GROUND-WATER RESOURCES OF LEE COUNTY, SOUTH CAROLINA

STATE OF SOUTH CAROLINA
DEPARTMENT OF NATURAL RESOURCES

LAND, WATER AND
CONSERVATION DIVISION

WATER RESOURCES
REPORT 33

2004

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by

Roy Newcome, Jr.

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STATE OF SOUTH CAROLINA

The Honorable Mark H. Sanford, Governor

South Carolina Department of Natural Resources

Board Members

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GROUND-WATER RESOURCES OF LEE COUNTY, SOUTH CAROLINA

by
Roy Newcome, Jr.

ABSTRACT

Lee County, S.C., has abundant ground-water resources available for public and industrial supplies and crop irrigation. The Middendorf and Black Creek Formations, of Cretaceous age, overlie the Paleozoic bedrock that lies at depths ranging from 200 to 800 feet from northwest to southeast in the county. Both formations contain numerous sand aquifers capable of supporting moderate to large well supplies. Irrigation wells with yields of 2,000 gallons per minute have been constructed, and public-supply wells produce as much as 1,000 gallons per minute. Pumping tests indicate that considerably larger yields can be obtained, in many places, from high-efficiency wells that take advantage of the available drawdown.

The water has remarkably low mineralization, usually less than 50 milligrams per liter in total dissolved solids concentration. The water has almost no hardness, and it is acidic. A study currently under way is seeking the source, extent, and means of alleviation of excessive radioelement concentrations in some public-supply wells.

INTRODUCTION

Location and General Features

Lee County is an irregular area of 410 square miles in northeastern South Carolina (Fig. 1), not far from the center of the State. It ranks 40th in size among South Carolina's 46 counties. Geographically, Lee County is between lat 33°57' and 34°22' N, long 80° and 80°30' W. It is bounded by the counties of Kershaw on the northwest, Darlington and Florence on the east, and Sumter on the south.

The topography is varied, gently rolling for the most part but with small areas of steep slopes and substantial swampy stretches along the Lynches and Black Rivers and Scape Ore Swamp. Elevations range from 440 feet above sea level in the west at Spring Hill and near Woodrow to 115 feet where the Black River leaves the county.

Nearly all of the county is drained by the Lynches and Black Rivers (Fig. 1). They are subbasins of the Pee Dee River basin, which drains the northeastern part of the State. A small area in the western extremity of the county is in the Catawba-Wateree subbasin of the Santee River basin, the largest of South Carolina's basins.

Climate

Lee County's climate is classified as humid subtropical. The summers are long and hot, the winters short and mild. Long-term average rainfall is 45.5 inches. Average summer and winter temperatures are 78.2° F and 44.4° F, respectively, with July the hottest month and January the coldest. The growing season is 7 months long. July and November are the wettest and driest months, respectively.

Snow is rare in this county. Summer thunderstorms are common. In the hurricane season, an occasional storm makes its way to the Midlands, rarely causing severe damage. The 5-year drought that ended in early 2003 was felt by farmers here, as elsewhere in South Carolina. Recovery of the water resources has been rapid, however. Ponds, which were greatly affected by the drought, showed a return to normalcy in the first quarter of 2003.

Population and Development

Lee County's population was 20,119 in the 2000 U.S. census, which showed a 9.1 percent increase since the 1990 census. The county seat, and largest town, is Bishopville with a population of 3,670.

Lee is basically an agricultural county, with nearly 40 percent of its total area in cropland. Soybeans, cotton, wheat, and corn are the major crops. More than half of the county is forested, much of it grown for commercial harvesting.

Industrial employment totals about 500 workers. Major employers are South Atlantic Canners, Inc., and Rexam Beverage Can Americas. Two new industrial parks, located adjacent to Interstate I-20 near Bishopville, have added workers to the area.

Transportation facilities include Interstate Highway 20, east-west across the county and passing just south of Bishopville. By I-20, Columbia is 54 miles to the west-southwest and Florence is 34 miles to the east. Sumter is 23 miles to the south by U.S. 15. The CSX Railroad connects Bishopville with Sumter and with Hartsville on the northeast. Another track of the CSX connects Lynchburg with Sumter and Florence. The airports at Sumter, Florence, and Columbia serve Lee County.

Municipal water systems serve Bishopville and Lynchburg. Both obtain their water from wells.

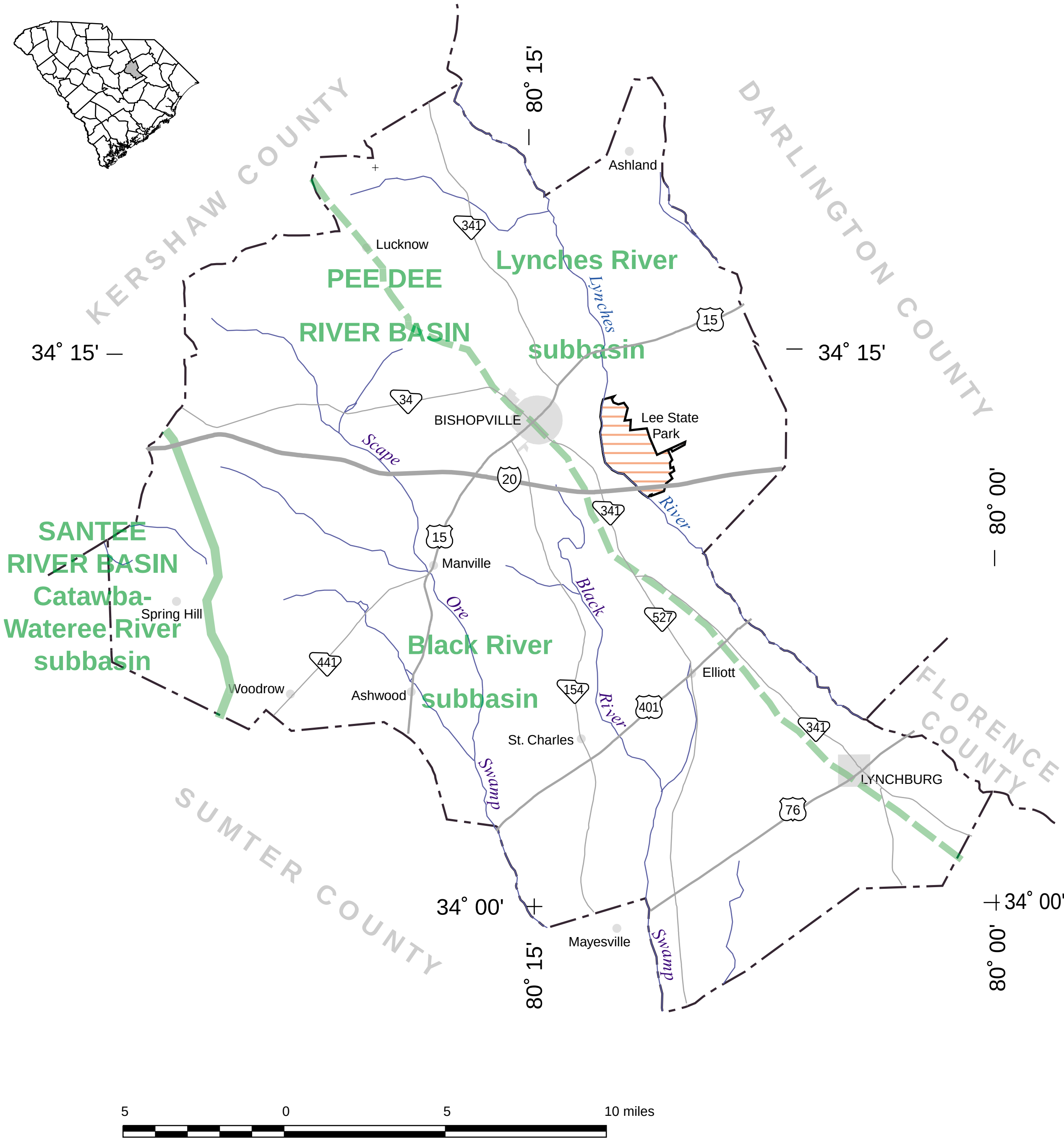


Figure 1. Location and drainage of Lee County, S.C.

Purpose and Scope of Report

This report was prepared from data in the files of the South Carolina Department of Natural Resources (DNR), augmented by well-drillers' records submitted to the South Carolina Department of Health and Environmental Control (DHEC). The purpose of the report is to provide information on the ground-water resources that can be used in evaluating the availability of water for various uses, such as public supply, industry, and irrigation. In scope, the report addresses the depth and thickness of water-bearing sand beds, their hydraulic properties, and the quality of the water contained in them. Much of the information is presented on maps or in tables.

Supporting Data

To properly place the subject of this report in the geography and hydrology of South Carolina, it is necessary to locate it with regard to surface drainage and topography. Figure 1 shows that Lee County is mostly in the Pee Dee River basin, the easternmost of four major drainage basins that transport all of South Carolina's surface flow to the sea. A small area forming the western extremity of the county is in the Santee River basin, which drains most of the north-central part of the State. Each of these basins is subdivided into several subbasins that localize the flow patterns. The Pee Dee basin in Lee County comprises parts of the Lynches River and Black River subbasins, and the Santee basin is represented by the Catawba-Wateree River subbasin.

Figure 2 shows topographic-map coverage for Lee County. All or part of fourteen 7.5-minute quadrangles are required to provide land-surface elevations and topographic features for the entire county.

