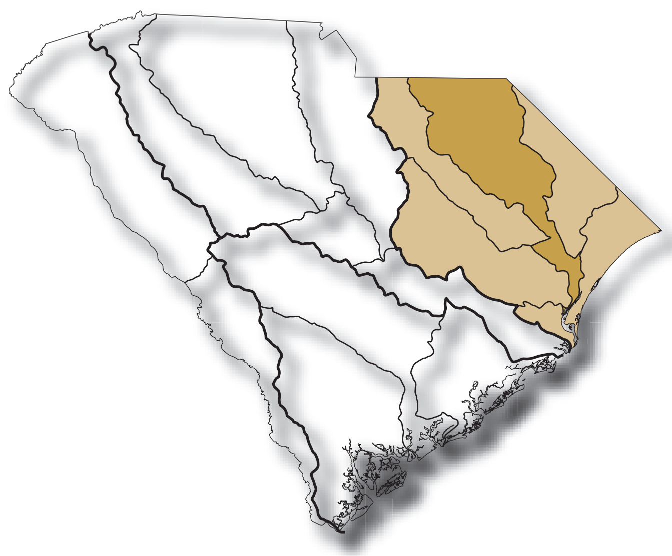
WATERSHED CONDITIONS: PEE DEE RIVER BASIN

PEE DEE RIVER SUBBASIN



PEE DEE RIVER SUBBASIN

The Pee Dee River subbasin extends from the North Carolina border southeast to Winyah Bay and encompasses parts of eight South Carolina counties, including most of Chesterfield, Darlington, Florence, and Marlboro Counties, approximately half of Marion County, and small parts of Dillon, Georgetown, and Williamsburg Counties (Figure 5-1). The subbasin area is approximately 2,350 square miles, 7.8 percent of South Carolina's land area.

DEMOGRAPHICS

The 2000 subbasin population was estimated at 227,200, which is about 5.7 percent of the State's total population. By the year 2020 the population in the subbasin is expected to reach 271,000. The counties expected to exhibit the largest population increases from 2000 to 2025 are Georgetown, with a projected increase of 27 percent, and Florence, with an increase of 12 percent.

The counties in the Pee Dee River subbasin are predominantly rural in character and population. Florence County overall is classified as urban, Georgetown County is classified as rural, and the remaining subbasin counties are classified as very rural. The major population centers in the subbasin are Florence (30,248), Bennettsville (9,425), Darlington (6,720), Marion (7,622), Hartsville (7,556), and Cheraw (5,524). Bennettsville, Darlington, Marion, and Cheraw saw population declines of 0.5 to 8.1 percent between 1990 and 2000.

The 2005 per capita income in the subbasin counties ranged from a low of $20,005 in Williamsburg County to $30,399 in sixth-ranked Georgetown County. The 2005 per capita income in South Carolina averaged $28,285. Median household income for 1999 ranged from $28,205 in Williamsburg County to $35,312 in Georgetown County, all below the State median household income of $37,082.

The 2000 annual-average employment of non-agricultural wage and salary workers in the subbasin's counties was about 130,000. The distribution by type of employment included management, professional, and related, 26 percent; production, transportation, and materials moving, 25 percent; sales and office, 24 percent; service, 14 percent; and construction, extraction, and maintenance, 11 percent.

In the sectors of manufacturing, mining, and public utilities, the combined annual product value from the subbasin counties exceeded $8 billion in 1997. Major employers in those counties included Sonoco Products, Wellman Incorporated, and Galey and Lord.

Agriculture remains important in this section of the State, and crops and livestock have a cash value of more than $325 million. Florence County ranked fifth in the State for cash-crop and livestock receipts from farm marketing, and Dillon and Darlington Counties ranked twelfth and fourteenth, respectively. The delivered value of timber in the subbasin counties ranged from $10 million to $36 million in 2005, when Georgetown, Williamsburg, and Florence Counties ranked fourth, eighth, and tenth in delivered value (South Carolina Forestry Commission, 2008).

SURFACE WATER

Hydrology

The main stem of the Great Pee Dee River is the dominant hydrologic feature of the subbasin. This river originates in North Carolina and receives most of its flow from drainage in North Carolina. (Although its formal name is the Great Pee Dee River, it is often referred to simply as the Pee Dee River and will be referred to as such herein.) Major tributary streams in South Carolina

Figure 5-1. Map of the Pee Dee River subbasin.

include Black Creek, Catfish Creek, Jefferies Creek, and Thompson Creek. Black Creek, the largest of these tributaries, flows through the more urbanized (Hartsville, Darlington, Florence) part of the subbasin. Streams in the upper part of the subbasin originate in or traverse the upper Coastal Plain. Most streams in this subbasin are associated with extensive swamp areas and follow indistinct channels that often divide and recombine.

A 70-mile segment of the Pee Dee River from the US 378 bridge to Winyah Bay was designated as a State Scenic River in 2002. (See the *River Conservation* section of Chapter 9, *Special Topics*.)

Although the Pee Dee River in South Carolina is free-flowing, in North Carolina it is heavily regulated by a series of six large reservoirs, the last of which, Blewett Falls Lake, is located about 15 miles upstream from the state border. The operation of these reservoirs, primarily for hydroelectric power generation, strongly influences the behavior of the Pee Dee River in South Carolina, particularly during periods of low flow.

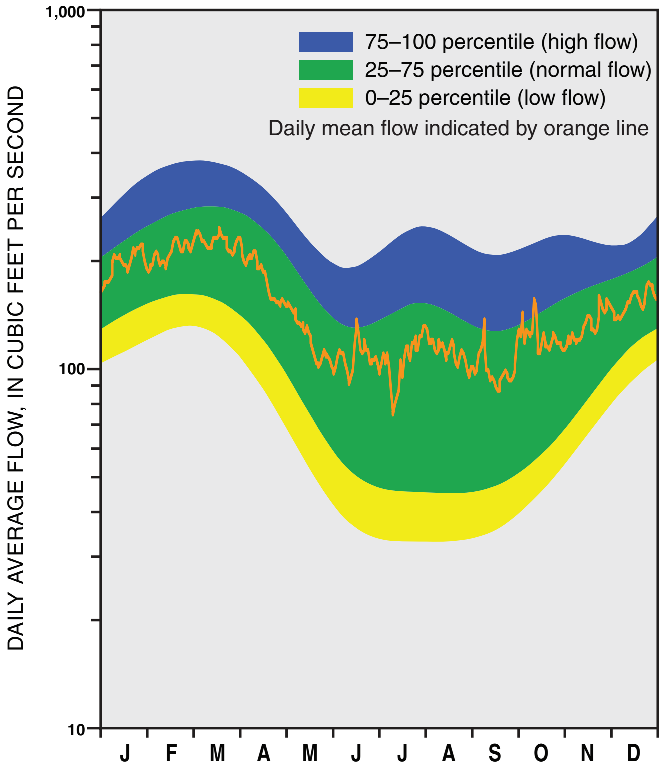
Six U.S. Geological Survey (USGS) streamflow monitoring sites are active within this subbasin, three on the Pee Dee River and three on Black Creek. A gaging station on the Pee Dee River outside the subbasin near Rockingham, N.C., also provides useful flow data. The entire period of record on the main stem reflects regulated flows by hydroelectric-power facilities in North Carolina. Black Creek streamflow is affected by two impoundments, Lake Robinson and Prestwood Lake. Streamflow statistics for seven active and four discontinued gaging stations are presented in Table 5-1.

Table 5-1. Selected streamflow characteristics at USGS gaging stations in the Pee Dee River subbasin

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
Pee Dee River near Rockingham, N.C. 1290	1927 to 2007*	6,863	7,903	1.15	1,490	58 1951	242,000 1945	270,000 1945
Whites Creek near Wallace 1295.9	1979 to 1995	26.4	29.2	1.11	4.7	0.0 1990	732 1987	911 1992
Juniper Creek near Cheraw 1305	1940 to 1958	64	72.6	1.13	18.0	0.0 1945, 51, 55, 56	– – –	3,910 1945
Pee Dee River near Bennettsville 1305.61	1990 to 2007*	7,600	7,456	0.98	1,160	48 2000	118,000 2003	124,000 2003
Cedar Creek at Society Hill 1306	1970 to 1981	58.2	92.8	1.59	32.0	8.7 1981	850 1979	1,030 1971
Black Creek near McBee 1309	1959 to 2007*	108	150	1.38	44	9.7 2002	2,460 1990	4,500 1990
Black Creek near Hartsville 1309.1	1960 to 2007*	173	213	1.23	89	6.1 2002	2,890 1990	4,450 1990
Black Creek near Quinby 1309.8	2001 to 2007*	438	400	0.91	148	48 2002	6,090 2004	6,450 2004
Pee Dee River at Peedee 1310	1938 to 2007*	8,830	9,655	1.09	2,810	653 2001	217,000 1945	220,000 1945
Pee Dee River below Peedee 1310.1	1996 to 2007*	8,850	8,069	0.91	1,720	671 2001	96,600 2003	99,000 2003
Catfish Canal at Sellers 1311.5	1966 to 1992	27.4	26.3	0.96	2.0	0.0 1978	755 1971	890 1971

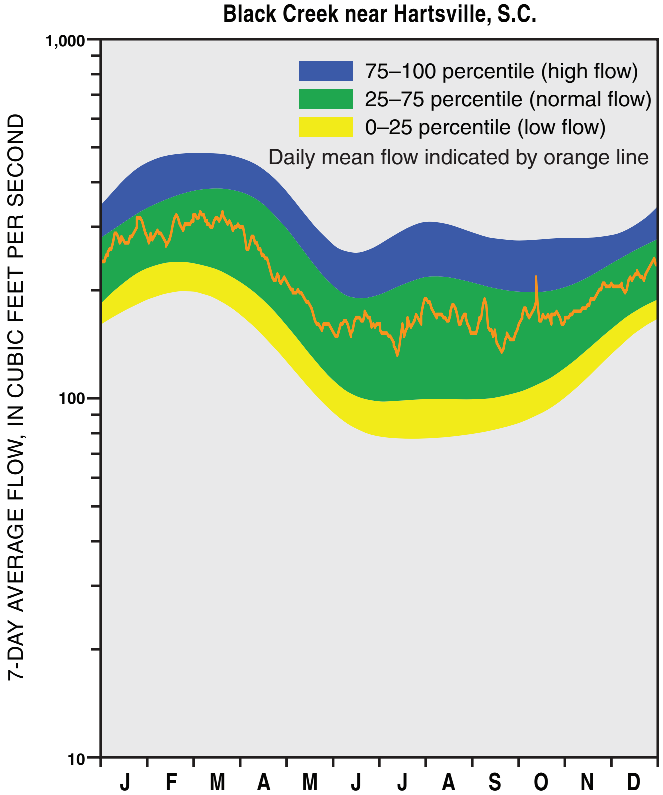
mi^2, square miles; cfs, cubic feet per second; cfsm, cubic feet per second per square mile of drainage area
90% exceeds flow: the discharge that has been exceeded 90 percent of the time during the period of record for that gaging station
** 2007 is the most recent year for which published data were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

1309 (unregulated)
Black Creek near McBee, S.C.



Where it enters South Carolina from North Carolina, the Pee Dee River has an average annual streamflow of about 8,000 cfs (cubic feet per second). At Peedee, in northwestern Marion County, the river has an average annual streamflow of 9,655 cfs and can be expected to be at least 2,810 cfs 90 percent of the time. Streamflow in this river is reasonably steady as indicated by the relatively flat flow-duration curve (Figure 5-2). Flow in the upper portion of the Pee Dee River may be quite variable on a weekly basis due to hydropower discharges upstream in North Carolina; however, discharges from hydropower facilities, in addition to ground-water support from the upper Coastal Plain, sustain relatively steady long-term flows. The lowest flow of record of the Pee Dee River at Peedee is 653 cfs and occurred during July 2007. The highest flow (220,000 cfs) was the result of an unnamed tropical storm in 1945 that caused flooding in much of the eastern part of the State.

1309.1 (regulated)
Black Creek near Hartsville, S.C.



1310 (regulated)
Pee Dee River at Peedee, S.C.

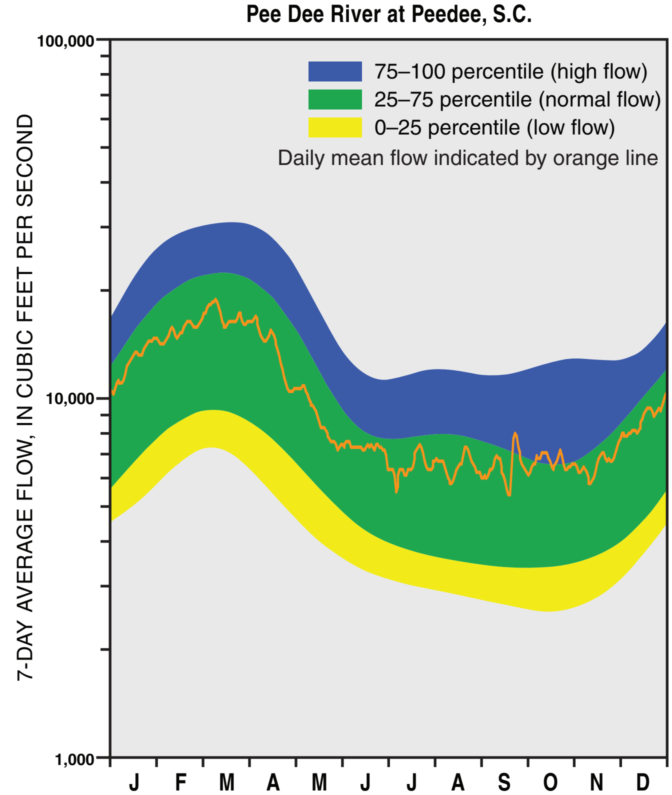


Figure 5-2. Duration hydrographs for selected gaging stations in the Pee Dee River subbasin.

Average annual flows in the gaged tributary streams are 72.6 cfs for Juniper Creek, 92.8 cfs for Cedar Creek, 150 cfs for Black Creek near McBee, 213 cfs for Black Creek near Hartsville, and 27.4 cfs for Catfish Canal. Streamflows in these tributaries equal or exceed 18 cfs, 32 cfs, 44 cfs, 89 cfs, and 2.0 cfs, respectively, 90 percent of the time. Tributaries in the upper Coastal Plain, such as Black Creek and Cedar Creek, exhibit steady flows that are maintained by discharge from ground-water storage, particularly during periods of low rainfall. Lower Coastal Plain streams, such as Catfish Canal, exhibit more variable flow and typically are more dependent on rainfall and runoff than on ground-water discharge to support flows.

The Pee Dee River has a large and well-sustained streamflow year round (Figure 5-2). This river provides a reliable source of freshwater for activities requiring large quantities of water. The recent multiyear drought showed it to be vulnerable, however, to extended low-rainfall periods when the portion of the river in North Carolina is also severely affected by drought. Tributary streams in the upper Coastal Plain, such as Black Creek and Cedar Creek, also provide reliable flows but of much lower volume. Catfish Canal, and probably other lower Coastal Plain streams, provide somewhat less reliable streamflow, and use of these streams may require provision for water storage to ensure adequate availability during summer and fall low-flow periods.

Development

The Pee Dee River subbasin has experienced limited surface-water development in South Carolina, consisting primarily of small-scale flood-control projects. The largest reservoir, Lake Robinson, is owned and operated by Progress Energy and has a surface area of 2,250 acres and a volume of approximately 31,000 acre-ft. Located on Black Creek a few miles northwest of Hartsville, the lake was constructed in 1959 to provide cooling water for the 174-megawatt H.B. Robinson coal-fired power plant. The H.B. Robinson nuclear plant, completed in 1971 and capable of 710 megawatts, also draws cooling water from the lake. Collectively, the two power facilities generate enough power to serve about 400,000 homes. The lake also serves industrial and recreational needs.

Lakes greater than 10 acres in the subbasin have a combined surface area greater than 7,000 acres and a total volume of about 57,000 acre-ft. Lakes greater than 200 acres are listed in Table 5-2.

Table 5-2. Lakes 200 acres or more in the Pee Dee River subbasin (see Figure 5-1 for location of lakes)

Number on map	Name	Stream	Surface area (acres)	Storage capacity (acre-feet)	Purpose
1	Lake Robinson	Black Creek	2,250	31,000	Industry, power, and recreation
2	Lake Wallace	Crooked Creek	416	1,661	Irrigation, recreation, and water supply
3	Prestwood Lake	Black Creek	300	1,800	Industry and recreation
4	Eureka Lake	Sandy River	260	1,660	Recreation
5	Drakes Mill Pond	Three Creeks	250	7,000	Irrigation and recreation

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

There are no active U.S. Army Corps of Engineers navigation projects in the subbasin. The Natural Resources Conservation Service completed flood-control, drainage, and erosion projects in the Carters Branch-Muddy Creek and Back Swamp watersheds in the early 1970's; the former project included 33 miles of channel improvement. A Corps of Engineers project near Cheraw developed nonstructural flood control in the Wilson Branch watershed and was completed in 1985.

Surface-Water Quality

All water bodies in the Pee Dee River subbasin, except Winyah Bay, are designated "Freshwater" (Class FW) (DHEC, 2007b). This water-use classification is assigned to water that is suitable for the survival and propagation of aquatic life, primary- and secondary-contact recreation, drinking-water supply, fishing, and industrial and agricultural uses.

Winyah Bay is designated "Tidal Saltwater" (Class SB). Class SB water is suitable for primary- and secondary-contact recreation, crabbing, and fishing. Dissolved-oxygen levels in Class SB water must be at least 4.0 mg/L (milligrams per liter). This water is not protected for harvesting clams, mussels, or oysters for market purposes or human consumption.

Figure 5-3. Surface-water-quality monitoring sites evaluated by DHEC for suitability for aquatic life and recreational uses. Impaired sites are listed in Table 5-3 (DHEC, 2007b).

As part of its ongoing Watershed Water-Quality Assessment program, DHEC sampled 71 surface-water sites in the Pee Dee River subbasin in 2003 in order to assess the water's suitability for aquatic life and recreational use (Figure 5-3). Aquatic-life uses were fully supported at 53 sites, or 75 percent of the water bodies sampled in this subbasin; water at many of the impaired sites exhibited pH excursions and dissolved-oxygen levels below the concentrations needed to support aquatic life. Recreational use was fully supported in 75 percent of the sampled water bodies; the water bodies that did not support recreational use exhibited high levels of fecal-coliform bacteria (DHEC, 2007b). Water-quality impairments in the subbasin are listed in Table 5-3.

Table 5-3. Water-quality impairments in the Pee Dee River subbasin (DHEC, 2007b)

Water-body name	Station number	Use	Status	Water-quality indicator
Clay Creek	RS-02305	Aquatic life	Nonsupporting	Dissolved oxygen
Thompson Creek	PD-673	Aquatic life	Partially supporting	Macroinvertebrates
	PD-246	Recreation	Nonsupporting	Fecal coliform
	PD-247	Recreation	Nonsupporting	Fecal coliform
Deep Creek	RS-01013	Aquatic life	Nonsupporting	Turbidity
		Recreation	Partially supporting	Fecal coliform
North Prong Creek	PD-677	Aquatic life	Partially supporting	Macroinvertebrates
Eureka Lake	RL-03346	Aquatic life	Nonsupporting	pH
Juniper Creek	PD-340	Aquatic life	Nonsupporting	pH
Westfield Creek	PD-339	Aquatic life	Partially supporting	Macroinvertebrates, dissolved oxygen, pH
Great Pee Dee River	PD-015	Recreation	Partially supporting	Fecal coliform
Cedar Creek	PD-151	Aquatic life	Nonsupporting	pH
Lake Robinson	RL-03342	Aquatic life	Nonsupporting	pH
Black Creek	PD-021	Recreation	Partially supporting	Fecal coliform
	RS-01043	Aquatic life	Nonsupporting	Copper
	PD-025	Recreation	Partially supporting	Fecal coliform
Snake Branch	PD-258	Aquatic life	Nonsupporting	pH
		Recreation	Nonsupporting	Fecal coliform
Boggy Swamp	RS-03507	Recreation	Partially supporting	Fecal coliform
Tilefield to Swift Creek	PD-141	Recreation	Nonsupporting	Fecal coliform
Swift Creek tributary	RS-01023	Aquatic life	Nonsupporting	Copper
		Recreation	Partially supporting	Fecal coliform
Three Creeks	PD-341	Aquatic life	Nonsupporting	pH
Jeffries Creek	PD-256	Recreation	Nonsupporting	Fecal coliform
Gulley Branch	PD-065	Aquatic life	Partially supporting	pH
		Recreation	Nonsupporting	Fecal coliform
Middle Swamp	PD-230	Aquatic life	Nonsupporting	Dissolved oxygen
		Recreation	Partially supporting	Fecal coliform
Willow Creek	PD-167	Recreation	Partially supporting	Fecal coliform
Smith Swamp	PD-320	Recreation	Nonsupporting	Fecal coliform
	PD-187	Recreation	Partially supporting	Fecal coliform
Catfish Creek	PD-097	Aquatic life	Nonsupporting	Dissolved oxygen
Great Pee Dee River	PD-060	Aquatic life	Nonsupporting	Copper
	MD-275	Aquatic life	Nonsupporting	Dissolved oxygen

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 the most recent impairments and water-quality trends online in their 303(d) listings and 305(b) reports.

In 2008, DHEC issued fish-consumption advisories for the Great Pee Dee River, Black Creek, and Lake Robinson. The advisories are issued where fish contaminated with mercury have been found: the contamination is only in the fish and does not make the water unsafe for skiing, swimming, or boating.

GROUND WATER

Hydrogeology

Almost all of the Pee Dee River subbasin is in the Coastal Plain province. A small part of Chesterfield County, in the northwestern part of the subbasin, is in rocks of the Carolina terrane of the Piedmont province, where ground water occurs in the overlying mantle of saprolite and in joint systems and fracture zones of crystalline bedrock.

East of the Fall Line, the Coastal Plain sediments reach a thickness of 650 feet along the southern border of Marlboro County. The area is underlain by the Middendorf aquifer, which can yield as much as 1,000 gpm (gallons per minute) to individual wells. Gravel mines in alluvial deposits along the Great Pee Dee River and test wells drilled in the Cheraw area by the U.S. Geological Survey indicate a potentially favorable situation for infiltration wells if the water-bearing sand beds are hydraulically connected to the river. Several wells have been drilled successfully into the alluvial and terrace deposits on the east bank of the Great Pee Dee River near Wallace.

In the vicinity of Darlington, the Black Creek and Middendorf aquifers lie beneath a thin veneer of Pleistocene sand and clay and the Duplin Marl. Total thickness of the unconsolidated material overlying the basement rock ranges between 500 and 650 feet.

In Florence County, the Peedee Formation, within the top of the Black Creek aquifer, has a thickness of about 200 feet and reported well yields of about 20 gpm. Yields elsewhere, however, are normally much higher. Selected data on well yields are listed in Table 5-4. The Black Creek aquifer has a thickness of about 250 feet, and the transmissivity calculated from wells screened in Black Creek sand beds and the upper sand beds of the Middendorf ranges between about 1,600 and 2,000 ft^2/day near Florence. Aucott (1988) used a transmissivity range of 2,000 to 5,000 ft^2/day across the subbasin; however, Newcome (1993) reported a Black Creek aquifer transmissivity of almost 10,000 ft^2/day at Lake City, southwest of the subbasin. Where the maximum yield is desired, wells are screened in both the Middendorf and Black Creek aquifers.

Table 5-4. Selected ground-water data for the Pee Dee River subbasin

Vicinity	Aquifer	Well depth (feet)	Major well yield (gpm)
Cheraw-Patrick	Black Creek	135–240	105
Bennettsville-McColl-Clio	Middendorf	105–415	150–625
Wallace	Pee Dee River alluvium	45–98	720
Darlington	Middendorf	141–665	825
Florence	Black Creek	200–500	400–1,300
	Black Creek/ Middendorf	400–740	250–1,060
	Middendorf	400–720	500–2,100
Pamplico	Black Creek	190–300	100–540
Hartsville	Middendorf	215–315	260–1,020

The principal source of ground water in the Florence County section of the subbasin is the deeper Middendorf aquifer, in which transmissivity generally increases south to north. Aucott (1988) based his predevelopment water-level simulations on transmissivity ranges of 2,000 to 5,000 ft^2/day across most of Florence, Dillon, and Marion Counties and 5,000 to 10,000 ft^2/day across Darlington and Marlboro Counties. Newcome (2005b) reported a Middendorf transmissivity range of 1,000 to 6,000 ft^2/day in the Florence area.

