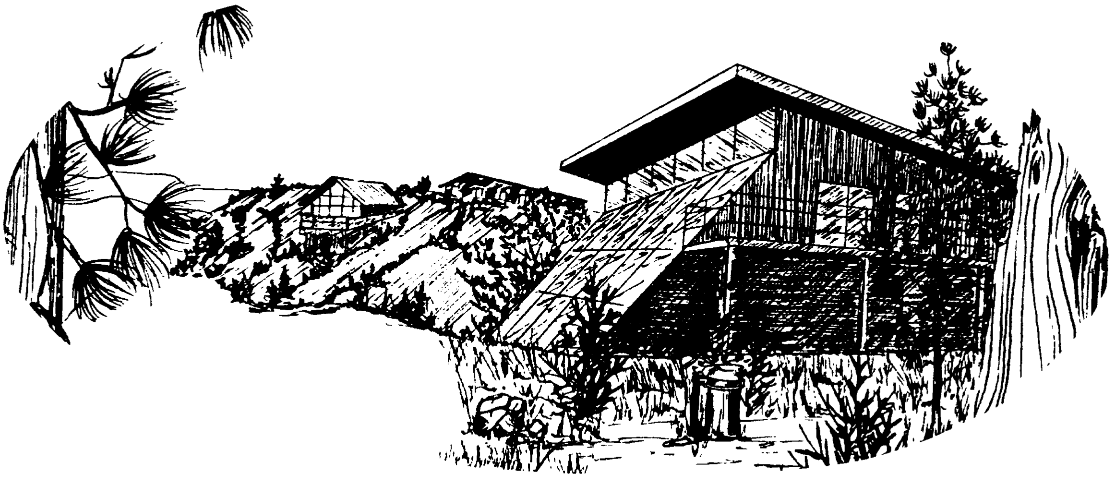
GROUND-WATER AVAILABILITY AND QUALITY IN EASTERN BERNALILLO COUNTY AND VICINITY, CENTRAL NEW MEXICO

by G.E. KUES



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CONVERSION FACTORS

In this report, measurements (except chemical concentrations) are given in inch-pound units. The following table contains factors for converting to metric (International System) units.

Multiply inch-pound units	By	To obtain metric units
inch	2.540	centimeter
foot	0.3048	meter
mile	1.609	kilometer
acre	4,047	square meter
square mile	2.590	square kilometer
gallon per minute	0.06309	liter per second

Water temperature in degrees Celsius (°C) can be converted to degrees Fahrenheit (°F) by the following equation:

$$°F = 9/5\ (°C) + 32$$

Chemical concentrations are reported in milligrams per liter. Specific conductance is reported in microsiemens per centimeter at 25 degrees Celsius.

Sea level: In this report "sea level" refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)--a geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called "Sea Level Datum of 1929."

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ABSTRACT

The study area includes the eastern one-third of Bernalillo County and parts of southeastern Sandoval County, southwestern Santa Fe County, northwestern Torrance County, and northeastern Valencia County. Several north-trending mountain ranges are in the study area. The mountains consist of tilted fault blocks of Precambrian granitic and metamorphic rock. They have a rugged west face and gentle eastward slope primarily mantled by carbonate sedimentary rocks of the Pennsylvanian and Permian Madera Group.

The Madera Group crops out over three-fourths of the study area and forms the most areally extensive water-yielding unit. Granitic material eroded by drainage systems forms the eastern one-fifth of the study area. Roughly centered in the area is a sequence of primarily clastic sedimentary rocks from Permian to Cretaceous age. Thin soil zones (1 to 10 feet thick) cover most of the area.

Ground-water availability depends on the lithology of the water-yielding unit and proximity to faults. Previous researchers in other areas have demonstrated a direct relation between faults and well yields in limestone units. A relation between faults and well yields was confirmed in one part of this study area.

Precipitation, the only source of recharge to the ground-water system, is greatest at and near mountain crests. A direct correlation appears to exist between changes in precipitation and ground-water levels in the Sandia Park area. The time of response of ground-water levels to recharge from precipitation is about 2½ years.

Ground-water-level declines since the late 1950's have been almost entirely restricted to wells completed in shale units that supply an average of about 4 gallons per minute. In areas where clastic materials such as sandstone and shale crop out, short-term changes in ground-water levels of as much as 117 feet in 4 months have occurred, causing temporary water shortages; recovery of ground-water levels occurred within 7 to 9 months. Such short-term ground-water fluctuations probably are caused by earlier changes in precipitation and resulting changes in recharge.

Although ground water in the study area generally is acceptable for human consumption, maximum contaminant levels established by the U.S. Environmental Protection Agency (primary drinking-water regulations) for nitrate (10 milligrams per liter) and fluoride (4.0 milligrams per liter) were exceeded in a few samples obtained in the area. Samples from Tijeras Canyon had nitrate concentrations as large as 30 milligrams per liter. Water from the new (1984) community supply well in Chilili contained 16 milligrams per liter of nitrate. Of wells resampled since the last major study in the area in the early 1960's, a well near Sandia Park had the largest increase in nitrate concentration, from 1.6 to 7.8 milligrams per liter. Fluoride concentrations were greatest in ground water in the vicinity of Barton.

INTRODUCTION

The population of eastern Bernalillo County and vicinity is increasing because of the area's desirable setting and its proximity to the largest population center in New Mexico, the city of Albuquerque. Much of the area is rural, forested, and scenic. Most development consists of single-family dwellings that have individual wells and septic systems. Proposed housing developments have a density of as much as one dwelling per quarter acre, much higher than has existed in most of the area. High-density developments will create proportionately large demands on water-supply and septic systems. All future development probably will affect ground-water supplies as a result of increased withdrawals and a probable increase in the number of point sources of pollution, such as septic systems and sanitary landfills. Because of these concerns, the U.S. Geological Survey, in cooperation with the Bernalillo County Commission and New Mexico State Engineer Office, began a study of the availability and quality of ground water in mountainous areas of eastern Bernalillo County and vicinity.

Location of Study Area

The study area includes the eastern one-third of Bernalillo County and parts of southeastern Sandoval County, southwestern Santa Fe County, northwestern Torrance County, and northeastern Valencia County (fig. 1). The area covers about 600 square miles.

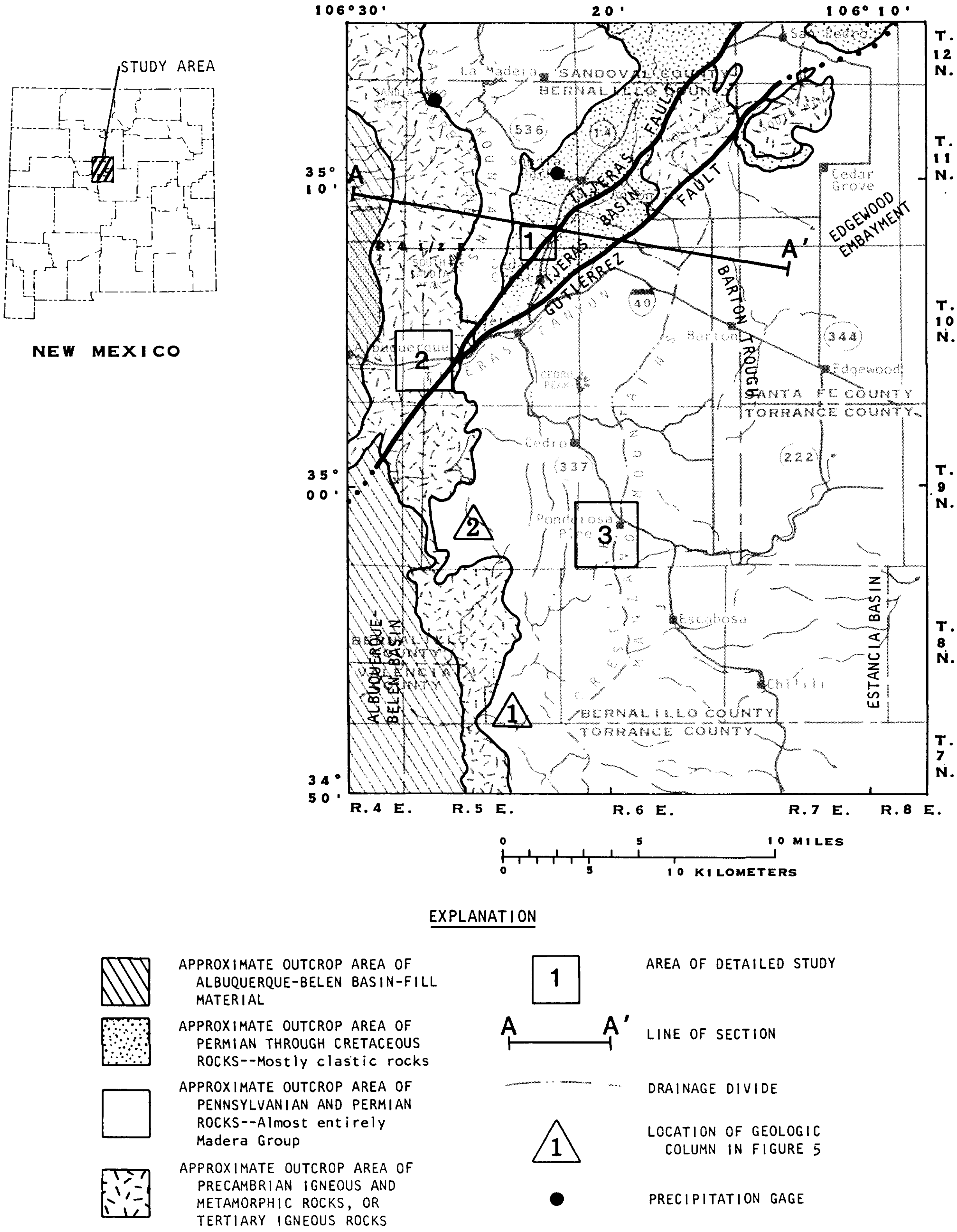


Figure 1.--Location and generalized geology of study area (modified from Titus, 1980, p. vi).

Purpose and Scope

The purpose of this study was to provide hydrologic information that would help planners and water managers identify water-availability and water-quality problems in order to make informed decisions regarding future development in the area. Objectives of the study were to: (1) identify geohydrologic conditions needed for the development of adequate supplies of ground water for domestic and small community use; (2) identify areas where concentrations of dissolved nitrate and fluoride exceed the U.S. Environmental Protection Agency maximum contaminant level for drinking water; (3) identify mechanisms of ground-water contamination; and (4) collect data to document changes in ground-water levels and in quality of ground water that have taken place since a study by Titus (1980) in the 1960's.

The purpose of this report is to provide a general description of the availability and quality of ground water in eastern Bernalillo County and vicinity, central New Mexico. Three small areas were selected for intense study because an intensive study of the entire area was beyond the scope of the investigation. The areas represent the three major types of geohydrologic settings in the study area. Area 1 consists of fractured and faulted clastic rocks, primarily sandstone, conglomerate, clay, and shale. Area 2 consists of fractured and faulted igneous and metamorphic rocks covered by colluvium and alluvium. Area 3 consists of fractured and faulted carbonate rocks. Water-level, well-construction, well-yield, and water-quality data are presented for each area. Geologic sections and fracture-trace maps also are provided. Data for this project were collected in 1984 and 1985.

Previous Studies

Smith (1957) conducted a ground-water resource study of Torrance County that includes the southeastern part of the present study area. Hudson (1978, 1980) monitored ground-water levels, spring discharge, and surface-water discharge in part of Tijeras Canyon from 1972 to 1978 to document possible effects of interstate-highway construction in Tijeras Canyon on local aquifer conditions.

Titus (1980) studied an area that includes the present study area, the Placitas area northwest of the present study area, and an additional area that extends 6 miles south of the present study area. Water-level and water-quality data for the Titus study were collected in the late 1950's and early 1960's. He described the ground-water-flow pattern for the central part of the study area and the inconsistent areal availability of ground water, particularly in carbonate rocks. He also documented chemical analyses of ground-water samples from geologic units (grouped by geologic system) and noted large concentrations of fluoride and nitrate in some samples. The investigation by Titus was a major study conducted over several years and remains the only major previous hydrologic investigation in the area. Work done in the 1950's and 1960's mentioned in this report is a reference to Titus' report.

Methods

Water-level and water-quality data were obtained primarily from newer producing wells that have construction information available. Records at the New Mexico State Engineer District 1 Office in Albuquerque were used to select wells for data and sample collection. Approximately three-fourths of the selected wells were used for data and sample collection because their owners could be contacted by telephone prior to going into the field. Water levels in 12 wells measured by Titus (1980) were remeasured during this study.

Specific-conductance, temperature, and pH measurements were made where untreated well water could be obtained at or near well sites. Samples for laboratory analysis were collected from 33 wells. Sample collection was relatively intensive in Tijeras Canyon where large concentrations of nitrate were detected in the late 1950's and early 1960's.

Geologic unit descriptions were derived from reports by Armstrong (1967), Myers (1969, 1973), Kelley and Northrop (1975), and Titus (1980). Stereo-pair aerial photographs of the three areas of detailed study, in conjunction with field observations, were used to prepare fracture-trace maps of part of each area.

Within areas of detailed study, the apparent effect of faults and fractures on the ground-water-flow system was determined by comparing water levels, specific conductance, pH, and reported production for each well to the well's location relative to mapped faults and fractures. Observations made in the detailed areas were then extended to other parts of the study area where similar geologic materials and faults or fractures are present. A fault is a break in rock along which significant relative movement has occurred. A fracture is a break in rock along which no discernible amount of relative movement has occurred.

Acknowledgments

The generous help of personnel of the Albuquerque office of the New Mexico State Engineer in locating well records is gratefully acknowledged. Homeowners who allowed access to their wells are also acknowledged.

Local Well-Numbering System

The system of numbering wells in New Mexico is based on the common subdivision of public lands into sections (fig. 2). The well number, in addition to designating the well, locates its position to the nearest 10-acre tract in the land network. The number is divided into four segments. The first segment denotes the township north or south of the New Mexico base line, the second denotes the range east or west of the New Mexico principal meridian, and the third denotes the section. The fourth segment of the number, which consists of three digits, denotes the 160-, 40-, and 10-acre tracts, respectively, in which the well is situated. For this purpose, the section is divided into four quarters, numbered 1, 2, 3, and 4, in the normal reading order, for the northwest, northeast, southwest, and southeast quarters, respectively. The first digit of the fourth segment gives the quarter section, which is a tract of 160 acres. Similarly, the quarter section is divided into four 40-acre tracts numbered in the same manner, and the second digit denotes the 40-acre tract. Finally, the 40-acre tract is divided into four 10-acre tracts, and the third digit denotes the 10-acre tract. For example, well 10N.05E.02.233 is in the SW¼ of the SW¼ of the NE¼ of section 2, Township 10 N., Range 5 E. Letters a, b, c, and so on are added to the last segment of the well number to designate the second, third, fourth, and succeeding wells in the same 10-acre tract. This numbering system is used in table 5 (table 5 is in the back of the report).

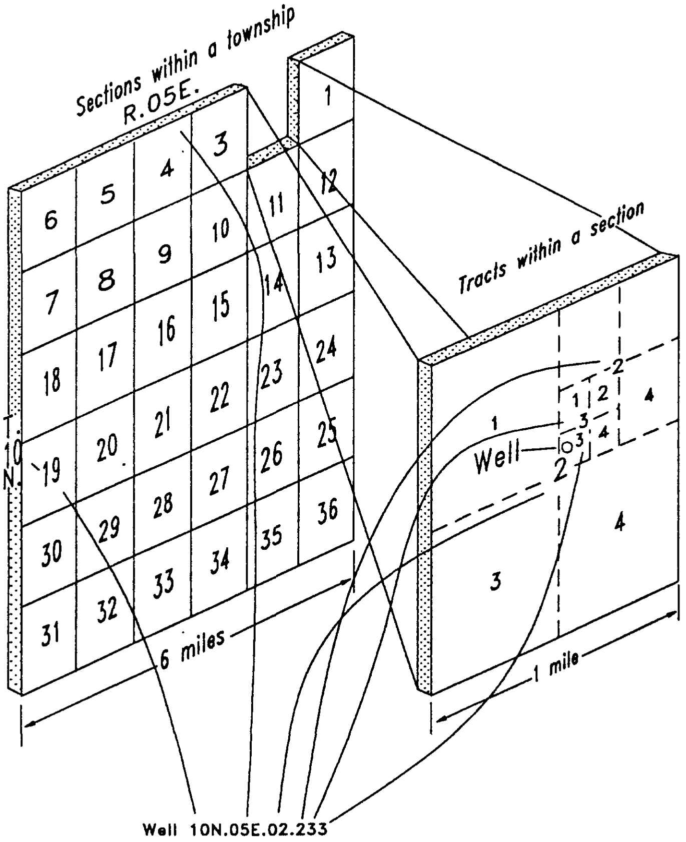


Figure 2.--Method of numbering wells.

REGIONAL GEOHYDROLOGIC SETTING

The study area is part of a mountainous region situated between two north-trending structural depressions, the Albuquerque-Belen Basin on the west and the Estancia Basin on the east (fig. 1). This mountainous area primarily consists of tilted fault blocks that form the Sandia and Manzano Mountains.

The Sandia and Manzano Mountains have a gently dipping eastward slope and a steep rugged west face. They are composed predominantly of slightly to moderately metamorphosed igneous Precambrian rock. A generalized geologic section through the Sandia Mountains is shown in figure 3. The eastern slope is mantled primarily by carbonate sedimentary rocks of the Pennsylvanian and Permian Madera Group; sedimentary rocks of Permian through Cretaceous age crop out in the north-central part of the area (fig. 1).

The geology of the area is complex and was described in detail by Smith (1957), Myers (1969, 1973, 1982), Kelley and Northrop (1975), and Titus (1980). The description of the geology of the area presented below is summarized from these sources. The wide variety of rock types present in the area is shown in a stratigraphic column in figure 4. Descriptions of measured sections in Armstrong (1967, p. 50), and in Kelley and Northrop (1975, p. 33 (Szabo section), p. 50-58, 125-127, and 129) were used to construct the column.

The Pennsylvanian and Permian Madera Group is composed mainly of carbonate and shale but greatly varies in composition (fig. 5). These rocks crop out in approximately three-fourths of the area (fig. 1). Metamorphic and igneous rocks, eroded in places by alluvium-filled stream channels, crop out in the western one-fifth of the area and also form Monte Largo in the northeastern part of the study area (fig. 1). An outcrop of carbonate and clastic rocks of Mississippian age is in Tijeras Canyon (fig. 1). Shale, sandstone, and minor carbonate units of Permian through Cretaceous age crop out in and around the Tijeras structural basin. In the northeast, South Mountain and dikes and sills in the San Pedro area are igneous rock.

The Tijeras basin is in the north-central part of the area (fig. 1); it is a triangular block that has rotated downward on its southwest side relative to its surroundings. Movement was apparently hinged on the northeast side of the block. The youngest consolidated sedimentary rocks in the study area, the Cretaceous Mesaverde Group and the underlying Cretaceous Mancos Shale (fig. 3), crop out in the basin. Bordering the northwest side of the basin are Cretaceous, Jurassic, and Triassic sedimentary rocks. Bordering the southeast side of the basin are Permian and Pennsylvanian sedimentary rocks. The northwest side of the basin is bounded by Tijeras fault, and the southeast side is bounded by Gutierrez fault (fig. 1). Monte Largo is on the northeast side of Tijeras basin. Monte Largo is composed of metamorphic Precambrian rock and, like Tijeras basin, is between Tijeras and Gutierrez faults. The age of outcropping units decreases in the direction of Tijeras basin.

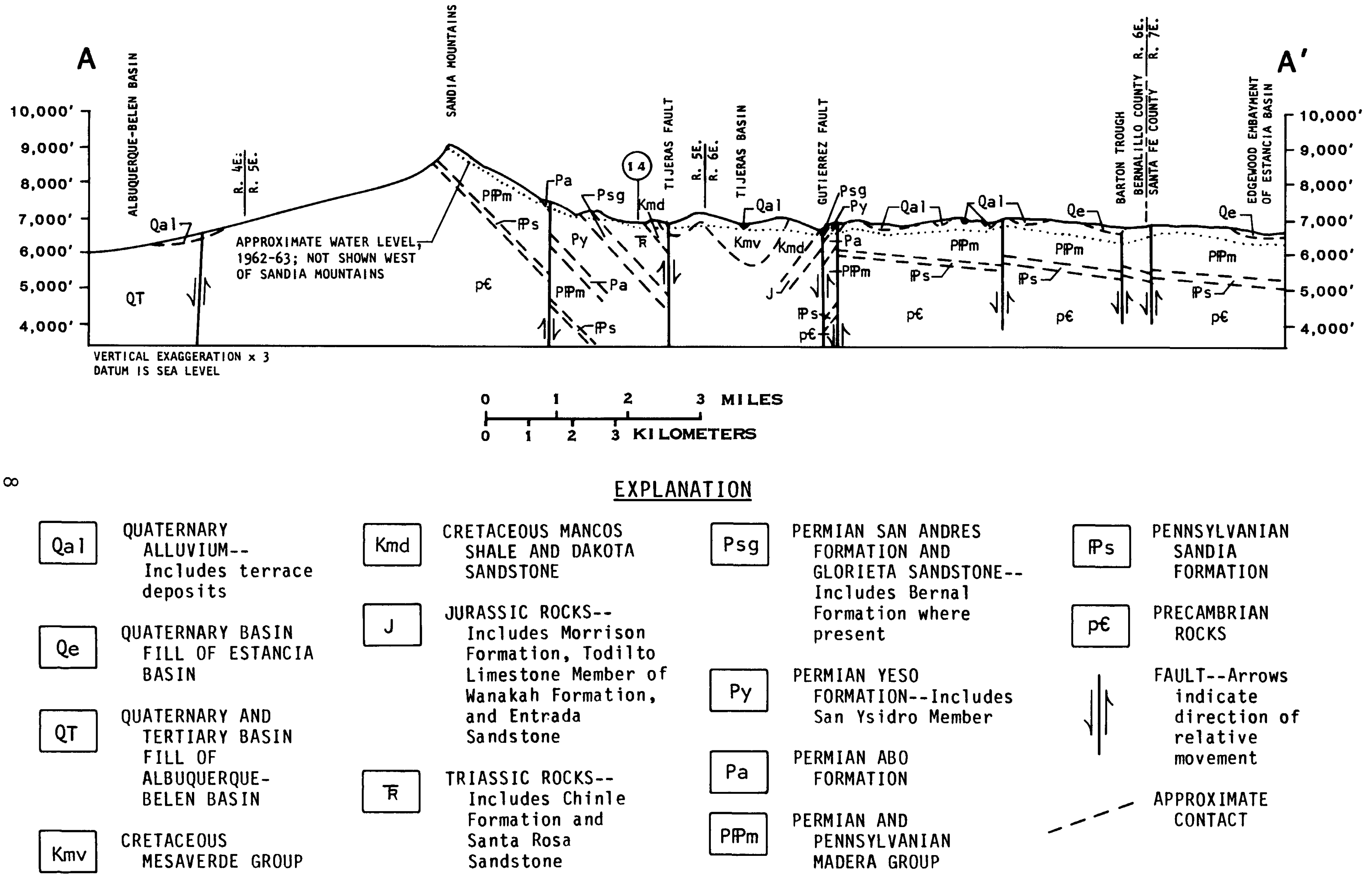


Figure 3.--Geologic section A-A' (location of section shown in fig. 1; modified from Titus, 1980, p. 24).

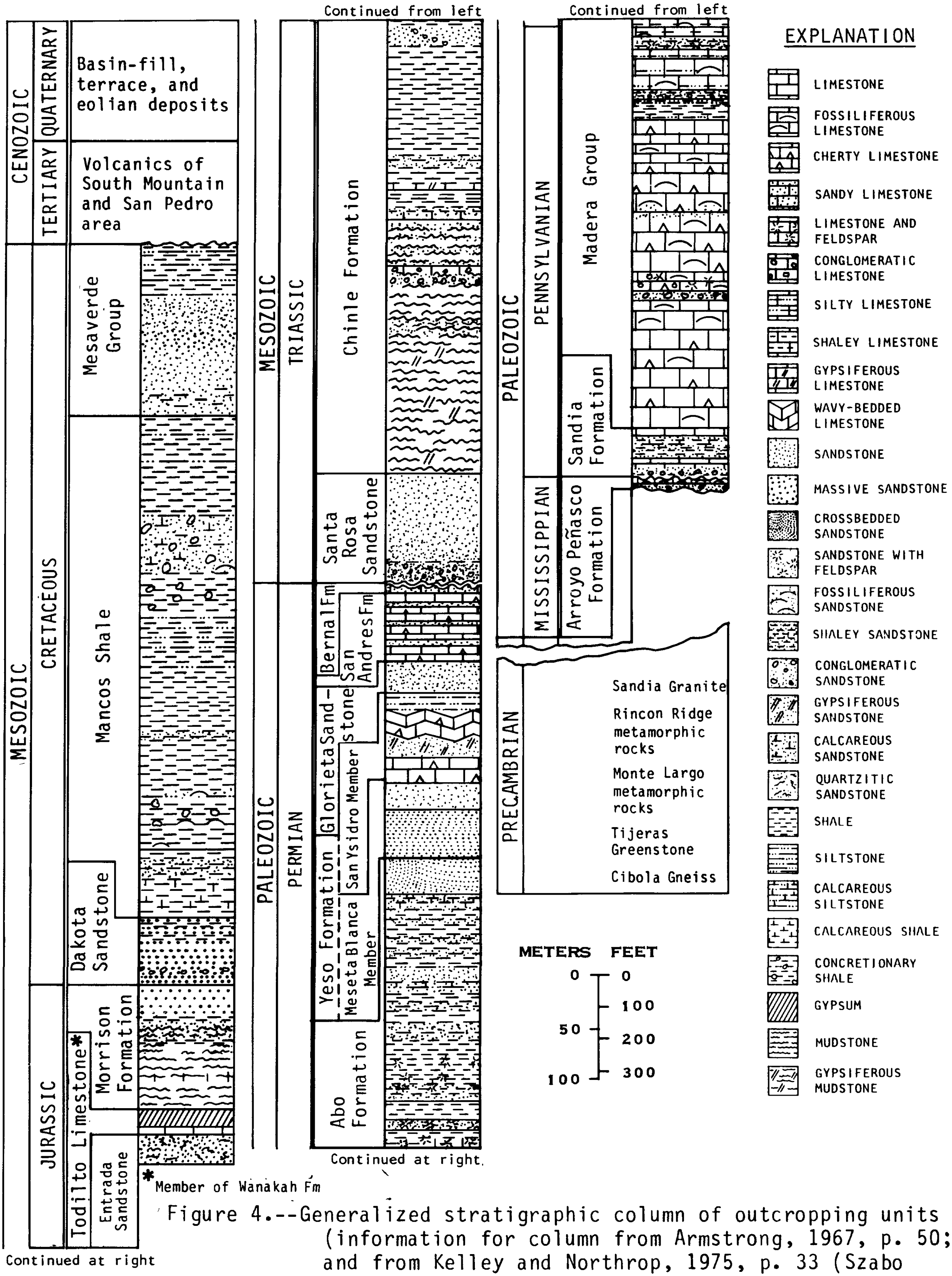


Figure 4.--Generalized stratigraphic column of outcropping units (information for column from Armstrong, 1967, p. 50; and from Kelley and Northrop, 1975, p. 33 (Szabo section), 50-58, 125-127, and 129).

