HYDROGEOLOGIC FRAMEWORK OF WEST-CENTRAL SOUTH CAROLINA

STATE OF SOUTH CAROLINA
DEPARTMENT OF NATURAL RESOURCES

WATER RESOURCES DIVISION
REPORT 5

1995

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By
Rolf K. Aadland
Westinghouse Savannah River Company

Joseph A. Gellici
South Carolina Department of Natural Resources

Paul A. Thayer
University of North Carolina at Wilmington

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CONVERSION FACTORS

Factors for converting inch-pound units to the International System (SI) of units.

Multiply	*By*	*To obtain*
	Length	
inches (in)	25.4	millimeters (mm)
feet (ft)	0.3048	meters (m)
miles (mi)	1.609	kilometers (km)
	Area	
square miles (mi^2)	2.59	square kilometers (km^2)
	Volume	
gallons (gal)	3.785	liters (L)
	3.785×10^{-3}	cubic meters (m^3)
	Flow	
gallons per minute (gal/min)	0.06309	liters per second (L)
	6.309×10^{-5}	cubic meters per second (m^3/s)
million gallons per day (Mgal/d)	0.04381	cubic meters per second (m^3/s)
inches per year (in/yr)	25.4	millimeters per year (mm/yr)
cubic feet per second (ft^3/s)	2.832×10^{-2}	cubic meters per second (m^3/s)
	Transmissivity	
feet squared per day (ft^2/d)	0.0929	meters squared per day (m^2/d)
	Hydraulic conductivity	
feet per day (ft/d)	0.3048	meters per day (m/d)
	Leakance	
feet per day per foot [(ft/d)/ft]	1.0	meters per day per meter [(m/d)/m]
	Gradient	
feet per mile (ft/mi)	0.1894	meters per kilometer (m/km)
	Drawdown	
feet per year (ft/yr)	0.3048	meters per year (m/yr)

"Sea level" in this report refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929) – a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called "Mean Sea Level of 1929."

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ABSTRACT

A detailed analysis of the hydrologic, geophysical, and core data from wells penetrating the updip Mesozoic-Cenozoic Coastal ain sequence in west-central South Carolina and adjacent east-central Georgia was made to evaluate ground water movement d contaminant transport potential in a comprehensive regional context. To accomplish the evaluation, a unified hydrogeologic ıssification was developed that defines and addresses the hydrologic characteristics of the aquifers underlying the region.

The classification of the aquifer and confining units utilizes a hierarchy of terms ranked at four levels. Level one is the drogeologic province and corresponds generally to the hydrologic systems classification of Miller and Renken (1988). The drogeologic province defines major regional rock and/or sediment packages that behave as a single unified hydrologic unit. vel two defines the aquifer and confining systems that transmit or retard ground water movement regionally. Level three, uifer and confining units, are mappable units more than 400 square miles in area. Level four refers to aquifer and confining nes and differentiates aquifer and confining units on the basis of locally significant hydrogeologic characteristics.

The basement complex is designated the Piedmont hydrogeologic province and consists of Lower Paleozoic-Precambrian neous and metamorphic rocks and Triassic terrigenous clastics of the Dunbarton basin. Overlying the Piedmont hydrogeologic ovince is the Southeastern Coastal Plain hydrogeologic province, which consists of unconsolidated sediments of Cretaceous d Tertiary age.

The Southeastern Coastal Plain hydrogeologic province is divided into three aquifer systems; in descending order the Floridan, ıblin, and Midville aquifer systems. The Floridan and Dublin aquifer systems are separated by the Meyers Branch confining stem; and the Dublin aquifer system is separated from the underlying Midville aquifer system by the Allendale confining stem. Towards the northwest, the Dublin and Midville aquifer systems coalesce, forming the Dublin-Midville aquifer system. ırther northwest the Floridan and Dublin-Midville aquifer systems coalesce, forming the Floridan-Midville aquifer system. ıe Appleton confining system is at the base of the Southeastern Coastal Plain hydrogeologic province; near the coast the stem thickens considerably and contains several aquifers.

The three aquifer systems extend southward from the study area to the coast. The Floridan aquifer system in the study area is e updip clastic equivalent of the carbonate sequence that constitutes the Floridan aquifer system in coastal South Carolina and eorgia. The Dublin and Midville aquifer systems also extend to the coast. Each aquifer system is subdivided into aquifers and nfining units. In site-specific studies, the aquifers and/or confining units may be further subdivided into aquifer zones and nfining zones as needed.

A set of comparative chronostratigraphic, lithostratigraphic, and hydrostratigraphic charts and a series of lithostratigraphic ıd hydrostratigraphic sections, isopachous, and unit-surface maps, potentiometric-surface maps, and well-cluster profiles illustrate e hydrogeologic setting of the study area.

INTRODUCTION

PURPOSE AND SCOPE

The purpose of this study was to define, describe, and name ıe hydrogeologic units that compose the Southeastern Coastal lain hydrogeologic province in west-central South Carolina ıd adjacent east-central Georgia (Fig. 1). Data on which this port is based are from the first phase of a multiphase study nducted for the Department of Energy (DOE) by the Westghouse Savannah River Company (WSRC) in collaboration ith the South Carolina Department of Natural Resources CDNR). This report is intended to evaluate ground-water ovement and contaminant-transport potential at the avannah River Site (SRS) (Fig. 2) and surrounding areas in a comprehensive regional context. Specific objectives of the report are to:

1) establish criteria for delimiting and naming hydrostratigraphic units in the SRS region;
2) examine and compile basic hydrogeologic data for the SRS region;
3) use the data to delineate and describe the hydrostratigraphic units in the study area;
4) establish a regional hydrostratigraphic framework and nomenclature for the Southeastern Coastal Plain hydrogeologic province.

The results of this study should serve as a foundation for

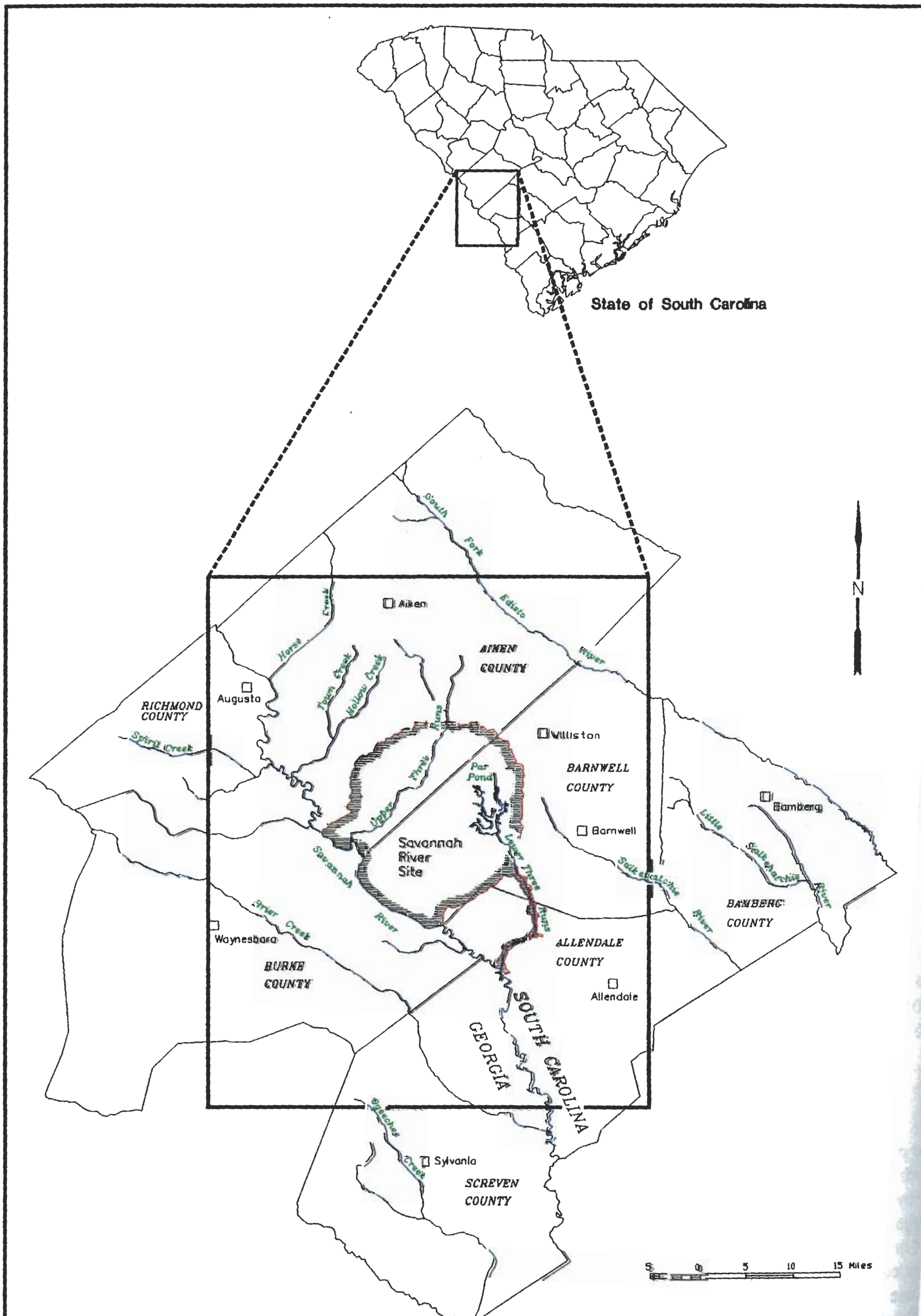


Figure 1. Location of the Savannah River Site and adjacent study area.

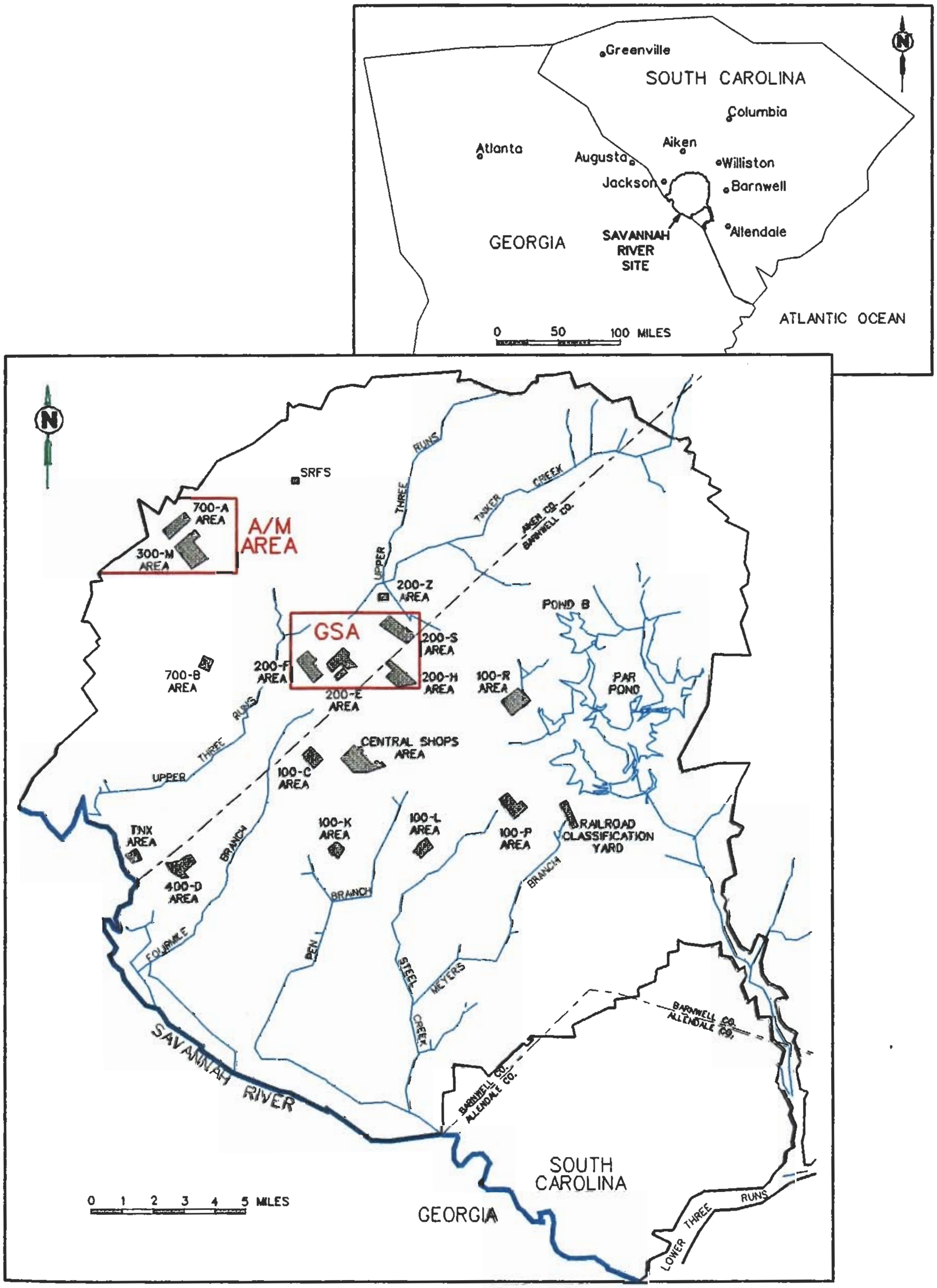


Figure 2. Features of the Savannah River Site.

future studies on ground-water movement and contaminant-transport potential at SRS and in surrounding areas.

DATA USED IN THE STUDY

A detailed analysis of down-hole geophysical, core, and hydrogeologic data from more than 183 deep wells installed at 26 cluster locations, as well as a number of other strategically located boreholes and wells onsite at SRS and in the surrounding region, were utilized in the study (Plate 1). Down-hole geophysical logs, including gamma-ray, gamma-ray density, neutron density, various resistivity surveys, and detailed descriptions of drill core (by binocular examination of the core at 1-foot intervals, petrographic examination of thin sections, and x-ray diffraction analysis of core samples) were used to delineate lithologic types and facies relationships.

Approximately 3,500 unconsolidated-sediment samples have been analyzed for grain-size distribution. All samples were oven dried at 40 °C (degrees celcius) and examined visually for mud (silt + clay) content. Sand samples containing less than 15 percent mud were sieved at 0.5 ϕ (phi) unit intervals, using screen sizes from -2.50 ϕ (5.66 mm or No. 3.5 U.S. mesh) to 4.00 ϕ (0.062 mm or No. 230 U.S. mesh) according to the procedures of Ingram (1971), which are based on ASTM specification D422. The distribution of particle sizes larger than 62.5 microns (retained on the No. 230 sieve) was determined by sieving, and the distribution of particle sizes smaller than 62.5 microns was determined by hydrometer and pipette analysis. Samples containing more than 15 percent mud were analyzed by the hydrometer or pipette method according to standard procedures (Galehouse, 1971); the sand fractions of these samples were sieved by using the screen intervals listed above. Folk and Ward (1957) and Trask (1930) grain-size statistics were calculated by computer. Porosity and permeability of unconsolidated sand containing less than 15 percent mud matrix were calculated by using median grain size and Trask (1930) sorting values according to the method of Beard and Weyl (1973).

Eight lithostratigraphic sections were constructed from the drill-core descriptions and geophysical logs in the study area (Plates 2-10). Plate 2 shows the location of the eight regional lithostratigraphic sections. The lithologic units were correlated and assigned to specific hydrostratigraphic units on the basis of the hydrologic properties exhibited by the various lithofacies. A list of the wells with elevations and location coordinates (Latitude - Longitude and SRS Site Coordinates) and the baseline hydrostratigraphic data used in the study to construct the eight sections is presented in Appendix 1.

To better define the lithology of the hydrostratigraphic units, the number and thickness of the clay, sandy clay, and clayey sand layers in each unit were determined from the geophysical logs and drill-core descriptions. These confining beds were delimited where an individual bed equaled or exceeded 2 ft (feet) in thickness. The total confining thickness, the number of clay and/or clayey sand beds (2 ft thick or greater), and the percentage of the confining lithologies within the total confining thickness were determined for each confining unit in each well.

In cases where carbonate and/or carbonate-rich sediment constituted a significant part of an aquifer or confining unit, the carbonate beds were divided on the basis of being either confining or transmissive. This information was also used in determining the total confining/transmissive thickness and percentage of confining lithologies in each hydrostratigraphic unit where applicable. The total clean-sand thickness, the number of sand beds (5 ft thick or greater), and the percentage of sand beds within the total aquifer thickness were determined for each aquifer unit in each well. These data are presented in Appendix 1.

Geophysical logs and drill-core data from additional SRS wells were used to supplement the regional data. Data from additional wells located in the General Separations Area (GSA) (Fig. 3) are listed in Appendix 2, and data from wells in A-M Area (Plate 11) are listed in Appendix 3.

Isopachous and unit-surface maps were constructed to show the overall geometry, thickness, and continuity of hydrostratigraphic units in the study area (Plates 12-26). Hydrologic data, including results from well tests (water-level measurements; single-well, multiple-well, short- and long-duration aquifer pumping tests; and slug tests) and laboratory analyses of undisturbed samples (Shelby-Tube or Pitcher-Barrel samplers) taken during coring of the wells, were used to assess the hydrologic parameters of the units. Horizontal and vertical permeability and porosity values were determined by the falling-head method (ASTM D2434), using core samples oriented in the horizontal and vertical directions (Tables 1 and 2).

DESCRIPTION OF THE STUDY AREA

This report describes the hydrogeology over an area of approximately 2,500 mi^2 (square miles) in the Atlantic Coastal Plain physiographic province in west-central South Carolina and east-central Georgia (Fig. 1). The Savannah River Site (SRS) is located in the approximate center of the study area. Major drainage features include the Savannah, Salkehatchie, and Edisto Rivers that flow southeastward across the area.

The Atlantic Coastal Plain physiographic province (Fig. 4) extends southward from Cape Cod, Mass., to south-central Georgia, where it merges with the Gulf Coastal Plain physiographic province. The province is underlain by a seaward-dipping wedge of unconsolidated and poorly consolidated sediments that extend from their contact with crystalline rocks of the Piedmont physiographic province at the Fall Line to the edge of the continental shelf (Plate 27). Coastal Plain sediments in South Carolina range from early Late Cretaceous (Cenomanian) to Recent in age (Hazel and others, 1977). Sediment thickness increases from zero at the Fall Line to more than 4,000 ft at the South Carolina coast (Colquhoun and others, 1983).

Colquhoun and Johnson (1968) divided the South Carolina Coastal Plain into three physiographic belts: Upper, Middle, and Lower Coastal Plain (Fig. 5). The Upper Coastal Plain slopes from a maximum elevation of 650 ft at the Fall Line to about 250 ft on its southeastern boundary. Primary depositional topography of the Upper Coastal Plain has been obliterated by fluvial erosion. The Upper Coastal Plain is separated from the Middle Coastal Plain by the Orangeburg scarp. This scarp has approximately 100 ft of relief over a distance of a few

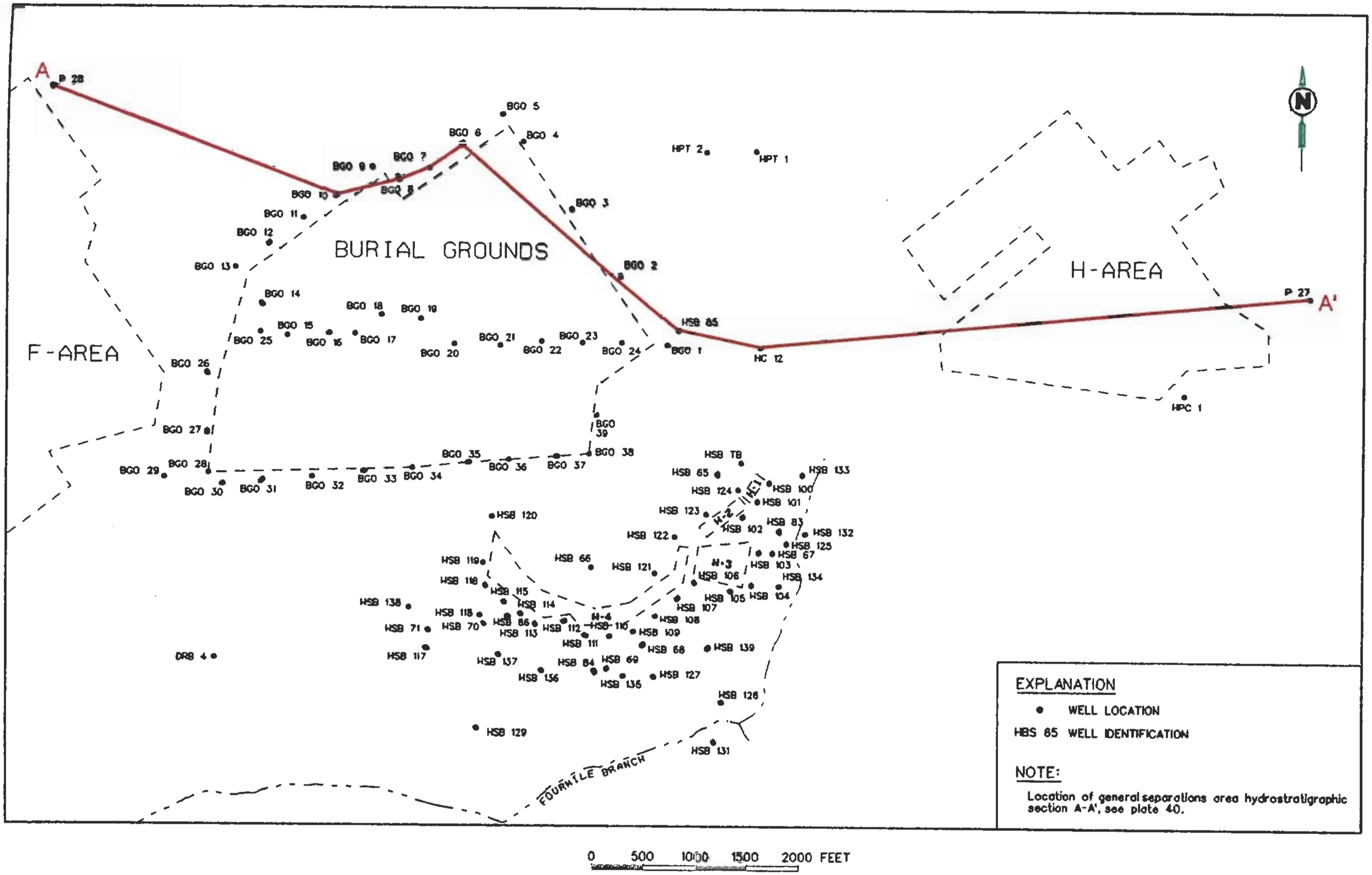


Figure 3. Location of wells in the General Separations Area, SRS.

Table 1. Laboratory hydraulic-conductivity values for clayey sand samples

Well	Hydrologic unit	Sample depth (ft)	Total porosity (%)	Hydraulic conductivity: Vertical (cm/s)	Vertical (ft/d)	Horizontal (cm/s)	Horizontal (ft/d)	Geometric mean vertical (ft/d)	Geometric mean horizontal (ft/d)	Porosity: Arithmetic mean (%)
P-14	Crouch Br. AU	510-512	33	1.50E-04	4.25E-01	1.30E-04	3.68E-01			
P-14	Crouch Br. AU	530-532	39	1.80E-04	5.10E-01	1.30E-04	3.68E-01			
P-16	Crouch Br. AU	255-257	33	6.50E-07	1.84E-03	9.50E-07	2.69E-03	2.11E-02	4.13E-02	36
P-19	Crouch Br. AU	548-550	31	7.00E-06	1.98E-02	2.80E-06	7.93E-03			
P-24	Crouch Br. AU	546-549	46	3.66E-06	1.04E-02	–	–			
P-28	Crouch Br. AU	464-465	35	3.83E-07	1.09E-03	–	–			
P-14	Crouch Br. CU	240-242	44	2.60E-07	7.37E-04	8.20E-08	2.32E-04			
P-15	Crouch Br. CU	257-259	48	1.20E-05	3.40E-02	6.50E-06	1.84E-02			
P-15	Crouch Br. CU	305-307	47	5.30E-07	1.50E-03	1.67E-05	4.73E-02			
P-15	Crouch Br. CU	359-361	30	4.00E-07	1.13E-03	2.70E-05	7.65E-02			
P-16	Crouch Br. CU	158-161	55	1.70E-07	4.82E-04	5.30E-07	1.50E-03			
P-16	Crouch Br. CU	179-181	35	2.50E-06	7.08E-03	1.10E-05	3.12E-02	7.92E-03	1.89E-02	39
P-18	Crouch Br. CU	261-263	27	1.40E-05	3.97E-02	3.10E-05	8.79E-02			
P-19	Crouch Br. CU	282-283	36	3.40E-06	9.64E-03	3.50E-05	9.92E-02			
P-21	Crouch Br. CU	325-327	30	1.20E-04	3.40E-01	5.10E-04	1.45E+00			
P-24	Crouch Br. CU	370-373	40	3.40E-05	9.64E-02	–	–			
P-25	Crouch Br. CU	281-284	43	4.14E-05	1.17E-01	3.77E-05	1.07E-01			
P-28	Crouch Br. CU	293-299	28	1.01E-07	2.86E-04	3.92E-08	1.11E-04			
P-14	Gordon AU	168-170	37	4.50E-05	1.28E-01	2.40E-07	6.80E-04	–	–	–
P-13	Gordon CU	237-239	37	5.60E-05	1.59E-01	5.30E-05	1.50E-01			
P-15	Gordon CU	171-173	44	4.10E-07	1.16E-03	1.70E-06	4.82E-03	4.06E-03	5.86E-03	44
P-20	Gordon CU	210-211	45	9.10E-07	2.58E-03	1.10E-06	3.12E-03			
P-28	Gordon CU	132-134	51	2.01E-07	5.70E-04	1.85E-07	5.24E-04			
P-15	McQueen Br. CU	670-672	38	1.50E-05	4.25E-02	4.10E-08	1.16E-04	–	–	–
P-30	Steed Pond	105-108	53	8.08E-07	2.29E-03	6.78E-07	1.92E-03	–	–	–
P-22	UTR	140-142	46	1.30E-07	3.68E-04	6.60E-08	1.87E-04			
P-22	UTR	61-63	51	1.70E-07	4.82E-04	3.40E-07	9.64E-04	2.76E-03	7.64E-03	48
P-25	UTR	110-113	46	4.19E-05	1.19E-01	8.74E-04	2.48E+00			
Mean		–	40	2.61E-05	7.40E-02	7.48E-05	2.12E-01	–	–	–
Geometric mean		–	40	3.14E-06	8.90E-03	3.66E-06	1.04E-02	–	–	–
Standard error		–	2	8.96E-06	2.54E-02	–	–	–	–	–
Median		–	40	2.95E-06	8.36E-03	2.80E-06	7.93E-03	–	–	–
Mode		–	46	1.70E-07	4.82E-04	1.30E-04	3.68E-01	–	–	–
Standard deviation		–	8	4.74E-05	1.34E-01	1.96E-04	5.56E-01	–	–	–
Variance		–	63	2.25E-09	1.80E-02	3.86E-08	3.10E-01	–	–	–
Kurtosis		–	-1	4.72E+00	4.72E+00	1.26E+01	1.26E+01	–	–	–
Skewness		–	0	2.30E+00	2.30E+00	3.51E+00	3.51E+00	–	–	–
Range		–	28	1.80E-04	5.10E-01	8.74E-04	2.48E+00	–	–	–
Minimum		–	27	1.01E-07	2.86E-04	3.92E-08	1.11E-04	–	–	–
Maximum		–	55	1.80E-04	5.10E-01	8.74E-04	2.48E+00	–	–	–
Sum		–	1128	7.31E-04	2.07E+00	1.87E-03	5.30E+00	–	–	–
Count		–	28	28	28	25	25	–	–	–

AU, aquifer unit; CU, confining unit; UTR, Upper Three Runs aquifer

Table 2. Laboratory hydraulic-conductivity values for sandy clay and clay samples

Well	Hydrologic unit	Sample depth (ft)	Total porosity (%)	Hydraulic conductivity: Vertical (cm/s)	Vertical (ft/d)	Horizontal (cm/s)	Horizontal (ft/d)	Geometric mean vertical (ft/d)	Geometric mean horizontal (ft/d)	Porosity: Arithmetic mean (%)
P-13	Crouch Br. AU	610-612	48	1.80E-07	5.10E-04	6.50E-06	1.84E-02			
P-17	Crouch Br. AU	443-445	38	1.20E-07	3.40E-04	2.40E-07	6.80E-04			
P-19	Crouch Br. AU	495-497	34	3.00E-08	8.50E-05	2.30E-06	6.52E-03			
P-21	Crouch Br. AU	495-497	29	2.20E-07	6.23E-04	2.70E-07	7.65E-04			
P-21	Crouch Br. AU	522-524	29	6.40E-09	1.81E-05	1.00E-08	2.83E-05			
P-21	Crouch Br. AU	560-562	37	3.30E-08	9.35E-05	--	--			
P-22	Crouch Br. AU	612-614	40	4.20E-08	1.19E-04	9.90E-08	2.81E-04			
P-23	Crouch Br. AU	361-363	28	3.40E-07	9.64E-04	9.00E-09	2.55E-05	1.48E-04	2.60E-04	37
P-23	Crouch Br. AU	401-403	39	4.10E-08	1.16E-04	8.70E-08	2.47E-04			
P-24	Crouch Br. AU	546-549	34	3.38E-08	9.58E-05	3.98E-08	1.13E-04			
P-25	Crouch Br. AU	440-443	35	3.95E-08	1.12E-04	4.51E-08	1.28E-04			
P-26	Crouch Br. AU	282-285	38	2.48E-08	7.03E-05	2.63E-08	7.45E-05			
P-27	Crouch Br. AU	458-461	39	4.37E-08	1.24E-04	4.84E-08	1.37E-04			
P-28	Crouch Br. AU	370-373	32	2.70E-08	7.65E-05	3.61E-08	1.02E-04			
P-28	Crouch Br. AU	370-377	41	2.99E-08	8.47E-05	3.92E-08	1.11E-04			
P-28	Crouch Br. AU	465-467	40	2.69E-07	7.62E-04	2.98E-07	8.45E-04			
P-29	Crouch Br. AU	365-368	43	2.92E-08	8.28E-05	3.49E-08	9.89E-05			
P-13	Crouch Br. CU	330-332	57	1.70E-07	4.82E-04	3.10E-05	8.79E-02			
P-15	Crouch Br. CU	417-419	37	3.71E-09	1.05E-05	1.50E-08	4.25E-05			
P-15	Crouch Br. CU	440-442	43	1.20E-09	3.40E-06	--	--			
P-16	Crouch Br. CU	180-182	46	1.90E-07	5.38E-04	--	--			
P-17	Crouch Br. CU	308-310	50	4.50E-09	1.28E-05	3.60E-08	1.02E-04			
P-18	Crouch Br. CU	410-412	39	3.20E-08	9.07E-05	3.70E-08	1.05E-04			
P-19	Crouch Br. CU	355-358	23	1.40E-08	3.97E-05	2.10E-08	5.95E-05			
P-22	Crouch Br. CU	331-333	46	5.00E-08	1.42E-04	4.30E-08	1.22E-04			
P-22	Crouch Br. CU	390-392	58	3.60E-07	1.02E-03	--	--	1.26E-04	4.88E-04	43
P-23	Crouch Br. CU	185-187	39	3.40E-08	9.64E-05	4.00E-08	1.13E-04			
P-23	Crouch Br. CU	224-226	44	1.50E-08	4.25E-05	1.30E-08	3.68E-05			
P-23	Crouch Br. CU	301-303	35	1.20E-08	3.40E-05	4.00E-05	1.13E-01			
P-24	Crouch Br. CU	373-376	46	6.11E-06	1.73E-02	--	--			
P-24	Crouch Br. CU	473-475	35	2.14E-08	6.06E-05	3.61E-08	1.02E-04			
P-25	Crouch Br. CU	254-257	47	1.82E-08	5.16E-05	1.14E-04	3.23E-01			
P-26	Crouch Br. CU	152-155	52	2.77E-06	7.85E-03	--	--			
P-27	Crouch Br. CU	340-343	36	3.44E-08	9.64E-05	3.93E-08	1.11E-04			
P-29	Crouch Br. CU	229-232	35	6.02E-08	1.71E-04	6.16E-08	1.75E-04			
P-19	Gordon AU	190-193	39	1.20E-08	3.40E-05	2.80E-06	7.93E-03	--	--	--
P-23	Gordon CU	97-99	71	1.30E-07	3.68E-04	--	--	2.87E-04	--	55
P-25	Gordon CU	166-169	38	7.91E-08	2.24E-04	1.11E-04	3.15E-01			
P-24	McQueen Br. AU	779-781	51	5.52E-08	1.56E-04	--	--			
P-26	McQueen Br. AU	554-556	36	3.62E-08	1.03E-04	5.85E-08	1.66E-04	1.38E-04	1.46E-04	35
P-29	McQueen Br. AU	591-593	24	2.76E-08	7.82E-05	1.89E-08	5.36E-05			
P-30	McQueen Br. AU	615-617	28	1.01E-07	2.86E-04	1.23E-07	3.49E-04			

AU, aquifer unit; CU, confining unit

Table 2 (continued). Laboratory hydraulic-conductivity values for sandy clay and clay samples

Well	Hydrologic unit	Sample depth (ft)	Total porosity (%)	Hydraulic conductivity: Vertical (cm/s)	Vertical (ft/d)	Horizontal (cm/s)	Horizontal (ft/d)	Geometric mean vertical (ft/d)	Geometric mean horizontal (ft/d)	Porosity: Arithmetic mean (%)
P-15	McQueen Br. CU	652-654	41	6.75E-08	1.91E-04	1.65E-08	4.68E-05			
P-16	McQueen Br. CU	415-417	39	6.30E-08	1.79E-04	6.70E-07	1.90E-03			
P-17	McQueen Br. CU	662-664	31	2.70E-07	7.65E-04	–	–			
P-18	McQueen Br. CU	643-645	33	2.40E-08	6.80E-05	–	–			
P-25	McQueen Br. CU	650-653	69	1.56E-06	4.42E-03	1.45E-06	4.11E-03	3.77E-04	3.46E-04	41
P-26	McQueen Br. CU	442-444	37	2.63E-08	7.45E-05	3.12E-08	8.84E-05			
P-27	McQueen Br. CU	607-610	39	3.45E-08	9.78E-05	5.46E-08	1.55E-04			
P-28	McQueen Br. CU	600-602	49	7.37E-06	2.09E-02	–	–			
P-30	McQueen Br. CU	506-509	33	4.52E-08	1.28E-04	–	–			
P-29	Steed Pond	191-194	51	3.38E-07	9.58E-04	3.07E-07	8.70E-04			
P-30	Steed Pond	215-217	50	4.64E-08	1.31E-04	1.43E-07	4.05E-04	3.04E-04	1.61E-07	53
P-30	Steed Pond	139-141	57	7.90E-08	2.24E-04	9.54E-08	2.70E-04			
P-27	UTR	95-98	36	3.44E-08	9.75E-05	3.93E-08	1.11E-04	–	–	–
Mean		–	41	3.97E-07	1.12E-03	7.26E-06	2.06E-02	–	–	–
Geometric mean		–	40	–	1.67E-04	–	4.07E-04	–	–	–
Standard error		–	1	1.78E-07	5.04E-04	–	–	–	–	–
Median		–	39	4.10E-08	1.16E-04	4.84E-08	1.37E-04	–	–	–
Mode		–	39	1.20E-08	9.64E-05	3.61E-08	1.02E-04	–	–	–
Standard deviation		–	10	1.32E-06	3.73E-03	2.47E-05	7.01E-02	–	–	–
Variance		–	96	1.74E-12	1.39E-05	6.11E-10	4.91E-03	–	–	–
Kurtosis		–	1	2.06E+01	2.06E+01	1.49E+01	1.49E+01	–	–	–
Skewness		–	1	4.52E+00	4.52E+00	3.91E+00	3.91E+00	–	–	–
Range		–	48	7.37E-06	2.09E-02	1.14E-04	3.23E-01	–	–	–
Minimum		–	23	1.20E-09	3.40E-06	9.00E-09	2.55E-05	–	–	–
Maximum		–	71	7.37E-06	2.09E-02	1.14E-04	3.23E-01	–	–	–
Sum		–	2244	2.18E-05	6.18E-02	3.12E-04	8.85E-01	–	–	–
Count		–	55	55	55	43	43	–	–	–

AU, aquifer unit; CU, confining unit; UTR, Upper Three Runs aquifer

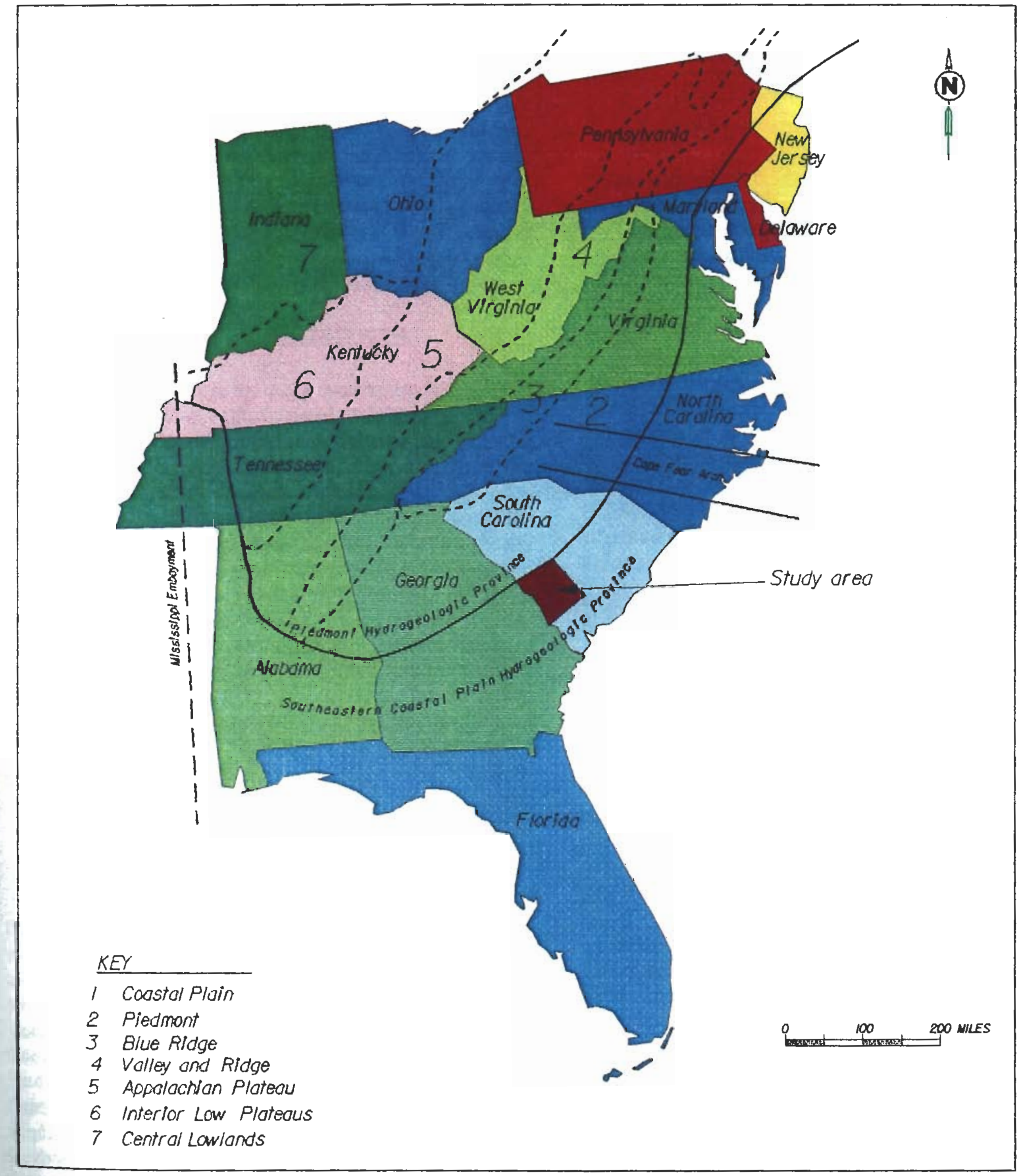


Figure 4. Physiographic provinces of part of Eastern United States.

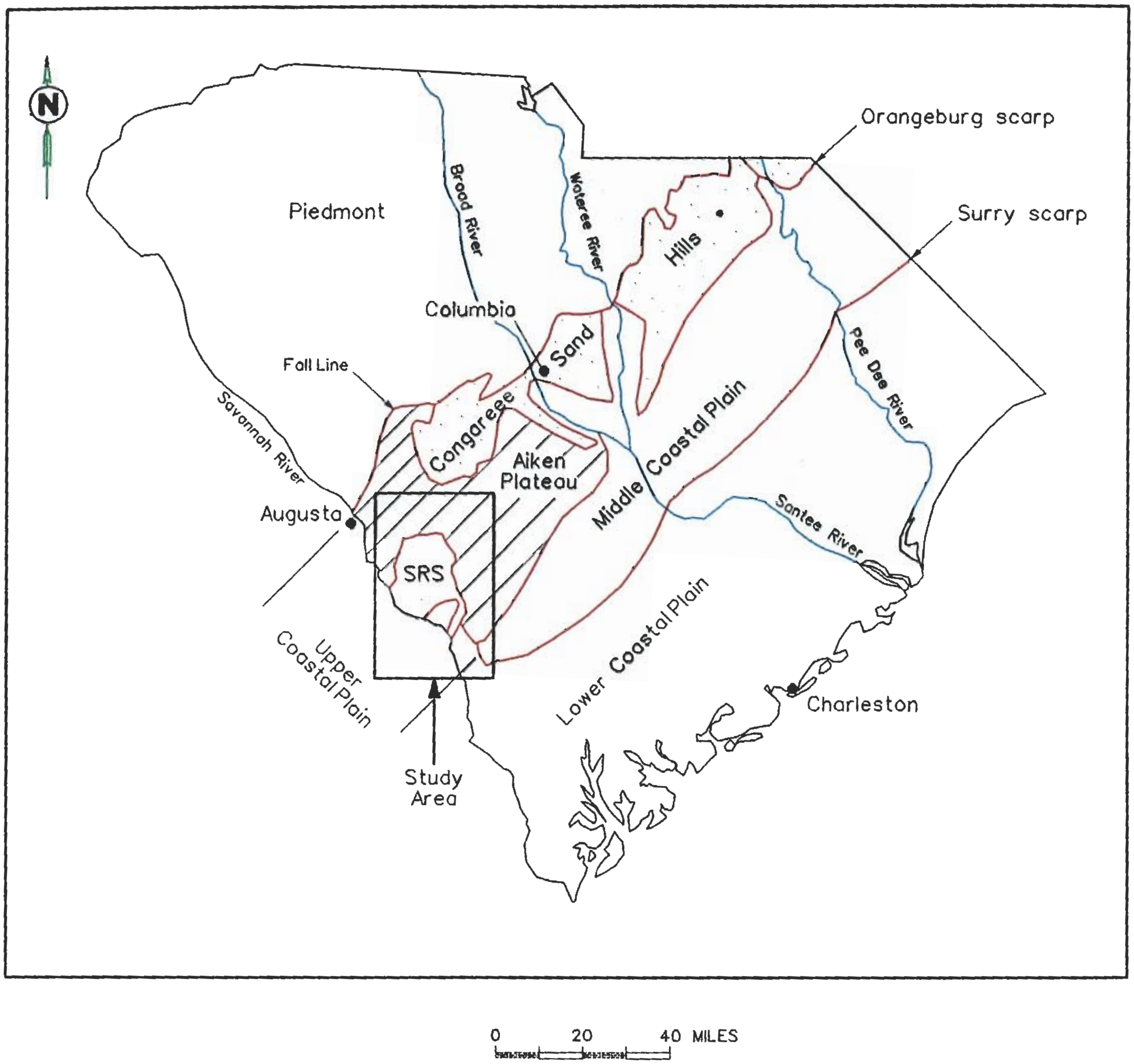


Figure 5. Physiographic belts of the South Carolina Coastal Plain.

miles. The Middle Coastal Plain is separated from the Lower Coastal Plain by the Surry scarp and is characterized by lower elevations and subtle depositional topography that has been significantly modified by fluvial erosion (Marine, 1967a). The Lower Coastal Plain is dominated by primary depositional topography that has been altered slightly by fluvial erosion. Cooke (1936) divided the Upper Coastal Plain of South Carolina into the Aiken Plateau and Congaree Sand Hills (Fig. 5).

The Aiken Plateau, where most of the study area is located, is bounded by the Savannah and Congaree Rivers and extends from the Fall Line to the Orangeburg scarp (Fig. 5). The surface of the Aiken Plateau is highly dissected and characterized by broad interfluvial areas with narrow, steep-sided valleys. Local relief is as much as 300 ft. The plateau is usually well-drained, although many poorly drained sinks and depressions exist, especially in topographically high areas (above 250 ft msl). Some depressions represent original depositional topography, whereas others may be related to dissolution of underlying calcareous sediment (Siple, 1967). The Aiken Plateau also contains elliptical depressions called Carolina bays. These features are common throughout the Atlantic Coastal Plain but are especially numerous in North Carolina and South Carolina. The Carolina bays on the Aiken Plateau have southeast-trending major axes as long as 6,000 ft long (Siple, 1967). Several Carolina bays are located in the study area, primarily east of the Savannah River and SRS, and are defined by elliptical contour patterns on topographic maps.

The Congaree Sand Hills trend along the Fall Line northeast and north of the Aiken Plateau (Fig. 5). These hills are characterized by gentle slopes and rounded summits that are

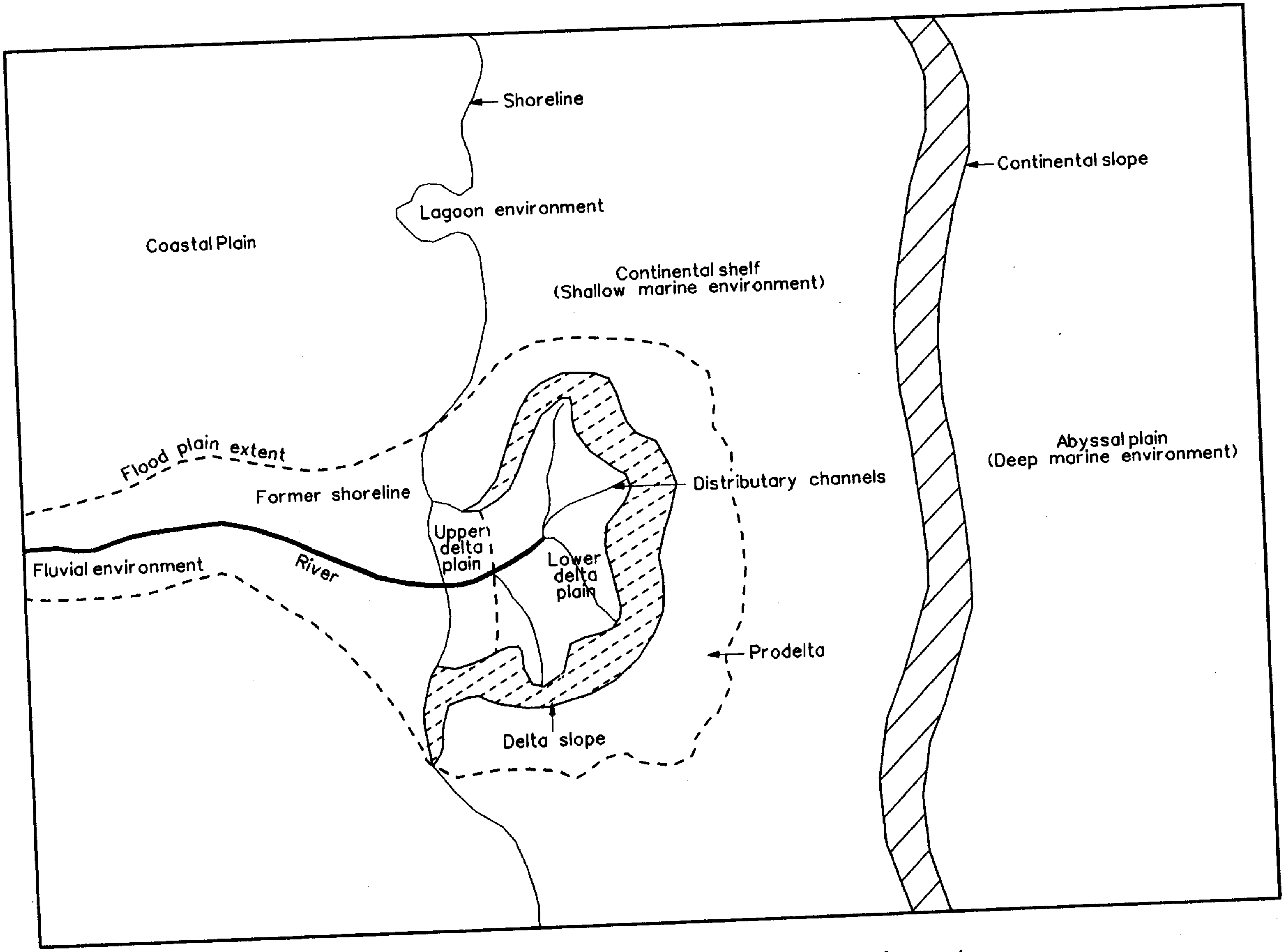


Figure 6. Spatial relationships of depositional environments.

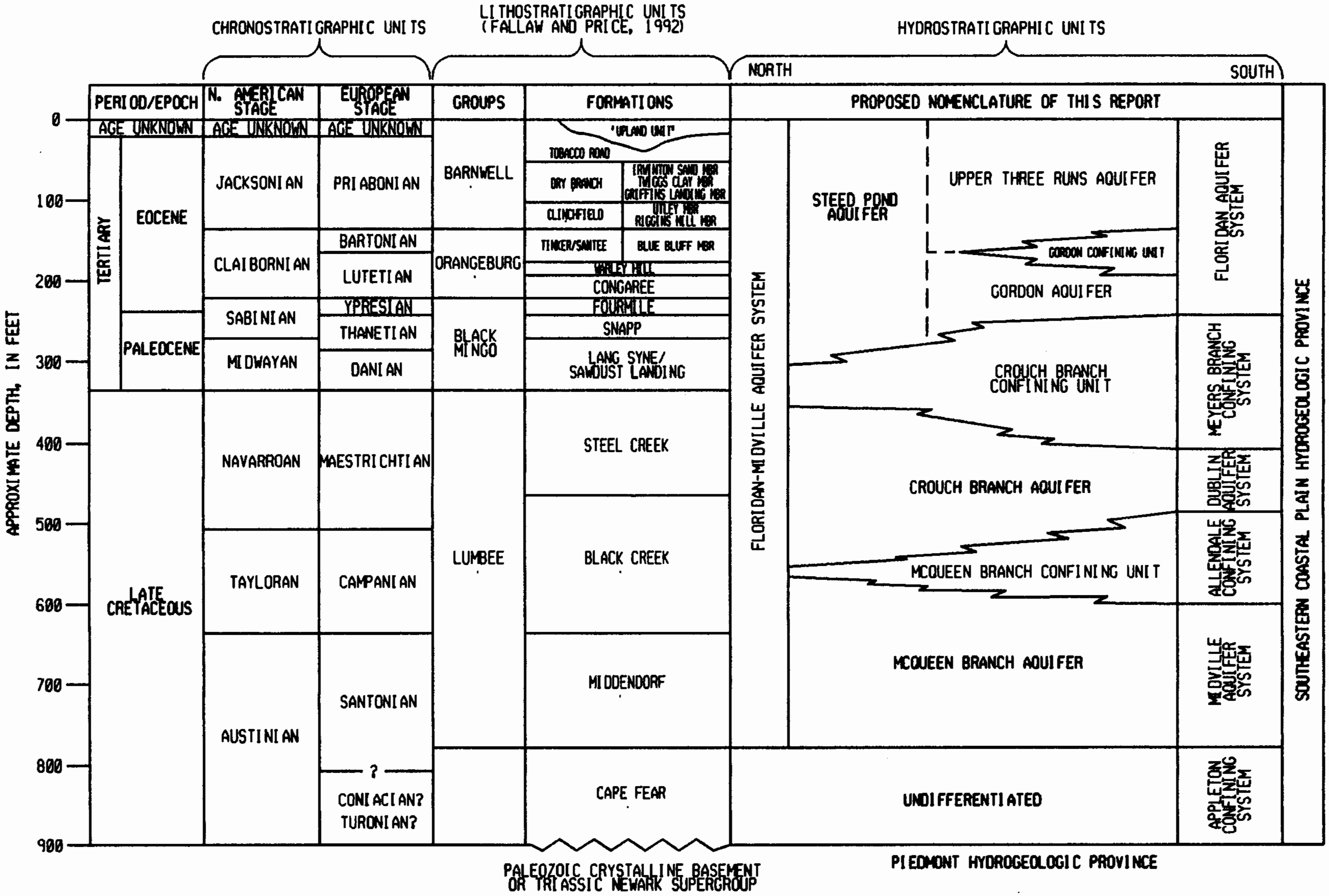


Figure 7. Comparison of chronostratigraphic, lithostratigraphic, and hydrostratigraphic units in the SRS region.

sediments form a clastic wedge that thickens and dips toward the southeast (Plate 27). Near the coast, the sediment wedge is 4,000 ft thick (Colquhoun and others, 1983).

The Coastal Plain sequence near the center of the study area consists of about 700 ft of Late Cretaceous quartz sand, pebbly sand, and kaolinitic clay, overlain by about 60 ft of Paleocene clayey and silty quartz sand, glauconitic sand, and silt (Plate 3). Paleocene beds are in turn overlain by about 350 ft of Eocene quartz sand, glauconitic quartz sand, clay, and limestone grading into calcareous sand, silt, and clay. The calcareous strata are common in the upper part of the Eocene section in downdip parts of the study area. In places, especially at higher elevations, the sequence is capped by deposits of pebbly, clayey sand, conglomerate, and clay of Miocene (?) or Oligocene (?) age. Lateral and vertical facies changes are characteristic of most of the Coastal Plain sequence, and the lithologic descriptions below are therefore generalized.

Cretaceous and Tertiary sediments in the study area were deposited during a series of transgressions and regressions in depositional environments ranging from fluvial to marine shelf (Fig. 6). Fluctuating depositional conditions account for the observed complex variations in sediment lithology in the study area. Because the lithology of the sediments largely determines hydraulic conductivity, the occurrence and flow of ground water in the region is influenced by the texture, composition, and bedding characteristics of the sediments.

UPPER CRETACEOUS SEDIMENTS

Upper Cretaceous sediments of possible Coniacian/Turonian (?) to Santonian through Maestrichtian age overlie Paleozoic crystalline rocks or lower Mesozoic sedimentary rocks throughout most of the study area (Plates 3-10). The Upper Cretaceous sequence includes the basal Cape Fear Formation and the overlying Lumbee Group that is divided into three formations (Fig. 7).

The Upper Cretaceous sequence in the study area consists mostly of poorly consolidated, clay-rich, fine- to medium-grained, micaceous sand, sandy clay, and gravel (Faye and Prowell, 1982), and is about 700 ft thick near the center of the study area. Thin clay layers are common. In parts of the section, clay beds and lenses up to 70 ft thick are present. Depositional environments were fluvial to prodeltaic (Fig. 6). In Georgia, the sediments were deposited in deltaic and shallow marine environments and attain a known thickness of 1,840 ft near the coast (Clarke and others, 1985).

Cape Fear Formation.—The Cape Fear Formation rests directly on a thin veneer of saprolitic bedrock. Saprolite ranges from less than 10 to more than 40 ft in thickness and defines the surface of the crystalline basement rocks and sedimentary rocks of the Newark Supergroup. Thickness of the saprolite reflects the degree of weathering of the basement prior to deposition of the Cape Fear Formation. The top of the Cape Fear is encountered at about -200 ft msl just south of well C-3 in the north and at about -1,200 ft msl at well C-10 in the south (Plates 3 and 4). The Cape Fear does not crop out in the study area, and its northern limit is just north of the C-1 and P-16 wells (Plates 4 and 8) and just south of wells C-2 and C-3 (Plates 3 and 4). The unit thickens to more than 230 ft at well C-10 and has a maximum known thickness of about 700 ft in Georgia (Prowell and others, 1985a). The top of the Cape Fear Formation dips approximately 30 ft/mi to the southeast across the study area (Plates 3, 4, and 5).

The Cape Fear Formation consists of firm to indurated, variably colored, poorly sorted, silty, clayey sand and sandy silt and clay. Bedding thickness of the sand, silt, and clay ranges from about 5 to 20 ft, with sand beds being thicker than the clay beds. Sand grains are angular to subangular and fine to, more typically, coarse grained with granule and pebble zones common. The sand is arkosic with rock fragments common in the pebbly zones.

The Cape Fear Formation is sparsely fossiliferous (Prowell and others, 1985a; Sohl and Smith, 1980). Microfossil data from samples in downdip wells at SRS are consistent with Pollen Zone V (Christopher and others, 1979; Hazel and others, 1977; Prowell and others, 1985b), indicating a Santonian (early Late Cretaceous) and possibly a Coniacian (?) or Turonian (?) age for the formation (Fig. 7).

Lithologic characteristics and the paucity of marine fossils are indicative of a high-energy environment close to the source area, possibly fluvial-deltaic environments (Prowell and others, 1985a) (Fig. 6) to marginal marine downdip (Gohn and Campbell, 1992). The Cape Fear Formation was erosionally truncated prior to deposition of the overlying Middendorf Formation (Plate 3).

The Cape Fear Formation is more indurated than other Cretaceous units because of the abundance of cristobalite cement. The unit is more indurated in the northern part of the study area than in the south. In the northern part of the area, the formation is represented on geophysical logs as a zone of low resistivity (Plate 3). In the southern part of the study area, the unit is less indurated, more sandy, and is characterized on geophysical logs by increased electrical resistivity (wells ALL-324 and C-10 on Plate 3). The transition from the indurated clayey sand in the north to the poorly consolidated cleaner sand in the south may be due to deeper incisement of the Cape Fear section to the north, bringing the deeper, more cristobalite-rich part of the section into proximity of the overlying unconformity that caps the formation. Clark and others (1985) attribute the difference to lithologic changes during deposition or to the southern limit of the cristobalite cementation process.

Lumbee Group

Three formations of the Late Cretaceous Lumbee Group (Swift and Heron, 1969) are present in the study area (Faye and Prowell, 1982). These are, from oldest to youngest, the Middendorf, Black Creek, and Steel Creek Formations (Fig. 7).

The Lumbee Group consists of fluvial and deltaic quartz sand, pebbly sand, and clay in the study area. The sedimentary sequence is more clayey and finer grained downdip, reflecting shallow to deep marine shelf sedimentary environments (Plate 28). Thickness ranges from about 400 ft at well C-3 in the north, to about 780 ft near well C-10 in the south (Plates 3 and 4). At least part of the Lumbee crops out in the northern part of the study area (Plate 27). Here, it is difficult to distinguish the individual formations, and they were mapped as undifferentiated Upper Cretaceous by Nystrom and Willoughby (1982). Dip of the upper surface of the Lumbee Group is to the southeast at approximately 20 ft/mi (Plates 3-10).

Middendorf Formation.—The Middendorf Formation unconformably overlies the Cape Fear Formation with a distinct contact (Plates 3-10). This formation was named by Sloan (1908), but Cooke (1936) later assigned these sediments to the Tuscaloosa Formation. Swift and Heron (1969) resumed use of the name Middendorf. The formation is marked by an abrupt change from the moderately indurated clay and clayey sand of the underlying Cape Fear to the slightly indurated sand and clayey sand of the Middendorf. The basal zone is often pebbly. Contact with the underlying Cape Fear is unconformable and marked by an increase in electrical resistivity on geophysical logs. Thickness of the formation ranges approximately from 120 ft in well C-2 in the north, to 240 ft in well C-10 in the south (Plate 3). It has a maximum known thickness of about 520 ft in Georgia (Clarke and others, 1985). The top of the formation dips to the southeast at 26 ft/mi across the study area (Plate 3).

Fossil data for the Middendorf are sparse and the formation is not well dated in the study area. Pollen samples from clay zones in the unit are characteristic of Pollen Zone V, indicating a Santonian (early Late Cretaceous) (Christopher, 1982) (Fig. 7) to perhaps early Campanian age, equivalent to the Austinian in the Gulf Coastal Plain (Fallaw and Lawrence, 1992). Regional studies by Prowell and others (1985a) suggest a Santonian age for the unit.

Sand of the Middendorf Formation is medium to very coarse grained, typically angular, slightly silty, tan, light-gray, and yellow in color. It is much cleaner and less indurated than sediments of the underlying Cape Fear. Sorting is generally moderate to poor. Pebble and granule zones are common in updip parts of the study area, whereas clay layers up to 10 ft thick are more common downdip. Clay clasts are abundant in places. Some parts of the unit are feldspathic and micaceous, but not as micaceous as the overlying Black Creek Formation. Lignitic zones are also common.

Over much of the study area, a zone of interbedded sand and variegated clay up to 60 ft thick is present at or near the top of the Middendorf Formation (Plate 29). The interbedded sand is upward-fining in places. This lithology and the marine microfauna found in core samples indicate that the unit was deposited in lower delta plain and delta front environments under some marine influence (Prowell and others, 1985a). In the northern part of the study area, the formation is variably colored, composed of tan, red, and purple sand. Here, the sediments have the characteristics of fluvial and upper delta plain deposits.

Near Bamberg, S.C. (Fig. 1) the Middendorf Formation consists of poorly sorted, gray, medium- to very coarse-grained, angular to subangular quartz sand with quartz pebbles and sparse feldspar grains (Logan and Euler, 1989). Silt and fine-grained sand are also present. The angularity and large overall grain size of the quartz and the presence of feldspar indicate that deposition occurred relatively close to the source area, most likely in an upper delta plain environment. In southeastern Georgia, the Middendorf includes some shallow shelf sediments.

Farther downdip, sediments of the Middendorf become finer grained. In Allendale County, S.C., in the vicinity of Millet, the unit consists of light-gray to colorless, fine- to coarse-grained quartzose sand, clayey sand, and silty clay. The sand is unconsolidated and poorly to moderately sorted. Trace amounts of heavy minerals and lignite are present. Deposition most probably occurred on a lower delta plain (Logan and Euler, 1989).

Black Creek Formation.—Sloan (1908) first described the Black Creek Formation as "Black Creek Shales" that cropped out in Darlington and Florence Counties, S.C. Although the formation was later included as part of the Tuscaloosa Formation, Swift and Heron (1969) assigned it formational status. Paleontological control for the Black Creek is poor in updip areas of South Carolina and Georgia. Prowell and others (1985b), citing Christopher (1978) and Sohl and Christopher (1983), suggested a Late Cretaceous (late Campanian to early Maestrichtian) age for the Black Creek Formation as indicated by various palynomorphs from the unit (Fig. 7). Sediments assigned to the Black Creek Formation in the study area yield Campanian (middle Late Cretaceous) to early Maestrichtian (late Late Cretaceous) paleontological ages. The Black Creek unconformably overlies the Middendorf Formation (Logan and Euler, 1989).

The Black Creek Formation is penetrated at virtually all well-cluster sites in the study area (Plates 3-10). The unit ranges in thickness from approximately 150 ft at well C-2 in the north (Plate 3) to 300 ft near the center of the study area in well PBF-3 and to 370 ft at well C-10 in the south. The unit dips approximately 22 ft/mi to the southeast.

The Black Creek is distinguished from the overlying and underlying Cretaceous units by its better sorted sand, fine-grained texture, and relatively high clay content. It is generally darker, more lignitic, and more micaceous, especially in the updip part of the section, than other Cretaceous units. In much of the study area, the lower third of the formation is mostly sand that is separated from the upper part of the unit by clay beds. The clay beds are 20 to 40 ft thick in the northern part of the study area and more than 150 ft at well C-10 in the south. In general, the top of the Black Creek Formation is picked at the top of a clay bed that ranges from 10 to 25 ft in thickness. The clay bed is exceptionally thick but not laterally extensive in the P-21, CPC-1, P-26, and P-29 wells, suggesting lagoonal/back barrier bay deposition associated with nearby shorelines (Plate 5). Clay beds are often thickest in areas that flank the Pen Branch and Steel Creek Faults. Overall, the Black Creek consists of two thick, fining-upward sequences, each capped by thick clay beds.

In the northern half of the study area, the Black Creek Formation consists of clayey, micaceous, poorly to moderately well-sorted, fine to medium, subangular to subrounded quartz sand beds and silty clay beds. Pebbly beds occur throughout the unit. This sandy lithology is indicative of fluvial to upper delta-plain environments; the clay beds that cap the upward-fining sandy sequences are typical of lower delta-plain depositional environments. In the vicinity of Millet, S.C., the basal beds of the Black Creek consist of sand and silty clay and are similar to underlying Middendorf sediments. Here, deposition occurred on a lower delta plain. Fossils recovered from the unit suggest marine influences during deposition of the sediments, especially the clay (Prowell and others, 1985a).

In the central and downdip part of the study area (wells P-22, ALL-324, C-6, C-10) (Plate 3), the unit grades into gray-green clayey silt, micritic clay, and fine- to medium-grained, upward-fining sand that is moderately well sorted, micaceous, carbonaceous, and locally glauconitic. The sequence suggests deposition in a delta front or shallow shelf environment, as indicated by the lithology and by an abundance of marine macrofauna and microfauna (Prowell and others, 1985a). The transition from fine-grained, prodelta or delta front deposits in the southern part of the study area to coarser grained, more landward deltaic deposits in the northern part of the area is reflected in the general increase in electrical resistivity noted on geophysical logs in the wells in the north, especially in the upper part of the Black Creek section (Plates 3-10).

Steel Creek Formation.—The Maestrichtian Peedee Formation was named by Ruffin (1843) in his description of beds cropping out along the Peedee River in Florence County, S.C. The Peedee Formation was previously considered by some investigators to be absent in the study area (Colquhoun and others, 1983); however, recent palynological evidence provides dates of Peedee age from sediment samples in the southern part of SRS (Logan and Euler, 1989). Because there is a considerable difference in lithology between the type Peedee (Heron, 1958) and the sediments in the SRS region, Peedee-equivalent sediments in the study area were referred to as the "Steel Creek Member" of the Peedee Formation (Fallaw and Price, 1992). Raising the Steel Creek Member to formational status was recommended by Fallaw and Price (1995) and is so used in this report. The type well for the Steel Creek Formation is P-21, located near Steel Creek (Plate 1). The top of the Steel Creek is picked at the top of a massive clay bed that ranges from 3 to more than 30 ft in thickness. The formation dips approximately 20 ft/mi to the southeast.

The unit ranges in thickness from approximately 60 ft at well P-30 to 175 ft at well C-10 in the south (Plate 3). It has a maximum known thickness of 380 ft in Georgia (Clarke and others, 1985). The Steel Creek thins dramatically between the ALL-324 and the P-22 wells (Plate 3) due to truncation by erosion at the Cretaceous-Tertiary unconformity. The Steel Creek Formation overlies the Black Creek Formation and is distinguished from it by a higher percentage of sand, which is represented on geophysical logs by a generally higher electrical resistivity and lower natural gamma radiation count. The formation consists of yellow, tan, and gray, medium to coarse, moderately sorted sand interbedded with variegated clay. The lower part of the unit consists of medium- to coarse-grained, poorly to well-sorted, quartz sand, silty sand, and off-white to buff clay that contains thin beds of micaceous and carbonaceous clay. Pebbly zones are common, as are layers with clay clasts. Fining-upward sand is interbedded with the clay and silty clay beds in some areas. It is difficult to differentiate the Steel Creek from the underlying Black Creek in the northwestern part of the study area. The unit appears to have been deposited in fluvial environments in updip areas and upper to lower delta plain environments in the south. A massive clay that caps the unit suggests lower delta plain to shallow shelf depositional environments. The presence of dinoflagellates indicates some marine influence in parts of the Steel Creek (Prowell and others, 1985a). A pebble-rich zone at the base of the unit suggests a basal unconformity.

TERTIARY SEDIMENTS

Tertiary sediments range from early Paleocene to Miocene (?) age and were deposited in fluvial to marine shelf environments. The Tertiary sequence of sand, silt, and clay generally grades into highly permeable platform carbonates in the southern part of the study area (Plate 27) and these continue southward to the coast. The Tertiary sequence is divided into three groups that are subdivided into formations and members (Fig. 7), all overlain by the Upland unit.

Black Mingo Group

Sloan (1908) first applied the name "Black Mingo" to outcrops of shale along Black Mingo Creek in Georgetown and Williamsburg Counties, S.C. The name was later used by Cooke (1936) in reference to all Eocene rocks older than the McBean Formation (early Eocene). Van Nieuwenhuise and Colquhoun (1982) raised the Black Mingo to group status.

The Black Mingo Group consists of quartz sand, silty clay, and clay that probably were deposited in lower delta plain environments under marine influences (Prowell and others, 1985a). In the southern part of the study area, massive clay beds, often more than 50 ft thick, predominate (Plates 3, 4, and 8). Downdip from the study area, thin red to brown sandy clay beds, gray to black clay beds and laminated shale dominate the Black Mingo Group and suggest deposition in shallow marine shelf environments. At the South Carolina coast, carbonate-platform facies-equivalents of the updip Black Mingo clastic sediments first appear (Plate 27). The carbonate units are all referred to as "unnamed limestones" by Colquhoun and others (1983) (Plate 30). These are equivalent to the thick beds of anhydrite and dolomite of the Paleocene Cedar Keys Formation (Miller, 1986; Krause and Randolph, 1989) and to the lower Eocene glauconitic limestone and dolomite of the Oldsmar Formation. Both carbonate units are delineated and mapped in coastal Georgia and northeastern Florida.

In the vicinity of the Pen Branch Fault and the Crackerneck Fault (Plates 1, 2, and 3), clay and clayey sand beds of the Black Mingo Group thin and often pinch out along the traces of the faults. This suggests that shoaling of depositional environments occurred contemporaneously with movement along the faults in Paleocene and lower Eocene time.

The upper surface of the Black Mingo Group dips to the southeast at 16 ft/mi, and thickens from 60 ft at well C-2 in the north, to about 170 ft near well C-10 in the south (Plate 3). The group is about 700 ft thick at the South Carolina coast (Colquhoun and others, 1983).

Throughout the downdip part of the South Carolina Coastal ain, the Black Mingo Group consists of the Rhems Forma- on and the overlying Williamsburg Formation (Van Nieu- enhuise and Colquhoun, 1982). The Rhems Formation ntains five members, each representing a depositional facies late 31). They are the Sawdust Landing Member, an upper lta plain fluvial deposit that unconformably overlies the retaceous Peedee Formation; the Lang Syne Member, a lower lta plain deposit of estuarine and littoral origin; the Perkins uff Member, a shallow shelf deposit; and the Browns Ferry ember, a deep water shelf deposit. Additionally, there is an nnamed unit that represents the carbonate-shelf facies ordana, 1984). In the study area, the Black Mingo Group nsists of the Midwayan Sawdust Landing and Lang Syne rmations (Fallaw and Price, 1992), which are equivalent to e Ellenton Formation of Siple (1967), the early and middle ibinian Snapp Formation (Fallaw and Price, 1992), which is e updip equivalent of the Williamsburg Formation of olquhoun and others (1983), and the late Sabinian Fourmile rmation (Fallaw and Price, 1992), which is the updip equi- lent of the Fishburne Formation of Gohn and others (1983) ig. 7).

Lang Syne/Sawdust Landing Formations.—Siple (1967) oposed the name "Ellenton Formation" for a subsurface hologic unit in the SRS area consisting of beds of dark, gnitic clay and coarse sand, which are equivalent to the Saw- st Landing and Lang Syne members of the Rhems Formation Colquhoun and others (1983). Fallaw and Price (1992) ggested that the Sawdust Landing Member and the over- ng Lang Syne Member of the Rhems be raised to forma- nal status and replace the term Ellenton in the study area. In the absence of detailed paleontological control, the wdust Landing Formation and the overlying Lang Syne rmation could not be systematically separated for the gional mapping undertaken for this report. Thus, they are ated as a single unit, the Lang Syne/Sawdust Landing undif- rentiated, on all sections and maps. Sediments of the unit nerally consist of two fining-upward sand-to-clay sequences late 29) that range from about 40 feet in thickness at the rthwestern boundary of SRS to about 100 ft near the utheastern boundary. The unit is mostly dark-gray to black, oderately to poorly sorted, fine- to coarse-grained, mica- ous, lignitic, silty and clayey quartz sand interbedded with rk-gray clay and clayey silt. Pebbly zones, muscovite, dspar, and iron-sulfide are common. Individual clay beds to 20 ft thick are present in the unit. Clay and silt beds ake up approximately one-third of the unit in the study area. e dark, fine-grained sediments represent lower delta plain, y-dominated environments. Tan, light-gray, yellow, brown, rple, and orange sand, pebbly sand, and clay are typical of per delta plain, channel-dominated environments.

In the southern part of the study area, dark, poorly sorted, caceous, lignitic sand and silty sand containing a diverse semblage of pollen and microfauna of early and middle leocene (Midwayan) age are present (Prowell and others, 85a). This unit is the Perkins Bluff Member of the Rhems rmation, which was deposited in lower delta plain or shallow elf environments (Plate 31).

Toward the coast, the Rhems Formation includes shallow to increasingly deeper water clastic shelf facies (Browns Ferry Member) that ultimately pass into a shallow carbonate platform facies at the South Carolina coastline. Colquhoun and others (1983) referred to the carbonate platform facies equivalent as "unnamed limestone." The carbonate platform sequence is correlative with the anhydrite- and gypsum-bearing dolomitized limestone and finely crystalline dolomite of the lower part of the Cedar Keys Formation (Krause and Randolph, 1989) that is mapped (Plate 30) in coastal Georgia and northeastern Florida. The carbonate sequence is about 250 ft thick at the South Carolina coastline (Colquhoun and others, 1983). The Cedar Keys Formation has a maximum thickness of 425 ft in coastal areas of Georgia (Herrick and Vorhis, 1963). The carbonate platform sediments of the Cedar Keys Formation are generally impermeable, and the unit acts as the underlying confining unit of the Floridan aquifer system in the coastal areas of South Carolina and Georgia.

Snapp Formation.—Sediments in the study area that are time equivalent to the Sabinian (mid-late Thanetian) Williamsburg Formation differ from the type Williamsburg and have been designated the "Snapp Member" of the Williamsburg Formation (Fallaw and others, 1990) (Fig. 7). Fallaw and Price (1995) suggested that the "Snapp Member" of the Williamsburg be raised to formational status. The Snapp Formation is used in this report. The unit is encountered in well P-22 in the southeastern part of SRS near Snapp Station (Plate 2). The basal contact with the underlying Lang Syne/Sawdust Landing is probably unconformable. The Snapp Formation appears to pinch out in the northwestern part of SRS and thickens to about 50 ft near the southeastern boundary of the site.

The Williamsburg Formation crops out in Calhoun County, S.C. Sediments in the upper part of the unit consist of low-density, fissile, dark-gray to black siltstone and thin layers of black clay interbedded with sand in the lower part. These and similar sediments in Aiken and Orangeburg Counties, S.C. were probably deposited in lagoonal or estuarine environments (Plate 32). In and near SRS, Snapp sediments typically are silty, medium- to coarse-grained quartz sand interbedded with clay. Dark, micaceous, lignitic sand also occurs, which is suggestive of a lower delta plain environment. In Georgia, the unit consists of thinly laminated, silty clay locally containing layers of medium- to dark-gray carbonaceous clay. This lithology is indicative of marginal marine (lagoonal to shallow shelf) depositional environments. Clayey parts of the unit are characterized on geophysical logs as zones of low electrical resistivity and relatively high gamma radiation. In the southernmost part of the study area (Plate 3), the Snapp (Clarke and others, 1985) consists of gray-green, fine to medium, well-rounded, calcareous quartz sand and interbedded micritic limestone and limy clay that is highly fossiliferous and glauconitic. This lithology suggests deposition in a normal marine, shallow shelf environment somewhat removed from clastic sediment input.

Farther south toward the coast, the Williamsburg Formation exhibits a deeper-water, clastic facies, which passes into a carbonate-platform facies that was first established in Danian time (early Paleocene) (Plate 31). Colquhoun and others (1983) referred to the carbonate platform sediments, which are about 350 ft thick at the coast, as "unnamed limestone." The unit is equivalent to anhydrite- and gypsum-bearing dolomitized limestone and finely crystalline dolomite of the upper part of the Cedar Keys Formation (Plate 30) mapped in southeastern Georgia and northeastern Florida (Krause and Randolph, 1989; Clarke and others, 1990) The carbonate platform expanded dramatically during Thanetian time (upper Paleocene) (Plate 32), reaching as far north as Bamberg County, S.C. (Colquhoun and others, 1983).

Fourmile Formation.—Early Eocene (Ypresian) ages, derived from palynological assemblages, indicate that sand immediately overlying the Snapp Formation in the study area is equivalent to the Fishburne Formation (Gohn and others, 1983), a calcareous unit that occurs downdip near the coast. The sand was initially designated the Fourmile Member of the Fishburne Formation (Fallaw and others, 1990). Owing to the distinctive difference in lithology between the type Fishburne Formation and the time-equivalent sediments observed in the study area, Fallaw and Price (1995) have recommended that the Fourmile Member of the Fishburne be raised to formational rank. The term Fourmile Formation is used in this report (Fig. 7).

The Fourmile Formation averages 30 ft in thickness, is mostly tan, yellow-orange, brown, and white, moderately to well-sorted sand, with clay beds a few feet thick near the middle and at the top of the unit. The sand is very coarse to fine grained, with pebbly zones common, especially near the base. Glauconite, up to about 5 percent, is present in places, as is weathered feldspar. In the center and southeastern parts of SRS the unit can be distinguished from the underlying Paleocene strata by its lighter color and lower content of silt and clay. Glauconite and dinoflagellate assemblages indicate that the Fourmile is a shallow marine deposit.

Overlying the Fourmile Formation in the study area is 30 ft or less of sand similar to the Fourmile. This sand is better sorted, contains fewer pebbly zones, less muscovite and glauconite, and in many wells is lighter in color. Dinoflagellate assemblages indicate that the sand is correlative with the early middle Eocene Congaree Formation. In some wells a thin clay occurs at the top of the Fourmile, separating the two units; however, the difficulty in distinguishing the Fourmile Formation from the overlying Congaree Formation has led many workers at SRS to include the entire 60-ft section in the Congaree Formation.

Downdip from the study area, the clean, shallow shelf sand of the Fourmile Formation passes into silt, massive clay, siltstone, and mudstone suggestive of a deep clastic shelf facies (Krause and Randolph, 1989). Toward the coast the stratigraphic interval is composed of calcareous, glauconitic sand and clay and sandy glauconitic, fossiliferous limestone indicative of deep shelf to carbonate platform environments. The carbonate facies equivalent of the Fourmile is correlative with the glauconitic, micritic limestone and interbedded fine to medium, commonly vuggy, crystalline dolomite platform facies of the Oldsmar Formation in coastal Georgia and northeastern Florida (Krause and Randolph, 1989; Clarke and others, 1990) (Plate 30). The Oldsmar Formation equivalents in South Carolina unconformably overlie clastic sediments of the Rhems Formation downdip in South Carolina and the correlative Clayton Formation in Georgia. The unit signals the rapid northward advance of the leading edge of the carbonate platform first established in lower Paleocene time near the South Carolina coast (Plate 31). The early Eocene carbonate sediments reach 800 ft in thickness in coastal Georgia (Clarke and others, 1990).

Orangeburg Group

The Claibornian (Lutetian-Bartonian) Orangeburg Group consists of the lower middle Eocene Congaree Formation (Tallahatta equivalent) and the upper middle Eocene Warley Hill Formation and Santee Limestone (Lisbon equivalent) (Fig. 7). Over most of the study area, these post-Paleocene units are more marine in character than the underlying Cretaceous and Paleocene units; they consist of alternating layers of sand, limestone, marl, and clay (Brooks and others, 1985).

The group crops out at lower elevations in many places within and in the vicinity of SRS. Sediments thicken from about 85 ft at well P-30 near the northwestern SRS boundary to 200 ft at well C-10 in the south (Plate 3). Downdip at the coast, the Orangeburg Group is about 325 ft thick (Colquhoun and others, 1983) and is composed of shallow carbonate platform deposits of the Santee Limestone (Plate 33). Dip of the upper surface is 12 ft/mi to the southeast.

In the extreme northern part of the study area, the entire middle Eocene Orangeburg Group is mapped as the Huber Formation (Nystrom and Willoughby, 1982). The cross-bedded, micaceous, poorly sorted sand and abundant channel fill deposits, and the carbonaceous kaolin clay in the Huber are indicative of fluvial, upper delta plain environments.

In the central part of the study area the group includes, in ascending order, the Congaree, Warley Hill, and Tinker/Santee Formation (Fallaw and others, 1990). The units consist of alternating layers of sand, limestone, marl, and clay (Brooks and others, 1985) that are indicative of deposition in shoreline to shallow shelf environments. From the base upward, the Orangeburg Group passes from clean shoreline sand characteristic of the Congaree Formation to shelf marl, clay, sand, and limestone typical of the overlying Warley Hill and Santee Limestone. Carbonate content of Santee sediments is as much as 30 percent of the unit near the center of the study area. The sequence is transgressive with the middle Eocene sea reaching its most northerly position during Santee deposition (Plates 3, 5, and 27).

Toward the south, near wells P-21, ALL-324, and C-10 (Plate 3), the carbonate content of all three formations increases dramatically. The shoreline sand of the Congaree undergoes a facies change to interbedded glauconitic sand and shale, grading to glauconitic, argillaceous, fossiliferous, sandy limestone. Downdip, the fine-grained, glauconitic sand and clay of the Warley Hill become increasingly limy and grade imperceptibly into comparable carbonate-rich facies of both the overlying and underlying units (Plate 3). Carbonate content in the glauconitic marl, calcareous sand and sandy limestone of the Santee increases towards the south, constituting the vast majority of the Santee from we

P-21 southward.

Toward the coast, sediments of the entire Orangeburg Group grade into the pure white to creamy-yellow fossiliferous and partly glauconitic Santee Limestone (Colquhoun and others, 1983) that was deposited on the shallow carbonate platform first established in early Paleocene time (Plate 31). The Santee is correlative with the chalky or indurated peloidal to micritic limestone interbedded with fine to medium, crystalline, slightly vuggy dolomite of the Avon Park Formation in coastal sections of Georgia and northeastern Florida (Krause and Randolph, 1989; Clarke and others, 1990) (Plate 30). The Avon Park Formation unconformably overlies the Oldsmar Formation (Miller, 1986), and reaches a thickness of about 1,000 ft in coastal Georgia.

The carbonate platform reached its maximum northern extent during middle Eocene time when the leading edge extended into Allendale County, S.C. north of well ALL-19 (Plates 3, 27, and 33). The three largely clastic formations that constitute the Orangeburg Group in the study area are the updip clastic equivalents of the platform carbonate rocks of the Santee to the south.

Congaree Formation.—Sloan (1908) was the first to describe the "Congaree Phase" as shale, sand, and buhrstone of early and middle Eocene age that overlies the "Black Mingo Phase" and underlies the "Warley Hill Phase". Cooke (1936) divided Sloan's Congaree and assigned part to the Black Mingo Formation and part to the McBean Formation. Cooke and MacNeil (1952) reinstated the Congaree Formation as the stratigraphic equivalent to the Tallahatta Formation of Mississippi and Alabama (Plate 30).

The early middle Eocene Congaree Formation has been traced from the Congaree valley in east-central South Carolina into the study area, and it has been paleontologically correlated with the early Claibornian or early (and middle) Eocene Tallahatta Formation in neighboring southeastern Georgia by Fallaw and others (1990).

The Congaree is about 30 ft thick near the center of the study area and consists of yellow, orange, tan, gray, green, and greenish-gray, well-sorted, fine to coarse quartz sand, with granule and small pebble zones common. Thin clay laminae occur throughout the section. The quartz grains tend to be better rounded than those in the rest of the stratigraphic column. The sand is glauconitic in places suggesting deposition in shoreline or shallow shelf environments.

To the south, near well ALL-324 (Plate 3), the Congaree Formation consists of interbedded glauconitic sand and shale, grading to glauconitic, argillaceous, fossiliferous sandy limestone suggestive of shallow to deeper shelf environments of deposition. Farther south, beyond well C-10 (Colquhoun and others, 1983), the Congaree grades into platform carbonate facies of the lower Santee Limestone (Plates 30 and 33).

The equivalent of the Congaree northwest of SRS has been mapped as the Huber Formation (Nystrom and Willoughby, 1982). At these locations it becomes more micaceous and poorly sorted, indicating deposition in fluvial and upper delta plain environments. On geophysical logs the Congaree has a distinctive low gamma-ray count and high electrical resistivity (Plates 3-10).

Warley Hill Formation.—Unconformably overlying the Congaree Formation are 10 to 20 ft of fine-grained, often glauconitic sand and green clay beds that have been referred to respectively as the Warley Hill and Caw Caw Members of the Santee Limestone (Fig. 7). The green sand and clay beds are referred to informally as the "green clay" in previous SRS reports. Sloan (1908) assigned outcrops of these sediments along Tinker Creek at SRS to his "Warley Hill phase", correlating them to the type locality in Calhoun County, S.C. (Sloan, 1908; Cooke and MacNeil, 1952). Both the glauconitic sand and the clay at the top of the Congaree are assigned to the Warley Hill Formation (Fallaw and others, 1990). In the updip parts of the study area (Plate 3), the Warley Hill apparently is missing or very thin, and the overlying Tinker/Santee Formation rests unconformably on the Congaree Formation.

Warley Hill sediments indicate shallow to deeper clastic shelf environments of deposition in the study area, generally deeper water than the underlying Congaree Formation. This suggests a continuation of the transgressive pulse of the sea during upper middle Eocene time. To the south, beyond well P-21 (Plates 5 and 8), the green silty sand and clay of the Warley Hill undergo a facies change to the clayey micritic limestone and limy clay typical of the overlying Santee Limestone (Plate 3). The Warley Hill grades imperceptibly into the thick clayey micritic limestone and clay that constitute the "middle confining unit" of Miller (1986), which divides the Floridan aquifer system into the Upper and Lower Floridan aquifers south of the study area. The Warley Hill is correlative with the lower part of the Avon Park Limestone in southern Georgia and the lower part of the Lisbon Formation in western Georgia (Plate 30).

In the study area, the thickness of the Warley Hill Formation is generally less than 20 ft. In the area where the Congaree Formation is not present in Bamberg County, S.C., the Warley Hill rests directly on the Williamsburg Formation (Logan and Euler, 1989).

Tinker/Santee Formations.—Late middle Eocene deposits overlying the Warley Hill Formation consist of moderately sorted, yellow and tan sand, calcareous sand, and clay, limestone, and marl. Calcareous sediments dominant downdip, are sporadic in the middle of the study area, and are missing in the northwest (Plate 3). The limestone represents the farthest advance to the northwest of the transgressing carbonate platform first developed in early Paleocene time near the South Carolina and Georgia coasts (Plates 31, 32, and 33). In the past, "McBean Formation" or "McBean Member" of the "Lisbon Formation" have been applied to these sediments. The term McBean, however, has also been applied to a variety of units including much of the overlying Dry Branch Formation and, consequently, the term has relatively little use. As a result, the name has been abandoned as a stratigraphic unit (Fallaw and Price, 1995). The term "Santee" has priority (Sloan, 1908). "Santee" was used in many variations by early investigators, but Cooke (1936) was first to use the term Santee Limestone. He considered this name to be appropriate because the formation's best and most fossiliferous exposures occur along or near the Santee River and because in that area the formation is predominately limestone. Cooke (1936) assigned the unit to the upper Eocene, but in 1952, Cooke and MacNeil reassigned it to the middle Eocene as the equivalent of the Cook Mountain Formation of the Claiborne Group of the Gulf Coast.

Fallaw and others (1990) divided the Santee into three members in the study area: the McBean, Blue Bluff, and Tims Branch. The McBean Member consisted of tan to white, calcilutite, calcarenite, shelly limestone, and calcareous sand and clay that dominates the Santee in the central part of the study area, and that constitutes the transitional lithologies between clastics in the north and northwest, and fine-grained carbonates in the south. The carbonate content is variable.

The Blue Bluff Member consists of the gray to green, laminated micritic limestone parts of the Santee. The unit includes gray, fissile, calcareous clay and clayey micritic limestone and very thinly layered to laminated, clayey, calcareous, silty, fine sand, with shells and hard, calcareous nodules, lenses, and layers. Blue Bluff cores are glauconitic, up to 30 percent in places. The Blue Bluff lithology suggests deposition in protected lagoonal-bay environments. Blue Bluff sediments dominate the formation in the southern part of the study area (Plate 3) and constitute a major part of the "middle confining unit" of Miller (1986) that separates the Upper and Lower Floridan aquifers south of the study area.

Fallaw and others (1990) described the Tims Branch Member of the Santee as the siliciclastic part of the unit, consisting of fine- and medium-grained, tan, orange, and yellow, poorly to well sorted, and slightly to moderately indurated sand. It is slightly glauconitic in places, which suggests siliciclastic, shallow marine to shore-face depositional environments. The clastic lithologies of the Tims Branch Member dominate the Santee in the northern part of the study area. Because the clastic lithologies differ so markedly from the type Santee, Fallaw and Price (1995) raised the Tims Branch Member of the Santee to formational rank, naming it the Tinker Formation. Because the clastic and carbonate lithologies of the Tinker/Santee sequence in the upper and middle parts of the study area are hydrologically undifferentiated, the units are not separated in this report, and they are designated Tinker/Santee Formation on all maps and sections.

The Tinker/Santee is about 70 ft thick near the center of the study area, and the sediments indicate deposition in shallow marine environments. The top of the unit is picked on geophysical logs where Tinker/Santee sediments with lower electrical resistivity are overlain by the more resistive sediments of the Dry Branch Formation. In general, the gamma-ray count is higher than in surrounding stratigraphic units.

Barnwell Group

Upper Eocene (Bartonian/Priabonian) sediments of the Barnwell Group represent the Jacksonian Stage in the Upper Coastal Plain of western South Carolina and eastern Georgia (Fig. 7) (Logan and Euler, 1989). Downdip, in the Lower Coastal Plain of western South Carolina, the Cooper Group, which includes sediments of both late Eocene (Jackson) and late Oligocene time, are recognized. Sediments of the Barnwell Group are chronostratigraphically equivalent to the lower (late Eocene) Cooper Group of Colquhoun and others (1982) (Plate 30).

Sediments of the Barnwell Group lie unconformably on the Tinker/Santee Formation (Fig. 7) and consist mostly of shallow marine quartz sand containing sporadic clay layers. Huddleston and Hetrick (1985) recently revised the upper Eocene stratigraphy of the Georgia Coastal Plain, and their approach has been extended into South Carolina (Nystrom and Willoughby, 1982; Nystrom and others, 1986). These authors elevated the Eocene (Jacksonian-Priabonian) "Barnwell Formation" to the "Barnwell Group", which in Burke County, Ga., includes (from oldest to youngest) the Clinchfield and Dry Branch Formations, and the Tobacco Road Sand (Fig. 7; Plate 30). The group is about 70 ft thick near the northwestern boundary of SRS and 170 ft near its southeastern boundary (Plate 3).

In the northern part of the study area the Barnwell Group consists of red or brown, fine- to coarse-grained, well-sorted, massive sandy clay and clayey sand, calcareous sand and clay, as well as scattered thin layers of silicified fossiliferous limestone. All are suggestive of lower delta plain and/or shallow shelf environments. Downdip, the Barnwell undergoes a facies change to phosphatic clayey limestone of the lower Cooper Group (Plate 30). The lower Cooper Group limestone beds indicate deeper shelf environments (Plate 34).

Clinchfield Formation.—The basal late Eocene Clinchfield Formation consists of light-colored quartz sand and glauconitic, biomoldic limestone, calcareous sand, and clay. Sand beds of the formation constitute the Riggins Mill Member (Huddlestun and Hetrick, 1985) of the Clinchfield Formation and are composed of medium to coarse, poorly to well sorted, loose and slightly indurated, tan, gray, and green quartz. The sand is difficult to identify unless it occurs between the carbonate layers of the Griffins Landing Member of the overlying Dry Branch Formation and the carbonate layers of the underlying Santee Limestone. The Clinchfield is about 25 ft thick in the southeastern part of SRS and pinches out or becomes unrecognizable at the center of the site. Sand probably was deposited as the Barnwell sea transgressed over the eroded Santee.

The carbonate sequence of the Clinchfield Formation constitutes the Utley Limestone Member (Fallaw and Price, 1995) of the formation. It is composed of sandy, glauconitic limestone and calcareous sand, with an indurated, biomoldic facies developed in places. In cores, the sediments are tan and white and slightly to well indurated.

Dry Branch Formation.—The Jacksonian (late Eocene) Dry Branch Formation is divided into the Irwinton Sand Member, the Twiggs Clay Member, and the Griffins Landing Member (Fallaw and Price, 1995) (Fig. 7). The unit is about 60 ft thick near the center of the study area (Plates 3-10). The top of the Dry Branch is picked on geophysical logs where a low gamma-ray count in the relatively clean Dry Branch sand increases sharply in the more argillaceous sediments of the overlying Tobacco Road Formation.

The Twiggs Clay Member is not mappable in the study area, but lithologically similar clay is present at various stratigraphic vels in the Dry Branch Formation. The tan, light-gray, and 'own clay is as thick as 12 ft in SRS wells but is not contin- ›us over long distances. This clay has been referred to in the ıst as the "tan clay" in SRS reports. The Twiggs Clay ember, which predominates west of the Ocmulgee River in eorgia, is not observed as a separate unit in the study area.

The Griffins Landing Member is composed mostly of tan green, slightly to well indurated, quartzose calcareous icrite and sparite, calcareous quartz sand and slightly cal- reous clay (Fallaw and others, 1990). Oyster beds are locally mmon in the Griffins Landing. The unit is widespread in e southeastern part of SRS, where it is about 50 ft thick, but comes sporadic in the center where it pinches out (Plate 3). ırbonate content is highly variable. In places, the unit lies conformably on the Utley Limestone Member, which ntains much more indurated, moldic limestone. In other eas it lies on the noncalcareous quartz sand of the inchfield. Updip, the Clinchfield is difficult to identify or missing, and the Griffins Landing may lie unconformably the sand and clay facies of the Tinker/Santee Formation. e Griffins Landing Member appears to have formed in ıllow marine to lagoonal environments.

The Irwinton Sand Member is composed of tan, yellow and ınge, moderately sorted, quartz sand, with interlaminated 1 interbedded clay abundant in places (Fallaw and others, 90). Pebbly layers are present, as are clay clast-rich zones viggs Clay lithology). Clay beds, which are not continuous er long distances, are tan, light-gray, and brown in color, 1 can be several feet thick in places. These are the "tan y" beds of various SRS reports. Irwinton sand beds have characteristics of a shallow marine deposit, and the clay y have formed in a lagoonal or marsh environment (Smith, 79). The Irwinton Sand crops out in SRS. Thickness is iable, but is about 40 ft near the northwestern site boundary l 70 ft near the southeastern boundary.

obacco Road Formation.—The late Jacksonian (latest late ene) Tobacco Road Formation consists of moderately to ırly sorted, red, brown, tan, purple, and orange, fine to rse, clayey quartz sand (Fallaw and others, 1990). Pebble ers are common, as are clay laminae and beds. Ophio- rpha (?) burrows are abundant in parts of the formation. iments have the characteristics of a shallow marine deposit. top of the Tobacco Road is picked where comparatively l-sorted sand is overlain by more poorly sorted sand, pebbly 1, and clay of the "Upland unit". Contact between the units lifficult to pick on geophysical logs because the upper ace of the unit is very irregular due to fluvial incision that mpanied deposition of the overlying "Upland unit" and r erosion. The lower part of the upper Eocene Cooper up is the probable downdip equivalent of the Tobacco Road mation (Plates 30 and 35).

Cooper Group

nce the early 1800's many names, including Cooper Marl, e been applied to sediments of the Cooper Group (Logan Euler, 1989). In 1908, Sloan compiled all the data avail- and assigned an upper Eocene age to the Cooper Marl. Malde (1959) stated that the Cooper Marl contains too little clay and too much sand to be considered a true marl. Pooser (1965), however, advocated the name because of its extensive use by Coastal Plain geologists. Colquhoun and others (1982) proposed group status for the Cooper and included all upper Eocene/Oligocene strata equivalent to the Cooper Formation lying above the Orangeburg Group and below the Hawthorn Formation or its equivalents (Plate 30). Gohn and others (1983) referred to the unit as the Cooper Formation. The Cooper Group is divided into the lower Cooper Group consisting of sediments of late Eocene age, and the upper Cooper Group consisting of sediments of Oligocene age.

In the southern part of the study area the upper Eocene lower Cooper Group (Colquhoun and others, 1983) is recognized and has been mapped as the downdip equivalent of the Barnwell Group (Plates 3, 5, and 27). Here, it consists of gray or white, silty, sandy, phosphatic, clayey limestone indicative of deeper shelf environments away from clastic sediment input. Farther south, sediments of the lower Cooper Group pass into the the Ocala Limestone (Plate 30). The Ocala is composed of white or gray, slightly glauconitic, fossiliferous, recrystallized, porous limestone, often with large solution cavities. It is about 200 ft thick near the South Carolina coastline where the formation unconformably overlies the Avon Park Formation. The carbonate platform regressed slightly during deposition of the Ocala Limestone and began the retreat southward from its northernmost geographic position, which was attained in middle Eocene time during deposition of Santee carbonates.

The upper Oligocene (Chattian) upper Cooper Group occurs in the southern part of the study area (Plate 5). The unit was described in well P-21 by Prowell and others (1985a) and pinches out in the vicinity of the P-22 well in the southern part of the study area (Plate 3). The unit is composed of soft, chalky limestone and phosphatic, sandy marl near the coast and mostly sandy clay, clayey sand and sand updip in the study area. Near the coast, the carbonate platform equivalent of the upper Cooper Group is the "unnamed limestone" of Colquhoun and others (1983), which is correlative with the soft chalky and fossiliferous limestone and dense calcitized saccharoidal and fossiliferous dolomite of the Suwannee Limestone mapped in coastal Georgia and northeastern Florida (Krause and Randolph, 1989) (Plate 30). The Suwannee Limestone is the youngest unit deposited on the carbonate platform first established in early Paleocene time. Suwannee carbonate platform equivalents in coastal South Carolina form the uppermost component of the upper Floridan aquifer.

"Upland Unit"/Hawthorn/Chandler Bridge Formations (?) Deposits of poorly sorted, silty, clayey sand, pebbly sand, and conglomerate of the "Upland unit" cap many of the hills at higher elevations over much of the study area (Fig. 7; Plates 3-10). Weathered feldspar is abundant in places. The color is variable, and facies changes are abrupt. Siple (1967) assigned these sediments to the Hawthorn Formation. Nystrom and others (1986), who mapped it as the "Upland unit", discuss evidence for a Miocene age. The environment of deposition appears to be fluvial, and the thickness changes abruptly owing to channeling of the underlying Tobacco Road Formation

during "Upland" deposition and subsequent erosion of the Upland unit itself. Thicknesses up to 60 ft have been documented (Nystrom and others, 1986).

Lithologic types comparable to the Upland unit but assigned to the Hawthorn Formation overlie the Barnwell Group and the Cooper Group in the southern part of the study area (Plate 36). The updip Hawthorn Formation consists of very poorly sorted, sandy clay, and clayey sand, with lenses of gravel and thin beds of sand similar to the Upland unit. Farther downdip, the Hawthorn consists of phosphatic, sandy clay and phosphatic, clayey sand and sandy, dolomitic limestone interbedded with layers of hard, brittle clay resembling fuller's earth. Here, the Hawthorn Formation acts as the confining layer overlying the Floridan aquifer system.

Preliminary findings of the Upland unit study currently under way by Colquhoun and others (1994) suggest that the Upland unit, Tobacco Road Formation, and Dry Branch Formation are similar in texture and composition, indicating that they might be similar genetically, i.e., that they are part of the same transgressive/regressive depositional cycle, with the Upland unit being the most continental end member (lithofacies) and the Dry Branch Formation being the most marine end member. Thus, the Upland unit represents a major regressive pulse that closed out deposition of the Barnwell Group/Cooper Group depositional cycle. Colquhoun and others (1994) suggested that the Upland unit is correlative with the Chandler Bridge Formation downdip toward the coast. This hypothesis is significant because it implies that there was no major hiatus between the Upland unit and the underlying Tobacco Road and Dry Branch Formations. However, the existence of a hiatus between the units has been reported by numerous researchers of the South Carolina Coastal Plain (for example, Siple, 1967; Logan and Euler, 1989; Nystrom, Willoughby and Price, 1991; and Fallaw and Price, 1992).

