WATERSHED CONDITIONS: SAVANNAH RIVER BASIN

UPPER SAVANNAH RIVER SUBBASIN

UPPER SAVANNAH RIVER SUBBASIN

The Upper Savannah River subbasin is located in northwestern South Carolina and extends 140 miles southeast from the North Carolina state line to the Edgefield-Aiken county line. It shares its western border with Georgia along reaches of the Chattooga, Tugaloo, and Savannah Rivers and encompasses McCormick and Oconee Counties and much of Abbeville, Anderson, Edgefield, Greenwood, Pickens, and Saluda Counties (Figure 8-1). The subbasin area is approximately 3,200 square miles, 10.3 percent of the State.

DEMOGRAPHICS

The year 2000 population of the subbasin was estimated at 343,100, 8.6 percent of the State's total population. By the year 2020, the subbasin population is expected to reach 428,000, an increase of 25 percent. Oconee and Pickens Counties are projected to experience the greatest population change between 2000 and 2020, both increasing about 26 percent. Edgefield and Saluda Counties are projected to lose 6 and 9 percent of their respective populations.

The region is predominantly rural, and its principal population centers are dispersed along its length. The major towns in 2000 were Anderson (25,514), Greenwood (22,071), Easley (17,754), Clemson (11,939), Seneca (7,652), and Abbeville (5,840).

The year 2005 per capita income for the subbasin counties ranged from $20,643 in McCormick County, which ranked 40th in the State, to $28,561 in Oconee County, which ranked ninth. All of the counties in the subbasin had 1999 median household incomes below the State average of $37,082. Abbeville and McCormick Counties had median household incomes more than $4,000 below the State average (South Carolina Budget and Control Board, 2005).

During 2000, the counties of the subbasin had combined annual average employment of non-agricultural wage and salary workers of about 216,000. Labor distribution within the subbasin counties included management, professional, and technical services, 26 percent; production, transportation, and materials moving, 25 percent; sales and office, 22 percent; service, 14 percent; construction, extraction, and maintenance, 13 percent; and farming, fishing, and forestry, 1 percent.

In the sector of manufacturing and public utilities, the 1997 annual product value for the subbasin's counties was $10.4 billion. Crop and livestock production in 2003 was valued at $214 million, and the delivered-timber value in 2001 totaled $135 million (South Carolina Budget and Control Board, 2005).

SURFACE WATER

Hydrology

The upper part of the Savannah River is the main watercourse of this drainage system. With headwaters in the Blue Ridge province of North Carolina and Georgia, the Tugaloo and Seneca Rivers converge to form the Savannah River. Several other tributaries drain South Carolina and Georgia watersheds and contribute to streamflow in the Savannah River. Those streams in South Carolina include the Chattooga River, Twelvemile Creek, Rocky River, Little River, and Stevens Creek. Since 1950, five large reservoirs have been built on the upper Savannah River and its major headwater tributaries

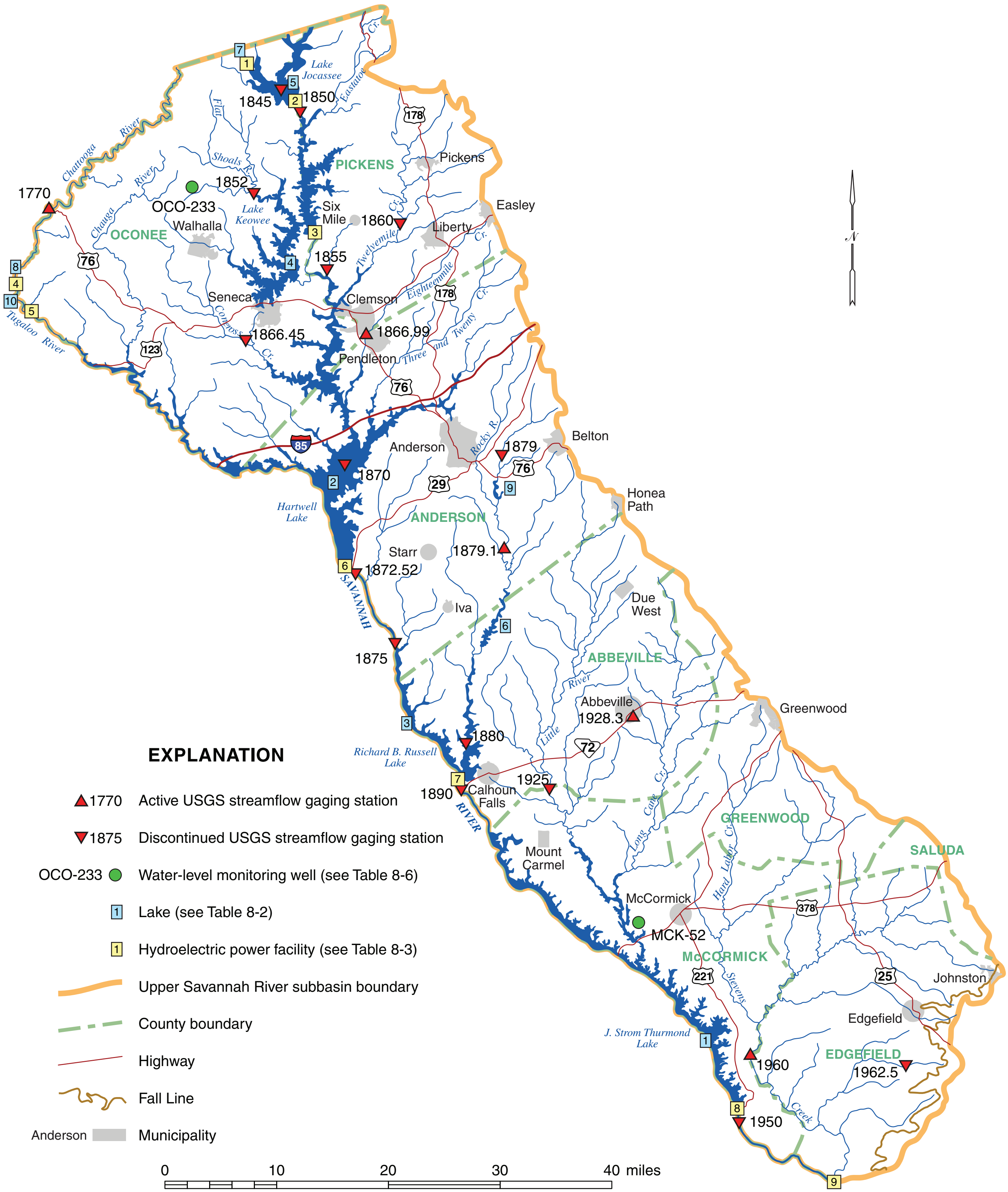


Figure 8-1. Map of the Upper Savannah River subbasin.

in South Carolina, inundating virtually all of the upper reach of the Savannah River valley. Controlled discharges from hydroelectric-power facilities associated with these reservoirs greatly affect streamflow in the main stem.

Streamflow is currently monitored at five U.S. Geological Survey (USGS) gaging stations, all on tributary streams. Gages on the Savannah River have all been discontinued. Streamflow statistics for these five active and 15 discontinued gaging stations are presented in Table 8-1.

Table 8-1. Selected streamflow characteristics at USGS gaging stations in the Upper Savannah River subbasin

Gaging station name, location, station number	Period of record	Drainage area (mi²)	Average flow (cfs)	Average flow (cfsm)	90% exceeds flow (cfs)	Minimum daily flow (cfs), year	Maximum daily flow (cfs), year	Maximum peak flow (cfs), year
Chattooga River near Clayton, Ga. 1770	1939 to 2007*	207	646	3.12	221	85 2007	18,500 2004	33,300 2004
Whitewater River at Jocassee 1845	1951 to 1968	47.3	177	3.74	56	24 1954	3,140 1964	6,900 1964
Keowee River near Jocassee 1850	1950 to 1968	148	488	3.30	159	57 1954	10,600 1964	21,000 1964
Little River near Walhalla 1852	1967 to 2003	72.0	173	2.40	61	8.0 2002	10,000 1967	12,800 1967
Keowee River near Newry 1855	1939 to 1961	455	1,153	2.53	376	152 1954	19,600 1940	25,200 1940
Twelvemile Creek near Liberty 1860	1954-64 and 1989-2001	106	192	1.81	64	23 2000	5,120 1998	6,730 1998
Coneross Creek near Seneca 1866.45	1989 to 2003	65.4	115	1.76	37	3.1 2002	2,800 1990	3,590 1994
Eighteenmile Creek above Pendleton 1866.99	1998 to 2007*	47	58	1.23	20	3.3 2002	2,980 2003	3,470 2003
Seneca River near Anderson 1870	1928 yo 1959	1,026	1,997	1.95	735	170 1931	76,000 1928	81,100 1928
Savannah River below Lake Hartwell 1872.52	1984 to 1999	2,090	2,879	1.38	102	10 1996	21,000 1998	– – –
Savannah River near Iva 1875	1950 to 1981	2,231	4,469	2.00	573	78 1961	47,200 1952	54,400 1952
Broadway Creek near Anderson 1879	1967 to 1970	26.4	25.6	0.97	– – –	7.0 1970	337 1967	904 1967

Table 8-1. Continued

Gaging station name, location, station number	Period of record	Drainage area (mi^2)	Average flow (cfs)	Average flow (cfsm)	90% exceeds flow (cfs)	Minimum daily flow (cfs), year	Maximum daily flow (cfs), year	Maximum peak flow (cfs), year
Rocky River near Starr 1879.1	1989-96; 1996-2001; 2003-07*	111	128	1.16	37	6.0 2007	3,810 1998	6,260 1998
Rocky River near Calhoun Falls 1880	1950 to 1966	267	307	1.15	103	9.0 1954	8,440 1964	10,900 1964
Savannah River near Calhoun Falls 1890	1896-1900; 1930-32; 1938-79	2,876	5,428	1.89	1,700	300 1961	– – –	96,500 1940
Little River near Mount Carmel 1925	1939-70 and 1986-2003	217	207	0.96	35	1.0 1954	15,200 1940	20,800 1940
Blue Hill Creek at Abbeville 1928.3	1998 to 2007*	3.2	2.9	0.91	0.47	0.0 2007	111 2003	294 2000
Savannah River near Clarks Hill 1950	1940 to 1954	6,150	8,479	1.38	3,130	1,120 1941	185,000 1940	– – –
Stevens Creek near Modoc 1960	1929-31; 1940-78; 1983-2007*	545	393	0.72	14	0.0 1954	31,700 1940	35,100 1940
Horn Creek near Colliers 1962.5	1981 to 1994	13.9	14.1	1.01	3.4	0.8 1982	530 1981	3,680 1985

mi^2, square miles; cfs, cubic feet per second; cfsm, cubic feet per second per square mile of drainage area
90% exceeds flow: the discharge that has been exceeded 90 percent of the time during the period of record for that gaging station
** 2007 is the most recent year for which published data were available when this table was prepared*

Extensive development on the Savannah River has eliminated most of the free-flowing streams in this region. Average streamflow of the Savannah River, measured at now-discontinued gaging stations, was 4,469 cfs (cubic feet per second) near Iva (below Lake Hartwell) and 5,428 cfs near Calhoun Falls (below Lake Russell); flow at these sites was at least 573 cfs and 1,700 cfs, respectively, 90 percent of the time. Although daily flows were variable due to fluctuating discharges from upstream hydroelectric power plants, minimum flows were well sustained because of reservoir releases.