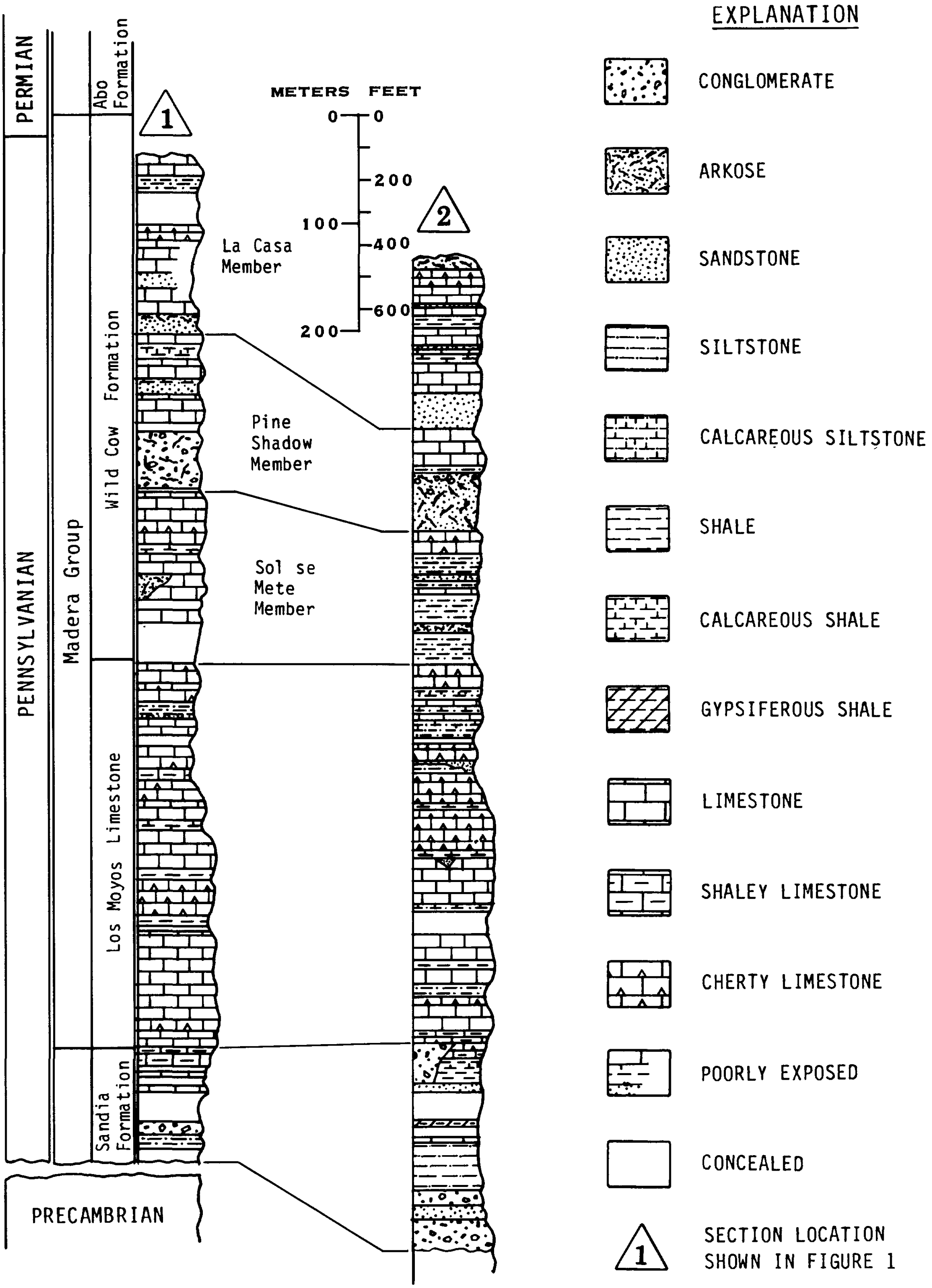


Figure 5.--Measured sections of Pennsylvanian and Permian rocks (modified from Myers, 1982, p. 235).

Immediately east of Monte Largo is South Mountain, a pluton of quartz monzonite emplaced during the Tertiary (fig. 4). During emplacement, stringers of quartz monzonite were injected between layers of adjacent sedimentary rock. Apparently, some landslide deposits occur on the southwestern flank of South Mountain. In the Edgewood embayment southeast of South Mountain (fig. 1), poorly developed karstic terrain is present.

The youngest materials in the study area are alluvial deposits of sand, silt, and gravel that have been washed into streambeds, and sand and silt that have been carried by wind and deposited on the land surface. Stream deposits in the southern part of the area commonly have formed where rocks at land surface have been faulted and are easily eroded (Titus, 1980, fig. 4). Valley-fill deposits are present in the Edgewood embayment, Estancia Basin, and Albuquerque-Belen Basin.

Recharge in the study area is entirely from precipitation. In the Sandia and Manzano Mountains area, ground water flows westward and eastward away from the crest lines (fig. 1). Water flowing westward probably enters fractures, eventually discharging at springs and to streams along the west face. Some or most of this water becomes recharge for the Albuquerque-Belen Basin. Water flowing eastward moves through relatively thin (usually 1 to 10 feet thick) soil zones and primarily into clastic and fractured carbonate units of the Pennsylvanian and Permian Madera Group that blanket the uppermost eastern mountain slopes.

In the southern one-half of the area, ground water typically flowed to the northwest, northeast, and east in 1984-85 (fig. 6). Seasonal ground-water-level changes are typically less than 100 feet on the basis of available data. Ground water moving to the northwest discharges to Tijeras Arroyo, whereas ground water moving to the northeast and east discharges to the Estancia Basin.

As ground water moves downslope through the Madera Group in the northern one-half of the area, it typically enters a sequence of eastward-dipping clastic and minor carbonate units ranging from the Permian Abo Formation to the Triassic Chinle Formation (fig. 4). Ground water then moves either southward toward Tijeras Arroyo or northward out of the area (fig. 6). From the South Mountain area, ground water moves either southward into the Estancia Basin or westward and northward out of the area. Titus (1980, fig. 16) showed the detailed flow pattern for the central part of the area.

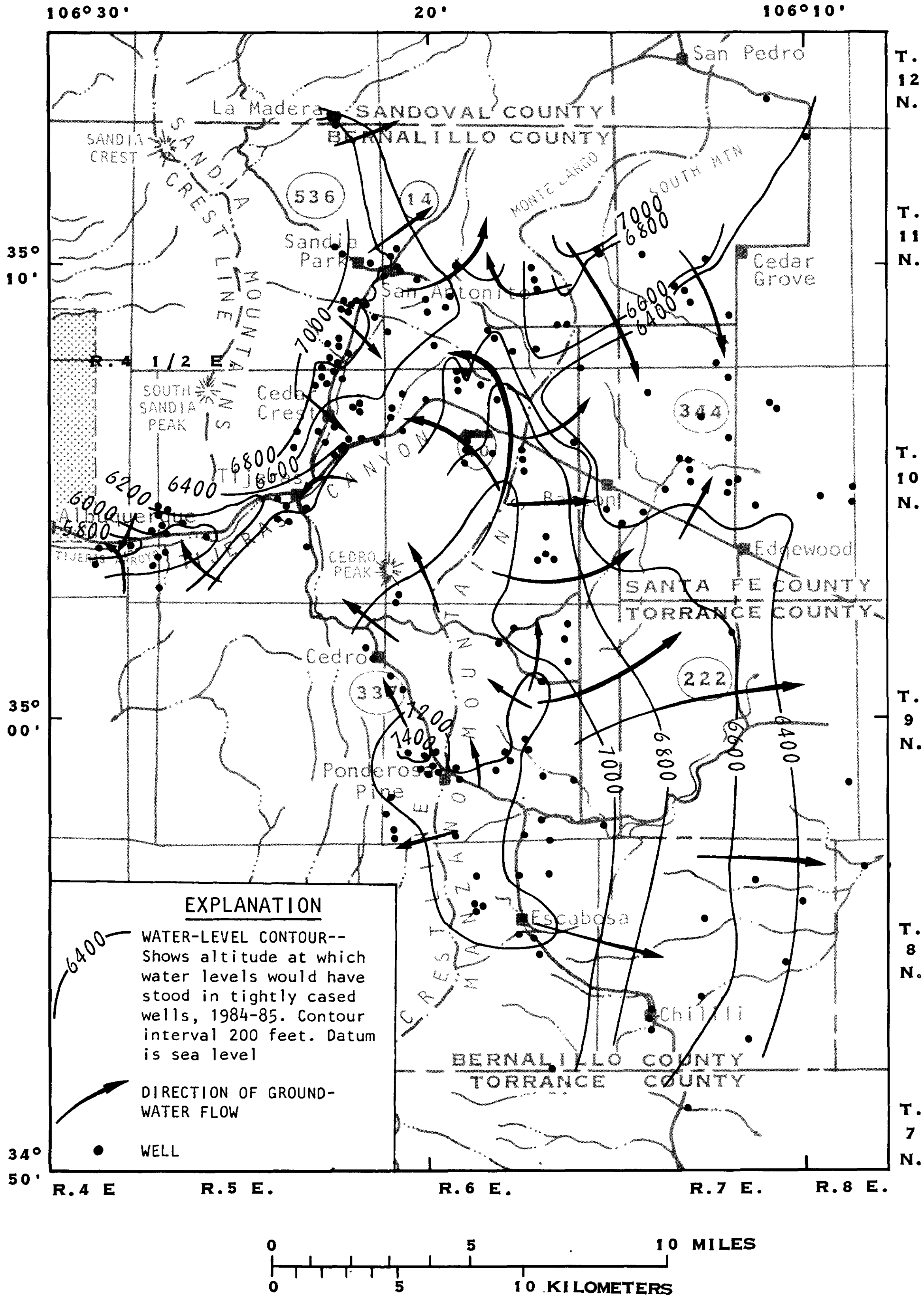


Figure 6.--Water-level contours and direction of ground-water flow in the study area, 1984-85.

GEOHYDROLOGY OF AREAS OF DETAILED STUDY

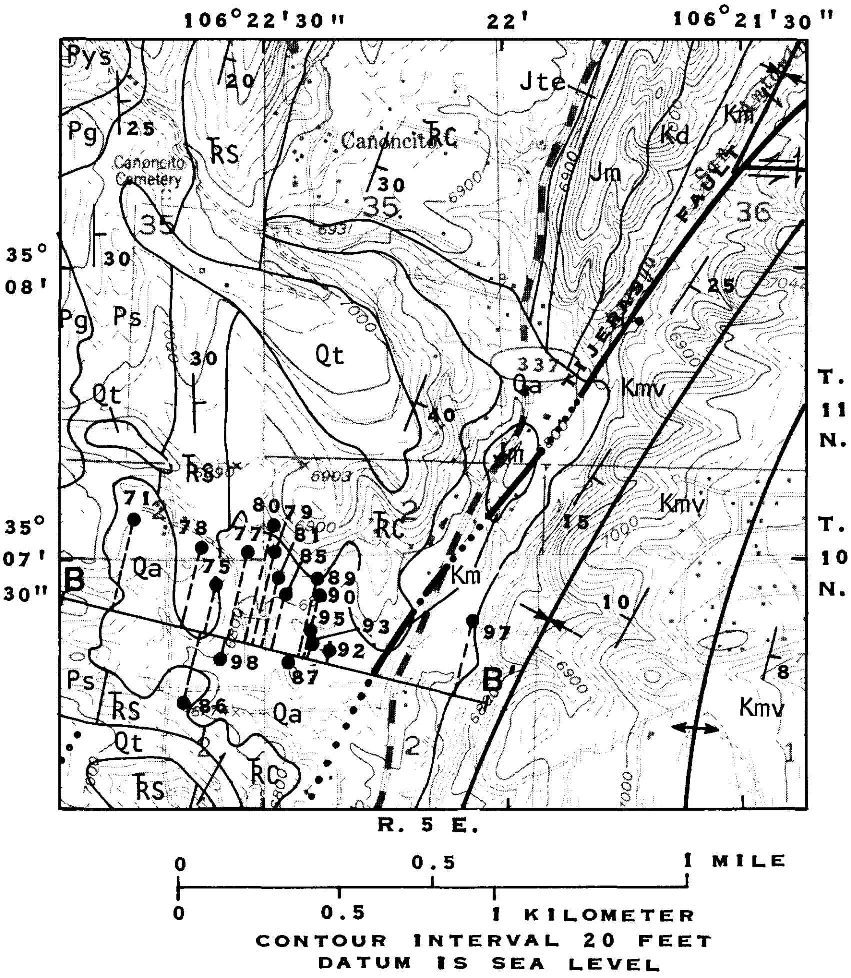
The entire study area could not be studied in detail because of the (1) large number of outcropping geologic units; (2) complex geological structure; (3) changes in water levels and direction of ground-water flow; and (4) substantial, localized changes in ground-water quality in the study area. Instead, the study area was divided into three regions on the basis of generalized types of outcropping units. The three regions have the following types of outcropping units: (1) clastic materials such as sandstone and shale; (2) Precambrian granitic and metamorphic rock eroded by alluvium-filled stream valleys; and (3) the predominantly carbonate sedimentary rocks of the Pennsylvanian and Permian Madera Group. A small area within each region was studied in detail. The geologic structure and stratigraphy of each area are similar to the geologic structure and stratigraphy throughout the region they represent.

Area 1

Area 1, chosen to represent the region where consolidated, clastic materials generally outcrop or subcrop, is approximately 2.3 square miles in area and is 3 miles north of Interstate 40 along New Mexico Highway 14 (figs. 1 and 7). A trailer park and at least 27 single-family dwellings with individual wells and septic systems are in the area. Most large-capacity wells in the area are on the western side of area 1. Water from these wells is piped to a subdivision that is in and adjacent to the southeastern part of the area.

Area 1 is on the eastward dip slope of the Sandia Mountains and contains outcrops and subcrops of a sequence of clastic and carbonate sedimentary rocks, ranging from the Permian San Ysidro Member of the Yeso Formation to the Cretaceous Mesaverde Group (figs. 7 and 8). Tijeras fault brings the Mancos Shale and Mesaverde Group into fault contact with Triassic, Jurassic, and Cretaceous units within area 1 (fig. 7). Ground-water flow generally is toward the east and southeast (fig. 6). Water levels in wells in area 1 typically are less than 100 feet below land surface (fig. 8).

Water levels were measured in selected wells in the southern part of area 1 by New Mexico State Engineer Office personnel in January and February of 1980 and 1981. The same wells were remeasured in 1984 as part of the current study. Water levels in most of these wells were similar or had risen by 1984, but water levels in wells 87 and 90 declined more than 30 feet (fig. 9).



EXPLANATION

Qa	ALLUVIUM
Qt	TERRACE DEPOSITS
Kmv	MESAVERDE GROUP
Km	MANCOS SHALE
Kd	DAKOTA SANDSTONE
Jm	MORRISON FORMATION
Jte	TODILTO LIMESTONE MEMBER OF WANAKAH FORMATION AND ENTRADA SANDSTONE
Ꞧc	CHINLE FORMATION
Ꞧs	SANTA ROSA SANDSTONE
Ps	SAN ANDRES FORMATION
Pg	GLORIETA SANDSTONE
Pys	YESO FORMATION, SAN YSIDRO MEMBER

HIGH-ANGLE FAULT--Dotted where concealed; bar and ball on downthrown side

B B' LINE OF SECTION

10 STRIKE AND DIP OF BEDS

AXIS OF SYNCLINE

AXIS OF ANTICLINE

CONTACT

●86 WELL AND WELL NUMBER FROM TABLE 5--All wells projected to section

Figure 7.--Geology of area 1 (modified from Kelley and Northrop, 1975, map 1).

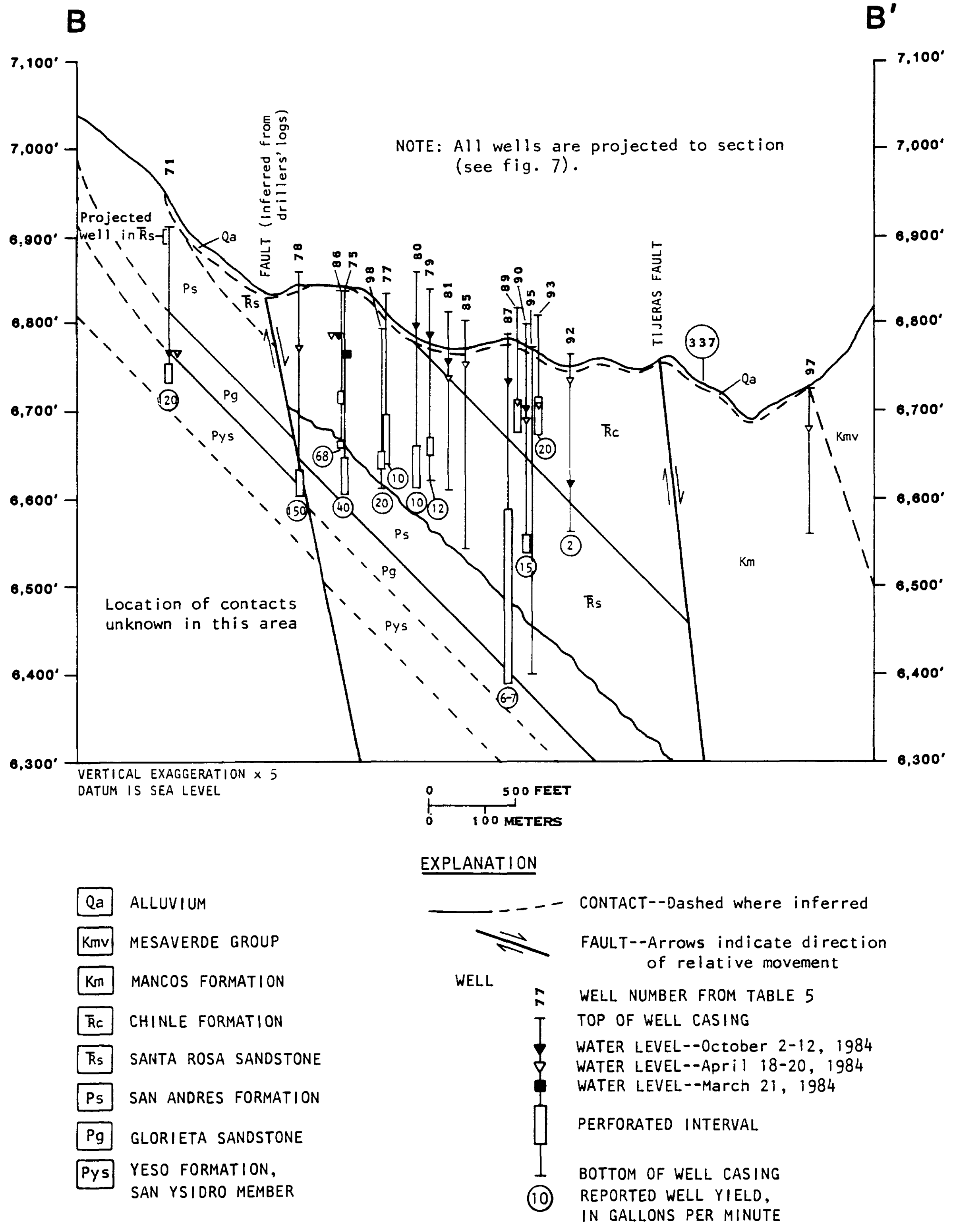


Figure 8.--Geohydrologic section B-B', area 1 (line of section shown in fig. 7).

During 1984, water levels were measured in March, April, and October in selected wells (fig. 8). The largest water-level change occurred in well 92. Water levels in that well were monitored by the U.S. Geological Survey and the well owner from April 1984 to July 1985 to document seasonal variations (fig. 10). Water levels in the well declined approximately 117 feet from April to October 1984. During October 1984, the well owner could not use the well, and a number of well owners in the vicinity reported that their wells were dry. By July 1985, water levels had almost recovered to April 1984 levels.

Yields appear to be greater for wells drilled near a fault on the western side of area 1 (fig. 8). This fault is inferred from drillers' logs and is an extension of a previously mapped fault, but was not confirmed at land surface. Yields of three wells in the vicinity of the fault range from 40 to 150 gallons per minute (wells 75, 86, and 78, fig. 8). These large-capacity wells are water-supply sources for a subdivision and for a trailer park. Well 87 (fig. 8), completed in rocks similar to those in which the three large-capacity wells are completed but approximately 1,000 feet downdip from the fault, reportedly yields only 6 to 7 gallons per minute.

Well yields cannot be compared statistically for several reasons. Some wells were constructed to provide water for water systems, whereas the majority of the wells were constructed to provide sufficient water only for domestic use. Drillers' logs generally are not detailed enough to precisely determine in which geologic unit a well was completed. Also, wells are completed in a wide variety of rock types so few wells are completed in any one of several water-yielding units. In area 1, each water-yielding unit has unique geohydrologic characteristics, making it difficult to generalize yields on the basis of rock type. Detailed fault maps of the area do not exist.

Fractures in the southwestern part of area 1 were mapped using aerial photographs to determine if there is a relation between well yields and fractures (fig. 11). In general, fractures do not appear to substantially enhance water yields in area 1.

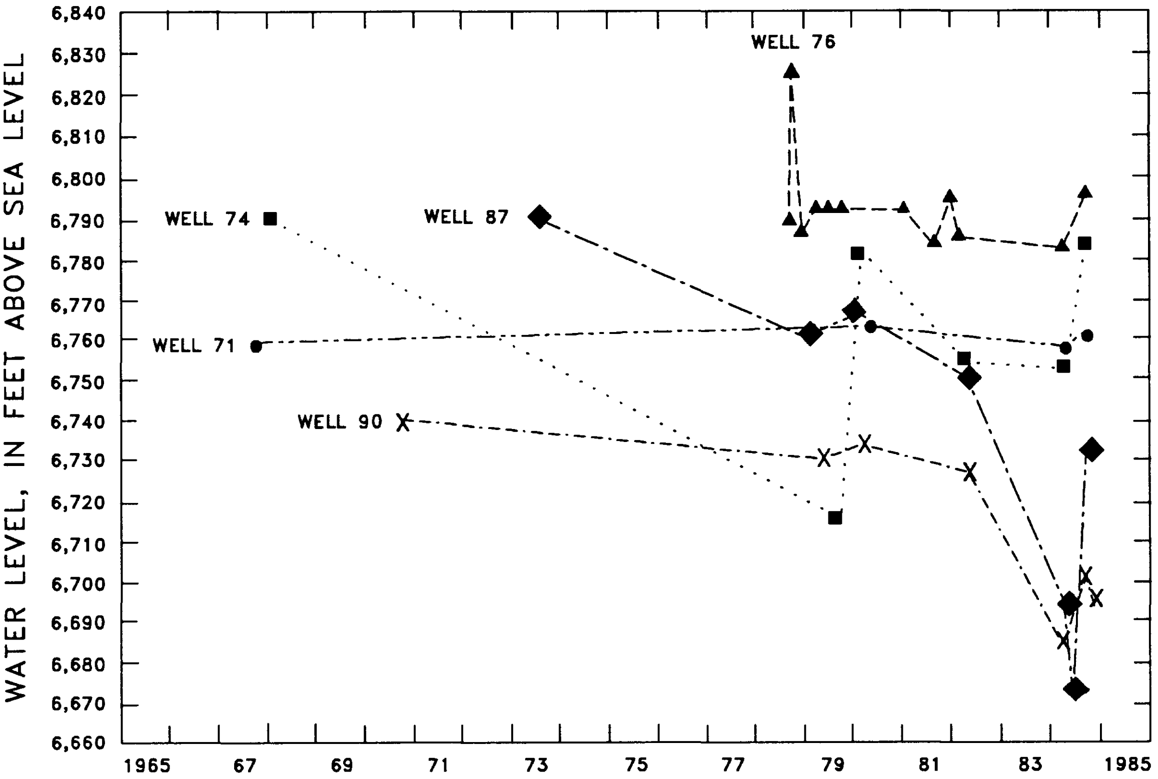
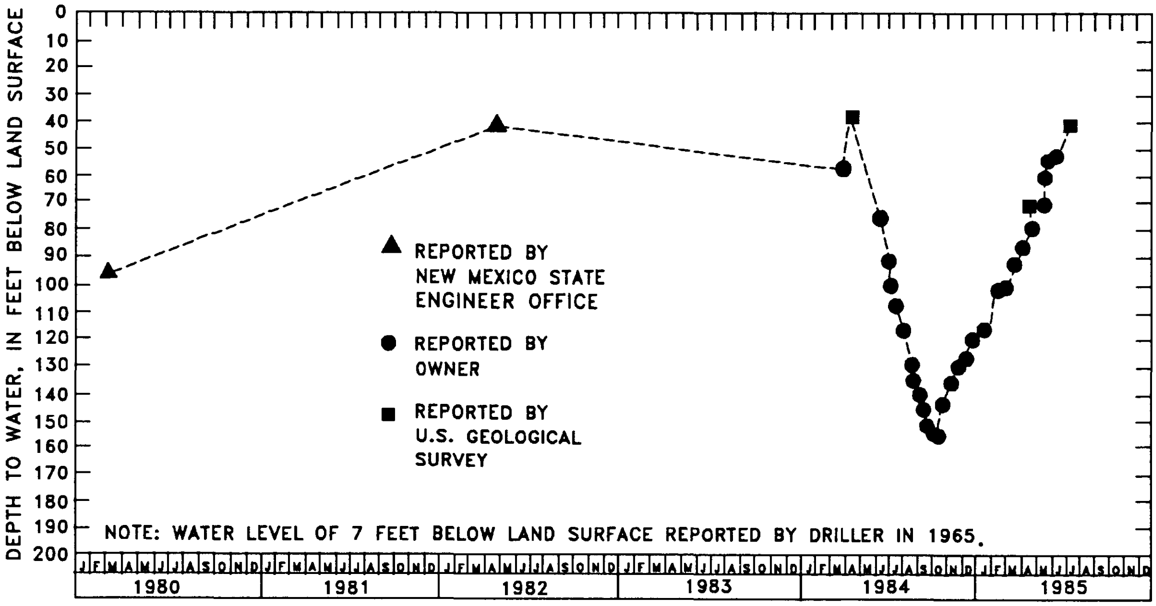
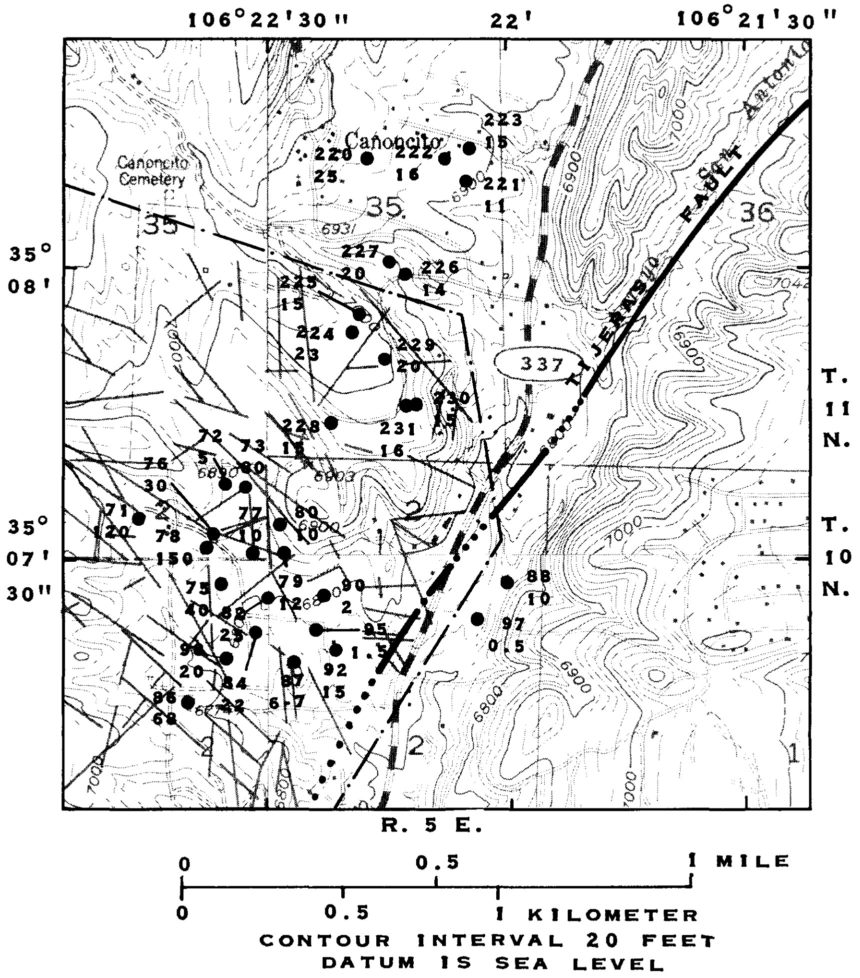


Figure 9.--Water levels in selected wells in area 1.