HYDROGEOLOGIC FRAMEWORK

PREVIOUS INVESTIGATIONS

Numerous studies in recent years have described and modeled the aquifers in the study area (Siple, 1967; Colquhoun and others, 1983; Brooks and others, 1985; Clarke and others, 1985; Aucott and others, 1987; Aucott, 1988; Krause and Randolph, 1989; Sperian and Aucott, 1991). Various hydrostratigraphic classifications have been devised: some very detailed, to characterize and classify aquifers in site-specific studies; others very generalized, to characterize and model aquifers regionally. Central to all previous classification schemes is the one-to-one relationship between hydrostratigraphic and lithostratigraphic units (Siple, 1967; Aucott, 1988) (Fig. 8). This fixed relationship is difficult to implement in studies at widely separated locations owing to abrupt facies changes in the updip Coastal Plain sequence and to the generally poor correspondence of hydrogeologic unit boundaries to stratigraphic unit boundaries and, in part, to the regional extent of the hydrogeologic units. Each hydrogeologic unit encompasses several formations or parts of formations.

Aucott and others (1987) defined regional aquifers in South Carolina using stratigraphic (for example, Black Creek aquifer) and chronostratigraphic/lithologic terminology (for example, Tertiary sand aquifer). These methods of naming hydrogeologic units should be avoided because hydrogeologic units are defined on the basis of the hydraulic characteristics of the unit (Laney and Davidson, 1986). Thus, the hydrogeologic unit may encompass several stratigraphic units and a variety of lithologies in different geographic areas but still retain coherent, continuous hydrogeologic properties.

Brooks and others (1985) and Clarke and others (1985), working immediately west of the study area in east-central Georgia, defined and described, from the base upward, the Midville, Dublin, and Gordon aquifer systems and the Jacksonian aquifer (Plate 37). The hydrostratigraphic intervals included in the Midville, Dublin, and Gordon aquifer systems are directly correlative with the hydrostratigraphic units delineated in this study; thus the names Midville, Dublin, and Gordon are used for the hydrogeologic units in the study area. The Midville and Dublin aquifer systems are named for towns near the type well that penetrates strata representative of the geologic and hydrologic properties of the aquifer system. The Gordon aquifer system is named for the town of Gordon, in Wilkinson County, Ga., where the well in which sediments that typify the aquifer system is located. Clarke and others (1985) did not attempt to formally name the intervening confining units (Plate 37).

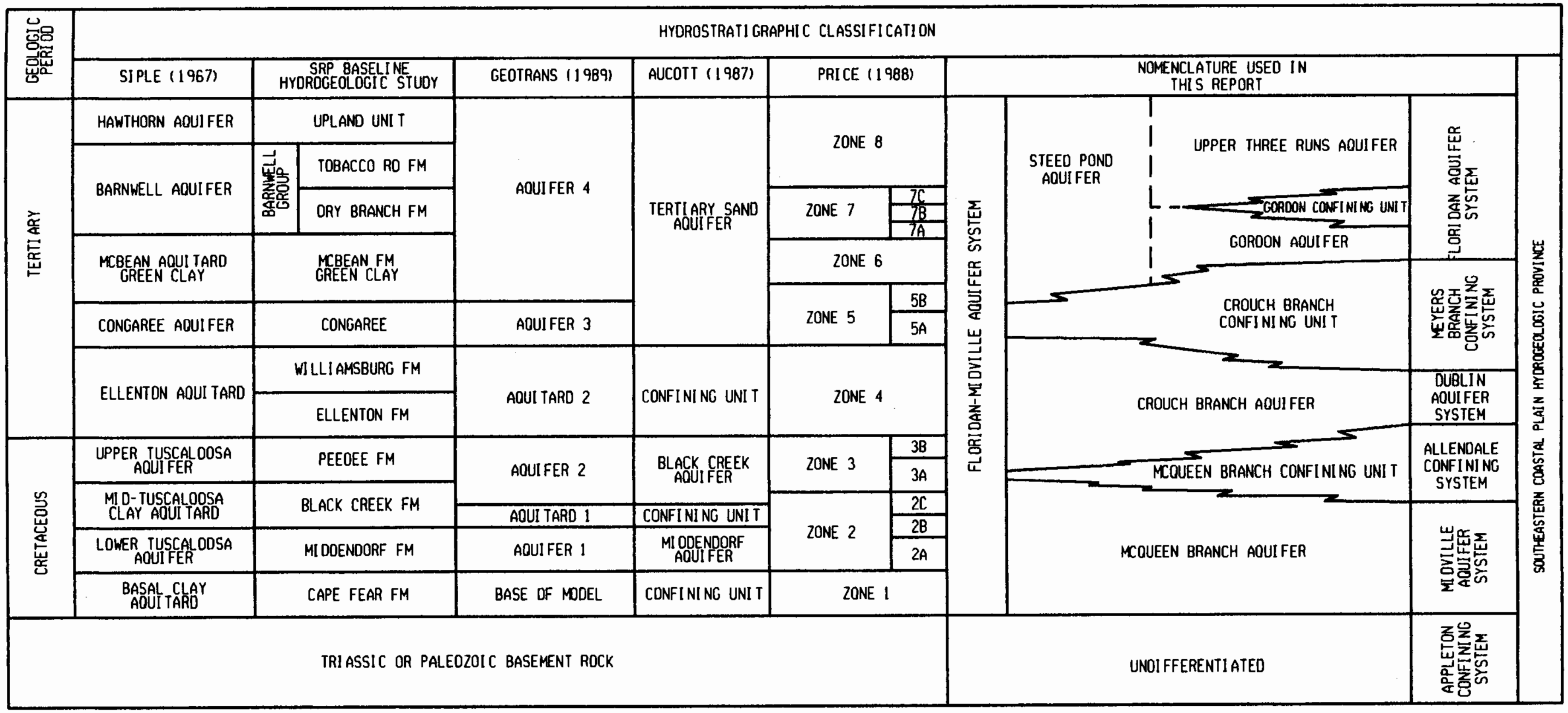
In the updip region of the sedimentary wedge that includes the Midville and Dublin aquifer systems, Clarke and others (1985) combined the two aquifer systems where they were no longer regionally separated and named the resulting system the Dublin-Midville aquifer system, by combining the names of the two downdip systems.

Several other methods for naming hydrogeologic units have been proposed. Miller and Renken (1988) divided the sediments that constitute their Southeastern Coastal Plain hydrologic system (hydrogeological province in this report) into seven regional hydrologic units: four aquifers separated by three confining units. Six of the regional hydrogeologic units are directly correlative with and fit the definition used for the aquifer and confining systems described in this report (Fig. 9). Miller and Renken (1988) named the four regional aquifers for major rivers that cut across outcrop areas and expose the aquifer materials. Regional confining units separating them are given the same name as the aquifer they overlie. Miller and Renken (1988) did not attempt to delineate the changes in the regional aquifer and confining units in the updip regions of their study area. Thus, they do not address nomenclatural changes in those areas.

Most recently, a temporary alphanumeric nomenclature to classify the aquifers in the SRS region was adopted (Aadland and Bledsoe, 1990a and b; Bledsoe and others, 1990) (Fig. 8). This nomenclature provided a useful shorthand approach to naming aquifers and confining units in the initial stages of this study.

DELINEATION AND CLASSIFICATION OF UNITS

The hydrostratigraphic classification used in this study is based largely on the recommended guidelines for the classification of hydrostratigraphic units developed by the South



NOTE:

(1) Included within the different units can be individual zones of higher or lower permeability.

(2) Hydrostratigraphic boundaries do not necessarily coincide with stratigraphic boundaries.

Figure 8. Comparison of hydrostratigraphic classifications in the SRS region.

Carolina Hydrostratigraphic Nomenclature Subcommittee (Burt, 1987a). The subcommittee consists of members from industry and federal and state agencies who are involved with ground water investigations throughout South Carolina and the surrounding region. The preliminary draft classification scheme developed by the subcommittee combines guidelines published by Laney and Davidson (1986), who developed a system for naming hydrogeologic units in U.S. Geological Survey (USGS) reports, and the proposed addition to the North American Stratigraphic Code (NASC) by Seaber (1986 and 1992).

The hydrostratigraphic classification used in this study utilizes a hierarchy of aquifer and confining units ranked at four levels. Level 1, hydrogeologic province, is comparable to the hydrologic systems described by Miller and Renken (1988) (Fig. 9). The hydrogeologic province defines major regional rock and/or sediment packages that behave as a single unified hydrologic unit.

Level	Proposed South Carolina Hydrostratigraphic Units (after Laney and Davidson, 1986)	Corresponding NASC Units (after Seaber, 1986 and 1992)
1	Hydrogeologic Province	N/A
2	Aquifer System/ Confining System	Aquigroup
3	Aquifer Unit/ Confining Unit	Aquiformation
4	Aquifer Zone/ Confining Zone (informal)	Aquimember, Aquibed

Levels 2 through 4 correspond to the guidelines of Laney and Davidson (1986) and are similar to the ranks and units defined by Seaber (1986 and 1992) for the North American Stratigraphic Commission. Ranked at level 2 are the aquifer and confining systems. The aquifer system may be composed of a single aquifer or two or more coalescing aquifers that transmit ground water on a regional basis. Aquifer systems may be locally divided by confining units that impede ground water movement but do not greatly affect the regional hydraulic continuity of the system (Poland and others, 1972). A confining system may be composed of a single confining unit or two or more confining units that serve as an impediment to regional ground water flow.

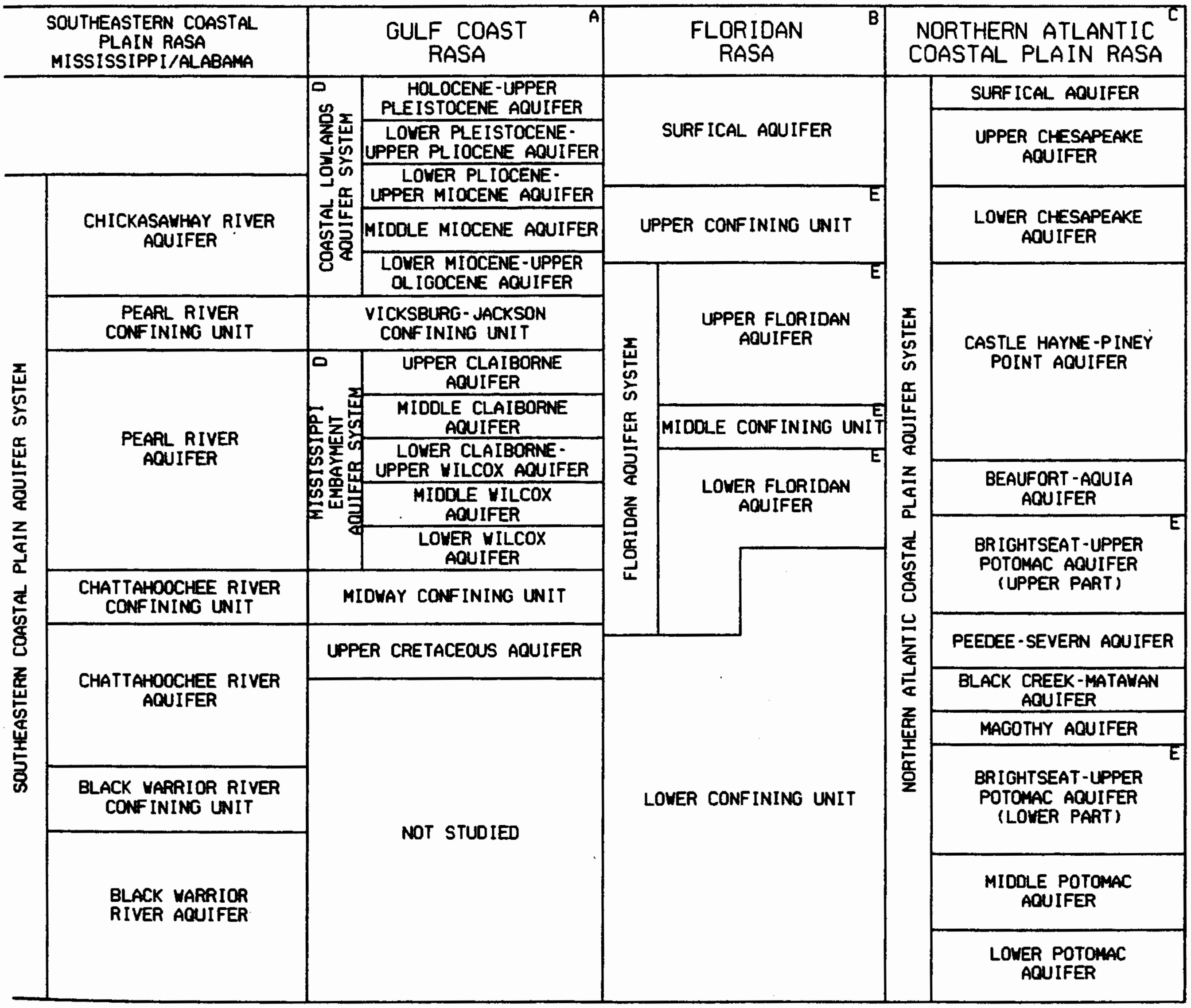
The study area is located near the updip limit of the aquifer and confining systems comprising the Coastal Plain sediments in the region (Plate 38). Here, the lateral continuity and thickness of the clay and clayey sand beds that constitute the confining systems decrease, and the beds become increasingly discontinuous. Where the clay beds no longer separate the overlying and underlying aquifers, the updip limit of the confining system is defined (Fig. 10). Updip from this line, the overlying and underlying aquifer systems coalesce and a single unified aquifer system is defined and named. Where aquifer systems have combined, the individual aquifer and confining units that constitute the downdip aquifer systems can and commonly do extend into and form part of the updip combined system.

Aquifer and confining units, which are ranked at level 3, are the fundamental units of the classification. As defined by the subcommittee (Burt, 1987a and b), an aquifer is a mappable (>400 mi²) body of rock or sediments that is sufficiently permeable to conduct ground water and yield significant quantities of water to wells and springs (Bates and Jackson, 1980). A confining unit, on the other hand, is a mappable (>400 mi²) body of rock or sediments, of significantly lower hydraulic conductivity than an adjacent aquifer, that serves as an impediment to ground water flow into or out of an aquifer (Lohman and others, 1972). A confining unit's hydraulic conductivity may range from nearly zero to some value distinctly lower than that of the nearby aquifer. The assignment of a unit level and name to a hydrostratigraphic unit does not imply a quantitative ranking of hydraulic continuity, but is intended to distinguish relative differences in hydraulic properties between adjacent units. Where the confining unit that separates one aquifer from another thins and becomes laterally discontinuous and/or is breached by faults and fractures, the overlying and underlying aquifers coalesce and a single unified aquifer may be defined.

Aquifer and confining units may be informally subdivided into zones (level 4) that are characterized by properties significantly different from the rest of the unit, such as hydraulic conductivity, water chemistry, lithology, or color. For example, an aquifer may contain a "confining zone" such as the "tan clay" confining zone of the Upper Three Runs aquifer in the General Separations Area at SRS. Conversely, a confining unit may contain an "aquifer zone" such as the "middle sand" aquifer zone of the Crouch Branch confining unit in A-M Area at SRS. Miller (1986) describes the "Fernandina permeable zone" in the Lower Floridan aquifer in coastal areas of Georgia, where the permeability greatly exceeds that of the rest of the aquifer.

In the study area, zonal differentiation is undertaken on a local site-specific scale where useful and necessary distinctions are made in the hydraulic characteristics of specific aquifer or confining units. Thus, the intermittent but persistent clay beds in the Dry Branch Formation, informally referred to as the "tan clay" in previous SRS reports, is designated the "tan clay" confining zone of the Upper Three Runs aquifer. The "tan clay" confining zone is defined specifically for the Dry Branch clay in the General Separations Area of SRS. Correlative clay beds in other parts of the study area may usefully be designated a confining zone but would be given a separate and distinct name.

Aquifer and confining systems and units delineated in this report are all defined at a type well that penetrates strata representative of the geological and hydrogeological properties typical of the unit (Plate 39). Hydrostratigraphic units are defined on the basis of hydraulic properties of the sediments, most significantly hydraulic conductivity and leakance coefficients. These criteria eliminate any formal reliance



[SOURCES: A. GRUBB, 1986, B. MILLER, 1986, C. HENRY TRAPP, JR., U.S. GEOLOGICAL SURVEY, WRITTEN COMM., D. CONFINING UNITS BETWEEN AQUIFERS NOT SHOWN.
E. STATIGRAPHIC POSITION VARIES. (MILLER AND RENKEN, 1988)]

gure 9. Relations among hydrogeologic units differentiated by the Southeastern Coastal Plain, Gulf Coast, Floridan, and Northern Atlantic Coastal Plain regional aquifer-system analysis studies.

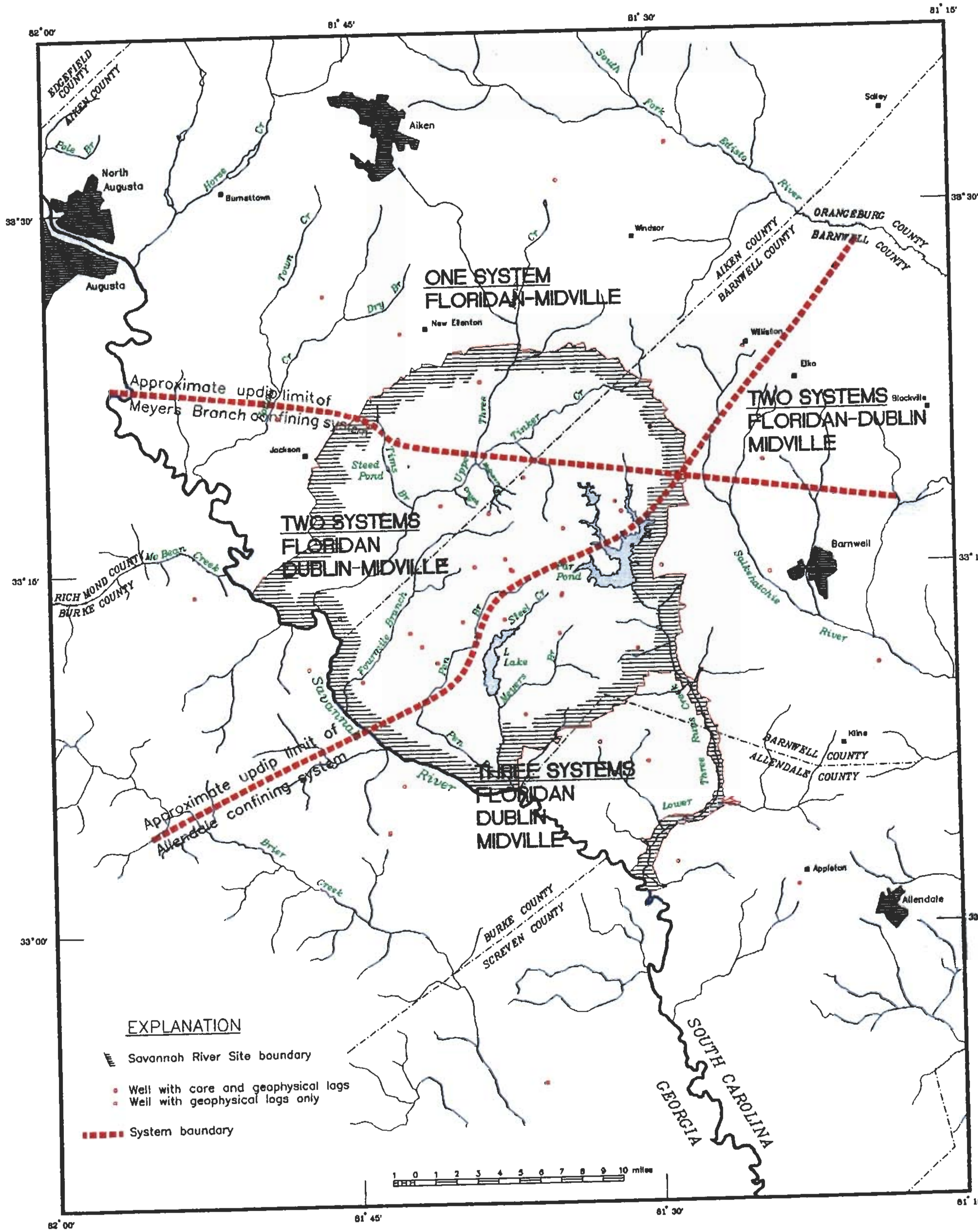


Figure 10. Location of aquifer and confining systems in the SRS region.

the classification system on lithology, age, geologic history, paleogeographic position, or other features that are unrelated to hydraulic properties of the units. Reliance of the formal classification on hydraulic properties, and the exclusion of lithologic properties as classification criteria, is not intended to deny the relationship that exists between lithology and hydraulic properties. Lithology certainly is used as a tool for correlation of hydrostratigraphic units, as are other features of the subsurface such as geophysical response, ground water chemistry, and hydrogeologic continuity. These lithologic properties should be viewed only as indications of the hydraulic characteristics of the units, and not as specific criteria for the formal classification of the units.

Aquifers that are described in this report are defined by hydraulic properties (hydraulic conductivity, hydraulic head relationships, porosity, transmissivity, and specific storage) of the units relative to hydraulic properties (hydraulic conductivity, leakance coefficients, and vertical flow velocity) measured in the overlying and underlying confining units (Aadland and others, 1990a and b; Bledsoe and others, 1990) at the type well or type-well cluster location. Aquifer and confining units are mapped on the basis of the hydrogeologic continuity, potentiometric conditions, and leakance-coefficient estimates for the units, which are largely dependent on the thickness, areal distribution, and continuity of the attendant lithology of the particular unit. For example, the Meyers Branch confining system is defined at the P-24 well cluster (Plate 39f) where the hydraulic characteristics of the unit were defined and delineated. The geographic area encompassed by the Meyers Branch confining system (Fig. 10; Plates 16 and 17), however, is defined by the lateral variation in hydraulic conductivity and leakance-coefficient values of the system, which is in turn dependent on the thickness, facies distribution, and continuity of the clay, silty clay and clayey sand observed at the type-well cluster location.

The proposed classification system is advantageous in several respects. Use of the more common terms (for example, aquifer, confining unit, aquifer system, confining system, and aquifer and confining zone), as opposed to the newer terms of Seaber (1992), is preferred because these terms are entrenched in the vocabulary of the hydrogeologic community. However, using criteria similar to Seaber's (1992) to define the units creates a system of classification for hydrostratigraphic units that relies entirely on the hydraulic properties of the units and eliminates any formal connection to attendant lithostratigraphy (Fig. 7). The system does allow for the informal designation of units (zones) described by other useful properties. The proposed system is also improved over that of Seaber (1992) in that a distinction is made between units perceived as aquifers and those perceived as confining units.

The hydrostratigraphic code described in this report accounts for and accommodates the rapid thinning of the sediment wedge and lateral variation in lithofacies observed in the study area. In addition, the hierarchical ranking of the hydrologic units into systems, units, and zones makes the classification flexible. It can be made as detailed as the complexity of the local hydrologic regime demands. Thus, the classification scheme is applicable to all locations in the region, resulting in a unified, consistent hydrostratigraphic classification amenable to all future hydrogeological studies and reports. For example, Figure 11 illustrates the hydrostratigraphic scheme as delineated in A-M Area located at the northwest edge of SRS. Note that the Crouch Branch confining unit and the Steed Pond aquifer are each subdivided into three hydrostratigraphic zones.

Methods Used

The method for establishing a nomenclature for the hydrogeologic units in the study generally follows the guidelines set forth by the South Carolina Hydrostratigraphic Subcommittee, and is as follows:

- The names, areal extent and underlying geological context of the regional hydrogeologic provinces used in this report are the same as those defined by Miller and Renken (1988) as regional hydrologic systems. For example, the "Southeastern Coastal Plain hydrologic system" of Miller and Renken reads "Southeastern Coastal Plain hydrogeologic province" in this report (Figs. 7 and 12).
- Aquifer systems are given formal names for a prominent geographic or cultural feature near the type well or well-cluster location where the system is defined.
- Established names, such as the Floridan aquifer system, are retained because of their wide recognition among workers and in the literature. The lateral and hydrostratigraphic limits of the unit may be redefined, bringing it into conformity with the defining criteria established here.
- Where aquifer systems coalesce, the new unified aquifer system is named by hyphenating the names of the individual downdip aquifer systems that make up the unit. Where three or more aquifer systems have combined, the resulting aquifer system will take the hyphenated name of the uppermost and lowermost of the downdip constituent aquifer systems.
- Aquifer units are named for a geographic or cultural feature near the type well or well-cluster location where the unit is defined.
- Confining systems are named for a prominent geographic or cultural feature located near the type well or well-cluster location where the system is defined. The confining systems are named independently of the overlying and underlying aquifer systems.
- Confining units are given the same name as the aquifers they overlie. For example, the McQueen Branch aquifer is overlain by the McQueen Branch confining unit.
- Zones are named by using geographic, cultural, or descriptive terms that may relate to lithology, mineralogy, hydraulic properties, water quality, or any other characteristics (except as noted below) that serve a useful purpose. For example, a water-bearing unit that is too small to be classified as an aquifer may be named a high-permeability zone within a confining unit, or a part of an aquifer containing ground water with a high chloride concentration may be named a salty zone.

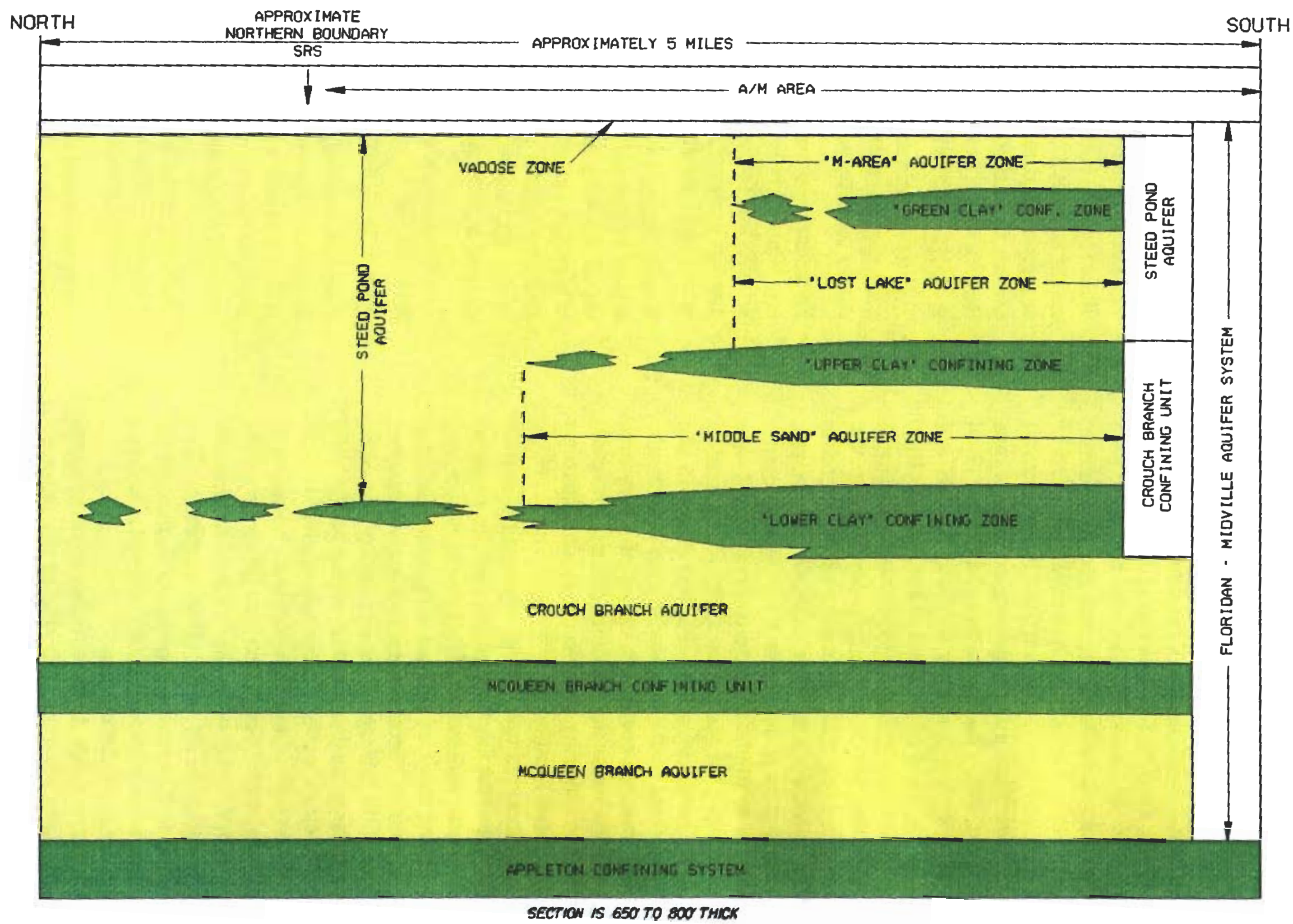


Figure 11. Schematic north-south hydrostratigraphic section of the A-M Area, SRS.

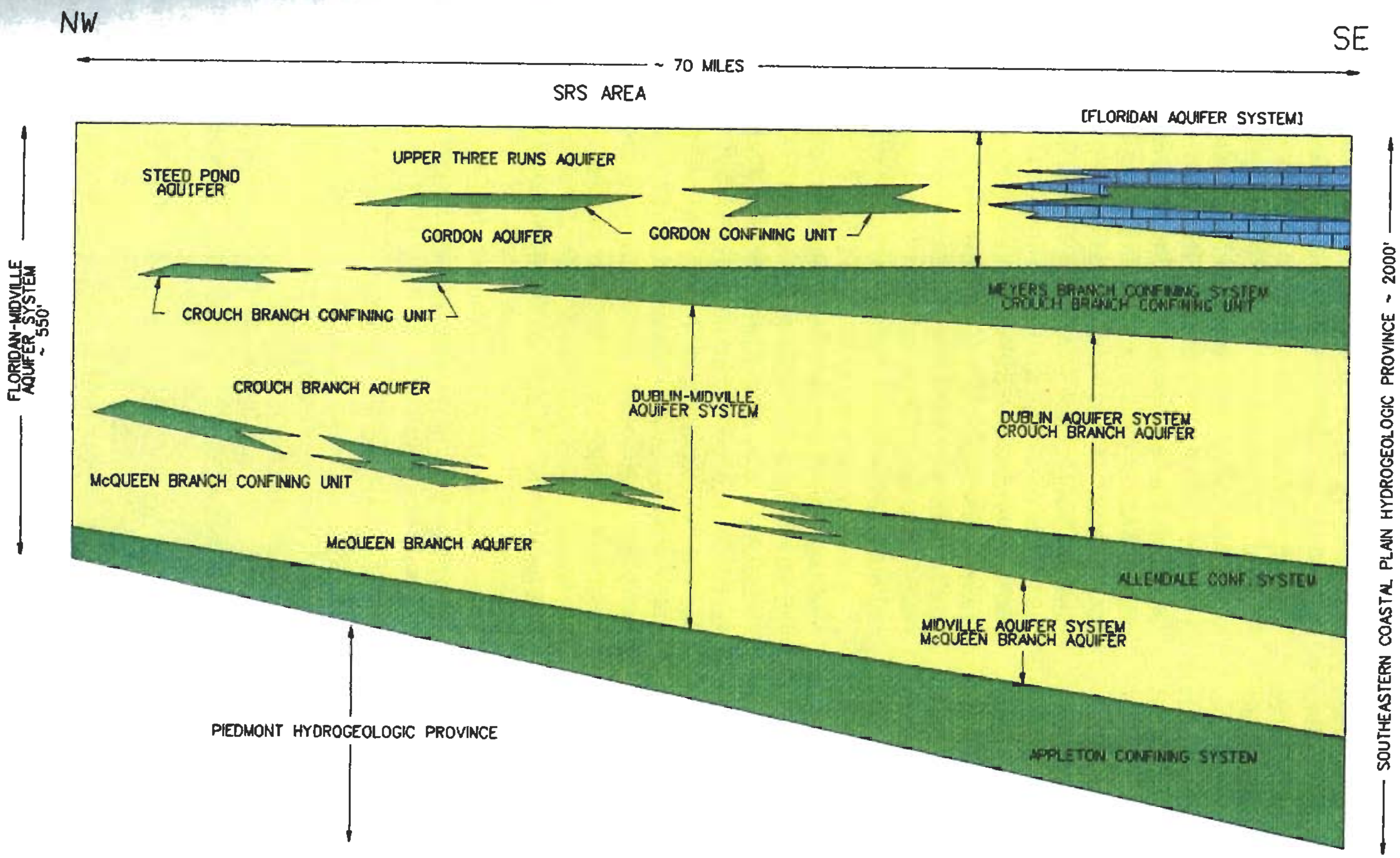


Figure 12. Hydrogeologic nomenclature for the SRS region.

- These criteria eliminate several characteristics and descriptions of hydrostratigraphic units from use in assigning names; including time or time-stratigraphically related terms, relative positions of units, alphanumeric names, depth of occurrence, depositional environment, geologic environment, geologic history, genesis, and acronyms. Hydraulic condition, lithology, chemistry, and mineralogy are not to be used in hydrostratigraphic unit names, except for naming zones.

A multifaceted, interdisciplinary approach was undertaken in delineating the lateral extent and hydrostratigraphic limits of the aquifers and confining systems and units in the study. Hydraulic-conductivity calculations from aquifer pumping tests and from laboratory analysis of core samples, hydraulic-head data, core data, and down-hole geophysical data were the primary sources upon which aquifer and confining systems and units were delineated.

The geometric mean vertical and horizontal hydraulic conductivity was calculated from laboratory permeameter tests made on 28 clayey sand and 55 sandy clay to clay samples from the various confining units and low-permeability zones in the aquifer units throughout the study area (Tables 1 and 2). Leakance-coefficient values calculated from the geometric mean hydraulic-conductivity values derived from laboratory analysis of core samples and from unit thicknesses at each well location, were mapped for each confining system, unit, and zone. Where available, the leakance-coefficient values derived from aquifer pumping tests were compared and contrasted with the laboratory-derived values. Laboratory-derived leakance values are point-source values and do not reflect the degree of continuity of the confining beds nor the degree of interconnection or hydraulic communication that may occur across confining beds in the areas between wells. Leakance values derived from aquifer pumping tests, on the other hand, have an "averaging" effect that reflects the leakance values determined at each well location and the degree of continuity of the confining beds between well locations.

The comparison of the two methods for determining leakance coefficients, along with the hydraulic head data and the regional potentiometric maps of the aquifer units, was reviewed in conjunction with the lithostratigraphic and structural characteristics and lateral continuity of the bedding in the attendant sedimentary section (using core and downhole geophysical data, lithostratigraphic sections, isopachous maps, and unit-surface maps) to determine the competence, continuity, thickness, and lateral extent of the various aquifer and confining units in the study area.

PRECIPITATION AND RECHARGE

A part of the precipitation in the study area infiltrates to the water table and recharges the ground-water system (GeoTrans, 1988). The amount of infiltration depends on several variables, including land-use patterns, surface runoff, evapotranspiration, and vertical permeability. Typically, these variables are not adequately defined to quantify areal variability in recharge. This is the case with the study area.

Hubbard and Emslie (1984) compiled hydrologic and climatological data for the area around the low-level radioactive-waste burial grounds located near the center of SRS (General Separations Area) (Fig. 3) for the purpose of defining a water budget. Because the climatological data were obtained from various locations in the study area, they have wider application than just the burial grounds. Precipitation is specified at an average annual rate of 47 inches. Evapotranspiration and surface runoff are estimated at 32 in/yr (inches per year) (64 percent of precipitation). This leaves 15 in/yr of precipitation available to become ground water recharge. Hubbard and Emslie (1984) also suggested that when rainfall changes from its mean of 47 inches, the excess or deficiency results in changes in the amount returned to the atmosphere as evapotranspiration. Therefore, 15 in/yr is an appropriate value for available recharge despite variations in precipitation.

Upper Three Runs Creek is useful in determining recharge. As a National Hydrologic Benchmark Stream it has never received heated discharges of cooling water from the production reactors, although it does receive some nonthermal discharges. Langley and Marter (1973) reported a low flow of 193 ft^3/sec (cubic feet per second) and a drainage area of 190 mi^2 for this stream at one location at SRS. Assuming that nonthermal discharges to the creek above this point are negligible, the recharge corresponding to this observed base flow is 13.8 in/yr. To account for ground-water evapotranspiration losses, an estimated available recharge of 15 in/yr is reasonable.

A more recent study by Hubbard (1986) in the region around the low-level radioactive-waste burial ground indicated that recharge may differ significantly in heavily forested areas in comparison with cleared areas. In areas where soil is either exposed or covered by grass, evapotranspiration is estimated at 30 in/yr and recharge at 16 in/yr, whereas in heavily forested areas evapotranspiration is estimated at 40 in/yr and recharge at 6 in/yr. This study suggests that the currently accepted recharge estimate of 15 in/yr may be inappropriate for SRS, because a majority of the site is heavily forested. Only in the vicinity of the reactors and along roadways is the ground cleared.

REGIONAL HYDROGEOLOGIC SETTING

Two hydrogeologic provinces are recognized in the subsurface beneath the study area (Aadland and Bledsoe, 1990a and b). The uppermost province, which consists of the wedge of unconsolidated Coastal Plain sediments of Late Cretaceous and Tertiary age, is referred to as the Southeastern Coastal Plain hydrogeologic province (Figs. 7 and 12). It is further divided into aquifer/confining systems, units, and zones. The underlying province, referred to as the Piedmont hydrogeologic province, includes Paleozoic metamorphic and igneous basement rocks and Upper Triassic lithified mudstone, sandstone, and conglomerate in the Dunbarton basin (Plates 9 and 26).

SOUTHEASTERN COASTAL PLAIN HYDROGEOLOGIC PROVINCE

The Southeastern Coastal Plain hydrogeologic province underlies 120,000 mi^2 of the Coastal Plain of South Carolina, Georgia, Alabama, Mississippi, and Florida and a small contiguous area of southeastern North Carolina (Fig. 4). It extends from the Mississippi embayment in central Mississippi to the southwest flank of the Cape Fear arch in southeastern North Carolina.

The Southeastern Coastal Plain hydrogeologic province grades laterally to the northeast into the Northern Atlantic Coastal Plain aquifer system (Meisler, 1980) and to the west into the Mississippi embayment and Coastal Lowlands aquifer systems (Grubb, 1986). The northern and northwestern limits of the province are its contact with crystalline rocks at the Fall Line, which marks the updip limit of Coastal Plain sediments.

The Southeastern Coastal Plain hydrogeologic province comprises a multilayered hydraulic complex in which retarding beds of clay and marl are interspersed with beds of sand and limestone that transmit water more readily. Ground water flow paths and flow velocity for each of these units are governed by the hydraulic properties, the geometry of the particular unit, and the distribution of recharge and discharge areas.

Miller and Renken (1988) divided the Southeastern Coastal Plain hydrogeologic province into seven regional hydrologic units (Fig. 9); four regional aquifer units separated by three regional confining units. Six of the seven hydrologic units are recognized in the study area and are referred to as hydrogeologic systems.

Sediments that make up the Southeastern Coastal Plain hydrogeologic province in west-central South Carolina and east-central Georgia have been grouped into three aquifer systems divided by two confining systems, all of which are underlain by the Appleton confining system (Figs. 7 and 12). The Appleton separates the Southeastern Coastal Plain hydrogeologic province from the underlying Piedmont hydrogeologic province (Plate 37). Locally, individual aquifer and confining units are delineated within each of the aquifer systems. These units are locally subdivided into aquifer zones and confining zones. The regional lithostratigraphy of the geologic sequence that constitutes the Southeastern Coastal Plain hydrogeologic province is shown with the attendant hydrostratigraphic subdivision of the province in Figure 7.

The complexly interbedded strata that form the three aquifer systems consist primarily of fine- to coarse-grained sand, and locally gravel and limestone, deposited under relatively high-energy conditions in fluvial or shallow marine environments (Miller and Renken, 1988). Locally, clay and marl beds are included in the aquifer systems where quiet water depositional environments prevailed. On a regional scale, however, each aquifer system behaves as a single hydrogeologic unit.

Less is known about the hydraulic characteristics of the confining systems and units than is known about the aquifer systems of the Coastal Plain (Aucott and others, 1987). In general, the fine-grained sediments that make up the regional confining systems were deposited in quiet-water marine to fluvial environments. Locally, each regional confining system may contain beds of sand or other high-permeability materials, but the unit acts overall to retard vertical flow between the overlying and underlying aquifer systems.

Each of the aquifer and confining systems and units is defined at a type well where the hydrogeologic characteristics typical of the unit were measured and is named for a geographic feature near the type well or well-cluster location where the unit is defined (Plate 39). In descending order, the aquifer systems in the study area include the Floridan, Dublin, and Midville (Fig. 12). In descending order, the confining systems include the Meyers Branch, Allendale, and Appleton.

Where the hydrogeologic characteristics of the confining beds that make up the various confining systems no longer hydrologically separate underlying and overlying aquifer systems, the aquifer systems are said to coalesce and a new consolidated aquifer system is defined. Thus, where the confining beds of the Allendale confining system no longer regionally separate the Dublin and Midville aquifer systems hydrologically, the Dublin-Midville aquifer system is defined (Figs. 10 and 12). Similarly, where the hydrogeologic characteristics of the confining beds of the Meyers Branch confining system indicate that it no longer regionally separates the Floridan aquifer system from the underlying Dublin-Midville aquifer system, the entire sedimentary sequence from the top of the basal Appleton confining system to the water table is hydraulically connected and the Floridan-Midville aquifer system is defined.

Aquifer and confining systems can consist of one or more aquifer and confining units. In the study area, the Midville and Dublin aquifer systems each consist of a single aquifer, the McQueen Branch and Crouch Branch, respectively. Downdip, beyond well C-10 (Plates 1 and 38) the two aquifer systems can be subdivided into several aquifers and confining units. The Floridan aquifer system consists of two aquifers in the study area, the Upper Three Runs and the underlying Gordon, which are separated by the Gordon confining unit. Northward, the Gordon and Upper Three Runs aquifers coalesce to form the Steed Pond aquifer (Figs. 11 and 12). The Allendale and Meyers Branch confining systems each consist of a single confining unit in the study area, the McQueen Branch and Crouch Branch, respectively (Figs. 7 and 12). The basal Appleton confining system is thought to consist of a single confining unit in the study area. The confining unit, however, has not been formally defined in this report, owing to sparse data. Downdip, each confining system may be subdivided into several confining units and aquifer units.

Floridan Aquifer System

Regional setting.—Miller (1986) defined the Floridan aquifer system as a "vertically continuous sequence of carbonate rocks of generally high permeability that are mostly of middle and late Tertiary age and hydraulically connected in varying degrees and whose permeability is, in general, an order to several orders of magnitude greater than that of those rocks that bound the system above and below." Thus, the definition of the Floridan aquifer system is partly lithologic and partly hydraulic. The system is sometimes referred to as the principal artesian aquifer in South Carolina, Georgia, and Alabama (Stringfield, 1966; Miller, 1986). Rocks that characterize the main body of the Floridan are mostly platform carbonates.

The transition zone between the carbonate rocks of the Floridan and the updip clastic facies equivalents of the system is the approximate northern extent of the thick carbonate platform that extended from the Florida peninsula through the coastal area of Georgia to southwestern South Carolina during early Tertiary time (Plates 27 and 31-35). The transition zone migrated northward from extreme southeastern Georgia during Paleocene and Eocene times (Chen, 1965) as the carbonate platform enlarged toward the north, culminating in middle Eocene time when the carbonate facies extended to a line approximated by the updip limit of the Santee Limestone carbonate platform beds (Plate 3) (Krause and Randolph, 1989). Thus, the base of the carbonate phase of the Floridan aquifer system is youngest in the updip part of the study area and is successively older downdip (Miller, 1986).

The downdip carbonate phase of the Floridan aquifer system is used extensively in the southeastern part of the Coastal Plain as an aquifer. To the north, in the study area, carbonates of the aquifer system interfinger with the updip clastic facies equivalent sediments of the Barnwell and Orangeburg Groups. The transitional carbonate/clastic facies boundary has been referred to as the Floridan/Tertiary sand aquifer by Aucott and Speiran (1985a and b).

The updip clastic facies equivalents of the Floridan carbonate rocks are not considered by Miller (1986) to be part of the Floridan aquifer system. They are, however, hydraulically connected with it and are part of its regional flow system (Fig. 13). Thus, the updip clastic facies equivalent of the Floridan aquifer system, as defined in this report, and the carbonate phase of the Floridan aquifer system are treated as a single hydrologic unit (the Floridan aquifer system) because there are no regionally significant water-level differences between them and there is no evidence of an effective intervening confining unit (Aucott and Speiran, 1985b).

In the study area, which lies north of the line established for the updip limit of the carbonate phase of the Floridan aquifer system, there are thin beds and lenses of limestone that may be either connected to the main limestone body or isolated from it, owing in part to depositional isolation or to postdepositional erosion or diagenetic alteration. They are considered part of the updip clastic phase of the Floridan (Plate 38).

South of the study area, the carbonate phase of the Floridan aquifer system is confined, and a surficial aquifer composed of interbedded clastics and carbonates, overlies the system. The surficial aquifer consists of post-Miocene, unconsolidated, fine to very coarse, well-sorted sand, commonly phosphatic and calcareous. Interbedded are layers of poorly sorted sand, clayey silt and sand, and argillaceous limestone. The confining unit that separates the surficial aquifer from the underlying Floridan aquifer system (often referred to as the "upper confining unit") consists primarily of low-permeability, interbedded, locally highly phosphatic sand, silt, clay, and sandy clay beds found in the Hawthorn Formation of middle to late Miocene age (Plates 30, 36, and 37). In most of the study area, the upper confining unit of the Floridan is absent and the calcareous-clastic sediments of the Floridan are largely unconfined, and the aquifer is under water-table conditions.

The carbonate phase of the Floridan aquifer system that develops in the southernmost fringe of the study area, just south of well C-10, is divided into the Upper and the Lower Floridan aquifers (Miller, 1986; Krause and Randolph, 1989), separated by the "middle confining unit." The Upper Floridan, also referred to as the "upper permeable zone" (Hayes, 1979; Spigner and Ransom, 1979), is more than 200 ft thick at the coast and consists of the very permeable Ocala Limestone and equivalents of late Eocene age, the upper Santee Limestone of middle Eocene age, and, near the coast, the overlying upper Oligocene Suwannee Limestone (upper Cooper Group equivalent) (Plate 30). Immediately downdip from the study area, calcareous clastic rocks of the late Eocene Barnwell Group and the upper part of the Orangeburg Group grade into the fossiliferous, argillaceous, glauconitic, calcareous clay of the lower Cooper Group and the Santee Limestone, which are the immediate updip clastic equivalents of the Upper Floridan aquifer (Plates 32, 33, and 34). In the study area, the sequence passes into the clastic units of the Upper Three Runs aquifer of the clastic phase of the Floridan aquifer system (Fig. 12; Plates 3-10). Hydraulically, these updip clastic facies do not represent a significant change in permeability compared to the immediately downdip carbonate rocks (Ocalla Limestone). Instead, these permeable clastic beds are hydraulically connected with the downdip carbonate rocks of the Upper Floridan aquifer (Plate 3).

Underlying the Upper Floridan aquifer is the "middle confining unit" of the carbonate phase of the Floridan aquifer system (Miller, 1986). At the coast, the unit is more than 200 ft thick and consists of hard, dense, low-permeability, middle Eocene dolomite and limestone of the upper part of the Avon Park Formation and equivalents (Plate 30) (Miller, 1986). Updip, the confining unit consists of low-permeability, glauconitic, silty sand and silty clay of the Warley Hill Formation and the soft clay and siliceous, clayey, micritic limestone of the Blue Bluff Member of the Santee Limestone that separate the Gordon and Upper Three Runs aquifers of the clastic phase of the Floridan aquifer system (Figs. 7 and 12; Plates 3-10 and 39).

The Lower Floridan aquifer near the South Carolina coast consists of middle- to lower-Eocene platform limestone and is generally less fossiliferous and more dolomitic than the limestone in the overlying Upper Floridan aquifer. The Lower Floridan near Hilton Head Island, S.C., also referred to as the "lower permeable zone" of Hayes (1979) and Spigner and Ransom (1979), is about 100 ft thick and consists of the basal middle Eocene Santee Limestone. In the coastal areas of South Carolina and Georgia the aquifer also includes the carbonate rocks of the lower Eocene Oldsmar Formation and the upper Paleocene Cedar Keys Formation (Plate 30). Updip, to the north of the Gulf Trough (Plates 32, 33, and 34), the Lower Floridan limestone was not deposited (Miller, 1986). Here, the stratigraphic interval consists of calcareous silt and sand, fossiliferous, glauconitic, sandy limestone, and clean quartz sand and gravel having high porosity and permeability. Although the units are mostly noncalcareous, they are the clastic equivalents of Miller's Lower Floridan aquifer flow system, differing only in lithology. The units are hydraulically connected to the carbonates of the Floridan flow system (Fig. 13).

The Floridan aquifer system is confined below by the low-permeability, evaporite-rich platform limestone of the Paleocene Cedar Keys Formation near the South Carolina and

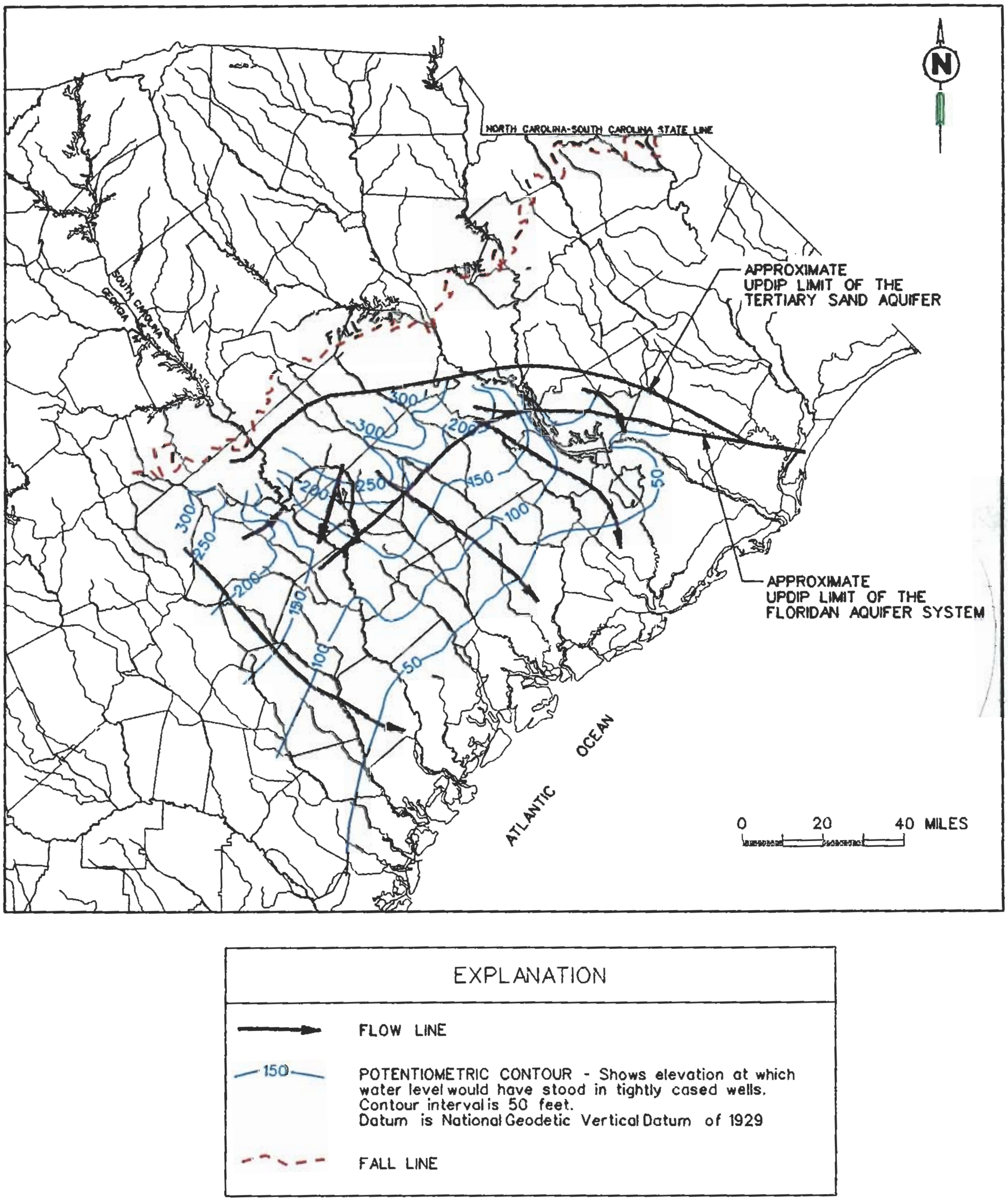


Figure 13. Regional potentiometric surface of the Floridan aquifer system prior to development (modified from Aucott, 1988).

Georgia coasts (Plate 30). Updip toward the study area, the Floridan is confined by the fine-grained, deep-water sediments and marl of the Rhems and Williamsburg Formations. The Rhems and Cedar Keys Formations are hydrostratigraphic facies-equivalents of the Black Mingo Group. The Black Mingo constitutes most of the Meyers Branch confining system in the study area.

The hydraulic characteristics of the carbonate phase of the Floridan aquifer system vary considerably in the South Carolina-Georgia region. This results from several different processes, the most important being the dissolution of calcium carbonate by ground water. The variability in the amount of dissolution is strongly influenced by the chemical composition of the water and the local differences in geology and lithology that affect the rate of ground water movement.

Pumping tests of 77 wells in the Floridan aquifer system in South Carolina (no distinction between Upper and Lower Floridan is reported) indicate a range in transmissivity from 2,400 to 740,000 gal/d/ft (gallons per day per foot) (320 to 100,000 ft^2/d) (feet squared per day) with a median of 120,000 gal/d/ft (16,000 ft^2/d) (Newcome, 1993). On the basis of field values from pumping tests and the results of model simulation (Krause and Randolph, 1989), the transmissivity of the Upper Floridan aquifer ranges from less than 10,000 ft^2/d in the area of the Gulf Trough in Bulloch County, Ga., to more than 500,000 ft^2/d in Charlton County, Ga. The transmissivity at Savannah, Ga., is about 28,000 to 33,000 ft^2/d (Krause and Randolph, 1989).

Average transmissivity of the Upper Floridan in coastal South Carolina ranges from about 10,000 ft^2/d in eastern Beaufort and northern Jasper Counties to 50,000 ft^2/d in western Beaufort and southern Jasper Counties (Hayes, 1979). Average hydraulic conductivity of the Upper Floridan is estimated to be 400 ft/d in western Beaufort County, Jasper County, and southeastern and southwestern Hampton County, and 175 ft/d in eastern Beaufort County (Hayes, 1979).

The "middle confining unit" that separates the Upper and Lower Floridan aquifers is a semiconfining (leaky) unit that ranges in thickness from 40 ft in northern Bulloch County, Ga., to 280 ft in the Savannah area. Vertical hydraulic-conductivity values of undisturbed samples were determined from laboratory analysis and ranged from 4.0×10^{-6} to 5.3×10^{-5} ft/d (feet per day) (Wait and Gregg, 1973). Locally, joints and fractures create zones of substantially higher secondary hydraulic conductivity (Clark and others, 1990).

Few wells tap the Lower Floridan aquifer and little information is available on its water-bearing properties. From geophysical logs and thickness data the simulated transmissivity of the aquifer ranges from 2,000 to 216,000 ft^2/d in the coastal areas (Krause and Randolph, 1989). Hayes (1979) reported a range in transmissivity values from 500 to 5,000 ft^2/d and a range in hydraulic conductivity from 75 to 100 ft/d for the Lower Floridan aquifer in coastal South Carolina.

Clastic phase of the Floridan aquifer system.—The updip clastic phase of the Floridan aquifer system, also referred to as the Tertiary sand aquifer (Aucott and Speiran, 1985a), is the hydrogeologic equivalent of the Pearl River regional aquifer (Fig. 9) of Miller and Renken (1988) and the Gordon aquifer system and overlying Jacksonian aquifer of Brooks and others (1985) defined west of the study area in east-central Georgia (Plate 37). Aucott and Speiran (1985a and b) combined all of the Eocene sandy units (Barnwell Group, Tinker/Santee Formation, and Congaree/Fourmile Formation) into the Tertiary sand aquifer because "they act hydraulically as a single aquifer in most of the State."

The updip Floridan aquifer system overlies the Meyers Branch confining system throughout the lower two-thirds of the study area. Toward the north, the confining beds of the Meyers Branch confining system thin, become intermittent, and the entire Floridan aquifer system coalesces with the Dublin-Midville aquifer system to form the Floridan-Midville aquifer system (Figs. 7 and 12; Plates 3-10).

The updip Floridan aquifer system extends southward from the upper part of the study area and consists of a thick sequence of Paleocene to late Eocene sand with minor gravel and clay and a few limestone beds. These were deposited under mostly marine conditions. At the southern fringe of the study area, the clastic sediments of the aquifer system grade into the platform limestone that forms the carbonate phase of the Floridan (Fig. 12). The lithologic transition between the clastic phase and the carbonate phase of the aquifer system does not represent a hydrologic boundary, and the two lithofacies are in direct hydrogeologic communication.

The sedimentary sequence that corresponds to the updip clastic phase of the Floridan aquifer system is penetrated in the P-27 reference well near the center of SRS (Plates 1, 2, 5, and 39a). The system at P-27 is 216 ft thick; the base is at 48 ft msl, and the top occurs at the water table, which is at 264 ft msl, or 10 ft below land surface. The system includes 22 ft of clay in five beds, and the remainder consists of sand and clayey sand beds. The stratigraphic units that constitute the clastic phase of the Floridan aquifer system include the Fishburne Formation and the locally sandy parts of the Williamsburg Formation of the Black Mingo Group, all of the Orangeburg and Barnwell Groups, and the overlying Miocene/Oligocene(?) "Upland unit" (Fig. 7; Plate 39a).

In the study area, clay to sandy clay beds in the Warley Hill Formation of the Orangeburg Group support a substantial head difference between overlying and underlying units. These fine-grained sediments constitute the Gordon confining unit, which divides the system into aquifers.

Where the Floridan aquifer system is very sandy (clastic phase), wells must be constructed with screens to keep the holes from collapsing. Near Kline, in southern Barnwell County (Plate 1), the system consists of calcareous sand and abundant shell hash (transitional between the clastic and carbonate phases) and still must be screened to complete a water well (Logan and Euler, 1989). South of the study area, the aquifer system consists of limestone (carbonate phase) that is well indurated, and wells are generally of open-hole construction.

Recharge of the Floridan occurs generally in the northwestern part of the study area where rainfall percolates into the outcrop and subcrop of the Floridan, namely into the Gordon and Upper Three Runs aquifers. The regional potentiometric map (Fig. 14) of the Gordon aquifer, indicates that major deviations in the flow direction are present where the aquifer is deeply incised by streams that drain water from the

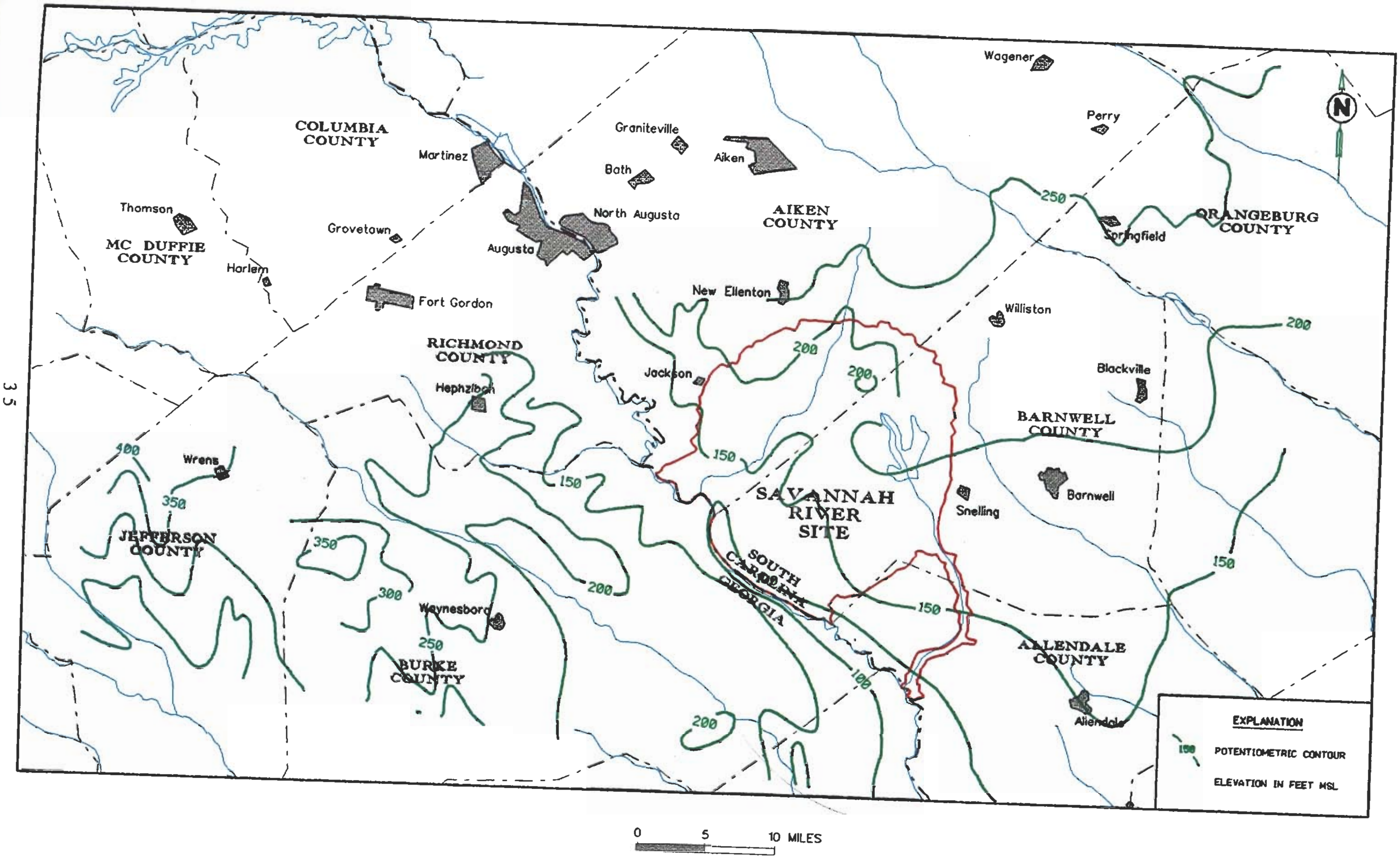


Figure 14. Regional potentiometric surface of the Gordon aquifer, reproduced from Faye and Prowell, 1982 (modified from Christensen and Gordon, 1983).

aquifers. The Savannah River has the greatest areawide influence on water levels, followed by the South Fork Edisto River and, to a much lesser degree, the Salkahatchie River. In the updip portion of the study area, Upper Three Runs Creek controls the direction of ground water movement. Here, the Gordon confining unit has been breached by the stream, creating a ground water sink that induces flow out of the Gordon toward the stream. Using an average transmissivity value of 300 ft^2/d and an average hydraulic gradient of 25 ft/mi near Upper Three Runs Creek, an estimated 112,000 gal/d is being discharged through each 1-mile strip of the aquifer along the creek, for a total of 1.4 million gal/d.

Calibrated transmissivities range from about 700 to 11,000 ft^2/d for both the clastic phase (Tertiary sand aquifer of Aucott, 1988) of the Floridan aquifer system and the actively simulated carbonate phase of the system (Aucott, 1988). The transmissivity of the clastic and carbonate phases of the Floridan is lowest near their updip limits because of the reduced aquifer thickness there. Krause (1982) observed that the transmissivity increases rapidly from the northwest to the southeast along the Savannah River through the clastic facies and across the limestone facies change of the Floridan aquifer system.

Floridan-Dublin Aquifer System

Over most of the study area, the Meyers Branch confining system extends north of the Allendale confining system, hydraulically isolating the Floridan from the underlying Dublin and Dublin-Midville systems (Fig. 12). However, in a small region in the eastern part of the study area, in the vicinity of well C-5 (Plate 6), clay beds of the Meyers Branch confining system thin dramatically, leakance values increase, and the Floridan and Dublin aquifer systems are in overall hydraulic communication. In this region, the Floridan and Dublin aquifer systems coalesce to form the Floridan-Dublin aquifer system. Thick, continuous clay beds in the underlying Allendale confining system continue to hydrogeologically isolate the Midville and Floridan-Dublin aquifer systems.

The Floridan-Dublin aquifer system is divided into three aquifers in the study area. In descending order these include the Upper Three Runs, Gordon, and Crouch Branch aquifers separated by the Gordon and Crouch Branch confining units. The Upper Three Runs and Gordon aquifers coalesce updip forming the Steed Pond aquifer. The Crouch Branch aquifer is continuous across the entire study area.

The Floridan-Dublin aquifer system is defined by the hydrogeologic properties of sediments penetrated in well C-5 located north of the town of Barnwell (Plates 1 and 39b). Here, the system is 560 ft thick and includes all sediments from the water table to the top of the McQueen Branch confining unit. The Upper Three Runs aquifer is 144 ft thick and consists entirely of sand. The Gordon aquifer is 108 ft thick and consists of two sand beds that total 105 ft. The Crouch Branch aquifer is 244 ft thick and consists of two sand beds that total 230 ft.

Floridan-Midville Aquifer System

Northwest of Upper Three Runs Creek, the permeable beds that correspond to the Floridan and Dublin-Midville aquifer systems are often in hydrologic communication owing to the thin and laterally discontinuous character of the intervening clay and silty clay beds, to faulting that breaches the confining beds, and to erosion by the local stream systems that dissect the interval. Here, the Floridan and Dublin-Midville aquifer systems coalesce to form the Floridan-Midville aquifer system (Figs. 10 and 12).

Over most of the study area, the Floridan-Midville aquifer system is divided into three aquifers: in descending order, the Steed Pond, Crouch Branch, and McQueen Branch aquifers, separated by the Crouch Branch and McQueen Branch confining units. Both the Crouch Branch and the McQueen Branch aquifers extend northwestward from the southern part of the study area where they are an integral part of the Dublin-Midville aquifer system. The Steed Pond aquifer, on the other hand, is the updip hydrostratigraphic equivalent of the Gordon and Upper Three Runs aquifers of the Floridan aquifer system. At the northern fringe of the study area, the Steed Pond and underlying Crouch Branch aquifers coalesce and a single, as yet unnamed, aquifer is present. Locally, as in the vicinity of the P-17 well cluster, the Gordon confining unit extends north beyond the updip limits of the Allendale and Meyers Branch confining systems. Here, the Floridan-Midville system consists of the Upper Three Runs, Gordon, Crouch Branch, and McQueen Branch aquifers.

The updip limit of the Gordon confining unit and the Meyers Branch confining system are not parallel to each other (Fig. 10; Plates 15 and 17); thus, at well P-29 the Steed Pond aquifer projects south beyond the updip limit of the Meyers Branch confining system (Fig. 10). At well P-17 (Plate 6), the Gordon and Upper Three Runs aquifers project north beyond the updip limit of the Meyers Branch confining system.

The Floridan-Midville aquifer system is defined by the hydrogeologic properties of the sediments penetrated in the ASB-8/MSB-12 type well (Plate 39c) located in A-M Area in the northwest corner of SRS (Plate 1). Here, the system is 557 ft thick and includes all sediments from the water table to the top of the Appleton confining system. The Steed Pond aquifer is 97 ft thick at the ASB-8/MSB-12 well and consists of 86 ft of sand in four beds. The Crouch Branch aquifer is 167 ft thick and consists of 139 ft of sand in four beds and is overlain by the Crouch Branch confining unit, which is 81 ft thick and consists of 31 ft of clay in four beds. The McQueen Branch aquifer is 169 ft thick and consists of 147 ft of sand in three beds. The McQueen Branch confining unit is 43 ft thick and consists of 28 ft of clay in two beds.

Vadose zone.—The vadose zone extends from the ground surface to the water table, which ranges from 7 ft at well PBF-5 to 179 ft at well C-2. The vadose zone lithologies consist of heterogeneous, clean, clayey or silty sand through which the uppermost aquifers are recharged. No areally extensive, low-permeability layers have been identified in the zone. Undisturbed samples from discontinuous low-permeability layers have been collected in A-M Area (at several MSB-well borings). Hydraulic-conductivity values from tests of these samples average 1.43×10^{-3} ft/d (vertical) and 1.37×10^{-2} ft/d (horizontal) (Sirrine, 1991c). These numbers do not represent the entire vadose zone but cohesive layers that are easily sampled.

Upper Three Runs aquifer unit.—The Upper Three Runs aquifer occurs between the water table and the Gordon confining unit and includes all strata above the Warley Hill Formation (in updip areas) and the Blue Bluff Member of the Santee Limestone (in downdip areas) (Plates 3-10). It includes the sandy and sometimes calcareous sediments of the Tinker/Santee Formation and all the heterogeneous sediments in the overlying Barnwell Group (Fig. 7). The Upper Three Runs aquifer is the updip clastic facies equivalent of the Upper Floridan aquifer in the carbonate phase of the Floridan aquifer system (Fig. 12).

The Upper Three Runs aquifer is defined by the hydrogeologic properties of sediments penetrated in well P-27 (Plate 39a) located near Upper Three Runs Creek in the center of SRS (Plates 2-10). Here, the aquifer is 132 ft thick and consists mainly of unconsolidated, moderately sorted, subangular, lower coarse- to medium-grained, slightly gravelly, immature yellow and tan quartz sand and clayey sand of the Tinker/Santee Formation; variably colored, poorly sorted to well-sorted sand with interbedded tan or gray clay of the Dry Branch Formation; and moderately to poorly sorted, variably colored, fine- to coarse-grained sand, pebbly sand, and minor clay beds of the Tobacco Road Formation. Calcareous sand and clay, and limestone, although not observed in the P-27 well, are present in the Tinker/Santee Formation throughout the General Separations Area (GSA) in the vicinity of well P-27 (Plate 1). Calcareous sand ranges in thickness from 2 to 33 ft in GSA; sandy and muddy limestone and clean limestone range in thickness from 3 to 30 ft. The calcareous sand is white to buff and contains up to 50 percent calcareous material (WSRC-RP-92-837, 1992). The sandy and muddy limestone and clean limestone are white to buff and contain more than 80 percent calcareous material. Many of the limestone beds are partially to fully consolidated with abundant moldic porosity resulting from dissolution of skeletal grains. Unconsolidated limestone is generally a "coquina-type" shell hash consisting of shell fragments of pelecypods, gastropods, echinoderms, bryozoans, and barnacles.

Downdip, at the C-10 reference well (Plate 39d), the Upper Three Runs aquifer is 380 ft thick and consists of unconsolidated, variably colored, poorly to moderately sorted clayey sand and sand of the upper Cooper Group; moderately indurated, white to tan, sandy, shelly limestone (Ocala equivalent) and moderately to well sorted, tan, calcareous sand of the lower Cooper Group/Barnwell Group; and moderately to well indurated, sandy, shelly, limestone and micritic limestone of the Santee Limestone.

Strom and Kaback (1992) determined the mineralogical composition of 28 P-well series samples from the Upper Three Runs aquifer by x-ray diffraction. The samples consist of quartz with 2 to 40 percent detrital clay. Smectite and kaolinite are the dominant clay minerals with minor to trace quantities of illite, chlorite, calcite, plagioclase, and K-feldspar. In addition, 12 muddy sand samples from the C-well series were analyzed by x-ray diffraction: kaolinite averages 58 percent; illite, 26 percent; mixed-layer illite/smectite, 16 percent; and smectite less than one percent (Gelting, 1990; Gellici and others, 1995).

A thin-section study of six sand samples from the aquifer shows that they are quartzarenites composed mostly of monocrystalline quartz. Trace quantities of polycrystalline quartz, K-feldspar, detrital kaolinite, metamorphic rock fragments, and opaque minerals are also present. The sand contains variable amounts of detrital matrix, ranging from less than 5 to 27 percent. Downdip, in the C-10 well, Upper Three Runs sand contains authigenic glauconite and 10 to 35 percent calcareous skeletal grains, including foraminifers, echinoderms, bryozoans, pelecypods, gastropods, and broken skeletal debris.

Table 3 gives summary statistics for Folk and Ward (1957) grain-size parameters, gravel-sand-mud percentages, and calculated porosity and permeability values of Upper Three Runs sand samples that contain less than 25 percent mud. The gravel fraction consists of pebble- and granule-size grains of rounded and subrounded quartz and quartzite. Figure 15 shows the distribution of percentage mud in samples with less than 25 percent mud. Note that in this and succeeding figures, n equals the total number of samples; x equals the sample arithmetic mean; and s equals the sample standard deviation.

Mean grain size of Upper Three Runs aquifer samples is lower medium sand (Table 3; Fig. 16). There is a slight downdip decrease in mean grain size of Upper Three Runs aquifer samples. Sand in the mid-Site area averages 1.63 ϕ, whereas that downdip (southeast of P-13) averages 1.98 ϕ. Most Upper Three Runs samples are moderately and poorly sorted (Fig. 17).

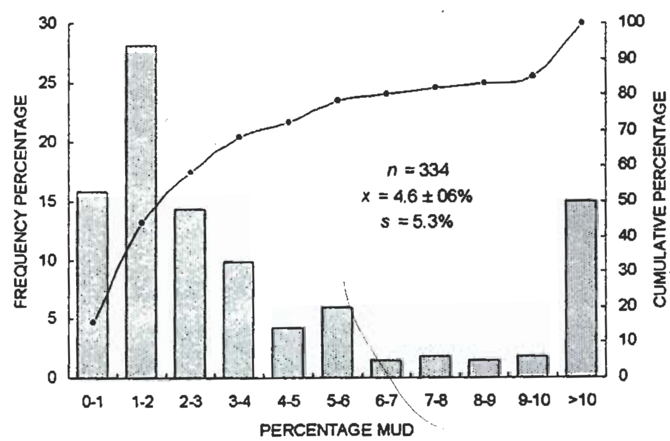


Figure 15. Percentage mud (silt + clay) in Upper Three Runs aquifer sand samples containing less than 25 percent mud.

Tables 4 and 5 present summary statistics for grain-size parameters and gravel-sand-mud percentages of muddy sand (25 to 50 percent mud) and sandy mud (50 to 75 percent mud) samples from intra-aquifer confining layers in the Upper Three Runs aquifer. Hydrometer analyses of the mud fractions of these sediments indicate that clay is usually more abundant than silt. Mean grain size of 20 muddy sand samples is lower fine sand (2.83 ϕ). Most of the muddy sand is poorly sorted (Table 4).

Water-level data are sparse for the Upper Three Runs aquifer except within SRS (Fig. 18). The hydraulic-head distribu-

Table 3. Summary of Folk and Ward statistics, gravel-sand-mud percentages, and calculated porosity and permeability values for sand samples from the Upper Three Runs aquifer that contain less than 25 percent mud

Parameter	Folk and Ward Statistics				Gravel	Sand	Mud	Porosity	Permeability	
	Mean[1]	Sorting[1]	Skewness	Kurtosis	(%)	(%)	(%)	(%)	(Darcy)	(ft/d)
Arithmetic Mean	1.607	0.957	0.028	1.240	1.2	94.1	4.6	35.3	41.5	100.9
Confidence Level (95%)	0.050	0.035	0.016	0.038	0.3	0.7	0.6	0.2	2.7	6.5
Number of samples	510	510	510	510	525	334	334	493	493	493
Median	1.524	0.897	0.018	1.161	0.1	96.7	2.3	35.0	33.0	80.3
Mode	1.468	0.863	0.180	0.949	0.0	98.6	1.8	35.0	25.0	60.8
25th percentile	1.218	0.704	-0.085	0.992	0.0	93.3	1.2	33.7	20.0	48.7
75th percentile	1.916	1.097	0.136	1.309	1.0	98.2	5.3	37.6	55.0	133.8
Standard deviation	0.573	0.404	0.189	0.438	2.9	7.0	5.3	2.8	30.4	74.0
Variance	0.328	0.163	0.036	0.192	8.6	48.3	28.4	7.7	924.6	5473.3
Kurtosis	2.115	6.676	1.169	19.101	31.9	7.8	3.0	-0.3	3.2	3.2
Skewness	0.893	1.962	0.351	3.632	5.1	-2.5	1.9	-0.1	1.5	1.5
Range	3.683	2.902	1.324	4.167	24.8	47.3	24.9	14.3	208.0	506.1
Maximum	0.304	3.231	0.717	4.754	24.8	99.9	25.0	41.0	210.0	510.9
Minimum	3.987	0.329	-0.607	0.587	0.0	52.7	0.1	26.7	2.0	4.9
Trimean (5%)	1.591	0.933	0.026	1.201	0.8	94.6	4.2	35.4	39.8	96.8
Geometric mean	-	-	-	-	-	-	-	-	31.5	76.7
Harmonic mean	-	-	-	-	-	-	-	-	22.5	54.8

[1] Values are in phi units

tion of the aquifer is controlled by the location and depth of incisement of creeks that dissect the area. Incisement of these streams and their tributaries has divided the interstream areas of the water-table aquifer into "ground water islands." Each "ground water island" behaves as an independent hydrogeologic subset of the water-table aquifer with unique recharge and discharge areas. The stream acts as the ground water discharge boundary for the interstream area.

The head distribution pattern in these "ground water islands" tends to follow topography and is characterized by higher heads in interstream areas with gradually declining heads toward the bounding streams. Ground water divides are present near the center of the interstream areas. Water-table elevations reach a maximum of 250 ft msl in the northwest corner of the study area and decline to approximately 100 ft msl in the vicinity of the Savannah River (Fig. 18).

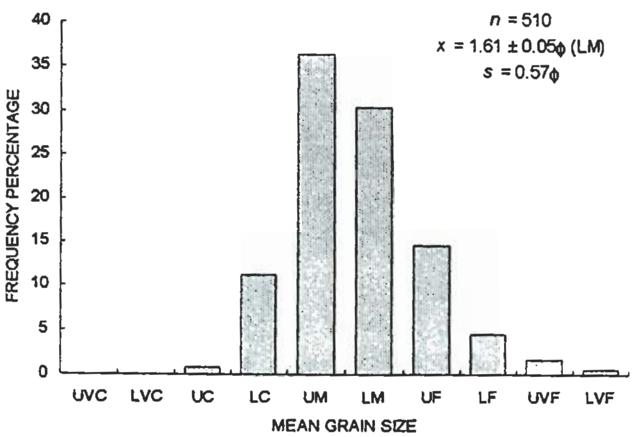


Figure 16. Mean grain size of samples from the Upper Three Runs aquifer. UVC, upper very coarse sand; LVC, lower very coarse sand; UC, upper coarse sand; LC, lower coarse sand; UM, upper medium sand; LM, lower medium sand; UF, upper fine sand; LF, lower fine sand; UVF, upper very fine sand; and LVF, lower very fine sand.

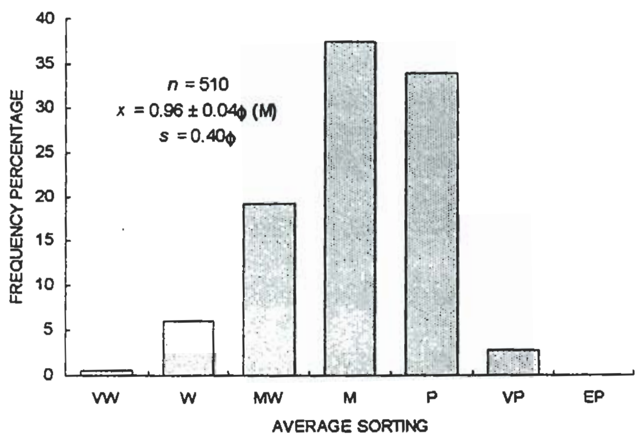


Figure 17. Sorting classes of Upper Three Runs aquifer samples. VW, very well sorted; W, well sorted; MW, moderately well sorted; M, moderately sorted; P, poorly sorted; VP, very poorly sorted; and EP, extremely poorly sorted.

Porosity and permeability of the Upper Three Runs aquifer are variable across the study area. In the northern and central regions, the aquifer yields only small quantities of water, owing to the presence of interstitial silt and clay and poorly sorted sediments that combine to significantly reduce permeability. Local lenses of relatively clean, permeable sand may, however, yield sufficient quantities for domestic use. Such high-permeability zones have been observed in the General Separations Area near the center of the study area and may locally influence the movement of ground water (Evans and Parizek, 1991). At the south end of the study area, near well C-10, sediments become increasingly calcareous, the amount of silt and clay tends to decline, and permeability and yields generally increase. This area is transitional between the low-permeability clastic sequence deposited in the north and the more permeable carbonate sequence deposited south of the study area where the Upper Floridan aquifer is present. These two aquifers (the Upper Three Runs and Upper Floridan) are hydraulically connected and provide water for domestic and public supply systems throughout much of Allendale County, S.C.

Porosity and permeability were determined for Upper Three Runs aquifer sand samples containing less than 25 percent mud with the Beard and Weyl (1973) method (Table 3). Porosity averages 35.3 percent; the distribution is approximately normal (Fig. 19), but skewed slightly toward higher values. Geometric mean permeability is 31.5 Darcies (76.7 ft/d) with about 60 percent of the values between 16 and 64 Darcies (39 and 156 ft/d) (Fig. 20 and Table 3). Calculated permeability values are skewed toward smaller values (Fig. 20) and follow an approximate log-normal distribution (Fig. 21). Considering only the sampled terrigenous sand population, there is no statistically significant difference in calculated porosity and permeability values of Upper Three Runs sand between updip and downdip parts of the study area.

Three of the 28 clayey sand samples (Table 1) and two of the 55 sandy, silty clay to clay samples (Table 2) used in this report, which were analyzed in the laboratory for porosity and permeability, are from "low permeability" beds in the Upper Three Runs aquifer (Bledsoe and others, 1990). Mean porosity of the muddy sand samples is 48 percent, the geometric mean vertical hydraulic conductivity value is 2.76 x 10^{-3} ft/d, and the geometric mean horizontal hydraulic conductivity value is 7.65 x 10^{-3} ft/d. Porosity of the mud sample analyzed is 36 percent; the vertical hydraulic conductivity is 9.75 x 10^{-5} ft/d; and the single horizontal hydraulic conductivity determined is 1.11 x 10^{-4} ft/d.

Few hydraulic data from aquifer tests are available for the entire Upper Three Runs aquifer. In the General Separations Area, the discussion of hydraulic-property estimates for the aquifer is divided into a discussion of properties of three hydrostratigraphic zones defined in the area. These zones have been referred to in previous SRS reports as the "upper" and "lower" aquifer zones separated by the "tan clay" confining zone. This nomenclature, which is used in this report, violates the criteria established for naming hydrostratigraphic zones and will be modified in future site-specific studies in order to conform to the hydrostratigraphic code. Because aquifer and confining zones have only local hydrogeologic significance, the terms "upper" aquifer zone, "lower" aquifer zone, and "tan clay" confining zone are restricted specifically to the

Table 4. Summary of Folk and Ward statistics and gravel-sand-mud percentages for Upper Three Runs aquifer samples that contain 25 to 50 percent mud

Parameter	Folk and Ward Statistics				Gravel	Sand	Mud
	Mean[1]	Sorting[1]	Skewness	Kurtosis	(%)	(%)	(%)
Mean	2.829	1.136	0.093	0.884	0.7	60.5	38.8
Confidence level (95%)	0.336	0.292	0.125	0.109	0.8	5.0	5.1
Number of samples	20	20	20	20	33	33	33
Median	3.016	0.975	0.070	0.808	0.0	65.8	32.0
Mode	-	-	0.211	-	0.0	27.5	72.5
25th percentile	2.587	0.725	-0.057	0.748	0.0	55.9	29.2
75th percentile	3.400	1.188	0.211	0.952	0.1	70.3	42.7
Standard deviation	0.767	0.666	0.285	0.250	2.4	14.7	14.9
Variance	0.589	0.443	0.081	0.062	5.8	215.4	222.4
Kurtosis	1.522	5.548	1.215	-0.147	13.8	0.9	1.0
Skewness	-1.183	2.288	0.848	0.933	3.8	-1.4	1.4
Range	3.220	2.708	1.118	0.788	10.8	49.5	49.5
Maximum	0.760	3.295	0.760	1.385	10.8	75.0	74.5
Minimum	3.980	0.587	-0.358	0.597	0.0	25.5	25.0
Trimean (5%)	2.829	1.136	0.093	0.884	0.7	60.5	38.8

[1] Values are in phi units

Table 5. Summary of Folk and Ward statistics and gravel-sand-mud percentages for sandy mud samples from intra-aquifer confining layers of the Upper Three Runs aquifer

Parameter	Folk and Ward Statistics				Gravel	Sand	Mud
	Mean[1]	Sorting[1]	Skewness	Kurtosis	(%)	(%)	(%)
Mean	5.094	2.904	0.595	1.159	0.0	54.5	45.5
Confidence level (95%)	0.558	0.388	0.129	0.402	0.0	11.9	11.9
Number	9	9	9	9	10	10	10
Median	4.728	2.582	0.717	1.003	0.0	64.8	35.2
Mode	-	-	0.723	-	0.0	-	-
Standard deviation	0.854	0.595	0.198	0.615	0.0	19.2	19.2
Variance	0.729	0.353	0.039	0.378	0.0	368.9	369.0
Kurtosis	0.469	-0.338	1.162	4.835	3.0	-1.3	-1.3
Skewness	1.029	1.019	-1.381	2.019	2.0	-0.9	0.9
Range	2.639	1.608	0.580	1.988	0.1	45.3	45.3
Maximum	6.799	3.998	0.760	2.643	0.1	70.8	74.5
Minimum	4.160	2.390	0.180	0.655	0.0	25.5	29.2

[1] Values are in phi units

three hydrostratigraphic zones described in GSA. Correlative hydrostratigraphic zones delineated elsewhere in the study area that can be used to subdivide the Upper Three Runs aquifer hydrostratigraphically will be named independently, using local geographic landmarks near the site under investigation or other distinguishing characteristics of the units.

The vast amount of hydrogeologic data available for the Upper Three Runs aquifer is from wells in the General Separations Area at SRS (Figs. 2 and 3). Thus, the discussion that follows is largely focused on that area. In GSA, the "upper" aquifer zone consists of all saturated strata in the upper parts of the Dry Branch Formation and the Tobacco Road Formation that lie between the water table and the "tan clay" confining zone (Plate 40). The aquifer zone has a general downward hydraulic potential into the underlying aquifer units. Confining beds of the "tan clay" located near the base of the Dry Branch Formation impede the vertical movement of water and often support a local hydraulic-head difference between the Barnwell Group sediments and underlying Tinker/Santee Formation. The "lower aquifer" zone of the Upper Three Runs aquifer occurs between the "tan clay" confining zone and the Gordon confining unit and consists of sand, clayey sand, and calcareous sand of the Tinker/Santee Formation and sand and clayey sand of the lower part of the Dry Branch Formation (Plate 40).

Recharge to the Upper Three Runs aquifer occurs at the water table by infiltration downward from the land surface. In the "upper" aquifer zone, part of this ground water moves laterally toward the bounding streams while part moves vertically downward. For example, all ground water moving toward Upper Three Runs Creek on the north flank of GSA (Fig. 3) leaks through the "tan clay" or enters small tributary streams. The generally low vertical hydraulic conductivity of the "upper" aquifer zone and the intermittent occurrence of the "tan clay" confining zone retard the downward flow of water, producing vertical hydraulic-head gradients in the "upper" aquifer zone and across the "tan clay" confining zone.

Downward hydraulic-head differences in the "upper" aquifer zone vary from 4.5 and 5.4 ft, whereas differences across the "tan clay" are as much as 15.8 ft in H-Area. At other locations in GSA, head differences across the "tan clay" confining zone are only 2 or 3 ft, essentially what might be expected due simply to vertical flow in a clayey sand aquifer. Therefore, the ability of the "tan clay" confining zone to impede water flow ranges greatly over GSA.

Ground water leaking downward across the "tan clay" confining zone recharges the "lower" aquifer zone of the Upper Three Runs aquifer. Most of this water moves laterally toward the bounding streams; the remainder flows vertically downward across the Gordon confining unit into the Gordon aquifer.

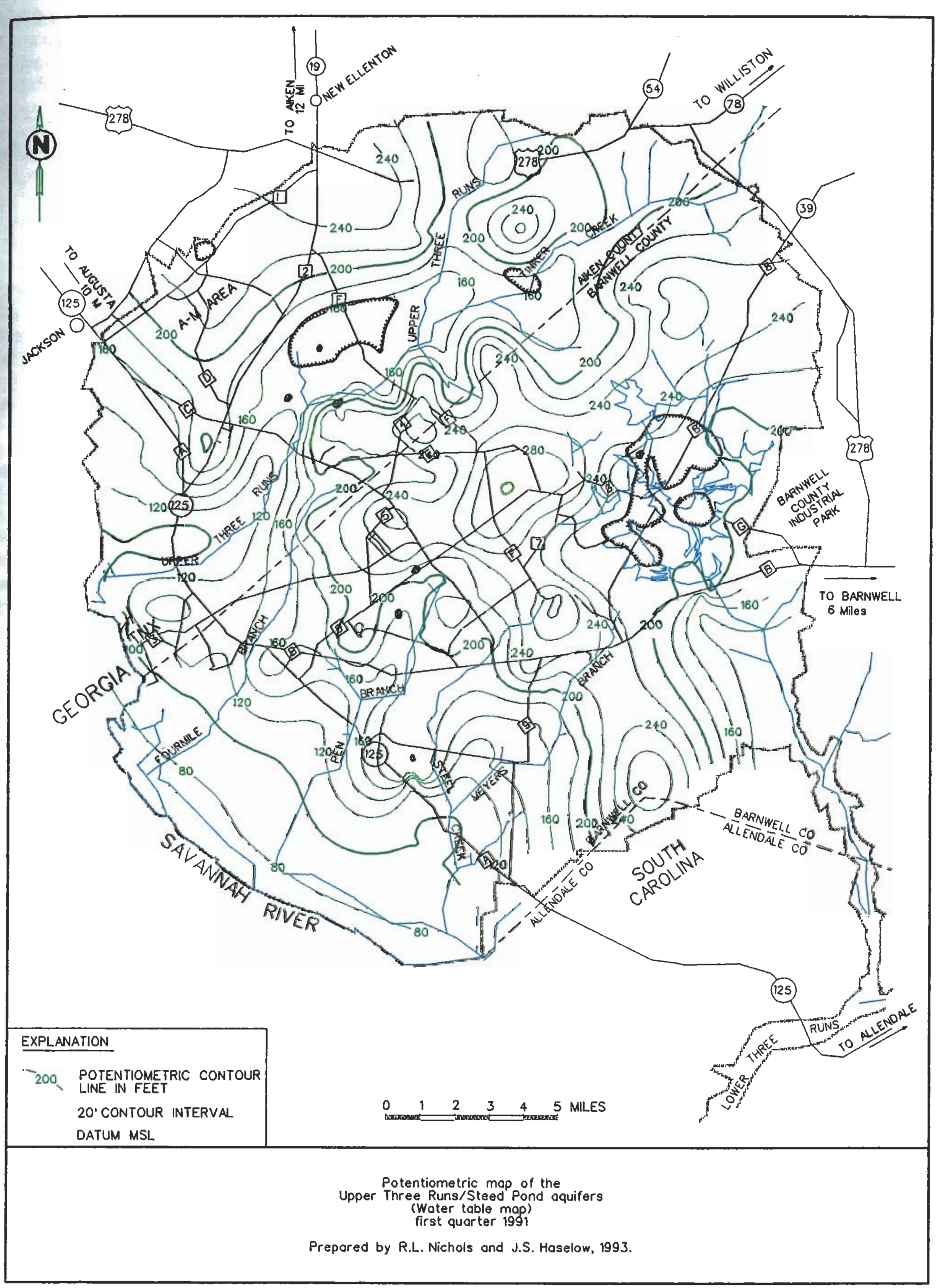


Figure 18. Potentiometric surface of the Upper Three Runs/Steed Pond aquifers, March-April 1991 (water-table map).

All ground water moving toward Upper Three Runs Creek leaks through the Gordon confining unit or enters small streams. Vertical hydraulic-head differences in the "lower" aquifer zone range from 1.5 to 2.7 ft in H-Area and indicate some vertical resistance to flow.

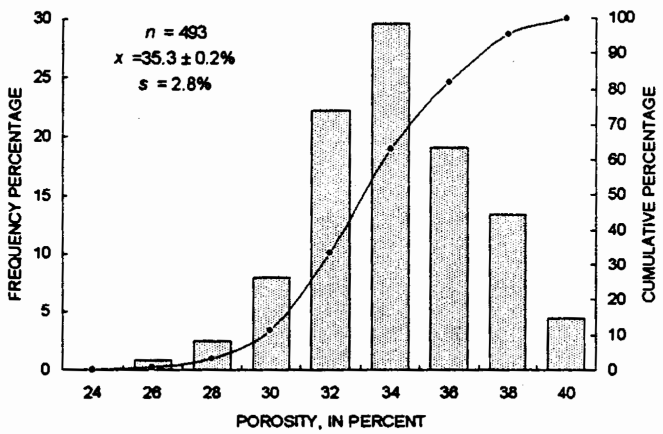


Figure 19. Calculated porosity values of Upper Three Runs aquifer sand samples containing less than 25 percent mud.

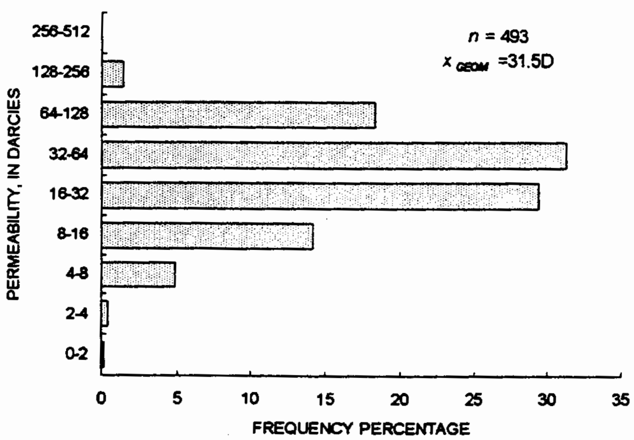


Figure 20. Calculated permeability values of Upper Three Runs aquifer sand samples containing less than 25 percent mud.

Slug tests, minipermeameter tests, pumping tests, and sieve analyses have been used to calculate hydraulic-conductivity values for the "upper" aquifer zone in the vicinity of GSA. Hydraulic-conductivity values derived from 103 slug tests range from 0.07 to 45.40 ft/d and average 5.10 ft/d (WSRC-RP-92-837, 1992). Arithmetic means from the slug tests were calculated at three locations in GSA: the Burial Ground Complex, the F-Area Seepage Basins, and the H-Area Seepage Basins (Fig. 3). Hydraulic-conductivity values in each area are:

- Burial Ground Complex: Mean = 3.03 ft/d, n = 36; Range = 0.07 to 15.87 ft/d
- F-Area Seepage Basins: Mean = 3.46 ft/d, n = 27; Range = 0.08 to 23.11 ft/d
- H-Area Seepage Basins: Mean = 8.08 ft/d, n = 40; Range = 0.08 to 45.40 ft/d

GeoTrans (1992b) compiled hydraulic data for 87 additional slug tests made in the "upper" aquifer zone at GSA. Hydraulic conductivity for the combined 190 slug tests averaged 5.62 ft/d and had a median value of 1.38 ft/d.

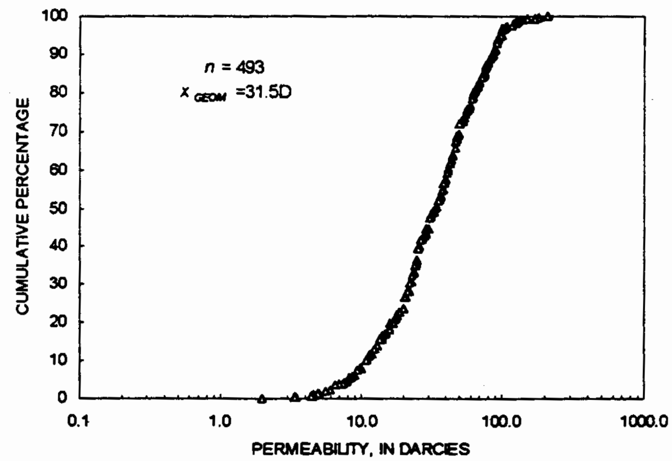


Figure 21. Cumulative frequency of calculated permeability values for Upper Three Runs aquifer sand samples with less than 25 percent mud.

Two series of low-discharge, short-duration, single-well pumping tests were made for the "upper" aquifer zone. Parizek and Root (1986) conducted 38 single-well pumping tests in the vicinity of GSA. Hydraulic-conductivity values calculated from these tests were reported to range from 0.30 to 3.6 ft/d, with an arithmetic mean of 0.67 ft/d and a median value of 0.61 ft/d. Most of these tests were at wells clustered around waste facilities at GSA. A more recent series of tests (Evans and Parizek, 1991) was made in areas of GSA where data were not previously available, resulting in hydraulic-conductivity values much higher than the highest value of 3.6 ft/d from the Parizek and Root study of 1986. In this study, hydraulic conductivity calculated from 14 low-discharge, short-duration, single-well pumping tests made in the "upper" aquifer zone ranged from 0.18 to 40.42 ft/d, with an arithmetic mean of 5.09 ft/d and a median value 1.22 ft/d, twice the median value derived from the earlier series of tests but similar to the hydraulic-conductivity values derived from the 190 slug tests.

The first series of single-well pumping tests was made in a limited area around specific waste facilities in GSA. Here, the range in lithologies was limited by the small area of investigation, possibility resulting in the limited range of hydraulic-conductivity values obtained. The second series of tests, however, was made over a much broader area of GSA, as were the 190 reported slug tests, and the hydraulic properties of the broad range of lithologies noted in the heterogeneous units that compose the Upper Three Runs aquifer were measured.

Hydraulic-conductivity data based on minipermeameter measurements (Kegley, 1993) were obtained on core samples from the MWD Experimental Well Field Site, located near well P-14 just northeast of GSA (Plate 1). Measurements were made at 0.3 m (meter) intervals on four cores spaced approximately 100 to 150 m apart. The measurements were made from land surface to a depth of 90 m. Hydraulic-conductivity values from "upper" aquifer zone core samples yielded a geometric mean of 10.2 Darcies (24.8 ft/d) for 86 samples from the upper Dry Branch Formation (lower part of the "upper" aquifer zone), 4.5 Darcies (10.9 ft/d) for 96 samples from the lower Tobacco Road Formation (middle part of the "upper" aquifer zone), 0.3 Darcies (0.7 ft/d) for 37 samples from the middle Tobacco Road Formation (middle-upper part of the "upper" aquifer zone), and 3.4 Darcies (8.2 ft/d) for 98 samples of the upper Tobacco Road Formation (upper part of the "upper" aquifer zone). The weighted average of the hydraulic-conductivity values for the "upper" aquifer zone is 12.6 ft/d.

Two multiple-well pumping tests were attempted in the "upper" aquifer zone in the vicinity of the F-Area Seepage Basins (Fig. 3) (Chas. T. Main, Inc., 1990). These tests were unsuccessful owing to insufficient discharge from the pumping wells. Pumping at a rate of approximately 5 gal/min, one well pumped dry after 10 minutes and the other after 1 hour and 16 minutes. Neither of the two wells fully penetrated the entire saturated thickness of the "upper" aquifer zone, and the wells pumped dry. Future pumping tests of this aquifer zone should utilize fully penetrating, fully screened wells to allow for the collection of adequate time-drawdown data (Chas. T. Main, Inc., 1990).

One successful large-scale aquifer test was performed in the "upper" aquifer zone of the Upper Three Runs aquifer northeast of H-Area. D'Appolonia (1981) calculated a transmissivity of 420 ft^2/d, a hydraulic conductivity of 13 ft/d, storage coefficients of 1.2×10^{-4} to 9.3×10^{-3}, and specific yields of 1.2×10^{-2} to 2.3×10^{-1} gal/min/ft. An estimate of 2.3×10^{-1} gal/min/ft is the most reasonable value for the specific yield; the smaller values probably are gravity yields due to incomplete drainage during an unconfined-aquifer test (D'Appolonia, 1981). Effective porosity values were assumed to be 20 to 25 percent.

