UNITED STATES
DEPARMENT OF THE INTERIOR
GEOLOGICAL SURVEY

A RECONNAISSANCE OF THE WATER RESOURCES OF THE SHOALWATER BAY INDIAN RESERVATION AND ADJACENT AREAS, PACIFIC COUNTY, WASHINGTON, 1978-1979

By W. E. Lum II

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SHOALWATER BAY INDIAN TRIBE

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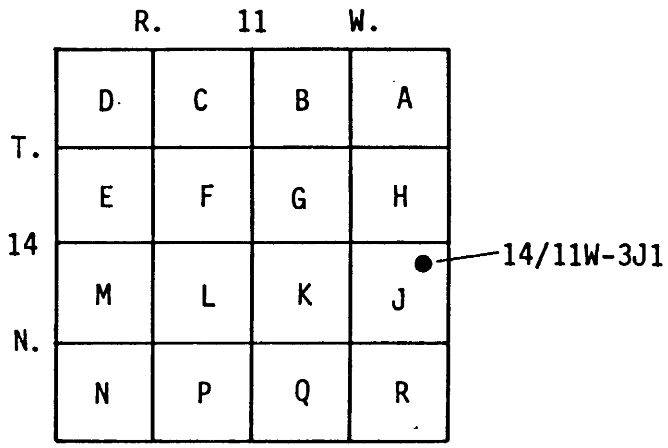
WELL-NUMBERING SYSTEM

In this report wells are designated by symbols that indicate their location according to the official rectangular public-land survey. For example, in the symbol 14/11W-3J1, the part preceding the hyphen indicates, successively, the township and range (T. 14 N., R. 11 W.) north and west of the Willamette base line and meridian. The first number following the hyphen indicates the section (sec. 3), and the letter (J) indicates the 40-acre subdivision of the section, as shown in the accompanying diagram.



Section 3

The last number is the number of the well assigned in sequence as the data are gathered in the particular 40-acre tract. Thus, well 14/11W-3J1 is in the NE¼SE¼ sec. 3, T. 14 N., R. 11 W., and is the first well in the tract to be listed. To simplify the mention of wells in the text, they are referred to only by their section, 40-acre subdivision, and serial number. For example, well 14/11W-3J1 is referred to in the text as well 3J1. In figure 4 (map of the study area) the section number is dropped and the same well is marked J1.

METRIC (SI) CONVERSION FACTORS

Multiply	By	To obtain
inches (in.)	25.4	millimeters (mm)
	2.540	centimeters (cm)
	0.0254	meters (m)
feet (ft)	0.3048	meters (m)
miles (mi)	1.609	kilometers (km)
square miles (mi^2)	2.590	square kilometers (km_2)
acres	4047.	square meters (m^2)
acre-feet (acre-ft)	1233.	cubic meters (m^3)
	0.001233	cubic hectometers (hm^3)
gallons per minute (gal/min)	0.06309	liters per second (L/s)
cubic feet per second (ft^3/s)	0.02832	cubic meters per second (m^3/s)
	28.32	liters per second (L/s)
micromho per centimeter at 25° Celsius (umho/cm at 25°C)	1.000	microsiemen per centimeter at 25° Celsius (uS/cm at 25°C)
degrees Celsius (°C)	1.8, then add 32	degrees Fahrenheit (°F)

National Geodetic Vertical Datum of 1929 (NGVD of 1929): A geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called "mean sea level." NGVD of 1929 is referred to as sea level in this report.

A RECONNAISSANCE OF THE WATER RESOURCES OF THE SHOALWATER BAY INDIAN RESERVATION AND ADJACENT AREAS, PACIFIC COUNTY, WASHINGTON, 1978-79

By W. E. Lum II

ABSTRACT

This study was undertaken in cooperation with the Shoalwater Bay Indian Tribe to summarize the water resources of the reservation and certain adjacent areas.

Ground water on the reservation comes primarily from an artesian aquifer that is about 180 to more than 400 feet below sea level. The water is suitable for most uses, and it is estimated that individual wells may produce as much as 100 to 500 gallons per minute. Long-term rates of pumpage cannot be calculated with the data presently available. Ground-water use for domestic and industrial purposes in 1979 in the study area is estimated to range from 40 gallons per minute in November to about 130 gallons per minute in August. Data indicate that for the period 1968-80 there has been no measurable decline in water levels or rates of flow of artesian wells due to pumping from the aquifer. Chloride-concentration data for ground-water samples indicate that there has been no seawater intrusion into the aquifer.

Mean monthly streamflows ranged from 0.53 cubic foot per second (ft^3/s) in August 1979 to 2.06 ft^3/s in February 1979 for Cannery Slough Tributary, and from 3.28 ft^3/s in August 1979 to 49.4 ft^3/s in February 1979 for Pacific County Drainage Ditch #1 (Ditch #1). Estimated average 7-day-low flows with a recurrence interval of 2 years are 0.3 and 3.0 ft^3/s for Cannery Slough Tributary and Ditch #1, respectively.

Analyses of surface-water samples for organic chemicals indicate that concentrations of Aldrin, DDD, DDT, Dieldrin, Diazinon, and Ethyl Parathion (generally ranging from 2 to 10 micrograms per liter) exceed levels of concentration which are set forth by the U.S. Environmental Protection Agency for protection of marine life. These high concentrations were observed in one or more samples from Cannery Slough Tributary and Ditch #1. Samples of the stream-bottom material from Ditch #1 indicate concentrations of Aldrin, DDD, DDE, DDT, Dichlobenil, and Dieldrin ranging from 0.4 to 42 micrograms per kilogram. Data were not sufficient to determine long-term trends in concentration. Further studies should be done before the surface water is used for any purpose. Tidelands that are part of the Shoalwater Bay Indian Reservation and into which Cannery Slough Tributary and Ditch #1 flow may be contaminated by these toxic chemicals.

INTRODUCTION

Purpose and Scope

The purpose of this study is to summarize the water resources of the Shoalwater Bay Indian Reservation and adjacent areas (fig. 1). The Shoalwater Bay Indian Tribe entered into this cooperative study with the U.S. Geological Survey in 1977 to (1) obtain background information on surface- and ground-water quality and quantity, (2) determine the effects of ground-water use on local aquifers, (3) determine if ground- and (or) surface-water supplies are sufficient to keep pace with an increasing water demand, and (4) gather data on the quality of surface water that flows onto tribally-owned tidelands.

Description of the Study Area

The Shoalwater Bay Indian Reservation is in southwest Washington near the Pacific Ocean on the north shore of Willapa Bay (fig. 1). The reservation, about 2 miles northwest of Tokeland, Wash., and about 58 miles southwest of Olympia, Wash., covers about 480 acres (including tidelands) and extends about 1 mile from east to west and 0.75 mile from north to south. One-third of the reservation is tidelands, one-third ranges from sea level to an altitude of 40 ft (this is the area inhabited by residents of the reservation); and one-third of the reservation is forested uplands ranging in altitude from 40 ft to more than 300 ft above sea level.

The local economy is based on ocean fishing, tourism, forestry products, and agriculture. Northwest of the reservation, more than 600 acres are cultivated for cranberry production.

Climate of the Study Area

The Shoalwater Bay Indian Reservation is in an area where the influence of the Pacific Ocean and the air over it dominate the weather patterns. The climate is wet and mild.

The average annual precipitation near the reservation is about 70 inches (U.S. Weather Bureau, 1965). A weather observation station at Willapa Harbor, 13 miles east of the reservation, provides long-term data on the monthly distribution of precipitation and average temperature that is also representative of the study area (fig. 2). Average monthly precipitation ranges from 1.35 inches in July to 13.78 inches in December. About 77 percent of the average annual precipitation occurs during the 6-month period October to March. Average monthly temperature ranges from 40.4°F in January to 61.9°F in August. All climatic data are from the U.S. National Oceanic and Atmospheric Administration (1980).

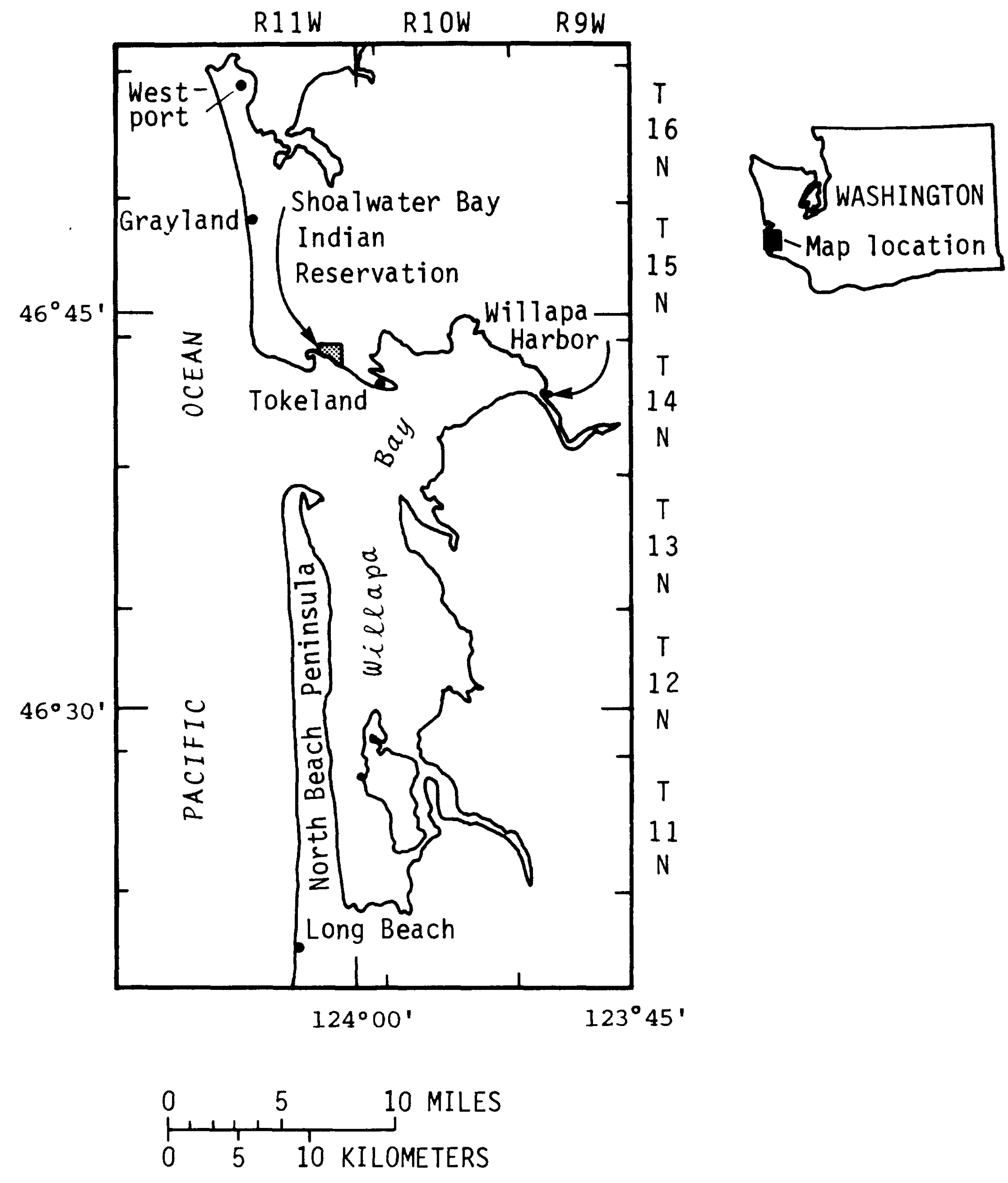


FIGURE 1.--Location of the Shoalwater Bay Indian Reservation, Washington.

