WATER LEVELS IN PERIODICALLY MEASURED WELLS IN THE YUCCA MOUNTAIN AREA, NEVADA, 1981-87

U.S. GEOLOGICAL SURVEY

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Prepared in cooperation with the
NEVADA OPERATIONS OFFICE,
U.S. DEPARTMENT OF ENERGY under
Interagency Agreement DE-AI08-78ET44802

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By James H. Robison, Diane M. Stephens,
Richard R. Luckey, and Darrell A. Baldwin

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Denver, Colorado
1988

DEPARTMENT OF THE INTERIOR

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CONVERSION TABLE

Multiply	*By*	*To obtain*
foot (ft)	0.3048	meter (m)
inch (in.)	25.40	millimeter (mm)
kilogram (kg)	2.205	pound (lb)
kilogram per meter (kg/m)	0.6720	pound per foot (lb/ft)
kilometer (km)	0.6214	mile (mi)
liter (L)	0.2642	gallon (gal)
liter per second (L/s)	15.85	gallon per minute (gal/min)
meter (m)	3.2808	foot (ft)
meter per meter (m/m)	1	foot per foot (ft/ft)
meter per (meter · degree) Celsius	1.8	foot per (foot · degree) Fahrenheit
meter per (meter · kilogram)	2.205	foot per (foot · pound)
millimeter (mm)	0.03937	inch (in.)
square kilometer (km^2)	0.3861	square mile (mi^2)

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

WATER LEVELS IN PERIODICALLY MEASURED WELLS IN THE YUCCA MOUNTAIN AREA, NEVADA, 1981-87

By J.H. Robison, D.M. Stephens, R.R. Luckey, and D.A. Baldwin

ABSTRACT

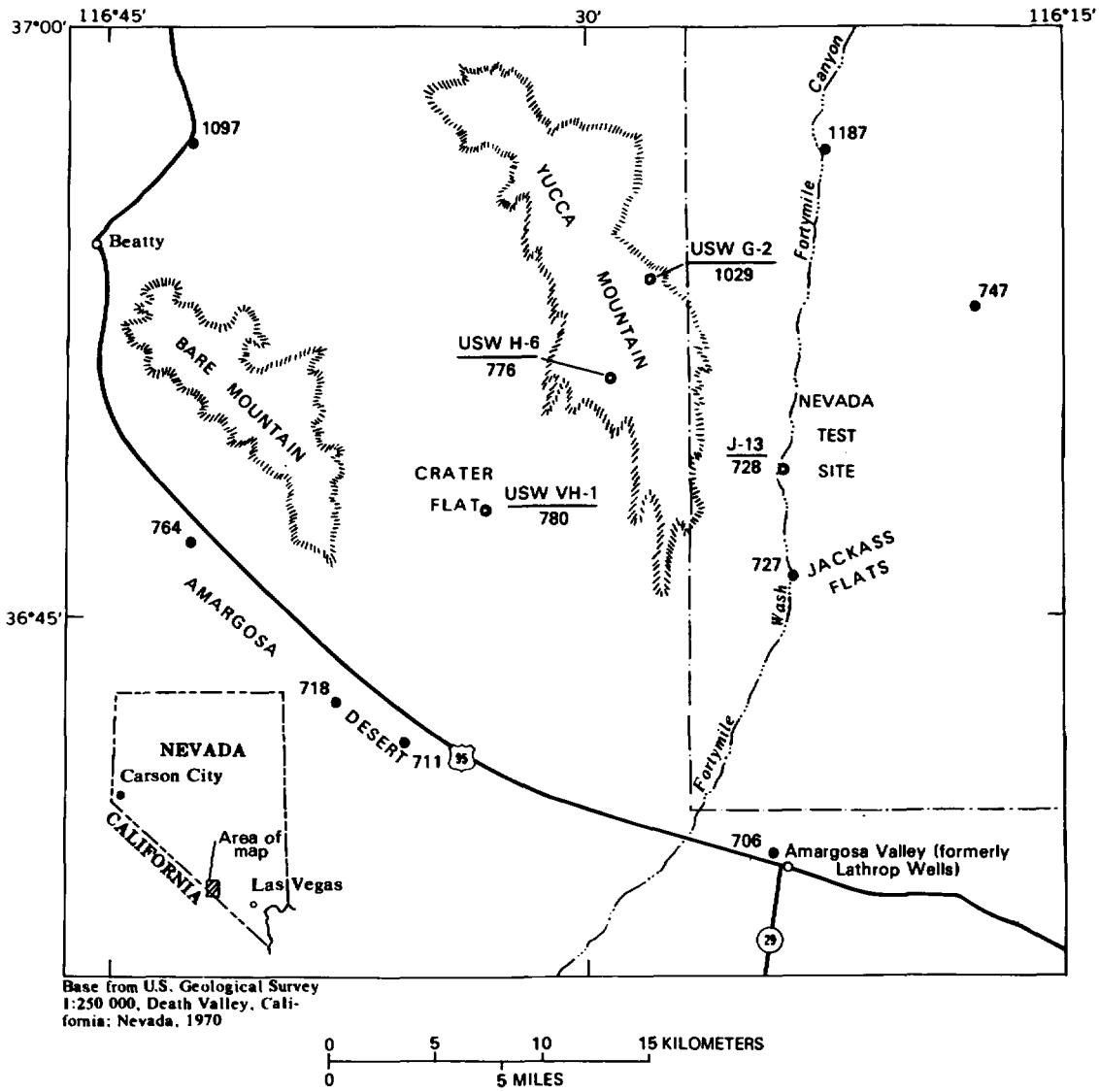
This report presents water-level data for 28 wells that have been periodically measured in the Yucca Mountain area, Nevada. The report includes discussions of the methods used and corrections applied to obtain water-level depths and altitudes from onsite measurements. Water levels for each well are presented in tabular and graphical (hydrograph) form. The altitude of the water level in the upper part of the saturated zone is about 775 meters above sea level to the west of and along part of the crest of Yucca Mountain; along the eastern edge and southern end of Yucca Mountain, the water level is nearly horizontal and is 728 to 730 meters above sea level. The water-level data were obtained in cooperation with the U.S. Department of Energy to help evaluate the suitability of the area for storing high-level nuclear waste.

INTRODUCTION

The Yucca Moutain area is being evaluated by the U.S. Department of Energy for suitability to store high-level nuclear waste in a mined, underground repository. A 150-km^2 area located about 150 km northwest of Las Vegas in southern Nevada is being studied extensively (fig. 1). Water levels in wells have been periodically measured during 1981-87 to gain a better understanding of the ground-water system in the candidate area. In the Yucca Mountain area, the water table is in air-fall and ash-flow tuff of Tertiary age, which is underlain at depth by carbonate rocks of Paleozoic age (Robison, 1984).

This report describes the methods used to collect and correct measurements of water levels and lists water-level altitudes for 28 wells. Water-level measurements have been made with steel tapes, single-conductor cables ("Iron Horses"), and hoist units that use multiconductor cables in mobile vans or trucks. Corrections have been made for thermal expansion, mechanical stretch, and borehole deviation from vertical. Water-level altitudes are computed based on the water-level measurement and the altitude of the measuring point; they are presented in a data table for each well, usually accompanied by one or more hydrographs. In this report, many of the data in Robison (1984, 1986) are updated. The water-level data in this report have been collected under quality-assurance procedures required for study of Yucca Mountain as a candidate site for storage of nuclear waste.

The water-level data were obtained as part of the Nevada Nuclear Waste Storage Investigations (NNWSI). This study is being made in part by the U.S. Geological Survey in cooperation with the U.S. Department of Energy (DOE) under Interagency Agreement DE-AI08-78ET44802.



EXPLANATION

USW VH-1 / 780 ● WELL–Upper number is well number; lower number is approximate altitude of water level, in meters above sea level

764 ● WELL–Number is altitude of water level reported in Waddell (1982), in meters above sea level

Figure 1.--Location of Yucca Mountain area and selected water-level altitudes.

WELL DESIGNATIONS

Each well used in the study of the Yucca Mountain area has a unique name or number. Wells on the Nevada Test Site (NTS) use the NTS designation, whereas wells off the NTS use a slightly different designation. Wells on the NTS begin with UE (U for underground and E for exploratory), followed by the NTS area number (always 25 in this report). This designation--UE-25--commonly is followed by one or more letters signifying the purpose or simply a sequential letter, followed by a sequence number. Wells off the NTS begin with the letters USW (U for underground, S for southern Nevada, and W for waste). The designation--USW--is followed by one or more letters signifying the purpose for the well followed by a sequence number. The letters signifying purpose that most commonly are used in this report are G (drilled primarily to collect geologic data), H (drilled primarily to collect hydrologic data), P (drilled to collect data on rocks of Paleozoic age), V (drilled to collect data on volcanism), and WT (drilled primarily to determine the water table). The only well not using this system and referred to in this report is well J-13.

Nevada State Coordinates are used to identify location of wells cited in this report. These coordinates are for the central zone of Nevada and are based on a Transverse Mercator projection. The origin of this projection for the central zone of Nevada is latitude 34°45' N., and the central meridian is at longitude 116°40' W. The Nevada State Coordinates given in the section on well data are in feet north of the baseline and in feet plus 500,000 east of the central meridian. The Nevada State Coordinates for the wells were determined by Holmes & Narver, Inc.[1], contractor to the U.S. Department of Energy for surveying at the NTS and Yucca Mountain area. Latitude and longitude values of the wells were calculated from the Nevada State Coordinates.

The Site ID number is used for unique identification of the site in the U.S. Geological Survey's computer files. The Site ID is generated by combining the original designations of the latitude and longitude with a two-digit sequence number. The Site ID is for convenience of identification only and should not be used as a location number because the original designations of latitude and longitude may be inaccurate. Even if original values of the latitude and longitude are revised later, the Site ID for the site is not changed. If more than one site exists within the 1-second rectangle of latitude and longitude, the two-digit sequence number is used to ensure uniqueness of the Site ID.

Some wells within the water-level network have had packers or piezometers installed so that the water level of discrete intervals could be measured. In this case, the well, before the packers or piezometers were installed, was assigned one Site ID (generally with a sequence number of 01) and each depth interval was assigned its own unique Site ID by incrementing the sequence number. Hence, some wells within the network have several Site ID's. When this occurs, all Site ID's are listed by location in the "Well data, water levels, and hydrographs" section, and the interval of the well represented by each Site ID is identified.

---

[1]Use of firm, brand, and trade names in this report is for identification purposes only and does not constitute endorsement by the U.S. Geological Survey.

GENERAL DESCRIPTION OF WATER-LEVEL SURFACE

The water-level altitude in the Yucca Mountain area ranges from about 700 m to about 1,200 m above sea level. Water-level altitudes of some wells are shown in figure 1, generally similar to the map included in Robison (1984, 1986), which also shows potentiometric surface contours.

Water-level altitudes beneath Yucca Mountain are shown in greater detail in figure 2, which also is similar to the map in Robison (1984, 1986), but without potentiometric-surface contours. Water-level altitudes shown in figure 2 are highest to the north at wells USW G-2 and UE-25 WT #6, at about 1,030 m above sea level.

In wells USW H-6, USW WT-7, and USW WT-10, west of the crest of Yucca Mountain, and in well USW H-5 on the crest, the water levels all are about 775 m above sea level. Water levels are as much as 45 m lower at wells USW G-3 and USW H-3, 1 km east of well USW WT-7. An inflatable packer in well USW H-3 was moved in May 1984 from a depth of 1,190 m to a depth of 1,114 m; the altitude of the water level in the zone above the packer is now more similar to that of other wells immediately to the east, and the altitude of the water level in the zone below the packer, at 770 m, is nearly as high as in wells west of the crest.

From the eastern edge and southern end of Yucca Mountain to western Jackass Flats, the water level decreases from about 730 to 728 m in altitude (fig. 2) and decreases further to 706 m at Amargosa Valley (formerly Lathrop Wells; fig. 1).

WATER-LEVEL NETWORK

History and Development

Well drilling for preliminary evaluation of the suitability of the Yucca Mountain site began in 1980; the first wells were completed in 1981. Water levels were measured as each well was completed and tested. After these initial water-level measurements, the U.S. Geological Survey began to measure the water levels periodically in order to determine stability of the original measurements and to determine if any cycles or trends of the water levels occur that might provide insight about the local hydrologic system. In addition, the nearly horizontal potentiometric surface beneath part of the area (Robison, 1984) indicated that periodic water-level measurements for calculating long-term average water levels might be needed at a number of wells to determine hydraulic gradients with adequate precision. As more water levels were measured, it became apparent that periodic measurements were not likely to be sufficient for calculating average water levels, nor for determining short-term changes that could help evaluate conceptual models and mechanisms of ground-water flow beneath Yucca Mountain. In late 1983, continuous water-level monitoring was begun at well UE-25b #1. Continuous water-level records were obtained intermittently in well USW H-1 in 1983 and in well USW H-4 in 1984, while overcoming operational difficulties. By 1986, the present network for continuous monitoring had evolved.

