

Seawater Intrusion Conditions

Much of the Pacific coast of Clallam County is within Olympic National Park and the ground water of that coastal strip is largely undeveloped. Because of the lack of ground-water development and deep wells in that area, seawater intrusion has not been observed nor is it likely to occur under present conditions. The Sequim-Dungeness area, where sizeable agricultural acreages are irrigated from wells, is the only part of the county where ground-water development has been extensive.

Deep wells are scarce along the shoreline of the Strait of Juan de Fuca between Neah Bay and Sequim Bay; domestic supplies in that area are taken from shallow wells, springs, or central systems that rely on streams. A few deep wells near the village of Neah Bay have been abandoned because of excessive chloride concentrations (Walters, 1971, p. 20).

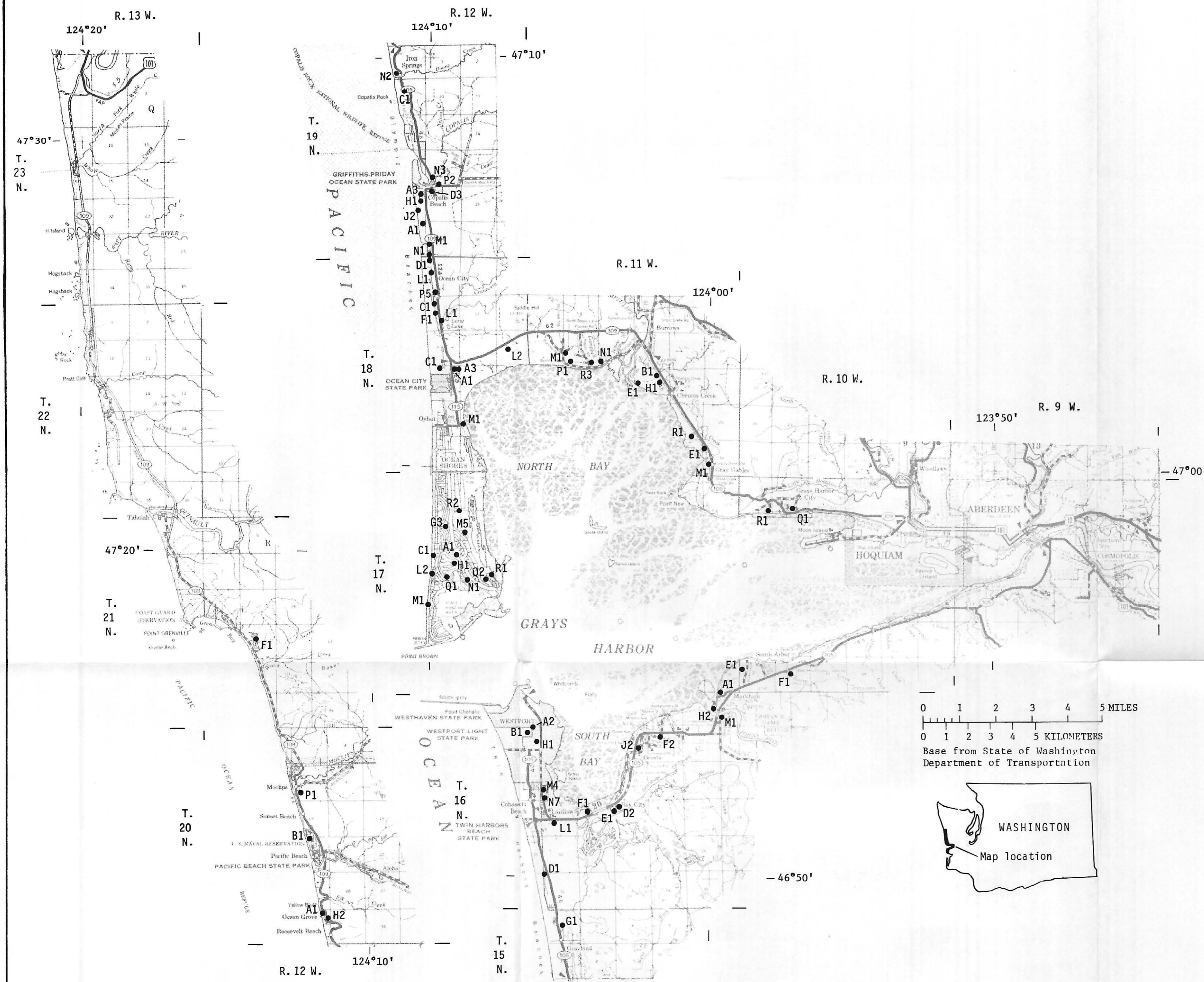
Water samples taken in 1978 from deep wells were low in chloride concentration (see table), indicating that seawater intrusion is probably not now a problem. Two shallow wells that supplied Neah Bay and were sampled in 1968 have since been abandoned, even though chloride concentrations in those wells were low. The village is now supplied by a central system fed by the Waatch River. Chloride concentrations in wells on the west shore of Sequim Bay are fairly high, as they were in 1968 (Walters, 1971, p. 21). Wells 29/3W-2K1 and 2Q1, which had high chloride concentrations in 1968, have since been abandoned. Wells 30/2W-15L1 and 16G1, near Diamond Point, reportedly high in chloride (145 and 313 mg/L, respectively) in 1968, have also been abandoned.

The overall chloride concentration of ground water in coastal Clallam County is low (table 1) and has not changed appreciably since 1968 (table 2). When local problems of seawater intrusion occurred many wells were abandoned. Large ground-water supplies probably cannot be developed in coastal areas of the county without the recurrence or aggravation of the intrusion problems previously observed.

Physical and chemical data for wells in Clallam County

Well number	Land-surface altitude (ft)	Depth of well (ft)	Specific conductance (micromhos at 25°C)	Chloride (mg/L)	Date of collection
28/15W-22N1	20	70	376.	62	7-12-78
29/ 3W- 1J1	30	94	390	7.3	7-06-78
-12D1	15	25	339	9.6	7-23-68
			331	11	7-06-78
-12F2	20	28	307	6.6	7-23-68
			284	6.5	7-06-78
30/ 6W-12H1	150	196	310	22	7-11-78
30/ 5W-12A1	140	152	321	21	7-30-68
			283	6.8	7-11-78
-12C1	140	144	315	7.0	7-30-68
			310	7.6	7-11-78
30/ 4W- 5J1	100	117	359	12	7-10-78
- 5L1	110	126	484	18	7-26-68
			482	17	7-11-78
30/ 3W- 5B1	5	265	250	2.2	7-24-68
			241	2.7	7-07-78
- 5B2	5	10	366	5.0	7-24-68
			366	6.5	7-07-78
- 5H1	8	30	352	4.3	7-07-78
-10N1	70	310	311	4.0	7-07-78
			391	5.4	7-24-68
-15G1	80	574	328	6.3	7-06-78
			328	3.8	8-02-68
-16B3	105	113	325	4.8	7-06-78
-22K1	15	355	676	5.3	7-07-78
			358	6.0	7-24-68
-23H1	40	107	375	3.7	7-06-78
			499	8.0	7-23-68
-25F1	100	186	480	7.5	7-06-78
			1,050	10	7-23-68
-27B2	40	64	1,010	16	7-06-78
			409	3.2	7-24-68
-34A1	60	258	370	3.7	7-06-78
-35E1	60	370	1,120	260	7-06-78
-36F1	40	--	1,580	400	7-06-78
			601	56	7-23-68
31/ 7W-33A1	10	13	520	36	7-06-78
			210	12	7-31-68
-33F1	10	14	195	13	7-11-78
			370	27	7-31-68
-34D1	15	30	351	30	7-11-78
			89	0.9	7-11-78
31/ 4W-25M1	5	300	294	5.1	7-25-68
			287	5.0	7-07-78
-25P2	50	63	233	4.8	7-07-78
-26G1	5	98	291	7.3	7-25-68
			283	7.3	7-10-78
-26Q2	70	90	369	10.	7-10-78
-27N1	90	118	340	11.	7-10-78
			368	12.	7-10-78
-27R1	35	53	377	13.	7-25-68
			356	10.	7-10-78
-35D1	70	94	261	5.8	7-10-78
31/ 3W-30M1	8	48	298	4.3	7-25-68
			296	5.0	7-07-78
-31B1	10	52	250	2.7	7-07-78
32/14W- 1A1	4	32	147	2.7	10-02-68
			173	5.0	7-12-78

SHEET 1. Seawater intrusion conditions in Clallam County.



**Seawater Intrusion Conditions**

Development of ground-water supplies in the coastal part of Grays Harbor County is limited to the area south of Moclips; little ground-water development has taken place on the Quinalt Indian Reservation. Moderately large quantities of ground water are used by cranberry growers in the area south of Westport. Nearshore wells are pumped intensively when the berry bogs are sprinkled for irrigation, for frost control, and to reduce heat damage. Moderate to large quantities of water also are used in the processing of seafoods and forest products.

Seawater intrusion does not appear to be a problem in coastal Grays Harbor County. Of the 69 water samples taken from wells in 1978, none had a chloride concentration in excess of 100 mg/L, and even wells as deep as 500 feet below sea level had chloride concentrations in 1978 that were generally less than 20 mg/L. A few scattered wells in the county, however, had chloride concentrations significantly higher than the median of 16 mg/L (table 1).