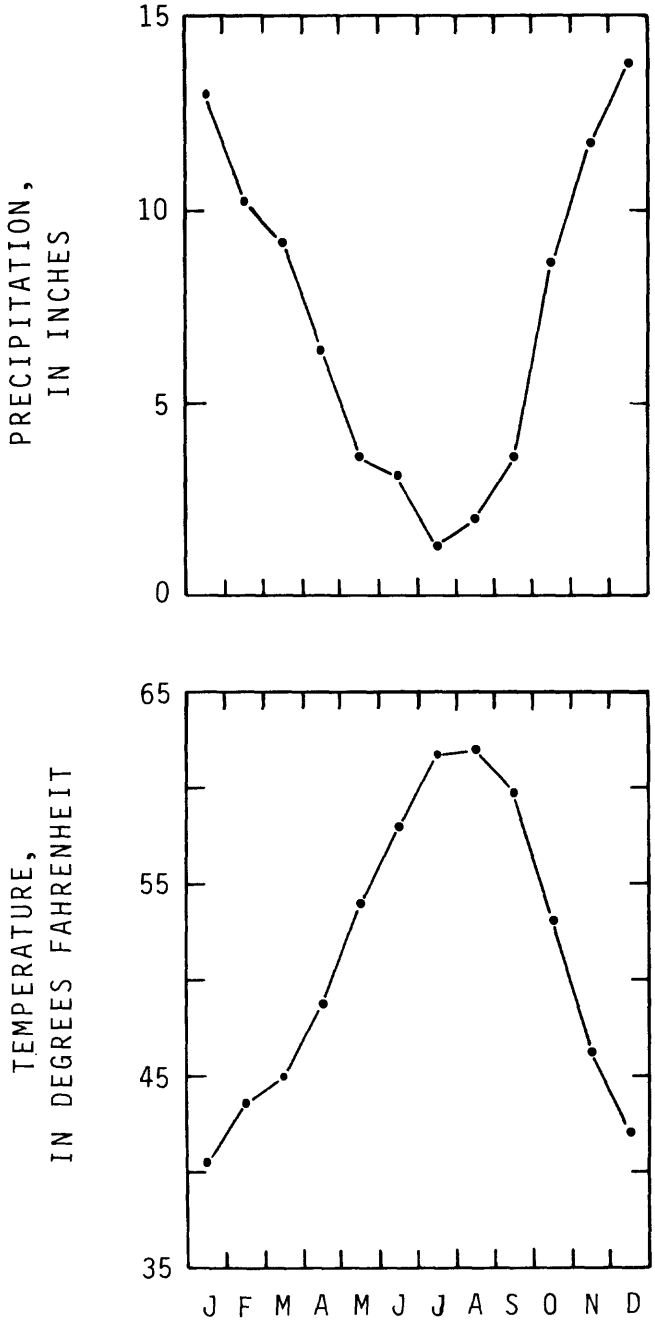


FIGURE 2.--Average monthly precipitation and temperature at Willapa Harbor, Washington, for the period 1900-79.

Previous Investigations

Southwest Grays Harbor County and northwest Pacific County, in the area near the Shoalwater Bay Reservation, have been the subject of numerous investigations during the past 35 years. Geology and ground-water availability in the Westport-Grayland area were described by Newcomb (1947), Wegner (1956) and Foxworthy and Walters (1971). Ground-water resources of the nearby North Beach Peninsula were reported on by Tracy (1978). Low-flow characteristics of streams and the severity of flood hazards in the nearby area were examined by Nassar (1973) and the Federal Insurance Administration (1976), respectively. The chemical quality of ground water was investigated during a study of seawater intrusion in coastal areas of Washington by Walters (1971) and Dion and Sumioka (1984). None of these studies dealt specifically with the water resources of the reservation; however, all provided valuable background information for this investigation.

Acknowledgments

This study was made in cooperation with the Shoalwater Bay Indian Tribe. The U.S. Bureau of Indian Affairs participated in the planning of the study. Individual members of the tribe and other residents of the study area helped in many ways during the field investigations.

The Hydrologic Cycle

The hydrologic cycle is the pattern of water movement as it circulates through the natural system. Precipitation, as rain and snow, runs off to streams, is evaporated directly back to the atmosphere, and soaks into the soil where some is drawn up by plants and returns to the atmosphere by transpiration from the leaves. The remainder percolates downward to a zone of saturation to become ground water. In the ground-water reservoir, saturated, permeable materials that can yield significant quantities of water to wells and (or) springs are called aquifers. In time, most of the ground water returns to the surface-water system by seepage to springs, lakes, streams, and the sea. Figure 3 diagrammatically illustrates the hydrologic cycle as it generally applies to the study area.

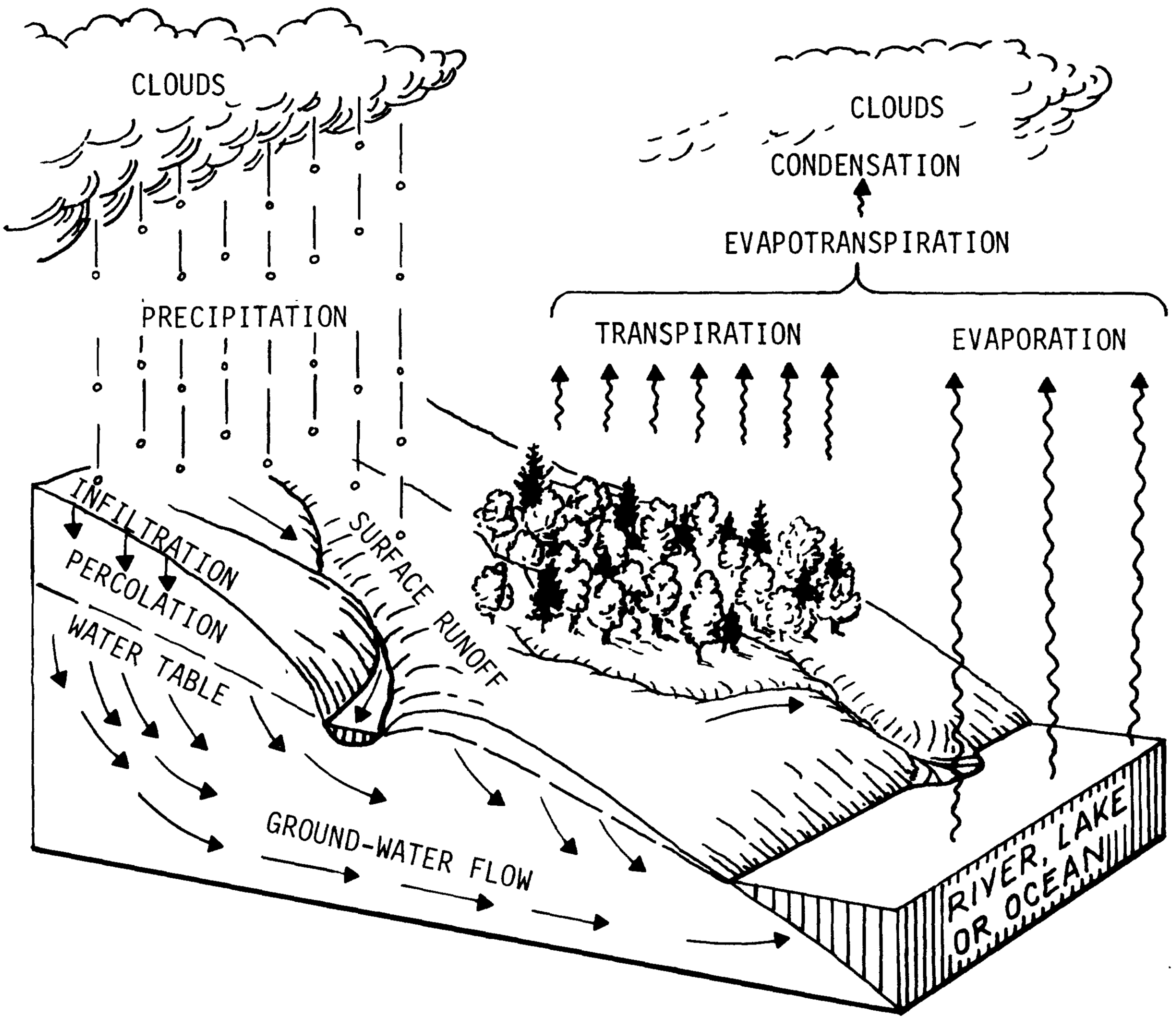


FIGURE 3.--Diagrammatic sketch of the hydrologic cycle.

