ESTIMATED USE OF WATER IN THE NEW ENGLAND STATES, 1990

By B.A. Korzendorfer and M.A. Horn

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BRUCE BABBITT, Secretary

U.S. GEOLOGICAL SURVEY

Gordon P. Eaton, Director

For additional information
write to:

District Chief
U.S. Geological Survey
450 Main Street
Room 525
Hartford, CT 06103

Copies of this report can be
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CONVERSION FACTORS AND ABBREVIATIONS

Multiply	By	To obtain
square mile (mi^2)	2.59	square kilometer
gallons per day (gal/d)	0.003785	cubic meter per day
million gallons per day (Mgal/d)	0.04381	cubic meter per second
inch per year (in/yr)	25.4	millimeter per year

kWh, kilowatt hours
Mgal/d/kWh, million gallons per day per kilowatt hour

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ABSTRACT

Data on freshwater withdrawals in 1990 were compiled for the New England States. An estimated 4,160 Mgal/d (million gallons per day) of freshwater was withdrawn in 1990 in the six States. Of this total, 1,430 Mgal/d was withdrawn by public suppliers and delivered to users, and 2,720 Mgal/d was withdrawn by domestic, commercial, industrial, agricultural, mining, and thermoelectric power-generation users. More than 83 percent of the freshwater was from surface-water sources. Massachusetts, with the largest population, had the largest withdrawals of water.

Data on saline water withdrawals, return flow, and instream flow at hydroelectric plants were also compiled. An estimated 9,170 Mgal/d of saline water was used for thermoelectric-power generation and industrial use in Connecticut, Maine, Massachusetts, New Hampshire, and Rhode Island. Return flow from public wastewater-treatment plants totaled 1,750 Mgal/d; more than half (55 percent) of this return flow was in Massachusetts. In addition, about 178,000 Mgal/d was used for instream hydroelectric power generation; the largest users were Maine (about 83,000 Mgal/d) and New Hampshire (46,000 Mgal/d).

These data, some of which were based on site-specific water-use information and some based on estimation techniques, were compiled through joint efforts by the U.S. Geological Survey and State cooperators for the 1990 national water-use compilation.

INTRODUCTION

The National Water-Use Information Program was established by the U.S. Geological Survey (USGS), at the direction of the U.S. Congress, to complement other Survey programs on the availability and quality of the Nation's water resources. The water-use program is a cooperative effort between USGS districts and various State and local agencies who are responsible for water-resources management. Currently (1994), a cooperative water-use program exists in all six New England States—Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont.

National compilations of water-use information have been done at 5-year intervals since 1950. Information is collected or estimated by the USGS or provided by cooperating State and local agencies. The most recent national compilation on the estimated use of water in the United States was done for 1990 (Solley and others, 1993). Individual reports based on the national compilation have been published for each of the six New England States (Bratton and others, in press; Craft and others, in press; Horn and Medalie, in press; Korzendorfer and others, in press; Loiselle and others, in press; Medalie and Horn, 1994).

Purpose and Scope

The purpose of this report is to present a summary of the water-use data collected during the 1990 compilation for the six New England States (fig. 1). Data are presented in

four sections: (1) public-supply withdrawals; (2) summaries by category of water use for domestic, commercial, industrial, agricultural, mining, and thermoelectric-power generation that combine withdrawals and public-supply deliveries; (3) public wastewater return flow; and (4) hydroelectric-power generation. Primary emphasis is on freshwater withdrawals because the saline source—the Atlantic Ocean—is an unlimited and unregulated supply. Methods of data collection and estimation also are discussed, and differences in water-use patterns among the States are noted.

Study-Area Characteristics

The six New England States differ substantially in size and population but share many of the same sociologic, historical, economic, climatic, and hydrologic characteristics that affect water use. For some comparisons, New England is often grouped into the northern New England States—Maine, New Hampshire, and Vermont—and the southern New England States—Connecticut, Massachusetts, and Rhode Island.

The size and population of the States are presented in table 1. New England has an average population density of 192 people per square mile. The northern New England States (Maine, 37 people per square mile; Vermont, 59 people per square mile; and New Hampshire, 120 people per square mile) are much less densely populated than the southern New England States (Connecticut, 593 people per square mile; Massachusetts, 750 people per square mile; and Rhode Island, 960 people per square mile). In southern New England, an industrial-based economy has led to urbanization since the 18th century, whereas northern New England is largely rural in character with localized industrial development.

