SELECTED HYDROLOGIC DATA FROM THE NORTHERN PART OF THE HUECO BOLSON, NEW MEXICO AND TEXAS

By Brennon R. Orr and Robert R. White

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CONVERSION FACTORS

In this report, measurements are given in inch-pound units. The following table contains factors for converting to metric units.

Multiply inch-pound units	By	To obtain metric units
inch	25.40	millimeter
foot	0.3048	meter
mile	1.609	kilometer
square mile	2.590	square kilometer
gallon	0.003785	cubic meter
acre	4,047	square meter
acre-foot	1,233	cubic meter

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ABSTRACT

Hydrologic data were collected in early 1985 from the northern part of the Hueco Bolson in Doña Ana County, New Mexico, and El Paso County, Texas, and in adjacent areas in the Tularosa Basin in New Mexico. Water-level measurements made in 50 wells are presented in this report. Information is also presented on ground-water withdrawals from the Hueco Bolson by El Paso and Ciudad Juarez municipal wells, by industrial and military wells, and by wells in the Chaparral, New Mexico, area that have been used for both irrigation and municipal purposes. Lithologic logs and geophysical logs are included for four test wells that were drilled as part of this project during August and September 1985.

INTRODUCTION

Location and Description of the Area

The Hueco Bolson includes parts of Doña Ana and Otero Counties in south-central New Mexico and most of El Paso County in westernmost Texas (fig. 1). The bolson extends southward into the State of Chihuahua, Mexico. The Hueco Bolson is bounded on the east by the Hueco Mountains, the Diablo Plateau, and the Finley, Malone, and Quitman Mountains, and on the west by the Franklin Mountains and several mountain ranges in Mexico. The Hueco Bolson is separated from the Tularosa Basin to the north by a low, broad topographic divide that is about 5 miles north of the New Mexico-Texas State line near the Franklin Mountains and as much as 10 miles north of the State line near the Hueco Mountains. However, the topographic divide is not a ground-water divide (Knowles and Kennedy, 1958a, pl. 2; McLean, 1970, fig. 5), and the Hueco Underground Water Basin as defined by the New Mexico State Engineer Office extends from the New Mexico-Texas State line northward for about 21 miles.

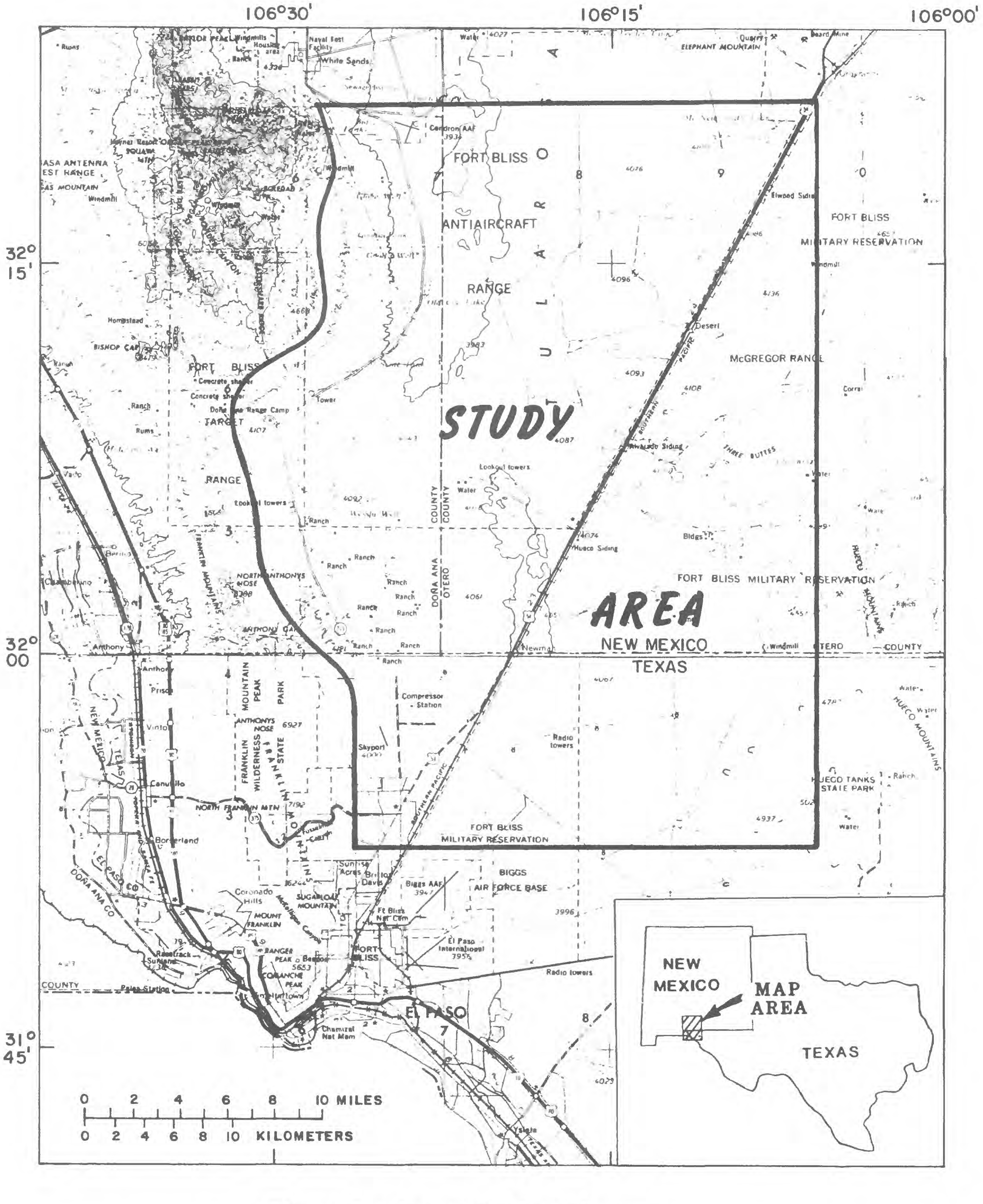


Figure 1.--Location of study area.

Purpose and Scope

The purpose of this report is to present results of recent data-collection activities in the northern part of the Hueco Bolson in New Mexico and Texas and in adjacent areas in the Tularosa Basin in New Mexico (fig. 1). This interim data report is a product of a cooperative study between the U.S. Department of the Army (Fort Bliss), the New Mexico State Engineer Office, the city of El Paso, and the U.S. Geological Survey. The objectives of this study are to determine: (1) The present distribution and availability of fresh ground water in the New Mexico part of the Hueco Bolson; (2) changes in water levels, water in storage, and water quality that would result from additional ground-water withdrawals in New Mexico; and (3) the effects on water levels, storage, and water quality of continued ground-water withdrawals from the Texas part of the Hueco Bolson.

Graphs of regional ground-water withdrawals from the Hueco Bolson are included in this report. Data on military and industrial withdrawals and municipal withdrawals by El Paso, Texas, and Juarez, Mexico, were compiled by the El Paso Water Utilities, the Texas Department of Water Resources, and by the Texas District of the U.S. Geological Survey. Information on ground-water withdrawals in the Chaparral, New Mexico, area was obtained from the New Mexico State Engineer Office and the Lake Section Water Co. Information on ground-water withdrawals is presented in graphical form in this report to facilitate comparison of information that is currently available. The data from which these graphs were made are available from the El Paso Water Utilities, the New Mexico State Engineer Office, and the U.S. Geological Survey.

As part of this cooperative project, four test wells were drilled in the Hueco Bolson during August and September 1985. Lithologic logs and electric logs for these test wells are included in this report.

Previous Studies

The Hueco Bolson has been the subject of numerous studies throughout this century. A bibliography listing more than 60 publications on the area is included at the end of this report. Slichter (1905) and Richardson (1909) described the area when there was very little ground-water development. Slichter made a considerable number of measurements relating to ground water and surface water in the El Paso area.

Numerous data reports have been published on ground water in the El Paso area during the past several decades, including reports by Scalapino and Irelan (1949), Leggat (1962), Davis (1965), and Meyer and Gordon (1972a). A comprehensive report on ground water in the El Paso area by Sayre and Livingston (1945) was published in 1945, and a similar report on the Hueco Bolson by Knowles and Kennedy (1958a) was published in 1958.

The Hueco Bolson has been the subject of a number of model studies that simulated ground-water declines that would be expected under future pumping conditions. Leggat and Davis (1966) developed an analog model of the Hueco Bolson; 10 years later, Meyer (1976) analyzed the same area using a digital model. Knowles and Alvarez (1979) simulated effects of ground-water withdrawals in parts of the Hueco Bolson. Two recent studies have given extensive descriptions of ground-water conditions in the El Paso area. Alvarez and Buckner (1980) presented approximately 300 pages of information on wells in the area, including water-level measurements, chemical analyses, and records of the salinity of water withdrawn from irrigation wells completed in the Rio Grande alluvium. White (1983) summarized the water situation in the El Paso area from 1903 to 1980 with a series of maps, graphs, and tables.

Well-Numbering Systems

The system of numbering wells in New Mexico is based on the common subdivision of public lands into sections. The well number, in addition to designating the well, locates its position to the nearest 10-acre tract in the land network. The well number is divided by periods 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; the third denotes the section (fig. 2). All wells in the New Mexico part of the Hueco Bolson are in townships south of the base line and east of the principal meridian. The fourth segment of the number, which consists of three digits, denotes the 160-, 40-, and 10-acre tracts in which the well is located in the section. For this purpose, the section is divided into four quarters, numbered 1, 2, 3, and 4, 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. Thus, well 23S.5E.10.413 is in the SW 1/4 of the NW 1/4 of the SE 1/4, section 10, Township 23 South, Range 5 East (fig. 2). The letters a, b, c, and so on are added to designate the second, third, fourth, and succeeding wells in the same 10-acre tract.

In the Texas part of the Hueco Bolson, the well-numbering system used in this report is that used by the Texas Water Development Board (fig. 3). Under this system, which is based on latitude and longitude, each 1-degree quadrangle in the State is given a two-digit number from 01 through 89. These are the first two digits of the well number. El Paso County is in parts of quadrangles 48 and 49. Each 1-degree quadrangle is subdivided into 7 1/2-minute quadrangles that are each given a two-digit number from 01 to 64. These are the third and fourth digits of the well number. Each 7 1/2-minute quadrangle is further subdivided into 2 1/2-minute quadrangles that are each given a single-digit number ranging from 1 through 9. This is the fifth digit of the well number. Finally, each well within a 2 1/2-minute quadrangle is given a two-digit number in the order in which the well was inventoried, starting with 01. These are the last two digits of the well number. In addition to the seven-digit well number, a two-letter prefix is used to identify the county; the prefix for El Paso County is JL.

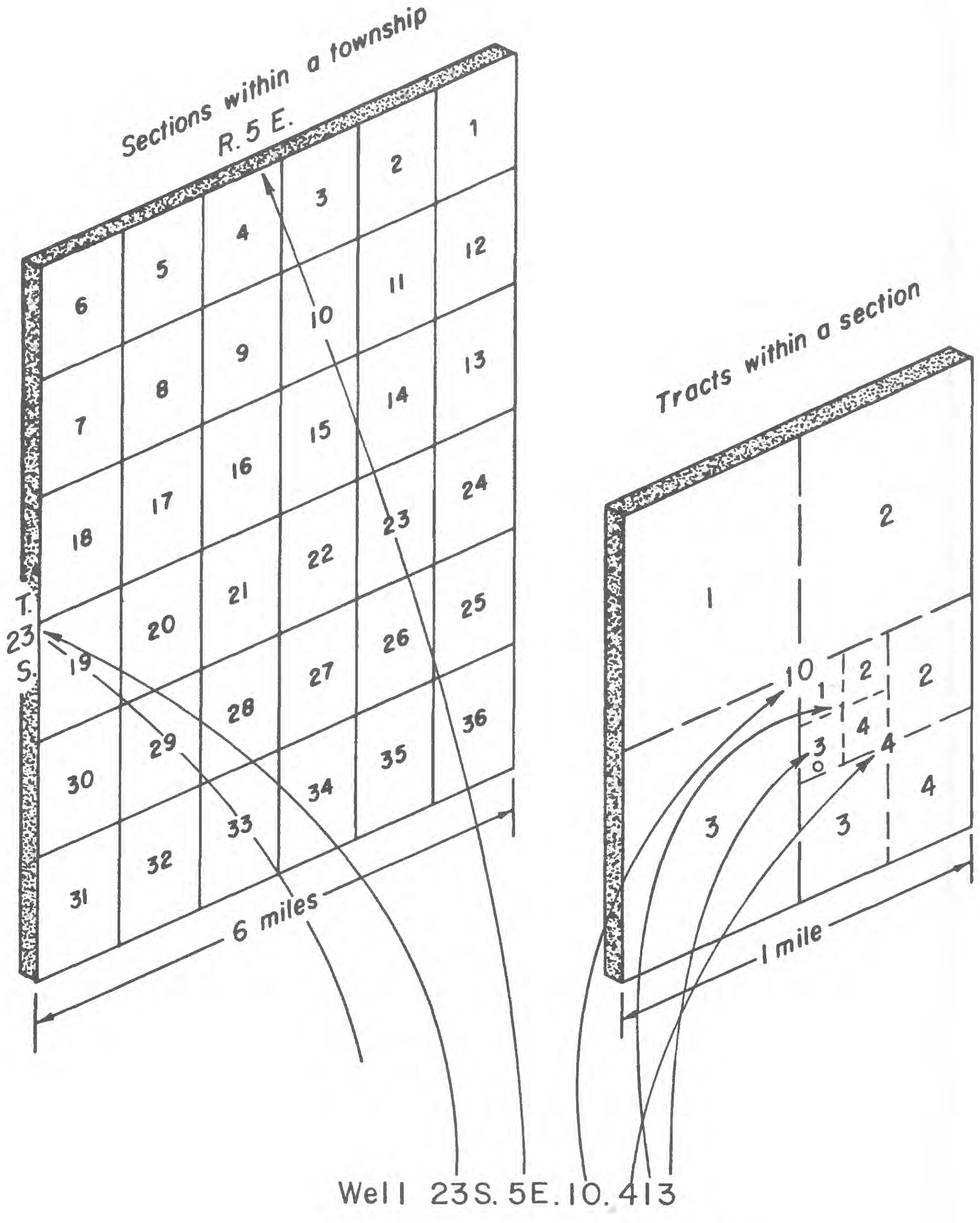


Figure 2.--System of numbering wells in New Mexico.

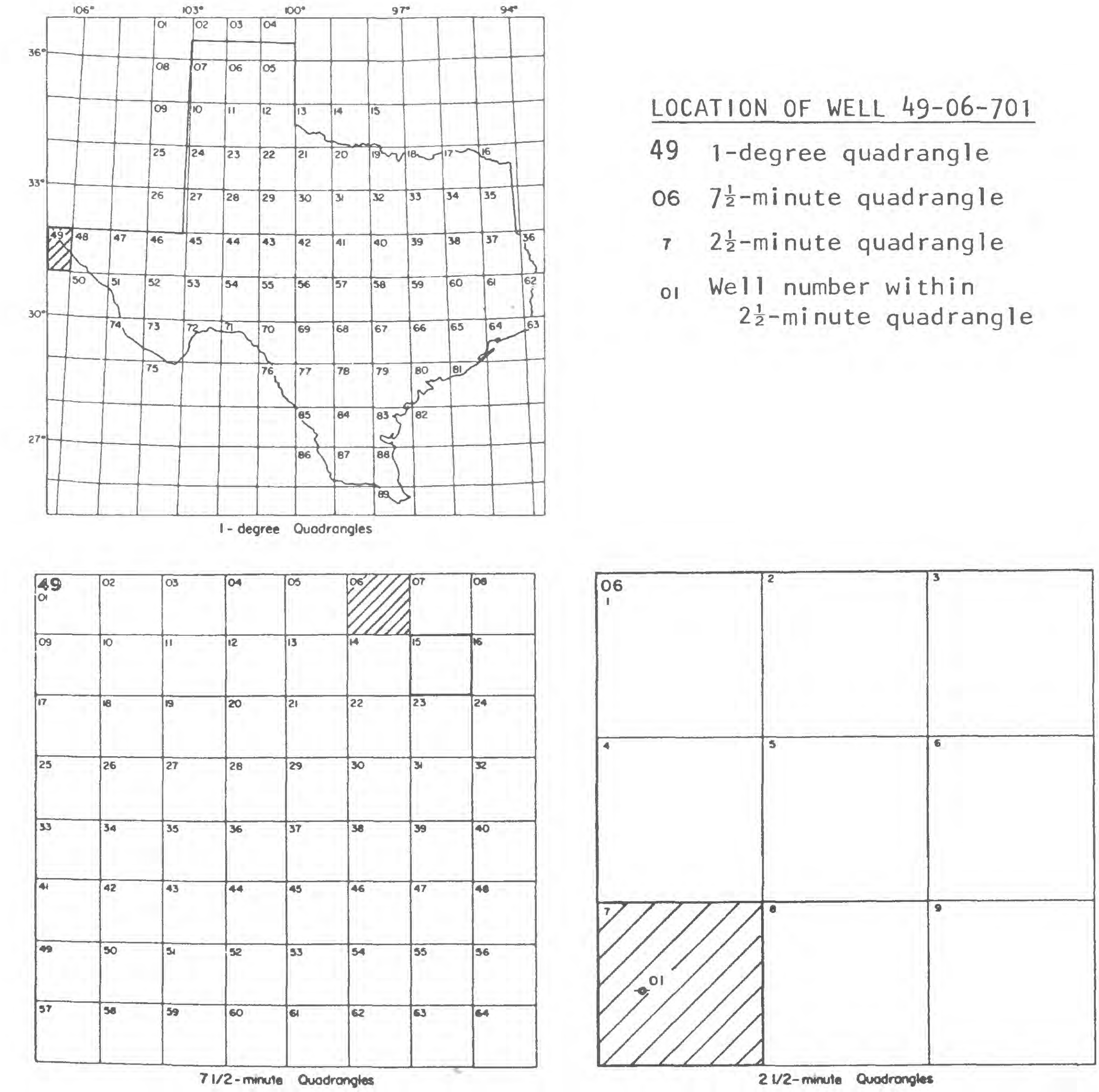


Figure 3.--System of numbering wells in Texas.

Acknowledgments

The authors acknowledge the assistance of John Nixon, Theodore Reyes, and Tom Valverde, New Mexico State Engineer Office, in making water-level measurements. William Lewis of the Fort Bliss water plant provided valuable information about Fort Bliss wells. Thomas Cliett of El Paso Water Utilities and Donald White of the U.S. Geological Survey, El Paso office, furnished most of the water-use data for this report. Estella Rosencrans of the Lake Section Water Co. and Delores Wright of the C.B.G. Maintenance Co. provided water-use information for the Chaparral area and answered questions that subsequently arose about water use. Wesley McCoy gave assistance regarding Texas well numbers.

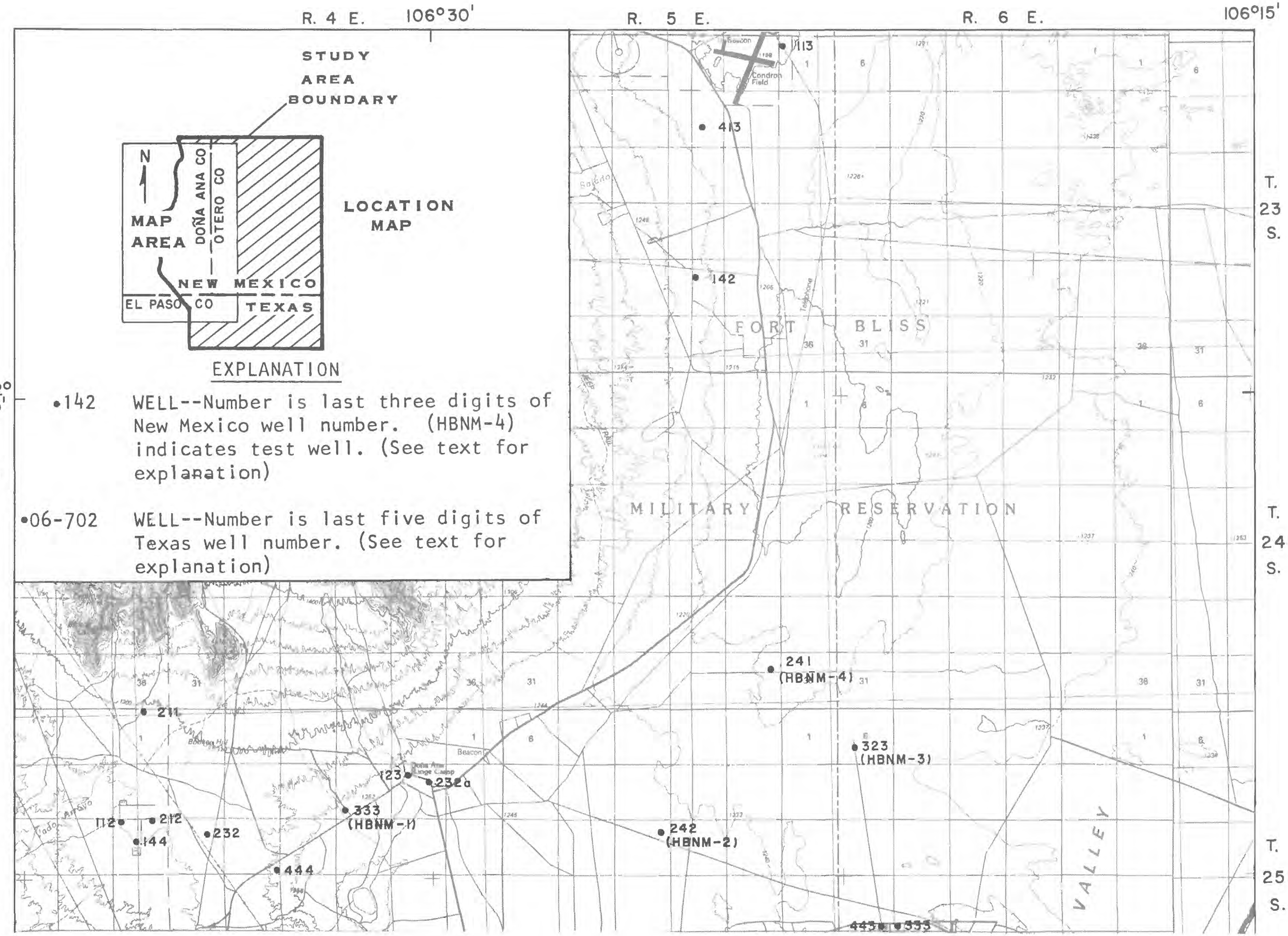
WATER-LEVEL MEASUREMENTS

Water levels were measured in 50 wells in the northern part of the Hueco Bolson (north of lat 31°52'30" N.) from January to March 1985 by hydrologists from the U.S. Geological Survey and the New Mexico State Engineer Office. The results of these measurements and some water-level information from previous years are shown in table 1. The location of wells for which water levels are given in table 1 is shown in figure 4.

GROUND-WATER WITHDRAWALS IN THE HUECO BOLSON

The first well to supply water to the city of El Paso was dug in 1892 a few hundred yards from the Rio Grande. The well supplied large quantities of water, but the quality was unsatisfactory, so, until 1904, drinking water was shipped into the city from Deming, New Mexico (Knowles and Kennedy, 1958a, p. 20). The International Water Co. began drilling wells on the mesa north of Fort Bliss in 1903; a score of wells had been drilled by 1910, including a 2,285-foot-deep test hole. The water company began supplying the city with water from the mesa wells in 1905 (Richardson, 1909, p. 11).

Although significant ground-water development began in the Hueco Bolson in 1903, records are not available before 1906 (White, 1983, p. 6). Annual ground-water withdrawals from the Hueco Bolson by the city of El Paso are shown in figure 5. Ground-water withdrawals were 0.35 billion gallons in 1906 and increased to 0.62 billion gallons in 1910 when the population of the city was 39,300. Ground-water withdrawals by the city from the Hueco Bolson gradually increased to 4.09 billion gallons in 1950 when the population was 130,000. Beginning in the early 1950's, water use and population started to increase rapidly in El Paso. By 1980, ground-water withdrawals by the city were 18.9 billion gallons at a time when the population was 425,100 (White, 1983, p. 7 and fig. 13). In 1984, El Paso city wells withdrew 21.3 billion gallons of water from the Hueco Bolson.


R. 4 E.
106°30'
R. 5 E.
R. 6 E.
106°15'
T. 23 S.
T. 24 S.
T. 25 S.
32° 15'
STUDY AREA BOUNDARY
LOCATION MAP
N
MAP AREA
DOÑA ANA CO
OTERO CO
NEW MEXICO
EL PASO CO
TEXAS
EXPLANATION
•142 WELL--Number is last three digits of New Mexico well number. (HBNM-4) indicates test well. (See text for explanation)
•06-702 WELL--Number is last five digits of Texas well number. (See text for explanation)
FORT BLISS
MILITARY RESERVATION
VALLEY
Condron Field
Beacon
113
413
142
241 (HBNM-4)
323 (HBNM-3)
242 (HBNM-2)
333 (HBNM-1)
123
232a
211
112
212
144
232
444
443
333

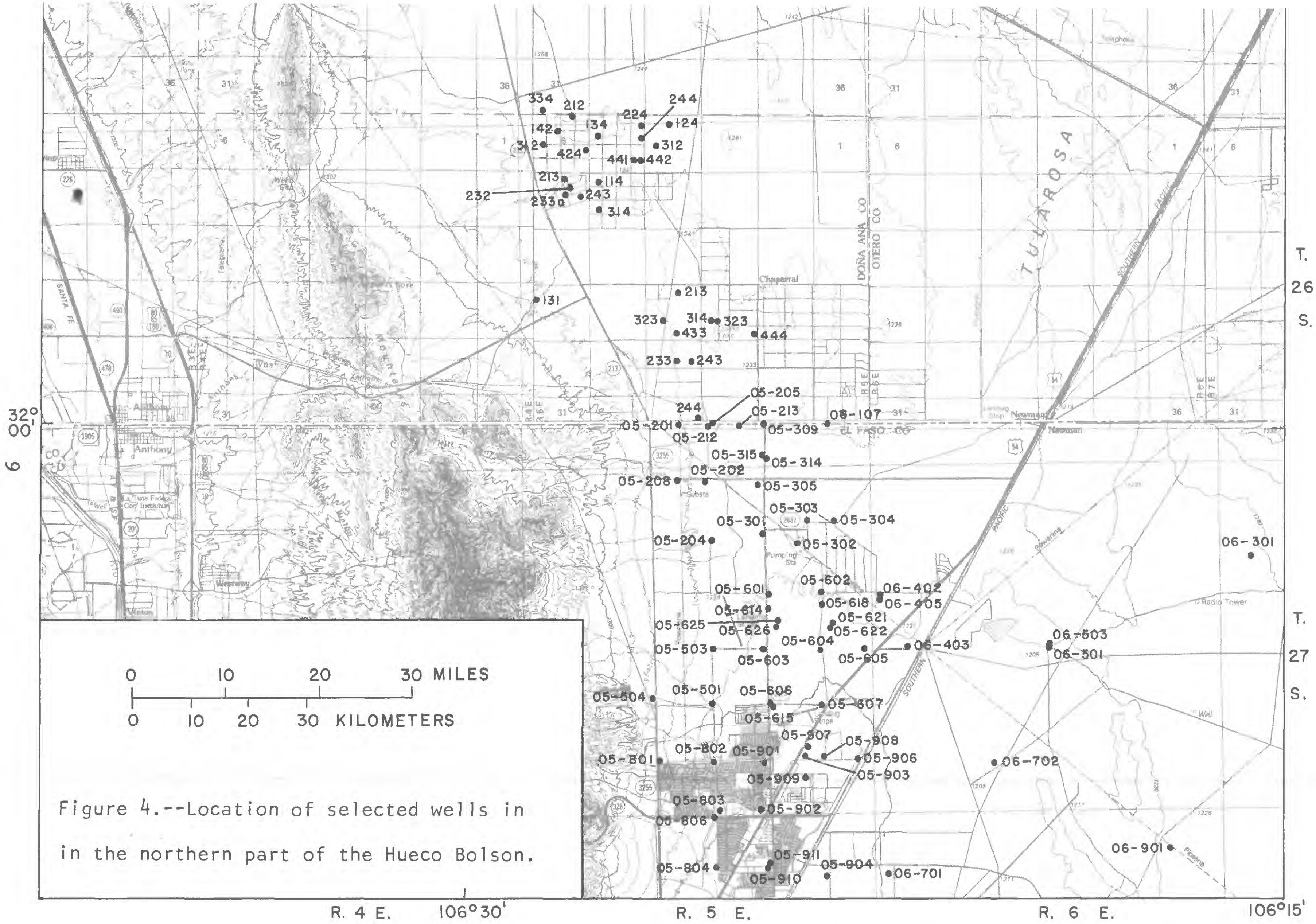


Figure 4.--Location of selected wells in in the northern part of the Hueco Bolson.

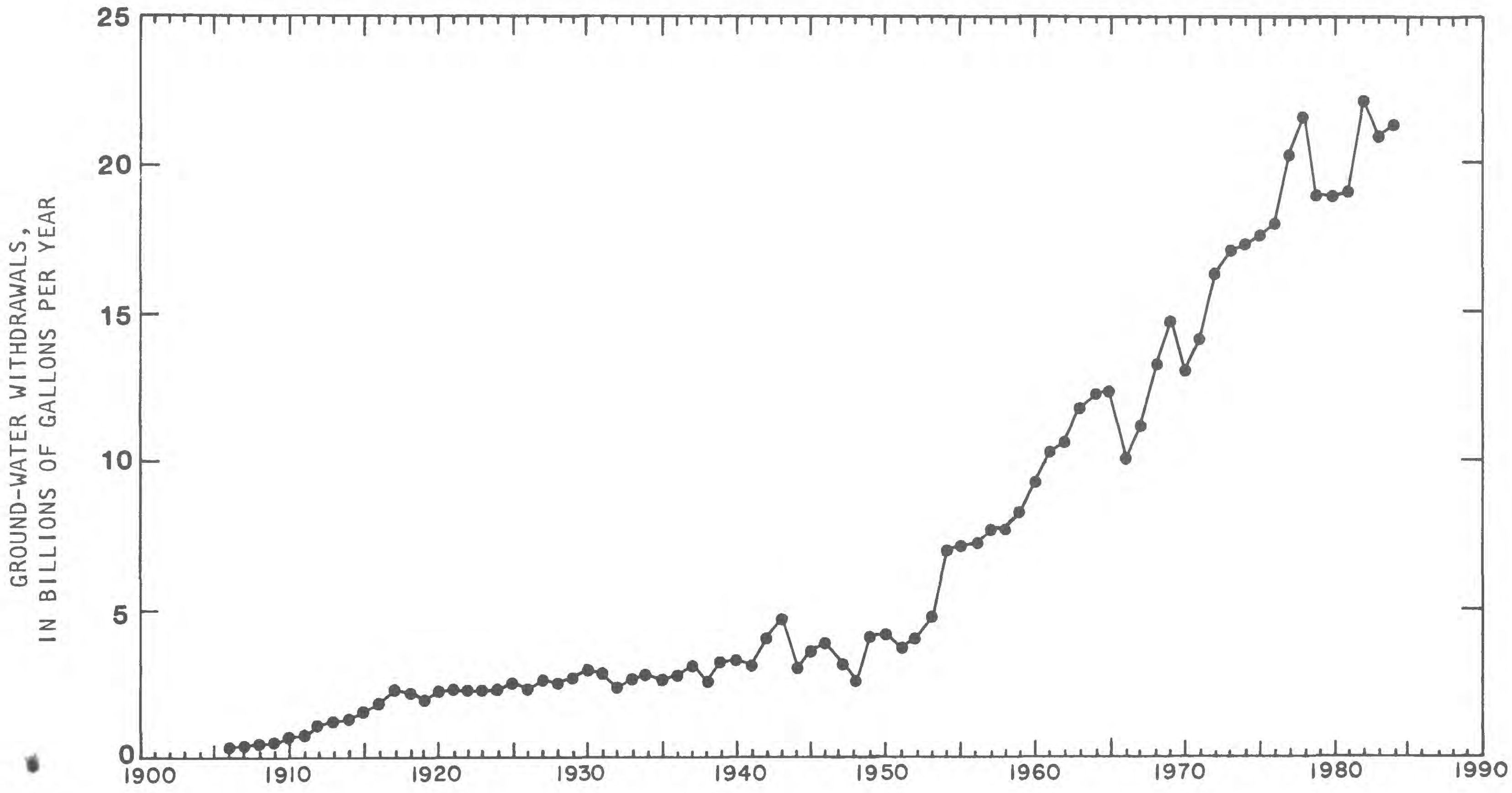


Figure 5.--Annual ground-water withdrawals from the Hueco Bolson by El Paso municipal wells, 1906-84.

Annual ground-water withdrawals from the Hueco Bolson by industrial wells in Texas during 1903-83 are shown in figure 6; these values include minor irrigation withdrawals. During the first two decades of record, the withdrawals plotted generally represent averages that have been made for groups of years. For example, the withdrawals from 1904 to 1911 are the estimated 8-year total divided into eight equal parts. Industrial ground-water withdrawals from the Hueco Bolson in Texas reached a maximum of 7.06 billion gallons in 1973. No records are available for industrial withdrawals from the New Mexico part of the Hueco Bolson, but such withdrawals are believed to be small or nonexistent.

