Table 1. Water withdrawals, in million gallons per day, by source in Catahoula Parish, Louisiana, 2010 (Sargent, 2011).

Aquifer or surface-water body	Groundwater	Surface water
Red River alluvial aquifer	0.21	
Mississippi River alluvial aquifer	20.49	
Catahoula aquifer	1.93	
Miscellaneous streams		7.38
Total	**22.63**	**7.38**

Table 2. Water withdrawals, in million gallons per day, by use category in Catahoula Parish, Louisiana, 2010 (Sargent, 2011).

Use category	Groundwater	Surface water	Total
Public supply	1.86	0.00	1.86
Rural domestic	0.11	0.00	0.11
Livestock	0.02	0.04	0.06
Rice irrigation	11.86	0.00	11.86
General irrigation	7.34	7.34	14.68
Aquaculture	1.44	0.00	1.44
Total	**22.63**	**7.38**	**30.01**

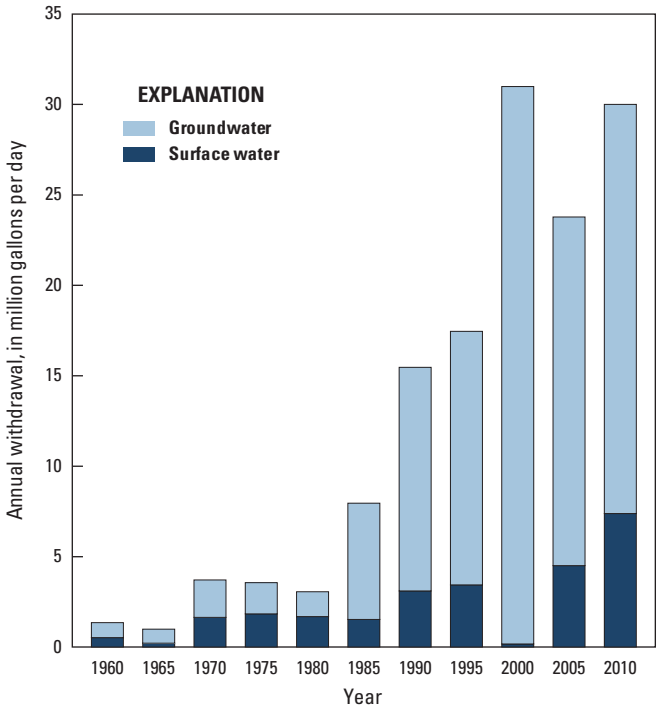

Figure 2. Water withdrawals in Catahoula Parish, Louisiana, 1960–2010 (Sargent, 2011).

Groundwater Resources

The primary freshwater-bearing aquifers underlying Catahoula Parish are the alluvial and Catahoula aquifers (figs. 1, 3). Other aquifers containing freshwater underlying Catahoula Parish include the Upland terrace and Jasper aquifers but are not considered major sources of freshwater in the parish because of their limited extents (Snider and Sanford, 1981; Martin and others, 1988). The base of fresh groundwater (water with a chloride concentration of 250 milligrams per liter [mg/L] or less) may be found in the alluvial aquifers at depths shallower than 100 feet (ft) below the National Geodetic Vertical Datum of 1929 (NGVD 29) in the northern part of the parish to deeper than 200 ft below NGVD 29 in the southern part of the parish. The base of fresh groundwater may be found at depths shallower than NGVD 29 in the northwestern part of the parish to deeper than 700 ft below NGVD 29 in the central part of the parish in the Catahoula aquifer (fig. 1) (Smoot, 1988). Saltwater (water with a chloride concentration greater than 250 mg/L) is present in some intermediate sands in the east-central part of the parish, and little to no fresh groundwater is available in the extreme northwestern corner of the parish (Smoot, 1988).

