WATER USE

The Clayton aquifer supplied an estimated 19.8 Mgal/d during 1980 (table 3), of which about 58 percent was used by municipalities, 35 percent by agriculture, and 7 percent by industry. Major users of the Clayton include the cities of Albany and Dawson; industries in Dougherty, Terrell, and Early Counties; and agricultural users in Calhoun, Lee, Clay, Dougherty, Terrell, Sumter, Early, and Randolph Counties.

Table 3.--Estimated water use from the Clayton aquifer, 1980

[<, less than]

County	Ground-water use (Mgal/d)			
	Agricultural[1]	Industrial	Municipal	Total[2]
Calhoun	1.1	—	0.5	1.6
Clay	.6	—	<.1	.6
Dooly	.1	—	<.1	.1
Dougherty	.4	0.2	7.9	8.5
Early	.3	.3	.8	1.4
Lee	.3	<.1	.5	.8
Mitchell	<.1	—	—	<.1
Randolph	2.7	—	.6	3.3
Sumter	.3	—	—	.3
Terrell	1.1	1.0	1.1	3.2
Webster	<.1	—	<.1	<.1
Total	6.9	1.5	11.4	19.8

1/ Values are estimated growing-season withdrawals averaged over a 365-day period.
2/ Total excludes domestic use.

MUNICIPAL USE

DAWSON

The city of Dawson is supplied by a system of three wells tapping the Clayton aquifer that yielded an average of 1 Mgal/d in 1980. Ground-water use in Dawson increased 0.65 Mgal/d or about 190 percent over the period 1958-80 (fig. 27).

BLAKELY

A system of three wells tapping the Clayton aquifer supplied an average 0.8 Mgal/d to the city of Blakely in 1980. Ground-water use in Blakely increased 0.2 Mgal/d or about 30 percent over the period 1960-80 (fig. 27).

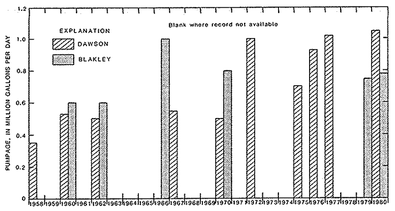

Figure 27.—Average daily ground-water withdrawals by Dawson and Blakely supply wells.

ALBANY

Since pumping began at Albany, water use has increased in response to population and industrial growth (fig. 21). Estimated water use at Albany increased from 0.025 Mgal/d in 1898 (McCallie, 1898, p. 181) to 4.8 Mgal/d in 1950. By 1980, the city of Albany was supplied by a system of 23 multiaquifer wells that produced 16 Mgal/d, an increase of about 235 percent from 1950. The Clayton aquifer yielded an estimated 7.2 Mgal/d, or about 45 percent of the 1980 supply.

CUTHBERT

The city of Cuthbert has a system of three wells tapping the Clayton aquifer that produced an average of 0.6 Mgal/d in 1980. Ground-water use increased 0.25 Mgal/d or 71 percent in Cuthbert over the period 1965-80 (fig. 26).

AGRICULTURAL USE

Ground-water withdrawals from the Clayton aquifer by agricultural users were computed by averaging the estimated growing season withdrawals over a 365-day period. The Clayton aquifer supplied an estimated 6.9 Mgal/d--about 35 percent of the total water pumped from the Clayton--to agricultural users during 1980 (table 3). Agricultural withdrawals exceeded 1 Mgal/d each in Randolph, Terrell, and Calhoun Counties. In addition, there are a large number of high-yielding irrigation wells of unknown construction in the study area, many of which probably tap the Clayton aquifer. Withdrawals from these wells were not estimated. Thus, total agricultural withdrawal from the Clayton during 1980 was probably greater than 6.9 Mgal/d. McFadden and Perriello (1983) included wells of unknown construction in their estimation of water use and reported that 15.5 Mgal/d was withdrawn from the Clayton aquifer by agricultural users in 1980.

