Estimated Water Use in Puerto Rico, 1995

By Wanda L. Molina-Rivera

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CONVERSION FACTORS, ABBREVIATED WATER-USE UNITS, AND ACRONYMS

Multiply	By	To obtain
foot	0.3048	meter
acre-foot (acre-ft)	1233.489	cubic meter
cubic foot per second	0.02832	cubic meter per second
gallon per minute	0.0630	liter per second
million gallon per day (Mgal/d)	43.81	liter per second
square mile	2.590	square kilometer

Additional abbreviated water-use units used in this report:

gWh	Gigawatt-hour
kWh	Kilowatt-hour
gal/d	gallon per day
gal/d/acre	gallon per day per acre

Acronyms

PRASA	Puerto Rico Aqueduct and Sewer Authority
PRDOH	Puerto Rico Department of Health
PRDNER	Puerto Rico Department of Natural and Environmental Resources
PREPA	Puerto Rico Electric Power Authority
PREQB	Puerto Rico Environmental Quality Board
USGS	U.S. Geological Survey
MSHA	U.S. Mine Safety and Health Administration
SWUDS	State Water-Use Data System

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Abstract

Water-use data during calendar year 1995 was compiled for the 78 municipios of the Commonwealth of Puerto Rico. Eight offstream water-use categories were considered during the study: public supply, wastewater treatment discharges, domestic, industrial, mining, thermoelectric power, livestock, and irrigation. Three instream water-use categories were considered: hydroelectric power, saline water used at thermoelectric power plants, and reservoir evaporation. Freshwater withdrawals for offstream use from surface- and ground-water sources in Puerto Rico were estimated to be 566 million gallons per day. The largest amount of freshwater withdrawn was 431 million gallons per day for public supply. Total discharge from public wastewater treatment facilities was reported as 185 million gallons per day. Fresh surface- and ground-water withdrawals for domestic and industrial self-supplied facilities were estimated to be about 19 million gallons per day. Mining activities, which in Puerto Rico are mostly limited to the production of sand and gravel, withdrew about 4.2 million gallons per day of freshwater. Livestock activities used 6.3 million gallons per day from surface- and ground-water sources to meet the water needs of the 12.1 million animals counted in the 1992 Census of Agriculture in Puerto Rico. Self-supplied ground-water withdrawals for thermoelectric facilities were estimated to be 2.2 million gallons per day. Freshwater withdrawals for irrigation purposes were estimated to be 103 million gallons per day, or approximately 18 percent of all offstream freshwater withdrawals. Instream freshwater withdrawals by hydroelectric facilities were 349 million gallons per day. Reservoir evaporation is considered to be a consumptive use associated with the storage of water. The evaporation from 15 reservoirs in Puerto Rico was estimated to average about 23,900 acre-feet from a total reservoir surface area of 6,900 acres. The largest amount of withdrawals was 2,260 million gallons per day of saline water (instream use) for thermoelectric power.

INTRODUCTION

The National Water-Use Information Program of the U. S. Geological Survey (USGS) is a Federal-State Cooperative Program designed to compile, store, and disseminate water-use information locally and nationwide. The program was implemented in Puerto Rico in 1980 to provide data for the management of the Commonwealth's water resources. It is essential for water resources planners and managers to have information regarding the amount of water used, and where and how it is used, so that they can adequately assess many of the critical water problems facing Puerto Rico.

The major objectives of the Water-Use Information Program in Puerto Rico are to:

1. Maintain accountability of the water use;
2. Create a computerized data base for data entry and retrieval of water-use information at the local, regional, and national levels;
3. Compile water-use data of uniform quality;
4. Define new methodologies for obtaining high quality water-use data;

5. Present information and reports that will help in projecting the future water needs of Puerto Rico;

6. Identify water-use problems so that appropriate management solutions can be determined; and

7. Improve the collection, analysis, and dissemination of water-use information.

In order to meet the general objectives of the Water-Use Information Program and to maintain an adequate data base, the USGS maintains cooperative agreements with the Puerto Rico Aqueduct and Sewer Authority (PRASA), the Puerto Rico Department of Natural and Environmental Resources (PRDNER), and the Puerto Rico Environmental Quality Board (PREQB) to compile water-use data for major use categories of importance to water resources managers and planners in Puerto Rico.

A number of terms are used throughout the body of this report that may be unfamiliar to the reader. All such terms are highlighted in boldface type at their first usage in the text. Concise working definitions of these terms are supplied in a glossary at the back of the report.

Purpose and Scope

This report presents estimates of the amount of water withdrawn from **surface-water and ground-water** sources and used for offstream and instream uses in Puerto Rico during calendar year 1995. The eight categories of **offstream water use** include **public supply, wastewater treatment discharges, domestic, industrial, mining, thermoelectric power, livestock,** and **irrigation**. Three categories of **instream water use** include **hydroelectric power** generation, **saline water use** at thermoelectric power plants, and **reservoir evaporation**. The data were obtained from the PRASA, PRDNER, the Puerto Rico Department of Health (PRDOH), the Puerto Rico Electric and Power Authority (PREPA), the U.S. Bureau of the Census, and the U.S. Mine Safety and Health Administration (MSHA).

Discussion about the sources and methods used to compile the data parallels the presentation and discussion of water-use data by category. The data are compiled by **municipio**, which constitutes the basic political sub-division in Puerto Rico. All data are stored in a computerized storage-retrieval system, the Aggregate Water-Use Data System (AWUDS), which is administered by the USGS.

Acknowledgments

The author gratefully acknowledges the following Commonwealth agencies for their cooperation: the PRASA, PRDNER, PRDOH, and PREPA. The author is also grateful to many other federal and local government employees who, in various ways, provided assistance during this study.

SOURCES AND METHODS USED TO COMPILE WATER-USE DATA

Puerto Rico is divided into 78 municipios (fig. 1). Water-use data for a number of categories were compiled for each municipio. The sources and the methods used to compile water-use data differ for each category and are described in the following sections.

Public-Supply Withdrawals and Deliveries to Domestic, Commercial, and Industrial Users

Public supply includes freshwater withdrawals and deliveries to domestic, **commercial,** and industrial water-use customers, and **public uses** such as water for firefighting, street washing, municipal parks, and swimming pools. The withdrawal data were obtained from annual reports prepared by the PRASA (Puerto Rico Aqueduct and Sewer Authority, 1994–95). Public-supply deliveries to domestic, commercial, industrial and public uses were estimated developing a coefficient based on the increase of population per municipio from 1993 to 1995. The deliveries reported by the PRASA for 1993 were then multiplied by this coefficient to obtain the estimated deliveries for 1995. The public-supply deliveries to commercial facilities also include the water distributed by the PRASA to government facilities (such as schools, offices, public parks, and buildings).

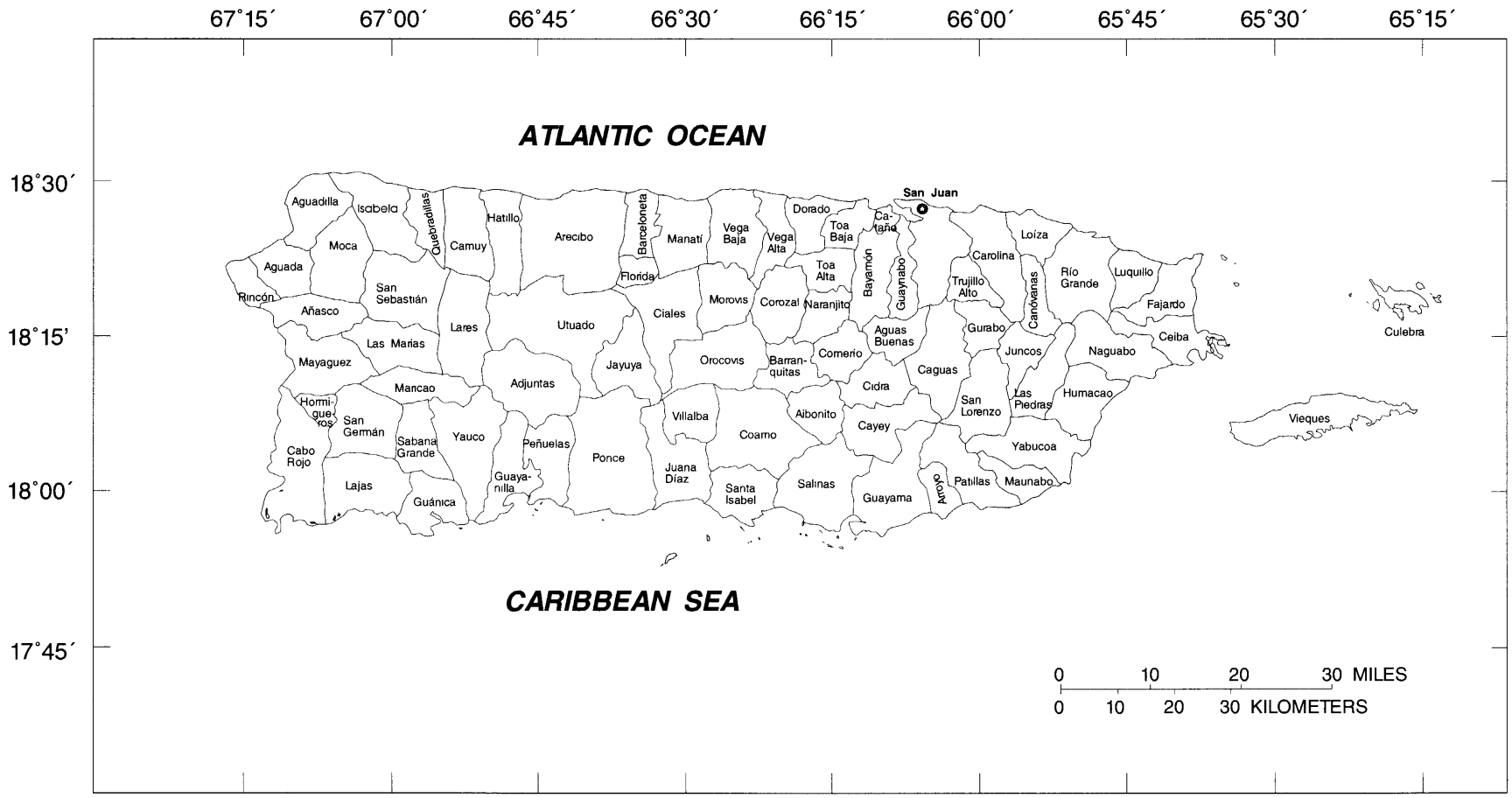

Figure 1. Location of municipios in Puerto Rico.