Ground-Water Quality

The Middendorf and Black Creek aquifers are the most widely used in the subbasin. A unit of the Tertiary sand aquifer is present but mainly southeast of Brittons Neck and only as a thin section of muddy, fine-grained sand and shale assigned to the Rhems Formation. The upper reach of the subbasin, in Chesterfield, western Darlington, and Marlboro Counties, is in the outcrop area of the Middendorf aquifer. There, Middendorf water is characterized by high dissolved oxygen, low TDS (total dissolved solids), low pH, and low alkalinity and is soft and corrosive. Total dissolved-solids concentrations less than 50 mg/L (milligrams per liter) and pH values below 6.5 are typical.

In the middle reach of the subbasin, in eastern Marlboro, northern Florence, and western Marion Counties, both Black Creek and Middendorf aquifers are used. Water of the Middendorf aquifer in this reach is low in dissolved oxygen, acidic, and high in dissolved iron: TDS are about 60 mg/L. Water of the Black Creek aquifer is low in dissolved oxygen, slightly acidic to slightly alkaline, and high in dissolved iron: TDS are about 140 mg/L. A black precipitate has been reported in some wells and indicates sulfides in the aquifer

(Rodriguez and others, 1994). Some constituents locally exceed secondary water-quality standards, including iron, magnesium, fluoride, and turbidity.

In the lower reaches of the subbasin, in northeastern Williamsburg and northern Georgetown Counties, the Black Creek aquifer is the main source of ground-water supply. Water in the Black Creek is low in dissolved oxygen, TDS are greater than 250 mg/L, and pH is generally above 8.5. Water in the Middendorf is similar to that of the Black Creek.

The major units of the shallow aquifer include outcrops of the Middendorf and Black Creek aquifers where they are poorly confined and Pleistocene and Pliocene terrace deposits that occur southeast of Chesterfield and northern Marlboro Counties. Water in the outcrop areas typically is a soft, acidic, sodium chloride type and has TDS concentrations less than 100 mg/L. Alkalinity, pH, and TDS are, on average, slightly greater at the subbasin's southeastern end, but they range widely. DHEC reported alkalinities of 0.0 to 360 mg/L, pH's of 4.3 to 8.2, and TDS concentrations of 50 to 400 mg/L. Iron concentrations above 300 µg/L (micrograms per liter) are common.

Water-Level Conditions

Ground-water levels are regularly monitored by DNR, USGS, and DHEC in 13 wells in the Pee Dee River subbasin in order to help assess trends or changes in water levels and to monitor areas with known water-level problems (Table 5-5). Water levels in other wells are sometimes measured to help develop potentiometric maps of the Middendorf and Black Creek aquifers.

Pumping ground water faster than it can be replenished results in the development of an area of locally or regionally lower ground-water levels called a cone of depression, which can, if severe enough, limit the availability of ground water within that area. There are at least two known cones of depression in each of the two major aquifers in the Pee Dee River subbasin (Figures 5-4 and 5-5).

Table 5-5. Water-level monitoring wells in the Pee Dee 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
CTF-56	DHEC	34 37 34 79 56 25	Middendorf	Cheraw State Park	141	undetermined
CTF-57	DHEC	34 37 36 79 56 26	Middendorf	Cheraw State Park	141	undetermined
CTF-81	DNR	34 38 35 79 54 41	Crystalline rock	Cheraw State Park	190	231–244
CTF-211	USGS	34 30 23 80 13 06	Middendorf	3 miles northeast of McBee	410	undetermined
DAR-96	DHEC	34 30 27 79 51 22	Middendorf	Society Hill	189	175–373
DAR-228	DNR	34 27 32 79 52 48	Middendorf	Lake Darpo	170	175–185
FLO-128	USGS	34 11 44 79 34 49	Middendorf	10 miles east of Florence	96	264–690
FLO-473	DHEC	34 12 11 79 50 26	Middendorf	Florence	130	undetermined
FLO-475	DHEC	34 01 01 79 45 16	Black Creek	12 miles southeast of Florence	108	undetermined
MLB-110	USGS	34 29 35 79 43 10	Middendorf	8 miles south of Bennettsville	135	75–115
MLB-112	USGS	34 37 35 79 41 22	Middendorf	Bennettsville	135	320–335
MRN-77	DNR	33 51 42 79 19 50	Black Creek	Brittons Neck	34	325–355
MRN-78	DNR	33 51 42 79 19 49	Middendorf	Brittons Neck	35	1,008–1,028

* *DHEC, South Carolina Department of Health and Environmental Control; DNR, South Carolina Department of Natural Resources; USGS, United States Geological Survey*

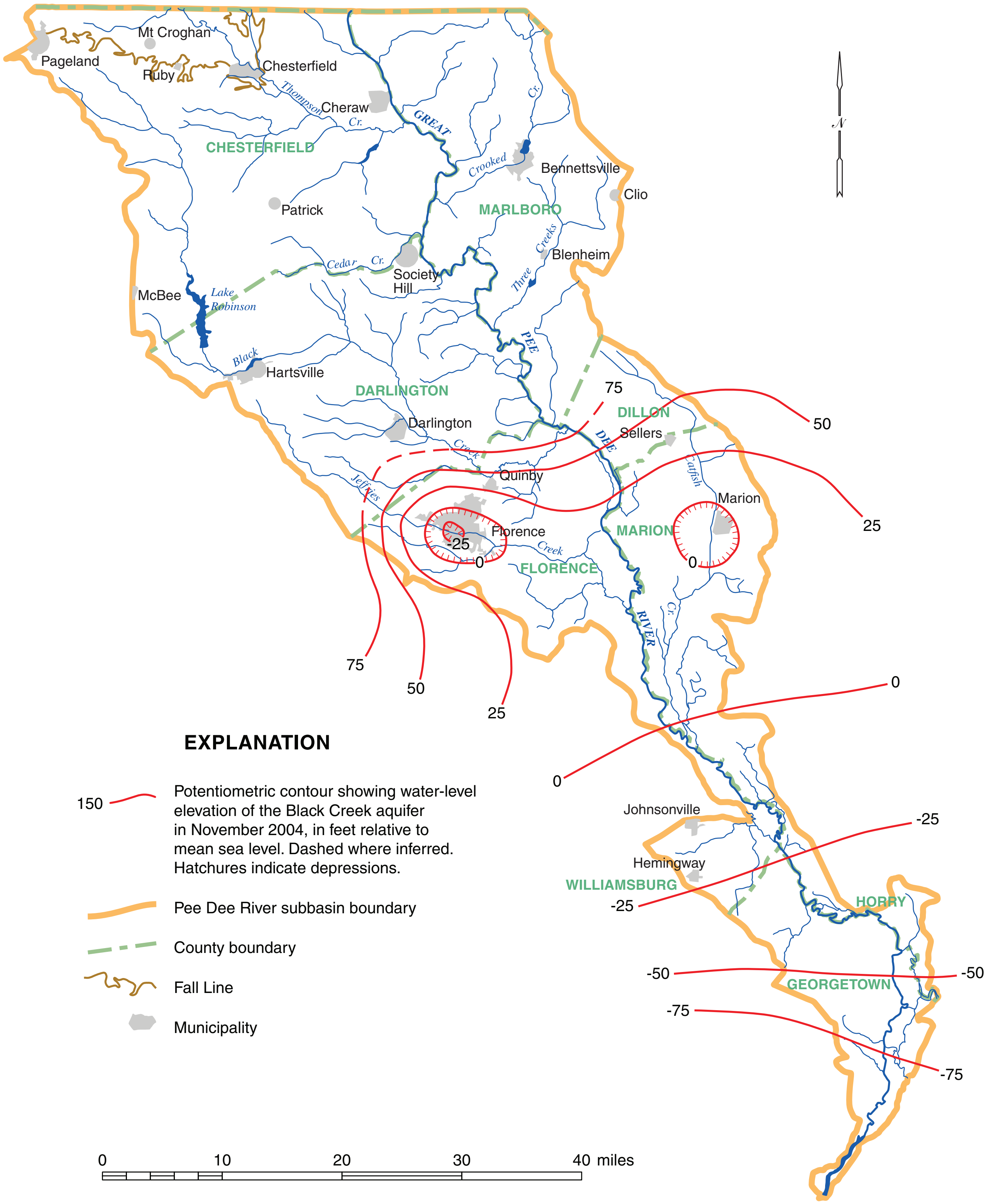


Figure 5-4. Potentiometric contours of the Black Creek aquifer in the Pee Dee River subbasin, November 2004 (from Hockensmith, 2008b).

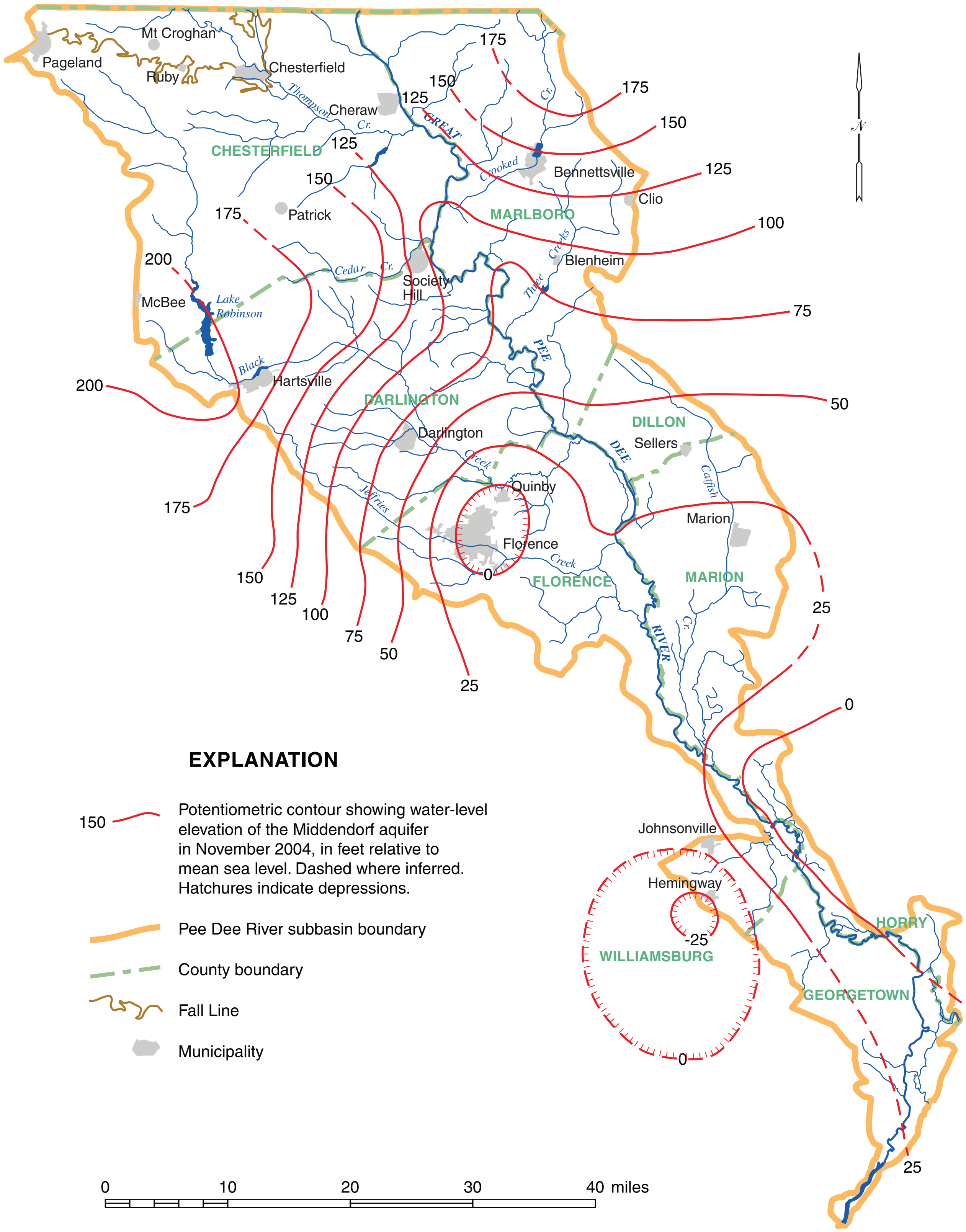


Figure 5-5. Potentiometric contours of the Middendorf aquifer in the Pee Dee River subbasin, November 2004 (from Hockensmith, 2008a).

The most significant cone of depression in the Black Creek aquifer is centered in northern Florence County and is a result of ground-water pumping by the city of Florence. At the center of this cone of depression, the water level is more than 100 feet lower than the predevelopment level. Water levels in this area have shown signs of recovery since the city began supplementing its water supply with surface-water withdrawals from the Pee Dee River in 2004 (Hockensmith, 2008b). Another cone of depression appears to be developing in the Black Creek aquifer in the vicinity of the city of Marion, where water levels have declined as much as 75 feet from predevelopment levels (Hockensmith, 2008b).

There is also a cone of depression centered in northern Florence County in the Middendorf aquifer, also the result of ground-water pumping by the city of Florence. Although the water level at the center of this cone is still more than 100 feet lower than the predevelopment level, water levels in the city of Florence area have recovered significantly since the city began supplementing its water supply with withdrawals from the Pee Dee River (Hockensmith, 2008a). A second cone of depression in the Middendorf aquifer, with a water-level decline of as much as 80 feet from the predevelopment level, has been mapped near the town of Hemingway, in eastern Williamsburg County (Hockensmith, 2008a).

In addition to these site-specific water-level concerns, years of ground-water pumping from wells in this and neighboring subbasins have resulted in regional water-level declines of as much as 50 feet from predevelopment levels in both aquifers in the southern portion of the subbasin.

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 Pee Dee River subbasin for the year 2006 is summarized in Table 5-6 and Figure 5-6. Total offstream water use in the subbasin was 355,129 million gallons, ranking it second among the 15 subbasins. Of this amount, 343,657 million gallons were surface water (97 percent) and 11,472 million gallons were ground water (3 percent). Thermoelectric use accounted for 83 percent of this total, followed by industry (10 percent) and water supply (6 percent). Consumptive use in this subbasin is estimated to be 13,187 million gallons, or about 4 percent of the total offstream use.

Table 5-6. Reported water use in the Pee Dee 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	33	0.3	33	0.0
Golf course	188	0.1	108	0.9	296	0.1
Industry	34,151	9.9	1,887	16.5	36,038	10.1
Irrigation	224	0.1	681	5.9	905	0.3
Mining	0	0.0	0	0.0	0	0.0
Other	0	0.0	0	0.0	0	0.0
Thermoelectric power	296,062	86.1	363	3.2	296,425	83.5
Water supply	13,032	3.8	8,401	73.2	21,433	6.0
Total	343,657		11,472		355,129	

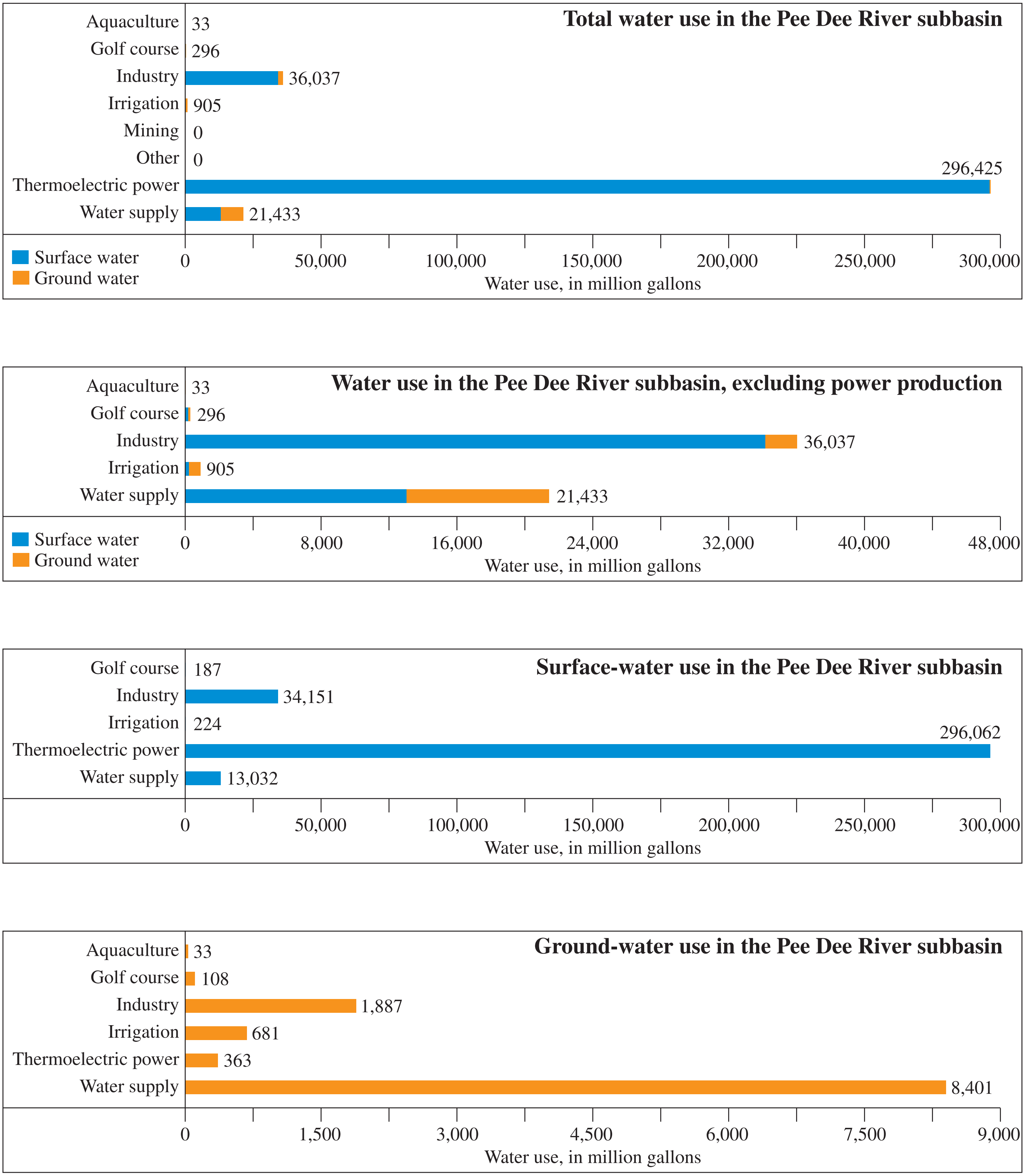


Figure 5-6. Reported water use in the Pee Dee River subbasin for the year 2006 (modified from Butler, 2007).

By far, the largest water user in this subbasin is Progress Energy's H.B. Robinson electrical generating station, which consists of side-by-side coal-fired thermoelectric and nuclear plants, located adjacent to Lake Robinson near Hartsville in Darlington County. In 2006, a total of 296,062 million gallons of surface water (from Lake Robinson) and 362 million gallons of ground water were used by the plants.

Industrial water use was greater in the Pee Dee subbasin than in any other subbasin in the State. Thirteen industries used a total of 36,038 million gallons of water in 2006. Of this amount, 34,151 million gallons were surface water (95 percent) and 1,887 million gallons were ground water (5 percent). Surface water came mainly from the Pee Dee River, and ground water from the Middendorf aquifer. Several of the largest industrial surface-water and ground-water users in the State, such as International Paper Co. and Sonoco Products Co., reside in the subbasin. International Paper Co. in Georgetown County, the fourth largest industrial surface-water user, withdrew 11,400 million gallons from the Sampit River, and Sonoco Products Co. in Darlington County, the second largest industrial ground-water user, withdrew 860 million gallons from the Middendorf aquifer.

Water-supply use in the subbasin totaled 21,433 million gallons. Surface water accounted for 13,032 million gallons (61 percent) and ground water for 8,401 million gallons (39 percent). The largest surface-water user was Grand Strand Water and Sewer Authority, which withdrew 9,904 million gallons from Bull Creek in the southeastern corner of the subbasin. Other large surface-water users include the cities of Florence (1,343 million gallons from the Pee Dee River), Cheraw (737 million gallons from the Pee Dee River), Georgetown (654 million gallons from the Pee Dee River), and Bennettsville (393 million gallons from Lake Wallace).

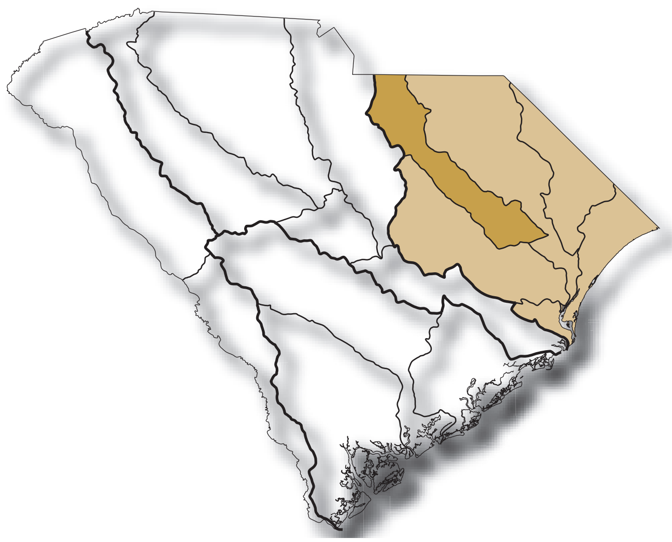
Among water-supply systems using ground water, the city of Florence was the largest user, withdrawing 3,445 million gallons in 2006. Second in ground-water use was Darlington County Water and Sewer Authority (1,367 million gallons), followed by the city of Bennettsville (636 million gallons), and Alligator Rural Water Co. (620 million gallons). Alligator Rural Water Co., which supplies most of Chesterfield County, also has several wells in the Lynches River subbasin to the west. In all, Alligator pumped about 937 million gallons in 2006. Darlington County Water and Sewer Authority also has a few wells in the Lynches subbasin that pumped an additional 219 million gallons. Most of the ground water in the Pee Dee subbasin is from the Middendorf aquifer, the most productive aquifer in the area, but some water is also pumped from the Black Creek and Cape Fear aquifers. It is worth noting that more ground water was used in the Pee Dee subbasin for water-supply use than in any other subbasin in the State.

Irrigation water use totaled 905 million gallons, which is 0.3 percent of the total water used in the subbasin in 2006. Of this amount, 681 million gallons were from ground-water sources (75 percent) and 224 million gallons were from surface-water sources (25 percent). McLeod Farms, in Chesterfield County, was the largest ground-water user. Renowned for its peach orchards, McLeod Farms used 329 million gallons in 2006. Most of this water was from the Middendorf aquifer. Lawson Turf Farms, near Darlington, was the largest surface-water irrigator, using 98 million gallons.

Golf-course water use totaled 296 million gallons, which is about 0.1 percent of the total water used in the subbasin in 2006. Of this amount, 188 million gallons came from surface water and 108 million from ground water. The largest user was Cheraw State Park Golf Course, which withdrew 58 million gallons of water from the Pee Dee River. Hartsville Country Club withdrew 40 million gallons from Prestwood Lake. Only one golf course—Goodson Inc. DBA Traces, located west of Florence—used ground water. It has seven wells, all of which probably produce from the Black Creek aquifer.

A minor amount of ground water (33 million gallons) was also used for aquaculture at one facility in this subbasin. No water use was reported for mining activities.

LYNCHES RIVER SUBBASIN



LYNCHES RIVER SUBBASIN

The Lynches River subbasin is a long, narrow basin transecting the heart of the Pee Dee region. The basin shares a northern border with North Carolina and encompasses parts of eight South Carolina counties: Chesterfield, Lancaster, Kershaw, Florence, Lee, Darlington, Sumter, and Williamsburg (Figure 5-7). The subbasin area is about 1,370 square miles, 4.4 percent of South Carolina's land area.

