REPORT OF A CAPACITY-USE INVESTIGATION FOR HAMPTON COUNTY SOUTH CAROLINA

by

A. Drennan Park

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and

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Open-File Report No. 40

South Carolina Water Resources Commission

March 1991

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OF
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ABSTRACT

On December 17, 1990 the County Council of Hampton County requested the South Carolina Water Resources Commission to declare Hampton County a Capacity Use Area. The request stemmed from complaints of domestic well interference.

Approximately 45 Floridan-aquifer wells in southern Hampton County experienced loss of yield as the result of extensive water level declines. Ground-water levels in the county declined as much as 20 feet prior to 1976, and as much as 8 feet between 1976 and 1990. The declines were caused by increased ground-water use by agriculture and aquaculture in Hampton County and by public-supply, industrial, and irrigation use in areas to the south.

The most severe water-level declines have occurred near new high-capacity wells. Well-interference problems can be mitigated by implementing conservation measures, including use of aquifers other than the upper Floridan, redistribution of withdrawals spatially and through time, and modification of the public-notice procedure employed in the ground-water use permitting program. Various drawdown experiments are illustrated to demonstrate the effects of each type of pumping scheme.

It is the authors' conclusion that the number of well-interference problems can be diminished by planning and coordination of ground-water use. They recommend the inclusion of Hampton County in the Lowcountry Capacity Use Area and the promulgation of policies and regulations to address water conservation and well interference.

INTRODUCTION

The South Carolina Water Resources Commission (SCWRC) has been requested to include Hampton County in a Capacity Use Area. The request was made by resolution of the County Council of Hampton County on December 17, 1990 (Appendix A). The location of the proposed Capacity Use Area is shown in Figure 1.

Background

Hampton County was included in the Lowcounty area Capacity Use investigation conducted by SCWRC and the U.S. Geological Survey (USGS) between 1976 and 1979. Spigner and Ransom (1979) subsequently recommended declaration of a Capacity Use Area for the four Lowcountry counties, and the County Council of Hampton County approved a resolution requesting exclusion from the Capacity Use Area. Regulations for the Lowcountry Capacity Use Area of Beaufort, Jasper, and Colleton Counties took effect in July 1980.

Hampton County residents became concerned about ground-water availability during the summer of 1990. Approximately 45 wells in the vicinities of Estill and Furman were debilitated as a result of regional and local artesian-pressure declines in the upper Floridan aquifer. Well problems included reduction in yield and water pressure, "dry" wells, and damage to pumps as water levels declined below pump intakes. Figure 2 shows the principal area of interference-induced well debilitation.

Previous Investigations

SCWRC investigated complaints by residents of the Lena-Estill area during May and June of 1990 (Whiting and Park, 1990; Gawne, 1990). Whiting and Park (1990) demonstrated that withdrawal at one site was a major contributor to well interference, but they noted that other users also contributed in varying degree. Gawne (1990) reviewed water-level data in a related study and reported seasonal declines of 5 to 10 ft (feet) in the western two-thirds of Hampton County and northwestern Jasper County.

Hayes (1979) presented geologic sections and structure, potentiometric, and isodecline maps of the Floridan aquifer in the Lowcountry area. Spigner and Ransom (1979) used Hayes' report as the basis of recommendations for ground-water management.

Information on Hampton County also is included in many regional reports. Counts and Krause (1976), Krause (1982), Randolph and Krause (1984), and Smith (1988) address digital models of the Floridan aquifer. Johnston and others (1980), Johnston and others (1982), Aucott and Speiran (1985a, 1985b, and 1985c) and Crouch and others (1987) included recent or predevelopment water-level data. Publications by Miller (1982a, 1982b, 1982c, and 1982d), Aucott and others (1987), and Krause and Randolph (1989) include the county as part of the regional hydrogeological framework.

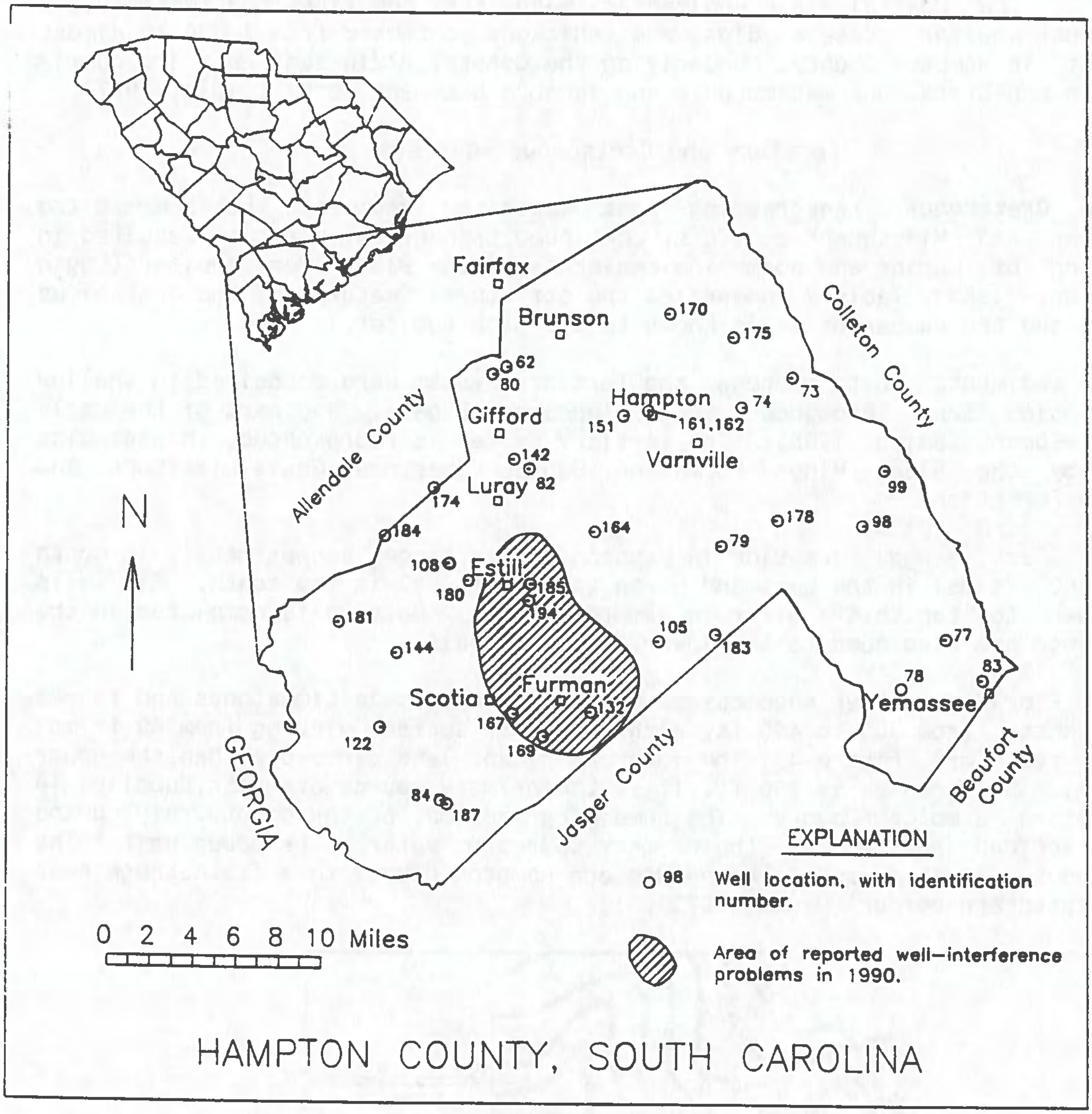

Figure 1. Location of Hampton County, selected observation wells, and area of reported well-interference.

HYDROGEOLOGY

All major aquifer systems of South Carolina's Coastal Plain are represented, in good thickness, in Hampton County (Newcome, 1989). The general geologic characteristics of these aquifers are summarized in Table 1 and Figure 3. The Coastal Plain sedimentary wedge that comprises the Tertiary and Cretaceous aquifer systems dips and thickens southward from 2,000 to almost 3,000 ft in Hampton County. Underlying the Coastal Plain sediments are poorly permeable pre-Cretaceous metamorphic and igneous basement rocks (Siple, 1957).

Tertiary and Cretaceous Aquifers

Late Cretaceous transgressing seas deposited sediments that compose the Cape Fear and Middendorf aquifers. Continued transgressive cycles resulted in deposition of marine and nonmarine sediments of the Black Creek aquifer (Logan and Euler, 1989). Table 2 summarizes the structural features of the Cretaceous aquifers and the number of wells known to tap each aquifer.

The sediments that compose the Tertiary System were deposited in shallow transgressing seas throughout the Paleocene, Eocene, and part of the early Miocene Epochs (Smith, 1988). The Tertiary System is represented, in ascending order, by the Black Mingo Formation, Santee Limestone, Ocala Limestone, and Hawthorn Formation.

The Black Mingo Formation in Hampton County ranges approximately in depth from -300 ft msl in the east and north to -500 ft msl in the south. Six wells are known to tap this aquifer in Hampton County. Most wells completed in the Black Mingo are also open to the lower Floridan aquifer.

The Floridan aquifer encompasses the Santee and Ocala Limestones and ranges in thickness from 300 to 400 ft, with the upper surface dipping from 80 ft msl to -50 feet msl (Figure 4). The lower Floridan, less permeable than the upper Floridan, is as thick as 200 ft. It is the primary source of water supplies in northeastern Hampton County. The remaining sections of the county rely on the upper Floridan aquifer as the primary source of water. The upper unit thins from about 100 ft in southern and western Hampton County to a featheredge near the northeastern border (Hayes, 1979).

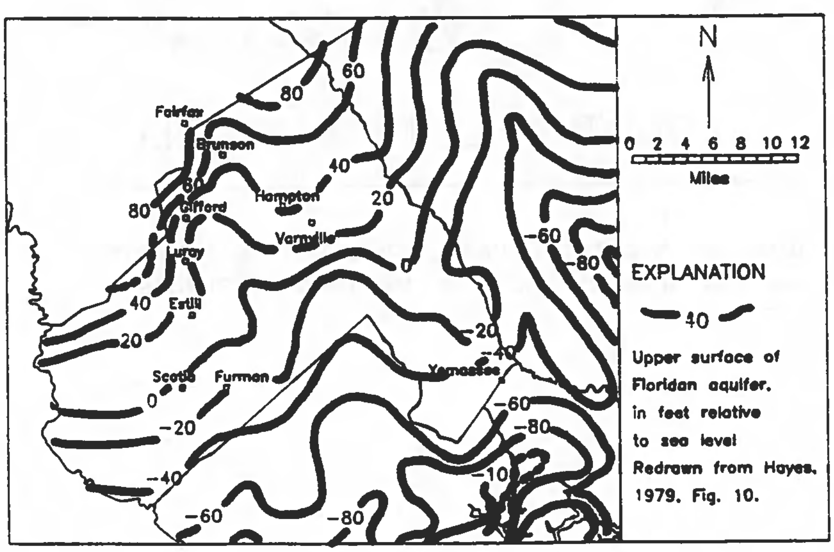

Figure 2. Configuration of the top of the Floridan aquifer (from Hayes, 1979).

The Hawthorn Formation exists in Hampton County but the lateral extent and thickness of this formation and its usefulness as an aquifer are not known. Wells tap the shallow aquifer system in parts of the Lowcountry and have yielded water of acceptable quantity and quality for domestic uses, but its use in Hampton County is uncertain (Hayes, 1979).

Table 1. Generalized geology of aquifer systems in Hampton County (adapted from Aucott and others, 1987)

Aquifer	System	Geologic formation	Description
Shallow	post-Miocene		Interbedded sand and clay
Hawthorn	Tertiary	Hawthorn Formation	Interbedded sandy green clay and gravelly sand beds
Floridan upper unit	Tertiary	Ocala	Calcitized, very fossiliferous limestone
lower unit		Santee Limestone	Siliceous, light-colored limestone
Black Mingo	Tertiary	Black Mingo Formation	Black sandy limestone; clay; light-gray sand; shell fragments
Black Creek	Cretaceous	Black Creek Formation	Gray and white calcareous sand; dark, thinly laminated clay
Middendorf	Cretaceous	Middendorf Formation	Fine- to coarse-grained sand, partially calcareous; green, purple, and maroon clay; greenish-gray silty sandstone
Cape Fear	Cretaceous	Cape Fear Formation	Clay; fine- to coarse-grained sand

Table 2. Upper surface structure of the Cretaceous aquifers in Hampton County (Aucott and others, 1987) and known number of wells completed in each

Aquifer	Dip	Depth below msl	Number of wells
Cape Fear	Southward, about 25 ft/mi	1,800 to 2,400 ft	0
Middendorf	Southward, about 30 ft/mi	1,200 to 1,800 ft	0
Black Creek	South to southeastward, about 20 ft/mi	600 to 1,100 ft	16

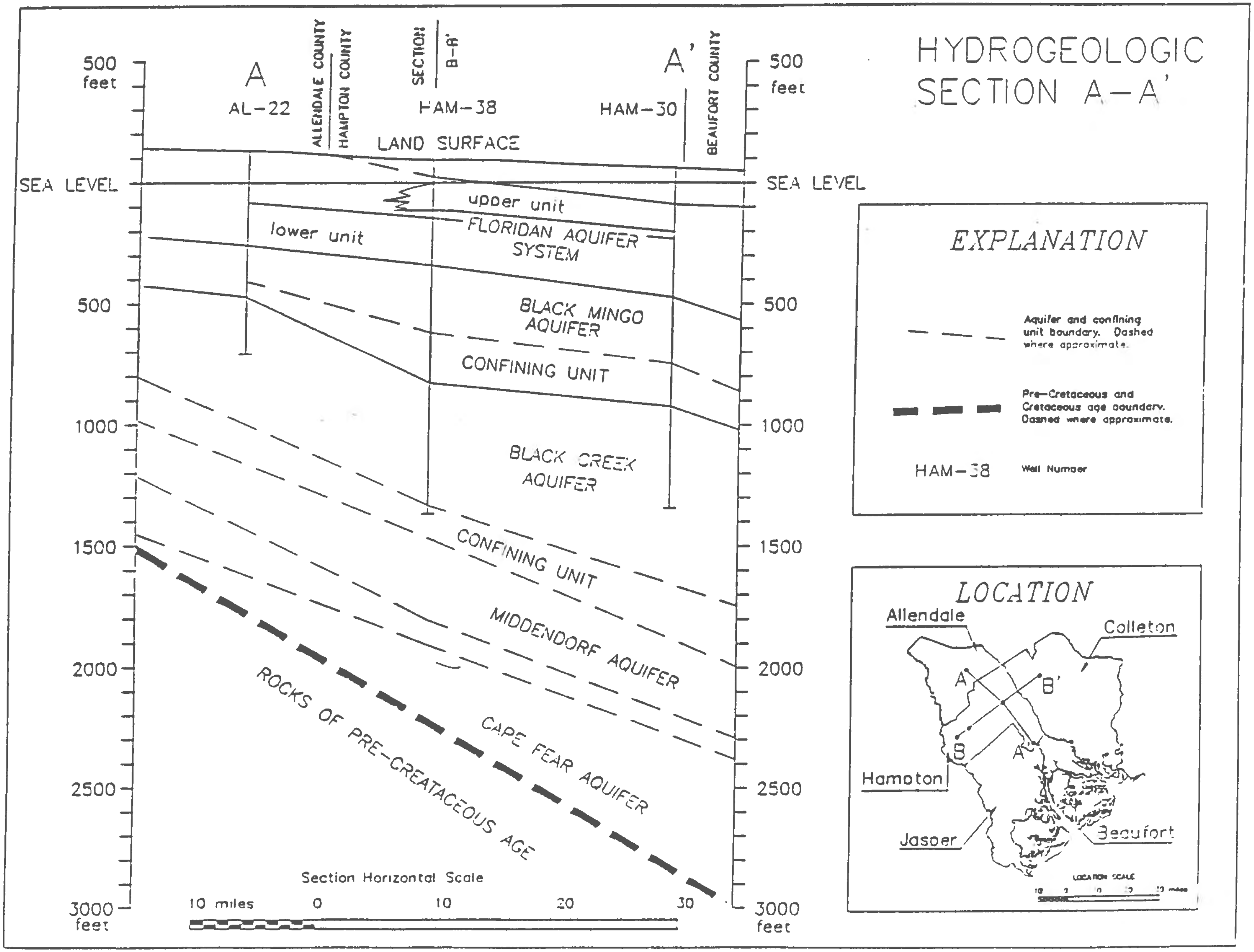

Figure 3. Hydrogeologic section A - A' (modified from Aucott and others, 1987).

