U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

PREPARED IN COOPERATION WITH THE
NEW HAMPSHIRE DEPARTMENT OF ENVIRONMENTAL SERVICES
WATER RESOURCES DIVISION, WATER MANAGEMENT BUREAU

WATER-RESOURCES INVESTIGATIONS REPORT 93-4096
Medalie, L. and Horn, M.A., 1994. Estimated withdrawals and use of freshwater in New Hampshire, 1990

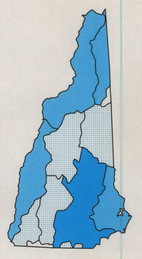
INTRODUCTION

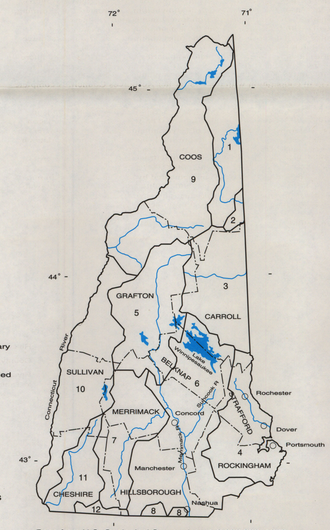
In 1977, the Congress of the United States, recognizing the need for accurate, comprehensive, and comparable information on water use, directed the U.S. Geological Survey (USGS) to establish a National Water-Use Information Program to complement other Survey programs on the availability and quality of the Nation's water resources. The Water-Use Program is a cooperative project between USGS offices and various State agencies who are responsible for water-resources management. Currently (1993), a cooperative water-use program is in place in New Hampshire and the other five States in New England. These six individual programs are closely coordinated to promote development of uniform water-use databases.

This report was prepared in cooperation with the New Hampshire Department of Environmental Services and is based on data for New Hampshire that were compiled for a national report (Solley and others, 1993). National compilations of water-use information have been done every 5 years since 1950. This report is one of six reports being prepared for the New England States.

The purpose of this report is to provide information on water use in New Hampshire to Federal and State agencies, water-resource professionals, and individuals interested in water-conservation issues. The report focuses on freshwater withdrawals and instream use for hydroelectric-power generation during 1990. Water withdrawals and use are reported in million gallons per day and are generally derived by dividing total annual withdrawals and use by 365 days. This procedure does not alter the values reported for water-use activities that are fairly constant throughout the year, such as domestic withdrawals; however, for water-use activities with significant seasonal variations (such as snowmaking, sand-and-gravel mining, and irrigation), the average daily withdrawal rate is smaller than the actual daily withdrawal rate during the season of activity. Data are aggregated by river basin, which is the most commonly used water-resource planning unit in New England. In most cases, however, river-basin boundaries do not coincide with State boundaries, and the data reported here are only for the part of each river basin within New Hampshire. The river basins are equivalent to hydrologic cataloging units that were delineated by the USGS in cooperation with the U.S. Water Resources Council. A complete description of the units can be found in Seaber and others (1987).

State water-use data collection has been ongoing since 1987 and is a major source of information for this report. The Water Resources Division of the New Hampshire Department of Environmental Services administers the State Water User Registration and Reporting Program. Site-specific data on public-water suppliers, thermoelectric-power producers, industrial, commercial, and mining withdrawals, and hydroelectric instream use are collected when the reporting threshold of 20,000 gallons per day is exceeded. These data have been supplemented by estimates derived in one of two ways. For small public suppliers and mining and industrial withdrawals, site-specific information, such as production data or number of employees, has been multiplied by a coefficient. For domestic, commercial, and agricultural withdrawals, aggregated data, such as census population data, has been multiplied by a coefficient (U.S. Bureau of the Census, 1989, 1991).





Base from U.S. Geological Survey data, 1:2,000,000, 1972

Index maps of New Hampshire showing river basins (larger map) and total freshwater withdrawals by river basin (smaller map), 1990.

REFERENCES CITED

Seaber, P.R., Kapinos, F.P., and Knapp, G.L., 1987, Hydrologic unit maps: U.S. Geological Survey Water-Supply Paper 2294, 63 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.