DEMOGRAPHICS

The 2000 population of the subbasin was estimated at 85,600, about 2.1 percent of the State's total population and a 3.6 percent increase since 1980. The largest increases in population are expected to occur in Lancaster and Florence Counties.

The eight counties included in the subbasin have a predominantly rural population, with the exception of two counties that are classified as being slightly over 50 percent urban. A majority of the urban residents live outside the subbasin boundary. The major population center in the subbasin is Lake City (6,478) in Florence County, but the urban areas of Florence (30,248) and Lancaster (8,177) lie near the basin boundaries.

Kershaw and Florence Counties had per capita incomes of $28,595 and $28,486 in 2005, slightly above the State average ($28,285), and respectively ranked eighth and tenth among South Carolina's 46 counties. The per capita incomes of Lee and Williamsburg Counties were $20,307 and $20,005, respectively, ranking 43rd and 45th in the State.

During 2000 the combined annual average employment of nonagricultural wage and salary workers in Florence and Lee Counties was about 63,000. Labor distribution in the subbasin counties included management, professional, and technical services, 25 percent; sales and office, 22 percent; production, transportation, and materials moving, 21 percent; service, 14 percent; construction, extraction, and maintenance, 11 percent; and farming, fishing, and forestry, 1 percent.

In the sectors of manufacturing, mining, and public utilities, the combined annual product value from the counties of the subbasin exceeded $10 billion in 2000. Major employers in those counties included Sonoco Products, Wellman Incorporated, Gold Kist, and Bosch Braking Systems.

The counties of the subbasin generally ranked high with respect to agricultural production, and crops-and-livestock cash value was about $308 million in 2000. Florence, Kershaw, and Sumter Counties ranked fifth, seventh, and eighth for crops-and-livestock cash receipts. The delivered value of timber in the subbasin counties ranged from about $7.6 million in Lee County to $28.2 million in Williamsburg County in 2005 (South Carolina Forestry Commission, 2008).

SURFACE WATER

Hydrology

The Lynches River flows across the Piedmont and Coastal Plain provinces, both of which influence streamflow of the tributary streams draining these regions and therefore the main river. Headwaters of the Lynches River and the tributary Little Lynches River originate in the lower Piedmont of South Carolina and North Carolina. The dendritic drainage pattern of this river extends through the upper Coastal Plain but exhibits characteristics of a trellis drainage pattern in the middle and lower Coastal Plain. Three other moderately-sized tributary streams in the

Figure 5-7. Map of the Lynches River subbasin.

subbasin, all in the lower Coastal Plain, are Bay Swamp, Lake Swamp, and Sparrow Swamp. Most large stream channels in the Coastal Plain are bordered by swamps, and associated streams break up into braided, indistinct channels.

A 54-mile segment of the river between US Highway 15 in Lee County and the eastern boundary of Lynches River County Park became a State Scenic River in 1994. In 2008, an additional 57 miles—from Lynches River County Park to the Pee Dee River—were also designated, making the Lynches River the longest State Scenic River at 111 miles. (See the *River Conservation* section of Chapter 9, *Special Topics*.)

The flow of the Lynches River is presently monitored at two gaging stations: near Bishopville, in Lee County, near the boundary of the upper and middle Coastal Plain; and at Effingham, in Florence County, in the middle Coastal Plain. Discontinued gages were located in the upper portion of the subbasin, near the Fall Line, on Fork Creek and Little Fork Creek in Chesterfield County and on Hanging Rock Creek in Lancaster County (Figure 5-7). No significant streamflow regulation occurs in the subbasin. Streamflow statistics for the active and inactive gages are presented in Table 5-7.

Table 5-7. Selected streamflow characteristics at USGS gaging stations in the Lynches River subbasin

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
Fork Creek at Jefferson 1313.09	1976 to 1997	24.3	25.7	1.06	1.3	0.0 1983, 86, 87, 88	2,600 1990	8,960 1990
Little Fork Creek at Jefferson 1313.2	1990 to 2000	15	16.2	1.08	1.5	0.14 1999	1,400 1990	2,440 1990
Hanging Rock Creek near Kershaw 1314.72	1980 to 2003	23.9	24.2	1.01	1.7	0.13 1986	1,080 1990	3,760 1990
Lynches River near Bishopville 1315	1942-71 and 2002-07*	675	750	1.11	218	33 2002	27,300 1945	29,400 1945
Lynches River at Effingham 1320	1929 to 2007*	1,030	1,023	0.99	245	69 2002	24,500 1945	25,000 1945

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*

Average annual streamflow at gaging stations on the Lynches River is 750 cfs (cubic feet per second) near Bishopville and 1,023 cfs at Effingham, and 90 percent of the time the streamflow at these gages equals or exceeds 218 cfs and 245 cfs, respectively. The lowest flows of record on the Lynches River are 33 cfs near Bishopville and 69 cfs at Effingham, both occurring in August 2002 near the end of the severe 1998–2002 drought. The highest flow of record is 29,400 cfs near Bishopville and was the result of runoff from a tropical storm in September 1945.

Tributary streams in the upper part of the subbasin typically have flows of less than 100 cfs and rarely exceed 1,000 cfs. These Piedmont and upper Coastal Plain streams exhibit a combination of streamflow characteristics of both provinces.

Average and above-average streamflows in the Lynches River are greatly dependent on direct runoff of rainfall, and low flows are well sustained by discharges from ground-water storage. In the upper Coastal Plain, the Lynches River near Bishopville exhibits better sustained base flow than farther downstream in the middle and lower Coastal Plain regions. Typically, middle and lower Coastal Plain streams do not have well-sustained low flows and have much more variable streamflow than upper Coastal Plain streams. This characteristic behavior can be seen at the Effingham gage, in the middle Coastal Plain (Figure 5-8).

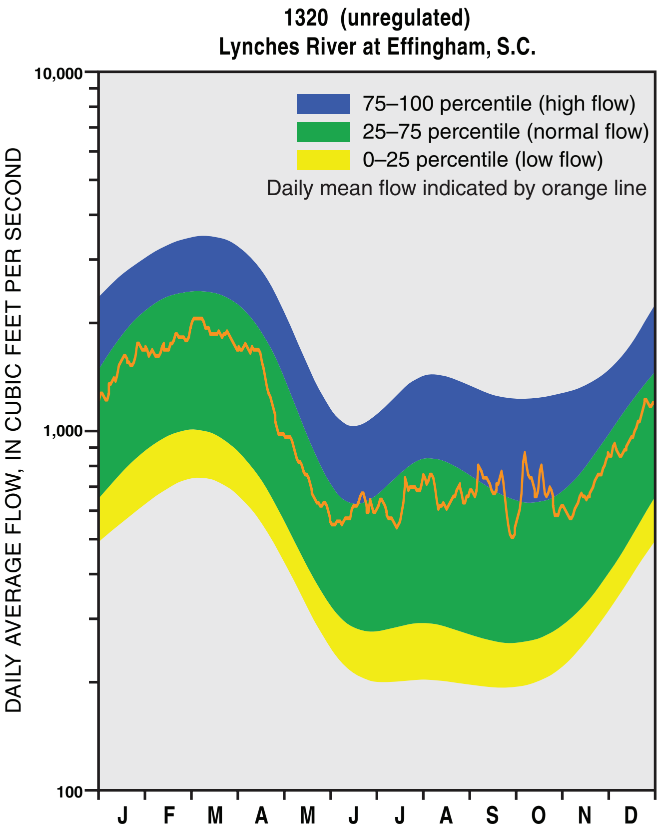


Figure 5-8. Duration hydrograph for the Lynches River at Effingham, S.C., gaging station.

Development

Surface-water development in the Lynches River subbasin is very limited and consists of small lakes and a few navigation and flood-control projects. There are no major reservoirs.

The largest lake has a surface area of 150 acres and a volume of 480 acre-ft. The aggregate surface area and volume of all lakes greater than 10 acres are approximately 1,840 acres and 8,550 acre-ft, respectively. Most of these lakes are used for recreational purposes, but many also are used for golf-course irrigation.

In 1982, the U.S. Army Corps of Engineers completed a navigation project on the Lynches River from S.C. Highway 41 downstream to Clarks Creek and on Clarks Creek from the Lynches River to the Great Pee Dee River.

Four flood-control projects were completed by the Natural Resources Conservation Service during the 1960's; work included drainage, 25 miles of channel improvement, one floodwater-retarding structure, and land-treatment practices to reduce erosion and sediment problems. Erosion-control, flood-control, and drainage work near the Salem community was authorized in 1986 but has been inactive.

Surface-Water Quality

All classified streams in the Lynches River subbasin are designated as "Freshwater" (Class FW). Class FW water is suitable for survival and propagation of aquatic life, primary- and secondary-contact recreation, a source for drinking-water supply, fishing, and industrial and agricultural uses (DHEC, 2007b).

As part of its ongoing Watershed Water-Quality Assessment program, DHEC sampled 49 surface-water sites in the Lynches River subbasin in 2003 in order to assess the water's suitability for aquatic life and recreational use (Figure 5-9). Aquatic-life uses were fully supported at 30 sites, or 61 percent of the water bodies sampled in this subbasin; water at the impaired sites exhibited low dissolved-oxygen levels, poor macroinvertebrate-community structure, pH excursions, or high copper levels. Recreational use was fully supported in 58 percent of the sampled water bodies; the water bodies that did not support recreational use exhibited high levels of fecal-coliform bacteria (DHEC, 2007b). Water-quality impairments in the subbasin are listed in Table 5-8.

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 the most recent impairments and water-quality trends online in their 303(d) listings and 305(b) reports.

In 2008, DHEC issued a fish-consumption advisory for the Lynches River from US Highway 15 to the Great Pee Dee River. Fish-consumption advisories are issued in areas where fish contaminated with mercury have been found. The contamination is only in the fish and does not make the water unsafe for skiing, boating, or swimming.

GROUND WATER

Hydrogeology

Most of the Lynches River subbasin is in the Coastal Plain province of South Carolina. Only the northern part of the subbasin is in the Piedmont province. The eastern half of Lancaster County and the extreme northwest corner of Chesterfield County are in rocks of the Carolina terrane, in which ground water occurs in fractures and along bedding and cleavage planes of the rocks or in the mantle of overlying weathered rock (saprolite). Owing to the conditions of ground-water occurrence in crystalline-rock aquifers, it is not unusual to have wells with high yields in close proximity to "dry holes."

There are two granite plutons in the Piedmont part of the subbasin. A large pluton occurs in the southern part of Lancaster County and covers only a small part of the northwest edge of the subbasin. A smaller pluton is in the eastern corner of Lancaster County and a portion of northwestern Chesterfield County. This area of Chesterfield

Figure 5-9. Surface-water-quality monitoring sites evaluated by DHEC for suitability for aquatic life and recreational uses. Impaired sites are listed in Table 5-8 (DHEC, 2007b).

Table 5-8. Water-quality impairments in the Lynches River subbasin (DHEC, 2007b)

Water-body name	Station number	Use	Status	Water-quality indicator
Hills Creek	PD-333	Aquatic life	Partially supporting	Macroinvertebrates
		Recreation	Nonsupporting	Fecal coliform
Lynches River	PD-113	Aquatic life	Nonsupporting	Copper
		Recreation	Partially supporting	Fecal coliform
North Branch Wildcat Creek	PD-179	Recreation	Nonsupporting	Fecal coliform
	PD-679	Aquatic life	Partially supporting	Macroinvertebrates
South Branch Wildcat Creek	PD-180	Aquatic life	Partially supporting	Macroinvertebrates
		Recreation	Partially supporting	Fecal coliform
Flat Creek	PD-182	Aquatic life	Partially supporting	Macroinvertebrates
	PD-342	Aquatic life	Nonsupporting	Copper
		Recreation	Partially supporting	Fecal coliform
Little Lynches River	PD-640	Aquatic life	Partially supporting	Macroinvertebrates
	PD-006	Aquatic life	Nonsupporting	Copper
		Recreation	Nonsupporting	Fecal coliform
	PD-632	Aquatic life	Partially supporting	Macroinvertebrates
	PD-344	Aquatic life	Nonsupporting	pH
Horton Creek	PD-335	Recreation	Partially supporting	Fecal coliform
Todds Branch	PD-005	Recreation	Nonsupporting	Fecal coliform
Lick Creek	PD-329	Recreation	Partially supporting	Fecal coliform
Hanging Rock Creek	PD-328	Recreation	Partially supporting	Fecal coliform
	PD-669	Aquatic life	Partially supporting	Macroinvertebrates
Lynches River	PD-066	Recreation	Partially supporting	Fecal coliform
Little Fork Creek	PD-647	Aquatic life	Partially supporting	Macroinvertebrates
	PD-215	Aquatic life	Nonsupporting	Copper
		Recreation	Partially supporting	Fecal coliform
Fork Creek	PD-067	Recreation	Nonsupporting	Fecal coliform
	PD-068	Recreation	Nonsupporting	Fecal coliform
Newman Swamp	PD-229	Recreation	Partially supporting	Fecal coliform
Sparrow Swamp	PD-072	Recreation	Partially supporting	Fecal coliform
Cousar Branch	PD-112	Aquatic life	Nonsupporting	pH
Lynches River	PD-364	Aquatic life	Nonsupporting	pH
	PD-319	Aquatic life	Partially supporting	pH
	PD-093	Aquatic life	Partially supporting	pH
Lake Swamp	PD-086A	Aquatic life	Nonsupporting	Dissolved oxygen
Lynches River	PD-281	Aquatic life	Nonsupporting	Copper
Big Swamp	PD-169	Recreation	Partially supporting	Fecal coliform

County also has a Triassic basin (indurated sedimentary rocks) exposed at the surface. The part of Kershaw County in the subbasin is completely overlain by Coastal Plain sediments, but many wells in the northeastern part of the county are drilled through the sediments and into the crystalline bedrock. Drilled bedrock wells in the northern (Piedmont) section of the subbasin range in depth from 45 to 600 feet, with an average depth of 205 feet (Table 5-9). Well yields are as great as 330 gpm (gallons per minute) locally; the average yield is 27 gpm. DNR has no records of bored wells in the Piedmont reaches of the subbasin.

Table 5-9. Well depths and yields for drilled bedrock wells in the northwest area of the Lynches River subbasin

County	Well depth (feet)		Well yield (gpm)	
	Average	Maximum	Average	Maximum
Chesterfield	196	420	29	50
Kershaw	455	550	135	330
Lancaster	196	600	24	200
Total	205	600	27	330

The southern part of the subbasin is underlain by rocks that range in age from Late Cretaceous to Holocene, and typical well depths and yields are shown in Table 5-10. The top of the Middendorf aquifer is 250 feet below sea level in the vicinity of Lynchburg and 440 feet below sea level at Lake City. An 800-foot test hole near Lynchburg did not penetrate the entire aquifer. Well yields of 800 gpm have been obtained in this area. Values for transmissivity as great as 13,000 ft^2/day and hydraulic conductivity of about 65 ft/day are calculated from pumping tests.

Table 5-10. Selected ground-water data for the Lynches River subbasin

Vicinity	Aquifer	Well depth (feet)	Major well yield (gpm)
Jefferson	Carolina slate belt	150–420	50
Kershaw	Granite	125–600	110
Bethune	Middendorf	94–218	500
Olanta	Black Creek	175–340	300–450
Lake City	Black Creek/ Middendorf	120–700	75–1,275

The top of the Black Creek aquifer is about 50 feet above sea level at Lynchburg and 100 feet below sea level at Lake City. The thickness of the aquifer increases from about 300 to 370 feet between the two sites. Wells with 8- and 10-inch casings in Florence County yield as much as 1,300 gpm with specific capacities of 20 gpm/ft or more. The transmissivity of the Black Creek aquifer at Pamplico is 4,000 ft^2/day. Hydraulic-conductivity values in eastern Florence County are in the range of 10 to 60 ft/day.

The Peedee Formation underlies the southeastern part of the Lynches River subbasin and mainly is a confining unit for the Black Creek aquifer. Its thickness is estimated to range from 20 feet in Lynchburg to 130 feet in the Lake City area. The formation probably yields sufficient water to supply domestic and light industrial needs, with well specific capacities of less than 5 gpm/ft.

The Black Mingo Formation, a component of the Tertiary sand aquifer, is at a shallow depth and generally is not differentiated from the shallow aquifer in the subbasin. The shallow aquifer there mainly is composed of the Duplin Formation and terrace deposits. Specific water-bearing characteristics of this aquifer are unknown in the Lynches River subbasin, although general well data indicate that yields are sufficient for domestic and light-industrial purposes.

Ground-Water Quality

The upper reaches of the subbasin lie in the Carolina slate belt, where the ground water is generally a calcium bicarbonate type, soft, and with low TDS (total dissolved solids), iron, and pH. Bedrock wells in Kershaw County are generally of good quality, with TDS less than 200 mg/L (milligrams per liter), pH between 7 and 8, and hardness variable from very soft to hard (Newcome, 2002). Crystalline-rock wells in the subbasin part of Lancaster and Chesterfield Counties show similar properties. Overall, TDS in the Piedmont segment of this subbasin have a median concentration of 54 mg/L. The pH of the ground water ranges from 5.8 to 8.7, with a median value of 6.7, and the alkalinity ranges from 0.04 to 2.40 meq/L (milliequivalents per liter), with a median of 0.4 meq/L.

The Middendorf and the Black Creek are the two most widely used aquifers in the middle and lower reaches of the subbasin. The middle reach of the basin, in eastern Lee and Kershaw Counties and western Darlington County, is in the outcrop area of the Middendorf aquifer, where the water is characterized by low TDS, low pH, low alkalinity, and is soft and corrosive. Sand wells in Kershaw County rarely have TDS greater than 30 mg/L, hardness is usually less than 10 mg/L, and pH ranges generally between 4 and 6. Iron-reducing bacteria are a problem in some wells; however, use of plastic pipe and proper well sanitation reduces the likelihood of bacteriological problems. The water quality for this aquifer ranges from a sodium chloride to a calcium bicarbonate type.

In the lower reach of the basin, in southern Florence County and part of northern Williamsburg County, the Black Creek aquifer is the primary ground-water source. Water of that aquifer is slightly acidic to alkaline and has TDS generally less than 200 mg/L. Some constituents locally exceed water-quality standards, including iron, magnesium, and fluoride. Water from the Cretaceous aquifers in this basin reach is a sodium bicarbonate type and becomes more mineralized toward the coast. Water in the Middendorf aquifer has low alkalinity and has TDS concentrations greater than 250 mg/L.

Shallow aquifers in the subbasin contain water having little mineral content. Total dissolved solids are usually less than 100 mg/L, with 30 mg/L or less being typical in Kershaw County and 50 mg/L or less in Sumter County. Values for pH are generally less than 6.5, and values between 4.0 and 5.0 occur locally.

Water-Level Conditions

Ground-water levels are regularly monitored by DNR, USGS, and DHEC in 10 wells within the Lynches River subbasin to help assess trends or changes in water levels and to monitor areas with known water-level problems (Table 5-11). Water levels in other wells in the subbasin are sometimes measured to help develop potentiometric maps of the Middendorf and Black Creek aquifers.

Table 5-11. Water-level monitoring wells in the Lynches 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
CTF-189	DHEC	34 31 05 80 17 22	Middendorf	4 miles northwest of McBee	304	50–85
CTF-197	USGS	34 39 07 80 16 44	Middendorf	7 miles east of Jefferson	564	100–130
CTF-221	DHEC	34 25 44 80 16 58	Middendorf	3 miles southwest of McBee	395	235–255
CTF-222	USGS	34 25 44 80 16 58	Black Creek	3 miles southwest of McBee	395	150–170
FLO-85	USGS	34 08 06 79 56 31	Middendorf	Timmonsville	145	235–515
FLO-274	DNR	33 51 20 79 45 59	Middendorf	Lake City Airport	79	540–560
FLO-276	DNR	33 51 22 79 46 00	Black Creek	Lake City Airport	79	230–250
FLO-474	DHEC	34 01 01 79 45 16	Black Creek/ Middendorf	3 miles north of Coward	80	undetermined
KER-263	DNR	34 33 30 80 26 37	Crystalline rock	Mt. Pisgah	470	103–455
LEE-75	DNR	34 12 08 80 10 30	Middendorf	Lee State Park	195	306–356

* *DHEC, South Carolina Department of Health and Environmental Control; DNR, South Carolina Department of Natural Resources; USGS, United States Geological Survey*

While there are currently no site-specific water-level problems in the Lynches River subbasin, a small cone of depression has developed in the Middendorf aquifer, centered in Lee County near Bishopville (in the Black River subbasin), and has lowered Middendorf water levels in the Bishopville area by about 60 feet (Hockensmith, 2008a). Water-level declines observed in both the Black Creek and Middendorf aquifers in the Florence area (Pee Dee River subbasin) do not appear to be significantly impacting water levels within the Lynches River subbasin. Similarly, lowered ground-water levels caused by pumping in Sumter County and near the town of Hemingway in Williamsburg County (both in the Black River subbasin) do not appear to be influencing ground-water levels within the Lynches River subbasin.

Years of pumping from wells in this subbasin and in neighboring subbasins have caused regional declines in water levels in both the Black Creek and Middendorf aquifers, particularly in the southernmost part of the subbasin. In southern Florence County, water levels in the Black Creek aquifer are about 50 feet lower than predevelopment levels, and water levels in the Middendorf aquifer have declined as much as 75 feet from predevelopment levels (Hockensmith, 2008a and 2008b).

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 Lynches River subbasin is summarized in Table 5-12 and Figure 5-10. Total offstream water use in the Lynches River subbasin was 3,184 million gallons in 2006, ranking it thirteenth among the 15 subbasins. Of this amount, 3,115 million gallons came from ground-water sources (98 percent) and 69 million gallons came from surface-water sources (2 percent). Water-supply use accounted for 64 percent of this total, followed by industry (32 percent) and golf course irrigation (3 percent). Consumptive use in this subbasin is estimated to be 449 million gallons, or about 14 percent of the total offstream use.

Table 5-12. Reported water use in the Lynches 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	62	89.4	22	0.7	84	2.6
Industry	0	0.0	1,022	32.8	1,022	32.1
Irrigation	7	10.6	20	0.7	27	0.9
Mining	0	0.0	17	0.5	17	0.5
Other	0	0.0	0	0.0	0	0.0
Thermoelectric power	0	0.0	0	0.0	0	0.00
Water supply	0	0.0	2,034	65.3	2,034	63.9
Total	69		3,115		3,184	

All of the 2,034 million gallons used for water-supply in this subbasin in 2006 were provided entirely by ground water. Of the 14 water-supply systems that have wells in the basin, Lake City is the largest and pumped 451 million gallons, all from the Middendorf aquifer. It was followed by the city of Bishopville, which pumped 429 million gallons (Middendorf aquifer); Alligator Rural Water Company in Chesterfield County, which pumped 317 million gallons (Middendorf aquifer); Darlington Water and Sewer Authority, which pumped 219 million gallons (Middendorf aquifer); and the town of Timmonsville in Florence County, which pumped 158 million gallons (Middendorf and Black Creek aquifers). Alligator Rural Water Company and Darlington Water and Sewer Authority have a number of wells in the Pee Dee River subbasin to the east, and Bishopville has two supply wells in the Black River subbasin to the west.

Industrial water use totaled 1,022 million gallons in the Lynches subbasin in 2006, all of it from wells. Wellman, Inc., near Johnsonville, had the highest use, pumping 635 million gallons from the Middendorf and Black Creek aquifers. BBA Fiberweb, near Bethune in Kershaw County, used 333 million gallons, pumping from the Middendorf aquifer.

Golf-course water use totaled 84 million gallons in 2006. Of this amount, 62 million gallons were surface water (74 percent) and 22 million gallons were ground water (26 percent). All of the irrigation was done at Fox Creek Golf Course in Darlington County near the town of Lydia. Water is pumped from a pond located on the golf course and from several wells.