Unregulated streams in the subbasin are heavily dependent on direct precipitation, surface runoff, and ground-water discharge to support flows. Streams in the Blue Ridge region, where average annual rainfall is high and ground-water storage is substantial, exhibit generally uniform year-round flows with well-sustained base flows (Figure 8-2). With increasing distance from the mountains, rainfall diminishes, ground-water discharge decreases, and streamflow becomes progressively more variable. Stevens Creek, the farthest gaged stream from the Blue Ridge region, exhibits the most variable flow and most poorly-sustained base flow among gaged tributary streams in this portion of the subbasin. No-flow conditions were recorded in this stream on numerous occasions during the drought of 1954.

The Savannah River main stem provides large quantities of water throughout the year. Although flow may be variable, minimum flows are uniform and substantial. Tributary streams in the upper part of the subbasin support well-sustained flows and are reliable water-supply sources, provided the quantity is adequate for the intended use. Tributary streams in the middle and lower parts of the subbasin are progressively less reliable sources of water because flows in these streams decline dramatically during the summer and fall months.

Development

The Upper Savannah River subbasin is one of the most intensely developed subbasins in the State and is a region of numerous flood-control projects and hydroelectric power facilities. Five of the largest reservoirs in South

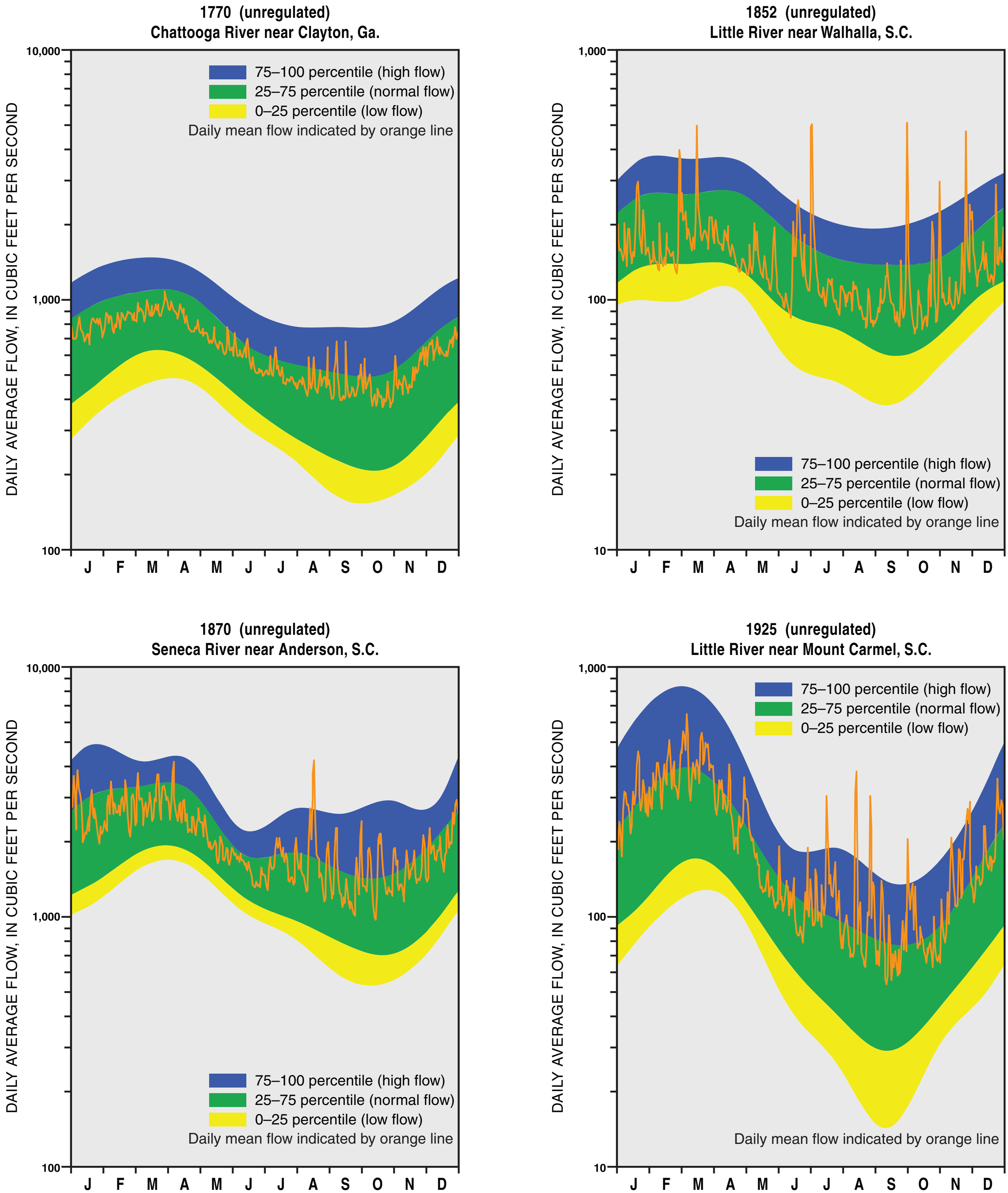


Figure 8-2. Duration hydrographs for selected gaging stations in the Upper Savannah River subbasin.

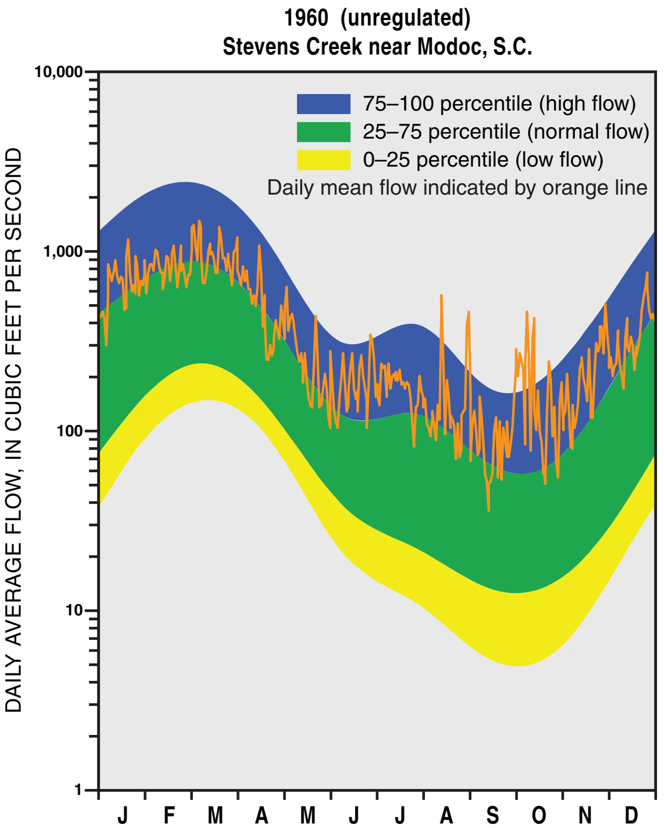


Figure 8-2. Continued.

Carolina—Jocassee, Keowee, Hartwell, Russell, and Thurmond—dominate the hydrology of this subbasin (Table 8-2).

Lake Jocassee, on the Keowee River near the northern edge of the subbasin, extends up the Toxaway and Whitewater Rivers. Completed in 1975, Lake Jocassee holds 1,185,000 acre-ft of water and has a surface area of 7,565 acres; it is the State's sixth-largest lake by volume. The Jocassee Hydroelectric Station is a pumped-storage generating facility that discharges into Lake Keowee. During periods of low electrical demand, reversible turbines pump water up from Lake Keowee back into Lake Jocassee, to be used again to generate power during periods of high electrical demand. The lake and generating facilities are owned and operated by Duke Energy, and the lake is a popular recreation area.

Immediately downstream from Lake Jocassee is Lake Keowee. Created in 1971 by damming the Keowee and Little Rivers, the lake contains nearly 1,000,000 acre-ft of water and has a surface area of 18,372-acres. Lake Keowee ranks seventh in area and eighth in volume among South Carolina lakes. In addition to providing water for Duke Energy's Keowee hydropower plant, the lake serves as a source of cooling water for the adjacent Oconee Nuclear Station, as a reservoir for the pumped-storage facility at Jocassee Dam, as a water-supply reservoir for the city of Greenville, and as a popular recreational area.

