

Estimated Water Use in Washington, 2005



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Cover: Photograph of Tacoma and Mount Rainier, taken August 20, 1984 by Lyn Topinka, U.S. Geological Survey.

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By R.C. Lane

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Conversion Factors

Multiply	By	To obtain
Length		
mile (mi)	5,280	foot (ft)
	1,609	meter (m)
	1.6093	kilometer (km)
Area		
acre	43,560	square foot (ft ²)
	4,047	square meter (m ²)
	0.001562	square mile (mi ²)
Flow rate		
gallon per day (gal/d)	3.785	liter per day (L/d)
million gallons per day (Mgal/d)	1.121	thousand acre-feet per year
	0.001547	thousand cubic feet per second
	0.6944	thousand gallons per minute
	0.003785	million cubic meters per day
	1.3815	million cubic meters per year
billion gallons per day (Bgal/d)	1.3815	billion cubic meters per year
thousand acre-feet per year	0.8921	million gallons per day
	0.001380	thousand cubic feet per second
	0.6195	thousand gallons per minute
	0.003377	million cubic meters per day

Some water relations in inch-pounds units are shown below:

1 gallon (gal)	=	8.34 pounds
1 million gallons (Mgal)	=	3.07 acre-feet
1 cubic foot (ft ³)	=	62.4 pounds
	=	7.48 gallons
1 acre-foot (acre-ft)	=	325,851 gallons
	=	43,560 cubic feet
1 inch of rain	=	17.4 million gallons per square mile
	=	27,200 gallons per acre
	=	100 tons per acre

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By R.C. Lane

Abstract

Water use in the State of Washington has evolved in the past century from meager domestic and stock water needs to the current complex requirements of domestic-water users, large irrigation projects, industrial plants, and numerous other uses such as fish habitat and recreational activities. Since 1950, the U.S. Geological Survey (USGS) has, at 5-year intervals, compiled data on the amount of water used in homes, businesses, industries, and on farms throughout the State. This water-use data, combined with other related USGS information, has facilitated a unique understanding of the effects of human activity on the State's water resources. As water availability continues to emerge as an important issue in the 21st century, the need for consistent, long-term water-use data will increase to support wise use of this essential natural resource.

This report presents state and county estimates of the amount of public- and self-supplied water used for domestic, irrigation, livestock, aquaculture, industrial, mining, and thermoelectric power purposes in the State of Washington during 2005. Offstream freshwater use was estimated to be 5,780 million gallons per day (Mgal/d). Domestic water use was estimated to be 648 Mgal/d or 11 percent of the total. Irrigation water use was estimated to be 3,520 Mgal/d, or 61 percent of the total. Industrial freshwater use was estimated to be 520 Mgal/d, or 9 percent of the total. These three categories accounted for about 81 percent (4,690 Mgal/d) of the total of the estimated offstream freshwater use in Washington during 2005.

Introduction

Water use in Washington has evolved in the past century from meager domestic and stock water needs to the current complex requirements of domestic-water users, large irrigation projects, industrial plants, and numerous other uses such as fish habitat and recreational activities. Although advances have been made in the ability to control, divert, and develop water supplies, it has been difficult to keep accurate accounts of the actual amounts of water being used. With increasing competition for water (especially during periods of drought), water-use information is of considerable value in determining water availability and in making sound resource-management decisions. Although Washington State is collecting some water-use information, there is currently no statewide program requiring the general reporting of water-use information to the State.

Water-use terminology, as used by the U.S. Geological Survey (USGS), has changed over the years. Terms used in this report are defined in the attached glossary. In the broadest sense water use pertains to the interaction of human activity with the hydrologic cycle, and can be divided into two types, offstream and instream use. Offstream use is the withdrawal or diversion of water from a groundwater or surface-water source for a specific purpose. Instream use is the use of water that remains in the groundwater or surface-water source. Quantitative estimates for most instream uses are undetermined, but are important because such uses compete with offstream uses and affect the quality and quantity of water resources. As used in this report, water use refers only to the estimated offstream use of freshwater for public supply, domestic, irrigation, livestock, aquaculture, industrial, mining, and thermoelectric power purposes in Washington State during 2005, and does not include water used for instream purposes or offstream uses other than those listed. However, these core categories encompass most of known offstream water use in the State.

Purpose and Scope

Since 1950, the USGS has, at 5-year intervals, compiled data on the amount of water used in homes, businesses, industries, and on farms throughout Washington State (see section, “[U.S. Geological Survey Water-Use Reports](#)”). These reports contain State-level estimates of the amount of public- and self-supplied water used offstream for commercial, domestic, industrial, irrigation, livestock, mining, power generation, and other purposes. This report presents State, regional, and county estimates of the amount of public- and self-supplied water used offstream for domestic, irrigation, livestock, aquaculture, industrial, mining, and thermoelectric power purposes in Washington State during 2005 and describes the methods and sources used to prepare the estimates.

Description of Study Area

The north-south-trending Cascade Range and the prevailing wind patterns divide Washington State into two regions of distinctly different climate (Dion, 1985; Williams, 1986). Western Washington has a predominantly marine climate with cool, dry summers and mild, wet winters. Precipitation averages about 70 in/yr, but ranges from less than 20 to about 200 in/yr. Potential evaporation ranges from 20 to 25 in/yr, and generally is less than precipitation. Eastern Washington has characteristics of both continental and marine climates, with hot, dry summers and cold, wet winters. Precipitation averages about 20 in/yr, but ranges from less than 7 to about 40 in/yr. Potential evaporation ranges from 25 to 45 in/yr, and generally exceeds precipitation.

Methods and Sources

Estimates of public-supply water use were based on data from the Washington State Department of Health (WDOH), USGS Washington Water Science Center (WAWSC) and the Washington Department of Ecology (Ecology). A list of all registered public water-supply systems in Washington was obtained from the WDOH on-line database (Washington State Department of Health, 2006). The database contained the names, locations, service populations, and other data for all

registered public-water systems in the State. The database did not, however, contain information on water withdrawals and use.

System specific withdrawal and use information were obtained from 483 class A public water-supply systems through the cooperative efforts of the WAWSC and Ecology. The criteria for selecting the individual systems were to provide spatial coverage of each county in the State and to include a representative mix of the municipal, non-municipal, or other types of public-supply systems in the individual counties. The withdrawal and use data from the reporting systems in each county were used to calculate per-capita rates for each of the 483 public-supply systems as follows:

Gross per-capita = Total water withdrawn / population served.

Residential per-capita = Residential use / population served.

For each county, the 25-75 percent trimmed-mean gross per-capita was combined with population and other data for the non-reporting systems to produce the estimates of total public-supplied water in the county. Similarly, the trimmed residential per-capita was used to estimate public-supplied domestic water use values.

Self-supplied domestic use was estimated for each county by using the trimmed residential per capita from the public supply estimates and the self-supplied population of each county from the population estimates. All domestic self-supplied water was assumed to be groundwater except for the small amount of surface water used in Ferry County. For the purposes of this report, the public-supplied domestic-use category includes only those people who are served by a class A public water-supply system. The self-supplied domestic-use category includes those who are self-supplied and those who are served by a class B public water-supply system.

Irrigation water use was estimated as the sum of crop-irrigation water use and golf-course-irrigation water use. Crop-irrigation acreage and application data for Washington State were not available for the 2005 growing season. Therefore, State and county data for the 2002 growing season (U.S. Department of Agriculture, 2003a, 2003b) were combined with similar county level data from the 2000 Washington water use report (U.S. Geological Survey, 2004) to approximate the 2005 growing season Washington State data.

Golf-course irrigation estimates were prepared by combining the county golf-course acreage data from the 2000 Washington water use report (U.S. Geological Survey, 2004) with the 2005 crop irrigation application rates from the 2005 compilation.

Estimates of livestock, aquaculture, and mining water use were compiled by the USGS National Water Use Information Office using a variety of sources and methods (John K. Lovelace, U.S. Geological Survey, written commun., 2007). The WAWSC reviewed and accepted the estimates without change.

Estimates of industrial water use were based on similar data from the 2000 Washington water use report (U.S. Geological Survey, 2004), and the change (by county) in the total industrial hours worked from the 1997 and 2002 reports (U.S. Department of Commerce, 2005) using the following equation.

$$\text{Water.2005} = \text{Water.2000} \times (\text{Industrial.hours.2005} / \text{Industrial.hours.2000})$$

The estimate of public-supplied industrial water use was based on data from the USGS inventory of selected public-water-supply systems discussed under public supply estimates and on similar estimates from the 2000 Washington water use report.

Estimates of water use for thermoelectric power generation were prepared for each individual power-generation facility in Washington with a nameplate rating of 10 megawatts or more. These estimates were prepared using the following equation.

$$\text{Water.2005} = \text{Water.2000} \times (\text{Power.2005} / \text{Power.2000})$$

The 2005 power generated data were provided by the National Water Use Information Program (Nancy L. Barber, U.S. Geological Survey, written commun., 2007).

State and county population data from the U.S. Census Bureau were provided by the USGS National Water Use Information Office and are available for on-line at: <http://www.census.gov/popest/datasets.html>.

Public supplied (class A systems) service population data were obtained from the Washington State Department of Health (WDOH) on-line database (Sentry Internet) and are available on line at: <http://www4.doh.wa.gov/SentryInternet/Intro.aspx>. State and county self-supplied domestic population estimates were calculated as the difference between the total county population and the population served by class A public-supply systems. As in past compilations, the self-supplied population figures are actually the sum of the population served by class B public-supply systems and the actual self supplied population.

Estimated Water Use

Freshwater use in Washington in 2005 was estimated to be about 5,780 Mgal/d ([table 1](#)). Surface water accounted for about 74 percent (4,280 Mgal/d) and groundwater accounted for 26 percent (1,490 Mgal/d) of the freshwater use in Washington. County-level freshwater use ranged from 1.33 to 1,170 Mgal/d ([fig. 1](#)). The per-capita rate of water use for Washington was estimated to be 919 gal/d ([table 1](#)); the county-level per-capita rates ranged from 120 to 14,400 gal/d ([fig. 2](#)). The large per capita rates for Grant and surrounding counties are due to a combination of large irrigation water use and small populations.

Total saline water use was estimated to be 33.2 Mgal/d, all of which was from saline surface-water sources in western Washington. Nearly all saline water use was for industrial purposes in Pierce (21.4 Mgal/d), Grays Harbor (6.6 Mgal/d), and Jefferson (5.2 Mgal/d) Counties. Various public-supply systems withdrew and desalinized 0.05 Mgal/d of seawater to augment freshwater supplies. County-level public supply saline-water-use data were not included in this report in order to avoid the disclosure of data for individual public water-supply facilities that use saline water. Thus, all subsequent water withdrawal and use information in this report refer to freshwater only.

4 Estimated Water Use in Washington, 2005

Table 1. Estimated freshwater use, by source and county, Washington, 2005.