Irrigation water use totaled 27 million gallons, which is 1 percent of the total water use in the subbasin. Of this amount, 20 million gallons came from wells (73 percent) and 7 million gallons were from surface-water sources (27 percent). Small amounts of ground water (17 million gallons) were used for mining activities in the subbasin.

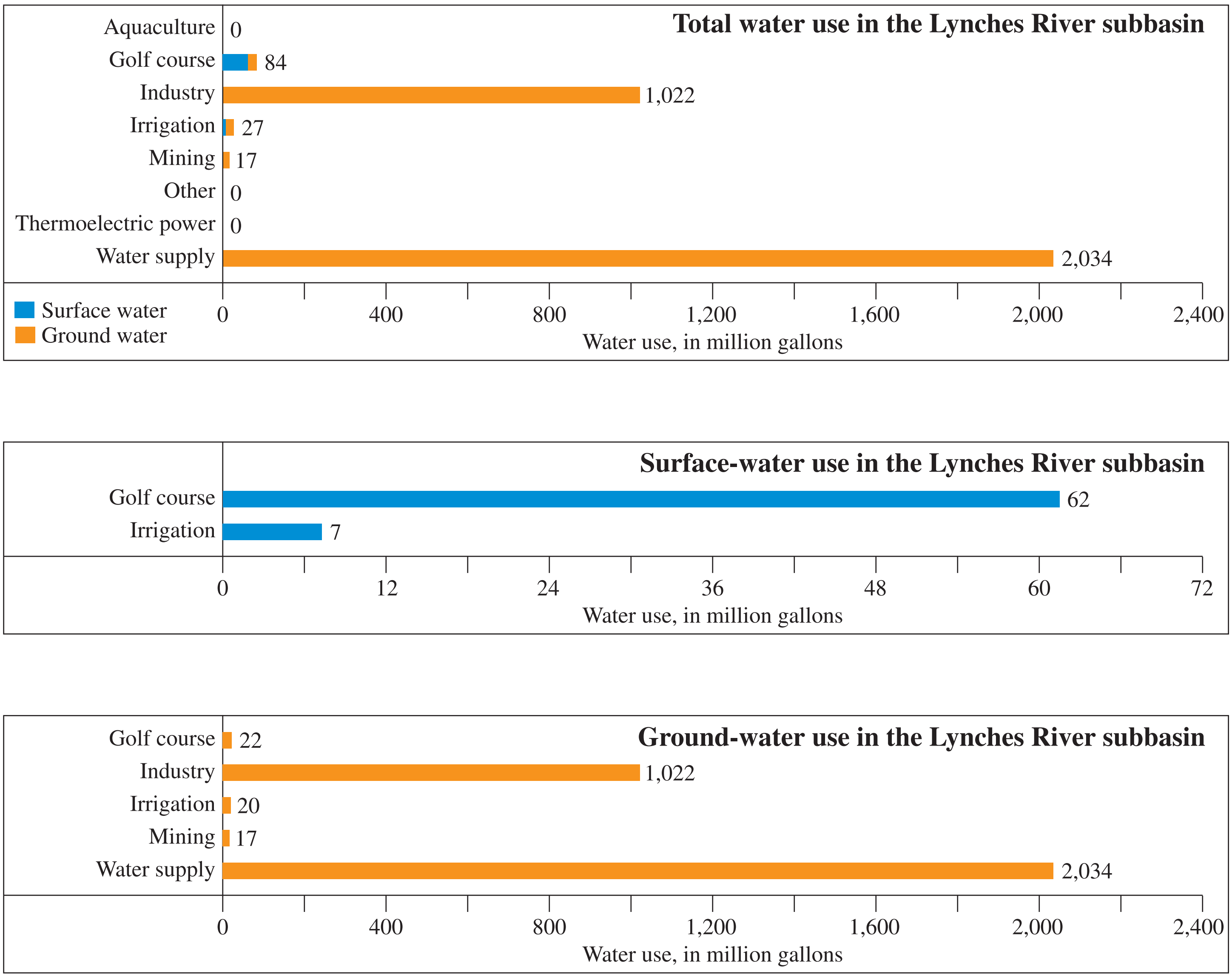
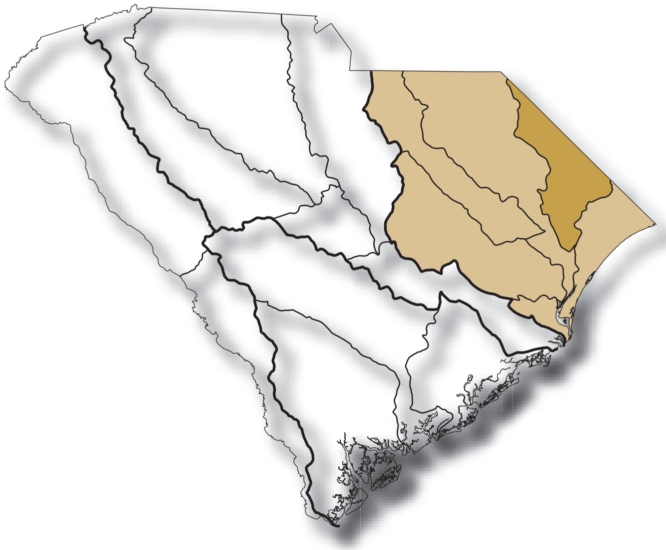


Figure 5-10. Reported water use in the Lynches River subbasin for the year 2006 (modified from Butler, 2007).

LITTLE PEE DEE RIVER SUBBASIN



LITTLE PEE DEE RIVER SUBBASIN

The Little Pee Dee River subbasin is in the northeastern part of the Pee Dee region of South Carolina. This subbasin shares a common border with North Carolina and encompasses parts of four South Carolina counties: Dillon, Marion, Horry, and Marlboro (Figure 5-11). The subbasin area is approximately 1,100 square miles, 3.5 percent of the State's land area.

DEMOGRAPHICS

The 2000 population of the subbasin was estimated at 75,500, less than 2 percent of the State's total population. The subbasin population is expected to reach almost 86,000 by the year 2020. The largest population increases from 2000 to 2020 are expected in Horry County (40 percent).

The four counties, where encompassed by the subbasin, have predominantly rural populations, with Dillon County being classified as over 65 percent rural. Although Horry County is about 40 percent rural overall, most of the rural population is in the Little Pee Dee subbasin whereas its urban population is in the Waccamaw subbasin to the east. The major centers of population in the subbasin are Dillon (6,316) in Dillon County and Mullins (5,029) in Marion County: both centers experienced population declines during the previous decade. The subbasin boundary is near the urban areas of Conway (11,788) on the east and Bennettsville (9,425) on the northwest.

All four counties in the subbasin had a year 2005 per capita personal income below the State average ($28,285). Horry County was closest, with a per capita income of $26,789, ranking 15th among the 46 counties. Marion County ranked 44th, with a per capita income of $20,299; Marlboro County ranked 41st, with $20,485; and Dillon County ranked 39th, with $20,850. The 1999 median household income ranged from $36,470 in Horry County to $26,526 in Marion County.

In 2000, the annual average employment of nonagricultural wage and salary workers in Dillon, Horry, and Marion Counties was about 124,000. Labor distribution in the subbasin counties included sales and office, 28 percent; management, professional, and technical services, 24 percent; service, 18 percent; production, transportation, and materials moving, 16 percent; construction, extraction, and maintenance, 13 percent; and farming, fishing, and forestry, 1 percent.

In the sectors of manufacturing, mining, and public utilities, the combined annual product value from the counties of the subbasin was $2.8 billion in 1997 (South Carolina Budget and Control Board, 2005), but most production occurred outside the Little Pee Dee subbasin boundaries.

Agriculture remained important in this section of the State, and crops and livestock produced a cash value of about $200 million in 2000. Timber production in the area generated $76.7 million in 2005, with Horry County accounting for nearly half of timber sales in the region (South Carolina Forestry Commission, 2008).

Figure 5-11. Map of the Little Pee Dee River subbasin.

SURFACE WATER

Hydrology

The two major watercourses in this subbasin are the Little Pee Dee River and a major tributary, the Lumber River. Headwaters for both streams are in the Sandhills region of North Carolina. Several small to moderately sized tributary streams drain the subbasin, including Buck Swamp, Bear Swamp, and Lake Swamp. Typical of many Coastal Plain streams, extensive swamplands are associated with much of the main stem and tributary streams, resulting in meandering and often ill-defined stream channels.

The General Assembly designated 14 miles of the Little Pee Dee River from Highway 378 to the confluence with the Great Pee Dee River as a State Scenic River in 1990. An additional 64 miles of the river extending upstream from Highway 378 were determined eligible for scenic-river status in 1997 but have not yet been formally designated. Lastly, in the upper portion of the Little Pee Dee River, a 46-mile segment in Dillon County that begins at Parish Mill Bridge on State Road 363 near the Marlboro County line and extends southeast to the State Road 72 bridge near the Marion County line was designated as a State Scenic River in 2005. (See the *River Conservation* section of Chapter 9, *Special Topics*.)

Streamflow is currently monitored at only one site in this subbasin, Galivants Ferry on the Little Pee Dee River. A discontinued streamflow-gaging station on the Little Pee Dee River near Dillon presently monitors only crest-stage data. The Lumber River is monitored by three gaging stations in North Carolina: near Maxton, at Lumberton, and at Boardman. One gaging station is active in North Carolina for a tributary stream of the Little Pee Dee River, Big Shoe Heel Creek near Laurinburg. There are also two streamflow gages on tributary streams, Drowning Creek near Hoffman and Big Swamp near Tarheel. Streamflow statistics for some of these stations are presented in Table 5-13.

Table 5-13. Selected streamflow characteristics at USGS gaging stations in the Little Pee Dee River subbasin

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
Little Pee Dee River near Dillon 1325	1939 to 1971	524	577	1.10	155	24 1954	– – –	9,810 1945
Lumber River at Boardman, N.C. 1345	1929 to 2007*	1,228	1,308	1.07	290	42 2002	13,400 1945, '99	13,400 1945, '99
Little Pee Dee River at Galivants Ferry 1350	1942 to 2007*	2,790	3,033	1.09	588	73 2002	27,500 1964	27,600 1964

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*

At the two gaging sites on the Little Pee Dee River, streamflow characteristics are similar and suggest somewhat variable and potentially limited surface-water availability (Figure 5-12). The unit-average discharges at the gages are nearly equal and similar to the regional unit-average discharge. Flows are mainly dependent on rainfall and direct runoff, with lower streamflows partially supplemented by base flow from ground-water storage. Average flow of the Little Pee Dee River is almost 600 cfs (cubic feet per second) near Dillon and more than 3,000 cfs at Galivants Ferry. The lowest flows of record were 24 cfs near Dillon in 1954 and 73 cfs at Galivants Ferry in 2002. The flood flow of record occurred in 1964 at Galivants Ferry (27,600 cfs) due to runoff from tropical storm Hilda that produced localized flooding.

Streamflow in the Little Pee Dee River is fairly reliable; however, surface-water storage would be needed to ensure adequate water supplies during periodic low-flow conditions. The similarity of streamflow characteristics at the main-stem gaging stations suggests similar characteristics for tributary streams in the same physiographic province in the subbasin.

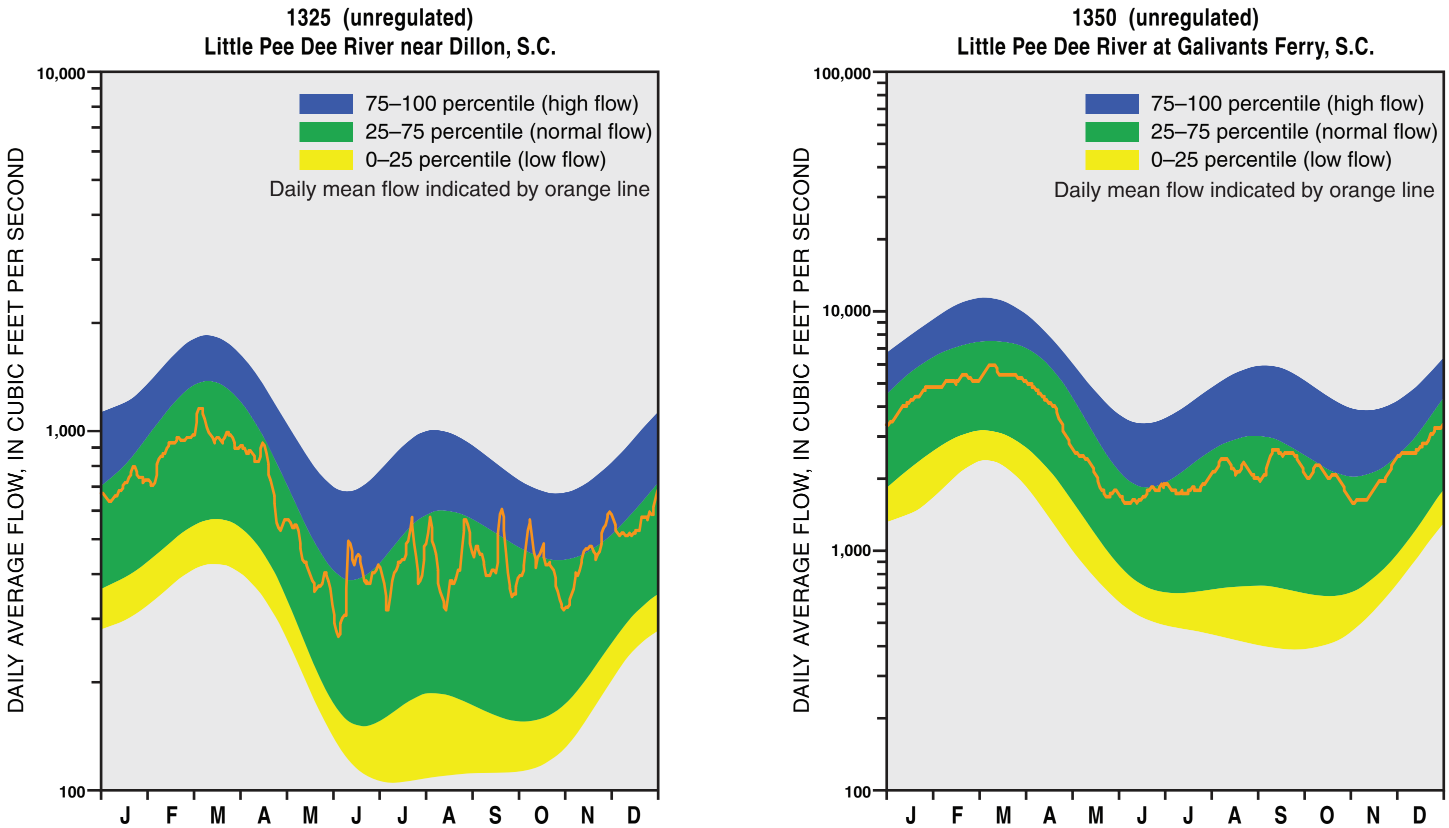


Figure 5-12. Duration hydrographs for selected gaging stations in the Little Pee Dee River subbasin.

Development

Surface-water development in the Little Pee Dee River subbasin is not extensive. Pages Mill Pond, near Lake View in Dillon County, is the largest body of water, with a surface area of 200 acres and a volume of 640 acre-ft. The aggregate surface area of all lakes of 10 acres or more is 1,310 acres, and the total volume is about 4,300 acre-ft.

The U.S. Army Corps of Engineers (COE) navigation projects for the Little Pee Dee River and Lumber River were deauthorized by Congress in 1977. Flood-control work in Gapway Swamp was completed by the COE in 1968. Natural Resources Conservation Service (NRCS) projects for the Cartwheel community and Maple Swamp were completed in the late 1960's; the later project included 10 miles of channel work. In 2006, the NRCS was authorized to plan flood control in the Latta watershed in Dillon County.

Surface-Water Quality

Most of the water bodies in the Little Pee Dee River subbasin are designated as "Freshwater" (Class FW). This class of water is suitable for the survival and propagation of aquatic life, primary- and secondary-contact recreation, drinking-water supply, fishing, and industrial and agricultural uses (DHEC, 2007b).

A part of the Little Pee Dee River and Cedar Creek are designated "Outstanding Resource Water" (Class ORW). These freshwater streams constitute outstanding recreational or ecological resources and are suitable as a drinking-water source with minimal treatment.

As part of its ongoing Watershed Water-Quality Assessment program, DHEC sampled 29 surface-water sites in the Little Pee Dee River subbasin in 2003 in order to assess the water's suitability for aquatic life and recreational use (Figure 5-13). Aquatic-life uses were fully supported at 21 sites, or 72 percent of the water bodies sampled in this subbasin; most of the impaired water exhibited dissolved-oxygen levels below the concentrations needed to support aquatic life. Recreational use was fully supported in 78 percent of the sampled water bodies; the water bodies that did not support recreational use exhibited high levels of fecal-coliform bacteria (DHEC, 2007b). Water-quality impairments in the subbasin are listed in Table 5-14.

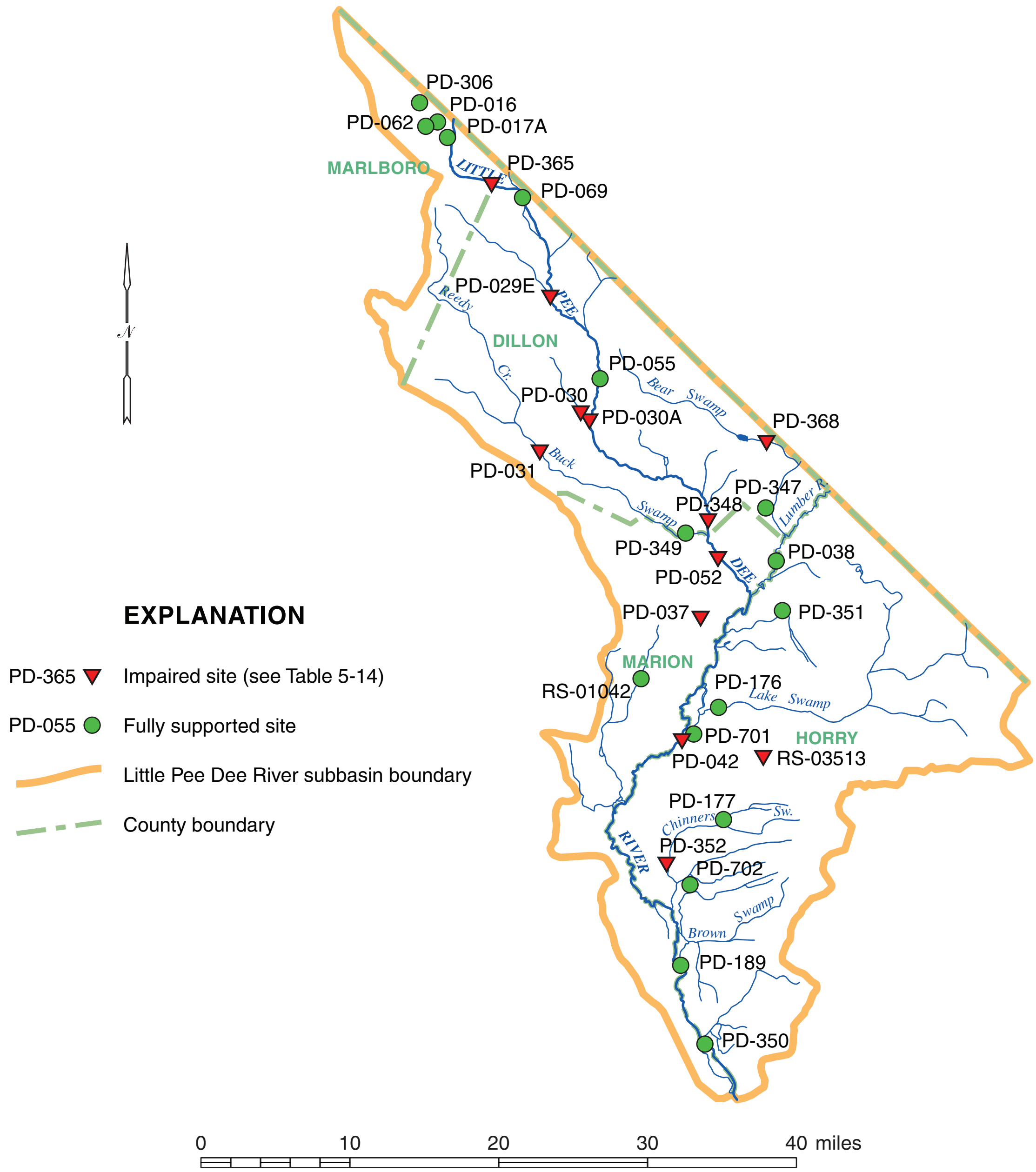


Figure 5-13. Surface-water-quality monitoring sites evaluated by DHEC for suitability for aquatic life and recreational uses. Impaired sites are listed in Table 5-14 (DHEC, 2007b).

Table 5-14. Water-quality impairments in the Little Pee Dee River subbasin (DHEC, 2007b)

Water-body name	Station number	Use	Status	Water-quality indicator
Bear Swamp	PD-368	Aquatic life	Nonsupporting	Dissolved oxygen
Little Pee Dee River	PD-365	Aquatic life	Nonsupporting	pH
Buck Swamp	PD-031	Recreation	Partially supporting	Fecal coliform
Little Pee Dee River	PD-029E	Recreation	Partially supporting	Fecal coliform
	PD-030A	Aquatic life	Nonsupporting	Dissolved oxygen
		Recreation	Partially supporting	Fecal coliform
	PD-348	Aquatic life	Nonsupporting	pH
	PD-052	Aquatic life	Partially supporting	Copper
Maple Swamp	PD-030	Recreation	Partially supporting	Fecal coliform
Loosing Swamp	RS-03513	Aquatic life	Nonsupporting	Dissolved oxygen
Chinners Swamp	PD-352	Recreation	Partially supporting	Fecal coliform
White Oak Creek	PD-037	Aquatic life	Partially supporting	Dissolved oxygen
		Recreation	Partially supporting	Fecal coliform
Little Pee Dee River	PD-042	Aquatic life	Nonsupporting	Dissolved oxygen, pH

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 the most recent impairments and water-quality trends online in their 303(d) listings and 305(b) reports.

In 2008, DHEC issued fish-consumption advisories for the Little Pee Dee River and the Lumber River from the North Carolina/South Carolina state line to the Great Pee Dee River. Fish-consumption advisories are issued where fish contaminated with mercury have been found. The contamination is only in the fish and does not make the water unsafe for skiing, swimming, or boating.

GROUND WATER

Hydrogeology

The Little Pee Dee River subbasin is entirely in the Coastal Plain. The northwestern part of the subbasin obtains much of its ground-water supply from the Middendorf and Black Creek aquifers. This part of the subbasin is underlain by approximately 600 feet of unconsolidated sediments, mostly of the Middendorf and Black Creek Formations. Selected ground-water data for the subbasin are presented in Table 5-15.

The southeastern part of the subbasin is underlain by about 1,500 feet of sediment, predominantly of the Cape Fear, Middendorf, Black Creek, and Peedee Formations. The Black Creek is used almost exclusively as the ground-water source for large-capacity wells. In this area, the Middendorf is deep and increasingly mineralized with depth. The Peedee Formation is not a consistently good aquifer and principally confines the Black Creek aquifer. With the exception of one well in Loris, there are no large-capacity wells in the Peedee Formation.

Table 5-15. Selected ground-water data for the Little Pee Dee River subbasin

Vicinity	Aquifer	Well depth (feet)	Major well yield (gpm)
Dillon	Black Creek/ Middendorf	210–485	360–1,150
Mullins	Black Creek	320–390	370–1,500
Aynor	Black Creek	300–350	150–800
Loris	Black Creek (Peedee Formation)	100–200	250–500
	Black Creek	320–460	250–800

Ground-Water Quality

Both the Middendorf and Black Creek aquifers are important ground-water sources in the Little Pee Dee subbasin. In the upper reach, both aquifers are used, and the water of both is of good quality. It is low in dissolved solids, with TDS (total dissolved solids) of about 150 mg/L (milligrams per liter), and is slightly acidic to slightly alkaline (Rodriguez and others, 1994; Speiran and Aucott, 1994). Locally, concentrations of manganese and iron exceed recommended limits. In Dillon County, water from these aquifer systems tends to be a sodium bicarbonate type (Newcome, 1989).

