62-31

Press release dated April 18, 1962

TEI-786

UNITED STATES DEPARTMENT OF THE INTERIOR

GEOLOGICAL SURVEY

TEST HOLES DRILLED IN SUPPORT OF GROUND-WATER INVESTIGATIONS, PROJECT GNOME, EDDY COUNTY, NEW MEXICO, BASIC DATA REPORT *

By

James B. Cooper

February 1961

Trace Elements Investigations Report 786

This preliminary report is distributed without editorial and technical review for conformity with official standards and nomenclature. It is not for public inspection or quotation.

*Prepared on behalf of the U. S. Atomic Energy Commission.

CONTENTS

ILLUSTRATIONS

TABLES

TEST HOLES DRILLED IN SUPPORT OF GROUND-WATER INVESTIGATIONS PROJECT GNOME, EDDY COUNTY, NEW MEXICO

BASIC DATA REPORT

By

James B. Cooper

ABSTRACT

Project Gnome is a proposed underground nuclear shot to be detonated within a massive salt bed in Eddy County, N. Mex. Potable and neat potable ground water is present in rocks above the salt and is being studied in relation to this nuclear event. This report presents details of two test holes which were drilled to determine ground-water conditions in the near vicinity of the shot point.

A well-defined aquifer is present at the site of USGS test hole 1, about 1,000 feet south of the access shaft to the underground shot point. Water with 75 feet of artesian pressure head is contained in the Culebra dolomite member of the Rustler formation. The dolomite aquifer is 32 feet thick and its top lies at a depth of 517 feet below land surface. The aquifer yielded 100 gpm (gallons per minute) with a drawdown of 40 feet during a pumping period of 24 hours. Water was not found in rocks above or below the Culebra dolomite.

At the site of USGS test hole 2, about 2 miles southwest of the access shaft no distinctive aquifer exists. About one-half gpm was yielded to the well from the rocks between the Culebra dolomite and the top of the salt. Water could not be detected in the Culebra dolomite or overlying rocks.

The report contains drawdown and recovery curves of yield tests, drilling-time charts, and electric logs. The data are given in tables; they include summaries of hole construction, sample description logs, water measurements, drilling-time logs, and water analyses.

TEST HOLES DRILLED IN SUPPORT OF GROUND-WATER INVESTIGATIONS, PROJECT GNOME, EDDY COUNTY, NEW MEXICO

BASIC DATA REPORT

By

James B. Cooper

INTRODUCTION

The U.S. Geological Survey is making a study of the geology and ground-water conditions of the Project Gnome area, Eddy and Lea Counties, New Mexico, for the office of test operations, Albuquerque Operations Office of the U.S. Atomic Energy Commission. As part of this study the Commission authorized the drilling of two test holes to expand the knowledge of the water-bearing formations in the immediate vicinity of the Gnome site. For purposes of identification these holes are designated USGS test hole 1 and USGS test hole 2. Their locations are 1,000 feet south of the shaft and about 2 miles southwest of the shaft, respectively. (See fig. 1.)

Access roads were built and the holes were drilled and completed during the period July 20 to September 23, 1960. Drilling operations were on a 24-hour day, 7-day per week basis. The holes were drilled by Everett D. Burgett Drilling Co., Carlsbad, N. Mex., under contract to the Atomic Energy Commission. Contractural phases of the operation were supervised by Holmes and Narver, Inc. The Ground Water Branch of the U.S. Geological Survey provided technical supervision during the drilling operations and collected geologic and hydrologic data of several types. Tests to determine the presence of water were made at major changes of geologic formations and elsewhere when the presence of water was suspected. Both

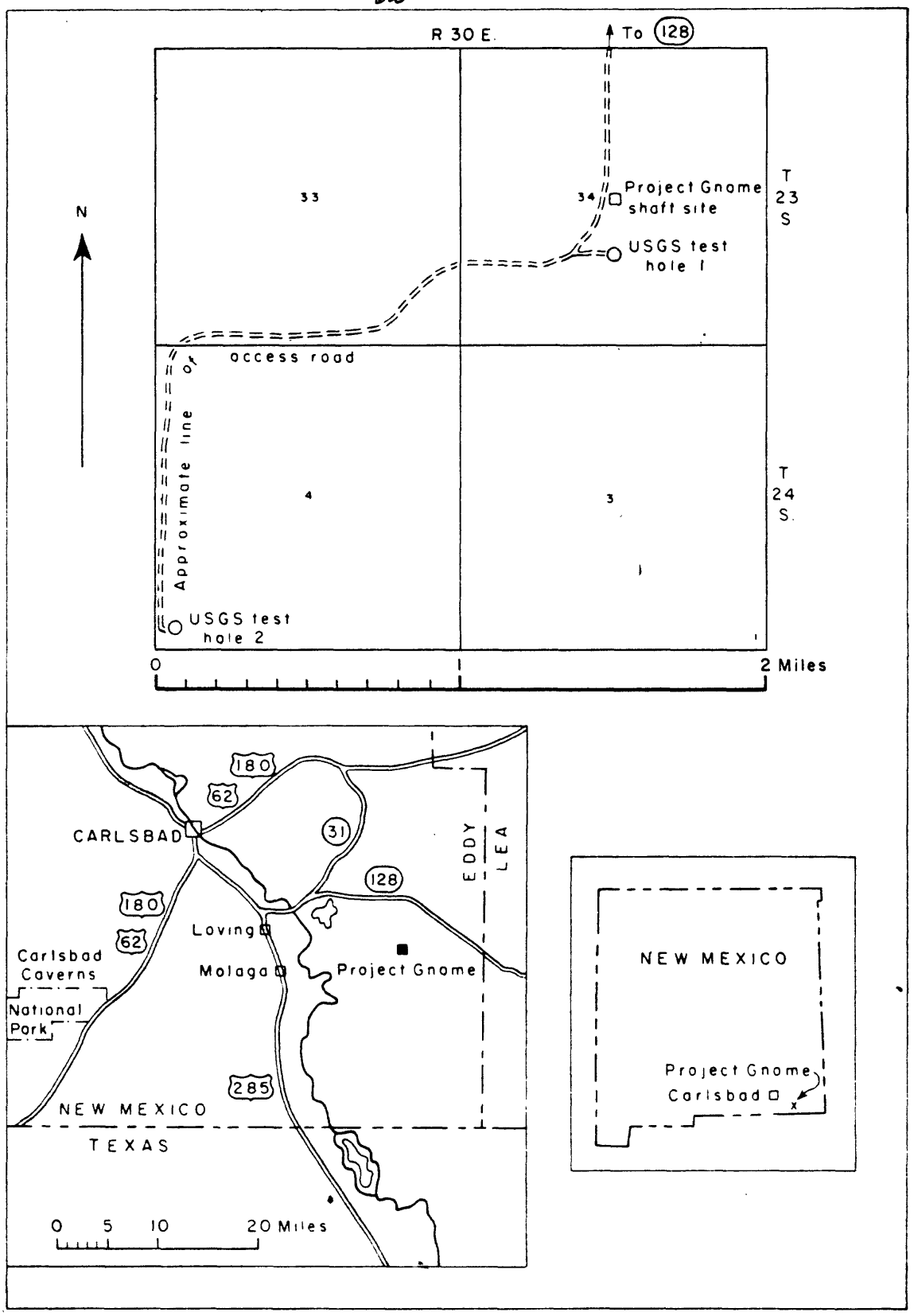

Figure 1.--Map showing location of USGS test holes and Project Gnome site, Eddy County, N. Mex.

test holes were completed as permanent observation wells. They are equipped with recording gages for the purpose of monitoring the level of the water in the aquifers prior to, during, and after the planned nuclear experiment.

Information obtained from this drilling will be used in the planned report of the geology and ground-water conditions of the Gnome area. The present report presents a tabulation of the basic data obtained from these two test holes.

SUMMARY OF DATA

The record of the construction and other pertinent data, including the geologic sections penetrated in the test holes, is summarized in table 1 for USGS test hole 1 and in table 7 for USGS test hole 2.

Lithologic descriptions of the well cuttings obtained during the drilling of the test holes were made by microscopic examination and are contained in sample description logs for each test hole. Color terms used are those of the "Rock Color Chart" prepared by a committee of the National Research Council. The well cuttings from USGS test holes 1 and 2 are described in tables 2 and 8, respectively.

A pumping and water-level recovery test was made in USGS test hole 1. Table 3 records the measurements and observations made during this prolonged test of the only water-bearing formation penetrated in the hole (the Culebra dolomite member of the Rustler formation). The test consisted of four phases: Part I--Pumping rate-determination test; part II--interrupted pumping test; part III--pumping test; and part IV--water-level recovery measurements. Figure 2 is a graphic plot of the drawdown of water level observed during pumping in this test hole. Depth to water (in feet) is

plotted against the logarithm of the ratio of the time since pumping started to the time since pumping stopped (in minutes).

Table 4 contains records of measurements of four tests made in USGS test hole 1 to determine the presence or absence of water in the formations penetrated during drilling. Measurements made at other points in hole 1 are contained in the Daily Drilling Operations Log, table 6. Similar records of eight tests made in USGS test hole 2 are given in table 9 and occasional additional measurements are listed in table 11. Water-level recovery measurements made in the last test in hole 2 are plotted graphically on figure 5 and show the time-relationship of the recovery rate of the water level in this hole following the bailing out of water in the hole.

Drilling-time logs containing records of the operating time of the drill bit required to drill each segment of the hole (not including bail-out time) are given for each hole. Penetration time of each interval is given in minutes per foot. Accompanying notes list various conditions that influenced the drilling. The drilling-time log for USGS test hole 1 covers the period August 1 to August 22, 1960. These records are contained in table 5 and are plotted graphically in figure 4. Similar data for USGS test hole 2 are given in table 10 and figure 6.

A water analysis listing the chemical components, physical characteristics, and radiochemical data of water collected during the pumping test of USGS test hole 1 is given in table 6. Similar data for water collected by bailing from USGS test hole 2 are given in table 11.

Electrical resistivity logs were made in the water-filled portion of each hole before final casing and completion of the holes. Figure 7 is a copy of the electric log for USGS test hole 1. The log of USGS test hole 2 is given in figure 10.

Radioactivity logs showing the Gamma-Neutron count of the formations were made in each hole following completion of the hole. These logs are shown in figure 8 for USGS test hole 1 and in figure 11 for USGS test hole 2.

Temperature logs made after hole completion are given in figure 9 for USGS test hole 1 and in figure 12 for USGS test hole 2.

Table 1.--Summary of test-hole construction

USGS Test Hole 1

Project Gnome

Location: SE¼NE¼SW¼ sec. 34, T. 23 S., R. 30 E., 1,000 feet south of GNOME shaft, Eddy County, N. Mex.

Altitude: 3,426 feet above sea-level datum. Altitude of rig floor, about 1 foot above land surface, which is reference point for all measurements.

Total depth: 723 feet. Plugged back to 567 feet.

Date drilled: August 1960.

Drilling contractor: Everett D. Burgett Drilling Co., Carlsbad, N.Mex.

Drilling method: Cable tool.

Casing and hole record: 24-inch hole from 0 to 115 feet. Cased with 20-inch OD casing from surface to 115 feet 11 inches. Casing cemented in hole at bottom.

Nineteen-inch hole from 115 feet 11 inches to 304 feet 4 inches. Cased with 18-inch OD casing from surface to 304 feet 11 inches. Casing cemented in hole at bottom.

Seventeen-and-a-half-inch hole from 304 feet 4 inches to 577 feet. Cased with 12 3/4-inch OD casing from surface to 577 feet. Casing cemented in hole at bottom.

Twelve-inch hole from 577 to 723 feet, total depth.

Table 1.--Summary of test-hole construction - Continued

USGS Test Hole 1 - Continued

Project Gnome - Continued

Hole completion record: Filled with cement from 567 to 723 feet. Twelve and three-fourths-inch OD casing perforated with 20 holes ½-inch in diameter between 520 feet and 533 feet 9 inches, 10 holes on opposite sides of casing. Upper 10 feet of annular space between 12 3/4-inch OD casing, 18-inch OD casing, and 20-inch OD casing filled with cement. Twelve and three-fourths-inch OD casing stubbed upward 2.27 feet and centered in 6-foot square, 6-inch thick reinforced concrete slab. Altitude of top of concrete slab is 3,425.91 feet above sea-level datum. Water-stage recorder installed over casing.

Water-bearing formation: Culebra dolomite member of Rustler formation between 518 and 550 feet. Formation was test pumped for 24 hours at a rate of 100 gallons per minute.

Formation logs: (1) Sample description, (2) electric, (3) radioactivity (Gamma-Neutron), and (4) temperature.

Geologic section:

Depth interval (feet)	Stratigraphic unit
0- 60	Windblown sand (sand and caliche)
60-108	Gatuna formation (sandstone, sand, and conglomerate) of Pleistocene (?) age.
108-303	Pierce Canyon redbeds (siltstone and sandstone) of Permian or Triassic age.

Table 1.--Summary of test-hole construction - Continued

USGS Test Hole 1 - Continued

Project Gnome - Continued

Geologic section - continued

Depth interval (feet)	Stratigraphic unit
303-379	Rustler formation Upper member (gypsum, anhydrite, and siltstone)
379-397	Rustler formation Maganta member (siltstone, dolomite, and anhydrite)
397-518	Rustler formation Middle member (anhydrite, and gypsum)
518-550	Rustler formation Culebra dolomite member (dolomite)
550-657	Rustler formation Lower member (sandstone, siltstone, and anhydrite)
657-713	Residuum of Rustler and Salado formations undifferentiated, of Permian age (siltstone, clay, and anhydrite)
713-723	Salado formation (salt) of Permian age

Table 2.--Sample description log

USGS Test Hole 1

Project Gnome

Depth interval (feet)	Lithologic description
0-8	Sand, quartz, moderate-brown (5 YR 4/4) to light-brown (5 YR 5/6); 20 percent very fine-, 60 percent fine-, and 20 percent medium-grained; subrounded to subangular; slightly frosted; opaque to clear; loose; scattered grains of feldspar and dark igneous material.
8-10	Sand, quartz, light-brown (5 YR 6/4); 10 percent very fine-, 75 percent fine-, and 15 percent medium-grained; subrounded; slightly frosted; clear to opaque; loose; 1 percent grains of feldspar and black and red igneous material; very minor amounts of white, friable caliche which includes fine quartz grains. (Driller logs caliche from 8 to 8.5 feet.)
10-15	Sand, quartz, light-brown (5 YR 6/4); 30 percent very fine-, 50 percent fine-, and 20 percent medium-grained; subrounded to subangular; slightly frosted; mostly clear to iron-stained; loose with traces of calcareous cement on a few grains; scattered grains of dark-red and black igneous material; trace of caliche. (Driller logs caliche from 11 to 14 feet.)

Table 2.--Sample description log - Continued

USGS Test Hole 1 - Continued

Project Gnome - Continued

Depth interval (feet)	Lithologic description
15-35	Sand, quartz, light-brown (5 YR 6/4); 10 percent very fine-, 80 percent fine-, and 10 percent medium-grained; subrounded to subangular; slightly frosted; mostly clear to iron-stained; loose with traces of calcareous cement on a few grains; scattered grains of dark-red and black igneous material.
35-40	Sand, quartz, light-brown (5 YR 6/4); 10 percent very fine-, 70 percent fine-, 15 percent medium-, and 5 percent coarse-grained; subrounded to subangular; slightly frosted; mostly clear to iron-stained; loose with traces of calcareous cement on a few grains; scattered grains of dark-red and black igneous material.
40-45	Sand, quartz, light-brown (5 YR 6/4); 10 percent very fine-, 70 percent fine-, 15 percent medium-, and 5 percent coarse-grained; subrounded to subangular; slightly frosted; mostly clear to iron-stained; loose with traces of calcareous cement on a few grains; scattered grains of dark-red and black igneous material with a few fragments of light-brown micaceous clay.

Table 2.--Sample description log - Continued

USGS Test Hole 1 - Continued

Project Gnome - Continued

Depth interval (feet)	Lithologic description
45-60	Sand, quartz, light-brown (5 YR 6/4); 10 percent very fine-, 70 percent fine-, 15 percent medium-, and 5 percent coarse-grained; subrounded to subangular; slightly frosted; mostly clear to iron-stained; loose with traces of calcareous cement on a few grains; scattered grains of red and black igneous material.
60-65	Top of Gatuna formation. Sand, 90 percent quartz and 10 percent heavy minerals and fine-grained igneous rocks; light-brown (5 YR 5/6); 20 percent very fine-, 70 percent fine-, and 10 percent medium-grained; fine and very fine grains subangular, medium grains rounded to subrounded; partly frosted; secondary undergrowth of small quartz grains; loose; a little light-brown, fine-grained, subangular sandstone; some caliche from above.
65-66	Conglomerate, light-brown (5 YR 6/4); gravel; sandy; mostly calcareous reddish-brown siltstone and chert; very fine- to fine-grained; subrounded to rounded; poorly sorted quartz sand with secondary overgrowths; some light-brown sand probably caved from above.

