Thermoelectric Power

The total quantity of water withdrawn for use by thermoelectric power plants during 2000 was an estimated 10,276 Mgal/d, which is more than all of the other offstream categories combined and an increase of 28 percent since 1995 (tables 13, 14, 15, and 26). The increase in withdrawals reflects the operation of additional generating units at the power plants since 1995. Surface water is the sole source of supply. Nearly all of the surface water used at these facilities was returned to the river. Return flow was 10,244 Mgal/d. For this report, return flow is limited to cooling-water discharge and excludes stormwater runoff. Approximately 0.3 percent, or 32.2 Mgal/d, was consumptively used as a result of once-through cooling, cooling tower, or pond cooling (table 13; fig. 13).

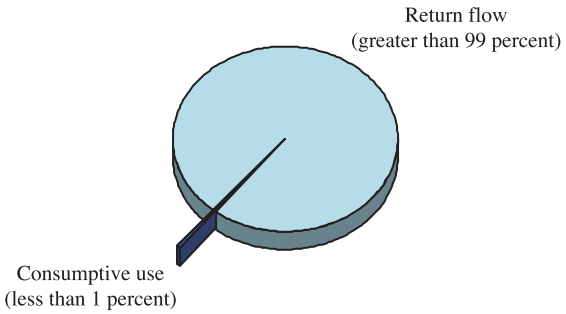

Figure 13. Disposition of water used by thermoelectric power plants in the Tennessee River watershed in 2000.

Table 13. Thermoelectric power water use by water-use tabulation area in 2000

[Figures may not add to totals because of independent rounding. All values in million gallons per day; WUTA, Water-use tabulation area]

Water-use tabulation area Reservoir catchment area	Surface-water withdrawal	Cooling water return flow	Net water demand	Power generated, in million kilowatt hours
Cherokee				
Cherokee	621.00	621.00	0.00	5,193
Douglas				
Douglas	4.97		4.97	2,561
Norris				
Norris	9.24	0.00	9.24	3,323
Melton Hill	469.00	469.00	0.00	5,968
WUTA total	**478.24**	**469.00**	**9.24**	**9,291**
Watts Bar-Chickamauga				
Watts Bar	1,484.10	1,345.00	139.10	18,855
Chickamauga	1,571.40	1,693.50	-122.10	16,777
WUTA total	**3,055.50**	**3,038.50**	**17.00**	**35,632**
Guntersville				
Guntersville	1,546.00	1,546.00	0.00	9,595
Wheeler-Wilson				
Wheeler	2,108.00	2,107.00	1.00	18,807
Pickwick				
Pickwick	1,251.00	1,251.00	0.00	7,201
Kentucky				
Kentucky	1,211.00	1,211.00	0.00	8,064
Watershed total	**10,276**	**10,244**	**32.2**	**96,344**

Thermoelectric power plants in the Tennessee River watershed are primarily powered by coal and nuclear energy, with small amounts of oil and natural gas burned in combustion turbine units. Water is used for condenser and reactor cooling and to replenish the boilers to produce steam. Nine fossil-fueled and three nuclear-fueled plants are located in the watershed. These 12 plants generated about 96,344 gigawatt-hours in 2000 compared to 76,600 gigawatt hours in 1995 (Solley and others, 1998). The thermoelectric plants are primarily located along the main stem of the Tennessee River (fig. 14). The Kingston fossil-fueled and the Watts Bar and Sequoyah nuclear-fueled power plants in the Watts Bar-Chickamauga WUTA (3,056 Mgal/d of water), the Browns Ferry nuclear-fueled power plant in the Wheeler-Wilson WUTA (2,108 Mgal/d), and the Widows Creek fossil-fueled power plant in the Guntersville WUTA (1,546 Mgal/d) account for about 65 percent of the water withdrawals for thermoelectric power (table 13). The spatial distribution by HUC of thermoelectric power water withdrawals as a total is shown in figure 15.

The relation between water availability, water use, and demographic and socioeconomic indicators over time has important implications for water use and management (Case and Alward, 1997), particularly for the thermoelectric power and industrial sectors. The electricity generated using water from the Tennessee River watershed, either for generating hydropower or for cooling water, accounted for about 67 percent of all the electricity generated by the TVA in 2000. The importance of the electricity generated, however, is much greater than the income from power sales. The electricity serves as a base for the economy of the region, which was valued in 2000 at about $246 billion for all goods and services (James H. Eblen, Tennessee Valley Authority, written commun., June 2002).