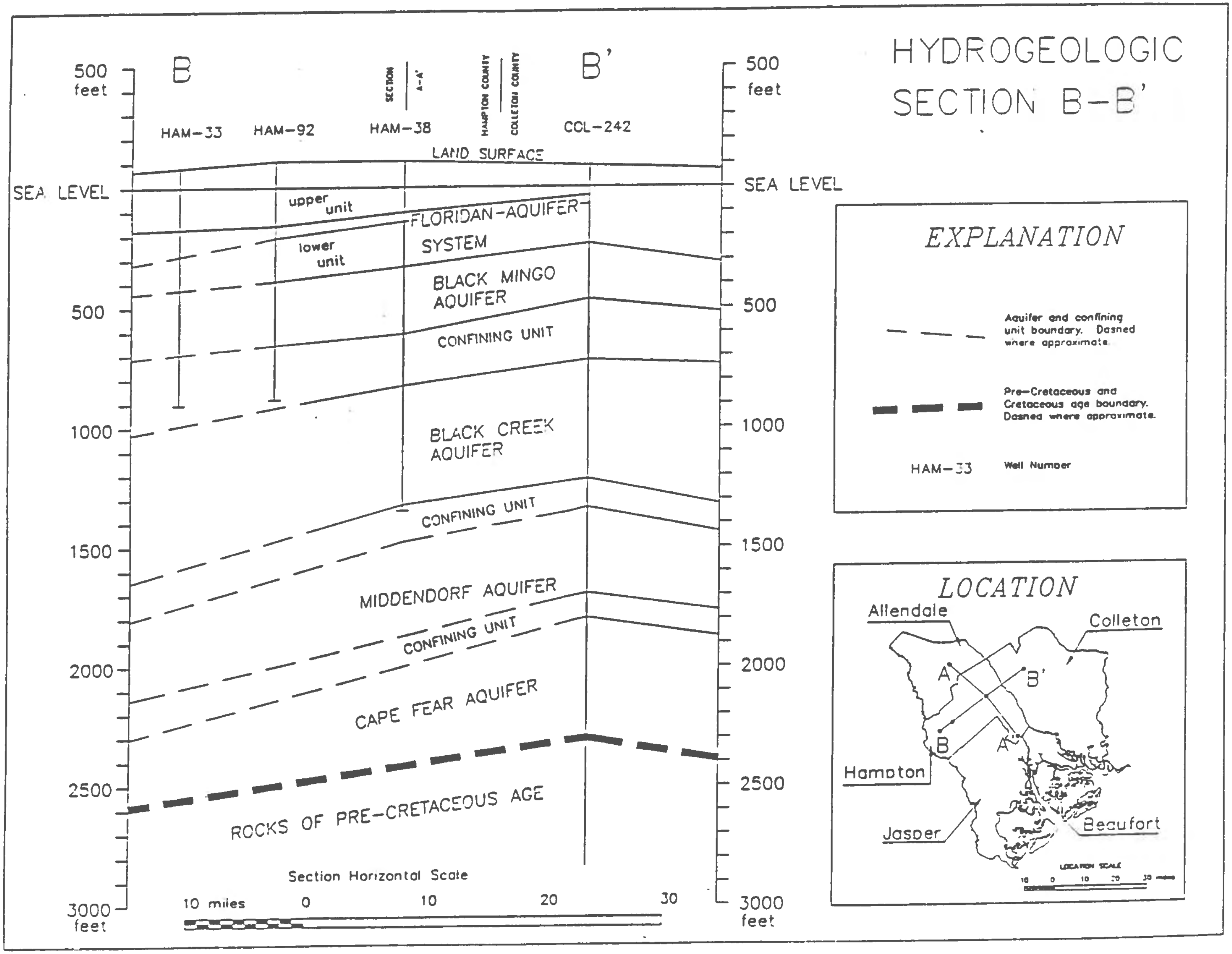

Figure 4. Hydrogeologic section B - B'(modified from Aucott and others, 1987).

FLORIDAN AQUIFER HYDRAULIC CHARACTERISTICS

The Floridan aquifer is a confined (artesian) aquifer throughout most of Hampton County. The upper unit of the Floridan is the principal source of water supply where present (see Fig. 5), and wells tapping the upper unit typically are 100 to 200 ft deep. The upper unit is thin or absent in western Hampton County, and wells there commonly are completed in the Floridan's lower unit at depths of 300 to 500 ft.

The transmissivity (T) of the aquifer, or its water-transmitting capacity, varies areally and with depth. The transmissivity of the lower unit appears to be uniformly low and commonly may be less than 8,000 gpd/ft (gallons per day per foot). The transmissivity of the upper unit increases from about 10,000 gpd/ft in the vicinity of Hampton to more than 75,000 gpd/ft near the Savannah River (Fig. 6). The variation in transmissivity also is reflected the specific capacities (gpm/ft of drawdown) of upper Floridan wells (Fig. 7). As with transmissivity, the well yield per foot of drawdown increases from northeast to southwest.

The storage coefficient (S) of the Floridan is about 0.0002. The coefficient is a dimensionless term that indicates the amount of water released from or taken into storage as the water level (pressure) changes. A coefficient of 0.0002 means that 0.0002 cubic foot of water, or 0.0015 gallon, is released from each square foot column of the aquifer when the water level declines 1 foot.

It is the transmissivity that exerts the greatest control on the amount and extent of drawdown caused by a given pumping rate. Withdrawals from high-transmissivity aquifers result in broad, shallow cones of depression, and withdrawals from low-transmissivity aquifers result in narrow, deep cones of depression (Fig. 8). The design of well fields and pumping schedules to minimize well interference requires the most of transmissivity values. Preferably, they should be determined by means of aquifer tests.

The aquifer tests most commonly conducted by SCWRC and required of permit applicants are based on water-level measurements taken in the pumped well. These single-well tests can be used to estimate transmissivity only. Determination of the storage coefficient and the recharge supplied by adjacent formations requires that measurements be made in separate observation wells. Observation wells can be required of permit applicants but are not unless the calculation of pumping effects requires exceptional accuracy or there is need for long-term water-level or water-quality monitoring.

Table 3 shows how differences in transmissivity and storage estimates can affect drawdown calculations, illustrating the benefits of observation wells.

Table 3. Differences in calculated drawdown caused by erroneous estimation of storage and transmissivity coefficients. (Q = 250 gpm, t = 30 days)

Distance from pumped well, in feet	Well	1,000	2,000	3,000	4,000
Drawdown, in feet					
T=20,000 S=0.0001	27.96	8.17	6.20	5.05	4.24
T=20,000 S=0.0006	30.53	10.74	8.75	7.60	6.77
T=18,000 S=0.0006	33.75	11.76	9.56	8.27	7.36

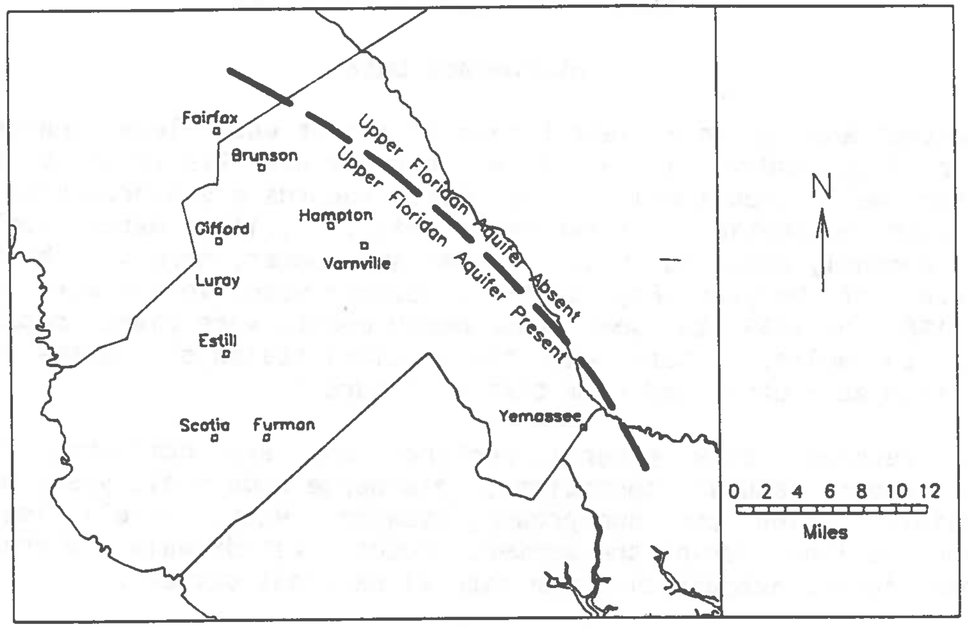

Figure 5. Approximate northeastward extent of the upper Floridan aquifer.

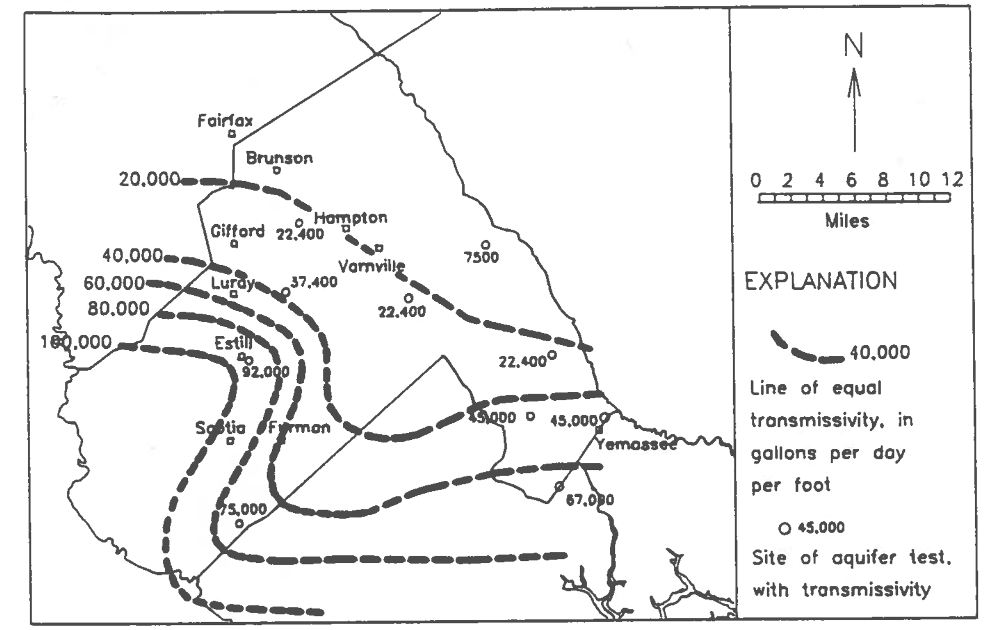

Figure 6. Estimated transmissivity of the upper Floridan aquifer.

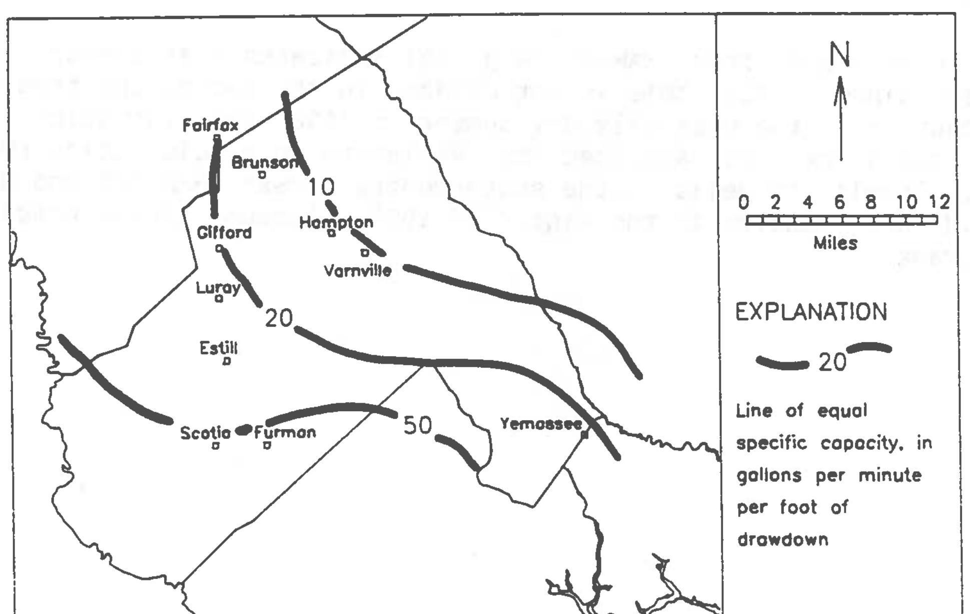

Figure 7. Specific capacities of wells in the upper Floridan aquifer.