Annual ground-water withdrawals from the Hueco Bolson by military wells in Texas and New Mexico are shown in figure 7. Withdrawals in New Mexico at Doña Ana Range Camp and Hueco Range Camp are small compared to withdrawals in Texas. Therefore, the New Mexico withdrawals have been plotted at the same scale as the Texas withdrawals as well as at an expanded scale so that the annual variations can be seen. Some ground-water withdrawals by the military occurred prior to 1960 in New Mexico, but records are not available. Withdrawals by military wells in Texas from 1906 to 1916 are the estimated 11-year total divided into 11 equal parts; likewise, the withdrawals for 1917 to 1919 are averages.

Records begin in 1926 for withdrawals from the Hueco Bolson by Ciudad Juarez municipal wells (fig. 8). Withdrawals remained at less than 2 billion gallons per year until the early 1950's. In the late 1950's and throughout the 1960's, ground-water withdrawals by Ciudad Juarez were about 5 billion gallons per year, but in the early 1970's water use began to increase sharply to the extent that withdrawals in 1984 amounted to 21.5 billion gallons. In 1980, the population of Ciudad Juarez was 544,900, 28 percent greater than that of El Paso.

Historic withdrawals from selected wells in the study area (fig. 4) are shown in a series of graphs (figs. 9, 10, and 11). Withdrawal data for wells in Texas were compiled and provided by the city of El Paso. Withdrawal data for wells in New Mexico were obtained from Lake Section Water Co., Fort Bliss, and Geological Survey files. Withdrawal records are available for 23 municipal wells, 2 military wells, and at least 21 industrial and irrigation wells in the area south of the New Mexico-Texas State line and north of lat 31°52'30" N. In New Mexico, records are available for three military wells and six public-supply and irrigation wells.

Annual ground-water withdrawals from the Hueco Bolson by the Lake Section Water Co. in Chaparral, New Mexico, for 1968-84 are shown in figure 12. The company's first two wells were drilled in 1960; another five wells were added to the system between 1965 and 1974. The wells were used for irrigation until they were needed for public supply. Records of ground-water withdrawals are not available until 1968 when water was first supplied for public supply. Customer service provided by the Lake Section Water Co. increased from 10 connections in 1968 to 952 connections in 1984 (fig. 13).

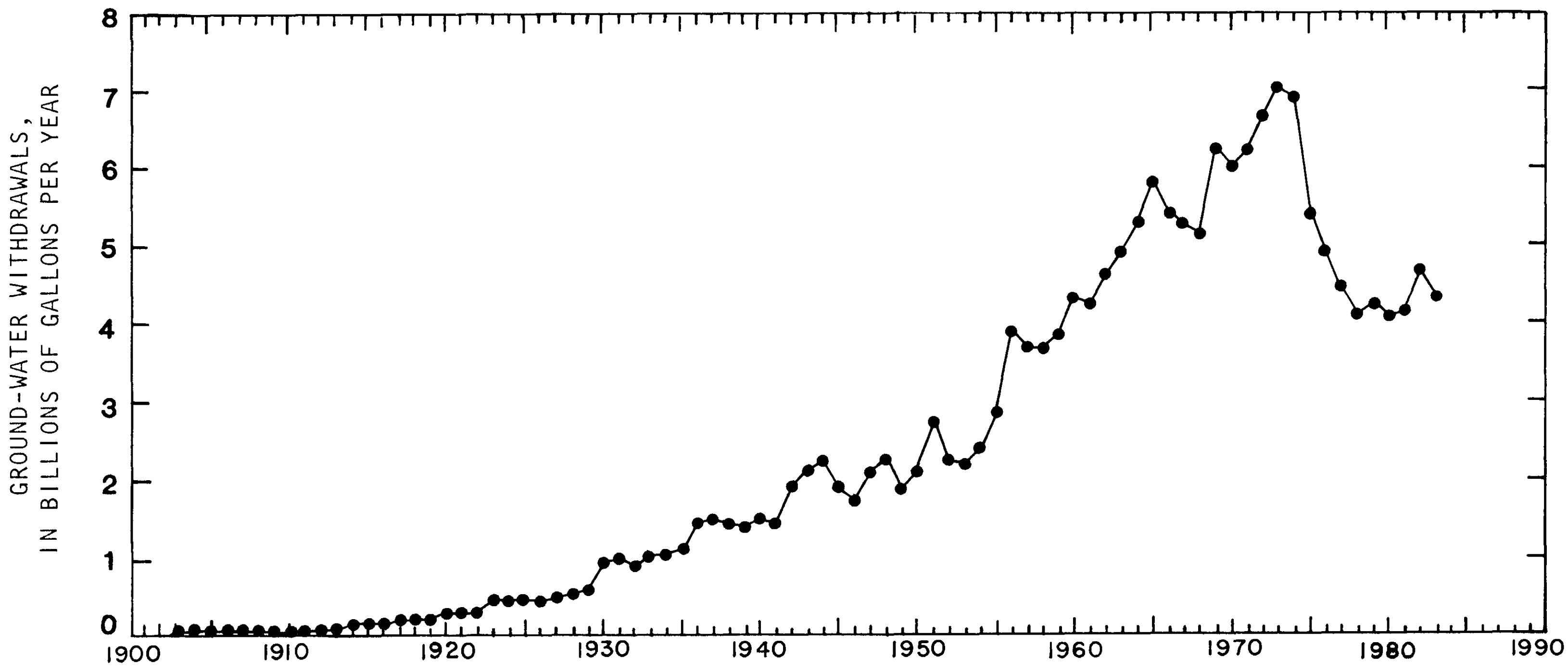


Figure 6.--Annual ground-water withdrawals from the Hueco Bolson by industrial wells in Texas, 1903-83.

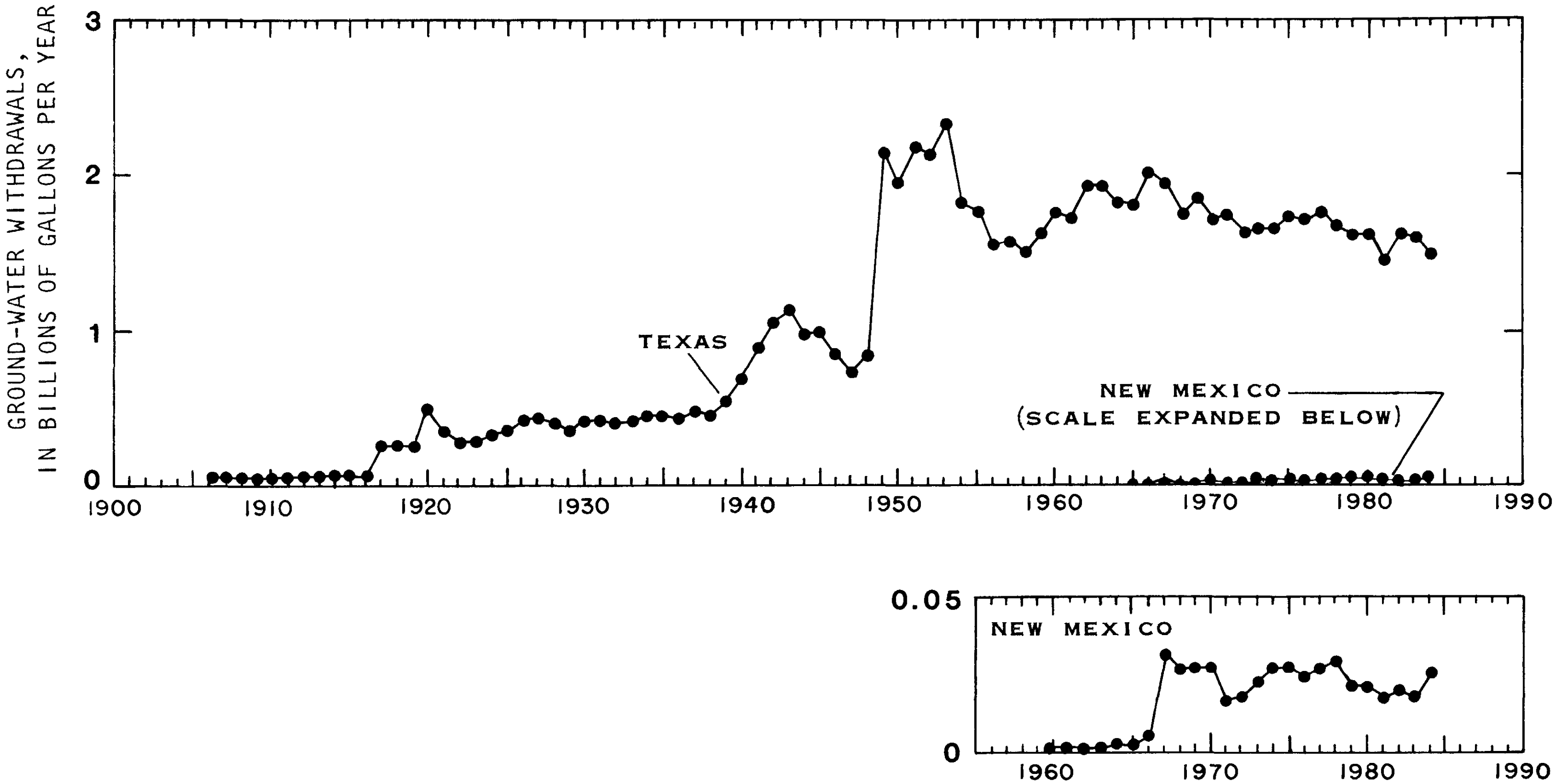


Figure 7.--Annual ground-water withdrawals from the Hueco Bolson by military wells in Texas and New Mexico, 1906-84.

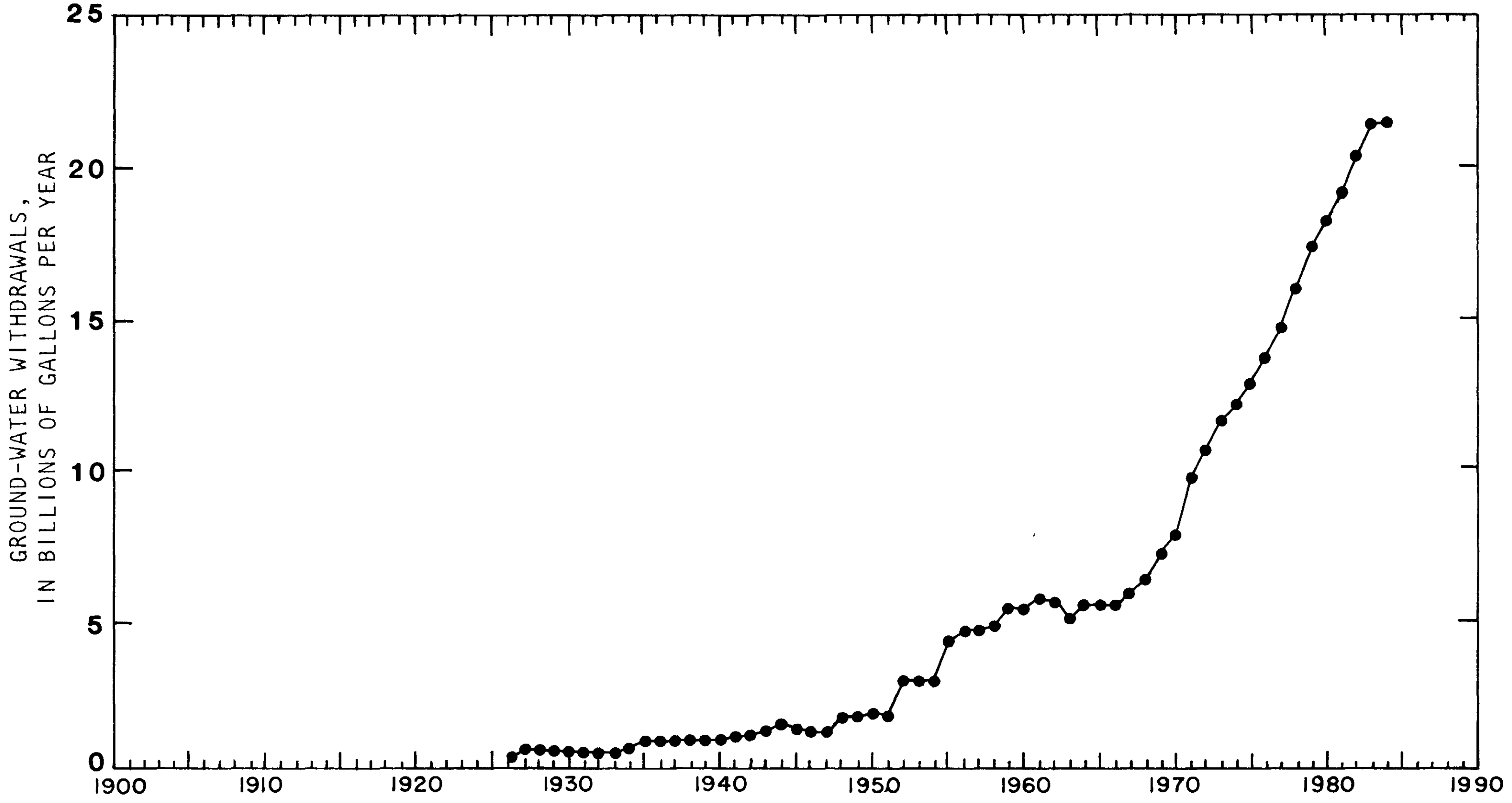


Figure 8.--Annual ground-water withdrawals from the Hueco Bolson by Ciudad Juarez municipal wells, 1926-84.

Withdrawals for public supply by Lake Section Water Co. wells for 1968-84 are shown in figures 10 and 11. Annual withdrawals by well from 1968 through 1978 (fig. 10) were derived from metered data supplied by the company. Annual withdrawals by well from 1979 through 1984 (fig. 11) were estimated by the Lake Section Water Co. These estimates are provided only to illustrate the relative withdrawals by well. Estimates are not in complete agreement with the withdrawals shown in figure 12, which were derived from monthly pumpage records kept by the water company.

Monthly graphs of combined public-supply withdrawals from the Lake Section Water Co. wells for 1980 and 1984 (fig. 14) indicate the approximate distribution of water withdrawn for public supply during the year in the northern part of the Hueco Bolson in New Mexico. Annual withdrawals from military wells at Doña Ana and Hueco Range Camps are shown in graphs for wells 25.04.11.232a, 25.04.11.123, and 25.06.19.443 (fig. 9). Records for withdrawals from the two wells at the Doña Ana Range Camp were reported as combined and are not shown by individual well. Usage from these military wells varies according to the level of military-training activities, which may change from year to year.

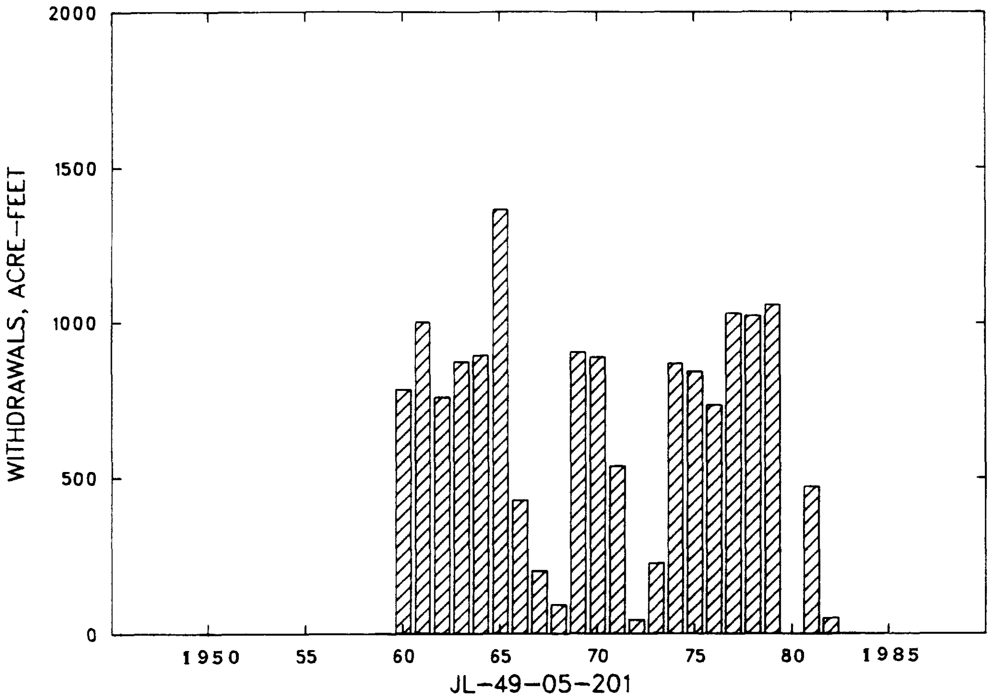
The C.B.G. Maintenance Co. also serves public-supply customers in the Chaparral area. No estimates of withdrawals are available for this water system. However, the company began providing service in 1977 and was providing water to 105 connections in 1985.

The Colquitt Co. began irrigating land in the Chaparral area in 1960. Wells used for irrigation were converted to public supply as development progressed. Estimates of irrigation withdrawals by well were provided by the Lake Section Water Co. and are shown in figure 15.

Estimates of other withdrawals for irrigation in the Chaparral area are not available. However, some indication of the extent of irrigation withdrawals can be obtained through records of irrigated acreage. The New Mexico State Engineer Office, in the course of extensive inventory of the Chaparral area, made estimates of irrigated acreage (New Mexico State Engineer Office, written commun., 1985). By 1985, more than 550 acres were being irrigated. Ninety percent of this acreage is irrigated by nine wells. Estimates of the acreage irrigated by each well are shown in table 2.

The remaining 10 percent of irrigated acreage in the vicinity of Chaparral consists of plots of less than 10 acres that are supplied by small wells. These wells and individual domestic-supply wells account for additional ground-water withdrawals in the Chaparral area.

Total irrigation withdrawals in 1975 for the State of New Mexico were 3,662,900 acre-feet (Sorensen, 1977, p. 7), and the total irrigated acreage for that year was 1,348,080 acres (Lansford and others, 1981, p. 4) for a statewide average of 2.72 feet of applied water. No published estimates of applied water are available for the Chaparral area.



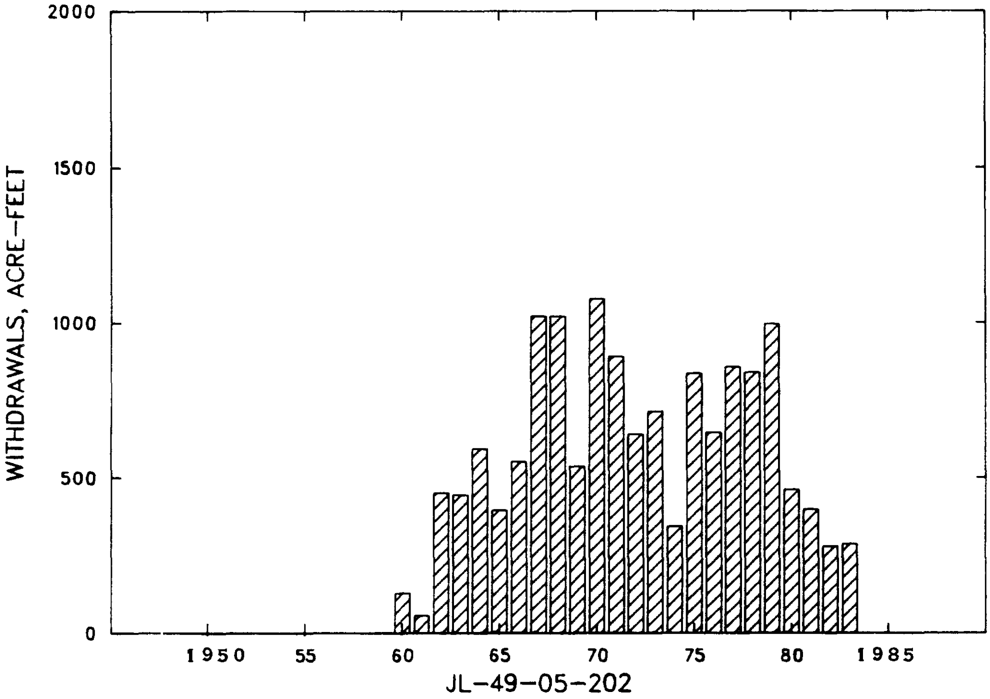
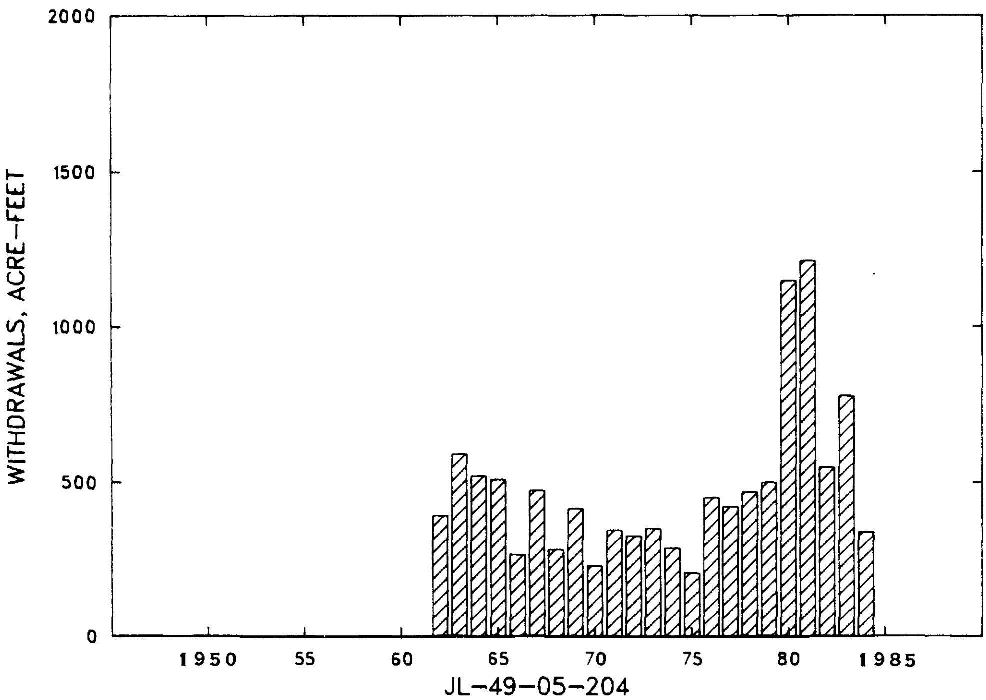
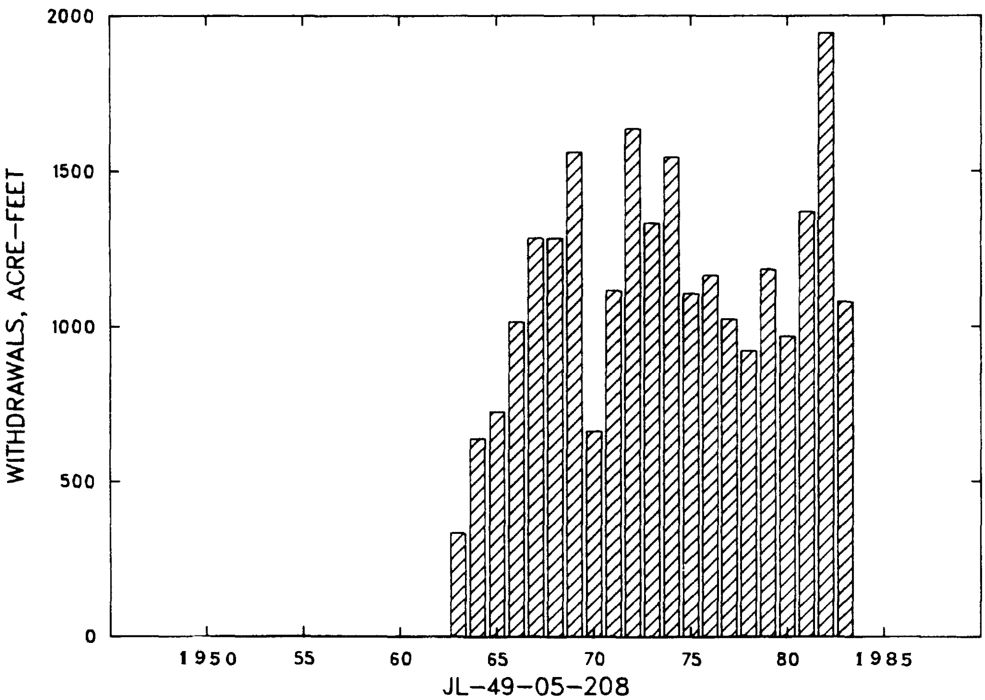


Figure 9.--Annual ground-water withdrawals from selected wells in the northern part of the Hueco Bolson.





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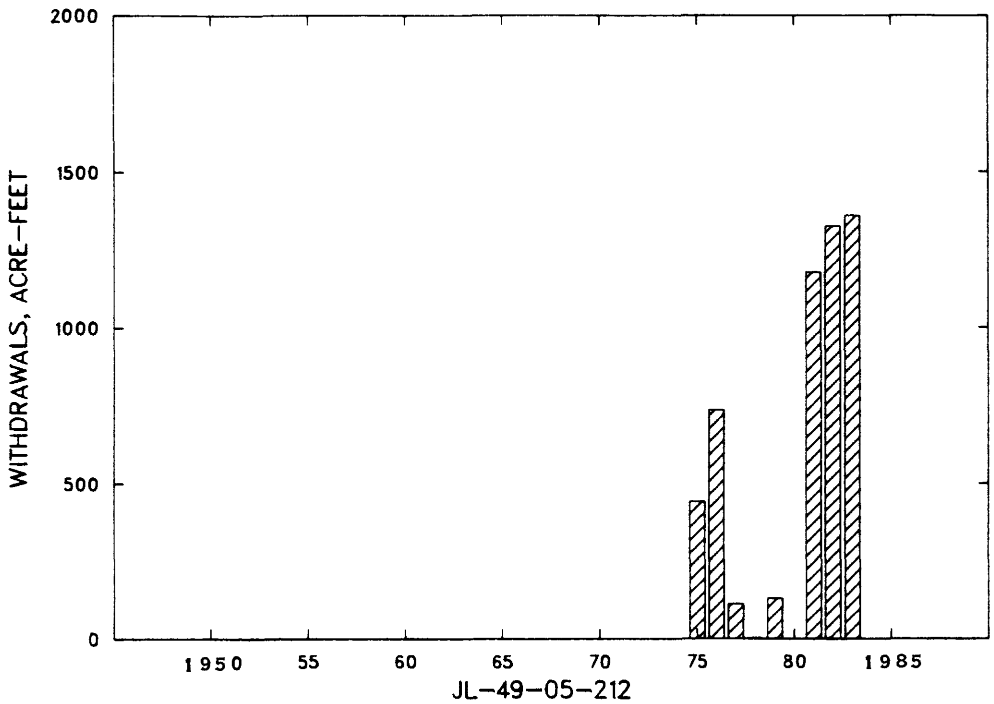

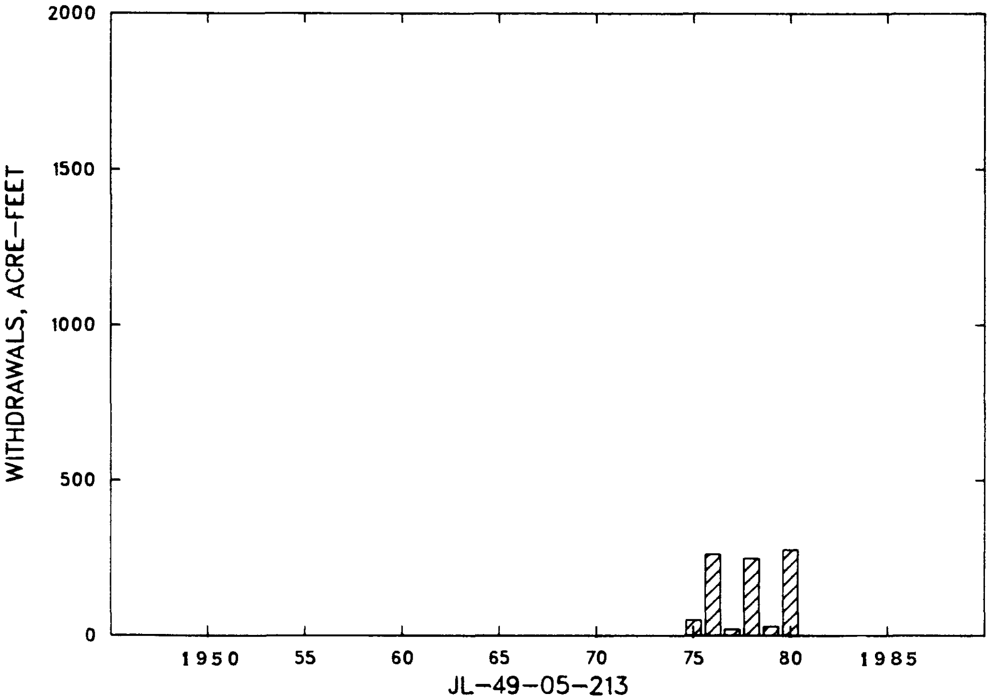

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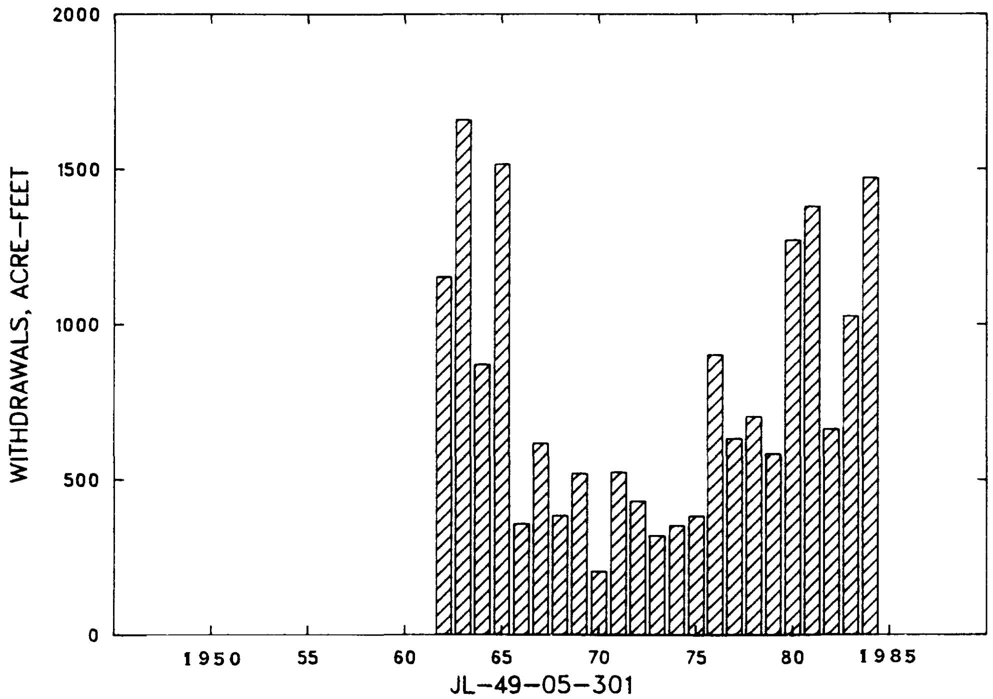

