	ADT	2036
TRUCKS	5 %	

BEGIN CONSTRUCTION
PROJECT ID P029461 S-51
STA. 55+60.00



END CONSTRUCTION
PROJECT ID P029461 S-51
STA. 86+00.00

LAYOUT
NOT TO SCALE

WILLIAMSBURG COUNTY

CONSTRUCT 164 LF BRIDGE
PROJECT ID P029461 S-51
FROM STA. 67+61.00 TO
STA. 69+25.00

PROPOSED PROJECT

	TOTAL	
NET LENGTH OF ROADWAY	0.545	MILES
NET LENGTH OF BRIDGES	0.031	MILES
NET LENGTH OF PROJECT	0.576	MILES
LENGTH OF EXCEPTIONS	-	MILES
GROSS LENGTH OF PROJECT	0.576	MILES

EQUALITIES IN STATIONING
NONE

NOTE: EXCEPT AS MAY BE OTHERWISE SPECIFIED ON THE PLANS OR IN THE SPECIAL PROVISIONS, ALL MATERIALS AND WORKMANSHIP ON THIS PROJECT SHALL CONFORM TO THE SOUTH CAROLINA DEPARTMENT OF TRANSPORTATION STANDARD SPECIFICATIONS FOR HIGHWAY CONSTRUCTION (2007 EDITION) AND THE STANDARD DRAWINGS FOR ROAD CONSTRUCTION IN EFFECT AT THE TIME OF FINAL RFP.

NPDES PERMIT INFORMATION

DISTURBED AREA = 2.67 ACRES

PERMITTED AREA = 5.14 ACRES

APPROXIMATE LOCATION OF ROADWAY IS

BEGIN
LATITUDE 33° 42'50.30"N
LONGITUDE 79° 34'33.74"W

END
LATITUDE 33° 42'22.51"N
LONGITUDE 79° 34'39.22"W

Hydraulic and NPDES Design provided by:

ICE

Designs may be obtained from the SCDOT Regional Production Group

For Right Of Way Acquisition:

Consultant Engineer of Record ____ Date ____

Regional Production Engineer ____ Date ____

ENGINEER OF RECORD

SOUTH CAROLINA PROFESSIONAL ENGINEER No. 26136 AARON O. LIVINGSTON

SOUTH CAROLINA INFRASTRUCTURE CONSULTING & ENGINEERING, PLLC No. 4470 CERTIFICATE OF AUTHORIZATION

FOR CONSTRUCTION : ____ DATE ____

CONSULTING ENGINEERING FIRM

INFRASTRUCTURE
CONSULTING & ENGINEERING

Z:\Projects\15-42 Emerg Bridge Replace PKG 4\S-51Battery Park Rd\Roadway\DGN\Plans\SHT_01.dgn
2/17/2016

FED. RD. DIV. NO.	STATE	COUNTY	PROJECT ID	ROAD / ROUTE NO.	SHEET NO.
3	SC	WILLIAMSBURG	P029461	S–51	3

SCDOT
South Carolina Department of Transportation

TYPICAL SECTIONS

NOTES:

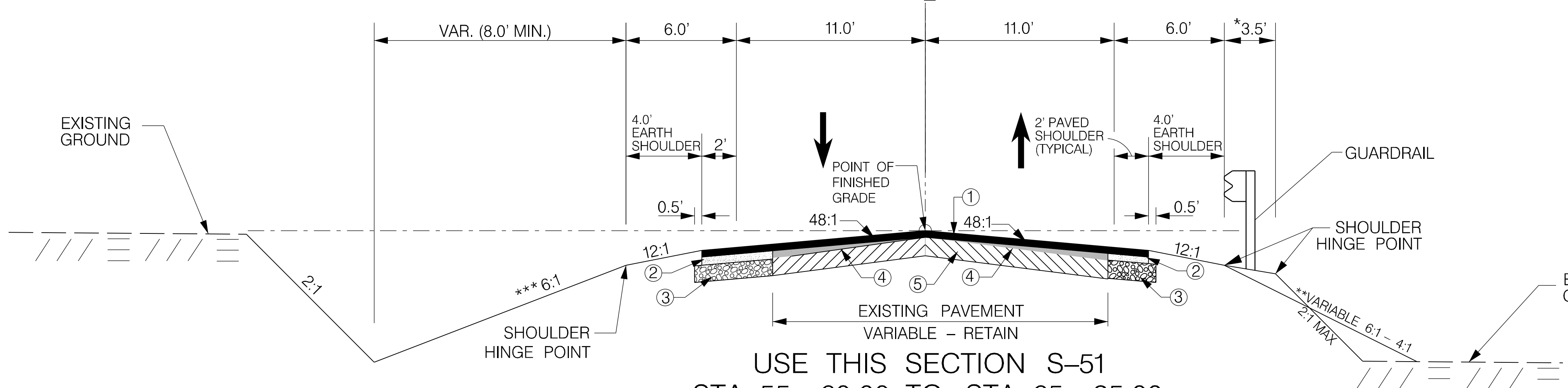
* SHOULDER WIDTH TO BE INCREASED AN ADDITIONAL 3.5' WHERE GUARDRAIL IS REQUIRED. EXCEPT WHERE ADDITIONAL LENGTH GUARDRAIL POSTS ARE NOTED IN THE PLANS

