

Status Report
Modeling Technical Review Group (MTRG)
Savannah Harbor Expansion Project
November 8, 2001

A meeting was held on Thursday, November 8, 2001 in Atlanta, GA at the EPA offices. The goals of the meeting were as follows:

- Discuss Federal Agency coordination process,
- Discuss Federal Agency overall modeling expectations for the project,
- Review status of the hydrodynamic and salinity model calibration and related work to address modeling issues
- Present overview and preliminary results of marsh ecology studies, and discuss linkage of marsh succession model with the hydrodynamic model output.

The following persons attended the meeting and participated in the MTRG discussions:

Bo Ellis	ATM	843-884-8750	boellis@worldnet.att.net
Matt Goodrich	ATM	843-884-8750	mgoodrich@appliedtm.com
Roy Burke	GAEPD	404-675-1665	roy_burke@mail.dnr.state.ga.us
Larry Neal	Harbor Committee	770-499-6791	lneal@lawco.com
John Sawyer	City of Savannah	912-964-0698	jsawyer@ci.savannah.ga.us
Paul Conrads	USGS	803-750-6140	pconrads@usgs.gov
William Bailey	USACE	912-652-5781	william.g.bailey@sas02.army.mil
Jim Greenfield	EPA-R4	404-562-9238	greenfield.jim@epa.gov
George Otto	ATM	352-870-1089	gotto@appliedtm.com
Daniel Mendelsohn	ASA	401-789-6224	dmendelsohn@appsci.com
Pete Wallace	ATM	386-462-5005	ecores@aol.com
John Bossart	ATM	352-870-1089	jbossart@appliedtm.com
Wade Cantrell	SCDHEC	803-898-3548	cantrewm@columb32.dhec.state.sc.us

Discussion of Federal Agency review process

Bo Ellis started the MTRG meeting by summarizing the model-related project coordination activities over the past 8 months, as follows:

1. Draft Hydrodynamic Model Calibration Report was completed in March 2001.
2. MTRG review comments compiled and distributed.
3. MTRG meeting held April 24, 2001 to discuss all comments and recommend a resolution for each. The MTRG discussed model calibration acceptability and the need to provide additional statistical comparisons for certain modeling goals.
4. The federal Agency representatives met in May 2001 to discuss their expectations of the proposed modeling.
5. The Federal Agencies met with ATM and GPA representatives in June 2001 to discuss modeling expectations and requested additional coordination.

6. In August 2001, ATM developed a response to the Federal Agencies request and presented a more complete methodology for use of the hydrodynamic model, field data and transfer functions for the freshwater marsh vegetation studies.
7. In September and October, the Federal Agencies met with ATM to further discuss modeling expectations for the project.

Paul Conrads distributed the draft "Savannah Harbor Data Analysis and Modeling Expectations of Federal Agencies" document. The document is included as Attachment A to this status report. Paul explained the development process and the elements of the document. He asked the MTRG to review the document and provide feedback to him.

Larry Neal commented that the criteria for the dissolved oxygen should include capturing the DO deficit. Larry also recommended that the document specify the vertical location in the water column of the evaluation criteria.

Presentation of the Savannah River Marsh Studies

John Bossart presented a description of the marsh studies currently undertaken by ATM. The Power Point presentation is shown in Attachment B and includes a description of the marsh data collection, including instrumentation (water level and salinity meters), data collection locations, and results. Preliminary plots of measured water surface elevations and salinity measurements were presented.

John described the process by which the marsh data will be used to predict the succession of the marsh following the proposed Savannah Harbor Expansion Project. Linkage of three separate models will be utilized for this task:

1. The hydrodynamic and salinity model will be used to predict the changes in salinity and water surface elevation in the river. As part of the calibration process, post-processing techniques will be investigated, including correlations and neural networks, to enable the Lower Savannah River Model's predictions to more accurately simulate the measured conditions.
2. A marsh salinity model will be developed based on relationships between the measured data in the marsh and in the river. The relationships between these data may be determined based on correlations, neural network models, or systems identification models (such as ARX, state-space, etc.). The predicted change in the river salinity and water surface elevations will then be input to the marsh salinity model, which will then predict the marsh water surface elevations and salinity concentrations (at the marsh surface and in the root mat).
3. The predicted change in the marsh environment will then be input to the marsh succession model. The marsh succession model will predict changes in marsh vegetation based on the predicted changes in marsh salinity and water surface elevations. The change in marsh vegetation is the ultimate goal for assessing the impact of the proposed project on the marshes.