In 1955 there were only 57 ground-water-supplied irrigation systems in southwest Georgia, but by 1979 the number had risen to about 3,000, an increase of more than 5,000 percent (Ripy and others, 1981, p. 4-5). The number of ground-water-supplied irrigation systems in southwest Georgia increased sharply from 1976 to 1981. According to Ripy and others (1981, p. 4-5), the number of irrigation wells increased 77 percent during 1977 in the area that includes Early, Clay, Quitman, Stewart, Randolph, Calhoun, Dougherty, Terrell, Webster, Lee, Sumter, Schley, Macon, Dooly, and Crisp Counties. Because the Clayton aquifer is an important source of water in these counties, it is likely that many of the wells tap the Clayton aquifer.

WELL CONSTRUCTION

Wells tapping the Clayton aquifer typically have open-hole or screenline construction, or a combination of both types (fig. 28; Appendix A). Where the aquifer consists of competent limestone, open-hole construction generally is used. Where the aquifer consists of sand and sandy limestone, screenlines generally are used (well 9P3, fig. 7; Appendix A). A combination of open-hole and screen-line construction may be used in areas where the Clayton consists of both consolidated limestone and loose sand or sandy limestone (well 12L9, fig. 7; Appendix A).

In some areas, the Clayton aquifer supplies insufficient quantities of water to meet municipal and industrial requirements and is used in combination with other aquifers. At Americus, Sumter County, multiaquifer wells tap combinations of the Clayton, Providence, Cusseta, and Blufftown aquifers. In municipal wells at Albany, the Clayton aquifer is used in combination with the Providence and Claiborne aquifers (well 12L9, fig. 7; Appendix A).

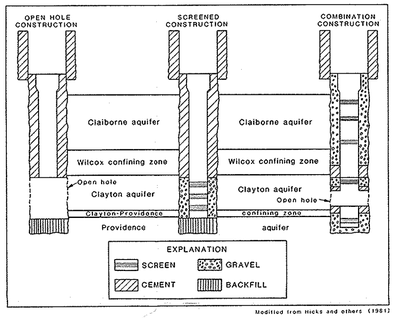

Figure 28.—Typical well construction.

WATER QUALITY

Water from the Clayton aquifer shows areal variations in constituent concentrations, but in that part of the study area where data are available, the concentrations generally do not exceed the Georgia Environmental Protection Division (1977) standards and recommended limits for drinking water (Appendix B).

The concentrations of dissolved solids and most other constituents appear to increase from the outcrop area southward (fig. 29; Appendix B). Concentrations of dissolved constituents in the southeastern part of the area, both within and south of the Gulf Trough (fig. 8), may exceed drinking water standards. Evidence of poor-quality water in the principal artesian and Claiborne aquifers (table 1) south of the Gulf Trough was reported by Wait (1960d).

The iron concentration in water from three wells (7N1, 7M1, 6M1) tapping the Clayton aquifer in Randolph County exceeds the 300 ug/L recommended limit set for drinking water (Appendix B). Iron concentrations in excess of 300 ug/L may result in the formation of a reddish-brown precipitate which will stain porcelain, white enamel, and clothing. Iron may be removed from water by aeration, coagulation, and filtration.

Throughout much of the study area where data are available, water from the Clayton aquifer has a calcium, magnesium hardness exceeding 100 mg/L and is classified as moderately hard to hard (fig. 29; Appendix B). Hardness exceeding 100 mg/L may result in reduced lathering of soap and the formation of scale on cooking utensils, and in boilers and hot water lines (Hem, 1970, p. 225). Hard water can be softened by ion exchange and through chemical treatment.

A diagram showing the chemical classification of ground water according to type is shown in figure 30. The plots represent the percentage concentrations of the various groups of ions in the water. The percentages were calculated from concentrations in milliequivalents per liter and were based on the sum of

Figure 29.—Distribution of hardness as $CaCO_3$ and dissolved-solids concentrations in ground water from the Clayton aquifer, 1946-83.