NOTE: WATER LEVEL OF 7 FEET BELOW LAND SURFACE REPORTED BY DRILLER IN 1965.

Figure 10.--Water-level data for well 92, 10N.5E.2.233A, February 1980 through July 1985.



EXPLANATION

/ FRACTURE TRACE--Mapped from aerial photography

—·—·— BOUNDARY OF AREA MAPPED FOR FRACTURES

● 86 68 WELL--Upper number is well number from table 5; lower number is reported well yield, in gallons per minute

Figure 11.--Fractures, well locations, and reported well yields in area 1.

Area 2

Area 2 was chosen to represent the region characterized by outcrops of Precambrian granite and metamorphic rock eroded by alluvium-filled stream valleys. Within the area, the Precambrian Sandia Granite (Kelley and Northrop, 1975), Precambrian metamorphic rocks, and various slope and streambed deposits crop out (fig. 12). Area 2 is an area of 5.4 square miles in Tijeras Canyon, 3 miles west and 1 mile south of the village of Tijeras (fig. 1).

All producing wells in area 2 are domestic wells that each provide water for one to five households. Area 2 includes the Monticello subdivision (fig. 12). Wells in area 2 typically are drilled to depths of 220 feet or less (fig. 13). Water levels generally conform to the land-surface slope except for a distance of about 1,000 feet north of U.S. Highway 66, where the hydraulic gradient, or slope, flattens. Fracture traces and water levels in area 2 are shown in figure 14. No relation between fracture traces and water levels or yields was found. Ground water appears to flow into the area from the northeast, east, and southeast and discharges to Tijeras Arroyo, which flows west.

Sufficient historical water-level data do not exist in areas 2 and 3 to determine changes in water levels over time. Detailed, historical water-level data are available only for area 1.

Area 3

Area 3, chosen to represent the region where the Pennsylvanian and Permian Madera Group generally crops out or subcrops, is 11.9 square miles in area and is 7 miles south and 3 miles east of the village of Tijeras along New Mexico Highway 337 (figs. 1 and 15). Area 3 includes the Tranquillo Pine and Ponderosa Pine subdivisions and is situated at the north end of the crest line of the Manzano Mountains. The Tranquillo Pine Water Users Cooperative gets its water from four production wells. Most residents in the Ponderosa Pine subdivision have domestic wells.

Water levels ranged from 23 to 375 feet below land surface in area 3 in 1984 (fig. 16). Water levels and producing zones in wells near a mapped fault were higher than in the rest of the area, indicating a vertical gradient. Water is produced from a variety of rock types including fractured limestone, sandstone, and thin shale layers. The vast majority of producing zones are in fractured limestone. These zones usually are about 1 foot thick.

Water levels in area 3 (fig. 17) are higher than in any surrounding area (fig. 6). Water-level data shown in figure 17 cannot be contoured because of the large vertical differences of water levels in wells completed to different depths. Area 3, especially the northern part of the area, is a recharge zone for the southern one-half of the entire study area.

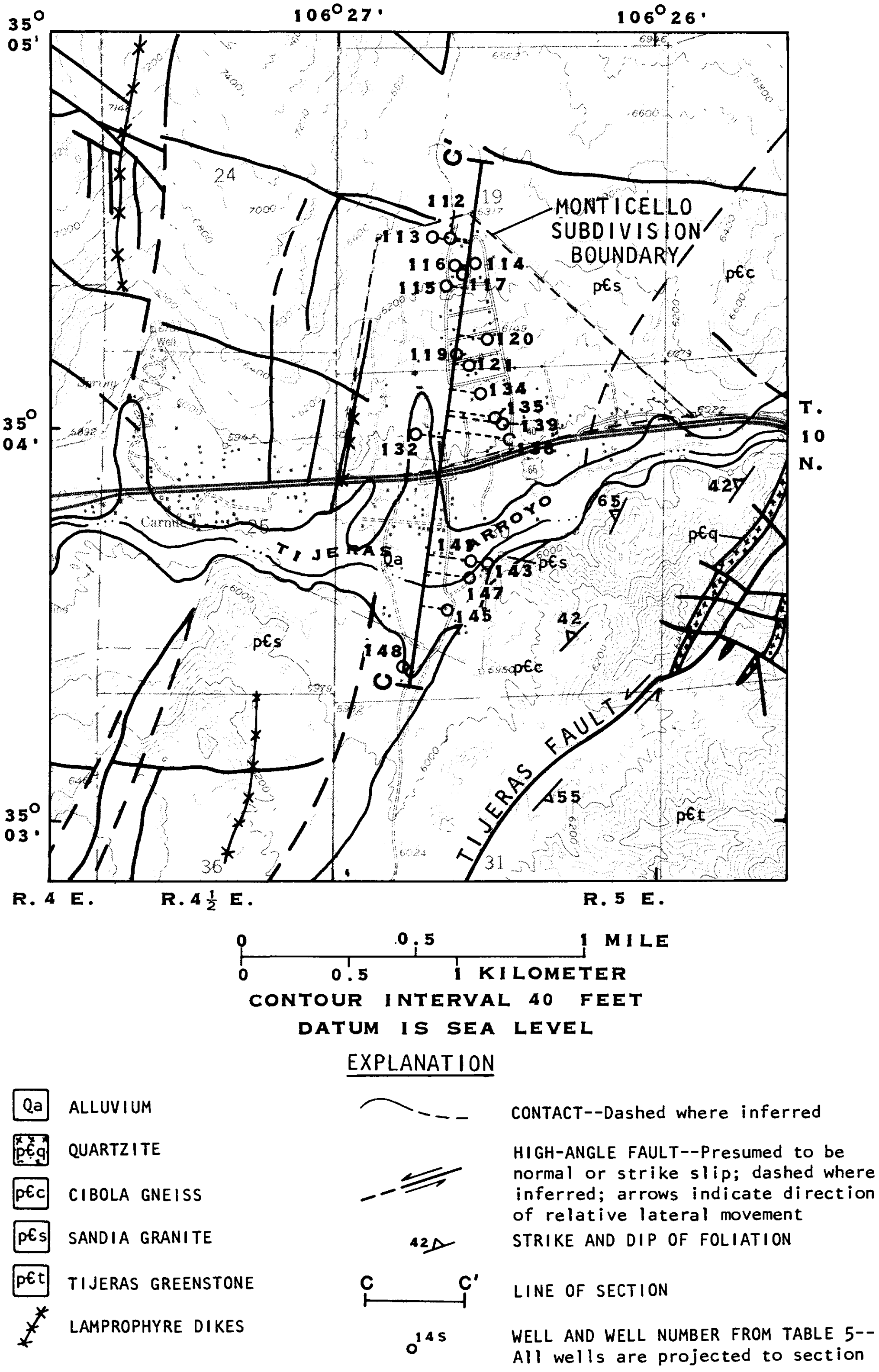


Figure 12.--Geology of area 2 (modified from Kelley and Northrop, 1975, map 1).

Because of limited availability of aerial photographic coverage, only fractures in the northwestern part of area 3 were mapped (fig. 18). Because similar rock types crop out throughout area 3 and because the entire area probably has been subjected to similar geologic stresses, it is probable that the density of fractures in the northwestern part of area 3 is indicative of fracturing throughout the area. These fractures appear to be poorly interconnected, as evidenced by the large variation in water levels (fig. 17) and well yields (fig. 19). Although studies in other areas have demonstrated a direct relation between faults and well yields in limestone (Lattman and Parizek, 1964, p. 78), sufficient data do not exist in area 3 to show such a relation.

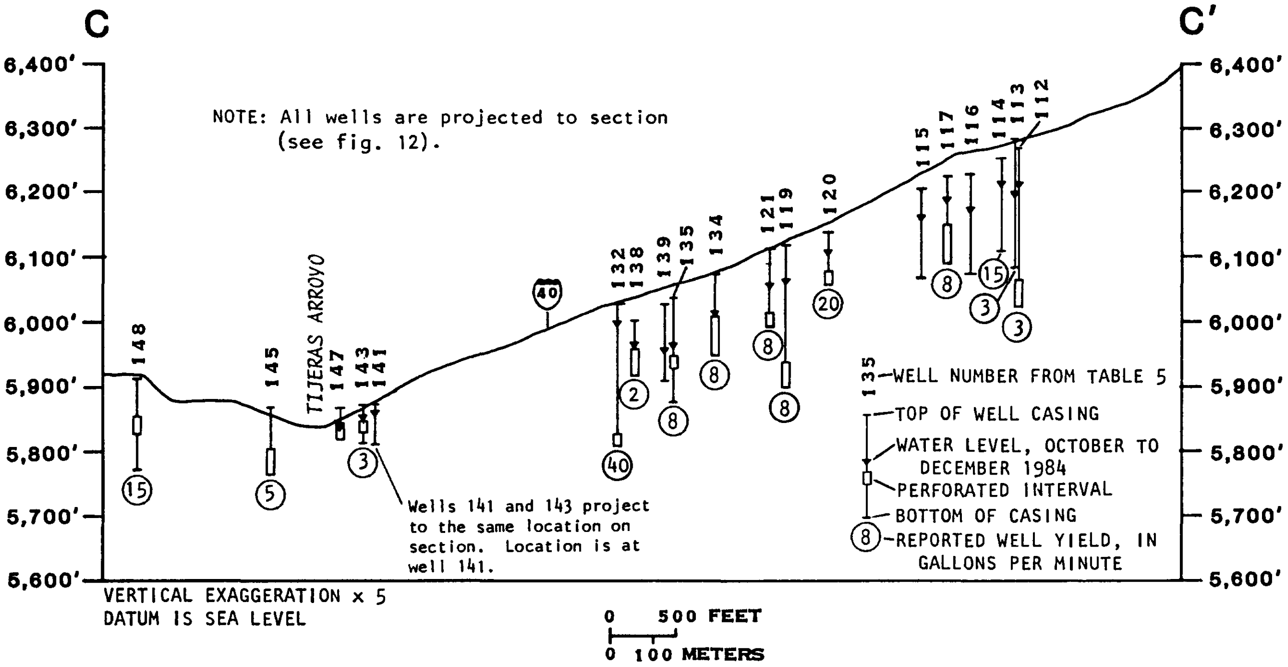
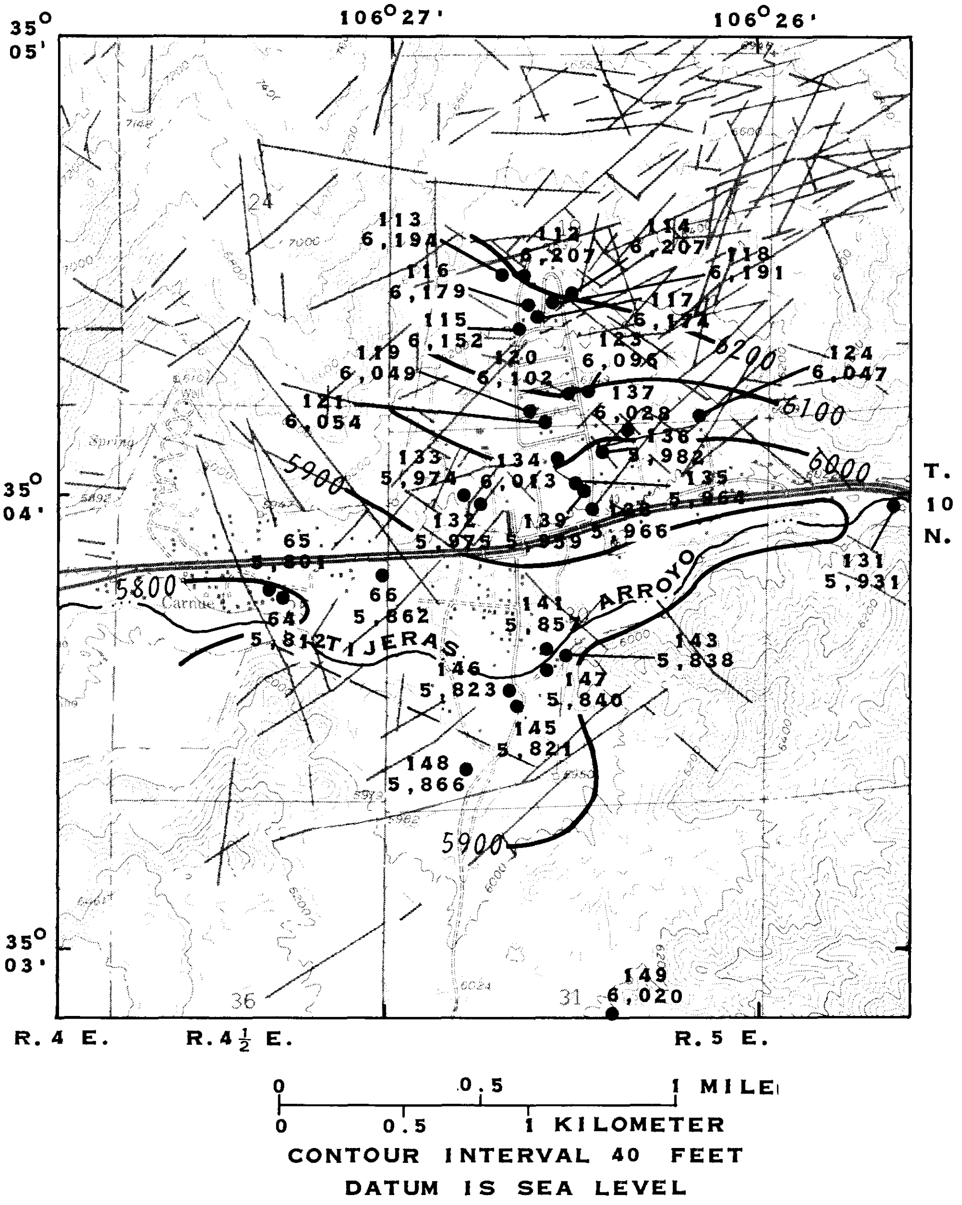


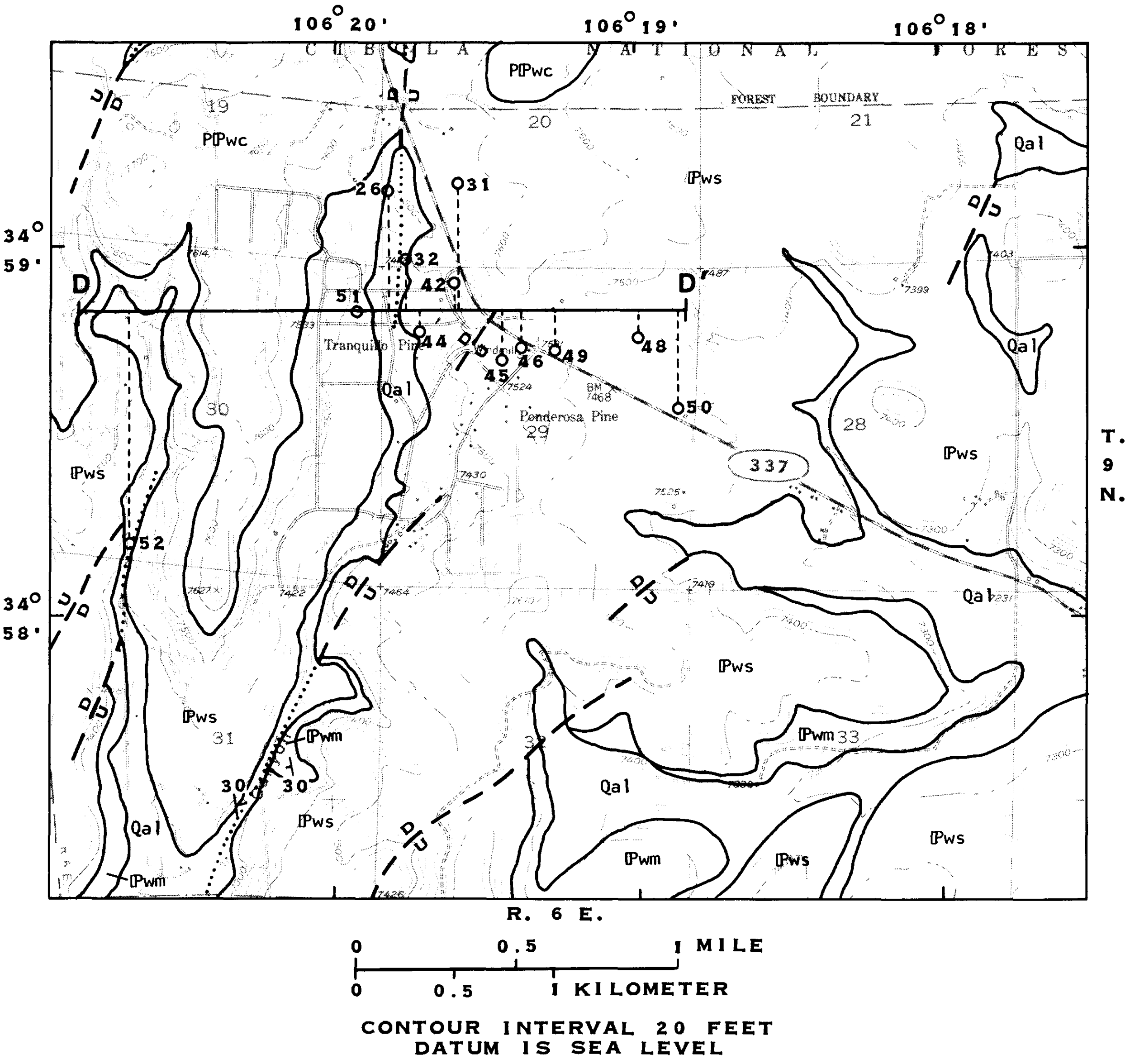
Figure 13.--Hydrologic section C-C', area 2 (line of section shown in fig. 12).



EXPLANATION

/	FRACTURE--Mapped from aerial photography
5800 ———	APPROXIMATE WATER-LEVEL CONTOUR--Shows altitude at which water levels would have stood in tightly cased wells, October to December, 1984. Datum is sea level. Contour interval 100 feet
● 149 6,020	WELL--Upper number is well number from table 5; lower number is altitude of water level, in feet above sea level

Figure 14.--Fractures, well locations, and water-level contours in area 2.



EXPLANATION

Qal ALLUVIUM

WILD COW FORMATION:

PIPwc LA CASA MEMBER

IPws PINE SHADOW MEMBER

IPwm SOL SE METE MEMBER

CONTACT

D/U FAULT--Approximately located; dotted where concealed; U, upthrown side; D, downthrown side

30 STRIKE AND DIP OF BEDS

D D' LINE OF SECTION

○ 48 WELL AND WELL NUMBER FROM TABLE 5

Figure 15.--Geology of area 3 (modified from Myers, 1969).

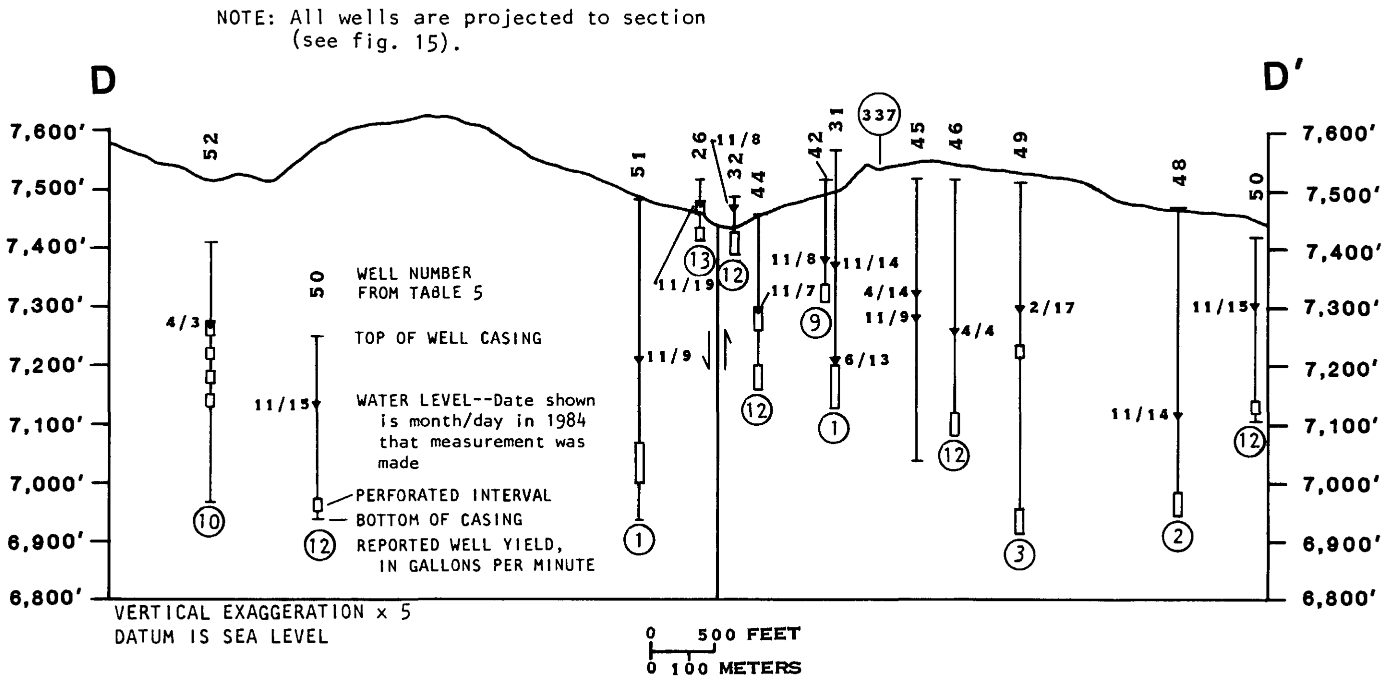
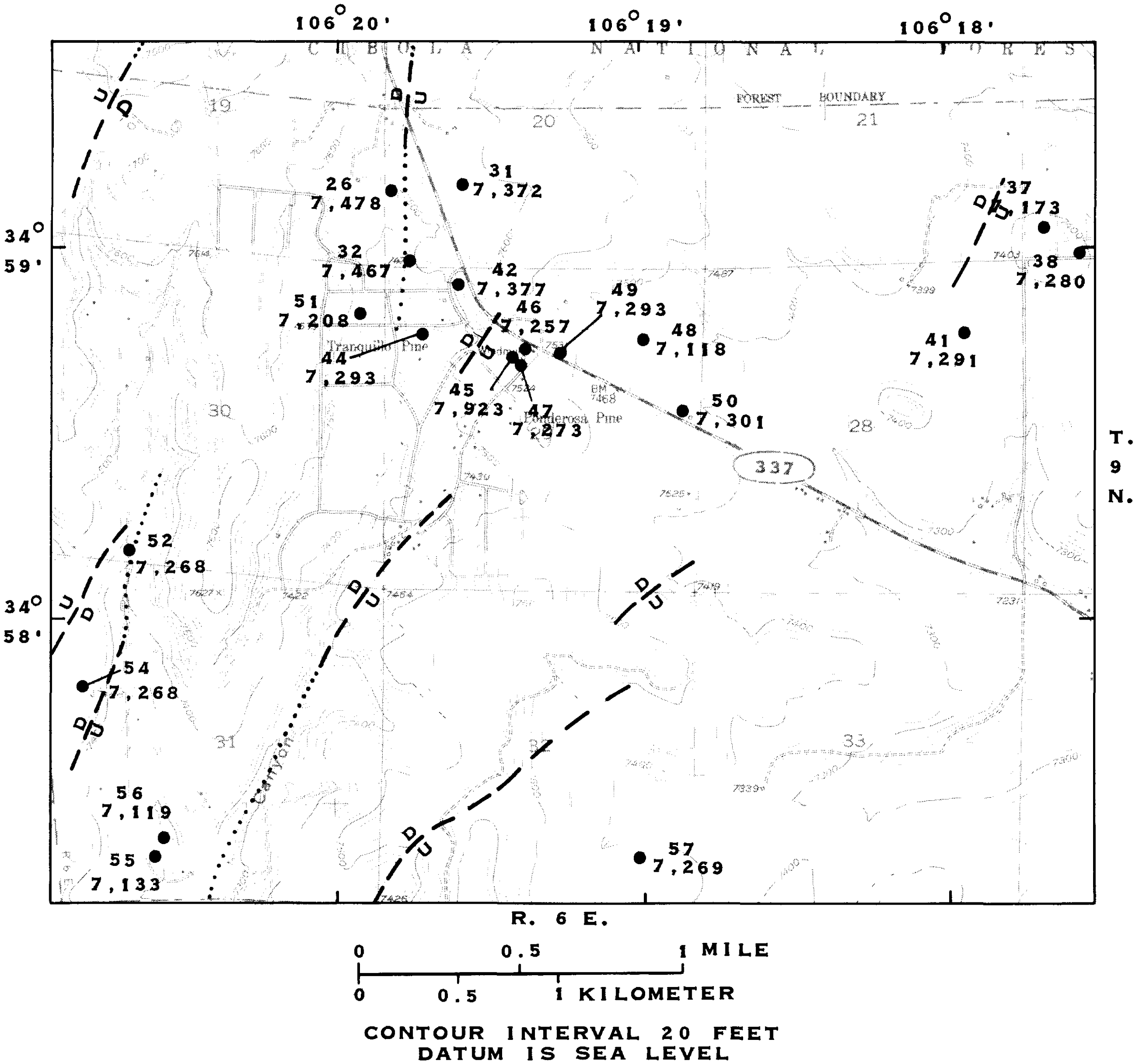


Figure 16.--Hydrologic section D-D', area 3 (line of section shown in fig. 15).