Table 8-2. Lakes 200 acres or more in the Upper Savannah River subbasin (shown on Figure 8-1)

Number on map	Name	Stream	Surface area (acres)	Storage capacity (acre-feet)	Purpose
1	Lake Thurmond	Savannah River	70,000	2,510,000	Power, recreation, flood control and water supply
2	Lake Hartwell	Savannah River	56,000	2,549,000	Power, recreation and water supply
3	Lake Russell	Savannah River	26,650	1,026,000	Power, recreation, flood control and water supply
4	Lake Keowee	Keowee River	18,372	1,000,000	Power, recreation and water supply
5	Lake Jocassee	Keowee River	7,565	1,185,000	Power, recreation and water supply
6	Lake Secession	Rocky River	880	19,360	Power, recreation and water supply
7	Bad Creek Reservoir	Bad Creek	310	24,650	Power
8	Lake Tugaloo	Tugaloo River	300	18,000	Power and recreation
9	Broadway Lake	Rocky River	300	1,800	Recreation
10	Lake Yonah	Tugaloo River	200	6,400	Power and recreation

Source: U.S. Army Corps of Engineers (1991)

Lake Hartwell, located west of Anderson on the Savannah River, was constructed by the U.S. Army Corps of Engineers (COE). The lake, completed in 1963, extends up the Savannah, Tugaloo, and Seneca Rivers and has a surface area of 56,000 acres and a volume of 2,549,000 acre-ft. It ranks fourth in surface area and first in volume among lakes in the State. The lake is an important source of water for hydroelectric power production, public water supplies, and recreation.

Almost immediately below Lake Hartwell on the Savannah River is Richard B. Russell Lake. With a surface area of 26,650 acres and volume of 1,026,000 acre-ft, it ranks sixth and seventh, respectively, among South Carolina lakes. It was constructed by the COE in 1985 primarily for hydroelectric-power production and flood control, but it also is used for recreation and water supply.

Immediately below Lake Russell is J. Strom Thurmond Lake, which occupies most of the western border of McCormick County. (Before 1988, this reservoir was named Clarks Hill Lake, and it is still officially referred to as such by the State of Georgia.) With a surface area of 70,000 acres and a volume of 2,510,000 acre-ft, this lake is the second largest in both surface area and volume of all lakes in the State. Completed in 1954, this was the COE's first reservoir on the Savannah River. Originally constructed for hydropower, flood control, and to assist with downstream navigation, the reservoir is now also important for water supply and recreation. Releases from Lake Thurmond control the behavior of the lower Savannah River, particularly in the upper reaches of the Lower Savannah River subbasin.

The ten largest lakes in the subbasin are listed in Table 8-2. The total surface area of all lakes larger than 10 acres in the subbasin is about 196,000 acres and the total volume is approximately 9,000,000 acre-ft (U.S. Army Corps of Engineers, 1991).

In addition to the hydroelectric power projects associated with these large reservoirs, the subbasin contains several other hydroelectric projects (Table 8-3), including Duke Energy's Bad Creek pumped-storage facility above Lake Jocassee and SCE&G's Stevens Creek project, which helps to mitigate the downstream effects of widely-varying releases from Lake Thurmond.

There are no navigation projects in the subbasin. The COE reservoirs serve as important flood-control projects by virtue of their large floodwater-storage capacities. Many smaller flood-control projects have been constructed by the NRCS (Natural Resources Conservation Service). Most projects are in the upper reaches of the subbasin, mainly in Oconee, Pickens, and Anderson Counties. In 1954, the NRCS (formerly the U.S. Soil Conservation Service) completed the State's first floodwater-retarding

Table 8-3. Major hydroelectric power generating facilities in the Upper Savannah River subbasin (shown on Figure 8-1)

Number on map	Facility name and operator	Impounded stream	Reservoir	Generating capacity (megawatts)	Water use in year 2006 (million gallons)
1	Bad Creek pumped-storage Duke Energy	Bad Creek	Bad Creek Reservoir	1,065	1,412,404
2	Jocassee pumped-storage Duke Energy	Keowee River	Lake Jocassee	662.5	2,168,735
3	Keowee Duke Energy	Keowee River	Lake Keowee	158	155,852
4	Tugalo Georgia Power	Tugaloo River	Lake Tugaloo	45	unavailable
5	Yonah Georgia Power	Tugaloo River	Lake Yonah	23	unavailable
6	Hartwell Corps of Engineers	Savannah River	Lake Hartwell	420	686,485
7	Richard B. Russell Corps of Engineers	Savannah River	Lake Russell	628	1,297,653
8	J. Strom Thurmond Corps of Engineers	Savannah River	Lake Thurmond	280	1,199,816
9	Stevens Creek SCE&G	Savannah River	Stevens Creek Reservoir	18	939,326

structure on Twelvemile Creek as a pilot program. The project succeeded and prompted many others.

Surface-Water Quality

Water bodies in the upper Savannah River subbasin encompass three water-use classifications. Most are designated "Freshwater" (Class FW). Class FW are freshwater bodies that are suitable for survival and propagation of aquatic life, primary- and secondary-contact recreation, drinking-water supply, fishing, and industrial and agricultural uses (DHEC, 2003c).

Eastatoe Creek, Rocky Bottom Creek, and parts of the Chauga and Chattooga Rivers are designated "Outstanding Resource Water" (Class ORW). These freshwater bodies constitute an outstanding recreational or ecological resource and are suitable as a drinking-water source with minimal treatment.

Lake Jocassee is designated as "Trout Put, Grow and Take Water" (Class TPGT). These are freshwater bodies suitable for supporting the growth of stocked-trout populations and a balanced indigenous aquatic community of fauna and flora. This lake is also listed as one of the least eutrophic large lakes in South Carolina, and it is characterized by low nutrient concentrations and very clear water.

As part of its ongoing Watershed Water-Quality Assessment program, DHEC sampled 115 surface-water sites within the subbasin in order to assess the water's suitability for aquatic life and recreational uses (Figure 8-3). Aquatic-life uses were fully supported in 99 sites, or 84 percent of the water bodies sampled. Water was considered partially or fully impaired primarily because of poor macroinvertebrate-community structures or high concentrations of heavy metals. Recreational use was fully supported in 75 percent of the sampled water bodies; water bodies that did not support recreational use exhibited high levels of fecal-coliform bacteria (DHEC, 2003c). Water-quality impairments in the subbasin are summarized in Table 8-4. DHEC publishes recently observed impairments and water-quality trends online in their 303(d) listings and 305(b) reports.

Lake Keowee is listed as the least eutrophic large lake in South Carolina and is characterized by low nutrient concentrations. Lake Yonah is listed as one of the least eutrophic small lakes in the State.

In 2008, as in previous years, DHEC issued a fish-consumption advisory for Lakes Yonah, Jocassee, Russell, and Thurmond because of mercury contamination. A fish consumption advisory for Lake Hartwell was issued because of polychlorinated biphenyl (PCB) contamination that originated from an industrial site near Pickens. Fish-consumption advisories are issued in areas where contaminated fish are found; the contamination is only in the fish and does not make the water unsafe for swimming or boating.

GROUND WATER

Hydrogeology

The Upper Savannah River subbasin occupies part of the Blue Ridge and Piedmont physiographic provinces and is crossed by several geologic belts or terranes trending northeast to southwest. From northwest to southeast, these begin with the Blue Ridge, composed of the Toxaway Gneiss and the Tallulah Falls Formation. The Brevard zone, a narrow unit of cataclastic rocks that extends from North Carolina to Alabama, separates the Blue Ridge to the northwest, in Oconee County, from the rocks of the Piedmont to the southeast. Immediately southeast of the Brevard zone is the Chauga belt (Oconee, Pickens, and northwestern Greenville Counties), which is overlain to the southeast by the Walhalla thrust sheet (Oconee and Pickens Counties). The Walhalla thrust sheet is, in turn, overlain by the Sixmile thrust sheet (Anderson, Oconee, and Pickens Counties), followed by the Laurens thrust stack in southeastern Anderson County and northwestern Abbeville County.

To the southeast, separated by the Lowndesville shear zone, lie the Charlotte terrane (Abbeville, Greenwood, and McCormick Counties) and the Carolina terrane (McCormick, Edgefield, southern Greenwood, and western Saluda Counties). Finally, the Modoc shear zone separates the Carolina terrane from the rocks of the Savannah River terrane and the Augusta terrane at the southernmost extent of the Upper Savannah River subbasin. Additionally, a few gabbro intrusions occur in Abbeville and McCormick Counties and a small granite intrusion occurs on the Edgefield-McCormick county line.

Most of the subbasin ground water occurs in the saprolite, which stores rainfall and provides recharge to fractures in the underlying rock. The saprolite is as thick as 150 feet in places. About a quarter of the wells in the subbasin are domestic wells bored into the saprolite.

The number and size of bedrock fractures beneath the saprolite diminish with depth, and most wells are less than 300 feet deep. The greatest depth is 1,100 feet. Water supplies from fractured rocks are reliable but limited. Well yields, although locally as great as 600 gpm (gallons per minute), usually are less than 50 gpm.

Topography and well yields generally are related. Because valleys and draws provide large areas for aquifer recharge and usually are areas of weak rock where fractures are common, wells located in low areas tend to have larger yields than those in topographically high areas. Wells carefully sited with regard to topography and geology produce yields that are much above the average. The ground-water potential is not well known in much of this subbasin, and specific aquifer or hydrogeologic units are not delineated. Table 8-5 summarizes the drilled-well depths and yields for the subbasin.

Figure 8-3. Surface-water-quality monitoring sites evaluated by DHEC for suitability for aquatic life and recreational uses. Impaired sites are listed in Table 8-4 (DHEC, 2003c).