All six States are characterized by a temperate climate and evenly distributed

Table 1. Size and population of the New England States, 1990

[Population numbers (in thousands) are rounded to the nearest thousand people; values may not add to totals because of independent rounding; population data from U.S. Department of Commerce, 1991a-f]

State	Area	Total population	Population on self supply		Population on public supply	
	(square miles)	(thousands)	(thousands)	percentage of total population	(thousands)	percentage of total population
Connecticut	5,543	3,287	615.7	19	2,672	81
Maine	33,265	1,228	538.8	44	689	56
Massachusetts	8,025	6,016	511.8	9	5,505	92
New Hampshire	9,265	1,109	414.9	37	694	63
Rhode Island	1,045	1,003	69.3	7	934	93
Vermont	9,605	563	229.5	41	333	59
TOTAL	66,748	13,207	2,380	18	10,827	82

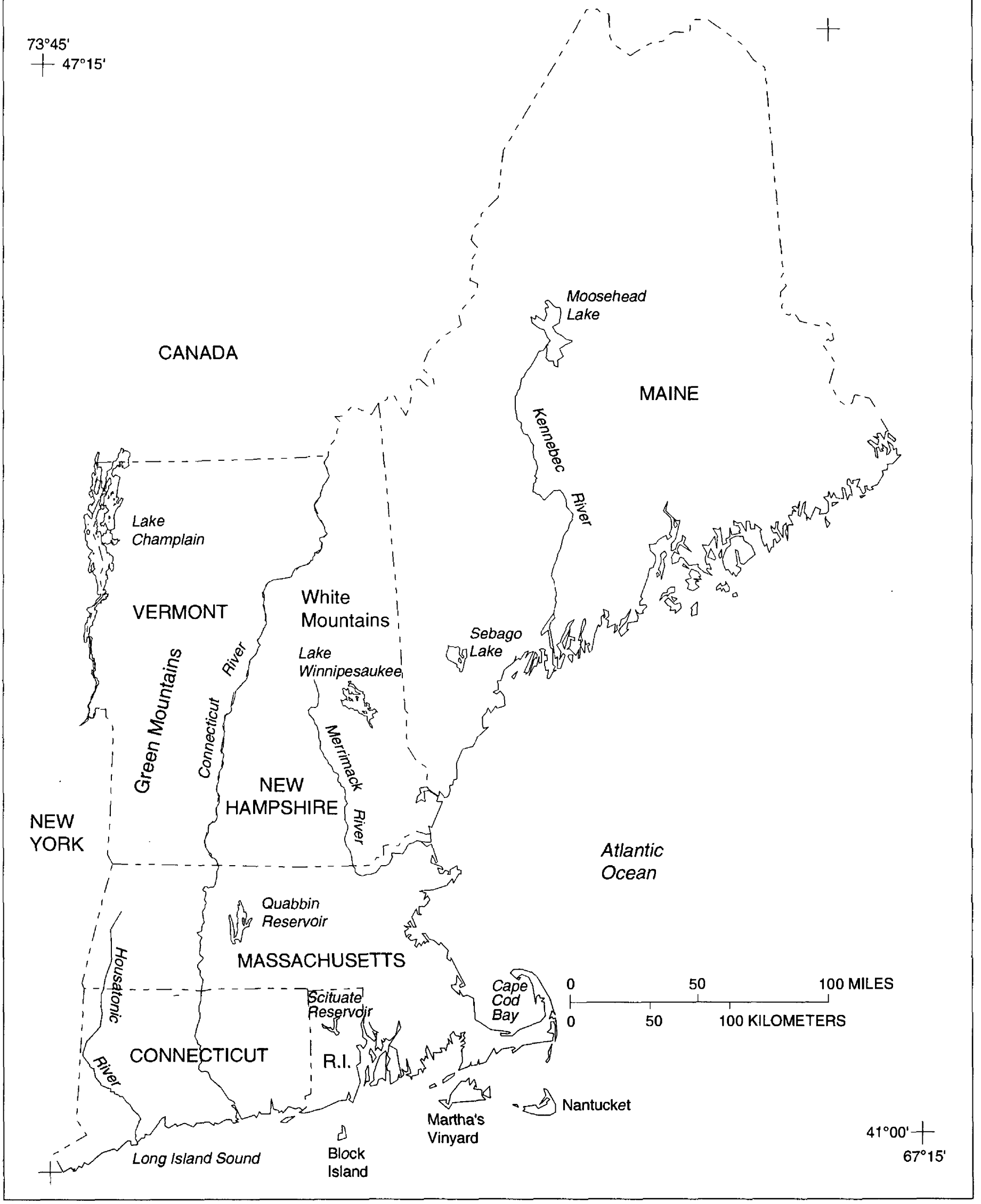

Figure 1. The New England States

precipitation that averages 40 to 48 in/yr, although mountainous parts of northern New England receive larger amounts (White Mountains of New Hampshire—up to 89 in/yr; Green Mountains of Vermont—up to 53 in/yr (Moody and others, 1986, p. 329, 461)). As much as 50 percent of the precipitation evaporates or is transpired by plants. Runoff varies seasonally; it is highest during April and May as a result of snowmelt, precipitation, saturated soil conditions, and reduced evapotranspiration, and it is lowest during July, August, and September as a result of increased evapotranspiration and depletion of soil moisture during the growing season (Moody and others, 1986). Runoff to streams, rivers, and lakes contributes to the region's abundant surface-water resources, which include Lake Champlain, Lake Winnipesaukee, Sebago Lake, Moosehead Lake, Quabbin and Scituate Reservoirs, and the Kennebec, Connecticut, Housatonic, and Merrimack Rivers.

