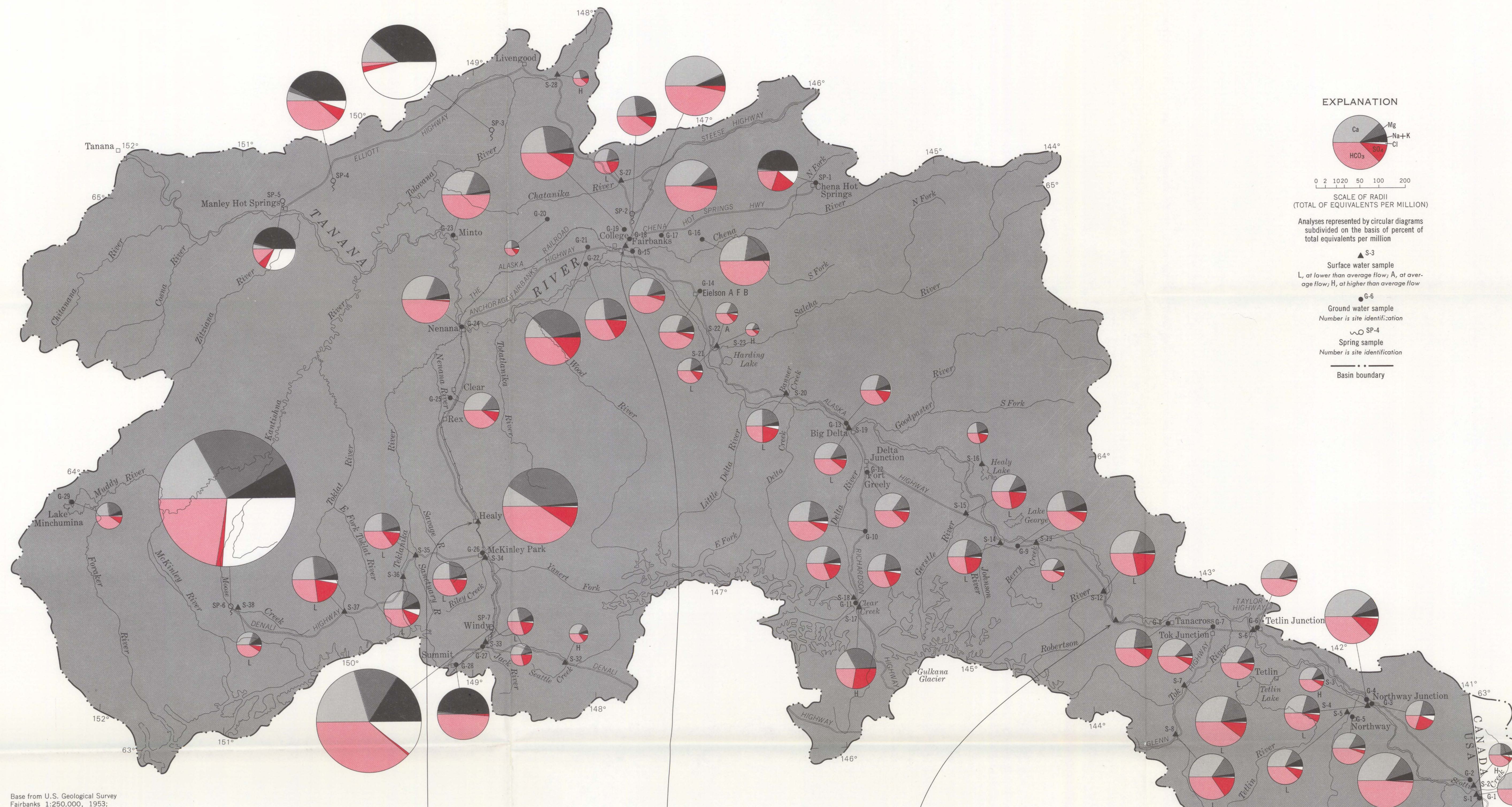