GEOLOGY AND GROUND-WATER RESOURCES

Geology

The generalized surficial geology of the reservation and surrounding areas and a generalized geologic section are shown in figures 4 and 5, respectively. The bedrock consists of volcanic rocks, such as basalt, some of the bedrock has been eroded and weathered. Unconsolidated and partially consolidated terrace deposits (some of which have been derived from the erosion of the bedrock), beach sands, and deposits of alluvium, cover the bedrock.

The basalt bedrock extends beneath the area at varying depths. A Union Oil Company oil test well (well 15/11W-31G1, not shown in fig. 4) about 3 miles northwest of the reservation encountered basalt at about 1,040 ft below sea level (McFarland, 1979). Six miles east of the reservation, near the mouth of the North River, the basalt is exposed at altitudes ranging from 200 to 600 or more feet above sea level.

The terrace deposits consist of many layers of various mixtures of clay, silt, sand, and gravel. These deposits were laid down by streams that flowed from the east over the basalt. Some layers were deposited in shallow lakes near the margins of glaciers that once covered part of the area, some in deltas formed in the Pacific Ocean, and some in embayments similar to the present Willapa Harbor. These deposits have compacted, and some are partially consolidated.

In some places, the terrace deposits have been eroded and redeposited by streams and rivers. These reworked deposits, the alluvium, are 10 to 40 ft thick in the low-lying areas of the reservation. The alluvium also covers most of the area south and east of the reservation (fig. 4).

The beach sands that occur in the area are derived primarily from Columbia River sand that has been transported northward by ocean currents. A secondary source of beach sand is the erosion and reworking of the alluvium and terrace deposits.

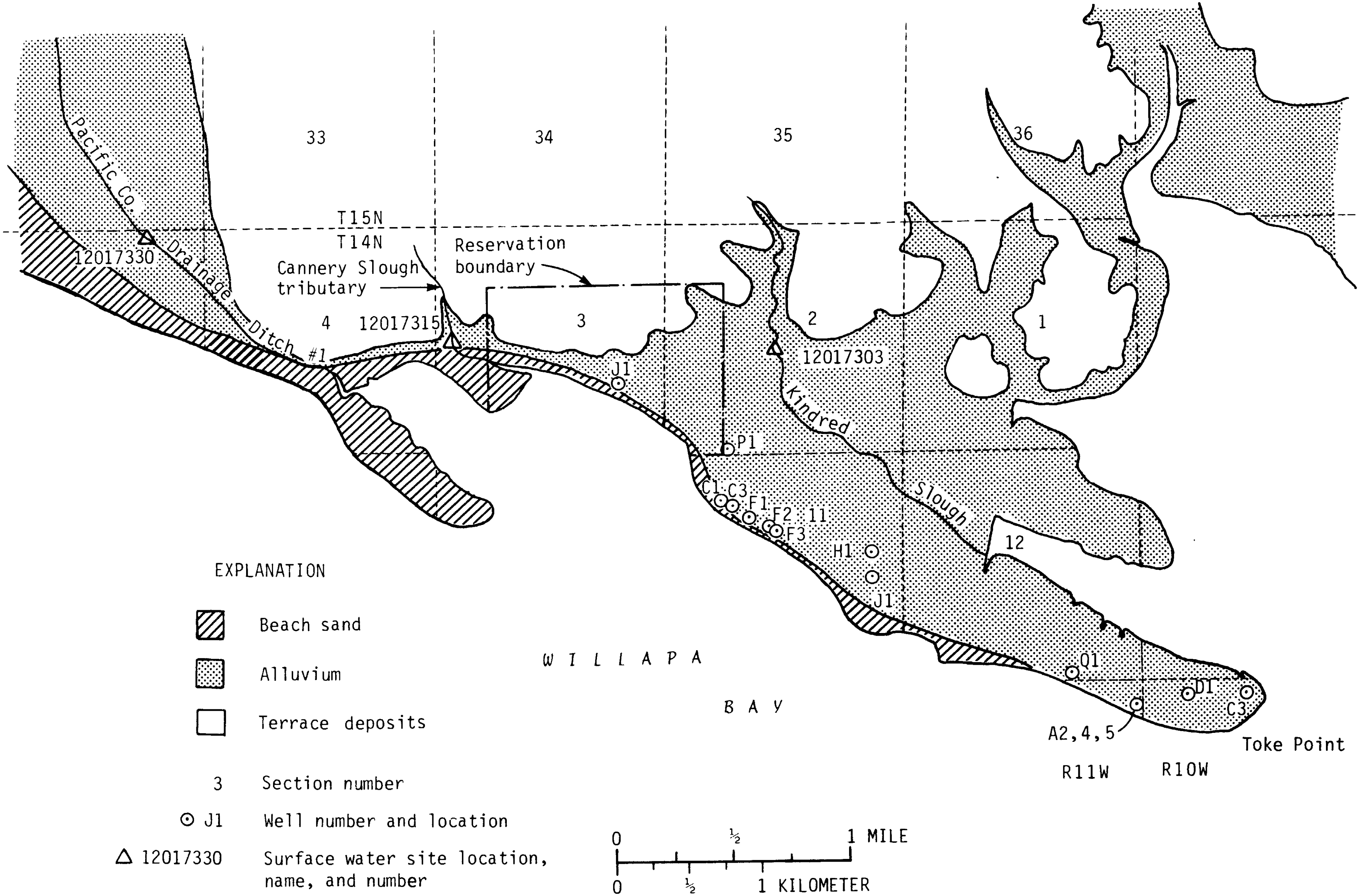


FIGURE 4.--Generalized surficial geology and location of data-collection sites.

Ground-Water Occurrence and Water Use

Ground water occurs in most of the unconsolidated deposits beneath the reservation that lie above the volcanic bedrock. Some ground water may also exist in the bedrock, but the quantity and quality of this source were not investigated for this report.

The most productive water-bearing zones (aquifers) in the area surrounding the reservation are in the terrace deposits. These aquifers occur at depths of 180 to more than 400 ft below sea level. These deposits of permeable sand and gravel are usually 5 to greater than 20 ft thick and produce 10 to 75 gal/min to properly constructed wells. Ground water in these zones is commonly under artesian pressure; wells tapping these zones are usually flowing wells. Tables 1 and 2 give data on construction and materials penetrated for selected wells in the study area.

The alluvium and beach sands (figs. 4 and 5) may also contain ground water. However, this potential source of ground-water supplies was not investigated for this report.

Estimated pumpage for domestic use in 1979 from well 3J1 on the reservation, ranges from about 3.9 gal/min in November to about 6.5 gal/min in August. Estimated pumpage for domestic and industrial use from wells in the study area (but not including well 3J1) ranges from about 36 gal/min in November to about 120 gal/min in August.

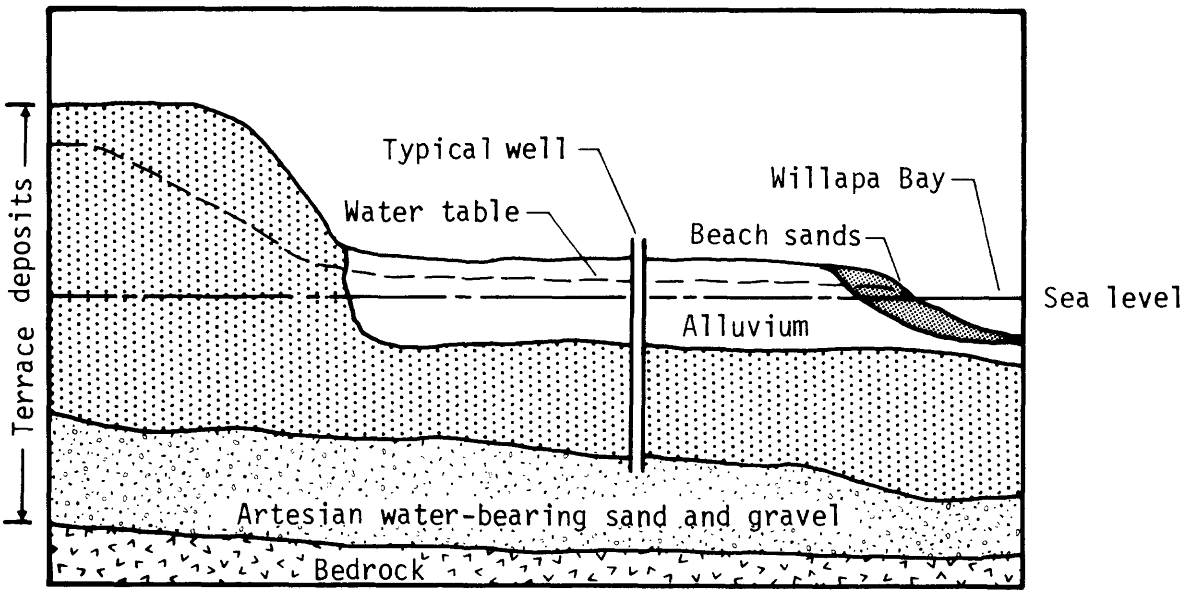


FIGURE 5.--Diagrammatic geologic section across the Shoalwater Bay Indian Reservation, Washington.

TABLE 1.--Records of selected wells on the Shoalwater Bay Indian Reservation and selected adjacent areas, Wash.

Well No. (shown in fig. 9)	Owner (1978)	Casing		Openings		Test pumping		
		Diam-meter (in.)	Depth (ft)	Type	Depth (ft)	Yield (gal/min)	Draw-down (ft)	Dura-tion (hrs)
14/11W-2P1	R. Nelson	2	195	Open end	195	--	--	--
-3J1	Shoalwater Bay Tribe	6	224	Perforations	206-208	[a]75	--	--
-11C1	Dexter-by-the-sea	2	198	--do.-----	189-192	[b]10-15	--	--
-11C3	Duncan	2	200	Open end	200	[b]10-15	--	--
-11F1	Trade Winds Motel	6	290	--do.---	290	[a]55	20	1
-11F2	Bankey	2	220	Perforations	--	[b]10	--	--
-11F3	Vogen	2	217	--do.-------	--	[b]10	--	--
-11H1	R. Nelson	6	250	--do.-------	234-247	[a]45	14	2
-11J1	D. Hawthorn	2	200	--	--	--	--	--
-12Q1	K. Widders	1.25	210	--	--	[b]20	--	--
-13A2	Nelson Crab	2	200	--	--	--	--	--
-13A4,5	--do.------	8	490	--	--	--	--	--
14/10W-18C3	Port of Willapa Harbor	6	340	Open end	340	--	--	--
-18D1	J. Brockhoff	2.25	200	Sand point	200	--	--	--

[a]Reported pumping test.