Well drillers' reports, required to be submitted to DHEC, are useful in statistically analyzing the various aspects of water-well completion; especially depth, yield, water level. This information helps in forecasting several important factors involved in locating and constructing wells, especially where large yields are required.

Electric logs of wells probably constitute the single most valuable tool in locating a well-water supply. They reveal the depth and thickness of sand aquifers and, in conjunction with pumping tests and chemical analyses, can permit reasonable estimates of well capacity and water quality for not only the well but for large areas beyond the well site.

Pumping tests reveal how much a well can produce and how much production the aquifer can support. They also indicate the well efficiency and provide the hydraulics information required for predicting pumping effects at various times and distances.

Lastly, but of great importance, are water-quality analyses. The primary analysis, referred to as a "standard complete analysis," reports the concentrations of major constituents (the cations and anions and silica) and several properties; including pH, hardness, dissolved solids, and specific electrical conductance. Temperature and color may also be included. More detailed analyses may include a multitude of constituents and properties determined for special purposes. Among these are hydrocarbons, radioactivity, and pesticides. What the water-quality analysis shows will determine the suitability of the water for its intended use and what treatment, if any, is needed.

Previous Studies

Most of the South Carolina Coastal Plain counties have been described in multicounty or individual county ground-water reports. Lee is one of the few counties for which no such report has been prepared. It was mentioned specifically, but briefly, by this writer in a description of the ground-water resources of the Coastal Plain (Newcome, 1989, p. 74, 103, and 122). In addition, two open-file reports by this writer contain the results of several aquifer tests made in Lee County (Newcome, 2000, p. 21) and a list of the wells used for public supply by the towns of Bishopville and Lynchburg (Newcome, 2001, p. 35).

Reports on the ground-water resources of counties adjacent to Lee have been published for Sumter and Florence Counties (Park, 1980); Darlington County (also Dillon, Florence, Marion, and Marlboro Counties) (Rodriguez and others, 1994); and Kershaw County (Newcome 2002).

Useful studies of Coastal Plain hydrogeology were prepared by Aucott and others (1987) and by Colquhoun and others (1983). They contain structure-contour maps and hydrogeologic sections that show the depth and thickness of water-bearing zones.

Well-Numbering System

Wells in DNR files have county numbers assigned sequentially as their records are obtained, as LEE-73. They also are given a number in the South Carolina well-location grid system that locates the wells to the nearest minute of latitude and longitude and assigns a sequential number within that minute. Thus, LEE-73 has the grid number 21O-d1, which would place it in the south-central part of the county, as may be seen on Figure 3.

WATER SUPPLY

Municipal water supplies serve Bishopville and Lynchburg. Bishopville pumps about 1½ mgd (million gallons per day) from five wells, one of them added in 2003. More than half of Bishopville's pumpage is used by the nearby industries. Lynchburg normally pumps about ¼ mgd from two wells (one is temporarily inoperative). The Cassatt Water Company, headquartered in Kershaw County but with a widely distributed rural water system, has seven wells in Lee County. Three of these are in the rural communities of Lucknow, Elliot, and St. Charles. Another is near the Manville community.

Table 1 lists the wells of the Bishopville and Lynchburg water systems and of the Cassatt Water Company in Lee County. The kinds of information available for them in DNR files are indicated.

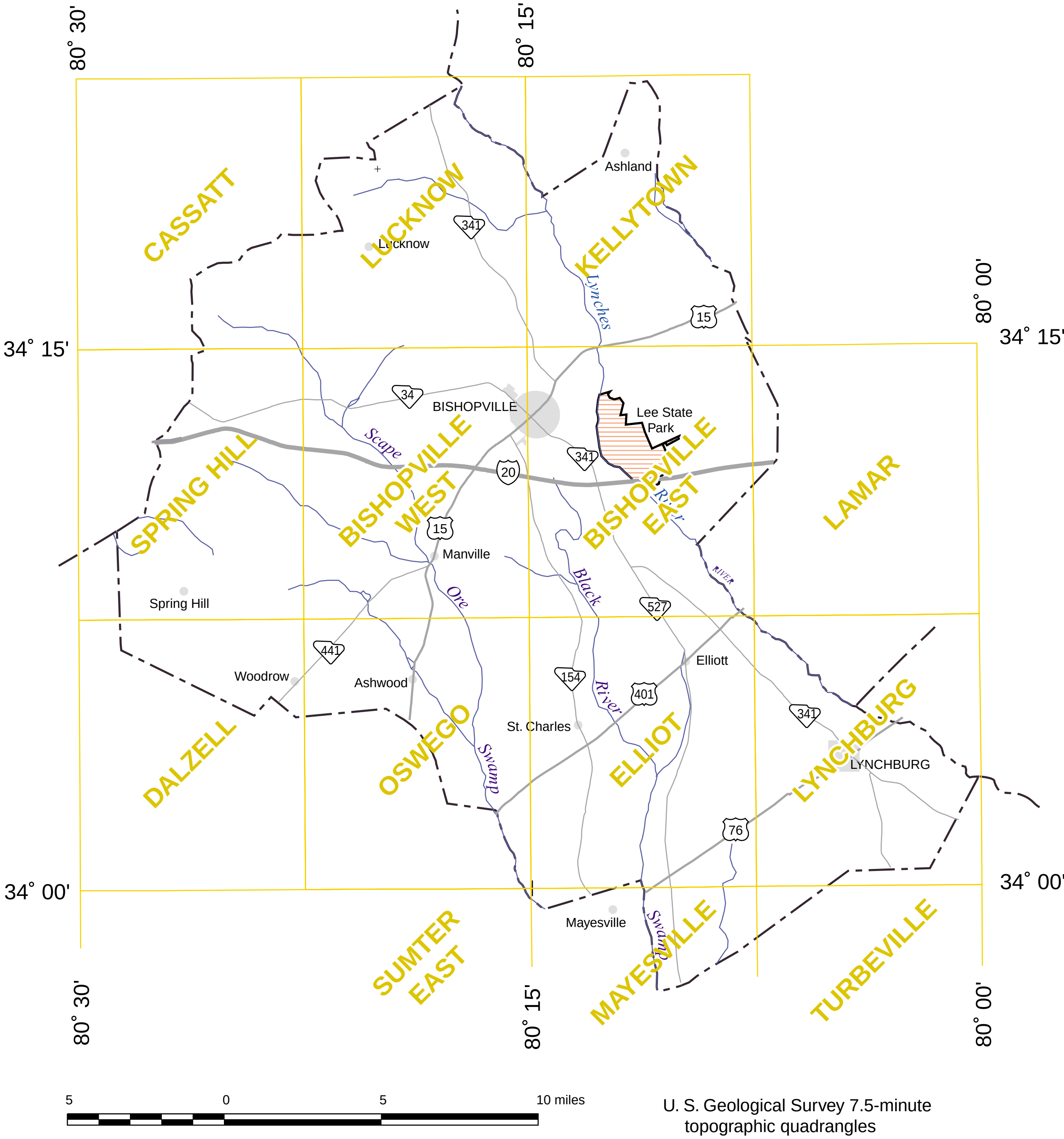


Figure 2. Lee County topographic-map coverage.