U.S. Department of Commerce, 1989, 1987 census of agriculture, volume 1-geographic area series, part 29--New Hampshire State and county data: Washington D.C., Bureau of the Census, publication AC87-A-29, 190 p.

U.S. Department of Commerce, 1991, 1990 census of population and housing; summary population and housing characteristics, New Hampshire: Washington D.C., Bureau of the Census, publication 1990/CPH-1-31, 130 p.

CONVERSION FACTORS

Multiply	by	To obtain
million gallons per day	0.04381	cubic meter per second
square mile	2.590	square kilometer

Table 1.--Area, population, and estimated withdrawals and hydroelectric instream use of water for river basins in New Hampshire, 1990

[Units are in million gallons per day (Mgal/d), except where noted; population numbers are rounded to the nearest hundred people; other numbers are rounded to nearest 0.1 Mgal/d or to three significant figures; values may not add to totals because of independent rounding; mi², square miles]

Map code	River basin	Hydrologic catalog-ing unit	[1]Area (mi²)	Population (thousands)	Estimated withdrawals: Public supply	Self-supplied: Domes-tic	Commer-cial	Indus-trial	Mining	Agricul-ture	Thermo-electric	Total with-drawals	Hydro-electric instream use
1	Upper Androscoggin	01040001	647	17.3	4.2	0.2	0.1	27.8	0.1	0.0	0.0	32.4	14,400
2	Lower Androscoggin	01040002	78	.4	.0	.0	.0	.0	.0	.0	.2	.2	.0
3	Saco	01060002	870	24.2	2.1	.5	1.1	.0	.0	.1	.3	4.1	12.2
4	Piscataqua-Salmon Falls	01060003	830	207.8	16.0	4.3	.2	.7	.2	.2	.0	21.6	823
5	Pemigewasset	01070001	1,000	31.4	3.9	.8	.4	.2	.3	.2	.4	6.2	2,250
6	Merrimack	01070002	1,946	609.3	45.6	14.3	.2	.8	.7	.6	253	315	6,360
7	Contoocook	01070003	757	49.5	3.2	2.1	.1	.6	.5	.3	.5	7.3	3,000
8	Nashua	01070004	88	3.6	6.8	.2	.0	.1	.0	.0	.0	7.1	371
9	Upper Connecticut	01080101	1,463	32.6	4.2	.8	.1	6.3	.3	.2	.2	12.1	8,820
10	Upper Connecticut-Mascoma	01080104	1,084	80.7	6.8	2.6	.1	.8	.4	.2	.2	11.1	9,910
11	Middle Connecticut	01080201	425	45.4	2.4	.9	.0	.1	.2	.1	.0	3.7	12.7
12	Miller	01080202	79	7.0	.1	.3	.0	.0	.1	.0	.0	.5	.0
TOTAL			9,265	1,109.2	95.3	27.0	2.3	37.4	2.8	1.9	255	422	46,000

[1]Area given for the Pemigewasset basin is from Seaber and others (1987); areas for other basins are calculated because river basin boundaries extend beyond State boundaries.

A water withdrawal generally refers to water removed for use from streams, reservoirs, or the ground and can be divided into two components. The "return flow" component of a water withdrawal is returned to the stream after release from use. The remaining part of the withdrawn water becomes consumed during use as it is evaporated, transpired, incorporated into products or crops, consumed by humans or livestock, or otherwise removed from the immediate water environment. This component of water withdrawals is termed "consumptive use."