The lower portion of the "upper" aquifer zone, which consists of silty sand of the upper part of the Dry Branch Formation, has proved to be slightly more permeable than the clayey sand of the overlying Tobacco Road Formation. A pumping test of a sand lens in the silty sand of the Dry Branch Formation indicates a hydraulic conductivity of 0.99 ft/d. An average value of 0.13 ft/d for the hydraulic conductivity of the clayey sand of the Tobacco Road Formation has been calculated from point-dilution tracer tests at SRS (Christensen and Gordon, 1983).

Mean and median hydraulic-conductivity values derived from the slug tests and short-duration, single-well pumping tests are a significant departure from the 13 ft/d calculated from the one successful large-scale, multiple-well pumping test of the "upper" aquifer zone. The comparable range, median, and mean hydraulic-conductivity values derived by the slug-test method and the short-duration, single-well pumping test method may be due more to the limited area of investigation around the bore hole than to the actual hydraulic characteristics of the formation beyond. Slug tests and the low-discharge, short-duration, single-well pumping tests only stress the immediate area around the bore hole where formation damage may have occurred. Indeed, the consistency in the hydraulic-conductivity values derived from the slug tests of both the "upper" and "lower" aquifer zones of the Upper Three Runs aquifer and the Gordon aquifer corroborates the conclusion that the hydraulic characteristics of the sand pack and invaded zones of the formation are being measured, not the properties of the undisturbed formation. The grain size and construction of the sand pack in the screened interval of monitoring wells drilled at SRS are, by common design, virtually identical. In contrast, the large-scale, long-duration, multiple-well pumping tests stress the aquifer throughout the region of influence of the test. This gives a more reliable estimation of aquifer properties because it measures the formation throughout the area of influence of the test.

Sieve analyses were also used to estimate hydraulic conductivity of the "upper" aquifer zone in GSA with the method of Beard and Weyl (1973). Thirty-three samples yielded an average conductivity of 146 ft/d, ranging from 27 to 493 ft/d (WSRC-RP-92-837, 1992). These estimates were broken out into three areas (Fig. 3) at GSA:

- Burial Ground Complex: Mean = 109 ft/d, n = 14; Range = 27 to 315 ft/d
- F-Area Seepage Basins: Mean = 229 ft/d, n = 10; Range = 55 to 493 ft/d
- H-Area Seepage Basins: Mean = 106 ft/d, n = 9; Range = 36 to 204 ft/d

Hydraulic-conductivity values estimated from the sieve analyses are generally two orders of magnitude greater than those measured by field techniques. This large disparity between in situ values of hydraulic conductivity derived from pumping tests and slug tests and those derived from grain-size analyses may be attributed to the high clay content of the Upper Three Runs aquifer that effectively reduces porosity and results in the low hydraulic-conductivity values indicated by aquifer tests. The empirical relationship established between hydraulic conductivity and grain-size distribution (Beard and Weyl, 1973) may not be strictly applicable for clayey sand and, therefore, may give erroneous results. Evans and Parizek (1991), using regression analysis in an attempt to relate hydraulic-conductivity values calculated from slug tests for the "upper" and "lower" aquifer zones with those calculated from sieve analyses (Beard and Weyl, 1973), found no correlation between the two techniques. Additionally, weak correlations were found to exist between hydraulic conductivity calculated from slug tests and those calculated from median grain size and the Trask sorting coefficient. These poor correlations were thought to be due to the effects of other parameters that are not characterized by sieve analyses, such as cementation, pore-size distribution, and grain shape, all of which can influence the rate of flow through undisturbed sediments (Evans and Parizek, 1991). Sampling bias may also contribute to the discrepancy in the hydraulic-conductivity values. Sieve samples, collected solely from clean, sandy portions of screened intervals, will yield high hydraulic-conductivity values but will not represent the lithologic heterogeneity of sediments that compose the Upper Three Runs aquifer, which is best measured by in situ techniques. Preferential ground water movement through high-permeability zones in the aquifer at GSA has been suggested (Evans and Parizek, 1991), indicating that lithologic heterogeneity may be prevalent and may be an important aspect controlling ground-water flow in the aquifer.

The "tan clay" confining zone at GSA separates the "upper" aquifer zone from the "lower" aquifer zone in the Upper Three Runs aquifer (Plate 40). This zone is a leaky confining zone. Total thickness of the "tan clay" confining zone, based on measurements at 46 wells distributed throughout GSA, ranges from 0 to 32 ft and averages 11 ft (Appendix 2). Sandy clay to clay beds range from 0 to 18 ft in thickness and average 7 ft. Clayey sand beds range from 0 to 12 ft and average 3 ft.

Laboratory analyses including horizontal and vertical hydraulic conductivity were made on 28 selected clayey to very clayey, often silty, sand samples and 55 sandy, often silty clay, and clay samples from the various confining units and "low-permeability" beds in the aquifers of the Coastal Plain sequence (Tables 1 and 2) (Bledsoe and others, 1990). The laboratory analyses conducted on the two lithologies were too few in number for any one hydrogeologic unit. In addition, the very small, possibly non-representative core samples used for the analyses, and the possibility that individual samples may have been disturbed, precluded reliably characterizing the hydraulic properties of individual hydrogeologic units on the basis of the few samples analyzed from each unit. Therefore, the geometric means of the vertical and of the horizontal hydraulic conductivities calculated for the entire suite of clayey to very clayey sand samples and for the sandy clay and clay samples, irrespective of which Tertiary/Cretaceous hydrostratigraphic unit they were sampled from, were used to establish hydraulic-conductivity values for that lithology for each hydrostratigraphic unit. The geometric mean value was used in calculating the hydrogeologic parameters of the various hydrostratigraphic units because it more accurately reflects the central tendency of the values in the distribution and diminishes the effects of extreme outliers.

Vertical hydraulic-conductivity values of the 28 clayey sand samples analyzed (Bledsoe and others, 1990) (Table 1) ranged from 2.86×10^{-4} to 5.10×10^{-1} ft/d, with a geometric mean of 8.90×10^{-3} ft/d. Horizontal hydraulic-conductivity values analyzed for 25 of the clayey sand samples from the Tertiary/Cretaceous section, ranged from 1.11×10^{-4} ft/d to 2.48 ft/d, with a geometric mean of 1.04×10^{-2} ft/d.

Vertical hydraulic-conductivity values of the 55 sandy clay to clay samples analyzed ranged from 3.40×10^{-6} to 2.09×10^{-2} ft/d, with a geometric mean of 1.67×10^{-4} ft/d (Table 2). The horizontal hydraulic-conductivity values of 43 of the clay to sandy clay samples analyzed ranged from 2.55×10^{-5} to 3.23×10^{-1} ft/d, with a geometric mean of 4.07×10^{-4} ft/d.

Total porosity determined for the 55 clay to sandy clay samples analyzed ranges from 23 to 71 percent, averaging 41 percent (Table 2). Total porosity of the 28 clayey sand samples analyzed, ranges from 27 to 55 percent, averaging 40 percent (Table 1). The generally accepted value of effective porosity used in the study to determine vertical-flow velocities is 5 percent for the clay to sandy clay beds (Walton, 1970) and 12 percent for the clayey sand beds (Fetter, 1988).

Using the geometric mean hydraulic-conductivity values established for the two lithologies based on the 83 laboratory analyses conducted on the entire Tertiary/Cretaceous sample suite, leakance-coefficient values were estimated (See equation 1 on page 50) for the "tan clay" confining unit using the thickness of each lithology at each well location (Appendix 2). The leakance-coefficient values range from 8.47×10^{-6} to 1.35×10^{-3}/d, with a geometric mean value of 3.26×10^{-5}/d.

Laboratory analyses (Atlanta Testing and Engineering, 1987 and 1988; Bledsoe and others, 1990; WEGS, 1991; Sirrine, 1991a and b, 1992; WSRC-RP-92-837, 1992) of an unspecified number of undisturbed samples from the confining zone in GSA produced vertical hydraulic conductivities from 3.4×10^{-6} to 1.2×10^{-1} ft/d and horizontal hydraulic conductivities from 1.7×10^{-5} to 1.5×10^{-1} ft/d. The precise lithology of the samples tested was not indicated, but the values fall in the range of hydraulic-conductivity values calculated for the Tertiary/Cretaceous sample suite (Tables 1 and 2). In L-Area (Fig. 2) near well P-15 (Plate 1), laboratory analysis of an undisturbed sandy clay sample from the clay beds correlative with the "tan clay" confining zone in GSA (PSI, 1985) measured a vertical hydraulic-conductivity value of 1.3×10^{-6} cm/s (3.68×10^{-3} ft/d).

Four long-duration, multiple-well pumping tests that were made in the "lower" aquifer zone (D'Appolonia, 1981) in and near H-Area in GSA resulted in calculated vertical hydraulic-conductivity values in the overlying "tan clay" confining zone that averaged 2.3×10^{-3} ft/d (as calculated by the Hantush-Jacob method). Assuming an average thickness of 11 ft, the calculated leakance coefficient is 2.1×10^{-4}/d for the unit. GeoTrans (1992a) used a vertical hydraulic conductivity of 3.89×10^{-3} ft/d for the confining zone to calibrate a flow model in GSA. Assuming an average thickness of 11 ft for the unit, the calculated leakance coefficient is 3.54×10^{-4}/d.

The calculated leakance coefficients of the "tan clay" derived from the four pumping tests of the "lower" aquifer zone and from the GeoTrans flow model (2.1×10^{-4} to 3.54×10^{-4}/d) are as much as an order of magnitude greater than the average leakance value calculated at the well locations (3.26×10^{-5}/d) used to characterize the unit. The laboratory-derived, point-source leakance coefficients at each well do not give any indication of variations in the thickness or in the continuity of the confining beds that compose the unit between well locations. Pumping tests, on the other hand, do establish an average leakance over the area of influence of the test, thus reflecting not only the overall thickness of the unit, but the continuity of the confining beds that compose the unit. The disparity in leakance coefficients derived by the two methods suggests rapid lateral variations in the thickness and continuity of the confining beds in the unit. Stratigraphic analysis of the unit in GSA (Plate 40) corroborates this conclusion.

Hydraulic-conductivity values for the "lower" aquifer zone in and near GSA have been calculated from slug tests, large- and small-scale single-well pumping tests, minipermeameter tests, and sieve analyses. Hydraulic-conductivity values determined from 85 slug tests (WSRC-RP-92-837, 1992) range from a high of 24.4 ft/d to a low of 0.04 ft/d and average 2.36 ft/d, approximately one half of the average hydraulic-conductivity value of 5.62 ft/d calculated from slug tests for the "upper" aquifer zone. Arithmetic means from the slug tests were calculated at three locations in GSA (Fig. 3):

- Burial Ground Complex: Mean = 1.48 ft/d, n = 35; Range = 0.04 to 20.38 ft/d
- F-Area Seepage Basins: Mean = 3.49 ft/d, n = 25; Range = 0.14 to 24.03 ft/d
- H-Area Seepage Basins: Mean = 2.47 ft/d, n = 25; Range = 0.90 to 24.40 ft/d

GeoTrans (1992b) compiled hydraulic data from 88 additional slug tests of the "lower" aquifer zone. The hydraulic conductivity for all 173 slug tests averaged 5.62 ft/d, with a median value of 1.00 ft/d. A ground-water flow model of the Upper Three Runs aquifer in GSA (GeoTrans, 1992a) used a calibrated hydraulic conductivity estimate of 6.00 ft/d for the "lower" aquifer zone.

Minipermeameter measurements taken on "lower" aquifer zone core samples (Kegley, 1993) from the MWD Experimental Well Field Site (Plate 1) have yielded average hydraulic-conductivity values of 18.6 Darcies (45.2 ft/d) for 87 lower Dry Branch Formation samples (upper part of the "lower" aquifer zone), and 2.9 Darcies (7.1 ft/d) for 112 Tinker/Santee Formation samples (lower part of the "lower" aquifer zone). The weighted average hydraulic conductivity of the "lower" aquifer zone is 23.8 ft/d.

Parizek and Root (1986) made a series of 51 low-discharge, short-duration, single-well pumping tests from wells screened in the "lower" aquifer zone in and around GSA. Hydraulic-conductivity values reported from the tests range from 0.17 ft/d to 2.6 ft/d, with an arithmetic mean of 0.91 ft/d and a median value of 0.90 ft/d. Seven single-well pumping tests by Evans and Parizek (1991) in the "lower" aquifer zone yielded hydraulic-conductivity values ranging from 0.27 to 129.97 ft/d with an arithmetic mean of 33.3 ft/d and a median value of 1.67 ft/d. Five of the seven wells tested had been tested previously by Parizek and Root (1986) and Root (1987). The overall arithmetic mean hydraulic conductivity of the 58 pumping tests is 4.82 ft/d; the median value is 0.90 ft/d.

Four transmissivity values were obtained in the "lower" aquifer zone in the vicinity of GSA from long-term, multiple-well pumping tests in which partial-penetration corrections were not needed (D'Appolonia, 1981). Three tests in H-Area had an average transmissivity of 62 ft²/d. Given a thickness of 70 ft at this site, the average hydraulic conductivity was calculated to be 0.88 ft/d. The fourth test was performed northeast of H-Area and resulted in a transmissivity value of 88 ft²/d. Given a thickness of 55 ft at this site, the hydraulic conductivity for the "lower" aquifer zone is 1.6 ft/d. Effective porosities are probably on the order of 20 to 25 percent. All of these tests integrated hydraulic characteristics by testing both the sandy facies and the calcareous facies of the "lower" aquifer zone. A pumping test of the "lower" aquifer zone reported by Christensen and Gordon (1983) in GSA gave a transmissivity of 960 ft²/d and a hydraulic conductivity of 19 ft/d.

One long-term, multiple-well pumping test utilizing three monitoring wells was made in the "lower" aquifer zone in the vicinity of the F-Area Seepage Basins (Chas. T. Main, Inc., 1990). The pumping well ran for 31 hours and 35 minutes at 12.5 gal/min, and a 25-hour recovery period was recorded. Transmissivities ranged from 4,716 to 5,196 gal/d/ft (560 to 695 ft²/d) and averaged approximately 5,000 gal/d/ft (670 ft²/d). Storativity ranged from 1.1×10^{-4} to 2.6×10^{-4} and averaged about 1.6×10^{-4}. An aquifer thickness of 65 ft was used to estimate a hydraulic conductivity of 10 ft/d.

Sieve analyses were used to estimate hydraulic conductivity of the "lower" aquifer zone in GSA, using the method of Beard and Weyl (1973). Forty-four samples that were analyzed indicate an average hydraulic conductivity of 158 ft/d, ranging from 37 to 356 ft/d (Thayer, 1990; WEGS, 1991; WSRC-RP-92-837, 1992). The hydraulic conductivities were compiled at three sites in GSA (Fig. 3):

- Burial Ground Complex: Mean = 110 ft/d, n = 4; Range = 37 to 192 ft/d
- F-Area Seepage Basins: Mean = 162 ft/d, n = 20; Range = 38 to 270 ft/d
- H-Area Seepage Basins: Mean = 157 ft/d, n = 20; Range = 69 to 356 ft/d

Various ground-water flow models of the Upper Three Runs aquifer in the GSA area used calibrated hydraulic-conductivity estimates. GeoTrans (1986) used a calibrated hydraulic conductivity of 3.6 ft/d for the "upper" aquifer zone and 4.1 ft/d for the "lower" aquifer zone. A refinement of their flow model (GeoTrans, 1992a) used 3.4 ft/d for the "upper" zone and 6.0 ft/d for the "lower" zone.

A numerical ground-water flow model was developed by Root (1983) for the low-level radioactive-waste burial grounds near the center of SRS. The model was calibrated against hydraulic-head data from both the "lower" and "upper" aquifer zones of the Upper Three Runs aquifer and stream-discharge data for the "upper" aquifer zone of the aquifer. For the model, a hydraulic conductivity of about 6 ft/d was necessary for proper calibration. No aquifer-test values for hydraulic conductivity were available in the actual area of the model; however, on the basis of lithologic data, Root (1983) concluded that it is reasonable to assume the area to be hydraulically similar to nearby areas for which data are available.

The calibrated hydraulic conductivity of 6 ft/d used by Root (1983) is several times higher than results from single-well pumping tests of the "upper" and "lower" aquifer zones (that is, median hydraulic-conductivity values of 0.61 ft/d and 0.90 ft/d, respectively) and from median values of slug-test data (1.0 ft/d and 1.38 ft/d). The calibrated value is, however, similar to the mean values of the slug-test data for the two aquifer zones (that is, 5.12 ft/d and 5.62 ft/d), but greater than the mean values of the short-duration, single-well pumping-test data (0.67 ft/d and 4.82 ft/d). The 6 ft/d is less than the results from the large-scale, long-duration, multiple-well pumping tests (10 to 13 ft/d) and the weighted average hydraulic-conducivitity value (23.8 ft/d) from the minipermeater tests.

Preferential ground water movement through high-permeability zones in the Upper Three Runs aquifer at GSA has been discussed by Evans and Parizek (1991) and is suggested by the large-scale pumping tests and several of the slug tests. The high-permeability zones may be a significant controlling component of ground water movement and contaminant transport throughout the aquifer in GSA.

At the south end of the study area near well C-10 (Plates 1 and 3), in an area of transition from the clastic phase to the carbonate phase of the Floridan aquifer system, a limestone aquifer zone exists within the Upper Three Runs aquifer that is used as the municipal water supply for the towns of Allendale, Ulmer, and Fairfax. This moderately indurated limestone is correlative with the Santee Limestone. The updip clastic equivalents of the Santee Limestone (i.e., Tinker Formation) constitute much of the "lower" aquifer zone in GSA to the north. The limestone occurs between 30 and 90 ft below sea level at well C-10 and represents the leading edge of platform carbonates deposited during middle Eocene time (Plate 33). North of C-10, at wells C-6 and C-7 (Plate 1), the limestone is absent and the sequence consists of fine-grained marl and clay deposited in a deep-water shelf environment along the Gulf Trough (Plate 33). Here, municipalities (such as the town of Barnwell) must tap the underlying Gordon aquifer for sufficient public water supplies.

Allendale has three public supply wells completed in this limestone aquifer zone, with yields ranging from 375 to 550 gal/min. Pumping tests made on two of the three wells (ALL-310 and ALL-353) indicate transmissivities of 25,000 and 29,000 gal/d/ft (3,300 and 3,900 ft^2/d) and specific capacities of 7.4 and 13 gal/min/ft, respectively (Newcome, 1993). In Allendale, the zone is about 60 ft thick, and hydraulic-conductivity estimates are 56 and 65 ft/d for the two wells. These conductivity values are, on average, an order of magnitude larger than the calibrated conductivity estimates from modeling the Upper Three Runs aquifer in GSA.

Ulmer has two wells completed in this limestone zone (ALL-48 and BRN-295). Pumping tests made at the wells show transmissivities of 30,000 and 47,000 gal/d/ft (4,000 and 6,300 ft^2/d) and specific capacities of 14 and 4.7 gal/min/ft, respectively (Newcome, 1993). Geophysical logs show that the limestone zone has a thickness of 60 ft, resulting in a hydraulic conductivity of 67 ft/d at well ALL-48 and 105 ft/d at well BRN-295. All wells completed in this zone at the south end of the study area are gravel-packed and screened to filter out a very fine sand that occurs in the limestone. South of the study area, pure limestone dominates, and wells are constructed without screens.

Gordon confining unit.—Fine-grained, glauconitic, clayey sand, and clay of the Warley Hill Formation and clayey, micritic limestone of the Blue Bluff Member of the Santee Limestone constitute the Gordon confining unit (Fig. 7; Plates 3-10). The Gordon confining unit separates the Gordon aquifer from the overlying Upper Three Runs aquifer (Figs. 7 and 12). The unit has been informally termed the "green clay" in previous SRS reports.

In the study area, the thickness of the Gordon confining unit ranges from about 5 ft to 85 ft (Appendix 1; Plate 13). The unit thickens to the southeast. From Upper Three Runs Creek to the vicinity of L Lake and Par Pond, the confining unit generally consists of one or more thin clay beds, sandy mud beds, and sandy clay beds intercalated with subordinate layers and lenses of quartz sand, gravelly sand, gravelly muddy sand, and calcareous mud that together constitute the persistent updip clastic part of the Gordon confining unit (Plates 3-10). Southward from L Lake and Par Pond, however, the stratigraphic interval that includes the Gordon confining unit undergoes a facies change to clayey micritic limestone and limy clay typical of the Blue Bluff Member of the overlying Santee Limestone. The fine-grained carbonates and carbonate-rich muds constitute the farthest updip extent of the "middle confining unit" (of Miller, 1986) of the Floridan aquifer system (the hydrostratigraphic equivalent of the Gordon confining unit), which dominates in the coastal areas of South Carolina and Georgia (Fig. 7; Plates 3-10).

The Blue Bluff reaches its maximum thickness along a line extending from the Girard well in Georgia (Plate 1), where the Blue Bluff is 80 ft thick, to well C-7 where it is 86 ft thick. Between wells C-7 and C-10, and the Girard and Millhaven wells in Georgia, the thickness of the Blue Bluff thins to 65 ft and 57 ft, respectively, owing to a facies change from the micritic limy clay of the Blue Bluff to the shelly carbonate platform deposits typical of the Santee Limestone (Plate 13).

North of the updip limit of the Gordon confining unit, the fine-grained clastics of the Warley Hill Formation are thin, intermittent, and no longer effective in regionally separating ground water flow from the Upper Three Runs aquifer to the underlying Gordon aquifer. Here, the Steed Pond aquifer is defined (Fig. 12; Plate 13). Although thin and intermittent, the clay, sandy clay, and clayey sand beds of the Warley Hill Formation can be significant at the site-specific level and often divide the Steed Pond aquifer into aquifer zones (Fig. 11).

The head difference across the Gordon confining unit and its updip equivalents is illustrated on Figure 22. A persistent upward gradient (head reversal) exists across the confining unit along the Savannah River flood plain and its major tributaries. Here, the Savannah River and its tributaries have downcut into the sediments of the Upper Three Runs aquifer (water-table aquifer) resulting in the immediate discharge of the ground water to the local stream system, lowering the hydraulic head of the water table below that in the underlying Gordon aquifer. The resulting head reversal is an important consideration when siting facilities where contaminants may be discharged to the ground water system. Here, the deeper aquifers would be protected from the downward migration of contaminants.

The updip clastic portion of the Gordon confining unit is defined for hydrogeologic characteristics of sediments penetrated in well P-27 near the center of SRS (Plates 1 and 39a). The unit is 7 ft thick in well P-27 and occurs from 132 and 125 ft msl. It consists of a 3-ft thick greenish-gray, sandy clay bed and a 4-ft light-gray, moderately sorted, fine- to medium-grained clayey sand bed. The calculated leakance coefficient value is 4.98×10^{-5}/d.

Historically, investigators have treated the fine-grained clastic sequence that composes the Gordon confining unit as a single, horizontally continuous clay bed. Recent studies have revealed that the unit is not a single, continuous clay bed but usually consists of several lenses of green and gray clay that thicken, thin, and pinch out abruptly. Locally, beds of calcareous mud add to the thickness of the unit. Minor interbeds of clayey sand or sand are also present.

In GSA (Fig. 3), near the P-27 type well (Plate 40), data from more than 70 wells indicate that the confining unit ranges from 2 to 30 ft in thickness; clay and sandy clay beds range

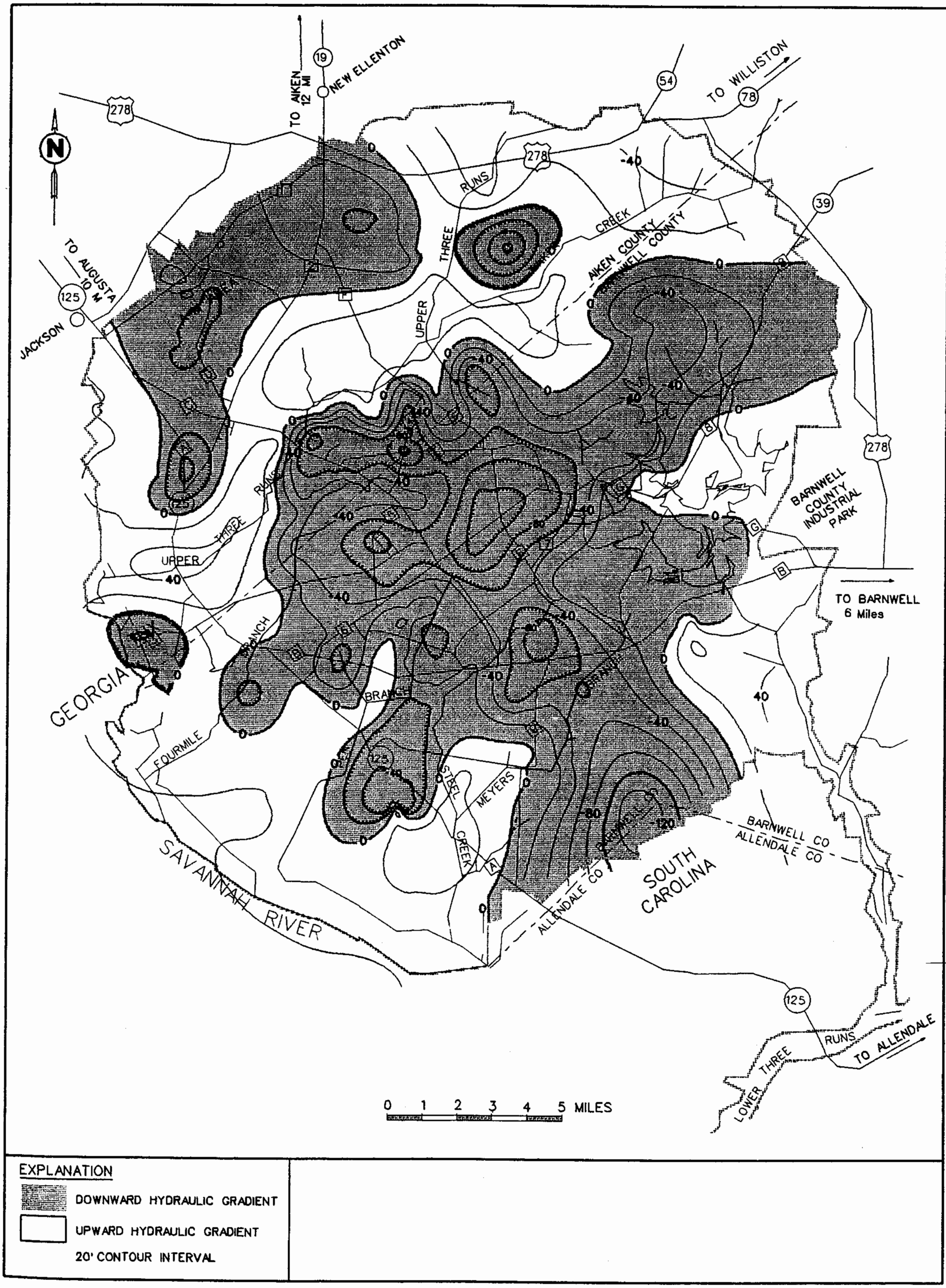


Figure 22. Hydraulic-head difference map across the Gordon confining unit, March-April 1991 (positive values indicate an upward gradient).

from 2 to 12 ft; clayey sand beds range from 1 to 14 ft; calcareous mud beds range from 3 to 11 ft; and sand beds range from 1 to 6 ft (WSRC-RP-92-837, 1992). Isolated, but extensive carbonate sediments typical of the transitional zone between the clastic-dominated Tinker Formation in the north and the carbonate-dominated Santee Limestone in the south, occur throughout GSA. These range from 0 to 45 ft in thickness and terminate laterally over short distances. Often, the clay beds of the Gordon confining unit thin or are truncated in the vicinity of, or by the carbonate buildups (Plate 40).

X-ray diffraction analyses of four muddy-sand samples, collected in the Gordon confining unit from the P-well series (Strom and Kaback 1992), indicate that the samples consist mostly of quartz with 18 to 42 percent clay minerals. Smectite was the dominant clay mineral, with minor to trace amounts of illite and kaolinite. Four micritic mud samples from wells C-5, C-6, and C-10 were analyzed for clay and bulk mineralogy using x-ray diffraction (Gelting, 1990; Gellici and others, 1995). The average clay mineral content was: Illite, 65 percent; mixed-layer illite/smectite, 26 percent; kaolinite, 7 percent; and smectite, 2 percent.

Downdip, the Gordon confining unit becomes increasingly calcareous and grades into clayey micritic limestone typical of the Blue Bluff Member of the Santee Limestone. The Blue Bluff ranges in thickness from 5 to 86 ft, thickening rapidly to the south-southeast. The updip limit of thick, continuous carbonate deposition is illustrated on Plates 3-10 and 13. North of the updip limit, carbonate deposition occurs as isolated buildups or lenses.

The Blue Bluff Member consists of gray, fissile, calcareous clay and clayey micritic limestone and very thinly layered to laminated, clayey, calcareous, silty, fine sand, with shells and hard, calcareous nodules, lenses, and layers. The Blue Bluff is glauconitic, up to 30 percent in some places. Thin-section analysis indicates that the dominant allochems are foraminifers, echinoderms, pelecypods, bryozoans, and broken skeletal debris. Monocrystalline quartz and clay matrix are the chief terrigenous constituents. Other constituents are authigenic pyrite, collophane, muscovite, and heavy and opaque minerals. Lithology of the Blue Bluff suggests deposition in protected, lagoonal-bay environments.

Textural analyses were made on 10 sandy mud to muddy sand samples from the Gordon confining unit (Bledsoe and others, 1990). On average, the samples contain 47.3 percent mud, 52.2 percent sand, and 0.5 percent gravel. Gravel-sand-mud ratios of 79 sand samples with less than 25 percent mud were determined for sandy layers in the Gordon confining unit (Table 6). Gravel averages two percent and consists of granule-size rounded and subrounded quartz. Sand averages 91.4 percent and mud 6.4 percent. The mean grain size of samples from sandy layers is upper fine sand (Table 6; Fig. 23); most are moderately or poorly sorted (Fig. 24) on the Folk and Ward (1957) verbal scale.

Lithology of the Gordon confining unit, as noted above, is characterized by variable facies ranging from clay-rich, calcareous sediment in the southern part of the study area (Plates 3-10), to sandy clay and clay in the central part, to clayey sand and clean quartz sand with subordinate clay beds in the north. As such, porosity and permeability of the confining unit vary widely, and the confining characteristics decrease to only localized influence in the northwestern part of SRS near A-M Area (Fig. 2) where the intermittent confining clay beds of the Warley Hill Formation constitutes the "green clay" confining zone of the Steed Pond aquifer (Fig. 11; Plate 41).

Table 6. Summary of Folk and Ward statistics, gravel-sand-mud percentages, calculated porosity and permeability values and for sand samples from the Gordon confining unit that contain less than 25 percent mud

Parameter	Folk and Ward Statistics				Gravel	Sand	Mud	Porosity	Permeability	
	Mean*	Sorting*	Skewness	Kurtosis	(%)	(%)	(%)	(%)	(Darcy)	(ft/d)
Arothmetic Mean	2.077	1.223	0.082	1.560	2.0	91.4	6.4	34.6	23.3	56.7
Confid. Level (95%)	0.169	0.161	0.062	0.200	1.3	1.9	1.4	0.9	4.5	10.8
Number	79	79	79	79	79	79	79	65	65	65
Median	2.030	1.040	0.059	1.292	0.3	94.3	4.2	34.5	16.0	38.9
Mode	-	0.655	0.122	1.802	0.0	-	5.7	34.5	13.0	31.6
25th Percentile	1.519	0.722	-0.113	1.057	0.1	88.2	1.7	32.5	7.5	18.2
75th Percentile	2.776	1.457	0.245	1.629	1.3	97.6	8.4	38.0	35.0	85.2
Standard Devoiation	0.765	0.731	0.279	0.909	5.7	8.4	6.2	3.8	18.3	44.6
Variamce	0.586	0.535	0.078	0.827	32.6	70.5	39.0	14.6	336.3	1991.0
Kurtosis	-0.409	3.477	0.744	7.297	38.2	3.7	0.7	-0.2	-0.5	-0.5
Skewness	-0.077	1.730	0.104	2.529	5.8	-1.7	1.3	-0.5	0.8	0.8
Range	3.343	3.931	1.530	5.203	43.4	44.5	23.8	16.0	65.0	158.1
Maximum	0.128	4.269	0.790	5.747	43.4	99.9	23.9	41.4	68.0	165.4
Minimum	3.471	0.338	-0.740	0.544	0.0	55.4	0.1	25.4	3.0	7.3
Trimean (5%)	2.084	1.195	0.084	1.518	1.5	91.7	6.2	34.7	22.9	55.8
Geometric Mean	-	-	-	-	-	-	-	-	16.3	39.7
Harmonic Mean	-	-	-	-	-	-	-	-	11.0	26.8

* Values are in phi units

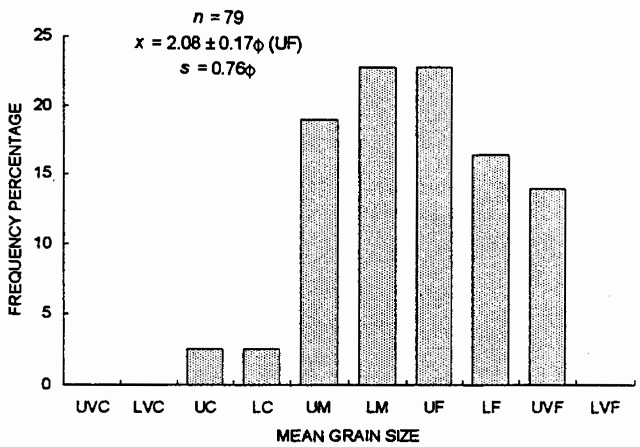


Figure 23. Mean grain size of samples from sandy layers in the Gordon confining unit. UVC, upper very coarse sand; LVC, lower very coarse sand; UC, upper coarse sand; LC, lower coarse sand; UM, upper medium sand; LM, lower medium sand; UF, upper fine sand; LF, lower fine sand; UVF, upper very fine sand; and LVF, lower very fine sand.

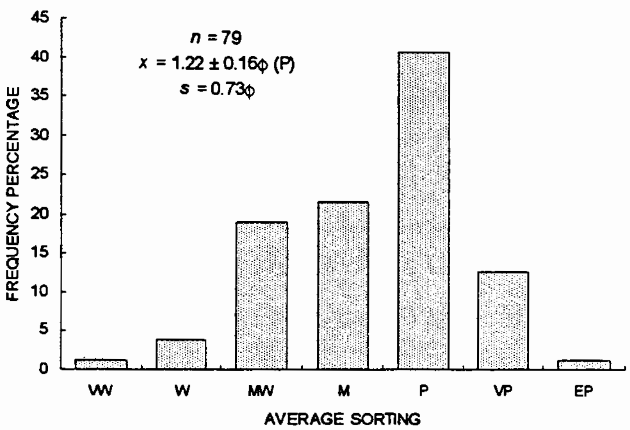


Figure 24. Sorting classes of samples from sandy layers in the Gordon confining unit. VW, very well sorted; W, well sorted; MW, moderately well sorted; M, moderately sorted; P, poorly sorted; VP, very poorly sorted; and EP, extremely poorly sorted.

Porosity calculated from sieve analyses (Beard and Weyl, 1973) of 65 sand samples with less than 25 percent mud from the Gordon confining unit averages 34.6 percent (Fig. 25). Geometric mean permeability of the sand samples is 16.3 Darcies (39.7 ft/d) (Fig. 26). In contrast, minipermeameter measurements done on Gordon confining unit core samples (Kegley, 1993) from the MWD Experimental Well Site (Plate 1), located just northeast of GSA, yielded an average hydraulic-conductivity value of 1.1 Darcies (2.6 ft/d). Most of the measurements, however, were on muddy sand and sandy mud.

Four clayey sand samples from the Gordon confining unit (Table 1) had vertical hydraulic conductivities (Bledsoe and others, 1990) that ranged from 5.70×10^{-4} to 1.59×10^{-1} ft/d, with a geometric mean of 4.06×10^{-3} ft/d; whereas two sandy clay samples analyzed from the Gordon confining unit had vertical hydraulic conductivities of 2.24×10^{-4} and 3.68×10^{-4} ft/d, with a geometric mean hydraulic conductivity (vertical) of 2.87×10^{-4} ft/d. Both values are comparable to the average vertical hydraulic-conductivity values of clayey sand (8.90×10^{-3} ft/d) and sandy clay to clay (1.67×10^{-4} ft/d) calculated for the 83 samples analyzed in the Tertiary/Cretaceous section. The geometric mean value of 8.90×10^{-3} ft/d for the clayey sand and the 1.67×10^{-4} ft/d for the sandy clay and clay was used because of the improved statistical reliability of the values and increased assurance that the sampled population is less biased.

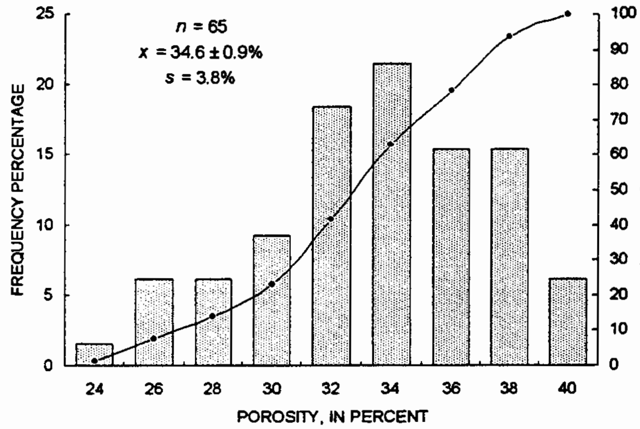


Figure 25. Calculated porosity values of sand samples containing less than 25 percent mud from sandy layers within the Gordon confining unit.

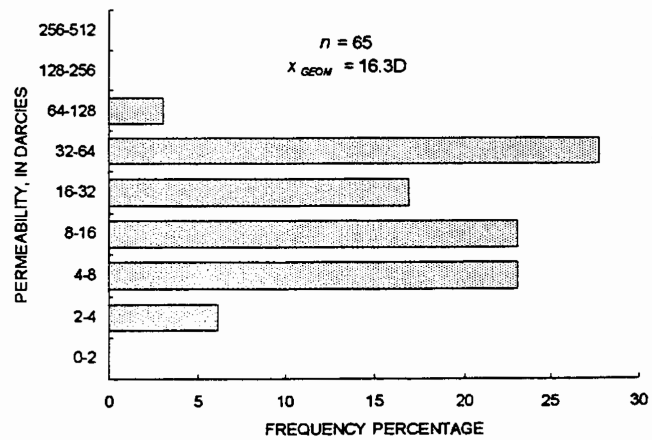


Figure 26. Calculated permeability values of sand samples containing less than 25 percent mud from sandy layers within the Gordon confining unit.

Laboratory analyses to determine physical characteristics, including horizontal and vertical hydraulic conductivity, were made on undisturbed samples of the undifferentiated "clayey" portions of the Gordon confining unit in GSA (Sirrine, 1991a and b, 1992; WEGS, 1991; WSRC-RP-92-837, 1992). Detailed lithology was not noted. Vertical hydraulic-conductivity estimates from 22 samples ranged from 1.1×10^{-6} to 2.7×10^{-3} ft/d. Horizontal hydraulic-conductivity estimates from 10 samples ranged from 5.39×10^{-6} to 5.67×10^{-3} ft/d. These values are similar to the range of hydraulic-conductivity values calculated by Bledsoe and others (1990), validating the use of the average value for the entire Tertiary/Cretaceous sample suite in the study area.

Hydraulic-conductivity values for the "green clay" confining zone in A-M Area are in the range of 10^{-8} to 10^{-5} cm/sec (3 x 10^{-5} to 3 x 10^{-2} ft/d) (Eddy and others, 1991). Values for total porosity were found to be in the expected range for clay samples, with most values ranging between 35 percent and 60 percent.

Few data are available for estimating the hydraulic properties of the calcareous mud and clayey micrite typical of the downdip portion of the Gordon confining unit (that is, Blue Bluff lithologies). Three Blue Bluff clayey micrite samples were analyzed in the laboratory, two from well C-6 and one from well C-7. The vertical hydraulic conductivity ranges from 1.22 x 10^{-4} to 1.95 x 10^{-4} ft/d, and the geometric mean value of the three vertical hydraulic conductivities is 1.51 x 10^{-4} ft/d, very close to the geometric mean value for the vertical hydraulic conductivity of the sandy clay to clay sample suite used in the study. The average porosity of the three Blue Bluff samples was determined to be 14.2 percent.

Thin-section porosity was estimated for the Blue Bluff carbonates and was found to be less than 5 percent because of the high content of terrigenous clay matrix and micrite (Thayer, 1989). Therefore, the thickness of the clayey micrite and calcareous mud beds was combined with the thickness of the clay and sandy clay beds for the purpose of estimating the hydraulic characteristics of the downdip portion of the Gordon confining unit (Appendix 1; Fig. 10).

A recent modeling study by GeoTrans (1992a) reported a calibrated vertical hydraulic-conductivity value for the Gordon confining unit of 1.43 x 10^{-4} ft/d for GSA; 1.14 x 10^{-4} ft/d near the F-Area Mixed Waste Management Facility (MWMF), and 1.79 x 10^{-4} ft/d north of the MWMF. These values compare well with the laboratory-derived estimates of vertical hydraulic conductivity of 1.67 x 10^{-4} ft/d for sandy clay and clay (Bledsoe and others, 1990).

Leakance coefficients were estimated for the Gordon confining unit at each well used in the study that penetrated the unit, utilizing the geometric mean value of vertical hydraulic conductivity established for the clay, sandy clay, and calcareous mud (1.67 x 10^{-4} ft/d) and the clayey sand (8.90 x 10^{-3} ft/d) divided by their respective thicknesses. Thickness of the various lithologies in the confining units was estimated from core and downhole geophysical data. Effective leakance (L_e), i.e., the leakance coefficients of the clay, sandy clay, and calcareous mud beds combined with the leakance coefficients of the clayey sand beds was determined at each well location. The equation used is:

$$L_e = \frac{1}{\dfrac{b_c}{K_{vc}} + \dfrac{b_{cs}}{K_{vcs}}} \qquad (1)$$

where:

L_e = effective leakance of confining unit (ft/d/ft)

K_{vc} = vertical hydraulic conductivity of clay to sandy clay beds and calcareous mud beds (ft/d)

K_{vcs} = vertical hydraulic conductivity of clayey sand beds (ft/d)

b_c = thickness of sandy clay to clay beds and calcareous mud beds (ft)

b_{cs} = thickness of clayey sand beds (ft)

Leakance-coefficient values, calculated for the Gordon confining unit from the laboratory-derived vertical hydraulic-conductivity values obtained from core samples, reflect only the lithology and thickness of the confining beds that constitute the confining unit at each well location. The laboratory-derived leakance values are point-source values and do not reflect the degree of continuity of the confining beds that compose the confining unit in areas between well locations nor the structural complexity, or structural integrity of the unit in the region under investigation.

Leakance coefficients derived from aquifer pumping tests give an integrated average leakance value in the adjacent confining units in the area of influence of the test. The leakance-coefficient values from pumping tests give an overall measure not only of the lithology and thickness of the confining beds but also of the degree of continuity of the confining beds that compose the confining unit and the structural integrity of the unit in the region of investigation.

Analysis of the stratigraphic interval that constitutes the Gordon confining unit and its updip equivalents indicates a general thinning of the confining beds in the interval and an overall thinning of the interval from south to north across the study area (Plates 3-10, 13, and 41). The attendant general increase in the laboratory-derived leakance-coefficient values (Plate 13) observed in the Gordon confining unit from south to north reflects these changes in lithofacies and thickness of the confining unit updip and is one of the primary factors used in defining the geographic extent and hydrostratigraphy of the confining unit.

The geographic distribution of the laboratory-derived leakance values calculated for the Gordon confining unit and its updip hydrostratigraphic equivalents is illustrated on Plate 13. Very low leakances were recorded in the southern half of the study area where leakance coefficients are of the 10^{-6}/d order of magnitude and the confining unit is composed mostly of thick beds of micritic clay. North of the updip limit of continuous carbonate deposition (Plate 13), leakance values are generally in the range of 1 x 10^{-5}/d to 5 x 10^{-5}/d except in the center of SRS along the trace of the Pen Branch Fault where they are on the order of 10^{-4}/d. North of Upper Three Runs Creek, leakance-coefficient values increase dramatically to the 10^{-4}/d to 10^{-3}/d range, with local exceptions. The southern limit of the area of high leakance-coefficient values marks the updip limit of the Gordon confining unit.

The laboratory-derived leakance-coefficient values for the Gordon confining unit observed in wells along the trace of the Pen Branch Fault are generally an order of magnitude greater than at well locations farther to the north or to the south of the fault trace. The lithofacies reconstruction of the confining unit along the fault trace indicates that shoaling (shallowing of the sea) occurred contemporaneously with movement along the fault, causing the stratigraphic section to become more sandy (Plates 3, 4, 5, and 13). This, in turn, is reflected in the higher leakance-coefficient values calculated for the Gordon along the fault trace and is due to the overall change in the lithology of the confining unit, not to breaching of the unit caused by offsets on the fault.

Leakance coefficients estimated from aquifer modeling of GSA were 4.4 x 10^{-5}/d (GeoTrans, 1986) and 2.38 x 10^{-5}/d (GeoTrans, 1992a). Leakance-coefficient values for the Gordon confining unit were estimated in GSA (Fig. 3) from a 7-day pumping test of the "Congaree" (Gordon) aquifer (CH2M Hill, 1989). The leakance coefficients ranged from 2.94 x 10^{-5}/d (well DRB-6W) to 5.72 x 10^{-5}/d (well HPT-2A), averaging 4.33 x 10^{-5}/d, using a calculated hydraulic-conductivity value of 1.47 x 10^{-4} ft/d at well DRB-6W and 2.86 x 10^{-4} ft/d at well HPT-2A and assuming 5 ft for the thickness of the unit. The limited amount of leakage occurring during the test was confirmed by the water level decline in well HPT-1B (0.18 ft), which is screened in the overlying Upper Three Runs aquifer.

The results of the pumping tests agree well with the leakance coefficients estimated from laboratory-derived hydraulic-conductivity values from wells P-27 and P-28 (Appendix 1) located near the pumping-test location. They ranged from 2.71 x 10^{-5}/d (at well P-28) to 5.43 x 10^{-5}/d (at well P-27), averaging 4.07 x 10^{-5}/d. The comparable, albeit very low, leakance values derived by the two methods of estimating leakance suggests that the Gordon confining unit is a significant barrier to flow in the central part of the study area. Indeed, it is generally observed that where laboratory-derived (point-source) leakance-coefficient values are comparable and track closely with those integrated values derived from pumping tests, the analysis of the lithostratigraphic and structural elements associated with the sedimentary section that composes the confining unit indicates that the thickness, lithologic composition, and continuity of the confining beds are consistent and correlative from well to well throughout the zone of influence of the subject pumping test. Thus, the consistency in the leakance-coefficient values derived by the two methods was found to correlate directly with both the lithology and thickness of the confining beds in the Gordon as well as to the overall continuity of the confining beds in the unit.

A multiple-well pumping test of the Gordon aquifer was conducted in GSA by Albenesius and others (1990), and hydraulic conductivity and leakance-coefficient values were estimated for the overlying Gordon confining unit. The leakance-coefficient values calculated from data at five of the six monitoring wells used during the test tracked very closely with the laboratory-derived values calculated at various wells in the test area. An exception to the comparable leakance-coefficient values occurred at well HSB-69A. Here, the hydraulic conductivity of the confining unit was estimated to be 2.9 x 10^{-3} ft/d, one to three orders of magnitude higher than estimates determined from undisturbed samples of the same clay beds in other wells in the same area. A leakance coefficient of 4.83 x 10^{-4}/d was estimated at well HSB-69A, using a value of 6 ft for the thickness of the Gordon confining unit. This is an order of magnitude higher than the average laboratory-derived leakance value (4.3 x 10^{-5}/d) from wells in the area, indicating a "localized area of increased leakance" or recharge. In the other five wells used for the test, no significant leakage (recharge) was reported during the pumping test and the data tended to fit the Theis non-leaky type curve. The marked departure of the leakance coefficient in the HSB-69A well from that calculated from laboratory permeameter tests of the Gordon confining-unit sediments suggests a breach and/or facies change near the well site that significantly changed the leakance (rate of recharge) through the confining unit into the underlying Gordon aquifer. Detailed stratigraphic analysis, high-resolution seismic surveys, and ground-penetrating radar surveys in the vicinity of HSB-69A indicate extensive faulting in the area (Wyatt and others, 1995) that breached the confining beds of the unit. The conclusion to be drawn is that in areas where there is a marked departure in leakance-coefficient values derived by the two methods as at well HSB-69A, breaching of the confining beds is suggested by lateral facies changes that disrupt the continuity of the confining beds and/or to offsets of the confining beds due to faulting.

Gordon aquifer unit.—The Gordon aquifer consists of all saturated strata that occur between the Gordon and the Crouch Branch confining units (Figs. 7 and 12). The aquifer is semiconfined, with a downward potential from the overlying Upper Three Runs aquifer (Fig. 22) observed in interfluvial areas, and an upward potential observed along the tributaries of the Savannah River where the Upper Three Runs aquifer is incised. The thickness of the Gordon aquifer ranges from 38 ft at well P-4A to 185 ft at well C-6 and generally thickens to the east and southeast (Plate 15). Thickness variations in the vicinity of the Pen Branch Fault suggest depositional effects owing to movements on the fault in early Eocene time. The Gordon aquifer is partially eroded in the vicinity of the Savannah River and Upper Three Runs Creek (Plate 15).

The Gordon aquifer is characterized by hydrogeologic properties of sediments penetrated in reference well P-27 located near the center of SRS (Plates 1 and 39a). The unit is 77 ft thick in well P-27 and occurs from 125 to 48 ft msl. The aquifer consists of the sandy parts of the Snapp Formation and the overlying Fourmile and Congaree Formations. The unit is composed of yellow, orange, and tan, moderately to poorly sorted, subangular, submature, fine- to coarse-grained, unconsolidated quartz sand with pebbly zones common (Robertson, 1990). Clay beds and stringers are present in the aquifer, but they are too thin and discontinuous to be more than local confining beds. The aquifer in wells P-21 and P-22 includes a clay bed that separates the Congaree and Fourmile Formations (Plates 3 and 5). The clay bed appears sufficiently thick and continuous to justify splitting the Gordon aquifer into zones in the southeastern quadrant of SRS.

Summary statistics for gravel-sand-mud percentages of 661 Gordon aquifer samples that contain less than 25 percent mud are given in Table 7. Gravel averages 1.7 percent, sand 95.6

Table 7. Summary of Folk and Ward statistics, gravel-sand-mud percentages, and calculated porosity and permeability values for samples from the Gordon aquifer unit that contain less the 25 percent mud

Parameter	Folk and Ward Statistics				Gravel	Sand	Mud	Porosity	Permeability	
	Mean[1]	Sorting[1]	Skewness	Kurtosis	(%)	(%)	(%)	(%)	(Darcy)	(ft/d)
Arithmetic mean	1.572	1.048	0.095	1.404	1.7	95.6	2.6	33.5	39.7	96.5
Confidence level (95%)	0.053	0.045	0.018	0.054	0.3	0.4	0.3	0.3	3.0	7.3
Number of samples	698	698	698	698	724	661	661	651	651	651
Median	1.521	0.877	0.080	1.172	0.2	97.7	1.3	34.0	26.0	63.3
Mode	1.380	0.780	0.299	1.107	0.0	98.8	1.2	35.0	9.0	21.9
25th percentile	1.075	0.700	-0.060	1.016	0.0	94.9	0.8	31.0	13.0	31.6
75th percentile	2.042	1.131	0.248	1.441	1.0	98.8	2.7	36.0	50.0	121.7
Standard deviation	0.708	0.613	0.242	0.724	4.5	5.6	3.5	3.7	38.9	94.6
Variance	0.501	0.376	0.058	0.525	20.5	31.9	12.3	13.9	1513.1	8956.5
Kurtosis	0.169	9.518	0.746	7.444	27.8	11.6	11.5	-0.7	4.2	4.2
Skewness	0.359	2.516	-0.188	1.923	4.0	-3.0	3.4	-0.3	1.6	1.6
Range	4.268	4.402	1.818	5.015	41.3	42.5	23.6	15.6	229.7	558.9
Maximum	-0.297	4.772	0.838	5.430	41.3	99.9	23.7	40.7	230.0	559.6
Minimum	3.971	0.370	-0.980	0.415	0.0	57.4	0.1	25.1	0.3	0.7
Trimean (5%)	1.565	0.996	0.094	1.347	1.1	96.2	2.2	33.5	36.9	89.7
Geometric mean	-	-	-	-	-	-	-	-	24.3	59.2
Harmonic mean	-	-	-	-	-	-	-	-	11.6	28.3

[1] Values are in phi units

percent, and mud 2.6 percent. Most gravel consists of subrounded to rounded grains of granule- and lower pebble-size quartz and quartzite. Hydrometer analyses of the mud fraction of seven Gordon sand samples show that silt- and clay-size particles occur in approximately equal amounts. The distribution of percent mud in the samples analyzed indicates that nearly 70 percent of them contain less than 2 percent mud (Fig. 27).

The mean grain size of 698 Gordon aquifer samples averages 1.57 ϕ (lower medium sand) and ranges from lower very coarse to lower very fine sand (Table 7; Fig. 28). Most of the sand is moderately and poorly sorted (Fig. 29). Robertson (1990) demonstrated that sorting of Gordon sand is controlled primarily by the amount of gravel and mud matrix; that is, the higher the percentage of gravel and mud matrix, the poorer the sorting. In part, this suggests that the mud in the Gordon sand may represent a diagenetic alteration product of original labile framework grains such as feldspar and ferromagnesian minerals.

Textural study of seven mud samples collected from thin, clay-rich layers in the Gordon aquifer shows that the sediment consists of 76.6 percent mud and 23.4 percent sand (Aadland and others, 1992b). Hydrometer analyses of the mud fractions of the samples indicate that clay-size particles are slightly more abundant than silt-size grains.

Robertson and Thayer (1990) demonstrated that Gordon aquifer sand plots as quartzarenite on Folk's (1980) classification diagram. Petrographic analyses of 42 thin sections show that the unit consists of 98.4 percent framework quartz, 0.3 percent feldspar, 0.5 percent heavy minerals, 0.4 percent opaque minerals, 0.4 percent muscovite, and 0.1 percent glauconite. Robertson and Thayer (1990) indicated that there is little or no variation in composition in the terrigenous sand between updip and downdip wells in the study area.

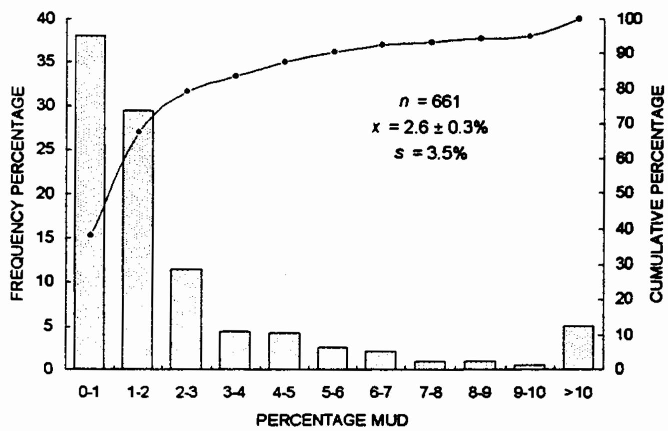


Figure 27. Percentage mud (silt + clay) in Gordon aquifer sand samples containing less than 25 percent mud.

Strom and Kaback (1992) did semiquantitative x-ray diffraction analyses on 18 Gordon clay-bearing sand samples collected from the P-well series. Their results show that the sand consists mostly of quartz with 5 to 18 percent clay. Smectite and kaolinite are the dominant clay minerals, with minor to trace quantities of illite. Authigenic minerals include clinoptilolite, 2-5 micron cristobalite lepispheres, and fibrous chalcedony (Strom and Kaback, 1992; Thayer, 1989). X-ray diffraction analyses of four sandy mud samples from intra-aquifer confining layers show that they consist of quartz and 51 to 64 percent clay minerals, chiefly kaolinite with minor illite and smectite. Five Gordon aquifer clayey sand to sand samples were analyzed from the C-well series by x-ray diffraction (Gelting, 1990; Gellici and others, 1995). The average clay mineral suite was: Illite, 58 percent; mixed-layer illite/smectite, 29 percent; kaolinite, 12 percent; and smectite, 1 percent.

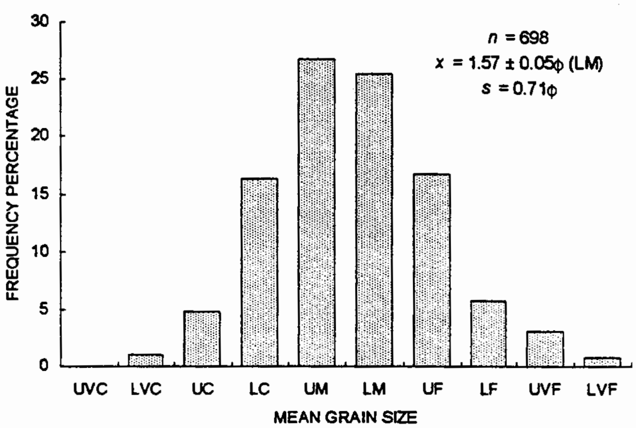


Figure 28. Mean grain size of samples from the Gordon aquifer. UVC, upper very coarse sand; LVC, lower very coarse sand; UC, upper coarse sand; LC, lower coarse sand; UM, upper medium sand; LM, lower medium sand; UF, upper fine sand; LF, lower fine sand; UVF, upper very fine sand; and LVF, lower very fine sand.

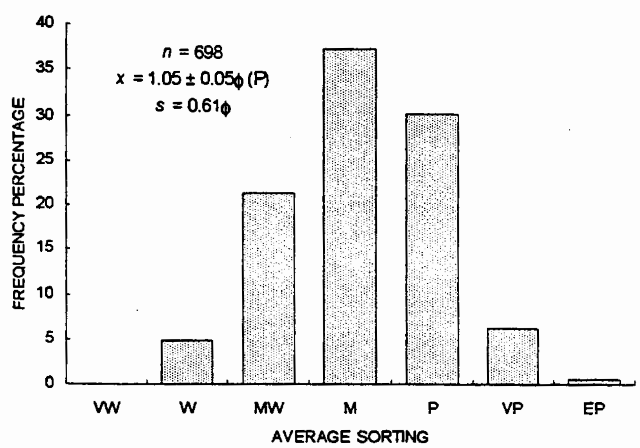


Figure 29. Sorting classes of Gordon aquifer samples. VW, very well sorted; W, well sorted; MW, moderately well sorted; M, moderately sorted; P, poorly sorted; VP, very poorly sorted; and EP, extremely poorly sorted.

Downdip, the quartz sand of the Gordon aquifer grades into quartz-rich, fossiliferous lime grainstone, packstone, and wackestone, which contain considerably more glauconite than their updip equivalents. The dominant allochems in the carbonate-rich rocks include foraminifers, pelecypods and other mollusks, echinoderms, bryozoans, intraclasts, and comminuted skeletal debris. Other constituents include detrital quartz, terrigenous clay, collophane, heavy and opaque minerals, and organic debris. Authigenic minerals include sparry calcite as a pore-filling cement and replacement, pyrite cubes and framboids, clinoptilolite, and fibrous chalcedony. Thin-section porosity of the limestone ranges from 5 to 30 percent and is mostly moldic and vuggy.

South of SRS, near well ALL-324 (Plate 1), the Gordon aquifer consists of interbedded glauconitic sand and shale, grading to glauconitic, argillaceous, fossiliferous, sandy limestone indicative of inner to middle shelf depositional environments. Farther south, beyond well C-10, the aquifer grades into platform limestone of the Lower Floridan aquifer of the carbonate phase of the Floridan aquifer system (Fig. 12).

Robertson (1990) and Robertson and Thayer (1990) constructed facies maps showing the areal distribution of textural parameters and permeability for the Gordon aquifer. The maps showed the following downdip (toward the southeast) changes. Mean and coarsest grain size decreased, sorting became poorer, and percent mud increased. Geometric mean permeability also decreased in a downdip direction and ranged from 90 Darcies (219 ft/d) in the northern part of SRS to 20 Darcies (49 ft/d) in the south. The decrease in permeability toward the south results from a decrease in mean grain size coupled with an increase in percent mud matrix and a deterioration of sorting (sorting becomes poorer).

The Gordon aquifer is recharged directly by precipitation in the outcrop area and in interstream drainage divides in and near the outcrop area (Fig. 22). South of the outcrop area, the Gordon is recharged by leakage from overlying and underlying aquifers. Because streams such as the Savannah River and Upper Three Runs Creek cut through the aquifers of the Floridan aquifer system, they represent no-flow boundaries. As such, water availability or flow patterns on one side of the boundary (stream) will not change appreciably due to water use on the other side. In the central part of SRS, where the Gordon confining unit is breached by faulting, recharge to the Gordon aquifer is locally increased (Aadland and others, 1991).

Most of the Gordon aquifer is under confined conditions, except along the fringes of Upper Three Runs Creek and the Savannah River. A potentiometric-surface map of the aquifer (Plate 42) shows that the natural discharge areas of the Gordon aquifer at SRS are the swamps and marshes along Upper Three Runs Creek and the Savannah River. These streams dissect the Floridan aquifer system, resulting in unconfined conditions in the stream valleys and probably in semiconfined (leaky) conditions near the valley walls. Reduced head in the vicinity of Upper Three Runs Creek induces upward flow from the Crouch Branch aquifer and develops the "head reversal" that is an important aspect of the SRS hydrogeological system (Fig. 30). The northeast-southwest oriented hydraulic gradient across SRS (Plate 42) is consistent and averages 4.8 ft/mi. The northeastward deflection of the contours along the Upper Three Runs Creek, indicates incisement of the sediments that constitute the aquifer by the creek.

Porosity and permeability of 651 Gordon aquifer sand samples were determined from sieve analyses (Beard and

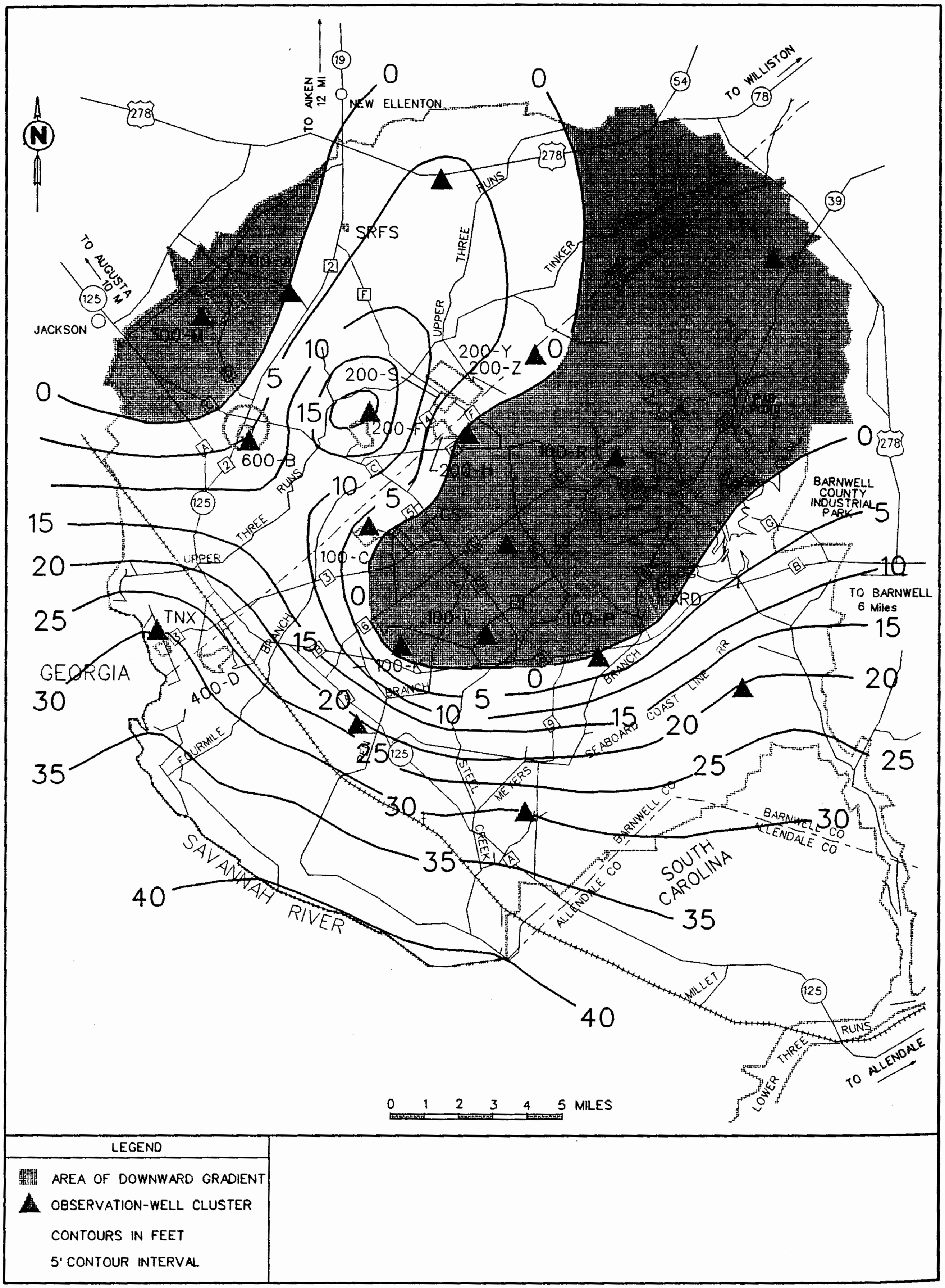


Figure 30. Hydraulic-head difference across the Crouch Branch confining unit, July 1990 (modified from Bledsoe and others, 1990).

Weyl, 1973). Porosity averages 33.5 percent and appears to follow a near-normal distribution (Fig. 31). Geometric mean permeability is 24.3 Darcies (59.1 ft/d) (Fig. 32); the distribution is approximately log-normal (Fig. 33).

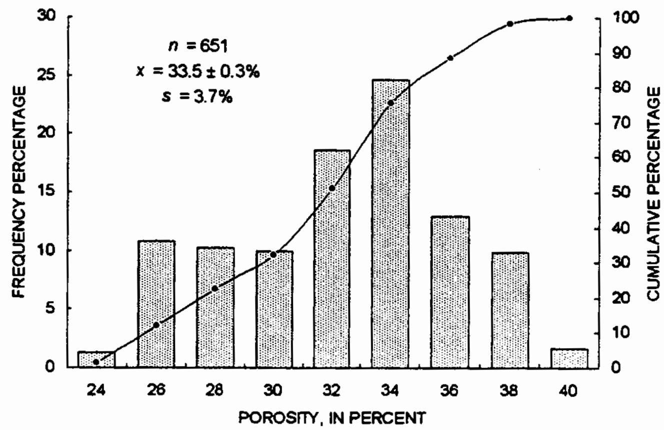


Figure 31. Calculated porosity values of Gordon aquifer sand samples containing less than 25 percent mud.

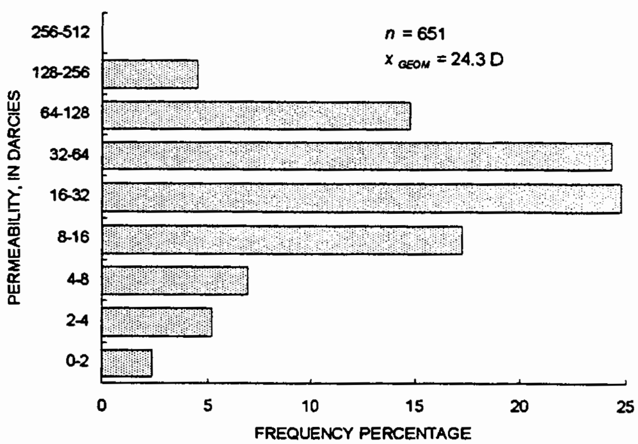


Figure 32. Calculated permeability values of Gordon aquifer sand samples containing less than 25 percent mud.

Hydraulic-conductivity data were obtained for 150 Congaree Formation core samples (upper part of the Gordon aquifer) from wells at the MWD Experimental Well Site (Kegley, 1993) just northeast of GSA (Plate 1). Results indicate that the Congaree Formation has an average permeability of 47.1 Darcies (114.4 ft/d), and the Fourmile Formation, 12.5 Darcies (30.4 ft/d).

GeoTrans (1992b) compiled data on 10 short-duration, low-discharge, single-well pumping tests of the Gordon aquifer at GSA. The average hydraulic-conductivity value was 13.8 ft/d, with a median of 1.91 ft/d. In addition, GeoTrans (1992b) compiled data from 41 Gordon aquifer slug tests in GSA. The average hydraulic-conductivity value was 4.90 ft/d and the median value was 2.82 ft/d. These data are generally an order of magnitude lower than the multiple-well, long-duration pumping test data for the Gordon.

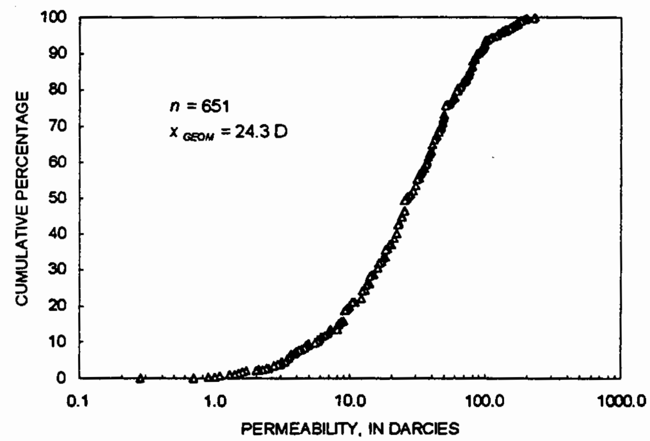


Figure 33. Cumulative frequency of calculated permeability values for Gordon aquifer sand sample with less than 25 percent mud.

Two constant-discharge, multiple-well pumping tests were made at Gordon aquifer wells at the H-Area Seepage Basins in GSA (Table 8; Fig. 34) (Albenesius and others, 1990). Transmissivity ranged from 1,644 ft^2/d to 2,253 ft^2/d, with an average of 2,013 ft^2/d, in Test 1; and from 1,812 ft^2/d to 2,562 ft^2/d, with an average of 2,269 ft^2/d, in Test 2. Some local leakage through the overlying Gordon confining unit was apparent in one of the six monitoring wells (HSB-69A well). Storage-coefficient estimates ranged from 2.2 x 10^{-4} to 3.1 x 10^{-4} for Test 1, with an average of 2.7 x 10^{-4}, and from 2.0 x 10^{-4} to 2.9 x 10^{-4} for Test 2, with an average of 2.5 x 10^{-4}. Using thicknesses of the aquifer measured at the individual monitoring wells, horizontal hydraulic conductivity estimates ranged from 24 to 38 ft/d, averaging 31 ft/d for Test 1; and they ranged from 27 to 41 ft/d, averaging 34 ft/d, for Test 2.

Where local leakage was observed through the overlying Gordon confining unit at monitoring well HSB-69A, transmissivity estimates obtained by the Hantush-Jacob leaky-aquifer solution were 1,292 ft^2/d for Test 1 and 1,247 ft^2/d for Test 2 (Albenesius and others, 1990). The storage-coefficient estimate was 3.6 x 10^{-4} for Test 1, and 2.9 x 10^{-4} for Test 2. The vertical hydraulic conductivity of the Gordon confining unit measured at the MSB-69A well was estimated to be 2.9 x 10^{-3} ft/d. This is one to three orders of magnitude higher than estimates based on undisturbed samples collected from the Gordon confining unit at wells in the area where the pumping test was made.

A long-duration, multiple-well pumping test of the Gordon aquifer in GSA was made in April 1989 (CH2M Hill, 1989) (Table 8). This test employed a fully penetrating pumping well with three observation wells screened in the Gordon aquifer and one in the overlying lower portion of the Upper Three Runs aquifer. The results of the test indicate that the Gordon aquifer has a transmissivity that ranges from 2,000 to 2,290 ft^2/d and a storage coefficient from 8.8 x 10^{-4} to 2.3 x 10^{-4}. The hydraulic conductivity is approximately 38 ft/d, utilizing an aquifer thickness of 61 ft (CH2M Hill, 1989). The value agrees well with the HSB-84A pumping tests. Transmissivity values also were very similar.

Results from three other aquifer pumping tests of the Gordon

Table 8. Hydraulic characteristics obtained from computer modeling and from aquifer tests of the Gordon aquifer

Source	Area	Pumped well	Monitored well	Transmissivity (ft^2/d)	Storage coefficient	Leakance (ft/d/ft)	Hydraulic conductivity (ft/d)
Albenesius and others (1990) Test 1	H-Area	HSB-84A	HSB-68A	2,009	2.2×10^{-4}	–	31
	H-Area	HSB-84A	HSB-86A	2,055	2.7×10^{-4}	–	38
	H-Area	HSB-84A	HSB-118A	2,102	3.0×10^{-4}	–	–
	H-Area	HSB-84A	HSB-139A	1,644	3.1×10^{-4}	–	–
	H-Area	HSB-84A	HSB-83A	2,253	2.3×10^{-4}	–	24
	H-Area	HSB-84A	HSB-69A	1,292	3.6×10^{-4}	4.83×10^{-4}	–
Albenesius and others (1990) Test 2	H-Area	HSB-84A	HSB-68A	2,202	2.0×10^{-4}	–	34
	H-Area	HSB-84A	HSB-86A	2,226	2.7×10^{-4}	–	41
	H-Area	HSB-84A	HSB-118A	2,543	2.6×10^{-4}	–	–
	H-Area	HSB-84A	HSB-139A	1,812	2.9×10^{-4}	–	–
	H-Area	HSB-84A	HSB-83A	2,562	2.2×10^{-4}	–	27
	H-Area	HSB-84A	HSB-69A	1,124	2.9×10^{-4}	–	–
CH_2M Hill (1989)	H-Area	HPT-1A	HPT-2A	2,290	2.3×10^{-4}	5.72×10^{-5}	38
	H-Area	HPT-1A	DRB-6WW	2,000	8.8×10^{-4}	2.94×10^{-5}	–
Snipes (per. com.)	MWD	–	–	–	–	–	29
Sirrine (1991d)	Par Pond	905-131G	905-18G	2,116	2.8×10^{-4}	–	35
Newcome (1993)	Barnwell	BRN-57	BRN-57	4,680	–	–	32
	Barnwell	BRN-61	BRN-61	5,880	–	–	41
	Blackville	BRN-75	BRN-75	4,140	–	–	41
Christensen and Gordon (1983)	C-Area	–	–	7,900	–	–	–
	P-Area	–	–	13,400	–	–	–
	M-Area	–	–	147	–	–	–
Duffield and others (1986)	GSA	Flow Model		3,800	–	4.4×10^{-5}	38?

aquifer (Christensen and Gordon, 1983)–two conducted near GSA, the third in A-M Area–are included in Table 8. The transmissivity values for the two tests made near GSA are significantly higher than the results from GSA, while the transmissivity value from the A-M Area pumping test is significantly lower. The aquifer tests reported by Christensen and Gordon (1983) are difficult to interpret because, in the past, the Congaree Formation and the overlying Tinker/Santee Formation or "rocks of Claiborne age" were combined hydrostratigraphically and included in the early tests.

A long-duration, multiple-well pumping test of the Gordon aquifer was conducted at the MWD Experimental Wellfield Site (Snipes, 1994, personal communication) located northeast of H-Area in the vicinity of well P-14 (Fig. 34). The well was pumped for 24 hours at 63 gal/min. Data from two observation wells indicate a hydraulic-conductivity value of 29 ft/d. No estimate of vertical hydraulic conductivity was attempted for the overlying Gordon confining unit; however, a monitoring well screened in the next-higher Upper Three Runs aquifer showed a drawdown of 0.08 ft during the test, most likely indicating leakage across the Gordon confining unit.

A multiple-well pumping test of well 905-131G (BRN-810) was made near Par Pond using observation well 905-18G. Both wells were screened in the lower portion of the Gordon aquifer (Fourmile Formation) (Sirrine, 1991d). The results indicate a transmissivity of 2,116 ft^2/d, a specific capacity of 1.07 gal/min/ft of drawdown, and a storage coefficient of 2.8 x 10^{-4}. Assuming a total sand thickness for the Gordon aquifer of 60 ft, a hydraulic conductivity of 35 ft/d is calculated. No evidence of leakage or recharge was observed from the drawdown data.

Two single-well, constant-discharge pumping tests were made near the town of Barnwell at wells screened in the Gordon aquifer (BRN-57 and BRN-61) (Fig. 34). The BRN-57 test produced a transmissivity value of 35,000 gal/d/ft (4,680 ft^2/d) and a specific capacity of 8.2 gal/min/ft while pumping at 536 gal/min (Newcome, 1993). The BRN-61 test yielded a transmissivity value of 44,000 gal/d/ft (5,880 ft^2/d) and a specific capacity of 15 gal/min/ft while pumping at 530 gal/min. Aquifer thickness is estimated to be 145 ft, indicating a hydraulic conductivity of 32 ft/d for well BRN-57 and 41 ft/d for well BRN-61, comparable to the test results in GSA. The town of Barnwell has a total of 11 wells screened in the Gordon aquifer, ranging in depth from 252 to 365 ft and pumping an average 2.3 mgd (Newcome, 1990).

A single-well pumping test in the town of Blackville at a well screened mostly in the Gordon aquifer but partly in the

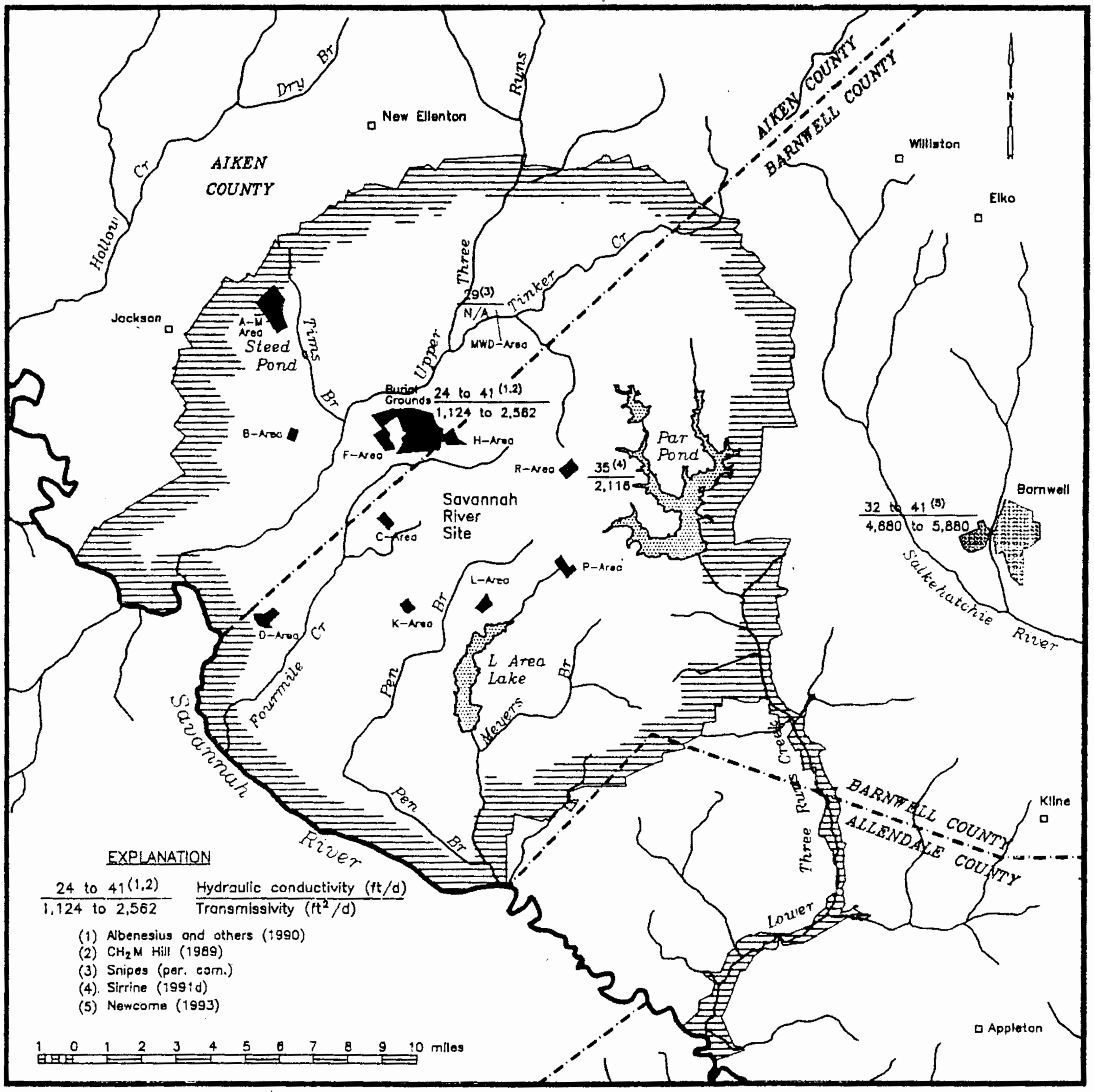


Figure 34. Distribution of pumping-test results for the Gordon aquifer.

Crouch Branch aquifer (BRN-75) produced a transmissivity of 31,000 gal/d/ft (4,100 ft^2/d) and a specific capacity of 6.9 gal/min/ft while pumping at 703 gal/min. Assuming an aquifer thickness of 100 ft, the hydraulic conductivity of the aquifer near Blackville is 41 ft/d.

The average hydraulic-conductivity value for the Gordon aquifer, derived from the eight long-duration pumping tests is 35 ft/d. A hydraulic-conductivity of 38 ft/d (GeoTrans, 1986, 1989, and 1992b) was used for calibrating a GSA areawide flow model. The value is well within the range of the hydraulic conductivities derived from the long-duration pumping tests made in the area. The weighted average hydraulic-conductivity value for the Gordon aquifer from the MWD Experimental Well Site is 95.7 ft/d, approximately three times the average hydraulic-conductivity value obtained from the eight long-duration, single- and multiple-well pumping tests of the Gordon aquifer in the study area.

Time-drawdown data were available for only two wells tapping the Gordon aquifer in Georgia (Clarke and others, 1985), one in Pulaski County and the other in Screven County. The transmissivity of the aquifer was calculated as 9,800 ft^2/d at the Pulaski County well and 3,500 ft^2/d at the Screven County well. Specific-capacity values for wells tapping the Gordon aquifer system range from 2.5 gal/min/ft in Glasscock County to 50.4 gal/min/ft in Screven County. Transmissivity values for the Gordon aquifer system, as computed from specific-capacity data and using Jacob's modified nonequilibrium formula (Ferris and others, 1962), range from 620 ft^2/d in Glasscock County to 13,000 ft^2/d in Screven county. Transmissivity computed from specific-capacity data was 10 percent lower than the value computed from the time-drawdown data in the Pulaski County well, indicating the well was 90 percent efficient. Transmissivity computed in the Screven County well was 30 percent lower than the value calculated from the time drawdown data, indicating the well was 70 percent efficient. Transmissivity of the Gordon aquifer system is generally greatest in the southern part of the area where the aquifer system is thickest (Clarke and others, 1985).

Transmissivity values obtained from wells that tap both the Gordon aquifer system and the overlying Jacksonian aquifer (Vincent, 1982), which is correlative with the Upper Three Runs aquifer in the study area, are only slightly higher than those of nearby wells that tap only the Gordon aquifer. In these wells the transmissivity ranges from 2,400 ft^2/d in Washington County to 14,900 ft^2/d in Bleckley County.

Yields of producing wells from the Gordon aquifer also are quite variable. Reported yields from some wells at SRS are as high as 660 gal/min, with a specific capacity of 13.2 gal/min/ft of drawdown, and as low as 30 gal/min, with a specific capacity of 1 gal/min/ft of drawdown. Wells in the Barnwell municipal well field (east of SRS) and screened in the Gordon aquifer produce 400 gal/min, with a specific capacity of 10 gal/min/ft of drawdown. Updip, in the northwestern part of the study area, the Gordon aquifer includes mostly clayey sand, and well yields are not nearly as high. Wells in this area generally produce 20-30 gal/min with about 30 ft of drawdown. This is sufficient, however, for some light industrial and commercial uses. The Edisto Experimental Station at Blackville, S.C., pumps an average of about 20,000 gal/d from the Gordon aquifer. Many rural domestic water supplies are developed in the Gordon in Barnwell and northern Bamberg Counties, S.C. Wells tapping the Gordon aquifer have yields ranging from 87 gal/min in Glasscock County, Ga. (Clarke and others, 1985), to 1,815 gal/min in Screven County. Head differences between the Gordon aquifer and overlying and underlying aquifers are illustrated in Figures 22 and 30.

In general, hydraulic-conductivity estimates derived from the long-duration, single- and multiple-well pumping tests of the Upper Three Runs, Gordon, and Steed Pond aquifers differ significantly (Table 9). The hydraulic-conductivity value calculated for the poorly sorted, often clayey sand of the "upper" aquifer zone of the Upper Three Runs aquifer in GSA is 13 ft/d (based on one reliable pumping test) and 10 ft/d for the "lower" aquifer zone (based on one reliable pumping test). In contrast, the average hydraulic conductivity is 35 ft/d (from eight reliable pumping tests) for the clean, moderately sorted sand of the Gordon aquifer (Table 9), and 58 ft/d (from eight reliable pumping tests) for the clean, coarse-grained pebbly sand of the "Lost Lake" aquifer zone (updip hydrostratigraphic equivalent of the Gordon aquifer) of the Steed Pond aquifer in A-M Area.

The hydraulic-conductivity values derived from slug tests and the short-duration, low-discharge, single-well pumping tests of the aquifer zones in the Upper Three Runs aquifer, the Gordon aquifer in GSA, and the updip "Lost Lake" aquifer zone of the Steed Pond aquifer in A-M Area are two to ten times lower than the values derived from the long-duration, single- and multiple-well pumping tests (Table 9). Differences in the average, and especially in the median hydraulic-conductivity values derived from the slug test data, and the short-duration, low-discharge, single-well pumping test data are insignificant between the aquifer units and zones in GSA and only 2.5 times greater in A-M Area compared to GSA.

In general, the monitoring wells used to conduct the slug tests and the short-duration (30-minute to 2-hour), low-discharge, single-well pumping tests at SRS are mud-rotary drilled wells. The technique commonly results in infiltration of the drilling mud into the formation and damage to the formation in the immediate vicinity of the bore hole. Slug tests and the low-discharge, short-duration, single-well pumping tests evidently stress the sand pack used in the construction and development of the screened interval in the well and the immediate area around the bore hole where damage caused by drilling mud infiltration may have occurred. In addition, the slug tests and low-discharge, short-duration, single-well pumping tests may reflect the impact of short screens and inefficient well design, resulting in reduced hydraulic-conductivity values.

The consistency in the hydraulic-conductivity values derived from the slug tests in the "upper" and "lower" aquifer zones of the Upper Three Runs aquifer and the Gordon aquifer supports the conclusion that it is mostly the hydraulic characteristics of the sand pack and invaded zones of the formation that are being measured and not the properties of the undisturbed formation. The grain size and construction of the sand pack in the screened interval of monitoring wells drilled at SRS are, by common design, virtually identical. In contrast, long-duration, large-scale, multiple-well pumping tests with fully penetrating screens stress the entire thickness of the aquifer throughout the region of influence of the tests and give a more reliable estimation of aquifer properties, because they measure the undisturbed formation throughout the area of influence of the tests.

Steed Pond aquifer unit.—North of Upper Three Runs Creek where the Floridan-Midville aquifer system is defined, the permeable beds that correspond to the Gordon and Upper Three Runs aquifers of the Floridan aquifer system are only locally separated, owing to the thin and intermittent character of the intervening clay beds of the Gordon confining unit (Warley Hill Formation) and to erosion by the local stream systems that dissect the interval. Here, the aquifers coalesce to form the Steed Pond aquifer of the Floridan-Midville aquifer system (Figs. 11 and 12; Plates 3, 4, and 5).

The Steed Pond aquifer is defined by hydrogeologic characteristics of sediments penetrated in well MSB-42 (Plates 39e and 41) located in A-M Area in the northwest corner of SRS (Fig. 2; Plate 11). The aquifer is 97 ft thick and includes sand and clayey sand in four beds, totaling 86 ft, of the Fourmile and Congaree Formations and the lower part of the Dry Branch Formation from the water table to the clay and clayey sand of the Crouch Branch confining unit. Permeable beds consist mainly of subangular, coarse- and medium-grained, slightly gravelly, submature quartz sand and clayey sand (Fallaw and Price, 1992). Locally, the Steed Pond aquifer can be divided into zones. In A-M Area three zones are delineated, the "Lost Lake" and the overlying "M Area" aquifer zones, separated by clay and clayey sand beds of the "green clay" confining zone (Fig. 11) (Aadland and others, 1992a). Core and downhole geophysical data from more than 142 wells were used in A-M Area to characterize the zones in the Steed Pond aquifer (Appendix 3) (Aadland and others, 1995; WSRC-RP-92-837, 1992).

Strom and Kaback (1992) determined the composition of eight Steed Pond sand samples from the P-well series with x-ray diffraction. The sand is quartz with less than 5 percent clay matrix. Smectite and kaolinite are the dominant clay minerals with minor to trace amounts of illite. Five Steed Pond clay and sandy clay samples from the C-well series were also analyzed by x-ray diffraction (Gelting, 1990; Gellici and

Table 9. Hydraulic-conductivity values from single- and multiple-well aquifer tests and slug tests for the Upper Three Runs, Gordon, and Steed Pond aquifers.

Hydrologic unit	Type of test	Number of tests	Mean hydraulic conductivity (ft/d)	Median hydraulic conductivity (ft/d)	Source
"Upper" aquifer zone of Upper Three Runs aquifer	Slug tests	190	5.62	1.38	GeoTrans (1992b)
do.	Short-duration single-well pumping tests	38	0.67	0.61	Parizek and Root (1986)
do.	Short-duration single-well pumping tests	14	5.09	1.22	Evans and Parizek (1991)
do.	Long-duration multiple-well pumping tests	1	13	--	D'Appolonia (1981)
do.	Minipermeameter tests	317	12.6	--	Kegley, (1993)
"Lower" aquifer zone of Upper Three Runs aquifer	Slug tests	173	5.62	1.00	GeoTrans (1992b)
do.	Short-duration single-well pumping tests	51	0.91	0.90	Parizek and Root (1986)
do.	Short-duration single-well pumping tests	7	33.3	1.67	Evans and Parizek (1991)
do.	Long-duration single-well pumping tests	4	1.06	N/A	D'Appolonia (1981)
do.	Long-duration multiple-well pumping test	1	10	--	Chas. T. Main, Inc. (1990)
do.	Pumping test	1	19	--	Christensen and Gordon (1983)
do.	Minipermeameter tests	199	23.8	--	Kegley, (1993)
Steed Pond aquifer	Long-duration multiple-well pumping tests	4	43	N/A	Geraghty and Miller (1986)
"M-Area" aquifer zone of the Steed Pond aquifer	Slug tests	6	2.19	N/A	Sirrine (1991c)
"Lost Lake" aquifer zone of the Steed Pond aquifer	Slug tests	14	18.9	N/A	Sirrine (1991c)
do.	Long-duration mulitple-well pumping tests	8	58	N/A	Geraghty and Miller (1986)
do.	Long-duration multiple-well pumping test	1	31.2	--	Hiergesell (1993)
Gordon aquifer	Slug tests	41	4.9	2.82	GeoTrans (1992b)
do.	Short-duration single-well pumping tests	10	13.8	1.91	do.
do.	Long-duration single- and multiple-well pumping tests	8	35	N/A	(see text)

others, 1995). Quartz averages 28 percent of the bulk sample and clay minerals 72 percent. The average clay-mineral suite is: kaolinite, 54 percent; Illite, 20 percent; mixed-layer illite/smectite, 12 percent; and smectite, 2 percent.

Petrographic analysis of five Steed Pond sand samples from well C-2 indicates that they are quartzarenite composed of monocrystalline quartz with accessory polycrystalline quartz and minor sedimentary rock fragments, heavy and opaque minerals, muscovite, and detrital grains of kaolinite (Thayer, 1989). Clay matrix ranges from 1.8 to 2.6 percent and consists of silt-size angular quartz, ground-up mica, and detrital clay.

Summary statistics were compiled for gravel-sand-mud percentages of 260 Steed Pond sand samples that contain less than 25 percent mud (Table 10). Gravel averages 2.7 percent, sand 94.3 percent, and mud 2.9 percent. Hydrometer analyses of the mud fraction of 14 sand samples indicate that clay is often more abundant than silt. The distribution of percent mud in Steed Pond samples shows that nearly 70 percent contain less than 3 percent mud (Fig. 35).

Mean grain size of the sampled population is 1.39 ϕ (upper medium sand); about 75 percent of the samples range from lower coarse to upper fine sand (Fig. 36). Sorting of Steed Pond samples averages 0.98 ϕ, which is moderately well sorted on the Folk and Ward (1957) verbal scale (Fig. 37). Generally, sorting is controlled by the amount of mud matrix; the higher the percentage of mud, the poorer the sorting.

Porosity and permeability of 285 Steed Pond samples containing less than 25 percent mud were determined from sieve analyses. The porosity of Steed Pond sand averages 33.9 percent (Table 10) and approximates a near-normal distribution (Fig. 38). The geometric mean permeability of the samples is 31.1 Darcies (75.6 ft/d) (Fig. 39). The permeability values follow an approximate log-normal distribution and are skewed toward lower values (Fig. 40).

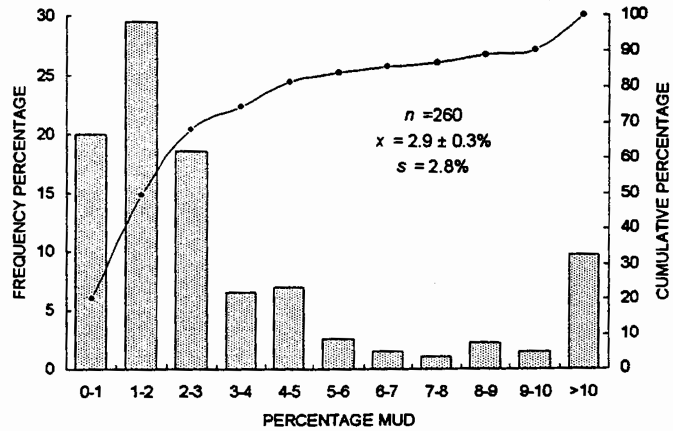


Figure 35. Percentage mud (silt + clay) in Steed Pond aquifer sand samples containing less than 25 percent mud.

Bledsoe and others (1990) measured the porosity and hydraulic conductivity of one muddy-sand sample and three intra-aquifer mud samples (silty clay and sandy clay) (Tables 1 and 2) from the Steed Pond aquifer. The porosity of the muddy-sand sample is 53 percent, and the vertical hydraulic conductivity is 2.29 x 10^{-3} ft/d. The horizontal hydraulic-conductivity value is 1.92 x 10^{-4} ft/d. The average porosity of

Table 10. Summary of Folk and Ward statistics, gravel-sand-mud percentages, and calculated porosity and permeability values for sand samples from the Steed Pond aquifer unit that contain less than 25 percent mud

Parameter	Folk and Ward Statistics				Gravel	Sand	Mud	Porosity	Permeability	
	Mean[1]	Sorting[1]	Skewness	Kurtosis	(%)	(%)	(%)	(%)	(Darcy)	(ft/d)
Arithmetic mean	1.390	0.981	0.093	1.249	2.7	94.3	2.9	33.9	44.9	109.2
Confidence level (95%)	0.081	0.045	0.019	0.043	0.7	0.8	0.3	0.4	4.3	10.6
Number of samples	295	295	295	295	302	260	260	285	285	285
Median	1.341	0.869	0.093	1.168	0.4	97.0	2.0	34.2	35.0	85.2
Mode	1.139	1.302	-0.014	1.429	0.0	97.9	5.5	34.0	20.0	48.7
25th percentile	0.946	0.729	-0.016	1.054	0.0	93.0	1.1	31.3	18.0	43.8
75th percentile	1.877	1.142	0.197	1.338	2.0	98.3	3.4	36.5	61.0	148.4
Standard deviation	0.710	0.391	0.171	0.373	6.0	6.7	2.8	3.7	37.4	91.1
Variance	0.505	0.153	0.029	0.139	36.4	45.3	7.6	14.0	1402.1	8300.0
Kurtosis	0.043	3.449	0.210	10.380	16.5	10.0	3.5	-0.7	3.4	3.4
Skewness	0.035	1.554	-0.088	2.649	3.8	-2.8	2.0	-0.3	1.6	1.6
Range	3.905	2.501	0.919	2.625	41.3	43.2	13.8	16.0	200.0	486.6
Maximum	-0.604	2.892	0.538	3.295	41.3	99.6	14.1	41.0	201.0	489.0
Minimum	3.301	0.391	-0.381	0.670	0.0	56.4	0.3	25.0	1.0	2.4
Trimean (5%)	1.728	0.907	-0.037	1.095	1.7	92.8	7.2	35.2	32.0	77.9
Geometric mean	-	-	-	-	-	-	-	-	31.1	75.6
Harmonic mean	-	-	-	-	-	-	-	-	18.1	44.1

[1] Values are in phi units

the three mud samples is 53 percent, and the geometric mean vertical hydraulic conductivity is 3.04×10^{-4} ft/d. The geometric mean horizontal hydraulic conductivity of the mud samples is 4.57×10^{-4} ft/d.

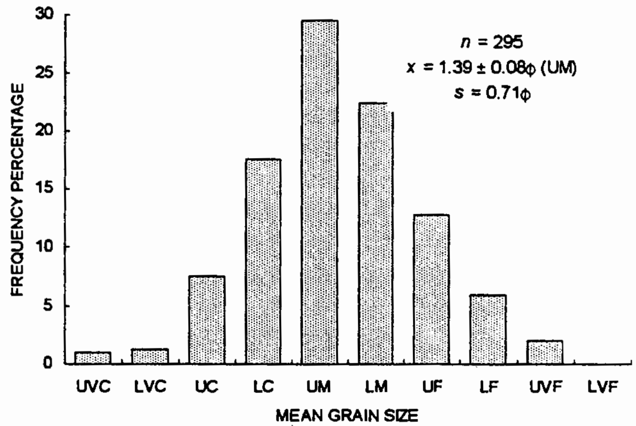


Figure 36. Mean grain size of Steed Pond aquifer samples. UVC, upper very coarse sand; LVC, lower very coarse sand; UC, upper coarse sand; LC, lower coarse sand; UM, upper medium sand; LM, lower medium sand; UF, upper fine sand; LF, lower fine sand; UVF, upper very fine sand; and LVF, lower very fine sand.

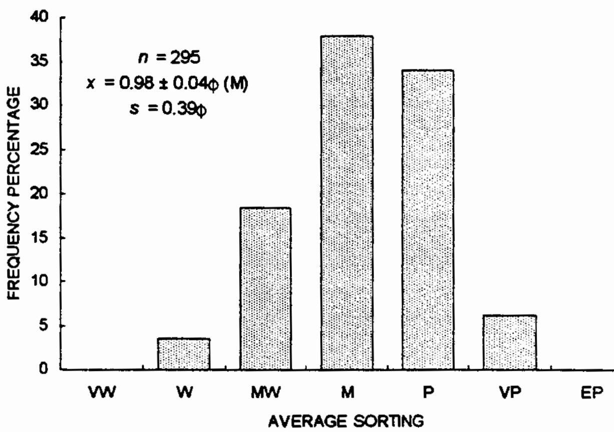


Figure 37. Sorting classes of Steed Pond aquifer samples. VW, very well sorted; W, well sorted; MW, moderately well sorted; M, moderately sorted; P, poorly sorted; VP, very poorly sorted; and EP, extremely poorly sorted.