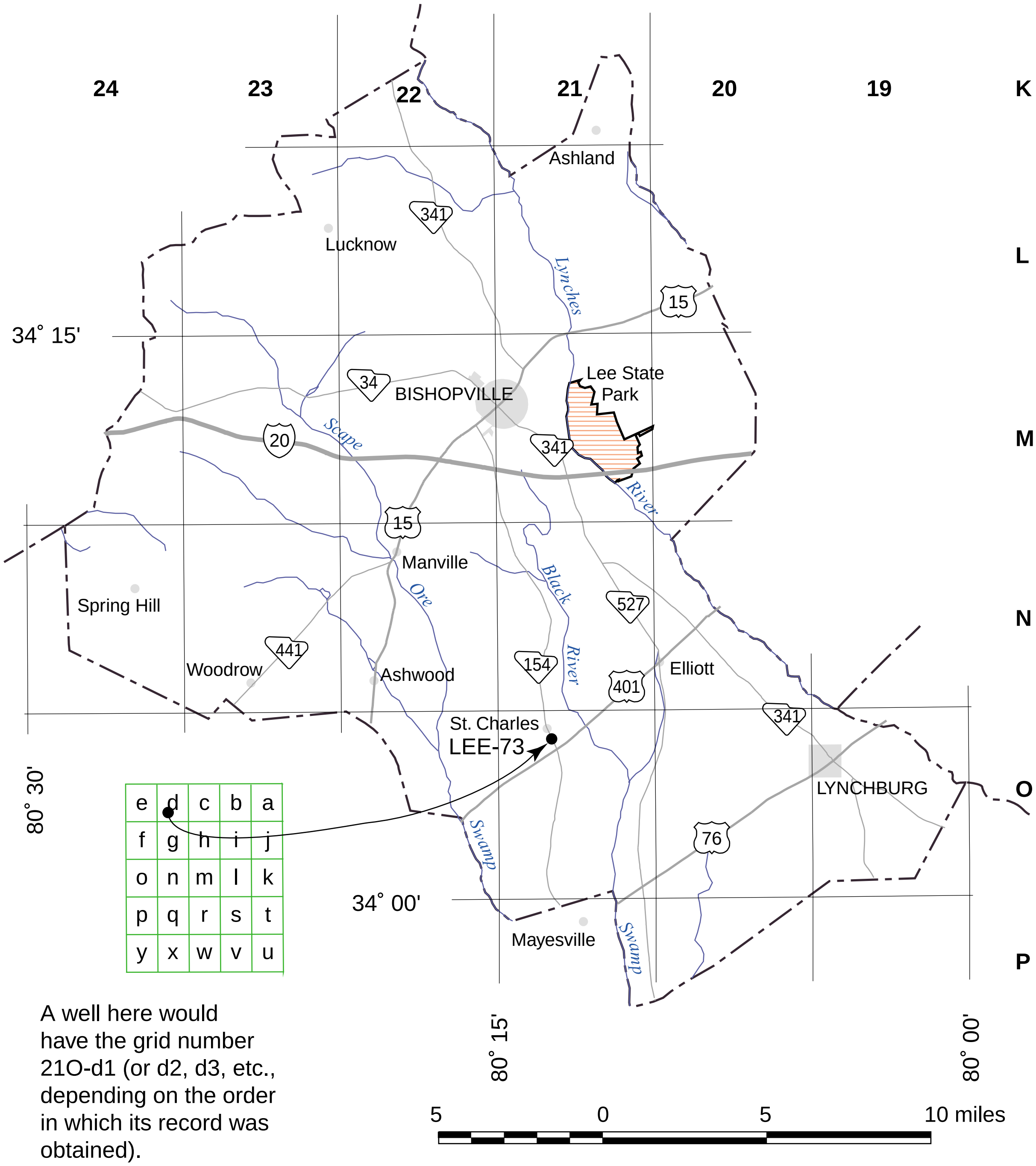


Figure 3. South Carolina well-location grid system as it applies to Lee County.

Table 1. Wells in the public-supply water systems of Lee County, S.C. — 2003

System	Well name	Owner no.	Depth (feet)	Yield (gpm)	Electric log	Chemical analysis	Pumping test	County number	S.C. grid number	Date drilled
Bishopville	Council St.	1	312	485				LEE-15	21M-f1	10/1960
	Highway Dept	2	332	525	X	X		LEE-20	21M-o1	10/1974
	Industrial Park	3	335	575	X	X		LEE-59	21M-r3	8/1982
	Piedmont Road	4	347	800	X		X	LEE-79	22M-l1	1/1996
	Highway 15	5	357	1,025			X	LEE-144	22M-l2	8/2002
Lynchburg	East Treatment Plant	1	544	350	X	X	X	LEE-19	19O-g2	1/1973
	West Treatment Plant	2	514	350	X	X	X	LEE-18	19O-g1	10/1972
Cassatt Water Co.	Joyner Lot	7	127	140				LEE-56	24M-k3	10/1980
	Cedar Creek	8	336	320		X	X	LEE-69	23M-j1	9/1985
	Baker Lot	9	347	610		X	X	LEE-113	23N-b6	1/2000
	Lucknow	10	263	210	X	X	X	LEE-36	23L-k1	5/1978
	Elliott Well	14	438	225	X	X		LEE-72	20N-p1	12/1991
	St. Charles Comm.	15	458	270	X	X	X	LEE-73	21O-d1	1/1992
	Spring Hill		455	535		X	X	LEE-112	24N-j2	9/2001

HYDROGEOLOGY

Igneous and metamorphic rocks of the Piedmont physiographic province underlie the Coastal Plain formations of South Carolina. The surface of the bedrock slopes southeastward at about 25 ft (feet) per mile in Lee County. Its position, relative to sea level, is depicted by the contours on the map of Figure 4. These hard rocks contain water in crevices and supply many wells in Kershaw County, just to the northwest.

Lee County is entirely in the Coastal Plain. Sand-and-clay units that compose the principal formations are of Cretaceous age and have an aggregate thickness ranging from 200 ft at the north end of Lee County to 800 ft at the south end. Two named formations represented are (1) the Middendorf Formation that overlies the Paleozoic bedrock throughout the county and crops out in the northern half; and (2) the Black Creek Formation that overlies the Middendorf Formation in the southern half of the county. Lithologically and hydrologically, the two formations are similar. Each formation is about 400 ft thick at the southern tip of the county. Tertiary-age sand and clay, in thicknesses as great as 130 ft, were mapped on the high points of Spring Hill and Woodrow by Kite (1987). These small-area occurrences probably have little hydrologic significance. The Black Mingo Formation, of Paleocene age, overlies the Black Creek beds southeast of Lee County, as indicated in the hydrogeologic section of Figure 5.

Availability of Aquifers

A scattering of electric logs that have been made in wells and test holes provides much useful information on the subsurface conditions in and near Lee County. Several of these logs are located on the map of Figure 6, and the sand intervals indicated on them are given in Table 2. It can be readily seen that the sand intervals are extremely irregular in depth and thickness.

In addition to the electric logs, there are numerous drillers' logs that record the depth and thickness of the sand beds penetrated during the construction of water wells. Most of these logs are for wells drilled to obtain small water supplies for domestic use or lawn irrigation, and they normally extend only to the depth necessary to provide sufficient water to satisfy the need. Of 135 wells drilled in the years 2000-2002 in Lee County, 70 percent were 100 ft or less in depth and are pumped at 30 gpm (gallons per minute) or less.

Deeper wells that penetrate more and thicker aquifers can yield many times the amount stated above. For 13 wells producing 1,000-2,000 gpm for irrigation, industry, and public supply in Lee County, the depth range is 300 to 542 ft. To obtain large well yields it is necessary to have a combination of high aquifer transmissivity and adequate available drawdown.

The hydrogeologic section of Figure 5 illustrates the thickness and depth of the Coastal Plain formations. Well LEE-75 on the section is a core hole drilled at Lee State Park headquarters by the U.S. Geological Survey and DNR. The core drilling is part of a cooperative project in aquifer delineation that is likely to produce new aquifer names.

About 540 ft of Coastal Plain sediments were penetrated before weathered Paleozoic bedrock (saprolite) was encountered. The electric log of the core hole (Fig. 7) suggests a sandy section, especially between the depths of 190 and 400 ft—with a clay interval from 260 to about 285 ft. Sand beds made up nearly 50 percent of this well's depth, near the average for the 13 wells in Table 2. The sand composition for the 13 wells ranged from 32 to 74 percent.

Hydraulics of Aquifers and Wells

More than 20 pumping tests are available for the aquifers in and near Lee County (Table 3 and Fig. 8). The tests made in Lee County, as well as those nearby in Kershaw and Darlington Counties, are for wells in the Middendorf Formation; whereas the tests in Sumter County, on the south, are for wells in the shallower Black Creek Formation or, in one case, both the Black Creek and Middendorf Formations. The tests typically involved pumping for 24 hours at a near-constant rate and recording the water level as it was drawn down in the well. Recovery of the water level after pumping ceased was also recorded in many of the tests, a very helpful part of the test for purposes of analyzing the aquifer and well hydraulics.

The information gained from the pumping tests can be used to predict the potential capacity of the aquifers and of the wells installed in them. The critical item revealed for an aquifer is the <u>transmissivity</u>, the rate of flow the aquifer can sustain. Aquifer transmissivity determines the potential specific capacity of wells. <u>Specific capacity</u> is the gallons per minute a well will produce per foot of water-level drawdown when pumped for a day. This is one of the two most important items needed for decisions on pump-setting depth and pump capacity. The other critical item is <u>available drawdown</u>, which is the distance between the well's static (nonpumping) water level and the top of the well screen. Specific capacity multiplied by available drawdown equals maximum well yield. Figure 9 illustrates these relations.

Another key element in the effort to obtain the most water from a well at the least cost is <u>well efficiency</u>. This is the ratio of the well's specific capacity, as measured in the pumping test, to the ideal specific capacity for a well producing from an aquifer having the transmissivity indicated by the pumping test. The greater the head loss, the less efficient is the well and the more costly is its use. See Figure 10 for an illustration of the effect of well inefficiency.

