D H E C
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C. Earl Hunter, Commissioner

*Promoting and protecting the health of the public and the environment.*



July 1, 2005

Joseph T. Hoke, Jr., P.E.
U.S. Army Corps of Engineers
Savannah District
P.O. Box 889
Savannah, GA 31402-0889

Dear Mr. Hoke,

We have reviewed the Savannah Harbor hydrodynamic and water quality models presented in *Development of the Hydrodynamic and Water Quality Models for the Savannah Harbor Expansion Project* (SHEP) prepared by Tetra Tech, Inc. on May 20, 2005. The purpose of the review was to determine whether or not the present models are suitable to evaluate impacts resulting from proposed harbor deepening. The review included an interim meeting of the model review group in Atlanta on June 16-17, at which model performance was discussed in detail. The model review group identified a number of issues and concerns that should be investigated and resolved before the models are used for final project impact evaluations (see meeting summary attached below). Depending on the results of these investigations, model re-calibration may be necessary.

Our position is final impact evaluations should wait until these investigations are complete, the model review group has the opportunity to consider the results, and any required model adjustment is performed. In the near term, the Department is not opposed to the use of the present models for preliminary screening purposes.

In addition to the concerns listed in the attached document, the following items would need to be addressed before the Department could accept the models for use in final impact analysis:

1. The hydrodynamic model projects too little salt water up the Middle River (see report figures J-21, J-23, K-21, and K-23). We understand that the neural network modeling linking the river segments to the marshes depends on salinity predictions at USGS-gaged locations on the Front and Little Back Rivers and not on the Middle River. However, stations MR-10 and MR-12R (and by extension, MR-12) were identified by the Federal agencies as important locations for the salinity calibration. We also note the model predicts Middle River is well mixed, so the model under-predicts salinity in Middle River in the mid-depth and bottom layers as well as the surface layer.

2. The report does not adequately account for the occasional, dramatic differences between predicted and observed dissolved oxygen which occur primarily in the 1997 confirmation simulation but also to some degree in the 1999 calibration simulation (see report figures P-1, P-3, P-11, P-5, Q-1, Q-2, Q-3, Q-4, Q-5, and Q-6). We understand that, in some cases, these differences are thought to reflect instrumentation problems with the dissolved oxygen monitoring equipment rather than inaccuracies in the water quality model. We understand that the dissolved oxygen dataset is currently being screened and possibly corrected when sampling error is identified. This effort should be concluded and documented, and the model and report should be modified as necessary. Finally, any significant differences between model and data that remain should be acknowledged and explained to the extent possible.

3. The potential impact of oxygen demand loading from the dredge spoil areas has not been identified. Loadings from the dredge spoil areas should be addressed by the future Total Maximum Daily Load (TMDL) rather than the SHEP if project alternatives do not increase loadings to the Savannah or Back Rivers. However, if project alternatives are in fact expected to increase loadings above existing levels, then any impacts on dissolved oxygen should be addressed by the SHEP.

4. Our acceptance of the hydrodynamic and water quality models for water quality certification will depend on more than the ability of the models to evaluate water quality impacts. In order for the Department to accept the models for certification purposes, we would also have to determine that the hydrodynamic and water quality models satisfy the requirements of the wetlands and fisheries impact evaluations. It is our understanding that these requirements have not yet been established. Until they are, we cannot give final acceptance of the hydrodynamic and water quality models for water quality certification.

Overall, we find the model calibration results to be encouraging. The Savannah Harbor system is complex, and the present models represent this complex system very well in many respects. We anticipate the issues identified above and in the attached meeting summary can be addressed prior to final impact evaluations. We appreciate the opportunity to review and comment on the models and look forward to continued cooperation on this important matter.

Sincerely,

Alton C. Boozer

Alton C. Boozer
Chief, Bureau of Water

ACB/wmc

**Savannah Harbor Expansion Model Review Meeting**
**June 16-17, 2005**
**Savannah Harbor Expansion Interagency Water Quality Team Meeting**
**June 17, 2005**
**Tetra Tech, Inc. – Atlanta, GA**

**Attendees:**
Roy Burke, GAEPD
Paul Lamarre, GAEPD
Wade Cantrell, SCDHEC
Bill Bailey, USACE Savannah District
Joe Hoke, USACE Savannah District
Jim Greenfield, USEPA Region 4
Paul Conrads, USGS (via phone)
Larry Neal, MACTEC
Margaret Tanner, MACTEC
Steven Davie, Tetra Tech, Inc.
Will Anderson, Tetra Tech, Inc.
Yuri Plis, Tetra Tech, Inc.

**Agenda:**
1. WASP model – consistency with enhanced grid and status of TMDL process
2. Status of calibration report from Tetra Tech
    - Issues/concerns from Federal and State agencies
    - Dr. Kim's (ITR USACE) comments
    - July 1, 2005 deadline for agency position
3. Application of the models for impact simulations (inputs and outputs)
    - Comments from states and other users

## I. Status of TMDL (Jim Greenfield):

- EPA will now use one model for the harbor – enhanced grid
- WQ standard for dissolved oxygen still being developed, EPA headquarters is going to talk to GAEPD about proposing the standard
- SCDHEC will still have to develop a site specific criteria for SC waters
- Recruitment (fish) model will be used to develop the criteria values; being used in the Escatawpa River Estuary for the dissolved oxygen criterion (3.0 g/L); using daily dissolved oxygen values and comparing to acute and chronic limits
- 2004 loads being used to update the TMDL – using July, August, and September average DMR data – Jim send to MACTEC for review
- Riverside Power Plant decommissioned
- Kerr McGee immediate oxygen demand load is now removed
- Need to check heat loads with GA Power (MACTEC to verify this with GA Power)

## II. Issues and Concerns on Final Report on Hydrodynamic and Water Quality Models:

1. Discussed Dr. Kim's comments and went around the table discussing issues and concerns from each agency/group represented.
2. Larry Neal summarized his organization's concerns in a handout.
3. The group then had a wide-ranging discussion of that included a number of issues. These are summarized in the next two sub-sections. The first paragraph is the group's attempt to develop categories for the comments that describe the amount of effort expected to address a concern. The second paragraph states the concern and the category of future effort (in bold) expected to address it. These issues should be considered further before using the models to identify impacts of the recommended plan.