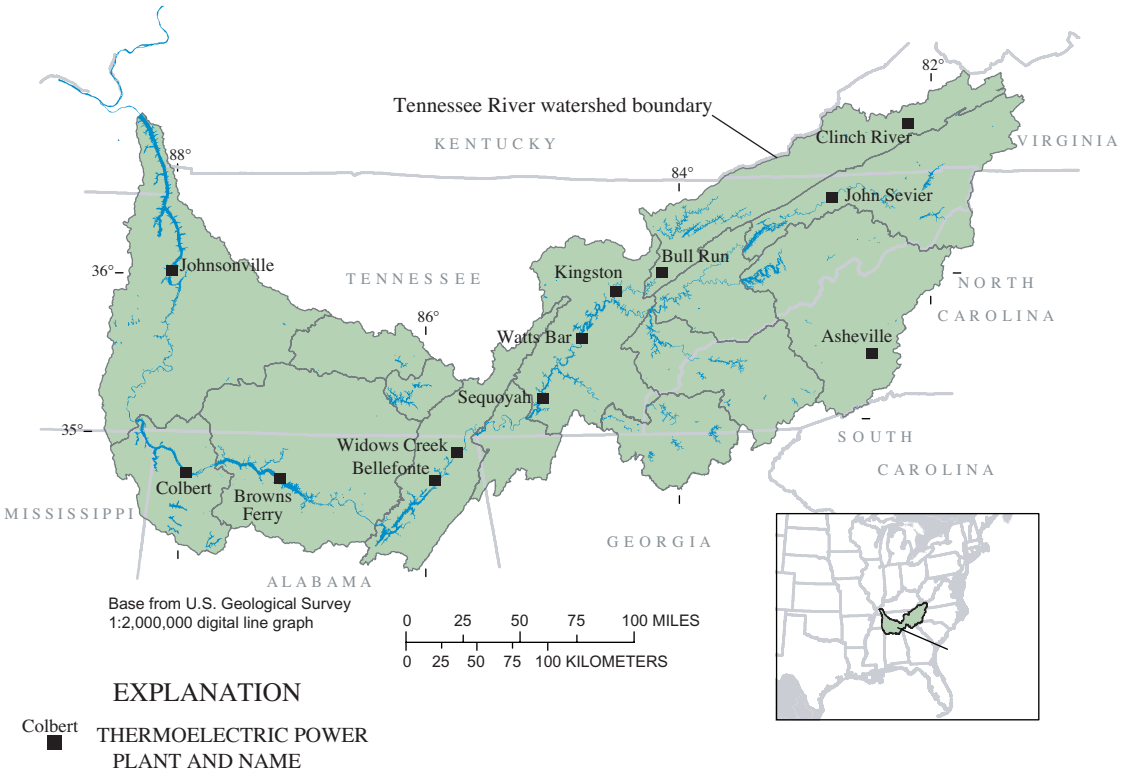

Figure 14. Distribution of thermoelectric power plants in the Tennessee River watershed in 2000.

Table 14. Thermoelectric power water use by hydrologic unit in 2000

[Figures may not add to totals because of independent rounding. Water-use transactions in million gallons per day]

Hydrologic unit code	Surface-water withdrawal	Cooling water return flow	Net water demand	Power generated, in million kilowatt-hours
06010101	621.00		621.00	5,193
06010104		621.00	-621.00	
06010105	4.97		4.97	2,561
06010201	139.10		139.10	9,076
06010205	9.24	0.00	9.24	3,323
06010207	1,814.00	469.00	1,345.00	15,746
06010208		1,345.00	-1,345.00	
06020001	1,571.40	1,693.50	-122.10	16,777
06030001	1,546.00	1,546.00	0.00	9,595
06030002	2,108.00	2,107.00	1.00	18,807
06030005	1,251.00	1,251.00	0.00	7,201
06040005	1,211.00	1,211.00	0.00	8,064
Watershed total	**10,276**	**10,244**	**32.2**	**96,343**

Table 15. Thermoelectric power water use by county in 2000

[Figures may not add to totals because of independent rounding. Water-use transactions in million gallons per day]

