CESAS-PD-E **18 May 2004**

INFORMATION PAPER

SUBJECT: Savannah Harbor Expansion Project;
Information to support a decision on a modeling path to best identify water quality impacts

1. Problem. The US Environmental Protection Agency {EPA}, U.S. Fish and Wildlife Service {USFWS}, National Marine Fisheries Service {NMFS}), Georgia Department of Natural Resources Environmental Protection Division (GADNR-EPD), South Carolina Department of Health and Environmental Control (SCDHEC), and City of Savannah, Georgia have expressed technical concerns about the ability of the Plan A Models (which are based on the Boundary Fitted Hydrodynamic code – BFHYDRO) developed by Applied Technology & Management (ATM) to be sufficiently defensible and accurate to be used to identify potential impacts from proposed alternatives we will be considering in this project. EPA is pursuing development of an alternate model (Plan B which is based on the Environmental Fluid Dynamics Code {EFDC}) that, with some relatively minor modifications, could also be used for the Expansion Project. The Corps and the Federal agencies need to recommend which modeling path the Project should follow at this time to develop a set of models to identify water quality impacts in the Savannah Harbor Expansion Project.

2. Assumptions.

a. Agency agreement on the adequacy of the tools used to identify environmental impacts will lead to easier agreement on the level of impacts expected to result from implementation of a proposed project alternative.

b. Several agencies will need to make decisions on the acceptability of the impacts from proposed project alternatives. Use of the same model by all those agencies is more likely to lead to agreement on the level of impacts that are likely to occur from a proposed alternative.

c. The Plan B Hydrodynamic and Dissolved Oxygen Models that EPA is pursuing for its Total Maximum Daily Load (TMDL) work will be able to satisfactorily meet the expectations that the Federal agencies defined for models for the Savannah Harbor Expansion Project.

3. Facts Bearing on the Problem.

a. Through its consultant ATM, Georgia Port Authority (GPA) has been pursuing development of Hydrodynamic & Salinity and Dissolved Oxygen Models for use on the Expansion Project.

b. EPA had been intending to use those models upon their completion for work that EPA needs to perform.

c. Due to delays in completing the GPA/ATM (Plan A) models and uncertainty on when the development of those models would be complete, EPA decided to pursue development of a separate set of models (Plan B) for its use on their required actions.

d. As a result of the review of the Final Calibration Reports for the GPA/ATM models by the Savannah Multi-Agency Review Team (SMART), GADNR-EPD, SC-DHEC, and the City of Savannah, questions have arisen on the defensibility and performance of the Plan A models. These natural resource agencies stated that the present version of the Plan A models is not acceptable for use on the Expansion Project.

e. The primary weakness in the Plan A models identified by the Federal agencies relates to an empirically-derived vertical mixing approach that is based upon data that is representative of the normal to low flow conditions of the Savannah River. The data was collected during the summer and fall of 1997 and 1999. Those seasons are typically low flow periods, and these years had abnormally low flows due to drought conditions. Since the vertical mixing approach used was empirically-derived, its ability to predict water quality outside the range of the conditions upon which it was formulated must be defensible. That includes the ability of the approach to correctly predict water quality changes that would occur with geometry modifications, including proposed deepening alternatives. The Plan A model could be used as a predictive tool when vertical mixing of salinity, dissolved oxygen, or oxygen-consuming constituents are not a concern and within the range of the observed flow conditions.

f. Agencies have completed their review of a calibration report for the Plan B Hydrodynamic Model. SMART and other agencies have identified no major concern about the defensibility of the Plan B EFDC-based Hydrodynamic Model.

g. Time and cost are important factors to the Corps and GPA in completing the work required to evaluate the Expansion Project.

h. Some members of the Stakeholders Evaluation Group (SEG) have requested that GPA ask the agencies to consider if a multi-model approach is an appropriate option. The SEG members indicated that although the various models would produce different answers, if there were a clustering of results this would provide more confidence that the overall prediction is in the right general area.