### Ways to address concerns with the models and the reports

The group categorized the concerns according to the level of action that is appropriate to fully address each concern. The following four categories were developed, roughly in order of the effort expected:

**A** Explain better in the report, no modeling action needed.
**B** Keep in mind when interpreting the model results.
**C** Additional sensitivity model runs are needed.
**D** Recalibrate / revise model.
(note: a "**C**" action could turn into a "**D**" action depending on the results)

### Summary of issues and concerns and actions to address each concern [option from above]:

1. **[B]** Marsh water quality loads:
    a. **[A]** Inclusion in the enhanced grid
    b. **[A]** Equal comparison between the TMDL and enhanced grids
    c. **[C]** Is the CBODu too high?
    d. **[C]** Mass exchange – flows and concentration
    e. **[C]** Surface to bottom – CBODu vertical differences are a function of how marsh areas were loaded into the enhanced model
2. **[C]** Offshore boundary:
    a. Salinity 34 to 36 ppt versus 32.5 to 35 ppt
        i. Mass flux surface to bottom – may need to re-distribute at FR-26
    b. Dissolved oxygen saturation 95 to 105% versus 90%
    c. Temperature
    d. Larry Neal gave info "World Ocean Atlas 2001" with data
    e. CBOD decay rate – confirmed 0.5 multiplier on ocean cells
3. **[C]** Surface salinity:
    a. Model appears to under predict surface salinity on the Front River. How does this impact the marsh succession modeling? The EFDC will output salinity for the neural net application, which feeds the marsh succession model. Right now, the neural net is using the USGS gages located between the Talmadge Bridge and I-95, located on Front and Back Rivers. These gages are considered to be mid-depth. The EFDC model is

predicting salinity well at the bottom and at mid-depth but under predicting salinity at the surface.

4. **[A & B]** Ebb flows and currents:
    a. Under prediction of the ebb flows and currents on the Little Back and Back Rivers
5. **[A]** Water level at SR-17 on the Upper Savannah River
    a. Potential of adding marsh storage areas upstream of I-95 Bridge
    b. Show comparisons at the USGS Hardeeville gage (show plot)
6. **[C & A]** Global versus source-specific BOD decay rates
    a. Sensitivity of calibration
    b. Sensitivity on allocation scenarios (more for TMDL)
7. **[A]** Check all point sources and heat loads, especially Plant MacIntosh (MACTEC to verify)
8. [none] BOD loads from Corps' confined dredged sediment placement sites in SC and potential impacts on dissolved oxygen (future TMDL issue)
9. **[A]** Grid convergence test:
    a. Show results of the TMDL grid with the same depth;
    b. Show results on TMDL grid, enhanced grid, and convergence grid on the same plots;
    c. Show comparisons on the Middle and Little Back Rivers;
    d. Perform moving average of results to reduce tidal noise; and
    e. Quantification of grid convergence test results.
10. **[B & C]** Delay in EFDC model salinity results at US FWS Dock comparisons of model versus data
11. **[A]** Clearer description of 1999 versus 2002 bathymetry and why the 2002 bathymetry data is representative of 1997 through 2003 conditions in the harbor
12. UA/SA Analysis: The group concluded that the inability to run the models over a 7-year duration was the result of synthetic data that was developed to fill in a data gap around December 2000. The group concluded that the inability of the model to run over the entire 7-year period of data does not reflect on the structure of the model or its performance, and should not be a consideration of the model's usefulness for its intended purposes of predicting impacts of the Savannah Harbor Expansion Project, developing a dissolved oxygen TMDL, or permitting point source discharges.

## III. Model Application for Identifying Impacts to Water Quality.

The Interagency Water Quality Team then discussed application of the models for identifying impacts to water quality from the Savannah Harbor Expansion Project.

1. The impact evaluation runs should use a varying flow, rather than the uniform flow that was previously proposed by Savannah District.

2. Dissolved oxygen should be reported at increments of 0.1 mg/L, rather than the 0.5 mg/L that was proposed by Savannah District.

3. Model results in hourly outputs will be sufficient.

4. BOD loads should use the loads reported in 2004, rather than what was reported in 1999. The loads should be averaged over the entire summer. The loads should be run through both the RIV1 model and WASP.