In the lower reach, in eastern Marion and western Horry Counties, the Black Creek is the principal aquifer system. Water from the Black Creek aquifer in Marion County is a sodium bicarbonate type with pH in the range of 7.0 to 8.0 and with high concentrations of TDS, manganese, fluoride, and sodium (Rodriguez and others, 1994). Water in western Horry County is similar in quality, although with pH greater than 8.5 and with TDS increasing to the east.

The Middendorf is generally unused in the lower reach of the subbasin, where it becomes increasingly mineralized with proximity to the coast and with depth. Total dissolved solids and bicarbonate concentrations exceed 500 mg/L at the southeast end. The toe of a diffuse saltwater wedge underlies southeast Marion County and northwestern Horry County, where chloride concentrations increase from less than 10 mg/L to about 100 mg/L (Speiran and Aucott, 1994).

Water-Level Conditions

Ground-water levels are continuously monitored by the DNR in only one well within the Little Pee Dee River subbasin, in Dillon County (Table 5-16). Water levels in other wells in the subbasin are sometimes measured to help develop potentiometric maps of the Middendorf and Black Creek aquifers.

Although there are no known site-specific water-level problems in this subbasin, years of pumping from wells in this subbasin and in neighboring subbasins have resulted in a regional lowering of water levels in the Black Creek aquifer throughout the southern half of the subbasin. In the Brittons Neck area of southern Marion County, water levels have declined nearly 60 feet from predevelopment levels (Hockensmith, 2008b).

Table 5-16. Water-level monitoring wells in the Little Pee Dee 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
DIL-121	DNR	34 19 58 79 16 48	Middendorf	Little Pee Dee State Park	95	269–284

* *DNR, South Carolina Department of Natural Resources*

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 Little Pee Dee River subbasin is summarized in Table 5-17 and Figure 5-14. Offstream water use totaled 2,487 million gallons in 2006, ranking it fourteenth among the 15 subbasins. Of this amount, 2,437 million gallons were from ground-water sources (98 percent) and 50 million gallons were from surface-water sources (2 percent). Water-supply use (2,352 million gallons) accounted for almost 95 percent of the total, followed by industry (3 percent), golf course use (2 percent), and irrigation (1 percent). Consumptive use in this subbasin is estimated to be 349 million gallons, or about 14 percent of the total offstream use.

Water-supply use in the subbasin was provided entirely by ground water. Of the 10 water-supply systems that have wells in the basin, Trico Water Company, Inc. in Dillon County was the largest user. It pumped 870 million gallons from 13 wells completed in the Middendorf aquifer. It was followed by the city of Dillon, which pumped 430 million gallons (Middendorf aquifer); the city of Mullins, which pumped 292 million gallons (Middendorf and Black Creek aquifers); and Marco Rural Water Company, Inc., which pumped 237 million gallons (Middendorf aquifer).

Industrial water use in the subbasin totaled 69 million gallons in 2006, all of it from ground-water sources. Golf-course water use totaled 37 million gallons, all of it from surface-water sources. Irrigation use totaled 29 million gallons, slightly more than half of which came from wells.

Table 5-17. Reported water use in the Little Pee Dee 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	37	75.1	0	0.0	37	1.5
Industry	0	0.0	69	2.8	69	2.8
Irrigation	12	24.9	16	0.7	29	1.2
Mining	0	0.0	0	0.0	0	0.0
Other	0	0.0	0	0.0	0	0.0
Thermoelectric power	0	0.0	0	0.0	0	0.0
Water supply	0	0.0	2,352	96.5	2,352	94.6
Total	50		2,437		2,487	

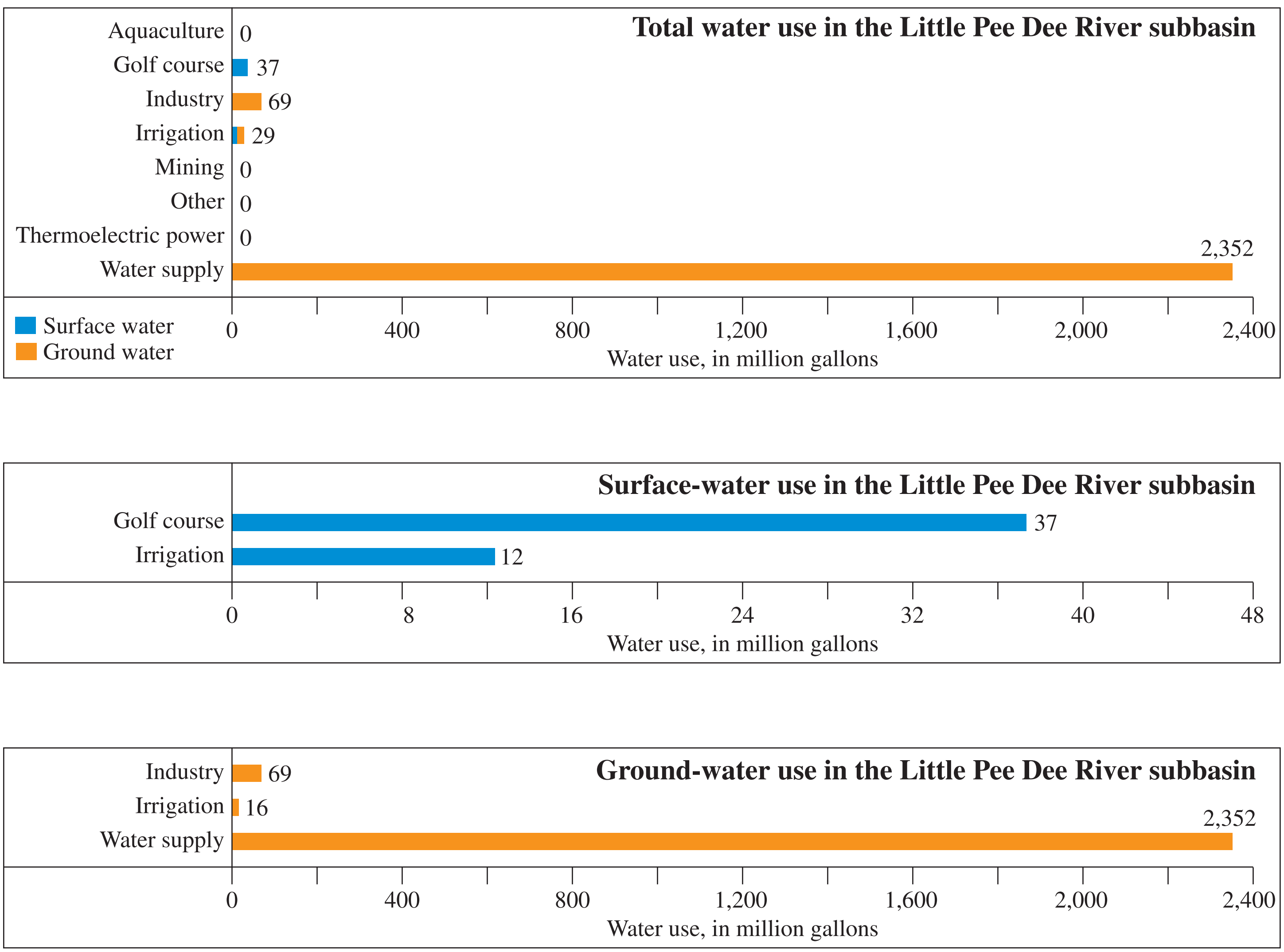
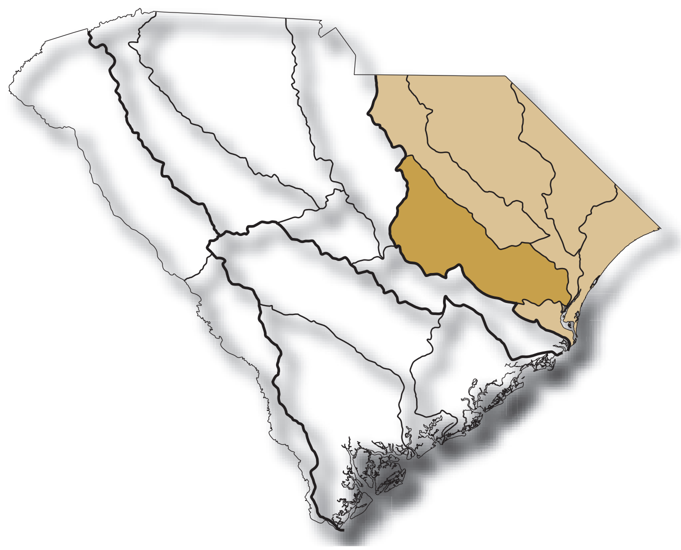


Figure 5-14. Reported water use in the Little Pee Dee River subbasin for the year 2006 (modified from Butler, 2007).

BLACK RIVER SUBBASIN



BLACK RIVER SUBBASIN

The Black River subbasin transects the central part of South Carolina from the western fringe of the Pee Dee region southeast to the upper extent of Winyah Bay. With a northwest-southeast orientation, the subbasin extends into the west edge of Kershaw County and encompasses parts of six additional counties, Sumter, Williamsburg, Georgetown, Clarendon, Lee, and Florence (Figure 5-15). The area of the subbasin is 2,045 square miles, 6.6 percent of the State's land area.

DEMOGRAPHICS

The 2000 subbasin population was estimated at 175,200, about 4.4 percent of the State's total population. The population in the subbasin is projected to increase by about 5 percent by the year 2020. In contrast, the total population of South Carolina is expected to increase 20 percent during this period, and Georgetown and Sumter Counties are expected to increase about 23 percent.

The Black River subbasin population is predominantly very rural, with the exception of Sumter County, in which over half of the residents are classified as urban. The city of Sumter contains more than half of Sumter County's urban population.

The major population centers are Sumter (39,643), Manning (4,025), Kingstree (3,496), Bishopville (3,670), and Andrews (3,068).

In the subbasin, year 2005 per capita income ranged from $30,399 in Georgetown County, which ranked sixth among the 46 counties, to $20,005 in Williamsburg County, which ranked 45th in the State. The 2005 per capita income in South Carolina averaged $28,285. Williamsburg County also had the lowest 1999 median household income ($24,214), about $13,000 lower than the State's median household income of $37,082. The median household incomes in Sumter and Georgetown Counties were $33,278 and $35,312, respectively.

The 2000 annual average employment of non-agricultural wage and salary workers in the counties of the subbasin totaled 158,000, almost 9 percent of the State's total. Labor distribution in the subbasin counties included management, professional, and technical services, 26 percent; sales and office, 24 percent; production, transportation, and materials moving, 21 percent; service, 16 percent; construction, extraction, and maintenance, 12 percent; and farming, fishing, and forestry, 1 percent.

Manufacturing, mining, and utilities in the principal counties of the subbasin produced about $6 billion in 1997. Florence and Sumter Counties accounted for more than two-thirds of that output, and the two counties ranked eighth and ninth in the State, respectively.

Agricultural output was nearly $300 million in 2000. Florence and Sumter Counties ranked fifth and eighth in the State, and all but Georgetown County ranked in the top one-third. The production of timber products exceeded $114 million in 2005, with Georgetown, Williamsburg, and Florence Counties ranking fourth, eighth, and tenth, respectively (South Carolina Forestry Commission, 2008).

SURFACE WATER

Hydrology

The dominant watercourse draining the subbasin is the Black River. The principal tributaries draining into the Black River include the Pocotaligo River, Scape Ore Swamp, Pudding Swamp, and Black Mingo Creek. The Black River discharges directly into Winyah Bay at the

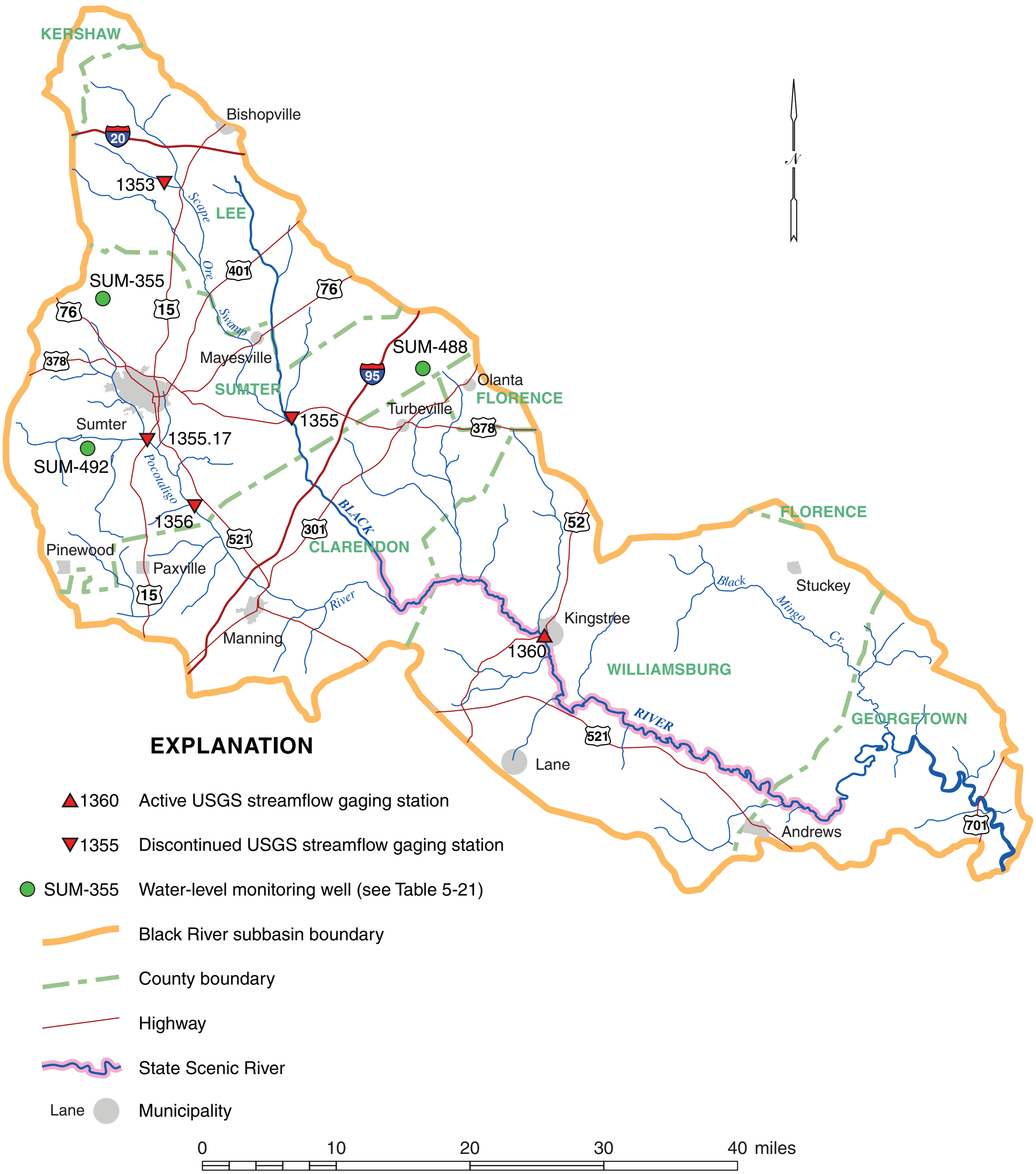


Figure 5-15. Map of the Black River subbasin.

southwest end of the Waccamaw subbasin. Most of the streams are entirely within the middle and lower Coastal Plain regions, with only Scape Ore Swamp located in the upper Coastal Plain region. Extensive swamplands border much of the Black River and its tributaries, frequently resulting in ill-defined and meandering stream channels.

A 75-mile segment of the Black River from County Road 40 in Clarendon County through Williamsburg County to Pea House Landing at the end of County Road 38 in Georgetown County became a State Scenic River in 2001. (See the *River Conservation* section of Chapter 9, *Special Topics*.)

Streamflow in the Black River is currently monitored at only one site, at Kingstree, although high flows are monitored at three crest-stage stations. Another Black River gage located near Gable in Sumter County was discontinued in 1992. Three other gages, two on the Pocotaligo River near Sumter and one in Scape Ore Swamp near Bishopville, are no longer in service (Figure 5-15). Streamflow statistics for these gages are presented in Table 5-18.

Table 5-18. Selected streamflow characteristics at USGS gaging stations in the Black River subbasin

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
Scape Ore Swamp near Bishopville 1353	1968 to 2003	96	97.5	1.02	17	3.5 1986	4,150 1990	4,500 1990
Black River near Gable 1355	1951-66 and 1972-92	401	381	0.95	25	0.0 1954, ’56, ’57	7,590 1965	12,500** 1971
Pocotaligo River at Sumter 1355.17	1992 to 1995	134	155	1.16	21	6.2 1994	4,550 1994	5,080 1994
Pocotaligo River near Sumter 1356	1992 to 1995	185	201	1.09	41	11 1993	2,690 1994	2,790 1994
Black River at Kingstree 1360	1929 to 2007*	1,252	948	0.76	48	2.0 1954	52,800 1973	58,000 1973

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*
*** calculated from peak stage measurement recorded by a crest-stage station installed at the site of this gage*

Average annual streamflow for gaged sites on the Black River is 381 cfs (cubic feet per second) near Gable and 948 cfs at Kingstree. Streamflow at these sites equals or exceeds 25 cfs and 48 cfs, respectively, 90 percent of the time.

The duration hydrographs (Figure 5-16) indicate highly variable streamflow in the Black River, which is dependent primarily on rainfall and ensuing runoff rather than ground-water discharge to maintain flows. Base flows at Kingstree appear to receive some ground-water support, whereas low flows at Gable receive little or no support from ground-water storage. Owing to the location of Scape Ore Swamp in the upper Coastal Plain, low flows are well-sustained by ground-water reserves.

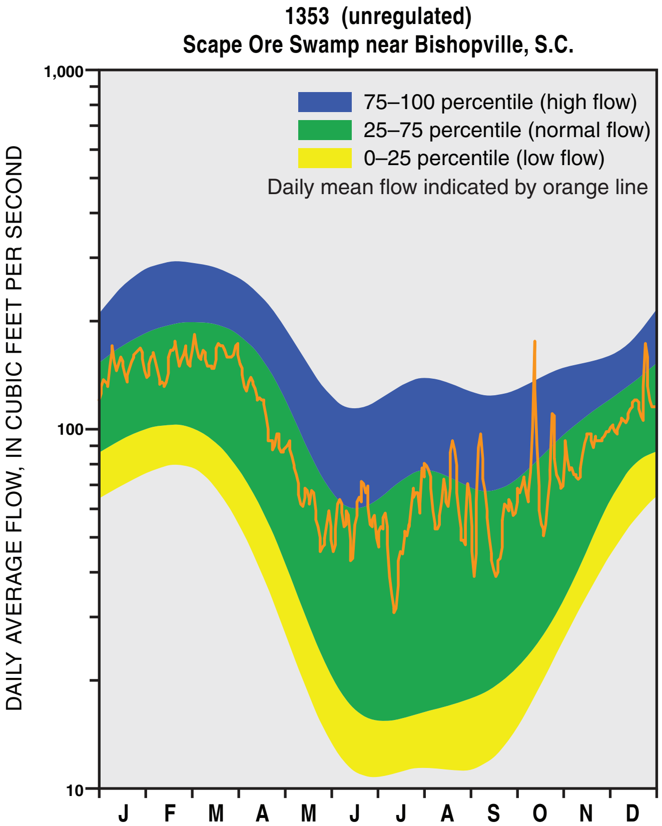
The lowest flows of record for the Black River were recorded at Gable where zero-flow conditions occurred for several days in 1954, 1956, and 1957. The highest flow of record (52,800 cfs) was recorded at Kingstree in 1973. Occasional high flows in the Black River cause flood damage in the cities of Sumter, Kingstree, and Andrews. Flooding of the Pocotaligo River occasionally impacts the city of Manning.

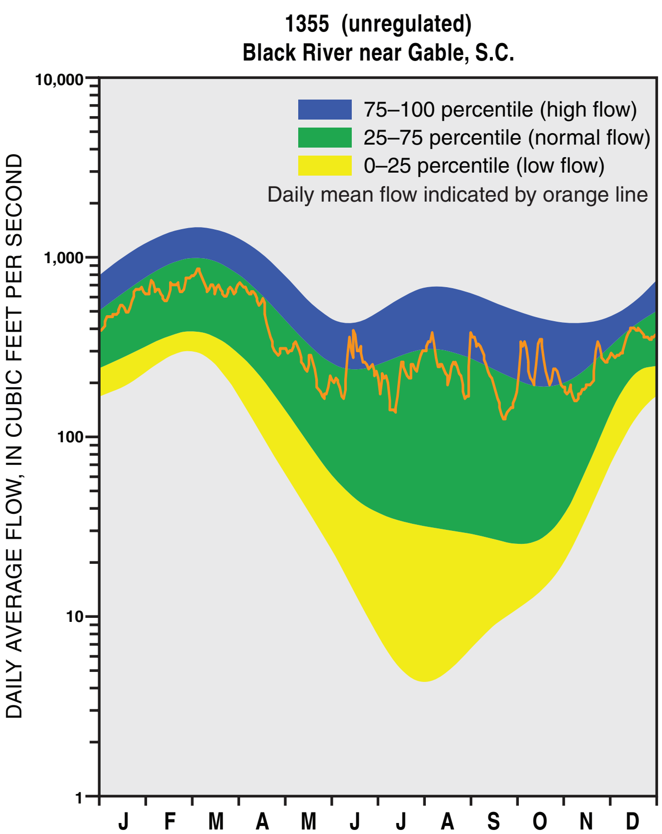
Streamflow in the Black River is highly variable and is not a reliable source of water, especially during the summer months. Water-storage facilities would enhance surface-water-dependent development on this river by providing adequate year-round water supplies. Although average streamflow in Scape Ore Swamp is less than in the Black River, the reliability of flow is greater. During periods of low rainfall, streamflow in Scape Ore Swamp may exceed that in the main river.

Development

Little surface-water development has occurred in the Black River subbasin, and most existing development consists of flood-control projects. The largest lake has a surface area of 150 acres and a volume of 600 acre-ft. The aggregate surface area of all lakes of 10 acres or more is about 1,700 acres and the total volume is about 4,000 acre-ft.

While there are no active navigation projects in this subbasin, the U.S. Army Corps of Engineers once had a project on Mingo Creek in Georgetown County. The Corps has also completed three flood-control projects. The Shot Pouch Creek Project in Sumter County included land enhancement and recreation. Numerous other flood-problem areas have been identified in the subbasin, and the Natural Resources Conservation Service has completed one project and has recently begun planning two others.





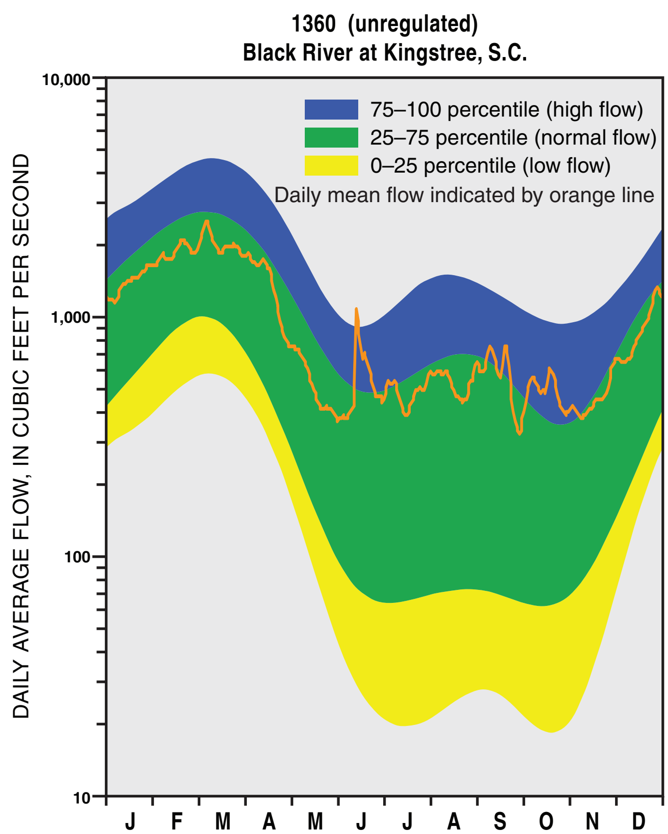


Figure 5-16. Duration hydrographs for selected gaging stations in the Black River subbasin.