This writer feels that any well should be at least 70-percent efficient. Some wells are practically 100-percent efficient. Unfortunately, too many wells are very inefficient; some are as poor as 25 percent. Well screen selection and placement, with adequate well development, are the main factors in achieving an efficient well. By this is meant screening the best parts of the aquifer with screen having openings properly chosen for the sand-grain size of the aquifer. If a gravel envelope is used, it should be sized to the aquifer and the well

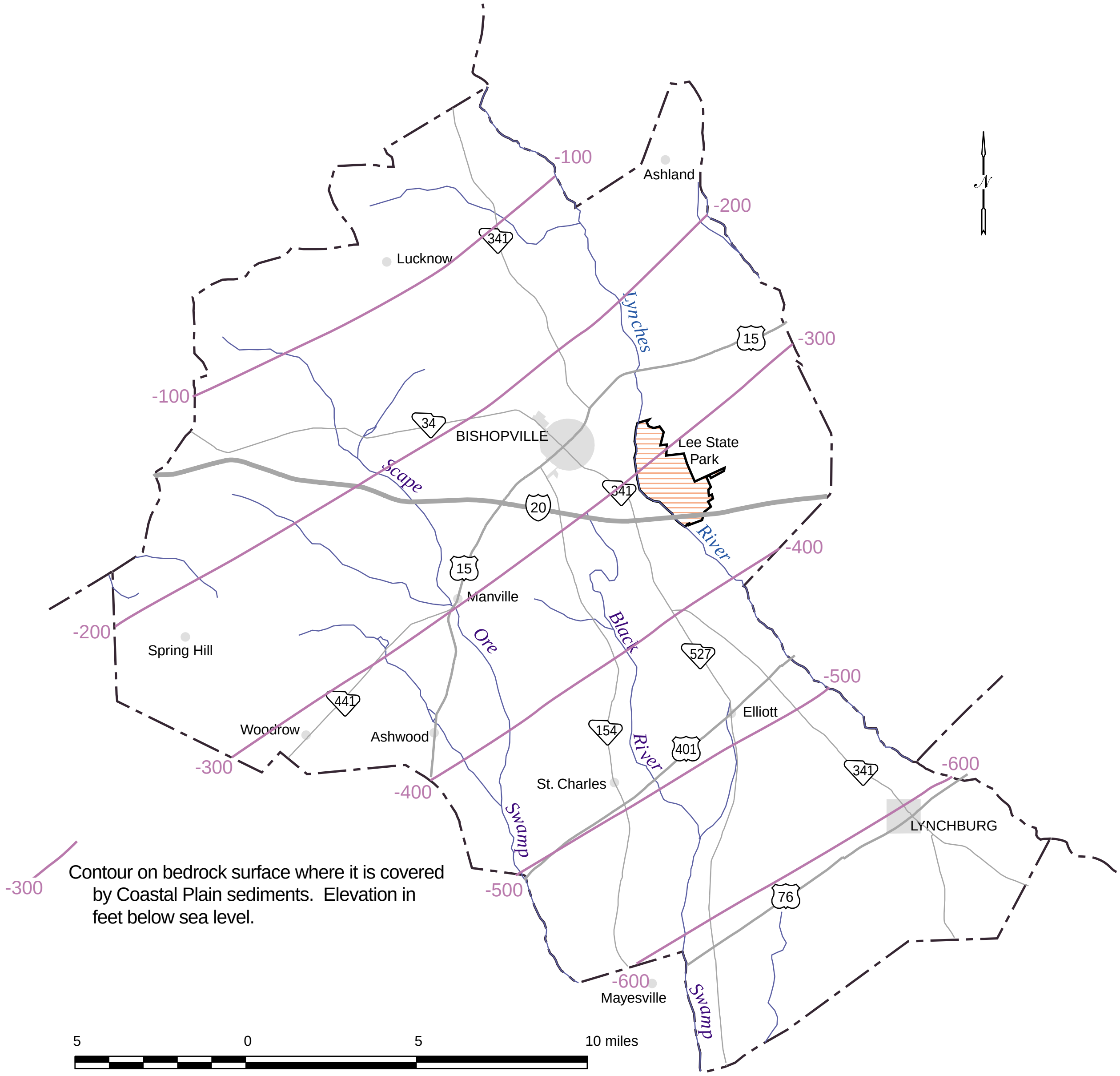


Figure 4. Approximate contours on the bedrock surface in Lee County.

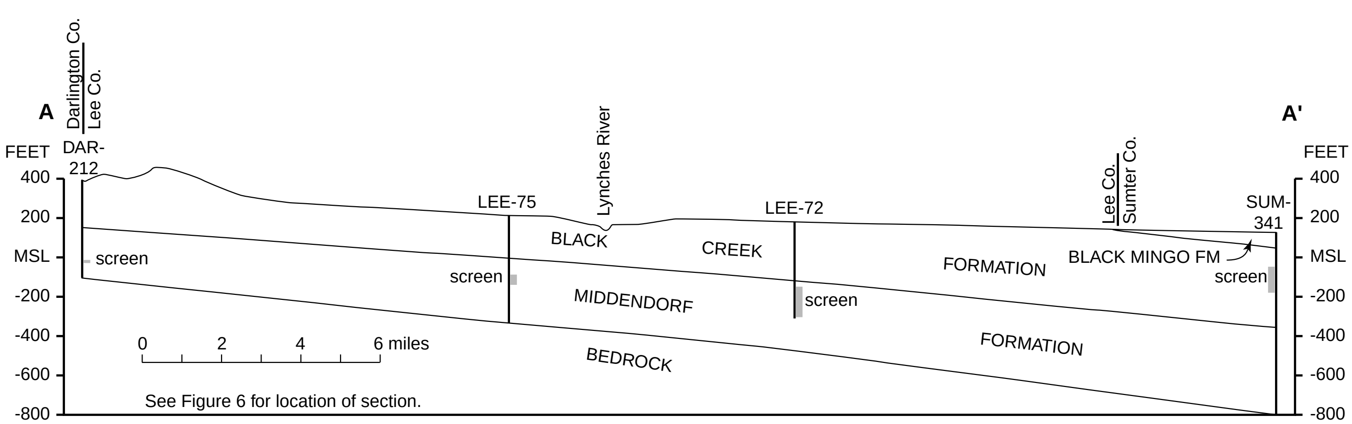


Figure 5. Hydrogeologic section down the eastern side of Lee County.

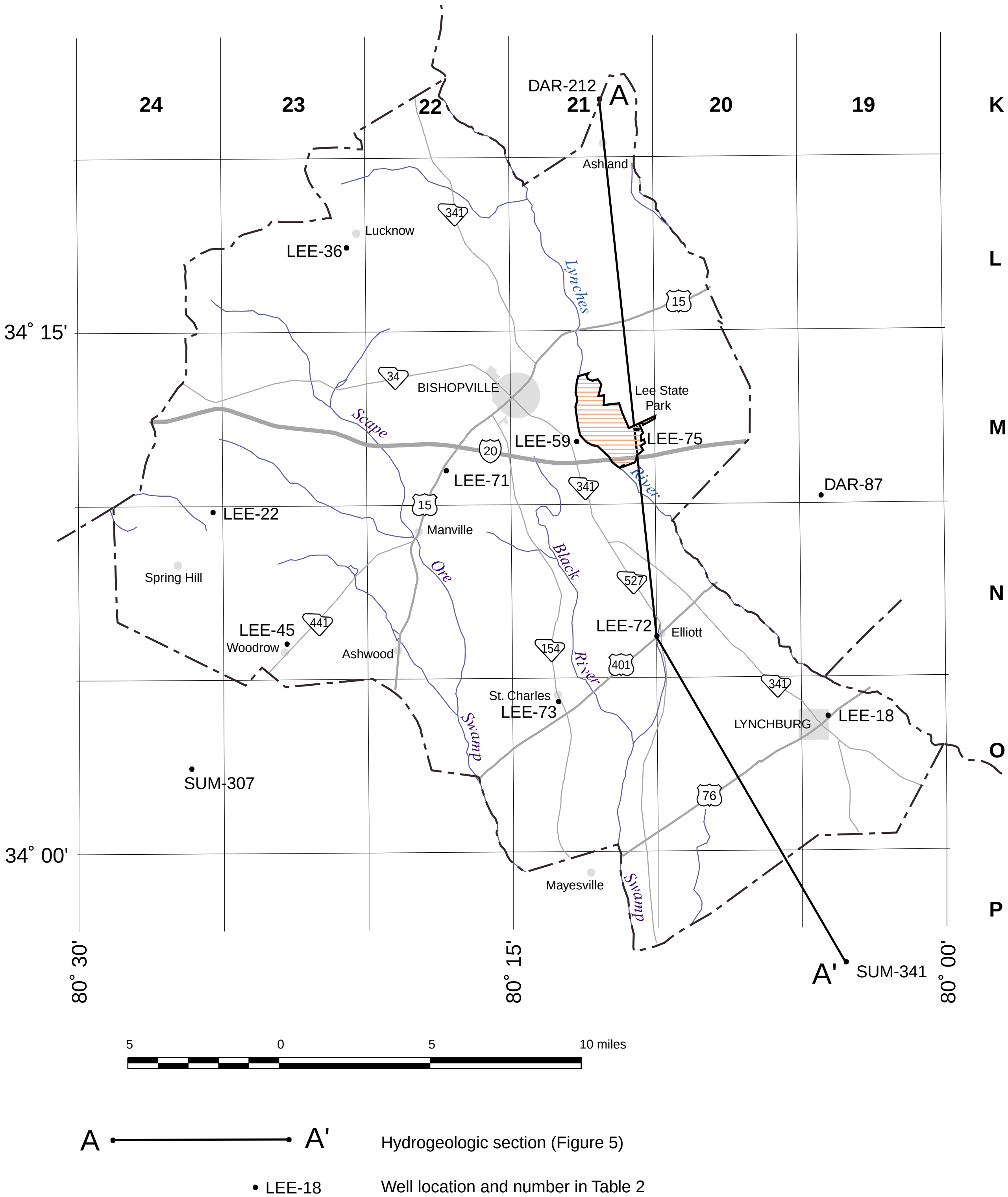


Figure 6. Locations of electric logs for which sand intervals are given in Table 2.