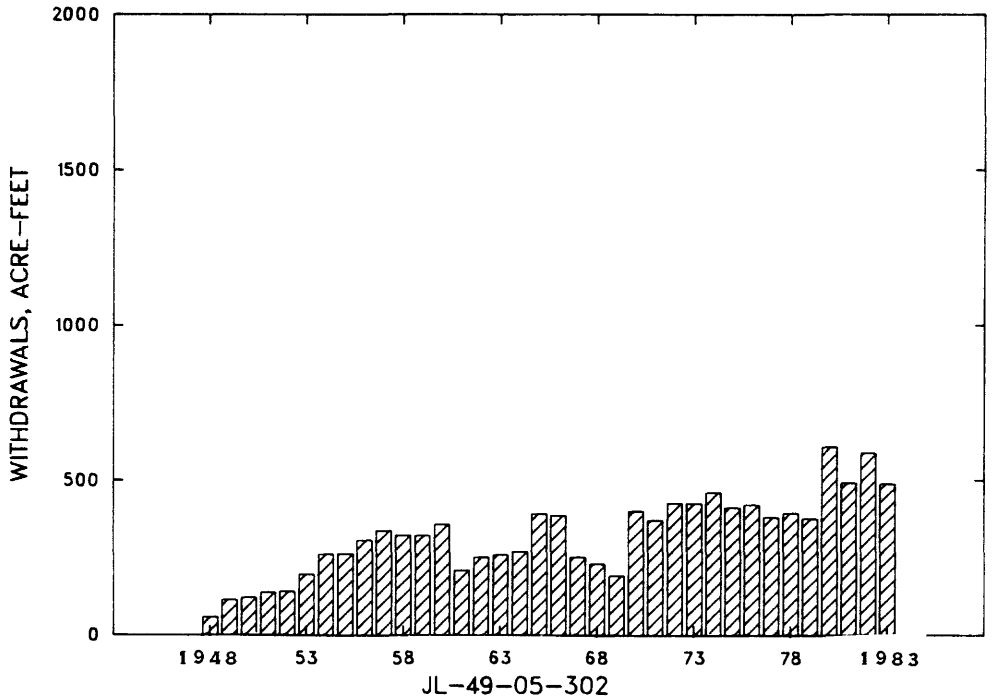

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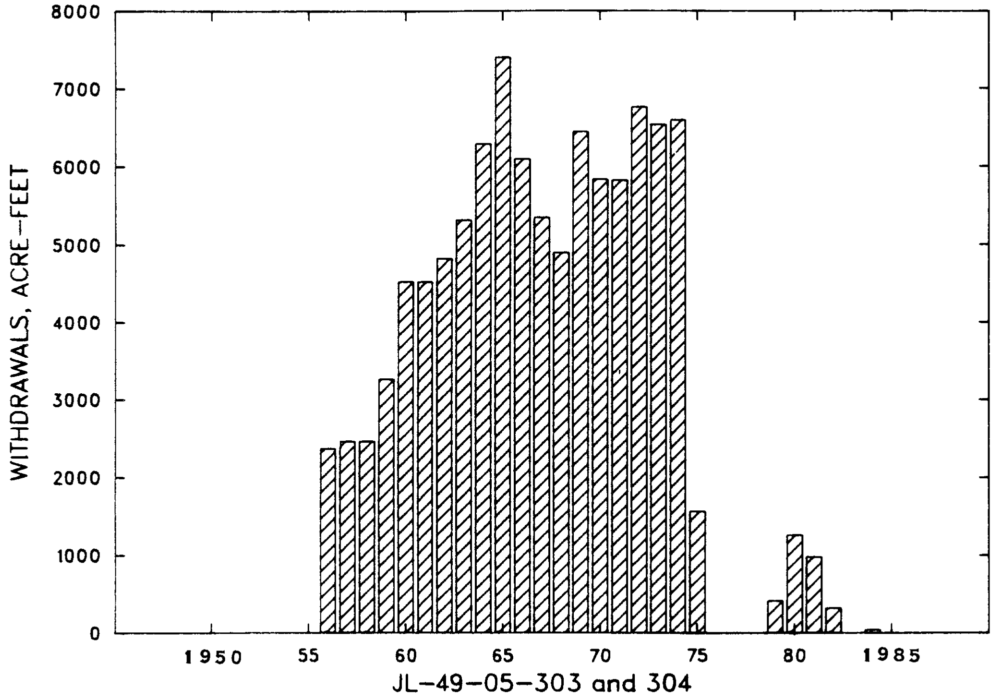

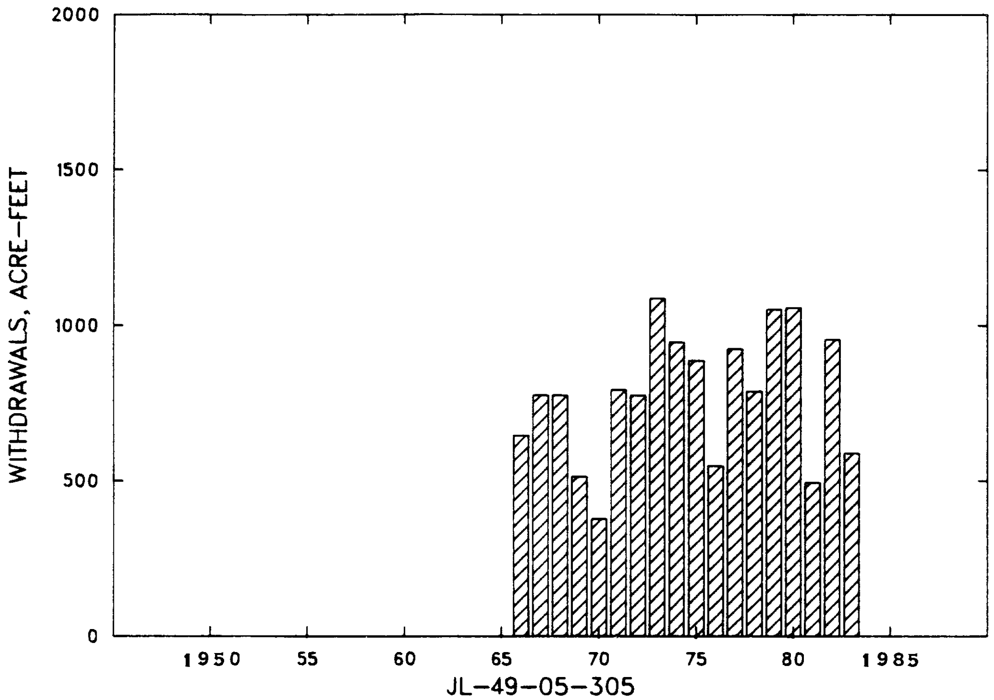

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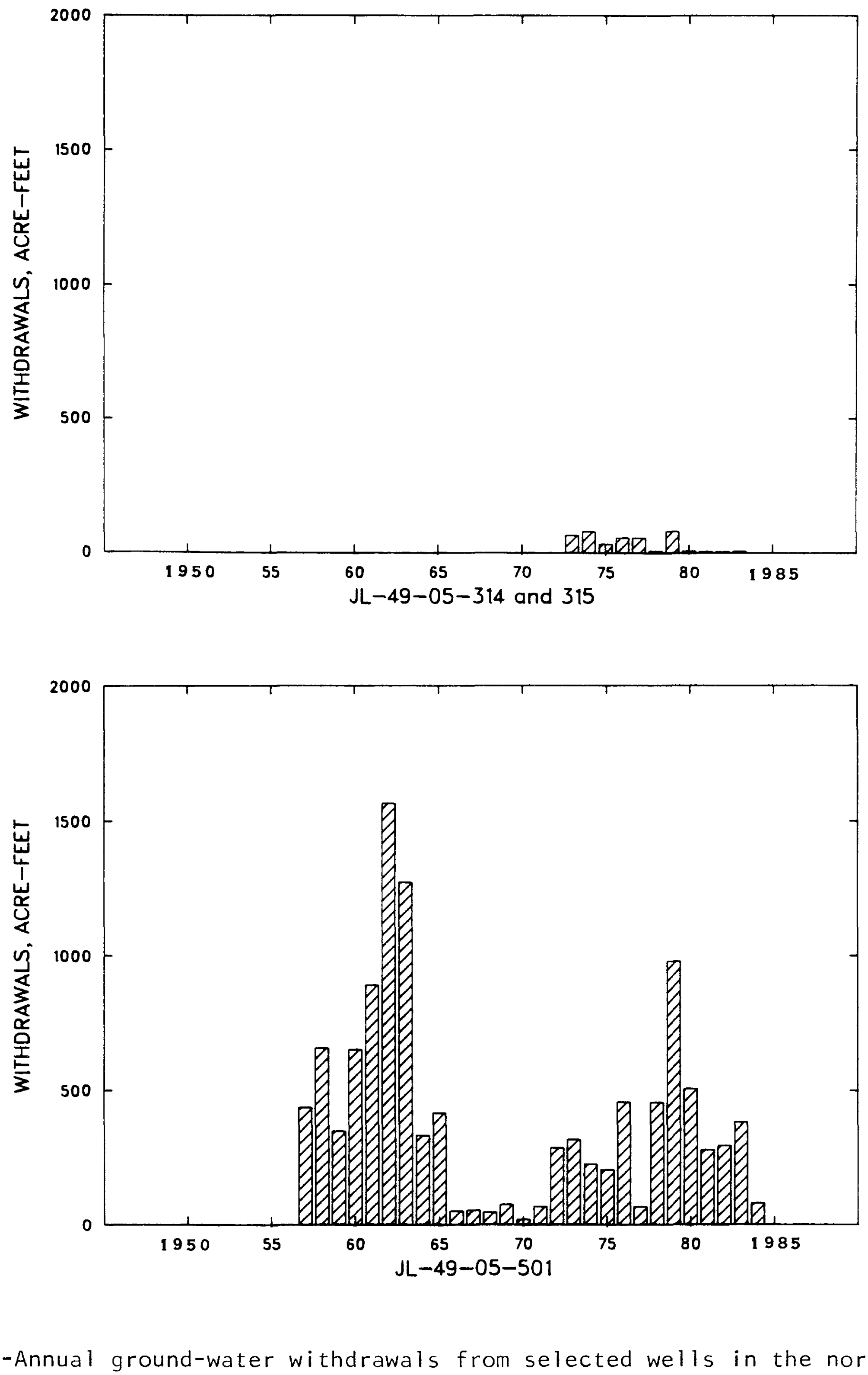

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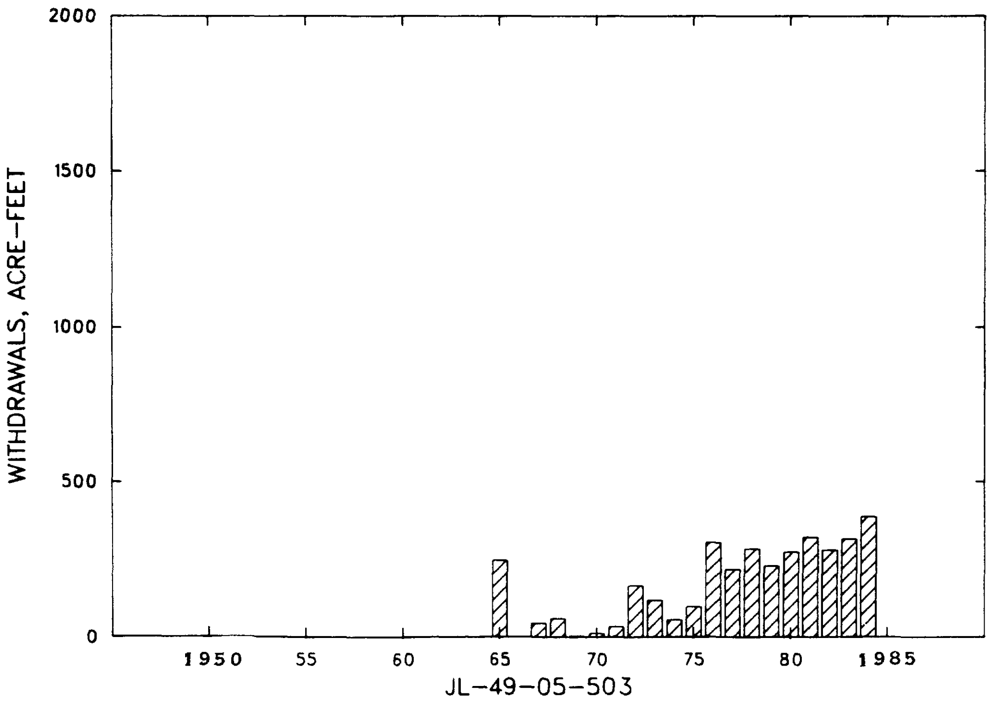

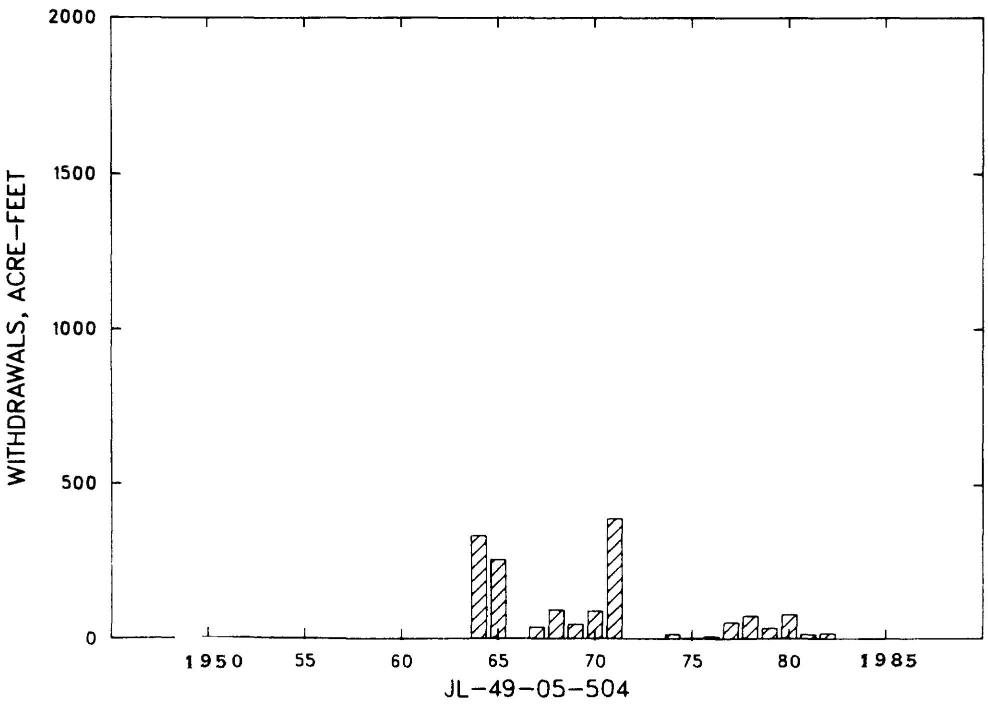

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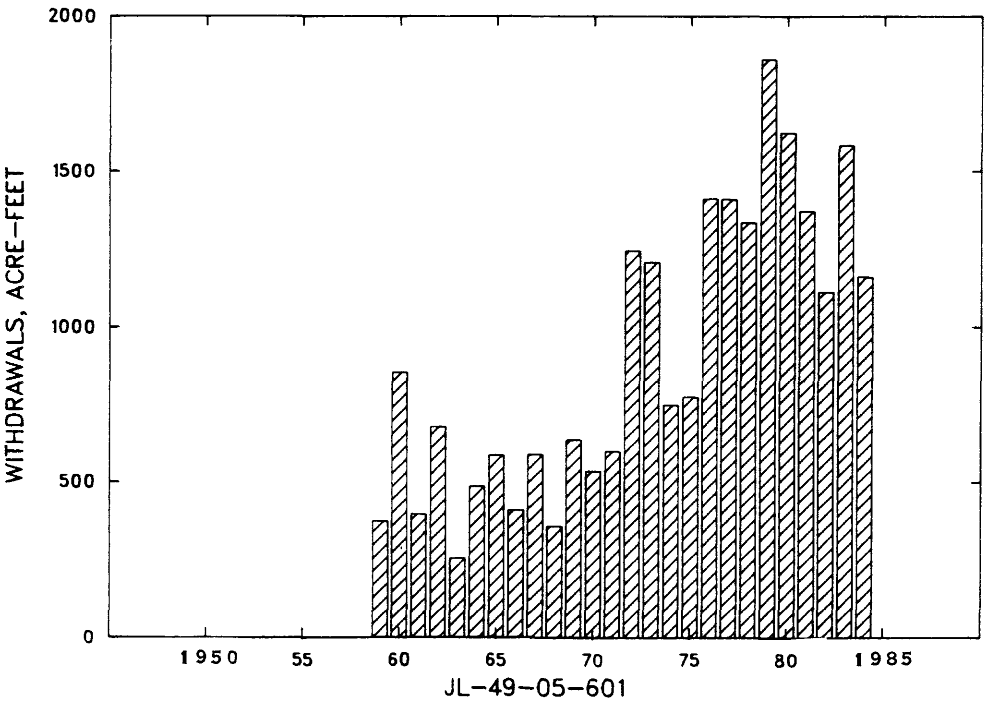

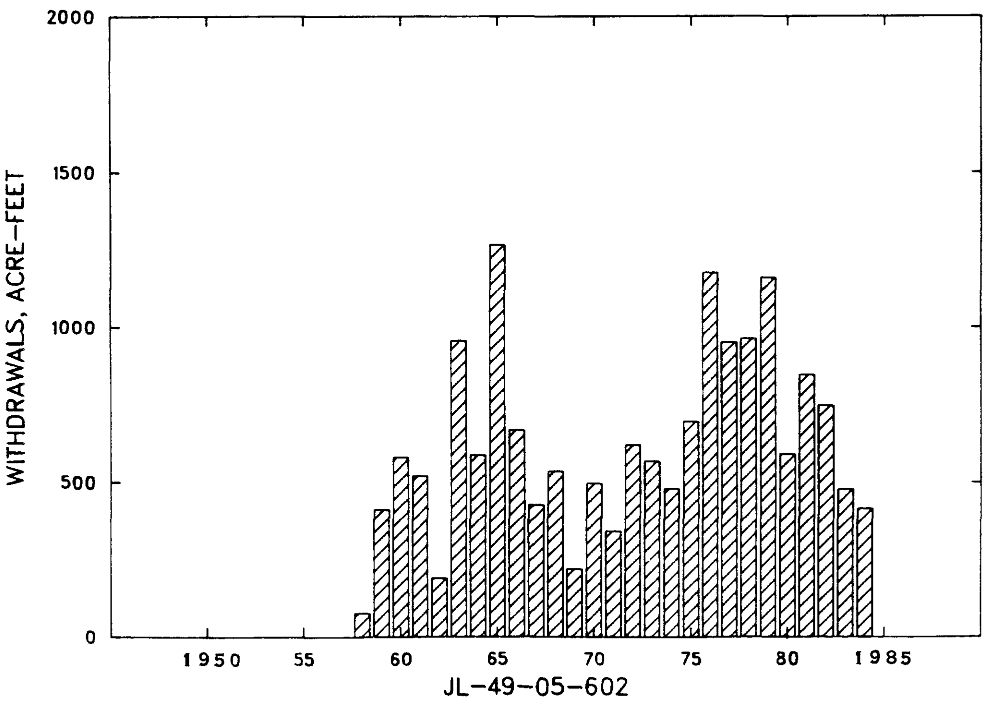

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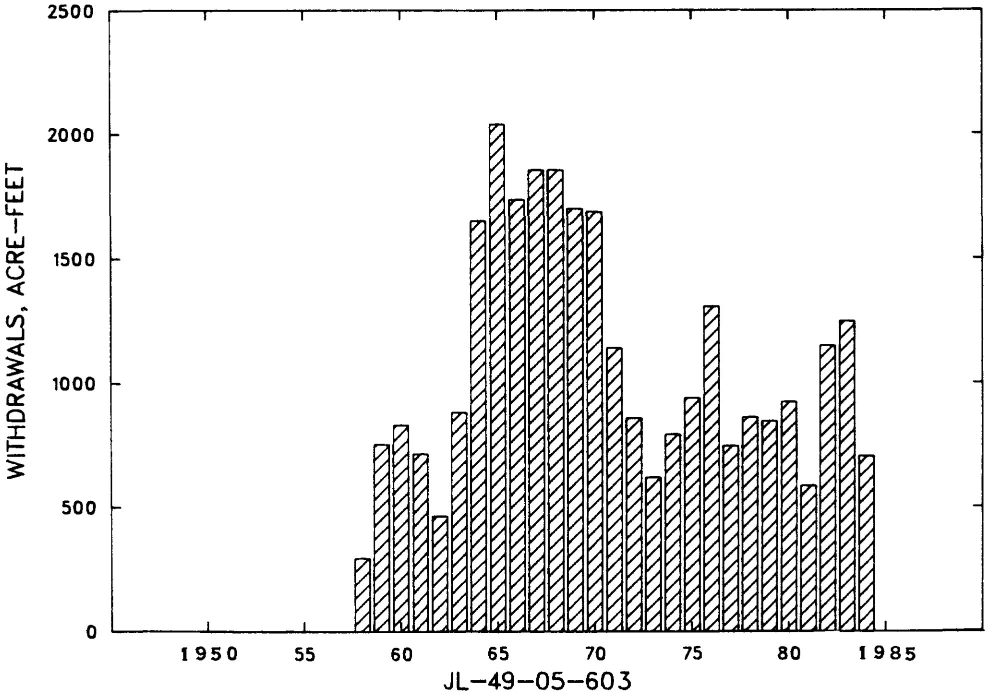

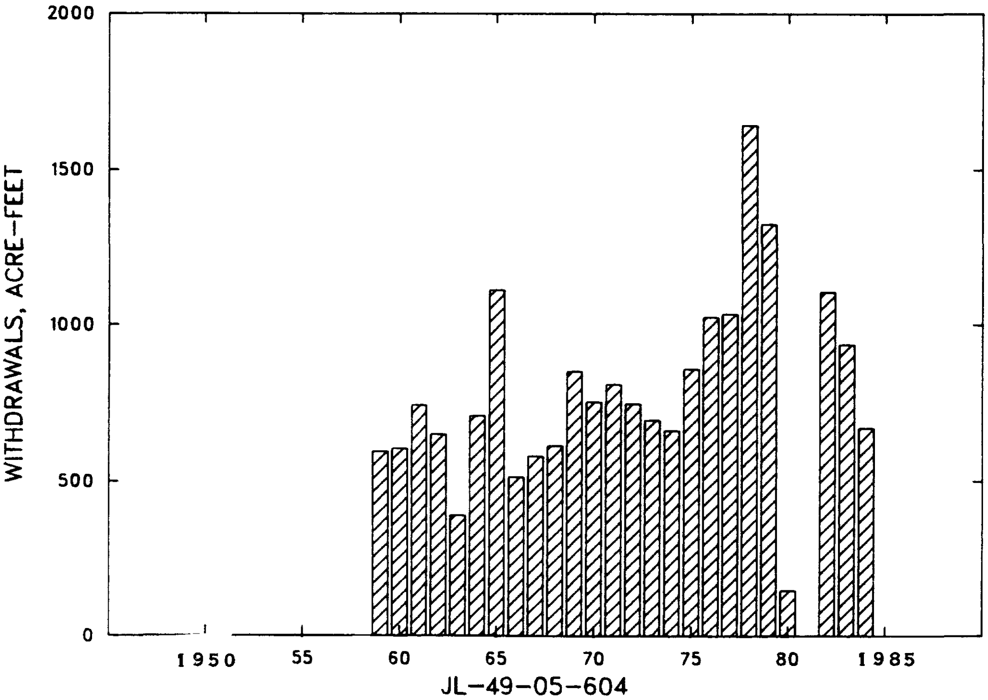

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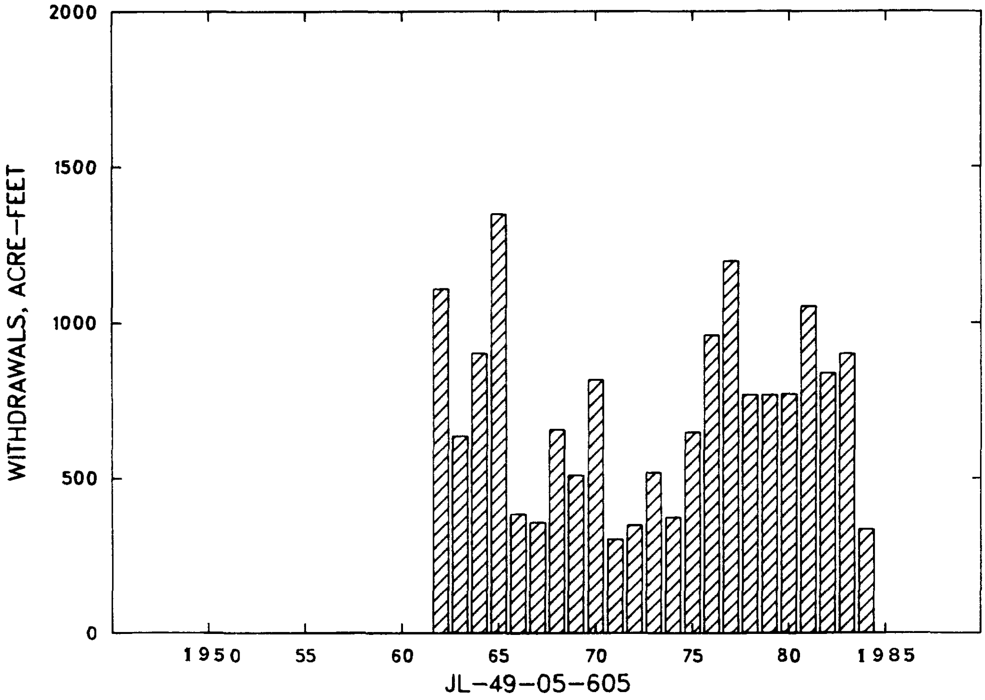


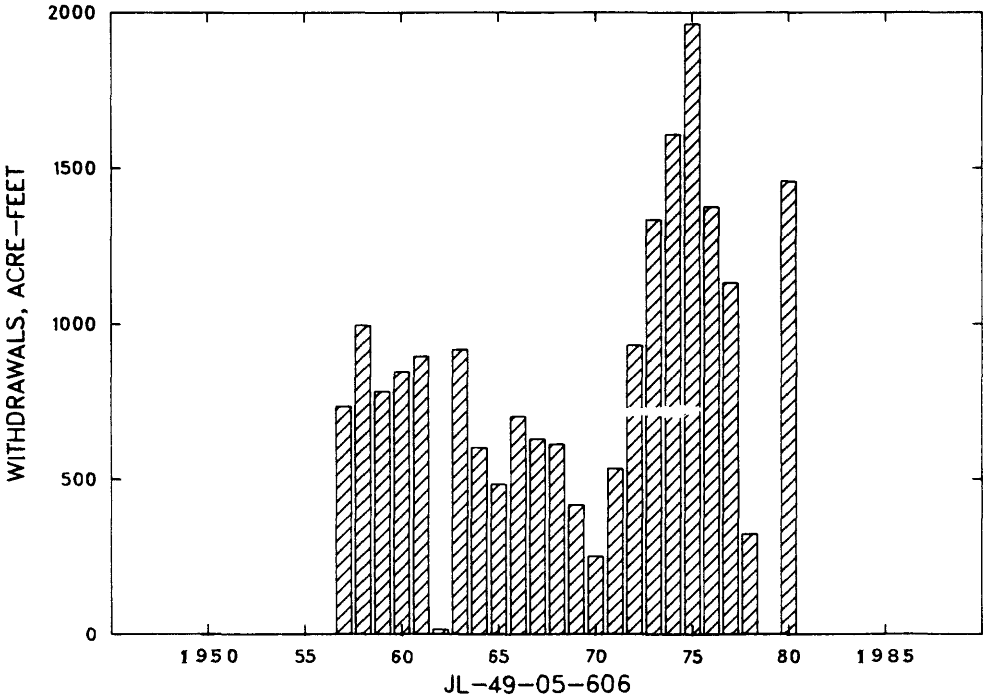
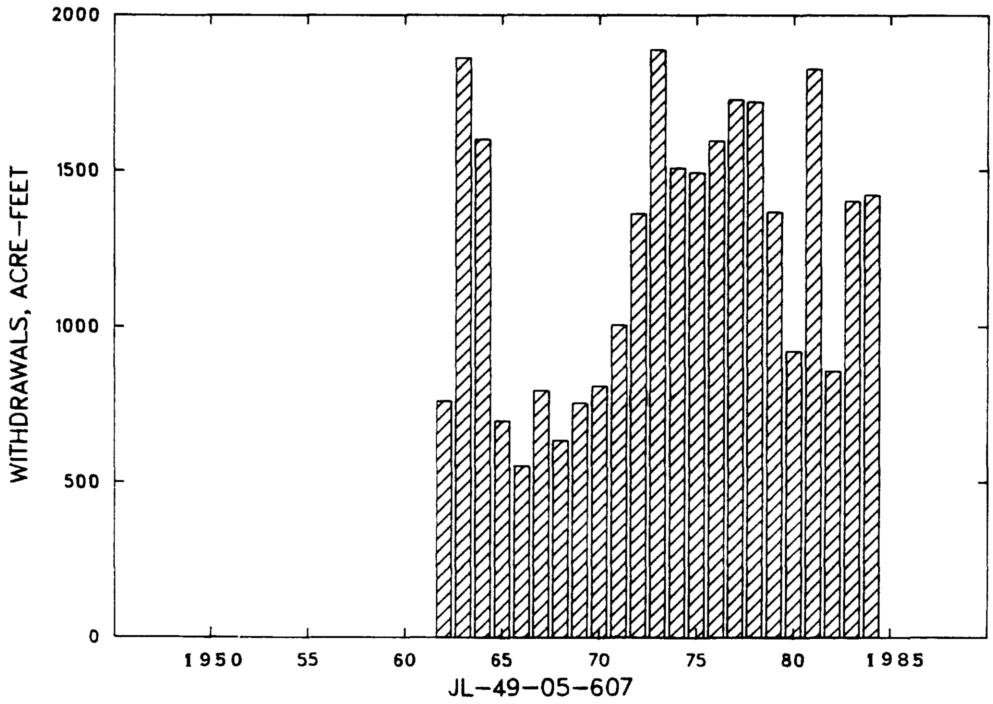


Figure 9.--Annual ground-water withdrawals from selected wells in the northern part of the Hueco Bolson. Continued



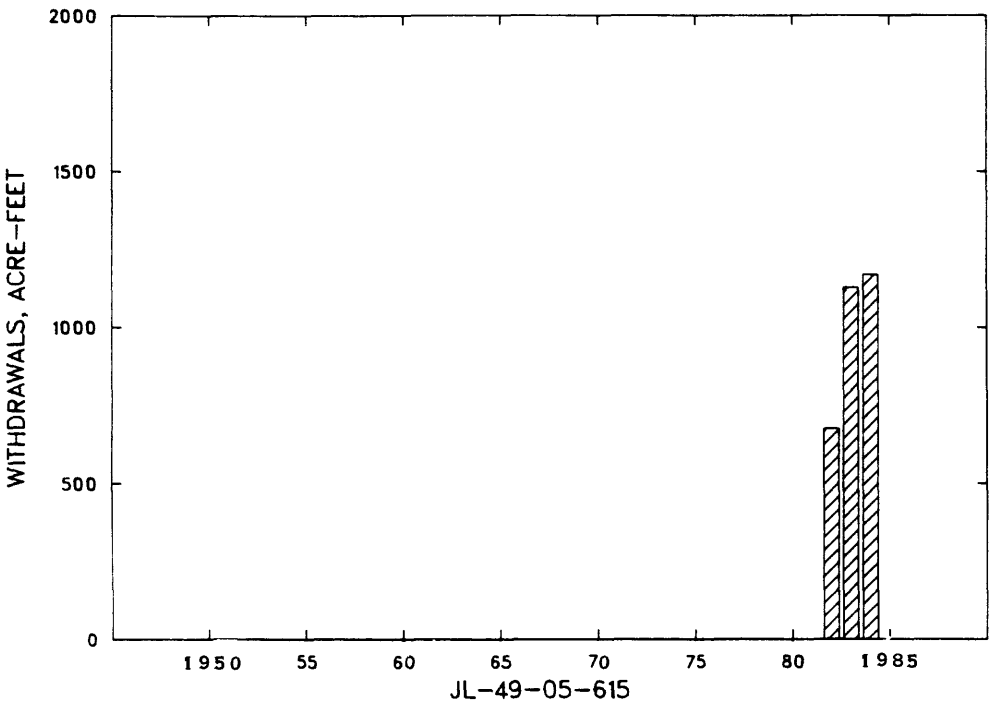
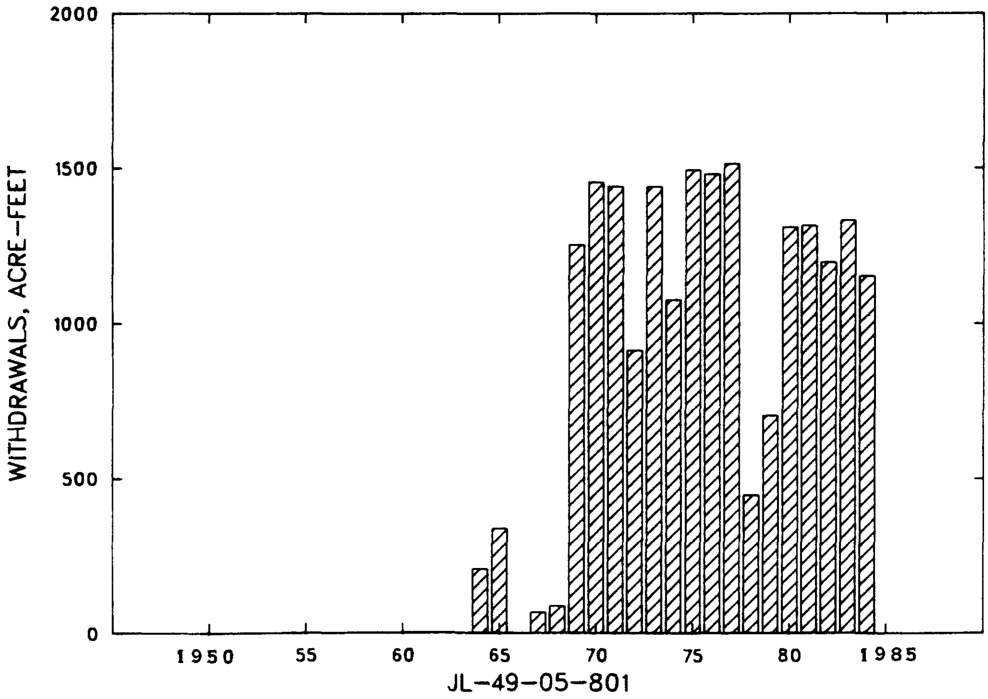


Figure 9.--Annual ground-water withdrawals from selected wells in the northern part of the Hueco Bolson. Continued