** FILL SLOPES VARIES :
0–5' HEIGHT 6:1
5'–10' HEIGHT 4:1
OVER 10' HEIGHT 2:1 WITH GUARDRAIL

*** THE DITCH SLOPE MAY BE VARIED TO PROVIDED POSITIVE DRAINAGE. USING A MINIMUM SLOPE OF 12:1 AND A MAXIMUM SLOPE OF 4:1. WHERE A DEEPER DITCH THAN PROVIDED BY A 4:1 IS NECESSARY, THE DITCH SHALL BE PLACED FARTHER FROM THE CENTERLINE CONTINUING THE 4:1 SLOPE TO PROVIDE FOR THE NECESSARY DEPTH. SEE PROFILE FOR THE LOCATION OF SPECIAL DITCHES.

1

CONST. ℄

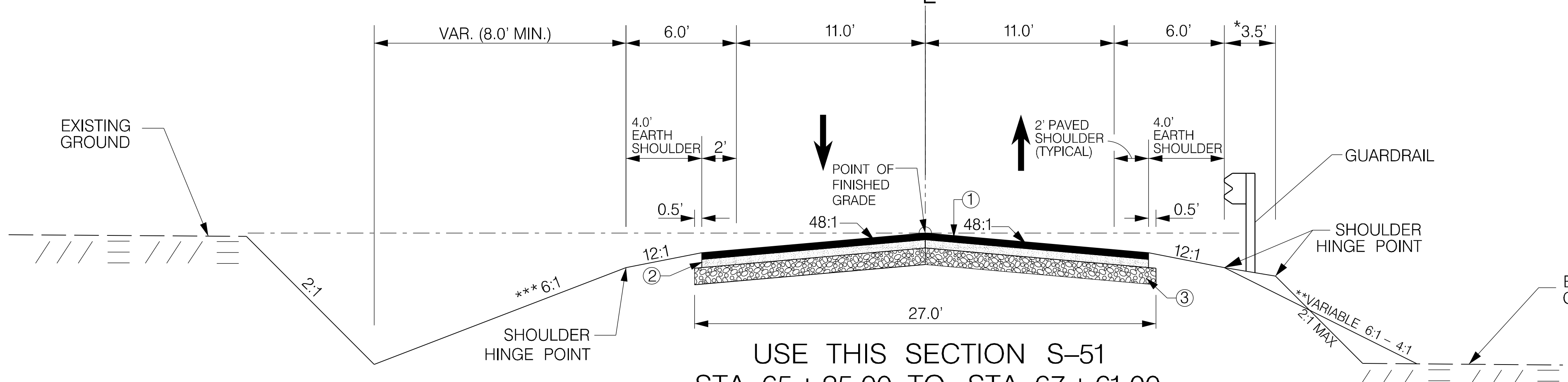


USE THIS SECTION S–51
STA. 55+60.00 TO STA. 65+25.00
STA. 70+05.00 TO STA. 78+50.00
STA. 80+25.00 TO STA. 86+00.00

CONSTRUCT 164 L.F. BRIDGE
STA. 67+61.00 TO STA. 69+25.00

2

CONST. ℄



USE THIS SECTION S–51
STA. 65+25.00 TO STA. 67+61.00
STA. 69+25.00 TO STA. 70+05.00
STA. 78+50.00 TO STA. 80+25.00

FUNCTIONAL CLASSIFICATION: RURAL MINOR COLLECTOR

1	HOT MIX ASPHALT SURFACE CR TYPE C (175 PSY)
2	HOT MIX ASPHALT SURFACE CR TYPE C (175 PSY)
3	HOT MIX ASPHALT BASE COURSE TYPE B (850 PSY)
4	HOT MIX ASPHALT INTERMEDIATE CR TYPE C (VARIABLE)
5	EXISTING PAVEMENT RETAIN