Presentation of the Savannah River Hydrodynamic Model Calibration Status

Daniel Mendelsohn presented the status of the hydrodynamic model calibration. Subsequent to the "Draft Hydrodynamic and Salinity Modeling Calibration Report," the significant improvements were made to the water surface elevation predictions. The improvements resulted in better simulation of the river slope effects above Houlihan Bridge, which provided the appropriate damping of the tidal signal, rise in the mean water surface elevation, and phasing of the tidal wave. However, the improvements to the water surface elevation calibration led to slightly worse prediction of the salinity concentrations.

The post-processing of the model results has been considered to improve the predictive capabilities of the model. As mentioned in the previous section of this status report, examples of post-processing techniques to be investigated include correlations and neural networks. A numerical model that is trained based on simulated and measured data can be used as a "correction function." Preliminary testing utilized an ARMAX model that was trained on one set of measured and simulated salinity data, and then used to predict salinity given the simulated salinity values. The preliminary testing demonstrated that the "correction function" is very useful to predict the dynamic range of salinity values that the model is incapable of reproducing within a semi-diurnal time period. Whereas the hydrodynamic and salinity model may well capture the mean salinity concentrations, the post-processed results will provide better estimates of the 10th and 90th percentile salinity values.

Discussion of Future Model Development Plans

Jim Greenfield noted that the improvements to the model will not likely affect the results of the water quality model or chlorides model significantly enough to further delay the calibration of those models. He further stated that the Federal Agencies were recommending to the COE and GPA that the development of the water quality model and the chlorides model occur concurrently with the finalization of the hydrodynamic and salinity model calibration. Additionally, the Federal Agencies were recommending that work begin on the development of the "correction function" for the post-processing of the hydrodynamic and salinity model results.

Larry Neal suggested that the 2nd BOD term could be added to the water quality model as part of the work concurrent with the hydrodynamic and salinity model finalization.

The MTRG recommended that the work proceed on preliminary calibration of the DO and chloride models.

Future Activity

Comments and questions related to this Status Report should be directed to Chris Ahern of ATM (cahern@appliedtm.com). The next MTRG meeting will be in Atlanta GA on Wednesday February 13th from 9 AM to 1 PM.

Please contact Chris Ahern if you have any comments or recommendations for the next meeting.

11-08-01 MTRG Status Report

November 8, 2001
Document Distribution:
*Savannah Harbor Data Analysis
and Modeling Expectations
of Federal Agencies*

ATTACHMENT A

Savannah Harbor Data Analysis and Modeling Expectations of Federal Agencies

The purpose of this memorandum is to establish criteria (guidelines) by which to evaluate the performance of the hydrodynamic and water-quality models and post-processing routines used to predict impacts associated with the proposed Savannah Harbor Deepening Project. This memo provides a brief background of the modeling effort to date, a description of the resource areas of concern, a description of the modeling approach, and a guide for the evaluation of the model performance.

Background:

The purpose of the 1997 Savannah Harbor data collection and subsequent modeling activities was to provide a hydrodynamic and water-quality model to analyze impacts of deepening on circulation, salinity, and dissolved oxygen. The aquatic resources in the system are sensitive to small changes in water level, salinity, and dissolved-oxygen concentration. Additional understanding of the system and its behavior, beyond the 1997 data set and model calibration was recommended in order to make the necessary absolute predictions of water-level, salinity, and dissolved oxygen necessary to evaluate the mitigation issues associated with the potential deepening of the harbor.

The purpose of the 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 and other tools to make the necessary absolute predictions for the evaluation of impact and mitigation issues. The 1999 data set provides the detailed data to develop this defensible hydrodynamic and water quality model.

Areas of Concern:

There are four resources of concern for federal agencies. These are:

1. Shortnose sturgeon
2. Striped bass
3. Tidal Wetlands
4. Dissolved oxygen

DRAFT -- Model calibration and validation criteria—DRAFT
Revised Nov 5, 2001

The federal agencies believe that accurate prediction of the following parameters and time scales at specific locations are necessary for evaluating project related impacts for each of the resources of concern:

Sturgeon:

- Critical parameters and statistic
 - Bottom DO --10th and 50th percentile
 - Bottom salinity – 50th and 90th percentile
- Critical time scale – hours for durations of DO concentrations below 3 mg/L
- Important stations- GPA8 and GPA22

Striped Bass:

- Critical parameter and statistics
 - High-tide surface salinities -- 90th percentile
 - Ebb and Flood velocity of top 2 meters
- Critical time scale – hours (maximum duration of salinity excursion)
- Important stations – GPA 5, 6, 7, 8, 9,10, 11R, 12R, 15, 22 and USGS Stations 02198840 (I-95), 02198920 (Houlihan Bridge), 02198979 (Limehouse), and 021989791 (USFW Dock).