State County	Surface-water withdrawal	Cooling water return flow	Net water demand	Power generated, in million kilowatt-hours
Alabama				
Colbert	1,251.00	1,251.00	0.00	7,201
Jackson	1,546.00	1,546.00	0.00	9,595
Limestone	2,108.00	2,107.00	1.00	18,807
State total	**4,905.00**	**4,904.00**	**1.00**	**35,603**
North Carolina				
Buncombe	4.97		4.97	2,561
State total	**4.97**	**0.00**	**4.97**	**2,561**
Tennessee				
Anderson	469.00	469.00	0.00	5,968
Hamilton	1,537.00	1,536.00	1.00	16,777
Hawkins	621.00	621.00	0.00	5,193
Humphreys	1,211.00	1,211.00	0.00	8,064
Rhea	173.50	157.50	16.00	9,076
Roane	1,345.00	1,345.00	0.00	9,778
State total	**5,356.50**	**5,339.50**	**17.00**	**54,858**
Virginia				
Russell	9.24	0.00	9.24	3,323
State total	**9.24**	**0.00**	**9.24**	**3,323**
Watershed total	**10,276**	**10,244**	**32.2**	**96,343**

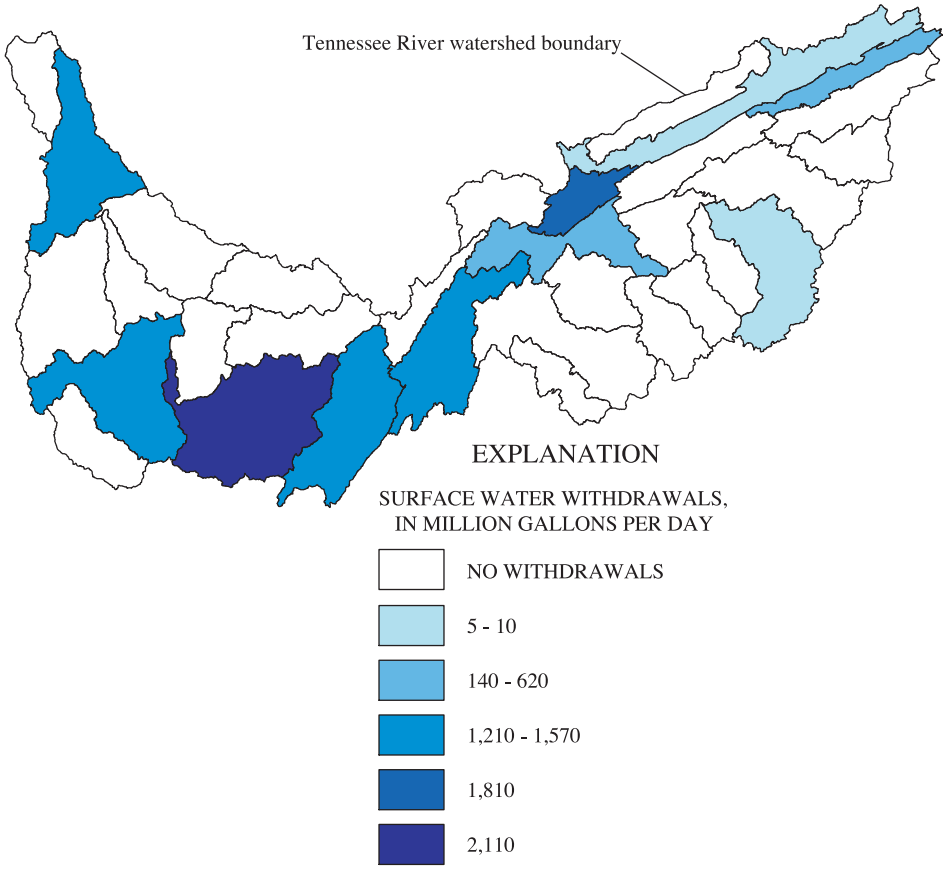

Figure 15. Thermoelectric power water withdrawals by hydrologic unit in the Tennessee River watershed in 2000.

Industrial

Water withdrawals for industrial use during 2000 were estimated to be 1,205 Mgal/d, which is an increase of 17 percent since 1995 (tables 16, 17, 18, and 26). Water withdrawals for industry account for about 10 percent of the total water withdrawals and for 62 percent of the nonpower water withdrawals. Return flows were estimated to be 942 Mgal/d and consumptive use to be 263 Mgal/d (table 16). Surface water supplied 94 percent of the water, 1,134 Mgal/d, for industrial purposes and ground water supplied the remaining 6 percent, 71.1 Mgal/d (fig. 16). The consumptive use of freshwater for industrial purposes was 22 percent and return flow was 78 percent of the disposition of the water.

