NVO-0655-04
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# COSO Geothermal Exploratory Hole No. 1

## CGEH No. 1 Completion Report

**March 1, 1978**



**CER Corporation**
**4220 Maryland Parkway**
**Las Vegas, Nevada 89109**

**Contract EY-76-C-08-0655**

**Prepared for**
**U.S. Department of Energy**
**Nevada Operations Office**

## DISCLAIMER

# ABSTRACT

Coso Geothermal Exploratory Hole No. 1 (CGEH No. 1) is the first deep exploratory hole drilled in the Coso Hot Springs area of Southeastern California. CGEH No. 1 was drilled to a depth of 4,845 ft in the central area of a large thermal anomaly and was a continuation of Government funded investigative work in that locale to determine the existence of a geothermal resource.

This report describes the drilling and completion of CGEH No. 1 and includes the daily drilling reports, drill bit records, descriptions of the casing, cementing, logging and coring program, and the containment equipment used during the drilling operation.

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# ABBREVIATIONS AND ACRONYMS

| | |
|---|---|
| BBL | barrel(s) |
| BOE | blow out equipment |
| BOP | blow out preventer |
| BPD | barrels per day |
| BPH | barrels per hour |
| CF | cubic feet |
| CFM | cubic feet per minute |
| CGEH No. 1 | Coso Geothermal Exploratory Hole No. 1 |
| DOE/NV | Department of Energy Nevada Operations Office |
| GL | ground level |
| NWC | China Lake Naval Weapons Center |
| RKB | Rotary Kelly Bushing |
| rpm | revolutions per minute |
| TD | total depth |
| vis | viscosity |
| W.O.B. | weight on bit |
| WOC | waiting on cement |

# 1. INTRODUCTION

This report describes the drilling of the first deep geothermal exploratory hole in the Coso Hot Springs area of Southeastern California. Figures 1-1, 1-2, and 1-3 show the site location. The Coso Geothermal Project was a continuation of Government funded investigative work in that locale to determine the existence of a geothermal resource.

The drill site is located in a large thermally anomalous region (Figure 1-4) the center of which is on the China Lake Naval Weapons Center (NWC). The location of the Coso Geothermal Exploratory Hole No. 1 (CGEH No. 1) is 157 ft northwest of the abandoned Battelle Deep Slim Hole No. 1, drilled to a depth of 1,350 ft. The CGEH No. 1 drilling operations commenced on September 2, and were completed at a total depth of 4,845 ft on December 3, 1977 with production testing planned for early 1978.

The Department of Energy (DOE), under license from and in cooperation with the Naval Weapons Center, China Lake, was responsible for project direction, management and execution of the Coso Geothermal Project. The drilling and completion work was performed by CER Corporation, 4220 S. Maryland Parkway, Las Vegas, Nevada 89109, under contract EY-76-C-08-0655, Modification No. 005 with the Department of Energy.

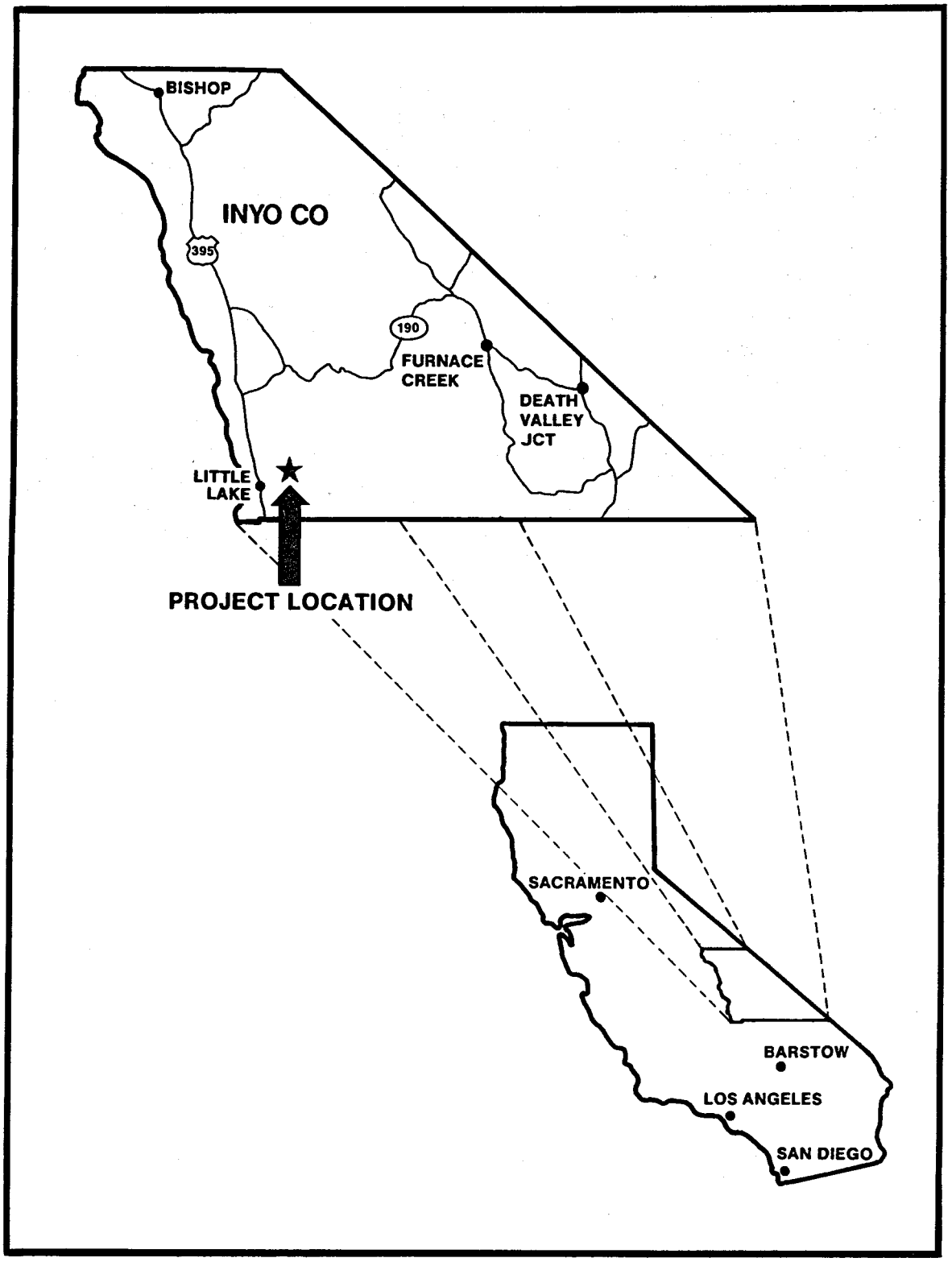


**FIGURE 1-1 SITE LOCATION**

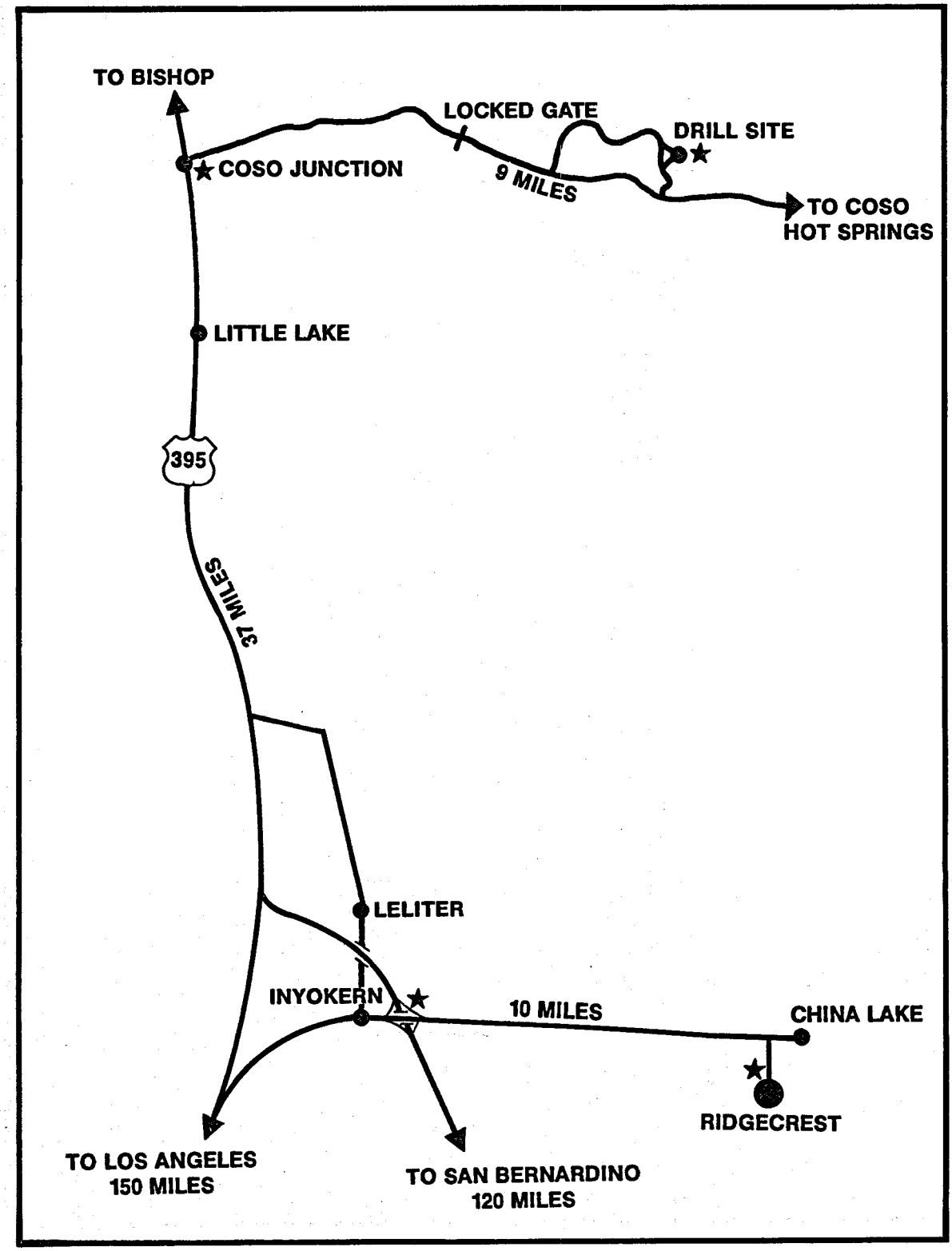


**FIGURE 1-2 SITE LOCATION**

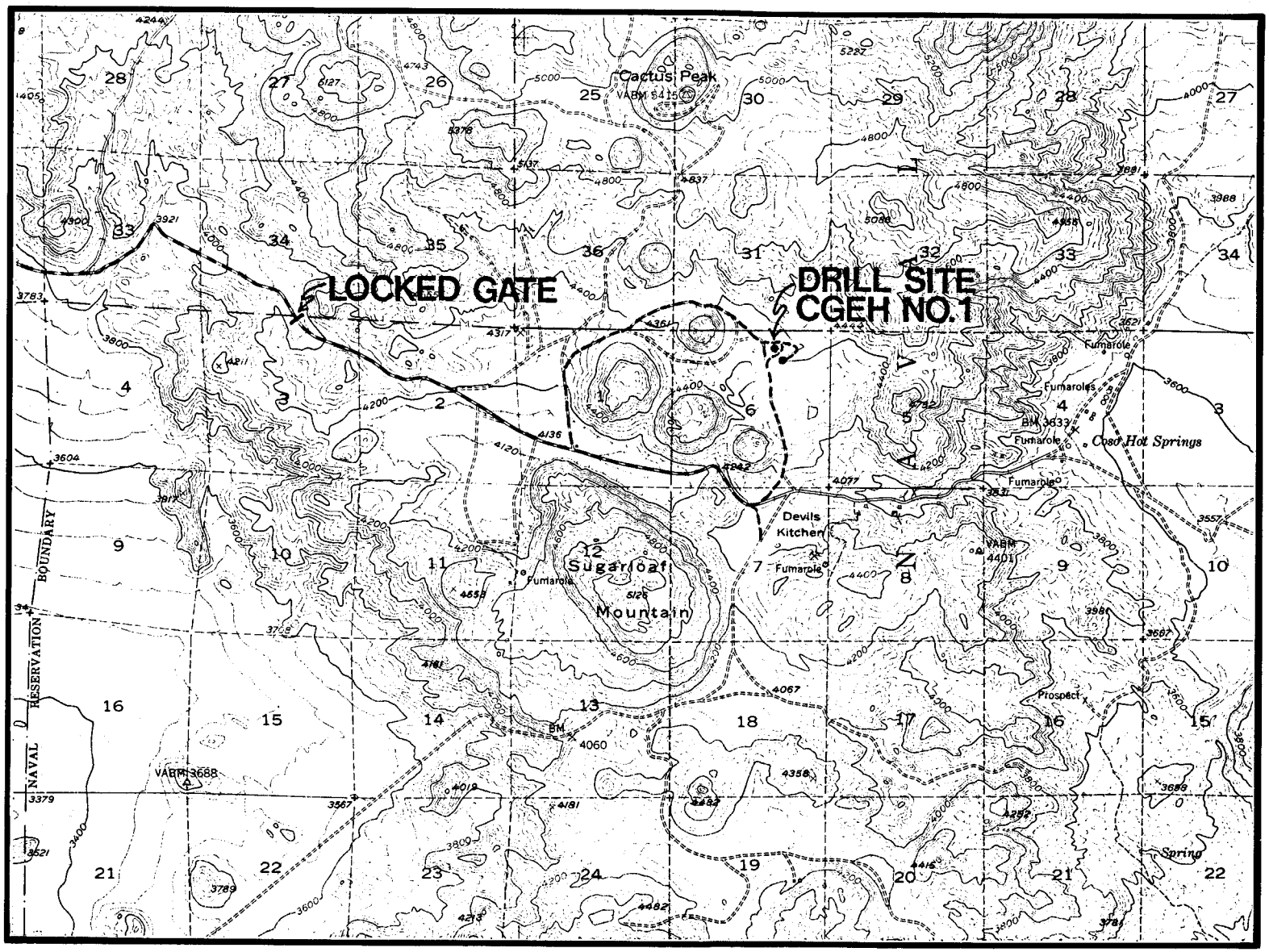


**FIGURE 1-3 SITE LOCATION**

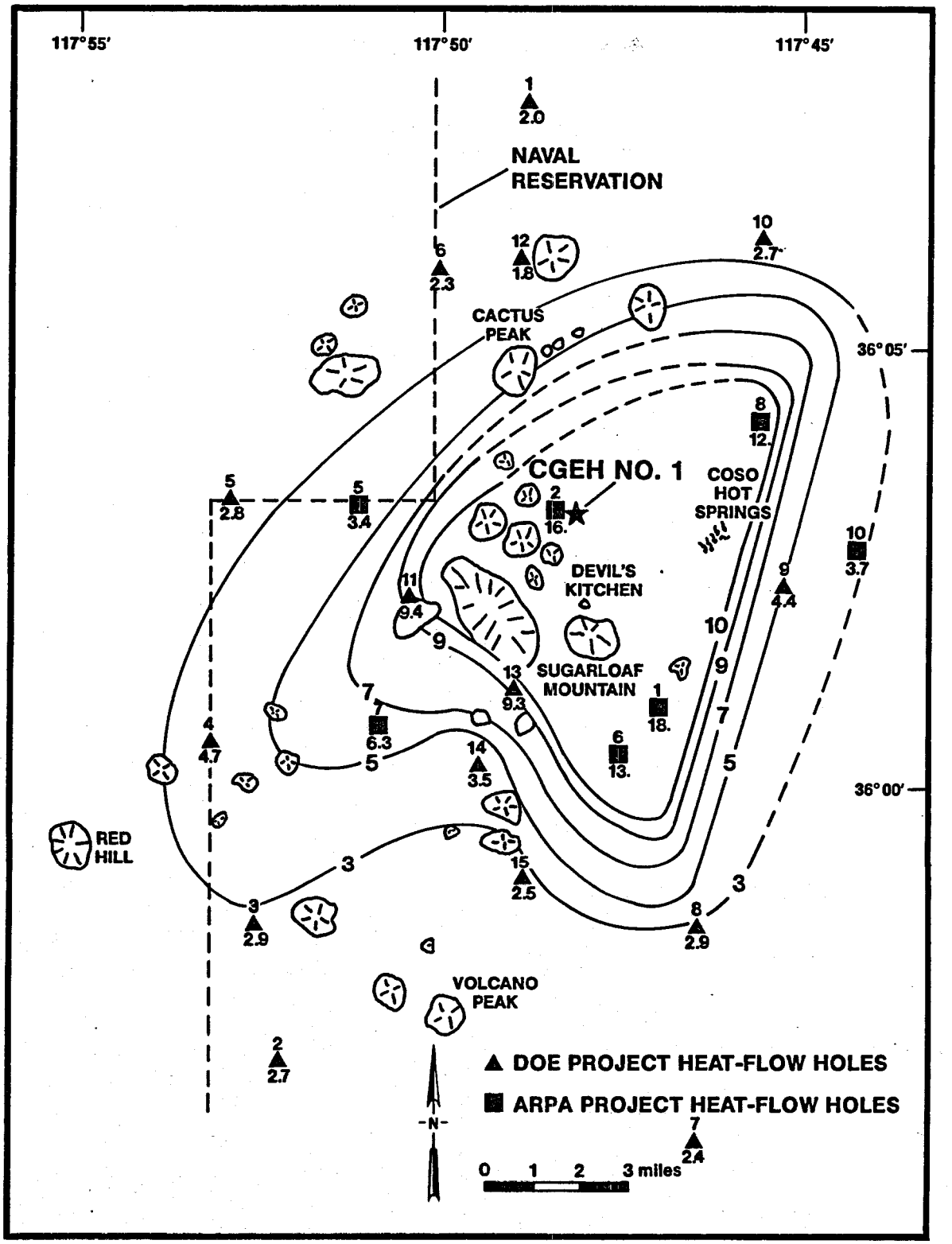


**FIGURE 1-4 GENERALIZED MAP OF THERMAL ANOMALOUS REGION AND CGEH NO. 1 WELL LOCATION**

# 2. EXPLORATORY HOLE DRILLING

## 2.1 Drilling Summary

NWC prepared the drill site by grading and leveling a drill pad of about 300 ft x 300 ft, grading adjoining storage surfaces, excavating fluid reserve pits, and grading the access road. Water for the majority of the drilling operation was obtained by NWC from a private irrigation well in Indian Springs Valley, west of the NWC and hauled approximately ten miles to the drill site. During the latter stages of drilling, water was obtained from the Los Angeles aqueduct at a point approximately ten miles from the drill site.