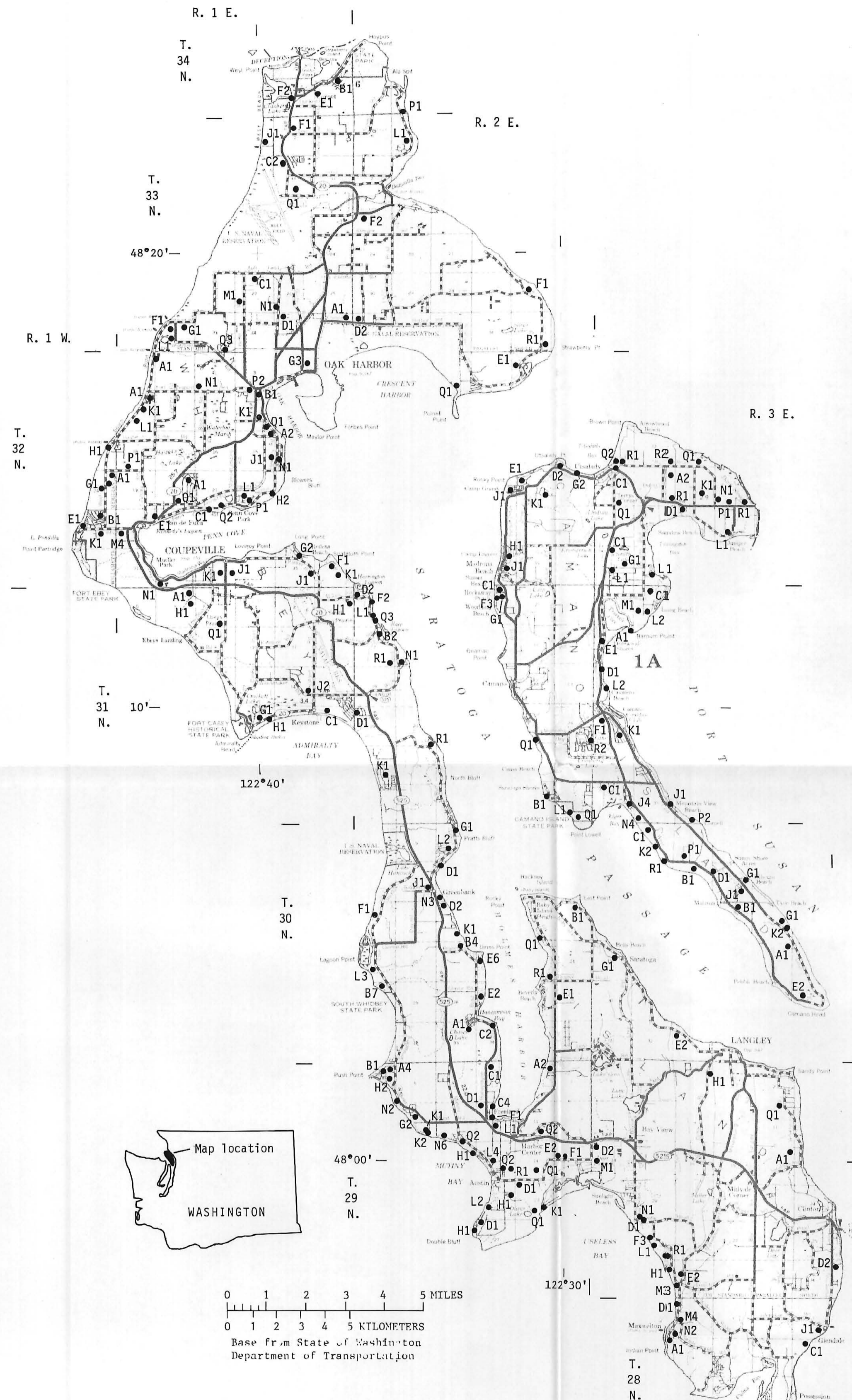
Widespread seawater intrusion has not been detected to date in areas such as the Westport and Ocean Shores peninsulas, where intrusion problems would be expected for physiographic reasons. In fact, a significant decrease in chloride concentration was noted between 1968 and 1978 in water from a shallow well (17/12W-15A1) on the Ocean Shores peninsula. When sampled in 1968, the well was used for domestic purposes and had a chloride concentration of 210 mg/L. In 1978 the well was used only for lawn sprinkling and the chloride concentration had decreased to 14 mg/L. This decrease was probably due to a reduction in the amount of water withdrawn from the well.

The overall chloride concentrations and specific-conductance values in ground water of coastal Grays Harbor County rose slightly but not significantly between 1968 and 1978 (table 2).

**Physical and chemical data for wells in Grays Harbor County**

Well number	Land-surface altitude (ft)	Depth of well (ft)	Specific conductance (micromhos at 25°C)	Chloride (mg/L)	Date of collection
15/11W- 661	17	130	278	11.	10-29-68
			261	12.	7-26-78
16/12W-12A2	15	86	267	27.	7-26-78
-12B1	20	110	262	24.	7-26-78
-12H1	10	42	359	27.	10-29-68
			321	27.	7-25-78
16/11W- 1M1	50	168	183	6.6	10-25-68
			172	9.4	7-25-78
- 2A1	10	150	210	8.3	10-25-68
			204	10.	7-25-78
- 2H2	10	150	188	8.0	10-25-68
			206	10.	7-25-78
- 9J2	25	148	205	7.7	10-25-68
			197	8.9	7-25-78
-10F2	25	310	138	7.7	7-25-78
-18M4	25	71	342	39.	7-26-78
-18N7	25	68	234	22.	10-28-68
			244	26.	7-26-78
-19L1	20	242	180	17.	7-26-78
-20F1	12	20	138	20.	10-28-68
			132	24.	7-25-78
-21D2	25	151	152	20.	7-25-78
-21E1	2	525	185	16.	10-25-68
			173	17.	7-25-78
-31D1	15	58	303	33.	10-29-68
			283	24.	7-26-78
17/12W- 3R2	10	513	339	7.4	7-19-78
-10G3	10	20	291	16.	10-22-68
			323	30.	7-19-78
-11M5	20	20	79	7.8	10-11-68
			120	14.	7-20-78
-14N1	12	28	479	18.	10-23-68
			422	20.	7-20-78
-14Q2	10	20	307	26.	10-10-68
			300	34.	7-20-78
-14R1	10	20	238	37.	10-09-68
			222	55.	7-20-78
-15A1	12	20	962	210.	10-22-68
			304	14.	7-20-78
-15C1	10	20	343	33.	10-22-68
			365	39.	7-20-78
-15H1	10	20	654	16	10-23-68
			700	13	7-20-78
-15L2	10	14	335	17	10-23-68
			392	22	7-20-78
-15Q1	10	20	281	9.6	10-23-68
			344	21	7-20-78
-22M1	10	20	191	11	10-23-68
			165	13	7-20-78
17/10W- 5Q1	140	201	165	8.7	7-24-78
- 6R1	40	107	213	16	10-24-68
			250	15	7-24-78
-31E1	70	166	197	8.9	7-25-78
-32F1	20	28	179	7.8	10-25-68
			262	10	7-25-78
18/12W- 3D1	15	126	425	6.9	10-08-68
			377	8.7	7-18-78
- 3L1	15	155	255	9.3	10-08-68
			240	11	7-18-78
- 3P5	10	400	173	9.5	10-08-68

-10C1	--	--	161	13	7-18-78
	20	55	515	78	10-08-68
	--	--	542	89	7-18-78
-10F1	20	100	198	18	10-08-68
	--	--	184	19	7-18-78
-10L1	15	23	294	32	10-08-68
	--	--	312	39	7-18-78
-13L2	15	508	130	16	7-21-78
-22A1	45	85	248	28	10-10-68
	--	--	287	25	7-19-78
-22A3	35	85	216	27	10-10-68
	--	--	264	22	7-19-78
-22C1	10	14	136	11	10-09-68
	--	--	442	37	7-19-78
-26M1	10	474	162	8.1	10-09-68
	--	--	146	12	7-19-78
18/11W-16N1	10	13	71	6.1	10-21-68
	--	--	60	8.7	7-21-78
-17M1	15	40	160	14	10-24-68
	--	--	142	13	7-21-78
-17P1	10	170	283	13	10-24-68
	--	--	272	13	7-21-78
-17R3	12	75	238	18	10-24-68
	--	--	222	18	7-21-78
-22B1	15	110	700	60	7-21-78
-22E1	20	325	151	5.5	10-21-68
	--	--	167	11	7-21-78
-22H1	15	300	178	9.6	10-21-68
	--	--	142	8.2	7-21-78
-26R1	10	90	128	6.2	10-21-68
	--	--	128	9.2	7-24-78
-36E1	40	60	74	8.6	10-21-68
	--	--	64	8.9	7-24-78
-36M1	12	13	75	7.5	10-21-68
	--	--	79	8.9	7-24-78
19/12W- 4N2	25	165	349	66	7-13-78
- 9C1	110	200	246	34	7-13-78
-22N3	10	86	155	8.6	10-04-68
	--	--	156	15	7-13-78
-22P2	20	42	218	20	10-04-68
	--	--	229	17	7-13-78
-27D3	6	100	171	14	10-04-68
	--	--	160	14	7-13-78
-28A3	10	100	240	22	10-04-68
	--	--	187	16	7-13-78
-28H1	15	111	198	15	10-04-68
	--	--	191	16	7-14-78
-28J2	12	109	226	18	10-07-68
	--	--	252	19	7-14-78
-33A1	12	120	202	19	10-07-68
	--	--	274	35	7-14-78
-34M1	20	171	204	15	10-07-68
	--	--	212	16	7-14-78
-34N1	15	51	388	8.5	10-07-68
	--	--	381	10	7-14-78
20/12W- 8P1	60	234	172	12	10-03-68
	--	--	161	14	7-13-78
-20B1	110	250	168	7.6	10-03-68
	--	--	150	9.1	7-13-78
-32A1	30	160	166	15	7-13-78
-32H2	40	320	165	6.9	10-03-68
	--	--	156	8.8	7-13-78
21/12W-20F1	120	264	210	15	10-03-68
	--	--	188	18	7-13-78



Seawater Intrusion Conditions

Ground-water development in Island County has resulted from a growing number of seasonal and permanent homes and small public-supply systems.