[Values may not add up to totals because of independent rounding. **Per-capita use:** Values are total water divided by population]

County	Population served (thousands)	Water use (million gallons per day)			Per-capita use (gallons per day)
		Groundwater	Surface water	Total water	
Adams	16.8	133	24.9	158	9,420
Asotin	21.2	4.09	1.10	5.19	245
Benton	158	68.6	778	846	5,360
Chelan	69.8	17.6	81.9	99.5	1,430
Clallam	69.7	16.7	9.01	25.7	369
Clark	404	122	45.2	168	415
Columbia	4.13	1.06	5.07	6.13	1,480
Cowlitz	97.3	12.2	142	154	1,590
Douglas	35.0	14.7	27.4	42.0	1,200
Ferry	7.54	4.20	3.77	7.97	1,060
Franklin	63.0	79.0	476	555	8,810
Garfield	2.34	0.54	2.58	3.12	1,330
Grant	81.2	190	979	1,170	14,400
Grays Harbor	70.9	19.0	51.6	70.7	996
Island	79.3	6.82	2.71	9.53	120
Jefferson	28.7	3.65	15.2	18.8	656
King	1,790	84.4	148	232	129
Kitsap	241	29.4	5.52	34.9	145
Kittitas	36.8	15.2	266	281	7,620
Klickitat	19.8	33.4	16.4	49.7	2,510
Lewis	72.4	19.9	30.6	50.5	697
Lincoln	10.4	27.1	9.71	36.8	3,550
Mason	54.4	10.8	36.2	46.9	863
Okanogan	39.8	31.1	70.3	101	2,550
Pacific	21.6	5.14	5.14	10.3	476
Pend Oreille	12.7	2.97	1.34	4.31	340
Pierce	754	85.2	100	185	246
San Juan	15.3	1.23	0.69	1.92	126
Skagit	113	15.2	30.1	45.3	400
Skamania	10.7	1.09	24.0	25.1	2,350
Snohomish	656	27.2	107	134	204
Spokane	441	164	29.7	194	440
Stevens	42.0	10.7	27.5	38.2	910
Thurston	229	44.4	8.88	53.2	233
Wahkiakum	3.85	0.67	0.66	1.33	346
Walla Walla	57.6	26.2	130	156	2,720
Whatcom	183	36.2	47.9	84.2	459
Whitman	40.2	7.99	2.82	10.8	269
Yakima	232	118	542	660	2,850
Western	4,900	542	810	1,350	276
Eastern	1,390	950	3,470	4,430	3,190
State	6,290	1,490	4,280	5,780	919

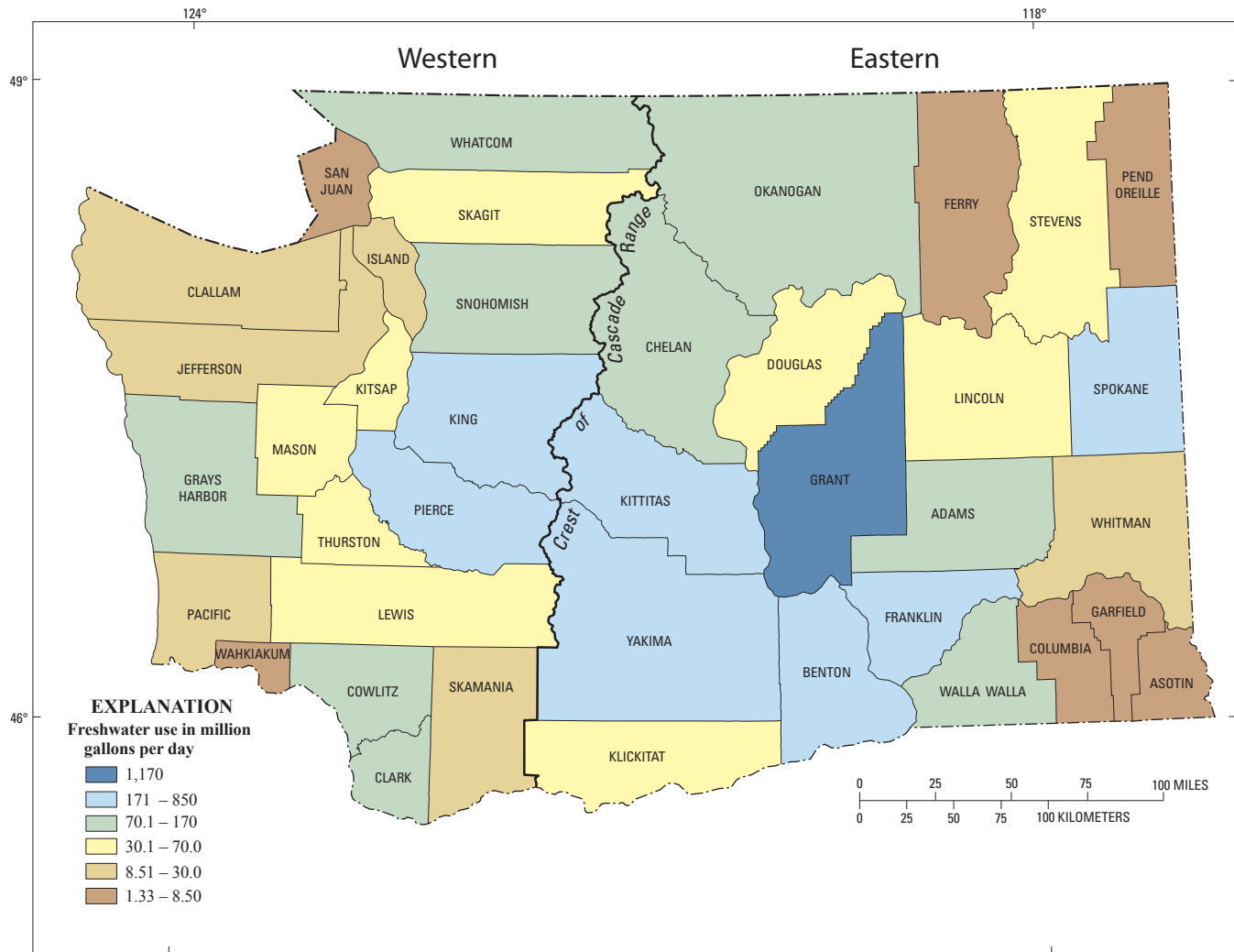


Figure 1. Estimated freshwater use, Washington, 2005.

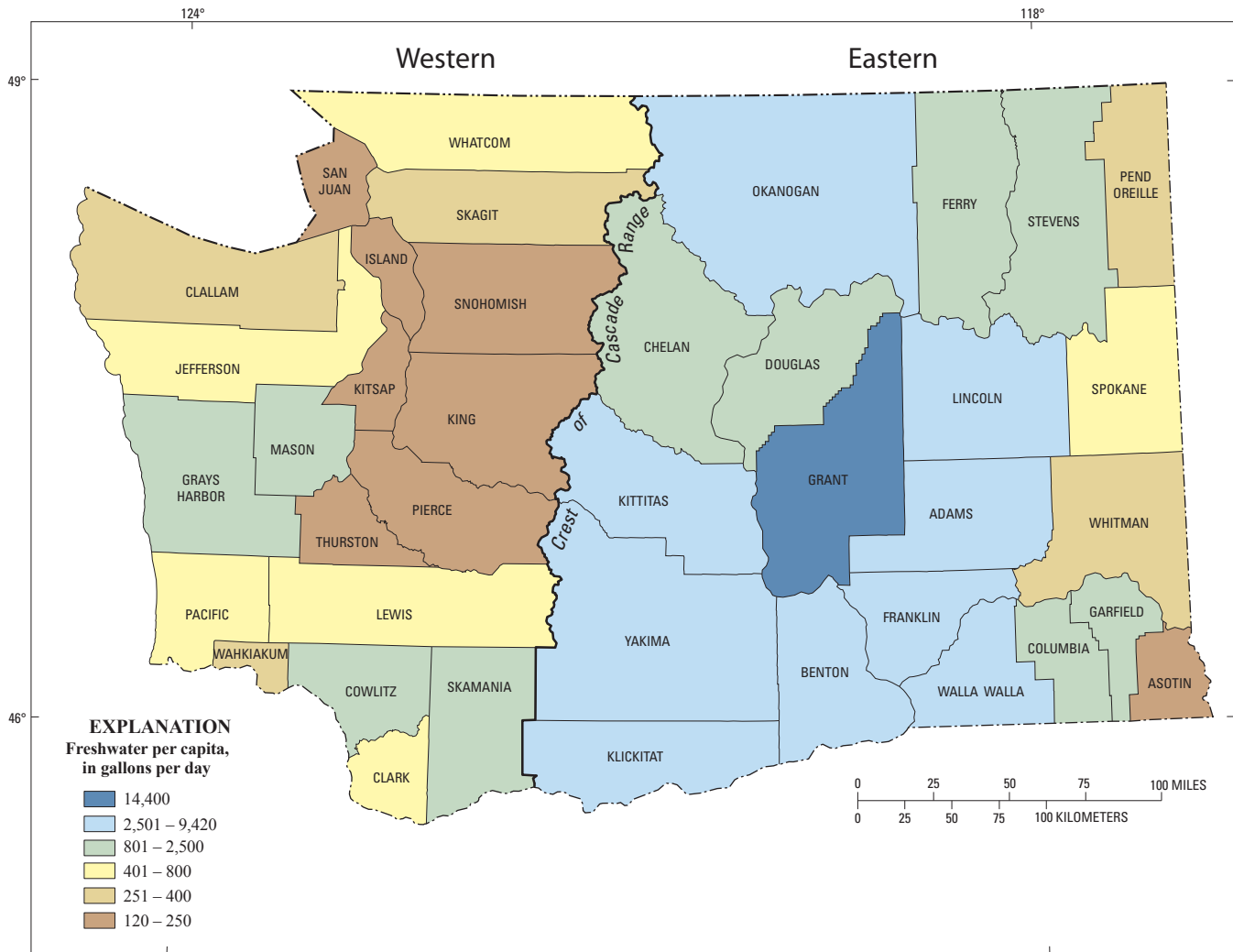
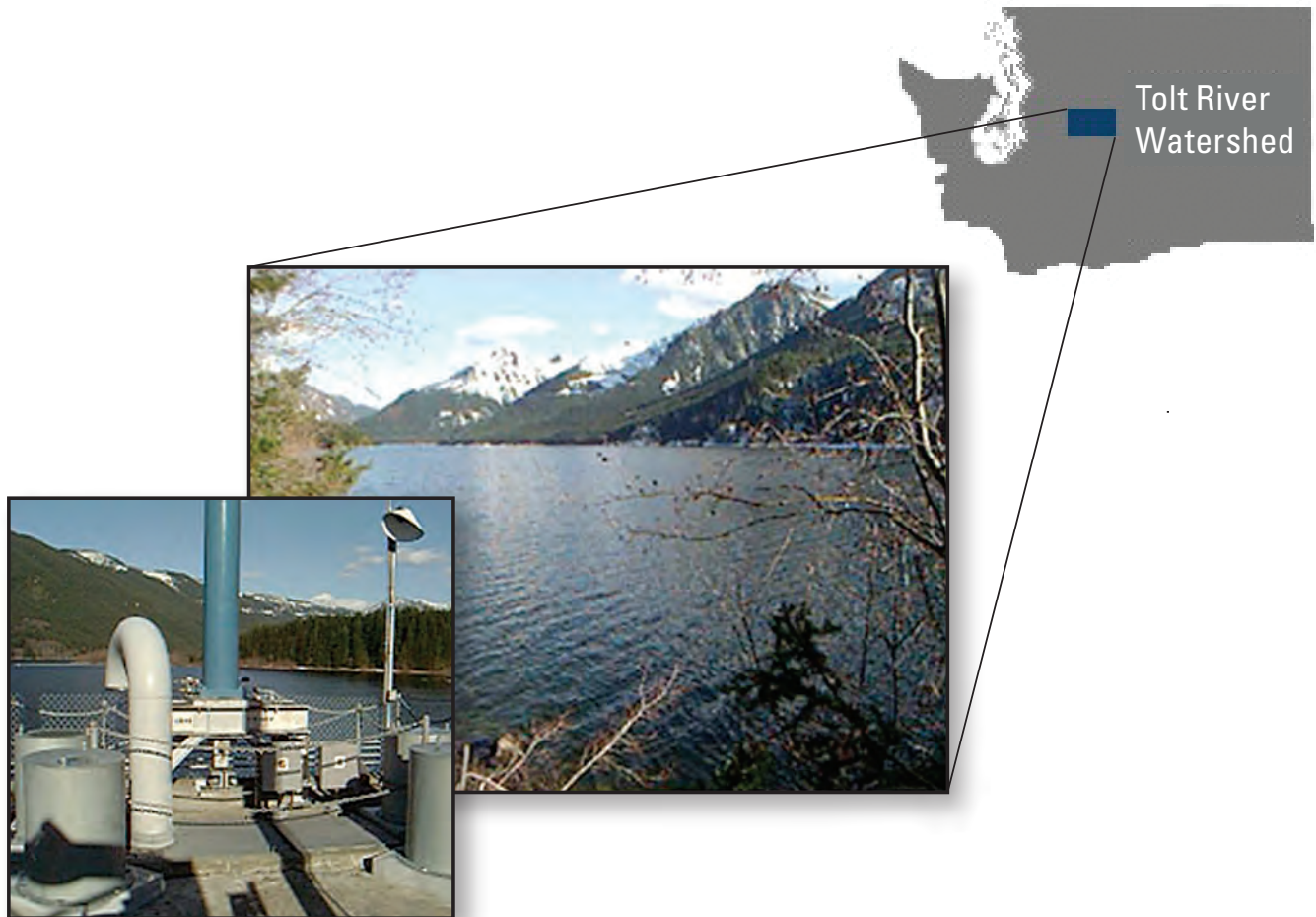


Figure 2. Estimated freshwater per-capita rates, Washington, 2005.

