

ESTIMATED USE OF WATER IN LINCOLN COUNTY, WYOMING, 1993

***By Kathy Muller Ogle, Cheryl A. Eddy-Miller, and
Christopher J. Busing***

**U.S. GEOLOGICAL SURVEY
Water-Resources Investigations Report 96-4162**

**Prepared in cooperation with the
Wyoming State Engineer**



Cheyenne, Wyoming

1996

U.S. DEPARTMENT OF THE INTERIOR
BRUCE BABBITT, Secretary

U.S. GEOLOGICAL SURVEY
Gordon P. Eaton, Director

For additional information
write to:

District Chief
U.S. Geological Survey, WRD
2617 E. Lincolnway, Suite B
Cheyenne, Wyoming 82001-5662

Copies of this report can be
purchased from:

U.S. Geological Survey
Branch of Information Services
Box 25286, Denver Federal Center
Denver, Colorado 80225

CONTENTS

	Page
Abstract	1
Introduction	1
Purpose and scope	1
Description of study area	2
Acknowledgments	2
Water-use estimates	2
Total use	2
Public supply	2
Self-supplied domestic	4
Commercial	6
Irrigation	6
Livestock	7
Industrial	9
Mining	9
Thermoelectric power	10
Hydroelectric power	10
Summary	10
References	11
Glossary	13

FIGURES

1. Map of Lincoln County, Wyoming	3
2. Diagram showing percent of surface water and ground water used in estimated total water use, excluding hydroelectric power, Lincoln County, Wyoming, 1993	4
3. Map showing estimated water use (1993) and census population (1990) for selected communities, Lincoln County, Wyoming	5
4. Graph showing number of domestic wells penetrating to selected depth intervals, Lincoln County, Wyoming, 1993	7
5. Map and diagrams showing conservation districts, estimated percent of surface-water and ground-water irrigation water use, and estimated percent of flood and sprinkler irrigation, Lincoln County, Wyoming, 1993	8
6. Diagrams showing water source and supplier for estimated industrial water use, Lincoln County, Wyoming, 1993	9

TABLES

1. Estimated ground-water, surface-water, and total water use, Lincoln County, Wyoming, 1993	2
2. Water source, estimated usage, and estimated percentage of domestic, commercial, and industrial water use from public supplies, Lincoln County, Wyoming, 1993	6
3. Estimated number of livestock, water-use coefficients, and estimated livestock water use, Lincoln County, Wyoming, 1993	9

ESTIMATED USE OF WATER IN LINCOLN COUNTY, WYOMING, 1993

By Kathy Muller Ogle, Cheryl A. Eddy-Miller, and Christopher J. Busing

ABSTRACT

Total water use in Lincoln County, Wyoming in 1993 was estimated to be 405,000 Mgal (million gallons). Water use estimates were divided into nine categories: public supply, self-supplied domestic, commercial, irrigation, livestock, industrial, mining, thermoelectric power, and hydroelectric power.

Public-supply water use, estimated to be 2,160 Mgal, primarily was supplied from wells and springs. Shallow ground-water wells were the primary source of self-supplied domestic water, estimated to be 1.7 Mgal, with 53 percent of those wells drilled to depths of 100 feet or less. Commercial water use, estimated to be 117 Mgal, was obtained from public-supply systems.

Surface water supplied an estimated 153,000 Mgal of the total estimated water use of 158,000 Mgal for irrigation in Lincoln County in 1993. Sprinkler and flood irrigation technology were used about equally in the northern part of Lincoln County, and flood irrigation was the primary technology in the southern part.

Livestock, industrial, and mining water use were not major in Lincoln County in 1993. Livestock water use totaled an estimated 203 Mgal. Industrial water use was estimated to be 120 Mgal from self-supplied water sources and 27 Mgal from public-supplied water sources. Mining water use was an estimated 153 Mgal.

Thermoelectric and hydroelectric power generation used surface-water sources. Thermoelectric power water use in 1993 was an estimated 5,900 Mgal. An estimated 238,000 Mgal of water was used to generate hydroelectric power in 1993 at Fontenelle Reservoir on the Green River.

INTRODUCTION

Water use was estimated in Lincoln County, Wyoming for 1993. Water-use estimates are categorized by: public supply, self-supplied domestic, commercial, irrigation, livestock, industrial, mining, thermoelectric power, and hydroelectric power. Lincoln County has a diverse topography, economy, and population. Likewise, water use in Lincoln County is diverse, depending on the category examined.

Water-use data are essential to management of water resources. The data provide information on the amount of water used for specific activities. Water-use data are needed for planning purposes by government, business, public interest groups, and individuals. Water-use information can be used to evaluate economic-development possibilities and conservation opportunities. This report summarizes estimates of water use in Lincoln County in 1993 as part of a cooperative study between the Wyoming State Engineer's Office and the U.S. Geological Survey.

Purpose and Scope

This report describes the water use for Lincoln County in 1993. Water-use estimates are summarized for nine categories, and the source of water used in each category is identified. The nine categories are: public supply, self-supplied domestic, commercial, irrigation, livestock, industrial, mining, thermoelectric power, and hydroelectric power. Within each category, the estimated amount of surface and ground water used are presented. Water use in this report refers to the amount of water withdrawn for a specific use. Federal, State, county, local entities, businesses, public interest groups, and individuals need quantitative data on water use for planning purposes. The report is limited to the categories compiled for water use in 1993.

