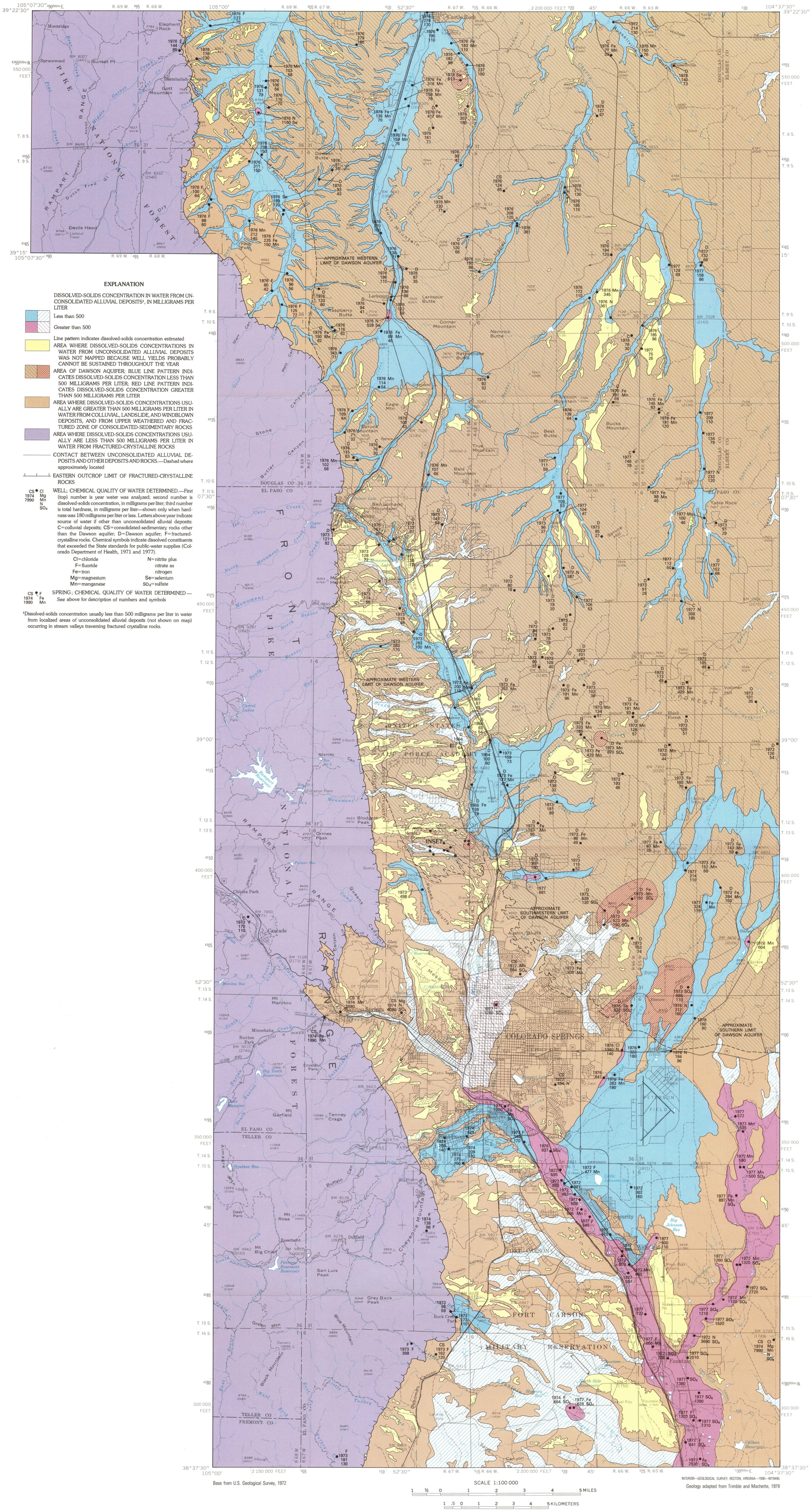

MAP SHOWING CHEMICAL QUALITY OF WATER

WELL YIELDS AND CHEMICAL QUALITY OF WATER FROM WATER-TABLE AQUIFERS IN THE COLORADO SPRINGS—CASTLE ROCK AREA, FRONT RANGE URBAN CORRIDOR, COLORADO

By
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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 uses associated with urban development. However, excessive concentrations of individual dissolved constituents, values of selected physical properties, amounts of radioactivity, and types and numbers of 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 were used in this study to indicate the chemical suitability of ground water.

Ground water containing more than 500 mg/L of dissolved solids is suitable 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, the widespread occurrence of wells and springs with water that contained excessive dissolved iron indicates that the iron probably occurs naturally in the water.

For the data collected, a summary of those constituents that could affect the chemical suitability of water for urban development is 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; 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 and excessive hardness. In addition, excessive hardness may reduce the "life" of hot-water heaters and impairs 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 (Durfor and Becker, 1964). Based on this classification, 61 wells and springs yielded soft water, 74 wells and springs yielded moderately hard water, 33 wells and springs yielded hard water, and 80 wells and springs yielded very hard water.

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

Fluoride, nitrite plus nitrate, and selenium in water may be health hazards. While fluoride is known to reduce 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 as nitrogen that are greater than 10 mg/L in the study area probably indicate 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 development of the aquifers for uses related to urban developments, 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 parameters 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, odor, hydrogen sulfide, and turbidity, could affect the suitability of the water for various uses.