Public Supply

Public-supply water use in Washington in 2005 was estimated to total 990 Mgal/d ([table 2](#)), while county-level use ranged from 0.25 to 205 Mgal/d ([fig. 3](#)). Surface water accounted for 46 percent (451 Mgal/d) and groundwater accounted for 54 percent (539 Mgal/d) of the total

public-supply water use in the state. The public-supply per-capita rate for the state was estimated to be 181 gal/d, with county level rates ranging from 106 to 899 gal/d ([fig. 4](#)). The large per-capita rates for Grays Harbor (899 gal/d) and Jefferson Counties (671 gal/d) were due to the use of public-supplied water for industrial and other non-residential purposes.



At 1,765 feet above sea level, Tolt Reservoir stores water to be used by the City of Seattle. Photograph courtesy of City of Seattle Public Utilities Department, accessed January 16, 2009, at <http://www2.cityofseattle.net/util/tours/ToltVirtualTour/slide14.htm>.

8 Estimated Water Use in Washington, 2005

Table 2. Estimated public-supply water use, by source and county, Washington, 2005.

[Values may not add up to totals because of independent rounding. **Per-capita use:** Values are total water divided by population]

County	Population (thousands)	Water use (million gallons per day)			Per-capita use (gallons per day)
		Groundwater	Surface water	Total water	
Adams	12.6	4.53	0	4.53	360
Asotin	20.6	3.37	0	3.37	164
Benton	134	13.9	7.15	21.1	157
Chelan	59.7	13.1	3.45	16.5	277
Clallam	53.1	7.92	0.93	8.85	167
Clark	295	56.5	0.71	57.2	193
Columbia	3.09	0.51	0	0.51	165
Cowlitz	73.0	2.39	15.8	18.1	249
Douglas	31.2	4.93	0	4.93	158
Ferry	3.23	0.77	0.01	0.78	241
Franklin	50.6	3.32	20.6	23.9	472
Garfield	1.49	0.25	0	0.25	168
Grant	61.7	26.9	0	26.9	436
Grays Harbor	58.5	3.66	48.9	52.6	899
Island	68.4	4.85	2.45	7.30	107
Jefferson	22.3	1.68	13.3	14.9	671
King	1,770	62.8	142	205	116
Kitsap	193	17.2	4.89	22.1	115
Kittitas	28.8	9.48	1.01	10.5	364
Klickitat	12.5	2.88	0	2.88	230
Lewis	40.2	4.34	2.61	6.95	173
Lincoln	6.82	2.01	0	2.01	295
Mason	38.0	7.50	0.03	7.53	198
Okanogan	23.1	6.31	0.36	6.67	289
Pacific	17.6	0.72	2.56	3.28	186
Pend Oreille	6.04	0.77	0.21	0.98	162
Pierce	714	58.8	56.2	115	161
San Juan	8.93	0.38	0.57	0.95	106
Skagit	98.4	1.50	23.6	25.1	255
Skamania	7.61	0.60	0.67	1.27	167
Snohomish	583	8.58	60.5	69.1	119
Spokane	378	131	0	131	348
Stevens	23.9	6.19	0.01	6.20	259
Thurston	177	22.7	0.50	23.2	131
Wahkiakum	2.88	0.17	0.15	0.32	111
Walla Walla	50.2	7.67	5.80	13.5	268
Whatcom	161	7.64	28.4	36.0	224
Whitman	38.3	6.79	0	6.79	177
Yakima	160	24.4	7.97	32.4	202
Western	4,380	270	404	674	154
Eastern	1,110	270	46.5	316	285
State	5,490	539	451	990	181

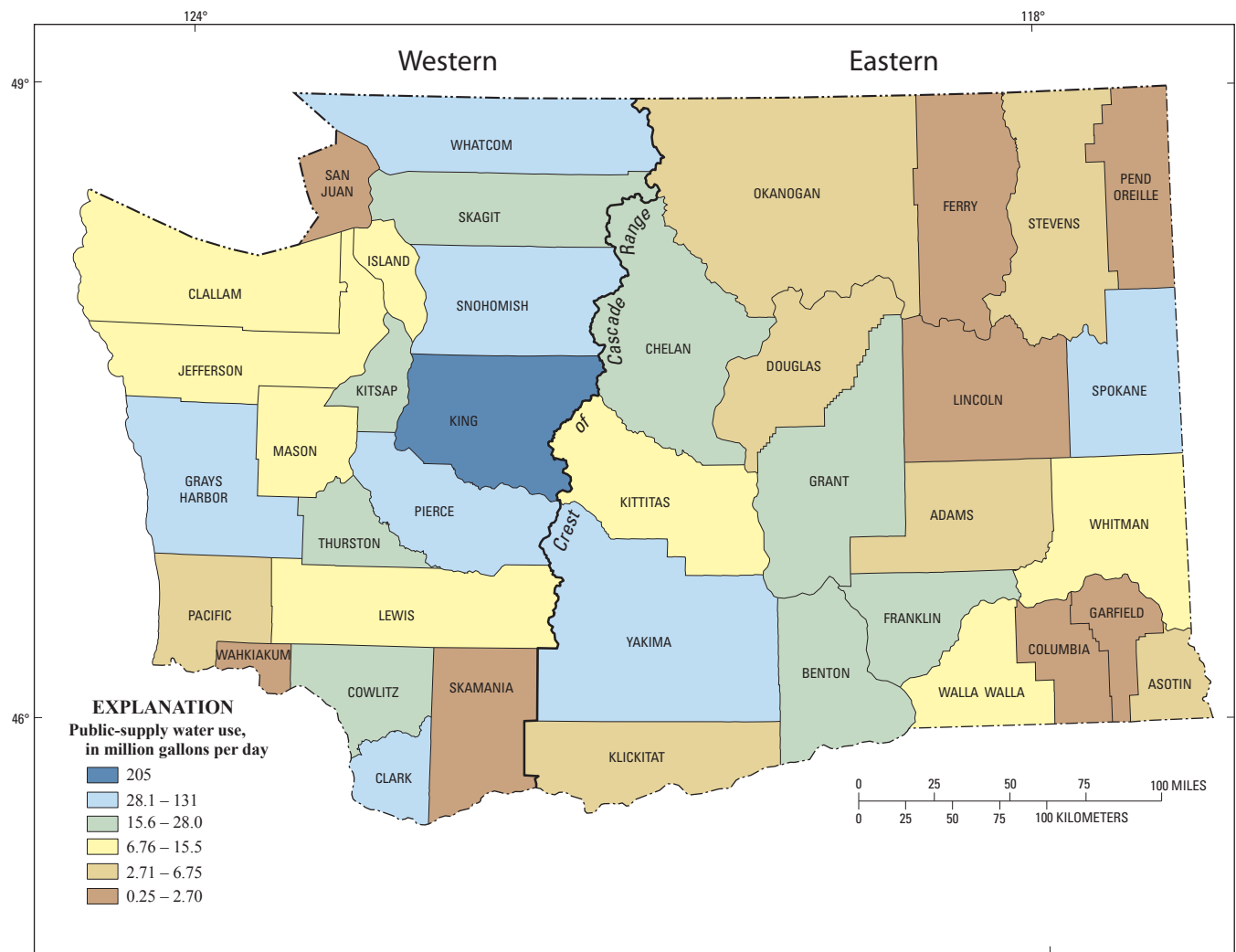


Figure 3. Estimated public-supply water use, Washington, 2005.

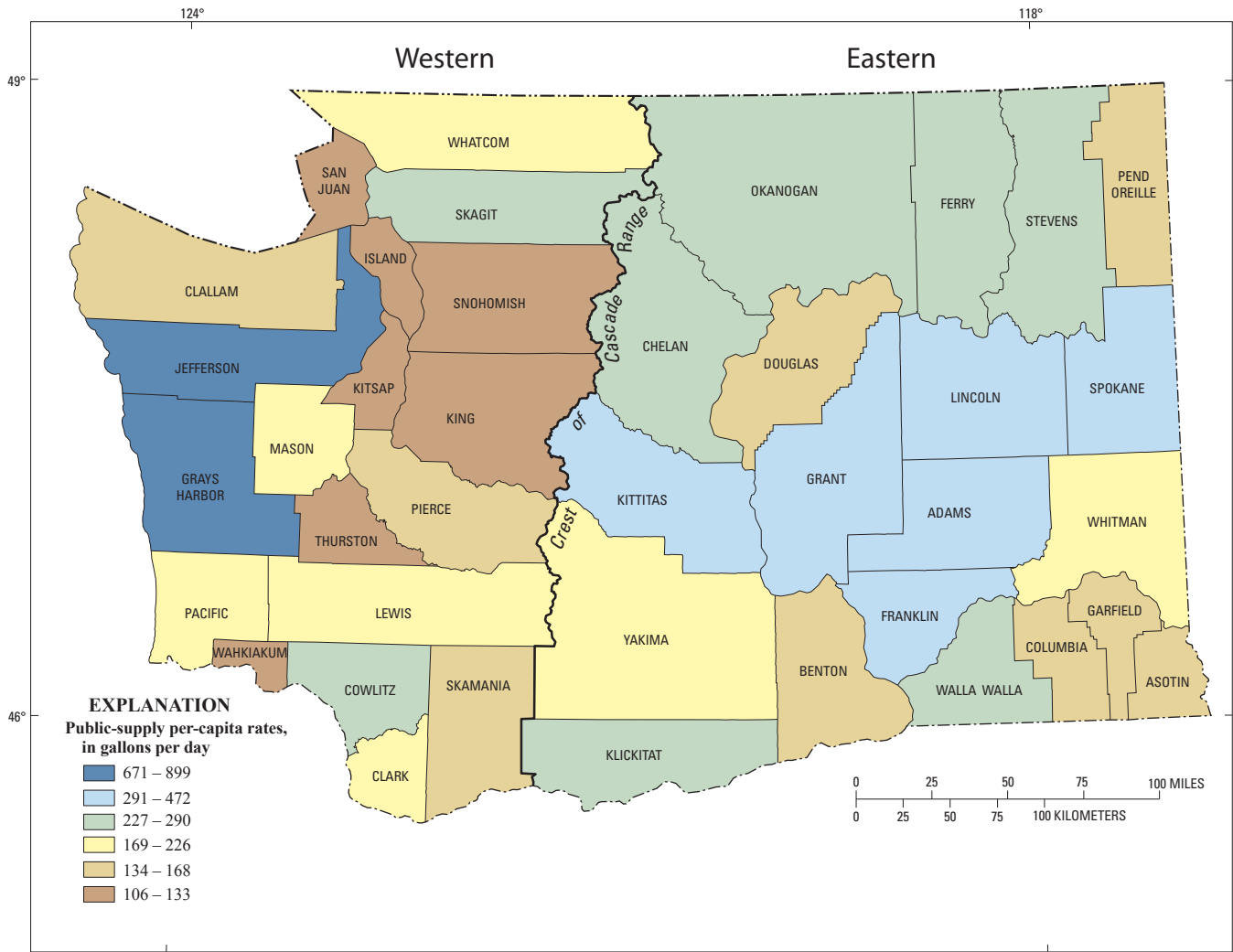


Figure 4. Estimated public-supply per-capita rates, Washington, 2005.

