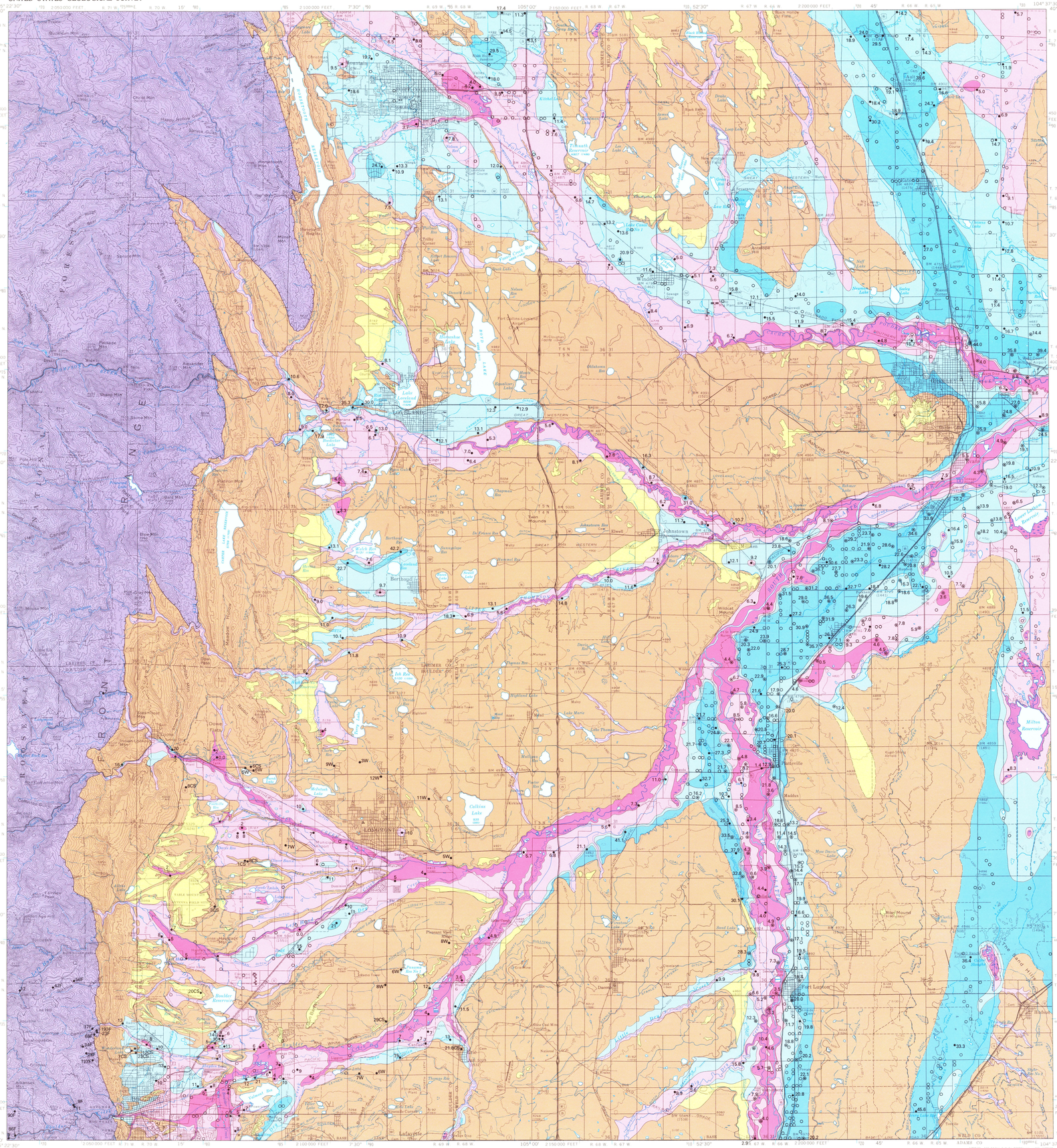
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

MISCELLANEOUS INVESTIGATIONS SERIES
MAP I-855-I



DEPTH TO THE WATER TABLE (1976–77) IN THE BOULDER—FORT COLLINS—GREELEY AREA, FRONT RANGE URBAN CORRIDOR, COLORADO

By
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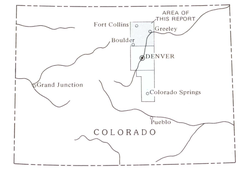
1979

INTRODUCTION

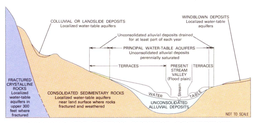
The depth to the water table is a hydrologic factor that can be used by State and local officials to assist them in making decisions regarding land-use conversion in the rapidly urbanizing Boulder—Fort Collins—Greeley area (index map)



MAP SHOWING AREA OF FRONT RANGE URBAN CORRIDOR

This report presents the results of a 2-year investigation to determine the depth to the water table, water-table fluctuations and trends, and to relate the results of the investigation to urban planning. The report is one of a series of geologic and hydrologic reports prepared by the U.S. Geological Survey to demonstrate the usefulness of earth-science information in urban planning.