Other factors not considered in this investigation are acquisition of well permits, land-use plans, and zoning ordinances. In Colorado, issuance of well permits, which specify from which aquifer water may be obtained and the amount 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; streamflow; 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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Summary of selected chemical constituents in water from springs
[mg/L=milligrams per liter, μg/L=micrograms per liter, 1 milligram per liter=1,000 micrograms per liter]

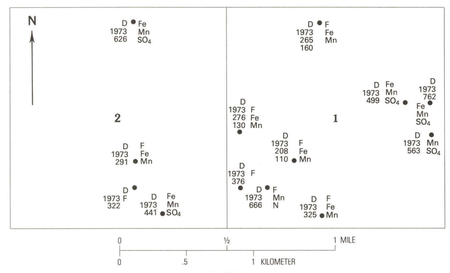
Constituent	Unit	Standard	Unconsolidated alluvial deposits: Range	Number of samples	Number of samples where standard was exceeded	Dawson aquifer, colluvial deposits derived from the Dawson aquifer, and consolidated sedimentary rocks overlying Dawson aquifer: Range	Number of samples	Number of samples where standard was exceeded	Other consolidated sedimentary rocks: Range	Number of samples	Number of samples where standard was exceeded
Dissolved solids, calculated	mg/L	[1]500	81–361	28	0	75–307	17	0	1,990–2,680	2	2
Dissolved arsenic	μg/L	[2]50	<1–50	27	0	<1–5	17	0	.....	.....	.....
Dissolved chloride	mg/L	[2]250	1.5–20	28	0	1.4–13	17	0	180–210	2	0
Dissolved fluoride	mg/L	[1]1.8	0.1–2.7	28	3	0.1–0.8	17	0	3.1–4.5	2	2
Dissolved iron	μg/L	[2]300	1–2,600	28	1	<1–2,000	17	2	220–13,000	2	1
Dissolved maganese	μg/L	[2]50	<1–790	28	7	<1–330	17	3	840–1,800	2	2
Dissolved magnesium	mg/L	[1]125	1.8–13	28	0	1.3–7.8	17	0	29–81	2	0
Dissolved nitrite plus nitrate as nitrogen	mg/L	[2]10	0.00–13	28	1	0.00–8.1	17	0	0.03–0.31	2	0
Dissolved selenium	μg/L	[2]10	<1–5	27	0	<1–5	17	0	.....	.....	.....
Dissolved sulfate	mg/L	[2]250	5.6–60	28	0	7.0–50	17	0	190–220	2	0
Hardness, as calcium carbonate	mg/L	None	32–240	28	.....	21–180	17	.....	540–1,400	2	.....

[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 flouride based on annual average of maximum daily air temperatures in the study area.

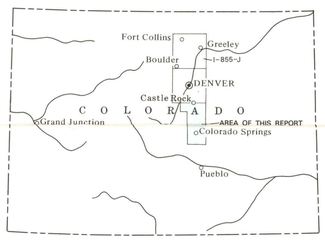
Summary of selected chemical constituents in water from wells
[mg/L=milligrams per liter, μg/L=micrograms per liter, 1 milligram per liter=1,000 micrograms per liter]

Constituent	Unit	Standard	Unconsolidated alluvial deposits: Range	Number of samples	Number of samples where standard was exceeded	Dawson aquifer and colluvial deposits derived from the Dawson aquifer: Range	Number of samples	Number of samples where standard was exceeded	Other consolidated sedimentary rocks: Range	Number of samples	Number of samples where standard was exceeded	Fractured crystalline rocks and colluvial deposits derived from fractured crystalline rocks: Range	Number of samples	Number of samples where standard was exceeded
Dissolved solids, calculated	mg/L	[1]500	80–3,690	108	42	78–1,150	84*	11	162–7,990	5	3	138–398	4	0
Dissolved arsenic	μg/L	[2]50	<1–12	83	0	<1–6	12	0	<1	2	0	.....	.....	.....
Dissolved chloride	mg/L	[2]250	0.4–320	108	1	1.0–200	84	0	1.9–400	5	1	1.0–6.3	4	0
Dissolved fluoride	mg/L	[1]1.8	0.1–5.8	108	16	0.0–4.1	84	10	0.3–2.2	5	1	0.1–2.7	4	3
Dissolved iron	μg/L	[2]300	<1–11,000	108	14	<1–130,000	84	30	20–300	5	0	10–90	4	0
Dissolved maganese	μg/L	[2]50	<1–2,700	108	26	<1–2,700	84	36	<1–340	5	2	<1–29	4	0
Dissolved magnesium	mg/L	[1]125	1.9–120	108	0	0.0–110	84	0	7.1–420	5	2	2.6–26	4	0
Dissolved nitrite plus nitrate as nitrogen	mg/L	[2]10	0.00–77	100	8	0.00–24	83	3	0.14–730	5	3	0.03–1.6	4	0
Dissolved selenium	μg/L	[2]10	<1–17	83	3	<1–100	11	2	<1–8	2	0	<1	1	0
Dissolved sulfate	mg/L	[2]250	5.5–2,300	108	22	2.6–560	84	11	29–2,600	5	3	19–100	4	0
Hardness, as calcium carbonate	mg/L	None	32–1,600	108	.....	18–570	84	.....	120–4,100	5	.....	98–220	4	.....

[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 flouride based on annual average of maximum daily air temperatures in the study area.



INSET



MAP SHOWING AREA OF FRONT RANGE URBAN CORRIDOR