On August 16, 1977, a dry hole digger was used to drill a 26 in. diameter hole about 35 ft below ground level (GL) to granitic rock. Twenty-inch diameter conductor pipe was set at 35 ft and cemented with 6 cu yd of concrete. An 8 ft x 8 ft x 3 ft deep cement-lined cellar was then constructed around the conductor pipe.

Drilling operations commenced on September 2, 1977. A 12-1/4 in. diameter hole was drilled to a depth of 604 ft Rotary Kelly Bushing (RKB*) and reamed to 17-1/2 in. diameter to a depth of 601 ft. The drilling and reaming of this top interval required 17 days due mainly to slow penetration through highly fractured and very hard granitic formation. Because of the fractured formation and the shallow depth, not more, and frequently less than 25,000 lb of weight could be carried on the bit. Excessive vibration throughout this interval required control measures such as reduced rotary speed and bit weight to prevent damage to the rig. There was also a minor fishing operation to recover twisted off drill pipe and some lost circulation problems because of the fractured rock. Thirteen and three-eights inch surface casing was run and cemented at 601 ft with good cement returns to the surface.

A 12-1/4 in. diameter hole was drilled with mud to 1,368 ft in four days, and 9-5/8 in. casing was run and cemented to the same depth with good cement returns to the surface. Though lost circulation problems continued through this interval, less extensive severe fracturing permitted the use of higher bit weights and insert bits.

For faster penetration and to eliminate masking any possible steam entry after setting the 9-5/8 in. casing , it was planned to air drill to total

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*Unless otherwise noted, all depths in this report are referenced to the Rotary Kelly Bushing (RKB) which is 21.6 ft above ground level.

depth, or to a depth where significant steam or high temperature water was encountered. The well was to be completed for testing without additional casing. The proposed total depth was 4,000 ft with an option to drill to 6,000 ft.

After setting 9-5/8 in. casing at 1,368 ft, an 8-3/4 in. hole was drilled to 1,681 ft with air. An interval of unconsolidated, fractured rock and clay was drilled and a severe washout was created from 1,535 ft to 1,555 ft. A 20 BPH water influx made the washout problem even more severe. Foaming agents added to the air failed to stabilize the hole or to correct the drilling problems. Consequently, a change from air-foam to mud as a circulating fluid was made. The hole was conditioned, stabilized and drilled to 1,702 ft. A caliper log was run to determine the location and size of the washed out zone. The log showed hole enlargement from 1,500 ft to 1,574 ft with the zone from 1,535 ft to 1,555 ft washed out to a diameter of more than 32 in. In an attempt to seal off the zone so that air drilling could be resumed, a cement plug was placed across the entire problem interval and extended approximately 200 ft into the 9-5/8 in. casing.

After drilling out the cement plug and obtaining a core at 1,702 - 1,707 ft, air drilling was again attempted. However, after drilling from 1,707 ft to a depth of 1,914 ft, a change from air to mud was again required due to failure of the cement plug and continued hole sloughing problems. Water influx gradually increased to 90 BPH through this interval. During air drilling operations between 1,368 and 1,914 ft, the drilling rate of penetration averaged 20 ft per hour except for the gouge zones which drilled at significantly higher penetration rates. However, because of the hole sloughing problems, this interval required seven days to drill.

After discontinuing attempts to drill with air due to the severe hole problems, the plan was modified to drill ahead with clay-base fluid to below the gouge zones, or until there was an indication of a silicified cap zone or other evidence of a possible geothermal reservoir. At that time, 7 in. casing would be set and drilling with air would be resumed.

An 8-3/4 in. hole was mud drilled from 1,914 - 2,882 ft in 9-1/2 days. Persistent lost circulation conditions were encountered while drilling this interval with severe mud loss occurring at 2,040 - 2,130 ft, 2,165 - 2,220 ft and 2,745 - 2,800 ft. Geologic analyses of cuttings and cores indicated virtually continuous highly permeable, near vertical fractures from 2,000 ft to about 2,800 ft. Lost circulation caused by these fractures, along with the need to control hole angle build-up, slowed the drilling rate. A cement plug was placed from 2,495 - 2,822 ft in an attempt to correct severe lost circulation. The hole was then drilled from 2,822 - 4,845 ft in 16 days with two additional days required for geophysical logging at 4,043 ft. Approximately 350 BPD of mud were lost while drilling this interval with a severe loss of approximately 1,400 BBL occuring in a 19 ft interval between 4,826 - 4,845 ft.

At this time, a decision was made to set 7 in. casing at 3,500 ft. A 100 ft sand plug was placed from TD to approximately 4,750 ft and a cement plug placed above that to temporarily seal the lost circulation zone, 4,826 - 4,845 ft.

Another cement plug was then set from 3,405 - 3,606 ft to serve as a casing seat for cementing the 7 in. casing. In order to insure that the casing would be cemented back to the surface, several cement plugs were run in an attempt to seal off the lost circulation zones above 3,400 ft. From November 6 to November 19, 18 cement plugs were placed essentially covering the entire interval between 1,368 and 3,400 ft. The plugs were drilled out and the hole was pressure tested to the equivalent cement column gradient. On November 11, the pipe became stuck at 3,500 ft while making a pressure gradient test. The subsequent fishing operation required 3-1/2 days before the pipe was successfully freed by spotting diesel fuel with "Pipe Release."

To determine additional loss zones, radioactive tracer surveys were run between the 9-5/8 in. casing shoe and 2,850 ft on November 18 and 19. The surveys were terminated when the wire line and tool were differentially stuck at approximately 2,822 ft. The tool was stripped over and recovered in 10 hrs on November 19.

On November 22, the 7 in. casing was run and cemented from 3,507 ft to the surface with cement returns to the surface. After cementing the 7 in. casing, the casing shoe and cement plug to 3,550 ft were drilled out with mud. The hole was then blown dry and air was used to drill out the rest of the cement plug and to clean out the hole to 4,734 ft with a 6-1/8 in. bit. Three days were spent trying to clean out from 4,734 ft to TD with air. The drill string became stuck several times and the well was making about 130 BPH of 170°F water. Static fluid level at this time was approximately 1,000 ft from the surface. Continued production of large volumes of water containing clay and rock fragments, required a conversion to aerated water. The hole was then cleaned out to 4,845 ft, finding 20 to 30 ft of fill on short trips. The hole continued making 120 to 150 BPH of water. At this point, the decision was made to cease drilling operations and test the well prior to moving the rig off the hole. During a 1-1/2 hr test using air, the well produced 187° water at the rate of 185 BPH.

The BOP stack was removed and a 7 in. x 9-5/8 in. WKM geothermal expansion spool and two 8 in. WKM steam valves were installed. On December 3, 1977 the drilling rig was released.

A summary of the Daily Drilling Reports is presented as Appendix A. Figure 2-1 depicts the drilling and operations summary and Figure 2-2 is a schematic of the down hole configuration of CGEH No. 1.

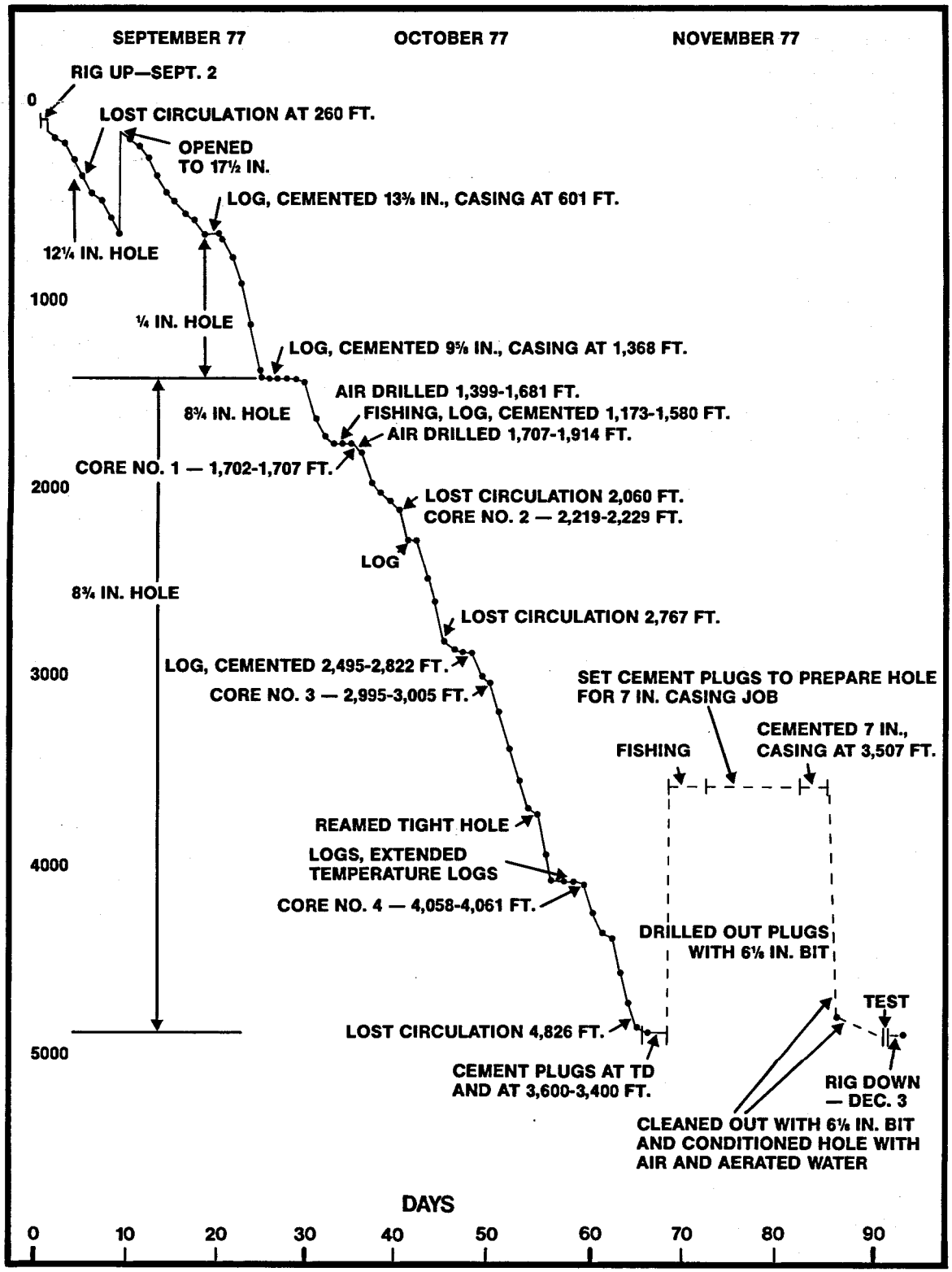


**FIGURE 2-1 DRILLING AND OPERATIONAL TIME VERSUS DEPTH**

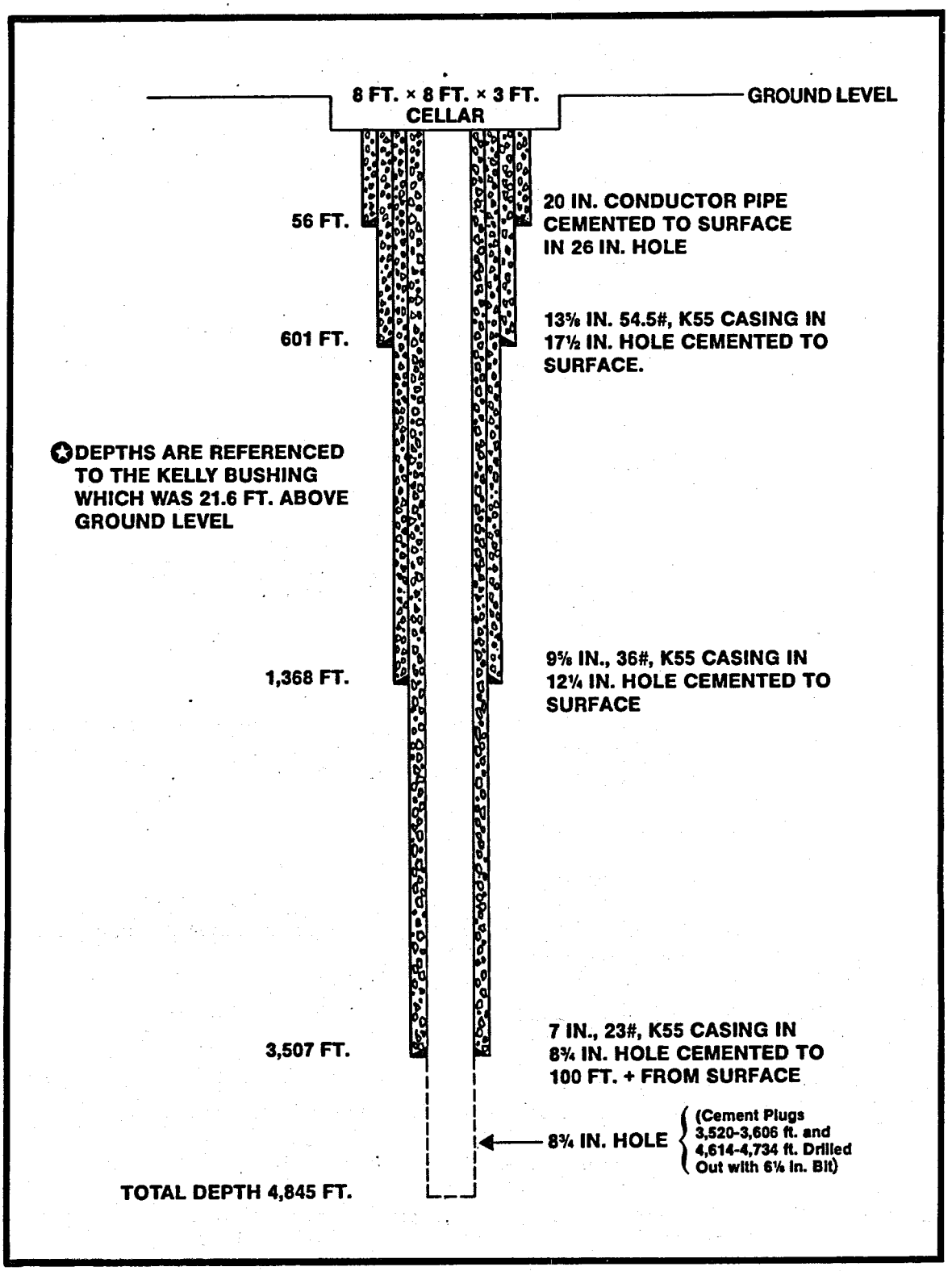


**FIGURE 2-2 CURRENT SUBSURFACE STATUS**

## 2.2 Surface Equipment and Services

### 2.2.1 Drilling Rig

The rig used was Big "O" Drilling, Incorporated Rig No. 2. This rig was equipped with a National 75CA double drum drawworks, two GM 6-71N diesel engines (total 800 hp), a 127 ft Late Style Bender mast (450,000 lb gross nominal capacity); 18-1/2 ft high substructure, and Ideco MM600 (7-3/4 x 16) 600 hp and National C-250 (7-1/4 x 15) 400 hp pumps.

### 2.2.2 Containment Equipment—17½ in. Hole

Containment equipment was not required for drilling of the 17-1/2 in. hole from the bottom of the 20 in. conductor to the 13-3/8 in. setting depth of 601 ft.

### 2.2.3 Containment Equipment—12¼ in. Hole

Containment equipment used for drilling the 12-1/4 in. hole from the bottom of the 13-3/8 in. casing at 601 ft to the 9-5/8 in. casing setting depth of 1,368 ft was a 12 in. series 900 GK Hydril on a 12 in. Series 900 Shaffer double hydraulic gate with blind and pipe rams.

### 2.2.4 Containment Equipment—8¾ in. Hole

Containment equipment used for the drilling of the 8-3/4 in. hole from the 9-5/8 in. casing shoe at 1,368 ft to TD of 4,845 ft was as follows (listed in order of position above the casing head):

WKM 10 in. steam gate valve

Crossover spacer spool

Shaffer 10 in. double hydraulic gate with complete shut off (blind) and pipe rams

Spacer Spool

Shafco 10 in. banjo box

Shaffer 10 in. single hydraulic gate with blind rams

Grant 10 in. high temperature rotating head

Figure 2-3 depicts the containment equipment installed.