The domestic use category also includes **public-supply facilities** which are not operated by the PRASA, but serve more than 25 people or have a minimum of 15 connections and are known as non-PRASA systems. These data were supplied by the PRDOH (Puerto Rico Department of Health, 1995).

The total population served by public-supply sources was estimated by extrapolating the PRASA data from 1993 to 1995. Also, a report prepared by PRDOH including the non-PRASA population was used to estimate the total population served from these systems (PRDOH, 1995). The population served from surface-water public-supply sources was calculated by dividing surface-water withdrawals by total withdrawals, and then multiplying the quotient by the estimated total population served from a public-supply source (PRASA + non-PRASA population). The population served from ground-water public-supply sources was estimated by subtracting the population served by surface-water systems from the total population served from a public-supply source. To estimate the water used per day per person (**per capita water use**), the daily domestic water use was divided by the population using potable water. Daily water use was determined by dividing the total domestic water use by the number of days in a year.

Wastewater Treatment

The wastewater treatment category was included in this report because it contains information on the amount of water returned to the hydrologic system by public wastewater treatment facilities and the number of public facilities that treat **wastewater**. Wastewater treatment discharges from domestic, commercial, and industrial users served from public-supply systems were obtained from annual reports prepared by the PRASA (Puerto Rico Aqueduct and Sewer Authority, 1995). These annual reports indicate the number of public wastewater treatment facilities and the volume of **sewage** treated by municipio.

Self-Supplied Domestic

Self-supplied domestic water withdrawals were estimated by multiplying the population not served by a public-supply system in each municipio by the per capita water-use estimate obtained for domestic users supplied from a public-supply source. The self-supplied domestic population was determined by subtracting the public-supplied population, served by PRASA and non-PRASA systems, from the total population. The total populations of each municipio for 1995 was estimated using a population projection prepared by the Bureau of Census (U.S. Department of Commerce, 1995).

Self-Supplied Industrial and Mining

The annual self-supplied industrial surface- and ground-water withdrawal estimates were obtained from individual facilities (by personal visits, and telephone and mail surveys). The surveys provide information concerning the location of the systems and the amount of water withdrawn by each industrial facility. Also a listing of franchises provided by the Permits and Franchise Division of the PRDNER was used to estimate the ground-water withdrawals of some industrial facilities.

The 1995 fresh surface- and ground-water withdrawals used for mining purposes were obtained from the Permits and Franchises Division of the PRDNER and from a list of site locations provided by the MSHA. This list contains information about the active facilities operating in Puerto Rico during 1995.

Thermoelectric and Hydroelectric

Freshwater use from public supply for the Puerto Nuevo and Palo Seco thermoelectric power plants from self-supplied ground-water withdrawals at the Aguirre and Costa Sur plants, and instream saline water use (seawater withdrawals) was obtained from reports prepared by the PREPA. Most of the freshwater withdrawn by thermoelectric power plants is used for boiler feed, whereas saline water is used for cooling purposes.

The total annual amount of instream water use by hydroelectric power plants throughout Puerto Rico during 1995 was obtained from monthly power generation reports by the PREPA. The amount of water used for hydroelectric power was obtained from the amount of power generated by each facility on a monthly basis. The following equation was used to obtain monthly instream water use:

$$\text{Water Use} = P\,(F / N) \qquad (1)$$

where

P is the gross power generation, in kilowatt-hours;

F is a specific factor for each reservoir, given the relation between monthly energy production and instream water requirement, in acre-feet per kilowatt-hour; and

N is the number of days in a month.

Table 1 shows the gross power generation in kilowatt-hours and the specific factor in acre-feet per kilowatt-hour used for each hydroelectric facility in Puerto Rico during 1995.

Table 1. Gross power generation in kilowatt-hours (P) and specific factor in acre-feet per kilowatt-hour (F) for each hydroelectric facility in Puerto Rico, 1995

Reservoir	P	F
Dos Bocas	26.26	0.0033598
Río Blanco	6.39	0.0003233
Toro Negro II	1.34	0.0001771
Garzas I	0.01	0.0002089
Garzas II	0.92	0.0002089
Caonillas I	13.73	0.0006161
Toro Negro I	14.16	0.0002469
Yauco I	26.99	0.0003589
Yauco II	11.17	0.001417

Livestock

Livestock in Puerto Rico totaled 12,103,626 animals according to the 1992 Census of Agriculture (U.S. Department of Commerce, 1994). The fresh surface- and ground-water withdrawals used for livestock watering purposes are presented in two subcategories: (1) the water associated with the production of red meat, poultry, eggs, and milk, called "stock" water use and (2) the "animal specialties" water use, which includes the water associated with the production of fur-bearing animals, horses, rabbits, and aquaculture (fish farms).

To estimate the total water use for livestock, the daily average watering requirements per animal (Kirk, 1982; table 2) was multiplied by the total number of animals reported in the agricultural census in each municipio. In general, the livestock watering requirements given in table 2 represent maximum rates in the life cycle. As an example, watering needs for hogs range from 0.6 gal/d for piglets to about 6.0 gal/d for lactating sows (U.S. Department of Commerce, 1990, p. 394).

Table 2. Daily livestock water requirements

[gal/d, gallons per day]

Livestock	Water required (gal/d)
Dairy cows	35
Cattle, horses, mules	12
Hogs	4
Sheep, goats	2
Rabbits	1
Chicken	0.06

Irrigation

Surface-water withdrawals for irrigation purposes were estimated using an inventory of the amount of water withdrawn from reservoirs owned by the PREPA. Ground-water withdrawals for irrigation purposes in the municipios of Guánica, Guayama, Guayanilla, Juana Díaz, Ponce, Salinas, and Santa

Isabel were obtained from a vegetable crops application rate based on a water delivery rate of 242 gal/d/acre and an average daily application of 7.2 hours per day for 365 days per year.

Irrigation withdrawals at municipios of Guayama, Patillas, Quebradillas, Villalba, and Yauco were obtained from data reported by the PREPA. The data presented on the number of acres irrigated were obtained from the 1992 Census of Agriculture (U.S. Department of Commerce, 1994).

Reservoir Evaporation

Evaporation of water from a reservoir is considered to be a **consumptive use** associated with the storage of water. It was calculated for the reservoirs in Puerto Rico that had capacity equal to or greater than 5,000 acre-ft when originally constructed. The annual water loss due to evaporation for reservoirs throughout Puerto Rico was calculated using the following equation:

$$RE = RA\ (PE)(K) \qquad (2)$$

where

RE is the estimated reservoir evaporation during 1995, in thousands of acre-feet per year;

RA is the reservoir surface area at normal pool elevation, in thousands of acres;

PE is the class A annual pan evaporation, in feet; and

K is a constant, equal to 0.7.

The surface area for each reservoir was obtained from the PREPA and PRDNER. Reservoir levels were assumed to be at the spillway elevation. Class A pan evaporation for each reservoir was based on the National Oceanic and Atmospheric Administration data sites located within the same climatic subdivision as the reservoir (U.S. Department of Commerce, 1995; table 3).

Table 3. Annual estimated evaporation loss from reservoirs in Puerto Rico during 1995

[$\overline{X}$, average]

Municipio	Reservoir	Surface area (in thousands of acres)	Climatological station	Class A pan evaporation (in inches)
Adjuntas	Lago Garzas	0.10	Adjuntas Substation	49.67
	Lago Guayo	0.28	Adjuntas Substation	49.67
Arecibo	Lago Dos Bocas	0.63	Corozal Substation	48.17
Cidra	Lago Cidra	0.27	Adjuntas and Gurabo Substation	$\overline{X}$=57.23
Comerio	Lago Comerio II	0.06	Corozal Substation	48.17
Guayama	Lago Carite	0.33	Adjuntas Substation	49.67
Patillas	Lago Patillas	0.31	Gurabo Substation	64.78
Ponce	Lago Cerrillos	0.61	Ponce 4E	79.10
Quebradillas	Lago Guajataca	1.00	Isabela Substation	42.33
Toa Alta	Lago La Plata	0.56	Corozal Substation	48.17
Trujillo Alto	Lago Loíza	0.60	Gurabo Substation	64.78
Utuado	Lago Caonillas	0.70	Corozal Substation	48.17
Villalba	Lago Toa Vaca	0.84	Ponce 4E	79.10
	Lago Guayabal	0.33	Ponce 4E	79.10
Yauco	Lago Luchetti	0.27	Ponce 4E and Lajas Substation	$\overline{X}$=59.38

WATER USE BY CATEGORY

Freshwater withdrawals during 1995 from surface- and ground-water sources for offstream use averaged 566 Mgal/d; surface-water withdrawals averaged 420 Mgal/d and ground-water withdrawals averaged 146 Mgal/d. Withdrawals during 1995 by municipio are summarized in tables 4 through 15 (at the end of the report) for the categories of water use presented in this section.

Public-Supply Withdrawals and Deliveries to Domestic, Commercial, and Industrial Users

The 144 public-supply facilities operating in Puerto Rico were supplied from surface-water sources and 349 public-supply wells during 1995. Culebra is the only municipio that uses a seawater desalinization plant to obtain public-supplied water.

Freshwater withdrawals by public-supply facilities from surface- and ground-water sources totaled 431 Mgal/d during 1995. The largest public-supply withdrawal was 89 Mgal/d from the Sergio Cuevas facility at Trujillo Alto (table 4, at end of report). This facility withdraws water from the Lago Loíza reservoir and provides water principally to the municipios of Trujillo Alto, Carolina, and San Juan, and augments the supply from other sources to the municipios of Guaynabo and Cataño.

The distribution of potable water by the PRASA during 1995 was as follows: 171 Mgal/d (40 percent) for domestic use; 61 Mgal/d (14 percent) for commercial use which also includes government facilities; 14 Mgal/d (3 percent) for industrial use; 1 Mgal/d (less than 1 percent) for thermoelectric use; and, 183 Mgal/d (42 percent) for unaccounted use (public uses and losses). Unaccounted use includes losses due to system distribution leaks, illegal connections, and accounting errors (fig. 2). Deliveries from public-supply systems by type of use for each municipio during 1995 are listed in table 5 (at end of report).

