Recommended Conceptual Study Plan
to
Determine Potential Impact to the Upper Floridan Aquifer
From
Savannah Harbor Expansion Alternatives

Final Determination

A Plan Developed by
The Working Group
of the
Aquifer Committee

June 4, 2002

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Participants include active and retired geology, chemistry and hydrogeology faculty members of regional universities, such as Georgia Southern University and Georgia State University; federal and state government agencies, such as United States Geological Survey, United States Army Corps of Engineers, South Carolina Department of Health and Environmental Control , and Georgia Department of Environmental Protection Division; and groundwater, geological or engineering consultants currently engaged in private practice.

Purpose and History of The Working Group

1. The Aquifer Committee was formed by the Stakeholders Evaluation Group in response to concerns regarding the hydraulic integrity of the Upper Floridan Aquifer confining unit.

2. The Working Group was formed to directly support the mission of the Aquifer Committee, that is, to identify the concerns regarding the potential effect upon the Floridan Aquifer of dredging the Savannah River navigation channel to the maximum depth required to maintain a project depth of – 48 feet MLW, and to recommend to SEG the scope of scientific or engineering investigation(s) and analysis(es) to address these concerns.

3. The Working Group met March 13-14, 2001 to determine the relevant technical concerns that should be addressed. These concerns include:

- **Rate and quantity of saltwater leakage through the Upper Floridan confining unit that may result from harbor deepening is unknown;**

- **Changes in chloride concentration (salinity) with time in the Upper Floridan aquifer that may be caused by harbor deepening are unknown;**

- **The hydraulic properties, salinity, and hydraulic head within the Upper Floridan confining unit are poorly known, as is the spatial variability of these parameters;**

- **The hydraulic properties and geometry of the paleochannels are poorly understood;**

- **The geologic framework needs to be better defined.**

4. **These technical concerns were recommended to, and accepted by, the Aquifer Committee on April 20, 2001.**

5. **A Working Group status report was presented to SEG on May 1, 2001**

6. **The Working Group reconvened July 24-25, 2001 and:**

   - **Identified ten (10) potential study tasks;**
   - **Determined an initial Draft Study Plan was prepared and distributed to The Working Group for review and comment.**

7. **The Working Group met on December 6, 2001 to discuss the initial Draft Study Plan and to refine the study tasks.**

8. **Six work tasks were <u>retained</u> for inclusion in the Draft Final Study Plan. Two additional work tasks were <u>not</u> retained.**

9. **The Draft Final Study Plan is presented to the Aquifer Committee for its consideration, review, and comment on April 5, 2002.**

Recommend Technical Approach Involving Multiple Tasks

Task 1. Seismic Reflection Survey to:

- **More accurately determine the thickness of the Upper Floridan confining unit;**
- **Gain better resolution of the geometry and orientation of paleochannels;**
- **Identify potential exploratory drilling locations along the navigation channel.**

Task 2. Geologic Transect to:

- **Obtain hydrogeologic data;**
- **Correlate stratigraphic units;**
- **Develop geologic section;**
- **Develop chloride concentration profile.**

Task 3. Construct monitoring well clusters to:

- **Obtain hydraulic head data.**

Task 4. In-Channel Exploratory Drilling to:

- **Determine thickness of paleochannel sediments;**
- **Determine hydrologic characteristics of paleochannel sediments;**
- **Develop chloride concentration profile within paleochannel sediments.**

Task 5. Compile database to:

- **Research all relevant historic data;**
- **Develop digital database.**

Task 6. Develop numerical model of the hydrologic system including the underlying navigation channel to:

- **Predict vertical saltwater encroachment into and transport within the Upper Floridan aquifer that may result from the Savannah Harbor expansion alternatives**

- **Provide a tool for future decision-making**

Difference of Opinion

- **Two additional tasks had been identified by The Working Group but not included in the final document following a close vote of The Working Group members.**

- **When presented to the Aquifer Committee, and following a lengthy discussion by Aquifer Committee members, the two tasks were reinserted.**

These two tasks are (identified by letters rather than numbers to avoid confusion):

Task A. Conduct in-situ hydraulic test of the Upper Floridan Confining Unit.

Approach: A pumping well would be installed at Ft. Pulaski transect site in addition to the monitoring well cluster. The pumping well would be open to the uppermost water-bearing part of the Upper Floridan aquifer. Well specifications for the pumping well would be developed upon further review of the lithologic data obtained during completion of Task 2.

After installation of monitoring well clusters (or pressure transducer array) and the pumping well, an *in-situ* hydraulic test of the Upper Floridan confining unit would be conducted by pumping water from the uppermost part of the Upper Floridan aquifer and monitoring head changes within each monitoring well (or pressure transducer) and the pumping well. The duration and rate of pumping of the Upper Floridan aquifer necessary to

induce measurable hydraulic responses within the confining are unknown at this time. The pumping rate and duration needed to induce a measurable response would be estimated during the actual design phase of the aquitard test and be based on reasonable estimates of vertical-hydraulic conductivity and storativity of the confining unit.

Rationale—The Minority Position of Working Group members for conducting in-situ *hydraulic test of the Upper Floridan confining unit:*

1. ***vertical hydraulic conductivity is a scale dependent parameter;***
2. ***aquitard tests are recognized as the best approach to determining estimates of***
3. ***vertical hydraulic conductivity;***
4. ***laboratory-derived estimates of vertical hydraulic conductivity are less representative of field conditions than are aquitard tests;***
5. ***the cost associated with conducting aquitard tests is nominal; and aquitard testing is the best approach to determine vertical hydraulic conductivity, which was deemed a critical parameter by the entire Working Group.***

Task B. Evaluate and analyze in-situ hydraulic test data.

<u>Discussion</u>: Hayes (1979) calculated the vertical hydraulic conductivity of the Upper Floridan confining unit using aquifer tests data from the Burton, South Carolina well field and Port Royal Clay Company well (both on Port Royal Island, South Carolina) using the Hantush-Jacob method. His analyses yielded values of 5.0 E-3 feet/day and 1.5 E-2 feet/day. Smith (1987) compared the vertical hydraulic conductivity values determined from these tests with falling-head permeameter tests of 23 Hawthorn Formation (part of the Upper Floridan aquifer confining unit) samples, having lithologies described as sandy clay and clayey sands, collected from eight sites beneath Port Royal Sound. Although the results of the permeameter analyses ranged over four orders of magnitude, the mode and the median vertical hydraulic conductivity values of the 23 samples were between the vertical hydraulic conductivity values calculated from the aquifer tests.

Approach: The field data collected during the *in-situ* hydraulic tests will be reduced and analyzed using an appropriate method such as Hantush-Jacob (Lohman, 1979), Newman-Witherspoon (1972), or others. The data analysis would be completed to determine estimates of the vertical hydraulic conductivity of the Upper Floridan confining unit that account for any secondary vertical permeability enhancement such as inter-connected, vertically oriented, fractures and/or joints. It will be necessary to account for background noise and interference from pumping, and barometric and tidal changes and fluctuations during the test and in the analysis of the data.

***The initial* in-situ *hydraulic test would be evaluated to determine the feasibility and necessity of conducting additional tests at other locations along the geologic transect.* Should the initial aquitard test be successful in eliciting a measurable head response, thereby allowing vertical-hydraulic conductivity to be computed, additional aquitard tests should then be performed at other sites. Field testing would cease following the first unsuccessful test, or following the fourth or fifth successful one. (i.e. about 4-5 tests should be sufficient to complete this task and meet study objectives.) If the field vertical-hydraulic conductivity values are different than the lab-derived data, then a correlation factor will be applied to the existing lab-derived data.**