Table 2.--Sample description log - Continued

USGS Test Hole 1 - Continued

Project Gnome - Continued

Depth interval (feet)	Lithologic description
66-70	Sandstone, moderate reddish-brown (10 R 4/6); fine-grained; subangular; partly a light-brown, gravel conglomerate.
70-75	Sandstone, moderate reddish-brown (10 R 4/6); fine-grained; subangular; and light brown (5 YR 6/4); siltstone and chert; gravel conglomerate; some very fine- to fine-grained, subrounded to rounded, poorly sorted quartz sand.
75-78	Sandstone, moderate reddish-brown (10 R 4/6); fine-grained subangular; and very fine- to fine-grained; subrounded to rounded; poorly sorted quartz sand containing rounded pebbles of conglomerate and siltstone.
78-80	Sandstone, moderate reddish-brown (10 R 4/6); fine-grained; subangular; and silty, moderate reddish-brown (10 R 4/6) sand.
80-83	Sand, quartz, light-brown (5 YR 6/4); 20 percent very fine-, 70 percent fine-, and 10 percent medium-grained; subangular; slightly frosted; opaque to clear; loose; scattered dark grains; minor amounts of light-brown sandy clay; occasional fine- to very coarse-grained, angular to subangular sand; some quartzite fragments noted.

Table 2.--Sample descriptive log - Continued

USGS Test Hole 1 - Continued

Project Gnome - Continued

Depth interval (feet)	Lithologic description
83-95.5	Sand, quartz, light-brown (5 YR 6/4); 10 percent very fine-, 70 percent fine-, 15 percent medium-, and 5 percent coarse-grained; and sandy conglomerate with up to ½-inch fragments.
95.5-100	Sandstone, light-brown (5 YR 6/4) to light-brown (5 YR 5/6); 20 percent very fine-, 20 percent fine-, and 60 percent medium-grained; subrounded; minimum frosted; few polished grains; few cemented grains; mainly quartz with a few dark and red grains.
100-105	Sandstone, light-brown (5 YR 6/4) to light-brown (5 YR 5/6); 20 percent very fine-, 20 percent fine-, and 60 percent medium-grained; subrounded; slightly frosted; few polished grains; few cemented grains; mainly quartz with a few dark and red grains; trace of caliche from above; some fragments of very fine-grained cemented sandstone.
105-111	Sandstone, light-brown (5 YR 6/4) to light-brown (5 YR 5/6); 20 percent very fine-, 50 percent fine-, and 30 percent medium-grained; subrounded; slightly frosted; few angular gravels. (Top of Pierce Canyon redbeds at 108 feet.)

Table 2.--Sample description log - Continued

USGS Test Hole 1 - Continued

Project Gnome - Continued

Depth interval (feet)	Lithologic description
111-115	Siltstone, moderate reddish-brown (10 R 4/6); slightly micaceous; light greenish-gray round reduction spots; much of sample is sand from above.
115-155	Siltstone, sandy, pale reddish-brown (10 R 5/4); calcareous; slightly micaceous with green spots.
155-165	Siltstone, slightly sandy, red-brown (10 R 3/4); poorly indurated.
165-170	Siltstone, slightly sandy, red-brown (10 R 3/4); and medium-grained, rounded sand.
170-179	Sandstone, sandy, red-brown (10 R 3/4); 70 percent very fine-, and 30 percent medium-grained; and very pale-green, medium-grained, rounded sand.
179-185	Siltstone, slightly sandy, red-brown (10 R 3/4); and very pale-green, very fine-grained sand.
185-197.5	Siltstone, very sandy, reddish-brown (10 R 4/4); subrounded to rounded; frosted quartz grains; fairly well indurated; calcareous; pale-green reduction spots.
197.5-210	Sandstone, silty, pale reddish-brown (10 R 5/4); 70 percent very fine- and 30 percent medium-grained; angular to subrounded; fairly well sorted; mostly subrounded quartz grains; well indurated; calcareous.

Table 2.--Sample description log - Continued

USGS Test Hole 1 - Continued

Project Gnome - Continued

Depth interval (feet)	Lithologic description
210-215	Sandstone, silty, pale reddish-brown (10 R 5/4); 95 percent fine- and 5 percent medium-grained; angular to subangular; well sorted; mostly quartz.
215-225	Siltstone, sandy, moderate reddish-orange (10 R 6/6); 10 percent very fine-grained sand and 90 percent coarse-grained silt; angular to subangular; quartz; well sorted; few selenite crystals.
225-233	Sandstone, silty, moderate reddish-orange (10 R 4/6); mostly very fine-grained, less than 5 percent fine-grained; calcareous cement; few very pale-green spots. Particles of quartz, chert, limestone, and coarse sand to fine gravel are from material thrown in hole to straighten from 200 to 225 feet.
233-243	Sandstone, silty, moderate reddish-orange (10 R 4/6); mostly very fine-grained, less than 5 percent fine-grained; calcareous cement; few very pale-green spots; and a little moderate reddish-brown (10 R 4/6) siltstone with very pale-green spots. Particles of quartz, chert, limestone, and coarse sand to fine gravel are from material thrown in hole to straighten from 200 to 225 feet.

Table 2.--Sample description log - Continued

USGS Test Hole 1 - Continued

Project Gnome - Continued

Depth interval (feet)	Lithologic description
243-246	Siltstone, sandy, pale reddish-brown (10 R 5/4); few pale-green spots. A few grains of coarse sand to fine gravel probably from material used to straighten hole.
246-251	Siltstone, sandy, pale reddish-brown (10 R 5/4); few pale-green spots; and slightly clayey siltstone.
251-265	Siltstone, sandy, pale reddish-brown (10 R 5/4); pale-green reduction spots; and claystone.
265-300	Siltstone, sandy, pale reddish-brown (10 R 5/4); numerous reduction spots; and claystone.
300-303	Siltstone, sandy, pale reddish-brown (10 R 5/4); numerous reduction spots; and gypsum at bottom.
303-304.3	Top of Rustler formation. Gypsum, gray to white.
304.3-309	Gypsum, white, amorphous; about 50 percent of sample is cement.
309-314	Gypsum, white; amorphous; trace of anhydrite; minor amounts of cement.
314-319	Gypsum, white; amorphous; and brownish-white anhydrite.
319-324	Gypsum, white; amorphous; 50 percent; and 50 percent brownish-white anhydrite.
324-329	Anhydrite, brownish-white; 80 percent; and 20 percent white amorphous gypsum.

Table 2.--Sample description log - Continued

USGS Test Hole 1 - Continued

Project Gnome - Continued

Depth interval (feet)	Lithologic description
329-334	Gypsum, white; amorphous; 80 percent; and 20 percent gray to yellow anhydrite.
334-339	Gypsum, white; amorphous; trace of anhydrite.
339-343	Gypsum, white; amorphous; trace of selenite and 2 percent red, sandy clay. Top of redbed 342 feet.
343-354	Siltstone, pale, reddish-brown (10 R 5/4); trace of gypsum from above.
354-359	Gypsum, white; amorphous.
359-369	Gypsum, pink to white; trace of orange siltstone.
369-374	Gypsum, pink to white; 70 percent; and 30 percent gray anhydrite.
374-379	Gypsum, pink to white; 70 percent; some fibrous and lamellar; 20 percent gray anhydrite; and 10 percent, very fine-grained, limy, gray sandstone.
379-384	Gypsum, pink to white; 50 percent; 40 percent pale-olive (10 Y 6/2) dolomite; and 10 percent gray anhydrite.
384-394	Gypsum, pink to white and clear; 50 percent; platy; and 50 percent nodular orange-pink (5 YR 8/4); limy siltstone.
394-397	Siltstone, grayish-orange-pink (5 YR 7/2); calcareous; trace of gypsum.

Table 2.-- Sample description log - Continued

USGS Test Hole 1 - Continued

Project Gnome - Continued

Depth interval (feet)	Lithologic description
397-400	Gypsum, white; amorphous; trace of grayish-orange-pink (5 YR 7/2); calcareous siltstone.
400-409	Anhydrite, light-brown to white; 80 percent; and 20 percent light-brown to white gypsum.
409-414	Anhydrite, light-brown to white; 80 percent; finely crystalline; and 20 percent light-brown to white gypsum.
414-435	Anhydrite, pale-pink (5 RP 8/2); 80 percent; finely crystalline; and 20 percent pale-pink (5 RP 8/2) gypsum.
435-440	Anhydrite, light-brown to white; 80 percent; and 20 percent white mottled with pink gypsum; trace of selenite.
440-445	Gypsum, white, and selenite; 75 percent; and 25 percent light-brown to white anhydrite.
445-455	Anhydrite, white; 50 percent; amorphous; and 50 percent white gypsum.
455-460	Anhydrite, light-brown; 70 percent; microcrystalline; and 30 percent white gypsum.
460-465	Anhydrite, light-brown; 80 percent; microcrystalline; and 20 percent white gypsum.
465-470	Anhydrite, light-brown; 90 percent; microcrystalline; and 10 percent white gypsum.

Table 2.--Sample description log - Continued

USGS Test Hole 1 - Continued

Project Gnome - Continued

Depth interval (feet)	Lithologic description
470-475	Anhydrite, light-brown; 80 percent; and 20 percent white gypsum and selenite; few grains of stained quartz.
475-480	Anhydrite, white with some brown-stained; and white gypsum.
480-485	Anhydrite, white; 70 percent; and 30 percent white gypsum.
485-490	Anhydrite, white to medium-light gray (N 6); and white gypsum.
490-500	Anhydrite, white to medium-light gray (N 6); and white gypsum.
500-509	Gypsum, pink; 80 percent; and 20 percent white to medium-light-gray (N 6) anhydrite; with a red clay matrix.
509-514	Gypsum, white to pale-pink (5 RP 8/2); amorphous; and selenite; 80 percent; and greenish-gray (5 GY 6/1) to yellowish-gray (5 Y 8/1) anhydrite; some fragments of gypsum and anhydrite; some fragments of gypsum and anhydrite in clay matrix.
514-519	Gypsum, some white; mostly selenite; amorphous. (Hole measurement places top of Culebra dolomite member at 518 feet.)

Table 2.--Sample description log - Continued

USGS Test Hole 1 - Continued

Project Gnome - Continued

Depth interval (feet)	Lithologic description
519-523	Dolomite, light-olive-gray (5 Y 6/1); porous; some amorphous gypsum, mostly selenite; and some brown to red anhydrite.
523-539	Dolomite, light-olive-gray (5 Y 6/1); porous.
539-544	Dolomite, pinkish-gray (5 YR 8/1); microcrystalline; solid appearance, fewer vugs than dolomite above.
544-548	Dolomite, pinkish-gray (5 YR 8/1); microcrystalline; solid appearance; balls of cream clay mixed with small dolomite fragments (crevice filling).
548-550	Dolomite, pinkish-gray (5 YR 8/1); microcrystalline; solid appearance; and light-greenish-gray (5 G 8/1) clayey siltstone.
550-555	Siltstone and claystone, grayish-red (10 R 4/2); 60 percent; and 40 percent gypsum.
555-570	Anhydrite, white to light-gray; white to light-gray gypsum; gray to dark-red siltstone; and a little dolomite from above.
570-579	Siltstone, clayey, dark-reddish-brown (10 R 3/4); plastic; contains pebbles of gypsum and anhydrite.

Table 2.--Sample description log - Continued

USGS Test Hole 1 - Continued

Project Gnome - Continued

Depth interval (feet)	Lithologic description
579-584	Siltstone, clayey, dark-reddish-brown (10 R 3/4); contains gypsum pebbles and some light-greenish-gray (5 G 8/1) anhydrite. 579-580 feet is probably mostly gypsum.
584-597	Siltstone, clayey, dark-reddish-brown (10 R 3/4); contains gypsum pebbles and some light-greenish-gray (5 G 8/1) anhydrite.
597-602	Siltstone, clayey, dark-reddish-brown (10 R 3/4); contains gypsum pebbles and some light-greenish-gray (5 G 8/1) anhydrite; and some greenish-gray (5 GY 6/1), very fine-grained sandstone.
602-608	Sandstone, greenish-gray (5 GY 6/1); very fine-grained; and dark-reddish-brown (10 R 3/4), clayey siltstone containing gypsum pebbles and light-greenish-gray anhydrite. Dark-reddish-brown siltstone probably from above, call 602 feet the sandstone contact.
608-622	Sandstone, pale-yellowish-brown (10 YR 6/2); very fine-grained; well sorted.
622-627	Sandstone, pale-yellowish-brown (10 YR 6/2); very fine-grained; well sorted, minor amounts of gypsum.

Table 2.-- Sample description log - Continued

USGS Test Hole 1 - Continued

Project Gnome - Continued

Depth interval (feet)	Lithologic description
627-632	Sandstone, pale-yellowish-brown (10 YR 6/2); very fine-grained; well sorted; minor amounts of gypsum and dark-reddish-brown (10 R 3/4), silty sandstone.
632-652	Sandstone, pale-yellowish-brown (10 YR 6/2); very fine-grained; well sorted.
652-657	Sandstone, pale-yellowish-brown (10 YR 6/2); very fine-grained; well sorted; lower foot containing dark-reddish-brown (10 R 3/4) grains of silty sandstone and some gypsum.
657-660	Siltstone, dark-reddish-brown (10 R 3/4) with some white grains; well sorted; minor amounts of gypsum.
660-665	Siltstone, dark-reddish-brown (10 R 3/4); minor amounts of gypsum.
665-668	Siltstone, pale-reddish-brown (10 R 5/4); minor amounts of gypsum.
668-675	Siltstone, pale-reddish-brown (10 R 5/4); and white to light-gray gypsum and anhydrite.
675-685	Gypsum, pale-greenish-gray; very fine-grained sand size; orangish-red mineral, probably langbeinite or polyhalite.

Table 2.--Sample description log - Continued

USGS Test Hole 1 - Continued

Project Gnome - Continued

Depth interval (feet)	Lithologic description
685-695	Siltstone, sandy to clayey, pale-reddish-brown (10 R 5/4); contains gypsum pebbles.
695-700	Siltstone, sandy to clayey, pale-reddish-brown (10 R 5/4); contains gypsum pebbles and trace of anhydrite.
700-705	Anhydrite, light-olive-gray (5 Y 6/1); some gypsum; some pale-reddish-brown (10 R 5/4) siltstone; probably caved from above.
705-710	Siltstone, sandy, pale-reddish-brown (10 R 5/4); and light-olive-gray (5 Y 6/11) anhydrite; some orangish-red mineral, probably langbeinite or polyhalite.
710-713	Anhydrite, light-olive-gray (5 Y 6/11); some gypsum and halite; pale-reddish-brown siltstone probably from above.
713-718	Salado formation. Salt, white; crystalline.
718-723	Salt, yellowish-brown; crystalline.

Table 3.--Pumping and water-level recovery test

USGS Test Hole 1

Project Gnome

Hole depth: 550 feet

Formations: Culebra dolomite of Rustler formation

Dates: August 16-19, 1960

Part I--Pumping rate-determination test

Time	Depth to water (feet)	Orifice reading (inches)1/	Gallons per minute	Pump revolutions per minute	Remarks
8-16-60					
6:00 p.m.	443.21				Static water level. Measuring point for depth to water is top of 1¼-inch pipe 0.84 foot above top of 20-inch casing. Altitude of 3426.84 feet above sea-level datum.
7:15	443.42				Steel tape measurement. Static water level.

Table 3.--Pumping and water level recovery test - Continued

USGS Test Hole 1 - Continued

Project Gnome - Continued

Part I - Continued

Time	Depth to water (feet)	Orifice reading (inches 1/)	Gallons per minute	Pump revolutions per minute	Remarks
8-16-60 - Continued					
7:25 pm	443.12				Static water level. Top of pump bowls at 520 feet. 518 feet of 1¼-inch pipe in hole. All depth-to-water measurements by electric line unless otherwise noted.
8:31					Pump on.
8:33					Water out. Very dirty brown.
8:36		6 3/4	62	1,400	
8:50		7 3/4	66		
8:52	460.00				
9:00	460.35				Water fairly clear.
9:01					Increased pump rate.
9:02		19	102	1,550	Temperature 74°F.