Alluvial Aquifers

The alluvial aquifers are composed of sand and gravel deposited by streamflow in Catahoula Parish. The Mississippi River alluvial aquifer, which includes the Red River alluvial and Ouachita River alluvial aquifers, is the major aquifer underlying the parish. (Some classifications describe these aquifers as distinct but connected aquifers; see Lovelace and Lovelace, 1995.) The alluvial aquifer is composed of the sand and gravel component of sediments deposited by the rivers. In Catahoula Parish, the Mississippi River alluvial deposit thickness ranges from less than 80 ft to greater than 160 ft (Whitfield, 1975). The base of the aquifer generally ranges from less than about 25 ft below NGVD 29 in the north-central part of the parish to greater than 200 ft below NGVD 29 in the southeastern part of the parish (Saucier, 1994).

The primary source of recharge for the alluvial aquifer is the infiltration of precipitation, with lesser amounts of recharge coming from streams and rivers during high stage. Groundwater discharges naturally by way of flow into streams and rivers and evapotranspiration and artificially by way of well withdrawals (Whitfield, 1975).

In 1990, water levels in wells screened in the Mississippi River alluvial aquifer ranged from less than 50 ft above NGVD 29 in the northern part of the parish to about 20 ft above NGVD 29 in the south-central part of the parish (Seanor and Smoot, 1995). These water levels indicate that groundwater generally flows south to southwest in the Mississippi River alluvial aquifer in Catahoula Parish. Water levels in well Ct-87, located in the southern part of the parish and screened in the Mississippi River alluvial aquifer, have fluctuated annually and declined about 2 ft overall from fall of 1972 to fall of 2015 (fig. 4). Water levels in well Ct-74, located in the southern part of the parish and screened in the Red River alluvial aquifer, have fluctuated annually, declined during the late 1970s, and recovered in the early 1980s. Dewatering wells in operation during 1978–84 for the construction of the Red River Lock and Dam No. 1 caused the water-level declines in well Ct-74 during that period (Smoot and Martin, 1991). Water levels in well Ct-347, located in the northern part of the parish and screened in the Mississippi River alluvial aquifer, have generally fluctuated less than 5 ft annually and declined about 8 ft from 1990 to 2016.

State well-registration records listed 467 active water wells screened in the Mississippi River and Red River alluvial aquifers in Catahoula Parish in 2015, including 419 irrigation, 36 domestic, 10 public supply, and 2 industrial. Depths of these wells ranged from 30 to 187 ft below land surface, and reported yields ranged from 3 to 4,300 gallons per minute (gal/min) (Louisiana

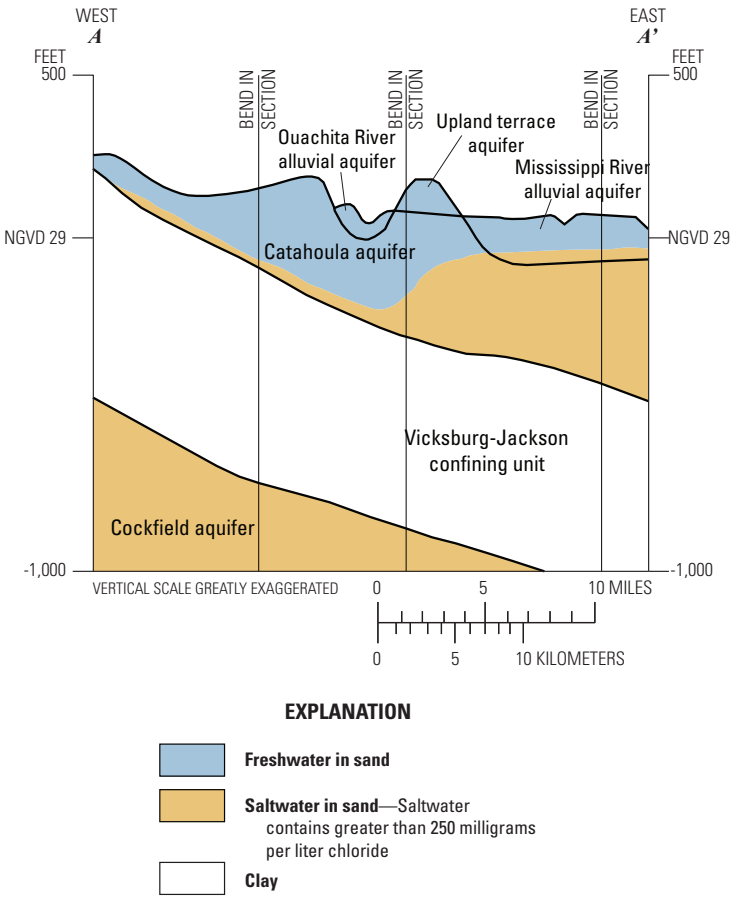

Figure 3. Idealized west-to-east hydrogeologic section through Catahoula Parish, Louisiana (modified from Smoot, 1989). Trace of section shown on figure 1.