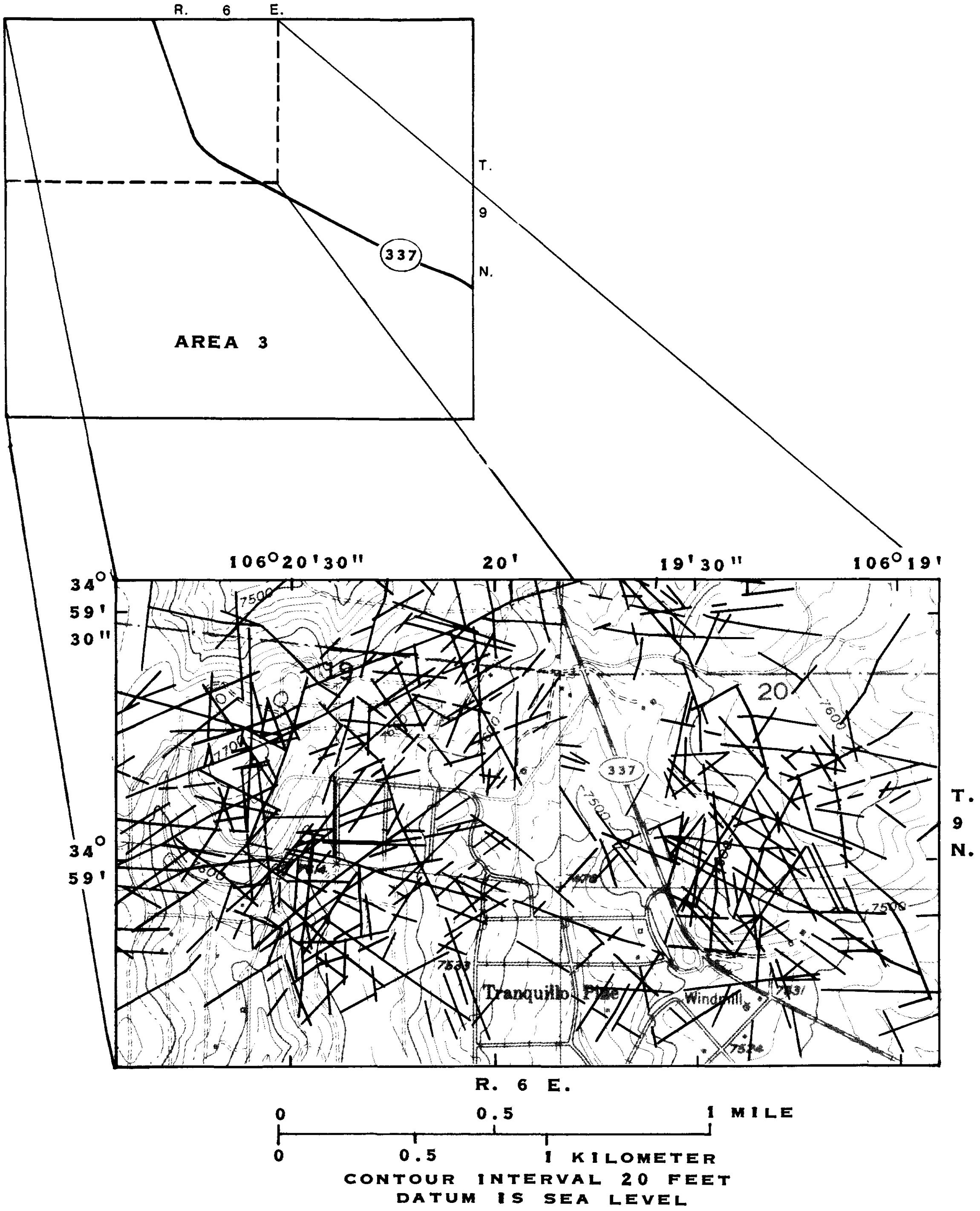


EXPLANATION

U D FAULT--Approximately located; dotted where concealed; U, upthrown side; D, downthrown side

● 55 7,133 WELL--Upper number is well number from table 5; lower number is altitude of water level, in feet above sea level

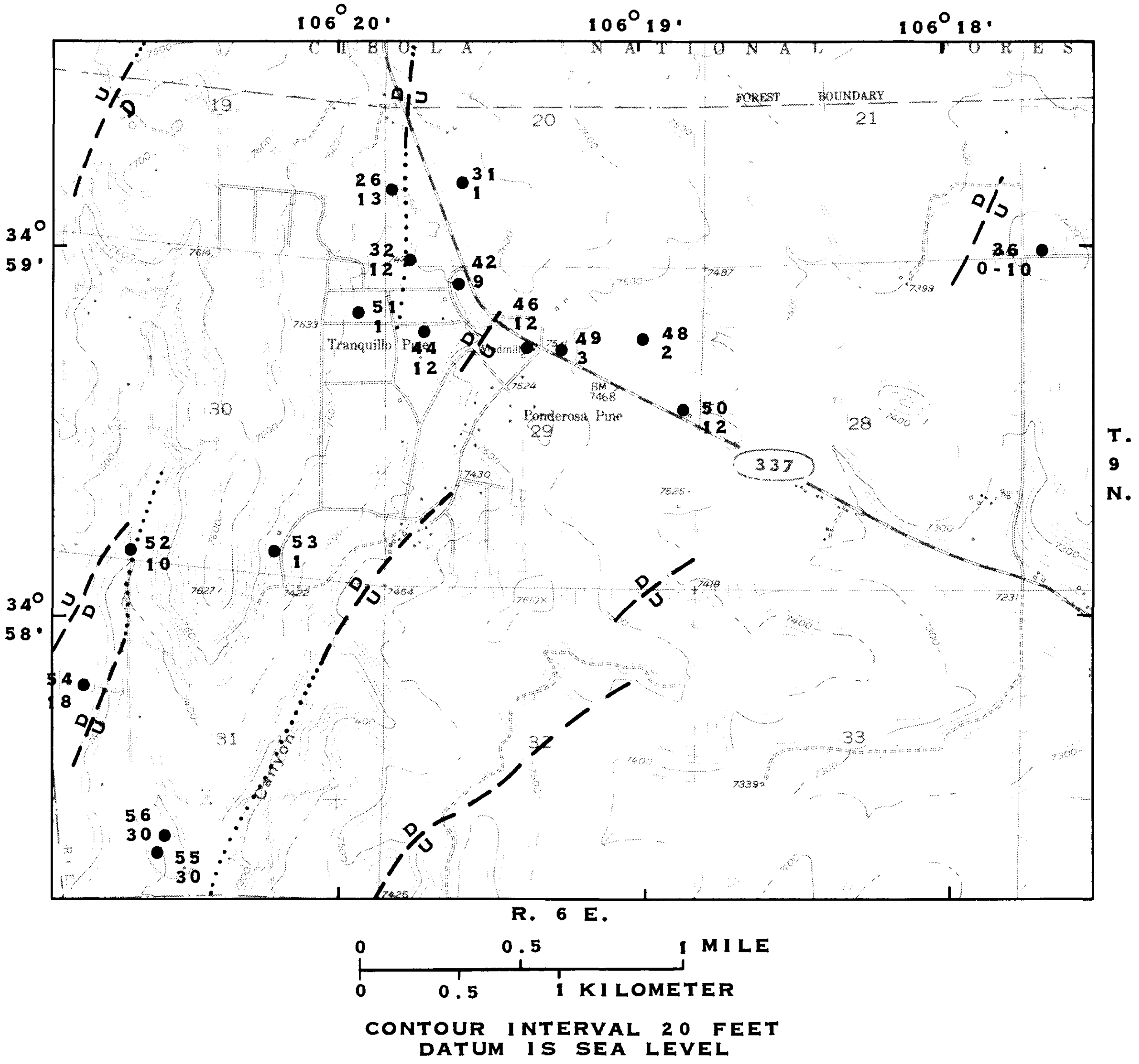
Figure 17.--Water-level altitudes in area 3, 1975-84 (geology from Myers, 1969)



EXPLANATION

/ FRACTURE TRACE--Mapped from aerial photography

Figure 18.--Fractures in the northwestern part of area 3.



EXPLANATION

U ....— D FAULT--Approximately located; dotted where concealed; U, upthrown side; D, downthrown side

● 55 30 WELL--Upper number is well number from table 5; lower number(s) is yield or range of yields, in gallons per minute

Figure 19.--Location of faults and reported well yields in area 3 (fault locations from Myers, 1969).

GROUND-WATER AVAILABILITY

Water-yielding units in the study area are composed of a variety of rock types that have undergone moderate to intensive faulting, creating large local variations in well yield. Reported well yields from the late 1950's and early 1960's ranged from zero (dry hole) (Titus, 1980, p. 33-35) to 1,470 gallons per minute (Titus, 1980, p. 13).

Declines in water levels between 1950 and 1985 have occurred in localized areas. Wells in these areas typically are completed in shale that produces relatively small quantities of water.

Seasonal ground-water fluctuations have created periods of ground-water shortage. During the summer and early fall of 1984, well owners reported that several wells in the Cedar Crest area (fig. 1) went dry. Seven to 9 months after maximum water-level declines, wells in the area were again producing.

Information on well yields from selected wells obtained from drillers or well owners is summarized in table 1 and discussed below. Wells were selected if information was available on well completion and if they were primarily (or only) open to water-yielding units of one lithology within a geologic formation. Because Titus (1980) reported only the geologic unit that wells were completed in and not the type of rock, only well information obtained during the present study is included in table 1.

Clastic Rock Represented by Area 1

The most used water-yielding units in the study area are the Chinle Formation and the Santa Rosa Sandstone of Triassic age (fig. 4) such as are found in area 1 (fig. 7). The average yield of 14 wells completed in these units was about 15 gallons per minute. Triassic rocks, such as the Santa Rosa Sandstone, have been extensively developed for domestic water supplies, partly because they subcrop along established roadways, and because of relatively consistent yields. Porosity in these rocks is intergranular (between grains) as well as secondary (faults and fractures).

Large yields have been reported for wells completed in other units in the region represented by area 1. Yields as large as 150 gallons per minute have been reported for wells completed in the Permian San Ysidro Member of the Yeso Formation (well 78, fig. 8). Yields of 100 gallons per minute have been reported for a well completed in the Permian Abo Formation (Kim Fraser, New Mexico State Engineer Office, Albuquerque, oral commun., 1985).

Precambrian Rock and Quaternary Alluvium Represented by Area 2

A large variety of Precambrian granitic and metamorphic rocks, such as in area 2, crop out in the study area. Ground water occurs in fractures and faults in Precambrian rock. The average yield of 13 wells completed in fractured Precambrian rocks was 15 gallons per minute.

Table 1.—Summary of reported yields from selected wells in the study area

Geologic unit or area	Lithology of water-yielding unit	Number of wells	Yield (gallons per minute) Range	Average
Clastic rock				
Mesaverde Group	Shale and sandstone	3	0.5 - 10	5
Mancos Shale	Shale	4	0.5 - 6	4
Morrison Formation	Sandstone, clay, and limestone	3	4 - 80	40
Chinle Formation	Shale	5	10 - 23	15
Santa Rosa Sandstone	Sandstone	9	2 - 25	15
San Andres Formation	Limestone	2	3 - 40	21
Abo Formation	Sandstone	3	15 - 20	18
Igneous and metamorphic rock and alluvium				
Alluvium	Sand, silt, and gravel	7	3 - 18	9
Precambrian	Fractured, igneous, and metamorphic rock	13	2 - 37.5	15
Carbonate rock				
Madera Group:				
Barton trough area	Shale	4	0.5 - 10	5
	Sand and gravel	1	-	0.5
	Unknown	5	1.5 - 7	4
Edgewood embayment	Fractured limestone	8	8 - 250	72
	Sandstone and clay	2	15 - 75	64
	Unknown	5	6 - 50	24
All other areas	Fractured limestone	26	1 - 49	9
	Sandstone	6	1 - 12	6
	Unknown	18	1.5 - 37	12

Quaternary alluvial material is present primarily along and within Tijeras Arroyo. The average yield of seven wells completed in alluvium was 9 gallons per minute.

Madera Group Represented by Area 3

Gray limestone units, such as are present in area 3, comprise the largest water-yielding units where the Madera Group is present. Ground water is stored in faults and solution channels. Fractures do not appear to store large amounts of ground water. Yields of wells completed in fractured limestone units are highly variable but average about 9 gallons per minute. Six wells drilled in the Madera Group and completed in sandstone units had an average yield of about 6 gallons per minute. Yields of wells completed in units of the Madera Group range from 1 to 20 gallons per minute, but numerous dry holes have been described (Titus, 1980, p. 33-34).

In contrast to reported yields for wells in the majority of the area where the Madera Group is present, very large yields have been reported for wells completed in the Madera Group in the southeastern part of the study area. Titus (1980, p. 13) stated that a well "has reportedly been test pumped at 1,470 gallons per minute, and two other wells yield 450 and 120 gallons per minute."

In the southern one-half of the study area, where water availability is highly variable, it is not uncommon for dry wells to be drilled adjacent to and deeper than wells that produce 5 to 20 gallons per minute. Well yield is dependent on the penetration of fractures that transmit or store water.

Wells in the vicinity of Barton (fig. 1) are producing water from black shale that forms the upper part of the Madera Group (figs. 4 and 5). In this area, yields of 10 wells completed in all types of rocks average about 4 gallons per minute and range from 0.5 to 10 gallons per minute.

In the Edgewood embayment (fig. 1), the average yield of 15 wells drilled in the Madera Group ranged from 24 to 72 gallons per minute, substantially greater than the average of 6 to 12 gallons per minute for wells drilled in the Madera Group in most other areas. Well yields are especially large in the northwestern part of the embayment, averaging approximately 72 gallons per minute. Fractured limestone is the principal water-yielding unit in this area.

Changes in Water Levels

Water levels in several wells measured during the late 1950's and early 1960's were measured again for this study (table 2). Water levels in these wells have not changed substantially except in the vicinity of Barton, the Tijeras basin, and the vicinity of Edgewood.

Table 2.--Water levels in selected wells reported by Titus (1980) and measured during the current study

[--, not available]

Well number	Well owner(s)	Well depth (feet)	Water level		
			Date	Depth to water (feet below land surface)	Change (feet)
1	Dan F. Brinkley	100	- -63	80R[1]	--
		100	02-15-84	73.8	[2]+6.2
20	Earnest A. Dow	86	09-27-63	36.8	--
		81	06-07-85	21.6	+15.2
70	C.H. Carder	500	10-21-60	70.9	--
	Ron Morris	375+	12-07-84	72.5	-1.6
104	D.M. Bush	140	06-05-62	96.4	--
	James J. Carnes	142	09-25-84	129.7	-33.3
111	Charles Hobby	118	- -62	12R	--
		118	04-06-84	30.0	-18
114	Fred S. Leib	146	06-13-62	49.8	--
		146	10-19-84	46.5	+3.3
164	T.O. Harrell	485	--	410R	--
		485	04-27-85	439R	-29
171	K.D. Stout	329	03-15-50	142.4	--
	D.M. Bush	329	09-24-84	296.1	-153.7
181	Elmer Bassett	203	04-27-50	148.4	--
		203	05-09-85	151.3	-2.9
201	Donald Huston	200	03-05-64	151.3	--
		200	05-07-85	Dry part of year	-48.7
238	W.A. Arias	136	07-06-62	83.0	--
	Mike Arias	136	12-12-84	77.3	+5.7
267	Fernando Nieto	160	07-02-62	108	--
		160	08-21-84	108.7	-0.7

---

[1] "R" indicates a reported depth to water.
[2] A positive value indicates a water-level rise.

Large water-level declines were measured in wells that may be completed in fine-grained material such as shale. The ground-water level declined 153.7 feet between 1950 and 1984 in well 171 (table 2), which is in the vicinity of the Barton trough. Possibly this well is completed in a fine-grained rock such as shale. Titus (1980, p. 52) reported that water from the well had a "potability problem" that is typical for water from shale. Wells in the vicinity are completed in black shale. Water from well 164, in the Barton trough, also had a potability problem (Titus, 1980, p. 51), and the water level in this well had a reported decline of 29 feet from the early 1960's (Titus gave no date for the reported water level in this well) to 1985 (table 2). The water level in well 104, completed in the Mancos Shale in the Tijeras basin, had 33.3 feet of decline between 1962 and 1984.

Water levels in the remainder of the remeasured wells have remained about the same or have risen. An increase in water level of 15.2 feet occurred between 1963 and 1985 in well 20. This well is no longer in use, but in 1963 the measured water level may have been obtained after the well was pumped.

Precipitation in the study area increases with altitude. Annual precipitation since 1950 for Sandia Crest, Sandia Park (fig. 1), and the Albuquerque Airport are shown in figure 20. Annual rainfall at the Albuquerque Airport (about 7 miles west of the study area) is included as a comparison of rainfall at lower altitudes away from the mountain areas of Sandia Crest and Sandia Park. The mean annual precipitation at Sandia Crest (altitude 10,675 feet) from 1954 to 1978 was about 23 inches. The 1950 to 1983 mean annual precipitation at Sandia Park (altitude 7,130 feet) was about 18 inches. The 1950 to 1984 mean annual precipitation at the Albuquerque Airport (altitude 5,311 feet) was about 8 inches. Precipitation-data collection was terminated at Sandia Crest in 1979. Data collection at Sandia Park is continuing but has been interrupted for several months at a time since 1984.

Water-level fluctuations in the Sandia Park area (fig. 1) appear to be dependent on fluctuations in the amount of precipitation that has fallen in the area. A comparison between annual precipitation at Sandia Park and instantaneous depth to water in a well at the Bernalillo County Fire Station No. 6 (well 239) is shown in figure 21. The well is 1.2 miles east and 0.4 mile south of Sandia Park. Increases in precipitation seem to have been followed by rises in ground-water levels. The lag time between the two appears to be roughly 2½ years. Other factors, such as pumpage from wells near the observation well, could have influenced the water levels. The apparent correlation at this site cannot be extended to other areas without further study.

The apparent correlation between increases in precipitation and rises in ground-water levels indicates that variability in precipitation may have an effect on long-range ground-water availability. As ground-water withdrawals continue or increase, the effect of potential future declines in precipitation (and recharge) and associated declines in water levels could become increasingly significant. Wells that were producing could go dry and would have to be deepened or abandoned. If precipitation-data collection were resumed at Sandia Crest, and if an increased number of weather stations were established throughout the area, the precipitation distribution and probable distribution of recharge for the area could be better determined.

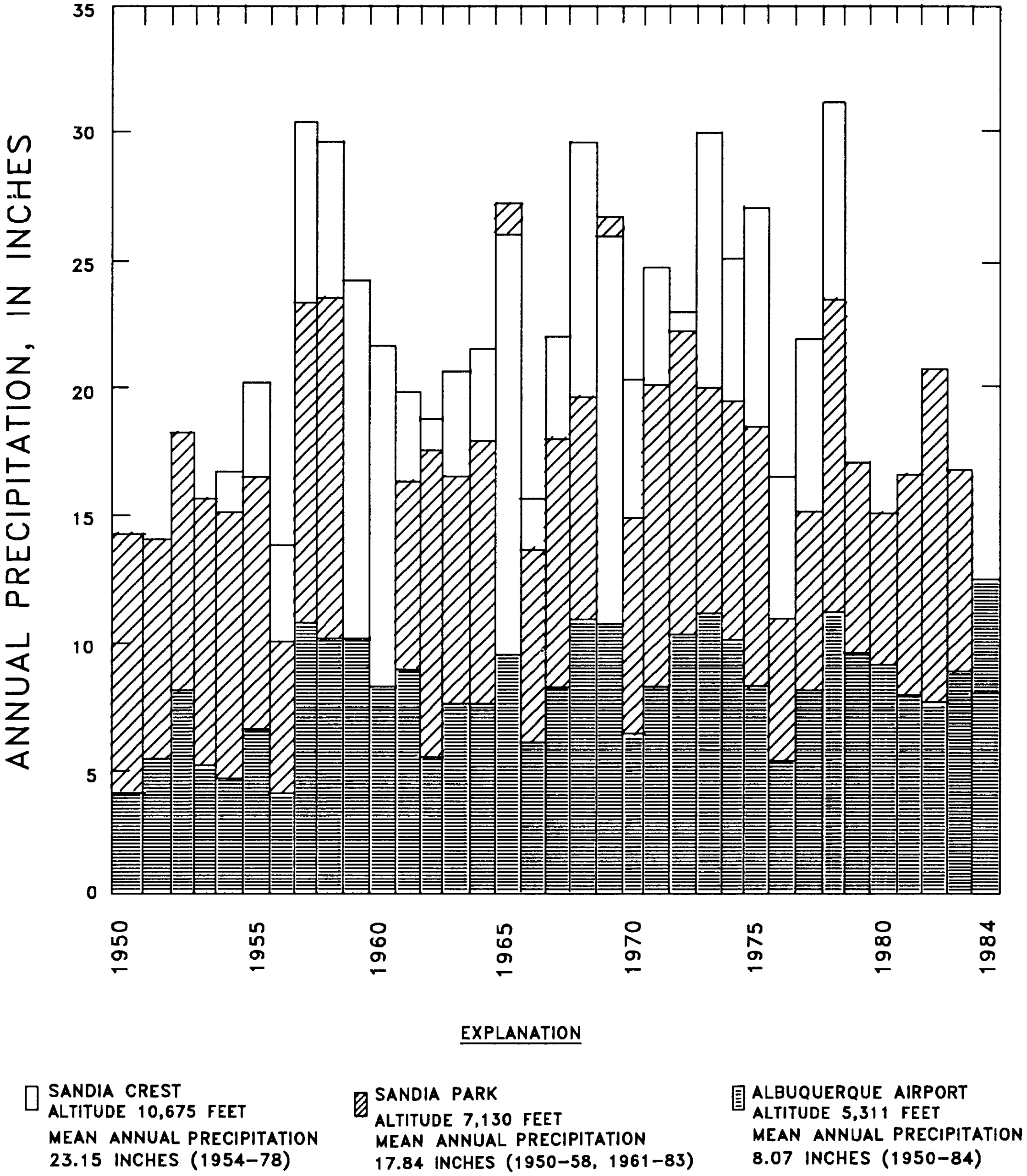


Figure 20.--Annual precipitation at Sandia Crest (1954-78), Sandia Park (1950-58, 1961-83), and Albuquerque Airport (1950-84).

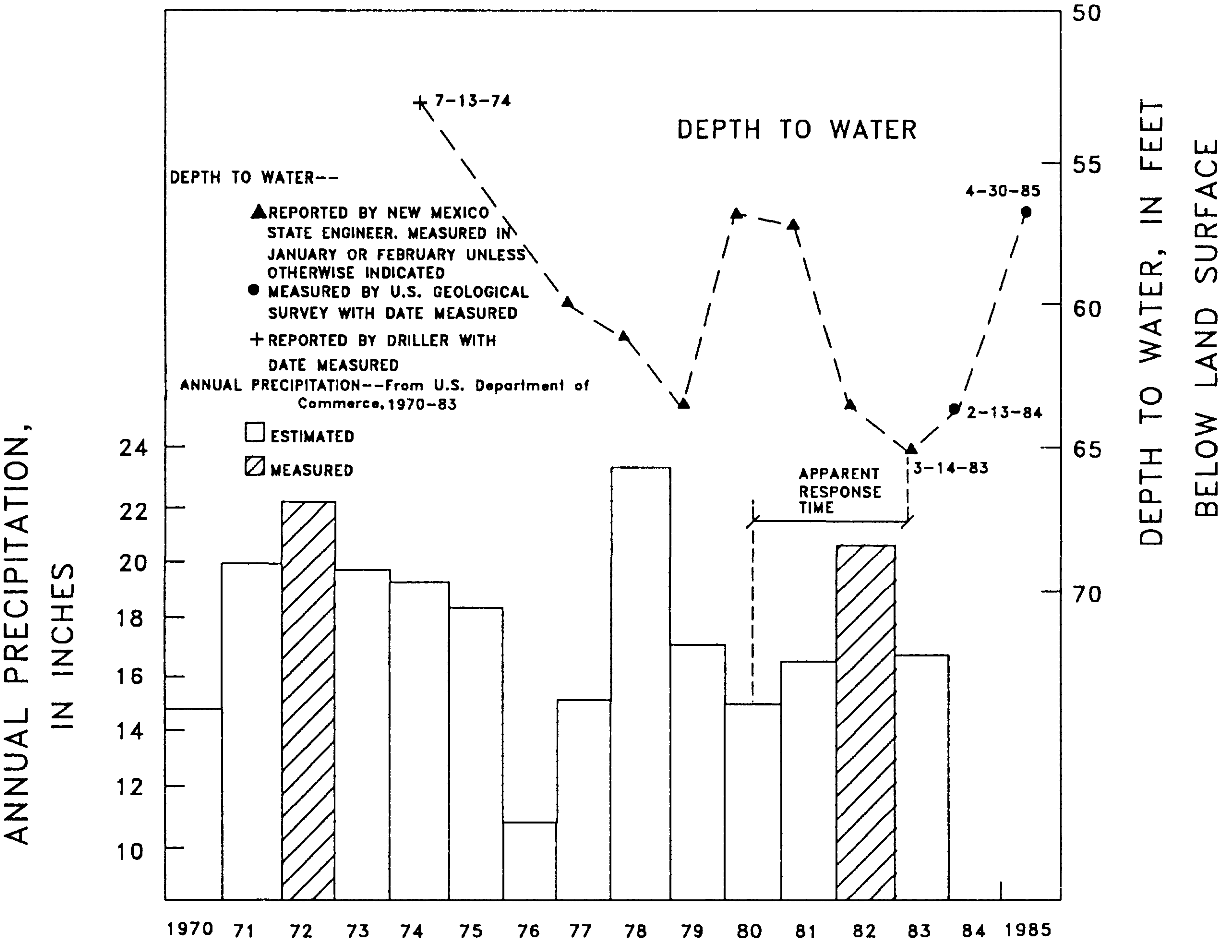


Figure 21.--Annual precipitation at Sandia Park (1970-83), and depth to water in well 239 (1974-85).