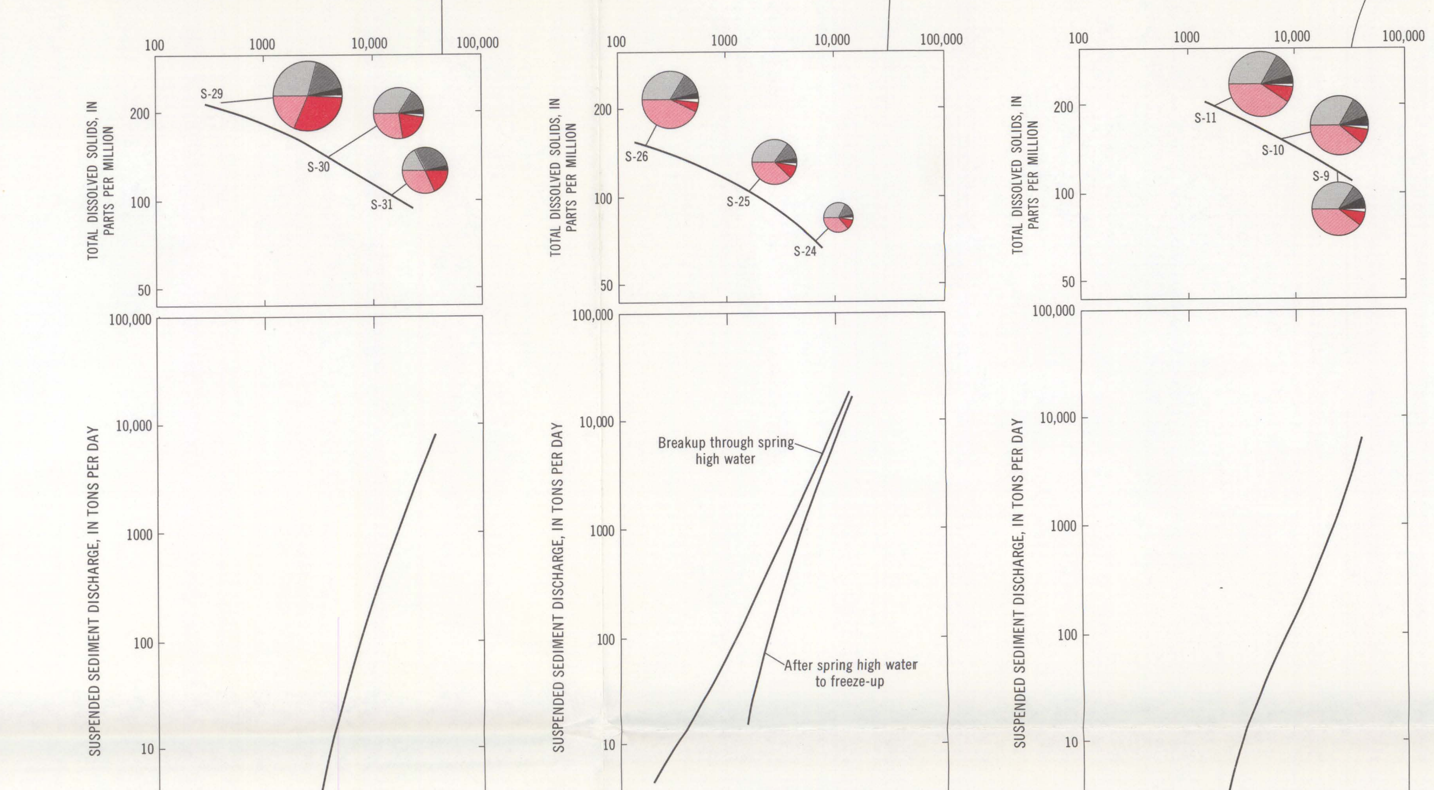
QUALITY OF WATER



