

**OCCURRENCE, QUALITY, AND USE OF GROUND WATER IN ORCAS, SAN JUAN, LOPEZ, AND SHAW ISLANDS, SAN JUAN COUNTY, WASHINGTON**

Estimated Ground-Water Use in 1980

By K. J. Whiteman, Dee Molenaar, G. C. Bortleson, and J. M. Jacoby  
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**INTRODUCTION**

This sheet, along with sheet 10, describes ground-water use on Orcas, San Juan, Lopez, and Shaw Islands. Sheet 10 shows the locations of major (all uses except single-family domestic) ground-water withdrawals, by water-use sheet 11 gives the estimated amount of pumpage during 1980. These sheets also evaluate relations between water use and water-quality problem areas (sheet 7) and discuss population growth and development trends as they relate to increasing demands on the ground-water resource.

**METHODS OF DATA COLLECTION AND ANALYSIS**

The adjacent map on this sheet shows estimated amounts of ground-water pumpage during 1980. The rock type from which the water is withdrawn (defined on sheet 7) is also shown. Water-use information was collected during field visits by U.S. Geological Survey personnel, from San Juan County Health Department records, Washington State Department of Ecology (DOE) water-rights records, and from the Washington State Department of Social and Health Services (DSHS) water-facilities inventory. The Agricultural Stabilization and Conservation Service (ASCS) in Friday Harbor provided information on stock and irrigation-water use. In addition, approximately 120 questionnaires were mailed out during late summer 1981; 50 were returned, 30 of which included quantitative estimates of water use.

A brief account of each water-use category and the methods used for estimating total ground-water pumpage is given below.

**Public Supply** For purposes of this study, a public supply well is defined as a single well, supplying two or more individual uses up to and including large municipal-supply wells. When no other information was available for a well, yearly pumpage rates were estimated on the basis of a consumption rate of 60 gallons per day (gal/d) per person, or 200 gal/d per household of 2.5 persons. The average household size of 2.5 persons (Fretwell, 1975) reflects the high proportion of retirees residing in the county. Although these rates are lower than those generally applied to other areas in the State, they are supported by data collected from metered San Juan County public-supply systems, including the village of Eastsound. A breakdown was made between permanent and seasonal residences; seasonal use was applied over a 90-day period.

**Stocks** The ASCS committee identified owners of stock on the islands and also supplied information on herd size and water source. The following estimates of average daily water consumption by various kinds of livestock are a combined result of ASCS data and the U.S. Soil Conservation Service Field Manual (1982):

- Beef cattle and horses—12-15 gal/d
- Dairy cows—15 gal/d
- Hogs—4 gal/d
- Sheep—2 gal/d
- Lambs—1 gal/d for 182 days

**Commercial** Uses of ground water for commercial purposes includes small businesses, restaurants, motels, resorts, and private camps. Estimates were made on a site-by-site basis according to the number of people using the facility, period of use, and type of services provided.

**Irrigation** There is little use of ground water for irrigation in the islands except on Lopez Island. To obtain an estimate for the quantity of water used by irrigation, an application rate of 1 acre-foot per acre over a 4-month irrigation season was used on the basis of water-use studies made in Island County in 1979 (Cline and others, 1982).

**Recreation** The recreational use of ground water in campgrounds is low due to the type of services provided at most of the campgrounds. Pumpage estimates are based on the type of plumbing, the number of people using the facility in 1980, and (or) the number of sites and days in use. A consumption rate of 15 gal/d per person was used for campers. If the facility had plumbing restrooms with flush toilets, a consumption rate of 42 gal/d per person was used (San Juan County, 1979). The recreational period was assumed to be 120 days.

**Industrial** For this report ground-water use for industrial purposes was confined to three small sand-and-gravel operations, one on San Juan Island and two on Lopez Island. Pumpage rates were estimated from data provided by the owners.

**Domestic** Ground-water use for single domestic systems (one residence per well) was estimated using figures for the permanent population of San Juan County obtained from the 1980 census. Consumption rates of 30 gal/d per person and 200 gal/d per household were used. Population figures were corrected for those people already represented in public supplies and for those on surface-water systems. Residents on Lopez and Shaw Islands rely almost totally on ground-water resources, whereas approximately 65 percent of the population on San Juan and Orcas Islands use ground water to supply their domestic needs (Kramer, Chin, and Mayo, 1970).