GROUND-WATER QUALITY

Onsite analyses of specific conductance and pH were made at most wells where water levels were measured. Water samples were collected from wells throughout the area to determine concentrations of nitrate or fluoride. Concentrations of nitrate and fluoride were compared to Environmental Protection Agency maximum and secondary maximum contaminant levels (U.S. Environmental Protection Agency, 1986a and b). Changes in nitrate and fluoride concentrations since the late 1950's and early 1960's also were determined.

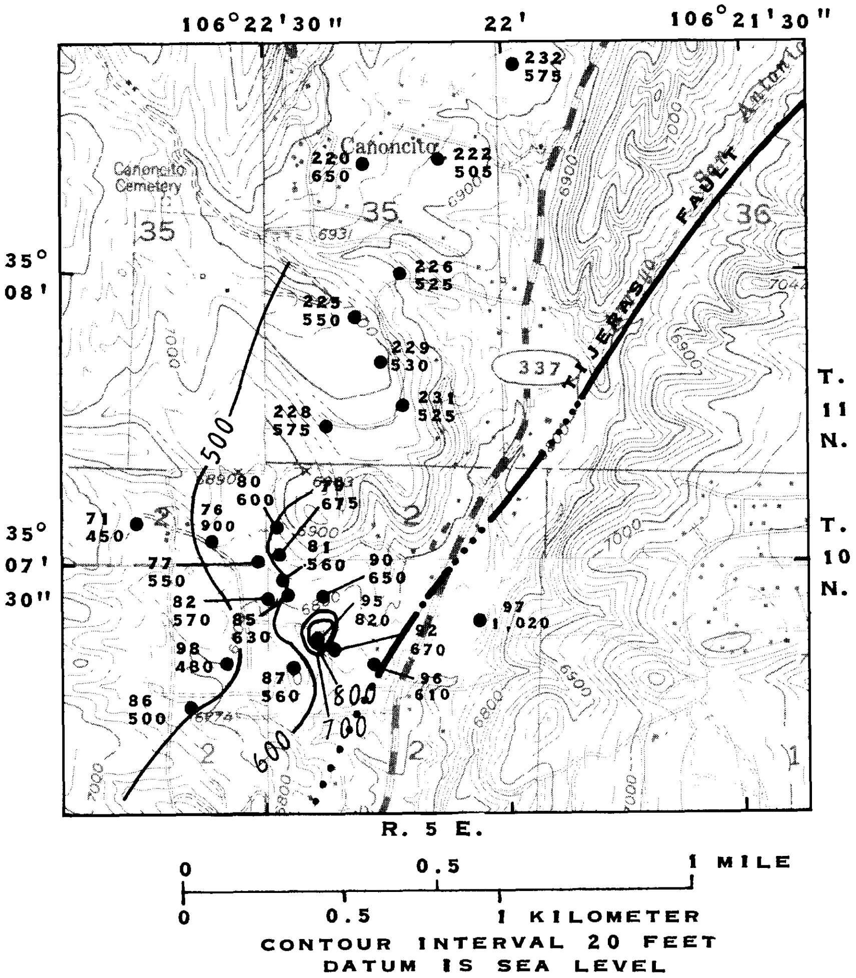
Indicators of Direction of Ground-Water Flow

Specific conductance (a measure of the water's ability to conduct an electrical charge) and pH (a measure of hydrogen ion activity) were measured in water from selected wells and were used to confirm ground-water-flow directions determined from water-level maps.

In area 1, specific conductance, which has a direct relation to the amount of dissolved solids (Hem, 1985, p. 67), ranges from 450 microsiemens per centimeter at 25 degrees Celsius on the area's west side to 1,020 microsiemens per centimeter near Tijeras fault on the east side (fig. 22). Hem (1985, p. 69) related that researchers have "reported conductivities of melted snow in the Western United States ranging from about 2 to 42 [microsiemens per centimeter]." Because precipitation is the source of recharge in the study area, small values of specific conductance generally indicate ground water that is near a recharge zone. Specific conductance increases downslope to the east and southeast in the direction of ground-water flow determined from ground-water-level measurements. Specific conductance increases in the direction of ground-water flow because as ground water slowly moves through the ground, progressively larger amounts of minerals and salts dissolve in the water. Increasing amounts of dissolved minerals and salts in the ground water increases the water's specific conductance.

West of Tijeras fault, specific conductance does not appear to be related to any specific water-yielding unit, indicating a high degree of hydraulic connection between units. Sufficient data are not available east of Tijeras fault to determine trends in specific conductance.

Within area 2, specific conductance generally increases with increasing proximity to Tijeras Arroyo (fig. 23). Near the arroyo, specific conductance also increases westward in the downstream direction of flow. In the Monticello subdivision, specific conductance generally increases southwestward from 550 to 980 microsiemens per centimeter (fig. 23), although the ground-water-flow direction determined from water-level measurements is generally southward. Specific-conductance values indicate ground water is moving into Monticello subdivision from the northeast as well as from the north. Within the Tijeras Arroyo flood plain, specific conductance ranges from 885 to 1,840 microsiemens per centimeter. No relation between specific conductance and sampling depth could be determined within area 2.

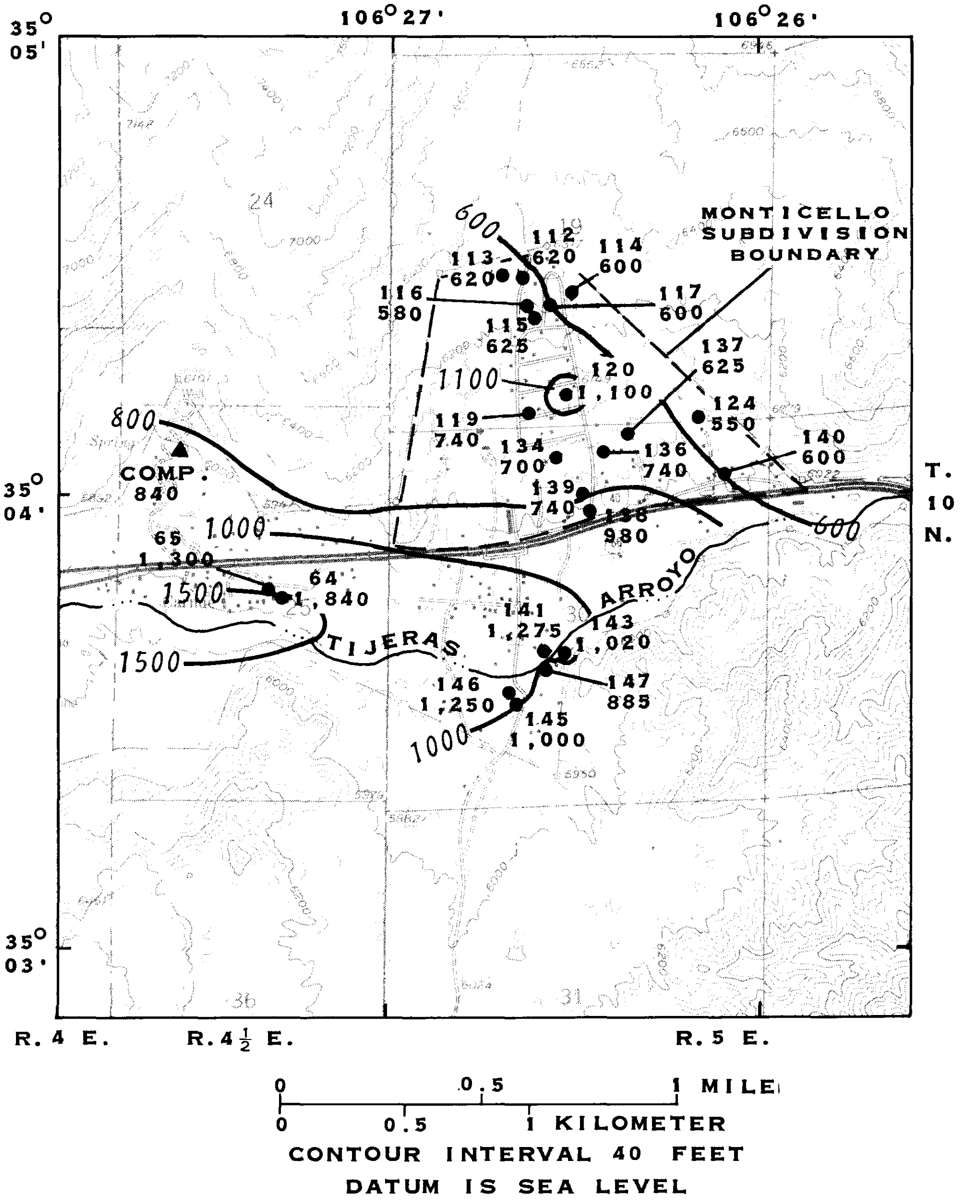


EXPLANATION

—500— APPROXIMATE LINE OF EQUAL SPECIFIC CONDUCTANCE--Interval 100 microsiemens per centimeter at 25 degrees Celsius

● 86 500 WELL--Upper number is well number from table 5; lower number is specific conductance, in microsiemens per centimeter at 25 degrees Celsius

Figure 22.--Specific conductance of ground water in area 1.



EXPLANATION

——*1000*——	APPROXIMATE LINE OF EQUAL SPECIFIC CONDUCTANCE--Intervals 200 and 500 microsiemens per centimeter at 25 degrees Celsius
● 146 1,250	WELL--Upper number is well number from table 5; lower number is specific conductance, in microsiemens per centimeter at 25 degrees Celsius
▲ COMP. 840	COMPOSITE SAMPLE--Number is specific conductance, in microsiemens per centimeter at 25 degrees Celsius

Figure 23.--Specific conductance of ground water in area 2.

Specific conductance in area 3 ranges from 530 to 1,180 microsiemens per centimeter (fig. 24). No relation between areal distribution or sampling depth and specific conductance is evident in area 3. Values of specific conductance could not be used to confirm ground-water-flow directions.

In area 1, pH increases in the direction of ground-water flow determined from water-level measurements and ranges from 7.0 on the west side to 9.2 near Tijeras fault (fig. 25). Hem (1985, p. 63-64) stated that "Most ground waters found in the United States have pH values ranging from around 6.0 to about 8.5. * * * Water having a pH much greater than 9.0 is unusual but by no means unknown." The unusually large value cannot be explained with available information.

Values for pH for water samples from wells in area 2 north of Tijeras Arroyo range from 7.2 to 7.9 (fig. 26). A group of samples having relatively small pH values, from 7.3 to 7.4, on the north side of area 2 coincided with one area of ground-water inflow (fig. 14). No other relation between pH values and ground-water-flow directions was evident.

Three wells (143, 145, and 146) on the south side of the arroyo had pH values from 6.4 to 6.8. The reason for these small pH values is unknown.

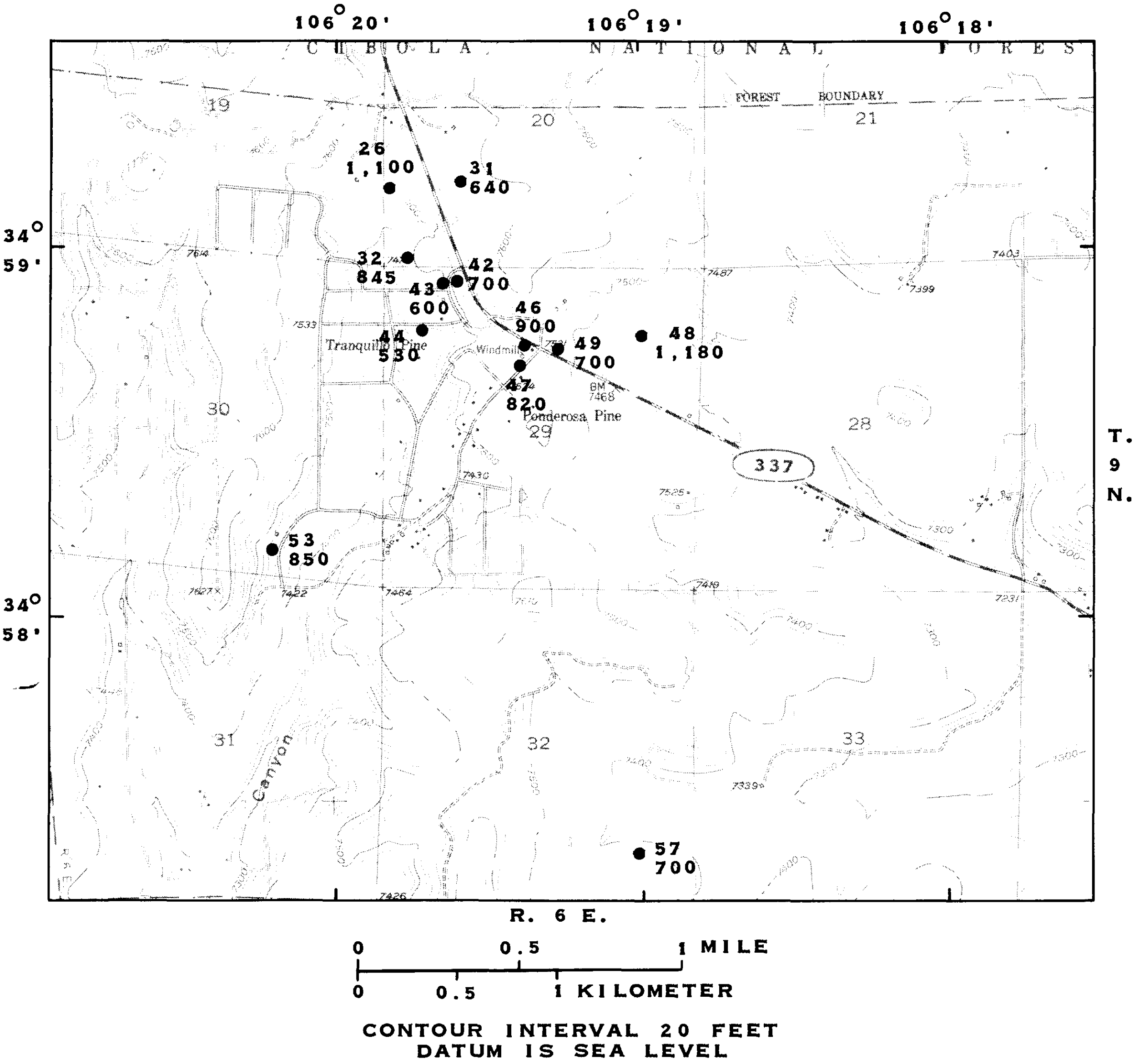
Values of pH for water from wells sampled in area 3 range from 6.9 to 7.7 (fig. 27). No correlation between areal distribution, sampling depth, or ground-water-flow directions and pH is evident in area 3.

Occurrence of Nitrate and Fluoride in Ground Water

Water samples from 26 wells were collected and analyzed for nitrates. The maximum contaminant level of nitrate for drinking water, 10 milligrams per liter reported as nitrogen (U.S. Environmental Protection Agency, 1986a), was exceeded in the community of Chilili (fig. 28) and in the Tijeras Canyon area (fig. 29).

Titus (1980) reported nitrate concentrations in milligrams per liter as nitrate. The laboratory analyses for this study are for nitrite plus nitrate and are reported in milligrams per liter as nitrogen. Because nitrite concentrations usually are very small, the nitrite plus nitrate concentrations usually are almost all nitrate. In this study all nitrite concentrations were less than 0.1 milligram per liter.

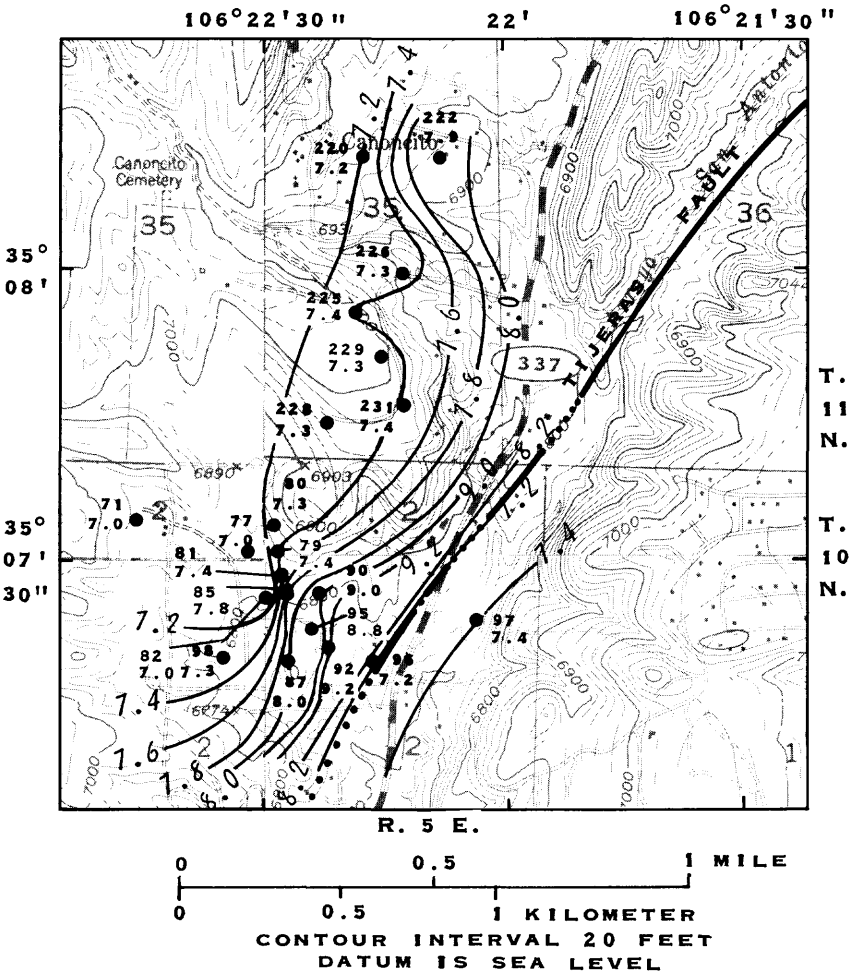
Care must be taken when comparing nitrate concentrations reported by Titus (1980) to concentrations reported in this study or when comparing Titus' concentrations to Federal standards; the 10-milligram-per-liter nitrate-nitrogen limit is equivalent to 45 milligrams per liter as nitrate. Concentrations reported as nitrate can be converted to nitrogen if multiplied by 0.2259.



EXPLANATION

● 57 700	WELL--Upper number is well number from table 5; lower number is specific conductance, in microsiemens per centimeter at 25 degrees Celsius

Figure 24.--Specific conductance of ground water in area 3.

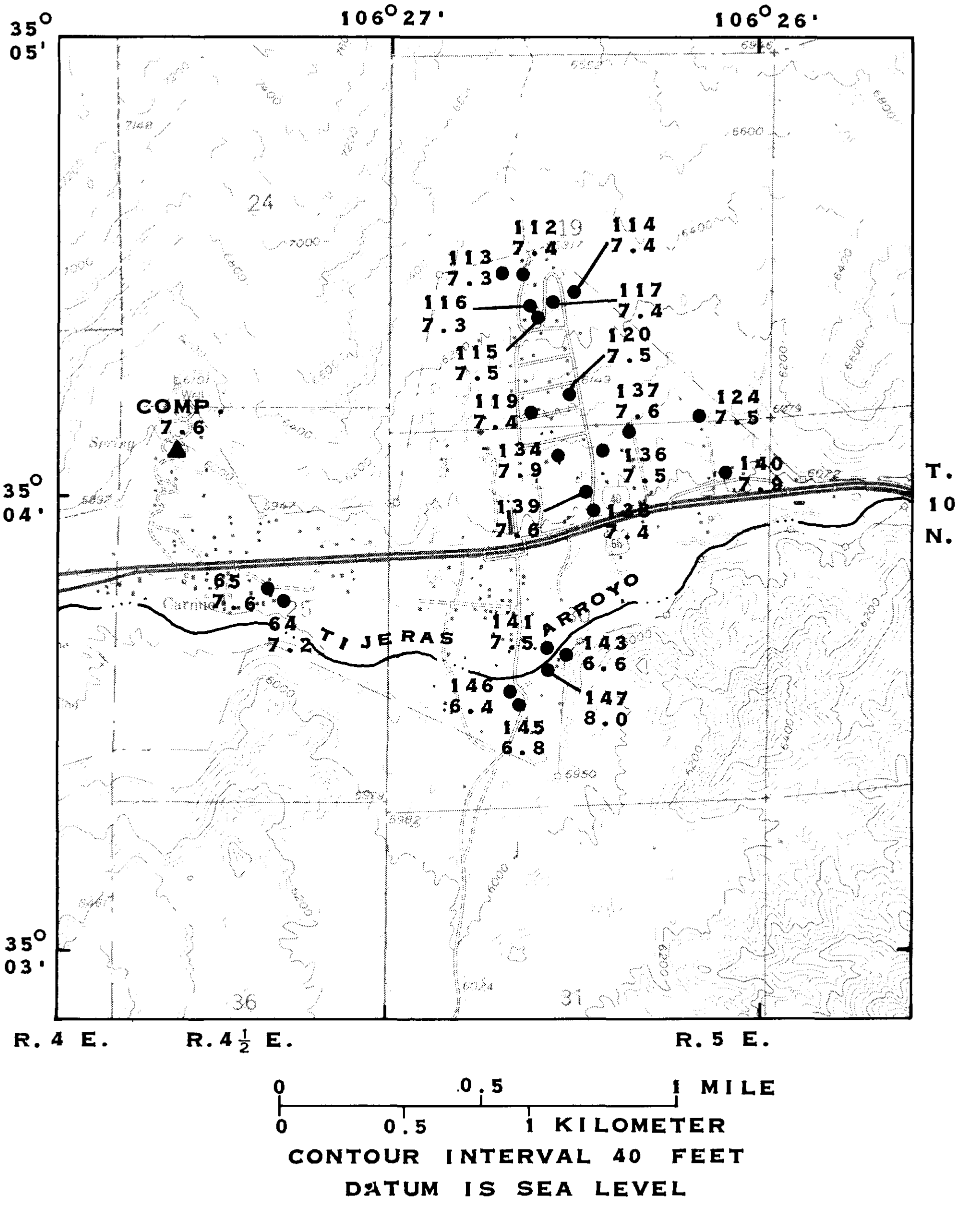


EXPLANATION

—8.0— LINE OF EQUAL pH--Intervals 0.2 and 1.0 unit

82 7.0 WELL--Upper number is well number from table 5; lower number is pH of water

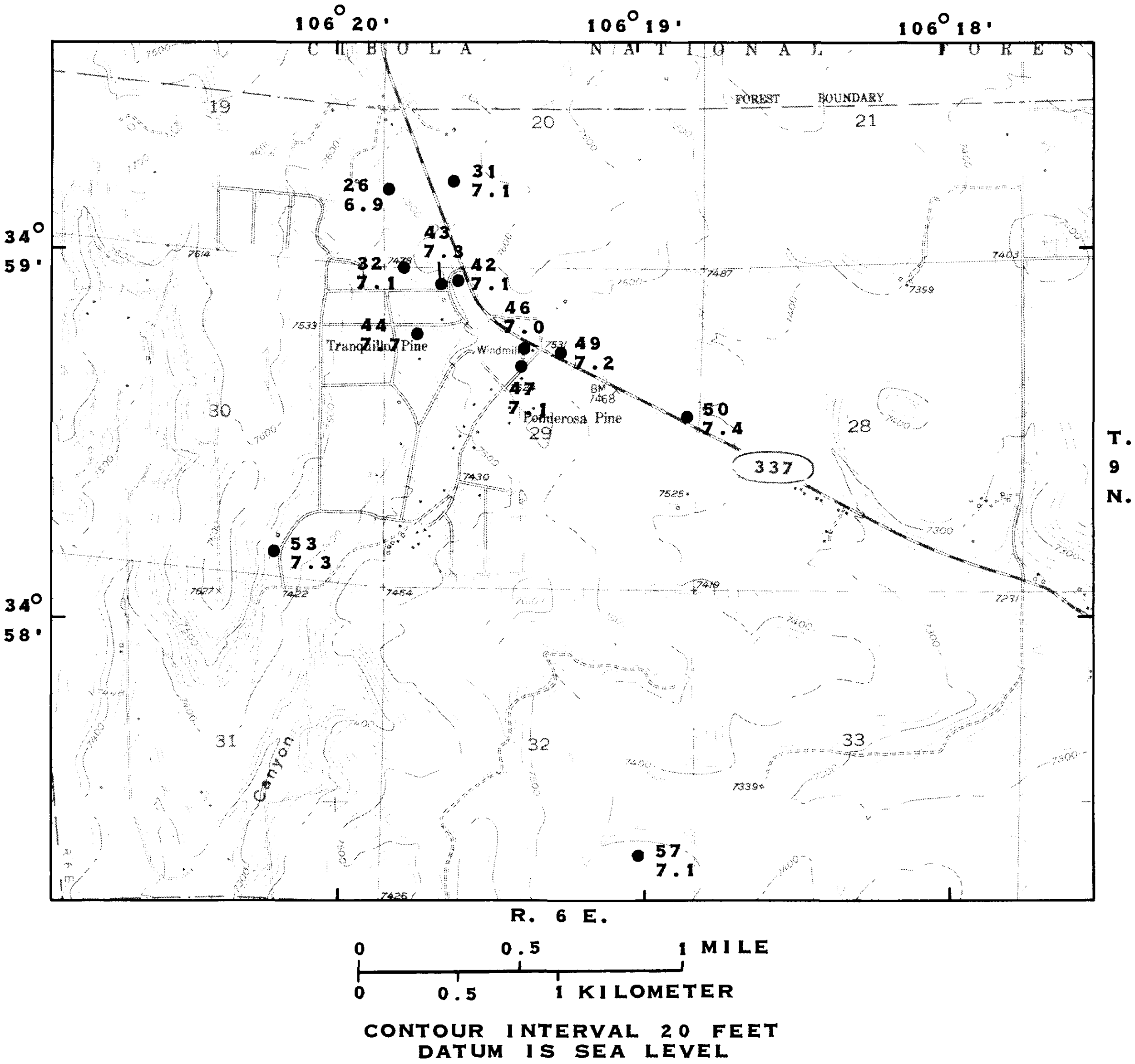
Figure 25.--Values of pH of ground water in area 1.