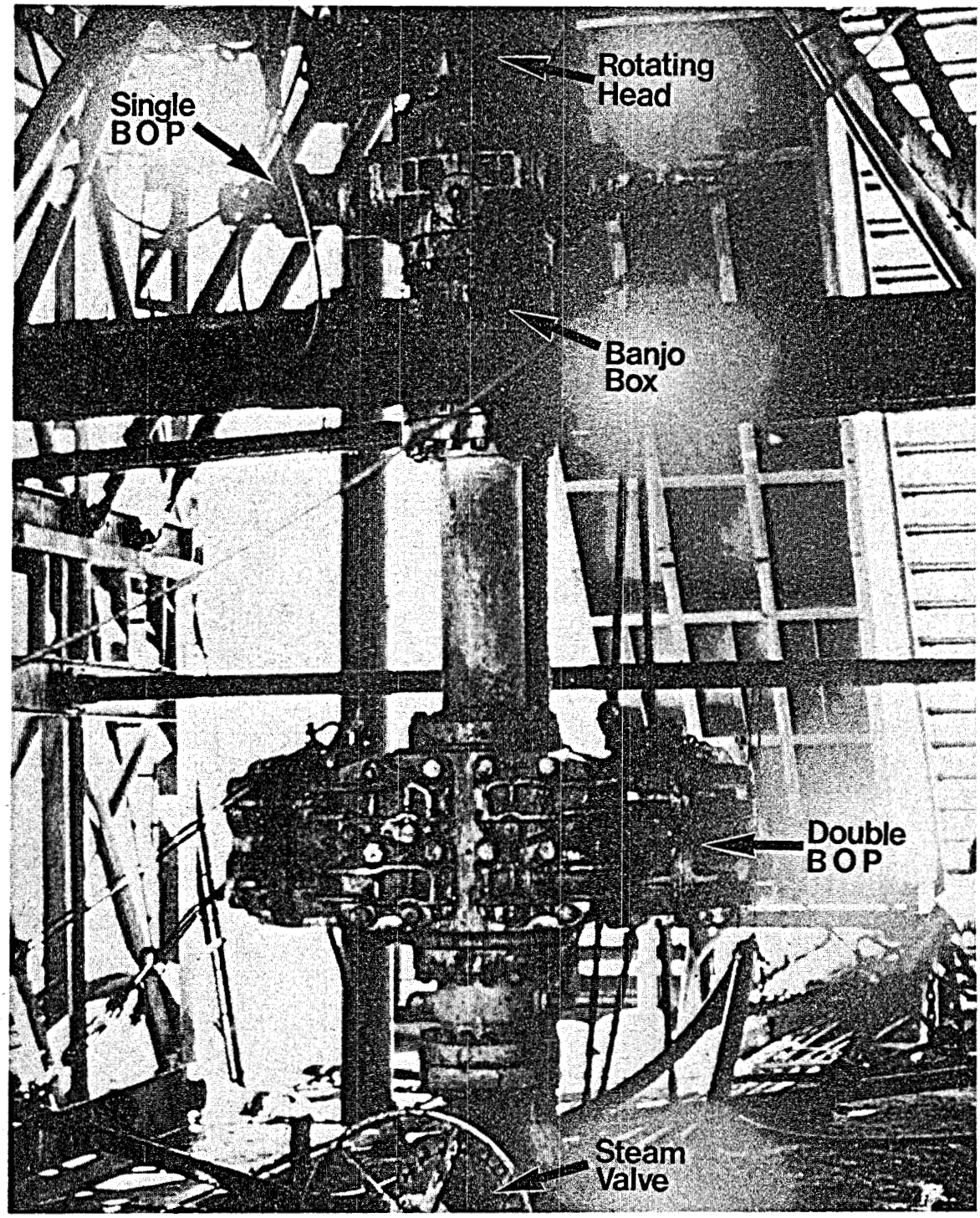


**FIGURE 2-3 PICTURE OF THE BOE STACK DURING THE DRILLING OF THE 8¾ IN. HOLE**

### 2.2.5 Flow Line Equipment—Air Drilling

A 10 in. blooie line extended from the Shafco banjo box to the Dresser combination tangential separator and muffler. The blooie line was equipped with a flange for orifice plate insertion to measure any steam flow. Figure 2-4, 2-5 and 2-6 depict the flow line equipment.

### 2.2.6 Wellhead

The wellhead (Figure 2-7) consists of two 8 in. WKM Series 600 ANSI Pow-R-Seal gate valves on top of a 10 in. 2,000 psi x 8 in. 2,000 psi expansion spool equipped with two 3 in. 2,000 psi WKM Pow-R-Seal gate valves. There are also two 3 in. 1,400 psi annulus vent valves on the 9-5/8 in. casing head. The top flange of the upper 8 in. steam gate valve is 8 ft above ground level.

### 2.2.7 Instrument Equipment

An alarm-type hydrogen sulfide ($H_2S$) monitor system was installed after the 13-3/8 in. casing was set. The readout panel (Figure 2-8) was installed in the crew change trailer and the three detection sensors (Figure 2-9) were placed near the rig cellar and at the mud and air return lines.

A two-pen drilling recorder was used to record penetration rate and the amount of weight on the drill bit. This was continually operational below 3,500 ft only.

Mud pit fluid levels were recorded by a device that included a high-low mud pit level audio warning. Circulating drilling fluid temperatures were also monitored.

