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Georgia Department of Natural Resources

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EXECUTIVE DIVISION

November 8, 2000

Mr. David Schaller
Deputy Executive Director
Georgia Ports Authority
P. O. Box 2406
Savannah, GA 31402

Dear Mr. Schaller:

EPD has performed a second review of the U.S. Army Corps of Engineers' (COE's) 1998 report entitled "Potential Ground-Water Impacts, Savannah Harbor Expansion Feasibility Study." This second review was done after considering written and oral stakeholder critiques of the COE's report that were performed as part of the SEG process. Further, EPD has reviewed several recommendations for additional studies to assess the potential impact of harbor deepening on the Upper Floridan Aquifer.

In 1997, prior to finalizing their report, the COE requested that EPD, the USGS, and Georgia Southern University perform a colleague review to identify any errors or omissions as well as to review the appropriateness of the COE investigative methods. A meeting was held on this matter in Savannah in September, 1997, which was attended by the following reviewers: William McLemore (EPD), Napoleon Caldwell (EPD), Richard Krause (USGS), Chris Leeth (USGS), and Vernon Henry (GSU). Representatives of the Ports Authority and Lockwood-Greene also were in attendance. I do not recall any specific errors or omissions that were identified at the meeting; nor do I recall any person raising any particular concern at the meeting. I left the meeting with the impression that all of the reviewers were in agreement that the COE's technical approach was sound and the preliminary conclusion that the proposed channel deepening would not significantly adversely impact the Upper Floridan Aquifer also was reasonable.

EPD's 1998 review and recent re-review indicate that the data reported in the COE's 1998 report are reasonable and were collected in a manner consistent with the professional practice of geology. Assuming that the dredge depths presented in the COE report are correct, the approach, analyses, and interpretations used by the COE are technically-sound, reasonable, appropriate, and quite importantly conservative. Data provided in the COE report are internally consistent and support the COE's interpretations. Data in the COE report are consistent with other hydrogeological work performed in the Savannah area. No information has been provided to indicate that any measurements or analyses performed by the COE are incorrect. No data or measurements have been provided that contradict the COE's report and interpretation.

Further, EPD independently reperformed the COE's leakage analysis at multiple locations and calculated vertical leakage values that were less than the COE's two estimated values of 0.026 and 0.034 gpd/sq. ft.

In the Spring of 2000, some two years after the Corps completed its report, two new pieces of information became available. These are the identification of Miocene-aged fractures in coastal Georgia and the USGS's development of a conceptual model for salt-water intrusion.

EPD's recent review of critiques of the COE's work revealed discrepancies in the critiques. These include: inappropriate use of citations (i.e., the actual document presents a different picture than that presented in the critique), selective use of citations (i.e., identifying inconsistencies between COE work and USGS work but not identifying consistencies between COE work and USGS work), not recognizing that the COE examined leakage at two locations not just one, not identifying any actual data that supported/justified the critique, and emphasizing vertical fractures as opposed to fractures with a less-steep dip component. In other words, the critiques did not demonstrate any actual deficiencies in the COE's work.

Although not specifically addressed in the COE report, there is adequate information in the report to demonstrate that near vertical fractures are of little concern. If near vertical fractures do exist in Miocene strata beneath the Savannah River and if such fractures have dips of 85 degrees or less (photographs of the fractures indicate that while fractures do have steep dips, the fractures are not truly vertical) and have a one-meter spacing or less (the largest Miocene fracture spacing described in the relevant published literature), a fracture would be encountered every 38 feet of continuous coring. Inasmuch as the COE obtained over 402 feet of continuous core with 100% recovery, the COE should have intercepted a significant number of fractures if they were present. The fact that the COE encountered only two fractures, indicates that fractures are not common in the Savannah River area. In other words, actual field data do not support the concept that fractures provide a significant pathway for salt water to move from the river bottom through the Miocene Aquitard into the Upper Floridan Aquifer.

The issue of enhanced leakage via vertical fractures also has been addressed by three Ph.D. level and Georgia-registered (i.e., professional engineer or professional geologist) ground-water professionals (James Wallace and Joseph Wilson of Law Engineering and Robert Carver, a retired professor from the University of Georgia). All of the individuals have experience in ground-water related issues and in coastal Georgia. Two of the individuals (Wallace and Wilson) performed special field studies and made ground-water related observations and interpretations. All of the individuals agreed that leakage through the Miocene Aquitard via fractures would be minimal.

From a geological point-of-view, the Savannah-Chatham County area is the most thoroughly studied portion of Georgia. Previous and current studies have included

drilling, subsurface geologic mapping, aquifer testing, chemical analysis, geophysical surveys, and ground-water modeling. As a result of these previous and current studies, the geology and the hydrogeology of the area are well understood, straightforward, and a clear picture (i.e., conceptual model) of salt-water intrusion and its impact on the Upper Floridan Aquifer has emerged for the area under consideration for harbor deepening, in particular, and for the entire region, in general

According to the USGS, the conceptual model for salt-water intrusion in the Savannah area is:

"Intrusion of sea water [occurs] through areas where the confining unit is thin or breached, and subsequent lateral migration into the aquifer."