Tidal Wetlands:

- Critical parameter—high tide water levels and salinities over 60 days
- Critical time scale – daily, weekly to monthly
- Important stations -- GPA 5, 6, 7, 8, 9,10, 11R, 12R, 15, and USGS Stations 02198840 (I-95), 02198920 (Houlihan Bridge), 02198979 (Little Back River nr Limehouse), and 021989791 (USFW Dock).

Dissolved-Oxygen:

- Critical parameter--10th and 50th percentiles
- Critical time scale – hourly to daily
- Important stations -- GPA 2, 4, 6, 8, 9,10, 11R, 14, 21, and 22.

Based on the resources of concern, the model calibration should focus on the following stations:

- Elevation and Salinity: GPA 5, 6, 7, 8, 9,10, 11R, 12R, 15, 22 and USGS Stations 02198840 (I-95), 02198920 (Houlihan Bridge), 02198979 (Limehouse), and 021989791 (USFW Dock).
- Temperature: GPA 2, 4, 6, 8, 9,10, 11R, 14, 21, and 22.
- Dissolved oxygen: GPA 2, 4, 6, 8, 9,10, 11R, 14, 21, and 22.

Description of Modeling Approach:

A key issue for the Resource Agencies, researchers and managers is the need for the model calibration to be capable of accurately predicting extreme conditions that are expected to occur less than 5 to 10 percent of the time. The reason for this request is the desire to have the full range of values (peak or minimum), “absolute numbers”, regardless of the duration, for various conditions that might, in later analysis, be found to be important in the evaluation of impacts. The agencies conclude that the numbers for the long-term effects alone of post-project conditions being predicted by the hydrodynamic/salinity model (e.g., change in 50th percentile values only) would be necessary, but may not be sufficient to fulfill their needs for identifying all likely project effects.

The approach for meeting these expectations incorporates a hydrodynamic model that is being calibrated for predicting long-term trends (the mean) for all of the selected parameters. However, because of the need to model absolute values for hypothesis testing purposes, the calibrated model will be supplemented with adjunct data based interfaces (such as transfer functions based on neural networking methods, system identification methods, relative change techniques, or other acceptable approaches). These adjunct models utilize the extensive field data to develop the relationship between the model simulation output and the measured absolute values. If the hydrodynamic model is well calibrated to the mean, then its performance will be consistent and a translation of model predictions to provide absolute value predictions is possible.

Modeling Expectations:

The following provides the federal agencies’ viewpoint on the necessary statistical analyses and the performance goals of the modeling results for selective parameters.

Statistical Analyses:

Statistical analysis should include calculation of the mean error, root mean square error, absolute mean error and relative error. Additionally, comparison of selected percentiles should be used to evaluate model performance.

Statistical analysis should be performed on the 1997 and 1999 data sets. For the 1999 calibration data set, analysis should 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. *{Need to identify spring/neap cycles for the validation data set. For the 1997 validation data set, analysis should be performed on each of the ___ spring/neap tidal cycles between ___ and ___ 1997. The Julian dates for the ___ periods are: __.}*

Evaluation Criteria:

This memorandum puts forward a number of criteria for salinity, dissolved oxygen, water levels, circulation, and temperature based on resources of concern, namely, shortnose sturgeon, striped bass, tidal wetlands and dissolved oxygen. No actual physical or biological evidence is discussed herein, whether in terms of literature citation or data, to support that the tolerance in the criteria listed is appropriate for the evaluation of impacts on resources in the study domain. These criteria are therefore viewed as performance goals to which model predictions will be compared and evaluated for strengths and weaknesses and by which an understanding of their uncertainties may be developed. The stated criteria will not be used individually (by station and parameter) for “pass/fail” evaluation of the model calibration and/or post-processing routine.

The Federal agencies recently received the water quality database from ATM and need to evaluate the data in order to finalize the proposed model criteria. The preliminary criteria for the model performance are tabulated below:

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
Temperature (°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 max. ebb and flood conditions for current and flow

Model Defensibility:

The federal agencies believe that the following analyses should be completed to ensure that the model is defensible:

Convergence testing:

- Convergence testing of the model must be performed on the application to the Savannah Harbor.

Sensitivity Analysis: Sensitivity analysis needs to be performed on the following model parameters and boundary inputs:

- 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:

- For the 1999 data set, some time periods are missing due to equipment failure and an approaching hurricane. Data analysis and descriptions are needed that describe boundary stations and critical internal stations. Descriptions should include a general statistical summary and a narrative outlining over data quality and, for boundary stations, techniques used to fill period of missing record.

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PowerPoint Presentation:
*Savannah River Marsh
Studies Overview*

ATTACHMENT B

