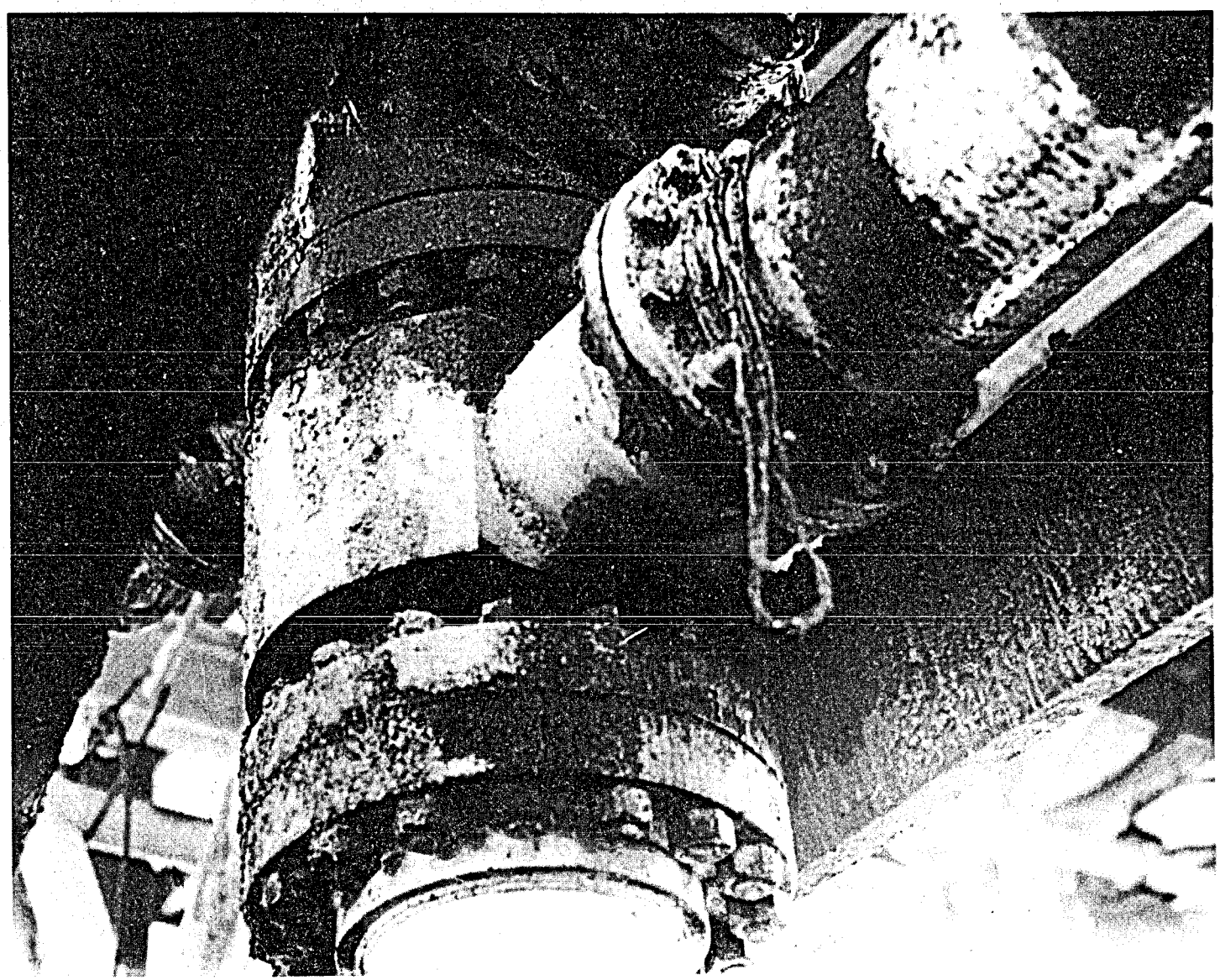

**FIGURE 2-4 BLOOIE LINE CONNECTION AT THE BANJO BOX**

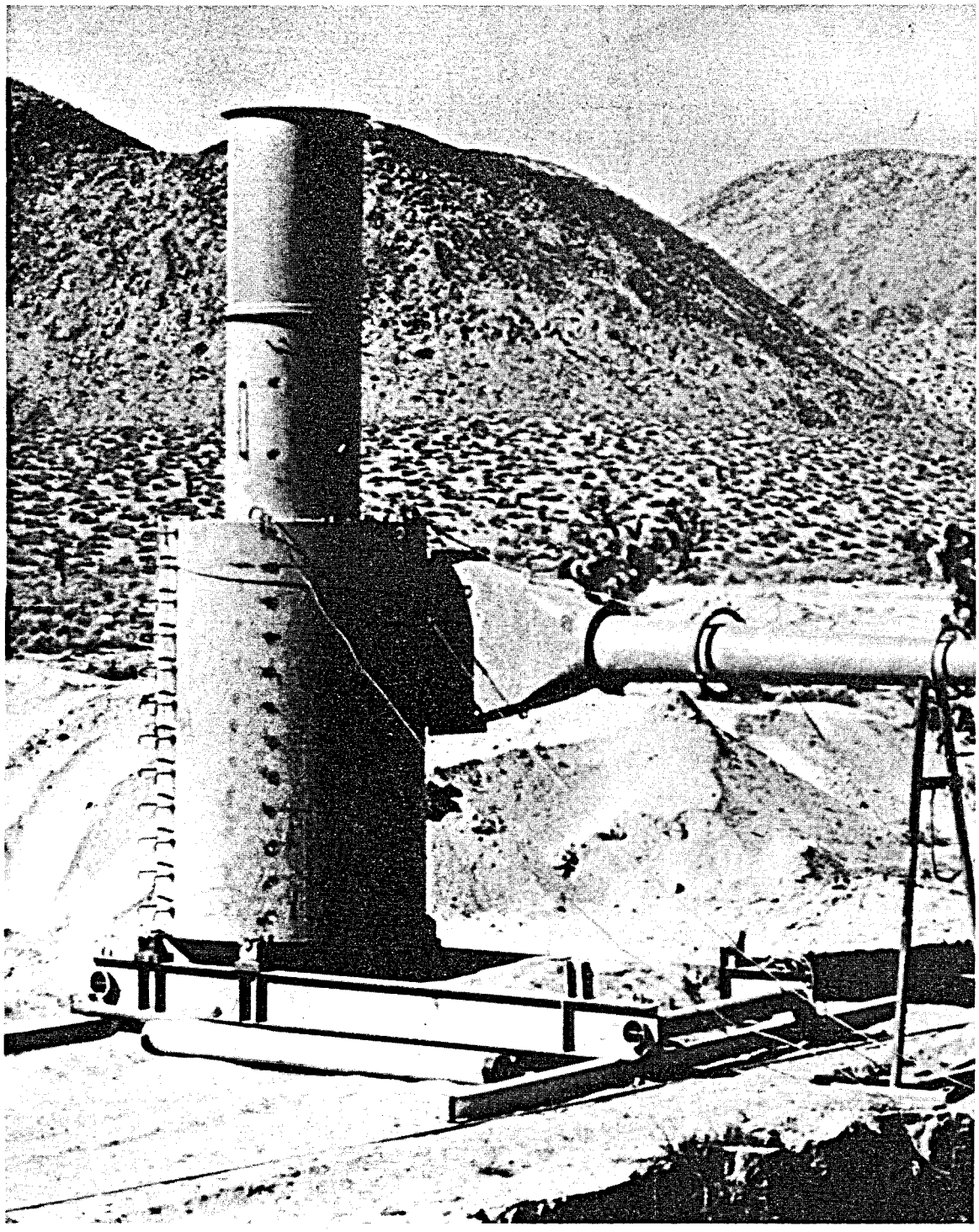

**FIGURE 2-5 DRESSER COMBINATION TANGENTIAL SEPARATOR AND MUFFLER**

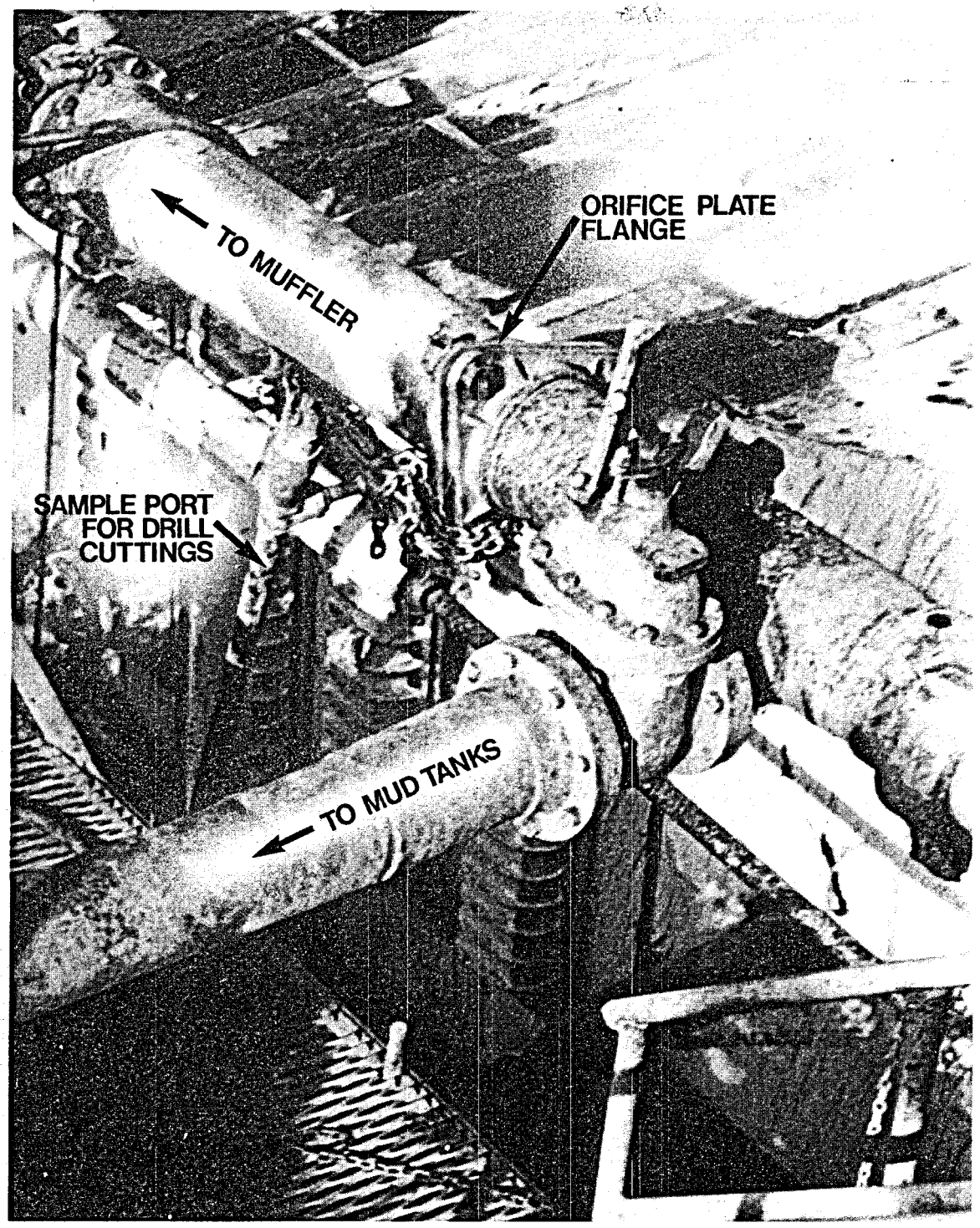


**FIGURE 2-6 MUD TEE**

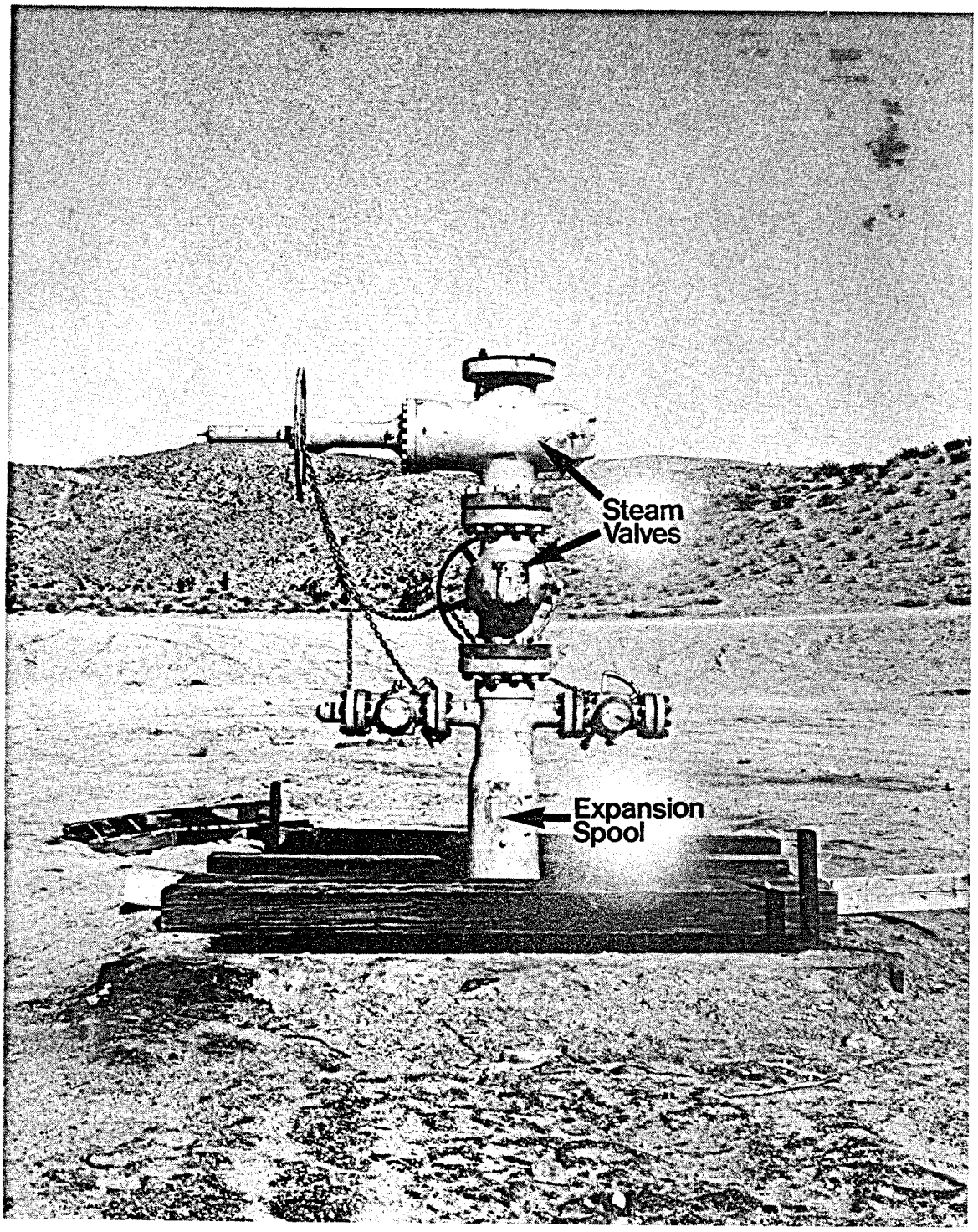


**FIGURE 2-7 WELLHEAD AT COMPLETION OF DRILLING**

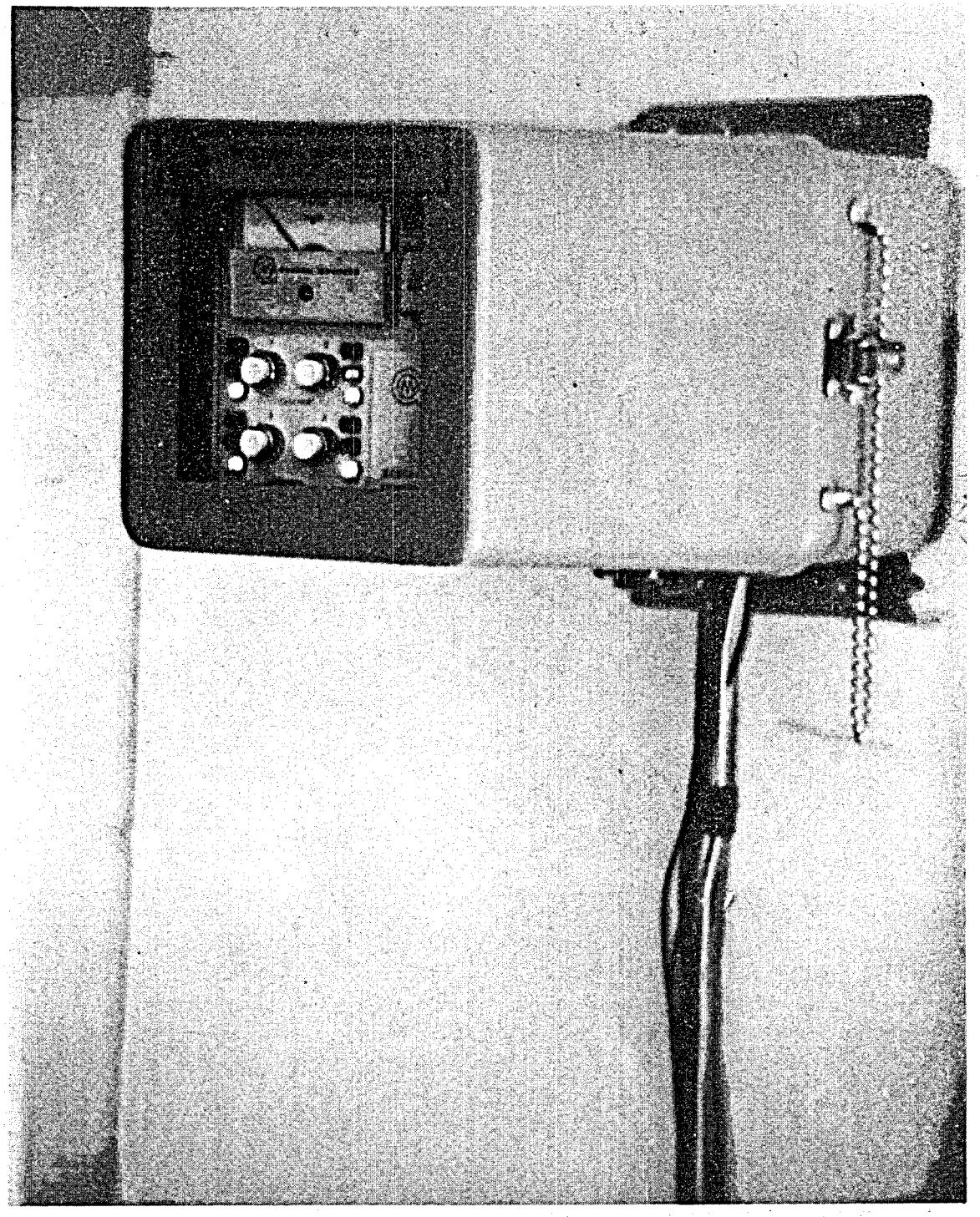

**FIGURE 2-8 $H_2S$ READOUT PANEL IN CREW CHANGE TRAILER**

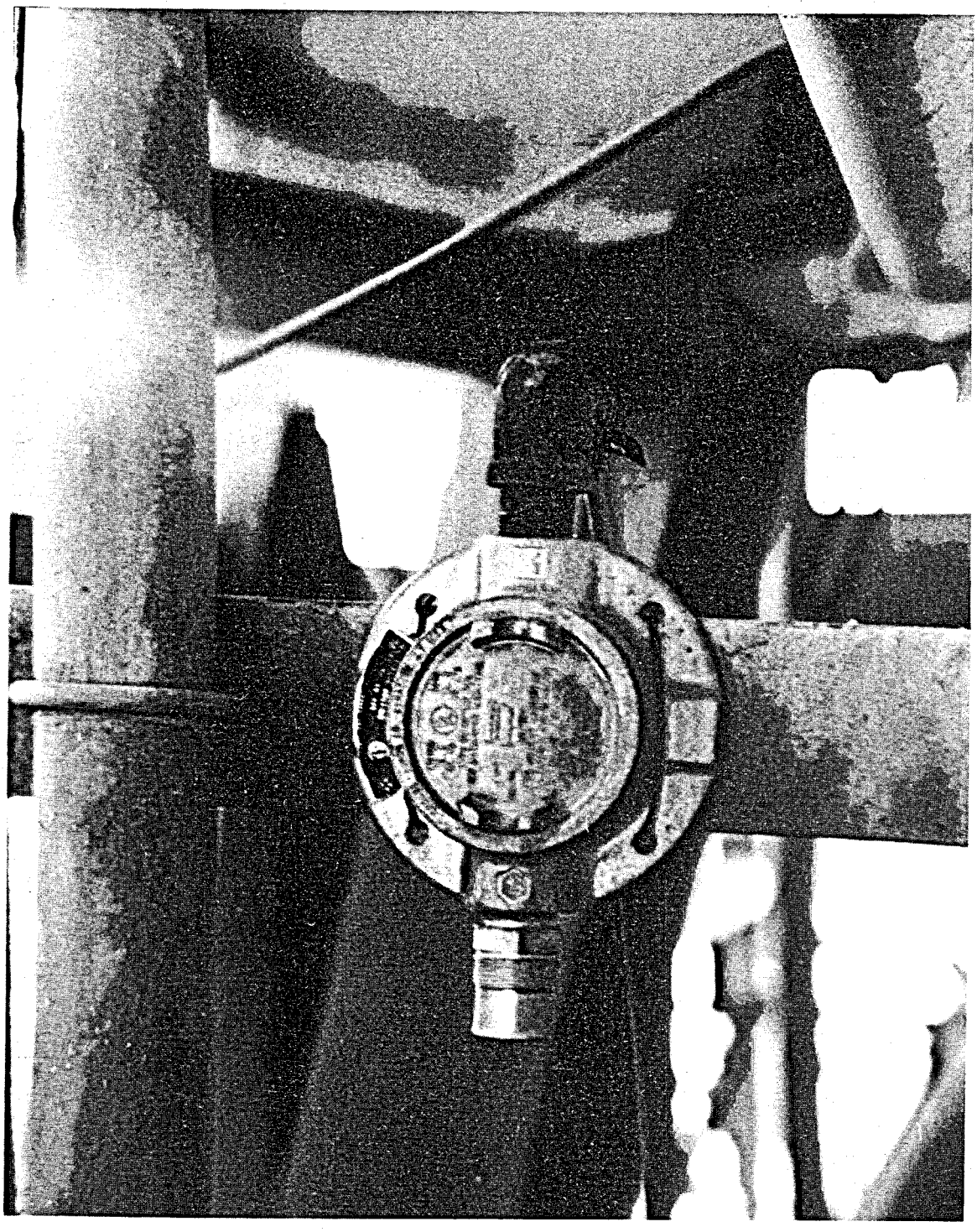

**FIGURE 2-9 $H_2S$ SENSOR**

# 3. DOWNHOLE EQUIPMENT AND SERVICES

## 3.1 Surface Casing

Fourteen joints (608 ft) of 13-3/8 in., 54.5 lb/ft, K-55, Buttress thread casing was cemented at 601 ft. The casing was equipped with a Dowell cement guide shoe, Dowell baffle plate on top of the bottom joint (41 ft) and seven centralizers placed one each at the middle of the bottom two joints and then, one at every other collar.

## 3.2 Intermediate Casing

Thrity-two joints (1,374 ft) of 9-5/8 in., 36 lb/ft, K-55, Buttress thread casing was cemented at 1,368 ft. The casing was equipped with a Baker cement guide shoe, Dowell self-fill insert with flapper on top of the bottom joint (42 ft), ten centralizers, one placed at the middle of the bottom two joints and then one at every other collar to 725 ft, and at 400 ft. Four scratchers were placed on each of the bottom two joints.

## 3.3 Production Casing

Eighty-four joints (3,510 ft) of 7 in., 23 lb/ft, K-55, Buttress thread casing was cemented at 3,507 ft. The casing was equipped with a Halliburton cement guide shoe, Halliburton self-fill insert with flapper on top of the shoe joint (42 ft) and fifteen centralizers placed one each at the middle of the bottom two joints and then, one on every other collar to 2,380 ft.

## 3.4 Directional Control

A Kuster single-shot magnetic survey tool was used to monitor and control hole deviation throughout the drilling operation. Surveys of the hole deviation were taken approximately every 100 ft. A summary has been tabulated in Appendix B. Also in Appendix B is a plan view plot of the directional survey.

## 3.5 Maximum Recording Thermometer

Two maximum recording thermometers were run in a Kuster wire line housing approximately every 100 ft. These temperature data were greatly influenced by different mud-water make-up rates necessitated by almost constant lost circulation conditions. The thermometers were run in conjunction with the directional single-shot film disc and the necessary short time period on bottom for film resulted in temperatures which were not consistent. Temperatures measured are included in the Daily Drilling Reports as Appendix A.

## 3.6 Samples

Triplicate drill cutting samples were obtained approximately every 10 ft by University of Utah geologists. Two samples were sent to the University of Utah and one to the NWC. A detailed geologic report for the well has been prepared under separate cover by the Earth Science Laboratory of the University of Utah.

## 3.7 Coring

Conventional diamond bit coring techniques were used and four cores were cut when directed by the Uinversity of Utah geologists. The cores were cut at the following points:

| Core No. | Zone Cut | Drilling Fluid | Core Bit Size & Type | Amount Cored | Core Recovered |
|---|---|---|---|---|---|
| 1 | 1,702-1,707 | Clay Base | 8-1/2", MC-23 | 5 ft | 3.3 ft |
| 2 | 2,219-2,229 | Clay Base | 7-7/8", MC-23 | 10 ft | 10.0 ft |
| 3 | 2,995-3,005 | Clay Base | 7-7/8", MC-23 | 10 ft | 10.0 ft |
| 4 | 4,058-4,061 | Clay Base | 7-7/8", MC-23 | 3 ft | 3.0 ft |

Cores were sent to the Earth Science Laboratory at the University of Utah.

## 3.8 Drill Bit Summary

The initial 26-in. conductor hole was drilled to 56 ft RKB (35 ft below ground level) with a rat hole digger.

The 12-1/4 in. pilot hole for the 13-3/8 in. casing was drilled from 56 ft to 604 ft (548 ft) in 153 rotating hours with seven milltooth bits. This hole was opened to 17-1/2 in. in 194-3/4 rotating hours with five hole openers.

The 12-1/4 in. hole for the 9-5/8 in. casing was drilled from 604 ft to 1,368 ft (764 ft) in 89-1/2 rotating hours with one milltooth and one insert bit.

The 8-3/4 in. hole from 1,368 ft to 4,845 ft (3,449 ft drilled and 28 ft cored) was drilled in 448-1/2 rotating hours with nine insert and seven milltooth bits.

Three 6-1/8 in. bits were used during hole cleaning operations after the 7 in. casing had been set.

The complete bit record is presented as Appendix C.

## 3.9 Drilling Fluid Summary

A fresh water-base gel mud was used to drill the entire hole except for two intervals (1,339 - 1,681 ft and 1,707 - 1,914 ft) which were drilled with air. Aerated water was used for hole cleaning operations after the 7 in. casing was run.

The mud used was a lightweight (approximately 8.7 to 9.1 ppg), low solids fluid. Sepiolite clay for high temperature stability, was used to replace part of the bentonite after the 9-5/8 in. casing was set at 1,368 ft. Walnut hulls, sawdust, cottonseed hulls and mica were used to combat extensive lost circulation problems. Fine mica appeared to give the best results in the fractured intervals below 2,000 ft. A mud cooler was utilized after reaching a depth of 3,500 ft in order to lower pump inlet temperatures which exceeded 150°F (Figure 3-1).

## 3.10 Logging Program

For the geophysical logs which were run on CGEH No. 1 refer to Table 3-1.

## 3.11 Cementing

Light-weight slurries were used to minimize lost circulation while cementing casings. Silica flour was used for high temperature strength characteristics and low ratios of mix water to cement were maintained to avoid water pockets.

### 13-3/8 in. Casing

The 13-3/8 in. casing was cemented through the shoe at 601 ft with 832 CF of Class "G" cement premixed with 1:1 perlite, 40% silica flour, 3% gel and 0.5% friction reducer. The plug was bumped with 500 psi. There were approximately 200 CF of cement returns circulated to the surface. The actual volume of cement required to fill the casing-hole annulus exceeded the calculated annular volume by 188 CF or 42%.