Industrial water use includes water for such purposes as processing, washing, and cooling in facilities that manufacture products and for mining. Estimates of industrial and mining withdrawals were obtained from State agencies that issue permits or from the water-use inventory conducted in conjunction with this investigation. In the Tennessee River watershed, the major water-using industries are chemical and allied products, paper and allied products, and primary metals and account for about 79 percent (950 Mgal/d) of the industrial water withdrawals in 2000.

In 2000, mining water use was estimated to be 51 Mgal/d. Mining water use is for the extraction of minerals and other uses associated with quarrying, milling (crushing, screening, washing, and flotation), and other preparations done at a mine site. Dewatering is not considered as a mining water use unless the water is put to a beneficial use, such as washing or dust control. Water used in mining is difficult to quantify. Except for some washing and milling, water used at mining sites tends to be an impediment to or a byproduct of the extraction process. Unless water is needed for the mining operation, little attention is paid to quantities withdrawn.

Industrial return flow is water disposed from use in sanitary, process, or cooling activities and excludes stormwater runoff. Return-flow data for industry and mining were obtained from the USEPA, PCS database. A strict site-specific accounting of industrial withdrawals and return flows is difficult because of the different ways in which water is obtained and disposed. For example, industries that purchase water from a public supplier may discharge to a stream, and bypass the wastewater-treatment plant; or self-supplied industries may release water to a wastewater-treatment plant rather than to a stream. Uncertainty about the amount of return flow also may result from an industry including estimates of stormwater runoff in the sanitary, process, or cooling water return-flow volumes. Meter registration errors also may occur.

Industrial water withdrawals in the Cherokee and Wheeler-Wilson WUTA's were 509 and 260 Mgal/d, respectively, and account for the 64 percent of the industrial water withdrawals (table 16). The spatial distribution of industrial water withdrawals by HUC as a total and by source is shown in figure 17.

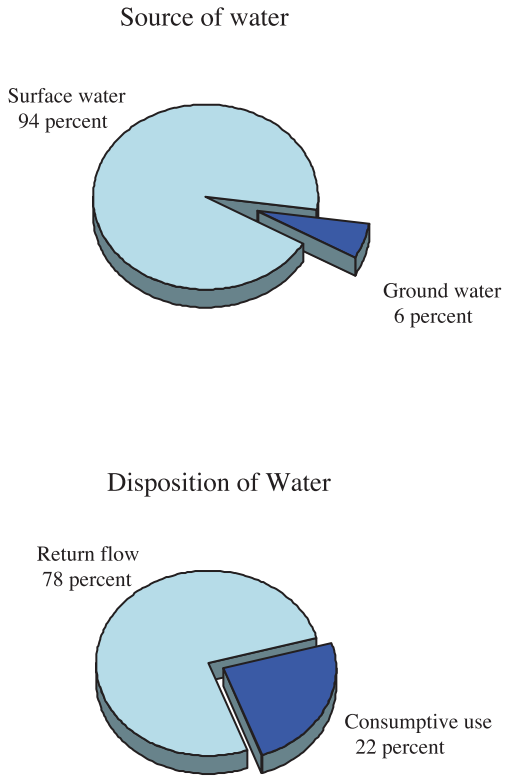

Figure 16. Source and disposition of water used by industry in the Tennessee River watershed in 2000.