The important sources of ground water in New England are contained in several types of aquifers: (1) stratified-drift deposits scattered throughout New England that increase in frequency and extent southward, culminating in sheet-like glacial outwash deposits that mantle Cape Cod; (2) early Mesozoic sandstones, siltstones, shales, and conglomerates interbedded with thin units of basalt and diabase in the Connecticut River Valley in Massachusetts and Connecticut; (3) crystalline bedrock throughout New England; (4) carbonate rock in the western parts of Connecticut, Massachusetts, and Vermont and the eastern part of Maine; and (5) Coastal Plain sediments on Block Island, Martha's Vineyard, and Nantucket. In addition, till, which covers most of New England, yields quantities of water that can be sufficient for domestic water supply.

Sources of freshwater in the New England States include surface water and ground water, although there is heavy reliance on surface-water sources. In 1990, 83 percent of total freshwater withdrawals were from surface-water sources. Surface water was also used for instream uses, such as hydroelectric power generation. A state-by-state breakdown of total freshwater withdrawals from ground-water and surface-water sources is shown in

Table 2. Sources of water in the New England States, 1990

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

State	Total freshwater withdrawals	Ground water	Surface water	Total saline withdrawals (surface water)
Connecticut	1,070	165	902	3,780
Maine	532	85.2	447	609
Massachusetts	1,370	329	1,040	3,490
New Hampshire	422	63.7	358	894
Rhode Island	133	25.3	108	393
Vermont	632	44.9	587	0
TOTAL	4,160	713	3,440	9,170

table 2. Withdrawals of saline water in New England were more than twice the freshwater withdrawals. Saline water is used primarily for thermoelectric-power generation and industrial use in Connecticut, Massachusetts, and New Hampshire. Total saline withdrawals also are shown in table 2.

Methods of Data Collection

Data were collected in accordance with guidelines developed by the USGS for preparation of State water-use estimates (U.S. Geological Survey, written commun., 1990). Water-use data are reported in million gallons per day and are generally derived by dividing total annual withdrawals and use by 365 days. In this report, only State totals are reported; however, in the original compilation, data were aggregated by counties and by river basins, which are equivalent to the 8-digit hydrologic cataloging units designated by the USGS in cooperation with the U.S. Water Resources Council (Seaber and others, 1987). Unless specifically stated, all values reported here do not include instream use for hydroelectric-power generation.

The data presented in this report were collected and estimated by the USGS, State water-use program cooperators (table 3), or through a joint effort. Tables 4 to 11 provide information on who was primarily responsible for data collection.

Some States have site-specific water-use information, whereas others have only estimated data. This is primarily because of differences in State regulations on issuing permits for water use and reporting requirements. In Connecticut, site-specific information was collected on withdrawals for public supply and thermoelectric-power generation and on instream use for hydroelectric-power generation; data for other categories were estimated. In Massachusetts, site-specific data were collected on withdrawals for public supply and for users that withdrew more than 100,000 gal/d; data for other categories and users who withdrew less than 100,000 gal/d were estimated. In New Hampshire, site-specific data were collected on withdrawals for public supply and for users that withdrew more than 20,000 gal/d; data for other categories and for users who withdrew less than 20,000 gal/d were estimated. In Maine, Rhode Island, and Vermont, most of the data were estimated because these States do not have a water-use permit or registration program through which water-use data are routinely collected.

Estimates for some categories were made in either of the following two ways: (1) Site-specific information about the facility was multiplied by a water-use coefficient. For example, for the industrial-use category, the number of employees for a given industrial facility might be known. That number would be multiplied by a coefficient of how much water typically is used per employee for the type of industry to obtain an estimate of how much water is used by that facility. (2) Aggregated data (such as county-wide information) were multiplied by a coefficient. For example, in the agricultural-use category, aggregated data on the number of cows in a given county is available from census tables. A coefficient of how much water a farmer typically uses per cow per day is then multiplied by the total number of cows. Specific methods for estimating data will be discussed by category in the section titled "Water Use." For many categories, a combination of methods was used to estimate water use.

Table 3. Cooperating State agencies in the water-use program in New England, 1990

State	Cooperating agency(s)
Connecticut	Connecticut Department of Environmental Protection
Maine	Maine Department of Conservation, Maine Geological Survey;
	Maine Department of Human Services
Massachusetts	Massachusetts Department of Environmental Management;
	Massachusetts Department of Environmental Protection
New Hampshire	New Hampshire Department of Environmental Services
Rhode Island	Rhode Island Department of Environmental Management;
	Providence Water Supply Board
Vermont	Vermont Department of Environmental Conservation

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Public-Supply Withdrawals And Deliveries

Public supply is water that is withdrawn by public and private-water suppliers and delivered to users. Public suppliers are defined here as those who provide water to at least 25 people or have a minimum of 15 service connections. Public-supply data were compiled by the cooperators directly from public suppliers (for Connecticut, Massachusetts, New Hampshire, and parts of Rhode Island) and from information provided by State Health Departments (for Vermont, Maine, and parts of Rhode Island). Total population on public supply is shown in table 1.