### 9-5/8 in. Casing

The 9-5/8 in. casing was cemented through the shoe at 1,368 ft with 790 CF of Class "G" cement premixed with 1:1 perlite, 40% silica flour, 3%

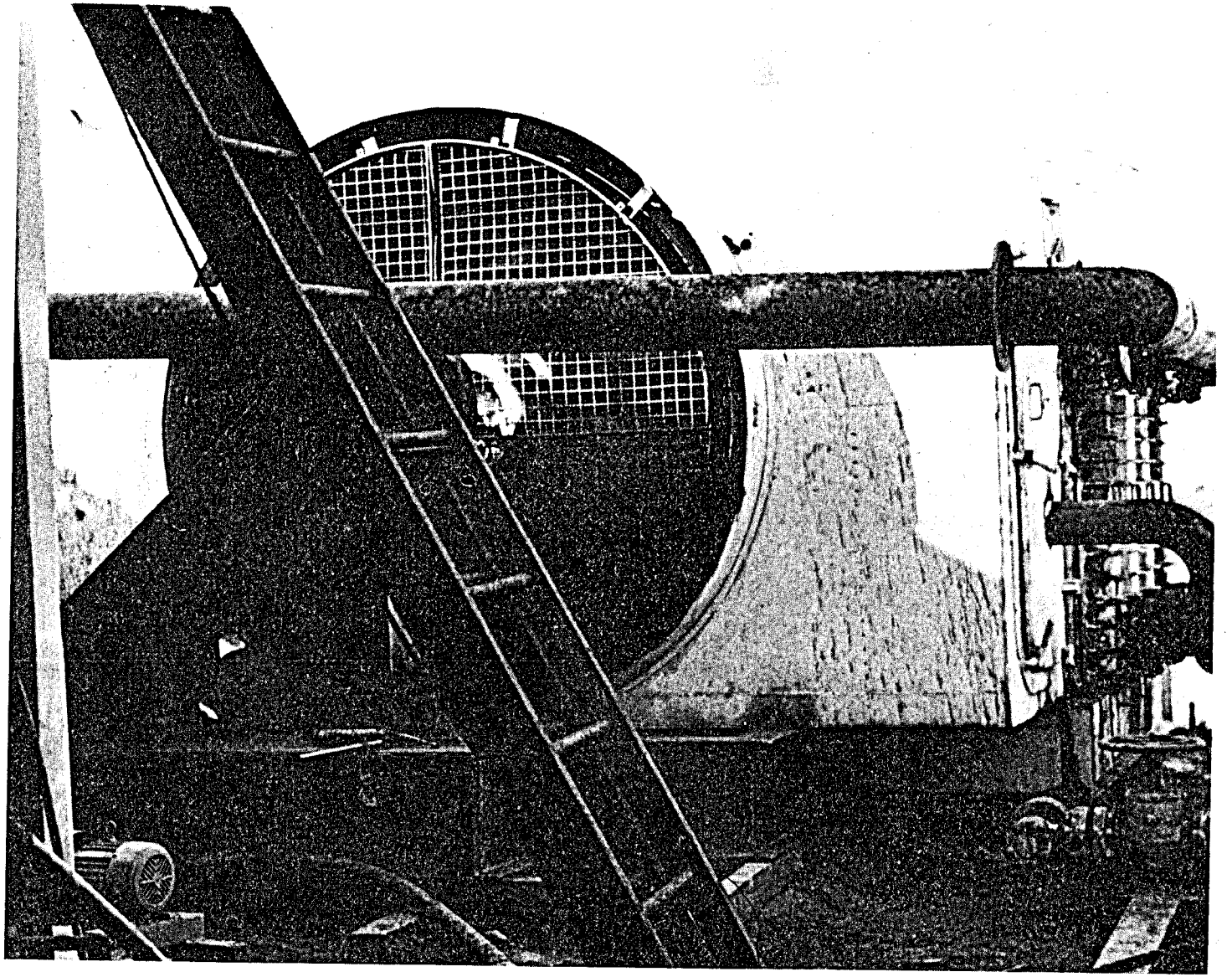

**FIGURE 3-1 MUD COOLER**

## TABLE 3-1 CGEH NO. 1 GEOPHYSICAL LOGS

| DATE | COMPANY | TYPE OF LOG | INTERVAL, FT. |
|---|---|---|---|
| 9-19-77 | Dresser Atlas | Temperature | 62- 604 |
| 9-19-77 | Dresser Atlas | Caliper | 55- 602 |
| 9-19-77 | Dresser Atlas | Induction Electric | 55- 600 |
| 9-25-77 | Go Wireline | Temperature | 592-1,363 |
| 9-25-77 | Go Wireline | Caliper | 595-1,363 |
| 9-25-77 | Go Wireline | Induction Electric | 596-1,363 |
| 9-25-77 | Go Wireline | Gamma Ray, Formation Density, Neutron | 44-1,363 |
| 9-27-77 | Go Wireline | Cement Bond | 30-1,387 |
| 9-28-77 | Go Wireline | Formation Density in Pipe | 30-1,372 |
| 9-28-77 | Go Wireline | Temperature | 30-1,370 |
| 9-28-77 | Birdwell | 3-D Velocity | 22-1,378 |
| 9-28-77 | Birdwell | Nuclear Cement Top Locator | 22-1,378 |
| 10-03-77 | Go Wireline | Temperature | 1,333-1,699 |
| 10-03-77 | Go Wireline | Caliper | 1,367-1,697 |
| 10-03-77 | Go Wireline | Gamma Ray | 1,371-1,700 |
| 10-03-77 | Go Wireline | Induction Electric | 1,371-1,700 |
| 10-11-77 | Go Wireline | Temperature | 1,352-2,227 |
| 10-11-77 | Go Wireline | Caliper | 1,369-2,226 |
| 10-16-77 | PDI Inc. | Temperature | 22-2,832 |
| 10-26-77 | Dresser Atlas | Temperature | 22-4,075 |
| 10-26-77 | Dresser Atlas | Induction | 1,338-4,039 |
| 10-27-77 | Dresser Atlas | Fraclog | 1,328-4,030 |
| 10-27-77 | Dresser Atlas | Gamma Ray, Formation Density, Neutron | 1,318-4,044 |
| 10-27-77 | Go Wireline | Temperature | 22-4,030 |
| 11-11-77 | Go Wireline | Caliper | 1,365-3,510 |
| 11-11-77 | Go Wireline | Temperature | 1,350-3,510 |
| 11-22-77 | Birdwell | Nuclear Cement Top Locator | 0-1,651 |
| 2-03-78 | Dresser Atlas | Density | 3,499-4,845 |
| 2-03-78 | Dresser Atlas | Neutron | 3,499-4,845 |
| 2-03-78 | Dresser Atlas | Acoustic | 4,217-4,838 |
| 2-03-78 | Dresser Atlas | Gamma Ray | 1,317-4,838 |
| 2-03-78 | Dresser Atlas | Caliper | 3,477-4,838 |
| 2-03-78 | Dresser Atlas | Induction Electric | 3,499-4,843 |
| 2-04-78 | Triangle Service | Temperature | 50-4,823 |

gel, 0.5% friction reducer and 0.1% D-13 retarder. The weight was 103 lb per cu ft. A 100 CF lead slurry weighing 90 lb per cu ft was also used. Cement was displaced with 575 CF of drilling fluid at a rate of approximately 80 CFM. The top plug was bumped with 1,000 psi. There were approximately 95 CF of main slurry cement returns circulated to the surface. The actual volume of cement required to fill the casing-hole annulus exceeded the calculated annular volume by 220 CF or 46%.

7 in. Casing

The 7 in. casing was cemented through the shoe at 3,507 ft with 200 CF lead slurry Class "G" cement, premixed with 1:1 pozmix A, 4% gel, 0.5% CFR-2 friction reducer, and 0.2% HR-12 retarder, mixed at 88 lb per cu ft. This was followed with 540 CF Class "G" cement, premixed with 1:1 perlite, 40% silica flour, 2% gel, 0.5% CFR-2 friction reducer and 0.2% HR-12 retarder mixed at 88 to 94 lb per cu ft. The cement was displaced with 766 CF of mud at an approximate rate of 32 CFM. Returns were lost after approximately 500 CF had been displaced and did not begin again until approximately 650 CF had been displaced. There were partial returns between 650 and 766 CF. The plug was bumped with 1,600 psi. Approximately 200 CF of cement was circulated to the surface. The actual volume of cement required to fill the annulus exceeded the calculated annular volume amount by 472 CF or 84%. The cement top in the annulus is estimated to be at 100 ft below GL based upon a Nuclear Cement Top Locator log and also by the volume of water required to fill the annulus.

# APPENDIX A

## DAILY DRILLING REPORTS

All depths are from the Kelly Bushing which is 21.6 ft above ground level. Big "O" Drilling Incorporated Rig No. 2 was used to drill the well.

1977

8/16 Dug 26 in. hole to 35 ft from ground level (56 ft Big "O" RKB ) with O'Meara and Rogers Construction Corp. rat hole digger. Cemented 20 in. conductor pipe at 56 ft with 6 cu yd of concrete.

8/17-19 O'Meara and Rogers Corp. dug the mouse and rat holes and constructed an 8 ft x 8 ft x 3 ft deep cement lined cellar around the conductor pipe.

9/1 Began moving in and rigging up drilling equipment at 1000 hrs.

9/2 Finished rigging up. Mixed clay-base drilling fluid. Spudded in at 0400 hrs. Drilled 12-1/4 in. hole from 56 to 97 ft.

9/3 Drilled 12-1/4 in. hole to 106 ft. Changed bit and added shock sub to drilling assembly. Drilled 12-1/4 in. hole to 125 ft. Lost 180 BBL of drilling fluid from 105 to 115 ft. Mud wt: 8.8; vis: 50.

9/4 Drilled 12-1/4 in. hole to 182 ft. Lost 250 BBL of mud from 135 to 138 ft. Changed bit and drilled to 211 ft. Lost 10 BBL mud at 184 ft and 30 BBL at 206 ft. Mud wt: 8.8; vis: 50-60.

9/5 Drilled 12-1/4 in. hole to 260 ft. Lost 70 BBL mud at 245 ft, 50 BBL at 255 ft and lost circulation at 260 ft. Mixed mud and lost circulation material (4 hrs). Drilled ahead with full returns to 299 ft.

9/6 Drilled 12-1/4 in. hole to 301 ft, changed bit and drilled to 389 ft. Mud wt: 8.8; vis 68-40; W.O.B.: 30,000; rpm : 60.

9/7 Drilled 12-1/4 in. hole to 430 ft. Lost 15 BBL of mud from 423 to 425 ft. Changed bit and drilled to 498 ft. Mud wt: 8.9; vis: 60-70.

9/8 Drilled 12-1/4 in. hole to 515 ft. Changed bit. Twisted off at Kelly saver sub while reaming to bottom. Ran overshot and recovered fish. Drilled to 520 ft. Waited for tools, fishing and extra trips (9 hrs).

9/9 Drilled 12-1/4 in. hole to 575 ft. Changed bit and added Monel drill collar, drilled to 604 ft. Mud wt: 8.9; vis: 57-66; W.O.B.: 30-35,000; rpm: 60-50.

9/10 Took directional surveys at 604, 507, 410, 312, 214 and 114 ft. Ran hole opener and opened hole from 12-1/4 in. to 17-1/2 in. from 56 to 100 ft. Directional and temperature surveys: 114 ft - 1°, N 20° W, 104°F; 214 ft - 1°45', N 6° E, 105°F; 312 ft - 1°45', N 11° E, 106°F; 410 ft - 1°30', N 25°W, 111°F; 507 ft - 1°30', N 39° W, 112°F; 604 ft - 2°, N 53° W, 112°F.

9/11 Opened 12-1/4 in. hole to 17-1/2 in. to 123 ft. Changed hole opener and shock sub, opened hole to 135 ft.

9/12 Opened 12-1/4 in. hole to 17-1/2 in. to 191 ft. Mud wt: 9.1; vis: 45-65; W.O.B.: 10-20,000; rpm: 40-60.

9/13 Opened 12-1/4 in. hole to 17-1/2 in. to 214 ft. Changed hole opener and opened hole to 290 ft. Mud wt: 9.0-9.1; vis: 40-50.

9/14 Opened 12-1/4 in. hole to 17-1/2 in. to 366 ft. Mud wt: 9.0-9.1; vis: 40-55.

9/15 Opened 12-1/4 in. hole to 17-1/2 in. to 380 ft. Changed hole opener and opened hole to 435 ft. Mud wt: 9.0-9.1, vis: 40-48.

9/16 Opened 12-1/4 in. hole to 17-1/2 in. to 495 ft. Mud wt: 9.0-9.1; vis: 43-49.

9/17 Replaced cones on hole opener. Opened 12-1/4 in. hole to 17-1/2 in. to 527 ft. Mud wt: 9.0; vis: 40-50.

9/18 Opened 12-1/4 in. hole to 17-1/2 in. to 601 ft. Mud wt: 9.0; vis: 39-50.

9/19 Pulled out of hole and rigged up loggers. Ran Dresser Atlas Differential Temperature log (tool failed), Induction Electrolog and Caliper log (5-1/2 hrs). Ran 14 joints (608 ft) of 13-3/8 in., 54.5 lb, K-55, Buttress thread casing to 601 ft. Casing equipped with Dowell cement guide shoe, baffle plate on top of bottom joint and seven centralizers at the middle of the bottom two joints and then at every other collar. Cemented with 832 CF class "G" cement premixed with 1:1 perlite, 40% silica flour, 3% gel and 0.5% friction reducer. Bumped plug with 500 psi. Had approximately 200 CF of cement returns to the surface. Cement in place at 0930 hrs. Used Dowell cementing equipment. Waited on cement for 6 hrs. Installed casing head and blow out prevention equipment.

9/20 Finished installing BOE (2 hrs). Pressure test did not hold. Removed BOE and rewelded 13-3/8 in. head. Installed BOE. Pressure tested casing and BOE to 1,000 psi. Laid down 10 in. drill collars and picked up 7 in. drill collars (15 hrs). Drilled out plug, baffle plate, cement and shoe from 556 to 604 ft (2 hrs). Drilled 12-1/4 in. hole to 625 ft (5 hrs).

9/21 Drilled 12-1/4 in. hole to 677 ft. Changed bit and drilled to 736 ft. Mud wt: 9.0; vis: 33-42. Directional and temperature survey: 689 ft - 2°30', N 76° W, 100°F.

9/22 Drilled 12-1/4 in. hole to 861 ft. Mud wt: 9.0; vis: 42-44. Directional and temperature survey: 788 ft - 2°45', N 75° W, 110°F.

9/23 Drilled 12-1/4 in. hole to 1,091 ft. Took 15 minute temperature reading of 126°F at 876 ft after no circulation for 4-1/2 hrs while checking tool joints. Mud wt: 9.0; vis 40-42. Directional and temperature surveys: 880 ft - 2°30', N 65° W, 110°F; 992 ft - 2°30', N 76°W, 116°F.

9/24 Drilled 12-1/4 in. hole to 1,323 ft. Mud wt: 9.0; vis: 43-48. Directional and temperature surveys: 1,092 ft - 2°30', N 75° W, 124°F; 1,186 ft - 4°30', N 75° W, 128°F; 1,216 ft - 4°30', W, broken thermometers; 1,279 ft - 4°30', N 88° W, 134°F.

9/25 Drilled 12-1/4 in. hole to 1,368 ft. Conditioned hole, pulled out and ran GO International Caliper, Temperature, Induction Electric, Compensated Density and Gamma Ray-Neutron logs. Maximum temperature was 221°F (10 hrs). Ran in and conditioned hole for casing. Pulled out (4 hrs). Ran 32 joints (1,374 ft) of 9-5/8 in., 36 lb, K-55, Buttress thread casing. Casing equipped with Baker cement guide shoe, Dowell self fill insert with flapper on top of shoe joint, 10 centralizers - two at middle of bottom two joints and one every other collar and at 400 ft - and four scratchers on each of the bottom two joints. Cemented at 1,368 ft with 790 CF class "G" cement with 1:1 perlite, 40% silica flour, 3% gel, 0.5% friction reducer and 0.1% D-13 retarder. Weight was 103 lb/cu ft. Used 100 CF of lead slurry as above, but weighing 90 lb/cu ft. Displaced cement with 575 CF of drilling fluid. Bumped top plug with 1,000 psi. Cement in place at 2030 hrs. Had 95 CF of main slurry returns to the surface. Used Dowell cementing equipment. Waiting on cement 3-1/2 hrs. Directional and temperature survey; 1,368 ft - 4°30', N 88° W, 134°F.

9/26 Installed 10 in. BOE stack and part of flow line and blooie line.

9/27 Installed flow line and pressure tested casing and BOE to 1,000 psi. Evacuated site for 1-1/2 hrs for Naval weapons test. Layed down 7 in. collars. Ran maximum recording thermometer to 1,307 ft. Temperature was 285°F after 40 hrs without circulation. Changed from drilling mud to water. Drilled out hard cement below the flapper, shoe and formation to 1,382 ft. Pulled out and ran GO International Cement Bond log. Rigged up to magnaflux 6 in. collars.

9/28 Finished magnafluxing collars. Installing blooie line and muffler. Ran GO International Density and Temperature logs.

9/29 Ran Birdwell Density and Cement Bond logs. Cement Bond sonde parted while running after log calibration at 20 ft. Left 6 ft of sonde in the hole. Finished installation of blooie line and muffler. Evacuated site for 2 hrs for Naval weapons test. Ran San Joaquin junk basket and washed over fish. Did not recover. Ran bit and drilled up fish to 1,399 ft. Pulled out of hole and changed bit and drilling assembly.

9/30 Ran in to 800 ft and displaced water with air using Ingersol Rand air compressor equipment. Displaced water with air at 1,399 ft. Shut off air for 1 hr to test for water entry. Recovered 2.2 BBL of water. Drilled 8-3/4 in. hole to 1,589 ft with air. Directional survey at 1,455 and 1,549 ft. Directional and temperature surveys: 1,455 ft - 3°30', S 85° W, 212°F; 1,549 ft - 3°30', S 66° W, 209°F.

10/1 Drilled 8-3/4 in. hole to 1,681 ft using air. Water to sump gradually increased to 15-20 BBL/hr from 1,399 to 1,681 ft. Rate of penetration averaged 20 ft/hr except for gouge zones which were 100+ ft/hr. Hole was tight and had running clays and gravel. Air: 2,550 CFM, 130 psi; Temperature out: 140°F. Pulled up to 9-5/8 in. casing shoe at 1,368 ft and ran back. Found 106 ft of fill. Conditioned mud in tank and changed from air to mud. Reamed to bottom and conditioned mud. Drilled to 1,685 ft.