In the Boulder—Fort Collins—Greeley area, the principal water-table aquifers consist of thick unconsolidated alluvial deposits that are perennially saturated. These deposits occur in present and ancestral stream valleys and in terraces both along present stream valleys and on slopes of the foothills east of the Front Range (diagrammatic section).



DIAGRAMMATIC SECTION SHOWING OCCURRENCE OF WATER-TABLE AQUIFERS

Ranges in depth to the water table shown on the map were delineated only for these aquifers.

Locally water-table aquifers also occur in the upper weathered and fractured zone of consolidated sedimentary rocks that form the foothills east of the Front Range and that crop out in the eastern part of the area; in colluvial and landslide deposits that occur on the slopes of the consolidated sedimentary rocks; and in windblown deposits that cover much of the eastern part of the area. In the crystalline rocks that form the Front Range in the western part of the area, water occurs locally in fractures to a depth of about 300 feet below land surface (diagrammatic section). Because of the localized occurrence of these water-table aquifers and because some of the aquifer material and fractures are drained for part of the year, these aquifers were not studied in detail during this investigation. Where water levels were measured in wells completed in these localized aquifers, only the locations of the wells and the measured depths to water are shown on the depth-to-water map.

Artesian aquifers, which occur in the consolidated sedimentary rocks in the eastern part of the area, were not studied during this investigation.

Water levels were measured once in 320 wells during 1976 or 1977 to determine the depth to the water table. Additional information about the wells in which water levels were measured is included in a report by Schneider and Hillier (1978). A comparison between water levels measured during 1976–77 and water levels measured by the U.S. Geological Survey since the late 1950's in areas where ground-water pumpage is greatest indicated that no significant upward or downward trend in the water table has developed in most of the areas during the last 20 years. Therefore, water levels reported by Major, Kerbs, and Penley (1975), Schneider (1962), Jenkins (1961), and Schneider and Hershey (1961) and water levels reported by well drillers were used to supplement the 1976–77 data in the compilation of the depth-to-water map. The reported data were obtained from the files of the Colorado Department of Natural Resources, Division of Water Resources, Office of the State Engineer.

Physiography and geology (Colton, 1978) also were used in the compilation. For example, the presence of swamps was used to delineate areas where the depth to the water table is less than 5 feet. Along the South Platte River and its principal tributaries, the character of the mapped depth-zone boundaries often reflects the boundary between the alluvial deposits in the flood plain and the terraces. Also, in the flood plains of the South Platte River and its principal tributaries, the geologic contact between the youngest alluvium, which occurs at lower altitudes, and the older alluvium, which occurs at higher altitudes, was used in conjuction with the water-level measurements to delineate areas where the depth to the water table is less than 5 feet.

Appreciation is extended to the many well owners in the Boulder—Fort Collins—Greeley area for permitting access to and collection of water data from their wells. Dennis C. Hall, Elaine L. Boyd, and Doug L. Cain of the U.S. Geological Survey provided all data for wells in Boulder County.

RELEVANCE TO URBAN PLANNING

The depth to the water table is a relevant factor in planning for urban development as indicated by the following examples:

A. Depth to the water table is less than 5 feet either seasonally or annually:

1. The effectiveness of individual domestic waste-disposal systems could be reduced and untreated wastes could enter the ground-water system. Some of the biochemical reactions associated with individual waste-disposal systems occur in the unsaturated zone below or adjacent to the system. Because the reactions do not occur in water, the greater the depth to the water table, the greater the possibility that these reactions will complete the conversion of waste to an effluent that is not a health hazard.

2. Road and highway stability could be affected. Public access to lands might be limited where marshy ground exists.

3. Soil-salinity problems could exist. The types of vegetation that could be grown in these areas would be dependent on the degree of the salinity, but even without any salinity problems, many types of vegetation could not grow in these areas.

4. Unstable soil structure, which often limits the use of land, could exist.

5. Construction of structural or building foundations could be hampered by the flow of ground water into the construction excavations.