Public-supply data for 1990, including the total public-supply deliveries for five categories, are presented for the New England States in table 4. A total of 1,430 Mgal/d was withdrawn for public supply in New England; Massachusetts withdrew 714 Mgal/d (about 50 percent) and Connecticut withdrew about 374 Mgal/d (about 26 percent) of total New England public-supply withdrawals. The column "Public use and losses" includes water for public use (fire fighting, hydrant flushing, sanitation, and parks), losses that result from leaks in the distribution system, and meter errors that may over-register or under-register the actual volume of water flowing through the meter.

Public-supply deliveries (amount of water provided to users through a public-supply distribution system) for domestic, commercial, and industrial uses were estimated in the following ways: (1) Some public-suppliers provided information on the portion of total public-supply deliveries that were for domestic, commercial, or industrial use. (2) Where this breakdown was not available from public suppliers, an assumption was made (by either USGS or the cooperator) as to what the domestic-, commercial-, or industrial-use amount would be for a given public supplier, on the basis of population. (It was assumed that public-supply deliveries to commercial and industrial users would receive a larger proportion of deliveries in urbanized areas with large populations than they would in less urbanized areas.)

Patterns of deliveries from public suppliers varied in each State. In general, total

Table 4. Public-supply withdrawals and deliveries in the New England States, 1990

[All water-use values are in million gallons per day. Numbers are rounded to the nearest 0.1 Mgal/d or to three significant figures; values may not add to totals because of independent rounding; coop., cooperator; joint, U.S. Geological Survey and cooperator; —, not applicable]

State	Data source	Public-supply deliveries				Public use and losses	Total public-supply withdrawals	Percentage of total withdrawals in State represented by this category
		Domestic	Commercial	Industrial	Thermo-electric			
Connecticut	coop.	188	51.0	63.8	2.6	68.6	374	35
Maine	joint	39.8	24.4	16.6	1.2	24.3	106	20
Massachusetts	coop.	365	58.1	108	4.6	179	714	52
New Hampshire	coop.	49.0	16.6	15.4	.0	14.3	95.3	23
Rhode Island	joint	62.6	22.1	12.5	.0	4.4	102	77
Vermont	joint	26.6	3.1	3.1	.1	5.8	38.7	6
TOTAL	—	731	175	219	8.5	296	1,430	34

public-supply deliveries in a State were related to the total population. Massachusetts, with the largest population, had the largest public-supply deliveries, whereas Vermont, with the smallest population, had the smallest public-supply deliveries. Other variables that affect the pattern of delivery included (1) population on public supply, (2) magnitude of public use and losses, and (3) different assumptions used by different agencies in estimating deliveries. In Maine, only 38 percent of the total public-supply deliveries were to domestic users. Percentages of deliveries to domestic users in other States were Connecticut, 50 percent; Massachusetts, 50 percent; New Hampshire, 51 percent; Rhode Island, 61 percent; and Vermont, 69 percent (table 4).

Water Use

The USGS collects water-use information by selected categories of use. In this section, water use will be presented for the domestic, commercial, industrial, agricultural (a combination of irrigation, livestock, and animal specialties), mining, and thermoelectric power generation (a combination of fossil-fuel and nuclear) categories. For each category, information is presented on public-supply deliveries (amount of water provided to users through a public-supply distribution system) and self-supplied withdrawals (amount of water withdrawn from a surface- or ground-water source by a user). Total water use, as used in this report, is the combination of public-supply deliveries and self-supplied withdrawals.

Domestic

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

Domestic self-supplied withdrawals were estimated in the following manner: the number of persons on public supply for a given area (known or estimated as described previously) was subtracted from the total population in the area (from census figures). The remainder was assumed to be self-supplied (shown in table 1). This number was then multiplied by a coefficient for the average amount of water typically used for domestic purposes; coefficients used in each State ranged from 65 to 90 gallons per person per day (table 5). All domestic self-supplied withdrawals were assumed to be from ground water. Domestic public-supply deliveries were estimated according to the methods described in section "Public Supply Withdrawals and Deliveries."

Water-use data for the domestic-use category in 1990 are presented for the New England States in table 5. Although total water use for domestic purposes was related to the total population, the percentages of domestic use from self-supplied withdrawals differed among the States. In Maine, about 55 percent of domestic use was self-supplied; in Vermont, 38 percent was self-supplied, and in New Hampshire, 36 percent was self-supplied, as reflected by the rural character of northern New England. In Connecticut, about 20 percent of domestic use was self-supplied; in Massachusetts, 9 percent was self-supplied; and in Rhode Island, 7 percent was self-supplied, as reflected by the urban and suburban character of southern New England, which has larger cities and surrounding population centers than does northern New England.