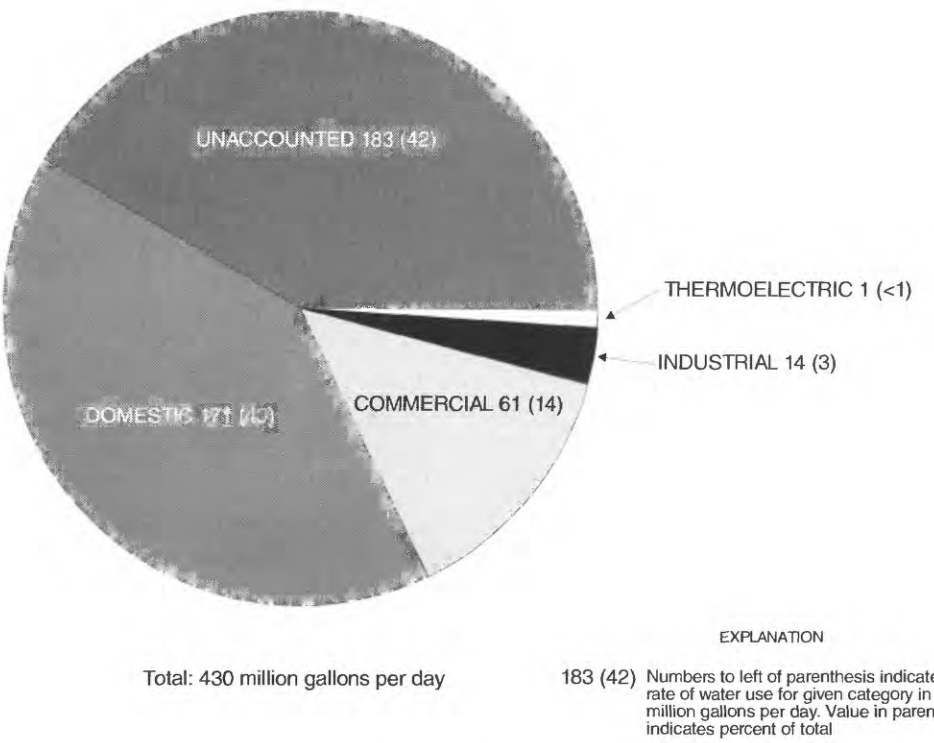

Figure 2. Public-supply deliveries to domestic, commercial, industrial, thermoelectric, and unaccounted uses in Puerto Rico during 1995.

Positive values resulting from the difference between withdrawals and deliveries within a municipio and listed under "unaccounted use" in table 5 may represent exports of public-water supply to adjacent municipios in addition to the reasons previously defined under unaccounted use. Negative values indicate importation of public-water supply from adjacent municipios to such an extent that public-supply deliveries to a municipio exceed its public-supply withdrawals.

Wastewater Treatment

Most public wastewater treatment facilities in Puerto Rico are located in the vicinity of the principal urban center in each municipio. Twelve regional wastewater treatment plants (RWWTP) operated islandwide during 1995. These plants were (1) the Puerto Nuevo RWWTP located in San Juan serving principally the municipios of San Juan, Cataño, and parts of Guaynabo; (2) the Carolina RWWTP located in Loíza serving Loíza, Carolina, Canóvanas, and Trujillo Alto; (3) the Bayamón RWWTP located in Cataño serving Bayamón, parts of Guaynabo, and part of Cataño and Toa Baja; (4) the Arecibo RWWTP located in Arecibo serving Arecibo, (5) the Barceloneta RWWTP located in Barceloneta serving Barceloneta, Manatí, and part of Vega Baja; (6) the Mayagüez RWWTP located in Mayagüez, serving the municipios of Mayagüez, Hormigueros, and part of Cabo Rojo; (7) the Aguada RWWTP located in Aguada serving Aguada, Aguadilla, and Moca; (8) the Camuy RWWTP located in Camuy serving the municipios of Camuy and Hatillo; (9) the Ponce RWWTP located in Ponce serving Ponce; (10) the Cayey RWWTP located in Cidra serving the municipios of Cidra and Cayey; (11) the Guayama RWWTP located in Guayama and serving the municipios of Guayama, Salinas, and Arroyo; and (12) Humacao RWWTP located in Humacao serving the municipios of Humacao, Naguabo, and Las Piedras. The regional wastewater treatment plants only provide primary treatment to wastewater (except the Cayey RWWTP) and all discharge their effluent offshore.

Total discharge from 70 active public wastewater treatment facilities was reported as 185 Mgal/d in 1995. Public wastewater treatment facilities which discharge to streams in Puerto Rico provide secondary treatment. A summary of the amount of water released by public wastewater treatment plants and the number of operating facilities by municipio during 1995 are presented in table 6 (at end of report).

Self-Supplied Domestic

About 40 percent of the total offstream freshwater withdrawn in Puerto Rico was used for domestic purposes during 1995. The population served by self-supplied systems was estimated to be about 217,000 in 1995; withdrawals from self-supplied systems totaled about 12 Mgal/d. The municipios of Vega Baja, Guaynabo, Las Piedras, and Toa Alta had the greater domestic self-supplied withdrawal during 1995 with 2, 1.4, 0.47, and 0.44 Mgal/d, respectively. Those municipios had an average per capita domestic water use from public supply of about 60 gal/d. Public-supply systems delivered 171 Mgal/d for domestic use to an estimated population of 3.5 million people (table 7, at end of report).

Self-Supplied Industrial and Mining

Ground-water self-supplied withdrawals by industrial users were estimated only for municipios at which withdrawals were equal to or greater than 1.0 Mgal/d. During 1995, ground-water self-supplied withdrawals were mostly by industrial users such as the largest chemical and allied products manufacturers [Standard Industrial Classification (SIC 28)]. Most of these industries are located along the north coast of Puerto Rico and have ground-water withdrawals greater than 1.0 Mgal/d. The municipios of Arecibo, Barceloneta, and Manatí, where a number of pharmaceutical companies have large facilities, have the largest ground-water withdrawals during 1995 (table 8, at end of report). Yabucoa had a significant industrial activity related to the refining of petroleum products (SIC 29) and withdrew more than 1.0 Mgal/d from ground-water sources during 1995 (table 8). The

total industrial self-supplied ground-water withdrawals in Puerto Rico were estimated to be 7 Mgal/d for 1995.

The principal mining activity in Puerto Rico is the production of sand and gravel for the construction industry. Mining water withdrawals were about 4.2 Mgal/d during 1995. Most of the production was concentrated in the northeastern part of Puerto Rico, with the largest fresh ground water withdrawal occurring in Manatí and Vega Baja. Mining water-use activities during 1995 are summarized by municipio in table 9 (at end of report).

Thermoelectric and Hydroelectric

Puerto Rico has four thermoelectric power plants: Costa Sur in Guayanilla; Aguirre in Salinas; Puerto Nuevo in Guaynabo; and Palo Seco in Toa Baja (fig. 3). These four power plants generated 15,760 gWh of electricity in 1995. The instream water use of surface water (seawater) for cooling was 2,260 Mgal/d, and the PRASA delivered a total of 2.2 Mgal/d of freshwater to the Puerto Nuevo and Palo Seco power plants. The Aguirre and Costa Sur power plants had a ground-water self-supplied withdrawal of 2.2 Mgal/d in 1995 (table 10, at end of report).

During 1995, Puerto Rico had nine active hydroelectric power plants located in Arecibo (Dos Bocas), Naguabo (Río Blanco), Orocovis (Toro Negro II), Peñuelas (Garzas I and II), Utuado (Caonillas I), Villalba (Toro Negro I), and Yauco (Yauco I and II) (fig. 3). These power plants generated 101 gWh of electricity in 1995 with an average instream freshwater use of 349 Mgal/d (table 11, at end of report).

Livestock

Livestock enterprises reported 12,103,626 animals in Puerto Rico according to the 1992 Census of Agriculture (U.S. Department of Commerce, 1994). The "stock" water use sub-category which includes dairy cows, cattle, poultry, hogs and pigs, sheep, and goats totaled 12,042,485 animals. About 6.2 Mgal/d was withdrawn from surface- and ground-water sources during 1995 for this stock sub-category. The largest withdrawal rate was in the municipio of Hatillo, where about 0.92 Mgal/d was used mostly for dairy cows (table 12, at end of report).

In the "animal specialties" water use sub-category in Puerto Rico there were a total of 7,469 horses and 53,672 rabbits reported during 1992 (U.S. Department of Commerce, 1994). The estimated withdrawals during 1995 for these animal specialties sub-categories were 0.05 Mgal/d from surface- and ground-water sources (table 13, at end of report).

Irrigation

During 1995, irrigation withdrawals from irrigated areas in Puerto Rico averaged about 103 Mgal/d to irrigate approximately 30,620 acres of land (17,450 acres by micro-irrigation methods and 13,170 acres by flood irrigation methods) (table 14, at end of report). Surface-water sources accounted for 75 Mgal/d of the total withdrawals and ground-water withdrawals were estimated at about 28 Mgal/d.

Surface-water withdrawals for irrigation use consist of four major irrigation systems: the Guayama and Juana Díaz Irrigation Districts on the south coast; the Valle de Lajas Irrigation District in the southwest; and the Isabela Irrigation District in northwestern Puerto Rico (fig. 4). The Guayama Irrigation District withdraws water from the Río Guamaní and Lago Patillas reservoir, and delivers it to agricultural lands in Patillas, Arroyo, Guayama, and Salinas. The Juana Díaz Irrigation District withdraws water from the Lago Guayabal reservoir and delivers it to agricultural lands in Juana Díaz and Santa Isabel. The Valle de Lajas Irrigation District withdraws water from the Lago Loco reservoir and delivers it to Cabo Rojo, Lajas, Guánica, and some sections of Yauco and Sabana Grande. The Isabela Irrigation District withdraws water from the Lago Guajataca reservoir, and delivers it to the municipios of Aguadilla, Isabela, and Moca. In addition to the pubic irrigation network operated by PREPA, there is an independent irrigation district at Ponce. Irrigation withdrawals in the Ponce Irrigation District area were estimated at about 6 Mgal/d during 1995. Ground-water withdrawals were estimated to be about 28 Mgal/d at the municipios of Guánica, Guayama, Guayanilla, Juana Díaz, Ponce, Salinas, and Santa Isabel.