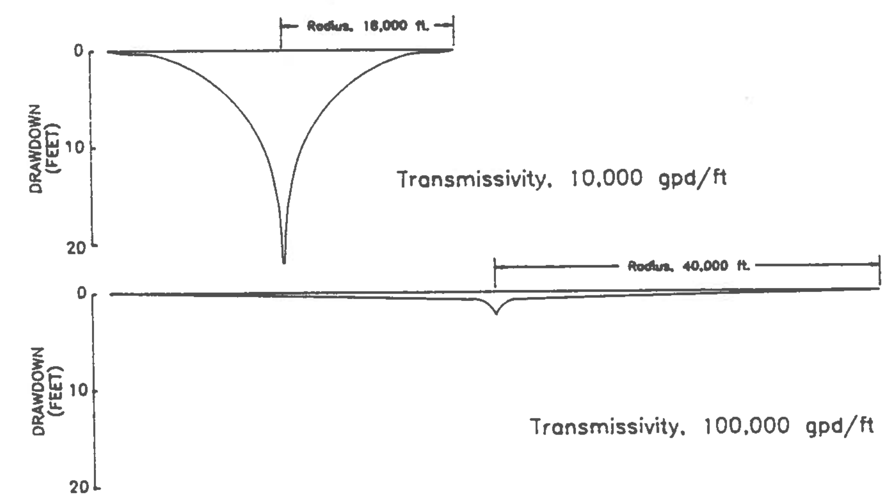

Figure 8. Illustrated effects of different transmissivities on the depth and extent of the cone of depression, with the same pumping rate.

GROUND-WATER LEVELS AND FLOWS

Hydrograph Data

The extent and regional distribution of recent water-level changes is shown by records from individual wells monitored since 1976 (Figs. 9, 10, 11; see Fig. 1 for well locations). The best records are hydrographs from wells equipped with automatic data recorders (Figs. 10, 11). Water levels in other wells are commonly measured in late winter and summer, normally the highest and lowest levels of the year (Fig. 11 A-D). Summer water levels were not measured in 1987, 1988, or 1989, and some other measurements were missed because of lack of access to wells. Note that the vertical scales of Figures 9 and 10 are different from each other and from that of Figure 11.

These records show general declines and are dominated by seasonal variation. Under natural conditions, discharge occurs all year, but recharge occurs mainly during the non-growing season; water levels rise during the winter and decline during the summer. Pumping withdrawals are greater during summer than winter, exaggerating the natural seasonal pattern.

Wells in eastern and northern Hampton County have experienced only minor long-term declines and moderate seasonal fluctuations (HAM-83, Fig. 9; HAM-82, Fig. 10; HAM-79 and HAM-98, Fig. 11A; HAM-74, Fig. 11B). Those in the western part of the county (HAM-144 and HAM-122, Fig. 11C) show little long-term decline but greater seasonal fluctuation. The south-central part of the county, around Furman, shows the greatest long-term decline (HAM-105, HAM-132, and HAM-169, Fig. 11D). The north-central area, through Estill and Hampton (HAM-108 and HAM-151, Fig. 11B) shows less long-term decline but greater summer drawdown.

The hydrograph from HAM-82 (Fig. 10) indicates that summer drawdowns have increased since 1983; this is not evident in the hydrograph from HAM-83 (Fig. 9), except for the unusually dry summer of 1990. Some variation in winter and summer levels can be ascribed to variation in precipitation (Gawne, 1990); however, levels in wells in the south-central areas (HAM-105 and HAM-169, Fig. 11D) did not recover in the winter of 1990, although winter precipitation was near average.

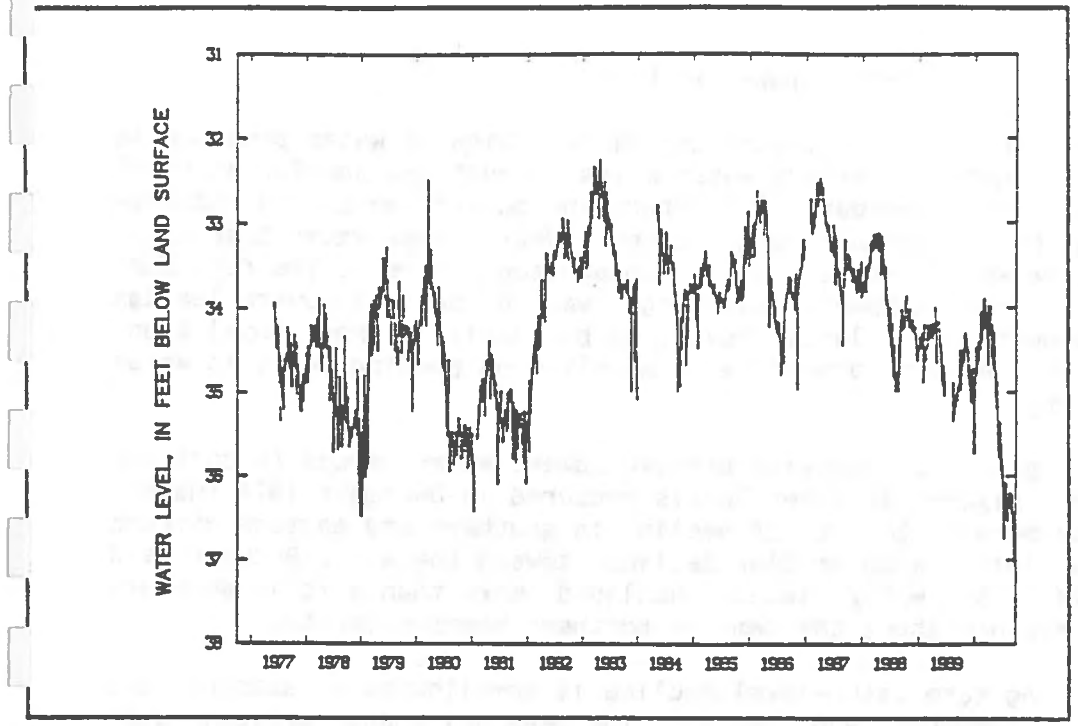

Figure 9. Hydrograph of well HAM-83.

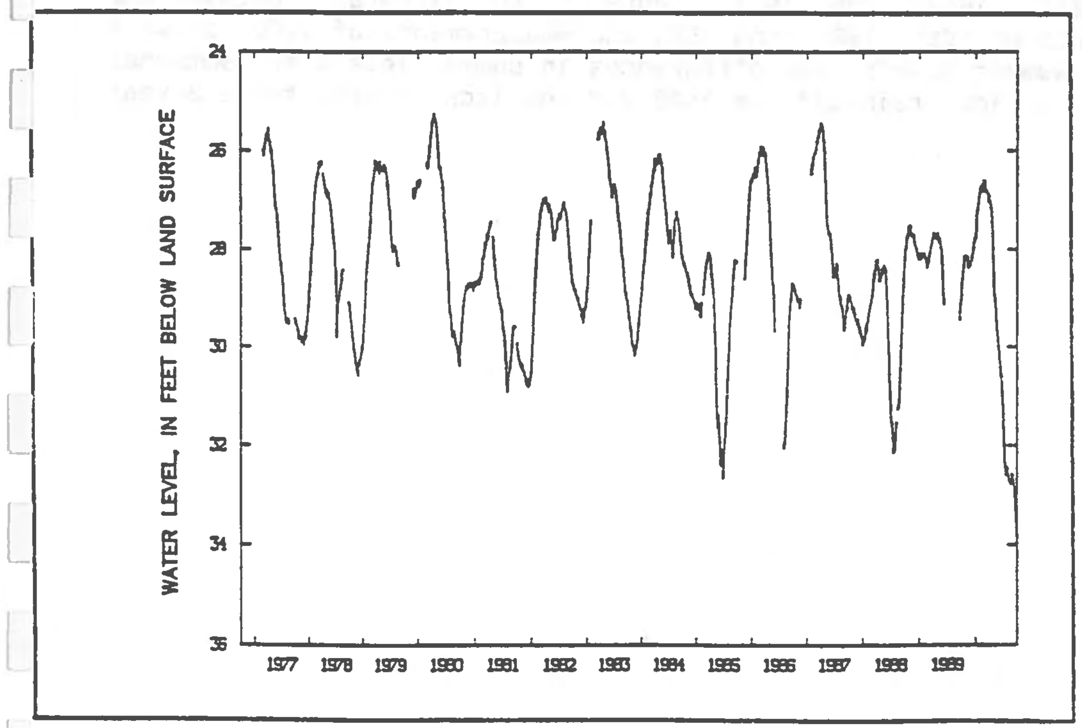

Figure 10. Hydrograph of well HAM-82.

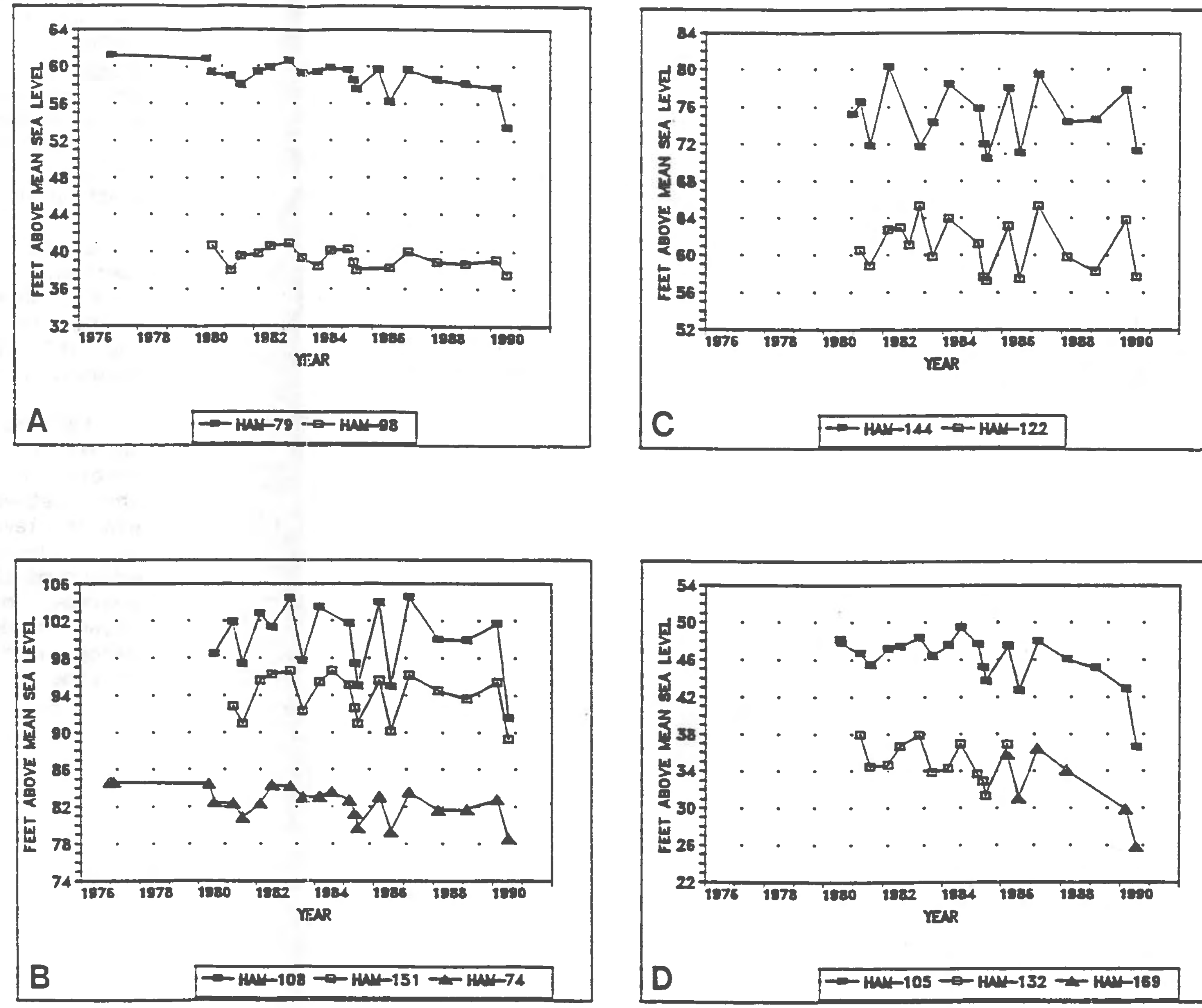

Figure 11. Graphs of manual water-level measurements.

Potentiometric Data

Water-level maps (Figs. 12-15) show the distribution of water pressure in the upper Floridan aquifer. Ground water moves through the aquifer at right angles to the water-level contours. It enters the aquifer mainly in recharge areas in Allendale County and northern Hampton County. Some water discharges into the Savannah, Salkehatchie, and upper Coosawhatchie Rivers; the remainder moves southeastward. Predevelopment discharge was by natural upward leakage adjacent to and beneath the Atlantic Ocean, in particular at Port Royal Sound (Smith, 1988, Fig. 16). Present discharge is mainly from pumping wells in areas south of Hampton County.

Comparison of Figure 12, showing predevelopment water levels (Aucott and Speiran, 1985), and Figure 13, water levels measured in December 1976 (Hayes, 1979), shows approximately 20 ft of decline in southern and eastern Hampton County from before 1976, with smaller declines toward the west. Between 1976 and 1990 (Figs. 14, 15) water levels declined more than 3 ft in southern Hampton County and remained about the same in northern Hampton county.

Estimation of long-term water-level decline is complicated by seasonal and annual variation in recharge and pumping. The seasonal change between water levels in March 1990 (Fig. 14) and July 1990 (Fig. 15) equalled or exceeded that between December 1976 and March 1990. Figure 16 shows a trend of declining winter levels during the past decade; the trend was determined by subtracting the averaged measurements of 1988, 1989, and 1990 from the averaged measurements of 1981, 1982, and 1983. Figure 17, the difference between the averaged measurements of 1981, 1982, and 1983 and measurements of 1990, shows a trend of declining summer levels. The differences in summer levels are somewhat exaggerated owing to low rainfall in 1990 and the lack of data for a 3-year average.

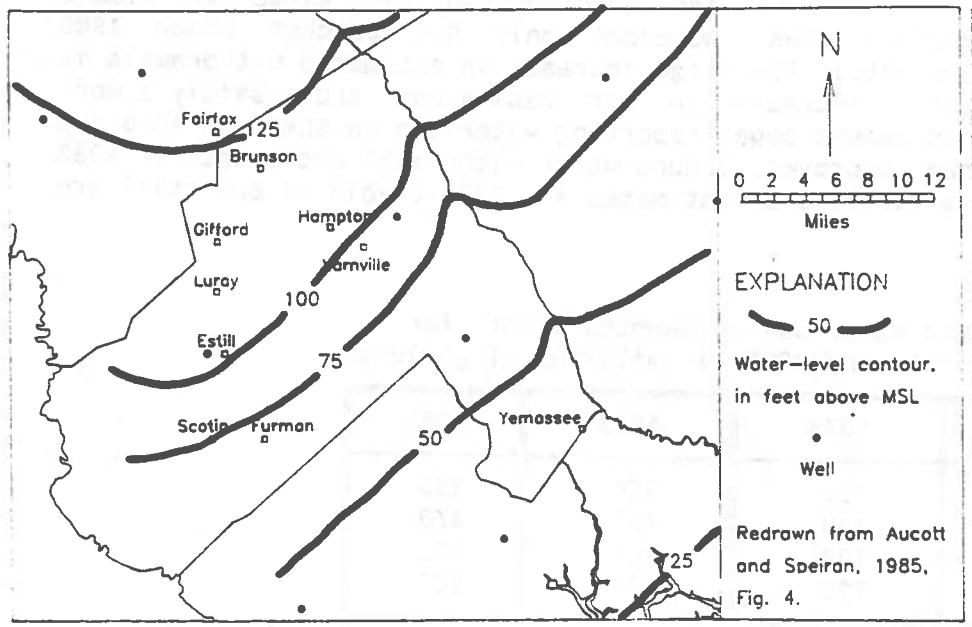

Figure 12. Predevelopment water levels.