RTE.	DESIGN SPEED	
MPH	FROM STA.	TO STA
45	55+60.00	86+00.00
EXCEPTIONS TO DESIGN SPEED		

SOUTH CAROLINA PROFESSIONAL ENGINEER No. 26136 AARON O. LIVINGSTON

SOUTH CAROLINA INFRASTRUCTURE CONSULTING & ENGINEERING, PLLC No. 4470 CERTIFICATE OF AUTHORIZATION

SCALE: 1" = NTS

REV. NO.	BY	DATE	DESCRIPTION OF REVISION
7			
6			
5			
4			
3			
2			
1			

SOUTH CAROLINA DEPARTMENT OF TRANSPORTATION
S–51

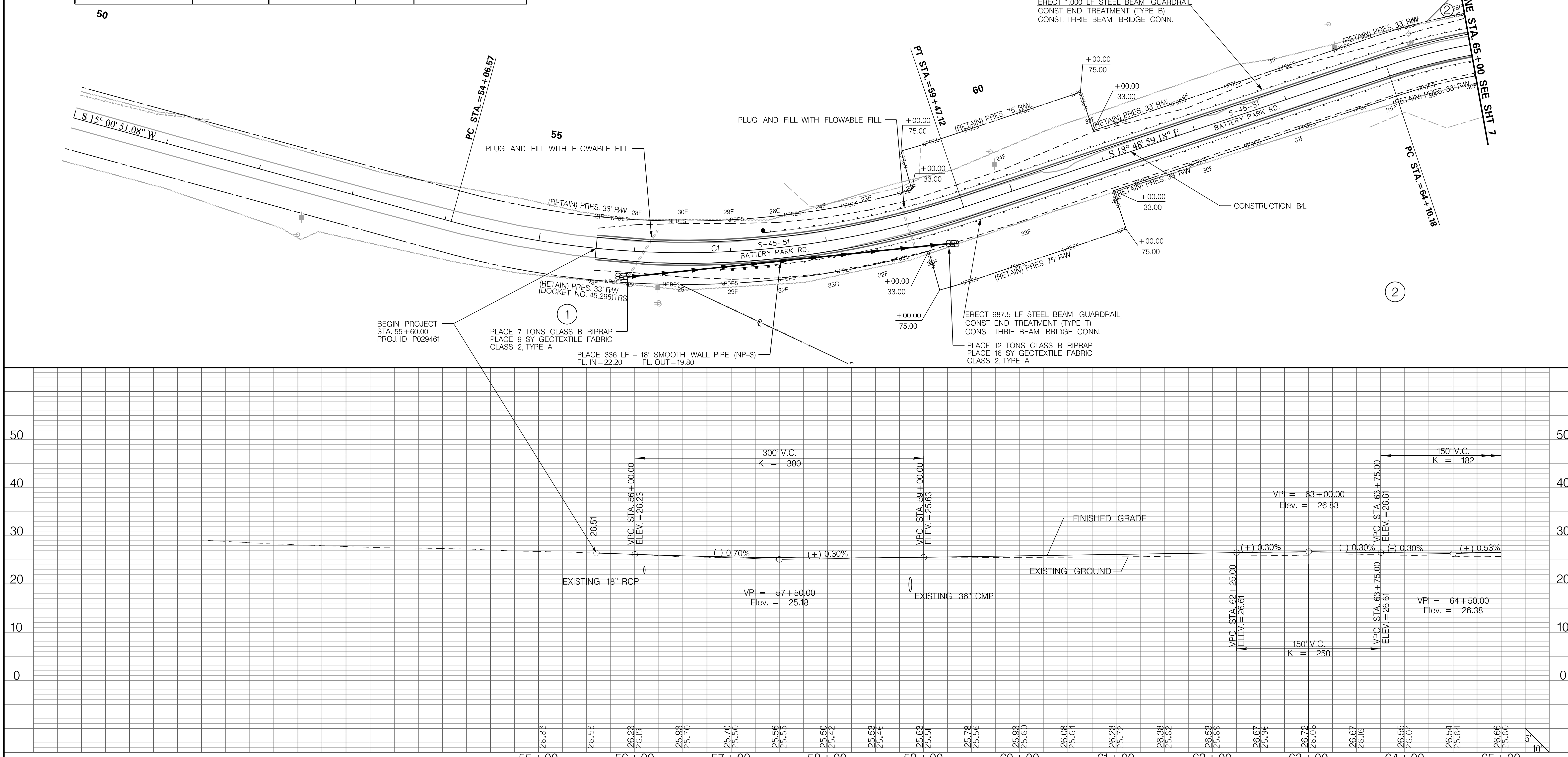
TYPICAL SECTIONS

S–51 BRIDGE REPLACEMENT
OVER BLACK MINGO CREEK
(BATTERY PARK RD.)

Z:\Projects\15-42 Emerg Bridge Replace PKG 4\S-51Battery Park Rd\Roadway\DGN\Plans\SHT03_TYPICAL.dgn
2/17/2016

FED. RD. DIV. NO.	STATE	COUNTY	PROJECT ID	ROAD / ROUTE NO.	SHEET NO.
3	SC	WILLIAMSBURG	P029461	S-51	6

UTILITY	CONTACT NAME	EMAIL ADDRESS	PHONE NUMBER	ALTERNATE PHONE NUMBER
Santee Electric Coop., Inc.				
Farmers Telephone Coop.				
Williamsburg County Water and Sewer				



SOUTH CAROLINA PROFESSIONAL ENGINEER No. 26136 AARON O. LIVINGSTON

SOUTH CAROLINA INFRASTRUCTURE CONSULTING & ENGINEERING, PLLC No. 4470 CERTIFICATE OF AUTHORIZATION

SCALE: 1" = 50'