[b]Observed flowing at this rate by USGS personnel.

TABLE 2.--Drillers' logs of selected wells on the Shoalwater Indian Reservation and adjacent areas, Wash.

Material	Thickness (ft)	Depth (ft)
14/11W-2P1		
Sand--	50	50
"Tide mud"--	15	65
Sand and clay-------------------------------------	85	150
Clay--	17	167
Sand, coarse, and clay----------------------------	28	195
14/11W-3J1		
Soil, sandy---------------------------------------	15	15
Sand, brown---------------------------------------	9	24
Sand, blue--	11	35
Sand, fine, with silt, water-bearing--------------	1	36
Clay, blue, and sand------------------------------	50	86
Sand, yellow, with clay---------------------------	53	139
Clay, yellow, with some gravel--------------------	4	143
Sand, yellow, fine, and gravel--------------------		143
Sand, yellow, fine--------------------------------	15	159
Gravel and sand-----------------------------------		159
Sand, fine--	4	164
Sand, yellow clay, and some gravel----------------	11	175
Gravel and sand-----------------------------------		175
Sand, fine, and clay------------------------------	9	185
Gravel and sand-----------------------------------	1	186
Clay and sand-------------------------------------	19	206
Gravel, pea-sized, water-bearing------------------	2	208
Clay, yellow, and gravel--------------------------	6	214
(unknown)---	9	224
14/11W-11C1		
Sand--	23	23
Clay--	3	26
Sand with clay layers-----------------------------	74	100
"Hardpan"---	18	118
Sand--	70	188
Gravel--	4	192
Sand, yellow--------------------------------------	6	198
14/11W-11H1		
Sand, blue--	30	30
Mud, blue---	29	59
Sand, blue--	38	97
Clay, blue--	31	128
Sand, brown---------------------------------------	106	234
Gravel, blue--------------------------------------	1	235
Sand, brown---------------------------------------	6	241
Gravel, blue--------------------------------------	4	245
Sand, brown---------------------------------------	2	247
Gravel, blue--------------------------------------	1	248
Sand, brown---------------------------------------	2	250

Fluctuations in Water Levels

Ground-water levels, as measured in wells, may be subject to seasonal changes due to many factors, including variations in the rate of recharge to the aquifer and changes in the amount of water pumped from the aquifer (Garling, Molenaar, and others, 1965). In western Washington, water levels are lowest in late fall or early winter (October-December)—about 3 to 4 months after the period of lowest average monthly precipitation and highest water usage. Conversely, highest water levels usually occur in late spring or early summer (May-July), after the heavy winter precipitation has had time to percolate downward and recharge the aquifer. The magnitude of these seasonal changes usually ranges from 1 to more than 10 ft. Longer term fluctuations in water levels are usually related to changes in the amount of water being pumped from an aquifer or, possibly, changes in local climatic conditions, such as a drought.

Fluctuations of the water level in well 3J1 appear to be less than 1 ft (fig. 6). The small fluctuations are probably the result of (1) the thick sediments overlying the aquifer evening out the rate of recharge and (2) the low pumping rates having little effect on water level.

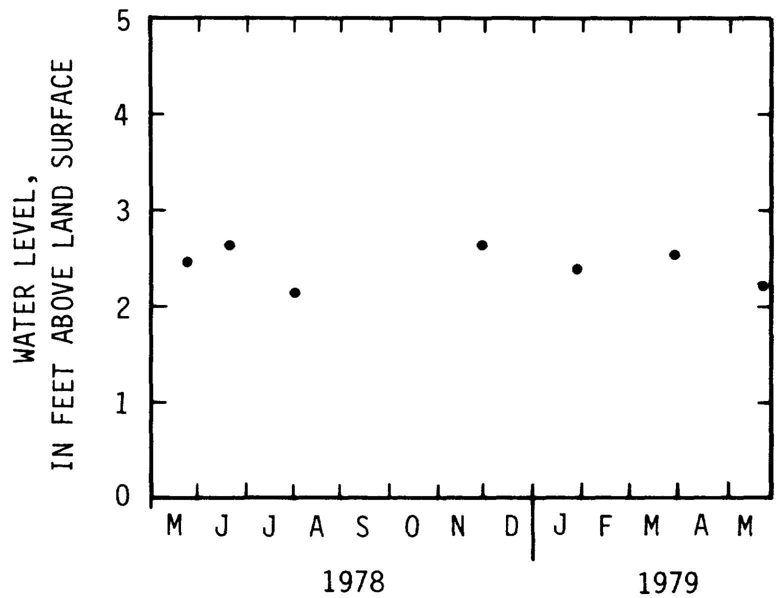


FIGURE 6.--Water-level fluctuations in well 3J1, on the Shoalwater Bay Indian Reservation, Washington.

The recorded observations of wells in the study area that can be used to evaluate long-term fluctuations are shown below. Water-level data collected from well 3J1 in 1968, 1978, and 1979 indicate no significant change in the water level during these years. Observations of other wells made during 1968 and 1978 (Walters, 1971; and Dion and Sumioka, 1984) also indicate no significant changes. Local well owners reported slight seasonal variations, but no long-term changes in water levels or flow rates.

Well number	Well was observed to be flowing on the following dates: From Walters, 1971 or well driller's report	From Dion and Sumioka, 1984, or author's field observation
14/11W-2P1	—	12-20-78
-3J1	12-16-68	[a]1978-79
-11C1	10-31-68	6-20-78
-11C3	—	6-20-78
-11F1	10-31-68	6-20-78
-11F2	—	6-20-78
-11F3	—	6-20-78
-11H1	—	8-10-79
-11J1	10-31-68	7-28-78
-12Q1	10-31-68	7-28-78
-13A2	10-31-68	6-20-78
-13A4,5	—	7-27-78
14/10W-18C3	10-23-68	7-27-78
-18D1	10-31-68	7-27-78

[a] Observation well, see table 3.

The amount of water pumped from the aquifer for use on or off the reservation is not large enough to cause measurable effects on water levels or flow rates. Reduction of water levels and flow rates could result from increased rates of pumping owing to increased population or industrial development. There are not sufficient data available to predict the response of the aquifer to increased pumpage.

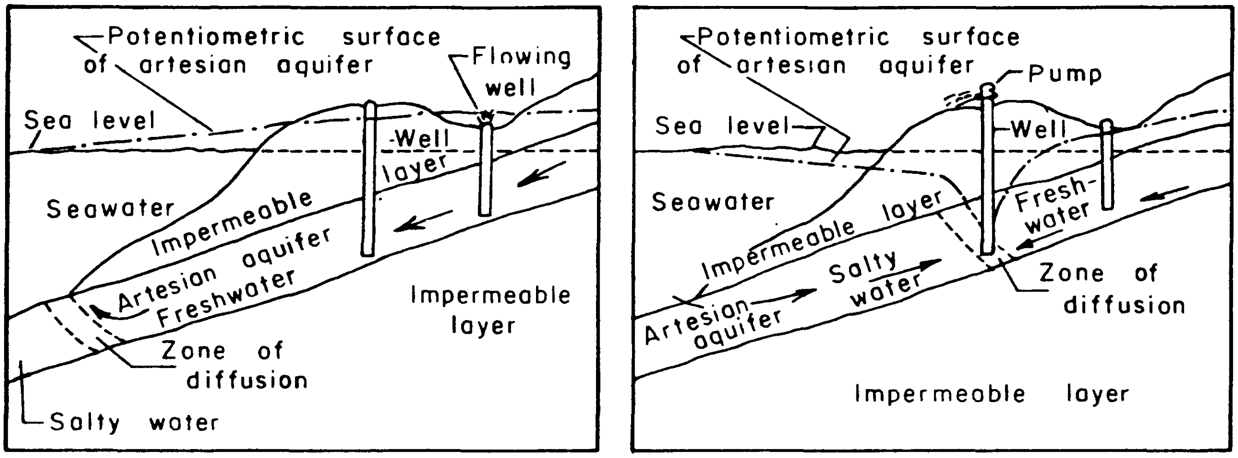
TABLE 3.--Water-level measurements in well 3J1, on the Shoalwater Bay Indian Reservation, Wash.

Date	Water level (feet above land surface)
1968	
December 16	about 2.5
1978	
May 24	2.44
May 31	2.39
June 20	2.62
August 1	2.14
November 29	2.64
1979	
January 31	2.37
March 28	2.54
May 23	2.21

Ground-Water Quality

Well 3J1 was sampled three times in 1978 to determine the concentrations of selected chemical constituents (table 4). Samples were also collected from seven additional wells in 1968 and 1978 to determine chloride concentration (see table next page). The concentration of chemical constituents in well 3J1 were all within limits considered safe for irrigation and public water supply (U.S. Environmental Protection Agency, 1977a, b).

Pumping water from a well, near a marine shoreline, that is open to an aquifer below sea level has the potential for causing seawater intrusion into the aquifer. Hydrologic conditions in an artesian aquifer before and after seawater intrusion are shown in figures 7A and 7B. Before any significant amount of water is pumped from the aquifer, the ground-water flow is in equilibrium—that is, the ground water is flowing past the well, mixing with the salty ground water in the zone of diffusion, and then discharging into the seawater (fig. 7A). As the well is pumped intensively for an extended period of time, the flow system of the ground water changes. The potentiometric surface around the well is lowered as the fresh ground water is pumped out faster than it can be replenished. The direction of flow past the well may then reverse and salty ground water may flow to the well (fig. 7B). Increasing chloride concentration in well water is an indicator of seawater intrusion.



A. Two wells tapping a confined (artesian) aquifer under conditions of equilibrium--no intrusion has occurred.

B. The same wells under conditions of intensive pumping--intrusion has reached the well nearest to the shoreline, flow in shallow well has ceased.

FIGURE 7.--Schematic diagrams showing conditions before after seawater intrusion.

The following is a list of wells in the area between the reservation and Toke Point, about 2.5 miles southeast, that were sampled for chloride concentration during 1968 and for 1978 for studies by Walters (1971) and Dion and Sumioka (1984), respectively.