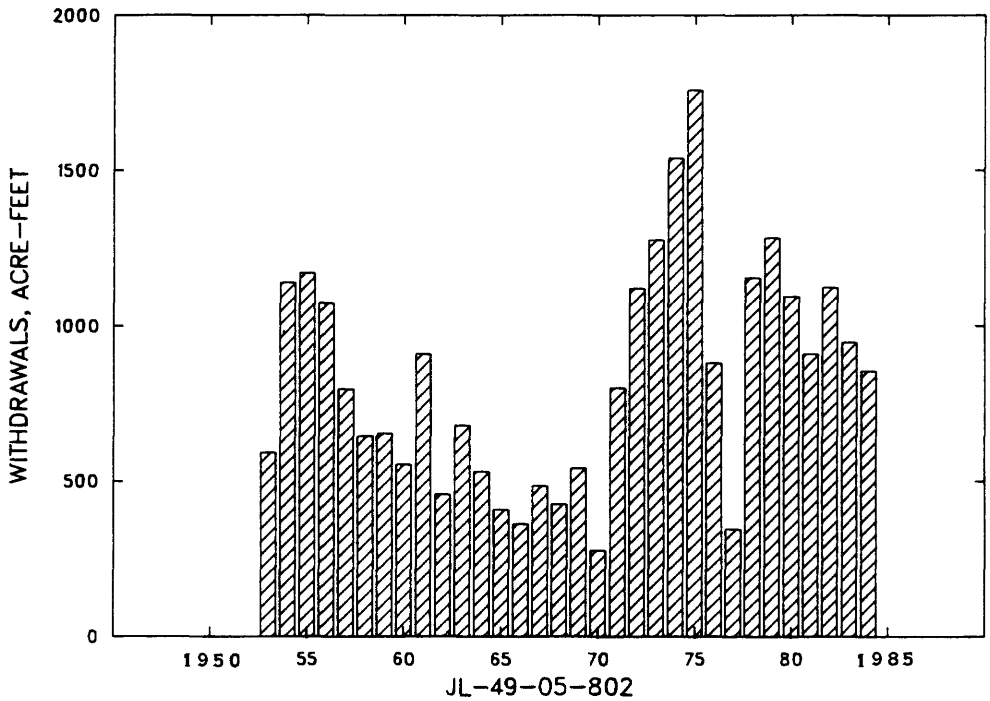
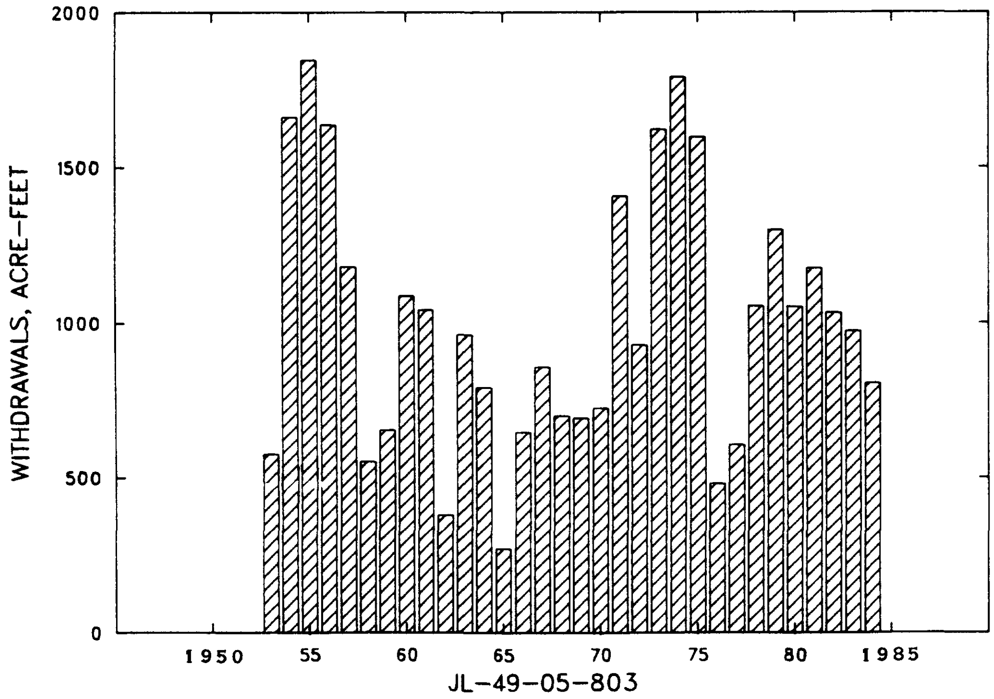


Figure 9.--Annual ground-water withdrawals from selected wells in the northern part of the Hueco Bolson. Continued



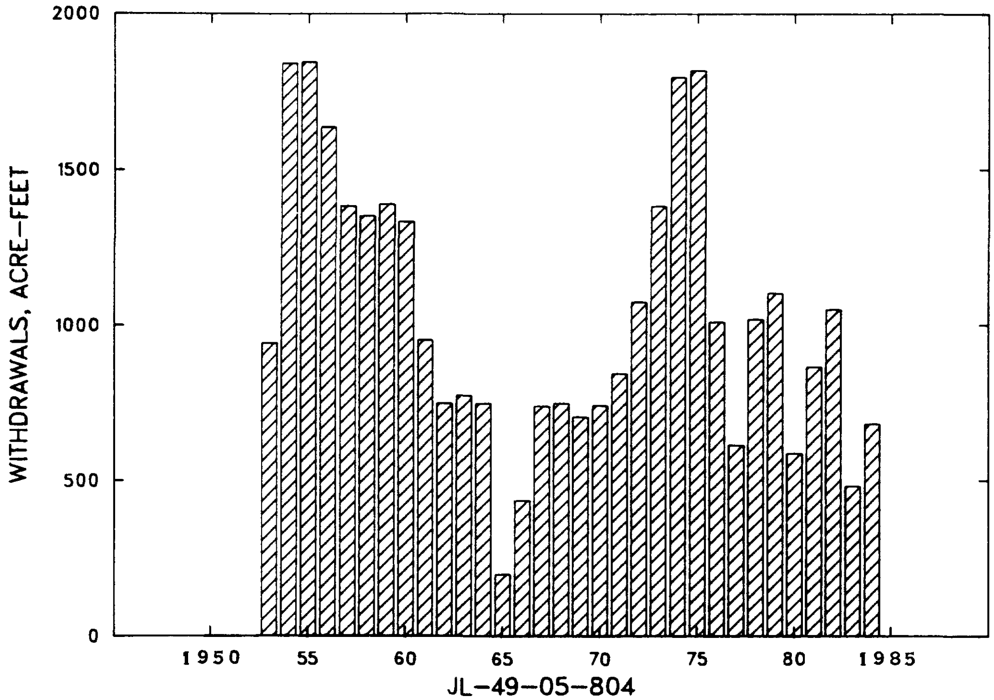
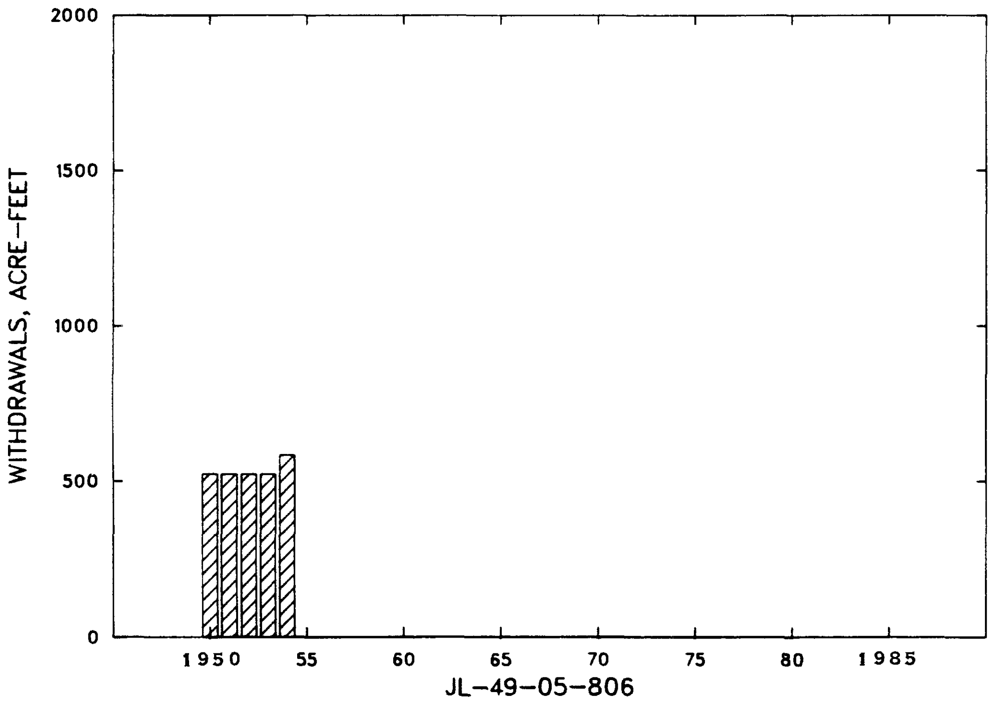


Figure 9.--Annual ground-water withdrawals from selected wells in the northern part of the Hueco Bolson. Continued



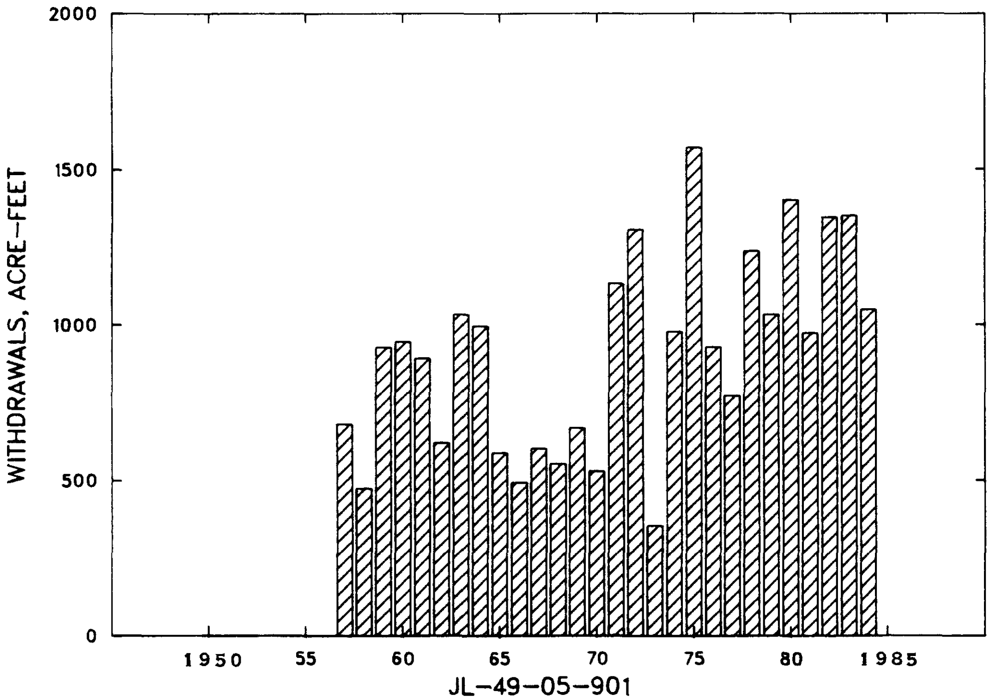
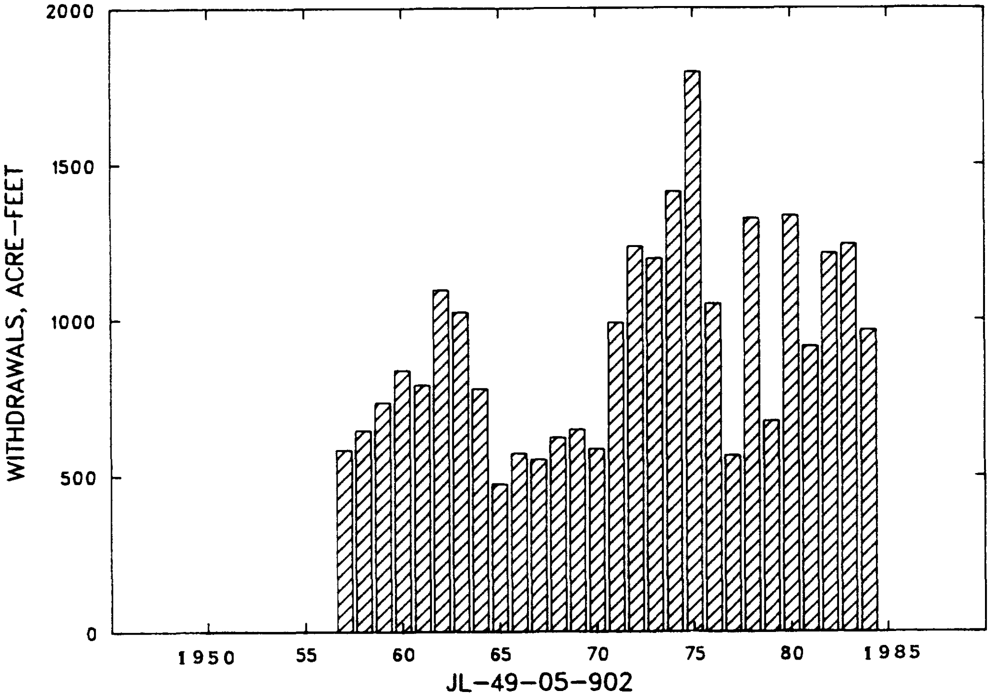


Figure 9.--Annual ground-water withdrawals from selected wells in the northern part of the Hueco Bolson. Continued



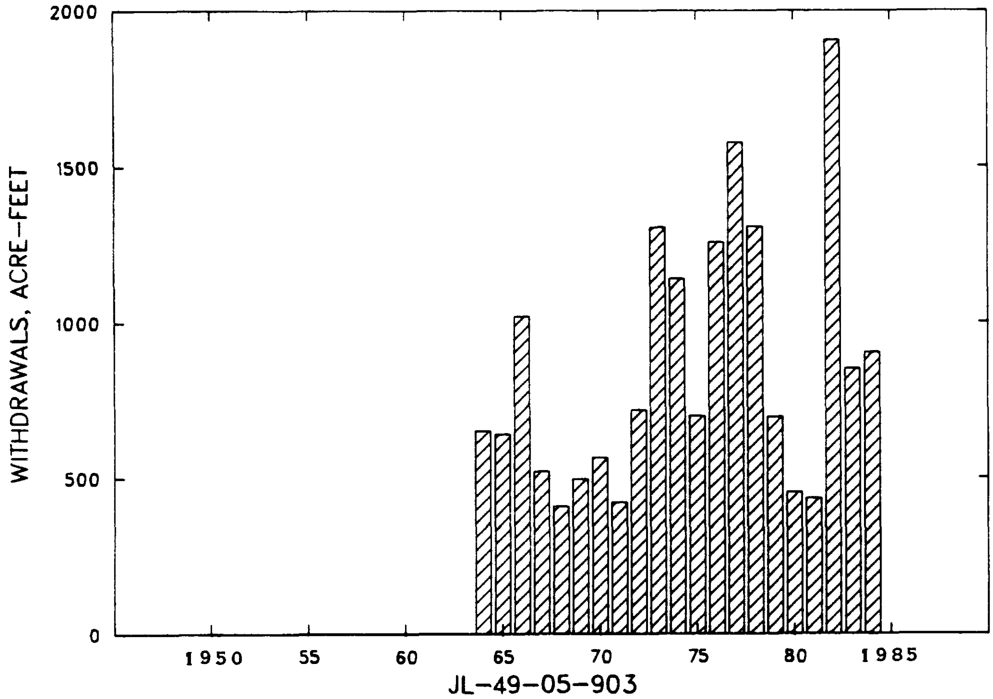
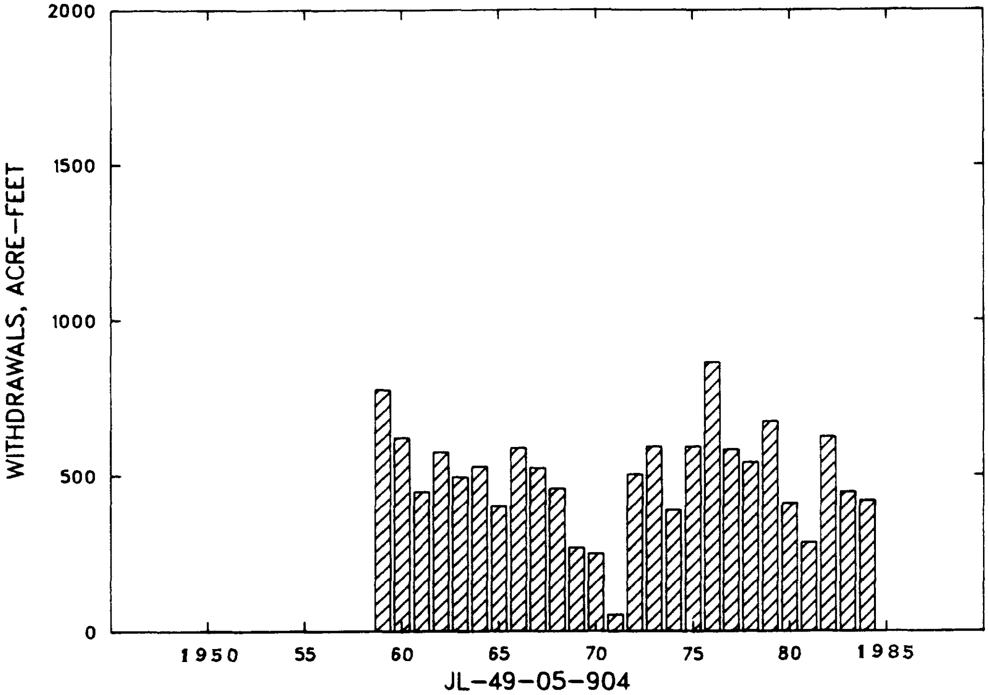


Figure 9.--Annual ground-water withdrawals from selected wells in the northern part of the Hueco Bolson. Continued



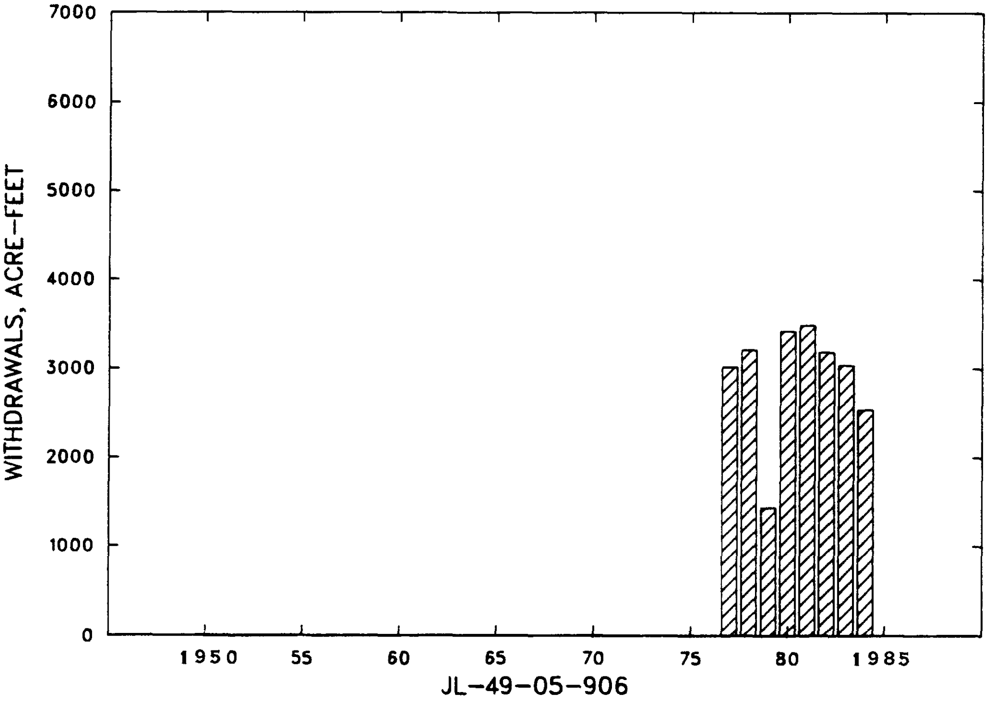
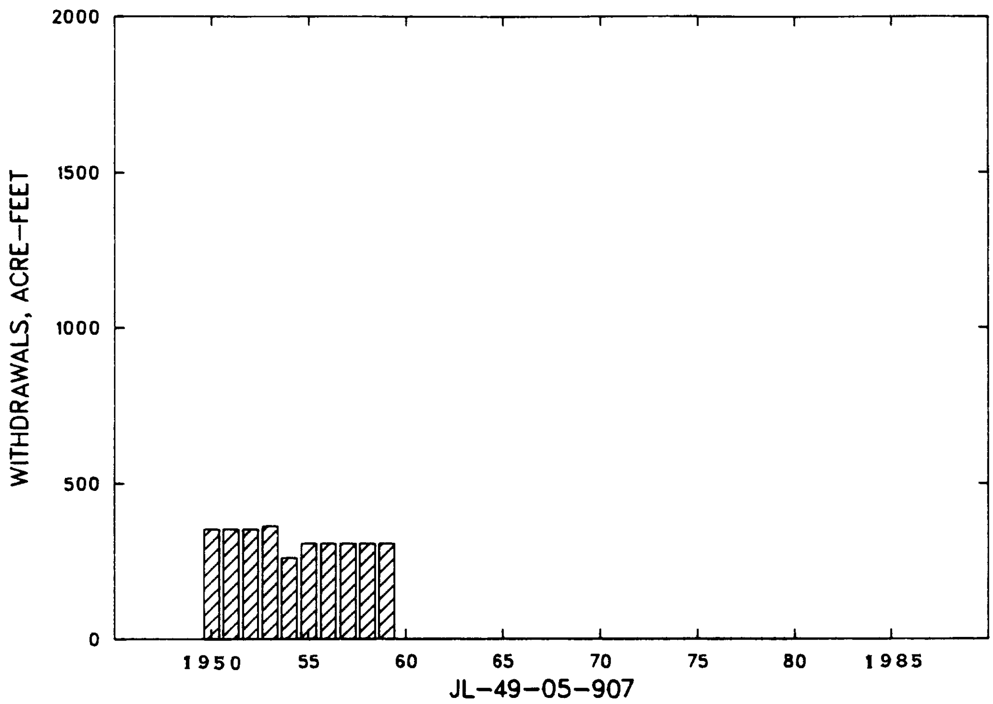


Figure 9.--Annual ground-water withdrawals from selected wells in the northern part of the Hueco Bolson. Continued



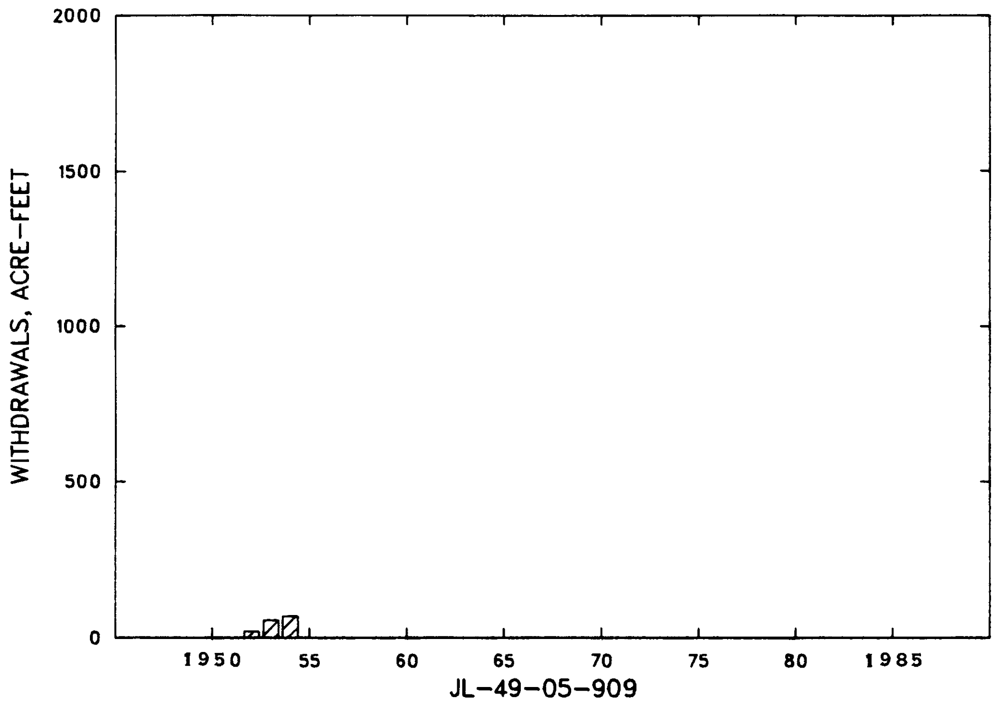
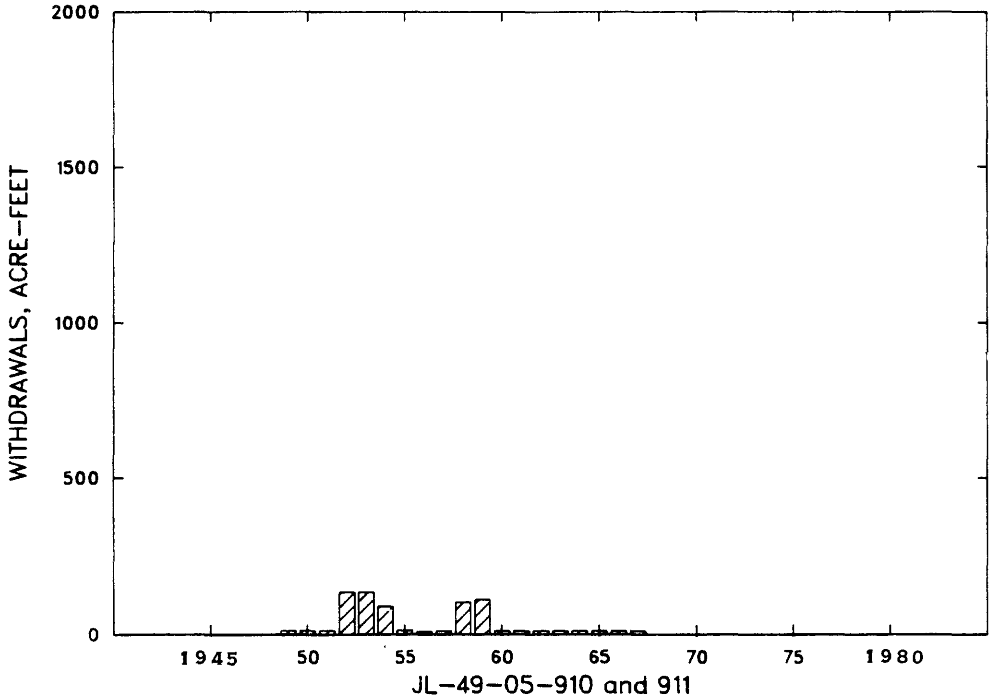


Figure 9.--Annual ground-water withdrawals from selected wells in the northern part of the Hueco Bolson. Continued



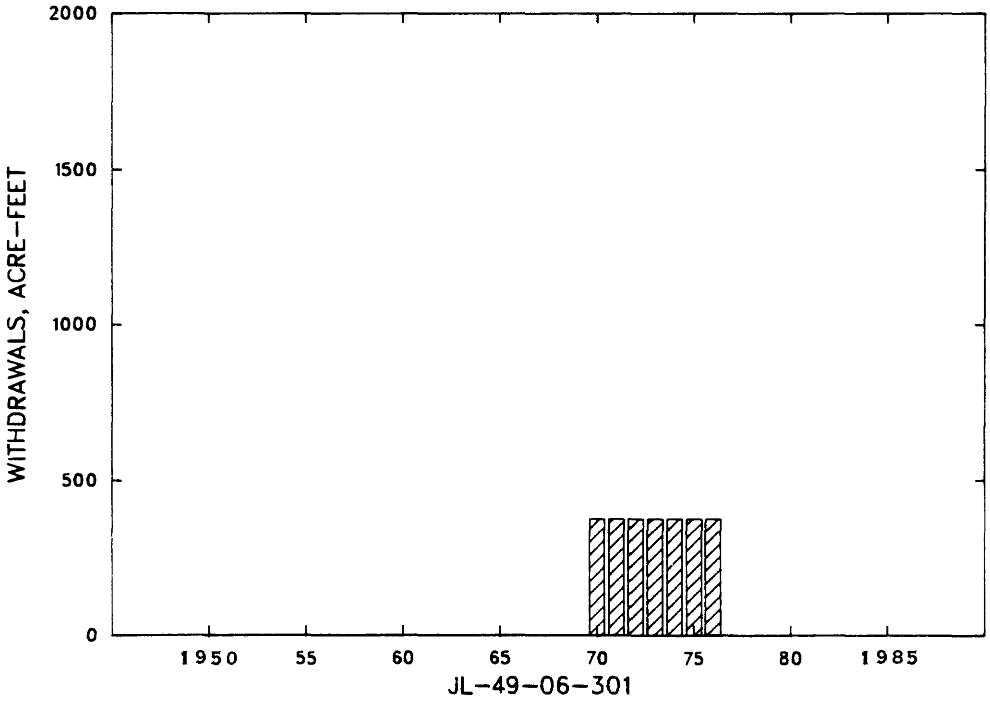
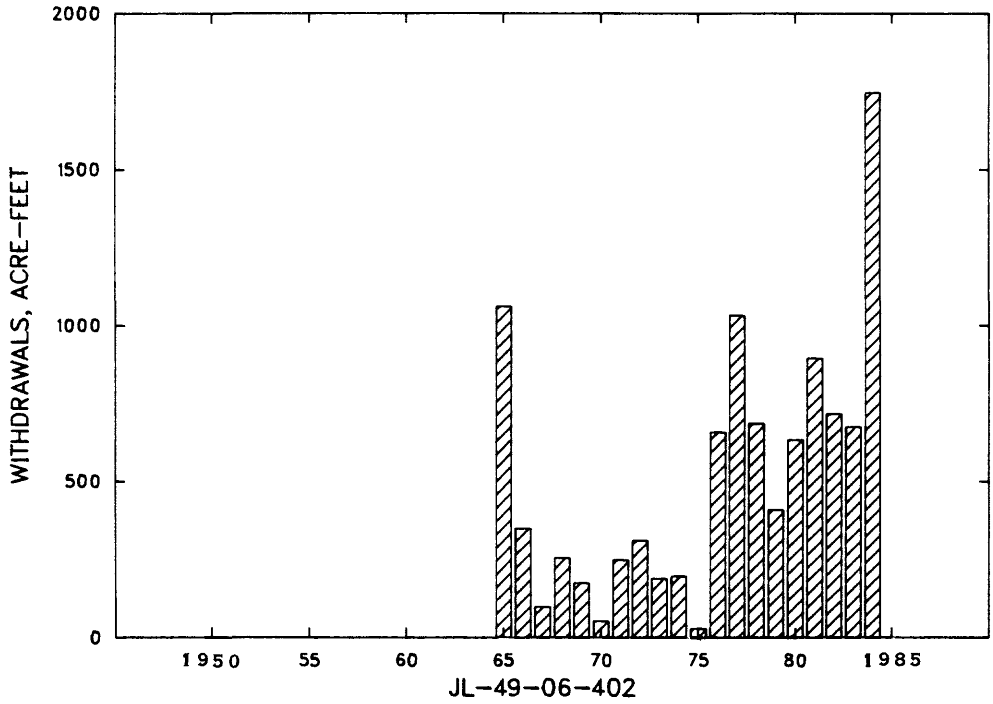


Figure 9.--Annual ground-water withdrawals from selected wells in the northern part of the Hueco Bolson. Continued