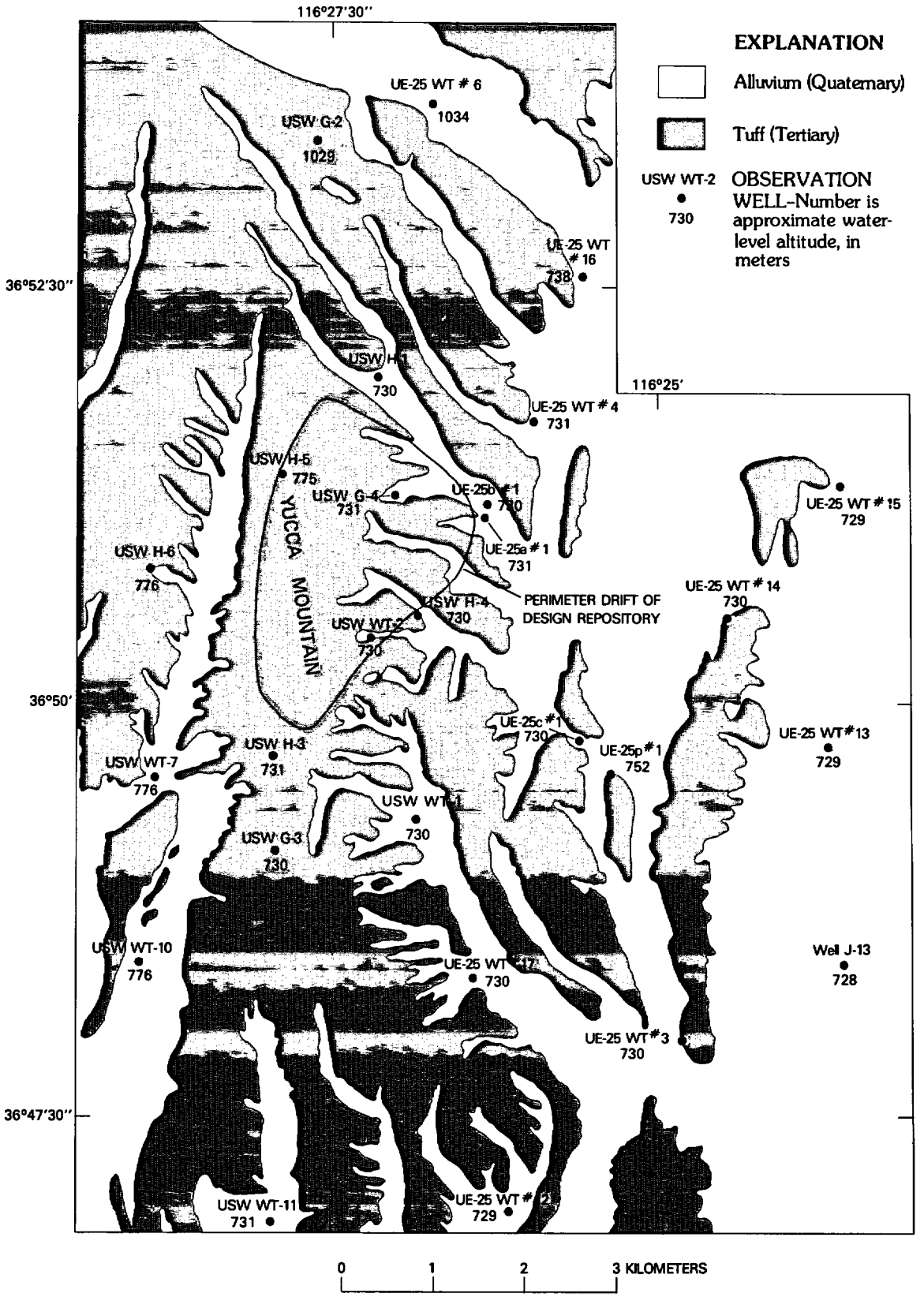


Figure 2.--Locations of wells and water-level altitudes in the vicinity of Yucca Mountain (modified from Robison, 1984, 1986).

Present Water-Level Network

The water-level network has evolved into one that presently (1988) includes about 25 to 30 wells (table 1); not all wells that have reported water levels are necessarily part of a formally defined observation network. One-half of these wells are monitored continuously, the others only periodically. A summary of these wells is given in table 1; the location of the wells are shown in figures 1 and 2.

DATA-COLLECTION SYSTEM

History of Measurement Techniques Used at Yucca Mountain

Most water-level measurements made in 1981 and the in first part of 1982 were made with a single-conductor cable (Iron Horse 6), using a correction factor of +0.00178 m/m in 1981 and +0.00210 m/m in 1982, to adjust to values that would have been recorded had the 2,000-ft reference steel tape been used.

Most measurements from September 10, 1982, through January 21, 1983, were made with a four-conductor cable (logging truck 81890). No calibration factor is available so these measurements are not corrected for cable errors. However, these measurements are corrected for borehole deviation.

Most measurements from February 1, 1983, through April 29, 1985, were made with a four-conductor cable (logging van I-127410). No correction factor was used initially to adjust onsite measurements made in 1983, but a factor of -0.0007 m/m was applied retroactively. Beginning with this report, the 1983-85 water-level measurements have been corrected in accordance with the method described in the section "Multiconductor cable", including the correction factor versus time.

Most measurements from May 1985 until January 8, 1986, were made with the 2,800-ft steel tape. A series of calibrations with the 2,000-ft steel tape as the reference tape were performed April 23, 1985, through June 27, 1985. Adjustments were made that are based on mechanical stretch and thermal expansion, which are individual to each well (table 2). Measurements made after January 8, 1986, were made with the 2,600-ft steel tape.

Periodic Measurements

Periodic water-level measurements at wells require onsite visits by trained personnel, who perform specific operations and record the results. Frequency of periodic measurements necessarily is a compromise between availability of personnel and cost of operation. The maximum frequency is continuous monitoring. Present (1988) operational plans result in measurements about twice per month at each periodically measured well. However, frequency can vary. Some newly drilled wells have been measured more frequently immediately after completion and, at times, some wells have been measured less frequently because of such factors as temporary shortage of personnel, breakdown of equipment, or inaccessibility due to road washouts.

Table 1.--*Summary of wells monitored for water levels*

[p, periodic measurements; c, continuous monitoring]

Well number	Drilled depth (meters)	Date completed	Water level: Approximate depth[1] (meters)	Water level: Approximate altitude[1] (meters)	Frequency monitored
USW WT-1	515	5-83	471	730	p
USW WT-2	628	7-83	571	730	p, c
UE-25 WT #3	348	5-83	300	730	p, c
UE-25 WT #4	482	6-83	439	731	p
UE-25 WT #6	383	6-83	281	1,034	p, c
USW WT-7	491	7-83	421	776	p
USW WT-10	431	8-83	347	776	p
USW WT-11	441	8-83	363	731	p
UE-25 WT #12	399	8-83	346	729	p
UE-25 WT #13	354	7-83	303	729	p
UE-25 WT #14	399	9-83	346	730	p
UE-25 WT #15	415	11-83	354	729	p
UE-25 WT #16	521	11-83	473	738	p
UE-25 WT #17	443	10-83	394	730	p
UE-25a #1	762	9-78	469	731	p
UE-25b #1	1,220	9-81	471	730	p, c
UE-25c #1	914	10-83	401	730	p
UE-25p #1	1,805	5-83	362	752	p, c
USW G-2	1,831	10-81	525	1,029	p
USW G-3	1,533	3-82	751	730	p
USW G-4	915	11-82	539	731	p
USW H-1	1,829	1-81	573	730	p, c
USW H-3	1,219	3-82	752	731	p, c
USW H-4	1,219	6-82	518	730	p, c
USW H-5	1,219	8-82	704	775	p, c
USW H-6	1,220	10-82	526	776	p, c
USW VH-1	762	2-81	185	779	p
J-13	1,063	1-63	283	728	p, c

[1]Composite water level of saturated interval, or level of shallowest zone monitored. See section on "Well data, water levels, and hydrographs."

Table 2.--*Corrections applicable to steel tapes used for measuring water levels in the vicinity of Yucca Mountain*

[Total correction may not equal sum of thermal expansion and mechanical stretch due to rounding]

Well number	Approximate depth to water (meters)	Average air temperature in well (degrees Celsius)	Correction for 2,000-foot reference tape (meters)			Correction for 2,800-foot reference tape (meters)			Correction for reeled (2,600-foot) tape (meters)			Correction for borehole deviation from vertical (meters)
			Thermal expansion	Mechanical stretch	Total	Thermal expansion	Mechanical stretch	Total	Thermal expansion	Mechanical stretch	Total	
USW WT-1	470.9	25.0	0.021	-0.099	-0.078	0.027	-0.043	-0.016	0.027	-0.054	-0.027	-0.33
USW WT-2	571.5	24.4	.022	-.105	-.084	.029	-.038	-.008	.029	-.054	-.024	-.53
UE-25 WT #3	300.2	26.1	.017	-.076	-.059	.021	-.041	-.020	.021	-.046	-.024	-.27
UE-25 WT #4	438.9	25.0	.019	-.096	-.077	.025	-.044	-.019	.025	-.054	-.028	-.46
UE-25 WT #6	283.5	23.3	.007	-.073	-.066	.011	-.040	-.029	.011	-.044	-.033	-.24
USW WT-7	420.6	27.8	.032	-.094	-.062	.038	-.044	-.006	.038	-.053	-.015	-.03
USW WT-10	347.5	29.4	.033	-.084	-.051	.038	-.043	-.005	.038	-.049	-.011	-.03
USW WT-11	364.2	28.3	.030	-.087	-.057	.035	-.044	-.008	.035	-.050	-.015	-.12
UE-25 WT#12	345.9	27.2	.024	-.084	-.060	.029	-.043	-.014	.029	-.049	-.020	-.20
UE-25 WT#13	303.3	24.4	.011	-.077	-.066	.016	-.041	-.025	.016	-.046	-.030	-.01
UE-25 WT#14	345.9	24.4	.013	-.084	-.071	.018	-.043	-.025	.018	-.049	-.031	-.09
UE-25 WT#15	353.6	23.9	.011	-.085	-.074	.016	-.043	-.027	.016	-.050	-.034	-.19
UE-25 WT#16	472.4	26.1	.027	-.099	-.073	.034	-.043	-.010	.034	-.054	-.021	-.06
UE-25 WT#17	394.7	25.0	.017	-.091	-.073	.023	-.044	-.021	.023	-.052	-.029	-.48
UE-25a #1	469.4	25.0	.021	-.099	-.078	.027	-.043	-.016	.027	-.054	-.027	-1.70
UE-25b #1	470.9	25.6	.024	-.099	-.075	.030	-.043	-.013	.030	-.054	-.024	-.27
UE-25c #1	399.3	24.4	.015	-.091	-.076	.021	-.044	-.024	.021	-.052	-.032	-.06
UE-25p #1	365.8	25.6	.018	-.087	-.069	.024	-.044	-.020	.024	-.050	-.027	-.06
USW G-2	524.3	22.8	.010	-.103	-.093	.017	-.041	-.024	.017	-.055	-.038	-.16
USW G-3	749.8	23.3	.019	-.104	-.085	.029	-.015	.014	.029	-.042	-.013	-.57
USW G-4	539.5	24.4	.020	-.104	-.084	.028	-.040	-.012	.028	-.055	-.027	-1.53
USW H-1[1]	571.5	25.0	.025	-.105	-.080	.033	-.038	-.005	.033	-.054	-.021	-.17
USW H-1[2]	518.2	25.0	.023	-.103	-.080	.030	-.041	-.011	.030	-.055	-.025	-.14
USW H-3[3]	749.8	26.1	.043	-.104	-.061	.053	-.015	.038	.053	-.042	.011	-.08
USW H-3[4]	725.4	26.1	.041	-.105	-.064	.051	-.019	.032	.051	-.045	.007	-.08
USW H-3[5]	711.7	26.1	.040	-.105	-.065	.050	-.021	.029	.050	-.046	.005	-.08
USW H-4	518.2	24.4	.020	-.103	-.083	.027	-.041	-.015	.027	-.055	-.028	-.06
USW H-5	704.1	23.9	.022	-.106	-.084	.032	-.022	.009	.032	-.047	-.015	-.08
USW H-6	525.8	25.0	.023	-.103	-.080	.031	-.041	-.010	.031	-.055	-.024	-.05
USW VH-1	184.4	[6]23.9	.006	-.053	-.047	.008	-.031	-.022	.008	-.033	-.024	-.05
J-13	283.5	25.0	.013	-.073	-.061	.016	-.040	-.023	.016	-.044	-.028	([7])

[1]These corrections are for the intervals of well USW H-1 described by the Site ID's ending in 03, 04 and 05.
[2]These corrections are for the interval of well USW H-1 described by Site ID ending in 02.
[3]These corrections are for the intervals of well USW H-3 described by the Site ID's ending in 01, 02 and 04.
[4]These corrections are for the interval of well USW H-3 described by Site ID ending in 03.
[5]These corrections are for the interval of well USW H-3 described by Site ID ending in 05.
[6]The average air temperature for well USW VH-1 is estimated from water temperature and the air temperature in nearby wells.
[7]Gryoscopic survey not available for well J-13 so no correction is made for borehole deviation.

Periodic measurements of the observation-well network have been made using reference and reeled steel tapes, single and multiconductor cables, and pressure transducers. The equipment and measuring techniques vary and depend on a number of factors, such as development and availability of equipment, well construction that limits some equipment or techniques, or length of time or number of personnel needed for a technique.

Reference Steel Tape

The reference steel tape is a steel surveyor's chain. From 1981 to January 8, 1986, this was a tape 3.2 mm wide and 610 m long, to which another 152 m of similar tape could be attached. From January 8, 1986, through 1987, a steel tape 6.4 mm wide and 853 m long has been considered the reference. The steel tapes are marked in feet rather than meters; therefore, they are identified as the 2,000- and 2,800-ft tapes. Tapes are marked at 1-ft intervals, except for the lower part, which is marked in hundredths of a foot. When water levels are measured, the end of the tape is lowered to slightly below the estimated water level in the well, until a convenient foot value on the tape is reached; this point on the tape is held against a measuring point (MP) of known altitude, such as the top of the well casing. The level of the water is indicated on the tape by the limit of wetted chalk, color-change paste, or salt previously applied to the lower part of the tape. The tape is removed from the well and the distance between the foot value and the top of the wetted interval is calculated immediately. This distance is the apparent depth to water below the MP; the distance between the MP and the land surface is either subtracted or added to obtain the apparent depth to water below land surface. Because depths to water beneath Yucca Mountain are as much as 750 m, it may take as long as 2 hours to obtain a single water-level measurement. A small plumb bob, typically weighing about 0.45 kg is attached to the end of the tape to keep it hanging straight. Mechanical-stretch coefficients (because of weight of the plumb bob and the weight of the tape), thermal-expansion coefficients, and other tape specifications are used to make corrections to obtain the actual depth to water below the land surface.

The correction for mechanical stretch of the tapes is given by:

$$C = \frac{L^2\ WS}{2} + PLS - KLS, \tag{1}$$

where C is the correction, in meters;
L is the apparent length of tape, in meters;
W is the unit weight of the tape, in kilograms per meter;
S is the stretch coefficient, in meters per (meter · kilogram);
P is the weight of the plumb bob, in kilograms; and
K is reference tension during manufacture, in kilograms.

Equation 1 differs from that of Garber and Koopman (1968, p. 4), which does not account for reference tension during manufacture of the tape.

The mechanical-stretch properties for the tapes are as follows:

Property	2,000-ft tape	2,800-ft tape
W, in kilograms per meter	1.34×10^{-2}	2.08×10^{-2}
S, in meters per (meter · kilogram)	7.94×10^{-6}	5.10×10^{-6}
K, in kilograms	9.07	9.07

Correction for thermal expansion of the tapes is determined by:

$$E = (D - R)\ TL, \tag{2}$$

where E is the correction, in meters;
D is the average air temperature in the well, in degrees Celsius;
R is the reference temperature during manufacture, in degrees Celsius;
T is the expansion coefficient, in meters per (meter · degree); and
L is the apparent length of the tape, in meters.

The thermal-expansion properties for the tapes are as follows:

Property	2,000-ft tape	2,800-ft tape
R, in degrees Celsius	21.1	20.0
T, in meters per (meter · degree)	1.13×10^{-5}	1.16×10^{-5}

The two reference tapes have been checked against each other by making concurrent water-level measurements in wells with differing depths to water. These measurements indicate the two reference tapes are equivalent.