Multiple-well, long-duration, pumping tests by Geraghty and Miller (1986), in A-M Area, using wells screened in the entire Steed Pond aquifer (Table 11) resulted in four transmissivity estimates from tests with moderate to high levels of confidence. The reported transmissivities ranged from 18,909 gal/d/ft (2,528 ft^2/d) to 37,882 gal/d/ft (5,064 ft^2/d), and averaged 25,826 gal/d/ft (3,453 ft^2/d). Hydraulic conductivities, calculated by using the thickness of the aquifer, ranged from 31.6 ft/d to 63.1 ft/d and averaged 43.0 ft/d.

In A-M Area, the clay and clayey sand beds of the Warley Hill Formation (Fig. 11; Plate 41) divide the Steed Pond aquifer into two aquifer zones, the "M-Area" aquifer zone and the underlying "Lost Lake" aquifer zone (Aadland and others, 1992a; Lewis and Aadland, 1992). The "M-Area" aquifer zone extends from the water table to the "green clay" confining zone and consists of sand of the Tinker and Dry Branch Formations where saturated below the water table (Plate 41). The aquifer zone is composed of orange to tan and yellow, fine to coarse, poorly to well-sorted sand (Fallaw and Price, 1992). Pebbly layers are common. Interbedded clay laminae are common, as are tan, green, yellow, and brown clay beds that are up to 8 ft thick.

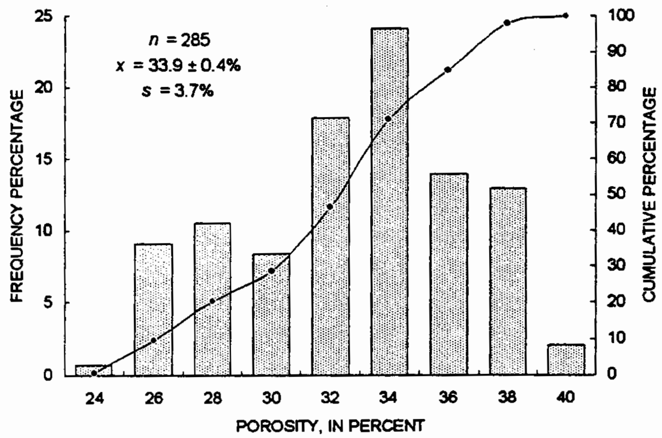


Figure 38. Calculated porosity values of Steed Pond aquifer sand samples containing less than 25 percent mud.

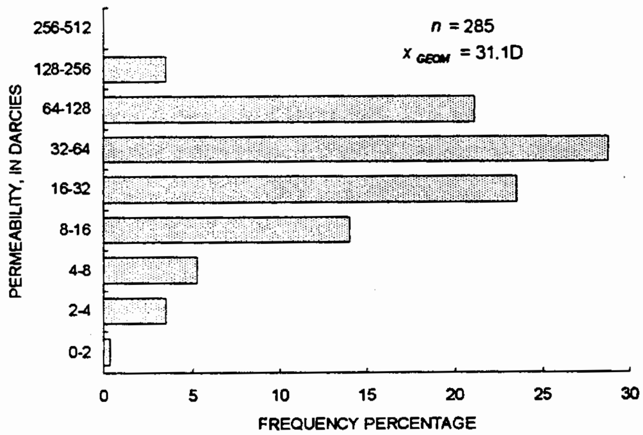


Figure 39. Calculated permeability values of Steed Pond aquifer sands containing less than 25 percent mud.

The water table occurs approximately 150 ft below land surface in the divide area between Tims Branch and the Savannah River flood plain (Fig. 22; Plate 1). The water table ranges from 235 ft msl in northern A-M Area to 203 ft msl in southern A-M Area near Tims Branch. The aquifer zone ranges from about 40 ft in saturated thickness at the MSB-19 well (Plate 11) to 5 ft or less at the horizontal well demonstration site (Eddy and others, 1991) and to zero feet elsewhere. In approximately one-third of the 70 wells screened below the water table that were used in the A-M Area regional hydrogeologic study (Aadland and others, 1992a; Lewis and Aadland, 1992), the well screens and the gravel pack (screens are generally 20 ft in length and the gravel packs range from 32 to 35 ft in length) straddle the sand of the basal Tinker/Santee Formation and the clay-rich beds of the Warley Hill Formation. Consequently, some of the water-level measurements made in these wells represent a composite "averaged" water level of the "M-Area" aquifer zone and the underlying "Lost Lake" aquifer zone, or they reflect a perched water table resting on the clay-rich beds of the "green clay" confining zone, and not the main regional water table.

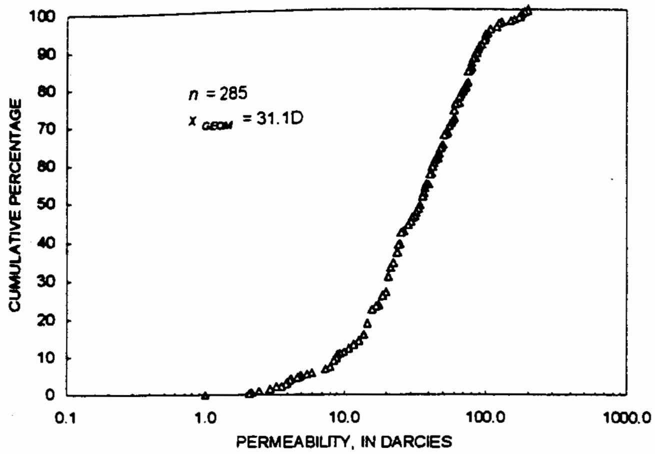


Figure 40. Cumulative frequency of calculated permeability values for Steed Pond aquifer sand samples with less than 25 percent mud.

In A-M Area, water enters the subsurface through precipitation, and recharge into the "M-Area" aquifer zone occurs at the water table by infiltration downward from the land surface. Ground water moves, in part, laterally to the southeast towards Tims Branch (Plate 11) and southwest towards Upper Three Runs Creek and the Savannah River flood plain, or it moves downward and leaks through the "green clay" confining zone into the "Lost Lake" aquifer zone (Aadland and others, 1992a).

Few data are available on the hydraulic properties of the "M-Area" aquifer zone. Hydraulic-conductivity estimates for the zone, based on seven slug tests, were reported by Sirrine (1991d). In one of the wells used for the tests the screen extended into the "Lost Lake" aquifer zone, resulting in questionable data. The hydraulic-conductivity values for the six reliable slug tests range from 0.01 to 10.87 ft/d, averaging 2.19 ft/d, compared to the 5.18 ft/d value reported by Sirrine for the seven tests.

Several ground water flow and transport models have been developed to support the ground water corrective action program in A-M Area (DuPont, 1986; Haselow, 1991, written communication). Ground water modeling of the "M-Area" aquifer zone used calibrated horizontal hydraulic-conductivity estimates of 9 ft/d (DuPont, 1986) and 7 ft/d (Haselow, 1991, written communication). The vertical hydraulic-conductivity was generally assumed to be one order of magnitude less than the horizontal hydraulic conductivity (namely, 0.9 or 0.7 ft/d, respectively), which is typical of clay-rich coastal plain sediments. Calibration of these models is based on matching water levels as well as data on recharge and stream flow in the model area. Thus, the calibrated models provide a means of determining aquifer parameters, and they represent the consolidation of several types of data based on fundamental hydrologic relationships and mathematical algorithms. Table 12 lists aquifer parameters resulting from model calibration in A-M Area (Eddy and others, 1991).

A ground-water divide exists in A-M Area in which water flows southwest towards the Savannah River flood plain and south to Tims Branch and Upper Three Runs Creek (Aadland and others, 1992a). The horizontal hydraulic gradient of the "M-Area" aquifer zone is calculated to be 0.0034 ft/ft towards the southwest and 0.0068 ft/ft towards the south, twice the gradient observed to the southwest. Using a horizontal hydraulic conductivity of 7 ft/d (Haselow, 1991, written communication) and an effective porosity of 20 percent, the ground water flow velocity to the southwest, towards the Savannah River flood plain, is estimated to be 0.119 ft/d or 43 ft/yr. Using the same parameters, the ground water flow

Table 11. Pumping-test results for the Steed Pond aquifer in A-M area

Pumped well	Monitored well	Well separation (ft)	Transmissivity (gal/d/ft)	Transmissivity (ft^2/d)	Storage coefficient	Leakance (ft/d/ft)	Hydraulic conductivity (ft/d)
RWM-6	RWM-7	720	21,366	2,856	6.0×10^{-4}	5.0×10^{-4}	35.7
RWM-7	RWM-6	760	18,909	2,528	6.3×10^{-4}	1.3×10^{-3}	31.6
RWM-8	RWM-10	870	25,148	3,362	9.0×10^{-4}	3.6×10^{-4}	42.0
RWM-11	RWM-5	720	37,882	5,064	5.0×10^{-5}	5.7×10^{-4}	63.1

velocity to the south, towards Tims Branch and Upper Three Runs Creek, is 0.238 ft/d or 86 ft/yr.

In analyses made by Sirrine (1991c), a horizontal hydraulic gradient of 0.0035 ft/ft was calculated for the "M-Area" aquifer zone. Sirrine used an average horizontal hydraulic-conductivity value of 5.18 ft/d determined from seven slug tests, in one of which the screen extended into the "Lost Lake" aquifer zone resulting in questionable data. Assuming an effective porosity of 20 percent for slightly silty or clayey sand, the ground water flow velocity in the "M-Area" aquifer zone was estimated to be 0.09 ft/d or 33 ft/yr. As with their analysis of the other aquifer zones, they concluded that the flow rate could be considerably higher or lower, depending on the horizontal hydraulic conductivity estimate used to calculate it.

None of the well clusters in A-M Area include more than one well screened entirely in the "M-Area" aquifer zone. Therefore, vertical hydraulic gradients for the zone could not be measured directly. Water-table wells in these well clusters are screened in the sand of the "M-Area" aquifer zone, as well as the clayey sand and clay beds of the underlying "green clay" confining zone. The next lower screen typically is set in the sand of the underlying "Lost Lake" aquifer zone (Plate 41). Thus, the vertical hydraulic gradients measured between the two screens are those across the "green clay" confining zone. A vertical hydraulic gradient, however, can be estimated for the "M-Area" aquifer zone in those areas where the clay beds of the "green clay" confining zone are very thin or absent. Here, the lithology of the "green clay" confining zone interval is comparable to that observed in the overlying "M-Area" aquifer zone, and the vertical hydraulic gradient measured at these well clusters reflects the gradient typical of the overlying aquifer zone.

Using five wells in northern A-M Area (Plate 11) (MSB-37, MSB-42, MSB-47, MSB-54, and MSB-69) where clay beds are very thin or absent in the "green clay" confining zone, the vertical hydraulic gradient ranged from 0.031 to 0.114 ft/ft, averaging 0.081 ft/ft. The 4- to 5-ft head differences observed across the "green clay" confining zone in northern A-M Area, where the clay beds are thin or absent, are essentially what would be expected due simply to vertical flow in clayey sand aquifer material comparable to the "M-Area" aquifer zone. Assuming a vertical hydraulic conductivity of 0.7 ft/d, which is one order of magnitude less than the horizontal hydraulic conductivity of 7 ft/d used to calibrate the A-M Area flow model (Haselow, 1991, written communication), the vertical

Table 12. Hydraulic-property values from modeling calibration of the Steed Pond aquifer in A-M Area

Layer	Hydrologic unit	Transmissivity (ft^2/d)	Hydraulic conductivity (ft/d)	Leakance coefficient (ft/d/ft)	Effective vertical hydraulic conductivity (ft/d)
1	"M-Area" aquifer zone	175	9 7[a]	–	6.1×10^{-3}
1-2	"Green clay" confining zone	–	–	3.52×10^{-4}	–
2	upper "Lost Lake" aquifer zone	2,200	46 58[a]	–	2.0×10^{-2}
2-3	unnamed	–	–	4.03×10^{-4}	–
3	lower "Lost Lake" aquifer zone	1,300	35 44[a]	–	1.5×10^{-2}
3-4	"Upper clay" of Crouch Branch confining unit	–	–	2.66×10^{-4}	–
4	"Middle sand" of Crouch Branch confining unit	1,600	29	–	1.1×10^{-2}
4-5	"Lower clay" of Crouch Branch confining unit	–	–	6.43×10^{-5}	–
5	Crouch Branch aquifer	12,000	73	–	6.5×10^{-3}

(Haselow, written communication)[a]

hydraulic gradient of 0.081 ft/ft, and an effective porosity of 20 percent, the vertical-flow velocity in the "M-Area" aquifer zone is estimated to be 0.284 ft/d (103 ft/yr). This suggests that the potential for downward flow or recharge in the "M-Area" aquifer zone is greater than the potential for lateral flow. Considering the distance to discharge areas and the topography of A-M Area (Plate 11), this indication seems valid.

The "green clay" confining zone that underlies the "M-Area" aquifer zone is correlative with the clay and silty clay beds of the Gordon confining unit that separate the Gordon and Upper Three Runs aquifers of the Floridan aquifer system south of Upper Three Runs Creek (Figs. 11 and 12). The "green clay" confining zone consists of the mostly orange and yellow, fine to coarse, poorly to well-sorted, often pebbly sand and clayey sand interbedded with zero to three generally gray, green, and tan clay to silty clay beds of the Warley Hill Formation (Fallaw and Price, 1992). Where the sandy clay to clay beds and the clayey sand beds are sufficiently thick and continuous (Plate 43), they constitute the "green clay" confining zone (Aadland and others, 1992a).

The overall unit thickness of the "green clay" confining zone in A-M Area, based on data from 142 wells (Appendix 3), ranges from 1 to 44 ft and averages 17 ft. The clayey sand beds range from 0 to 21 ft and average 6 ft; and the clay to sandy clay beds range from 0 to 16 ft and average 3 ft.

In the southern part of A-M Area, the "green clay" confining zone was characterized using core and downhole geophysical data from 33 wells (Appendix 3; Plate 11). Total thickness of the confining zone ranges from 4 to 44 ft and averages 22 ft; it consists of clayey sand beds that range from 0 to 21 ft and average 8 ft, and sandy clay to clay beds that range from 0 to 16 ft and average 5 ft. In all the wells analyzed in southern A-M Area, the "green clay" confining zone included some clay, sandy clay, and clayey sand beds.

In the central part of A-M Area (Plate 11), 59 wells were used to characterize the confining zone (Appendix 3). Total thickness of the zone ranges from 0 to 31 ft and averages 17 ft. Sandy clay to clay beds range from 0 to 14 ft and average 4 ft, and clayey sand beds range from 0 to 14 ft and average 5 ft. One of the wells (MBC-4SB) encountered neither clay, sandy clay, nor clayey sand beds.

In the northern part of A-M Area (Plate 11), 50 wells were used to characterize the confining zone (Appendix 3). Five of the wells analyzed contained neither sandy clay, clay nor clayey sand beds. Indeed, in the northern part of A-M Area, (Aadland and others, 1992a), the "green clay" confining zone is largely devoid of clay beds and the confining zone consists mostly of clayey sand and sand beds similar to that observed in the overlying "M-Area" aquifer zone, with only minor clay beds present. The confining zone ranges in total thickness from 0 to 30 ft and averages 13 ft. The clayey sand beds range from 0 to 13 ft and average 4 ft, and the sporadic clay beds range from 0 to 7 ft and average 1 ft. Lithostratigraphic analysis (Plate 41) suggests that in northern A-M Area the confining zone appears to be generally ineffective in hydraulically isolating the "Lost Lake" aquifer zone from the overlying "M-Area" aquifer zone.

Sediments analyzed in the five wells in northern A-M Area and in the one well in central A-M Area, that included neither sandy clay, clay nor clayey sand beds in the stratigraphic interval that includes the "green clay" confining zone, appear lithologically similar to the poorly sorted, often clayey, pebbly sand that characterizes the overlying "M-Area" aquifer zone. In all probability, the stratigraphic interval behaves hydrologically much like the sediments in the overlying "M-Area" aquifer zone, and a horizontal hydraulic-conductivity (Kh) value of 7 ft/d (Haselow, 1991, written communication), which was determined from ground water modeling of the "M-Area" aquifer zone, is assumed for the interval. In determining vertical ground water velocities through the aquifer zone, Haselow (1991, written communication) and Sirrine (1991c) assumed a one order of magnitude lower value for the vertical hydraulic conductivity (Kv) than that for the horizontal hydraulic conductivity, which is thought to be typical of clayey coastal plain sediments. In general, the thickness of the sandy stratigraphic interval that corresponds to the "green clay" confining zone averages approximately 15 ft. Assuming a Kv of 7×10^{-1} ft/d, a leakance coefficient of 4.7×10^{-2}/d is estimated for the sandy stratigraphic equivalent of the "green clay" confining zone. More data derived from pumping tests and permeameter tests is necessary to confirm the value postulated here.

A leakance coefficient was determined for the "green clay" confining zone at 136 of the 142 wells studied in A-M Area (Appendix 3), which included sandy clay, clay and clayey sand beds. Leakance coefficients were calculated by using the overall average laboratory-derived vertical hydraulic conductivity of 1.67×10^{-4} ft/d for sandy clay and clay and 8.90×10^{-3} ft/d for clayey sand (Tables 1 and 2) and the thickness of the clayey sand and sandy clay and clay beds at each of the wells. In those wells where clay to sandy clay beds and clayey sand beds are absent, the leakance-coefficient of 4.7×10^{-2}/d was assumed. Leakance coefficients for the entire A-M Area derived from 136 of the 142 wells analyzed range from 1.04×10^{-5} to 4.70×10^{-2}/d and average 2.54×10^{-3}/d.

Leakance-coefficient values for the 33 wells studied in the southern A-M Area ranged from 1.04×10^{-5} to 4.45×10^{-3}/d and averaged 3.16×10^{-4}/d. Leakance coefficients for the "green clay" confining zone were estimated from multiple-well pumping tests of the "Lost Lake" aquifer zone by Geraghty and Miller (1986). In seven of the aquifer tests, where the level of confidence was moderate to high (Table 13), the pumping and monitoring wells were located in the southern and south-central regions of A-M Area (Plate 43). The range in leakance values determined from the tests was 1.34×10^{-3}/d to 6.02×10^{-5}/d, with a mean leakance coefficient of 5.7×10^{-4}/d.

A pumping test was made in 1993 in the "Lost Lake" aquifer zone in southern A-M Area (Hiergesell, 1993). Hydraulic conductivity was calculated for the overlying "green clay" confining zone for wells RWM-16PA (1.59×10^{-3} ft/d), RWM-16PB (9.07×10^{-3} ft/d), and MSB-40B (5.10×10^{-3} ft/d), with a resulting geometric mean hydraulic conductivity of 4.19×10^{-3} ft/d. A 6-ft thickness was assumed for the "green clay" confining zone in the report by Hiergesell, and a leakance coefficient of 6.98×10^{-4}/d was calculated from the pumping test data. This agrees well with the leakance coefficient of

5.7 x 10^{-4}/d calculated from the data derived from the Geraghty and Miller (1986) pumping tests.

The close correspondence between the leakance coefficients derived from pumping test data (5.7 to 6.98 x 10^{-4}/d) and the average leakance-coefficient value calculated at the 33 well locations (3.16 x 10^{-4}/d) in the southern A-M Area, reflects the overall continuity of the "green clay" confining zone between well locations in the area (Plate 41). Indeed, detailed structural and stratigraphic analysis of the "green clay" in southern A-M Area indicates that the unit is continuous from well to well in the area and is generally not breached by faulting.

It should be noted that the laboratory and pumping test derived leakance values across the "green clay" confining zone in the southern A-M Area are generally an order of magnitude greater than the average leakance-coefficient value calculated from laboratory analyses and well data (4.07 x 10^{-5}/d) in the correlative Gordon confining unit to the south in GSA. This greater overall leakance reflects the generally thin and laterally discontinuous nature of the confining beds that constitute the "green clay" confining zone in the southern part of A-M Area compared to the thicker more laterally continuous confining beds that constitute the Gordon confining unit to the south.

Leakance coefficients for the "green clay" confining zone, calculated from thickness estimates based on 58 of the 59 wells analyzed in central A-M Area that include sandy clay, clay, and clayey sand beds (Appendix 3) and from laboratory-derived vertical hydraulic-conductivity values for the sandy clay to clay beds and the clayey sand beds, and the leakance coefficient value of 4.70 x 10^{-2}/d assumed for the one well that contained no clay to clayey sand beds, ranged from 1.18 x 10^{-5} to 4.07 x 10^{-2}/d, and averaged 1.27 x 10^{-3}/d. This value is four times greater than the average leakance coefficient determined from well data in southern A-M Area (3.16 x 10^{-4}/d).

Leakance coefficients for the "green clay" confining zone, calculated from thickness estimates based on 45 of the 50 wells analyzed in northern A-M Area that include sandy clay, clay, and clayey sand beds (Appendix 3) and laboratory-derived vertical hydraulic-conductivity values for the sandy clay to clay beds and the clayey sand beds, and the leakance coefficient value of 4.7 x 10^{-2}/d assumed for the five wells that include no clay to clayey sand beds, ranged from 2.38 x 10^{-5} to 4.70 x ~~10^{-2}~~/d, and averaged 5.51 x 10^{-3}/d. This value is 17 times greater than the average laboratory-derived leakance calculated in southern A-M Area and about four times greater than the leakance coefficient determined in central A-M Area. The laboratory-derived leakance coefficients, being point-source values, reflect only the lithology and thickness of the confining beds in the "green clay" confining zone at the well location used. Consequently, the observed difference indicates the overall thinning and/or decrease in the number of confining beds that constitute the confining zone. This is corroborated by the general thinning and pinching out of the confining beds from south to north, illustrated on Plates 41 and 43 (Aadland and others, 1992a; Lewis and Aadland, 1992).

The estimate of leakance through the "green clay" confining zone derived from the seven aquifer tests (Geraghty and Miller, 1986) of the upper portion of the "Lost Lake" aquifer zone in northern and north-central A-M Area, where the level of confidence was moderate to high, ranged from 1.15 x 10^{-2} to 5.75 x 10^{-4}/d, with a mean leakance coefficient of 5.14 x 10^{-3}/d (Table 13). This value is similar to the leakance coefficients noted in wells C-2, P-30, P-16, P-29, P-15, P-25, and CPC-1 (Appendix 1), where the "green clay" confining zone and the downdip Gordon confining unit consist of clayey sand beds and are largely devoid of clay beds. The 5.14 x 10^{-3}/d leakance coefficient is approximately one order of magnitude

Table 13. Pumping-test results for the "Lost Lake" aquifer zone in A-M Area

Pumped well	Monitored well	Well Separation (ft)	Transmissivity (gal/d/ft)	Transmissivity (ft^2/d)	Storage coefficient	Leakance (ft/d/ft)	Hydraulic conductivity (ft/d)
RWM-5	MSB-16A	960	15,960	2,134	2.3 x 10^{-4}	3.7 x 10^{-4}	35.6
RWM-3	MSB-24A	196	18,732	2,504	1.1 x 10^{-3}	1.0 x 10^{-2}	41.7
RWM-11	MSB-24A	609	39,902	5,334	2.0 x 10^{-3}	5.8 x 10^{-4}	88.9
RWM-11	MSB-34A	157	64,940	8,682	1.8 x 10^{-2}	3.5 x 10^{-3}	144.7
RWM-5	MSB-11B	1,508	19,194	2,566	3.5 x 10^{-4}	2.8 x 10^{-4}	42.8
RWM-7	MSB-11B	1,143	9,783	1,307	2.8 x 10^{-4}	3.6 x 10^{-4}	21.8
RWM-6	MSB-35B	806	32,522	4,348	7.0 x 10^{-4}	6.0 x 10^{-5}	72.5
RWM-4	MSB-11C	990	9,753	1,304	5.6 x 10^{-4}	1.3 x 10^{-3}	21.7

greater than the pumping-test leakance coefficient calculated in southern A-M Area (5.7×10^{-4}/d) and sixteen times greater than the average laboratory-derived leakance coefficient value calculated to the south (3.16×10^{-4}/d). The significantly greater disparity in leakance values between the laboratory and pumping-test values from southern to northern A-M Area suggests an increasingly greater degree of discontinuity in the confining beds in northern A-M Area. Indeed, stratigraphic and structural analysis in the region indicates thinning of the confining beds, extensive and rapid lateral facies changes, and faulting that often breaches the "green clay" towards the north (Plate 41).

Hydraulic-head differences across the "green clay" confining zone range from less than 2 ft at well MSB-43 in the north, to approximately 25 ft at well MSB-40 in the south (Plate 41). In general, head differences of 4 to 6 ft are common in northern A-M Area, and head differences of 8 to 10 ft are common in the south. These head differences are attributable to three factors: 1) the low vertical hydraulic conductivity of the confining beds in the "green clay" confining zone, 2) the higher hydraulic conductivity of the clean, well-sorted, medium- to coarse-grained sand in the "Lost Lake" aquifer zone compared to that observed in the clayey, silty, poorly sorted sand in the overlying "M-Area" aquifer zone, producing rapid lateral flow through the "Lost Lake" aquifer zone and resulting in low vertical-head gradients in the zone and high vertical head gradients across the overlying "green clay" confining zone, and 3) to a lesser degree, the influence on head gradients across the confining zone due to the distribution of the boundary conditions (Root, 1987), in this case the proximity of Tims Branch, Upper Three Runs Creek, and the Savannah River flood plain.

The large vertical hydraulic head differences across the "green clay" confining zone, especially in southern A-M Area, are due in part to the low vertical hydraulic conductivities of both the clay-rich sand of the "M-Area" aquifer zone and, especially, to the thicker and more laterally persistent confining beds that typify the "green clay" confining zone in the south. The low hydraulic conductivities restrict the vertical movement of ground water into the underlying "Lost Lake" aquifer zone which, in combination with the rapid lateral withdrawal of water from the "Lost Lake" aquifer zone attributable to the higher hydraulic conductivity of the aquifer zone, results in increasing the hydraulic head across the "green clay" confining zone.

Vertical hydraulic gradients were calculated for the "green clay" confining zone in both northern and southern A-M Area. In northern A-M Area, where the confining zone contains few or no clay beds, the vertical hydraulic gradient was estimated to be 0.081 ft/ft. In southern A-M Area (Plate 11), the vertical hydraulic gradient was estimated, using seven wells (MSB-3, MSB-19, MSB-40, MSB-62, MSB-63, MSB-74, and 905-82A) properly screened to straddle the "green clay" confining zone. The gradient ranges from 0.178 to 0.717 ft/ft, averaging 0.397 ft/ft.

Vertical-flow velocity across the "green clay" confining unit was determined using the vertical hydraulic conductivity of 1.67×10^{-4} ft/d typical of sandy clay to clay and 8.90×10^{-3} ft/d typical of clayey sand, and an effective porosity of 12 percent for the clayey sand beds and 5 percent for the sandy clay to clay beds. The vertical-flow velocity in northern A-M Area was estimated to be 9.4×10^{-2} ft/yr and in southern A-M Area to be 4.6×10^{-1} ft/yr. These values are a measure of the flow rate of water through the confining beds and do not represent or take into account breaching of the confining beds through which flow rates are greatly increased.

The "Lost Lake" aquifer zone includes the undifferentiated sand of the Congaree and Fourmile Formations and consists of yellow, tan, orange, and brown, loose to slightly indurated, fine to coarse, moderately to well-sorted, occasionally pebbly sand and minor clayey sand (Fallaw and Price, 1992). The zone ranges from 55 to 86 ft thick and averages approximately 60 ft (Aadland and others, 1992a).

Hydraulic-conductivity estimates for the "Lost Lake" aquifer zone, based on 14 slug tests reported by Sirrine (1991c), range from 1.3 to 77.7 ft/d and average 18.9 ft/d. The values were obtained at monitoring wells, where the slug tests are "impacted by short screens and inefficient well design, resulting in reduced hydraulic-conductivity values" (Eddy and others, 1991).

Geraghty and Miller (1986) made long-duration, multiple-well pumping tests with observation wells screened in the "Lost Lake" aquifer zone. The range of transmissivity values for eight of those tests where the level of confidence is high (where data and type-curve matching is very good) is from 9,753 gal/d/ft (1,304 ft^2/d) to 64,940 gal/d/ft (8,682 ft^2/d) averaging approximately 26,000 gal/d/ft (3,475 ft^2/d) (Table 13). These transmissivity values are nearly identical to the results obtained in the tests of the entire Steed Pond aquifer (Table 11). The reason is that the vast majority of the total clean sand thickness of the Steed Pond aquifer is contributed by the "Lost Lake" aquifer zone, with the addition of only a few feet of generally clayey, less transmissive sand thickness contributed by the "M-Area" aquifer zone and the "middle sand" aquifer zone of the Crouch Branch confining unit. Using the overall estimated sand thickness of 60 ft for the "Lost Lake", the hydraulic conductivities range from 22 to 145 ft/d, resulting in an average hydraulic conductivity of 58 ft/d (Table 13). The average hydraulic conductivity estimated for the undifferentiated Steed Pond aquifer was 43 ft/d, slightly less than that estimated for the "Lost Lake" because an average screen length of 80.3 ft (considered the thickness of the aquifer), was used to calculate the hydraulic conductivity from the average transmissivity that was derived from the aquifer tests.

A pumping test was made in the upper part of the "Lost Lake" aquifer zone in southern A-M Area (Hiergesell, 1993). Transmissivities ranged from 9.47×10^{-2} to 5.79×10^{-2} m^2/min (1,470 to 897 ft^2/d). Using 40.1 ft for the thickness of the upper portion of the "Lost Lake", hydraulic conductivity ranges from 1.29×10^{-2} to 7.89×10^{-3} cm/s (36.6 to 22.4 ft/d), averaging 31.2 ft/d. Ground water modeling of the "Lost Lake" aquifer zone used calibrated horizontal conductivity estimates of 46 ft/d (DuPont, 1986) and 58 ft/d (Haselow, 1991, written communication) for the upper part of the aquifer zone and 35 ft/d (DuPont, 1986) and 44 ft/d (Haselow, 1991, written communication) for the lower part of the aquifer zone.

The hydrostratigraphic framework of the Steed Pond aquifer is well illustrated on Plate 41. In the southern half of

A-M Area, between wells MSB-40 and 905-82A, the "green clay" confining zone supports a head of more than 25 ft (at well MSB-40), whereas the other wells screened in the "M-Area" aquifer zone measured no water in the pipe. Here, beneath the "green clay" confining zone, the "Lost Lake" aquifer zone has a horizontal hydraulic gradient of 0.0027 ft/ft, with water levels that range from 226.0 ft msl at well MSB-42 in the north to 204.8 ft msl at well MSB-40 in the south. Virtually no vertical gradient was observed in the "Lost Lake" aquifer zone. A horizontal ground water flow velocity of 191 ft/yr was calculated for the "Lost Lake" aquifer zone in southern A-M Area, assuming an effective porosity of 30 percent, a horizontal hydraulic conductivity of 58 ft/d, and a horizontal hydraulic gradient of 0.0027 ft/ft.

North of well 905-82A, the clay beds of the "green clay" confining zone thin and pinch out rapidly (Plate 41), and a vertical head difference of 1.1 ft was measured at well MSB-47 across the "green clay" interval. In this region, however, a clay to clayey sand bed occurs that divides the "Lost Lake" aquifer zone at the Congaree/Fourmile contact.

Clay beds in the "Lost Lake" aquifer zone, occurring at the base of the Congaree Formation, are locally significant in A-M Area and hydraulic characteristics have been estimated (Geraghty and Miller, 1986) for the attendant aquifer zones (informally referred to as the upper and lower Congaree in previous SRS reports). These clay beds observed in wells in the northeast quadrant of A-M Area support vertical hydraulic heads of as much as 7.7 ft, as observed at well MSB-47 (Plate 11).

Geraghty and Miller (1986) made six pumping tests using a single monitoring well (MSB-11A) reportedly screened in the "Ellenton sands", that is, the "middle sand" aquifer zone of the Crouch Branch confining unit of this report (Fig. 12). Upon review of the hydrostratigraphy of the region, it is concluded that well MSB-11A is actually screened in the lower portion of the "Lost Lake" aquifer zone of the overlying Steed Pond aquifer. The hydrologic data derived from the six pumping tests reflects the hydrogeologic conditions of the lower "Lost Lake" aquifer zone and not of the Crouch Branch confining unit. Leakance values thus reflect the confining beds (as at MSB-42) that locally divide the "Lost Lake" aquifer zone at the Congaree-Fourmile contact (Plate 41). The results of three of the pumping tests where the level of confidence is moderate to high (where data and type-curve matching is good) indicate leakance coefficients that range from 1.9×10^{-2} to 3.0×10^{-4} gal/d/ft^3 (2.5×10^{-3} to 4.0×10^{-5}/d) with a geometric mean of 2.9×10^{-3} gal/d/ft^3 (3.9×10^{-4}/d).

Lateral movement of water in the sand beneath the clay bed at the Congaree/Fourmile contact appears to be locally influenced by faults that breach the underlying Crouch Branch confining unit (Plate 41). The faulting creates pathways for the rapid infiltration of water from the lower sand into both the Crouch Branch confining unit and the Crouch Branch aquifer. This increases the head across the overlying confining clay bed, thus increasing the leakance in order to replenish the aquifer zone from above. This clay bed may be formally delineated as a confining zone in future studies.

__Unnamed aquifer unit__.—In the northernmost portion of the study area, north of the C-2 well location (Plate 1), the clay and silty clay beds of the Crouch Branch confining unit thin and are generally few in number. In addition, they are often breached by the tributaries of the Savannah River and the South Fork of the Edisto River. Here, the Crouch Branch aquifer and the Steed Pond aquifer coalesce, forming an as yet unnamed aquifer. The aquifer consists of sediments of the upper part of the Black Creek Formation and the Steel Creek Formation of the Lumbee Group and all the Tertiary sediments below the water table. The aquifer is separated from the underlying McQueen Branch aquifer by the clay of the McQueen Branch confining unit that persists in the far updip section. Farther north, beyond Aiken, S.C. all aquifers of the Coastal Plain sequence are in communication owing to the updip stratigraphic position and to erosion and surface exposure of the sequence. This is the catchment area for the entire Coastal Plain sequence and it acts as a single aquifer from the water table to the basement.

Meyers Branch Confining System

The Meyers Branch confining system separates the Floridan aquifer system from the underlying Dublin and Dublin-Midville aquifer systems (Fig. 12). North of the updip limit of the confining system, the Floridan and Dublin-Midville aquifer systems are in hydraulic communication and the aquifer systems coalesce to form the Floridan-Midville aquifer system (Fig. 10; Plates 16 and 17).

The Meyers Branch is correlative with the Chattahoochee River confining unit (Fig. 9) of Miller and Renken (1988), the unnamed confining unit that separates the Black Creek aquifer of Aucott and Sperian (1985a) from the overlying Tertiary sand/Floridan aquifer in South Carolina (Fig. 8), and the Baker Hill-Nanafalia unit (Clarke and others, 1985) in neighboring eastern Georgia (Plates 36 and 37).

Sediments of the Meyers Branch confining system correspond to lignitic clay and interbedded sand of the upper Steel Creek Formation, and to gray to black clay and laminated shale of the Lang Syne/Sawdust Landing and Snapp Formations of the Paleocene Black Mingo Group (Fig. 7). Black Mingo Group sediments also consist of poorly sorted, red to brown sandy clay and white to yellow muddy sand and sand. In the northwestern part of the study area, the sediments in the stratigraphic interval that is correlative with the Meyers Branch confining system are better sorted and less silty, with thinner clay interbeds (Plate 41). It is here that the updip limit of the Meyers Branch confining system is established, where it ceases to act as a regional confining system and the Floridan-Midville aquifer system is defined (Figs. 10 and 12; Plates 16 and 17).

Near the coast the Meyers Branch confining system consists of the low-permeability, evaporite-rich platform carbonate of the Paleocene Cedar Keys Formation, which was deposited beneath the transmissive carbonate of the Floridan aquifer system (Krause and Randolph, 1989) (Plates 36 and 37). The Cedar Keys Formation consists mostly of gray and cream-colored, gypsum- and anhydrite-bearing, dolomitic limestone to finely crystalline dolomite and anhydrite. Generally, the

Cedar Keys exhibits extremely low permeability. Indeed, in the lower Coastal Plain the confining system is so effective in inhibiting the vertical movement of water that the flow system in the Floridan aquifer system above and the Dublin and Midville aquifer systems below, differ more than for any of the adjacent aquifers (Aucott and Speiran, 1985a).

Updip toward the study area, the confining system consists mostly of the fine-grained, deep-water clastics and marls of the Rhems and Williamsburg Formations. The Rhems, Williamsburg, and Cedar Keys Formations are hydrostratigraphic facies-equivalents of the Black Mingo Group sediments that constitute most of the Meyers Branch confining system in the study area.

In the study area, the Meyers Branch confining system consists of a single hydrostratigraphic unit, the Crouch Branch confining unit, which includes several thick and relatively continuous (over several miles) clay beds. The Crouch Branch confining unit extends north of the updip limit of the Meyers Branch (Plates 3-10 and 41) where the clay of the confining unit thins and is locally absent, and the faulting observed in the region locally breaches the unit. Here, the Crouch Branch confining unit no longer regionally separates the Floridan aquifer system from the underlying aquifer systems, but simply separates the Steed Pond aquifer from the underlying Crouch Branch aquifer of the Floridan-Midville aquifer system. Downdip, generally south of the study area, the Meyers Branch confining system could be subdivided into aquifer and confining units if this should prove useful for hydrogeologic characterization (Plate 38).

The hydraulic-head difference across the Crouch Branch confining unit in the vicinity of SRS is illustrated on Figure 30. Owing to deep incisement by the Savannah River and Upper Three Runs Creek into the sediments of the overlying Gordon aquifer, an upward hydraulic gradient (vertical-head reversal) persists across the Crouch Branch confining unit over a large area adjacent to the Savannah River flood plain and the Upper Three Runs Creek drainage system. Here, the hydraulic heads in the Crouch Branch aquifer are higher than those in the overlying Gordon aquifer. This "head reversal" is an important aspect of the ground water flow system in the vicinity of SRS and provides a natural means of protection from contamination of the lower aquifers.

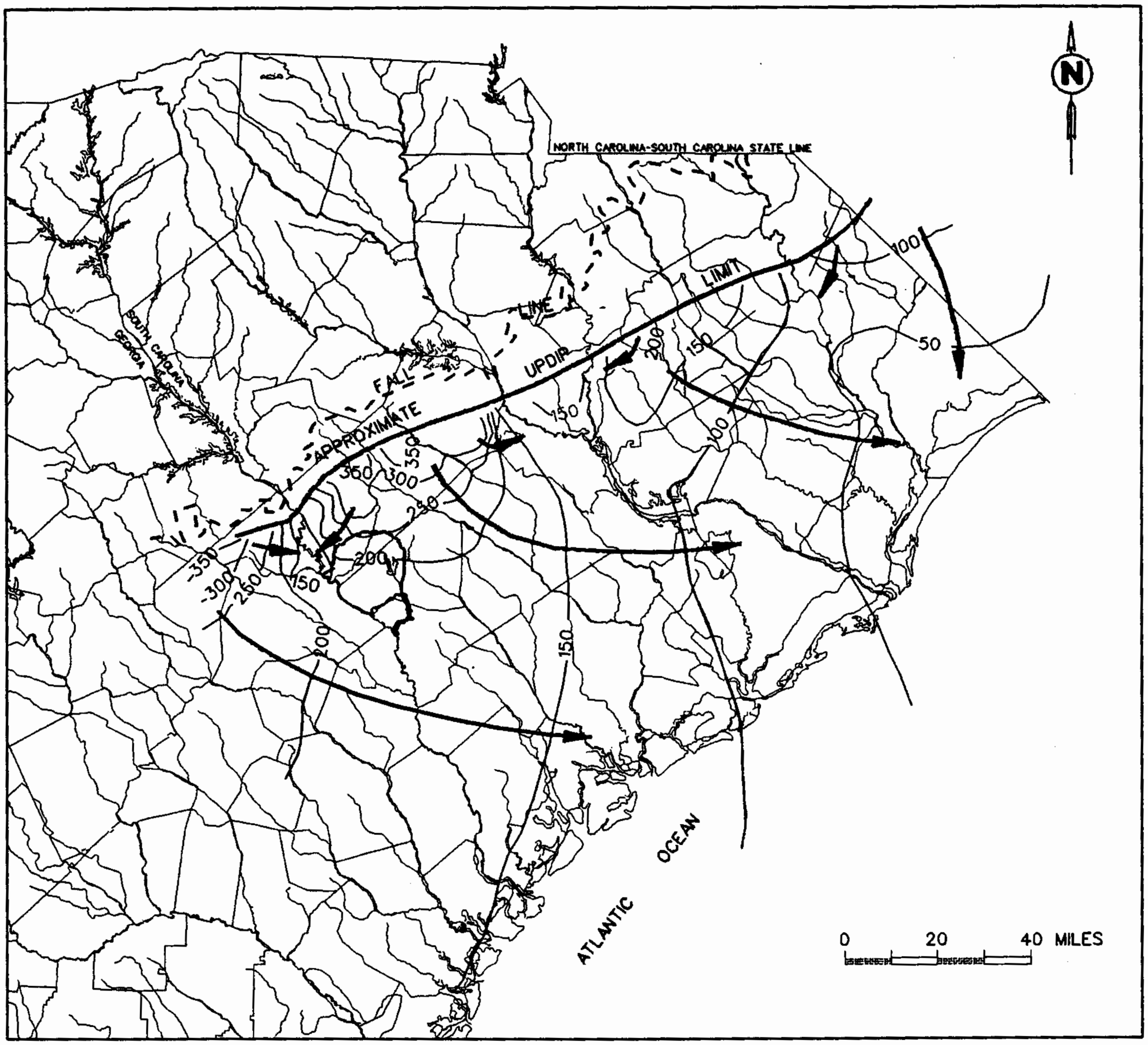
The Meyers Branch confining system is herein defined by the hydrogeologic characteristics of sediments penetrated in well P-24 located in the southeast quadrant of SRS (Plates 1, 3, and 39f). The unit is named for Meyers Branch, a tributary of Steel Creek located near the type well. The Meyers Branch confining system is 134 ft thick in well P-24 and is present from -41 to -175 ft msl (Appendix 1). The total clay to silty, sandy clay thickness of the confining system is 69 ft in five clay beds interbedded with four sand beds (Plate 39f). The basal clay to silty clay bed constitutes the uppermost part of the Peedee Formation. The remainder of the confining system consists of dark gray clay and silty clay interbedded with dark-gray to black, moderately to poorly sorted, fine- to coarse-grained, micaceous, lignitic, silty and clayey sand of the Lang Syne/Sawdust Landing and Snapp Formations. The leakance coefficient calculated at well P-24 is 2.41×10^{-6}/d, which is typical of the leakance coefficients calculated for the Meyers Branch throughout the southern part of the study area.

In general, the leakance-coefficient estimates calculated by Aucott (1988) for the Meyers Branch confining system in the South Carolina Coastal Plain are greatest near the updip limit of the system, where the confining beds are thinnest and typically consist of coarser sediments, and lowest toward the coast where the sediments in the system have undergone a facies change to fine-grained, mostly carbonate sediments. For example, near Charleston, S.C., calibrated vertical hydraulic-conductivity values for all confining units were estimated to be within the 2×10^{-9} to 1×10^{-8} ft/d range. If a thickness of 200 ft for the Meyers Branch is assumed, then leakance coefficients of 1×10^{-11} to 5×10^{-11}/d are reasonable. There are, however, few data available to provide quantitative verification for these values (Aucott, 1988).

To the north, in the vicinity of the study area, Aucott (1988) derived calibrated leakance coefficients for the Meyers Branch confining system that range from about 2×10^{-9} to 5×10^{-4}/d. Specifically, Aucott calculated the range in leakance coefficient for the Crouch Branch confining unit in both the Meyers Branch confining system and the Floridan-Midville aquifer system in the study area to be on the order of 10^{-4} to 10^{-6}/d. Assuming an average thickness of the confining beds of 60 ft, vertical hydraulic-conductivity values range from about 6×10^{-5} to 6×10^{-3} ft/d, well within the range reported in the present study.

In modeling studies of GSA by GeoTrans (1988), the vertical hydraulic-conductivity estimate used is 3×10^{-4} ft/d. Assuming a thickness of 60 ft, the leakage coefficient would be 5×10^{-6}/d. This value falls in the range of values calculated by Aucott (1988).

The ground water flow pattern in the Dublin and Midville aquifer systems in the lower Coastal Plain is essentially from southwest to northeast, parallel to the coast (Figs. 41 and 42). Aucott (1988) ascribed this phenomenon to three factors. First, the clayey sediments of the Paleocene Black Mingo Group that make up most of the Meyers Branch confining system in the west constitute a much more effective confining unit than the more permeable sandy clay and clayey sand of the Peedee Formation that makes up most of the confining system in the east. Thus, the confining system is more effective in inhibiting upward leakage in southwestern South Carolina than in eastern South Carolina, which supports the general hypothesis that the direction of flow in the lower Coastal Plain in the Dublin and Midville aquifer systems is at least in part due to the east-west difference in the leakance coefficients in the overlying Meyers Branch confining system. Secondly, because the dip of the Coastal Plain sediments in southeastern North Carolina is substantially less than the dip in southwestern South Carolina, the Cretaceous aquifer systems are closer to the land surface and in better hydraulic contact with the rivers farther downdip in the east than the west. Thus, discharge is facilitated through the underlying aquifer systems towards the east. Third, the Cape Fear River, and to a lesser extent the Peedee River, are lower in elevation farther upstream than rivers to the west. The lower elevation enables a lower potentiometric surface to occur in the Cretaceous aquifer systems in the east. These factors provide for more effective discharge in the northeastern part of the lower Coastal Plain than in the southwest.



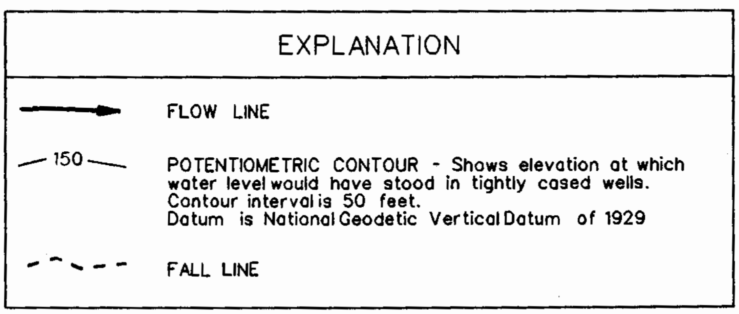
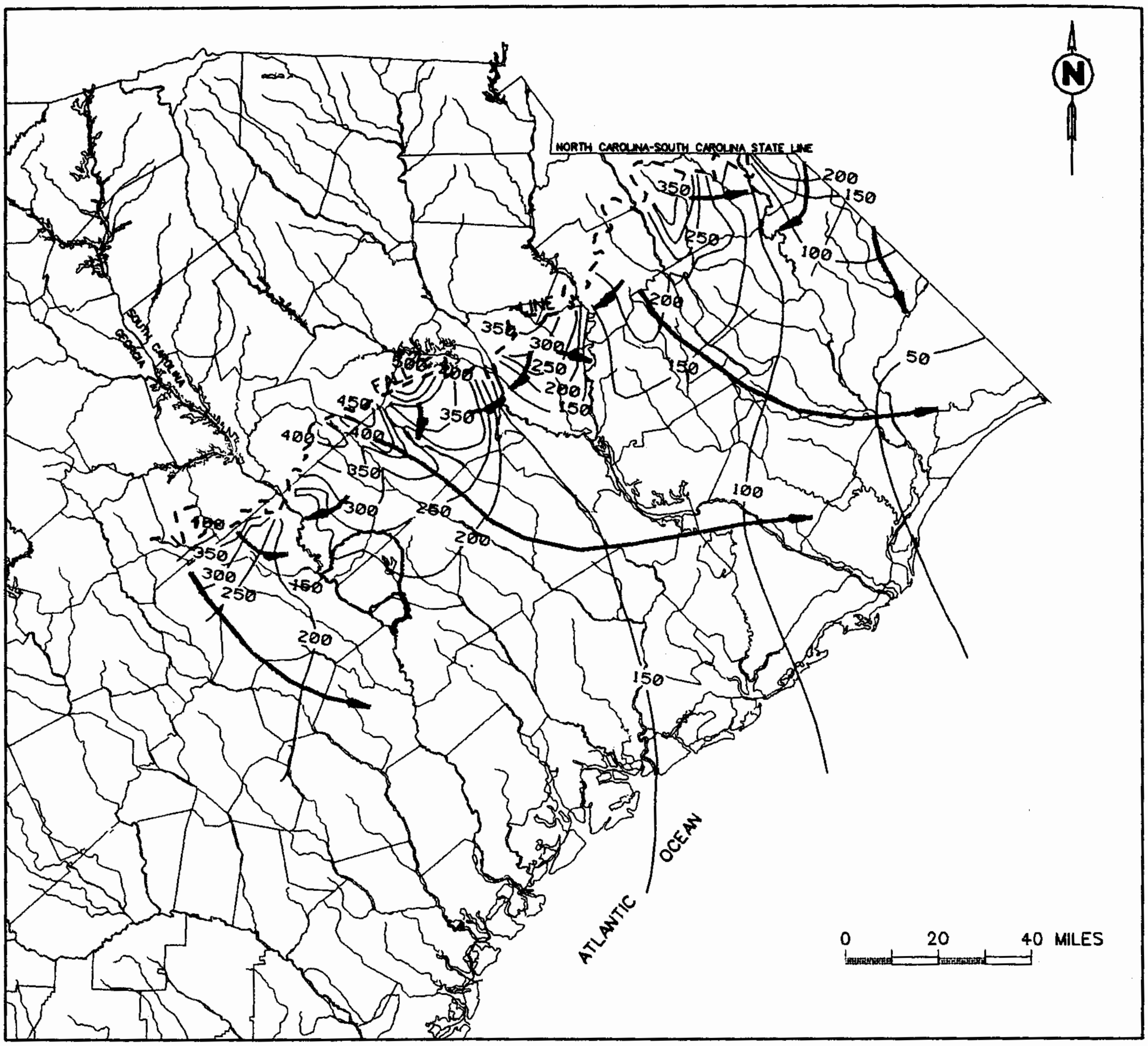


Figure 41. Potentiometric surface of the Dublin aquifer system prior to development (modified from Aucott and Speiran, 1985b).



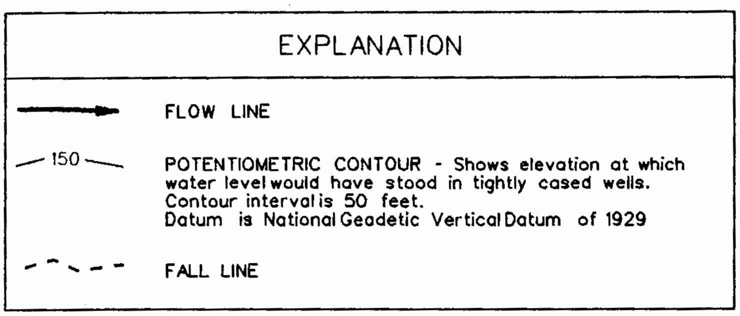


Figure 42. Potentiometric surface of the Midville aquifer system prior to development (modified from Aucott and Speiran, 1985b).

This east-to-west imbalance in discharge alters the flow direction from perpendicular to the coast to nearly parallel to the coast toward the primary discharge area in southeastern North Carolina.

Crouch Branch confining unit.—The Crouch Branch confining unit extends from north of SRS, where it is an integral part of the Floridan-Midville aquifer system, southward through the study area where it constitutes the Meyers Branch confining system (Fig. 12). The total thickness of the Crouch Branch confining unit where it constitutes the Meyers Branch confining system ranges from 57 to 184 ft; the clay and sandy clay beds range from 19 to 106 ft, and the clayey sand beds from 0 to 45 ft thick (Plate 17). Updip, north of the updip limit of the Meyers Branch confining system, the thickness of the Crouch Branch confining unit ranges from 0 to 104 ft; the clay and sandy clay beds vary from 0 to 84 ft, and the clayey sand beds from 0 to 27 ft. The confining unit dips approximately 16 ft/mi to the southeast (Plate 16).

In general, the confining unit contains 2 to 7 clay to sandy clay beds separated by clayey sand and sand beds that are relatively continuous over distances of several miles. The clay beds in the confining unit are anomalously thin and fewer in number along a line that parallels the southwest-northeast trend of the Pen Branch and Steel Creek Faults and the northeast-southwest trending Crackerneck Fault (Stieve and others, 1991) (Plates 3, 5, and 17). The reduced clay content in the vicinity of the faults suggests shoaling due to uplift along the faults during deposition of the Paleocene Black Mingo Group sediments, resulting in the deposition of increased quantities of shallow-water, coarse-grained, sandy sediments along the crest of the fault trace. Thick clay beds observed at and near the top of the Black Creek Formation in the P-21, P-26, C-6, and P-29 wells (Plates 5, 6, and 7) were not included in the Meyers Branch confining system because of the limited lateral continuity of the clay beds, and because wells screened immediately above and below the clay beds did not demonstrate any appreciable vertical head gradient (Appendix 4).

A recent, long-duration, multiple-well pumping test was made in B-Area (Plate 1), utilizing production well BPC-1 as the pumping well and the wells in the P-29 well cluster as observation wells (Plate 7) (Snipes, 1994, personal communication). BPC-1 was pumped from the "lower" aquifer zone of the McQueen Branch aquifer (Fig. 7; Plates 3 and 4). The "lower" and "upper" aquifer zones of the McQueen Branch aquifer, the sand in the lower part of the Crouch Branch aquifer below the thick clay bed that caps the Black Creek Formation in the region, and the sand of the overlying Steel Creek Formation that constitute the upper part of the Crouch Branch aquifer were screened and monitored at the P-29 well cluster. Water level declines were observed in each screened interval, indicating hydraulic communication throughout the Dublin-Midville aquifer system in B-Area. Thus, the thick clay bed that caps the Black Creek Formation at the P-29 well cluster does not act as a regionally significant confining bed in the Dublin-Midville aquifer system.

The Crouch Branch confining unit is herein defined by the hydrogeolgic characteristics of sediments penetrated in well P-27 near the center of the study area (Plates 1 and 39a). The unit is named for Crouch Branch, a tributary of Upper Three Runs Creek located near the type well. The Crouch Branch confining unit is 130 ft thick in P-27 and is present from +48 to -82 ft msl (Appendix 1). Total thickness of the clay to silty, sandy clay beds is 59 ft and these occur in five beds intercalated with one 12-ft clayey sand bed and four sand beds (Plate 39a). The basal clay and silty clay bed constitute the uppermost part of the Steel Creek Formation. The remainder of the confining unit consists of dark-gray clay and silty clay interbedded with dark-gray to black, moderately to poorly sorted, fine- to coarse-grained, micaceous, lignitic, silty and clayey sand of the Lang Syne/Sawdust Landing and Snapp Formations. A leakance coefficient of 2.82 x 10^{-6}/d was calculated at P-27 (Plate 17), typical of leakance coefficients calculated for the confining unit throughout the lower two-thirds of the study area.

The Crouch Branch confining unit continues north of the updip limit of the Meyers Branch confining system where the Floridan-Midville aquifer system is defined. Here, the confining unit separates both the Steed Pond and Gordon aquifers from the underlying Crouch Branch aquifer (Figs. 10 and 12) and ranges in thickness from 0 to 104 ft (Appendices 1 and 3). The clay to sandy clay beds range in thickness from 0 to 84 ft, and the clayey sand beds from 0 ft to 27 ft. The clay to sandy clay beds in the Crouch Branch confining unit in the Floridan-Midville aquifer system are, on average, thinner and fewer in number than those observed to the south in the Meyers Branch confining system (Plates 3, 4, and 5).

The updip reference well of the Crouch Branch confining unit is well MSB-42 located in A-M Area (Fig. 2; Plate 11). The unit is 78 ft thick in the MSB-42 well (Plate 39e) and consists of 46 ft of clay to sandy clay in 5 beds, separated by 4 sand beds (Appendix 3). The Crouch Branch confining unit ranges in thickness from zero in northern A-M Area, near the SRS boundary, to more than 100 ft at the MSB-21 well to the south (Plate 41). In portions of A-M Area, the Crouch Branch confining unit is divided into three hydrogeologic zones: 1) the "lower clay" confining zone; 2) the "middle sand" aquifer zone; and 3) the "upper clay" confining zone (Fig. 11; Plate 44).

Sediments of the Crouch Branch confining unit are mainly poorly sorted, gravelly sandy mud, sandy mud, and sandy clay according to the classification of Folk (1954). Initial screening of 47 mud-rich samples (Aadland and others, 1992b) shows that gravel averages 1.5 percent, sand 58.8 percent, and mud 39.7 percent (Table 14). Pipette and hydrometer analyses of the mud fractions indicate that clay is usually more abundant than silt. The grain size of 24 mud-rich samples analyzed by Aadland and others (1992b) ranges from muddy, upper fine sand to very fine silt (Table 14). Most of the samples are very poorly sorted (Table 14).

Size analyses of samples containing less than 25 percent mud from sandy layers in the Crouch Branch confining unit show that they average 2.7 percent gravel, 91.9 percent sand, and 5.5 percent mud (Table 15). Mean grain size averages 1.68 (lower medium sand). Most of the samples are poorly sorted, although sorting ranges from well to extremely poor and is dependent on the amount of gravel and mud present (Table 15).

Table 14. Summary of Folk and Ward statistics and gravel-sand-mud percentages for muddy sand and mud samples from the Crouch Branch confining unit

Parameter	Folk and Ward Statistics				Gravel	Sand	Mud
	Mean[1]	Sorting[1]	Skewness	Kurtosis	(%)	(%)	(%)
Arithmetic mean	4.582	3.153	0.396	0.995	1.5	58.8	39.7
Confidence level (95%)	0.618	0.314	0.177	0.183	1.1	8.4	8.5
Number of samples	24	24	24	24	47	47	47
Median	4.170	3.422	0.557	0.800	0.0	61.0	34.0
Mode	-	3.480	0.127	-	0.0	38.0	62.0
25th percentile	3.797	3.057	0.184	0.673	0.0	45.0	16.0
75th percentile	5.818	3.678	0.661	1.165	0.9	84.0	54.3
Standard deviation	1.545	0.785	0.443	0.458	3.7	29.5	29.7
Variance	2.387	0.617	0.196	0.210	13.8	872.6	883.7
Kurtosis	-0.039	0.592	2.933	4.523	14.4	-0.9	-0.8
Skewness	0.632	-1.108	-1.733	1.943	3.6	-0.4	0.5
Range	5.814	2.990	1.659	1.953	20.0	94.9	94.9
Maximum	2.089	4.483	0.856	2.531	20.0	97.9	97.0
Minimum	7.903	1.493	-0.803	0.578	0.0	3.0	2.2
Trimean (5%)	4.582	3.153	0.396	0.995	1.1	59.1	39.3

[1] Values are in phi units

Strom and Kaback (1992) analyzed the composition of 18 mud and 13 sand samples from the Crouch Branch confining unit in the P-well series. The mud consists of silt-size quartz and 43 to 80 percent clay minerals. X-ray diffraction analysis of the mud samples indicates that kaolinite is the major clay mineral with minor illite and smectite. X-ray diffraction study of the sand samples shows that they consist of quartz with 5 to 37 percent clay, mainly kaolinite and minor to trace illite and smectite.

Gelting (1990) analyzed the mineral composition of 9 Crouch Branch mud samples from the C-well series using x-ray diffraction. The average composition was: silt-sized quartz, 16 percent; clay minerals, 82 percent; and others, 2 percent. The clay mineral suite consisted of illite, 39 percent; kaolinite, 36 percent; mixed-layer illite/smectite, 23 percent; and smectite, 2 percent.

A petrographic study of a sandy mudstone from the Crouch Branch confining unit at a depth of 657 ft in well C-10 shows that the sample consists of 65 percent clay and 14 percent very fine sand- and silt-size quartz, with accessory muscovite, plagioclase, pyrite, glauconite, organic debris, foraminifers, sponge spicules, radiolarians, and broken skeletal debris. Modal analyses of two sand samples from sandy layers in the Crouch Branch confining unit show that they are quartzarenites consisting of monocrystalline quartz with accessory polycrystalline quartz and minor to trace amounts of K-feldspar, plagioclase, sedimentary and igneous rock fragments, muscovite, and heavy and opaque minerals. Matrix forms up to 13 percent of the whole-rock volume and consists of silt-size quartz and clay minerals.

Table 15 gives porosity estimates for 142 sand samples containing less than 25 percent mud from sandy layers in the Crouch Branch confining unit. The geometric mean permeability of the 142 sand samples is 18.2 Darcies (49.8 ft/d).

Vertical hydraulic-conductivity values derived from the laboratory analysis of 18 clay and sandy clay samples from the Crouch Branch confining unit (Bledsoe and others, 1990) range from 3.4 x 10^{-6} to 1.73 x 10^{-2} ft/d, with a geometric mean of 1.26 x 10^{-4} ft/d (Table 2). Horizontal hydraulic-conductivity values derived from 13 clay and sandy clay samples analyzed range from 3.68 x 10^{-5} to 3.23 x 10^{-1} ft/d, with a geometric mean of 4.88 x 10^{-4} ft/d (Table 2).

Vertical hydraulic-conductivity values for 12 clayey sand samples range from 2.86 x 10^{-4} to 3.40 x 10^{-1} ft/d, with a geometric mean value of 7.92 x 10^{-3} ft/d (Table 1). Horizontal hydraulic-conductivity values derived from 11 clayey sand samples range from 1.11 x 10^{-4} to 1.45 ft/d, with a geometric mean of 1.89 x 10^{-2} ft/d. The porosity of the 18 sandy clay to clay samples ranged from 23 to 58 percent and the mean value was 43 percent (Table 2). The range in porosities calculated for the 12 clayey sand samples was 28 to 55 percent, with a mean porosity of 39 percent (Table 1).

Other laboratory tests on undifferentiated "fine-grained" sediments from M-Area were done to characterize the hydraulic properties of the Crouch Branch confining unit (GeoTrans, 1988). Horizontal hydraulic conductivities were determined to be in the range of 1.6 x 10^{-3} to 3.1 x 10^{-5} ft/d; vertical hydraulic conductivities were determined to be in the range

Table 15. Summary of Folk and Ward statistics, gravel-sand-mud percentages, and calculated porosity and permeability values for sand samples from the Crouch Branch confining unit that contain less than 25 percent mud

Parameter	Folk and Ward Statistics				Gravel	Sand	Mud	Porosity	Permeability	
	Mean[1]	Sorting[1]	Skewness	Kurtosis	(%)	(%)	(%)	(%)	(Darcy)	(ft/d)
Arithmetic mean	1.681	1.457	0.267	1.839	2.7	91.9	5.5	32.0	35.8	98.0
Confidence level (95%)	0.137	0.116	0.038	0.137	0.9	1.2	0.9	0.6	7.1	19.5
Number of samples	175	175	175	175	175	170	170	142	142	142
Median	1.624	1.248	0.264	1.525	0.4	94.9	2.6	32.5	22.7	62.1
Mode	1.202	1.503	0.395	1.396	0.0	-	1.7	34.0	29.0	79.3
25th percentile	1.112	0.852	0.073	1.157	0.0	89.4	1.2	28.4	8.3	22.6
75th percentile	2.236	1.939	0.455	2.320	2.0	97.6	8.1	35.0	46.8	127.9
Standard deviation	0.925	0.780	0.259	0.927	6.0	8.0	5.9	3.9	43.3	118.5
Variance	0.856	0.609	0.067	0.859	35.7	63.9	35.1	15.4	1877.1	14045.6
Kurtosis	-0.162	1.396	-0.526	1.848	14.9	3.6	1.8	-1.2	5.2	5.2
Skewness	0.164	1.227	-0.105	1.372	3.6	-1.8	1.6	0.1	2.3	2.3
Range	4.604	3.890	1.269	4.976	40.8	42.9	24.6	14.3	219.6	600.7
Maximum	-0.736	4.282	0.791	5.612	40.8	99.4	24.9	39.9	220.0	601.8
Minimum	3.868	0.392	-0.478	0.636	0.0	56.5	0.3	25.6	0.4	1.1
Trimean (5%)	1.679	1.422	0.269	1.793	2.1	92.4	5.1	32.0	33.0	90.4
Geometric mean	-	-	-	-	-	-	-	-	18.2	49.8
Harmonic mean	-	-	-	-	-	-	-	-	7.0	19.1

[1] Values are in phi units

of 10^{-3} to 10^{-5} ft/d. At the MSB-47 well, a vertical hydraulic conductivity of 1 x 10^{-7} cm/s (2.83 x 10^{-4} ft/d) was obtained for a clay in the Crouch Branch confining unit (Sirrine, 1987a). The large variation in these measurements can be attributed to the difference in the lithology of the sediments tested.

The close correspondence between the geometric mean of the laboratory-derived vertical hydraulic conductivities for the 18 clay to sandy clay samples (1.26 x 10^{-4} ft/d) analyzed from the Crouch Branch confining unit and the overall geometric mean (1.67 x 10^{-4} ft/d) for the Tertiary/Cretaceous clay to sandy clay sample suite attests to the validity of using the geometric mean derived from the larger Tertiary/Cretaceous sample suite in calculating hydraulic properties of the unit. Similarly, the correspondence between the geometric mean of the vertical hydraulic conductivities (7.92 x 10^{-3} ft/d) for the 12 clayey sand samples analyzed from the Crouch Branch confining unit and the geometric mean derived from the entire Tertiary/Cretaceous clayey sand sample suite (8.90 x 10^{-3} ft/d) again justifies using the values derived from the entire Tertiary/Cretaceous sample suite.

Leakance coefficients were estimated at each well used in the study that penetrated the Crouch Branch confining unit (Appendix 1). Effective leakances, that is, leakance coefficients of the clay and sandy clay beds combined with the leakance coefficients of the clayey sand beds, were estimated from the geometric mean of the laboratory-derived vertical hydraulic conductivities of the various confining lithologies divided by the thickness estimates of each of the lithologies at the wells penetrating the unit. The geographic distribution of leakance coefficient is illustrated in Plate 17. In general, leakance coefficients are on the order of 10^{-6}/d where the Crouch Branch confining unit is part of the Meyers Branch confining system. To the north, beyond the updip limit of the Meyers Branch confining system, leakance coefficients are generally on the order of 10^{-5}/d with some localities devoid of confining beds altogether. In most of the study area, the clay and sandy clay beds of the Crouch Branch confining unit, where it constitutes the Meyers Branch confining system, are sufficiently thick and continuous so that offsets due to the faulting commonly observed in the region (Stieve and others, 1991) do not breach the continuity of the confining unit. North of the updip limit of the confining system, however, where the confining beds of the Crouch Branch confining unit thin and decrease in number, faulting commonly breaches the confining unit and is an important feature controlling the hydrologic characteristics of the unit (Plate 41).

The ground water flow model for the M-Area Settlement Basin and Lost Lake in A-M Area, developed by Papadopulos and Associates (DuPont, 1986), used a calibrated leakance coefficient of 6.4 x 10^{-6}/d for the Crouch Branch confining unit established at well P-4A. This value was determined by calibrating the model to reproduce the water level measured in the "Tuscaloosa" (Crouch Branch aquifer of this report) at the P-4A well-cluster location. This leakance coefficient is about one order of magnitude lower than the values used in the model in the vicinity of A-M Area, but it is consistent with the point-source laboratory-derived leakance coefficient of 2.58 x 10^{-6}/d calculated for the Crouch Branch confining unit at the P-4A well cluster (Appendix 1).

The close correspondence between the laboratory-derived leakance coefficient and the model calibrated value at the P-4A well cluster suggests that the Crouch Branch confining unit is a significant confining unit there and that the thickness, lateral continuity, and lithology of the confining beds are consistent and correlative from well to well throughout the region. This is corroborated by the lithostratigraphic analysis conducted for this study (Plate 8).

Geraghty and Miller (1983) did a study designed to assess leakance across the Crouch Branch confining unit in A-M Area. They determined that leakance of the confining unit ranged from 1.46 x 10^{-4} to 4.34 x 10^{-4}/d and averaged 2.45 x 10^{-4}/d.

During the period in 1985 when pumping tests were made in the Tertiary aquifers in A-M Area by Geraghty and Miller (1986), it was observed that withdrawal of water from production wells screened in the Crouch Branch aquifer appeared to influence the water levels in monitoring wells screened in the overlying Steed Pond aquifer. They concluded that water production from the high-capacity Crouch Branch aquifer production wells does impact the hydraulic-head distribution in the overlying Steed Pond aquifer. Thus, communication occurs between the two aquifers in A-M Area. No other large-scale pumping tests of the Crouch Branch or McQueen Branch aquifers, or both combined, were used to determine leakance coefficients for the overlying Crouch Branch confining unit.

In A-M Area, the Crouch Branch confining unit is divided into three hydrostratigraphic zones: 1) the "upper clay" confining zone; 2) the "middle sand" aquifer zone; and 3) the "lower clay" confining zone (Fig. 11). The three zones are well delineated in the north-central region of A-M Area (as at reference well MSB-42; Plates 11, 39e, and 44). In the western half of A-M Area, the individual zones are not delineated because the stratigraphic interval is generally clayey and the sand beds of the "middle sand" aquifer zone are thin or absent. Here, the Crouch Branch confining unit is not readily subdivided into hydrostratigraphic zones and is undifferentiated. In the northeastern part of A-M Area, clay beds of the "upper clay" and the "lower clay" confining zones, especially the "upper clay", are thin or absent (Plates 41 and 44) and the Crouch Branch often does not act as a viable confining unit. Indeed, north of A-M Area, as at well AIK-858, and to the southeast, as at well P-30 (Plates 3 and 17), the confining beds of the Crouch Branch confining unit are locally missing (the interval is sanded up) and the confining unit presents no effective barrier to water flow between the overlying and underlying aquifers.

The Crouch Branch confining unit was characterized in A-M Area using 60 wells that fully penetrated the unit. The total thickness of the Crouch Branch ranges from 2 to 104 ft and averages 63 ft (Appendix 3). Clay to sandy clay beds range from 1 to 84 ft and average 34 ft. Clayey sand beds range from 0 to 32 ft in thickness and average 9 ft. Laboratory-derived leakance coefficients range from 1.99 x 10^{-6} to 1.64 x 10^{-4}/d and average 1.05 x 10^{-5}/d. This is about four times greater than the calculated leakance coefficients typical of the Crouch Branch confining unit in most of the study area (Appendix 1).

In the western portion of A-M Area the Crouch Branch confining unit is undifferentiated and the confining beds are thickest and most continuous (Plate 44). Here, the total thickness of the unit, based on 26 wells that penetrate the unit, ranges from 32 to 104 ft and averages 70 ft (Appendix 3). Thickness of the clay to sandy clay beds ranges from 18 to 84 ft and averages 47 ft. The clayey sand beds in the unit range from 0 to 27 ft in thickness and average 11 ft. Leakance-coefficient values determined from these wells vary from 1.99 x 10^{-6} to 9.20 x 10^{-6}/d and average 4.00 x 10^{-6}/d.

In the central region of A-M Area (Plate 44) the Crouch Branch confining unit is readily subdivided into three zones. Based on hydrogeologic data from 25 wells that penetrate the unit in the area, the total thickness of confining lithologies is generally less than it is to the west. Here, the total thickness of the unit ranges from 18 to 102 ft and averages 72 ft. Clay to sandy clay beds range from 6 to 55 ft and average 28 ft. Clayey sand beds range from 0 to 32 ft and average 10 ft. Leakance-coefficient values in the central area range from 3.03 x 10^{-6} to 2.78 x 10^{-5}/d and average 8.26 x 10^{-6}/d. Leakance in the central part of A-M Area is twice that compared to western A-M Area and reflects a general thinning of the confining lithologies in the area.

In the northeasternmost quadrant of A-M Area (Plates 11 and 44) the confining lithologies are thin and laterally pinch-out over short distances. Total thickness of the Crouch Branch, based on nine wells that penetrate the unit, ranges from 2 to 82 ft and averages 22 ft. Clay to clayey sand beds range in thickness from 1 to 31 ft and average 13 ft, and clayey sand beds range from 0 to 14 ft and average 4 ft. Leakance coefficients calculated from the nine wells that penetrate the unit range from 5.35 x 10^{-6} to 1.64 x 10^{-4}/d and average of 3.55 x 10^{-5}/d. This is similar to the leakance coefficients calculated throughout the northern part of the study area, north of the SRS site boundary (Plate 17). Here, leakances are, on the average, approximately one order of magnitude greater than those observed to the south. This indicates that in the northeastern-most quadrant of A-M Area and throughout the northern part of the study area the clay and sandy clay beds in the Crouch Branch confining unit are thin and sometimes locally absent as corroborated by the lithostratigraphic analysis of the region (Plates 3, 4, 5, 7, and 41).

Pumping tests of the combined McQueen Branch-Crouch Branch aquifers made by Geraghty and Miller (1983) indicate that the leakance coefficient calculated for the overlying Crouch Branch confining unit (1.47 x 10^{-4}/d) is about one order of magnitude greater (1.05 x 10^{-5}/d) than those calculated from the laboratory-derived hydrologic data at the 60 wells used to characterize the confining unit in A-M Area. The departure in the leakance coefficients is the result of breaching of the confining unit due primarily to faulting that is pervasive in A-M Area and, to a lesser degree, lateral discontinuities in the confining beds that commonly occur in this updip stratigraphic setting (Plate 41). In addition, the one order of magnitude difference between the laboratory-derived leakance coefficients and the pumping-test leakance coefficients indicates that the Crouch Branch confining unit in A-M Area is not continuous and regionally effective and is not, therefore, part of the Meyers Branch confining system. It is, however, a confining unit in the Floridan-Midville aquifer system, which is defined north of the updip limit of the Meyers

Branch confining system (Fig. 11; Plate 17).

The leakance coefficients of the undifferentiated Crouch Branch confining unit in the western part of A-M Area were estimated at each of the 26 well locations where the unit was penetrated. Leakance coefficients ranged from 1.99×10^{-6} to 9.20×10^{-6}/d and averaged 4.00×10^{-6}/d. In addition, vertical hydraulic gradients were determined at 6 well locations (MSB-23, MSB-27, MSB-31, MSB-36, MSB-40, and MSB-82; Plate 11), where the undifferentiated Crouch Branch confining unit (Plate 44) is well developed and wells screened in the overlying and underlying aquifers are properly located. Vertical hydraulic gradients range from 0.23 to 0.16 ft/ft and average 0.18 ft/ft. Assuming an effective porosity of 12 percent for clayey sand and silty clay (Fetter, 1988) and 5 percent for the clay to sandy clay (Walton, 1970), the average vertical flow velocity was calculated for the unit by using the equations:

$$V_c = \frac{i_v K_{vc}}{n_c} \qquad (2)$$

$$V_{cs} = \frac{i_v K_{vcs}}{n_{cs}} \qquad (3)$$

$$V_v = \frac{1}{\frac{1}{V_c} + \frac{1}{V_{cs}}} \qquad \textit{(added in series)} \ (4)$$

where:

V_v = vertical flow velocity through confining unit (ft/d)

V_c = vertical flow velocity through clay to sandy clay beds of the confining unit (ft/d)

V_{cs} = vertical flow velocity through clayey sand beds of the confining unit (ft/d)

K_{vc} = vertical hydraulic conductivity of clay to sandy clay beds (ft/d)

K_{vcs} = vertical hydraulic conductivity of clayey sand beds (ft/d)

n_c = average effective porosity of clay to sandy clay beds (fraction)

n_{cs} = average effective porosity of clayey sand beds (fraction)

i_v = vertical hydraulic gradient (ft/ft)

$V_c = 6.01 \times 10^{-4}$ ft/d

$V_{cs} = 1.34 \times 10^{-2}$ ft/d

$V_v = 5.75 \times 10^{-4}$ ft/d or 0.21 ft/yr

These values are a measure of the flow rate of water through the confining beds and do not represent or take into account breaching of the confining beds through which flow rates would be greatly increased.

In the central and northeastern part of A-M Area where the Crouch Branch confining unit is readily subdivided into zones, the "upper clay" confining zone generally consists of the dark-gray to black, fissile, well-indurated silty clay of the Lang Syne/Sawdust Landing Formation (Fallaw and Lawrence, 1992). The total thickness of the "upper clay" confining zone, based on 38 wells that penetrate the unit, ranges from 2 to 34 ft and averages 13 ft (Appendix 3). The thickness of the clay to sandy clay beds ranges from 0 to 34 ft and averages 8 ft. Clayey sand beds in the unit range from 0 to 12 ft in thickness and average 2 ft.

Leakance coefficients of the "upper clay" confining zone were estimated at each of the 38 well locations where the "upper clay" was penetrated. Leakance coefficients ranged from 4.91×10^{-5} to 8.09×10^{-4}/d and averaged 5.78×10^{-5}/d.

Vertical hydraulic gradients were determined at six well locations (MSB-37, MSB-42, MSB-54, MSB-69, MSB-47, and 905-82A), where the "upper clay" confining zone is well developed and wells screened in the overlying and underlying aquifer zones are properly located. The vertical hydraulic gradients range from 0.106 ft/ft to 0.243 ft/ft, averaging 0.16 ft/ft. An average vertical flow velocity was calculated for the "upper clay" confining zone by using equations 2, 3, and 4:

$V_c = 5.34 \times 10^{-4}$ ft/d

$V_{cs} = 1.19 \times 10^{-2}$ ft/d

$V_v = 5.11 \times 10^{-4}$ ft/d or 0.19 ft/yr

These values are a measure of the flow rate of water through the confining beds and do not represent or take into account breaching of the confining beds through which flow rates would be greatly increased.

The "middle sand" aquifer zone consists of the very poorly sorted sediments of the Lang Syne/Sawdust Landing Formation (Fig. 7). The unit consists of either dark-gray to black, poorly sorted, fine to coarse, clayey, silty, occasionally pebbly, quartz sand and dark, kaolinitic clay and clayey silt, with muscovite, feldspar, iron sulfide, and lignite common, or tan, light-gray, yellow, brown, purple, and orange, moderately sorted sand and clay that tend to lack the sulfide and lignite found in the darker sediments. The lighter facies is more common in A-M Area. The thickness of the aquifer zone is variable, ranging from 10 to 68 ft and averaging 33 ft (Appendix 3). Clay to sandy clay beds range from 0 to12 ft in thickness and average 2 ft, and the clayey sand beds range from 0 to 28 ft in thickness and average 4 ft.

In places, especially in the northern part of A-M Area, the clay bed that caps the "middle sand" aquifer zone ("upper clay" confining zone) is very thin or absent (Plates 11 and 44). Here, only the basal clay ("lower clay" confining zone) is capable of acting as the confining unit between the "Lost Lake" aquifer zone of the Steed Pond aquifer and the underlying Crouch Branch aquifer. Thus, where the sand in the "middle sand" zone of the Crouch Branch confining unit is in hydraulic communication with the "Lost Lake" aquifer zone, it is considered to be part of the overlying Steed Pond aquifer (Fig. 11). Similarly, when the clay beds of the "lower clay" confining zone are very thin or absent, the sand beds of the "middle sand" aquifer zone are in hydraulic communication with the sand in the underlying Crouch Branch aquifer and are considered to be part of that unit.

The "middle sand" aquifer zone has a flow direction that is predominantly south/southwest toward Upper Three Runs Creek (Aadland and others, 1992a). The typical horizontal hydraulic gradient in the aquifer zone, based on mapping of the potentiometric surface (Aadland and others, 1992a), is 0.005 ft/ft. Hydraulic-conductivity estimates based on seven slug tests range from 4.10 to 80.51 ft/d and average 47.4 ft/d (Sirrine, 1991). Assuming a porosity of 0.30 for coarse sand, the ground water flow velocity in the aquifer zone is estimated to be 0.67 ft/d, or 245 ft/yr. This estimate is an average and if the maximum horizontal hydraulic-conductivity estimate was used, then the flow-rate estimate would be much higher. Conversely, if the minimum horizontal hydraulic-conductivity estimate was used, the flow-rate estimate would be much lower. The "middle sand" aquifer zone typically is too thin (less than 30 ft) to accurately estimate the vertical hydraulic gradient. One exception occurs at the ASB-8 well cluster where two wells were screened in the "middle sand" aquifer zone. A vertical gradient of 0.0044 ft/ft was measured, suggesting little vertical flow in the "middle sand".

A ground water flow model developed by Papadopulos and Associates (DuPont, 1986) for the M-Area Settling Basin and Lost Lake used a calibrated horizontal hydraulic conductivity of 29 ft/d for the "middle sand" aquifer zone and a vertical hydraulic conductivity of 1.1×10^{-2} ft/d. Assuming that the vertical hydraulic gradient measured at well ASB-8 is accurate, the vertical flow velocity in the "middle sand" aquifer zone is 1.6×10^{-4} ft/d or 5.8×10^{-2} ft/yr. This value is less than the vertical velocities calculated across the "upper clay" and "lower clay" confining zones.

The "lower clay" confining zone has been referred to as the lower Ellenton clay, the Ellenton clay, the Peedee clay, and the Ellenton/Peedee clay in previous SRS reports. The "lower clay" confining zone consists of the variegated gray, red, purple, yellow, and orange, and in places dark- to light-gray, massive clay bed that caps the Steel Creek Formation. The "lower clay" confining zone is variable in total thickness and, based on 31 wells that penetrate the unit, ranges from 5 to 62 ft and averages 24 ft (Appendix 3; Plate 41). In the far northeastern quadrant of A-M Area, the "lower clay" confining zone is occasionally missing, and where it is missing the sand beds of the "middle sand" aquifer zone are hydraulically connected with the sand beds of the underlying Crouch Branch aquifer and are considered part of that unit.

The thickness of the clay to sandy clay beds in the "lower clay" ranges from 0 to 46 ft and averages 18 ft. The thickness of the clayey sand beds ranges from 0 to 14 ft and averages about 4 ft. Leakance-coefficient values for the "lower clay" confining zone range from 3.26×10^{-6} to 7.42×10^{-4}/d and average 3.85×10^{-5}/d. In addition, vertical hydraulic gradients were determined at nine well locations (MSB-33, MSB-34, MSB-37, MSB-42, MSB-47, MSB-54, MSB-69, ASB-6, and ASB-8; Plate 11) where the "lower clay" confining zone is well developed and screen zones in the overlying and underlying aquifer zones are properly located. The vertical hydraulic gradient ranged from 0.046 to 0.344 ft/ft and averaged 0.13 ft/ft. The average vertical flow velocity through the confining zone calculated from equations 2, 3, and 4 is:

$$V_c = 4.34 \times 10^{-4} \text{ ft/d}$$

$$V_{cs} = 9.64 \times 10^{-3} \text{ ft/d}$$

$$V_v = 4.16 \times 10^{-4} \text{ ft/d or } 0.15 \text{ ft/yr}$$

These values are a measure of the flow rate of water through the confining beds and do not represent or take into account breaching of the confining beds through which flow rates are greatly increased.

The ground water flow model developed at the M-Area Settling Basin and Lost Lake in A-M Area by Papadopulos and Associates (DuPont, 1986) subdivided the Crouch Branch confining unit into three hydrogeologic zones that correspond to the zonation used in this report. Layer 3-4 corresponds to the "upper clay" confining zone, layer 4 to the "middle sand" aquifer zone, and layer 4-5 to the "lower clay" confining zone. The calibrated leakance coefficient was determined to be 2.66×10^{-4}/d for the "upper clay" confining zone, and 6.43×10^{-5}/d for the "lower clay" confining zone (Table 12). The calibrated leakance coefficient for the "upper clay" confining zone is 5 times greater than the leakance coefficients derived by laboratory means (5.78×10^{-5}/d). In contrast, the calibrated leakance coefficient for the "lower clay" confining zone (6.43×10^{-5}/d) is about two times the laboratory-derived leakance coefficient (3.85×10^{-5}/d). These differences suggest breaching of the confining zones due to stratigraphic discontinuities in the confining beds and, more importantly, to the extensive faulting in A-M Area (PSI, 1985) delineated in the area where the three zones are well developed. Indeed, the greater differences in the leakance coefficients derived by the two methods in the "upper clay" confining zone suggests that the pervasive faulting noted in the northern A-M Area (Plate 41) commonly breaches the thinner confining beds that constitute the "upper clay" confining zone, whereas the generally thicker confining beds that constitute the "lower clay" confining zone are less often breached by the faults in the area.

Dublin Aquifer System

The Dublin aquifer system is present in the southeastern half of the study area and consists of one aquifer, the Crouch Branch aquifer (Plates 18 and 19). It is underlain by the Allendale confining system and overlain by the Meyers Branch confining system (Fig. 12). The Dublin is correlative with the upper portion of the Chattahoochee River aquifer of Miller and Renken (1988) (Figs. 9 and 43). The updip limit of the Dublin aquifer system in the study area corresponds to the updip limit of the Allendale confining system (Fig. 10; Plates 18 and 19). North of this line, the Dublin-Midville aquifer system is defined (Fig. 12).

Thickness of the Dublin aquifer system generally increases toward the south and ranges from approximately 175 to 290 ft (Appendix 1). The top of the unit dips 20 ft/mi to the

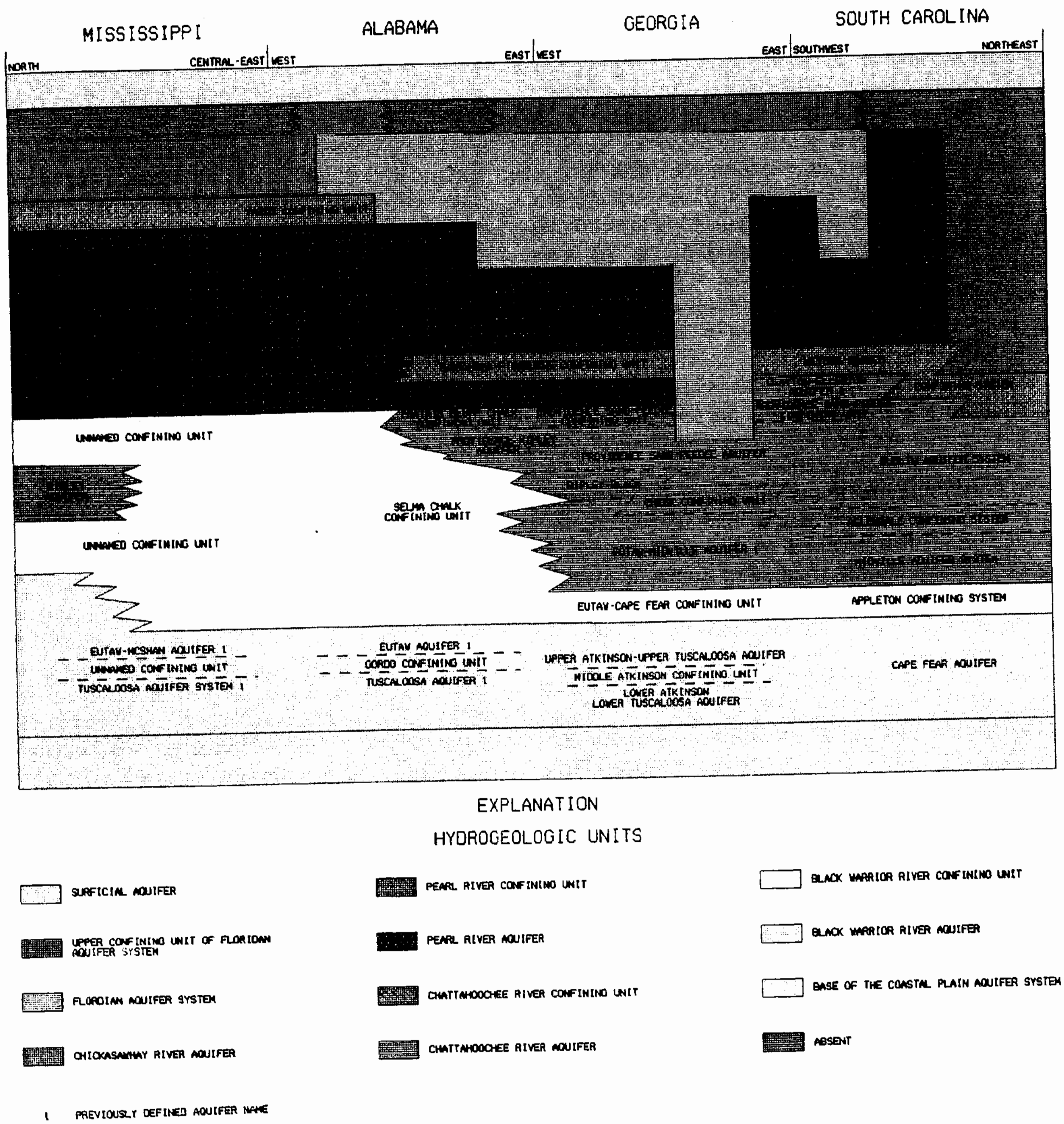


Figure 43. Relationships among regional and subregional hydrogeologic units in the Southeastern Coastal Plain hydrogeologic province.

southeast. The unit thins to the east toward the Salkehatchie River and to the west toward Georgia. Near the updip limit of the system, thicknesses are variable and probably reflect the effects of movement along the Pen Branch Fault during deposition of the middle Black Creek clay that thins dramatically near the trace of the fault (Plates 3, 4, and 5).

The Dublin aquifer system was defined and named by Clarke and others (1985) for sediments penetrated by well 21U4 drilled near the town of Dublin in Laurens County, Ga. The upper part of the Dublin aquifer system consists of fine to coarse sand and limestone of the lower Huber-Ellenton unit (Plate 37). Comparable stratigraphic units serve as confining beds in the study area and are considered part of the overlying Meyers Branch confining system. Clarke and others (1985) noted that to the east near the Savannah River, clay in the upper part of the lower Huber-Ellenton unit forms a confining unit that separates an upper aquifer of Paleocene age from a lower aquifer of Late Cretaceous age. The upper aquifer of Clarke and others (1985) is the Gordon aquifer as defined in the study, and their confining unit constitutes the Meyers Branch confining system of the SRS region. The lower part of the Dublin aquifer system consists of alternating layers of clayey sand and clay of the Peedee-Providence unit (Plate 37).

Sediments typical of the Dublin aquifer system are penetrated in the reference well P-22 (Plates 1 and 39g). Here, the system consists of well-sorted sand and clayey, lignitic, and micaceous sand of the upper fining-upward sequence of the Black Creek Formation, and the medium to coarse, moderately sorted sand and interbedded sand and variegated clay of the Steel Creek Formation. The Dublin is overlain by the clay beds that cap the Steel Creek Formation. These clay beds constitute the base of the Meyers Branch confining system (Figs. 7 and 12; Plate 39g).

The Dublin aquifer system is 213 ft thick in well P-22; the top is at an elevation of -223 ft msl and the bottom at -436 ft msl (Appendix 1). Total thickness of sand and clayey sand is 184 ft in six beds (86 percent sand). The Dublin includes five clay beds in this well; the thick clay bed near the base of the system is the unit that caps the upper, fining-upward sequence of the Black Creek Formation (Plate 39g).

In the southern part of the study area, where the Dublin aquifer system is defined, and farther south and east, a transition from lower delta plain to shallow and deeper shelf depositional environments is indicated by a decrease in grain size and an increase in clay content (Plate 28). This results in much lower values for the hydraulic conductivity and transmissivity in the Dublin and is probably due to the presence of the deep-shelf, fine-grained sediments toward the coast (Aucott and others, 1987). A reduction in the transmissivity in the aquifer system between wells in Screven and Bulloch Counties, Ga., may also be due to the effects of the increasingly greater presence of fine-grained sediments toward the Georgia coast (Clarke and others, 1985).

Zack (1977) reported values for transmissivity ranging from 390 to 5,350 ft²/d in Horry and Georgetown Counties, S.C. In Charleston County, S.C., Park (1980) calculated a value of about 1,200 ft²/d. Calculated transmissivities used to model the Dublin aquifer system in South Carolina range from 400 to 11,000 ft²/d (Aucott, 1988). A value of 30 ft/d is to be the average hydraulic conductivity for the Du fer system in coastal areas of South Carolina. Spec cities range from 0.8 to 4.8 gal/min/ft (Clarke an 1985).

Dublin-Midville Aquifer System

The Dublin-Midville aquifer system underlies the part of SRS (Figs. 10 and 12; Plates 3-10) and inclu sediments in the Cretaceous Lumbee Group from the Mi dorf Formation up to the sand in the lower part of the Creek Formation (Fig. 7; Plate 39h). The system is ov by the Meyers Branch confining system and underlain b indurated clayey silty sand and silty clay of the Appleton fining system (Figs. 7 and 12). The updip limit of the sy is established at the updip pinchout of the overlying Me Branch confining system (Fig. 10). Here, the Dublin-Mid coalesces with the overlying Floridan aquifer system, form the Floridan-Midville aquifer system. The downdip limi the Dublin-Midville is established at the updip limit of t underlying Allendale confining system (Fig. 10). South of t line, the Dublin-Midville aquifer system splits into the Dubl and Midville aquifer systems. The aquifer system forms wedge with the apex of the wedge developed just west well C-5 northeast of SRS (Fig. 10). The wedge opens to the southwest across the central part of SRS and into Georgia. The Dublin-Midville and the updip Floridan-Midville aquifer systems were referred to as the Tuscaloosa aquifer by Siple (1967). The aquifer system is the equivalent of the Chattahoochee River aquifer of Miller and Renken (1988) (Figs. 9 and 43) and the Dublin-Midville aquifer system as defined by Clarke and others (1985) in west-central Georgia (Plate 37).

Thickness of the Dublin-Midville aquifer system ranges from approximately 250 to 550 ft (Appendix 1). The dip of the upper surface of the system is about 20 ft/mi to the southeast. Near the downdip limit of the system, thicknesses are variable and probably reflect the effects of movement along the Pen Branch Fault (Plates 19 and 23), where shoaling along the trace of the fault locally increased the relative quantity of coarser-grained sediments in the interval comprising the McQueen Branch confining unit. This resulted in a relative increase in the thickness of the aquifers above and below the confining unit near the fault.

The Dublin-Midville aquifer system includes two aquifer units, the McQueen Branch and the Crouch Branch, separated by the McQueen Branch confining unit (Figs. 7 and 12; Plates 3-10). The two aquifers can be traced northward, where they continue to be an integral part of the Floridan-Midville aquifer system and southward where they constitute the aquifer units of the Midville and Dublin aquifer systems, respectfully (Fig. 10; Plate 38).

The Dublin-Midville aquifer system is defined for the hydrogeologic properties of sediments penetrated in type well P-27 (Plate 39h). Here, the system is 505 ft thick and occurs from -82 ft msl to -587 ft msl. It consists of medium- to very coarse-grained, typically angular, slightly silty sand of the Middendorf Formation and the clayey, micaceous, poorly to moderately well sorted, fine to medium sand and silty clay beds of the Black Creek Formation (Fallaw and Price, 1992). The system includes a thick clay bed, occurring from -329 ft msl to -384 ft msl, which constitutes the McQueen Branch confining unit.

A regional potentiometric surface map prepared by Siple (1967) for his "Tuscaloosa aquifer," which includes the Floridan-Midville aquifer system in the northernmost part of the study area and the Dublin-Midville aquifer system to the southeast, is illustrated in Figure 44. The map shows an arcuate flow pattern toward a sink along the Savannah River. These data indicate that the Savannah River has breached the Cretaceous sediments and is a regional discharge area for the Floridan-Midville aquifer system, the Dublin-Midville aquifer system, and the updip part of both the Dublin and Midville aquifer systems (Faye and Prowell, 1982; Bechtel, 1982). The Savannah River therefore, represents a no-flow boundary preventing the ground water in these aquifer systems from flowing southward into Georgia.

Crouch Branch aquifer unit.—The Crouch Branch aquifer constitutes the Dublin aquifer system in the southern part of the study area. Farther south, the Dublin can be subdivided into several aquifers and confining units. In the central part of the study area, the Crouch Branch aquifer is the uppermost of the two aquifers that constitute the Dublin-Midville aquifer system. Farther north in the northwestern part of SRS and north of the site, the Crouch Branch aquifer is the middle aquifer of the three aquifers that constitute the Floridan-Midville aquifer system (Fig. 12; Plate 1). Indeed, the entire Coastal Plain sequence acts as a single aquifer from the water table to the basement near the updip limit of the sequence.

The Crouch Branch aquifer is overlain by the Crouch Branch confining unit of the Meyers Branch confining system in the southern and central parts of the study area (Fig. 12; Plates 3-10 and 38) where the Dublin and Dublin-Midville aquifer systems are defined and by the Crouch Branch confining unit where it is part of the Floridan-Midville aquifer system in the northern part of the study area. The Crouch Branch aquifer is underlain by the McQueen Branch confining unit in both the northern portion of the study area where it is part of the Dublin-Midville and Floridan-Midville aquifer systems (Fig. 12) and the southern portion of the study area where it constitutes the Allendale confining system. It persists throughout the northern part of the study area, but near the updip limit of the Coastal Plain sedimentary clastic wedge the Crouch Branch confining unit ceases to be effective and the Crouch Branch aquifer coalesces with the Steed Pond aquifer.

The Crouch Branch aquifer is defined by the hydrogeologic properties of sediments penetrated in well P-27 near the center of SRS (Plates 1 and 39h) and named for Crouch Branch, a tributary of Upper Three Runs Creek. At the type well, the Crouch Branch aquifer is 247 ft thick and is present from -82 to -329 ft msl. It includes the sand beds in the upper one-third of the Black Creek Formation, which are fine-grained, have a relatively high clay content, and are better sorted relative to the overlying and underlying Cretaceous units (Fallaw and Price, 1992), as well as the medium- to coarse-grained, poorly to well-sorted sand and silty sand and thin beds of micaceous and carbonaceous clay in the overlying Steel Creek Formation. The aquifer dips approximately 20 ft/mi to the southeast across the study area (Plate 18).

The Crouch Branch aquifer ranges in thickness from about 100 to 350 ft (Appendix 1; Plate 19). Thickness of the unit is variable near the updip limit of the Dublin aquifer system where sedimentation was affected by movement along the Pen Branch Fault. Here, the fine-grained clayey sediments typical of the Paleocene Black Mingo Group, which constitutes much of the overlying Crouch Branch confining unit of the Meyers Branch confining system, and the clay and clayey sand typical of the middle third of the Black Creek Formation, which constitutes the underlying McQueen Branch confining unit, are more sandy. The reduced clay content in this vicinity suggests shoaling due to uplift along the fault during Late Cretaceous and Paleocene time, resulting in the deposition of increased quantities of shallow-water, coarse-grained clastics along the crest of the fault trace. The sandy beds act hydrogeologically as part of the Crouch Branch aquifer, resulting in fewer and thinner, less persistent clay beds in the overlying and underlying confining units.

The Crouch Branch aquifer thins dramatically in the eastern part of the study area at the same general location where the clay beds of the underlying McQueen Branch confining unit of the Allendale confining system and the clay beds at the base of the overlying Crouch Branch confining unit thicken at the expense of Crouch Branch sand (Plates 7 and 19). In addition, clay beds in the Crouch Branch aquifer generally thicken in the same area and constitute as much as 33 percent of the unit at well C-6 (Plate 5). This may suggest that the eastern flank of the upper Black Creek-Steel Creek delta complex is located along a line extending from Williston to Allendale, S.C. East of the line shelf clay dominates the section.

Sediments of the Crouch Branch aquifer are chiefly sand, muddy sand, and slightly gravelly sand intercalated with thin, discontinuous layers of sandy clay and sandy mud. Statistical analysis of 303 Crouch Branch aquifer samples containing less than 25 percent mud shows that gravel averages 3.2 percent, sand 85.9 percent, and mud 10.8 percent (Table 16). The distribution of mud in the sampled population is approximately normal and is skewed slightly toward lower mud percentages (Fig. 45).

Mean grain size of Crouch Branch aquifer samples is upper medium sand (Table 16), and ranges from upper very coarse to upper very fine sand (Fig. 46). Most Crouch Branch aquifer samples are poorly sorted (Fig. 47), which results from the high average mud content of the sand.

X-ray diffraction analysis was done on 39 sand and 5 mud samples collected from the Crouch Branch aquifer in the P-well series. The sand samples consist of quartz with 5 to 20 percent clay matrix and trace amounts of plagioclase, K-feldspar, and pyrite (Strom and Kaback, 1992). Kaolinite is the dominant clay mineral in all sand samples, with minor to trace amounts of illite and smectite. The five mud samples consist of quartz and clay minerals, chiefly kaolinite with trace amounts of illite.