Department of Natural Resources, written commun., 2015). In 2010, about 20.71 Mgal/d were withdrawn from the alluvial aquifers, primarily the Mississippi River alluvial aquifer, with use categories including 1.44 Mgal/d for aquaculture, 0.07 Mgal/d for rural domestic, 7.19 Mgal/d for general irrigation, 11.86 Mgal/d for rice irrigation, and 0.14 Mgal/d for public supply (B.P. Sargent, U.S. Geological Survey, written commun., 2015).

Catahoula Aquifer

The Catahoula aquifer is present across the central part of the State of Louisiana and crops out in a narrow band extending from the Texas State line to northern Catahoula Parish. The aquifer contains freshwater in the parish from about Jonesville west to the parish line and north to near Sicily Island (fig. 1). In the outcrop area, the Catahoula aquifer dips to the south at a rate of about 50–70 ft per mile. The aquifer is composed of sands that are typically white to light gray, range from very coarse to very fine grained, are seldom areally extensive, and are interbedded with silts and clays. Recharge to the aquifer is from infiltration of precipitation in the outcrop area and flow from adjacent aquifers (Martin and Whiteman, 1986; Fendick and Carter, 2015).

In 2013, water levels in wells screened in the Catahoula aquifer in the northwestern part of the parish were about 100 ft above NGVD 29 and in the central part of the parish were less than 20 ft above NGVD 29, indicating that groundwater in the aquifer generally flows to the southeast in Catahoula Parish. Localized levels are as high as about 80 ft above NGVD 29 under Sicily Island. Levels in central and north-central Catahoula Parish have declined about 20 ft or more from 1980 to 2015 (Martin and Whiteman, 1986; Fendick and Carter, 2015; U.S. Geological Survey, 2016). Levels in well Co-50 screened in the Catahoula aquifer in neighboring Concordia Parish to the east have declined over 45 ft during 1970–2015 (fig. 4).

State well-registration records listed 58 active water wells screened in the Catahoula aquifer in Catahoula Parish in 2015, including 24 domestic, 1 industrial, 4 irrigation, and 29 public supply. Depths of these wells ranged from 124 to 798 ft below land surface, and reported yields ranged from 5 to 608 gal/min (Louisiana Department of Natural Resources, written commun., 2015). In 2010, 1.93 Mgal/d were withdrawn from the Catahoula aquifer, including 0.04 Mgal/d for rural-domestic use, 0.15 Mgal/d for general irrigation, 0.02 Mgal/d for livestock, and 1.72 Mgal/d for public-supply use (B.P. Sargent, U.S. Geological Survey, written commun., 2015).

Groundwater Quality

Freshwater samples taken from wells screened in the Mississippi River and Red River alluvial aquifers were found to have similar median values for pH of 7.1 and 6.9 standard units, respectively; similar median hardness[2] of 300 and 320 mg/L as calcium carbonate, respectively; and similar median magnesium of 28.5 and 28 mg/L, respectively (table 3). Iron concentrations exceeded the U.S. Environmental Protection Agency's Secondary Maximum Contaminant Levels (SMCLs)[3] in 71 percent of Mississippi River alluvial aquifer samples and 95 percent of Red River alluvial aquifer samples. Samples from both aquifers were within the very hard range for hardness.