EXPLANATION

● 145 6.8	WELL--Upper number is well number from table 5; lower number is pH of water
▲ COMP. 7.6	COMPOSITE SAMPLE AND pH

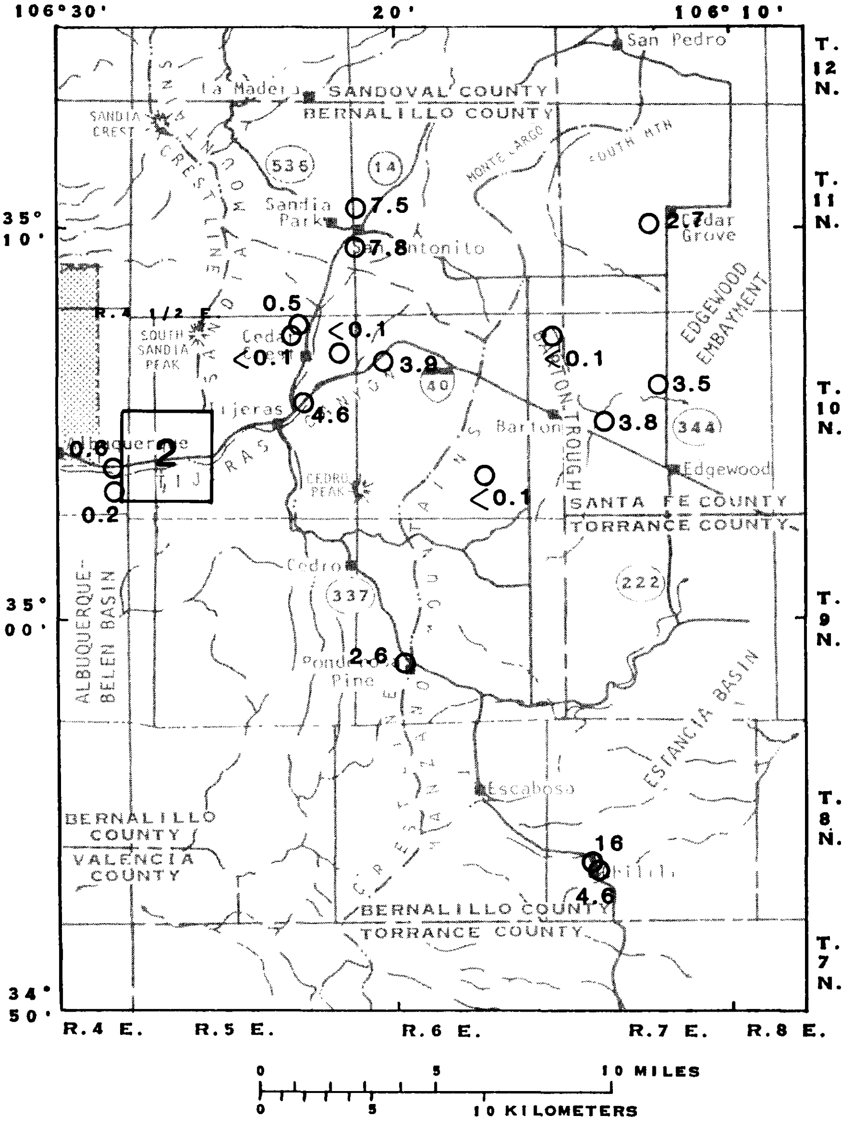
Figure 26.--Values of pH of ground water in area 2.



EXPLANATION

● 57 7.1	WELL--Upper number is well number from table 5; lower number is pH of water

Figure 27.--Values of pH of ground water in area 3.



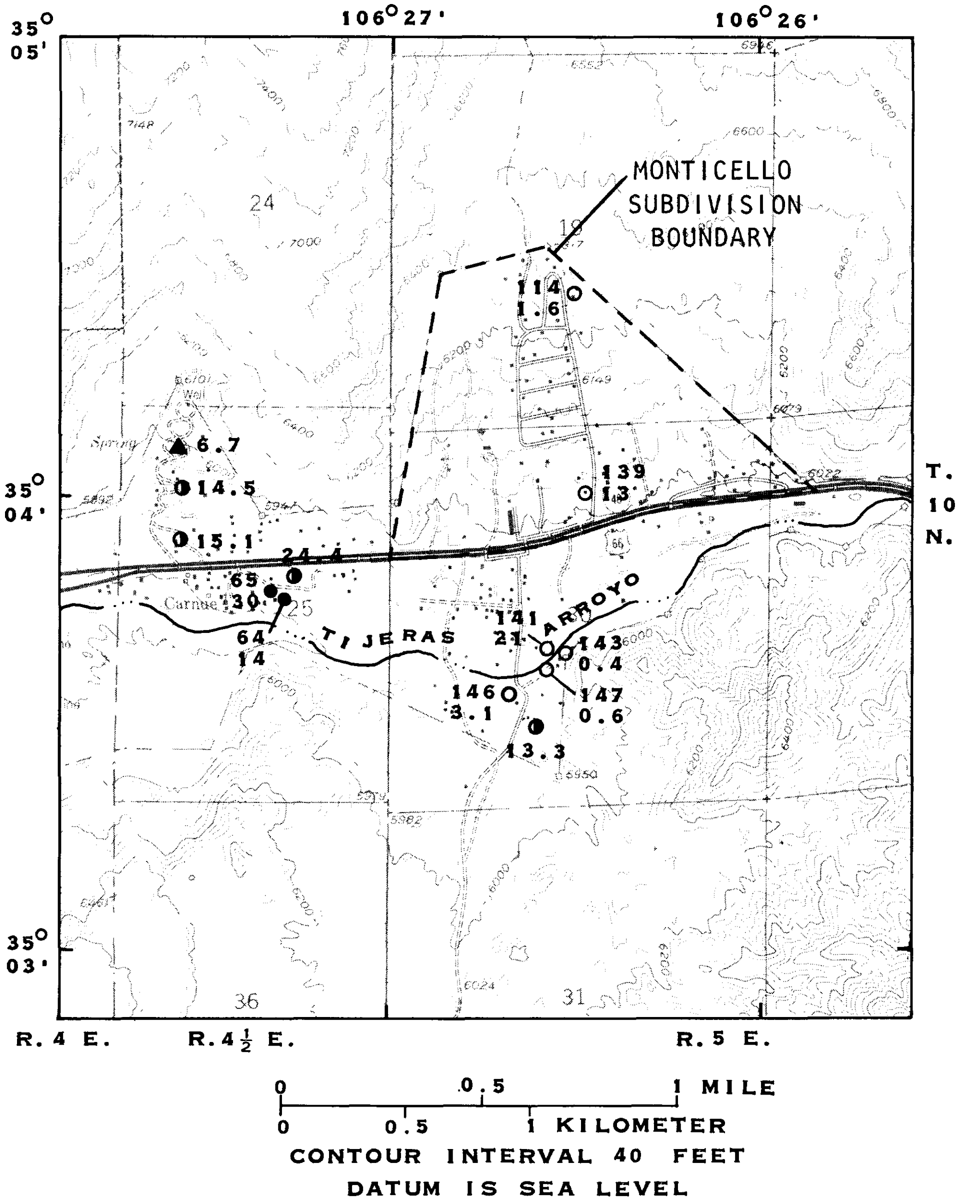
EXPLANATION

○ 3.8 WELL AND NITRATE-NITROGEN CONCENTRATION, IN MILLIGRAMS PER LITER

2 STUDY AREA 2--See figure 29

Modified from Titus, 1980

Figure 28.--Location of sampling sites and nitrate-nitrogen concentrations in ground water.



EXPLANATION

○ 146 3.1 WELL--Upper number is well number from table 5; lower number is nitrate-nitrogen concentration, in milligrams per liter; solid circle (●) indicates nitrate-nitrogen concentration exceeds 10 milligrams per liter in samples analyzed for this report

◐ 13.3 WELL--Sampled by Titus (1980); number is nitrate-nitrogen concentration, in milligrams per liter

▲ 6.7 COMPOSITE SAMPLE--Obtained from home supplied by several wells; number is nitrate-nitrogen concentration, in milligrams per liter

Figure 29.--Location of sampling sites and nitrate-nitrogen concentrations in area 2.

Nitrate concentrations reported by Titus in milligrams per liter as nitrate were converted to concentrations as nitrogen for the purpose of comparison with nitrate values analyzed in ground water for this study. Titus' values for nitrate have been converted both in the text and in figure 29. The only nitrate concentrations Titus measured that exceeded the current maximum contaminant level allowable were for samples from Tijeras Canyon (fig. 29).

Nitrate in Ground Water in Tijeras Canyon

Nitrate concentrations in ground water in Tijeras Canyon outside area 2 (fig. 28) do not exceed Federal standards. Nitrate concentrations in area 2 measured during the current study are greatest on the north side of Tijeras Arroyo, in the southern part of Monticello subdivision, and immediately southwest of Monticello subdivision (fig. 29). The largest concentration of nitrate, 30 milligrams per liter as nitrogen, occurred in water from well 65 (fig. 29), which is reportedly 200 feet deep. Water from nearby well 64, which is 60 feet deep, had a nitrate-nitrogen concentration of 14 milligrams per liter. This raises the possibility that large concentrations of nitrate may be found at depths as great as 200 feet in the vicinity of Tijeras Arroyo.

Well 141 is 50 feet deep and well 143 is 60 feet deep (table 5); both wells are perforated in the bottom 10 feet. Water from well 141 on the north side of Tijeras Arroyo had a nitrate-nitrogen concentration of 21 milligrams per liter, whereas water from well 143 on the south side of Tijeras Arroyo had a nitrate-nitrogen concentration of 0.4 milligram per liter (fig. 29). Concentrations of nitrate of less than 10 milligrams per liter were detected in water samples from all wells near the arroyo on its south side. These data are not consistent with Titus' (1980) report of a nitrate-nitrogen concentration of 13.3 milligrams per liter in water from a well south of the arroyo (fig. 29). The largest nitrate-nitrogen concentration reported by Titus (1980) of 24.4 milligrams per liter occurred on the west side of area 2 near where the largest concentration for nitrate-nitrogen (30 milligrams per liter) was determined in the current study (fig. 29).

Nitrate in Ground Water in Chilili

Samples were collected from two wells (wells 21 and 19) in Chilili (table 3). Well 21 is connected to the community water system and has been a water-supply well for the community for many years. The new Chilili community well (well 19) was completed on October 8, 1984, and is approximately 150 feet west of well 21. The concentration of nitrite plus nitrate as nitrogen in water sampled from well 21 increased from 0.10 to 4.6 milligrams per liter from August 1984 to May 1985. In June 1985 the concentration of nitrite plus nitrate in well 19 was greater than 10 milligrams per liter, the maximum contaminant level for nitrate. In view of the rapid increase in the nitrate concentration in water sampled from well 21, and the large concentration in well 19, frequent monitoring of nitrate concentrations in this and other areas would help detect water-quality degradation if it should occur.

Table 3.—Concentrations of nitrite plus nitrate reported as nitrogen in water from wells in the community of Chilili, 1984-85

Well number	Well owner	Date of sample	Concentration of nitrite (NO_2) + nitrate (NO_3) as nitrogen (N), in milligrams per liter
21	Earnest A. Dow	08-09-84	0.10
		05-31-85	4.6
19	Community of Chilili	06-07-85	16

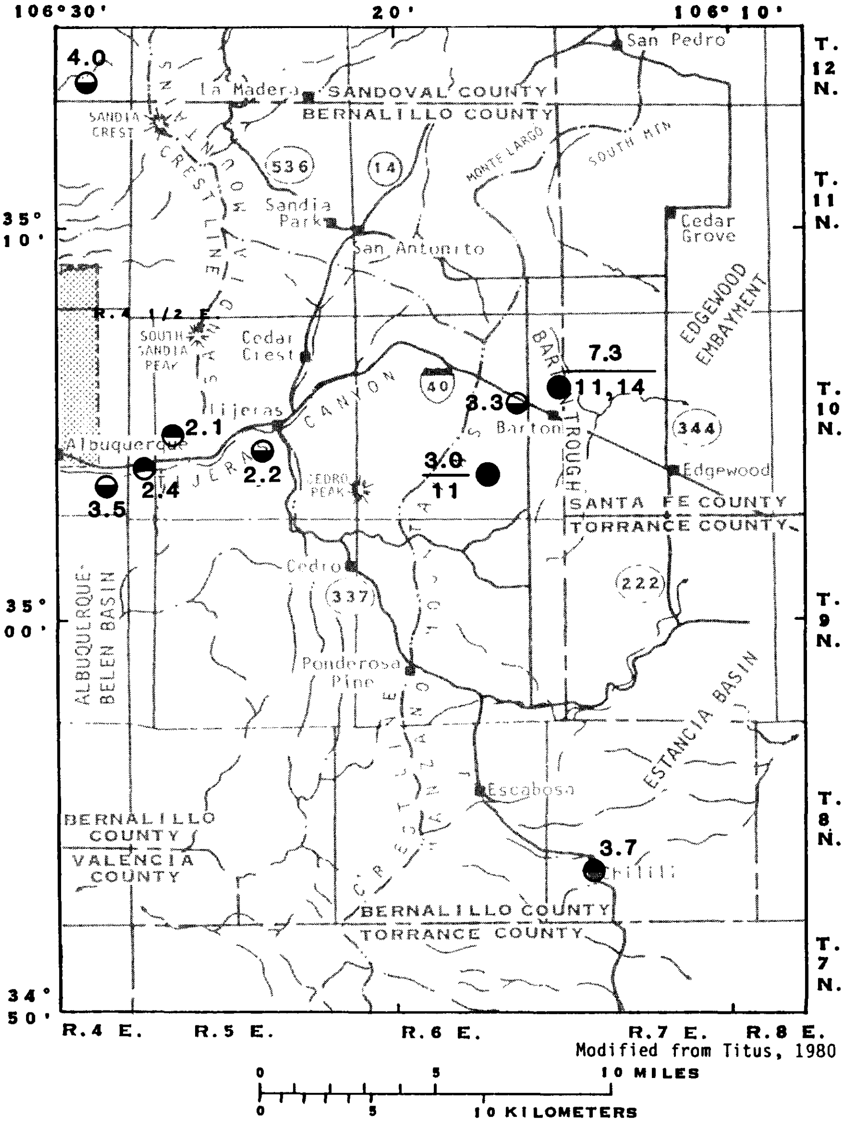
Fluoride

The maximum allowable concentration for fluoride is 4.0 milligrams per liter (U.S. Environmental Protection Agency, 1986a, p. 525). According to the U.S. Environmental Protection Agency (1986b), however, "Some children exposed to levels of fluoride greater than about 2.0 milligrams per liter may develop dental fluorosis. Dental fluorosis, in its moderate and severe forms, is a brown staining and/or pitting of the permanent teeth." Samples at five sites had fluoride concentrations greater than 2.0 milligrams per liter during the current study (fig. 30). Occurrences of fluoride in concentrations greater than 2.0 milligrams per liter as reported by Titus (1980) also are shown in figure 30. Water in only three wells contained fluoride concentrations equal to or greater than the recommended primary drinking-water maximum contaminant level of 4.0 milligrams per liter.

Changes in Ground-Water Quality with Time

Values of specific conductance and nitrate and fluoride concentrations, reported by Titus (1980) for samples collected in 1960 and 1962 from wells that were resampled during the current study, are shown in table 4. Two wells (46 and 64) that were sampled by Titus could not be resampled, so similarly completed, nearby wells were sampled instead.

Specific conductance has remained about the same or has increased in most resampled wells. In well 238, specific conductance approximately doubled from 1962 to 1984, and the nitrate-nitrogen concentration increased from 1.6 to 7.8 milligrams per liter. Fluoride concentrations have remained about the same in samples from most wells, but the large concentrations of fluoride reported in water from wells 164 and 171 in 1962 decreased by about 50 percent or more by 1984 or 1985.



Modified from Titus, 1980

EXPLANATION

◓ 2.4 WELL SAMPLED DURING THIS STUDY--Number is fluoride concentration, in milligrams per liter

◒ 3.5 WELL OR SPRING SAMPLED BY TITUS (1980)--Number is fluoride concentration, in milligrams per liter

● $\frac{3.0}{11}$ WELL SAMPLED DURING BOTH STUDIES--Upper number is fluoride concentration reported in current study; lower number is fluoride concentration reported by Titus. Units are milligrams per liter

Figure 30.--Location of sampling sites where fluoride concentration exceeds 2.0 milligrams per liter.

Table 4.—Specific conductance and fluoride and nitrate concentrations in water from wells sampled by Titus (1980) and during the current study

[Qal, Quaternary alluvium; Qe, Quaternary eolian deposits; Km, Cretaceous Mancos Shale; TRc, Triassic Chinle Formation; PIPm, Pennsylvanian and Permian Madera Group; p€, Precambrian rocks. —, no data]

Well number	Well owner[1]	Sample date	Geologic unit	Well depth (feet below land surface)	Specific conductance (microsiemens per centimeter at 25 degrees Celsius)	Fluoride (F) (milligrams per liter)	Nitrate (as NO_3) (milligrams per liter)	Nitrate ($NO_2 + NO_3$ as N) (milligrams per liter)
46	Earl Hovenden	10-7-60	PIPm	315	762	—	4.2	[2]0.9
[3]46	Robert Allison	9-27-84	PIPm	440	900	0.5	—	2.6
70	C.H. Carder	9-12-62	Qal, p€	500	1,610	[4]3.5	0.0	[2]0.0
	Ron Morris	12-19-84	Qal, p€	375+	1,960	—	—	0.22
64	Antonio Salazar	6-15-62	Qal	60	1,030	—	108	[2]24
[3]64	Manuel Griego	12-7-84	Qal	60	1,840	—	—	[4]14
104	D.M. Bush	7-11-62	Km	140	2,010	0.6	0.0	[2]0.0
	James J. Carnes	9-25-84	Km	142	2,200	0.9	—	0.10
114	Fred S. Lieb	6-13-62	Qal	146	583	—	20	[2]4.5
		9-27-84	Qal	146	600	[4]2.1	—	1.6
139	Norris	6-13-62	Qal	—	639	—	36	[2]8
	Floyd McIver	12-17-84	Qal	120	740	—	—	[4]13

Table 4.—Specific conductance and fluoride and nitrate concentrations in water from wells sampled by Titus (1980) and during the current study—Concluded

Well number	Well owner[1]	Sample date	Geologic unit	Well depth (feet below land surface)	Specific conductance (microsiemens per centimeter at 25 degrees Celsius)	Fluoride (F) (milligrams per liter)	Nitrate (as NO_3) (milligrams per liter)	Nitrate ($NO_2 + NO_3$ as N) (milligrams per liter)
164	T.O. Harrell	6-25-62	PIPm		1,150	11	0.1	[2]0.02
		9-13-62	PIPm	485	1,150	14	—	—
		4-27-85	PIPm	485	1,100	[4]7.3	—	0.10
171	K.D. Stout	11-9-62	PIPm	329	1,200	[4]11	0.3	[2]0.07
	D.M. Bush	9-24-84	PIPm	329	1,100	[4]3	—	0.10
180	Howard Hill	6-27-62	PIPm	340	1,020	0.3	7	[2]1.6
		11-15-84	PIPm	340	790	0.3	—	3.5
238	W.A. Arias	7-12-62	Qal, TRc	136	629	—	7	[2]1.6
	Mike Arias	12-12-84	Qal, TRc	136	1,240	0.4	—	7.8
267	Fernando Nieto	7-2-62	Qe	160	515	0.4	14	[2]3.2
		8-21-84	Qe	160	500	0.3	—	2.7

[1] Well owner at time of visit.
[2] Value calculated.
[3] Not same well sampled by Titus.
[4] Exceeds U.S. Environmental Protection Agency secondary maximum contaminant levels (1986b).

Factors that May Contribute to Ground-Water-Quality Degradation

The majority of the study area is composed of limestone that stores ground water in fractures, faults, and solution channels. In such material, where a ground-water gradient exists, ground water is not retained in any given area for long periods. Water flows into, through, and out of an area fairly rapidly. Clastic rocks, such as sandstone and shale, are not areally extensive; where they occur, they also are broken by numerous faults. This faulting increases the tendency for ground water to move into and out of areas of clastic rock more rapidly than it would otherwise. Rapid ground-water movement shortens the time of response of the ground-water system to changes in recharge, pumpage, and water quality. Fault systems in the study area have not been mapped in detail, and it is likely that more faults are present in the study area than have been mapped. The degree of interconnection between fault systems is unknown.

The presence of large numbers of faults affects ground-water flow. Flow is more rapid in faults than within unbroken material. Flow in fractured material is not uniform. Ground water generally flows faster along faults than across faults. Vertical ground-water flow is much greater in faulted rock than in unfaulted rock. Consequently, contamination introduced into an area broken by faults will be introduced to the ground-water system much faster and possibly will infiltrate to much greater depths than in an area not broken by faults. Transport of contaminants mixed with ground water also will be relatively fast.

The short distance between recharge and discharge areas such as Tijeras Arroyo, combined with enhanced permeability due to faults, fractures, and solution channels, allows contaminants to move into and throughout the ground-water system relatively rapidly.

A downward component of ground-water flow apparently exists in many parts of the study area (Titus, 1980, p. 26). Wastes introduced at or near land surface in areas having a downward hydraulic gradient tend to be carried downward into the ground-water system along with natural recharge. Contaminated ground water moves toward discharge areas, such as Tijeras Canyon, and can degrade ground-water quality in those areas.

Within a given area and particular water-yielding unit, water availability appears to correlate to fault locations more than any other factor. Prospective landowners research water availability prior to purchasing property; as a result, individual home sites, each having a domestic well and septic system, probably tend to be located along faults or fault zones where water availability is large. Although ground-water availability is enhanced in areas where fault zones exist, so are the chances of ground-water contamination because septic systems may also tend to be located over fault systems to take advantage of rapid draining.

Most common forms of ground-water contamination result from human activity that occurs at or near land surface. Many contaminants are filtered out of ground water by contact with soil grains (Fair and others, 1968, p. 27-1). Over most of the study area, soil zones are reportedly from 1 to 10 feet thick. The absence of thick soil zones indicates that contaminants may not be filtered out of wastewater applied at or near land surface and instead may contaminate the ground-water system.

No records are available to define the type of waste material that has been disposed of in the past because sanitary landfills were unregulated. Dumping of waste materials in streambeds continues to occur. Because many arroyos form along faults, vertical movement of ground water through arroyo bottoms is probably rapid. Any contaminants dumped into streambeds probably are washed downward into the ground-water system. Runoff from agricultural lands, where high-nitrate fertilizer or other potential contaminants are used, and rainwater or snowmelt mixed with liquid and solid livestock waste may be channeled into streams with the same result.

At times, sources of contamination are in places where their potential detrimental impact is maximized. Septic-system leach fields are sometimes located over faults so they will drain faster. Titus (1980, p. 45) reported that an abandoned well (well 08N.07E.22.143) was being used as a latrine.

Poorly designed or constructed wells can act as conduits for deep injection of contaminants into an aquifer. An example of this is a well that is gravel packed to land surface. If upper levels of an aquifer are contaminated and have a hydraulic head greater than that of lower levels, water will move from the upper to lower layers in the aquifer. Contaminated ground water in the upper layer can flow down through the gravel pack between the casing and the hole wall and mix with water in the well and in the aquifer. This can occur even if the well is not pumped and can continue as long as the well casing and gravel pack remain. Other than water-sample collection and analysis periodically done by the New Mexico Environmental Improvement Division for wells serving community water systems, no ground-water-quality monitoring is taking place (1985).

SUMMARY

Because of concerns by the Bernalillo County Commission and New Mexico State Engineer Office about effects of future development on ground-water supplies in the area, the U.S. Geological Survey conducted a cooperative investigation of the ground-water availability and quality in the eastern one-third of Bernalillo County and vicinity, central New Mexico. The study area includes the Sandia and Manzano Mountains, which trend north and consist of tilted fault blocks that have a rugged western face and a gentle eastern slope. The mountain cores are composed of Precambrian igneous and metamorphic rock. The eastern slopes primarily are mantled by carbonate rocks of Pennsylvanian and Permian age. A sequence of Permian to Upper Cretaceous clastic rocks crops out near and in the Tijeras basin near the center of the study area.

Recharge to the system is entirely due to precipitation, which increases with increasing altitude and averages 23 inches per year at the top of the Sandia Mountains. Ground water moves away from the vicinity of mountain crests to the west and east. Water flowing westward generally is not accessible for development. Eastward-flowing ground water apparently moves

downward into faults in Madera Group carbonates of Pennsylvanian and Permian age that cover upper slopes. In the northern part of the study area, ground water then flows into clastic units in the north-central part of the study area. In the northern one-half of the study area, water discharges to the north and east. Ground water in the Tijeras Arroyo drainage area moves toward the arroyo and westward out of the study area. In the southern one-half of the study area, ground water generally flows eastward out of the area.

An apparent direct correlation between changes in precipitation and ground-water levels was measured in one well in the Sandia Park area. The lag time between a change in annual precipitation and a change in ground-water levels is about 2½ years. It is not known if this apparent correlation exists throughout the area.

The study area can be divided into three regions on the basis of prevalent types of water-yielding rocks characterized by: (1) fractured, consolidated, clastic rocks; (2) fractured Precambrian igneous and metamorphic rocks partly covered by colluvium and alluvium; and (3) fractured carbonate rocks. In areas where clastic rocks crop out, principal water-yielding units are the Triassic Chinle and Santa Rosa Formations, which yield approximately 15 gallons per minute to wells. These are the most extensively developed water-yielding units in the study area. Fractured Precambrian rocks yield approximately 15 gallons per minute to wells. Alluvium in Tijeras Canyon that overlies Precambrian rock generally yields 9 gallons per minute to wells.

The most extensive water-yielding material is carbonate rock of the Pennsylvanian and Permian Madera Group. Water yields of wells completed in the Madera Group range from zero to 1,470 gallons per minute over the study area. In the Edgewood embayment, water yields from wells completed in carbonate rocks of the Madera Group average approximately 24 gallons per minute. Approximately 25 percent of wells completed in the Madera Group are completed in sandstone units that yield approximately 6 gallons per minute. Apparently, wells in the Barton trough area are completed in shale and yield an average of approximately only 4 gallons per minute. Many dry holes have been drilled in carbonates. In areas where clastic rocks crop out, ground-water yields are large (40-150 gallons per minute) for wells located along a fault. In areas where Precambrian rocks and alluvium crop out, no relation between faults and well yields was found. In areas where primarily carbonates (such as limestone) crop out, fractures do not appear significantly to enhance well yields. Previous researchers in other areas have demonstrated a direct relation between faults and well yields in limestone.

Throughout most of the area, ground-water levels have not declined since the late 1950's or early 1960's. In fact, ground-water levels have risen as much as 15.2 feet in wells completed in carbonate rock although localized drawdowns have occurred. Ground-water levels have declined as much as 153.7 feet in isolated wells completed in shale in the Barton trough area. Declines in ground-water levels appear to have occurred primarily in wells completed in shale units. Shale tends to impede ground-water flow and to lessen rates of recharge to wells.

Short-term ground-water-level declines of as much as 117 feet in 4 months were measured in wells. Water shortages occurred at times of maximum declines, but recovery of ground-water levels occurred within 7 to 9 months. Ground-water-level fluctuations of this type could be at least partly a result of lower precipitation rates in previous years. Currently, precipitation is measured in the study area only at Sandia Park. More precipitation stations would allow more detailed determination of precipitation patterns throughout the study area.

Water quality varies significantly in small areas. In an area of less than 1 square mile near Cedar Crest, specific conductance varies from 450 to 1,020 microsiemens per centimeter and pH varies from 7.0 to 9.2.