5. Potential impacts to the assimilative capacity of the harbor would need to be identified. This should be performed with the following model inputs:

- August 1999 tides, flows, temperature, and salinity
- Loads from upstream sources should include CBOD and ammonia

NOTE: A. flows would be varying, rather than uniform as previously proposed
B. flows measured at Clyo are considered representative of the critical conditions and the 7Q10 flow did occur during 1999

6. Natural condition runs would need to be performed. This should be performed with the following model inputs:

- Without point sources – no heat and BOD loads in harbor and upstream
- Without nonpoint sources – no stormwater loads, but marshes should be included
- Existing bathymetry (as expressed in calibrated model)

7. Further identification of potential impacts to temperature would be developed as part of the impact runs for Fisheries, which will include runs over January,

8. For water quality impact evaluation runs, the following scenarios would need to be evaluated:

A. Natural condition without deepening
B. Natural condition with deepening
C. 2004 point source loads with deepening
D. 2004 point source loads without deepening

9. The Corps expects to perform the following runs to evaluate potential effects of deepening the navigation channel:

1. existing = 42 feet
2. 44 feet
3. 45 feet
4. 46 feet
5. 47 feet
6. 48 feet

10. The team recognized that the various scenarios and model outputs that had been requested will require a great deal of effort and would produce a very large quantity of information. The team also recognized that some of that information may, ultimately, not be useful. To minimize the time spent developing, presenting, and interpreting model outputs, the team recommended they meet again as soon as the initial water quality model runs had been completed. The hope is that the initial outputs would show what type of information is truly needed to identify impacts from the proposed actions and

differentiate between the plans. This would allow other information to no longer be developed, presented or interpreted. The team recommended that the initial runs consist of (A) 2004 point source loadings, (B) natural conditions, and (C) maximum permitted loadings. Each of these three scenarios should be run for both the existing channel depth and the maximum deepening being considered.

Prepared by:
Steven Davie
Tetra Tech, Inc.

**Georgia Department of Natural Resources**
2 Martin Luther King, Jr. Drive, S.E., Suite 1152 East Tower, Atlanta, Georgia 30334-9000
Noel Holcomb, Commissioner
Carol A. Couch, Ph.D., Director
Environmental Protection Division
404/656-4713

July 1, 2005

Mr. William Bailey
U.S. Army Corps of Engineers, Savannah District
Post Office Box 889
Savannah, Georgia 31402-0889

Subject: Savannah Harbor Expansion Project
Harbor Models Suitability

Dear Mr. Bailey:

The U.S. Army Corps of Engineers is currently developing a Tier II EIS for the proposed Savannah Harbor Expansion Project (SHEP). To identify and assess potential environmental impacts complex hydrodynamic and water quality models have been developed. The development process included representatives from four Federal Agencies, Georgia EPD and South Carolina DHEC, and stakeholders representing the Harbor dischargers. Model development recently culminated with the issuance of the final report: Development of the Hydrodynamic and Water Quality Models for the Savannah Harbor Expansion Project dated May 2005.

On June 16 and 17 of this year the Savannah Harbor Expansion Interagency Water Quality Team, including representatives from EPD, met to discuss comments on these models and unresolved issues. These deliberations were summarized in the minutes of this meeting provided to each Team member on June 27th. In brief, the Team agreed that the models were ready to use for screening Harbor deepening alternatives. However, the Team added that the remaining issues summarized in the minutes should be addressed and resolved before quantifying specific impacts. Based on recommendations from my technical staff, Georgia EPD concurs with the Team's assertions.

Sincerely,

Linda MacGregor, P.E.
Branch Chief
Watershed Protection Branch

cc: Keith Parsons

# United States Department of the Interior

**FISH AND WILDLIFE SERVICE**
176 Croghan Spur Road, Suite 200
Charleston, South Carolina 29407

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PM-C

July 5, 2005

w/o encl.
DE
DC
DX
DP

Colonel Mark S. Held
District Engineer
U.S. Army Corps of Engineers
P.O. Box 889
Savannah, GA 31402-0889

Dear Colonel Held:

The Fish and Wildlife Service (Service) has completed a review of the report "Development of the Hydrodynamic and Water Quality Models for the Savannah Harbor Expansion Project" prepared by Tetra Tech, Inc. for the U.S. Army Corps of Engineers, Savannah District. The U.S. Geological Survey (USGS) is assisting the Fish and Wildlife Service (Service) in evaluating the hydrodynamic and water quality models for the Savannah Harbor Expansion Study. Copies of the USGS letter and review comments to the Service are enclosed for your consideration.

The three-dimensional hydrodynamic model selected for this project is based on the Environmental Fluid Dynamics Code (EFDC), a physics-based turbulence closure model that has been applied in a number of estuarine and riverine systems in the southeastern United States. The Savannah Harbor expansion version of the EFDC is based on the model originally developed by Tetra Tech for the Environmental Protection Agency to determine the total maximum daily load for dissolved oxygen in the lower Savannah River. This model and the associated water quality model have been improved with an enhanced grid and other modifications.

On June 16-17, Federal and State Agencies met with the model developers to discuss their comments and concerns on the models. At the meeting, the concerns of each agency were identified along with recommended approaches to address the concern. Recommended approaches included additional explanation in the report, additional sensitivity simulations, and recalibration/revision of the model. In addition, USGS documented a number of these issues, as well as other issues, in their specific review comments. It is anticipated that most of the concerns could be addressed with additional documentation for the report and sensitivity runs. However, additional sensitivity runs may indicate that model modification could significantly improve performance. In that case, additional model calibration and revision would be needed.

The hydrodynamic and water quality models are the critical impact assessment tools for the entire harbor expansion project. Most of the other impact assessments will be based on predictions from the model. Therefore, it is imperative that the hydrodynamic model be as reliable as possible and scientifically defensible. However, in applying these tools, the users must be cognizant that any model in a complex system, such as the Savannah estuary, will have limitations in how well it will predict reality. Therefore, even if a model is judged to be acceptable for use, there will always be some level of uncertainty in its performance. One important area of uncertainty will be in evaluating the predicted effects of mitigation plans involving flow diversions from the Front River to the Middle and Back River (see USGS comment number 9).