Table 2. Sand intervals on electric logs in and near Lee County (See Figure 6 for locations)

County well number	LEE-18	LEE-22	LEE-36	LEE-45	LEE-59	LEE-71	LEE-72	LEE-73	LEE-75	DAR-87	DAR-212	SUM-307	SUM-341
S.C. grid number	19O-g1	24N-a1	23L-k1	23N-r1	21M-r3	22M-w1	20N-p1	21O-d1	21M-k1	19M-y1	21K-s1	24O-k2	19P-q1
Elevation in feet MSL	140	380	355	260	195	219	175	170	199	170	397	258	125
	108-128	20-48	-36	18-108	30-50	58-94	102-114	77-146	106-114	96-112	35-55	42-82	140-154?
	148-185	52-72	40-51 br	132-176	88-94	120-140	140-164	164-188	118-185	145-216	70-135	86-178	160-183
	210-224	92-120	73-98 br	200-212 br	102-190	TD 148	169-178	191-196	190-208	224-232	166-187	186-208	190-196
	229-296	136-168	124-148	220-230	210-234 br		187-218	226-262	212-261	298-444	194-205	272-297	203-226 br
	312-342	174-200	152-157	254-262	244-270 br		222-226	296-329	275-318 br	450-466	226-255	326-376	241-260
Sand intervals in feet	388-528	205-238	170-240	265-288 br	TD 270		230-236	336-358	322-332	472-513 br	266-420	TD 380	282-299
below land surface	558-603 br	242-256	245-288 br	296-336			241-251	364-383	335-348	522-542	439-457		306-320
	620-632	266-272	TD 289	343-387 br			261-268	388-396	352-367	550-612 br	TD 458		343-349
	640-648	290-308		397-432			272-284 br	426-480	374-400	TD 617			358-368
	654-665	TD 308		442-510			313-335	TD 492	TD 552				TD 418
	TD 687			518-532 br			353-365						
				BR at 550			378-402						
							418-478						
							TD 489						

br, broken by clay layers; BR, bedrock; TD, total depth of log

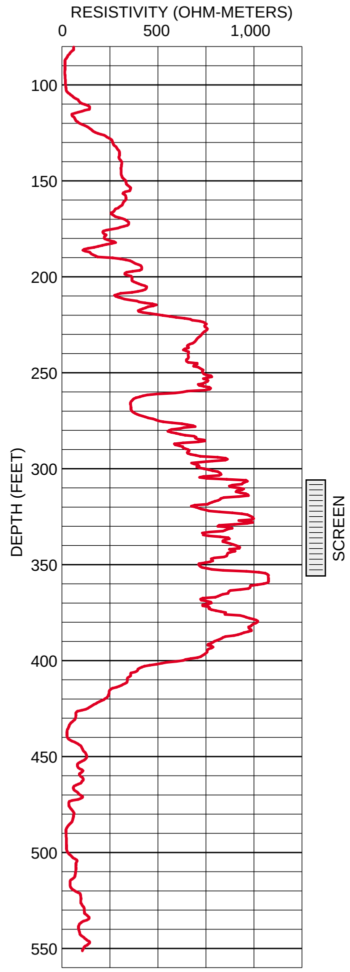


Figure 7. Electric log of core hole (LEE-75) at Lee State Park.

screen sized to retain nearly all of the gravel-pack material. Thorough well development is important in achieving an efficient well, regardless of the type of construction. Driscoll (1986) is an excellent source of information on the construction and development of wells.

Well Interference

Pumping from high-yielding wells can lower water levels in the aquifer being tapped. The amount of lowering depends on aquifer transmissivity, pumping rate, duration of pumping, and distance from the pumping site. The graphs of Figure 11 illustrate the effect on water levels (termed "interference") that could be expected in Lee County. It is important to install wells far enough apart to minimize the interference.

The magnitude of well interference can be reduced or increased by hydrologic boundaries, which may be sources of recharge or discharge. Sources of recharge may be nearby streams or lakes, thickening of the aquifer, increased permeability with distance, or leakage from a higher or lower aquifer. Sources of discharge may be thinning of the aquifer, decreased permeability with distance, blocking of the aquifer by faulting, or interception of the pumping influence of other wells by the spreading cone of depression in the potentiometric surface. Inasmuch as interception of a hydrologic boundary affects the water level in the pumping well only after the boundary is encountered, and this usually is after most of the drawdown has occurred, the boundaries generally are not a major problem nor a major benefit.

Well Depths and Yields

In the years 2000-02, there were 135 new wells installed in the county. Ninety-five of these were low-yield wells and most were less than 100 ft in depth. Because they were designed to supply a home or irrigate a lawn, pumps were selected to produce in the 15-30 gpm range as a rule, though many of the wells are capable of much higher yields.

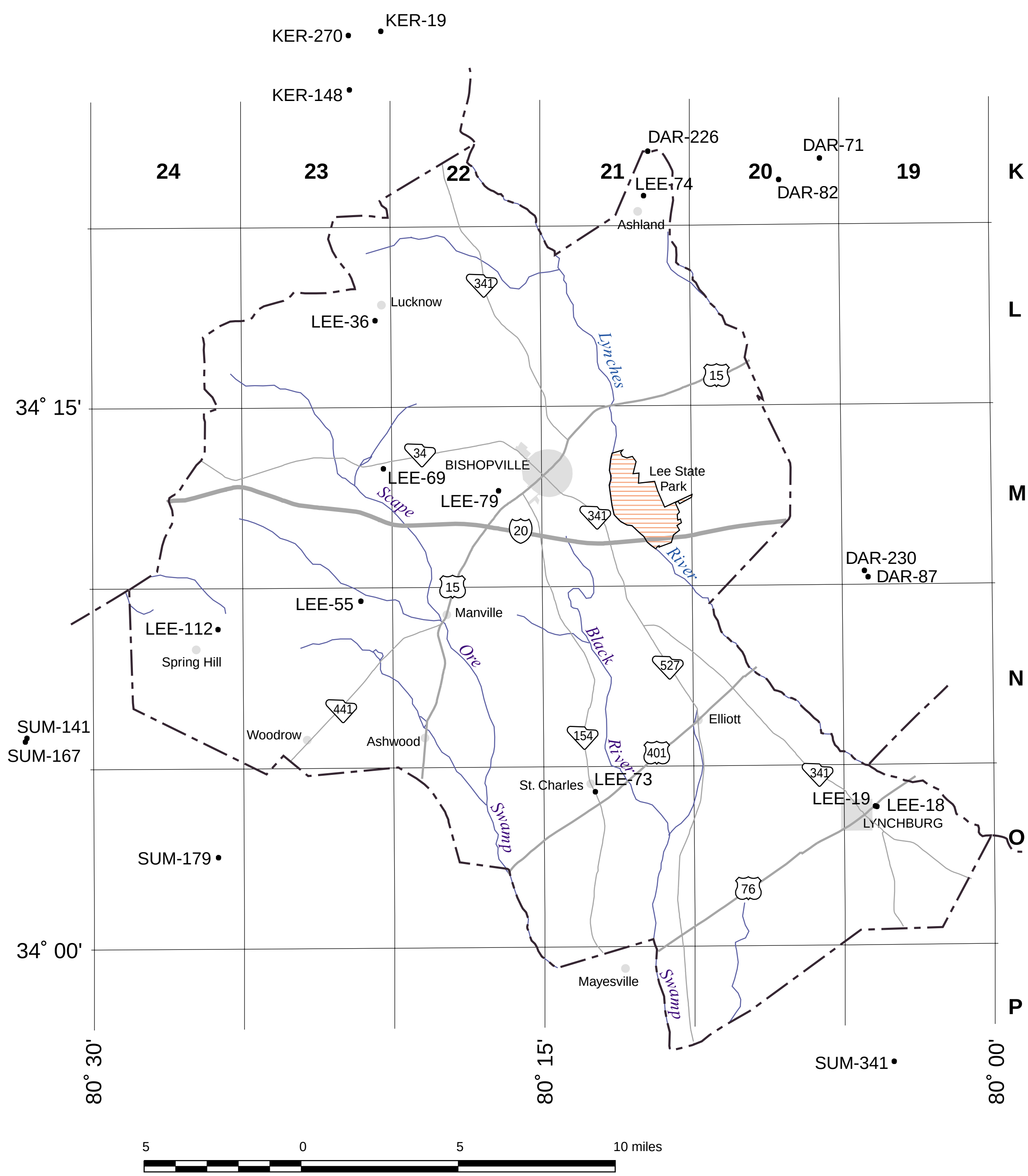
DNR files contain records on 16 industrial-supply and irrigation wells capable of producing 1,000-2,000 gpm. The large wells installed in 2000-02 were mostly for crop irrigation. At least seven irrigation wells pumping 500 gpm or more were constructed, the greatest yield being 1,500 gpm. Several other wells producing less than 500 gpm were added for irrigation. Three public-supply wells—at Bishopville, Spring Hill, and Manville—were completed. They produce in the 500-1,000 gpm range. All of the large wells are between 300 and 600 ft deep.

Water Levels

Water levels in Lee County wells are generally within 30 ft of the land surface. Most aquifers are confined (artesian), and pressure forces the water to shallow depths. In 2000-02, about 15 percent of the wells were completed in unconfined (water-table) aquifers. Wells of the latter type are generally adequate for domestic and lawn-irrigation supplies but are limited for other uses by the lack of available drawdown. They also are more likely to be severely affected by drought conditions. Even the artesian aquifers are affected by prolonged drought, but to a much less degree.

For wells drilled in the 2000-02 years, 131 water levels are available. Their distribution, as depth in feet below the land surface, is shown in the following table.

Water level (ft)	Number of wells
<10	21
10 - 20	47
21 - 30	31
31 - 40	5
41 - 50	6
51 - 75	12
76 - 100	7
101 - 150	1
151 - 200	0
>200	1



• LEE-18 Well location and number in Table 3

Figure 8. Locations of pumping tests in and near Lee County.