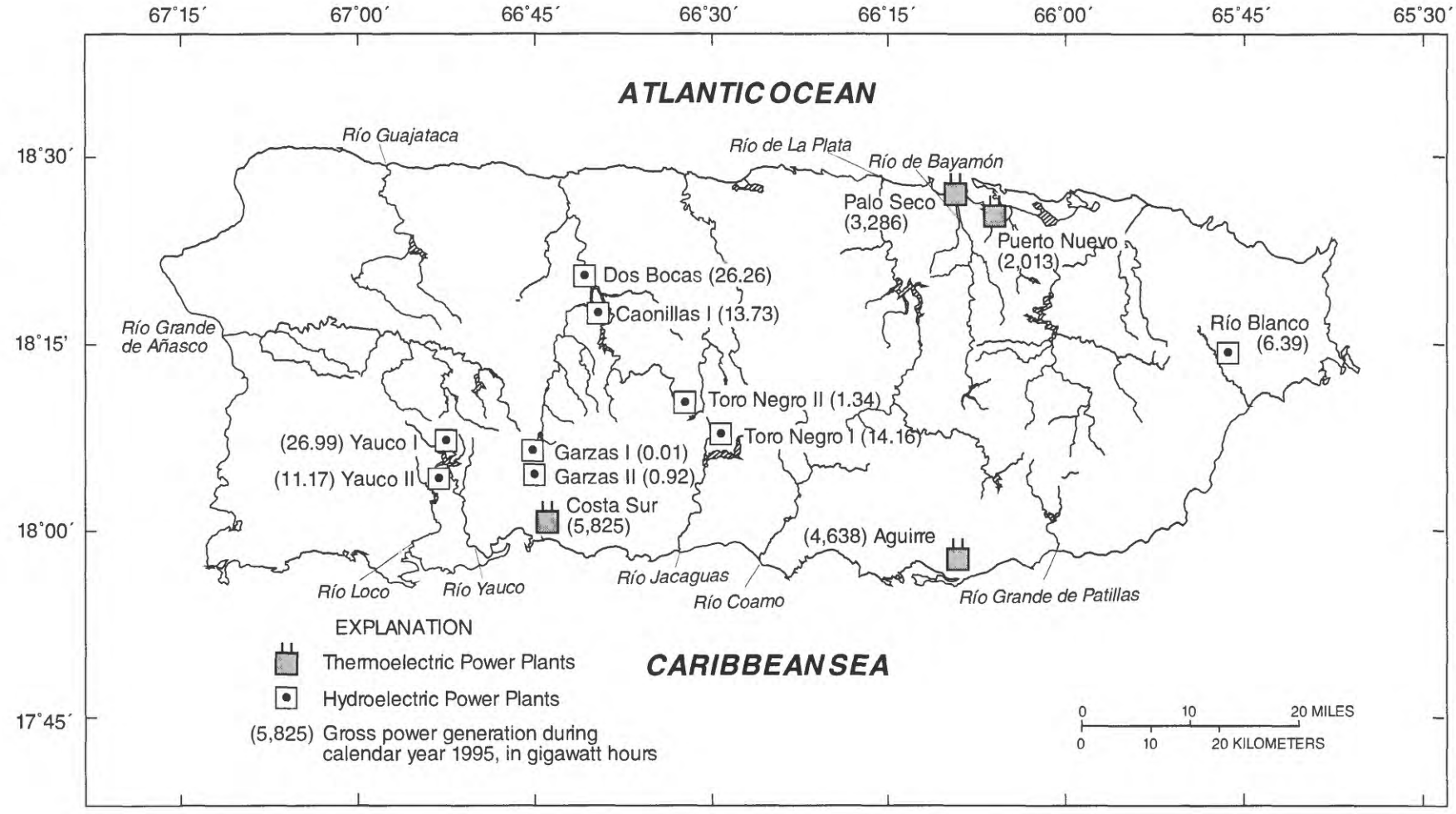

Figure 3. Location of active thermoelectric and hydroelectric power plants in Puerto Rico during 1995.

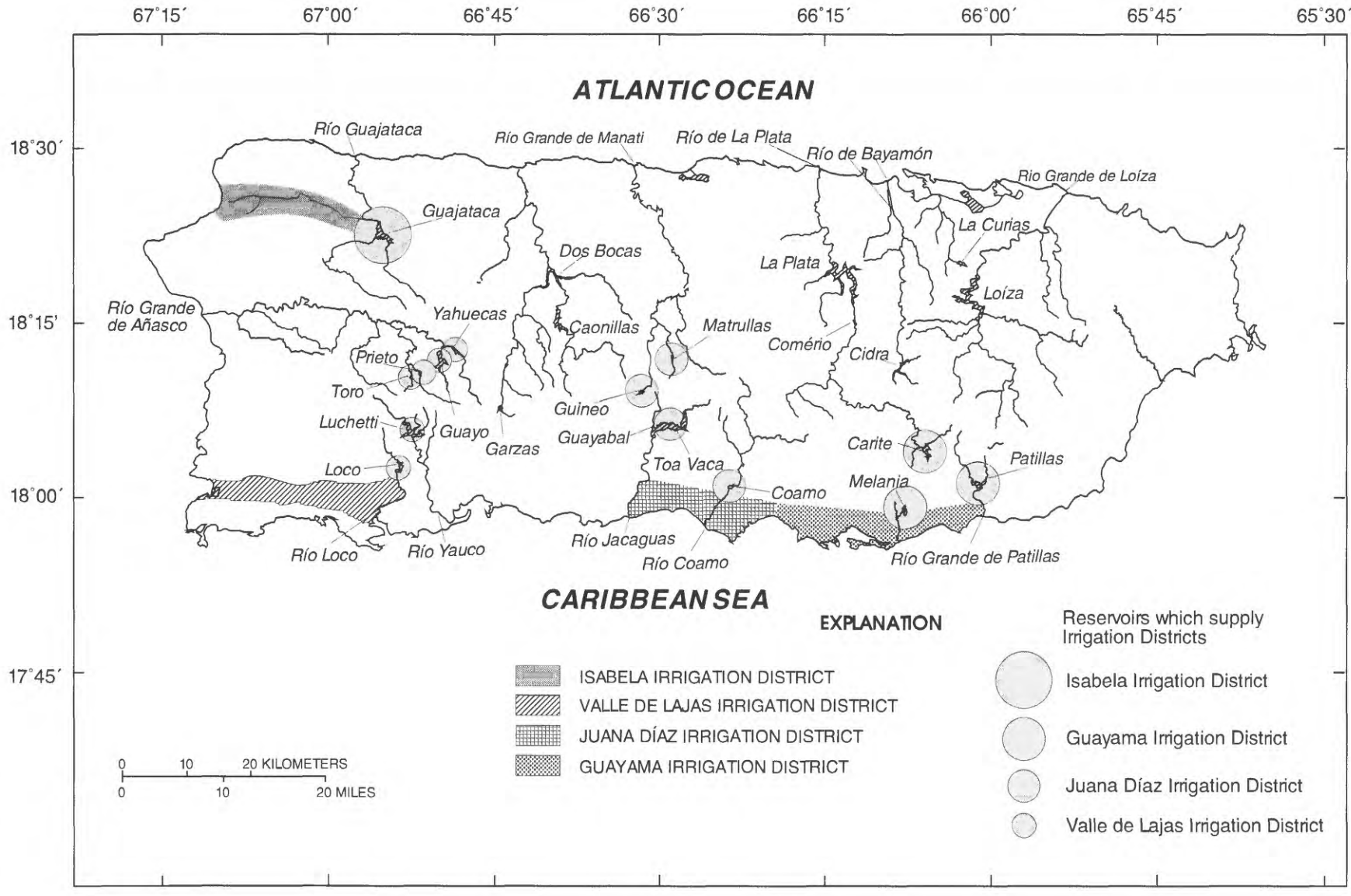

Figure 4. Location of Puerto Rico Electric Power Authority Irrigation Districts and principal reservoirs in Puerto Rico.

Reservoir Evaporation

The amount of water that evaporated from 15 reservoirs throughout Puerto Rico was estimated to be about 23,900 acre-ft from a total reservoir area of 6,900 acres. Lago Toa Vaca and Lago Guayabal, in Villalba, had the largest amount of evaporation, totaling 5,370 acre-ft from a total reservoir area of 1,170 acres (table 15, at end of report; fig. 4).

SUMMARY

Puerto Rico is divided into 78 municipios. Water-use data for 1995 were compiled for each municipio in Puerto Rico. The data were compiled for eight offstream water-use categories: public-supply, wastewater treatment discharges, domestic, industrial, mining, thermoelectric power, livestock, and irrigation. Three instream water-use categories were considered: hydroelectric power, saline water used at thermoelectric power plants, and reservoir evaporation.

During 1995, freshwater withdrawals from surface- and ground-water sources (excluding wastewater treatment) averaged 566 Mgal/d. Freshwater withdrawals to public-supply facilities from surface- and ground-water sources totaled 431 Mgal/d. The largest amount of water delivered by the PRASA in 1995 was 183 Mgal/d (42 percent) for unaccounted uses. The second largest delivery by the PRASA was 171 Mgal/d for domestic uses. Public wastewater treatment plants treated 185 Mgal/d.

About 40 percent of the total offstream freshwater withdrawn was used for domestic purposes. Ground-water self-supplied withdrawals by industrial users (estimated only for municipios in which withdrawals were 1.0 Mgal/d or greater) totaled 7 Mgal/d. Withdrawals for mining activity totaled about 3 Mgal/d of ground water.

Puerto Rico has four thermoelectric power plants that consume large amounts of saline surface water for cooling. These withdrawals totaled 2,260 Mgal/d. The PRASA also delivered 2.2 Mgal/d of fresh ground water to the Puerto Nuevo and Palo Seco plants. The Aguirre and Costa Sur power plants withdrew 2.2 Mgal/d of freshwater from their ground-water wells. There were nine active hydroelectric power plants located throughout Puerto Rico. These power plants used 349 Mgal/d of instream freshwater in 1995.

Livestock enterprises reported 12,103,626 animals in Puerto Rico according to the 1992 Census of Agriculture. The stock sub-category totaled 12,042,485 animals, and used 6.2 Mgal/d from surface- and ground-water sources during 1995. The animal specialties sub-category totaled 7,469 horses and 53,672 rabbits, and used 0.05 Mgal/d from surface- and ground-water sources.

Surface water for irrigation use was withdrawn from the public irrigation district operated by the PREPA which consists of four major systems. An independent irrigation district at Ponce and several municipios also obtain their irrigation water from ground water systems. About 103 Mgal/d of surface- and ground-water was withdrawn to irrigate 30,620 acres of land.

Reservoir evaporation is considered to be a consumptive use associated with the storage of water. The evaporation of water from 15 reservoirs in Puerto Rico totaled 23,900 acre-ft during 1995 from a total reservoir surface area of 6,900 acres.

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GLOSSARY

Commercial water use: Water for motels, hotels, restaurants, office buildings, other commercial facilities, and civilian and military institutions. The water is obtained from a public supply or is self-supplied.

