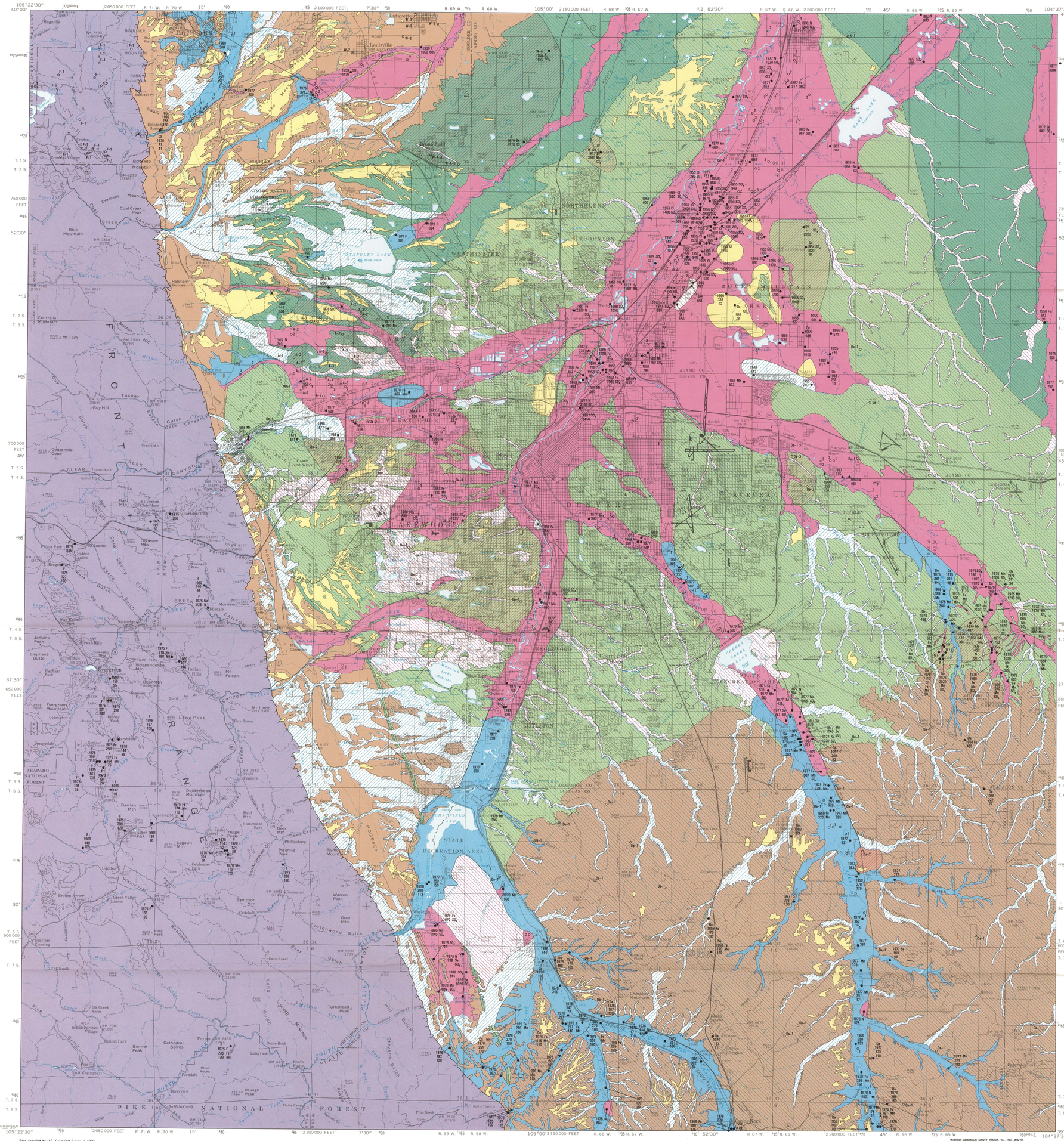
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

MISCELLANEOUS INVESTIGATIONS SERIES
MAP I-856-J (SHEET 2 of 2)



Base compiled by U.S. Geological Survey in 1972 from 1:24,000 quadrangles dated 1954–1969
Limited revision from aerial photographs taken 1969
50,000-foot grid based on Colorado coordinate system, north zone
5000-meter Universal Transverse Mercator grid ticks, zone 13, shown in blue
Metric elevations are shown in parenthesis