10/2 Drilled 8-3/4 in. hole to 1,702 ft. Pulled up to 1,642 ft, circulated and conditioned mud. Ran to bottom. Hole was tight from 1,680 to 1,702 ft. Wiped hole from 1,702 to 1,368 ft. Had 5 ft of fill. Ran 6-3/4 in. core barrel. Twisted off pin in drill collar. Ran San Joaquin fishing tools and recovered fish. Directional and temperature survey: 1,702 ft - 5°, S 71° W, 212°F.

10/3 Ran 8-3/4 in. bit to 1,702 ft and circulated hole clean. Ran GO International Caliper, Temperature, Induction Electric and Gamma-Ray logs. Caliper indicated 20 to 32 in. wash out from 1,534 to 1,555 ft. Ran open-ended 5 in. drill pipe to 1,580 ft and cemented with 200 CF of class "G" cement with 0.1% HR-7 retarder. Displaced cement with 130 CF of mud. Pulled up to 1,130 ft, closed rams, and squeezed cement with 6 CF of mud to 1,200 psi. Found top of cement with bit at 1,173 ft after 6 hrs. Drilled out hard cement from 1,173 to 1,262 ft.

10/4 Drilled out cement from 1,262 to 1,580 ft, and cleaned out to 1,702 ft. Pulled out and ran Christenson 30 ft x 6-3/4 in. core barrel with 8-1/2 in. core head with one 8-15/32 in. stabilizer directly above the core head. Reamed tight hole 1,398 to 1,702 ft (8 hrs). Mud wt: 9.0; vis: 40-45.

10/5 Cored 8-1/2 in. hole 1,702 to 1,707 ft. Pulled out and recovered 3.3 ft of core. Ran drilling assembly and reamed from 1,702 to 1,707 ft. Changed over from mud to water and to air in three stages. Drilled 8-3/4 in. hole to 1,759 ft with air.

10/6 Air drilled 8-3/4 in. hole to 1,914 ft. Water flow increased from 9 BPH at 1,840 ft to 90 BPH at 1,914 ft. Pulled up to 1,507 ft and changed from air to mud. Cleaned out bridge from 1,547 to 1,642 ft. Drilled 8-3/4 in. hole to 1,924 ft. Air/water out temperature at 1,914 ft was 165°F. Directional and temperature survey: 1,873 ft - 7°30', S 50° W, 210°F.

10/7 Drilled 8-3/4 in. hole to 1,965 ft. Pulled out, changed bit and added reamer. Reamed hole from 1,460 to 1,850 ft. Lost 150 BBL of fluid while reaming. Directional and temperature surveys: 1,934 ft - 9°15', S 50° W, 210°F; 1,965 ft - 8°45', S 50° W, broken thermometers.

10/8 Reamed hole to 1,965 ft. Removed reamer and drilled 8-3/4 in. hole to 2,012 ft. Lost approximately 75 BBL of fluid. Mud wt: 9.1; vis: 42-46. Directional and temperature survey: 2,000 ft - 8°45', S 52° W, 151°F.

10/9 Drilled 8-3/4 in hole to 2,060 ft. Lost circulation at 2060 ft. Mixed mud and lost circulation material and regained circulation. Lost 600 BBL of fluid. Drilled to 2,127 ft losing a small volume of mud. Mud wt: 9.1; vis: 40-46. Directional and temperature surveys: 2,020 ft - 8°30', S 49° W, 149°F; 2,080 ft - 8°30', S 45° W, 152°F.

10/10 Drilled 8-3/4 in. hole to 2,219 ft and circulated and conditioned the hole for coring. Pulled out and ran Christensen 7-7/8 in. core head on 5-3/4 in. x 30 ft core barrel. Cored from 2,219 to 2,226 ft. Lost approximately 300 BBL of mud. Mud wt: 9.0; vis: 44. Directional and temperature survey: 2,180 ft - 7°45', S 34° W, broken thermometers.

10/11 Cored 7-7/8 in. hole from 2,226 to 2,229 ft. Recovered 10 ft of core. Ran GO International Caliper and Temperature logs. Bottom hole temperature was recorded at 311°F. Ran 8-3/4 in. bit and reamed from 2,056 to 2,219 ft. and opened 7-7/8 in. hole to 8-3/4 in. from 2,219 to 2,229 ft. Took 65 BBL to fill hole after logging.

10/12 Drilled 8-3/4 in. hole to 2,431 ft. Mud wt: 8.7; vis: 40-46. Added lost circulation material. Directional and temperature surveys: 2,278 ft - 7°30', S 23° W, 199°F; 2,375 ft - 7°, 30', S 18° W, 196°F.

10/13 Drilled 8-3/4 in. hole to 2,556 ft. Changed bit. Drilled to 2,595 ft. Mud wt: 8.7; vis: 44-48. Added lost circulation material. Directional and temperature surveys: 2,459 ft - 8°, S 23° W, 210°F; 2,551 ft - 8°30', S 25° W, 189°F.

10/14 Drilled 8-3/4 in. hole to 2,729 ft. Pulled up to 9-5/8 in. shoe and secured rig for Naval weapons test (6 hrs). Ran in and drilled to 2,767 ft. Lost circulation at 2,767 ft. Lost 600 BBL of fluid. Directional and temperature surveys: 2,640 ft - 7°45', S 1° E, 220°F; 2,700 ft - 8°, S 20° W, broken thermometers.

10/15 Mixed mud and lost circulation material. Drilled with partial returns to 2,786 ft. Pulled up to shoe and built up mud volume. Drilled ahead to 2,806 with partial mud returns. Lost approximately 1,500 BBL of mud.

10/16 Drilled 8-3/4 in. hole to 2,822 ft. Pulled up to shoe to mix mud and lost circulation material. Pulled out of hole and ran Production Data Inc. Temperature log. Maximum temperature was 322°F. Ran open end 5 in. drill pipe to 2,778 ft and cemented with 100 CF of class "G" cement with 40% silica flour, 0.5% friction reducer and 0.2% H-R7 retarder. Balanced plug and pulled out of hole.

10/17 Waited on cement (6 hrs). Ran bit and found top of cement plug at 2,660 ft. Pulled out and ran in open ended to 2,660 ft. Set 100 CF cement plug as before. Magnafluxed drill collars. After 9 hrs drilled out cement from 2,495 to 2,822 ft and drilled formation to 2,826 ft. Good circulation.

10/18 Changed bits and reamed hole from 2,762 to 2,826 ft. Drilled 8-3/4 in. hole to 2,959. Mud wt: 8.5; vis: 36-42. Directional and temperature survey: 2,837 ft - 7°15', S 23° W, 175°F.

10/19 Drilled 8-3/4 in. hole to 2,995 and conditioned hole for core. Ran Christensen coring assembly and cored 7-7/8 in. hole from 2,995 to 3,005 ft. Recovered 10 ft of core. Mud wt: 8.5; vis: 36-43. Directional and temperature survey: 2,990 ft - 4°30', S 64° W, 176°F.

10/20 Ran 8-3/4 in. bit. Cleaned out fill 2,945 to 2,995 ft. Opened 7-7/8 in. hole to 8-3/4 in. to 3,005 ft and drilled to 3,142 ft. Mud wt: 8.6; vis: 32-42. Directional and temperature survey: 3,085 ft - 4°30', S 84° W, 218° and 232°F.

10/21 Drilled 8-3/4 in. hole to 3,343 ft. Started losing mud at 3,260 ft. Lost approximately 1,000 BBL from 3,260 to 3,343 ft. Mixed mud and lost circulation material. Directional and temperature surveys: 3,195 ft - 5°30', N 75° W, 181° and 220°F; 3,294 ft - 4°30', N 64° W, 222°F.

10/22 Drilled 8-3/4 in. hole to 3,506 ft. Lost approximately 1,100 BBL mud. Mixed mud and lost circulation material. Directional and temperature surveys: 3,376 ft - 5°15', N 69° W, 180°F; 3,476 ft - 5°45', N 50° W, 172°F.

10/23 Drilled 8-3/4 in. hole to 3,661 ft. Lost approximately 300 BBL mud. Installed mud cooling apparatus. Directional and temperature survey: 3,570 ft - 5°15', N 45°W, 206°F.

10/24 Changed bit. Reamed with bit 1,605 to 1,645 ft; 2,794 to 2,834 ft; and 2,975 to 2,995 ft. Pulled out and added reamer to drilling assembly. Reamed tight hole from 2,986 to 3,661 ft. Drilled 8-3/4 in. hole to 3,688 ft. Lost approximately 200 BBL of mud. Mud wt: 8.7; vis: 36-38. Directional and temperature survey: 3,661 ft - 5°, N 45°W, 210°F.

10/25 Drilled 8-3/4 in. hole to 3,900 ft. Lost approximately 500 BBL of mud. Mud wt: 8.9; vis: 38-42. Directional and Temperature surveys: 3,765 ft - 4°45', N 60° W, 204°F; 3,855 ft - 4°30', N 55° W, 204°F.

10/26 Drilled 8-3/4 in. hole to 4,043 ft. Lost 150 BBL of mud. Good circulation at 4,043 ft. Pulled out and ran Dresser Atlas Induction Electrical and Temperature logs. Maximum temperature was 274°F. Directional and temperature surveys: 3,960 ft - 5°30', N 60° W, 212°F; 4,043 ft - 6°45', N 72° W, 206°F.

10/27 Ran Dresser Atlas Variable Density, Gamma-Ray-Caliper-Compensated Neutron logs. Ran GO International Temperature Gradient Surveys at 18 hrs, 20 hrs and 26 hrs since hole circulation.

10/28 Ran GO International Temperature gradient survey at 39-1/2 hrs since circulation. Evacuated site for Naval test (2 hrs). Magnafluxed drill collars. Ran GO International Temperature survey at 51-1/2 hrs since circulation. Maximum temperature was 360°F.

10/29 Ran bit and conditioned mud. Drilled to 4,058 ft. Pulled out and ran core barrel. Cored 7-7/8 in. hole 4,058 to 4,061 ft. Recovered 3 ft. Ran in hole.

10/30 Spot reamed from 2,571 to 4,058 ft. Opened core hole 4,058 to 4,061 ft. Drilled 8-3/4 in. hole to 4,214 ft. Lost approximately 100 BBL of mud. Mud wt: 8.6; vis: 35-65. Directional and temperature survey: 4,120 ft - 7°30', N 82° W, 204°F.

10/31 Drilled 8-3/4 in. hole to 4,224 ft. Pulled out, changed bit and removed bottom two stabilizers to control angle. Drilled 8-3/4 in. hole to 4,331 ft. Lost approximately 70 BBL of mud. Mud wt: 8.6; vis: 41. Directional and temperature surveys: 4,224 ft - 7°45', N 88° W, 208°F; 4,298 ft - 8°15', N 87° W, 203°F.

11/1 Drilled 8-3/4 in. hole to 4,335 ft. Secured rig and evacuated site for Naval test (4 hrs). Changed bit and drilled 8-3/4 in. hole to 4,367 ft. Lost approximately 80 BBL of mud. Mud wt: 8.5; vis: 41-54; Temperature out: 160°F.

11/2 Drilled 8-3/4 in. hole to 4,536 ft. Lost approximately 300 BBL of mud. Mud wt: 8.4; vis: 36-41; Temperature out: 167°F. Directional and temperature surveys: 4,401 ft - 9°30', S 76° W, 189°F; 4,461 ft - 9°45', S 70° W, 192°F.

11/3 Drilled 8-3/4 in. hole to 4,683 ft. Lost approximately 300 BBL of mud. Evacuated site for Naval test (4 hrs). Mud wt: 8.5; vis: 35-54; Temperature out: 168°F. Directional and temperature surveys: 4,567 ft - 10°30', S 57° W, 202°F; 4,638 ft - 10°45', S 45° W, 204°F.

11/4 Drilled 8-3/4 in. hole to 4,739 ft. Changed bit. Drilled to 4,826 ft. Lost circulation. Pulled up to shoe and mixed mud and lost circulation materials. Directional and temperature survey: 4,739 ft - 11°30', S 43° W, 204°F.

11/5 Drilled 8-3/4 in. hole to 4,845 ft. Lost approximately 1,400 BBL from 4,826 to 4,845. Mixed mud and lost circulation materials. Pulled out of the hole. Waited on Halliburton (4 hrs). Ran in with open-end 5 in. drill pipe to 4,813 ft and placed a 43 sack 10 x 20 mesh sand plug. Found top at 4,754 ft. Cemented with 50 CF of class "G", 1:1 perlite, 4% gel and 0.5% HR-7 retarder through open-end drill pipe at 4,723 ft. Displaced with 447 CF of mud and 10 CF of water. Cemented with 100 CF of cement as above at 3,639 ft. Displaced with 325 CF of mud and 10 CF of water. Cement in place at midnight. Directional and temperature survey: 4,845 ft - 12°45', S 46° W, 186°F.

11/6 Laid down drill pipe, unloaded 7 in. casing. Shut down due to high winds (5 hrs). Found top of cement at 3,405 ft (calculated 3,399) at 1400 hrs. Cemented with same slurry mix as above as follows: 3,300 to 3,180 ft calculated, 50 CF; 2,809 to 2,675 ft calculated, 60 CF; 2,102 to 1,934 ft calculated, 70 CF; 1,577 to 1,409 ft calculated, 70 CF. Cement in place at 1630 hrs. WOC 7-1/2 hrs.

11/7 WOC 1-1/2 hrs. Drilled extremely soft cement 1,690 to 1,710 ft, firm cement 2,060 to 2,140 ft; 2,731 to 2,804 ft; 3,181 to 3,295 ft; and 3,405 to 3,520 ft. Circulated and conditioned mud. Closed rams and made differential mud to proposed 7 in. casing cement gradient test. Hole took 3 BPM at 325 psi (9-5/8 in. shoe ΔP) and 6 BPM at 575 psi (half way from 9-5/8 in shoe to total depth ΔP). Pressure bled to 50 psi in 1/2 min and held. Stuck pipe at 3,500 ft at 1900 hrs. Circulated mud and worked pipe while waited on Dia Log Company. Mud wt: 8.5; vis: 32.

11/8 Worked pipe while awaiting Dia Log (9 hrs). Evacuated site for Naval test (1-1/2 hrs). Ran Dia Log free point indicator and back off string shot. Backed off fish at 2,588 ft. Bottom of fish at 3,500 ft. Ran in hole with wash pipe.

11/9 Washed over fish from 2,588 to 2,782 ft. Pulled out and ran San Joaquin fishing tools and attempted unsuccessfully to screw into fish at 2,588 ft. Ran overshot, latched onto fish. Could not work or pull fish free. Ran free point tool. The top of the fish at 2,588 ft and the joint below at 2,618 ft were free. Could not work bumper subs. Fishing string became stuck above the fishing tools.

11/10 Worked stuck pipe and circulated and conditioned mud. Lost circulation material and cement were circulated out. Mixed 1-1/4 gal of American Mud Company Pipe Release per BBL of diesel oil and placed 137 BBL in the drill pipe to 2,588 ft and from 2,588 to 1,368 ft in the annulus. Moved diesel and worked pipe for 1 hr until upper pipe could move. Ran string shot and backed off at 2,588 ft. Pulled out of the hole. Ran in with fishing tools and screwed into fish.

11/11 Conditioned and circulated mud. Mixed 75 BBL of Pipe Release and diesel treatment and displaced to 3,500 to 2,588 ft in the annulus. Worked pipe and moved treatment. Fish was free in 5 min. Pulled out all of fish. Ran in with bit to 3,520 ft and circulated mud and conditioned the hole. Pulled out and ran GO International Caliper log.

11/12 Rigged up Halliburton equipment and pressure tested hole. Had slight loss at 250 psi. Hole took 1 BPM at 400 psi. Ran open-ended drill pipe to 2,749 ft and set cement plugs as follows: 2,749 - 2,550 ft, 100 CF slurry; 2,410 - 2,200 ft, 100 CF slurry; 2,009 - 1,800 ft, 100 CF slurry; 1,762 - 1,600 ft, 70 CF slurry. Last plug balanced at 0300 hrs. Slurry was class "G", 1:1 perlite, 4% gel with 0.4% HR-7 retarder. WOC 7 hrs. Ran in with bit to feel for top plug. Circulated out unset cement at 1,640 ft. Pulled out and ran in open-ended and cemented with 200 CF cement from 1,587 - 1,300 ft. Pulled up to 800 ft, closed rams and squeezed away 5 CF at 500 psi. Slurry was the same as before except that 0.3% HR-7 retarder was used. Held 500 psi pressure and WOC (10 hrs).

11/13 WOC (4 hrs). Bled pressure and pulled out. Ran bit. Found firm cement at 1,281 ft. Drilled out hard cement to 1,582. Pulled up to shoe and satisfactorily pressure tested hole to 500 psi. Ran in, found cement at 1,640 ft and drilled out soft cement to 1,774 ft. Found next cement plug at 1,827 ft. Pulled to shoe and pressue tested hole to 500 psi. Hole took fluid at a 1 BPM rate. Pulled out and ran in open ended to 1,824 ft. Cemented with 100 CF of cement as above. Pulled up to shoe, closed rams and squeezed with 30 CF of mud. Could not build up pressure. WOC 1-1/2 hrs. Pressured to 500 psi which rapidly bled off. WOC 7 hrs.