Consumptive use: That part of water withdrawn that is evaporated, transpired, incorporated into products or crops, consumed by humans or livestock, or otherwise removed from the immediate water environment.

Domestic water use: Water for household purposes, such as drinking, food preparation, bathing, washing clothes and dishes, flushing toilets, and watering lawns and gardens. The water is obtained from a public supply or is self-supplied.

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

Ground water: Generally all subsurface water as distinct from surface water; specifically, that part of the subsurface water in the saturated zone, where the water is under pressure greater than atmospheric.

Hydroelectric power water use: The use of water in generating electricity at power plants where the turbine generators are driven by falling water; an instream use.

Industrial water use: The water used to manufacture products such as steel, chemical, and paper products. It includes water used in petroleum refining such as processing, washing, and cooling operations. This category includes self-supplied water and water purchased from a water supplier.

Instream water use: Water use taking place within the stream channel for such purposes as hydroelectric power generation, navigation, water quality improvement, fish propagation, and recreation. In Puerto Rico instream water is mainly used in the generation of hydroelectric power.

Irrigation water use: The 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 stock watering, feed lots, dairy operations, fish farming, and other farm needs. Livestock as used here includes cattle, sheep, goats, hogs, and poultry. Also included are such animal specialities as horses, rabbits, bees, pets, fur-bearing animals in captivity, and fish in captivity.

Mining water use: Water use for 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 other preparations customarily completed at the mine site or as part of a mining activity. The main mining activity in Puerto Rico is the production of sand and gravel.

Municipio: The minimum legal or jurisdictional unit in Puerto Rico as used by the U.S. Bureau of Census. It is more or less equivalent to a county in the United States.

Offstream water use: Water withdrawn or diverted from a ground- or surface-water source for use in public supply, industry, source for irrigation, livestock, thermoelectric power generation, and other activities.

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

Public-supply use: Water withdrawn by public and private water suppliers and delivered to groups of 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 supply and used for such purposes as firefighting, street washing, and municipal parks and swimming pools.

Reservoir evaporation: Water loss by evaporation from man-made impoundments which have a normal capacity equal to or greater than 5,000 acre-feet. Normal capacity is defined as the total volume in a reservoir below the normal retention level, including dead storage but excluding flood-control and surcharge storage.

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

Self-supplied water: Water withdrawn from a surface- or ground water source by a user rather than being obtained from a public supply.

Sewage: Wastewater carried off by sewer and drains.

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

Thermoelectric power water use: The amount of water used in the production of electric power generated with fossil fuel. Fossil fuels include coal, oil, and natural gas. The water used is self-supplied or is delivered by a water supplier through a distribution system.

Wastewater treatment discharges: Water that carries wastes from homes, businesses, and industries.

Withdrawal: Water removed from the ground or diverted from a surface-water source for use.

Table 4. Total freshwater withdrawals by public-supply facilities and population served by municipio, by source for 1995

[Location of municipios is shown in figure 1. Numbers may not add to totals listed because of independent rounding. Mgal/d, million gallons per day]

Municipio	Freshwater withdrawals (Mgal/d)			Population served (thousands)		
	Surface water	Ground water	Total	Surface water	Ground water	Total
Adjuntas	1.56	0.21	1.77	13.99	1.52	15.51
Aguada	.00	.15	.15	35.99	1.64	37.63
Aguadilla	14.53	.00	14.53	60.98	.00	60.98
Aguas Buenas	1.50	.51	2.01	22.57	4.49	27.06
Aibonito	2.28	.44	2.72	16.17	.81	16.98
Añasco	.23	.09	.32	23.22	1.37	24.59
Arecibo	2.28	13.76	16.04	16.73	76.71	93.44
Arroyo	.00	1.02	1.02	.00	19.24	19.24
Barceloneta	.00	2.94	2.94	.00	22.00	22.00
Barranquitas	1.06	.50	1.56	21.88	4.16	26.04
Bayamón	.58	.03	.61	230.56	.77	231.33
Cabo Rojo	.00	3.90	3.90	.00	39.93	39.93
Caguas	6.49	1.03	7.52	137.94	1.35	139.29
Camuy	1.03	.57	1.60	16.84	13.99	30.83
Canóvanas	5.87	.16	6.03	49.15	.06	49.21
Carolina	.00	.05	.05	187.08	.00	187.08
Cataño	.00	.00	.00	32.66	.00	32.66
Cayey	4.63	.52	5.15	49.16	.46	49.62
Ceiba	.00	.00	.00	13.16	.00	13.16
Ciales	1.79	.01	1.80	16.63	.34	16.97
Cidra	2.43	.23	2.66	35.86	1.24	37.10
Coamo	1.02	.67	1.69	28.36	5.26	33.62
Comerío	.99	.08	1.07	14.29	2.45	16.74
Corozal	3.33	.04	3.37	31.16	1.02	32.18
Culebra	.13	.00	.13	1.60	.00	1.60
Dorado	.00	8.18	8.18	.00	32.12	32.12
Fajardo	6.69	.00	6.69	37.10	.00	37.10
Florida	.00	1.60	1.60	.00	8.74	8.74
Guánica	.00	2.97	2.97	.00	21.01	21.01
Guayama	4.79	.45	5.24	40.56	1.49	42.05
Guayanilla	.26	2.14	2.40	3.33	19.67	23.00
Guaynabo	20.18	.01	20.19	84.56	.08	84.64
Gurabo	.00	1.11	1.11	.00	26.03	26.03
Hatillo	3.76	1.15	4.91	21.09	12.19	33.28
Hormigueros	.00	.62	.62	.00	16.21	16.21
Humacao	2.68	.08	2.76	57.02	1.59	58.61
Isabela	3.65	.00	3.65	40.15	.00	40.15
Jayuya	1.30	.00	1.30	16.13	.00	16.13
Juana Díaz	.88	3.93	4.81	37.96	.15	38.11

Table 4. Total freshwater withdrawals by public-supply facilities and population served by municipio, by source for 1995—Continued

Municipio	Freshwater withdrawals (Mgal/d)			Population served (thousands)		
	Surface water	Ground water	Total	Surface water	Ground water	Total
Juncos	4.33	.00	4.33	32.63	.00	32.63
Lajas	3.00	.00	3.00	23.89	.00	23.89
Lares	1.59	.03	1.62	27.64	.74	28.38
Las Marías	.84	.00	.84	8.45	.00	8.45
Las Piedras	.11	.08	.19	19.74	4.49	24.23
Loíza	.00	.00	.00	28.63	.00	28.63
Luquillo	1.81	.00	1.81	16.25	.00	16.25
Manatí	.00	7.92	7.92	.00	39.46	39.46
Maricao	1.37	.00	1.37	3.55	.00	3.55
Maunabo	.07	.92	.99	1.29	10.51	11.80
Mayaguez	17.15	.64	17.79	87.10	12.95	100.05
Moca	.36	.49	.85	22.55	4.50	27.05
Morovis	3.27	.25	3.52	24.33	2.69	27.02
Naguabo	12.14	.00	12.14	22.42	.00	22.42
Naranjito	1.89	.19	2.08	24.99	3.09	28.08
Orocovis	2.06	.11	2.17	20.06	2.50	22.56
Patillas	1.19	.42	1.61	16.10	3.65	19.75
Peñuelas	1.54	.17	1.71	22.09	.57	22.66
Ponce	16.31	8.40	24.71	3.71	186.83	190.54
Quebradillas	3.14	.36	3.50	19.33	3.09	22.42
Rincón	.00	.95	.95	.00	12.28	12.28
Río Grande	15.87	.01	15.88	47.96	.30	48.26
Sabana Grande	2.23	.26	2.49	15.11	8.54	23.65
Salinas	.00	3.00	3.00	.00	28.70	28.70
San Germán	1.16	1.62	2.78	26.44	8.01	34.45
San Juan	.00	.93	.93	438.08	.00	438.08
San Lorenzo	3.22	.06	3.28	29.09	2.04	31.13
San Sebastián	3.21	.02	3.23	39.96	.26	40.22
Santa Isabel	.00	6.03	6.03	.00	18.17	18.17
Toa Alta	42.14	.00	42.14	44.37	.00	44.37
Toa Baja	.00	3.63	3.63	.00	91.14	91.14
Trujillo Alto	89.29	.00	89.29	72.32	.00	72.32
Utuado	2.93	.01	2.94	33.40	.32	33.72
Vega Alta	.15	1.78	1.93	3.60	30.22	33.82
Vega Baja	1.84	5.52	7.36	44.00	3.34	47.34
Vieques	.00	.00	.00	8.97	.00	8.97
Villalba	2.43	.07	2.50	21.20	.82	22.02
Yabucoa	.98	1.93	2.91	25.90	9.43	35.33
Yauco	2.24	.13	2.37	42.07	.36	42.43
Total	335.78	95.08	430.86	2,711.10	827.09	3,538.19

Table 5. Public-supply deliveries by municipios and type of use for 1995

[Location of municipios is shown in figure 1. Unaccounted use: Positive values are the difference between withdrawals and deliveries in a municipio. Negative values indicate importation of public-water supply from adjacent municipios to such an extent that public-supply deliveries to a municipio exceed its public-supply withdrawals. Numbers may not add to totals listed because of independent rounding. Mgal/d, million gallons per day]