Base from U.S. Geological Survey
Fairbanks 1:250,000, 1953;
Big Delta 1:250,000, 1958;
Healy 1:250,000, 1956 and Mt.
Hayes 1:250,000, 1955



CHEMICAL COMPOSITION

The chemical composition of water in the Tanana basin is discussed under two headings, surface water, including streams and lakes, and ground water, including wells and springs. The adjacent map shows graphically the chemical types of water that are found in the basin. Insets on the map present the chemical constituents of selected streams at periods of low, moderate, and high flows. The size of circles on the map is proportional to the total dissolved constituents in the sample.

SURFACE WATER

The dissolved-solids concentration in surface-water samples ranged from 60 to 484 ppm (parts per million). Most surface water in the basin, however, contains less than 200 ppm dissolved solids; the principal constituents are calcium, magnesium, and bicarbonate. During periods of low flow, the highest dissolved constituents are in streams draining mineralized bedrock areas, notably in the Alaska Range.

Chemical analyses of river water indicate that the higher flows have lower dissolved-solids concentration as shown by the graphs of the Chena, Nenana, and Tanana Rivers. This is because the peak discharges are derived from rapid runoff of rain or snowmelt which is low in dissolved mineral matter, whereas the low flow has a high proportion of ground-water inflow.

In general, the streams flowing from the Alaska Range are higher in sulfate and magnesium content than other streams in the basin. None of the streams that have been sampled, however, exceed standards suggested by the U.S. Public Health (1962) with respect to these constituents. The only constituent which does exceed the standards is iron. Iron in excess of the recommended limits has been found in two places, both near the Canadian border. One of these two waters is from a lake (S-1 analysis); the other is from a small stream (S-20 analysis) draining a swampy area. The iron there is associated with organic matter and is not indicative of the overall quality of surface water in the basin.

GROUND WATER

The chemical quality of ground water reflects its geologic environment. Hot springs in the area, such as SP-1, are assumed to be connected with deep-seated sources that may account for high concentrations of sodium, chloride, bicarbonate, and magnesium. A few of the springs in the area, such as SP-2, have shallow ground-water sources and the type of water discharged from those springs is similar to most ground water in the area.

Most of the wells drilled along the boundaries of the basin tap igneous and metamorphic rocks and yield water that is high in magnesium bicarbonate or magnesium sulfate. Four of the wells that tap crystalline rocks contain more magnesium than the recommended limits. There, wells that tap the alluvial deposits and the streams that drain the bedrock areas also reflect the high magnesium sulfate. The highest nitrate concentration is from wells tapping crystalline rock. One of them, well G-18, exceeds the recommended limits for nitrate(U.S. Public Health Service, 1962). The source of the nitrate is not known. Ground water in the bedrock wells is generally, but not invariably, low in iron.

Wells drilled in the alluvial fans along the southern margin of the valley produce water that is relatively low in iron, of moderate hardness, and of quality similar to the streams that flow across the alluvial fans.The alluvial fans provide the largest source of good-quality water in the Tanana basin.

Water from wells drilled in organic-rich sediments of the flood plains, terraces, and valley fill are low in sulfate, moderate to high in hardness, and moderate to high in iron. The origin of this water in the Fairbanks area is described by Cederstrom (1963, p. 47); presumably his explanation applies to much of the Tanana basin lowland. As water passes through the organic-rich sediments, the sulfate is reduced to form carbon dioxide and hydrogen sulfide. Carbonic acid, formed from the carbon dioxide, attacks limy materials and increases hardness. Excessive carbon dioxide imparts corrosive properties to the water bringing iron into solution. The hydrogen sulfide imparts disagreeable odors to the water.

Most water in the Tanana basin can be characterized as calcium magnesium bicarbonate, commonly containing objectionable concentrations of iron. The quality of water ranges from very good to very poor with most municipal water requiring treatment for iron removal prior to use. Chloride and fluoride concentrations are low in all samples.