Description of Study Area

Lincoln County, which has an area of 4,182 square miles (Wyoming Department of Administration and Information, 1991, p. 250), is located in western Wyoming (fig. 1) and borders Idaho and Utah. The 1990 census reported a population of 12,625 (Wyoming Department of Administration and Information, 1991, p. 6). The topography of the county ranges from a flat, intermontane valley in the west, to high mountains in the center, and to flat grasslands and desert in the south and east. Altitudes range from about 5,600 feet above mean sea level near Star Valley to 11,378 feet above mean sea level at Wyoming Peak. Green River, Bear River, and Snake River and their tributaries are the principal drainages in Lincoln County.

Lincoln County was developed as a result of mining, westward expansion, and settlement by members of the Church of Jesus Christ of Latter-Day Saints (Wyoming Historical Records Survey, 1941). Mining, agriculture, light manufacturing, and tourism currently are the primary industries in this rural county.

Acknowledgments

The assistance of the Wyoming State Engineer's Office, the Soil Conservation Service (now Natural Resources Conservation Service), the Star Valley and Lincoln County Conservation Districts, the Wyoming Tourist Bureau, John P.R. Holland II, and the companies and residents of Lincoln County in providing data and information gratefully is acknowledged.

WATER-USE ESTIMATES

Water-use estimates were made for nine categories: public supply, self-supplied domestic, commercial, irrigation, livestock, industrial, mining, thermoelectric power, and hydroelectric power. The amount of surface-water and ground-water use in each category also was estimated. Estimates within each category were summed to provide an estimated total water use for each category.

Total Use

Total water use in Lincoln County in 1993 was estimated to be 405,000 Mgal (million gallons) by summing the water use in individual categories (table 1). Hydroelectric power and irrigation used the largest amount of water. Self-supplied domestic accounted for the smallest amount of water used. The primary water source in Lincoln County was surface water (fig. 2).

Table 1. *Estimated ground-water, surface-water, and total water use, Lincoln County, Wyoming, 1993*

Category	Estimated Water Use, 1993 (million gallons)		
	Ground water	Surface water	Total
Public supply	1,870	299	¹ 2,160
Self-supplied domestic	1.7	0	1.7
Commercial	² (72)	² (45)	² (117)
Irrigation	5,170	153,000	¹ 158,000
Livestock	163	40	203
Industrial	³ (27) + 49	71	³ (27) + 120
Mining	68	85	153
Thermoelectric power	0	5,900	5,900
Hydroelectric power	0	238,000	238,000
TOTAL	7,321.7 ¹ 7,320	397,395 ¹ 397,000	404,537.7 ¹ 405,000

¹Rounded total.

²All commercial water use was from public supply; thus the numbers are reported but not added in the total.

³Part of the industrial water use was from public supply; thus the numbers are reported but not added in the total.

Public Supply

Public supply is defined as water withdrawn by public and private water suppliers and delivered to multiple users for domestic, commercial, and industrial uses. Public water suppliers were contacted to determine the amount of water supplied, population served, percent of domestic, commercial, and industrial use,