A reference tape is one to which other tapes or measuring equipment are standardized, directly or indirectly. Because it is a standard, a reference tape is not used for routine measurements to prevent undue wear or stretch.

Reeled Steel Tape

The reeled steel tape, referred to in this report as the 2,600-ft tape, is a surveyor's chain, 6.4 mm wide and 792 m long, generally similar to that of the 2,800-ft reference steel tape; the measurement technique is similar. The equipment was custom built in 1985 for needs of the U.S. Geological Survey at Yucca Mountain and is used for many routine periodic measurements. It is calibrated directly to the reference steel tape and measurements have similar accuracy and precision. The reference tension (K) for this tape is 9.07 kg,

the stretch coefficient is 2.50×10^{-5} meters per (meter · kilogram), and the unit weight is 1.70×10^{-2} kg/m. The reference tension was provided by the manufacturer, and the unit weight was measured by U.S. Geological Survey personnel. The coefficient of mechanical stretch was determined by comparing concurrent water-level measurements of the reference tape and this tape. The correction for mechanical stretch of the tape is given by

$$C = 2.12 \times 10^{-7} L^2 + 2.50 \times 10^{-5} PL - 2.27 \times 10^{-4} L , \qquad (3)$$

where the variables are the same as for equation 1.

The correction for thermal expansion for the tape is given by

$$E = (D - 20.0) \times 1.16 \times 10^{-5} L , \qquad (4)$$

where the variables are the same as for equation 2. The coefficient of thermal expansion was provided by the tape manufacturer.

In some wells with small-diameter access tubes, water condensation in the tube, or possibly pipe dope, causes excess friction between the flat steel tape and the tube, inhibiting insertion of the tape even with the standard plumb bob on the end of the tape; when this happens, the water-level measurements are made with other equipment.

Single-Conductor Cable

A single-conductor armored cable, with reel and housing, is commonly referred to as an "Iron Horse" because of its distinctive shape. This device has been used by the U.S. Geological Survey to measure deep water levels in Nevada, including the NTS and vicinity, for about 30 years (Weir and Nelson, 1976). The cable, about 900 m long and 2.5 mm in diameter, passes over a counter wheel, 0.457 m in circumference, as the cable is lowered into the well. When the water level is reached, an electrical float switch or similar device connected to the end of the cable causes deflection of a millivolt meter mounted on the cable housing (a ground through the armored cable completes the electrical circuit).

This method of measurement is reliable but is best used by careful and experienced personnel. The counter sheave is susceptible to slippage that, if unnoticed, will result in a substantial error of the depth measurement.

Multiconductor Cable

A four-conductor, armored cable, about 1,000 m long, mounted on a powered reel and housed in a truck or mobile van, uses several different possible sensing devices on the end to indicate contact with the water.

The cable passes over a sheave that indicates depth. It is not as susceptible to slippage as the Iron Horse. The sensing device may be a float switch or similar device, to indicate electrical contact with water, or a pressure transducer, used to indicate initial submergence.

Fifteen calibration measurements were made between May 1983 and June 1984. For each measurement, a correction factor is defined as the ratio of the difference between the reference-tape measurement and the cable measurement to the reference-tape measurement. Review of the data indicates that three of these measurements, made in well USW H-5 during May and June 1984, were invalid probably because of an obstruction in the access tube immediately below the water level. The remaining 12 correction factors are plotted versus time on figure 3, along with a correction line. The line has been fitted subjectively to the data; as indicated by the data in the figure, there may be a considerable range in the correction value for any particular time. These data indicate that the correction factor changed with time; changes with time are not unexpected (Garber and Koopman, 1968, p. 9-10). For this cable, the change could be caused by one or more of the following factors: (1) The cable became more kinked over time; (2) the diameter of the cable decreased over time, causing the cable to be lower in the counting wheel; or (3) the depth of the notch in the counting wheel increased with time. The rate of decrease of the correction factor was about 4.8×10^{-5} m/m per month. After mid-1985, this cable was no longer used. The rate of change in correction was projected for about 1 year past the date of the last calibration; the original cable is no longer available, so this projection of the calibration cannot be checked.

Based on the above discussion, measurements made with the multiconductor cable (housed in logging van I-127410) have been corrected using the equation:

$$D = C + (F \times C) \ , \qquad (5)$$

where D is the corrected depth to water, in meters;
C is the apparent length of cable measured by the counter, in meters; and
F is the time-varying correction factor given below, in meters per meter.

The correction factor F, in (meter per meter) x 10^{-4} versus time is:

Year	Month	F	Year	Month	F	Year	Month	F
			1984	1	-5.3	1985	1	-11.1
1983	2	0.0		2	-5.8		2	-11.6
	3	-0.5		3	-6.3		3	-12.1
	4	-1.0		4	-6.8		4	-12.6
	5	-1.4		5	-7.2		5	-13.0
	6	-1.9		6	-7.7		6	-13.5
	7	-2.4		7	-8.2		7	-14.0
	8	-2.9		8	-8.7			
	9	-3.4		9	-9.2			
	10	-3.9		10	-9.7			
	11	-4.4		11	-10.2			
	12	-4.8		12	-10.6			

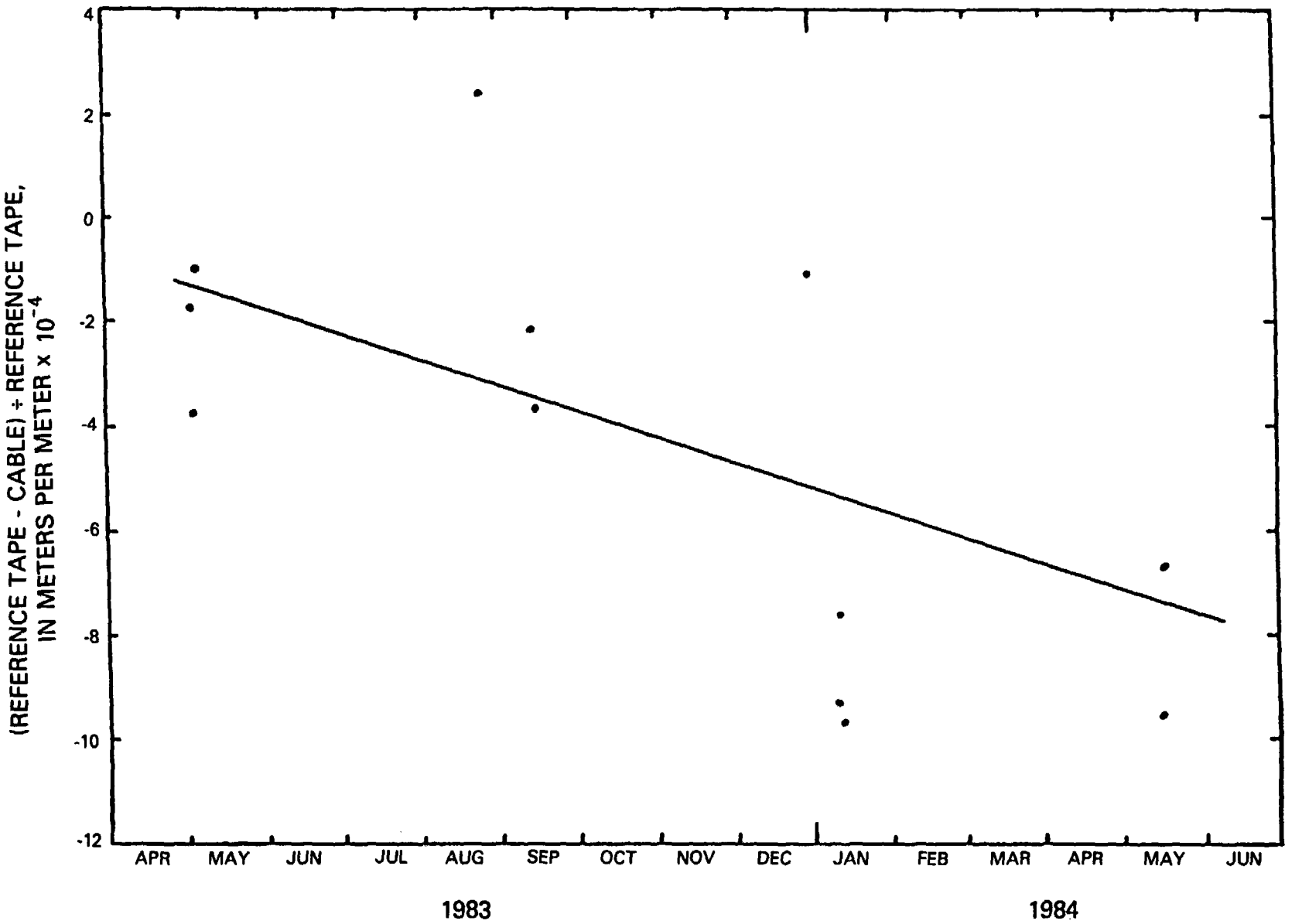


Figure 3.--Correction factor versus time for multiconductor cable.

For example, if the apparent length of cable was 471.20 m in March 1985, the corrected depth to water would have been

$$D = 471.20 + [(-12.1 \times 10^{-4}) \times 471.20]$$
$$= 471.20 - 0.57$$
$$= 470.63 \text{ m.}$$

Corrections and Adjustments

Various factors that can or may affect the accuracy of periodic water-level measurements and, depending upon the measurement technique, whether they already are accounted for, or likely are significant, need to be considered in the process of determining apparent depth below land surface, true depth below land surface, and altitude. All of the measurements in this report have been corrected as previously described to reflect the true depth or altitude, except as noted in the section on "Well data, water levels, and hydrographs". The correction factors applied to steel-tape measurements for each well are summarized in table 2.

Apparent Depth

Stretch is associated with the weight of tape, cable, and plumb bob and probe (Garber and Koopman, 1968). This mechanical stretch may be several tenths of a meter or more for the single or multiconductor cable; however, no additional correction should be necessary if the cable length has been calibrated to a reference tape. For reference steel tapes, the calculated adjustment, based on stretch coefficients given previously and an assumed weight of 0.45 kg for the plumb bob on the end of the tape, ranges from -0.01 to -0.11 m for water levels measured in wells at Yucca Mountain.

Thermal expansion of tape or cable occurs because of downhole increase or decrease of temperature. For reference steel tapes, the calculated correction for expansion is based on manufacturers' specifications for expansion coefficients and on temperature profiles of wells at Yucca Mountain (Sass and Lachenbruch, 1982). The correction ranges from +0.01 to +0.05 m and usually is not made separately from other corrections. No additional adjustment should be necessary for tapes or cables already calibrated to a reference tape.

Sheave slippage occurs because of change of diameter or operator error. Slippage can vary with hoist design, but errors can be minimized by comparing the "in" and "out" readings of water levels. The sheaves used for depth counters can wear, eventually causing errors in measurements. This factor is not applicable to steel tapes with permanently marked depths.

True Depth

Factors that affect determination of the true depth to water below land surface include the apparent-depth factors, above, plus: Correction for boreholes that are not plumb or not straight. High precision gyroscopic surveys were made in all the reported wells except well J-13. Corrections for most wells are 0.1 m or less, but they range from 0.01 to 1.7 m (table 2). Corrections generally increase with increasing well depth.

Altitude

Factors that affect determination of water-level altitude include the apparent-depth and true-depth factors. Water-level altitude is calculated by subtracting the true depth to water from the altitude of the land surface, or the altitude of the measuring-point datum, adjusted to land surface.

Precision of the altitude of water levels is limited to precision of the altitude of the reference points and measuring points at or near land surface. Water-level altitudes reported by Robison (1984) are based on land-surface or measuring-point altitudes of Holmes & Narver, Inc., contractor to the U.S. Department of Energy for surveying at the NTS and Yucca Mountain area. Most of the observation-well network in the vicinity of Yucca Mountain was resurveyed in late 1984 by the U.S. Geological Survey. Water-level altitudes in this report and those reported by Robison (1986) were revised from those reported by Robison (1984) to reflect the resurveying.

Example Calculations

Two example measurements for well USW WT-1 are shown to illustrate the calculations that are made to derive the true altitude of the water surface. True altitude is the value reported in the section on "Well data, water levels, and hydrographs." The first measurements of 1985 and 1987 were chosen as the examples.

Water-level measurements at well USW WT-1 are made from the top of a 62-mm inside-diameter steel tube, which is the MP at this well. The measurements are corrected to the reference point, which at this well is the top of a metal tag welded to the casing. Because the precise altitude of the reference point is known, it is used as a basis for determining the true altitude of the water surface in the well. The difference in altitude between the MP and the reference point can be measured with a pocket tape; at well USW WT-1 the MP is 0.31 m or 1.03 ft above the reference point. The water-level measurements, which are recorded to the nearest 0.01 ft, later are converted to meters. Most intermediate calculations are made to three decimal places; the final values for water levels are rounded to two decimal places.

At least two measurements of the water level are made and averaged during each visit to the well. Additional measurements are made if the values differ substantially. After averaging, the appropriate corrections are applied.

Example A

Water-level measurements on January 18, 1985, were made with a multi-conductor cable (housed in logging van I-127410). The IN reading is the indicated footage of cable displayed by the measuring counter when the sensing device is at the water surface, and the OUT reading is the indicated footage when the sensing device has been withdrawn to the MP. A measurement is made by initially setting the depth counter to exactly zero at the MP and lowering the sensing device to the water surface to obtain an IN reading; the cable is withdrawn and an OUT reading is obtained at the MP. Frequently, as the

sensing device is withdrawn to the MP while obtaining an OUT reading, the depth counter returns to slightly past zero; when this occurs, the value indicated by the depth counter is recorded in field log books as a number slightly less than 100, reflecting the final digits displayed on the depth counter. For example, a recorded OUT reading of 99.70 ft is actually -0.30 ft, and -0.30 is the value used in the calculations.

The readings for January 18, 1985, were:

Reading	Measurement 1	Measurement 2
IN reading (feet)	1,548.95	1,549.15
Recorded OUT reading (feet)	99.70	99.85
Actual OUT reading (feet)	-0.30	-0.15
Apparent depth below measuring point--IN reading minus OUT reading (feet)	1,549.25	1,549.30

The following calculations were made:

Determination of apparent depth below reference point:	
Average of two apparent depths below MP (ft)	1,549.28
MP height above reference point (ft)	-1.03
Apparent depth below reference point (ft)	1,548.25
Determination of true depth:	
Apparent depth below reference point (1,548.25 × 0.3048) (m)	471.907
Cable correction (471.907 × -11.1×10^{-4}) (m)	-0.524
Correction for borehole deviation from vertical from table 2 (m)	-.330
True depth below reference point (m)	471.053
Determination of water-level altitude	
Altitude of reference point (m)	1,201.11
True depth (m)	-471.053
Altitude of water surface (m)	730.06

Example B

Water-level measurements on January 13, 1987, were made with a reeled steel tape (2,600-ft tape). The HELD is the indicated footage on the tape when it is held at the MP during a measurement, and LEVEL is the footage of tape that is wetted during its submersion in the water. The difference between HELD and LEVEL is the apparent depth to water below the MP.