The percentage of total withdrawals used for domestic purposes averaged about 22 percent for New England. The percentage for Rhode Island (51 percent) is much higher because there were no freshwater thermoelectric withdrawals. The percentage for Vermont (7 percent) was much lower because of the high rate of withdrawals for thermoelectric-power generation.

Table 5. *Domestic water-use category*—Self-supplied withdrawals, public-supply deliveries, and total water use in the New England States, 1990

[All water-use values are in million gallons per day (Mgal/d); per capita values are in gallons per day (gal/d); numbers are rounded to the nearest 0.1 Mgal/d or to three significant figures; values may not add up to totals because of independent rounding; coop., cooperator; USGS, U.S. Geological Survey; —, not applicable]

State	Data source	Self-supplied withdrawals (Mgal/d)	Self-supplied per capita (gal/d)	Public-supply deliveries (Mgal/d)	Public-supply per capita (gal/d)	Total domestic water use (Mgal/d)	Percentage of total withdrawals in State represented by category
Connecticut	coop.	46.3	75	188	70	234	22
Maine	USGS	48.5	90	39.8	58	88.3	17
Massachusetts	USGS	36.8	72	365	66	402	29
New Hampshire	USGS	27.0	65	49.0	71	76.0	18
Rhode Island	USGS	4.9	71	62.6	67	67.5	51
Vermont	USGS	16.5	72	26.6	80	43.1	7
TOTAL	—	180	76	731	68	911	22

Commercial

Commercial water use includes 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, snowmaking, and fish hatcheries also is included.

Commercial self-supplied withdrawals were compiled or estimated by use of the following methods: (1) Site-specific data were available from large permitted facilities (in Massachusetts and New Hampshire). (2) Coefficients were used that related water use to the number of employees per type of commercial user. The coefficients were from the library of the Institute for Water Resources, Municipal and Industrial Needs (IWR-MAIN) model of the U.S. Army Corps of Engineers (Davis and others, 1991). Census data for 1987 on number of employees in each commercial Standard Industrial Classification (SIC)-code grouping were multiplied by the coefficient for average water use per employee (for Maine, Rhode Island, Vermont, partially for Massachusetts, and New Hampshire). (3) The ratio of domestic public-supply deliveries to commercial public-supply deliveries was calculated and then applied to domestic self-supplied withdrawals (for Connecticut). Commercial public-supply deliveries were estimated according to the methods described in "Public Supply Withdrawals and Deliveries."

Water-use data for the commercial-use category in 1990 are presented for the New England States in table 6. Total water use for commercial purposes, like domestic use, can be related to the total population because the number of restaurants, hotels, and office buildings in a given area usually corresponds roughly to the number of people. Fish hatcheries and snowmaking operations—both large-volume water users—may have been a large component of commercial water use in areas where they were present. Commercial self-supplied withdrawals in New Hampshire were primarily used for snowmaking.

Table 6. *Commercial water-use category*—Self-supplied withdrawals, public-supply deliveries, and total water use in the New England States, 1990

[All water-use values are in million gallons per day; numbers are rounded to the nearest 0.1 Mgal/d or to three significant figures; values may not add to totals because of independent rounding; coop., cooperator; USGS, U.S. Geological Survey; joint, U.S. Geological Survey and cooperator; —, not applicable]

State	Data source	Self-supplied withdrawals	Public-supply deliveries	Total commercial water use	Percentage of total withdrawals in State represented by category
Connecticut	coop.	18.1	51.0	69.1	6
Maine	USGS	34.0	24.4	58.4	11
Massachusetts	joint	73.6	58.1	132	10
New Hampshire	joint	2.3	16.6	18.9	4
Rhode Island	USGS	5.6	22.1	27.7	21
Vermont	USGS	3.8	3.1	6.9	1
TOTAL	—	137	175	313	8

Industrial

Industrial water use includes water withdrawn for use in fabricating, processing, washing, and cooling industrial materials. Industrial self-supplied withdrawals were estimated by use of the following methods: (1) Site-specific data were available from industrial facilities (in Connecticut, Massachusetts, New Hampshire, and Rhode Island). (2) Coefficients were used that related water use to the number of employees per type of industrial user. The coefficients were developed by the Census Bureau (U.S. Department of Commerce, 1986) during the 1980's based on surveys of water used by industrial companies grouped by common activities or SIC Codes. The coefficients were more recently refined and incorporated into the IWR-MAIN model of the Institute for Water Resources, U.S. Army Corps of Engineers (Davis and others, 1991). Census data for 1987 on number of employees in each industrial SIC-code grouping were multiplied by the appropriate coefficient for average water use per employee. Information for Connecticut, Massachusetts, New Hampshire, and Rhode Island was estimated from a combination of both methods. No site-specific data were available for Vermont or Maine. Industrial public-supply deliveries were estimated according to the methods described in "Public Supply Withdrawals and Deliveries."

