GROUND-WATER QUALITY IN NORTH IDAHO

By D. J. Parliman, Harold R. Seitz, and Michael L. Jones

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CONVERSION FACTORS

For the convenience of those who prefer SI (International System of Units) rather than the inch-pound system of units, conversion factors for terms used in this report are listed below.

Multiply inch-pound unit	By	To obtain SI unit
	Length	
inch (in.)	25.4	millimeter
foot (ft)	0.3048	meter
mile (mi)	1.609	kilometer
	Area	
acre	4047	square meter
acre-foot (acre-ft)	1233	cubic meter
square mile (mi^2)	2.590	square kilometer
	Flow	
gallon per minute (gal/min)	0.06309	liter per second
	Mass Per Unit Volume	
ton per acre-foot (ton/acre-ft)	0.8236	kilogram per cubic meter
	Temperature	
degrees Fahrenheit (°F)	5/9 (°F - 32)	degrees Celsius (°C)

Concentrations of chemical constituents are given in mg/L (milligrams per liter) or µg/L (micrograms per liter). (One milligram equals 1,000 micrograms.) These values, within the range of values presented, are numerically equal to values expressed in parts per million and parts per billion, respectively. Specific conductance is expressed as µmhos/cm (micromhos per centimeter at 25 degrees Celsius). SAR (sodium-adsorption-ratio) values, calculated from ion concentrations and expressed in meq/L (milliequivalents per liter), are determined by dividing the milligrams per-liter concentration of a constituent by the atomic weight of the constituent.

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ABSTRACT

From July 1977 to May 1978, water samples were collected from 116 wells north of the Palouse River in Idaho to define water-quality conditions, on a reconnaissance level, in major aquifers. Geologic and hydrologic data were combined with water-quality data to develop an understanding of factors affecting present and future ground-water quality.

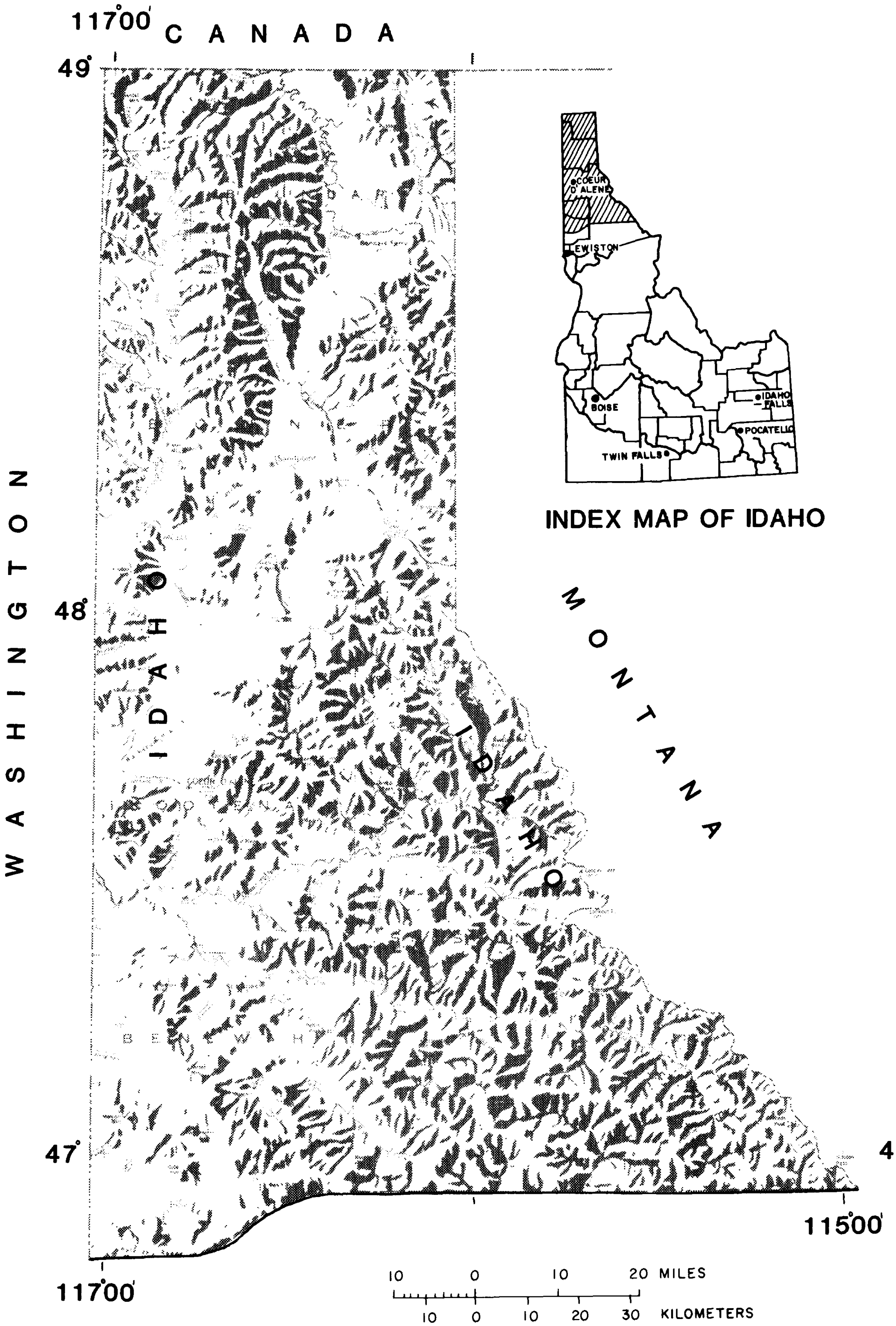
Samples were analyzed for 16 major chemical constituents, selected metallic trace elements, pH, specific conductance, water temperature, and total- and fecal-coliform bacteria. Locally, concentrations of dissolved solids, nitrite plus nitrate, iron, and cadmium exceeded mandatory or recommended limits established for public water supplies. Hardness exceeding 300 milligrams per liter may restrict ground-water use esthetically or economically. Ground-water quality is adequate and quantity is sufficient to meet population and economic demands as of 1978.

INTRODUCTION

Use of ground water in Idaho north of the Palouse River (see fig. 1 for map of study area) is increasing rapidly as available surface-water supplies become appropriated. Aquifers (water-yielding formations) are an important source of water for municipal and rural domestic use, irrigation, and manufacturing processes. The increasing use of ground water may affect the quantity and quality of water available for further development.

An understanding of the factors affecting ground-water quality is needed to evaluate effects of development. Prior to this study, little information was available regarding quality of water in major aquifers in north Idaho. Previous reports (most recently, Eisenbarth, 1978) provide some local ground-water quality data, but information was insufficient to adequately define overall current (1978) conditions.

This study was made by the U.S. Geological Survey, in cooperation with the Idaho Department of Water Resources. Similar studies are planned, specifically to obtain ground-water quality data in areas where land and water-resource development are expected or increasing.



Base from U. S. Geological Survey
1:500,000, 1977

Figure 1.--Shaded relief map of study area.

The authors gratefully acknowledge the many well owners, municipal officials, and private industries who provided well information and allowed collection of water samples on their property.

Purposes

The major purposes of this report are to: (1) Provide water-quality data representative of the water in different aquifers in the study area, and (2) relate these data to natural and manmade influences. Another purpose is to provide a basis for comparing changes in ground-water quality. Understanding the cause-and-effect relations that affect water quality will aid in planning and managing land and water-resource development.

Well-Numbering System

The well-numbering system (fig. 2) used by the U.S. Geological Survey in Idaho indicates the location of wells within the official rectangular subdivision of the public lands, with reference to the Boise base line and meridian. The first two segments of the number designate the township and range. The third segment gives the section number, followed by three letters and a numeral, which indicate the ¼ section (160-acre tract), the ¼-¼ section (40-acre tract), the ¼-¼-¼ section (10-acre tract), and the serial number of the well within the tract, respectively. Quarter sections are lettered A, B, C, and D in counterclockwise order from the northeast quarter of each section. Within the quarter sections, 40-acre and 10-acre tracts are lettered in the same manner. Well 56N-2W-10CAB1 is in the NW¼NE¼SW¼ sec. 10, T. 56 N., R. 2 W., and is the first well inventoried in that tract.

DESCRIPTION OF STUDY AREA

North Idaho, as described in this report, comprises Benewah, Bonner, Boundary, Kootenai, and Shoshone Counties, and part of Latah County. The total area is about 8,000 mi^2, including about 250 mi^2 of water surface. Topography is dominated by glacially scoured valleys and rugged northwest-trending mountain chains. Major hydrologic features include the Priest, Pend Oreille, Coeur d'Alene, St. Joe, and St. Maries River drainage basins; parts of the Kootenai, Spokane, and Palouse River drainage basins; and several large lakes, including Priest, Pend Oreille, and Coeur d'Alene Lakes (pl. 1).

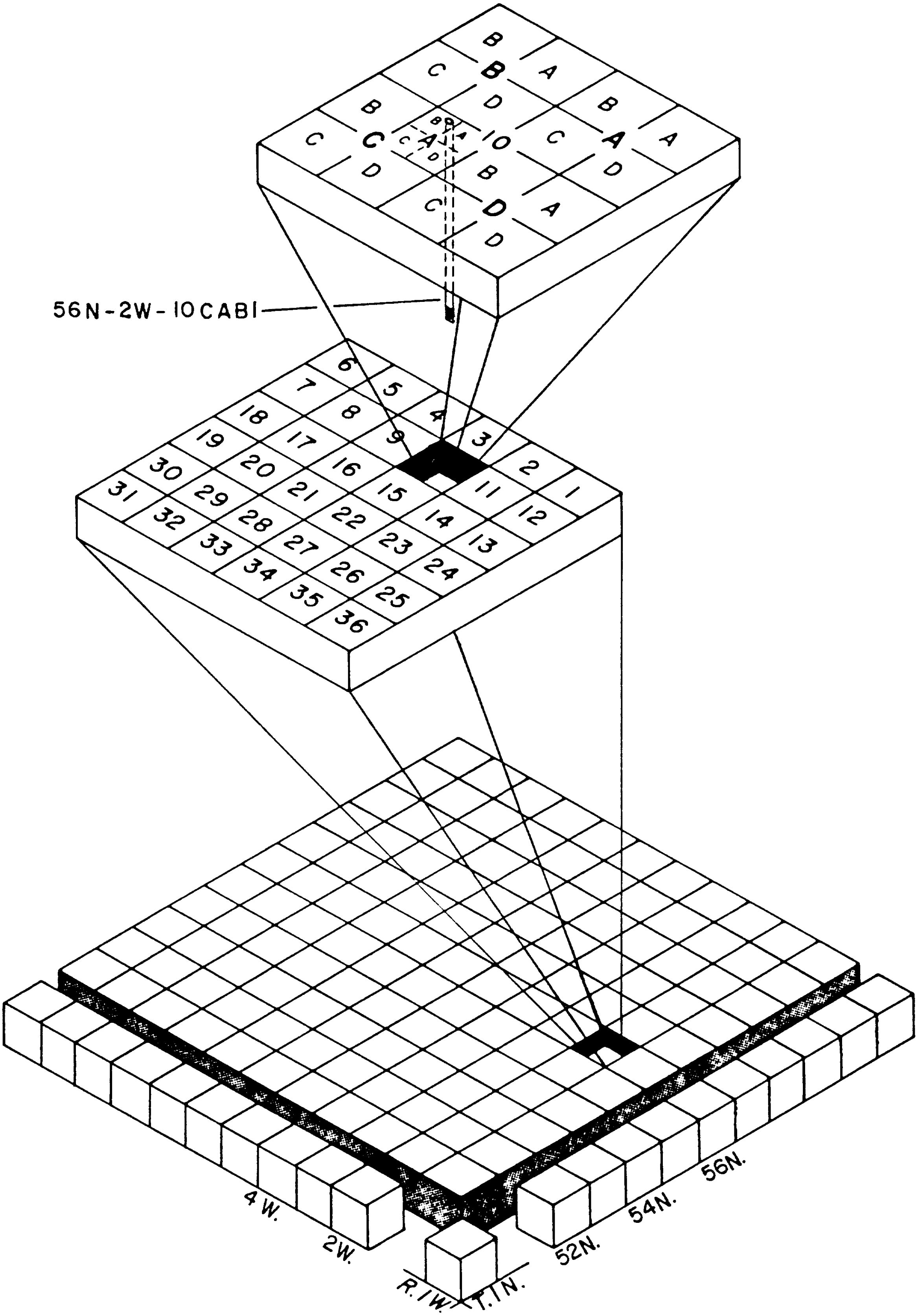


Figure 2.--Well-numbering system.

Population, based on census estimates (Idaho Department of Water Resources and Boise State University, 1978), was 90,450 in 1975. About one-half of the population lives in rural areas or small towns of 1,200 or fewer inhabitants.

The economy of north Idaho is based largely on wood-products industries, local wholesale-retail trade, and State and local government. Six percent of the land is used for agriculture. Mining is locally important, especially along the South Fork Coeur d'Alene River.

Increases in urban population and industrial development are predicted, particularly in the Coeur d'Alene and Sandpoint areas. These increases, together with probable increases in farmland irrigated by ground water, are expected to affect the ground-water resources of north Idaho, both in quality and quantity.

Generalized Geology

Geologic formations ranging in age from Precambrian to Quaternary occur in north Idaho (Bond, 1978). The formations are grouped, for hydrologic purposes, into four major units: (1) Cambrian and Precambrian, (2) Tertiary and Cretaceous, (3) Tertiary, and (4) Quaternary. Generalized geology of north Idaho and correlation, description, and water-yielding characteristics of geologic units are shown on plate 2.

Rocks of Precambrian age consist of metamorphosed sediments and igneous intrusives. The metamorphic rocks are folded, faulted, and uplifted and constitute one of the major rock types in the mountainous areas of north Idaho. Rocks of Cambrian age consist of limestone and claystone, which crop out in the mountains along the east side of Pend Oreille Lake and in areas north and east of Bayview. Together, the undifferentiated sedimentary, igneous, and metamorphic rocks compose the basement complex in north Idaho.

Granitic rocks of Tertiary and Cretaceous age, principally associated with the Idaho batholith, occur north and west of Pend Oreille Lake. Many fault-related mineral and ore deposits of economic importance occur in these rocks.

Rocks of Tertiary age, consisting of basalt flows and interbedded sediments of the Columbia River Basalt Group, crop out in the St. Joe, St. Maries, and Coeur d'Alene River valleys and around Coeur d'Alene Lake. These rocks are mantled by loess (windblown silt) of Quaternary age in western Latah, Benewah, and Kootenai Counties.

