

Ground-Water Conditions of Island County

ABSTRACT

Increased ground-water withdrawals associated with the population increase in Island County have caused concern about ground-water availability and potential seawater intrusion. The most widely used aquifers (units C and D) lie near sea level and locally, one or more water-bearing zones lie above these units. Pumpage in 1979 was about 1.67 billion gallons, about 90 percent of which was pumped from aquifer units C and D. Most large producing wells in the county have pumping water levels near or below sea level, so that if pumping continues for a long enough time, seawater intrusion may result, particularly in wells located near the coast. Chloride concentrations of water samples from some wells indicate that seawater intrusion is occurring in parts of northeastern and southern Camano Island and in central Whidbey Island.

PROBLEM

Island County, Washington, is an area of rapidly increasing population, having grown from 6,700 in 1940 to 20,000 in 1960 and 46,000 in 1982 (State of Washington, 1940-1982); growth was particularly rapid in the 1975-82 period (see fig. 1). This population growth is attributed to the attractiveness of the area for both residential and recreational purposes.

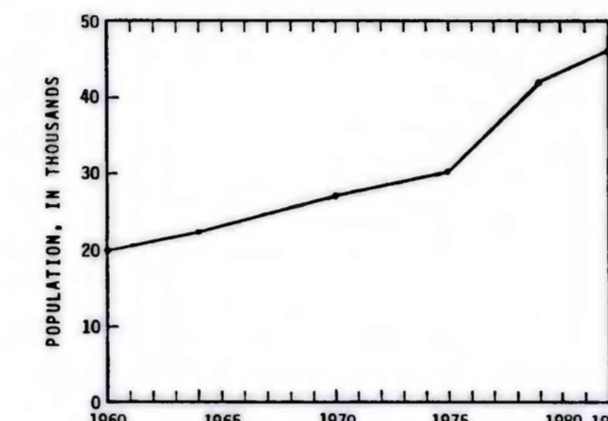


FIGURE 1.--Population increase in Island County, 1960-1982.

The growth of population has not been without problems. Because the county is almost devoid of significant streams, the population depends on ground-water supplies for most of its water needs. Water is imported from the Skagit River on the mainland, however, to supply the Navy's Ault Field and to supplement Oak Harbor's ground-water supply. Increased ground-water withdrawals and reports of chloride problems associated with the increased use of ground water have caused concern about ground-water availability and the possibility of seawater intrusion.

To serve the needs of present and future populations adequately, information on the quantity and chemical quality of available ground water in Island County must be obtained. In order to provide planners and administrators with this information, the U.S. Geological Survey in 1980 began a hydrologic investigation of the county in cooperation with Island County and the State of Washington Department of Ecology.

The study, scheduled for completion in December 1984, has as its objectives 1) determination of the availability of ground water in the county; 2) prediction of the hydrologic effects of increased withdrawals of ground water on water levels and water quality; and 3) preparation of a report documenting the study. To accomplish these objectives, data on selected geohydrologic parameters collected during the study period 1980 to 1983 were compared with previous data. Parameters included static and pumping water levels, water quality (predominately chloride concentrations and specific conductance), pumpage distribution and rates, and location and extent of the aquifers. The data collected for the final report are useful in their own right, however, and are presented here in a map atlas form at a scale that should be useful to those involved in water management. Six maps have been prepared that present the following topics.

Sheet number	Title
1 (this sheet)	Ground-Water Conditions of Island County.
2	Generalized Geohydrologic Setting: Areal Extent of Unit E.
3	Generalized Geohydrologic Setting: (a) Areal Extent of Units A, B, C; (b) Areal Extent of Unit D.
4	Ground-Water Occurrence and Use.
5	Seawater Intrusion--Process and Potential.
6	Comparisons of Chloride Concentrations from 1979 to 1983.

ACKNOWLEDGMENTS

The cooperation of many well drillers, well owners, and tenants who supplied information and allowed access to the wells is gratefully acknowledged. Well records and miscellaneous well data also were made available through the State of Washington Department of Ecology. Special thanks are extended to the Washington Department of Social and Health Services for providing laboratory analyses of ground-water samples collected in April and August of 1980, and Oelke Drilling Co., for drilling eight test holes.

PREVIOUS STUDIES

The ground-water resources of Island County were first described by Anderson (1968) and Van Denburgh (1968). Additional reports by Walters (1971) and Dion and Sumioka (1984) discussed the occurrence of seawater intrusion in the coastal areas of Washington, including Island County. A report by Cline and others (1982) discussed the general availability and quality of ground water in Island County and the extent of seawater intrusion.

DESCRIPTION OF STUDY AREA

Island County is located in the northwestern part of Washington State, between the mainland of Washington and the San Juan Islands (sheet 1). Although the county comprises several islands, the two major islands are Whidbey and Camano.

The land area of Whidbey and Camano Islands combined is approximately 210 square miles. Whidbey, the larger of the two islands, is about 40 miles long and 1 to 10 miles wide. Camano Island is about 15 miles long and 1 to 7 miles wide. Because of indentations in the shoreline, no point on either island is more than 2 1/2 miles from shore.

The topographic setting and mild climate of Island County have made it one of the more scenic and desirable areas for residence and recreation of the Pacific Northwest. Island County has a temperate marine climate characterized by mild, dry summers and cool, wet winters. The mean annual temperature is about 50°F. The coolest month of the year is January, with an average temperature of 38°F, and the warmest are July and August, with average temperatures of 61°F.