Water-use data for the industrial-use category in 1990 are presented for the New England States in table 7. Total industrial water use reflects the type of industries that are present in each State. Maine used the largest volume of water for industrial purposes to manufacture lumber/wood products and paper/allied products, which are particularly water-intensive types of industries. The largest use of water for industrial purposes in New Hampshire, Vermont, and Massachusetts was also for wood and paper industries. The transportation-equipment industry (manufacture of aircraft and ships) used the most water in Connecticut (Carr and others, 1990). More than 90 percent of water used for industrial purposes in Maine and Vermont was self-supplied, whereas that percentage decreased substantially in the more urbanized States (48 percent in Rhode Island and 54 percent in Massachusetts).

An additional 68 Mgal/d of saline water (not shown in table 7) was used for industrial purposes in Connecticut. This water was withdrawn from Long Island Sound and used by industries for cooling along the southern shore of the State.

Table 7. *Industrial water-use category*—Self-supplied withdrawals, public-supply deliveries, and total water use in the New England States, 1990

[All water-use values are in million gallons per day; numbers are rounded to the nearest 0.1 Mgal/d or to three significant figures; values may not add to totals because of independent rounding; USGS, U.S. Geological Survey; joint, U.S. Geological Survey and cooperator; —, not applicable]

State	Data source	Self-supplied withdrawals	Public-supply deliveries	Total industrial water use	Percentage of total withdrawals in State represented by category
Connecticut	USGS	80.1	63.8	144	13
Maine	joint	254	16.6	270	51
Massachusetts	joint	129	108	237	17
New Hampshire	joint	37.4	15.4	52.8	13
Rhode Island	USGS	11.6	12.5	24.1	18
Vermont	USGS	43.7	3.1	46.8	7
TOTAL	—	556	219	775	19

Agricultural

Agricultural water use includes water withdrawn for use in irrigation, livestock, and animal specialties. Irrigation water use is the artificial application of water on land to assist in crop growing or to maintain vegetative growth in recreational areas, such as parks and golf courses. Livestock water use is associated with the production of meat, poultry, eggs, milk, and wool; animal specialties water use is associated with the production of fur-bearing animals, horses, and fish in captivity. In New England, the primary contributor to animal specialties is horses.

All water used in this category was assumed to be from self-supplied withdrawals. In general, water used for irrigation was estimated by multiplying the number of irrigated acres under cultivation by a coefficient for the average amount of water needed per acre, on the basis of crop type. Site-specific withdrawals were included, where available. Water use for livestock was estimated by taking data from census records aggregated by State (U.S. Department of Commerce, 1989a-e) and multiplying numbers of animals by coefficients for amount of water needed per animal. Typical livestock coefficients used were 12 to 16 gal/d for beef cows, 20 to 35 gal/d for dairy cows, 1 to 2 gal/d for sheep, and 2 to 4 gal/d for pigs.

Water-use data for the agricultural-use category in 1990 are presented for the New England States in table 8. The largest user of agricultural water in New England was Massachusetts, where large amounts of water were used to flood cranberry bogs during harvest and at other times. Irrigation of golf courses and ornamental shrub nurseries contributed to the high value for Connecticut. Agricultural use in the other four States was a small component of overall water use. The livestock component of total agricultural water use was generally less than the irrigation component, except in Vermont where substantially more water was used for dairy cattle than crop production. In general, agricultural water use in New England is small in comparison with the rest of the United States (Solley and others, 1993) and accounts for an average of 3 percent of total freshwater withdrawals in New England.

Table 8. *Agricultural water-use category*—Total water use (equal to self-supplied withdrawals) in the New England States, 1990

[All water-use values are in million gallons per day; numbers are rounded to the nearest 0.1 Mgal/d or to three significant figures; values may not add to totals because of independent rounding; <, less than; joint, U.S. Geological Survey and cooperator; USGS, U.S. Geological Survey; —, not applicable]

State	Data source	Irrigation	Livestock and animal specialties	Total agricultural water use	Percentage of total with drawals in State represented by category
Connecticut	joint[1]	15	1.5	16.5	2
Maine	USGS	1.8	1.7	3.5	1
Massachusetts	joint	100	1.7	102	7
New Hampshire	joint	.9	1.0	1.9	<1
Rhode Island	USGS	2.1	.3	2.4	2
Vermont	joint	.5	6.1	6.6	1
TOTAL	—	120	12.3	132	3

[1] Irrigation data were estimated by cooperators; livestock and animal specialties data were estimated by USGS.

Mining

Mining water use includes water withdrawn in the extraction of minerals; this includes withdrawals associated with quarrying, dewatering, milling (crushing, screening, washing, floatation), and other preparations customarily done at the mine site or as part of a mining activity. Sand and gravel, crushed stone, and dimension stone are the major mineral commodities produced in New England, and water is primarily used for washing sand and gravel and for controlling dust in quarries and gravel pits.

All water used in this category was assumed to be from self-supplied withdrawals. Mining water use in five of the six States was estimated by multiplying production data (tons of sand and gravel mined) by a coefficient. In New Hampshire, mining water use was determined from reported data.