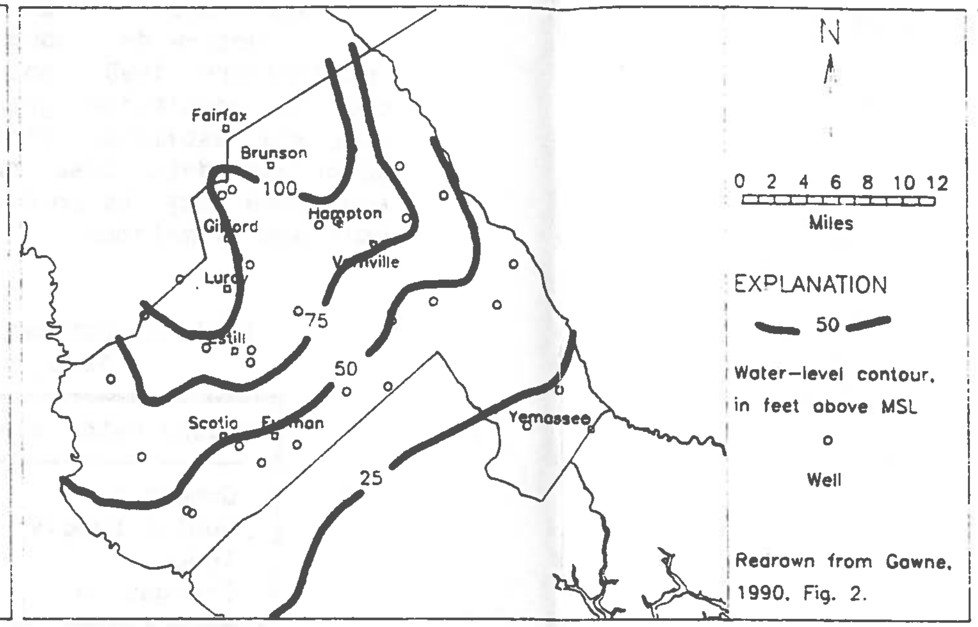

Figure 14. Water levels of March 1990.

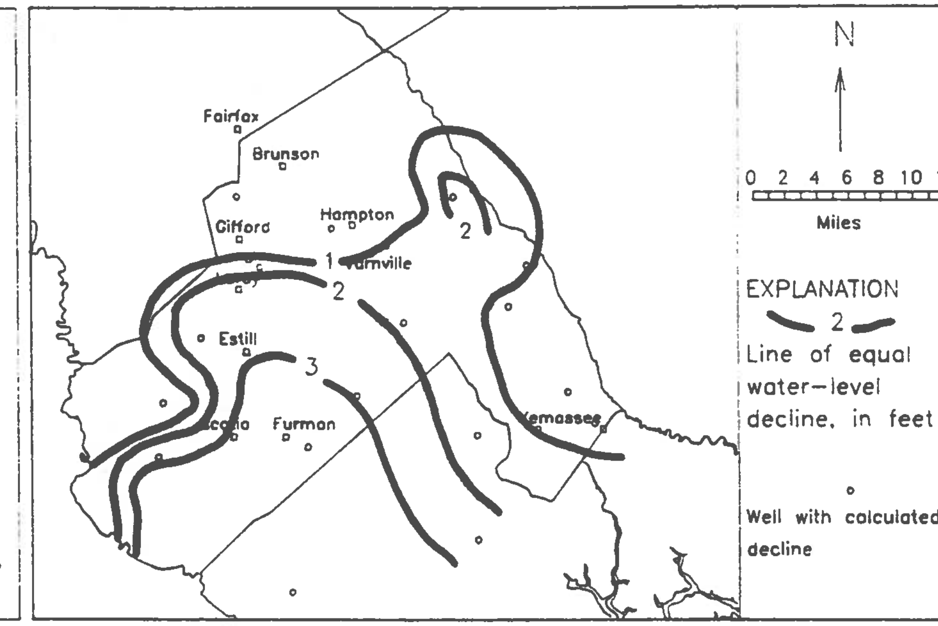

Figure 16. Decline in winter water levels, calculated from average of winter levels of 1981-93 and 1988-90.

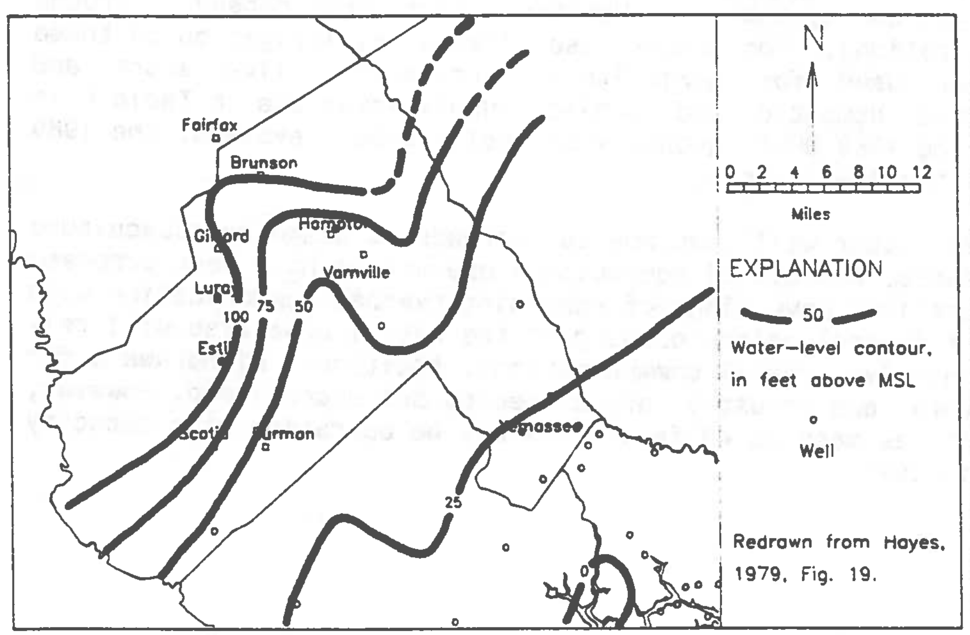

Figure 13. Water levels of December 1976.

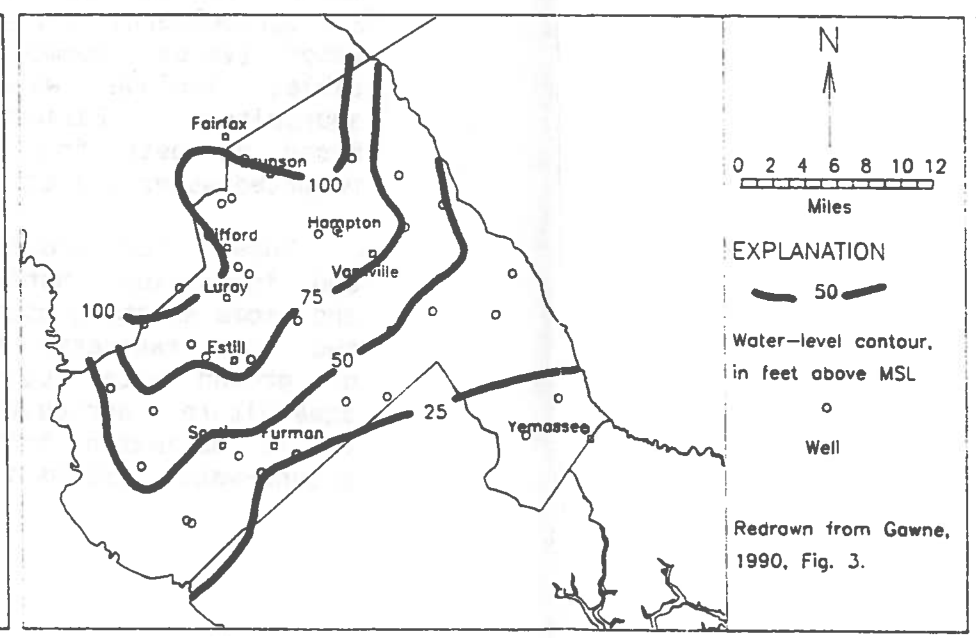

Figure 15. Water levels of late July 1990.

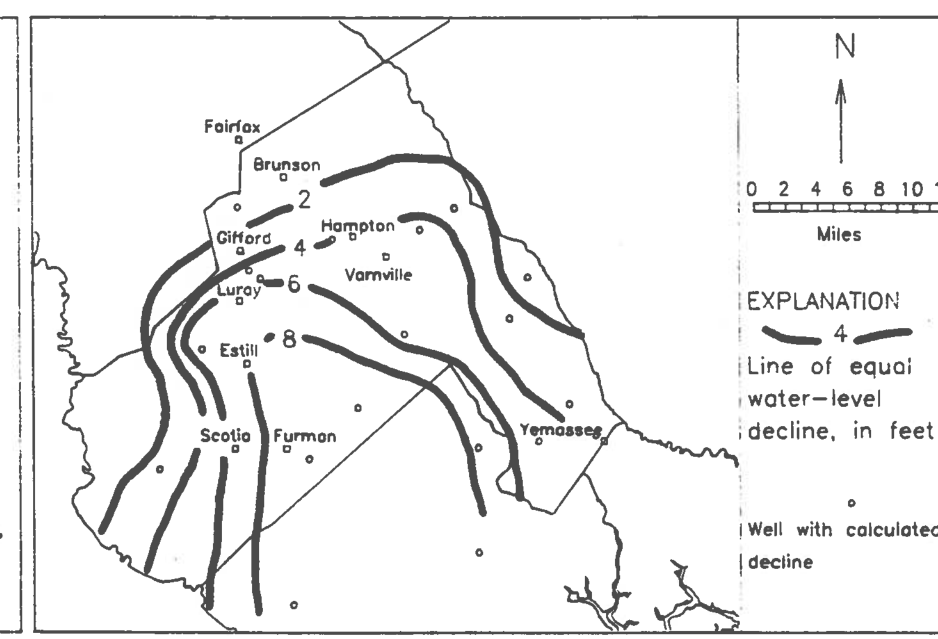

Figure 17. Decline in summer water levels, calculated from average of summer levels of 1981-83 and summer level of 1990.

GROUND-WATER WITHDRAWALS

Water use in Hampton County has increased substantially since 1976 (Table 4). County-wide population has increased only 0.2 percent since 1980 (preliminary 1990 census data). The large increase in estimated withdrawals is due to population growth, increase in per capita use, and possibly a more accurate estimate. Since owners began reporting water use to SCWRC in 1983 the water-use data base has improved. Ground-water withdrawal estimates for 1983 and 1989 may be more accurate than estimates for 1976 (Table 4) but still are only approximations.

Table 4. Estimated water use in Hampton County for 1976, 1983, and 1989 (in millions of gallons)

Ground water use	1976	1983	1989
Domestic	130	396	380
Public Supply	140	420	470
Industry	100	206	590
Irrigation	130	1033	268
Total	500	2055	1708

Yearly since 1983, six to twelve facilities in Hampton County have voluntarily reported monthly water withdrawals to SCWRC. Twelve owners reported water use in 1989 (Table 5). Clemson Extension Service has indicated there are 21 agricultural irrigation systems in Hampton County that depend on ground water (verbal communication). The water use listed as irrigation in these tables include water used for agricultural irrigation, live stock and aquaculture. Estimated domestic and public supply water use in Table 6 is based on data from the 1989 DHEC inventory of public supply systems, the 1989 reported water use and the 1990 census.

Demand for ground water will continue to increase as usage by aquaculture and industries increases. Additional aquaculture operations have been proposed and some existing operations have plans of expanding (verbal communication with two pond managers). A federal prison opening in the Estill area also will rely on ground water (Lonnie Dye, verbal communication). Additional withdrawals for aquaculture, agriculture and industry are suspected but unconfirmed. However, it is estimated that as many as 40 facilities may be operating high capacity ground-water systems in 1991.

Table 5. 1989 reported ground-water withdrawals, in millions of gallons

User	Water use	Max. month	Amount	Year total
Westinghouse Electric	Industrial	Sept	46.200	471.400
Peeples Farm	Irrigation	May	13.200	34.960
Bowers Farm	Irrigation	April	2.16	8.400
Bowers Farm	Irrigation	Apr	2.16	8.400
Bowers Farm	Irrigation	May	3.24	8.100
Bowers Farm	Irrigation	May	1.900	8.100
McMillan Farm	Irrigation	June	.930	1.940
McMillan Farm	Irrigation	May	2.770	11.520
McMillan(Jr) Farm	Irrigation	May	3.900	10.620
Youmans Farm	Irrigation	May	15.000	28.000
Youmans Farm	Irrigation	May	10.000	26.000
Youmans Farm	Irrigation	May	5.000	10.000
Youmans Farm	Irrigation	May	5.000	10.000
Platts Farm	Irrigation	June	5.100	8.500
Platts Farm	Irrigation	All	1.600	19.200
Rouse Farm	Irrigation	June	20.700	50.040
Rouse Farm	Irrigation	June	11.076	23.748
Town of Hampton	Public Supply	June	10.700	116.057
Town of Varnville	Public Supply	July	9.241	76.065
Town of Estill	Public Supply	February	14.700	21.800
Town of Estill	Public Supply	July	15.171	138.797
Town of Yemassee	Public Supply	August	3.010	25.401
Town of Yemassee	Public Supply	March	2.781	23.784
1989 Total				1,140.832

Table 6. Ground-water withdrawals not regularly reported
Mgy - millions of gallons per year
Mgd - millions of gallons per day

User	Water use	Estimated rate of use
Town of Luray	Public Supply	3.5 Mgy
Town of Brunson	Public Supply	28.5 Mgy
Town of Scotia	Public Supply	8.5 Mgy
Town of Furman	Public Supply	9.5 Mgy
Town of Gifford	Public Supply	18.3 Mgy
Domestic Wells	Domestic	379.6 Mgy
Southland Exchange	Industrial	117.9 Mgy
Total		565.8 Mgy
Elliot Saw Milling	Industrial	.13 Mgd } Maximum
Propst AquaFarm	Aquaculture	2.26 Mgd } Maximum
Clemson Extension	Aquaculture	.66 Mgd } Maximum

IMPACT OF GROUND-WATER USE

The behavior of ground water in Hampton County is impacted by withdrawals outside the county in addition to those within. Conversely, the effects of withdrawals in Hampton County extend many miles beyond its boundaries. The impact of increased pumping in the county has been manifested as local water-level declines of several tens of feet, instances of debilitating well interference, and increases in seasonal water-level differences. Increases in ground-water use also can contribute to water-level declines in the surrounding counties and to the acceleration of saltwater intrusion in Beaufort County.