REV. NO.	BY	DATE	DESCRIPTION OF REVISION
7			
6			
5			
4			
3			
2			
1			

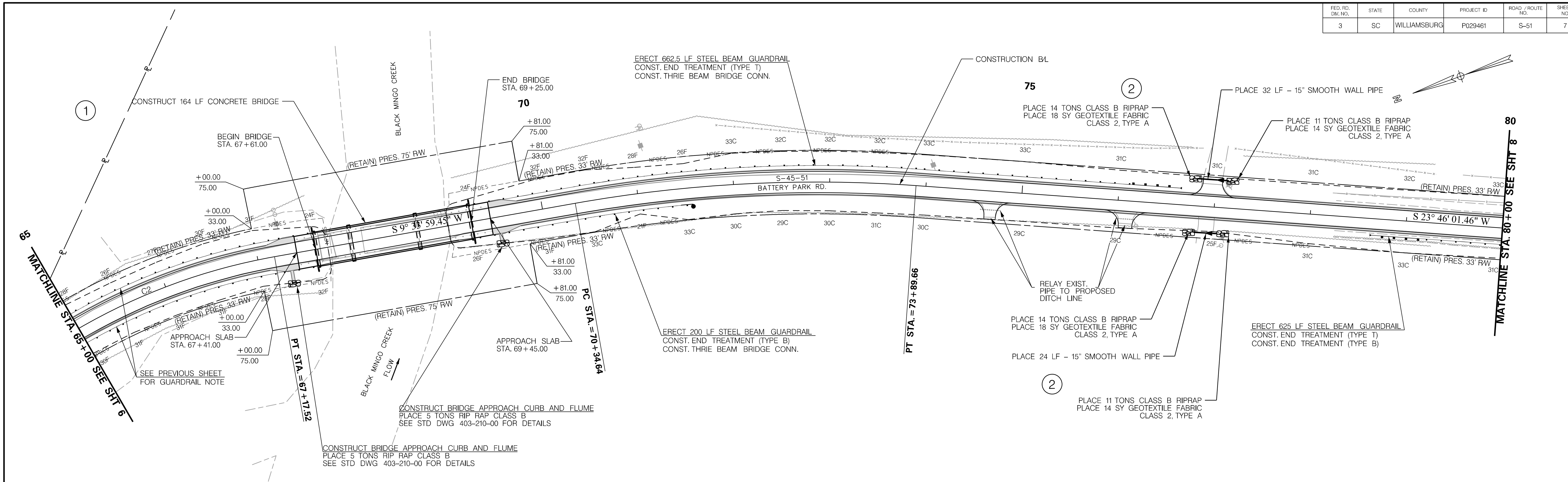
SOUTH CAROLINA DEPARTMENT OF TRANSPORTATION
S-51

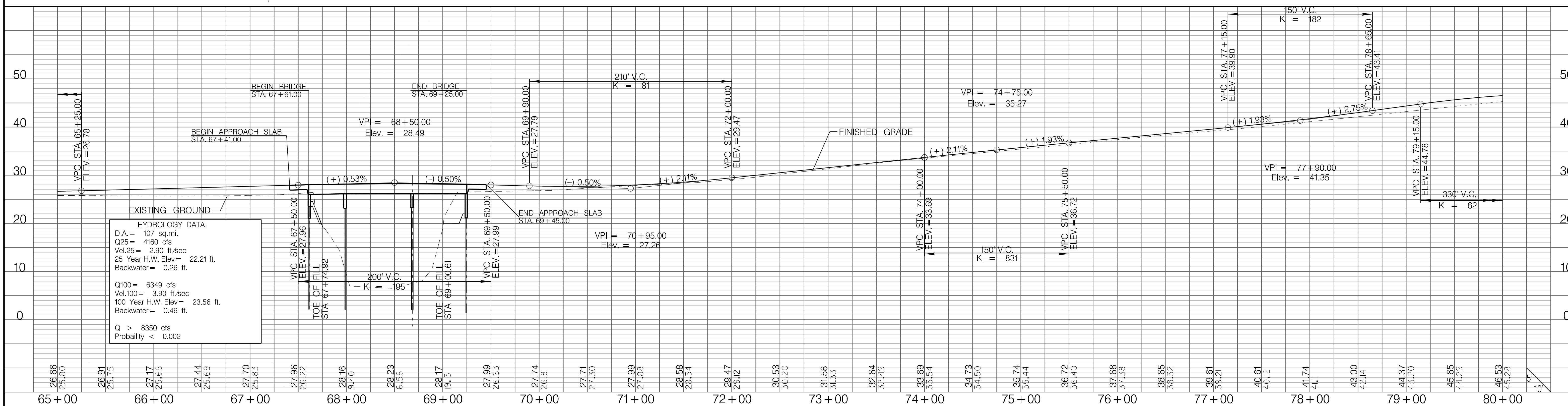
PLAN PROFILE SHEET

S-51 BRIDGE REPLACEMENT
OVER BLACK MINGO CREEK
(BATTERY PARK RD.)