Table 8-4. Water-quality impairments in the Upper Savannah River subbasin (DHEC, 2003c)

Water-body name	Station number	Use	Status	Water-quality indicator
Lake Yonah	SV-358	Aquatic life	Nonsupporting	Total phosphorus
Chauga River	SV-344	Recreation	Partially supporting	Fecal coliform
Norris Creek	SV-301	Recreation	Nonsupporting	Fecal coliform
Choestoea Creek	SV-108	Recreation	Nonsupporting	Fecal coliform
Beaverdam Creek	SV-345	Recreation	Nonsupporting	Fecal coliform
Little Eastatoe Creek	SV-341	Recreation	Partially supporting	Fecal coliform
Sixmile Creek	SV-205	Recreation	Partially supporting	Fecal coliform
Six and Twenty Creek	SV-181	Recreation	Partially supporting	Fecal coliform
Little Cane Creek	SV-343	Recreation	Nonsupporting	Fecal coliform
Cane Creek	SV-342	Recreation	Nonsupporting	Fecal coliform
North Fork	SV-206	Recreation	Partially supporting	Fecal coliform
Twelvemile Creek	SV-015	Recreation	Nonsupporting	Fecal coliform
	SV-137	Recreation	Partially supporting	Fecal coliform
Twelvemile Creek tributary	SV-136	Recreation	Partially supporting	Fecal coliform
Golden Creek	SV-239	Recreation	Nonsupporting	Fecal coliform
Coneross Creek	SV-333	Aquatic life	Partially supporting	Copper
		Recreation	Partially supporting	Fecal coliform
	SV-004	Aquatic life	Nonsupporting	Copper
		Recreation	Partially supporting	Fecal coliform
Eighteenmile Creek	SV-017	Recreation	Nonsupporting	Fecal coliform
	SV-245	Recreation	Nonsupporting	Fecal coliform
	SV-135	Recreation	Nonsupporting	Fecal coliform
	SV-268	Aquatic life	Nonsupporting	Total phosphorus, pH, Chlorophyll-*a*
		Recreation	Partially supporting	Fecal coliform
Woodside Branch	SV-241	Recreation	Partially supporting	Fecal coliform
Three and Twenty Creek	SV-111	Recreation	Nonsupporting	Fecal coliform
Big Generostee Creek	SV-316	Recreation	Nonsupporting	Fecal coliform
	SV-101	Aquatic life	Partially supporting	Macroinvertebrates
Cupboard Creek	SV-139	Aquatic life	Nonsupporting	Dissolved oxygen
		Recreation	Nonsupporting	Fecal coliform
	SV-140	Recreation	Nonsupporting	Fecal coliform
Broadway Creek	SV-141	Aquatic life	Partially supporting	Macroinvertebrates
		Recreation	Nonsupporting	Fecal coliform
Betsy Creek	SV-037	Aquatic life	Nonsupporting	Copper
Cherokee Creek	SV-043	Recreation	Nonsupporting	Fecal coliform
Rocky River	SV-031	Recreation	Nonsupporting	Fecal coliform
	SV-041	Recreation	Partially supporting	Fecal coliform
Lake Secession	SV-331	Aquatic life	Nonsupporting	Total phosphorus, pH
Wilson Creek	SV-347	Recreation	Partially supporting	Fecal coliform

Table 8-4. Continued

Water-body name	Station number	Use	Status	Water-quality indicator
Little River	SV-164	Recreation	Partially supporting	Fecal coliform
	SV-348	Recreation	Nonsupporting	Fecal coliform
	SV-192	Recreation	Partially supporting	Fecal coliform
Sawney Creek	SV-052	Aquatic life	Partially supporting	Dissolved oxygen
		Recreation	Nonsupporting	Fecal coliform
Johns Creek	SV-734	Aquatic life	Partially supporting	Macroinvertebrates
Blue Hill Creek	SV-053B	Aquatic life	Nonsupporting	Turbidity
		Recreation	Nonsupporting	Fecal coliform
Double Branch	SV-054	Aquatic life	Partially supporting	Macroinvertebrates
Long Cane Branch	SV-349	Recreation	Nonsupporting	Fecal coliform
Stevens Creek Reservoir	SV-294	Aquatic life	Partially supporting	Dissolved oxygen, pH
Hard Labor Creek	SV-151	Aquatic life	Partially supporting	Macroinvertebrates
		Recreation	Nonsupporting	Fecal coliform
Cuffytown Creek	SV-351	Recreation	Partially supporting	Fecal coliform
Rocky Creek	SV-730	Aquatic life	Partially supporting	Macroinvertebrates

Table 8-5. Well depths and yields for drilled bedrock wells in the Upper Savannah River subbasin

County	Well depth (feet)		Well yield (gpm)	
	Average	Maximum	Average	Maximum
Abbeville	259	730	22	300
Anderson	316	1,100	28	600
Edgefield	232	600	15	100
Greenwood	243	620	21	150
McCormick	220	325	23	47
Oconee	241	565	23	400
Pickens	296	885	21	200
Saluda	323	560	16	60
Total	277	1,100	24	600

Ground-Water Quality

Total dissolved solids (TDS) concentrations in the ground water of this subbasin commonly are less than 100 mg/L (milligrams per liter); concentrations as low as 5 mg/L and as high as 850 mg/L have been recorded. The highest TDS concentrations—greater than 500 mg/L—are found in the Carolina terrane, especially in McCormick County. A pH range of 4.5 to 8.9 suggests a wide range of alkalinity. Alkalinity concentrations also are greater in the Carolina terrane. The lowest pH values—less than 6.0—tend to occur in the Blue Ridge belt and in the Walhalla and Sixmile thrust sheets in Oconee and Pickens Counties.

Water-Level Conditions

Ground-water levels are routinely monitored by the USGS in two wells in the Upper Savannah River subbasin to help assess trends or changes in hydrologic conditions (Table 8-6). Water levels in these wells are often indicative of local hydrologic conditions that impact the surface-water systems to which the ground water is connected. Changes in observed water levels are typically a reflection of changes in above-ground hydrologic conditions.

Because ground-water use in this subbasin is very limited, no areas within the subbasin are known to be experiencing significant water-level declines caused by overpumping.

WATER USE

Water use information presented in this chapter is derived from water-use data for the year 2006 that were collected and compiled by DHEC (Butler, 2007) and represents only withdrawals reported to DHEC for that year. Water-use categories and water-withdrawal reporting criteria are described in more detail in the *Water Use* chapter of this publication.

Water use in the Upper Savannah River subbasin for the year 2006 is summarized in Table 8-7 and Figure 8-4. Total offstream water use in the subbasin was 944,953 million gallons in 2006, ranking it first among the 15 subbasins. Of this amount, 944,907 million gallons came from surface-water sources (99.95 percent) and 47 million

Table 8-6. Water-level monitoring wells in the Upper Savannah River subbasin

Well number	Monitoring agency*	Latitude Longitude (deg min sec)	Aquifer	Well location	Land surface elevation (feet)	Depth (feet) to screen top, bottom; or open interval
MCK-52	USGS	33 53 36 82 21 46	Crystalline rock	3 miles west of McCormick	400	54–202
OCO-233	USGS	34 50 51 83 04 18	Crystalline rock	5 miles north of Walhalla	1,080	24–433

* *USGS, United States Geological Survey*

gallons came from ground-water sources (0.05 percent). Thermoelectric power use accounted for 97 percent of this total, followed by water supply (2 percent) and industry (less than 1 percent). Consumptive use in this subbasin is estimated to be 22,144 million gallons, or about 2 percent of the total offstream use.

Almost all of the water used for thermoelectric power, and thus most of the offstream water use in the subbasin, was used by Duke Energy's Oconee Nuclear Station. Located near Seneca in Oconee County, the Oconee Nuclear Station is one of the largest nuclear plants in the nation, with three reactors and a generating capacity of 2,538 MW (megawatts). In 2006, the plant used 919,732 million gallons of water, more than any other single offstream use in the State. The Oconee Nuclear Station withdraws water from Lake Keowee.

The other thermoelectric power facility in the subbasin is Santee Cooper's John S. Rainey Station, a gas-combustion turbine plant that uses natural gas and compressed air to turn turbines and produce electricity. Exhaust heat generated in the process is used to produce additional electrical power from steam. The plant, located in western Anderson County on the Savannah River, used 334 million gallons of water in 2006.

Water-supply use in the Upper Savannah River subbasin totaled 20,977 million gallons. Surface water accounted for 20,930 million gallons (99.8 percent) and ground water for 47 million gallons (0.2 percent). The largest surface-water user was the city of Greenville, which withdrew 7,293 million gallons from Lake Keowee. Greenville also draws water from the North Saluda Reservoir and Table Rock Reservoir in the Saluda River subbasin. Anderson Regional Water System used 7,098 million gallons for public supply from Lake Hartwell. Other systems of note include the city of Seneca (2,394 million gallons from Lake Keowee), Westminster Commission of Public Works in Oconee County (903 million gallons from Chauga River), and the city of Abbeville (858 million gallons from Lake Russell). The town of Salem in Oconee County had the largest ground-water system in the subbasin, with withdrawals from the crystalline rock aquifer totaling 44 million gallons. Water-supply is the only significant ground-water use in the subbasin.

Industrial water use was 3,110 million gallons in 2006, all of it from surface-water sources. Clemson University was the largest user, withdrawing a total of 2,038 million gallons.

Instream water use for hydroelectric power generation totaled 7,885,878 million gallons in 2006, more than any other subbasin. Duke Energy owns and operates both the Jocassee Hydroelectric Station in Pickens County and the Bad Creek Hydroelectric Station in Oconee County. Both stations are pumped-storage facilities that reuse water repeatedly to generate hydroelectric power. The Jocassee Station, with a capacity of 662.5 MW, used more water than any other facility in the State—2,168,735 million gallons (see Table 8-3). The Bad Creek Station, with a capacity of 1,065 MW, had the third highest use in the State—1,412,404 million gallons. Duke Energy also owns and operates the Keowee Hydroelectric Station at Lake Keowee, which has a capacity of 158 MW and used 155,852 million gallons in 2006.