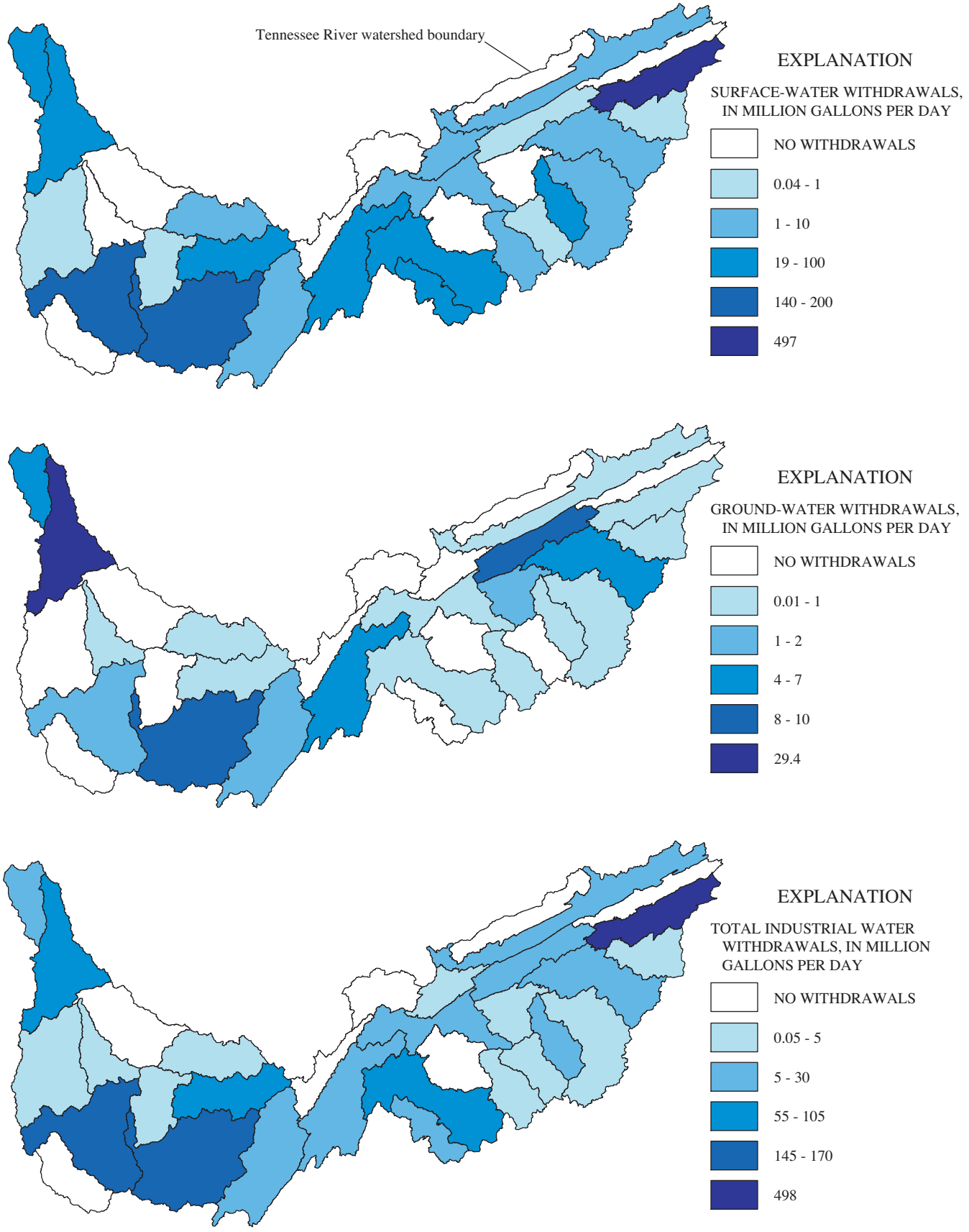

Figure 17. Industrial water withdrawals by source and by hydrologic unit in the Tennessee River watershed in 2000.

Many industries that depend on large amounts of water also are industries that provide relatively high earnings and are important to the economy of local communities. This link is evident in the Tennessee River watershed, where high water use in the chemical and paper industry involves the use of process water and large amounts of cooling water. The five counties in the watershed in which chemical or paper industries use large amounts of water, Lawrence and Morgan Counties in Alabama, and Humphreys, McMinn, and Sullivan Counties in Tennessee (fig. 5), directly generated about $1.0 billion of earnings in 1999 with an estimated total impact on the local economies between 2.0 and 2.5 billion dollars (U.S. Department of Commerce, 2001). The distribution of industrial water withdrawals by county is shown on figure 18.