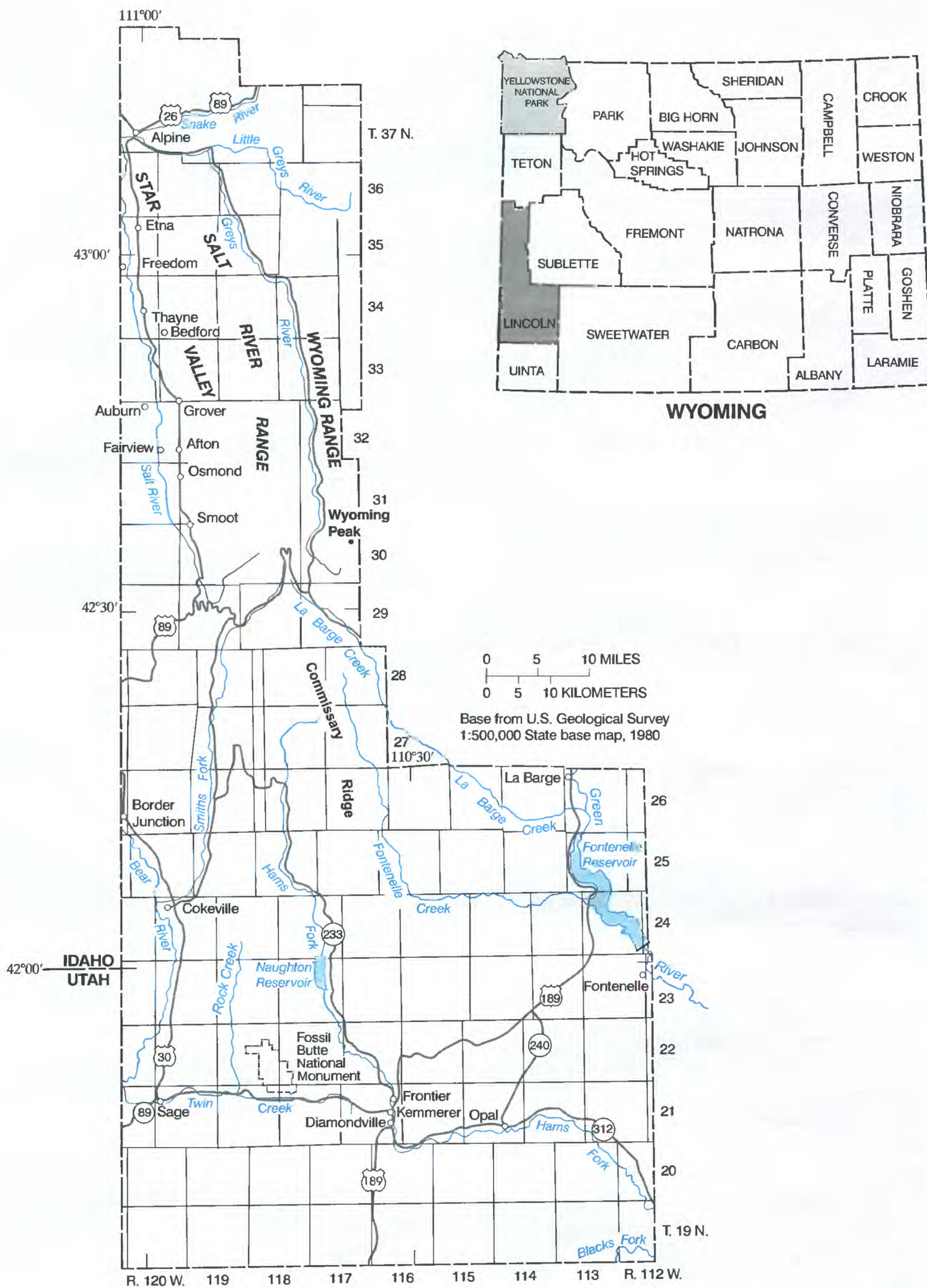


Figure 1. Lincoln County, Wyoming.

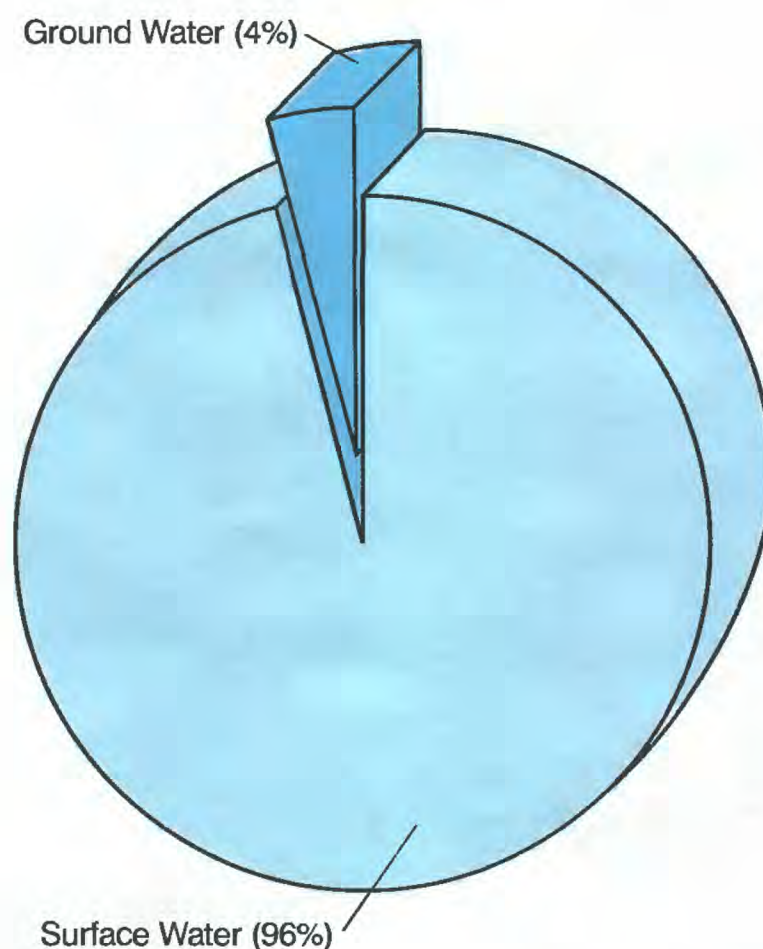


Figure 2. Percent of surface water and ground water used in estimated total water use, excluding hydroelectric power, Lincoln County, Wyoming, 1993.

water source, and method of measurement. Public-supply water use was estimated to be 2,160 Mgal in 1993, with the largest use being domestic. Public-supply water use estimates in Lincoln County in 1993 are summarized for the communities of Afton, Alpine, Cokeville, Kemmerer and Diamondville, La Barge, Opal, Thayne, Star Valley Ranches, and an aggregate of six water districts in Star Valley (Etna, Freedom, Grover, Osmond, Fairview, and Smoot) (fig. 3).

The largest percentage of public supply in Lincoln County in 1993 was used for domestic purposes, but small percentages were used by commercial and industrial businesses (table 2). No public supply water was used in thermoelectric power generation. The primary source of public water supplies in Lincoln County, in 1993, was ground water obtained from wells and springs (table 2). An exception is the Kemmerer and Diamondville system, which was supplied by surface water from the Hams Fork River. Communities generally use master meters, pump meters, or outflow meters to measure the total amount of water delivered from a source to their system.

Self-Supplied Domestic

Self-supplied domestic water is water withdrawn from a source by the user rather than a public supplier. The self-supplied domestic water use for Lincoln County in 1993 was estimated using population and public water-use information. The number of people using self-supplied water was estimated by subtracting the number of people using a public supply from the total population of Lincoln County. The per capita self-supplied domestic water use was estimated using a population-weighted average per capita water use from all public supplies in the county.

