DOE/NV/10845--8

DE92 017988

HYDROGEOLOGIC CHARACTERIZATION OF WELLS HTH-1, UE18r, UE6e, AND HTH-3, NEVADA TEST SITE

by

Brad F. Lyles
W. Alan McKay
Jenny B. Chapman
Scott W. Tyler

June 1991

Publication #45087

DOE/NV/10845-08
UC-703

HYDROGEOLOGIC CHARACTERIZATION OF WELLS HTH-1, UE18r, UE6e, AND HTH-3, NEVADA TEST SITE

by

Brad F. Lyles[1]
W. Alan McKay[2]
Jenny B. Chapman[1]
Scott W. Tyler[3]

Water Resources Center
Desert Research Institute
University and Community College System of Nevada
Las Vegas/Reno, Nevada

Publication No. 45087

prepared for

Nevada Field Office
U.S. Department of Energy
Las Vegas, Nevada

June 1991

[1] Assistant Research Hydrogeologist
[2] Staff Hydrogeologist
[3] Assistant Research Professor

The work upon which this report is based was supported by the U.S. Department of Energy under Contract #DE-AC08-90NV10845.

CONTENTS

FIGURES

TABLES

PURPOSE

Monitoring for the migration of contaminants in groundwater or for the proper design of nuclear test emplacement holes at the Nevada Test Site (NTS) requires proper placement and completion of monitoring wells. This is only possible if the hydrogeologic system is understood in a regional and local context, necessitating data from existing wells and boreholes. Though the NTS Groundwater Characterization Project will be drilling wells, their great expense limits the number of new wells. However, there are many existing boreholes and wells on the NTS which have not been completely evaluated hydrologically. Some of these are incorporated in the Long-Term Hydrologic Monitoring Program (LTHMP) of the U.S. Environmental Protection Agency (EPA), others are related to the testing programs. In all cases, additional site investigation is necessary to properly interpret the hydrogeologic data from these wells.

Monitoring wells on the NTS are poorly characterized with regard to aquifers penetrated, vertical hydraulic gradients, and vertical variations in water quality. One of the goals of the well validation program was to gain a thorough understanding of the parameters needed to interpret the source and fate potential hazardous and radioactive substances that may be detected in these wells in the future. One of the most critical parameters for monitoring is the knowledge of what aquifer or geologic unit is being sampled when a water sample is collected. Pumped water samples are weighted most heavily to the water quality of the most productive (highest transmissivity) aquifer penetrated by the well.

Wells which are not pumped are of even greater concern. These wells are traditionally sampled by bailing a small quantity of water from some specified depth below the water table. Bailed wells, or wells that are only slightly stressed (low volume pumps) and penetrate multiple transmissive zones, pose two problems. First, vertical hydraulic gradients may exist between the transmissive zones. Differences in hydraulic head between the transmissive zones will induce vertical flow within the borehole. Water will move into the borehole from the highest head zone and flow out of the borehole in those zones where the head is lower. As a result, water bailed from some arbitrary depth may not represent the water quality of the depth sampled, but instead may be a mixed water quality from several transmissive zones. If contamination is detected, it will be difficult to define the zone or zones from which it came. The second major difficulty in the use of bailed wells without detailed hydraulic data is the use of the static water level in characterizing hydraulic head. Vertical head variations found in the few wells tested to date suggest that the measured static water level is a composite head measurement of all the aquifers and transmissive zones penetrated by the well.

A multi–phased approach was developed to characterize the hydrology of selected wells on the NTS. Available data from monitoring wells and other open holes on the NTS were reviewed and four wells were chosen for detailed study by Desert Research Institute (DRI) and the U.S. Geological Survey (USGS), based on their hydrogeologic setting, their relative importance as downgradient monitoring wells, and for scientific interest. Phase I testing procedures were developed based on the available data from each site. Phase II testing procedures were then developed based on the available historic data and data collected as a result of Phase I testing.

PHASE I TESTING PROCEDURES

Four wells were chosen for Phase I testing: HTH–1 (USGS Test Well #1, TW1), UE18r, UE6e, and HTH–3 (USGS Test Well #3, TW3). HTH–1 and UE18r are currently part of the Long–Term Hydrologic Monitoring Program, UE6e is monitored occasionally by the USGS, and HTH–3 is visited infrequently due to its location on Air Force land with restricted access (Figure 1). The four wells were categorized based on their hydrogeologic setting; HTH–1 was theorized to be in a recharge area, downgradient from the Rainier Mesa testing area; UE18r was theorized to be in a discharge/regional flow area, downgradient from the Pahute Mesa testing area; UE6e was theorized to be in a regional flow area of Yucca Flat, and was of scientific interest due to its close proximity to testing in Yucca Flat; and HTH–3 was theorized to be in a regional flow area of the carbonate aquifer, upgradient from potential contamination sources.

Phase I testing procedures were as follows: 1) log each of the wells for temperature, electrical conductivity (EC), and caliper; 2) measure vertical flow in the well bore with the USGS thermal flowmeter at predetermined depths based on the well completion (casing history), variations in temperature and EC, and borehole wash–out zones measured by the caliper log; and 3) collect water samples from each flow zone identified from the thermal flowmeter results.

The DRI logging equipment was used to electrically log temperature and EC for wells HTH–1, UE6e, and HTH–3, prior to the USGS caliper and thermal flowmeter logging (access limitations prohibited DRI from logging UE18r). The USGS ran caliper and thermal flowmeter logs at HTH–1, UE18r, and UE6e, but were unable to access HTH–3 due to the small diameter tubing in the well. Water samples were collected from wells HTH–1 and HTH–3, but access limitations have prohibited DRI from collecting samples at UE18r.

Detailed descriptions of the available data and preliminary results from this study are listed in individual sections for each well.

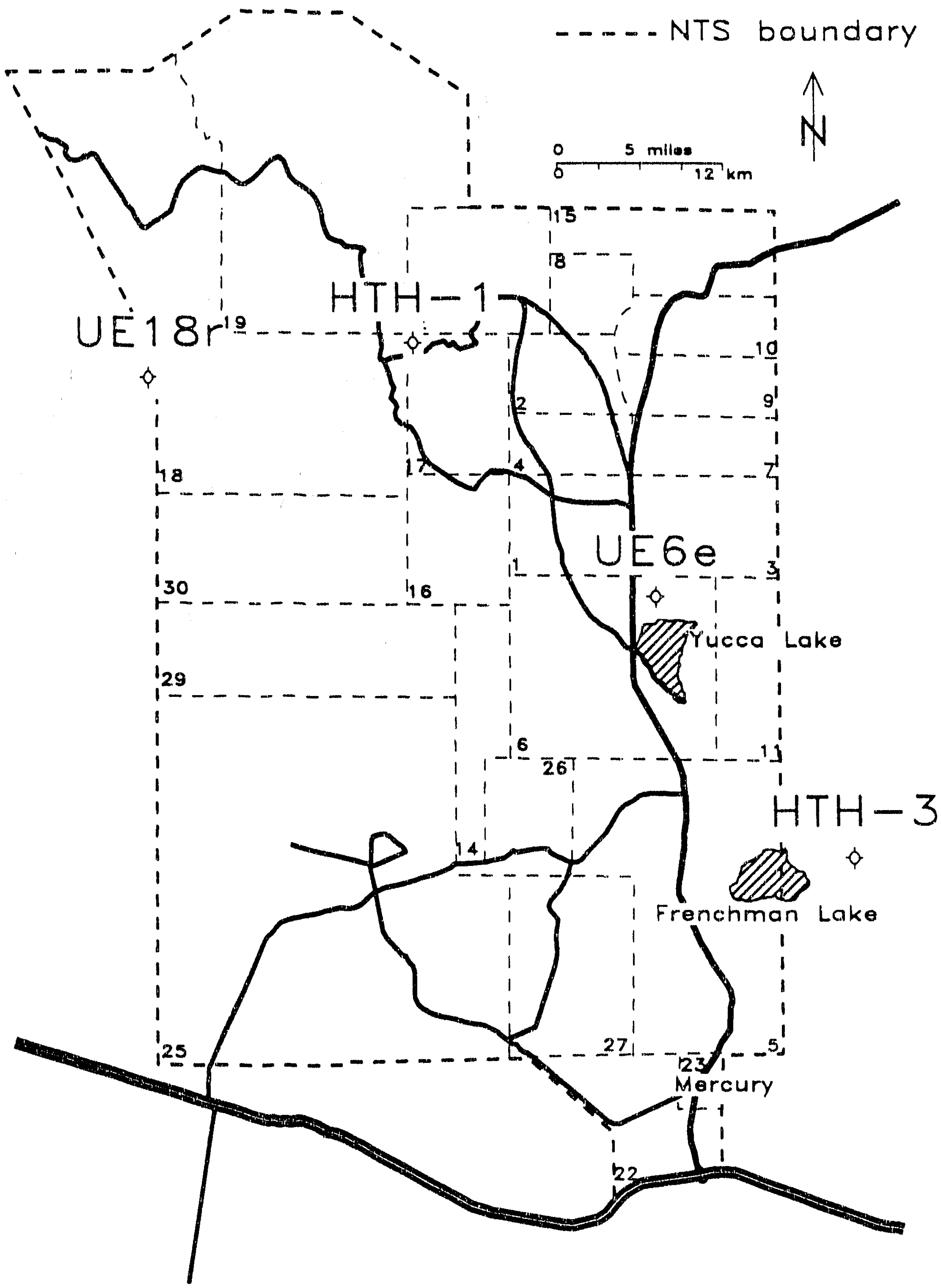


FIGURE 1. General Location Map of Wells Discussed in this Report.

WELL: HTH-1

General Background

Hydrologic Test Hole 1 (HTH–1) was drilled in Stockade Wash, south of Rainier Mesa (N. 267,254 m, E. 191,804 m), at an elevation of 1876 m (6,156 ft) above mean sea level (Figure 1). It was one of several wells drilled to explore hydrologic conditions at the NTS in the early 1960s (Thordarson and Winograd, 1961). Conveyance hardware (pipes, valves, etc.) in the near vicinity of HTH–1 suggests that this well may, at one time, have been part of a water supply system for the Area 12 camp; however, there is nothing in the written record to confirm this and the hardware previously referred to may simply be artifacts of earlier construction activities in the area.

Construction Details

Following is a narrative summary of the drilling and construction history of HTH–1 as contained in Thordarson and Winograd (1961) and Fenix and Scisson (unpublished data, see Appendix A). Figure 2 is a schematic of the well.

HTH–1 was spudded on September 24, 1960. A 31–cm (12–inch) hole was drilled to 561 m (1,840 ft) using a cable–tool rig. A 22.9–cm (9–inch) hole was then drilled to 1,131 m (3,711 ft) using rotary equipment. A 19–cm ($7^1/_2$–inch) hole was either drilled or cored another 6 m (20 ft) to a depth of 1,137 m (3,731 ft). Casing with a diameter of 29.3 cm (11 inches) was installed from the surface to 492 m (1,615 ft) and 20.3–cm (8–inch) casing was installed from 476 to 1,131 m (1,560 to 3,711 ft). The bottom 6 m (20 ft) were left uncased. This portion of HTH–1 construction was completed on June 10, 1961.

In July 1962, deepening work on HTH–1 began. The purpose of this additional work appears to have been primarily to obtain core, perforate discrete intervals of blank casing, and obtain hydrogeologic data throughout the hole. The original hole was deepened from 1,137 to 1,282 m (3,731 to 4,206 ft) during this effort. Six core runs and various hydrologic tests were performed (Appendix A). No additional casing was installed in the deepened portion (145 m (475 ft)) of the hole, leaving a total of 151 m (495 ft) of uncased hole at the bottom of HTH–1.

Role in Well Validation Program

Several factors make HTH–1 an attractive "hole of opportunity" in the well validation program. With respect to the regional hydrology of the NTS, HTH–1 is located in a somewhat ambiguous area. Although observed decreasing head with depth measurements could indicate that the Stockade Wash area is in a zone of active recharge, Thordarson and Winograd (1961)

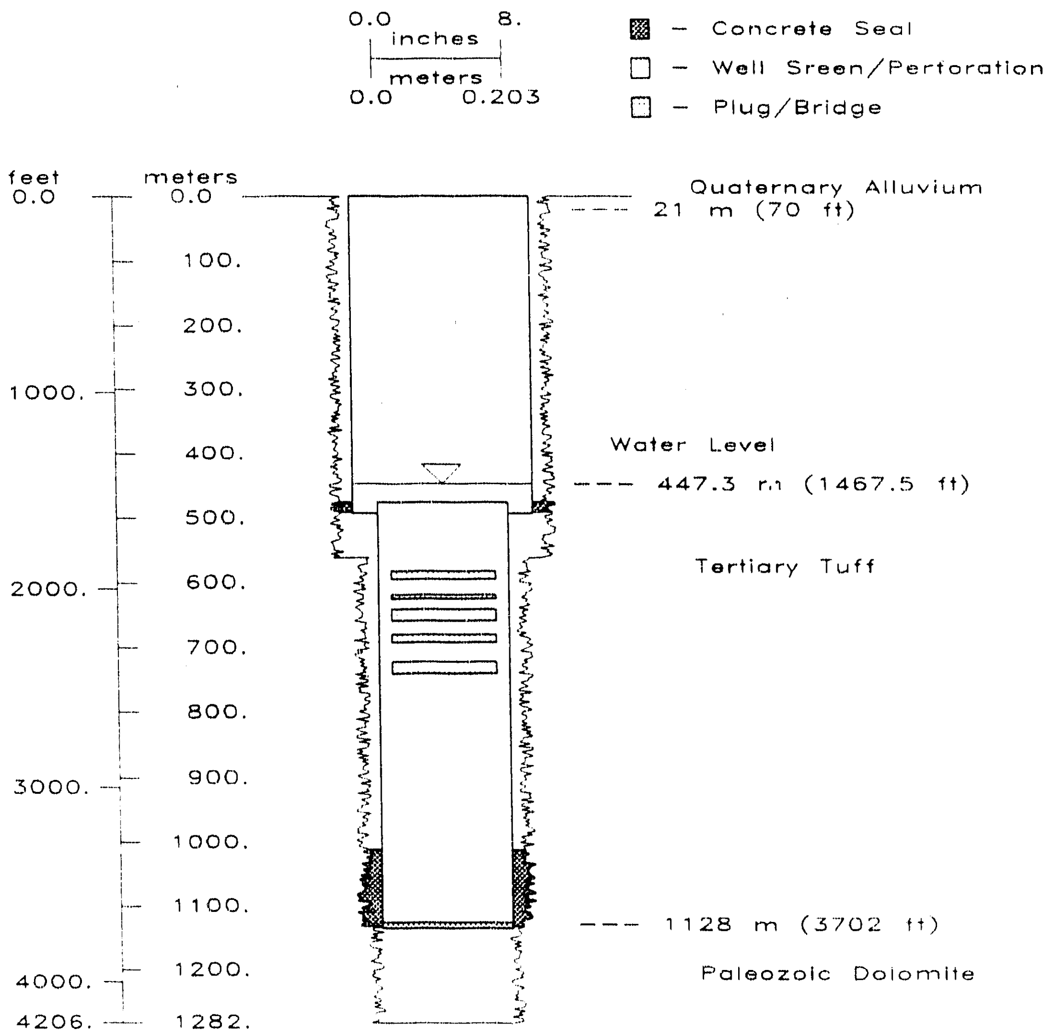


Figure 2. Generalized Schematic of Well HTH–1.

suggest that these measurements more likely reflect a series of perched aquifers at several depths. Previous attempts at delineating groundwater–flow systems and directions at NTS (Boughton, 1986; Feeney et al., 1987; Waddell, 1982) generally agree that there is a pronounced southerly component to groundwater flow in the Stockade Wash area. However, perusal of available water level contour maps reveals three possible direction interpretations within the southerly flow scenario: southwest toward Oasis Valley; southeast toward Yucca Valley; and due south toward Tippipah Spring and Shoshone Mountain. While detailed analysis of flow systems at the NTS is beyond the scope of this report, the preceding should provide an appreciation for the unique position occupied by HTH–1 within the regional framework of NTS hydrology. HTH–1 is also downgradient from testing activities in Rainier Mesa, and may be in a prime location to monitor radionuclide migration from the testing area.

The stratigraphic setting at HTH–1 is also somewhat unique with respect to other available holes at NTS. Lithologic information from Thordarson and Winograd (1961) indicates that the hole penetrated 21 m (70 ft) of Quaternary alluvium, 1,107 m (3,632 ft) of Tertiary volcanic rocks, and 9 m (29 ft) of Paleozoic carbonate rock. Lithologic data from the previously mentioned deepening efforts are not available, but it's assumed that this additional 145 m (475 ft) penetrated the Paleozoic rocks.

Since one of the stated goals of the well validation program is to "characterize wells with regard to lithology, aquifers penetrated, vertical hydraulic gradients, and vertical variations in water quality," hole construction is of critical importance. As indicated in the earlier section on hole construction, several intervals of casing are perforated in HTH–1. Specifically, five different 18.3–m (60–ft) sections were gun perforated (6.6 shots per meter; 2 shots per foot) from a depth of 582 to 741 m (1,910 to 2,430 ft). The 20.3–cm (8–inch) tubing was gun perforated in–situ; therefore, there is no gravel pack or annular seals within the screened intervals of the well. The prospect of an additional 151 m (495 ft) of open hole in carbonate rocks was an additional attraction; however, recent logging and sampling efforts reveal some sort of obstruction at approximately 1,128 m (3,700 ft), rendering the Paleozoic section at this site inaccessible (temporarily at least) to further studies.

Recent Activities at HTH–1 (1986–1990)

In June 1986, HTH–1 was visited by a DRI logging crew with the intention of obtaining downhole electrical conductivity (EC) and temperature logs, as well as fluid samples from discrete intervals. A significant and unexpected layer of petroleum product was encountered at the top of the fluid column, temporarily disabling the logging equipment. HTH–1 was revisited by DRI in July 1987. Using an open top bailer, the oil layer was removed from the well and the temperature and EC logs were successfully run. The oil was analyzed and identified as pump oil and contained no PCBs. Additionally, fluid samples were collected at two depths (725 and 119 m (2,380 and 3,670 ft)) and analyzed for tritium (^3H). Enriched tritium analysis yielded above–background levels of 48 and 90 pCi/L, respectively. Due to the number of screened intervals, it was impossible to determine which hydrostratigraphic zones were yielding the slightly elevated tritium concentrations.

In June 1990, HTH–1 was visited by personnel from DRI and the USGS, Denver. Using the USGS logging equipment, temperature, caliper and thermal flowmeter logs were run. The caliper log confirmed an obstruction which was noted previously at a depth of approximately 1,128 m (3,700 ft) and the temperature log was consistent with earlier DRI results.

The vertical variations in above–background tritium concentrations suggest that inflow from different hydrostratigraphic zones is occurring at HTH–1. To understand the nature of this inflow, thermal flowmeter logging was performed in the borehole. The principle behind thermal flowmeter logging is conceptually simple. The thermal flowmeter is lowered to discrete depths of interest, the flowmeter's heat grid is energized, and the resulting heat pulse is monitored by thermistors above and below the heat grid. The travel time (seconds) from the heat grid excitation to the heat pulse response at the thermistor gives the fluid velocity in the well; the direction of vertical flow is then determined based on which thermistor received the signal first (if the upper thermistor receives the heat pulse first, then upward flow is indicated, alternatively if the lower thermistor receives the heat pulse first, then downward flow is indicated (Morin et al., 1988)).

Preliminary interpretation of thermal flowmeter data from HTH–1 reveals several zones of inflow and a distinct downward component to vertical flow (Morin, personal communication, 1990) (Figure 3). Outflow may be occurring at the junction of the two different sized casings, suggesting that upward flow may be occurring; however, the dominant vertical gradient in the well appeared to be downward. Based on rough field notes, it is unclear that flow measurements were made at the bottom of the well; therefore, it may be necessary to re–log the hole to verify that water from the volcanic aquifer is mixing with water in the carbonate aquifer. The downward–flow interpretation is consistent with previous studies (for example, see Feeney et al., 1987) which identify Stockade Wash as a groundwater–recharge area at the NTS.