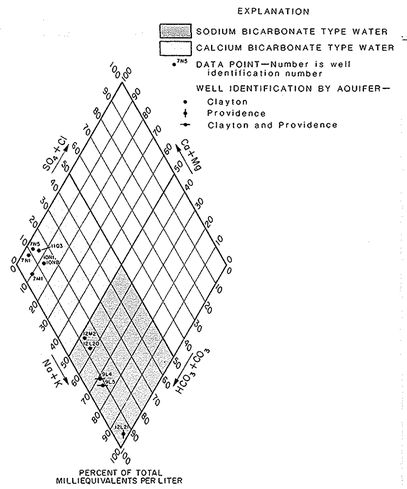

Figure 30.—Chemical classification according to type of ground water from the Clayton and Providence aquifers.

either the cations or the anions. Water from the Clayton and Providence aquifers has distinct chemical characteristics. Water from the Clayton is generally a moderately hard to hard, calcium carbonate type characteristic of limestone (well 7N1, at Cuthbert, Randolph County). On the other hand, water from the Providence aquifer is a soft, sodium bicarbonate type (well 12L21, at Albany, Dougherty County) typical of sand that contains much sodium feldspar. The sodium also may be derived from base exchange between calcium in the ground water and sodium in certain clay minerals (Wait, 1960b, p. 99). Wells tapping both aquifers yield a composite water representing a mixture controlled by the percentage of yield from each aquifer (well 9L4, at Morgan, Calhoun County).

In the Albany area, water from the Clayton aquifer has higher concentrations of sodium than elsewhere, and is a sodium bicarbonate type water (wells 12L20, 12M2), similar to water from the Providence aquifer (well 12L21). The similarity of water in the aquifers may indicate that: (1) water in the Clayton aquifer was derived, in part, from sodium-bearing sand in the lower part of the Clayton aquifer; (2) water from the Providence aquifer flowed into the Clayton aquifer through multiaquifer wells; or (3) water from the Providence aquifer leaked through the Clayton-Providence confining zone into the Clayton aquifer.

The first process, postulated by Wait (1960d, p. 12), probably has an effect on water quality in areas where the lower part of the Clayton aquifer consists of sodium-bearing sand. The second process occurs in the Albany, Dawson, and Leary areas, where multiaquifer wells tap both the Clayton and Providence aquifers. The third process may happen in areas where water from the Providence aquifer under higher head leaks upward into the Clayton aquifer. This probably occurs north and upgradient from multiaquifer wells at Albany where the Clayton aquifer does not include sodium-bearing sands (well 12N2; fig. 30).

CONVERSION FACTORS

For use of readers who prefer to use metric units, conversion factors for terms used in this report are listed below:

Multiply	By	To obtain
Length		
foot (ft)	0.3048	meter (m)
inch (in)	25.4	millimeter (mm)
mile (mi)	1.609	kilometer (km)
Area		
square mile (mi^2)	2.590	square kilometer (km^2)
Flow		
gallon per minute (gal/min)	0.06309	liter per second (L/s)
million gallon per day (Mgal/d)	0.04381	cubic meter per second (m^3/s)
	43.81	liter per second (L/s)
Volume		
Part per million	1.0	milligram per liter (mg/L)
	1000.0	microgram per liter (ug/L)
Transmissivity		
foot squared per day (ft^2/d)	0.0929	meter squared per day (m^2/d)
Specific capacity		
gallon per minute per foot [(gal/min)/ft]	0.2070	liter per second per meter [(L/s)/m]
Specific conductance		
micromho per centimeter at 25° Celsius (umoho/cm at 25°C)	1.000	microsiemens per centimeter at 25° Celsius (uS/cm at 25°C)
Temperature		
degree Fahrenheit (°F)	°C = 5(°F-32)/9	degree Celsius (°C)

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.

SUMMARY

The Clayton aquifer of southwest Georgia consists of limestone and calcareous sand of Paleocene age and ranges in thickness from about 10 to 265 ft. The lithology of the aquifer is characterized by three provinces: (1) A clastic province in the northern part of the study area in which the principal sediments are sand and clay, (2) a carbonate province in the southern two thirds of the study area in which the principal sediments are limestone and calcareous sand, and (3) a transition province that occurs between the clastic and carbonate provinces and contains sedimentary elements common to both areas. The water-bearing characteristics of the aquifer are greatest in the carbonate province where transmissivities of 11,000 ft^2/d and yields of 2,150 gal/min have been reported.

During 1980, an estimated 20 Mgal/d was pumped from the Clayton aquifer. The greatest pumpage was in the Dawson and Albany areas where, by 1981, water levels in the Clayton aquifer had declined below predevelopment levels by as much as 150 and 175 ft, respectively. The rate of decline accelerated after 1976, corresponding to a significant increase in irrigation pumping throughout the study area.