4. Discussion.

There are five possible courses of action: (A) Continue with Plan A as the primary tool for identifying changes expected to result from an alternative considered in the Expansion Project, (B) Pursue the development and use of the Plan B models for use on the Expansion Project, (C) Continue to develop the Plan A models for identifying physical changes to water quality parameters other than salinity and dissolved oxygen that are expected to result from a project alternative (Dual Plans), (D) Use the present version Plan A Hydrodynamic Model to identify project-induced changes to water surface elevation and velocity (Plan A Limited), or (E) Use both the Plan A and Plan B models as components of a multi-model approach. The PROS and CONS for each course of action are described in the following paragraphs.

a. Continue with Plan A modeling approach.

PROS:

- With sufficient well-directed effort, Plan A could be developed into an acceptable tool to identify changes from proposed alternatives in the Expansion Project.

- The Plan A models were state-of-the-art when GPA started their application to the Savannah Harbor in 1997. Much effort has already been expended to bring the models to this point in their development. Completing the development process would allow the agencies to use these new tools to assess impacts from potential construction activities in the harbor.

CONS:

- Substantial work would be required to address the agencies' concerns about the defensibility of the vertical mixing in the Plan A BFHYDRO Model. This effort is estimated by the Corps to take 2 months to accomplish, plus an additional month to produce a revised Calibration Report.

- When the Plan A BFHYDRO Model is revised such that its vertical mixing approach is acceptable to the agencies, the performance of that model must then be assessed. The agencies could still find that the performance of the Plan A BFHYDRO Model is not acceptable for impact evaluation purposes.

- When the Plan A BFHYDRO Model is revised such that its vertical mixing approach is acceptable to the agencies, the Plan A Dissolved Oxygen Model must then be recalibrated and another calibration report prepared.

- The agencies could find that the performance of the revised Plan A Dissolved Oxygen Model is not acceptable for impact evaluation purposes.

- Because of the lengthy time period it has taken to develop the Plan A models, the technical reviewers at the natural resource agencies have lost a degree of confidence in the ability of GPA/ATM to be able to successfully apply the Plan A models to the Savannah estuary.

- It is estimated by the Corps that 4 months of effort would be required to get to the point where another set of calibration reports for the Plan A models is available for agency review. That review would likely take 90 days. So the Plan A models would not be available for application runs until January 2005.

b. Pursue the development and use of the Plan B models.

PROS:

- EPA is developing the Plan B models for their use to prepare a TMDL analysis and develop Dissolved Oxygen Standards for the State of Georgia. They are fully confident in the technical defensibility of the models and that the performance of the models will be at acceptable levels. EPA's development work and support for the Plan B Models should increase the likelihood of the other agencies accepting the models.

- The project's adoption of EPA-developed models to identify environmental impacts should increase the acceptability of the model results to those individuals and organizations concerned about environmental protection. This should decrease any perception that the Expansion Project would use a tool that is not well suited to identify potential project-induced environmental changes.

- Since EPA is developing the Plan B models to meet their needs, they are absorbing much of the cost for development of those models.

- Since EPA has a court-mandated schedule for release of a draft TMDL in August 2004, there is more confidence in the estimated June completion date for the models.

- The agencies have not identified any foundational problems with the Plan B EFDC Model, as they did with the Plan A BFHYDRO Model.

- The agencies have concurred that the Plan B EFDC Hydrodynamic Model is adequate to move on to development of a Dissolved Oxygen Model.

- The Plan B models are expected to require less time to run that the Plan A models, even after incorporating a similar grid resolution, so application runs using Plan B would take less time and cost less money.

CONS:

- Although they have presently not identified any foundational problems with the Plan B EFDC Hydrodynamic Model, the agencies could ultimately determine that the performance of the model is not acceptable for impact evaluation purposes.

- The agencies could find that the performance of the Plan B Dissolved Oxygen Model is not acceptable for impact evaluation purposes.

- EPA's is scheduled to complete the development of their Plan B models in June. Modification of the models for use in the Expansion Project could probably be accomplished in a month. Preparation of calibration reports would likely take another month. Agency review would likely require an additional 90 days. Therefore, the Plan B models would not be available for application runs until December 2005.

c. Continue to develop the Plan A models for identifying some Expansion Project impacts (Dual Plans).