X-ray diffraction analysis was done on 15 clay to sandy clay samples from the Crouch Branch aquifer, taken from the C-well series (Gelting, 1990; Gellici and others, 1995). Quartz averages 19 percent and clay minerals 81 percent. The average

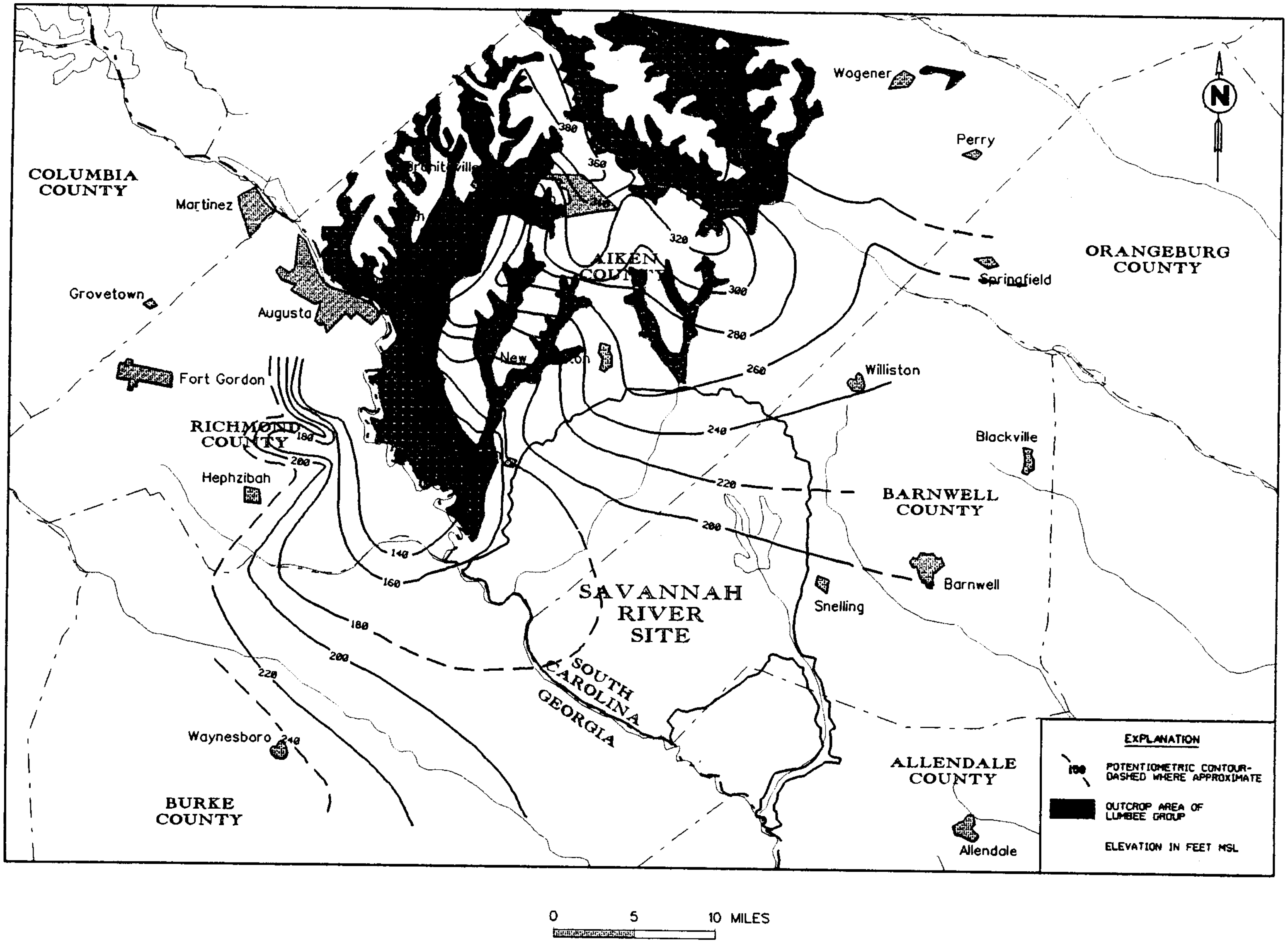


Figure 44. Potentiometric surface and outcrop area of the Dublin-Midville and Floridan-Midville aquifer systems (modified from Siple, 1967).

Table 16. Summary of Folk and Ward statistics, gravel-sand-mud percentages, and calculated porosity and permeability values for sand samples from the Crouch Branch aquifer unit that contain less than 25 percent mud.

Parameter	Folk and Ward Statistics				Gravel	Sand	Mud	Porosity	Permeability	
	Mean[1]	Sorting[1]	Skewness	Kurtosis	(%)	(%)	(%)	(%)	(Darcy)	(ft/d)
Arithmetic mean	1.356	1.481	0.323	1.580	3.2	85.9	10.8	33.5	69.8	169.8
Confidence level (95%)	0.082	0.057	0.020	0.073	0.6	0.8	0.6	0.4	7.0	17.0
Number of samples	305	305	305	305	347	303	303	234	234	234
Median	1.298	1.387	0.324	1.411	1.2	86.6	10.8	33.9	48.5	118.0
Mode	1.468	1.288	0.295	1.220	0.0	86.5	7.5	34.0	39.0	94.9
25th percentile	0.830	1.157	0.220	1.184	0.2	82.6	7.2	32.1	29.3	71.2
75th percentile	1.825	1.729	0.428	1.756	3.7	90.4	14.2	35.1	100.0	243.3
Standard deviation	0.730	0.511	0.174	0.649	5.2	7.0	5.1	2.8	54.6	132.9
Variance	0.533	0.262	0.030	0.421	27.5	48.3	25.9	7.9	2982.9	17657.5
Kurtosis	-0.100	2.354	0.423	3.694	24.5	3.2	-0.3	0.4	-0.2	-0.2
Skewness	0.293	1.226	-0.227	1.810	4.0	-1.2	0.1	-0.5	0.9	0.9
Range	4.444	3.258	1.075	3.555	51.2	50.2	24.3	16.1	250.4	609.2
Maximum	-0.966	3.612	0.774	4.250	51.2	98.9	24.4	41.2	252.0	613.1
Minimum	3.478	0.354	-0.301	0.695	0.0	48.6	0.1	25.1	1.6	3.9
Trimean (5%)	1.350	1.460	0.325	1.541	2.7	86.1	10.7	33.5	68.3	166.1
Geometric mean	-	-	-	-	-	-	-	-	48.1	117.0
Harmonic mean	-	-	-	-	-	-	-	-	26.1	63.6

[1] Values are in phi units

clay mineral suite is: kaolinite, 65 percent; illite, 22 percent; mixed-layer illite/smectite, 10 percent; and smectite, about 2 percent.

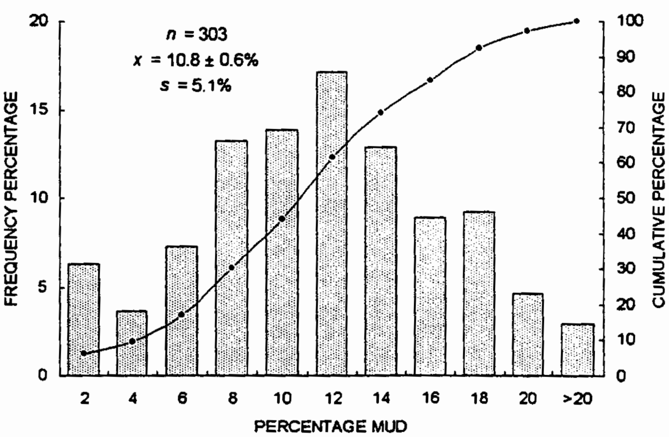


Figure 45. Percentage mud (silt + clay) in Crouch Branch aquifer sand samples containing less than 25 percent mud.

Petrographic analysis of eight Crouch Branch sand samples from wells C-2, C-3, C-5, and C-10 indicate that they are quartzarenites (Folk, 1980 classification) consisting of monocrystalline and polycrystalline quartz, muscovite and 5 to 8 percent detrital mud matrix. Accessory constituents include K-feldspar, plagioclase, detrital "books" of kaolinite, and heavy and opaque minerals. Authigenic kaolinite and pyrite are rare. Measured thin-section porosity of four samples from C-5 and C-10 ranges from 20 to 25.5 percent.

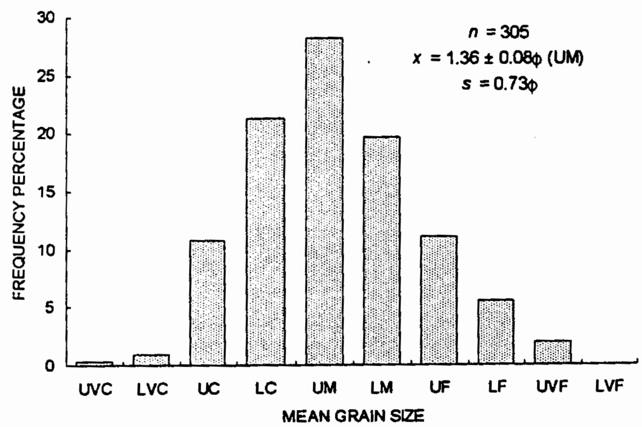


Figure 46. Mean grain size of sand samples from the Crouch Branch aquifer. UVC, upper very coarse sand; LVC, lower very coarse sand; UC, upper coarse sand; LC, lower coarse sand; UM, upper medium sand; LM, lower medium sand; UF, upper fine sand; LF, lower fine sand; UVF, upper very fine sand; and LVF, lower very fine sand.

The porosity of 234 Crouch Branch aquifer samples containing less than 25 percent mud averages 33.5 percent (Table 16; Fig. 48), and geometric mean permeability is 48.1 Darcies (117 ft/d) (Fig. 49). Permeability values are skewed toward high values (Fig. 49) and appear to follow a log-normal distribution (Fig. 50).

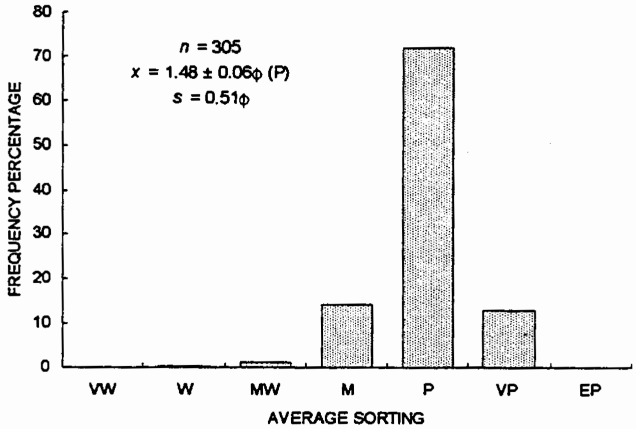


Figure 47. Sorting classes of Crouch Branch aquifer samples. VW, very well sorted; W, well sorted; MW, moderately well sorted; M, moderately sorted; P, poorly sorted; VP, very poorly sorted; and EP, extremely poorly sorted.

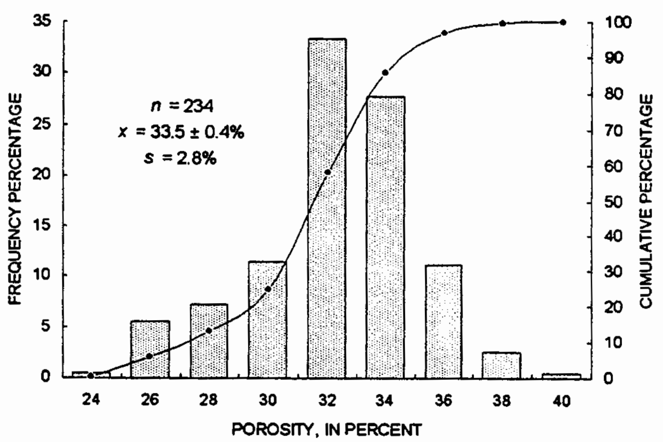


Figure 48. Calculated porosity values of Crouch Branch aquifer sand samples containing less than 25 percent mud.

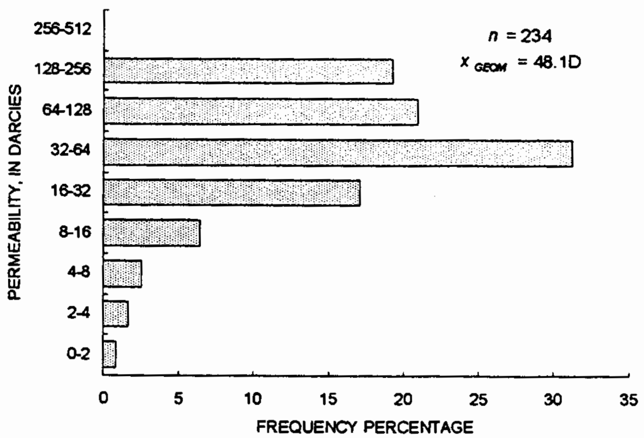


Figure 49. Calculated permeability values of Crouch Branch aquifer sand samples containing less than 25 percent mud.

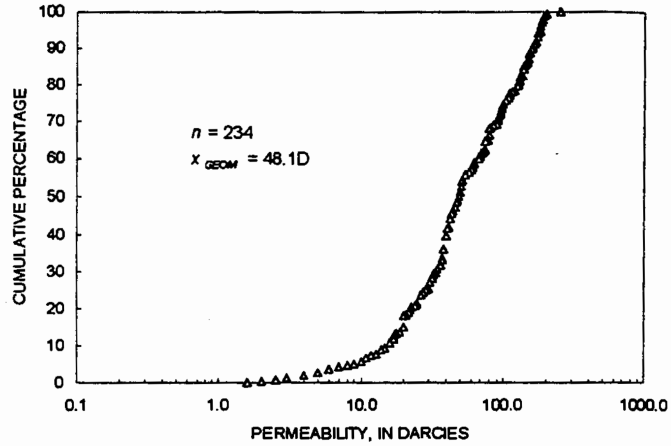


Figure 50. Cumulative frequency of calculated permeability values for Crouch Branch aquifer sand samples with less than 25 percent mud.

Crouch Branch sediments containing greater than 25 percent mud are muddy sand, sandy mud, and mud that occur as thin, discontinuous beds in the aquifer. Summary grain-size statistics for these sediments are presented in Table 17.

Vertical hydraulic-conductivity values derived from the laboratory analysis of 17 clay to sandy clay samples from the Crouch Branch aquifer (Bledsoe and others, 1990) range from 1.81 x 10^{-5} to 9.64 x 10^{-4} ft/d, with a geometric mean value of 1.48 x 10^{-4} ft/d (Table 2). Horizontal hydraulic-conductivity values derived from 16 clay to sandy clay samples analyzed range from 2.55 x 10^{-5} to 1.84 x 10^{-2} ft/d, with a geometric mean value of 2.60 x 10^{-4} ft/d (Table 2).

Vertical hydraulic-conductivity values for six clayey sand samples from the Crouch Branch aquifer (Bledsoe and others, 1990) range from 1.09 x 10^{-3} to 5.10 x 10^{-1} ft/d, with a geometric mean value of 2.11 x 10^{-2} ft/d (Table 1). Horizontal hydraulic-conductivity values for four clayey sand samples range from 2.69 x 10^{-3} to 3.68 x 10^{-1} ft/d, with a geometric mean value of 4.13 x 10^{-2} ft/d. The porosity of the 17 clay to sandy clay samples range from 28 to 48 percent, with a mean value of 37 percent. The range in porosities for the six clayey sand samples is 31 to 46 percent, with a mean of 36 percent.

The Crouch Branch aquifer is persistent throughout the study area (Plates 3-10, 18, and 19) and is the principal water-producing aquifer at SRS. Transmissivity values in the Crouch Branch aquifer are relatively high because of the coarse sand and low clay content of the aquifer. Near the Fall Line in the catchment area of the Cretaceous aquifers, Aucott (1988) estimated a transmissivity of less than 2,000 ft^2/d for the Crouch Branch-McQueen Branch aquifers undifferentiated. To the south, in the lower Coastal Plain, the hydraulic conductivity and transmissivity in the downdip hydrostratigraphic equivalents of the Crouch Branch appear to be much lower, probably due to the presence of deeper shelf, fine-grained sediments deposited in the area (Aucott and others, 1987) (Plate 28).

Hydraulic properties for the Crouch Branch aquifer in the central part of SRS were compiled by GeoTrans (1988) (Table 18). The lowest transmissivity measurement was 3,000 ft^2/d, in K-Area; the highest transmissivity measurement was

Table 17. Summary of Folk and Ward statistics and gravel-sand-mud percentages for sand samples from the Crouch Branch aquifer unit that contain more than 25 percent mud

Parameter	Folk and Ward Statistics				Gravel	Sand	Mud
	Mean[1]	Sorting[1]	Skewness	Kurtosis	(%)	(%)	(%)
Arithmetic mean	2.916	2.099	0.105	0.787	2.5	37.8	59.7
Confidence level (95%)	0.410	0.534	0.249	0.084	2.0	7.9	8.5
Number of samples	13	13	13	13	35	35	35
Median	2.959	1.614	0.032	0.791	0.0	42.3	57.6
Mode	-	-	-	-	0.0	19.5	80.5
25th percentile	2.793	1.373	-0.122	0.666	0.0	14.8	36.8
75th percentile	3.365	2.987	0.611	0.891	0.8	59.1	85.3
Standard deviation	0.754	0.982	0.458	0.155	6.1	23.8	25.7
Variance	0.568	0.965	0.209	0.024	36.9	565.5	661.5
Kurtosis	2.501	-0.938	-1.097	-0.356	10.2	-1.5	-1.6
Skewness	-1.275	0.850	-0.163	-0.332	3.1	-0.1	0.2
Range	2.891	2.831	1.361	0.528	28.2	71.7	73.7
Maximum	1.014	3.873	0.681	1.006	28.2	72.1	99.6
Minimum	3.905	1.042	-0.680	0.478	0.0	0.4	25.9
Trimean (5%)	2.916	2.099	0.105	0.787	2.5	37.8	59.7

[1] Values are in phi units

27,000 ft²/d, in D-Area. The majority of transmissivity measurements are between 10,000 and 20,000 ft²/d.

Table 18. Hydraulic-property ranges for the Crouch Branch aquifer (modified from GeoTrans, 1988)

Area	Transmissivity (ft^2/d)	Hydraulic conductivity (ft/d)
C	1.1×10^4 - 1.9×10^4	118 - 211
D	1.6×10^4 - 2.7×10^4	135 - 227
F-H	1.0×10^4 - 1.5×10^4	57 - 86
K	3.0×10^3 - 6.7×10^3	30 - 83
L	9.1×10^3 - 1.3×10^4	91 - 126

Hydraulic properties for the Crouch Branch aquifer were determined from the results of pumping tests made in 1951 and 1952 (Siple, 1967) (Table 19). The Theis nonequilibrium and the Cooper-Jacob straight-line methods were used to analyze the data from the tests in which measurements were obtained in one or more observation wells. The Theis recovery formula was used to analyze the data from the tests in which measurements were made only in the pumped well (Siple, 1967).

Wells near the center of SRS were test pumped at various rates and had specific capacities that ranged from 3.5 to 38 gal/min/ft. Results from 9 pumping tests indicate an average transmissivity of 11,237 ft²/d and a storage coefficient of 4×10^{-4} (Table 19)

Hydraulic-conductivity estimates for the Crouch Branch aquifer in the central part of SRS range from 30 ft/d to 227 ft/d and average 116 ft/d (GeoTrans, 1988). According to Logan and Euler (1989), the sand beds of the Crouch Branch in the study area have an average hydraulic conductivity approaching that of the McQueen Branch aquifer: 90 ft/d for the Crouch Branch compared to 110 ft/d for the McQueen Branch.

A high degree of variance in the results of the pumping tests was noted by Logan and Euler (1989). They attributed the variance to several factors, among them being partial penetration by some of the wells, differences in the location of well screens, and heterogeneity of the hydrostratigraphic units. Depending on the screen setting in the pumping well and on the distance between the observation well and pumping well compared to the aquifer thickness, the calculated values for transmissivity may be reliable or misleading representations of the true transmissivity (Logan and Euler, 1989).

Few wells are screened entirely within the Crouch Branch aquifer in A-M Area, thus few hydraulic data for the Crouch Branch aquifer in the northern part of the study area are available. One pumping test in A-M Area done by Geraghty and Miller (1983), in the undifferentiated McQueen Branch-Crouch Branch aquifers established representative values for the hydraulic properties of the two aquifers. Transmissivity is estimated to be 79,000 gal/d/ft (10,500 ft²/d), the storage coefficient is calculated to be 4.2×10^{-4}, and a leakance value

Table 19. Pumping-test results for the Crouch Branch and McQueen Branch aquifers (modified from Siple, 1967)

Aquifer unit	Date tested	Area	Well pumped	Well observed	Average pumping rate (gal/min)	Sand thickness (ft)	Transmissivity (gal/d/ft)	Transmissivity (ft^2/d)	Hydraulic conductivity ($gal/d/ft^2$)	Hydraulic conductivity (ft/d)	Storage coefficient
Crouch Br.	09/20/51	P	25-P	25-P	540	219	63,500	8,500	290	39	--
Crouch Br.	11/03/51	P	30-P	30-P	540	144	52,000	7,000	361	48	--
Crouch Br.	10/09/51	R	27-R	27-R	560	--	90,000	12,000	--	--	--
Crouch Br.	08/10/52	R	27-R	105-R	440	103	90,000	12,000	874	117	0.0004
Crouch Br.	12/31/51	K	33-K	33-K	578	154	109,000	14,600	708	95	--
Crouch Br.	05/26/52	C	51-C	51-C	589	--	95,000	12,700	--	--	--
Crouch Br.	06/16/52	C	52-C	52-C	567	136	140,000	18,700	1,029	138	--
Crouch Br.	08/03/52	P	25-P	105-P	370	219	46,000	6,200	210	28	0.0004
Crouch Br.	11/28/51	L	29-L	29-L	525	124	71,000	9,500	573	77	--
Crouch Br.	04/23/51	M	15-M	15-M	450	160	33,500	4,500	209	28	--
Crouch Br.	03/10/53	Aiken	AK-266	AK-266	383	138	95,000	12,700	690	92	--
McQueen Br.	04/28/52	F	49-F	49-F	562	267	105,000	14,000	393	53	--
McQueen Br.	11/16/51	F	21-F	24-F	1,870	237	252,000	33,700	1,065	142	0.0007
McQueen Br.	09/29/51	F	24-F	24-F	610	237	253,000	33,800	1,063	142	--
McQueen Br.	09/29/51	F	24-F	21-F	600	237	215,000	28,700	907	121	0.0008
McQueen Br.	05/08/52	H	35-H	35-H	1,350	273	196,000	26,200	720	96	--
McQueen Br.	01/03/52	H	35-H	35-H	560	273	198,000	26,500	725	97	--
McQueen Br.	02/23/52	H	43-H	43-H	560	277	204,000	27,300	736	98	--
McQueen Br.	05/06/52	H	48-H	48-H	600	260	198,000	26,500	762	102	--
McQueen Br.	03/17/52	H	44-H	44-H	570	239	375,000	50,100	1,569	210	--
McQueen Br.	02/29/52	F	37-F	37-F	589	213	178,000	23,800	836	112	--
McQueen Br.	01/19/52	M	31-M	4-M, 20-M	1,500	181	147,000	19,700	812	109	0.0003
McQueen Br.	09/10/52	Williston	BW-44	BW-44	530	255	120,000	16,000	470	63	--

of 1.1 x 10^{-3} gal/d/ft^3 (1.5 x 10^{-4}/d) was calculated across the overlying Crouch Branch confining unit. Assuming a clean sand thickness of 286 ft, as observed at well MSB-12, a hydraulic conductivity of 37 ft/d is estimated for the undifferentiated aquifers. By comparison, Siple (1967) estimated a transmissivity of 90,000 gal/d/ft (12,000 ft^2/d) and a storage coefficient of 3 x 10^{-4}, using the same pumping well (905-20A) as Geraghty and Miller (1983). Assuming a clean-sand thickness of 286 ft, a hydraulic-conductivity value of 42 ft/d is estimated for the aquifers.

A single-well pumping test at a municipal well in Williston (well BRN-79) yielded a transmissivity of 110,000 gal/d/ft (14,700 ft^2/d) and a specific capacity of 11 gal/min/ft pumping at a rate of 1,404 gal/min (Newcome, 1993). This well is screened in both the McQueen Branch and Crouch Branch aquifers of the Floridan-Midville aquifer system. Assuming a total sand thickness of 300 ft, as determined from geophysical logs, a hydraulic conductivity of 49 ft/d is estimated, which is comparable to the hydraulic-conductivity values of 37 and 42 ft/d calculated for the undifferentiated aquifers in A-M Area.

A single-well test (Siple, 1967) of the Crouch Branch aquifer in A-M Area in 1951 (Table 19), pumping at a rate of 450 gal/min, indicated a transmissivity of 33,500 gal/d/ft (4,500 ft^2/d) (Fig. 51). Assuming a clean-sand thickness of 160 ft, a hydraulic conductivity of 28 ft/d was calculated for the aquifer. Upon inspection of the lithologic characteristics of the two aquifers in the A-M Area (Plate 3), the sediments that constitute the Crouch Branch aquifer are more poorly sorted and, on average, have a higher clay content than sediments in the underlying McQueen Branch aquifer. This is reflected in the lower hydraulic conductivity estimated for the Crouch Branch aquifer as compared to the hydraulic conductivity for the two aquifers undifferentiated.

In F-H Area, GeoTrans (1988) recorded transmissivity data from an unspecified number of pumping tests of the Crouch

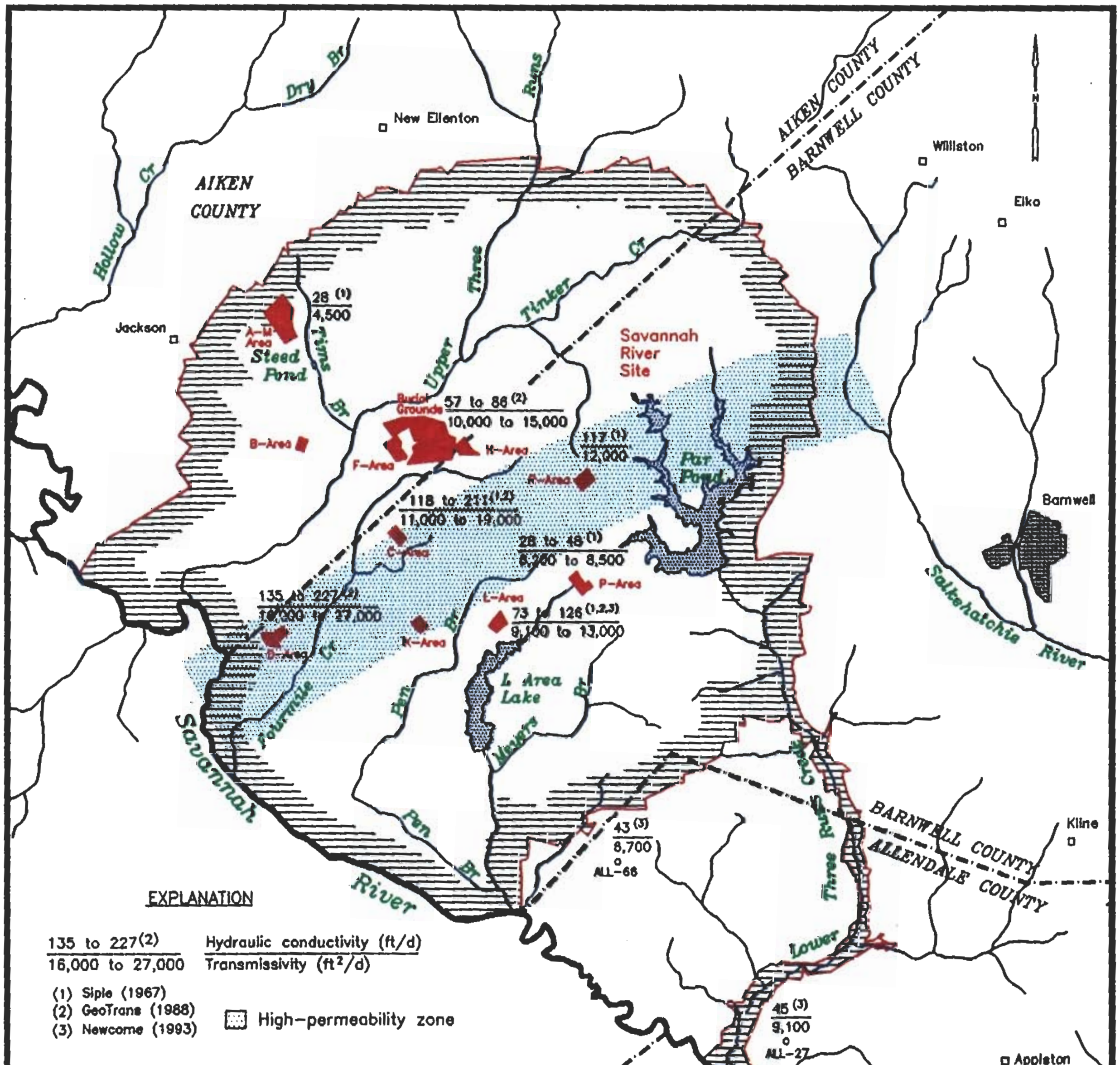


Figure 51. Distribution of pumping-test results for the Crouch Branch aquifer.

Branch aquifer (Table 18). Transmissivities range from 10,000 to 15,000 ft²/d and hydraulic-conductivity values from 57 to 86 ft/d. The transmissivity and hydraulic conductivity are three times greater than those calculated in A-M Area (Fig. 51), due largely to the lower clay and mica content and better sorting of the sand in the aquifer toward the south (Plates 3, 4, and 5). In F-H Area, the average thickness of the sand in the aquifer increases by only about 50 percent over the sand thickness in A-M Area, thus sand thickness alone cannot account for the dramatic increase in the transmissivity values of the aquifer toward the south.

South of F-H Area, in the Central Shops Area (Fig. 2), transmissivity estimated from pumping tests of the Crouch Branch aquifer (GeoTrans, 1988) ranges from 11,000 to 19,000 ft²/d; hydraulic conductivity ranges from 118 to 211 ft/d (Table 18). Two single-well pumping tests (Siple, 1967) of the Crouch Branch aquifer in C-Area had transmissivities of 12,700 and 18,700 ft²/d (51-C and 52-C in Table 19). Using a sand thickness of 136 ft, a hydraulic conductivity of 138 ft/d was determined at well 52-C.

Transmissivity values derived from pumping tests of the Crouch Branch aquifer in D-Area (GeoTrans, 1988) range from 16,000 to 27,000 ft²/d, indicating hydraulic conductivity ranging from 135 to 227 ft/d (Table 18). A transmissivity value of 12,000 ft²/d for the Crouch Branch aquifer was recorded in R-Area (Siple, 1967), with a resulting hydraulic conductivity of 117 ft/d (Table 19).

Comparatively high hydraulic conductivity in the Crouch Branch aquifer occurs in a northeast-southwest trending region connecting D-Area, Central Shops, and R-Area and defines a "high permeability" zone in the aquifer (Fig. 51). Here, hydraulic conductivities range from 117 to 227 ft/d. The lower hydraulic-conductivity values, those ranging from 117 to 138 ft/d, tend to cluster in data provided by Siple (1967), whereas the higher values, 135 to 227 ft/d, were generally those recorded by GeoTrans (1988) (Tables 18 and 19). The "high permeability" zone parallels the trace of the Pen Branch Fault (Fig. 51), and reflects the response of the depositional environment to movement along the fault that resulted in coarse-grained, clean, shallow-water sand being deposited along the trace of the fault.

South of the trace of the Pen Branch Fault, in P- and L-Areas and throughout the southern part of the study area, lower transmissivity and hydraulic conductivity for the Crouch Branch aquifer reflects the return to a deeper water, shelf/deltaic depositional regime. In P-Area, Siple (1967) recorded transmissivities ranging from 6,200 to 8,500 ft²/d and averaging 7,100 ft²/d; and hydraulic conductivities from 28 to 48 ft/d and averaging 38 ft/d (Table 19; Fig. 51).

In L-Area, Siple (1967) recorded a transmissivity value of 9,500 ft²/d, and a hydraulic conductivity of 77 ft/d. GeoTrans (1988) recorded transmissivities in L-Area that range from 9,100 to 13,000 ft²/d, and hydraulic conductivities from 91 to 126 ft/d (Table 18). Single-well pumping tests at two production wells in L-Area at SRS were screened in the Crouch Branch aquifer and produced transmissivity values of 79,000 and 76,000 gal/d/ft (10,600 and 10,200 ft²/d). Production well 905-104L had a specific capacity of 27 gal/min/ft while pumping at 750 gal/min, and production well 905-105L had a specific capacity of 19 gal/min/ft while pumping at 751 gal/min. Assuming a sand thickness of 139 ft as observed in nearby well P-15, the hydraulic conductivity is estimated at 76 ft/d at well 905-104L and 73 ft/d at well 905-105L.

A pumping test made just south of SRS at Creek Plantation near Martin, S.C. (well ALL-66) (Fig. 51) yielded a transmissivity of 50,000 gal/d/ft (6,700 ft²/d) and a specific capacity of 16 gal/min/ft at 1,500 gal/min (Newcome, 1993). This well is mostly screened in the Crouch Branch aquifer of the Dublin aquifer system (107 ft of screen is in the Crouch Branch aquifer and 20 ft of screen is in the Gordon aquifer). From geophysical logs, the total sand thickness of the Crouch Branch aquifer is 156 ft, resulting in a hydraulic conductivity of 43 ft/d.

A single-well pumping test made at a flowing artesian well (ALL-27) in the southern part of the study area (Fig. 51) is screened solely in the Crouch Branch aquifer of the Dublin aquifer system. The test indicated a transmissivity of 68,000 gal/d/ft (9,100 ft²/d) and a specific capacity of 18 gal/min/ft while pumping at 2,150 gal/min (Newcome, 1993). Sand thickness in this well is 201 ft, and the calculated hydraulic conductivity is 45 ft/d.

The potentiometric-surface map of the Crouch Branch aquifer (Plate 45), indicates that the direction of ground water flow is generally southwesterly across the study area, discharging into the Savannah River flood plain. Hydraulic gradients are steeper in the northern part of the study area, averaging 0.0010 ft/ft in the northwestern most part of SRS. Gradients decrease at GSA, averaging 0.0008 ft/ft in the vicinity of Four Mile Branch and Upper Three Runs Creek, and 0.0005 ft/ft in the vicinity of L-Area and Par Pond to the south. In general, the gradients decrease everywhere in the direction of the Savannah River flood plain. The northeasterly projecting curvature exhibited by the 160 ft to 190 ft contours on Plate 45, suggests that ground water flow, which is mostly perpendicular to the contours, converges toward a line that connects the D-, CS-, and R-Areas. This line coincides with the "high permeability" zone that extends across the study area (Fig. 51) and suggests a preferential pathway for ground water flow through the aquifer.

Potentiometric-surface maps of the Crouch Branch and McQueen Branch aquifers (Bledsoe and others, 1990) show water levels in the southeastern one-third of SRS to be significantly different in the Crouch Branch aquifer from those in the underlying McQueen Branch aquifer (Fig. 52). Direction of flow is also different. Ground water flow in the Crouch Branch aquifer is southwesterly toward the Savannah River, whereas flow in the McQueen Branch aquifer is toward the west. In the northern part of SRS in the Dublin-Midville aquifer system, the head difference between the two aquifers is 1 ft or less at eight of nine well clusters, and ground water flow in both aquifers is to the south-southwest, toward the Savannah River. This indicates that the McQueen Branch and Crouch Branch aquifers are connected hydraulically in the northern part of SRS and are part of the same regional aquifer system.

Throughout most of the region north and west of Upper Three Runs Creek, the Crouch Branch aquifer receives leakage from the overlying Gordon and Steed Pond aquifers. The deep incisement of Upper Three Runs Creek in the central part of

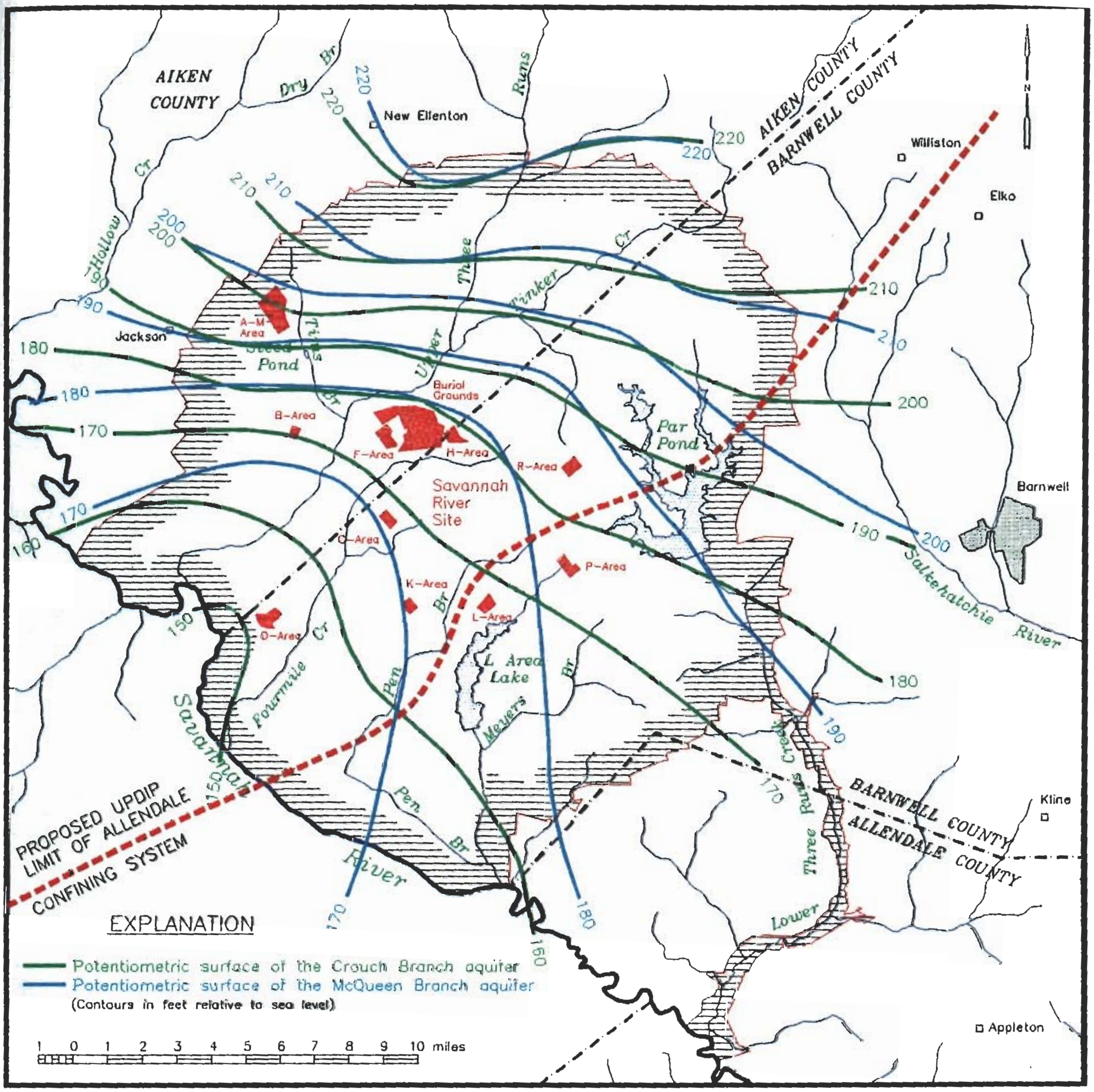


Figure 52. Overlay of the Crouch Branch aquifer potentiometric surface on the McQueen Branch aquifer potentiometric surface (data from Bledsoe and others, 1990).

SRS, however, has caused the development of a lower head in the overlying Gordon aquifer of the Floridan aquifer system. This causes a vertical head reversal over a large area adjacent to the Upper Three Runs Creek drainage system (Fig. 30). In this area, the hydraulic heads in the Crouch Branch aquifer are higher than those of the Gordon aquifer. This "head reversal" is an important aspect of the flow system in the vicinity of SRS and provides a naturally induced means of protection for the lower aquifers.

Ground water velocity in the Crouch Branch aquifer is variable across the study area. Flow rates were determined from the following equation:

$$V_h = \frac{i_h K_h}{n} \qquad (5)$$

where:

V_h = horizontal flow velocity through aquifer (ft/d)

i_h = horizontal hydraulic gradient (ft/ft)

K_h = horizontal hydraulic conductivity (ft/d)

n = average effective porosity of sand beds (fraction)

Velocity calculations are based on horizontal hydraulic gradients determined from the potentiometric map (Plate 45). Hydraulic-conductivity values are the average values calculated from pumping-test data (Table 19). An effective porosity of 30 percent is used, which is typical of medium- to coarse-grained, generally poorly sorted sand (Siple, 1967).

For the Crouch Branch aquifer in the northwestern part of SRS, where K_h = 28 ft/d, n = .30, i_h = 5.26 ft/mi or 0.0010 ft/ft, a flow velocity (V_h) of 0.093 ft/d (34 ft/yr) is calculated. Assuming an effective porosity of 25 percent, which may be more indicative of the sediments in the aquifer in updip areas, a flow velocity (V_h) of 0.112 ft/d (41 ft/yr) is estimated.

The horizontal hydraulic gradient for the aquifer near the center of the study area, in the vicinity of GSA, is 0.0008 ft/ft (Plate 45). Horizontal hydraulic-conductivity values determined by Siple (1967) in C- and R-Areas average 116 ft/d (Table 19). Assuming that n = 0.30, the calculated velocity of ground water movement (V_h) is 0.309 ft/d (113 ft/yr).

In the southern part of the study area in the vicinity of L-Area and Par Pond, the hydraulic gradient of the Crouch Branch aquifer averages 0.0005 ft/ft. Horizontal hydraulic-conductivity values determined from three pumping tests in L-Area average 75 ft/d. Assuming that n = 0.30, the flow velocity (V_h) is 0.125 ft/d (46 ft/yr). If an average horizontal hydraulic conductivity of 109 ft/d is used, which was was estimated by GeoTrans (1988) (Table 18), a flow velocity (V_h) of 0.1817 ft/d (66 ft/yr) is calculated.

Flow velocity in the central part of the study area is approximately three times greater than that calculated to the north or south. The region of greater flow velocity corresponds to the "high permeability" zone observed in the central region of the study area (Fig. 51).

Two methods were used to estimate natural discharge through the Crouch Branch aquifer. Using transmissivity values calculated from pumping tests (Table 19), natural discharge is estimated from the following equation (from Siple, 1960):

$$Q = TWi_h \qquad (6)$$

where:

Q = volume of flow (ft^3/d)
T = transmissivity (ft^2/d)
W = width of aquifer perpendicular to the direction of flow (ft)
i_h = hydraulic gradient (ft/ft)

The values used to calculated the discharge are:

T = 83,000 gal/d/ft = 11,100 ft^2/d (median value, Table 19)
W = 79,200 ft (width of aquifer in SW sector of SRS)
i_h = 0.0008 ft/ft

Substitution yields:

Q = 11,100 ft^2/d x 79,200 ft x 0.0008 ft/ft
= 7.03 x 105 ft^3/d = 5.26 x 10^6 gal/d

The second method used to estimate the natural discharge through the aquifer uses the hydraulic conductivities calculated from sieve analyses (Table 16) and the following equation (from Marine and Siple, 1974):

$$Q = K_h i_h A \qquad (7)$$

where:

Q = volume of flow (ft^3/d)
K_h = horizontal hydraulic conductivity (ft/d)
i_h = hydraulic gradient (ft/ft)
A = area of aquifer (aquifer width x aquifer thickness) (ft^2)

For the Crouch Branch aquifer, the values used for the above parameters are:

K_h = 125 ft/d (median value, Table 16)
i_h = 0.0008 ft/ft
A = 14,889,600 ft^2 (width = 79,200 ft and thickness = 188 ft)

Substitution yields:

Q = 125 ft/d x 0.0008 ft/ft x 79,200 ft x 188 ft
= 1.49 x 106 ft^3/d = 1.11 x 10^7 gal/d

The flow velocity derived from hydraulic-conductivity values calculated from sieve analyses is about two times that derived from pumping test data. Thus, the approach may not be as reliable an estimate of the flow velocity and should be used cautiously.

Allendale Confining System

The Allendale confining system is present in the southeastern half of the study area and separates the Midville aquifer system from the overlying Dublin aquifer system (Figs. 10 and 12). In the study area, the Allendale confining system consists of a single unit, the McQueen Branch confining unit. The confining system is correlative with the unnamed confining unit that separates the Middendorf and Black Creek aquifers of Aucott and others (1987) (Fig. 8) and with the Black Creek-Cusseta confining unit of Clark and others (1985) (Plate 37). The system dips approximately 22 ft/mi to the southeast (Plate 20) and thickens uniformly from about 50 ft at the updip limit to about 200 ft near the eastern boundary of the study area (Plate 21). The rate of thickening is greater in the east than in the west. The updip limit of the system is established where pronounced thinning occurs parallel to the Pen Branch Fault (Plate 21; Fig. 10). South of the fault trace, leakance coefficients for the Allendale average 2.85 x 10^{-6}/d. Leakance coefficients increase six-fold in the vicinity of the fault, averaging 1.84 x 10^{-5}/d (Plate 21). Farther north, very thin clay beds occur (as at well P-29) and leakance coefficients diminish significantly, averaging 1.02 x 10^{-5}/d.

Hydrographs of three wells near the center of SRS (Fig. 53) that are screened in the lower and upper parts of the McQueen Branch and Crouch Branch aquifers, denote changes in water levels related to pumping. The almost identical response in each well to pumping suggests an ineffective confining unit, namely the McQueen Branch confining unit, between the aquifers. East and southeast of this area, the McQueen Branch confining unit increases in thickness and becomes less

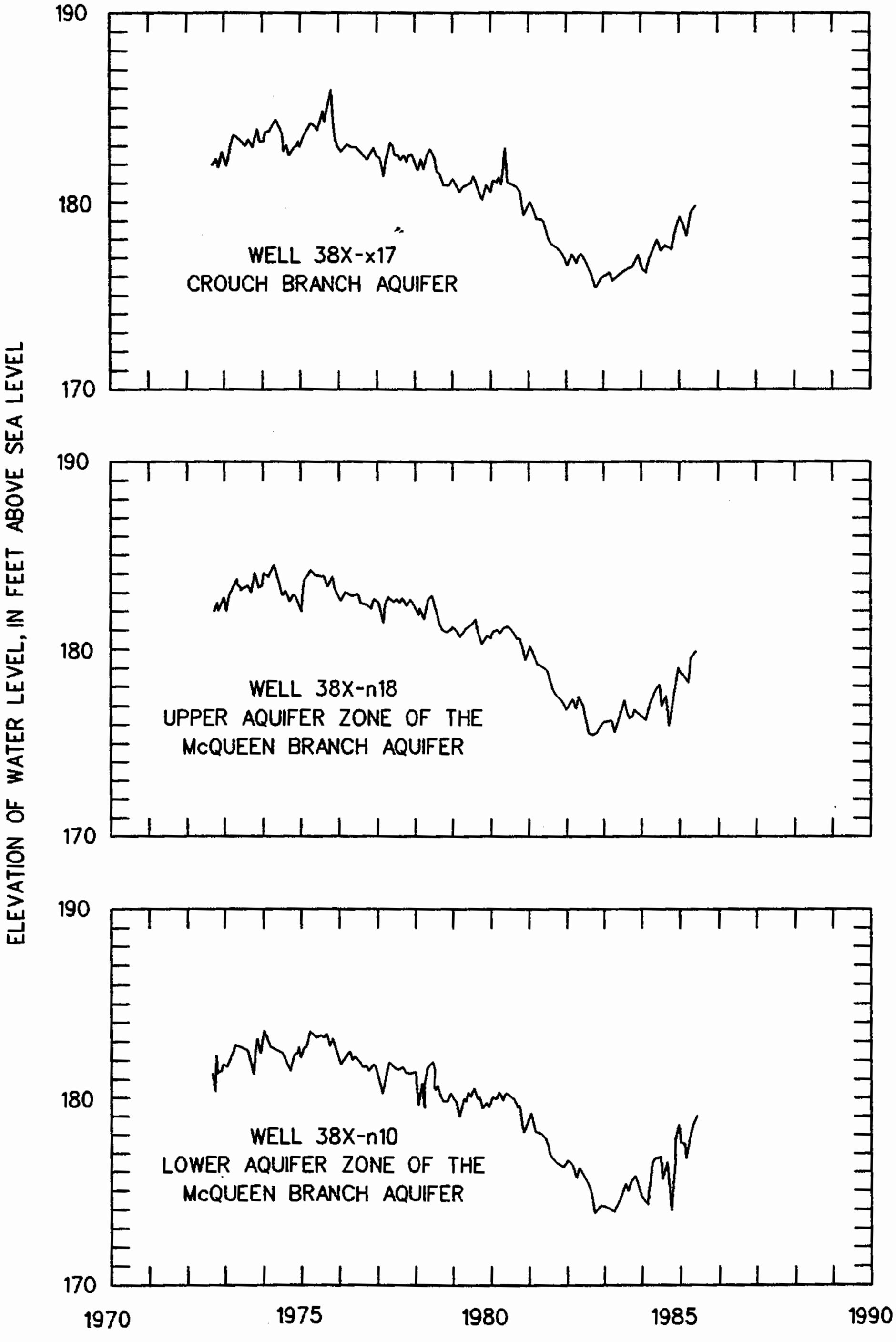


Figure 53. Hydrographs of selected wells at SRS (modified from Logan and Euler, 1989).

permeable. Here, the confining unit constitutes the Allendale confining system, which separates the Dublin and Midville aquifer systems (Figs. 10 and 12).

Sediments of the Allendale confining system are fine grained and consist of clayey, silty sand, clay, and silty clay and micritic clay beds that constitute the middle third of the Black Creek Formation. An abundance of macrofauna and microfauna in the unit (Prowell and others, 1985a) suggests prodelta and shallow shelf environments (Fig. 6). North of the updip limit of the confining system, where the McQueen Branch confining unit is part of the Dublin-Midville aquifer system (Fig. 10), the section consists of coarser grained, clayey, silty sand and clay beds, suggesting a lower delta plain environment of deposition. The approximate northern limit of the shallow shelf or prodelta deposits generally corresponds to the northern limit of the Allendale confining system and the corresponding Black Creek-Cusseta confining unit that separates the Dublin from the Midville aquifer systems in east-central Georgia (Clarke and others, 1985) (Plate 37).

The Allendale confining system is defined for the hydrogeologic characteristics of sediments penetrated in well C-10 located near Allendale, S.C. (Plates 1 and 39i). Here, the system is 162 ft thick and occurs between -698 ft msl and -860 ft msl (Appendix 1), and it consists primarily of clay, micritic clay, and micritic, silty clay with minor interbedded sand and clayey sand. The total clay thickness is 158 ft (98 percent of the total thickness of the system), with a leakance-coefficient value of 2.92×10^{-6}/d (Appendix 1). Updip, the system consists of beds of slightly lignitic, glauconite-bearing, micaceous clay, with occasional silty, sandy clay and clayey sand beds. At well P-22 the system is 93 ft thick, with a total clay and sandy clay thickness of 70 ft (75 percent of the total thickness of the system), and it has a leakance coefficient of 6.51×10^{-6}/d (Plate 39j).

Few hydrogeologic data are available for the Allendale confining system. Calibrated leakance coefficients range from about 2×10^{-9} to 5×10^{-4}/d (Aucott, 1988). In general, the leakance coefficients are greatest near the updip limit of the unit, where the confining beds typically consist of coarser sediments and are thinnest, and lowest toward the coast, where the unit has undergone a facies change to finer sediments. For example, near Charleston, S.C., calibrated vertical hydraulic-conductivity values for the Allendale confining system are within the 2×10^{-9} to 1×10^{-8} ft/d range. There are, however, few data available to provide quantitative verification for these values (Aucott, 1988).

McQueen Branch confining unit.—The McQueen Branch confining unit constitutes the Allendale confining system in the southern part of the study area and is an integral part of the Dublin-Midville and Floridan-Midville aquifer systems in the north. Throughout the study area the confining unit separates the McQueen Branch aquifer from the overlying Crouch Branch aquifer (Figs. 10 and 12; Plates 3-10).

The McQueen Branch confining unit is defined by the hydrogeologic properties of sediments penetrated in well P-27 located near the center of the study area (Plates 1 and 8), and named for McQueen Branch, a tributary of Upper Three Runs Creek. At its type-well location, the McQueen Branch confining unit is 55 ft thick (Plate 39h) and is present from -329 ft to -384 ft msl (Appendix 1). Total clay thickness is 45 feet in three beds, which is 82 percent of the total thickness of the unit, with a leakance coefficient of 1.03×10^{-5}/d. The confining unit in well P-27 consists of the interbedded, silty, often sandy clay and sand beds that constitute the middle third of the Black Creek Formation. The clay beds suggest deposition in a lower delta plain environment (Fig. 6), such as interdistributary bays or back-barrier bays where clay thicknesses can vary greatly over relatively short distances.

Clay beds tend to be anomalously thin along a line that parallels the southwest-northeast trend of the Pen Branch Fault and the north-south trend of the ATTA Fault (Stieve and others, 1991) (Plates 1 and 21). Reduced clay content in these areas suggests shoaling due to uplift along the faults during Upper Black Creek-Steel Creek time, resulting in the deposition of increased quantities of shallow-water, coarse-grained sediments along the fault trace.

The silty clay of the McQueen Branch confining unit becomes thick and continuous in the southern part of the study area (Plate 21), suggesting delta-front or shallow-marine depositional environments (Fig. 6). Here, the unit constitutes the Allendale confining system.

Twenty-six samples from the McQueen Branch confining unit were analyzed for grain size. The samples are chiefly mud with minor muddy sand and slightly gravelly, muddy sand. The average gravel-sand-mud ratio of 14 samples containing more than 25 percent mud is 67.5 percent mud, 30.6 percent sand, and 1.8 percent gravel. Texturally, the average sample is a very poorly sorted, slightly gravelly and sandy mud according to Folk's (1954) classification scheme. The average gravel-sand-mud ratio of a subset of 7 samples containing more than 50 percent mud is 84.4 percent mud, 14.5 sand, and 1.1 percent gravel (Aadland and others, 1992b). Pipette analyses of samples containing greater than 50 percent mud show that clay-size particles range from 48 to 69.5 percent of the total sample and are more than twice as abundant as silt-size particles.

Summary statistics for 12 sand samples containing less than 25 percent mud indicate that gravel averages 1.4 percent, sand 84.6 percent, and mud 14.0 percent. The sand ranges from lower coarse to lower fine grained and is poorly sorted (Table 20). Owing to poor sorting and high mud content, estimates of porosity and permeability based on the Beard and Weyl (1973) method could only be determined for five samples (Table 20). Porosity averages 35.1 percent and geometric mean permeability is 15.8 Darcies (38.5 ft/d).

Four mud samples from well C-10 were analyzed for grain size utilizing laser-particle techniques (Core Laboratories, 1992). The samples consist of 17.4 percent sand, 71.5 percent silt, and 11.1 percent clay. The mean grain size averages 5.1 (medium silt).

Strom and Kaback (1992) did x-ray diffraction analysis of seven mud-rich samples of the McQueen Branch confining unit taken from the P-well series. The samples consisted of 40 to 70 percent clay, 30 to 60 percent quartz, and trace pyrite and muscovite. Kaolinite was the dominant clay mineral in all samples. Nine clay and sandy clay samples from the C-well series were analyzed by x-ray diffraction for bulk and clay

Table 20. Summary of Folk and Ward statistics, gravel-sand-mud percentages, and calculated porosity and rmeability values for sand samples from the McQueen Branch confining unit that contain less than 25 percent mud

Parameter	Folk and Ward Statistics				Gravel	Sand	Mud	Porosity	Permeability	
	Mean[1]	Sorting[1]	Skewness	Kurtosis	(%)	(%)	(%)	(%)	(Darcy)	(ft/d)
Arithmetic mean	2.119	1.875	0.414	1.692	1.4	84.6	14.0	35.1	27.4	66.7
Confidence level (95%)	0.380	0.494	0.093	0.326	1.1	3.6	3.1	1.9	27.5	66.8
Number of samples	11	11	11	11	12	12	12	5	5	5
Median	2.220	1.783	0.454	1.429	0.9	85.6	13.8	35.7	8.0	19.5
Mode	-	-	0.556	-	-	-	-	33.0	-	-
25th percentile	1.709	1.121	0.291	1.318	0.1	80.9	9.4	33.0	7.0	17.0
75th percentile	2.675	2.619	0.549	1.994	1.6	90.1	17.2	35.8	38.0	92.5
Standard devoiation	0.644	0.835	0.157	0.551	1.9	6.3	5.4	2.1	31.3	76.2
Variance	0.414	0.698	0.025	0.304	3.6	39.4	29.2	4.5	980.8	5805.8
Kurtosis	-0.841	-1.517	-1.239	2.000	6.3	-1.2	-0.9	-1.3	1.2	1.2
Skewness	-0.516	0.130	-0.701	1.350	2.3	-0.5	0.3	0.3	1.4	1.4
Range	-1.894	2.301	0.399	1.894	6.7	18.3	17.6	5.0	72.0	175.2
Maximum	2.839	3.102	0.556	2.991	6.7	92.1	23.5	38.0	78.0	189.8
Minimum	0.945	0.801	0.157	1.097	0.0	73.8	5.9	33.0	6.0	14.6
Trimean (5%)	2.119	1.875	0.414	1.692	1.4	84.6	14.0	35.1	27.4	66.7
Geometric mean	-	-	-	-	-	-	-	-	15.8	38.5
Harmonic mean	-	-	-	-	-	-	-	-	10.6	25.7

[1] Values are in phi units

nineralogy (Gelting, 1990; Gellici and others, 1995). Quartz veraged 16 percent and clay minerals 83 percent. The clay raction consisted of 42 percent illite, 31 percent kaolinite, 3 percent mixed-layer illite/smectite, and 3 percent smectite. race amounts of chlorite were also reported.

Petrographic study of one McQueen Branch mudstone ample from well C-10 (-738 ft msl) shows that it is a fossilif- rous silty clay consisting of monocrystalline quartz and clay ninerals with minor to trace amounts of muscovite, collo- hane, heavy minerals, organic debris, pyrite, and skeletal ragments, including foraminifers, pelecypods, and bryozoans.

Vertical hydraulic conductivity derived from the laboratory nalysis of nine clay to sandy clay samples from the McQueen ranch confining unit (Bledsoe and others, 1990) ranges from .80 x 10^{-5} to 2.09 x 10^{-2} ft/d, with a geometric mean value of .77 x 10^{-4} ft/d (Table 2). Horizontal hydraulic conductivity erived from five clay to sandy clay samples ranges from .68 x 10^{-5} to 4.11 x 10^{-3} ft/d, with a geometric mean value of .46 x 10^{-4} ft/d (Table 2). Total porosity of the nine clay to andy clay samples ranges from 31 to 69 percent and averages 1 percent.

One clayey sand sample from the McQueen Branch confin- ng unit was analyzed. The vertical hydraulic conductivity is .25 x 10^{-2} ft/d, the horizontal hydraulic conductivity is 1.16 10^{-4} ft/d, and the porosity is 38 percent (Table 1).

The average vertical hydraulic conductivity of the clay to andy clay samples (1.67 x 10^{-4} ft/d) and clayey sand samples 3.90 x 10^{-3} ft/d) of the entire Tertiary/Cretaceous sample suite s used in lieu of the limited number of McQueen Branch confining unit samples available for estimating leakance-coefficient values. Leakance coefficients were calculated by dividing the geometric mean value of the vertical hydraulic conductivity of the entire sample suite for that lithology by the bed thickness at each well location where the confining beds were penetrated. The effective leakance of the confining units was determined by combining the individual leakance coefficients of the sandy clay and clay beds with those of the clayey sand beds (Appendix 1; Plate 21).

In the study area, leakance coefficients of the McQueen Branch confining unit range from a low of 1.04 x 10^{-6}/d to a high of 5.57 x 10^{-5}/d (Appendix 1), with an arithmetic mean of 9.90 x 10^{-6}/d. In the Allendale confining system, the leak- ance coefficients of the McQueen Branch confining unit are lowest and range from 1.04 x 10^{-6} to 5.33 x 10^{-6}/d, with an arithmetic mean of 2.85 x 10^{-6}/d. North of the updip limit of the system, leakance values are significantly higher. In the immediate vicinity of the Pen Branch Fault, clay beds thin dramatically and leakance coefficients are, on average, about six times greater than they are to the south in the Allendale confining system. Here, the leakance coefficients range from 7.90 x 10^{-6} to 4.18 x 10^{-5}/d and average 1.84 x 10^{-5}/d. Farther north, clay beds are thicker compared to those in the imme- diate vicinity of the Pen Branch Fault; consequently, leakance coefficients decrease, ranging from 2.42 x 10^{-6} to 5.57 x 10^{-5}/d and averaging 1.02 x 10^{-5}/d. Leakances decrease drama- tically in the vicinity of well C-1 immediately northwest of SRS (Plate 21).

Simulated leakance coefficients from Aucott (1988) range from 10^{-4} to 10^{-8}/d across the study area. Leakance coefficients ranging from 10^{-6} to 10^{-8}/d define a band along the lower half of the study area, where the McQueen Branch confining unit constituting the Allendale confining system is defined. In much of the area north and west of the Aiken/Barnwell County line, the Crouch Branch aquifer contributes downward leakage into the McQueen Branch aquifer. Here, leakance coefficients ranging from 10^{-4} to 10^{-6}/d are found in the upper half of the study area where the McQueen Branch confining unit is an integral part of the Dublin-Midville and Floridan-Midville aquifer systems.

Midville Aquifer System

The Midville aquifer system is present in the southern half of the study area. It overlies the Appleton confining system and is separated from the overlying Dublin aquifer system by the Allendale confining system (Figs. 7, 10, and 12; Plates 3-10). In the study area, the Midville aquifer system consists of one aquifer, the McQueen Branch. Southward beyond well C-10, the system may warrant further subdivision into several aquifers and confining units. The updip limit and thickness of the Midville aquifer system are illustrated on Figure 10 and Plates 22 and 23. Thickness of the unit ranges from 232 ft at well P-21 to 339 ft at well C-10 (Plate 23; Appendix 1). Variation in the thickness of the unit, as well as the updip limit of the system, results from variation in the thickness and persistence of clay beds in the overlying Allendale confining system. In the vicinity of the Pen Branch Fault, contemporaneous movement on the fault may have resulted in shoaling in the depositional environment, resulting in the accumulation of coarse-grained sediments along the trace of the fault. The upper surface of the aquifer system dips approximately 25 ft/mi to the southeast across the study area (Plate 22).

The Midville aquifer system was defined and named by Clarke and others (1985) for the hydrogeologic properties of sediments penetrated in well 28X1, near the town of Midville in Burke County, Ga. Here, the upper part of the aquifer system consists of fine to medium sand of the lower part of the Black Creek-Cusseta unit; the lower part of the system consists of alternating layers of medium to coarse sand, silt, and clay of the Middendorf-Blufftown unit (Clarke and others, 1985) (Plate 37). The name Midville aquifer system is carried over and used in the study area for correlative hydrostratigraphic units. The Midville is comparable to the lower portion of the Chattahoochee River aquifer (Plate 37) of Miller and Renken (1988) and correlative with the Middendorf aquifer of Aucott and Sperian (1985a) (Fig. 8).

Hydrogeologic properties of sediments penetrated in reference well P-24 are typical of the Midville aquifer system in the study area (Plate 39k). At well P-24, the Midville, which occurs from -405 to -676 ft msl, is 271 ft thick and has a total sand thickness of 213 ft (79 percent sand) contained in nine beds (Plate 5). Here, the Midville consists of medium to very coarse-grained sand of the Middendorf Formation and fine-grained, often clayey, sand of the lower one-third of the Black Creek Formation (Fig. 7). The two formations are usually separated by the interbedded sand and variegated clay that cap the Middendorf Formation. The clay beds are 39 ft thick in P-24 but are as thick as 80 ft elsewhere.

Vertical hydraulic head measurements at well cluster P-24, made in two monitoring wells (P-24TA and P-24TB) screened at the top and base of the Midville aquifer system, differ by only 0.2 ft, suggesting hydraulic communication throughout the aquifer system (Appendix 4). Two additional monitoring wells in the P-24 well cluster (P-24TC and P-24TD) are screened in the overlying Dublin aquifer system. Each of these wells has a vertical hydraulic head 7.6 ft less than the two wells screened in the Midville system, indicating hydraulic separation of the two aquifer systems and an upward vertical hydraulic gradient across the intervening Allendale confining system. The Allendale confining system has a leakance coefficient of 3.41×10^{-6}/d at P-24, as estimated by laboratory permeameter and unit thickness data.

Hydraulic separation of the Dublin and Midville aquifer systems in the vicinity of well cluster P-24 was also inferred during a 24-hour, constant-discharge pumping test at nearby production well 905-120P (Bledsoe, 1990). This well, screened at the base of the Midville, was pumped at 756 gal/min. Water-level declines were recorded in both of the monitoring wells (P-24TA and P-24TB) screened in the Midville system. Water levels in monitoring wells P-24TC and P-24TD, screened in the Dublin system, exhibited no response during pumping. Refer to the "McQueen Branch aquifer" discussion for details concerning this pumping test.

Transmissivity increases from a minimum near the updip limit of the Midville aquifer system and is greatest about one-third of the way toward the coast. In the lower Coastal Plain the hydraulic conductivity of the aquifer system generally decreases toward the coast as the percentage of clay in the aquifer system increases. This is due primarily to the presence of deeper-shelf depositional environments and results in a general decrease in transmissivity despite a small increase in thickness of the unit in most areas. Statewide, transmissivity values for the Midville are greater in the west than in the east. This is due to the coarser grain size of sediments in the west (Aucott, 1988). Calibrated transmissivity values range from about 300 to 30,000 ft^2/d for the Midville aquifer system (Aucott, 1988).

Transmissivity values for the Midville aquifer system in Georgia (Clarke and others, 1985) have been calculated by analysis of time-drawdown or time-recovery data and by application of a linear regression model to specific-capacity data. The transmissivity of the Midville aquifer system ranges from about 5,000 ft^2/d in Laurens County to about 29,000 ft^2/d in Houston County. Yields exceeding 1,000 gal/min are recorded for wells tapping the Midville aquifer system in Houston County. Multiaquifer wells tapping both the Dublin and the Midville aquifer systems in Houston and Burke Counties also have been reported to yield more than 1,000 gal/min (Clarke and others, 1985).

McQueen Branch aquifer unit.—The McQueen Branch aquifer occurs beneath the entire study area and is an integral part of the Midville, Dublin-Midville, and the Floridan-Midville aquifer systems (Figs. 7, 10, and 12; Plates 3-10). It is everywhere overlain by the McQueen Branch confining unit, which consists of the silty clay bed that caps the basal upward-fining sequence of the Black Creek Formation, and underlain by the Appleton confining system.

The McQueen Branch aquifer thickens from the northwest to the southeast and ranges from 118 ft at well AIK-858 to 339 ft at well C-10 to the south (Appendix 1; Plate 23). Locally, thicknesses are greater along the trace of the Pen Branch Fault because of the absence and/or thinning of clay beds that compose the overlying McQueen Branch confining unit. The upper surface of the McQueen Branch dips approximately 25 ft/mi to the southeast (Plate 22).

Sediments of the McQueen Branch aquifer in the study area were deposited in an upper delta plain environment. In the lower Coastal Plain, which is south of the study area, sediments that constitute the Midville aquifer system are lithologically similar to the fine-grained, silty, clayey, micaceous sand and clay of the Crouch Branch aquifer in the southern part of study area, which suggests deposition in lower delta-plain to shallow shelf environments. Here, the Midville system can include several aquifers.

The McQueen Branch aquifer unit is defined for the hydrogeologic properties of sediments penetrated by well P-27 near the center of the study area (Plates 1 and 39h). The aquifer is named for McQueen Branch, a tributary of Upper Three Runs Creek located near the type well.

The McQueen Branch aquifer is 203 ft thick in well P-27 and occurs from -384 to -587 ft msl. It contains 183 ft of sand in four beds (which is 90 percent of the total thickness of the unit). The aquifer consists of medium- to very coarse-grained, angular, slightly silty sand of the Middendorf Formation and clayey, micaceous, poorly to moderately well-sorted, fine to medium sand and silty clay of the lower one-third of the Black Creek Formation (Fallaw and Price, 1992). Typically, a clay bed or several clay beds that cap the Middendorf Formation are present in the aquifer. These clay beds locally divide the aquifer into two aquifer zones (Plates 3, 4, and 5). At well P-27, two clay beds totaling 16 ft in thickness are present from -421 to -448 ft msl and represent the clay that commonly divides the aquifer into zones.

Five single-well pumping tests were made in H-Area at SRS in 1952 in the vicinity of well P-27 (Siple, 1967). Transmissivity ranged from 196,000 gal/d/ft (26,200 ft^2/d) to 375,000 gal/d/ft (50,100 ft^2/d) and averaged 230,000 gal/d/ft (30,800 ft^2/d) (Table 19). On the basis of the unit's thickness, which ranges from 239 to 277 ft, hydraulic-conductivity estimates ranged between 720 gal/d/ft^2 (96 ft/d) and 1,569 gal/d/ft^2 (210 ft/d) and averaged 900 gal/d/ft^2 (120 ft/d). At well P-27, total sand thickness of the aquifer measures 183 ft in four beds, and a hydraulic conductivity of 169 ft/d is calculated. This value, which is larger than the hydraulic-conductivity estimates of Siple (1967), is probably due to his use of gross unit thickness where detailed lithologic data were not available for the deep aquifers. Consequently, hydraulic-conductivity estimates based on unit thickness may be less than hydraulic-conductivity estimates using transmissive-sand thickness as done for this report.

Summary statistics for 318 sediment samples from the McQueen Branch aquifer are given in Table 21. The samples average 3.6 percent gravel, 86.2 percent sand, and 10.2 percent mud. McQueen Branch aquifer sand is relatively clean with about 60 percent of the samples containing less than 10 percent mud (Fig. 54). The sand is mainly coarse and medium grained (Fig. 55), and typically poorly sorted (Fig. 56).

Table 21. Summary of Folk and Ward statistics, gravel-sand-mud percentages, and calculated porosity and permeability values for sand samples from the McQueen Branch aquifer unit that contain less than 25 percent mud

Parameter	Folk and Ward Statistics				Gravel	Sand	Mud	Porosity	Permeability	
	Mean[1]	Sorting[1]	Skewness	Kurtosis	(%)	(%)	(%)	(%)	(Darcy)	(ft/d)
Arithmetic mean	1.334	1.427	0.242	1.379	3.6	86.2	10.2	33.2	60.1	146.1
Confidence level (95%)	0.076	0.048	0.019	0.050	0.5	0.8	0.6	0.3	5.3	13.0
Number	285	285	285	285	318	318	318	211	211	211
Median	1.296	1.383	0.244	1.318	1.9	87.0	9.4	33.3	49.0	119.2
Mode	0.970	1.080	0.244	1.200	0.0	89.0	8.0	34.0	39.0	94.9
25th percentile	0.820	1.124	0.137	1.101	0.4	82.0	5.6	32.0	30.0	73.0
75th percentile	1.839	1.661	0.352	1.517	5.1	91.6	14.2	34.3	81.5	198.3
Standard deviation	0.651	0.412	0.163	0.433	4.8	7.3	5.8	2.3	39.5	96.1
Variance	0.424	0.169	0.027	0.187	22.8	52.7	34.0	5.3	1559.7	9232.5
Kurtosis	-0.319	0.628	-0.021	4.153	9.4	3.6	-0.6	0.2	0.9	0.9
Skewness	0.086	0.703	-0.155	1.567	2.6	-1.1	0.4	-0.1	1.1	1.1
Range	3.699	2.288	0.890	3.072	35.0	53.5	24.4	11.5	180.0	437.9
Maximum	-0.425	2.843	0.696	3.644	35.0	99.0	24.9	38.8	186.0	452.5
Minimum	3.274	0.555	-0.194	0.572	0.0	45.5	0.5	27.3	6.0	14.6
Trimean (5%)	1.334	1.414	0.243	1.358	3.2	86.5	10.1	33.2	58.5	142.2
Geometric mean	-	-	-	-	-	-	-	-	47.7	116.1
Harmonic mean	-	-	-	-	-	-	-	-	36.0	87.6

[1] Values are in phi units

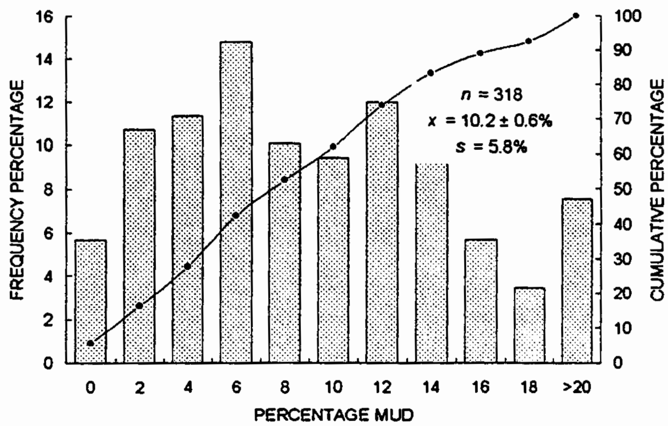


Figure 54. Percentage mud (silt + clay) in McQueen Branch aquifer sand samples containing less than 25 percent mud.

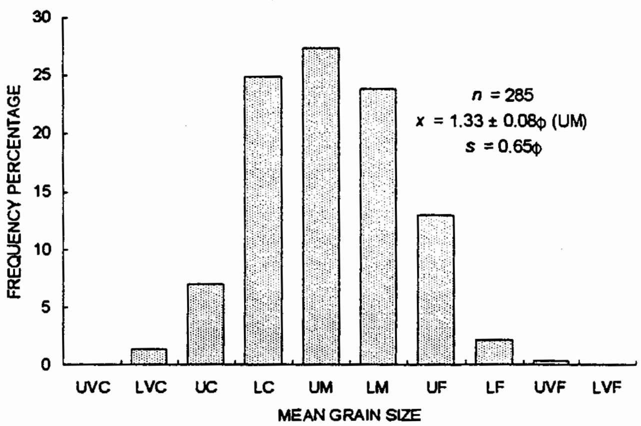


Figure 55. Mean grain size of sand samples from the McQueen Branch aquifer. UVC, upper very coarse sand; LVC, lower very coarse sand; UC, upper coarse sand; LC, lower coarse sand; UM, upper medium sand; LM, lower medium sand; UF, upper fine sand; LF, lower fine sand; UVF, upper very fine sand; and LVF, lower very fine sand.

X-ray diffraction analysis of 39 McQueen Branch sand samples from the P-well series indicates that the framework grains are quartz with minor to trace amounts of potassium feldspar, plagioclase, muscovite, and pyrite (Strom and Kaback, 1992). The matrix, which forms 5 to 30 percent of the whole rock, consists of kaolinite with minor to trace amounts of illite and smectite (Strom and Kaback, 1992).

X-ray diffraction study of 27 McQueen Branch sand and mud samples from the C-well series was done for bulk and clay mineralogy (Gelting, 1990; Gellici and others, 1995). Quartz averages 36 percent and clay minerals 63 percent. Analysis of the clay fraction shows that kaolinite averages 75 percent; illite about 16 percent; mixed-layer illite/smectite about 7 percent; and smectite 2 percent.

Thin-section study of McQueen Branch sand samples from the C-well series indicates that they are quartzarenite and subarkose (Folk, 1980 classification). Framework grains consist of subangular to subrounded monocrystalline and polycrystalline quartz with minor to trace amounts of plagioclase, K-feldspar (microcline and orthoclase), muscovite, metavolcanic rock fragments, sedimentary rock fragments, glauconite, detrital "books" of kaolinite, and heavy and opaque minerals. Minor authigenic quartz and kaolinite are present as pore-filling cement. Mud matrix forms 5 to 15 percent of whole-rock volume and consists of silt-size grains of quartz and muscovite mixed with detrital clay minerals. McQueen Branch sand is believed to have originally contained considerably more feldspar, as suggested by the presence of corroded "skeletal" feldspar grains and authigenic kaolinite.

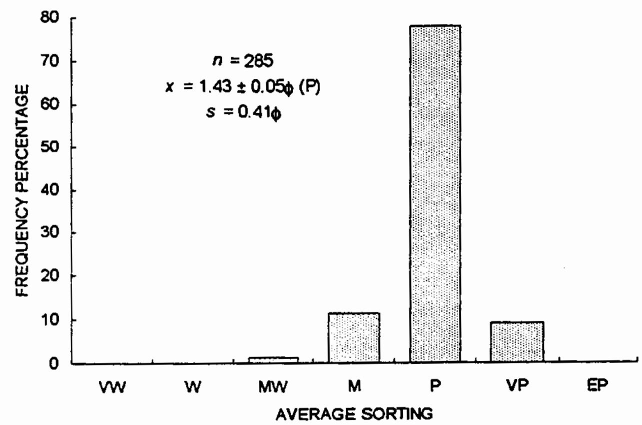


Figure 56. Sorting classes of McQueen Branch aquifer samples. VW, very well sorted; W, well sorted; MW, moderately well sorted; M, moderately sorted; P, poorly sorted; VP, very poorly sorted; and EP, extremely poorly sorted.

Wells screened in the McQueen Branch aquifer are commonly screened in the overlying Crouch Branch aquifer as well. The lack of data exclusively for the McQueen Branch aquifer makes determination of hydraulic characteristics difficult (Logan and Euler, 1989). Because of the similarity in lithology, water levels, and water quality and the almost identical response of the water levels in both aquifers to applied stress in the updip areas (northeast of the Aiken-Barnwell County line at SRS), the two aquifers are considered part of the same hydrogeologic system, namely the Dublin-Midville aquifer system.

What are now known as the McQueen Branch and Crouch Branch aquifers of the Dublin-Midville aquifer system have been referred to previously as the "Tuscaloosa aquifer" (Siple, 1967) (Fig. 8). When the original water-level measurements were made, some of the data reflected water levels in the McQueen Branch aquifer, some in the overlying Crouch Branch aquifer, and some a composite of the two.

Aucott and Speiran (1985a and b) noted similarities in water levels and flow patterns in what they referred to as the Black Creek aquifer and the Middendorf aquifer in outcrop areas and in the northern part of the study area. These are the Crouch Branch aquifer and the McQueen Branch aquifer of this report. In these updip regions, where the McQueen Branch confining unit separating the two aquifers thins and is relatively permeable, they treated the aquifers as part of a single aquifer system. Here, water levels in the two aquifers are nearly the same and the water is free to move between the aquifers where head differentials are created.

The McQueen Branch aquifer can be divided into two aquifer zones over much of the northern third of SRS by the persistent clay to clayey, silty, sand beds in the upper part of the Middendorf Formation (Plates 3-10). Near the center of the site, the clay and sandy clay beds in the upper part of the Middendorf Formation, which separate the two aquifer zones elsewhere, pinch out in the vicinity of well P-19 adjacent to the Pen Branch Fault. This suggests shoaling of the depositional environment along the trace of the Pen Branch Fault during uppermost Middendorf time, resulting in deposition of coarse-grained sediments. South of well P-19 (Plate 1), on the south flank of the shoal zone along the Pen Branch Fault, clay beds in the stratigraphic interval where the confining zone is present are reestablished but are not as thick or persistent as the clay beds deposited north of the fault trace. The thin clay beds and silty sand beds deposited to the south may reduce the hydraulic conductivity in the aquifer but do not constitute a definable confining zone.

Ground water mapping at SRS supports the presence of two aquifer zones in the McQueen Branch aquifer (Bledsoe and others, 1990) (Fig. 57; Plates 46 and 47). Water levels in the lower and upper parts of the aquifer were the same or within 1 ft of each other in all wells in the southern two thirds of SRS. In the northern third of SRS, the differences in water

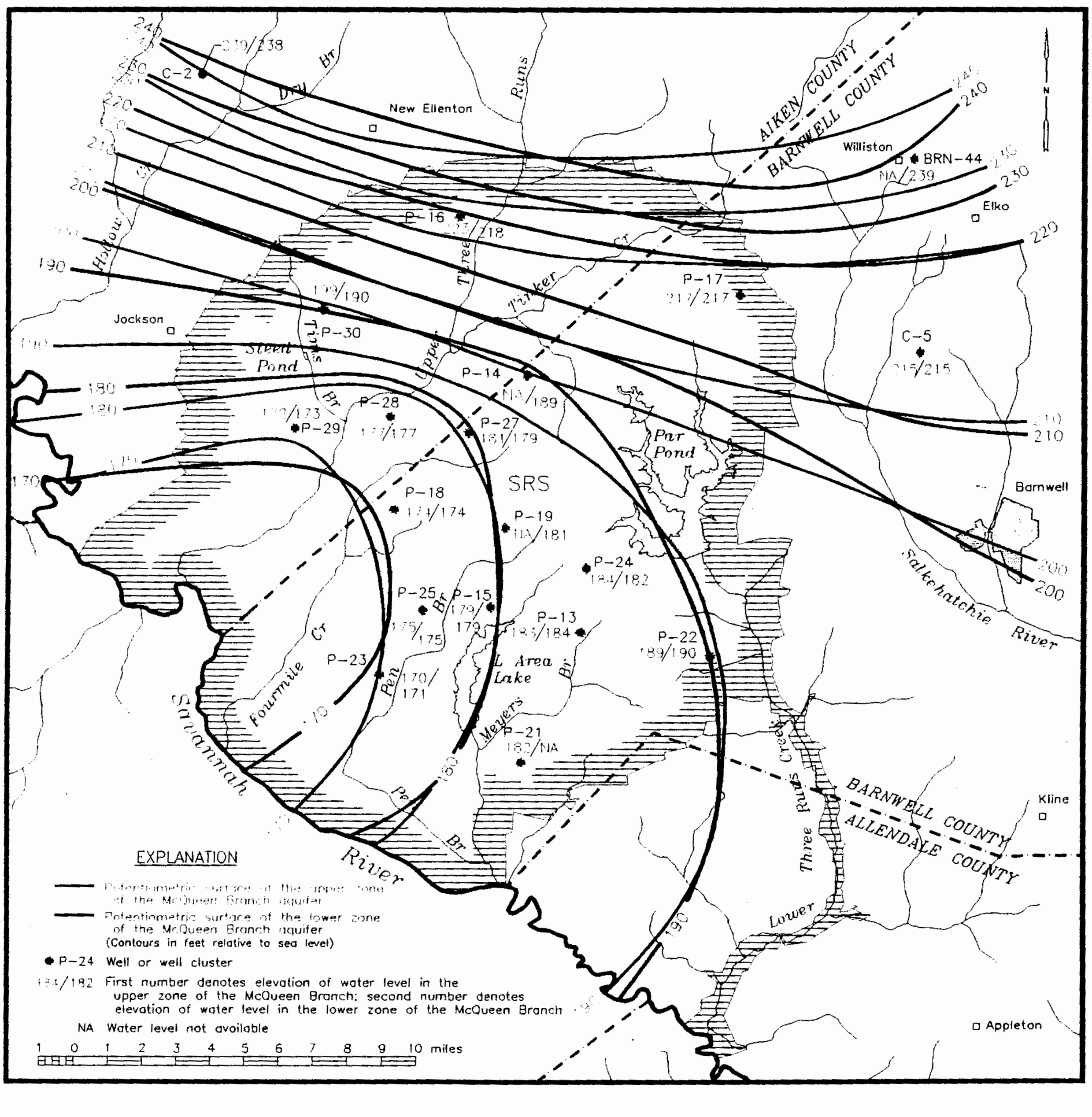


Figure 57. Overlay of the potentiometric surface of the "upper" and "lower" aquifer zones of the McQueen Branch aquifer (from Bledsoe and others, 1990).

levels ranged from 2 to 9 ft, with the greater head occurring in the "upper" aquifer zone. Thus, water level differences produced by the presence of the confining unit in the northern third of SRS support the hypothesis that the McQueen Branch aquifer is divided into the two aquifer zones (Aadland and Bledsoe, 1990a and b).

A McQueen Branch aquifer pumping test in P-Area south of the trace of the Pen Branch Fault (Bledsoe, 1990) monitored responses to pumping from the lower part of the aquifer. The monitoring wells were screened in the lower and upper parts of the McQueen Branch aquifer and in the overlying Crouch Branch aquifer. A vertical hydraulic conductivity of 1.7 x 10^{-2} ft/d was calculated for the confining beds near the top of the Middendorf Formation. Assuming a thickness of 50 ft, a leakance coefficient of 3.4 x 10^{-4}/d is estimated. This suggests semiconfining (leaky) conditions for the confining zone, typical of clayey sand sediments.

A thick clay bed occurs at the base of the Black Creek Formation in the McQueen Branch aquifer at wells P-23 (Plate 4) and PBF-6 (Plate 10) near the southwest corner of SRS (Plate 1). The clay bed possibly divides the McQueen Branch locally into two other aquifer zones, or this may be a new shifted upper boundary between the McQueen Branch aquifer and the overlying Crouch Branch aquifer. A third possibility is that two new aquifers occur in the area; future work may prove that such a subdivision is warranted. If future studies redefine the clay bed at the base of the Black Creek Formation to be the upper boundary of the McQueen Branch aquifer, then the updip edge of the Allendale confining system would shift north beyond wells P-23 and PBF-6.

Porosity of 211 McQueen Branch aquifer sand samples containing less than 25 percent mud averages 33.2 percent (Table 21). The distribution of calculated porosity values appears to follow a normal distribution (Fig. 58). Calculated permeability values (Beard and Weyl, 1973) range from 6 to 186 Darcies (14.6 to 452.5 ft/d) (Fig. 59; Table 21) and approximate a log-normal distribution (Fig. 60).

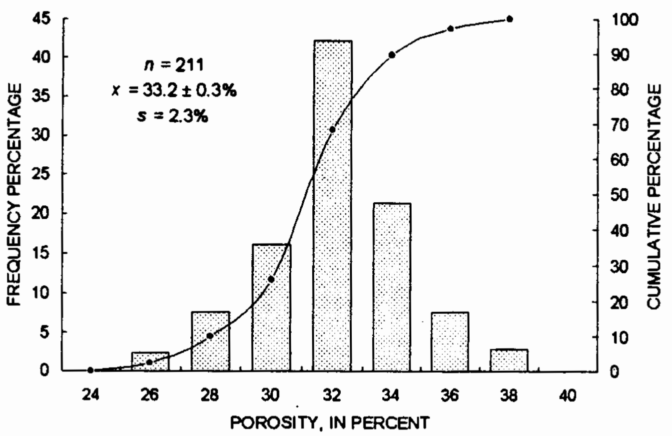


Figure 58. Calculated porosity values of McQueen Branch aquifer sand samples containing less than 25 percent mud.

Laboratory-derived vertical hydraulic-conductivity values for four clay to sandy clay samples from the McQueen Branch aquifer (Bledsoe and others, 1990) range from 7.82 x 10^{-5} to 2.86 x 10^{-4} ft/d, with a geometric mean of 1.38 x 10^{-4} ft/d (Table 2). Horizontal hydraulic-conductivity values calculated for three clay to sandy clay samples range from 5.36 x 10^{-5} to 3.49 x 10^{-4} ft/d, with a geometric mean value of 1.46 x 10^{-4} ft/d. Total porosity ranges from 24 to 51 percent, averaging 35 percent (Table 2).

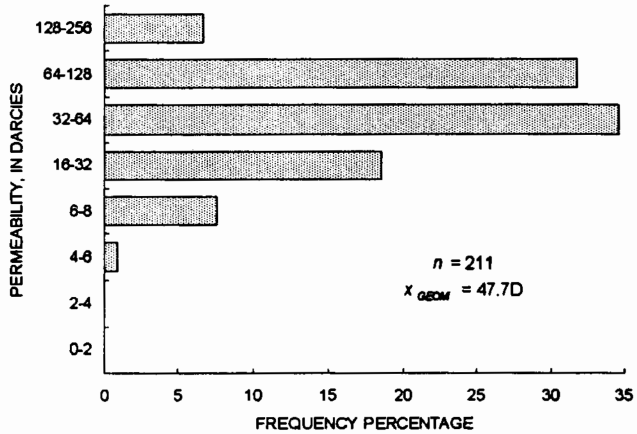


Figure 59. Calculated permeability values of McQueen Branch aquifer sand samples containing less than 25 percent mud.

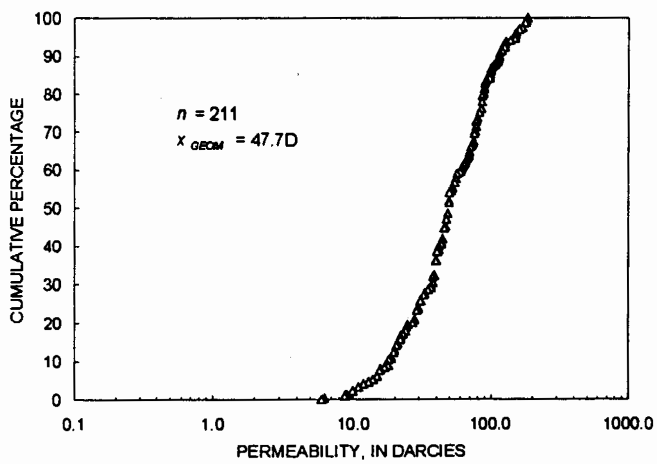


Figure 60. Cumulative frequency of calculated permeability values for McQueen Branch aquifer sand samples with less than 25 percent mud.

Pumping tests of the McQueen Branch aquifer indicate an average transmissivity of about 13,000 ft²/d in central Aiken County north of SRS (Logan and Euler, 1989), where the aquifer is part of the Floridan-Midville aquifer system. A single-well test made in 1952 at Williston, S.C. (Siple, 1967) indicates a transmissivity of 120,000 gal/d/ft (16,000 ft²/d) (Table 19; Fig. 61). A hydraulic conductivity of 470 gal/d/ft² (63 ft/d) was calculated based of a sand thickness of 255 ft. Storage coefficients were not obtained for tests made north of SRS because measurements made only in the pumping well are not usable for calculation of the storage coefficient.

As the thickness of the aquifer increases toward the south and southeast in the vicinity of SRS, the transmissivity of the McQueen Branch aquifer, now part of the Dublin-Midville

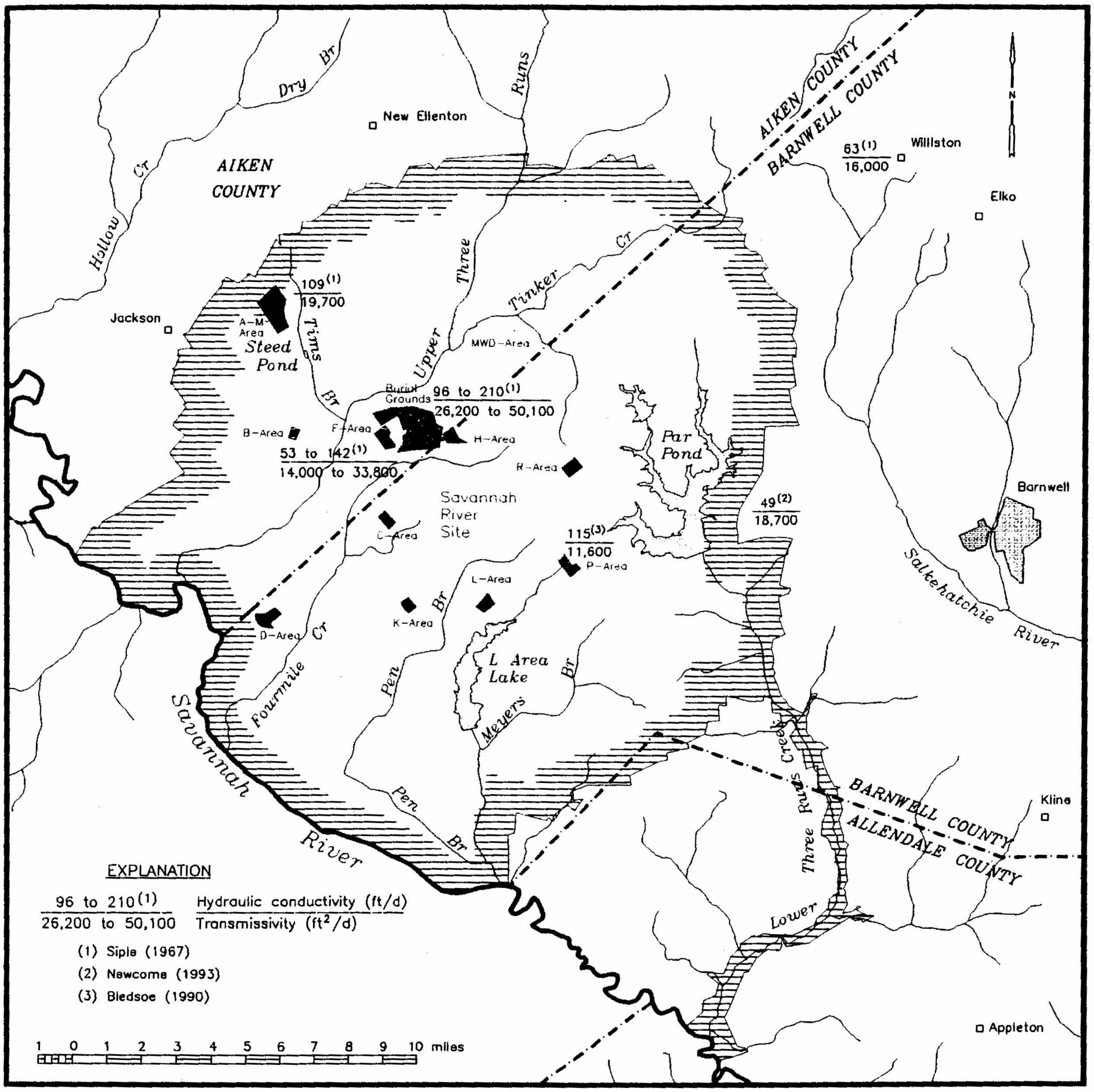


Figure 61. Distribution of pumping-test results for the McQueen Branch aquifer.

aquifer system, also increases (Fig. 10). Siple (1967) reported 11 pumping tests of the McQueen Branch aquifer from 1951 to 1952 at SRS (Table 19). Two of the tests duplicated previous tests; therefore, the results from nine tests are used in the following discussion. Siple reported an average value of transmissivity for the McQueen Branch aquifer to be about 208,000 ft²/d (27,800 ft²/d). One pumping test was conducted in A-M Area (Siple, 1967), and it produced a transmissivity value of 147,000 gal/d/ft (19,700 ft²/d). A storage coefficient of 3 x 10^{-4} was computed from the test. A hydraulic conductivity of 812 gal/d/ft² (109 ft/d) was calculated, using a sand thickness of 181 ft.

The remaining eight pumping tests were made in the F- and H-Areas, in the central part of the study area (Fig. 61). Transmissivity ranged from 105,000 to 375,000 gal/d/ft (14,000 to 50,100 ft²/d) and averaged 216,000 gal/d/ft (28,900 ft²/d) (Table 19). Two storage coefficients were calculated, 7 x 10^{-4} and 8 x 10^{-4}. Hydraulic-conductivity values ranged from 393 to 1,569 gal/d/ft² (53 to 210 ft/d) and averaged 874 gal/d/ft² (117 ft/d).

Three pumping tests were reported by GeoTrans (1988) in the McQueen Branch aquifer at SRS; two in F-Area and one in L-Area. Transmissivity ranged from 12,000 to 24,000 ft²/d and averaged 16,000 ft²/d. Hydraulic conductivity ranged from 41 to 290 ft/d in F-Area and was 93 ft/d in L-Area. No additional details or references were provided.

A 60-day, multiple-well pumping test was made at the Barnwell Nuclear Fuel Plant, utilizing two observation wells (Fig. 61). The pumping well was screened in the lower part of the Crouch Branch and in the upper part of the McQueen Branch aquifers. Average transmissivity calculated from the three wells was 140,000 gal/d/ft (18,700 ft²/d) (Newcome, 1993). The pumping well had a specific capacity of 32 gal/min/ft while pumping at a rate of 2,000 gal/min. A sand thickness of 380 ft was determined from geophysical logs and a hydraulic conductivity of 49 ft/d was calculated from the test.

A pumping test in P-Area (Bledsoe, 1990) used production well 905-120P located 584 ft from the P-24 well cluster (Plate 1). The production well was screened from -617 to -667 ft msl, which corresponds to the lower part of the McQueen Branch aquifer in the Midville aquifer system. Four wells were monitored at the cluster site. Wells P-24TA and TB are completed in the lower and upper parts of the McQueen Branch aquifer, respectively (Appendix 4). Wells P-24TC and TD are completed in the overlying Crouch Branch aquifer of the Dublin aquifer system.

Well 905-120P was pumped at an average rate of 755.6 gal/min over a 24-hour period. Wells P-24TC and TD did not respond to the pumping, indicating no hydraulic communication between the Crouch Branch aquifer and the McQueen Branch aquifer across the Allendale confining system. This justifies assignment of the aquifers to separate aquifer systems in the southern part of the study area (Fig. 10). Monitor well P-24TA responded to pumping within 1 minute of test startup; whereas well P-24TB responded to pumping after 10 minutes and continued to drawdown for the duration of the test. On the basis of the analysis of data from P-24TA, transmissivity of the lower part of the aquifer was calculated to be 86,600 gal/d/ft (11,600 ft^2/d) and the storage coefficient to be 1.5 x 10^{-4}. Assuming a thickness of 100 ft, the horizontal hydraulic-conductivity value of the lower McQueen Branch aquifer is approximately 115 ft/d.

Most of the water contained in the McQueen Branch aquifer is derived from leakage through overlying sediments, particularly in the updip areas where the aquifer is covered by a thin veneer of Tertiary sediments. The water moves in an arcuate path toward the Savannah River (Plates 46 and 47). Toward the southeast, near Allendale, S.C., ground water flow tends to parallel the river toward the southeast. Flow on the Georgia side of the river appears to follow a similar pattern, and the intersecting flow lines suggest that flow is forced towards and discharged into the Savannah River (Fig. 42).

The potentiometric surface of the McQueen Branch aquifer (Plate 46) indicates a decline in the hydraulic head from 220 ft msl near the northeastern boundary of SRS to approximately 170 ft msl on the southwestern boundary adjacent to the Savannah River. The horizontal hydraulic gradient ranges from approximately 4.5 ft/mi (0.00085 ft/ft) near A-M Area to about 4.1 ft/mi (0.00078 ft/ft) in GSA; to about 2.1 ft/mi (0.00039 ft/ft) in the vicinity of P-Area. In general, the gradients decrease in the direction of the Savannah River flood plain. The northeasterly projecting curvature exhibited by the 170- to 200-ft contours on Plate 46, suggests that ground water flow converges towards a line which connects the D-, CS-, and R-Areas. This flow pattern is comparable to, but more pronounced than, the flow pattern exhibited in the overlying Crouch Branch aquifer (Plate 45) and is consistent with the "high permeability" zone that parallels the trace of the Pen Branch Fault (Fig. 51).

Ground water flow velocities in the McQueen Branch aquifer were determined from velocity equation 5. The velocity calculations are based on hydraulic gradients determined from potentiometric surface maps (Plate 46). Hydraulic conductivities are average values determined by pumping test data listed in Table 19. In the northern portion of the study area, north of SRS and near the outcrops, a flow velocity (V_h) of 1.17 ft/d (426 ft/yr) was calculated by using horizontal hydraulic conductivity (K_h) of 110 ft/d, a hydraulic gradient (i_h) of 14 ft/mi (0.0027 ft/ft), and an effective porosity (n) of 0.25 (Logan and Euler, 1989). In the northern part of SRS, in the vicinity of A-M Area, the hydraulic gradient of the McQueen Branch aquifer is much gentler than in the outcrop areas to the north, and it averages 4.5 ft/mi (0.00085 ft/ft). Assuming a hydraulic conductivity of 812 gal/d/ft^2 (109 ft/d) (Table 19) (Siple, 1967) and an effective porosity of 30 percent, the flow velocity is approximately 0.31 ft/d (113 ft/yr). Assuming an effective porosity of 25 percent, the flow velocity estimate increases to 0.37 ft/d (135 ft/yr).

Near the center of the study area, in the GSA area (Fig. 2), hydraulic conductivity for the McQueen Branch aquifer ranges from 53 to 210 ft/d, averaging 117 ft/d (Table 19) (Siple, 1967). The horizontal hydraulic gradient averages about 4.1 ft/mi (0.00078 ft/ft) and assuming an effective porosity of 30 percent, results in a flow velocity of 0.30 ft/d (110 ft/yr). This is similar to the calculated flow velocity in A-M Area in the north.