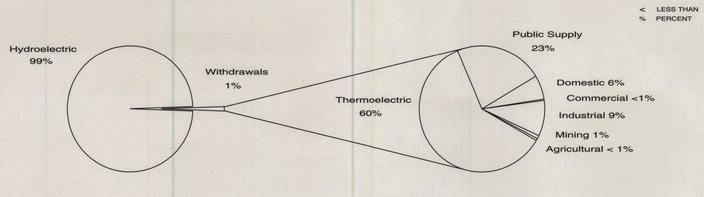
Water can also be used without being moved from the stream channel--this is called instream use. The dominant instream use in New Hampshire is for hydroelectric-power generation. Hydroelectric instream use is discussed separately from withdrawals in this report for two reasons. First, unlike withdrawals, virtually no change in the quantity of the water takes place during hydroelectric instream use. Second, the volume of water used for hydroelectric power generation is so large that it overshadows the combined withdrawals for all other uses. In New Hampshire, hydroelectric instream use is more than 100 times the total withdrawals. Other instream uses include boating, fishing, wastewater assimilation, and aquatic habitat.

Total withdrawals and hydroelectric instream use:

46,400 million gallons per day

Total withdrawals:

422 million gallons per day



Hydroelectric instream use and total withdrawals in New Hampshire, 1990

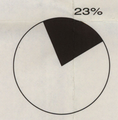
WITHDRAWALS BY WATER-USE CATEGORY AND RIVER BASIN

WATER WITHDRAWALS IN MILLION GALLONS PER DAY
0 - 1
1.1 - 10
10.1 - 100
101 - 1,000
1,001 - 5,000
5,001 - 15,000
RIVER BASIN BOUNDARY
< LESS THAN
% PERCENT

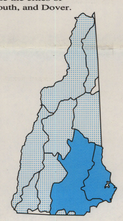
Public Supply Withdrawals

Public-supply withdrawals: Water withdrawn by public and private water suppliers who provide water to various users, such as domestic, commercial, industrial users, and thermoelectric powerplants. Public supply also includes public use, losses, and transfers to other public suppliers or basins.

* Public-supply withdrawals, 95.3 million gallons per day, accounted for 23 percent of total withdrawals.
* Public suppliers served approximately 694,300 people or about 63 percent of the State's population.
* The largest withdrawals for public supply were in the Merrimack and Piscataqua-Salmon Falls river basins, which include the cities of Manchester, Nashua, Concord, Rochester, Portsmouth, and Dover.



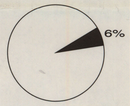
Percentage of Withdrawals for Public Supply



Domestic Withdrawals

Domestic withdrawals: Water withdrawn for normal household purposes in homes, apartments, or in any place where people are included in a census survey. Domestic withdrawals include water used for drinking, preparing food, bathing, washing clothes and dishes, flushing toilets, and watering lawns and gardens.

* Domestic self-supplied withdrawals, 27.0 million gallons per day, accounted for 6 percent of total withdrawals.
* Approximately 414,900 people or about 37 percent of the State's population were self supplied.
* The largest withdrawals for domestic self-supply were in the Merrimack, and the Piscataqua-Salmon Falls river basins--the areas with the largest suburban populations.

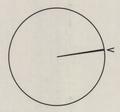


Percentage of Withdrawals for Domestic Use

Commercial Withdrawals

Commercial withdrawals: Water withdrawn for use in motels, hotels, restaurants, office buildings, and other commercial facilities, plus institutions such as hospitals or schools. Water withdrawn for air conditioning and fish hatcheries also is included.

* Commercial self-supplied withdrawals, 2.3 million gallons per day, accounted for less than 1 percent of total withdrawals.
* Withdrawals for snowmaking accounted for 74 percent of commercial self-supply; the largest withdrawals for snowmaking were in the Saco and the Pemigewasset river basins.

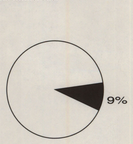


Percentage of Withdrawals for Commercial Use

Industrial Withdrawals

Industrial withdrawals: Water withdrawn for use in fabricating, processing, washing, and cooling industrial materials.

* Industrial self-supplied withdrawals, 37.4 million gallons per day, accounted for 9 percent of withdrawals.
* By far, the largest industrial withdrawals were in the Upper Androscoggin river basin, where several large paper mills withdrew water from the Androscoggin River. Paper mills along the Upper Connecticut River also withdrew a significant amount of water.
* The lumber-and-wood-product and the paper-and-allied-product industries were the largest industrial groups to withdraw water. Other important industrial water users included the electronic and the textile-products industries.