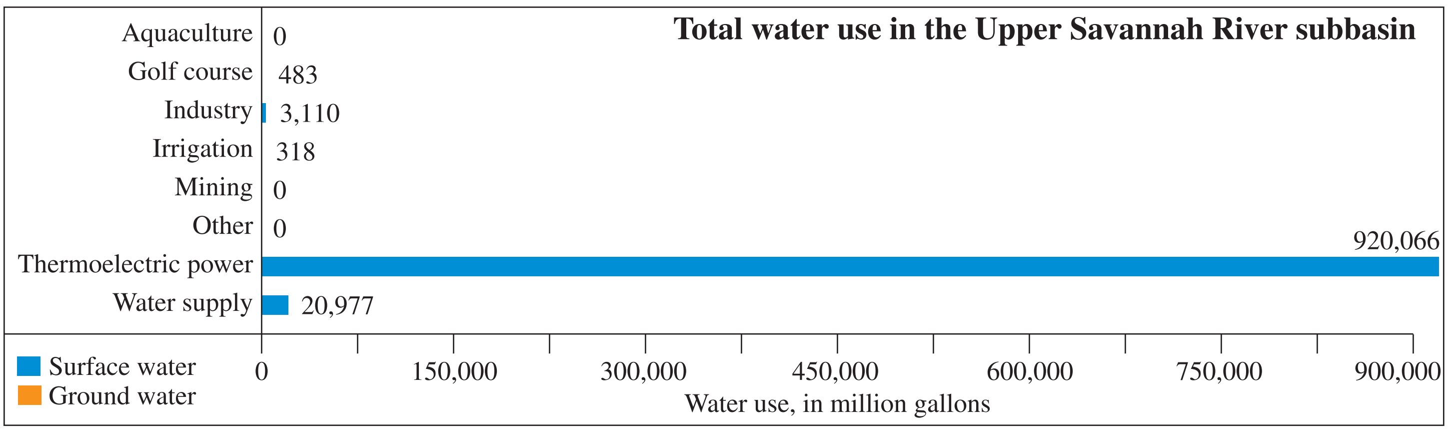
The COE's Lake Russell power plant, a pumped-storage facility with a capacity of 628 MW, used 1,297,653 million gallons in 2006. The Lake Thurmond facility, which has a capacity of 280 MW, used 1,199,816 million gallons, and the Lake Hartwell facility, which has a capacity of 420 MW, used 686,485 million gallons.

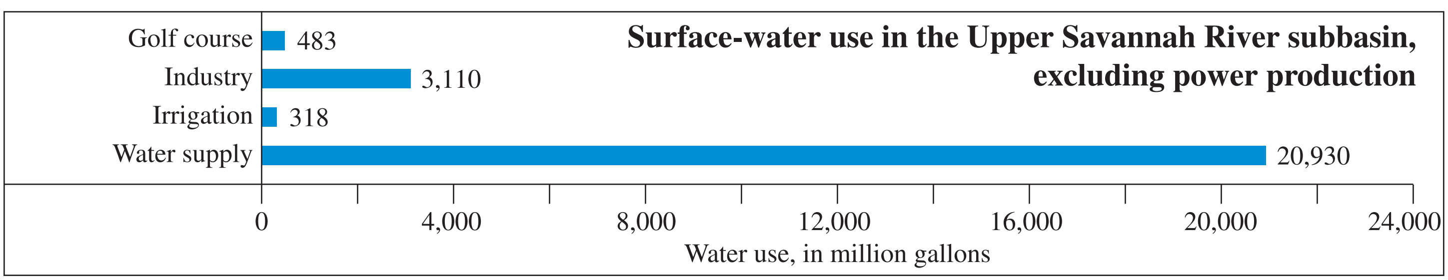
SCE&G's Stevens Creek Hydroelectric Station on the Savannah River has a capacity of 18.4 MW and used 939,326 million gallons in 2006.

The city of Abbeville owns and operates the Rocky River hydroelectric plant at Lake Secession. It has a capacity of 2.6 MW and used 15,807 million gallons in 2006. Aquaenergy Systems, Inc. owns Coneross Creek, a 0.9 MW plant located just south of Seneca in Oconee County that used 9,800 million gallons.

Table 8-7. Reported water use in the Upper Savannah River subbasin for the year 2006 (modified from Butler, 2007)

Water-use category	Surface water		Ground water		Total water	
	Million gallons	Percentage of total surface-water use	Million gallons	Percentage of total ground-water use	Million gallons	Percentage of total water use
Aquaculture	0	0.0	0	0.0	0	0.0
Golf course	483	0.1	0	0.0	483	0.1
Industry	3,110	0.3	0	0.0	3,110	0.3
Irrigation	318	0.0	0	0.0	318	0.0
Mining	0	0.0	0	0.0	0	0.0
Other	0	0.0	0	0.0	0	0.0
Thermoelectric power	920,066	97.4	0	0.0	920,066	97.4
Water supply	20,930	2.2	47.1	100.0	20,977	2.2
Total	944,907		47.1		944,953	





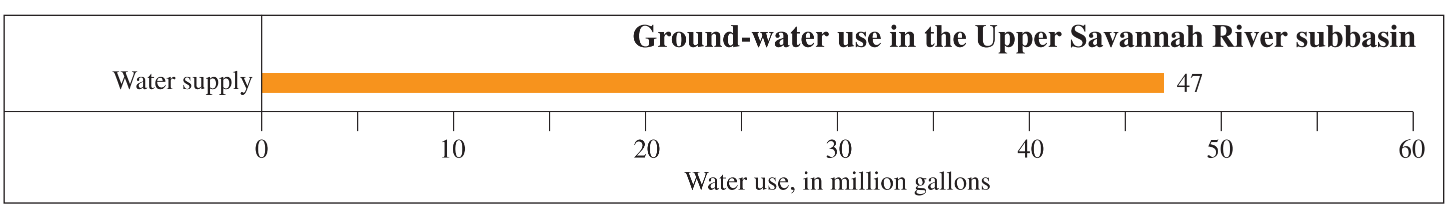


Figure 8-4. Reported water use in the Upper Savannah River subbasin for the year 2006 (modified from Butler, 2007).

LOWER SAVANNAH RIVER SUBBASIN

LOWER SAVANNAH RIVER SUBBASIN

The Lower Savannah River subbasin parallels the State's western boundary with Georgia and is a 125-mile-long subbasin extending south-southeast from the Edgefield-Aiken county line to the coast. Parts of five South Carolina counties are included in the subbasin: Aiken, Allendale, Barnwell, Hampton, and Jasper (Figure 8-5). The subbasin area is approximately 1,295 square miles, 4.2 percent of the State's area.

DEMOGRAPHICS

The year 2000 population of the subbasin was estimated at 127,500, 3.2 percent of the State's total population. The largest population increases by 2020 are expected in Aiken and Allendale Counties, whose populations are projected to increase 22 percent and 16 percent, respectively. Hampton County is projected to experience a population loss.

The subbasin is rural with the exception of Aiken County, where more than 60 percent of the population is classified as urban. Industries and government, such as textiles and the Savannah River Site in Barnwell and Aiken Counties, have created greater employment opportunities at the northern end of the subbasin than at the southern end. The major cities in the subbasin are Aiken (25,337) and North Augusta (17,544), both located in Aiken County.

Aiken County ranked twelfth in the State by per capita income ($28,418) in 2005, whereas Allendale County ranked last with $18,871. The 1999 median household income in Aiken County was $37,889, slightly above the State average. The median household income in the other four counties ranked in the lowest third in the State; median household income in Allendale County was $20,898, the lowest in the State (South Carolina Budget and Control Board, 2005).

During 2000, the counties of the subbasin had combined annual average employment of non-agricultural wage and salary workers of about 76,000. Labor distribution within the subbasin counties included management, professional, and technical services, 29 percent; sales and office, 23 percent; production, transportation, and materials moving, 20 percent; service, 15 percent; construction, extraction, and maintenance, 12 percent; and farming, fishing, and forestry, 1 percent.

In the sector of manufacturing and public utilities, the 1997 product value from all subbasin counties totaled $5.2 billion; about 80 percent of this total, or $4.3 billion, was generated in Aiken County. Crop and livestock value in 2003 totaled $94 million and delivered-timber value in 2001 totaled $97 million, respectively.

SURFACE WATER

Hydrology

The lower portion of the Savannah River from the confluence with Stevens Creek near the Fall Line to the Atlantic Ocean forms the main stem of this drainage system. Several small to moderately-sized tributary streams drain the Lower Savannah River subbasin. The largest of these are in the upper Coastal Plain region and include Horse Creek, Upper Three Runs Creek, and Lower Three Runs Creek. Tributary streams in the middle and lower Coastal Plain region are generally small and associated with swamplands and follow ill-defined, meandering channels. Two large urban areas, Augusta-