Table 3.--Pumping and water level recovery test - Continued

USGS Test Hole 1 - Continued

Project Gnome - Continued

Part I - Continued

Time	Depth to water (feet)	Orifice reading (inches)1/	Gallons per minute	Pump revolutions per minute	Remarks
8-16-60 - Continued					
9:11 pm		18½	101		Measured into barrel (50 gal) in 30 seconds.
9:15	472.70				
9:27	474.20	18 3/4			
9:31					Speeded pump.
9:32		34½	138	1,725	
9:37		33¼	135+		
9:45	488.85	33			Water clear.
9:58	491.13	32 3/4	135		
10:00					Slowed pump.
10:05	482.15	18½	100	1,550	
10:15	480.52				
10:28	479.16	18½	100		
10:30					Pump off -- water run into discharge to lubricate shaft.
10:33½	450.00				Recovery measurement.
10:38	449.77				

Table 3.--Pumping and water-level recovery test - Continued

USUS Test Hole - Continued

Project Gnome - Continued

Part I - Continued

Time	Depth to water (feet)	Orifice reading (inches)1/	Gallons per minute	Pump revolutions per minute	Remarks
8-16-60 - Continued					
11:02 pm	447.56				
11:30	447.29				
8-17-60					
12:10 am	445.55				
12:30	445.10				
1:00	448.80				
1:30	444.54				
2:00	444.30				
2:30	443.12				
3:00	443.12				End of measurements.

Table 3.--Pumping and water-level recovery test - Continued

USGS Test Hole 1 - Continued

Project Gnome - Continued

Part II--Interrupted pumping test

Time	Depth to water (feet)	Minutes since pumping started	Remarks
8-17-60 - Continued			
3:02 am	454.0	1	Pump on 3:01 am.
	460.8	2	
	464.75	3	
	466.75	4	
	468.20	5	
	468.85	6	
	469.47	7	
	469.90	8	
	470.38	9	
	470.90	10	
3:14			Pump off due to valve on line vibrating loose and loosening connections on discharge line.
3:26	444.80		Recovery measurements.
3:32	444.68		
3:40	444.56		
4:12	444.18		
4:26	444.10		
4:36	444.05		End of measurements.

Table 3.--Pumping and water-level recovery test - Continued

USGS Test Hole 1 - Continued

Project Gnome - Continued

Part III--Pumping test

Time	Depth to water (feet)	Minutes since pumping started	Orifice reading (inches)1/	Gallons per minute	Remarks
8-17-60 - Continued					
4:40 am	456.90	1			Pump on 4:39 am.
	462.50	2			Electric-line measurements.
	463.70	3			
	465.20	4	18½	100	
	466.50	5			Water clear.
	467.45	6			
	468.25	7			
	468.96	8			
	469.54	9			
	470.09	10	18½	100	
	470.97	12			
	471.61	14			
	472.21	16			
	472.60	18			
	472.92	20	18½	100	
	473.20	22			
	473.53	24			
	473.79	26			

Table 3.--Pumping and water-level recovery test - Continued

USGS Test Hole 1 - Continued

Project Gnome - Continued

Part III - Continued

Time	Depth to water (feet)	Minutes since pumping started	Orifice reading (inches)1/	Gallons per minute	Remarks
8-17-60 - Continued					
4:40 am	474.07	28			
	474.25	30	18½	100	
5:12 am	474.58	33			
	474.84	36			
	475.02	39			
	475.18	42			
	475.32	45			
	475.51	48	18½	100	
	475.68	51			
	475.82	54			
	476.05	57			Temperature 74°F.
	476.18	60	18½	100	
5:44	476.46	65			
	476.73	70			
	476.92	75			
	477.20	80	18½	100	
	477.22	85			
	477.39	90			

Table 3.--Pumping and water-level recovery test - Continued

USGS Test Hole 1 - Continued

Project Gnome - Continued

Part III - Continued

Time	Depth to water (feet)	Minutes since pumping started	Orifice reading (inches)1/	Gallons per minute	Remarks
8-17-60 - Continued					
544 am	477.43	95			
	477.53	100			
	477.95	105	18¾	100	
	478.13	110			
634 am	478.22	115			
	478.25	120			
	478.40	130	18½	100	Fluctuating.
	478.60	140			
	478.97	150			
	478.93	160	18½	100	
	479.14	170			
7:39	479.18	180			
	479.50	190	18½	100	
	479.58	200			
	479.74	210			
	479.66	220			
	479.71	230			
8:39	479.84	240	18½	100	Temperature 74°F.

Table 3.--Pumping and water-level recovery test - Continued

USGS Test Hole 1 - Continued

Project Gnome - Continued

Part III - Continued

Time	Depth to water (feet)	Minutes since pumping started	Orifice reading (inches)1/	Gallons per minute	Remarks
8-17-60 - Continued					
8:39 am	479.99	250			
	480.00	260			
	480.07	270	18½	100	
	480.19	280			
9:39	480.00	300	18.25	100-	Adjusted back to 18½ inches.
	480.89	320	18½	100	
10:19	480.97	340			
10:39	481.08	360			
10:59	481.14	380	18½	100	
11:19	481.14	400	18½	100	
11:49	481.40	430			
12:19 pm	481.35	460	18½	100	
12:49	481.82	490	18½	100	
1:19	481.82	520	18½	100	
1:49	481.99	550	18½	100	
2:19	481.92	580	18½	100	
2:49	481.84	610			
3:19	482.15	640	18½	100	

Table 3.--Pumping and water-level recovery test - Continued

USGS Test Hole 1 - Continued

Project Gnome - Continued

Part III - Continued

Time	Depth to water (feet)	Minutes since pumping started	Orifice reading (inches)1/	Gallons per minute	Remarks
8-17-60 - Contimued					
3:49 pm	482.24	670	18½	100	
4:19	482.39	700			
4:49	480.65	730	15	91	Refill butane tank -- lost pressure.
4:59	482.38	740	18½	100	
5:19	483.20	760	19	102	Cut back valve to 18½ inches.
6:00	483.26	801	18½	100	
7:00	483.36	861	18½	100	
8:00	483.19	921	18½+	100+	Trimmed valve.
9:00	482.93	981	18½	100	
10:00	482.89	1041	18½	100	
11:00	483.00	1101	18½	100	
11:10					Specific conductance 5,000; temperature 74°F.
12:00 am	482.93	1161	18½-	100-	Adjusted valve.
8-18-60					
1:00 am	483.00	1221	18½-	100-	Water sample collected 74°F.
2:00	483.60	1281	18½+	100+	Adjusted valve.

Table 3.--Pumping and water-level recovery test - Continued

USGS Test Hole 1 - Continued

Project Gnome - Continued

Part III - Continued

Time	Depth to water (feet)	Minutes since pumping started	Orifice reading (inches)1/	Gallons per minute	Remarks
8-18-60 - Continued					
3:00	483.69	1341	18½	100	
4:00	483.73	1401	18½	100	
4:40	483.85	1441	18½	100	
4:41					Turned off pump.

1/ Orifice is 2½ inches in diameter. Pump-discharge line is 4 inches in diameter and consists of 6-inch to 4-inch reduction nipple, 4-inch gate valve, 5 feet of 4-inch pipe, and orifice plate. Opening in discharge line for measuring inches of head is 1/8 inch in diameter and located 1 foot back from orifice plate.

Table 3.--Pumping and water-level recovery test - Continued

USGS Test Hole 1 - Continued

Project Gnome - Continued

Part IV--Water-level recovery measurements

Time	Depth to water (feet)	Minutes since pumping started	Minutes since pumping stopped	Remarks
8-18-60				
4:41 am		1442		
	453.90	1444	2	Recovery measurements.
	451.88	1445	3	
	452.26	1446	4	
	453.68	1447	5	
	454.20	1448	6	
	454.52	1449	7	
	454.55	1450	8	
	454.50	1451	9	
	454.39	1452	10	
	454.25	1453	11	
	454.10	1454	12	
	454.00	1455	13	
	453.82	1456	14	
	453.73	1457	15	
	453.62	1458	16	
	453.50	1459	17	
	453.36	1460	18	

Table 3.--Pumping and water-level recovery test - Continued

USGS Test Hole 1 - Continued

Project Gnome - Continued

Part IV - Continued

Time	Depth to water (feet)	Minutes since pumping started	Minutes since pumping stopped	Remarks
8-18-60 - Continued				
4:41 am	453.18	1461	19	
	453.18	1462	20	
5:03	452.87	1464	22	
	452.67	1466	24	
	452.47	1468	26	
	452.35	1470	28	
	452.18	1472	30	
	452.00	1474	32	
	451.88	1476	34	
	451.63	1478	36	
	451.55	1480	38	
	451.43	1482	40	
5:24	451.22	1485	43	
	451.08	1488	46	
	450.95	1491	49	
	450.74	1494	52	
	450.60	1497	55	
	450.45	1500	58	

Table 3.--Pumping and water-level recovery test - Continued

USGS Test Hole 1 - Continued

Project Gnome - Continued

Part IV - Continued

Time	Depth to water (feet)	Minutes since pumping started	Minutes since pumping stopped	Remarks
8-18-60 - Continued				
5:24 am	450.25	1503	61	
	450.20	1506	64	
	450.05	1509	67	
	449.93	1512	70	
5:56	449.73	1517	75	
	449.54	1522	80	
	449.40	1527	85	
	449.23	1532	90	
	449.09	1537	95	
	448.91	1542	100	
	448.83	1547	105	
	448.67	1552	110	
	448.52	1557	115	
6:41		1562	120	
	448.26	1567	125	
	448.19	1572	130	
7:01	447.96	1582	140	
7:11	447.76	1592	150	

Table 3.--Pumping and water-level recovery test - Continued

USGS Test Hole 1 - Continued

Project Gnome - Continued

Part IV - Continued

Time	Depth to water (feet)	Minutes since pumping started	Minutes since pumping stopped	Remarks
8-18-60 - Continued				
7:21 am	447.62	1602	160	
7:31	447.42	1612	170	
7:41	447.28	1622	180	
7:51	447.14	1632	190	
8:01	447.00	1642	200	
8:11	449.86	1652	210	
8:21	446.75	1662	220	
8:31	446.64	1672	230	
8:41	446.53	1682	240	
9:01	446.35	1702	260	
9:21	446.15	1722	280	
9:41	446.03	1742	300	
10:01	445.88	1762	320	
10:21	445.72	1782	340	
10.51	445.52	1812	370	
11.01	445.48	1822	380	
11:21	445.36	1842	400	
11:51	445.21	1872	430	
12:21 pm	445.09	1902	460	
12:51	444.94	1932	490	

Table 3.--Pumping and water-level recovery test - Continued

USGS Test Hole 1 - Continued

Project Gnome - Continued

Part IV - Continued

Time	Depth to water (feet)	Minutes since pumping started	Minutes since pumping stopped	Remarks
8-18-60 - Continued				
1:21 pm	444.82	1962	520	
1:51	444.73	1992	550	
2:21	444.62	2022	580	
2:51	444.54	2052	610	
3:21	444.46	2082	640	
3:51	444.40	2112	670	
4:21	444.38	2142	700	
4:51	444.30	2172	730	
5:21	444.25	2202	760	
5:51	444.22	2232	790	
6:51	444.25	2292	850	
7:51	444.16	2352	910	
8:51	444.09	2412	970	
9:51	444.05	2472	1030	
10.51	444.00	2532	1090	
11:51	443.96	2592	1190	

Table 3.--Pumping and water-level recovery test - Continued

USGS Test Hole 1 - Continued

Project Gnome - Continued

Part IV - Continued

Time	Depth to water (feet)	Minutes since pumping started	Minutes since pumping stopped	Remarks
8-19-60 - Continued				
12:55 am	443.90	2656	1214	
1:51	443.84	2712	1270	
2:51	443.81	2772	1330	
3:51	443.79	2832	1390	
4:51	443.78	2892	1450	End of measurements and test. Measurements made by J. B. Cooper, G. C. Doty, and G. A. Dinwiddie.