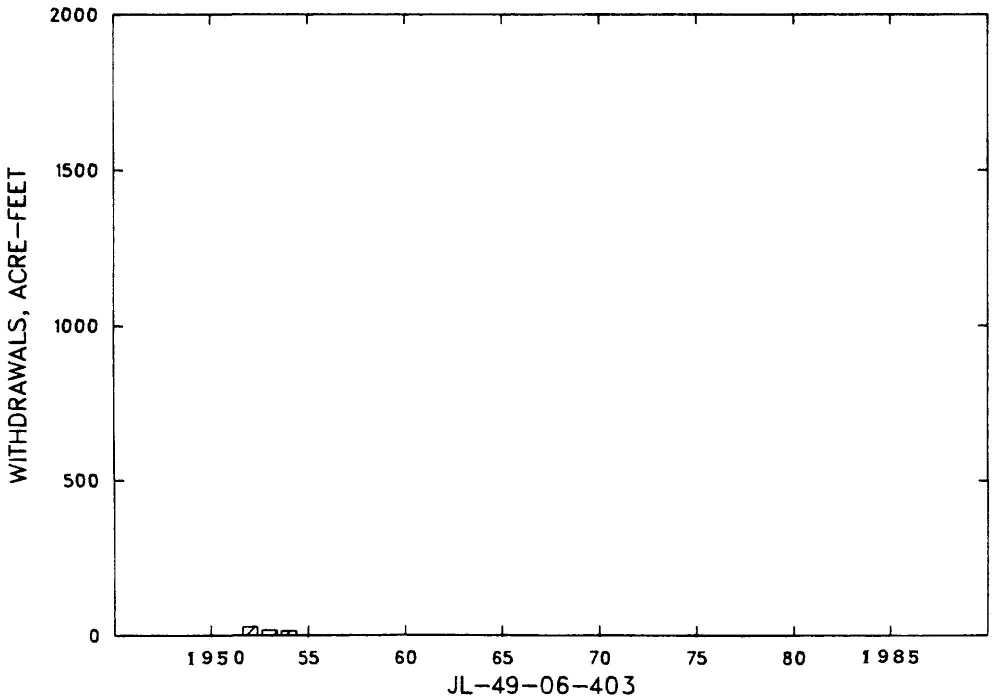
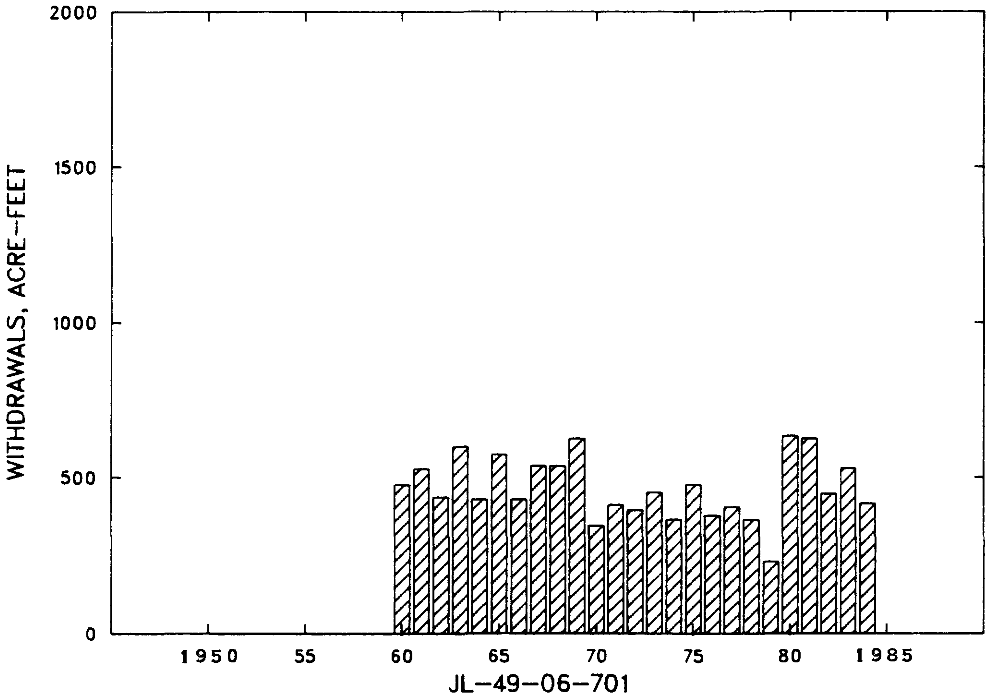


Figure 9.--Annual ground-water withdrawals from selected wells in the northern part of the Hueco Bolson. Continued



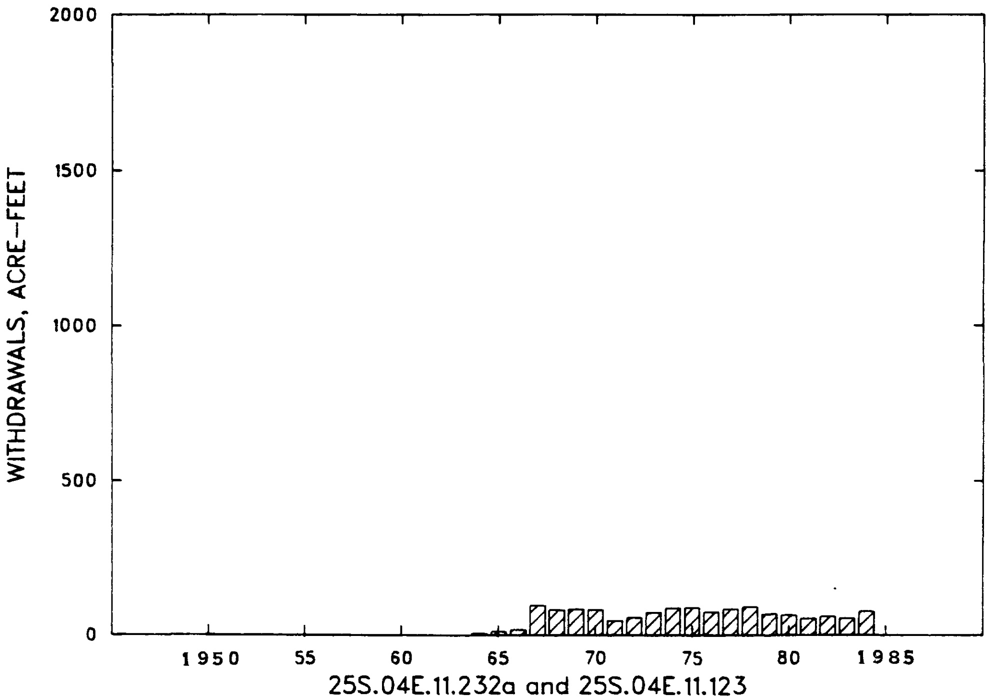


Figure 9.--Annual ground-water withdrawals from selected wells in the northern part of the Hueco Bolson. Continued

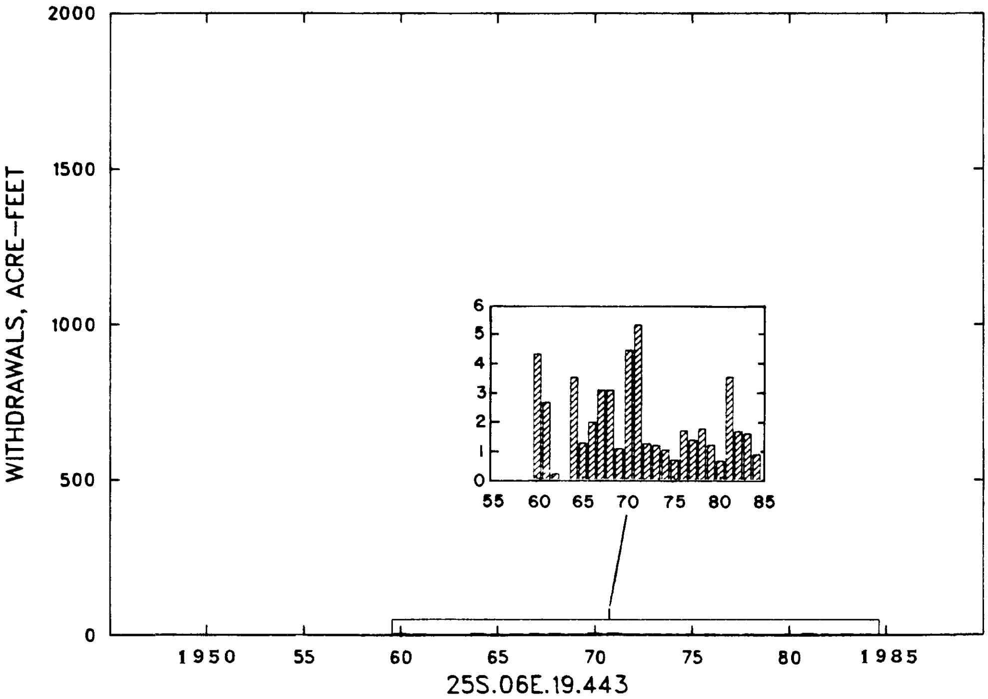


Figure 9.--Annual ground-water withdrawals from selected wells in the northern part of the Hueco Bolson. Concluded

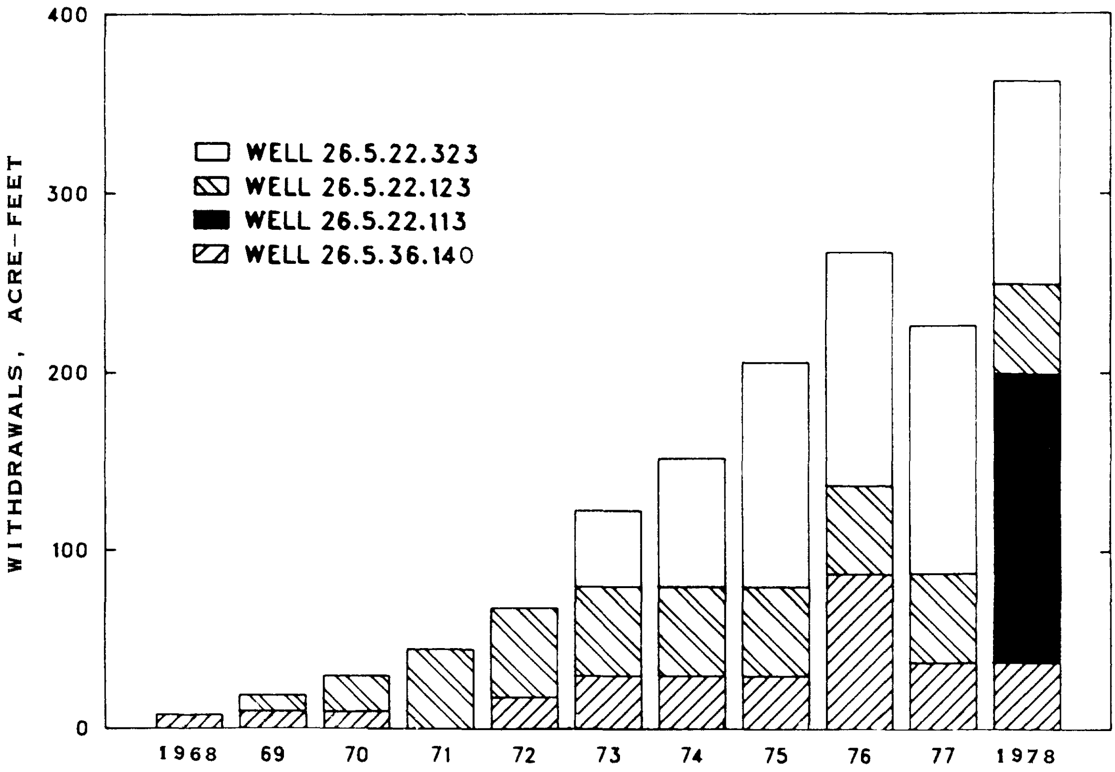


Figure 10.--Ground-water withdrawals by the Lake Section Water Company, 1968-78.

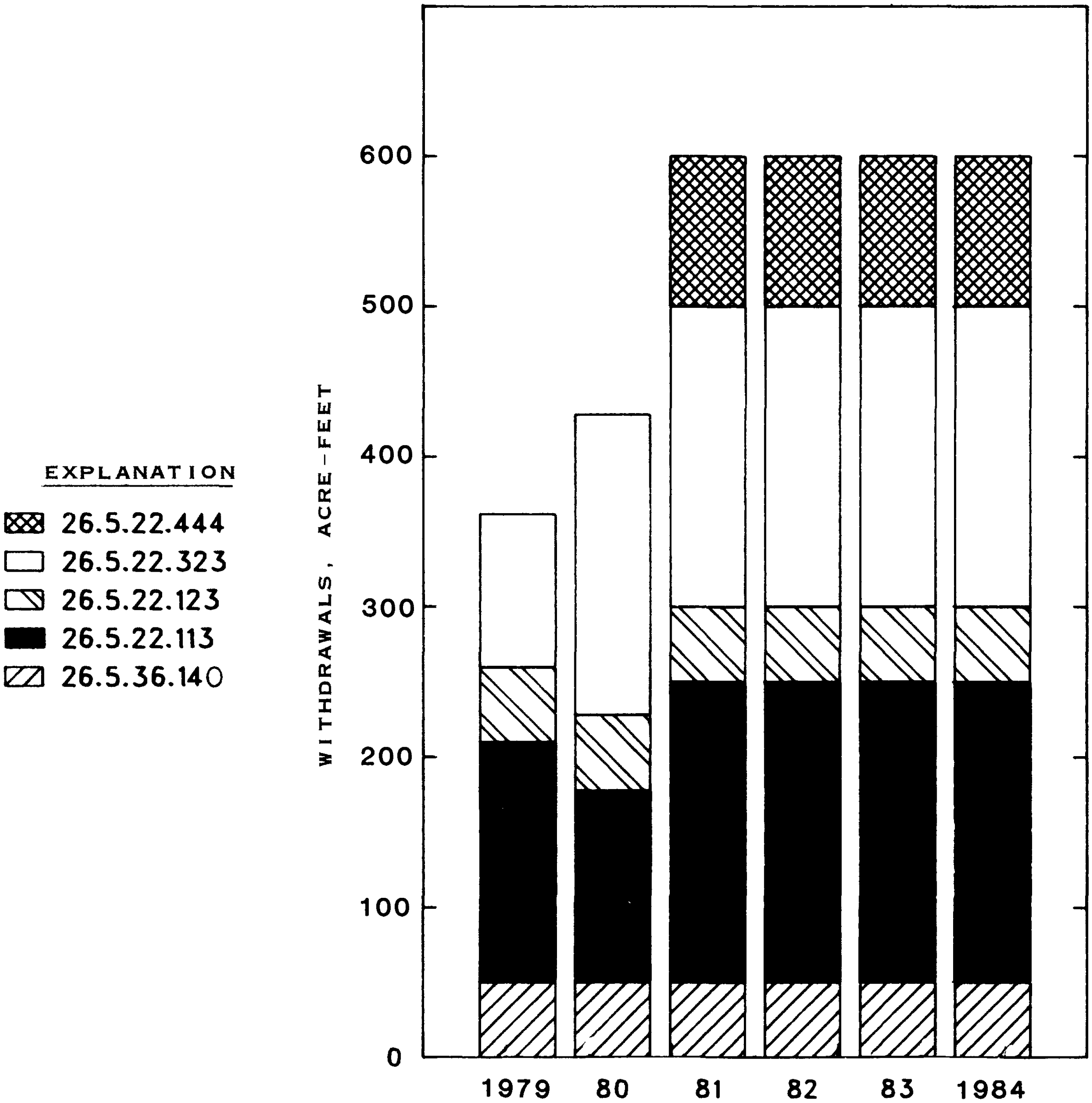


Figure 11.--Estimated ground-water withdrawals by the Lake Section Water Company, 1979-84.

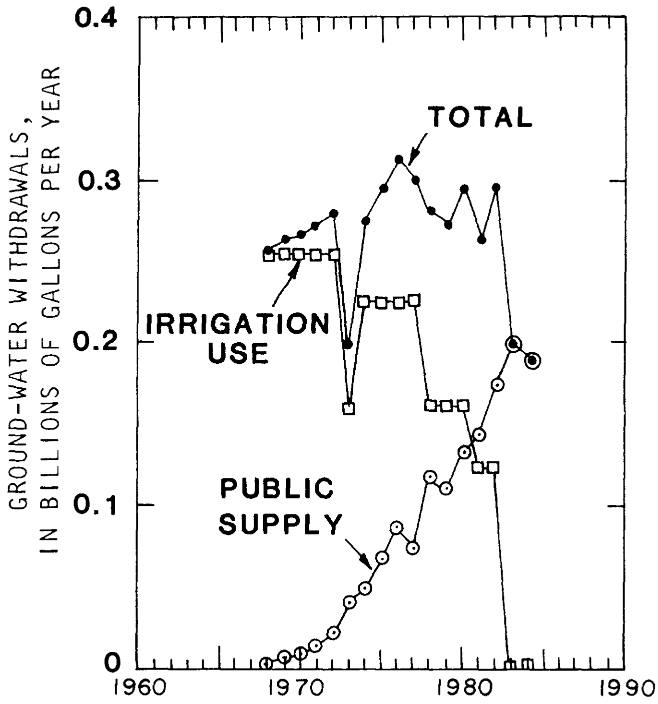


Figure 12.--Annual ground-water withdrawals by the Lake Section Water Company, 1968-84.

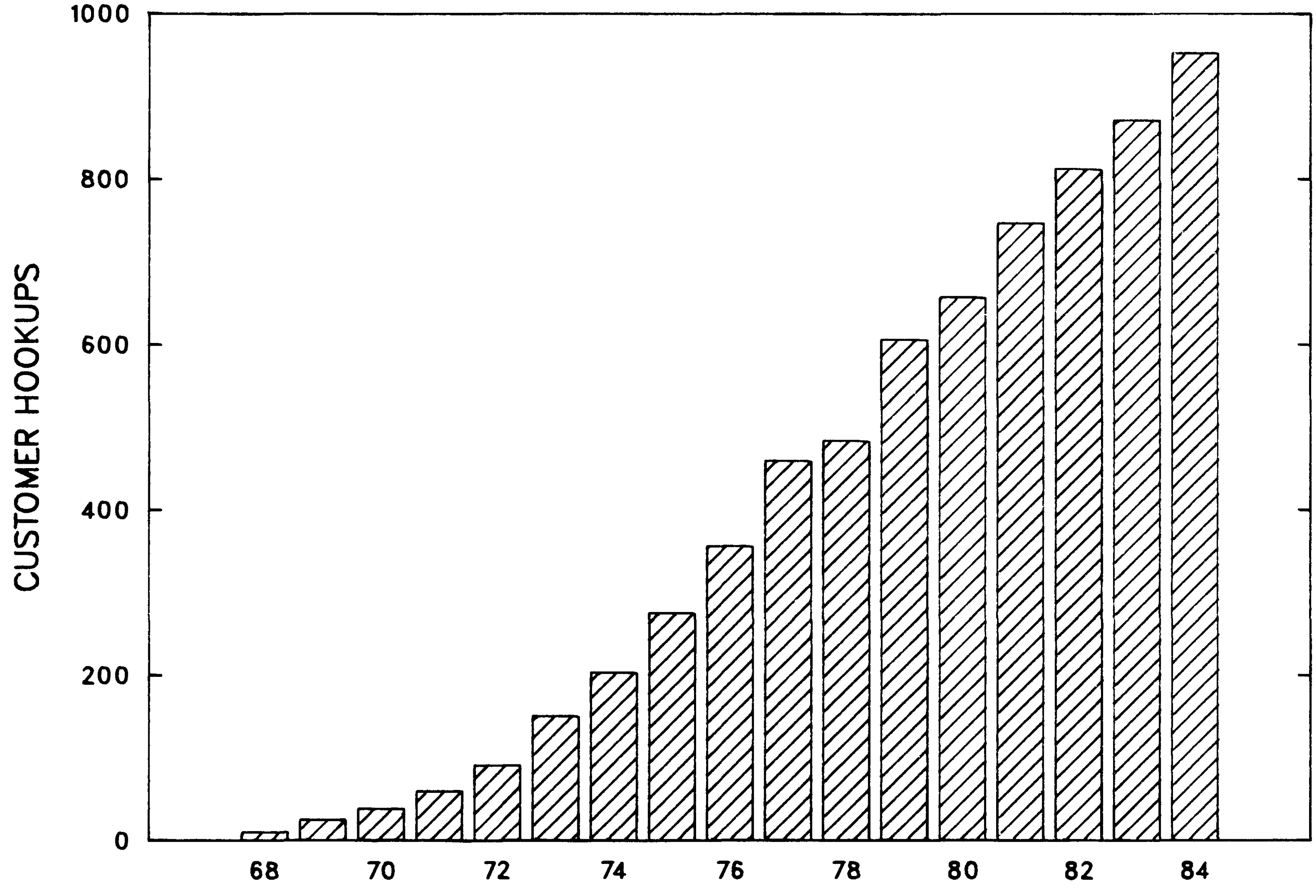


Figure 13.--Customer hookups for the Lake Section Water Company.

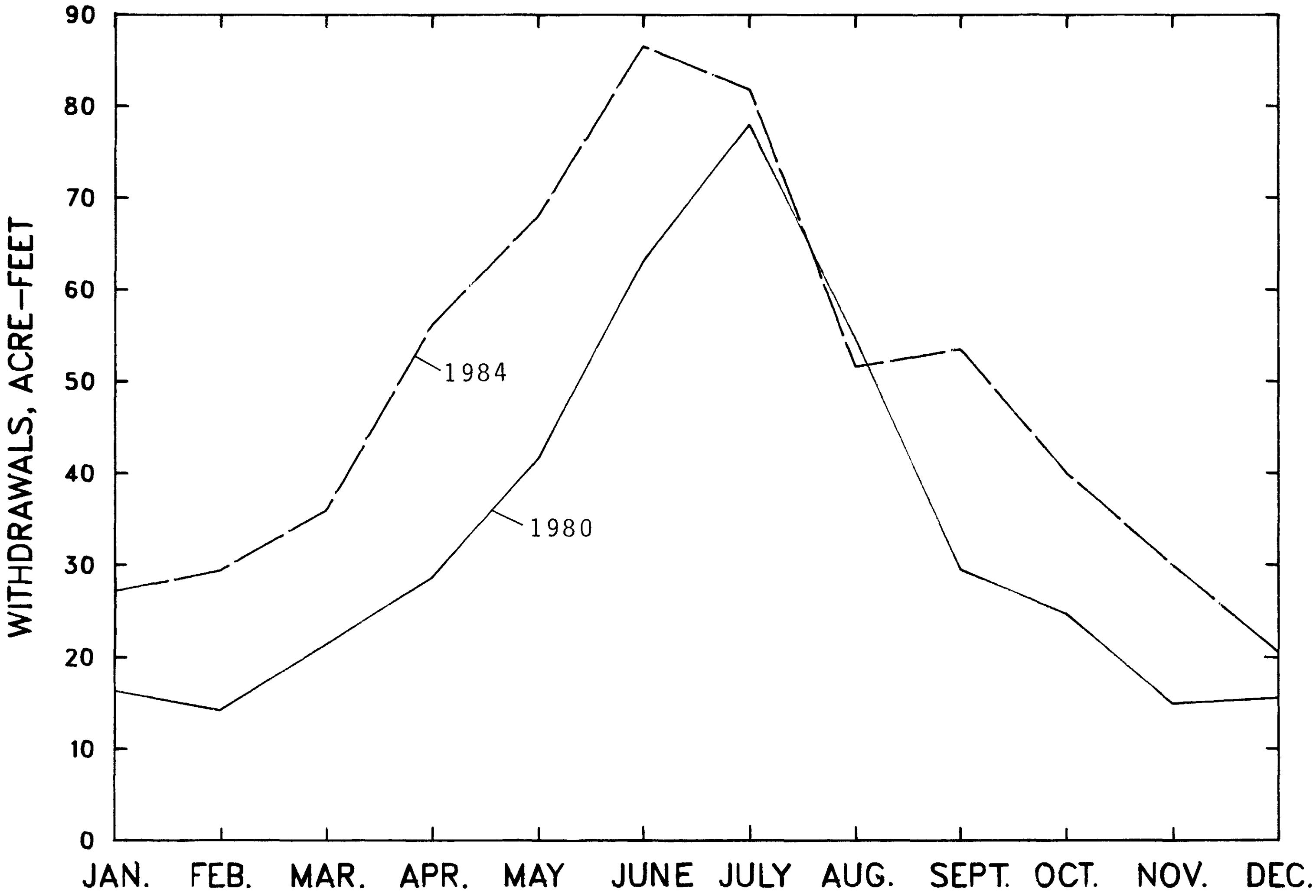


Figure 14.--Monthly distribution of ground-water withdrawals by the Lake Section Water Company, 1980 and 1984.

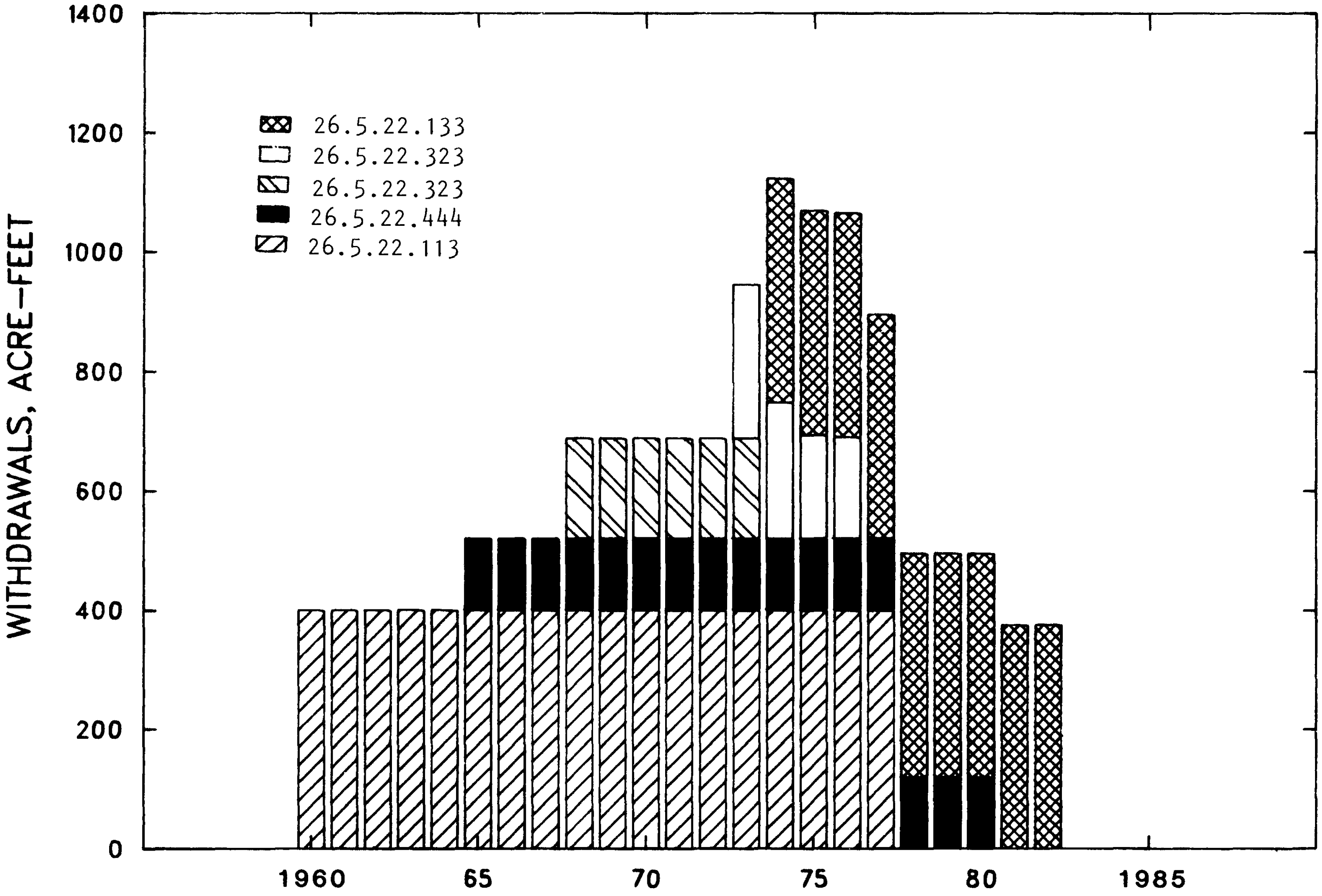


Figure 15.--Ground-water withdrawals for irrigation by the Lake Section Water Company, 1960-84.

TEST-WELL DRILLING PROGRAM

Four test wells were drilled during August and September 1985. The purpose of these test wells was to provide geohydrologic information that would assist in the interpretation of electrical-resistivity sounding data collected from 55 sites in the study area (Bisdorf, 1985). The wells were completed as monitor wells to provide long-term water-level and water-quality data. The location of wells HBNM-1, HBNM-2, HBNM-3, and HBNM-4 is shown in figure 4. Each well was to be drilled to a depth of approximately 1,000 feet, geophysical logs were to be run, and a cement plug was to be set about 100 feet below the water table. A 5-foot interval was to be selected from the geophysical logs, and a 4.5-inch-diameter steel casing and wire-wound steel screen were to be installed. An appropriate gravel pack was to be placed at the screen. The well was then to be developed by air-jetting techniques, and water samples were to be collected for chemical analyses.

Test Well HBNM-1

Drilling began on test well HBNM-1 (25S.04E.10.334) on August 24, 1985. Technical problems resulted in abandonment of the initial borehole at a depth of 12 feet. The drilling rig was moved 10 feet north and drilling began again. The diameter of the drilling bit was 7 7/8 inches, and a bentonite drilling fluid was used. The total depth of 966 feet was reached on August 28, 1985. Samples of the drill cuttings were collected at 10-foot intervals. A lithologic log was prepared from descriptions of these samples (table 3). Borehole-geophysical logs included gamma, neutron, density, caliper, long and short normal, spontaneous-potential, and resistivity logs (fig. 16).

The well was filled with high-density bentonite drilling fluid, and a cement plug was set at depths from 467 feet to 487 feet. A screen interval from 443.5 to 448.5 feet was selected based on geophysical logs. A total of 443.5 feet of 4.5-inch-diameter steel casing, 5 feet of wire-wound steel screen, and 8.5 feet of blank casing was placed in the hole. About 50 gallons of pea-sized rounded gravel were washed down the annulus for a gravel pack. Well-construction details are shown in figure 17.

The well was developed by running the drill pipe into the casing and jetting through the drill pipe with compressed air. The drilling fluid was removed through this process, but only minimal amounts of formation water could be airlifted to the surface because the total submergence of the drill pipe was less than 30 percent of the total length of drill pipe in the well (Johnson Division, Universal Oil Products Co., 1975, p. 305). Because of the small quantity of water recovered, water samples were not collected for chemical analyses. Samples for chemical analyses will be bailed from the well at a later date. The water level in the completed well on September 10, 1985, was 380.80 feet below land surface.

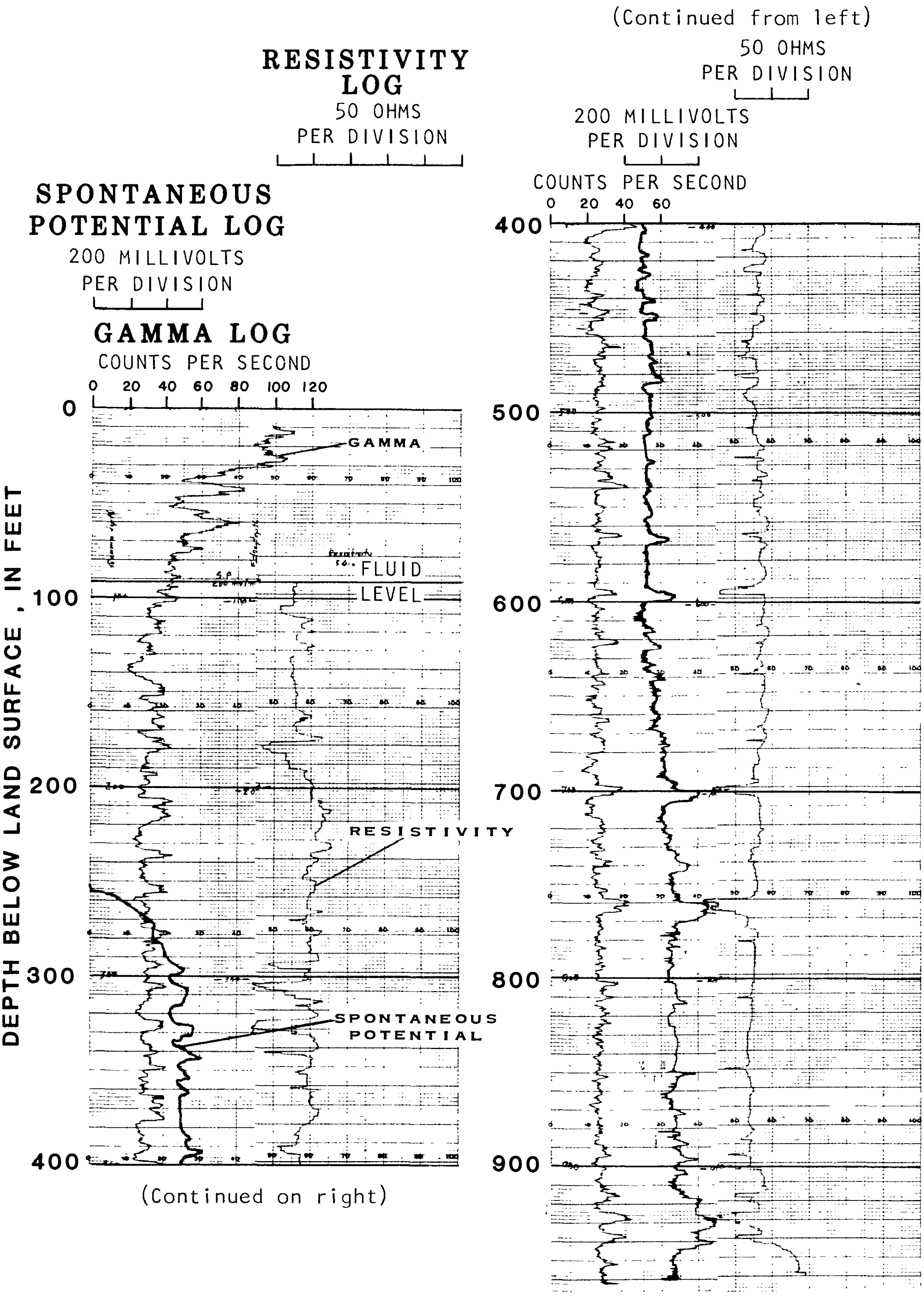


Figure 16.--Borehole-geophysical logs for test well HBNM-1.