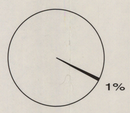


Percentage of Withdrawals for Industrial Use

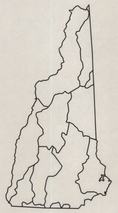
Mining Withdrawals

Mining withdrawals: Water withdrawn for use in the extraction of minerals, which includes withdrawals associated with quarrying, dewatering, milling (crushing, screening, washing, flotation), and other preparations customarily done at the mine site, or as part of a mining activity.

* Mining withdrawals, 2.8 million gallons per day, accounted for 1 percent of total withdrawals. All mining operations in New Hampshire were assumed to be self-supplied.
* The largest water withdrawals for mining were in the Merrimack and the Contoocook river basins.
* Construction sand-and-gravel and crushed and dimension stone were the major commodities mined in New Hampshire.



Percentage of Withdrawals for Mining Use

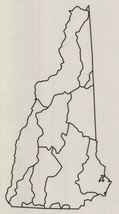


Agricultural Withdrawals

Agricultural withdrawals: Water withdrawn for use in irrigation (including golf courses), livestock watering, and fish farming.

* Agricultural withdrawals, 1.9 million gallons per day, accounted for less than 1 percent of total withdrawals. All agricultural use in New Hampshire was assumed to be self-supplied.
* The largest withdrawals for agriculture were in the Merrimack and the Contoocook river basins.
* The primary use for agricultural withdrawals was for irrigation of harvested cropland. Dairy farming was an important nonirrigation agricultural use.

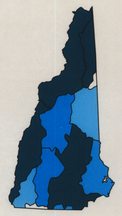
Percentage of Withdrawals for Agricultural Use



Hydroelectric Instream Use

Hydroelectric instream use: Water used in the generation of electricity at plants where the turbine generators are driven by moving water.

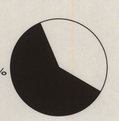
* Hydroelectric instream use, 46,000 million gallons per day from several large and many small plants, used more than 100 times the total volume of water withdrawn for all other uses.
* The largest hydroelectric instream uses were in the Upper Androscoggin, the Upper Connecticut-Mascoma, and the Upper Connecticut river basins.
* Hydroelectric powerplants generated approximately 17 percent of all electric power in New Hampshire in 1990.



Thermoelectric Withdrawals

Thermoelectric withdrawals: Water withdrawn for use in the process of generating thermoelectric power. The water is primarily used for cooling.

* Self-supplied withdrawals for thermoelectric-power generation, 255 million gallons per day, accounted for 60 percent of total withdrawals.
* Ninety-nine percent (253 million gallons per day) of thermoelectric withdrawals were in the Merrimack river basin at the Merrimack Generating Station.
* Other fossil-fuel and nuclear power plants in the seacoast region of New Hampshire used saline water and are not included in these totals.



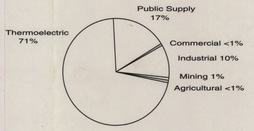
Percentage of Withdrawals for Thermoelectric Use

SURFACE-WATER AND GROUND-WATER WITHDRAWALS

Table 2.--Withdrawals of water by category and source in New Hampshire, 1990

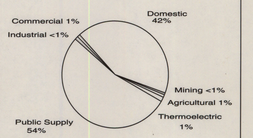
[Numbers are rounded to nearest 0.1 Mgal/d or to three significant figures; values may not add to totals because of independent rounding; Mgal/d, million gallons per day]

Category	Source: Ground water (Mgal/d)	Surface water (Mgal/d)	Total (Mgal/d)
Public supply	34.3	61.0	95.3
Domestic	27.0	.0	27.0
Commercial	.4	1.9	2.3
Industrial	.3	37.1	37.4
Mining	.1	2.7	2.8
Agriculture	.8	1.1	1.9
Thermoelectric	.8	254	255
TOTAL	63.7	358	422