Table 3. Results of pumping tests in and near Lee County, S.C. (Modified from Newcome, 2000)

County well number	S.C. grid number	Location	Electric log available	Depth (ft)	Aquifer/ Thickness (ft)	Date of test	Duration of test (hours) drawdown /recovery	Static water level (ft)	Discharge (gpm)	Transmissivity (gpd/ft)	Storage coefficient	Specific capacity (gpm/ft)	Available drawdown (ft)
LEE-1	19O-g1	Lynchburg, NE edge	X	514	M/175	11/1972	28/	Flowing	805	27,000		<9	316
LEE-19	19O-g2	Lynchburg, NE edge	X	544	M/150	3/1973	24/	Flowing	798	22,000		<6	390
LEE-36	23L-k1	Lucknow (water tank)	X	263	M/100	5/1978	21/	42	268	21,000		2.4	133
LEE-55	23N-b3	Manville, 3 mi W		130	M/90	1/1981	24/1	35	454	36,000		17	29
LEE-69	23M-j1	Bishopville, 5 mi W		336	M/75	9/1985	24/3.5	49	500	78,000		22	211
LEE-73	21O-d1	St. Charles	X	458	M/180	1/1992	24/2.5	7	403	62,000		16	298
LEE-74	21K-v1	Ashland, ½ mi, NE		445	M/100	4/1993	25/.5	122	900	70,000		35	153
LEE-79	22M-l1	Bishopville (Piedmont Road)		347	M/80	2/1995	24/1.8	36	806	100,000		42	177
LEE-112	24N-j2	Spring Hill		455	M/85	9/2001	24/3.5	203	535	42,000		7.6	77
KER-19	23J-u2	Bethune, ¾ mi NE		194	M/60	9/1953	46/20	20	300	3,000	0.0002	2.6	119
KER-148	23K-i1	Bethune, 1 mi SSW		157	M/80	2/1977	24/2	42	300	36,000		7.5	81
KER-270	23J-v4	Bethune, NW edge		150	M/	9/1987	24/1	20	178	17,000		4.1	90
DAR-71	20K-t1	Hartsville (Magnolia Cemetery)	X	297	M/100	1/1963	23/	39	700	84,000		37	176
DAR-82	20K-s3	Hartsville (hosiery plant)	X	300	M/210	3/1971	24/6.5	38	1,012	100,000		60	170
DAR-87	19M-y1	Lamar	X	486	M/160	11/1972	24/48	12	626	57,000		8.0	356
DAR-226	21K-11	Ashland, 2 mi NNE	X	417	M/120	12/1989	24/2	99	900	68,000		30	121
DAR-230	19M-y3	Lamar	X	425	M/117	10/1993	24/	24	250	26,000		5.4	291
SUM-141	25N-w1	Rembert	X	164	BC/20	2/1970	24/	69	55	2,900		2.9	76
SUM-167	25N-w2	Rembert		155	BC/20	3/1970	24/	63	60	3,200		3.9	76
SUM-179	24O-k1	Dalzell, 2 mi N	X	440	BC,M/235	3/1979	22/1	67	1,302	100,000		22	73
SUM-341	19P-g1	Shiloh	X	224	BC/45	8/1999	24/2	34	250	3,100		3.2	130

Locations of tests are shown on Figure 8. Aquifer: M, Middendorf; BC, Black Creek.

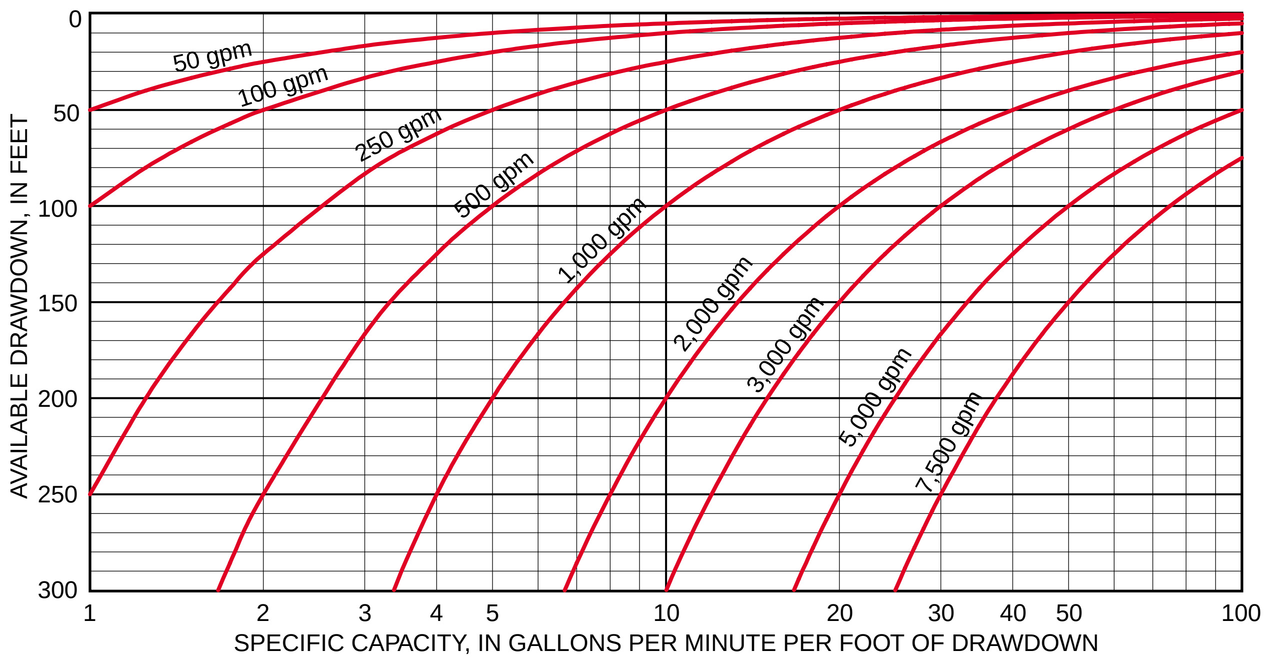


Figure 9. Well yields for various combinations of specific capacity and available drawdown.

POTENTIAL WELL YIELDS

Lee County is in an enviable position for obtaining large water supplies from wells. The county is far enough below the Fall Line to have a good thickness of Coastal Plain sediments but sufficiently updip for those sediments to have high permeability. The pumping-test results in Table 3 can be used to calculate potential yields for the wells in that table. For the nine Lee County wells, a range of 300 to 7,400 gpm is indicated. Six of the nine could yield 2,000 gpm or more each, although well construction and pumping equipment would require alterations to handle the larger yields.

From the transmissivity and aquifer-thickness values for Lee County in Table 3, it seems justified to employ a median value of 400 gpd/ft^2 (gallons per day per square foot) for aquifer hydraulic conductivity. Multiplying this value by the sand thickness indicated on an electric log will provide a general transmissivity value. For example, a 50-ft sand would have a transmissivity of 20,000 gpd/ft. A fully efficient well in such an aquifer would have a specific capacity of 10 gpm per foot of drawdown. If the available drawdown were 100 ft, a 1,000-gpm well yield would be feasible.

A few well-distributed electric logs (or reliable driller's logs) and several pumping tests will permit the water seeker to make very useful predictions of the potential well yields in an area.

WATER QUALITY

Chemical analyses of water from 36 wells in Lee County and nearby in adjacent counties are presented in Table 4. Locations of the wells are shown on the map in Figure 12. These wells range in depth from 42 to 514 ft. Current and former public-supply wells are flagged by having their county well numbers in bold type. These analyses are considered the most representative of the natural water—that is, least likely to be contaminated by fertilizer and other pollutants introduced by humans and animals.

The water represented by the analyses can be described, with very few expectations, as remarkably unmineralized, extremely soft, and definitely acidic. As with many aquifers of the Coastal Plain, the water in the Middendorf and Black Creek Formations in Lee County is very near, in chemical quality, to rainwater. It follows, then, that the water is ideal for crop irrigation. For public supply and some industrial uses, treatment is required to raise the pH (corrosion control) and for disinfection (chlorination). Iron removal is required at Lynchburg, and fluoridation is employed at Bishopville and also at Mayesville (nearby in Sumter County).