Freshwater samples taken from the Catahoula aquifer had a greater median pH (7.4 standard units) than median pH values in samples from the Mississippi River and Red River alluvial aquifers (table 3). Catahoula aquifer samples had median concentrations of hardness (8.5 mg/L), magnesium (0.5 mg/L), iron (205 micrograms per liter [µg/L]), and manganese (35 µg/L) that were less than median concentrations in samples from the Mississippi River and Red River alluvial aquifers. Little to no fresh groundwater is present in the far northwestern corner of the parish where the Vicksburg-Jackson confining unit (fig. 3) crops out and saltwater is present in underlying aquifers.

Surface-Water Resources

Numerous surface-water resources in Catahoula Parish are present in three regional drainage basins, which are composed of multiple subbasins. The Boeuf-Tensas Basin (Hydrologic Unit Code [HUC] 080500) is present along the northern border and eastern border of the parish, north of Jonesville (fig. 1). The Lower Ouachita Basin (HUC 080402) is present in the northern interior of Catahoula Parish, and the Lower Red Basin (HUC 080403) is present in about the southern half of the parish (fig. 1; U.S. Geological Survey, 2016). Numerous lakes are present within

[2]Hardness ranges, expressed as milligrams per liter of calcium carbonate, are as follows: 0–60, soft; 61–120, moderately hard; 121–180, hard; greater than 180, very hard (Hem, 1985).

[3]The SMCLs are nonenforceable Federal guidelines regarding cosmetic effects (such as tooth or skin discoloration), aesthetic effects (such as taste, odor, or color), or technical effects (such as damage to water equipment or reduced effectiveness of treatment for other contaminants) of drinking water. The SMCLs were established as guidelines by the U.S. Environmental Protection Agency (2016).

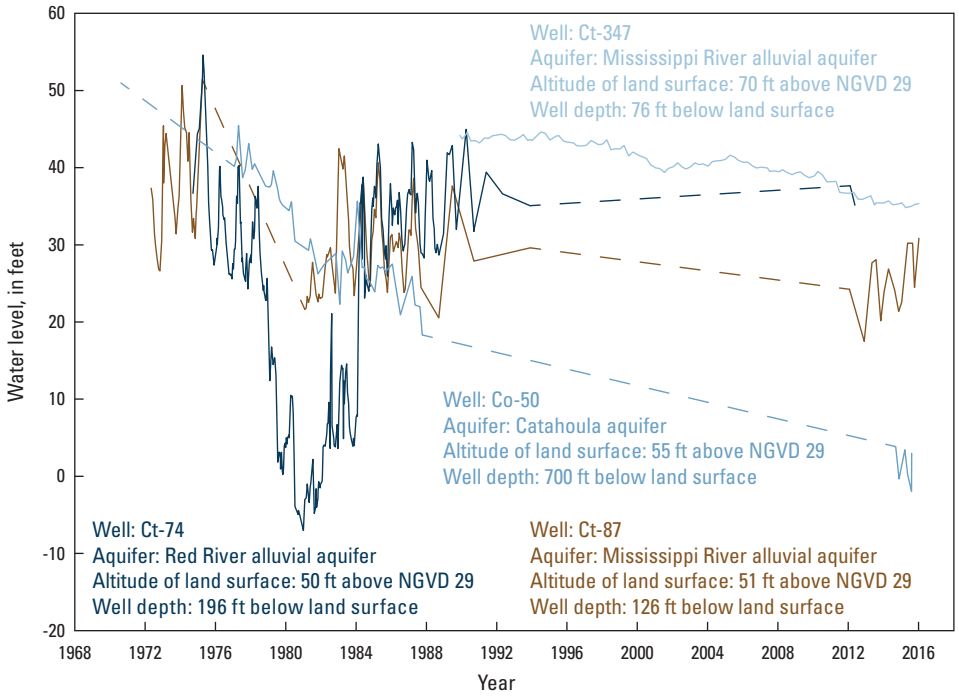

Figure 4. Water levels in well Ct-87 and Ct-347 screened in the Mississippi River alluvial aquifer, well Ct-74 screened in the Red River alluvial aquifer, and well Co-50 screened in the Catahoula aquifer in Catahoula and Concordia Parishes, Louisiana (see fig. 1 for well locations; U.S. Geological Survey, 2016). Land surface and water levels are in feet (ft) relative to the National Geodetic Vertical Datum of 1929 (NGVD 29). Dashed lines indicate gaps in available data.