The readings for January 13, 1987, were:

Reading	Measurement 1	Measurement 2
HELD (feet)	1,547.00	1,548.00
CUT (feet)	-0.39	-1.35
Apparent depth below measuring point (feet)	1,546.61	1,546.65

The following calculations were made:

Determination of apparent depth below reference point	
Average of two apparent depths below MP (ft)	1,546.63
MP height above reference point (ft)	-1.03
Apparent depth below reference point (ft)	1,545.60
Determination of true depth	
Apparent depth below reference point (1,545.60 × 0.3048) (m)	471.099
Tape correction, from table 2 (m)	-0.027
Correction for borehole deviation from vertical from table 2 (m)	-.330
True depth below reference point (m)	470.742
Determination of water-level altitude	
Altitude of reference point (m)	1,201.11
True depth below reference point (m)	-470.742
Altitude of water surface (m)	730.37

Quality Assurance

Data in this report may be used in characterizing the Yucca Mountain site in order to evaluate its suitability for a nuclear-waste repository. Adequate confidence in the reliability of collection, processing, and reporting of the water-level data is necessary so that the data may be used in assessing the expected performance of a proposed repository. Quality assurance can be considered to include all the actions and records of those actions supporting the reliability of the data. Aside from assuring reliable water-level data, accuracy and precision are required by potential users, and data need to be available for intervals that are sufficiently frequent for the analytical needs of the users.

Field Checks and Processing

As discussed previously, in the section on "Periodic Measurements", water-level measurements are obtained by methods described in the formal technical procedures. The technical procedures include tests and adjustments

performed during the measuring operation that ensure that the equipment is operating properly and that expected precision and accuracy will be attained. For example, procedures for single-conductor cable (Iron Horse) measurements include checks for:

1. Electrical continuity of the system.
2. Zeroing of a voltmeter that deflects when the probe contacts the water surface.
3. Zeroing of the depth counter.
4. Rechecking the depth counter after an operational test is performed.
5. Recording the depth counter OUT reading when the sensing probe is returned to the MP near the land surface at the completion of a measurement.
6. Completion of a subsequent water-level measurement that must be within 0.3 m of the previous measurement (measurements by all methods are made at least twice).

Data are recorded at the well site on standardized forms that are designed to minimize the likelihood of omission of necessary steps or information. Data recorded are: time and date of the measurement; names of operators making the measurement; technical procedure used; identification of specific measuring equipment used, including date of its last calibration; adjustment from the MP to the land surface, uncorrected data for each measurement; and correction factor or factors, if any, applied to the uncorrected data.

In addition to recording the detailed information, above, on the provided forms, a general record of measuring operations is maintained in a logbook with daily entries; it includes comments about anything that may be relevant to the data, such as discussion of problems with equipment, or temporary inaccessibility of the well site to obtain measurements.

Office processing and review

After completion of the water-level measurements, the detailed measurement information is reviewed for completeness and accuracy by the supervisor responsible for onsite operations. The original logbooks and records are maintained at the onsite operations headquarters, near Mercury, Nev. Photocopies are made periodically and transmitted to the office of the project chief for water-level measurements, located in Denver, Colo. The transmitted records are reviewed, and any needed adjustments or corrections are made that were not performed during onsite operations.

The reviewed, corrected, and adjusted data are entered into a temporary computer data base and are then printed in tabular form for further review. In addition, water levels in the temporary data base are plotted graphically to facilitate general review for reasonableness and to discover any data-entry errors. After this review, the data are ready for inclusion in manuscripts intended for publication by the U.S. Geological Survey.

After completion of the technical review and appropriate revisions based on reviews, the water-level data are available for release to any users, including the general public. The water-level data also are available for transfer to a permanent computer data base, such as the Ground Water Site Inventory system used by the U.S. Geological Survey.

Accuracy, precision, and frequency of water-level data

Particular requirements for accuracy, precision, and frequency of water-level data are grouped into three general categories:

1. Monitoring of water-level with time at individual wells in order to enable long-term prediction of water-level trends at the well sites.

For this purpose, relative changes are essential; accuracy of one water-level measurement is not as important as the precise changes between subsequent water-level measurements. For example, an apparent trend of as little as 0.1 m in a year would indicate a water-level change of 100 m in only 1,000 years.

Systems using stationary equipment that remains in the well for succeeding measurements have the inherent capability of detecting extremely small changes (for pressure transducers, this is as little as a millimeter of water; unfortunately, pressure transducers are subject to long-term drift that needs to be tracked, and for which adjustments to the data need to be made). Methods involving the lowering and withdrawing of a steel tape or cable for successive measurements usually are much less precise for deep water levels. This partly is because the tape or cable may not hang in exactly the same position each time and the water level actually may change during the time between confirmation measurements. Methods using sheaves with depth counters rather than marked tape or cable are subject to slippage. These methods may not be able to measure, with assurance, real changes or differences of less than 0.1 m.

In order to make long-term projections of water-level trends, the measurements need not necessarily be frequent, but there needs to be a sufficient number so that short-term or cyclic variations do not affect long-term projections.

2. Short-term water-level variations that can be used to estimate or determine hydraulic properties of the rocks.

At Yucca Mountain, continuous records at about 15 wells with pressure transducers have indicated that water levels are affected by changes of atmospheric pressure, earth tides, and possibly other phenomena. The data indicate that the combined effect of atmospheric-pressure changes and earth tides may account for as much as about 0.2 m of cyclic change of water levels in many wells.

The periodic data are not suitable for analysis of hydraulic properties, inasmuch as normal water-level fluctuation within a well may be as large as 0.1 m within a day, and frequency of periodic measurements at Yucca Mountain

has been about twice a month. However, knowledge of short-term fluctuations of measurable magnitude is important in calibrating measuring equipment and for long-term projections of water levels.

3. Water-level data to map areal differences of hydraulic head among wells.

Because the hydraulic gradients are nearly horizontal in the vicinity of Yucca Mountain, reference-point altitudes at the wells need to be tied to the same survey; these reference-point altitudes need to be both accurate and precise. Ideally, water levels in wells compared for gradients need to represent the hydraulic potential of similar, connected hydrogeologic intervals, but this assurance may not be feasible at Yucca Mountain because of complex geology.

Because water-level measurements at Yucca Mountain have been made at or near the water surface (rather than pressure measurements in intervals assumed to be most directly connected hydraulically among the wells), temperature-density corrections to the depths of the common aquifers would be appropriate. At Yucca Mountain, insufficient data exist to make such adjustments. The geothermal gradient is both small and generally similar throughout the Yucca Mountain area (Sass and Lachenbruch, 1982); temperature-density corrections likely would be small, and similar, for each well (temperature corrections for determining vertical hydraulic gradients <u>within</u> a single well are unnecessary)

WELL DATA, WATER LEVELS, AND HYDROGRAPHS

Information and specifications are given for individual wells; water levels for each well are given in tabular form and, for most wells, in a hydrograph. The sources of information, published or unpublished, are indicated for each well; the published sources also are listed in the "References" at the back of the report. The section on "History of measurement techniques used at Yucca Mountain" may be relevant and important to the understanding or analysis of the data from each well.

Water-Table Wells

Well USW WT-1

1. References or information sources: Robison (1984, 1986); Holmes & Narver, Inc. (written commun., 1986); Fenix & Scisson, Inc (1986b, 1987c).

2. Well specifications:

   a. Location:
   Nevada State Central Zone Coordinates (feet): N 753,941; E 563,739.
   Latitude and longitude: 36°49'16" N.; 116°26'56" W.
   Site ID: 364916116265601.

   b. Land-surface altitude: 1,201.7 m (Robison, 1984); 1,201.4 m (Robison, 1986; based on survey by U.S. Geological Survey in 1984).

   c. Date well started: April 28, 1983.

   d. Date well completed: May 18, 1983.

   e. Drilling method: Rotary, using rock bits and air, water, soap circulating medium; bottom-hole core obtained.

   f. Bit diameter below water level: 222 mm (8 3/4 in.).

   g. Casing extending below water level: None [surface casing only, to a depth of 10 m (32 ft)].

   h. Total drilled depth: 515 m (1,689 ft).

   i. Description of access for measuring water levels, including tubes or piezometers: 62-mm (2.4-in.) inside-diameter tubing with 3.6-m-(12-ft) long well screen on bottom extending from land surface to a depth of 507 m (1,665 ft); saturated interval of borehole within tuffaceous beds of Calico Hills to Bullfrog Member of Crater Flat Tuff.

   j. Description and altitude of reference point: Top of metal tag on well casing, 1,201.11 m (surveyed by U.S. Geological Survey, 1984).

   k. Depth correction for measured water levels because of borehole deviation from vertical (the correction is subtracted from measured depth to obtain true depth): 0.33 m, based on approximate depth to water of 471 m (1,541 ft).

3. History of instrumentation and water-level measurements, and comments:

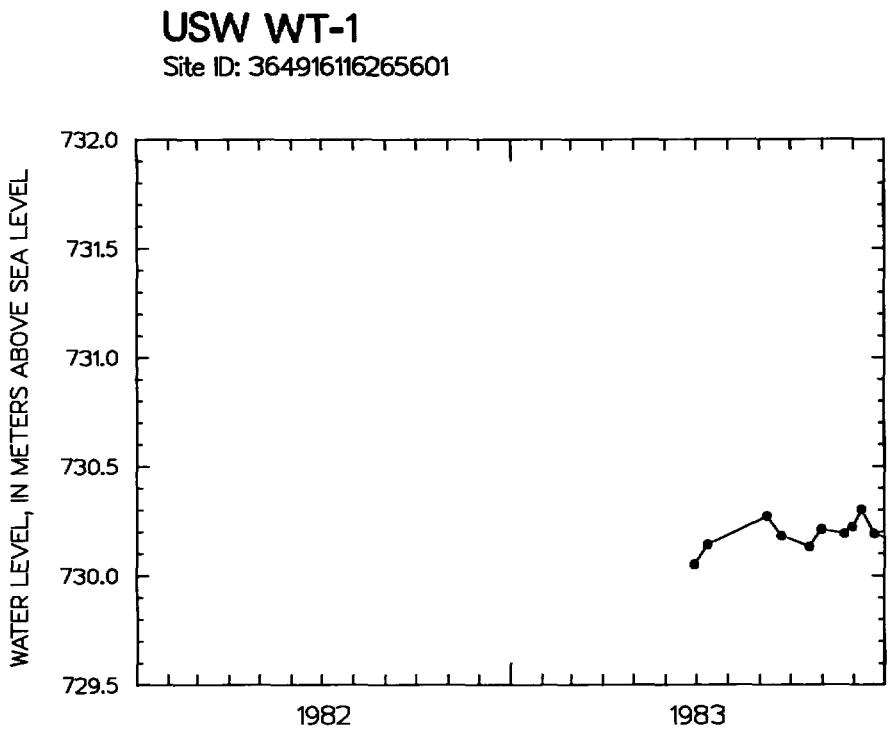
The water-level measurements were made with a four-conductor cable (logging van I-127410), from June 29, 1983, through April 11, 1985. Measurements were made with the 2,800-ft steel tape from June 13, 1985, through December 27, 1985, and with the 2,600-ft steel tape from January 27, 1986, through December 26, 1986. The apparent water-level rise of about 0.4 m in mid-1985 and the apparent water-level decline of about 0.1 m in early 1986 correspond to changes in measuring equipment and probably were not actual water-level changes.

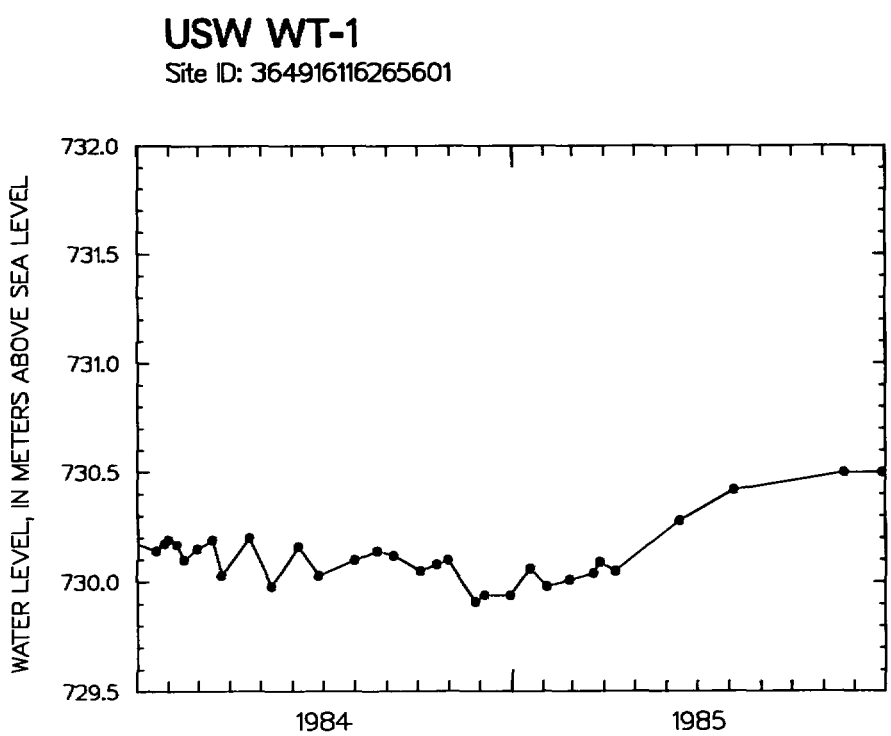
4. Periodic measurements of water-level altitude in well USW WT-1:

Site ID: 364916116265601
Depth interval: 471-515 m (composite)