The median chloride concentration of ground water in Island County was 26 mg/L (table 1), and was exceeded only by the median concentration in San Juan County. The high chloride concentrations of ground water in the county may be due to the presence of fine-grained sediments that underlie the surface of the islands...

Local problems of seawater intrusion in Island County are common, and numerous wells have been abandoned or destroyed because of excessive salinity. Data collected in 1978 indicate that problems of seawater intrusion, or of relict seawater, are especially acute east of Fort Casey Historical State Park and in the Penn Cove area of Whidbey Island...

Most high-chloride wells were completed in sand or sand and gravel. As in 1968, the highest known chloride concentration (13,000 mg/L) of ground water in Island County in 1978 was from industrial well 32/1-32N1 near Coupeville.

Island County is an area of rapid development. As the area continues to develop with concurrent and increasing ground-water withdrawals, the extent of seawater intrusion will presumably broaden and intensify unless precautionary steps are taken concomitant with development.

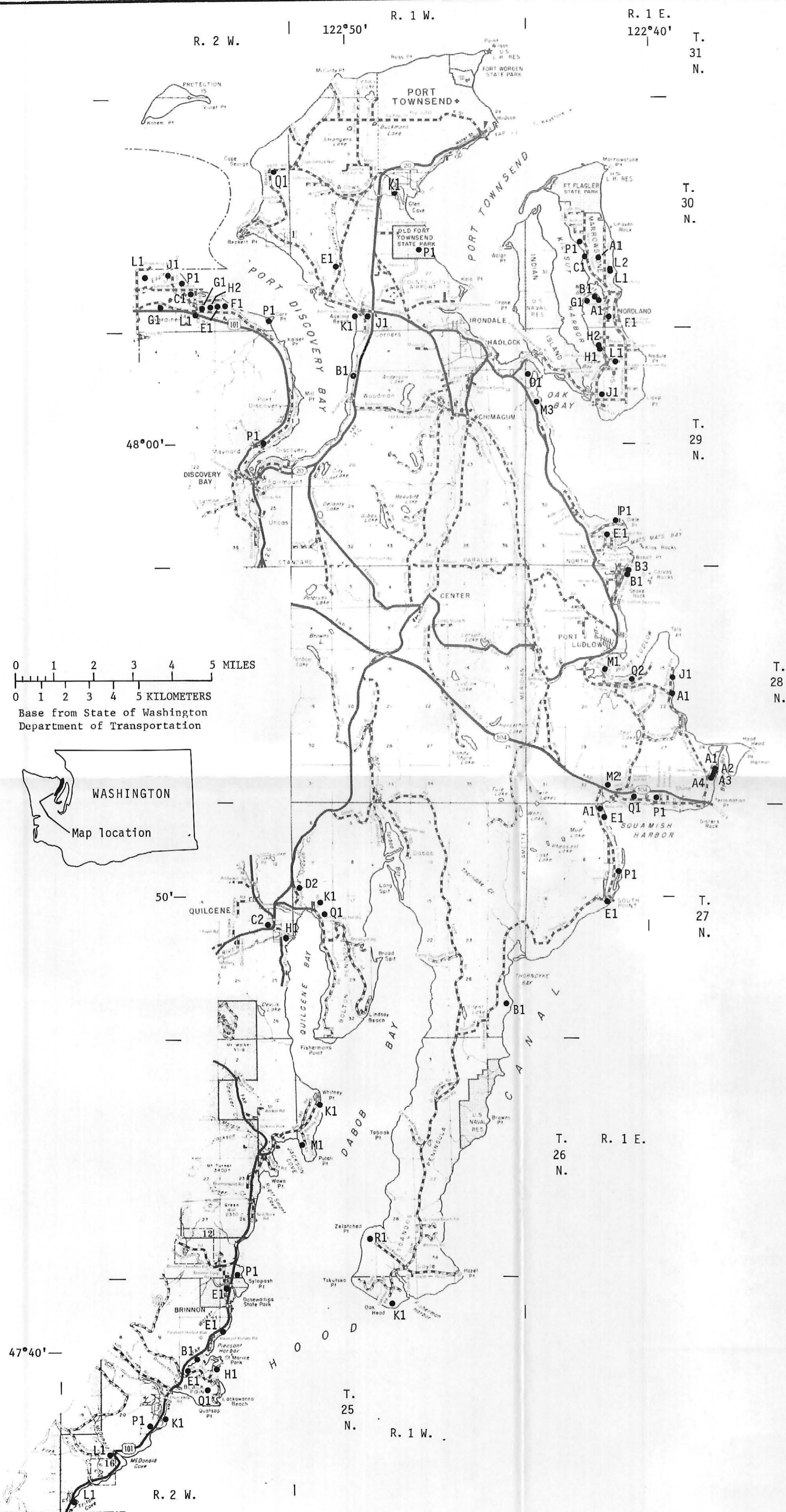
Median values of specific conductance and of chloride concentration decreased from 1968 to 1978 (table 2), despite increased development of ground water during the decade. We must renew our warning in the general discussion that various factors may contribute to seeming changes, and that comparison of only two numbers (median 1968, median 1978) might lead to spurious conclusions.

Physical and chemical data for wells in Island County

Table with columns: Well number, Land-surface altitude (ft), Depth of well (ft), Specific conductance (micromhos at 25°C), Chloride (mg/L), Date of collection. Lists data for numerous wells across the county.

Large data table listing well identifiers (e.g., 29/4 -31D2, 30/2 -4G1) and their corresponding physical and chemical data, including specific conductance, chloride concentration, and collection dates.

1/ Data furnished by Washington Department of Ecology.



Seawater Intrusion Conditions

The ground water of coastal Jefferson County is largely undeveloped; most of the Pacific coast in the western part of the county is within Olympic National Park. Local areas in the eastern part of the county are being developed for residential use. Because of the lack of ground-water development along the Pacific coast, no ground-water samples were collected from that area in 1978. No wells were found on Indian Island immediately west of Marrowstone Island in 1968 or 1978. The Navy installation there is supplied with surface water from the mainland.

In the Gardiner area of eastern Jefferson County, samples from five wells had chloride concentrations ranging from 170 to 2,300 mg/L. Five other wells in the same area and drilled to the same general depths had much lower chloride concentrations, ranging from 9.6 to 28 mg/L. Samples taken from a third group of wells in the Gardiner area which did not extend below sea level had very high chloride concentrations. The high chloride concentrations in the Gardiner area are probably the result of incomplete flushing of relict seawater rather than excessive pumping of deep wells (Walters, 1971, p. 21). Data from the shallow wells are not included in the table.

In the northern part of Marrowstone Island, three wells yielded water with chloride concentrations ranging from 100 to 610 mg/L. In the southern part of Marrowstone Island, well 29/1-5H2, which taps a sandstone aquifer about 60 feet below sea level, yielded water with 360 mg/L chloride in 1978 and 1,150 mg/L in 1968.

Water from two wells on the west side of Bywater Bay had chloride concentrations of 250 and 350 mg/L. The wells are completed at depths of 15 and 70 feet below sea level, respectively. Two nearby wells that tap aquifers at the same general altitude had chloride levels below 50 mg/L, indicating that the seawater intrusion problem in the Bywater Bay area is of a local nature and is probably controlled by geologic conditions.