An adaptive management approach, as described in Corp's Environmental Circular 1105-2-409, "Planning in a Collaborative Environment," dated 31 May 2005, is a way to deal with uncertainty. This document discusses the necessity of a well designed monitoring program as a cornerstone to adaptive management. The document also discusses phased project implementation, in which the initial phase is constructed and monitored, and a future phase may be constructed as planned, modified, or not constructed. The decision on the future phase is based on the monitoring results and defined decision criteria.

For the Savannah Harbor deepening Project, phased implementation could involve deepening of the navigation channel by an identified increment with appropriate mitigation measures, followed by monitoring and a defined decision process. This approach would require collection of adequate pre-project baseline water quality and biological data prior to project implementation. Much of this data has been collected but data gaps need to be identified and filled. Then, a comprehensive post-project monitoring plan would need to be developed and implemented so that project impacts and mitigation effectiveness can be documented. The monitoring data could be compared to previous model predictions to determine the adequacy of impact predictions and mitigation measures. We recommend further discussion of this approach as project planning continues.

Based on the information reviewed, we would support use of the hydrodynamic and water quality models for initial evaluation of Savannah Harbor deepening impacts. If the additional sensitivity runs indicate that performance could be significantly improved, then additional model calibration and revision will be recommended before definitive impact evaluation and mitigation assessment.

A great deal of time and money has been expended to develop an acceptable model and we are hopeful that the additional work can be completed and applied to successfully conclude this effort. We appreciate the efforts of you and your staff to coordinate this project with the Service.

If you have any questions or wish to discuss this issue, please contact Ed EuDaly at 843-727-4707 x 220.

Sincerely,

Timothy N. Hall
Field Supervisor

TNH/EME

cc:

Mr. John Hefner, U.S. Fish and Wildlife Service, Atlanta, GA
Mr. Tom Prusa, U.S. Fish and Wildlife Service, Savannah Coastal Refuges, Savannah, GA
Mr. Gerald Miller, Environmental Protection Agency, Atlanta, GA
Mr. Prescott Brownell, National Marine Fisheries Service, Charleston, SC
Mr. Paul Conrads, U.S. Geological Survey, Columbia, SC

# United States Department of the Interior

U.S. GEOLOGICAL SURVEY

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June 28, 2005

Mr. Ed EuDaly
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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 May 20, 2005" prepared by Tetra Tech (Tt) for the U.S. Army Corps of Engineers – Savannah District. The report and its appendices describe the hydrodynamic, salinity transport, and dissolved-oxygen models and their application, calibration, validation, and confirmation to the Lower Savannah River and Harbor. The Environmental Fluid Dynamic Code (EFDC) model was originally developed for U.S. Environmental Protection Agency–Region IV by Tt for determining the TMDL for dissolved oxygen for Savannah Harbor. A previous review of the EFDC application to Savannah Harbor (Paul Conrads, written communication April 24, 2004) noted that although the modeling efforts by Georgia Ports Authority (GPA) and EPA share common goals of a defensible model, there were differences in their applications and goals that would need to be resolved if one hydrodynamic and water-quality model would be used to meet the needs of Harbor Expansion and TMDL determination.

The report represents the refinement of the EFDC model. The report addresses many of the comments and concerns from the previous review of the TMDL model report but more detailed descriptions or additional sensitivity runs are required to fully document the application and performance of the model. My major concern with the model is its inability to simulate ebb-tide currents in the Front River and ebb-tide stream flows throughout the system. In addition, there are areas in the model domain in the upper reaches of the Little Back River where the model does not simulate reversing tidal flows. Although these flows are small, this area of the model domain is significant if mitigation scenarios include diverting flows from the Front River the Middle and Little Back Rivers. My specific comments on the report are attached.

A Savannah Harbor Expansion Model Review meeting was held June 16-17 for Federal and State Agencies to discuss their comments and concerns with the model developers. During that meeting, the salient concerns of each agency were identified along with approaches to address the concern. Approaches included additional explanation in the report, explanation in the interpretation of mitigation scenarios results, additional sensitivity simulations, and recalibration/revision of the model. The majority of the concerns could be addressed with additional explanations in the report and sensitivity runs. Depending on the results of the

sensitivity runs, additional model recalibration/revision may be warranted. A summary of the Savannah Harbor Expansion Model Review Meeting is attached.

Knowing there are inherent errors and uncertainties in the model, special attention should be given to the selection of input conditions for impact and mitigation scenarios and in the evaluation of the results. Using historical input conditions instead of synthetic conditions will allow the evaluation of the error of the baseline simulation to actual historical conditions. Using synthetic boundary conditions (computed tidal water level, constant or average flows, and statistically derived meteorological conditions) does not allow for the evaluation of the baseline model predictions to actual conditions. The model presented in the report can be used for making preliminary evaluation of the impact of the potential deepening of the harbor. In the event that sensitivity simulations indicate that model recalibration/revision is warranted, it is recommended that final evaluations of harbor deepening impacts and mitigation scenarios should proceed after the needed revisions are made.

The model development and review for Savannah Harbor Expansion Model has been a long process. It is encouraging to see the model development and review in the final stages of producing an acceptable model. We appreciate the opportunity to participate in this 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. Please call me at (803) 750-6140 if you have any questions or need additional information.