Alluvium, colluvium, and glacial deposits of Quaternary age are the predominant valley fill throughout north Idaho. Alluvium and colluvium, hereafter referred to as alluvium, include unconsolidated to well-consolidated beds of poorly sorted to well-sorted stream and lake deposits. Most of the valley fill, however, is of glacial origin.

Glacial deposits include unconsolidated to well-consolidated, poorly sorted to well-sorted beds. They are mineralogically similar and are difficult to distinguish from alluvium. Surficial distinctions between alluvial and glacial deposits in this report are based solely on the State Geologic Map (Bond, 1978). These deposits are hydrologically significant because: (1) A majority of the population centers are located on or near them; and (2) future agricultural, industrial, and urban development will directly affect the quality of water in them.

Hydrology

Hydrologic, geologic, and well-construction data were collected for 116 wells in the study area during the period May 1977 to May 1978 (table 1). Hydrologic data included onsite water-level measurement, discharge estimation, and well-use information. Hydrologic data from well drillers' logs included pump-test information where available. Geologic data from drillers' logs included lithologic description and thickness of geologic units penetrated. Well-construction information from drillers' logs included diameter of borehole, diameter and depth of well casing(s), type and depth of surface seal, and manner of well completion, such as screen or open hole.

Aquifer Recharge and Ground-Water Movement

Aquifers in the study area are recharged largely by infiltration of precipitation, seepage from rivers and tributary streams, and leakage from large lakes. For example, aquifers that underlie Rathdrum Prairie are recharged by precipitation, seepage from streams, and leakage from Pend Oreille, Coeur d'Alene, Hayden, Twin, and Spirit Lakes. Basalt aquifers of the Coeur d'Alene Lake valley are mainly recharged by leakage from Coeur d'Alene Lake and percolation of precipitation through overlying loess deposits.

The altitude of the water table is depicted in figure 3 on the basis of water-level measurements in wells (table 1). Ground water moves approximately at right angles to

Table 1. Well data

Aquifer(s): Qal - Alluvium and colluvium
Qgl - Glacial deposits
Tcr - Columbia River Basalt Group
TKi - Granitic rocks, undifferentiated
€p€ - Sedimentary, igneous, and metamorphic rocks, undifferentiated

Altitude: From U.S. Geological Survey quadrangle map

Well finish: O - Open end
P - Perforated casing
S - Screen
X - Open hole

Water level: F - Flowing

Use of water: C - Commercial
H - Domestic
I - Irrigation
N - Industrial
P - Public supply

Notations: > - Greater than
< - Less than
-- No data available
E - Estimated

Well number	Aquifer(s)	Altitude of land surface (ft, National Geodetic Vertical Datum of 1929)	Reported depth of well (ft below land surface)	Casing: Diameter (in.)	Casing: Depth to first perforation or bottom of casing (ft below land surface)	Well finish	Water level: Depth (ft below land surface)	Water level: Date measured	Reported discharge (gal/min)	Use of water	Date of well completion
BENEWAH COUNTY											
44N-2W-33BAA1	Qal	2,830	76	6	62	P	15.0	9- 3-75	< 5	H	1975
44N-5W-11CCC1	Tcr	2,560	190	6	92	X	F	5-18-78	E15	H	1974
46N-2W-16BBD1	Tcr	2,200	80	6	79	X	41.65	5-16-78	E15	H	1975
46N-2W-20BDA1	Qgl	2,210	125	6	108	X	66.87	5-16-78	> 5	H	1973
46N-2W-36DDA1	Tcr	2,320	214	6	93	X	63.61	5-16-78	E10	H	1958
46N-4W-7CDB1	Tcr	1,610	100	10	66.5	X	28.40	5-16-78	E15	H	1974
46N-4W-11ACC1	€p€	2,800	600	6	56	X	51.65	5-16-78	E10	H	1974
BONNER COUNTY											
54N-2W-19CBA1	Qgl	2,440	125	6	121	X	98.74	7-28-77	E10	H	1975
54N-3W-25BCB1	TKi	2,360	375	6	70	X	149.29	8-10-77	E20	H	1971
54N-3W-27DDC1	Qgl	2,240	90	8	79	S	69.95	8-18-77	E20	P	1967
54N-4W-17CAD1	Qgl	2,312	195	6	187	P	166.50	8-11-77	E10	H	1971
54N-4W-19BCD1	Qgl	2,300	200	6	200	O	142.13	7-19-77	E20	H	1975
54N-4W-31DDD1	Qgl	2,565	538	6	538	O	515.00	7- 1-76	> 20	H	1976
54N-5W-18AAA1	Qgl	2,280	146	8	138	P	109.60	8-23-77	> 25	H	1973
54N-5W-30ABD1	€p€(?)	2,415	252	6	77	X	124.49	8- 9-77	E5	H	1973
54N-5W-36AAD1	TKi	2,360	325	6	115	X	276.34	8- 8-77	E25	H	1972
55N-3E-19CAD1	Qgl	2,160	110	6	106	P	93.86	11-15-77	<15	H	1974
55N-3E-29DDD1	Qgl	2,280	239	6	239	O	213.55	11-15-77	<15	H	1967
55N-5W-19CBD1	Qal	2,280	189	14	138	P	130.05	8-23-77	>60	I	1967
55N-6W-1DDD1	Qgl	2,360	210	6	207	X	174.24	8-11-77	6.0	H	--
56N-2E-6CCC1	Qgl	2,160	75	6	70	P	60.55	11-16-77	<15	H	1971
56N-2E-19ADD1	Qgl	2,160	70	6	65	P	33.82	11-16-77	<15	H	1969
56N-1W-10CCD1	Qgl	2,280	73	6	32	X	21.80	12- 1-77	<15	H	1970
56N-2W-10CAB1	TKi	2,200	50	6	45	P	49.07	11-30-77	E15	H	1973
56N-2W-15CCB1	Qgl	2,180	182	6	182	O	28.17	12- 1-77	E15	H	1971
56N-3W-4AAA1	TKi	2,086	162	6	142	P	F	11-29-77	E15	H	1975
56N-3W-4ADB1	Qgl	2,120	53	6	47	P	12.96	11-30-77	E15	H	1972

Table 1. Well data (Continued)

Well number	Aquifer(s)	Altitude of land surface (ft, National Geodetic Vertical Datum of 1929)	Reported depth of well (ft below land surface)	Casing		Well finish	Water level		Reported discharge (gal/min)	Use of water	Date of well completion
				Diameter (in.)	Depth to first perforation or bottom of casing (ft below land surface)		Depth (ft below land surface)	Date measured			
BONNER COUNTY (CONTINUED)											
56N-3W-30BAC1	Qal	2,149	80	6	59	P	48.35	11-30-77	E15	H	1972
56N-5W-27AAB1	Qal	2,260	232	6	226	P	202.57	8-23-77	20	H	1961
56N-6W-36AAA1	Qgl	2,340	67	6	67	P	48.74	8-23-77	25	H	1966
57N-1E-21BAB1	Qgl	2,120	54	6	50	P	27.30	11-17-77	<15	H	1970
57N-2W-1BCB1	Qgl	2,132	28	24	18	P	8.45	11-29-77	E15	H	1973
57N-2W-16ACC2	TKi	2,160	175	6	21	X	47.13	11-28-77	E15	H	1962
57N-2W-16BAA1	Qgl	2,140	118	6	111	X	F	11-29-77	E1	H	1965
57N-2W-19CAD1	TKi	2,280	106	6	72	P	39.82	11-18-77	<15	H	1971
57N-5W-14DCC1	Qgl	2,380	178	6	87	P	115.01	8-24-77	E10	H	1973
58N-1W-2ADC1	Qgl	2,220	105	6	76	P	34.41	11-17-77	<15	H	1970
58N-1W-24ADB1	Qal	2,080	73	8	19	P	7.49	11-17-77	<15	H	1974
58N-1W-30AAB1	€p€	2,200	151	6	65	X	16.29	11-18-77	<15	H	1975
60N-4W-31CBD1	Qgl	2,540	46	6	42	P	44.26	8-25-77	E10	H	1962
60N-5W-24ABC1	Qgl	2,440	70	6	70	O	F	8-25-77	60	P	1963
61N-4W-16BCA1	Qgl	2,460	40	6	40	O	23.78	8-25-77	E15	H	1967
BOUNDARY COUNTY											
60N-1W-34ADB1	Qgl	2,150	60	6	50	P	40.04	1-16-78	E15	H	1960
61N-1E-8ABC1	Qgl	1,845	118	8	113	P	64.03	1-19-78	E15	H	1974
61N-1E-15ADD1	Qgl	2,290	42	24	27	P	27.11	1-19-78	E10	H	1973
62N-2E-7DAB1	€p€	2,380	200	6	85	P	34.58	1-18-78	E5	H	1973
62N-2E-17BCC1	Qgl	2,250	270	6	190	X	115.96	1-19-78	E15	H	1973
62N-2E-29CDC1	Qgl	1,780	60	6	60	O	27.20	1-18-78	E10	H	1967
63N-1E-4AAB1	Qgl	2,210	260	6	257	X	100.00	7-25-75	E10	H	1975
63N-1W-24CAC1	Qgl	1,785	45	6	30	P	22.81	1-18-78	E20	H	1962
65N-2E-26BCD1	Qgl	2,740	102	6	98	P	58.80	1-17-78	E10	H	1971
65N-1W-34ADD1	Qal	1,750	172	6	133	S	10.43	1-17-78	E10	H	1972
KOOTENAI COUNTY											
48N-1W-18BBB1	€p€	2,160	125	6	80	X	26.12	3- 2-78	E10	P	1972
49N-1W-15DAC1	€p€	2,300	150	6	73	X	13.37	3- 1-78	E10	H	1968
49N-1W-22DDC1	Qal	2,200	135	6	116	P	22.70	3- 2-78	E20	P	1975
50N-4W-5DDA1	Qgl	2,146	153	8	--	O	127.80	8- 3-77	>5	H	1950
50N-5W-1AAD1	Qgl(?)	2,193	<230	30	--	--	199.04	8-17-77	700	P	1976
50N-5W-1CBB1	Qgl	2,194	275	16	235	S	195.85	7-20-77	1,400	P	1974
50N-5W-6DCC1	Qgl	2,112	152	26	125	P	140.99	7-21-77	>3,000	I	1957
50N-5W-7ADD1	Qgl	2,120	110	6	--	O	91.72	8- 1-77	E10	H	1969
51N-3W-19BAB1	Qgl	2,293	221	6	220	X	162.70	7-28-77	E10	H	1976
51N-4W-6ADA1	Qgl	2,244	277	18	249	P	245.51	7-12-77	>1,000	I	1965
51N-4W-12ABA1	Tcr	2,410	232	6	39	X	71.67	7-27-77	E25	H	1972
51N-4W-15AAA1	Qgl	2,300	348	10	328	S	301.55	7-13-77	>100	P	1968
51N-4W-15DAB1	Qgl	2,300	343	8	323	S	300.53	7-26-77	E20	N	1972
51N-4W-17CBC1	Qgl	2,258	305	6	292	P	267.93	7-27-77	E20	H	1967
51N-4W-19DCC2	Qgl	2,251	384	24	256	P	257.22	7-21-77	>1,000	I	1953
51N-4W-22BCA1	Qgl	2,297	357	12	337	S	299.47	4-27-77	>200	I	1966
51N-4W-23DAA1	Qgl	2,276	330	8	307	P	267.14	7-12-77	>100	P	1971
51N-4W-24ABB1	Qgl	2,250	217	6	210	P	186.41	7-26-77	E20	H	1968
51N-4W-27DDB1	Qgl	2,274	310	18	255	P	266.73	7-28-77	>500	I	1964
51N-4W-29DBB1	Qgl	2,232	268	26	237	P	237.69	7-12-77	>1,000	I	1965
51N-4W-35ADB1	Qgl	2,220	228	6	203	P	202.20	7-26-77	E15	P	1971
51N-5W-11DDB1	Qgl	2,207	264	16	244	S	217.13	7-13-77	>100	I	1966
51N-5W-12ABA1	Qgl	2,213	278	18	251	S	222.86	7-13-77	>1,000	I	1968
51N-5W-19CAD1	Qgl	2,129	208	12	188	S	149.90	7-21-77	>500	P	1967
51N-5W-25DAB1	Qgl	2,210	290	16	250	S	228.42	7-20-77	>1,000	I	1968

Table 1. Well data (Continued)