Well number	Chloride concentration, in milligrams per liter: Collected in 1968	Chloride concentration, in milligrams per liter: Collected in 1978
3J1	—	14 (21 in Nov.)
11C1	9	12
11F1	10	11
11J1	10	11
12Q1	8	9
13A2	6	7
18C3	7	9
18D1	8	9

Background concentrations of chloride in western Washington range from less than 10 to about 50 mg/L (Walters, 1971). Based on the results of the 1968 and 1978 samples, there is no evidence of seawater intrusion in the reservation-Toke Point area. The slight increase (1 to 3 mg/L) in chloride concentration between 1968 and 1978 (as shown above for all wells sampled during both years) is not significant enough to indicate seawater intrusion. Sufficient data are not available to determine if seawater intrusion may occur in the study area in the future.

TABLE 4.--Chemical analyses of water from well 3J1, on the Shoalwater Bay Indian Reservation, Wash.

Property or constituent	Concentration or value (in milligrams per liter, unless otherwise specified)		
	April 14, 1978	May 24, 1978	November 29, 1978
Water temperature (°C)	9.8	9.8	9.4
Specific conductance (umho/cm at 25°C)	163	170	159
pH (units)	--	7.8	7.5
Alkalinity (as $CaCO_3$)	--	53	53
Bicarbonate (as HCO_3)	--	65	--
Carbonate (as CO_3)	--	0	--
Nitrite-plus-nitrate (as N)	.07	.08	.11
Hardness (as $CaCO_3$)	--	53	48
Hardness, noncarbonate	--	0	0
Calcium	--	12	11
Magnesium	--	5.5	4.9
Sodium	--	13	12
Potassium	--	1.0	1.0
Chloride	--	14	21
Sulfate	--	2.6	4.0
Fluoride	--	.1	.1
Silica	--	31	31
Iron, total (ug/L)	--	760	--
Iron, dissolved (ug/L)	--	--	0
Manganese, total (ug/L)	--	10	--
Manganese, dissolved (ug/L)	--	--	2
Dissolved solids (residue at 180°C)	--	111	114

Future Ground-Water Supplies

Additional ground water could probably be obtained from the terrace deposits that underlie the reservation. Due to the limited amount of data available for these deposits, it is not possible to determine precise locations for wells, the depths to which wells should be drilled, or their probable yields. However, some general guidelines for future water-supply wells are discussed below.

The site of a new well can probably be at almost any convenient location near the area where the water will be used. The well should be located away from any septic tanks or sewage-treatment sites to reduce the possibility of bacterial or chemical contamination from those sources. Because most wells off the reservation are less than 250 ft deep, any new well should be drilled deeper than these wells to minimize the chances for interference.

On the basis of previous studies of areas with similar geologic-hydrologic conditions (Foxworthy and Walters, 1971; Wegner, 1956; Tracy, 1978), short-term water yields will probably range from about 100 to more than 500 gal/min. Accurate determination of the yield of any well or zone in the aquifer would require more exploratory drilling and testing. The amount of water that can be pumped from the aquifer over a long time is unknown. Any planned uses of large amounts of water should include an additional water-supply study aimed at accurately determining the long-term potential yield of the aquifer.

SURFACE-WATER RESOURCES

Several small stream valleys provide drainage channels for surface-water runoff from the reservation. However, only intermittent runoff from within the reservation boundaries was observed during this study. Two perennial streams, Pacific County Drainage Ditch #1 and Cannery Slough tributary, which drain areas near the reservation, were studied in more detail. These two streams discharge into tribally owned tidelands adjacent to the reservation. Data were gathered on water quality and streamflow at one site on each of these two streams at varying frequencies. Kindred Slough, which has part of the reservation within its drainage basin, was sampled once for chemical quality during this study.

Streamflow Characteristics

Continuous streamflow-recording gages were installed and operated from September 1978 to December 1979 near the mouths of Cannery Slough tributary and Pacific County Drainage Ditch #1 (fig. 4). Daily mean flow of Cannery Slough ranged from 4.9 to 0.33 ft^3/s, and Pacific County Drainage Ditch #1 from 114 to 2.4 ft^3/s. The mean flow for each day of record for these streams is given in table 5.

The flow of Cannery Slough tributary (drainage basin area about 0.23 mi^2) is composed of surface runoff (overland flow of rain) and ground-water outflow into the streambed. Streamflow patterns closely follow seasonal and daily trends of precipitation in the local area (fig. 8). Highest mean monthly streamflows, resulting from the high amounts of precipitation, were recorded during October-March, when 70 to 80 percent of the average annual precipitation occurs. During late summer and early fall, a period of low precipitation and high evaporation and transpiration by vegetation, streamflow is sustained by ground water flowing into the streambed.

Occasional periods of heavy rain can also cause increased streamflow. A comparison of daily rainfall and mean daily streamflow (fig. 9) shows this relationship.

There is insufficient data to accurately calculate the flow of Cannery Slough tributary during the late-summer and early-fall low-flow period. It is estimated, however, that the 7-day-average low flow, based on a recurrence interval of 2 years, is about 0.3 ft^3/s (Nassar, 1973). The July-August 1979 7-day-average low flow was about 0.4 ft^3/s.

The source of water discharged in Pacific County Drainage Ditch #1 (hereinafter referred to as Ditch #1) is overland runoff, ground-water flow into the streambed, and surplus irrigation water (mostly pumped ground water). Within the drainage basin (5.13 mi^2) about 1.0 mi^2 is cultivated for commercial cranberry production.

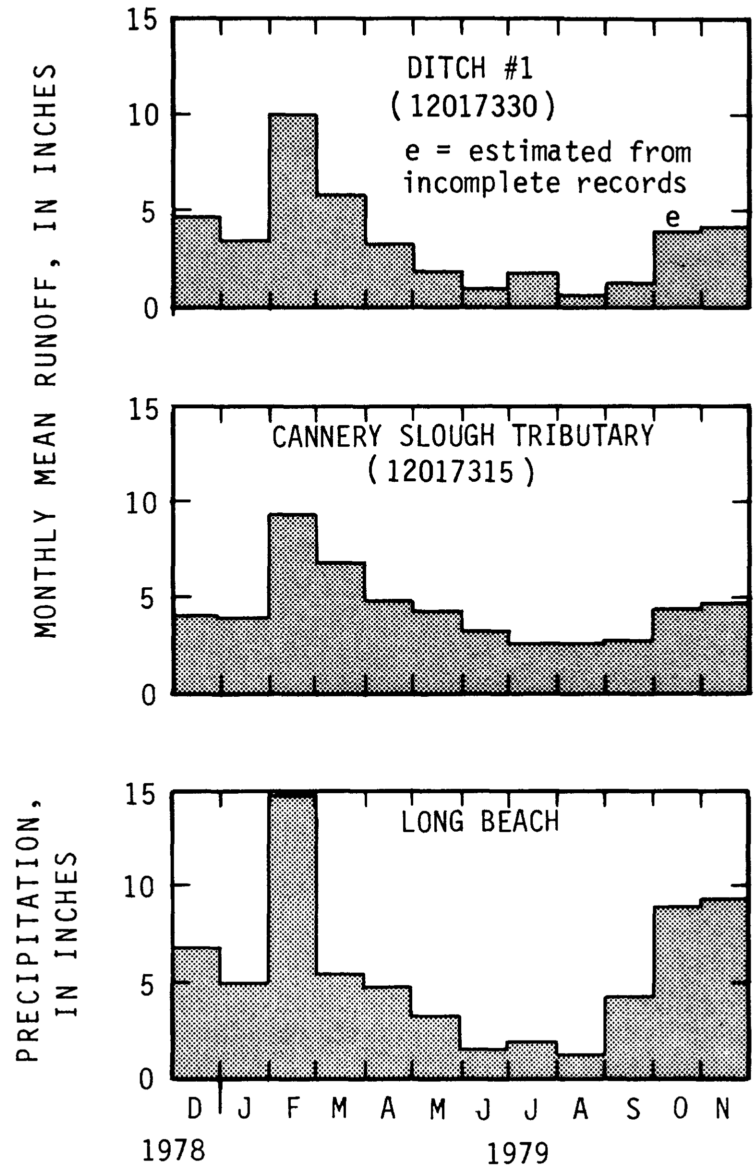


FIGURE 8.--Monthly mean streamflow at selected sites and monthly precipitation at Long Beach, Washington.