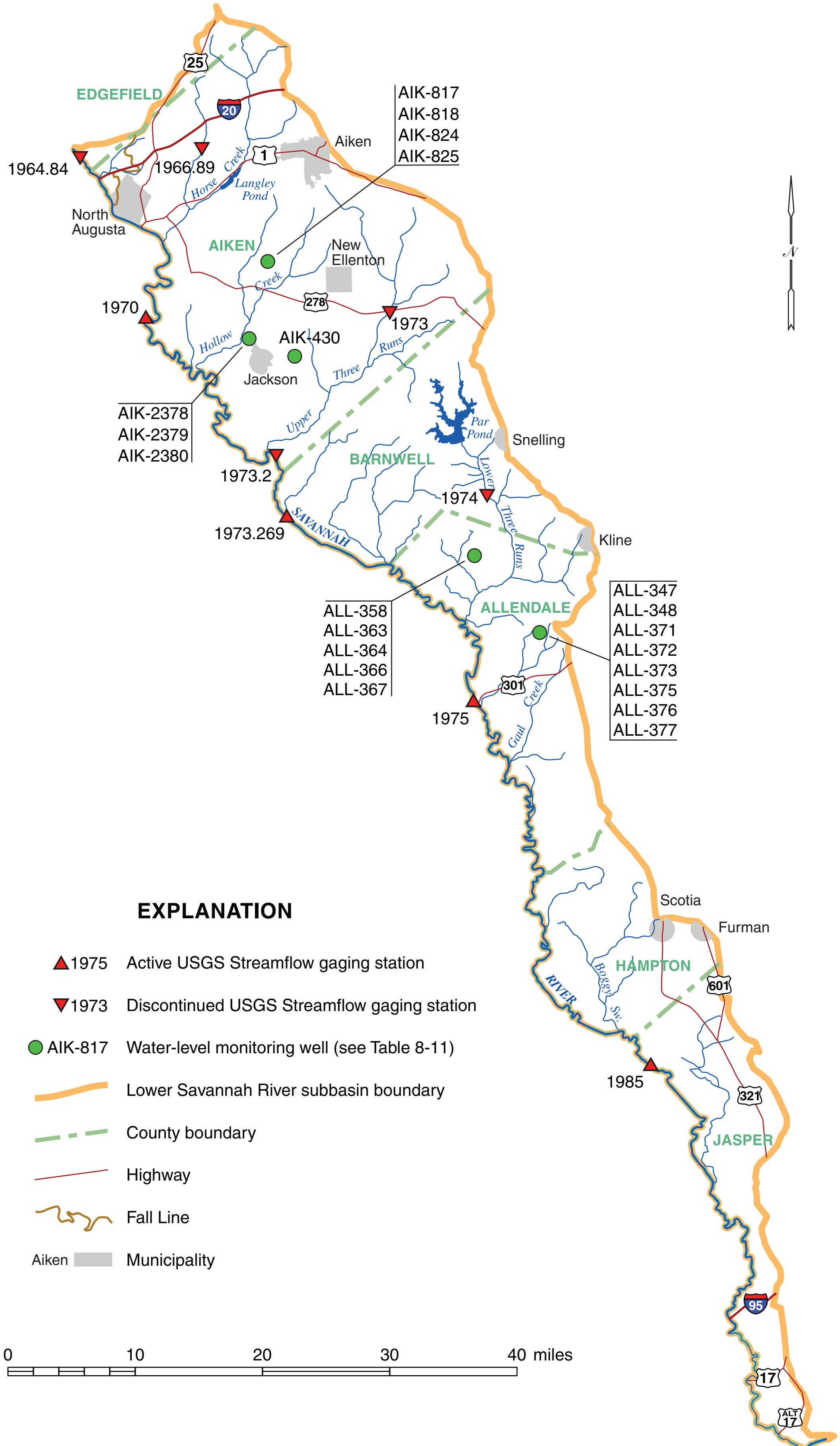


Figure 8-5. Map of the Lower Savannah River subbasin.

North Augusta and Savannah, Georgia, make extensive use of these streams.

Flow in the Savannah River has been regulated since 1951 by controlled releases from Lake Thurmond in the Upper Savannah River subbasin. Streamflow in the subbasin is presently monitored at four gaging stations, all on the Savannah River (Figure 8-5). Three active gaging stations were in place before hydroelectric development upstream and reflect the combination of flow conditions before and after regulation. Several other gages on the Savannah River and its tributaries are no longer active. Streamflow statistics for some of these active and discontinued gaging stations are presented in Table 8-8. In addition to these streamflow gages, several stage-only gages are active near the coast.

Average streamflow in the Savannah River is 9,135 cfs (cubic feet per second) at Augusta, Georgia, and increases to 11,620 cfs downstream near Clyo. Ninety percent of the time, streamflow at these sites should be at least 4,580 cfs and 5,520 cfs, respectively. Releases from Lake Thurmond and subsequent reregulation by the Stevens Creek Dam are such that the flow of the Savannah River at Augusta is almost always at least 3,600 cfs.

Flow characteristics at all main-stem gaging stations reflect controlled discharges from upstream hydroelectric

Table 8-8. Selected streamflow characteristics at USGS gaging stations in the Lower Savannah River subbasin

Gaging station name, location, station number	Period of record	Drainage area (mi²)	Average flow (cfs)	Average flow (cfsm)	90% exceeds flow (cfs)	Minimum daily flow (cfs), year	Maximum daily flow (cfs), year	Maximum peak flow (cfs), year
Savannah River near North Augusta 1964.84	1988 to 2002	7,150	6,697	0.94	1,790	65 1989	39,000 1993	54,200 1990
Little Horse Creek near Graniteville 1966.89	1989 to 2001	26.6	33.8	1.27	16	4.1 1993	305 1990	593 1990
Savannah River [1] at Augusta, Ga. 1970	1883-91; 1896-1906; 1925-51	7,510	10,640	1.42	3,180	1,040 1927	315,000 1929	350,000 1929
Savannah River [2] at Augusta, Ga. 1970	1951 to 2007*	7,510	9,135	1.22	4,580	1,770 1951	84,500 1964	87,100 1964
Upper Three Runs Creek near New Ellenton 1973	1996 to 2002	87.0	103	1.18	72	46 2002	509 1992	820 1990
Savannah River near Jackson 1973.2	1971 to 2002	8,110	6,277	0.77	4,620	3,220 1981	22,000 1976	– – –
Savannah River near Waynesboro, Ga. 1973.269	2005 to 2007*	8,300	6,484	0.78	4,540	4,000 2006	21,800 2005	21,900 2005
Lower Three Runs Creek near Snelling 1974	1974 to 2002	59.3	78.9	1.33	27	13 1986	743 1990	1,130 2000
Savannah River near Millhaven, Ga. 1975	1937-70 and 1982-2007*	8,650	10,180	1.18	4,960	2,120 1951	138,000 1940	141,000 1940
Savannah River near Clyo, Ga. 1985	1929-33 and 1937-2007*	9,850	11,620	1.18	5,520	1,950 1931	203,000 1929	270,000 1929

mi², square miles; cfs, cubic feet per second; cfsm, cubic feet per second per square mile of drainage area

90% exceeds flow: the discharge that has been exceeded 90 percent of the time during the period of record for that gaging station

** 2007 is the most recent year for which published data were available when this table was prepared*

1 *Records from before Lake Thurmond began regulating flow of the Savannah River*

2 *Records from after Lake Thurmond began regulating flow of the Savannah River*

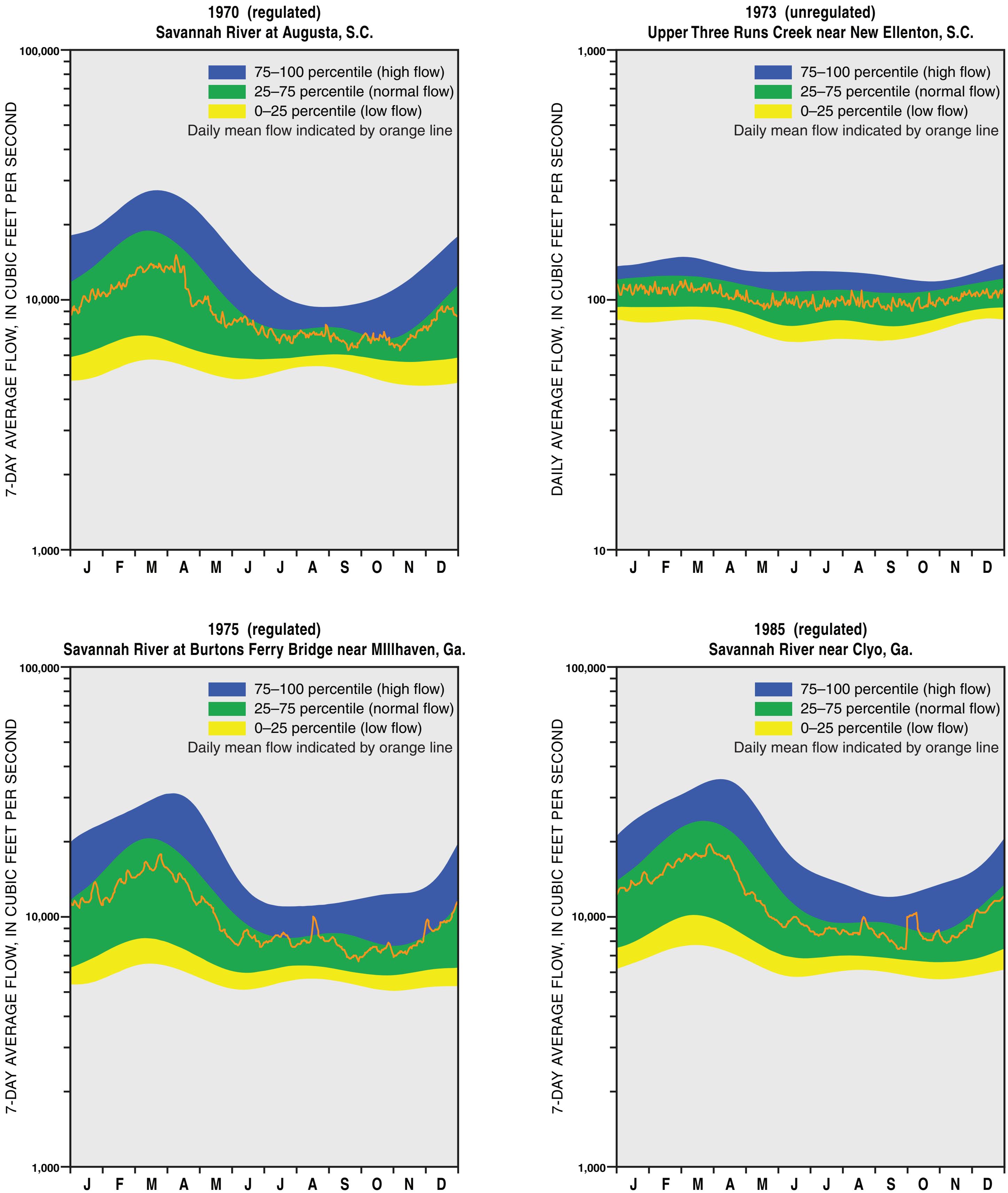


Figure 8-6. Duration hydrographs for selected gaging stations in the Lower Savannah River subbasin.

power facilities (Figure 8-6). This streamflow regulation has resulted in higher and more well-sustained low flows. In the upper portion of the main stem, streamflow is generally more variable due to upstream releases; in the lower portion of the main stem, streamflow becomes more uniform as inflow from tributary streams and the modifying effect of surrounding wetlands stabilize flow.

One gaged tributary stream, Upper Three Runs Creek in Aiken County, is located in the upper Coastal Plain and exhibits the characteristically well-sustained flows of streams in that province (Figure 8-6). Streamflow is uniform and shows well-supported base flow. No data exist for tributary streams in the middle and lower Coastal Plain regions of the subbasin; however, streamflow characteristics for these streams are probably similar to those of other middle and lower Coastal Plain streams that exhibit highly-variable flow and poorly-sustained base flow during periods of low rainfall.