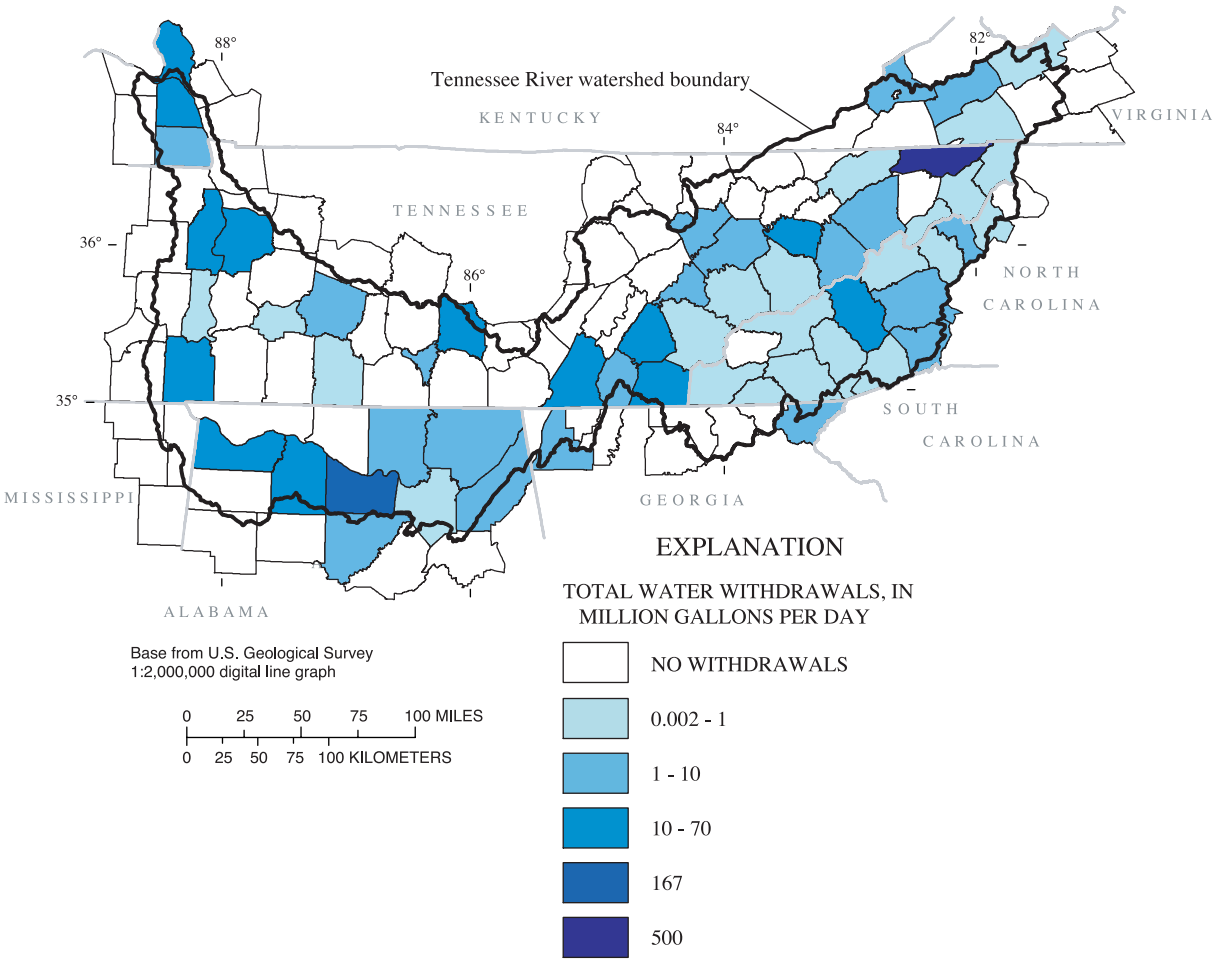

Figure 18. Industrial water withdrawals by State and county in the Tennessee River watershed in 2000.

Table 16. Industrial water use by water-use tabulation area in 2000

[Figures may not add to totals because of independent rounding. All values in million gallons per day; WUTA, water-use tabulation area]