SEDIMENT LOAD

Sediment loads transported by streams have a direct effect on the cost and feasibility of water-resources development. High sediment loads have to be considered in reservoir design. Treatment is necessary if the water is to be used for domestic supply. Sediment deposition in streams reduces channel capacity and increases the flood potential.

A comparison of the annual sediment yields of the three streams that have been sampled daily is shown below.

ANNUAL SEDIMENT YIELDS IN THE TANANA BASIN

Stream and location	Length of record (years)	Drainage area (square miles)	Annual sediment yield, Tons per square mile: Avg	Max	Min
Tanana River near Tanacross	10	8,550	1,000	1,410	750
Chena River at Fairbanks	4	1,980	106	188	36
Nenana River near Healy	13	1,910	1,700	2,600	760

The sediment loads do not include bedload (sediment transported on or very near the streambed). The Nenana River near Healy and the Tanana River near Tanacross receive the bulk of their sediment load as a result of glacial melt. The Chena River receives sediment principally during snowmelt and rainstorm runoff. From the limited data available, annual loads contributed to the Tanana River from nonglacial streams of the Yukon-Tanana Upland are inferred to be less than 150 tons per square mile. The streams draining the Alaska Range, of which the majority originate from glaciers, contribute loads ranging from 150 tons per square mile in the flat bottom land adjacent to the Tanana River to several thousand tons per square mile at the termini of the glaciers. An annual yield of 5,000 tons per square mile was estimated from the record of a periodic sampling station on the Susitna River. That river drains to the south from the Alaska Range and receives its sediment load from a glacial source similar to that draining to the Tanana River. The Susitna River station is located approximately 20 miles from the terminus of the glacier.

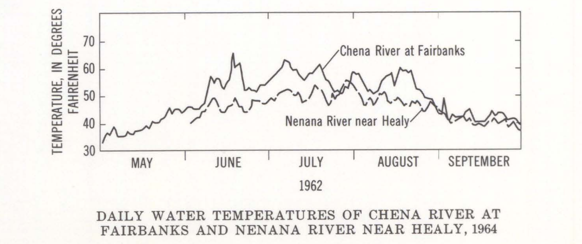
The quality-of-water map illustrates the typical relationship of sediment load to concurrent water discharge. For any given stream, sediment concentrations change rapidly with changes in water discharge. The Chena River shows a seasonal variation in sediment transport characteristics. Sediment concentrations are much higher for concurrent discharge during spring breakup than for other times of the year. This relationship is typical and is probably due to the mechanical action of freezing and thawing of fine-grained sediments in the Chena basin (see sheet 2).

More than 99 percent of the annual load at the three daily sediment stations is transported during the summer (May through October). In the glacier-fed streams the sediment load is fairly well distributed throughout the summer. However, on the Chena River, approximately 50 percent of the annual load is transported during the period of spring runoff (generally in May).

WATER TEMPERATURE

The thermal regimen of the water is an important consideration in the development of water supplies in the Tanana basin. The temperature of the water presents serious problems in the development, treatment, distribution, and use of water in the basin.

Surface-water temperatures range from less than 32°F, to about 70°F during the year. Water temperatures below 32°F (supercooled) are common in surface water without ice cover and in some ground water in permafrost areas. Records of river temperature show rather uniform patterns of cooling by October to 32°F, or slightly below, remaining there until April, then warming to their seasonal highs in June and July (see graph below).



DAILY WATER TEMPERATURES OF CHENA RIVER AT FAIRBANKS AND NENANA RIVER NEAR HEALY, 1964

Ground-water temperatures have a much smaller range than the surface water of the area. Ground-water temperatures, except for the hot springs, are less than 40°F; most range from 32°F, to 34°F.

Wells drilled in permafrost are subject to freezing and must be protected by special equipment and procedures. Withdrawal systems from surface-water sources are also subject to freezing during the winter. Especially troublesome is frazil ice that clogs intakes and adheres to any material that is cooled below the freezing point. After the waters have been withdrawn from their respective sources, specially designed distribution systems are required during winter.