Well number	Aquifer(s)	Altitude of land surface (ft, National Geodetic Vertical Datum of 1929)	Reported depth of well (ft below land surface)	Casing		Well finish	Water level		Reported discharge (gal/min)	Use of water	Date of well completion
				Diameter (in.)	Depth to first perforation or bottom of casing (ft below land surface)		Depth (ft below land surface)	Date measured			
					KOOTENAI COUNTY (CONTINUED)						
51N-5W-26BCA1	Qgl	2,241	274	30	242	P	254.34	7-20-77	> 1,000	I	1963
51N-5W-27BBB1	Qgl	2,143	184	6	184	X	157.86	7-21-77	E10	H	1969
51N-5W-31ACA1	Qgl	2,105	189	16	167	S	129.95	7-21-77	> 1,500	I	1975
51N-5W-35BDC1	Qgl	2,206	242	20	212	P	218.41	7-20-77	> 1,000	I	1965
52N-3W-7DAC1	Qgl	2,300	117	8	95	P	92.20	8- 4-77	> 5	H	1975
52N-3W-7DCA1	Qgl	2,308	270	12	106	P	95.86	8- 2-77	> 200	N	1969
52N-3W-19AAB1	Qgl	2,360	310	6	245	S	193.34	8- 2-77	E5	H	1972
52N-4W-10DBA1	TKi	2,305	432	6	280	X	327.22	8- 2-77	E2	H	1969
52N-4W-14DCD1	Qgl	2,305	365	6	--	P	217.26	8- 2-77	E10	H	1974
52N-4W-17DDD1	Qgl	2,298	350	8	331	P	272.09	8- 9-77	150	P	1974
52N-4W-20CCB1	Qgl & TKi	2,266	500	8	225	P	219.32	7-14-77	<15	H	1973
52N-4W-27DCD1	Qgl	2,260	306	8	265	P	258.22	7-14-77	>20	P	1970
52N-4W-31DAB1	Qgl	2,197	220	8	210	S	198.04	7-13-77	E30	P	1970
52N-4W-32ABC1	Qgl	2,217	234	30	204	P	216.64	7-13-77	>1,000	I	1964
52N-4W-35DCB1	Qgl(?)	2,310	--	--	--	--	320.68	7-12-77	>1,000	I	--
53N-2W-7CAA1	Qgl	2,432	404	6	404	O	381.37	7-19-77	E10	H	1974
53N-2W-19ADD1	TKi	2,520	401	6	126	X	127.78	7-19-77	>8	H	1970
53N-3W-3BAB1	Qgl	2,400	369	8	369	O	351.46	7-19-77	>5	H	1976
53N-3W-9CDD1	Qgl	2,384	357	6	--	P	336.96	8- 2-77	70	P	--
53N-3W-21CDC1	TKi & Qgl	2,369	198	8	156	P	156.98	7-27-77	E20	H	1971
53N-3W-22DAB1	TKi	2,424	410	8	--	X	191.50	7-14-77	>20	H	1966
53N-4W-6DDB2	Qgl	2,454	328	8	--	--	302.10	7-19-77	>500	P	1963
53N-4W-22CDD1	Qgl	2,438	441	6	--	--	427.23	8- 2-77	E10	H	1970
53N-4W-24BBA1	Qgl	2,487	485	25	449	P	468.05	8- 2-77	>500	I	pre-1929
53N-4W-33CBB1	Qgl(?)	2,422	--	--	--	--	415.05	7-28-77	E20	H	1972
53N-4W-36BBA1	Qgl	2,419	426	6	421	S	403.26	7-27-77	E20	H	1970
54N-2W-34CCB1	Qgl	2,180	144	6	144	O	131.32	8-22-77	>5	H	1964
					LATAH COUNTY						
41N-3W-3BCB1	ꞒpꞒ	2,640	98	8	71	X	15.71	5-17-78	E10	H	1971
41N-3W-9BBD1	ꞒpꞒ	2,600	170	8	--	--	67.82	5-17-78	E10	P	1971
41N-4W-6BAC1	Tcr	2,620	51	8	180.5	X	148.79	5-18-78	E20	P	1971
41N-4W-9BAD1	Tcr	2,520	261	6	257	X	27.00	10-16-62	E10	H	1962
41N-5W-3DBC1	Tcr	2,520	41	8	34	X	21.97	5-18-78	E10	H	1972
					SHOSHONE COUNTY						
48N-2E-3ABC1	ꞒpꞒ	2,060	200	6	35	X	14.21	2-28-78	E10	P	1974
48N-2E-5BDA1	Qal	2,230	95	8	85	P	0.0	2-28-78	E20	C	1975
48N-3E-6ADA1	ꞒpꞒ & Qal	2,300	152	8	57	P	40.00	5-21-75	E10	P	1975
48N-3E-11DDD1	Qgl & ꞒpꞒ	2,450	75	6	30	P	11.16	2-28-78	E10	H	1973
48N-5E-36BBB1	Qgl(?)	3,460	--	--	--	--	8.98	3- 2-78	E5	I	--
49N-1E-34BCD1	Qal	2,140	83	12	30	S	10.00	8- 5-71	E200	P	1971
49N-2E-8CAA1	ꞒpꞒ	2,330	197	6	12	X	56.30	3- 1-78	E10	H	1967

the contours, from areas of recharge in the mountains to areas of discharge in the valley lowlands. Arrows in figure 3 indicate direction of ground-water movement only in the water-table aquifers. Where data are sparse, direction of flow arrows are based on topography, geology, and hydrography. In figure 3, a water level is shown for each well measured, except for those completed in the water-table aquifer underlying Rathdrum Prairie, where water-table contours indicate the water level in wells.

Yields From Wells

Yields from wells completed in alluvium range generally from 5 to 200 gal/min (table 1). Wells completed in thick (more than 400 ft) glacial deposits underlying the Rathdrum Prairie have yields ranging from 5 to as much as 3,000 gal/min. In relatively thin (less than 200 ft) glacial deposits in mountain valleys, however, yields from wells range generally from 1 to 60 gal/min. Percolation rates and ground-water movement through alluvial and glacial deposits vary with particle size and sorting, degree of compaction of deposits, and clay-lens interbedding. Yields from wells completed in these aquifers are generally adequate for most uses.

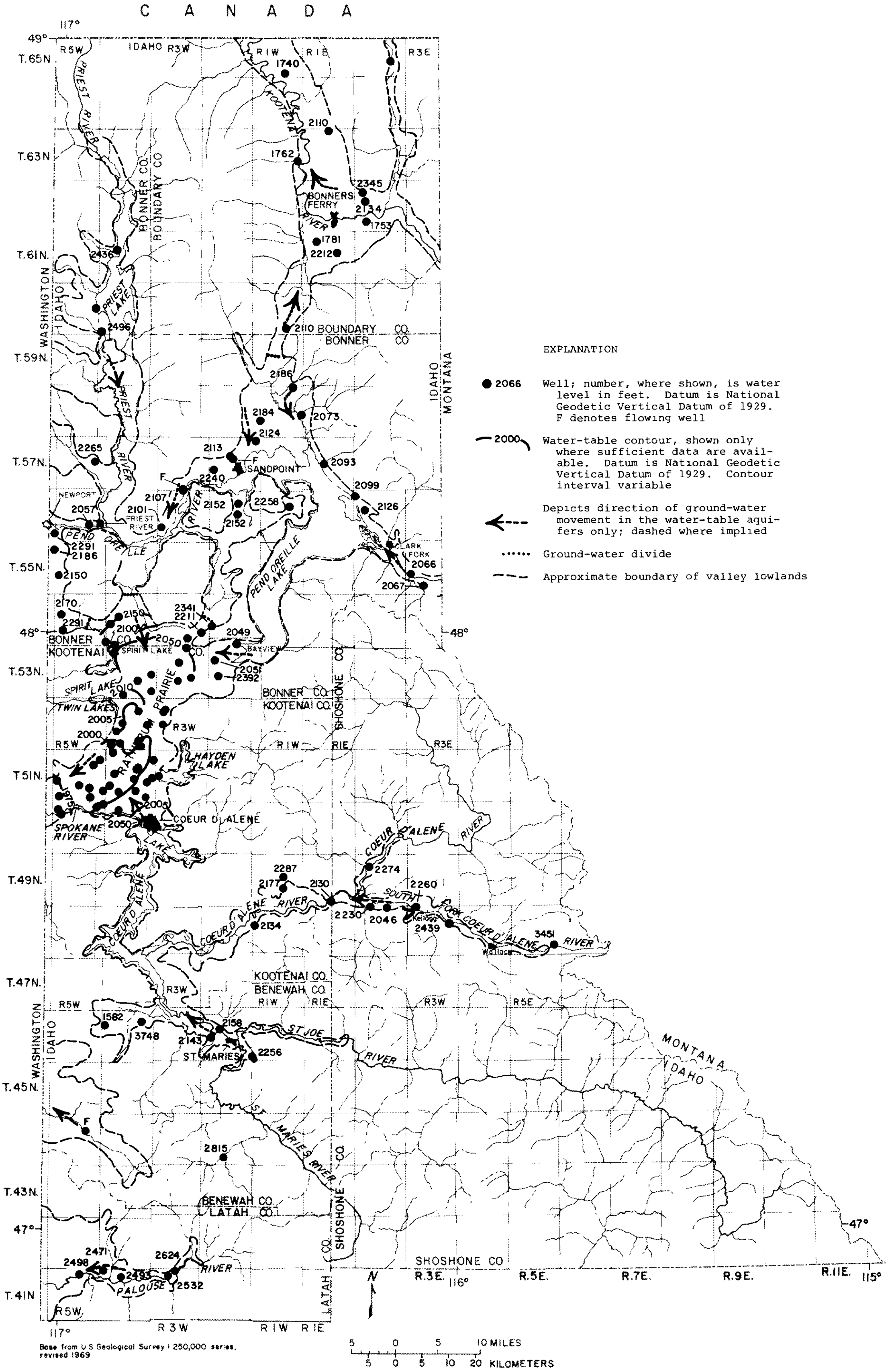
Yields from wells completed in basalt, granite, or the basement complex range generally from 2 to 25 gal/min and average 13 gal/min. Fractures, joints, deeply weathered sections, and permeable sedimentary interbeds locally increase the ability of these rocks to transmit water. Percolation rates and ground-water movement are relatively slow. Yields of wells completed in these aquifers are generally sufficient for domestic use only.

Wells open to more than one aquifer, such as alluvial or glacial deposits and basement complex, are relatively common; because these wells tap more than one aquifer, water-quality and well-yield information obtained are not representative of any one aquifer. Four multiaquifer wells were measured and sampled in this study. Data for these wells are included for comparative purposes only.

GROUND-WATER QUALITY

Obtaining Samples for Ground-Water Quality Analyses

The most representative water samples are obtained from municipal, irrigation, and industrial wells. These wells generally are pumped frequently, thereby yielding water recently obtained from the aquifers in which they are com-



Base from U.S. Geological Survey 1:250,000 series, revised 1969

Figure 3.--Altitudes of water levels in wells and contours of the water table, summer 1977.

pleted. When obtaining water samples from domestic wells equipped with pressure systems, the wells were pumped long enough to insure that water was obtained from the aquifer without being stored in the pressure tank for a significant period of time. Also, some wells may provide nonrepresentative samples if surface seals are absent, allowing contamination from surface sources. Old well casings may be cracked or corroded, allowing surface or subsurface leakage into the well.

Certain physical properties and chemical constituents, as well as bacterial concentrations, may change with time after sample collection. Therefore, determinations of water temperature, pH, specific conductance, alkalinity (carbonate and bicarbonate), total coliform bacteria, and fecal coliform bacteria are made at the well site.

Suitability of Water For Use

Factors such as geologic environment, contact time with aquifer materials, source of recharge, and activities of man affect the physical, chemical, and bacteriological quality of water in an aquifer. Although man's activities may cause dramatic changes in water quality, the geologic environment has the greatest effect in north Idaho.

Generally, water becomes more mineralized with depth below land surface. As percolating water passes through rock or sediment, the water accumulates increasingly greater concentrations of dissolved solids as a function of contact time with, and solubility of, the rock or sediment minerals.

Bacterial concentrations usually decrease with depth, owing to the filtering effects of fine-grained sediments or organic material that build up near the source of bacterial contamination (Vecchioli and others, 1972). Water containing bacteria may enter an aquifer, however, where overlying sediments are thin or where water moves through fractured and faulted rocks, which have little filtering action.

Whatever factors determine its quality, the water's suitability for use is the important consideration. In relation to human needs, water-quality criteria (U.S. Environmental Protection Agency, hereafter referred to as EPA, 1976), designate maximum chemical concentrations, physical properties, and bacterial concentrations that, when not exceeded, will cause no harm to water users.

In contrast, water-quality regulations (EPA, 1977a and 1977b), which use criteria as a basis, describe legally established recommended (secondary) and mandatory (primary) limits for constituents and properties and bacterial concentrations. Local natural conditions, esthetic or economic considerations, and resource protection considerations may result in variations of regulations in different places. Also, Federal drinking-water quality regulations legally apply only to public water supplies, not to domestic, agricultural, or industrial supplies for nonpublic use. Regulation limits do, however, provide a comparative base for all water-quality discussion.

A list of constituents and properties commonly important to water users is presented in table 2. Current (1978) water-quality criteria and regulations are given where possible. Water-quality analyses for wells sampled in north Idaho in 1977 and 1978 are shown in table 3.

Hardness

Water hardness is caused principally by calcium and magnesium dissolved in water. Hardness is expressed in milligrams per liter of calcium carbonate ($CaCO_3$). Other ions, such as iron, strontium, and manganese, can contribute to hardness if the concentrations are exceptionally large.

Hardness is a measure of the soap-consuming potential of a water. Calcium and magnesium react with soap, forming precipitates of calcium and magnesium, or soap scum. After the reaction is complete, the remaining soap is available to produce lather. When hard water is heated and evaporated, calcium and magnesium react with bicarbonate, carbonate, sulfate, and silica to form heat-retarding, pipe-clogging scale. This scale is commonly seen as white crust inside teakettles and plumbing and as rings in bathtubs.

High concentrations of hardness generally are not a health problem but may create an economic problem. The costs of softening some natural water may be considerable before the water is suitable for domestic use, and especially for some industrial uses. Hardness in domestic water supplies probably is not objectionable at concentrations less than 100 mg/L.

Most water in north Idaho has less than 150 mg/L hardness (table 3). Geographical differences in hardness were evident; the hardest water, as much as 610 mg/L, occurred in unconsolidated deposits of the Kootenai River valley.

Hardness in ground water in north Idaho is shown in figure 4. The table in figure 4 shows the range and median concentration of hardness in water from each of the various geologic units.