APPROXIMATE MEAN DECLINATION, 1983

INTERIOR—GEOLOGICAL SURVEY, RESTON, VA.—1983—W60796

Geology modified from Trimble and Machette, 1979 and Shroba, 1980

EXPLANATION

DISSOLVED-SOLIDS CONCENTRATION IN WATER FROM UNCONSOLIDATED ALLUVIAL DEPOSITS,[1] IN MILLIGRAMS PER LITER

- Less than 500
- Greater than 500

Line pattern indicates dissolved-solids concentration estimated

- AREA WHERE DISSOLVED-SOLIDS CONCENTRATIONS IN WATER FROM UNCONSOLIDATED ALLUVIAL DEPOSITS WERE NOT MAPPED BECAUSE WELL YIELDS PROBABLY CANNOT BE SUSTAINED THROUGHOUT THE YEAR
- AREA WHERE WATER-TABLE CONDITIONS PREDOMINATE IN THE DAWSON AQUIFER; BLUE LINE PATTERN INDICATES DISSOLVED-SOLIDS CONCENTRATION LESS THAN 500 MILLIGRAMS PER LITER; RED LINE PATTERN INDICATES DISSOLVED-SOLIDS CONCENTRATION GREATER THAN 500 MILLIGRAMS PER LITER
- AREA WHERE WATER-TABLE CONDITIONS PREDOMINATE IN THE DENVER AQUIFER; BLUE LINE PATTERN INDICATES DISSOLVED-SOLIDS CONCENTRATION LESS THAN 500 MILLIGRAMS PER LITER; RED LINE PATTERN INDICATES DISSOLVED-SOLIDS CONCENTRATION GREATER THAN 500 MILLIGRAMS PER LITER
- AREA WHERE WATER-TABLE CONDITIONS PREDOMINATE IN THE ARAPAHOE AQUIFER; BLUE LINE PATTERN INDICATES DISSOLVED-SOLIDS CONCENTRATION LESS THAN 500 MILLIGRAMS PER LITER; RED LINE PATTERN INDICATES DISSOLVED-SOLIDS CONCENTRATION GREATER THAN 500 MILLIGRAMS PER LITER
- AREA WHERE DISSOLVED-SOLIDS CONCENTRATIONS GENERALLY ARE GREATER THAN 500 MILLIGRAMS PER LITER IN WATER FROM COLLUVIAL, LANDSLIDE, AND WINDBLOWN DEPOSITS, AND FROM UPPER WEATHERED AND FRACTURED ZONE OF CONSOLIDATED SEDIMENTARY ROCKS
- AREA WHERE DISSOLVED-SOLIDS CONCENTRATIONS GENERALLY ARE LESS THAN 500 MILLIGRAMS PER LITER IN WATER FROM FRACTURED CRYSTALLINE ROCKS

CONTACT.—Dashed where approximately located

EASTERN OUTCROP LIMIT OF FRACTURED CRYSTALLINE ROCKS

W-Da-1 1977 3910 — WELL; CHEMICAL QUALITY OF WATER DETERMINED.—First (top) number is year water was analyzed; second number is dissolved-solids concentration, in milligrams per liter; third number is total hardness, in milligrams per liter—shown only when hardness was 180 milligrams per liter or less. Letters above year indicate source of water if other than unconsolidated alluvial deposits: A = Arapahoe aquifer; Da = Dawson aquifer; De = Denver aquifer; F = fractured crystalline rocks; W = windblown deposits. Chemical symbols indicate dissolved constituents that exceeded the State standards for public water supplies (Colorado Department of Health, 1971 and 1977).

Fe = iron; F = fluoride; Mn = manganese; Mg = magnesium; N = nitrite plus nitrate as nitrogen; Se = selenium; SO_4 = sulfate

CS 1976 87 41 — SPRING; CHEMICAL QUALITY OF WATER DETERMINED.—First (top) number is year water was analyzed; second number is dissolved-solids concentration, in milligrams per liter; third number is total hardness, in milligrams per liter—shown only when hardness was 180 milligrams per liter or less. Letters above year indicate source of water if other than unconsolidated alluvial deposits: CS = consolidated sedimentary rocks; Da = Dawson aquifer; F = fractured crystalline rocks; Chemical symbols indicate dissolved constituents that exceeded the State standards for public water supplies (Colorado Department of Health, 1971 and 1977).