Domestic

Domestic water use in Washington for 2005 was estimated to be 648 Mgal/d ([table 3](#)), with county level domestic use ranging from 0.24 to 153 Mgal/d ([fig. 5](#)). Public-supplied water accounted for 87 percent (562 Mgal/d) of the total domestic water use in the state, while self-supplied

withdrawals of groundwater accounted for almost all of the remaining 13 percent (86.0 Mgal/d). Self-supplied surface-water withdrawals amounted to only 0.02 Mgal/d. The total domestic per-capita rate for the state was estimated to be 103 gal/d, while county level rates ranged from 72.3 to 210 gal/d ([fig. 6](#)).



Although usually associated with suburban and rural settings, domestic water use also occurs in urban environments. (Scenic view of downtown Seattle, Washington, with Puget Sound in the background.) Photograph by Gary Wilson, 2000; used with permission of the U.S. Department of Agriculture, National Resources Conservation Service.

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Table 3. Estimated domestic water use, by source and county, Washington, 2005.

[Values may not add up to totals because of independent rounding. Mgal/d, million gallons per day; gal/d, gallons per day]

County	Self-supplied		Public-supplied		Total domestic		Per-capita use (gal/d)
	Population (thousands)	Groundwater (Mgal/d)	Population (thousands)	Water (Mgal/d)	Population (thousands)	Total water (Mgal/d)	
Adams	4.23	0.55	12.6	1.73	16.8	2.28	136
Asotin	0.60	0.06	20.6	2.08	21.2	2.14	101
Benton	23.6	2.86	134	16.3	158	19.1	121
Chelan	10.1	1.01	59.7	6.95	69.8	7.96	114
Clallam	16.6	1.78	53.1	5.61	69.7	7.39	106
Clark	108	10.5	295	31.0	404	41.4	103
Columbia	1.04	0.10	3.09	0.31	4.13	0.41	99
Cowlitz	24.4	2.38	73.0	7.63	97.3	10.0	103
Douglas	3.75	0.46	31.2	3.46	35.0	3.92	112
Ferry ¹	4.31	¹ 0.47	3.23	0.37	7.54	0.84	111
Franklin	12.4	1.47	50.6	6.17	63.0	7.64	121
Garfield	0.85	0.09	1.49	0.15	2.34	0.24	102
Grant	19.6	3.36	61.7	11.9	81.2	15.2	187
Grays Harbor	12.4	1.05	58.5	5.20	70.9	6.25	88
Island	10.9	0.80	68.4	4.93	79.3	5.73	72
Jefferson	6.42	0.63	22.3	2.01	28.7	2.64	92
King	25.0	2.10	1,770	151	1,790	153	85
Kitsap	47.6	3.71	193	14.5	241	18.2	75
Kittitas	8.03	1.30	28.8	5.20	36.8	6.50	176
Klickitat	7.31	1.22	12.5	2.30	19.8	3.52	177
Lewis	32.3	3.24	40.2	4.28	72.5	7.52	104
Lincoln	3.56	0.54	6.82	1.24	10.4	1.78	171
Mason	16.4	1.66	38.0	5.12	54.4	6.78	125
Okanogan	16.7	2.96	23.1	4.08	39.8	7.04	177
Pacific	3.98	0.35	17.6	1.45	21.6	1.80	83
Pend Oreille	6.63	0.76	6.04	0.71	12.7	1.47	116
Pierce	40.3	3.97	714	64.6	754	68.5	91
San Juan	6.34	0.52	8.93	0.71	15.3	1.23	81
Skagit	14.8	1.30	98.4	8.18	113	9.48	84
Skamania	3.05	0.31	7.61	0.76	10.7	1.07	100
Snohomish	72.9	5.94	583	54.1	656	60.0	92
Spokane	62.9	13.0	378	79.8	441	92.7	210
Stevens	18.1	2.11	23.9	3.60	42.0	5.71	136
Thurston	52.2	4.26	177	14.1	229	18.3	80
Wahkiakum	0.97	0.07	2.88	0.22	3.85	0.29	75
Walla Walla	7.38	0.84	50.2	5.77	57.6	6.61	115
Whatcom	22.6	2.05	161	14.8	183	16.8	92
Whitman	1.88	0.22	38.3	3.67	40.2	3.89	97
Yakima	71.2	6.08	160	16.2	232	22.3	96
Western	517	46.6	4,380	390	4,900	437	89
Eastern	284	¹ 39.4	1,110	172	1,390	211	152
State	801	¹ 86.0	5,490	562	6,290	648	103

¹ Includes 0.02 million gallons per day of self-supplied surface water.

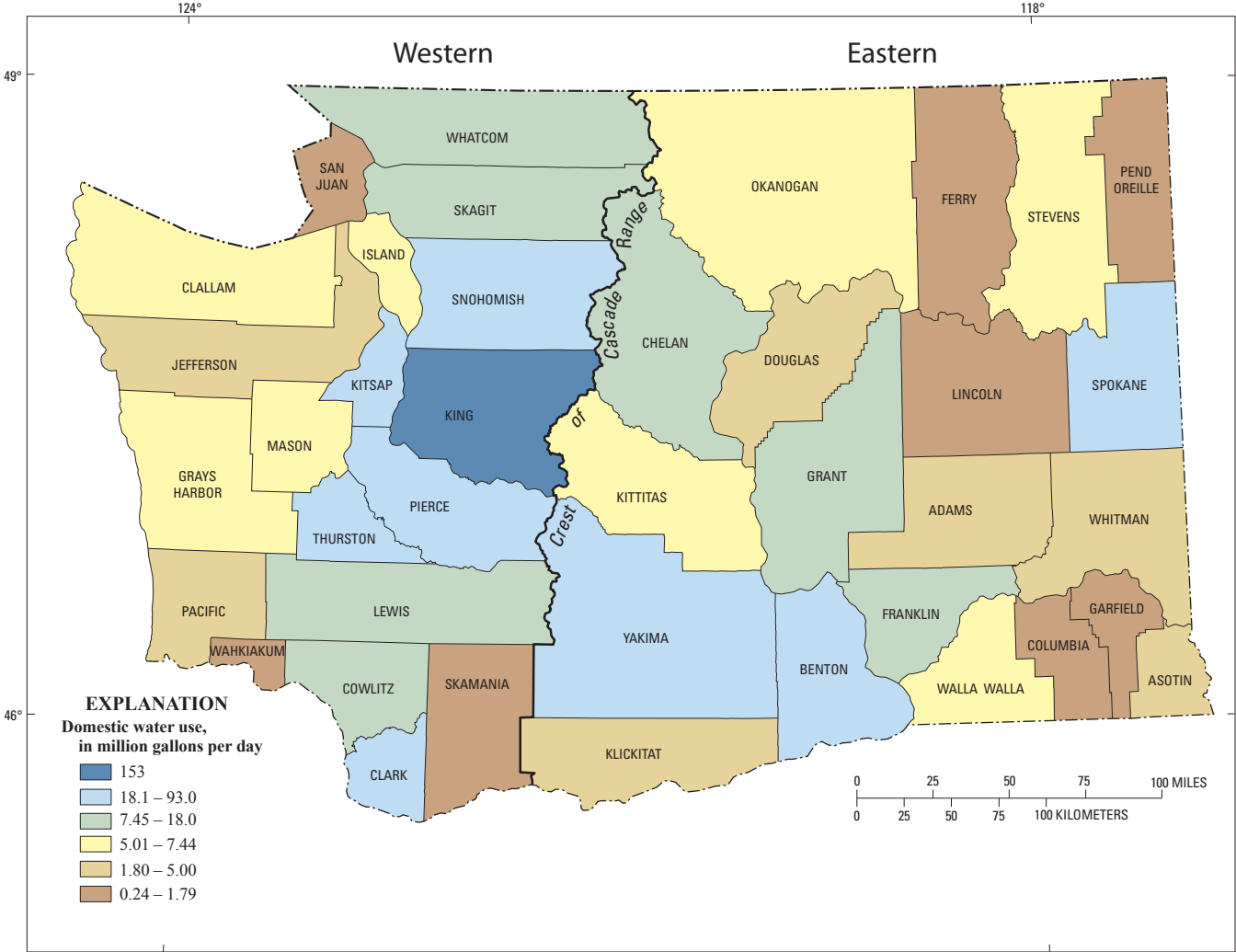


Figure 5. Estimated domestic water use, Washington, 2005.

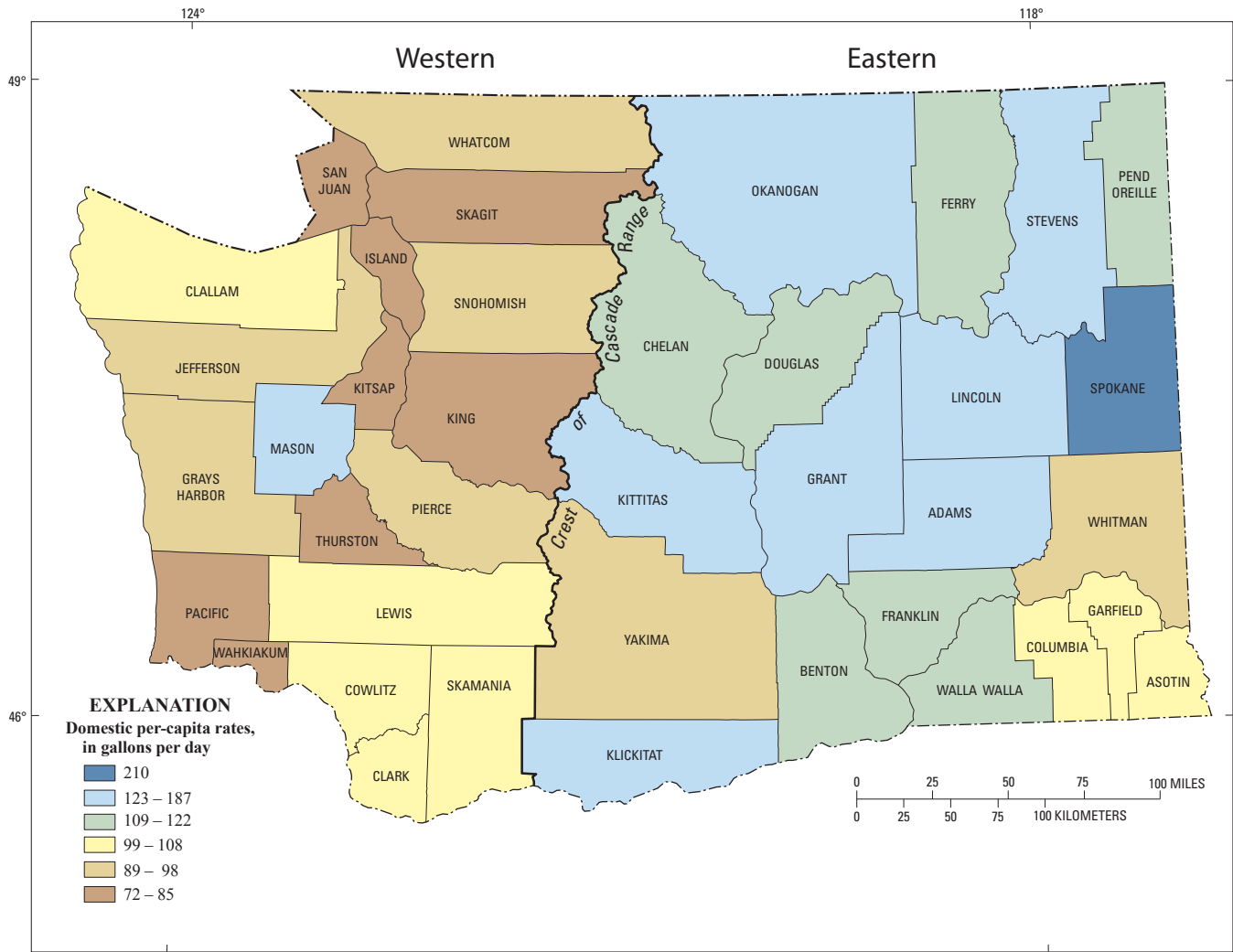


Figure 6. Estimated domestic per-capita rates, Washington, 2005.