The estimates of water used by seasonal residents was based on the proportion of seasonal to permanent housing units for public-supply systems. This assumes that the proportion of seasonal to permanent domestic users is the same as that of public-supply users. A weighted average of 21 percent was applied on the basis of the ratio between the number of public supply homes on each island and the total for the four islands. Seasonal use was applied over a 90-day period.

Use of ground water by tourists was not estimated separately, but was considered in the pumpage estimates for commercial and recreational uses.

**SIGNIFICANT FINDINGS**

Figure 1 shows totals by island and by aquifer type for the pumpage shown on the adjacent map. (This figure does not include domestic ground-water use.) Most of the large ground-water supplies on Orcas and Lopez Islands are withdrawn from glacial drift, whereas on San Juan and Shaw Islands most pumpage is from bedrock. Shaw Island uses only a small fraction of the quantity of ground water used on the other three islands.

Ground-water use for public supplies accounts for the greatest portion of pumpage on each island as shown in figure 2. Orcas Island has the greatest amount of water use for both public supply and commercial purposes. The only island showing a significant amount of ground-water pumpage for agricultural purposes is Lopez. This is due in part to the use of surface-water sources for stock and irrigation on the other islands; in addition, wells in glacial drift have higher specific capacities (sheet 3) and generally are more capable of producing the quantities of water necessary for irrigation and ranching purposes.

Table 1 shows estimated total ground-water pumpage in San Juan County in 1980, obtained by totaling all the pumpage shown on the adjacent map and adding the amount calculated for domestic use. Public supply and domestic uses account for about 90 percent of the total 220 million gallons; irrigation, stock, and commercial purposes account about 9 percent, and industrial and recreational uses total less than 1 percent.

San Juan Island consumes the largest quantity of ground water overall, followed by Orcas, Lopez, and Shaw Islands. Most of the residences on Orcas Island rely on public-supply systems rather than individual wells, as indicated by the higher pumpage totals for public supply than for domestic use. This is not true for the other three islands, where domestic use exceeds all other uses.

**EFFECTS OF PUMPAGE ON THE FRESHWATER-SEAWATER INTERFACE**

Ground-water pumpage, even in small amounts, can affect the location and movement of the freshwater-seawater interface (sheet 7). Pumpage will cause a decline in the water-level altitude, which in turn allows the interface to move upward and inward toward the point of withdrawal. The actual amount of pumpage that an area can tolerate before seawater intrusion occurs depends on the geohydrologic characteristics of the aquifer and the distribution of the pumpage.

On Lopez Island there is a general relationship between ground-water withdrawal and areas having high chloride concentrations (sheet 7). The region immediately south of Shoal Bay has several wells with high chloride concentrations, high pumping rates, and a high density of public-supply water systems within a small area. Ground water in the southern third of Lopez Island also contains high concentrations of chloride; the affected area coincides with a large number of major water systems. This part of Lopez Island yields water from both bedrock and glacial-drift materials. Most of the high chloride concentrations occur in bedrock wells, suggesting that the fractures in the bedrock are in hydraulic connection with the freshwater-seawater interface.

Because the location of the freshwater-seawater interface is a function of several related factors such as aquifer permeability, discharge rate, and type of connection between the fresh and salt water, heavy pumping rates are not always preconditions for the occurrence of seawater intrusion. In some coastal areas, intrusion has occurred where large ground-water withdrawals are not evident. For example, water in well 35/3-36E1 on San Juan Island (sheet 7) has high concentrations of chloride, yet the only ground-water pumping is from a single domestic well yielding small amounts of water from bedrock. This suggests that well 35/3-36E1 is drawing water from a somewhat restricted fracture system directly connected with seawater.

**GROWTH AND WATER-USE TRENDS**

San Juan County's permanent population doubled from 1970 to 1980 (fig. 3) as the islands, well-known for their natural beauty and isolation, became increasingly popular for retirement and rural second homes. The growing number of permits granted by DOE for public-supply systems from 1940 to 1980 demonstrates the increased demand for ground water in recent years (fig. 4).

Another important water-use consideration is the seasonal variation in pumping rates. Pumping rates generally peak in late summer when recharge from precipitation is low and tourism and seasonal population demands are high. Figure 5 compares 1980 monthly precipitation at the Olga weather station with the Eastsound Water Users Association's monthly pumping rates; precipitation was low in July and August, when Eastsound's water use peaked for the year. In terms of the freshwater-seawater interface (sheet 7), water-level declines, which naturally occur when precipitation and recharge are low, are amplified by declines caused by heavy pumping. Thus, the interface in late summer and early fall is at its most shallow, most landward position.