Nitrate concentrations exceeding the U.S. Environmental Protection Agency drinking-water standard of 10 milligrams per liter were measured in a few wells in the Tijeras Canyon area and in one well in the community of Chilili. The largest nitrate concentration, 30 milligrams per liter, was present in water from a well on the north side of Tijeras Arroyo in Tijeras Canyon. The arroyo appears to form a boundary between ground water containing large nitrate concentrations to the north and small nitrate concentrations to the south. A nitrate concentration of 16 milligrams per liter was measured in water from the new (1984) Chilili community well. Nitrate concentrations increased from 1.6 to 7.8 milligrams per liter between 1962 and 1984 in a well in the Sandia Park area, an area that has undergone considerable development.

Fluoride concentrations in a few samples of ground water in the study area also exceeded the primary drinking-water maximum contaminant level (4 milligrams per liter). However, ground water in the study area generally is acceptable for human consumption.

A variety of factors contribute to the potential for ground-water-quality degradation. The majority of the study area is composed of fractured carbonate and Precambrian rock that does not store large amounts of water. Ground-water flow is relatively rapid, and the system quickly responds to changes in recharge and discharge. This effect is intensified by the relatively short distances between recharge and discharge areas. Contaminants mixed with ground water also will move into and through the system rapidly. Wells commonly are located on or near faults, especially in areas where carbonate rock crops out. Because most households have septic systems, some septic systems may also be located near faults. Faults in the rocks increase vertical permeability and increase the likelihood that contaminants will rapidly move deep into the system. Most contaminants are introduced into the system at or near land surface and to some extent are filtered by contact with soils. The thinness of soil zones, typically 1 to 10 feet thick, increases the potential for introduction of contamination into the ground-water system. Landfills have been operated in the area and no records were kept detailing the types or amounts of materials they contain. Contaminants from waste dumps can be dissolved in ground water moving through buried waste materials and eventually may contaminate ground-water supplies. Poorly designed, poorly constructed, or abandoned wells can act as conduits for the downward migration of contaminants.

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Table 5.--Well information and water-level data

[Depth of measurements and intervals are reported in feet below land surface. Method of measurement: R, reported by well owner or driller; S, measured with a steel tape; W, reported by Titus (1980); A, reported by New Mexico State Engineer; T, measured with an electric tape; E, estimated. --, no data]

							Water-level data		
Well number	Local well number	Well owner	Date well constructed	Depth of well (feet)	Top of open interval (feet)	Bottom of open interval (feet)	Date measured	Depth to water (feet)	Method of measurement
1	07N.07E.09.121	Dan F. Brinkley	01-01-00	100	--	--	- -63	80	R
			--		--	--	02-15-84	73.81	S
2	08N.06E.02.331	Thomas J. Baca	01-01-78	250	--	--	02-16-84	182.86	S
3	08N.06E.09.222	Mark Thomason	--	--	--	--	02-28-84	184.46	S
4	08N.06E.09.444	Eddie de Luna	04-13-79	600	--	--	04-13-79	--	-
5	08N.06E.09.444A	Eddie de Luna	05-02-79	380	--	--	--	--	-
6	08N.06E.09.444B	Eddie de Luna	05-06-79	520	400	410	05-09-79	345	R
					420	436	02-16-84	197.82	S
					480	500	--	--	-
7	08N.06E.10.331	Manuel M. Mora	01-01-61	500	--	--	02-16-84	251.30	S
8	08N.06E.11.222	Bob Clauss	01-01-72	133	--	--	02-16-83	91.24	S
9	08N.06E.14.113	Andres M. Montoya	06-20-75	80	55	80	06-24-75	25	R
					--	--	02-16-84	17.42	S
10	08N.06E.14.323	Thomas Montoya	01-01-57	75	--	--	02-15-84	29.69	S
11	08N.06E.14.323A	Andres Mora	05- -54	142	--	--	02-28-84	56.71	S
12	08N.06E.23.211	Ofeniano Martinez	03-08-80	345	305	345	03-13-80	245	R
					--	--	02-15-84	167.57	S
13	08N.06E.35.444	Eli Rusiuko	05-24-82	185	145	185	05-24-82	70	R
					--	--	02-28-84	17.23	S
14	08N.07E.11.113	Antonio J. Montaño	01-01-36	10	--	--	- -36	--	-

Table 5.--Well information and water-level data--Continued

Well number	Local well number	Well owner	Date well constructed	Depth of well (feet)	Top of open interval (feet)	Bottom of open interval (feet)	Water-level data		
							Date measured	Depth to water (feet)	Method of measurement
14	08N.07E.11.113	Antonio J. Montaño	01-01-36	10	--	--	02-27-84	1.2	S
15	08N.07E.12.224	Ross Thompson	01-01-63	175	--	--	02-27-84	--	-
16	08N.07E.12.323	Manuel Gallegos	--	238	--	--	02-27-84	145.70	S
17	08N.07E.16.221	Russell S. Welch	08-11-80	400	--	--	02-28-84	49.97	S
18	08N.07E.28.221	Lupe B. Castillo	08-24-74	45	25	45	08-26-74	19	R
					--	--	02-15-84	17.68	S
19	08N.07E.29.324B	Comm. of Chilili	10-08-84	260	50	130	10-10-84	33.5	R
					150	170	06-07-85	30.96	S
					190	210	--	--	-
					230	250	--	--	-
20	08N.07E.29.324	Earnest A. Dow	01-01-48	86	--	--	09-27-63	36.8	W
				81	--	--	06-07-85	21.62	S
21	08N.07E.29.324A	Earnest A. Dow	--	100	--	--	08-09-84	18.82	S
22	08N.07E.34.222	Thomas J. Baca	01-01-73	500	--	--	02-27-84	269.90	S
23	08N.08E.06.423	Ross Thompson	01-01-55	143	--	--	02-27-84	97.14	S
24	09N.05E.12.213	Matthew Groves	04-27-83	160	110	160	04-05-84	115.75	S
25	09N.05E.12.243	Jorge Giacoboni	12-06-78	125	100	125	12-07-78	60	R
					--	--	04-05-84	54	S
26	09N.05E.20.313	John Wilson	12-03-80	105	40	60	12-04-80	60	R
					85	104	- -84	45	R
					--	--	11-19-84	42.07	S
27	09N.06E.02.432	George Keough	08-12-83	220	--	--	04-09-84	119.00	-
28	09N.06E.11.412	David Salazar	01-01-67	500	--	--	04-04-84	326.41	S
29	09N.06E.18.412	Thomas Brill	11-11-82	320	280	320	11-12-82	245	R
					--	--	04-05-84	137.80	S

Table 5.--Well information and water-level data--Continued

							Water-level data		
Well number	Local well number	Well owner	Date well constructed	Depth of well (feet)	Top of open interval (feet)	Bottom of open interval (feet)	Date measured	Depth to water (feet)	Method of measurement
30	09N.06E.19.413	Joe C. Clayton	10-07-80	680	460	480	10-13-80	375	R
31	09N.06E.20.314	Gerald Reynolds	06-12-84	440	380	440	06-13-84	360	R
					--	--	11-14-84	197.32	S
32	09N.06E.20.333	Don/Diane Buster	09-21-77	100	60	100	09-23-77	50	-
					--	--	11-08-84	22.60	S
33	09N.06E.22.243	Henry Coors	--	--	--	--	04-09-84	203.77	S
					--	--	11-14-84	193.10	S
34	09N.06E.22.243A	Sam Negron	12-01-83	140	--	--	04-05-84	84.55	S
					--	--	11-14-84	83.49	S
35	09N.06E.22.331	David Lanier	01-01-81	250	--	--	11-21-84	221.71	S
36	09N.06E.22.333	David Lanier	06-29-83	375	--	--	--	--	-
37	09N.06E.22.333A	Ralph Chilton	01-01-78	240	--	--	11-20-84	--	-
38	09N.06E.22.334	Charles Leader	--	250	--	--	11-21-84	134.79	S
39	09N.06E.26.131	David Salazar	05-01-81	175	--	--	04-04-84	50.48	S
40	09N.06E.26.244	John Kelton	--	103	--	--	02-17-84	67.47	S
41	09N.06E.28.223	Jim Henrich	--	350	--	--	02-17-84	78.90	S
					--	--	11-13-84	79.85	S
42	09N.06E.29.112	Larry Bowen	05-09-84	210	182	205	11-08-84	142.52	S
43	09N.06E.29.112A	Don Cowan	01-01-61	320	--	--	11-09-84	223	S
44	09N.06E.29.114	Bruce Allison	09-29-82	300	160	200	09-29-82	165	R
					260	300	04-04-84	168.60	S
					--	--	11-07-84	182.27	S
45	09N.06E.29.142	Robert Allison	09-22-81	480	--	--	04-04-84	197.12	S
					--	--	11-09-84	241.07	S
46	09N.06E.29.142B	Robert Allison	09-25-81	440	400	440	09-25-81	365	R

Table 5.--Well information and water-level data--Continued

					Top of	Bottom of	Water-level data		
Well number	Local well number	Well owner	Date well constructed	Depth of well (feet)	open interval (feet)	open interval (feet)	Date measured	Depth to water (feet)	Method of measurement
46	09N.06E.29.142B	Robert Allison	09-25-81	440	--	--	04-04-84	263.43	S
					--	--	09-27-84	289.47	S
					--	--	11-13-84	282.88	S
47	09N.06E.29.142A	Gordon Gaskill	09-01-57	327	--	--	11-21-84	262	S
48	09N.06E.29.223	Samuel Parnell	07-09-79	525	485	525	07-16-79	280	R
					--	--	11-14-84	352.29	S
49	09N.06E.29.231	BC Fire Station 11	02-25-78	600	280	300	02-25-78	300	R
					560	600	02-17-84	221.69	S
					--	--	11-07-84	247.80	S
50	09N.06E.29.244	James Mosier	10-19-79	315	280	300	10-22-79	260	R
					--	--	11-15-84	119.42	S
51	09N.06E.30.224	Gary Rothwell	08-27-80	540	420	480	08-30-80	180	R
					--	--	11-09-84	279.35	S
52	09N.06E.30.334	Tran. Pines Coop.	12-29-82	440	130	160	12-29-82	135	R
					180	200	04-03-84	141.80	S
					220	240	--	--	-
					260	280	--	--	-
53	09N.06E.30.434	Fred Hainds	04- -84	600	240	260	11-09-84	200	R
					540	560			
54	09N.06E.31.131	Louis Heckroth	01-01-79	345	--	--	04-03-84	262.50	S
55	09N.06E.31.341	Tran. Pines Coop.	10-02-75	400	--	--	10-18-75	131	R
					--	--	04-03-84	176.80	S
56	09N.06E.31.341A	Tran. Pines Coop.	10-02-75	300	--	--	10-18-75	127	R
					--	--	04-03-84	175.80	S
57	09N.06E.32.441	Jim Travelstead	10-03-77	360	300	360	10-05-77	190	-

Table 5.--Well information and water-level data--Continued

Well number	Local well number	Well owner	Date well constructed	Depth of well (feet)	Top of open interval (feet)	Bottom of open interval (feet)	Water-level data		
							Date measured	Depth to water (feet)	Method of meas-urement
57	09N.06E.32.441	Jim Travelstead	10-03-77	360	--	--	04-04-84	161.23	-
					--	--	11-13-84	160.89	-
58	09N.06E.34.242A	James Ullrick	09-28-84	155	80	155	10-02-84	80	R
					--	--	11-13-84	30.45	S
59	09N.06E.34.431	James Ullrick	05-16-83	160	80	100	05-17-83	80	R
					140	160	02-17-84	61.70	S
60	09N.06E.35.334	John Klassen	10-28-83	200	160	200	10-29-83	85	R
					--	--	02-17-84	82.65	S
61	09N.06E.36.411	State Hwy Dept.	--	--	--	--	04-09-84	13.55	S
62	09N.07E.25.234	Phil Parlington	09-01-82	185	165	185	09-25-84	143.35	-
63	10N.04.5E.25.144	Gary Akin	11-15-82	186	146	186	11-16-82	20	R
					--	--	03-15-84	17.20	S
64	10N.04.5E.25.144A	Manuel Griego	01-01-14	60	--	--	- -14	--	-
					--	--	12-07-84	22.65	S
65	10N.04.5E.25.234B	Antonio Salazar	01-01-79	200	--	--	12-03-84	39.19	S
66	10N.04.5E.25.244	State Hwy Dept.	--	--	--	--	04-06-84	43.30	S
67	10N.04E.25.324	State Hwy Dept.	01-01-60	--	--	--	04-02-84	34.57	S
68	10N.04E.25.341	Gretchen Wagner	11-18-80	50	25	55	11-18-80	30	R
					--	--	12-06-84	11.90	S
69	10N.04E.25.441	Bob Antoine	- -82	189	--	--	03-15-84	24.62	S
70	10N.04E.36.123	C.H. Carder	09-01-59	500	--	--	10-21-60	70.92	W
		Ron Morris			--	--	12-02-60	71	R
					--	--	02-05-81	71.84	S
					--	--	12-07-84	72.52	S
71	10N.05E.02.113	A. Montoya	09-25-67	375+	159	179	09-25-67	156	R

Table 5.--Well information and water-level data--Continued

							Water-level data		
Well number	Local well number	Well owner	Date well constructed	Depth of well (feet)	Top of open interval (feet)	Bottom of open interval (feet)	Date measured	Depth to water (feet)	Method of measurement
71	10N.05E.02.113	Alb. Pub. Sch.	09-25-67	179	--	--	04-03-80	152.47	-
					--	--	04-18-84	157.63	-
					--	--	10-11-84	153.67	-
72	10N.05E.02.121	SV Util. Coop., North	03-23-74	240	60	70	04-01-74	40	R
					220	240	04-18-84	98.99	S
					--	--	10-02-84	97.83	S
73	10N.05E.02.122	SV Dev. Coop., South	05-15-74	331	321	331	05-17-74	50	R
					--	--	04-18-84	95	S
74	10N.05E.02.123	Paul Thompson	02-05-68	130	80	130	02-05-68	45	R
		Dale Goens			--	--	10- -79	120	R
					--	--	02-26-80	53.35	A
					--	--	04-20-82	81.08	A
					--	--	04-19-84	83	S
					--	--	10-11-84	51.98	S
75	10N.05E.02.123A	SV Dev. Coop., South	05-14-74	180	118	131	05-14-74	42	R
					173	180	04-18-84	56.88	S
					--	--	10-11-84	56.38	S
76	10N.05E.02.123B	SV Util. Coop., North	07-01-69	220	--	--	10-01-78	86	-
					--	--	10-09-78	48	R
					--	--	11-19-78	90	R
					--	--	03-25-79	83	R
					--	--	06-09-79	83	R
					--	--	08-20-79	83	R
					--	--	12-31-80	83	R
					--	--	09-09-81	92	R

Table 5.--Well information and water-level data--Continued

							Water-level data		
Well number	Local well number	Well owner	Date well constructed	Depth of well (feet)	Top of open interval (feet)	Bottom of open interval (feet)	Date measured	Depth to water (feet)	Method of measurement
76	10N.05E.02.123B	SV Util. Coop., North	07-01-69	220	--	--	12-13-81	80	R
					--	--	02-14-82	90	R
					--	--	04-18-84	92.37	S
					--	--	10-02-84	79.70	S
77	10N.05E.02.123C	Paul L. Thompson	06-25-81	195	140	196	06-25-81	160	R
					--	--	04-19-84	81.65	S
					--	--	04-20-84	82.08	A
					--	--	10-11-84	52.76	S
78	10N.05E.02.123D	SV Util. Coop., North	09-27-83	257	227	257	10-14-83	94	R
					--	--	04-18-84	92.10	S
					--	--	10-02-84	91.54	S
79	10N.05E.02.124	Barbara J. Duffy Sanchez	09-11-74	220	170	190	09-13-74	158	R
					--	--	02-26-80	49.80	R
					--	--	04-20-82	78.96	R
					--	--	04-19-84	66.91	S
					--	--	10-12-84	70.44	S
80	10N.05E.02.124A	Marvin E. Bauder	07-10-78	245	200	245	07-12-78	80	R
					--	--	02-26-80	50.80	R
					--	--	04-20-82	80.93	R
					--	--	10-12-84	73.14	S
81	10N.05E.02.141	Jules Cooper	01-01-72	200	--	--	02-26-80	54.54	A
					--	--	04-20-82	80.62	A
					--	--	10-02-84	61.64	S
82	10N.05E.02.141A	Jack Healey	08-12-78	160	135	160	08-12-78	140	R

Table 5.--Well information and water-level data--Continued

Well number	Local well number	Well owner	Date well constructed	Depth of well (feet)	Top of open interval (feet)	Bottom of open interval (feet)	Water-level data		
							Date measured	Depth to water (feet)	Method of measurement
82	10N.05E.02.141A	Jack Healey	08-12-78	160	--	--	02-26-80	40.51	-
					--	--	04-20-82	69.58	-
					--	--	10-02-84	48.96	-
83	10N.05E.02.142	SV Util. Coop., North	- -69	130	--	--	10- -70	65	R
					--	--	08- -79	95	R
					--	--	04-18-84	60.50	S
					--	--	10-02-84	39.50	S
84	10N.05E.02.142A	SV Util. Coop., North	08-09-78	211	65	75	08-09-78	48	R
					135	155	04-18-84	58.18	-
					--	--	10-02-84	39.15	-
85	10N.05E.02.142B	Parke H. Davis	03-01-83	260	--	--	10-02-84	56.04	S
86	10N.05E.02.143	Harwood T. Rice	07-03-71	232	192	232	07-06-71	62	R
					--	--	03-21-84	70.94	S
87	10N.05E.02.144	George S. Rost	07-01-73	400	200	400	07- -73	-.10	R
					--	--	- -79	30	R
					--	--	02-06-80	23.42	R
					--	--	04-20-82	40.18	R
					--	--	04-19-84	95	S
					--	--	07-03-84	118.49	S
					--	--	10-11-84	58.28	S
88	10N.05E.02.224	Guy Blake	06-28-84	100	75	100	06-28-84	30	R
					--	--	10-30-84	19.43	S
89	10N.05E.02.231	Dorthy McKaige	10-02-70	140	100	140	10-02-70	80	R
					--	--	02-26-80	74.61	A
					--	--	04-20-82	78.08	A

Table 5.--Well information and water-level data--Continued

							Water-level data		
Well number	Local well number	Well owner	Date well constructed	Depth of well (feet)	Top of open interval (feet)	Bottom of open interval (feet)	Date measured	Depth to water (feet)	Method of meas-urement
89	10N.05E.02.231	Dorthy McKaige	10-02-70	140	--	--	04-19-84	111.03	S
					--	--	10-02-84	107.75	S
90	10N.05E.02.231A	Dorthy McKaige	10-06-70	260	240	260	10-06-70	60	R
					--	--	05- -79	70	R
					--	--	02-26-80	65.97	A
					--	--	04-20-82	73.40	A
					--	--	04-19-84	115.90	S
					--	--	10-02-84	99.26	S
					--	--	12-12-84	106.88	S
91	10N.05E.02.233	Bob Sturgeon	04-01-64	65	--	--	04- -64	13	R
					--	--	10- -78	32	R
					--	--	04-20-82	50.61	R
					--	--	04-19-84	49.60	S
					--	--	10-01-84	--	-
92	10N.05E.02.233A	John Southwick	01-01-65	200	--	--	- -65	7	R
					--	--	02-26-80	96.20	A
					--	--	04-20-82	43.02	A
					--	--	04-08-84	58	R
					--	--	04-19-84	37.60	S
					--	--	06-25-84	76	R
					--	--	07-02-84	92	R
					--	--	07-07-84	100	R
					--	--	07-08-84	97	R
					--	--	07-09-84	97	R
					--	--	07-23-84	108	R

Table 5.--Well information and water-level data--Continued

							Water-level data		
Well number	Local well number	Well owner	Date well constructed	Depth of well (feet)	Top of open interval (feet)	Bottom of open interval (feet)	Date measured	Depth to water (feet)	Method of measurement
92	10N.05E.02.233A	John Southwick	01-01-65	200	--	--	08-01-84	114	R
					--	--	08-04-84	117	R
					--	--	08-21-84	129	R
					--	--	08-23-84	130	R
					--	--	08-27-84	129	R
					--	--	08-31-84	135	R
					--	--	09-04-84	138	R
					--	--	09-07-84	140	R
					--	--	09-14-84	144	R
					--	--	09-18-84	146	R
					--	--	09-19-84	146	R
					--	--	09-21-84	148	R
					--	--	09-22-84	149	R
					--	--	09-27-84	151	R
					--	--	10-02-84	152.08	S
					--	--	10-03-84	153	R
					--	--	10-05-84	155	R
					--	--	10-06-84	155	R
					--	--	10-07-84	155	R
					--	--	10-08-84	155	R
					--	--	10-09-84	155	R
					--	--	10-10-84	155	R
					--	--	10-11-84	155	R
					--	--	10-12-84	155	R
					--	--	10-13-84	155	R

Table 5.--Well information and water-level data--Continued

Well number	Local well number	Well owner	Date well constructed	Depth of well (feet)	Top of open interval (feet)	Bottom of open interval (feet)	Water-level data Date measured	Water-level data Depth to water (feet)	Water-level data Method of measurement
92	10N.05E.02.233A	John Southwick	01-01-65	200	--	--	10-14-84	153	R
					--	--	10-17-84	152	R
					--	--	10-30-84	144	R
					--	--	11-08-84	139	R
					--	--	11-15-84	136	R
					--	--	11-29-84	130	R
					--	--	12-04-84	128	R
					--	--	12-07-84	127	R
					--	--	12-28-84	121	R
					--	--	01-21-85	115	R
					--	--	02-14-85	102	R
					--	--	02-27-85	101	R
					--	--	03-18-85	93	R
					--	--	04-01-85	86	R
					--	--	04-16-85	83	R
					--	--	04-23-85	80	R
					--	--	04-30-85	71.13	S
					--	--	05-06-85	70	R
					--	--	05-15-85	71	R
					--	--	05-23-85	61	R
					--	--	05-30-85	55	R
					--	--	06-10-85	53	R
					--	--	06-18-85	48	R
					--	--	06-25-85	47	R
					--	--	07-03-85	41.73	S

Table 5.--Well information and water-level data--Continued

Well number	Local well number	Well owner	Date well constructed	Depth of well (feet)	Top of open interval (feet)	Bottom of open interval (feet)	Water-level data		
							Date measured	Depth to water (feet)	Method of measurement
92	10N.05E.02.233A	John Southwick	01-01-65	200	--	--	07-06-85	42	R
					--	--	07-14-85	40	R
					--	--	07-20-85	39	R
					--	--	07-27-85	38	R
					--	--	08-02-85	38	R
					--	--	08-08-85	36	R
					--	--	08-15-85	36	R
					--	--	08-28-85	35	R
					--	--	09-03-85	34	R
					--	--	09-10-85	30.5	R
					--	--	09-14-85	30	R
					--	--	09-17-85	29.5	R
					--	--	01-15-86	10.93	S
93	10N.05E.02.233B	Robert Sturgeon	03-07-79	125	85	125	03-07-79	75	R
					--	--	02-26-80	98.65	A
					--	--	04-20-82	49.24	A
					--	--	04-19-84	47.28	S
					--	--	10-11-84	95.52	S
94	10N.05E.02.233C	Robert Sturgeon	03-01-79	60	--	--	02-26-80	47.95	A
95	10N.05E.02.233D	Robert Sturgeon	06-01-79	375	--	--	02-26-80	89.70	A
					--	--	04-20-82	55	A
					--	--	04-19-84	52.21	S
					--	--	09-27-84	94	R
					--	--	10-04-84	94	R
					--	--	10-05-84	93.5	R

Table 5.--Well information and water-level data--Continued

Well number	Local well number	Well owner	Date well constructed	Depth of well (feet)	Top of open interval (feet)	Bottom of open interval (feet)	Water-level data		
							Date measured	Depth to water (feet)	Method of measurement
95	10N.05E.02.233D	Robert Sturgeon	06-01-79	375	--	--	10-11-84	95.5	R
					--	--	10-12-84	91.11	S
					--	--	10-20-84	90	R
					--	--	11-01-84	95	A
					--	--	11-02-84	93	R
					--	--	11-14-84	102	R
					--	--	11-30-84	97	R
					--	--	12-07-84	93	R
					--	--	12-13-84	93.2	R
					--	--	03-15-85	94	R
					--	--	04-02-85	93	R
					--	--	05-08-85	84	R
					--	--	06-06-85	65	R
					--	--	07-03-85	41.73	S
					--	--	07-09-85	48	R
					--	--	07-31-85	47	R
					--	--	08-08-85	40	R
					--	--	08-18-85	38	R
					--	--	09-17-85	30	R
96	10N.05E.02.234	Holloman	--	200	--	--	12-10-84	6.85	S
97	10N.05E.02.241	Ben Candelaria	07-08-77	165	120	165	07-12-77	25	R
					--	--	10-30-84	51.58	S
98	10N.05E.02.243	Richard Smith	07-10-73	180	140	160	07-10-73	60	R
					--	--	10-11-84	30.19	S
99	10N.05E.10.423	Douglas Drumheller	04-26-83	25	15	25	04-26-83	11	R

Table 5.--Well information and water-level data--Continued

							Water-level data		
Well number	Local well number	Well owner	Date well constructed	Depth of well (feet)	Top of open interval (feet)	Bottom of open interval (feet)	Date measured	Depth to water (feet)	Method of meas- urement
99	10N.05E.10.423	Douglas Drumheller	04-26-83	25	--	--	03-16-84	9.23	S
100	10N.05E.11.324	Kennith Bouxsein	10-11-67	80	20	80	10-13-67	15	R
					--	--	03-21-84	13.88	S
101	10N.05E.11.343	Henry Deaton	09-12-83	425	300	425	09-14-83	100	R
102	10N.05E.11.433	VSM Boy's Town	11-12-70	85	35	85	11-20-70	16	R
					--	--	04-18-84	16.70	S
103	10N.05E.12.112	Allan Abbott	01-01-67	432	412	432	10-12-84	192.06	S
104	10N.05E.12.122	D.M. Bush	- -62	140	--	--	06-05-62	96.4	W
		James J. Carnes		142	--	--	09-25-84	129.68	S
105	10N.05E.12.332	State Hwy Dept.	11-04-69	423	358	400	12-02-69	62	R
					--	--	03-29-84	29.87	S
106	10N.05E.12.344	State Hwy Dept.	--	390	--	--	06-13-72	46.70	R
					--	--	09-01-72	47.23	R
					--	--	01-01-73	45.55	R
					--	--	04-01-73	43.83	R
					--	--	07-01-73	44.47	R
					--	--	10-01-73	44.99	R
					--	--	01-01-74	44.02	R
					--	--	04-01-74	45.28	R
					--	--	08-28-74	46.18	R
					--	--	04-02-84	28.46	S
107	10N.05E.12.443	Tommy Tafoya	--	286	--	--	03-21-84	--	-
108	10N.05E.12.443A	Tommy Tafoya	08-18-83	480	360	380	08-20-83	460	R
					460	480	03-21-84	124.60	S
109	10N.05E.14.232	BC Fire Station 10	--	125	--	--	02-15-84	37.84	S