Surface-water withdrawals in New Hampshire by category, 1990

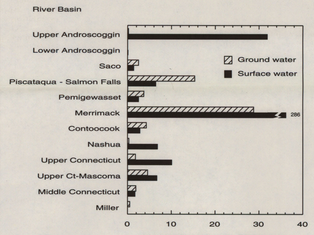
358 million gallons per day



Ground-water withdrawals in New Hampshire by category, 1990

63.7 million gallons per day

< LESS THAN
% PERCENT



Withdrawals in New Hampshire by river basin and source, 1990

SURFACE-WATER AND GROUND-WATER WITHDRAWALS

Surface water is water that is present at land surface, such as in streams, reservoirs, and lakes. The largest surface-water bodies in New Hampshire are the Connecticut River along the western border with Vermont, the Merrimack River, and Lake Winnipesaukee in the central part of the State.

During 1990, surface-water withdrawals were 358 million gallons per day and accounted for 85 percent of total withdrawals in New Hampshire. The largest surface-water withdrawal, 253 million gallons per day, was used for cooling in the thermoelectric plant on the Merrimack River near Concord, just north of the confluence of the Suncook River. This withdrawal accounted for 71 percent of total freshwater surface-water withdrawals. Withdrawals for public supply, 61.0 million gallons per day, accounted for 17 percent of total surface-water withdrawals.

Ground water is the subsurface water that is present beneath the water table in soils and geologic formations that are fully saturated. When the geologic formations yield significant quantities of water, they can be referred to as "aquifers". New Hampshire has two major types of aquifers--those in glacial deposits (such as stratified drift) and those in crystalline bedrock (such as granite).

During 1990, ground-water withdrawals were 63.7 million gallons per day and accounted for 15 percent of total withdrawals in New Hampshire. The largest ground-water withdrawals, 34.3 million gallons per day, were for public supply and accounted for 54 percent of total ground-water withdrawals. Most of these withdrawals were from small-diameter (less than or equal to four inches) wells in crystalline-bedrock aquifers. The largest ground-water withdrawals were in the Merrimack and the Piscataqua-Salmon Falls river basins, predominantly for domestic use.

SELF-SUPPLY WITHDRAWALS AND PUBLIC-SUPPLY DELIVERIES

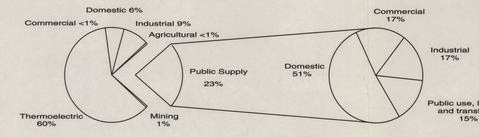
Total withdrawals

422 million gallons per day

Public supply deliveries

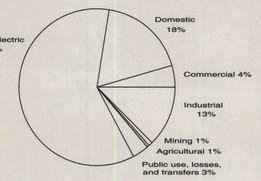
95.3 million gallons per day

Total Water Use (withdrawals and deliveries)



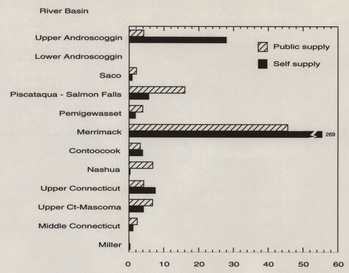
Total withdrawals and distribution of public-supply deliveries in New Hampshire, 1990

< LESS THAN
% PERCENT



Total water use in New Hampshire by category, 1990 (excluding hydroelectric instream use)

422 million gallons per day



Self supply withdrawals and public supply deliveries in New Hampshire, 1990

PUBLIC-SUPPLY AND SELF-SUPPLY USE

Public supply is water withdrawn by public and private water suppliers who provide water to various users, such as domestic, commercial, industrial users, and thermoelectric powerplants. It also includes public use, (water used for fire fighting, hydrant flushing, sanitation, and parks), losses that result from leaks in the distribution system, transfers to or from other river basins, and meter errors that may over-register or under-register the actual volume of water flowing through the meter. In the table below, large values in the column headed "Public use, losses, and transfers" reflect large exports of public-supply water to other river basins.

