

Section 1

Background

1.1 Introduction

In support of the development of Regional Water Development and Conservation Plans (Regional Plans) as called for by the Georgia Comprehensive State-wide Water Management Plan (Water Plan), the State of Georgia is assessing the availability of groundwater resources in Georgia to meet current and future water needs. Ten Regional Water Planning Councils in Georgia will develop these Regional Plans, with input from all of the stakeholders, while following guidance and recommendations provided by the Georgia Environmental Protection Division (EPD) through the Georgia State-wide Groundwater Resources Assessment program (Program).

The primary purposes of this Program are to assist Georgia EPD with regional water planning via the following activities:

- Compiling and reviewing available data on Georgia's groundwater resources;
- Prioritizing aquifers and aquifer units for determination of sustainable yields; and
- Developing groundwater flow models and water balances for estimating the sustainable yields in these prioritized units.
- Sustainable yield is defined in the Water Plan (Section 2: Definitions, p. 11), as follows:

"Sustainable yield is the amount of water a source can supply for current and future water needs without unreasonably foreclosing the ability of future generations of humans to meet their own water needs."

Georgia EPD will provide estimates of the ranges of sustainable yields of the prioritized aquifers to Regional Water Planning Councils so that they may assess how groundwater can help satisfy current and future water demands. The groundwater flow models developed under this Program will be used to assist these Councils in determining how groundwater can be optimized through implementation of best management practices (BMPs).

As described in the State-wide Water Plan, determinations of sustainable yield were prioritized based on the following criteria:

- Functional characteristics of the aquifer;
- Existing evidence of adverse effects due to withdrawals from the aquifer;
- Forecasts suggesting significant increases in demands placed on the aquifer; and
- Acceptability of impacts due to increased groundwater withdrawals.

Groundwater withdrawals that exceed sustainable yields can lead to unacceptable short-term and/or long-term impacts. These impacts from increased groundwater withdrawals may include, but not be limited to:

- Progressive reduction of the groundwater resource as indicated by dropping water levels that do not recover;
- Reduction in water levels;
- Development of uneconomic pumping conditions;
- Degradation of groundwater quality (as defined by Georgia EPD);
- Reduction of surface water flows in streams hydraulically connected with an aquifer or aquifer unit; and
- Land subsidence or saltwater intrusion caused by lowered groundwater levels.

Sustainable yield may reflect more than one unacceptable impact, and the unacceptable impacts driving sustainable yield may differ across geologic and physiographic areas of the State. For instance, salt-water intrusion may be an unacceptable impact in portions of the coastal areas of Georgia; sinkhole development may be an unacceptable impact in northwestern and southwestern Georgia; and reduction of stream flows may be an unacceptable impact in the Dougherty Plain of Georgia.

In order to assist the State of Georgia in evaluating the sustainable yields of its groundwater resources, Camp Dresser & McKee Inc. (CDM) was retained by Georgia EPD to conduct groundwater modeling under the State of Georgia Groundwater Resource Assessment Contract. The groundwater modeling work associated with this project was performed in two phases. Phase I consisted of model development and calibration, and Phase II consisted of model simulations of sustainable yield application and reporting.

Four different modeling approaches were used to quantify groundwater availability in different aquifer systems during a long-term drought year period. These approaches ranged from simple water balance models to sophisticated, three-dimensional numerical models with transient simulation capabilities. Each approach provides a different level of information and estimates of the sustainable yield of the aquifers within Georgia.

1.2 Prioritized Aquifers in Georgia

The prioritized aquifers are located in southern Georgia in the Coastal Plain Aquifer System, northwestern Georgia in the Paleozoic-rock aquifers, and in the Crystalline-rock aquifers of the Piedmont and Blue Ridge physiographic provinces. The locations of the prioritized aquifers are shown on **Figure 1-1**.