Municipio	Water deliveries by type of use (Mgal/d)					
	Domestic	Commercial	Industrial	Thermoelectric power	Unaccounted uses	Total deliveries
Adjuntas	0.47	0.16	0.00	0.00	1.14	1.77
Aguada	2.42	.22	.04	.00	-2.53	.15
Aguadilla	2.71	1.53	.33	.00	9.96	14.53
Aguas Buenas	.87	.14	.02	.00	.98	2.01
Aibonito	1.09	.25	.52	.00	.86	2.72
Añasco	1.69	.13	.10	.00	-1.60	.32
Arecibo	4.72	1.69	.10	.00	9.53	16.04
Arroyo	.91	.18	.05	.00	-.12	1.02
Barceloneta	1.02	.36	.01	.00	1.55	2.94
Barranquitas	.84	.26	.02	.00	.44	1.56
Bayamón	11.12	4.68	2.31	.00	-17.50	.61
Cabo Rojo	2.13	.52	.02	.00	1.23	3.90
Caguas	6.10	1.80	.30	.00	-.68	7.52
Camuy	1.35	.37	.02	.00	-.14	1.60
Canóvanas	2.16	.32	.36	.00	3.19	6.03
Carolina	9.59	3.86	.86	.00	-14.26	.05
Cataño	1.61	.41	.23	.00	-2.25	.00
Cayey	2.06	.36	.11	.00	2.62	5.15
Ceiba	.48	.07	.01	.00	-.56	.00
Ciales	.66	.23	.02	.00	.89	1.80
Cidra	1.66	.26	.15	.00	.59	2.66
Coamo	1.25	.45	.60	.00	-.61	1.69
Comerío	.53	.11	.02	.00	.41	1.07
Corozal	.97	.18	.01	.00	2.21	3.37
Culebra	.07	.03	.00	.00	.03	.13
Dorado	1.70	.33	.33	.00	5.82	8.18
Fajardo	1.82	.72	.11	.00	4.04	6.69
Florida	.41	.07	.01	.00	1.11	1.60
Guánica	1.02	.25	.01	.00	1.69	2.97
Guayama	1.77	.71	.23	.00	2.53	5.24
Guayanilla	1.15	.26	.00	.00	.99	2.40
Guaynabo	6.09	4.13	.19	1.10	8.68	20.19
Gurabo	1.15	.36	.03	.00	-.43	1.11
Hatillo	1.39	.39	.04	.00	3.09	4.91
Hormigueros	.83	.11	.03	.00	-.35	.62
Humacao	2.55	1.54	.54	.00	-1.87	2.76
Isabela	1.90	.38	.03	.00	1.34	3.65
Jayuya	.45	.24	.07	.00	0.54	1.30

Table 5. Public-supply deliveries by municipios and type of use for 1995

Municipio	Water deliveries by type of use (Mgal/d)					
	Domestic	Commercial	Industrial	Thermoelectric power	Unaccounted uses	Total deliveries
Juana Díaz	1.57	0.30	0.10	0.00	2.84	4.81
Juncos	1.70	.27	.10	.00	2.26	4.33
Lajas	1.19	.24	.01	.00	1.56	3.00
Lares	1.12	.21	.00	.00	.29	1.62
Las Marías	.76	.07	.00	.00	.01	.84
Las Piedras	.83	.19	.13	.00	-.96	.19
Loíza	1.77	.23	.00	.00	-2.00	.00
Luquillo	.86	.33	.03	.00	.59	1.81
Manatí	2.07	1.09	.08	.00	4.68	7.92
Maricao	.13	.05	.01	.00	1.18	1.37
Maunabo	.46	.14	.00	.00	.39	.99
Mayaguez	4.72	2.18	2.96	.00	7.93	17.79
Moca	1.08	.18	.01	.00	-.42	.85
Morovis	1.04	.19	.01	.00	2.28	3.52
Naguabo	.79	.20	.02	.00	11.13	12.14
Naranjito	1.64	.13	.00	.00	.31	2.08
Orocovis	.77	.12	.01	.00	1.27	2.17
Patillas	.74	.16	.02	.00	.69	1.61
Peñuelas	.94	.20	.01	.00	.56	1.71
Ponce	8.66	3.02	.42	.00	12.61	24.71
Quebradillas	1.11	.24	.01	.00	2.14	3.50
Rincón	.65	.15	.01	.00	.14	.95
Río Grande	1.82	.23	.03	.00	13.80	15.88
Sabana Grande	1.25	.20	.05	.00	.99	2.49
Salinas	1.20	.22	.20	.00	1.38	3.00
San Germán	1.38	.38	.19	.00	.83	2.78
San Juan	24.21	16.88	1.01	.00	-41.17	.93
San Lorenzo	.95	.13	.04	.00	2.16	3.28
San Sebastián	2.65	.83	.06	.00	-.31	3.23
Santa Isabel	.75	.18	.04	.00	5.06	6.03
Toa Alta	2.93	.24	.03	.00	38.94	42.14
Toa Baja	4.82	.68	.21	.29	-2.37	3.63
Trujillo Alto	3.78	.67	.07	.00	84.77	89.29
Utuado	1.15	.29	.00	.00	1.50	2.94
Vega Alta	1.90	.39	.25	.00	-.61	1.93
Vega Baja	2.86	.56	.06	.00	3.88	7.36
Vieques	.51	.14	.00	.00	-.65	.00
Villalba	.71	.16	.02	.00	1.61	2.50
Yabucoa	.97	.26	.03	.00	1.65	2.91
Yauco	2.04	.52	.03	.00	-.22	2.37
Total	171.19	60.91	14.09	1.39	183.28	430.86

Table 6. Wastewater treatment water releases and number of facilities by municipio, 1995

[Location of municipios is shown in figure 1. Mgal/d, million gallons per day]

Municipio	Public facilities		Municipio	Public facilities	
	Total public releases (Mgal/d)	Number of facilities		Total public releases (Mgal/d)	Number of facilities
Adjuntas	0.51	1	Lajas	0.32	3
Aguada	3.53	1	Lares	.73	1
Aguadilla	.00	0	Las Marías	.20	1
Aguas Buenas	.32	1	Las Piedras	.13	1
Aibonito	.78	1	Loíza	16.86	1
Añasco	.00	0	Luquillo	.85	1
Arecibo	6.66	1	Manatí	.00	0
Arroyo	.00	0	Maricao	.06	1
Barceloneta	4.85	1	Maunabo	.16	1
Barranquitas	.19	1	Mayaguez	10.72	1
Bayamón	.00	0	Moca	.00	0
Cabo Rojo	.62	1	Morovis	.50	2
Caguas	6.60	2	Naguabo	.05	1
Camuy	1.22	1	Naranjito	.20	1
Canóvanas	.75	1	Orocovis	.12	2
Carolina	.00	0	Patillas	.54	1
Cataño	23.27	1	Peñuelas	.45	1
Cayey	.21	1	Ponce	15.07	1
Ceiba	.46	1	Quebradillas	.00	0
Ciales	.38	1	Rincón	.00	0
Cidra	3.37	2	Río Grande	.58	3
Coamo	.00	0	Sabana Grande	.90	1
Comerío	.30	1	Salinas	.00	0
Corozal	.78	1	San Germán	1.41	1
Culebra	.00	0	San Juan	53.85	1
Dorado	1.35	1	San Lorenzo	.60	1
Fajardo	1.96	1	San Sebastián	.87	2
Florida	.00	0	Santa Isabel	1.69	1
Guánica	.57	2	Toa Alta	1.13	2
Guayama	3.71	1	Toa Baja	.00	0
Guayanilla	.38	1	Trujillo Alto	.08	1
Guaynabo	.00	0	Utuado	.59	1
Gurabo	.87	1	Vega Alta	.94	1
Hatillo	.00	0	Vega Baja	1.84	1
Hormigueros	.00	0	Vieques	.33	1
Humacao	5.15	1	Villalba	.00	0
Isabela	1.17	1	Yabucoa	.76	1
Jayuya	.44	1	Yauco	1.15	1
Juana Díaz	.00	0	Total	184.75	70
Juncos	.67	1			

Table 7. Domestic self-supplied withdrawals and deliveries from public-supply systems by municipio, for 1995

[Location of municipios is shown in figure 1. Mgal/d, million gallons per day; gal/d, gallons per day; --, not applicable]

Municipio	Self supplied				Public supplied		Total withdrawals and deliveries (Mgal/d)	Per capita use (gal/d)
	Population (thousands)	Withdrawals (Mgal/d)			Population served (thousands)	Deliveries from public supply (Mgal/d)		
		Surface water	Ground water	Total				
Adjuntas	4.46	0.02	0.12	0.14	15.51	0.47	0.61	30.30
Aguada	.15	.00	.01	.01	37.63	2.42	2.43	64.31
Aguadilla	5.21	.19	.00	.19	60.98	2.71	2.90	44.44
Aguas Buenas	2.69	.02	.07	.09	27.06	.87	.96	32.15
Aibonito	9.09	.00	.58	.58	16.98	1.09	1.67	64.19
Añasco	2.48	.00	.17	.17	24.59	1.69	1.86	68.73
Arecibo	7.61	.00	.38	.38	93.44	4.72	5.10	50.51
Arroyo	.17	.00	.01	.01	19.24	.91	.92	47.30
Barceloneta	3.27	.00	.44	.44	22.00	1.02	1.46	46.36
Barranquitas	1.91	.00	.06	.06	26.04	.84	.90	32.26
Bayamón	.00	.00	.00	.00	231.33	11.12	11.12	48.07
Cabo Rojo	5.67	.00	.30	.30	39.93	2.13	2.43	53.34
Caguas	.49	.00	.02	.02	139.29	6.10	6.12	43.79
Camuy	1.35	.00	.06	.06	30.83	1.35	1.41	43.79
Canóvanas	.00	.00	.00	.00	49.21	2.16	2.16	43.90
Carolina	.00	.00	.00	.00	187.08	9.59	9.59	51.26
Cataño	.00	.00	.00	.00	32.66	1.61	1.61	49.30
Cayey	.79	.00	.03	.03	49.62	2.06	2.09	41.52
Ceiba	5.12	.11	.00	.11	13.16	.48	.59	36.47
Ciales	1.50	.02	.04	.06	16.97	.66	.72	38.89
Cidra	8.55	.00	.38	.38	37.10	1.66	2.04	44.74
Coamo	1.71	.03	.04	.07	33.62	1.25	1.32	37.18
Comerío	3.52	.04	.07	.11	16.74	.53	.64	31.66
Corozal	3.63	.05	.06	.11	32.18	.97	1.08	30.14
Culebra	.00	.00	.00	.00	1.60	.07	.07	43.75
Dorado	.00	.00	.00	.00	32.12	1.70	1.70	52.93
Fajardo	.72	.03	.00	.03	37.10	1.82	1.85	49.06
Florida	.00	.00	.00	.00	8.74	.41	.41	46.91
Guánica	.00	.00	.00	.00	21.01	1.02	1.02	48.55
Guayama	.00	.00	.00	.00	42.05	1.77	1.77	42.09
Guayanilla	3.28	.02	.15	.17	23.00	1.15	1.32	50.00
Guaynabo	19.23	1.38	.00	1.38	84.64	6.09	7.47	71.95
Gurabo	4.88	.00	.21	.21	26.03	1.15	1.36	44.18
Hatillo	4.84	.00	.19	.19	33.28	1.39	1.58	41.77
Hormigueros	.42	.00	.02	.02	16.21	.83	.85	51.20
Humacao	.00	.00	.00	.00	58.61	2.55	2.55	43.51
Isabela	.56	.05	.00	.05	40.15	1.90	1.95	47.32
Jayuya	.48	.01	.00	.01	16.13	.45	.46	27.90
Juana Díaz	9.37	.30	.08	.38	38.11	1.57	1.95	41.20