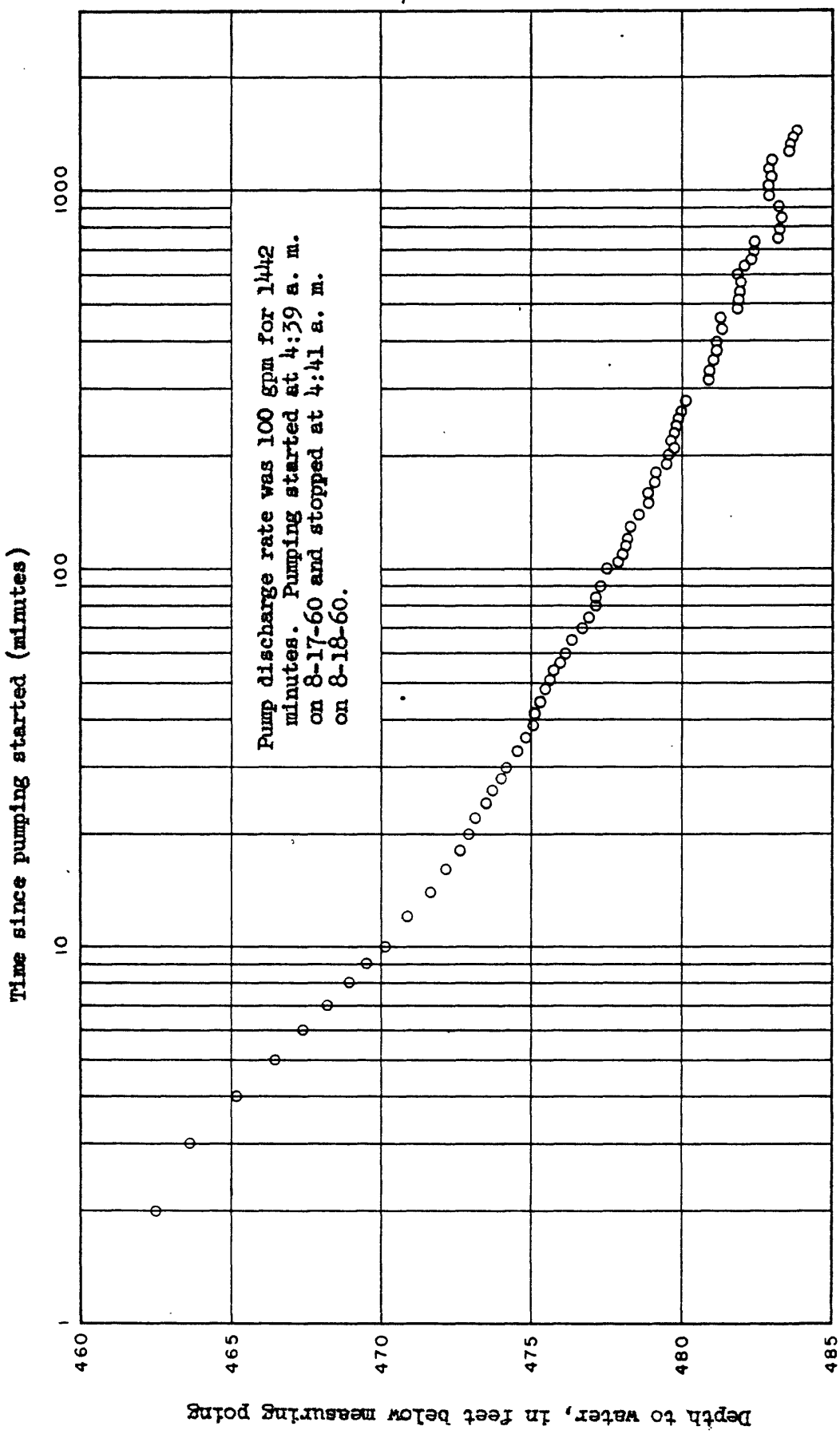

Figure 2.--Water-level drawdown plot, USGS test hole 1, Project Gnome

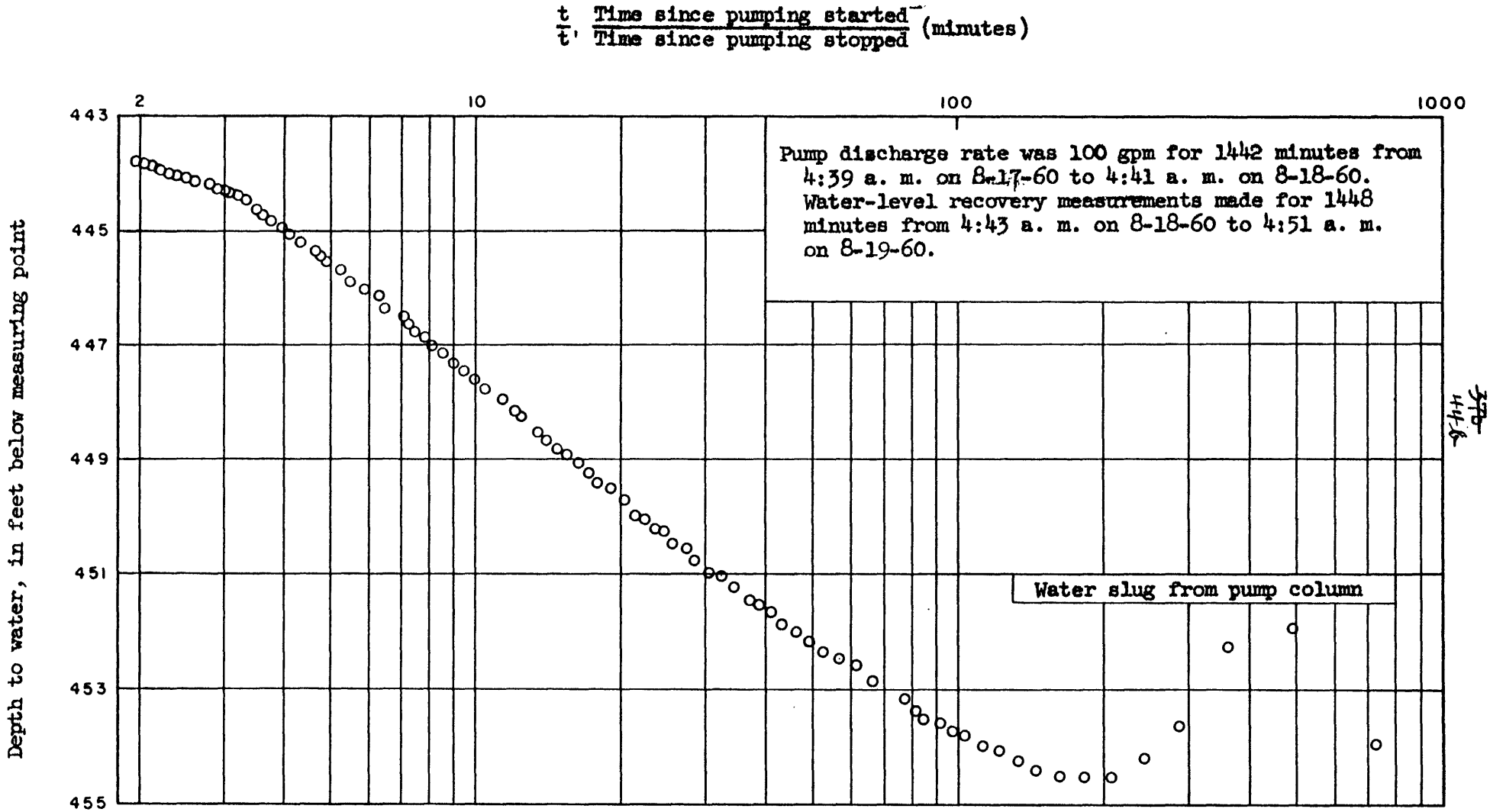

Figure 3.--Water-level recovery plot, USGS test hole 1, Project Gnome

Table 4.--Water measurements

USGS Test Hole 1

Project Gnome

Test 1

Hole depth: 197½ feet

Formation: Sandstone in Pierce Canyon redbeds

Date: August 4, 1960

Time	Depth to water (feet)	Remarks
12:16 pm	196.16	Measuring point is top of 20-inch casing 0.7 foot above rig floor. Altitude 3,426.70 feet. Hole was bailed out six times between 11:45 am and 12:16 pm before starting water-level observation. Electric tape used for measurements.
12:17	do.	
12:18	do.	
12:19	do.	
12:20	do.	Total depth of hole measured with steel tape and 4-lb. weight as 197.22 feet below rig floor.
12:21	do.	
12:22	do.	
12:23	do.	
12:24	do.	
12:25	do.	

Table 4.--Water measurements - Continued

USGS Test Hole 1 - Continued

Project Gnome - Continued

Test 1 - Continued

Time	Depth to water (feet)	Remarks
12:26	196.16	
12:27	do.	
12:28	do.	
12:29	do.	
12:30	do.	
12:31	do.	
12:32	do.	End of measurements. The 1.76 feet of water in hole did not lower or raise at all during test. Measurements made by W. A. Mourant.

Table 4.--Water measurements - Continued

USGS Test Hole 1 - Continued

Project Gnome - Continued

Test 2

Hole depth: 404 feet

Formation: Base of Magenta member of Rustler formation

Date: August 11, 1960

Time	Depth to water (feet)	Remarks
2:20 pm		Driller's total depth 403 feet. Driller washing and bailing hole. Hole flushed three times with 50±gals water and bailed out each time.
2:47		Last bailer out of hole.
2:50	402.34	Water level measured with electrical tape.
2:55		Measuring point is top of 18-inch casing above rig floor. Altitude of 3,426 feet above sea-level datum.
3:00	402.15	Hole total depth measured as 404.30 feet from floor with steel tape.
3:10	402.12	
3:20	402.10	
3:30	402.08	
3:40	402.08	
3:50	402.08	
3:55	402.08	End of measurements.

Table 4.--Water measurements - Continued

USGS Test Hole 1 - Continued

Project Gnome - Continued

Test 2 - Continued

Time	Depth to water (feet)	Remarks
4:00 pm		Collected sample from bailer and from drilling tank.
		Released crew to start drilling.
4:10		Drilling water at 89°F has field specific conductance of 8,000.
4:15		Fluid in hole at 79°F has field specific conductance of 8,000.
		Concluded no water is entering hole at this point.
		Measurements made by J. B. Cooper.

Table 4.--Water measurements - Continued

USGS Test Hole 1 - Continued

Project Gnome - Continued

Test 3

Hole depth: 523 feet

Formation: Top of Culebra dolomite member of Rustler formation

Date: August 13, 1960

Time	Depth to water (feet)	Remarks
5:41 am	519.10	Measuring point is top of 18-inch casing--top of rig floor--altitude of 3,426 feet above sea-level datum. Water level measured with electric tape.
5:42	518.98	
5:43	518.74	
5:44	518.44	
5:46	517.95	
5:47	517.69	
5:48	517.47	
5:53	516.53	
5:55	515.85	
5:57	515.40	
5:59	514.95	
6:01	514.46	
6:06	513.24	
6:10	512.17	

Table 4.--Water measurements - Continued

USGS Test Hole 1 - Continued

Project Gnome - Continued

Test 3 - Continued

Time	Depth to water (feet)	Remarks
6:15 am	511.15	
6:20	509.95	
6:25	508.80	
6:30	507.60	
6:36	506.65	Sounded depth 522.8 feet with weighted line.
6:40	505.75	
6:45	504.85	
6:50	503.91	
6:55	502.88	
7:00	502.01	
7:05	500.99	
7:10	500.05	
7:15	499.05	
7:20	498.04	
7:25	497.07	
7:30	496.12	
7:35	494.81	
7:40	403.75	
7:45	492.94	
7:50	492.09	

Table 4.--Water measurements - Continued

USGS Test Hole 1 - Continued

Project Gnome - Continued

Test 3 - Continued

Time	Depth to water (feet)	Remarks
7:55 am	491.20	
8:00	490.21	
8:05	489.29	
8:10	488.40	
8:15	487.47	
8:20	486.52	
8:25	485.69	End of measurements. Measurements made by G. C. Doty and G. A. Dinwiddie.

Table 4.--Water measurements - Continued

USGS Test Hole 1 - Continued

Project Gnome - Continued

Test 4

Hole depth: 550 feet

Formation: Culebra dolomite member of Rustler formation

Date: August 14-15, 1960

Part I--Hole cleanout

Time	Depth to water (feet)	Remarks
8-14-60		
8:20 pm		Hole bailed three times in normal fashion. Then six additional times. Fluid fairly thin. Bailer holds 100 gallons. Measuring point is top of 18-inch casing--top of rig floor--altitude of 3,426 feet above sea-level datum.
8:37		Stopped bailing.
8:40	452.35	Recovery measurements.
8:45	450.00	
8:50	499.21	
8:55	488.90	
9:00	488.67	
9:05	448.55	Measured hole total depth as 549.8 feet.
9:15	448.30	
9:20	448.10	
9:25	448.02	

Table 4.--Water measurements - Continued

USGS Test Hole 1 - Continued

Project Gnome - Continued

Test 4 - Continued

Part I--Hole cleanout - Continued

Time	Depth to water (feet)	Remarks
8-14-60 - Continued		
9:30	447.99	
9:35	447.94	
9:40	447.87	
9:45	447.76	End of measurements.

Part II--Bailing test

Time	Remarks
8-14-60	
9:53 pm	Started bailing test. Time starts when first bailer starts out.
	Bailing from bottom of hole.
1:52 am	End of bailing. All bailers full of water. Approximately 11,000 gallons of water removed. Hole bailed 4 hours at rate of about 48 gallons per minute.

Table 4.--Water measurements - Continued

USGS Test Hole 1 - Continued

Project Gnome - Continued

Test 4 - Continued

Part III--Recovery measurements

Time	Depth to water (feet)	Remarks
8-15-60		
1:58 am	448.40	Electric-line measurements.
1:59	447.86	Measuring point is top of 18-inch casing--top of rig floor at altitude of 3,426 feet above sea-level datum.
2:00	447.62	
2:01	447.36	
2:02	447.20	
2:03	447.05	
2:04	446.89	
2:06	446.70	
2:07	446.63	
2:08	446.53	
2:10	446.41	
2:12	446.24	
2:14	446.15	
2:16	446.05	
2:18	445.94	
2:20	445.85	
2:22	445.79	

Table 4.--Water measurements - Continued

USGS Test Hole 1 - Continued

Project Gnome - Continued

Test 4 - Continued

Part III--Recovery measurements - Continued

Time	Depth to water (feet)	Remarks
8-15-60 - Continued		
2:24	445.72	
2:26	445.63	
2:28	445.60	
2:33	445.46	
2:37	445.36	
2:41	445.23	
2:45	445.12	
2:49	445.08	
2:53	445.05	
2:57	444.99	
3:01	444.88	
3:05	444.85	
3:10	444.77	
3:15	444.68	
3:20	444.62	
3:25	444.50	
3:30	444.51	
3:35	444.40	
3:40	440.37	

Table 4.--Water measurements - Continued

USGS Test Hole 1 - Continued

Project Gnome - Continued

Test 4 - Continued

Part III--Recovery measurements - Continued

Time	Depth to water (feet)	Remarks
8-15-60 - Continued		
3:45 am	444.36	
3:50	444.29	
3:55	444.28	
4:00	444.22	
4:10	444.16	
4:20	444.06	
4:30	443.89	
4:40	443.80	
4:50	443.80	
5:00	443.72	
5:10	443.66	
5:20	443.62	
5:30	443.59	
5:40	443.55	
5:50	443.60	
6:00	443.50	End of 4-hour measuring period.
8:00	443.21	

Table 4.--Water measurements - Continued

USGS Test Hole 1 - Continued

Project Gnome - Continued

Test 4 - Continued

Part III--Recovery measurements - Continued

Time	Depth to water (feet)	Remarks
8-15-60 - Continued		
9:00 am	443.11	
10:00	443.06	
11:00	442.98	End Of measurements. Measurements made by J. B. Cooper, G. C. Doty and G. A. Dinwiddie.

Table 5.--Drilling-time log

USGS Test Hole 1

Project Gnome

Hole interval From (feet)	To	Time Start	Stop	Minutes per foot	Remarks
		6-1-60			
10	15	8:01 am	8:50	10	Drilling 24-inch hole
15	20	8:55	9:30	6	Down 5 min. to remove tool guide.
20	22	9:37	9:49	6	Sand caving.
22	25	9:55	10:20	8	
25	29	10:29	10:45	4	
29	30	10:50	11:03	13	
30	35	11:06	11:50	8	Down 5 min. to bail hole at 32½ feet.
35	37½	11:55	12:07 pm	5	
37½	40	12:15	12:55	16	
40	42½	1:00	1:27	11	
42½	45	1:32	2:00	11	Hole being bailed to within 2-3 feet of bottom.
45	47½	2:07	2:34	11	
47½	50	2:40	2:57	7	Added water to thin slush.
50	52½	3:05	3:40	14	
52½	55	3:48	4:32	18	Rigged larger bailer to bail this interval.
55	57	4:55	5:20	12	Sand caving.

Table 5.--Drilling-time log - Continued

USGS Test Hole 1 - Continued

Project Gnome - Continued

Hole interval From (feet)	To	Time Start	Stop	Minutes per foot	Remarks
			8-1-60 - Continued		
57	58	5:28 pm	6:12	36	Sand caving. Down 8 min. to rig electric cord.
58	60	6:20	7:30	35	Measured hole at 58 feet.
60	61½	7:55	8:33	25	Sand caving; grease rig, end of bailing.
61½	54	9:02	9:44	12	Sand caving
			8-2-60		
65	66	12:30 am	12:47	8	
66	70	1:24	1:53	7	Measured depth to start.
70	73	2:15	2:36	7	Gravel, fine.
73	75	3:02	3:35	16	
75	78	3:55	4:19	8	Bailed poorly consolidated sandstone.
78	80	4:40	5:05	12	
80	83	-	6:30	30	Time estimated.
83	85	6:45	7:50	32	
85	89	8:05	8:58	13	Shut down to adjust rig and tighten tools. Measured hole at 89 feet.
89	93	10:05	10:20	4	
93	95½	10:37	10:50	5	
95½	100	10:58	11:05	2	Caving sand.

Table 5.--Drilling-time log - Continued

USGS Test Hole 1 - Continued

Project Gnome - Continued

Hole interval From (feet)	To	Time Start	Stop	Minutes per foot	Remarks
		8-2-60 - Continued			
100	105	11:15 am	11:34	4	Caving slightly
105	108	11:45	12:30 pm	15	Driller reports sand at 95 to 100 feet caving into hole.
108	110	2:15 pm	2:35	10	
110	112½	3:00	3:38	15	Pierce Canyon redbeds in samples.
112½	115	3:53	4:20	11	Pierce Canyon redbeds in samples. 115 feet measured with steel tape. Checked for water in hole.
		8-3-60			
115	117½	8:35 pm	8:42	2	Drilling 19-inch hole. 20-inch casing to 115 feet 11 inches.
117½	120	8:13	9:30	7	
120	125	9:40	10:00	4	
125	130	10:10	10:28	4	Drilling good.
130	135	10:35	10:58	5	
135	140	11:14	11:30	3	
140	145	11:42	12:02 am	4	
		8-4-60			
145	150	12:12 am	12:32	4	

Table 5.--Drilling-time log - Continued

USGS Test Hole 1 - Continued

Project Gnome - Continued

Hole interval From (feet)	To	Time Start	Stop	Minutes per foot	Remarks
		8-4-60 - Continued			
150	155	12:45 am	1:10	5	
155	160	1:19	1:38	4	
160	165	1:48	2:05	3	
165	170	2:15	2:28	3	
170	175	2:35	2:52	3	Drills harder; may have been little water.
175	179	3:05	3:14	2	Shutdown to check for water in hole. No water.
179	185	4:28	5:44	13	
185	190	6:55	8:05	14	
190	193	8:20	9:45	28	Driller reports very sticky drilling.
193	195	9:55	10:45	25	Motor trouble.
195	197½	11:15	11:45	12	Water-level observations. No water.
197½	200	12:55 pm	1:15	8	
200	205	1:25	1:38	3	
205	210	1:45	2:05	4	
210	215	2:13	2:29	3	
215	220	2:45	3:06	4	

Table 5.--Drilling-time log - Continued

USGS Test Hole 1 - Continued

Project Gnome - Continued

Hole interval From (feet)	To	Time Start	Stop	Minutes per foot	Remarks
		8-4-60 - Continued			
220	225	3:14	3:35	4	Shutdown to have bit faced.
		8-6-60			
225	228	1:20 am	1:46	9	
228	233	2:00	2:20	4	
233	238	2:33	3:02	6	
238	243	-	4:02	6	Time estimated.
		8-7-60			
243	246	11:30 am	11:50	7	
246		12:17 pm	12:20		Stopped drilling to adjust rig.
		12:38	12:41		do.
		12:44	1:05		Stopped drilling to adjust rig. Clutch bolt broke.
	251	2:32	2:40	7	
251	256	2:55	3:18	5	
256	260	3:50	4:15	6	
260	265	4:35	5:07	6	
265	270	5:21	5:49	6	
270	275	6:12	6:35	5	

Table 5.--Drilling-time log - Continued

USGS Test Hole 1 - Continued

Project Gnome - Continued

Hole interval From (feet)	To	Time Start	Stop	Minutes per foot	Remarks
		8-7-60 - Continued			
275	280	7:40 pm	8:00	4	
280	285	8:14	8:31	3	
285	290	8:50	9:13	5	
290	295	9:40	9:58	4	
295	300	10:10	10:29	4	
300	303	10:45	11:07	7	Hit top gypsum 303 feet.
303	304.3	11:24	11:58	20	Rustler formation. Tested for water.
		8-9-60			
304.3	309	11:20 am	12:50 pm	20	Drilling 17½-inch hole. 18-inch casing to 304 feet 4 inches. Bit sticking at base of casing.
309	314	1:00	1:50	10	
314	319	2:05	3:00	11	
319	324	3:14	4:15	12	
324	329	4:25	5:25	12	
329		5:45	6:05		Shutdown for very heavy rain.
	334	11:00	12:05 am	17	Rig started drilling again.