Sincerely,

Paul A. Conrads
Hydrologist

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"
prepared by Tetra Tech (Tt)
for the U.S. Corps of Engineers–Savannah District

1. The report did document convergence testing to evaluate the adequacy of the spatial and temporal resolution of the model grid and time step used in the model. Additional documentation is needed to show that the convergence test is adequate. figure A-3 shows differences in salinity predictions between the two simulations of 1-2 part per thousand (ppt). More important than the small differences in the predictions is whether there is a divergence between the two simulations. Although over sixty days are shown in Figure A-4, due to the resolution of the graph, it is difficult to see if the two simulations are diverging. Additional documentation should include results for sites in the Middle, Little Back, and Back Rivers. To show the two simulations diverge, a filter to remove the tidal signal could be applied to the results and displayed along with the simulations.

2. The report did document the sensitivity of the EFDC and WASP7 to selected parameters and boundary inputs. For the EFDC model, eight parameters and inputs are listed but only the results only 4 parameters or inputs are presented. The results of all eight parameters and inputs should be included in the tables. It is worth noting that the results of the sensitivity of the boundary freshwater flow and salinity for certain sites are non-linear. For example, in figure 12-1 the salinity response for a 1 ppt salinity change is not evenly distributed around the baseline simulation. These results are not unexpected but show the importance of carefully selecting boundary conditions for mitigation scenarios. For the sensitivity of the water-quality model, additional sites in the Middle, Little Back, and Back Rivers should be shown.

3. A large effort was expended to improve the bathymetry from the original application of EFDC for the TMDL model. Many of the improvements in the calibration of the model can be attributed to the refined bathymetry. Figure 4-6 and 4-7 compares cross-sections for two locations from the 1999 and 2002 bathymetric surveys. Although there are the obvious similarities between the two cross sections, there are differences of 2-3 feet in the depth (figure 4-6) and 100 feet in the width (figure 4-7). These differences indicate that there may be a 5 to 10 percent increase in the area in the 2002 survey. If the volume of the system (as represented from the two surveys) is different, is it appropriate to use the 2002 bathymetric data for the calibration data set of 1999?

4. In the description of the offshore water-level boundary (page 29), it is unclear whether USGS or National Ocean Service (NOS) data is being used. The text references a NOS gage at Fort Pulaski but gives a USGS station number.

5. In the discussion of SOD and reaeration ($K_2$) (Section 8.4.3 and 8.4.4), there are two plots, figures 8-12 and 8-13, that compare SOD and $K_2$ rates in different locations of the system. These values can vary significantly through the system. Unfortunately, the figures are not referenced in the text and should be discussed.

6. The following comments on the model performance and comparing the measured data and model predictions for selected stations. The EFDC was developed using the data collected by GPA and the USGS. Problems with the GPA data sets were noted in the previous report on the EFDC application. Many revisions to the data released by GPA have occurred with the development of the two models. Although not a technical concern with the EFDC application, one must remember that there could be significant error with the measured data being compared to the model predictions.

7. Water-level predictions in the model are generally good with the better simulations in the lower reaches of the Front and Back Rivers. Farther upstream, the model over-predicts the tides and under-predicts the higher water elevation of the riverine flows. For example, figure B-12 (page B-8) shows water-level calibration at I-95 (station SR-14) and the model is over-predicting the high tides by as much as a half a meter. Figure B-13 (page B-9) shows water-level at station SR-17. The measured data show little tidal variation (less than 0.3 meters) and higher water-surface elevations characteristic of the more riverine dominated segments of the system. The model simulates a tide range of approximately a foot and the mean water levels under-predicts the measured data by a meter. The model does dampen the tidal wave between SR-14 and SR-17 by a meter. Site SR-14 (I-95) is the upper reaches of concern for the marshes in the vicinity of the Savannah National Wildlife Refuge (SNWR) so model error in the upper reaches have less direct impact on the predictions around SNWR.

8. The velocity and flow predictions in the model generally under-predicts the ebb-tide currents and flow. This is most clearly seen in the plots of the bottom currents for FR-04 and FR-06 (figures D-2 and D-4, respectively). The inability to predict the ebb-tide currents may be related to the model over-predicting tidal dynamics in the upper reaches and under-predicting riverine dynamics (see comment 7). Ebb-tide currents and flows appear to be difficult to accurately predict in this system with the recently applied three-dimensional models. The TMDL EFDC model and a previous model developed by GPA also under-predicted ebb-tide currents and flow.

9. Evaluation of the flow simulations is more difficult due to the scarcity of the data. Modeling flows in the Middle, Little Back, and Back Rivers is very difficult due

to the complexity of this branched network of shallow tidal rivers and creeks. Lack of the continuous tidal flow data and inflow data from Union Creek make the modeling effort more difficult. The flow predictions have improved from previous applications of the model but are only satisfactory. Possible mitigation scenarios include diverting a portion of the flow from the Savannah River to the Middle and Little Back Rivers. The inability of the model to capture the ebb-tide flow dynamics in these reaches should be remembered while interpreting scenarios where increased flows in the vicinity of SNWR are significant.

10. The model generally predicts the overall trend of the salinity dynamics of the system well. One behavior that appears at a few of the sites (BR-05 bottom, BR-07 surface, FR-06 bottom, FR-22 bottom, MR-12R surface – figures J-10, J-11, J-13, J-15 J-23) is the model over-predicting low-tide salinity concentrations. When the low-tide salinity is over predicted, usually the 50$^{th}$ percentile values are also over predicted although the high-tide salinity intrusion is under predicted.