Table 7. Domestic self-supplied withdrawals and deliveries from public-supply systems by municipio, for 1995

Municipio	Self supplied				Public supplied		Total withdrawals and deliveries (Mgal/d)	Per capita use (gal/d)
	Population (thousands)	Withdrawals (Mgal/d)			Population served (thousands)	Deliveries from public supply (Mgal/d)		
		Surface water	Ground water	Total				
Juncos	7.27	0.17	0.00	0.17	32.63	1.70	1.87	52.10
Lajas	2.33	.29	.00	.29	23.89	1.19	1.48	49.81
Lares	3.59	.02	.12	.14	28.38	1.12	1.26	39.46
Las Marías	1.19	.11	.00	.11	8.45	.76	.87	89.94
Las Piedras	6.51	.01	.46	.47	24.23	.83	1.30	34.26
Loíza	.00	.00	.00	.00	28.63	1.77	1.77	61.82
Luquillo	2.54	.09	.00	.09	16.25	.86	.95	52.92
Manatí	.31	.00	.06	.06	39.46	2.07	2.13	52.46
Maricao	2.48	.09	.00	.09	3.55	.13	.22	36.62
Maunabo	2.04	.08	.00	.08	11.80	.46	.54	38.98
Mayaguez	1.63	.07	.00	.07	100.05	4.72	4.79	47.18
Moca	8.96	.36	.00	.36	27.05	1.08	1.44	39.93
Morovis	5.25	.19	.00	.19	27.02	1.04	1.23	38.49
Naguabo	1.47	.03	.00	.03	22.42	.79	.82	35.24
Naranjito	1.54	.04	.05	.09	28.08	1.64	1.73	58.40
Orocovis	.90	.01	.02	.03	22.56	.77	.80	34.13
Patillas	1.22	.04	.00	.04	19.75	.74	.78	37.47
Peñuelas	3.06	.09	.03	.12	22.66	.94	1.06	41.48
Ponce	.00	.00	.00	.00	190.54	8.66	8.66	45.45
Quebradillas	2.07	.30	.03	.33	22.42	1.11	1.44	49.51
Rincón	1.45	.00	.06	.06	12.28	.65	.71	52.93
Río Grande	.54	.01	.01	.02	48.26	1.82	1.84	37.71
Sabana Grande	.66	.02	.01	.03	23.65	1.25	1.28	52.85
Salinas	.00	.00	.00	.00	28.70	1.20	1.20	41.81
San Germán	2.52	.10	.00	.10	34.45	1.38	1.48	40.06
San Juan	.00	.00	.00	.00	438.08	24.21	24.21	55.26
San Lorenzo	5.19	.02	.14	.16	31.13	.95	1.11	30.52
San Sebastián	1.93	.00	.13	.13	40.22	2.65	2.78	65.89
Santa Isabel	1.37	.00	.05	.05	18.17	.75	.80	41.28
Toa Alta	10.97	.44	.00	.44	44.37	2.93	3.37	66.04
Toa Baja	.00	.00	.00	.00	91.14	4.82	4.82	52.89
Trujillo Alto	.00	.00	.00	.00	72.32	3.78	3.78	52.27
Utuado	1.51	.05	.01	.06	33.72	1.15	1.21	34.10
Vega Alta	2.26	.00	.08	.08	33.82	1.90	1.98	56.18
Vega Baja	12.98	.50	1.51	2.01	47.34	2.86	4.87	60.41
Vieques	.00	.00	.00	.00	8.97	.51	.51	56.86
Villalba	1.55	.05	.00	.05	22.02	.71	.76	32.24
Yabucoa	5.70	.06	.10	.16	35.33	.97	1.13	27.46
Yauco	.79	.03	.01	.04	42.43	2.04	2.08	48.08
Total	216.93	5.54	6.37	11.91	3,538.19	171.19	183.10	--

Table 8. Self-supplied ground-water withdrawal estimates for industrial facilities by municipio, 1995

[Location of municipios is shown in figure 1. Municipios at which total withdrawals are equal to or greater than 1.0 Mgal/d. SIC, Standard Industrial Classification. Mgal/d, million gallons per day]

Municipio	SIC	Self- supplied ground-water withdrawals
Arecibo	28	1.16
Barceloneta	28	3.02
Manatí	28	1.49
Yabucoa	29	1.22
Total	--	6.89

Table 9. Mining withdrawals by muncipio, for 1995

[Location of municipios is shown in figure 1. Mgal/d, million gallons per day]

Municipio	Freshwater withdrawals (Mgal/d)		
	Surface water	Ground water	Total
Bayamón	0.00	0.02	0.02
Caguas	.00	.01	.01
Guaynabo	.02	.00	.02
Gurabo	.00	.29	.29
Humacao	.00	.03	.03
Isabela	.00	.19	.19
Juana Díaz	.03	.00	.03
Manatí	.00	.67	.67
Peñuelas	.60	.00	.60
Ponce	.00	.06	.06
Salinas	.00	.22	.22
San Germán	.04	.25	.29
San Lorenzo	.26	.00	.26
San Sebastián	.08	.19	.27
Toa Alta	.02	.00	.02
Toa Baja	.30	.18	.48
Vega Alta	.00	.03	.03
Vega Baja	.00	.68	.68
Total	1.35	2.82	4.17

Table 10. Self-supplied withdrawals, deliveries from public supply, and power generated by thermoelectric power plants, by muncipio for 1995

[Location of municipios is shown in figure 1. Mgal/d, million gallons per day; gWh, gigawatt-hours]

Municipio	Self-supplied withdrawals (Mgal/d)			Deliveries from public supply (Mgal/d)	Total withdrawals and deliveries (Mgal/d)	Power generated (gWh)
	Saline surface water	Fresh ground water	Total			
Guayanilla	734.82	1.29	736.11	0.00	736.11	5,824.56
Guaynabo	525.66	.00	525.66	1.10	526.76	2,013.80
Salinas	482.99	.87	483.86	.00	483.86	4,637.87
Toa Baja	518.84	.00	518.84	1.10	519.13	3,286.24
Total	2,262.31	2.16	2,264.47	2.20	2,266.67	15,762.47

Table 11. Water use and power generated by hydroelectric power plants by municipio, 1995

[Location of municipios is shown in figure 1. Mgal/d, million gallons per day; gWh, gigawatt- hours]

Municipio	Water use (Mgal/d)	Power generated (gWh)
Arecibo	239.70	26.26
Naguabo	5.65	6.39
Orocovis	.87	1.34
Peñuelas	.54	.93
Utuado	23.05	13.73
Villalba	9.54	14.16
Yauco	69.56	38.16
Total	348.91	100.97

Table 12. Total freshwater withdrawals and number of animals served for each stock subcategory by municipio, for 1995

[Location of municipios is shown in figure 1. Mgal/d, million gallons per day; --, no population reported]

Municipio	Freshwater withdrawals (Mgal/d)			Stock population					
	Surface water	Ground water	Total	Dairy cows	Cattle	Poultry	Hogs and pigs	Sheep and goats	Total
Adjuntas	0.01	0.00	0.01	90	159	11,063	292	20	11,624
Aguada	.00	.01	.01	6	744	4,574	391	158	5,873
Aguadilla	.00	.03	.03	591	882	11,157	--	--	12,630
Aguas Buenas	.03	.00	.03	259	1,045	41,309	2,546	49	45,208
Aibonito	.00	.14	.14	48	1,669	1,746,951	3,044	431	1,752,143
Añasco	.00	.02	.02	98	1,188	4,648	653	22	6,609
Arecibo	.00	.69	.69	17,001	5,949	205,507	7,271	83	235,811
Arroyo	.00	.00	.00	--	217	--	--	346	563
Barceloneta	.00	.05	.05	1,095	870	--	511	91	2,567
Barranquitas	.10	.00	.10	263	1,048	1,106,138	2,938	579	1,110,966
Bayamón	.02	.00	.02	44	295	1,359	2,764	262	4,724
Cabo Rojo	.00	.12	.12	522	4,404	25,189	689	555	31,359
Caguas	.01	.16	.17	2,707	2,497	321,992	6,602	1,745	335,543
Camuy	.00	.37	.37	9,343	4,321	8,096	1,410	47	23,217
Canóvanas	.00	.08	.08	282	4,777	--	4,149	1,755	10,963
Carolina	.09	.00	.09	1,089	2,260	43,618	5,171	538	52,676
Cataño	.00	.00	.00	--	--	--	--	--	--
Cayey	.00	.09	.09	703	1,618	552,131	4,732	324	559,508
Ceiba	.02	.00	.02	235	687	--	926	--	1,848
Ciales	.00	.03	.03	471	1,153	5,064	415	24	7,127
Cidra	.10	.00	.10	1,526	1,612	529,572	1,617	184	534,511
Coamo	.00	.23	.23	539	3,459	2,527,610	3,647	3.286	2,538,541
Comerío	.08	.00	.08	236	1,912	549,516	4,407	915	556,986
Corozal	.08	.00	.08	556	1,303	310,851	6,855	254	319,819
Culebra	.01	.00	.01	--	812	--	--	336	1,148
Dorado	.00	.00	.00	--	--	--	--	--	--
Fajardo	.01	.00	.01	--	737	--	493	--	1,230
Florida	.00	.03	.03	669	956	357	300	73	2,355
Guánica	.00	.00	.00	--	281	--	339	126	746
Guayama	.00	.03	.03	17	1,412	101,679	1,384	587	105,079
Guayanilla	.00	.01	.01	--	700	1,266	2,005	34	4,005
Guaynabo	.01	.00	.01	--	51	--	2,307	12	2,370
Gurabo	.00	.08	.08	1,731	1,733	19,093	746	47	23,350
Hatillo	.00	.92	.92	22,932	7,641	28,153	12,034	304	71,064
Hormigueros	.00	.00	.00	--	--	1,224	37	--	1,261
Humacao	.00	.05	.05	559	1,885	1,118	1,981	55	5,598
Isabela	.00	.11	.11	2,680	1,487	3,849	1,785	265	10,066
Jayuya	.01	.00	.01	48	620	5,740	1,432	--	7,840
Juana Díaz	.00	.05	.05	--	2,215	61,439	5,217	2,010	70,881

Table 12. Total freshwater withdrawals and number of animals served for each stock subcategory by municipio, for 1995