Surface-Water Quality

All water bodies, but one, in the Black River subbasin are designated "Freshwater" (Class FW). This water-use classification is assigned to water that is suitable for the survival and propagation of aquatic life, primary- and secondary-contact recreation, drinking-water supply, fishing, and industrial and agricultural uses (DHEC, 2007b).

A section of the Black River (4 miles northeast of Georgetown) is designated "Tidal Saltwater" (Class SA). Class SA water bodies encompass tidal saltwater suitable for the survival and propagation of a balanced indigenous aquatic community of marine fauna and flora, suitable for primary- and secondary-contact recreation, crabbing, and fishing. This water is not protected for harvesting of clams, mussels, or oysters for market purposes or human consumption.

As part of its ongoing Watershed Water-Quality Assessment program, DHEC sampled 43 surface-water sites in the Black River subbasin in 2003 in order to assess the water's suitability for aquatic life and recreational use (Figure 5-17). Aquatic-life uses were fully supported at 29 sites, or 67 percent of the water bodies sampled in this subbasin; most of the impaired water exhibited dissolved-oxygen levels below the concentrations needed to support aquatic life. Recreational use was fully supported in 76 percent of the sampled water bodies; water bodies that did not support recreational use exhibited high levels of fecal-coliform bacteria (DHEC, 2007b). Water-quality impairments in the subbasin are listed in Table 5-19.

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 the most recent impairments and water-quality trends online in their 303(d) listings and 305(b) reports.

Table 5-19. Water-quality impairments in the Black River subbasin (DHEC, 2007b)

Water-body name	Station number	Use	Status	Water-quality indicator
Scape Ore Swamp	PD-355	Recreation	Partially supporting	Fecal coliform
McGrits Creek	RS-01017	Aquatic life	Nonsupporting	Turbidity
		Recreation	Nonsupporting	Fecal coliform
Lake Ashwood	CL-077	Aquatic life	Nonsupporting	Total nitrogen, Chlorophyll-*a*
Mechanicsville Swamp	PD-356	Aquatic life	Nonsupporting	Dissolved oxygen
Canal to Atkins drainage canal	PD-354	Aquatic life	Nonsupporting	Dissolved oxygen
Brunson Swamp	RS-03345	Aquatic life	Partially supporting	Macroinvertebrates
		Recreation	Nonsupporting	Fecal coliform
Nasty Branch	PD-239	Aquatic life	Nonsupporting	Dissolved oxygen
		Recreation	Partially supporting	Fecal coliform
Green Swamp	PD-039	Aquatic life	Nonsupporting	Dissolved oxygen
Pocotaligo River	PD-091	Aquatic life	Nonsupporting	Dissolved oxygen
Turkey Creek	PD-098	Recreation	Nonsupporting	Fecal coliform
	PD-040	Recreation	Partially supporting	Fecal coliform
Big Branch	PD-627	Aquatic life	Partially supporting	Macroinvertebrates
Deep Creek	PD-693	Aquatic life	Nonsupporting	Macroinvertebrates
		Recreation	Nonsupporting	Fecal coliform
Black River	PD-116	Aquatic life	Partially supporting	Dissolved oxygen
Clapp Swamp	RS-02325	Aquatic life	Nonsupporting	Dissolved oxygen
Black River	PD-170	Aquatic life	Nonsupporting	Dissolved oxygen, copper
	PD-325	Aquatic life	Partially supporting	Dissolved oxygen
Green Creek	RS-03353	Recreation	Partially supporting	Fecal coliform

Figure 5-17. Surface-water-quality monitoring sites evaluated by DHEC for suitability for aquatic life and recreational uses. Impaired sites are listed in Table 5-19 (DHEC, 2007b).

In 2008, as in several prior years, DHEC issued fish-consumption advisories for the entire reaches of the Black River, Pocotaligo River, and Black Mingo Creek. 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.

GROUND WATER

Hydrogeology

The Black River subbasin is wholly within the Coastal Plain. The Lee County area of the subbasin is underlain by the Middendorf aquifer, which is the principal source of ground water in this area. Selected ground-water data for the subbasin are presented in Table 5-20.

Table 5-20. Selected ground-water data for the Black River subbasin

Vicinity	Aquifer	Well depth (feet)	Major well yield (gpm)
Lee County	Middendorf	260–535	700–2,000
City of Sumter	Middendorf/ Black Creek	90–750	1,000–2,500
Sumter County	Black Creek	100–410	50–650
Clarendon/ Williamsburg Counties	Black Creek	100–800	100–750
Manning	Black Creek/ Middendorf	400–765	80–755
Andrews	Black Creek	770–825	210–500
	Shallow	22–60	150

Pumping tests indicate that the transmissivity of the Middendorf aquifer in the Bishopville area averages about 11,000 ft^2/day. The total thickness of sediments overlying the crystalline bedrock ranges from about 250 feet at the north end of Lee County to 800 feet at the south end.

The total thickness of sediments overlying the crystalline rocks in Sumter County ranges from about 350 feet in the northwestern part of the county to about 900 feet on the border with Clarendon County. About 20 miles northwest of Sumter, at the Kershaw County line, the top of the Middendorf lies at a depth of 200 feet. Beneath the city of Sumter, it is at a depth of 470 feet.

Sumter's municipal water supply is the largest ground-water user in the State. Its pumpage in 2006 averaged 12.4 million gallons per day, drawn from the Middendorf and Black Creek aquifers. Water levels in the Sumter area are generally between 90 and 115 feet above sea level. Aquifer transmissivity at Sumter is indicated by numerous pumping tests to range between 2,500 and 10,000 ft^2/day, depending on the number of sand beds screened.

Productive sand and gravel beds compose most of the Middendorf aquifer in Sumter County, and it is the area's best source of ground-water supply. The top of the aquifer occurs between sea level and 400 feet below sea level. The Black Creek aquifer also underlies most of Sumter County. The top of the aquifer ranges from about 250 feet above sea level at the north border to sea level at the south border. The thickness is as great as 300 feet, and many water systems in the county include wells that tap the Black Creek aquifer.

The shallow aquifer in Sumter County supplies domestic wells ranging in depth from 10 to more than 100 feet. Shallow wells developed in alluvial deposits along the Black River may be able to obtain substantial amounts of water transmitted from the river through these deposits.

Clarendon and Williamsburg Counties, in the center of the Black River subbasin, are entirely underlain by the Cape Fear, Middendorf, and Black Creek aquifers. The top of the Cape Fear dips southward and ranges from 500 to 1,100 feet below sea level. In the vicinity of Turbeville the top of the Middendorf occurs at a depth of 500 feet, and the aquifer is about 150 feet thick. A pumping test of a Middendorf well at Manning indicated an aquifer transmissivity of 5,300 ft^2/day. The Black Creek aquifer underlying Clarendon and Williamsburg Counties is 300 to 350 feet thick, and its top is between sea level and 400 feet below sea level. Measurements of transmissivity range from 460 to 3,600 ft^2/day. The lower part of the Peedee Formation is included in the Black Creek aquifer in the lower reaches, and upper Peedee sediment generally confines the Black Creek system. Sandy intervals that occur in the upper section of the Peedee along the southeastern boundary of the subbasin are grouped in the Tertiary sand aquifer and produce yields adequate for domestic supply. The shallow aquifer in these counties also supplies domestic needs in rural areas.

In Georgetown County the top of the Middendorf aquifer is about 1,000 feet below sea level, and the aquifer is not widely used as a source of water supply. The Black Creek aquifer, with its top between 350 and 650 feet, and the upper part of the Middendorf aquifer are tapped by a number of public-supply wells, such as those at Andrews. Domestic water supplies are obtained from the shallow aquifer and Tertiary sand aquifers by wells that are less than 100 feet deep. A few shallow wells are known to produce as much as 150 gallons per minute, but yields are usually much smaller.

Ground-Water Quality

The Black Creek and Middendorf aquifers are widely used in the Black River subbasin. Water quality of both aquifers is generally good. The quality varies considerably in the aquifers, with a general trend of increasing mineralization downgradient and with depth.

Water from the Middendorf is low in TDS (total dissolved solids), chloride, fluoride, and pH and is soft and corrosive in the upper reaches of the subbasin. High iron concentrations are common. Total dissolved solids, sodium, and alkalinity increase to more than 500, 250, and 500 mg/L (milligrams per liter), respectively, near the coast (Speiran and Aucott, 1994), and pH increases to 8.5. The electrical-resistivity log of a 1,318-foot test hole near Kingstree indicates brackish or salty water in the underlying Cape Fear aquifer at 1,180 feet below land surface. Iron-reducing bacteria are known to cause problems in wells where iron concentrations are high (Park, 1980).

Water from the Black Creek aquifer is a soft, sodium bicarbonate type. TDS range from about 20 mg/L in the upper reaches to more than 500 mg/L near the coast (Speiran and Aucott, 1994). The pH ranges from 5.0 to 6.0 in Sumter County and from 8.0 to 9.0 in Georgetown County. Excessive iron is a widespread problem in Sumter County (Park, 1980), and fluoride concentrations commonly exceed recommended levels near the coast (Johnson, 1978). Turbidity, caused by a colloidal suspension of the calcium carbonate mineral aragonite, has occurred in some wells in Clarendon, Williamsburg, and Georgetown Counties (Johnson, 1978; Pelletier, 1985).

The Tertiary sand aquifer, where present in Clarendon, Williamsburg, and Georgetown Counties, yields water of good quality for rural domestic needs; however, it commonly contains high iron concentrations (Johnson, 1978). The typical water quality in Georgetown and Williamsburg Counties is a calcium bicarbonate type.

Water-Level Conditions

DNR regularly monitors ground-water levels in three wells in the Black River subbasin, all in Sumter County (Table 5-21). Water levels in other wells in the subbasin are sometimes measured to help develop potentiometric maps of the Middendorf and Black Creek aquifers.

Pumping ground water at a rate faster than it is naturally replenished results in cones of depressions—localized areas of lower ground-water levels—and can also result in regionally lower ground-water levels. Several areas with known pumping-related water-level problems occur in the Black River subbasin, affecting both the Black Creek and Middendorf aquifers.

Table 5-21. Water-level monitoring wells in the Black 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
SUM-355	DNR	34 00 59 80 24 07	Surficial	Ebenezer Elementary School	190	undetermined
SUM-488	DNR	33 52 28 80 26 16	Middendorf	4 miles southwest of Sumter	183	511–541
SUM-492	DNR	33 56 44 79 58 48	Middendorf	Woods Bay State Park	125	502–517

* *DNR, South Carolina Department of Natural Resources*

The Black River subbasin contains two major cones of depression in the Black Creek aquifer (Figure 5-18) (Hockensmith, 2008b). Pumping in and around the city of Sumter has created a cone of depression east of the city, the center of which represents a water-level decline of 165 feet from predevelopment conditions. In the southern end of the subbasin, a widespread cone of depression has formed around Andrews and Georgetown, with water-level declines as great as 200 feet from predevelopment levels.

At least three known cones of depression occur in the Middendorf aquifer in the Black River subbasin (Figure 5-19) (Hockensmith, 2008a). Pumping in and around the city of Sumter has created a cone of depression southwest of the city, with water levels as much as 50 feet lower that predevelopment conditions. A small cone of depression centered near Bishopville in Lee County has resulted from local water levels declining as much as 60 feet. A more widespread cone of depression has developed near the town of Hemingway in Williamsburg County, with water levels as much as 80 feet lower than predevelopment levels.

In addition to these site-specific water-level concerns, years of ground-water pumping in this and neighboring subbasins have caused regional declines in water levels in both the Black Creek and Middendorf aquifers throughout the subbasin by as much as 75 feet from predevelopment conditions.

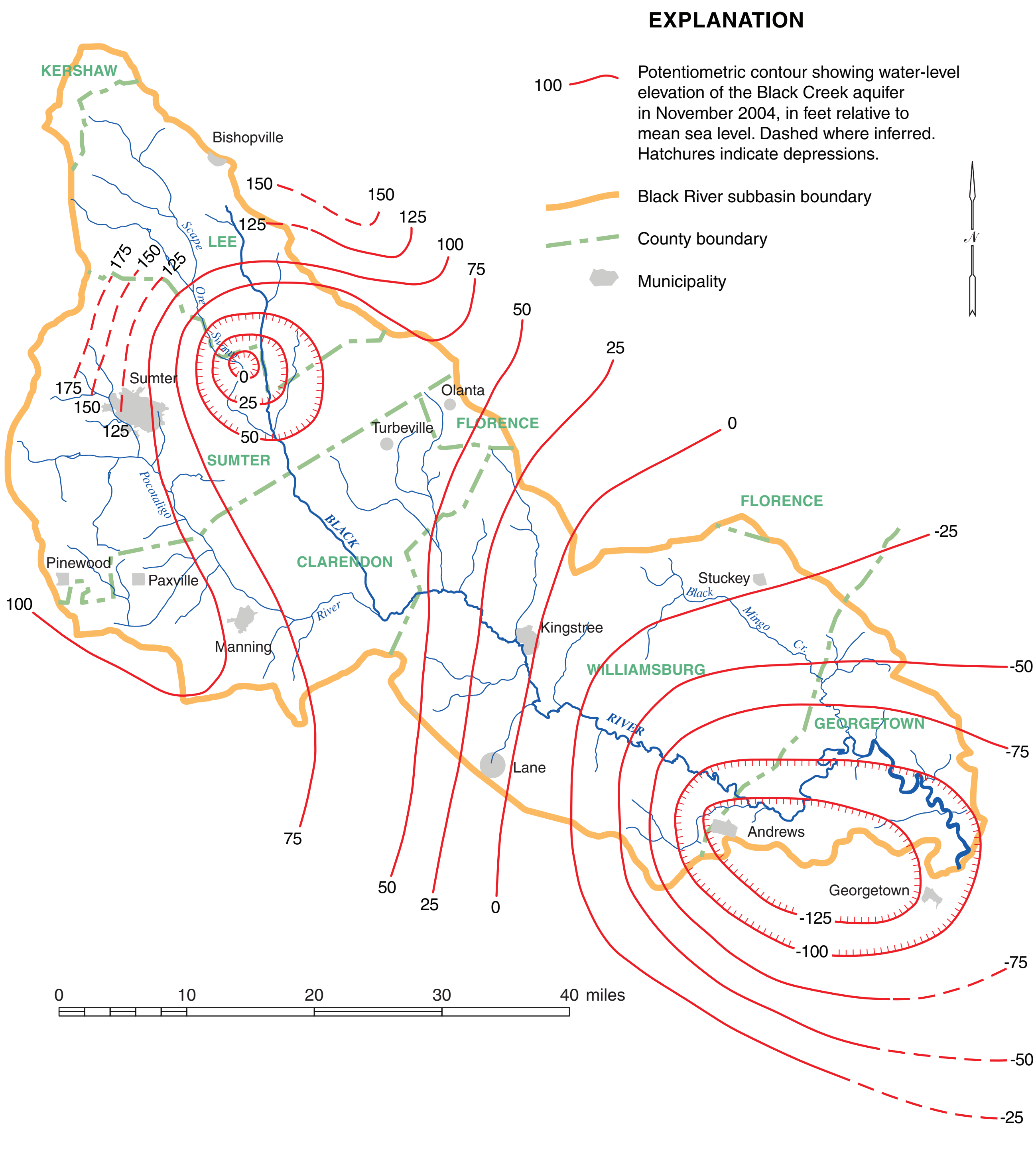


Figure 5-18. Potentiometric contours of the Black Creek aquifer in the Black River subbasin, November 2004 (from Hockensmith, 2008b).

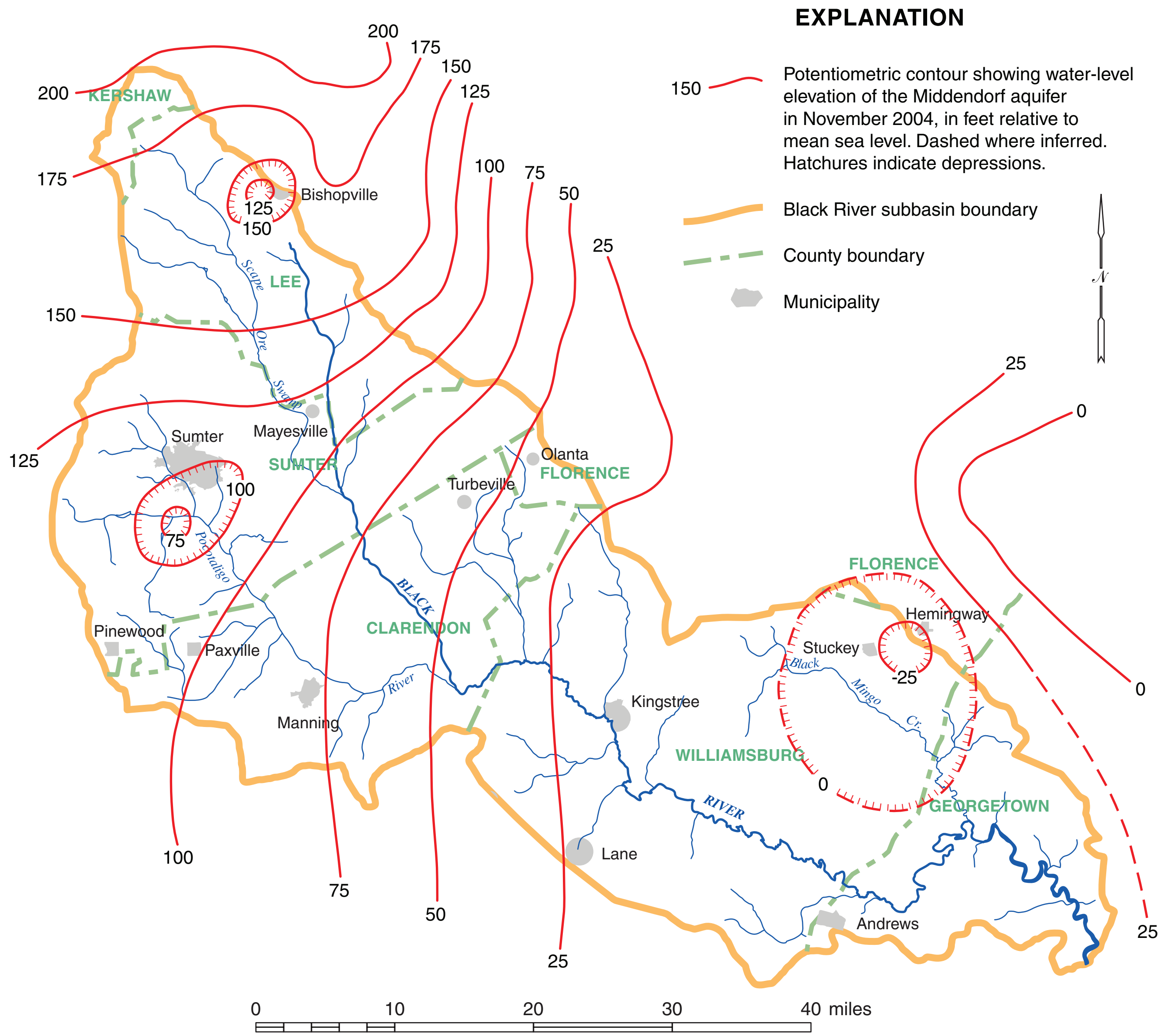


Figure 5-19. Potentiometric contours of the Middendorf aquifer in the Black River subbasin, November 2004 (from Hockensmith, 2008a).

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 Black River subbasin is summarized in Table 5-22 and Figure 5-20. Offstream water use in the Black River subbasin was 10,100 million gallons in 2006, ranking it twelfth among the 15 subbasins. Of this amount, 9,580 million gallons were from ground-water sources (95 percent) and 520 million gallons were from surface-water sources (5 percent). Water-supply use accounted for 73 percent of the total use, followed by irrigation (15 percent) and industry (9 percent). Consumptive use in this subbasin is estimated to be 2,655 million gallons, or about 26 percent of the total offstream use.

Water-supply use in the subbasin was provided entirely by ground water. At 7,287 million gallons, this basin ranked second behind the Pee Dee River subbasin in terms of the amount of ground water used for water supply. Twenty-three ground-water supply systems have wells in the subbasin. Some of these wells are located just inside the boundary of the subbasin and actually supply water to regions in adjacent subbasins. For example, although the city of Bishopville is located primarily in the Lynches River subbasin, its wells are located in both the Lynches and Black subbasins. This is not uncommon. Often, water-supply wells are drilled near elevated water-storage tanks, and storage tanks are typically located at high points so that water can be gravity-fed to customers. Likewise, watershed boundaries are located along locally high topography and, as a result, water-supply wells are commonly located very close to basin boundaries.

Table 5-22. Reported water use in the Black 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	274	52.7	97	1.0	371	3.7
Industry	0	0.0	938	9.8	938	9.3
Irrigation	246	47.3	1,257	13.1	1,503	14.9
Mining	0	0.0	0	0.0	0	0.0
Other	0	0.0	0	0.0	0	0.0
Thermoelectric power	0	0.0	0	0.0	0	0.0
Water supply	0	0.0	7,287	76.1	7,287	72.1
Total	520		9,580		10,100	

The city of Sumter has the largest ground-water public-supply system in the State. In 2006, 4,525 million gallons were pumped from 17 wells located in and around the city. Most of the water is from the Middendorf aquifer, although screens in some wells are set adjacent to both the Middendorf and Black Creek aquifers. The second largest user was High Hills Rural Water Company, which supplies water to rural areas of Sumter County. It withdrew 490 million gallons in 2006 from the Black Creek and Middendorf aquifers. Also of note are the city of Manning (391 million gallons from the Middendorf and Cape Fear aquifers), Shaw Air Force Base in Sumter County (377 million gallons from the Black Creek and Middendorf aquifers), and the town of Kingstree (366 million gallons from the Black Creek and Middendorf aquifers).

Irrigation water use totaled 1,503 million gallons in the subbasin in 2006. Of this amount, 1,257 million gallons were from ground-water sources (84 percent) and 246 million gallons were from surface-water sources (16 percent). Edens Farms, in Sumter County, was the largest ground-water irrigator (500 million gallons from the Black Creek and Middendorf aquifers) and Black Crest Farms, also in Sumter County, was the largest surface-water irrigator (195 million gallons).

Industrial water use totaled 938 million gallons in 2006, all of it from ground-water sources. The largest user was Martek Biosciences Kingstree Corp. in Williamsburg County, which withdrew 607 million gallons from the Middendorf aquifer. Golf-course water use totaled 371 million gallons in 2006, 274 million from surface-water sources (74 percent) and 97 million from ground-water sources (26 percent).