The estimated 3,000 people who had a self-supplied, domestic water supply used an estimated 1.7 Mgal of water in 1993. The primary source of water for self-supplied domestic use was ground water. Domestic well permit information was obtained from the Wyoming State Engineer's Office (WSEO) data base (Wyoming State Engineer's Office, 1993). A total of 633 wells used for domestic water supply were identified by the WSEO. Fifty-three percent of the

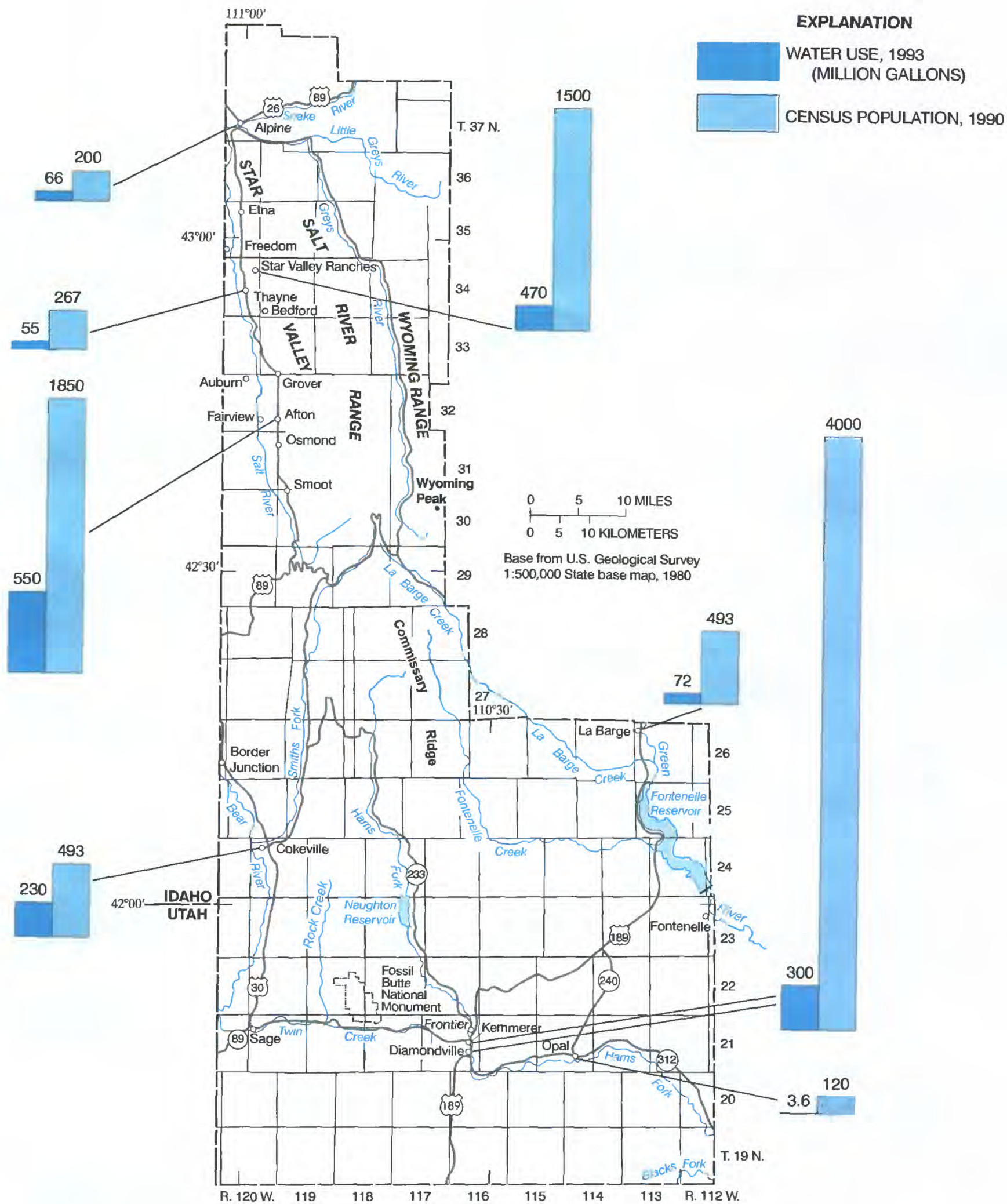


Figure 3. Estimated water use (1993) and census population (1990) for selected communities, Lincoln County, Wyoming.

Table 2. *Water source, estimated usage, and estimated percentage of domestic, commercial, and industrial water use from public supplies, Lincoln County, Wyoming, 1993*

[NA, data not available]

Public water supply	Source	Estimated use (million gallons)	Estimated percent of use, 1993		
			Domestic	Commercial	Industrial
Afton	Periodic spring	550	90	5	5
Alpine	spring and two wells	66	67	33	0
Cokeville	spring	230	95	5	0
Kemmerer and Diamondville	Hams Fork River	300	85	15	0
La Barge	collection gallery ¹	72	NA	NA	NA
Opal	wells	3.6	100	0	0
Thayne	springs	55	80	20	NA
Star Valley Ranches	springs	470	100	0	0
Star Valley Water Districts aggregate	springs and wells	418	NA	NA	NA

¹Collection gallery—one or more horizontal wells which remove water to a common vertical shaft. May be located close to a stream or lake to take advantage of aquifer filtration.

wells were drilled to less than 100 feet below land surface. The distribution of those wells by depth is shown in figure 4.

Commercial

Commercial water use is water used for motels, hotels, restaurants, office buildings and other commercial facilities, and institutions. Total estimated commercial water use in 1993 was 117 Mgal (table 1). For this report, all commercial water use was obtained from public supply (table 2). No self-supplied commercial users were identified.