Although precipitation on Island County ranges from 18 inches per year at Coupeville (near the central region of Whidbey Island) to 42 inches at Lake Goss (in the southern region of Whidbey Island), the seasonal precipitation patterns at five weather stations are similar. The variation in rainfall amounts between stations is influenced by two factors: the rain shadow cast by the Olympic Mountains on the west, and the land-surface altitude. A comparison of average annual precipitation with altitude suggests that, in general, precipitation increases with increasing altitude.

The topography of the area reflects the processes of glacial erosion and deposition. The continental glacier advanced and retreated over the island in a north-south direction. Bedrock exposed at higher altitudes was carved, scraped, and rounded; low-lying areas were covered with unconsolidated glacial deposits consisting of clay, silt, sand, gravel, and boulders.

The land surface of Whidbey and Camano Islands consists primarily of rolling uplands generally extending 100 to 300 feet above sea level. The greatest relief occurs on the northeastern and southeastern areas of Whidbey Island, where altitudes are as high as 600 feet above sea level.

Surface-water runoff from Island County is low compared with most other areas of western Washington. Most of the island streams flow only intermittently, in direct response to precipitation. Lakes, ponds, and reservoirs occur throughout the county and are locally important sources of water for domestic, commercial, industrial, and irrigation needs, as well as centers of water-related recreation.

METHODS OF INVESTIGATION

Information on 1,800 wells is available for Island County. During the course of this study, this information was examined in an effort to define the geologic setting of the county and to select wells from which water levels and (or) water samples or both might be obtained. Only 339 wells were used to help define the geologic setting of the county. Well selection was based on geographic location, the availability of a well log, and well depth. Only 26 of the 1,800 wells are completed to a depth greater than 200 feet below sea level. Therefore, eight test wells were drilled by the Washington State Department of Ecology at selected locations (sheet 1) during the course of this investigation to improve knowledge of the geohydrologic conditions below this depth. Well cuttings and water-quality data obtained from the test wells were also used to help evaluate interpretations of geology based on drillers' logs, and to obtain information on the zone of freshwater-seawater mixing. Total depth of drilling was limited to 1,000 feet or bedrock, whichever was reached first.

Water levels and (or) water samples or both were obtained from 446 wells (sheet 1) during the course of this investigation. Some of these wells were visited as many as 16 times between 1980 and 1983. Well selection was based on geographic location, depth, use, reported yield, existing water-quality data, and availability of permission from the owner or tenant to include the well in this study. All of the water samples were analyzed for chloride concentrations and specific conductance. Thirty-four of the samples were analyzed for specific conductance, pH, alkalinity, hardness, nitrogen concentration, and concentrations of dissolved calcium, magnesium, iron, chloride, fluoride, manganese, potassium, and sodium to determine the general water quality of Island County.

Numerous well owners and managers were contacted in order to assess the rates and volumes of ground-water pumpage for public-supply, industrial, and irrigation uses. Records provided by well drillers were the main source of information for well-yield data and descriptions of aquifers penetrated.

SIGNIFICANT FINDINGS

Ground water, which supplies most of the water needs in Island County, occurs in the unconsolidated glacial and interglacial deposits that overlie older bedrock. As part of this study, five aquifers, identified as units A-E, were described (see text, sheet 2) within the unconsolidated deposits. Specific-capacity values (see text, sheet 2) varied within and among aquifer units. The highest specific capacity, 135 gal/min (gallons per minute) per foot of drawdown, was recorded in aquifer E. For the most part, however, specific capacities were less than 20 gal/min per foot of drawdown for all aquifers.

Most of the wells in Island County are screened (5 to 10 feet) to sea level or slightly below; the deepest wells generally occur along the coast. With the exception of the shallowest sand-and-gravel aquifer (unit E), water levels were generally within 25 feet of sea level. Because of these conditions, many Island County wells have a high potential for seawater intrusion.

Of the 193 wells sampled for chloride concentration in August 1981, concentrations in 17 percent of the wells exceeded 100 mg/L (milligrams per liter) and therefore appeared to be affected by seawater intrusion (see table 1, sheet 6). All the affected wells were located within 1.5 miles of the coast. Chloride concentrations in water from 6 percent of the affected wells exceeded the Environmental Protection Agency's secondary drinking-water recommendation of 250 mg/L (milligrams per liter).

Pumpage estimates collected from 1979 to 1982 for this study show an increase in ground-water withdrawal of 13 percent and an increase in population of 14 percent (table 1, sheet 4). The largest increase was in domestic-supply pumpage, which more than doubled. In 1982 an estimated 1.73 billion gallons of ground water was withdrawn in Island County, slightly more than 4.9 million gallons per day. Areas of heavy pumping at the northern and southern tips of Camano Island corresponded with areas of seawater intrusion identified in this study. This should not suggest, however, that heavy ground-water pumping is the only prerequisite to the occurrence of seawater intrusion. In many coastal areas where seawater intrusion was apparent, large ground-water withdrawals were not evident.

REFERENCES

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OCCURRENCE OF GROUND WATER AND POTENTIAL FOR SEAWATER INTRUSION, ISLAND COUNTY, WASHINGTON

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1985

ITEM 1
S-BLACK

BASE SHEET T-1
FOR PLATES 1, 2, 3