Fe = iron; Mn = manganese; N = nitrite plus nitrate as nitrogen; Se = selenium; SO_4 = sulfate

Da-2 — WELL; DISSOLVED-SOLIDS CONCENTRATION ESTIMATED FROM SPECIFIC CONDUCTANCE.—Letters indicate source of water if other than unconsolidated alluvial deposits: A = Arapahoe aquifer; Da = Dawson aquifer; De = Denver aquifer; F = fractured crystalline rocks; W = windblown deposits. Number corresponds to the tabulation below indicating estimated dissolved-solids concentrations, in milligrams per liter, based on a correlation between specific conductance and dissolved-solids concentration.

1 = less than 500; 2 = 500 to 1000; 3 = 1000 to 3000; 4 = greater than 3000

[1]Dissolved-solids concentrations generally less than 500 milligrams per liter in water from localized areas of unconsolidated alluvial deposits (not shown on map) occurring in stream valleys traversing fractured crystalline rocks.

CHEMICAL QUALITY OF WATER

The concentration of dissolved solids was the principal criterion used in this investigation to determine the suitability of ground water for urban development. Water containing 500 mg/L or less of dissolved solids generally is suitable for all uses associated with urban development, including public drinking-water supplies. However, concentrations of individual dissolved constituents, values of selected physical properties, amounts of radioactivity, and numbers of fecal-coliform bacteria in the water may cause the water to be unsuitable for a particular use. In addition to dissolved solids, concentrations of dissolved arsenic, chloride, fluoride, iron, magnesium, manganese, nitrite plus nitrate, selenium, sulfate, and hardness as calcium carbonate were used to indicate the chemical suitability of ground water.

Ground water containing more than 500 mg/L of dissolved solids is suitable, depending primarily on the degree of salinity, for only limited uses associated with urban development as illustrated by the examples given in the section RELEVANCE TO URBAN PLANNING. As dissolved-solids concentrations increase, the possible uses in urban development decrease.

The dissolved-solids concentrations of water from water-table aquifers are shown on the chemical-quality map. Also shown are other dissolved constituents that exceeded State standards for public-water supplies (Colorado Department of Health, 1971; 1977). Dissolved iron, fluoride, and manganese were the analyzed constituents that commonly exceeded State standards for public-water supplies in water containing less than 500 mg/L of dissolved solids. The concentrations of dissolved iron could result from corrosion of well casings and water-distribution systems and may not be representative of water in the aquifers. However, because of the widespread occurrence of wells and springs with water that contained excessive dissolved iron, the iron probably occurs naturally in the water.

Summaries of the data collected for those constituents that could affect the chemical suitability of water for urban development are shown in the tables. The effects of these constituents in concentrations exceeding the standards for public-water supplies are listed below and are summarized from publications of the Colorado Department of Health (1971) and the U.S. Environmental Protection Agency (1976, 1977).

The taste of water is affected by dissolved solids, chloride, iron, and manganese. Dissolved solids and chloride impart a salty taste to the water, whereas iron and manganese impart a bitter metallic taste to the water and to beverages made using the water.

Discolored water, stained laundry and porcelain fixtures, and incrusted plumbing are caused by iron and manganese in the water. Incrusted plumbing also is caused by dissolved solids, magnesium, and excessive hardness. In addition, excessive hardness may reduce the "life" of hot-water heaters and impair the quality of frozen or canned fruits and vegetables. The classification of hardness used in this report is: Concentration less than 60 mg/L—soft water; 60 to 120 mg/L—moderately hard water; 120 to 180 mg/L—hard water; and greater than 180 mg/L—very hard water. Based on this classification, 13 wells and springs yielded soft water, 46 wells and springs yielded moderately hard water, 31 wells and springs yielded hard water, and 240 wells and springs yielded very hard water.

Water containing excessive magnesium and sulfate may have a laxative effect on people who are unaccustomed to drinking it. However, this condition abates with continued use of the water.

Fluoride, nitrite plus nitrate, and selenium in water may be health hazards. Although fluoride is known to decrease dental cavities, concentrations greater than 1.8 mg/L may cause mottling of teeth, especially in children. Concentrations of nitrite plus nitrate as nitrogen greater than 10 mg/L may cause methemoglobinemia ("blue-baby disease") in infants less than 9 months old who drink the water or who are breast-fed by mothers who drink the water. Concentrations of nitrite plus nitrate in the study area that are greater than 10 mg/L as nitrogen usually are indicative of contamination from septic-tank systems, barnyards, corrals, or commercial fertilizers. Concentrations of selenium greater than 10 µg/L (micrograms per liter) may cause selenium poisoning in people and livestock. "Alkali disease" that afflicts livestock is caused by selenium.