The low temperature of ground and surface water requires a longer time for chemical reactions to reach equilibrium. In the design of water-treatment systems, sufficient retention time must be allowed for the treatment process to reach completion. Also, use of surface water for waste disposal is adversely affected because the stream's natural ability for self purification is reduced; many biological processes cease at temperatures near the freezing point.

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SELECTED CHEMICAL ANALYSES OF GROUND WATER

Chemical analyses in parts per million except conductance, pH, and color

Number	Date of collection	Owner or user	Major aquifer	Depth of well (feet)	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids (residue on evaporation at 180°C)	Hardness as $CaCO_3$: Carbonate	Hardness as $CaCO_3$: Non-carbonate	Specific conductance (micromhos at 25°C)	pH	Color
G-1	3/10/66	Custom Station, Internat. Border	schist	297	9.0	0.02	37	335	66	1.8	494	1120	8.9	0.1	0.0	1820	1560	1155	2440	7.6	–
G-2	6/8/65	Border Trading Post	gravelly-sand	175	36	2.20	135	25	17	7.9	602	5.3	2.8	0.4	0.8	529	438	0	859	7.6	140
G-3	11/21/59	Northway Motel	granite	206	29	Tr.	27	12	17		–	56	10	–	0.6	244	90	26	283	7.4	–
G-4	7/16/64	Northway ACS	granite	90	30	2.69	103	39	18	0.2	404	97	9.2	0.3	9.4	508	418	87	722	6.6	200
G-5	1/23/64	Northway FAA	gravelly-sand	237	33	0.03	56	19	8.5	2.7	288	2.0	2.0	0.2	0.6	266	220	–	415	8.1	5
G-6	2/–/52	Tetlin Junction 40-mi. Road House	silty-sand	250	31	0.87	52	12	6.0		217	4.0	6.5	–	–	–	178	0	336	7.2	
G-7	3/16/64	Tok ACS	gravel	115	15	0.05	55	10	5.6	0.3	203	28	3.0	0.3	0.4	218	180	14	355	7.8	0
G-8	8/15/62	Tanacross Preposition Storage	sandy-gravel	100	3.0	Tr.	47	21	3.0		–	39	2.0	–	1.2	255	206	65	397	7.6	–
G-9	3/27/63	Sears Creek Pump Station	sandy-gravel	67	13	0.05	64	14	13	1.0	241	41	3.5	0.8	1.0	269	219	21	459	8.2	5
G-10	7/21/65	Donnelly Flats AFB	sandy-gravel	102	11	0.02	46	20	5.1	1.9	210	31	5.3	0.3	1.3	225	197	25	377	8.0	5
G-11	2/20/61	U.S. Army Black Rapids Tr. Center	sandy-gravel	110	4.3	0.02	35	16	3.2	2.3	124	59	2.5	0.2	0.0	184	154	52	312	7.5	10
G-12	9/29/48	Fort Greely	sandy-gravel	198	10	0.04	46	10	4.4		146	36	2.8	0.1	4.8	186	156	36	313	–	–
G-13	7/26/51	Bert & Mary's Road House	bedrock	230	13	–	31	9.4	7.4		112	33	3.5	–	0.9	153	116	–	248	7.1	5
G-14	9/7/65	Eielson AFB	gravel	115	28	7.11	38	9.7	7.5	0.8	166	15	4.6	0.1	0.0	135	135	0	290	7.5	15
G-15	5/2/62	Fort Wainwright	gravel	105	19	12	61	11	5.2	3.4	229	19	3.5	0.0	0.3	197	188	9	382	7.4	5
G-16	9/27/66	Linsey	weath. bedrock	200	35	25	83	30	15	2.6	484	0.0	0.0	0.4	0.2	429	332	–	649	7.8	10
G-17	9/27/66	James Day	weath. bedrock	137	8.5	0.02	115	14	17	4.1	425	15	0.0	0.1	28	411	343	0	681	7.4	5
G-18	9/30/66	Don Peterson	schist	175	18	0.00	189	0.4	30	3.6	559	32	0.0	0.1	51	599	473	15	865	7.3	5
G-19	9/30/66	Richard Wein	schist	325	16	0.30	84	60	11	1.6	442	72	2.1	0.3	0.4	465	456	94	811	7.1	0
G-20	4/10/61	Murphy Dome AC & W	bedrock	130	8.9	0.10	6.4	3.5	0.8	0.3	28	8.0	1.0	0.0	1.2	44	32	8	70	6.5	0
G-21	9/28/66	Ester Community	bedrock	100+	18	1.67	46	78	11	2.9	423	125	0.7	0.2	0.3	492	437	90	740	7.5	0
G-22	9/28/66	D. Becker	schist	260	5.5	6.60	43	27	4.4	3.5	189	77	0.7	0.2	3.8	265	218	63	430	8.1	0
G-23	12/–/61	Minto PHS	sandy-gravel	40	24	0.10	87	26	5.2	4.8	418	0.0	1.0	0.2	0.3	335	325	0	599	7.3	5
G-24	2/25/55	Nenana High School	sandy-gravel	20	20	32	95	24	9.4	5.7	427	1.0	5.0	0.0	0.2	370	336	0	655	7.2	0
G-25	8/11/52	Clear AFB	gravel	65	13	0.02	47	11	0.5		156	31	2.0	0.1	0.6	182	162	35	305	7.4	–
G-26	10/1/62	Alaska Railroad	bedrock	148	17	0.02	70	179	5.1	8.2	896	166	5.0	0.6	1.1	893	912	177	1410	7.6	–
G-27	11/2/66	State Highway Department	gravel	–	4.2	0.51	20	3.9	2.0	0.5	50	28	1.8	0.2	0.3	86	66	15	153	7.9	0
G-28	9/14/66	Summit FAA	bedrock	–	6.2	0.87	4.0	0.2	188	2.7	500	9.6	0.0	5.8	0.6	463	11	0	760	7.6	–
G-29	12/11/59	Minchumina FAA	bedrock	210	7.8	0.10	21	11	6.0	0.7	106	20	2.0	0.2	0.2	121	98	10	207	7.0	0