11. There is a significant lag in the recession of the salinity intrusion for Lucknow Canal (figure J-27, page J-18). The model is able to predict the magnitude of the salinity intrusion on September 22, 1999 but exhibits a 5 or 6 day lag on the recession. For the next intrusion on October 9, 1999, the lagged is carried through to the peak intrusion and recession of the salinity. The lag may be a result of the way the marshes are schematized in the model as large storage volumes. As this volume increases in salinity, there is a reservoir (or storage) of higher salinity water that takes quite a few tidal cycles to flow back into the system. Similar behavior is seen at the U.S. Fish and Wildlife dock (figure J-26, page J-17), although not as pronounced as at Lucknow Canal.

12. The Middle, Little Back, and Back Rivers are considered well mixed systems. The salinity simulations support this and there are not significant vertical salinity gradients in these areas. Many of the water-quality constituents (for example CBODu in figures O-11-14) show significant stratification that is uncharacteristic of a well mixed system. The stratification is probably a result of how the marsh loads are input into the system and the lack of mixing between the vertical layers in the model.

13. A seven-year water-level and salinity simulation (1997-2003) were presented to confirm the performance of the EFDC model to the long-term USGS data. The salinity simulations are particularly useful in evaluating how well the model is able to capture the salinity dynamics through the full historical range of flows for the Savannah River. The 7-year period includes the high flows of the El Nino in 1998 and the recent extend drought. Figures M-3 and M-4 show the 7-year comparison for Fish and Wildlife Dock and Luchnow Canal. In both plots, the model is able to capture the increased salinity intrusion during the extended 5-year drought and the freshening of the system with the end of the drought at the end of 2002.

14. Unlike the salinity model where there are long-term data sets for flows, offshore water levels and salinities to evaluate the performance of the model over the full range of historical conditions, the DO model only has a limited amount of data during the summer of 1997 and 1999 to calibrate and evaluate the model. The DO model is calibrated to a small range of flow, temperature, and tidal conditions. Unfortunately, the limited characterization of input loads, especially for the offshore boundary and marshes, the incompleteness of the dissolved-oxygen record, and the limited number measured rates, makes it difficult to develop a clear understanding of the DO oxygen dynamics of the system. The situation for Savannah with limited measurements of field conditions, rate kinetics, and input characterizations is not atypical of the development of DO model to complex estuarine systems. Given the above caveats, the model should be used to make evaluations of relative impacts and should not be used for making absolute impacts on DO.

15. There appears to be a large source of oxygen-consuming constituents in the system in August 1999. The measured data for stations Fr-21, FR-06, FR-22, and BR-05 show ammonia values of greater than 0.12 mg/L (Appendix N, figures N-3, N-4, and N-7) where the typical background concentrations are between 0.02 and 0.05 mg/L. Unfortunately, the source of the input of ammonia is not characterized in any of the point-source and marsh inputs to the model. The transformation of ammonia to nitrate consumes a large amount of oxygen. Although the concentrations are small, the volume of water is large so the amount of oxygen consumed during this 14-day period might not be insignificant. Without knowing the source of the ammonia load, the model developers are correct in not fabricating a load to match the in stream ammonia data. The comment is made to illustrate the difficulty and limitations of the data and the model to fully capture the DO dynamics of the system.

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.

**UNITED STATES DEPARTMENT OF COMMERCE**
**National Oceanic and Atmospheric Administration**
NATIONAL MARINE FISHERIES SERVICE
Southeast Regional Office
263 13th Avenue South
St. Petersburg, Florida 33701

August 17, 2005

Colonel Mark S. Held
District Engineer
Department of the Army, Corps of Engineers
P.O. Box 889
Savannah, Georgia 31402-0889

Dear Colonel Held:

The National Marine Fisheries Service (NMFS) has reviewed the May 25, 2005, report titled "Development of the Hydrodynamic and Water Quality Models for the Savannah Harbor Expansion Project" (Models) provided by Mr. Joseph Hoke of your staff. We have coordinated with U.S. Fish and Wildlife Service and U.S. Geological Survey staff and we have reviewed their technical comments and recommendations.

Development of the Models has been a lengthy process with extensive interagency technical review steps. Based on our review of the report and the comments of the review team members, we believe that the Models will be valuable for use in assessing large-scale impacts to estuarine habitats in connection with the Savannah Harbor Expansion Project. At the same time, we note that the information produced by any mechanistic model cannot fully negate the importance of other science-based environmental assessments. We also note that continuous development and adaptation of the model will be needed once the model runs and outputs are measured against real observed changes in the ecological system that is being studied.

As noted by the U.S. Fish and Wildlife Service in their July 5, 2005, comment letter, an adaptive management approach, as outlined in the Corps' planning guidance (EC-1105-2-409, May 31, 2005) may be appropriate for implementation of the Savannah Harbor Expansion Project and associated environmental mitigation and enhancement features. An adaptive approach, facilitated by careful application of the Models, integrated with a well designed long-term environmental monitoring program, should be considered by the Corps, Georgia Ports Authority, and the interagency team.

NMFS supports application and continued development of the Models for the Savannah Harbor Expansion Project. We appreciate the opportunity to work with you and your staff during development of the Models, and we look forward to their application.

Please direct related questions or comments to the attention of Mr. Prescott Brownell at our South Atlantic Branch Office. He may be reached at P.O. Box 12559, Charleston, South Carolina 29422, or at (843) 953-7204.