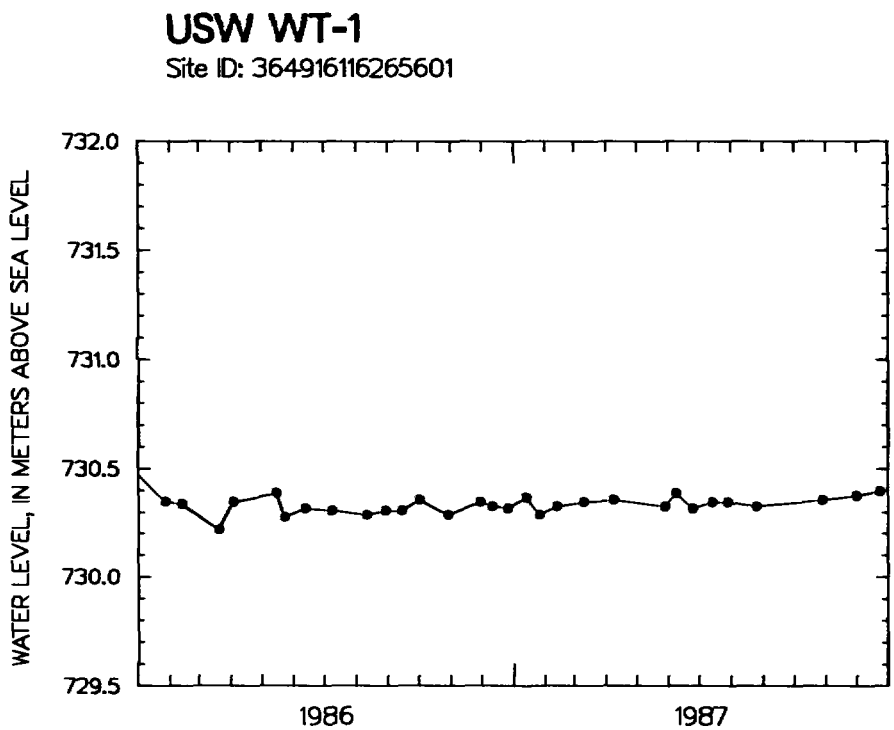
Date	Altitude (meters)	Date	Altitude (meters)
06-29-83	730.05	04-11-85	730.05
07-12-83	730.14	06-13-85	730.28
09-08-83	730.27	08-05-85	730.42
09-22-83	730.18	11-20-85	730.50
10-19-83	730.13	12-27-85	730.50
10-31-83	730.21	01-27-86	730.35
11-22-83	730.19	02-12-86	730.34
11-30-83	730.22	03-20-86	730.22
12-09-83	730.30	04-03-86	730.35
12-21-83	730.19	05-15-86	730.39
01-19-84	730.14	05-23-86	730.28
01-27-84	730.17	06-12-86	730.32
01-31-84	730.19	07-08-86	730.31
02-08-84	730.17	08-11-86	730.29
02-15-84	730.10	08-29-86	730.31
02-28-84	730.15	09-14-86	730.31
03-14-84	730.19	10-01-86	730.36
03-23-84	730.03	10-29-86	730.29
04-19-84	730.20	11-29-86	730.35
05-11-84	729.98	12-11-86	730.33
06-06-84	730.16	12-26-86	730.32
06-26-84	730.03	01-13-87	730.37
07-31-84	730.10	01-26-87	730.29
08-22-84	730.14	02-12-87	730.33
09-07-84	730.12	03-10-87	730.35
10-03-84	730.05	04-08-87	730.36
10-19-84	730.08	05-28-87	730.33
10-30-84	730.10	06-08-87	730.39
11-26-84	729.91	06-24-87	730.32
12-05-84	729.94	07-13-87	730.35
12-30-84	729.94	07-28-87	730.35
01-18-85	730.06	08-25-87	730.33
02-04-85	729.98	10-28-87	730.36
02-26-85	730.01	11-30-87	730.38
03-21-85	730.04	12-23-87	730.40
03-27-85	730.09		

5. Hydrographs of water-level altitude (plotted from data in section 4):





5. Hydrographs of water-level altitude (plotted from data in section 4) --Continued:



Well USW WT-2

1. References or information sources: Robison (1984, 1986); Holmes & Narver, Inc. (written commun., 1986); Fenix & Scisson, Inc. (1986b, 1987c).

2. Well specifications:

   a. Location:
   Nevada State Central Zone Coordinates (feet): N 760,661; E 561,924.
   Latitude and longitude: 36°50'23" N.; 116°27'18" W.
   Site ID: 365023116271801.

   b. Land-surface altitude: 1,301.4 m (Robison, 1984); 1,301.3 m (Robison, 1986; based on surveys by U.S. Geological Survey in 1984).

   c. Date well started: July 8, 1983.

   d. Date well completed: July 16, 1983.

   e. Drilling method: Rotary, using rock bits and air-foam circulating medium; bottom-hole core obtained.

   f. Bit diameter below water level: 222 mm (8 3/4 in.).

   g. Casing extending below water level: None [surface casing only, to a depth of 18 m (58 ft)].

   h. Total drilled depth: 628 m (2,060 ft).

   i. Description of access for measuring water levels, including tubes or piezometers: 62-mm (2.4-in.) inside-diameter tubing with 3.6-m-(12-ft) long well screen on bottom, extending from land surface to a depth of 622 m (2,040 ft); saturated interval of borehole within Prow Pass Member of Crater Flat Tuff.

   j. Description and altitude of reference point: Top of metal tag on well casing 1,301.13 m (surveyed by U.S. Geological Survey, 1984).

   k. Depth correction for measured water levels because of borehole deviation from vertical (the correction is subtracted from measured depth to obtain true depth): 0.53 m, based on approximate depth to water of 571 m (1,873 ft).

3. History of instrumentation and water-level measurements, and comments:

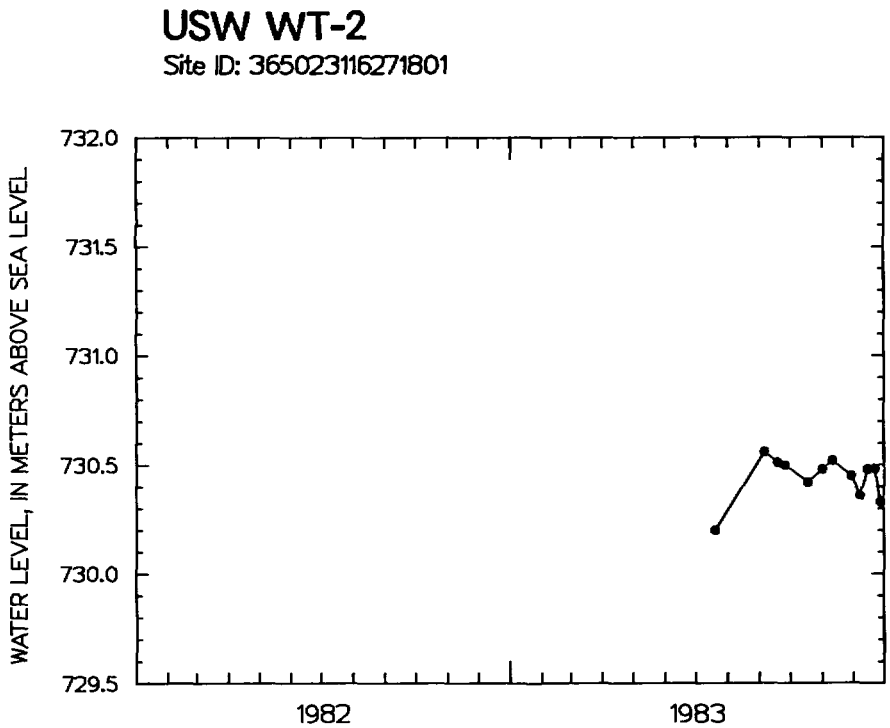
The water-level measurements were made with a four-conductor cable (logging van I-127410) from July 20, 1983, through March 20, 1985. Beginning in March 1985, the water level has been monitored continuously using a downhole pressure transducer with a datalogger at the land surface.

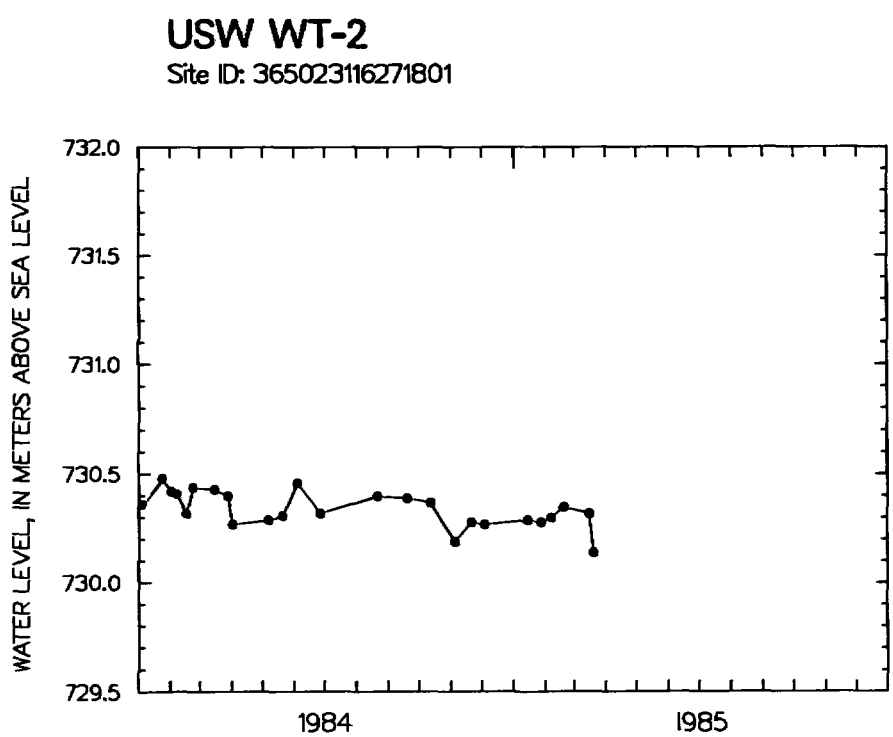
4. Periodic measurements of water-level altitude in well USW WT-2:

Site ID: 365023116271801
Depth interval: 571-628 m (composite)

Date	Altitude (meters)	Date	Altitude (meters)
07-20-83	730.20	03-15-84	730.43
09-06-83	730.56	03-28-84	730.40
09-19-83	730.51	04-02-84	730.27
09-26-83	730.50	05-07-84	730.29
10-18-83	730.42	05-21-84	730.31
11-01-83	730.48	06-04-84	730.46
11-11-83	730.52	06-27-84	730.32
11-29-83	730.45	08-21-84	730.40
12-08-83	730.36	09-19-84	730.39
12-15-83	730.48	10-12-84	730.37
12-22-83	730.48	11-05-84	730.19
12-28-83	730.33	11-21-84	730.28
01-04-84	730.36	12-04-84	730.27
01-24-84	730.48	01-15-85	730.29
02-02-84	730.42	01-28-85	730.28
02-07-84	730.41	02-07-85	730.30
02-17-84	730.32	02-19-85	730.35
02-23-84	730.44	03-16-85	730.32
		03-20-85	730.14

5. Hydrographs of water-level altitude (plotted from data in section 4):





Well UE-25 WT #3

1. References or information sources: Robison (1984, 1986); Holmes & Narver (written commun., 1986); Fenix & Scisson, Inc. (1986b, 1987c).

2. Well specifications:

   a. Location:
   Nevada State Central Zone Coordinates (feet): N 745,995; E 573,384.
   Latitude and longitude: 36°47'57" N.; 116°24'58" W.
   Site ID: 364757116245801.

   b. Land-surface altitude: 1,029.8 m (Robison, 1984); 1,030.0 m (Robison, 1986; based on survey by U.S. Geological Survey, 1984).

   c. Date well started: April 29, 1983.

   d. Date well completed: May 25, 1983.

   e. Drilling method: Rotary, using rock bits and air-foam circulating medium; bottom-hole core obtained.

   f. Bit diameter below water level: 222 mm (8 3/4 in.).

   g. Casing extending below water level: None [surface casing only, to a depth of 12 m (40 ft)].

   h. Total drilled depth: 348 m (1,142 ft).

   i. Description of access for measuring water levels, including tubes or piezometers: 62-mm (2.4-in.) inside-diameter tubing with 3.6-m-(12-ft) long well screen on bottom, extending from land surface to a depth of 343 m (1,142 ft); saturated interval of borehole within Bullfrog Member of Crater Flat Tuff.

   j. Description and altitude of reference point: Top of metal tag on well casing, 1,030.11 m (surveyed U.S. Geological Survey, 1984).

   k. Depth correction for measured water levels because of borehole deviation from vertical (the correction is subtracted from measured depth to obtain true depth): 0.27 m, based on approximate depth to water of 300 m (984 ft).

3. History of instrumentation and water-level measurements, and comments:

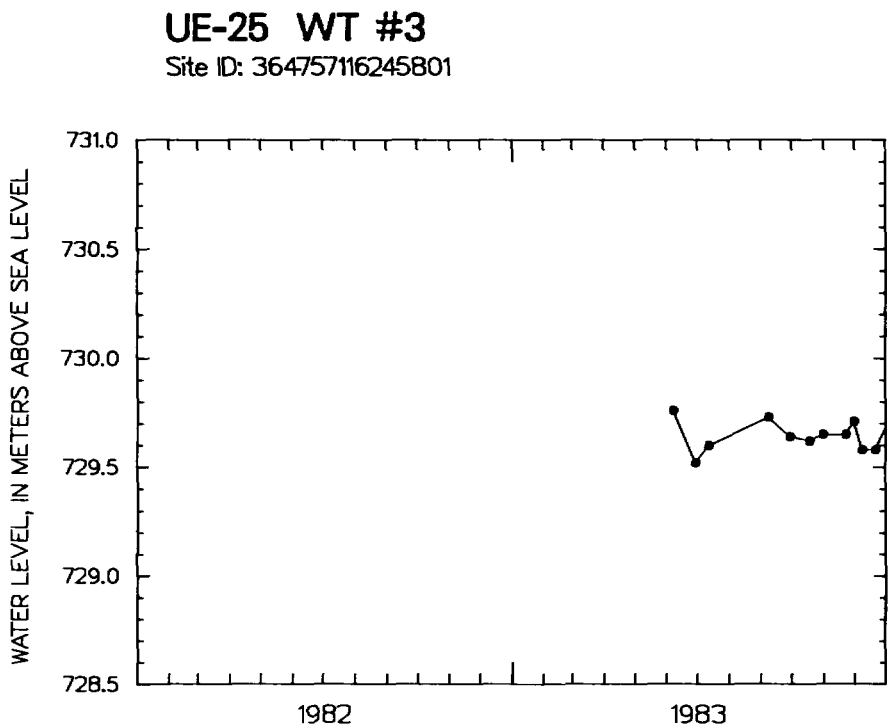
The water-level measurements were made with a four-conductor cable (logging van I-127410) from June 7, 1983, through March 22, 1985. Beginning in March 1985, the water level has been monitored continuously using a downhole pressure transducer with a datalogger at the land surface.