1.3 Objectives and Scope of Work

The purpose of this report is to document groundwater model development, model calibration, and groundwater model simulations performed for this project. The primary objectives of the modeling are as follows:

- To provide sound technical numerical tools for the State to evaluate the state-wide groundwater resources;
- To quantify groundwater availability during a long-term drought period in the Upper Floridan Aquifer, Claiborne Aquifer, and Cretaceous Aquifer in the Coastal Plain Aquifer System; and
- To provide guidance and recommendations to Georgia EPD for development of the Regional Plans.

In order to achieve these objectives, the following major tasks in support of state-wide groundwater modeling have been completed by CDM per the scope of work under the State of Georgia Groundwater Resource Assessment Contract:

- **Task 1:** Two streamflow-based water balance models to determine ranges of sustainable yields in the Crystalline-rock aquifers of the Piedmont and Blue Ridge physiographic provinces;
- **Task 2:** A numerical groundwater flow model (Northwest Georgia model) to determine the range of sustainable yield the Paleozoic-rock aquifers of the Valley and Ridge physiographic provinces;
- **Task 3:** Modeling evaluations to determine sustainable yields of the Upper Floridan Aquifer in subbasins of the Dougherty Plain of southwestern Georgia using the MODFE Dougherty Plain model developed by the United States Geological Survey (USGS); and
- **Task 4:** Four three-dimensional numerical groundwater flow models (a regional steady-state model and three sub-regional transient models) to determine ranges of sustainable yields in the Upper Floridan Aquifer, Claiborne Aquifer, and Cretaceous Aquifer in southern Georgia's Coastal Plain physiographic provinces.

In accordance with Task 4, this report documents the development and calibration of one regional and three (sub-regional) telescoping Coastal Plain Aquifer models within southern Georgia. Preliminary sustainable yield evaluations for portions of the Upper Floridan Aquifer, Claiborne Aquifer, and Cretaceous Aquifer within Georgia are presented herein. The groundwater model developed and calibrated under Task 4 includes the entire Coastal Plain Aquifer System in Georgia, including aquifers and aquifer units that were not prioritized for determination of sustainable yield, which extends from the surficial aquifer system to the Upper Atkinson Aquifer, as follows:

- A regional Georgia Coastal Plain groundwater flow model;
- An Upper Floridan Aquifer groundwater flow model for south-central Georgia;
- An Upper Floridan Aquifer groundwater flow model for the eastern Coastal Plain of Georgia;
- A Claiborne Aquifer groundwater flow model that encompasses the entire horizontal extent of the Claiborne Aquifer in southwestern Georgia; and
- A Cretaceous Aquifer groundwater flow model for the Cretaceous Aquifer between the cities of Augusta and Macon.

The model boundaries for the regional groundwater flow model and the three sub-regional groundwater flow models are shown on **Figure 1-2**.

Groundwater model development and simulation results for the other models listed in Tasks 1 through 3 are presented in separate reports, which are appended to this report.

1.4 General Description of Georgia Coastal Plain Aquifer System

This section presents a very brief description of the Georgia Coastal Plain Aquifer system. A more detailed description of the hydrostratigraphy, hydrogeology and geology of the Georgia Coastal Plain Aquifer system is presented in Section 2.

The Coastal Plain Aquifer System within Georgia consists of seven regional (major) aquifer systems that are composed of both carbonate and clastic sediments ranging in age from Holocene to Cretaceous. As shown on **Figure 1-3**, the seven major regional aquifer systems in descending order, based on depth located within the Coastal Plain of Georgia, consist of the following:

1. Surficial Aquifer System ;
2. Brunswick Aquifer;
3. Floridan Aquifer System;
4. Claiborne Aquifer;
5. Gordon Aquifer;
6. Clayton Aquifer; and
7. Cretaceous Aquifer System.

Since the Clayton aquifer directly underlies the Claiborne Aquifer it cannot be readily shown in plan view on Figure 1-3. Also, note that not all these regional aquifers are prioritized for sustainable yield assessment. Only the Upper Floridan, Claiborne and Cretaceous Aquifers have been prioritized by EPD for assessment of sustainable yield at this time. Figure 1-3 also shows the major rivers in the Coastal Plain of Georgia. As described later in Section 5.4.7, only the portions of the major rivers that overlap the aquifer outcrop areas within the Coastal Plain are included in the regional model and subregional models as described in Sections 5, 6 and 8 through 10.