Even in the exceptionally transmissive Floridan aquifer, a single large withdrawal will cause notable drawdown. A 10-day, 1,500-gpm discharge at Lena (east of Estill), where transmissivity is about 90,000 gpd/ft, resulted in drawdowns ranging from 5 to 40 ft within a 1-mile radius. Drawdown at a radius of 3 miles was nearly 2 ft (Fig. 18) (Whiting and Park, 1991). Figure 19 illustrates how the range in transmissivity in Hampton County can result in differing amounts of drawdown. The drawdowns assume a 30-day, 250-gpm discharge with all water being supplied from aquifer storage. Actual drawdowns will be somewhat less owing to leakage (recharge) from adjacent formations.

Whiting and Park (1990) also demonstrated the additive effects of drawdowns by multiple wells. The combined 1,300-gpm withdrawal by 3 wells located 1 mile west of Estill can result in a composite drawdown of 2 to 3 ft at Lena (Fig. 20). The drawdown caused by these three wells would be in addition to the drawdown illustrated in Figure 18 if all four wells operated simultaneously.

Approximately 45 Hampton County residents reported problems with domestic wells during the summer of 1990 (R. Harper, written communication; Appendix B). Commission staff hydrologists inspected 14 wells. The problems ranged from reduction in household water pressure to damaged pumps. At least one well was replaced owing to water-level decline below the bottom of the well casing. Problems commonly were remedied by lowering pump intakes; however, pump replacement was required where shallow-jet pumps had been used or pumps were ruined owing to lack of water sensors and automatic shutoffs.

M. W. Dale, of the South Carolina Water Resources Commission, has estimated the extent to which Hampton and Jasper County pumping might affect saltwater intrusion at Hilton Head Island. He calculated that as much as 13.5 mgd could be withdrawn from southern Hampton County and northern Jasper County without significantly increasing the intrusion rate. The boundaries of the area are controlled by aquifer characteristics, the location of recharge areas, and pumping in southern Beaufort County and Chatham County, Ga. Excessive withdrawals in Jasper County and southern and central Hampton County could undermine policies to control intrusion. The extent to which pumping there affects coastal Beaufort County is evidence of the need for regional planning and management.

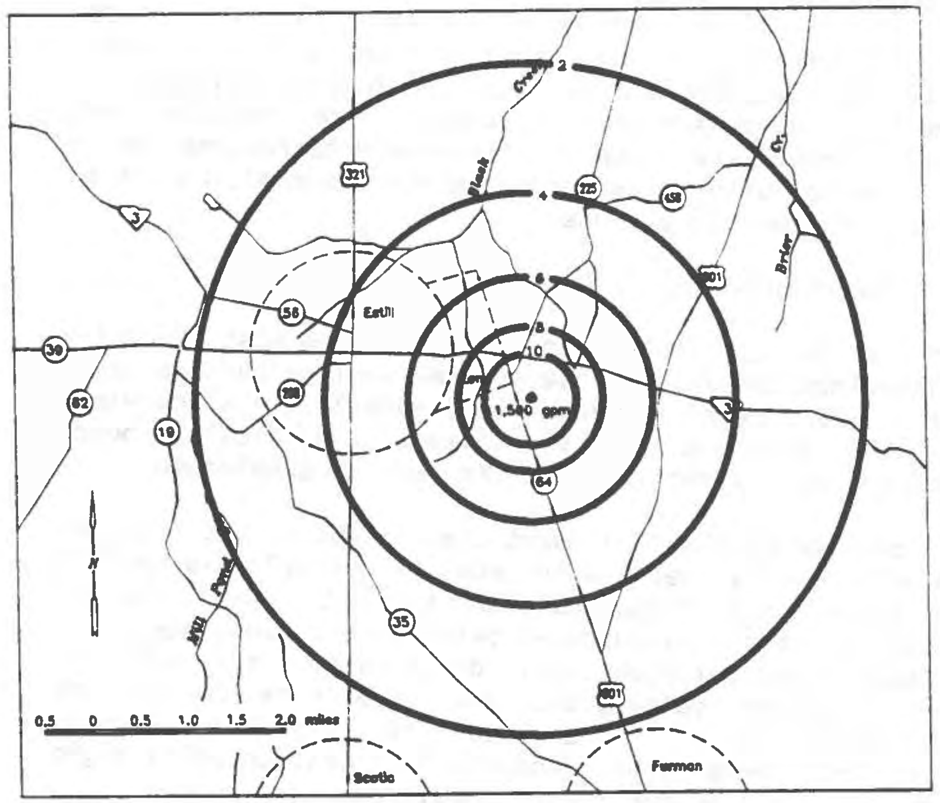

Figure 18. Simulated drawdown in a well pumping 1,500 gpm for 10 days.

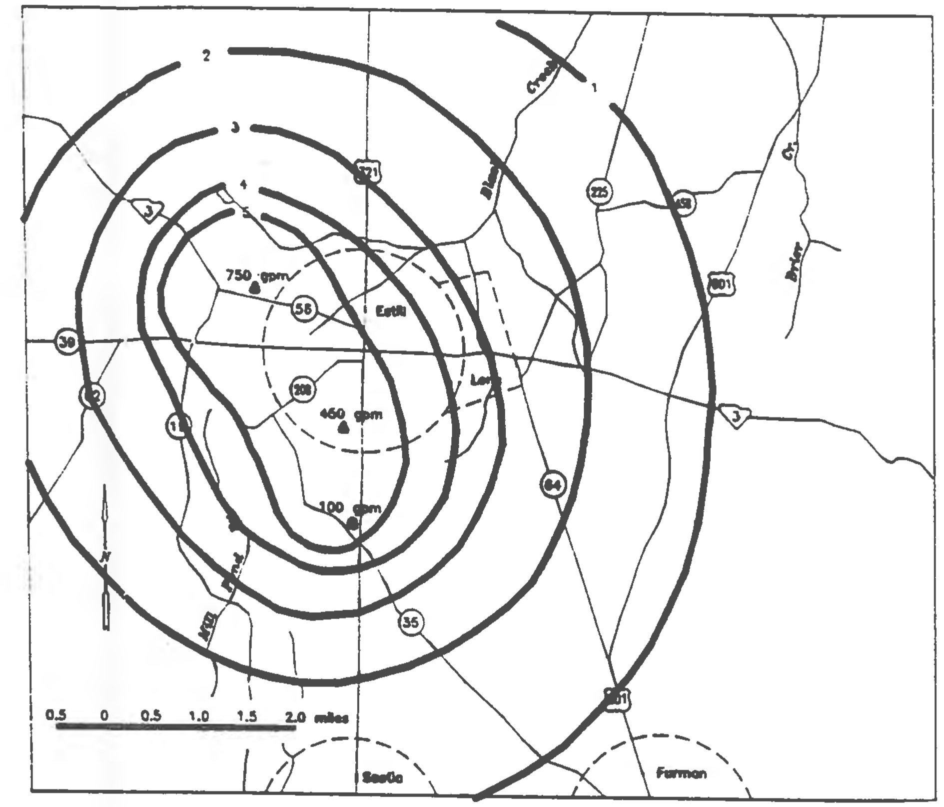

Figure 20. Simulated drawdown from three wells pumping a combined average of 1,300 gpm for 10 days.

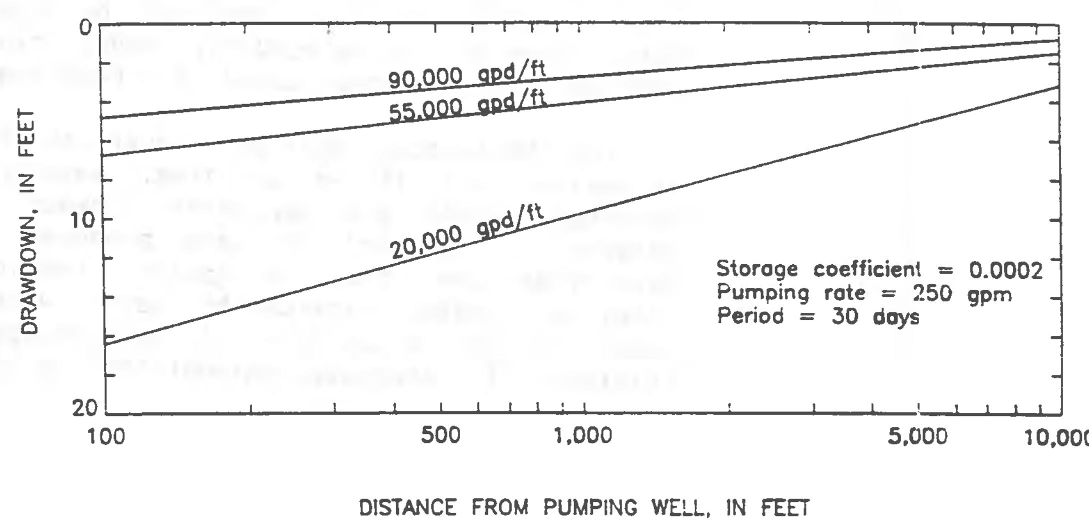

Figure 19. Semi-logarithmic plot of drawdown versus distance.

METHODS OF MINIMIZING WELL INTERFERENCE

The best means of mitigating well-interference problems will depend on the local hydrogeological conditions and the purpose of the water use. The purpose of the use will impose limitations on the range of acceptable well yield, pumping frequency, and chemical quality. Policies and regulations to limit interference should include consideration of conservation measures and distribution of withdrawals through space and time. The methods recommended by Whiting and Park (1990) include using alternative sources, minimizing yield, multiple-well use, and scheduling pumping periods.

Use of Alternative Sources

Use of sources other than the upper Floridan aquifer is the most effective means of avoiding well interference. Alternative sources include surface-water bodies, water-table ponds, the lower Floridan and underlying Black Mingo aquifers, and the Cretaceous aquifers. The viability of a particular source depends on the yield and water quality required and the cost of development.

Streams and lakes can provide substantial quantities of water, but they are not available to most Hampton County users. Water quality typically is good in most respects, being low in dissolved solids, calcium, and iron. The direct use of surface water is not practical for some purposes owing to high suspended-solids concentrations, temperature fluctuations, or bacteriological quality. Problems caused by suspended solids, temperature, and bacteria can be overcome by using induced infiltration where the surface water is hydraulically connected with underlying sand formations. Induced-infiltration wells might yield as much as several hundred gallons per minute locally.

Water-table ponds also can provide large yields, and at least one Hampton County irrigator already relies on a pond as a source of supply. The ponds are most effective where sited in topographically low areas to capture recharge from higher elevations and minimize seasonal water-level fluctuations. Ponds sited near topographic highs typically will tap the water table near ground-water divides, experience greater declines during periods of low rainfall and high evapotranspiration, and must be constructed to relatively greater depths. Ponds tapping low-permeablity sands can be suitable for intermittent uses provided they are constructed with adequate storage capacity.

The Cretaceous aquifers underlying Hampton County are productive, areally extensive, and little utilized. Reported well depths are 700 to 1,030 ft and reported yields are generally between 300 and 1,200 gpm. A 1,030-ft well at Hampton is reported to have produced 3,000 gpm (Newcome, 1989). Specific capacities are about 20 gpm/ft. Chemical analyses indicate soft, slightly alkaline, sodium bicarbonate water with low dissolved solids (Table 7). As noted in the discussion of hydrogeological conditions, there is a great thickness of Cretaceous sediment that is yet untapped.

Table 7. Concentrations of selected chemical species in samples from Cretaceous aquifer wells in Hampton County. Hardness is reported in $CaCO_3$ equivalents

Well No.	Depth (ft)	Fe	Ca	Na	K	HCO3	SO4	Cl	Dis. solids	Hard- ness	pH
		(milligrams per liter)									
HAM 12	844	.24	4.4	54	3.6	151	7.2	3	164	14	8.2
HAM 41	853	.56	4.2	51	4.5	140	11	2	144	12	8.1
HAM 92	985	.00	4.6	56	3.9	154	6.3	3	159	12	8.7
HAM 191	870	.04		51		164	8.4	5	180	17	8.1

Minimizing Well Yields

Drawdowns and well-interference problems can be reduced greatly by distributing withdrawals over an extended period of time. Figures 21a and 21b show the drawdown caused by a 21.6 million gallon withdrawal where transmissivity is 75,000 gpd/ft. The drawdown in Figure 21a results from a pumping rate of 1,500 gpm for 10 days: the drawdown in Figure 21b results from a pumping rate of 500 gpm for 30 days.

Note that at a radius of about 13,000 ft the 500-gpm discharge results in a decline of 2 ft, or half that of the 1,500-gpm discharge. The 500-gpm discharge causes a decline of about 4 ft at a radius of 2,500 ft, and is about 40 per cent of the decline caused by the 1,500-gpm discharge. Reducing discharge by as little as 10 to 20 percent can substantially reduce drawdown, particularly in the vicinity of the pumping well.

Reduction of well discharge is most applicable to aquacultural and irrigation uses. The greatest disadvantage to aquacultural users is that new ponds would have to be filled over a relatively longer period. Users could incur additional costs owing to delays in using portions of their investment. If ponds are constructed in stages to minimize unused investment, there might be recurring mobilization costs for construction equipment. Some of these costs can be offset by considering lower discharge rates while planning construction schedules.

Aquacultural users also benefit by minimizing discharge rates. Well construction costs diminish substantially as borehole, casing, and screen diameters decrease and as pumps are downsized. Long-term energy costs also are reduced because of higher pumping water levels and the generally greater efficiency derived from operating smaller pumps for relatively longer durations. Their greater efficiency and lessened impact on neighboring wells make smaller pumps more appropriate for pond-stage maintenance after the ponds are filled.

Irrigation users might adapt to smaller well discharges to a lesser degree. Water-efficient irrigation systems are prerequisites, but the use of storage ponds would have to be the principal means of accommodating smaller well yields. Ponds generally must be dug where the soil is relatively impermeable, unless the pond is lined, or where the seasonal low water table will remain above the system intake. More planning is required owing to the fact that well operation must begin some time before irrigation can begin. The drawdowns caused by discharging 1 million gallons at 1,500, 1,200, and 900 gpm where the transmissivity is 75,000 gpd/ft are illustrated in Figure 22. The discharge durations are 11, 14, and 19 hours, respectively.