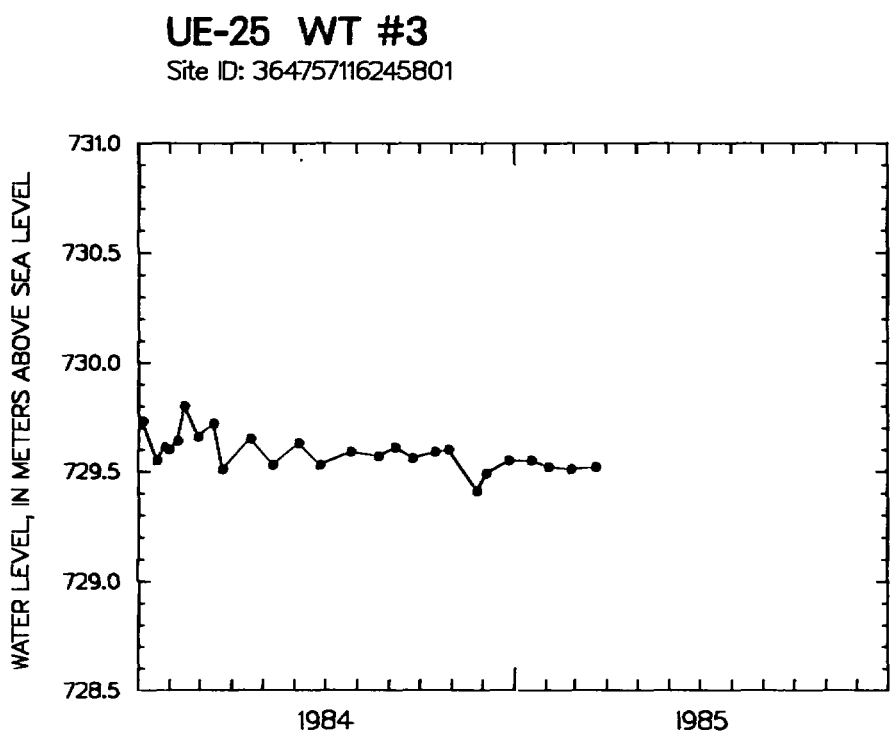
4. Periodic measurements of water-level altitude in well UE-25 WT #3:

Site ID: 364757116245801
Depth interval: 301-348 m (composite)

Date	Altitude (meters)	Date	Altitude (meters)
06-07-83	729.76	03-14-84	729.72
06-29-83	729.52	03-23-84	729.51
07-12-83	729.60	04-19-84	729.65
09-08-83	729.73	05-11-84	729.53
09-29-83	729.64	06-05-84	729.63
10-18-83	729.62	06-26-84	729.53
10-31-83	729.65	07-26-84	729.59
11-22-83	729.65	08-22-84	729.57
11-30-83	729.71	09-07-84	729.61
12-08-83	729.58	09-24-84	729.56
12-21-83	729.58	10-16-84	729.59
01-05-84	729.73	10-29-84	729.60
01-19-84	729.55	11-26-84	729.41
01-27-84	729.61	12-05-84	729.49
01-31-84	729.60	12-27-84	729.55
02-08-84	729.64	01-18-85	729.55
02-15-84	729.80	02-04-85	729.52
02-28-84	729.66	02-26-85	729.51
		03-22-85	729.52

5. Hydrographs of water-level altitude (plotted from data in section 4):





Well UE-25 WT #4

1. References or information sources: Robison (1984, 1986); Holmes & Narver, Inc. (written commun., 1986); Fenix & Scisson, Inc. (1986b, 1987c).

2. Well specifications:

   a. Location:
   Nevada State Central Zone Coordinates (feet): N 768,512; E 568,040.
   Latitude and longitude: 36°51'40" N.; 116°26'03" W.
   Site ID: 365140116260301.

   b. Land-surface altitude: 1,167.11 m (Holmes & Narver Inc., June 7, 1983); 1,167.1 m (Robison, 1984); 1,169.2 m (Robison, 1986; based on survey by U.S. Geological Survey, 1984).

   c. Date well started: May 28, 1983.

   d. Date well completed: June 6, 1983.

   e. Drilling method: Rotary, using rock bits and air-foam circulating medium; bottom-hole core obtained.

   f. Bit diameter below water level: 222 mm (8 3/4 in.).

   g. Casing extending below water level: None [surface casing only, to a depth of 15 m (50 ft)].

   h. Total drilled depth: 482 m (1,580 ft).

   i. Description of access for measuring water levels, including tubes or piezometers: 62-mm (2.4-in.) inside-diameter tubing with 3.6-m-(12-ft) long well screen on bottom, extending from land surface to a depth of 478 m (1,567 ft); saturated interval of borehole within tuffaceous beds of Calico Hills.

   j. Description and altitude of reference point: Top of metal tag on well casing, 1,169.21 m (surveyed by U.S. Geological Survey, 1984).

   k. Depth correction for measured water levels because of borehole deviation from vertical (the correction is subtracted from measured depth to obtain true depth): 0.46 m, based on approximate depth to water of 439 m (1,440 ft).

3. History of instrumentation and water-level measurements, and comments:

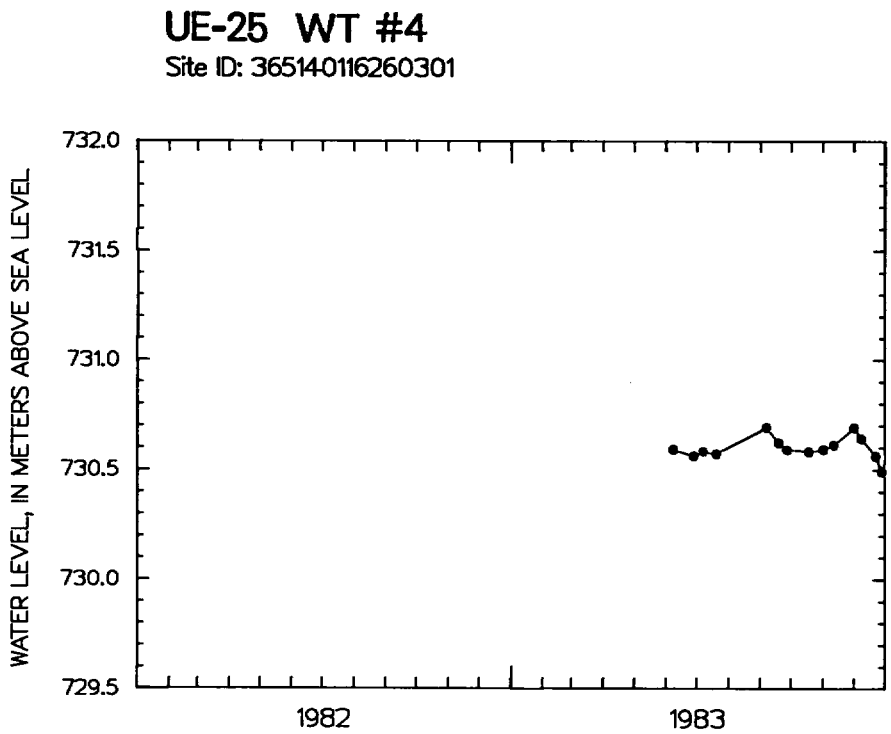
The water-level measurements were made with a four-conductor cable (logging van I-127410) from June 8, 1983, through April 29, 1985. Measurements were made with the 2,800-ft steel tape from June 12, 1985, through December 6, 1985, and with the 2,600-ft steel tape from January 29, 1986, through December 23, 1987.

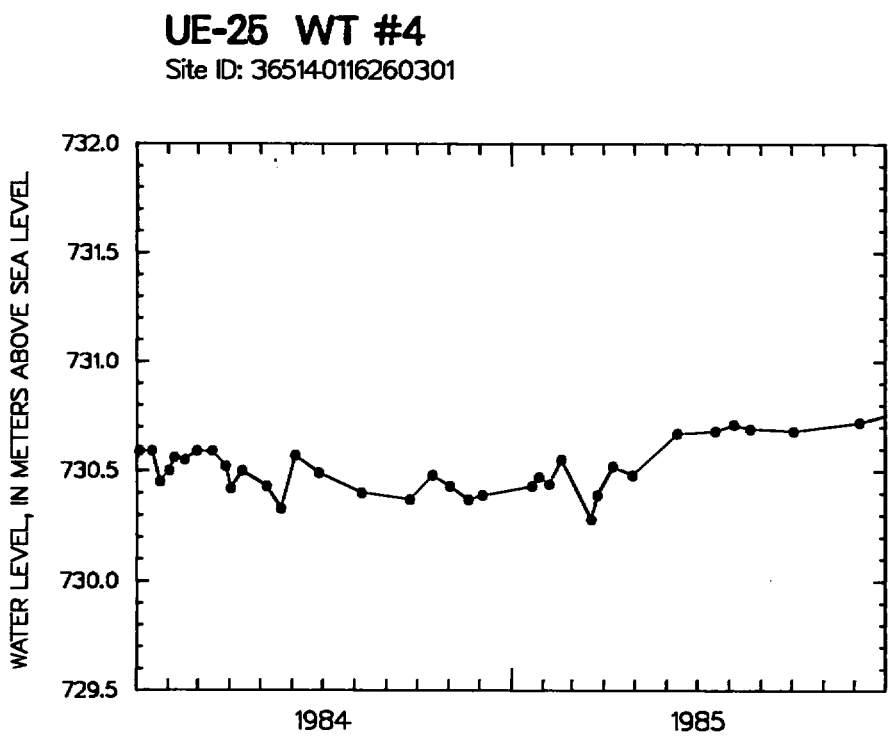
4. Periodic measurements of water-level altitude in well UE-25 WT #4:

Site ID: 365140116260301
Depth interval: 439-482 m (composite)

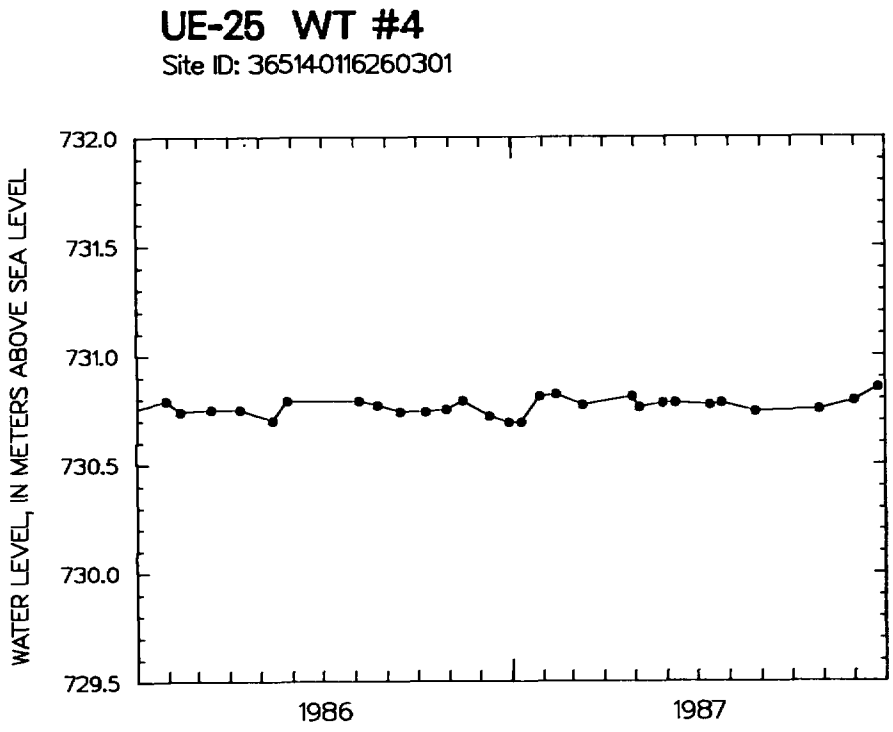
Date	Altitude (meters)	Date	Altitude (meters)
06-08-83	730.59	03-20-85	730.28
06-28-83	730.56	03-26-85	730.39
07-07-83	730.58	04-10-85	730.52
07-20-83	730.57	04-29-85	730.48
09-07-83	730.69	06-12-85	730.67
09-19-83	730.62	07-19-85	730.68
09-27-83	730.59	08-06-85	730.71
10-18-83	730.58	08-22-85	730.69
11-01-83	730.59	10-03-85	730.68
11-11-83	730.61	12-06-85	730.72
12-01-83	730.69	01-29-86	730.79
12-08-83	730.64	02-12-86	730.74
12-22-83	730.56	03-14-86	730.75
12-28-83	730.49	04-11-86	730.75
01-04-84	730.59	05-13-86	730.70
01-16-84	730.59	05-27-86	730.79
01-24-84	730.45	08-05-86	730.79
02-02-84	730.50	08-23-86	730.77
02-07-84	730.56	09-14-86	730.74
02-17-84	730.55	10-09-86	730.74
02-29-84	730.59	10-29-86	730.75
03-15-84	730.59	11-14-86	730.79
03-28-84	730.52	12-10-86	730.72
04-02-84	730.42	12-29-86	730.69
04-13-84	730.50	01-10-87	730.69
05-07-84	730.43	01-28-87	730.81
05-21-84	730.33	02-13-87	730.82
06-04-84	730.57	03-11-87	730.77
06-27-84	730.49	04-28-87	730.81
08-08-84	730.40	05-05-87	730.76
09-24-84	730.37	05-28-87	730.78
10-16-84	730.48	06-09-87	730.78
11-02-84	730.43	07-13-87	730.77
11-20-84	730.37	07-24-87	730.78
12-04-84	730.39	08-26-87	730.74
01-21-85	730.43	10-27-87	730.75
01-28-85	730.47	11-30-87	730.79
02-07-85	730.44	12-23-87	730.85
02-19-85	730.55		

5. Hydrographs of water-level altitude (plotted from data in section 4):





5. Hydrographs of water-level altitude (plotted from data in section 4) --Continued:



Well UE-25 WT #6

1. References or information sources: Robison (1984, 1986); Holmes & Narver, Inc. (written commun., 1986); Fenix & Scisson, Inc. (1986b, 1987c).

