Florence & Hutcheson, Inc.
CONSULTING ENGINEERS

August 31, 2009

Tuhin Basu, P.E.
Tuhin Basu & Associates, Inc.
7921 Jones Branch Drive, Suite G08
McLean, Virginia 22102

Re: U.S. Route 701 Bridge Replacements
Horry / Georgetown Counties, South Carolina
Summary of Hydraulic Study

Dear Mr. Basu:

The following summary has been prepared in support of the Environmental Assessment for the U.S. Route 701 Bridge Replacements over the Great Pee Dee River and floodplain area. The proposed project includes the replacement of three bridges along U.S. Route 701, the Great Pee Dee River Bridge, Great Pee Dee River Overflow Bridge, and the Yauhannah Lake Bridge. The project is located along the border of Georgetown and Horry County. The purpose of the project is to replace structurally deficient and obsolete bridges while maintaining the direct route between the towns of Conway and Georgetown. The bridges will be replaced on a new alignment located adjacent to the existing roadway. After completion of the project, the existing bridges will be removed.

The proposed project is located within a FEMA defined Special Flood Hazard Area Zone A. As a Zone A area, the floodplain area shown on the FEMA Flood Insurance Rate Maps was developed based on approximate methods. There is no existing effective hydraulic model for this area.

The project hydraulic analysis and design is being completed based on SCDOT guidelines and applicable FEMA regulations. The information in this letter is based on existing bridge plans and preliminary design for the project provided by Tuhin Basu & Associates.

Qualitative Analysis

The Great Pee Dee River floodplain is approximately 9000' wide at the U.S. Route 701 crossing. Approaching the project from the south, U.S. Route 701 crosses Yauhannah Lake, the Great Pee Dee River, and lastly the Great Pee Dee River overflow area. Field reviews during normal flow conditions indicated an approximate flow velocity of 1.0 fps within the Great Pee Dee River. Field observations also indicated, flow from the Great Pee Dee River was filling into the Yauhannah Lake area. There was no measurable flow at the overflow bridge.

The floodplain area is heavily wooded and experiences frequent flooding with minimal depth. The banks along the Great Pee Dee River are stabilized with trees, although there are some areas of exposed roots. Based on historical maps, there is no significant evidence of stream migration, however as with any major river, a large flood event will most likely result in some relocation of the river.

The Great Pee Dee River watershed is approximately 14,700 square miles and includes the Little Pee Dee River basin, the Lumber River, and the Lynches River. The Great Pee Dee River begins as the Yadkin River in western North Carolina. Throughout North Carolina, the river is dammed in several locations for hydroelectric power generation and water reservoirs. In South Carolina the river converges with the Little Pee Dee River approximately 5 miles upstream of the project and discharges into Winyah Bay near Georgetown. Although heavily regulated throughout North Carolina, the Great Pee Dee River remains unimpeded in South Carolina.

Bottom of channel elevations were approximately -25 along the river and -15 at Yauhannah Lake. Although there is some tidal influence in the river, the analysis of flooding history, field data, and the watershed indicates the design flood would be the result of a riverine flow condition and any tidal influence would not have a significant impact on water surface elevations or flow velocities.

Hydrological Analysis

A hydrological analysis was completed for the watershed area to estimate design flows for the hydraulic modeling. The hydrological study incorporated USGS gage data at the project site, upstream USGS gage data, as well as the characteristics of the river. Three methods were used to estimate the design flows, unit value method (utilizes limited USGS gage data at the project site), slope conveyance method (utilizes stream characteristics including channel slopes), and a ratio method (utilizes upstream USGS gage data). The regression equations were not chosen for the hydrological study because the equations do not account for the natural storage and detention within the floodplain area.

Design flows calculated by each of the three methods were consistent. The resulting design flows are shown in Table 1.

Table 1: Project Design Flows

Design Storm	Flow (cfs)
50-Year	114,000
100-Year	128,000
500-Year	163,000

The analysis of the USGS gage data at the project site indicated the presence of tidal flow, however during the design storm events, tidal flow will have no significant impact on the riverine flow conditions.

One-Dimensional Hydraulic Analysis

In accordance with the SCDOT requirements, a one-dimensional flow analysis was completed for the project. The hydraulic analysis was completed using HEC-RAS version 4.0. The HEC-RAS model was developed based on project mapping, field surveying, and available USGS and SCDNR topographic data. A HEC-RAS model was developed for the natural, existing, and proposed conditions. The project design flows shown in Table 1 were used for the analysis. The model boundary conditions, as well as roughness coefficients were based on survey data as well as field studies.

The existing conditions model was developed based on field surveys and existing as-built bridge plans. The existing bridge configuration includes approximately 4300' of total bridge length including a 1600' bridge at the Great Pee Dee River. The proposed conditions model was based on the preliminary design and includes approximately 5250' of total bridge length including a 2435' bridge at the Great Pee Dee River. The natural

conditions model was developed neglecting the presence of the roadway causeway and bridges. The results of the natural conditions model are used to estimate backwater by the proposed and existing bridge structures.

The results of the natural, existing, and proposed conditions modeling is provided in Table 2 for the 50-year, 100-year, and 500-year storms.