SELECTED CHEMICAL ANALYSES OF SPRINGS

Chemical analyses in parts per million except conductance, pH, and color

Number	Date of collection	Location	Mean discharge (gpm)	Temperature (°F)	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids (residue on evaporation at 180°C)	Hardness as $CaCO_3$: Carbonate	Hardness as $CaCO_3$: Non-carbonate	Specific conductance (micromhos at 25°C)	pH	Color
SP-1	8/5/15	Chena Hot Springs	220	149	77	—	2.3	1.2	94		118	78	26	—	—	388	—	—	—	—	—
SP-2	9/30/66	Fox Spring	8	36	11	0.00	40	23	5.5	3.7	200	41	0.7	0.2	0.5	224	196	32	543	7.1	0
SP-3	1962	Tolovana Hot Springs	—	125	75	0.02	82	1.2	321	23	49	40	615	0.2	0.2	1180	210	170	2090	7.7	0
SP-4	8/6/15	Hutlinana Hot Springs	50	114	44	0.09	22	6.0	208		494	67	38	—	—	634	—	—	—	—	—
SP-5	8/5/15	Manley Hot Springs	110	125	59	0.80	9.1	0.9	121	8.2	86	48	120	—	—	417	—	—	—	—	—
SP-6	1957	Near Kantishna	—	—	36	6.80	405	347	210	8.0	1960	90	850	0.0	—	2910	2440	831	4820	7.2	0
SP-7	7/26/66	Near Windy	—	44	8.7	0.29	435	26	253		1886	11	295	—	0.2	2089	1440	—	—	—	—