2. Well specifications:

   a. Location:
   Nevada State Central Zone Coordinates (feet): N 780,576; E 564,524.
   Latitude and longitude: 36°53'40" N.; 116°26'46" W.
   Site ID: 365340116264601.

   b. Land-surface altitude: 1,312.74 (Holmes & Narver, Inc., January 2, 1984); 1,312.9 m (Robison, 1984); 1,314.8 m (Robison, 1986; based on survey by U.S. Geological Survey, 1984).

   c. Date well started: June 20, 1983.

   d. Date well completed: June 29, 1983.

   e. Drilling method: Rotary, using rock bits and air-foam circulating medium; bottom-hole core obtained.

   f. Bit diameter below water level: 171 mm (6 3/4 in.).

   g. Casing extending below water level: None [surface casing only, to a depth of 76.5 m (251 ft)].

   h. Total drilled depth: 383 m (1,256 ft).

   i. Description of access for measuring water levels, including tubes or piezometers: 62-mm (2.4-in.) inside-diameter tubing with 3.6-m-(12-ft) long well screen on bottom, extending from land surface to a depth of 372 m (1,221 ft); saturated interval of borehole within tuffaceous beds of Calico Hills.

   j. Description and altitude of reference point: Top of metal tag on well casing, 1,314.78 m (surveyed by U.S. Geological Survey, 1984).

   k. Depth correction for measured water levels because of borehole deviation from vertical (the correction is subtracted from measured depth to obtain true depth): 0.24 m, based on approximate depth to water of 284 m (932 ft).

3. History of instrumentation and water-level measurements, and comments:

Altitude of the water level was 1,021.58 m on July 6, 1983, a week after completion of the well (measured with a four-conductor cable; logging van I-127410); this measurement is not included in the table or hydrograph. Measurements made September 7, 1983, through April 11, 1985, were made with a four-conductor cable (logging van I-127410), and subsequent measurements in 1985 were made with the 2,800-ft steel tape. The rapid rise of more than 8 m in the first 2 months was followed by a continued, but decreasing rate of rise; this is likely the result of drilling effects; this period could have been unusually long because of very low permeability of the rocks that were penetrated below the water table (tuffaceous beds of Calico Hills).

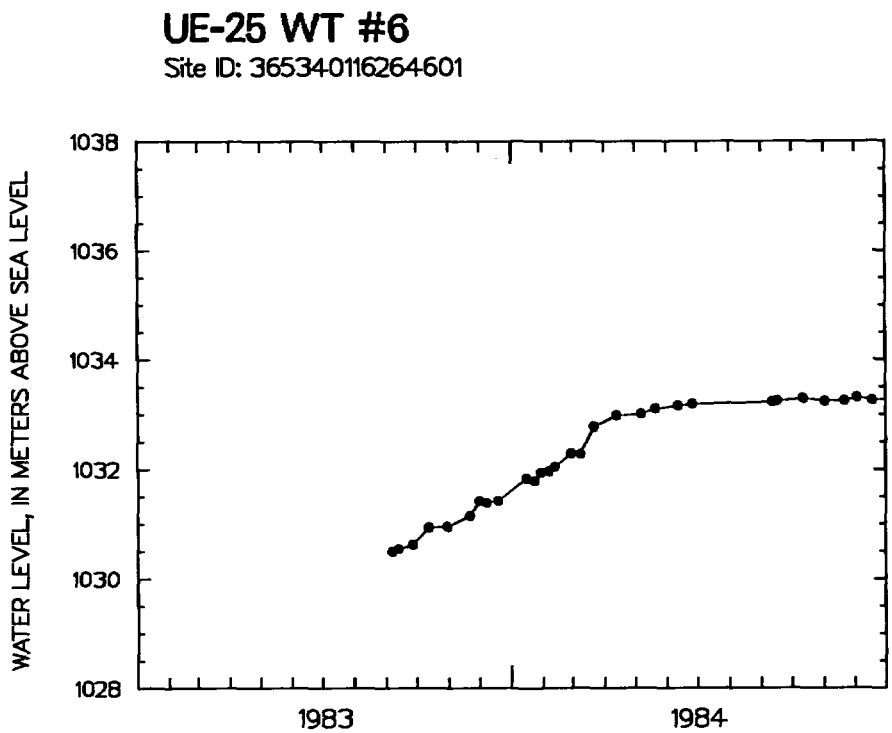
Beginning in July 1986, the water level has been monitored continuously using a downhole pressure transducer with a datalogger at the land surface. Measurements indicate that the water level may have continued to rise at a slow rate through 1987.

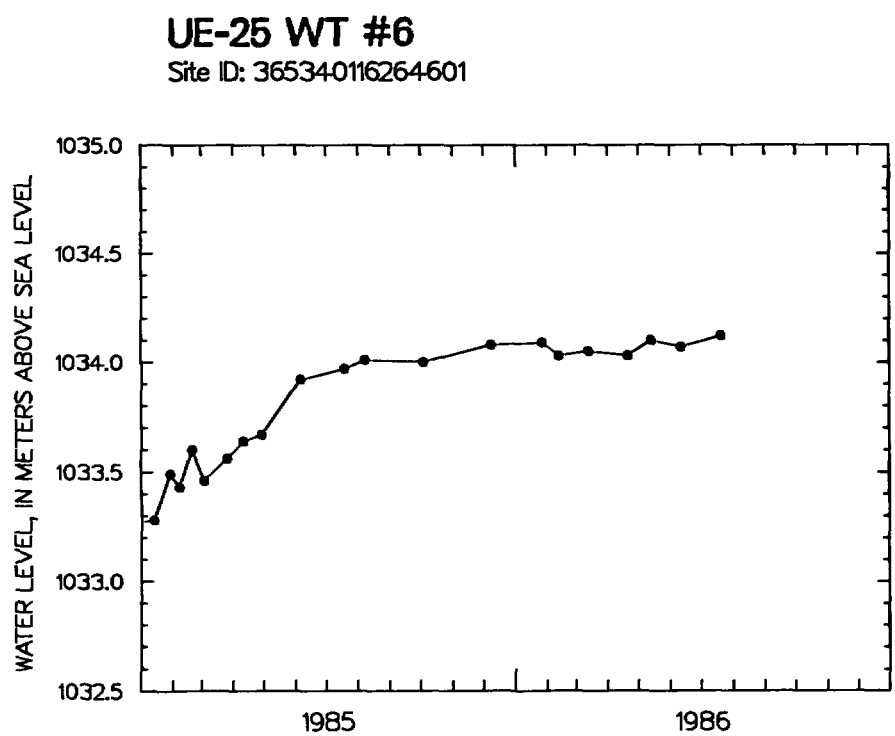
4. Periodic measurements of water-level altitude in well UE-25 WT #6:

Site ID: 365340116264601
Depth interval: 281-383 m (composite)

Date	Altitude (meters)	Date	Altitude (meters)
09-07-83	1,030.50	11-02-84	1,033.24
09-13-83	1,030.54	11-21-84	1,033.25
09-27-83	1,030.62	12-03-84	1,033.31
10-13-83	1,030.94	12-18-84	1,033.26
10-31-83	1,030.95	01-14-85	1,033.28
11-22-83	1,031.15	01-30-85	1,033.49
12-01-83	1,031.42	02-08-85	1,033.43
12-08-83	1,031.39	02-20-85	1,033.60
12-19-83	1,031.42	03-04-85	1,033.46
01-16-84	1,031.83	03-26-85	1,033.56
01-24-84	1,031.79	04-11-85	1,033.64
01-30-84	1,031.93	04-29-85	1,033.67
02-07-84	1,031.96	06-06-85	1,033.92
02-13-84	1,032.04	07-19-85	1,033.97
02-29-84	1,032.29	08-08-85	1,034.01
03-09-84	1,032.28	10-04-85	1,034.00
03-22-84	1,032.78	12-09-85	1,034.08
04-13-84	1,032.98	01-28-86	1,034.09
05-07-84	1,033.01	02-13-86	1,034.03
05-21-84	1,033.10	03-14-86	1,034.05
06-12-84	1,033.16	04-21-86	1,034.03
06-26-84	1,033.19	05-14-86	1,034.10
09-12-84	1,033.23	06-12-86	1,034.07
09-17-84	1,033.25	07-21-86	1,034.12
10-12-84	1,033.29		

5. Hydrographs of water-level altitude (plotted from data in section 4):





Well USW WT-7

1. References or information sources: Robison (1984, 1986); Holmes & Narver, Inc. (written commun., 1986); Fenix & Scisson, Inc. (1986b, 1987b).

2. Well specifications:

   a. Location:
   Nevada State Central Zone Coordinates (feet): N 755,570; E 553,891.
   Latitude and longitude: 36°49'33" N.; 116°28'57" W.
   Site ID: 364933116285701.

   b. Land-surface altitude: 1,197.01 m (Holmes & Narver, Inc., February 6, 1984; 1,197.0 m (Robison, 1984); 1,196.9 m (Robison, 1986; based on survey by U.S. Geological Survey, 1984).

   c. Date well started: July 19, 1983.

   d. Date well completed: July 26, 1983.

   e. Drilling method: Rotary, using rock bits and air-foam circulating medium; bottom-hole obtained.

   f. Bit diameter below water level: 222 mm (8 3/4 in.).

   g. Casing extending below water level: None [surface casing only, to a depth of 16 m (52 ft)].

   h. Total drilled depth: 491 m (1,610 ft).

   i. Description of access for measuring water levels, including tubes or piezometers: 62-mm (2.4-in.) inside-diameter tubing with 3.6-m-(12-ft) long well screen on bottom, extending from land surface to a depth of 481 m (1,579 ft); saturated interval of borehole within Topopah Spring Member of Paintbrush Tuff to Prow Pass Member of Crater Flat Tuff.

   j. Description and altitude of reference point: Top of metal tag on well casing, 1,196.88 m (surveyed by U.S. Geological Survey, 1984).

   k. Depth correction for measured water levels because of borehole deviation from vertical (the correction is subtracted from measured depth to obtain true depth): 0.03 m, based on approximate depth to water of 421 m (1,381 ft).

3. History of instrumentation and water-level measurements, and comments:

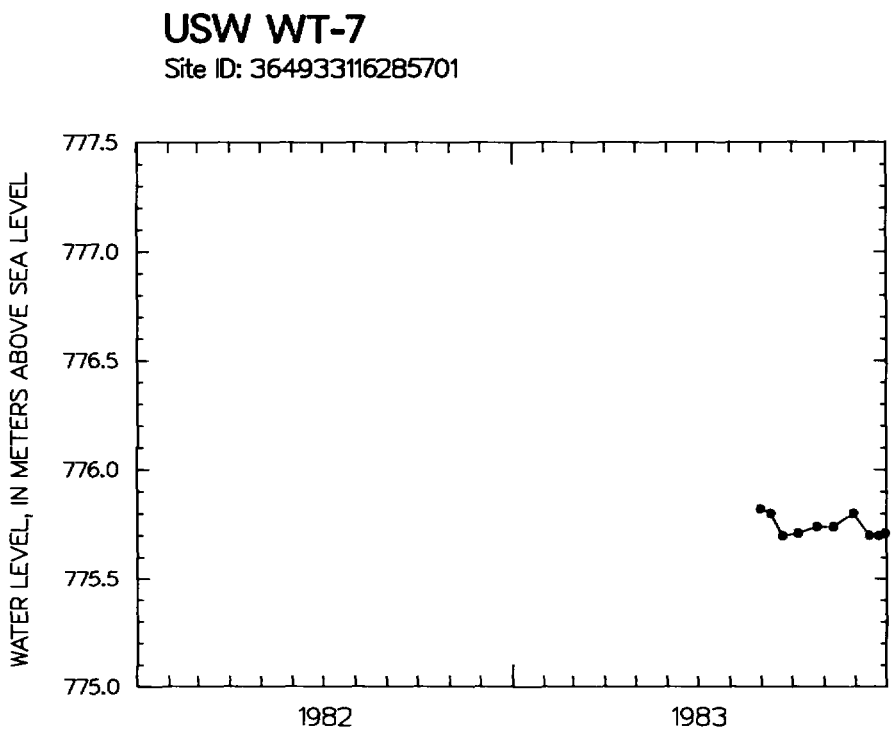
The water-level measurements were made with a four-conductor cable (logging van I-127410) from August 30, 1983, through April 16, 1985. Measurements were made with the 2,800-ft steel tape from June 21, 1985, through December 28, 1985, and with the 2,600-ft steel tape from January 1, 1986, through May 27, 1987.

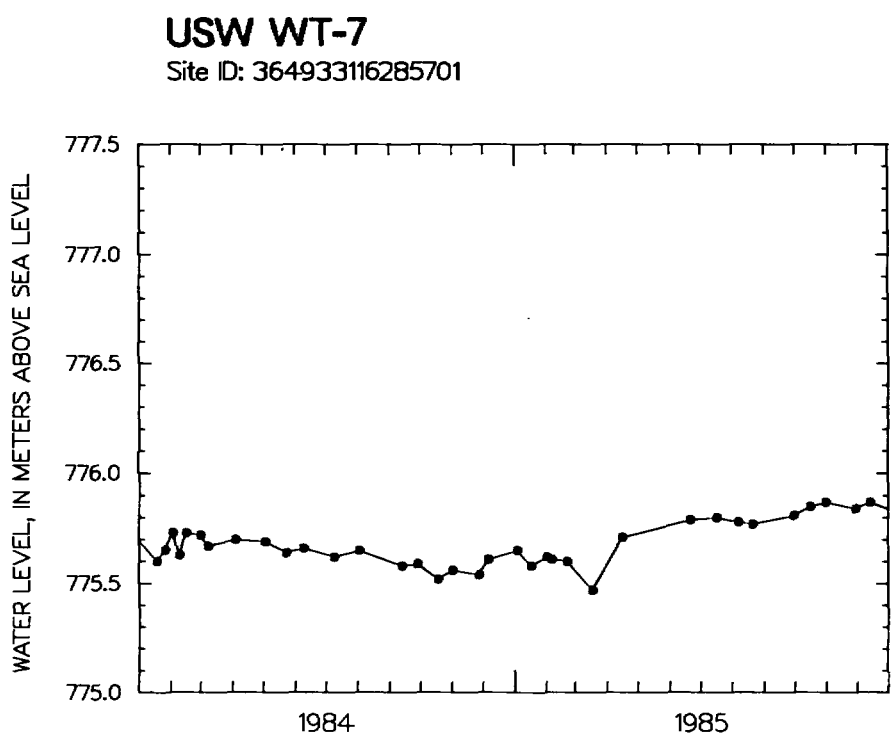
4. Periodic measurements of water-level altitude in well USW WT-7:

Site ID: 364933116285701
Depth interval: 421-491 m (composite)