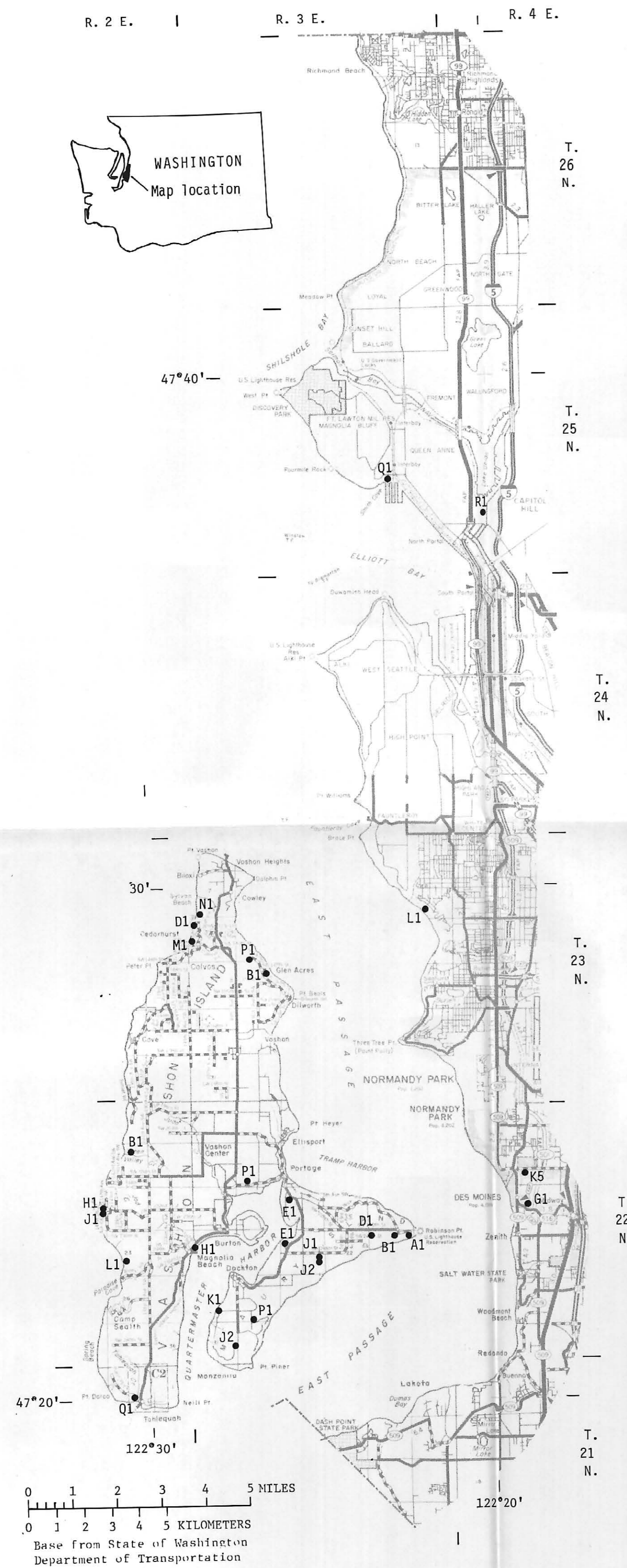
A comparison of chloride concentrations and specific-conductance values measured in Jefferson County in 1968 and 1978 (table 2) indicates that chemical conditions in the coastal ground water are virtually unchanged. Increased ground-water development from deep wells could, however, lead to higher chloride levels. The geologic conditions on Indian Island are similar to those on Marrowstone Island; seawater intrusion would probably ensue if ground-water development from deep wells were to take place on Indian Island.

The potential for the worsening of seawater intrusion problems exists for Bywater Bay, Port Ludlow Bay, and South Point, where incipient problems have already been detected. However, in those areas such as the Gardiner area, where high-chloride concentrations may be the result of relict seawater, chloride concentrations probably will not increase. These areas could possibly benefit from increased ground-water withdrawals which induce ground-water flow from adjacent areas and result in a flushing of the affected aquifer.

Physical and chemical data for wells in Jefferson County

Well number	Land-surface altitude (ft)	Depth of well (ft)	Specific conductance (micromhos at 25°C)	Chloride (mg/L)	Date of collection
25/ 2W- 2E1	20	60	75	1.0	8-14-68
			48	1.6	6-20-78
-11E1	80	84	277	31	8-13-68
			246	33	6-20-78
-15B1	15	47	85	1.3	8-09-68
			115	4.1	6-20-78
-15E1	125	214	148	2.1	6-20-78
-15H1	45	100	114	2.8	6-20-78
-15Q1	200	270	114	2.1	6-20-78
-21K1	20	70	213	1.9	8-09-68
			211	2.6	6-20-78
-21P1	30	39	77	1.0	8-09-68
			50	2.1	6-20-78
-29L1	10	40	82	1.0	8-08-68
			54	1.0	6-20-78
-31L1	30	120	150	2.6	6-20-78
25/ 1W- 4K1	220	222	142	2.6	6-22-78
26/ 2W-35P1	10	28	97	0.2	8-14-68
			100	1.3	6-20-78
26/ 1W- 7K1	70	150	127	1.8	8-14-68
			128	2.3	6-21-78
-18M1	50	130	165	6.9	8-14-68
			154	9.6	6-21-78
-29R1	180	300	260	31	8-14-68
			356	56	6-22-78
27/ 2W-24C2	50	141	281	39	6-21-78
-24H1	10	20	141	14	8-14-68
			101	6.2	6-21-78
27/ 1W-18D2	25	147	756	31	6-21-78
-18K1	40	60	328	3.9	6-21-78
-18Q1	45	134	296	3.4	6-21-78
-36B1	40	183	366	6.8	8-15-68
			366	8.5	6-22-78
27/ 1 - 4E1	30	120	172	6.2	6-22-78
- 5A1	30	97	183	4.1	8-15-68
			176	5.4	6-22-78
- 9P1	10	--	293	26	8-15-68
			346	46	6-22-78
-16E1	5	92	1,190	301	8-15-68
			1,550	410	6-22-78

28/ 1 - 4B1	50	92	390	11	7-09-68
			406	12	6-26-78
- 4B3	75	140	461	18	6-26-78
-15J1	65	101	206	4.9	6-23-78
-16M1	30	125	947	241	7-09-68
			1,230	330	6-23-78
-16Q2	50	83	219	3.3	7-09-68
			213	3.9	6-23-78
-22A1	80	92	167	6.8	7-09-68
			183	8.0	6-23-78
-33M2	130	165	286	3.6	6-22-78
-33Q1	25	30	415	22	8-16-68
			496	63	6-22-78
-34P1	20	65	517	45	8-16-68
			491	32	6-23-78
-35A1	105	120	1,430	350	8-28-78
-35A2	110	113	519	41	8-28-78
-35A3	80	110	303	5.8	8-28-78
-35A4	40	110	927	250	8-28-78
29/ 2W-13P1	40	60	283	7.0	10-01-68
			284	11	7-05-78
29/ 1W- 8B1	100	150	305	12	6-30-78
29/ 1 - 4L1	120	250	705	91	6-29-78
- 5H1	14	88	367	11	7-24-68
			390	18	6-29-78
- 5H2	20	80	4,090	1,150	7-24-68
			1,520	360	6-29-78
- 7D1	40	60	665	74	7-11-68
			646	67	6-27-78
- 7M3	45	56	327	9.2	7-10-68
			306	9.6	6-27-78
- 8J1	75	112	596	23	6-27-78
-28P1	30	100	321	12	7-10-68
			281	14	6-26-78
-33E1	45	79	346	7.8	6-26-78
30/ 2W-12Q1	230	300	470	27	6-29-78
-27P1	80	131	1,370	330	8-28-78
-28J1	130	130	192	12	8-29-78
-28L1	100	137	270	9.6	8-29-78
-33G1	310	420	179	20	8-29-78
-34C1	20	77	2,900	820	10-01-68
			2,490	650	7-05-78
-34G1	175	245	354	13	8-28-78
-34H2	220	340	745	170	7-05-78
-34L1	240	360	389	28	10-01-68
			231	20	7-05-78
-35E1	130	175	2,300	665	10-01-68
			2,290	700	7-05-78
-35F1	72	180	6,900	2,300	7-05-78
-36P1	20	93	415	23	7-05-78
30/ 1W-16K1	30	31	515	27	7-25-68
			452	24	6-29-78
-22P1	180	270	436	12	7-25-68
			456	21	6-27-78
-29E1	75	290	525	16	7-25-68
			540	12	6-29-78
-32J1	120	145	314	7.0	9-30-68
			305	9.9	6-30-78
-32K1	44	47	422	2.0	9-30-68
			449	6.5	6-30-78
30/ 1 -20P1	50	75	1,340	240	6-28-78
-28L1	40	60	609	55	7-11-68
			516	47	6-28-78
-28L2	55	63	599	46	7-11-68
			646	58	6-28-78
-29A1	100	136	2,420	610	6-28-78
-29C1	25	32	1,680	358	7-11-68
			911	100	6-28-78
-32A1	35	371	2,220	610	6-28-78
-32B1	60	168	1,970	47	6-28-78
-32G1	40	168	996	63	6-28-78
-33E1	20	35	790	66	7-24-68
			816	73	6-28-78



Seawater Intrusion Conditions

In coastal areas of King County many wells have been abandoned or destroyed because of a decreasing need of water from ground-water sources. Much of the area is now served by public-supply systems that obtain water from surface sources or from highly productive wells that are several miles inland, and thereby less susceptible to seawater intrusion. Those parts of Vashon and Maury Islands not served by public water-supply systems rely on springs and shallow wells.

Most of coastal King County is highly urbanized and public water-supply systems are supplied from surface-water sources. Wells were difficult to find in the county; of the 27 wells sampled in the 1978 survey, five were on the mainland and the remainder were on Vashon and Maury Islands.