11/14 WOC 3 hrs. Hole would not hold pressure. Tagged top of cement at 1,700 ft. Cemented with 70 CF of cement 1,700 to 1,500 ft calculated. Pulled up to shoe and squeezed with 500 psi. WOC 7 hrs. Pulled out and ran bit (3 hrs). Drilled soft cement 1,529 to 1,559 ft. Circulated for 2 hrs to let cement harden. Drilled out hard cement 1,559 to 1,735 ft and ran into top of cement at 1,807 ft. Pulled up to 1,302 ft, closed rams and pressured hole to 400 psi. Pressure decreased to 200 psi in 2 min. Pulled out of hole and ran in open-ended to 1,793 ft. Cemented with 100 CF of same slurry. Pulled up to 1,239 ft. Pressured up to 400 psi with 5 cu ft mud. Pressure decreased to 200 psi in 5 min. WOC 2 hrs.

11/15 WOC 6 hrs. Pressured hole to 400 psi with 6 CF of mud. Pressure decreased to 300 psi in 6 min. Pulled out of hole. Ran bit and found cement top at 1,615 ft. Secured rig and evacuated site for Naval test (3 hrs). Drilled out cement 1,615 to 1,795 ft. Pulled to shoe and pressure tested to 400 psi. Pressure decreased to 240 psi in 5 min. Drilled soft cement 1,826 to 2,021 ft. Tagged next plug at 2,237 ft. Pulled up to shoe and pressure tested. Pressure decreased from 400 psi to 190 psi in 5 min. Drilled very soft cement 2,237 to 2,427 ft. Tagged next plug at 2,547 ft. Pulled to shoe and pressure tested. Pressure decreased from 400 psi to 150 psi in 5 min. Pulled out of hole.

11/16 Ran in with open-ended drill pipe to 2,533 ft. Cemented with 100 CF of cement. Pulled up to the shoe, closed rams and squeezed to 400 psi. WOC 3-1/2 hrs. Pulled out of hole and ran bit. Found top of the cement at 2,331 ft. Pulled to the shoe, pressure tested to 500 psi. Pressure would not hold. Pulled out and ran in open-ended to 2,318 ft. Cemented with 100 CF of cement slurry. Pulled up to 2,041 ft and cemented with 100 CF of cement slurry. Pulled up to the shoe and squeezed plugs in 5 stages from 1330 hrs to 1700 hrs. Final pressure was 500 psi. WOC 4 hrs. Pressure tested hole to 550 psi. WOC 4 hrs. Pulled out and ran in with bit.

11/17 Drilled stringers of hard cement 1,939 to 2,016 ft, hard cement 2,016 to 2,046 ft, 2,056 to 2,320 ft and ran in to top of cement plug at 2,334 ft. Pulled up to the shoe and pressure tested the hole to 400 psi. Drilled medium hard cement 2,334 to 2,540 ft. Pulled up and pressure tested to 500 psi. Hole took 5 CFM at 450 psi. Drilled very soft cement 2,547 to 2,710 ft, hard cement 2,710 to 2,760 ft. Pulled up to shoe, pressure tested. Hole took 4 CFM at 350 psi and 6 CFM at 440 psi. Ran in to 3,520 ft and circulated hole clean. Pulled out.

11/18 Ran in open-ended to 1,301 ft and ran GO International radioactive tracer and temperature surveys. Log indicated a fluid loss from 2,830 - 2,850 ft. Sonde stuck in hole at 2,830 ft. Waited for fishing tools (6 hrs). Stripped over wire line and freed sonde.

11/19 Pulled out of hole and ran bit to 3,520 ft, circulated hole. Pulled out and ran in open-ended to 3,390 ft. Set 100 CF cement plug. Pulled up to 2,992 ft. Set 100 CF cement plug. Pulled up to 2,716 ft. Set 60 CF cement plug. Pulled to shoe and squeezed in stages for 2-1/2 hrs with 67 CF of mud. Final pressure was 160 psi. WOC 8 hrs.

11/20 Ran in with bit and drilled medium hard cement 2,641 to 2,728 ft, 2,748 to 3,025 ft and 3,205 to 3,398 ft. Ran in to 3,515 ft and cleaned out fill to 3,520 ft. Circulated and conditioned the hole. Pulled out and set Baker 9-5/8 in. bridge plug at 90 ft. Removed BOE. Cut off 9-5/8 in. casing head and welded on 9-5/8 in. WKM tapered bore head 9 in. lower to accommodate expansion spool. Set GK hydril preventer and mud riser.

11/21 Finished installation of stack. Retrieved bridge plug. Ran in to 3,520 ft and circulated and conditioned the hole for casing. Pulled out, laying down 5 in. drill pipe and 6 in. drill collars. Ran in 7 in. casing.

11/22 Ran 84 joints (3,510 ft) of 7 in., 23 lb, K55 Buttress thread casing to 3,507 ft. Casing equipped with Halliburton cement guide shoe, Halliburton self-fill insert with flapper on top of shoe joint and 15 centralizers, placed at the middle of the bottom two joints and on every other collar. Cemented with 200 CF lead slurry class "G" cement, 1:1 posmix A, 4% gel, 0.5% CFR-2 friction reducer, 0.2% HR-12 retarder mixed at 85 lb/cu ft followed with 495 CF class "G" cement, 2:1 perlite, 40% silica flour, 2% gel, 0.5% CFR-2 and 0.2 HR-12 mixed at 88 lb/cu ft followed with 540 CF class "G" cement, 1:1 perlite, 40% silica flour, 2% gel, 0.5% CFR-2 and 0.2T HR-12 mixed at 88 to 94 lb/cu ft. Displaced cement with 766 CF of mud. No circulation while displacing between 500 CF and 650 CF. Had partial returns between 650 CF and 766 CF. Bumped plug at 0300 hrs with 1,600 psi. Float held. Had approximately 200 CF of slurry returns to the surface. Raised hydril and set WKM centralizer in casing head. WOC 14 hrs. Ran Birdwell Nuclear Cement Top Locator log. Cement top in annulus estimated to be at approximately 100 ft based upon log and also filling the annulus with water. Pulled rotary table.

11/23 Removed GK hydril, cut off 7 in. casing 29 in. above casing head flange, installed 54 in. temporary expansion spool. Evacuated site for Naval test (3-1/2 hrs). Installed BOE and flow lines.

11/24 Changed pipe rams. Picked up 4-3/4 in. drill collars and 3-1/2 in. drill pipe. Found top of plugs at 3,453 ft. Pressure tested casing and rams to 1,000 psi. OK. Drilled out cement, shoe and cement to 3,550 ft. Pulled out of the hole and rigged up for air drilling.

11/25 Ran in, in stages, with 6-1/8 in. bit, blowing hole dry with air at 700 ft, 1,200 ft, 1,700 ft, 2,200 ft, 2,700 ft and 3,550 ft. Drilled out cement to 3,606 ft. Cleaned out to 4,749 ft, top of plug at 4,734 ft. Stuck pipe at 4,749 ft while taking maximum recording temperature reading. Worked free. Blew hole clean. Pulled up to 4,079 and blew hole clean.

11/26 Ran in and reamed and cleaned out fill and sand from 4,617 to 4,811 ft. Stuck pipe at 4,771 ft. Worked free after 3 hrs. Pulled up to the shoe and blew hole clean. Fluid level was at approximately 1,000 ft. Staged back towards bottom from 7 in. shoe.

11/27 Circulated out fine sand from 4,650 to 4,791 ft. Hole packed off. Worked pipe free. Reamed to 4,791 ft. Hole packed off. Worked stuck pipe up to 4,765 ft. Pipe free after 4 hrs. Pulled up to 3,485 ft. Circulated out 179°F water at a 130 BPH rate for 2 hrs. Air pressure was 300 psi. Pulled up to 500 ft and staged in to determine water level. Found water at 1,000 ft. Rigged up to use aerated water. Ran in the hole.

11/28 Ran in to 4,596 ft and circulated the hole clean. Reamed and cleaned out to 4,780 ft. Circulated and reamed tight hole to 4,845 ft. Hole making approximately 110 BPH of 160°F water and fine to medium grained formation. Conditioned hole 4,845 to 4,785 ft for 3 hrs. Found 20 ft of fill each time on bottom. Twisted off pin in heavy weight drill pipe at 2,192 ft. Ran San Joaquin fishing tools and recovered fish.

11/29 Changed bit, removed reamer and staged back in hole to 4,038 ft. Circulated hole. Found fill at 4,775 ft. Pulled up to shoe, secured rig and evacuated site for Naval test (3-1/2 hrs). Cleaned out to 4,590 ft. Circulated out fine to medium grained formation. Hole making approximately 120 BPH of 177°F water.

11/30 Cleaned out from 4,590 ft to 4,845 ft. Circulated out fine to coarse grained formation. Hole making approximately 150 BPH of 185°F water. Worked tight hole. Pulled up to the shoe, secured rig and evacuated site for Naval test (3 hr). Staged in the hole to 4,747 ft.

12/1 Circulated and staged in the hole to total depth at 4,845 ft. No fill. Water out was 180°F and clean. Rate: 150± BPH. Pulled up to 4,600 ft and changed from aerated water to air alone. Air pressure 1,000 psi and rate 1,350 CFM at 0730 hrs. No returns, so added water at 0900 hrs. Had returns at 1000 hrs. Gradually shut down rig water pump. All air at 1020 hrs.

| Time | Water Rate* BPH | Water Temp °F | Air press psi |
|---|---|---|---|
| 1030 | - | 178 | 870 |
| 1045 | 230 | 187 | 780 |
| 1100 | 230 | 186 | 760 |
| 1115 | 185 | 187 | 750 |
| 1130 | 185 | 187 | 740 |
| 1145 | 185 | 187 | 730 |

*Water samples were sent to the USGS

Pulled to shoe at 1145 hrs. Secured rig and evacuated site for Naval test (3-1/4 hrs). Directed by the Department of Energy to not resume the well test. Laid down and loaded out drill pipe.

12/2 Set Baker 7 in. retrievable bridge plug at 90 ft. Tore out BOE, blooie line and mud cooler. Installed WKM expansion spool, 8 in. WKM steam valve and annular preventer. Retrieved Baker bridge plug.

12/3 Removed annular preventer and installed top 8 in. WKM steam valve. Loaded out rental equipment. Released Big "O" rig at 0600 hrs.

# APPENDIX B

## TABLE B-1 DIRECTIONAL SURVEY DATA

**DIRECTIONAL SURVEY DATA**

KUSTER COMPANY — LONG BEACH, CALIF.

Company CER CORPORATION Well No. CGEH No.1

Location Field COSO Date 9/10/77

City State or County Inyo, California

✓ Section Bearing

Elevation 4,360 ± ft

Survey By Big "O" Drilling

Type

Calculated By Jack F. Foehr, CER

Checked By

| MEASURED DEPTH | COURSE LENGTH | TERMINAL DRIFT ANGLE | TERMINAL DIRECTION OF DEVIATION | AVERAGE DRIFT ANGLE | VERTICAL DEPTH COURSE | VERTICAL DEPTH TOTAL | COURSE DEVIATION | AVERAGE DIRECTION OF DEVIATION | COURSE COORDINATES NORTH | COURSE COORDINATES SOUTH | COURSE COORDINATES EAST | COURSE COORDINATES WEST | TOTAL COORDINATES NORTH | TOTAL COORDINATES SOUTH | TOTAL COORDINATES EAST | TOTAL COORDINATES WEST | SECT. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 114 | 114 | 1°00' | N20W | 0°30' | 114.00 | 114.00 | 0.97 | N20W | 0.91 | | | 0.33 | 0.91 | | | 0.33 | |
| 214 | 100 | 1°45' | N 6E | 1°30' | 99.97 | 213.97 | 2.62 | N 7W | 1.99<br>0.62 | | | 0.24<br>0.08 | 3.52 | | | 0.65 | |
| 312 | 98 | 1°45' | N11E | 1°45' | 97.95 | 311.92 | 2.99 | N8½E | 1.98<br>0.98 | | 0.30<br>0.15 | | 6.48 | | | 0.20 | |
| 410 | 98 | 1°30' | N25W | 1°30' | 97.97 | 409.89 | 2.57 | N 7W | 1.99<br>0.57 | | | 0.24<br>0.07 | 9.04 | | | 0.51 | |
| 507 | 97 | 1°30' | N39W | 1°30' | 96.97 | 506.86 | 2.54 | N32W | 1.70<br>0.46 | | | 1.06<br>0.28 | 11.20 | | | 1.86 | |
| 604 | 97 | 2°00' | N53W | 1°45' | 96.95 | 603.81 | 2.96 | N46W | 1.39<br>0.67 | | | 1.44<br>0.69 | 13.26 | | | 3.99 | |
| 689 | 85 | 2°30' | N76W | 2°15' | 84.93 | 688.74 | 3.34 | N65W | 1.41 | | | 3.03 | 14.67 | | | 7.02 | |
| 788 | 99 | 2°45' | N75W | 2°45' | 98.89 | 787.63 | 4.75 | N75W | 1.23 | | | 4.58 | 15.90 | | | 11.60 | |
| 880 | 92 | 2°30' | N65W | 2°30' | 91.91 | 879.54 | 4.01 | N70W | 1.37 | | | 3.77 | 17.27 | | | 15.37 | |
| 992 | 112 | 2°30' | N76W | 2°30' | 111.89 | 991.43 | 4.88 | N71W | 1.59 | | | 4.61 | 18.86 | | | 19.98 | |
| 1,092 | 100 | 2°30' | N75W | 2°30' | 99.90 | 1091.33 | 4.36 | N76W | 1.06 | | | 4.23 | 19.92 | | | 24.21 | |
| 1,186 | 94 | 4°30' | N75W | 3°30' | 93.82 | 1185.15 | 5.74 | N75W | 1.48 | | | 5.54 | 21.40 | | | 29.75 | |
| 1,216 | 30 | 4°30' | W | 4°30' | 29.91 | 1215.06 | 2.35 | N82W | 0.33 | | | 2.33 | 21.73 | | | 32.08 | |
| 1,279 | 63 | 4°30' | N88W | 4°30' | 62.81 | 1277.87 | 4.94 | N89W | 0.09 | | | 4.94 | 21.82 | | | 37.02 | |
| 1,368 | 89 | 4°30' | N88W | 4°30' | 88.73 | 1366.60 | 6.98 | N88W | 0.24 | | | 6.98 | 22.06 | | | 44.00 | |
| 1,455 | 87 | 3°30' | S85W | 4°00' | 86.79 | 1453.39 | 6.07 | S88W | | 0.21<br>-- | | 6.00<br>0.07 | 21.85 | | | 50.07 | |
| 1,549 | 94 | 3°30' | S66W | 3°30' | 93.82 | 1547.21 | 5.74 | S75W | | 1.29<br>0.19 | | 4.83<br>0.71 | 20.37 | | | 55.61 | |
| 1,702 | 153 | 5°00' | S71W | 4°15' | 99.73<br>52.85 | 1699.79 | 7.41<br>3.93 | S68W | | 4.12<br>0.13 | | 10.20<br>0.32 | 16.12 | | | 66.13 | |
| 1,873 | 171 | 7°30' | S50W | 6°15' | 99.41<br>70.58 | 1869.78 | 10.89<br>7.73 | S60W | | 4.00<br>7.73 | | 15.59<br>0.54 | 6.81 | | | 82.26 | |
| 1,934 | 61 | 9°15' | S50W | 8°30' | 60.33 | 1930.11 | 9.02 | S50W | | 5.79<br>0.01 | | 6.89<br>0.02 | 1.01 | | | 89.17 | |
| 1,965 | 31 | 8°45' | S50W | 9°00' | 30.62 | 1960.73 | 4.85 | S50W | | 3.12 | | 3.71 | | 2.11 | | 92.88 | |
| 2,000 | 35 | 8°45' | S52W. | 8°45' | 34.59 | 1995.32 | 5.32 | S51W | | 3.35 | | 4.14 | | 5.46 | | 97.02 | |
| 2,020 | 20 | 8°30' | S49W | 8°30' | 19.78 | 2015.10 | 2.96 | S50W | | 1.91 | | 2.27 | | 7.37 | | 99.29 | |
| 2,080 | 60 | 8°30' | S45W | 8°30' | 59.34 | 2074.44 | 8.87 | S47W | | 6.05 | | 6.49 | | 13.42 | | 105.78 | |
| 2,180 | 100 | 7°45' | S34W | 8°00' | 99.03 | 2173.47 | 13.92 | S40W | | 10.55 | | 9.06 | | 23.97 | | 114.84 | |
| 2,278 | 98 | 7°30' | S23W | 7°30' | 97.16 | 2270.63 | 12.79 | S28W | | 11.30 | | 6.00 | | 35.27 | | 120.84 | |
| 2,375 | 97 | 7°30' | S18W | 7°30' | 96.17 | 2366.80 | 12.66 | S20W | | 11.90 | | 4.33 | | 47.17 | | 125.17 | |
| 2,459 | 84 | 8°00' | S23W | 7°45' | 83.23 | 2450.03 | 11.33 | S22W | | 10.51 | | 4.24 | | 57.68 | | 129.41 | |
| 2,551 | 92 | 8°30' | S25W | 8°15' | 91.05 | 2541.08 | 13.20 | S24W | | 12.06 | | 5.37 | | 69.74 | | 134.78 | |
| 2,640 | 89 | 7°45' | S01E | 8°00' | 88.13 | 2629.21 | 12.39 | S12W | | 12.12 | | 2.57 | | 81.86 | | 137.35 | |
| 2,700 | 60 | 8°00' | S20W | 8°00' | 59.42 | 2688.63 | 8.35 | S10W | | 8.22 | | 1.45 | | 90.08 | | 138.80 | |
| 2,837 | 137 | 7°15' | S23W | 7°30' | 99.14<br>36.68 | 2824.45 | 13.05<br>4.83 | S22W | | 15.76<br>0.82 | | 6.37<br>0.33 | | 106.66 | | 145.50 | |
| 2,990 | 153 | 4°30' | S64W | 5°45' | 99.50<br>52.73 | 2976.68 | 10.02<br>5.31 | S44W | | 10.79<br>0.24 | | 10.42<br>0.23 | | 117.69 | | 156.15 | |
| 3,085 | 95 | 4°30' | S84W | 4°30' | 94.71 | 3071.39 | 7.45 | S74W | | 1.93<br>0.12 | | 6.73<br>0.43 | | 119.74 | | 163.31 | |
| 3,195 | 110 | 5°30' | N75W | 5°00' | 99.62<br>9.96 | 3180.97 | 8.72<br>0.87 | S85W | 0.78<br>0.05 | | | 8.97<br>0.59 | | 118.91 | | 172.87 | |
| 3,294 | 99 | 4°30' | N64W | 5°00' | 98.62 | 3279.59 | 8.63 | N69W | 2.87<br>0.23 | | | 7.47<br>0.59 | | 115.81 | | 180.93 | |
| 3,376 | 82 | 5°15' | N69W | 5°00' | 81.69 | 3361.28 | 7.15 | N67W | 2.74<br>0.06 | | | 6.44<br>0.14 | | 113.01 | | 187.51 | |
| 3,476 | 100 | 5°45' | N50W | 5°30' | 99.54 | 3460.82 | 9.58 | N60W | 4.79 | | | 8.29 | | 108.22 | | 195.80 | |
| 3,570 | 94 | 5°15' | N45W | 5°30' | 93.57 | 3554.39 | 9.01 | N48W | 6.03 | | | 6.70 | | 102.19 | | 202.50 | |
| 3,661 | 91 | 5°00' | N45W | 5°00' | 90.65 | 3645.04 | 7.93 | N45W | 5.61 | | | 5.61 | | 96.58 | | 208.11 | |
| 3,765 | 104 | 4°45' | N60W | 5°00' | 103.60 | 3748.64 | 9.07 | N52W | 5.58 | | | 7.15 | | 91.00 | | 215.26 | |
| 3,855 | 90 | 4°30' | N55W | 4°45' | 89.69 | 3838.33 | 7.45 | N58W | 3.95 | | | 6.32 | | 87.05 | | 221.58 | |
| 3,960 | 105 | 5°30' | N60W | 5°00' | 105.60 | 3942.93 | 9.16 | N58W | 4.85 | | | 7.77 | | 82.20 | | 229.35 | |
| 4,043 | 83 | 6°45' | N72W | 6°15' | 82.51 | 4025.44 | 9.04 | N66W | 3.68 | | | 8.26 | | 78.52 | | 237.61 | |
| 4,120 | 77 | 7°30' | N82W | 7°15' | 76.38 | 4101.82 | 9.72 | N77W | 2.02<br>0.16 | | | 8.77<br>0.70 | | 76.34 | | 247.08 | |
| 4,224 | 104 | 7°45' | N88W | 7°45' | 99.09<br>3.96 | 4204.87 | 13.49<br>0.54 | N85W | 1.22<br>-- | | | 13.95<br>0.03 | | 75.12 | | 261.06 | |
| 4,298 | 74 | 8°15' | N87W | 8°00' | 73.28 | 4,278.15 | 10.30 | N87W | 0.52<br>0.02 | | | 9.99<br>0.03 | | 74.58 | | 271.35 | |
| 4,401 | 103 | 9°30' | S76W | 9°00' | 98.77<br>2.96 | 4379.88 | 15.64<br>0.47 | S84W | | 1.67<br>0.01 | | 15.91<br>0.11 | | 76.25 | | 287.37 | |
| 4,461 | 60 | 9°45' | S70W | 9°45' | 59.13 | 4439.01 | 10.16 | S73W | | 2.92<br>0.05 | | 9.56<br>0.15 | | 79.22 | | 297.08 | |
| 4,567 | 106 | 10°30' | S57W | 10°15' | 98.40<br>5.90 | 4543.31 | 17.79<br>1.07 | S63W | | 8.17<br>0.39 | | 16.04<br>0.77 | | 87.78 | | 313.98 | |
| 4,638 | 71 | 10°45' | S45W | 10°45' | 69.75 | 4613.06 | 13.24 | S51W | | 8.18<br>0.15 | | 10.10<br>0.19 | | 96.11 | | 324.27 | |
| 4,739 | 101 | 11°30' | S43W | 11°15' | 98.08<br>0.98 | 4712.12 | 19.51<br>0.20 | S44W | | 13.67<br>0.51 | | 13.20<br>0.49 | | 110.29 | | 337.95 | |
| 4,845 | 106 | 12°45' | S46W | 12°15' | 97.72<br>05.86 | 4815.70 | 21.22<br>1.27 | S45W | | 15.56<br>0.35 | | 13.66<br>0.35 | | 126.20 | | 353.86 | |

