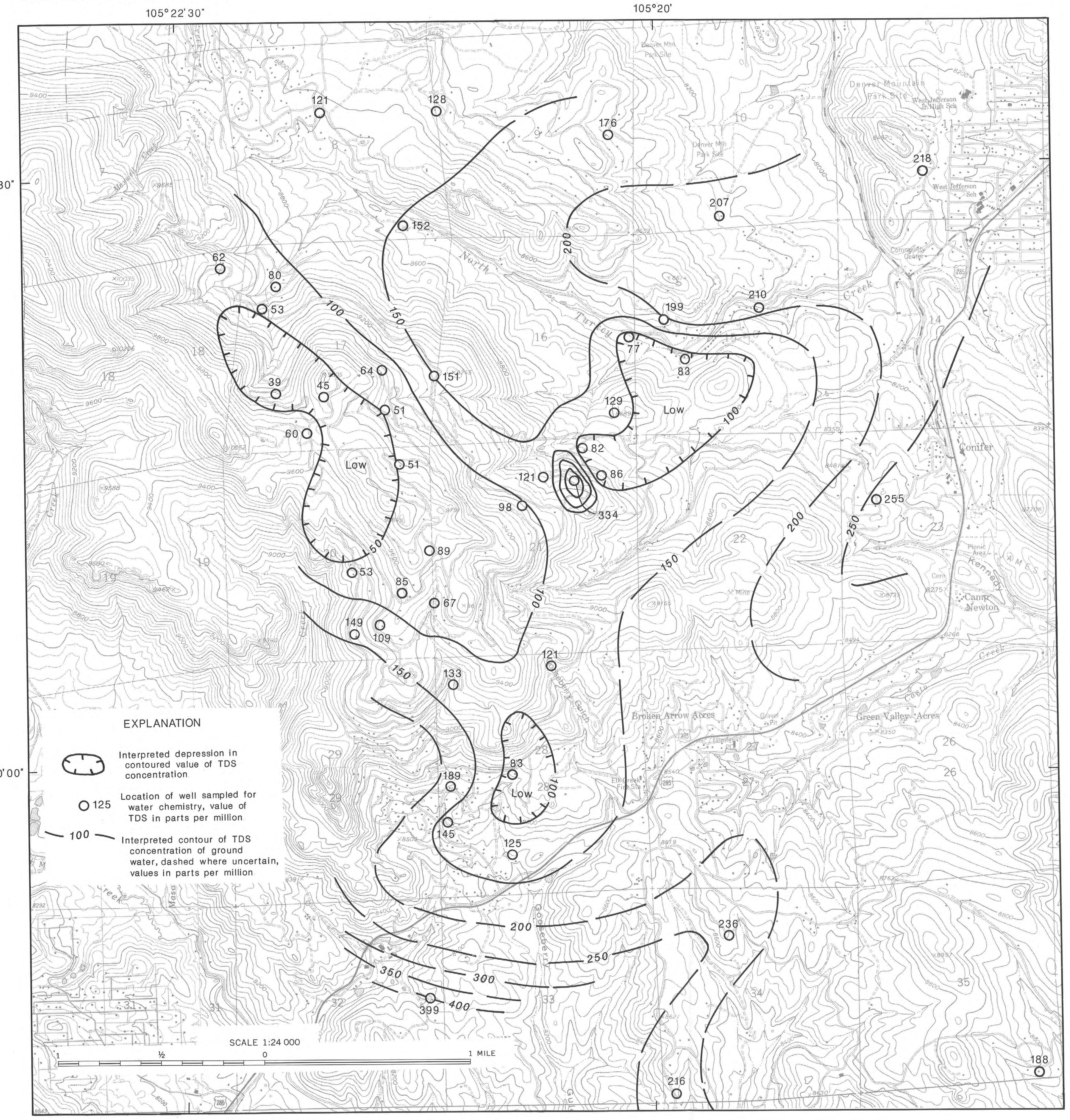
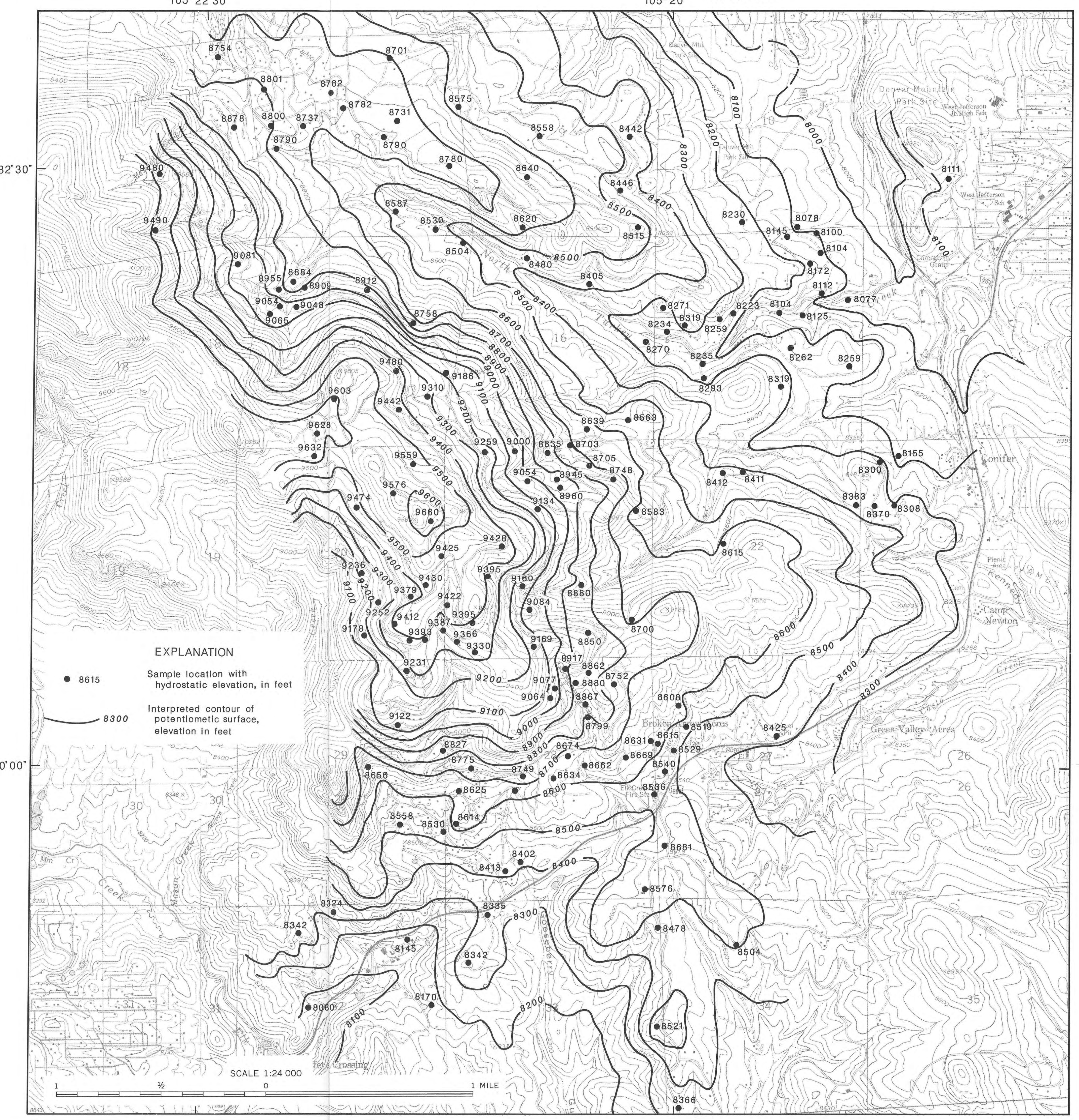
U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