Irrigation

Irrigation water use in Washington for 2005 was estimated to be 3,950 thousand acre-feet (acre-ft) or about 3,520 Mgal/d (table 4). County-level irrigation water use was estimated to range from 0.12 to 1,200 thousand acre-ft per year (fig. 7). Surface water accounted for 82 percent (3,240 thousand acre-ft) and groundwater accounted for

18 percent (704 thousand acre-ft) of the total irrigation water use in Washington in 2005. The irrigation application rate for Washington was estimated to be 2.14 acre-feet per acre per year (acre-ft/yr) while county-level application rates ranged from 0.27 to 3.25 acre-ft/yr (fig. 8). In terms of acres-irrigated, the five major crops in Washington in 2005 were alfalfa, orchards and vineyards, wheat, potatoes, and hay.



Aerial view of Dry Falls Dam and Banks Lake which provide much of the surface water used to irrigate crops in Washington State. Photograph courtesy of Bureau of Reclamation, accessed January 16, 2009, at <http://www.usbr.gov/dataweb/dams/dryfalls2.htm>

Table 4. Estimated irrigation water use, by source and county, Washington, 2005.

[Values may not add up to totals because of independent rounding. **Application rate:** Values are total water divided by irrigated land. acre-ft/yr, acre-feet per year; (acre-ft/acre)/yr, acre-feet per acre per year]

County	Irrigated land (thousand acres)	Water use (million gallons per day)			Water use (thousand acre-ft/yr)			Application rate [(acre-ft/acre)/yr]
		Groundwater	Surface water	Total water	Groundwater	Surface water	Total water	
Adams	121	125	24.9	150	140	27.9	168	1.39
Asotin	1.88	0.22	1.00	1.22	0.25	1.12	1.37	0.73
Benton	189	38.7	280	318	43.4	313	357	1.89
Chelan	35.1	3.48	60.3	63.8	3.90	67.5	71.5	2.04
Clallam	4.93	0.56	7.89	8.45	0.63	8.84	9.47	1.92
Clark	5.40	4.98	1.90	6.88	5.58	2.13	7.71	1.43
Columbia	2.84	0.25	3.56	3.81	0.28	3.99	4.27	1.50
Cowlitz	3.45	0.42	3.53	3.95	0.47	3.95	4.42	1.28
Douglas	24.3	3.55	27.3	30.9	3.98	30.6	34.6	1.42
Ferry	4.22	0.71	3.70	4.41	0.80	4.14	4.94	1.17
Franklin	241	67.6	455	523	75.7	510	586	2.43
Garfield	0.88	0.07	0.65	0.72	0.08	0.73	0.81	0.92
Grant	494	147	977	1,120	165	1,090	1,260	2.55
Grays Harbor	5.56	3.22	2.52	5.74	3.61	2.82	6.43	1.16
Island	1.51	0.78	0.24	1.02	0.87	0.27	1.14	0.76
Jefferson	0.95	0.73	0.52	1.25	0.82	0.58	1.40	1.47
King	7.28	3.50	3.48	6.98	3.92	3.90	7.82	1.07
Kitsap	1.40	0.99	0.52	1.51	1.11	0.58	1.69	1.21
Kittitas	92.1	2.76	264	267	3.09	296	299	3.25
Klickitat	25.4	19.6	14.8	34.4	21.9	16.6	38.5	1.52
Lewis	9.61	4.73	5.67	10.4	5.30	6.35	11.7	1.22
Lincoln	44.4	24.2	9.61	33.9	27.1	10.8	37.9	0.85
Mason	1.11	0.90	0.29	1.19	1.01	0.32	1.33	1.20
Okanogan	48.5	18.8	60.8	79.6	21.0	68.1	89.1	1.84
Pacific	2.95	0.93	2.12	3.05	1.04	2.37	3.42	1.16
Pend Oreille	1.43	0.23	0.47	0.70	0.26	0.53	0.78	0.55
Pierce	8.14	6.46	2.80	9.26	7.24	3.14	10.4	1.27
San Juan	0.45	0.02	0.09	0.11	0.02	0.10	0.12	0.27
Skagit	18.1	11.3	4.56	15.8	12.6	5.11	17.7	0.98
Skamania	0.68	0.18	0.55	0.73	0.20	0.62	0.82	1.20
Snohomish	7.26	2.47	3.11	5.58	2.77	3.48	6.25	0.86
Spokane	13.6	10.3	2.06	12.3	11.5	2.31	13.8	1.02
Stevens	11.7	1.75	10.4	12.2	1.96	11.6	13.6	1.17
Thurston	7.31	5.97	2.32	8.29	6.69	2.60	9.29	1.27
Wahkiakum	0.52	0.22	0.42	0.64	0.25	0.47	0.72	1.38
Walla Walla	93.6	17.0	114	131	19.0	128	147	1.57
Whatcom	33.1	21.5	9.14	30.7	24.1	10.2	34.4	1.04
Whitman	6.34	0.75	2.80	3.55	0.84	3.14	3.98	0.63
Yakima	270	77.0	529	606	86.2	593	679	2.52
Western	120	69.9	51.7	122	78.3	57.9	136	1.14
Eastern	1,720	559	2,840	3,400	626	3,180	3,810	2.21
State	1,840	629	2,890	3,520	704	3,240	3,950	2.14

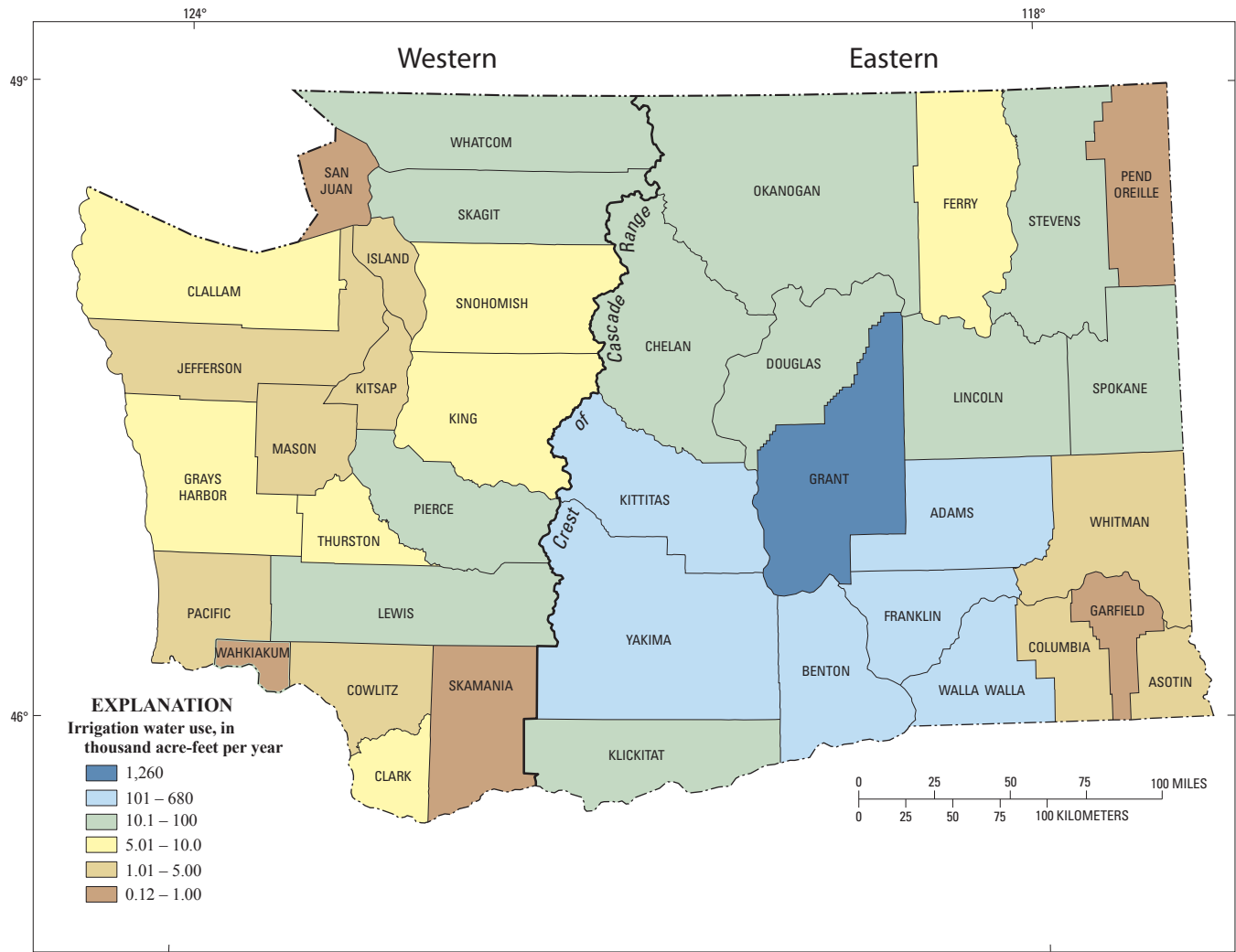


Figure 7. Estimated irrigation water use, Washington, 2005.