Catahoula Parish, including Larto Lake, Wallace Lake, Tew Lake, and Mean Lake (fig. 1). In 2010, 7.38 Mgal/d of surface water were withdrawn in Catahoula Parish from miscellaneous streams, including 7.34 Mgal/d for general irrigation and 0.04 Mgal/d for livestock (tables 1 and 2).

Boeuf-Tensas Basin

The Boeuf River forms part of the north-central border of Catahoula Parish and flows into the Ouachita River on the northwestern side of Sicily Island. The Tensas River flows along the eastern border of Catahoula Parish until it empties into the Black River.

Lower Ouachita Basin

The Ouachita River is the primary water body draining the Lower Ouachita Basin (fig. 1). The river flows into Catahoula Parish from Caldwell Parish; receives flow from tributaries including Bayou Louis, Gastis Creek, and many other small streams; and finally ends near Jonesville. The average daily discharge for the Ouachita River at Columbia Lock and Dam near Riverton (site number 07367630; fig. 1) during 1982–87 was about 21,326 cubic feet per second (ft^3/s) (U.S. Geological Survey, 2016).

Lower Red Basin

The Red, Black, and Little Rivers are primary drainages of the Lower Red Basin in Catahoula Parish. The Little River flows into Catahoula Parish from LaSalle Parish and ends near Jonesville as it merges with the Ouachita River and Tensas River to form the Black River (fig. 1). The Black River flows south, forming the eastern border of the parish until it flows into the Red River. The Red River forms the southern border of the parish. The average discharge of an upstream site, Red River at Alexandria (site number 07355500), was 30,770 ft^3/s during 1928–82 (Carlson and others, 1983).

Surface-Water Quality

Samples taken from the Ouachita River at Columbia during 1974–93, Red River at Lock and Dam No. 1 near Vick during 1983–95, and Black River at Jonesville during 1958–72 were found to have median values for hardness that ranged from soft to hard and median pH values of 6.7–7.6 standard units (table 4). Chloride and sulfate concentrations generally did not exceed SMCLs in samples from these rivers. Median dissolved-oxygen concentrations in the Ouachita River samples were 7.2 mg/L and in the Red River samples were 8.1 mg/L; a concentration of 5 mg/L is considered the minimum value for a diverse population of fresh, warmwater biota, including sport fish (Louisiana Department of Environmental Quality, 2008).

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Table 3. Summary of selected freshwater-quality characteristics for the Mississippi River alluvial, Red River alluvial, and Catahoula aquifers in Catahoula Parish, Louisiana (U.S. Geological Survey, 2016).

[Values are in milligrams per liter, except as noted. µS/cm, microsiemen per centimeter; °C, degree Celsius; SU, standard unit; $CaCO_3$, calcium carbonate; µg/L, microgram per liter; SMCL, Secondary Maximum Contaminant Level established by the U.S. Environmental Protection Agency (2016); NA, not applicable; <, less than]

	Specific conductance, field (µS/cm at 25 °C)	pH, field (SU)	Hardness (as $CaCO_3$)	Calcium, filtered (as Ca)	Magnesium, filtered (as Mg)	Sodium, filtered (as Na)	Chloride, filtered (as Cl)	Sulfate, filtered (as SO_4)	Iron, filtered, in µg/L (as Fe)	Manganese, filtered, in µg/L (as Mn)	Dissolved solids, filtered
Mississippi River alluvial aquifer, 1941–2015 (47 wells)											
Median	805	7.1	300	93	28.5	46	30	3.3	2,960	500	451
10th percentile	473.2	6.1	93.6	43.7	21.2	17	13	1.4	24.1	219.2	294.2
90th percentile	1,060	7.6	408.4	110	37.1	92.5	80.4	18	9,890	1,564	640.6
Number of samples	23	21	33	20	20	16	35	18	14	7	17
Percentage of samples that do not exceed SMCLs	NA	76	NA	NA	NA	NA	100	100	29	14	59
Red River alluvial aquifer, 1970–92 (48 wells)											
Median	886	6.9	320	87.5	28	65	35.5	1.2	5,500	595	531
10th percentile	686.8	6.6	170	61.4	20	22.8	19	<0.2	534	143	409.4
90th percentile	1,316	7.2	540	236	77.6	190	130	110	11,000	1,200	1,200
Number of samples	153	142	203	98	98	60	222	174	155	164	59
Percentage of samples that do not exceed SMCLs	NA	98	NA	NA	NA	NA	100	99	5	0	41
Catahoula aquifer, 1949–84 (47 wells)											
Median	450	7.4	8.5	2.2	0.5	100	26	3.6	205	35	308
10th percentile	280	6.4	2	0.5	<0.1	52.6	14.0	0	20	<10	213.8
90th percentile	1,060	8	50	11.6	5.3	230	188	20.8	880	90	636
Number of samples	41	39	52	35	35	35	53	35	36	24	35
Percentage of samples that do not exceed SMCLs	NA	87	NA	NA	NA	NA	100	100	64	75	66
SMCLs											
	NA	6.5–8.5	NA	NA	NA	NA	250	250	300	50	500