In P-Area, in the southern part of SRS (Fig. 2), a horizontal hydraulic gradient of about 2.1 ft/mi (0.00039 ft/ft) (Plate 46) was estimated. Using a hydraulic conductivity of 115 ft/d, as computed in GSA, and an effective porosity of 30 percent, a flow velocity of 0.150 ft/d (55 ft/yr) is estimated. This flow velocity is about one-half the flow rate observed in the central and northern parts of SRS.

The potentiometric surface of the McQueen Branch aquifer indicates that in outcrop areas water is immediately discharged to nearby streams that disect the aquifer (Siple, 1967). Some recharge occurs in interstream areas, but most of the water is discharged to nearby streams and to the Savannah River. Two methods were used to estimate the natural discharge through the McQueen Branch aquifer. Using the transmissivity values calculated from pumping tests (Table 19), the natural discharge is estimated with equation 6. For the McQueen Branch aquifer, the values used for the equation are:

T = 198,000 gal/d/ft = 26,500 ft^2/d (median value, Table 19)

W = 15 mi = 79,200 ft (width of the aquifer in SW sector of SRS)

i_h = 3.6 ft/mi or 0.00068 ft/ft

Substitution yields:

Q = 26,500 ft^2/d x 79,200 ft x 0.00068 ft/ft
= 1.43 x 106 ft^3/d = 1.07 x 10^7 gal/d
= 0.71 Mgal/d/mi

The second method used to estimate the natural discharge through an aquifer uses the hydraulic conductivities calculated from sieve analyses (Table 21) and equation 7. For the McQueen Branch aquifer, the values used for the equation are:

K_h = 910 gal/d/ft^2 = 122 ft/d (median value, Table 21)

i_h = 0.00068 ft/ft
A = 20,592,000 ft^2 (width = 79,200 ft and thickness = 260 ft, which is the median value from Table 19)

Substitution yields:

Q = 122 ft/d x 0.00068 ft/ft x 79,200 ft x 260 ft
= 1.71 x 106 ft^3/d = 1.28 x 10^7 gal/d
= 0.85 Mgal/d/mi

A comparison shows the results of the two methods to be reasonably close. Using the transmissivity from pumping tests (Table 19), the combined natural discharge of the McQueen Branch and Crouch Branch aquifers to the Savannah River through SRS is estimated to be 16 Mgal/d. Discharge from the McQueen Branch aquifer (10.7 Mgal/d) is approximately twice that of the Crouch Branch aquifer (5.26 Mgal/d), owing to the greater transmissivity of the McQueen Branch aquifer.

The natural discharge through the McQueen Branch aquifer and the Crouch Branch aquifer exceeds the daily usage of water at SRS (6.4 Mgal/d in 1993, daily usage reported to the S.C. Water Resources Commission) by a factor of approximately 2.5. In addition, leakage from aquifers higher in the section through the Crouch Branch confining unit in the Floridan-Midville aquifer system and the Meyers Branch confining system increases the potential water supply available from the Floridan-Midville and Dublin-Midville aquifer systems. Accordingly, the withdrawal of water from these aquifers will not significantly affect the overall direction of ground water flow in the Floridan-Midville or the Dublin-Midville aquifer systems in the foreseeable future.

Appleton Confining System

The Appleton confining system is the lowermost confining system of the Southeastern Coastal Plain hydrogeologic province and separates the province from the underlying Piedmont hydrogeologic province (Fig. 12; Plates 3-10 and 38). It is equivalent to the Black Warrior River aquifer and Black Warrior River confining unit of Miller and Renken (1988) (Fig. 43) and to the basal unnamed confining unit of Aucott and others (1987) (Fig. 8). The confining system is essentially saprolite of the Paleozoic and Mesozoic basement rocks and indurated, poorly sorted, silty and sandy clay beds, silty clayey sand and sand beds of the Cretaceous Cape Fear Formation. Thickness of saprolite ranges from 6 to 47 ft in wells used in this report, reflecting the degree of weathering on the basement unconformity prior to deposition of the Cape Fear terrigenous clastics. Thickness of saprolite determined from the Deep Rock Borings study (DRB wells) ranges from 30 to 97 ft and averages 40 ft in wells DRB-1 to DRB-7 (Benedict and others, 1969). Sediments of the Cape Fear Formation are generally more indurated than sediments in the overlying aquifers and confining units. In the northern part of the study area, north of wells C-1 and P-30, the Cape Fear Formation pinches out and the Appleton consists solely of saprolite (Plates 3 and 8).

Elevation and thickness of the Appleton confining system are illustrated on Plates 24 and 25. Some variability in thickness is noted along the trace of the Pen Branch Fault but, overall, the Appleton is typical of the seaward-thickening sedimentary wedge that typifies the Southeastern Coastal Plain hydrogeologic province. It dips at about 31 ft/mi to the southeast (Plate 24) and thickens from 15 ft in well C-2 near the north end of the study area to 237 ft in well C-10 in the south (Plate 25). Sediments of the confining system do not crop out in the study area. Thinning of the Appleton confining system in well PBF-2 (Plate 25) is probably a result of truncation of the section by the Pen Branch Fault, cutting well PBF-2 somewhere between -620 and -683 ft msl. North dip noted between the C-7 and ALL-324 wells (Plate 3) suggests the presence of the postulated Martin Fault (Snipes and others, 1993).

The confining system consists of a single confining unit throughout the study area. Toward the coast, however, the Appleton confining system thickens considerably and includes several aquifers (Clarke and others, 1985), which is more typical of the Black Warrior River regional aquifer in all the states in the Southeastern Coastal Plain hydrogeologic province except South Carolina (Miller and Renken, 1988) (Fig. 43). Aquifers included in the confining system in the downdip region are poorly defined because few wells penetrate them. They are potentially water producing but the depth and generally poor quality of water in the aquifers probably precludes their utilization in the foreseeable future (Aucott and others, 1987). The Appleton confining system includes no aquifer units or zones in the northern and central parts of the study area. At wells C-6 and C-10 to the south, thin sand beds are present that may constitute the updip edge of the aquifers observed in the Appleton south of the study area.

Fine- to coarse-grained sand beds, often very silty and clayey, occur in the upper part of the Cape Fear Formation in the southern part of the study area. The sand appears to be in communication with sand of the overlying McQueen Branch aquifer system and are included with that unit (Plate 3).

The Appleton confining system is defined for the hydrogeologic properties of sediments penetrated at well C-10 near the town of Appleton, in Allendale County, S.C. (Plates 1 and 391). It includes the interval from -1,199 to -1,436 ft msl and is 237 ft thick. Here, the confining system consists of 6 ft of saprolite weathered from basement rocks and interbedded sand, clayey sand and clay of the Cape Fear Formation. The Cape Fear Formation consists of stiff gray, brown, or variegated red, tan, and gray, silty clay and stiff gray, red or brown, micaceous, very clayey, very silty, feldspathic, very fine to very coarse sand. Some coarse pebble zones are present. Updip, the Appleton confining system is typified by sediments penetrated in well PBF-3 (Plate 39m). Here, the system includes the interval from -668 to -802 ft msl and is 134 ft thick. The saprolite is 34 ft thick. The Cape Fear Formation consists of mottled, poorly sorted, well indurated clayey sand beds to sandy clay to clay beds.

Three mud samples from the Appleton confining system in well C-10 were analyzed for grain size using laser-particle techniques (Core Laboratories, 1992). They averaged 21 percent sand, 64 percent silt, and 14 percent clay. Mean grain size was coarse silt (4.5).

Thirty-one sand samples containing less than 25 percent mud were analyzed for grain size (Table 22). The samples were collected from sandy layers in the confining system and range from upper fine- to upper coarse-grained. The sand is texturally immature and poorly and very poorly sorted.

Sand beds in the Appleton confining system are chiefly quartzarenite and subarkose (Folk, 1980 classification). The subangular framework grains consist of monocrystalline and polycrystalline quartz, with minor to trace amounts of potassium feldspar, plagioclase, sedimentary rock fragments, igneous rock fragments, muscovite, and heavy and opaque minerals. Matrix forms 5 to 35 percent of whole rock volume and consists of silt-size grains of angular quartz mixed with clay. Authigenic pyrite and secondary iron oxides are common.

X-ray diffraction analysis of seven sand and mud samples from the Appleton confining system in wells P-18, P-19, P-21, P-22, and P-23 indicates that kaolinite is the dominant clay mineral, with minor to trace amounts of illite and smectite (Strom and Kaback, 1992). Gelting (1990) did x-ray diffraction analyses of 16 clay and sandy clay samples from the Appleton confining system in the downdip C-well series. The average bulk composition was 25 percent quartz, 66 percent clay minerals, and 9 percent feldspar. The clay fraction consisted of 45 percent kaolinite, 29 percent illite, 24 percent mixed-layer illite/smectite, and 2 percent smectite.

Laboratory-measured porosity (helium extraction) of three mud samples from well C-10 averages 28.1 percent and ranges from 26.0 to 30.6 percent (Core Laboratories, 1992). Hydraulic-conductivity values average 1.1×10^{-2} ft/d and range from 3.8×10^{-3} to 1.6×10^{-2} ft/d. Marine (1975) reported vertical hydraulic-conductivity values for the saprolitic material from two wells in the Appleton confining system to be 6.5×10^{3} gal/d/ft^2 (8.7×10^{-4} ft/d) and 3.6×10^{-2} gal/d/ft^2 (4.8×10^{-3} ft/d); the porosity was 38 percent. For the upper part of the confining system (Cape Fear Formation), the reported vertical hydraulic conductivities averaged 1×10^{-3} gal/d/ft^2 (1.3×10^{-4} ft/d), and the porosity averaged 29.6 percent. Porosity and permeability were calculated for 15 sand samples containing less than 25 percent clay. Porosity averaged 32.2 percent and geometric mean permeability was 36.3 Darcies (99.3 ft/d).

Transmissivity values for the aquifers in the Appleton confining system were calculated for modeling purposes in downdip South Carolina (Aucott, 1988). The calculated transmissivity used to model the unit ranged from about 1,100 to 3,600 ft^2/d and averaged less than 2,000 ft^2/d. The sparse hydraulic and lithologic data in the area suggest that the transmissivity is even poorer than that derived from the model calibration.

Water levels monitored in the sand at well C-10 indicate a head difference of 9 ft between the Appleton (206.1 ft msl) and the overlying Midville aquifer system (197.3 ft msl) (Gellici, 1991). Water chemistry differences also exist between water samples obtained from the well screened in the Midville aquifer system at the C-10 well cluster, where the total dissolved solids of the water is low (69 mg/L), and the well screened in a thin sand bed in the Appleton confining system at C-10, where the total dissolved solids are relatively high (300 mg/L) (Simones, 1992).

Table 22. Summary of Folk and Ward statistics, gravel-sand-mud percentages, and calculated porosity and permeability values for sand samples from the Appleton confining system that contain less than 25 percent mud

Parameter	Folk and Ward Statistics				Gravel	Sand	Mud	Porosity	Permeability	
	Mean[1]	Sorting[1]	Skewness	Kurtosis	(%)	(%)	(%)	(%)	(Darcy)	(ft/d)
Mean	1.773	1.514	0.214	1.213	5.4	80.8	13.8	32.2	41.3	112.9
Confidence level (95%)	0.279	0.188	0.076	0.170	3.3	4.0	2.6	1.1	9.4	25.6
Number of samples	27	27	27	27	31	31	31	15	15	15
Median	1.675	1.497	0.226	1.094	1.8	82.7	14.3	32.2	39.0	106.7
Mode	-	-	-	1.074	0.0	-	-	31.2	39.0	106.7
25th percentile	1.230	1.209	0.083	0.967	0.3	75.9	7.5	31.1	36.5	99.8
75th percentile	2.375	1.776	0.318	1.275	4.4	87.6	20.2	33.6	48.5	132.7
Standard deviation	0.740	0.497	0.201	0.451	9.4	11.4	7.3	2.3	18.5	50.6
Variance	0.547	0.247	0.040	0.204	88.4	129.9	53.1	5.1	342.6	2563.8
Kurtosis	-0.980	4.417	0.802	5.685	5.7	1.5	-1.3	-0.6	0.2	0.2
Skewness	0.138	1.492	-0.047	2.277	2.5	-1.1	-0.1	0.2	0.1	0.1
Range	2.765	2.420	0.963	2.084	37.4	49.1	23.0	7.7	70.0	191.5
Maximum	0.363	3.240	0.670	2.750	37.4	97.1	24.9	36.4	78.0	213.4
Minimum	3.128	0.820	-0.293	0.666	0.0	48.0	1.9	28.7	8.0	21.9
Trimean (5%)	1.773	1.514	0.214	1.213	5.4	80.8	13.8	32.2	41.3	112.9
Geometric mean	-	-	-	-	-	-	-	-	36.3	99.3
Harmonic mean	-	-	-	-	-	-	-	-	29.7	81.3

[1] Values are in phi units

PIEDMONT HYDROGEOLOGIC PROVINCE

The basement complex, designated the Piedmont hydrogeologic province in this report, consists of Paleozoic crystalline rocks and consolidated to semiconsolidated Upper Triassic sedimentary rocks of the Dunbarton basin (Plate 26; Table 23); all of which have low permeability (Wait and Davis, 1986). The hydrogeology of the province was studied intensively at SRS to assess the safety and feasibility of storing radioactive waste in these rocks (Marine, 1966, 1967a and b, and 1974; Webster and others, 1970). The upper surface of the province dips approximately 36 ft/mi to the southeast (Plate 26).

Origins of the crystalline and sedimentary basement rocks are different, but their hydraulic properties are similar. The rocks are massive, dense, and practically impermeable except where fracture openings are encountered. Water quality in these units is also similar. Both contain water that is hard and has high levels of calcium, sodium, sulfate, and chloride. The low aquifer permeability and poor water quality in the Paleozoic and Triassic rocks render them undesirable for water supply in the study area.

Hydrogeology of the Paleozoic Basement Rocks

Water injection and withdrawal tests were conducted on packed-off sections of the crystalline Paleozoic metamorphic rocks that underlie the sediments at SRS. The tests indicated that two types of fractures exist in the crystalline bedrock (Marine, 1966). The first consists of minute fractures that pervade the entire rock mass but transmit water slowly. Rocks containing only this type of fracture are called "virtually impermeable rocks." The second type of fracture has larger openings that transmit water more readily. They are vertically restricted but can be traced laterally. Rocks containing this type of fracture are called "hydraulically transmissive rocks."

Marine (1967a and 1974) reported representative hydraulic-conductivity values of 3×10^{-4} gal/d/ft^2 (4×10^{-5} ft/d) for the "virtually impermeable rocks" and 8×10^{-1} gal/d/ft^2 (1.1×10^{-1} ft/d) for the "hydraulically transmissive rocks." Analysis of a two-well tracer test (in wells DRB-5 and DRB-6) indicates a fracture porosity of 0.08 percent in a hydraulically transmissive fracture zone. Laboratory analyses of cores indicate an average intergranular porosity of 0.13 percent (Webster and others, 1970).

Water-level measurements were made in the deep-rock borings that penetrated the basement rocks and in wells completed in the overlying sediments (Logan and Euler, 1989). These measurements indicate a head difference averaging about 14 ft between the crystalline rock of the Piedmont hydrogeologic province and the overlying sediments of the Southeastern Coastal Plain hydrogeologic province, with the crystalline rock having the greater head. This head difference is caused largely by the continuous pumping of process-water supply wells in the area, which reduce the head in the Midville and Dublin-Midville aquifer systems. When compared with static water levels before plant operations began, the head in the crystalline rock is about 2 ft higher than in the overlying aquifer systems. Although there appears to be a regional upward gradient, the water in the Piedmont hydrogeologic province is separated from water in the overlying aquifer systems by the Appleton confining system. Two clay-rich zones form an effective seal that separates ground water in the Coastal Plain sediments from ground water in the underlying crystalline Paleozoic bedrock and the Triassic basin. The first clay layer is a residual clayey material (saprolite) that immediately overlies the bedrock. The second is the clay-rich, Cretaceous Cape Fear Formation that overlies the saprolite.

Marine (1979) presented a potentiometric map for the crystalline metamorphic rock of the Piedmont hydrogeologic province (Fig. 62). Heads range from more than 230 ft msl along the Fall Line in northern Aiken County to 195 ft msl near the center of SRS and to 110 ft msl along the Savannah River where the river crosses the Fall Line. These potentials define an arcuate path, first flowing south from the recharge area along the Fall Line, then swinging to the west beneath SRS and moving north to the discharge area near the intersection of the Savannah River with the Fall Line. This flow has been estimated at 2.5 in/yr (Marine, 1979). Because the data are sparse, Logan and Euler (1989) suggested that it is unclear whether this indicates a regional direction of flow or simply an alteration of the flow path because of the local orientation of the fracture zones.

Water in the Paleozoic bedrock is not pumped at SRS except in testing programs, because of the prolific aquifers and good water in the overlying Coastal Plain sediments. The Paleozoic bedrock probably will not be used as a water source at SRS or in surrounding communities. The hydrologic regime of the metamorphic and igneous basement rocks in the study area, therefore, is unlikely to change appreciably. Immediately south of the Fall Line, and north of it in the Piedmont, the Paleozoic metamorphic and igneous rocks are used for domestic water supplies.

Hydrogeology of the Mesozoic Sedimentary Rocks

In the Dunbarton basin (Plate 26), ground water is present in the primary and secondary porosity of the clastic rocks. The hydraulic conductivity is extremely low, however, and water movement is almost nonexistent. The hydraulic conductivity of the Triassic sedimentary rock, as determined from field tests, ranges from 10^{-4} to 10^{-7} gal/d/ft^2 (1.3×10^{-5} to 1.3×10^{-8} ft/d) (Marine, 1974). The average total porosity is 8.0 percent for sandstone and 3.3 percent for mudstone. Average effective porosity is 7.0 percent for sandstone and 0.53 percent for mudstone. Water is not pumped from rocks in the Dunbarton basin, nor is there likely to be any pumped in the future because of the poor water quality and low permeability of the rocks.

SUMMARY

The hydrostratigraphic classification used in this study utilizes a hierarchy of aquifer and confining units ranked at four levels. Level 1, the hydrogeologic province, defines major regional rock and/or sediment packages that behave as a single unified hydrologic unit. Ranked at level 2 are the aquifer systems and confining systems that transmit or impede ground

Table 23. Depth to the Piedmont hydrogeologic province in and near SRS.

Well	Latitude	Longitude	Elevation (ft)	Depth to hard rock (ft)	Elevation of hard rock (ft)	Source
905-53A?	332027	814414	381.8	739	-357.2	Siple (1967)
AIK-10	333335	814325	N/A	N/A	-15.0	Siple (1967)
AIK-203	332601	815440	N/A	N/A	-21.0	Siple (1967)
AIK-266	333148	814221	N/A	N/A	-39.0	Siple (1967)
AIK-454	333138	815623	470.0	260	210.0	This report
AIK-59	333831	811915	N/A	N/A	-192.0	Siple (1967)
AIK-830	333030	814421	480.0	541	-61.0	This report
AIK-831	333036	814421	505.0	538	-33.0	This report
AIK-832	333158	814225	480.0	515	-35.0	This report
AIK-858	332441	814221	435.0	651	-216.0	This report
ALL-27	330223	812918	186.0	1,476	-1,290.0	This report
ALL-324	330737	813245	203.0	1,355	-1,152.0	This report
C-1	332112	814832	235.0	567	-332.0	This report
C-2	332617	814615	418.8	553	-134.2	This report
C-3	333230	812905	295.2	523	-227.8	This report
C-5	331914	812428	265.6	1,073	-807.4	This report
C-6	331042	811855	208.7	1,374	-1,165.3	This report
C-7	330648	813022	252.0	1,416	-1,164.0	This report
C-10	330130	812303	289.6	1,726	-1,436.4	This report
DRB-1	331747	814015	261.6	877	-615.4	Benedict and others (1969)
DRB-2	331645	813929	281.6	972	-690.4	Benedict and others (1969)
DRB-3	331708	813949	285.5	934	-648.5	Benedict and others (1969)
DRB-4	331635	814011	250.8	887	-636.2	Benedict and others (1969)
DRB-5	331724	813926	286.7	930	-643.3	Benedict and others (1969)
DRB-6	331714	813909	269.1	950	-680.9	Benedict and others (1969)
DRB-7	331705	813901	277.8	960	-682.2	Benedict and others (1969)
Girard	330354	814313	250.0	1,375	-1,125.0	This report
Millers Pond	331348	815344	245.0	852	-607.0	This report
P4R	331502	814812	105.3	690	-584.7	Benedict and others (1969)
P5R	330848	813626	208.4	1230	-1,021.6	Benedict and others (1969)
P6R	331636	814418	253.0	842	-589.0	Benedict and others (1969)
P7R	332000	813554	273.0	888	-615.0	Benedict and others (1969)
P8R	331936	814436	357.0	830	-473.0	Benedict and others (1969)
PBF-1	331736	813149	276.1	1,053	-776.9	This report
PBF-2	331711	333131	268.4	996	-727.6	This report
PBF-3	331515	813719	316.7	1,119	-802.3	This report
PBF-4	331212	814203	208.0	1,069	-861.0	This report
PBF-5	331138	814128	241.0	1,050	-809.0	This report
PBF-6	331011	814428	92.5	874	-781.5	This report
PBF-8	331448	813703	292.0	993	-701.0	This report
PPC-1	331342	813433	313.0	1,158	-845.0	This report
RI-3	N/A	N/A	N/A	N/A	60.0	Siple (1967)
RI-69	N/A	N/A	N/A	N/A	70.0	Siple (1967)

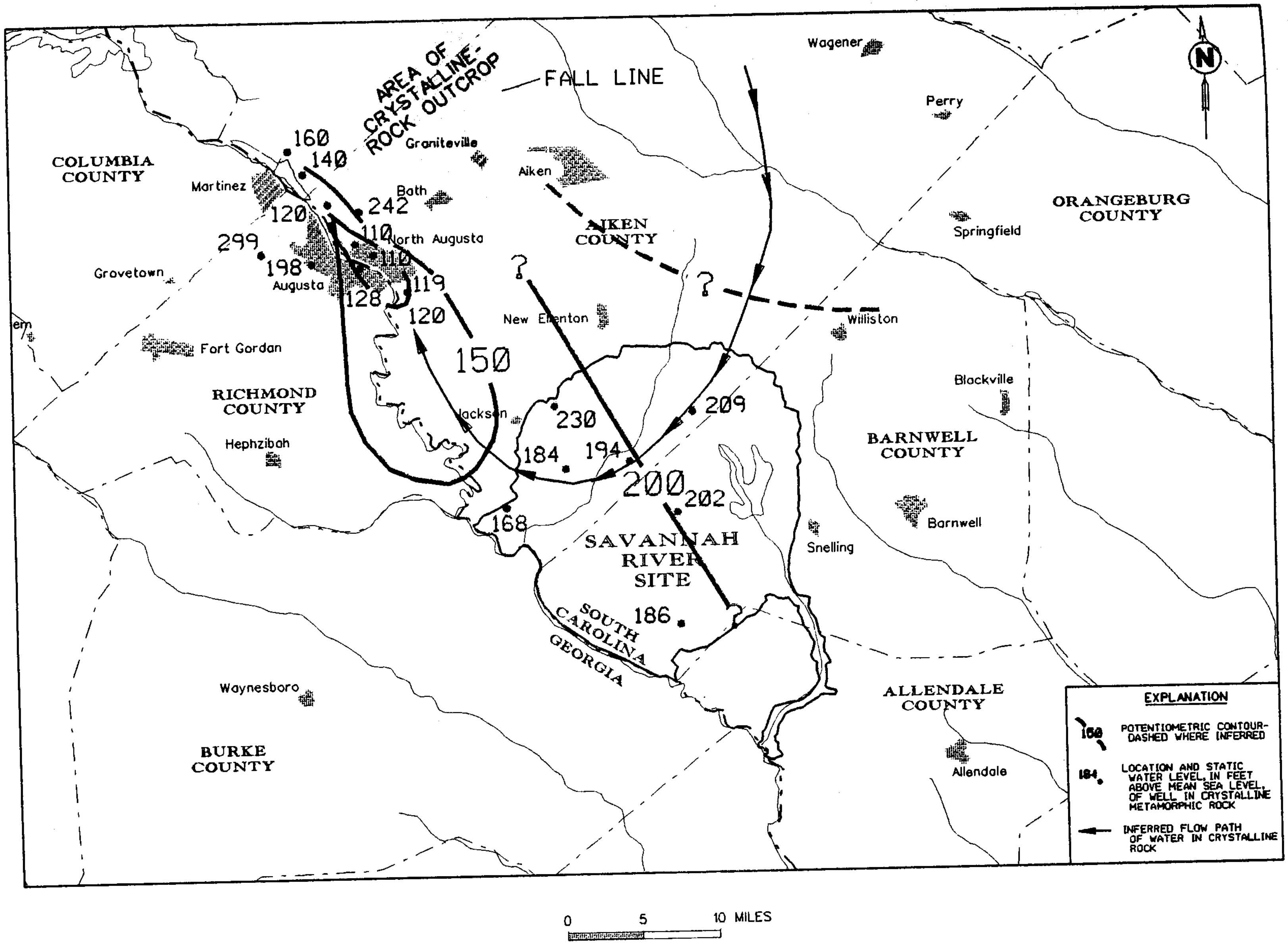


Figure 62. Potentiometric contours for the Piedmont hydrogeologic province (modified from Marine, 1979).

water regionally. Aquifer systems may be composed of a single aquifer unit or of two or more coalescing aquifer units. Aquifer systems may be locally divided by confining units that impede ground water movement but do not greatly affect the regional hydraulic continuity of the system (Poland and others, 1972). A confining system may be composed of a single confining unit or of two or more confining units that serve as an impediment to regional ground water flow.

Ranked at level 3 are aquifer and confining units, which are the fundamental units of the classification. An aquifer is a mappable (>400 mi^2) body of rock or sediments that is sufficiently permeable to transmit ground water and yield significant quantities of water to wells and springs (Bates and Jackson, 1980). A confining unit, on the other hand, is a mappable (>400 mi^2) body of rock or sediments of substantially lower hydraulic conductivity than an adjacent aquifer, that serves as an impediment to ground water flow into or out of an aquifer (Lohman and others, 1972).

Aquifer and confining units may be informally subdivided into zones (level 4) that are characterized by properties significantly different from the rest of the unit, such as hydraulic conductivity, water chemistry, lithology, and color. In the study area, zonal differentiation is undertaken on a local site-specific scale where useful and necessary distinctions are made in the hydraulic characteristics of specific aquifer or confining units.

The hydrostratigraphy of the study area comprises crystalline and sedimentary rocks of the Piedmont hydrogeologic province and generally unconsolidated clastic sediments and limestone of the Southeastern Coastal Plain hydrogeologic province (Fig. 4). Rocks in the Piedmont hydrogeologic province are undifferentiated hydrostratigraphically. Sediments of the Southeastern Coastal Plain hydrogeologic province have been grouped into three aquifer systems and three confining systems. The basal confining system, the Appleton, separates the Southeastern Coastal Plain hydrogeologic province from the underlying Piedmont hydrogeologic province. Locally, individual aquifer and confining units are delineated within each of the aquifer systems. The regional lithostratigraphy and the attendant hydrostratigraphy are compared in Figure 7. The entire complex dips to the southeast and thickens in the downdip direction (Plates 27 and 38).

The three aquifer systems consist of complexly interbedded strata composed primarily of fine- to coarse-grained sand and limestone deposited under relatively high energy conditions in fluvial to shallow marine environments (Miller and Renken, 1988). Locally, clay and marl beds are included in the aquifer systems where quiet water depositional environments prevailed. On a regional scale, however, each aquifer system behaves as a single hydrogeologic unit.

Fine-grained sediments that constitute the regional confining systems were deposited in quiet water marine to fluvial environments. Locally, each confining system contains beds of sand or other high-permeability materials, but, overall, the units act to retard vertical flow between overlying and underlying aquifer systems.

Each of the aquifer and confining systems and units is defined at a type-well cluster location where hydrogeologic characteristics typical of the unit were measured, and is named for a geographic feature near the type-well or well-cluster location where the unit is defined. In descending order f the surface, the aquifer systems are: 1) Floridan, 2) Du and 3) Midville. Note that the Dublin and the Midville aqui systems are defined and named at type-well locations Georgia (Clarke and others, 1985). These names have b carried over into the study area to delineate correlati hydrogeologic units. In descending order from the surfac the confining systems are: 1) Meyers Branch, 2) Allendal and 3) Appleton. The approximate updip limit of each confin- ing system is illustrated on Figure 10.

The Floridan aquifer system is correlative with the Pearl River regional aquifer of Miller and Renken (1988) (Fig. 43) and the Gordon aquifer system and overlying Jacksonian aquifer of Brooks and others (1985) (Plate 37) defined to the west of the study area in east-central Georgia. In the study area, the Floridan is composed mostly of clastic sediments, which are the updip equivalent of the platform limestone that constitutes the main body of the system to the south (Plates 3 and 38). Updip clastic facies of the Floridan aquifer system, also known as the Tertiary sand aquifer (Aucott, 1988), although not considered by Miller (1986) to be part of the Floridan aquifer system, are evidently hydraulically connected with it because there are no regionally significant water-level differences between them and there is little evidence of an intervening confining unit (Aucott and Speiran, 1985b); thus the two are considered to be part of the same regional flow system (Fig. 13). To summarize, the updip clastic phase and the carbonate phase of the Floridan aquifer system are treated together as a single hydrogeologic unit, namely the Floridan aquifer system in this report.

In the central part of the study area, the Floridan aquifer system includes two aquifers, the Gordon and Upper Three Runs, separated by the Gordon confining unit (Fig. 7). The Upper Three Runs aquifer is the updip clastic facies equivalent of the Upper Floridan aquifer and consists of heterogeneous clastic sediments of the Barnwell Group and sandy or locally calcareous sediments of the Tinker/Santee Formation. Porosity and permeability of the Upper Three Runs aquifer are variable across the study area. In the northern and central regions, the aquifer yields only small quantities of water owing to the presence of interstitial silt and clay and poorly sorted sediments that combine to significantly reduce permeability. Local lenses of relatively clean, permeable sand may, however, yield sufficient quantities of water for domestic use. Such high-permeability zones have been observed in GSA near the center of the study area and may locally influence the movement of ground water (Evans and Parizek, 1991). Pumping-test and slug-test results in GSA indicate that hydraulic conductivity is variable, ranging from less than 1 to 33 ft/d. Hydraulic-conductivity values derived from long-duration, multiple-well aquifer tests are in the range of 10 ft/d, which may be a more reliable estimation of average hydraulic conductivity. At the south end of the study area, near well C-10, sediments in the aquifer become increasingly calcareous, the amount of silt and clay tends to decline, and permeability and yields generally increase. Here, hydraulic-conductivity values are in the 60 ft/d range.

The Gordon confining unit consists of silty, clayey sand and clay of the Warley Hill Formation. Downdip, the confining unit thickens and includes clayey, micritic limestone and marl of the Blue Bluff Member of the Santee Limestone, as well as limy, fine-grained clastics of the Warley Hill Formation. South of the study area, the Gordon confining unit ultimately becomes the "middle confining unit" of Miller (1986), which separates the Upper and Lower Floridan aquifers of the carbonate phase of the Floridan aquifer system.

The Gordon aquifer unit consists of sandy parts of the Snapp Formation and the overlying Fourmile and Congaree Formations. In the updip part of the study area, the Gordon aquifer and the Upper Three Runs aquifer coalesce to form the Steed Pond aquifer of the Floridan-Midville aquifer system (Figs. 7, 11, and 12). The Steed Pond aquifer and the underlying Crouch Branch aquifer coalesce towards the Fall Line, north of SRS in central and northern Aiken County (Plate 3).

Hydraulic characteristics of the Gordon are less variable than those noted in the Upper Three Runs aquifer. Hydraulic conductivity derived from eight long-duration pumping tests ranged from 24 to 41 ft/d and averaged 35 ft/d. Hydraulic conductivity decreases downdip near well C-10 owing to poor sorting, finer grain size, and an increase in clay content. Long-duration pumping tests of the Steed Pond aquifer had hydraulic conductivities that ranged from 32 ft/d to 63 ft/d and averaged 43 ft/d.

The Floridan aquifer system is separated from the underlying Dublin and Dublin-Midville aquifer systems in most of the Coastal Plain of South Carolina and Georgia by the Meyers Branch confining system. The Meyers Branch is correlative with the Chattahoochee River confining unit of Miller and Renken (1988) (Fig. 43) and with the Baker Hill-Nanafalia unit (Clarke and others, 1985) in neighboring eastern Georgia (Plate 37).

The Meyers Branch confining system is composed of clay, sandy clay, and sand of Late Cretaceous to Paleocene age and has the greatest effect on the Coastal Plain flow system. In the study area the Meyers Branch confining system consists of a single confining unit, the Crouch Branch. Southward beyond the study area, the Meyers Branch may include several aquifers. The confining system is locally absent in updip parts of the Coastal Plain in east-central Georgia and west-central South Carolina where the Dublin-Midville aquifer system and the Floridan aquifer system are in direct communication and coalesce to form the Floridan-Midville aquifer system (Figs. 10 and 12; Plate 3).

The Dublin and Midville aquifer systems are equivalent to the Chattahoochee River aquifer of Miller and Renken (1988) (Fig. 43) and are directly correlative with the Dublin and Midville aquifer systems of Clark and others (1985), which were defined and described in west-central Georgia (Plate 37). The two systems have previously been referred to as all or part of the "Tuscaloosa aquifer" (Siple, 1967; Park, 1980) (Fig. 8). Each aquifer system is composed of a single aquifer in the study area; the Crouch Branch and the McQueen Branch, respectively. Downdip, south of the study area, the aquifer systems can be further subdivided into several aquifer and confining units (Plates 3 and 38).

Hydraulic conductivity of the Crouch Branch aquifer is variable, ranging from 28 to 227 ft/d. Comparatively high hydraulic conductivity occurs in a northeast-southwest trending region connecting D-Area, Central Shops, and R-Area and defines a "high permeability" zone in the aquifer (Fig. 51). Here, hydraulic conductivity ranges from 117 to 227 ft/d. The "high permeability" zone parallels the trace of the Pen Branch Fault, and reflects changing depositional environments in response to movement along the fault that resulted in coarse-grained, clean, shallow-water sand being deposited along the trace of the fault. South of the trace of the Pen Branch Fault, in P- and L-Areas and throughout the southern part of the study area, lower hydraulic conductivity of the aquifer reflects the return to a deeper water, shelf/deltaic depositional regime. Transmissivity of the aquifer ranges from about 5,000 to 20,000 ft^2/d.

The McQueen Branch is the most prolific aquifer in the study area. Hydraulic-conductivity values obtained from pumping tests range from 53 to 210 ft/d and average 117 ft/d. Transmissivity ranges from about 14,000 to 50,000 ft^2/d, roughly twice that of the Crouch Branch aquifer.

The Dublin and Midville aquifer systems are separated by the Allendale confining system (Figs. 10 and 12; Plate 38). The Allendale consists of a single confining unit in the study area, the McQueen Branch. The confining system is composed of thick, dark-gray and black, micaceous clayey silt and silty clay included in the lower part of the Late Cretaceous Black Creek Formation (Fig. 7). The system is sufficiently thick and continuous in the southern third of the study area to act as a regional confining system from the lower part of the study area to the coast (Plates 3, 4, 5, and 38). In the central and northern regions of the study area, clay beds thin and are no longer effective in hydrologically isolating the Dublin and Midville systems. Here, the Dublin-Midville aquifer system is defined.

Throughout the study area, the Midville aquifer system, as well as the Dublin-Midville and Floridan-Midville aquifer systems, are underlain by the Appleton confining system, which separates the entire Southeastern Coastal Plain hydrogeologic province from the underlying Piedmont hydrogeological province. The Appleton consists of saprolite and the sandy or silty clay beds of the Late Cretaceous Cape Fear Formation. South of the study area, sand beds increase in number and thickness in the Cape Fear, and aquifers and aquifer zones are locally delineated.

System boundaries are delineated where thick, regionally extensive confining beds systematically separate and hydraulically isolate adjacent aquifers, as evidenced by: 1) significant hydraulic-head differences noted across the confining beds at well-cluster sites; 2) significant differences in ground water flow patterns between aquifers, as noted on regional potentiometric maps; 3) a decrease in leakance coefficients of the confining beds, as measured by pumping and lab permeameter tests; and 4) lithostratigraphic analysis that determines the regional continuity of the clay beds. Aquifer systems coalesce updip where confining beds thin and/or become discontinuous, leakance coefficients increase, head differences across confining beds are minimal, and ground water flow patterns converge.

A systematic approach was undertaken in delineating the lateral extent and hydrostratigraphic limits of the aquifers and confining systems and units in the study. Leakance coefficients were calculated (from the geometric mean vertical hydraulic conductivity derived from laboratory analysis of core samples and using unit thicknesses estimated at each well location) and were mapped for each confining system, unit, and zone. Where available, the leakance coefficients derived from pumping tests were compared and contrasted with the laboratory-derived values. The laboratory-derived leakances are point-source values and do not reflect the degree of continuity of the confining beds nor the degree of interconnection or hydraulic communication that may occur across the confining beds in the areas between wells. Leakance values derived from pumping tests, on the other hand, have an "averaging" effect in the radius of influence that reflects both the leakance determined at each well location and the degree of continuity of the confining beds between well locations.

The analysis and comparison of the two methods for determining leakance coefficients, along with the hydraulic head data and the regional potentiometric maps of the aquifer units, were reviewed in conjunction with the lithostratigraphic and structural characteristics and lateral continuity of the bedding in the attendant sedimentary section (using core and downhole geophysical data, lithostratigraphic sections, isopachous, and unit-surface maps) to determine the competence, continuity, thickness, and lateral extent of the various aquifer and confining units in the study.

The geographic distribution of the laboratory-derived leakance values, calculated for the Gordon confining unit are of the 10^{-6}/d order of magnitude in the southern half of the study area where the confining unit is composed mostly of thick beds of micritic limy clay (Plate 12). North of the updip limit of continuous carbonate deposition, clay beds thin and leakance values are generally in the range of 1×10^{-5} to 5×10^{-5}/d. Farther north, north of the Upper Three Runs Creek, leakance coefficients increase dramatically to the 10^{-4} to 10^{-3}/d range, with local exceptions. The updip limit of the Gordon confining unit (Plate 13) is immediately north of Upper Three Runs Creek in the area where leakance coefficients increase and where lithostratigraphic analysis indicates thinning and discontinuity of the clay to sandy clay beds comprising the unit.

Local anomalies occur, as in the center of SRS along the trace of the Pen Branch Fault, where clay beds are generally absent and leakance values are high, on the order of 10^{-4}/d. The increase in leakance along the fault trace is thought to be due to the overall change in lithology and not to breaching of the unit caused by offsets by the fault.

North of the fault, clay beds recur and the comparable leakance coefficients derived from pumping tests and from laboratory permeameter and unit thickness data indicate that the Gordon confining unit is, for the most part, continuous, and effective in GSA. An exception occurs at well HSB-69A, where the laboratory-derived leakance coefficient is an order of magnitude lower than that determined from pumping tests. This difference suggests a breach and/or facies change that increased leakage in the vicinity of the well site. Indeed, detailed lithostratigraphic analysis, high-resolution seismic, and ground-penetrating radar surveys indicate faulting and breaching of the confining beds near well HSB-69A.

Farther north, in southern A-M Area and north of the updip limit of the Gordon confining unit, there is also an order-of-magnitude difference in leakance coefficients [illegible] pumping test data and those derived from [illegible] thickness data, similar to the order-of-magni[illegible] observed downdip in well HSB-69A. Detailed [illegible] graphic and structural analysis (Plate 41) [illegible] confining beds of the "green clay" confining zone [illegible] stratigraphic equivalent of the Gordon confin[illegible] southern A-M Area are generally discontinuous [illegible] well and/or are breached by faulting.

In northern A-M Area, leakance coefficients [illegible] two methods increase. Furthermore, differences [illegible] coefficients derived by the two methods widen. [illegible] cantly greater disparity suggests thinning and an [illegible] greater degree of discontinuity in the confining beds [illegible] ern A-M Area. This is borne out by the lithostra[illegible] analysis (Plate 41) that indicates overall thinning [illegible] ing out of the confining beds and extensive facies [illegible] and faulting toward the north.

In general, leakance coefficients of the Crouch [illegible] confining unit were on the order of 10^{-6}/d where the [illegible] unit is part of the Meyers Branch confining system [illegible] To the north, beyond the updip limit of the Meyers [illegible] confining system, leakance coefficients are generally [illegible] order of 10^{-5}/d, with some localities devoid of confining [illegible] In most of the study area, the clay and sandy clay beds [illegible] Crouch Branch confining unit, where it constitutes the [illegible] Branch confining system, are sufficiently thick and contin[illegible] that offsets due to the faulting commonly observed in the region (Stieve and others, 1991) do not breach the contin[illegible] of the confining system. North of the updip limit of the confining system however, where the confining beds of the Crouch Branch confining unit thin and decrease in number, faulting commonly breaches the confining unit and is an important feature controlling the hydrologic characteristics of the unit (Plate 41).

The close correspondence between the laboratory-derived leakance coefficient and the model-calibrated value at the P-4A well cluster, where the Crouch Branch confining unit constitutes the Meyers Branch confining system, suggests that the Crouch Branch confining unit is a significant barrier to interaquifer flow and that the thickness, lateral continuity, and lithology of the confining beds are consistent and correlative from well to well throughout the region. This is corroborated by the lithostratigraphic analysis made for this study (Plate 8).

The one to two orders of magnitude difference between the laboratory-derived leakance coefficients and the pumping test leakance coefficients indicates that the Crouch Branch confining unit in A-M Area is not a continuous, regionally effective unit and is not, therefore, part of the Meyers Branch confining system. It is, however, a viable confining unit in the Floridan-Midville aquifer system that is defined north of the updip limit of the Meyers Branch confining system (Fig. 10; Plate 17).

In the northeasternmost quadrant of A-M Area (Plate 11) at wells MSB-77, MSB-48, MSB-53, MSB-54, MSB-85, and ASB-6, calculated leakance coefficients had an arithmetic mean of 2.69×10^{-5}/d. This is similar to the leakance coefficients calculated throughout the northern part of the study area, north of SRS boundary (Plate 17). Here, leakances are, on the average, approximately six times greater than that observed to the south. This indicates that in the northeasternmost quadrant of A-M Area and throughout the northern part of the study area, the clay and sandy clay beds in the Crouch Branch confining unit are thin and sometimes locally absent, as corroborated by the lithostratigraphic analysis of the region (Plates 3, 4, 5, 7, and 41).

In the southern part of the study area, where the McQueen Branch confining unit constitutes the Allendale confining system, leakance coefficients average 2.85 x 10^{-6}/d. North of the updip limit of the system, leakance values are significantly higher. In the immediate vicinity of the Pen Branch Fault, clay beds thin dramatically and leakance coefficients average approximately six times greater than the Allendale confining system in the south. Here, the leakance coefficients average 1.84 x 10^{-5}/d. Farther north, clay beds thicken compared to those in the immediate vicinity of the Pen Branch Fault; consequently, leakance coefficients decrease, averaging 1.02 x 10^{-5}/d.

The map of the potentiometric surface of the Crouch Branch aquifer indicates that ground water flow in the northern part of the study area and in the vicinity of SRS is influenced by the Savannah River, which causes ground water to move in an arcuate flow path toward the river (Plate 45). Downdip from SRS in the vicinity of Allendale, S.C., ground water flow is no longer strongly influenced by the river, and it moves to the southeast. The ground water divide between the Savannah River and the South Fork of the Edisto River is located northeast of SRS boundary (Plate 11).

The map of the potentiometric surface of the McQueen Branch aquifer is similar to that for the Crouch Branch aquifer (Fig. 52). Ground water flow in the northern part of the study area and in the vicinity of SRS also moves in an arcuate path towards the Savannah River. South of SRS, flow is generally to the southeast. The location of the ground water divide is similar to that for the Crouch Branch aquifer.

The dip direction and gradient of the potentiometric heads for the McQueen Branch and Crouch Branch aquifers are virtually identical in the northwestern half of SRS, where the Dublin-Midville aquifer system is defined. The head difference between the two aquifers was 1 ft or less at eight of nine well clusters studied, and the direction of ground water flow was similar, suggesting that the aquifers are hydraulically connected and constitute a single aquifer system. The potentiometric heads deviate significantly in the southeastern half of SRS, being 5 to 14 ft lower in the Crouch Branch aquifer than in the McQueen Branch aquifer of the Midville aquifer system. Here, the clay beds of the intervening Allendale confining system begin to systematically separate the two aquifers of the Dublin-Midville aquifer system into the Crouch Branch aquifer of the Dublin aquifer system and the McQueen Branch aquifer of the Midville aquifer system, respectively.

The Midville aquifer system and the combined Dublin-Midville aquifer system are the most prolific aquifer systems in the region and are greatly relied upon for municipal, industrial, and agricultural supplies, especially in the northern part of the study area (Logan and Euler, 1989). The Midville aquifer system is present at increasingly greater depths toward the southeast and is progressively overlain by aquifer systems that contain water of equal or better quality. Large-capacity wells are screened mainly in:

1. the Floridan-Midville and the Dublin-Midville aquifer systems in the northern part of the study area,
2. the Midville in conjunction with the Dublin and Floridan aquifer systems in Barnwell County, northern Bamberg County, and southern Aiken County,
3. the Dublin and Floridan aquifer systems in Allendale County.

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APPENDICES

APPENDIX 1. Baseline hydrostratigraphic data from regional wells.

Hydrostratigraphic data from wells in the vicinity of the Savannah River Site

VADOSE ZONE

Well	Ground elevation	SRS northing	SRS easting	North latitude	West longitude	Top depth	Base depth	Top elevation	Unit thickness
AIK-344	430.0	--	--	33.5161	81.5758	N/A	N/A	N/A	N/A
AIK-858	435.0	--	--	33.4114	81.7058	N/A	N/A	N/A	N/A
ALL-27	186.0	-28343.10	47049.00	33.0397	81.4883	N/A	N/A	N/A	N/A
ALL-324	203.0	7655.90	51664.70	33.1269	81.5458	N/A	N/A	N/A	N/A
ASB-8/MSB-12	347.0	106381.60	53136.60	33.3477	81.7336	0	115.9	347	116
BPC-1	281.5	86417.06	42023.04	33.2855	81.7240	N/A	N/A	N/A	N/A
BRN-76	255.0	34500.00	91000.00	33.2504	81.4943	0	33.6	255	34
BRN-78	340.0	--	--	33.3994	81.4222	N/A	N/A	N/A	N/A
BRN-386	181.0	--	--	33.2428	81.4033	N/A	N/A	N/A	N/A
C-1	235.0	1216910.00	35853.60	33.3533	81.8089	N/A	N/A	N/A	N/A
C-2	418.8	139569.20	63522.40	33.4381	81.7708	0	179.3	419	179
C-3	295.2	118157.60	156122.20	33.5417	81.4847	0	42.5	295	43
C-5	265.6	39431.00	127406.60	33.3206	81.4078	0	17.8	266	18
C-6	208.7	-19044.30	119595.60	33.1783	81.3153	0	28.3	209	28
C-7	252.0	--	--	33.1133	81.5061	N/A	N/A	N/A	N/A
C-10	289.6	-51506.70	69541.30	33.0250	81.3842	N/A	N/A	N/A	N/A
CPC-1	285.1	66855.77	47183.78	33.2490	81.6473	N/A	N/A	N/A	N/A
GGS-92-6	250.0	--	--	33.1789	81.7858	N/A	N/A	N/A	N/A
GIRARD	250.0	21219.30	-4710.60	33.0650	81.7203	N/A	N/A	N/A	N/A
MILLERS PD.	245.0	--	--	33.2300	81.8956	N/A	N/A	N/A	N/A
MILLHAVEN	110.0	-52692.10	-11595.90	32.8903	81.5953	N/A	N/A	N/A	N/A
P-4A	105.3	90583.00	14957.00	33.2504	81.8033	N/A	N/A	N/A	N/A
P-13	252.1	35600.00	60000.00	33.2024	81.5780	0	22.7	252	23
P-14	292.9	72445.00	76440.00	33.3107	81.6062	0	50.3	293	50
P-15	252.6	47007.90	50863.70	33.2127	81.6242	0	21.4	253	21
P-16	261.3	98222.00	82318.00	33.3773	81.6408	0	46.6	261	47
P-17	332.6	63199.00	109791.00	33.3446	81.5003	0	45.8	333	46
P-18	296.3	67579.00	47653.00	33.2530	81.6726	0	71.2	296	71
P-19	296.8	55296.00	60035.00	33.2460	81.6161	0	29.2	297	29
P-20	287.4	56094.00	76768.00	33.2751	81.5736	0	16.4	287	16
P-21	206.5	24675.00	40739.00	33.1468	81.6075	0	48.4	207	48
P-22	215.0	20593.00	73555.00	33.1912	81.5133	0	46.1	215	46
P-23	180.6	48063.00	30931.00	33.1825	81.6787	0	37.0	181	37
P-24	313.1	43096.00	66565.00	33.2297	81.5753	0	42.1	313	42
P-25	264.7	52494.00	42261.00	33.2108	81.6575	0	54.0	265	54

... data from wells in the vicinity of the Savannah River Site

VADOSE ZONE

Well	Ground elevation	SRS northing	SRS easting	North latitude	West longitude	Top depth	Base depth	Top elevation	Unit thickness
P-26	151.5	71959.00	18052.00	33.2143	81.7590	0	34.4	152	34
P-27	273.6	70382.00	64023.00	33.2859	81.6349	0	10.0	274	10
P-28	284.9	79284.00	55441.00	33.2916	81.6748	0	77.7	285	78
P-29	265.6	86483.00	42796.00	33.2869	81.7221	0	97.5	266	97
P-30	354.4	98933.00	57105.00	33.3377	81.7086	0	98.1	354	98
PBF-1	276.1	53623.10	91388.62	33.2934	81.5303	N/A	N/A	N/A	N/A
PBF-2	268.4	50667.38	91082.89	33.2864	81.5254	N/A	N/A	N/A	N/A
PBF-3	316.7	58766.62	60380.36	33.2543	81.6220	N/A	N/A	N/A	N/A
PBF-4	208.0	58148.66	29985.13	33.2033	81.7008	0	38.7	208	39
PBF-5	241.0	53591.29	30319.43	33.1938	81.6910	0	7.3	241	7
PBF-6	92.5	55612.75	12814.48	33.1697	81.7410	N/A	N/A	N/A	N/A
PBF-8	292.0	55744.48	59812.89	33.2466	81.6176	N/A	N/A	N/A	N/A
PPC-1	313.0	42727.22	66137.83	33.2282	81.5757	N/A	N/A	N/A	N/A
VG-7	250.6	28450.00	5500.00	33.0977	81.7075	N/A	N/A	N/A	N/A

Notes:

All thicknesses are in feet
All depths are in feet below land surface
All elevations are in feet relative to mean sea level
Values in italics are estimated by R.K. Aadland

ABS, Hydrostratigraphic unit is absent in this well.
ER, Unit eroded.
N/A, Data not available.
N/D, Hydrostratigraphic unit is not delineated in this well.
NP, Hydrostratigraphic horizon is not penetrated in this well.

Hydrostratigraphic data from wells in the vicinity of the Savannah River Site

STEED POND AQUIFER

Well	Ground elevation	Hydrologic system	Top depth	Base depth	Top elevation	Unit thickness	Clay thickness	Sand thickness	Number of sand beds > 5 ft	Total % sand
AIK-344	430.0	F-M	WT	222	430	222	N/A	N/A	N/A	N/A
AIK-858	435.0	F-M	WT	274	435	274	0	274	1	100%
ALL-27	186.0	--	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
ALL-324	203.0	--	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
ASB-8/MSB-12	347.0	F-M	115.9	213	231	97	11	86	4	89%
BPC-1	281.5	F	WT	244	281	244	N/A	N/A	N/A	N/A
BRN-76	255.0	--	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
BRN-78	340.0	--	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
BRN-386	181.0	--	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
C-1	235.0	F	WT	103	235	103	8	95	2	92%
C-2*	418.8	--	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
C-3	295.2	F-M	42.5	90	253	48	8	40	2	83%
C-5	265.6	--	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
C-6	208.7	--	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
C-7	252.0	--	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
C-10	289.6	--	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
CPC-1	285.1	--	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
GGS-92-6	250.0	--	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
GIRARD	250.0	--	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
MILLERS PD.	245.0	F	WT	161	245	161	7	97	5	60%
MILLHAVEN	110.0	--	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
P-4A	105.3	--	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
P-13	252.1	--	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
P-14	292.9	--	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
P-15	252.6	--	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
P-16	261.3	F-M	46.6	158	215	111	4	107	2	96%
P-17	332.6	--	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
P-18	296.3	--	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
P-19	296.8	--	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
P-20	287.4	--	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
P-21	206.5	--	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
P-22	215.0	--	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
P-23	180.6	--	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
P-24	313.1	--	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
[illegible]	[illegible]	--	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D

Well	Ground elevation	Hydrologic system	Top depth	Base depth	Top elevation	Unit thickness	Clay thickness	Sand thickness	Number of sand beds > 5 ft	Total % sand
P-26	151.5	--	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
P-27	273.6	--	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
P-28	284.9	--	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
P-29	265.6	F	97.5	216	168	119	3	116	2	97%
P-30	354.4	F-M	98.1	*280*	256	182	12	170	3	93%
PBF-1	276.1	--	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
PBF-2	268.4	--	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
PBF-3	316.7	--	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
PBF-4	208.0	--	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
PBF-5	241.0	--	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
PBF-6	92.5	--	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
PBF-8	292.0	--	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
PPC-1	313.0	--	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
VG-7	250.6	--	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D

Notes:

All thicknesses are in feet
All depths are in feet below land surface
All elevations are in feet relative to mean sea level
Values in italics are estimated by R.K. Aadland

ABS, Hydrostratigraphic unit is absent in this well.
ER, Unit eroded.
N/A, Data not available.
N/D, Hydrostratigraphic unit is not delineated in this well.
NP, Hydrostratigraphic horizon is not penetrated in this well.
WT, Top of unit at water table (water table not available).
* Water table below projected base of Steed Pond aquifer.

F, Floridan aquifer system.
F-M, Floridan-Midville aquifer system.

Hydrostratigraphic data from wells in the vicinity of the Savannah River Site

UPPER THREE RUNS AQUIFER

Well	Ground elevation	Hydrologic system	Top depth	Base depth	Top elevation	Unit thickness	Clay thickness	Confining carbonate thickness	Transmissive carbonate thickness	Number of transmissive carbonate beds > 5 ft	Sand thickness	Number of sand beds > 5 ft	Total transmissive thickness	Total % transmissive thickness
AIK-344*	430.0	F-M	WT	103	430	103	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
AIK-858	435.0	--	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
ALL-27	186.0	F	WT	214	N/A	214	7	0	56	2	151	3	207	97%
ALL-324	203.0	F	WT	180	N/A	180	18	10	20	1	132	3	152	84%
ASB-8/MSB-12*	347.0	F-M	115.9	118	231	2	0	0	0	0	2	1	2	100%
BPC-1*	281.5	F	WT	124	281	124	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
BRN-76	255.0	F	33.6	196	221	162	6	22	0	0	134	2	134	83%
BRN-78	340.0	F-M	WT	142	340	142	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
BRN-386	181.0	F	WT	119	181	119	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
C-1*	235.0	F	WT	16	235	16	0	0	0	0	16	1	16	100%
C-2	418.8	--	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
C-3	295.2	--	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
C-5	265.6	F-D	17.8	162	248	144	0	0	0	0	144	1	144	100%
C-6	208.7	F	28.3	173	180	145	0	0	0	0	145	1	145	100%
C-7	252.0	F	WT	227	252	227	16	4	21	1	186	3	207	91%
C-10	289.6	F	WT	380	290	380	23	0	78	2	279	6	357	94%
CPC-1	285.1	F	WT	210	285	210	25	25	26	2	134	4	160	76%
GGS-92-6	250.0	F	WT	173	250	173	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GIRARD	250.0	F	WT	242	250	242	32	0	47	4	163	7	210	87%
MILLERS PD.	245.0	--	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
MILLHAVEN	110.0	F	WT	305	110	305	5	0	169	4	131	4	300	98%
P-4A	105.3	--	ER	ER	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P-13	252.1	F	22.7	228	229	205	26	0	18	1	161	2	179	87%
P-14	292.9	F	50.3	155	243	105	0	0	5	1	100	1	105	100%
P-15	252.6	F	21.4	170	231	149	11	0	0	0	138	3	138	93%
P-16*	261.3	F-M	46.6	83	215	36	4	0	0	0	32	2	32	89%
P-17	332.6	F-M	45.8	179	287	133	0	0	15	1	118	2	133	100%
P-18	296.3	F	71.2	176	225	105	4	0	21	1	80	2	101	96%
P-19	296.8	F	29.2	179	268	150	39	0	0	0	111	6	111	74%
P-20	287.4	F	16.4	206	271	190	16	0	40	1	134	4	174	92%
P-21	206.5	F	48.4	162	158	114	3	28	0	0	83	3	83	73%
P-22	215.0	F	46.1	182	169	136	7	25	35	1	69	3	104	76%
P-23	180.6	F	37.0	97	144	60	30	0	29	1	1	4	30	50%
P-24	313.1	F	42.1	243	271	201	19	42	0	0	140	6	140	70%
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	18	6	0	0	88	4	88	79%

Well	Ground elevation	Hydrologic system	Top depth	Base depth	Top elevation	Unit thickness	Clay thickness	Confining carbonate thickness	Transmissive carbonate thickness	Number of transmissive carbonate beds > 5 ft	Sand thickness	Number of sand beds > 5 ft	Total transmissive thickness	Total % transmissive thickness
P-26	151.5	F	34.4	44	117	10	0	0	0	0	10	1	10	100%
P-27	273.6	F	10.0	142	264	132	19	0	0	0	113	3	113	86%
P-28	284.9	F	77.7	129	207	51	5	0	0	0	46	2	46	90%
P-29*	265.6	F	97.5	98	168	1	0	0	0	0	1	1	1	100%
P-30*	354.4	F-M	98.1	124	256	26	9	0	0	0	17	2	17	65%
PBF-1	276.1	F	WT	175	276	175	13	0	12	1	150	5	162	93%
PBF-2	268.4	F	WT	137	268	137	6	0	0	0	131	3	131	96%
PBF-3	316.7	F	WT	246	317	246	51	0	0	0	195	4	195	79%
PBF-4	208.0	F	38.7	141	169	102	26	0	0	0	76	4	76	75%
PBF-5	241.0	F	7.3	141	234	134	28	0	0	0	106	2	106	79%
PBF-6	92.5	F	ER	ER	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
PBF-8	292.0	F	WT	186	292	186	40	0	0	0	146	8	146	78%
PPC-1	313.0	F	WT	238	313	238	11	0	0	0	227	2	227	95%
VG-7	250.6	F	WT	205	251	205	64	0	0	0	141	5	141	69%

Notes:

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All depths are in feet below land surface
All elevations are in feet relative to mean sea level
Values in italics are estimated by R.K. Aadland

ABS, Hydrostratigraphic unit is absent in this well.
ER, Unit eroded.
N/A, Data not available.
N/D, Hydrostratigraphic unit is not delineated in this well.
NP, Hydrostratigraphic horizon is not penetrated in this well.
WT, Top of unit at water table (water table not available).
* "M-Area" aquifer zone of the Steed Pond aquifer and hydrostratigraphic equivalents.

F, Floridan aquifer system.
F-D, Floridan-Dublin aquifer system.
F-M, Floridan-Midville aquifer system.

Hydrostratigraphic data from wells in the vicinity of the Savannah River Site

GORDON CONFINING UNIT

Well	Ground elevation	Hydrologic system	Top depth	Base depth	Top elevation	Unit thickness	Clay thickness	Number of clay beds > 2 ft	Clayey-sand thickness	Number of clayey-sand beds > 2 ft	Confining carbonate thickness	Number of confining carbonate beds > 2 ft	Total confining thickness	Leakance (ft/d/ft)	Total % confining thickness
AIK-344*	430.0	F-M	103	112	327	9	2	0	5	2	0	0	7	7.98E-05	78%
AIK-858	435.0	--	ABS	ABS	ABS	0	0	0	0	0	0	0	0	0.00E+00	0%
ALL-27	186.0	F	214	300	-28	86	0	0	0	0	69	2	69	2.42E-06	80%
ALL-324	203.0	F	180	250	23	70	17	1	0	0	53	1	70	2.39E-06	100%
ASB-8/MSB-12*	347.0	F-M	118	146	229	28	6	1	2	1	0	0	8	2.77E-05	29%
BPC-1*	281.5	F	124	127	158	3	1	0	2	1	0	0	3	1.61E-04	100%
BRN-76	255.0	F	196	230	59	34	0	0	0	0	34	0	34	4.91E-06	100%
BRN-78	340.0	F-M	142	180	198	38	N/A	N/A	N/A	N/A	N/A	N/A	38	N/A	100%
BRN-386	181.0	F	119	160	62	41	10	1	0	0	31	1	41	4.07E-06	100%
C-1*	235.0	F	16	30	219	14	2	1	4	2	0	0	6	8.05E-05	43%
C-2*	418.8	F-M	96	102	323	6	0	0	5	2	0	0	5	1.78E-03	83%
C-3	295.2	--	ER	ER	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
C-5	265.6	F-D	162	172	104	10	7	2	3	1	0	0	10	2.37E-05	100%
C-6	208.7	F	173	241	36	68	0	0	0	0	68	1	68	2.46E-06	100%
C-7	252.0	F	227	313	25	86	28	1	0	0	58	1	86	1.94E-06	100%
C-10	289.6	F	380	445	-90	65	0	0	0	0	65	1	65	2.57E-06	100%
CPC-1	285.1	F	210	218	75	8	0	0	8	1	0	0	8	1.11E-03	100%
GGS-92-6	250.0	F	173	182	77	9	6	2	0	0	0	0	6	2.78E-05	67%
GIRARD	250.0	F	242	322	8	80	80	1	0	0	0	1	80	2.09E-06	100%
MILLERS PD.	245.0	--	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
MILLHAVEN	110.0	F	305	362	-195	57	0	0	0	0	57	1	57	2.93E-06	100%
P-4A	105.3	--	ER	ER	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P-13	252.1	F	228	238	24	10	4	1	0	0	6	1	10	1.67E-05	100%
P-14	292.9	F	155	165	138	10	6	1	4	1	0	0	10	2.75E-05	100%
P-15	252.6	F	170	172	83	2	0	0	2	1	0	0	2	4.45E-03	100%
P-16*	261.3	F-M	83	95	178	12	0	0	4	2	0	0	4	2.23E-03	33%
P-17	332.6	F-M	179	197	154	18	13	2	5	1	0	0	18	1.28E-05	100%
P-18	296.3	F	176	187	120	11	3	1	8	2	0	0	11	5.30E-05	100%
P-19	296.8	F	179	183	118	4	4	1	0	0	0	0	4	4.18E-05	100%
P-20	287.4	F	206	212	81	6	6	1	0	0	0	0	6	2.78E-05	100%
[illegible]	[illegible]	F	162	232	45	70	0	0	0	0	70	1	70	2.39E-06	100%

... in the vicinity of the Savannah River Site

... CONFINING UNIT

Well	Ground elevation	Hydrologic system	Top depth	Base depth	Top elevation	Unit thickness	Clay thickness	Number of clay beds > 2 ft	Clayey-sand thickness	Number of clayey-sand beds > 2 ft	Confining carbonate thickness	Number of confining carbonate beds > 2 ft	Total confining thickness	Leakance (ft/d/ft)	Total % confining thickness
P-26	151.5	F	44	55	108	11	7	2	0	0	0	0	7	2.39E-05	64%
P-27	273.6	F	142	149	132	7	3	1	4	1	0	0	7	5.43E-05	100%
P-28	284.9	F	129	147	156	18	6	1	9	1	0	0	15	2.71E-05	83%
P-29*	265.6	F	98	111	168	13	0	0	6	2	0	0	6	1.48E-03	46%
P-30*	354.4	F-M	124	141	230	17	0	0	6	3	0	0	6	1.48E-03	35%
PBF-1	276.1	F	175	197	101	22	10	1	7	1	5	1	22	1.10E-05	100%
PBF-2	268.4	F	137	148	131	11	0	0	0	0	8	2	8	2.09E-05	73%
PBF-3	316.7	F	246	258	71	12	0	0	7	3	0	0	7	1.27E-03	58%
PBF-4	208.0	F	141	168	67	27	19	2	8	1	0	0	27	8.72E-06	100%
PBF-5	241.0	F	141	163	100	22	14	2	8	2	0	0	22	1.18E-05	100%
PBF-6	92.5	F	*0*	10	*93*	10	10	1	0	0	0	0	10	1.67E-05	100%
PBF-8	292.0	F	186	204	106	18	0	0	10	2	0	0	10	8.90E-04	56%
PPC-1	313.0	F	*238*	240	*75*	2	2	1	0	0	0	0	2	8.35E-05	100%
VG-7	250.6	F	205	270	46	65	65	1	0	0	0	0	65	2.57E-06	100%

Notes:

All thicknesses are in feet
All depths are in feet below land surface
All elevations are in feet relative to mean sea level
Values in italics are estimated by R.K. Aadland

ABS, Hydrostratigraphic unit is absent in this well.
ER, Unit eroded.
N/A, Data not available.
N/D, Hydrostratigraphic unit is not delineated in this well.
NP, Hydrostratigraphic horizon is not penetrated in this well.
* "Green clay" confining zone of the Steed Pond aquifer and hydrostratigraphic equivalents.

F, Floridan aquifer system.
F-D, Floridan-Dublin aquifer system.
F-M, Floridan-Midville aquifer system.

Hydrostratigraphic data from wells in the vicinity of the Savannah River Site

GORDON AQUIFER

Well	Ground elevation	Hydrologic system	Top depth	Base depth	Top elevation	Unit thickness	Clay thickness	Confining carbonate thickness	Transmissive carbonate thickness	Number of transmissive carbonate beds > 5 ft	Sand thickness	Number of sand beds > 5 ft	Total transmissive thickness	Total % transmissive
AIK-344*	430.0	F-M	112	222	318	110	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
AIK-858	435.0	--	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
ALL-27	186.0	F	300	443	-114	143	8	0	33	1	102	2	135	94%
ALL-324	203.0	F	250	328	-47	78	0	0	10	1	68	1	78	100%
ASB-8/MSB-12*	347.0	F-M	146	213	201	67	5	0	0	0	62	3	62	93%
BPC-1*	281.5	F	127	244	155	117	9	0	0	0	108	5	108	92%
BRN-76	255.0	F	230	326	25	96	29	0	0	0	67	3	67	70%
BRN-78	340.0	F-M	180	306	160	126	7	0	0	0	119	2	119	94%
BRN-386	181.0	F	160	262	21	102	7	0	0	0	95	3	95	93%
C-1*	235.0	F	30	103	205	73	8	0	0	0	65	2	65	89%
C-2	418.8	--	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
C-3*	295.2	F-M	42.5	90	253	47.5	8	0	0	0	39.5	2	39.5	83%
C-5	265.6	F-D	172	280	94	108	3	0	0	0	105	2	105	97%
C-6	208.7	F	241	426	-32	185	0	0	0	0	185	1	185	100%
C-7	252.0	F	313	407	-61	94	0	0	12	1	82	1	94	100%
C-10	289.6	F	445	600	-155	155	6	0	75	2	74	3	149	96%
CPC-1	285.1	F	218	296	67	78	10	0	0	0	68	3	68	87%
GGS-92-6	250.0	F	182	263	68	81	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
GIRARD	250.0	F	322	422	-72	100	0	0	20	1	80	1	100	100%
MILLERS PD.	245.0	--	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D	N/D
MILLHAVEN	110.0	F	362	504	-252	142	0	44	19	2	79	4	98	69%
P-4A	105.3	F	ER	38	105	38	0	0	0	0	38	1	38	100%
P-13	252.1	F	238	322	14	84	0	0	0	0	84	1	84	100%
P-14	292.9	F	165	219	128	54	0	0	0	0	54	1	54	100%
P-15	252.6	F	*172*	258	*81*	*86*	0	0	0	0	86	1	86	100%
P-16*	261.3	F-M	*95*	158	*166*	63	0	0	0	0	63	1	63	100%
P-17	332.6	F-M	197	307	136	110	4	0	0	0	106	2	106	96%
P-18	296.3	F	187	259	109	72	0	0	0	0	72	1	72	100%
P-19	296.8	F	183	272	114	89	12	0	0	0	77	1	77	87%
P-20	287.4	F	212	299	75	87	0	0	0	0	87	1	87	100%
P-21	206.5	F	232	326	-26	94	5	0	7	1	82	2	89	95%
P-22	215.0	F	232	330	-17	98	12	0	0	0	86	3	86	88%
P-23	180.6	F	124	185	57	61	0	0	0	0	61	1	61	100%
P-24	313.1	F	260	354	53	94	3	0	0	0	91	2	91	97%
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4	0	0	0	79	2	79	95%

Hydrostratigraphic data from wells in the vicinity of the Savannah River Site

GORDON AQUIFER

Well	Ground elevation	Hydrologic system	Top depth	Base depth	Top elevation	Unit thickness	Clay thickness	Confining carbonate thickness	Transmissive carbonate thickness	Number of transmissive carbonate beds > 5 ft	Sand thickness	Number of sand beds > 5 ft	Total transmissive thickness	Total % transmissive
P-26	151.5	F	55	133	97	78	10	0	0	0	68	3	68	87%
P-27	273.6	F	149	226	125	77	0	0	0	0	77	1	77	100%
P-28	284.9	F	147	222	138	75	0	0	0	0	75	1	75	100%
P-29*	265.6	F	111	216	155	105	0	0	0	0	105	1	105	100%
P-30*	354.4	F-M	141	*280*	213	139	3	0	0	0	136	2	136	98%
PBF-1	276.1	F	197	253	79	56	2	0	0	0	54	2	54	96%
PBF-2	268.4	F	148	220	120	72	0	0	0	0	72	1	72	100%
PBF-3	316.7	F	258	338	59	80	4	0	0	0	76	2	76	95%
PBF-4	208.0	F	168	279	40	111	4	0	0	0	107	2	107	96%
PBF-5	241.0	F	163	235	78	72	0	0	0	0	72	1	72	100%
PBF-6	92.5	F	10	86	83	76	2	0	0	0	74	2	74	97%
PBF-8	292.0	F	204	283	88	79	0	0	0	0	79	1	79	100%
PPC-1	313.0	F	*240*	367	*73*	*127*	0	0	0	0	127	1	127	100%
VG-7	250.6	F	270	369	-19	99	0	0	0	0	99	1	99	100%

Notes:

All thicknesses are in feet
All depths are in feet below land surface
All elevations are in feet relative to mean sea level
Values in italics are estimated by R.K. Aadland

ABS, Hydrostratigraphic unit is absent in this well.
ER, Unit eroded.
N/A, Data not available.
N/D, Hydrostratigraphic unit is not delineated in this well.
NP, Hydrostratigraphic horizon is not penetrated in this well.
* "Lost Lake" aquifer zone of the Steed Pond aquifer and hydrostratigraphic equivalents.

F, Floridan aquifer system.
F-D, Floridan-Dublin aquifer system.
F-M, Floridan-Midville aquifer system.

Hydrostratigraphic data from wells in the vicinity of the Savannah River Site

CROUCH BRANCH CONFINING UNIT

Well	Ground elevation	Hydrologic system	Top depth	Base depth	Top elevation	Unit thickness	Clay thickness	Number of clay beds > 2 ft	Clayey-sand thickness	Number of clayey-sand beds > 2 ft	Total confining thickness	Leakance (ft/d/ft)	Total % confining thickness
AIK-344	430.0	F-M	222	230.0	208	8	8	1	0	0	8	2.09E-05	100%
AIK-858	435.0	F-M	274	274	161	0	0	0	0	0	0	0.00E+00	0%
ALL-27	186.0	MB	443	555	-257	112	64	2	20	1	84	2.59E-06	75%
ALL-324	203.0	MB	328	450	-125	122	48	6	51	5	99	3.41E-06	81%
ASB-8/MSB-12	347.0	F-M	213	294	134	81	31	4	10	2	41	5.35E-06	51%
BPC-1	281.5	MB	244	314	38	70	43	2	4	1	47	3.88E-06	67%
BRN-76	255.0	MB	326	436	-71	110	76	3	18	1	94	2.19E-06	85%
BRN-78	340.0	F-M	306	318	34	12	12	1	0	0	12	1.39E-05	100%
BRN-386	181.0	MB	262	406	-81	144	70	5	0	0	70	2.39E-06	49%
C-1	235.0	MB	103	160	132	57	46	3	11	2	57	3.61E-06	100%
C-2	418.8	F-M	176	187	243	11	11	1	0	0	11	1.52E-05	100%
C-3	295.2	F-M	90	106	205	16	16	1	0	0	16	1.04E-05	100%
C-5	265.6	F-D	280	316	-14	36	11	3	8	1	19	1.50E-05	53%
C-6	208.7	MB	426	571	-217	145	106	3	40	2	146	1.56E-06	101%
C-7	252.0	MB	407	522	-155	115	97	3	11	2	108	1.72E-06	94%
C-10	289.6	MB	600	747	-310	147	101	3	0	0	101	1.65E-06	69%
CPC-1	285.1	MB	296	459	-11	163	86	3	0	0	86	1.94E-06	53%
GGS-92-6	250.0	MB	263	360	-13	97	61	4	0	0	61	2.74E-06	63%
GIRARD	250.0	MB	422	563	-172	141	41	3	45	2	86	3.99E-06	61%
MILLERS PD.	245.0	MB	161	294	84	133	71	5	0	0	71	2.35E-06	53%
MILLHAVEN	110.0	MB	504	685	-394	181	93	5	43	4	136	1.78E-06	75%
P-4A	105.3	MB	38	130	67	92	59	2	30	2	89	2.80E-06	97%
P-13	252.1	MB	322	478	-70	156	96	5	0	0	96	1.74E-06	62%
P-14	292.9	MB	219	294	74	75	52	2	0	0	52	3.21E-06	69%
P-15	252.6	MB	258	442	-5	184	74	5	8	1	82	2.25E-06	45%
P-16	261.3	F-M	158	183	103	25	12	2	0	0	12	1.39E-05	48%
P-17	332.6	F-M	307	381	26	74	17	2	0	0	17	9.82E-06	23%
P-18	296.3	MB	259	423	37	164	97	6	13	2	110	1.72E-06	67%
P-19	296.8	MB	272	408	25	136	44	4	8	1	52	3.78E-06	38%
[illegible]	287.4	MB	299	338	-12	39	34	1	0	0	34	4.91E-06	87%

P-25 264.7 MB 255 380 10 125 35 4 36 2 71 [illegible] [illegible]

Hydrostratigraphic data from wells in the vicinity of the Savannah River Site

CROUCH BRANCH CONFINING UNIT

Well	Ground elevation	Hydrologic system	Top depth	Base depth	Top elevation	Unit thickness	Clay thickness	Number of clay beds > 2 ft	Clayey-sand thickness	Number of clayey-sand beds > 2 ft	Total confining thickness	Leakance (ft/d/ft)	Total % confining thickness
P-26	151.5	MB	133	214	19	81	43	5	0	0	43	3.88E-06	53%
P-27	273.6	MB	226	356	48	130	59	5	12	1	71	2.82E-06	55%
P-28	284.9	MB	222	318	63	96	56	5	0	0	56	2.98E-06	58%
P-29	265.6	MB	216	297	50	81	30	4	0	0	30	5.57E-06	37%
P-30	354.4	F-M	*280*	*280*	*74*	0	0	0	0	0	0	0.00E+00	0%
PBF-1	276.1	MB	253	346	23	93	52	4	15	1	67	3.19E-06	72%
PBF-2	268.4	MB	220	317	48	97	67	4	22	2	89	2.48E-06	92%
PBF-3	316.7	MB	338	457	-21	119	51	7	17	3	68	3.25E-06	57%
PBF-4	208.0	MB	279	367	-71	88	58	4	17	2	75	2.86E-06	85%
PBF-5	241.0	MB	235	358	6	123	75	5	22	2	97	2.21E-06	79%
PBF-6	92.5	MB	86	153	7	67	19	3	5	1	24	8.75E-06	36%
PBF-8	292.0	MB	283	388	9	105	51	5	29	4	80	3.24E-06	76%
PPC-1	313.0	MB	367	489	-54	122	92	3	30	2	122	1.80E-06	100%
VG-7	250.6	MB	369	NP	-118	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Notes:

All thicknesses are in feet
All depths are in feet below land surface
All elevations are in feet relative to mean sea level
Values in italics are estimated by R.K. Aadland

ABS, Hydrostratigraphic unit is absent in this well.
ER, Unit eroded.
N/A, Data not available.
N/D, Hydrostratigraphic unit is not delineated in this well.
NP, Hydrostratigraphic horizon is not penetrated in this well.

F-D, Floridan-Dublin aquifer system.
F-M, Floridan-Midville aquifer system.
MB, Meyers Branch confining system.

Hydrostratigraphic data from wells in the vicinity of the Savannah River Site

CROUCH BRANCH AQUIFER

Well	Ground elevation	Hydrologic system	Top depth	Base depth	Top elevation	Unit thickness	Clay thickness	Sand thickness	Number of sand beds > 5 ft	Total % sand
AIK-344	430.0	F-M	230	*400*	200	*170*	12	158	4	93%
AIK-858	435.0	F-M	*274*	486	161	212	0	212	1	100%
ALL-27	186.0	D	555	*821*	-369	*266*	65	201	5	76%
ALL-324	203.0	D	450	740	-247	290	62	228	9	79%
ASB-8/MSB-12	347.0	F-M	294	461	53	167	28	139	4	83%
BPC-1	281.5	D-M	314	526	-33	212	57	155	4	73%
BRN-76	255.0	D	436	632	-181	196	35	161	4	82%
BRN-78	340.0	F-M	318	576	22	258	52	206	4	80%
BRN-386	181.0	D	406	*586*	-225	*180*	26	154	6	86%
C-1	235.0	D-M	160	274	75	114	0	114	1	100%
C-2	418.8	F-M	187	382	232	195	22	173	2	89%
C-3	295.2	F-M	106	270	189	164	14	150	2	91%
C-5	265.6	F-D	316	560	-50	244	14	230	2	94%
C-6	208.7	D	571	758	-362	187	63	124	4	66%
C-7	252.0	D	522	806	-270	284	77	207	9	73%
C-10	289.6	D	747	988	-457	241	30	211	5	88%
CPC-1	285.1	D-M	459	684	-174	225	75	150	5	67%
GGS-92-6	250.0	D-M	360	543	-110	183	31	152	4	83%
GIRARD	250.0	D	563	779	-313	216	76	140	7	65%
MILLERS PD.	245.0	D-M	294	470	-49	176	10	166	2	94%
MILLHAVEN	110.0	D	685	928	-575	243	64	179	6	74%
P-4A	105.3	D-M	130	308	-25	178	10	168	3	94%
P-13	252.1	D	478	654	-226	176	10	166	2	94%
P-14	292.9	D-M	294	641	-1	347	6	341	2	98%
P-15	252.6	D	442	630	-189	188	49	139	4	74%
P-16	261.3	F-M	183	413	78	230	16	214	4	93%
P-17	332.6	F-M	381	663	-48	282	16	266	4	94%
P-18	296.3	D-M	423	637	-127	214	14	200	4	93%
P-19	296.8	D-M	408	622	-111	214	20	194	3	91%
P-20	287.4	D-M	338	NP	-51	N/A	N/A	N/A	N/A	N/A
P-21	206.5	D	472	705	-266	233	80	153	6	66%
P-22	215.0	D	438	651	-223	213	29	184	6	86%
P-23	180.6	D-M	327	555	-146	228	35	193	3	85%
P-24	313.1	D	488	662	-175	174	24	150	7	86%
[illegible]	[illegible]	D-M	[illegible]	633	-115	253	24	229	4	91%

Hydrostratigraphic data from wells in the vicinity of the Savannah River Site

CROUCH BRANCH AQUIFER

Well	Ground elevation	Hydrologic system	Top depth	Base depth	Top elevation	Unit thickness	Clay thickness	Sand thickness	Number of sand beds > 5 ft	Total % sand
P-26	151.5	D-M	214	442	-63	228	48	180	3	79%
P-27	273.6	D-M	356	603	-82	247	8	239	3	97%
P-28	284.9	D-M	318	547	-33	229	14	215	3	94%
P-29	265.6	D-M	297	485	-31	188	38	150	3	80%
P-30	354.4	F-M	280	503	74	223	4	219	2	98%
PBF-1	276.1	D-M	346	617	-70	271	18	253	5	93%
PBF-2	268.4	D-M	317	578	-49	261	24	237	5	91%
PBF-3	316.7	D-M	457	694	-140	237	29	208	9	88%
PBF-4	208.0	D-M	367	613	-159	246	30	216	8	88%
PBF-5	241.0	D-M	358	617	-117	259	44	215	6	83%
PBF-6	92.5	D-M	153	372	-61	219	42	177	5	81%
PBF-8	292.0	D-M	388	590	-96	202	36	166	4	82%
PPC-1	313.0	D	489	672	-176	183	14	169	3	92%
VG-7	250.6	D-M	NP	NP	NP	N/A	N/A	N/A	N/A	N/A

Notes:

All thicknesses are in feet
All depths are in feet below land surface
All elevations are in feet relative to mean sea level
Values in italics are estimated by R.K. Aadland

ABS, Hydrostratigraphic unit is absent in this well.
ER, Unit eroded.
N/A, Data not available.
N/D, Hydrostratigraphic unit is not delineated in this well.
NP, Hydrostratigraphic horizon is not penetrated in this well.

D, Dublin aquifer system.
D-M, Dublin-Midville aquifer system.
F-D, Floridan-Dublin aquifer system.
F-M, Floridan-Midville aquifer system.

Hydrostratigraphic data from wells in the vicinity of the Savannah River Site

MCQUEEN BRANCH CONFINING UNIT

Well	Ground elevation	Hydrologic system	Top depth	Base depth	Top elevation	Unit thickness	Clay thickness	Number of clay beds > 2 ft	Clayey-sand thickness	Number of clayey-sand beds > 2 ft	Total confining thickness	Leakance (ft/d/ft)	Total % confining thickness
AIK-344	430.0	--	NP	NP	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
AIK-858	435.0	F-M	486	508	-51	22	22	1	0	0	22	7.59E-06	100%
ALL-27	186.0	AL	*821*	*976*	*-635*	*155*	N/A	N/A	N/A	N/A	N/A	N/A	N/A
ALL-324	203.0	AL	740	857	-537	117	107	2	0	0	107	1.56E-06	91%
ASB-8/MSB-12	347.0	F-M	461	504	-114	43	28	2	0	0	28	5.96E-06	65%
BPC-1	281.5	D-M	*526*	*526*	*-245*	0	0	0	0	0	0	0.00E+00	0%
BRN-76	255.0	AL	632	694	-377	62	62	1	0	0	62	2.69E-06	100%
BRN-78	340.0	F-M	576	592	-236	16	16	1	0	0	16	1.04E-05	100%
BRN-386	181.0	AL	586	NP	-405	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
C-1	235.0	D-M	274	350	-39	76	69	2	0	0	69	2.42E-06	91%
C-2	418.8	F-M	382	404	37	22	22	1	0	0	22	7.59E-06	100%
C-3	295.2	F-M	270	314	25	44	39	2	0	0	39	4.28E-06	89%
C-5	265.6	AL	560	625	-294	65	31	3	17	2	48	5.33E-06	74%
C-6	208.7	AL	758	918	-549	160	160	1	0	0	160	1.04E-06	100%
C-7	252.0	AL	806	938	-554	132	132	1	0	0	132	1.27E-06	100%
C-10	289.6	AL	988	1,150	-698	162	158	2	4	1	162	1.06E-06	100%
CPC-1	285.1	D-M	684	702	-399	18	18	1	0	0	18	9.28E-06	100%
GGS-92-6	250.0	D-M	543	566	-293	23	9	2	0	0	9	1.86E-05	39%
GIRARD	250.0	AL	779	881	-529	102	33	4	15	1	48	5.02E-06	47%
MILLERS PD.	245.0	D-M	470	549	-225	79	35	4	6	1	41	4.76E-06	52%
MILLHAVEN	110.0	AL	928	1,085	-818	157	149	2	0	0	149	1.12E-06	95%
P-4A	105.3	D-M	308	386	-203	78	51	4	17	2	68	3.25E-06	87%
P-13	252.1	AL	654	713	-402	59	40	3	19	2	59	4.14E-06	100%
P-14	292.9	D-M	641	662	-348	21	21	1	0	0	21	7.95E-06	100%
P-15	252.6	AL	630	690	-377	60	60	1	0	0	60	2.78E-06	100%
P-16	261.3	F-M	413	434	-152	21	21	1	0	0	21	7.95E-06	100%
P-17	332.6	F-M	663	673	-330	10	10	1	0	0	10	1.67E-05	100%
P-18	296.3	D-M	637	649	-341	12	12	1	0	0	12	1.39E-05	100%
P-19	296.8	D-M	622	628	-325	6	6	1	0	0	6	2.78E-05	100%
P-20	287.4	--	NP	NP	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
P-21	206.5	AL	705	789	-499	84	38	3	10	1	48	4.37E-06	57%
P-22	215.0	AL	651	744	-436	93	70	2	14	1	84	2.38E-06	90%

12	2	0	0	12	1.39E-05	50%	

... BRANCH CONFINING UNIT

Well	Ground elevation	Hydrologic system	Top depth	Base depth	Top elevation	Unit thickness	Clay thickness	Number of clay beds > 2 ft	Clayey-sand thickness	Number of clayey-sand beds > 2 ft	Total confining thickness	Leakance (ft/d/ft)	Total % confining thickness
P-26	151.5	D-M	442	514	-291	72	35	4	8	1	43	4.75E-06	60%
P-27	273.6	D-M	603	658	-329	55	45	3	0	0	45	3.71E-06	82%
P-28	284.9	D-M	547	609	-262	62	39	3	0	0	39	4.28E-06	63%
P-29	265.6	D-M	485	488	-219	3	3	1	0	0	3	5.57E-05	100%
P-30	354.4	F-M	492	553	-138	61	47	3	0	0	47	3.55E-06	77%
PBF-1	276.1	D-M	617	630	-341	13	7	2	6	1	13	2.35E-05	100%
PBF-2	268.4	D-M	578	590	-310	12	4	2	8	1	12	4.02E-05	100%
PBF-3	316.7	D-M	694	732	-377	38	21	3	8	2	29	7.90E-06	76%
PBF-4	208.0	D-M	613	637	-405	24	19	2	5	1	24	8.75E-06	100%
PBF-5	241.0	D-M	617	640	-376	23	18	2	0	0	18	9.28E-06	78%
PBF-6	92.5	D-M	372	382	-280	10	4	2	0	0	4	4.18E-05	40%
PBF-8	292.0	D-M	590	625	-298	35	18	2	9	1	27	9.19E-06	77%
PPC-1	313.0	AL	672	727	-359	55	41	3	14	2	55	4.05E-06	100%
VG-7	250.6	--	NP	NP	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Notes:

All thicknesses are in feet
All depths are in feet below land surface
All elevations are in feet relative to mean sea level
Values in italics are estimated by R.K. Aadland

ABS, Hydrostratigraphic unit is absent in this well.
ER, Unit eroded.
N/A, Data not available.
N/D, Hydrostratigraphic unit is not delineated in this well.
NP, Hydrostratigraphic horizon is not penetrated in this well.

AL, Allendale confining system.
D-M, Dublin-Midville aquifer system.
F-M, Floridan-Midville aquifer system.

Hydrostratigraphic data from wells in the vicinity of the Savannah River Site

MCQUEEN BRANCH AQUIFER

Well	Ground elevation	Hydrologic system	Top depth	Base depth	Top elevation	Unit thickness	Clay thickness	Sand thickness	Number of sand beds > 5 ft	Total % sand
AIK-344	430.0	--	NP	NP	N/A	N/A	N/A	N/A	N/A	N/A
AIK-858	435.0	F-M	508	626	-73	118	0	118	1	100%
ALL-27	186.0	M	*976*	*1,269*	*-790*	*293*	N/A	N/A	N/A	N/A
ALL-324	203.0	M	857	1,124	-654	267	68	199	12	75%
ASB-8/MSB-12	347.0	F-M	504	*673*	-157	*169*	*22*	*147*	*3*	*87%*
BPC-1	281.5	D-M	526	792	-245	266	22	244	10	92%
BRN-76	255.0	M	694	1,006	-439	312	70	242	4	78%
BRN-78	340.0	F-M	592	*832*	-252	*240*	N/A	N/A	N/A	N/A
BRN-386	181.0	--	NP	NP	N/A	N/A	N/A	N/A	N/A	N/A
C-1	235.0	D-M	350	521	-115	171	0	171	1	100%
C-2	418.8	F-M	404	538	15	134	11	123	3	92%
C-3	295.2	F-M	314	504	-19	190	19	171	5	90%
C-5	265.6	M	625	930	-359	305	45	260	5	85%
C-6	208.7	M	918	1,213	-709	295	63	232	6	79%
C-7	252.0	M	938	1,185	-686	247	34	213	6	86%
C-10	289.6	M	1,150	1,489	-860	339	42	297	9	88%
CPC-1	285.1	D-M	702	938	-417	236	14	222	4	94%
GGS-92-6	250.0	D-M	*566*	NP	*-316*	N/A	N/A	N/A	N/A	N/A
GIRARD	250.0	M	881	1,168	-631	287	36	251	6	87%
MILLERS PD.	245.0	D-M	549	760	-304	211	52	159	5	75%
MILLHAVEN	110.0	M	1,085	1,375	-975	290	41	249	10	86%
P-4A	105.3	D-M	386	584	-281	198	28	170	5	86%
P-13	252.1	M	713	992	-461	279	66	213	7	76%
P-14	292.9	D-M	662	*865*	-369	*203*	39	164	5	81%
P-15	252.6	M	690	929	-437	239	23	216	5	90%
P-16	261.3	F-M	434	631	-173	197	13	184	3	93%
P-17	332.6	F-M	673	895	-340	222	22	200	5	90%
P-18	296.3	D-M	649	905	-353	256	20	236	4	92%
P-19	296.8	D-M	628	878	-331	250	22	228	7	91%
P-20	287.4	--	NP	NP	N/A	N/A	N/A	N/A	N/A	N/A
P-21	206.5	M	789	1,021	-583	232	36	196	5	84%
[illegible]	215.0	M	744	1,059	-529	315	39	276	9	88%

	313.1	M	718	989	-405	271	58	213	9	79%
	[illegible]	[illegible]	[illegible]	[illegible]	-392	218	24	194	4	89%

[illegible] data from wells in the vicinity of the Savannah River Site

MCQUEEN BRANCH AQUIFER

Well	Ground elevation	Hydrologic system	Top depth	Base depth	Top elevation	Unit thickness	Clay thickness	Sand thickness	Number of sand beds > 5 ft	Total % sand
P-26	151.5	D-M	514	713	-363	199	20	179	7	90%
P-27	273.6	D-M	658	861	-384	203	20	183	4	90%
P-28	284.9	D-M	609	806	-324	197	41	156	3	79%
P-29	265.6	D-M	488	756	-222	268	19	249	5	93%
P-30	354.4	F-M	553	724	-199	171	28	143	3	84%
PBF-1	276.1	D-M	630	933	-354	303	48	255	10	84%
PBF-2	268.4	D-M	595	886	-327	291	34	257	9	88%
PBF-3	316.7	D-M	732	985	-415	253	40	213	8	84%
PBF-4	208.0	D-M	637	892	-429	255	46	209	6	82%
PBF-5	241.0	D-M	640	888	-399	248	51	197	5	79%
PBF-6	92.5	D-M	382	680	-290	298	62	236	5	79%
PBF-8	292.0	D-M	625	873	-333	248	53	195	11	79%
PPC-1	313.0	M	727	1,028	-414	301	17	284	4	94%
VG-7	250.6	--	NP	NP	N/A	N/A	N/A	N/A	N/A	N/A

Notes:

All thicknesses are in feet
All depths are in feet below land surface
All elevations are in feet relative to mean sea level
Values in italics are estimated by R.K. Aadland

ABS, Hydrostratigraphic unit is absent in this well.
ER, Unit eroded.
N/A, Data not available.
N/D, Hydrostratigraphic unit is not delineated in this well.
NP, Hydrostratigraphic horizon is not penetrated in this well.

D-M, Dublin-Midville aquifer system.
F-M, Floridan-Midville aquifer system.
M, Midville aquifer system.

Hydrostratigraphic data from wells in the vicinity of the Savannah River Site

APPLETON CONFINING SYSTEM

Well	Ground elevation	Hydrologic system	Top depth	Base depth	Top elevation	Unit thickness	Clay thickness	Number of clay beds > 2 ft	Total % confining thickness
AIK-344	430.0	--	NP	NP	N/A	N/A	N/A	N/A	N/A
AIK-858	435.0	AP	626	651	-191	25	N/A	N/A	N/A
ALL-27	186.0	AP	*1,269*	*1,476*	*-1,083*	*207*	N/A	N/A	N/A
ALL-324	203.0	AP	1,124	1,355	-921	231	93	8	40%
ASB-8/MSB-12	347.0	AP	*673*	NP	*-326*	N/A	N/A	N/A	N/A
BPC-1	281.5	AP	792	NP	-511	N/A	N/A	N/A	N/A
BRN-76	255.0	AP	1,006	NP	-751	N/A	N/A	N/A	N/A
BRN-78	340.0	--	NP	NP	N/A	N/A	N/A	N/A	N/A
BRN-386	181.0	--	NP	NP	N/A	N/A	N/A	N/A	N/A
C-1	235.0	AP	521	567	-286	46	N/A	N/A	N/A
C-2	418.8	AP	538	553	-119	15	N/A	N/A	N/A
C-3	295.2	AP	504	523	-209	19	N/A	N/A	N/A
C-5	265.6	AP	930	1,073	-664	143	N/A	N/A	N/A
C-6	208.7	AP	1,213	1,374	-1,004	161	83	4	52%
C-7	252.0	AP	1,185	1,416	-933	231	86	8	37%
C-10	289.6	AP	1,489	1,726	-1,199	237	51	9	22%
CPC-1	285.1	AP	938	1,096	-653	158	N/A	N/A	N/A
GGS-92-6	250.0	--	NP	NP	N/A	N/A	N/A	N/A	N/A
GIRARD	250.0	AP	1,168	1,375	-918	207	N/A	N/A	N/A
MILLERS PD.	245.0	AP	760	852	-515	92	39	4	42%
MILLHAVEN	110.0	AP	1,375	NP	-1,265	NP	NP	NP	NP
P-4A	105.3	AP	584	NP	-479	N/A	N/A	N/A	N/A
P-13	252.1	AP	992	NP	-740	N/A	N/A	N/A	N/A
P-14	292.9	AP	*865*	NP	*-572*	N/A	N/A	N/A	N/A
P-15	252.6	AP	929	NP	-676	N/A	N/A	N/A	N/A
P-16	261.3	AP	631	NP	-370	N/A	N/A	N/A	N/A
P-17	332.6	AP	895	NP	-562	N/A	N/A	N/A	N/A
P-18	296.3	AP	905	NP	-609	N/A	N/A	N/A	N/A
P-19	296.8	AP	878	NP	-581	N/A	N/A	N/A	N/A
P-20	287.4	AP	NP	NP	N/A	N/A	N/A	N/A	N/A
P-21	206.5	AP	1,021	NP	-815	N/A	N/A	N/A	N/A
P-22	215.0	AP	1,059	NP	-844	N/A	N/A	N/A	N/A
P-23	180.6	AP	868	NP	-687	N/A	N/A	N/A	N/A
P-24	313.1	AP	989	NP	-676	N/A	N/A	N/A	N/A
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	N/A	N/A	N/A	N/A

Hydrostratigraphic data from wells in the vicinity of the Savannah River Site

Hydrostratigraphic data from wells in the vicinity of the Savannah River Site

APPLETON CONFINING SYSTEM

Well	Ground elevation	Hydrologic system	Top depth	Base depth	Top elevation	Unit thickness	Clay thickness	Number of clay beds > 2 ft	Total % confining thickness
P-26	151.5	AP	713	NP	-562	N/A	N/A	N/A	N/A
P-27	273.6	AP	861	NP	-587	N/A	N/A	N/A	N/A
P-28	284.9	AP	806	NP	-521	N/A	N/A	N/A	N/A
P-29	265.6	AP	756	NP	-490	N/A	N/A	N/A	N/A
P-30	354.4	AP	724	NP	-370	N/A	N/A	N/A	N/A
PBF-1	276.1	AP	933	1,053	-657	120	N/A	N/A	N/A
PBF-2	268.4	AP	886	996	-618	110	N/A	N/A	N/A
PBF-3	316.7	AP	985	1,119	-668	134	N/A	N/A	N/A
PBF-4	208.0	AP	892	1,044	-684	152	40	4	26%
PBF-5	241.0	AP	888	1,050	-647	162	N/A	N/A	N/A
PBF-6	92.5	AP	680	874	-588	194	49	6	25%
PBF-8	292.0	AP	873	993	-581	120	58	2	48%
PPC-1	313.0	AP	1,028	1,158	-715	130	N/A	N/A	N/A
VG-7	250.6	--	NP	NP	N/A	N/A	N/A	N/A	N/A

Notes:

All thicknesses are in feet
All depths are in feet below land surface
All elevations are in feet relative to mean sea level
Values in italics are estimated by R.K. Aadland

ABS, Hydrostratigraphic unit is absent in this well.
ER, Unit eroded.
N/A, Data not available.
N/D, Hydrostratigraphic unit is not delineated in this well.
NP, Hydrostratigraphic horizon is not penetrated in this well.

AP, Appleton confining system.

Hydrostratigraphic data from wells in the vicinity of the Savannah River Site

PIEDMONT HYDROGEOLOGIC PROVINCE (Pre-Cretaceous Basement)

Well	Ground elevation	Top depth	Top elevation
AIK-344	430.0	NP	NP
AIK-858	435.0	651	-216
ALL-27	186.0	*1,476*	*-1,290*
ALL-324	203.0	1,355	-1,152
ASB-8/MSB-12	347.0	NP	NP
BPC-1	281.5	NP	NP
BRN-76	255.0	NP	NP
BRN-78	340.0	NP	NP
BRN-386	181.0	NP	NP
C-1	235.0	567	-332
C-2	418.8	553	-134
C-3	295.2	523	-228
C-5	265.6	1,073	-807
C-6	208.7	1,374	-1,165
C-7	252.0	1,416	-1,164
C-10	289.6	1,726	-1,436
CPC-1	285.1	1,096	-811
GGS-92-6	250.0	NP	NP
GIRARD	250.0	1,375	-1,125
MILLERS PD.	245.0	852	-607
MILLHAVEN	110.0	NP	NP
P-4A	105.3	NP	NP
P-13	252.1	NP	NP
P-14	292.9	NP	NP
P-15	252.6	NP	NP
P-16	261.3	NP	NP
P-17	332.6	NP	NP
P-18	296.3	NP	NP
P-19	296.8	NP	NP
P-20	287.4	NP	NP
P-21	206.5	NP	NP

P-23 180.0 NP NP

Hydrostratigraphic data from wells in the vicinity of the Savannah River Site

PIEDMONT HYDROGEOLOGIC PROVINCE (Pre-Cretaceous Basement)

Well	Ground elevation	Top depth	Top elevation
P-26	151.5	NP	NP
P-27	273.6	NP	NP
P-28	284.9	NP	NP
P-29	265.6	NP	NP
P-30	354.4	NP	NP
PBF-1	276.1	1,053	-777
PBF-2	268.4	996	-728
PBF-3	316.7	1,119	-802
PBF-4	208.0	1,069	-861
PBF-5	241.0	1,050	-809
PBF-6	92.5	874	-782
PBF-8	292.0	993	-701
PPC-1	313.0	1,158	-845
VG-7	250.6	NP	NP

Notes:

All thicknesses are in feet
All depths are in feet below land surface
All elevations are in feet relative to mean sea level
Values in italics are estimated by R.K. Aadland

ABS, Hydrostratigraphic unit is absent in this well.
ER, Unit eroded.
N/A, Data not available.
N/D, Hydrostratigraphic unit is not delineated in this well.
NP, Hydrostratigraphic horizon is not penetrated in this well.

APPENDIX 2. Lithologic and leakance-coefficient data for the "tan clay" confining zone in the General Separations Area.