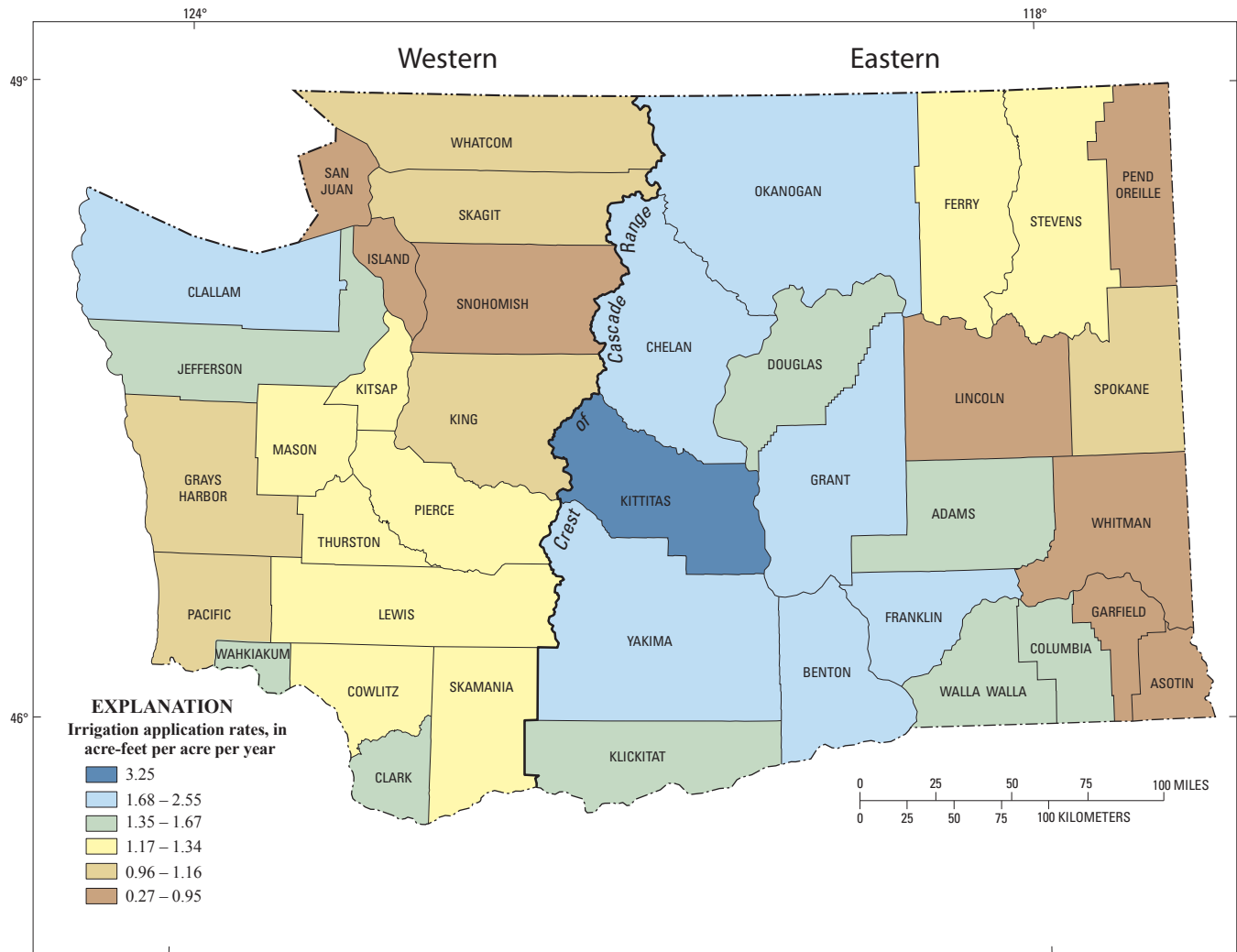


Figure 8. Estimated irrigation application rates, Washington, 2005.

Livestock

Livestock water use in Washington for 2005 was estimated to be 30.7 Mgal/d (table 5) and county-level water use was estimated to range from 0.01 to 7.15 Mgal/d (fig. 9). Surface water accounted for 32 percent (9.82 Mgal/d) and

groundwater accounted for 68 percent (20.9 Mgal/d) of the total livestock water use in the State. Dairy and beef cattle accounted for almost all of the livestock water use in Washington, although most of the other farm animal groups were represented in the State.



Although most major farm animal groups are represented in Washington, the rearing of cattle for meat and dairy products continues to dominate the Livestock Water Use Category. Photograph courtesy of the Washington State Department of Agriculture, Livestock Brand Inspection Program. Access January 23, 2009, at <http://agr.wa.gov/foodanimal/livestock/default.aspx>

20 Estimated Water Use in Washington, 2005

Table 5. Estimated livestock and aquaculture water use, by source and county, Washington, 2005.

[Values may not add up to total due to independent rounding. All values in million gallons per day]

County	Livestock			Aquaculture		
	Groundwater	Surface water	Total water	Groundwater	Surface water	Total water
Adams	0.88	0.01	0.89	0	0	0
Asotin	0.09	0.04	0.13	0	0	0
Benton	0.48	0.05	0.53	2.40	1.20	3.60
Chelan	0.01	0.03	0.04	0	8.34	8.34
Clallam	0.10	0.05	0.15	6.23	0	6.23
Clark	0.40	0.11	0.51	2.16	0	2.16
Columbia	0.06	0.02	0.08	0	1.47	1.47
Cowlitz	0.11	0.03	0.14	6.71	0	6.71
Douglas	0.11	0.04	0.15	3.09	0	3.09
Ferry	0.09	0.03	0.12	1.98	0	1.98
Franklin	0.79	0.20	0.99	3.23	0	3.23
Garfield	0.10	0.03	0.13	0	1.90	1.90
Grant	2.74	0.30	3.04	6.43	1.61	8.04
Grays Harbor	0.17	0.17	0.34	9.55	0	9.55
Island	0.14	0.02	0.16	0	0	0
Jefferson	0.10	0	0.10	0	1.37	1.37
King	1.00	0.08	1.08	7.78	0	7.78
Kitsap	0.02	0.02	0.04	6.92	0	6.92
Kittitas	0.24	0.23	0.47	0	0	0
Klickitat	0.20	0.14	0.34	9.18	0	9.18
Lewis	0.76	0.35	1.11	3.36	0	3.36
Lincoln	0.23	0.08	0.31	0	0	0
Mason	0.02	0.02	0.04	0	27.4	27.4
Okanogan	0.51	0.10	0.61	0	9.03	9.03
Pacific	0.14	0.09	0.23	2.71	0	2.71
Pend Oreille	0.04	0.03	0.07	0	0	0
Pierce	0.52	0.05	0.57	0	36.8	36.8
San Juan	0.02	0.02	0.04	0	0	0
Skagit	0.78	0.77	1.55	0	1.12	1.12
Skamania	0	0.01	0.01	0	15.4	15.4
Snohomish	0.76	0.73	1.49	6.63	0.04	6.67
Spokane	0.54	0.01	0.55	1.07	1.07	2.14
Stevens	0.32	0.24	0.56	0	8.69	8.69
Thurston	0.64	0.43	1.07	5.79	5.31	11.1
Wahkiakum	0.04	0.04	0.08	0.02	0.03	0.05
Walla Walla	0.20	0.12	0.32	0	0	0
Whatcom	3.06	2.24	5.30	1.46	1.46	2.92
Whitman	0.23	0.02	0.25	0	0	0
Yakima	4.28	2.87	7.15	0.03	1.74	1.77
Western	8.78	5.23	14.0	59.3	89.0	148
Eastern	12.1	4.59	16.7	27.4	35.1	62.5
State	20.9	9.82	30.7	86.7	124	211

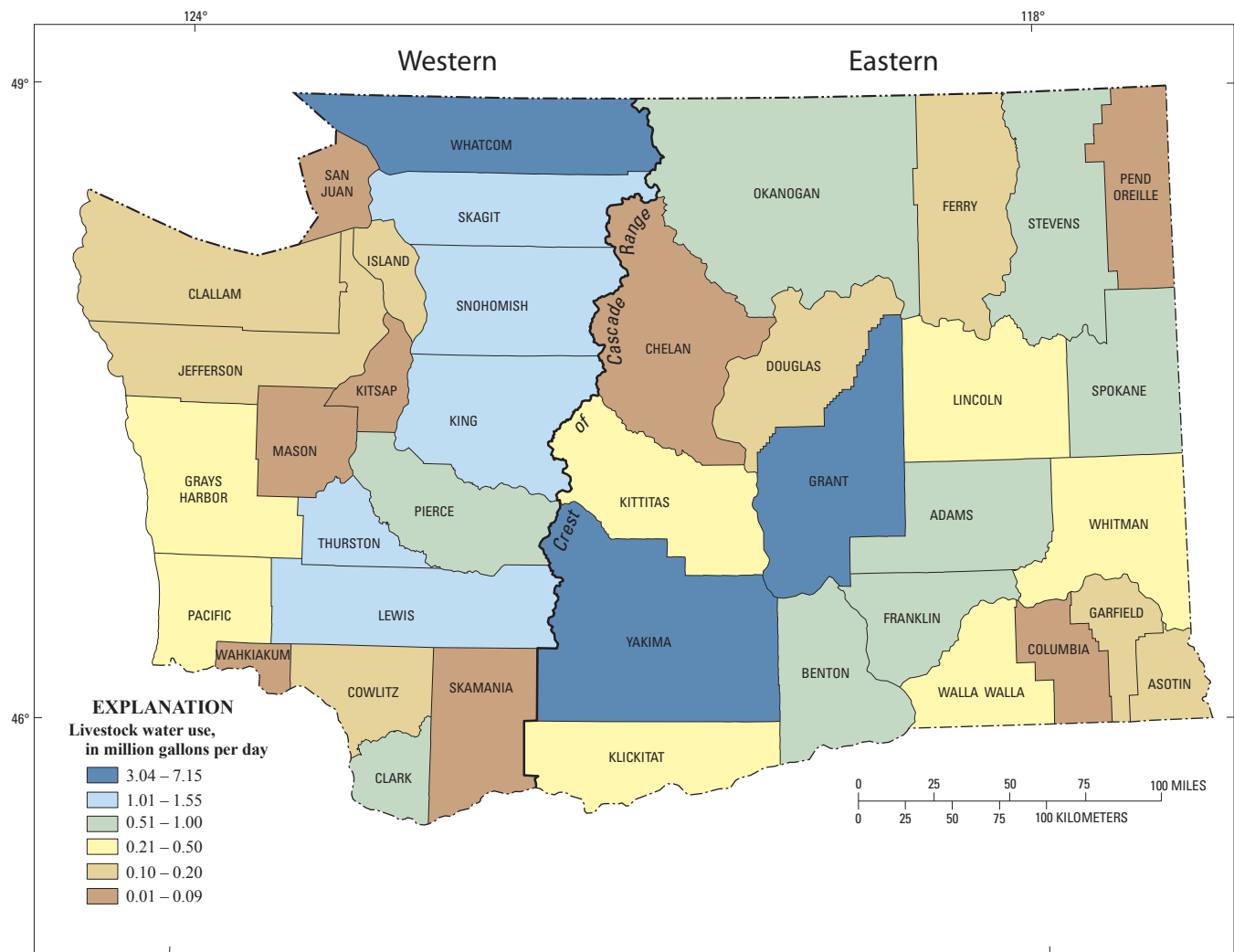


Figure 9. Estimated livestock water use, Washington, 2005.

Aquaculture

Aquaculture water use in Washington for 2005 was estimated to be 211 Mgal/d (table 5), while county-level water use was estimated to range from 0.05 to 36.8 Mgal/d (fig. 10). Surface water accounted for 59 percent (124 Mgal/d) and groundwater for the remaining 41 percent (86.7 Mgal/d) of the total State use. Water used in the rearing of salmon and trout in fish hatcheries comprised most of the aquaculture water use in Washington in 2005.



Covered raceways at Willard National Fish Hatchery used in the rearing of Coho salmon. Photograph by C. Anderson, courtesy of Willard National Fish Hatchery.