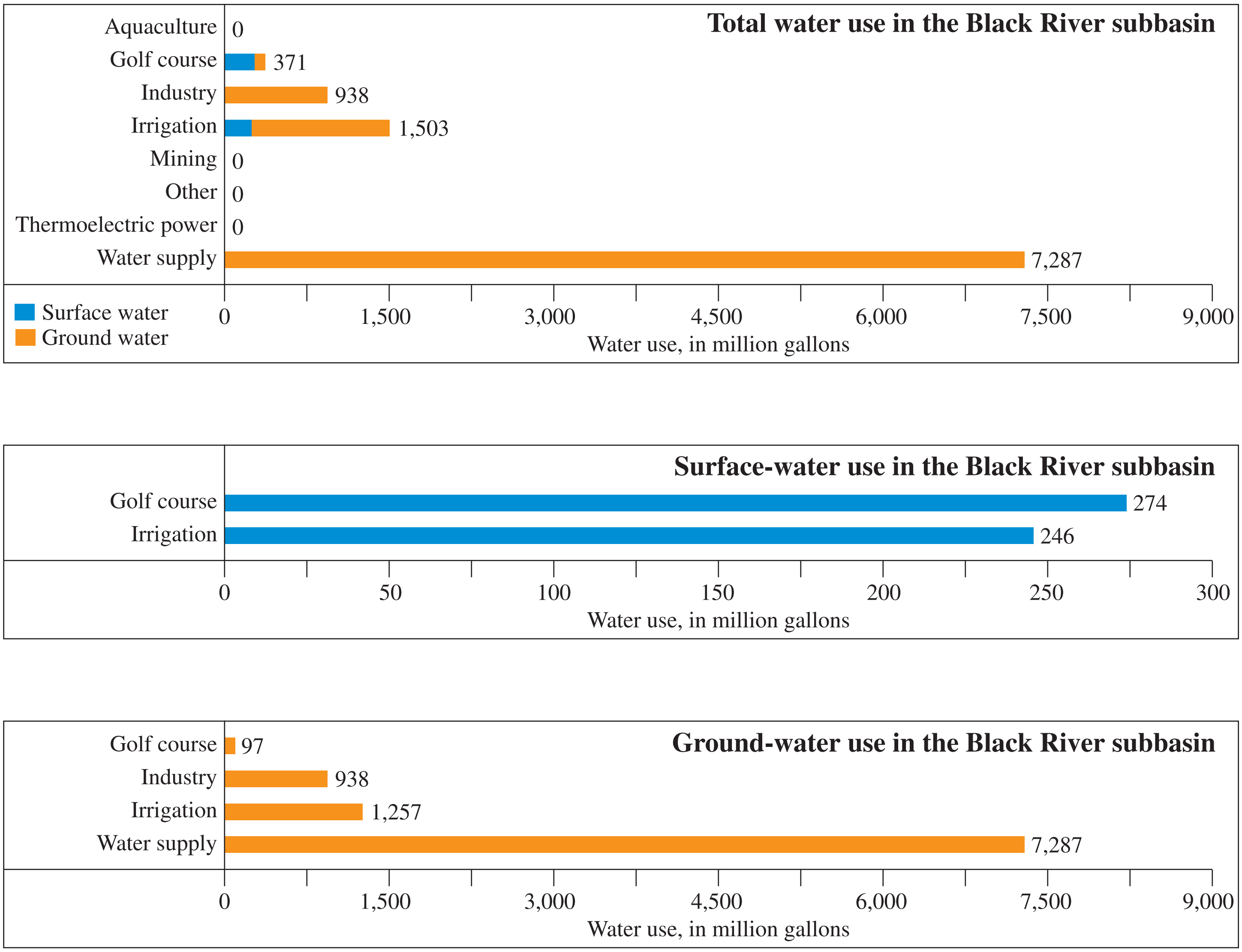
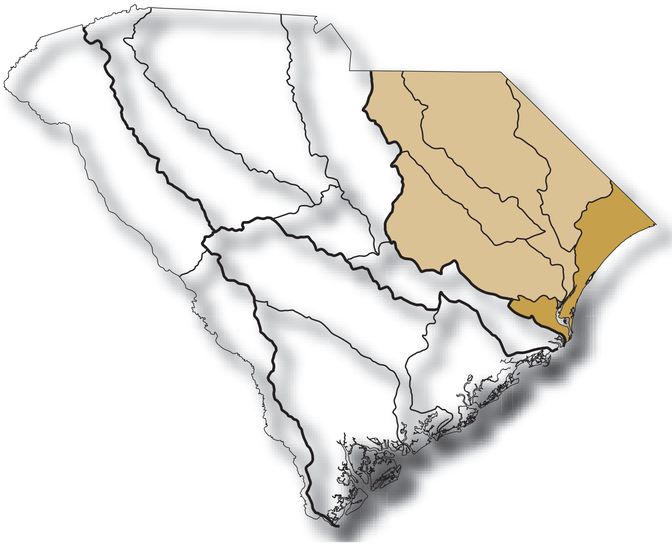


Figure 5-20. Reported water use in the Black River subbasin for the year 2006 (modified from Butler, 2007).

WACCAMAW RIVER SUBBASIN



WACCAMAW RIVER SUBBASIN

The Waccamaw River subbasin is in the easternmost part of the State and runs roughly parallel with the coast, which forms the eastern boundary of the basin. Sharing a 30-mile northern border with North Carolina, the basin includes all of Winyah Bay and the city of Georgetown at its southern extreme. The subbasin encompasses most of Horry County and a part of Georgetown County (Figure 5-21). Within the boundary of the basin is the popular seashore vacation area known as the Grand Strand. This coastal strip comprises a series of towns extending from Cherry Grove near the North Carolina border to Pawleys Island near Georgetown, S.C. The area of the subbasin is about 995 square miles, or 3.2 percent of the State's land area.

DEMOGRAPHICS

The 2000 population of the subbasin was estimated at 206,700, 5.2 percent of the State's total population, but this is a rapidly growing region. The total population of Horry County is projected to increase 30 percent from 2000 to 2020, and Georgetown County's population is projected to increase 19 percent, with most of that growth occurring in the Waccamaw subbasin. By the year 2020 the subbasin population is expected to reach about 261,000, a 26-percent increase in just 20 years.

Horry County has a 40-percent rural population, but most of its urban population is in the Waccamaw subbasin. Rural and urban population growths were 33 percent and 39 percent, respectively, between 1990 and 2000.

The major centers of population in the subbasin are Myrtle Beach (22,759) and Conway (11,788) in Horry County and Georgetown (8,950) in Georgetown County. The transient population of the coastal Grand Strand area of Horry County increases dramatically during the summer months; for example, the population in Myrtle Beach increases nearly tenfold during the peak of the tourist season.

The 2005 per capita income was $30,399 in Georgetown County and $26,789 in Horry County, ranking them 6th and 15th among South Carolina's 46 counties. In that year, South Carolina's per capita income was $28,285. The 1999 median household income in Horry and Georgetown Counties was $36,470 and $35,312, respectively.

In 2000, the annual-average employment of nonagricultural wage and salary workers in Horry and Georgetown Counties was 97,600 and 23,600, respectively. Labor distribution in the subbasin counties included sales and office, 28 percent; management, professional, and technical services, 26 percent; service, 20 percent; construction, extraction, and maintenance, 13 percent; production, transportation, and materials moving, 2 percent; and farming, fishing, and forestry, 1 percent. Employment in service and in sales and offices was 4 to 5 percent greater than the State averages, and employment in production, transportation, and materials moving was 7 percent below the State average. The marked differences in employment reflect the importance of tourism in this subbasin.

Manufacturing output was $2 billion, equally divided between Horry and Georgetown Counties and reflecting the tourism-oriented economies of the area. Crops and livestock production generated $93.5 million, mainly in Horry County. Timber products generated more than $70 million in 2005 (South Carolina Forestry Commission, 2008).

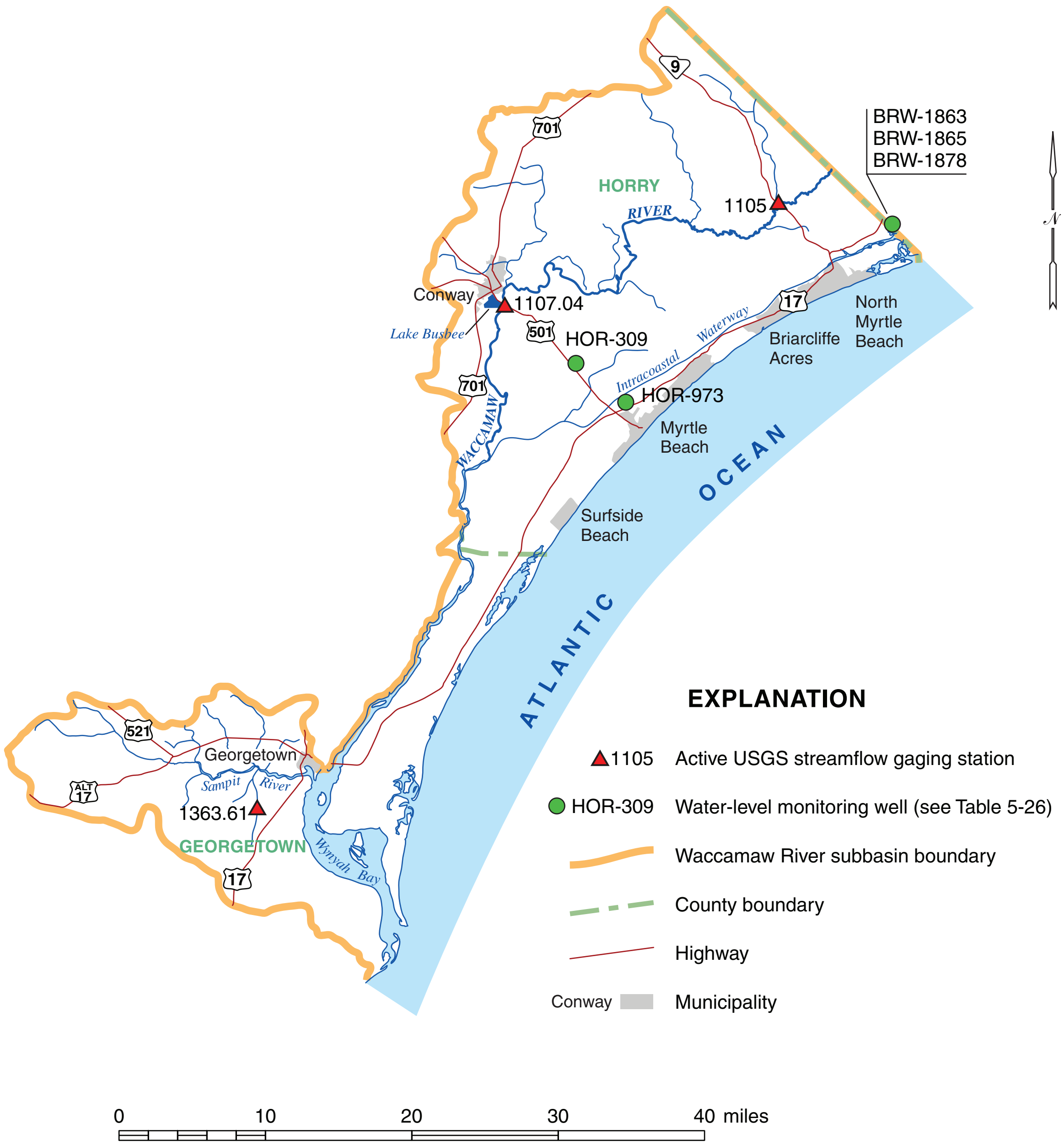


Figure 5-21. Map of the Waccamaw River subbasin.

SURFACE WATER

Hydrology

The Waccamaw River, Intracoastal Waterway, Sampit River, and Winyah Bay constitute the subbasin's major water bodies. Much of the subbasin is occupied by cypress and hardwood swamps and small tributary-stream valleys. The Waccamaw River is entirely in the lower Coastal Plain and has its headwaters and over half of its drainage area in North Carolina. The Waccamaw River and Sampit River flow directly into Winyah Bay. This large and important estuary also receives freshwater inflow directly from the Black and Pee Dee Rivers. The cities of Georgetown and Conway rely heavily on these streams for commercial transportation.

Streamflow of the Waccamaw River is currently monitored at two gaging stations in South Carolina, near Longs and at the Conway Marina at Conway (Figure 5-21). A gaging station also exists on the Waccamaw River outside the subbasin, at Freeland, N.C. A gaging station is also active on Turkey Creek, a tributary of the Sampit River, in Georgetown County. Streamflow statistics for these stations are presented in Table 5-23. Streamflow statistics for the gage at Conway are not presented because at that location the Waccamaw River is heavily influenced by astronomical tides during periods of low and medium flow.

Table 5-23. Selected streamflow characteristics at USGS gaging stations in the Waccamaw River subbasin

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
Waccamaw River at Freeland, N.C. 1095	1939 to 2007*	680	728	1.07	27	0.10 1954	30,600 1999	31,200 1999
Waccamaw River near Longs 1105	1950 to 2007*	1,110	1,258	1.13	53	1.0 1954	28,100 1999	28,200 1999
Waccamaw River at Conway Marina at Conway 1107.04	1994 to 2007*	Indeter-minate	– – –	– – –	– – –	– – –	24,100 1999	– – –
Turkey Creek near Maryville 1363.61	1993 to 2007*	4.7	6.4	1.36	0.37	0.03 1997	1,350 1995	1,500 1995

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*

Average annual flow of the Waccamaw River near Longs is 1,258 cfs (cubic feet per second), with streamflow at this location equal to or exceeding 53 cfs 90 percent of the time. The flow-duration curve (Figure 5-22) indicates highly variable streamflows in this river. Such poorly sustained streamflows are typical of streams in the lower Coastal Plain owing to diminished base-flow support from shallow ground-water sources.

The lowest flow of record at the Longs gage is 1.0 cfs and occurred during the drought of 1954. The record flood flow (28,100 cfs) was the result of Hurricane Floyd in 1999. Occasional high flows in the Waccamaw River and poor drainage cause flooding in the vicinity of Conway.

Surface-water availability in the Waccamaw River is variable and generally unreliable as a major source of supply. Adequate surface-water supplies can be guaranteed only if provisions for storage are developed.

Development

Surface-water development in the Waccamaw River subbasin includes few impoundments and no hydropower facilities, but there are numerous navigation and flood-control projects. The only impoundment with a surface area greater than 200 acres is Lake Busbee, at Conway, with a surface area of 400 acres and a volume of 1,100 acre-ft. This lake is used for recreation and as a source of cooling water for the Grainger Steam Plant, a thermoelectric power plant currently owned by the Central Electric Power Cooperative and operated by Santee Cooper.

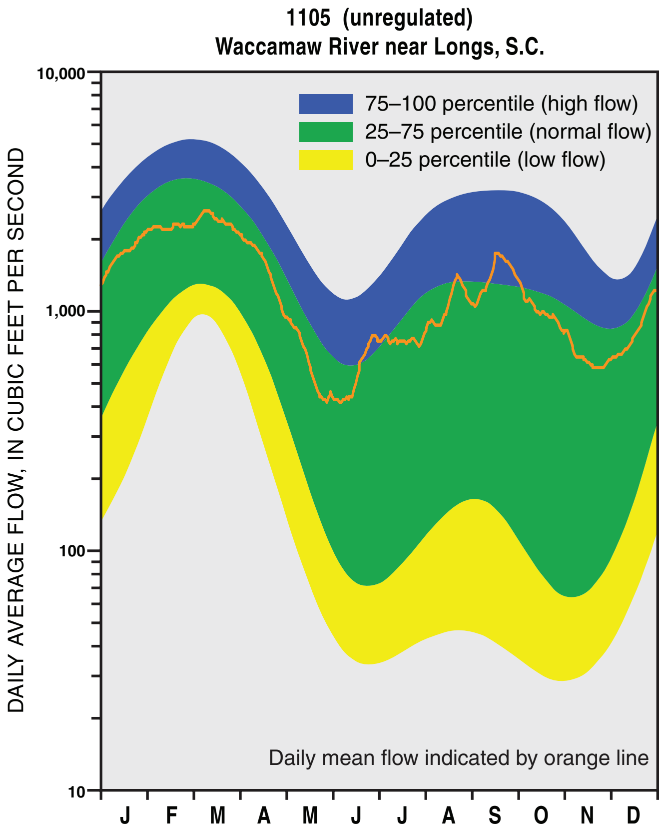


Figure 5-22. Duration hydrograph for the Waccamaw River near Longs, S.C., gaging station.

The U.S. Army Corps of Engineers (COE) has a continuing navigation project in Georgetown Harbor, where a channel is maintained from the ocean through Winyah Bay and into the Sampit River; the Steel Mill Channel was dredged in 2004. The Murrells Inlet navigation project was completed in 1980, and the most recent maintenance dredging was completed in 2002. A survey of the Atlantic Intracoastal Waterway between Winyah Bay and Charleston was made during 2005.

The COE completed five flood-control projects in the subbasin during the 1950's and 1960's, and the Natural Resources Conservation Service has two active flood-control projects.

Surface-Water Quality

Most of the water bodies in the Waccamaw River subbasin are designated "Freshwater" (Class FW). Class FW is freshwater suitable for the survival and propagation of aquatic life, primary- and secondary-contact recreation, and for drinking-water supply, fishing, and industrial and agricultural use (DHEC, 2007b).

Parts of Little River and the Atlantic Intracoastal Waterway and its tributaries (from the crossing of S.C. highway 9 to the North Carolina line) are designated "Tidal Saltwater" (Class SA). This water is suitable for the survival and propagation of a balanced indigenous aquatic community of marine fauna and flora. Average dissolved oxygen in these waters should not be less than 5.0 mg/L (milligrams per liter), with a minimum of 4.0 mg/L. Class SA water is not protected for harvesting clams, mussels, or oysters for market purposes or human consumption.

Winyah Bay and the Sampit River are designated "Tidal Saltwater" (Class SB). Class SB water is the same as Class SA water except that Class SB water must maintain dissolved-oxygen averages above 4.0 mg/L (DHEC, 2007b).

As part of its ongoing Watershed Water-Quality Assessment program, DHEC sampled 42 surface-water sites in the Waccamaw River subbasin in 2003 in order to assess the water's suitability for aquatic life and recreational use (Figure 5-23). Aquatic-life uses were fully supported at 23 sites, or 55 percent of the water bodies sampled in this subbasin; most of the impaired water exhibited dissolved-oxygen levels below the concentrations needed to support aquatic life. Recreational use was fully supported in 95 percent of the sampled water bodies; the two water bodies that did not support recreational use exhibited high levels of fecal-coliform bacteria (DHEC, 2007b). Water-quality impairments in the subbasin are listed in Table 5-24.

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 the most recent impairments and water-quality trends online in their 303(d) listings and 305(b) reports.

In 2008, as in previous years, DHEC issued a fish-consumption advisory for the Waccamaw River (from the North Carolina/South Carolina state line to Winyah Bay) and the Intracoastal Waterway in Horry County. Fish-consumption advisories are issued in areas where fish contaminated with mercury have been found. The contamination is only in the fish and does not make the water unsafe for skiing, swimming, or boating.

GROUND WATER

Hydrogeology

The Waccamaw River subbasin is wholly within the Coastal Plain. Basement rocks lie at a depth of about 1,000 feet below sea level at the North Carolina/South Carolina border and dip southward to 2,000 feet at Winyah Bay. The top of the Cape Fear aquifer dips southward and ranges from 750 to 1,300 feet below sea level. The Middendorf aquifer overlies the Cape Fear, and its surface is between 550 and 1,000 feet below sea level. Above the Middendorf aquifer lies the Black Creek aquifer, which has a thickness greater than 300 feet throughout most of the subbasin. A confining layer between the Black Creek and the Middendorf hydraulically separates the two aquifers. Selected ground-water data for the subbasin are presented in Table 5-25.

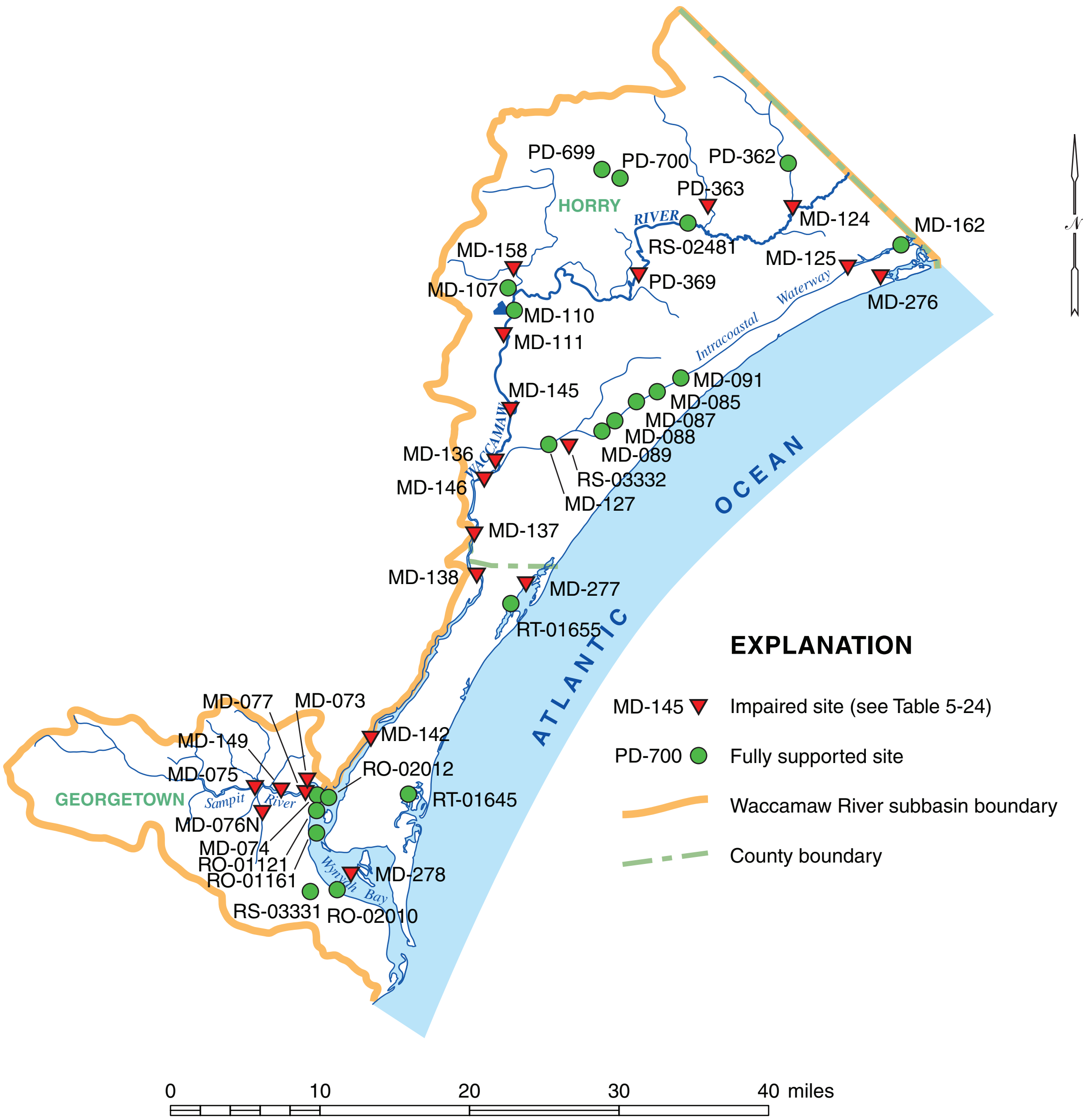


Figure 5-23. Surface-water-quality monitoring sites evaluated by DHEC for suitability for aquatic life and recreational uses. Impaired sites are listed in Table 5-24 (DHEC, 2007b).