The aquifer is recharged by precipitation in the northeast-trending outcrop belt; by leakage from the underlying Providence aquifer and overlying Wilcox confining zone downdip; and through idle multiaquifer wells in Albany, Dawson, and Leary. Declining water levels in the Clayton aquifer have increased the potential for leakage from the overlying and underlying units.

Constituent concentrations in water from the Clayton aquifer generally do not exceed drinking water standards. Exceptions are high concentrations of iron in Randolph County and possibly high dissolved-constituent concentrations in the vicinity of the Gulf Trough in the southeastern part of the study area.

SELECTED REFERENCES

Applin, E. R., and Applin, P. L., 1964, Logs of selected wells in the Coastal Plain of Georgia: Georgia Geological Survey Bulletin 74, 229 p.

Chowns, T. M., and Williams, C. T., 1983, Pre-Cretaceous rocks beneath the Georgia Coastal Plain--Regional implications, in Gohn, G. S., ed., Studies related to the Charleston, South Carolina earthquake of 1886--Tectonics and seismicity: U.S. Geological Survey Professional Paper 1313-L, p. L1-L42.

Clarke, J. S., Faye, R. E., and Brooks, Rebekah, 1983, Hydrogeology of the Providence aquifer of southwest Georgia: Georgia Geologic Survey Hydrologic Atlas 11, 5 sheets.

Copeland, C. W., 1974, Generalized stratigraphy of southeastern Alabama, in Stafford, L. P., [compiler], Symposium on the petroleum geology of the Georgia Coastal Plain: Georgia Geological Survey Bulletin 87, 85 p.

Ferris, J. G., Knowles, R. H., Brown, R. H., and Stallman, R. W., 1962, Theory of aquifer tests: U.S. Geological Survey Water-Supply Paper 1536-E, 173 p.

Georgia Environmental Protection Division, 1977, Rules for safe drinking water: chapter 391-3-5, 57 p.

Georgia Geological Survey, 1976, Geologic map of Georgia: Atlanta, Ga., scale 1:500,000.

Gibson, T. G., 1982a, New stratigraphic unit in the Wilcox Group (upper Paleocene-lower Eocene) in Alabama and Georgia, in U.S. Geological Survey, 1982, Stratigraphic notes, 1980-82, U.S. Geological Survey Bulletin 1529-H, p. H23-H32.

_____1982b, Revision of the Hatchetigbee and Bashi Formations (lower Eocene) in the eastern Gulf Coastal Plain, in U.S. Geological Survey, 1982, Stratigraphic notes, 1980-82, U.S. Geological Survey Bulletin 1529-H, p. H33-H41.

Gibson, T. G., and Bybell, L. M., 1981, Facies changes in the Hatchetigbee Formation in Alabama-Georgia and the Wilcox-Claiborne unconformity: Transactions of the Gulf Coast Association of Geological Societies, v. 31, p. 301-306.

Hem, J. D., 1970, Study and interpretation of the chemical characteristics of natural water, 2nd ed., U.S. Geological Survey Water-Supply Paper 1473, 363 p.

Herrick, S. M., 1961, Well logs of the Coastal Plain of Georgia: Georgia Geological Survey Bulletin 70, 462 p.

Herrick, S. M., and Vorhis, R. C., 1963, Subsurface geology of the Georgia Coastal Plain: Georgia Geological Survey Information Circular 25, 79 p.

Hicks, D. W., Krause, R. E., and Clarke, J. S., 1981, Geohydrology of the Albany area, Georgia: Georgia Geologic Survey Information Circular 57, 31 p.

LeGrand, H. E., 1962, Geology and ground-water resources of the Macon area, Georgia: Georgia Geological Survey Bulletin 72, 68 p.

Lohman, S. W., 1972, Ground-water hydraulics: U.S. Geological Survey Professional Paper 708, 70 p.

McCallie, S. W., 1898, A preliminary report on the artesian well system of Georgia: Georgia Geological Survey Bulletin 7, 214 p.

McFadden, S. S., and Perriello, D. P., 1983, Hydrogeology of the Clayton and Claiborne aquifers in southwestern Georgia: Georgia Geologic Survey Information Circular 55, 59 p.