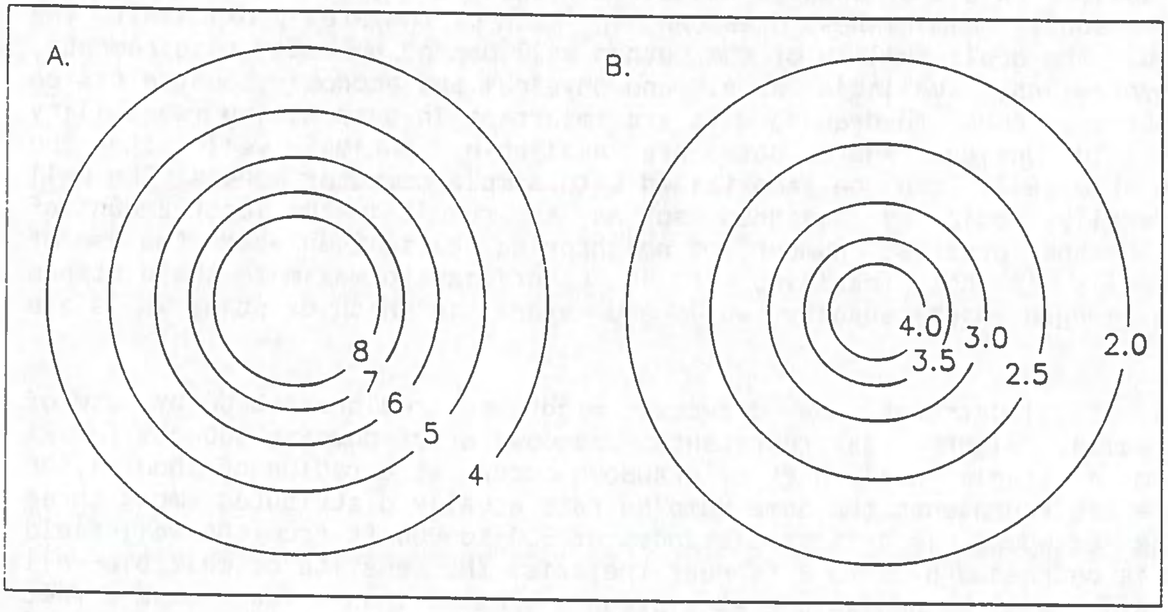

Figure 21. Drawdowns caused by a 21.6 million gallon withdrawal at discharges of (a) 1,500 gpm and (b) 500 gpm.

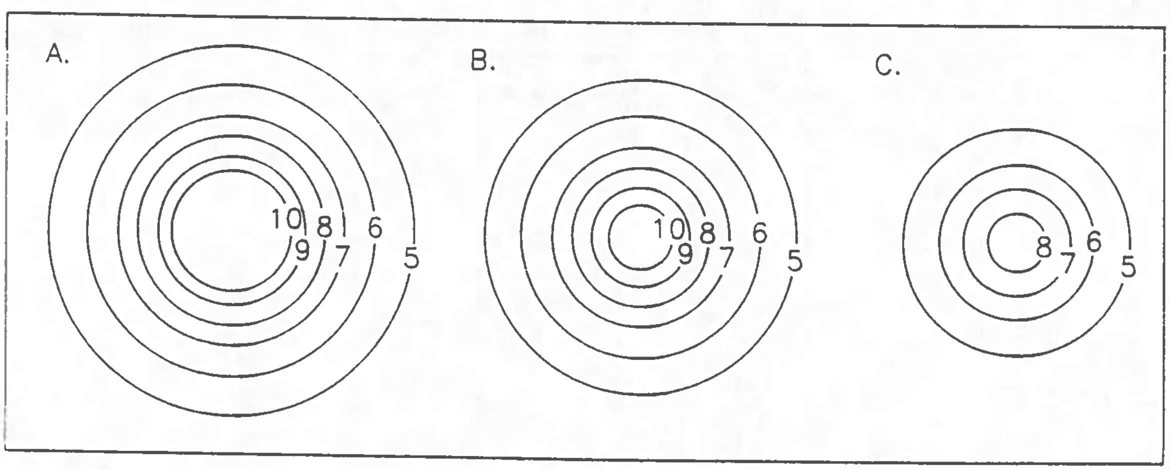

Figure 22. Drawdowns caused by a 1 million gallon withdrawal at discharges of (a) 1,500 gpm, (b) 1,200 gpm, and (c) 900 gpm.

Multiple-Well Use

The impact of a ground-water withdrawal also can be minimized by use of multiple wells. The use of several wells distributes drawdown over a wider area but simultaneously diminishes drawdown in much of the area proximate to the well field. The applicability of the method will depend on water requirements, aquifer hydraulics, available area, and physical and economic constraints on site selection. Good hydraulic data are important in determining feasibility and well-field design. Where data are available, optimal well sites and discharges typically can be ascertained with simple computer models. The well field generally would be designed so as to result in the least amount of drawdown in the greatest number of neighboring wells. Even where the use of multiple wells is not feasible, it is beneficial to maximize the distance between a single high-capacity well and areas in which existing wells are concentrated.

Figure 23 illustrates how drawdown might be redistributed by use of multiple wells. Figure 23a represents drawdown after pumping 500 gpm for 24 hours from a single well; 6 ft of drawdown occurs at a radius of about 1,500 ft. Figure 23b represents the same pumping rate equally distributed among three wells. The drawdown is 6 ft at distances of 500 to 900 ft from the well-field axis and is decreased by 1 to 3 ft near the axis. The benefits of multiple-well use typically will be negligible at distances greater than a few thousand feet from the well field. The multiple-well user will benefit by using less energy to pump water from higher levels.

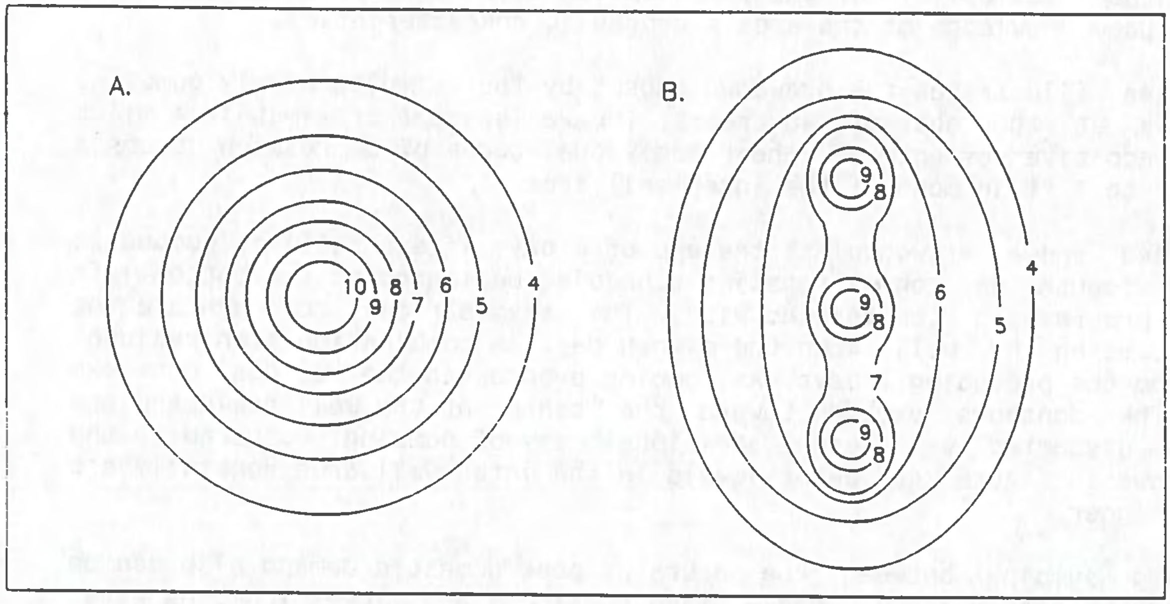

Figure 23. Drawdowns caused by (a) a single, 500-gpm well, and (b) three 167-gpm wells spaced at 1,000 ft intervals.

Withdrawal Scheduling

Drawdowns can be lessened by scheduling pumping so that a large number of wells in the same vicinity are not pumped simultaneously. As with the case of minimizing individual discharges, withdrawals are made over an extended period. The method is applicable where wells need not be used with great regularity. Determining the feasibility of the practice can be a relative complex process and requires good knowledge of the area's hydraulic characteristics.

Figure 24a illustrates the drawdown caused by four simultaneously pumping, 750-gpm wells at the end of 48 hours. The wells are approximately 4 miles apart. The additive effect of their individual cones of depression causes a drawdown of 2 to 3 ft in most of the inter-well area.

Figure 24b shows drawdown at the end of 8 days if each well is pumped 24 hours every fourth day on a rotating schedule, beginning at the bottom left corner and progressing counterclockwise. The asymmetrical contours are the result of pumping by well 4 on the eighth day, in combination with residual drawdown from the preceding 7 days. As pumping progresses the residual drawdown increases. The contours expand toward the center of the well field and are increasingly distorted with each additional day of pumping. Compared to the scenario shown in Figure 24a, water levels in the inter-well area generally are 0.5 to 1 ft higher.

Scheduling pumping between the hours of peak domestic demand also can be used to reduce interference. Peak-demand periods and lowest pumping water levels typically occur between 6:00 and 9:00 a.m. and 6:00 and 10:00 p.m. Scheduling to this extent generally would be worthwhile only in more extreme instances, such as in cases of unanticipated and debilitating interference. Propst Aquafarm, at Lena, adopted this method for a period of time (Whiting and Park, 1990). Had interference problems been anticipated, a lower yielding well could have been constructed. The lower discharge would have caused less interference and would have been less expensive to construct and operate.

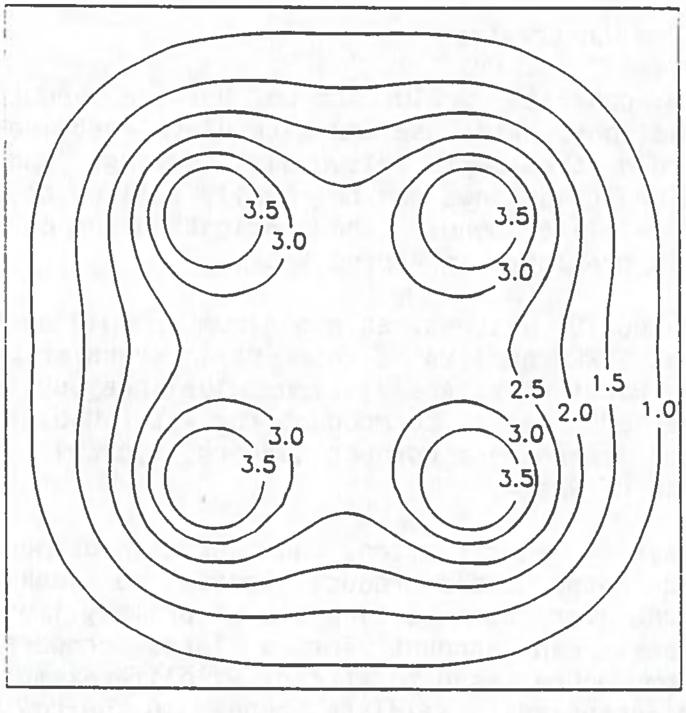

Figure 24a. Drawdowns caused by four 750-gpm wells pumped simultaneously for 48 hours.

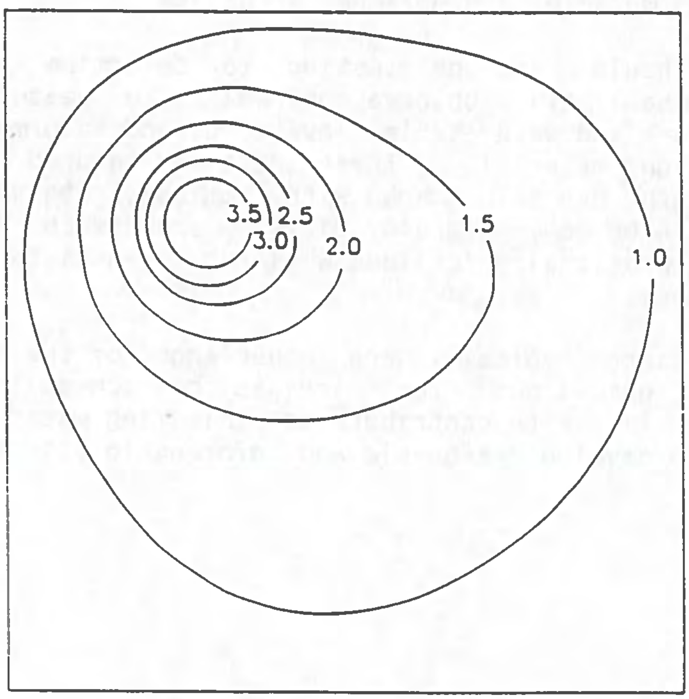

Figure 24b. Drawdowns caused by four 750-gpm wells pumped rotating, 24-hour schedules for 8 days.

Conservation

Both long- and short-term benefits would accrue by the adoption of conservation policies and regulations. Water use and water-level declines would increase less rapidly, as would treatment, disposal, pumping, and well-construction costs. Conservation guidelines can be readily applied to public-supply systems, aquaculture, wildlife ponds, and irrigation. An outline of possible conservation measures is presented in Appendix C.

Ground-water based public-supply systems, at a minimum, should be subject to the same requirements that SCWRC applies to inter-basin transfer permits. These are based on American Water Works Association guidelines published in 1990 or earlier equivalents. Periodic audits to account for water use, followed by programs to detect system leakage and conduct repairs, typically lead to cost savings as well as reduction of waste.

General standards for the siting, construction, and operation of ponds used to store and transmit ground water could reduce losses to leakage and unnecessary discharge. Standards for pond siting are of primary importance, since leakage, in some cases, can account for a large proportion of ground-water use. Leakage from ponds used to attract wildlife exemplify the need for testing and siting standards. Wildlife ponds in the Low Country Capacity Use Area typically are filled seasonally to depths of 2 ft or less, but in some cases use as much as 1.4 mg/acre (4.3 acre-ft/acre). Leakage locally may exceed 0.5 mg/acre (1.5 acre-ft/acre) during a period of several months. By comparison, an established, healthy catfish pond would be expected to operate with less than 0.435 mg/acre (1.3 mg/acre) annually.

Pond-siting standards should include testing to determine vertical hydraulic conductivity (permeability), observation wells to measure head differences between pond stages and water-table elevations, and information on pond geometry and construction material. These data can be used to model leakage losses, which in turn can be compared with Commission standards for acceptable leakage losses. The Geology- Hydrolgy Division expects to recommend standards in July 1991. Operational guidelines will require assistance from expert sources outside the agency.

Agricultural irrigation users typically are conscience of the need for conservation, and general guidelines for irrigation scheduling and soil-moisture monitoring are likely to contribute to minimizing water demand. Outside assistance is needed to develop reasonable and enforceable standards.

ALTERNATIVES TO CAPACITY USE REGULATION

The Ground Water Use Act, Section 49-5-40(C)(2), requires that, in conducting a capacity use investigation, the executive director should determine ".... whether timely action by any agency or person may preclude the need for additional regulation...".

The County Council of Hampton County has proposed "An ordinance to establish registration, permitting requirements, and to control the water use of high-capacity wells in Hampton County" (Appendix D). The ordinance currently proposes to register existing wells equipped with pumps of 5 horsepower or greater, and to require submittal of SCDHEC well-report forms by owners of new wells. The board may consist of eight or more members, to include a representative of SCWRC. The board's main function is well registration. It may propose standards as deemed necessary and assess penalties for ordinance violations.