Irrigation

Irrigation was the second largest water use in Lincoln County (table 1). Irrigation water use is

limited to the artificial application of water on land to assist in the growing of crops and pastures. An estimated total of 158,000 Mgal of water was used for irrigation in 1993 in Lincoln County, on the basis of data and information provided by the Conservation Districts. Water was used for irrigation in two areas: the Star Valley Conservation District and the Lincoln County Conservation District (fig. 5).

In the Star Valley Conservation District, the primary source of irrigation water was surface water. Ken Mills (Soil Conservation Service, Star Valley District Conservationist, oral commun., 1993) estimated that 96 percent of the irrigation water was surface water and the remaining 4 percent was ground water. About 55 percent of the irrigated acreage was applied by sprinkler irrigation and 45 percent by flood irrigation (fig. 5).

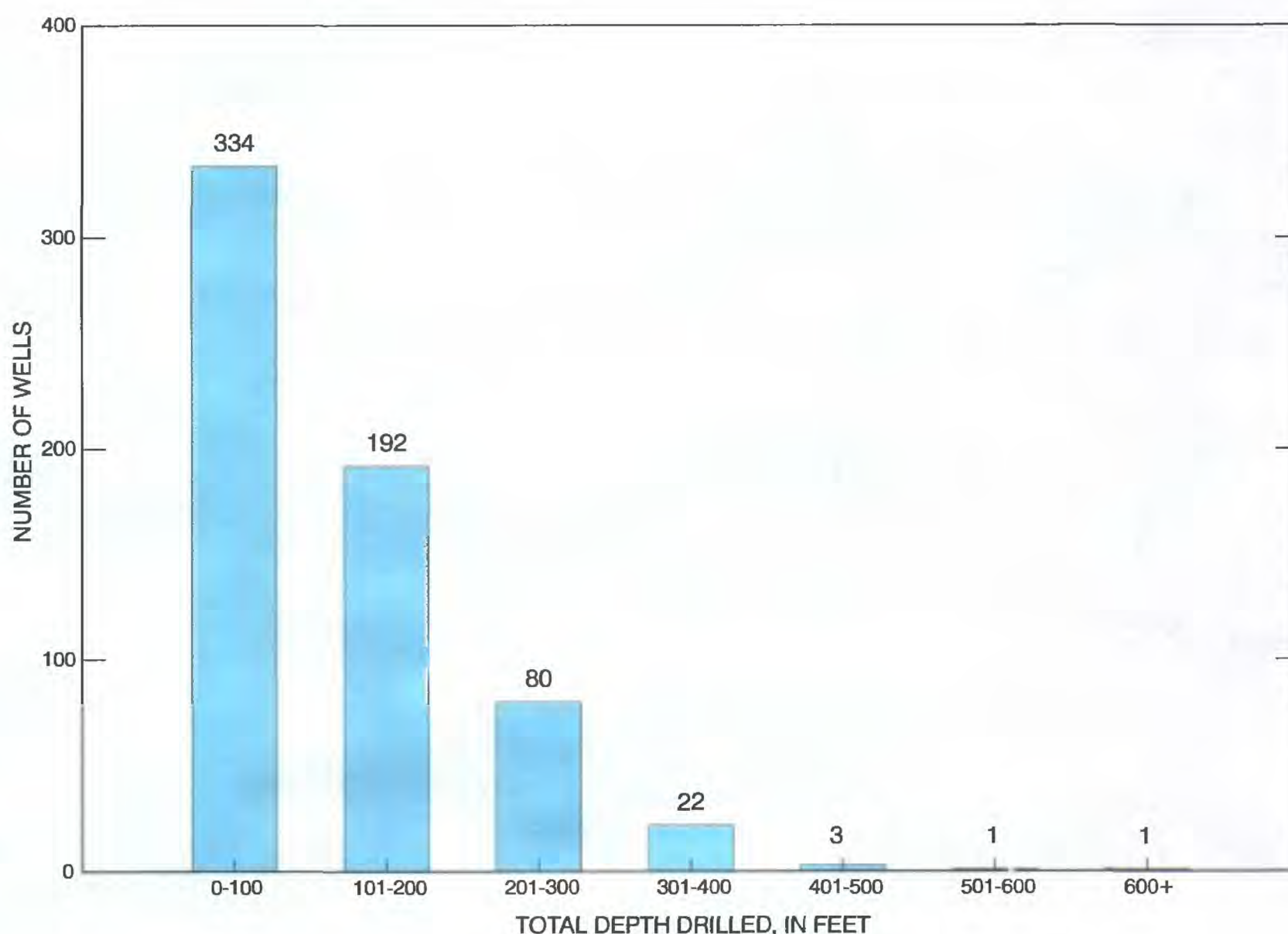


Figure 4. Number of domestic wells penetrating to selected depth intervals, Lincoln County, Wyoming, 1993.

In the Lincoln County Conservation District, surface water also was the primary source of irrigation water. DeMont Grandy (Soil Conservation Service, Lincoln County District Conservationist, oral commun., 1993) estimated that 97 percent of the irrigation water was surface water and 3 percent was ground water. However, in contrast to the Star Valley Conservation District, the Lincoln County Conservation District primarily used flood irrigation to apply the water (fig. 5). Flood irrigation was used on an estimated 94 percent of the irrigated acreage and sprinkler irrigation on the remaining 6 percent.