Table 2. Source or cause and significance of physical properties and chemical constituents of water

Constituent or property	Source or cause	Range of concentrations in sampled wells	Significance
Silica (SiO_2)	Dissolved from practically all rocks and soils.	8.0-52.0 mg/L SiO_2	Together with calcium and magnesium, silica forms a low heat-conducting, hard, glassy scale in boilers and turbines. Silica inhibits deterioration of zeolite-type water softeners and corrosion of iron pipes by soft (0-75 mg/L $CaCO_3$) water.
Iron (Fe)	Dissolved from practically all rocks and soils. Present in some industrial wastes. Also caused by corrosion of iron pipes, pumps, and other equipment.	0-13 mg/L Fe (0-13,000 µg/L) Fe	When concentrations are more than 0.1 mg/L (more than 100 µg/L), iron commonly precipitates on exposure to air, causing turbidity, staining of plumbing fixtures and laundry, and tastes and colors that are objectionable in food, beverages, textile processes, and ice manufacture. Recommended maximum limit for public water supplies is 0.3 mg/L, or 300 µg/L.[1]
Sodium-adsorption-ratio[2] (SAR)	Dissolved calcium, magnesium, and sodium from rocks and soils.	0.1-3.2	Estimates the degree to which sodium in irrigation water tends to enter into cation-exchange reactions in soil. High values indicate that sodium replaces adsorbed calcium and magnesium. This replacement damages soil structure and decreases permeability.
Calcium (Ca), Magnesium (Mg)	Dissolved from practically all soils and rocks, but especially from limestone, dolomite, and gypsum.	4.4-180 mg/L Ca 0.7-38 mg/L Mg	Causes most of the hardness and scale-forming properties of water; soap consuming (see hardness). Water having small amounts of calcium and magnesium is desired in electroplating, tanning, dyeing, and textile manufacturing. Small amounts are desirable to prevent corrosion.
Sodium (Na), Potassium (K)	Dissolved from practically all rocks and soils. Present in industrial wastes, sewage, and commercial fertilizers.	1.1-110 mg/L Na 0.4-10 mg/L K	More than 50 mg/L sodium and potassium in the presence of suspended matter causes foam in boilers, which accelerates scale formation and corrosion.
Bicarbonate (HCO_3), Carbonate (CO_3)	Action of carbon dioxide in water on carbonate cementing material and rocks, such as limestone, dolomite, and travertine.	11-530 mg/L HCO_3 0 mg/L CO_3	Produce alkalinity. When heated in the presence of calcium and magnesium, can form scales in pipes and release corrosive carbon-dioxide gas. Aid in coagulation for the removal of suspended matter from water.
Sulfate (SO_4)	Dissolved from rocks and soils containing gypsum, sulfides, and other sulfur compounds. May be derived from industrial wastes, both liquid and atmospheric.	0.7-140 mg/L SO_4	Sulfate in water containing calcium forms hard scale in steam boilers. In large amounts, sulfate, in combination with other ions, imparts bitter taste to water. Some calcium sulfate is considered beneficial in brewing processes. Recommended maximum limit for public water supplies is 250 mg/L.[1]
Chloride (Cl)	Dissolved from rocks and soils. Present in sewage and industrial wastes.	0.1-100 mg/L Cl	A salty taste can be detected when concentrations exceed 100 mg/L. In large quantities, increases the corrosiveness of water. Present available removal methods not generally economical for most uses. Recommended maximum limit for public water supplies is 250 mg/L.[1]
Fluoride (F)	Dissolved in small quantities from most rocks and soils. Added to many public supplies.	0.00-1.4 mg/L F	Fluoride concentrations in limited amounts have beneficial effect on the structure and resistance to decay of children's teeth. Excessive concentrations produce objectionable dental fluorosis (tooth mottling). Optimum recommended limits for public water supplies range from 0.7 to 1.2 mg/L and are based on annual average maximum daily air temperatures.[3]

Table 2. Source or cause and significance of physical properties and chemical constituents of water (Continued)

Constituent or property	Source or cause	Range of concentrations in sampled wells	Significance
Nitrite (NO_2)-plus-nitrate (NO_3) as nitrogen (N)	Decaying organic matter, sewage, fertilizers, and nitrates in soils.	0.00-25 mg/L N	Small amounts help reduce cracking of high-pressure boiler steel. Encourages growth of algae and other organisms that produce undesirable taste and odors. Concentrations in excess of 10 mg/L are suspected as cause of methemoglobinemia (bluebaby disease) in infants. Mandatory maximum limit for public water supplies is 10 mg/L.[3]
Dissolved solids (calculated sum)	Mineral constituents dissolved from rocks and soils.	28-773 mg/L	Recommended maximum limit for public water supplies is 500 mg/L.[1] Water containing more than 1,000 mg/L of dissolved solids is unsuitable for many purposes.
Hardness as $CaCO_3$	In most waters, nearly all hardness is due to calcium and magnesium.	14-610 mg/L	Soap consuming capacity of a water. Forms white scale on teakettles and plumbing and rings in bathtubs. Although hardness is less of a factor with synthetic detergents than with soap, it is still desirable to soften hard water for esthetic as well as economic reasons.
Specific conductance	Mineral content of water.	32-1,050 μmhos/cm	Indicator of mineral content. A measure of the capacity of the water to conduct a current of electricity, and varies with the concentration and degree of ionization of the different minerals in solution; the more minerals, the larger the specific conductance.
pH	Hydrogen-ion concentration.	pH 6 - pH 8.2	A pH of 7.0 indicates neutrality of a solution. Values higher than 7.0 denote increased alkalinity; values lower than 7.0 indicate increased acidity. Corrosiveness of water generally increases with decreasing pH, but excessively alkaline water also may be corrosive. Recommended level for public water supplies ranges from 6.5 to 8.5.[1]
Fecal coliform bacteria	Derived from fecal matter of humans and other warm-blooded animals. Indicators of potential presence of pathogenic bacteria.	<1-19 col./100 mL	Indicates contamination from human or animal wastes. Mandatory maximum contaminant limits for public water supplies vary with sample method and frequency.[3]

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[1] U.S. Environmental Protection Agency (1977b)

[2] U.S. Salinity Laboratory Staff (1954) $SAR = \dfrac{(Na+)}{\sqrt{\dfrac{(Ca^{+2})+(Mg^{+2})}{2}}}$, in meq/L

[3] U.S. Environmental Protection Agency (1977a)

Table 3. Water-

<u>Local identifier</u>: Well number

<u>Well yield</u>: GAL/MIN - gallons per minute
E - estimated or reported

<u>Coliform bacteria</u>: COLS./100 ML - Colonies per 100 milliliters
K - Less than ideal colony count

<u>Aquifer(s)</u>: Qal - Alluvium and colluvium; Qgl - Glacial deposits; TCr - Columbia River Basalt Group; TKi - Granitic rocks, undifferentiated; ꞒpꞒ - Sedimentary, igneous, and metamorphic rocks, undifferentiated

LOCAL IDENT-I-FIER	AQUIFER(S)	DATE OF SAMPLE	WELL YIELD (GAL/MIN)	SPE-CIFIC CON-DUCT-ANCE (MICRO-MHOS)	PH (UNITS)	WATER TEMPER-ATURE (DEG C)	COLI-FORM, TOTAL, IMMED. (COLS. PER 100 ML)	COLI-FORM, FECAL, 0.7 UM-MF (COLS./100 ML)	HARD-NESS, DIS-SOLVED (MG/L AS CACO3)	HARD-NESS, NONCAR-BONATE, DIS. (MG/L CACO3)	CALCIUM DIS-SOLVED (MG/L AS CA)	MAGNE-SIUM, DIS-SOLVED (MG/L AS MG)
												BENEWAH
44N 02W 33BAA1	Qal	78-05-17	<5	133	6.9	9.5	1	<1	49	0	12	4.5
44N 05W 11CCC1	Tcr	78-05-18	E15	191	7.7	13.0	<1	<1	74	0	14	9.6
46N 02W 16ABD1	Tcr	78-05-16	E15	290	6.9	10.5	<1	<1	140	0	36	13
46N 02W 20BDA1	Qgl	78-05-16	>5	227	7.0	9.5	<1	<1	120	0	29	12
46N 02W 36DDA1	Tcr	78-05-16	E10	313	7.6	10.0	<1	<1	140	0	30	15
46N 04W 07CDB1	Tcr	78-05-16	E15	262	6.9	12.0	<1	<1	73	5	17	7.3
46N 04W 11ACC1	ꞒpꞒ	78-05-16	E10	333	7.4	10.0	<1	<1	150	0	19	26
												BONNER
54N 02W 19CBA1	Qgl	77-07-28	E10	175	7.0	8.5	<1	<1	92	2	29	4.7
54N 03W 25BCB1	TKi	77-08-10	E20	246	7.8	11.0	<1	<1	120	0	40	4.1
54N 03W 27DDC1	Qgl	77-08-10	E20	185	7.0	13.0	<1	<1	83	0	25	4.9
54N 04W 17CAD1	Qgl	77-08-11	E10	245	7.7	9.5	<1	<1	140	4	31	14
54N 04W 19BCD1	Qgl	77-07-19	E20	246	7.9	11.0	<1	<1	120	0	34	9.3
54N 04W 31DDD1	Qgl	77-08-23	>20	43	6.6	20.0	<1	<1	16	0	5.0	.8
54N 05W 18AAA1	Qgl	77-08-23	>25	301	7.2	9.5	<1	<1	150	19	44	8.8
54N 05W 30ABD1	ꞒpꞒ(?)	77-08-09	E5	343	7.6	9.0	<1	<1	190	5	51	14
54N 05W 36AAD1	TKi	77-08-08	E25	205	7.0	10.0	<1	<1	110	12	30	7.9
55N 03E 19CAD1	Qgl	77-11-15	<15	221	8.2	8.0	<1	<1	110	2	22	13
55N 03E 29DDD1	Qgl	77-11-15	<15	171	7.8	6.5	<1	<1	90	0	20	9.8
55N 05W 19CBD1	Qal	77-08-23	>60	214	7.3	8.0	<1	<1	110	0	32	7.4
55N 06W 01DDD1	Qgl	77-08-11	6	341	7.8	12.0	<1	<1	180	0	47	14
56N 01W 10CCD1	Qgl	77-12-01	<15	367	7.1	10.6	<1	<1	190	28	61	9.7
56N 02E 06CCC1	Qgl	77-11-16	<15	32	6.1	12.5	<1	<1	14	1	4.5	.7
56N 02E 18ADD1	Qgl	77-11-16	<15	639	7.2	10.5	<1	<1	360	10	81	39
56N 02W 10CAB1	TKi	77-11-30	E15	400	6.9	6.0	<1	<1	160	0	44	13
56N 02W 15CCB1	Qgl	77-12-01	E15	212	7.0	5.0	K19	<1	98	0	23	9.9
56N 03W 04AAA1	TKi	77-11-29	E15	110	6.3	5.5	<1	<1	37	0	8.8	3.7
56N 03W 04ADB1	Qgl	77-11-30	E15	174	6.6	8.4	<1	<1	77	0	18	7.7
56N 03W 30BAC1	Qal	77-11-30	E15	84	6.1	6.2	<1	<1	28	5	7.7	2.1
56N 05W 27AAB1	Qal	77-08-23	20	312	7.4	12.0	<1	<1	150	0	41	12
56N 06W 36AAA1	Qgl	77-08-23	25	249	7.4	16.5	<1	<1	130	0	34	11
57N 01E 21BAB1	Qgl	77-11-17	<15	48	6.5	8.0	<1	<1	20	1	6.6	.8
57N 02W 01BCB1	Qgl	77-11-29	E15	420	7.5	8.2	<1	<1	220	8	64	15
57N 02W 16ACC2	TKi	77-11-28	E15	65	6.6	7.6	<1	<1	26	0	6.3	2.6
57N 02W 16BAA1	Qgl	77-11-29	E1	107	6.7	8.2	0	0	44	0	12	3.4
57N 02W 19CAD1	TKi	77-11-18	<15	139	7.0	10.0	<1	<1	53	0	15	3.7
57N 05W 14DCC1	Qgl	77-08-24	E10	163	6.7	10.0	<1	<1	66	0	18	5.2
58N 01W 02ADC1	Qgl	77-11-17	<15	155	6.8	7.5	<1	<1	69	15	23	2.8
58N 01W 24ADB1	Qal	77-11-17	<15	56	6.4	7.0	4	<1	24	0	7.8	1.0
58N 01W 30AAB1	ꞒpꞒ	77-11-18	<15	282	7.3	7.0	<1	<1	150	9	38	13
60N 04W 31CBD1	Qgl	77-08-25	E10	41	6.2	7.0	<1	<1	14	0	4.4	.8
60N 05W 24ABC1	Qgl	77-08-25	60	48	6.5	6.0	<1	<1	16	0	5.0	.9
61N 04W 16BCA1	Qgl	77-08-25	E15	58	6.7	7.0	<1	<1	26	0	7.5	1.7
												BOUNDARY
60N 01W 34ADB1	Qgl	78-01-16	E15	426	7.5	3.0	<1	<1	240	7	70	17
61N 01E 08ABC1	Qgl	78-01-19	E15	659	7.4	6.0	<1	<1	360	13	84	36
61N 01E 15ADD1	Qgl	78-01-19	E10	1050	7.2	9.0	<1	<1	610	170	180	38
62N 02E 07DAB1	ꞒpꞒ	78-01-18	E5	471	7.6	7.0	<1	<1	170	21	54	8.3
62N 02E 17BCC1	Qgl	78-01-19	E15	282	8.1	8.5	<1	<1	120	0	39	5.5
62N 02E 29CDC1	Qgl	78-01-18	E10	412	7.2	8.0	K0	<1	190	29	56	13
63N 01E 04AAB1	Qgl	78-01-17	E10	738	7.7	6.0	<1	<1	300	0	77	27
63N 01W 24CAC1	Qgl	78-01-18	E20	43	6.4	8.0	<1	<1	16	0	4.9	.8
65N 01W 34ADD1	Qal	78-01-17	E10	567	7.7	8.0	<1	<1	250	0	62	22
65N 02E 26BCD1	Qgl	78-01-17	E10	79	6.7	10.0	<1	<1	29	0	7.4	2.6

Notations: 0 - Analyzed for, but not detected
-- Determination deleted; improper sample
< - Less than
> - Greater than

Units: MICROMHOS - micromhos per centimeter at 25°C
DEG C - degrees Celsius
MG/L - milligrams per liter
UG/L - micrograms per liter