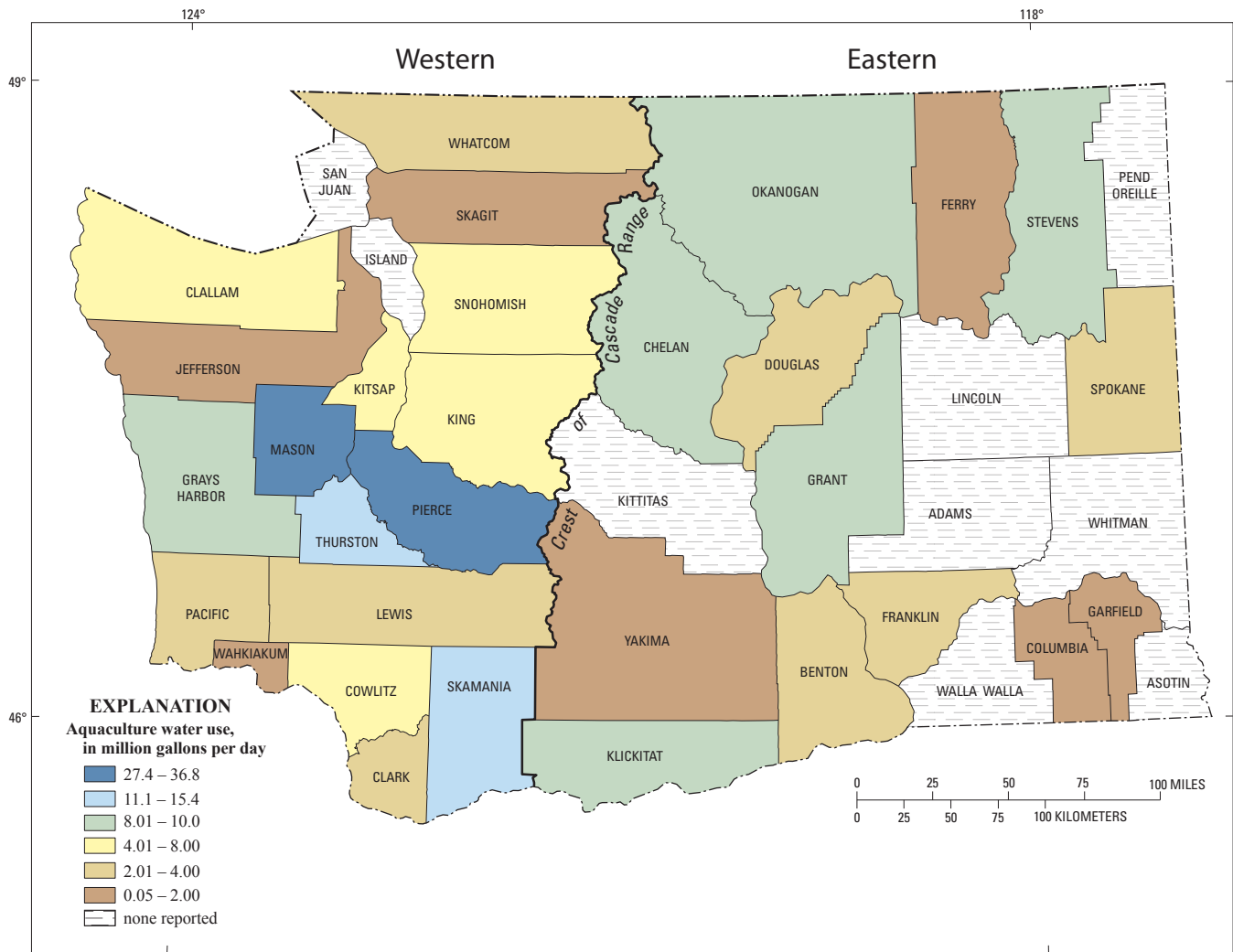


Figure 10. Estimated aquaculture water use, Washington, 2005.

Industrial

Industrial water use in Washington for 2005 was estimated to be 520 Mgal/d (table 6), with individual county-level use ranging from 0.01 to 123 Mgal/d (fig. 11). Public-supplied water accounted for 13 percent (66.0 Mgal/d), self-supplied surface water accounted for 67 percent (346 Mgal/d),

and self-supplied groundwater accounted for 21 percent (107 Mgal/d) of the total State use. In terms of production hours worked, the three major industrial groups in Washington in 2005 were manufacturing of transportation equipment, wood products and paper, computer and electrical products, and the fabrication of various metallic and non-metallic products.



The production of lumber and other wood products continues to be a major use of water for industrial purposes in Washington State in 2005. Photograph courtesy of U.S. Geological Survey, Washington Water Science Center, accessed January 16, 2009, at http://wa.water.usgs.gov/cgi/adr_photo.cgi?station=12439500&photo= 03

Table 6. Estimated industrial and mining water use, by source and county, Washington, 2005.

[Values may not add up to total due to independent rounding. All values in million gallons per day]

County	Industrial					Mining		
	Self-supplied			Public-supplied deliveries	Total water	Self-supplied		
	Groundwater	Surface water	Total			Groundwater	Surface water	Total water
Adams	2.79	0	2.79	0.51	3.30	0	0	0
Asotin	0	0	0	0.01	0.01	0.35	0.06	0.41
Benton	9.56	64.0	73.6	0.85	74.4	0.64	0.11	0.75
Chelan	0	9.71	9.71	0.25	9.96	0.01	0.02	0.03
Clallam	0.02	0.01	0.03	0.06	0.09	0.09	0.13	0.22
Clark	47.5	42.1	89.6	0.27	89.9	0.47	0.35	0.82
Columbia	0.06	0	0.06	0.03	0.09	0.08	0.02	0.10
Cowlitz	0	123	123	0.11	123	0.18	0.06	0.24
Douglas	2.20	0	2.20	0.05	2.25	0.34	0	0.34
Ferry	0.19	0	0.19	0	0.19	0.01	0.01	0.02
Franklin	2.03	0	2.03	1.95	3.98	0.55	0	0.55
Garfield	0.01	0	0.01	0	0.01	0.02	0	0.02
Grant	2.95	0	2.95	0.43	3.38	0.25	0	0.25
Grays Harbor	1.07	0.01	1.08	10.2	11.3	0.31	0	0.31
Island	0.01	0	0.01	0.09	0.10	0.24	0	0.24
Jefferson	0	0	0	2.46	2.46	0.51	0	0.51
King	2.46	2.10	4.56	3.86	8.42	4.77	0.23	5.00
Kitsap	0.03	0.09	0.12	0.48	0.60	0.54	0	0.54
Kittitas	1.20	0	1.20	0.12	1.32	0.23	0.23	0.46
Klickitat	0	1.31	1.31	0.01	1.32	0.32	0.14	0.46
Lewis	2.55	0	2.55	0.02	2.57	0.96	0.41	1.37
Lincoln	0.01	0	0.01	0.01	0.02	0.08	0.02	0.10
Mason	0.35	8.39	8.74	0	8.74	0.34	0	0.34
Okanogan	2.42	0	2.42	0.03	2.45	0.14	0.02	0.16
Pacific	0.20	0.28	0.48	0.13	0.61	0.09	0.09	0.18
Pend Oreille	0	0.63	0.63	0.12	0.75	1.17	0	1.17
Pierce	10.9	3.98	14.8	8.07	22.9	4.62	0.38	5.00
San Juan	0.25	0	0.25	0.01	0.26	0.04	0.01	0.05
Skagit	0.01	0.02	0.03	3.96	3.99	0.29	0.08	0.37
Skamania	0	7.33	7.33	0.01	7.34	0	0.01	0.01
Snohomish	1.72	41.4	43.1	12.2	55.3	1.14	0.85	1.99
Spokane	5.99	25.5	31.5	2.42	33.9	1.90	0.21	2.11
Stevens	0	0.12	0.12	0.04	0.16	0.34	0.17	0.51
Thurston	4.31	0	4.31	0.04	4.35	0.70	0.32	1.02
Wahkiakum	0.04	0	0.04	0	0.04	0.11	0.02	0.13
Walla Walla	0.52	9.75	10.3	0.49	10.8	0	0	0
Whatcom	0	6.60	6.60	15.5	22.1	0.48	0.11	0.59
Whitman	0	0	0	0.61	0.61	0	0	0
Yakima	6.12	0	6.12	0.62	6.74	0.13	0.09	0.22
Western	71.4	235	307	57.5	364	15.9	3.05	18.9
Eastern	36.1	111	147	8.55	156	6.56	1.10	7.66
State	107	346	454	66.0	520	22.4	4.15	26.6

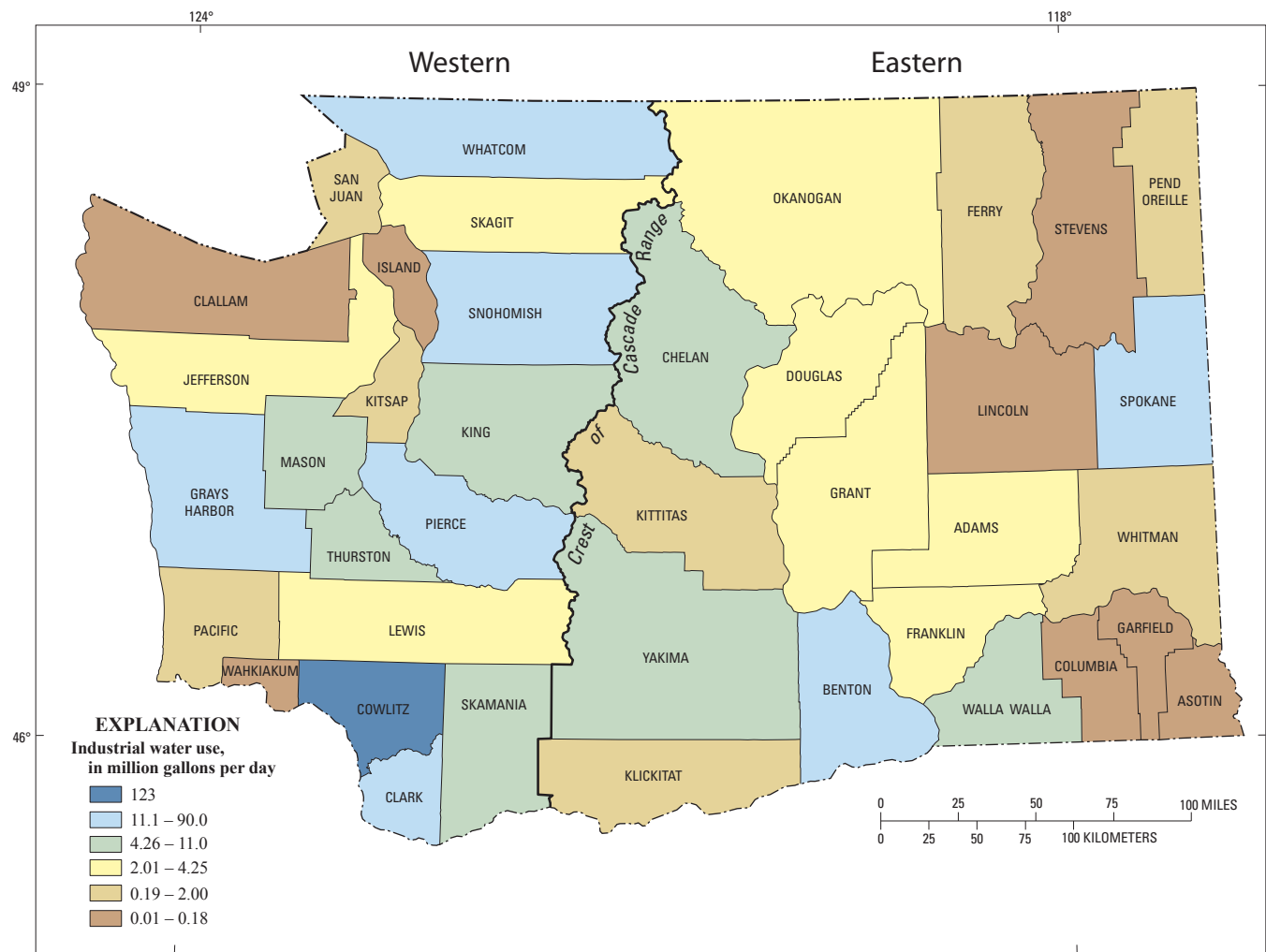


Figure 11. Estimated industrial water use, Washington, 2005.

Mining

Mining water use in Washington for 2005 was estimated to be 26.6 Mgal/d (table 6), and county-level use was estimated to range from 0.01 to 5.00 Mgal/d (fig. 12). Self-supplied surface water accounted for 16 percent (4.15 Mgal/d) and self-supplied groundwater accounted for the remaining 84 percent (22.4 Mgal/d) of total mining water use in the State. County-level mining water use estimates ranged from 0.01 to 5.00 Mgal/d. Nearly all of the mining water use in Washington was for the mining and quarrying of sand, gravel, stone, and other non-metallic minerals.