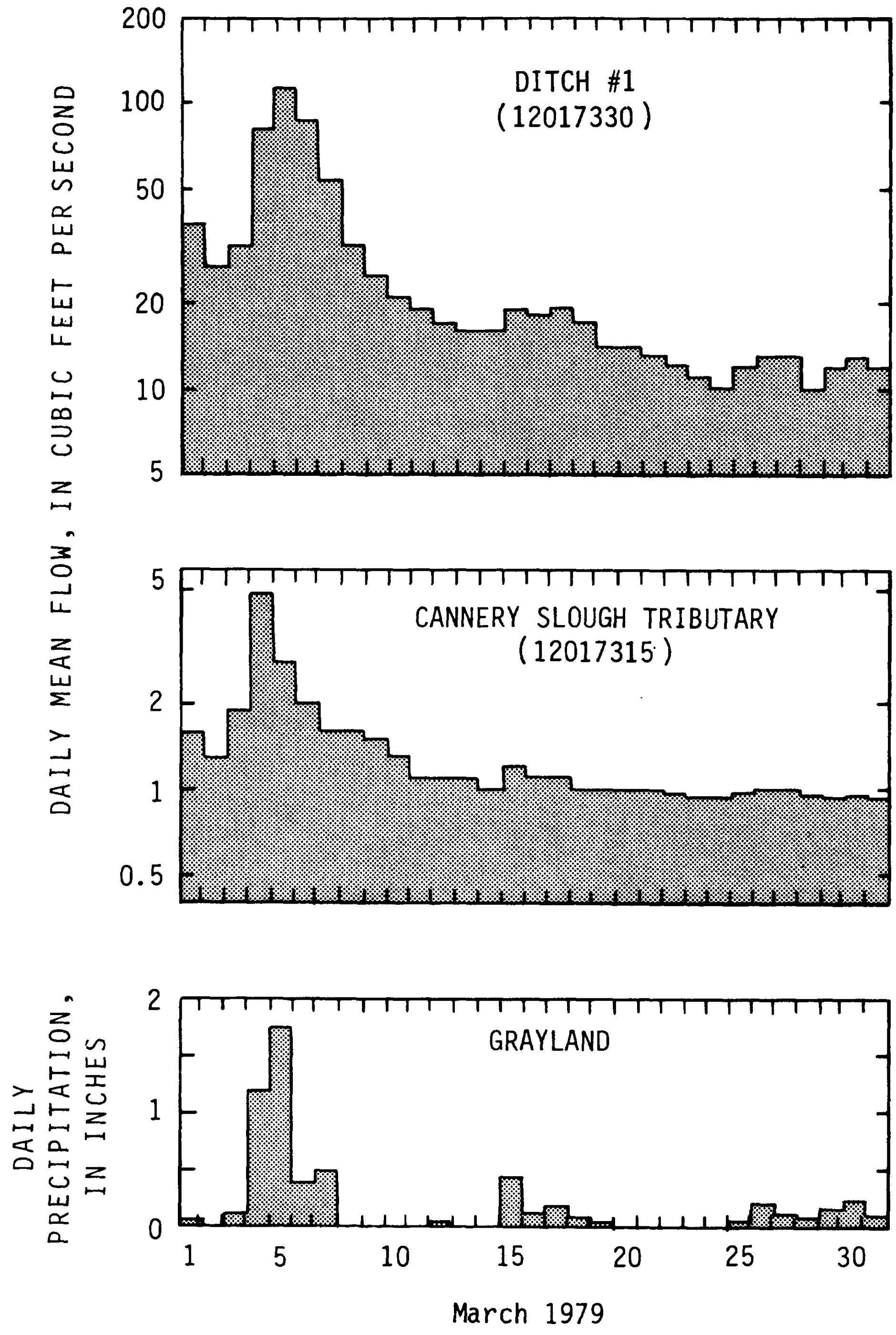


FIGURE 9.--Daily mean streamflow at selected sites and daily precipitation at Grayland, Washington.

TABLE 5.--Daily mean streamflow at selected sites near the Shoalwater Bay Indian Reservation, Washington

CANNERY SLOUGH TRIBUTARY
[streamflow in cubic feet per second]

	197B			1979											
DAY	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1		--	.84	.62	.66	1.6	.99	.82	.70	1.1	.44	.62	4.1	14	27
2		--	.68	.62	.66	1.3	1.0	.82	.70	.74	.46	.64	3.8	14	91
3		--	1.6	.62	1.1	1.9	1.0	.82	.70	.54	.47	.82	3.4	29	56
4		--	.99	.65	1.1	4.9	1.2	1.4	.71	.53	.51	.56	--	44	--
5		--	.76	.67	2.3	2.8	.98	1.4	.82	.46	.53	.66	--	50	--
6		--	.74	.66	3.9	2.0	.94	.99	.73	.40	.52	.52	--	25	--
7		--	.75	.63	1.6	1.6	.91	1.3	.70	.44	.48	.41	--	17	--
8		--	.78	.65	1.2	1.6	1.1	.98	.70	.47	.49	.48	--	14	--
9		--	1.2	.74	1.3	1.5	1.1	.91	.70	.51	.48	.43	--	12	--
10		--	1.3	2.1	1.8	1.3	1.4	.86	.69	.61	.53	.39	--	11	--
11		--	.95	.73	1.8	1.1	1.1	.82	.67	.62	.51	.40	--	10	--
12		--	.76	.73	5.1	1.1	1.6	.82	.67	.56	.52	.38	--	9.6	--
13		--	.68	.7D	1.7	1.1	1.2	.84	.69	.52	.51	.42	--	9.4	--
14		--	.94	.77	1.3	1.0	1.1	.82	.67	.51	.54	.49	--	8.7	--
15		--	.72	.74	1.4	1.2	1.0	.82	.68	.50	.54	.55	--	8.2	--
16		--	.72	.74	1.7	1.1	.99	.82	.77	.50	.51	.55	--	8.9	--
17		--	.78	.74	3.6	1.1	.98	.82	.73	.53	.52	.58	--	17	--
18		--	.74	.74	2.2	1.0	.99	.82	.69	.54	.65	.59	--	21	--
19		--	.70	1.0	2.3	1.0	1.3	.82	.69	.56	.57	.60	--	20	--
20		--	.72	1.6	2.0	1.0	1.0	.82	.67	.55	.54	.59	--	15	--
21		.74	.71	1.1	2.1	1.0	.94	.82	.67	.52	.60	.59	--	13	--
22		.74	.73	.75	2.2	.97	.94	.78	.67	.50	.57	.59	--	26	--
23		.70	.87	.71	2.2	.94	.91	.74	.67	.54	.54	.58	--	49	--
24		.70	.91	.70	2.9	.94	.86	.74	.65	.54	.54	.59	37	34	--
25		.74	.75	.66	3.5	.97	.82	.73	.64	.55	.53	.62	79	23	--
26		.74	.70	.70	2.2	1.0	.82	.69	.62	.50	.55	.68	58	23	--
27		1.1	.72	.93	2.2	1.0	.82	.72	.64	.49	.59	.67	46	18	--
28		.90	.70	.75	1.6	.96	.82	.74	.65	.46	.58	.70	40	15	--
29		.94	.67	.72	--	.94	.82	.69	.65	.43	.58	.70	29	14	--
30		2.4	.66	.70	--	.95	.82	.70	.71	.33	.56	.70	23	13	--
31		--	.63	.68	--	.94	--	.70	--	.40	.56	--	18	--	--
TOTAL	--	--	25.40	24.85	57.62	41.81	30.45	26.57	20.65	16.45	16.52	17.10	--	585.8	--
MEAN	--	--	.82	.80	2.06	1.35	1.02	.86	.69	.53	.53	.57	--	19.5	--
MAX	--	--	1.6	2.1	5.1	4.9	1.6	1.4	.82	1.1	.65	.82	--	50	--
MIN	--	--	.63	.62	.66	.94	.82	.69	.62	.33	.44	.38	--	8.2	--
AC-FT	--	--	50	49	114	83	60	53	41	33	33	34	--	1160	--

DAY	OCT	NOV	DEC	DAY	OCT	NOV	DAY	OCT	NOV	DAY	OCT	NOV	DAY	OCT	NOV
1	0.69	0.78	4.5	7	0.70	0.78	13	0.74	0.78	19	0.62	0.94	25	1.6	1.4
2	.69	.94	1.4	8	.70	.78	14	.74	.78	20	1.2	.88	26	1.2	1.8
3	.70	1.4	1.3	9	.70	.78	15	.75	.82	21	.88	.67	27	1.1	.79
4	.70	1.8	1.1	10	.70	.78	15	.94	.88	22	.78	1.7	28	1.3	.78
5	.70	1.1	--	11	.70	.78	17	.95	1.0	23	.74	1.5	29	.94	.79
6	.70	.82	--	12	.74	.78	18	.82	1.1	24	2.1	.99	30	.88	.82
													31	.82	--
TOTAL	27.52	29.94													
MEAN	.89	1.00													
MAX	2.1	1.8													
MIN	.62	.67													
AC-FT	55	59													

TABLE 5.--Daily mean streamflow at selected sites near the Shoalwater Bay Indian Reservation, Washington--cont.

PACIFIC COUNTY DRINAGE #1
[streamflow in cubic feet per second]

	1978				1979								
DAY	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1		14	--	39	12	9.1	38	12	7.2	5.1	12	3.1	3.4
2		13	--	22	11	8.7	27	13	7.0	4.6	13	3.1	4.1
3		11	--	31	11	15	32	12	6.6	4.8	12	2.8	8.7
4		10	--	44	10	22	82	14	9.6	5.1	12	2.5	12
5		9.8	--	26	9.6	52	114	14	28	6.4	11	3.0	13
6		9.6	--	17	9.4	62	87	12	17	6.2	9.8	2.7	9.1
7		9.1	--	15	8.7	83	54	10	21	4.8	9.6	4.7	7.6
8	17	8.9	--	14	8.7	42	32	14	16	4.1	10	3.1	10
9	72	9.1	--	22	9.4	38	25	16	13	4.6	10	2.5	12
10	61	9.6	--	28	35	40	21	23	10	4.8	14	2.7	8.9
11	27	9.6	--	38	25	41	19	28	8.4	3.9	15	2.7	6.5
12	19	8.2	--	22	17	86	17	30	7.6	3.0	15	2.7	6.2
13	20	8.0	--	17	15	98	16	36	7.8	3.8	12	2.5	5.3
14	20	7.8	--	22	17	62	16	24	7.2	3.3	10	3.0	4.8
15	16	7.4	--	19	16	29	19	22	6.6	3.4	9.4	3.0	4.8
16	13	7.4	--	19	12	37	18	16	6.4	5.1	12	2.7	4.6
17	19	7.0	--	22	12	60	19	17	6.0	5.1	7.4	2.4	4.4
18	14	6.8	--	22	10	68	17	16	6.2	5.3	5.5	3.3	4.1
19	11	6.6	--	19	18	41	14	16	5.7	5.1	5.1	4.8	4.2
20	13	7.2	--	18	35	30	14	16	5.8	4.9	4.9	4.4	4.1
21	26	6.6	16	19	40	26	13	14	4.8	4.4	4.8	4.2	4.1
22	71	6.2	14	17	22	23	12	12	5.8	3.6	4.2	4.9	3.8
23	100	6.4	12	17	16	23	11	11	5.7	4.1	3.9	4.2	3.8
24	77	7.2	11	20	14	55	10	9.8	6.0	3.9	3.9	3.9	3.6
25	31	--	10	16	12	103	12	8.9	5.3	3.3	3.9	3.6	3.4
26	20	--	10	14	13	96	13	7.2	5.8	3.4	3.8	3.4	3.6
27	18	--	11	14	16	81	13	7.6	5.8	3.6	3.8	3.3	3.6
28	18	--	22	14	15	53	10	7.8	5.7	3.4	3.8	3.1	3.9
29	17	--	20	14	12	--	12	7.4	5.3	3.9	3.4	3.3	3.9
30	16	--	37	13	11	--	13	7.2	4.9	4.1	3.4	3.0	4.4
31	--	--	--	12	9.6	--	12	--	4.4	--	3.3	3.0	--
TOTAL	--	--	--	646	481.4	1383.8	812	453.9	262.6	131.1	251.9	101.6	175.9
MEAN	--	--	--	20.8	15.5	49.4	26.2	15.1	8.47	4.37	8.13	3.28	5.86
MAX	--	--	--	44	40	103	114	36	28	6.4	15	4.9	13
MIN	--	--	--	12	8.7	8.7	10	7.2	4.4	3.0	3.3	2.4	3.4
AC-FT	--	--	--	1280	955	2740	1610	900	521	260	500	202	349

Cranberry production uses relatively large amounts of irrigation water—2 to 4 acre-feet per acre. This water is used for plant-growth enhancement, frost- and heat-damage reduction, herbicide and pesticide application, and to facilitate harvesting of the crop. Only a small part of this water is consumptively used; most leaves the area through overland flow into Ditch #1 or percolates back into the ground.