The clastic portion of the Coastal Plain Aquifer System underlies an area of about 90,000 square miles in Alabama, Georgia, and South Carolina and it extends for a short distance into northern Florida (Miller, 1992). The system also extends westward throughout much of Mississippi, where it underlies an area of about 32,000 square miles. The upper part of the Coastal Plain Aquifer System grades into the Mississippi Embayment Aquifer System in western Alabama. The clastic portion of the Coastal Plain Aquifer underlies an area of approximately 35,000 square miles in Georgia.

The carbonate portion of the Coastal Plain Aquifer System consists of the Floridan Aquifer System. The Floridan Aquifer System is one of the most productive aquifers in the world. This aquifer system underlies an area of about 100,000 square miles in southern Alabama, southeastern Georgia, southern South Carolina, and all of Florida. The Floridan Aquifer System generally thickens seaward from a thin edge near its northern limit south of the Fall Line. The thickness of the aquifer system ranges from as little as 50 feet at the updip northern extent of the aquifer in Alabama, Georgia, and South Carolina to greater than 3,000 feet in south Florida. Some of the large-scale features in the Floridan Aquifer System are related to geologic structures such as the Gulf Trough and the Beaufort Arch. The effect that these structural features have on groundwater flow patterns in the Upper Floridan Aquifer will be discussed in Section 2. For example, the thick areas in Glynn County, Georgia, and in Gulf and Franklin Counties, Florida, coincide with two downwarped areas: the Southeast and Southwest Georgia embayments, respectively. In north-central peninsular Florida, the limestone units that comprise the aquifer system are thin over the upwarped peninsular arch.

The Georgia Coastal Plain Aquifer System models (described in Sections 5 through 10) include multiple aquifers and were assigned to different layers in the models. Any given layer may have different aquifers in western and eastern Georgia that reflect aquifer geologies.