6. Basements could be subject to collapse from water pressure and flooding.

The situations described in items 4, 5, and 6 also could occur in areas where the depth to the water table is not more than 10 feet either seasonally or annually.

B. Depth to the water table related to depth of installation:

1. Liquid wastes or leachates from solid waste could be introduced directly into the ground-water system by water moving through landfills and related types of facilities, resulting in degradation or pollution of the ground water. The possibility of degradation or pollution would be dependent on the type and amount of waste, the depth of burial of the waste, and the seasonal or annual depth of the water table in the area of the landfill or related type of facility.

2. Ground water could enter leaky sanitary sewers, resulting in a significant increase in the volume of waste to be processed by waste-treatment facilities. The volume of water entering a leaky sanitary sewer would be dependent on the depth of burial of sewer and the seasonal or annual depth to the water table.

3. The placement of electric and telephone utility lines below ground and the type of insulation and conduits required for below-ground installation would be, in part, dependent on the depth to the water table.

DEPTH TO THE WATER TABLE

Measured depths to the water table during 1976–77 in the unconsolidated alluvial deposits ranged from 0 to 45.6 feet. Generally the depth to the water table in the flood plains of present streams was less than 10 feet and, in many localities, it was less than 5 feet. The depth to the water table in ancestral stream valleys, such as Beebe Draw, and in the terraces ranged from 0.5 to 45.6 feet. Water levels in wells completed in windblown deposits, consolidated sedimentary rocks, and fractured crystalline rocks were measured only in Boulder County. In the county, the depth to the water table in the windblown deposits ranged from 3 to 12 feet; in the consolidated sedimentary rocks, it ranged from 1 to 29 feet; and in the fractured crystalline rocks, it ranged from 9 to 193 feet.

WATER-TABLE FLUCTUATIONS AND TRENDS

Annual fluctuations of the water table in all the aquifers except the fractured crystalline rocks generally are less than 6 feet although the maximum fluctuation is not known. Both seasonal and annual fluctuations usually are smaller in the aquifers underlying the flood plains of perennial streams because of the hydraulic connection between the streams and the aquifers. Because of the limited storage capacity in the fractures, seasonal and annual fluctuations of the water table in the fractured crystalline rocks may be greater than 10 feet.

In areas that are not extensively irrigated, the depth to the water table generally is shallowest during the spring and early summer when the aquifers are being recharged by snowmelt and rain. The greatest depth to the water table generally occurs in the late autumn when recharge is minimal and water in the aquifers has been partly depleted by pumpage from wells, evapotranspiration, or by natural discharge to lakes, ponds, springs, streams, and swamps. In areas that are extensively irrigated, the depth to the water table may remain within a few feet of the land surface throughout the growing season because part of the applied water percolates through the soil and recharges the aquifer.

Water-table trends in the area are shown both by the hydrographs and the data in the table.

COMPARISON BETWEEN WATER LEVELS MEASURED IN THE LATE 1950'S AND WATER LEVELS MEASURED DURING 1976–77 IN THE SAME WELLS

Location of 10-acre area			Year	Depth to water (feet below land surface)	Year	Depth to water (feet below land surface)	Rise (+) or decline (–) in water level (feet)
Section	Township, north	Range, west					
UNCONSOLIDATED ALLUVIAL DEPOSITS							
25	1	66	1957	43.1	1977	45.6	–2.5
30	1	66	1957	17.0	1977	20.8	–3.8
14	1	70	1959	5.3	1976	4	+1.3
24	1	70	1959	4.1	1976	3	+1.1
24	1	70	1958	11.9	1976	10	+1.9
29	2	66	1957	20.4	1977	19.5	+.9
36	2	67	1957	8.4	1977	9.8	+1.4
20	2	69	1959	12.9	1976	21	–8.1
1	3	67	1957	17.7	1977	21.6	–3.9
10	3	67	1957	19.1	1977	21.7	–2.6
24	3	67	1957	1.8	1977	1.4	+.4
27	3	67	1957	22.9	1977	32.7	–9.8
35	3	67	1957	25.8	1977	25.3	+.5
36	3	67	1957	5.7	1977	3.4	+2.3
18	4	65	1957	10.3	1977	10.5	–.2
13	4	66	1957	20.4	1977	22.1	–1.7
14	4	66	1957	29.3	1977	28.2	+1.1
15	4	66	1957	13.2	1977	18.1	–4.9
19	4	66	1957	30.3	1977	27.2	+3.1
27	4	66	1956	9.4	1977	7.6	+1.8
28	4	66	1957	22.2	1977	26.3	–4.1
31	4	66	1956	26.2	1977	25.3	+.9
25	4	67	1957	19.8	1977	24.9	–5.1
36	5	66	1957	5.6	1977	6.3	–.7
10	6	65	1959	8.4	1977	10.7	–2.3
18	6	65	1959	25.0	1977	27.0	–2.0
16	7	65	1959	4.0	1977	5.0	–1.0
21	7	65	1959	5.8	1977	6.9	–1.1
16	7	68	1959	7.3	1977	8.3	–1.0
36	8	66	1959	11.9	1977	14.2	–2.3
CONSOLIDATED SEDIMENTARY ROCKS							
4	1	70	1959	16.1	1976	20	–3.9