The presence of radionuclides in concentrations exceeding maximum contaminant levels (MCL) has recently been observed by the South Carolina Department of Health and Environmental Control in some public-supply wells in Lee County. The areal and depth extent of the radioactivity, as

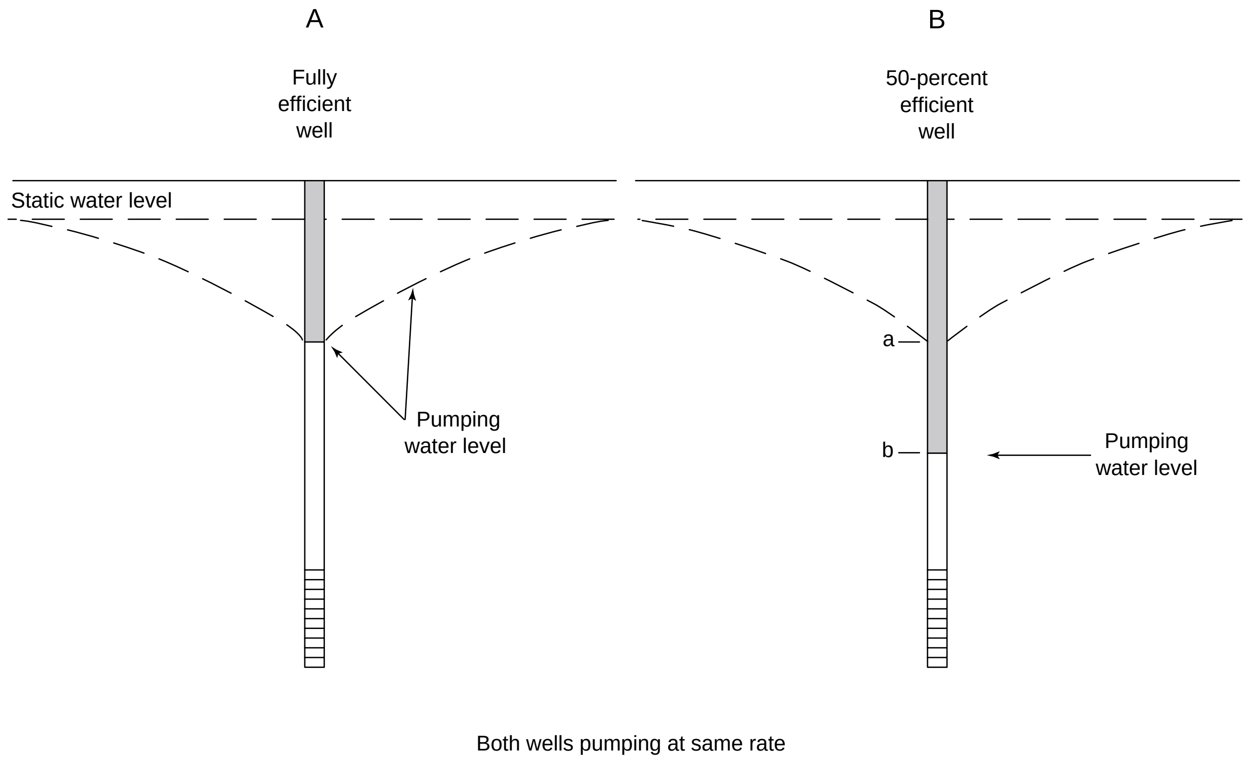


Figure 10. Illustration of the effect of well inefficiency (ab is additional pumping lift).

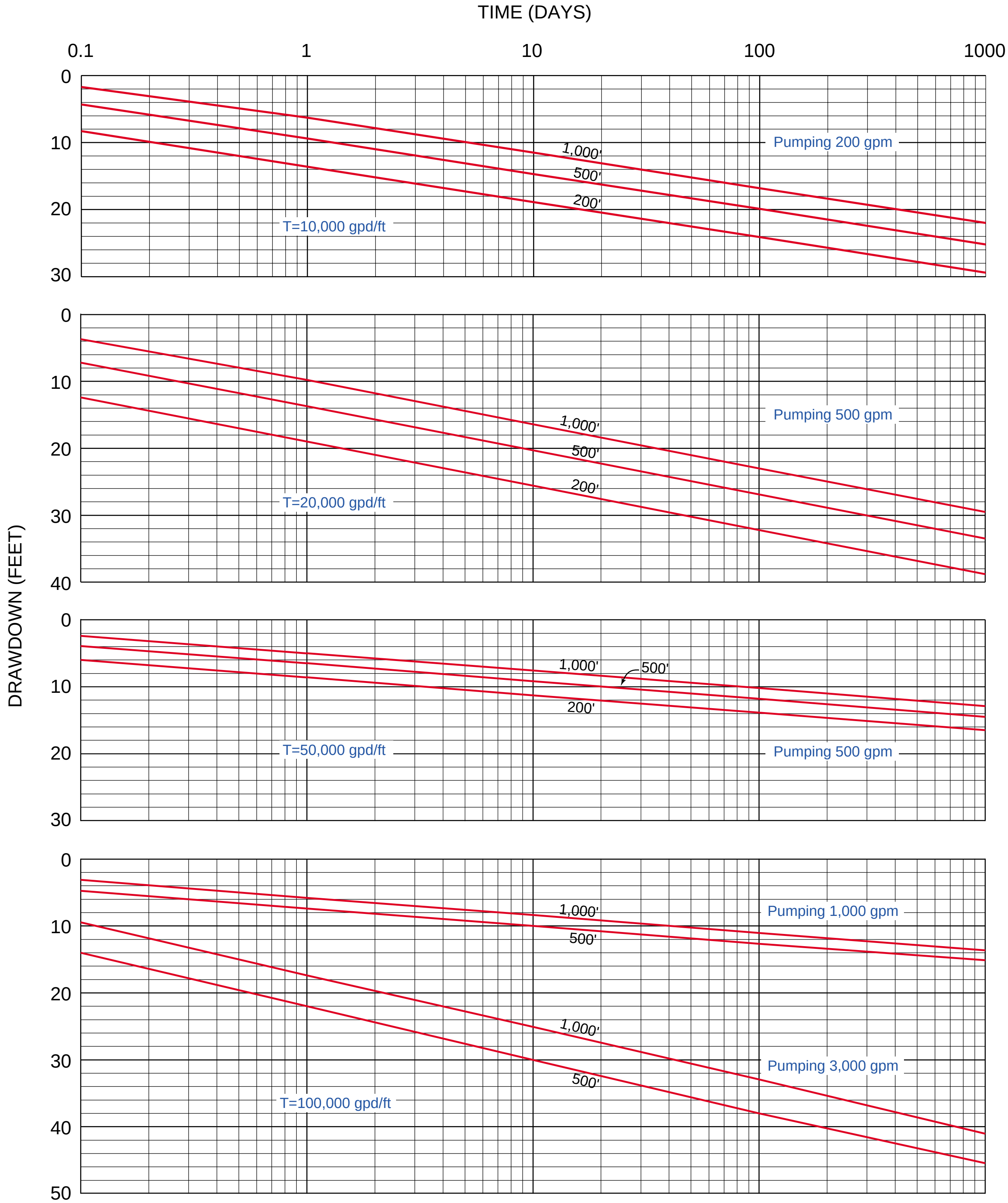
well as its source and severity, are under investigation at this writing. A useful explanation of radionuclide occurrence in ground water was provided by Hem (1985), who included a reference to "a relatively high proportion of radium-228 in ground water in South Carolina."

SUMMARY

Abundant ground-water resources are available for public supply, irrigation, and industry in Lee County. Sand aquifers in the Cretaceous-age Middendorf and Black Creek Formations make up one-third to three-fourths of the depth penetrated by numerous deep wells for which electric logs are available. These wells are as deep as 700 ft, but few go all the way to bedrock, which slopes from sea level at the northwest edge of the county to 700 ft below sea level at the southeast edge.

Most wells are drilled for domestic or lawn-irrigation supplies and are pumped at 30 gpm or less. Large wells drilled for farm irrigation, public supply, and industry produce as much as 2,000 gpm, and even larger yields are available to wells designed and constructed to take advantage of the thick and transmissive aquifers.

The ground water is acidic, extremely soft, and very low in total mineralization. Radionuclides in concentrations exceeding maximum contaminant levels, as defined by the U.S. Environmental Protection Agency, have been recorded in some public-supply wells.



ASSUMED CONDITIONS

Pumping rate and transmissivity as indicated. Storage coefficient: 0.0002 (artesian)
For other pumping rates, the drawdown will vary in direct proportion.
For example, doubling the pumping rate will double the drawdown at a given distance and time.

Figure 11. Predicted pumping effects at various times and distances for the Middendorf and Black Creek Formations in Lee County.

Table 4. Chemical analyses of water from wells in and near Lee County, S.C. (constituents and properties in milligrams per liter, except pH)