The chloride concentration of well 23/3-7N1 was significantly higher in 1978 (150 mg/L) than in 1968 (86 mg/L); the chloride concentration of well 23/3-18D1 was slightly lower in 1978 (630 mg/L) than in 1968 (658 mg/L). The salinity of water from other wells sampled on Vashon and Maury Islands increased slightly between 1968 and 1978.

Seawater-intrusion problems are unlikely to occur in mainland King County because of the small amounts of ground water withdrawn. Intrusion problems are likely to increase on Vashon and Maury Islands if additional water supplies are obtained from ground-water sources. The most serious problems are likely to occur in the northern part of Vashon Island, where some intrusion already has been detected.

The overall chloride concentration of ground water in King County was low (table 1) in 1978 and decreased between 1968 and 1978 (table 2).

Physical and chemical data for wells in King County

Well number	Land-surface altitude (ft)	Depth of well (ft)	Specific conductance (micromhos at 25°C)	Chloride (mg/L)	Date of collection
21/ 1 - 2Q1	10	10	287	14	7-02-68
	--	--	280	25	5-30-78
22/ 2 -11B1	70	--	182	3.5	7-03-68
	--	--	176	4.9	5-30-78
-15H1	72	256	206	5.2	5-30-78
-15J1	105	280	273	3.9	7-02-68
	--	--	256	4.1	5-30-78
-23L1	50	205	162	1.8	7-11-68
	--	--	148	2.8	5-30-78
-24H1	30	112	159	2.7	7-10-68
	--	--	150	3.4	5-30-78
22/ 3 - 8P1	15	--	253	2.9	7-10-68
	--	--	248	4.1	6-01-78
-16E1	60	462	497	7.2	7-08-68
	--	--	686	4.1	5-31-78
-21E1	120	475	271	2.9	7-09-68
	--	--	270	4.4	5-31-78
-21J1	425	518	190	4.7	5-31-78
-21J2	340	348	190	4.7	5-31-78
-23A1	35	148	493	6.8	7-09-68
	--	--	493	10	5-31-78
-23B1	130	132	196	11	5-31-78
-23D1	380	388	209	4.7	5-31-78
-29P1	315	619	232	2.3	7-09-68
	--	--	217	3.9	5-31-78
-30K1	5	7	201	6.6	7-09-68
	--	--	154	6.7	5-31-78
-31J2	375	573	618	6.2	5-31-78
22/ 4 - 8K5	155	200	177	4.5	3-31-67
	--	--	149	2.8	6-05-78
-17G1	102	200	300	14	3-29-67
	--	--	277	12	6-05-78
23/ 3 - 7N1	30	125	994	86	7-05-68
	--	--	1,080	150	6-01-78
-12L1	70	131	293	9.6	6-05-78
-17P1	40	--	565	83	7-08-68
	--	--	547	85	6-01-78
-18D1	100	320	2,400	658	7-05-68
	--	--	2,400	630	6-01-78
-18M1	70	250	210	2.9	7-05-68
	--	--	217	3.5	6-01-78
-20B1	50	75	280	5.3	7-08-68
	--	--	249	6.0	6-01-78
25/ 3 -23Q1	20	1,084	413	38	4-06-67
	--	--	348	27	6-05-78
25/ 4 -30R1	115	555	327	14	4-12-67
	--	--	195	4.7	6-05-78

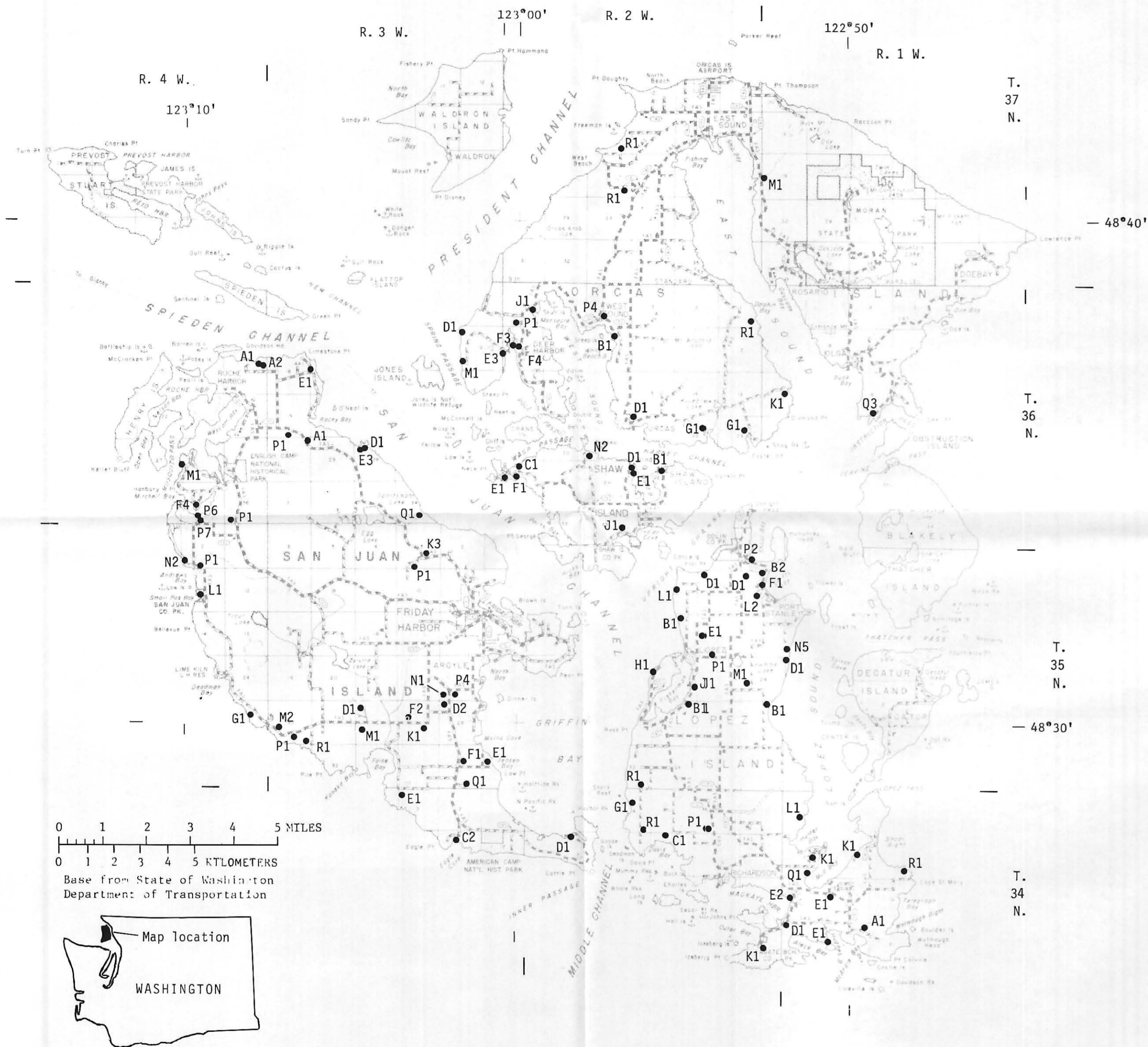












Seawater Intrusion Conditions

Seawater intrusion is a widespread problem on the principal islands of San Juan County. In the past, numerous wells drilled in coastal areas and/or to depths below sea level have encountered water that was too salty for the intended purpose. Most wells were either abandoned or destroyed shortly after completion.

Water samples were collected from 94 wells in San Juan County in 1978; of the 94, 15 showed signs of seawater intrusion. Nine of the 15 wells were on Lopez Island; the remainder were on Orcas, San Juan, and Shaw Islands. The smaller islands of the County were not surveyed because of logistical difficulties and their general lack of ground-water development.