Water-use data for the mining-use category in 1990 are presented for the New England States in table 9. The amount of water used in mining operations was similar among the States. Mining water use in the New England States is small compared to other parts of the United States (Solley and others, 1993) and accounts for less than 1 percent of total freshwater withdrawals.

Table 9. *Mining water-use category*—Total water use (equal to self-supplied withdrawals) in the New England States, 1990

[All water-use values are in million gallons per day; numbers are rounded to the nearest 0.1 Mgal/d or to three significant figures; values may not add to totals because of independent rounding; joint, U.S. Geological Survey and cooperator, USGS, U.S. Geological Survey, <, less than; —, not applicable]

State	Data source	Total mining water use	Percentage of total withdrawals in State represented by category
Connecticut	USGS	2.2	<1
Maine	USGS	3.7	1
Massachusetts	joint	5.0	<1
New Hampshire	joint	2.8	<1
Rhode Island	USGS	1.4	1
Vermont	USGS	3.7	1
TOTAL	—	18.8	<1

Thermoelectric-Power Generation

Thermoelectric-power generation includes water used in the process of generating electrical power from fossil-fuel, biomass, or nuclear energy. This water is primarily used for reactor and condenser cooling in thermoelectric powerplants. Saline water-use data are included in this category where it is available, as all States, except Vermont, use saline water for all or part of the water used for thermoelectric-power generation. The quantities of saline water used are substantially larger than the quantities of freshwater. Many thermoelectric powerplants with access to saline water use a "once-through system," where water for cooling is used once and then returned to a surface-water body. This method uses significantly more water than systems where water is recycled, but evaporation is negligible (Solley and others, 1993).

Water-use data for the thermoelectric-power-generation category were estimated from site-specific data (for public-supply deliveries and self-supplied withdrawals) from individual facilities. Water-use data for the thermoelectric-power-generation category in 1990 are presented for the New England States in table 10. Thermoelectric-power generation was the dominant use of freshwater in three of the six States, even though almost 85 percent of the water used in this category was saline. Connecticut and Massachusetts used the largest amounts of water for thermoelectric-power generation, and a total of 93,261 kWh was generated in New England using an average of 0.12 Mgal/d/kWh.

Table 10. *Thermoelectric-power generation water-use category*—Self-supplied withdrawals, public-supply deliveries, and total water use of freshwater and saline water in the New England States, 1990

[All water-use values are in million gallons per day; numbers are rounded to the nearest 0.1 Mgal/d or to three significant figures; values may not add to totals because of independent rounding; coop., cooperator; joint, U.S. Geological Survey and cooperator; kWh, kilowatt hour; --, not applicable]

State	Data source	Self-supplied withdrawals (fresh)	Public-supply deliveries (fresh)	Total water use (fresh)	Percentage of total withdrawals in State represented by category (fresh)	Self-supplied withdrawals (saline)	Total water use (fresh and saline)	Thermoelectric power generated (million kWh)
Connecticut	coop.	530	2.6	533	50	3,710	4,243	33,100
Maine	joint	82.2	1.2	83.4	16	609	692	9,390
Massachusetts	joint	307	4.6	312	23	3,490	3,801	36,200
New Hampshire	joint	255	0	255	60	894	1,149	10,200
Rhode Island	joint	0	0	0	0	393	393	591
Vermont	joint	519	.1	519	82	0	519	3,780
TOTAL	—	1,690	8.5	1,700	41	9,100	10,800	93,300

Public-Wastewater-Return Flow

Public-wastewater-return flow, also termed sewage treatment, includes data on treated wastewater discharged from publicly owned treatment plants that are engaged primarily in the collection, treatment, and disposal of wastewater conveyed through a sewer system. The wastewater data were obtained from the U.S. Environmental Protection Agency (USEPA) Permit Compliance system database, which supports the National Pollutant Discharge Elimination System (NPDES). Wastewater-treatment plants have NPDES permits because the permits are required whenever a discharge is made into waters of the United States.

Public-wastewater-return flow and public-supply-withdrawal data for the New England States are presented in table 11. Massachusetts public-supply withdrawals and public-wastewater returns were the largest in New England, but returns were about 35 percent more than withdrawals. Some of this can be accounted for by users, not on public supply, who discharged into the sewer system. In addition, combined sewers (stormwater and sanitary sewers), inflow (discharge of surface water to a sewer system), and infiltration (seepage of ground water to a sewer system) may have contributed to the increased returns. New Hampshire discharged about 52 percent more wastewater through public wastewater-treatment plants than was withdrawn by public suppliers.