In September 1990, discrete samples were collected from HTH–1 at seven depths following the sampling protocol outlined in Appendix B. Water samples were collected and analyzed at DRI for major cations and anions, and tritium. The significant results are shown diagrammatically alongside the well completion, EC log, and temperature log in Figure 4. The water

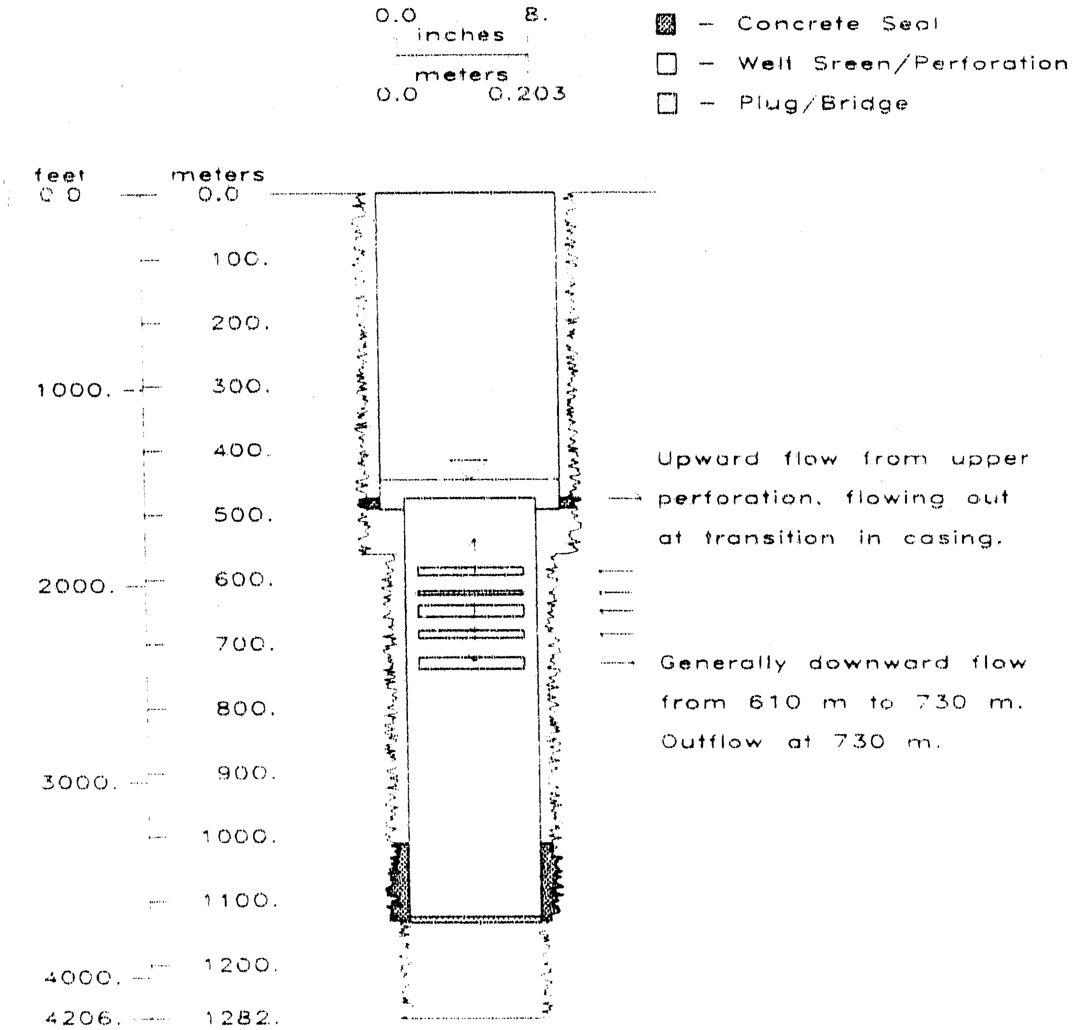


Figure 3. Preliminary Summary of Thermal Flowmeter Results for Well HTH-1.

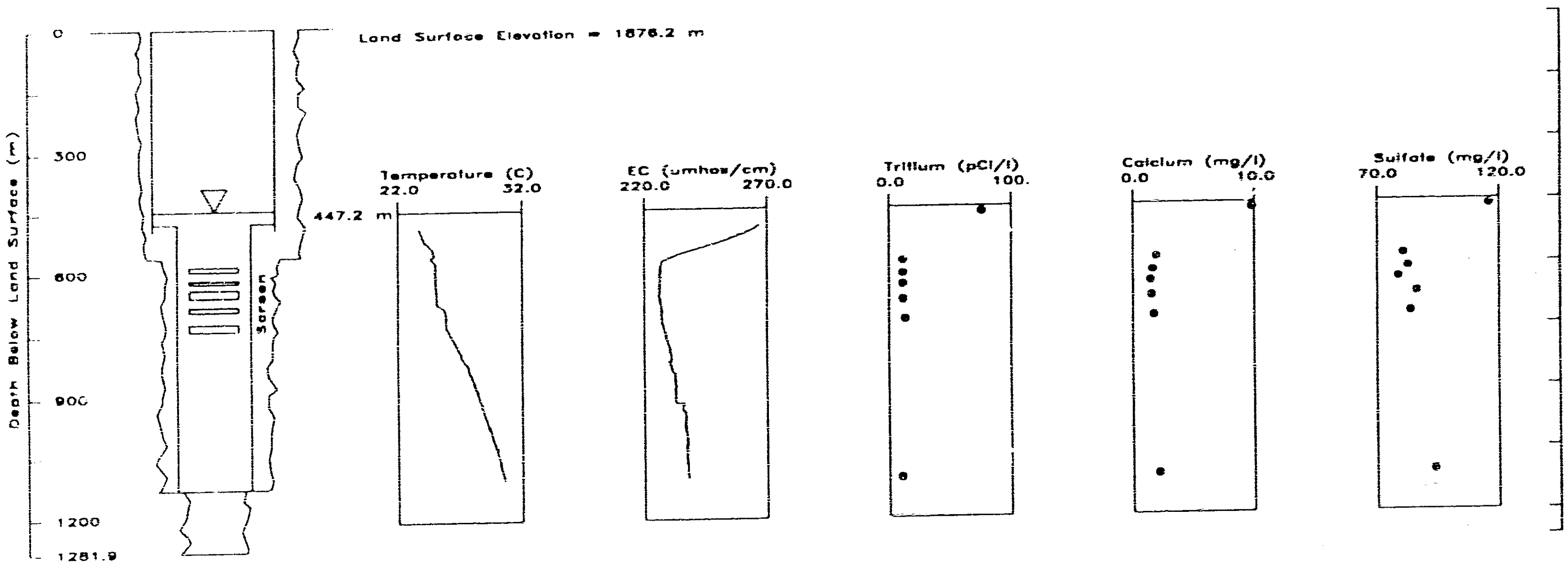


Figure 4. Variations in Temperature, EC, Tritium, Calcium, and Sulfate Versus Depth for Well HTH-1.

chemistry was relatively uniform along the depth of the hole, with the only significant difference observed near the change in casing diameter (Table 1). At this depth, the pH was slightly lower, the calcium concentration was approximately five times higher, and sulfate concentration was approximately two times higher than values below this depth. The highest tritium concentration was also observed at this depth, 76 pCi/L, compared with 10 to 13 pCi/L observed below this depth. The geochemical variations may be resulting from residual oil contamination or possible groundwater mixing; further sampling may be required to fully understand the variations.

In November 1990, discrete samples were collected at 588 m (1,930 ft) with a commercial tool made by TAM International. A 250-ml sample was collected once the tool was lowered to 588 m (1,930 ft) (referred to as "before" in Table 1). Packers were inflated in the well above and below the screened interval, with the sampler positioned equal distance between the packers. Several times the volume of the packed-off interval were then pumped to the zone above the upper packer. A 250-ml sample was then collected (referred to as "after" in Table 1), the packers were deflated, and the sampler tool was retrieved from the well. Samples were contaminated with oil that apparently was used as a lubricant in the sampler. The samples were analyzed for major cations and were compared to bailed samples from the same depth, collected two months earlier. Both TAM samples were higher in dissolved cation concentrations than previous bailed samples. Conversations with TAM personnel revealed that the tool had been tested in a well at their facility in Texas three days prior to the test at HTH-1. The current tool design precludes complete decontamination of the tool; therefore, the samples collected by TAM were probably contaminated with residual water left in the sampler.

Although thermal flowmeter logging has helped confirm inflow zones and vertical gradients, a discrete fluid sampling technique analogous to the flowmeter method will ultimately be required to accurately assess the source of elevated tritium at HTH-1. Toward this end, tentative plans are underway to employ a wireline packer and sampling device at HTH-1 to collect fluid samples from discrete intervals in the well.

Conclusions

Given its location relative to testing activities at Rainier Mesa, HTH-1 is a logical monitoring location for activities at the NTS. Elevated tritium levels at HTH-1 raise questions regarding the source of inflow to the Stockade Wash groundwater regime. Flow system analysis by Feeney et al. (1987) suggests that in addition to being in a zone of active recharge, Stockade Wash receives significant groundwater inflow from Rainier and Pahute Mesas to the north. Thermal-pulse flowmeter logging confirmed several zones of inflow and downward flow at HTH-1.

TABLE 1. CHEMICAL ANALYSES FOR WELL HTH–1.

Sample Depth (m) (ft)	Date (MDY)	Temp °C	EC fld	EC lab	pH fld	pH lab	Ca	Mg	Na	K	Cl	SO_4	HCO_3 fld	HCO_3 lab	SiO_2	Enriched Tritium pCi/L
461 (1513)	07/24/86	–	–	227.0	–	8.29	1.5	0.2	52.0	1.29	5.8	5.7	–	127.0	13.0	–
472 (1549)	09/24/90	18.0	276.0	269.0	9.00	8.76	9.8	0.3	53.1	1.13	3.4	17.4	115.9	116.0	10.7	76+/–9
588 (1930)	09/24/90	21.0	250.0	224.0	9.29	9.15	1.9	0.8	52.1	0.79	3.3	8.8	103.7	80.7	19.8	11+/–7
622 (2040)	09/24/90	21.0	245.0	225.0	9.04	9.15	1.6	0.2	51.6	0.38	3.3	8.5	91.5	82.7	20.1	<10
649 (2130)	09/25/90	23.0	255.0	224.0	9.21	9.21	1.4	0.2	51.4	0.41	3.3	8.6	125.6	78.5	20.0	<10
686 (2250)	09/25/90	23.0	252.0	222.0	9.29	9.24	1.5	0.2	51.8	0.38	3.2	8.4	101.3	85.9	21.5	11+/–6
732 (2400)	09/25/90	22.0	245.0	225.0	9.26	9.25	1.7	0.2	51.6	0.34	3.2	7.6	128.1	83.7	22.0	13+/–8
1122 (3680)	09/26/90	30.0	245.0	225.0	9.24	9.18	2.1	0.2	51.4	0.77	3.6	0.9	128.1	93.5	2.5	<10
588 (1930)	11/14/90	–	–	–	–	–	4.2	0.7	69.1	1.05	–	–	–	–	–	TAM test before
588 (1930)	11/14/90	–	–	–	–	–	3.0	0.5	89.4	1.18	–	–	–	–	–	TAM test after

– Not Analyzed

The lack of annular seals in the perforated zones add additional complexity to the interpretation of the vertical geochemical variations observed during this study. Inflow and outflow zones measured in the well can be used to interpret potential sources for the geochemical variation. However, the thermal pulse flowmeter results need to be refined prior to making any firm conclusions about geochemical sources and sinks.

Recommendations

1. Run thermal flowmeter below 741 m (2,430 ft).
2. Establish access to the carbonate aquifer for monitoring and testing.
3. Upon review of results from steps number 1 and 2, recommendations will be made addressing the recompletion of the well.

WELL: UE18r

General Background

Well UE18r was the first deep exploration hole in the Timber Mountain caldera and is located on the western boundary of the NTS (N. 264,584 m, E. 172,112 m), at an elevation of 1,688 m (5,538 ft) above mean sea level (Figure 1). It was drilled to investigate the structure, stratigraphy, and hydrology of the northern part of the caldera (Carr et al., 1968). An aquifer test was run in the well in 1968 for 47 hours at 15.1 liters per second (240 gpm), producing 5.8 m (19 ft) of drawdown. Well logs recorded during construction and testing in 1967–1968, and during a second period of testing in 1978, are listed in Appendix C.

Construction Details

The following summarizes the hole history report received from Fenix and Scisson, Nevada. Appendix C contains this document and Figure 5 illustrates a schematic of the well.

Well UE18r was spudded on November 29, 1967. A 91–cm (36–inch) hole was drilled to 11.6 m (38 ft) and a 59.1–cm (23.25–inch) surface casing was set in place with 8.5 m^3 (300 cubic feet) of cement. A 38.1–cm (15–inch) hole was then drilled to 497 m (1,632 ft) and a 25.5–cm (10.05–inch) casing was set in place with 63.4 m^3 (2,240 cubic feet) of cement, from the surface to a depth of 497 m (1,629 ft). A 25.1–cm (9.875–inch) hole was then drilled 1,520 m (4,988 ft) and a 15.6–cm (6.125–inch) hole was drilled 1,525 m (5,004 ft); both lower sections were left uncased. The well was completed on February 8, 1968. After the completion of a vibroseis survey on June 24, 1978, a Gearhart Owens wire line bridge was set at 763 m (2,505 ft) and 9.7 *l* (2.55 gal) of Cal–Seal were dumped in the well to form a plug (recent logging efforts show that this plug no longer exists).

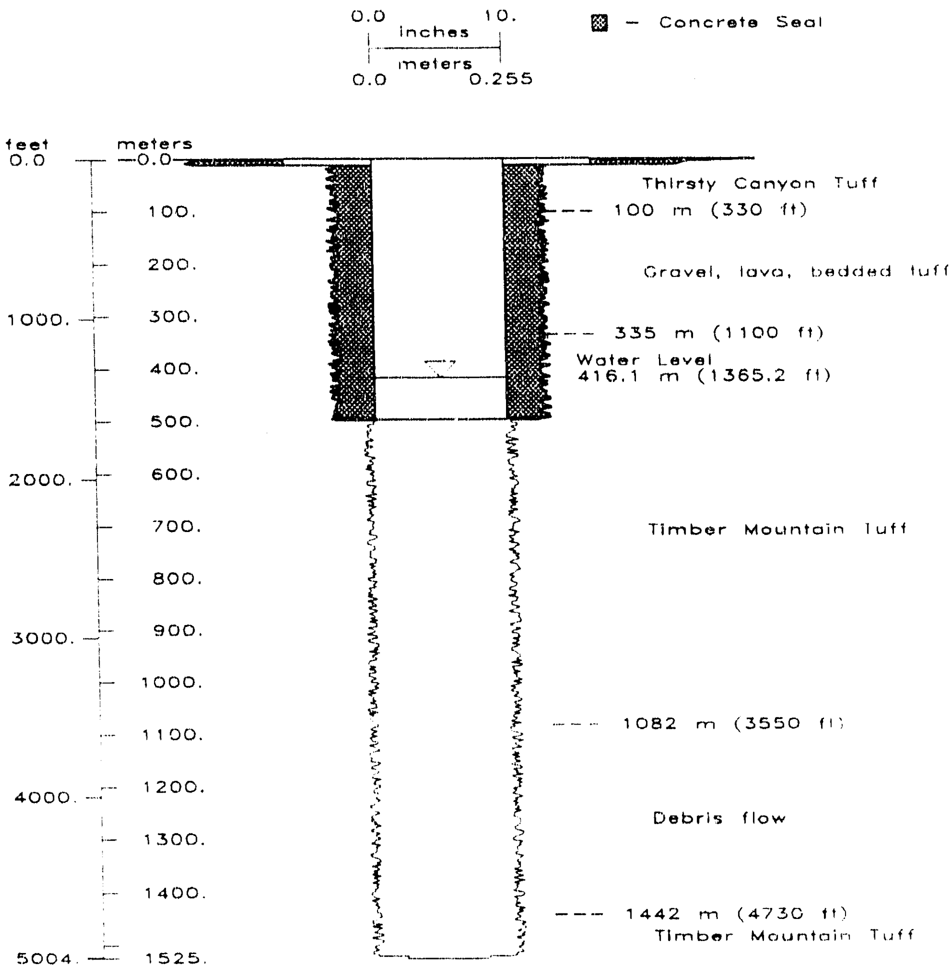


Figure 5. Generalized Schematic of Well UE18r.

Role in Well Validation Program

Well UE18r is one of only a few wells that exist on the western boundary of the NTS; wells along this boundary are hydrologically downgradient from testing conducted on Pahute Mesa (Blankennagel and Weir, 1973). Predictions of groundwater flow and contaminant migration from Pahute Mesa will rely on hydrogeologic data from this location. Therefore, it is crucial that the hydrogeology of the site is fully understood prior to further modeling.

The major geologic units encountered consist of volcanic rocks, primarily rhyolites, tuffs, and debris flows; a detailed description of the geology was reported by Carr et al. (1968). Several hydrologic tests were conducted in 1967; three major water production zones were found above a depth of 732 m (2,400 ft), from 797 to 858 m (2,616 to 2,816 ft) and from 1,049 to 1,110 m (3,442 to 3,642 ft) (Carr et al., 1968). A tracejector survey was conducted by Blankennagel and Weir, USGS (Carr et al., 1968) which showed that 52 percent of the water pumped from the well came from the zone 506 to 510 m (1,660 to 1,675 ft) below land surface (bls); the next highest production comprised 12 percent of the flow and came from the zone 1,082 to 1,085 m (3,550 to 3,560 ft).

Blankennagel and Weir (1973) categorized UE18r as an intermediate transmissivity well 1.44×10^{-3} to 5.75×10^{-3} m^2/s (between 10,000 and 40,000 gpd/ft), with respect to other wells on Pahute Mesa. A 47-hour single well aquifer test was conducted under the supervision of Blankennagel and Weir in 1967. The test was conducted at 15.1 *l*/s (240 gpm) and 5.8 m (19 ft) of drawdown was observed. From these data, a specific capacity of 2.7 *l*ps/m (13 gpm/ft) and a transmissivity of 3.3×10^{-3} m^2/s (23,000 gpd/ft) were computed.

A water chemistry sample was collected from UE18r on January 29, 1968, at the end of the aquifer test. This was a composite sample representing the interval from 497 to 1,525 m (1,629 to 5,004 ft). The chemical analysis is listed in Table 2.

TABLE 2. CHEMICAL ANALYSIS FOR WELL UE18r (concentration in mg/l and EC in µmhos/cm @ 25°C).

Date	Source	Temp °C	Ca	Mg	Na	K	Cl	SO_4	HCO_3	SiO_2	EC	pH
1/29/68	USGS	32.2	26	1.0	81	3.1	7.8	24	252	45	449	8.0
9/23/88	DRI	27.5	20.6	0.95	75	3.32	6.9	23.4	225	52	416	8.15

Recent Activities at UE18r (1988–1990)

In October 1988, UE18r was visited by DRI to log for electrical conductivity (EC) and temperature, and to collect a water sample. The well was logged to a depth of 1,189 m (3,900 ft) (the maximum depth capability of the DRI logging equipment), and a water chemistry sample was collected from 914 m (3,000 ft). These logs showed abrupt changes in EC and temperature at the following three zones: 427 to 506 m (1,400 to 1,660 ft); 579 to 640 m (1,900 to 2,100 ft); and 1,116 to 1,183 m (3,660 to 3,880 ft).

In June 1990, UE18r was visited by DRI and the USGS, Denver. Using the USGS logging equipment, temperature, EC, caliper, and thermal flowmeter logs were run. Only preliminary results are available from the USGS logging; the following are observations recorded by DRI during the logging effort. The caliper log was run from approximately 411 to 1,518 m (1,350 to 4,980 ft) (starting from above the water table and extending to the bottom of the hole). The standing water level was encountered at 415 m (1,362 ft) bls. The caliper log showed a decrease in well–bore diameter at the water table from 25.4 cm (10 inches) down to approximately 12.7 cm (5 inches), suggesting that there is an obstruction in the well at the water table. Additionally, the caliper log identified four zones where the well–bore diameter increased significantly: at 579 m, 823 m, 1,097 m, and 1,341 m (1,900 ft, 2,700 ft, 3,600 ft, and 4,400 ft, respectively); these zones are believed to be areas of high fracture density or nonwelded tuff, and therefore were the areas targeted for thermal flowmeter logging.

The flowmeter was run first at 421 m (1,380 ft) (6.7 m (22 ft) below the water table) to determine if vertical flow existed in the casing. A slight upward gradient was measured inside the casing, suggesting that water is flowing out of the casing somewhere. It is possible that the obstruction found at the water table may be cement that squeezed into the well through an opening in the casing during pressure grouting and that the outflow previously noted is occurring into a zone of lower head through this opening. Thus, the water level measured in the well may be influenced by a fracture in the casing and subsequent outflow through this fracture. As a result, the hydraulic head represented by the current depth to water may be a composite of those zones below the casing bottom, and some upper zones in the vicinity of the casing fracture. If this is the case, a composite head of only those zones below the casing is expected to be greater than one which includes this upper zone.

