Evaluation of Savannah Harbor Estuary Models by Federal Agencies

INTRODUCTION

The southeastern offices of certain Federal agencies (EPA, USFWS, USGS, and USACOE) will be evaluating the performance of the Hydrodynamic & Salinity and Dissolved Oxygen Models. The critical issue in the evaluation is the defensibility of the models as an acceptable tool to evaluate environmental impacts of a potential deepening. Many aspects of the model will be reviewed to determine the defensibility including, but not limited to, model assumptions, model prediction capabilities, model performance, documentation of models, and the report of the models' application and performance on the Savannah River Estuary. This document does not supercede previous documents on evaluation or approval of models and/or reports.

EVALUATION FACTORS

Model Assumptions: The Savannah River estuary is a complex inter-connected river/estuary system. All models include some assumptions that are inherent in their solution to the hydrodynamic and water-quality equations contained within the model. The modeling report will identify the major assumptions and the assumptions will be evaluated to insure that application of the model to the Savannah River estuary does not violate these assumptions and the defensibility of the model.

Model Prediction Capability: The models will simulate many scenarios that address various deepening and "re-plumbing" alternatives. Models are used to be able to predict how the physics and chemistry of the system will respond to the various alternatives. Do the assumptions of the model compromise the models ability to be used in a predictive capacity? For example, a specific issue identified for WQMAP is "Does the vertical mixing approach limit the predictive capabilities of the model and compromise the defensibility of the model?" The modeling report must document how the model can be used in the predictive mode.

Model Performance: The purpose of the 1997 and 1999 Savannah Harbor data collection and modeling effort was to better understand and quantify the processes affecting circulation and water quality in the system, and to develop a defensible hydrodynamic and dissolved-oxygen model. These models are then to be used in conjunction with the extensive monitoring data, other available data, and other tools to make the necessary absolute predictions for the evaluation of impact and mitigation issues.

In 2001, the Federal agencies prepared a Draft Expectations Document that described (1) the resources of primary concern in the estuary, (2) the locations and conditions under which project impacts should be evaluated for those resources, (3) the modeling approach to be taken, (4) the statistical analyses to be performed to document the model's performance, and (5) and the evaluation criteria.

The Expectations Document stated that its listed criteria were to be viewed as performance goals to which model predictions would be compared and evaluated for strengths and weaknesses and by which an understanding of their uncertainties may be developed. The stated criteria would not be used individually (by station and parameter) for a "pass/fail" evaluation of the model calibration and/or any post-processing routine.

The Document also stated that statistical analysis were to include calculation of the mean error, root mean square error, absolute mean error and relative error. Additionally, comparison of selected percentiles are to be used to evaluate model performance. The statistical analyses are to be performed on both the 1997 and 1999 data sets. For the 1997 validation data set, analyses are to be performed on each of the six spring/neap tidal cycles between July 9, 1997 and Oct 5, 1997. The Julian dates for those six periods are: 191-204, 205-219, 220-234, 235-249, 250-263, 264-279. For the 1999 calibration data set, analyses are to be performed on each of the five spring/neap tidal cycles between July 31 and October 13, 1999. The Julian dates for the five periods are: 213-226, 227-241, 242-255, 256-270, and 271-285.

Other statistical measures which are to be included in the Calibration Reports were separately provided to ATM by the SMART during the model development process.

In addition to statistical evaluation of prediction of specific parameters, other aspects of model performance will be evaluated to ensure the defensibility of the model performance. These consist of the following:

- Convergence Testing
- Vertical Mixing Approach (explanation and technical justification)
- Sensitivity Analyses
    - Turbulence scheme coefficients
    - Offshore salinity concentration
    - Freshwater inflow rate and timing
    - Bottom friction
    - Horizontal eddy viscosity
    - Selected water-quality rate kinetics
- Data Description and Analysis
- Weight of Evidence Approach where the report describes, based on the modeler's expertise, why the model is an appropriate predictive tool for analyzing potential physical changes in the Savannah River estuary.

The input and output files that were developed for the calibration and verification runs are to be provided so that the reviewers can check the performance of the model, if desired.

SUMMARY OF MODEL EVALUATION CRITERIA

Parameter		Percentiles					Timing of Maxima (Min)
		5 %	10 %	50 %	90 %	95 %	
Elevation (cm)		+/- 2	-	+/- 2	-	+/- 2	+/- 30
Salinity (ppt)	50% > 5 ppt	-	+/- 10%	-	+/- 10%	-	+/- 30
	50% < 5 ppt	-	-	+/- 0.5	+/- 0.5	-	+/- 30
DO (mg/L)		-	+/- 0.2	+/- 0.2	-	-	+/- 30
DO Deficit (mg/L)		-	+/- 0.2	+/- 0.2	-	-	+/- 30
Temperature (^{o}C) *		-	-	+/- 1	-	-	-
Surface Currents (m/s) **		+/- 25%	-	-	-	+/- 25%	+/- 30
Volume Flows (m/s) **		+/- 25%	-	-	-	+/- 25%	-

* 50% represent Absolute Mean Error for temperature
** 5% and 95% represent the maximum ebb and flood conditions for current and flow

Documentation of models: Models are constantly undergoing modifications and enhancements. The documentation of the code and subsequent modifications / enhancements are critical documents for the defensibility of the model. The evaluation of the final models will also include an evaluation of the documentation of the code.

Report of the models application and performance: The final report will be a critical document for the evaluation of the models that will address the evaluation factors previously discussed.

EVALUATION PROCESS

The agencies will first examine the issues related to the models' defensibility. This would include the historic use of the model, ie. does the model have a solid history of being applied in similar circumstances. This examination will ensure the models are technically defensible for these proposed applications.

The agencies will then examine the performance of the models. They will carry this out by following the evaluation priorities stated in the previous section. That will enable the reviewers to assess how well the models meet the Expectations Document, and thereby their usefulness in identifying physical changes expected to result from various Expansion Project alternatives. The reviewers will primarily consider the statistics of the models, which reflect how well the models replicate the measured physical conditions.

Other aspects of the model, although not specific issues of defensibility, will be reviewed and noted including, public domain/ and licensing issues, agency and public accessibility issues, simulation times, and ease of model input modifications for alternative scenarios.

Each agency's representative on the Savannah Multi-Agency Review Team will then provide Savannah District with their assessment of the technical adequacy of the models to identify physical changes in the estuary that are expected to result from various Expansion Project alternatives. If questions are posed by the reviewers, Savannah District will attempt to obtain answers to those questions from the model developers. The District will then request each reviewer prepare a letter from his agency to Savannah District stating the agency's position on the usefulness of the models for impact evaluation purposes on the Savannah Harbor Expansion Project. Although Savannah District will be reviewing the model itself, it will rely most heavily on the views of the Independent Technical Reviewer (Dr. Kim at CE-ERDC) to determine the position of the U.S. Army Corps of Engineers on the technical adequacy of the model.