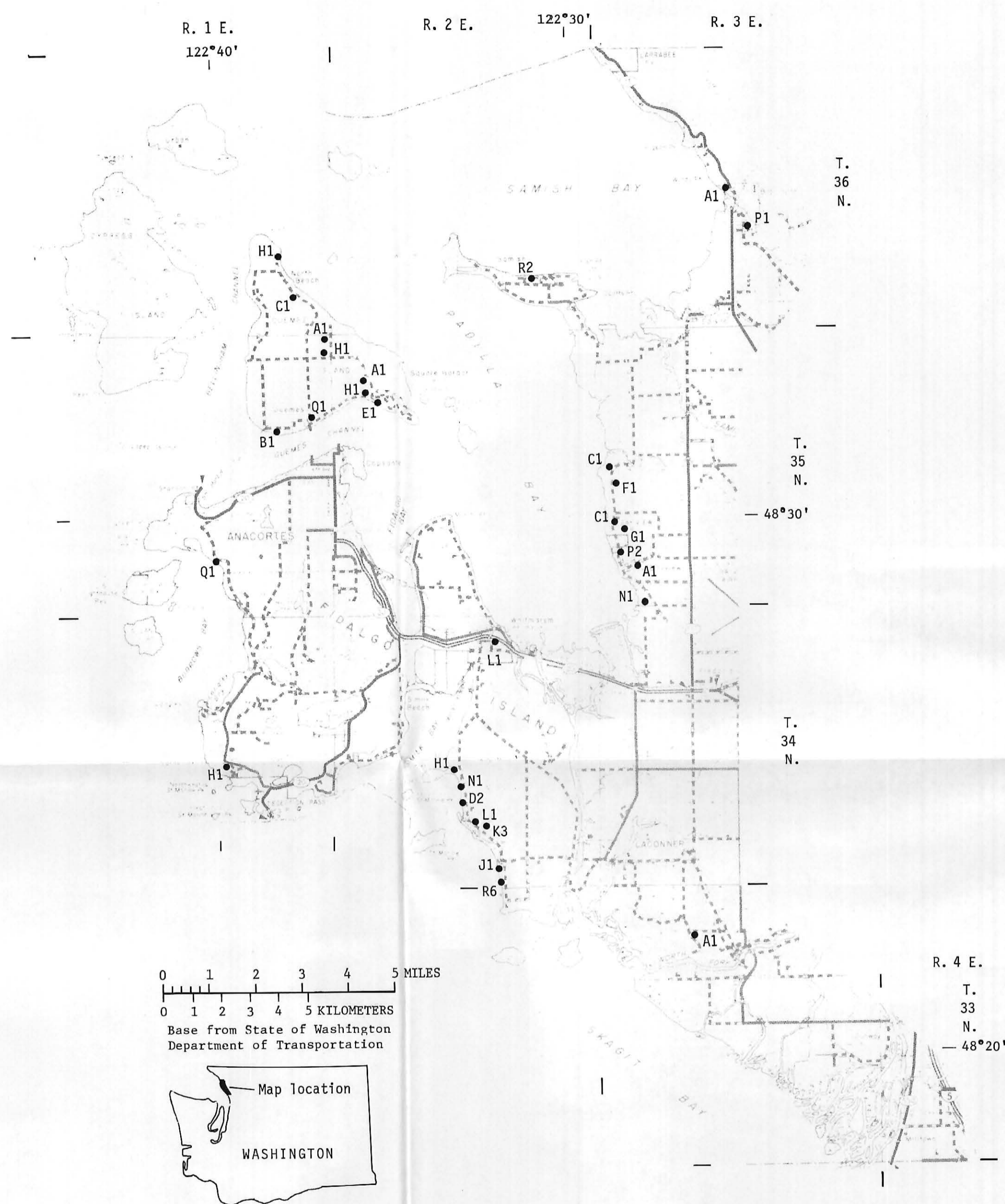
The median chloride concentration of samples from the county in 1978 was 40 mg/L (table 1), the highest of all the counties surveyed. This high value is due, at least in part, to the thinness of the surficial unconsolidated aquifers, the low permeability of the bedrock aquifers, the low precipitation (18-28 inches per year) on the islands, and the increasing demands on the poorly productive aquifers by a rapidly growing population. Even though the median concentration was high, the maximum chloride concentration observed (580 mg/L) was relatively low as compared to other counties sampled.

The wells of San Juan County were not sampled by Walters (1971) as part of his investigation because of logistical considerations; consequently, there were no salinity values earlier than 1978 with which to make comparisons. However, the high chloride concentrations measured as part of this study and the widespread abandonment of wells suggest that seawater intrusion is a serious water-quality problem in the county. Because the population of the county is increasing rapidly, ground-water withdrawals are also increasing. The potential exists, therefore, for a worsening of the intrusion conditions documented to date.

Physical and chemical data for wells in San Juan County

Well number	Land-surface altitude (ft)	Depth of well (ft)	Specific conductance (micromhos at 25°C)	Chloride (mg/L)	Date of collection
34/ 3W- 4A1	90	220	760	53	8-11-78
-11C2	70	160	900	150	8-11-78
34/ 2W- 2P1	120	410	830	150	8-01-78
- 4G1	90	118	710	72	7-31-78
- 4R1	65	129	970	31	7-31-78
- 8D1	40	41	800	150	8-11-78
-10C1	130	209	750	68	8-01-78
-24K1	60	203	685	77	8-01-78
34/ 1W- 6L1	60	214	505	28	8-02-78
- 7K1	100	108	750	89	8-02-78
- 7Q1	110	285	810	150	8-01-78
- 8K1	60	95	1,490	150	8-01-78
- 9R1	60	164	735	72	8-01-78
-17E1	80	115	755	52	8-01-78
-18E2	100	260	1,820	410	8-01-78
-19D1	30	200	730	83	8-01-78
-20A1	180	189	940	110	8-01-78
-20E1	40	164	510	42	8-01-78
35/ 4W- 2N2	65	165	465	21	8-10-78
- 2P1	75	180	825	39	8-10-78
-11L1	40	30	380	16	8-10-78
-25G1	80	306	361	16	8-10-78
35/ 3W- 3K3	180	200	368	34	8-09-78
- 3P1	200	244	530	31	8-09-78
-23P4	100	323	477	58	8-11-78
-26D2	160	242	760	75	8-11-78
-26D3	190	250	480	36	8-11-78
-27F2	80	305	530	46	8-11-78
-27K1	110	224	590	46	8-11-78
-28D1	100	206	485	25	8-11-78
-28M1	155	163	538	36	8-11-78
-30K2	200	185	720	77	8-10-78
-30M2	200	450	390	30	8-10-78
-30R1	120	255	725	77	8-10-78
-35F1	140	275	1,100	100	8-11-78
-35Q1	220	406	815	52	8-11-78
-36E1	50	382	860	230	8-11-78
35/ 2W- 1P2	35	41	1,320	280	7-31-78
-10L1	70	88	430	30	7-31-78
-11D1	50	68	521	34	7-31-78
-12B2	45	72	580	84	8-02-78
-12D1	70	83	535	50	8-02-78
-12F1	25	36	980	82	8-02-78
-12L2	60	70	945	56	8-02-78
-14E1	100	113	680	27	7-31-78
-14P1	90	135	615	27	7-31-78
-15B1	130	159	1,450	200	7-31-78
-21H1	15	219	995	150	7-31-78
-22I1	40	50	510	73	7-31-78
-24M1	280	408	1,400	280	8-02-78
-25B1	45	141	545	74	8-02-78
-27B1	30	64	395	26	8-01-78
-33R1	160	160	612	44	7-31-78

35/ 1W-18N5	70	147	720	86	8-02-78
-19D1	70	154	760	56	8-02-78
36/ 4W-13G1	75	50	500	12	8-09-78
-13G2	95	160	580	15	8-09-78
-26M1	50	266	715	42	8-11-78
-35F4	20	202	865	77	8-10-78
-35P6	125	150	482	21	8-09-78
-35P7	110	198	481	29	8-17-78
-36P1	45	329	430	58	8-10-78
36/ 3W-12D1	30	366	540	16	8-03-78
-12M1	35	206	785	21	8-03-78
-17E1	70	48	402	20	8-09-78
-19P1	170	255	400	17	8-09-78
-28F1	50	220	461	13	8-09-78
-28F2	90	222	485	12	8-09-78
-30A1	165	226	365	14	8-09-78
-34Q1	80	240	520	18	8-09-78
36/ 2W- 1R1	80	300	338	14	8-07-78
- 4P4	25	356	415	86	8-04-78
- 6J1	60	140	445	21	8-04-78
- 6P1	80	266	495	21	8-04-78
- 7E3	100	186	340	11	8-03-78
- 7F3	40	206	440	26	8-04-78
- 7F4	25	206	435	17	8-04-78
- 9B1	130	326	420	18	8-04-78
-15N4	200	446	435	7.1	8-07-78
-21N2	75	90	580	8.1	8-03-78
-23G1	80	606	450	16	8-07-78
-24G1	80	230	380	16	8-07-78
-27B1	15	138	640	41	8-03-78
-27D1	40	161	770	51	8-03-78
-27E1	25	130	605	36	8-03-78
-30C1	40	466	650	32	8-03-78
-30E1	30	300	2,240	580	8-03-78
-30F1	60	293	650	32	8-03-78
-33J1	50	86	530	20	8-03-78
36/ 1W-16Q3	40	576	515	21	8-07-78
-18K1	180	266	465	34	8-07-78
37/ 2W-16R1	145	186	311	12	8-08-78
-21R1	150	346	1,070	270	8-08-78
37/ 1W-19M1	100	346	560	60	8-08-78



Seawater Intrusion Conditions

Ground-water development in coastal Skagit County is minor, due chiefly to low well yields and the abundance of surface water.

Despite the paucity of wells, seawater intrusion was detected in several scattered locations in 1978. Water from well 34/2-34R6, on the Swinomish Indian Reservation, had a chloride concentration of 400 mg/L. Walters (1971, p. 45) found no evidence of intrusion beneath the reservation in 1967, but he did not sample well 34/2-34R6.