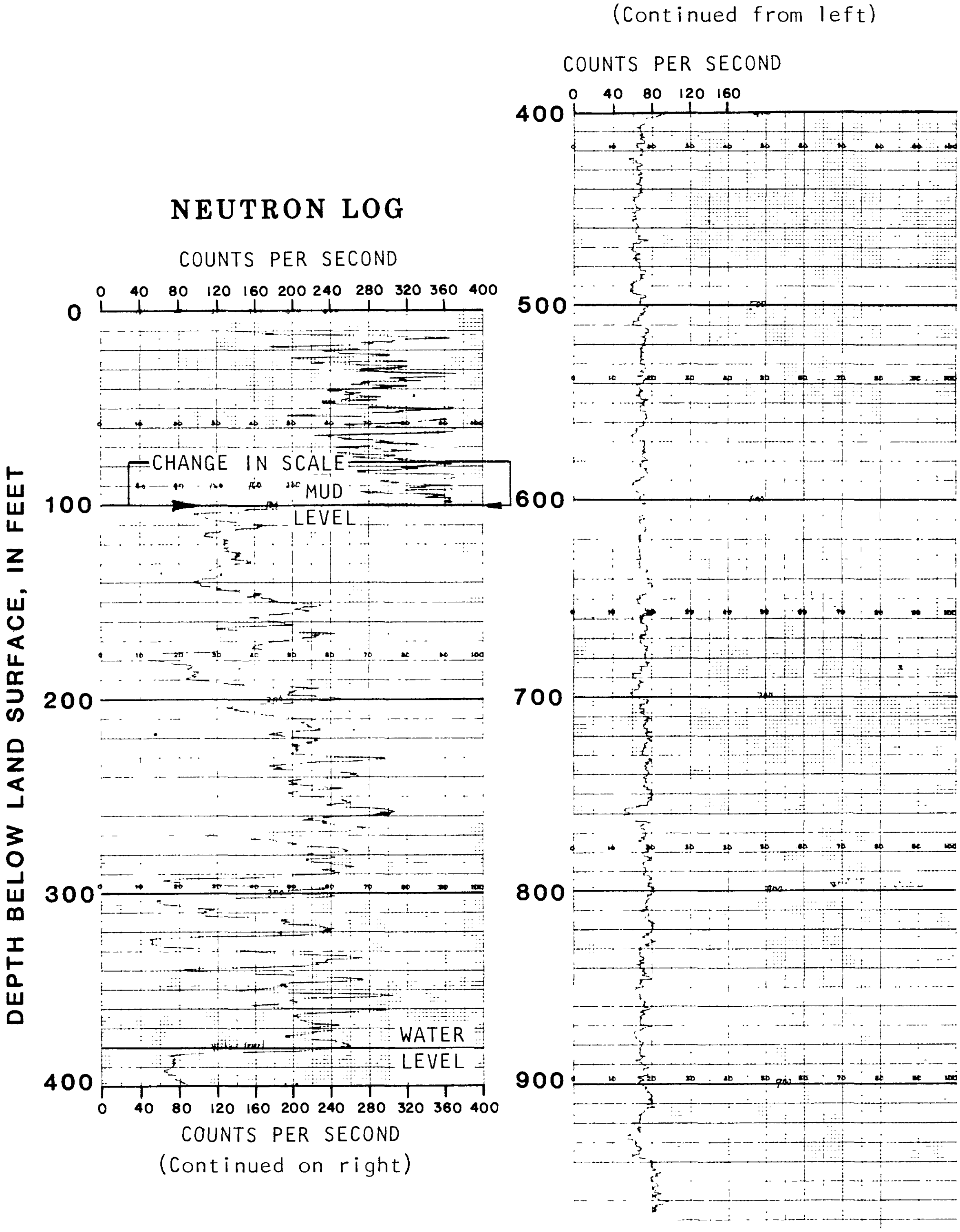


Figure 16.--Borehole-geophysical logs for test well HBNM-1. Continued

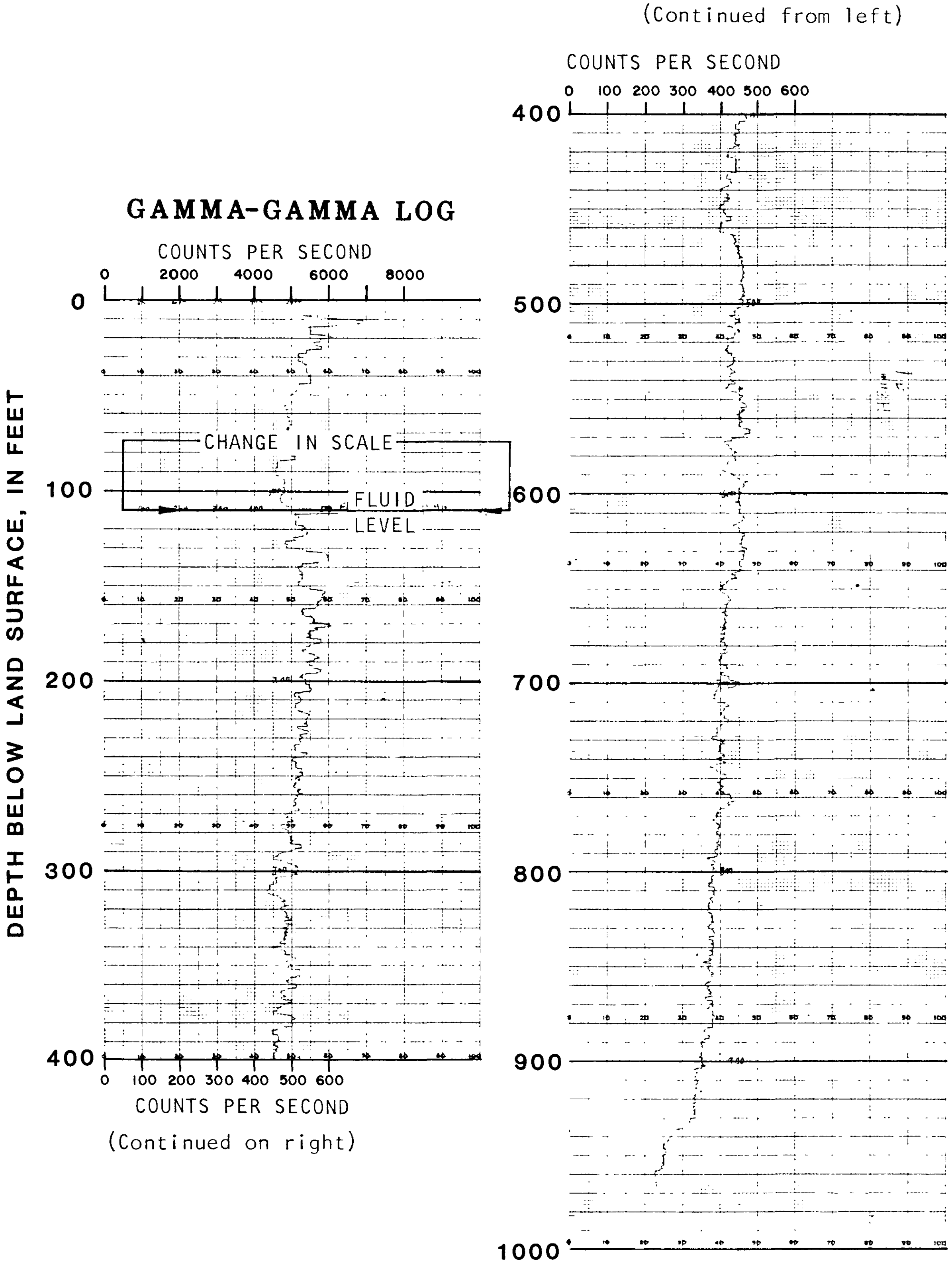


Figure 16.--Borehole-geophysical logs for test well HBNM-1. Continued

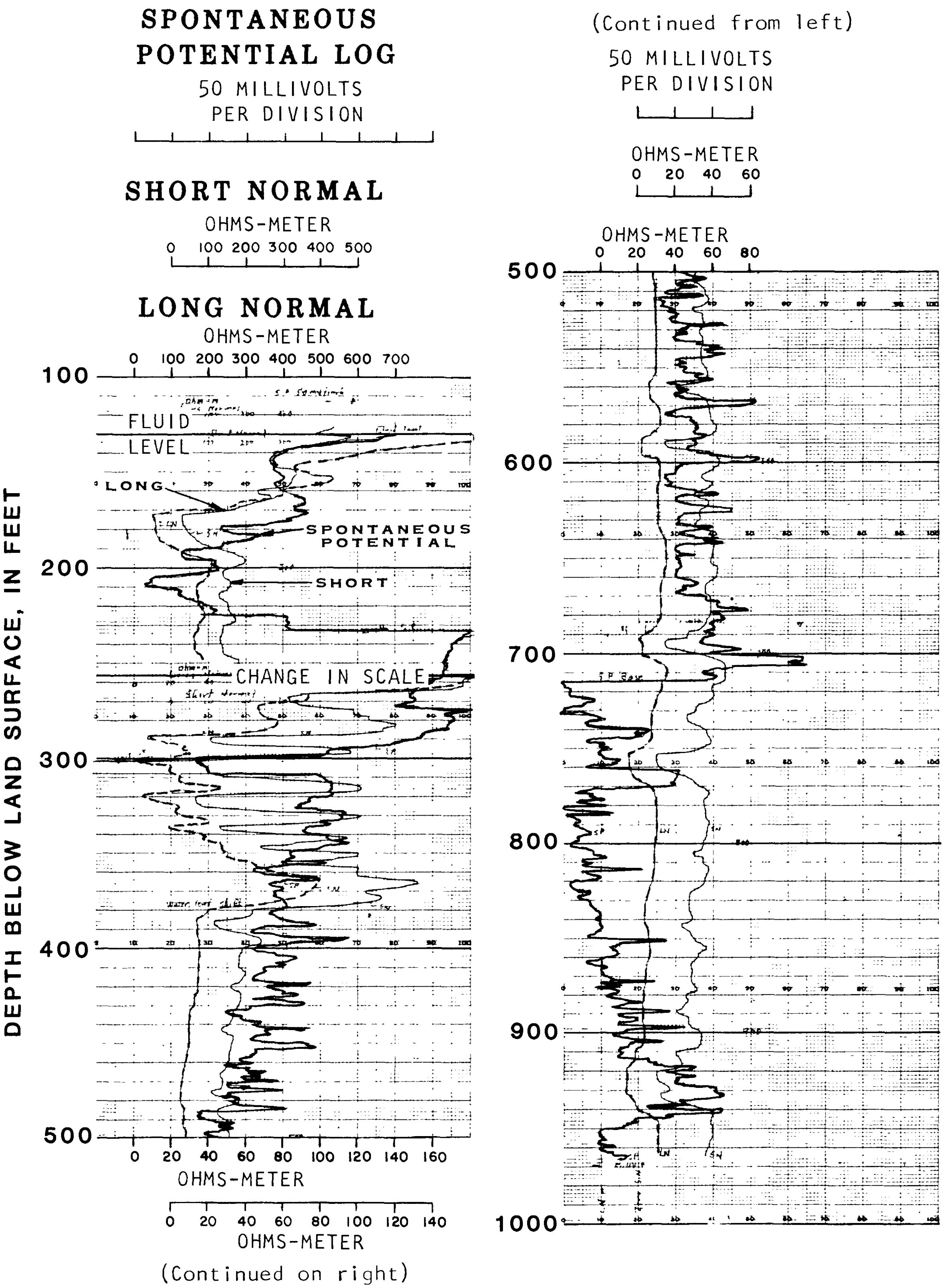


Figure 16.--Borehole-geophysical logs for test well HBNM-1. Continued

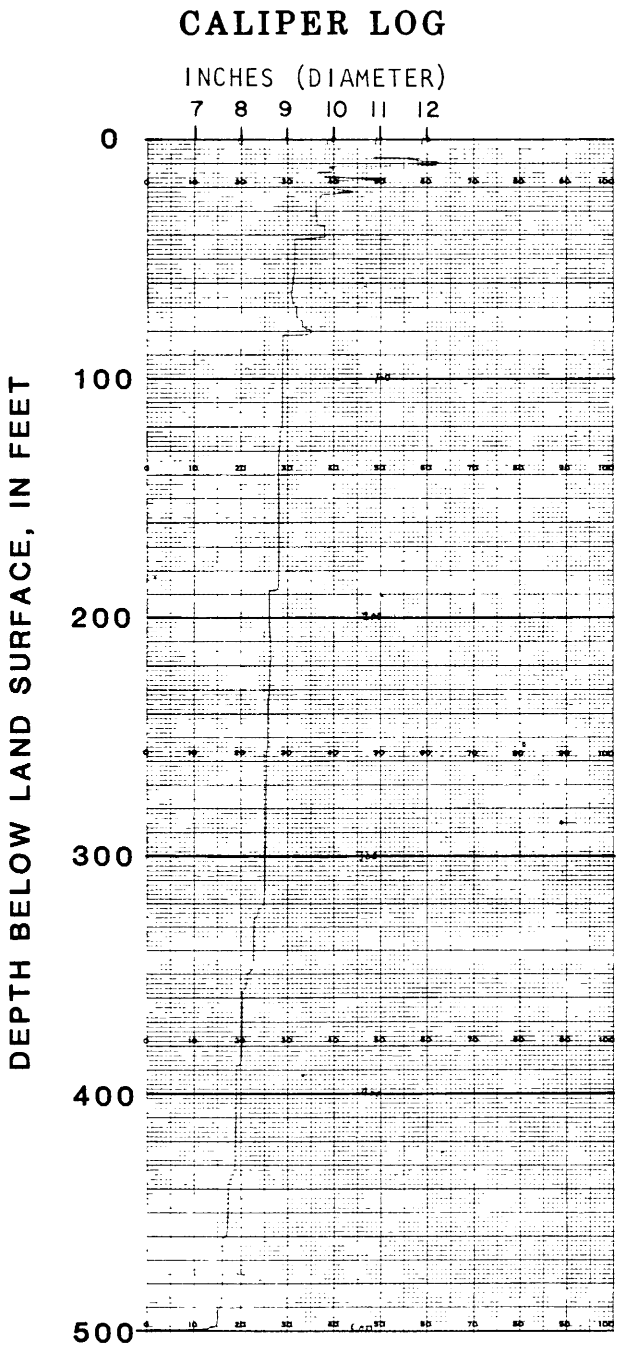


Figure 16.--Borehole-geophysical logs for test well HBNM-1. Concluded

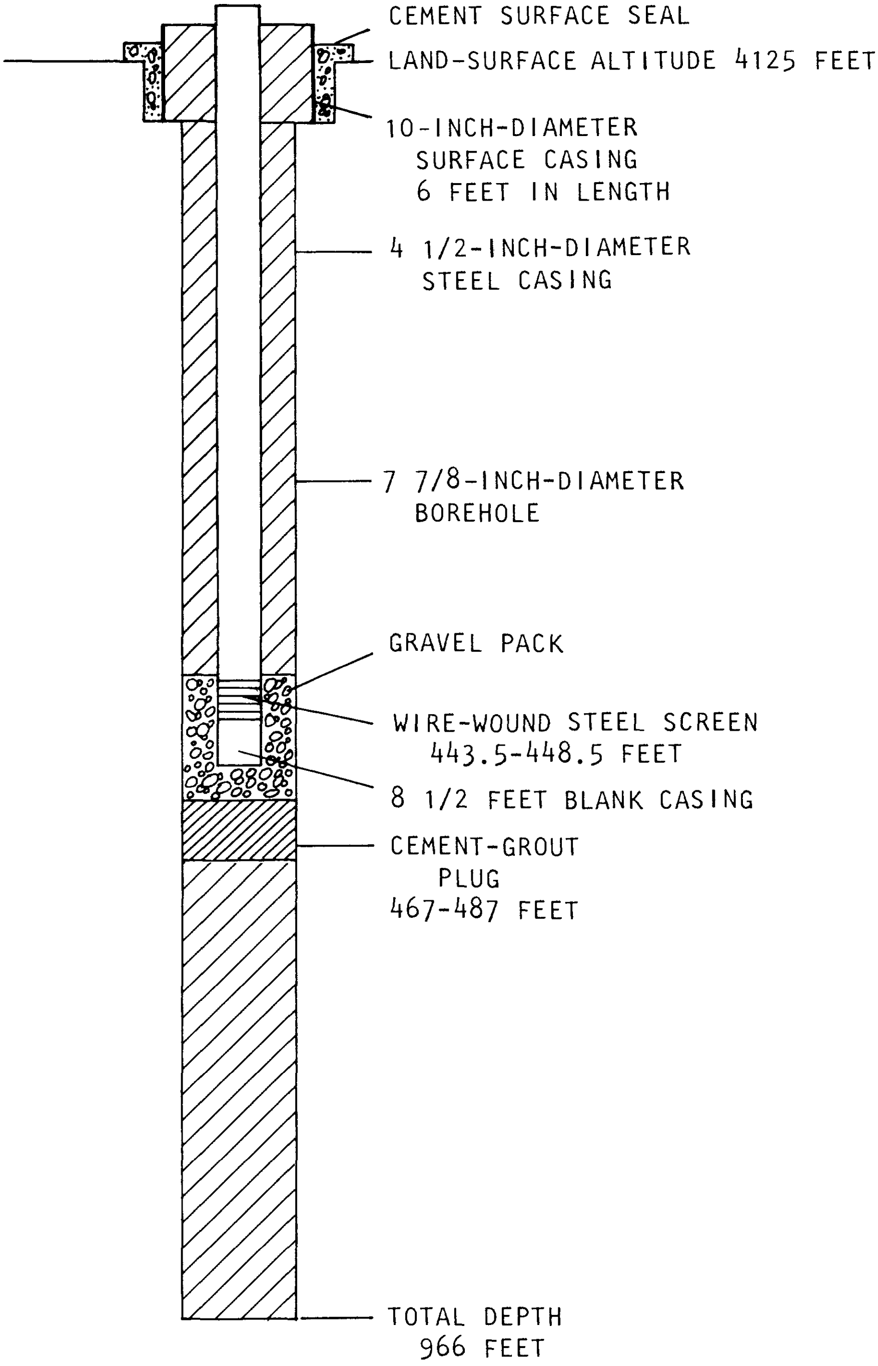


Figure 17.--Well-construction details for test well HBNM-1.

Test Well HBNM-2

Drilling began on test well HBNM-2 (25S.05E.16.232) on September 5, 1985. Bentonite drilling fluid was used during the drilling of the 7 7/8-inch-diameter borehole. Coarse gravel penetrated throughout drilling caused difficulty in maintaining circulation of the drilling fluid to the surface. Consequently, drilling was halted at a depth of 582 feet on September 6, 1985, when circulation could not be regained despite the use of additives to inhibit the loss of drilling fluid to the formation. A lithologic description of those cuttings that were recovered is shown in table 4. Borehole-geophysical logs included gamma, neutron, caliper, laterolog, and resistivity logs (fig. 18).

Borehole conditions precluded setting a cement plug. Geophysical logs were used to select a screen interval from 330 to 335 feet below land surface. A total of 330 feet of 4.5-inch-diameter steel casing, 5 feet of wire-wound steel screen, and 10 feet of blank casing was placed in the borehole. No gravel pack was installed because of borehole conditions. Well-construction details are shown in figure 19.

The well was developed by jetting through the drill pipe with compressed air. A large quantity of drilling fluid was removed from the well during the development procedure. Following the removal of the drilling fluid, only minimal amounts of water could be airlifted to the surface, again because of the inadequate submergence of the drill pipe. No water samples were collected. Samples for chemical analyses will be bailed at a later date. The water level in the completed well on September 9, 1985, was 308.59 feet below land surface.

Test Well HBNM-3

Drilling began on test well HBNM-3 (25S.6E.06.323) on August 31, 1985. A polymer drilling fluid was used during the drilling of the 7 7/8-inch-diameter borehole. The total depth of 1,088 feet was reached on September 2, 1985. Lithologic descriptions of borehole cuttings are shown in table 5. The driller reported that clay was predominant during drilling. Borehole-geophysical logs included gamma, neutron, caliper, long and short normal, resistivity, and spontaneous-potential logs (fig. 20).

A cement plug was installed at depths from 475 to 495 feet. A screen interval from 450 to 455 feet was selected based on geophysical logs, but difficulties were encountered running the casing to that depth, and an alternative screen interval from 372 to 377 feet was selected. A total of 372 feet of 4.5-inch-diameter steel casing, 5 feet of wire-wound steel screen, and 10 feet of blank casing was placed in the borehole. Approximately 100 gallons of pea-sized rounded gravel were washed down the annulus for a gravel pack. Well-construction details are shown in figure 21.

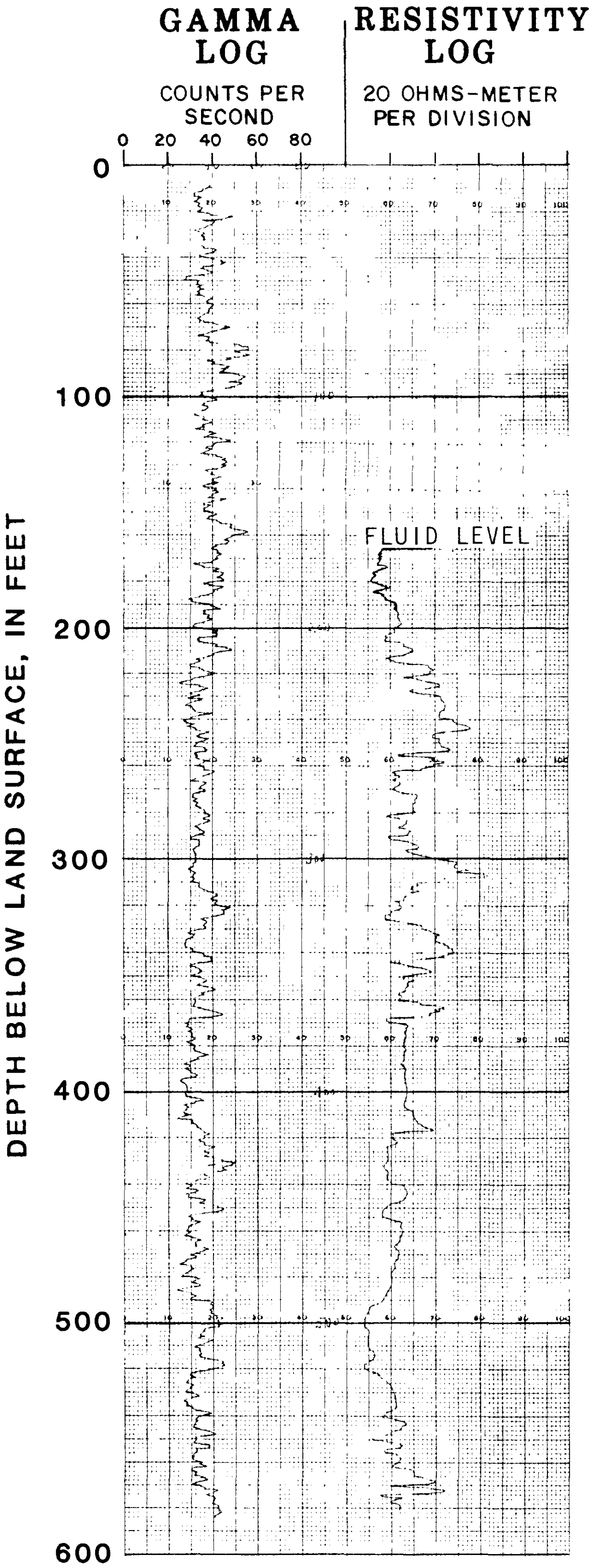


Figure 18.--Borehole-geophysical logs for test well HBNM-2.

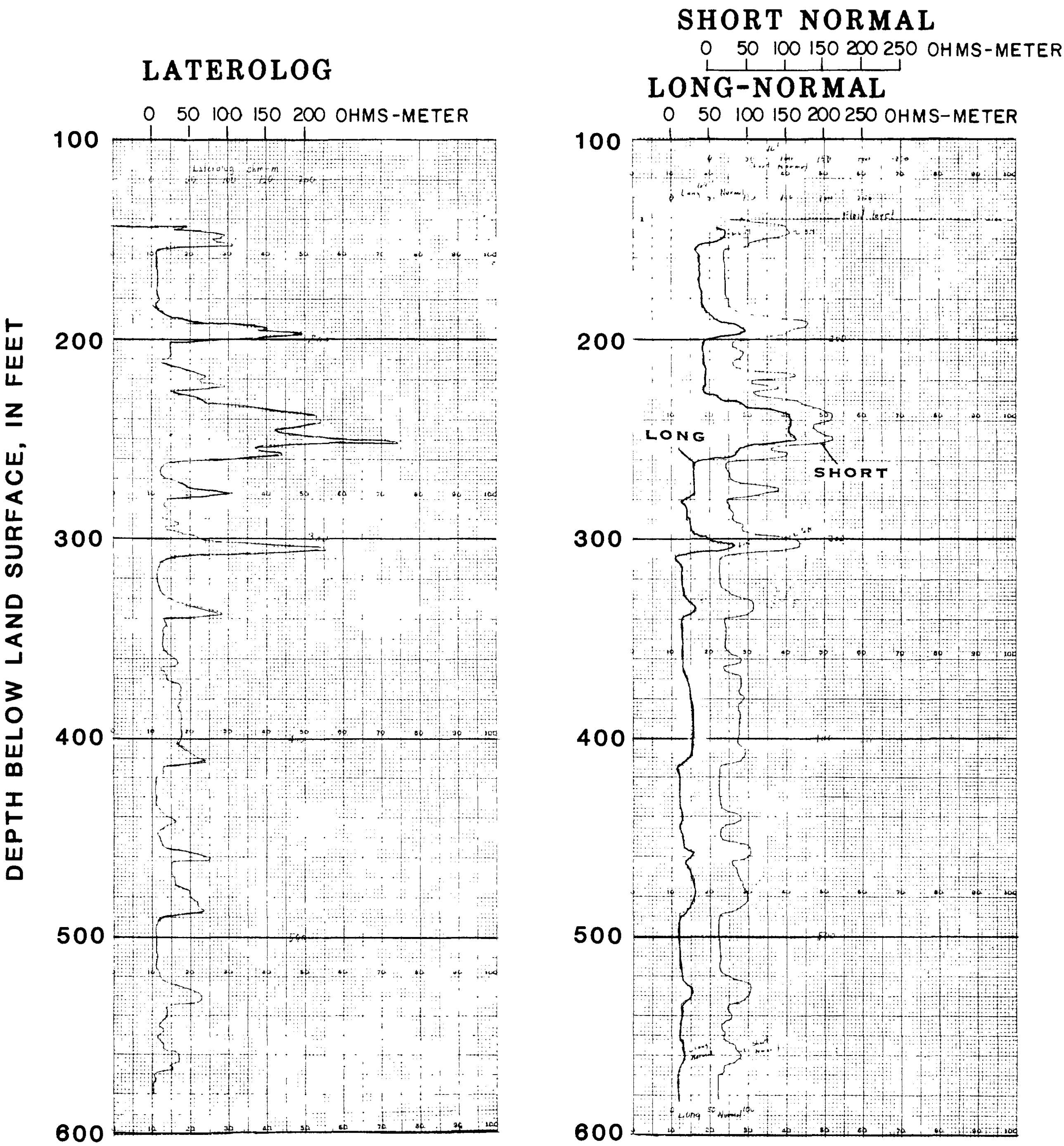


Figure 18.--Borehole-geophysical logs for test well HBNM-2. Continued

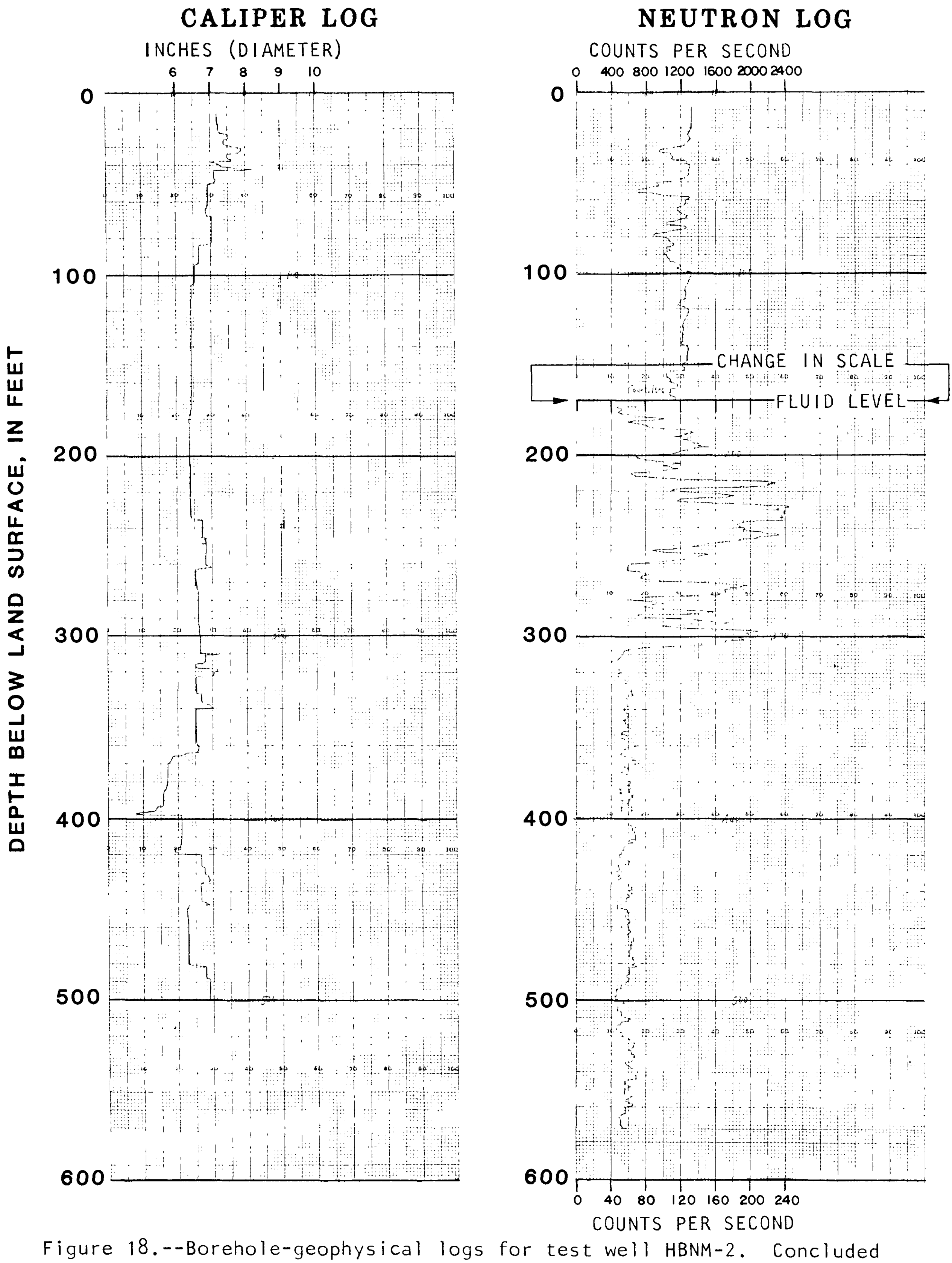


Figure 18.--Borehole-geophysical logs for test well HBNM-2. Concluded

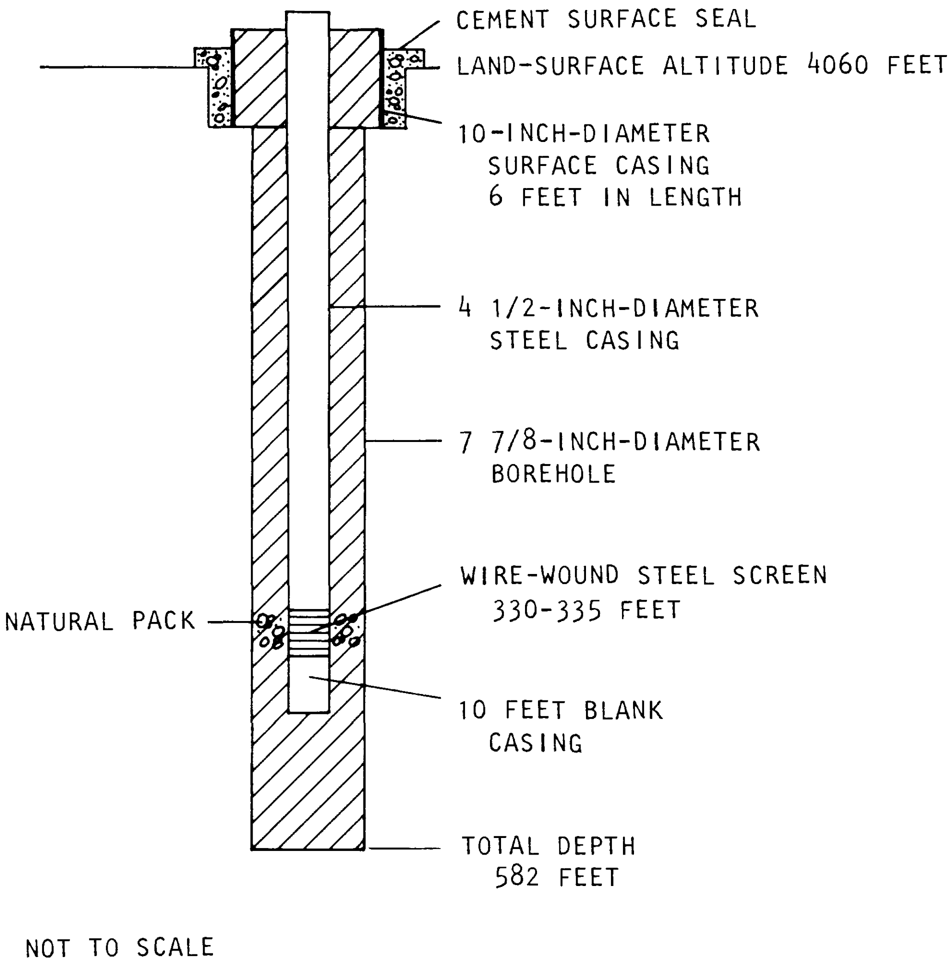


Figure 19.--Well-construction details for test well HBNM-2.