Livestock

Livestock water use is water used for livestock watering, feed lots, dairy operations, fish farming, and other on-farm needs. Livestock water use was esti-

mated for dairy cattle, beef cattle, and sheep (table 3). Water use for hogs and chickens was not included; the quantity of water used by these animals was small compared to total livestock water use. An estimated 203 Mgal of water was used for livestock in 1993. Livestock water use was calculated using a coefficient of estimated water use for each animal per day (Cheeke, 1991, p. 278, and Holechek and others, 1989, p. 327). The number of animals in the county was obtained from the Wyoming Agricultural Statistics (Burger, 1993, p. 36-60). An 80 percent ground-water and 20 percent surface-water distribution of the total livestock water use was estimated (DeMont Grandy, Soil Conservation Service, Lincoln County Conservation District, oral commun., 1995). The number of livestock in the county, the water-use coefficient for each type of livestock, and the total livestock water use are summarized in table 3.

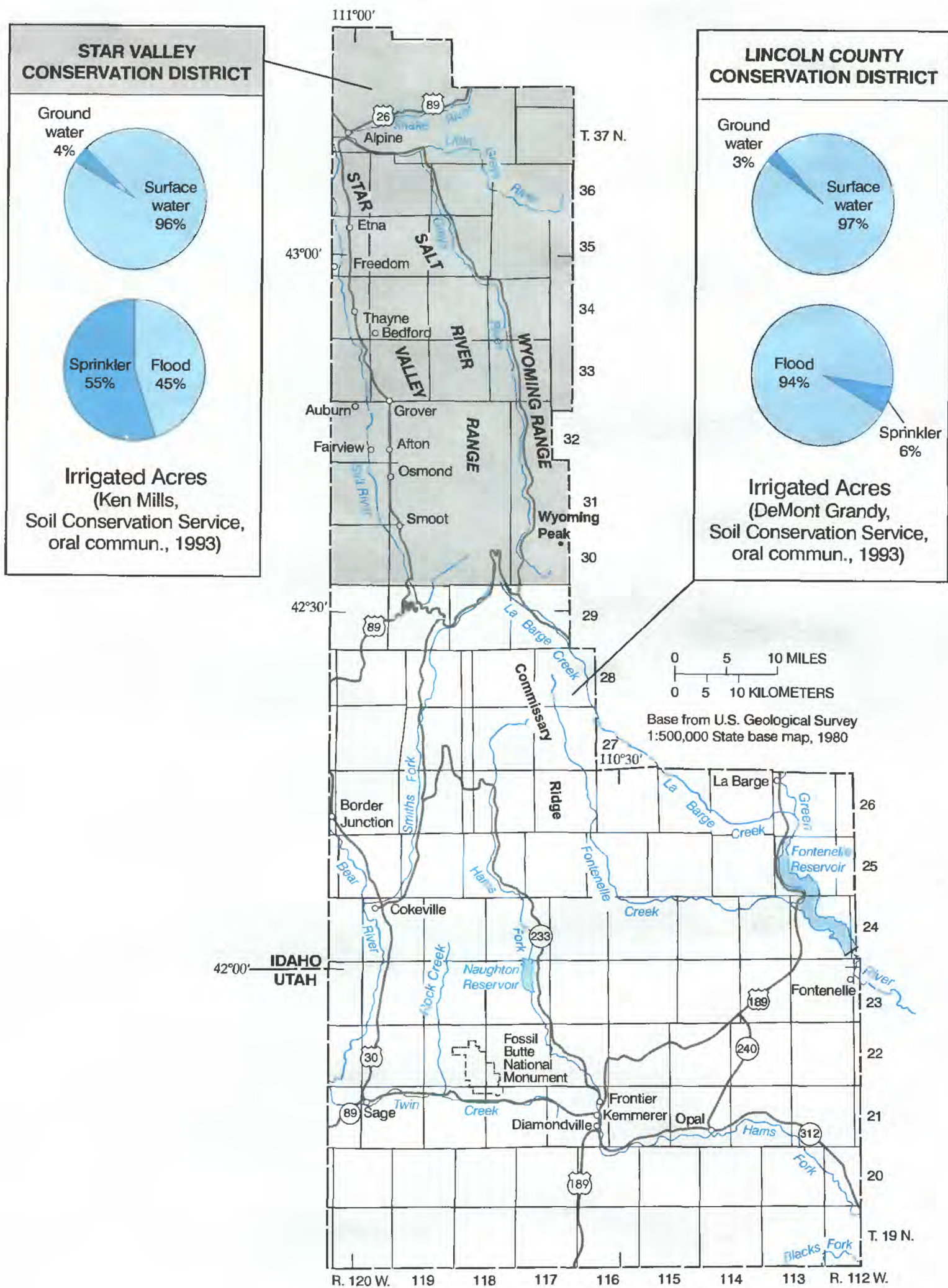


Figure 5. Conservation districts, estimated percent of surface-water and ground-water irrigation water use, and estimated percent of flood and sprinkler irrigation, Lincoln County, Wyoming, 1993.

Table 3. *Estimated number of livestock, water-use coefficients, and estimated livestock water use, Lincoln County, Wyoming, 1993*

Live-stock type	Number of animals	Water-use coefficient (gallons per day per animal)	Estimated water use, 1993		
			Ground water	Surface water	Total
			(million gallons)		
Dairy cattle	3,800	19.5	22	5.4	27
Beef cattle	39,200	11	126	31	157
Sheep	35,000	1.5	15	3.8	19

Industrial

Industrial water use is defined as water used for industrial purposes such as fabrication, processing, washing, and cooling. Industrial water use was estimated by contacting individual users. An estimated 147 Mgal of water was used for industrial purposes in Lincoln County in 1993 (table 1). The source of the water was approximately evenly divided between

ground water and surface water (fig. 6). However, most of the industrial water was self-supplied rather than obtained from public-water systems (fig. 6).