Municipio	Freshwater withdrawals (Mgal/d)			Stock population					
	Surface water	Ground water	Total	Dairy cows	Cattle	Poultry	Hogs and pigs	Sheep and goats	Total
Juncos	0.00	0.14	0.14	3,078	3,282	--	431	--	6,791
Lajas	.00	.09	.09	643	5,536	--	626	683	7,488
Lares	.01	.00	.01	38	218	56,052	1,381	70	57,759
Las Marías	.00	.00	.00	--	94	1,682	315	--	2,091
Las Piedras	.17	.00	.17	2,733	5,052	36,857	4,048	296	48,986
Loíza	.03	.00	.03	12	1,618	4,438	2,963	1,027	10,058
Luquillo	.01	.00	.01	--	618	--	1,335	61	2,014
Manatí	.01	.18	.19	4,137	2,682	--	3,895	--	10,714
Maricao	.00	.00	.00	--	--	379	390	169	938
Maunabo	.00	.00	.00	--	170	116	555	--	841
Mayaguez	.00	.01	.01	--	222	7,855	1,014	43	9,134
Moca	.03	.00	.03	421	1,080	1,396	975	19	3,891
Morovis	.15	.00	.15	3,299	2,370	--	3,299	471	9,439
Naguabo	.21	.00	.21	4,678	4,335	1,654	1,124	186	11,977
Naranjito	.07	.00	.07	259	1,156	549,760	3,000	420	554,595
Orocovis	.05	.00	.05	893	1,250	3,063	1,021	18	6,245
Patillas	.00	.04	.04	67	3,423	23,.694	1,078	183	28,445
Peñuelas	.00	.04	.04	36	1,852	--	4,202	318	6,408
Ponce	.00	.01	.01	--	302	--	1,104	48	1,454
Quebradillas	.00	.15	.15	3,361	2,527	--	3,432	415	9,735
Rincón	.00	.00	.00	--	264	555	--	40	859
Río Grande	.03	.00	.03	87	1,854	160,598	--	247	162,786
Sabana Grande	.00	.02	.02	52	1,484	41,431	392	84	43,443
Salinas	.00	.12	.12	43	2,807	1,395,100	559	474	1,398,983
San Germán	.00	.04	.04	422	1,870	28,947	774	341	32,354
San Juan	.01	.00	.01	--	24	98,524	507	12	99,067
San Lorenzo	.07	.00	.07	1,180	2,591	3,034	1,015	26	7,846
San Sebastián	.16	.00	.16	3,478	3,412	3,882	1,377	168	12,317
Santa Isabel	.00	.05	.05	12	100	789,000	122	330	789,564
Toa Alta	.06	.00	.06	1,236	1,095	26,668	1,048	283	30,330
Toa Baja	.00	.06	.06	1,505	528	--	1,237	--	3,270
Trujillo Alto	.01	.00	.01	95	262	--	537	21	915
Utuado	.07	.00	.07	1,034	2,331	55,908	1,468	587	61,328
Vega Alta	.00	.01	.01	--	846	611	501	129	2,087
Vega Baja	.00	.09	.09	1,451	1,915	--	4,458	125	7,949
Vieques	.00	.03	.03	--	2,346	2,716	480	667	6,209
Villalba	.03	.00	.03	72	1,509	90,440	464	143	92,628
Yabucoa	.00	.04	.04	758	1,365	1,227	--	--	3,350
Yauco	.00	.03	.03	130	2,069	26,469	809	911	30,388
Total	1.76	4.45	6.21	101,550	131,058	11,642,319	143,026	24,532	12,042,485

Table 13. Total freshwater withdrawals and number of animals served for each animal specialties subcategory by municipio, for 1995

[Location of municipios is shown in figure 1. Mgal/d, million gallons per day; --, no population reported]

Municipio	Freshwater withdrawals (Mgal/d)			Animal specialties population		
	Surface water	Ground water	Total	Horses	Rabbits	Total
Adjuntas	0.00	0.00	0.00	129	770	899
Aguada	.00	.00	.00	24	--	24
Aguadilla	.00	.00	.00	0	0	0
Aguas Buenas	.00	.00	.00	110	741	851
Aibonito	.00	.00	.00	110	--	110
Añasco	.00	.00	.00	61	344	405
Arecibo	.00	.00	.00	177	1,375	1,552
Arroyo	.00	.00	.00	46	190	236
Barceloneta	.00	.00	.00	15	--	15
Barranquitas	.01	.00	.01	45	4,783	4,828
Bayamón	.00	.00	.00	50	530	580
Cabo Rojo	.00	.00	.00	175	2,166	2,341
Caguas	.00	.01	.01	765	2,310	3,075
Camuy	.00	.01	.01	17	6,078	6,095
Canóvanas	.00	.00	.00	146	--	146
Carolina	.00	.00	.00	130	795	925
Cataño	.00	.00	.00	0	0	0
Cayey	.00	.00	.00	164	--	164
Ceiba	.00	.00	.00	53	134	187
Ciales	.00	.00	.00	73	308	381
Cidra	.00	.00	.00	90	360	450
Coamo	.00	.01	.01	520	1,822	2,342
Comerío	.00	.00	.00	77	2,850	2,927
Corozal	.00	.01	.01	228	7,150	7,378
Culebra	.00	.00	.00	72	0	72
Dorado	.00	.00	.00	0	0	0
Fajardo	.00	.00	.00	78	0	78
Florida	.00	.00	.00	10	--	10
Guánica	.00	.00	.00	17	0	17
Guayama	.00	.00	.00	213	--	213
Guayanilla	.00	.00	.00	58	1,008	1,066
Guaynabo	.00	.00	.00	--	1,980	1,980
Gurabo	.00	.00	.00	42	158	200
Hatillo	.00	.00	.00	8	0	8
Hormigueros	.00	.00	.00	0	593	593
Humacao	.00	.00	.00	75	--	75
Isabela	.00	.00	.00	134	553	687
Jayuya	.00	.00	.00	86	513	599
Juana Díaz	.00	.00	.00	47	--	47

Table 13. Total freshwater withdrawals and number of animals served for each animal specialties subcategory by municipio, for 1995—Continued

Municipio	Freshwater withdrawals (Mgal/d)			Animal specialties population		
	Surface water	Ground water	Total	Horses	Rabbits	Total
Juncos	0.00	0.00	0.00	123	754	877
Lajas	.00	.00	.00	232	1,515	1,747
Lares	.00	.00	.00	42	217	259
Las Marías	.00	.00	.00	12	--	12
Las Piedras	.00	.00	.00	95	1,134	1,229
Loíza	.00	.00	.00	220	191	411
Luquillo	.00	.00	.00	54	181	235
Manatí	.00	.00	.00	32	--	32
Maricao	.00	.00	.00	0	140	140
Maunabo	.00	.00	.00	6	--	6
Mayaguez	.00	.00	.00	51	1,806	1,857
Moca	.00	.00	.00	15	2,430	2,445
Morovis	.00	.00	.00	230	0	230
Naguabo	.00	.00	.00	72	540	612
Naranjito	.00	.00	.00	17	827	844
Orocovis	.00	.00	.00	26	74	100
Patillas	.00	.00	.00	92	39	131
Peñuelas	.00	.00	.00	99	281	380
Ponce	.00	.00	.00	51	0	51
Quebradillas	.00	.00	.00	230	0	230
Rincón	.00	.00	.00	18	478	496
Río Grande	.00	.00	.00	40	0	40
Sabana Grande	.00	.00	.00	21	--	21
Salinas	.00	.00	.00	106	--	106
San Germán	.00	.00	.00	45	--	45
San Juan	.00	.00	.00	6	0	6
San Lorenzo	.00	.00	.00	206	0	206
San Sebastián	.00	.00	.00	52	530	582
Santa Isabel	.00	.00	.00	270	0	270
Toa Alta	.00	.00	.00	205	--	205
Toa Baja	.00	.00	.00	35	0	35
Trujillo Alto	.00	.00	.00	24	704	728
Utuado	.00	.00	.00	172	2,593	2,765
Vega Alta	.00	.00	.00	--	--	--
Vega Baja	.00	.00	.00	116	510	626
Vieques	.00	.00	.00	269	825	1,094
Villalba	.00	.00	.00	30	210	240
Yabucoa	.00	.00	.00	46	--	46
Yauco	.00	.00	.00	64	182	246
Total	.01	.04	.05	7,469	53,672	61,141

Table 14. Freshwater withdrawals for irrigation use and irrigated land by micro-irrigation and flood by municipio, for 1995

[Location of municipios is shown in figure 1. Mgal/d, million gallons per day]

Municipio	Freshwater withdrawals (Mgal/d)			Irrigated land by type (thousand acres)		
	Surface water	Ground water	Total	Micro-irrigation	Flood	Total
Guánica	0.00	1.76	1.76	0.40	0.61	1.01
Guayama	5.58	3.60	9.18	2.07	.00	2.07
Guayanilla	.00	3.66	3.66	2.10	.00	2.10
Juana Díaz	.00	3.31	3.31	1.52	.38	1.90
Patillas	15.32	.00	15.32	.00	1.06	1.06
Ponce	.00	6.46	6.46	3.71	.00	3.71
Quebradillas	23.51	.00	23.51	.02	.08	.10
Salinas	.00	1.43	1.43	.68	.14	.82
Santa Isabel	.00	7.96	7.96	3.88	.68	4.56
Villalba	16.25	.00	16.25	.00	3.99	3.99
Yauco	13.98	.00	13.98	3.07	6.23	9.30
Total	74.64	28.18	102.82	17.45	13.17	30.62

Table 15. Water evaporation from reservoirs in Puerto Rico and their surface area, by municipio, 1995

[Location of municipios is shown in figure 1]

Municipio	Reservoir	Reservoir area (thousand acres)	Evaporation (thousand acre-feet)
Adjuntas	Lago Garzas	0.10	0.31
	Lago Guayo	.28	.83
Arecibo	Lago Dos Bocas	.63	1.78
Cidra	Lago Cidra	.27	1.28
Comerío	Lago Comerío II	.06	.17
Guayama	Lago Carite	.33	.96
Patillas	Lago Patillas	.31	1.18
Ponce	Lago Cerillos	.61	2.84
Quebradillas	Lago Guajataca	1.00	2.47
Toa Alta	Lago La Plata	.56	1.57
Trujillo Alto	Lago Loíza	.60	2.26
Utuado	Lago Caonillas	.70	1.97
Villalba	Lago Toa Vaca	.84	3.86
	Lago Guayabal	.33	1.51
Yauco	Lago Luchetti	.27	.92
Total		6.89	23.91