The pattern of flow in Ditch #1 is similar to that of Cannery Slough tributary; high mean monthly flows occur in months of high rainfall, low flows occur in months of low rainfall. Similarly, daily flows reflect daily rainfall patterns (see figs. 8 and 9).

The 7-day-average low flow for Ditch #1, based on a recurrence interval of 2 years, is estimated to be 3.0 ft^3/s. For 1 year in 5, it is estimated to be 2.6 ft^3/s (Nassar, 1973). The July-August 1979 7-day-average low flow was about 2.9 ft^3/s.

Surface-Water Quality

One site on each of three streams was visited to gather quality-of-water data for this study. Kindred Slough was sampled only once for a variety of common chemical constituents. Cannery Slough tributary and Ditch #1 were sampled at varying frequencies for selected physical characteristics, common chemical constituents, and organic chemicals. Due to the lack of longer term water-quality data at these three sites, no conclusions are made concerning the suitability of the water for a particular use.

Kindred Slough

Kindred Slough (fig. 4) drains an area, mainly north and east of the reservation, that consists of recently logged forests and some pastureland. The drainage basin includes 1.50 mi^2 above the sample site; only about 0.16 mi^2 of this lies within the reservation boundary. To provide water-quality information in this area, one sample of water from Kindred Slough was collected and analyzed. The results of the analyses (tables 6 and 7) indicate that the concentration of chemical constituents (and physical characteristics) of the water from the slough were all within limits safe for irrigation and public-water supply. However, more data are needed before any conclusions concerning the use of water from this stream can be made.

Cannery Slough Tributary

Cannery Slough tributary (fig. 4) has a drainage basin that lies north and west of the reservation and includes 0.23 mi^2 of recently logged forest land. This stream discharges water into tribally-owned tidelands. Water-quality data are needed to guide development of suggested nearshore or offshore aquaculture that might be sensitive to degraded water quality or chemicals transported into the nearshore area. In addition, Cannery Slough has a perennial flow and was considered to have potential for fisheries-enhancement projects such as salmon-egg hatching and (or) salmon-fry rearing and release.

Between April 1978 and May 1979, this stream was visited numerous times to collect data on selected physical and chemical characteristics of the water, including flow, specific conductance, pH, water temperature, dissolved oxygen, and coliform-bacteria concentrations in the water (table 6). In addition, four samples were collected and analyzed for common chemical constituents including calcium, magnesium, sodium, and nutrients (table 7). In May 1979, one sample was collected and analyzed for selected organic chemicals, mainly herbicides and insecticides (table 8).

The results of the sampling for selected physical and chemical characteristics and common chemical constituents indicate no unusually high or harmful levels of these constituents in Cannery Slough tributary. However, certain organic chemicals, known to be harmful to humans as well as certain aquatic animals, were found to be dissolved in the water at varying levels of concentration. The organic chemicals determined to exceed limits (U.S. Environmental Protection Agency, 1977a, b) for protection of marine aquatic life are DDD, DDT, Dieldrin, Diazinon, and Parathion. These compounds are insecticides that may be currently in use or were used in the past in this area. The exact source of these chemicals could not be determined from the data available. The presence of these chemicals in the water from the stream indicate that further study is needed before the water is used for any purpose.

Pacific County Drainage Ditch #1

Ditch #1 drains an area north and west of the reservation consisting of 5.13 mi^2; about 1.0 mi^2 of the drainage basin is under commercial cranberry cultivation, and the remainder is recently logged forest lands, residential areas, swamps, and undeveloped areas. This stream was studied because it discharges into tribally-owned tidelands and data were needed on water quality to guide development in those areas.

Between April 1978 and May 1979, this stream was visited numerous times to collect data on selected physical and chemical characteristics of the water, including those mentioned in the previous section (p. 24) and listed in table 6. Samples were collected and analyzed on four occasions for common chemical constituents (table 7). Samples were collected and analyzed on six occasions to determine the concentration of selected organic chemicals in the water and bottom materials (silt, clay, sand, and decaying vegetation) of the streambed. The results of the analyses for organic chemicals are listed in table 8.

The results indicate that high fecal-coliform-bacteria concentrations, low dissolved-oxygen concentration, and high turbidity observed in the water may limit the utility of the water. Analyses of water for organic chemicals indicates a similar pattern to that of Cannery Slough tributary. Concentrations of organic chemicals exceeding the EPA specified limits (U.S. Environmental Protection Agency, 1977a, b) include Aldrin, DDD, DDT, Dieldrin, and Diazinon. These compounds are insecticides that may be currently in use or were used in the past in this area. Analyses of bottom material from the streambed showed significant concentrations of Aldrin, DDD, DDE, DDT, Dichlobenil (Casaron), and Dieldrin.

There are insufficient data to determine the source of these chemicals, but their presence in the water that flows into the tribally-owned tidelands is cause for further study before the water is used for any purpose.

TABLE 6.--Selected physical and chemical characteristics of samples from selected surface-water sites near the Shoalwater Bay Indian Reservation, Wash.

Site and date of collection	Streamflow (ft^3/s)	Specific conductance (umho/cm at 25°C)	pH (units)	Water temperature (°C)	Dissolved oxygen (mg/L)	Fecal coliform bacteria (col/100 mL)
Cannery Slough tributary						
Apr. 14, 1978[a]	0.86	118	--	8.4	11.1	--
May 18	.80	110	6.6	9.6	10.7	2
May 24[a]	.93	120	7.6	8.8	--	--
July 7	.70	--	--	11.4	--	--
Aug. 1	.58	120	7.4	11.4	9.8	[b]48 B
Nov. 29[a]	.94	119	7.0	7.8	11.6	19
Jan. 31, 1979[a]	.68	116	7.0	2.4	13.1	5
Mar. 28	.96	110	7.1	7.4	11.0	<1
May 23[a]	.74	121	6.9	10.4	10.1	10 B
Pacific County Drainage Ditch #1						
Apr. 26, 1978[a]	14.0	230	7.2	11.2	--	860 B
May 18	11.0	245	6.6	11.4	5.8	370
May 31	8.9	255	6.9	11.2	--	--
July 7[a]	5.7	280	7.2	12.4	--	--
Aug. 1	3.5	245	7.1	13.8	6.3	510
Nov. 29[a]	17.0	203	6.8	8.0	6.6	170 B
Jan. 31, 1979[a]	9.6	250	6.9	2.4	7.7	180
Mar. 28[a]	10.0	265	7.0	9.2	6.3	250
May 23[a]	5.7	272	7.0	12.4	6.1	260
Kindred Slough						
May 25, 1978[a]	--	100	7.4	12.8	--	--

[a]Additional water-quality data for this date are listed in tables 7 and 8.
[b]B, concentration out of ideal range.

TABLE 7.--Chemical constituents of samples from selected surface-water sites near the Shoalwater Bay Indian Reservation, Wash.

[mg/L, milligrams per liter; ug/L, micrograms per liter; < , less than; ND, none detected; --, no analysis available this date]

DATE	TIME	HARDNESS (MG/L AS CACO3)	CALCIUM DISSOLVED (MG/L AS CA)	MAGNESIUM, DISSOLVED (MG/L AS MG)	SODIUM, DISSOLVED (MG/L AS NA)	POTASSIUM, DISSOLVED (MG/L AS K)	BICARBONATE FET-FLD (MG/L AS HCO3)	CARBONATE FET-FLD (MG/L AS CO3)	ALKALINITY FIELD (MG/L AS CACO3)	SULFATE DISSOLVED (MG/L AS SO4)
12017303 - KINDRED SLOUGH AT HWY 105 NEAR TOKELAND, WASH. (LAT 46 43 39 LONG 124 00 29)										
MAY , 1978										
25...	1125	20	3.1	2.9	14	.6	21	0	17	8.4
12017315 - CANNERY SLOUGH TRIBUTARY NEAR TOKELAND, WASH. (LAT 46 43 45 LONG 124 02 15)										
APR , 1978										
14...	1028	--	--	--	--	--	--	--	--	--
MAY										
24...	0902	19	3.4	2.6	15	.8	17	0	14	6.7
NOV										
29...	0945	18	3.0	2.5	17	.9	19	0	16	8.9
JAN , 1979										
31...	0915	13	2.7	1.5	16	.8	--	--	14	5.3
MAY										
23...	0950	18	2.9	2.5	16	1.0	15	0	12	14
12017330 - DRAINAGE DITCH #1 NEAR TOKELAND, WASH. (LAT 46 44 09 LONG 124 03 56)										
APR , 1978										
26...	1100	46	8.2	6.2	28	3.4	65	0	53	11
JUL										
07...	1115	--	--	--	--	--	--	--	--	--
NOV										
29...	1030	44	9.0	5.2	26	3.4	57	0	47	12
JAN , 1979										
31...	1025	47	7.0	7.1	34	4.0	--	--	59	19
MAR										
28...	1100	--	--	--	--	--	--	--	--	--
MAY										
23...	1100	31	8.3	2.4	37	4.3	67	0	55	11

TABLE 7.--Chemical constituents of samples from selected surface-water sites near the Shoalwater Bay Indian Reservation, Wash.--Cont.