County well no. (public supply wells in bold)	S.C. grid no.	Location	Date	Depth (ft)	Silica	Iron	Calcium	Magnesium	Sodium	Potassium	Bicarbonate*	Sulfate	Chloride	Fluoride	Nitrate	Dissolved solids	Hardness	pH	Analyst**
LEE-1	19O-f1	Lynchburg	11/58	400	16	0.3	1.6	1.0	1.8	3.6	9	7.2	1.5	0.1	0.2	39	8	5.7	USGS
LEE-18	19O-g1	Lynchburg	11/72	514		2.2	1.2	.5	(2)		10	1	4	.0		23	5	6.2	COM
LEE-20	21M-o1	Bishopville	1/83	332	12	.8	.4	.2	1.0	.1	2.4	3.3	2.5	.2		21	2	6.0	WRC
LEE-26	21M-g4	Bishopville, 1 ½ mi NE	1/84	300	9.2	.0	.1	.2	1.6	.2	1.2	3.1	2.5	.0	.0	34	2	5.0	WRC
LEE-36	23L-k1	Lucknow	5/78	263		.0	1.6	.5	(2.1)		6	.6	4	.0		17	6	5.9	COM
LEE-44	22N-h1	Manville, 1 mi ESE	1/83	380	7.9	.2	.3	.2	1.4	.1	1.2	3.6	2.5	.2		17	3	6.8	WRC
LEE-51	22N-w2	Ashwood, 1 ½ mi SE	1/83	400	10	.2	.3	.2	1.2	.2	1.8	3.4	2.0	.2		19	2	5.7	WRC
LEE-55	23N-b3	Manville, 3 mi W	12/80	127		.0	.2	.4	3.9		4.8	3	1.6	.4	1.6	24	2	5.0	COM
LEE-57	22K-r1	S.C. 341, ½ mi S of Ker. line	1/83	254	6.4	.1	1.1	1.2	4.4	.4	1.2	3.0	5.0	.2		23	8	6.0	WRC
LEE-59	21M-r3	Bishopville, 2 ¾ mi SE	1/83	335	6.4	.2	.2	.2	.9	.1	2.4	3.9	2.5	.2		16	2	5.4	WRC
LEE-60	21N-q1	Elliott, 3 ½ mi W	1/83	470	12	.2	.6	.2	1.1	.2	0	5.1	2.0	.2		22	2	4.9	WRC
LEE-64	21M-b3	Bishopville, 4 mi ENE	1/83	340	10	.1	.4	.2	1.2	.2	2.4	4.6	2.5	.2		20	2	6.0	WRC
LEE-65	24N-c1	Spring Hill, 2 mi WNW	1/83	440	6.4	.1	.9	.8	2.8	.3	1.8	3.4	4.0	.2		20	3	5.3	WRC
LEE-69	23M-j1	Bishopville, 5 mi W	1/85	336		.4	.1	5.0	1.6	.2	1.2	2	2	<.1	.2	20	20	6.2	COM
LEE-73	21O-d1	St. Charles, ¼ mi N	1/92	458			<1	.2	<2	<2	<1	26	2.6	.4	<1	35	2±	5.0	COM
LEE-74	21K-v1	Ashland	4/93	445		<.1	<1	.1	<2	<2	<5	<1	4.4	<.2	<1	20	2±	6.0	COM
LEE-75	21M-k1	Lee State Park	12/98	356	7.3	<.1	.3	.2	1.4	.3	0	4.1	2.8	.0	.0	16	1	4.8	DNR
LEE-112	24N-j2	Spring Hill	9/01	455		.1	<1	.4	5.4		<1	15	15	<.2	.6	48±	2±	4.7	COM
LEE-113	23N-b6	Manville, 3 mi W	3/00	347		.0	<1	1.3	6.6		10	6.4	3.0	<.2	<.5	30±	6±	7.4	COM
LEE-144	22M-l2	Bishopville	10/02	357		<.1	<1	.1	2.2		<1	3.3	2.3	<.2	<.5	10±	<2	6.0	COM
KER-11	23K-a2	Bethune	3/46	165		.2					3	1.0	4.0	.1	9.2	24			USGS
KER-19	23J-u2	Bethune, 1 mi NE	9/53	194	7.9	.1	1.5	.8	(1.8)		6	2.6	2.0	.1	.3	20	7	5.6	USGS
KER-96	25M-a1	Camden, 4 ½ mi E	9/81	61		<.1	1.2				133		5.0			130	1	6.8	DHEC
KER-148	23K-i1	Bethune, 1 ¼ mi SW	2/77	157	6.4	.0	1.2	.6	(5.7)		9.8	.8	2.0	.1	7.3	29	5	4.6	COM
DAR-30	19M-y4	Lamar	1/55	285	11	2.0	15	1.4	1.6	1.4	48	4	2.8	.1	.3	60	42	6.4	USGS
DAR-55	19L-y1	Oats	1/55	142	9.3	.4	1.9	.3	1.8	.1	3	4.8	2.5		.6	22	6	5.1	USGS
DAR-64	19M-x1	Lamar	3/59	42	8.3	<.1	1.2	.7	8.1	.3		.1	6.2	.1	13	40	7	5.4	?
DAR-82	20K-s3	Hartsville, 3 mi SW	3/71	300	13	.1	.4	.1	(6.7)		9.8	1.2	5.0	.2	.6	26	8	8.0	COM
DAR-87	19M-y1	Lamar	1/84	486	10	.6	.6	.4	2.0	.8	0	7.4	2.0	.0		21	3	4.1	WRC
DAR-207	20K-e7	Hartsville, 5 mi W	7/73	221		.0	.4	.2	(4.6)		6.1	.0	5	.0		16	2	5.6	COM
DAR-212	21K-s1	Hartsville, 7 mi W	7/84	141	10	.4	.4	.1			12	<1	4.1	<.1		24	1	5.9	COM
DAR-219	21K-s2	Hartsville, 7 mi W	12/85	440		.0	.4	.2	.8	2.6	.8	2.0	2.7	.5	1.5	20	2	5.1	COM
DAR-220	21K-s3	Hartsville, 7 mi W	7/84	250	8	.1		.2			5.8	<.1	9	<.1		20	1	5.9	COM
DAR-226	21K-11	Hartsville, 7 mi W	12/89	417	7.5	<.1	.1	.1	<.1	<.1	6.3	6.6	.2	<.1	<1.0	20	2	6.0	COM
SUM-50	21P-o3	Mayesville, 3 mi SW	4/49	250	29	.9	11	3.9	(4.5)		48	10	2.2	.1	.1	84	44	6.8	USGS
SUM-167	25N-w2	Rembert	5/97	155	9.7	.3	.3	.2	1.4	.3		6.1	2.2	.1	.1	19	2	4.3	USGS

*Bicarbonate is calculated where alkalinity is reported.

**Analysts are COM, commercial; DHEC, Department of Health and Environmental Control; DNR, Department of Natural Resources; USGS, U.S. Geological Survey; WRC, Water Resources Commission.

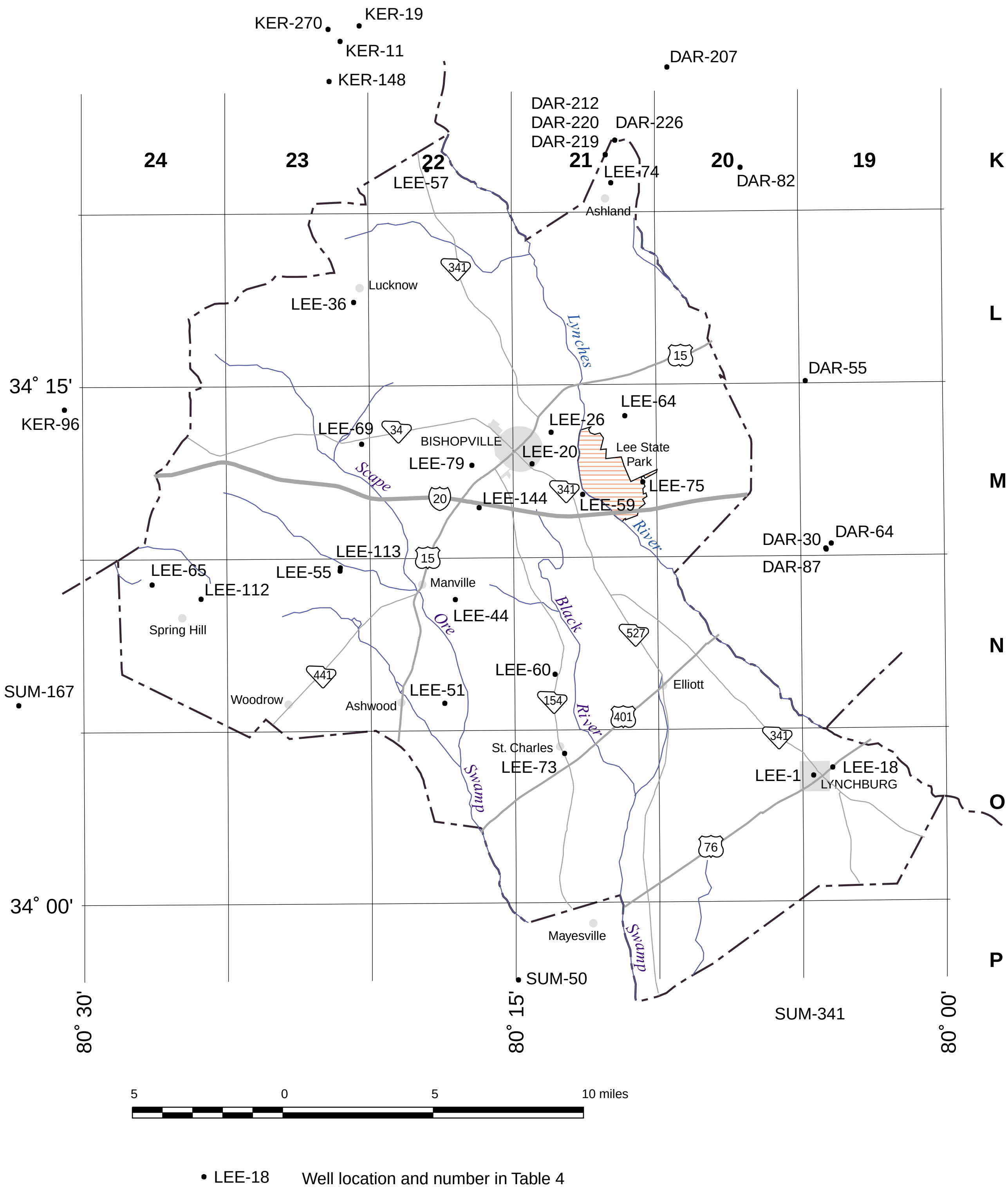


Figure 12. Locations of wells for which chemical analyses are given in Table 4.

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