Mining

Mining water use includes water used for the extraction of minerals, liquids, and gases. Mining water use estimates in Lincoln County were limited to coal mining, and oil and gas production. Mining water use was estimated to be 153 Mgal in Lincoln County in 1993. The water use for coal mining was estimated from data obtained from the individual companies. The oil and gas water use was estimated from data published by the Wyoming Oil and Gas Conservation Commission (1993).

Two mines in the county—the Skull Point Coal Mine and the Kemmerer Coal Mine—together used an estimated 113 Mgal of water in 1993. At both mines, this water was obtained by pumping pit inflow that was a result of both ground-water seepage and surface-water runoff. The primary use of this water was for

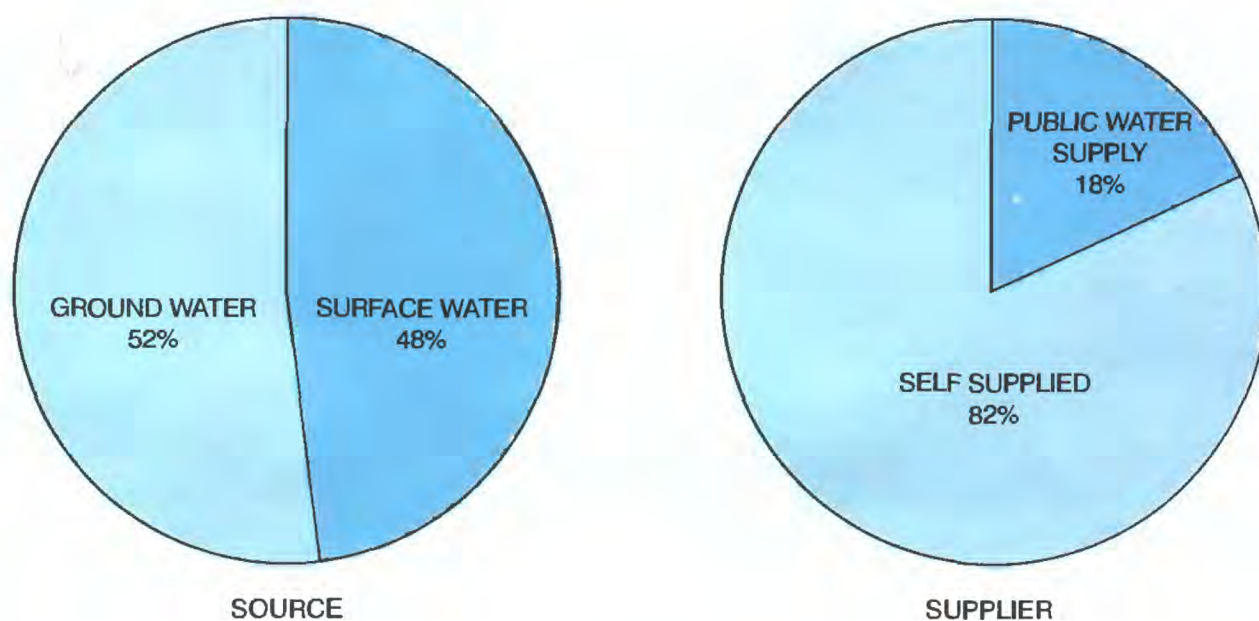


Figure 6. Water source and supplier for estimated industrial water use, Lincoln County, Wyoming, 1993.

dust suppression, but other uses included mining operations and fire suppression. An estimated 4.1 million tons of bituminous and subbituminous coal were mined in Lincoln County in 1993 (Wyoming State Geological Survey, 1994, p. 24).

For this report, water use associated with oil and gas production includes all co-produced water. Estimated water use for oil and gas production in Lincoln County was 40 Mgal in 1993. Oil production in Lincoln County in 1993 was 1,040,918 barrels (Wyoming Oil and Gas Conservation Commission, 1993, p. 1). Natural gas production in Lincoln County in 1993 was 101,575,970 million cubic feet (Wyoming Oil and Gas Conservation Commission, 1993, p. 1).

Thermoelectric Power

Thermoelectric power water use is water used in the process of the generation of electricity. Thermoelectric power is defined as electricity generated from fossil fuels, nuclear energy, or geothermal energy. The primary use for water in thermoelectric plants is in cooling reactors and condensers. Generally, the plants recycle water through cooling towers or discharge the water to a surface-water body.

The Naughton power plant, the only thermoelectric plant in Lincoln County, has an estimated average annual water use of 5,900 Mgal. The Naughton power plant is a coal-fired, steam generating thermoelectric plant. Water withdrawn from the Naughton Reservoir is used for the cooling towers, and then is reused in an industrial metallurgical coke plant.

Hydroelectric Power

Hydroelectric power water use is the use of water in the generation of electricity at power plants where turbine generators are driven by falling water. Water used for this purpose is not withdrawn from the source and therefore, is classified as nonwithdrawal use. The Fontenelle Reservoir Dam in Lincoln County produced 57 gigawatt hours of electricity in 1993 using an estimated 238,000 Mgal of water (table 1). Naughton Reservoir also has a hydroelectric plant, but water-use data were unavailable.