SODIUM, DIS-SOLVED (MG/L AS NA)	SODIUM AD-SORPTION RATIO	POTAS-SIUM, DIS-SOLVED (MG/L AS K)	BICAR-BONATE (MG/L AS HCO3)	CAR-BONATE (MG/L AS CO3)	ALKA-LINITY, TOTAL (MG/L AS CACO3)	SULFATE DIS-SOLVED (MG/L AS SO4)	FLUO-RIDE, DIS-SOLVED (MG/L AS F)	SOLIDS, SUM OF CONSTI-TUENTS, DIS-SOLVED (MG/L)	NITRO-GEN, NO2+NO3 DIS-SOLVED (MG/L AS N)	PHOS-PHORUS, TOTAL (MG/L AS P)	IRON, DIS-SOLVED (UG/L AS FE)	CHLO-RIDE, DIS-SOLVED (MG/L AS CL)	SILICA, DIS-SOLVED (MG/L AS SIO2)
COUNTY													
9.4	0.6	1.3	70	0	57	8.5	0.1	103	0.06	0.00	510	1.3	31
13	.7	2.3	120	0	98	2.7	.3	143	.00	.07	350	1.6	40
9.2	.3	2.4	200	0	160	3.1	.2	208	.09	.05	60	1.3	44
6.2	.2	1.8	160	0	131	2.8	.4	181	.08	.13	10	1.1	49
11	.4	10	200	0	160	3.9	.2	197	.00	.05	0	1.0	27
24	1.2	1.9	82	0	67	5.4	.3	171	.09	.07	60	40	34
14	.5	.6	220	0	180	7.0	.4	199	.04	.00	30	1.2	22
COUNTY													
3.1	.1	1.6	110	0	90	7.2	.1	126	.30	.19	10	.8	24
15	.6	.5	180	0	148	3.3	.1	173	.21	.01	20	1.0	19
5.3	.3	2.0	110	0	90	6.0	.2	120	.39	.04	60	.8	20
3.8	.1	1.8	160	0	130	8.9	.1	153	.16	.00	10	.7	13
4.1	.2	1.7	160	0	131	8.7	.1	153	.18	.02	10	.6	15
2.0	.2	.9	29	0	24	2.3	.0	42	.12	.02	40	.4	16
5.6	.2	2.0	160	0	131	9.0	.2	178	2.0	.03	10	2.7	19
5.1	.2	2.0	220	0	180	6.0	.2	220	2.0	.04	10	.8	24
5.2	.2	1.8	120	0	98	15	.2	145	.11	.01	630	.6	24
2.5	.1	.7	130	0	110	9.0	.1	123	.10	.02	20	.6	11
1.8	.1	.6	110	0	90	6.8	.1	104	.07	.02	30	.3	9.7
5.6	.2	1.8	150	0	123	9.1	.1	152	.47	.03	10	.8	19
6.1	.2	2.2	220	0	180	11	.1	201	.01	.05	60	.5	12
5.6	.2	1.1	200	0	160	29	.2	230	.01	.00	160	3.9	21
1.3	.2	.4	16	0	13	1.5	.0	28	.04	.02	60	.2	11
2.5	.1	1.2	430	0	350	8.2	.1	361	.03	.02	50	1.2	16
17	.6	1.9	210	0	172	29	.5	233	.03	.00	50	1.6	22
7.8	.3	.7	120	0	98	11	.1	135	.09	.02	30	.7	22
5.0	.4	2.3	57	0	47	3.0	.1	77	.06	.02	50	.5	25
5.6	.3	1.5	100	0	82	5.7	.2	112	.18	.07	60	1.5	22
3.4	.3	1.4	28	0	23	5.8	.1	68	1.6	.01	50	1.6	25
12	.4	2.0	190	0	156	28	.3	206	.21	.02	10	.9	15
3.1	.1	2.8	170	0	139	11	.1	156	.01	.02	110	.4	9.7
1.2	.1	.5	23	0	19	5.6	.1	36	.02	.02	50	.2	10
2.4	.1	1.3	260	0	210	2.4	.1	230	.09	.00	20	1.3	15
3.4	.3	.8	37	0	30	1.7	.2	76	.51	.06	50	1.0	39
4.4	.3	1.3	57	0	47	6.1	.2	76	.04	.01	20	.9	19
7.6	.5	1.9	80	0	66	6.1	.3	102	.02	.08	50	.4	27
5.6	.3	1.4	93	0	76	17	.2	124	.01	.06	5300	.7	25
2.8	.1	1.5	66	0	54	17	.1	99	.01	.03	220	.4	19
1.8	.2	1.4	31	0	25	.7	.1	45	.04	.03	340	.4	16
5.5	.2	1.8	170	0	140	16	.3	178	.01	.02	170	.2	19
2.5	.3	.9	24	0	20	2.1	.0	47	.41	.07	60	.7	22
3.0	.3	1.1	32	0	26	2.3	.1	54	.08	.03	70	.6	25
1.5	.1	.8	39	0	32	3.1	.1	47	.05	.01	50	.1	13
COUNTY													
2.5	.1	2.5	290	0	240	21	.2	273	.05	.02	1100	.7	15
14	.3	4.1	420	0	340	47	.6	416	.04	.15	2000	1.2	20
33	.6	3.2	530	0	430	52	.1	773	25	.02	40	60	35
39	1.3	2.6	180	0	150	100	.4	312	.02	.02	160	3.8	15
13	.5	1.6	170	0	140	18	.3	175	.03	.05	40	.8	13
11	.3	3.0	200	0	160	37	.1	245	.03	.01	2700	10	13
58	1.5	4.0	490	0	400	29	.5	456	.01	.02	730	3.5	15
1.9	.2	1.0	19	0	16	2.7	.1	35	.40	.01	20	.7	12
34	.9	3.3	380	0	310	18	.2	342	.01	.09	2000	1.6	12
4.7	.4	.8	44	0	36	1.0	.1	65	.10	.01	70	.5	26

Table 3. Water-quality

KOOTENAI

LOCAL IDENT- I- FIER	AQUIFER(S)	DATE OF SAMPLE	WELL YIELD (GAL/MIN)	SPE- CIFIC CON- DUCT- ANCE (MICRO- MHOS)	PH (UNITS)	WATER TEMPER- ATURE (DEG C)	COLI- FORM, TOTAL, IMMED. (COLS. PER 100 ML)	COLI- FORM, FECAL, 0.7 UM-MF (COLS./ 100 ML)	HARD- NESS, DIS- SOLVED (MG/L AS CACO3)	HARD- NESS, NONCAR- BONATE, DIS. (MG/L CACO3)	CALCIUM DIS- SOLVED (MG/L AS CA)	MAGNE- SIUM, DIS- SOLVED (MG/L AS MG)
48N 01W 18BBB1	€p€	78-03-02	E10	208	6.7	5.5	<1	<1	89	8	20	9.4
49N 01W 15DAC1	€p€	78-03-01	E10	151	6.5	5.5	<1	<1	43	4	7.9	5.6
49N 01W 22DDC1	Qal	78-03-02	E20	102	6.5	8.0	<1	<1	42	8	11	3.5
50N 04W 05DDA1	Qgl	77-08-03	>5	109	6.6	14.5	<1	<1	51	11	14	4.0
50N 05W 01AAD1	Qgl	77-07-20	700	123	8.2	15.0	<1	<1	59	7	17	4.0
50N 05W 01CBB1	Qgl	77-07-20	1400	83	7.2	15.5	<1	<1	35	3	9.9	2.5
50N 05W 06DCC1	Qgl	77-07-21	>3000	82	6.8	10.0	<1	<1	37	3	10	2.8
50N 05W 07ADD1	Qgl	77-08-01	E10	83	6.6	12.0	<1	<1	35	7	10	2.5
51N 03W 19BAB1	Qgl	77-07-28	E10	63	6.5	9.0	<1	<1	26	0	7.3	1.8
51N 04W 06ADA1	Qgl	77-07-12	>1000	181	8.1	8.0	<1	<1	90	0	24	7.3
51N 04W 12ABA1	Tcr	77-07-27	E25	180	6.7	14.0	<1	<1	81	0	20	7.5
51N 04W 15AAA1	Qgl	77-07-13	>100	248	8.0	7.0	<1	<1	120	0	30	11
51N 04W 15DAB1	Qgl	77-07-26	E20	144	8.0	9.5	<1	<1	71	0	20	5.1
51N 04W 17CBC1	Qgl	77-07-27	E20	320	7.6	8.0	<1	<1	180	24	36	22
51N 04W 19DCC2	Qgl	77-07-21	>1000	335	7.8	9.0	<1	<1	190	30	38	22
51N 04W 22BCA1	Qgl	77-08-04	>200	301	8.2	9.5	<1	<1	170	0	42	17
51N 04W 23DAA1	Qgl	77-07-12	>100	121	8.1	11.0	<1	<1	57	0	18	3.0
51N 04W 24ABB1	Qgl	77-07-26	E20	97	7.1	10.0	<1	<1	48	2	13	3.7
51N 04W 27DDB1	Qgl	77-07-28	>500	257	7.9	8.0	<1	<1	130	9	28	15
51N 04W 29DBB1	Qgl	77-07-12	>1000	262	8.1	10.0	<1	<1	150	15	29	18
51N 04W 35ADB1	Qgl	77-07-26	E15	327	8.1	10.0	<1	<1	180	15	37	21
51N 05W 11DDB1	Qgl	77-07-13	>100	128	8.3	7.0	<1	<1	65	0	19	4.3
51N 05W 12ABA1	Qgl	77-07-13	>1000	285	7.7	12.0	<1	<1	150	0	34	16
51N 05W 19CAD1	Qgl	77-07-21	>500	337	7.6	10.0	<1	<1	170	0	53	8.9
51N 05W 25DAB1	Qgl	77-07-20	>1000	269	8.0	8.5	<1	<1	140	1	31	15
51N 05W 26BCA1	Qgl	77-07-20	>1000	272	7.9	8.5	<1	<1	140	1	32	15
51N 05W 27BBB1	Qgl	77-07-21	E10	264	7.9	9.0	<1	<1	150	2	32	16
51N 05W 31ACA1	Qgl	77-07-21	>1500	276	8.0	8.5	<1	<1	160	12	36	18
51N 05W 35BDC1	Qgl	77-07-20	>1000	248	8.0	15.0	<1	<1	130	17	28	15
52N 03W 07DAC1	Qgl	77-08-04	>5	186	7.8	8.5	<1	<1	100	6	34	4.8
52N 03W 07DCA1	Qgl	77-08-02	>200	164	7.0	9.0	83	81	83	1	26	4.3
52N 03W 19AAB1	Qgl	77-08-02	E5	89	6.5	9.5	<1	<1	38	0	11	2.5
52N 04W 10DAB1	TKi	77-08-02	E2	304	7.6	14.0	<1	<1	160	0	42	13
52N 04W 14DCD1	Qgl	77-08-03	E10	199	7.2	10.0	<1	<1	96	0	17	13
52N 04W 17DDD1	Qgl	77-08-09	150	162	8.1	10.5	<1	<1	85	3	23	6.8
52N 04W 20CCB1	Qgl & TKi	77-07-14	<15	65	6.9	13.5	<1	<1	21	0	6.6	1.2
52N 04W 27DCD1	Qgl	77-07-14	>20	297	7.9	9.5	<1	<1	170	9	33	20
52N 04W 31DAB1	Qgl	77-07-13	E30	187	7.7	8.5	<1	<1	94	0	26	7.1
52N 04W 32ABC1	Qgl	77-07-13	>1000	232	7.8	8.5	<1	<1	120	0	28	12
52N 04W 35DCB1	Qgl(?)	77-07-12	>1000	495	7.9	11.5	<1	<1	270	0	50	36
53N 02W 07CAA1	Qgl	77-07-19	E10	273	7.8	10.0	<1	<1	140	1	33	14
53N 02W 19ADD1	TKi	77-07-19	>8	274	7.8	10.0	<1	<1	130	0	39	8.7
53N 03W 03BAB1	Qgl	77-07-19	>5	278	8.0	11.0	<1	<1	150	2	35	16
53N 03W 09CDD1	Qgl	77-08-02	70	297	7.8	8.0	84	<1	160	20	36	17
53N 03W 21CDC1	TKi & Qgl	77-07-27	E20	374	7.3	8.5	<1	<1	210	4	54	18
53N 03W 22DAB1	TKi	77-07-14	>20	402	7.9	12.0	<1	<1	200	28	50	17
53N 04W 06DDB2	Qgl	77-07-19	>500	53	6.7	13.0	81	<1	21	0	6.4	1.3
53N 04W 22CDD1	Qgl	77-08-02	E10	315	7.6	9.5	<1	<1	170	6	35	20
53N 04W 24BBA1	Qgl	77-08-02	>500	262	7.8	8.0	<1	<1	140	7	34	13
53N 04W 33CBB1	Qgl(?)	77-07-28	E20	302	7.7	8.0	<1	<1	170	22	36	19
53N 04W 36BBA1	Qgl	77-07-27	E20	199	7.6	7.0	<1	<1	92	2	27	6.0
54N 02W 34CCB1	Qgl	77-08-22	>5	279	7.3	11.5	<1	<1	130	0	36	10

analyses (Continued)

SODIUM, DIS-SOLVED (MG/L AS NA)	SODIUM AD-SORP-TION RATIO	POTAS-SIUM, DIS-SOLVED (MG/L AS K)	BICAR-BONATE (MG/L AS HCO3)	CAR-BONATE (MG/L AS CO3)	ALKA-LINITY, TOTAL (MG/L AS CACO3)	SULFATE DIS-SOLVED (MG/L AS SO4)	FLUO-RIDE, DIS-SOLVED (MG/L AS F)	SOLIDS, SUM OF CONSTI-TUENTS, DIS-SOLVED (MG/L)	NITRO-GEN, NO2+NO3 DIS-SOLVED (MG/L AS N)	PHOS-PHORUS, TOTAL (MG/L AS P)	IRON, DIS-SOLVED (UG/L AS FE)	CHLO-RIDE, DIS-SOLVED (MG/L AS CL)	SILICA, DIS-SOLVED (MG/L AS SIO2)
COUNTY													
7.7	0.4	1.9	98	0	80	24	0.4	141	0.02	0.01	780	0.5	28
4.5	.3	1.0	47	0	39	13	.1	92	.01	.16	13000	.5	23
4.6	.3	.7	41	0	34	18	.I	81	.20	.04	0	1.3	20
2.5	.2	1.2	49	0	40	6.2	.0	69	.57	.01	10	1.6	13
2.2	.1	1.3	63	0	52	5.2	.0	79	.86	.01	10	.9	14
1.8	.1	.9	39	0	32	4.9	.0	54	.26	.01	10	.3	13
2.1	.2	.8	41	0	34	4.6	.0	54	.54	.01	10	.6	11
2.0	.1	.8	34	0	28	9.2	.1	54	.34	.04	60	.6	10
1.8	.2	.8	34	0	28	2.2	.1	42	.17	.00	10	.6	10
2.4	.1	1.3	110	0	90	6.8	.0	110	--	.00	10	.6	13
7.0	.3	2.5	110	0	90	9.4	.2	155	.35	.09	10	.8	52
2.3	.1	1.5	160	0	131	4.0	.0	140	--	.01	10	1.2	11
2.3	.1	1.4	88	0	72	11	.1	98	.61	.00	10	1.5	11
3.1	.1	2.1	190	0	156	17	.1	193	2.0	.00	10	.8	9.9
2.7	.1	2.2	190	0	160	19	.1	197	1.6	.01	10	1.1	11
3.5	.1	2.1	210	0	172	11	.1	203	2.1	.01	0	2.5	12
1.9	.1	1.1	88	0	72	2.9	.0	82	--	.02	10	.5	11
1.8	.1	1.0	56	0	46	2.9	.1	63	.34	.00	20	.7	11
3.1	.1	2.0	150	0	120	9.3	.1	153	1.6	.02	0	2.1	12
2.7	.1	1.8	160	0	130	9.5	.0	153	--	.00	10	1.5	12
3.6	.1	2.1	200	0	160	13	.0	202	2.9	.00	10	2.8	11
2.1	.1	1.0	83	0	68	3.4	.0	83	--	.01	10	.8	12
3.4	.1	1.7	200	0	164	7.3	.0	177	--	.01	10	.6	15
4.4	.1	2.0	210	0	170	2.9	.1	198	.85	.01	10	1.6	18
2.7	.1	1.8	170	0	139	8.8	.0	159	1.0	.01	10	.7	11
3.3	.1	1.7	170	0	139	14	.1	163	.27	.01	10	.5	11
3.2	.1	1.8	180	0	148	15	.1	170	.37	.01	10	.6	11
2.9	.1	1.9	180	0	148	15	.1	179	.92	.01	30	1.0	11
2.1	.1	2.0	140	0	110	8.2	.1	149	2.2	.01	10	1.5	13
2.2	.1	2.0	120	0	98	3.9	.1	12S	.38	.02	40	1.0	16
2.5	.1	2.0	100	0	82	3.7	.1	110	1.2	.02	10	.8	16
2.6	.2	1.5	51	0	42	2.1	.1	66	.37	.01	250	.9	18
6.8	.2	1.1	200	0	160	11	.5	185	.05	.01	10	.3	11
4.7	.2	1.4	140	0	115	2.7	.4	136	.01	.04	2600	.5	25
2.6	.1	1.2	100	0	82	4.4	.1	103	.26	.01	10	.5	14
3.5	.3	.8	39	0	32	2.9	.1	45	--	.00	20	.3	10
2.1	.1	2.5	190	0	160	10	.1	172	--	.02	20	.3	10
2.4	.1	1.3	150	0	123	5.2	.0	131	--	.00	10	.6	14
2.9	.1	1.5	160	0	131	12	.1	148	--	.00	20	.5	12
3.4	.1	4.0	350	0	287	41	.1	320	--	.03	40	.5	13
3.4	.1	1.6	170	0	139	13	.1	159	.34	.01	20	.9	8.0
7.8	.3	.9	170	0	139	12	.1	168	.15	.01	10	.5	15
3.7	.1	2.1	180	0	148	7.7	.1	172	.37	.01	10	.8	16
2.8	.1	2.3	170	0	140	19	.1	175	.85	.00	10	2.5	7.9
2.5	.1	2.4	250	0	210	9.6	.1	224	.28	.00	10	.9	12
9.3	.3	.7	210	0	172	23	.1	223	--	.00	20	8.8	11
2.4	.2	1.0	29	0	24	1.4	.0	43	.33	.02	20	.5	14
2.5	.1	2.3	200	0	164	16	.1	188	.64	.01	10	.7	10
3.0	.1	1.6	160	0	130	1S	.1	157	.34	.01	30	.8	9.5
3.4	.1	2.0	180	0	148	19	.1	180	.21	.00	20	.8	10
1.9	.1	1.2	110	0	90	3.4	.1	112	.40	.00	10	.6	16
2.8	.1	1.5	160	0	131	13	.1	156	.32	.02	20	1.2	11