MISCELLANEOUS FIELD STUDIES
MAP MF-2165



Base from U.S. Geological Survey Bailey, 1987; Conifer, 1965; Meridian Hill, 1957; and Pine, 1965

MAP A. DISTRIBUTION OF TOTAL-DISSOLVED-SOLIDS CONCENTRATIONS



Base from U.S. Geological Survey Bailey, 1987; Conifer, 1965; Meridian Hill, 1957; and Pine, 1965

MAP B. POTENTIOMETRIC SURFACE

STATIC WATER LEVEL MEASUREMENTS

Static water levels (SWL's) were measured in more than one hundred wells in the study area during April-May 1989. The water levels were monitored for 10-15 minutes to determine if they were static. If a given level was found not to be static, the measurement was repeated at a later date when the level was static.

The SWL measurements obtained during this study were combined with data from Hicks (1987) and the monitoring system of the Mountain Water Sanitation District (MWSD) in order to construct a potentiometric-surface map (Map B) of a part of the study area. The SWL data collected during this study were used as the primary controls for mapping the potentiometric surface. The data from Hicks (1987) and MWSD were used in areas where there was little other well control. Hicks collected data from April 1985 to May 1986 and the MWSD program has been monitoring wells since 1983. Data points from these two studies were used as controls for mapping only if the measurements were made near April-May and if the readings were reasonably stable (that is, fluctuated only a few feet over a period of several months). Contour lines representing the interpreted potentiometric surface have been drawn with consideration of topographic features such that the equipotential lines lie uphill of the same land-surface contour. Streams and ponds have been interpreted as points where the water table and land surfaces coincide. Further information on the hydrologic properties and ground-water chemistry can be found in Lawrence (1990).

POTENTIOMETRIC SURFACE VERSUS WATER CHEMISTRY

In addition to the SWL measurements, water samples were collected from approximately 50 wells within the study area for chemical analysis. The concentrations of major cations such as Ca, Mg, Na, and K were determined using inductively coupled plasma atomic emission spectroscopy (Lichte and others, 1987). The concentrations of major anions (Cl, NO_3, and SO_4) were determined using ion chromatography (Fishman and Pyen, 1979). Bicarbonate concentration was determined at each site using electrometric titration (Skougstad and others, 1979). The map of total dissolved solids (TDS) (Map A) shows the total of the concentrations of Ca, Mg, Na, K, Cl, HCO_3, NO_3, and SO_4. Together, these constituents dominated the TDS content of the waters.

Comparison of the TDS map (Map A) with the potentiometric-surface map (Map B) shows significant correlations. The TDS map can be superimposed over the potentiometric-surface map to show that TDS generally increases downgradient, from high to low potential. Low TDS commonly occurs along the basin divides in the center of the mapped area, near the Conifer Mountain topographic high. The Conifer Mountain ground-water system exhibits a systematic increase in dissolved solids as the ground water moves downgradient. The ground-water recharge to this system is predominantly from precipitation events, as well as some minor inflow that may originate from Black Mountain, which lies to the northwest. This pattern of increasing TDS downgradient in the waters of the Conifer Mountain system probably results from increased residence time in the flow system. Longer residence times result in increased time for water-rock reactions to occur. Based on the results of chemical reaction modelling using PHREEQE (Parkhurst and others, 1980), all of the water samples collected were found to be under-saturated with respect to the major rock-forming minerals present in the aquifers. Therefore, mineral dissolution reactions should continue within this flow system along the length of the flow path. The farther along the flow path that water has moved (that is, the greater the distance from the basin divide), the greater is the concentration of dissolved species. Thus, the overall water chemistry is systematically changing as the result of long-term processes. The fact that the concentration map generally correlates with the mapped potentiometric surface (which mimics the surface topography) suggests that the Conifer Mountain ground-water system must have a high degree of hydraulic connection.

HOW TO USE THE MAPS

The map of the potentiometric surface (Map B) shows the elevation of the water table for the period April-May 1989. The water-table elevation is the elevation to which water may rise in a well bore at a given location. This map can be used in conjunction with the appropriate topographic map to estimate the depth to water in a well bore at a given location, assuming that water-conducting fractures are intersected by the well bore. The map cannot be used to predict the depth at which such fractures will be intersected to produce a reliable water supply. When a water-producing zone is intercepted during drilling operations, this map could be used to estimate the overall length of the water column in the well and, therefore, to estimate bore-hole storage. When using the map, it should be kept in mind that seasonal or annual fluctuation in the water-table elevation may occur. It is probable that the potentiometric surface shown on this map is near a maximum level for the year because the measurements were made in the spring, when snowmelt and runoff are near maximum.

The TDS map (Map A) may be used to evaluate the overall quality of water produced by a well. The highest value on the map is 399 parts per million (ppm), well below the Environmental Protection Agency's recommended maximum contaminant level (MCL) of 500 ppm TDS. Thus, all the waters in the study area are of potable quality with respect to TDS. On the other hand, several of the wells sampled exceeded EPA's MCL for individual dissolved constituents. The quality of water produced from a well should be checked for the concentration of individual constituents if the user of the well is concerned about the concentration of a particular contaminating element. As with the potentiometric-surface map, the TDS map has a transient quality in that the overall water quality may change with time. Such changes could occur in response to perturbations in the hydrogeologic system caused by increased withdrawal rates or changes in the rate of recharge.

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MAPS SHOWING HYDROSTATIC LEVELS AND GENERAL GROUND-WATER QUALITY FOR AN AREA NEAR CONIFER, COLORADO

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1991

Manuscript approved for publication March 5, 1991
Interior–Geological Survey, Reston, Virginia–1991
For sale by U.S. Geological Survey Map Distribution
Box 25286, Federal Center, Denver, CO 80225