All data collected as part of previous investigations and as part of the Sound Science Initiative support this conceptual model; therefore, if this model is correct, then the most vulnerable portion of the Savannah River proposed to be deepened will be at the six Unit "B" scour channels located between +15,000 and -58,000. While the COE's work indicates that these scour channels do not provide a significant pathway for salt water to enter the aquifer, the COE did not independently evaluate each channel. In this regard, the Ports Authority might wish to consider continuously coring some but not necessarily all of these scour channels from river bottom to 10-20 feet into the Upper Floridan. If the Ports Authority decides to pursue this work, then the core holes should be geophysically logged, representative samples should be collected for measurements of vertical hydraulic conductivity, and cores should be squeezed for measurements of salinity (i.e., to generally define the fresh water-salt water interface). Analyses should be generally consistent with recommendations #1 and #3 suggested by South Carolina DHEC on September 7, 2000, should reflect accurate dredge depths, and should include a re-assessment of the published and unpublished literature. Because of their access to equipment (a jack-up drilling rig), their past experience with the harbor deepening project, their demonstrated high technical skills, and their accountability to the public, the COE is the most appropriate organization to perform the work.

Some suggested additional work is unnecessary; namely:

- (1) "Worst case analysis," as opposed to conservative engineering design, is used only in environmental decision making in lieu of making measurements. Worst case analysis is by its very nature biased and non-scientific. This approach is not used by state regulatory agencies; further the approach is contradictory to Georgia's EPA-approved ground-water policy, which stresses making environmental decisions on the basis of scientific facts.
- (2) Aquifer testing, which has been suggested, is expensive and if the governing assumptions are not met, such testing may produce ambiguous results. EPD has performed an analysis of the twelve commonly accepted assumptions governing the validity of an aquifer test (see Fetter, 1994, pg 198 for a listing);

- this analysis indicates that most of the governing assumptions can not be demonstrated to be valid in the Savannah area. If the Ports Authority elects to perform an aquifer test, the Authority should recognize that the test, in addition to being quite expensive, may not produce scientifically valid results.
- (3) Numeric ground-water modeling along with analyses duplicative of the Sound Science Initiative, has been suggested. In this regard, it needs to be remembered that numeric ground-water modeling is not inherently superior to other methods of ground-water assessment. Straightforward calculations based on measurements provide scientifically sound assessments. Further, another group of stakeholders has already determined that the existing numeric ground-water models in the Savannah area are not adequate for assessing the impact of salt-water intrusion and has recommended that EPD develop new models, as part of the Sound Science Initiative, to address this issue. New models, such as the one EPD currently is developing, require the gathering of new field data; this is a time-consuming and often expensive undertaking. The specific data needed to prepare a new model to address the impacts of Savannah harbor deepening, however, are not being gathered as part of the Sound Science Initiative (i.e., defining the localized potentiometric surface of Miocene in the vicinity of the River, assessing transient pumpage in the Upper Floridan Aquifer in Chatham County, and gathering of Miocene hydraulic property information in the immediate vicinity of the Savannah River). Still further, the results of ground-water models are highly dependent on the simplifying assumptions used in the construction of the model. If any single assumption is determined to be inappropriate, then the entire modeling effort can be discredited. Acceptance of model assumptions requires considerable stakeholder input and concurrence; if such concurrence is not obtained early-on in the modeling process, then stakeholder acceptance of a model may be difficult or impossible to achieve. If the Ports Authority elects to perform ground-water modeling, then the Authority needs to recognize that (a) considerable new field information will need to be gathered; (b) the modeling assumptions will be susceptible to being discredited; and (c) up-front and progress meetings with stakeholders will be required in order to achieve model acceptance. There are other methods, namely straightforward analysis using empirical formulae, which are highly credible and which can produce a scientifically valid assessment. There is nothing wrong in using such methods.

In summary, while there are considerable data that indicate that the proposed deepening the Savannah River will not adversely impact the quality of water in the Upper Floridan Aquifer and there are no data to suggest otherwise, the Ports Authority might want to consider gathering some additional information. If such additional data/interpretations are consistent with the previous data/interpretations, the Ports Authority would be able to adequately demonstrate that the proposed deepening would not significantly adversely impact the Upper Floridan Aquifer. [Note: although it is not necessary to discuss at this

particular time, if harbor deepening actually occurs, then a program of long-term ground-water monitoring would be appropriate.] On the other hand, if new data demonstrate that public water supplies would be significantly adversely affected, then deepening would not be appropriate.

Both EPD and South Carolina DHEC are currently performing hydrogeologic studies in the Savannah area. Some of these studies may provide information useful for assessing the impact of harbor deepening. Both agencies are willing to share technical information with the COE and the Ports Authority.

At this time, EPD is willing to provide technical guidance to the Ports Authority, the COE, and the SEG's Aquifer Committee in developing a technically sound work plan for additional studies. EPD, further, is willing to request that South Carolina DHEC and the USGS assist us with this effort.

We hope the above is useful to the Ports Authority in addressing the issue of potential aquifer impacts in scientifically sound manner.

Sincerely,



William H. McLemore
State Geologist

Cc: Harold Reheis