Sincerely,

Miles M. Croom
Assistant Regional Administrator
Habitat Conservation Division

cc:
GADNR
SCDNR
USFWS

**UNITED STATES ENVIRONMENTAL PROTECTION AGENCY**
REGION 4
ATLANTA FEDERAL CENTER
61 FORSYTH STREET
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DE
PM-C

AUG 25 2005

Colonel Mark S. Held
District Engineer
Savannah District
P. O. Box 889
Savannah, GA 31402-0889

cf: DE
DC
DP
DX

Subject: **Final Report - *Hydrodynamic and Water Quality Model for the Savannah Harbor* [May 20, 2005]**

Dear Colonel Held:

The U.S. Environmental Protection Agency, Region 4 (EPA) has completed its review of the subject report prepared by Tetra Tech (TT) for the U.S. Army Corps of Engineers – Savannah District (District). The report and its appendices describe the hydrodynamic, salinity transport, and dissolved oxygen models being used to characterize ambient conditions in the Lower Savannah River and Harbor environs. These documents also discuss the specifics as to how these models will be applied to predict water quality impacts based upon changes in pollution loading and proposed Harbor dredging. The documentation also includes information related to model calibration, validation, and confirmation.

Because this river system is complex hydro-dynamically, it was necessary to develop these water quality assessment tools in an evolutionary manner. TT originally formulated the Environmental Fluid Dynamic Code (EFDC) model for EPA to use in determining the Total Maximum Daily Loading (TMDL) for dissolved oxygen conditions in the Savannah Harbor. TT has subsequently updated/modified this model with a higher resolution model to better evaluate the water quality impacts of the various harbor dredging scenarios to enhance the navigation channel.

While the above report addresses most of the comments/concerns cited by EPA in its previous review of the TMDL model report, we understand that a more detailed analysis is currently underway to further document the model's application/performance. Jim Greenfield of my staff has been involved in the on-going water quality modeling efforts and is confident that any remaining issues can be addressed after additional model sensitivity runs are performed and evaluated.

The model development and review for upgrading Savannah Harbor has been a long and demanding process for all stakeholders. However, it is encouraging that we are in the final stages of producing an acceptable model for use in making the critical water quality decisions regarding this Harbor project and the TMDL. We will continue to provide support for the successful completion of this water quality modeling effort which is a priority for both of our Agencies.

Sincerely,

James D. Giattina, Director
Water Management Division

South Carolina Water Science Center
Stephenson Center, Suite 129
720 Gracern Road
Columbia, SC 29210-7651
Phone: (803) 750-6100
FAX: (803) 750-6181

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 be 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 is 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 Clyo, 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 evaluated 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 BODu 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.

March 1, 2006

Colonel Mark S. Held
District Engineer
U.S. Army Corps of Engineers
P.O. Box 889
Savannah, GA 31402-0889

Dear Colonel Held:

The Fish and Wildlife Service (Service) has completed a review of the report "Development of the Hydrodynamic and Water Quality Models for the Savannah Harbor Expansion Project" dated January 30, 2006 prepared by Tetra Tech, Inc. for the U.S. Army Corps of Engineers, Savannah District. The U.S. Geological Survey (USGS) is assisting the Fish and Wildlife Service (Service) in evaluating the hydrodynamic and water quality models for the Savannah Harbor Expansion Study. Copies of the USGS letter and review comments to the Service are enclosed for your review.

The three-dimensional hydrodynamic model selected for this project is based on the Environmental Fluid Dynamics Code (EFDC), a physics-based turbulence closure model that has been applied in a number of estuarine and riverine systems in the southeastern United States. The Savannah Harbor expansion version of the EFDC is based on the model originally developed by Tetra Tech for the Environmental Protection Agency to determine the total maximum daily load (TMDL) for dissolved oxygen in the lower Savannah River. This TMDL model has been improved with an enhanced grid and other modifications.

The Service letter of July 5, 2006 and the USGS letter dated June 28, 2005 identified concerns on the models and recommended approaches to address the concerns. Recommended approaches included additional explanation in the final report, additional sensitivity simulations, and recalibration/revision of the model. We anticipated that most of these concerns could be addressed with additional documentation for the report and sensitivity runs. At subsequent meetings and conference calls the Service reiterated the need to address these concerns and document the outcome in the final report. We are

disappointed that several of the concerns were not addressed in the final report (please see enclosed USGS letter).

The Service recommends that the following previously requested information be provided in a supplemental report:

- Convergence testing results at additional sites in Middle River, Back River and Little Back River

- Sensitivity analysis results at additional sites in Middle River, Back River and Little Back River

- Clarify whether NOAA or USGS data is used for approximation of the offshore boundary

- A chart providing relative contributions (from point sources, storm water, ocean, upstream and marsh) of biochemical oxygen demand and nitrogen loading input to the system.

Information in the final report indicates that water level and tidal and riverine dynamics in the upper reaches of the model have been significantly improved. Salinity predictions in the Middle River and Little Back River and Savannah National Wildlife Refuge have also been improved. If the supplemental report does not disclose any unforeseen significant model problems, we believe that salinity prediction performance is adequate to use in project planning. However, we must caution that there continues to be a limited understanding and modeling ability of the velocity and flow dynamics in the Middle River, Little Back River and Back River. This limitation will cause some uncertainty regarding salinity and water quality predictions for mitigation alternatives that involve channel modifications in the Savannah River system.

With regard to dissolved oxygen, the model has limited ability to simulate the variability and trends in the data. Fourteen of 17 sites have $R^2$ values of less than 0.5 (explain 50 percent of the variability of the data) and nine of 17 sites have $R^2$ values of less than 0.25. These results indicate a limited understanding and modeling ability of the dissolved oxygen dynamics for the Savannah River estuary. However, the dissolved oxygen model results are similar to results in other southeastern estuaries and reflect the difficulty in modeling these systems. As a result, a great deal of caution will be needed in utilizing model dissolved oxygen predictions.