Table 3. Water-quality

LATAH

LOCAL IDENT-I-FIER	AQUIFER(S)	DATE OF SAMPLE	WELL YIELD (GAL/MIN)	SPECIFIC CONDUCTANCE (MICROMHOS)	PH (UNITS)	WATER TEMPERATURE (DEG C)	COLIFORM, TOTAL, IMMED. (COLS. PER 100 ML)	COLIFORM, FECAL, 0.7 UM-MF (COLS./100 ML)	HARDNESS, DISSOLVED (MG/L AS CACO3)	HARDNESS, NONCARBONATE, DIS. (MG/L CACO3)	CALCIUM DISSOLVED (MG/L AS CA)	MAGNESIUM, DISSOLVED (MG/L AS MG)
41N 03W 03BCB1	Єpє	78-05-17	E10	129	7.1	8.5	<1	<1	54	0	14	4.6
41N 03W 09BBD1	Єpє	78-05-17	E10	968	7.1	10.5	<1	<1	230	50	78	8.7
41N 04W 06BAC1	Tcr	78-05-18	E20	324	8.0	15.5	<1	<1	65	0	18	4.8
41N 04W 09BAD1	Tcr	78-05-18	E10	338	8.1	10.5	<1	<1	72	0	20	5.3
41N 05W 03DBC1	Tcr	78-05-18	E10	396	7.2	12.0	14	<1	180	45	44	16

SHOSHONE

LOCAL IDENT-I-FIER	AQUIFER(S)	DATE OF SAMPLE	WELL YIELD (GAL/MIN)	SPECIFIC CONDUCTANCE (MICROMHOS)	PH (UNITS)	WATER TEMPERATURE (DEG C)	COLIFORM, TOTAL, IMMED. (COLS. PER 100 ML)	COLIFORM, FECAL, 0.7 UM-MF (COLS./100 ML)	HARDNESS, DISSOLVED (MG/L AS CACO3)	HARDNESS, NONCARBONATE, DIS. (MG/L CACO3)	CALCIUM DISSOLVED (MG/L AS CA)	MAGNESIUM, DISSOLVED (MG/L AS MG)
48N 02E 03ABC1	Єpє	78-02-28	E10	171	6.3	9.0	<1	<1	69	36	14	8.3
48N 02E 05BDA1	Qal	78-02-28	E20	46	6.1	9.0	<1	<1	16	7	4.5	1.2
48N 03E 06ADA1	Єpє & Qal	78-02-28	E10	274	6.1	10.5	--	--	100	59	27	7.8
48N 03E 11DDD1	Qgl & Єpє	78-02-28	E10	199	6.2	8.5	<1	<1	88	44	25	6.3
48N 05E 36BBB1	Qgl(?)	78-03-02	E5	104	6.4	5.5	--	--	49	3	15	2.9
49N 01E 34BDC1	Qal	78-03-01	E200	166	6.0	9.0	<1	<1	68	51	18	5.6
49N 02E 08CAA1	Єpє	78-03-01	E10	106	6.3	4.0	<1	<1	42	17	6.2	6.4

Metallic

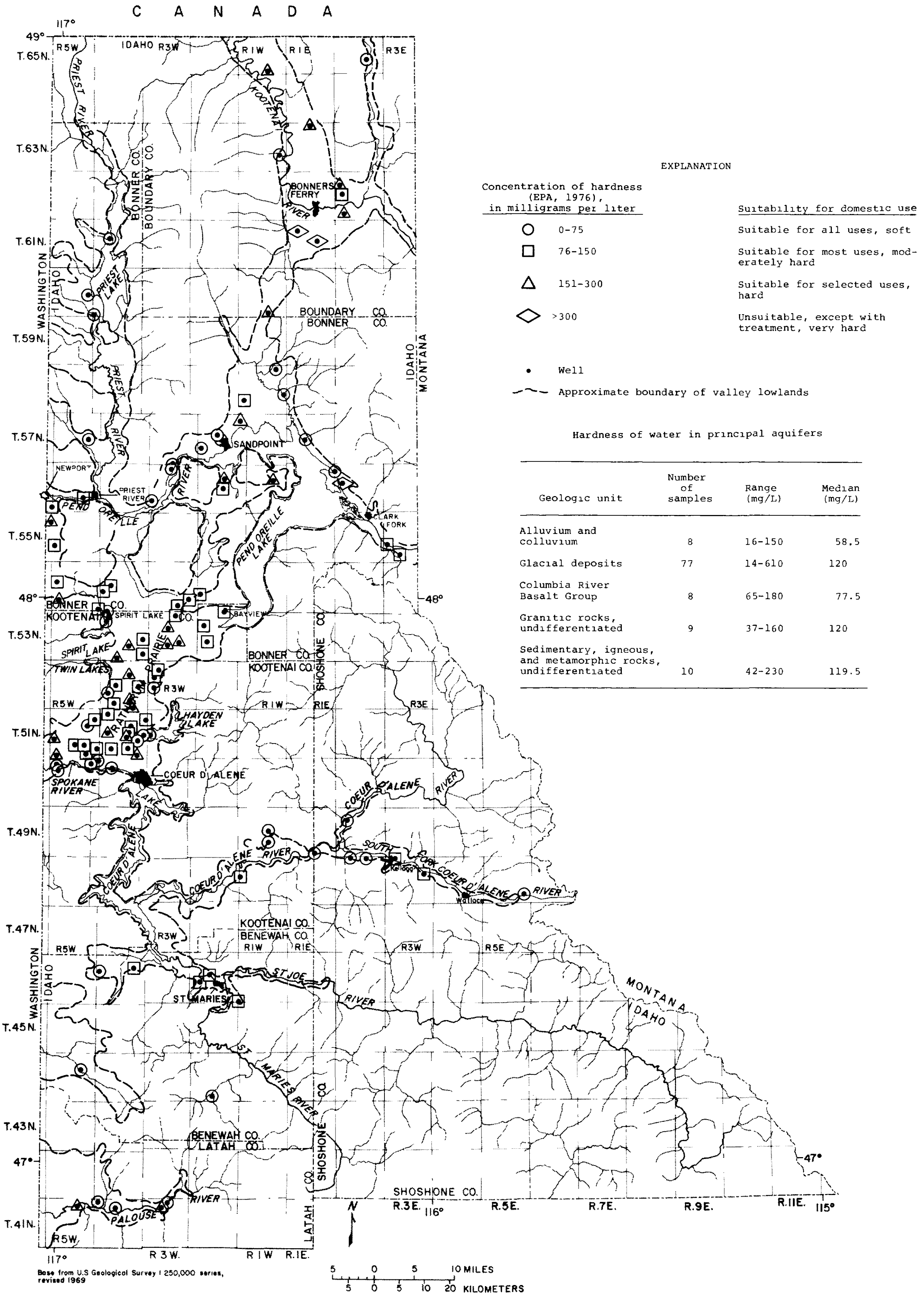
LOCAL IDENT-I-FIER	DATE OF SAMPLE	IRON, DISSOLVED (UG/L AS FE)	LEAD, DISSOLVED (UG/L AS PB)	MERCURY DISSOLVED (UG/L AS HG)	MOLYBDENUM, DISSOLVED (UG/L AS MO)
48N 02E 03ABC1	78-02-28	30	5	0.0	1
48N 02E 05BDA1	78-02-28	0	9	.0	0
48N 03E 06ADA1	78-02-28	130	7	.0	0
48N 03E 11DDD1	78-02-28	30	10	.0	0
48N 05E 36BBB1	78-03-02	90	15	.0	0
49N 01E 34BDC1	78-03-01	380	7	.0	1
49N 02E 08CAA1	78-03-01	30	7	.0	1

analyses (Continued)

SODIUM, DIS- SOLVED (MG/L AS NA)	SODIUM, AD- SORP- TION RATIO	POTAS- SIUM, DIS- SOLVED (MG/L AS K)	BICAR- BONATE (MG/L AS HCO3)	CAR- BONATE (MG/L AS CO3)	ALKA- LINITY, TOTAL (MG/L AS CACO3)	SULFATE DIS- SOLVED (MG/L AS SO4)	FLUO- RIDE, DIS- SOLVED (MG/L AS F)	SOLIDS, SUM OF CONSTI- TUENTS, DIS- SOLVED (MG/L)	NITRO- GEN, NO2+NO3 DIS- SOLVED (MG/L AS N)	PHOS- PHORUS, TOTAL (MG/L AS P)	IRON, DIS- SOLVED (UG/L AS FE)	CHLO- RIDE, DIS- SOLVED (MG/L AS CL)	SILICA, DIS- SOLVED (MG/L AS SIO2)
COUNTY													
5.6	0.3	2.2	79	0	65	2.1	0.1	106	0.01	0.03	20	1.4	37
110	3.2	4.1	220	0	180	140	1.4	565	.00	.00	1400	100	13
50	2.7	2.9	200	0	160	9.7	.3	206	.00	.02	60	2.9	19
49	2.5	2.8	200	0	160	11	.2	208	.01	.01	50	3.4	18
13	.4	1.7	160	0	130	5.8	.2	278	12	.07	0	17	48
COUNTY													
5.6	.3	1.3	41	0	34	44	.1	117	.12	.00	30	.7	22
1.1	.1	.5	11	0	9	9.7	.0	35	.20	.01	0	.3	11
9.6	.4	1.4	49	0	40	73	.1	165	.52	.00	130	.2	18
2.6	.1	1.1	54	0	44	44	.0	128	1.3	.01	30	2.0	11
1.3	.1	2.9	56	0	46	5.6	.0	66	.43	.01	90	.8	6.1
3.6	.2	1.2	21	0	17	52	.0	112	.46	.03	380	1.5	17
5.2	.4	.9	30	0	25	23	.1	91	1.0	.17	30	.5	29

trace elements

SELE- NIUM, DIS- SOLVED (UG/L AS SE)	VANA- DIUM, DIS- SOLVED (UG/L AS V)	ZINC, DIS- SOLVED (UG/L AS ZN)	ARSENIC DIS- SOLVED (UG/L AS AS)	CADMIUM DIS- SOLVED (UG/L AS CD)	CHRO- MIUM, DIS- SOLVED (UG/L AS CR)	COPPER, DIS- SOLVED (UG/L AS CU)
0	0.0	210	0	2	0	77
0	.0	110	0	3	0	27
0	.0	1200	8	4	0	8
0	.0	3600	0	23	0	3
0	.0	210	1	4	0	22
0	.0	110	0	3	0	9
1	.0	230	0	3	0	67



Base from U.S Geological Survey 1:250,000 series, revised 1969

EXPLANATION

Concentration of hardness (EPA, 1976), in milligrams per liter		Suitability for domestic use
○	0-75	Suitable for all uses, soft
□	76-150	Suitable for most uses, moderately hard
△	151-300	Suitable for selected uses, hard
◇	>300	Unsuitable, except with treatment, very hard

• Well

—⌒— Approximate boundary of valley lowlands

Hardness of water in principal aquifers

Geologic unit	Number of samples	Range (mg/L)	Median (mg/L)
Alluvium and colluvium	8	16-150	58.5
Glacial deposits	77	14-610	120
Columbia River Basalt Group	8	65-180	77.5
Granitic rocks, undifferentiated	9	37-160	120
Sedimentary, igneous, and metamorphic rocks, undifferentiated	10	42-230	119.5

Figure 4.--Hardness in ground water.

Dissolved Solids

Dissolved-solids concentrations are an indication of total mineral content in water. As used in this report, "dissolved solids" represents the sum of the major chemical constituents in each water sample. Dissolved solids consist mainly of the cations (calcium, magnesium, potassium, and sodium) and anions (bicarbonate, carbonate, chloride, fluoride, nitrate, and sulfate), plus silica.

Dissolved-solids concentrations exceeding 500 mg/L occurred in water from only two wells--one in the Kootenai River valley and one in the Palouse River valley (see table 3). Concentrations ranging from 250 to 500 mg/L occurred most often in samples collected from wells tapping alluvial and glacial deposits in the Kootenai River valley. Dissolved-solids concentrations less than 250 mg/L were most common and reflect the general ground-water quality in north Idaho.