Z:\Projects\15-42 Emerg Bridge Replace PKG 4\S-51Battery Park Rd\Roadway\DGN\Plans\SHT-06_Plan.dgn
2/17/2016

FED. RD. DIV. NO.	STATE	COUNTY	PROJECT ID	ROAD / ROUTE NO.	SHEET NO.
3	SC	WILLIAMSBURG	P029461	S-51	7





SCALE: 1" = 50'

REV. NO.	BY	DATE	DESCRIPTION OF REVISION
7			
6			
5			
4			
3			
2			
1			

SOUTH CAROLINA DEPARTMENT OF TRANSPORTATION
S-51

PLAN PROFILE SHEET

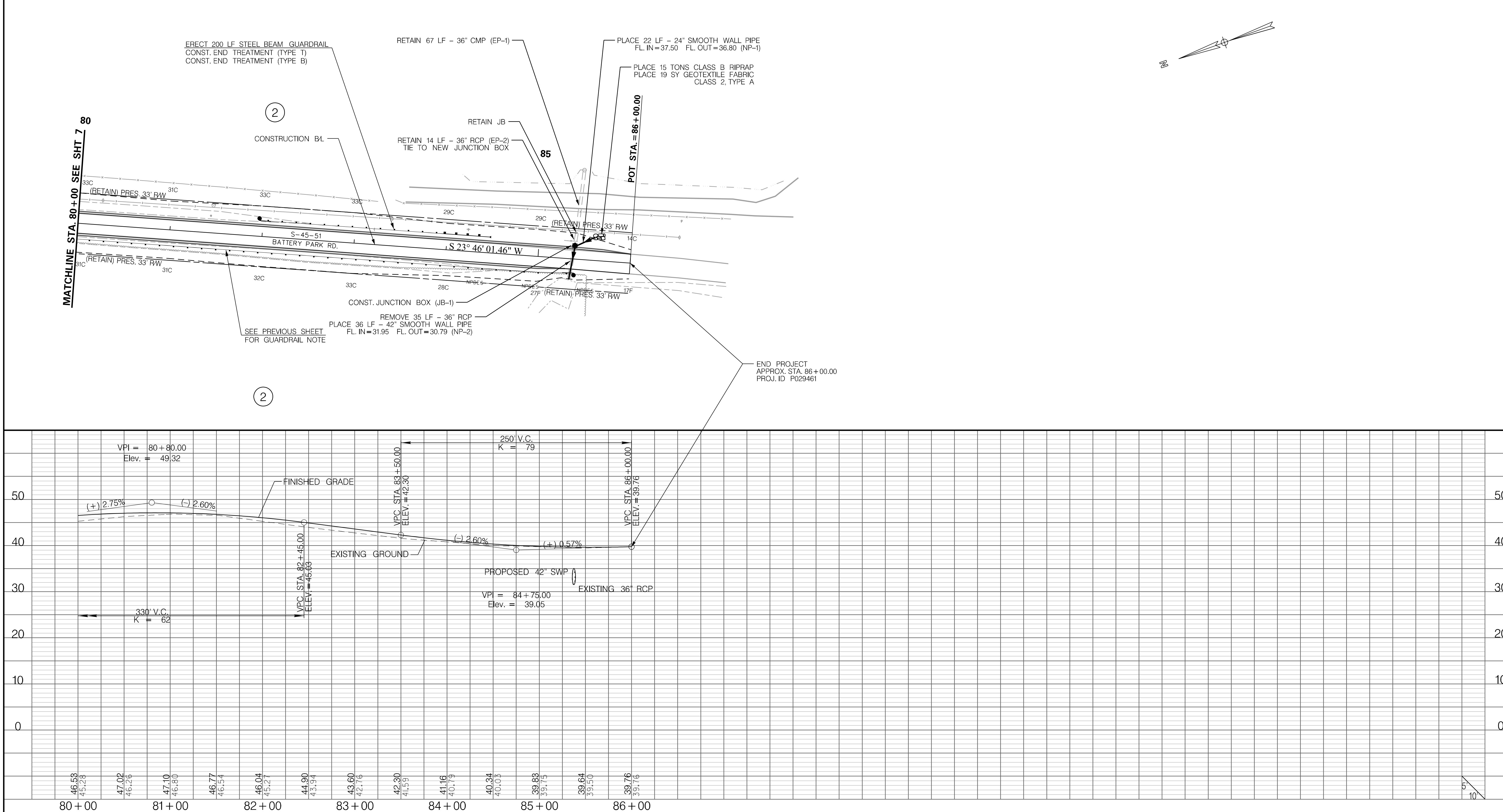
S-51 BRIDGE REPLACEMENT
OVER BLACK MINGO CREEK
(BATTERY PARK RD.)