Inflow zones were identified at approximately 792 and 1,341 m (2,600 and 4,400 ft) and outflow zones were identified at approximately 579 and 1,097 m (1,900 and 3,600 ft); a stagnation zone was identified between 792 and 1,079 m (2,600 and 3,600 ft), where vertical flow was below the detection limit of the thermal flowmeter (approximately 0.5 mm/sec (0.1 ft/min)) (Figure 6). The outflow zone at 579 m (1,900 ft) was considered minor and most of the water from the 792–m (2,600–ft) inflow zone was leaving the well at the water table (415 m (1,362 ft)).

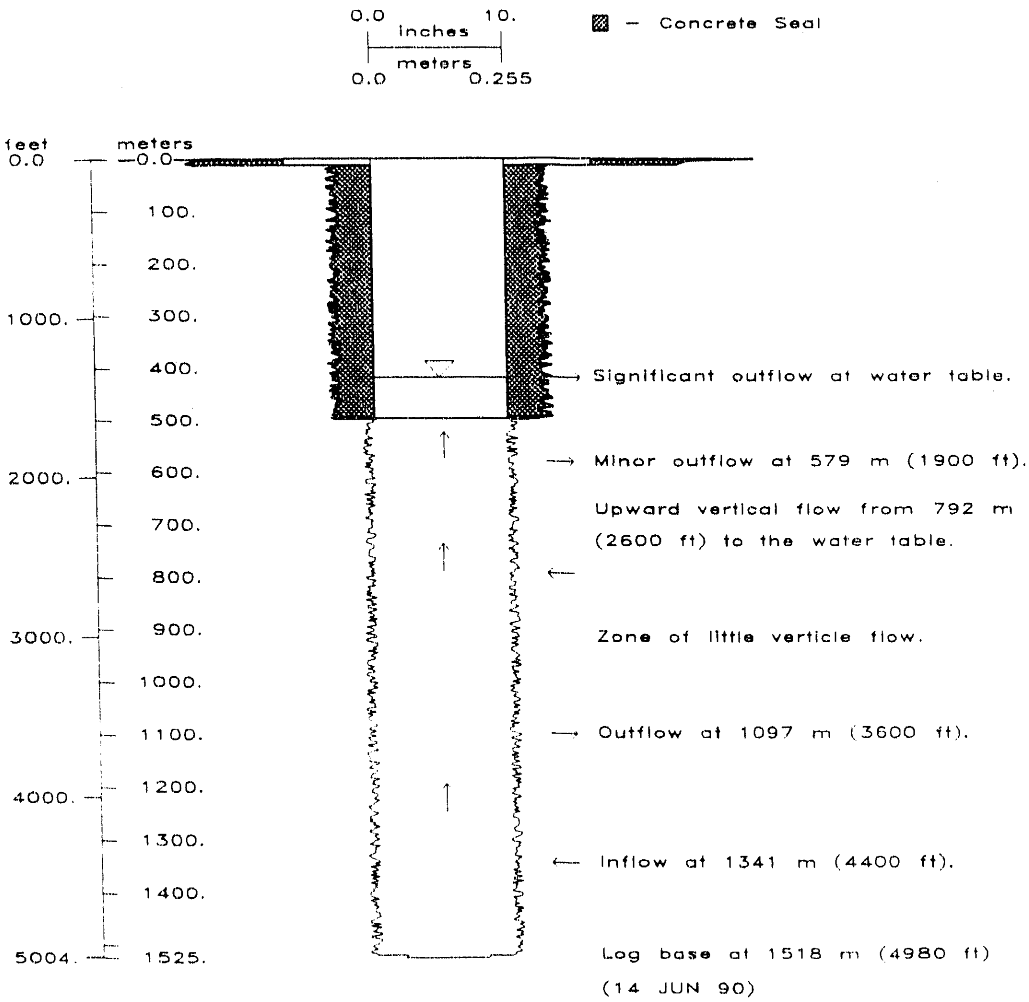


Figure 6. Preliminary Summary of Thermal Flowmeter Results for Well UE18r.

Conclusions

Given the downgradient location of UE18r from testing activities on Pahute Mesa, a detailed understanding of the hydrogeology is critical so that monitoring data can be analyzed properly. Currently, water samples are collected from UE18r every six months by the EPA from the upper flow zone (507 m (1,663 ft) bls), as part of the LTHMP. Geologic structural complexities and laterally discontinuous formations may make the lower flow zone just as important as the upper flow zone, from a contaminant transport point of view. Therefore, samples should be collected from two intervals: 686 and 1,219 m (2,250 and 4,000 ft) bls.

Based on the thermal flowmeter data, the composite water level measured in the well should be considered a minimum water level for the aquifers encountered, and a packer and transducer should be set at 421 m (1,380 ft) and the shut–in pressure monitored so that a true composite head can be computed.

Recommendations

1. Collect water samples from four depths for major ions and environmental isotopes: 418, 762, 914, and 1,219 m (1,370, 2,500, 3,000, and 4,000 ft).

2. Set a packer at 421 m (1,380 ft) and use the shut–in pressure to compute a true composite head.

3. Upon review of geochemical samples and head measurements (from steps 1 and 2 above), recommendations should be made with regard to future work at well UE18r.

WELL: UE6e

General Background

Well UE6e is an exploration hole in Yucca Flat (N. 248,095 m, E. 209,753 m) at a land surface elevation of 1,199.5 m (3,935.6 ft) above mean sea level (Figure 1). The well was presumably drilled to explore the hydrogeology of southern Yucca Flat. The well intersected alluvium, volcanic tuff, and Paleozoic carbonate rocks.

Construction Details

The following summarizes the hole history received from Fenix and Scisson, Nevada. Appendix D contains this document and Figure 7 illustrates a schematic of the well.

Well UE6e was spudded on February 27, 1973. A 91.4–cm (36–inch) hole was drilled to 37 m (120 ft), and a 49.5–cm (19.5–inch) inside–diameter surface casing was set in place with

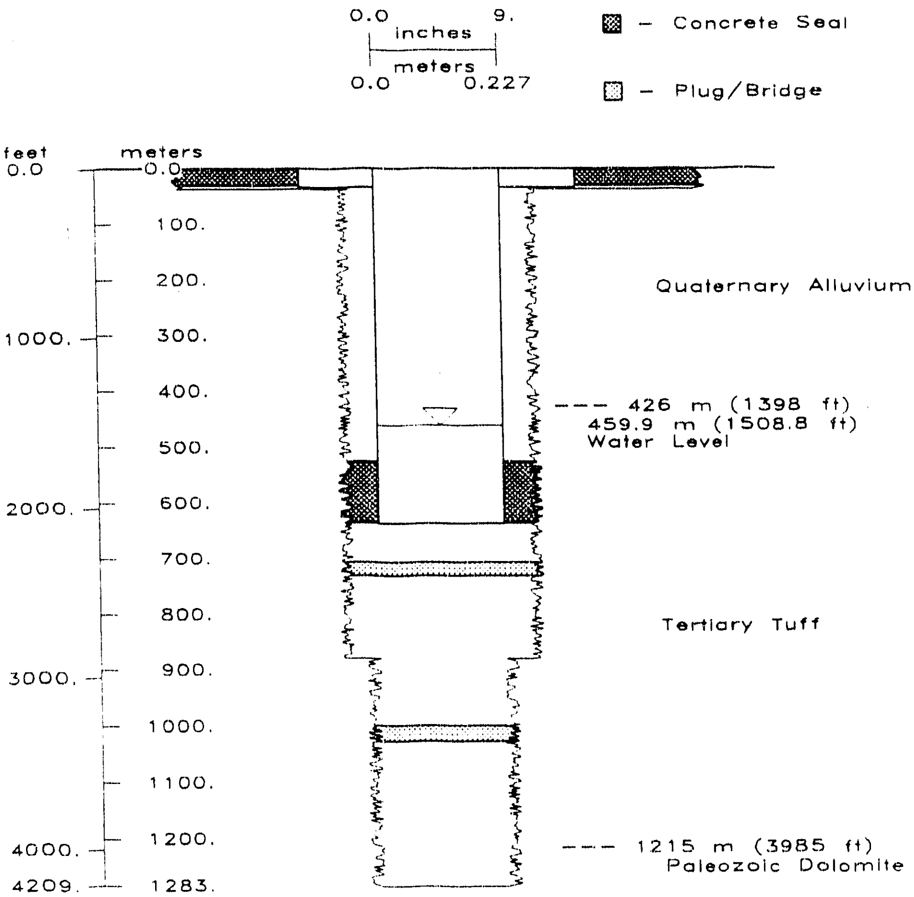


Figure 7. Generalized Schematic of Well UE6e.

21 m^3 (760 cubic feet) of cement. A 31.1–cm (12.25–inch) hole was then drilled to 880 m (2,886 ft); 22.7–cm (8.921–inch) inside–diameter casing was set in place with 18.3 m^3 (645 cubic feet) of cement, from the surface to a depth of 637 m (2,090 ft). A 22.2–cm (8.75–inch) hole was then drilled 1,283 m (4,209 ft); the hole was left uncased from 637 to 1,283 m (2,090 to 4,209 ft). Hole stability problems were mentioned in the daily summaries and several bridges were drilled out during the completion of the well. The well was completed on December 3, 1973, at a depth of 998 m (3,275 ft).

Role in Well Validation Program

Well UE6e is located hydrologically downgradient from the Yucca Flat underground testing area. Slightly elevated tritium concentrations have been observed in wells near UE6e, at Well A and Test Well B. Similar elevated tritium values would be expected in UE6e in the alluvium and volcanic rocks; additionally, UE6e may provide an opportunity to study the poorly monitored carbonate aquifer. Paleozoic rocks are believed to convey water beneath the NTS, basically from the northeast toward the southwest. A thorough understanding of the interaction between the regional carbonate aquifer and the overlying aquifer(s) is imperative to adequately monitor the carbonate aquifer for possible radionuclide migration.

Well UE6e intersected 417 m (1,368 ft) of alluvium, 798 m (2,617 ft) of volcanic tuff and 68 m (223 ft) of Paleozoic carbonate rocks; a lithologic description was included in a report by Fernald et al. (1975). The lithologic log contains detailed descriptions of the alluvium, identifies the volcanic units (Timber Mountain Tuff, Paintbrush Tuff, Rhyolites of Area 20, Tunnel Beds, Redrock Valley Tuff, and Horse Springs Formation), and postulates the carbonates to be from the Devonian Nevada Formation. No known hydrologic tests were conducted on UE6e; however, numerous electrical logs were run during construction of the well.

Recent Activities at UE6e (1990)

In June 1990, UE6e was visited by DRI and the USGS, Denver. Using DRI equipment, the water table was measured at a depth of 460 m (1,508.8 ft) and an obstruction was encountered at 704 m (2,308.2 ft). A sample was bailed from the well and analyzed with a portable field scintillation counter. The analysis did not reveal unusually high tritium activities in the water. A sample was collected for laboratory tritium analysis to compare with results from Well A and Test Well B (analysis results were received upon publication of this document). The USGS ran a caliper log and used the thermal flowmeter to identify possible vertical flow. Preliminary field notes collected by DRI suggested that little or no vertical flow existed in the 66 m (216 ft) of available open hole explored by the USGS.

Conclusions

Well UE6e is of hydrologic importance for two reasons: 1) its downgradient location from underground testing on Yucca Flat makes it an excellent location for monitoring potential radionuclide migration; and 2) its completion into the Paleozoic carbonate rocks provides an opportunity to measure the interaction between the regional carbonate aquifer and the overlying aquifers. Caliper logs run during construction and after completion of the well, and based on the vast number of reported slough zones during construction, suggest that the well was unstable prior to completion; therefore, the obstruction encountered at 703 m (2,308 ft) is believed to be a slough or earthen bridge. Although the well may contain several bridges, it may be acting as a conduit between the alluvial/volcanic aquifer and the regional carbonate aquifer.

The thermal flowmeter data were inconclusive due, in part, to the limited amount of open hole that could be examined. It is possible that UE6e is in a regional hydrologic setting where vertical flow may not be occurring; however, without more open hole, no conclusion can be drawn from the available data.

Recommendations

1. Clean out hole from 637 to 1,283 m (2,090 to 4,209 ft) and install sliding sleeve casing to maintain access to the well. The carbonate rock aquifer should be isolated from the overlying aquifers. Sleeved sample ports should be installed at multiple depths based on thermal flowmeter results, lithology, and chemical/isotopic variations. If this is cost prohibitive, then tubing should be installed to the carbonate aquifer and the upper portion of the hole sealed.

2. Collect water samples from each aquifer delineated in recommendation 1 as part of the LTHMP; at a minimum, two samples should be collected, one from the carbonate and one from the overlying aquifers.

WELL: HTH-3

General Background

Hydrologic Test Hole 3 (HTH-3) is one of a group of wells drilled in the early 1960s to explore general hydrologic conditions around the NTS. It is located outside the NTS boundary in the eastern part of Frenchman Flat (N. 228,646 m, E. 224,607 m). The site is currently part of the Nellis Air Force Base Bombing and Gunnery Range. The well is on the flank of the Ranger Mountains, at an elevation of 1,060 m (3,477 ft) above sea level (Figure 1).

Construction Details

Drilling of HTH–3 began on March 22, 1962 and was completed on May 11, 1962. The hole history can be found in Appendix E. The well was drilled to a depth of 565 m (1,853 ft) with air–rotary drilling equipment. A 34.0–cm ($13^3/_8$–inch) outside–diameter casing was installed from 0 to 50 m (163 ft) and 17.8–cm (7–inch) outside–diameter casing with a Baker shoe in the bottom was installed from 0 to 462 m (1,517 ft) bls (Figure 8). The casing is slotted between 364 and 462 m (1,193 and 1,516 ft) bls. The hole was apparently left open between 462 and 565 m (1,516 and 1,853 ft) bls, though the shoe prevents sounding below 462 m (1,516 ft) to verify this.

Electric, neutron, induction, temperature, sonic, caliper, and density logs were run in the well between May 3 and 8, 1962. Twenty–six cores were collected during the drilling operation, with generally good recovery (Appendix E). The well penetrated Quaternary/Tertiary–age alluvium from 0 to 48 m (157 ft) bls, and limestone, dolomite, and shale of Paleozoic age from 48 to 565 m (157 to 1,853 ft) bls. The Pogonip Group, the Goodwin Formation, and Windfall Formation were tentatively identified in the Paleozoic rocks (Meyer and Young, 1962).

A water level of 337 m (1,105.8 ft) bls was measured during drilling when the hole was 373 m (1,225–ft) deep. Meyer and Young (1962) report a static water level in the well of 336 m (1,103 ft) bls, presumably after completion to the final depth. They also report that packer tests

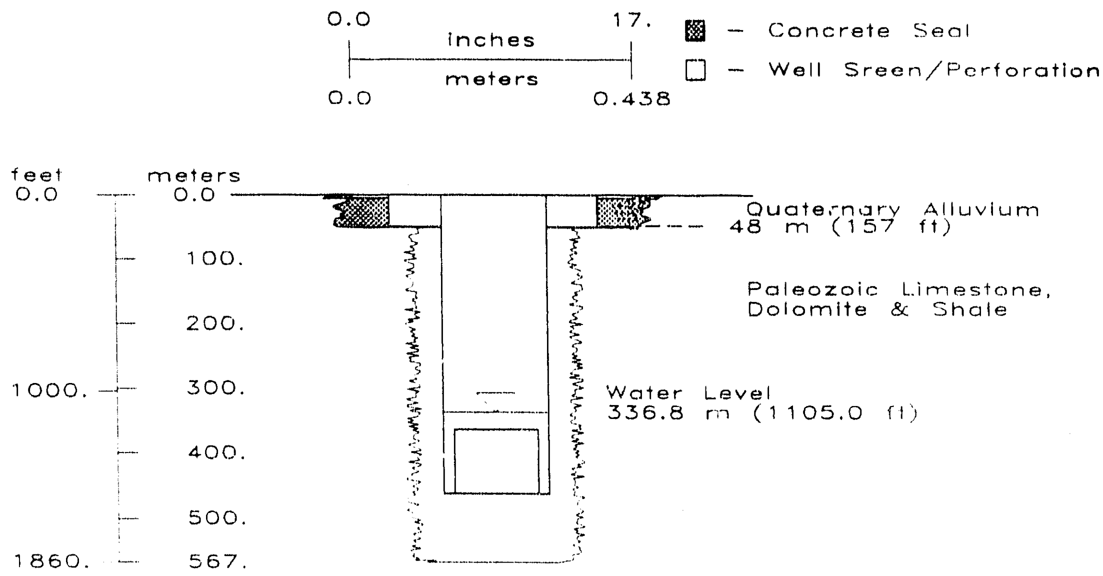


Figure 8. Generalized Schematic of Well HTH–3.

in the intervals 441 to 519 m (1,448 to 1,702 ft) and 491 to 519 m (1,612 to 1,702 ft) indicated the same head.

A high transmissivity zone was identified in the interval from 371 to 415 m (1,217 to 1,360 ft) bls during swabbing tests. A pump test was performed from May 9 to 10, 1962, with a Reda submersible pump set at 415 m (1,360 ft). Discharge rates were 1.8, 2.6, and 3.0 *l*ps (29, 41, and 48 gpm), and specific capacity ranged from 0.10 to 0.13 *l*ps/m (0.5 to 0.64 gpm/ft) of drawdown. The well was considered capable of yielding at least 2.5 *l*ps (40 gpm). A water sample was collected at the end of the pump test and analyzed by the USGS.

Hydrogeologic Setting

HTH–3 is of great interest to the well validation project because of its completion in the Paleozoic carbonates and location on the east side of the NTS. On the frequently–referenced potentiometric map by Winograd and Thordarson (1975), the only data point that supports the curving of potentiometric contours that creates the southerly–directed potentiometric surface trough in the carbonate rocks along the axis of Yucca Flat, is the water level in HTH–3 (Figure 9). The head measured at HTH–3 was identical to that at Well C, over 16 km (10 miles) away. Not only is verifying the hydraulic head and what unit it represents important at HTH–3, the well also provides access to the regional carbonate aquifer in an area undisturbed by NTS activities. Obtaining a reliable age for water from HTH–3 could greatly aid regional flow and transport analysis of the NTS.

The apparent upgradient position of HTH–3 from the NTS testing areas makes the well attractive for determining background chemical and radiochemical characteristics for the carbonate aquifer. The well could also eventually serve as an upgradient monitoring well in the NTS monitoring network.

Recent Activities at HTH–3 (1990)

There is no record in the Fenix and Scisson hole history of any activities at HTH–3 since 1962. Little has been done at the well in large part due to the difficulty in coordinating access between the NTS and Air Force property. Water levels were apparently measured by the USGS in 1963 (336 m (1,103.4 ft) bls on 1/25/63), and reportedly in the 1980s, though no record of this last visit could be found.