[mg/L, milligrams per liter; ug/L, micrograms per liter; < , less than; ND, none detected; --, no analysis available this date]

DATE	CHLORIDE, DISSOLVED (MG/L AS CL)	SOLIDS, SUM OF CONSTITUENTS, DISSOLVED (MG/L)	NITROGEN, NITRATE TOTAL (MG/L AS N)	NITROGEN, NITRITE TOTAL (MG/L AS N)	NITROGEN, AMMONIA TOTAL (MG/L AS N)	NITROGEN, ORGANIC TOTAL (MG/L AS N)	NITROGEN, TOTAL (MG/L AS N)	PHOSPHORUS, TOTAL (MG/L AS P)	PHOSPHORUS, ORTHO, DISSOLVED (MG/L AS P)	ARSENIC DISSOLVED (UG/L AS AS)
12017303 - KINDRED SLOUGH AT HWY 105 NEAR TOKELAND, WASH. (LAT 46 43 39 LONG 124 00 29)										
MAY , 1978										
25...	17	--	--	--	--	--	--	--	--	--
12017315 - CANNERY SLOUGH TRIBUTARY NEAR TOKELAND, WASH. (LAT 46 43 45 LONG 124 02 15)										
APR , 1978										
14...	--	--	7.8	.010	.040	.25	--	.020	.080	--
MAY										
24...	20	--	--	--	--	--	--	--	--	--
NOV										
29...	25	--	.73	.010	.020	.46	1.2	.020	.010	--
JAN , 1979										
31...	19	--	--	--	--	--	--	--	--	--
MAY										
23...	19	63	.62	<.010	.040	.33	1.2	.030	<.010	<1
12017330 - DRAINAGE DITCH #1 NEAR TOKELAND, WASH. (LAT 46 44 09 LONG 124 03 56)										
APR , 1978										
26...	36	--	--	--	--	--	--	--	--	--
JUL										
07...	--	--	--	--	--	--	--	--	--	6
NOV										
29...	41	--	.09	.010	.160	.46	.72	.380	.250	5
JAN , 1979										
31...	33	--	--	--	--	--	--	--	--	--
MAR										
28...	--	--	--	--	--	--	--	--	--	8
MAY										
23...	40	--	.05	.020	.110	.36	.54	.590	.140	2

TABLE 7.--Chemical constituents of samples from selected surface-water sites near the Shoalwater Bay Indian Reservation, Wash.--Cont.

[mg/L, milligrams per liter; ug/L, micrograms per liter; < , less than; ND, none detected; --, no analysis available this date]

DATE	BARIUM, DIS-SOLVED (UG/L AS BA)	CADMIUM DIS-SOLVED (UG/L AS CD)	CHRO-MIUM, DIS-SOLVED (UG/L AS CR)	COPPER, DIS-SOLVED (UG/L AS CU)	LEAD, DIS-SOLVED (UG/L AS PB)	MERCURY TOTAL RECOV-ERABLE (UG/L AS HG)	SELE-NIUM, DIS-SOLVED (UG/L AS SE)	SILVER, DIS-SOLVED (UG/L AS AG)	ZINC, DIS-SOLVED (UG/L AS ZN)
12017303 - KINDRED SLOUGH AT HWY 105 NEAR TOKELAND, WASH. (LAT 46 43 39 LONG 124 00 29)									
MAY , 1978									
25...	--	--	--	--	--	--	--	--	--
12017315 - CANNERY SLOUGH TRIBUTARY NEAR TOKELAND, WASH. (LAT 46 43 45 LONG 124 02 15)									
APR , 1978									
14...	--	--	--	--	--	--	--	--	--
MAY									
24...	--	--	--	--	--	--	--	--	--
NOV									
29...	--	--	--	--	--	--	--	--	--
JAN , 1979									
31...	--	--	--	--	--	--	--	--	--
MAY									
23...	<100	ND	<20	ND	ND	<.1	<1	ND	ND
12017330 - DRAINAGE DITCH #1 NEAR TOKELAND, WASH. (LAT 46 44 09 LONG 124 03 56)									
APR , 1978									
26...	--	--	--	--	--	--	--	--	--
JUL									
07...	300	ND	ND	ND	ND	<.1	<1	ND	ND
NOV									
29...	<100	ND	ND	2	ND	<.1	<1	ND	<20
JAN , 1979									
31...	--	--	--	--	--	--	--	--	--
MAR									
26...	<100	ND	ND	ND	ND	--	<1	ND	<20
MAY									
23...	<100	ND	ND	ND	ND	<.1	<1	ND	<20

TABLE 8.--Concentration of organic chemicals in samples of water and bottom materials at selected sites near the Shoalwater Indian Bay Reservation, Wash.

	Maximum contaminant concentration[a]	Pacific County Drainage Ditch #1							Cannery Slough tributrary
		4/26/78	4/26/78 Bottom material[b]	7/7/78	11/29/78	3/28/79	3/28/79 Bottom material[b]	5/23/79	5/23/79
Aldrin	0.003 ([c]0.2)	[d]0.00	0.4	0.010	0.003	0.002	0.5	0.001	0.001
Chlordane	.004	.0	0	.0	.0	.0	0	.0	.0
DDD	.001	.01	28	.007	.010	.010	14	.010	.009
DDE	.001	.00	8.1	.000	.000	.001	42	.001	.001
DDT	.001	.01	7.3	.002	.005	.006	2.5	.003	.002
Diazinon	[e].009	.00	.0	.18	.01	.00	.0	.19	.37
Dichlobenil (Casoron)	--	[f].043	[f].45	--	--	--	--	--	--
Dieldrin	.003	.01	.4	.029	.020	.010	.7	.008	.007
Endosulfan	.001	--	--	.000	.000	.000	--	.000	.000
Endrin	.004 ([c]0.2)	.00	.0	.001	.000	.000	.0	.000	.000
Ethyl parthion	--	.00	.0	.02	.00	.00	.0	.00	.39
Ethyl trithion	--	.00	.0	.00	.00	.00	.0	.00	.00
Ethion	--	.00	.0	.00	.00	.00	.0	.00	.00
Guthion	.010	.00	.0	--	--	--	--	--	--
Heptachlor	.001	.00	.0	.000	.000	.000	.0	.000	.000
Heptachlor epoxide	--	.00	.0	.000	.000	.000	.0	.000	.000
Lindane	.004 (([c]4.0)	.00	.0	.000	.000	.000	.1	.000	.000
Malathion	.100	.00	.0	.00	.00	.00	.0	.00	.00
Methyl parthion	--	.00	.0	.00	.00	.00	.0	.00	.00
Methyl trithion	--	.00	.0	.00	.00	.00	.0	.00	.00
Methoxychlor	.030 ([c]100)	.00	.0	.00	.00	.00	--	.00	.00
Mirex	.001	.00	.0	.00	.00	.00	.0	.00	.00
Parathion	.040	.00	--	.02	.00	.00	--	.00	.39
Perthane	--	--	--	.00	.00	.00	--	.00	.00
Plychlorinated biphenyls (P.C.B.)	.001	.0	0	.0	.0	.0	.0	.0	.0
Polychlorinated naphthalenes (P.C.N.)	--	.0	0	.0	.0	--	--	--	--
Silvex	--	.00	0	--	--	0	--	--	--
Simazine	--	[f].23	[f]0	--	--	--	--	--	--
Toxaphene	.005 ([c]5.0)	.0	0	.0	.0	.0	0	.0	.0
Trithion	--	--	--	--	--	--	--	--	.00
2,4-D	-- ([c]100)	.29	0	--	--	.00	--	--	--
2,4-DP	--	.00	0	--	--	.23	--	--	--
2,4,5-T	--	.05	0	--	--	.02	--	--	--

Note: All values are micrograms per liter, unless otherwise noted. Values exceeding the maximum contaminant concentration given here are underlined for emphasis.

[a] U.S. Environmental Protection Agency, 1976, limit for marine aquatic life, in micrograms per liter (ug/L).

[b] Analysis for suspended and (or) dissolved contaminants in the sand, silt, gravel, or organic material scooped from the streambed bottom, in micrograms per kilogram (ug/kg); "maximum contaminant concentration" does not apply to bottom samples.

[c] U.S. Environmental Protection Agency, 1977, limit for public water supply, in ug/L (or ug/kg).

[d] 0.00 means "not detected" using analytical techniques where level of detection is 0.01 ug/L (or ug/kg); 0., 0.0, and 0.000 are similar.

[e] Limit from National Academy of Sciences, National Academy of Engineering, 1972.

[f] For sample collected on May 31, 1978.

SUMMARY AND CONCLUSIONS

Background data on ground- and surface-water quantity and quality are summarized for the Shoalwater Bay Indian Reservation. Ground-water use (largely for domestic purposes) on the reservation ranges from 3.9 gal/min in November to 6.5 gal/min in August. Ground-water use (for domestic and industrial purposes) from the same artesian aquifer outside the reservation ranges from 36 gal/min in November to 120 gal/min in August. Effects of this water pumpage from the aquifer appear to be very small, and could not be measured. Increased pumpage in the future may have an effect on water levels and rates of flow from wells, but the response cannot be accurately predicted from available data.

The use of surface water from two streams that discharge into tribally owned tidelands would be governed by the quantity and quality of water available. The 7-day-average minimum flows, based on a statistical recurrence interval of 2 years, are estimated to be 0.3 ft^3/s for Cannery Slough tributary and 3.0 ft^3/s for Pacific County Drainage Ditch #1 (Ditch #1). High coliform bacteria, low dissolved-oxygen concentrations, and high turbidity occurred in all samples collected from Ditch #1. Organic chemicals, including Aldrin, DDD, DDT, Dieldrin, Diazinon, and Parathion, exceeded levels of concentration that are considered safe by the U.S. Environmental Protection Agency for protection of marine life. These high concentrations of organic chemicals (generally 2 to 10 micrograms per liter) were observed for one or both streams in samples collected during the study. Concentrations of Aldrin, DDD, DDE, DDT, Dichlobenil, and Dieldrin ranged from 0.4 to 42 micrograms per kilogram of bottom material in samples taken from Ditch #1. No long-term trends in concentration of organic chemicals in the water or bottom material of these streams could be determined from the data available. Any proposed use of the stream water or the tidelands into which they flow should take into consideration the presence of these potentially toxic chemicals.

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