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February 28, 2006

Mr. Ed EuDaly
U.S. Fish and Wildlife Service
Suite 200
176 Croghan Spur Road
Charleston, SC 29407

Dear Mr. EuDaly,

I have completed my review of the report "Development of the Hydrodynamic and Water Quality Models for the Savannah Harbor-Final Report January 30, 2006" prepared by Tetra Tech (Tt) for the U.S. Army Corps of Engineers – Savannah District. This report and its appendices is the final report from the draft report we commented on in July 2005. The emphasis of my review focused on the predictive ability of the model in the vicinity of the Savannah National Wildlife Refuge (SNWR). Changes to the model since the review of the previous draft have improved the model. Water-level predictions in the upper reaches at Station SR17 have significantly improved and demonstrate the model appropriately simulates the riverine and tidal influences on water level in this area. The salinity predictions in the Middle and Little Back Rivers also have been improved.

I assumed that the comments from the previous review of the draft report would be addressed in this report. Four of our comments were not addressed. Two of the comments were requests for results from the convergence testing and sensitivity analysis to be shown for locations in the vicinity of the SNWF. The other two comments were a request for clarification of the source of Fort Pulaski data and a figure summarizing the relative contribution of loading of oxygen-consuming constituents for the model. Addressing these comments would not have required significant resources. For the convergence testing and sensitivity analysis, the request was only to present results for additional sites rather than additional testing and analysis. For the clarification of data sources, rewording of a sentence would have been sufficient to address the comment. For a summary of the loading to the system, one additional figure needed to be presented. It may be that my assumption that all the comments would be addressed in this report is incorrect and the comments will be addressed in a separate or subsequent document.

There are two areas where I have concerns about the predictive ability of the model and using model results for various mitigation scenarios. The flow simulation for the Middle and Little Back River often do not simulate reversing flows although the data from 1999 show reversing flows. Similar concern is expressed for the ebb current flows on the Front River. These concerns also were communicated in our previous review of the model. The latest version of the model does not make any significant improvement in these areas. Also of concern are the simulations of dissolved-oxygen concentrations from the model. The predictions will need to be used with great caution. The ability of the model to capture the overall trend of the dissolved

oxygen, as represented by the coefficient of determination (R^2), indicated that only three of the 17 sites evaluated were able to explain over 50 percent of the variability in dissolved-oxygen concentration (Table P-2). The majority of sites (9 of 17) explained 25 percent, or less, of the variability. The results for the Savannah River Estuary Model are not atypical of water quality models of other Southeastern Estuarine system and reflect the difficulty in modeling these types of system. The challenge is in determining how to interpret and utilize results from a model with known limitations to its predictive ability for certain parameters.

The Savannah River Estuary is a complex system to measure, analyze, and ultimately, to predict. The data collection and modeling effort, by both Applied Technology and Management and Tetra Tech, over the past ten years has demonstrated the difficulty of the monitoring and modeling the system. The model and the report demonstrate there is a limited understanding and modeling ability of the flow/velocity dynamics in the Middle, Little Back, and Back Rivers and of the dissolved-oxygen dynamics for the system as a whole. These limitations demonstrate the need for continued monitoring and analysis of the system to improve on our understanding of the system. The limitations also demonstrate the need for an adaptive management approach to accommodate further understanding of the system.

The model development and review for Savannah Harbor Expansion Model has been a long process. The goal of all of the participants has been to produce the best tool for determining future impacts of the Savannah Harbor Expansion Project on Savannah River resources. Despite the limitations of the model, the model presented in the report is the best currently available model of the system. Please call me at (803) 750-6140 if you have any questions or need additional information.

Sincerely,

Paul A. Conrads
Hydrologist

Enclosure

Review Comments

by Paul Conrads, U.S. Geological Survey, Columbia, SC

On

“Development of the Hydrodynamic Model and Water Quality Models for the Savannah Harbor Expansion Project FINAL January 30, 2006”

prepared by Tetra Tech (Tt)

for the U.S. Corps of Engineers–Savannah District

1. From our previous review (June 28, 2005), the following comments do not appear to have been addressed:
 - a. Comment 1 on the convergence testing: “Additional documentation should include results for sites in the Middle, Little Back, and Back Rivers.” Only results from the original three sites on the Savannah and Front River were shown in latest report.
 - b. Comment 2 on the sensitivity analysis: “For the sensitivity of the water-quality model, additional sites in the Middle, Little Back, and Back Rivers should be shown.” Only results on the Savannah and Front River sites are either presented in the tables or in the figures. No results are presented for sites on the Middle, Little Back, and Back Rivers.
 - c. Comment 4. It is still unclear whether NOAA or USGS data is used for the approximation of the offshore boundary.
 - d. Comment 16. “It is difficult to get an appreciation of the relative contributions of the BOD and nitrogen loading input to the system. A bar or pie chart the average or total load from point sources, storm water, ocean, upstream, and marsh loading would be helpful.” The relative contribution of the loading from various sources is not summarized in a table or figure.
2. Sensitivity analysis shows that the sites near the SNWR are sensitive to small (10 percent) changes in flow. Flow information below Clio, such as the contribution of intervening basins/tributaries, for example Union Creek, has not been measured and documented. The model assumes a 10-percent increase due to change in the drainage area and a constant inflow from Union Creek. These assumptions should be kept in mind when evaluating mitigation scenarios and future monitoring needs.
3. The water-level simulations in the latest version of the model have been much improved. Specifically, the simulation at SR-17 (figure B-14) in the previous model showed too much tidal influence and not enough riverine influence. The latest calibration shows an appropriate balance between the two forces.
4. The model still generally under predicts the ebb-tide currents and flow in the system. It was previously speculated (Comment 8, previous review) that the under predictions may be due to the model not satisfactorily simulating the riverine dynamics in the system. The improvements in the riverine dynamics

(as seen in figure B-14) did not correspond to an improvement in ebb-tide currents and flow predictions. Overall flow statistics have improved slightly in the latest calibration.

5. Salinity simulations in the vicinity of SNWR have improved (compare figures J-18, J-26, J-27 in both reports). The lag in salinity response noted in previous review (Comment 11) still evident but significantly improved with latest calibration.
6. The over prediction of BOD_u in the Middle River has been reduced but the model still predicts two to three times too much BOD_u.
7. The complexity of dissolved oxygen dynamics in Southeastern estuaries are difficult to simulate. Often dissolved-oxygen models are not able to make absolute prediction and typically do not simulate the diel and diurnal variability in dissolved oxygen, as seen in the differences in standard deviations of measured and predicted data. Hopefully, the model captures the overall trend. The coefficient of determination (R^2) statistic measures the ability of the model to capture the overall trend of the data. Fourteen of the 17 sites have R^2 's of less than 0.5 and 9 of 17 have R^2 's of less than 0.25. Therefore, the majority of sites could only explain 25 percent, or less, of the variability in dissolved oxygen. The U.S. Fish and Wildlife Service should use caution when evaluating impacts to dissolved oxygen based on model prediction.