Table 5.--Well information and water-level data--Continued

Well number	Local well number	Well owner	Date well constructed	Depth of well (feet)	Top of open interval (feet)	Bottom of open interval (feet)	Water-level data: Date measured	Water-level data: Depth to water (feet)	Water-level data: Method of measurement
110	10N.05E.14.413	Tijeras Village	--	69	--	--	02-15-84	45.34	S
111	10N.05E.15.223	Charles Hobby	10-01-60	118	--	--	- -62	12	R
					--	--	04-06-84	30	S
112	10N.05E.19.321	Glen F. McFall	04-16-81	245	205	245	04-16-81	150	R
					--	--	10-19-84	63.16	S
113	10N.05E.19.321A	Charles Treat	01-01-65	200	--	--	12-17-84	90.62	S
114	10N.05E.19.322	Fred S. Leib	01-01-60	146	--	--	06-13-62	49.8	W
					--	--	09-27-84	47.09	S
					--	--	10-19-84	46.49	S
115	10N.05E.19.323	Frank Langford	01-01-44	135	--	--	10-19-84	53.42	S
116	10N.05E.19.324	Raymond Thomas	10-27-83	140	80	140	10-28-83	60	R
					--	--	10-19-84	55.50	S
117	10N.05E.19.324A	Stephen Wells	--	--	--	--	03-14-84	59.97	S
					--	--	10-19-84	61.75	S
118	10N.05E.19.324B	Roy/Helen Boast	01-01-78	160	--	--	10-31-84	64.17	S
119	10N.05E.19.343	R.J. Senseney	05-11-84	220	180	220	05-11-84	80	R
					--	--	10-29-84	74.61	S
120	10N.05E.19.344	Richard Peterson	01-21-78	80	60	80	01-21-78	50	R
					--	--	10-31-84	36.35	S
121	10N.05E.19.344A	Charles Morga	06-28-79	120	100	120	06-28-79	60	R
							10-19-84	61.45	S
122	10N.05E.19.431	Byron Elerick, Reggie/Pam Fletcher	01-01-70	135	--	--	10-31-84	78.71	S
123	10N.05E.19.431A	Byron Elerick, Reggie/Pam Fletcher	--	--	--	--	10-31-84	46.64	S

Table 5.--Well information and water-level data--Continued

Well number	Local well number	Well owner	Date well constructed	Depth of well (feet)	Top of open interval (feet)	Bottom of open interval (feet)	Water-level data: Date measured	Water-level data: Depth to water (feet)	Water-level data: Method of meas-urement
124	10N.05E.19.443	Tom Herrera	01-01-64	62	--	--	- -64	42	R
					--	--	11-06-84	26.27	S
125	10N.05E.22.141	State Hwy Dept.	01-01-72	65	--	--	09-13-72	57.78	R
					--	--	04-02-84	46.94	S
126	10N.05E.22.322	Alb Pub. Sch.	--	126	103	126	02-09-84	25.55	S
127	10N.05E.22.344	Ideal Cement Co. #1	01-01-57	1,100	--	--	- -57	--	-
128	10N.05E.22.433	Ideal Cement Co. #2	01-01-57	1,100	--	--	- -57	--	-
129	10N.05E.23.313		03-18-69	253	60	253	03-29-69	-10	R
130	10N.05E.26.314	Ron W. Ashcraft	--	--	--	--	04-05-84	9.54	S
131	10N.05E.29.141	State Hwy Dept.	--	--	--	--	04-02-84	39.68	S
132	10N.05E.30.114	H.K. Riddle	08-28-78	220	200	220	08-31-78	150	R
					--	--	03-14-84	54.78	S
					--	--	10-22-84	55.61	S
133	10N.05E.30.114A	H.K. Riddle	01-01-70	194	--	--	03-14-84	35.80	S
					--	--	10-22-84	36.65	S
134	10N.05E.30.122	Max Lowry	07-29-82	125	65	125	07-29-82	65	R
					--	--	10-19-84	62	R
135	10N.05E.30.124	Bob Coulter	08-02-82	160	90	110	08-03-82	80	R
					135	155	10-19-84	76.46	S
136	10N.05E.30.211	Rhevis Cothran	--	--	--	--	10-31-84	94.70	S
137	10N.05E.30.212	Flavio Otero	01-01-68	140	--	--	11-06-84	53.53	S
138	10N.05E.30.213	David Thornburg	10-17-80	85	45	85	10-17-80	60	R
					--	--	10-19-84	38.94	S
139	10N.05E.30.213A	Norris	01-01-57	120	--	--	- -57	72	R
				--	--	--	06-13-62	66.8	W

Table 5.--Well information and water-level data--Continued

Well number	Local well number	Well owner	Date well constructed	Depth of well (feet)	Top of open interval (feet)	Bottom of open interval (feet)	Water-level data		
							Date measured	Depth to water (feet)	Method of meas- urement
139	10N.05E.30.213A	Floyd McIver	01-01-57	120	--	--	12-17-84	70.52	S
140	10N.05E.30.223	Antonio Gonzales	05-06-82	300	260	300	--	--	-
141	10N.05E.30.322	Nat Jaramillo	--	50	--	--	--	--	-
142	10N.05E.30.322C	Ray W. McDaniels	01-01-71	50	--	--	10-01-76	23	R
143	10N.05E.30.322A	Ray W. McDaniels	11-23-76	60	25	45	11-23-76	22.19	R
144	10N.05E.30.322B	Ray W. McDaniels	01-01-77	20	--	--	12-10-84	11.05	S
145	10N.05E.30.323	Onesimo Martinez	03-08-83	105	65	105	--	--	-
146	10N.05E.30.323B	Onesimo Martinez	01-01-79	175	--	--	03-15-84	39.50	S
					--	--	10-22-84	41.54	S
147	10N.05E.30.324A	Billy J. Dickson	01-01-71	50	20	50	--	--	-
148	10N.05E.30.334	J.R. Shelton	01-03-81	140	60	80	11-01-84	45	R
149	10N.05E.31.411	Sue/Ron Rymarz	01-01-75	433	--	--	06-15-81	87	R
					--	--	07-03-81	61	R
					--	--	06-14-83	350	R
					--	--	05-12-84	200	R
150	10N.05E.31.412		--	--	--	--	--	--	-
151	10N.06E.04.113	James M. Grisham	01-11-78	565	500	565	01-11-78	260	-
					--	--	03-29-84	270.25	S
152	10N.06E.04.444	Randy E. Asbill	03-14-79	175	135	175	04-03-84	131.07	S
153	10N.06E.05.241	Michael Garrett	09-14-83	560	220	260	09-14-83	200	-
					360	380	03-28-84	177.75	-
					460	560	--	--	-
154	10N.06E.05.242	Michael Garrett	11-28-83	440	360	380	11-28-83	260	-
					400	420	03-28-84	198.25	S
155	10N.06E.05.332	State Hwy Dept.	01-01-72	84	--	--	09-06-72	63.98	R

Table 5.--Well information and water-level data--Continued

Well number	Local well number	Well owner	Date well constructed	Depth of well (feet)	Top of open interval (feet)	Bottom of open interval (feet)	Water-level data		
							Date measured	Depth to water (feet)	Method of meas-urement
155	10N.06E.05.332	State Hwy Dept.	01-01-72	84	--	--	01-01-76	60.83	R
					--	--	04-01-76	62.20	R
					--	--	07-01-76	62.68	R
					--	--	11-01-76	60.16	R
					--	--	04-02-84	62.75	S
156	10N.06E.05.424	Michael Garrett	02-21-83	640	400	440	02-23-83	285	R
					560	640	03-28-84	181.55	S
157	10N.06E.07.114	Peppyuung, Roy Tadlock	--	185	--	--	06-15-84	116.40	S
158	10N.06E.07.322	Sandia Well Drilling	05-07-81	140	100	140	05-07-81	90	-
					--	--	03-30-84	33.61	-
					--	--	11-30-84	31.21	-
159	10N.06E.09.331	John M. Saavedra	10-22-80	365	130	180	10-24-80	180	R
					--	--	06-15-84	211.85	T
160	10N.06E.09.331A	Felipe Rael	10-02-83	400	300	400	10-04-83	330	R
					--	--	06-15-84	198.66	T
161	10N.06E.09.333	Fred Rael	10-30-80	365	200	265	11-04-80	260	R
					--	--	06-15-84	246.73	S
162	10N.06E.10.344	Woody's Truck Stop	02-26-79	1,180	1,120	1,180	09-26-79	840	-
163	10N.06E.13.134	Robert Marshall	03-02-81	375	225	375	03-03-81	225	R
					--	--	03-24-81	150	R
					--	--	05-06-85	256.48	S
					--	--	05-08-85	183.18	S
164	10N.06E.13.224	T.O. Harrell	01-01-45	485	--	--	04-27-85	439	R
165	10N.06E.13.321	E.M. Tolman	07-28-80	275	175	275	07-30-80	175	R

Table 5.--Well information and water-level data--Continued

Well number	Local well number	Well owner	Date well constructed	Depth of well (feet)	Top of open interval (feet)	Bottom of open interval (feet)	Water-level data		
							Date measured	Depth to water (feet)	Method of measurement
166	10N.06E.15.231	Luciano Chavez	04-18-73	420	280	320	04-20-73	270	-
					--	--	03-29-84	122	S
167	10N.06E.15.413	Thomas J. Ruiz	09-30-78	220	--	--	--	--	-
168	10N.06E.15.413A	Thomas J. Ruiz	11-10-78	260	160	260	11-10-78	225	-
					--	--	03-29-84	196.27	-
169	10N.06E.24.421	James Thomas	06-13-75	500	--	--	--	--	-
170	10N.06E.24.421A	James Thomas	07-09-76	540	520	540	07-14-76	440	R
					--	--	06-13-84	508.40	S
171	10N.06E.26.132	K.D. Stout	--	329	--	--	03-15-50	142.4	W
		Donald/Carol Bush			--	--	09-24-84	296.06	S
					--	--	09-28-84	250.16	S
172	10N.06E.26.331	Earl Taute	10-01-80	180	--	--	04-05-84	77.38	S
173	10N.06E.26.341	Ed Auten	11-07-80	300	200	300	11-07-80	130	R
					--	--	04-04-84	54.39	S
174	10N.06E.27.444	Richard Silco	04-06-80	250	192	250	04-06-80	125	R
					--	--	04-04-84	85.18	S
175	10N.06E.31.343	Tom Hund	03-30-78	160	40	50	03-30-78	35	R
					120	130	04-09-84	29.10	S
					150	160	--	--	-
176	10N.07E.03.444	Elmer Bassett	01-01-40	287	250	287	03-01-64	156	R
					--	--	05-09-85	156.46	S
177	10N.07E.04.242	Tom C. Horton	04-15-79	415	305	415	05-22-79	306	R
					--	--	04-10-84	304.09	S
178	10N.07E.06.421	Mark Jenson	04-18-83	1,000	--	--	--	--	-
179	10N.07E.09.442	Howard Hill	03-19-74	420	370	420	03-19-74	342	R

Table 5.--Well information and water-level data--Continued

Well number	Local well number	Well owner	Date well constructed	Depth of well (feet)	Top of open interval (feet)	Bottom of open interval (feet)	Water-level data: Date measured	Water-level data: Depth to water (feet)	Water-level data: Method of measurement
179	10N.07E.09.442	Howard Hill	03-19-74	420	--	--	11-15-84	312.58	S
180	10N.07E.09.444	Howard Hill	09-12-56	340	260	290	09-12-56	263	R
					--	--	06-27-62	263	-
							11-15-85	300+	E
181	10N.07E.11.111	Elmer Bassett	--	203	--	--	04-27-50	148.39	-
					--	--	03-03-83	150.44	-
					--	--	05-09-85	151.28	S
182	10N.07E.15.334	Eleanor Hill	--	280	--	--	- -83	Dry	
					--	--	04-30-85	257.24	S
184	10N.07E.16.444	Edgewood Elem. Sch.	06-25-81	380	340	380	07-08-81	280	R
					--	--	05-31-84	285.95	S
185	10N.07E.16.444A	Edgewood Elem. Sch.	06-27-82	600	260	300	07-13-82	280	R
					400	600	05-31-84	281	S
186	10N.07E.17.234	James Kobs	07-31-79	493	460	480	08-02-79	466	R
187	10N.07E.17.234A	Fred Hill	05-11-78	480	420	440	05-15-78	339	R
					460	480	05-01-85	286.15	S
188	10N.07E.17.241	Paul Sievert	01-01-77	420	--	--	05-03-85	295.30	S
189	10N.07E.17.243	Paul Sievert	01-01-78	520	--	--	05-03-85	300.13	S
190	10N.07E.17.244	William Degroot	--	420	--	--	--	--	-
191	10N.07E.17.421	Ron Thurman	01-01-78	520	--	--	--	--	-
192	10N.07E.17.422	George Davidson	01-01-78	540	--	--	--	--	-
193	10N.07E.17.431	Duffy	--	510	--	--	--	--	-
194	10N.07E.17.441	Joe Mock	08-01-77	400	--	--	05-01-84	314.35	S
195	10N.07E.19.412	Faye King	01-01-74	450	--	--	05-07-85	387.20	S
196	10N.07E.19.412A	Gilbert	01-01-81	460	--	--	--	--	-

Table 5.--Well information and water-level data--Continued

Well number	Local well number	Well owner	Date well constructed	Depth of well (feet)	Top of open interval (feet)	Bottom of open interval (feet)	Water-level data		
							Date measured	Depth to water (feet)	Method of measurement
197	10N.07E.20.121	Peggy/Mike Sillings	05-20-78	435	400	435	05-23-78	285	R
					--	--	05-06-85	357.90	S
198	10N.07E.21.112	Lonnie Wright	- -71	380	--	--	--	--	-
199	10N.07E.21.221	Lonnie Wright	- -80	380	--	--	05-09-85	300.49	S
200	10N.07E.22.322	Willie Farmer	01-01-68	430	--	--	05-06-85	290.29	S
201	10N.07E.23.212	G.F. Mosley	01-01-48	200	--	--	08-25-48	138.33	-
		Donald Huston			--	--	08-29-50	136	R
					--	--	03-05-64	151.3	W
					--	--	- -72	159.03	R
					--	--	- -74	153.75	R
					--	--	- -76	155.98	R
					--	--	- -79	154.90	R
					--	--	- -80	155.31	R
					--	--	- -81	154.28	R
					--	--	- -82	156.14	R
					--	--	03-09-83	157.29	R
					--	--	05-07-85	Dry	
202	10N.07E.24.132	Donald Huston	08-01-76	238	95	238	10- -76	127	R
					--	--	03-01-77	127	R
					--	--	05-07-85	131.64	S
203	10N.07E.24.132A	Donald Huston	02-01-76	--	--	--	--	--	-
204	10N.07E.24.224	Herman Dinkle	04-20-55	264	170	190	09-15-55	135	R
					188	242	05-08-85	141	R
					240	264	--	--	-
205	10N.07E.30.111	Mark Villarose	--	500	--	--	06-14-84	350.99	S

Table 5.--Well information and water-level data--Continued

Well number	Local well number	Well owner	Date well constructed	Depth of well (feet)	Top of open interval (feet)	Bottom of open interval (feet)	Water-level data		
							Date measured	Depth to water (feet)	Method of measurement
206	11N.05E.01.111A	Jennie Sanchez	01-01-79	100	--	--	05-31-84	51.82	S
207	11N.05E.23.222	Richard Carpenter	12-16-83	40	35	40	12-16-83	10	R
					--	--	03-16-84	19.71	S
208	11N.05E.23.222A	Grier B. Gould	08-01-74	80	60	80	08-07-74	30	R
					--	--	03-16-84	35.27	S
209	11N.05E.24.113	David Kidd	01-01-72	95	--	--	09-03-83	8.4	S
					--	--	09-06-83	8.95	S
210	11N.05E.24.241	William Dismuke	05-20-74	175	145	180	05-31-74	140	R
					--	--	02-13-84	136.20	S
211	11N.05E.25.133	Knute Miller	05-01-83	185	145	185	05-02-83	150	R
					--	--	08-27-84	131.75	S
212	11N.05E.25.133A	Henrietta Douglas	06-08-83	320	240	320	06-09-83	180	R
					--	--	10-09-84	156.81	S
213	11N.05E.25.143	Doloras Carlson	07-27-84	300	220	300	07-27-84	155	R
					--	--	08-24-84	138.85	S
					--	--	10-10-84	154.93	S
214	11N.05E.25.143A	Doloras Carlson	06-05-80	175	95	175	--	--	-
215	11N.05E.25.144	Roger Smith	01-01-59	110	--	--	10-11-84	108.69	S
216	11N.05E.25.144A	Roger Smith	09-23-83	200	150	200	09-23-83	80	R
					--	--	10-11-84	99.74	S
217	11N.05E.25.144B	Jeff McDowell	03-28-81	210	160	180	03-28-81	92	R
					--	--	08-24-84	96.27	S
					--	--	10-09-84	97.42	S
218	11N.05E.25.311	Rick Rupert	06-08-83	240	160	200	06-08-83	160	R
					220	240	08-27-84	135.93	S

Table 5.--Well information and water-level data--Continued

Well number	Local well number	Well owner	Date well constructed	Depth of well (feet)	Top of open interval (feet)	Bottom of open interval (feet)	Water-level data		
							Date measured	Depth to water (feet)	Method of measurement
218	11N.05E.25.311	Rick Rupert	06-08-83	240	--	--	10-09-84	141.13	S
219	11N.05E.25.423	John Steenson	03-01-84	400	--	--	05-30-84	285.27	S
220	11N.05E.35.234	Jim Willis	11-07-83	293	100	293	11-09-83	95	R
					--	--	03-21-84	91.32	S
221	11N.05E.35.244	Jim Willis	07-20-72	110	50	110	07-25-72	40	R
					--	--	03-21-84	89.25	S
					--	--	06- -84	--	-
222	11N.05E.35.244A	Jim Willis	07-19-72	180	120	180	07-19-72	120	R
					--	--	03-21-84	113.70	S
					--	--	10-29-84	119.20	S
223	11N.05E.35.244B	Jim Willis	07-18-72	110	55	115	07-18-72	50	R
					--	--	03-21-84	96.32	S
					--	--	10-29-84	--	-
224	11N.05E.35.414	Ambrose Rivera	04-10-79	224	205	245	04-10-79	150	R
					--	--	10-29-84	202.39	S
225	11N.05E.35.414A	Ambrose Rivera	10-12-84	350	250	350	10-13-84	165	R
					--	--	10-29-84	177.33	S
226	11N.05E.35.421	Neal McEwen	10-10-84	275	200	275	10-11-84	165	R
					--	--	10-22-84	132.59	S
227	11N.05E.35.421A	Neal McEwen	01-16-79	135	100	137	01-19-79	87	R
					--	--	10-22-84	129.37	S
228	11N.05E.35.434	Hugh Pierson	03-17-78	176	116	126	03-17-78	85	R
					166	176	10-29-84	137.22	S
229	11N.05E.35.441	Demitrio Lucero	04-30-77	255	225	235	04-30-77	120	R
					245	255	10-30-84	194.34	S

Table 5.--Well information and water-level data--Continued

Well number	Local well number	Well owner	Date well constructed	Depth of well (feet)	Top of open interval (feet)	Bottom of open interval (feet)	Water-level data		
							Date measured	Depth to water (feet)	Method of meas- urement
230	11N.05E.35.443	David Schafer	08-23-80	200	140	200	08-23-80	100	R
					--	--	04- -84	--	-
					--	--	10-29-84	--	-
231	11N.05E.35.443A	David Schafer	02-01-84	410	--	--	10-29-84	159.16	S
232	11N.05E.36.113	Tauno Keranan	03-14-79	200	110	120	03-14-79	90	R
233	11N.05E.36.131	Bella Vista	--	139	--	--	02-08-84	47.07	S
234	11N.05E.36.311	Mtn. Church	08-28-81	200	125	200	08-28-81	55	R
					--	--	03-21-84	47.90	S
					--	--	10-22-84	45.51	S
235	11N.06E.18.433	San Antonito Sch.	--	200	120	140	02-13-84	82.12	S
					165	175	--	--	-
					185	200	--	--	-
236	11N.06E.19.141	Alva Parker	--	128	--	--	02-13-84	24.34	S
237	11N.06E.19.143	Pete Jojola	06-16-78	125	80	125	06-16-78	40	R
					--	--	03-13-84	27.92	S
238	11N.06E.19.313	W.A. Arias	01-01-42	136	--	--	07-06-62	83	W
		Mike Arias			--	--	10-10-84	80.14	S
					--	--	12-12-84	77.29	S
239	11N.06E.19.322	BC Fire Station 6	07-13-74	140	55	65	07-13-74	53	R
					90	152	- -77	60.02	R
					--	--	- -78	61.15	R
					--	--	- -79	63.75	R
					--	--	- -80	56.79	R
					--	--	- -81	57.30	R
					--	--	- -82	63.59	R

Table 5.--Well information and water-level data--Continued

Well number	Local well number	Well owner	Date well constructed	Depth of well (feet)	Top of open interval (feet)	Bottom of open interval (feet)	Water-level data		
							Date measured	Depth to water (feet)	Method of meas-urement
239	11N.06E.19.322	BC Fire Station 6	07-13-74	140	--	--	03-14-83	63.18	R
					--	--	02-13-84	63.60	S
					--	--	10-10-84	68.39	S
					--	--	04-30-85	56.60	S
					--	--	01-15-86	46.79	S
240	11N.06E.19.341	Pete Jojola	- -55	80	--	--	03-13-84	30.69	S
241	11N.06E.20.242	Vincent Botarelli	01-22-78	300	280	300	01-23-78	245	R
					--	--	03-13-84	236.97	S
242	11N.06E.20.313	Randy Sanchez	09-09-83	278	60	100	09-13-83	70	R
					120	140	03-13-84	41.94	S
					240	278	--	--	-
243	11N.06E.22.414	Pete Jojola	10-02-78	420	350	390	10-04-78	345	R
					--	--	03-13-84	365.78	S
244	11N.06E.22.444	Elizabeth Leach	--	460	--	--	03-14-84	267.65	S
245	11N.06E.24.122	Victor Chavez	01-01-62	110	--	--	04-10-84	67.67	S
246	11N.06E.24.211	Victor Chavez	01-01-65	300	--	--	04-10-84	231.28	S
247	11N.06E.26.111	T.P. Conlon	10-20-74	360	300	360	10-22-74	272	-
					--	--	03-14-84	208.94	-
248	11N.06E.26.344	R.T. West	01-01-59	175	150	175	01-11-85	121.70	S
249	11N.06E.26.443	Tom Horton	08-06-66	190	--	--	01-11-85	137.35	S
250	11N.06E.28.322	Harry Steffy	07-01-82	150	--	--	04-10-84	72.03	S
251	11N.06E.29.123	Bernard Parker	12-27-78	117	97	117	12-27-78	77	R
					--	--	06-13-84	87.35	S
252	11N.06E.29.131	Charles Kitchell	--	178	--	--	03-15-84	168.09	S
253	11N.06E.29.214	Charles Kitchell	10- -59	155	--	--	03-15-84	122.95	S

Table 5.--Well information and water-level data--Continued

Well number	Local well number	Well owner	Date well constructed	Depth of well (feet)	Top of open interval (feet)	Bottom of open interval (feet)	Water-level data: Date measured	Water-level data: Depth to water (feet)	Water-level data: Method of measurement
254	11N.06E.29.214A	Charles Kitchell	- -62	160	--	--	03-15-84	107	S
255	11N.06E.29.312	Bernado Parker	12-26-78	117	97	117	12-27-78	77	R
					--	--	06-13-84	59.85	S
256	11N.06E.29.442	Ruth Kitchell	04-30-81	378	--	--	03-15-84	242.20	S
257	11N.06E.31.112	Galen Swift, Frank White	01-01-73	700	--	--	05-31-84	503.90	S
258	11N.06E.32.144	Lance Fleming	01-01-84	485	--	--	06-15-84	287.60	S
259	11N.06E.33.221	Bob Hacker	08-23-71	385	--	--	11-12-71	300	R
					--	--	03-15-84	306.55	S
260	11N.06E.33.224	Bob Hacker	03-15-79	310	270	310	03-17-79	270	R
					--	--	03-15-84	172.56	S
261	11N.06E.34.322	Charles Kennington	03-20-72	935	450	900	08-01-72	400	R
					--	--	05-30-84	409.40	S
262	11N.06E.34.422	Wayne Miller	08-24-74	600	300	320	08-27-74	264	R
					--	--	03-16-84	257.38	S
263	11N.06E.36.333	Vernon	01-01-45	920	--	--	- -62	610	R
					--	--	06-27-62	712.5	W
264	11N.07E.02.224	Paul Butt	10-17-83	620	340	620	10-17-83	460	R
		Wilbur Stearns			--	--	09-24-84	401.70	S
265	11N.07E.19.211	Tom Horton	12-01-77	370	300	370	12-10-77	250	R
					--	--	10-01-84	299.99	S
266	11N.07E.20.112	Tom Horton, Elmo Darrah	01-01-19	360	340	360	02-16-78	290	R
267	11N.07E.21.144	Fernando Nieto	--	160	--	--	07-02-62	108	W
					--	--	08-21-84	108.70	S

Table 5.--Well information and water-level data--Concluded

Well number	Local well number	Well owner	Date well constructed	Depth of well (feet)	Top of open interval (feet)	Bottom of open interval (feet)	Water-level data		
							Date measured	Depth to water (feet)	Method of meas- urement
268	11N.07E.22.111	CG Co-op	01-01-72	610	--	--	08-26-75	475	R
					--	--	09-24-84	424.50	S
269	11N.07E.24.224	Herman Dinkle	01-01-57	180	--	--	- -57	172	R
					--	--	10-30-64	--	-
					--	--	05-07-85	172	R
270	11N.07E.28.442	Tom Horton	12-01-78	567	310	330	04-10-84	316.09	S
					410	465	10-01-84	351.86	S
271	11N.07E.29.211	Tom Horton	01-01-72	252	--	--	- -72	238.11	R
					--	--	01-19-82	239	R
					--	--	10-01-84	237.06	S
272	11N.07E.29.242	Tom Horton	11-09-82	625	400	602	03-10-83	435	R
					--	--	06-04-84	440.32	R
					--	--	10-01-84	437.62	S
273	11N.07E.33.434	Tom Horton	06-01-80	451	--	--	12-31-81	316.6	R
					--	--	04-10-84	316.72	S
274	11N.07E.33.442	Tom Horton	01-01-74	400	--	--	12-31-81	312	R
275	11N.07E.34.111	Wesley Moomey	01-01-30	375	--	--	--	--	-
276	12N.05E.36.331	Jennie Sanchez	09-12-79	390	360	380	--	--	-
277	12N.05E.36.332	Jennie Sanchez	01-01-84	--	--	--	05-31-84	313.06	S
278	12N.05E.36.343	Steve Wright	05-01-84	430	--	--	05-31-84	358.30	S
279	12N.07E.34.224	M.M. Iverson	06-29-68	600	570	600	05-21-73	464.44	-
					--	--	06-17-76	464	R
					--	--	09-24-84	466.82	S

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