Marsalis, W. E., and Friddell, M. S., 1975, A guide to selected Upper Cretaceous and lower Tertiary outcrops in the lower Chattahoochee River valley of Georgia: Georgia Geological Survey, Guidebook 15, 79 p.

Miller, J. A., 1982, Geology and configuration of the top of the Tertiary limestone aquifer system, Southeastern United States: U.S. Geological Survey Open-File Report 81-1178, 1 sheet.

Newton, J. G., 1965, Geologic map of Barbour County, Alabama: Geological Survey of Alabama Map 33.

Owen, Vaux, 1963, Geology and ground-water resources of Lee and Sumter Counties, southwest Georgia: U.S. Geological Survey Water-Supply Paper 1666, 67 p.

Patterson, S. H., and Herrick, S. M., 1971, Chattahoochee anticline, Apalachicola embayment, Gulf Trough, and related structural features, southwestern Georgia: Georgia Geological Survey Information Circular 41, 16 p.

Reinhardt, Juergen, and Gibson, T. G., 1980, Upper Cretaceous and lower Tertiary geology of the Chattahoochee River valley, western Georgia and eastern Alabama, with contributions by Bybell, L., Edwards, L. E., Frederickson, N., Smith, C., and Shol, N. F.: Geological Society of America Fieldtrip Guidebook 20, 78 p.

Ripy, B. J., McFadden, S. S., Perriello, P. D., and Gernazian, A. M., 1981, An interim report on the hydrogeology of the Clayton and Claiborne aquifers in southwestern Georgia: Georgia Geologic Survey Open-File Report 82-2, 66 p.

Rountree, R. G., Jones, F. B., and Arden, D. D., 1978, Evidence for faulting in Sumter County, Georgia (abs.): Georgia Scientific Journal, v. 36, p. 94.

Stephenson, L. W., and Veatch, J. O., 1915, Underground waters of the Coastal Plain of Georgia, and a discussion of The quality of the waters, by R. B. Dole: U.S. Geological Survey Water-Supply Paper 341, 539 p.

Stewart, J. W., 1973, Dewatering of the Clayton Formation during construction of the Walter F. George Lock and Dam, Fort Gaines, Clay County, Georgia: U.S. Geological Survey Water-Resources Investigations 2-73, 22 p.

Toulmin, L. D., and LaMoreaux, P. E., 1963, Stratigraphy along the Chattahoochee River, connecting link between the Atlantic and the Gulf Coastal Plains: American Association of Petroleum Geologists, v. 47, no. 3, p. 385-403.

U.S. Environmental Protection Agency, 1977, National interim primary drinking water regulations: EPA-570/9-76-003, 159 p.

Wait, R. L., 1960a, Summary of the ground-water resources of Calhoun County, Georgia: Georgia Geological Survey Mineral Newsletter, v. 13, no. 1, p. 26-31.

_____1960b, Summary of the geology and ground-water resources of Clay County, Georgia: Georgia Geological Survey Mineral Newsletter, v. 13, no. 2, p. 93-101.

_____1960c, Summary of the ground-water resources of Terrell County, Georgia: Georgia Geological Survey Mineral Newsletter, v. 13, no. 3, p. 117-122.

_____1960d, Source and quality of ground water in southwestern Georgia: Georgia Geological Survey Information Circular 18, 74 p.

_____1963, Geology and ground-water resources of Dougherty County, Georgia: U.S. Geological Survey Water-Supply Paper 1539-P, p. P1-P102.

Warren, M. H., 1944, Artesian water in southeastern Georgia, with special reference to the coastal area: Georgia Geological Survey Bulletin 49, 140 p.

Zapp, A. D., 1943, Andersonville bauxite district, Georgia: U.S. Geological Survey Strategic Minerals Investigations Preliminary Map.

_____1965, Bauxite deposits of the Andersonville District, Georgia: U.S. Geological Survey Bulletin 1199-G, p. G9.

Zimmerman, E. A., 1977, Ground-water resources of Colquitt County, Georgia: U.S. Geological Survey Open-File Report 77-56, 41 p.

HYDROGEOLOGY OF THE CLAYTON AQUIFER OF SOUTHWEST GEORGIA.

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1984

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