Typical gravel mine operation in Washington State, 2005. Photograph by Eric de Place, June 20, 2006. Copyright by Sightline Institute, Seattle, Washington; used with permission, accessed January 16, 2009, at <http://www.sightline.org/images/blog2006/gravel-mine/view>

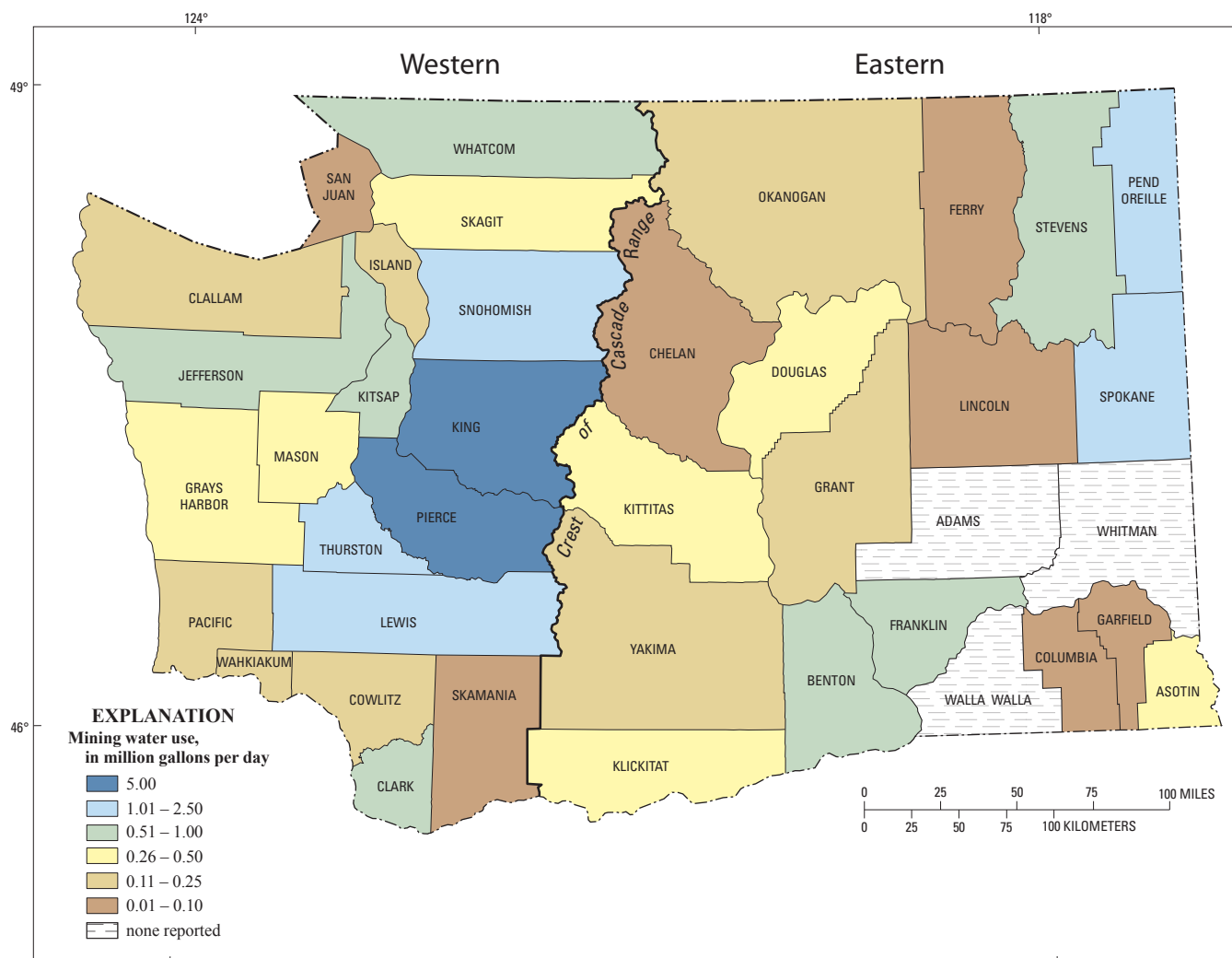


Figure 12. Estimated mining water use, Washington, 2005.

Thermoelectric Power

Thermoelectric power water use in Washington in 2005 was estimated to be 456 Mgal/d or about 8 percent of total water use in the state. Public-supply deliveries accounted for 0.2 percent (0.81 Mgal/d) of the total thermoelectric power water use in Washington. Self-supplied surface water accounted for the remaining 99.8 percent (455 Mgal/d) of the total thermoelectric power water use in Washington. There was no reported use of groundwater or of saline surface water for thermoelectric purposes in the State in 2005. Regional and county-level use data are not included in this report to avoid disclosing data for the individual thermoelectric power facilities in Washington.

Summary

As used in this report, water use refers only to the offstream use of freshwater for public supply, domestic, irrigation, livestock, aquaculture, industrial, mining, and thermoelectric power purposes in the State of Washington during 2005, and does not include water used for instream purposes or offstream uses beyond those listed. Likewise, the term ‘total water’ refers only to the sum of the individual estimates for the specified uses and should not be confused with the absolute total amount of water used for all purposes in Washington.

Total freshwater use (public-supplied plus self-supplied) in Washington for 2005 was estimated to be about 5,780 Mgal/d. Fresh surface water accounted for 74 percent (4,280 Mgal/d). Fresh groundwater accounted for the remaining 26 percent (1,490 Mgal/d) of the total freshwater use.

Total saline water use was estimated to be 33.2 Mgal/d, all of which was from surface-water sources in western Washington. Nearly all saline water use was for industrial purposes in Pierce (21.4 Mgal/d), Grays Harbor (6.6 Mgal/d), and Jefferson (5.2 Mgal/d) Counties. Various public-supply systems withdrew and desalinized 0.05 Mgal/d of seawater to augment freshwater supplies.

Public-supply water use was estimated to total 990 Mgal/d or about 17 percent of total water use in Washington in 2005. Surface water accounted for 46 percent (451 Mgal/d) and groundwater accounted for the remaining 54 percent (539 Mgal/d) of the total use. The per-capita rate of public-supply water use was estimated to be 181 gal/d while the county-level rates ranged from 106 to 899 gal/d.

Domestic water use was estimated to be 648 Mgal/day or about 11 percent of total water use in the state in 2005. Public-supplied water accounted for 87 percent (562 Mgal/d) and self-supplied withdrawals of groundwater accounted for almost all of the remaining 13 percent (86.0 Mgal/d) of the total domestic water use. The per-capita rate of domestic use was estimated to be 103 gal/d while the county-level rates ranged from 72 to 210 gal/d.

Irrigation water use was estimated to be 3,520 Mgal/d or about 61 percent of total water use in the state in 2005. Surface water accounted for 82 percent (2,890 Mgal/d) and groundwater accounted for the remaining 18 percent (629 Mgal/d) of the total use. The state-level irrigation application rate was estimated to be 2.14 ft/yr while the county-application rates ranged from 0.27 to 3.25 ft/yr.

Livestock water use was estimated to be 30.7 Mgal/d or about 0.5 percent of total water use in Washington in 2005. Surface water accounted for 32 percent (9.82 Mgal/d) and groundwater accounted for 68 percent (20.9 Mgal/d) of the total livestock water use in the State.

Aquaculture water use was estimated to be 211 Mgal/d or about 4 percent of total water use in Washington in 2005. Surface water accounted for 59 percent (124 Mgal/d) and groundwater for the remaining 41 percent (86.7 Mgal/d) of the total State use.

Industrial freshwater use was estimated to be 520 Mgal/d or about 9 percent of total freshwater in the State in 2005. Public-supplied water accounted for 13 percent (66.0 Mgal/d); self-supplied withdrawals of fresh surface water accounted for 67 percent (346 Mgal/d); and self-supplied groundwater accounted for 21 percent (107 Mgal/d) of use.

Mining water use was estimated to be 26.6 Mgal/d or about 0.5 percent of the total water use in the State in 2005. Self-supplied surface water accounted for 16 percent (4.15 Mgal/d) and self-supplied groundwater accounted for the remaining 84 percent (22.4 Mgal/d) of total mining water use in the State.

Thermoelectric power water use was estimated to be 456 Mgal/d. Thermoelectric water use was about 8 percent of total water use in Washington in 2005. Public-supply deliveries accounted for 0.2 percent (0.81 Mgal/d) of the total thermoelectric power water use in Washington. Self-supplied fresh surface water accounted for the remaining 99.8 percent (455 Mgal/d) of the total thermoelectric power water use in Washington in 2005.

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Glossary

The concepts and terms in this glossary are modified from the U.S. Geological Survey's National Handbook of Recommended Methods for Water Data Acquisition, available on the Web at <http://water.usgs.gov/pubs/chapter11/chapter11M.html>, and from its guidelines for preparation of State water-use estimates.

Aquaculture: Water used in the rearing of organisms that live in water, such as fish, shellfish, and algae, within a confined space and under controlled feeding, sanitation, and harvesting procedures.

Class A system: A public water-supply system that has a full-time service population of at least 25 people or that has at least 15 connections.

Class B system: A public water-supply system that has a full-time service population of less than 25 people or that has fewer than 15 connections.

Domestic (residential): Water used for household purposes such as drinking, food preparation, bathing, washing clothes and dishes, flushing toilets, car washing, and watering lawns and gardens.

Freshwater: Water that contains less than 1,000 mg/L of dissolved solids; generally, more than 500 mg/L of dissolved solids is undesirable for drinking and many industrial uses.

Groundwater: Generally all subsurface water as distinct from surface water; specifically, that part of the subsurface water in the saturated zone (a zone in which all voids are filled with water).

Industrial: Water used for industrial purposes such as fabrication, processing, washing, and cooling, and includes such industries as steel, chemical and allied products, paper and allied products, smelting, and petroleum refining.

Instream use: Water that remains in a surface or groundwater source during use.

Irrigation: Artificial application of water on lands to assist in the growing of crops and pastures or to maintain vegetative growth in recreational lands such as parks and golf.

Livestock: Water for livestock watering, feedlots, dairy operations, and other on-farm needs in the rearing, cleaning, and processing of all animals other than fish or shellfish.

Mining: Water used for the extraction of minerals occurring naturally including solids, such as coal and ores; liquids, such as crude petroleum; and gases, such as natural gas. Water use associated with quarrying, well operations (dewatering), milling (crushing, screening, washing, floatation, and so forth), and other preparations customarily done at the mine site or as part of mining activity also are included. Mining uses do not include water used in processing, such as smelting, refining petroleum, or slurry pipeline operations; these uses are included in industrial water use.

Offstream use: Water withdrawn or diverted from a groundwater or surface-water source for a specific use.

Per capita: The average amount of water used per person during a standard time period, generally per year.

Public water-supply system: A publicly or privately owned facility that supplies water to a variety of users such as cities, towns, rural water districts, mobile-home parks, Indian reservations and military installations.

Residential: see Domestic

Saline water: Water that contains more than 1,000 milligrams per liter of dissolved solids.

Self-supplied: Water withdrawn from a surface-water or a groundwater source by an individual user and not obtained from a public-supply system.

Surface water: An open body of water, such as a stream or lake.

Thermoelectric: Water used in the process of the generation of thermoelectric power.

Water use: (1) In a restrictive sense, the term refers to water that is actually used for a specific purpose, such as for domestic use, irrigation, or industrial processing. (2) More broadly, water use pertains to human's interaction with and influence on the hydrologic cycle, and includes elements such as water withdrawal, distribution, consumptive use, wastewater collection, and return flow.

Withdrawal: Surface water or groundwater removed from the natural hydrologic system for use.

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