The board has the potential to regulate wells in ways similar to those of the Capacity Use Areas. It could not regulate wells outside the county that affect ground water and well owners within the county. It is unlikely the board could consider the impact of Hampton County wells on conditions in the Low Country Capacity Use Area. As noted in a previous section, withdrawals in Hampton County could have an impact on SCWRC's effort to control saltwater intrusion.

The methods of controlling well interference and reducing the risks of debilitating interference generally must be applied case by case. An understanding of geology and the principles of physics used in hydrological analysis is prerequisite. The county can apply these principles in a regulatory program if it chooses to retain a hydrologist. Given the level of detail needed for application review, there could be justification for engaging a full-time professional. The board instead could require new users to engage consultants to aid in planning ground-water use. The practice would increase greatly the cost of developing ground-water supplies.

The methods of controlling interference also can be applied voluntarily by individual water users; however, users would need access to ground-water consultants, and coordination of water use would be unlikely.

It is difficult to envision an effective means of mitigating well-interference problems or slowing the rate of ground-water level decline short of regulation.

PROS AND CONS OF CAPACITY USE DECLARATION

The methods discussed in previous sections can be useful in mitigating problems with water-level declines and debilitating well interference. The most obvious and general advantages and disadvantages to capacity use declaration are outlined here.

Advantages

1. Regulation can minimize local and large-scale interference problems if SCWRC adopts policies to address these problems. An outline of policies useful in the control of unreasonable adverse effects on existing water users is presented in Appendix E.

2. The public notice process can be modified to serve as a warning of potential adverse effects (see Appendix E). The modified public notice procedure would allow time for neighboring well owners to prepare for future conditions. The Commission could delay the initiation of ground-water use in special cases.

3. Hampton County's inclusion in the program is a recognition of the continuity of aquifer systems and allows SCWRC to address Hampton County pumping effects in Beaufort and Jasper County (and the reverse). Inclusion of Hampton County in the present Capacity Use Area is consistent with the recommendations of SCWRC Report No. 132 (Spigner and Ransom, 1979).

4. The permitting program generates technical data useful to planning and public-assistance programs. SCWRC files contain records of about 200 Hampton County wells, but information on well yields, hydraulic characteristics, and water quality is scant. A data base useful for planning and permitting would expand rapidly as the result of permitting existing and future wells.

5. The accuracy and consistency of water-use reporting are enhanced. Less than half of the withdawals from high-capacity wells may be reported at the present time. Knowledge of ground-water use is critical to policy decisions concerning the Low County Capacity Use Area.

6. An improved data base would contribute to refinement and expansion of the ground-water flow model now in use. The current model is not applicable to the prediction of pumping effects in western Jasper County or Hampton County. Expansion of the useful model area is possible with additional data from Hampton County and adjacent areas.

Disadvantages

Disadvantages to capacity use declaration are related current policies and the requirements of administering a program that would require a relatively greater amount of technical analysis. In considering possible disadvantages, it is assumed that existing permitting procedures will continue.

1. Current policies do not address interference specifically. A framework for policy development is presented in Appendix E. The Ground Water Use Act and regulations consider well-interference problems only in general terms.

2. Residents may not be satisfied with the level of "protection" provided by State law. Even reasonable and beneficial uses of ground water will result in water-level declines, and instances of debilitating well interference still would occur from time to time. Total prevention of further declines would require a moratorium on new uses and cessation of growth in Hampton County. Such an approach would fall short of the goal of deriving maximum beneficial use from the ground-water resource.

3. Ground-water development costs in some cases will increase, owing to requirements for metering, testing, and well construction.

4. The number of permit applications for staff review will increase by about 50 percent. There are about 40 potential permittees in the county, compared with 78 in the present capacity use area.

5. The time required for the evaluation of applications could double during the first year of a capacity use program. New applications generally take longer to review than do renewals.

6. Standards applied to Hampton County should be applied to the entire area. More detailed and stringent reviews will increase the amount of time devoted to permitting activities in Beaufort, Jasper, and Colleton Counties.

7. If the current policy of limiting permits to 2 years continues, inclusion of Hampton County will necessitate additional staff or a 40 to 50 percent reduction in data collection and research. The staff typically makes up to 900 water-level and water-quality measurements annually. Studies to determine potential for upconing at Edisto Island, lateral intrusion at St. Helena Island, and downward leakage of seawater south of Port Royal Sound are important priorities.

SUMMARY

At least 45 Hampton County households experienced well-yield problems as a result of interference from high-capacity wells and a general trend of water-level decline. Ten or more Beaufort County households and a significant number of Jasper County households experienced similar problems. The number of occurrences of well interference probably will increase unless measures are taken to plan for and manage water-level declines. Domestic wells within 1 to 3 miles of high-capacity wells are the most likely to experience problems. Wells in northeastern Hampton County are the most vulnerable to debilitating interference, owing to the relatively low transmissivities of the Floridan aquifer in that area.

Water levels in western Jasper County and central and southern Hampton County declined about 3 ft during the past decade. As much as 20 ft of decline occurred prior to 1976. Declines are greatest in southern Hampton County and the adjoining area. Water levels fluctuate 3 to 10 ft between winter and late summer, and the difference in seasonal water levels has increased with time and growth in water use. Estimated ground-water use averaged 4.7 mgd in 1989.

Water-level declines and well interference can be mitigated by applying principles of ground-water science in planning water use and in well-field design. The probability of debilitating well interference can be reduced by the practice of conservation, use of sources other than the upper Floridan aquifer, and proper distribution of withdrawals spatially and through time. Alternatives to the upper Floridan include surface water, induced infiltration wells, water-table ponds, and lower Floridan, Black Mingo and Cretaceous aquifers. Methods of control of the amount, extent, and distribution of drawdown include limiting individual well yields, use of multiple wells, and withdrawal scheduling. The application of conservation methods to public supply, irrigation, aquacultural, and industrial uses also would help to minimize drawdowns.

Existing policies and regulations to address the problem of well interference are limited in scope. Effective management of Hampton County's ground-water resource will require policies and regulations that are more clearly defined than those of the current Low Country Capacity Use Area. New policies intended to manage ground water and protect ground-water users in Hampton also should be applied to the area now within the Capacity Use program.

RECOMMENDATIONS

The incorporation of Hampton County in the Lowcounty Capacity Use Area is recommended to the Executive Director, with qualification. The principal factors leading to the recommendation are discussed.

1. Hampton County withdrawals affect policies to control saltwater intrusion in eastern Beaufort County. The unmanaged growth of ground-water use has the potential to undermine those policies and the Commission's position in an interstate dispute.

2. The Ground Water Use Act and Capacity Use regulations address well interference. The Act indicates that declining artesian pressures and well interference can be considered during Capacity Use investigations [(49-5-40(B)(1) and (2)]. The regulations provide general guidance for considering declines and interference while evaluating permit applications. In that interference has affected 45 wells in Hampton County, a comparable number in Beaufort and Jasper Counties, and the 150 to 200 people who relied on those wells, there is justification to address the problem by regulation.

3. The disadvantages regarding policy and the practicability of administering an expanded capacity use area can be surmounted. The promulgation of appropriate regulations and policies can be accomplished in a short time. Such regulations and policies are, in any event, needed in the current Lowcountry Capacity Use Area.

4. The disadvantages pertaining to additional and more detailed application reviews also are surmountable. Ground-water users who report under the Water Use Reporting and Coordination Act need not be subject to the first-time, two-year permit requirement. Ten-year permits should be the norm in most areas. The burden on the regulated community consequently would decrease.

5. Existing Hampton County ground-water users will not be greatly inconvenienced. They already must keep water-use records and have submitted well-construction data in accordance with the Water Use Reporting and Coordination Act. If they have complied with the law, they have documented their requirements and probably qualify for long-term permits. Since their wells and use are established, they should incur no new expenses (presuming they have acceptably accurate metering devices and discharge tests).

Inclusion of Hampton County in the Capacity Use program is beneficial and administratively feasible if:

1. the Commission adopts policies to address interference encompassing conservation, well-siting, aquifer-testing, alternative sources, and use scheduling.

2. the Commission issues 5- to 10-year permits where appropriate. Ten-year permits generally are appropriate in Hampton, Colleton, and Jasper Counties, and can be issued in southern Beaufort County once withdrawal limits are finalized.

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APPENDIX A

County Council of Hampton County capacity use resolution

RECEIVED DEC 27 1990

STATE OF SOUTH CAROLINA

COUNTY OF HAMPTON

RESOLUTION

WHEREAS, the County Council of Hampton County believes that groundwater is a natural resource which should be used for the benefit of all residents and property owners; and

WHEREAS, recent events have illustrated to the Council that there exists a potential for conflicting uses, e.g., when the use by one resident, or owner, may be detrimental to an established neighboring user; and

WHEREAS, the Hampton County Planning Commission has recommended that protection of the public interest requires some coordination and/or control of the use of groundwater; and

WHEREAS, the County Council Committee on Water Resources has made recommendations which are contained in the resolutions which follow; and

WHEREAS, the County Council concludes that the public interest requires coordination and possible regulation;

NOW, THEREFORE, LET IT BE RESOLVED BY THE COUNTY COUNCIL OF HAMPTON COUNTY, that , as one means of providing coordination and possible regulation, the South Carolina Water Resources Commission is requested to include the entire lands of Hampton County in an appropriate CAPACITY USE AREA as provided for in the 1976 Code of Laws of South Carolina, Section 49-5-40, et seq, as amended by the Senate House on the 7th day of June, 1990, and approved by the Governor on the 12th day of June, 1990.

BE IT FURTHER RESOLVED, that copies of this Resolution be forwarded to:

1. The S. C. Water Resources Commission.
2. The legislative delegation which represents Hampton County.

ENACTED this 17th day of December, 1990.

Lee S. Bowers, Chairman

Willard E. Wilson, Vice Chairman

Willingham Cohenm, Sr.

Harold B. Harvey

James H. Wood, Jr.

ATTEST:

Clerk to Council

APPENDIX B

Hampton County households reporting reduction or loss of well yield in 1990

APPENDIX B. Hampton County residents reporting water-level related well problems.

NAME	LOCATION	DATE
1. Benjamin Grant	McKensie Subdivision, north of Furman	June 1990
2. McArthur Williams	As above	As above
3. Essie Benton	As above	As above
4. Lillie Lewis	As above	As above
5. Isaac Williams	As above	As above
6. Earl Johnson	Furman, 3 miles south	July 1990
7. John G. Causey	As above	As above
8. Connor Causey	Furman, 2 miles east	June 1990
9. Ben Griner	Mt. Carnel Area	July 1990
10. Dennie Griner	Southeast of Furman	July 1990
11. Bennie Griner	As above	As above
12. K.G. McKenzie	Furman, 1 mile east	June 1990
13. Julia Jones (3 wells	As above	As above
14. N.T. McKenzie	As above	As above
15. Mark DeLoach	East of Furman, near Stafford Crossroads	June 1990
16. Mrs. S.W. Tuten	Furman, 2 miles east	As above
17. Pauline Bolden	Furman, 1 mile east	As above
18. M.V. Mungin	As above	As above
19. Verna Cherry	As above	As above
20. Rodney Causey	West of Furman	As above
21. C.M. Shuman (2 wells)	Highway 333 between Scotia and Furman	As above
22. Joanne White	West of Furman Steep Bottom Road	July 1990
23. Kent Young	Pleasant Hill Plantation	As above
24. Annie Mae Zorn	Estill, 3 miles east	As above
25. Mockey Terry	Lena	May 1990
26. Stro Morrison	As above	As above
27. Mikie Mikell	As above	As above
28. Martha Ellen Duncan	As above	April/May 1990
29. Asbury Taylor	Immediate Lena Area	As above
30. Etha Washington	As above	As above
31. O.W. Taylor	As above	As above
32. Rudolph Bowers	As above	As above
33. Steve Wood	As above	As above
34. Chris Lyon	As above	As above
35. Harry Morrison	As above	As above
36. J.P. Long	As above	As above
37. Joe Brown	As above	As above
38. Stiles Harper	Northwest Estill	July/Aug 1990
39. Sterling Laffitte	As above	As above
40. C.H. "Bubsy" Mikell	As above	As above
41. Montegue Laffitte	As above	As above
42. Leslie Hanna	As above	As above
43. Rosa C. Wright	Brighton Community West of Garnett	July 1990

APPENDIX C

Proposed policy guidelines for ground-water conservation

121-X.XX CONSERVATION OF GROUNDWATER

A. Considerations
   1. efficacy of conservations methods
   2. loss to ground, surface, and atmosphere
   3. unreasonable or wasteful use
   4. best available means/technology
   5. economic feasibility

B. Set permit limits in accordance with quantity of water required if reasonable conservation methods are employed.

C. Conservation methods required
   1. testing, monitoring, and auditing to account for and predict uses and waste.
      a. water audits
      b. pressure tests of water systems
      c. leakage tests of ponds/lagoons
      d. soil-moisture capacity tests
      e. permeability tests
      f. aquifer tests
      g. geological sampling
      h. water-table elevations
      i. rain gauge
      j. soil-moisture monitors
      k. evaporation pans
   2. leak detection and repair programs
      a. public-supply systems
      b. systems with more than 2,500 feet of water line
      c. systems having unaccounted losses of greater than 5 %
      d. limit of program cost = cost:benifit = $1/$2 in 2 years
   3. plumbing codes
      a. public-supply systems shall serve only users subject to conservation regulations, ordinances, covenants acceptable to WRC.
         1. spec toilets, shower heads, etc.
      b. where ordinances arennot legally possible: permittees implement WRC-approved public education and plumbing retrofit programs
   4. plumbing retrofits
      a. required program in critical areas
   5. conservation education programs
      a. required of all public supply systems
      b. educational material on hand
      c. distributed minimum once yearly
      d. more stringent requirements in critical areas
   6. rain sensor shutoffs
      a. on all new irrigation systems served by PS systems
      b. in critical areas
   7. Golf-course irrigation
      a. rain gauge and soil-moisture monitoring required
      b. wetting agents required
      c. irrigated rough not to exceed 10 % of played areas

   d. maximum irrigated area = 110 acres
   e. maximum irrigated area in critical area = 75 acres
   f. sprinkler head maintenance programs
   g. use of lagoon sytems, effluent as practical
   h. require irrigation scheduling in accordance with best available conservation practices

8. Agricultural irrigation
   a. rain gauges and moisture monitoring required
   b. use of lagoons, effluent as practical
   c. require irrigation scheduling in accordance with best available conservation practices

9. Pond use - aquaculture, wildlife, aestetics, storage, and conveyance
   a. set standards for pond siting and construction
   a. set ranges of pond stage for groundwater discharge allowed
   b. require access storage capacity for pond-water reuse
   c. require reuse systems and schedules
   d. site conditions shall limit leakage losses to < 200,000 gal/acre/year and 16,700 gal/acre/mo
   e. WRC may prohit discharge into ponds in critical areas.
   f. require use of best available technology
   g. require water-table monitoring wells for control of leakage
   h. require rainfall, evaportation, and pond-stage monitoring
   i. storage-/conveyance-pond design and operation shall prevent groundwater loss (well-water in </= water withdrawn)

10. Industrial/commercial use
   a. require water-use audits
   b. require sequential use where feasible
   c. require recycling where feasible
   d. require treatment of recirculating water and reduction of bleed water use
   e. conserving plumbing fixtures and retrofits
   f. landscape irrigation scheduling
   g. leak-detection and repair

APPENDIX D

Ordinance to create the Hampton County Water Resources Board

STATE OF SOUTH CAROLINA

ORDINANCE

COUNTY OF HAMPTON

AN ORDINANCE TO ESTABLISH REGISTRATION, PERMITTING REQUIREMENTS, AND TO CONTROL THE WATER USE OF HIGH-CAPACITY WELLS IN HAMPTON COUNTY.