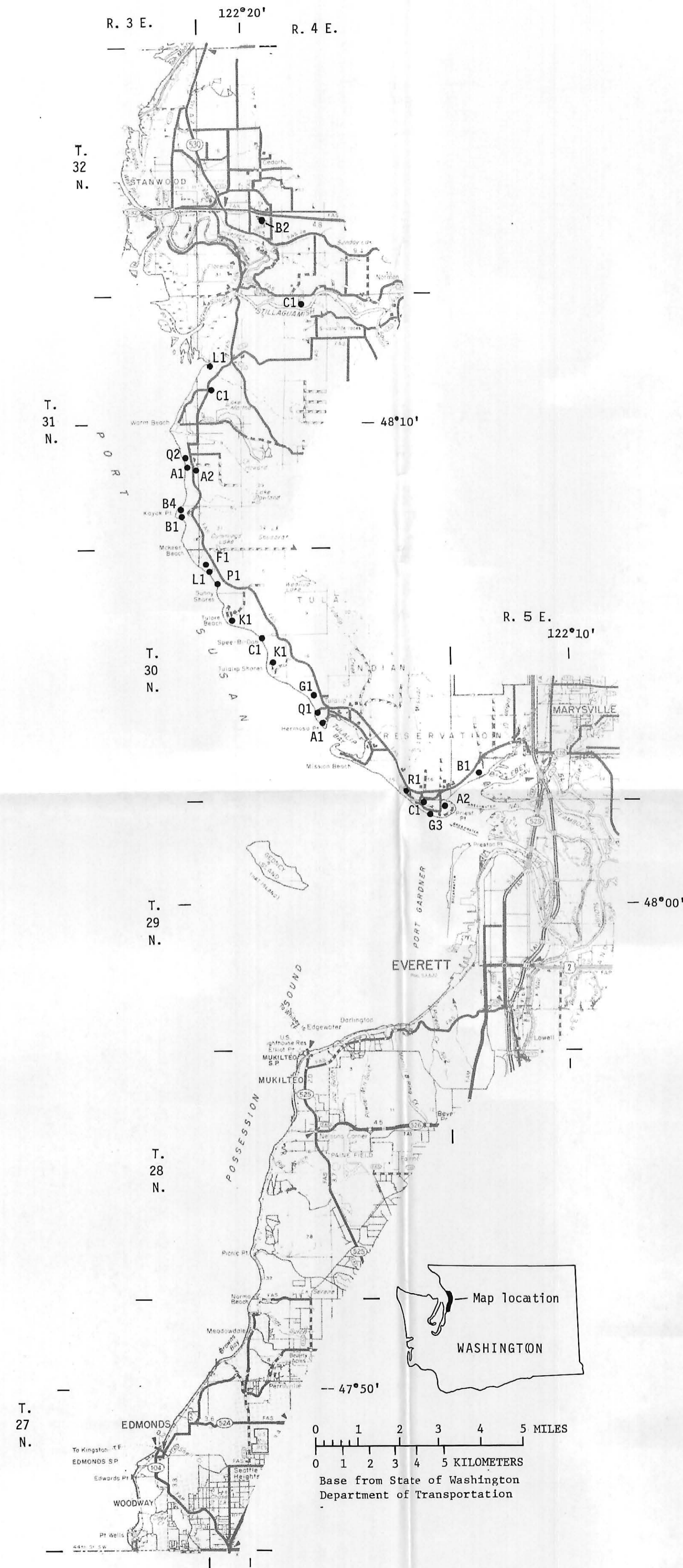
Water from domestic well 35/1-27Q1 had 120 mg/L of chloride when sampled in April 1987; this had decreased to 83 mg/L in June 1978. Walters (1971, p. 45) presented evidence that the high chloride concentration in this well is probably due to relict seawater rather than true seawater intrusion.

Because of the limited development of ground water in coastal Skagit County, problems of seawater intrusion probably will continue to be restricted to individual wells.

The median chloride concentration of 30 ground-water samples collected in 1978 was 25 mg/L (table 1). A comparison of 18 sets of chemical analyses indicates that the median concentration increased from 22 mg/L in 1967 to 24 mg/L in 1978 (table 2).

Physical and chemical data for wells in Skagit County

Well number	Land-surface altitude (ft)	Depth of well (ft)	Specific conductance (micromhos at 25°C)	Chloride (mg/L)	Date of collection
33/ 3 - 8A1	35	120	1,040	110	6-09-78
34/ 1 -22H1	40	78	580	46	4-28-67
			550	42	6-13-78
34/ 2 - 3L1	90	108	261	16	6-13-78
-21H1	30	65	578	55	5-03-67
			455	38	6-12-78
-22N1	30	52	657	30	5-03-67
			600	29	6-12-78
-27D2	15	72	536	44	5-03-67
			570	47	6-12-78
-27K3	45	48	484	25	5-02-67
			613	26	6-12-78
-27L1	40	99	555	57	6-12-78
-34J1	105	160	348	17	6-09-78
-34R6	45	200	2,620	400	6-09-78
35/ 1 - 1A1	100	163	268	11	6-15-78
- 1H1	130	166	228	17	5-04-67
			245	15	6-15-78
-12Q1	30	171	321	20	5-04-67
			306	17	6-15-78
-14B1	25	81	386	36	6-15-78
-27Q1	30	54	868	120	4-28-67
			739	83	6-13-78
35/ 2 - 7A1	60	110	538	32	5-04-67
			510	24	6-15-78
- 7H1	15	72	539	52	6-15-78
- 8E1	40	154	905	16	6-15-78
35/ 3 -19C1	15	70	543	39	4-27-67
			539	37	6-14-78
-19F1	55	--	499	18	5-03-67
			520	23	6-14-78
-30C1	65	70	461	12	4-27-67
			465	9.3	6-14-78
-30G1	150	157	337	12	4-26-67
			342	11	6-14-78
-30P2	30	98	496	18	4-26-67
			510	20	6-13-78
-31A1	105	125	557	16	4-26-67
			285	8.9	10-17-78
-32N1	30	76	431	10	6-13-78
36/ 1 -26H1	100	134	2,280	630	6-15-78
-36C1	50	54	1,330	315	5-04-67
			1,190	270	6-15-78
36/ 2 -26R2	15	89	1,180	270	6-14-78
36/ 3 -21A1	35	52	382	12	4-27-67
			331	10	6-14-78
-22P1	9	20	196	4.0	4-27-67
			85	5.2	6-14-78



**Seawater Intrusion Conditions**

In coastal areas of Snohomish County, less ground water is being pumped now than in the past. Much of the area now relies on public-supply systems that obtain water from surface sources or from productive wells that are several miles inland and thereby less susceptible to seawater intrusion.

Only 23 wells were sampled in coastal Snohomish County in 1978, fewer than in any other county. The paucity of available wells is due in part to unproductive aquifers in the southwestern part of the county and to the general lack of development in the northwestern part of the county. Of the wells sampled, none yielded water in excess of 100 mg/L, indicating that seawater intrusion presently is not a problem in Snohomish County. The median chloride concentration in 1978, as shown in table 1 was low (7.2 mg/L), and chloride levels generally declined between 1967 and 1978 (table 2).

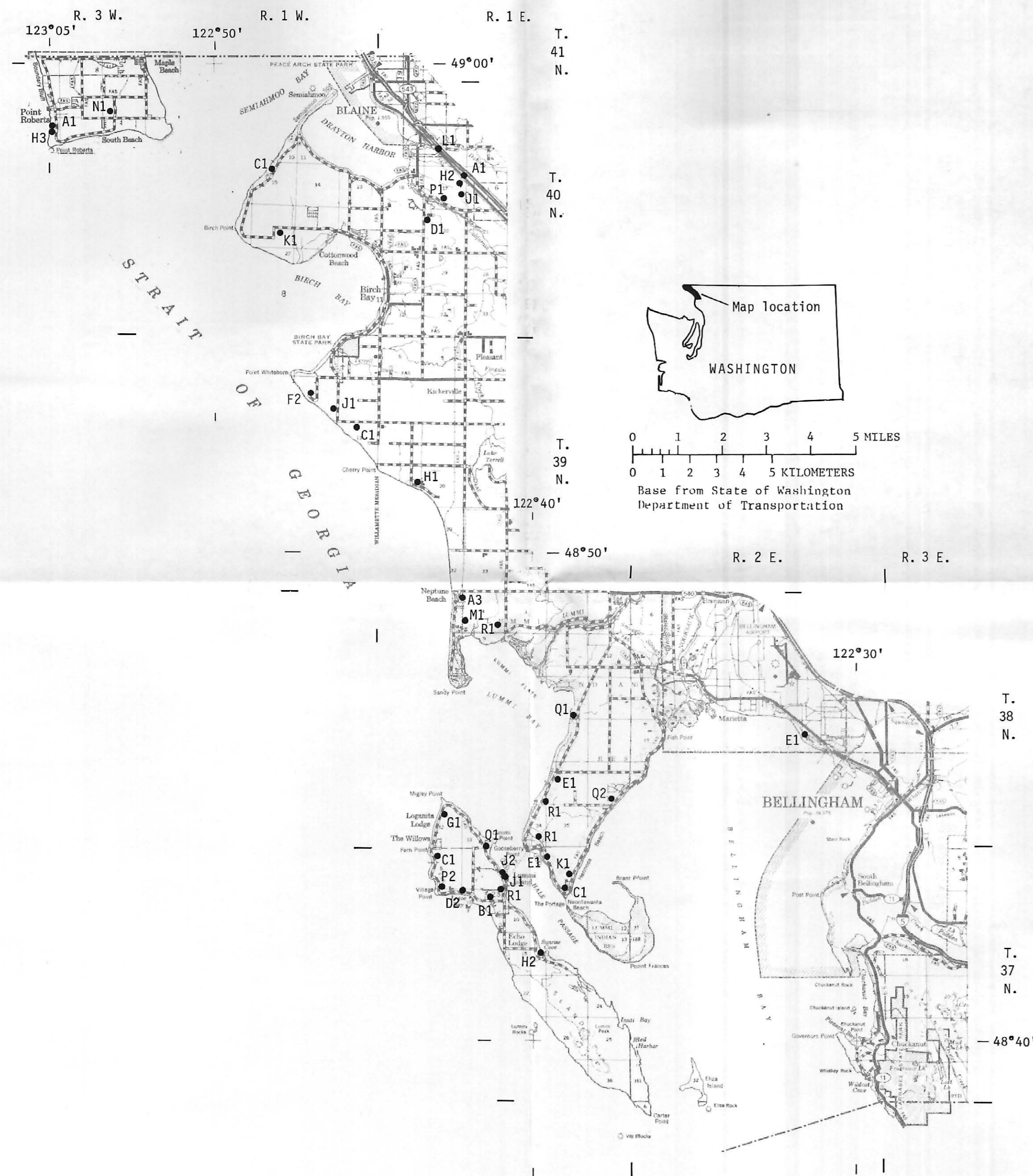
Although no intrusion problems were evident in 1978, they have occurred in Snohomish County in the past. Walters (1971, p. 39-40) reported that several public-supply wells had been abandoned because of excessive chloride concentrations. Intrusion problems are not likely to increase, however, unless ground-water development in coastal Snohomish County increases greatly over present conditions.