LIMITATIONS OF THE INVESTIGATION

Well-yield data are few for those localities where the unconsolidated alluvial aquifers are known to contain water with less than 500 mg/L of dissolved solids. Therefore, prior to any potential development of the aquifers for uses related to urban development, a comprehensive hydrologic investigation to determine the physical and hydraulic characteristics of the aquifers would be useful to adequately evaluate the potential of the aquifers for the intended uses. Also, all chemical constituents and physical properties that govern the suitability of water for a public supply were not determined during this investigation. In addition to the chemical constituents included in this report, concentrations of trace elements, such as barium, cadmium, chromium, copper, lead, mercury, silver, uranium, and zinc, as well as concentrations of certain pesticides, amounts of radioactivity, numbers of fecal-coliform bacteria, and the concentrations or values of ammonia, color, foaming agents, hydrogen sulfide, pH, and turbidity, could affect the suitability of the water for various uses.

Other factors not considered in this investigation were acquisition of well permits and land-use plans and zoning ordinances as established by State and local governments. In Colorado, issuance of well permits, specifying from which aquifer water may be obtained and the volume of water that may be pumped, is determined in part by factors other than availability and chemical quality of the water. Some factors considered in issuing well permits are the effects of new wells on: existing wells; streamflows; surface-water features, such as lakes, ponds, and wetlands; and recharge to underlying aquifers. Land-use plans and zoning ordinances also may preclude a particular type of land development even though there are adequate supplies of suitable quality water for an intended use.

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ADDITIONAL WELLS IN TOWNSHIPS 4 AND 5 SOUTH, RANGE 65 WEST, COMPLETED IN DENVER AQUIFER

Number on map	Year sampled	Dissolved solids (milligrams per liter)	Hardness as lime (milligrams per liter	Constituents that exceeded State standards for public-water supplies
1	1975	1,530	—	Chloride, manganese, sulfate
2	1975	1,400	—	Sulfate
3	1976	1,980	—	—
4	1976	980	—	Sulfate
5	1976	309	51	Manganese
6	1975	1,020	—	Sulfate
7	1975	1,830	—	—
8	1976	1,450	—	Iron, manganese, sulfate
9	1975	1,620	—	Sulfate
10	1976	2,000	—	Sulfate
11	1976	1,890	—	Sulfate
12	1975	376	138	—

Table 1.—*Summary of selected chemical constituents in water from wells*

[mg/L-milligram per liter, µg/L-microgram per liter, 1 milligram per liter = 1,000 micrograms per liter]

Constituent	Unit	Standard	Unconsolidated alluvial deposits: Range	Unconsolidated alluvial deposits: Number of samples	Unconsolidated alluvial deposits: Number of samples where standard exceeded	Dawson aquifer: Range	Dawson aquifer: Number of samples	Dawson aquifer: Number of samples where standard exceeded	Denver aquifer: Range	Denver aquifer: Number of samples	Denver aquifer: Number of samples where standard exceeded	Arapahoe aquifer: Range	Arapahoe aquifer: Number of samples	Arapahoe aquifer: Number of samples where standard exceeded	Fractured crystalline rocks: Range	Fractured crystalline rocks: Number of samples	Fractured crystalline rocks: Number of samples where standard exceeded
Dissolved solids	mg/L	[1]500	139-7,600	242	166	137-488	13	0	175-7,110	27	17	343-1,920	4	3	107-520	30	1
Dissolved arsenic	µg/L	[2]50	<1-6	99	0	<1-1	7	0	<1	1	0	<1	1	0	<1	6	0
Dissolved chloride	mg/L	[2]250	1.4-4,250	242	19	1.2-42	13	0	3.0-3,050	27	3	37-85	4	0	8-47	30	0
Dissolved fluoride	mg/L	[2]1.8	.1-5.2	197	11	.3-1.2	13	0	.2-2.0	8	2	1.0-4.2	4	1	.2-3.4	30	2
Dissolved iron	µg/L	[1]300	<1-12,700	167	34	<1-5,500	13	5	<1-6,900	21	3	70-150	3	0	<1-31,000	30	5
Dissolved magnesium	mg/L	[2]125	1.5-355	225	2	.9-14	13	0	0.2-180	20	1	2.80	4	0	2.5-29	30	0
Dissolved manganese	µg/L	[1]50	<1-8,300	145	51	<1-500	13	3	<1-12,500	19	6	30-100	2	1	<1-210	30	6
Dissolved nitrite plus nitrate as nitrogen	mg/L	[2]10	.02-40	227	12	.00-4.7	12	0	.00-3.5	27	0	.00-8.4	4	0	.01-18	30	1
Dissolved selenium	µg/L	[2]10	<1-40	99	12	<1-6	7	0	8	1	0	20	1	1	------	--	-
Dissolved sulfate	mg/L	[2]250	15-1,900	239	84	14-149	13	0	1.7-1,190	22	14	3.3-980	4	3	2.3-81	30	0
Hardness, as calcium carbonate	mg/L	None	32-1,660	242	---	71-330	13	-	32-3,870	27	--	30-696	4	-	49-350	30	-