PROS:

- It is still unknown the extent to which EPA's Plan B models will meet with expectations the agencies previously defined for models to be used on the Expansion Project. Continuing to develop the Plan A models would provide the Expansion Project with a safety net should the Plan B models not perform as well as desired.

- A large number of model runs will be required to evaluate the potential environmental impacts of the Expansion Project. Having an alternate method of performing some of the analyses would allow a wider distribution of the work, enabling a shorter time frame for the evaluations to be accomplished.

CONS:

- The Plan B models will be able to analyze the same types of physical changes in the system as would the Plan A models. Either set of models would be able to answer the questions the agencies will have to consider. Completing both Plan A and Plan B models available for the Expansion Project would be a duplication of effort.

- Completing the development of both the Plan A and Plan B models for the Expansion Project would require additional funds beyond what would be required for completing either plan by itself.

- The Plan B models are publicly available and more widely distributed than the Plan A models. Therefore, it would be cheaper and easier for the Expansion Project to simultaneously conduct analyses at multiple locations using the Plan B models.

- Needing to review two sets of models will require more staff time from the natural resource agencies.

- Requiring the agencies to review two sets of models over the same time period could slow the completion of the reviews, delaying the date at which model application runs could begin.

- Since the development of Plan A and Plan B models is being performed by different personnel, the time period until the model development is complete would be the longest duration of the two paths. Revised Final Calibration Reports on the Plan A models are expected to be available for review in 4 months. If a 1-month delay occurs as a result of the two model reviews required from each agency, the models would not be available to perform application runs until February 2005.

d. Use the Plan A Hydrodynamic Model to identify Expansion Project-induced impacts to water surface elevation and velocity (Plan A Limited).

PROS:

- This would allow the Plan A Hydrodynamic Model to be used for velocity and water surface elevation, for which there are no present concerns about the defensibility of the model.

- A large number of model runs will be required to evaluate the potential environmental impacts of the Expansion Project. Having a separate method for performing a portion of the analyses would distribute the workload, enabling a shorter time frame for the evaluations to be accomplished.

- This alternative would avoid the expenses of Alternative C, since no modifications would be needed to the Plan A BFHYRDO Hydrodynamic Model.

CONS:

- Only the performance of the vertical mixing approach of the Plan A Hydrodynamic Model was evaluated by the Federal natural resource agencies, not the full model. Therefore, the acceptability of the model's predictive capability for velocity and water surface elevation is unknown at this time. The agencies would have to review the performance of the Plan A BFHYDO Hydrodynamic Model and determine its acceptability for this limited application. This review would likely take 60 days.

- The Plan B models will be able to analyze the same types of physical changes in the system as would the Plan A models. Either set of models would be able to answer the questions the agencies will have to consider.

- Since both the Plan A and Plan B models may be able to predict Project-induced changes to these parameters, having both models operational would result in having two sets of predictions for the same water quality parameters (velocity and water surface elevation). This would necessitate additional staff time to explain the differences between the two results.

- Applying both the Plan A and the Plan B models would require a larger overhead of modeling expertise to be able to predict Expansion Project-induced changes.

This larger overhead of expertise base would be more expensive to maintain and keep ready to apply.

- The Plan A models are not publicly available, so the ability of Non-Governmental Organizations or government agencies, not closely associated with the Expansion Project, to confirm the model results would be reduced.

- The Plan A models are more expensive to apply per run than are the Plan B models. This factor would be exacerbated if the runs were only used to evaluate changes to velocity and water surface elevation.

- This alternative would still require that the Plan B models be modified to predict Expansion Project-induced changes to the other water quality parameters.

e. Use both Plan A and Plan B as components of a multi-model approach (Multi-model Approach).

PROS:

- The clustering of several predictions increases the confidence that the results are in the right general area – that the predicted impact is not too far off from reality. The use of several models to make several predictions of expected physical changes would allow decision-makers to be more confident when making decisions about potential effects to valuable environmental resources.

- Much work has already been completed on the Plan A and Plan B models. Completing the development of both of those models would require less funding than has already been expended. Variations of these two models could be produced fairly easily – such as use of distinct vertical mixing schemes, allowing the creation of unique models at a much lower cost.