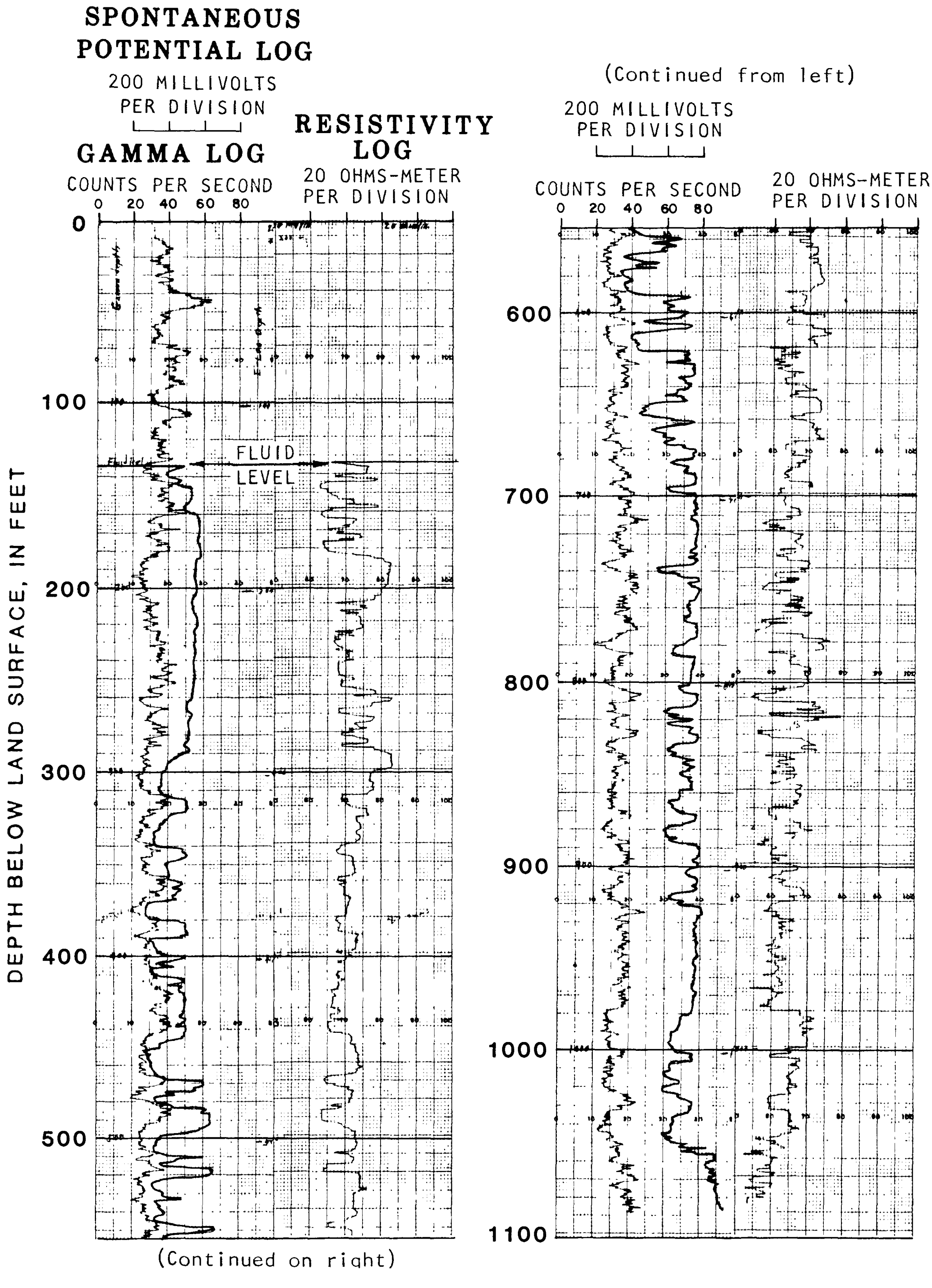


Figure 20.--Borehole-geophysical logs for test well HBNM-3.

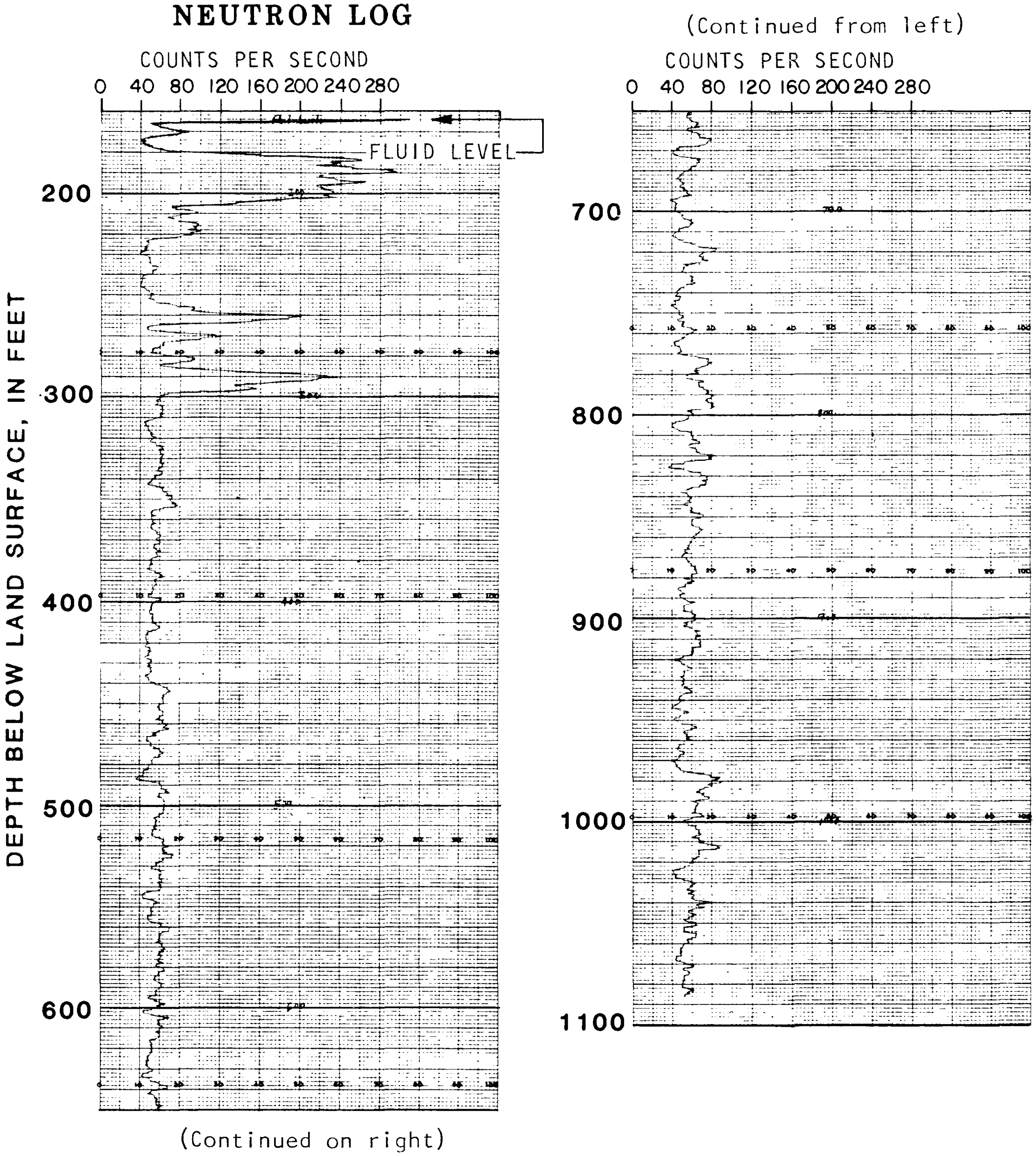


Figure 20.--Borehole-geophysical logs for test well HBNM-3. Continued

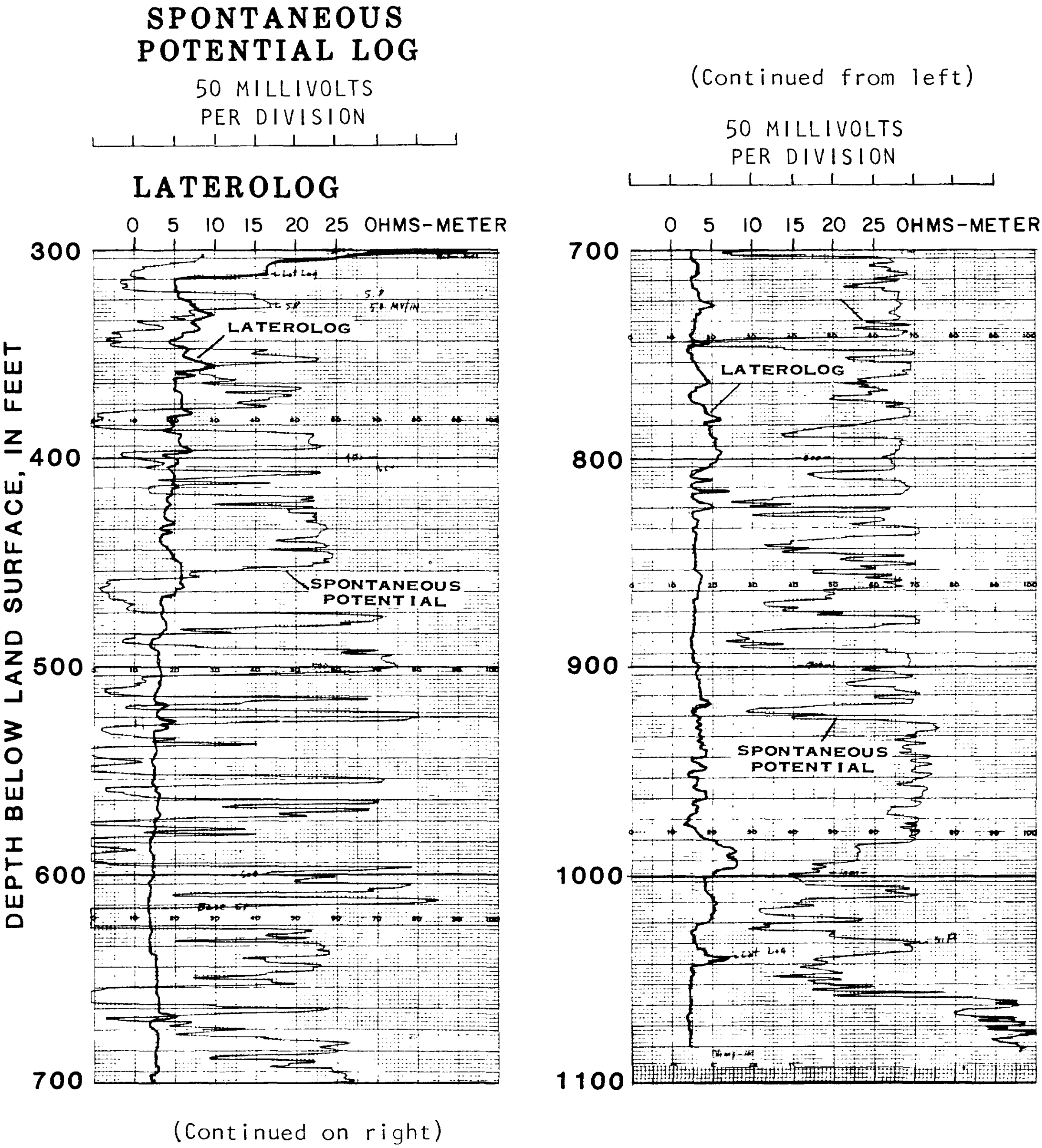


Figure 20.--Borehole-geophysical logs for test well HBNM-3. Continued

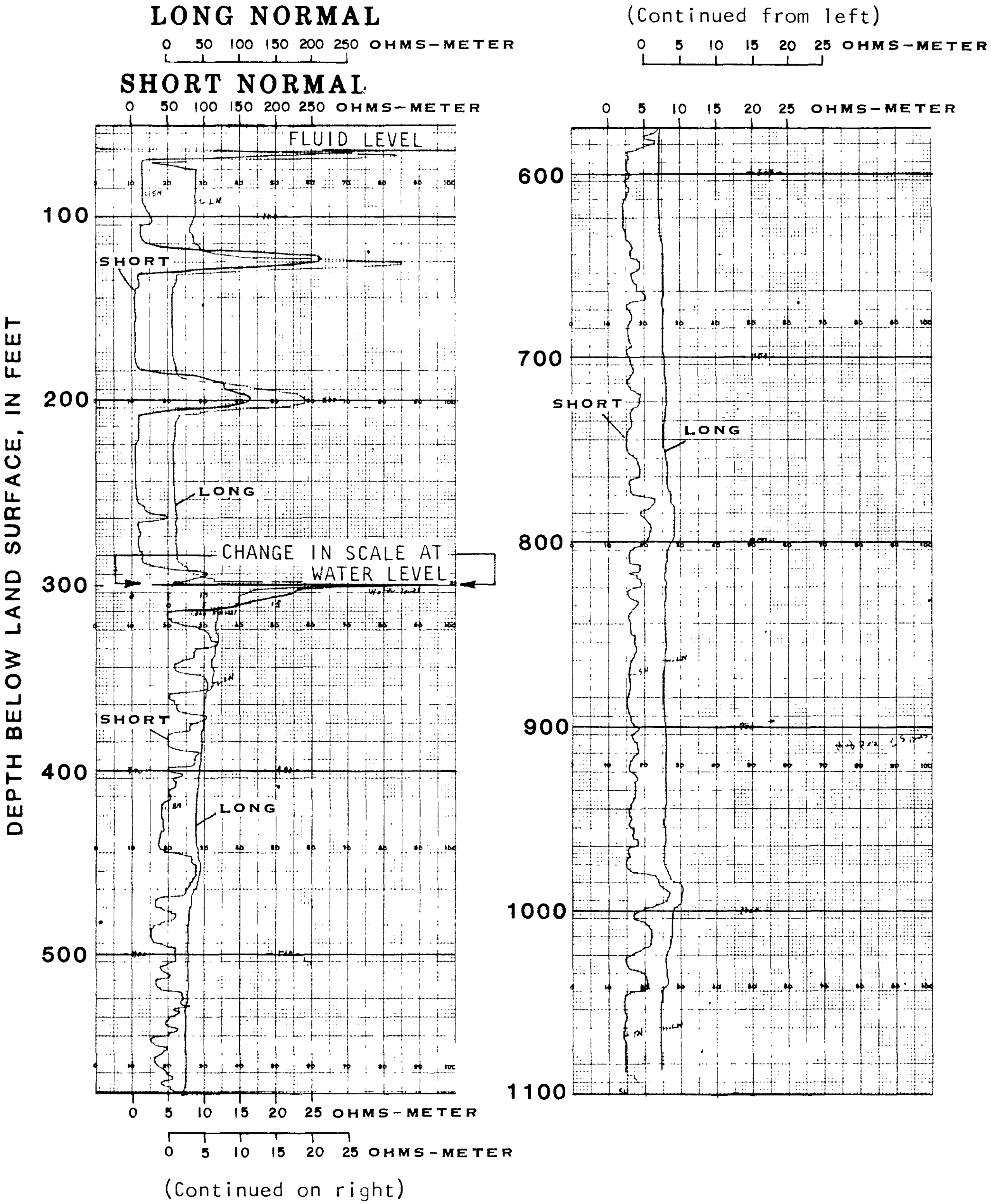


Figure 20.--Borehole-geophysical logs for test well HBNM-3. Continued

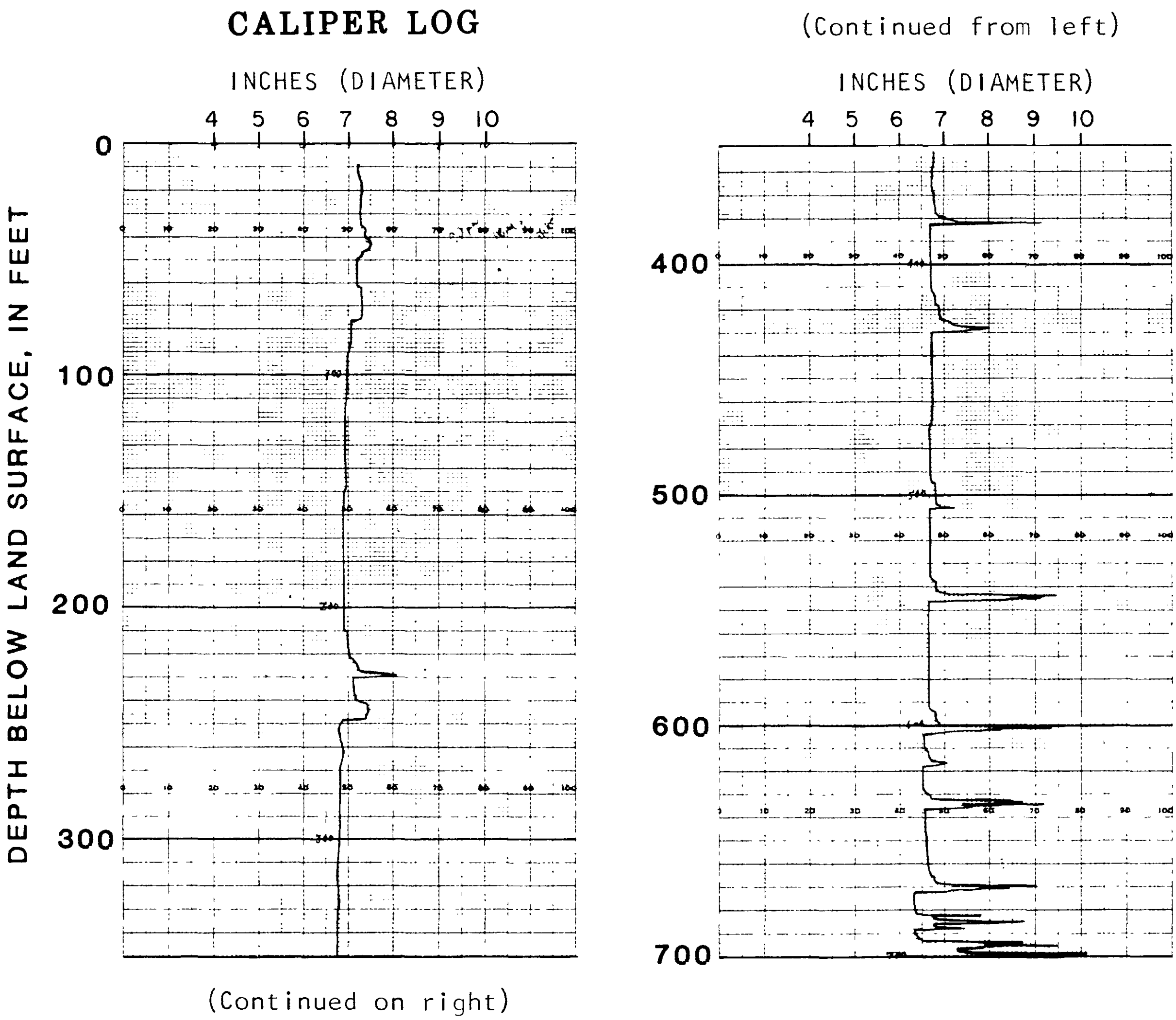


Figure 20.--Borehole-geophysical logs for test well HBNM-3. Concluded

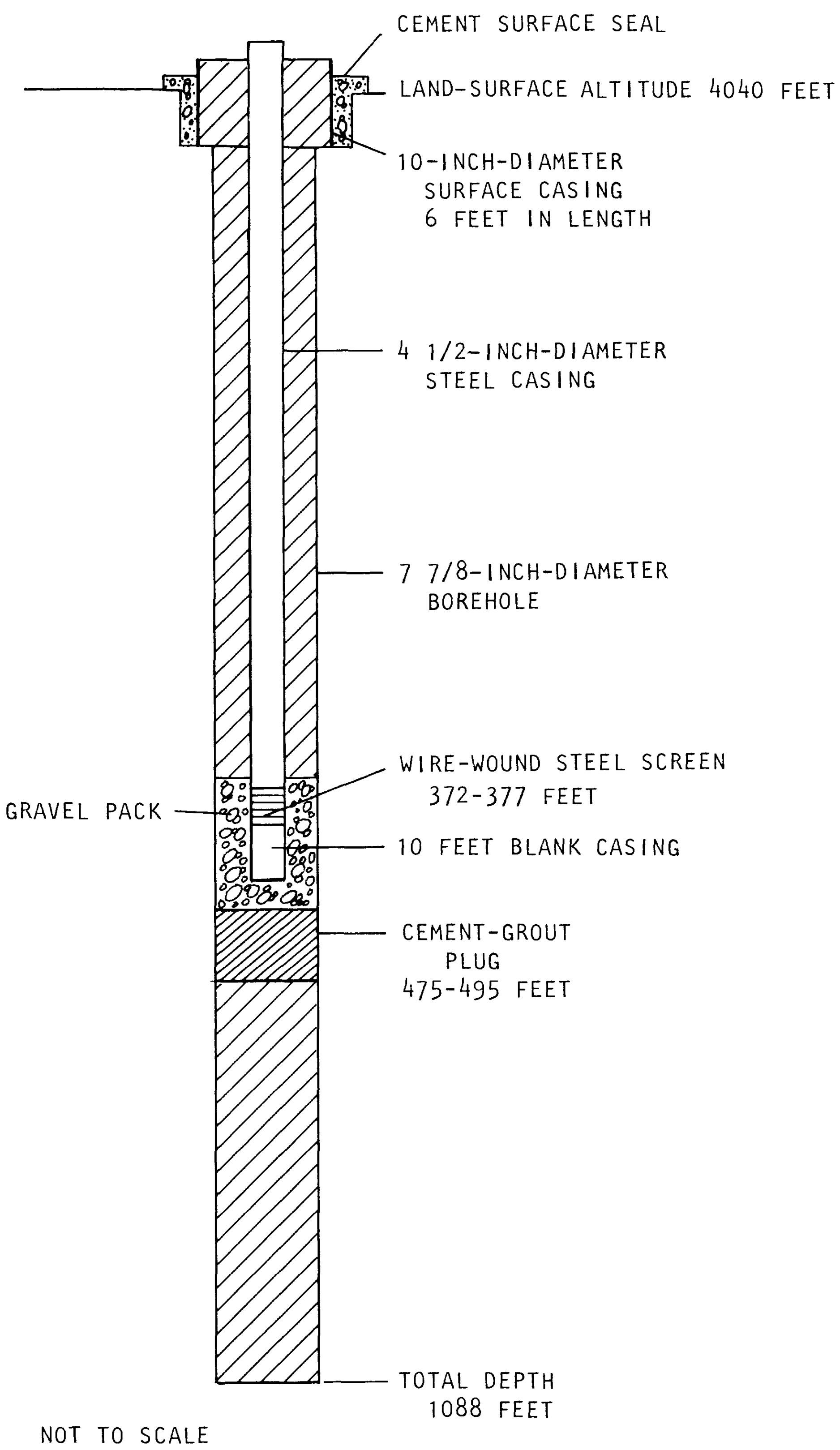


Figure 21.--Well-construction details for test well HBNM-3.

The well was developed by air-jetting through the drill pipe. Following the removal of drilling fluid, minimal amounts of water were jetted to the surface, again because of inadequate submergence of the drill pipe. No water sample was collected. Samples for chemical analyses will be bailed at a later date. The water level in the completed well on October 7, 1985, was 298.72 feet below land surface.

Test Well HBNM-4

Drilling began on test well HBNM-4 (24S.05E.35.241) on September 9, 1985. Bentonite drilling fluid was used during the drilling of the 7 7/8-inch-diameter borehole. A total depth of 1,111 feet was reached on September 10, 1985. A lithologic description of cuttings is shown in table 6. Borehole-geophysical logs included gamma, neutron, caliper, long and short normal, laterolog, and resistivity logs (fig. 22).

A cement plug was installed and a screen interval from 450 to 455 feet was selected based on geophysical logs. A total length of 450 feet of 4.5-inch-diameter steel casing, 5 feet of wire-wound steel screen, and 9 feet of blank casing was placed in the borehole. Approximately 50 gallons of pea-sized rounded gravel were washed down the annulus for a gravel pack. Well-construction details are shown in figure 23.

The well was developed by air-jetting through the drill pipe. Approximately 30 gallons per minute of water were airlifted to the surface. Jetting continued for several hours until the water cleared and the specific conductance of the water had stabilized. Samples were collected for chemical analyses (in process at time of report preparation). The onsite specific conductance of the water was 2,400 microsiemens at 25 degrees Celsius, the onsite pH was 7.5, and the water temperature was 26.5 degrees Celsius. The water level in the completed well on October 7, 1985, was 220.32 feet below land surface.

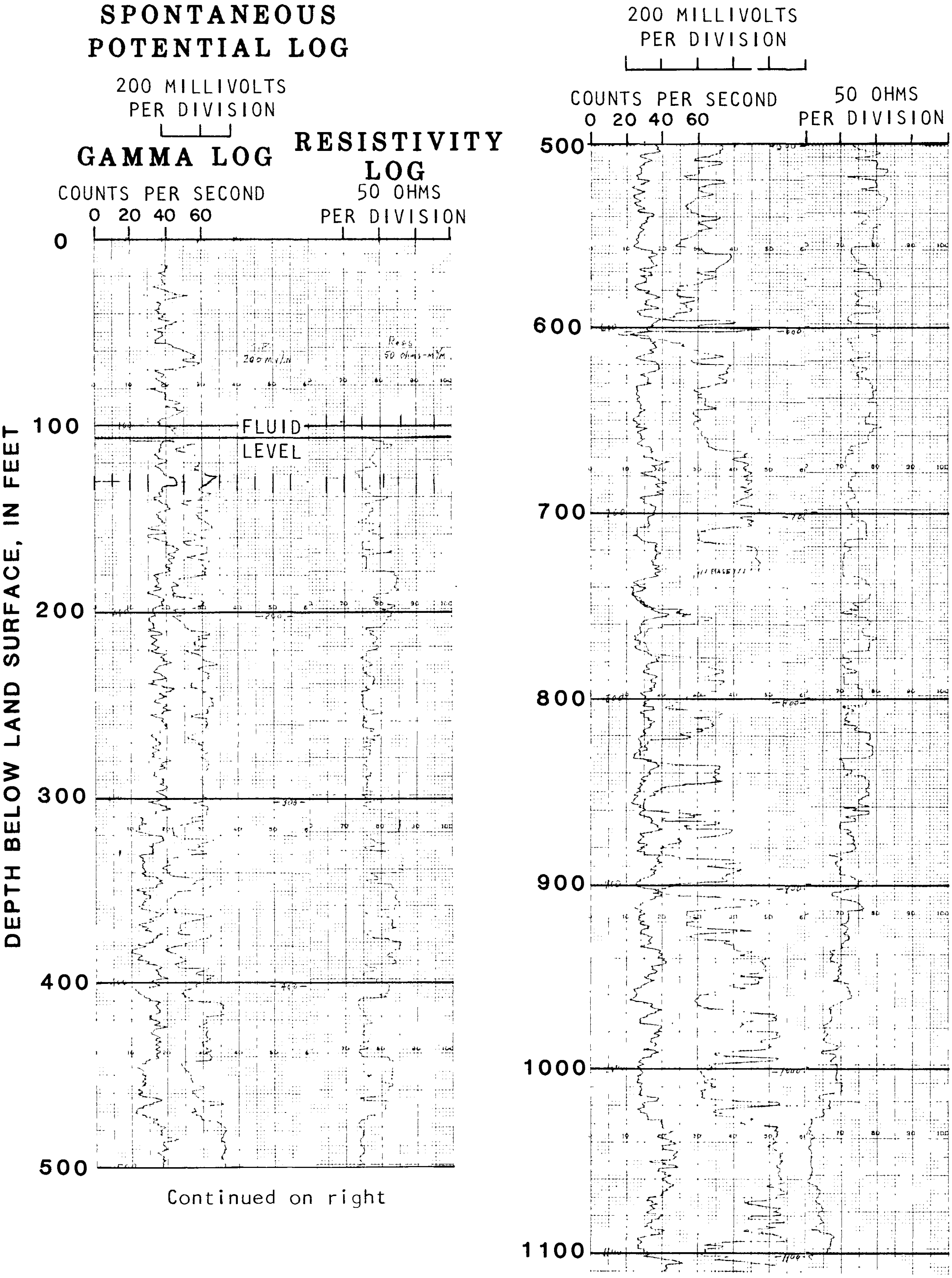


Figure 22.--Borehole-geophysical logs for test well HBNM-4.