[1]Recommended State standards for public-water supplies (Colorado Department of Health, 1971); with exception of magnesium, standards are the same as the recommended Federal standards established for public-water supplies (U.S. Environmental Protection Agency, 1977); no recommended Federal standard for magnesium.

[2]Primary (mandatory) State standards for public-water supplies (Colorado Department Health, 1977); standards are the same as the mandatory Federal standards established for public-water supplies (U.S. Environmental Protection Agency, 1976); standard for fluoride based on annual average of maximum daily air temperatures in the study area.

Table 2.—*Summary of selected chemical constituents in water from springs*

[mg/L-milligram per liter, µg/L-microgram per liter, 1 milligram per liter = 1,000 micrograms per liter]

Constituent	Unit	Standard	Unconsolidated alluvial deposits: Range	Unconsolidated alluvial deposits: Number of samples	Unconsolidated alluvial deposits: Number of samples where standard exceeded	Consolidated sedimentary rocks: Range	Consolidated sedimentary rocks: Number of samples	Consolidated sedimentary rocks: Number of samples where standard exceeded	Fractured crystalline rocks: Value	Fractured crystalline rocks: Number of samples	Fractured crystalline rocks: Number of samples where standard exceeded
Dissolved solids	mg/L	[1]500	141-1,140	10	4	87-251	3	0	140	1	0
Dissolved arsenic	µg/L	[2]50	<1-4	8	0	1-4	3	0	----	-	-
Dissolved chloride	mg/L	[2]250	2.5-45	10	0	1.0-9.8	3	0	1.7	1	0
Dissolved fluoride	mg/L	[2]1.8	.3-1.6	10	0	.2-.6	3	0	.3	1	0
Dissolved iron	µg/L	[1]300	<1-4,200	9	1	20-270	3	0	30	1	0
Dissolved magnesium	mg/L	[2]125	5.8-57	10	0	3-4.14	3	0	9.0	1	0
Dissolved manganese	µg/L	[1]50	<1-500	8	5	<1-80	3	1	0	1	0
Dissolved nitrite plus nitrate as nitrogen	mg/L	[2]10	.13-39	10	2	.06-2.0	3	0	1.4	1	0
Dissolved selenium	µg/L	[2]10	<1-39	8	1	<1-2	3	0	----	-	-
Dissolved sulfate	mg/L	[2]250	.7-530	10	2	6.1-21	3	0	18	1	0
Hardness, as calcium carbonate	mg/L	None	104-660	10	-	41-120	3	-	97	1	-

[1]Recommended State standards for public-water supplies (Colorado Department of Health, 1971); with exception of magnesium, standards are the same as the recommended Federal standards established for public-water supplies (U.S. Environmental Protection Agency, 1977); no recommended Federal standard for magnesium.

[2]Primary (mandatory) State standards for public-water supplies (Colorado Department of Health, 1977); standards are the same as the mandatory Federal standards established for public-water supplies (U.S. Environmental Protection Agency, 1976); standard for fluoride based on annual average of maximum daily air temperatures in the study area.

Map showing chemical quality of water

WELL YIELDS AND CHEMICAL QUALITY OF WATER FROM WATER-TABLE AQUIFERS IN THE GREATER DENVER AREA, FRONT RANGE URBAN CORRIDOR, COLORADO

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1983