DRI and the USGS–Las Vegas visited HTH–3 on June 9, 1990. Rather than the 17.8–cm (7–inch) diameter open well expected, 7.3–cm ($2^7/_8$–inch) tubing was extending from the hole, with a large discharge pipe over the entire well bore, leading to a pit north of the well. No record

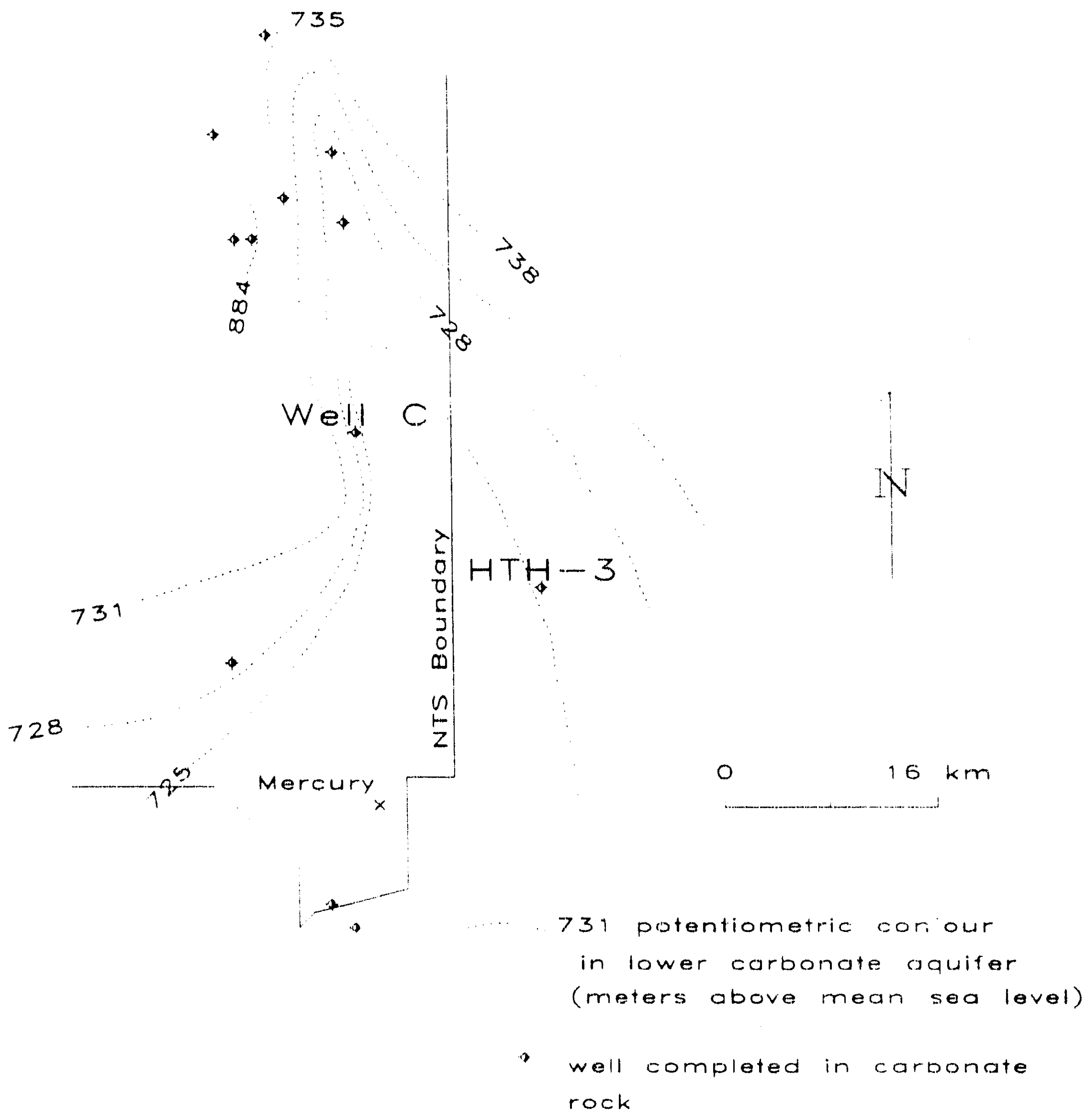


Figure 9. Generalized Potentiometric Surface Map of Carbonate Aquifer Near Well HTH-3.

of this material being installed at HTH–3 could be found, nor could personnel at the USGS, DRI, or Fenix and Scisson recall any activities there. The tubing and discharge pipe suggest that air–lifting was performed at HTH–3, but when and why this was done remain unknown.

Access into HTH–3 is currently possible only through the 7.3–cm ($2^7/_8$–inch) tubing. This prohibited use of the USGS–Denver geophysical tools and DRI's Bennett sampling pump. The water level on 6/9/90 measured by the USGS–Las Vegas and DRI was 337 m (1,105 ft) bls, comparable to the measurements during and shortly after drilling. DRI tagged the bottom of the well at 459 m (1,507 ft), reasonably consistent with the location of the Baker shoe.

DRI collected water samples on 6/9/90 and 6/16/90. Oil was encountered at the top of the water column, but efforts to remove it by bailing had limited success.

Purging and cleaning of the well would normally precede water sampling, but given the difficulty of gaining access to the site and uncertainty as to when it could be sampled in the future, the maximum possible quantity of water was collected. The chemical analysis of the June 1990 samples compares favorably with the 1962 analysis (Table 3). Tritium activity, determined using enrichment techniques, was found to be le ;s than 10 pCi/L (<3.1 Tritium Units), indicating that the water in the well was recharged befo.e 1953. A sample was collected for carbon–14 analysis but the results were not received as of the writing of this report (the sample was sent to the University of Arizona for analysis because the presence of the tubing and limited time–of–access prohibited collection of the large sample volume required for a standard carbon–14 analysis).

Conclusions

The stable water level measured in HTH–3 and total depth consistent with the Baker shoe in the bottom of the casing suggest that structurally, HTH–3 is in good condition. There remains uncertainty as to the condition of the hole from the shoe to the total drilled depth. The comparable 1962 and 1990 chemical analyses further supports the integrity of the well. The oil encountered may be a residue from earlier pumping activities.

TABLE 3. CHEMICAL ANALYSIS FOR HTH–3 (concentration in mg/L and EC in µmhos/cm @ 25°C). F = FIELD MEASUREMENT.

Date	Source	Temp (°C)	pH	HCO_3	Cl	SO_4	NO_3	Na	K	Ca	Mg	SiO_2	Fe	Sr	Li	^3H
5/10/62	USGS	38	7.3	328	23	84	0.9	83	7.6	51	21	24			0.12	
6/16/90	DRI		8.27	343	23.2	66.8	<0.04	79.6	9.18	48.8	19.7	17.4	0.12	0.89	0.11	<10pCi/L
6/16/90	DRI	34.5 F	7.4 F	323 F												

Recommendations

1. Remove the tubing and discharge pipe assembly from HTH–3 to allow free access into the well.

2. Evaluate drilling out the Baker shoe in the bottom of the 17.8–cm (7–inch) casing to allow geophysical logging (USGS teleseismic viewing) of the open hole. This would also allow confirmation of the hole condition between 462 and 565 m (1,517 and 1,853 ft) bls, but should only be done after a thorough records search to confirm that the horizon was not cemented.

3. Perform a long–term pump test to measure hydraulic properties, clean out the well, and collect a purged water sample.

4. Maintain well integrity (e.g., add a locking cap) and add the well to the LTHMP network.

PHASE II TESTING PROCEDURES

Phase II testing procedures were developed for each well based on historical information and the results of Phase I testing.

Phase I testing at HTH–1 yielded valuable information about vertical flow in the well, and water samples collected from discrete depths indicated slightly elevated tritium concentrations near the water table. Phase II testing procedures are as follows:

1. Repeat thermal flowmeter measurements at each depth previously made in Phase I testing, to evaluate the long–term repeatability of thermal flowmeter measurements, and to make additional measurements between each of these points and at the bottom of the hole, to help quantify the downward flux in the hole.

2. Collect water samples from four discrete depths near the water table to verify that the elevated tritium that was encountered in Phase I testing is still of the same magnitude, and secondly, to more accurately measure the vertical extent of the elevated tritium in the well. This information will be used to develop hypotheses about the origin of the tritium and its flow path into the well.

3. Based on information from Phase I testing and from the above mentioned measurements, a recommendation will be made regarding the most appropriate depth from which samples should be collected for long–term hydrologic monitoring and/or recompletion of the well.

Phase I testing at UE18r also yielded interesting information about vertical flow in the well, both within the cased and uncased portions of the hole. Two aquifers were identified during Phase I testing and a potential outflow zone may have been identified in the casing at the water table. Phase II testing procedures will be developed to further understand the hydraulic and geochemical significance of the Phase I results.

1. Repeat thermal flowmeter measurements near the water table to more accurately quantify the extent of outflow through the casing. Repeat measurements will also be made at the same depth as Phase I testing to measure potential time-series variations of flux.

2. Collect water samples from four depths for major cations and anions, trace ions, and environmental isotopes. Samples will be collected near the water table, from the upper and lower flow zones, and from the stagnation zone between the two flow zones. These data will be used to quantify the geochemical similarities and differences between the two aquifers.

3. Currently, EPA collects water samples from 508 m (1,665 ft) bls, which is 11 m (35 ft) below the bottom of the casing. Based on the results from Phase I testing and the above mentioned measurements, a recommendation will be made regarding the depth(s) from which samples should be collected as part of the LTHMP.

Phase II testing of Wells UE6e and HTH-3 will require the removal of debris and/or hardware from each well, which is beyond the scope and monetary constraints of this study. However, the steps necessary to complete Phase II testing at these sites will be covered for completeness.

Phase I testing at UE6e yielded limited results, due to the small amount of open hole encountered between the bottom of the casing and an earthen bridge (approximately 61 m (200 ft)). These findings were regrettable due to the hydrologic importance of the well, for monitoring of radionuclide migration and for measuring the hydrologic interaction between the volcanic and carbonate rocks. Although a bridge was encountered at 703 m (2,308 ft) bls, the integrity of the remaining hole is unclear, and may be acting as conduit for radionuclide migration between the volcanic and underlying carbonate aquifers. Since the carbonate aquifer is believed to be the most probable transport path for radionuclides off the NTS, it is important that at a minimum the well be cleaned out and that the carbonate aquifer is sealed off from the volcanic aquifers. It is further recommended that a piezometer be installed into the carbonate aquifer prior to setting this seal for long-term monitoring of the carbonate aquifer, and to fully utilize this well a piezometer should be installed in the volcanic aquifers to measure the interaction between the two aquifers. Once the hole is cleaned out, the following Phase II testing procedures are recommended.

1. Log the hole for temperature, EC, and caliper. Compare the logging results to previously recorded information and outline areas of interest for thermal flowmeter measurements. Conduct thermal flowmeter measurements and recommend piezometer completion depths.

2. Collect discrete water samples from each aquifer prior to piezometer installation.

3. Oversee piezometer installation.

4. Collect bulk samples from each piezometer with a low volume pump once the EC and pH have stabilized, and analyze the samples for radionuclide contamination.

5. Develop a monitoring plan for water level measurements and for sampling based on results from the above steps.

Phase I testing at HTH–3 was hampered by the presence of tubing in the well, restricting access into the hole. Despite this limitation, a water sample was collected with a small discrete bailer and yielded a chemical analysis similar to that obtained when the well was drilled and tested in the early 1960s. This result suggests that downhole conditions have remained chemically stable and this stability, along with the well's geographic and stratigraphic location, makes HTH–3 an excellent candidate for monitoring background conditions in the carbonate aquifer. Also important is the acquisition of high quality samples after purging for determining the age of the water because the well is postulated to be on a very long flow path, with recharge possible in the Pahranagat Lakes area. Obtaining an age date and hydraulic properties from HTH–3 will be important for establishing boundary conditions on the east side of the NTS for regional flow analysis.

The following actions are recommended at HTH–3 outside the scope of this study:

1. Evacuate the well by air lifting prior to removing the tubing (the tubing in HTH–3 and piping leading from the well head to a surface pit appear suitable for an airlifting operation). This will purge the well and eject the layer of oil currently on the top of the water column.

2. Remove the tubing from HTH–3 and run a caliper log to evaluate downhole conditions.

3. Consider drilling out the Baker shoe at the bottom of the casing.

Once these activities are complete, the following Phase II testing procedures are recommended:

1. Monitor water level rise in the well after air lifting.
2. Log the hole for temperature and EC and conduct thermal flowmeter measurements to establish vertical flow directions in the hole.
3. Collect discrete water samples from producing horizons identified in step number 2.
4. Collect a large volume sample from one or more horizons (depending on previous results) for Carbon–14 analysis. This will be done using a low–volume pump (e.g., Bennett pump).
5. Provide the LTHMP with necessary information to add HTH–3 to the monitoring program.

ACKNOWLEDGEMENTS

The authors would like to thank Al Hess, Roger Morin, and Barbara Allen from the U.S. Geological Survey for coming out from Denver and running their thermal flowmeter tool.

Additionally, the authors thank, Sam Hokett for overseeing the DRI logging activities and reviewing this document, Todd Mihevc and Bruce Wert for helping with field data collection, and Roger Jacobson for coordinating activities with DOE.

REFERENCES

Blankennagel, R.K. and J.E. Weir, 1973. Geohydrology of the Eastern Part of Pahute Mesa, Nevada Test Site, Nye County, Nevada, U.S. Geological Survey, Prof. Paper 712–B, pp. 35.

Boughton, C.J., 1986. Integrated Geochemical Analyses of Nevada Test Site Ground Water Systems, unpublished Master's Thesis, University of Nevada, Reno.

Carr, W.J., F.M. Byers and E.C. Jenkins, 1968. Geology of Drill Hole UE18r, Timber Mountain Caldera, Nevada Test Site, U.S. Geological Survey, Technical Letter, Special Studies–69, pp. 23.

Feeney, T.A., M.E. Campana and R.L. Jacobson, 1987. A Deuterium–Calibrated Groundwater Flow Model of the Western Nevada Test Site and Vicinity, 1987, Desert Research Institute, Water Resources Center, Publication No. 45057.

Fernald, A.T., F.M. Byers and J.P. Ohl, 1975. Lithologic Logs and Stratigraphic Units of Drill Holes and Mining Shafts in Areas 1 and 6, Nevada Test Site, U.S. Geological Survey, NTS–256, USGS–474–206, pp. 62.

Meyer, G.L. and R.A. Young, 1962. Summary of Hydraulic Data and Abridged Log for Ground–Water HTH–3, Frenchman Flat, Nevada Test Site, U.S. Geological Survey, Technical Letter NTS–30.

Morin, R.H., 1990. Personal communication, U.S. Geological Survey, Geophysicist, Denver, Colorado.

Morin, R.H., A.E. Hess and F.L. Paillet, 1988. Determining the Distribution of Hydraulic Conductivity in a Fractured Limestone Aquifer by Simultaneous Injection and Geophysical Logging, Groundwater, Vol. 26, No. 5, pp. 587–595.

Thordarson, W. and I.J. Winograd, 1961. Abridged Log of Ground–Water Test Well 1 Stockade Wash, Nevada Test Site, Nevada, U.S. Geological Survey, Technical Letter, NTS–6.

Waddell, R.K., 1982. Two–Dimensional, Steady–State Model of Ground Water Flow, Nevada Test Site and Vicinity, Nevada–California, U.S. Geological Survey, W.R.I. 82–4085.

Winograd, I.J. and W. Thordarson, 1975. Hydrogeologic and Hydrochemical Framework, South–Central Great Basin, Nevada–California, with Special Reference to the Nevada Test Site, U.S. Geological Survey Professional Paper 712–C, pp. 126.

APPENDIX A

Hole History Data for HTH–1
(Fenix and Scisson, Nevada)

FENIX & SCISSON OF NEVADA
HOLE HISTORY DATA

Approved: [signature]
Date:

Hole No.: USGS HTH #1/Test Well #1 | Type Hole: Hydrologic Test
User: USGS/AEC | Area: 17 | Site Prep. W.O.#: None
Location: NTS | County: Nye | W.O.#:AT(29-2)-1302
Surface Coordinates: N 876,855' E 629,310'
Ground Elevation: 6155.8' | Pad Elevation: N/A | Top Casing Elevation: N/A
Bottom Hole Deviation: 4°00' @4200' MD | Reference: TOTCO
Rig On Location: N/A | Spudded: 09-24-60 | Completed: 06-10-61
Circulating Media: Conventional-air foam | Recompleted: 08-20-62
Main Rig & Contractor: Rig #17, Western Republic
No. Of Compressors & Capacity: N/A

Bore Hole Record			Casing Record						
From	To	Size	I.D.	Wt/Ft	Wall	Grade	From	To	Ft³ Cmt.
0'	1840'	12" + *	11"	N/A	0.375"	N/A	0'	1615'	None
1840'	3711'	9" + *	8"	N/A	0.3125"	N/A	1560'	3711'**	N/A ***
3711'	3731'	7-1/2"*							
3711'	4206'	7-5/8"							

Total Depth: 4206' | Plugs: 50 ft³ Cal-Seal plug top at 2710' then drilled out.
Junk: None
Logging Data: Acoustic, Minilog-caliper, Gamma ray-neutron, Temperature, Density, Electric

Rigs Used

Rig No.	Name	Type	Class	Days Operating	Sec. W/Crew	Sec. W/O Crew	Total Days On Location
*	W.D. Falls, Inc.	Cable-Tool Rig	N/A	---	--	---	N/A
*	W.D. Falls, Inc.	Rotary Rig	N/A	---	--	---	N/A
#17	Western Rep.	Rotary Rig	N/A	---	--	---	39

Remarks: * Original hole. Kelly bushing measurement was 8.4' above ground level.
** Gun perforated at 2 shots per foot, 2430'-2370', 2270'-2230', 2160'-2100' 2050'-2030' and 1950'-1910'.
*** Annular top of cement at 3311'.

Prepared By:JEC:llh [signature] 12-7-89
Reviewed By:LWM [signature] 12/7/89

USGS HTH #1/Test Well #1
Area 17
<u>ORIGINAL WORK SUMMARY</u>

09-24-60 Spudded 09-24-60. D. W. Falls, Inc. was contractor.

12" + hole was drilled to 1840′ using a cable-tool rig. 11-3/4" O.D., 3/8" wall casing was set at 1615′. 9" + hole was drilled to 3711′ with a rotary rig using conventional air foam circulation. 8-5/8" O.D., 5/16" wall liner was set at 3717′ with Burns liner hanger top at 1560′ and the annulus cemented to 3311′ using Halliburton. 7-1/2" hole was either drilled or cored to 3731′.

Measurements are from kelly bushing, 8.4′ above ground surface.

Fluid level was at 412′ when hole was at 560′. Fluid level was at 1033′ after casing was set at 1615′ and hole drilled to 1840′ using cable-tools.

05-10-61 Hole completed 05-10-61.

USGS HTH #1/Test Well #1
<u>DEEPENING WORK</u>

(Information from "Daily Drilling Reports". Time interval, approximately 0700 hours to 0700 hours.)

07-12-62 Moved in Western Republic rig #17 and started rigging up.

07-13-62 Continued rigging up.

07-14-62 Continued rigging up.

07-15-62 Continued rigging up.

07-16-62 Continued rigging up and secured rig.

07-18-62 Rig secured from 07-15-61 to 1200 hours 07-17-61. Continued rigging up.

07-19-62 Continued rigging up.

07-20-62 Completed rigging up. Started in the hole with 7-5/8" drilling assembly on 3-1/2" drill pipe, tagged top of liner at 1560′.

07-21-62 Cleaned out liner to 3708′. Made trip to remove drilling assembly. Pumped in 50 ft^3 of Hydrogel at 1868′. Pumped in 25 ft^3 Cal-Seal plug with opened drill pipe at 1708′. Made trip for 7-5/8" drilling assembly, tagged plug at 1665′, and filled casing with water. Fluid level dropped at 1′ per hour. Set Baker squeeze tool at 1394′. Pumped in 40 ft^3 of water in 2 minutes at 300 psi, pressure at zero in 2 minutes.

07-22-62	Pumped in 150 ft³ of 50% cement & 50% Pozmix at top of 8-5/8" liner. Pressure tested squeeze job at 250 psi. Tagged top of cement inside 11-3/4" casing at 1470′ using 9-7/8" bit.
07-23-62	Drilled cement to 4′ below top of liner and pressure tested 8-5/8" liner and 11-3/4" casing lap to 300 psi for 30 minutes. Drilled Cal-Seal plug and opened 7-1/2" hole to 7-5/8" to 3720′.
07-24-62	Opened 7-1/2" hole to 7-5/8" to 3729′ and drilled on junk to 3730′. Recovered small pieces of junk using junk basket. Recovered small pieces of metal on 2 runs using a 7" magnet. Drilled 7-5/8" hole to 3753′ using air foam.
07-25-62	Cut 7-1/2" core hole from 3753′ to 3757′ using diamond corehead, 4′ #1 core recovery. Opened core hole and drilled 7-5/8" hole from 3757′ to 3787′. Deviation survey at 3750′ = 3°45′.
07-26-62	Drilled 7-5/8" hole from 3787′ to 3808′. Cut 7-1/2" core hole to 3824′, 1′ #2 core recovery. Started running USGS swab test using 3-1/2" tubing at 0400 hours.
07-27-62	Swab tested at 2600′ to 1200 hours, static fluid level at 1986′. Opened core hole and drilled 7-5/8" hole from 3808′ to 3868′.
07-28-62	Drilled 7-5/8" hole from 3868′ to 3924′ using air.
07-29-62	Cut 7-1/2" core hole from 3924′ to 3934′, 2′ #3 core recovery. Ran swab test with 3-1/2" tubing at 2730′, static fluid level at 1982′. Opened core hole and drilled 7-5/8" hole from 3924′ to 3942′.
07-30-62	Drilled 7-5/8" hole from 3942′ to 3971′. Cut 7-1/2" core hole to 3981′, 10" #4 core recovery. Opened core hole and drilled 7-5/8" hole from 3971′ to 4008′.
07-31-62	Drilled 7-5/8" hole from 4008′ to 4046′. Deviation survey at 4040′ = 3°30′.
08-01-62	Ran swab test with 3-1/2" tubing and 1-1/2" tubing strapped on outside at 2911′ for 2-1/4 hours, static fluid level at 1985′. Worked on sandline drum clutch from 1000 hours.
08-02-62	Repaired clutch and reinstalled sand line at 2000 hours. Ran swab test to 0100 hours, static fluid level at 2040′.
08-03-62	Drilled 7-5/8" hole from 4046′ to 4075′.
08-04-62	Cut 7-1/2" core hole from 4075′ to 4080′, 2′ #5 core recovery. Opened core hole to 7-5/8" hole from 4075′ to 4080′.