Table 11. Total public-supply withdrawals, public-wastewater-return flow and number of wastewater-treatment facilities in the New England States, 1990

[All water-use values are in million gallons per day; numbers are rounded to the nearest 0.1 Mgal/d or to three significant figures; values may not add to totals because of independent rounding]

State	Total public-supply withdrawals	Total public-wastewater-return flow	Total number of wastewater-treatment facilities
Connecticut	374	364	144
Maine	106	129	90
Massachusetts	714	964	547
New Hampshire	95.3	145	114
Rhode Island	102	110	35
Vermont	38.7	37.7	58
TOTAL	1,430	1,750	988

Hydroelectric Instream Use

Water that is used without being moved a great distance from the stream channel is called instream use. One major instream use of water in New England is for generation of hydroelectric power—turbine generators, driven by falling water, generate electricity. Most of the hydroelectric power generated in New England goes into the New England Power Pool, a voluntary association of 93 New England electric utility companies. Member companies produce 99.5 percent of the electric-power generation and transmission in the region. Other important instream uses in New England that are not discussed here include navigation, wastewater assimilation, recreation, and aquatic habitat.

Water use for the hydroelectric-power generation category was estimated from power- generation data or compiled from site-specific data from individual facilities. Data on instream use for hydroelectric-power generation in 1990 are presented for the New England States in table 12. Maine used the largest amount of instream water for hydroelectric-power generation—almost 83,000 Mgal/d (47 percent of the water used for this category in New England); this water generated about 46 percent of New England's hydroelectric power. New Hampshire was the second largest user of instream water for hydroelectric-power generation—46,000 Mgal/d (23 percent).

Table 12. Total instream water use for the hydroelectric-power-generation water-use category in the New England States, 1990

[All water-use values are in million gallons per day; numbers are rounded to the nearest 0.1 Mgal/d or to three significant figures; values may not add to totals because of independent rounding]

State	Total instream water use for hydroelectric-power generation	Gigawatt[1] hours generated	Mgal/d per Gigawatt hour
Connecticut	6,870	452	15.2
Maine	82,700	3,960	20.9
Massachusetts	24,500	1,090	22.5
New Hampshire	46,000	1,980	23.2
Rhode Island	339	6	56.5
Vermont	17,700	1,096	16.1
TOTAL	178,000	8,580	20.7

[1] A gigawatt is 10^9 watts.

SUMMARY

The National Water-Use Information Program complements other Survey programs on the availability and quality of the Nation's water resources. The water-use program is a cooperative effort between USGS districts and various State and local agencies who are responsible for water-resources management. The data presented in this report were collected and estimated by the USGS, State water-use program cooperators, or through a joint effort in support of the 1990 national compilation on the estimated use of water in the United States (Solley and others, 1993). Some data are based on specific water-use information, whereas others are on estimated data.

Data are presented in four sections: (1) public-supply withdrawals; (2) water use for domestic, commercial, industrial, agricultural, mining, and thermoelectric-power generation categories, which combines public-supply deliveries and self-supply withdrawals; (3) public-wastewater-return flow, and (4) water used for hydroelectric-power generation.

An estimated 4,160 Mgal/d of freshwater was withdrawn in 1990 in the six New England States. Massachusetts, which had the largest population, withdrew about a third of the water (1,370 Mgal/d). A total of 1,430 Mgal/d was withdrawn for public supply in New England; Massachusetts public suppliers withdrew 714 Mgal/d (50 percent of total public-supply withdrawals) and Connecticut public suppliers withdrew about 374 Mgal/d (about 26 percent of total public-supply withdrawals). Other freshwater withdrawals totaled 2,720 Mgal/d, about twice the public-supply withdrawals. Connecticut and Massachusetts each withdrew about 25 percent of total self-supplied withdrawals in New England.

An estimated 9,170 Mgal/d of saline water was used primarily for thermoelectric-power generation and industrial use in Connecticut, Massachusetts, and New Hampshire. Return flow from public wastewater-treatment plants totaled 1,750 Mgal/d, which was about 22 percent more than was withdrawn by public suppliers, and more than half (55 percent) of the public wastewater return flow was in Massachusetts. In addition, about 178,000 Mgal/d was used for instream hydroelectric power generation—about 83,000 Mgal/d (47 percent) in Maine and 46,000 Mgal/d (26 percent) in New Hampshire for hydroelectric-power generation.

A summary of water-use data is shown in table 13. In this table, "Total public-supply deliveries" plus "Total self-supplied withdrawals" equal "Total freshwater use."

Table 13. Summary of water-use data in the New England States, 1990

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

State	Total population (thousands)	Total public-supply withdrawals	Total self-supplied withdrawals	Total freshwater use	Total saline withdrawals	Total public-wastewater-return flow	Total instream use for hydroelectric
Connecticut	3,287.2	374	693	1,070	3,780	364	6,870
Maine	1,227.9	106	426	532	609	129	82,700
Massachusetts	6,016.4	714	653	1,370	3,490	964	24,500
New Hampshire	1,109.2	95.3	327	422	894	145	46,000
Rhode Island	1,003.4	102	31.3	133	393	110	339
Vermont	562.8	38.7	593	632	0	37.7	17,700
TOTAL	13,206.9	1,430	2,720	4,160	9,170	1,750	178,000

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