SELECTED CHEMICAL ANALYSES OF SURFACE WATER

Chemical analyses in parts per million except conductance, pH, and color

Number	Date of collection	Location	Mean discharge (cfs)	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids (residue on evaporation at 180°C)	Hardness as $CaCO_3$: Carbonate	Hardness as $CaCO_3$: Non-carbonate	Specific conductance (micromhos at 25°C)	pH	Color
S-1	6/18/65	Lake (no name) near Northway Junction	——	4.3	0.73	36	14	5.2	2.1	181	4.3	2.8	0.4	1.0	160	149	1	275	7.5	120
S-2	6/17/65	Scottie Creek near Northway Junction	——	6.2	0.41	15	6.4	3.2	1.3	70	8.6	2.1	0.3	0.5	78	64	7	134	7.5	120
S-3	7/27/53	Chisana River near Northway Junction	——	7.1	0.00	26	4.2	0.8		90	13	2.0	0.1	0.3	102	85	11	185	8.0	0
S-4	12/30/57	Chisana River near Northway Junction	827	15	0.05	44	13	6.9	2.9	183	24	4.0	0.2	0.4	200	163	13	328	7.3	0
S-5	10/20/66	Nabesna River near Northway Junction	620	14	——	45	8.9	11	2.0	165	29	7.8	0.1	1.7	174	149	14	331	7.4	5
S-6	2/17/53	Tanana River near Tok Junction	1,600	17	0.03	49	10	6.8	2.2	182	24	2.0	0.0	1.5	202	164	15	316	7.2	5
S-7	2/11/58	Tok River near Tok Junction	——	30	0.02	111	32	8.3	3.6	416	89	1.5	0.1	3.2	484	408	68	751	7.6	5
S-8	12/10/52	Little Tok River near Tok Junction	——	18	0.01	88	20	5.1	2.1	271	92	1.0	0.1	1.3	361	303	81	545	7.2	5
S-9	6/21-30/57	Tanana River near Tanacross	23,700	12	0.00	29	4.1	5.6	1.3	102	17	2.5	0.2	0.9	123	89	6	202	7.8	10
S-10	5/25-31/64	Tanana River near Tanacross	7,710	12	0.00	36	7.8	5.5	1.2	127	22	2.5	0.1	0.6	151	122	18	266	6.9	10
S-11	4/9/59	Tanana River near Tanacross	1,960	17	0.02	46	10	5.5	2.0	168	26	3.0	0.1	0.6	193	156	18	322	6.6	0
S-12	12/31/57	Robertson River near Tanacross	——	6.3	0.02	77	27	3.5	3.2	217	131	1.5	0.0	1.4	358	303	125	578	8.2	0
S-13	2/5/52	Berry Creek near Dot Lake	——	17	0.01	20	3.6	4.9		75	8.5	2.2	0.4	1.0	95	65	3	143	7.5	10
S-14	11/21/57	Johnson River near Dot Lake	——	4.5	0.02	40	16	3.4	3.9	119	73	1.0	0.2	0.2	202	166	68	333	7.4	0
S-15	9/20/55	Gerstle River near Big Delta	——	5.6	0.00	47	12	3.7	2.7	117	74	1.2	0.4	0.5	205	167	71	340	7.6	5
S-16	7/14/51	Healy Lake near Big Delta	——	6.2	——	12	6.3	3.9		46	23	1.5	——	1.1	77	56	——	97	7.2	30
S-17	6/22/51	Clear Creek near Rapids	——	4.2	0.01	34	40	6.4		143	138	0.4	0.0	2.3	296	249	132	495	7.9	5