Water-use tabulation area Reservoir catchment area	Withdrawal			Return flow	Net water demand
	Ground water	Surface water	Total water		
Cherokee					
Watauga	0.40	0.24	0.64	0.47	0.17
South Holston	0.59	0.24	0.83	0.47	0.36
Boone	0.00		0.00	0.04	-0.04
Fort Patrick Henry		496.70	496.70		496.70
Cherokee	10.12	0.60	10.72	467.53	-456.81
WUTA total	**11.11**	**497.78**	**508.89**	**468.51**	**40.38**
Douglas					
Douglas	6.19	36.09	42.28	28.49	13.80
Fort Loudoun					
Fort Loudoun	0.02	5.00	5.02	1.37	3.66
Fontana-Tellico					
Fontana	0.03	1.91	1.94	1.36	0.58
Santeetlah			0.00		0.00
Tellico			0.00		0.00
WUTA total	**0.03**	**1.91**	**1.94**	**1.36**	**0.58**
Norris					
Norris	0.95	5.28	6.23	0.21	6.02
Melton Hill		1.48	1.48	0.90	0.58
WUTA total	**0.95**	**6.76**	**7.72**	**1.11**	**6.61**
Hiwassee-Ocoee					
Chatuge	0.00	0.04	0.04		0.04
Nottely			0.00		0.00
Hiwassee	0.00	0.08	0.08		0.08
Apalachia			0.00		0.00
Blue Ridge		31.77	31.77		31.77
Ocoee			0.00	24.37	-24.37
WUTA total	**0.00**	**31.88**	**31.88**	**24.37**	**7.51**
Watts Bar-Chickamauga					
Watts Bar		0.03	0.03	0.24	-0.21
Chickamauga	0.12	68.24	68.36	68.14	0.22
WUTA total	**0.12**	**68.27**	**68.38**	**68.37**	**0.01**
Nickajack					
Nickajack	4.92	18.74	23.67	15.30	8.36
Guntersville					
Guntersville	1.79	9.18	10.97	19.49	-8.52
Tims Ford	0.78	55.48	56.26	35.93	20.33

Table 16. Industrial water use by water-use tabulation area in 2000—Continued

Water-use tabulation area Reservoir catchment area	Withdrawal			Return flow	Net water demand
	Ground water	Surface water	Total water		
Wheeler-Wilson					
Wheeler	8.16	221.46	229.62	147.86	81.76
Wilson	0.53	29.48	30.01	21.01	9.00
WUTA total	**8.69**	**250.94**	**259.63**	**168.87**	**90.76**
Pickwick					
Pickwick	0.53	53.08	53.61	26.66	26.95
Cedar Creek			0.00		0.00
Upper Bear Creek			0.00		0.00
WUTA total	**0.53**	**53.08**	**53.61**	**26.66**	**26.95**
Normandy					
Normandy	0.01	1.44	1.45		1.45
Kentucky					
Kentucky	35.97	97.20	133.17	82.55	50.61
Watershed total	**71.1**	**1,134**	**1,205**	**942**	**263**

Table 17. Industrial water use by hydrologic unit in 2000

[Figures may not add to totals because of independent rounding. All values in million gallons per day]

Hydrologic unit code	Withdrawal			Return flow	Net water demand
	Ground water	Surface water	Total water		
06010101	0.00	0.00	0.00		0.00
06010102	0.59	496.94	497.53	465.70	31.83
06010103	0.01	0.04	0.05	0.04	0.01
06010104	10.12	0.60	10.72	2.94	7.78
06010105	0.48	4.00	4.48	2.25	2.23
06010106	0.59	28.41	29.00	22.63	6.37
06010107	1.61		1.61	0.72	0.89
06010108	3.89	3.89	7.78	4.08	3.70
06010201	0.02	5.00	5.02	0.24	4.79
06010202	0.03	2.13	2.16	1.36	0.80
06010203	0.00	0.07	0.07		0.07
06010205	0.95	5.28	6.23	0.21	6.02
06010206	0.00	0.00	0.00		0.00
06010207		1.51	1.51	0.90	0.61
06020001	5.04	19.29	24.33	15.30	9.02
06020002	0.01	67.51	67.52	68.14	-0.62
06020003		31.77	31.77	24.37	7.40
06030001	1.79	9.18	10.97	19.49	-8.52
06030002	8.16	161.29	169.45	99.20	70.25
06030003	0.78	55.48	56.26	37.34	18.92
06030004		0.32	0.32	0.07	0.25
06030005	1.06	142.41	143.47	94.93	48.54
06040001		0.07	0.07	19.89	-19.82
06040002	0.01	1.44	1.45	2.05	-0.60
06040003			0.00	2.45	-2.45
06040004	0.09		0.09		0.09
06040005	29.38	75.81	105.19	58.09	47.10
06040006	6.50	21.32	27.82		27.82
Watershed total	**71.1**	**1,134**	**1,205**	**942**	**263**

Table 18. Industrial water use by county in 2000

[Figures may not add to totals because of independent rounding. All values in million gallons per day]