08-05-62 Drilled 7-5/8" hole from 4080′ to 4200′. Ran Lane Wells gamma ray-neutron, sonic, electric, densilog, minilog-caliper logs. Deviation survey at 4200′ = 4°00′.

08-06-62 Static fluid level at 1984′ (KBM). Ran swab test with 3-1/2" tubing and 1-1/2" tubing strapped on outside at 2910′.

08-07-62 Swab tested 6 hours, static fluid level at 1985′. Cleaned out hole to bottom. Cut 7-1/2" core hole from 4200′ to 4206′.

08-08-62 2′ #6 core recovery. Opened core hole to 7-5/8" from 4200′ to 4206′ T.D..

08-09-62 Lowered and set Reda pump (100 gpm capacity) on 3-1/2" tubing and 1-1/2" tubing strapped on outside with intake at 2502′. Ran pump test 4-3/4 hours at full capacity, fluid drawdown to 2170′ and static level at 1985′. Started pump test at 50 gpm at 0330 hours.

08-10-62 Completed test at 0900 hours. Fluid drawdown was to 2130′ and static level at 1983′ after 3 hours. Continued pump test at 100 gpm.

08-11-62 Continued pump test. Test stopped 12-1/2 hours for rig repair.

08-12-62 Static fluid level at 1985′, tests completed. Set 100 ft^3 of Hydrogel for plug at 3012′ and 50 ft^3 of Cal-Seal for plug at 2710′. Tagged plug top at 2710′ and tested to 6000#. Blew fluid out of casing. Filled casing to 1500′ with water.

08-13-62 8-5/8" liner was gun perforated from 2430′ to 2370′, 2270′ to 2230′, 2160′ to 2100′, 2050′ to 2030′, and 1950′ to 1910′ using Lane Wells 15/32" bullets at 2 shots per foot. Static fluid level was at 1461′. Made trip in with 7-5/8" bit on 3-1/2" drill pipe and blew out fluid from 1330 hours at 44 gpm.

08-14-62 Made trip out and lowered 3-1/2" tubing to 2466′. Ran USGS fluid check, fluid at 1468′. Swab tested hole 3 hours. Ran fluid check, fluid at 1455.6′. Lowered tubing to 2655′ and swabbed hole at 35 gpm. Pulled out tubing.

08-15-62 Lowered and set Reda pump on 3-1/2" tubing at 2443′. Ran fluid check, fluid at 1455′. Pumped out water from 2200 hours to 0500 hours at 25 gpm.

08-16-62 Increased pump rate to 50 gpm to 1000 hours. Ran recovery test to 1400 hours, fluid at 1460′. Resumed pump test.

08-17-62 Ran pump test to 1300 hours and recovery test to 1500 hours, fluid at 1455′. Continued pump test to 0200 hours at 70 gpm and recovery test to 0400 hours, fluid at 1457′.

08-18-62	Ran fluid check at 0900 hours, fluid at 1461′. Ran pump test to 1900 hours and recovery test to 2300 hours. Laid down tubing and Reda pump.
08-19-62	Drilled Cal-Seal plug and cleaned hole to 4206′ using 7-5/8" bit. Scraped 8-5/8" liner from 1560′ to 2800′ and blew hole clean.
08-20-62	Laid down drill pipe. Lowered and set Baker packer on 27/8" tubing along with 1600′ of 1-1/2" tubing strapped on the outside at 2752.62′. Checked fluid level at 1464.8′. Swabbed tested hole for 2 hours. Lain down both strings of tubing and Baker packer. Welded steel plate on top of casing. Rigged down and moved out. Hole recompleted 08-20-62.

USGS HTH #1

REVIEW OF HOLE CONDITIONS

298 mm (11-3/4") casing was set at 492.3 m (1615') in a hole drilled of sufficient size to 560.8 m (1840') using a cable-tool rig. A hole of sufficient size was drilled to 1131.1 m (3711') using the conventional air foam circulating method. 219 mm (8-5/8") liner was set at 1131.1 m (3711') with top of Burns liner hanger at 475.5 m (1560') and the annulus cemented to 1009.2 m (3311'). 191 mm (7-1/2") hole was either drilled or cored to a total depth of 1137.2 m (3731') using the conventional air foam circulating method. USGS hydrologic tests were run during drilling. Hole spudded 09-24-60 and completed 06-10-61. Top of 219 mm (8-5/8") liner and bottom of 298 mm (11-3/4") casing annulus was squeezed using 4.25 m^3 (150 ft^3) of 50% cement & 50% Pozmix and pressure tested 07-21-62. The original hole was deepened to 1282.0 m (4206') using 194 mm (7-5/8") drilling assembly and conventional air foam circulating method between 07-23-62 and 08-09-62. A total of 6 core runs and USGS hydrologic tests were made during deepening. Lane Wells gamma ray-neutron, sonic, electric, density, and minilog-caliper logs were run 08-05-62 when hole was at 1280.2 m (4200'). Liner was perforated from 740.7 m (2430') to 722.4 m (2370'), 691.9 m (2270') to 679.7 m (2230'), 658.4 m (2160') to 640.1 m (2100'), 624.8 m (2050') to 618.7 m (2030'), and 594.4 m (1950') to 582.2 m (1910') using Lane Wells wireline bullet guns. Swab and pump tests were run. Baker packer on 64 mm (2-1/2") tubing along with 487.7 m (1600') of 38 mm (1-1/2") tubing strapped on the outside was set at 839.1 m (2753') and 2 hour swab test run. Packer and tubing were removed and steel plate welded on top of casing. Hole recompleted 08-20-62.

HTH #1 Area 17
ADDITIONAL WORK

03-02-88	Ran USGS fluid check, fluid level indicated at 1466.7'.
05-02-89	Ran USGS fluid check, fluid at 1465'.
05-04-89	Ran USGS fluid check, fluid at 1465'.
09-18-89	Moved in and rigged up Joy #1, rig # 85172. Made trip in with spear on bottom of 2-3/8" Hydril tubing and tagged bottom at 3694'. Started out of hole.
09-19-89	Laid down tubing, spear clean. Rigged down and moved out.
10-04-89	Ran USGS fluid check, fluid at 1465'.

APPENDIX B

Nevada Test Site Deep Sampling HTH–1
(Workplan, Todd Mihevc, DRI)

May 1, 1989

NEVADA TEST SITE DEEP SAMPLING WELL TW1

by
Todd Mihevc

The Desert Research Institute acquired access from DOE to enter Well TW1 (Test Well #1) in Area 17, to sample six discrete intervals. From previous excursions on 06/24/86 and 07/21/87, it was learned that the water surface in the borehole had an oil layer on it (probably pump oil) which was bailed clean for sampler access.

On 04/25/89, the DRI deep sampling rig was set up at Well TW1 again. The first task was to skim the well for oil with an open–top bailer (6″ diameter x 5′ long). A total of four skimming runs were made indicating little or no oil left in the well bore. Although, to our surprise, other foreign debris was skimmed from the water surface. The first skim produced a 2″ diameter aluminum foil ball and fiber–like scum. The second skim was over–filled clean water. The third skim produced several cellophane pieces (6″ x 4″), more aluminum foil, a couple of white/green mold balls and fiber–like scum. The fourth skim produced fairly clear water with some fiber scum.

The discrete interval sample bailer (2 liter) was attached and sent down the hole. Due care was taken, slow winch speeds of approximately 20 feet per minute, at the water table interface at approximately 1,460 feet and the casing narrowing point (from $11^3/_4$″ to $8^3/_4$″) at 1,1551.5 feet. A total of eleven samples were pulled below the casing narrowing before the problems arose. Of the relevant trips through this opening, only twice was a light bounce observed.

On the twelfth trip down the hole (04/26/89), problems were encountered. The sampling sonde passed through the casing narrowing with a light bounce. Approximately 40 feet below this point, the winch and cable jumped in the rig. Immediate shutdown was initiated. Once everything was stopped, the tension gauge showed a substantial tension loss. The first step was to try to pull up out of the problem — hoping the sonde is not stuck or lost. Full tension was regained while pulling up. We returned the sonde to surface for inspection. All was okay with no visible scars on the sonde or cable. The sonde was again sent down carefully to check the hole condition. This time a total tension loss was encountered at the casing narrowing at 1,551.5 feet.

Multiple attempts were made to try to dislodge or get by the obstruction — all unsuccessful. Attempts were made to direct the sonde and cable around all edges of the surface casing. The sampling excursion was discontinued.

Conclusions can be drawn as follows: The hole is definitely blocked at the casing narrowing at 1,551.5 feet. The hole is not straight. The outside of the sonde and cable always return greasy, indicating that it is running on the side of the casing no matter where the tripod is positioned. Thus, we always hit the same spot in the hole at the casing narrowing. Floating debris in the well made us cautious of submersed debris. Whatever debris that was below the water was dislodged and came down on top of us — fortunately, not trapping the tools in the hole. This large debris was between 1,460 feet and 1,550 feet, due to the fact that the 6″ diameter bailer ran smoothly to 1,467 feet. It also should be noted that approximately 1.5 feet due east of the well opening was a bent–over galvanized pipe — $2^1/_2$″ diameter by approximately $2^1/_2$″ long. This bent galvanized pipe was always in the way on the 1986 and 1987 excursions. It was broken off and gone on the 1989 excursion (possibly down the hole?). Finally, there is no lock on the well securing it.

Suggestions: 1) video camera to bottom of hole; 2) remove the debris or dislodge it to the bottom of the hole; and 3) lock well.

APPENDIX C

Hole History Data for Well UE18r (Fenix and Scisson, Nevada)

(reproduced from the best available copy)

FENIX & SCISSON, INC.

HOLE HISTORY DATA

2-9-68 APPROVED: [signature]

HOLE No.:	UE-18r	W.O. No.:	1010-183	I.D. No.:	1504
USER:	LRL	TYPE HOLE:	Exploratory		
LOCATION:	NTS	COUNTY:	Nye	AREA:	18
SURFACE COORDINATES:	L/O N 868,100' E 564,700'			GROUND ELEVATION:	5538.2'
RIG ON LOCATION:	11-28-67	SPUDDED:	11-29-67	COMPLETED:	2-8-68
CIRCULATING MEDIA:	Air and Davis Mix				
No. of COMPRESSORS & SIZE:	3-900 cfm				

BORE HOLE RECORD			CASING RECORD							
FROM	TO	SIZE	I.D.	WT./FT.	WALL	GRADE	CPL'G	FROM	TO	CU. FT. CMT.
0'	38'	36"	23 1/4"	95#	3/8"			0'	37'	300
38'	1632'	15"	10.05	40.5#	.35"	J-55		0'	1629'	2240**
1632'	4988'	9 7/8"								
4988'	5004'	6 1/8"								

TOTAL DEPTH: 5004' MANDREL DEPTH PLUGS:

JUNK:

LOGGING DATA *** SURVEYS PAGE: CORING PAGE:

BOTTOM HOLE COORDINATES: REFERENCE:

NON-OPERATIONAL TIME		OPERATIONAL DELAY TIME		WORKING TIME	
Move Rig up & down	4.54 days	Equipment Repair	.40 days	Drilling Time	22.06 days
Secured	11.86 days	Caving	.06 days	Trip Time	5.62 days
Drill & Run Mandrel	days	Lost Circ.	days	Single Shot Survey Time	.76 days
Logging	3.50 days	Fishing	.33 days	Mud in Hole	.12 days
Survey	1.18 days	W.O. Equipment	days	Total	28.56 days
Casing	.54 days	Weather Delay	.39 days	Total Suspended Time	days
Cement	2.10 days	Unload Water	1.32 days	Non-Operational Time	41.32 days
Coring	5.74 days	Drill Out Cement	.12 days	Operational Delay Time	2.62 days
Hydro Tests	11.86 days		days	Working Time	28.56 days
TOTAL	41.32 days	TOTAL	2.62 days	TOTAL ELAPSED TIME	72.50 days

REMARKS: *Site Prep.

**Included 49 ft^3 inside casing.

***Logging Data

		Rig No.	Name	Type	
(1) Caliper	(2) Temperature	85124	Ideco	525	72.50 days
(1) NCTT 10 Runs	(2) Radioactive Tracer				days
(1) Sonic	(2) Velocity				days
(1) Electric	(5) 3-D 8 Runs				days
(1) Gamma Ray/Neutron	(2) Water Locator				days
					days

Prepared by: R. Harris

UE18r
Hole History

11–28–67	Moved in Ideco #525 rig #85124 and started to rig up.
11–29–67	Finished rigging up. Picked up 26″ x 36″ bit assembly and started drilling. Drilled 36″ hole from 0′ to 18′.
11–30–67	Drilled 36″ hole from 18′ to 38′. Set 24″ O.D. casing at 37′. Cemented stage #1 with 30 ft^3 of neat cement and 3% $CaCl_2$. CIP at 1700 hours. Cemented stage #2 with 220 ft^3 of neat cement and 3% $CaCl_2$. CIP at 2030 hours.
12–1–67	Cemented stage #3 to the surface with 50 ft^3 of neat cement and 3% $CaCl_2$. CIP at 0400 hours. Drilled out cement from 34′ to 37′. Cleaned out hole from 37′ to 38′. Drilled 15″ hole from 38′ to 42′ using air and Davis mix as the circulating media. Hole was secured from 12–1–67 to 12–11–67.
12–11–67	Drilled 15″ hole from 42′ to 155′. Ran gyro surveys.
12–12–67	Drilled 15″ hole from 155′ to 409′.
12–13–67	Drilled 15″ hole from 409′ to 508′. Hole was secured from 12–13–67 to 12–15–67.
12–15–67	Cleaned out 2′ of fill. Made trip out and picked up core barrel. Cored $6^1/_8$″ hole (Core #1) from 508′ to 516′ with 6′ recovery. Made trip for 15″ bit.
12–16–67	Opened $6^1/_8$″ hole to 15″ from 508′ to 516′. Drilled 15″ hole from 508′ to 750′.
12–17–67	Drilled 15″ hole from 750′ to 838′. Made trip for core barrel. Plugged core barrel from 838′ to 839′. Pulled out and unplugged core barrel.
12–18–67	Made trip into hole. Cored $6^1/_8$″ hole (Core #2) from 839′ to 847′ with 8′ recovery. Made trip for 15″ bit. Opened $6^1/_8$″ hole to 15″ from 838′ to 847′. Drilled 15″ hole from 847′ to 1022′.
12–19–67	Drilled 15″ hole from 1022′ to 1148′. Made trip for core barrel. Cored $6^1/_8$″ hole (Core #3) from 1148′ to 1156′ with 8′ recovery. Made trip for 15″ bit.
12–20–67	Ran in hole. Opened $6^1/_8$″ hole to 15″ from 1148′ to 1156′. Drilled 15″ hole from 1156′ to 1366′. Made trip for core barrel.

12–21–67 Cored $6^1/_8''$ hole (Core #4) from 1366′ to 1373′ with 6′ of recovery. Made trip for 15″ bit. Opened $6^1/_8''$ hole to 15″ from 1366′ to 1373′. Drilled 15″ from 1373′ to 1482′.

12–22–67 Drilled 15″ hole from 1482′ to 1615′. Made trip for $6^1/_8''$ core barrel. Cored $6^1/_8''$ hole (Core #5) from 1615′ to 1622′ with 6′ recovery. Made trip for 15″ bit. Opened $6^1/_8''$ hole to 15″ from 1615′ to 1622′. Drilled 15″ hole from 1622′ to 1636′.

12–23–67 Made trip out with drilling assembly. Ran Birdwell fluid probe locating fluid level at 1423′. Ran Birdwell caliper log to 1629′. Ran Birdwell gamma ray/neutron, density, electric, and CVL logs. Ran drill pipe open ended and corrected depth to 1632′. Pumped 600 barrels of mud in the hole. Ran Birdwell fluid probe locating fluid level at 1008′.

12–24–67 Ran Birdwell 3–D and electric logs. Set $10^3/_4''$ O.D. casing at 1629′. Pumped 40 barrels of water ahead of cement. Cemented stage #1 with 350 ft^3 of neat cement and 2% $CaCl_2$. CIP at 1530 hours. Hole was secured from 12–24–67 to 12–26–67.

12–26–67 Tagged top of cement with tubing inside casing at 1552′. Tagged top of cement outside casing with tubing at 1126′. Cemented stage #2 with 500 ft^3 of neat cement and 2% $CaCl_2$. CIP at 0900 hours. Tagged top of cement at 932′. Cemented stage #3 with 400 ft^3 of neat cement and 2% $CaCl_2$. CIP at 1500 hours. Tagged top of cement at 514′. Cemented stage #4 with 500 ft^3 of neat cement and 2% $CaCl_2$. CIP at 2100 hours. Located top of cement with NCTL log at 362′. Tagged top of cement with tubing at 356′.

12–27–67 Cemented stage #5 with 180 ft^3 of neat cement and 2% $CaCl_2$. CIP at 0130 hours. Tagged top of cement at 202′. Cemented stage #6 to the surface with 310 ft^3 of neat cement and 2% $CaCl_2$. CIP at 0630 hours. Total cement used was 2240 ft^3. Calculated annular volume was 1357 ft^3. Ran Sperry–Sun Multishot Gyroscopic survey in and out on 25′ stations. Lay down $6^5/_8''$ drill pipe. Reran gyro survey.

12–28–67 Finished running gyro survey. Made up drilling assembly which consisted of $9^7/_8''$ bit, Float sub, $7^7/_8''$ O.D. hammer, sub, Monel DC, Reamer, Monel DC, Steel DC (6) sub, and $4^1/_2''$ O.D. drill pipe. Made trip in hole. Tagged top of cement inside casing at 1546′. Drilled out cement and plug from 1546′ to 1629′. Cleaned out hole from 1629′ to 1632′. Drilled $9^7/_8''$ hole from 1632′ to 1819′.

12–29–67	Drilled $9^7/_8''$ hole from 1819′ to 1922′. Made trip for core barrel. Cored $6^1/_8''$ hole (Core #6) from 1922′ to 1931′ with 9′ recovery. Made trip for $9^7/_8''$ bit. Opened $6^1/_8''$ hole to $9^7/_8''$ from 1922′ to 1931′. Drilled $9^7/_8''$ hole from 1931′ to 1998′.
12–30–67	Drilled $9^7/_8''$ hole from 1998′ to 2105′.
12–31–67	Drilled $9^7/_8''$ hole from 2105′ to 2228′. Hole was secured from 12–31–67 to 1–2–68.
1–2–68	Made trip for core barrel. Cored $6^1/_8''$ hole (Core #7) from 2228′ to 2234′ with 6′ recovery. Made trip for $9^7/_8''$ bit. Opened $6^1/_8''$ hole to $9^7/_8''$ from 2228′ to 2234′. Drilled $9^7/_8''$ hole from 2234′ to 2275′.
1–3–68	Drilled $9^7/_8''$ hole from 2275′ to 2384′.
1–4–68	Drilled $9^7/_8''$ hole from 2384′ to 2479′.
1–5–68	Drilled $9^7/_8''$ hole from 2479′ to 2594′.
1–6–68	Drilled $9^7/_8''$ hole from 2594′ to 2721′. Twisted off drill column. Fish in the hole consisted of four steel drill collars, two monel collars, air hammer, three subs, and $9^7/_8''$ bit. Fish was 179′ long with top at 2542′.
1–7–68	Made up fishing tools and ran in hole. Latched on to and recovered fish from the hole. Made up $9^7/_8''$ drill assembly. Drilled $9^7/_8''$ hole from 2721′ to 2752′.
1–8–68	Drilled $9^7/_8''$ hole from 2752′ to 2811′. Made trip for core barrel. Cored $6^1/_8''$ hole (Core #8) from 2811′ to 2815′ with 4′ recovery.
1–9–68	Made trip for $9^7/_8''$ bit. Opened $6^1/_8''$ hole to $9^7/_8''$ from 2811′ to 2815′. Drilled $9^7/_8''$ hole from 2815′ to 2898′.
1–10–68	Drilled $9^7/_8''$ hole from 2898′ to 3023′.
1–11–68	Drilled $9^7/_8''$ hole from 3023′ to 3096′. Made trip for core barrel. Ran Birdwell caliper log to 3096′. Cored $6^1/_8''$ hole (Core #9) from 3096′ to 3106′ with 10′ recovery. Ran Birdwell temperature survey.
1–12–68	Made trip for $9^7/_8''$ bit. Opened $6^1/_8''$ hole to $9^7/_8''$ from 3096′ to 3106′. Drilled $9^7/_8''$ hole from 3106′ to 3342′.