The hydrographs present water-level measurements made at approximately the same time each year to eliminate the effects of seasonal fluctuations of the water table. The hydrographs indicate that, with a few exceptions, no significant upward or downward trend in the water table has developed since the late 1950's.

The data in the table also indicate that, with a few exceptions, the water table in the area was at about the same depth in the late 1950's as in 1976–77. Of the 31 wells listed in the table, water levels in 3 of the wells have declined more than 5 feet; the maximum decline was 9.8 feet. No water levels have risen more than 3.1 feet.

A long-term downward trend of water levels, which may indicate that water is being pumped or mined from the aquifer(s) at a rate that is greater than the rate of recharge to the aquifer(s), is apparent on the hydrographs of the wells in sec. 9, T. 4 N., R. 66 W. and in sec. 16, T. 5 N., R. 68 W. Data are not sufficient, however, to verify that ground-water mining is occurring. Mining of ground water also may be occurring in those parts of the area where continual long-term water-level data are not available. The data in the table for the wells in sec. 20, T. 2 N., R. 69 W. (decline of 8.1 feet) and in sec. 27, T. 3 N., R. 67 W. (decline of 9.8 feet) may be indicative of ground-water mining.

If ground-water mining is occurring, continued pumping of existing wells at the same or increased rates will result in the following sequence of events:

1. Water levels decline, well yields decrease, and pump intakes have to be lowered in the wells.

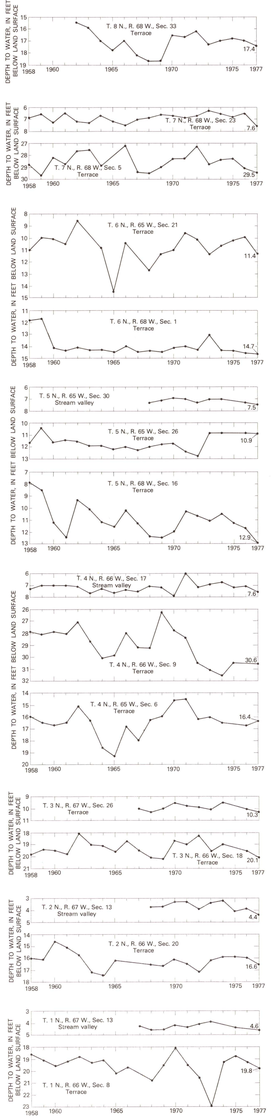
2. Wells have to be deepened, in some localities to the base of the aquifer, and pump intakes lowered to as near the bottom of the well as possible, if this has not been done previously.

3. Aquifers are dewatered. Water levels of surface-water features may decline if there is hydraulic connection between them and the aquifers. Pumping wells could deplete streamflow and significantly lower water levels in lakes, ponds, and swamps.

Installing additional wells in areas where water is being mined only accelerates the sequence of events listed above. The existence of, or potential for, ground-water mining are factors that need to be evaluated in planning for urban development.

LIMITATIONS OF THE INVESTIGATION

The users of this report need to be aware that the water-table data represent a compilation of water levels measured throughout 1976 and 1977. Because of seasonal or annual variations in ground-water recharge or discharge, the data do not necessarily represent either the shallowest or the greatest depth to the water table that could occur or has occurred. Water-level measurements would have to be made at least during the spring and late fall, and perhaps throughout the year, at a specific site intended for a specific use, to determine the potential effects of water levels on the use of the site. The scale of the map in this report precludes its use for specific site selection; larger scale maps need to be used for this purpose. Also, areas of shallower depths to the water table than those shown on the map occur locally, especially around the edges of lakes, ponds, and reservoirs; along canals where leakage occurs; and in the stream valleys where the depth to the water table is shown in the range from 5 to 10 feet.



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METRIC CONVERSIONS

MULTIPLY	BY	TO OBTAIN
Foot	0.3048	Meter
Mile	1.609	Kilometer
Acre	0.4047	Hectare

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