Table 2: One-Dimensional Modeling Results

	50-Year WSE	100-Year WSE	500-Year WSE	100-Year Backwater
Natural Conditions	15.3	16.5	19.1	-
Existing Conditions	15.7	16.9	19.6	0.4
Proposed Conditions	15.6	16.8	19.5	0.3

The results shown in Table 2 indicate the proposed bridge configuration will lower water surface elevations and reduce backwater upstream of U.S. Route 701. The resulting backwater is less than 1.0 and therefore the proposed design satisfies SCDOT and FEMA design criteria.

Based on the preliminary roadway and bridge design, the preliminary hydraulic data for the project is shown below:

Hydrology Data
D.A.=14,700 sq. miles
Q_{50}=114,000 cfs
$Vel._{50}$=4.4 fps
50-Year Headwater Elevation=15.6
Including 0.3 ft. backwater
Q_{100}=128,000 cfs
$Vel._{100}$=4.6 fps
100-Year Headwater Elevation=16.8
Including 0.3 ft. backwater

Overtopping Flood
Q>163,000 cfs
Probability<0.2%

50-Year High Water Elevation Including Backwater=15.6
100-Year High Water Elevation Including Backwater=16.8

Two-Dimensional Hydraulic Analysis

The complexity of the Great Pee Dee River floodplain warrants a two-dimensional hydraulic analysis for the project. The two-dimensional analysis will verify water surface elevations and provide improved velocity data in the vicinity of the bridge structures. The two-dimensional hydraulic analysis will be completed based on the project mapping and survey data. The water surface elevations developed with the one-dimensional analysis will be used as the boundary conditions for the two-dimensional analysis. The results of the two-dimensional analysis will be used to estimate scour and design scour countermeasures for the proposed bridges.

Summary

The results of the preliminary hydraulic analysis for the U.S. Route 701 Bridge Replacements over the Great Pee Dee River and Floodplain Areas indicate the proposed bridge configuration satisfies SCDOT and FEMA design criteria and reduces existing backwater as compared to existing conditions. The improved conveyance is the result of the additional bridge length and improved efficiency by using larger bridge span lengths and reducing obstructions within the waterway.

In support of the Environmental Assessment, the attached Floodplains Checklist has been completed based on the above data. The proposed project will not be a significant longitudinal encroachment as defined under 23 CFR 650A, nor is it expected to have an appreciable environmental impact on the base floodplain.

Please review the summary above as well as the attached data. The results provided in this summary are based on preliminary design and may be revised as design progresses for the project. If you have any questions or comments, please contact me at 803-254-5800 or 803-730-8912.

Respectfully Submitted,

FLORENCE & HUTCHESON, INC.

Edward J. Owens, Jr., P.E.
Project Engineer

SOUTH CAROLINA
FLORENCE & HUTCHESON, INC.
No. C00643
CERTIFICATE OF AUTHORIZATION

SOUTH CAROLINA
LICENSED PROFESSIONAL ENGINEER
No. 24246
EDWARD J. OWENS, JR.

8/31/2009

South Carolina Department of Transportation
Location and Hydraulic Design of Encroachments on Floodplains Checklist

23 CFR 650, this regulation shall apply to all encroachments and to all actions which affect base floodplains, except for repairs made with emergency funds. Note: These studies shall be summarized in the environmental review documents prepared pursuant to 23 CFR 771.

I. PROJECT DESCRIPTION

The proposed project includes the replacement of three bridges along U.S. Route 701 over the Great Pee Dee River, Yauhannah Lake, and the Great Pee Dee River Overflow Area. The existing bridges include 4300' of total bridge length with a 1600' bridge over the Great Pee Dee River. The proposed bridge configuration includes 5250' of total bridge length including a 2435' over the Great Pee Dee River. The proposed bridges will be replaced on an offset alignment adjacent to the existing roadway. The existing bridges will be removed upon the completion of the proposed project.

A. Narrative Describing Purpose and Need for Project
   a. Relevant Project History:
   b. General Project Description and Nature of Work (attach Location and Project Map):
   c. Major Issues and Concerns:

Refer to the Environmental Assessment for project details.

B. Are there any floodplain(s) regulated by FEMA located in the project area?
   Yes☒ No☐

C. Will the placing of fill occur within a 100-year floodplain?
   Yes☒ No☐

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

The project will include a roadway profile grade change in order to provide clearance for deeper bridge beams, allowing longer bridge spans. The existing profile will be raised approximately 2 to 2.5' on average.

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

Not Applicable

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:

a. What are the risks associated with implementation of the action?

Not Applicable. No baseflood impacts, not a significant encroachment.

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

The proposed project will include an additional 800' (approximate) of bridge length as compared to the existing conditions. The proposed bridge configuration results in a backwater less than 1.0', therefore satisfying SCDOT and FEMA design criteria. The proposed bridges also utilize longer span lengths, reducing the impacts from the placement of piers within the waterway and floodplain area.

c. The support of probable incompatible floodplain development.

Not Applicable

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

The proposed bridge length includes an additional 800' (approximate) of bridge length as well as longer bridge spans to reduce pier impacts within the waterway and floodplain area.

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

The proposed bridge configuration utilizes increased bridge span lengths to reduce impacts within the waterway and floodplain areas. Also, the proposed construction plans will require erosion control best management practices throughout the construction area to minimize floodplain impacts.

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

Not Applicable, not a significant encroachment.

H. Were 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 and to obtain current information on development and proposed actions in the affected? Please include agency documentation.

Refer to the Environmental Assessment for project details. A copy of the completed Hydraulic Design and Risk Assessment will be provided to the Horry and Georgetown County Floodplain Manager.