1-13-68 Drilled $9^7/_8''$ hole from 3342′ to 3604′. Made trip for core barrel. Cored $6^1/_8''$ hole (Core #10) from 3604′ to 3610′ with 6′ recovery.

1-14-68 Made trip for $9^7/_8''$ bit. Opened $6^1/_8''$ hole to $9^7/_8''$ from 3604′ to 3610′. Drilled $9^7/_8''$ hole from 3610′ to 3740′.

1-15-68 Drilled $9^7/_8''$ hole from 3740′ to 3899′. Made trip for core barrel. Cored $6^1/_8''$ hole (Core #11) from 3899′ to 3907′ with 8′ recovery. Made trip for $9^7/_8''$ bit.

1-16-68 Opened $6^1/_8''$ hole to $9^7/_8''$ from 3899′ to 3907′. Drilled $9^7/_8''$ hole from 3907′ to 4094′.

1-17-68 Drilled $9^7/_8''$ hole from 4094′ to 4212′. Made trip for core barrel. Cored $6^1/_8''$ hole (Core #12) from 4212′ to 4217′ with 4′ recovery. Made trip for $9^7/_8''$ bit.

1-18-68 Opened $6^1/_8''$ hole to $9^7/_8''$ from 4212′ to 4217′. Drilled $9^7/_8''$ hole from 4217′ to 4402′.

1-19-68 Ran Birdwell caliper log to 4398′.

1-20-68 Drilled $9^7/_8''$ hole from 4402′ to 4588′. Made trip for core barrel. Cored $6^1/_8''$ hole (Core #13) from 4588′ to 4600′ with 12′ recovery.

1-21-68 Made trip for $9^7/_8''$ bit. Opened $6^1/_8''$ hole to $9^7/_8''$ from 4588′ to 4600′. Drilled $9^7/_8''$ hole from 4600′ to 4714′.

1-22-68 Drilled $9^7/_8''$ hole from 4714′ to 4867′. Made trip for core barrel. Cored $6^1/_8''$ hole (Core #14) from 4867′ to 4879′ with 12′ recovery. Made trip out for $9^7/_8''$ bit.

1-23-68 Opened $6^1/_8''$ hole to $9^7/_8''$ from 4867′ to 4879′. Drilled $9^7/_8''$ hole from 4879′ to 4988′ Made trip for core barrel. Cored $6^1/_8''$ hole (Core #15) from 4988′ to 4992′.

1-24-68 Cored $6^1/_8''$ hole from 4992′ to 5004′ with 16′ recovery. Made trip out of hole. Ran Birdwell gamma ray/neutron, density, electric, CVL, and 3-D logs.

1-25-68 Ran Birdwell temperature study and Trace Ejector log. Prepared to run Reda pump in hole.

1-26-68 Ran Reda pump on $2^7/_8''$ tubing to 1736′. Started pumping water out of hole.

1-27-68 Pumped the well.

1–28–68	Pumped the well. Ran Birdwell Trace Ejector log.
1–29–68	Ran USGS fluid probe. Pulled Reda pump. Ran Lynes straddle packers on $2^7/_8''$ tubing.
1–30–68	Attempted to fill tubing with water. Tubing was found to be leaking. Made trip out of hole to check packers. Ran packers back in hole and performed hydrologic tests. Ran USGS fluid probe. Swabbed $2^7/_8''$ tubing.
1–31–68	Swabbed $2^7/_8''$ tubing. Performed hydrologic tests. Ran and reran USGS fluid probe locating fluid level at 1385′.
2–1–68	Continued performing hydrologic tests and running fluid probes.
2–2–68	Continued hydrologic testing.
2–3–68	Continued hydrologic tests.
2–4–68	Continued hydrologic tests.
2–5–68	Finished hydrologic tests. Ran Birdwell temperature survey and Input Profile log.
2–6–68	Ran Birdwell electric log. Started to run Sperry–Sun gyro survey.
2–7–68	Completed running Sperry–Sun gyro survey in and out on 30′ stations to 4981′. Rigged down.
2–8–68	Moved off. Hole was completed 2–8–68.

TABLE C-1. LIST OF AVAILABLE ELECTRIC WELL LOGS FOR WELL UE18r.

Site Name	Date (MDY)	Type	Drill Depth (ft)	Interval Logged (ft)
UE18r	12/23/67	3-D velocity	1636.00	1000-1623
	12/23/67	caliper	1636.00	0-1626
	12/23/67	density	1636.00	0-1628
	12/23/67	nuclear	1636.00	0-1616
	12/23/67	velocity	1636.00	1010-1623
	12/23/67	water locator	1636.00	1300-1431
	12/24/67	3-D velocity	1636.00	1100-1619
	12/24/67	electric (2)	1636.00	1100-1627
	12/24/67	3-D velocity	1636.00	1160-1620
	12/26/67	nuclear cement top locator	1632.00	342-494
	12/26/67	nuclear cement top locator	1632.00	842-1000
	12/26/67	nuclear cement top locator	1632.00	992-1552
	12/27/67	nuclear cement top locator	1632.00	0-1550
	01/11/68	caliper	3096.00	1600-3094
	01/11/68	tempera ure	3096.00	0-3104
	01/19/68	caliper	4402.00	1550-4395
	01/24/68	3-D velocity 12′ (2)	5004.00	1800-4980
	01/24/68	caliper	5004.00	1500-4988
	01/24/68	density (2)	5004.00	1600-4985
	01/24/68	nuclear (2)	5004.00	1600-4975
	01/24/68	velocity	5004.00	2000-4986
	01/25/68	3-D velocity (2)	5004.00	1800-4983
	01/25/68	radioactive tracer	5004.00	2050-3532
	01/25/68	temperature (2)	5004.00	1600-4992
	02/06/68	electric	5004.00	1620-4986
	11/11/77	caliper	5004.00	0-4990
	06/11/78	density borehole compensate	5004.00	1600-4992
	06/11/78	density dual proximity	5004.00	1600-4993
	06/12/78	3-D velocity 12′	5004.00	1600-4983
	06/12/78	3-D velocity 6′	5004.00	1600-4987
	06/12/78	electric	5004.00	1650-4987
	10/25/90	high resolution temperature	5004.00	1351-2504

Deviation Surveys

Depth	Deviation
150′	0° 7′ (S 62° 52′ E)
300′	0° 4′ (S 44° 40′ E)
450′	0° 5′ (S 50° 02′ E)
600′	0° 11′ (S 59° 51′ E)
740′	0° 13′ (S 00° 10′ W)
890′	0° 12′ (S 55° 46′ W)
1040′	0° 15′ (S 76° 29′ W)
1190′	0° 10′ (S 68° 39′ W)
1330′	0° 17′ (S 46° 13′ W)
1480′	0° 18′ (S 41° 13′ W)
1630′	0° 33′ (S 24° 31′ W)
1780′	0° 40′ (S 22° 38′ W)
1920′	0° 40′ (S 15° 58′ W)
2070′	0° 36′ (S 21° 39′ W)
2220′	0° 42′ (S 19° 13′ W)
2370′	1° 00′ (S 28° 29′ W)
2520′	1° 00′ (S 27° 40′ W)
2670′	0° 50′ (S 00° 51′ W)
2820′	0° 45′ (S 03° 19′ E)
2970′	0° 32′ (S 04° 35′ E)
3120′	0° 43′ (S 17° 46′ W)
3270′	0° 58′ (S 13° 33′ W)
3420′	1° 04′ (S 12° 44′ W)
3570′	0° 51′ (S 00° 10′ W)
3720′	0° 54′ (S 04° 14′ E)
3870′	1° 11′ (S 14° 14′ E)
4020′	1° 30′ (S 35° 57′ E)
4170′	0° 58′ (S 30° 09′ E)
4320′	0° 28′ (S 18° 11′ E)
4490′	0° 25′ (S 67° 40′ W)
4650′	0° 38′ (S 63° 18′ W)
4880′	0° 47′ (W 89° 55′ W)
4950′	0° 50′ (W 56° 02′ W)
4981′	0° 53′ (W 65° 10′ W)

Sperry–Sun Multishot Gyroscopic Survey

Date	MD	TVD	Horizontal Displacement	Reference	Run
12–27–67	1540′	1539.98′	2.59′ (S 38° 20′ W)	151–SU3–304	In
12–27–67	1540′	1539.98′	2.51′ (S 36° 59′ W)	151–SU3–304	Out
02–06–68	3000′	2999.86′	21.91′ (S 17° 31′ W)	151–SU3–331	In
02–06–68	3000′	2999.86′	21.71′ (S 21° 07′ W)	151–SU3–331	Out
02–06–68	4981′	4980.61′	44.94′ (S 13° 12′ W)	151–SU3–331	In
02–06–68	4981′	4980.61′	44.56′ (S 12° 06′ W)	151–SU3–331	Out

Core Data

Run #	Interval	Recovery
1	0508′ – 0516′	8′
2	0839′ – 0847′	8′
3	1148′ – 1156′	8′
4	1366′ – 1373′	6′
5	1615′ – 1622′	6′
6	1922′ – 1931′	9′
7	2228′ – 2234′	6′
8	2611′ – 2615′	4′
9	3096′ – 3106′	10′
10	3604′ – 3610′	6′
11	3899′ – 3907′	8′
12	4212′ – 4217′	4′
13	4588′ – 4600′	12′
14	4867′ – 4879′	12′
15	4988′ – 5004′	16′

Review of Hole Conditions

Spudded: 11–29–67

Completed: 2–8–68

36″ hole to 38′

Set 24″ O.D. casing at 37′. Cemented annulus to $8^{1}/_{2}$′ below surface with 300 ft^3 of cement slurry.

15″ hole to 1632′
Cemented annulus to the surface with 2191 (plus 49 ft^3 inside casing of cement) slurry.

Set $10^{3}/_{4}$″ O.D. casing at 1629′.

$9^{7}/_{8}$″ hole to 4988′

$6^{1}/_{8}$″ hole to 5004′

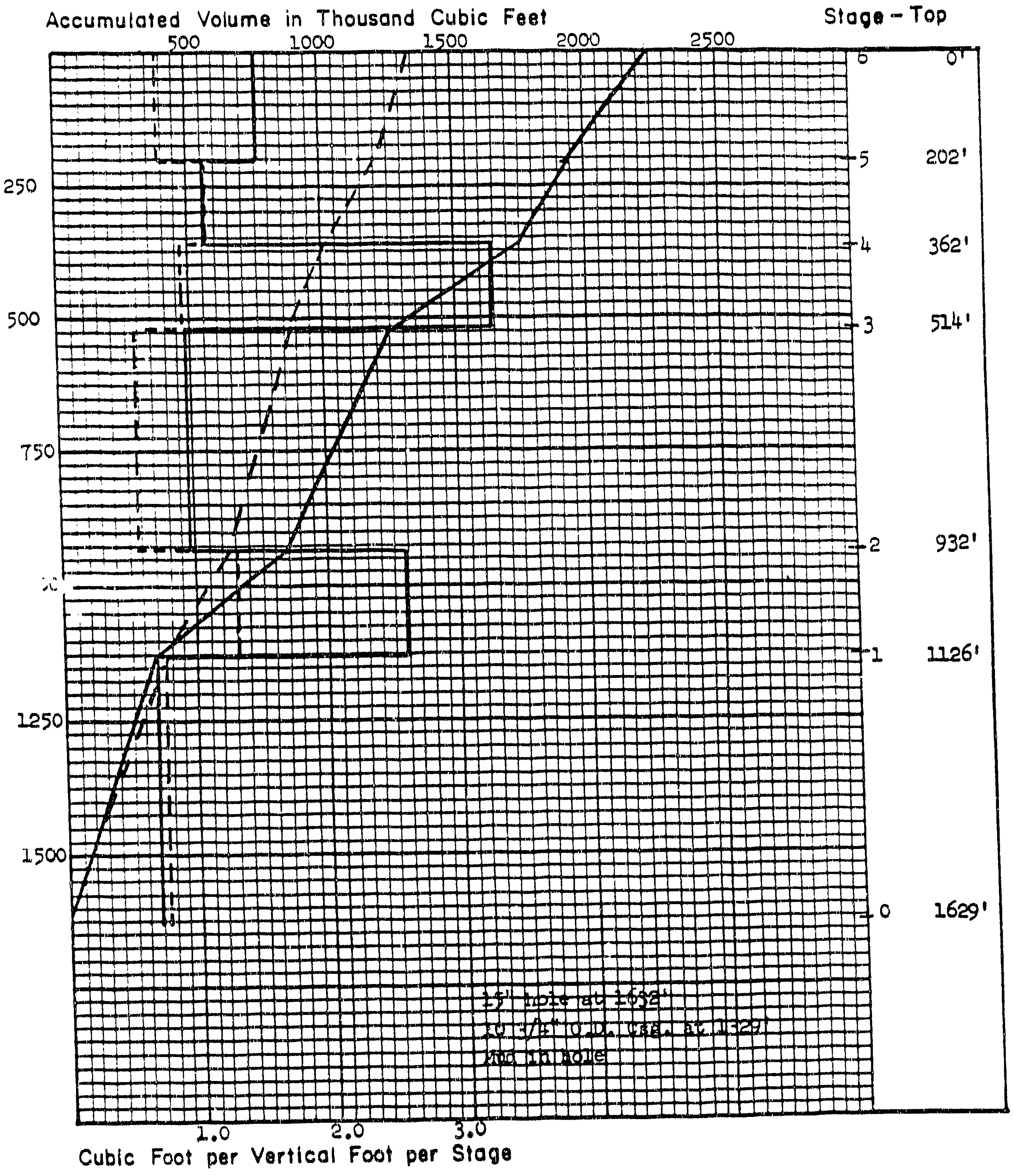
I. This hole was drilled using air and Davis mix as the circulating media. A caliper log run to 1626′ indicated very little erosion.

II. Cementing of $10^{3}/_{4}$″ O.D. casing (mud in hole).

Stage #	Interval	Actual Cement Used	Cal. Ana. Vol.
1	1629′ – 1126′	350 ft^3	379 ft^3
2	1126′ – 0932′	500 ft^3	254 ft^3
3	0932′ – 0514′	400 ft^3	245 ft^3
4	0514′ – 0362′	500 ft^3	144 ft^3
5	0362′ – 0202′	180 ft^3	182 ft^3
6	0202′ – 0′	310 ft^3	153 ft^3
		2240 ft^3	1357 ft^3

UE-18r

CEMENTING GRAPH



— — — — — Calc. Ann. Vol.

———————— Cement Used

Total Cement Used = 2240 ft^3

Total Calculated = 1357 ft^3

Difference + 883 ft^3

UE-18r

ADDITIONAL WORK

03-28-72	Unable to pull USGS downhole package using Birdwell equipment.
09-11-75	Prior to 09-11-75 packer and USGS instruments were retrieved using USGS equipment.
11-11-75	Ran Birdwell caliper log to 1990'.
06-11-78	Ran Birdwell bore hole compensated and dual proximity density logs to 4994'. Ran fluid density log, fluid level at 1370'.
06-12-78	Ran Birdwell 3-D logs to 4993'. Ran electric log to 4988'.
06-23-78	Started running Birdwell vibroseis survey.
06-24-78	Completed vibroseis survey. Set Gearhart Owens 9-5/8" wire line bridge plug in the hole at 2505'. Dumped 2.55 gallons of sand and 2.55 gallons of Cal-Seal on plug.

APPENDIX D

Hole History Data for UE6e
(Fenix and Scisson, Nevada)

FENIX & SCISSON, INC.
HOLE HISTORY DATA

DATE: 9-27-74 APPROVED: [signature]

HOLE NO.: UE-6e | W. O. NO.: 1052-334 B | I. D. NO.:

USER: LASL | TYPE HOLE: Exploratory

LOCATION NTS | COUNTY: Nye | AREA: 6

SURFACE COORDINATES: L/O 814,000'; E 688,200'

GROUND ELEVATION: 3935.6' | PAD ELEVATION: | TOP CASING ELEVATION:

RIG ON LOCATION: | SPUDDED: 2-27-73 | COMPLETED: 12-3-73

CIRCULATING MEDIA: Air foam 120' to 1977' and 2886' to 4113', conventional * *

MAIN RIG & CONTRACTOR Ideco #525, REECo | NO. OF COMPRESSORS & CAPACITY: 3-1000 cfm

BORE HOLE RECORD			CASING RECORD							
FROM	TO	SIZE	I. D.	WT./FT.	WALL	GRADE	CPL'G.	FROM	TO	CU. FT. CMT.
0'	120'	36"	19.50"	52.73#	¼"	BW		0'	110'	760
120'	2886'	12¼"	8.921"	36.00#		J-55		0'	2090'	645
2886'	4209'	8-3/4"								

TOTAL DEPTH: 4209' GL | AVERAGE MANDREL DEPTH: | FROM REFERENCE ELEVATION ?

JUNK & PLUGS LEFT IN HOLE:

SURVEYS PAGE: | CORING PAGE: | | CU. FT. CMT. TOTAL IN PLUGS, ETC:

LOGGING DATA: Caliper (6), NCTL (2-3 runs), Density (3), Water Locator (3-4 runs) * * *

BOTTOM HOLE COORDINATES: | REFERENCE:

RIGS USED *(Site Prep Rigs *)*

RIG NO.	NAME	TYPE	CLASS	DAYS OPERATING	SECURED W CREW	SECURED W/O CREW	TOTAL DAY ON LOC.
85127	Auger	LL-DH-110	VIII	0.25	-	0.65	0.90
85124	Ideco #525	Ideco 525	I	68.72	2.39	91.83	162.94

REMARKS: * *Site Prep Items*

* * Circulation, reverse air-water 1977' to 2886' and conventional circulation with mud 4113' to 4209'.

* * * Fluid Density (10-12 runs), Electric (2), Gamma (1), Epithermal Neutron (3), Seisviewer (1), 3-D (4-6 runs), Vibroseis

PREPARED BY: TIME BREAKDOWN ON NEXT PAGE

UE-6e

TIME BREAKDOWN

SITE PREPARATION

DRILLING OPERATION TIME (DOT)		OTHER SCHEDULED TIME (OST)		OPERATIONAL DELAY TIME (ODT)	
DRILL		MOVE		RIG REPAIRS	
TRIPS		RUN CASING		W. O. DRILLING SUPPLIES	
SURVEYS		CEMENT CASING		CLEAN OUT FILL	
				SECURED WITH CREWS	
SITE DOT ______ DAYS		SITE OST ______ DAYS		SITE ODT ______	

TOTAL SITE PREP TIME ______ DAYS | REMARKS:

MAIN HOLE CONSTRUCTION

DRILLING OPERATION TIME (DOT)		OTHER SCHEDULED TIME (OST)		OPERATIONAL DELAY TIME (ODT)	
DRILL	10.59	MOBILIZATION & DEMOBILIZATION	6.79	RIG REPAIRS	2.22
TRIPS	1.83	CORE	23.22	W. O. EQUIPMENT	0.17
DRESS DRILLING ASSEMBLY		LOG	6.08	FISH	2.98
SINGLE SHOT DEV. SURVEYS	0.23	CASED HOLE DIR. SURVEYS		CLEAN OUT FILL	2.80
OPEN HOLE DIRECTION SURVEYS		UNLOAD CASED HOLE	0.31	UNLOAD WATER INFLOW	0.33
Multishot Surveys	0.25	RUN MANDREL		REAM CROOKED HOLE	
		HYDROLOGICAL TESTS		PLUG BACK	
		Safety Meeting	0.23	DRILL OUT PLUGS	
MAIN HOLE DOT 12.90 DAYS		Sidewall Samples	4.01	SECURED WITH CREWS	2.39
CASING OPERATION TIME (COT)		Mobe-Demobe Reverse		W. O. Loggers	0.23
RUN ______ CASING		Circulation	1.42	W. O. Pad	0.04
RUN ______ CASING				Repair Drill Pipe Leaks	4.02
CEMENT ______ CASING				Pump Mud in Hole	0.06
CEMENT ______ CASING					
DRILL OUT SHOE					
MAIN HOLE COT 1.68 DAYS		MAIN HOLE OST 42.06 DAYS		MAIN HOLE ODT 15.24 DAYS	

TOTAL MAIN HOLE CONST. TIME ______ DAYS | REMARKS:

TOTAL ELAPSED TIME

TOTAL SITE PREP TIME		DAYS
TOTAL MAIN HOLE CONST. TIME	71.88	DAYS
SEC. W/O CREW SITE PREP		DAYS
SEC. W/O CREW MAIN HOLE CONST.	92.48	DAYS
TOTAL SUSPENDED (NO RIG)	119.09	DAYS
TOTAL ELAPSED TIME	283.45	DAYS

REMARKS:

Hole History

2-27-73 Moved in Auger rig #85127 and drilled 36" hole from 0' to 87'.