**FUTURE STUDIES**

Continued efforts are necessary to identify and quantify major ground-water withdrawals, update pumpage data, and monitor the impacts of increased water use. Particular attention could be given to areas with high concentrations of water systems and (or) high pumping rates. Further development in coastal areas that have experienced seawater intrusion needs to be carefully evaluated.

**TABLE 1.—Total estimated ground-water pumpage for San Juan County, 1980**  
(In millions of gallons)

	San Juan Island	Lopez Island	Shaw Island	Orcas Island	Totals
Domestic	59.2	23.9	3.9	23.5	110.5
Public Supply	26.5	21.3	1.3	38.9	88.0
Industry	0.4	0.3	—	—	0.7
Irrigation	0.6	7.4	—	—	8.0
Stock	1.7	2.4	0.1	1.1	5.3
Commercial	1.2	1.2	1	4.5	7.0
Recreation	.3	.1	.02	—	.4
Totals	89.9	56.6	5.4	68.0	219.9

Figure 1. Pumpage of major ground-water supplies in 1980 by island and rock type.

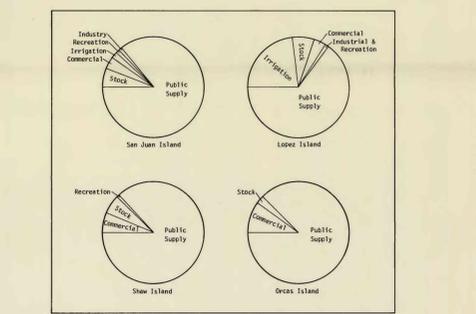


Figure 2. Pumpage of major ground-water systems by island and use.

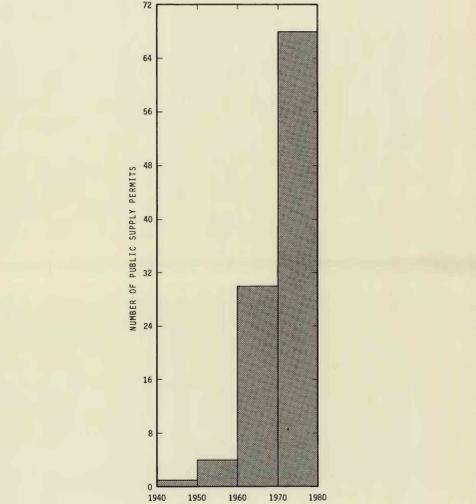


Figure 3. Number of public supply permits for ground-water systems granted in San Juan County, 1940-1980.

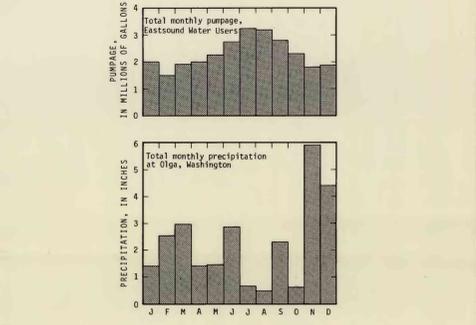


Figure 4. Seasonal variations in pumpage in relation to precipitation, 1980.

**SUMMARY**

The total estimated 1980 ground-water pumpage for Orcas, San Juan, Lopez, and Shaw Islands is 220 million gallons. It is evident that present withdrawal rates are already resulting in a deterioration of ground-water quality in some areas. Increasing population, the pattern of development around coastal areas, the seasonality of water use, limitations to recharge due to the island geology (the rainshadow effect), in addition to the absence of high mountains for snowmelt runoff to recharge the island's ground-water reservoirs, and the complex geohydrologic setting all serve to complicate planning and management of the county's ground-water resources.

Currently, there is heavy reliance on ground water to supply water for numerous beneficial uses. Residents on Shaw and Lopez Islands rely almost entirely on ground water for domestic needs, and on San Juan and Orcas Islands at least 65 percent of the residents use ground water (Kramer, Chin, and Mayo, 1970). Surface-water resources have been developed to serve Friday Harbor and Roche Harbor on San Juan Island and Rosario, Olga, and Doe Bay on Orcas Island.