S-18	1/5/58	Delta River near Rapids	——	5.7	0.02	39	12	5.3	2.5	121	55	3.0	0.0	0.6	183	147	48	308	7.5	0
S-19	12/11-20/50	Tanana River near Big Delta	6,160	15	0.01	44	9.3	4.9	0.8	154	30	1.5	——	0.6	187	148	22	305	7.4	5
S-20	2/5/52	Banner Creek near Richardson	——	18	0.60	32	17	3.4		100	70	0.8	0.1	1.2	207	150	68	301	7.1	55
S-21	12/9/52	Salcha River near Salchaket	360	9.2	0.03	20	5.6	2.2	1.2	67	25	0.2	0.1	1.5	98	74	18	156	6.5	5
S-22	10/3/48	Salcha River near Salchaket	1,880	10	——	19	5.7	1.8		66	18	1.0	0.0	1.5	90	71	17	141	——	——
S-23	5/10/50	Salcha River near Salchaket	8,800	4.9	0.12	7.6	2.7	0.8		28	7.0	0.2	——	1.4	60	30	7	66	——	——
S-24	6/17/55	Chena River at Fairbanks	6,920	6.7	0.14	13	2.9	1.1	0.8	43	11	0.2	0.0	1.3	72	44	9	94	6.8	——
S-25	10/10/54	Chena River at Fairbanks	1,440	9.4	0.19	24	5.4	2.4	0.8	81	19	1.0	——	1.4	104	82	16	170	7.1	10
S-26	2/13/58	Chena River at Fairbanks	170	21	0.02	34	7.9	4.0	2.0	134	14	1.0	0.2	1.4	152	118	8	241	6.8	20
S-27	7/28/57	Chatanika River near Fairbanks	140	7.7	0.12	19	7.2	1.6	0.9	60	28	0.2	0.1	0.3	95	77	28	159	7.0	10
S-28	6/16/56	Tolovana River near Livengood	——	6.6	——	8.3	5.0	1.8	0.3	36	9.6	0.0	——	0.6	——	41	12	82	7.6	165
S-29	4/4/58	Nenana River near Healy	416	3.0	0.02	40	16	4.4	1.9	80	112	1.5	0.2	0.6	219	166	100	349	7.6	0
S-30	9/21-30/63	Nenana River near Healy	4,100	5.9	0.02	33	7.5	3.3	1.6	90	43	2.0	0.1	0.5	141	113	39	234	7.7	5
S-31	6/21-30/62	Nenana River near Healy	15,700	5.0	0.02	25	5.7	1.9	1.4	70	32	0.0	0.1	0.2	105	86	29	176	7.7	5
S-32	7/5/60	Seattle Creek near Windy	——	11	0.04	13	2.8	2.4	0.9	45	13	1.0	0.1	0.2	66	44	7	88	7.5	0
S-33	9/7/66	Jack River near Cantwell	610	7.0	0.00	13	7.2	5.0	1.2	50	27	0.7	0.2	1.1	87	62	21	160	6.4	0
S-34	9/7/66	Riley Creek near Mt. McKinley	200	5.7	0.06	36	18	6.4	1.2	138	57	1.4	0.1	1.5	195	164	51	316	6.9	0
S-35	9/7/66	Sanctuary River near Mt. McKinley	214	5.3	0.06	34	17	7.0	1.3	154	49	1.4	0.1	0.1	191	154	28	325	7.0	0
S-36	9/7/55	Teklanika River near Mt. McKinley	123	5.5	0.00	44	16	11	1.6	174	53	6.4	0.1	0.5	224	176	33	385	7.1	0
S-37	9/6/66	Toklat River near Mt. McKinley	100	5.6	0.04	58	33	10	2.3	204	120	11	0.3	0.7	341	280	113	559	7.4	0
S-38	9/6/66	Moose Creek near Kantishna	162	10	0.02	20	5.1	4.7	0.9	79	12	0.7	0.1	1.5	94	71	6	175	6.7	0

HYDROLOGIC RECONNAISSANCE OF THE TANANA BASIN, CENTRAL ALASKA

By

G. S. Anderson

1970