Development

Little surface-water development occurs in the lower Savannah River subbasin. Most development consists of navigation projects in the Savannah River from the Savannah Harbor to Augusta, Georgia.

The only large lake in the subbasin is Par Pond, located on Lower Three Runs Creek on the Savannah River Site in Barnwell County. Par Pond has a surface area of 2,700 acres and a volume of 54,000 acre-ft. The next largest impoundment—Langley Pond, on Horse Creek near Graniteville in Aiken County—has a surface area of 250 acres and a total volume of 1,250 acre-ft.

Nearly all of the lower Savannah River is included in two U.S. Army Corps of Engineers (COE) navigation projects. One project involves maintaining a navigation channel in the Savannah Harbor and the other involves maintaining a navigation channel in the Savannah River from Savannah Harbor to Augusta, Georgia. The channel to Augusta provides the only inland commercial navigation in the State.

The COE actively maintains a 42-foot deep navigation channel in the Savannah Harbor. A plan to deepen the harbor was authorized in 1999 and remains in the planning stage. If completed, it will deepen the Savannah River channel from the ocean bar (Atlantic Ocean and Savannah River entrance) to the Georgia Ports Authority by as much as 6 feet, for a total depth of 48 feet.

The New Savannah Bluff Lock and Dam, located on the Savannah River 13 miles below Augusta, was constructed by the COE in 1937 to improve navigation on the Savannah River between the Savannah Harbor and Augusta. Commercial traffic through the lock ceased in 1979, and maintenance of the facility and its navigation channel was discontinued. Although the lock is no longer used for commercial navigation, the dam creates a relatively stable pool of water in the river that serves as a source for municipal, industrial, and agricultural water supply for the North Augusta area.

There are no completed flood-control projects in the subbasin, although the COE completed reconnaissance studies of two problem areas in Aiken County—Sand River and Horse Creek—many years ago.

Surface-Water Quality

Water bodies in the Lower Savannah River subbasin, except for near the coast, are designated “Freshwater” (Class FW). This water-use classification is assigned to water bodies that are suitable for the survival and propagation of aquatic life, primary- and secondary-contact recreation, drinking-water supply, fishing, and industrial and agricultural uses (DHEC, 2003c).

The sections coastward of U.S. Highway 17 are designated as “Tidal Saltwater” (Class SB). Class SB represents tidal saltwater suitable for primary- and secondary-contact recreation, crabbing, and fishing. These water bodies are not protected for harvesting clams, mussels, or oysters for market purposes or human consumption. Class SB waters must maintain dissolved-oxygen concentrations of at least 4.0 mg/L (milligrams per liter).

As part of its ongoing Watershed Water Quality Assessment program, DHEC sampled 29 sites in the subbasin in order to assess the water’s suitability for aquatic life and recreational use (Figure 8-7). Aquatic life was fully supported at 25 sites, or 86 percent of the water bodies sampled; four sites were impaired, mainly because of pH excursions. Recreational use was fully supported in 75 percent of the tested water bodies; water that did not fully support recreational use exhibited high levels of fecal-coliform bacteria (DHEC, 2003c). Water-quality impairments in the subbasin are summarized in Table 8-9.

Water-quality conditions can change significantly from year to year, and water bodies are reassessed every 2 years for compliance with State water-quality standards. DHEC publishes recent impairments and water-quality trends online in their 303(d) listings and 305(b) reports.

In 2008, as in several prior years, DHEC has issued fish-consumption advisories for the entire Savannah River downstream from Stevens Creek and for Langley, Flat Rock, and Vaucluse ponds in Aiken County. Fish-consumption advisories are issued in areas where fish are contaminated with mercury; the contamination is only in the fish and does not make the water unsafe for swimming or boating.

Figure 8-7. Surface-water-quality monitoring sites evaluated by DHEC for suitability for aquatic life and recreational uses. Impaired sites are listed in Table 8-9 (DHEC, 2003c).

Table 8-9. Water-quality impairments in the Lower Savannah River subbasin (DHEC, 2003c)

Water-body name	Station number	Use	Status	Water-quality indicator
Horse Creek	SV-071	Aquatic life	Nonsupporting	pH
	SV-096	Aquatic life	Partially supporting	pH
	SV-072	Recreation	Partially supporting	Fecal coliform
	SV-250	Aquatic life	Nonsupporting	pH
		Recreation	Partially supporting	Fecal coliform
Hollow Creek	SV-350	Recreation	Partially supporting	Fecal coliform
Tims Branch	SV-324	Recreation	Partially supporting	Fecal coliform
Fourmile Creek	SV-326	Recreation	Partially supporting	Fecal coliform
Cypress Creek	SV-356	Aquatic life	Nonsupporting	Dissolved oxygen
Savannah River	SV-191	Recreation	Partially supporting	Fecal coliform

GROUND WATER

Hydrogeology

The Lower Savannah River subbasin is almost entirely in the Coastal Plain and is generally underlain by the same aquifers that occur throughout the Coastal Plain of South Carolina. The aquifers originate southeast of the Fall Line and dip toward the coast. The lowermost aquifer is the Cape Fear, which rarely is tapped by wells. The overlying Middendorf aquifer first occurs at a depth of 50 to 100 feet below the ground surface in the upper extent of the subbasin and deepens to approximately 2,800 feet in southern Jasper County. The Middendorf aquifer ranges in thickness from 0 to 300 feet between the upper and lower ends of the subbasin. Overlying the Middendorf is the Black Creek aquifer, which is in turn overlain by the Black Mingo, Congaree, McBean, and Barnwell Formations of the Tertiary sand aquifer and the shallow aquifer. In the lower Coastal Plain, the Floridan aquifer and shallow aquifer overlay the Tertiary sand aquifer. Selected ground-water data for the subbasin are presented in Table 8-10.

Table 8-10. Selected ground-water data for the Lower Savannah River subbasin

Vicinity	Aquifer	Well depth (feet)	Major well yield (gpm)
Aiken County	Middendorf	120–625	80–1,500
Savannah River Site	Middendorf	400–875	370–2,200
Williston	Tertiary sand/ Black Creek/ Middendorf/	100–700	120–1,350
Scotia	Floridan	54–374	1,250
Hardeeville	Floridan	182–600	1,040

The major aquifers underlying Aiken and Barnwell Counties are the Middendorf, Black Creek, and Tertiary sand aquifers. The Middendorf aquifer underlies the two-county area and is the principal aquifer. At sites close to the Fall Line, where overlying sand deposits become very thin, the Middendorf aquifer produces less water than in the areas farther south and east. A well for the city of Aiken reached basement granite at a depth of 517 feet below land surface; a test hole near the center of the Savannah River Site reached basement at a depth of 985 feet below land surface; and triassic rocks (basement) were reached at 1,240 feet in a well in the southern part of the Savannah River Site.

Transmissivities determined from pumping tests of Middendorf-aquifer wells in Aiken County range from 700 to 31,000 ft^2/day. Pumping tests of two wells screened in both the Middendorf and overlying Black Creek aquifers indicated composite transmissivities of 6,400 and 13,000 ft^2/day; these wells were pumped at 1,550 and 2,200 gpm (gallons per minute), respectively.

The Black Creek aquifer, either screened alone in wells or in combination with the Middendorf, is an important source of supply in the subbasin, and well yields as great as 1,000 gpm have been obtained from the Black Creek aquifer.

In places near the Fall Line, the Black Creek Formation evidently was eroded before deposition of the Black Mingo or equivalent Tertiary sand sediments, thus the latter directly overlies the Middendorf in a limited area. The Black Mingo component of the Tertiary sand aquifer is a minor source of supply in this part of the subbasin.

The Tertiary sand aquifer also encompasses the Congaree, McBean, and Barnwell Formations above the Black Mingo. Their thickness ranges from about 125 feet in the northwestern part of the Savannah River Site to about 400 feet in the southeastern part near the Allendale County line. Yields of Tertiary-sand wells tapping the

McBean and Congaree Formations range from 60 to 660 gpm in the Savannah River Site area. The Barnwell Formation section of the Tertiary sand aquifer thickens southeastward across Aiken and Barnwell Counties from a featheredge to approximately 90 feet and may be in hydraulic continuity with the McBean Formation.

Few wells tap the Cretaceous aquifers in Hampton and Jasper Counties because of the greater depth and, in some cases, poor water quality, especially near the coast. A few large wells in Hampton County withdraw water in excess of 1,000 gpm from the Black Creek aquifer. The top of the Tertiary sand, consisting mainly of the Black Mingo Formation in Hampton County, occurs at a depth of 400 to 600 feet. The Peedee Formation, which principally is a confining unit within and above the Black Creek aquifer, supplies deep wells at Hampton and Varnville in Hampton County.

The Floridan aquifer is the most widely used ground-water source in the Allendale, Hampton, and Jasper County reaches of the lower Savannah River. The Ocala Limestone forms the uppermost and most productive section of the Floridan, and the top of the principal permeable zone generally occurs within 50 to 150 feet of land surface. Transmissivities are highest of any aquifer in the State and exceed 40,000 ft^2/day in Jasper County. Wells capable of 500 to 2,000 gpm are possible nearly everywhere in the subbasin.

Ground-Water Quality

The quality of water in the Middendorf aquifer varies throughout the subbasin. In the upper reaches the water is low in total dissolved solids (TDS), is soft, and has a low pH. Because of its acidity and the appreciable amount of dissolved carbon dioxide, the water is corrosive to steel and brass well screens. Sodium chloride type water predominates in this region (Logan and Euler, 1989). Near the outcrop, TDS, chloride, and alkalinity are about 25, 5.0, and 2.5 mg/L, respectively, and pH is 6.5. These concentrations increase toward the coast, where TDS concentrations exceed 1,000 mg/L and the pH increases to more than 8.5 (Speiran and Aucott, 1994).

Ground-water contamination has been documented at the Savannah River Site. Metals, nitrates, and radioactive materials have been detected in shallow aquifers, and organic contaminants (Triclene, Perclene, and trichloroethylene) were found in wells open to the Middendorf aquifer.