During 1990, withdrawals for public supply were 95.3 million gallons per day, almost 23 percent of water withdrawn in New Hampshire. (Public use, losses, and transfers were included in this amount and accounted for 15 percent of public-supply withdrawals.) The allocation of public-supply withdrawals among domestic, commercial and industrial users (in Table 4) was estimated based on coefficients related to population. The largest public-supplied deliveries were in the Merrimack and the Piscataqua-Salmon Falls river basins where public-supply systems in the cities of Manchester, Nashua, Portsmouth, Concord and Rochester supply most of the water used by residents and local commercial and industrial users. The largest use of public-supply water, 49.0 million gallons per day, was by domestic users and accounted for 51 percent of public-supply water.

Self-supply water is water that is withdrawn from a surface- or ground-water source by a user rather than being obtained from a public supply. During 1990, self-supplied withdrawals were 327 million gallons per day, or 77 percent of water withdrawn in New Hampshire. Cooling water for one thermoelectric powerplant in the Merrimack River basin, 253 million gallons per day, accounted for the largest use of self-supplied water. Industrial and domestic uses accounted for the second and third largest withdrawals of self-supply water.

Total water use is the quantity of water use for a specific category and is the combination of self-supply withdrawals and public-supply deliveries. The difference between total withdrawals and total use is public use, losses, and transfers. The domestic use category, which only accounts for 6 percent of total withdrawals, is the second largest total water use category (18 percent) in New Hampshire.

Table 3.--Use of water by category and supply type in New Hampshire, 1990

[Numbers exclude hydroelectric instream use; values are rounded to nearest 0.1 Mgal/d or to three significant figures; values may not add to totals because of independent rounding; Mgal/d, million gallons per day]

Category	Supply type: Public supply (Mgal/d)	Self supply (Mgal/d)	Total (Mgal/d)
Domestic	49.0	27.0	76.0
Commercial	16.6	2.3	18.9
Industrial	15.4	37.4	52.8
Mining	.0	2.8	2.8
Agriculture	0.0	1.9	1.9
Thermoelectric	.0	255	255
Public use, losses, and transfers	14.3	.0	14.3
TOTAL	95.3	327	422

Table 4.--Population with public- and self-supply water, and public-supply deliveries of water in New Hampshire, 1990

[Units are in million gallons per day (Mgal/d), except where noted; population numbers are rounded to the nearest hundred people; other numbers are rounded to nearest 0.1 Mgal/d or to three significant figures; values may not add to totals because of independent rounding]

River basin	Population with public supply (thousands)	Population with self supply (thousands)	Public-supply deliveries: Public use, losses, and transfers	Domestic	Commercial	Industrial	Thermo-electric	Total
Upper Androscoggin	14.7	2.6	0.6	2.5	0.5	0.6	0.0	4.2
Lower Androscoggin	.0	.4	.0	.0	.0	.0	.0	.0
Saco	16.5	7.7	.3	1.3	.3	.2	.0	2.1
Piscataqua-Salmon Falls	141.1	66.7	2.4	7.9	3.0	2.8	.0	16.0
Pemigewasset	18.9	12.5	.6	2.4	.5	.3	.0	3.9
Merrimack	349.5	220.0	6.8	22.6	8.4	7.8	.0	45.6
Contoocook	17.9	31.6	.5	2.0	.4	.3	.0	3.2
Nashua	39.8	3.6	1.1	3.4	1.2	1.2	.0	6.8
Upper Connecticut	20.9	11.7	.6	2.0	.7	.9	.0	4.2
Upper Connecticut-Mascoma	40.9	39.8	1.0	3.5	1.2	1.0	.0	6.8
Middle Connecticut	32.3	13.1	.4	1.3	.4	.3	.0	2.4
Miller	1.8	5.2	.0	.1	.0	.0	.0	.1
TOTAL	694.3	414.9	14.3	49.0	16.6	15.4	.0	95.3

ESTIMATED WITHDRAWALS AND USE OF FRESHWATER IN NEW HAMPSHIRE, 1990

By

Laura Medalie and M.A. Horn

1994

For additional information write to:

District Chief
U.S. Geological Survey
525 Clinton Street
Bow, New Hampshire 03304

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