Physical and chemical data for wells in Snohomish County

Well number	Land-surface altitude (ft)	Depth of well (ft)	Specific conductance (micromhos at 25°C)	Chloride (mg/L)	Date of collection
29/ 4 - 1A2	125	146	302	22	4-19-67
	--	--	305	24	6-06-78
- 1C1	125	165	312	11	4-19-67
	--	--	290	9.6	6-06-78
- 1G3	85	130	218	11	4-19-67
	--	--	196	10	6-06-78
30/ 4 - 6F1	305	311	195	7.2	6-07-78
- 6L1	205	230	223	8.5	4-07-67
	--	--	198	6.7	6-07-78
- 6P1	85	190	190	6.2	6-07-78
- 7K1	30	62	246	14	6-07-78 <sup>1/</sup>
-17C1	100	372	181	8.0	4-07-67
	--	--	180	6.7	6-07-78
-17K1	180	518	184	8.0	4-18-67
	--	--	172	5.7	6-07-78
-21G1	175	375	159	4.7	6-07-78
-21Q1	20	20	409	17	6-07-78
-28A1	60	163	167	6.5	4-18-67
	--	--	161	4.7	6-06-78
-35R1	125	190	355	7.5	4-20-67
	--	--	366	12	6-06-78
30/ 5 -31B1	15	26	236	8.5	4-20-67
	--	--	249	8.3	6-06-78
31/ 3 -24Q2	165	186	339	8.5	4-05-67
	--	--	129	15	6-08-78
-25A1	215	300	270	9.5	4-06-67
	--	--	260	7.2	6-08-78
-25A2	255	309	405	13	4-05-67
	--	--	433	9.1	6-08-78
-36B1	10	75	204	7.0	4-06-67
	--	--	192	6.0	6-08-78
-36B4	10	81	198	7.5	4-06-67
	--	--	196	6.0	6-08-78
31/ 4 - 4C1	23	262	188	6.0	4-04-67
	--	--	180	4.1	6-08-78
- 7L1	165	219	207	7.5	4-04-67
	--	--	202	6.2	6-08-78
-18C1	210	224	357	9.0	4-07-67
	--	--	335	8.5	6-08-78
32/ 4 -29B2	80	250	282	6.0	6-08-78

<sup>1/</sup> Sample is a composite from two or more wells.





Seawater Intrusion Conditions

Several areas of high-chloride water were detected in Whatcom County in 1978. Seawater intrusion is not necessarily indicated in every case, however; some problems may be related to the presence of relict seawater.

When sampled in September 1968, wells 40/3W-9A1 and 9H3, near Point Roberts, yielded water with chloride concentrations of 285 and 113 mg/L, respectively. When sampled in May 1978, the salinity levels were 20 and 67 mg/L, respectively. Both wells are close to the coast, are finished in gravel aquifers at or near sea level, and are pumped heavily in summer only. The large decreases in chloride concentrations are probably a reflection of seasonal fluctuations rather than a long-term, permanent trend.

Wells 40/1-17P1 and 20D1, southeast of Blaine along California Creek, produced water containing 390 and 140 mg/L of chloride, respectively, but the wells flow with sufficient hydraulic head to preclude the likelihood of the high chlorides being a result of seawater intrusion.

On the west side of the Lummi peninsula southwest of Ferndale, wells 38/1-14Q1 and 34R1 produced water with chloride concentrations of 430 and 130 mg/L, respectively. When sampled in September 1968 well 38/1-34R1 produced water with a chloride concentration of only 24 mg/L. The May 1978 chloride concentration of 130 mg/L suggests that intrusion has taken place in the Gooseberry Point area since 1968. In a study of the water resources of the Lummi Indian Reservation, Cline (1974) stated that (1) the occurrence of salty ground water beneath the reservation was a major water-quality problem; (2) ground water in the southern part of the Lummi peninsula and the western part of the reservation was generally fresh; and (3) water from public-supply wells in the Gooseberry Point area was increasing in salinity.

With the exception of two of the sampled wells, chloride concentrations on Lummi Island were below 100 mg/L but several wells on the island have reportedly been abandoned or destroyed because of excessive salinity.

Seawater intrusion will most likely continue to be a problem on the peninsulas and islands of Whatcom County, especially where high-yield wells are drilled close to the coast and to depths below sea level. In areas of predominantly summer residences and seasonal pumping, such as Point Roberts, intrusion probably will not advance beyond its present state.

The median chloride concentration of 37 ground-water samples collected in Whatcom County in 1978 was 20 mg/L (table 1). According to table 2, the median concentration decreased from 23 to 21 mg/L between 1968 and 1978. At least some of this decrease is due to seasonal fluctuations in chloride and not to long-term changes.

Physical and chemical data for wells in Whatcom County

Well number	Land-surface altitude (ft)	Depth of well (ft)	Specific conductance (micromhos at 25°C)	Chloride (mg/L)	Date of collection
37/ 1 - 2E1	35	85	374	18	9-11-68
	--	--	370	16	5-09-78
- 2K1	10	42	534	40	9-11-68
	--	--	555	40	5-10-78
- 4J1	20	55	2,000	355	9-19-68
	--	--	1,800	340	5-10-78
- 4J2	20	100	1,200	170	5-10-78
- 4R1	35	250	380	11	5-10-78
- 5C1	50	180	350	30	9-19-68
	--	--	395	41	5-10-78
- 5P2	45	301	224	16	5-10-78
- 9B1	90	240	441	15	9-19-68
	--	--	420	15	5-10-78
- 9D2	15	95	420	29	5-10-78
-11C1	12	124	424	22	9-11-68
	--	--	415	20	5-10-78
-15H2	20	32	274	14	9-19-68
	--	--	505	18	5-10-78
38/ 1 - 4M1	19	37	295	21	5-09-78
- 4R1	120	124	370	19	5-09-78
- 5A3	110	120	375	7.2	5-09-78
-14Q1	30	107	2,200	430	5-09-78
-25Q2	40	88	405	51	5-09-78
-26E1	40	112	300	19	5-09-78
-27R1	130	164	320	17	5-09-78
-32G1	100	153	574	15	9-19-68
	--	--	445	17	5-10-78
-33Q1	15	40	305	13	5-10-78
-34R1	75	138	416	24	9-10-68
	--	--	775	130	5-09-78
38/ 2 -23E1	75	120	281	15	9-10-68
	--	--	290	21	5-10-78
39/ 1W-11F2	95	113	339	23	9-13-68
	--	--	355	23	5-09-78
-11J1	100	147	271	9.1	9-13-68
	--	--	276	12	5-09-78
-13C1	100	135	693	84	9-13-68
	--	--	775	100	5-09-78
39/ 1 -19H1	18	180	779	67	9-12-68
	--	--	305	22	5-09-78
40/ 3W- 2N1	125	140	242	14	9-18-68
	--	--	256	18	5-08-78
- 9A1	10	10	1,390	285	9-18-68
	--	--	271	20	5-08-78
- 9H3	10	14	864	113	9-18-68
	--	--	485	67	5-08-78
40/ 1W-15C1	60	72	305	11	9-16-68
	--	--	271	11	5-08-78
-22K1	80	125	921	10	9-16-68
	--	--	945	0.0	5-08-78
40/ 1 - 8L1	25	625	492	63	8-30-78
-17A1	40	53	214	7.6	8-30-78
-17H2	40	87	216	7.9	8-30-78
-17P1	15	365	2,200	495	9-16-68
	--	--	1,880	390	5-09-78
-17J1	30	85	234	7.4	8-30-78
-20D1	45	440	931	120	9-16-68
	--	--	935	140	8-30-78