SECTION 1. PURPOSE

1.1. Residents and businesses in Hampton County depend on groundwater for agriculture, industrial operations, aquaculture, public supply and individual domestic uses.

1.2 (a) The County Council of Hampton County believes that the groundwater is a natural resource which should be equitably used for the benefit of all residents and property owners.

(b) The Council is concerned by recent events, in an area of the County, which illustrate the potential adverse effects that new high-capacity use may cause to neighboring long-time existing use.

(c) The Council RESOLVED on the 17th day of December, 1990, to request admission to the Lowcountry Capacity Use Area as one means of providing for coordination of the multiple, potentially conflicting if uncoordinated, uses of the groundwater.

(d) To enhance coordination, to protect against or abate unreasonable adverse effects on other users by a high-capacity user, and to minimize waste, the Council does hereby enact this Ordinance;

(e) The Council believes that mandatory regulations should be avoided if voluntary measures will produce the results desired as heretofore expressed. Therefore, this Ordinance provides the mechanism for adoption of voluntary standards. A mechanism for adoption of mandatory regulations is provided herein, which may be utilized only if voluntary standards do not achieve the goals sought.

SECTION 2. AUTHORITY

This Ordinance, which is intended to advance the general welfare and public interest, is enacted pursuant to specific authority granted in the 1976 Code of Laws of South Carolina, 4-9-30 (6) et. seq. and in accordance with the General Law.

SECTION 3. JURISDICTION

This Ordinance shall apply to all high-capacity wells within the boundaries of Hampton County except as may otherwise be exempted herein.

SECTION 4. DEFINITIONS

4.1 Rules of Language and Interpretation

(a) The word "shall"is mandatory; the word "may" is permissive.

(b) The particular shall control the general.

(c) Words used in the present tense shall include the future.

(d) Words used in the singular include the plural, and plural the singular, unless the context clearly indicates the contrary.

4.2 Definitions

Words used in this Ordinance shall have their customary meanings as determined by standard dictionary definition unless modified or otherwise defined herein:

(a) <u>County</u>. Hampton County, State of South Carolina

(b) <u>County Agent</u>. A person designated by Cooperative Extension Service, Clemson University, as Agent for Hampton County.

(c) <u>Engineer</u>. A person who is registered by the State of South Carolina as a Professional Engineer, or a person who has graduated from an accredited college or university with a bachelor or higher degree in any branch of Engineering recognized by the South Carolina Board of Registration for Professional Engineers and Land Surveyors.

(d) <u>Geologist</u>. A person who is registered by the State of South Carolina as a Professional Geologist or a person who has graduated with a bachelor or higher degree from an accredited college or university in a course recognized by the South Carolina Board for Registration of Geologists.

(e) <u>Hampton County Water Resources Board</u>. A Board created by this Ordinance whose members are appointed or designated by the County Council, the governing body of the County.

(f) <u>High-Capacity Well</u>. A well equipped with a pump of five (5.0) horsepower (hp) or greater.

(g) <u>Hydrologist</u>. A person who has graduated from an accredited college or university with a bachelor or higher degree in hydrology or a physical science with a major in hydrology.

(h) <u>Resource Specialist</u>. A person who has graduated from an accredited college or university with a bachelor or higher degree with a major study of at least thirty (30) semester hours related to natural ground or water resources and with a minimum of one (1) year experience in the management or information retrieval of groundwater resources.

(i) <u>SCWRC</u>. The South Carolina Water Resources Commission.

(j) <u>Well</u>. Any excavation that is cored, bored, drilled, jetted, dug or otherwise constructed for the purpose of withdrawing groundwater (this is a restrictive definition of a well for the purposes of this Ordinance.)

SECTION 5. REGISTRATION

5.1 Existing Wells.

All high-capacity wells existing at the time of adoption of this Ordinance shall be registered by the owner with Hampton County Water Resources Board on a form provided by the County. Wells shall be registered within forty-five (45) days following legal notice of this requirement in a local newspaper.

5.2 New Wells.

The Hampton County Water Resources Board shall be notified of the construction of high-capacity wells, completed subsequent to the adoption of this Ordinance, by the owner or the water well contractor designated by the owner. Notification shall consist of submittal of a copy of the water well construction report which is submitted to the South Carolina Department of Health and Environmental Control, or the permit form report to the SCWRC if the well is in a Capacity-Use Area.

SECTION 6 - WATER RESOURCES BOARD

6.1 Composition.

The Hampton County Water Resources Board shall consist of the following voting and non-voting members:

(a) Designee by the SC Water Resources Commission. One (1) member shall be appointed who is nominated by SCWRC to represent its Beaufort Region. He (she) shall be a voting member.

(b) County Agent. The County Agent shall be a voting member.

(c) Qualified members. Three (3) voting members, residents of the County, shall be appointed who are qualified as an Engineer, Geologist, Hydrologist, or Resource Specialist.

(d) General Members. Three (3) voting members shall be appointed from among the residents of the County.

(e) Ex-officio Members. The County Council may, as in its best judgement it deems desirable, appoint members to the Board who may participate in all Board activities except that they shall not be entitled to a vote.

6.2. Terms of Office.

The members of the Board shall be appointed by the County Council for terms as follows:

(a) Designated Members. The SCWRC designee, and the County Agent, shall be appointed to indefinite terms from time to time.

(b) Qualified Members. The three (3) qualified members shall be appointed for terms of two (2) years.

(c) General Members. The three (3) general members shall be appointed for terms of two (2) years.

(d) Ex-officio Members. The non-voting members shall be appointed to indefinite terms from time to time.

6.3. Vacancies.

(a) Members shall serve for the terms designated. When vacancies occur, the Board may continue to exercise its defined functions only so long as five (5) unvacated seats of voting members exists.

(b) A vacancy in voting membership exists whenever:
 (i) A member resigns or is deceased.
 (ii) A member becomes ineligible by reason of his change of residence when County residence is mandatory.
 (iii) A member is removed for cause.
 (iv) The status of a designated member has changed and the sponsor has not provided a replacement nominee.
 (v) The Council fails to make the necessary appointments for any reason.

6.4. Removal

A qualified or general voting member may be removed by the County Council for cause providing that:

(a) The alleged cause shall be stated in writing and presented to the member prior to any other action except the determination of probable cause.

(b) There shall be a public hearing, if the accused member requests it, which is advertised at least one week prior to the hearing in a local newspaper or radio.

(c) And there shall be no executive session of the Council on the subject of removal prior to the public hearing without the consent of the accused.

(d) And prior to a mandatory vote by the Council in the public presence, the Council, if it meets in executive session after the public hearing, explains to the public the general nature and reason for such executive session.

6.5. Functions, Duties, Powers.

(a) The Board shall establish its own by-laws and operating procedures providing they are in harmony with this Ordinance, the general law and the Constitution of the State of South Carolina.

(b) Any money appropriated to the Board for operating expense by either the County or other governmental agency, and any money donated by any private business or organization, for aid to the Board in executing its functions, shall be deposited in an account which is controlled by the Treasurer of the County. And the expenditure of all funds shall be reported to the County Administrator, who shall be supplied with such detail as he (she) requires that is consistent with the law.

(c) The Board shall adopt standards which are intended to achieve the purposes of this Ordinance through voluntary participation by users of high-capacity water wells.

(d) If voluntary participation is either not achieved or fails to produce the desired results, the Board shall propose mandatory regulations.

(e) The proposed mandatory regulations shall be considered adopted if approved by a majority vote of the County Council at a meeting following a public hearing, providing notice of at least seven (7) days is given of the public hearing in a local newspaper or radio. All changes or modifications of mandatory regulations shall be effective only after complying with the same procedure as for adoption.

SECTION 7. EXCEPTIONS

7.1. Registration of Existing and New Wells.

The registration of wells owned and/or operated by any agency of the Federal Government or the State of South Carolina is exempt if so desired by the specific Agency.

7.2 Mandatory Regulations.

(a) Wells which are owned and/or operated by any Agency of the Federal Government or the State of South Carolina are exempt from mandatory regulations.

(b) Any Town or Water District within the borders of the County may challenge the applicability of mandatory regulations to any water well used for public water supply which is owned and/or operated by such Town or District.

(1) If a challenge is made by delivery in writing to the Board the regulation(s) shall not apply to the specific well(s) for which the challenge is made.

(11) The inapplicability shall remain until it is negotiated otherwise between the parties or until a Court of competent jurisdiction orders the applicability of the regulation.

SECTION 8. ENFORCEMENT

8.1 Inspections and Investigations.

The Board is authorized, on its own or through other county agencies, to make reasonable inspections of wells and records, and to enter private or public property at reasonable times with reasonable notice as it deems is necessary and is lawful in performing its duties under this Ordinance. And no person shall interfere with an authorized representative who presents proper credentials and states the lawful purpose of an inspection or investigation.

8.2. Penalty.

Any person who violates this Ordinance shall be deemed guilty of a misdemeanor which is punishable by a fine not to exceed one thousand ($1,000) dollars, or imprisonment for not more than six (6) months, or both. Each day of a continuing violation shall constitute a separate offense.

SECTION 9. LEGAL STATUS

9.1 Effective Date.

This Ordinance takes effect on the day which immediately follows its adoption after a third reading.

9.2. Separability.

If any section, clause, or portion of this Ordinance shall be ruled invalid or unconstitutional by a Court of competent jurisdiction, such ruling shall not affect any other section, clause or portion of this Ordinance.

APPENDIX E

Proposed guidelines for mitigation of unreasonable adverse effects on ground-water users

121-X.XX UNREASONABLE ADVERSE EFFECTS ON OTHER WATER USERS

A. Unreasonable adverse effects:
   1. inducing the migration of contaminants beneath another's property
   2. inducing the migration of contaminants to within the radius of influence of another's well(s)
   3. causing the formation of sinkholes or causing land subsidence within another's property.
   4. causing reduction in discharge or water pressure from public supply wells, fire-protection supply wells, domestic wells discharging less than 15 gpm and used principly for household purposes, or wells essential to the continuation of commerce.
   5. causing excessive reduction in the flow of a water course or excessive water-level declines in ponds or in naturally-occurring freshwater wetlands.
   6. causing a loss of income to another user.
   7. provided, however, any person subject to an adverse effect and filing notice thereof with the Commission shall be required to make reasonable compromise to assure groundwater is put to maximum beneficial use.

B. Control measures:
   1. Pumping arrangements
      a. prescribe the number and distribution of wells, and limit withdrawals from wells, to minimize water-level declines and flow velocities, and to control the direction of flow.
      b. prescribe pumping schedules and well discharges.
      c. prescribe water levels in pumping and observation wells.
      c. prescribe well design with respect to open-hole intervals, screen intervals, casing depths, pump-intake depths, automatic water-level sensors and shutoffs, and other means of controlling water levels in wells and aquifers.
      d. require coordination of well loctions, pumping rates, and pumping schedules among groundwater users.
   2. Alternative sources
      See section C2 of "Capture and diversion of contaminants"
   3. Test and monitoring wells:
      a. require construction and testing of test and observation wells for the purpose of determining hydraulic and geological characteristics of aquifers.
      b. require construction and monitoring of wells for the purpose of maintaning prescribed water levels.
   4. Inventories:
      a. require representative inventory of wells within the calculated radius of influence of a proposed withdrawal.
         1. owner name/address
         2. well location
         3. well construction
         4. pump used
         5. type of use
      b. representative inventory:
         1. the greater of 10 wells or 15 percent of the wells with in the radius of influence.
         2. the number of wells determined to be statistically representative of an area by the Commission.

3. records of water-well contractors having experience in the area.

c. require inventory of wetlands and ponds within the radius of influence of a proposed withdrawal from a water-table aquifer or an artesian aquifer less than 50 feet below land surface.

C. Notice of drawdown potential:

1. may require publication of notice where:
   a. the radius of influence encompasses domestic and/public-supply wells, and
   b. withdrawal from a water-table aquifer may cause a drawdown of two feet or greater beneath lands not owned, leased, or otherwise controlled by the applicant, or
   c. withdrawal from an artesian aquifer may cause a drawdown of five feet of greater beneath lands not owned, leased, or otherwise controlled by the applicant, or
   d. withdrawal may cause a drawdown of two feet or greater in known domestic wells
2. notices shall be published in a paper of general circulation in the county of the proposed withdrawal for a period of 30 days. notices may be published in conjunction with public notices for groundwater use permits.
3. the notice shall specify:
   a. approximate radius of influence
   b. range of potential drawdowns
   c. warning to lower pump intakes where set at shallow depths.
   c. location of Commission office requiring the notice.
   d. advisement to contact Commission for a report of its findings in regard to the proposed withdrawal.
   e. other information deemed necessary by the Commission
4. prior to requiring publication of notices, the Commission shall prepare reports outlining its findings and including drawdown-countour maps and/or its most current potentiometric maps.
5. where any person can demonstrate a proposed withdrawal will adversely affect well performance and that 30 days is insufficient to implement corrective measures, the Commission may suspend permit processing for an additional 30 days after the closing date of the notice. Requests to suspend permitting shall be submitted in writting to the Commission within the 30-day notice period on forms provided by the WRC.

   conditions under which 30 days may be considered unsufficient:
   a. unavailability of water-well contractor
   b. construction of new well(s) essential
   c. necessary pumps or related equipment are temporarily unavailable
   d. complaintant(s) has made reasonable effort to aquire all necessary equipment and services
   e. other factors

C. Ponds, water courses and naturally-occurring wetlands.
   1. Withdrawals must not cause the water level in a pond or wetland to be lowered more than one foot unless the pond or wetland is wholly owned, leased, or otherwise controlled by the applicant, accept:
      a. the applicant can provide a release from each affected party
      b. water-level declines are temporary owing to future reduction of water use or seasonal water use
   2. Withdrawals must not cause a reduction in flow of any surface-water course by more than five per cent at the time and point of withdrawal, accept that the reduction is temporary.
   3. Withdrawals whose radius of influence encompass a surface-water course may be suspended or reduced where a condition of extreme drought has been declared and flows are inadequate to support fish and wildlife, or to treat or dilute effluent.

D. Contamination of aquifers and wells:
   1. prohibit withdrawals which cause contaminants to migrate beneath areas not owned by the applicant, and thereby reducing the quantity of water available to other users or potential users.
   2. prohibit withdrawals which cause contaminants to migrate within the radius of influence of another user's well(s).
   3. require written notification to leasors of contamination potential where the applicant does not own the property from which the proposed withdrawal will be made.