Table 5-24. Water-quality impairments in the Waccamaw River subbasin (DHEC, 2007b)

Water-body name	Station number	Use	Status	Water-quality indicator
Sampit River	MD-075	Aquatic life	Nonsupporting	Dissolved oxygen
	MD-077	Aquatic life	Partially supporting	Dissolved oxygen
	MD-073	Aquatic life	Partially supporting	Dissolved oxygen
Turkey Creek	MD-076N	Aquatic life	Nonsupporting	pH
Whites Creek	MD-149	Aquatic life	Nonsupporting	Dissolved oxygen, copper
Winyah Bay	MD-278	Aquatic life	Partially supporting	Dissolved oxygen
Waccamaw River	MD-124	Aquatic life	Nonsupporting	Copper
Simpson Creek	PD-363	Aquatic life	Nonsupporting	Zinc
Crab Tree Swamp	MD-158	Recreation	Partially supporting	Fecal coliform
Waccamaw River	PD-369	Aquatic life	Partially supporting	Dissolved oxygen
	MD-111	Aquatic life	Nonsupporting	Dissolved oxygen
	MD-145	Aquatic life	Partially supporting	Dissolved oxygen
	MD-136	Aquatic life	Nonsupporting	Dissolved oxygen
Atlantic Intracoastal Waterway tributary	RS-03332	Recreation	Partially supporting	Fecal coliform
Waccamaw River	MD-146	Aquatic life	Nonsupporting	Dissolved oxygen
	MD-137	Aquatic life	Nonsupporting	Dissolved oxygen
	MD-138	Aquatic life	Partially supporting	Dissolved oxygen
	MD-142	Aquatic life	Partially supporting	Dissolved oxygen
Atlantic Intracoastal Waterway	MD-125	Aquatic life	Nonsupporting	Copper
House Creek	MD-276	Aquatic life	Nonsupporting	Dissolved oxygen, copper
Parsonnage Creek	MD-277	Aquatic life	Partially supporting	Dissolved oxygen

Table 5-25. Selected ground-water data for the Waccamaw River subbasin

Vicinity	Aquifer	Well depth (feet)	Major well yield (gpm)
Myrtle Beach	Black Creek	265–770	200–1,000
Bucksport	Black Creek	500–710	165–1,000
Georgetown	Black Creek	650–884	520

The Black Creek aquifer is the main source of ground water for municipal, industrial, and domestic water supply in Horry and Georgetown Counties. Aquifer tests in the Myrtle Beach area indicate a value of 15 ft/day for the average hydraulic conductivity, 2,000 ft^2/day for the transmissivity, and 0.0002 for the storage coefficient. In the Bucksport area, pumping tests of wells screened in the Black Creek aquifer indicate a transmissivity of 1,300–2,500 ft^2/day. At Georgetown the transmissivity is less, ranging from 150 to 600 ft^2/day.

The Tertiary sand aquifer occurs in Georgetown County but is absent in most of Horry County. The confining unit that separates the Black Creek aquifer from the Tertiary sand aquifer in Georgetown County and from the shallow aquifers in Horry County consists mainly of the Peedee Formation. Because of a large percentage of clay and fine-grained sand, the hydraulic conductivity of this aquifer is low but sufficient to meet domestic requirements.

Throughout the Waccamaw River subbasin, thin beds of fine clayey sand, fine calcareous sand, and coquina of Tertiary and Quaternary ages overlie the Peedee Formation. This shallow aquifer is often used for domestic water supply where the contained water is of good quality.

Ground-Water Quality

The primary source of ground water for public supplies is the Black Creek aquifer system. Water from the Black Creek is a soft, alkaline, low-iron, sodium bicarbonate type and is generally suitable for most purposes.

Chloride concentrations vary with depth and area. They are greatest and occur at the shallowest depths in eastern Horry County, where concentrations exceed 250 mg/L (milligrams per liter) (Pelletier, 1985; Zack and

Roberts, 1988). These high levels of chloride represent incompletely flushed seawater over the southern flank of the Cape Fear Arch. The minimum, mean, and maximum chloride concentrations recorded in Horry County are 7.0, 140, and 490 mg/L, respectively (Hockensmith and Castro, 1993). Chlorides ranged between 40 and 500 mg/L in Georgetown County (Zack and Roberts, 1988).

Sodium levels in the Black Creek aquifer range from 250 mg/L near Garden City to 700 mg/L near Little River (Pelletier, 1985). They average about 300 mg/L in Horry County (Hockensmith and Castro, 1993).

Fluoride levels commonly exceed the recommended 2.0 mg/L limit. Concentrations range from 0.9 to 6.9, with a mean of 4.1 mg/L in Horry County (Hockensmith and Castro, 1993). The fluoride is attributed to the fluorapatite of fossilized shark teeth—fossils that are abundant in the sediment of the Black Creek aquifer (Zack, 1980).

Total dissolved solids (TDS) concentrations are greatest near the North Carolina/South Carolina border, exceeding 1,500 mg/L; TDS decrease to about 600 mg/L at the Horry-Georgetown county boundary (Pelletier, 1985) and average about 800 mg/L (Hockensmith and Castro, 1993). The excessive turbidity found intermittently throughout the subbasin, presumably caused by aragonite in suspension, generally dissipates with pumping (Pelletier, 1985).

The Middendorf aquifer contains water that is mineralized and unsuitable for public supplies. Concentrations of TDS, sodium, alkalinity, and chloride exceed 500, 250, 500, and 100 mg/L, respectively, throughout most of the subbasin. The distribution of these properties and constituents, is, in part, related to the diffuse saltwater wedge underlying the region, and their concentrations decrease toward the subbasin's northwest boundary (see the *Saltwater Contamination* section of Chapter 9, *Special Topics*).

The shallow aquifers that overlie the Black Creek aquifer consist mainly of Pleistocene and Pliocene terrace deposits that also are important sources of water. They supply domestic water needs in rural areas and, by means of ponds, provide irrigation water for many golf courses in the Grand Strand area. The water quality is variable, ranging from good to very poor. Calcium and bicarbonate are the predominant ions owing to the abundance of fossil-shell. TDS concentrations locally exceed several hundred milligrams per liter, hardness ranges from negligible to 200 mg/L (as calcium carbonate) and pH values range from about 5.0 to 7.0 (Glowacz and others, 1980). Elevated levels of hydrogen sulfide and color occur locally. Iron concentrations range from 5 to 35,000 µg/L (micrograms per liter), but are usually less than 2,000 µg/L (Speiran and Lichtler, 1986). Chlorides are high where the aquifer is in contact with saltwater bodies.

Water-Level Conditions

Ground-water levels are regularly monitored by DNR in five wells in the Waccamaw River subbasin in order to help assess trends or changes in water levels and to monitor areas with known water-level problems (Table 5-26). Water levels in other wells are sometimes measured to help develop potentiometric maps of the Middendorf and Black Creek aquifers.

Table 5-26. Water-level monitoring wells in the Waccamaw 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
BRW-1863	DNR	33 53 33 78 35 22	Black Creek	Calabash, N.C.	48	496–506
BRW-1865	DNR	33 53 30 78 35 23	Middendorf	Calabash, N.C.	48	810–820
BRW-1878	DNR	33 53 35 78 35 20	Cape Fear	Calabash, N.C.	48	1,042–1,052
HOR-309	DNR	33 46 05 78 57 59	Black Creek	Conway	43	360–375
HOR-973	DNR	33 43 17 78 54 10	Middendorf	Myrtle Beach	20	1,012–1,328

* *DNR, South Carolina Department of Natural Resources*

Extensive development and over-pumping of the Black Creek aquifer in the Grand Strand area during the 1970's and 1980's lowered water levels nearly 200 feet below predevelopment levels, and declines of more than 10 feet per year were observed in some wells during the mid-1980's (Pelletier, 1985). Had this water-level depression continued into the 1990's, water levels would have reached the top of the aquifer, possibly resulting in aquifer compaction—the loss of storage capacity because of particle rearrangement. Beginning in 1988, with the prospect of permanently damaging the aquifer, public water suppliers in Horry County began switching from ground-water to surface-water sources, allowing Black Creek water levels to recover somewhat. Since 1988, the water level in one well in Myrtle Beach has recovered more than 100 feet from its lowest measured level (Figure 5-24).

The effect on water quality of the large regional withdrawals from the Black Creek aquifer prior to 1988 and the subsequent pumping reduction are not specifically known. There was intrusion of the saltwater/freshwater interface inland while withdrawals occurred, but with little observed impact because the shallow hydraulic gradients and low hydraulic conductivity caused slow rates of ground-water flow. Saltwater upconing and cross-contamination also occurred before 1988, but those avenues of contamination have been in part mitigated by water-level recovery and shifts in pumping centers and by regulation of well-screen placement.

Although water levels in most of Horry County have recovered substantially in the last two decades, a significant cone of depression has developed around the town of Andrews and city of Georgetown in Georgetown County (Figure 5-25). This depression, which reflects a

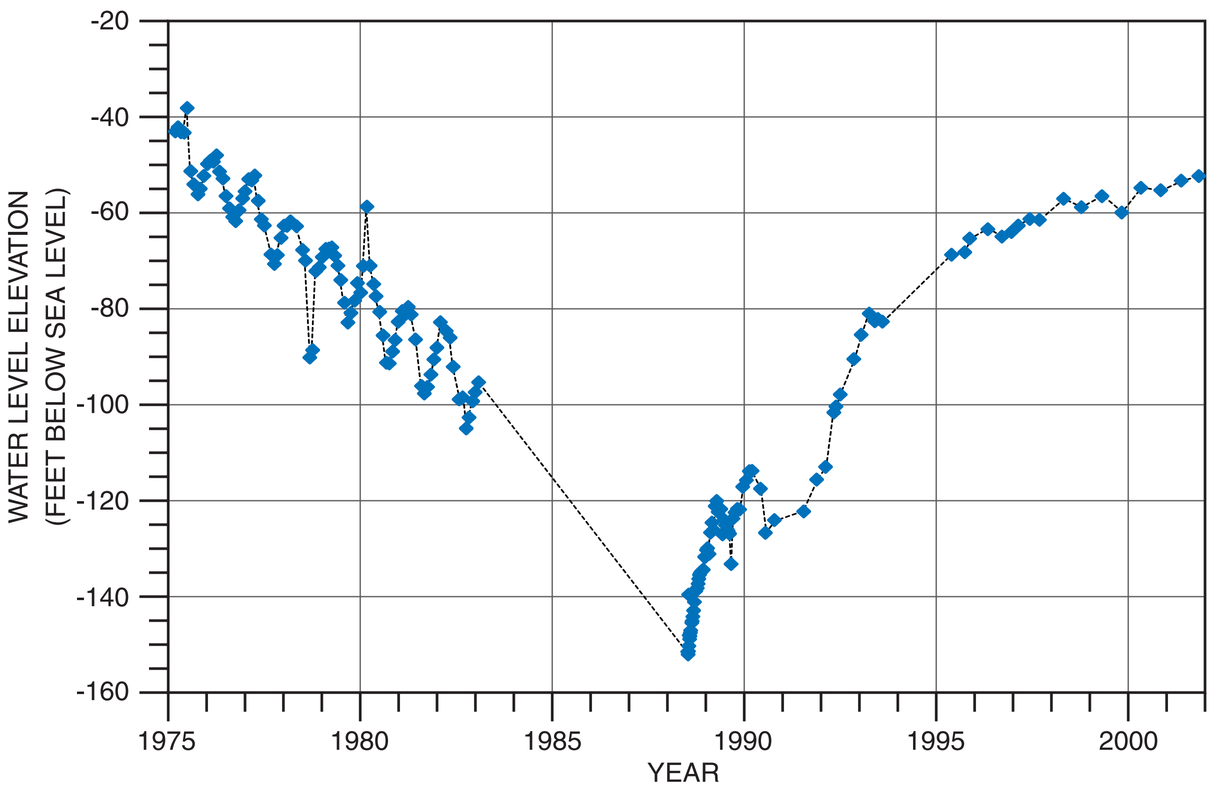


Figure 5-24. Water levels measured in a Black Creek aquifer well (HOR-290) at Myrtle Beach. Water-level declines caused by excessive pumping recovered significantly after regional ground-water pumping was reduced in the late 1980's.

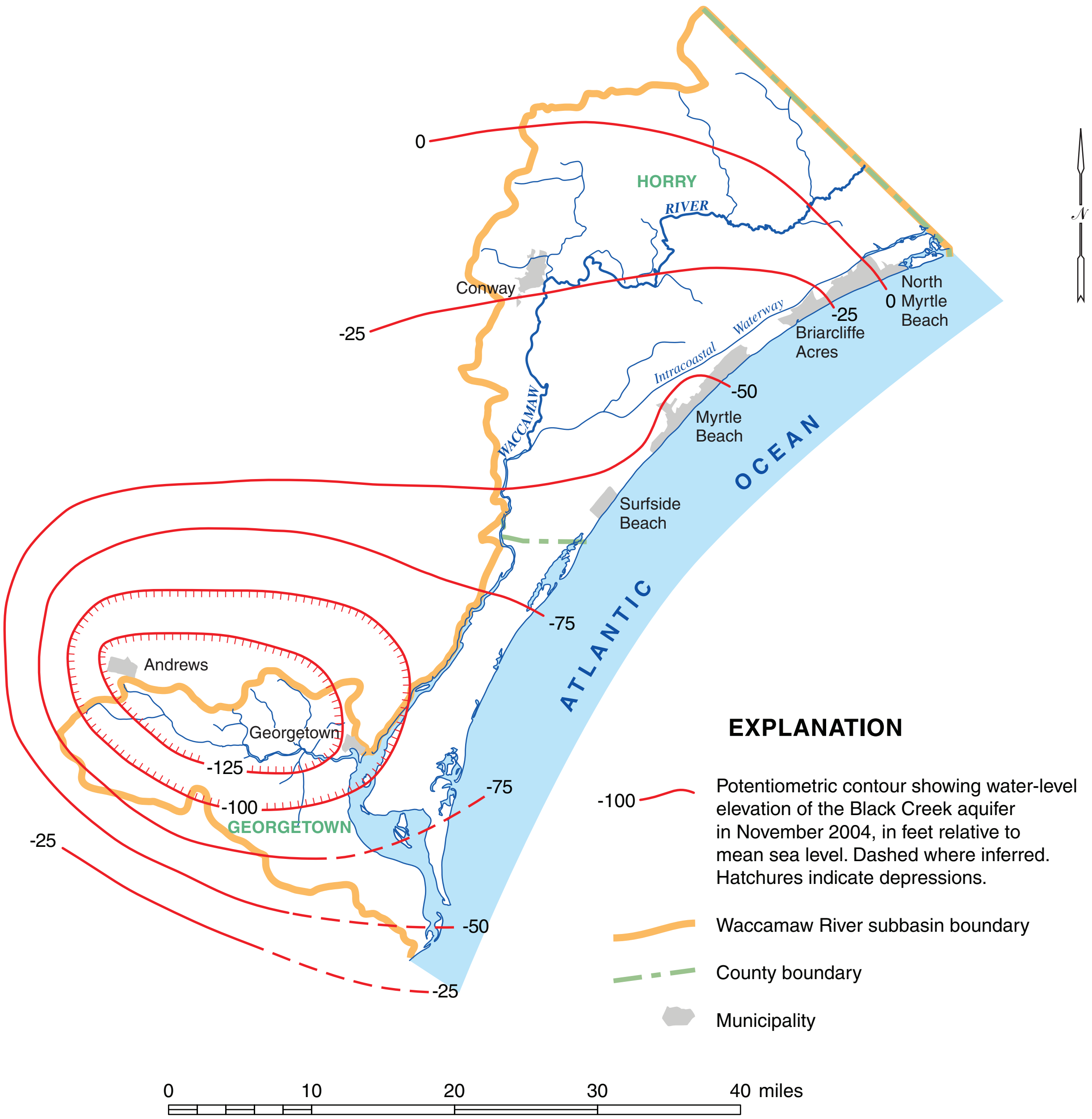


Figure 5-25. Potentiometric contours of the Black Creek aquifer in the Waccamaw River subbasin, November 2004 (from Hockensmith, 2008b).

decline of about 200 feet from predevelopment levels, contains the lowest point on the potentiometric surface of the Black Creek aquifer (Hockensmith, 2008b). Outside of this cone of depression, Black Creek aquifer water levels in this subbasin are generally 50 to 100 feet lower than estimated predevelopment levels.

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 Waccamaw River subbasin is summarized in Table 5-27 and Figure 5-26. Offstream water use in this subbasin was 67,039 million gallons in 2006, ranking it eighth among the 15 subbasins. Of this amount, 65,130 million gallons were from surface-water sources (97 percent) and 1,909 million gallons were from ground-water sources (3 percent). Thermoelectric power production accounted for 73 percent of this total use, followed by water supply (13 percent) and golf course (7 percent). Consumptive use in this subbasin is estimated to be 12,221 million gallons, or about 18 percent of the total offstream use.

By far, the largest water user in this subbasin is Santee Cooper's Grainger electrical generating station, located adjacent to Lake Busbee at Conway in Horry County. This facility used 44,499 million gallons in 2006, which is about 90 percent of water used for power generation in the subbasin, and about two-thirds of the total reported water use for the entire subbasin. The subbasin's only other thermoelectric power plant, Santee Cooper's Winyah generating station, located near Georgetown, used 4,715 million gallons of surface water in 2006. Both are coal-fired plants that use steam to drive turbines and produce electricity.

Table 5-27. Reported water use in the Waccamaw 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	3,810	5.9	568	29.8	4,379	6.5
Industry	788	1.2	209	11.0	997	1.5
Irrigation	3,583	5.5	208	10.9	3,791	5.7
Mining	104	0.2	0	0.0	104	0.2
Other	0	0.0	21	1.1	21	0.0
Thermoelectric power	49,214	75.6	0	0.0	49,214	73.4
Water supply	7,631	11.7	902	47.2	8,533	12.7
Total	65,130		1,909		67,039	

Water-supply use in the subbasin totaled 8,533 million gallons in 2006. Surface water accounted for 7,631 million gallons (89 percent) and ground water for 902 million gallons (11 percent). The largest surface-water user was the city of Myrtle Beach, which withdrew 5,964 million gallons from the Atlantic Intracoastal Waterway in 2006. Georgetown Water and Sewer District was the other major surface-water supplier in the subbasin, withdrawing 1,667 million gallons from the Waccamaw River. Some of the larger water suppliers that used ground water were the Grand Strand Water and Sewer Authority (231 million gallons); the city of Georgetown (140 million gallons); Georgetown County Water and Sewer District (135 million gallons); and North Myrtle Beach (116 million gallons). Most of the ground water is pumped from the Black Creek aquifer.

Because of the large number of golf courses in Horry and Georgetown Counties, golf-course irrigation is a major use of water in the subbasin, ranking first among the 15 subbasins in this category. A total of 4,379 million gallons of water were used at 67 golf courses in 2006. Of this amount, 3,810 million gallons were from surface-water sources (87 percent) and 568 million gallons were from ground-water sources (13 percent). Most ground water is pumped from the surficial aquifer, within 100 feet of land surface. Some wells also tap the deeper Black Creek aquifer. Some of the larger users included the Reserve at Litchfield (340 million gallons) and Burroughs and Chapin Grande Dunes in Myrtle Beach (260 million gallons).

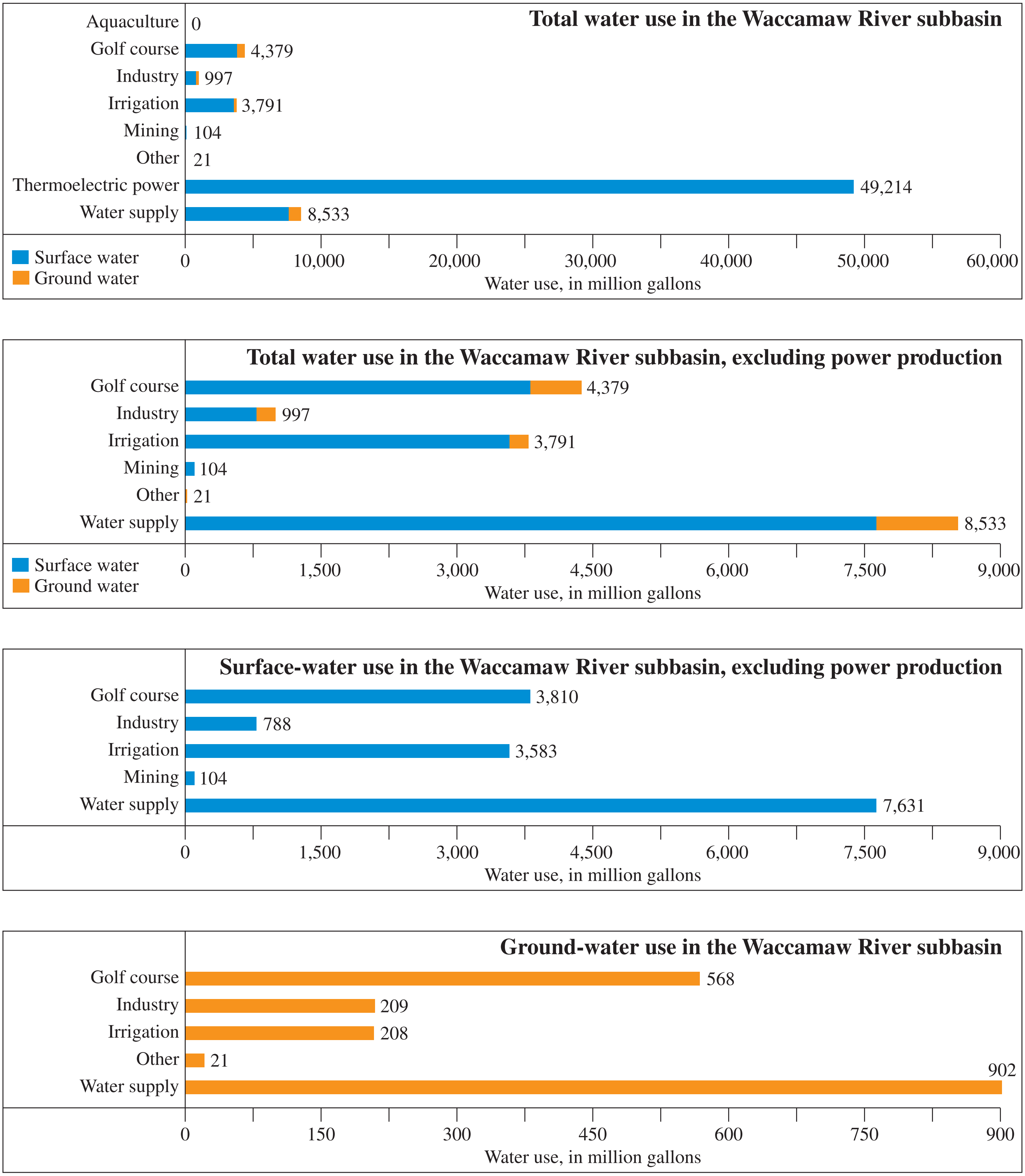


Figure 5-26. Reported water use in the Waccamaw River subbasin for the year 2006 (modified from Butler, 2007).

Irrigation water use totaled 3,791 million gallons, which was 5.7 percent of the water used in the subbasin in 2006. Of this amount, 3,583 million gallons were from surface-water sources (94 percent) and 208 million gallons were from ground-water sources (6 percent). By far the greatest user was Debordieu Colony Community Association in Georgetown, which used 3,517 million gallons.

Industrial water use in the subbasin was 997 million gallons in 2006. Of this amount, 788 million gallons were from surface-water sources (79 percent) and 209 million gallons were from ground-water sources (21 percent). The largest user was 3V, Inc. in Georgetown, which used 780 million gallons.

About 104 million gallons of surface water were used for mining purposes. This represents about 0.2 percent of the total reported water use in the subbasin.

AQUIFER STORAGE AND RECOVERY PROGRAM

In the Grand Strand area, the demand for water increases as much as 70 percent during the summer months, when the population swells because of an influx of tourists (Castro, 1995). In order to provide adequate amounts of drinking water in the summer, water suppliers need water treatment plants whose capacities greatly exceed the average daily demand; most days of the year, however, the treatment plants would operate much below their optimum capacities. As a way to operate their treatment plants more efficiently, and to provide additional water for high-demand summer days, the city of Myrtle Beach began an aquifer storage and recovery (ASR) program in the 1990's.

The concept of an ASR program is to treat more surface water than is needed during times of low demand, inject the excess treated water into an aquifer and store it in the ground until the demand for water is high, and then pump the water out of the ground when it can be used to supplement surface-water supplies. ASR wells can provide water for short-term, high-demand periods, which can allow water systems to meet user demands with smaller treatment plants, thereby reducing the overall cost of providing the water. Additionally, the use of an ASR system can reduce water-production costs by allowing treatment plants to operate more efficiently by stabilizing plant production to an optimum flow rate and by treating more surface water in the winter, when the water quality is better than in the summer, and is thus less expensive to treat.

Begun in the mid-1990's, the Myrtle Beach ASR program was the first of its kind in South Carolina. The Grand Strand Water and Sewer Authority, which recently took over operation of the Myrtle Beach water-treatment plants, now operates this ASR program that currently consists of 15 ASR wells in operation or under development. The combined storage volume is nearly two billion gallons and treated water can be withdrawn from these ASR wells at a rate of 14.9 million gallons per day.