- Pursuit of a multi-model approach would show that the agencies are willing to consider new approaches and the concerns of project stakeholders.

CONS:

- Even when several models are used, their results may not cluster around a central value. Their predictions may be quite diverse if the models are truly unique and respond to different changes. The predictions that these models produce may not provide a great deal of additional certainty.

- If the model results differ widely, explanations must be provided in the EIS for why the decision-makers chose to rely on certain predictions and discounted other ones. Initially, additional effort would be expended to examine how the models function and why their results differ so widely. Then reasons for the varying results would need to be included in the EIS. These additional efforts would increase the project cost, while explaining the varying results would complicate the decision documents.

- If some readers find the explanations in the EIS for why certain model predictions are discounted to be unconvincing, the multi-model approach would have made the decisions seem less reliable in the eyes of those readers.

- The single-model approach the Expansion Project has been following is based on the use of the best tool to predict impacts from the proposed actions. Use of other models would, by default, result in the use of less accurate predictive tools. If these additional models are less accurate, they are also less valuable as predictive tools and less reliable for decision-making purposes.

- Some of the beneficial effect of a multi-model approach could be gained by running a single model over a range of input conditions or range of values for a constant. Varying such values would be much less expensive than developing several unique models. Thus, there may be a way of accomplishing the major goal of the multi-model approach at a much lower cost.

- The cost to apply several models would be substantially higher than the cost for a single model. While a single model may require 50 runs to be made, use of five models would require 250 runs. At up to $5,000 per run, the cost for applying several models would be expensive. The additional information produced by the multi-model approach would result in more work in the impact analysis and report preparation phase of the project. This additional work would require additional expenses for those phases of the project.

5. Conclusions.

GPA pursued development of the Plan A BFHYDRO and Dissolved Oxygen Models under the oversight of the Corps and the natural resource agencies. All parties have worked toward making the Plan A models successful. The data collection, data analysis, review and coordination associated with the Plan A work produced to date has been beneficial to an understanding of the Savannah River estuary.

When the full model documentation was made available in January 2004, the natural resource agencies concluded that the present versions of the Plan A BFHYDRO and D.O. Models are not satisfactory for use in identifying changes likely to occur from proposed alternatives in the Savannah Harbor Expansion Project. Either (a) additional time and money will have to be invested into revising the Plan A models, or (b) an alternate modeling approach is needed.

EPA is developing Plan B (EFDC-based) models so they can conduct a TMDL analysis and develop a D.O. standard for the Georgia portion of the harbor. That model could be used for the Expansion Project with relatively minor adaptation.

In theory, either the Plan A or the Plan B models should be able to answer all of the types of questions that the Expansion Project will need to address. The paths are identical in this respect.

The use of an EPA-produced model as the foundational tool for identifying potential impacts from proposed Expansion alternatives would increase the confidence of environmentally-minded members of the public in the results of the models. That confidence should transfer directly to the environmental conclusions of the entire Expansion Project.

Performing the application runs using the Plan B models would take less time and cost less money than if they were performed using the Plan A models. That difference could minimize study costs and shorten the time it takes to complete the impact identification and evaluation work. Use of both models or several models would increase the time and cost required to perform the application runs.

Performing some application runs using the Plan A models and some with the Plan B models may reduce the overall time needed to conduct the Project impact evaluations. However, the proprietary nature of the Plan A models reduces their availability to NGOs and government agencies not directly involved in the Expansion Project. In addition, using both modeling systems would require more overhead in maintaining the modeling superstructure and expertise for two modeling systems, rather than just one.

A multi-model approach could increase the confidence in the model results and the final decisions on the project. However, if the model results vary widely, additional effort would be required to attempt to resolve the differences. If the results cannot be resolved, the widely differing results would decrease the confidence in the decisions made based on the model results.

A multi-model approach would require the greatest expenditure of funds since more work would be performed in the modeling and data analysis phases.