SUMMARY

Total water use in Lincoln County in 1993 was estimated to be 405,000 Mgal. Water use was estimated for nine categories; public supply, self-supplied domestic, commercial, irrigation, livestock, industrial, mining, thermoelectric power, and hydroelectric power. The largest uses of water were for hydroelectric power generation and for irrigation.

Public-supply water use, estimated to be 2,160 Mgal, was supplied primarily from ground water obtained from wells and springs, except for Kemmerer and Diamondville, where water is obtained from the Hams Fork River. Self-supplied domestic water use, estimated to be 1.7 Mgal, was supplied primarily by shallow wells with 53 percent of the wells drilled to depths of 100 feet or less. Commercial water use, estimated to be 117 Mgal, was delivered from public-water suppliers.

Irrigation water use, estimated to be 158,000 Mgal, was obtained primarily from surface-water sources. Flood and sprinkler irrigation technology were used about equally for irrigation in northern Lincoln County within the Star Valley Conservation District. Flood irrigation was the primary application technology for irrigation in the southern part of Lincoln County in the Lincoln County Conservation District.

Livestock, industrial, and mining water use were not major in Lincoln County in 1993. Livestock water use was estimated to be 203 Mgal. Industrial water use was estimated to be 147 Mgal. Mining water use was estimated to be 153 Mgal.

Surface water was used for power generation at one thermoelectric and two hydroelectric plants. Thermoelectric power water use was estimated to be 5,900 Mgal. Hydroelectric power water use was estimated to be 238,000 Mgal.

REFERENCES

- Burger, Michele, ed., 1993, Wyoming Agricultural Statistics 1993: Wyoming Department of Agriculture, 98 p.
- Cheeke, P. R., 1991, Applied animal nutrition-feeds and feeding: New York, Mcmillan Publishing Co., 504 p.
- Holechek, J. L., Pieper, R. D., and Herbel, C. H., 1989, Range management principles and practices: Englewood Cliffs, New Jersey, Prentice Hall, 501 p.
- Solley, W.B., Pierce, R.R., and Perlman, H.A., 1993, Estimated use of water in the United States in 1990: U.S. Geological Survey Circular 1081, 76 p.
- Wyoming Historical Records Survey, 1941, Inventory of the county archives of Wyoming--No. 12 Lincoln County (Kemmerer): Cheyenne, Wyoming, Work Projects Administration, 12 p.
- Wyoming Oil and Gas Conservation Commission, 1993, 1993 Statistical summaries, State of Wyoming: Casper, Wyoming, Wyoming Oil and Gas Commission, 410 p.
- Wyoming State Engineer's Office, 1993, Ground water computer data base, July 1993: Cheyenne, Wyoming, Wyoming State Engineer.
- Wyoming State Geological Survey, 1994, Wyoming Geonotes, No. 43: Laramie, Wyoming, Wyoming State Geological Survey, August 1994, 49 p.
- Wyoming Department of Administration and Information, Division of Economic Analysis, 1991, Wyoming data handbook, 1991, (10th ed.): Cheyenne, Wyoming, 285 p.

GLOSSARY

(from Solley and others, 1993)

COMMERCIAL WATER USE—water for motels, hotels, restaurants, office buildings, other commercial facilities, and institutions. The water may be obtained from a public supply or may be self supplied.

DOMESTIC WATER USE—water for household purposes, such as drinking, food preparation, bathing, washing clothes and dishes, flushing toilets, and watering lawns and gardens. Also called residential water use. The water may be obtained from a public supply or may be self supplied.

GROUND WATER—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) where the water is under pressure greater than atmospheric.

HYDROELECTRIC POWER WATER USE—the use of water in the generation of electricity at plants where the turbine generators are driven by falling water. Hydroelectric water use is classified as a nonwithdrawal use in this report.

INDUSTRIAL WATER USE—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, mining and petroleum refining. The water may be obtained from a public supply or may be self supplied.

IRRIGATION WATER USE—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 courses.

LIVESTOCK WATER USE—water for livestock watering, feed lots, dairy operations, fish farming, and other on-farm needs. Livestock as used here includes cattle, sheep, goats, hogs, and poultry.

MINING WATER USE—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. Also includes uses 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 a mining activity. Does not include water used in processing, such as smelting, refining petroleum or slurry pipeline operations. These uses are included in industrial water use.

NONWITHDRAWAL USE—water that is used, but not withdrawn, from a ground- or surface-water source for such purposes as hydroelectric power generation, navigation, water-quality improvement, fish propagation, and recreation. Sometimes called instream use or in-channel use.

PER CAPITA USE—the average amount of water used per person during a standard time period.

PUBLIC SUPPLY—water withdrawn by public and private water suppliers and delivered to users. Public suppliers provide water for a variety of uses, such as domestic, commercial, thermoelectric power, industrial, and public water use.

PUBLIC WATER USE—Water supplied from a public-water supply and used for such purposes as firefighting, street washing, and municipal parks and swimming pools.

SELF-SUPPLIED WATER—water withdrawn from a surface- or ground-water source by a user rather than being obtained from a public supply.

SURFACE WATER—an open body of water, such as a stream or a lake.

THERMOELECTRIC POWER WATER USE—water used in the process of generation of thermoelectric power. The water may be obtained from a public supply or may be self supplied.

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. In this report, the quantity of water used for a specific category is the combination of self-supplied withdrawals and public-supply deliveries. (2) More broadly, water use pertains to human's interaction with and influence on the hydrologic cycle, and includes elements such as water withdrawal, delivery, consumptive use, wastewater release, reclaimed wastewater, return flow, and nonwithdrawal use.