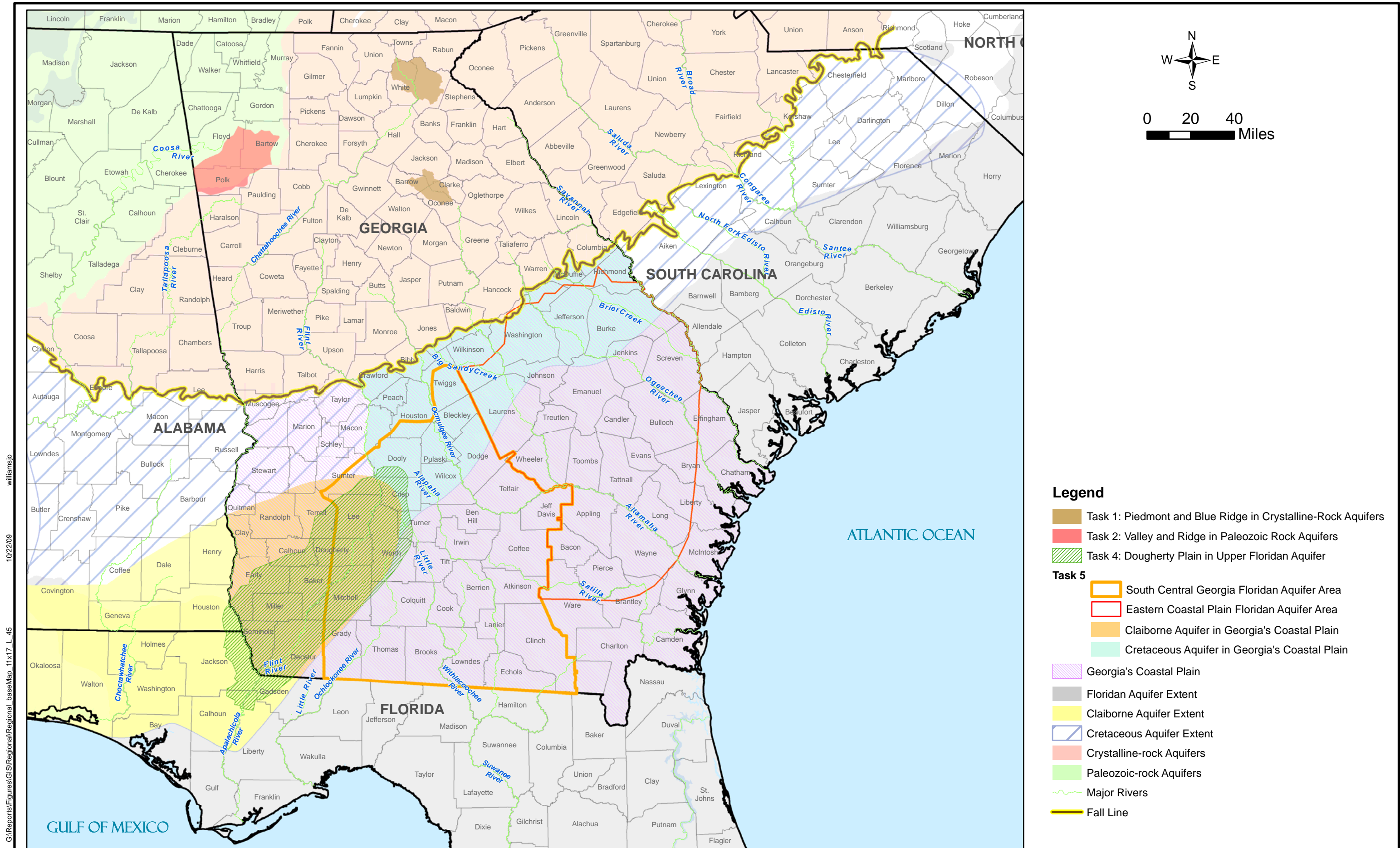
The northern limit of the Coastal Plain Aquifer System is its contact with metamorphic/igneous rocks of Precambrian and Paleozoic age at the Fall Line, which marks the updip extent of Coastal Plain sediments. The southern and southeastern limits of the aquifer system extend past the coastline in various locations, as the rocks that comprise some of the water-yielding units of the aquifer system are permeable enough to maintain their character as aquifers for some distance off-shore. However, some of the aquifers contain saltwater with total dissolved solids concentrations of