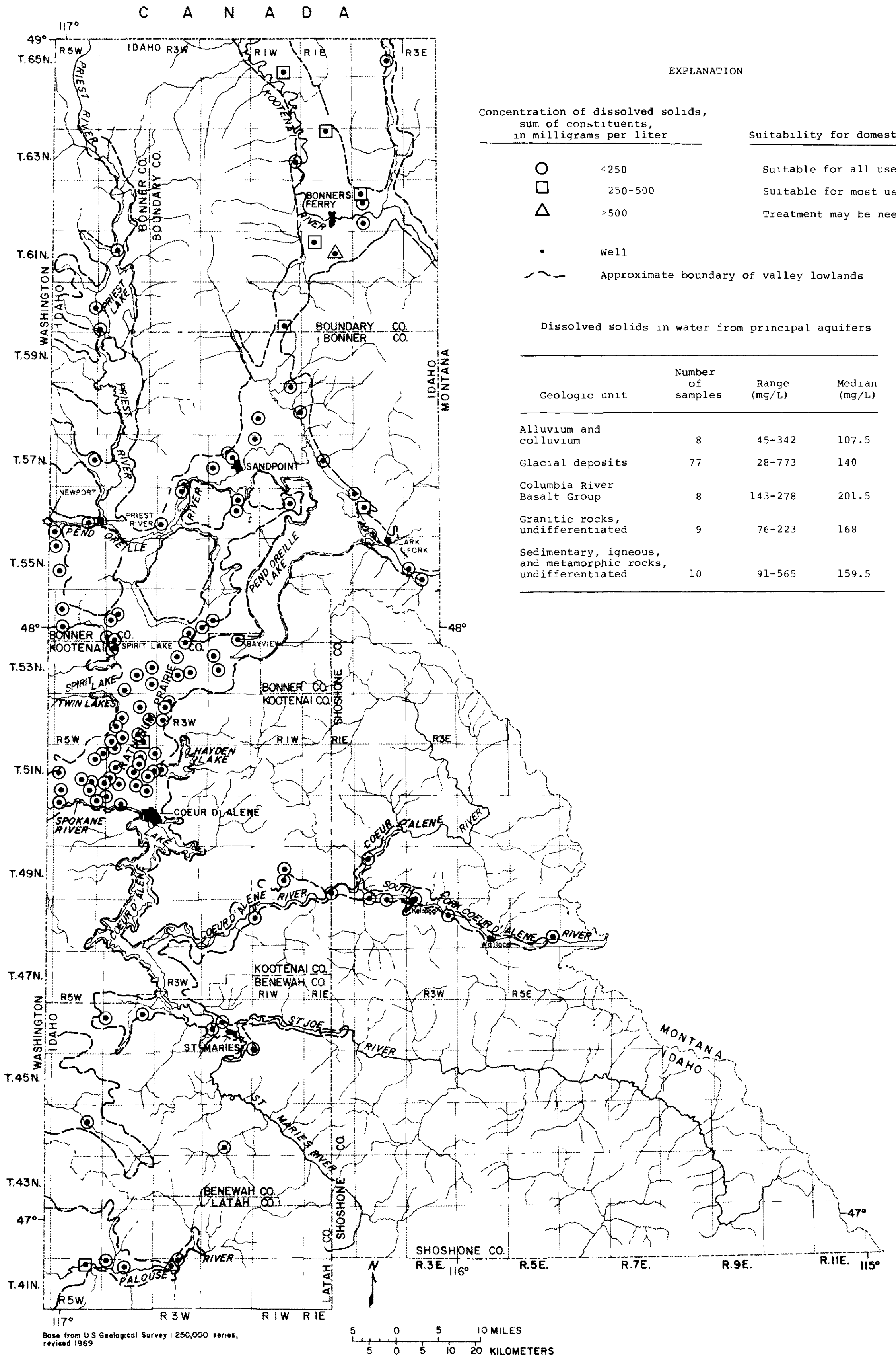
The EPA (1977b) recommends that dissolved-solids concentrations in water for public supplies not exceed 500 mg/L. However, their recommendation relates to the esthetic qualities of drinking water. If none of the individual constituents that contribute to the dissolved-solids concentration are present in a concentration that would be harmful, dissolved-solids concentrations greater than 500 mg/L may have no harmful physiological effects and even may be beneficial to health (EPA, 1977c).

Dissolved solids affect the suitability of water for livestock, irrigation, industry, and domestic uses; but, because the concentrations in the study area are relatively low, ranging from 28 to 773 mg/L, there is little cause for concern by ground-water users.

The distribution of dissolved solids in water from aquifers that locally provide the first occurrence (with depth) of a suitable water supply is shown in figure 5. The table in figure 5 shows the range and median concentration of dissolved solids in water from each of the various geologic units.

Nitrate

For convenience, the concentration of nitrite-plus-nitrate ions is expressed in terms of the concentration of elemental nitrogen present, and nitrite-plus-nitrate is hereafter referred to collectively as nitrate. Nitrate



EXPLANATION

Concentration of dissolved solids, sum of constituents, in milligrams per liter		Suitability for domestic use
○	<250	Suitable for all uses
□	250-500	Suitable for most uses
△	>500	Treatment may be needed

• Well

Approximate boundary of valley lowlands

Dissolved solids in water from principal aquifers

Geologic unit	Number of samples	Range (mg/L)	Median (mg/L)
Alluvium and colluvium	8	45-342	107.5
Glacial deposits	77	28-773	140
Columbia River Basalt Group	8	143-278	201.5
Granitic rocks, undifferentiated	9	76-223	168
Sedimentary, igneous, and metamorphic rocks, undifferentiated	10	91-565	159.5

Figure 5.--Dissolved solids in ground water.

concentrations in water samples from wells in the study area ranged from 0.00 to 25 mg/L (see table 3). A mandatory limit of 10 mg/L nitrate has been established for public water supplies by EPA (1977a). In the 104 water samples analyzed for nitrate, concentrations exceeded 1 mg/L in 15 samples and exceeded 10 mg/L in 2 samples (fig. 6). Most nitrate concentrations were less than 0.5 mg/L.

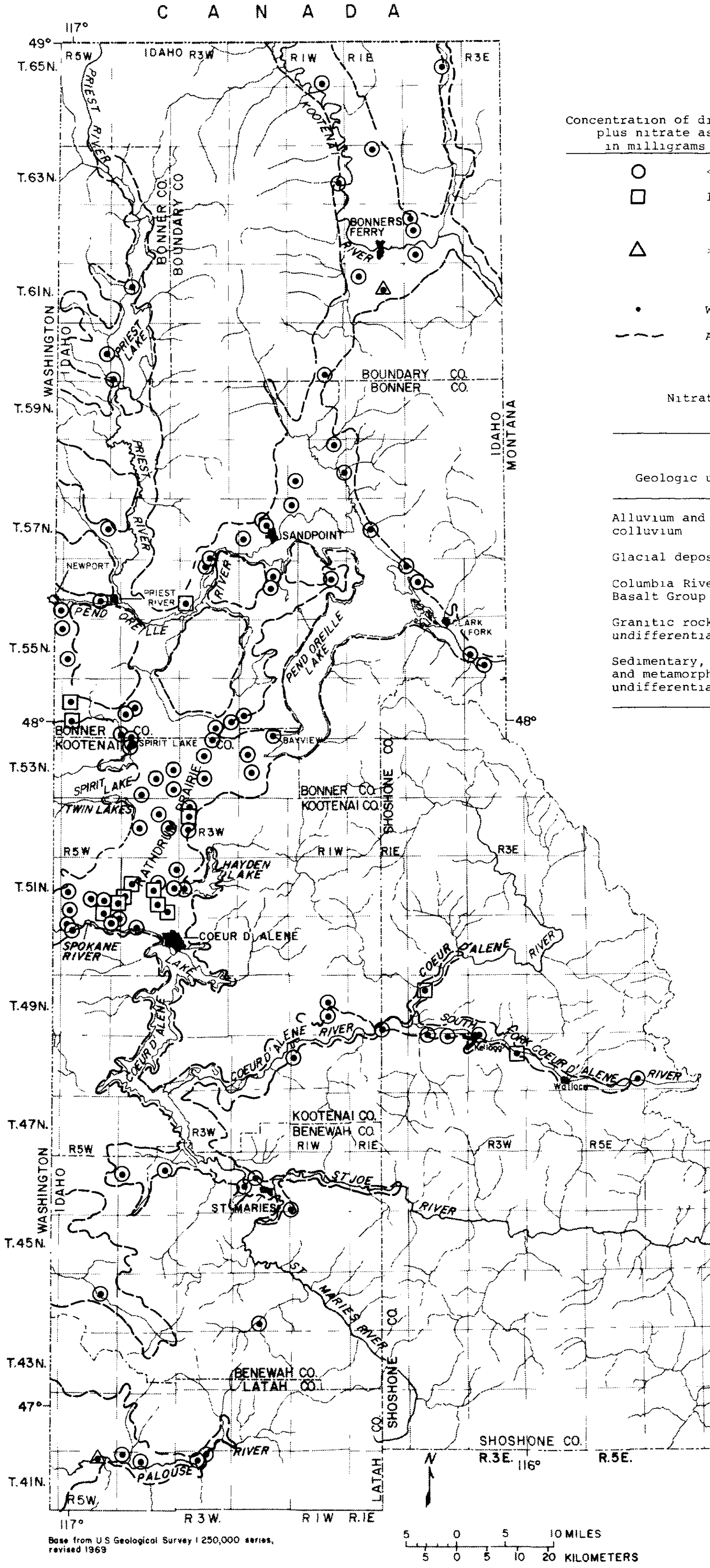
Excessive concentrations of nitrate in a water supply generally are an indication of man-caused contamination. Potential sources of nitrate in water supplies are municipal and industrial waste waters, septic-tank effluent, leachates from barnyards and feedlots, cropland and lawn fertilizers, animal wastes, leachates from garbage dumps and landfills, and certain kinds of mine drainage. Natural sources of nitrate in ground water include decaying plants and soluble nitrogen compounds or minerals in soils and rock materials. Natural sources are minor contributors of nitrogen to most ground water in north Idaho.

Ten water samples that had nitrate concentrations between 1 and 10 mg/L were from glacial deposits consisting of sand and gravel, in which water levels in wells ranged from 11 to 299 ft below land surface. Additional data are necessary to accurately determine the principal source(s) leading to the elevated concentration of nitrate in north Idaho ground water.

Concentrations exceeding 1 mg/L were common in the southern part of Rathdrum Prairie north of Coeur d'Alene and west of Hayden Lake. Wells sampled in this area are completed in glacial deposits consisting of sand and gravel, in which water levels generally are greater than 200 ft below land surface. Nitrate concentrations averaged 1.8 mg/L and were consistently higher than the probable ambient concentration of less than 0.5 mg/L. Potential sources of these nitrates are described above.

Iron

Concentrations of dissolved iron in water from 116 wells in the study area ranged from 0 to 13,000 μg/L (see table 3). Concentrations in 15 of 116 samples (fig. 7) exceeded the recommended limit of 300 μg/L for public water supplies (EPA, 1977a). The highest iron concentrations were from wells in alluvial aquifers, glacial deposits, and the basement complex. The highest individual concentration, 13,000 μg/L, was in a sample from well 49N-1W-15DAC1 completed in argillite of Precambrian age. A concentration of



Base from U S Geological Survey 1 250,000 series, revised 1969

EXPLANATION

Concentration of dissolved nitrite plus nitrate as nitrogen, in milligrams per liter		Suitability for domestic use
○	<1	Suitable for all uses
□	1-10	Suitable for most uses, may indicate contamination
△	>10	Unsuitable, except with treatment

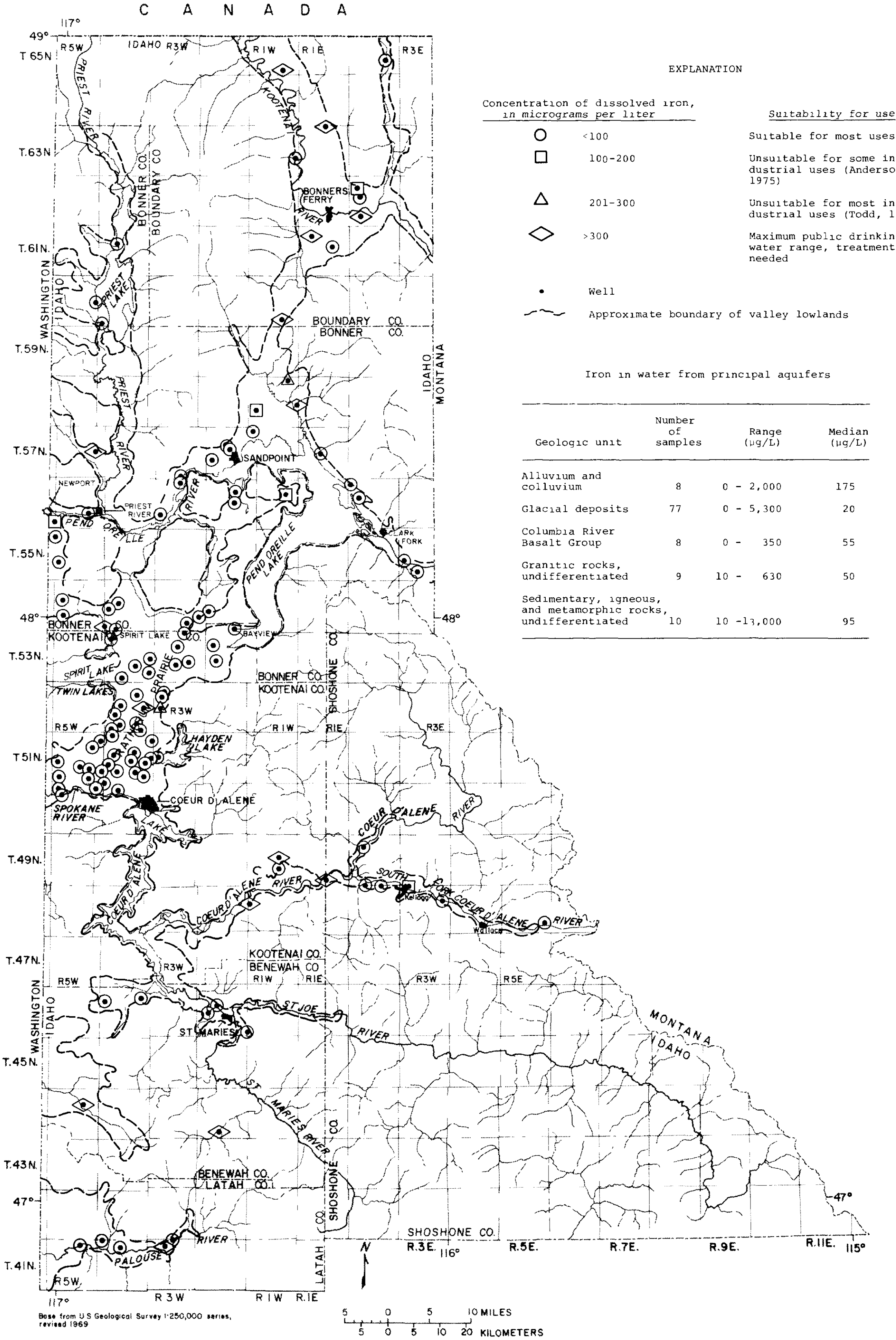
• Well

— — — Approximate boundary of valley lowlands

Nitrate in water from principal aquifers

Geologic unit	Number of samples	Range (mg/L)	Median (mg/L)
Alluvium and colluvium	8	0.01- 0.47	0.20
Glacial deposits	67	.01-25	.32
Columbia River Basalt Group	8	.00-12	.05
Granitic rocks, undifferentiated	8	.02- .51	.085
Sedimentary, igneous, and metamorphic rocks, undifferentiated	10	.00- 2.0	.02

Figure 6.--Nitrate in ground water.