State County	Withdrawal Ground water	Withdrawal Surface water	Withdrawal Total water	Return flow	Net water demand
Alabama					
Colbert	1.06	58.96	60.02	47.45	12.57
Cullman		1.15	1.15		1.15
Dekalb	1.11		1.11	0.88	0.23
Jackson	0.02	9.18	9.20	18.09	-8.89
Lawrence		59.85	59.85	47.26	12.59
Madison		1.34	1.34	1.03	0.31
Marshall	0.66		0.66	0.52	0.14
Morgan	8.16	158.80	166.96	99.20	67.76
State total	**11.01**	**289.28**	**300.29**	**214.42**	**85.87**
Georgia					
Rabun		1.63	1.63	1.36	0.27
Walker	1.51	0.84	2.35	2.31	0.04
State total	**1.51**	**2.47**	**3.98**	**3.67**	**0.31**
Kentucky					
Calloway	1.59		1.59		1.59
Livingston	2.44	19.85	22.29		22.29
Lyon			0.00	0.01	-0.01
Marshall	2.47	12.97	15.45		15.45
State total	**6.50**	**32.82**	**39.33**	**0.01**	**39.32**
North Carolina					
Avery	0.39	0.20	0.59	0.47	0.12
Buncombe	0.45	2.02	2.48	1.38	1.10
Cherokee	0.00	0.08	0.08		0.08
Clay	0.00	0.04	0.04		0.04
Haywood	0.14	28.41	28.55	22.53	6.02
Henderson	0.00	0.97	0.97	0.87	0.10
Jackson	0.00	0.07	0.07		0.07
Macon	0.03	0.21	0.24		0.24
Mitchell	3.50	0.34	3.84	0.00	3.84
Transylvania	0.03	1.00	1.03	0.00	1.03
Yancey	0.00		0.00		0.00
State total	**4.55**	**33.33**	**37.88**	**25.25**	**12.63**
Tennessee					
Anderson		1.48	1.48	0.90	0.58
Bedford			0.00	0.06	-0.06
Benton	19.20	2.90	22.10		22.10
Bradley		2.50	2.50	2.41	0.09
Carter			0.00	0.04	-0.04
Cocke	0.45		0.45	0.10	0.35
Coffee	0.04	55.00	55.04	35.93	19.11
Decatur		0.07	0.07		0.07
Giles		0.32	0.32	0.07	0.25
Greene	0.00	3.35	3.35	3.49	-0.13
Hamilton	3.53	18.74	22.27	13.00	9.27
Hardin		23.60	23.60	19.89	3.71
Hawkins		0.56	0.56	0.53	0.03

Table 18. Industrial water use by county in 2000—Continued

State County	Withdrawal Ground water	Withdrawal Surface water	Withdrawal Total water	Return flow	Net water demand
Tennessee—Continued					
Hickman			0.00	0.08	-0.08
Humphreys	10.18	61.41	71.59	58.08	13.51
Jefferson	11.60	0.04	11.64	2.31	9.34
Johnson	0.01	0.00	0.01		0.01
Knox	0.13	0.08	0.21	0.18	0.03
Lawrence			0.00	0.23	-0.23
Lewis	0.09		0.09		0.09
Loudoun		4.95	4.95	0.12	4.83
Marshall			0.00	1.99	-1.99
Maury		1.44	1.44	2.36	-0.92
McMinn	0.00	64.90	64.90	65.73	-0.82
Monroe			0.00	0.12	-0.12
Moore	0.75	0.47	1.23	0.38	0.85
Polk		31.77	31.77	24.37	7.40
Sevier	0.01		0.01	0.65	-0.63
Sullivan	0.00	496.70	496.70	465.23	31.47
Unicoi	0.00	0.04	0.04	0.10	-0.07
Washington			0.00	0.02	-0.02
State total	**46.00**	**770.33**	**816.33**	**698.37**	**117.98**
Virginia					
Lee	0.00		0.00		0.00
Russell	0.00	3.79	3.79		3.79
Smyth	0.00		0.00		0.00
Tazewell	0.28	0.00	0.28	0.21	0.07
Washington	0.59	0.24	0.83	0.47	0.36
Wise	0.68	1.49	2.17		2.17
State total	**1.54**	**5.52**	**7.06**	**0.68**	**6.38**
Watershed total	**71.1**	**1,134**	**1,205**	**942**	**263**