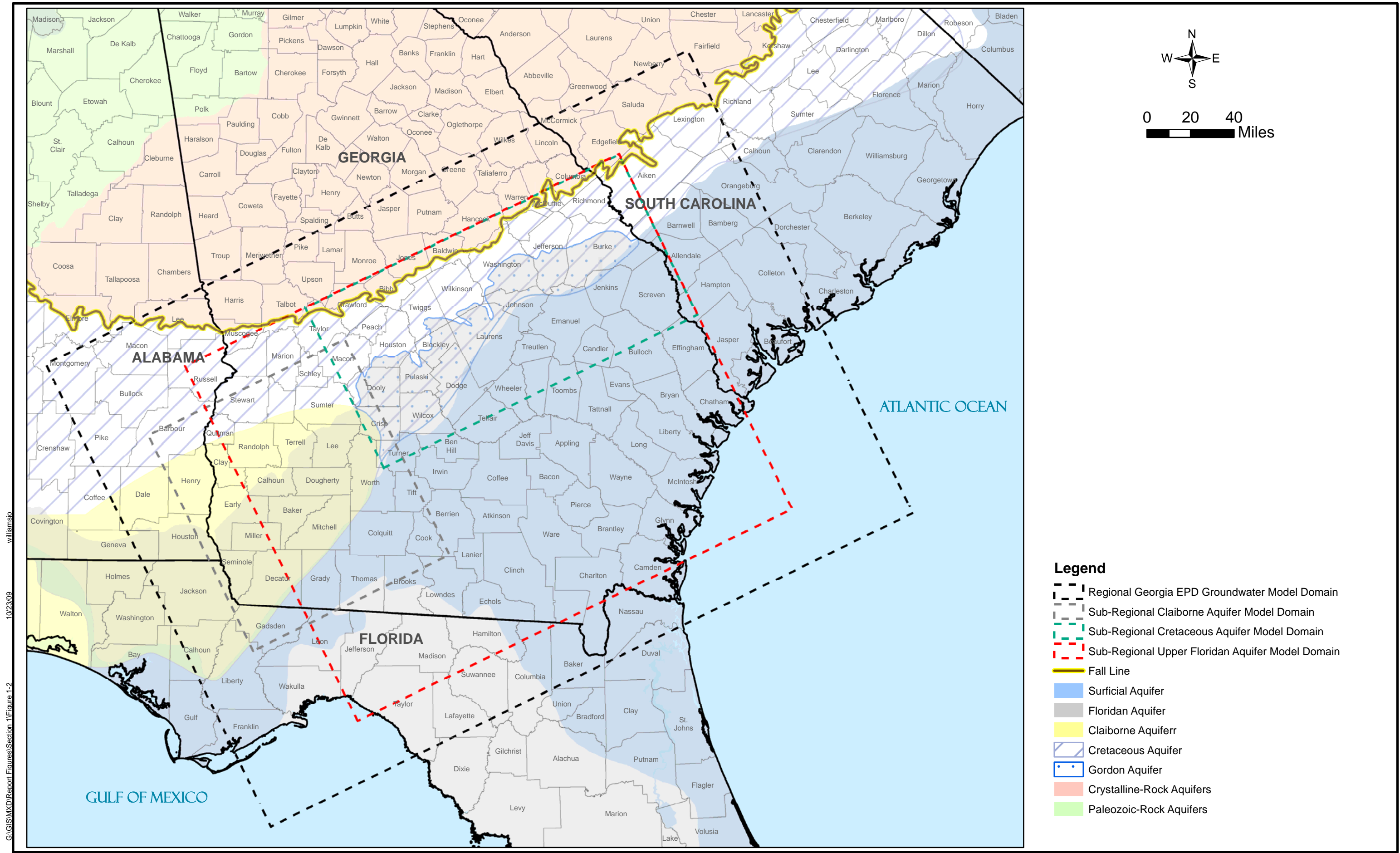
10,000 milligrams per liter or more near the coast in most areas. The southern limit of the aquifer system extends into peninsular Florida.

1.5 Modeling Approach and Objectives

The Coastal Plain Aquifer modeling approach (Task 4) is described as follows:

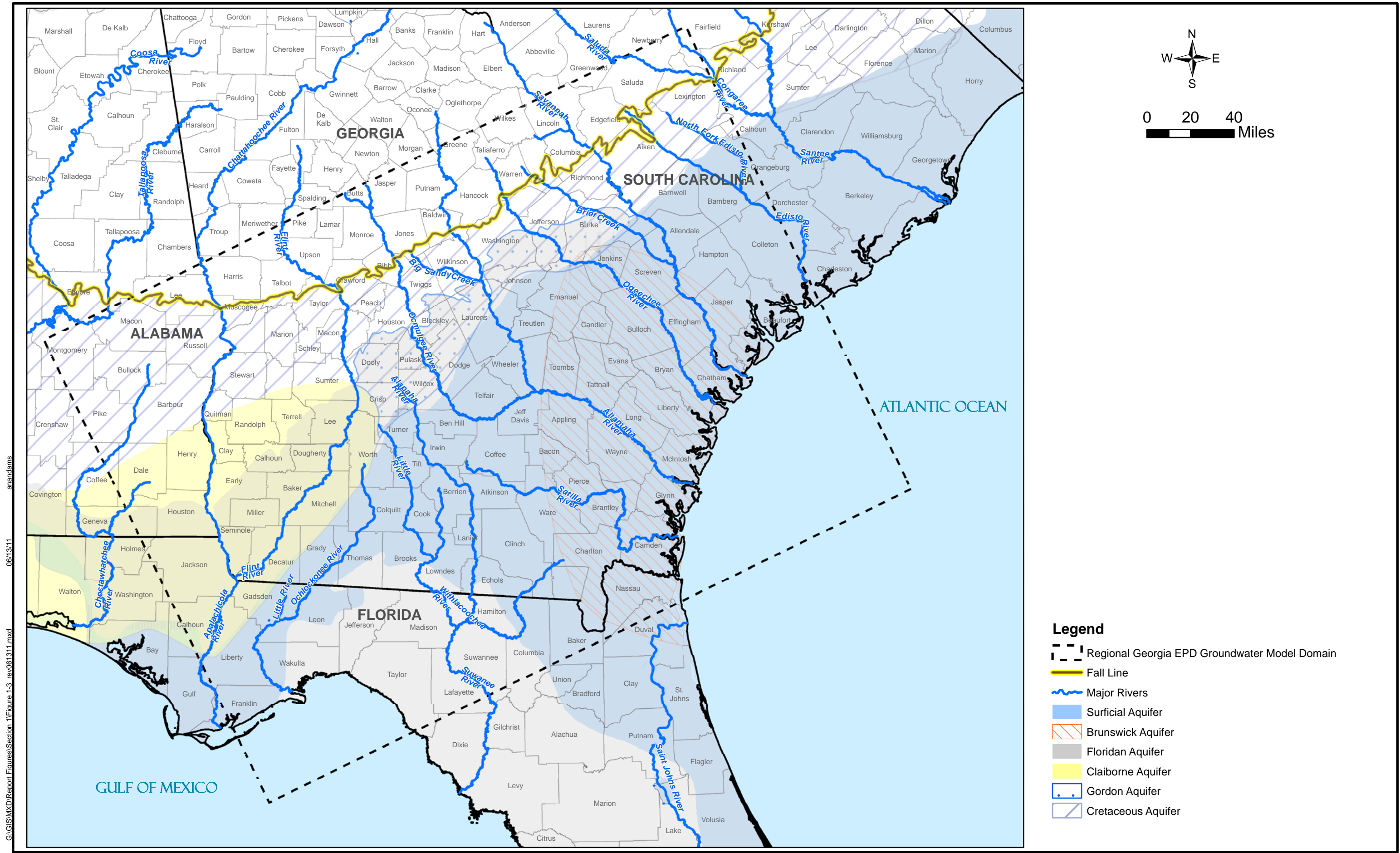
- Recommend a groundwater modeling approach for the prioritized Coastal Plain Aquifers that maximizes the use of existing published information and data for developing a regional groundwater flow model, which will form the basis for the sub-regional groundwater models with boundaries appropriate for the prioritized aquifer units;
- Develop and calibrate a regional groundwater model using available hydrogeologic data, groundwater monitoring well data, and existing models under steady-state conditions to establish boundary conditions (elevations) for the sub-regional models;
- Develop three sub-regional groundwater flow models for the prioritized aquifers – Upper Floridan Aquifer, Claiborne Aquifer, and the Cretaceous Aquifer based on the calibrated regional groundwater model;
- Calibrate the three sub-regional models under transient conditions that represent average, high, and low rainfall years;
- Perform groundwater model simulations using the three calibrated sub-regional groundwater models to determine the ranges of sustainable yields of each prioritized aquifer system; and
- Provide these models to Georgia EPD for use in regional water planning efforts.





G:\GISMXD\Report Figures\Section 1\Figure 1-2
10/23/09
williams

Figure 1-2
Coastal Plain Model Boundaries



G:\GIS\MXD\Report Figures\Section 1\Figure 1-3 rev061311.mxd 06/13/11 anandams

Figure 1-3
Aquifers Within Study Area