The following four points summarize the findings and conclusions:

- From a cost perspective, the multi-model approach would be the most expensive of the five options. Adapting and using the Plan B models appears to be the least expensive option. The cost of applying the models would also be least with Plan B.

- From a schedule perspective, the first four approaches considered would be quite similar, differing by only a month or so. The multi-model approach would extend the project schedule by another six months.

- From a likelihood of success perspective, adapting and using the Plan B models appears to be best, since EPA is developing and will be supporting those models

on its actions (TMDL and DO Standard). The multi-model approach has a potential high level of success by increasing the confidence in the ultimate decisions made on the Project; however, it also has the highest potential for failure, should the model results differ widely and the explanations provided for why the results of certain model are relied upon while others are discounted are not convincing to some readers.

- The dual and combined plans would result in a duplication of effort to develop and maintain expertise on two modeling systems. The multi-model approach would result in even greater duplication of effort.

6. Summary of Resource Impacts.

	Plan A	Plan B	Dual Plans	Plan A Limited	Multi-Model Approach
Costs to Project:					
- Model development	$110K	$105K	$225K	$105K	$375K
- Application runs	250K	100K	350K	130K	650K
- Sediment modeling	500K	300K	500K	300K	300K
Date available for application	Jan 05	Dec 04	Feb 05	Dec 04	Aug 05

NOTE: The details for these cost estimates are included in the attached Memorandum. These estimates were developed by Savannah District's Planning Division based on input from Tetra Tech and Savannah District's Engineering Division.

// ss //

William Bailey
Physical Scientist

CESAS-PD-E **5 May 2004**

MEMORANDUM FOR RECORD

SUBJECT: Savannah Harbor Expansion Project;
Cost backup for EMG Information Paper

This information is based on input from Tetra Tech and Savannah District's Engineering Division.

Costs for Plan A

Modify vertical mixing	$40K	
New Hydro Calibration Report	20K	
New D.O. Calibration Report	20K	
Respond to comments on performance	30K	
Contracting	0K	
	$110K	

Other cost considerations:

Cost per application run	$ 5K	With 50 runs, total = $250K
Chloride Model	$ 40K	20K SOW / 20K responses
Sediment modeling	$500K	

Costs for Plan B

Finer Grid	$30K	
Training	20K	
DO Calibration Report	30K	
Hydro Calibration Report	15K	
Respond to comments on performance	0	
Contracting	10K	
	$105K	

Other cost considerations:

Cost per application run	$ 2K	With 50 runs, total = $100K
Plan B Chloride Model	$ 30K	10 T-T / 20 USGS
Plan B Sediment modeling	$300K	

Costs for Dual Plans

Fully develop both Plan A and Plan B.

Same as Plan A	$110K	
Same as Plan B	105K	
Contracting	10K	
	$225K	

Other cost considerations:

Cost per Plan A application run	$ 5K	With 50 runs, total = $250K
Cost per Plan B application run	$ 2K	With 50 runs, total = $100K
Plan A Chloride Model	$ 40K	20K SOW / 20K responses
Plan A Sediment modeling	$500K	

Costs for Plan A Limited

Use Plan A used for water surface elevation and velocity.
No modification to present Plan A models. No use of Plan A D.O. Model.

Plan A	0	
Same as Plan B	$105K	
	$105K	

Other cost considerations:

Cost per Plan A application run	$ 5K	With 10 runs, total = $50K
Cost per Plan B application run	$ 2K	With 40 runs, total = $80K
Plan B Chloride Model	$ 30K	10 T-T / 20 USGS
Plan B Sediment modeling	$300K	

Costs for Multi-Model Approach

Develop both Plan A and Plan B
Develop variations of these models as additional predictive tools

Same as Plan A	$110K	
Same as Plan B	105K	
Develop variations	150K	3 variations @ $50K each
Contracting	10K	
	$375K	

Other cost considerations:

Cost per Plan A application run	$ 5K	With 50 runs, total = $250K
Cost per Plan B application run	$ 2K	With 50 runs, total = $100K
Cost per variation application run	$ 2K	With 150 runs, total = $300K
Plan B Chloride Model	$ 30K	10 T-T / 20 USGS
Plan B Sediment modeling	$300K	