2-28-73 Drilled 36" hole from 87' to 120' and moved out rig. Ran and welded 20" O.D., 1/4" wall casing with a crane. Set at 110' G.L. Cemented annulus as follows:

Stage No.	Interval	Cement Used	Calc. Ann. Volume	CIP
1	120'-108'	110 ft^3 neat cmt. + 3% $CaCl_2$	85 ft^3	1410 hrs.
2	108'- 58'	290 ft^3 ditto	254 ft^3	1745 hrs.
3	58'- 0'	360 ft^3 ditto	283 ft^3	2215 hrs.
	Totals	760 ft^3	622 ft^3	

3-19-73 Hole suspended from 2-28-73 to 3-19-73. Moved in Ideco #85124 and started rigging up.

3-20-73 Continued rigging up.

3-21-73 Completed rigging up. Drilled out cement from 110' to 120' and 12-1/4" hole from 120' to 133'. Blew hole dry. Cut core #1 from 133' to 147', recovered 6-1/2'. Reamed core hole to 147' with 12-1/4" bit. Drilled and reamed using conventional circulation with air foam. Cored with rubber sleeve core barrel, 7-1/2" core bit, circulated with air.

3-22-73 Drilled 12-1/4" hole from 147' to 151'. Blew hole with air and bailed. Cut core #2 from 151' to 167', recovered 4-1/2'. Reamed core hole to 167' with 12-1/4". Blew hole with air and bailed, circulated out 2' of formation to 169'. Cut core #3 from 169' to 187', recovered 13'. Cleaned out 12' of fill and reamed core hole to 187' with 12-1/4" bit. Cut core #4 from 187' to 204', recovered 6'. Secured rig at 2400 hours. Reamed using conventional circulation with air foam. Cored with rubber sleeve core barrel, 7-1/2" core bit, circulated with air.

3-23-73 Rig secured to 1600 hours. Cleaned out 5' of fill and reamed core hole to 204' with 12-1/4" bit. Blew hole with air and bailed. Circulated out 4' of formation and cut core #5 from 208' to 224', recovered 8-1/2'. Reamed core hole to 224' and drilled 12-1/4" hole to 230'. Reamed and drilled using conventional circulation with air foam. Cored with rubber sleeve core barrel, 7-1/2" core bit, circulated with air.

3-24-73 Blew hole with air and bailed. Cut core #6 from 230' to 248', recovered 12-1/2'. Cleaned out 10' of fill and reamed core hole to 248' with 12-1/4" bit. Blew hole with air. Cut core #7 from 248' to 267' recovered 12'. Cleaned out 12' of fill and reamed core hole to 267' with 12-1/4" bit. Blew hole with air and bailed. Circulated out 7' of formation to 274' and cut core #8 from 274' to 286', recovered 5.1'. Reamed core hole to 286' with 12-1/4" bit. Blew hole with air and bailed. Reamed using conventional circulation with air-foam. Cored with rubber sleeve core barrel, 7-1/2" core bit, circulated with air.

3-25-73 Circulated out 4' of formation to 290', cut core #9 from 290' to 313' recovered 12'. Reamed core hole to 313' with 12-1/4" bit. Blew hole with air and bailed. Circulated out 1' of formation to 314', cut core #10 from 314' to 334', no recovery. Cleaned out 22' of fill and reamed core hole to 334' with 12-1/4" bit. Blew hole with air and bailed. Circulated out 3' of formation to 337' and cut core #11 from 337' to 357', recovered 1'. Reamed core hole to 357' with 12-1/4" bit. Blew hole with air and bailed.

3-26-73 Cut core #12 from 357' to 376', recovered 15-1/2'. Cleaned out 13' of fill and reamed core hole to 376' with 12-1/4" bit. Blew hole with air and bailed. Circulated out 2' of formation and cut core #13 from 378' to 388', recovered 5'. Cleaned out 7' of fill and re-amed core hole to 388' and drilled 12-1/4" hole to 398'. Cut core #14 from 398' to 421', recovered 16-1/2'. Dropped 12" crescent wrench in the hole. Reamed and drilled using conventional circulation with air foam. Cored with rubber sleeve core barrel, 7-1/2" core bit, circulated with air.

3-27-73 Reamed core hole to 421' and drilled 12-1/4" hole from 421' to 425' to sidetrack crescent wrench. Blew hole with air and bailed. Circulated out 4' of formation to 429' and cut core #15 from 429' to 448', recovered 15-1/2'. Reamed core hole to 448' with 12-1/4" bit. Blew hole with air and bailed. Circulated out 1' of formation to 449' and cut core #16 from 449' to 469', recovered 15.7'. Reamed core hole to 469' with 12-1/4" bit. Blew hole with air and bailed. Cut core #17 from 469' to 495', recovered 15.3'. Reamed core hole to 495' with 12-1/4" bit. Blew hole with air and bailed. Cut core #18 from 495' to 508', recovered 13'. Reamed and drilled using conventional circulation with air foam. Cored with rubber sleeve core barrel, 7-1/2" core bit, circulated with air.

3-28-73 Reamed core hole to 508' with 12-1/4" bit. Blew hole with air and bailed. Circulated out 2' of formation to 510' and cut core #19 from 510' to 530', recovered 14-1/4'. Reamed core hole to 530' with 12-1/4" bit. Blew hole with air and bailed. Cut core #20 from 530' to 550', recovered 17'. Reamed core hole to 550' with 12-1/4" bit. Blew hole with air and bailed. Circulated out 5' of formation to 555' and cut core #21 from 555' to 573'. Reamed using conventional circulation with air-foam. Cored with rubber sleeve core barrel, 7-1/2" core bit, circulated with air.

3-29-73 Pulled core #21, recovered 12'. Reamed core hole to 573' with 12-1/4" bit. Blew hole with air and bailed. Circulated out 2' of formation to 575' and cut core #22 from 575' to 595', recovered 6'. Cleaned out fill from 567' and reamed core hole to 595' with 12-1/4" bit. Blew hole with air and bailed. Cut core #23 from 595' to 615', re-covered 20'. Reamed core hole to 615' with 12-1/4" bit. Blew hole with air and bailed. Circulated out 5' of formation to 620' and cut core #24 from 620' to 640', recovered 18'. Reamed using conventional circulation with air foam. Cored with rubber sleeve core barrel, 7-1/2" core bit, circulated with air.

3-30-73 Reamed core hole to 640' with 12-1/4" bit. Blew hole with air and bailed. Circulated out 2' of formation to 642' and cut core #25 from 642' to 662', recovered 18-1/2'. Reamed core hole to 662' with 12-1/4" bit. Blew hole with air. Ran Birdwell caliper log to 661'. Bailed hole. Cut core #26 from 662' to 682', recovered 18-1/4'. Reamed core hole to 682' with 12-1/4" bit. Blew hole with air and bailed. Circulated out 3' of formation to 685' and cut core #27 from 685' to 705', recovered 18'. Reamed core hole to 705' with 12-1/4" bit. Reamed using conventional circulation with air-foam. Cored with rubber sleeve core barrel, 7-1/2" core bit, circulated with air.

3-31-73 Blew hole with air and bailed. Circulated out 2' of formation to 707' and cut core #28 from 707' to 727', recovered 19-1/2'. Reamed core hole to 727' with 12-1/4" bit. Blew hole with air and bailed. Cut core #29 from 727' to 747', recovered 18-1/2". Reamed core hole to 747' with 12-1/4" bit. Circulated out 2' of formation to 749' and cut core #30 from 749' to 769', recovered 18-1/2'. Reamed core hole to 769' with 12-1/4" bit. Reamed using conventional circulation with air foam. Cored with rubber sleeve core barrel, 7-1/2" core bit, circulated with air.

4-1-73 Blew hole with air and bailed. Cut core #31 from 769' to 790', recovered 19.3'. Reamed core hole to 790' with 12-1/4" bit. Blew hole with air and bailed. Cut core #32 from 790' to 810', recovered 19'. Reamed core hole to 810' with 12-1/4" bit. Blew hole with air and bailed. Circulated out 2' of formation to 812' and cut core #33 from 812' to 832', recovered 17.5'. Reamed core hole to 832' with 12-1/4" bit. Reamed using conventional circulation with air foam. Cored with rubber sleeve core barrel, 7-1/2" core bit, circulated with air.

4-2-73 Blew hole with air and bailed. Cut core #34 from 832' to 852', recovered 17'. Reamed core hole to 852' with 12-1/4" bit. Blew hole with air and bailed. Cut core #35 from 852' to 872', recovered 16.5'. Reamed core hole to 872' with 12-1/4" bit. Blew hole with air and bailed. Cut core #36 from 872' to 892', recovered 16.7'. Reamed core hole to 892' with 12-1/4" bit. Reamed using conventional circulation with air foam. Cored with rubber sleeve core barrel, 7-1/2" core bit, circulated with air.

4-3-73 Blew hole with air and bailed. Cut core #37 from 892' to 910', recovered 15'. Reamed core hole to 910' with 12-1/4" bit. Blew hole with air and bailed. Cut core #38 from 910' to 930', recovered 18'. Reamed core hole with 12-1/4" bit to 930'. Blew hole with air and bailed. Cut core #39 from 930' to 950', recovered 16'. Reamed core hole to 950' with 12-1/4" bit. Pulled out of hole and secured rig at 2400 hours. Reamed using conventional circulation with air foam. Cored with rubber sleeve core barrel, 7-1/2" core bit, circulated with air.

4-4-73 Rig secured to 0900 hours. Blew hole with air and bailed. Cut core #40 from 950' to 970', recovered 18'. Reamed core hole to 970' with 12-1/4" bit. Circulated out 2' of formation to 972' and cut core #41 from 972' to 992', recovered 17'. Reamed core hole to 992' with 12-1/4" bit. Blew hole with air. Secured rig at 2400 hours.

4-5-73 Rig secured to 0900 hours. Bailed hole. Cut core #42 from 992' to 1012', recovered 17'. Reamed core hole to 1012' with 12-1/4" bit. Blew hole with air and bailed. Cut core #43 from 1012' to 1032', recovered 15-1/2'. Reamed core hole to 1032' with 12-1/4" bit. Reamed using conventional circulation with air-foam. Cored with rubber sleeve core barrel, 7-1/2" core bit, circulated with air.

4-6-73 Blew hole with air and bailed. Cut core #44 from 1032' to 1052', recovered 17.1'. Reamed core hole to 1052' with 12-1/4" bit. Blew hole with air and bailed. Cut core #45 from 1052' to 1071', recovered 16'. Reamed core hole to 1071' with 12-1/4" bit. Cut core #46 from 1071' to 1091', recovered 16.2'. Reamed core hole to 1091' with 12-1/4" bit. Reamed using conventional circulation with air foam. Cored with rubber sleeve core barrel, 7-1/2" core head, circulated with air.

4-7-73 Blew hole with air and bailed. Cut core #47 from 1091' to 1111', recovered 11'. Reamed core hole to 1111' with 12-1/4" bit. Cut core #48 from 1111' to 1131', recovered 15'. Reamed core hole to 1131' with 12-1/4" bit. Blew hole with air and bailed. Circulated out 4' of formation to 1135' and cut core #49 from 1135' to 1155', recovered 13'-7". Reamed core hole to 1155' with 12-1/4" bit. Reamed using conventional circulation using air foam. Cored with rubber sleeve core barrel, 7-1/2" core bit, circulated with air.

4-8-73 Blew hole with air and bailed. Cut core #50 from 1155' to 1167', recovered 9'. Reamed core hole and drilled 12-1/4" hole from 1167' to 1174'. Blew hole with air and bailed. Cut core #51 from 1174' to 1194', recovered 12'. Reamed core hole to 1194' with 12-1/4" bit. Blew hole with air and bailed. Cut core #52 from 1194' to 1214', recovered 13-1/2'. Reamed core hole to 1214' with 12-1/4" bit. Reamed using conventional circulation with air foam. Cored with rubber sleeve core barrel, 7-1/2" core bit, circulated with air.

4-9-73 Blew hole with air and bailed. Cut core #53 from 1214' to 1234', recovered 1'. Reamed core hole to 1234' with 12-1/4" bit. Blew hole with air and bailed. Circulated out 10' of formation to 1244' and cut core #54 from 1244' to 1255', recovered 5'. Reamed core hole to 1255' with 12-1/4" bit. Blew hole with air and bailed. Cut core #55 from 1255' to 1267', recovered 1/2'. Reamed using conventional circulation with air foam. Cored with rubber sleeve core barrel, 7-1/2" core bit, circulated with air.

4-10-73 Reamed core hole to 1267' with 12-1/4" bit. Blew hole with air and bailed. Cut core #56 from 1267' to 1287', recovered 12'. Reamed core hole 1287' with 12-1/4" bit. Blew hole with air and bailed. Cut core #57 from 1287' to 1307', recovered 18'. Reamed core hole to 1307' with 12-1/4" bit. Blew hole with air and bailed. Cut core #58 from 1307' to 1327', recovered 14'. Reamed core hole to 1327' with 12-1/4" bit. Reamed using conventional circulation with air foam. Cored with rubber sleeve core barrel, 7-1/2" core bit, circulated with air.

4-11-73 Blew hole with air and bailed. Cut core #59 from 1327' to 1347', recovered 14'. Reamed core hole to 1347' with 12-1/4" bit. Blew hole with air and bailed. Circulated out 3' of formation to 1350' and cut core #60 from 1350' to 1370', recovered 11.2'. Reamed core hole to 1370' with 12-1/4" bit. Blew hole with air and bailed. Cut core #61 from 1370' to 1390', recovered 5'. Reamed using conventional circulation with air foam. Cored with rubber sleeve core barrel, 7-1/2" core bit, circulated with air.

4-12-73 Reamed core hole and drilled 12-1/4" hole from 1390' to 1460'. Cut core #62 from 1460' to 1470', recovered 10'. Cut oriented core #63 from 1470' to 1478', recovered 8'. Reamed core hole and drilled 12-1/4" hole from 1478' to 1493'. Reamed and drilled using conventional circulation with air foam. Cored with conventional core barrel 8-11/16" core bit, circulated with air foam.

4-13-73 Drilled 12-1/4" hole from 1493' to 1625'. Secured rig at 1200 hours. (Drilled 132' in 8 rotating hours, 100/110 rpm, 3/5000# wt. on bit, 90 psi, conventional circulation using air foam.)

4-14-73 Rig secured.

4-15-73 Rig secured.

4-16-73 Rig secured to 0800 hours. Ran Birdwell fluid density, caliper, density and epithermal neutron logs to 1624', fluid level at 1520'.

4-17-73 Completed running Birdwell epithermal neutron log. Rig secured at 0500 hours.

4-21-73 Rig secured from 4-17-73 to 0900 hours on 4-21-73. Ran Birdwell fluid density log to 1624', fluid level at 1520'. Ran Sperry-Sun multishot survey in and out of the hole on 30' stations. Took Hunt sidewall samples at 10' intervals from 1450' to 1400', at 1370', 1365', 1330', 1325', 1270', 1265', 1260' and 1245'.

4-22-73 Continued taking sidewall samples at 590', 585', 505', 500,' 495', 490', 470', 465', 425', 420', 395', 390', at 5' intervals from 355', to 315', and 290' to 265', at 225', 205', 200', 165', 145', 130', and 125'. Drilled 12-1/4" hole from 1625' to 1748' using conventional circulation with air foam. Cut oriented core #64 from 1748' to 1762', recovered 14'. Cored with conventional core barrel, 8-11/16" core bit, circulated with air foam.

4-23-73	Reamed core hole to 1762' and drilled 12-1/4" hole from 1762' to 1885'. Cut oriented core #65 from 1885' to 1895', recovered 5'. Cored with conventional core barrel, 8-11/16" core bit. Drilled and cored using conventional circulation with air foam.
4-24-73	Reamed core hole to 1895' and drilled 12-1/4" hole from 1895' to 1977'. Secured rig at 2400 hours.
5-4-73	Rig secured from 4-24-73 to 1800 hours on 5-4-73. Rigged up for dual string drilling.
5-5-73	Rigged up for dual string drilling with air and water. Tagged fill at 1940'. Cleaned out fill from 1940' to 1950'.
5-6-73	Cleaned out fill from 1950' to 1977' and drilled 12-1/4" hole from 1977' to 2050' using dual string reverse circulation with air and water. Ran Birdwell fluid density log to 2005', fluid level at 1592'. Cut core #66 from 2050' to 2060', recovered 2'. Cored with conventional core barrel, 8-11/16" core bit, circulated with water.
5-7-73	Reamed core hole and drilled 12-1/4" hole from 2060' to 2086'. Hole stopped unloading. Pulled out of hole to check inner string.
5-8-73	Repaired leaks in dual string drill pipe and cleaned out fill from 2020' to 2040' using air and water. Secured rig at 2400 hours.
5-9-73	Rig secured to 0800 hours. Tagged fill at 2010'. Cleaned out fill from 2010' to 2086'. Drilled 12-1/4" hole from 2086' to 2129'. (Drilled 43' in 8 rotating hours, 40 rpm, 15,000# wt. on bit, 400 psi, dual string drilling with reverse circulation using air and water.)
5-10-73	Drilled 12-1/4" hole from 2129' to 2202'. Cleaned out fill from 2040' to 2138' after trip. (Drilled 73' in 14-1/2 rotating hours, 40/50 rpm, 15,000# wt. on bit, 400 psi, dual string drilling with reverse circulation using air and water.)
5-11-73	Drilled 12-1/4" hole from 2202' to 2295'. Pumped 280 barrels of mud in the hole. Pulled out of hole. Ran Birdwell fluid density log and depth check. Tagged bottom at 2293', fluid level at 1169'. Ran core barrel in the hole. (Drilled 93' in 12-1/2 rotating hours, 50 rpm, 10/15,000# wt. on bit, 375 psi, dual string drilling with reverse circulation using air and water.)
5-12-73	Cut core #67 from 2295' to 2297', recovered 1'. Left matrix off of core bit in hole. Ran Birdwell fluid density and caliper logs to 2294', fluid level at 961'. Ran 11-1/4" O.D. Globe basket in the hole, could not get below 2145'. Ran 12-1/4" bit in the hole and drilled on junk from 2297' to 2302'.
5-13-73	Drilled 12-1/4" hole from 2302' to 2428'. No sign of junk. (Drilled 126' in 15-1/2 rotating hours, 50/40 rpm, 15,000# wt. on bit, 400 psi, dual string drilling with reverse circulation using air and water.)

5-14-73 Drilled 12-1/4" hole from 2428' to 2458'. Pumped in 250 barrels of mud and pulled out of hole. Secured rig at 0800 hours. (Drilled 30' in 4 rotating hours, 35 rpm, 15,000# wt. on bit, 400 psi, dual string drilling with reverse circulation using air and water.)

5-15-73 Rig secured to 1030 hours. Unload hole. Drilled 12-1/4" hole from 2458' to 2499'. (Drilled 41' in 4 rotating hours, 40 rpm, 15,000# wt. on bit, 400 psi, dual string drilling with reverse circulation using air and water.)

5-16-73 Drilled 12-1/4" hole from 2499' to 2728'. Pulled out of hole to check for leaks in inner string. Checked fluid level at 2130' on connection at 2510' and at 1970' on connection at 2634'. Ran Birdwell water locator on connection at 2696', fluid level at 1544'. (Drilled 229' in 18-1/2 rotating hours, 35/40 rpm, 10/15,000# wt. on bit, 450/525 psi, dual string drilling with reverse circulation using air and water.)

5-17-73 Checked drill pipe for leaks. Cleaned out 12' of fill and drilled 12-1/4" hole from 2728' to 2796'. (Drilled 68' in 5-1/2 rotating hours, 40 rpm, 15,000# wt. on bit, 525 psi, dual string drilling with reverse circulation using air and water.)

5-18-73 Drilled 12-1/4" hole from 2796' to 2885'. Made trip for new bit and could not break circulation. Pulled out of hole to check inner string for leaks. (Drilled 89' in 12 rotating hours, 40 rpm, 15/20,000# wt. on bit, 525/500 psi, dual string drilling with reverse circulation using air and water.)

5-19-73 Pulled out of hole checking inner string for leaks. Ran Birdwell water locator, fluid level at 1511'. Ran back in hole. Ran water locator, fluid level at 1476'. Could not get hole to unload. Made trip to check for leaks. Cleaned out 20' of fill to 2843' and could not get hole to unload.

5-20-73 Checked drill pipe for leaks. Ran 12-1/4" bit in the hole and cleaned out fill from 2808' to 2824'.

5-21-73 Cleaned out fill from 2824' to 2885'. Pumped 280 barrels of mud in the hole. Ran Birdwell caliper log to 1881'. Ran fluid density log, fluid level at 1215'. Ran vibroseis survey.