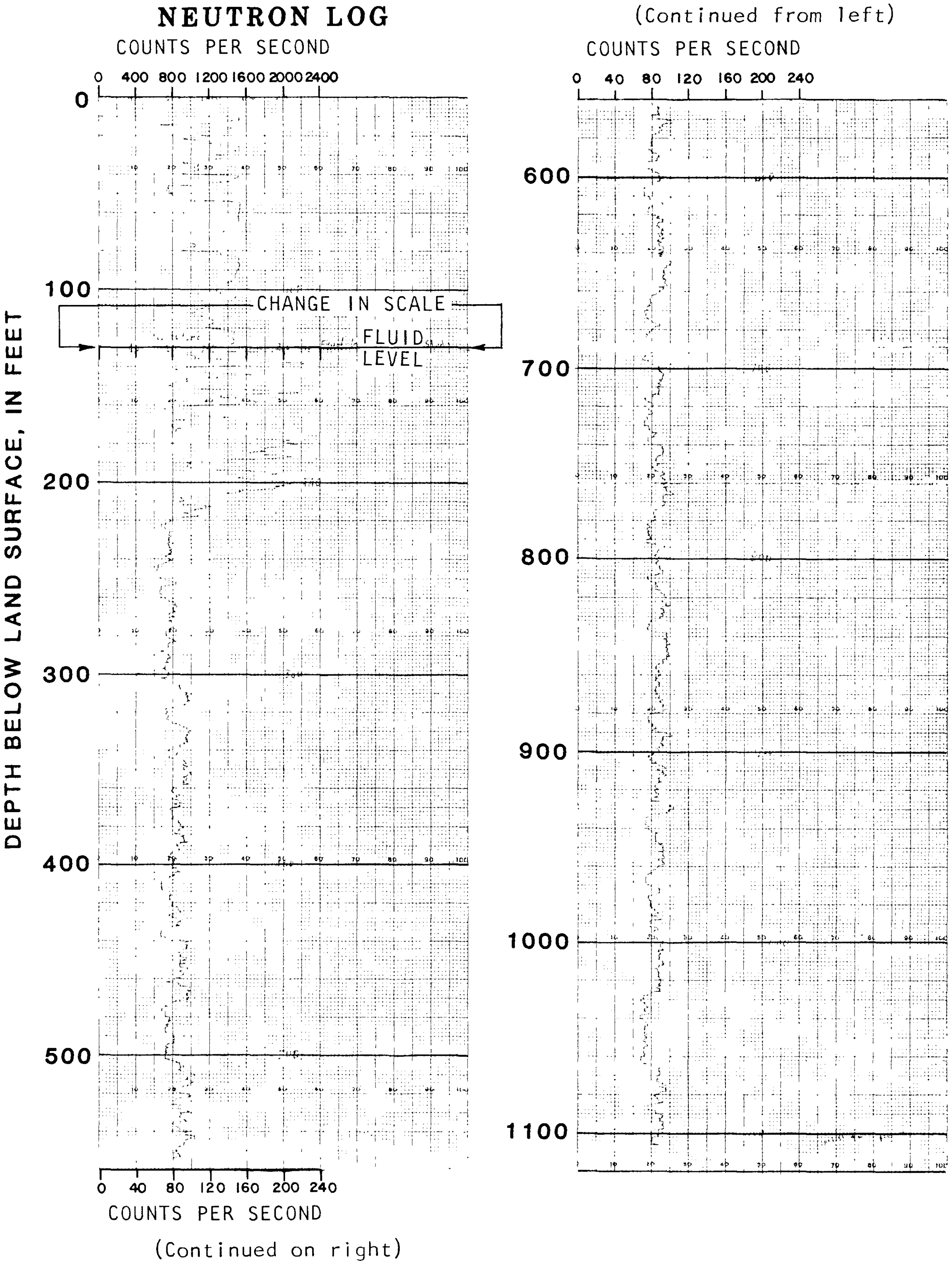


Figure 22.--Borehole-geophysical logs for test well HBNM-4. Continued

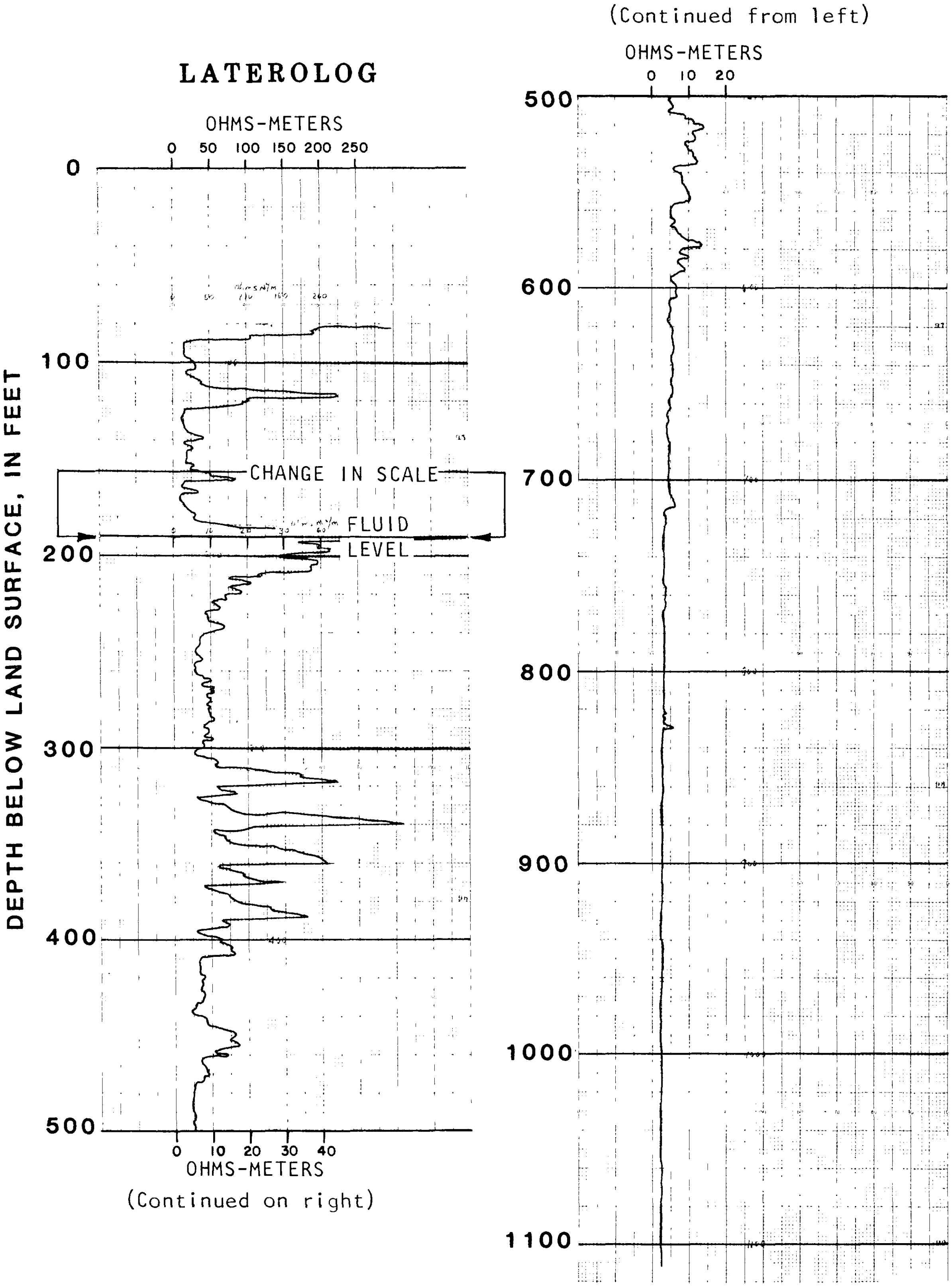


Figure 22.--Borehole-geophysical logs for test well HBNM-4. Continued

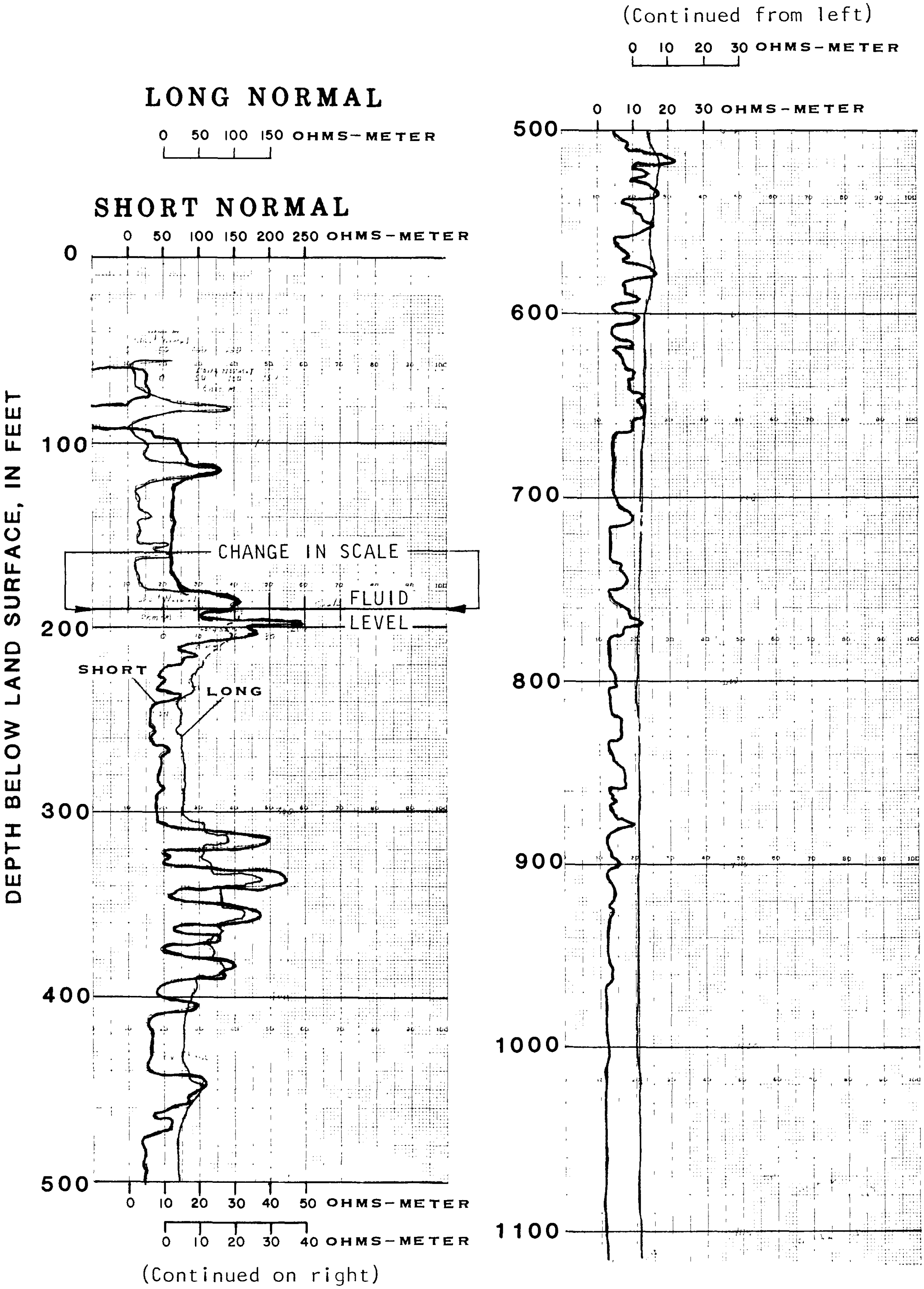


Figure 22.--Borehole-geophysical logs for test well HBNM-4. Continued

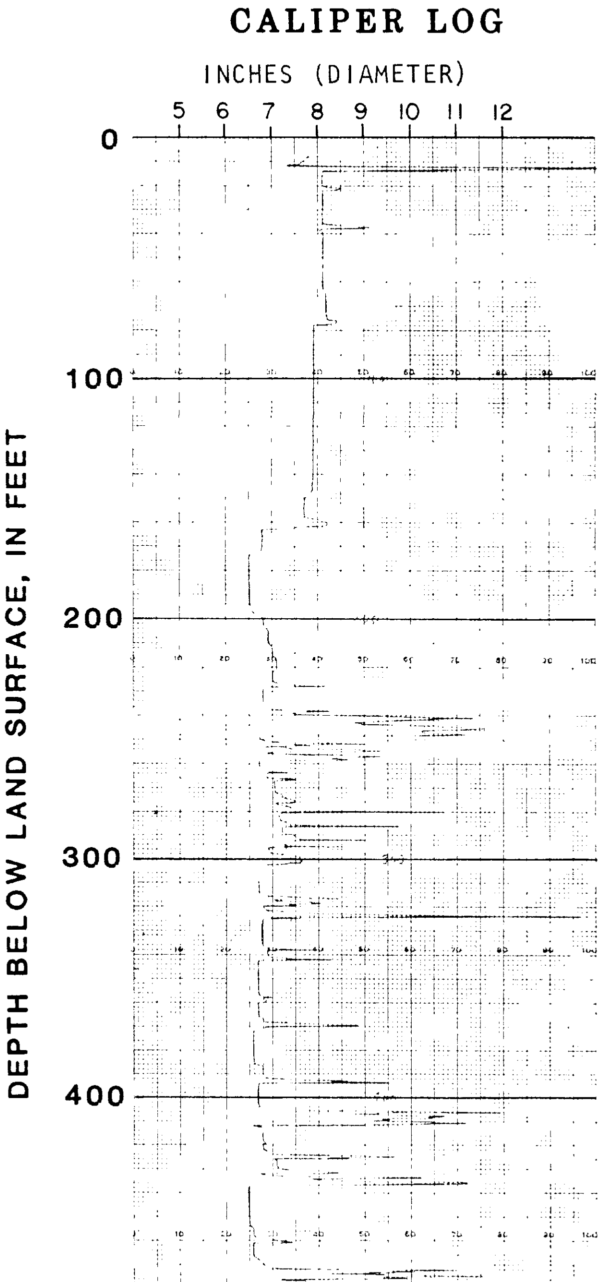


Figure 22.--Borehole-geophysical logs for test well HBNM-4. Concluded

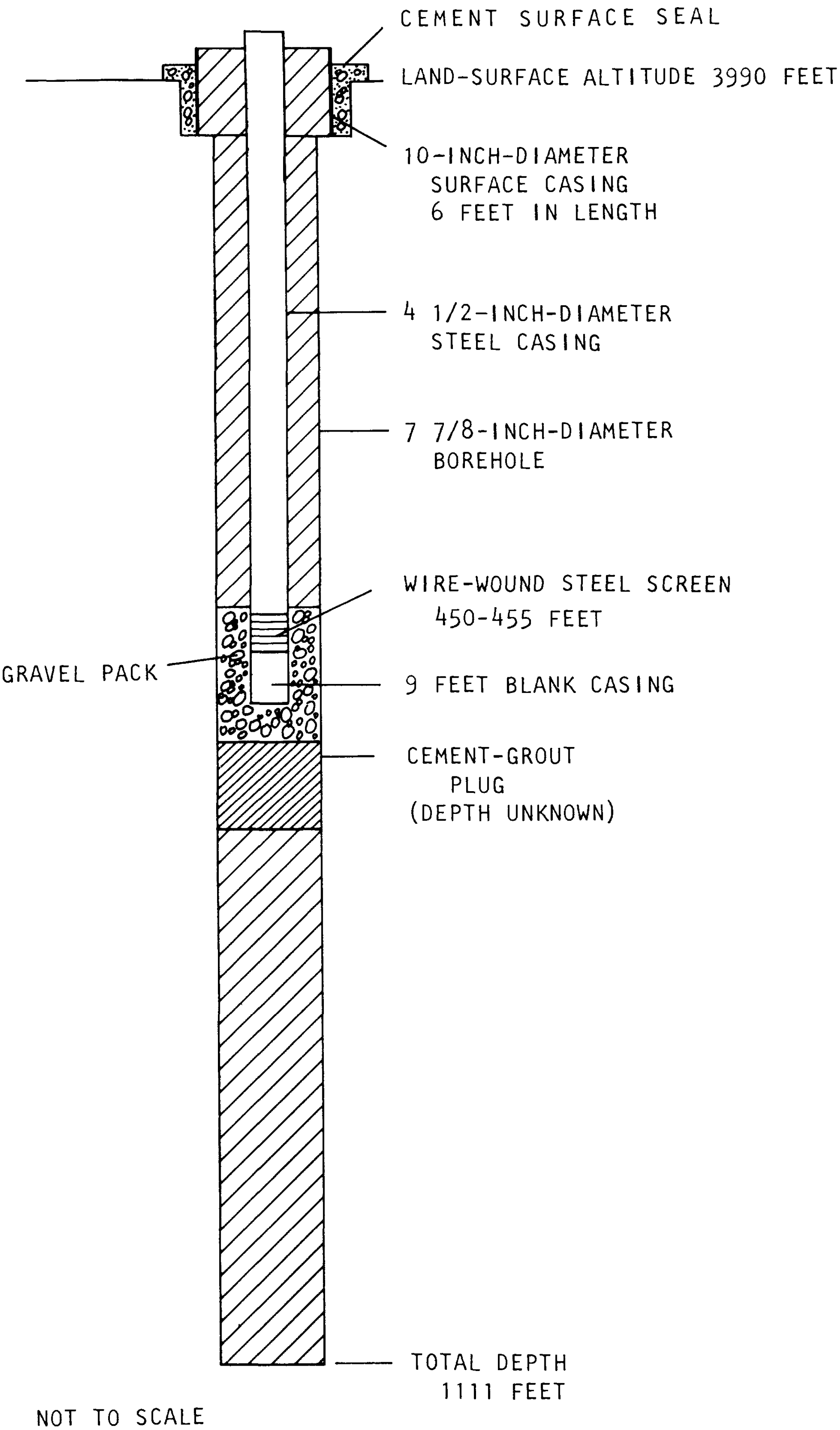


Figure 23.--Well-construction details for test well HBNM-4.

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Table 1.—Records of selected wells and test holes, northern part of the Hueco Bolson, New Mexico and Texas

[R, reported data]

Well location	Well or owner name	Altitude of land surface (feet)	Water level: Depth below land surface (feet)	Water level: Date measured	Depth of well (feet)	Depth of hole (feet)	Remarks
23S.5E.01.113	B-6	3,929	133.70	3-5-85	180	200	Borehole, White Sands Missile Range
23S.5E.10.413	T-16	3,980	183.99	3-5-85	710	2,007	Test hole, White Sands Missile Range
23S.5E.27.142	T-17	4,020	242.33	3-5-85	564	2,500	Test hole, White Sands Missile Range
25S.3E.01.211	—	—	428.08	1-29-85	—	—	Irrigation well
25S.3E.13.112	Lord's Ranch	—	387.45	1-29-85	—	—	
25S.3E.13.144	Lord's Ranch	—	382.98	1-29-85	—	—	
25S.3E.13.212	Winston	—	386.88	1-29-85	—	—	
25S.4E.11.123	K-29	4,107	359.00	2-7-85	800 R	—	Doña Ana Range Camp supply well
25S.4E.17.444	K-14	4,168	354.29	2-7-85	902	—	Test well
25S.4E.18.244	K-13	4,200	387.04	2-7-85	768	977	Test well

Table 1.—Records of selected wells and test holes, northern part of the Hueco Bolson, New Mexico and Texas - Continued

Well location	Well or owner name	Altitude of land surface (feet)	Water level: Depth below land surface (feet)	Water level: Date measured	Depth of well (feet)	Depth of hole (feet)	Remarks
25S.5E.31.334	L-3	4,075	348.13	2-7-85	462	—	
25S.6E.20.333	L-17	4,023	298.37	2-7-85	378 R	—	Hueco Range Camp supply well
26S.5E.04.124	—	—	352.08	1-23-85	—	—	
26S.5E.04.312	L-25 (Bell)	4,073	352.26	2-7-85	504 R	—	
26S.5E.05.134	Rush	—	336.42	2-8-83	500 R	—	
26S.5E.05.224	Hamilton	—	346.68	1-8-85	532 R	—	
26S.5E.05.244	—	—	352.59	1-8-85	510 R	—	
26S.5E.05.441	D. Martinez	—	367.62	1-8-85	550 R	—	
26S.5E.05.442	—	—	354.16	2-9-83	—	—	Well dry in 1985
26S.5E.06.142	Edwards	—	334.05	1-8-85	510 R	—	
26S.5E.06.212	Little	—	333.25	1-8-85	520 R	—	
26S.5E.06.312	—	—	369.50	1-8-85	—	—	

Table 1.—Records of selected wells and test holes, northern part of the Hueco Bolson, New Mexico and Texas - Continued

Well location	Well or owner name	Altitude of land surface (feet)	Water level: Depth below land surface (feet)	Water level: Date measured	Depth of well (feet)	Depth of hole (feet)	Remarks
26S.5E.06.424	Allen	—	345.70	1-8-85	—	—	
26S.5E.07.213	Gamboa	—	393.44	1-9-85	—	—	
26S.5E.07.232	Puga	—	361.34	1-9-85	550 R	—	
26S.5E.07.233a	Holguin	—	387.90	1-9-85	500 R	—	
26S.5E.07.243	Lang	—	372.15	1-9-85	508 R	—	
26S.5E.08.114	Long	—	368.35	1-23-85	—	—	
26S.5E.08.314	Peel	—	373.17	1-9-85	—	—	
26S.5E.19.131	—	—	385.00	1-23-85	—	—	
26S.5E.21.213	L-22	4,048	351.68	2-7-85	700 R	—	
26S.5E.21.323	L-33 (Hamilton)	4,068	372.33	2-9-83	554 R	—	
		—	374.18	1-21-85	—	—	
26S.5E.21.433	Shirley	—	376.83	1-21-85	—	—	

Table 1.—Records of selected wells and test holes, northern part of the Hueco Bolson, New Mexico and Texas - Continued

Well location	Well or owner name	Altitude of land surface (feet)	Water level: Depth below land surface (feet)	Water level: Date measured	Depth of well (feet)	Depth of hole (feet)	Remarks
26S.5E.22.314	L-31	4,023	325.72	2-7-85	502 R	—	
26S.5E.22.323	Colquitt	—	324.00 325.58	2-10-83 1-21-85	—	—	
26S.5E.22.444	—	—	320 R	1981	690 R	—	
26S.5E.28.233	HU-10 (Phillips)	—	358 R	5-84	700 R	—	
26S.5E.28.243	L-26 (Smith)	—	357.70	1-22-85	537 R	—	
26S.5E.33.244	L-12	4,046	355.71	1-29-85	1,209	—	
JL-49-05-205	R-2	4,041	351.35	1-29-85	520	1,018	Unused well
JL-49-05-309	R-102	4,025	334.22	1-29-85	660	795	Domestic and stock well
JL-49-05-614	OB-8	3,990	345.03	2-4-85	—	—	
JL-49-05-618	OB-5	3,996	353.64	2-4-85	—	—	
JL-49-05-621	OB-4A	3,989	344.62	2-4-85	—	—	

Table 1.—Records of selected wells and test holes, northern part of the Hueco Bolson, New Mexico and Texas - Concluded

Well location	Well or owner name	Altitude of land surface (feet)	Water level: Depth below land surface (feet)	Water level: Date measured	Depth of well (feet)	Depth of hole (feet)	Remarks
JL-49-05-622	OB-4B	3,984	342.40	2-4-85	—	—	
JL-49-05-625	OB-7A	3,982	343.52	2-4-85	—	—	
JL-49-05-626	OB-7B	3,984	345.03	2-4-85	—	—	
JL-49-05-904	FB-14	3,920	297.71	2-9-85	—	834	Public supply
JL-49-06-102	R-4	4,046	348.37	1-29-85	520	825	Observation well
JL-49-06-405	OB-1	4,015	357.07	2-4-85	—	—	
JL-49-06-501	S-5	3,973	281.52	1-29-85	450	1,005	Observation well
JL-49-06-503	S-5A	3,973	271.93	1-29-85	—	—	
JL-49-06-701	FB-15	3,944	315.27	1-29-85	—	819	Public supply
JL-49-06-702	R-15	3,973	311.28	1-29-85	450	450	Observation well
JL-49-06-901	HB-4	4,005	318.70	7-23-83	—	—	Unable to measure in 1985 (vandalized)

Table 2.--Irrigated acreage for wells with no estimates of ground-water withdrawals (New Mexico State Engineer Office, written commun., 1985)

Well location	Owner	Irrigated acres	Year drilled
26.05.21.341	Martinez	29.0	1973
26.05.06.112	Steagall	30.0	1977
26.05.06.212	Little	39.0	1979
26.05.06.221	Stromberg	40.0	1969
26.05.08.243	Martin	22.0	1975
26.05.21.112	Wright	110.0	1977
26.05.21.124	Wright	200.0	1974
26.05.21.414	Fernandez	15.0	--
26.05.22.241	Campbell	11.0	1965

Table 3.--Lithologic log for test well HBNM-1

[Driller: Unzicker and Wells Drilling Company, Hanksville, Utah]

Cuttings description	Thickness (feet)	Depth interval (feet)
Gravel; cobbles, small; sand, medium- to coarse-grained.	60	0-60
Clay, light-brown.	30	60-90
Gravel; sand, medium- to coarse-grained, well-rounded.	20	90-110
Sand, fine- to coarse-grained, rounded; fine pebble gravel.	30	110-140
Clay, light-brown.	10	140-150
Sand, fine- to coarse-grained, rounded; fine pebble gravel.	50	150-200
Sand, fine- to coarse-grained; light-brown clay.	10	200-210
Sand, fine- to coarse-grained, rounded; fine pebble gravel.	60	210-270
Sand, fine- to coarse-grained; light-brown clay.	10	270-280
Sand, medium- to very coarse grained, subangular to rounded.	20	280-300
Clay, light-brown; minor medium- to coarse-grained sand.	30	300-330
Sand, very fine to fine-grained; clay.	110	330-440
Sand, fine-grained; very fine pebble gravel.	10	440-450
Sand, fine-grained; very fine pebble gravel; some clay.	10	450-460
Sand, fine-grained; very fine pebble gravel.	40	460-500
Sand, fine-grained; very fine pebble gravel; light-brown clay.	10	500-510
Clay, light-brown; very fine to coarse-grained, rounded sand.	10	510-520

Table 3.--Lithologic log for test well HBNM-1 - Concluded

Cuttings description	Thickness (feet)	Depth interval (feet)
Gravel, fine pebble.	10	520-530
Sand, coarse- to very fine grained; very fine, angular pebble gravel.	10	530-540
Sand, fine- to medium-grained, rounded, quartz; light-brown clay.	100	540-640
Sand, coarse- to very fine grained; light-brown clay.	10	640-650
Sand, fine- to medium-grained, rounded, quartz; light-brown clay.	40	650-690
Clay, brown.	10	690-700
Sand, medium-grained, subangular to rounded, quartz.	10	700-710
Sand, fine- to coarse-grained, rounded, quartz; pebble gravel; clay.	30	710-740
Sand, very fine to medium-grained, subangular to rounded, quartz.	10	740-750
Clay, light-reddish-brown.	30	750-780
Sand, very fine to medium-grained; coarse silt; light-reddish-brown clay.	10	780-790
Sand, very fine to medium-grained, subangular to rounded, quartz.	50	790-840
Sand, very fine grained, uniform, subangular to rounded, quartz.	10	840-850
Sand, medium- to very fine grained, subangular to rounded, quartz.	20	850-870
Sand, medium- to very fine grained; some clay.	70	870-940
Clay, light-reddish-brown.	26	940-966

Table 4.--Lithologic log for test well HBNM-2

[Driller: Unzicker and Wells Drilling Company, Hanksville, Utah]

Cuttings description	Thickness (feet)	Depth interval (feet)
Sand, fine- to coarse-grained, light-reddish-brown, rounded, quartz.	40	0-40
Gravel, fine to medium pebble, subrounded, granitic.	10	40-50
Gravel, very fine to medium pebble.	30	50-80
Gravel, very fine to fine pebble.	10	80-90
Gravel, fine to medium pebble, subangular to subrounded.	10	90-100
Sand, medium- to coarse-grained, rounded, quartz; fine pebble gravel.	20	100-120
Sand, medium- to coarse-grained, rounded; fine pebble gravel; clay.	10	120-130
Sand, fine- to coarse-grained, rounded; very fine pebble gravel; clay.	50	130-180
Gravel, fine to medium pebble, subrounded, granitic.	20	180-200
Gravel, fine to medium pebble; medium- to coarse-grained sand.	10	200-210
Sand, fine- to coarse-grained, rounded; very fine pebble gravel; clay.	30	210-240
Sand, fine- to coarse-grained; very fine pebble gravel.	10	240-250
Sand, fine- to coarse-grained, rounded; very fine pebble gravel; clay.	40	250-290
Sand, fine- to coarse-grained, rounded, quartz; lost-circulation material.	10	290-300

Table 4.--Lithologic log for test well HBNM-2 - Concluded

Cuttings description	Thickness (feet)	Depth interval (feet)
Sand, fine- to coarse-grained, rounded; very fine pebble gravel.	20	300-320
Sand, fine- to coarse-grained; very fine pebble gravel; reddish-brown clay.	10	320-330
Sand, fine- to coarse-grained; very fine granitic pebble gravel.	80	330-410
Sand, very fine to coarse-grained, rounded; very fine pebble gravel.	30	410-440
Sand, very fine to fine-grained, rounded, quartz; reddish-brown clay.	50	440-490
Missing sample.	10	490-500
Sand, very fine to fine-grained, rounded, quartz; reddish-brown clay.	30	500-530
Sand, very fine to fine-grained; very fine pebble gravel; clay.	10	530-540
Missing samples, no cuttings returns.	42	540-582

Table 5.--Lithologic log for test well HBNM-3

[Driller: Unzicker and Wells Drilling Company, Hanksville, Utah]

Cuttings description	Thickness (feet)	Depth interval (feet)
Caliche, well-cemented; light-reddish-brown dune sand.	10	0-10
Sand, very fine to fine-grained, rounded, quartz.	10	10-20
Silt; fine- to medium fine grained quartz sand.	10	20-30
Sand, very fine to medium-grained, rounded; fine to coarse silt.	10	30-40
Clay, brown; very fine to medium-grained sand.	20	40-60
Sand, very fine to medium-grained, rounded, quartz; brown clay.	10	60-70
Clay, brown; very fine to medium-grained sand.	40	70-110
Sand, very fine to coarse-grained, rounded, quartz.	20	110-130
Clay, brown; very fine to coarse silt; very fine grained quartz sand.	10	130-140
Clay, brown.	30	140-170
Clay, brown; very fine to medium-grained, rounded quartz sand; silt.	10	170-180
Silt, light-brown; very fine to medium-grained, rounded quartz sand.	20	180-200
Clay, brown; silt.	60	200-260
Clay, brown; fine-grained, rounded quartz sand.	10	260-270
Clay, brown.	10	270-280
Sand, very fine to coarse-grained, rounded quartz; light-brown silt.	30	280-310

Table 5.--Lithologic log for test well HBNM-3 - Continued

Cuttings description	Thickness (feet)	Depth interval (feet)
Clay, brown.	10	310-320
Clay, brown; very fine to medium-grained, rounded quartz sand.	10	320-330
Sand, very fine to medium-grained, rounded, quartz.	10	330-340
Clay, brown.	60	340-400
Clay, brown; fine pebble gravel; medium-grained sand.	20	400-420
Clay, brown.	20	420-440
Clay, brown; very fine to medium-grained, rounded quartz sand.	10	440-450
Sand, very fine to fine-grained, rounded, quartz; brown clay.	20	450-470
Clay, brown; fine-grained sand.	30	470-500
Sand, very fine to medium-grained, subangular, quartz; tan silt.	10	500-510
Sand, medium-grained, quartz; reddish-brown clay.	20	510-530
Sand, very fine to medium-grained, subrounded, quartz; silt; clay.	30	530-560
Sand, very fine to medium-grained, rounded to subangular; clay.	40	560-600
Clay, reddish-brown to brown; medium-grained quartz sand.	20	600-620
Sand, very fine to medium-grained, rounded to subangular; tan silt.	20	620-640
Sand, very fine to medium-grained, rounded to subangular; clay.	30	640-670

Table 5.--Lithologic log for test well HBNM-3 - Concluded

Cuttings description	Thickness (feet)	Depth interval (feet)
Clay, reddish-brown.	80	670-750
Sand, very fine grained, rounded to subangular, quartz; reddish-brown clay.	10	750-760
Clay, reddish-brown.	10	760-770
Clay, reddish-brown; very fine to fine-grained quartz sand.	10	770-780
Clay, reddish-brown.	20	780-800
Sand, medium-grained, rounded to subangular, quartz.	10	800-810
Sand, very fine to medium-grained, rounded to subangular, quartz; clay.	50	810-860
Clay, reddish-brown; medium-grained quartz sand.	20	860-880
Clay, reddish-brown.	40	880-920
Clay, reddish-brown; fine- to medium-grained quartz sand.	30	920-950
Clay, reddish-brown.	20	950-970
Sand, very fine to medium-grained, rounded to subangular, quartz; clay.	10	970-980
Clay, reddish-brown to brown.	40	980-1020
Clay, brown; fine- to medium-grained, quartz sand.	10	1020-1030
Clay, brown.	40	1030-1070
Clay, brown; medium-grained sand.	10	1070-1080
Clay, brown.	8	1080-1088

Table 6.--Lithologic log for test well HBNM-4

[Driller: Unzicker and Wells Drilling Company, Hanksville, Utah]

Cuttings description	Thickness (feet)	Depth interval (feet)
Gravel, very fine; rounded quartz sand.	20	0-20
Clay, brown.	10	20-30
Sand, fine-grained, rounded, quartz; brown clay.	10	30-40
Sand, fine-grained, rounded, quartz; fine to medium, angular gravel.	20	40-60
Sand, medium- to fine-grained, quartz.	20	60-80
Sand, very fine to fine-grained, quartz.	10	80-90
Sand, very fine to fine-grained, quartz; clay.	20	90-110
Silt, brown; very fine grained quartz sand.	20	110-130
Clay, brown; angular caliche fragments.	30	130-160
Clay, brown; very fine grained quartz sand.	20	160-180
Sand, very fine to medium-grained, rounded, quartz.	10	180-190
Clay, brown; brown silt.	20	190-210
Clay, brown; silt; very fine to coarse-grained sand; gravel.	20	210-230
Sand, very fine to medium-grained, rounded, quartz.	10	230-240
Silt; very fine to coarse-grained, quartz sand; very fine gravel.	20	240-260
Clay, brown.	20	260-280
Clay, brown; silt; fine to medium granite gravel.	60	280-340

Table 6.--Lithologic log for test well HBNM-4 - Continued

Cuttings description	Thickness (feet)	Depth interval (feet)
Sand, very fine to fine-grained, rounded, quartz.	20	340-360
Sand, very fine to coarse-grained, quartz.	40	360-400
Sand, very fine to fine-grained, quartz; brown clay.	10	400-410
Clay, brown; very fine to fine-grained, quartz sand.	10	410-420
Sand, very fine to coarse-grained, quartz; brown clay.	30	420-450
Clay, brown; silt; fine pebble gravel.	10	450-460
Sand, medium- to coarse-grained, quartz.	20	460-480
Sand, very fine to fine-grained, quartz.	20	480-500
Sand, very fine to medium-grained, quartz.	60	500-560
Clay, brown; silt.	20	560-580
Sand, fine- to medium-grained, rounded, quartz.	60	580-640
Sand, fine- to medium-grained, rounded, quartz; brown clay.	20	640-660
Clay, brown.	20	660-680
Sand, fine- to coarse-grained, rounded, quartz.	30	680-710
Clay, brown.	10	710-720
Sand, very fine to coarse-grained, rounded, quartz.	10	720-730
Sand, very fine to coarse-grained, rounded, quartz; silt.	10	730-740

Table 6.--Lithologic log for test well HBNM-4 - Concluded

Cuttings description	Thickness (feet)	Depth interval (feet)
Sand, very fine to medium-grained, rounded, quartz.	70	740-810
Sand, very fine to medium-grained, rounded, quartz; silt.	20	810-830
Sand, very fine to medium-grained, rounded, quartz; brown clay.	10	830-840
Sand, very fine to fine-grained, quartz.	20	840-860
Sand, very fine to coarse-grained, rounded, quartz.	10	860-870
Sand, very fine to coarse-grained, rounded, quartz; brown clay.	10	870-880
Clay, brown.	30	880-910
Clay, brown; very fine grained sand.	30	910-940
Sand, very fine to fine-grained, rounded, quartz.	10	940-950
Clay, brown; very fine grained sand.	10	950-960
Sand, very fine to fine-grained, rounded, quartz.	30	960-990
Sand, very fine to fine-grained, rounded, quartz; brown clay.	60	990-1050
Sand, very fine to medium-grained, rounded, quartz.	10	1050-1060
Clay, brown; very fine to medium-grained, rounded quartz sand.	30	1060-1090
Sand, very fine to fine-grained, rounded, quartz; silt.	20	1090-1110

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