Table 5.--Drilling-time log - Continued

USGS Test Hole 1 - Continued

Project Gnome - Continued

Hole interval From (feet)	To	Time Start	Stop	Minutes per foot	Remarks
		8-10-60			
334		12:30 am	1:10		Shutdown for heavy rain.
		8:30	-		Started rig to dry out belts, etc.
	339	9:00	9:20	12	Started drilling.
339	343	10:30	11:05	9	Hit redbeds at 342 feet.
343	349	11:40	12:15 pm	6	
349	354	12:30	12:53	5	
354		1:30	2:13		Rain started very heavy. Driller reports hard formation.
	359	2:55	3:08	11	Intermittent rain.
359	364	3:58	5:00	12	
364	369	5:11	6:05	11	
369	374	6:17	7:00	9	
374	379	7:32	8:18	9	
379	384	8:30	9:05	7	
384	389	9:20	10:05	9	
389	394	10:15	11:35	10	Stopped 10:40 to 11:10 because of power failure.

Table 5.--Drilling-time log - Continued

USGS Test Hole 1 - Continued

Project Gnome - Continued

Hole interval From (feet)	To	Time Start	Stop	Minutes per foot	Remarks
		8-10-60 - Continued			
394	397	11:45	12:07 am	7	Lost tool in hole; fishing.
		8-11-60			
397	400	12:00 pm	12:17	5	
400		12:30	12:37		
		12:41	12:43		Shutdown to change drillers and grease rig.
	404.3	1:23	2:15	20	Drilled total depth
404.3	(Hole total depth)				Making water-level observations. Measured hole; total depth.
404	409	4:20	5:08	10	
409	414	5:18	6:12	11	
414	419	6:26	7:28	12	
419	424	7:35 pm	8:30	11	Made hole alinement survey.
424	430	8:55	9:53	10	Driller reports hole measures long.
430	435	10:10	10:52	8	
435		11:08	11:50		Shutdown for rain.
		8:12-60			
	440	12:20 pm	12:38	12	Rain - no activity. Started drilling.

Table 5.--Drilling-time log - Continued

USGS Test Hole 1 - Continued

Project Gnome - Continued

Hole Interval From (feet)	To	Time Start	Stop	Minutes per foot	Remarks
		8-12-60 - Continued			
440	445	12:50 pm	1:50	12	
445	450	2:00	2:43	9	
450	455	2:52	3:35	9	
455	460	4:03	5:05	12	
460	465	5:15	6:03	10	
465	470	6:12	6:55	9	
470	475	7:12	7:50	8	
475	480	8:00	8:45	9	
480	485	8:56	9:37	8	Grease rig.
485	490	10:04	10:38	5	
490	495	10:56	11:47	10	
		8-13-60			
495	500	12:01 am	12:35	7	Driller reports change in formation at 500 feet.
500	505	12:45	1:19	7	
505	509	1:30	2:04	8	
509	514	2:20	3:13	6	
514	519	3:42	4:34	10	

Table.5--Drilling-time log - Continued

USGS Test Hole 1 - Continued

Project Gnome - Continued

Hole interval From (feet)	To	Time Start	Stop	Minutes per foot	Remarks
		8-13-60 - Continued			
519	523	4:55 am	5:15	4	Hole into Culebra member. Made water-level observations. Measured hole total depth at 522.8 feet "iron horse."
523	528	8:45	9:17	6	Corrected hole depth to 523 feet.
528	531	11:26	12.26 pm	20	Dropped bit at 531 feet.
		8-14-60			
531		1:43 pm	2:40		Fixing something.
	535	2:45	2:55	17	
535	539	3:08	4:12	16	
539	544	4:39	5:40	12	
544	549	5:56	7:06	14	Believe hole is actually at 548 feet. Think driller has over-measured line 1 foot.
549	550	7:24 pm	8:05	20	Driller reports change at 551 feet.
		8-19-60			
550	551	3:23 pm	3:50	27	Hole depth "iron horse" 551.4 feet.
551	555	4:17	4:50	8	

Table 5.--Drilling-time log - Continued

USGS Test Hole 1 - Continued

Project Gnome - Continued

Hole interval From (feet)	To	Time Start	Stop	Minutes per foot	Remarks
		8-19-60 - Continued			
555	560	5:04		12	Time estimated.
560	565		7:00	12	Do.
565	577		11:20	15	Do.
		8-20-60			
577	579	2:55 pm	3:30	17	Drilling 12-inch hole. 12 3/4 inch. casing to 576 feet 4 inches.
		8-21-60			
579	584	11:16 am	11:34	4	
584	589	11:45	11:55	2	
589	594	12:05 pm	12:14	2	
594	597	12:24	12:42	6	
597	602	1:35	1:50	3	
602	608	1:55	2:07	2	
608	614	2:16	2:25	2	
614	617	2:33	2:41	3	
617	622	2:55	3:07	2	
622	627	3:25	3:55	2	
627	632	3:46	4:00	3	

Table 5.--Drilling-time log - Continued

USGS Test Hole 1 - Continued

Project Gnome - Continued

Hole interval From (feet)	To	Time Start	Stop	Minutes per foot	Remarks
			8-21-60 - Continued		
632	637	4:08 pm	4:18	2	
637	642	4:26	4:38	2	
642	647	4:49	4:56	1	
647	652	5:07	5:20	3	
652	657	5:33	5:47	3	Shutdown for measurements.
657	660	8:08	8:19	4	
660	665	9:61	10:09	4	
665	668	10:21	10:40	6	
668	670	10:44	11:06	11	
670	672	11:16	11:40	12	
			8-22-60		
672	675	12:08 am	1:12	21	
675	680	-	-	20	Time estimated.
680	685	3:50	4:58	14	
685	690	5:15	6:40	17	
690	695	7:00	7:34	7	
695	700	7:52	8:27	7	
700	703	8:43	10:08	28	

Table 5.--Drilling-time log - Continued

USGS Test Hole 1 - Continued

Project Gnome - Continued

Hole interval From (feet)	To	Time Start	Stop	Minutes per foot	Remarks
		8-22-60 - Continued			
703	705	10:25 am	11:54	45	
705	709	12:39 pm	2:27	27	Dropped tools.
709	710	5:30	5:49	19	
710	713	6:05	6:34	10	
713	718	6:51	7:48	11	
718	723	8:01	8:47	9	Total depth of hole.

~~62a~~
70a

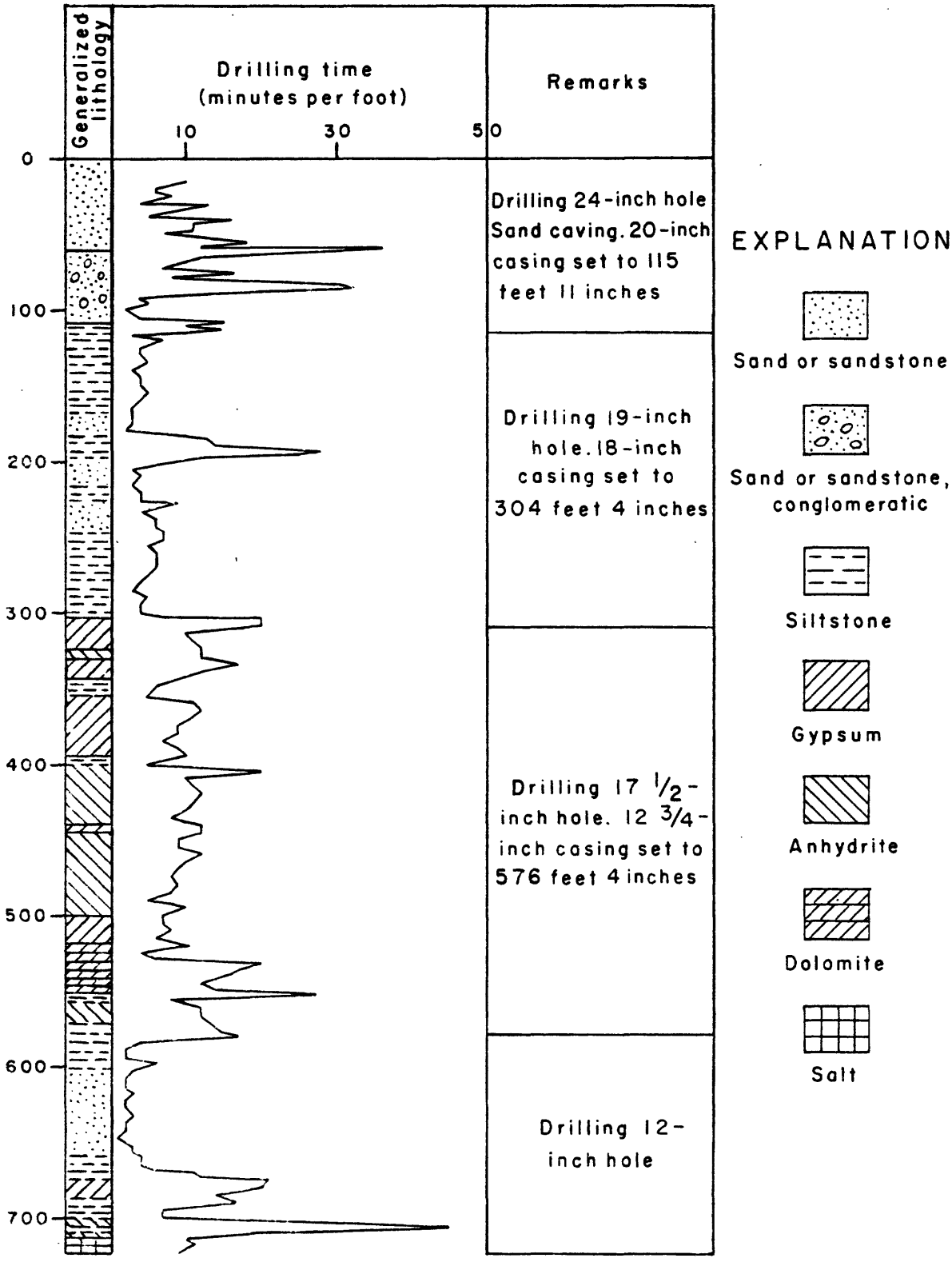

Figure 4.--Drilling time of formations penetrated in USGS test hole 1, Project Gnome

Table 6.--Water Analysis

USGS Test Hole 1

Project Gnome

(Analyses by U. S. Geological Survey)

Date collected: 8-18-60		Lab. No.: 3913	
Chemical components Parts per million (ppm)		Physical characteristics and computed values	
Silica (SiO_2)	30	Dissolved solids (ppm)	4860
Aluminum (Al)	2.2	Hardness as $CaCO_3$ (ppm)	
Iron (Fe)	.0	Total	2120
Manganese (Mn)	.0	Non-carbonate	2020
Calcium (Ca)	608	Specific conductance Micromhos at 25°C	5200
Magnesium (Mg)	146	pH	7.6
Sodium (Na)	520	Color	3
Potassium (K)	11	Temperature (°F)	74
Bicarbonate (HCO_3)	114	Radiochemical data	
Carbonate (CO_3)	0	Alpha activity[1] (pc/l) as of 12-2-60	68 ± 41
Sulfate (SO_4)	1960	Beta activity (pc/l) as of 11-15-60	54 ± 8
Chloride (Cl)	770	Radium (Ra) (pc/l)	8.9 ± 1.8
Fluoride (F)	.3		7.1 ± 0.7
Nitrate (NO_3)	7.8	Extractable alpha activity (net) (pc/l)	9.5 ± 4.0
Phosphate (PO_4)	.0	Strontium 90 (pc/l)	< 0.6

1/ Picocuries (micromicrocuries) per liter

2/ Micrograms per liter

Table 7.--Summary of test-hole construction

USGS Test Hole 2

Project Gnome

Location: SW¼SW¼SW¼ sec. 4, T. 24 S., R. 30 E., (about 2 miles southwest of the Gnome shaft), Eddy County, N. Mex.

Altitude: 3,403 feet above sea-level datum. Altitude of rig floor, about 1 foot above land surface, which is reference point for all measurements.

Total Depth: 608 feet.

Date Drilled: September 1960.

Drilling Contractor: Everett D. Burgett Drilling Co., Carlsbad, N. Mex.

Drilling Method: Cable tool.

Casing and Hole Record: 24-inch hole from 0 to 36 feet.

Twenty-inch hole from 36 to 212 feet. Cased with 20-inch outer-diameter casing from surface to 209 feet 9 inches. Casing cemented in hole at bottom.

Nineteen-inch hole from 212 to 323 feet. Cased with 18-inch outer-diameter casing from surface to 322 feet 6 inches. Casing cemented in hole at bottom.

Seventeen and a half-inch hole from 323 to 541 feet.

Twelve-inch hole from 541 to 608 feet, total depth. Cased with 8 5/8-inch outer-diameter casing from surface to total depth.

Hole Completion record: 8 5/8-inch outer-diameter casing slotted from 453 to 583 feet. Upper 10 feet of annular space between 8 5/8-inch outer-diameter casing, 18-inch outer-diameter casing, and 20-inch outer-diameter casing filled with cement. Eight and five-eighths-inch

Table 7.--Summary of test-hole construction - Continued

USGS Test Hole 2 - Continued

Project Gnome - Continued

outer-diameter casing stubbed upward 2.0 feet and centered in 6-foot square, 6-inch thick reinforced concrete slab. Altitude of top of concrete slab is 3,402.89 feet above sea-level datum. Water-stage recorder installed over casing.

Water-bearing formation: Lower member of Rustler formation and residuum of Rustler and Salado formations. Water was in insufficient quantities to test yield accurately. Estimated yield is approximately half a gallon per minute.

Formation logs: 1) sample description, 2) electric, 3) radioactivity (Gamma-Neutron), 4) temperature.

Geologic section:

Depth interval (feet)	Stratigraphic unit
0-40	Wind-blown sand (sand caliche)
40-206	Gatuna formation of Pleistocene (?) age, (sandstone, sand, and conglomerate)
206-309.5	Pierce Canyon redbeds of Permian or Triassic age (siltstone, sandstone, and gravel)
309.5-375	Rustler formation, Middle member, of Permian age (gypsum and siltstone)
375-405	Rustler formation, Culebra dolomite, member of Permian age. (calcite, limestone, and dolomite)

Table 7.--Summary of test hole construction - Continued

USGS Test Hole 2 - Continued

Project Gnome - Continued

Geologic section - Continued

Depth interval (feet)	Stratigraphic unit
405-515	Rustler formation, Lower member, of Permian age (clay, sand, gypsum, and siltstone)
515-586	Rustler and Salado formations undifferentiated, of Permian age (claystone, siltstone, and anhydrite)
586-608	Salado formation, of Permian age (salt and polyhalite)

Table 8.--Sample description log

USGS Test Hole 2

Project Gnome

Feet	Lithologic description
0-5	Sand, quartz, light-brown (5 YR 6/4); 40 percent fine- and 60 percent medium-grained, subrounded; mostly clear to opaque quartz grains; some iron-stained; no cementation; trace of sandy caliche. Driller reports caliche 4-5 feet.
5-40	Sand, quartz, light-brown (5 YR 6/4); 50 percent fine- and 50 percent medium-grained, subrounded; mostly clear to opaque quartz grains, some iron-stained; no cementation. Caliche bed about 1-foot thick at 12 feet.
40-50	Gatuna formation Sand, quartz, light-brown (5YR 6/4); 50 percent fine- and 50 percent medium-grained, subrounded; mostly clear to opaque quartz grains, some iron-stained; no cementation; few sandstone fragments.
50-55	Sand, quartz, light-brown (5 YR 6/4); 50 percent fine- and 50 percent medium-grained, subrounded; mostly clear to opaque quartz grains, some iron-stained; no cementation.
55-60	Sand, quartz, light-brown (5 YR 6/4); 50 percent fine- and 50 percent medium-grained, subrounded; mostly clear to opaque quartz grains, some iron-stained; no cementation; some sandstone.