TAN CLAY CONFINING ZONE

Well	Ground elevation	Top depth	Base depth	Top elevation	Unit thickness	Clay thickness	Number of clay beds	Clayey-sand thickness	Number of clayey-sand beds	Clean sand thickness	Number of clean sand beds	Leakance (ft/d/ft)	Total % confining thickness
BGO-5	294.0	76	79	218	3	3	1	0	0	0	0	5.57E-05	100%
BGO-6	284.0	73	88	211	15	7	3	8	2	0	0	2.34E-05	100%
BGO-8	281.0	69	85	212	16	7	4	9	3	0	0	2.33E-05	100%
BGO-10	299.0	87	106	212	19	5	2	11	2	3	1	3.21E-05	84%
BGO-12	311.0	85	96	226	11	0	0	5	2	6	1	1.78E-03	45%
BGO-14	300.0	78	91	222	13	9	3	0	0	4	2	1.86E-05	69%
BGO-25	294.5	81	90	214	9	6	2	1	1	2	1	2.77E-05	78%
BGO-26	285.0	71	88	214	17	3	2	12	3	2	1	5.18E-05	88%
BGO-27	274.0	76	82	198	6	3	2	2	1	1	1	5.50E-05	83%
BGO-29	262.0	65	74	197	9	5	2	4	1	0	0	3.29E-05	100%
BGO-35	271.0	58	77	213	19	11	3	5	1	3	1	1.51E-05	84%
DRB-4	250.0	46	61	204	15	10	2	0	0	5	1	1.67E-05	67%
FSB-76	291.5	98	109	194	11	11	1	0	0	0	0	1.52E-05	100%
FSB-79	216.0	42	52	174	10	10	1	0	0	0	0	1.67E-05	100%
FSB-91	277.0	108	115	169	7	7	1	0	0	0	0	2.39E-05	100%
FSB-97	284.0	109	122	175	13	10	2	3	1	0	0	1.66E-05	100%
FSB-98	281.0	104	116	177	12	5	2	0	0	7	1	3.34E-05	42%
FSB-99	285.0	105	109	180	4	4	1	0	0	0	0	4.18E-05	100%
FSB-100	284.0	99	101	185	2	2	1	0	0	0	0	8.35E-05	100%
FSB-101	283.0	92	99	191	7	7	1	0	0	0	0	2.39E-05	100%
FSB-106	233.0	54	60	179	6	6	1	0	0	0	0	2.78E-05	100%
FSB-TA	275.0	85	88	190	3	3	1	0	0	0	0	5.57E-05	100%
HC-12	288.0	90	95	198	5	5	1	0	0	0	0	3.34E-05	100%
HPC-1	293.5	102	108	192	6	2	2	4	1	0	0	8.05E-05	100%
HPT-1	233.0	29	40	204	11	0	0	11	1	0	0	8.09E-04	100%
HPT-2	258.0	56	61	202	5	0	0	5	1	0	0	1.78E-03	100%
HSB-20	265.5	63	72	203	9	7	2	0	0	2	1	2.39E-05	78%
HSB-65	270.0	62	67	208	5	5	1	0	0	0	0	3.34E-05	100%
HSB-85	292.0	84	94	208	10	10	1	0	0	0	0	1.67E-05	100%
HSB-86	260.0	51	78	209	27	11	2	7	1	9	1	1.50E-05	67%

Hydrostratigraphic data from wells in the General Separations Area

TAN CLAY CONFINING ZONE

Well	Ground elevation	Top depth	Base depth	Top elevation	Unit thickness	Clay thickness	Number of clay beds	Clayey-sand thickness	Number of clayey-sand beds	Clean sand thickness	Number of clean sand beds	Leakance (ft/d/ft)	Total % confining thickness
HSB-115	267.0	57	70	210	13	10	2	3	1	0	0	1.66E-05	100%
HSB-116	255.0	46	60	209	14	13	2	1	1	0	0	1.28E-05	100%
HSB-117	234.0	19	45	215	26	8	6	4	1	14	5	2.07E-05	46%
HSB-119	254.5	43	60	212	17	14	2	3	1	0	0	1.19E-05	100%
HSB-123	262.0	64	69	198	5	0	0	0	0	5	1	0.00E+00	0%
HSB-129	212.5	14	34	199	20	12	3	2	1	6	1	1.39E-05	70%
HSB-130	216.0	0	26	216	26	18	2	8	1	0	0	9.20E-06	100%
HSB-133	253.0	50	54	203	4	4	1	0	0	0	0	4.18E-05	100%
HSB-137	233.5	29	61	205	32	17	6	10	3	5	2	9.72E-06	84%
HSB-TB	276.0	69	73	207	4	4	1	0	0	0	0	4.18E-05	100%
IDL-3	257.5	67	77	191	10	0	0	5	0	10	1	1.78E-03	50%
P-18	296.3	110	127	186	17	8	2	9	1	0	0	2.04E-05	100%
P-27	273.6	74	79	200	5	5	1	0	0	0	0	3.34E-05	100%
P-28	284.9	96	109	189	13	8	2	5	2	0	0	2.06E-05	100%
Mean		69	81	200.4	12	7	2	3	0.8	1.9	0.5	1.66E-04	87%

Notes:

All thicknesses are in feet
All depths are in feet below land surface
All elevations are in feet relative to mean sea level

N/A, Data not available.
NP, Hydrostratigraphic horizon is not penetrated in this well.

APPENDIX 3. Baseline hydrostratigraphic data from A-M Area wells.

Hydrostratigraphic data from wells in A-M Area

GREEN CLAY CONFINING ZONE

Well	Ground elevation (ft)	Location in A-M Area	Top depth (ft)	Base depth (ft)	Top elevation (ft)	Unit thickness (ft)	Clay thickness (ft)	Number of clay beds	Clayey-sand thickness (ft)	Number of clayey-sand beds (ft)	Total confining thickness (ft)	Leakance (ft/d/ft)	Total % confining beds	Head across unit (ft)
905-82A	373.9	N	146	168	228	22	6	1	6	1	12	2.73E-05	55%	-
ABP-3	351.9	S	112	156	240	44	2	1	8	2	10	7.77E-05	23%	-
ABP-8	369.8	S	128	155	242	27	0	0	18	3	18	4.94E-04	67%	-
AC-2	342.7	NC	131	149	212	18	0	0	12	3	12	7.42E-04	67%	-
AC-3	300.4	S	117	143	183	26	0	0	15	2	15	5.93E-04	58%	-
AMB-1 SB	381.0	NC	152	169	229	17	0	0	6	2	6	1.48E-03	35%	-
AMB-4	378.6	NC	153	168	226	15	0	0	3	2	3	2.97E-03	20%	-
AMB-5	378.0	NC	151	NP	227	-	-	-	-	-	-	-	-	-
AMB-6	375.0	NC	148	NP	227	-	-	-	-	-	-	-	-	-
AMB-7	371.0	NC	148	167	223	19	0	0	4	2	4	2.23E-03	21%	-
AMB-8	370.0	NC	148	NP	222	-	-	-	-	-	-	-	-	-
AMB-9	366.0	NC	144	NP	222	-	-	-	-	-	-	-	-	-
AMB-10	364.0	NC	147	165	217	18	0	0	7	3	7	1.27E-03	39%	-
AMB-11	362.0	NC	148	166	214	18	2	1	10	4	12	7.63E-05	67%	-
AMB-12	368.0	NC	150	NP	218	-	-	-	-	-	-	-	-	-
AMB-13	363.0	C	147	166	216	19	0	0	14	2	14	6.36E-04	74%	-
AMB-18	375.0	NC	150	171	225	21	0	0	8	2	8	1.11E-03	38%	-
AMB-19	362.0	C	150	163	212	13	2	1	6	2	8	7.91E-05	62%	-
ARP-5 A	347.3	S	130	151	217	21	0	0	6	3	6	1.48E-03	29%	-
ARP-6	NA	S	120	141	NA	21	0	0	9	3	9	9.89E-04	43%	-
ARP-7	344.1	S	119	139	225	20	0	0	7	2	7	1.27E-03	35%	-
ASB-2 CR	353.0	N	128	158	225	30	0	0	6	3	6	1.48E-03	20%	-
ASB-6	351.0	N	150	157	201	7	0	0	7	2	7	1.27E-03	100%	-
ASB-8	347.3	N	140	146	207	6	4	2	0	0	4	4.18E-05	67%	-
ASB-9	309.0	N	91	101	218	10	3	2	1	1	4	5.53E-05	40%	-
ASB-10	346.8	N	141	155	206	14	0	0	7	3	7	1.27E-03	50%	-
MBC-1 SB	372.0	N	150	155	222	5	1	1	2	1	3	1.61E-04	60%	-
MBC-2 SB	380.2	N	154	170	226	16	0	0	0	0	0	4.70E-02	0%	-
MBC-4 SB	381.2	NC	142	ABS	239	-	0	0	0	0	0	4.70E-02	0%	-
MBC-5 SB	370.5	NC	165	168	206	3	0	0	3	1	3	2.97E-03	100%	-
MBC-6 SB	NA	C	118	138	NA	20	13	4	7	4	20	1.27E-05	100%	-
MBC-7 SB	328.6	C	117	133	212	16	5	3	3	1	8	3.30E-05	50%	-

Hydrostratigraphic data from wells in A-M Area

GREEN CLAY CONFINING ZONE

Well	Ground elevation (ft)	Location in A-M Area	Top depth (ft)	Base depth (ft)	Top elevation (ft)	Unit thickness (ft)	Clay thickness (ft)	Number of clay beds	Clayey-sand thickness (ft)	Number of clayey-sand beds (ft)	Total confining thickness (ft)	Leakance (ft/d/ft)	Total % confining beds	Head across unit (ft)
MBC-10 SB	360.0	N	160	171	200	11	1	1	7	1	8	1.48E-04	73%	-
MBC-11 SB	361.0	C	148	167	213	19	4	1	8	2	12	4.02E-05	63%	-
MBC-12 SB	337.0	C	124	134	213	10	3	2	3	2	6	5.46E-05	60%	-
MCB-6	329.9	S	112	133	218	21	1	1	11	2	12	1.38E-04	57%	-
MCB-7	335.7	S	119	140	217	21	3	1	5	2	8	5.40E-05	38%	-
MHT-1	362.7	C	144	ND	219	-	0	0	0	0	0	4.70E-02	0%	-
MHT-2	364.1	C	143	168	221	25	0	0	7	3	7	1.27E-03	28%	-
MHT-3	362.6	C	162	166	201	4	3	1	1	1	4	5.53E-05	100%	-
MHT-4	367.4	C	150	167	217	17	0	0	4	2	4	2.23E-03	24%	-
MHT-5	364.1	C	142	166	222	24	0	0	10	3	10	8.90E-04	42%	-
MHT-6	369.6	C	149	169	221	20	2	1	6	1	8	7.91E-05	40%	-
MHT-7	368.0	C	165	168	203	3	0	0	3	1	3	2.97E-03	100%	-
MHT-8	369.3	C	147	169	222	22	3	3	2	1	5	5.50E-05	23%	-
MHT-9	367.7	C	145	168	223	23	0	0	9	2	9	9.89E-04	39%	-
MHT-10	368.9	C	152	167	217	15	0	0	3	2	3	2.97E-03	20%	-
MSB-1	353.0	C	138	154	215	16	3	2	3	2	6	5.46E-05	38%	-
MSB-2	352.3	C	138	147	214	9	2	2	3	2	5	8.12E-05	56%	-
MSB-3	358.8	C	142	158	217	16	1	1	3	1	4	1.58E-04	25%	-
MSB-4	353.1	C	136	152	217	16	1	1	4	3	5	1.55E-04	31%	-
MSB-5	337.1	C	129	150	208	21	10	2	3	1	13	1.66E-05	62%	-
MSB-6	341.8	SC	127	148	215	21	8	2	4	1	12	2.07E-05	57%	-
MSB-7	342.1	SC	122	142	220	20	6	2	5	1	11	2.74E-05	55%	-
MSB-8	341.8	SC	130	138	212	8	2	1	6	2	8	7.91E-05	100%	-
MSB-10	355.2	C	134	153	221	19	0	0	7	3	7	1.27E-03	37%	-
MSB-11	363.4	C	143	167	220	24	2	1	10	2	12	7.63E-05	50%	-
MSB-12	346.5	C	137	158	210	21	4	1	5	2	9	4.08E-05	43%	-
MSB-13	344.8	C	128	147	217	19	4	1	4	1	8	4.10E-05	42%	-
MSB-14	346.6	C	128	149	219	21	2	2	7	3	9	7.84E-05	43%	-
MSB-15	365.8	C	146	166	220	20	8	2	0	0	8	2.09E-05	40%	-
MSB-16	365.5	C	146	165	220	19	7	2	5	1	12	2.35E-05	63%	11
MSB-17	357.3	C	158	177	199	19	0	0	5	4	5	1.78E-03	26%	-
MSB-18	339.9	S	128	136	212	8	4	2	4	1	8	4.10E-05	100%	-
MSB-19	298.2	C	102	110	196	8	8	1	0	0	8	2.09E-05	100%	22

Hydrostratigraphic data from wells in A-M Area

GREEN CLAY CONFINING ZONE

Well	Ground elevation (ft)	Location in A-M Area	Top depth (ft)	Base depth (ft)	Top elevation (ft)	Unit thickness (ft)	Clay thickness (ft)	Number of clay beds	Clayey-sand thickness (ft)	Number of clayey-sand beds (ft)	Total confining thickness (ft)	Leakance (ft/d/ft)	Total % confining beds	Head across unit (ft)
MSB-20	353.3	C	147	167	206	20	4	1	4	2	8	4.10E-05	40%	-
MSB-21	352.6	C	157	162	196	5	0	0	5	1	5	1.78E-03	100%	-
MSB-23	370.1	C	162	180	208	18	4	1	6	2	10	4.06E-05	56%	-
MSB-26	360.7	NC	146	165	215	19	4	1	2	1	6	4.14E-05	32%	-
MSB-27	374.5	NC	167	184	208	17	4	1	3	1	7	4.12E-05	41%	-
MSB-29	362.9	N	147	ND	216	-	0	0	0	0	0	4.70E-02	0%	-
MSB-30	352.9	N	146	155	207	9	3	1	6	1	9	5.37E-05	100%	-
MSB-31	346.4	C	123	144	223	21	3	2	8	3	11	5.30E-05	52%	21
MSB-32	253.1	C	35	54	218	19	8	2	2	1	10	2.08E-05	53%	-
MSB-33	253.4	S	42	66	211	24	16	2	0	0	16	1.04E-05	67%	-
MSB-34	382.1	NC	146	167	236	21	7	2	1	1	8	2.38E-05	38%	-
MSB-35	348.2	C	135	158	213	23	7	2	4	1	11	2.36E-05	48%	-
MSB-36	338.4	C	117	134	221	17	10	2	6	1	16	1.65E-05	94%	-
MSB-37	380.1	N	142	164	238	22	0	0	6	2	6	1.48E-03	27%	4
MSB-38	357.0	C	137	155	220	18	5	1	4	1	9	3.29E-05	50%	-
MSB-39	339.7	C	116	136	224	20	5	1	4	1	9	3.29E-05	45%	-
MSB-40	319.0	S	96	122	223	26	2	1	21	2	23	6.98E-05	88%	26
MSB-41	321.9	C	97	116	225	19	5	2	4	3	9	3.29E-05	47%	-
MSB-42	374.5	NC	146	165	229	19	0	0	0	0	0	4.70E-02	0%	0
MSB-43	355.3	N	152	156	203	4	0	0	4	1	4	2.23E-03	100%	2
MSB-45	378.4	NC	152	156	226	4	4	1	0	0	4	4.18E-05	100%	-
MSB-47	366.2	N	138	156	228	18	3	1	8	2	11	5.30E-05	61%	1
MSB-48	359.8	N	153	156	207	3	3	1	0	0	3	5.57E-05	100%	9
MSB-49	331.8	S	122	132	210	10	8	2	2	1	10	2.08E-05	100%	-
MSB-50	221.3	S	0	16	221	16	5	3	2	1	7	3.32E-05	44%	-
MSB-51	261.1	S	37	57	224	20	2	1	7	2	9	7.84E-05	45%	-
MSB-52	319.5	NC	88	110	232	22	0	0	6	2	6	1.48E-03	27%	-
MSB-53	342.3	N	120	133	222	13	0	0	13	1	13	6.85E-04	100%	-
MSB-54	371.1	N	144	150	227	6	1	1	5	1	6	1.53E-04	100%	7
MSB-55	366.6	N	131	144	236	13	1	1	3	3	4	1.58E-04	31%	-
MSB-61	315.1	N	93	102	222	9	7	2	0	0	7	2.39E-05	78%	-
MSB-62	347.0	C	132	152	215	20	5	2	3	2	8	3.30E-05	40%	6
MSB-63	344.9	C	128	153	217	25	7	5	8	4	15	2.34E-05	60%	-

8 4 15 2.34E-05 60% -

Hydrostratigraphic data from wells in A-M Area

GREEN CLAY CONFINING ZONE

Well	Ground elevation (ft)	Location in A-M Area	Top depth (ft)	Base depth (ft)	Top elevation (ft)	Unit thickness (ft)	Clay thickness (ft)	Number of clay beds	Clayey-sand thickness (ft)	Number of clayey-sand beds (ft)	Total confining thickness (ft)	Leakance (ft/d/ft)	Total % confining beds	Head across unit (ft)
MSB-64	346.3	C	153	157	193	4	0	0	4	1	4	2.23E-03	100%	-
MSB-66	380.5	N	149	168	232	19	0	0	6	2	6	1.48E-03	32%	2
MSB-67	362.7	N	142	146	221	4	0	0	4	1	4	2.23E-03	100%	-
MSB-68	355.0	N	131	142	224	11	0	0	9	1	9	9.89E-04	82%	-
MSB-69	379.3	N	150	162	229	12	1	1	6	2	7	1.50E-04	58%	6
MSB-70	359.8	C	159	178	201	19	2	1	5	3	7	7.98E-05	37%	-
MSB-71	342.9	C	153	173	190	20	5	2	2	2	7	3.32E-05	35%	-
MSB-72	326.7	S	114	135	213	21	6	3	7	3	13	2.72E-05	62%	-
MSB-73	337.5	S	124	147	214	23	7	2	2	1	9	2.37E-05	39%	-
MSB-74	312.5	SC	90	117	223	27	15	4	4	3	19	1.11E-05	70%	20
MSB-75	324.7	S	107	127	218	20	5	3	2	1	7	3.32E-05	35%	-
MSB-76	350.0	C	154	162	196	8	2	1	4	3	6	8.05E-05	75%	-
MSB-77	354.9	N	150	164	205	14	0	0	7	3	7	1.27E-03	50%	11
MSB-78	361.1	C	144	*163*	217	19	-	-	-	-	-	-	-	-
MSB-79	345.8	S	118	138	228	20	7	2	5	1	12	2.35E-05	60%	-
MSB-81	265.1	N	51	64	214	13	3	2	6	2	9	5.37E-05	69%	-
MSB-82	371.8	N	136	153	236	17	0	0	3	2	3	2.97E-03	18%	-
MSB-83	369.8	N	134	150	236	16	0	0	5	3	5	1.78E-03	31%	-
MSB-84	359.9	N	126	134	234	8	F/O	F/O	F/O	F/O	F/O	F/O	F/O	-
MSB-85	378.4	N	148	163	230	15	0	0	0	0	0	4.70E-02	0%	-
MSB-86	354.8	N	132	153	223	21	7	3	0	0	7	2.39E-05	33%	-
MSB-87 B	334.0	C	116	139	218	23	0	0	12	2	12	7.42E-04	52%	-
MSB-88 B	236.0	S	36	40	200	4	0	0	2	1	2	4.45E-03	50%	-
MSB-89	337.0	S	124	144	213	20	5	4	6	3	11	3.27E-05	55%	-
MSS-1 SB	262.4	S	49	80	213	31	11	2	10	3	21	1.49E-05	68%	-
MSS-2 SB	299.3	S	89	117	210	28	9	2	18	3	27	1.79E-05	96%	-
MSS-3 SB	319.0	SC	92	126	227	34	7	4	16	5	23	2.29E-05	68%	-
MSS-4 SB	337.9	C	112	143	226	31	14	4	11	6	25	1.18E-05	81%	-
MSS-5 SB	305.0	C	104	117	201	13	1	1	7	3	8	1.48E-04	62%	-
MSS-6 SB	253.0	S	45	76	208	31	1	1	21	3	22	1.20E-04	71%	-
MSS-7 SB	298.0	S	74	103	224	29	13	5	13	6	26	1.26E-05	90%	-
MSS-8 SB	284.1	SC	74	98	210	24	14	3	2	2	16	1.19E-05	67%	-
MSS-9 SB	317.0	S	102	123	215	21	15	3	6	2	21	1.11E-05	100%	-

Hydrostratigraphic data from wells in A-M Area

GREEN CLAY CONFINING ZONE

Well	Ground elevation (ft)	Location in A-M Area	Top depth (ft)	Base depth (ft)	Top elevation (ft)	Unit thickness (ft)	Clay thickness (ft)	Number of clay beds	Clayey-sand thickness (ft)	Number of clayey-sand beds (ft)	Total confining thickness (ft)	Leakance (ft/d/ft)	Total % confining beds	Head across unit (ft)
MSS-10 SB	306.0	S	95	118	211	23	2	1	11	4	13	7.57E-05	57%	-
MW-1 SB	346.0	C	118	144	228	26	2	2	4	4	6	8.05E-05	23%	-
MW-2 SB	348.0	C	148	168	200	20	0	0	3	2	3	2.97E-03	15%	-
MW-3 SB	356.0	C	159	162	197	3	0	0	3	1	3	2.97E-03	100%	-
MW-4 SB	351.0	C	149	167	202	18	1	1	4	4	5	1.55E-04	28%	-
MW-5 SB	335.0	C	127	145	208	18	3	2	13	2	16	5.15E-05	89%	-
MW-6 SB	338.0	NC	144	148	194	4	0	0	4	1	4	2.23E-03	100%	-
RWM-12	359.0	N	146	147	213	1	1	1	0	0	1	1.67E-04	100%	-
RWM-13	333.0	N	130	136	203	6	2	1	4	1	6	8.05E-05	100%	-
RWM-14	349.0	N	143	155	206	12	0	0	12	1	12	7.42E-04	100%	-
RWM-15	366.0	N	164	170	202	6	0	0	4	1	4	2.23E-03	67%	-
RWM-16	319.0	S	95	122	224	27	2	2	21	3	23	6.98E-05	85%	-
SRW-3	330.0	C	143	162	187	19	7	1	5	2	12	2.35E-05	63%	-
SRW-4	318.1	C	132	146	186	14	4	1	2	1	6	4.14E-05	43%	-
SRW-8	286.7	C	90	110	197	20	9	2	0	0	9	1.86E-05	45%	-
SRW-10	301.0	C	118	131	183	13	2	2	7	2	9	7.84E-05	69%	-
SRW-17	331.0	C	160	167	171	7	3	2	2	2	5	5.50E-05	71%	-

ABS, Unit is absent in this well; F/O, Unit is faulted out; NA, Data not available for this well; ND, Unit is not delineated in this well.
NP, Unit is not penetrated by this well; -, Data is not applicable.
N, Northern A-M Area; NC, North-central A-M Area; C, Central A-M Area; SC, South-central A-M Area; S, Southern A-M Area.

Hydrostratigraphic data from wells in A-M Area
"Lost Lake" aquifer zone

Well	Ground elevation (ft)	Location in A-M Area	Top depth (ft)	Base depth (ft)	Top elevation (ft)	Base elevation (ft)	Unit thickness (ft)	Sand thickness (ft)	Clay thickness (ft)	Clayey-sand thickness (ft)	Confining thickness (ft)	Transmissive thickness (%)
905-82A	373.9	N	168	222	206	152	54	34	6	14	20	63%
ABP-3	351.9	S	156	206	196	146	50	28	2	20	22	56%
ABP-8	369.8	S	155	NP	215	NP	-	-	-	-	-	-
AC-2	342.7	NC	149	NP	194	NP	-	-	-	-	-	-
AC-3	300.4	S	143	NP	157	NP	-	-	-	-	-	-
AMB-1 SB	381.0	NC	169	233	212	148	64	53	0	11	11	83%
AMB-4	378.6	NC	168	235	211	144	67	64	1	2	3	96%
AMB-5	378.0	NC	NP	NP	NP	NP	-	-	-	-	-	-
AMB-6	375.0	NC	NP	NP	NP	NP	-	-	-	-	-	-
AMB-7	371.0	NC	167	227	204	144	60	50	0	10	10	83%
AMB-8	370.0	NC	NP	NP	NP	NP	-	-	-	-	-	-
AMB-9	366.0	NC	NP	NP	NP	NP	-	-	-	-	-	-
AMB-10	364.0	NC	165	220	199	144	55	42	8	5	13	76%
AMB-11	362.0	NC	166	222	196	140	56	44	0	12	12	79%
AMB-12	368.0	NC	NP	NP	NP	NP	-	-	-	-	-	-
AMB-13	363.0	C	166	213	197	150	47	35	4	8	12	74%
AMB-18	375.0	NC	171	232	204	143	61	44	4	13	17	72%
AMB-19	362.0	C	163	210	199	152	47	38	7	2	9	81%
ARP-5 A	347.3	S	151	231	196	116	80	68	0	12	12	85%
ARP-6	NA	S	141	NP	NP	NP	-	-	-	-	-	-
ARP-7	344.1	S	139	203	205	141	64	61	0	3	3	95%
ASB-2 CR	353.0	N	158	218	195	135	60	55	2	3	5	92%
ASB-6	351.0	N	157	209	194	142	52	46	4	2	6	88%
ASB-8	347.3	N	146	213	201	134	67	63	2	2	4	94%
ASB-9	309.0	N	101	188	208	121	87	71	5	11	16	82%
ASB-10	346.8	N	155	205	192	142	50	48	0	2	2	96%
MBC-1 SB	372.0	N	155	212	217	160	57	50	3	4	7	88%
MBC-2 SB	380.2	N	170	220	210	160	50	42	2	6	8	84%
MBC-4 SB	381.2	NC	ABS	224	ABS	157	NA	-	6	2	8	-
MBC-5 SB	370.5	NC	168	229	203	142	61	55	2	4	6	90%
MBC-6 SB	NA	C	138	198	NA	NA	60	60	0	0	0	100%
MBC-7 SB	328.6	C	133	F/O	196	F/O	-	-	-	-	-	-
MBC-9 SB	350.0	N	152	312	198	38	160	143	9	8	17	89%

Hydrostratigraphic data from wells in A-M Area
"Lost Lake" aquifer zone

Well	Ground elevation (ft)	Location in A-M Area	Top depth (ft)	Base depth (ft)	Top elevation (ft)	Base elevation (ft)	Unit thickness (ft)	Sand thickness (ft)	Clay thickness (ft)	Clayey-sand thickness (ft)	Confining thickness (ft)	Transmis-sive thickness (%)
MBC-10 SB	360.0	N	171	224	189	136	53	52	0	1	1	98%
MBC-11 SB	361.0	C	167	268	194	93	101	77	7	17	24	76%
MBC-12 SB	337.0	C	134	198	203	139	64	55	3	6	9	86%
MCB-6	329.9	S	133	214	197	116	81	72	3	6	9	89%
MCB-7	335.7	S	140	NP	196	NP	-	-	-	-	-	-
MHT-1	362.7	C	ND	NP	ND	NP	-	-	-	-	-	-
MHT-2	364.1	C	168	NP	196	NP	-	-	-	-	-	-
MHT-3	362.6	C	166	NP	197	NP	-	-	-	-	-	-
MHT-4	367.4	C	167	NP	200	NP	-	-	-	-	-	-
MHT-5	364.1	C	166	NP	198	NP	-	-	-	-	-	-
MHT-6	369.6	C	169	NP	201	NP	-	-	-	-	-	-
MHT-7	368.0	C	168	NP	200	NP	-	-	-	-	-	-
MHT-8	369.3	C	169	NP	200	NP	-	-	-	-	-	-
MHT-9	367.7	C	168	NP	200	NP	-	-	-	-	-	-
MHT-10	368.9	C	167	NP	202	NP	-	-	-	-	-	-
MSB-1	353.0	C	154	218	199	135	64	-	-	-	-	-
MSB-2	352.3	C	147	213	205	139	66	3	53	10	63	5%
MSB-3	358.8	C	158	226	201	133	68	-	-	-	-	-
MSB-4	353.1	C	152	218	201	135	66	-	-	-	-	-
MSB-5	337.1	C	150	220	187	117	70	56	0	14	14	80%
MSB-6	341.8	SC	148	210	194	132	62	57	0	5	5	92%
MSB-7	342.1	SC	142	204	200	138	62	54	0	8	8	87%
MSB-8	341.8	SC	138	202	204	140	64	58	0	6	6	91%
MSB-10	355.2	C	153	206	202	149	53	45	0	8	8	85%
MSB-11	363.4	C	167	236	196	127	69	62	0	7	7	90%
MSB-12	346.5	C	158	232	189	115	74	66	0	8	8	89%
MSB-13	344.8	C	147	214	198	131	67	63	0	4	4	94%
MSB-14	346.6	C	149	NP	198	NP	-	-	-	-	-	-
MSB-15	365.8	C	166	NP	200	NP	-	-	-	-	-	-
MSB-16	365.5	C	165	NP	201	NP	-	-	-	-	-	-
MSB-17	357.3	C	177	245	180	112	68	62	0	6	6	91%
MSB-18	339.9	S	136	NP	204	NP	-	-	-	-	-	-
MSB-19	298.2	C	110	167	188	131	57	51	0	6	6	89%

MSB-19	298.2	C	110	167	188	131	57	51	0	6	6	89%

Hydrostratigraphic data from wells in A-M Area
"Lost Lake" aquifer zone

Well	Ground elevation (ft)	Location in A-M Area	Top depth (ft)	Base depth (ft)	Top elevation (ft)	Base elevation (ft)	Unit thickness (ft)	Sand thickness (ft)	Clay thickness (ft)	Clayey-sand thickness (ft)	Confining thickness (ft)	Transmissive thickness (%)
MSB-20	353.3	C	167	NP	186	NP	-	-	-	-	-	-
MSB-21	352.6	C	162	218	191	135	56	54	0	2	2	96%
MSB-23	370.1	C	180	244	190	126	64	64	0	0	0	100%
MSB-26	360.7	NC	165	232	196	129	67	65	0	2	2	97%
MSB-27	374.5	NC	184	245	191	130	61	35	0	26	26	57%
MSB-29	362.9	N	ND	227	ND	136	-	-	0	5	5	-
MSB-30	352.9	N	155	NP	198	NP	-	-	-	-	-	-
MSB-31	346.4	C	144	205	202	141	61	53	3	5	8	87%
MSB-32	253.1	C	54	136	199	117	82	74	2	6	8	90%
MSB-33	253.4	S	66	124	187	129	58	54	4	0	4	93%
MSB-34	382.1	NC	167	241	215	141	74	62	7	5	12	84%
MSB-35	348.2	C	158	212	190	136	54	37	3	14	17	69%
MSB-36	338.4	C	134	194	204	144	60	60	0	0	0	100%
MSB-37	380.1	N	164	220	216	160	56	45	5	6	11	80%
MSB-38	357.0	C	155	215	202	142	60	54	0	6	6	90%
MSB-39	339.7	C	136	202	204	138	66	37	29	0	29	56%
MSB-40	319.0	S	122	211	197	108	89	27	53	9	62	30%
MSB-41	321.9	C	116	240	206	82	124	90	29	5	34	73%
MSB-42	374.5	NC	165	224	210	151	59	43	12	4	16	73%
MSB-43	355.3	N	156	229	199	126	73	55	2	16	18	75%
MSB-45	378.4	NC	156	NP	222	NP	-	-	-	-	-	-
MSB-47	366.2	N	156	220	210	146	64	56	3	5	8	88%
MSB-48	359.8	N	156	221	204	139	65	58	6	1	7	89%
MSB-49	331.8	S	132	204	200	128	72	26	0	46	46	36%
MSB-50	221.3	S	16	NP	205	NP	-	-	-	-	-	-
MSB-51	261.1	S	57	133	204	128	76	76	0	0	0	100%
MSB-52	319.5	NC	110	172	210	148	62	54	0	8	8	87%
MSB-53	342.3	N	133	203	209	139	70	60	7	3	10	86%
MSB-54	371.1	N	150	211	221	160	61	55	0	6	6	90%
MSB-55	366.6	N	144	198	223	169	54	10	44	0	44	19%
MSB-61	315.1	N	102	NP	213	NP	-	-	-	-	-	-
MSB-62	347.0	C	152	214	195	133	62	55	0	7	7	89%
MSB-63	344.9	C	153	217	192	128	64	58	2	4	6	91%

Hydrostratigraphic data from wells in A-M Area

"Lost Lake" aquifer zone

Well	Ground elevation (ft)	Location in A-M Area	Top depth (ft)	Base depth (ft)	Top elevation (ft)	Base elevation (ft)	Unit thickness (ft)	Sand thickness (ft)	Clay thickness (ft)	Clayey-sand thickness (ft)	Confining thickness (ft)	Transmissive thickness (%)
MSB-64	346.3	C	157	233	189	113	76	62	5	9	14	82%
MSB-66	380.5	N	168	255	213	126	87	80	7	0	7	92%
MSB-67	362.7	N	146	200	217	163	54	54	0	0	0	100%
MSB-68	355.0	N	142	207	213	148	65	62	0	3	3	95%
MSB-69	379.3	N	162	219	217	160	57	51	0	6	6	89%
MSB-70	359.8	C	178	NP	182	NP	-	-	-	-	-	-
MSB-71	342.9	C	173	214	170	129	41	32	0	9	9	78%
MSB-72	326.7	S	135	NP	192	NP	-	-	-	-	-	-
MSB-73	337.5	S	147	212	191	126	65	57	0	8	8	88%
MSB-74	312.5	SC	117	173	196	140	56	52	0	4	4	93%
MSB-75	324.7	S	127	180	198	145	53	42	2	9	11	79%
MSB-76	350.0	C	162	235	188	115	73	65	5	3	8	89%
MSB-77	354.9	N	164	223	191	132	59	44	3	12	15	75%
MSB-78	361.1	C	*163*	NP	198	NP	-	-	-	-	-	-
MSB-79	345.8	S	138	216	208	130	78	76	0	2	2	97%
MSB-81	265.1	N	64	125	201	140	61	51	0	10	10	84%
MSB-82	371.8	N	153	212	219	160	59	56	0	3	3	95%
MSB-83	369.8	N	150	203	220	167	53	47	0	6	6	89%
MSB-84	359.9	N	134	176	226	184	42	42	0	0	0	100%
MSB-85	378.4	N	163	215	215	163	52	46	6	0	6	88%
MSB-86	354.8	N	153	195	202	160	42	-	-	-	-	-
MSB-87 B	334.0	C	139	202	195	132	63	50	1	12	13	79%
MSB-88 B	236.0	S	40	119	196	117	79	79	0	0	0	100%
MSB-89	337.0	S	144	195	193	142	51	51	0	0	0	100%
MSS-1 SB	262.4	S	80	131	182	131	51	47	0	4	4	92%
MSS-2 SB	299.3	S	117	162	182	137	45	41	1	3	4	91%
MSS-3 SB	319.0	SC	126	180	193	139	54	54	0	0	0	100%
MSS-4 SB	337.9	C	143	202	195	136	59	59	0	0	0	100%
MSS-5 SB	305.0	C	117	162	188	143	45	38	1	6	7	84%
MSS-6 SB	253.0	S	76	142	177	111	66	61	3	2	5	92%
MSS-7 SB	298.0	S	103	162	195	136	59	58	0	1	1	98%
MSS-8 SB	284.1	SC	98	158	186	126	60	59	0	1	1	98%
MSS-9 SB	317.0	S	123	179	194	138	56	56	0	0	0	100%

Hydrostratigraphic data from wells in A-M Area

"Lost Lake" aquifer zone

Well	Ground elevation (ft)	Location in A-M Area	Top depth (ft)	Base depth (ft)	Top elevation (ft)	Base elevation (ft)	Unit thickness (ft)	Sand thickness (ft)	Clay thickness (ft)	Clayey-sand thickness (ft)	Confining thickness (ft)	Transmissive thickness (%)
MSS-10 SB	306.0	S	118	182	188	124	64	34	23	7	30	53%
MW-1 SB	346.0	C	144	210	202	136	66	65	0	1	1	98%
MW-2 SB	348.0	C	168	237	180	111	69	53	12	4	16	77%
MW-3 SB	356.0	C	162	233	194	123	71	65	3	3	6	92%
MW-4 SB	351.0	C	167	234	184	117	67	57	6	4	10	85%
MW-5 SB	335.0	C	145	212	190	123	67	64	1	2	3	96%
MW-6 SB	338.0	NC	148	208	190	130	60	58	2	0	2	97%
RWM-12	359.0	N	147	216	212	143	69	63	0	6	6	91%
RWM-13	333.0	N	136	248	197	85	112	105	6	1	7	94%
RWM-14	349.0	N	155	231	194	118	76	70	3	3	6	92%
RWM-15	366.0	N	170	228	196	138	58	53	2	3	5	91%
RWM-16	319.0	S	122	180	197	139	58	56	1	1	2	97%
SRW-3	330.0	C	162	215	168	115	53	53	0	0	0	100%
SRW-4	318.1	C	146	203	172	115	57	48	0	9	9	84%
SRW-8	286.7	C	110	169	177	118	59	53	3	3	6	90%
SRW-10	301.0	C	131	190	170	111	59	58	0	1	1	98%
SRW-17	331.0	C	167	217	164	114	50	47	1	2	3	94%

ABS, Unit is absent in this well; F/O, Unit is faulted out; NA, Data not available for this well; ND, Unit is not delineated in this well.

NP, Unit is not penetrated by this well; -, Data is not applicable.

N, Northern A-M Area; NC, North-central A-M Area; C, Central A-M Area; SC, South-central A-M Area; S, Southern A-M Area.

Hydrostratigraphic data from A-M Area

"Upper clay" confining zone of the Crouch Branch confining unit

Well	Ground elevation (ft)	Zone	Top depth (ft)	Base depth (ft)	Top elevation (ft)	Unit thickness (ft)	Clay thickness (ft)	Clayey-sand thickness (ft)	Total confining thickness (ft)	Leakance (ft/d/ft)	Total % confining thickness	Head across unit (ft)
905-82A	373.9	C	222	229	152	7	5	0	5	3.34E-05	100%	7
ABP-3	351.9	W	ND	ND	ND	-	-	-	-	-	-	-
ABP-8	369.8	W	ND	ND	ND	-	-	-	-	-	-	-
AC-2	342.7	W	ND	ND	ND	-	-	-	-	-	-	-
AC-3	300.4	W	ND	ND	ND	-	-	-	-	-	-	-
AMB-1 SB	381.0	C	233	NP	148	-	-	-	-	-	-	-
AMB-4	378.6	C	235	241	144	6	6	0	6	2.78E-05	100%	-
AMB-5	378.0	C	NP	NP	NP	-	-	-	-	-	-	-
AMB-6	375.0	C	NP	NP	NP	-	-	-	-	-	-	-
AMB-7	371.0	C	227	240	144	13	13	0	13	1.28E-05	100%	6
AMB-8	370.0	C	NP	NP	NP	-	-	-	-	-	-	-
AMB-9	366.0	C	NP	NP	NP	-	-	-	-	-	-	-
AMB-10	364.0	C	220	241	144	21	14	7	21	1.18E-05	100%	-
AMB-11	362.0	E	222	NP	140	-	-	-	-	-	-	-
AMB-12	368.0	C	NP	NP	NP	-	-	-	-	-	-	-
AMB-13	363.0	C	213	247	150	34	34	0	34	4.91E-06	100%	-
AMB-18	375.0	C	232	240	143	8	8	0	8	2.09E-05	100%	-
AMB-19	362.0	C	210	NP	152	-	-	-	-	-	-	-
ARP-5 A	347.3	W	ND	ND	ND	-	-	-	-	-	-	-
ARP-6	NA	W	ND	ND	ND	-	-	-	-	-	-	-
ARP-7	344.1	C	203	229	141	26	9	12	21	1.81E-05	100%	-
ASB-2 CR	353.0	C	218	240	135	22	5	3	8	3.30E-05	100%	-
ASB-6	351.0	C	209	218	142	9	5	3	8	3.30E-05	100%	5
ASB-8	347.3	E	213	216	134	3	3	0	3	5.57E-05	100%	3
ASB-9	309.0	E	188	193	121	5	2	0	2	8.35E-05	100%	-
ASB-10	346.8	C	205	210	142	5	2	3	5	8.12E-05	100%	-
MBC-1 SB	372.0	C	212	223	160	11	10	1	11	1.67E-05	100%	-
MBC-2 SB	380.2	C	220	233	160	13	6	3	9	2.76E-05	100%	-
MBC-4 SB	381.2	C	224	241	157	17	8	4	12	2.07E-05	100%	-
MBC-5 SB	370.5	C	229	248	142	19	14	2	16	1.19E-05	100%	-
MBC-6 SB	NA	C	198	212		14	4	10	14	3.99E-05	100%	-
MBC-7 SB	328.6	W	ND	ND	ND	-	-	-	-	-	-	-
MBC-9 SB	350.0	E	ND	ND	ND	-	-	-	-	-	-	-

Hydrostratigraphic data from A-M Area

"Upper clay" confining zone of the Crouch Branch confining unit

Well	Ground elevation (ft)	Zone	Top depth (ft)	Base depth (ft)	Top elevation (ft)	Unit thickness (ft)	Clay thickness (ft)	Clayey-sand thickness (ft)	Total confining thickness (ft)	Leakance (ft/d/ft)	Total % confining thickness	Head across unit (ft)
MBC-10 SB	360.0	C	224	232	136	8	1	2	3	1.61E-04	100%	-
MBC-11 SB	361.0	E	ND	ND	ND	-	-	-	-	-	-	-
MBC-12 SB	337.0	W	ND	ND	ND	-	-	-	-	-	-	-
MCB-6	329.9	W	ND	ND	ND	-	-	-	-	-	-	-
MCB-7	335.7	W	NP	NP	NP	-	-	-	-	-	-	-
MHT-1	362.7	W	ND	ND	ND	-	-	-	-	-	-	-
MHT-2	364.1	W	ND	ND	ND	-	-	-	-	-	-	-
MHT-3	362.6	W	ND	ND	ND	-	-	-	-	-	-	-
MHT-4	367.4	W	ND	ND	ND	-	-	-	-	-	-	-
MHT-5	364.1	W	ND	ND	ND	-	-	-	-	-	-	-
MHT-6	369.6	W	ND	ND	ND	-	-	-	-	-	-	-
MHT-7	368.0	W	ND	ND	ND	-	-	-	-	-	-	-
MHT-8	369.3	W	ND	ND	ND	-	-	-	-	-	-	-
MHT-9	367.7	W	ND	ND	ND	-	-	-	-	-	-	-
MHT-10	368.9	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-1	353.0	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-2	352.3	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-3	358.8	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-4	353.1	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-5	337.1	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-6	341.8	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-7	342.1	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-8	341.8	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-10	355.2	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-11	363.4	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-12	346.5	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-13	344.8	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-14	346.6	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-15	365.8	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-16	365.5	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-17	357.3	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-18	339.9	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-19	298.2	C	167	NP	131	-	-	-	-	-	-	-

Hydrostratigraphic data from A-M Area

"Upper clay" confining zone of the Crouch Branch confining unit

Well	Ground elevation (ft)	Zone	Top depth (ft)	Base depth (ft)	Top elevation (ft)	Unit thickness (ft)	Clay thickness (ft)	Clayey-sand thickness (ft)	Total confining thickness (ft)	Leakance (ft/d/ft)	Total % confining thickness	Head across unit (ft)
MSB-20	353.3	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-21	352.6	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-23	370.1	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-26	360.7	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-27	374.5	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-29	362.9	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-30	352.9	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-31	346.4	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-32	253.1	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-33	253.4	C	124	142	129	18	0	11	11	8.09E-04	61%	-
MSB-34	382.1	C	241	258	141	17	14	3	17	1.19E-05	100%	8
MSB-35	348.2	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-36	338.4	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-37	380.1	C	220	231	160	11	8	2	10	2.08E-05	100%	9
MSB-38	357.0	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-39	339.7	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-40	319.0	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-41	321.9	E	ND	ND	ND	-	-	-	-	-	-	-
MSB-42	374.5	C	224	240	151	16	16	0	16	1.04E-05	100%	7
MSB-43	355.3	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-45	378.4	C	NP	NP	NP	-	-	-	-	-	-	-
MSB-47	366.2	C	220	234	146	14	12	0	12	1.39E-05	100%	6
MSB-48	359.8	E	ND	ND	ND	-	-	-	-	-	-	-
MSB-49	331.8	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-50	221.3	C	93	NP	128	-	-	-	-	-	-	-
MSB-51	261.1	C	133	NP	128	-	-	-	-	-	-	-
MSB-52	319.5	E	172	NP	148	-	-	-	-	-	-	-
MSB-53	342.3	E	203	213	139	10	10	0	10	1.67E-05	100%	1
MSB-54	371.1	C	211	216	160	5	4	0	4	4.18E-05	100%	4
MSB-55	366.6	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-61	315.1	E	NP	NP	NP	-	-	-	-	-	-	-
MSB-62	347.0	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-63	344.9	W	ND	ND	ND	-	-	-	-	-	-	-

MSB-62	347.0	W	ND	ND	ND
MSB-63	344.9	W	ND	ND	

Hydrostratigraphic data from A-M Area

"Upper clay" confining zone of the Crouch Branch confining unit

Well	Ground elevation (ft)	Zone	Top depth (ft)	Base depth (ft)	Top elevation (ft)	Unit thickness (ft)	Clay thickness (ft)	Clayey-sand thickness (ft)	Total confining thickness (ft)	Leakance (ft/d/ft)	Total % confining thickness	Head across unit (ft)
MSB-64	346.3	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-66	380.5	C	255	268	126	13	10	0	10	1.67E-05	100%	-
MSB-67	362.7	C	200	218	163	18	18	0	18	9.28E-06	100%	7
MSB-68	355.0	C	207	220	148	13	11	0	11	1.52E-05	100%	5
MSB-69	379.3	C	219	233	160	14	14	0	14	1.19E-05	100%	6
MSB-70	359.8	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-71	342.9	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-72	326.7	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-73	337.5	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-74	312.5	C	173	NP	140	-	-	-	-	-	-	-
MSB-75	324.7	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-76	350.0	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-77	354.9	E	F/O	ND	F/O	-	-	-	-	-	-	-
MSB-78	361.1	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-79	345.8	W	ND	NP	ND	-	-	-	-	-	-	-
MSB-81	265.1	E	125	NP	140	-	-	-	-	-	-	-
MSB-82	371.8	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-83	369.8	C	203	NP	167	-	-	-	-	-	-	-
MSB-84	359.9	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-85	378.4	C	215	233	163	18	6	0	6	2.78E-05	100%	4
MSB-86	354.8	C	196	ABS	159	-	-	-	-	-	-	-
MSB-87 B	334.0	C	202	206	132	4	3	1	4	5.53E-05	100%	-
MSB-88 B	236.0	C	119	122	117	3	3	1	4	5.53E-05	100%	-
MSB-89	337.0	W	195	207	142	12	3	3	6	5.46E-05	100%	-
MSS-1 SB	262.4	C	131	136	131	5	1	4	5	1.55E-04	100%	-
MSS-2 SB	299.3	W	ND	ND	ND	-	-	-	-	-	-	-
MSS-3 SB	319.0	W	ND	ND	ND	-	-	-	-	-	-	-
MSS-4 SB	337.9	C	202	221	136	19	6	7	13	2.72E-05	100%	-
MSS-5 SB	305.0	C	162	181	143	19	15	0	15	1.11E-05	100%	-
MSS-6 SB	253.0	C	142	151	111	9	9	0	9	1.86E-05	100%	-
MSS-7 SB	298.0	W	ND	ND	ND	-	-	-	-	-	-	-
MSS-8 SB	284.1	C	158	178	126	20	11	1	12	1.52E-05	100%	-
MSS-9 SB	317.0	W	ND	ND	ND	-	-	-	-	-	-	-

Hydrostratigraphic data from A-M Area

"Upper clay" confining zone of the Crouch Branch confining unit

Well	Ground elevation (ft)	Zone	Top depth (ft)	Base depth (ft)	Top elevation (ft)	Unit thickness (ft)	Clay thickness (ft)	Clayey-sand thickness (ft)	Total confining thickness (ft)	Leakance (ft/d/ft)	Total % confining thickness	Head across unit (ft)
MSS-10 SB	306.0	W	ND	ND	ND	-	-	-	-	-	-	-
MW-1 SB	346.0	W	ND	ND	ND	-	-	-	-	-	-	-
MW-2 SB	348.0	W	ND	ND	ND	-	-	-	-	-	-	-
MW-3 SB	356.0	W	ND	ND	ND	-	-	-	-	-	-	-
MW-4 SB	351.0	W	ND	ND	ND	-	-	-	-	-	-	-
MW-5 SB	335.0	W	ND	ND	ND	-	-	-	-	-	-	-
MW-6 SB	338.0	W	ND	ND	ND	-	-	-	-	-	-	-
RWM-12	359.0	C	216	NP	143	-	-	-	-	-	-	-
RWM-13	333.0	E	ND	ND	ND	-	-	-	-	-	-	-
RWM-14	349.0	E	ND	ND	ND	-	-	-	-	-	-	-
RWM-15	366.0	E	228	230	138	2	1	1	2	1.64E-04	100%	-
RWM-16	319.0	W	ND	ND	ND	-	-	-	-	-	-	-
SRW-3	330.0	W	ND	ND	ND	-	-	-	-	-	-	-
SRW-4	318.1	W	ND	ND	ND	-	-	-	-	-	-	-
SRW-8	286.7	W	ND	ND	ND	-	-	-	-	-	-	-
SRW-10	301.0	W	ND	ND	ND	-	-	-	-	-	-	-
SRW-17	331.0	W	ND	ND	ND	-	-	-	-	-	-	-

ABS, Unit is absent in this well; F/O, Unit is faulted out; NA, Data not available for this well; ND, Unit is not delineated in this well.

NP, Unit is not penetrated by this well; -, Data is not applicable.

C, Central A-M Area; E, Eastern A-M Area; W, Western A-M Area.

Hydrostratigraphic data from A-M Area

"Middle sand" aquifer zone of the Crouch Branch confining unit

Well	Ground elevation (ft)	Zone	Top depth (ft)	Base depth (ft)	Top elevation (ft)	Base elevation (ft)	Unit thickness (ft)	Sand thickness (ft)	Clay thickness (ft)	Clayey-sand thickness (ft)	Confining thickness (ft)	Transmissive thickness (%)
905-82A	373.9	C	229	276	145	98	47	26	6	15	21	55%
ABP-3	351.9	W	ND	ND	ND	-	-	-	-	-	-	-
ABP-8	369.8	W	ND	ND	ND	-	-	-	-	-	-	-
AC-2	342.7	W	ND	ND	ND	-	-	-	-	-	-	-
AC-3	300.4	W	ND	ND	ND	-	-	-	-	-	-	-
AMB-1 SB	381.0	C	ND	ND	ND	-	-	-	-	-	-	-
AMB-4	378.6	C	241	262	138	117	21	21	0	0	0	100%
AMB-5	378.0	C	NP	NP	NP	-	-	-	-	-	-	-
AMB-6	375.0	C	NP	NP	NP	-	-	-	-	-	-	-
AMB-7	371.0	C	240	NP	131	-	-	-	-	-	-	-
AMB-8	370.0	C	NP	NP	NP	-	-	-	-	-	-	-
AMB-9	366.0	C	NP	NP	NP	-	-	-	-	-	-	-
AMB-10	364.0	C	241	268	123	96	27	24	3	0	3	89%
AMB-11	362.0	E	NP	NP	NP	-	-	-	-	-	-	-
AMB-12	368.0	C	NP	NP	NP	-	-	-	-	-	-	-
AMB-13	363.0	C	247	269	116	94	22	18	0	4	4	82%
AMB-18	375.0	C	240	271	135	104	31	25	0	6	6	81%
AMB-19	362.0	C	NP	NP	NP	-	-	-	-	-	-	-
ARP-5 A	347.3	W	ND	ND	ND	-	-	-	-	-	-	-
ARP-6	NA	W	ND	ND	ND	-	-	-	-	-	-	-
ARP-7	344.1	C	229	256	115	88	27	21	0	6	6	78%
ASB-2 CR	353.0	C	240	275	113	78	35	33	0	2	2	94%
ASB-6	351.0	C	218	286	133	65	68	61	2	5	7	90%
ASB-8	347.3	E	216	277	131	70	61	40	12	10	22	66%
ASB-9	309.0	E	193	NP	116	-	-	-	-	-	-	-
ASB-10	346.8	C	210	NP	137	-	-	-	-	-	-	-
MBC-1 SB	372.0	C	223	244	149	128	21	21	0	0	0	100%
MBC-2 SB	380.2	C	233	264	147	116	31	30	1	0	1	97%
MBC-4 SB	381.2	C	241	254	140	127	13	13	0	0	0	100%
MBC-5 SB	370.5	C	248	275	123	96	27	21	0	6	6	78%
MBC-6 SB	NA	C	212	225		-	13	7	0	6	6	54%
MBC-7 SB	328.6	W	ND	ND	ND	-	-	-	-	-	-	-
MBC-9 SB	350.0	E	ND	ND	ND	-	-	-	-	-	-	-

Hydrostratigraphic data from A-M Area

"Middle sand" aquifer zone of the Crouch Branch confining unit

Well	Ground elevation (ft)	Zone	Top depth (ft)	Base depth (ft)	Top elevation (ft)	Base elevation (ft)	Unit thickness (ft)	Sand thickness (ft)	Clay thickness (ft)	Clayey-sand thickness (ft)	Confining thickness (ft)	Transmis-sive thickness (%)
MBC-10 SB	360.0	C	232	300	128	60	68	63	2	3	5	93%
MBC-11 SB	361.0	E	ND	ND	ND	-	-	-	-	-	-	-
MBC-12 SB	337.0	W	ND	ND	ND	-	-	-	-	-	-	-
MCB-6	329.9	W	ND	ND	ND	-	-	-	-	-	-	-
MCB-7	335.7	W	NP	NP	NP	-	-	-	-	-	-	-
MHT-1	362.7	W	ND	ND	ND	-	-	-	-	-	-	-
MHT-2	364.1	W	ND	ND	ND	-	-	-	-	-	-	-
MHT-3	362.6	W	ND	ND	ND	-	-	-	-	-	-	-
MHT-4	367.4	W	ND	ND	ND	-	-	-	-	-	-	-
MHT-5	364.1	W	ND	ND	ND	-	-	-	-	-	-	-
MHT-6	369.6	W	ND	ND	ND	-	-	-	-	-	-	-
MHT-7	368.0	W	ND	ND	ND	-	-	-	-	-	-	-
MHT-8	369.3	W	ND	ND	ND	-	-	-	-	-	-	-
MHT-9	367.7	W	ND	ND	ND	-	-	-	-	-	-	-
MHT-10	368.9	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-1	353.0	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-2	352.3	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-3	358.8	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-4	353.1	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-5	337.1	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-6	341.8	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-7	342.1	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-8	341.8	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-10	355.2	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-11	363.4	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-12	346.5	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-13	344.8	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-14	346.6	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-15	365.8	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-16	365.5	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-17	357.3	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-18	339.9	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-19	298.2	C	NP	NP	NP	-	-	-	-	-	-	-

Hydrostratigraphic data from A-M Area

"Middle sand" aquifer zone of the Crouch Branch confining unit

Well	Ground elevation (ft)	Zone	Top depth (ft)	Base depth (ft)	Top elevation (ft)	Base elevation (ft)	Unit thickness (ft)	Sand thickness (ft)	Clay thickness (ft)	Clayey-sand thickness (ft)	Confining thickness (ft)	Transmis-sive thickness (%)
MSB-20	353.3	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-21	352.6	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-23	370.1	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-26	360.7	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-27	374.5	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-29	362.9	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-30	352.9	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-31	346.4	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-32	253.1	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-33	253.4	C	142	172	111	-	-	-	-	-	-	-
MSB-34	382.1	C	258	281	124	81	30	20	2	8	10	67%
MSB-35	348.2	W	ND	ND	ND	101	23	23	0	0	0	100%
MSB-36	338.4	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-37	380.1	C	231	279	149	-	-	-	-	-	-	-
MSB-38	357.0	W	ND	ND	ND	101	48	20	0	28	28	42%
MSB-39	339.7	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-40	319.0	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-41	321.9	E	ND	ND	ND	-	-	-	-	-	-	-
MSB-42	374.5	C	240	278	135	-	-	-	-	-	-	-
MSB-43	355.3	W	ND	ND	ND	97	38	32	6	0	6	84%
MSB-45	378.4	C	NP	NP	NP	-	-	-	-	-	-	-
MSB-47	366.2	C	234	272	132	-	-	-	-	-	-	-
MSB-48	359.8	E	ND	ND	ND	94	38	29	6	3	9	76%
MSB-49	331.8	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-50	221.3	C				221	-	-	-	-	-	-
MSB-51	261.1	C	NP	NP	NP						0	
MSB-52	319.5	E	NP	NP	NP	-	-	-	-	-	-	-
MSB-53	342.3	E	213	ND	129	-	-	-	-	-	-	-
MSB-54	371.1	C	216	257	155	-	-	-	-	-	-	-
MSB-55	366.6	W	ND	ND	ND	114	41	28	3	10	13	68%
MSB-61	315.1	E	NP	NP	NP	-	-	-	-	-	-	-
MSB-62	347.0	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-63	344.9	W	ND	ND	ND	-	-	-	-	-	-	-

Hydrostratigraphic data from A-M Area

"Middle sand" aquifer zone of the Crouch Branch confining unit

Well	Ground elevation (ft)	Zone	Top depth (ft)	Base depth (ft)	Top elevation (ft)	Base elevation (ft)	Unit thickness (ft)	Sand thickness (ft)	Clay thickness (ft)	Clayey-sand thickness (ft)	Confining thickness (ft)	Transmissive thickness (%)
MSB-64	346.3	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-66	380.5	C	268	307	113	74	39	39	0	0	0	100%
MSB-67	362.7	C	218	NP	145	-	-	-	-	-	-	-
MSB-68	355.0	C	220	256	135	99	36	31	4	3	7	86%
MSB-69	379.3	C	233	265	146	114	32	20	4	8	12	63%
MSB-70	359.8	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-71	342.9	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-72	326.7	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-73	337.5	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-74	312.5	C	NP	NP	NP	-	-	-	-	-	-	-
MSB-75	324.7	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-76	350.0	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-77	354.9	E	ND	ND	ND	-	-	-	-	-	-	-
MSB-78	361.1	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-79	345.8	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-81	265.1	E	NP	NP	NP	-	-	-	-	-	-	-
MSB-82	371.8	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-83	369.8	C	NP	NP	NP	-	-	-	-	-	-	-
MSB-84	359.9	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-85	378.4	C	ND	ND	ND	-	-	-	-	-	-	-
MSB-86	354.8	C	NP	NP	NP	-	-	-	-	-	-	-
MSB-87 B	334.0	C	206	219	128	115	13	13	0	0	0	100%
MSB-88 B	236.0	C	122	173	114	63	51	50	0	1	1	98%
MSB-89	337.0	W	ND	ND	ND	-	-	-	-	-	-	-
MSS-1 SB	262.4	C	136	168	126	94	32	27	0	5	5	84%
MSS-2 SB	299.3	W	ND	ND	ND	-	-	-	-	-	-	-
MSS-3 SB	319.0	W	ND	ND	ND	-	-	-	-	-	-	-
MSS-4 SB	337.9	C	221	239	117	99	18	12	0	6	6	67%
MSS-5 SB	305.0	C	181	217	124	88	36	35	1	0	1	97%
MSS-6 SB	253.0	C	151	161	102	92	10	10	0	0	0	100%
MSS-7 SB	298.0	W	ND	ND	ND	-	-	-	-	-	-	-
MSS-8 SB	284.1	C	178	216	106	68	38	38	0	0	0	100%

Hydrostratigraphic data from A-M Area

"Middle sand" aquifer zone of the Crouch Branch confining unit

Well	Ground elevation (ft)	Zone	Top depth (ft)	Base depth (ft)	Top elevation (ft)	Base elevation (ft)	Unit thickness (ft)	Sand thickness (ft)	Clay thickness (ft)	Clayey-sand thickness (ft)	Confining thickness (ft)	Transmis-sive thickness (%)
MSS-10 SB	306.0	W	ND	ND	ND	-	-	-	-	-	-	-
MW-1 SB	346.0	W	ND	ND	ND	-	-	-	-	-	-	-
MW-2 SB	348.0	W	ND	ND	ND	-	-	-	-	-	-	-
MW-3 SB	356.0	W	ND	ND	ND	-	-	-	-	-	-	-
MW-4 SB	351.0	W	ND	ND	ND	-	-	-	-	-	-	-
MW-5 SB	335.0	W	ND	ND	ND	-	-	-	-	-	-	-
MW-6 SB	338.0	W	ND	ND	ND	-	-	-	-	-	-	-
RWM-12	359.0	C	NP	NP	NP	-	-	-	-	-	-	-
RWM-13	333.0	E	ND	ND	ND	-	-	-	-	-	-	-
RWM-14	349.0	E	ND	ND	ND	-	-	-	-	-	-	-
RWM-15	366.0	E	ND	ND	ND	-	-	-	-	-	-	-
RWM-16	319.0	W	ND	ND	ND	-	-	-	-	-	-	-
SRW-3	330.0	W	ND	ND	ND	-	-	-	-	-	-	-
SRW-4	318.1	W	ND	ND	ND	-	-	-	-	-	-	-
SRW-8	286.7	W	ND	ND	ND	-	-	-	-	-	-	-
SRW-10	301.0	W	ND	ND	ND	-	-	-	-	-	-	-
SRW-17	331.0	W	ND	ND	ND	-	-	-	-	-	-	-

ABS, Unit is absent in this well; F/O, Unit is faulted out; NA, Data not available for this well; ND, Unit is not delineated in this well.

NP, Unit is not penetrated by this well; -, Data is not applicable.

C, Central A-M Area; E, Eastern A-M Area; W, Western A-M Area.

Hydrostratigraphic data from A-M Area

"Lower clay" confining zone of the Crouch Branch confining unit

Well	Ground elevation (ft)	Zone	Top depth (ft)	Base depth (ft)	Top elevation (ft)	Unit thickness (ft)	Clay thickness (ft)	Clayey-sand thickness (ft)	Total confining thickness (ft)	Leakance (ft/d/ft)	Total % confining thickness	Head across unit (ft)
905-82A	373.9	C	276	295	98	19	10	9	19	1.64E-05	100%	NA
ABP-3	351.9	W	ND	ND	ND	-	-	-	-	-	-	-
ABP-8	369.8	W	ND	ND	ND	-	-	-	-	-	-	-
AC-2	342.7	W	ND	ND	ND	-	-	-	-	-	-	-
AC-3	300.4	W	ND	ND	ND	-	-	-	-	-	-	-
AMB-1 SB	381.0	C	NP	NP	NP	-	-	-	-	-	-	-
AMB-4	378.6	C	262	NP	117	-	-	-	-	-	-	-
AMB-5	378.0	C	NP	NP	NP	-	-	-	-	-	-	-
AMB-6	375.0	C	NP	NP	NP	-	-	-	-	-	-	-
AMB-7	371.0	C	NP	NP	NP	-	-	-	-	-	-	-
AMB-8	370.0	C	NP	NP	NP	-	-	-	-	-	-	-
AMB-9	366.0	C	NP	NP	NP	-	-	-	-	-	-	-
AMB-10	364.0	C	268	NP	96	-	-	-	-	-	-	-
AMB-11	362.0	E	NP	NP	NP	-	-	-	-	-	-	-
AMB-12	368.0	C	NP	NP	NP	-	-	-	-	-	-	-
AMB-13	363.0	C	269	NP	94	-	-	-	-	-	-	-
AMB-18	375.0	C	271	NP	104	-	-	-	-	-	-	-
AMB-19	362.0	C	NP	NP	NP	-	-	-	-	-	-	-
ARP-5 A	347.3	W	ND	ND	ND	-	-	-	-	-	-	-
ARP-6	NA	W	ND	ND	ND	-	-	-	-	-	-	-
ARP-7	344.1	C	256	294	88	38	18	4	22	9.24E-06	58%	-
ASB-2 CR	353.0	C	275	304	78	29	21	8	29	7.90E-06	100%	-
ASB-6	351.0	C	286	292	65	6	5	0	5	3.34E-05	83%	5
ASB-8	347.3	E	277	295	70	18	16	0	16	1.04E-05	89%	5
ASB-9	309.0	E	NP	NP	NP	-	-	-	-	-	-	-
ASB-10	346.8	C	NP	NP	NP	-	-	-	-	-	-	-
MBC-1 SB	372.0	C	244	268	128	24	8	13	21	2.03E-05	88%	-
MBC-2 SB	380.2	C	264	273	116	9	4	3	7	4.12E-05	78%	-
MBC-4 SB	381.2	C	254	295	127	41	13	14	27	1.26E-05	66%	-
MBC-5 SB	370.5	C	275	300	96	25	25	0	25	6.68E-06	100%	-
MBC-6 SB	NA	C	225	269		44	41	3	44	4.07E-06	100%	-
MBC-7 SB	328.6	W	ND	ND	ND	-	-	-	-	-	-	-
MBC-9 SB	350.0	E	312	317	38	5	5	0	5	3.34E-05	100%	-

Hydrostratigraphic data from A-M Area

"Lower clay" confining zone of the Crouch Branch confining unit

Well	Ground elevation (ft)	Zone	Top depth (ft)	Base depth (ft)	Top elevation (ft)	Unit thickness (ft)	Clay thickness (ft)	Clayey-sand thickness (ft)	Total confining thickness (ft)	Leakance (ft/d/ft)	Total % confining thickness	Head across unit (ft)
MBC-10 SB	360.0	C	300	310	60	10	10	0	10	1.67E-05	100%	-
MBC-11 SB	361.0	E	268	294	93	26	20	4	24	8.32E-06	92%	
MBC-12 SB	337.0	W	ND	ND	ND	-	-	-	-	-	-	-
MCB-6	329.9	W	214	NP	116	-	-	-	-	-	-	-
MCB-7	335.7	W	NP	NP	NP	-	-	-	-	-	-	-
MHT-1	362.7	W	ND	ND	ND	-	-	-	-	-	-	-
MHT-2	364.1	W	ND	ND	ND	-	-	-	-	-	-	-
MHT-3	362.6	W	ND	ND	ND	-	-	-	-	-	-	-
MHT-4	367.4	W	ND	ND	ND	-	-	-	-	-	-	-
MHT-5	364.1	W	ND	ND	ND	-	-	-	-	-	-	-
MHT-6	369.6	W	ND	ND	ND	-	-	-	-	-	-	-
MHT-7	368.0	W	ND	ND	ND	-	-	-	-	-	-	-
MHT-8	369.3	W	ND	ND	ND	-	-	-	-	-	-	-
MHT-9	367.7	W	ND	ND	ND	-	-	-	-	-	-	-
MHT-10	368.9	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-1	353.0	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-2	352.3	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-3	358.8	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-4	353.1	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-5	337.1	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-6	341.8	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-7	342.1	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-8	341.8	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-10	355.2	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-11	363.4	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-12	346.5	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-13	344.8	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-14	346.6	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-15	365.8	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-16	365.5	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-17	357.3	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-18	339.9	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-19	298.2	C	NP	NP	NP	-	-	-	-	-	-	-

Hydrostratigraphic data from A-M Area

"Lower clay" confining zone of the Crouch Branch confining unit

Well	Ground elevation (ft)	Zone	Top depth (ft)	Base depth (ft)	Top elevation (ft)	Unit thickness (ft)	Clay thickness (ft)	Clayey-sand thickness (ft)	Total confining thickness (ft)	Leakance (ft/d/ft)	Total % confining thickness	Head across unit (ft)
MSB-20	353.3	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-21	352.6	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-23	370.1	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-26	360.7	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-27	374.5	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-29	362.9	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-30	352.9	W	NP	NP	NP	-	-	-	-	-	-	-
MSB-31	346.4	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-32	253.1	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-33	253.4	C	172	198	81	26	18	8	26	9.20E-06	100%	10
MSB-34	382.1	C	281	343	101	62	41	0	41	4.07E-06	66%	16
MSB-35	348.2	W	-	-	-	-	-	-	-	-	-	-
MSB-36	338.4	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-37	380.1	C	279	296	101	17	15	2	17	1.11E-05	100%	12
MSB-38	357.0	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-39	339.7	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-40	319.0	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-41	321.9	E	240	260	82	20	20	0	20	8.35E-06	100%	11
MSB-42	374.5	C	278	304	97	26	26	0	26	6.42E-06	100%	NA
MSB-43	355.3	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-45	378.4	C	NP	NP	NP	-	-	-	-	-	-	
MSB-47	366.2	C	272	288	94	16	16	0	16	1.04E-05	100%	NA
MSB-48	359.8	E	221	248	139	27	15	3	18	1.11E-05	67%	NA
MSB-49	331.8	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-50	221.3	C	NP	NP	NP	-	-	-	-	-	-	-
MSB-51	261.1	C	NP	NP	NP	-	-	-	-	-	-	-
MSB-52	319.5	E	NP	NP	NP	-	-	-	-	-	-	-
MSB-53	342.3	E	ND	ND	ND	-	-	-	-	-	-	-
MSB-54	371.1	C	257	265	114	8	4	4	8	4.10E-05	100%	3
MSB-55	366.6	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-61	315.1	E	NP	NP	NP	-	-	-	-	-	-	-
MSB-62	347.0	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-63	344.9	W	ND	ND	ND	-	-	-	-	-	-	-

Hydrostratigraphic data from A-M Area

"Lower clay" confining zone of the Crouch Branch confining unit

Well	Ground elevation (ft)	Zone	Top depth (ft)	Base depth (ft)	Top elevation (ft)	Unit thickness (ft)	Clay thickness (ft)	Clayey-sand thickness (ft)	Total confining thickness (ft)	Leakance (ft/d/ft)	Total % confining thickness	Head across unit (ft)
MSB-64	346.3	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-66	380.5	C	307	332	74	25	25	0	25	6.68E-06	100%	NA
MSB-67	362.7	C	NP	NP	NP	-	-	-	-	-	-	-
MSB-68	355.0	C	256	276	99	20	17	0	17	9.82E-06	85%	NA
MSB-69	379.3	C	265	276	114	11	11	0	11	1.52E-05	100%	6
MSB-70	359.8	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-71	342.9	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-72	326.7	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-73	337.5	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-74	312.5	C	NP	NP	NP	-	-	-	-	-	-	-
MSB-75	324.7	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-76	350.0	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-77	354.9	E	223	243	132	20	3	14	17	5.12E-05	85%	0
MSB-78	361.1	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-79	345.8	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-81	265.1	E	NP	NP	NP	-	-	-	-	-	-	-
MSB-82	371.8	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-83	369.8	C	NP	NP	NP	-	-	-	-	-	-	-
MSB-84	359.9	W	ND	ND	ND	-	-	-	-	-	-	-
MSB-85	378.4	C	ND	ND	ND	-	-	-	-	-	-	-
MSB-86	354.8	C	NP	NP	NP	-	-	-	-	-	-	-
MSB-87 B	334.0	C	219	NP	115	-	-	-	-	-	-	-
MSB-88 B	236.0	C	173	188	63	15	15	0	15	1.11E-05	100%	NA
MSB-89	337.0	W	ND	ND	ND	-	-	-	-	-	-	-
MSS-1 SB	262.4	C	168	221	94	53	46	7	53	3.62E-06	100%	NA
MSS-2 SB	299.3	W	ND	-	ND	-	-	-	-	-	-	-
MSS-3 SB	319.0	W	ND	-	ND	-	-	-	-	-	-	-
MSS-4 SB	337.9	C	239	NP	99	-	-	-	-	-	-	-
MSS-5 SB	305.0	C	217	253	88	36	36	0	36	4.64E-06	100%	NA
MSS-6 SB	253.0	C	161	194	92	33	33	0	33	5.06E-06	100%	NA
MSS-7 SB	298.0	W	ND	-	ND	-	-	-	-	-	-	-
MSS-8 SB	284.1	C	216	232	68	16	0	12	12	7.42E-04	75%	NA
MSS-9 SB	317.0	W	ND	-	-	-	-	-	-	-	-	-

Hydrostratigraphic data from A-M Area

"Lower clay" confining zone of the Crouch Branch confining unit

Well	Ground elevation (ft)	Zone	Top depth (ft)	Base depth (ft)	Top elevation (ft)	Unit thickness (ft)	Clay thickness (ft)	Clayey-sand thickness (ft)	Total confining thickness (ft)	Leakance (ft/d/ft)	Total % confining thickness	Head across unit (ft)
MSS-10 SB	306.0	W	ND	ND	ND	-	-	-	-	-	-	-
MW-1 SB	346.0	W	ND	ND	ND	-	-	-	-	-	-	-
MW-2 SB	348.0	W	ND	ND	ND	-	-	-	-	-	-	-
MW-3 SB	356.0	W	ND	ND	ND	-	-	-	-	-	-	-
MW-4 SB	351.0	W	ND	ND	ND	-	-	-	-	-	-	-
MW-5 SB	335.0	W	ND	ND	ND	-	-	-	-	-	-	-
MW-6 SB	338.0	W	ND	ND	ND	-	-	-	-	-	-	-
RWM-12	359.0	C	NP	NP	NP	-	-	-	-	-	-	-
RWM-13	333.0	E	248	256	85	8	8	0	8	2.09E-05	100%	NA
RWM-14	349.0	E	231	NP	118	-	-	-	-	-	-	-
RWM-15	366.0	E	ND	ND	ND	-	-	-	-	-	-	0
RWM-16	319.0	W	ND	ND	ND	-	-	-	-	-	-	-
SRW-3	330.0	W	ND	ND	ND	-	-	-	-	-	-	-
SRW-4	318.1	W	ND	ND	ND	-	-	-	-	-	-	-
SRW-8	286.7	W	ND	ND	ND	-	-	-	-	-	-	-
SRW-10	301.0	W	ND	ND	ND	-	-	-	-	-	-	-
SRW-17	331.0	W	ND	ND	ND	-	-	-	-	-	-	-

ABS, Unit is absent in this well; F/O, Unit is faulted out; NA, Data not available for this well; ND, Unit is not delineated in this well.

NP, Unit is not penetrated by this well; -, Data is not applicable.

C, Central A-M Area; E, Eastern A-M Area; W, Western A-M Area.

Hydrostratigraphic data from A-M Area

Crouch Branch confining unit undifferentiated

Well	Ground elevation (ft)	Zone	Top depth (ft)	Base depth (ft)	Top elevation (ft)	Base elevation (ft)	Unit thickness (ft)	Clay thickness (ft)	Number of clay beds	Clayey-sand thickness (ft)	Number of clayey-sand beds	Total confining thickness (ft)	Leakance (ft/d/ft)	Total % confining thickness
905-82A	373.9	C	-	-	-	-	-	-	-	-	-	-	-	-
ABP-3	351.9	W	206	NP	146	NP	-	-	-	-	-	-	-	-
ABP-8	369.8	W	NP	NP	NP	NP	-	-	-	-	-	-	-	-
AC-2	342.7	W	NP	NP	NP	NP	-	-	-	-	-	-	-	-
AC-3	300.4	W	NP	NP	NP	NP	-	-	-	-	-	-	-	-
AMB-1 SB	381.0	C	-	-	-	-	-	-	-	-	-	-	-	-
AMB-4	378.6	C	-	-	-	-	-	-	-	-	-	-	-	-
AMB-5	378.0	C	-	-	-	-	-	-	-	-	-	-	-	-
AMB-6	375.0	C	-	-	-	-	-	-	-	-	-	-	-	-
AMB-7	371.0	C	-	-	-	-	-	-	-	-	-	-	-	-
AMB-8	370.0	C	-	-	-	-	-	-	-	-	-	-	-	-
AMB-9	366.0	C	-	-	-	-	-	-	-	-	-	-	-	-
AMB-10	364.0	C	-	-	-	-	-	-	-	-	-	-	-	-
AMB-11	362.0	E	-	-	-	-	-	-	-	-	-	-	-	-
AMB-12	368.0	C	-	-	-	-	-	-	-	-	-	-	-	-
AMB-13	363.0	C	-	-	-	-	-	-	-	-	-	-	-	-
AMB-18	375.0	C	-	-	-	-	-	-	-	-	-	-	-	-
AMB-19	362.0	C	-	-	-	-	-	-	-	-	-	-	-	-
ARP-5 A	347.3	W	231	NP	116	NP	-	-	-	-	-	-	-	-
ARP-6	NA	W	NP	NP	NP	NP	-	-	-	-	-	-	-	-
ARP-7	344.1	C	-	-	-	-	-	-	-	-	-	-	-	-
ASB-2 CR	353.0	C	-	-	-	-	-	-	-	-	-	-	-	-
ASB-6	351.0	C	-	-	-	-	-	-	-	-	-	-	-	-
ASB-8	347.3	E	-	-	-	-	-	-	-	-	-	-	-	-
ASB-9	309.0	E	-	-	-	-	-	-	-	-	-	-	-	-
ASB-10	346.8	C	-	-	-	-	-	-	-	-	-	-	-	-
MBC-1 SB	372.0	C	-	-	-	-	-	-	-	-	-	-	-	-
MBC-2 SB	380.2	C	-	-	-	-	-	-	-	-	-	-	-	-
MBC-4 SB	381.2	C	-	-	-	-	-	-	-	-	-	-	-	-
MBC-5 SB	370.5	C	-	-	-	-	-	-	-	-	-	-	-	-
MBC-6 SB	NA	C	-	-	-	-	-	-	-	-	-	-	-	-
MBC-7 SB	328.6	W	183	215	146	114	32	27	2	5	1	32	6.16E-06	100%
MBC-9 SB	350.0	E	-	-	-	-	-	-	-	-	-	-	-	-

Hydrostratigraphic data from A-M Area

Crouch Branch confining unit undifferentiated

Well	Ground elevation (ft)	Zone	Top depth (ft)	Base depth (ft)	Top elevation (ft)	Base elevation (ft)	Unit thickness (ft)	Clay thickness (ft)	Number of clay beds	Clayey-sand thickness (ft)	Number of clayey-sand beds	Total confining thickness (ft)	Leakance (ft/d/ft)	Total % confining thickness
MBC-10 SB	360.0	C	-	-	-	-	-	-	-	-	-	-	-	-
MBC-11 SB	361.0	E	-	-	-	-	-	-	-	-	-	-	-	-
MBC-12 SB	337.0	W	198	284	139	53	86	84	2	2	1	86	1.99E-06	100%
MCB-6	329.9	W	NP	NP	NP	NP	-	-	-	-	-	-	-	-
MCB-7	335.7	W	NP	NP	NP	NP	-	-	-	-	-	-	-	-
MHT-1	362.7	W	NP	NP	NP	NP	-	-	-	-	-	-	-	-
MHT-2	364.1	W	NP	NP	NP	NP	-	-	-	-	-	-	-	-
MHT-3	362.6	W	NP	NP	NP	NP	-	-	-	-	-	-	-	-
MHT-4	367.4	W	NP	NP	NP	NP	-	-	-	-	-	-	-	-
MHT-5	364.1	W	NP	NP	NP	NP	-	-	-	-	-	-	-	-
MHT-6	369.6	W	NP	NP	NP	NP	-	-	-	-	-	-	-	-
MHT-7	368.0	W	NP	NP	NP	NP	-	-	-	-	-	-	-	-
MHT-8	369.3	W	NP	NP	NP	NP	-	-	-	-	-	-	-	-
MHT-9	367.7	W	NP	NP	NP	NP	-	-	-	-	-	-	-	-
MHT-10	368.9	W	NP	NP	NP	NP	-	-	-	-	-	-	-	-
MSB-1	353.0	W	218	NP	135	NP	-	-	-	-	-	-	-	-
MSB-2	352.3	W	213	276	139	76	63	53	2	10	1	63	3.14E-06	100%
MSB-3	358.8	W	226	NP	133	NP	-	-	-	-	-	-	-	-
MSB-4	353.1	W	218	NP	135	NP	-	-	-	-	-	-	-	-
MSB-5	337.1	W	220	NP	117	NP	-	-	-	-	-	-	-	-
MSB-6	341.8	W	210	NP	132	NP	-	-	-	-	-	-	-	-
MSB-7	342.1	W	204	NP	138	NP	-	-	-	-	-	-	-	-
MSB-8	341.8	W	202	NP	140	NP	-	-	-	-	-	-	-	-
MSB-10	355.2	W	NP	NP	NP	NP	-	-	-	-	-	-	-	-
MSB-11	363.4	W	236	NP	127	NP	-	-	-	-	-	-	-	-
MSB-12	346.5	W	232	290	115	57	58	29	2	13	2	42	5.71E-06	72%
MSB-13	344.8	W	214	NP	131	NP	-	-	-	-	-	-	-	-
MSB-14	346.6	W	NP	NP	NP	NP	-	-	-	-	-	-	-	-
MSB-15	365.8	W	NP	NP	NP	NP	-	-	-	-	-	-	-	-
MSB-16	365.5	W	NP	NP	NP	NP	-	-	-	-	-	-	-	-
MSB-17	357.3	W	245	NP	112	NP	-	-	-	-	-	-	-	-
MSB-18	339.9	W	NP	NP	NP	NP	-	-	-	-	-	-	-	-
MSB-19	298.2	C	-	-	-	-	-	-	-	-	-	-	-	-

Hydrostratigraphic data from A-M Area

Crouch Branch confining unit undifferentiated

Well	Ground elevation (ft)	Zone	Top depth (ft)	Base depth (ft)	Top elevation (ft)	Base elevation (ft)	Unit thickness (ft)	Clay thickness (ft)	Number of clay beds	Clayey-sand thickness (ft)	Number of clayey-sand beds	Total confining thickness (ft)	Leakance (ft/d/ft)	Total % confining thickness
MSB-20	353.3	W	NP	NP	NP	NP	-	-	-	-	-	-	-	-
MSB-21	352.6	W	218	322	135	31	104	54	8	21	6	75	3.07E-06	72%
MSB-23	370.1	W	244	325	126	45	81	68	2	13	1	81	2.45E-06	100%
MSB-26	360.7	W	232	314	129	47	82	62	4	18	2	80	2.68E-06	98%
MSB-27	374.5	W	245	313	130	62	68	47	2	14	1	61	3.53E-06	90%
MSB-29	362.9	W	227	264	136	99	37	26	4	3	2	29	6.41E-06	78%
MSB-30	352.9	W	NP	NP	NP	NP	-	-	-	-	-	-	-	-
MSB-31	346.4	W	205	280	141	66	75	60	2	7	2	67	2.78E-06	89%
MSB-32	253.1	W	136	176	117	77	40	18	4	8	2	26	9.20E-06	65%
MSB-33	253.4	C	-	-	-	-	-	-	-	-	-	-	-	-
MSB-34	382.1	C	-	-	-	-	-	-	-	-	-	-	-	-
MSB-35	348.2	W	212	282	136	66	70	50	3	13	2	63	3.32E-06	90%
MSB-36	338.4	W	194	261	144	77	67	45	3	9	2	54	3.70E-06	81%
MSB-37	380.1	C	-	-	-	-	-	-	-	-	-	-	-	-
MSB-38	357.0	W	215	290	142	67	75	47	4	20	3	67	3.53E-06	89%
MSB-39	339.7	W	202	255	138	85	53	43	3	6	1	49	3.87E-06	92%
MSB-40	319.0	W	211	273	108	46	62	53	3	9	2	62	3.14E-06	100%
MSB-41	321.9	E	-	-	-	-	-	-	-	-	-	-	-	-
MSB-42	374.5	C	-	-	-	-	-	-	-	-	-	-	-	-
MSB-43	355.3	W	229	284	126	71	55	26	5	7	1	33	6.39E-06	60%
MSB-45	378.4	C	-	-	-	-	-	-	-	-	-	-	-	-
MSB-47	366.2	C	-	-	-	-	-	-	-	-	-	-	-	-
MSB-48	359.8	E	-	-	-	-	-	-	-	-	-	-	-	-
MSB-49	331.8	W	204	NP	128	-	-	-	-	-	-	-	-	-
MSB-50	221.3	C	-	-	-	-	-	-	-	-	-	-	-	-
MSB-51	261.1	C	-	-	-	-	-	-	-	-	-	-	-	-
MSB-52	319.5	E	-	-	-	-	-	-	-	-	-	-	-	-
MSB-53	342.3	E	-	-	-	-	-	-	-	-	-	-	-	-
MSB-54	371.1	C	-	-	-	-	-	-	-	-	-	-	-	-
MSB-55	366.6	W	198	258	169	109	60	42	6	0	0	42	3.98E-06	70%
MSB-61	315.1	E	NP	NP	NP	NP	-	-	-	-	-	-	-	-
MSB-62	347.0	W	212	NP	135	-	-	-	-	-	-	-	-	-
MSB-63	344.9	W	217	NP	128	-	-	-	-	-	-	-	-	-

Hydrostratigraphic data from A-M Area

Crouch Branch confining unit undifferentiated

Well	Ground elevation (ft)	Zone	Top depth (ft)	Base depth (ft)	Top elevation (ft)	Base elevation (ft)	Unit thickness (ft)	Clay thickness (ft)	Number of clay beds	Clayey-sand thickness (ft)	Number of clayey-sand beds	Total confining thickness (ft)	Leakance (ft/d/ft)	Total % confining thickness
MSB-64	346.3	W	233	NP	113	-	-	-	-	-	-	-	-	-
MSB-66	380.5	C	-	-	-	-	-	-	-	-	-	-	-	-
MSB-67	362.7	C	-	-	-	-	-	-	-	-	-	-	-	-
MSB-68	355.0	C	-	-	-	-	-	-	-	-	-	-	-	-
MSB-69	379.3	C	-	-	-	-	-	-	-	-	-	-	-	-
MSB-70	359.8	W	NP	NP	NP	NP	-	-	-	-	-	-	-	-
MSB-71	342.9	W	214	NP	129	-	-	-	-	-	-	-	-	-
MSB-72	326.7	W	NP	NP	NP	NP	-	-	-	-	-	-	-	-
MSB-73	337.5	W	212	NP	126	-	-	-	-	-	-	-	-	-
MSB-74	312.5	C	-	-	-	-	-	-	-	-	-	-	-	-
MSB-75	324.7	W	180	NP	145	-	-	-	-	-	-	-	-	-
MSB-76	350.0	W	235	NP	115	-	-	-	-	-	-	-	-	-
MSB-77	354.9	E	-	-	-	-	-	-	-	-	-	-	-	-
MSB-78	361.1	W	NP	NP	NP	NP	-	-	-	-	-	-	-	-
MSB-79	345.8	W	216	NP	130	-	-	-	-	-	-	-	-	-
MSB-81	265.1	E	-	-	-	-	-	-	-	-	-	-	-	-
MSB-82	371.8	W	212	263	160	109	51	36	3	13	2	49	4.61E-06	96%
MSB-83	369.8	C	-	-	-	-	-	-	-	-	-	-	-	-
MSB-84	359.9	W	176	256	184	104	80	58	8	10	3	68	2.87E-06	85%
MSB-85	378.4	C	-	-	-	-	-	-	-	-	-	-	-	-
MSB-86	354.8	C	-	-	-	-	-	-	-	-	-	-	-	-
MSB-87 B	334.0	C	-	-	-	-	-	-	-	-	-	-	-	-
MSB-88 B	236.0	C	-	-	-	-	-	-	-	-	-	-	-	-
MSB-89	337.0	W	195	NP	142	NP	-	-	-	-	-	-	-	-
MSS-1 SB	262.4	C		-	-	-	-	-	-	-	-	-	-	-
MSS-2 SB	299.3	W	162	NP	137	NP	-	-	-	-	-	-	-	-
MSS-3 SB	319.0	W	180	NP	139	NP	-	-	-	-	-	-	-	-
MSS-4 SB	337.9	C	-	-	-	-	-	-	-	-	-	-	-	-
MSS-5 SB	305.0	C	-	-	-	-	-	-	-	-	-	-	-	-
MSS-6 SB	253.0	C	-	-	-	-	-	-	-	-	-	-	-	-
MSS-7 SB	298.0	W	162	250	136	48	88	77	3	11	3	88	2.16E-06	100%
MSS-8 SB	284.1	C	-	-	-	-	-	-	-	-	-	-	-	-

Hydrostratigraphic data from A-M Area

Crouch Branch confining unit undifferentiated

Well	Ground elevation (ft)	Zone	Top depth (ft)	Base depth (ft)	Top elevation (ft)	Base elevation (ft)	Unit thickness (ft)	Clay thickness (ft)	Number of clay beds	Clayey-sand thickness (ft)	Number of clayey-sand beds	Total confining thickness (ft)	Leakance (ft/d/ft)	Total % confining thickness
MSS-10 SB	306.0	W	182	NP	124	NP	-	-	-	-	-	-	-	-
MW-1 SB	346.0	W	210	NP	136	NP	-	-	-	-	-	-	-	-
MW-2 SB	348.0	W	237	NP	111	NP	-	-	-	-	-	-	-	-
MW-3 SB	356.0	W	233	NP	123	NP	-	-	-	-	-	-	-	-
MW-4 SB	351.0	W	234	NP	117	NP	-	-	-	-	-	-	-	-
MW-5 SB	335.0	W	212	NP	123	NP	-	-	-	-	-	-	-	-
MW-6 SB	338.0	W	208	NP	130	NP	-	-	-	-	-	-	-	-
RWM-12	359.0	C	-	-	-	-	-	-	-	-	-	-	-	-
RWM-13	333.0	E	-	-	-	-	-	-	-	-	-	-	-	-
RWM-14	349.0	E	-	-	-	-	-	-	-	-	-	-	-	-
RWM-15	366.0	E	-	-	-	-	-	-	-	-	-	-	-	-
RWM-16	319.0	W	180	NP	139	NP	-	-	-	-	-	-	-	-
SRW-3	330.0	W	215	298.0	115	32	83	50	9	11	7	61	3.33E-06	73%
SRW-4	318.1	W	203	281	115	37	78	43	4	0	0	43	3.88E-06	55%
SRW-8	286.7	W	171	267	116	20	96	48	8	3	1	51	3.48E-06	53%
SRW-10	301.0	W	190	268.0	111	33	78	30	6	19	6	49	5.50E-06	63%
SRW-17	331.0	W	217	306.0	114	25	89	52	9	27	6	79	3.18E-06	89%

ABS, Unit is absent in this well; F/O, Unit is faulted out; NA, Data not available for this well; ND, Unit is not delineated in this well.

NP, Unit is not penetrated by this well; -, Data is not applicable.

C, Central A-M Area; E, Eastern A-M Area; W, Western A-M Area.

Hydrostratigraphic data from A-M Area

Wells that fully penetrate the Crouch Branch confining unit in A-M Area

Well	Ground elevation (ft)	Zone	Top depth (ft)	Base depth (ft)	Top elevation (ft)	Base elevation (ft)	Unit thickness (ft)	Clay thickness (ft)	Clayey-sand thickness (ft)	Total confining thickness (ft)	Leakance (ft/d/ft)	Total % confining thickness
905-82A	373.9	C	222	295	152	79	73	21	24	45	7.79E-06	62%
ARP-7	344.1	C	203	294	141	50	91	27	22	49	6.09E-06	54%
ASB-2 CR	353.0	C	218	304	135	49	86	26	13	39	6.36E-06	45%
ASB-6	351.0	C	209	292	142	59	83	12	8	20	1.37E-05	24%
ASB-8	347.3	E	213	295	134	52	82	31	10	41	5.35E-06	50%
MBC-1 SB	372.0	C	212	268	160	104	56	18	14	32	9.14E-06	57%
MBC-2 SB	380.2	C	220	273	160	107	53	11	6	17	1.50E-05	32%
MBC-4 SB	381.2	C	224	295	157	86	71	21	18	39	7.83E-06	55%
MBC-5 SB	370.5	C	229	300	142	71	71	39	8	47	4.27E-06	66%
MBC-6 SB	NA	C	198	269	NA	NA	71	45	19	64	3.68E-06	90%
MBC-7 SB	328.6	W	183	215	146	114	32	27	5	32	6.16E-06	100%
MBC-9 SB	350.0	E	312	317	38	33	5	5	0	5	3.34E-05	100%
MBC-10 SB	360.0	C	224	310	136	50	86	13	5	18	1.28E-05	21%
MBC-11 SB	361.0	E	268	294	93	67	26	20	4	24	8.32E-06	92%
MBC-12 SB	337.0	W	198	284	139	53	86	84	2	86	1.99E-06	100%
MSB-2	352.3	W	213	276	139	76	63	53	10	63	3.14E-06	100%
MSB-12	346.5	W	232	290	115	57	58	29	13	42	5.71E-06	72%
MSB-21	352.6	W	218	322	135	31	104	54	21	75	3.07E-06	72%
MSB-23	370.1	W	244	325	126	45	81	68	13	81	2.45E-06	100%
MSB-26	360.7	W	232	314	129	47	82	62	18	80	2.68E-06	98%
MSB-27	374.5	W	245	313	130	62	68	47	14	61	3.53E-06	90%
MSB-29	362.9	W	227	264	136	99	37	26	3	29	6.41E-06	78%
MSB-31	346.4	W	205	280	141	66	75	60	7	67	2.78E-06	89%
MSB-32	253.1	W	136	176	117	77	40	18	8	26	9.20E-06	65%
MSB-33	253.4	C	124	198	129	55	74	20	27	47	8.14E-06	64%
MSB-34	382.1	C	241	343	141	39	102	55	3	58	3.03E-06	57%
MSB-35	348.2	W	212	282	136	66	70	50	13	63	3.32E-06	90%
MSB-36	338.4	W	194	261	144	77	67	45	9	54	3.70E-06	81%
MSB-37	380.1	C	220	296	160	84	76	23	32	55	7.08E-06	72%
MSB-38	357.0	W	215	290	142	67	75	47	20	67	3.53E-06	89%
MSB-39	339.7	W	202	255	138	85	53	43	6	49	3.87E-06	92%
MSB-40	319.0	W	211	273	108	46	62	53	9	62	3.14E-06	100%
MSB-41	321.9	E	240	260	82	62	20	20	0	20	8.35E-06	100%
MSB-42	374.5	C	224	304	151	71	80	48	0	48	3.48E-06	60%

Hydrostratigraphic data from A-M Area

Wells that fully penetrate the Crouch Branch confining unit in A-M Area

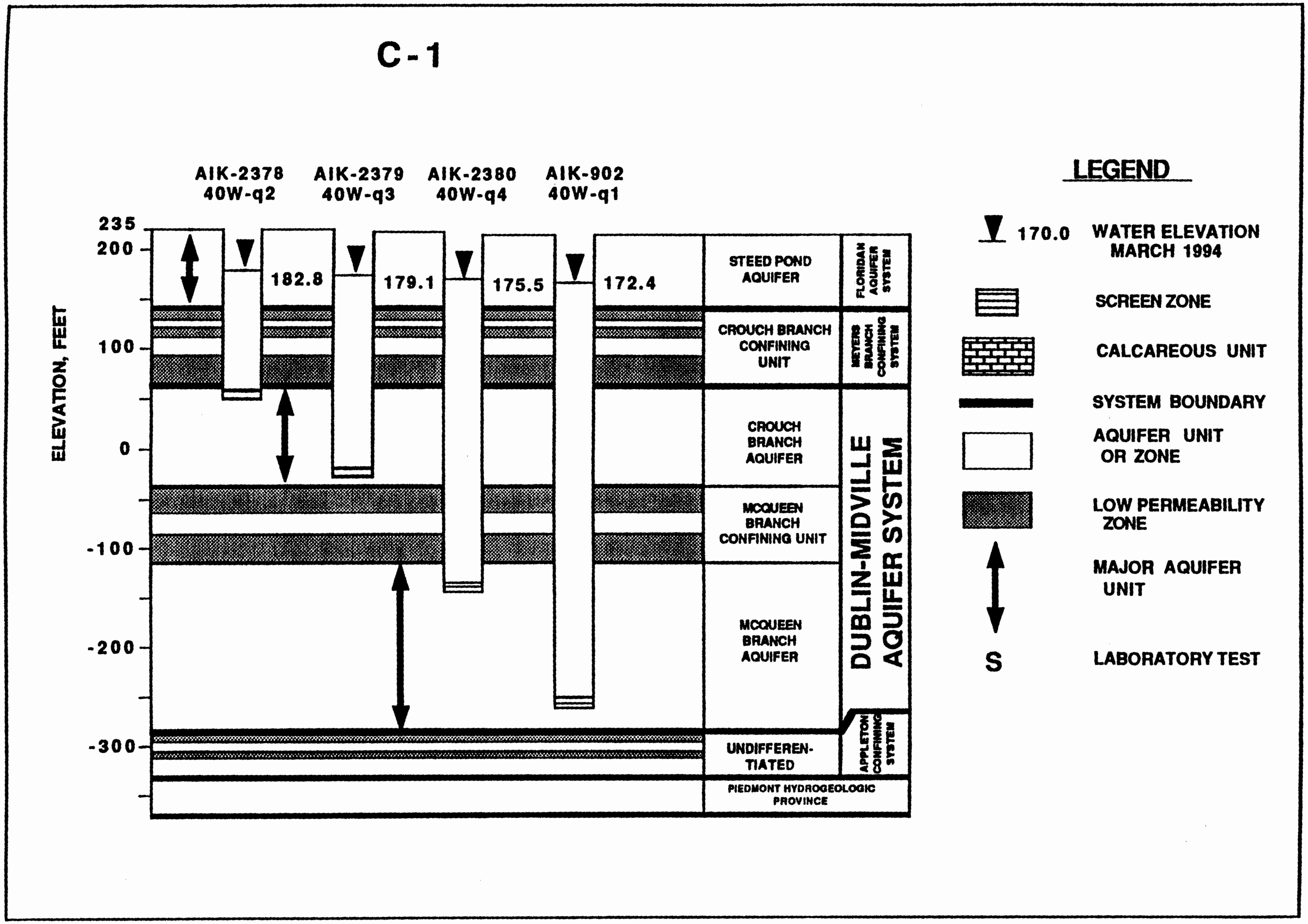
Well	Ground elevation (ft)	Zone	Top depth (ft)	Base depth (ft)	Top elevation (ft)	Base elevation (ft)	Unit thickness (ft)	Clay thickness (ft)	Clayey-sand thickness (ft)	Total confining thickness (ft)	Leakance (ft/d/ft)	Total % confining thickness
MSB-43	355.3	W	229	284	126	71	55	26	7	33	6.39E-06	60%
MSB-47	366.2	C	220	288	146	78	68	34	3	37	4.90E-06	54%
MSB-48	359.8	E	221	248	139	112	27	15	3	18	1.11E-05	67%
MSB-53	342.3	E	203	213	139	129	10	10	0	10	1.67E-05	100%
MSB-54	371.1	C	211	265	160	106	54	11	14	25	1.48E-05	46%
MSB-55	366.6	W	198	258	169	109	60	42	0	42	3.98E-06	70%
MSB-66	380.5	C	255	332	126	49	77	35	0	35	4.77E-06	45%
MSB-68	355.0	C	207	276	148	79	69	32	3	35	5.21E-06	51%
MSB-69	379.3	C	219	276	160	103	57	29	8	37	5.73E-06	65%
MSB-77	354.9	E	223	243	132	112	20	3	14	17	5.12E-05	85%
MSB-82	371.8	W	212	263	160	109	51	36	13	49	4.61E-06	96%
MSB-84	359.9	W	176	256	184	104	80	58	10	68	2.87E-06	85%
MSB-85	378.4	C	215	233	163	145	18	6	0	6	2.78E-05	33%
MSB-88 B	236.0	C	119	188	117	48	69	18	2	20	9.26E-06	29%
MSS-1 SB	262.4	C	131	221	131	41	90	47	16	63	3.53E-06	70%
MSS-5 SB	305.0	C	162	253	143	52	91	52	0	52	3.21E-06	57%
MSS-6 SB	253.0	C	142	194	111	59	52	42	0	42	3.98E-06	81%
MSS-7 SB	298.0	W	162	250	136	48	88	77	11	88	2.16E-06	100%
MSS-8 SB	284.1	C	158	232	126	52	74	11	13	24	1.49E-05	32%
RWM-13	333.0	E	248	256	85	77	8	8	0	8	2.09E-05	100%
RWM-15	366.0	E	228	230	138	136	2	1	1	2	1.64E-04	100%
SRW-3	330.0	W	215	298.0	115	32	83	50	11	61	3.33E-06	73%
SRW-4	318.1	W	203	281	115	37	78	43	0	43	3.88E-06	55%
SRW-8	286.7	W	171	267	116	20	96	48	3	51	3.48E-06	53%
SRW-10	301.0	W	190	268.0	111	33	78	30	19	49	5.50E-06	63%
SRW-17	331.0	W	217	306.0	114	25	89	52	27	79	3.18E-06	89%

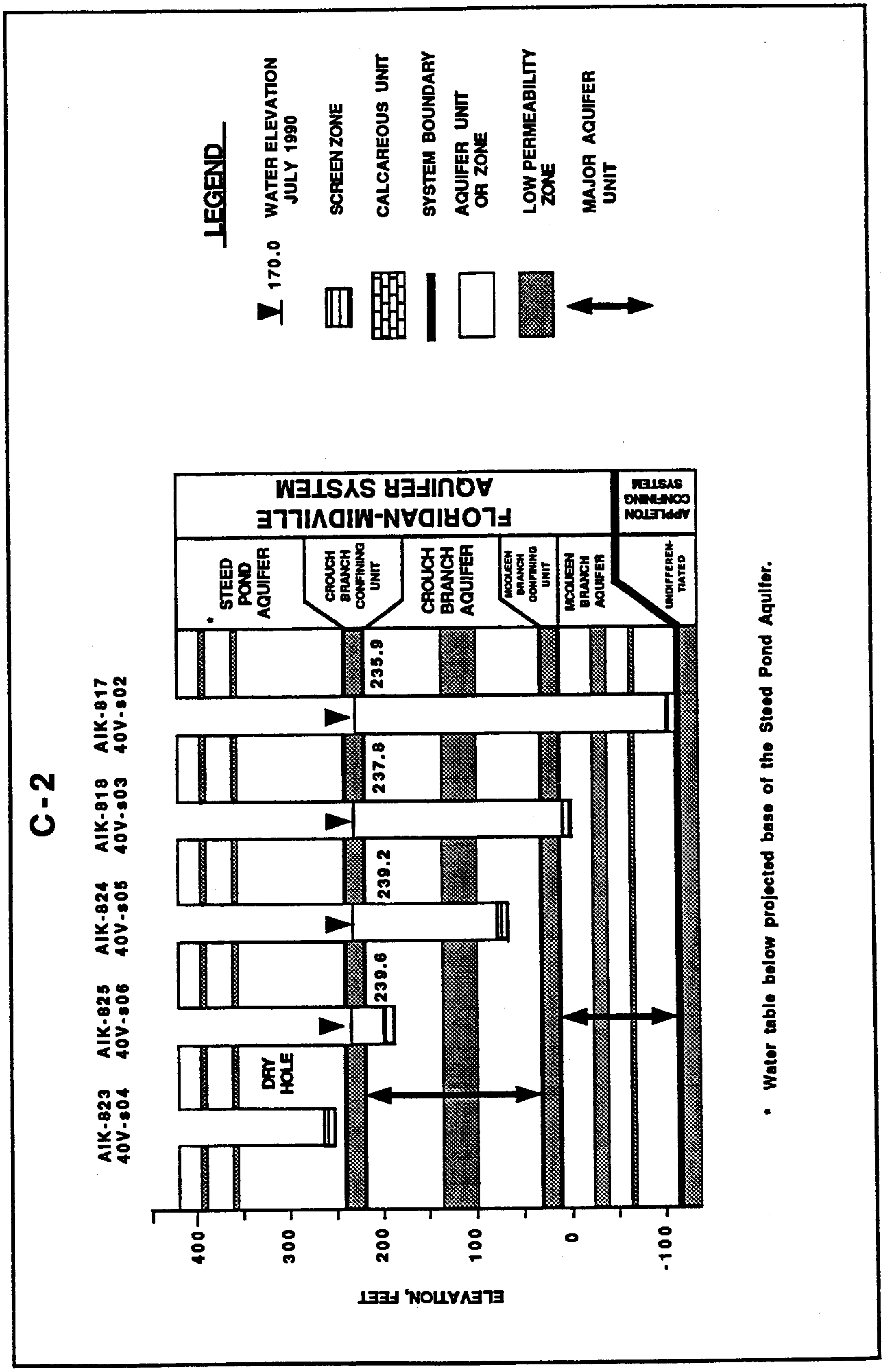
ABS, Unit is absent in this well; F/O, Unit is faulted out; NA, Data not available for this well; ND, Unit is not delineated in this well.