SOUTH CAROLINA REGISTERED PROFESSIONAL ENGINEER No. 26136 AARON O. LIVINGSTON

SOUTH CAROLINA INFRASTRUCTURE CONSULTING & ENGINEERING, PLLC No. 4470 CERTIFICATE OF AUTHORIZATION

Z:\Projects\15-42 Emerg Bridge Replace PKG 4\S-51 Battery Park Rd\Roadway\DGN\Plans\SHT-07_Plan.dgn
2/17/2016

FED. RD. DIV. NO.	STATE	COUNTY	PROJECT ID	ROAD / ROUTE NO.	SHEET NO.
3	SC	WILLIAMSBURG	P029461	S-51	8



SOUTH CAROLINA PROFESSIONAL ENGINEER No. 26136 AARON O. LIVINGSTON

SOUTH CAROLINA INFRASTRUCTURE CONSULTING & ENGINEERING, PLLC No. 4470 CERTIFICATE OF AUTHORIZATION

SCALE: 1" = 50'

REV. NO.	BY	DATE	DESCRIPTION OF REVISION
7			
6			
5			
4			
3			
2			
1			

SOUTH CAROLINA DEPARTMENT OF TRANSPORTATION
S-51

PLAN PROFILE SHEET

S-51 BRIDGE REPLACEMENT
OVER BLACK MINGO CREEK
(BATTERY PARK RD.)

Z:\Projects\15-42 Emerg Bridge Replace PKG 4\S-51Battery Park Rd\Roadway\DGN\Plans\SHT-08_Plan.dgn
2/17/2016

Appendix M
Photos from Site Visit January 2016

Looking Upstream From Center of Bridge

Looking Downstream From Center of Bridge

South Approach

North Approach

Interior Bent

South Abutment

Upstream Face

Upstream Right Overbank

Downstream Right Overbank

Downstream Face

North Abutment

Upstream Left Overbank

Downstream Left Overbank

Washed Out Bridge

North Approach Washout

North Approach Washout

North Approach Washout

Pond on North Approach within ROW on East Side with no Outlet Structure

Upstream Bridge Site– Looking Up-stream From Bridge

Upstream Bridge Site– Looking Up-stream From Bridge

Appendix N
FEMA Firm Map and FIS Report

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Coastal Base Flood Elevations shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD 88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures in this jurisdiction.

The **projection** used in the preparation of this map was South Carolina State Plane, FIPSZONE 3900. The **horizontal datum** was NAD83, GRS80 spheroid. Differences in datum, spheroid, projection or State Plane zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the North American Vertical Datum of 1988. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at http://www.ngs.noaa.gov or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey, SSMC-3, #9202
1315 East-West Highway
Silver Spring, Maryland 20910-3282
(301) 713-3242

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at **(301) 713-3242**, or visit their website at http://www.ngs.noaa.gov/.

Base map information shown on the Flood Insurance Rate Map (FIRM) was derived from U.S.Geological Survey (USGS), National Geodetic Survey, Census Bureau, Williamsburg County, SC and South Carolina Office of Research and Statistics. This information was developed at scales of 1"=2000', 1"=1000' and 1"=500'. Users of this FIRM should be aware that minor adjustments may have been made to specific base map features.

This map reflects more detailed and up-to-date **stream channel configurations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables in the Flood Insurance Study report (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on this map.

Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

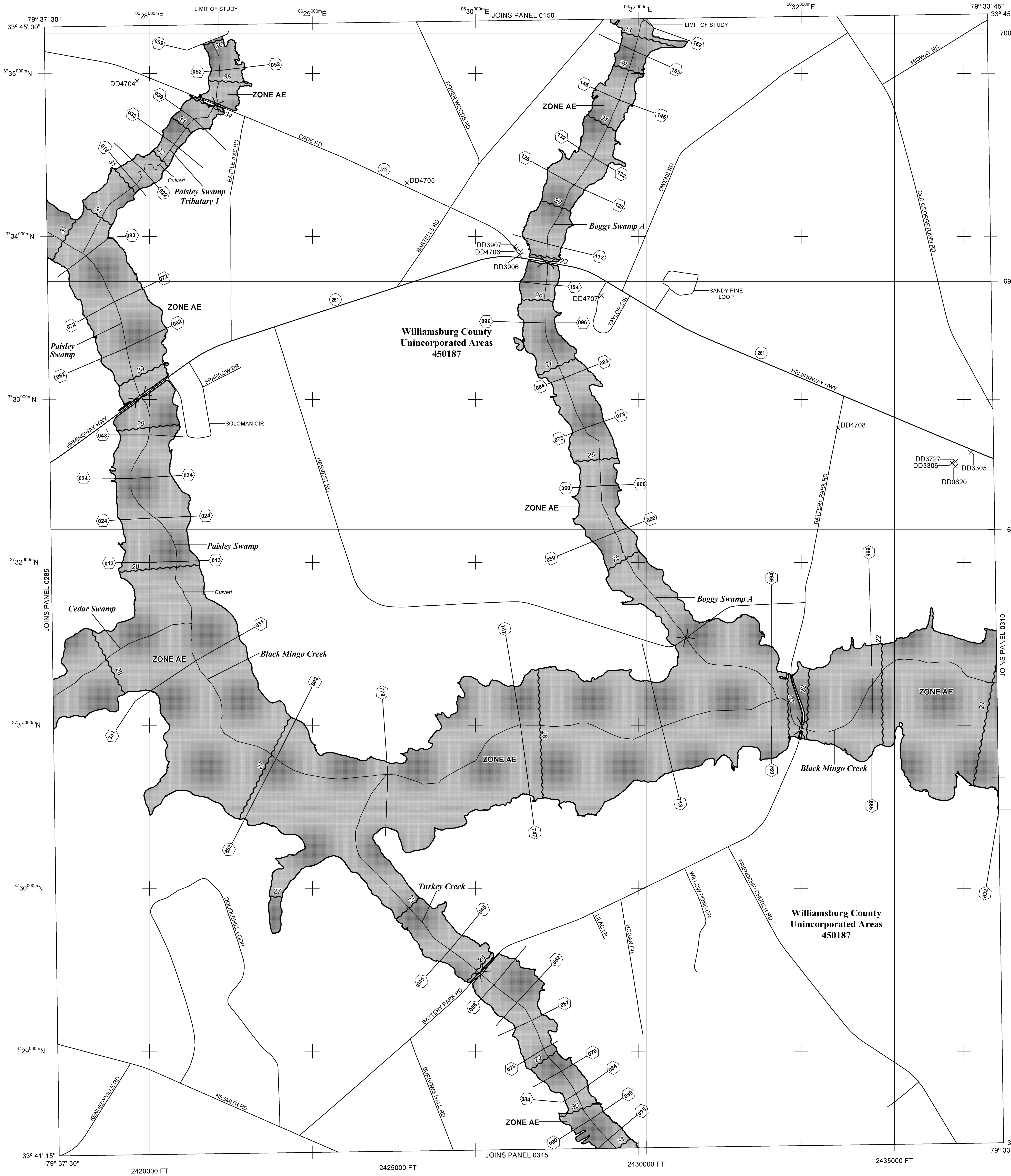
For information on available products associated with this FIRM visit the **Map Service Center (MSC)** website at http://msc.fema.gov. Available products may include previously issued Letters of Map Change, a Flood Insurance Study Report, and/or digital versions of this map. Many of these products can be ordered or obtained directly from the MSC website.

If you have **questions about this map**, how to order products or the National Flood Insurance Program in general, please call the **FEMA Map Information eXchange (FMIX)** at **1-877-FEMA-MAP** (1-877-336-2627) or visit the FEMA website at http://www.fema.gov/business/nfip.

DNR

This digital Flood Insurance Rate Map (FIRM) was produced through a unique cooperative partnership between the State of South Carolina and the Federal Emergency Management Agency (FEMA). The State of South Carolina has implemented a long-term approach of floodplain management to decrease the costs associated with flooding. This is demonstrated by the State's commitment to map floodplain areas at the local level. As a part of this effort, the State of South Carolina has joined in a Cooperating Technical State agreement with FEMA to produce and maintain this digital FIRM.

http://www.dnr.state.sc.us/



LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR	Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X Areas determined to be outside the 0.2% annual chance floodplain.
ZONE D Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

Floodplain boundary
Floodway boundary
Zone D Boundary
CBRS and OPA Boundary

Boundary dividing Special Flood Hazard Area Zones and boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.

513	Base Flood Elevation line and value; elevation in feet*
(EL 987)	Base Flood Elevation value where uniform within zone; elevation in feet*

*Referenced to the North American Vertical Datum of 1988

A — A	Cross section line
23 - - - 23	Transect line
	Culvert, Flume, Penstock or Aqueduct
	Road or Railroad Bridge
	Footbridge
97° 07' 30", 32° 22' 30"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83), Western Hemisphere
$^{42}76^{000m}$E	1000-meter Universal Transverse Mercator grid values, zone 17
600000 FT	5000-foot grid ticks: South Carolina State Plane coordinate system, FIPSZONE 3900, Lambert Conformal Conic Projection
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
• M1.5	River Mile

MAP REPOSITORIES
Refer to Map Repositories list on Map Index.

EFFECTIVE DATE OF COUNTYWIDE FLOOD
INSURANCE RATE MAP PANEL
November 16, 2012

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 1000'

500 0 1000 2000 FEET

300 0 300 600 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0305D

FIRM

FLOOD INSURANCE RATE MAP

WILLIAMSBURG COUNTY, SOUTH CAROLINA
AND INCORPORATED AREAS

PANEL 305 OF 700

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
WILLIAMSBURG COUNTY	450187	0305	D