Base from U S Geological Survey 1:250,000 series, revised 1969

EXPLANATION

Concentration of dissolved iron, in micrograms per liter		Suitability for use
○	<100	Suitable for most uses
□	100-200	Unsuitable for some industrial uses (Anderson, 1975)
△	201-300	Unsuitable for most industrial uses (Todd, 1970)
◇	>300	Maximum public drinking-water range, treatment needed

• Well

Approximate boundary of valley lowlands

Iron in water from principal aquifers

Geologic unit	Number of samples	Range (µg/L)	Median (µg/L)
Alluvium and colluvium	8	0 - 2,000	175
Glacial deposits	77	0 - 5,300	20
Columbia River Basalt Group	8	0 - 350	55
Granitic rocks, undifferentiated	9	10 - 630	50
Sedimentary, igneous, and metamorphic rocks, undifferentiated	10	10 -13,000	95

Figure 7.--Iron in ground water.

5,300 µg/L was in a sample from well 57N-5W-14DCC1 completed in a glacial-sand aquifer. Most concentrations such as these are probably due to minerals in the local geologic formations and are not widespread areally. Corrosion of well casings and iron bacteria in water also may add to the concentration of iron in some well water.

Iron in water is objectionable because concentrations greater than 100 µg/L may precipitate on exposure to air, resulting in turbidity and staining, changes in food and beverage taste, and possible deposition in plumbing. Most water for domestic use having excessive iron may be improved by the use of commercially available filters.

Most concentrations exceeding 300 µg/L were from wells in the Kootenai River valley, where 50 percent of the wells sampled had an iron concentration of 1,700 µg/L or more. The average iron concentration in all wells sampled in this valley was 949 µg/L. All samples in the Kootenai River valley containing more than 300 µg/L of iron were obtained from glacial aquifers consisting of sand and gravel, in which water levels in wells ranged from 10 to 100 ft below land surface. No specific iron source or cause for the high concentrations in these aquifers was determined.

Trace Elements

Ground water from seven wells upstream from Cataldo, Idaho, along the Coeur d'Alene and South Fork Coeur d'Alene River valleys, was analyzed for metallic trace elements (see table 3). Except for one sample in which the arsenic concentration was 8 µg/L, arsenic, chromium, mercury, molybdenum, selenium, and vanadium concentrations were negligible. Dissolved cadmium concentrations ranged from 2 to 23 µg/L; copper from 3 to 77 µg/L; lead from 5 to 15 µg/L; and zinc from 110 to 3,600 µg/L (fig. 8). Mandatory and recommended maximum limits for the most significant trace elements in public water supplies (EPA, 1977a and 1977b) are 10 µg/L for cadmium (mandatory); 1,000 µg/L for copper (recommended); 50 µg/L for lead (mandatory); and 5,000 µg/L for zinc (recommended). The concentration of cadmium exceeded the mandatory level at site 48N-3E-11DDD1. The presence of most of these elements probably is natural--a result of the geologic conditions of the sampling area; however, leachates from mining and smelting operations in the Coeur d'Alene mining district may also be contributing some of these elements.

Table 4 summarizes the more common possible sources of cadmium, copper, lead, and zinc in ground water. The significance of the elements to human health is also briefly discussed, as are the maximum limits permissible for public water supply.

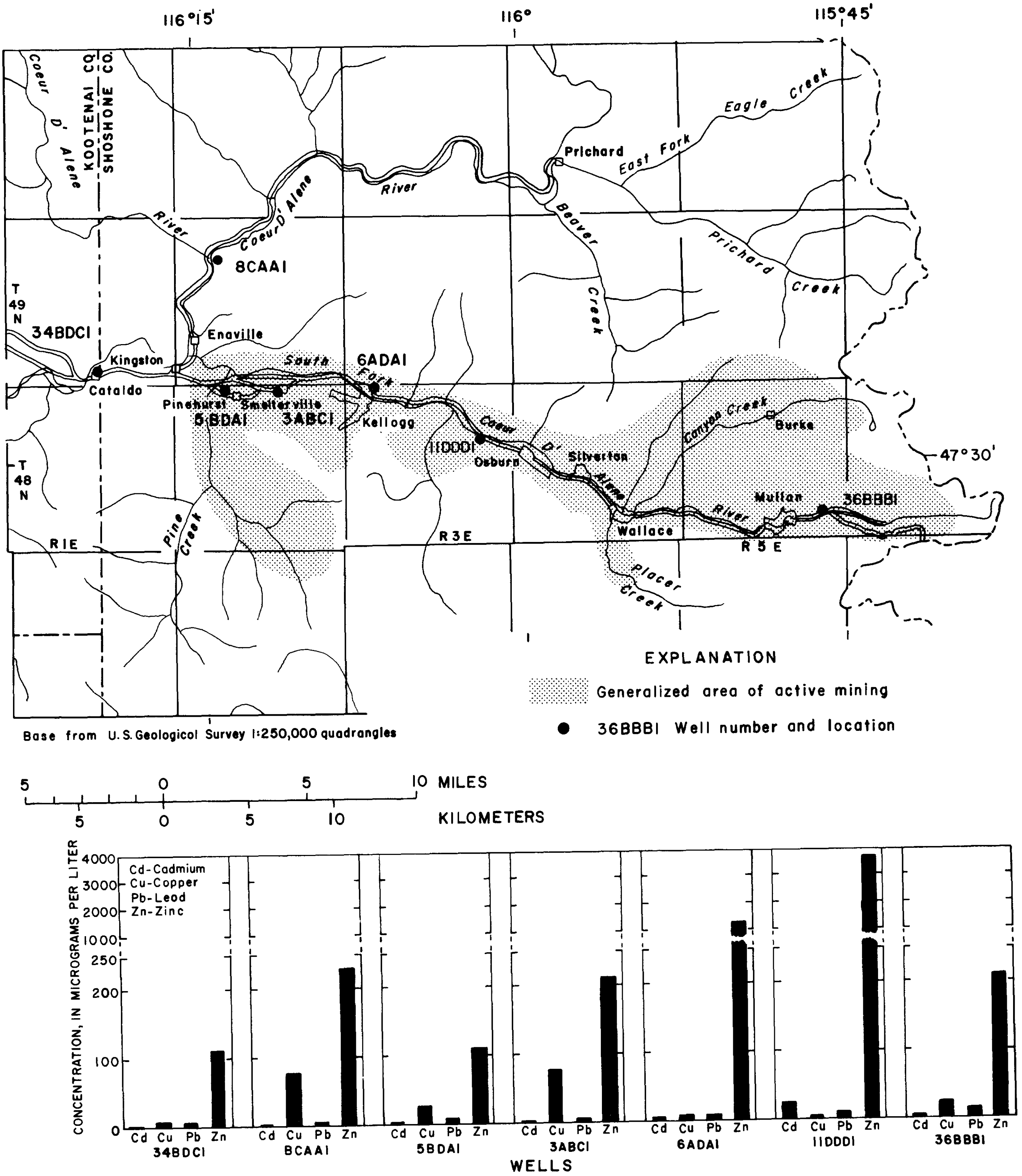


Figure 8.--Selected metallic trace elements in ground water in the Coeur d' Alene mining district.

Table 4. Source and significance of selected metallic trace elements in water

Constituent	Sources or causes	Range of concentrations in sampled wells	Significance
Cadmium (Cd)	Rare element. Occurs in nature chiefly as a sulfide salt in association with zinc and lead ores. Concentration of cadmium in most freshwater is 1 µg/L or less; greater concentrations are rare and often associated with mining or industrial processes.	2-23 µg/L	Nonessential, nonbeneficial element to animal and plant metabolism. Biologically recognized to be toxic, producing tumors, renal dysfunction, hypertension, arteriosclerosis, growth inhibition, chronic diseases of old age, and cancer. May be ingested or inhaled. Stored largely in the kidneys and liver and is excreted at an extremely slow rate. Mandatory maximum limit for public water supplies is 0.01 mg/L (10 µg/L).[2]
Copper (Cu)	Occurs as a natural or native metal and in various mineral forms, such as cuprite and malachite. Present in sewage, agricultural, and industrial wastes. Common constituent in industrial products. May be used as algicide in public water-supply systems. May be present in leachates from mine dumps and mill tailings.	3-77 µg/L	Essential in very small quantities to plant and animal metabolism. Recommended daily requirement for normal growth in children is 0.1 mg/day (100 µg/day).[3] Estimated daily requirement for adults is 2 mg/day (2,000 µg/day).[3] Natural concentrations in water are not known to have adverse effects on humans. An excess of 1 mg/L (1,000 µg/L)[3] may impart some taste to water. Ingestion of excessive quantities results in liver damage. Recommended maximum limit for public water supplies is mg/L (1,000 µg/L).[4]
Lead (Pb)	Occurs in nature commonly as lead sulfide, lead sulfate, lead carbonate, and lead chlorophosphate. Relatively insoluble. Incorporated into groundwater system through precipitation; lead-dust fallout; erosion and leaching of soil; urban runoff, and municipal, industrial, and mining wastes.	5-15 µg/L	A toxic metal that tends to accumulate in animal and human tissues. No beneficial or desirable nutritional value. Lead intoxication and lead poisoning most seriously affect children, frequently resulting in irreversible damage to the brain, anemia, neurological dysfunction, and renal impairment. Most common symptoms of lead poisoning are anemia, severe intestinal cramps, paralysis of nerves, loss of appetite, and fatigue; the symptoms usually develop slowly. Mandatory maximum limit for public water supplies is 0.05 mg/L (50 µg/L).[2]
Zinc (Zn)	Common sulfide mineral often associated with sulfides of other metals, especially lead, copper, cadmium, and iron. Widely used metal, found in many industrial wastes. Incorporated into many metallic industrial products. May be dissolved from galvanized pipe. Present in mine discharge and leachates from mine dumps and mill tailings.	110-3,600 µg/L	Daily intake requirement for preschool age children is 0.3 mg/kg (300 µg/kg) body weight[3]. Deficiency of zinc in children leads to growth retardation. Essential to human metabolism. More than 5,000 µg/L produces a bitter or astringent taste. Recommended maximum limit for public water supplies is 5 mg/L (5,000 µg/L).[4]

[1] Hem (1970)
[2] U.S. Environmental Protection Agency (1977a)
[3] U.S. Environmental Protection Agency (1976)
[4] U.S. Environmental Protection Agency (1977b)

SUMMARY AND CONCLUSIONS

Ground water occurs in all the geologic units described in this report--in alluvial and glacial deposits of Quaternary age, basalt of Tertiary age, granitic rocks of Tertiary and Cretaceous age, and undifferentiated sedimentary, igneous, and metamorphic rocks of Cambrian and Precambrian age (basement complex).

Wells completed in the alluvial and glacial aquifers generally yield 1 to 3,000 gal/min. Wells completed in basalt, granite, or basement-complex aquifers commonly yield 2 to 25 gal/min and average about 13 gal/min.

Hardness of the ground water ranges from 14 to 610 mg/L in samples. Most of the samples have hardness less than 150 mg/L.

Dissolved-solids concentrations in samples from the various aquifers range from 28 to 773 mg/L. In general, water in glacial deposits and basement-complex aquifers contains the highest dissolved-solids concentrations.

Nitrate concentrations range from 0 to 25 mg/L in samples. In the 104 water samples analyzed for nitrate, concentrations exceed 1 mg/L in 15 samples and exceed 10 mg/L in 2 samples, which surpasses the mandatory maximum limit for public water supplies. The natural background concentration of nitrate in ground water in most of the study area probably is less than 0.5 mg/L. Locally, where water contains excessive nitrate concentrations, contamination probably reflects certain land uses.

Dissolved-iron concentrations in ground-water samples range from 0 to 13,000 μg/L. Concentrations in 15 of 116 samples exceed the recommended maximum of 300 μg/L for public water supplies. Iron concentrations in water may be due, in part, to corrosion of the water system or iron bacteria.

Concentrations of dissolved arsenic, cadmium, chromium, copper, lead, mercury, molybdenum, selenium, vanadium, and zinc were analyzed for seven wells in the Coeur d'Alene River valley upstream from Cataldo, in the Coeur d'Alene mining district. All concentrations of mercury, molybdenum, selenium, and vanadium are negligible. One sample contains 8 μg/L of arsenic; all the other samples contain negligible arsenic. Dissolved cadmium concentrations range from 2 to 23 μg/L; copper from 3 to 77 μg/L; lead from 5 to 15 μg/L; and zinc from 110 to 3,600 μg/L. Of these four elements, only cadmium exceeds the mandatory maximum limit established for public water supplies. High zinc concentrations are an indication of ground-water contamination due to mining activities.

In the study area, ground-water quantity is sufficient and quality is adequate in most places to meet population and economic demands. Alluvial and glacial aquifers are used the most at present (1978) and will probably be subject to the greatest water-quality changes in the future. Future changes in population, urban development, industrial-center locations, mining activities, irrigation, crop treatment, and recreational land and water uses may affect water quality. Periodic reevaluation of ground-water quality may be required to monitor possible adverse changes.

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