Table 8.--Sample-description log - Continued

USGS Test Hole 2 - Continued

Project Gnome - Continued

Feet	Lithologic description
60-65	Sand, quartz, light-brown (5 YR 6/4); 50 percent fine- and 50 percent medium-grained, subrounded; mostly clear to opaque quartz grains, some iron-stained; no cementation; some pale-reddish-brown siltstone (10 R 5/4).
65-72	Sand, quartz, light-brown (5 YR 6/4); very fine-grained, subrounded; mostly clear to opaque quartz grains, some iron-stained; no cementation.
72-85	Sand, quartz, pale-reddish-brown (10 R 5/4); 20 percent very fine-, 50 percent fine-, and 30 percent medium-grained; rounded to subrounded; no cementation.
85-90	Sand, quartz, pale-reddish-brown (10 R 5/4); 20 percent very fine-, 50 percent fine-, and 30 percent medium-grained; rounded to subrounded; no cementation; some silt.
90-92	Sand, quartz, pale-reddish-brown (10 R 5/4); 20 percent very fine-, 50 percent fine-, and 30 percent medium-grained; rounded to subrounded; no cementation; estimated 1 percent dark grains; some silt.
92-95	Sand, quartz, pale-reddish-brown (10 R 5/4); 20 percent very fine-, 50 percent fine-, and 30 percent medium-grained; rounded to subrounded; no cementation; some clay and fragments of sand in clay-silt matrix.

Table 8.--Sample-description log - Continued

USGS Test Hole 2 - Continued

Project Gnome - Continued

Feet	Lithologic description
95-98	Sand, quartz, pale-reddish-brown (10 R 5/4); 20 percent very fine-, 50 percent fine-, and 30 percent medium-grained; rounded to subrounded; no cementation; some clay.
98-100	Sand, quartz, pale-reddish-brown (10 R 5/4); 20 percent very fine-, 50 percent fine-, and 30 percent medium-grained; rounded to subrounded; no cementation; some clay and siltstone fragments.
100-109	Sandstone, pale-reddish-brown (10 R 5/4); very fine- to fine-grained, subrounded; well sorted; mostly clear to opaque quartz grains, some iron-stained; friable to medium cemented with calcareous cement.
109-119	Sandstone, pale-red (10 R 6/2); very fine- to coarse-grained with some pebbles, subangular to rounded; poorly sorted; clear, frosted, and amber-stained quartz grains and yellow, green, and black chert grains; calcareous cement; pebble-size particles of hard sandstone and chert and some clay.
119-124	Sandstone, pale-red (10 R 6/2); very fine- to coarse-grained, subangular to rounded; poorly sorted; clear, frosted, and amber-stained quartz grains and yellow, green, and black chert grains; calcareous cement; some clay.

Table 8.--Sample description log - Continued

USGS Test Hole 2 - Continued

Project Gnome - Continued

Feet	Lithologic description
124-128	Sandstone, pale-red (10 R 6/2); very fine- to coarse-grained; subangular to rounded; poorly sorted; clear, frosted, and amber-stained quartz grains and yellow, green, and black chert grains; calcareous cement; and about 30 percent clay.
128-140	Sand, pale-red (10 R 6/2); fine- to coarse-grained, subangular to rounded; poorly sorted; clear and amber-stained quartz and multicolored chert; 20 to 30 percent of discrete lumps of clay intermixed with sand; and some fragments of claystone.
140-145	Sandstone, pale-reddish-brown (10 R 5/4); very fine- to medium-grained, angular to subrounded; mostly fine quartz grains; some firmly cemented.
145-150	Sandstone, pale-reddish-brown (10 R 5/4); very fine- to medium-grained; quartz grains; opaque to translucent; calcareous cement.
150-155	Sandstone, pale-reddish-brown (10 R 5/4); very fine- to fine-grained, subrounded; some pebbles and fragments of siltstone.
155-160	Sandstone, pale-reddish-brown (10 R 5/4); very fine- to medium-grained, angular to subrounded; calcareous cement.

Table 8.--Sample-description log - Continued

USGS Test Hole 2 - Continued

Project Gnome - Continued

Feet	Lithologic description
160-166	Sandstone, pale-reddish-brown (10 R 5/4); very fine- to medium-grained, subangular to subrounded; calcareous cement; 3 to 8 percent subangular to subrounded, small (around 12 mm) pebbles coated with calcareous cement; trace of silt.
166-168	Sandstone, pale-reddish-brown (10 R 5/4); very fine- to medium-grained, subangular to subrounded; calcareous cement; pebbles, and 10 to 20 percent silt.
168-173	Sandstone, pale-reddish-brown (10 R 5/4); fine- to coarse-grained; calcareous cement; fine pebbles, and 10 to 20 percent silt.
173-200	Sand, pale-reddish-brown (10 R 5/4); fine- to coarse-grained; clay balls and pebbles.
200-200.5	Sand, pale-reddish-brown (10 R 5/4); fine- to coarse-grained; some clay.
200.5-202	Sand, pale-reddish-brown (10 R 5/4); fine- to coarse-grained; some clay and siltstone fragments.
202-205	Sand, pale-reddish-brown (10 R 5/4); fine- to coarse-grained; clay, and about 10 to 15 percent siltstone with reduction spots (may be reworked Pierce Canyon redbeds).
205-208	Sand, pale-reddish-brown (10 R 5/4); fine- to coarse-grained; clay, and about 30 to 40 percent siltstone with reduction spots. Top of Pierce Canyon redbeds 206 feet.

Table 8.--Sample-description log - Continued

USGS Test Hole 2 - Continued

Project Gnome - Continued

Feet	Lithologic description
208-212	Siltstone, moderate-reddish-orange (10 R 6/6); white reduction spots.
212-216	Siltstone, moderate-reddish-orange (10 R 6/6); subrounded; gravel or pebbles, and 3 percent very coarse grained sand.
216-220	Siltstone, moderate-reddish-orange (10 R 6/6); subrounded; some white reduction spots, and angular to subrounded gravel.
220-223	Siltstone, moderate-reddish-orange (10 R 6/6), and gravel-sized fragments of firmly cemented, medium-gray (N 5) siltstone.
223-226	Siltstone, moderate-reddish-orange (10 R 6/6); subangular to subrounded gravel-sized fragments of medium-gray (N 5) siltstone, and 0.5 percent calcite and gypsum.
226-230	Siltstone, moderate-reddish-orange (10 R 6/6); very few white reduction spots; trace of calcite.
230-235	Siltstone, moderate-reddish-orange (10 R 6/6); white reduction spots, and loosely cemented, medium-gray (N 5) siltstone.
235-251	Siltstone, moderate-reddish-orange (10 R 6/6); white reduction spots.
251-258	Siltstone, moderate-reddish-orange (10 R 6/6); white reduction spots; some clay.

Table 8.--Sample description log - Continued

USGS Test Hole 2 - Continued

Project Gnome - Continued

Feet	Lithologic description
258-268	Siltstone, moderate-reddish-orange (10 R 6/6); white reduction spots; clay, and about 1 percent gypsum interbedded with siltstone.
268-278	Siltstone, moderate-reddish-brown (10 R 6/6); white reduction spots; and hard, well-indurated, grayish-orange-pink (10 R 8/2), limy siltstone with red spots and calcite veins; 15 percent calcite.
278-283	Siltstone, moderate-reddish-brown (10 R 6/6); white reduction spots; much clay, and some calcite.
283-288	Siltstone, pale-reddish-brown (10 R 5/4); calcite particles; few coarse sand grains, and trace of medium-light-gray (N 6) siltstone.
288-293	Sandstone, pale-red (10 R 6/2); very fine- to coarse-grained; medium-light-gray (N 6) siltstone with particles of calcite; 5 percent grayish-white clay; and possibly some gravel-sized, angular limestone fragments.
293-298	Clay, grayish-orange-pink (10 R 8/2); effervesces very readily; 3 percent calcite.
298-304	Siltstone, clayey, grayish-orange-pink (10 R 8/2); 5 percent medium- and coarse-grained sand; and 1 percent pale-reddish-brown (10 R 5/4) siltstone.

Table 8.--Sample description log - Continued

USGS Test Hole 2 - Continued

Project Gnome - Continued

Feet	Lithologic description
304-308	Rubble, fine- to cobble-size, angular to subrounded; composed of crystalline, pale-red (10 R 6/2) dolomite and grayish-orange-pink (5 YR 7/2) gypsum; trace of carbonaceous clay. Reworked Rustler formation.
308-310.6	Rubble, fine- to cobble-size, angular to subrounded; composed of crystalline, pale-brown (5 YR 5/2) dolomite, 35 percent very pale-orange (10 YR 8/2) gypsum, and 3 percent pale-reddish-brown (10 R 5/4) siltstone. Reworked Rustler formation. Top of Rustler formation 309.5 feet.
310.6-314	Gypsum, grayish-orange-pink (10 R 8/2); and pale-red (10 R 6/2) dolomite gravel (dolomite is caving from above).
314-323	Gypsum, grayish-orange-pink (10 R 8/2); some reworked dolomite.
323-330	Gypsum, white (N 9).
330-335	Gypsum, white (N 9); trace of anhydrite.
335-341	Gypsum, white (N 9); 1 to 4 mm selenite crystals, and 10 percent pale-reddish-brown clay. Top of clay 340 feet.
341-346	Clay, pale-red (10 R 6/2); 20 percent white selenite, and 5 percent white gypsum.
346-350	Siltstone, clayey, pale-red (10 R 6/2), 60 percent; 25 percent clear to opaque, white selenite, and 15 percent gypsum.
350-355	Selenite, white to grayish-orange-pink (10 R 8/2); 10 percent gypsum; some silt and clay.

Table 8.--Sample description log - Continued

USGS Test Hole 2 - Continued

Project Gnome - Continued

Feet	Lithologic description
355-360	Gypsum, grayish-orange-pink (10 R 8/2); traces of anhydrite, 1 to 4 mm selenite crystals, and calcite fragments.
360-365	Gypsum, grayish-orange-pink (10 R 8/2); 20 percent calcite, and 10 percent selenite crystals.
365-371.5	Gypsum, grayish-orange-pink (10 R 8/2), 50 percent; 40 percent anhydrite; calcite and selenite crystals.
371.5-375	Gypsum, yellowish-gray (5 Y 8/1); 20 percent calcite; few white selenite crystals.
375-385	Calcite, moderate-red (5 R 5/4); 40 percent weathered calcite; few gypsum fragments.
385-390	Calcite, grayish-orange-pink (5 YR 7/2); weathered; 10 percent calcite crystals.
390-395	Limestone, grayish-orange-pink (5 YR 7/2); weathered; 20 percent calcite crystals.
395-400	Calcite, crystalline, 60 percent; crystals mostly stained; 40 percent grayish-orange-pink (5 YR 7/2); weathered limestone.
400-405	Dolomite, light-gray (N 7); 10 percent calcite crystals.
405-410	Dolomite, light-gray (N 7), 50 percent, 30 percent gypsum, some sugary textured; and 20 percent pale-brown (5 YR 5/2) clay. Dolomite is cave material from above.

Table 8.--Sample description log - Continued

USGS Test Hole 2 - Continued

Project Gnome - Continued

Feet	Lithologic description
410-415	Clay, pale-brown (5 YR 5/2), 60 percent, and 40 percent white gypsum with a few selenite crystals.
415-418	Gypsum, white (N 9), 80 percent, and 20 percent pale-brown (5 YR 5/2) clay.
418-420	Gypsum, white (N 9).
420-425	Gypsum, white (N 9) with some red and gray.
425-435	Clay, silty, pale-reddish-brown (10 R 5/4), 75 percent, and 25 percent white with some red and gray gypsum.
435-440	Gypsum, white to light-greenish-gray (5 GY 8/1), 75 percent; some crystalline, and 25 percent pale-reddish-brown (10 R 5/4) silty clay and siltstone.
440-450	Siltstone, pale-reddish-brown (10 R 5/4) and greenish-gray (5 GY 6/1), 45 percent, 45 percent interbedded white gypsum, and 10 percent clay.
450-456	Clay, pale-red (10 R 6/2), 90 percent, and 10 percent pale-reddish-brown (10 R 5/4) and greenish-gray (5 GY 6/1) siltstone and white gypsum.
456-461	Siltstone, grayish-orange-pink (5 YR 7/2) and pale-red (10 R 6/2); trace of fibrous gypsum.
461-467	siltstone, sandy, light-gray (N 7), and 20 percent light-gray (N 7) clay; trace of pale-red (10 R 6/2) siltstone and fibrous gypsum.

Table 8.--Sample description log - Continued

USGS Test Hole 2 - Continued

Project Gnome - Continued

Feet	Lithologic description
467-472	Siltstone, light-gray (N 7) to pale-red (10 R 6/2), 50 percent, and 50 percent very fine-grained pale-red (10 R 6/2) and light-brown (5 YR 6/4) clay; some selenite crystals.
472-475	Clay, light-brown (5 YR 6/4) to moderate-brown (5 YR 3/4); very fine-grained pale-red (10 R 6/2) sand, and light gray (N 7) to medium-light-gray (N 6) siltstone.
475-479	Clay, light-brown (5 YR 6/4), 80 percent; very fine-grained pale-red (10 R 6/2) sand, and 5 to 10 percent medium light-gray (N 6) siltstone.
479-482	Clay, light-brown (5 YR 6/4), 60 percent; 20 percent very fine-grained pale-red (10 R 6/2) sand, and 20 percent light-gray (N 7) siltstone.
482-487	Clay, light-brown (5 YR 6/4), 50 percent; 35 percent light-gray (N 7) siltstone, and 15 percent very fine-grained pale-red (10 R 6/2)sand.
487-490	Clay, light-brown (5 YR 6/4), 70 percent; loosely cemented, very fine-grained, subangular to subrounded sandstone with opaque and iron-stained grains, and light-gray (N 7) siltstone.
490-497	Clay, light-brown (5 YR 6/4), 75 percent; pale-red (10 R 6/2) sand, and light-gray (N 7) siltstone; some selenite crystals.

Table 8.--Sample-description log - Continued

USGS Test Hole 2 - Continued

Project Gnome - Continued

Feet	Lithologic description
497-505	Clay, light-brown (5 YR 6/4), 95 percent, and 5 percent pale-red (10 R 6/2) sand. Material caved into hole while water-level observations were being made; 500 to 505 feet, 75 percent clay and 25 percent sand, probably from 460 to 500 feet.
505-507	Clay, light-brown (5 YR 6/4), 75 percent, and 25 percent pale-red (10 R 6/2) sand.
507-512	Clay, light-brown (5 YR 6/4), 85 percent, and 15 percent pale-red (10 R 6/2) sand.
512-515	Claystone, sandy and silty.
515-519	Claystone, moderate-brown (5 YR 3/4), 60 percent; 20 percent sandy grayish-red (10 R 4/2) siltstone, and 20 percent sandy medium-gray (N 5) siltstone.
519-523	Claystone, moderate-brown (5 YR 3/4), 60 percent; 20 percent sandy grayish-red (10 R 4/2) siltstone; and 20 percent sandy medium-gray (N 5) siltstone; few selenite crystals.
523-532	Claystone, moderate-brown (5 YR 3/4), 60 percent; 20 percent sandy grayish-red (10 R 4/2) siltstone, and 20 percent sandy medium-gray (N 5) siltstone; some white gypsum and selenite crystals.

Table 8.--Sample-description log - Continued

USGS Test Hole 2 - Continued

Project Gnome - Continued

Feet	Lithologic description
532-536	Claystone, moderate-brown (5 YR 3/4); sandy grayish-red (10 R 4/2) and medium-gray (N 5) siltstone; 10 to 15 percent white gypsum.
536-537	Siltstone, sandy, pale-red (10 R 6/2) to pale-reddish-brown (10 R 5/4), 75 percent; friable; calcareous; 24 percent clay and claystone, and 1 percent silt- to pebble-sized particles of gypsum; few small red-stained crystalline calcite fragments.
537-541	Claystone, grayish-red (10 R 4/2); 50 percent; 49 percent pale-red (10 R 6/2) to pale-reddish-brown (10 R 5/4), friable, calcareous claystone; and 1 percent pebble-sized particles of gypsum.
541-547	Clay, pale-reddish-brown (10 R 5/4), 50 percent; 20 percent pale-reddish brown (10 R 5/4) siltstone; 20 percent selenite and gypsum, and 10 percent calcite particles and very fine-grained sand.
547-552	Claystone and siltstone, pale-reddish-brown (10 R 5/4), 40 percent; 35 percent selenite and gypsum; 20 percent very fine-grained sand; 5 percent calcite.
552-555	Siltstone, sandy, pale-reddish brown (10 R 5/4), 50 percent; 20 percent very fine-grained sand; 15 percent pale-reddish-brown (10 R 5/4) clay; 15 percent selenite and gypsum.