Our July 5, 2005 letter stated that users must be cognizant that any model in a complex system, such as the Savannah estuary, will have limitations in how well it will predict reality. An adaptive management approach, as described in Corp's Environmental Circular 1105-2-409, "Planning in a Collaborative Environment", dated 31 May 2005, is a way to deal with uncertainty. This document discusses the necessity of a well designed monitoring program as a cornerstone to adaptive management. The document also discusses phased project implementation, in which the initial phase is constructed and

monitored, and a future phase may be constructed as planned, modified, or not constructed. The decision on the future phase is based on the monitoring results and defined decision criteria. If an environmentally acceptable alternative can be identified, we would recommend implementing an adaptive management approach.

Based on the information reviewed, we conclude that: (1) additional documentation is needed to address the Service and USGS concerns provided with our July 5, 2005 letter; (2) if the documentation does not disclose significant unforeseen problems, salinity and water level predictions have been improved and are adequate for impact analysis; (3) dissolved oxygen model predictions are highly uncertain and will need to be used with a great deal of caution; and (4) for any acceptable alternatives, an adaptive management approach is needed to deal with model uncertainty.

We appreciate the efforts of you and your staff to coordinate this project with the Service. If you have any questions or wish to discuss this issue, please contact Ed EuDaly at 843-727-4707 x 227.

Sincerely,

Tim Hall
Field Supervisor

**UNITED STATES ENVIRONMENTAL PROTECTION AGENCY**
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61 FORSYTH STREET
ATLANTA, GEORGIA 30303-8960

MAR 0 8 2006

Mr. Pete Oddi, P.E., PMP
Deputy District Engineer for
Programs and Project Management
Savannah District, Corps of Engineers
P.O. Box 889
Savannah, GA 31402-0889

Dear Mr. Oddi:

Thank you for your January 31, 2006, letter requesting our review of the report "Development of the Hydrodynamic and Water Quality Models for the Savannah Harbor-Final, January 30, 2005." As you know, the U.S. Environmental Protection Agency Region 4 (EPA-R4) has been actively involved in the development of the Savannah Harbor Expansion Model. The report and its appendices describe the hydrodynamic, salinity transport, and dissolved-oxygen models and their application, calibration, validation, and confirmation to the Lower Savannah River and Harbor. The Environmental Fluid Dynamic Code (EFDC) model was originally developed for EPA-by Tetra Tech for determining the TMDL for dissolved oxygen for Savannah Harbor. This model has been updated by Tetra Tech for the U.S. Army Corps of Engineers (USACE), Savannah Harbor Dredging Project. The new model represents the refinement of the EFDC model from the original EPA TMDL model and the final modeling report addresses the outstanding concerns raised by EPA and other stakeholders during the review of the 2005 draft report.

These models are acceptable for continued use in the Savannah Harbor Expansion Project to identify the effects of potential changes in the estuary water quality and hydrodynamics from proposed harbor activities. However, as with any complex model, we expect the model to be continually updated and refined as new information and data are available and the improved models should be used for final TMDL development and evaluation of harbor activities.

The model development and review of the Savannah Harbor Expansion Model has been a long process for both agencies. It is encouraging to see the model development reach the final stages where it can be used by both the USACE and EPA in making the critical water quality decisions for the harbor. If EPA may be of further assistance, please feel free to contact Jim Greenfield at 404/562-9238.

Sincerely,

James D. Giattina, Director
Water Management Division

**Georgia Department of Natural Resources**
2 Martin Luther King, Jr. Drive, S.E., Suite 1152 East Tower, Atlanta, Georgia 30334-9000
Noel Holcomb, Commissioner
Carol A. Couch, Ph.D., Director
Environmental Protection Division
404/656-4713

March 14, 2006

Mr. Peter Oddi
U.S. Army Corps of Engineers, Savannah District
Post Office Box 889
Savannah, Georgia 31402-0889

Subject: Savannah Harbor Expansion Project
Harbor Models Acceptability

Dear Mr. Oddi:

The U.S. Army Corps of Engineers (Corps) is currently developing a Tier II environmental impact statement (EIS) for the proposed Savannah Harbor Expansion Project (SHEP). To identify and assess potential environmental impacts complex hydrodynamic and water quality models have been developed. The development process included representatives from four Federal Agencies, Georgia EPD and South Carolina DHEC, and stakeholders representing the Harbor dischargers. Model development recently culminated with the issuance of the final report: Development of the Hydrodynamic and Water Quality Models for the Savannah Harbor Expansion Project dated January 30, 2006. This report incorporates modifications responding to comments from the technical review group on the May 2005 version of the report. The Corps now requests Georgia EPD's position on the acceptability of these models for the purpose of predicting project impacts and suitable mitigation for those impacts.

Georgia EPD staff has reviewed the final project report and acknowledge the changes made in response to the technical review group comments. In addition, Georgia EPD agrees that these models are the best available tools to use in assessing impacts of the SHEP and possible mitigation alternatives. Georgia EPD therefore approves the use of these models to assess the impacts and mitigation of the proposed Harbor deepening. However, proposed Harbor expansion alternatives, and their environmental impacts and mitigation, will be reviewed by Georgia EPD on a case-by-case basis for their technical merit and their ability to protect water quality standards.

Sincerely,

Linda MacGregor

Linda MacGregor, P.E.
Branch Chief
Watershed Protection Branch

cc: Keith Parsons