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

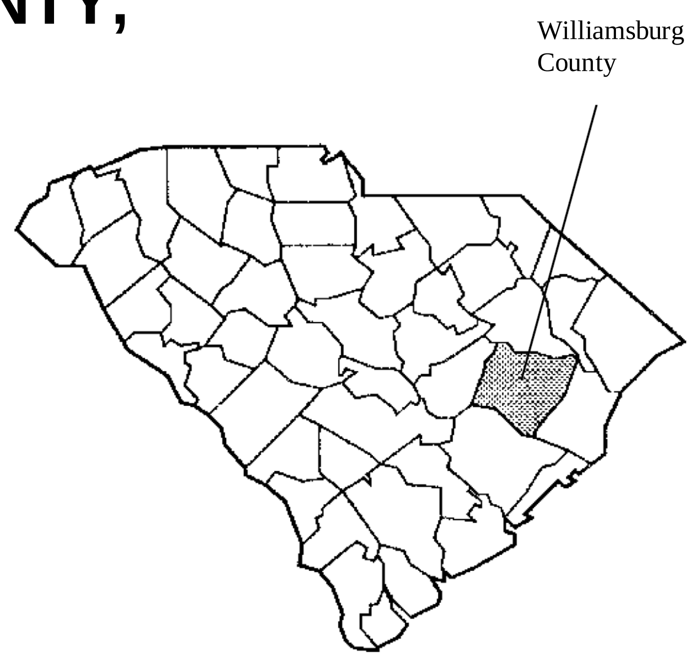
MAP NUMBER
45089C0305D

EFFECTIVE DATE
NOVEMBER 16, 2012

Federal Emergency Management Agency

FLOOD INSURANCE STUDY

WILLIAMSBURG COUNTY, SOUTH CAROLINA,
AND INCORPORATED AREAS



Community Name	**Community Number**
GREELEYVILLE, TOWN OF	450188
HEMINGWAY, TOWN OF	450189
KINGSTREE, TOWN OF	450190
LANE, TOWN OF	450191
STUCKEY, TOWN OF	450192
WILLIAMSBURG COUNTY (UNINCORPORATED AREAS)	450187

EFFECTIVE DATE: NOVEMBER 16, 2012

Federal Emergency Management Agency
FLOOD INSURANCE STUDY NUMBER
45089CV000A

TABLE 4—Limited Detailed Flood Hazard Data			
Cross Section[1]	Stream Station[2]	Flood Discharge (cfs)	1% Annual Chance Water-Surface Elevation (feet NAVD 88)
BLACK MINGO CREEK (continued)			
494	49436	7,039	17.7
501	50100	7,039	17.8
506	50627	7,039	17.87
513	51345	7,039	17.97
520	51975	7,039	18.04
527	52673	7,039	18.14
533	53325	7,039	18.29
541	54059	7,039	18.51
548	54764	7,039	18.69
553	55309	7,039	18.81
560	55973	7,039	19.01
566	56571	7,039	19.24
573	57277	6,349	19.47
578	57785	6,349	19.61
584	58402	6,349	19.77
591	59074	6,349	19.94
601	60141	6,349	20.19
613	61288	6,349	20.43
623	62288	6,349	20.65
632	63165	6,349	20.86
639	63935	6,349	21.05
649	64865	6,349	21.37
658	65806	6,349	21.82
665	66539	6,349	22.15
679	67923	6,349	22.69
684	68393	6,349	22.74
685	68519	6,349	24.36
694	69444	5,677	25.41
700	69977	5,677	25.46
706	70647	5,677	25.6
712	71151	5,677	25.68
718	71756	5,677	25.76
724	72377	5,677	25.83
732	73210	5,677	25.91
740	74035	5,677	25.97
747	74728	5,677	26.04
756	75575	5,677	26.13
764	76387	5,677	26.27
772	77191	5,677	26.46
779	77881	5,677	26.63
785	78506	5,058	26.76
791	79092	5,058	26.83

Appendix O
No-Rise Certification Letter

INFRASTRUCTURE
CONSULTING & ENGINEERING

January 18, 2016

Roosevelt Anderson
Deputy Codes Enforcer
Williamsburg County
201 West Main Street
Kingstree, SC 29556

Project: Emergency Bridge Replacement Package 4
S-45-51 Over Black Mingo Creek

Dear Mr. Anderson:

Infrastructure Consulting and Engineering is performing the hydraulic review of the Emergency Bridge Replacement Package 4. This project includes four bridges in Kershaw, Richland, and Williamsburg Counties in South Carolina. The S-45-51 Bridge over Black Mingo Creek is located in Williamsburg County. The closest major intersection is the S-45-51 (Battery Park Road) and SC-512 (Hemingway Hwy). This bridge will be replaced on the existing alignment with a temporary detour during construction.

The existing bridge on this site is 135 feet long and has collapsed during the recent flood event of October 2015. The proposed bridge will be 164 feet long. The project is located within a FEMA regulated stream. It is located on FIRM 45089C0305D, dated November 16, 2012. The hydraulic characteristics of the new bridge crossing are such that the 100-year flood profile upstream and downstream of the new bridge crossing will not increase, resulting in "no rise" conditions along Black Mingo Creek.

Enclosed is a copy of our hydraulic analysis report and "no rise" certification for the proposed bridge crossing. If you concur with the "no rise" submittal, please respond to me in writing. An approval by your department is required to continue with construction on this project.

Please contact me at 803-726-3159 if you have any questions or need any additional information.

Sincerely,

Ronnie Smoak, P.E.
Infrastructure Consulting and Engineering

Appendix P
HEC-RAS Data and CD