5-22-73 Completed running vibroseis survey. Pumped 520 barrels of mud in the hole. Monitored fluid level with Birdwell fluid density log, top of fluid at 16'. Fluid level dropped 22' in 15 minutes. Ran electric and 3-D logs to 2825'. Pumped in 175 barrels of mud keeping hole full whill logging.

5-23-73 Completed running Birdwell 3-D log to 2825'. Ran density tool to bridge at 2196', worked tool to 2112' and could not move. Pulled wire line out of the hole and started fishing for density tool. Secured rig at 2400 hours.

5-24-73 Rig secured.

5-25-73 Rig secured to 0530 hours. Ran Birdwell fluid density log to top of fish at 2821', fluid level at 549'. Ran 10-3/4" O.D. wash over pipe with 12" shoe, could not get below 2030'. Ran 2-7/8" drill pipe with a hook on the end and started fishing for the density tool.

5-26-73 Pulled out of hole and lost hook welded on bottom of the 2-7/8" drill pipe. Ran 11-3/4" O.D. Globe basket in the hole and milled from 2821' to 2826' and again from 2826' to 2832', recovered part of fish and 3 small piece of junk. Ran Birdwell gamma ray log to 2828'. Ran 11-3/4" O.D. Globe basket in the hole and washed from 2832' to 2885' and drilled from 2885' to 2886'. Pulled out of hole, recovered fish and radioactive source. Ran caliper log to 2875'.

5-27-73 Ran vibroseis survey. Ran Birdwell epithermal neutron log to 2868'. Ran density log to 2867'. Secured rig at 2400 hours.

5-28-73 Drilling operations secured for holiday.

5-29-73 Laid down drill pipe. Secured rig at 0800 hours.

5-30-73 Moved out drill pipe. Mechanics worked on rig.

5-31-73 Rig secured.

6-1-73 Rig secured to 1300 hours. Laid down dual string drill pipe. Started running 6-5/8" drill pipe in the hole.

6-2-73 Rig secured.

6-3-73 Ran Hunt sidewall sample tool and took samples as directed. Prepared to run casing.

6-4-73 Ran 9-5/8" O.D., 36#, J-55 casing in the hole with a Halliburton formation packer shoe on bottom and metal petal basket at 101.62 Set casing at 2090'. Ran Birdwell DCTL background log to 2079'. Cemented annulus using Halliburton as follows·

Stage No.	Interval	Cement Used	CIP
1	2090'-1722'	400 ft^3 neat cement	1107 Hrs.
2	102'- 93'	10 ft^3 gypsum Cmt.	1412 Hrs.
3	93'- 0'	150 ft^3 neat Cmt. 3% $CaCl_2$	1540 Hrs.

Monitored cementing with the DCTL log and fluid levels with the fluid density log. Stage #2 and #3 were cement down the annulus starting at the metal petal basket. Rig secured at 2200 hours.

6-5-73 Rig secured to 1200 hours. Completed rigging down. Hole suspended.

6-15-73 Hole suspended from 6-5-73 to 6-15-73. Cement in the annulus dropped to 45'. Cemented annulus to surface with 85 ft^3 of neat cement. CIP at 1830 hours. Hole suspended.

9-17-73	Hole suspended from 6-15-73 to 9-17-73. Moved in Ideco 525 rig #85124 and began rigging up.
9-18-73	Completed rigging up and began blowing water from hole.
9-19-73	Drilled out cement and shoe from 2085' to 2090'. Cleaned out fill from 2090' to 2886'. Drilled 8-3/4" hole from 2886' to 2968' using conventional circulation with air foam.
9-20-73	Drilled 8-3/4" hole from 2968' to 3175'. Had difficulty unloading hole at 3111'.
9-21-73	Drilled 8-3/4" hole from 3175' to 3501'. Ran Birdwell fluid density log, stopped at 2349'. Secured rig at 2400 hours.
9-24-73	Rig secured from 9-21-73 until 0 hours on 9-24-73. Ran Birdwell fluid density log, stopped at 2329'. Top of soapy fluid at 1515'. Laid down 2 crooked 6" drill collars. Trip in to 2526', could not unload. Pulled up to 2211', unloaded hole and cleaned out fill. Pushed through bridges at 2329' and 2349'. Drilled 8-3/4" hole from 3501' to 3814'.
9-25-73	Drilled 8-3/4" hole from 3814' to 4113'. Secured rig at 2400 hours.
9-26-73	Rig secured from 9-25-73 until 0800 hours on 9-26-73. Rigged down and secured operations at 1600 hours.
10-26-73	Rig secured from 9-26-73 until 0001 hours on 10-26-73. Rigged trip in hole to bottom of 9-5/8" casing. Secured rig at 2400 hours.
10-29-73	Rig secured from 10-26-73 until 0 hours on 10-29-73. Trip in hole, hit bridge at 3945'. Cleaned out bridge and pumped in 140 bbls. of mud. Finished trip in hole and drilled 8-3/4" hole from 4113' to 4114'. Cleaned out 35' of fill and cut core #68 from 4114' to 4128' Cored with conventional core barrel, 8-11/16" core bit. Drilled and cored using conventional circulation with mud.
10-30-73	Finished trip out of hole with core #68, no recovery. Reamed core interval and drilled 8-3/4" hole from 4128' to 4160' with bit and junk basket, attempting to pick up junk.
10-31-73	Conditioned hole and trip out. Picked up core barrel and cut core #69 from 4160' to 4173', recovered 12'. Cored with conventional core barrel, 8-11/16" bit. Reamed core interval and drilled 8-3/4" hole from 4160' to 4191'. Drilled and core using conventional circulation with mud.
11-1-73	Drilled 8-3/4" hole from 4191' to 4209'. Conditioned hole and attempted to run Birdwell epithermal neutron log, hit bridge at 2887'. Trip in and drilled out bridges. Conditioned hole and ran epithermal neutron log to 4208'. Began running density log.
11-2-73	Finished running density log to 4208'. Ran electric log to 4208'. Ran 3-D log, tool would not work. Attempted to re-run epithermal neutron log, tool stuck at 2250'. Worked loose and stuck tool at bottom of 9-5/8" casing at 2090'. Worked loose and pulled out of hole, tool leverage arm was disfigured. Ran depth check to 4208'. Secured rig at 2400 hours.

11-5-73	Rig secured from 11-2-73 until 0 hours on 11-5-73. Attempted to run temperature log. Worked tool thru bridge at 2730' and plugged tool. Pulled out and cleaned tool. Re-ran temperature log, could not work tool deeper than 3317'. Pulled out and ran in hole with 8-3/4" bit, conditioned hole and trip out. Ran epithermal neutron and 3-D logs to 4207'.
11-6-73	Finished running 3-D logs (2 runs) to 4207'. Attempted to run seisviewer log, no signal. Ran caliper log to 4208'. Picked up Hunt sidewall sampling tools and began sidewall sampling.
11-7-73	Sidewall sampled on 25' stations as directed by the User.
11-8-73	Continued sidewall sampling as directed by the User.
11-9-73	Completed sidewall sampling. Began rigging down. Secured rig at 1000 hours.
11-12-73	Rig secured from 11-9-73 until 0800 hours on 11-12-73. Trip in hole and circulated mud from hole. Trip out and secured rig at 1630 hours. Ran Birdwell seisviewer log from 4017' to 2080'. Ran fluid density log to 550', fluid level at 524'.
12-2-73	Rig secured from 11-12-73 until 1200 hours on 12-2-73. Trip in hole with 4½" drill pipe, hit bridge at 3275'. Trip out and began rigging down.
12-3-73	Completed rigging down and moved off. Hole completed.

SPERRY-SUN MULTISHOT SURVEY

Date	TD	TVD	Horizontal Displacement	Reference	Run
4-21-73	1619'	1618.95'	6.46', S33° 30' W	587-5U3-1999	In
4-21-73	1619'	1618.95'	6.48', S33° 57' W	587-5U3-1999	Out

Cementing ~~13-3/8~~ 9-5/8" O.D. Casing.

Stage No.	Interval	Cement Used - Ft^3	Calc. Annular Volume - Ft^3
1	2090'-1722'	400	189
2	102'- 93'	10	11
3	93'- 58'	150	97
4	58'- 0'	85	49
	TOTAL	645	346

UE-6e

REVIEW OF HOLE CONDITIONS

914mm (36") hole was drilled to 36.6m (120') with an auger rig. 508mm (20") casing was set at 33.5m (110') and the annulus filled to surface with 21.52m^3 (760 ft^3) of cement slurry in 3 stages. The calculated annular volume was 17.61m^3 (622 ft^3). 311mm (12¼") hole was drilled from 36.6m (120') to 602.6m (1977') using conventional circulation with air foam and with dual string reverse method of circulation using air and water from 602.6m (1977') to 879.7m (2886'). The caliper log ran on 5-26-73 indicated hole enlargement from 35.4m (116') to 571.2m (1874') to maximum diameters of 660mm (20") at 63.7m (209') and at 192.3m (631'). 244mm (9-5/8") casing was set at 637.0m (2090') with a formation packer on bottom. The annulus was cemented from the packer to 524.9m (1722') and from a metal petal basket at 31.1m (102') to surface with 18.26m^3 (645 ft^3) of cement slurry in 4 stages. The calculated annular volume for these intervals was 9.80m^3 (346 ft^3). Fill was cleaned out from 637.0m (2090') to 879.7m (2886') and 222mm (8-3/4") hole drilled to 1253.6m (4113') using conventional circulation with air foam and to a total depth of 1282.9m (4209') using mud. The caliper log ran on 11-6-73 indicated several enlarged intervals to beyond the caliper arm limits of 635mm (25") from 703.5m (2308') to 736.4m (2416') and from 873.6m (2866') to 874.8m (2870') to a diameter of 635mm (25"). 61 dry hole cores were cut from 40.5m (133') to 423.7m (1390'). 3 cores were cut from 445.0m (1460') to 577.5m (1895') using air foam. The hole was cored from 624.8m (2050') to 627.9m (2060') with water. 2 cores were cut from 1253.9m (4114') to 1271.9m (4173') using mud. Sidewall samples were taken from 38.1m (125') to 1281.7m (4205'). Caliper, NCTL, density, water locator, fluid density, electric, gamma, epithermal neutron, seisviewer and 3-D logs were run. A vibroseis survey was run. Fluid density log ran on 11-12-73 indicated fluid at 159.7m (524').

APPENDIX E

Hole History Data for Well HTH–3 (Fenix and Scisson, Nevada)

FENIX & SCISSON OF NEVADA
HOLE HISTORY DATA

Approved: Jerry Bill Covington
Date: Dec 11, 1989

Hole No.: USGS HTH #3 (Group II) | Type Hole: Hydrologic Test
User: USGS/AEC | Area: 5 | Site Prep. W.O.#: None
Location: NTS | County: Nye | Contract #: AT(29-2)-1302
Surface Coordinates: N 750,189' E 736,937'
Ground Elevation: 3477.2' | Pad Elevation: N/A | Top Casing Elevation: N/A
Bottom Hole Coordinates: N 750,199.40' E 736,892.17' @VD 1507.8' | Reference: Sperry Sun
Rig On Location: 03-19-62 | Spudded: 03-22-62 | Completed: 05-11-62
Circulating Media: Conventional, air, mud, air foam
Main Rig & Contractor: Rig #22 - Western Republic Drilling Co.
No. Of Compressors & Capacity: N/A

Bore Hole Record			Casing Record						
From	To	Size	I.D.	Wt/Ft	Wall	Grade	From	To	Ft³ Cmt.
0'	17'	20"	17.250"	N/A	0.375"	--	0'	16.5'	35
17'	165'	17-1/2"	12.715"	48#	0.330"	--	0'	163'	164
165'	1850'	9"	6.456"*	20#	0.272"	--	0'	1517'	None
1850'	1860'	7-1/2"							

Total Depth: 1860' | Plugs: None
Junk: None
Logging Data: Lane Wells: Electric, Gamma ray-neutron, Induction, Temperature, Sonic, Caliper, Density, Focus

Rigs Used

Rig No.	Name	Type	Class	Days Operating	Sec. W/Crew	Sec. W/O Crew	Total Days On Location
#22	Ideco HD-30		N/A	--	--	---	54.00±

Remarks: * Bottom 324' of casing slotted.

Prepared By: JEC:llh [signature] 12-11-89

Reviewed By: LWM [signature] 12/11/89

USGS/AEC
USGS HTH #3
Group II, Area 5
Hole History

03-19-62 Moved in Western Republic Drlg. Co. #22, Ideco HD-30 rig and started rigging up.

03-20-62 Continued rigging up.

03-21-62 Continued rigging up.

03-22-62 Rigged up. Drilled 20" hole from 0′ to 17′. Set 18" casing at 16.5′ and cemented annulus with 35 ft^3 of cement.

03-23-62 Waited on tools and made up surface installations.

03-24-62 Rigged up mud equipment. Drilled cement from 16′ to 17′ and 7" hole to 70′ with conventional circulation using mud.

03-25-62 Completed mud equipment installation. Drilled 9" hole from 70′ to 72′.

03-26-62 Drilled 9" hole from 72′ to 90′. Opened hole to 12-1/4" to 90′ and drilled 12-1/4" hole to 100′.

03-27-62 Drilled 12-1/4" hole from 100′ to 165′ and opened hole to 17-1/2" to 165′. Set 13-3/8" casing with shoe at 163′. Dev. survey @ 100′ = 0°25′.

03-28-62 Cemented the annulus with 165 ft^3 of common cement + 2% HA5. CIP at 0200 hours. Drilled cement and shoe to 165′ and 12-1/4" hole to 168′. Blew hole dry.

03-29-62 Cored #1 and #2 8-7/8" hole from 168′ to 175′ using air, 5.7′ recovery.

03-30-62 Opened core hole and drilled 9" hole from 175′ to 400′. Dev. survey @ 200′=0°30′, 300′=0°45′, and 393′=1°30′.

03-31-62 Drilled 9" hole from 400′ to 451′. Cored #3 8-7/8" hole to 462, 2.2′ recovery. Opened core hole. Dev. Survey @ 433′=1°00′.

04-01-62 Drilled 9" hole from 446′ to 600′.

04-02-62 Cored #4 8-7/8" hole from 600′ to 610′, 7′ recovery. Opened core hole and drilled 9" hole from 610′ to 632′. Cored #5 8-7/8" hole to 634′, 2′ recovery.

04-03-62 Opened core hole and drilled 9" hole from 632′ to 701′. Dev. servey @ 690′=1°30′.

04-04-62 Drilled 9" hole from 701′ to 764′. Dev. survey @ 746′=1°45′.

04-05-62 Drilled 9" hole from 764′ to 795′. Cored #6 8-7/8" hole to 805′, 5′ recovery. Opened core hole.

04-06-62 Drilled 9" hole from 805′ to 872′. Cored #7 8-7/8" hole to 877′, 5′ recovery. Opened core hole. Dev. survey @ 800′=1°45′.

04-07-62	Drilled 9" hole from 877' to 944'. Dev. survey @ 900'=2°00'.
04-08-62	Cored #8 8-7/8" hole to 949', 4.5' recovery. Opened core hole and drilled 9" hole from 949' to 1050'. Dev. survey @ 1000'=2°30'.
04-09-62	Drilled 9" hole from 1050' to 1127'. Cored #9 8-7/8" hole to 1132', 3.3' recovery. Opened core hole and drilled 9" hole from 1132' to 1139'. Dev. survey @ 1100'=2°45'.
04-10-62	Cored #10 8-7/8" hole to 1146', 1' recovery. USGS ran fluid check.
04-11-62	Cored #11 8-7/8" hole to 1152.5', 4.5' recovery and #12 to 1156', 2' recovery.
04-12-62	Cored #13 8-7/8" hole to 1158', 1.25' recovery. Opened core hole and drilled 9" hole from 1158' to 1190'.
04-13-62	Drilled 9" hole from 1190' to 1200'. Made trip to bottom with 3-1/2" tubing for swab test, no returns. Ran USGS static fluid level test.
04-14-62	Cored #14 8-7/8" hole to 1219', 4' recovery. Dropped bolt and nut in hole.
04-15-62	Recovered fish using magnetic basket. Opened core hole and drilled 9" hole to 1225'.
04-16-62	Ran USGS fluid probe, fluid at 1105.8'. Cored #15 8-7/8" hole to 1234', 7' recovery and #16 to 1235', 1' recovery. Opened core hole and drilled 9" hole to 1275'.
04-17-62	Drilled 9" hole from 1275' to 1296'. Cored #17 8-7/8" hole to 1301', 2.5' recovery. Opened core hole to 9" to 1301'. Attempted to run swab test using 3-1/2" tubing, lost swab in tubing.
04-18-62	Pulled tubing and recovered swab. Drilled 9" hole from 1301' to 1322'. Ran 3-1/2" tubing for production test, jetting with air. Recovered 1000 gallons of water in 6 hours.
04-19-62	Completed test. Drilled 9" hole from 1322' to 1340'. Dev. survey @ 1330'=2°45'.
04-20-62	Drilled 9" hole from 1340' to 1358'. Ran swab test with 3-1/2" tubing at 1358'.
04-21-62	Cored #18 8-7/8" hole to 1363', 3.5' recovery. Opened core hole and drilled 9" hole from 1363' to 1389'.
04-22-62	Drilled 9" hole from 1389' to 1400'. Ran swab test from 1140' to 1400' using 2-7/8" tubing.
04-23-62	Cleaned out 40' fill and drilled 9" hole from 1400' to 1450'. Dev. survey @ 1420'=2°50'.

04-24-62	Cored #19 8-7/8" hole to 1457', 3' recovery. Opened core hole and drilled 9" hole from 1457' to 1500'.
04-25-62	Ran swab test using 3-1/2" tubing at 1486'. Cored #20 8-7/8" hole to 1507', 6' recovery.
04-26-62	Opened core hole and drilled 9" hole from 1507' to 1550'. Dev. survey @ 1510'=2°50'.
04-27-62	Cored #21 8-7/8" hole to 1555', 2.3' recovery. Opened core hole and drilled 9" hole from 1555' to 1595'.
04-28-62	Cored #22 8-7/8" hole to 1602', 7' recovery. Ran USGS swab test using 3-1/2" tubing.
04-29-62	Cleaned out 40' fill, opened core hole, and drilled 9" hole from 1602' to 1650'. Dev. survey @ 1600'=2°30'.
04-30-62	Cored #23 8-7/8" hole to 1657', 7' recovery. Opened core hole and drilled 9" hole from 1657' to 1680'.
05-01-62	Drilled 9" hole from 1680' to 1700'. Cored #24 8-7/8" hole to 1707', 7' recovery. Opened core hole. Dev. survey at 1700'=2°30'.
05-02-62	Ran Lane Wells electric log tool, tool stopped at 479'. Drilled 9" hole from 1707' to 1710'.
05-03-62	Ran Lane Wells electric, induction, focus, temperature, gamma ray-neutron, caliper, and density logs. Ran USGS swab tests using Lynes packer on 3-1/2" tubing with packer set at 1614' then 1459'.
05-04-62	Drilled 9" hole from 1710' to 1745'.
05-05-62	Drilled 9" hole from 1745' to 1780'.
05-06-62	Cored #25 7-1/2" hole to 1800', 20' recovery. Opened core hole and drilled 9" hole from 1800' to 1850'.
05-07-62	Cored #26 7-1/2" hole to 1860', 7.5' recovery. Ran swab test with 3-1/2" tubing at 1610'.
05-08-62	Ran Lane Wells gamma ray-neutron, caliper, and electric logs. Ran and landed 7" O.D., 20#, J-55 casing with Baker shoe at 1516.64' and bottom 323.91' of casing slotted. Ran Sperry Sun gyroscopic survey.
05-09-62	Ran and landed Reda pump on 2-7/8" tubing at 1368' along with 1" tubing at 1350'. Started water entry test.
05-10-62	Completed pumping rate test.
05-11-62	Laid down tubing and Reda pump, rig released. Hole completed 05-11-62.

TABLE E-1. CORED INTERVALS AT HTH−3 AND RECOVERY.

Core Number	Interval (feet bls)	Feet Recovered
1 and 2	168−175	5.7
3	451−462	2.2
4	600−610	7
5	632−634	2
6	795−805	5
7	872−877	5
8	944−949	4.5
9	1127−1132	3.3
10	1139−1146	1
11	1146−1152.5	4.5
12	1152.5−1156	2
13	1156−1158	1.25
14	1200−1219	4
15	1225−1234	7
16	1234−1235	1
17	1296−1301	2.5
18	1358−1363	3.5
19	1450−1457	3
20	1500−1507	6
21	1550−1555	2.3
22	1595−1602	7
23	1650−1657	7
24	1700−1707	7
25	1780−1800	20
26	1850−1860	7.5

END

DATE FILMED

8 / 25 / 92