Table 8.--Sample-description log - Continued

USGS Test Hole 2 - Continued

Project Gnome - Continued

Feet	Lithologic description
555-561	Siltstone, sandy, pale-reddish-brown (10 R 5/4), 50 to 60 percent; 20 percent clay; traces of selenite and gypsum.
561-566	Siltstone, pale-reddish-brown (10 R 5/4), 40 percent; laminated with vugs; interbedded with 40 percent pale-brown (5 YR 5/2) claystone, and 20 percent gypsum, selenite, and moderate-brown (5 YR 3/4) clay.
566-570	Anhydrite, moderate-orange-pink (5 YR 8/4), 60 percent; 20 percent white selenite, and 20 percent gypsum, calcite, and pale-reddish-brown (10 R 5/4) siltstone.
570-574	Anhydrite, moderate-orange-pink (5 YR 8/4); microcrystalline; selenite and siltstone caved from above.
574-577	Anhydrite, moderate-orange-pink (5 YR 8/4) to pale-red (10 R 6/2); microcrystalline; some gypsum and selenite; trace of gray clay and siltstone probably caved from above.
577-582	Anhydrite, pale-red (10 R 6/2) to white (N 9) microcrystalline; siltstone caved from above.
582-587	Anhydrite, white (N 9); microcrystalline; few fragments of clear salt and polyhalite; siltstone caved from above. Top of Salado formation at 586 feet.
587-608	Salt, clear, and polyhalite; siltstone caved from above.

Table 9.--Water measurements

USGS Test Hole 2

Project Gnome

Test 1

Hole depth: 211.75 feet

Formation: Top of Pierce Canyon redbeds

Date: August 31, 1960

Time	Depth to water (feet)	Remarks
4:42 am	210.95	Measuring point is top of 20-inch casing 1.52 feet above rig floor. Altitude 3,404.50 feet. Electric tape used for measurements. Hole was bailed out following drilling, then flushed with two bailers of water (75 gallons per bailer) and bailed until fluid was thin.
4:47	210.95	
4:52	210.95	
4:57	210.95	
5:02	210.95	
5:07	210.95	
5:12	210.89	Chunk of formation fell in hole.
5:19	210.89	
5:22	210.89	
5:27	210.89	
5:32	210.89	
5:37	210.89	
5:42	210.89	End of measurements. Measurements indicate no water entering hole. Measurements made by G. C. Doty.

Table 9.--Water measurements - Continued

USGS Test Hole 2 - Continued

Project Gnome - Continued

Test 2

Hole depth: 283 feet

Formation: Pierce Canyon redbeds

Date: September 2, 1960

Time	Depth to water (feet)	Remarks
7:46 am	281.38	Driller reports hole may be making water. Measuring point is top of rig floor. Altitude 3,403 feet. Electric tape used for measurements. Hole bailed out, then flushed with one bailer of water and bailed nearly dry.
7:51	281.32	
7:56	281.40	
8:01	281.40	
8:06	281.40	
8:11	281.40	
8:16	281.40	
8:21	281.40	
8:26	281.40	
8:31	281.40	
8:36	281.40	
8:41	281.40	
8:46	281.40	End of measurements. Measurements indicate no water entering hole. Measurements made by G. C. Doty and J. B. Cooper.

Table 9.--Water measurements - Continued

USGS Test Hole 2 - Continued

Project Gnome - Continued

Test 3

Hole depth: 310.6 feet

Formation: Top of Rustler formation

Date: September 2, 1960

Time	Depth to water (feet)	Remarks
1:52 pm	308.44	Hole is 1 foot below gravel bed at base of Pierce Canyon redbeds. Measuring point is top of rig floor. Altitude 3,403 feet. Electric tape used for measurements.
1:57	308.42	
2:02	308.35	
2:07	308.39	
2:12	308.38	
2:17	308.39	
2:22	208.39	
2:27	308.39	
2:32	308.39	
3:37	308.39	
2:42	308.39	
2:47	308.39	End of water measurements.
2:52		Measured hole depth as 310.60 feet with steel tape. Measurements indicate no water entering hole. Measurements made by J. B. Cooper.

Table 9.--Water measurements - Continued

USGS Test Hole 2 - Continued

Project Gnome - Continued

Test 4

Hole depth: 420.16 feet

Formation: Culebra dolomite member of Rustler formation

Date: September 4-5, 1960

Time	Depth to water (feet)	Remarks
Sept. 4		
11:47 pm	416.78	Measuring point is top of rig floor. Altitude 3,403 feet. Electric tape used for measurements.
11:52	416.70	
11:57	416.64	
Sept. 5		
12:02 am	416.64	
12:07	416.64	
12:12	416.54	
12:17	416.52	
12:22	416.47	
12:27	416.41	
12:32	416.40	
12:37	416.36	
12:42	416.36	
12:47	416.33	End of measurements. Rise of water level probably due to drilling water returning to hole from permeable zones in the Culebra dolomite member. Measurements made by G. C. Doty.

Table 9.--Water measurements - Continued

USGS Test Hole 2 - Continued

Project Gnome - Continued

Test 5

Hole depth: 505 feet

Formation: Lower member of Rustler formation

Date: September 5, 1960

Time	Depth to water (feet)	Remarks
5:37 pm	500.34	Driller reports depth as 505 feet. Measuring point is top of rig floor. Altitude 3,403 feet. Electric tape used for measurements.
5:42	499.49	
5:47	499.17	
5:52	498.55	
5:57	499.95	Formation caving, may be the cause of water-level rise.
6:02	497.51	
6:07	497.01	
6:12	496.50	
6:17	496.09	
6:22	495.58	
6:27	495.34	
6:32	495.01	
6:40		Hole depth measured with bailer as 502 feet.
6:50	497.90	

Table 9.--Water measurements - Continued

USGS Test Hole 2 - Continued

Project Gnome - Continued

Test 5 - Continued

Time	Depth to water (feet)	Remarks
6:55 pm	497.19	
7:00	496.85	
7:05	496.06	
7:10	495.53	
7:15	495.01	
7:20	494.61	
7:25	494.10	
7:30	493.87	
7:35	493.32	
7:40	492.98	
7:45	492.56	
7:50	492.04	End of measurements. Measurements indicate that water is definitely entering hole, but in insufficient quantities for a yield test. Hole depth measured with bailer as 500 feet. Measurements made by W. A. Mourant.

Table 9.--Water measurements - Continued

USGS Test Hole 2 - Continued

Project Gnome - Continued

Test 6

Hole depth: 593 feet

Formation: Top of Salado formation

Date: September 6, 1960

Time	Depth to water (feet)	Remarks
6:30 pm	585.92	Hole depth reported by driller as 593 feet at 6:00 pm. Weighted line measurement at 6:10 pm was 592 feet. Measuring point is top of rig floor. Altitude 3,403 feet. Electric tape used for measurements.
6:35	585.18	
6:40	584.61	
6:45	584.46	
6:50	584.12	
6:55	583.50	
7:00	583.21	
7:05	582.75	
7:10	582.40	
7:15	581.88	
7:20	581.52	
7:25	580.95	

Table 9.--Water measurements - Continued

USGS Test Hole 2 - Continued

Project Gnome - Continued

Test 6 - Continued

Time	Depth to water (feet)	Remarks
7:30 pm	580.40	End of measurements.
7:35		Weighted line measurement of hole depth is 591 feet. Weighted line measurements indicate that some water is entering hole. However, some of the rise is due to material caving into hole. Measurements made by W. A. Mourant.

Table 9.--Water measurements - Continued

USGS Test Hole 2 - Continued

Project Gnome - Continued

Test 7

Hole depth: 608 feet

Formation: Lower member of Rustler formation and Rustler and Salado formations undifferentiated

Date: September 9, 1960

Time	Depth to water (feet)	Remarks
7:22 am	600.00	Measurements made in completed, cased hole. Casing perforated 453 to 583 feet. Measuring point is top of casing 3 feet 4 inches above rig floor. Altitude 3,406.3 feet. Electric tape used for measurements. Hole was bailed dry prior to measurements.
7:27	598.60	
7:32	597.72	
7:37	596.58	
7:42	595.50	
7:47	594.40	
7:52	593.35	
7:57	592.25	
8:02	591.20	

Table 9.--Water measurements - Continued

USGS Test Hole 2 - Continued

Project Gnome - Continued

Test 7 - Continued

Time	Depth to water (feet)	Remarks
8:07 am	590.10	
8:12	588.97	
8:17	587.90	
8:22	586.80	
8:30	585.30	End of measurements. Measurements indicate that small quantities of water are entering hole. Measurements made by G. C. Doty and J. B. Cooper.

Table 9.--Water measurements - Continued

USGS Test Hole 2 - Continued

Project Gnome - Continued

Test 8

Development test to increase yield of water from permeable zones in Lower member of Rustler formation and Rustler and Salado formations undifferentiated by washing mud, clay, and silt from the walls of the hole and away from the water-bearing horizons. Hole is cased from 0 to 608 feet, total depth, with perforated pipe section from 453 to 583 feet. Prior to test, hole was bailed dry, then approximately 4,000 gallons of clear water were put in hole.

Date: September 9-10, 1960

Time	Depth to water (feet)	Remarks
Sept. 9		
9:50 am	440.00	Measuring point is top of casing 3 feet 4 inches above rig floor. Altitude 3,406.3 feet. Electric tape used for water-level measurements.
10:00		Started surging with bailer. Bailer lowered to bottom of hole then raised until out of water.
11:00		Stopped surging. Started to bail hole. Bailing from bottom.

Table 9.--Water measurements - Continued

USGS Test Hole 2 - Continued

Project Gnome - Continued

Test 8 - Continued

Time	Depth to water (feet)	Remarks
Sept. 9 - Continued		
12:00 pm		About 800 gallons removed. Stopped by rain.
12:30		Started to bail.
2:54	465.00	About 3,000 gallons removed.
6:05	534.00	About 4,800 gallons removed.
7:40		Hole bailed dry. About 5,700 gallons removed.
8:00		Start 18-hour recovery test.

Table 9.--Water measurements - Continued

USGS Test Hole 2 - Continued

Project Gnome - Continued

Test 8 - Continued

Water-level recovery measurements

Time	Depth to water (feet)	Time	Depth to water (feet)	Time	Depth to water (feet)
Sept. 9					
8:00 pm	605.55	9:40 pm	584.30	11:20 pm	576.98
8:05	604.58	9:45	583.52	11:25 pm	576.72
8:10	603.35	9:50	583.11	11:30	576.40
8:15	602.32	9:55	582.86	11:35	575.93
8:20	601.07	10:00	582.47	11:40	575.41
8:25	600:13	10:05	582.18	11:45	575.08
8:30	599.02	10:10	581.90	11:50	574.64
8:35	597.61	10:15	581.44	11:55	574.15
8:40	596.68	10:20	581.02	12:00	573.67
8:45	595.95	10:25	580.63	Sept. 10	
8:50	594.73	10:30	580.22	12:20 am	571.62
8:55	593.60	10:35	576.86	12:40	569.76
9:00	592.30	10:40	579.41	1:00	567.98
9:05	591.13	10:45	578.95	1:20	566.03
9:10	589.92	10:50	578.40	1:40	564.44
9:15	588.98	10:55	578.19	2:00	563.12
9:20	587.93	11:00	577.95	2:20	561.96
9:25	586.90	11:05	577.60	2:40	560.51
9:30	586.03	11:10	577.41	3:00	599.17

Table 9.--Water measurements - Continued

USGS Test Hole 2 - Continued

Project Gnome - Continued

Test 8 - Continued

Water-level recovery measurements

Time	Depth to water (feet)	Time	Depth to water (feet)	Remarks
Sept. 10 - Continued				
9:35 pm	585.09	11:15	577.20	
3:20 am	558.00	6:40 am	545.68	
3:40	556.70	7:00	545.22	
4:00	555.43	7:20	544.66	
4:20	554.03	7:40	544.33	
4:40	552.65	8:00	544.00	
5:00	551.58	9:00	542.60	
5:20	550.50	10:00	540.35	
5:40	549.35	11:00	538.05	
6:00	548.06	12.00	535.50	
6:20	546.15	1:00 pm	533.10	
		2:00	531.30	End of measurements. Measurements by By J. B. Cooper, G. C. Doty, and W. A. Mourant.

~~131a~~
102a

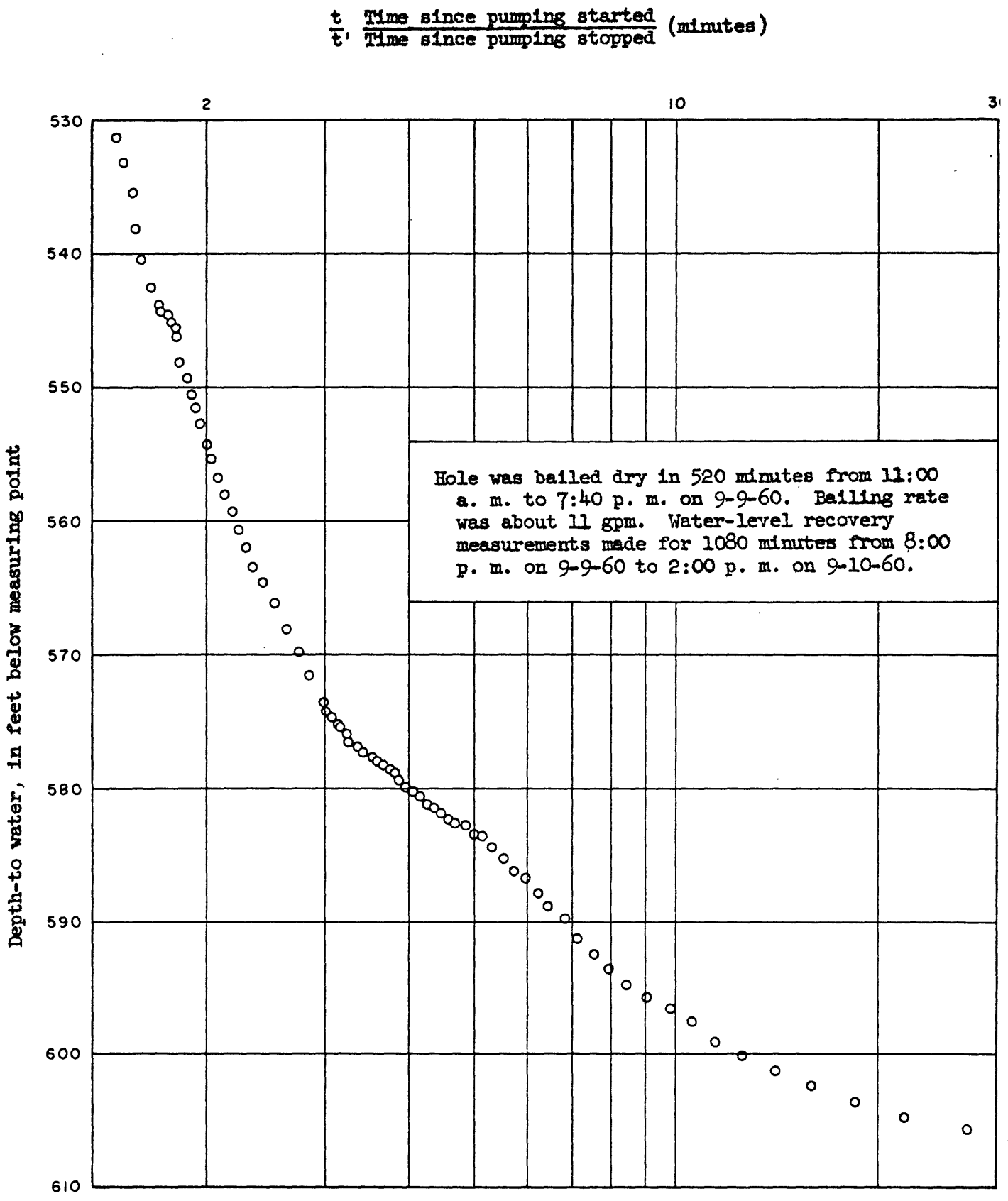

Figure 5.--Water level recovery plot, USGS test hole 2, Project Gnome

Table 10.--Drilling-time log

USGS Test Hole 2

Project Gnome

Hole interval From (feet)	To	Time Start	Stop	Minutes per foot	Remarks
			8-26-60		
0	3				Driller dug with spade. Spudded with 24-inch bit.
3	7	1:12 pm	1:25	3	Stop to reset rig and floor.
7	10	2:20	2:30	3	Stop to reset floor.
10	15	2:45	2:50	1	
12	16	3:00	3:05	5	Driller reports sand is caving.
16	20	3:12	3:28	4	
20	22	3:40	3:48	4	Sand caving.
22	25	4:05	4:16	4	
25	27	4:30	4:47	8	
27	28	5:11	5:25	14	Caving.
28	-	5:36	5:43	-	Caving. Rain.
-	30	6:10	6:19	8	Caving.
			8-27-60		
30	32	9:17 am	9:22	-	Hole caved and bailer would not go to 32 feet.
		2:30 pm			Hole filled with cave to 20± feet. Drilling stops--will run one joint of 20-inch casing.