Martin, Angel, Jr.; Whiteman, C.D., Jr.; and Becnel, M.J., 1988, Generalized potentiometric surfaces of the upper and lower Jasper and equivalent aquifers in Louisiana, 1984: U.S. Geological Survey Water-Resources Investigations Report 87–4139, 2 sheets.

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Table 4. Summary of selected water-quality characteristics for the Ouachita, Black, and Red Rivers near Catahoula Parish, Louisiana (U.S. Geological Survey, 2016).

[Values are in milligrams per liter, except as noted. µS/cm, microsiemen per centimeter; °C, degree Celsius; SU, standard unit; $CaCO_3$, calcium carbonate; µg/L, microgram per liter; SMCL, Secondary Maximum Contaminant Level established by the U.S. Environmental Protection Agency (2016); NA, not applicable]

	Specific conductance, field (µS/cm at 25 °C)	Oxygen, dissolved	pH, field (SU)	Hardness (as $CaCO_3$)	Calcium, filtered (as Ca)	Magnesium, filtered (as Mg)	Sodium, filtered (as Na)	Chloride, filtered (as Cl)	Sulfate, filtered (as SO_4)	Iron, filtered, in µg/L (as Fe)
Ouachita River at Columbia (1974–93)[1]										
Median	168	7.2	6.7	31	8.4	2.1	19	29	13	280
10th percentile	88	4.7	6.1	19	5	1.3	8.3	13	6.8	110
90th percentile	324	10.3	7.2	48	14	3.1	40	61	23	550
Number of samples	154	148	155	154	154	154	153	153	151	73
Percentage of samples that do not exceed SMCLs	NA	NA	66	NA	NA	NA	NA	100	100	62
Red River at Lock and Dam No.1 near Vick (1983–95)[2]										
Median	492	8.1	7.6	130	36.5	9.8	41	62	50	NA
10th percentile	213.2	6	7.1	66.3	19.1	3.9	15	20	20	NA
90th percentile	1,039	10.6	8.0	269.4	69.9	23	100	140	120	NA
Number of samples	123	121	123	122	122	122	110	120	119	NA
Percentage of samples that do not exceed SMCLs	NA	NA	100	NA	NA	NA	NA	99	100	NA
Black River at Jonesville (1958–72)[3]										
Median	402	NA	6.9	63	17	4.6	49.5	81	10	NA
10th percentile	155.5	NA	6.4	30.4	9.0	1.8	16	27.6	6.2	NA
90th percentile	763	NA	7.4	110	30	8.5	101.9	190	16	NA
Number of samples	536	NA	528	535	516	512	512	537	521	NA
Percentage of samples that do not exceed SMCLs	NA	NA	86	NA	NA	NA	NA	94	100	NA
SMCLs										
	NA	NA	6.5–8.5	NA	NA	NA	NA	250	250	300

[1]Site number 07367640 (see fig. 1).

[2]Site numbers 07355603 and 073556005 (see fig. 1).

[3]Site number 07373267 (see fig. 1).

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