NP, Unit is not penetrated by this well; -, Data is not applicable.

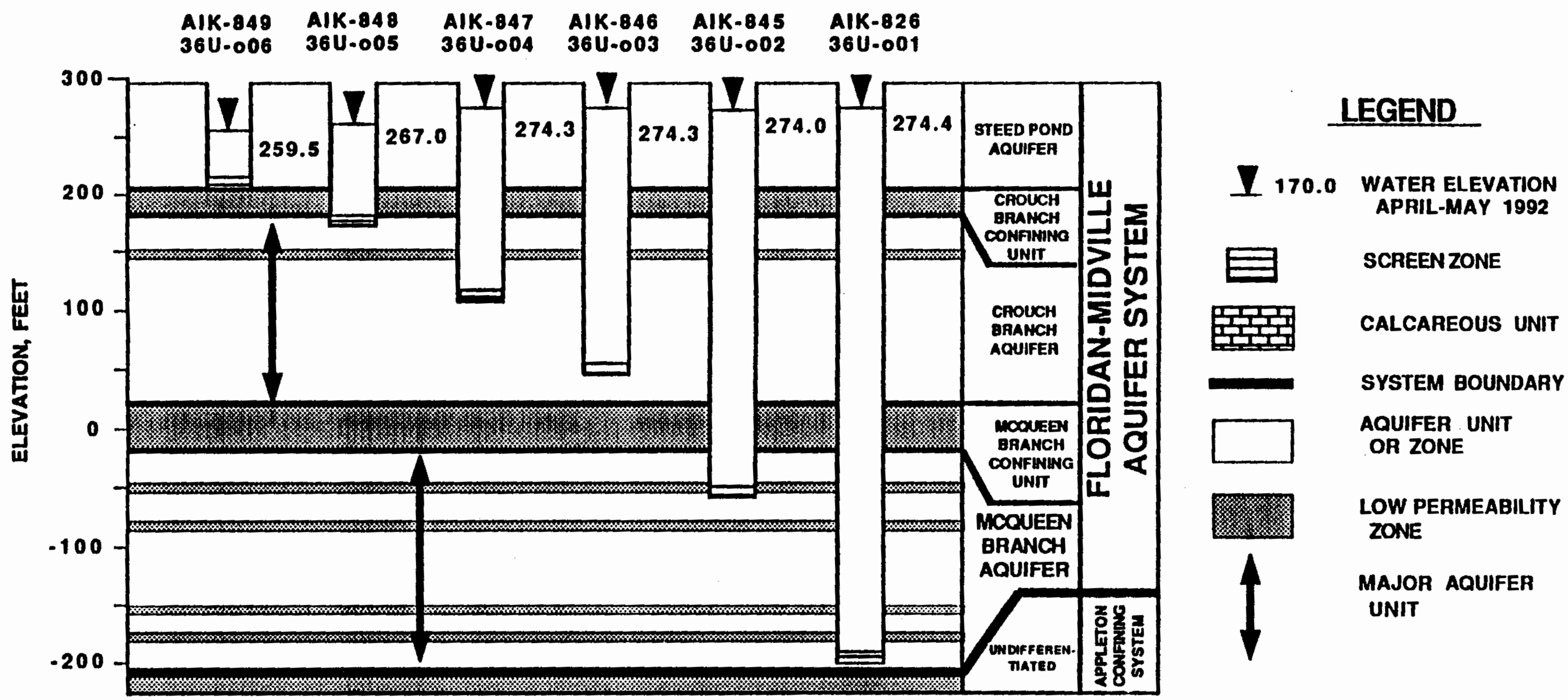
C, Central A-M Area; E, Eastern A-M Area; W, Western A-M Area.

APPENDIX 4. Well-cluster profiles of the C-well and P-well clusters, showing vertical hydraulic head relationships.

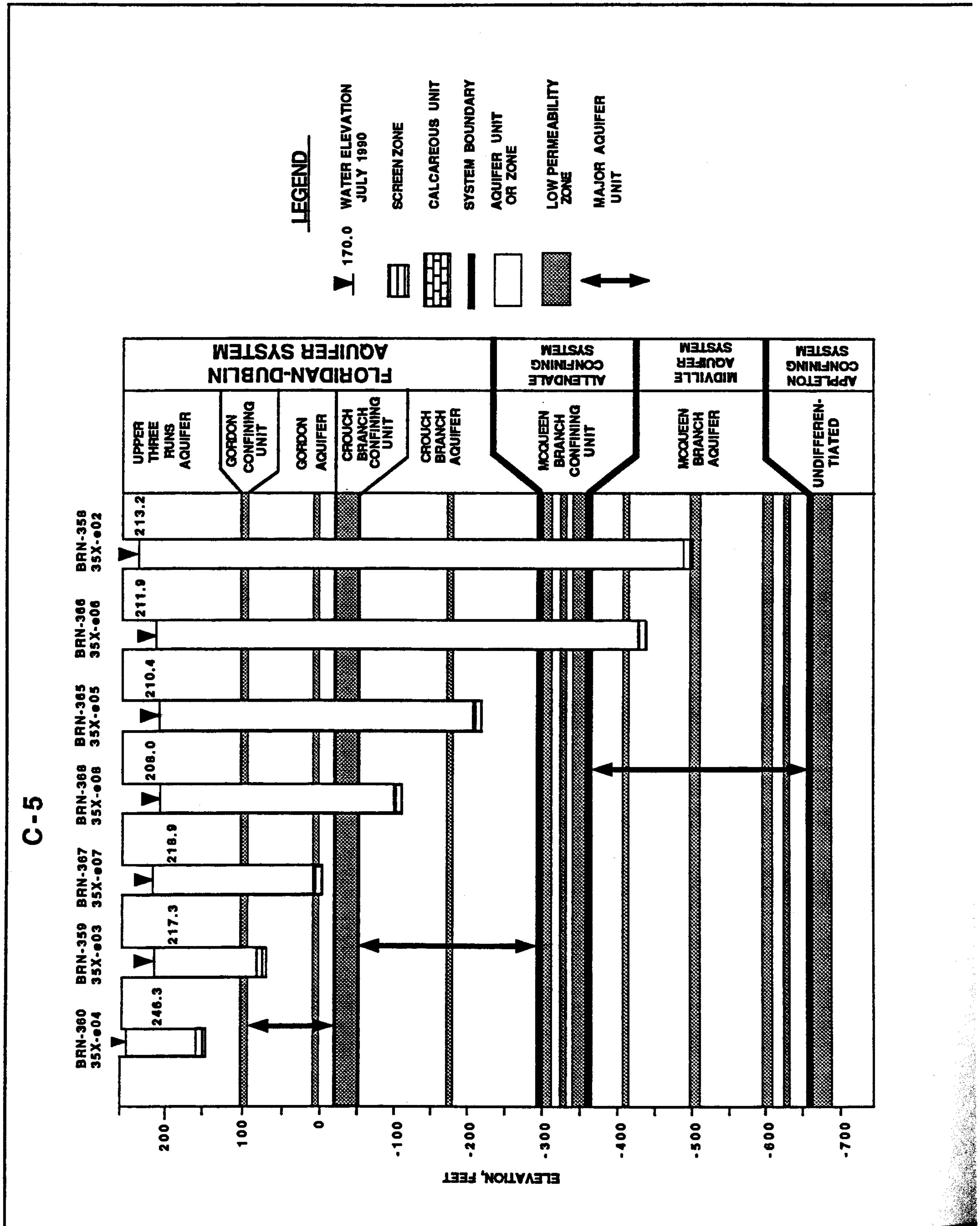

C-1
AIK-2378
40W-q2
AIK-2379
40W-q3
AIK-2380
40W-q4
AIK-902
40W-q1
ELEVATION, FEET
235
200
100
0
-100
-200
-300
182.8
179.1
175.5
172.4
STEED POND AQUIFER
CROUCH BRANCH CONFINING UNIT
CROUCH BRANCH AQUIFER
MCQUEEN BRANCH CONFINING UNIT
MCQUEEN BRANCH AQUIFER
UNDIFFEREN-TIATED
FLORIDAN AQUIFER SYSTEM
MEYERS BRANCH CONFINING SYSTEM
DUBLIN-MIDVILLE AQUIFER SYSTEM
APPLETON CONFINING SYSTEM
PIEDMONT HYDROGEOLOGIC PROVINCE
LEGEND
170.0 WATER ELEVATION MARCH 1994
SCREEN ZONE
CALCAREOUS UNIT
SYSTEM BOUNDARY
AQUIFER UNIT OR ZONE
LOW PERMEABILITY ZONE
MAJOR AQUIFER UNIT
S LABORATORY TEST

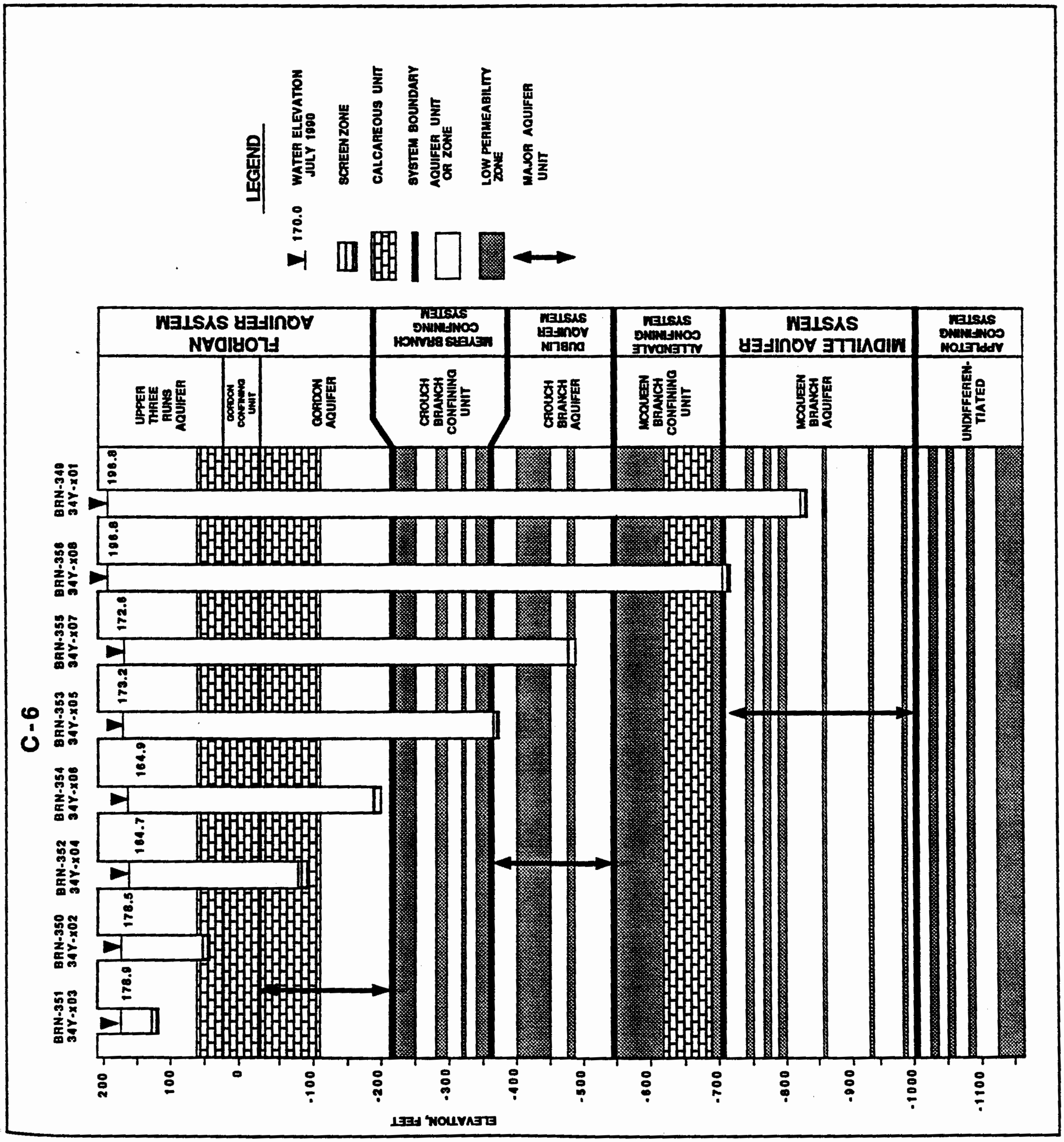

C-2
AIK-823 40V-s04
AIK-825 40V-s06
AIK-824 40V-s05
AIK-818 40V-s03
AIK-817 40V-s02
DRY HOLE
239.6
239.2
237.8
235.9
ELEVATION, FEET
400
300
200
100
0
-100
* STEED POND AQUIFER
CROUCH BRANCH CONFINING UNIT
CROUCH BRANCH AQUIFER
McQUEEN BRANCH CONFINING UNIT
McQUEEN BRANCH AQUIFER
UNDIFFERENTIATED
FLORIDAN-MIDVILLE AQUIFER SYSTEM
APPLETON CONFINING SYSTEM
LEGEND
170.0 WATER ELEVATION JULY 1990
SCREEN ZONE
CALCAREOUS UNIT
SYSTEM BOUNDARY
AQUIFER UNIT OR ZONE
LOW PERMEABILITY ZONE
MAJOR AQUIFER UNIT
* Water table below projected base of the Steed Pond Aquifer.

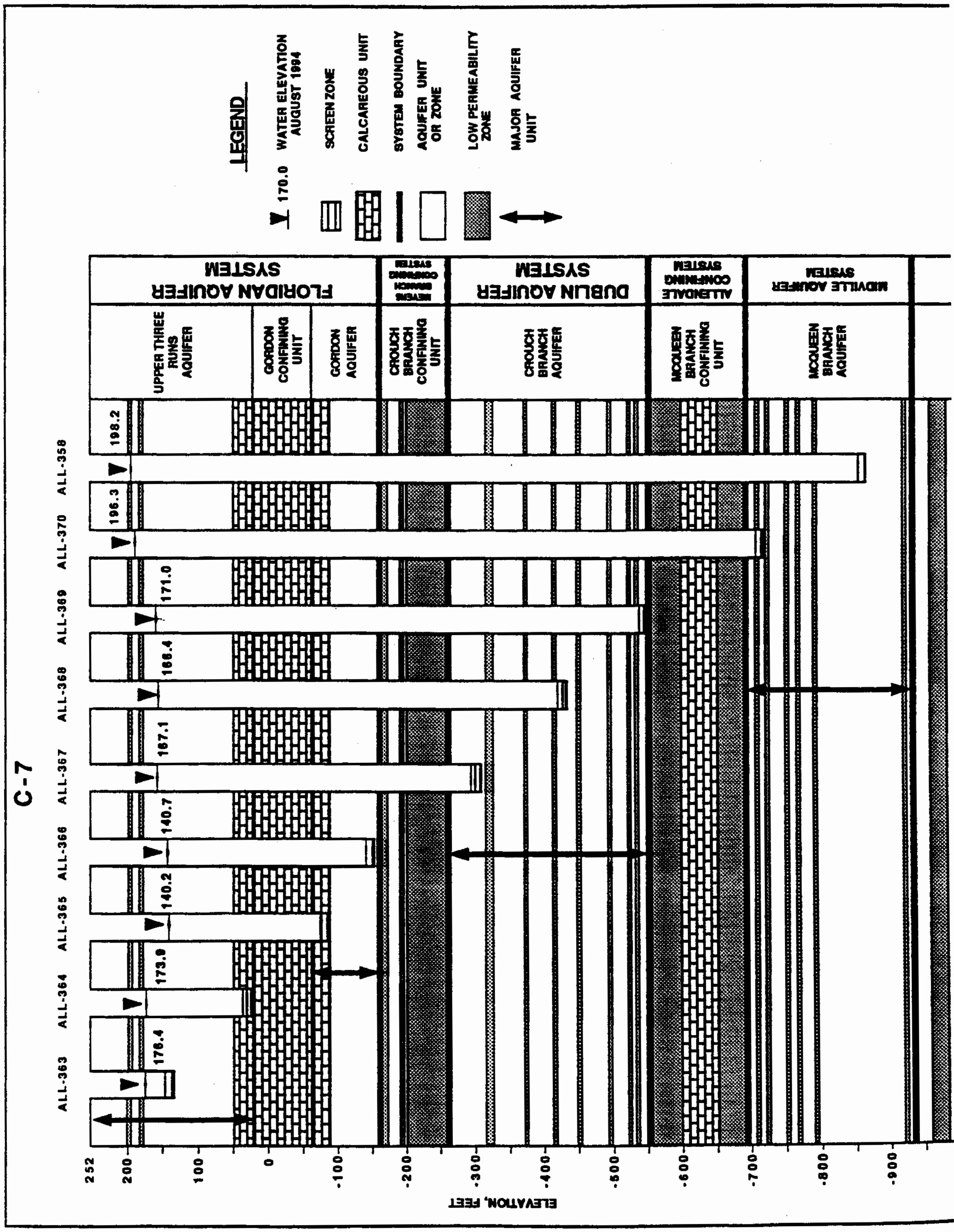
C-3

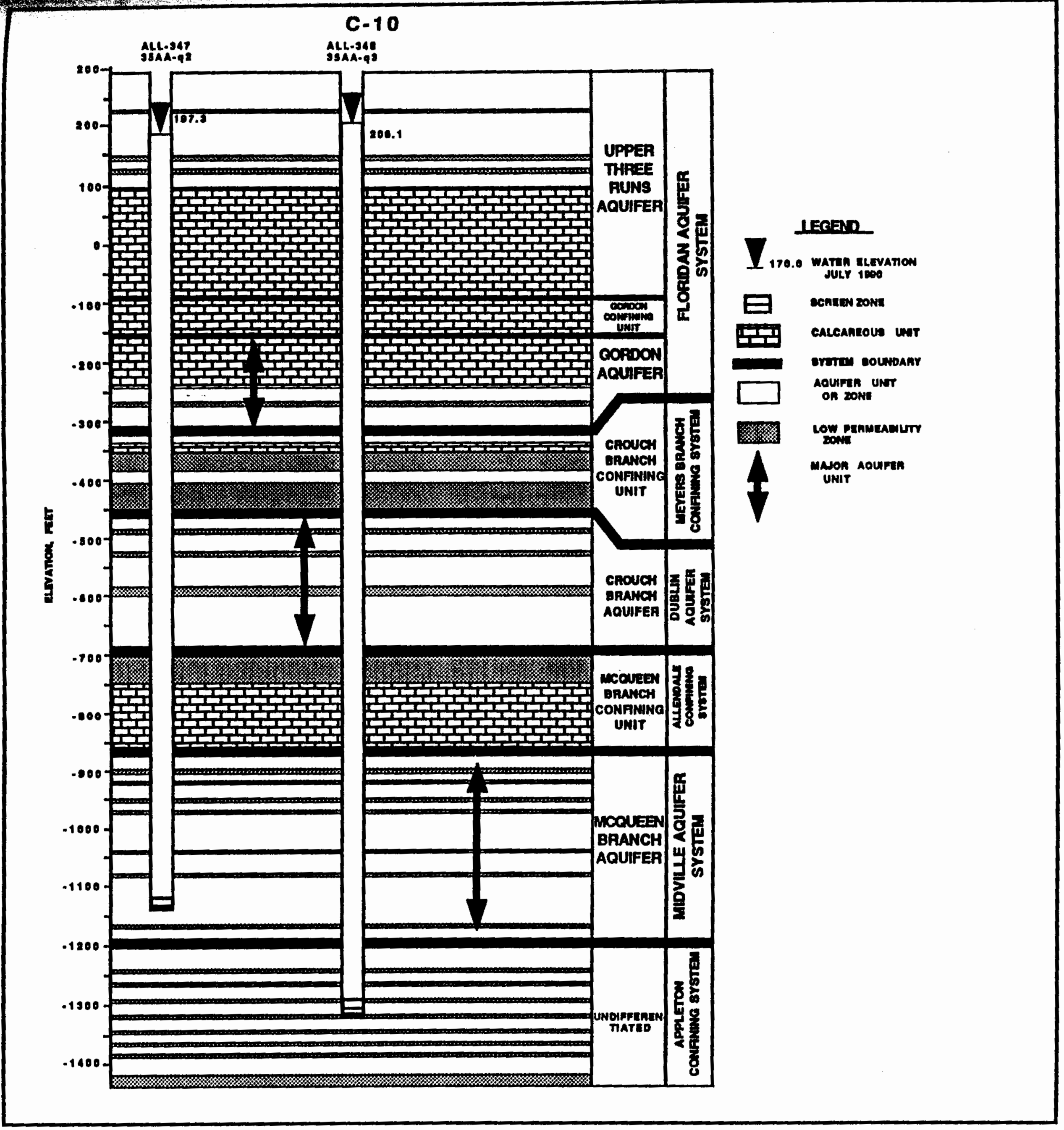


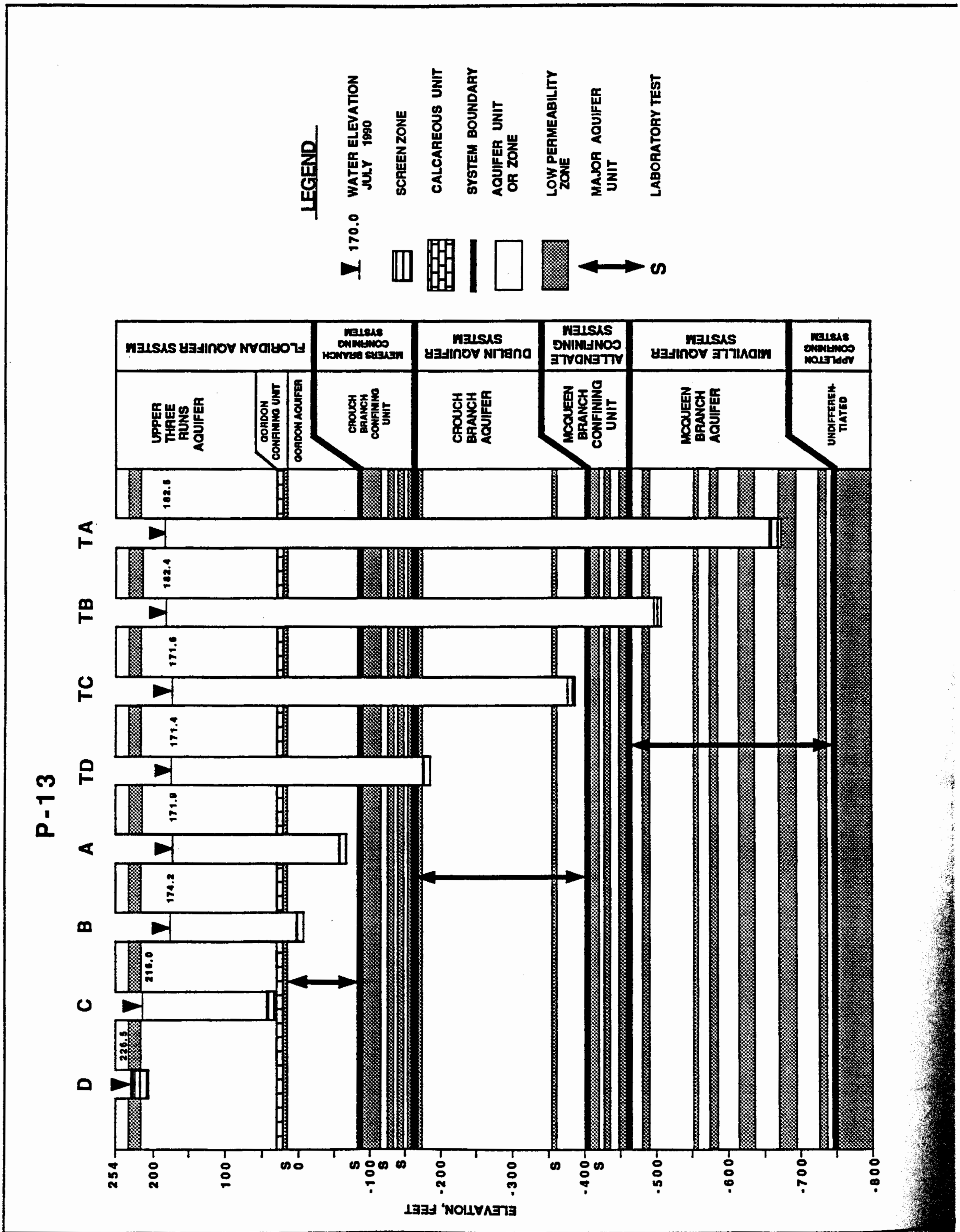
AIK-849
36U-o06
AIK-848
36U-o05
AIK-847
36U-o04
AIK-846
36U-o03
AIK-845
36U-o02
AIK-826
36U-o01
259.5
267.0
274.3
274.3
274.0
274.4
300
200
100
0
-100
-200
ELEVATION, FEET
STEED POND AQUIFER
CROUCH BRANCH CONFINING UNIT
CROUCH BRANCH AQUIFER
MCQUEEN BRANCH CONFINING UNIT
MCQUEEN BRANCH AQUIFER
UNDIFFEREN-TIATED
FLORIDAN-MIDVILLE AQUIFER SYSTEM
APPLETON CONFINING SYSTEM
LEGEND
170.0
WATER ELEVATION APRIL-MAY 1992
SCREEN ZONE
CALCAREOUS UNIT
SYSTEM BOUNDARY
AQUIFER UNIT OR ZONE
LOW PERMEABILITY ZONE
MAJOR AQUIFER UNIT


C-5
BRN-360 35X-e04
BRN-359 35X-e03
BRN-367 35X-e07
BRN-368 35X-e08
BRN-365 35X-e05
BRN-366 35X-e06
BRN-358 35X-e02
246.3
217.3
218.9
208.0
210.4
211.9
213.2
ELEVATION, FEET
200
100
0
-100
-200
-300
-400
-500
-600
-700
UPPER THREE RUNS AQUIFER
GORDON CONFINING UNIT
GORDON AQUIFER
CROUCH BRANCH CONFINING UNIT
CROUCH BRANCH AQUIFER
MCQUEEN BRANCH CONFINING UNIT
MCQUEEN BRANCH AQUIFER
UNDIFFEREN-TIATED
FLORIDAN-DUBLIN AQUIFER SYSTEM
ALLENDALE CONFINING SYSTEM
MIDVILLE AQUIFER SYSTEM
APPLETON CONFINING SYSTEM
LEGEND
170.0 WATER ELEVATION JULY 1990
SCREEN ZONE
CALCAREOUS UNIT
SYSTEM BOUNDARY
AQUIFER UNIT OR ZONE
LOW PERMEABILITY ZONE
MAJOR AQUIFER UNIT

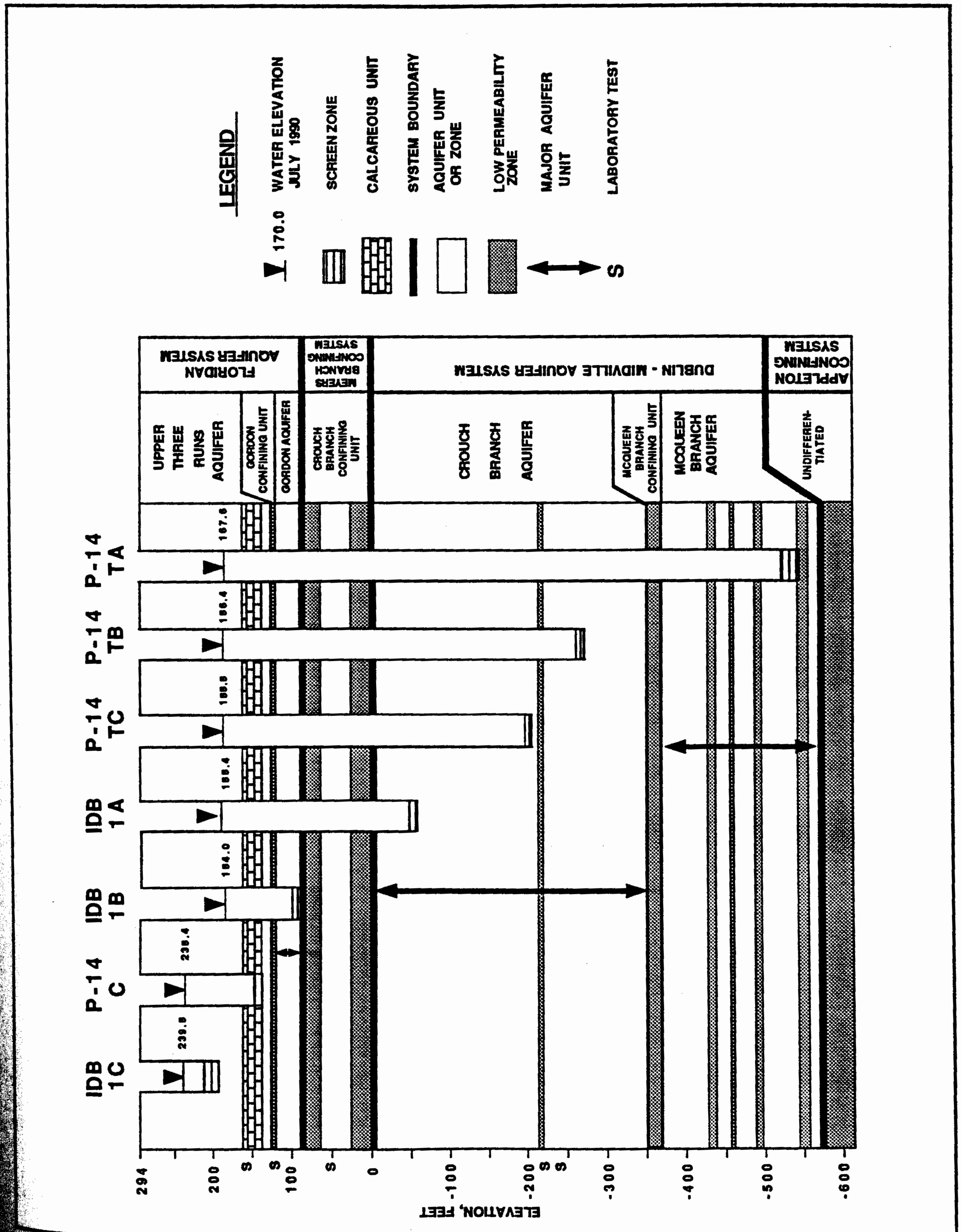

C-6
BRN-351 34Y-x03
BRN-350 34Y-x02
BRN-352 34Y-x04
BRN-354 34Y-x06
BRN-353 34Y-x05
BRN-355 34Y-x07
BRN-356 34Y-x08
BRN-349 34Y-x01
178.9
178.5
164.7
164.9
173.2
172.6
196.8
196.8
ELEVATION, FEET
200
100
0
-100
-200
-300
-400
-500
-600
-700
-800
-900
-1000
-1100
FLORIDAN AQUIFER SYSTEM
UPPER THREE RUNS AQUIFER
GORDON CONFINING UNIT
GORDON AQUIFER
MEYERS BRANCH CONFINING SYSTEM
CROUCH BRANCH CONFINING UNIT
DUBLIN AQUIFER SYSTEM
CROUCH BRANCH AQUIFER
ALLENDALE CONFINING SYSTEM
MCQUEEN BRANCH CONFINING UNIT
MIDVILLE AQUIFER SYSTEM
MCQUEEN BRANCH AQUIFER
APPLETON CONFINING SYSTEM
UNDIFFEREN-TIATED
LEGEND
170.0 WATER ELEVATION JULY 1990
SCREEN ZONE
CALCAREOUS UNIT
SYSTEM BOUNDARY
AQUIFER UNIT OR ZONE
LOW PERMEABILITY ZONE
MAJOR AQUIFER UNIT


C-7
ALL-363
ALL-364
ALL-365
ALL-366
ALL-367
ALL-368
ALL-369
ALL-370
ALL-358
176.4
173.9
140.2
140.7
167.1
166.4
171.0
196.3
198.2
LEGEND
170.0 WATER ELEVATION AUGUST 1994
SCREEN ZONE
CALCAREOUS UNIT
SYSTEM BOUNDARY
AQUIFER UNIT OR ZONE
LOW PERMEABILITY ZONE
MAJOR AQUIFER UNIT
FLORIDAN AQUIFER SYSTEM
UPPER THREE RUNS AQUIFER
GORDON CONFINING UNIT
GORDON AQUIFER
MEYERS BRANCH CONFINING SYSTEM
CROUCH BRANCH CONFINING UNIT
DUBLIN AQUIFER SYSTEM
CROUCH BRANCH AQUIFER
ALLENDALE CONFINING SYSTEM
McQUEEN BRANCH CONFINING UNIT
MIDVILLE AQUIFER SYSTEM
McQUEEN BRANCH AQUIFER
ELEVATION, FEET
252
200
100
0
-100
-200
-300
-400
-500
-600
-700
-800
-900

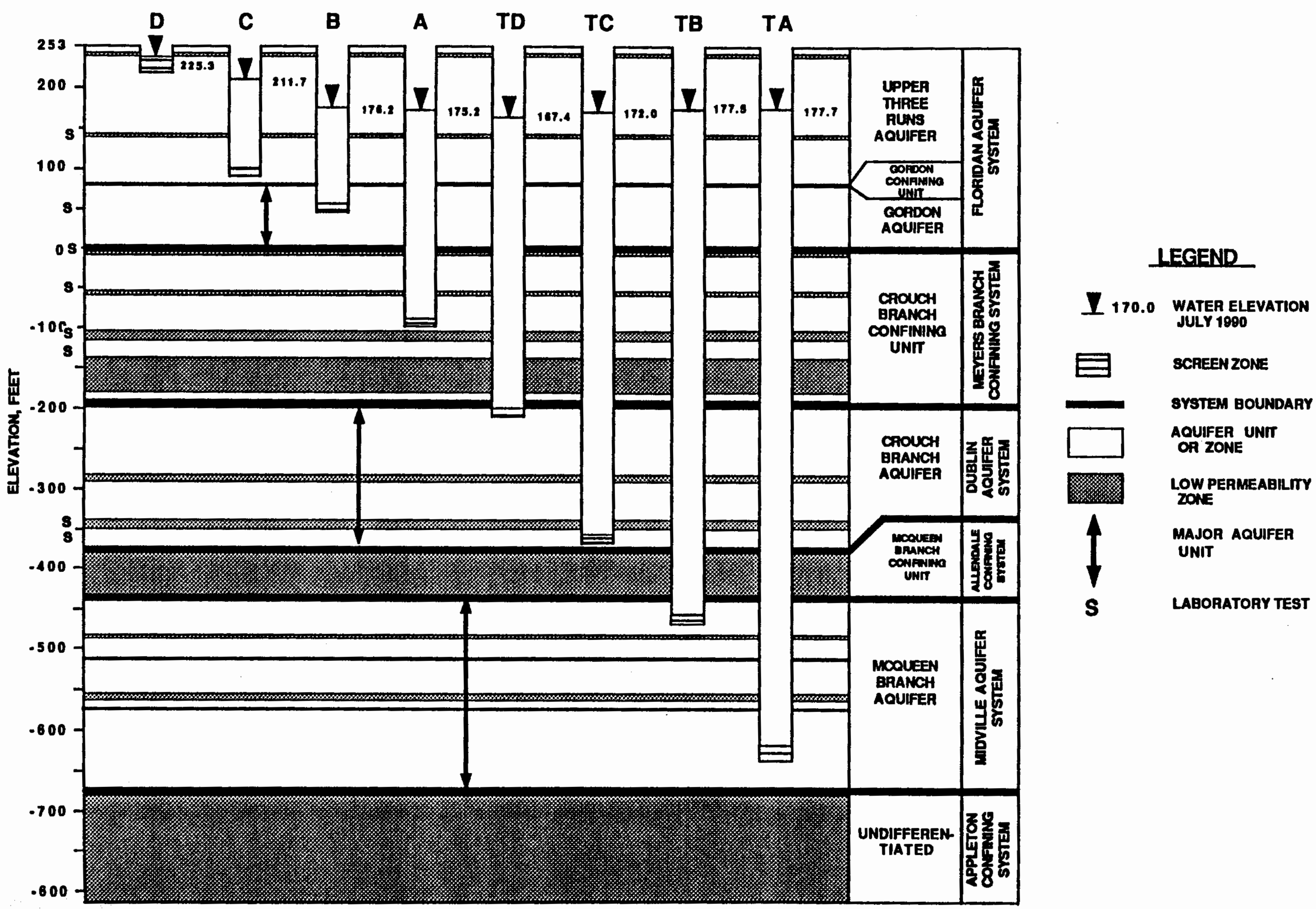

C-10
ALL-347
35AA-q2
ALL-348
35AA-q3
197.3
206.1
300
200
100
0
-100
-200
-300
-400
-500
-600
-700
-800
-900
-1000
-1100
-1200
-1300
-1400
ELEVATION, FEET
UPPER THREE RUNS AQUIFER
GORDON CONFINING UNIT
GORDON AQUIFER
FLORIDAN AQUIFER SYSTEM
CROUCH BRANCH CONFINING UNIT
MEYERS BRANCH CONFINING SYSTEM
CROUCH BRANCH AQUIFER
DUBLIN AQUIFER SYSTEM
MCQUEEN BRANCH CONFINING UNIT
ALLENDALE CONFINING SYSTEM
MCQUEEN BRANCH AQUIFER
MIDVILLE AQUIFER SYSTEM
UNDIFFERENTIATED
APPLETON CONFINING SYSTEM
LEGEND
170.0 WATER ELEVATION JULY 1990
SCREEN ZONE
CALCAREOUS UNIT
SYSTEM BOUNDARY
AQUIFER UNIT OR ZONE
LOW PERMEABILITY ZONE
MAJOR AQUIFER UNIT



P-13
D
C
B
A
TD
TC
TB
TA
226.5
216.0
174.2
171.9
171.4
171.6
182.4
182.8
ELEVATION, FEET
254
200
100
0
-100
-200
-300
-400
-500
-600
-700
-800
S
UPPER THREE RUNS AQUIFER
GORDON CONFINING UNIT
GORDON AQUIFER
FLORIDAN AQUIFER SYSTEM
CROUCH BRANCH CONFINING UNIT
MEYERS BRANCH CONFINING SYSTEM
CROUCH BRANCH AQUIFER
DUBLIN AQUIFER SYSTEM
MCQUEEN BRANCH CONFINING UNIT
ALLENDALE CONFINING SYSTEM
MCQUEEN BRANCH AQUIFER
MIDVILLE AQUIFER SYSTEM
UNDIFFERENTIATED
APPLETON CONFINING SYSTEM
LEGEND
170.0 WATER ELEVATION JULY 1990
SCREEN ZONE
CALCAREOUS UNIT
SYSTEM BOUNDARY
AQUIFER UNIT OR ZONE
LOW PERMEABILITY ZONE
MAJOR AQUIFER UNIT
S LABORATORY TEST

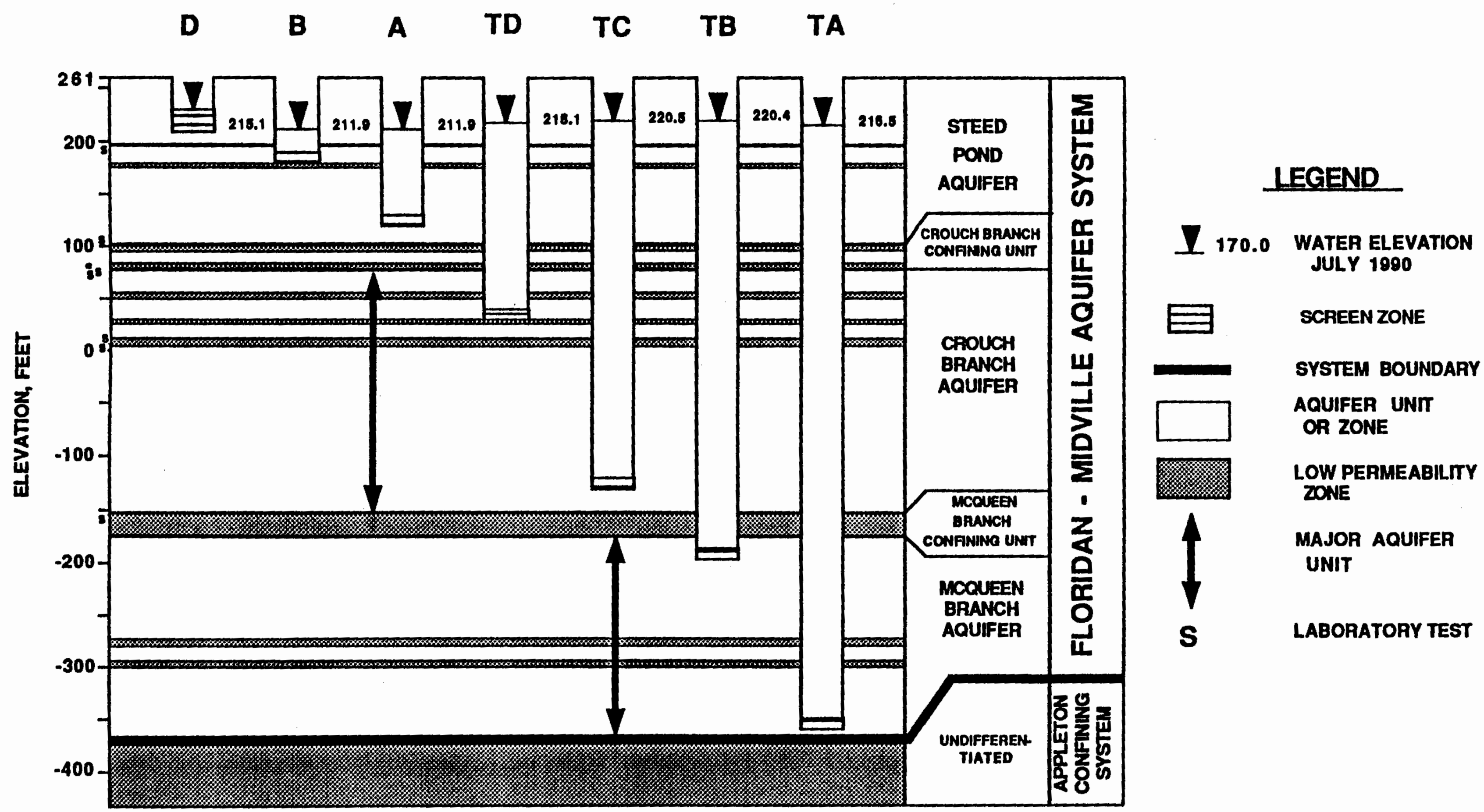

LEGEND
170.0 WATER ELEVATION JULY 1990
SCREEN ZONE
CALCAREOUS UNIT
SYSTEM BOUNDARY
AQUIFER UNIT OR ZONE
LOW PERMEABILITY ZONE
MAJOR AQUIFER UNIT
S LABORATORY TEST
FLORIDAN AQUIFER SYSTEM
MEYERS BRANCH CONFINING SYSTEM
DUBLIN - MIDVILLE AQUIFER SYSTEM
APPLETON CONFINING SYSTEM
UPPER THREE RUNS AQUIFER
GORDON CONFINING UNIT
GORDON AQUIFER
CROUCH BRANCH CONFINING UNIT
CROUCH BRANCH AQUIFER
MCQUEEN BRANCH CONFINING UNIT
MCQUEEN BRANCH AQUIFER
UNDIFFEREN-TIATED
IDB 1C
P-14 C
IDB 1B
IDB 1A
P-14 TC
P-14 TB
P-14 TA
239.8
238.4
184.0
188.4
188.8
186.4
167.6
ELEVATION, FEET
294
200
100
0
-100
-200
-300
-400
-500
-600

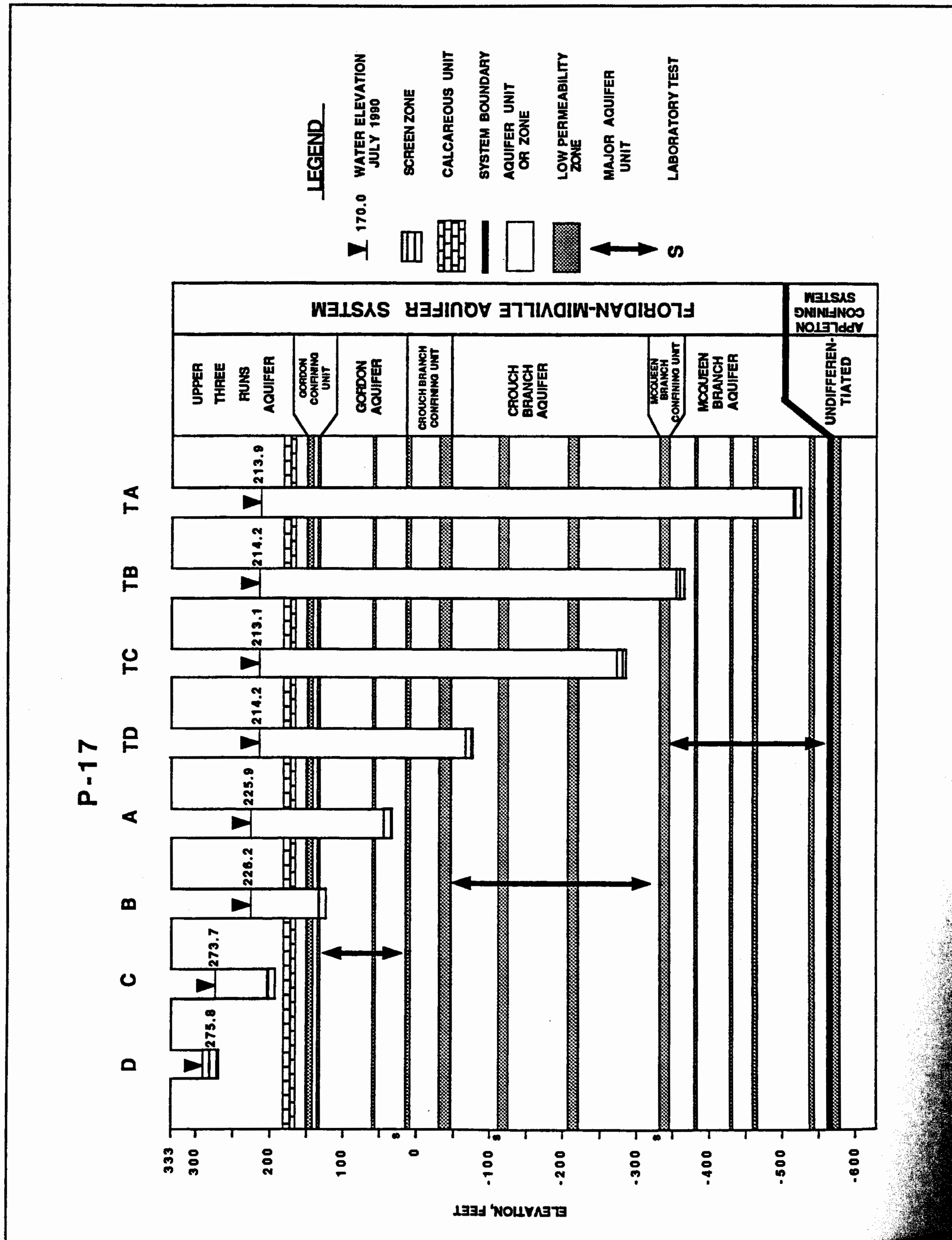
P-15

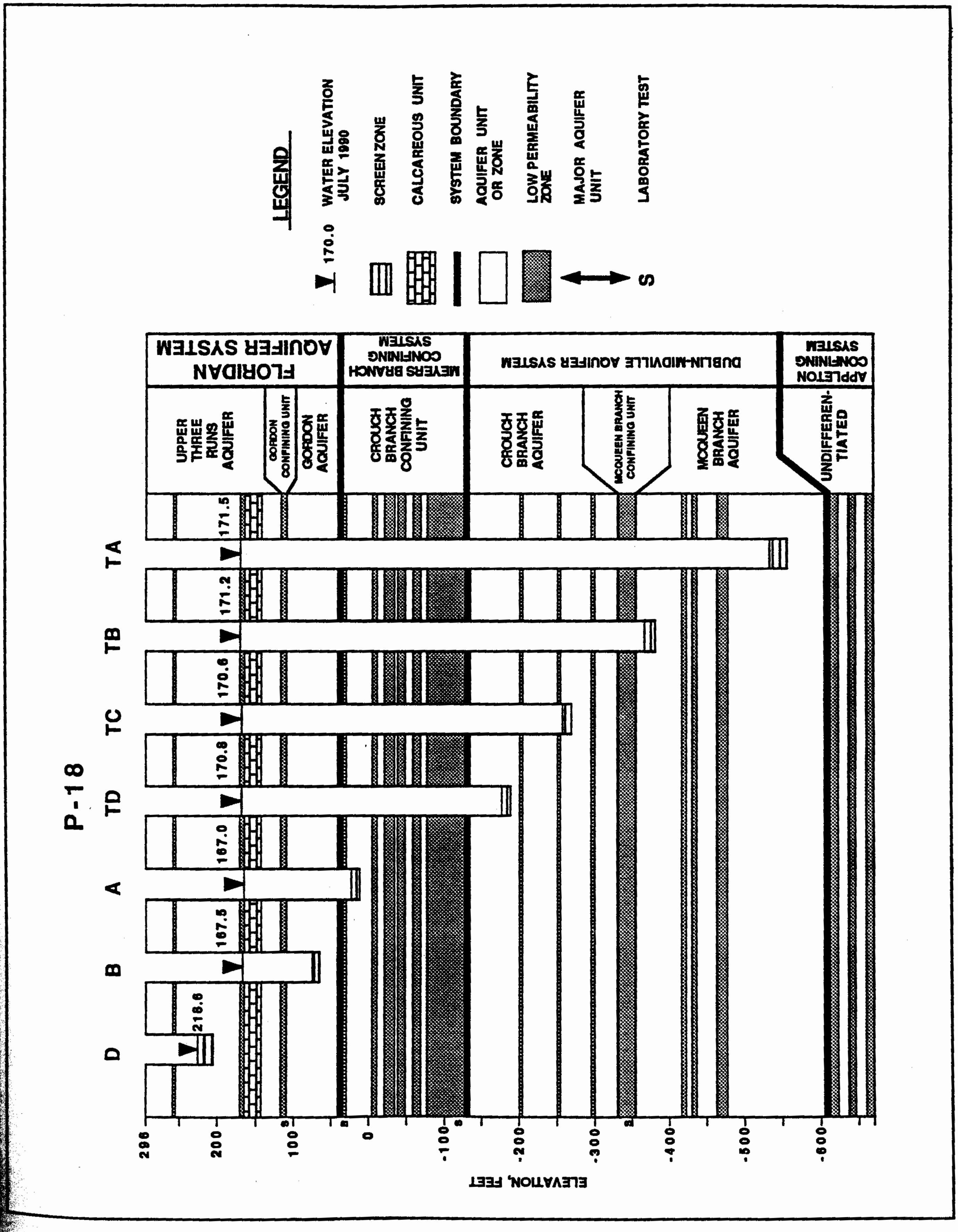


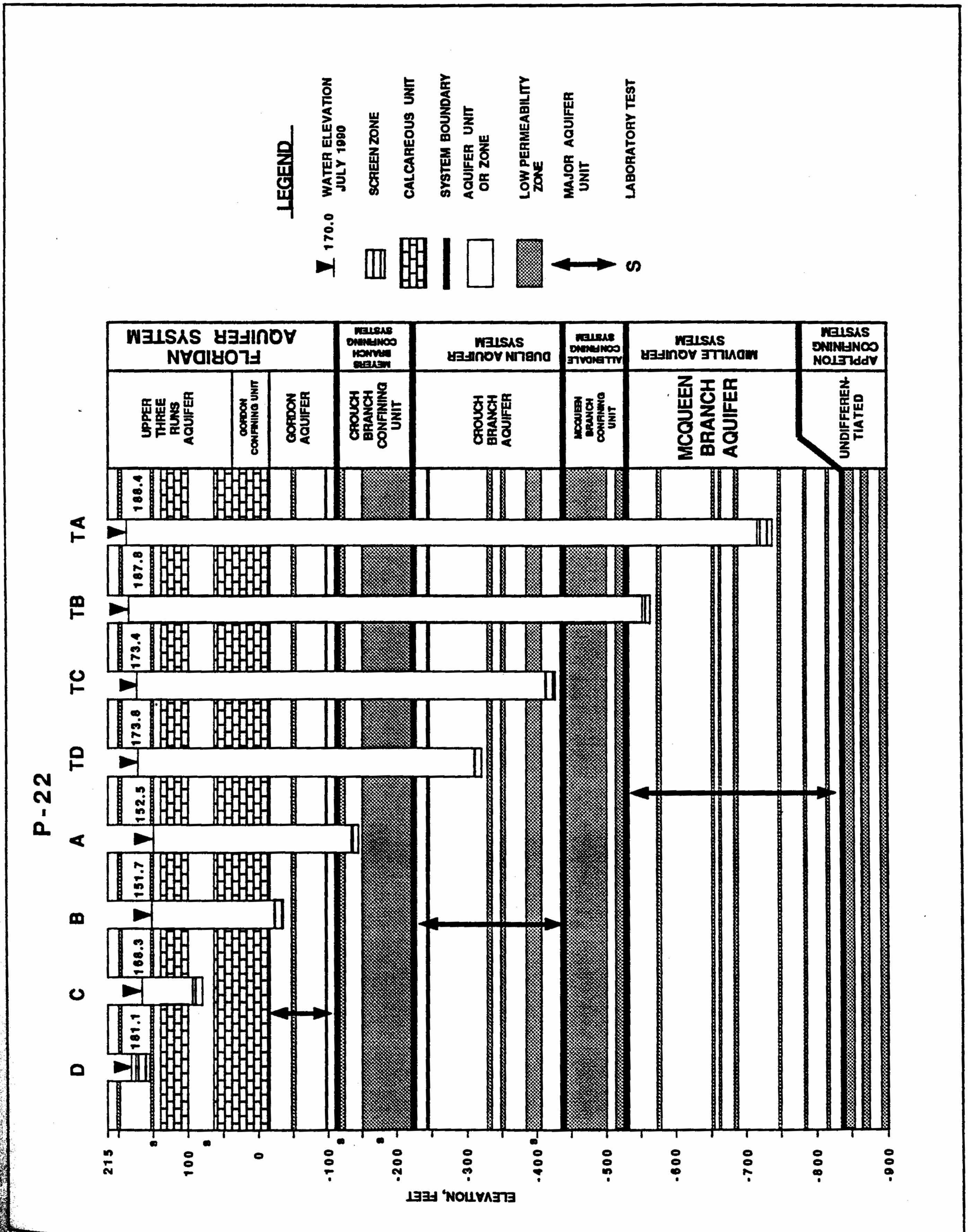
D
C
B
A
TD
TC
TB
TA
225.3
211.7
176.2
175.2
167.4
172.0
177.8
177.7
ELEVATION, FEET
253
200
100
0
-100
-200
-300
-400
-500
-600
-700
-800
S
UPPER THREE RUNS AQUIFER
GORDON CONFINING UNIT
GORDON AQUIFER
FLORIDAN AQUIFER SYSTEM
CROUCH BRANCH CONFINING UNIT
MEYERS BRANCH CONFINING SYSTEM
CROUCH BRANCH AQUIFER
DUBLIN AQUIFER SYSTEM
MCQUEEN BRANCH CONFINING UNIT
ALLENDALE CONFINING SYSTEM
MCQUEEN BRANCH AQUIFER
MIDVILLE AQUIFER SYSTEM
UNDIFFERENTIATED
APPLETON CONFINING SYSTEM
LEGEND
170.0 WATER ELEVATION JULY 1990
SCREEN ZONE
SYSTEM BOUNDARY
AQUIFER UNIT OR ZONE
LOW PERMEABILITY ZONE
MAJOR AQUIFER UNIT
S LABORATORY TEST

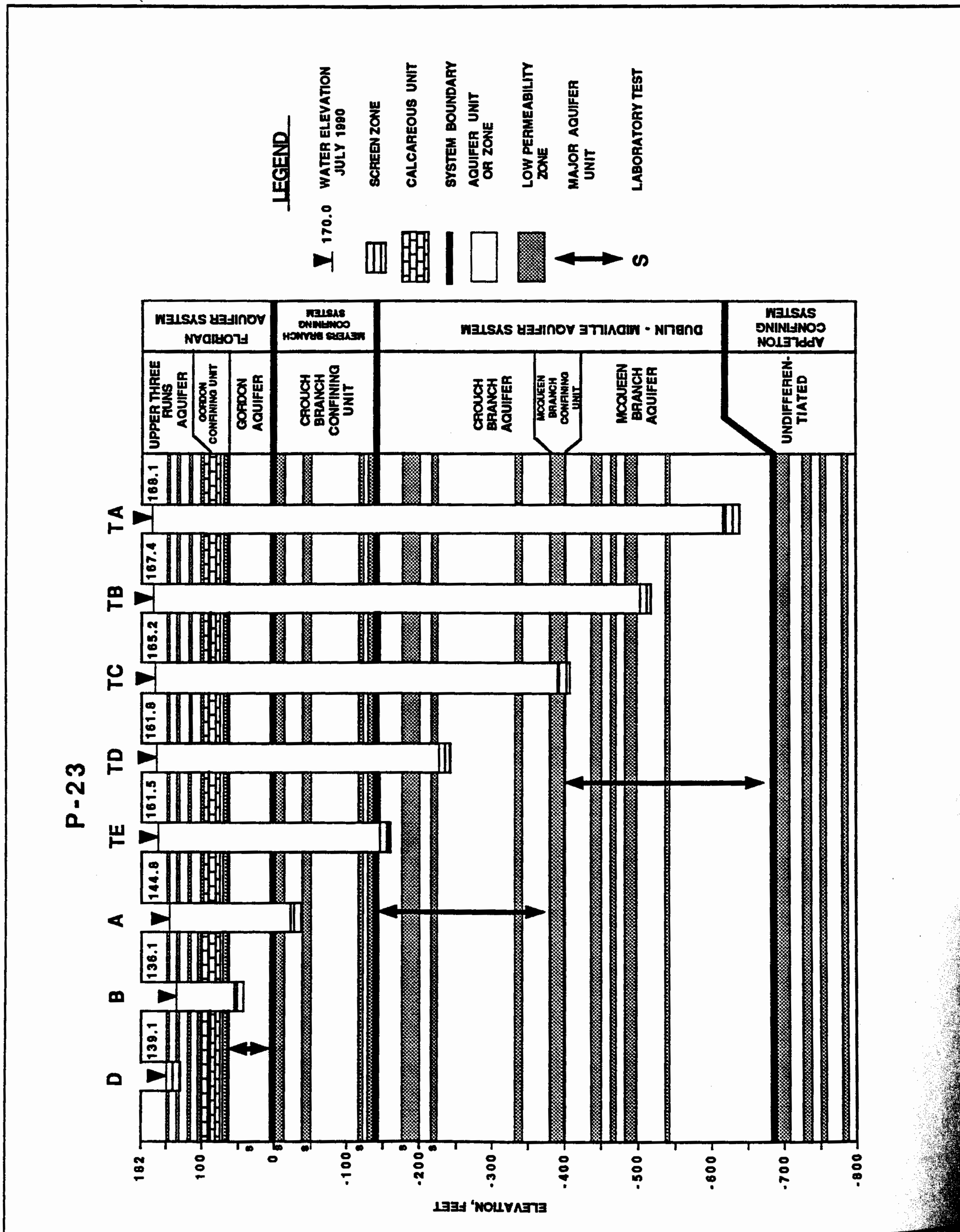
P-16


D
B
A
TD
TC
TB
TA
ELEVATION, FEET
261
200
100
0
-100
-200
-300
-400
215.1
211.9
211.9
218.1
220.5
220.4
216.5
STEED POND AQUIFER
CROUCH BRANCH CONFINING UNIT
CROUCH BRANCH AQUIFER
MCQUEEN BRANCH CONFINING UNIT
MCQUEEN BRANCH AQUIFER
UNDIFFEREN-TIATED
FLORIDAN - MIDVILLE AQUIFER SYSTEM
APPLETON CONFINING SYSTEM
LEGEND
170.0 WATER ELEVATION JULY 1990
SCREEN ZONE
SYSTEM BOUNDARY
AQUIFER UNIT OR ZONE
LOW PERMEABILITY ZONE
MAJOR AQUIFER UNIT
S LABORATORY TEST

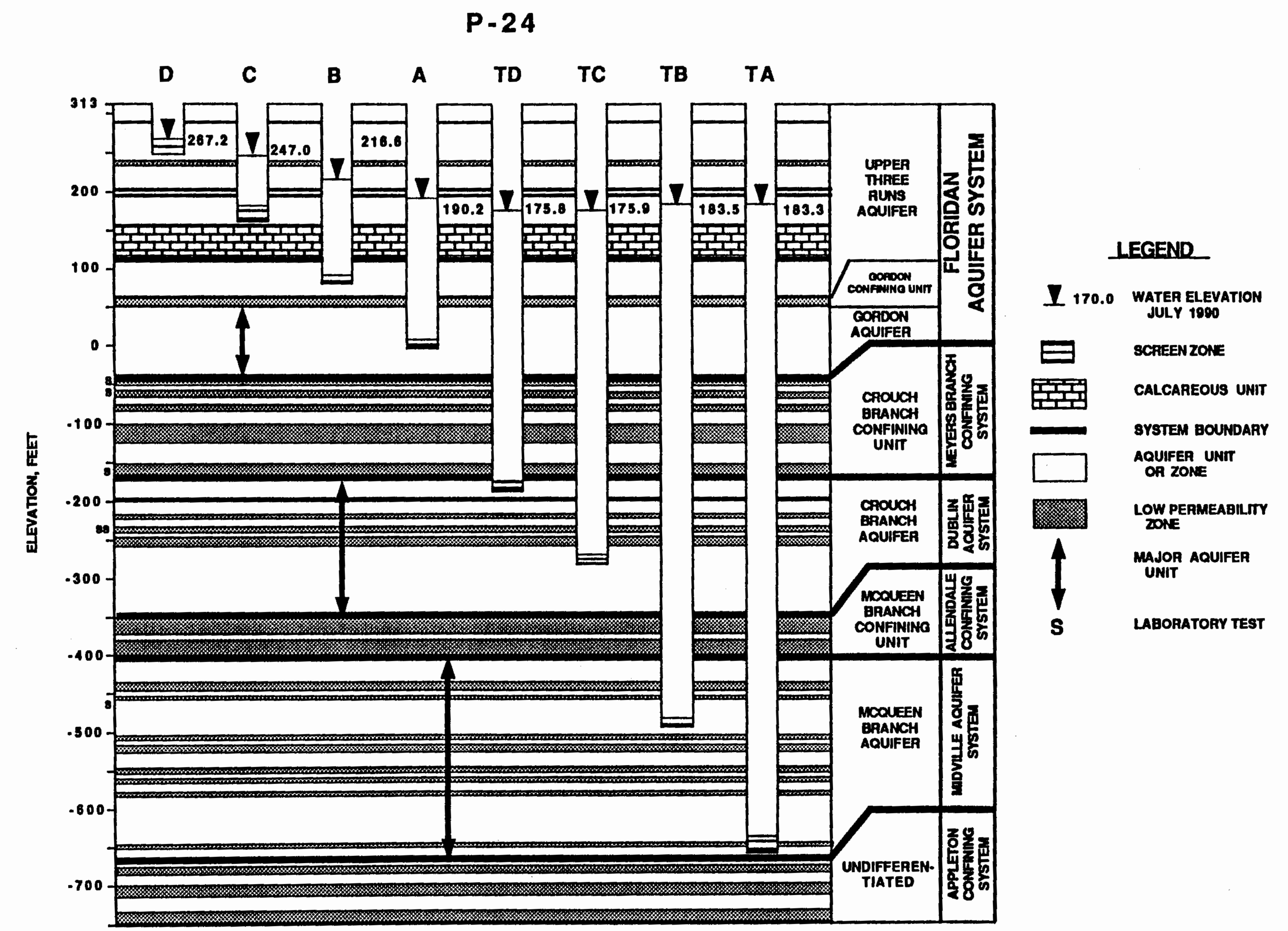

P-17
D
C
B
A
TD
TC
TB
TA
275.8
273.7
226.2
225.9
214.2
213.1
214.2
213.9
ELEVATION, FEET
333
300
200
100
0
-100
-200
-300
-400
-500
-600
S
UPPER THREE RUNS AQUIFER
GORDON CONFINING UNIT
GORDON AQUIFER
CROUCH BRANCH CONFINING UNIT
CROUCH BRANCH AQUIFER
MCQUEEN BRANCH CONFINING UNIT
MCQUEEN BRANCH AQUIFER
UNDIFFEREN-TIATED
FLORIDAN-MIDVILLE AQUIFER SYSTEM
APPLETON CONFINING SYSTEM
LEGEND
170.0 WATER ELEVATION JULY 1990
SCREEN ZONE
CALCAREOUS UNIT
SYSTEM BOUNDARY
AQUIFER UNIT OR ZONE
LOW PERMEABILITY ZONE
MAJOR AQUIFER UNIT
S LABORATORY TEST

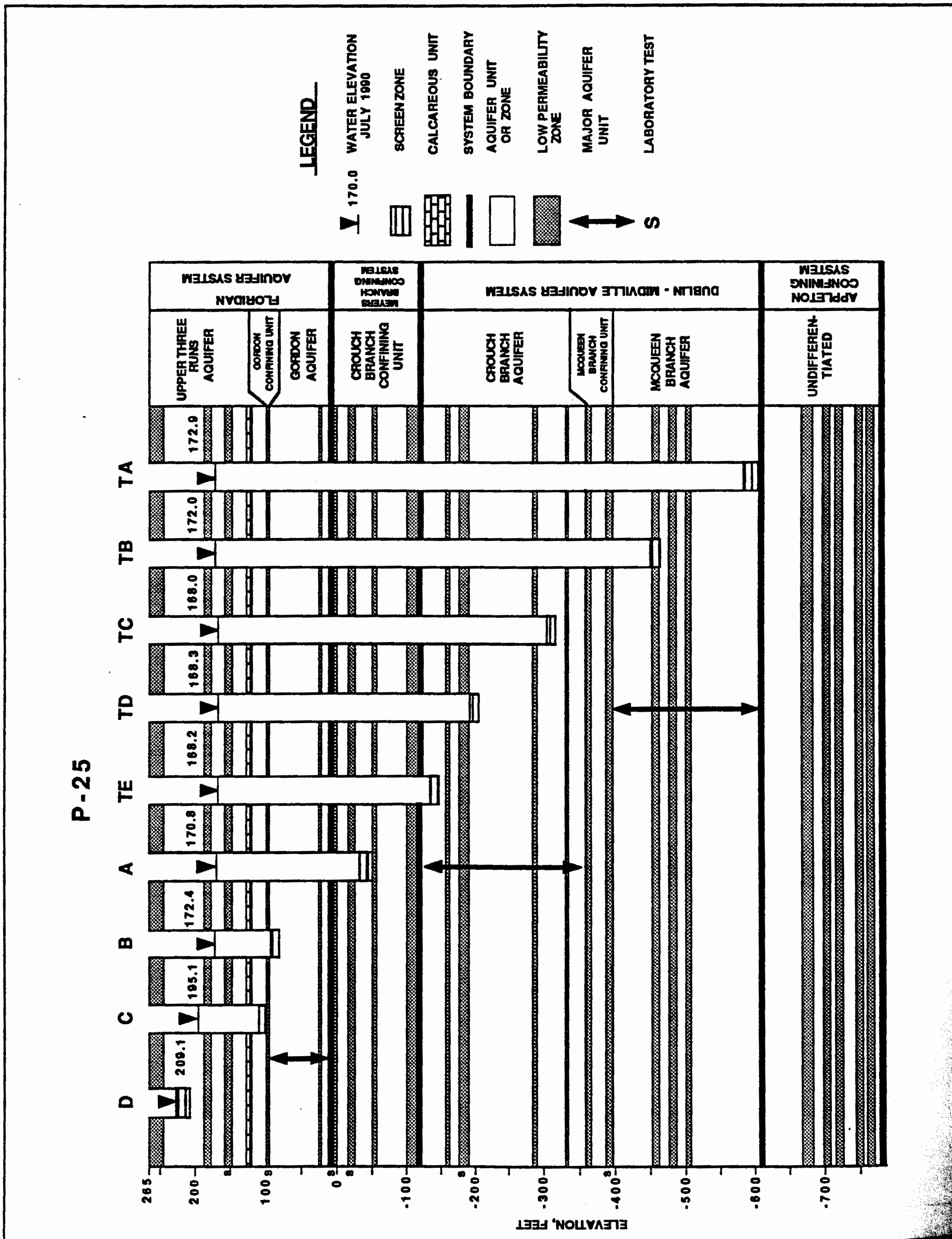

P-18
D
B
A
TD
TC
TB
TA
216.6
167.5
167.0
170.8
170.6
171.2
171.5
ELEVATION, FEET
296
200
100
0
-100
-200
-300
-400
-500
-600
S
UPPER THREE RUNS AQUIFER
GORDON CONFINING UNIT
GORDON AQUIFER
FLORIDAN AQUIFER SYSTEM
CROUCH BRANCH CONFINING UNIT
MEYERS BRANCH CONFINING SYSTEM
CROUCH BRANCH AQUIFER
McQUEEN BRANCH CONFINING UNIT
McQUEEN BRANCH AQUIFER
DUBLIN-MIDVILLE AQUIFER SYSTEM
UNDIFFERENTIATED
APPLETON CONFINING SYSTEM
LEGEND
170.0 WATER ELEVATION JULY 1990
SCREEN ZONE
CALCAREOUS UNIT
SYSTEM BOUNDARY
AQUIFER UNIT OR ZONE
LOW PERMEABILITY ZONE
MAJOR AQUIFER UNIT
S LABORATORY TEST


P-22
D
C
B
A
TD
TC
TB
TA
181.1
166.3
151.7
152.5
173.8
173.4
187.8
188.4
215
100
0
-100
-200
-300
-400
-500
-600
-700
-800
-900
ELEVATION, FEET
UPPER THREE RUNS AQUIFER
GORDON CONFINING UNIT
GORDON AQUIFER
CROUCH BRANCH CONFINING UNIT
CROUCH BRANCH AQUIFER
MCQUEEN BRANCH CONFINING UNIT
MCQUEEN BRANCH AQUIFER
UNDIFFERENTIATED
FLORIDAN AQUIFER SYSTEM
MEYERS BRANCH CONFINING SYSTEM
DUBLIN AQUIFER SYSTEM
ALLENDALE CONFINING SYSTEM
MIDVILLE AQUIFER SYSTEM
APPLETON CONFINING SYSTEM
LEGEND
170.0 WATER ELEVATION JULY 1990
SCREEN ZONE
CALCAREOUS UNIT
SYSTEM BOUNDARY
AQUIFER UNIT OR ZONE
LOW PERMEABILITY ZONE
MAJOR AQUIFER UNIT
S LABORATORY TEST

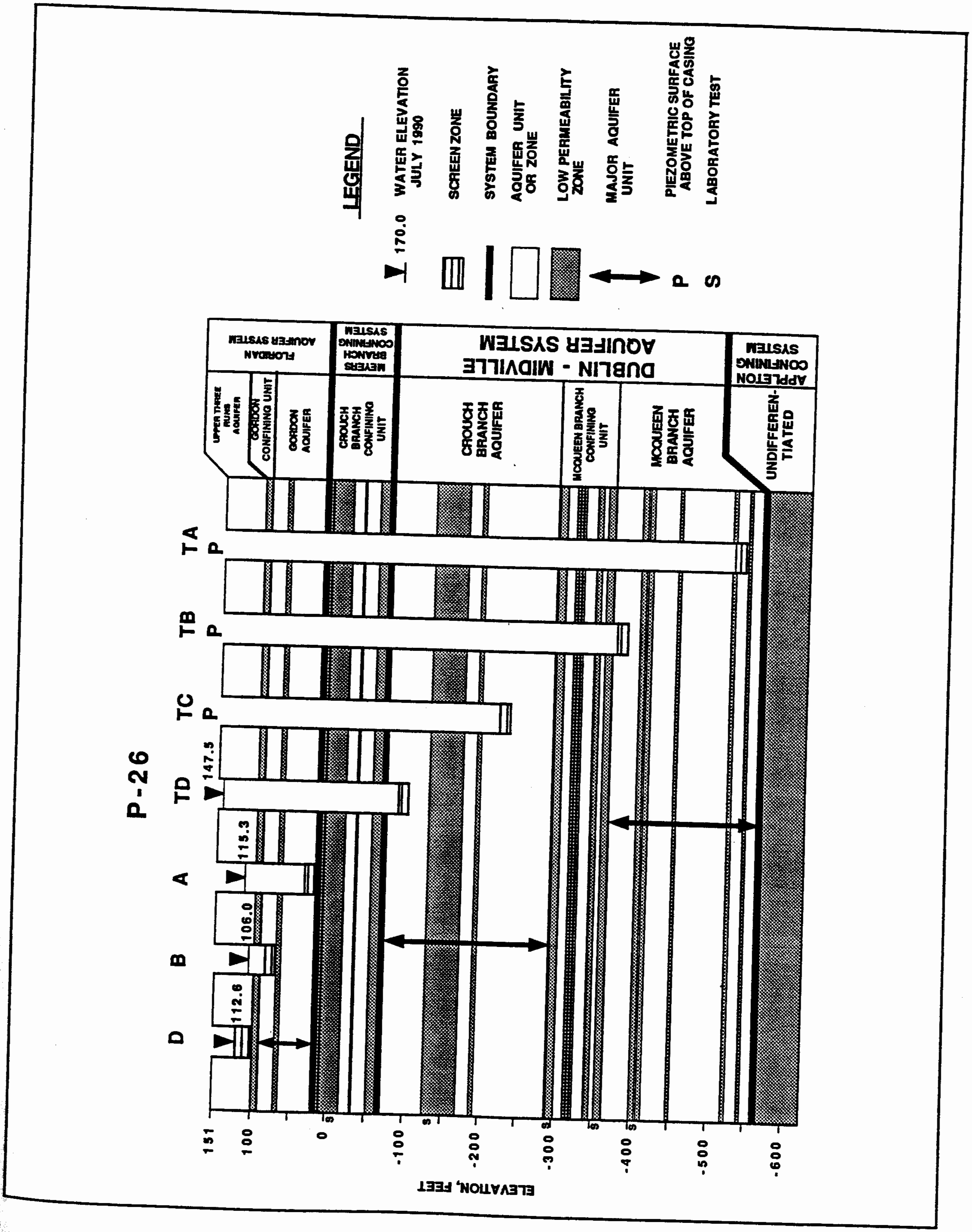


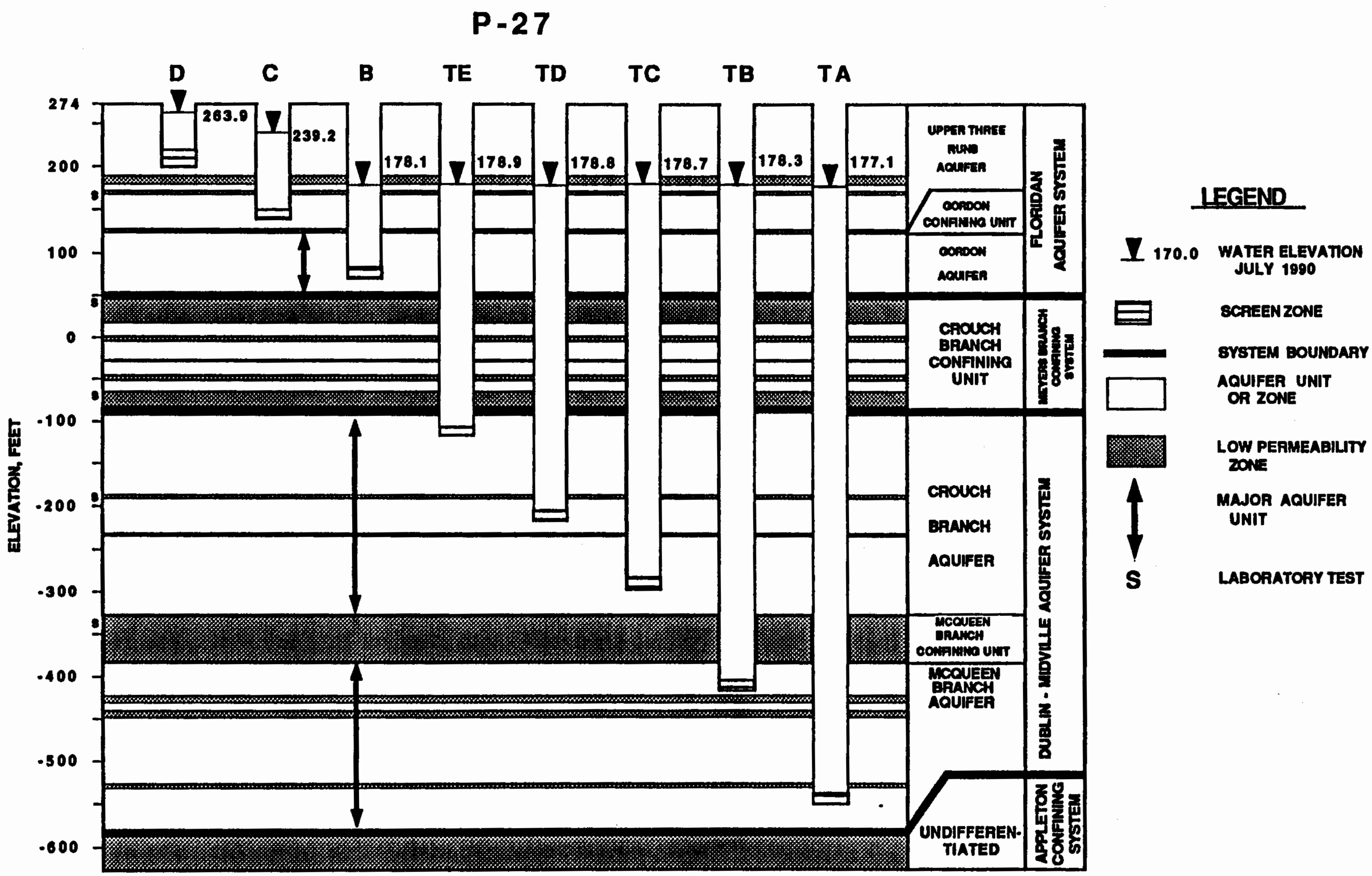
P-23
D
B
A
TE
TD
TC
TB
TA
139.1
136.1
144.8
161.5
161.8
165.2
167.4
166.1
UPPER THREE RUNS AQUIFER
GORDON CONFINING UNIT
GORDON AQUIFER
FLORIDAN AQUIFER SYSTEM
CROUCH BRANCH CONFINING UNIT
MEYERS BRANCH CONFINING SYSTEM
CROUCH BRANCH AQUIFER
MCQUEEN BRANCH CONFINING UNIT
MCQUEEN BRANCH AQUIFER
DUBLIN - MIDVILLE AQUIFER SYSTEM
UNDIFFEREN-TIATED
APPLETON CONFINING SYSTEM
LEGEND
170.0 WATER ELEVATION JULY 1990
SCREEN ZONE
CALCAREOUS UNIT
SYSTEM BOUNDARY
AQUIFER UNIT OR ZONE
LOW PERMEABILITY ZONE
MAJOR AQUIFER UNIT
S LABORATORY TEST
ELEVATION, FEET
182
100
0
-100
-200
-300
-400
-500
-600
-700
-800

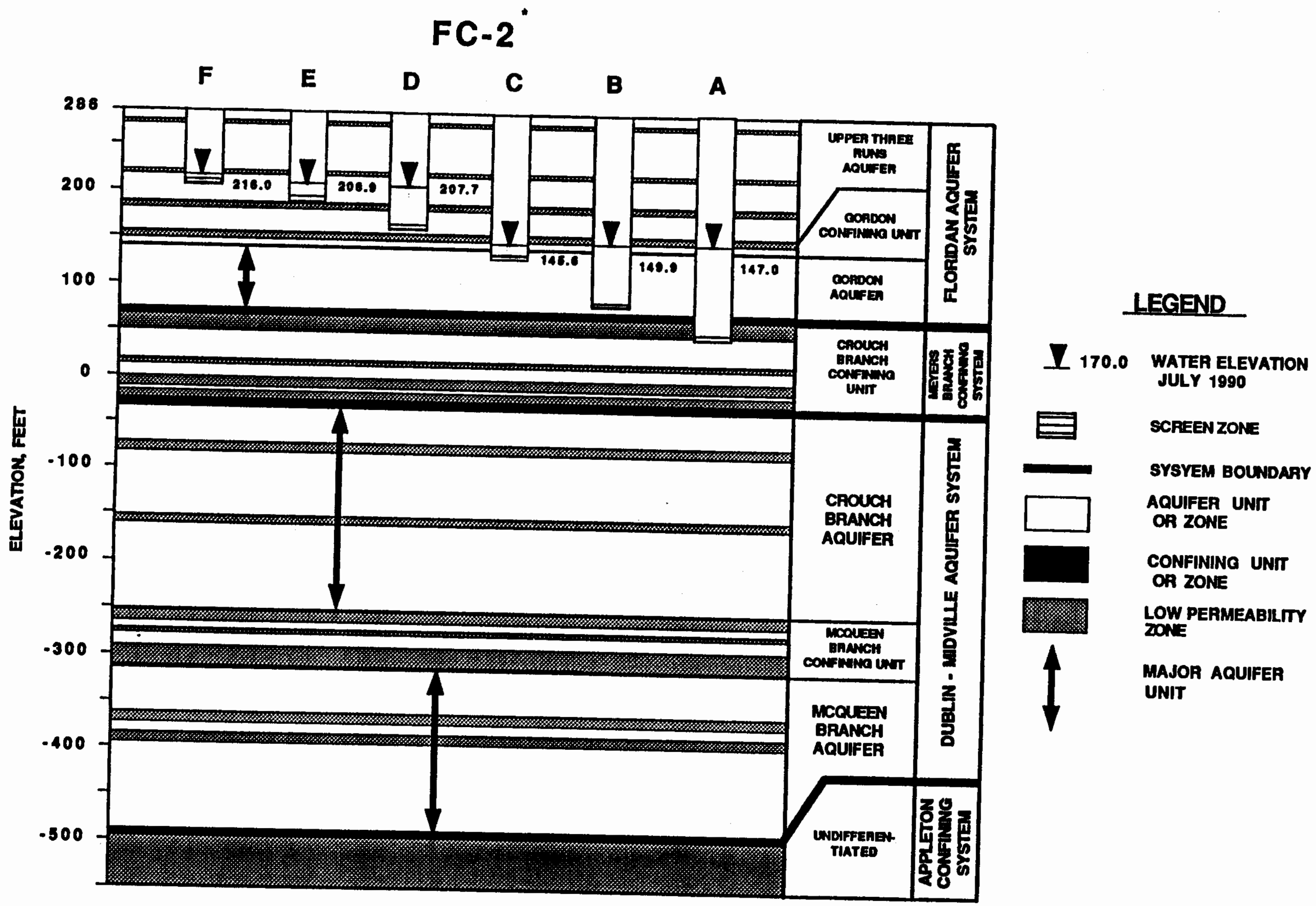

P-24
D
C
B
A
TD
TC
TB
TA
313
200
100
0
-100
-200
-300
-400
-500
-600
-700
ELEVATION, FEET
267.2
247.0
216.6
190.2
175.8
175.9
183.5
183.3
UPPER THREE RUNS AQUIFER
GORDON CONFINING UNIT
GORDON AQUIFER
FLORIDAN AQUIFER SYSTEM
CROUCH BRANCH CONFINING UNIT
MEYERS BRANCH CONFINING SYSTEM
CROUCH BRANCH AQUIFER
DUBLIN AQUIFER SYSTEM
MCQUEEN BRANCH CONFINING UNIT
ALLENDALE CONFINING SYSTEM
MCQUEEN BRANCH AQUIFER
MIDVILLE AQUIFER SYSTEM
UNDIFFEREN-TIATED
APPLETON CONFINING SYSTEM
LEGEND
170.0 WATER ELEVATION JULY 1990
SCREEN ZONE
CALCAREOUS UNIT
SYSTEM BOUNDARY
AQUIFER UNIT OR ZONE
LOW PERMEABILITY ZONE
MAJOR AQUIFER UNIT
S LABORATORY TEST



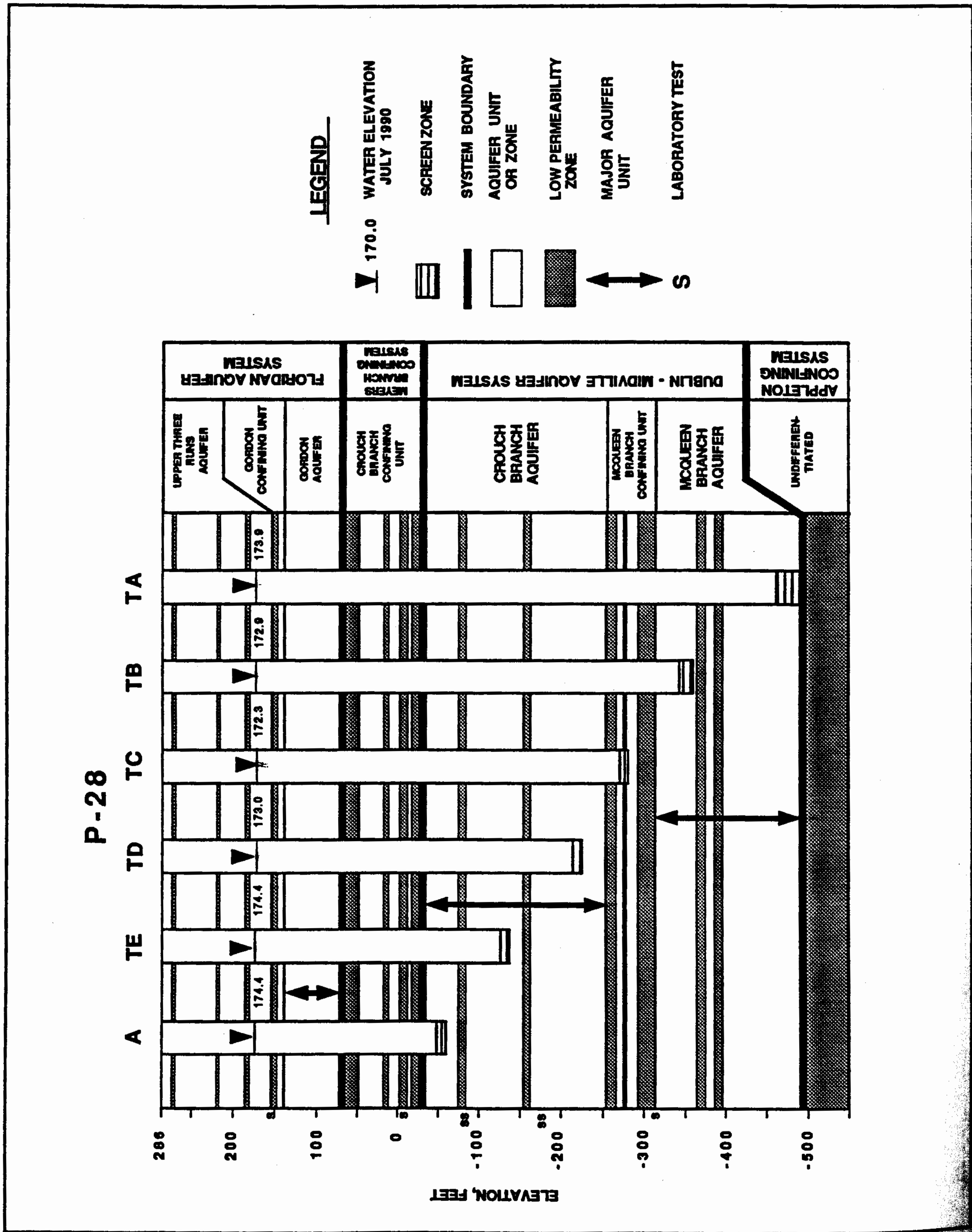
P-25
D
C
B
A
TE
TD
TC
TB
TA
209.1
195.1
172.4
170.8
168.2
168.3
168.0
172.0
172.9
ELEVATION, FEET
265
200
100
0
-100
-200
-300
-400
-500
-600
-700
UPPER THREE RUNS AQUIFER
GORDON CONFINING UNIT
GORDON AQUIFER
CROUCH BRANCH CONFINING UNIT
CROUCH BRANCH AQUIFER
MCQUEEN BRANCH CONFINING UNIT
MCQUEEN BRANCH AQUIFER
UNDIFFEREN-TIATED
FLORIDAN AQUIFER SYSTEM
MEYERS BRANCH CONFINING SYSTEM
DUBLIN - MIDVILLE AQUIFER SYSTEM
APPLETON CONFINING SYSTEM
LEGEND
170.0 WATER ELEVATION JULY 1990
SCREEN ZONE
CALCAREOUS UNIT
SYSTEM BOUNDARY
AQUIFER UNIT OR ZONE
LOW PERMEABILITY ZONE
MAJOR AQUIFER UNIT
S LABORATORY TEST


P-26
D
B
A
TD
TC P
TB P
TA P
112.6
106.0
115.3
147.5
UPPER THREE RUNS AQUIFER
GORDON CONFINING UNIT
GORDON AQUIFER
FLORIDAN AQUIFER SYSTEM
CROUCH BRANCH CONFINING UNIT
MEYERS BRANCH CONFINING SYSTEM
CROUCH BRANCH AQUIFER
MCQUEEN BRANCH CONFINING UNIT
MCQUEEN BRANCH AQUIFER
DUBLIN - MIDVILLE AQUIFER SYSTEM
UNDIFFEREN-TIATED
APPLETON CONFINING SYSTEM
ELEVATION, FEET
151
100
0
-100
-200
-300
-400
-500
-600
LEGEND
170.0 WATER ELEVATION JULY 1990
SCREEN ZONE
SYSTEM BOUNDARY
AQUIFER UNIT OR ZONE
LOW PERMEABILITY ZONE
MAJOR AQUIFER UNIT
P PIEZOMETRIC SURFACE ABOVE TOP OF CASING
S LABORATORY TEST

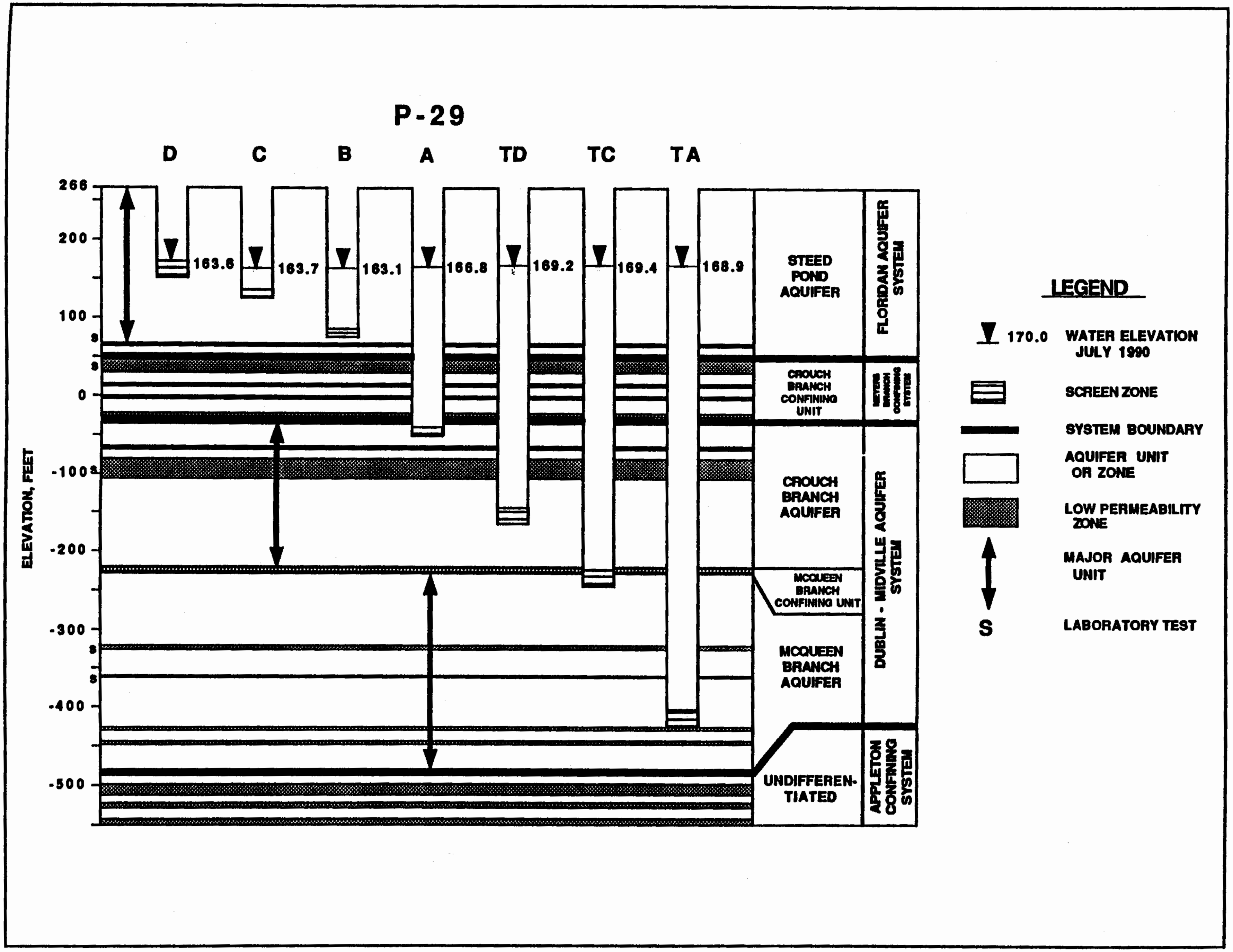

P-27
D
C
B
TE
TD
TC
TB
TA
263.9
239.2
178.1
178.9
178.8
178.7
178.3
177.1
ELEVATION, FEET
274
200
100
0
-100
-200
-300
-400
-500
-600
UPPER THREE RUNS AQUIFER
GORDON CONFINING UNIT
GORDON AQUIFER
FLORIDAN AQUIFER SYSTEM
CROUCH BRANCH CONFINING UNIT
MEYERS BRANCH CONFINING SYSTEM
CROUCH BRANCH AQUIFER
MCQUEEN BRANCH CONFINING UNIT
MCQUEEN BRANCH AQUIFER
DUBLIN - MIDVILLE AQUIFER SYSTEM
UNDIFFEREN-TIATED
APPLETON CONFINING SYSTEM
LEGEND
170.0 WATER ELEVATION JULY 1990
SCREEN ZONE
SYSTEM BOUNDARY
AQUIFER UNIT OR ZONE
LOW PERMEABILITY ZONE
MAJOR AQUIFER UNIT
S LABORATORY TEST



*Wells are screened in the shallow hydrostratigraphic interval at the P-28 cluster location.



P-28
A
TE
TD
TC
TB
TA
174.4
174.4
173.0
172.3
172.9
173.9
ELEVATION, FEET
286
200
100
0
-100
-200
-300
-400
-500
UPPER THREE RUNS AQUIFER
GORDON CONFINING UNIT
GORDON AQUIFER
CROUCH BRANCH CONFINING UNIT
CROUCH BRANCH AQUIFER
MCQUEEN BRANCH CONFINING UNIT
MCQUEEN BRANCH AQUIFER
UNDIFFERENTIATED
FLORIDAN AQUIFER SYSTEM
MEYERS BRANCH CONFINING SYSTEM
DUBLIN - MIDVILLE AQUIFER SYSTEM
APPLETON CONFINING SYSTEM
LEGEND
170.0 WATER ELEVATION JULY 1990
SCREEN ZONE
SYSTEM BOUNDARY
AQUIFER UNIT OR ZONE
LOW PERMEABILITY ZONE
MAJOR AQUIFER UNIT
S LABORATORY TEST


P-29
D
C
B
A
TD
TC
TA
266
200
100
0
-100
-200
-300
-400
-500
ELEVATION, FEET
163.6
163.7
163.1
166.8
169.2
169.4
168.9
STEED POND AQUIFER
CROUCH BRANCH CONFINING UNIT
CROUCH BRANCH AQUIFER
MCQUEEN BRANCH CONFINING UNIT
MCQUEEN BRANCH AQUIFER
UNDIFFEREN-TIATED
FLORIDAN AQUIFER SYSTEM
DUBLIN - MIDVILLE AQUIFER SYSTEM
APPLETON CONFINING SYSTEM
LEGEND
170.0 WATER ELEVATION JULY 1990
SCREEN ZONE
SYSTEM BOUNDARY
AQUIFER UNIT OR ZONE
LOW PERMEABILITY ZONE
MAJOR AQUIFER UNIT
S LABORATORY TEST

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