Table 10.--Drilling-time log - Continued

USGS Test Hole 2 - Continued

Project Gnome - Continued

Hole interval From (feet)	To	Time Start	Stop	Minutes per foot	Remarks
			8-28-60		
30	35	4:18 pm	4:37	4	Hole cased to 36 feet.
35	36±	4:46	4:51	5	Drilling 19-inch hole.
36±	38	5:01	5:08	4	
38	39	5:13	5:17	4	Making about 1-foot runs.
39	40	5:23	5:34	9	
40	45	5:39	5:50	2	
45	46	5:59	6:03	4	
46	47	6:06	6:15	9	
47		6:19	6:31	-	
		6:45	6:55	-	Caving badly. Bailing often.
		7:17	7:22	-	Do.
	50	7:30	7:41	13	
50		7:46	7:59	-	Making about 2-foot runs.
	55	8:04	8:19	6	
55	58	8:27	8:46	6	
58	60	8:57	9:05	4	
60	62	9:14	9:23	4	
62	65	9:28	9:45	6	

Table 10.--Drilling-time log - Continued

USGS Test Hole 2 - Continued

Project Gnome - Continued

Hole interval From (feet)	To	Time Start	Stop	Minutes per foot	Remarks
			8-28-60 - Continued		
65	68	10:04	10:15	4	
68	72	10:19	10:38	5	
72	75	10:43	11:00	6	
			8-29-60		
75	80	12:50 pm	1:16	5	
80	82	1:30	1:59	15	
82	83	2:16	2:30	14	Blew plug out of engine.
83	85	3:07	3:51	20	Driller reports drilling like sandstone at 83 feet.
85	87	4:30	4:40	5	
87	90	4:54	5:18	8	
90	92	5:40	5:51	5	
92	95	6:08 am	6:32	8	
95	98	6:56	7:14	9	
98	100	7:35	7:55	10	
100	103	8:10	8:35	8	Driller reports change in formation.

Table 10.--Drilling-time log - Continued

USGS Test Hole 2 - Continued

Project Gnome - Continued

Hole interval From (feet)	To	Time Start	Stop	Minutes per foot	Remarks
			8-29-60 - Continued		
103	105	8:58 am	9:18	10	Water being put in hole with dump bailer. Bit caught on bottom of 20-inch casing coming out and sand dropped and bridged hole about 95-100 feet. Hole cleaned out to 105 feet. Got sample then hole filled 10± feet before bit on bottom. Tools stuck in hole--2:05 pm.
			8-30-60		
105	109	1:52 am	2:50	16	Drilling at 106 feet after setting casing to 97.3 feet.
109	114	3:07	4:00	11	Driller reports change of formation at 109 feet.
114	119	4:25 am	4:44	4	
119	124	5:02	5:20	4	
124	128	5:32	5:54	5	

Table 10.--Drilling-time log - Continued

USGS Test Hole 2 - Continued

Project Gnome - Continued

Hole interval From (feet)	To	Time Start	Stop	Minutes per foot	Remarks
			8-30-60 - Continued		
128	134	6:30 am	6:50	3	
134	140	7:15	7:32	3	
140	145	7:50	8:06	3	
145	150	8:32	8:48	3	
150	155	9:13	9:34	4	
155	160	9:56	10:19	5	Driller thinks formation change at 159± feet.
160	166	11:28	12:07 pm	6	Driller taped hole depth. Approximately 166 feet.
166	168	3:10 pm	3:18	4	Cleaning out hole.
168	170	3:33	3:39	3	
170	173	3:52	4:04	4	Driller thinks formation shange at 172 feet.
173	176	4:23	4:32	3	
176	180	4:55	5:15	5	
180	184½	5:30	5:40	2	Measured depth of hole
184½	187	6:10	6:30	10	Very thick-- had to use water to bail.

Table 10.--Drilling-time log - Continued

USGS Test Hole 2 - Continued

Project Gnome - Continued

Hole interval From (feet)	To	Time Start	Stop	Minutes per foot	Remarks
			8-30-60 - Continued		
187	190	7:05 pm	7:20	5	
190	192	7:30	7:38	4	
192	193	7:50	8:00	10	
193	196	8:10	8:30	7	Bit built up.
196	197	9:25	9:40	15	
197	197½	10:00	10:05	10	
197½	198	10:30	10:36	12	
198	200	10:50	11:05	8	
200	200½	11:25	11:40	30	
200½	202	11:55	12:15 am	13	
			8-31-60		
202	205	12:45 am	1:00	5	
205	208	1:15	1:35	7	
208	210½	2:55	3:35	16	Stop to measure water level (at 4:00) and sound hole 211.75 feet below drill floor.

Table 10.--Drilling-time log - Continued

USGS Test Hole 2 - Continued

Project Gnome - Continued

Hole interval From (feet)	To	Time Start	Stop	Minutes per foot	Remarks
			9-1-60		
212		10:50am	10:56	-	20-inch casing set to 209 feet 9 inches. Shut down to check clutch. Drilling 19-inch hole.
	216	11:00	11:36	10	
216	220	11:50	12:05 pm	4	
220	223	12:10 pm	12:22	4	
223	226	12:32	12:35	4	
226	230	12:52	1:06	4	
230	235	1:13	1:32	4	Bailer cable broke.
235	238	5:23	5:40	6	
238	241	5:46	5:55	6	
241	246	6:02	6:15	3	Rig-down--plate loose on mast.
			9-2-60		
246	251	1:50 am	2:22	6	
251	258	2:47	3:36	7	
258	263	3:50	4:26	7	
263	268	4:42	5:12	6	
268	273	5:29	6:06	7	
273	278	6:20	6:37	3	

Table 10.--Drilling-time log - Continued

USGS Test Hole 2 - Continued

Project Gnome - Continued

Hole interval From (feet)	To	Time Start	Stop	Minutes per foot	Remarks
			9-2-60 - Continued		
278	283	6:50 am	7:08	4	7:25 Driller reports hole possibly making water. Measured water level.
283	288	10:17	10:40	5	
288	293	10:57	11:20	5	Driller reports formation change approximately 289 feet.
293	298	11:40	12:00 m	4	
298	304	12:10 pm	12:25	3	
304	308	12:35	12:47	3	
308	311	1:10	1:25	5	Hole depth is 310.60 feet. Measured water level.
311	314	2:58	3:20	7	Top of Rustler formation 309½ feet.
314	319	3:34	4:35	12	
319	323	4:56	5:45	12	Will set 18-inch casing.
			6:00	-	Hole measured with steel tape at 323 feet to 18-inch casing set to 322 feet and 6 inches. Sounded hole depth to top of concrete ar 308.33 feet. Drilling plug--stop to put on jars.

Table 10.--Drilling-time log - Continued

USGS Test Hole 2 - Continued

Project Gnome - Continued

Hole interval From (feet)	To	Time Start	Stop	Minutes per foot	Remarks
			9-4-60		
322.4	330	6:05 am	8:05	15	Depth sounded 322.4 feet. Started at 5:42 am but stopped to resound--depth 322.3 feet. Drilling 17½-inch hole.
330	335	8:31	9:20	10	Sounded depth as 330 feet.
335	341	9:38 am	10:35	10	Driller reports softer drilling at 340 feet.
341	346	10:50	11:20	6	Driller reports harder drilling at 343 feet.
346	350	11:55	12:08 pm	3	Driller reports harder drilling at 349 feet.
350	355	12:18 pm	12:45	5	
355	360	12:53	1:17	5	
360	365	1:25	2:08	9	
365	371½	2:17	3:07	8	Driller reports softer drilling at 370 feet.
371½	375	3:20	3:41	6	3:45 pm Tool cable about cut in half; cable frayed.

Table 10.--Drilling-time log - Continued

USGS Test Hole 2 - Continued

Project Gnome - Continued

Hole interval From (feet)	To	Time Start	Stop	Minutes per foot	Remarks
			9-4-60 - Continued		
375	380	4:45 pm	5:15	6	
380	385	5:25	5:40	3	Measured depth and water observation.
385	390	6:15	6:40	5	
390	395	6:55	7:20	5	
395	400	7:27	7:50	5	
400	405	8:00	8:25	5	
405	410	8:38 pm	9:05	5	
410	415	9:15	9:42	5	
415	418	9:50	10:25	12	
418	420	10:35	11:12	18	Measured depth and water observation.
			9-5-60		
420	425	12:55 am	2:17	4	
425	430	2:25	2:58	7	
430	435	3:12	3:59	9	Driller reports last foot hard drilling.
435	440	4:20	4:53	7	
440	445	5:09	5:45	7	

Table 10.—Drilling-time log - Continued

USGS Test Hole 2 - Continued

Project Gnome - Continued

Hole interval From (feet)	To	Time Start	Stop	Minutes per minute	Remarks
			9-5-60 - Continued		
445	450	5:58 am	6:19	4	Driller reports softer drilling.
450	456	6:47	7:05	3	Tighten belt on rig before drilling again.
456	461	7:25	7:50	5	
461	467	8:06	8:28	4	
467	472	8:45	9:22	7	Driller reports harder drilling at 469 feet.
472	475	9:47	10:40	18	Hole caving.
475	479	11:05	11:28	6	
479	482	11:44 am	11:56	4	Shutdown to change crew and grease.
482	487	12:12 pm	12:31	4	
487	490	12:50	1:10	7	Hole caving.
490	493	1:27	1:58	10	Out of drill water.
493	497	3:37	4:05	7	
497	501	4:24	4:42	5	
501	505	4:56	5:14	5	Trouble with caving material. Bailing and redrilling.
505	507	8:22	8:46	12	Adjusting rig.
507	512	9:16	9:50	7	

Table 10.--Drilling-time log - Continued

USGS Test Hole 2 - Continued

Project Gnome - Continued

Hole interval From (feet)	To	Time Start	Stop	Minutes per minute	Remarks
			9-5-60 - Continued		
512	515	10:03 pm	10:28	8	
515	519	10:42	11:00	5	
519	523	11:16	11:34	5	
			9-6-60		
523	528	12:00 m	12:53 am	11	
528	532	1:22	1:57	9	
532	537	2:17	2:50	7	
537	539	3:13	4:30	-	Hole sounded 536.8± feet, 0.2 feet at 539 feet (driller's depth).
537	541	5:16	6:07	13	Put on 12-inch bit at 541 feet.
541	547	7:30	7:58	5	
547	552	8:27	8:53	5	
552	555	9:47	10:08	7	Driller reports he thinks water in hole. Hole caving.
555	561	10:35	10:51	3	Hole caving had to be redrilled about 3 feet. Driller now says no water in hole.
561	566	11:37	12:27 pm	10	
566	570	12:42 pm	1:16	8	

Table 10.--Drilling-time log - Continued

USGS Test Hole 2 - Continued

Project Gnome - Continued

Hole interval From (feet)	To	Time Start	Stop	Minutes per minute	Remarks
			9-6-60 - Continued		
570	574	1:30 pm	2:21	13	
574	577	2:36	2:45	3	Driller reports soft drilling at 575 feet.
577	582	3:00	3:41	8	
582	587	4:02	5:01	12	Top salt 586 feet.
587	593	5:16	5:55	8	
		5:55	7:50	-	Material caved in hole during water-level observation to 590½ feet.
593	601	8:00	8:48	6	
601	608	9:08	9:51	6	Total depth of hole. Hole measured 607 feet and 8 inches after casing and cleaning.

~~144a~~
115a

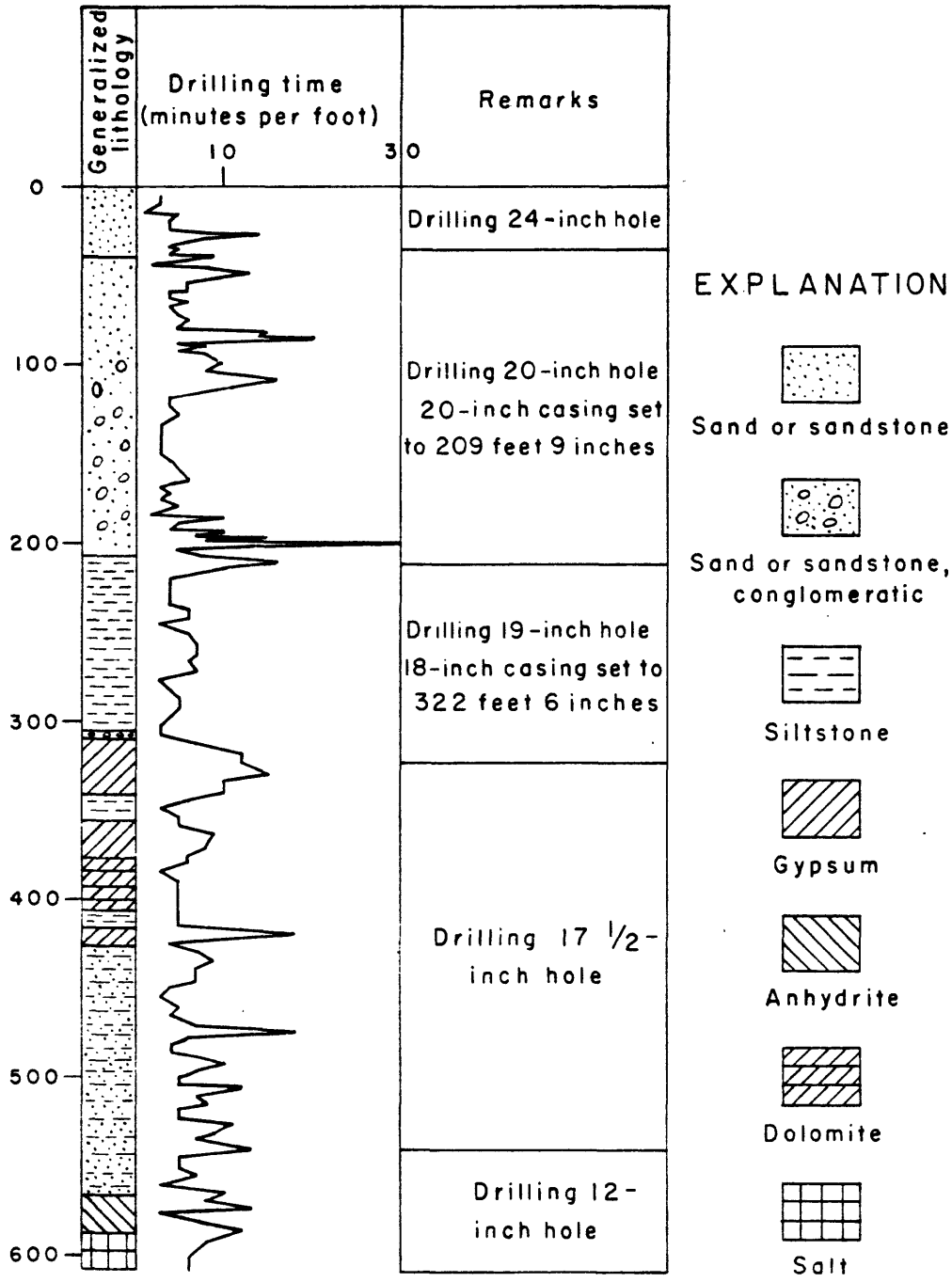

Figure 6.--Drilling time of formations penetrated in USGS test hole 2 Project Gnome

Table 11.--Water Analysis

USGS Test Hole 2

Project Gnome

(Analyses by U. S. Geological Survey)

Date collected: 9-10-60		Lab. No.: 3872	
Chemical components Parts per million (ppm)		Physical characteristics and computed values	
Silica (SiO_2)	4.5	Dissolved solids (ppm)	25,200
Aluminum (Al)	.9	Hardness as $CaCo_3$ (ppm)	
Iron (Fe)	.0	Total	4,720
Manganese (Mn)	.0	Non-carbonate	4,510
Calcium (Ca)	1,080	Specific conductance Micromhos at 25°C	34,800
Magnesium (Mg)	492	pH	7.3
Sodium (Na)	6,540	Color	3
Potassium (K)	14	Temperature (F°)	75
Bicarbonate (HCO_3)	258	Radiochemical data	
Carbonate (CO_3)	0		
Sulfate (SO_4)	3,047	Alpha activity[1] (pc/l) as of 12-2-60	350 ± 110
Chloride (Cl)	10,600	Beta activity (pc/l) as of 11-15-60	620 ± 90
Fluoride (F)	1.0	Radium (Ra) (pc/l)	20 ± 4
Nitrate (NO_3)	.0	Uranium (U)[2] (ug/l)	3.8 ± 0.4
Phosphate (PO_4)	.0	Extractable alpha activity (net) (pc/l)	6.0 ± 2.5
		Strontium 90 (pc/l)	< 6

1/ Picocuries (micromicrocuries) per liter
2/ Micrograms per liter