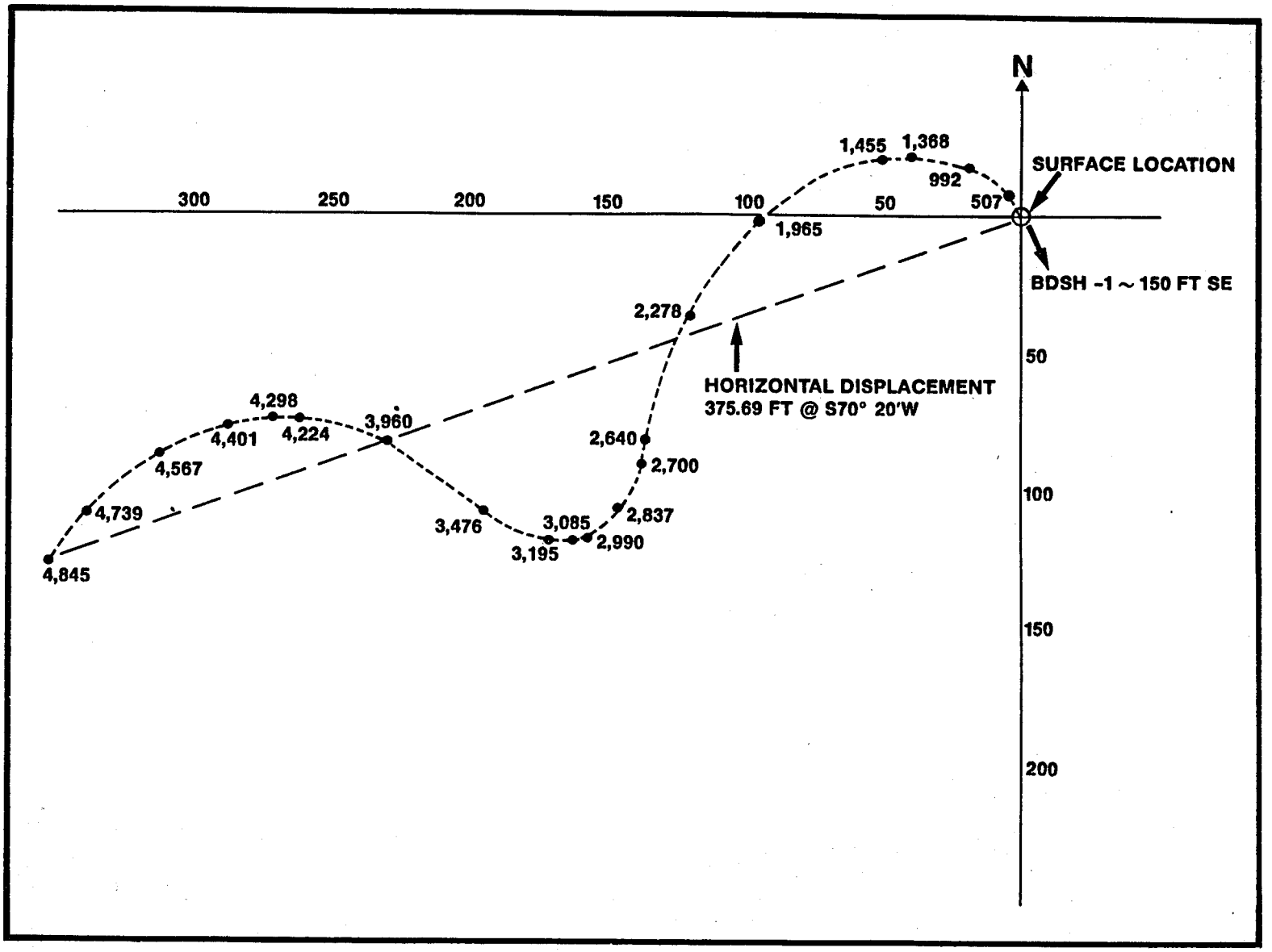


**FIGURE B-1 HORIZONTAL PROJECTION OF DISPLACEMENT IN FEET PLOTTED AS A FUNCTION OF MEASURED DEPTH**

# TABLE C-1 BIT RECORD

| BIT | MAKE | SIZE | TYPE | JETS 32nd IN. | HOLE DEPTH IN | HOLE DEPTH OUT | FOOT-AGE | HOURS | WEIGHT 1,000 LBS. | RPM | CIRCULATING PUMP PRESSURE | CIRCULATING RATE GAL/MIN | BIT CONDITION T | BIT CONDITION B | BIT CONDITION G | REMARKS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Smith | 12-1/4 | DTJ | 16-16-16 | 56 | 106 | 50 | 26-1/4 | 5- 8 | 50 | 250 | 344 | 4 | 2 | I | |
| 2 | Smith | 12-1/4 | V2HJ | 16-16-16 | 106 | 182 | 76 | 24-1/2 | 10-15 | 60 | 250-400 | 344 | 8 | 6 | I | |
| 3 | Smith | 12-1/4 | DGJ | 16-16-16 | 182 | 301 | 119 | 27 | 15-20 | 60 | 600-300 | 344 | 6 | 5 | I | |
| 4 | Reed | 12-1/4 | S21J | 16-16-16 | 301 | 430 | 129 | 31-1/2 | 25-35 | 60 | 500 | 344 | 2 | 5 | I | |
| 5 | Security | 12-1/4 | M4NGJ | 16-16-16 | 430 | 515 | 85 | 21-1/4 | 30-35 | 60 | 500 | 344 | 1 | 2 | I | |
| 6 | Smith | 12-1/4 | V2HJ | 16-16-16 | 515 | 575 | 60 | 16-1/2 | 30-35 | 60-50 | 500 | 344 | 1 | 2 | I | |
| 7 | Security | 12-1/4 | M4NJ | 16-16-16 | 575 | 604 | 29 | 6 | 30-35 | 50 | 500 | 344 | | INC. | | |
| H.O.1 | Smith | 17-1/2 | 3 Point | 16-16-16 | 56 | 123 | 67 | 35-1/2 | 5-10 | 40 | 100 | 325 | 4 | 4 | I | |
| H.O.2 | Smith | 17-1/2 | 3 Point | 16-16-16 | 123 | 214 | 91 | 35-1/2 | 10-20 | 40-60 | 100 | 325 | 4 | 4 | I | |
| H.O.3 | Smith | 17-1/2 | 3 Point | 16-16-16 | 214 | 380 | 166 | 42-1/4 | 15-25 | 40 | 150 | 325 | 5 | 5 | I | |
| H.O.4 | Security | 17-1/2 | 3 Point | 16-16-16 | 380 | 495 | 115 | 37-1/2 | 15-25 | 40 | 150 | 325 | 6 | 6 | I | |
| H.O.5 | Security | 17-1/2 | 3 Point | 16-16-16 | 495 | 601 | 106 | 44 | 15-30 | 40 | 150 | 325 | 4 | 3 | I | |
| R.R.7 | Security | 12-1/4 | M4NJ | 16-16-16 | 604 | 677 | 73 | 16 | 25-30 | 60 | 550 | 325 | 7 | 7 | I | 554 - 604 ft. cement |
| 8 | Hughes | 12-1/4 | J33* | 16-16-16 | 677 | 1,368 | 691 | 73-1/2 | 40-45 | 45 | 550 | 325 | 3 | 4 | I | |
| 9 | Reed | 8-3/4 | Y13TJ | 16-16-16 | 1,368 | 1,382 | 14 | 1/2 | | | | 325 | | | | 1,312 - 1,368 ft. cement |
| 10 | Reed | 8-3/4 | S13GJ | 16-16-16 | 1,382 | 1,399 | 17 | 3-1/2 | 10 | 40 | 200 | 325 | | — | | Drilled up Birdwell fish |
| 11 | Hughes | 8-3/4 | J33* | Open | 1,399 | 1,702 | 303 | 23-1/4 | 30-40 | 40 | 800 | 325 | | INC. | | |
| CH 1 | Christensen | 8-11/16 | MC-20 Diamond | | | | | | | | | | | | | Twisted off while reaming in at 1,397 ft. |
| 12 | Smith | 8-3/4 | DGJ | 16-16-16 | Cement Only | | | | | | | | | | | 1,173 - 1,580 ft. cement |
| CH 2 | Christensen | 8-1/2 | MC-23 Diamond | | 1,702 | 1,707 | | | | | | | | | | Reamed 1,398 - 1,702 ft. |
| 13 | Smith | 8-3/4 | F3* | Open | 1,707 | 1,965 | 258 | 31-1/2 | 10-40 | 40-70 | 300 | 325 | 7 | 7 | I | Reamed 1,702 - 1,707 ft. |
| 14 | Smith | 8-3/4 | DGJ | 16-16-16 | 1,965 | 2,000 | 35 | 7-1/2 | 15 | 40 | 400 | 325 | 1 | 1 | 1/2 | Reamed 1,465 - 1,965 ft. |
| 15 | Hughes | 8-3/4 | J33* | 16-16-16 | 2,000 | 2,219 | 219 | 34-1/2 | 30 | 50 | 400 | 325 | | INC. | | Reamed 1,965 - 2,000 ft. |
| CH 3 | Christensen | 7-7/8 | MC-23 Diamond | | 2,219 | 2,229 | | | | | | | | | | |
| R. R. 15 | Hughes | 8-3/4 | J33* | 16-16-16 | 2,229 | 2,556 | 327 | 39-1/2 | 10-15 | 75 | 600 | 325 | 6 | 2 | 1/16 | Reamed 2,056 - 2,229 ft. |
| R.R. 11 | Hughes | 8-3/4 | J33* | 16-16-16 | 2,556 | 2,822 | 266 | 38-1/2 | 20-25 | 60 | 40 | 325 | 2 | 1 | I | |
| 16 | Smith | 8-3/4 | DGTHJ | 16-16-16 | 2,822 | 2,826 | 4 | 2 | 25 | 65 | 600 | 122 | 3 | 5 | 1/4 | 2,495 - 2,822 ft. cement |
| 17 | Smith | 8-3/4 | F3* | 16-16-16 | 2,826 | 2,995 | 169 | 24-3/4 | 25-30 | 45-50 | 500 | 307 | 3 | 1 | 1/4 | |
| CH 3 R.R. | Christensen | 7-7/8 | MC-23 Diamond | | 2,995 | 3,005 | | | | | | | | | | |
| 18 | Smith | 8-3/4 | F3* | 16-16-16 | 3,005 | 3,661 | 656 | 84-1/2 | 30-40 | 40-60 | 550 | 298 | 3 | 5 | 1/4 | Reamed 2,995 - 3,005 ft. |
| 19 | Hughes | 8-3/4 | J33* | 16-16-16 | 3,661 | 4,043 | 382 | 42 | 40 | 45-55 | 550 | 318 | | INC. | | |
| 20 | Reed | 8-3/4 | S21GJ | 16-16-16 | 4,043 | 4,058 | 15 | 4 | 35 | 65 | 700 | 322 | | — | | Drilled up thermometer case |
| CH 3 R.R. | Christensen | 7-7/8 | MC-23 Diamond | | 4,058 | 4,061 | | | | | | | | | | |
| 21 | Smith | 8-3/4 | F4* | 16-16-16 | 4,061 | 4,227 | 166 | 22 | 20-30 | 50-60 | 600 | 322 | 5 | 1 | I | Reamed 4,058 - 4,061 ft. |
| R.R. 19 | Hughes | 8-3/4 | J33* | 16-16-16 | 4,227 | 4,335 | 108 | 22-1/2 | 20-25 | 60 | 600 | 322 | 6 | 4 | 1/8 | |
| 22 | Hughes | 8-3/4 | J33* | 16-16-16 | 4,335 | 4,739 | 404 | 59 | 30 | 60 | 600 | 322 | 5 | 5 | I | |
| 23 | Smith | 8-3/4 | F4* | 16-16-16 | 4,739 | 4,845 | 106 | 9 | 30 | 60 | 600 | 298 | 7 | 8 | I | |
| 24 | Smith | 8-3/4 | SVH | | Cement Only | | | | | | | | | | | |
| 25 | Smith | 6-1/8 | DTJ | | Cement Only | | | | | | | | | | | |
| 26 | Smith | 6-1/8 | F3* | | Cement Only | | | | | | | | | | | |
| 27 | Smith | 6-1/8 | F3* | | Condition Hole Only | | | | | | | | | | | |

*Insert type bits



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