Water quality of the Black Creek aquifer is similar to that of the Middendorf aquifer. Total dissolved solids range from 25 mg/L near the outcrop to 200 mg/L in southern Allendale County and probably are more than 2,500 mg/L at the coast. Chloride concentration increases along the subbasin from 3 to 1,000 mg/L, alkalinity increases from about 20 mg/L to more than 1,000 mg/L, and pH increases from 4.5 to more than 7.5 (Speiran and Aucott, 1994; Logan and Euler, 1989). High iron concentrations are common in Allendale County.

In Aiken and Barnwell Counties, water in the Tertiary sand aquifer is low in dissolved solids (usually less than 50 mg/L), acidic, and high in iron. Water in the lower part of the aquifer commonly contains hydrogen sulfide gas, which causes a “rotten-egg” odor (Logan and Euler, 1989). Downdip, dissolved solids and pH increase as aquifer sediments become more calcareous.

The Floridan aquifer yields calcium bicarbonate type water with pH between 7.5 and 8.8, TDS generally less than 200 mg/L, hardness less than 140 mg/L (as $CaCO_3$), and chloride concentrations less than 15 mg/L (Hayes, 1979).

Freshwater is present in the Floridan aquifer throughout the Jasper County reach; however, this condition is changing. Test wells drilled offshore from the mouth of the Savannah River and next to Bull River, on the Georgia side of the subbasin, show seawater migrating downward into the Floridan aquifer (see the *Special Topics* chapter).

Shallow aquifers vary in water quality depending on the geology and interactions with surface-water bodies. Total dissolved solids typically are less than 100 mg/L, and the greatest TDS usually are associated with the moderately-hard to hard water that occurs where shell material is abundant. High iron concentrations are common.

Water-Level Conditions

Ground-water levels are regularly monitored by DNR and USGS in 21 wells within the Lower Savannah River subbasin (Table 8-11). Water levels in other wells in the subbasin are sometimes measured to help develop potentiometric maps of the Middendorf, Black Creek, and Floridan aquifers.

Because the southern portion of this subbasin (in Jasper County) is very narrow and relatively undeveloped, this part of the subbasin experiences little use of ground water. Despite this, water levels in the Floridan aquifer in this region have declined significantly owing to pumping at Savannah, Georgia. The large cone of depression that has developed around Savannah, where water levels in the aquifer that were originally 10 to 35 feet above sea level in 1880 were as low as 140 feet below sea level in 2004, extends into Jasper County. Water levels estimated to be above sea level before development are now at or below sea level in southern Jasper County (see Figure 7-13). In 2004, the lowest point on the Floridan potentiometric surface in South Carolina, in southern Jasper County, was 57 feet below sea level, about 80 feet below the predevelopment level (Hockensmith, 2009). Research by DHEC and USGS shows that seawater is migrating vertically into the Floridan aquifer from the tidal streams and marshlands in the lower reaches of the subbasin (see the *Special Topics* chapter).

Table 8-11. Water-level monitoring wells in the Lower Savannah River subbasin

Well number	Monitoring agency*	Latitude Longitude (deg min sec)	Aquifer	Well location	Land surface elevation (feet)	Depth (feet) to screen top, bottom; or open interval
AIK-430	USGS	33 19 40 81 44 35	Middendorf	Savannah River Site	357	390–600
AIK-817	DNR	33 26 17 81 46 15	Middendorf	DNR cluster site C-2, New Ellenton	419	520–530
AIK-818	DNR	33 26 17 81 46 14	Middendorf	DNR cluster site C-2, New Ellenton	419	410–420
AIK-824	DNR	33 26 16 81 46 14	Black Creek	DNR cluster site C-2, New Ellenton	419	350–360
AIK-825	DNR	33 26 16 81 46 14	Black Creek	DNR cluster site C-2, New Ellenton	419	216–226
AIK-2378	DNR	33 21 11 81 48 33	Black Creek	DNR cluster site C-1, Jackson	220	170–180
AIK-2379	DNR	33 21 11 81 48 32	Black Creek	DNR cluster site C-1, Jackson	224	251–261
AIK-2380	DNR	33 21 12 81 48 32	Middendorf	DNR cluster site C-1, Jackson	228	370–380
ALL-347	DNR	33 01 28 81 23 03	Middendorf	DNR cluster site C-10, Appleton	282	1,408–1,418
ALL-348	DNR	33 01 29 81 23 05	Cape Fear	DNR cluster site C-10, Appleton	281	1,575–1,600
ALL-358	DNR	33 06 47 81 30 22	Middendorf	DNR cluster site C-7, Martin	243	1,108–1,118
ALL-363	DNR	33 06 48 81 30 22	Floridan	DNR cluster site C-7, Martin	246	90–100
ALL-364	DNR	33 06 48 81 30 22	Floridan	DNR cluster site C-7, Martin	245	210–220
ALL-366	DNR	33 06 47 81 30 22	Floridan	DNR cluster site C-7, Martin	244	385–395
ALL-367	DNR	33 06 47 81 30 22	Black Creek	DNR cluster site C-7, Martin	246	551–561
ALL-371	DNR	33 01 28 81 23 05	Floridan	DNR cluster site C-10, Appleton	282	192–212
ALL-372	DNR	33 01 28 81 23 04	Tertiary sand	DNR cluster site C-10, Appleton	282	140–150
ALL-373	DNR	33 01 28 81 23 03	Floridan	DNR cluster site C-10, Appleton	280	327–367
ALL-375	DNR	33 01 28 81 23 06	Tertiary sand	DNR cluster site C-10, Appleton	283	453–578
ALL-376	DNR	33 01 28 81 23 05	Black Creek	DNR cluster site C-10, Appleton	282	784–989
ALL-377	DNR	33 01 28 81 23 04	Middendorf	DNR cluster site C-10, Appleton	282	1,174–1,194

* *DNR, South Carolina Department of Natural Resources; USGS, United States Geological Survey*

In the upper part of the subbasin (Aiken and Barnwell Counties), water levels in the Middendorf and Black Creek aquifers are not significantly lower than estimated predevelopment levels. Water levels in this area are sensitive to both rainfall and pumping, and the extent to which pumping affects water levels is difficult to determine, owing to the high transmissivity of the aquifers and the effect of natural discharge to the Savannah River (Hockensmith, 2008a and b).

WATER USE

Water use information presented in this chapter is derived from water-use data for the year 2006 that were collected and compiled by DHEC (Butler, 2007) and represents only withdrawals reported to DHEC for that year. Water-use categories and water-withdrawal reporting criteria are described in more detail in the *Water Use* chapter of this publication.

Water use in the Lower Savannah River subbasin for the year 2006 is summarized in Table 8-12 and Figure 8-8. Total offstream water use in the subbasin was 97,263 million gallons in 2006, ranking it seventh among the 15 subbasins. Of this amount, 89,826 million gallons came from surface-water sources (92 percent) and 7,437 million gallons came from ground-water sources (8 percent). Thermoelectric power generation accounted for 58 percent of the total, followed by industry (25 percent) and water supply (16 percent). Consumptive use in this subbasin is estimated to be 6,665 million gallons, or about 7 percent of the total offstream use.

Table 8-12. Reported water use in the Lower Savannah River subbasin for the year 2006 (modified from Butler, 2007)

Water-use category	Surface water		Ground water		Total water	
	Million gallons	Percentage of total surface-water use	Million gallons	Percentage of total ground-water use	Million gallons	Percentage of total water use
Aquaculture	0	0.0	0	0.0	0	0.0
Golf course	226	0.3	115	1.6	341	0.3
Industry	22,232	24.7	1,961	26.4	24,193	24.9
Irrigation	0	0.0	1,042	14.0	1,042	1.1
Mining	0	0.0	0	0.0	0	0.0
Other	0	0.0	0	0.0	0	0.0
Thermoelectric power	56,012	62.4	0	0.0	56,012	57.6
Water supply	11,356	12.6	4,319	58.0	15,675	16.1
Total	89,826		7,437		97,263	

The only thermoelectric power plant in the subbasin reporting water use was SCE&G's Urquhart Station. Located near North Augusta on the Savannah River, the plant, which burns both coal and natural gas, has a capacity of 650 megawatts, and is SCE&G's oldest fossil-fuel thermoelectric plant, having been in operation since 1953. In 2006, the station used 56,012 million gallons of water, all from the Savannah River.

Industrial water use totaled 24,193 million gallons in the subbasin, third highest in the State. Of this amount, 22,232 million gallons came from surface-water sources (92 percent) and 1,961 million gallons came from ground-water sources (8 percent). Primesouth, in Aiken County, had the greatest surface-water use, withdrawing 18,184 million gallons from the Savannah River. Primesouth is the second largest industrial user in the State. The Savannah River Site (SRS) used a total of 1,036 million gallons of ground water at four different areas on the site, pumping from the Middendorf aquifer (known as the McQueen Branch aquifer at SRS), Black Creek aquifer (Crouch Branch aquifer at SRS), and the Tertiary sand aquifer (Gordon aquifer at SRS). The Savannah River Site also reported using 1,051 gallons of surface water in 2006. Clariant Corporation in Allendale County is the subbasin's other large industrial user of ground water, withdrawing 850 million gallons from the Black Creek aquifer.

Water-supply use in the Lower Savannah River subbasin totaled 15,675 million gallons. Surface water accounted for 11,356 million gallons (72 percent) and ground water for 4,319 million gallons (28 percent). Beaufort-Jasper Water and Sewer Authority was the largest of the three surface-water users, withdrawing 8,072 million gallons from the Savannah River, much of which is used outside the Lower Savannah River subbasin. Edgefield County Water and Sewer used 1,652 million gallons and the city of North Augusta used 1,632 gallons, both from the Savannah River. The city of Aiken had the largest ground-water system, pumping 2,124 million gallons, primarily from the Middendorf aquifer. Beech Island Water District had withdrawals of 502 million gallons from the Middendorf aquifer.

Figure 8-8. Reported water use in the Lower Savannah River subbasin for the year 2006 (modified from Butler, 2007).