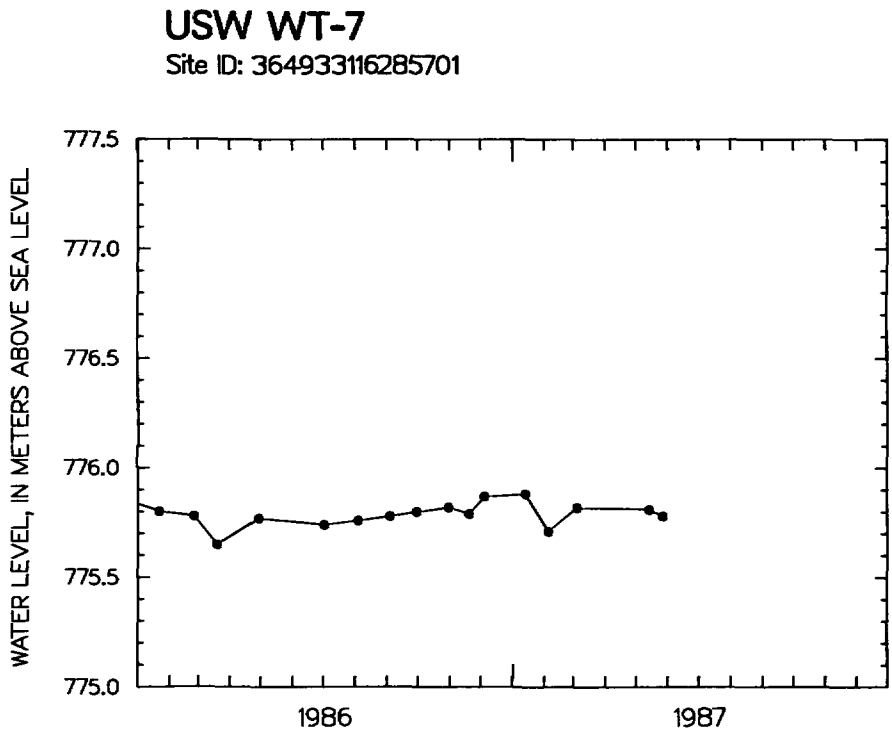
Date	Altitude (meters)	Date	Altitude (meters)
08-30-83	775.82	02-01-85	775.62
09-09-83	775.80	02-06-85	775.61
09-21-83	775.70	02-21-85	775.60
10-06-83	775.71	03-18-85	775.47
10-24-83	775.74	04-16-85	775.71
11-09-83	775.74	06-21-85	775.79
11-28-83	775.80	07-17-85	775.80
12-14-83	775.70	08-07-85	775.78
12-23-83	775.70	08-21-85	775.77
12-29-83	775.71	09-30-85	775.81
01-18-84	775.60	10-16-85	775.85
01-26-84	775.65	10-31-85	775.87
02-03-84	775.73	11-29-85	775.84
02-09-84	775.63	12-13-85	775.87
02-16-84	775.73	01-22-86	775.80
03-01-84	775.72	02-25-86	775.78
03-08-84	775.67	03-19-86	775.65
04-04-84	775.70	04-29-86	775.77
05-03-84	775.69	07-02-86	775.74
05-23-84	775.64	08-04-86	775.76
06-09-84	775.66	09-04-86	775.78
07-09-84	775.62	09-30-86	775.80
08-02-84	775.65	10-31-86	775.82
09-13-84	775.58	11-20-86	775.79
09-28-84	775.59	12-05-86	775.87
10-18-84	775.52	01-14-87	775.88
11-01-84	775.56	02-05-87	775.71
11-27-84	775.54	03-05-87	775.82
12-06-84	775.61	05-14-87	775.81
01-03-85	775.65	05-27-87	775.78
01-17-85	775.58		

5. Hydrographs of water-level altitude (plotted from data in section 4):





5. Hydrographs of water-level altitude (plotted from data in section 4) --Continued:



Well USW WT-10

1. References or information sources: Robison (1984, 1986); Holmes & Narver, Inc. (written commun., 1986); Fenix & Scisson, Inc. (1986b, 1987c).

2. Well specifications:

   a. Location:
   Nevada State Central Zone Coordinates (feet): N 748,771; E 553,302.
   Latitude and longitude: 36°48'25" N.; 116°29'05" W.
   Site ID: 364825116290501.

   b. Land-surface altitude: 1,123.49 (Holmes & Narver, Inc., May 31, 1985); 1,123.2 (Robison, 1984); 1,123.4 (Robison, 1986; based on survey by U.S. Geological Survey, 1984).

   c. Date well started: July 26, 1983.

   d. Date well completed: August 2, 1983.

   e. Drilling method: Rotary, using rock bits and air-foam circulating medium; bottom-hole core obtained.

   f. Bit diameter below water level: 222 mm (8 3/4 in.).

   g. Casing extending below water level: None [surface casing only, to a depth of 35 m (114 ft)].

   h. Total drilled depth: 431 m (1,413 ft).

   i. Description of access for measuring water levels, including tubes or piezometers: 62-mm (2.4-in.) inside-diameter tubing with 3.6-m-(12-ft) long well screen on bottom, extending from land surface to a depth of 403 m (1,321 ft); saturated interval of borehole within Topopah Spring Member of Paintbrush Tuff.

   j. Description and altitude of reference point: Top of metal tag on well casing, 1,123.40 m (surveyed by U.S. Geological Survey, 1984).

   k. Depth correction for measured water levels because of borehole deviation from vertical (the correction is subtracted from measured depth of obtain true depth): 0.03 m, based on approximate depth to water of 348 m (1,142 ft).

3. History of instrumentation and water-level measurements, and comments:

The water-level measurements were made with a four-conductor cable (logging van I-127410) from August 30, 1983, through April 16, 1985. Measurements were made with the 2,800-ft steel tape from June 21, 1985, through December 13, 1985, and measurements were made thereafter with the 2,600-ft steel tape, except that the measurement on December 16, 1987, was made with the 2,800-ft steel tape.

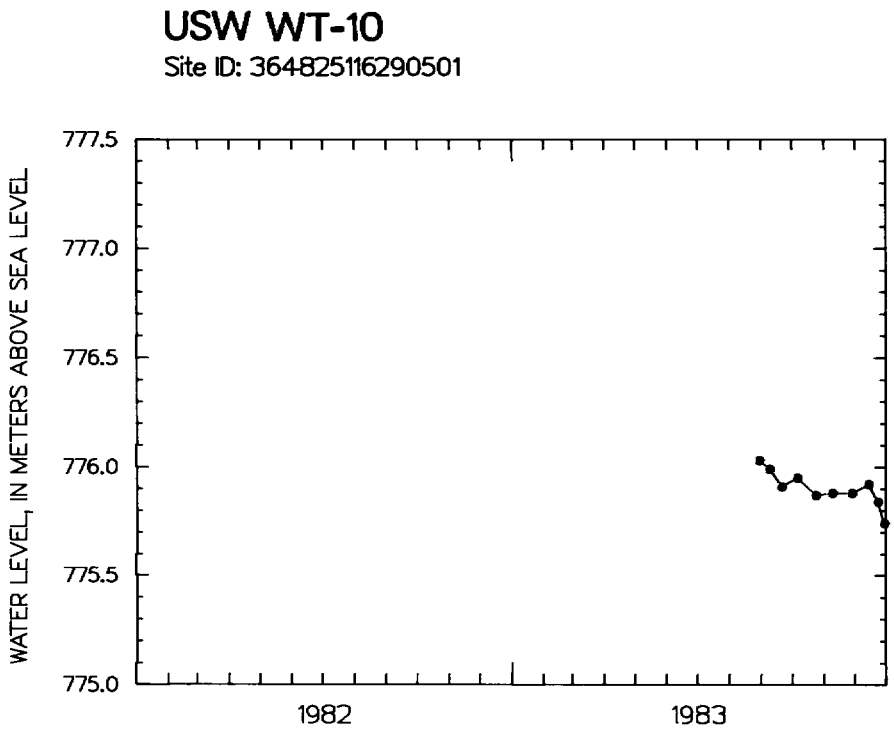
The measurement made on September 9, 1984 (see table, section 4, and hydrograph, section 5), was above the general trend, and the measurements made on February 6, 1985, and May 14, 1987, were below the general trend. These three measurements that are reported here in meters were measured in feet; for each of these measurements the apparent anomaly was exactly 1 ft. Because of the measurement process, unverifiable onsite-recording errors, when they occur, are more likely to be in multiples of feet; therefore, users are cautioned that these data indicated above may not be accurate.

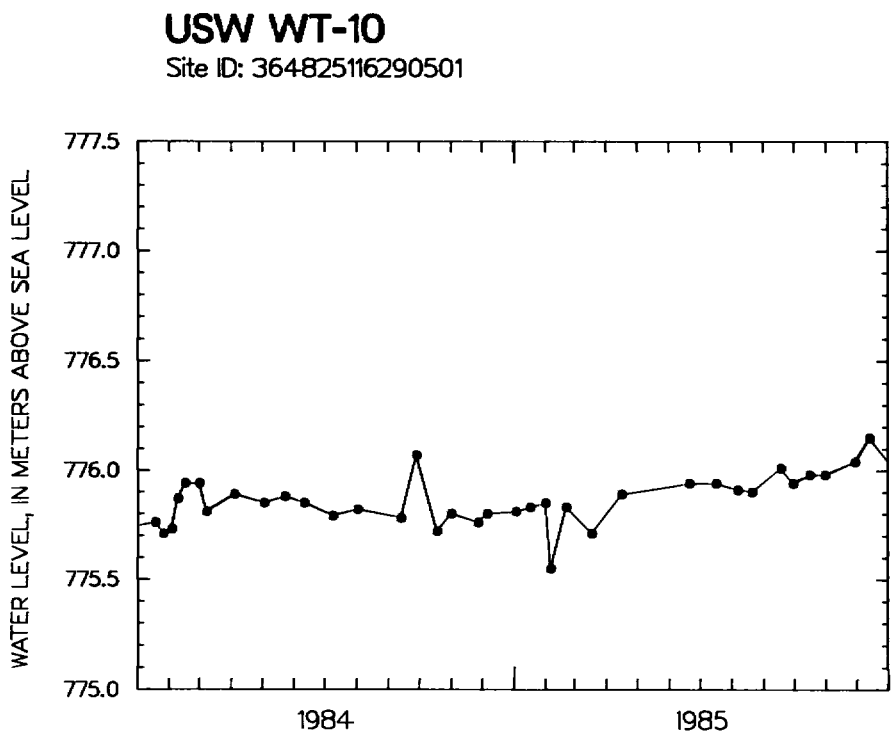
4. Periodic measurements of water-level altitude in well USW WT-10:

Site ID: 364825116290501
Depth interval: 348-431 m (composite)

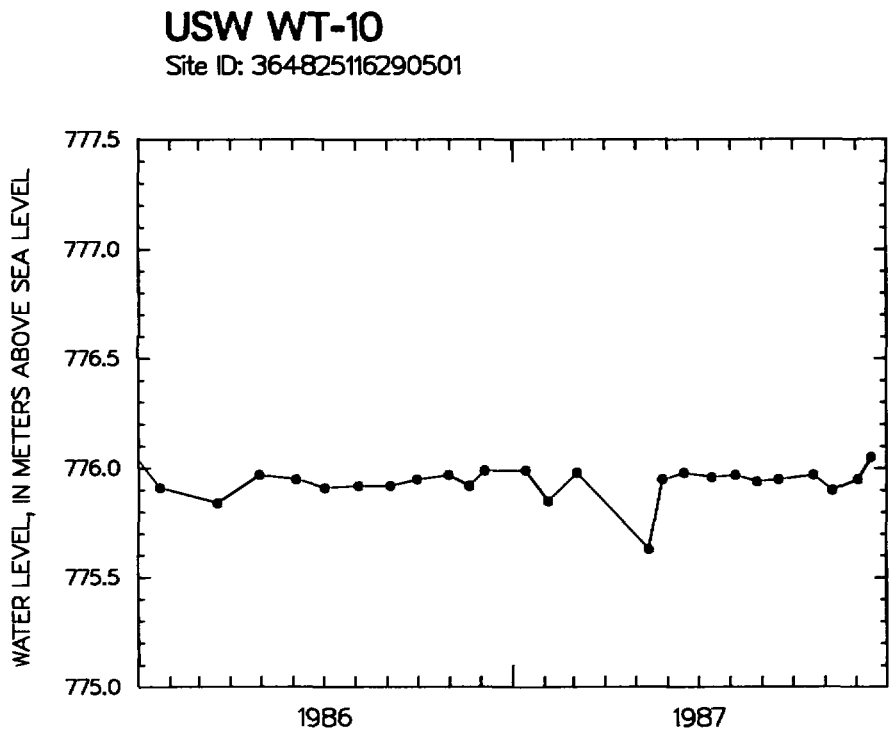
Date	Altitude (meters)	Date	Altitude (meters)
08-30-83	776.03	06-21-85	775.94
09-09-83	775.99	07-17-85	775.94
09-21-83	775.91	08-07-85	775.91
10-06-83	775.95	08-21-85	775.90
10-24-83	775.87	09-18-85	776.01
11-09-83	775.88	09-30-85	775.94
11-28-83	775.88	10-16-85	775.98
12-14-83	775.92	10-31-85	775.98
12-23-83	775.84	11-29-85	776.04
12-29-83	775.74	12-13-85	776.15
01-18-84	775.76	01-22-86	775.91
01-26-84	775.71	03-19-86	775.84
02-03-84	775.73	04-29-86	775.97
02-09-84	775.87	06-04-86	775.95
02-16-84	775.94	07-02-86	775.91
03-01-84	775.94	08-04-86	775.92
03-08-84	775.81	09-04-86	775.92
04-04-84	775.89	09-30-86	775.95
05-03-84	775.85	10-31-86	775.97
05-23-84	775.88	11-20-86	775.92
06-11-84	775.85	12-05-86	775.99
07-09-84	775.79	01-14-87	775.99
08-02-84	775.82	02-05-87	775.85
09-13-84	775.78	03-05-87	775.98
09-28-84	776.07	05-14-87	775.63
10-18-84	775.72	05-27-87	775.95
11-01-84	775.80	06-17-87	775.98
11-27-84	775.76	07-14-87	775.96
12-06-84	775.80	08-06-87	775.97
01-03-85	775.81	08-27-87	775.94
01-17-85	775.83	09-17-87	775.95
02-01-85	775.85	10-21-87	775.97
02-06-85	775.55	11-08-87	775.90
02-21-85	775.83	12-03-87	775.95
03-18-85	775.71	12-16-87	776.05
04-16-85	775.89		

5. Hydrographs of water-level altitude (plotted from data in section 4):





5. Hydrographs of water-level altitude (plotted from data in section 4) --Continued:



Well USW WT-11

1. References or information sources: Robison (1984, 1986); Holmes & Narver, Inc. (written commun., 1986); Fenix & Scisson, Inc. (1886b, 1987c).

2. Well specifications:

   a. Location:
   Nevada State Central Zone Coordinates (feet): N 739,070; E 558,377.
   Latitude and longitude: 36°46'49" N.; 116°28'02" W.
   Site ID: 364649116280201.

   b. Land-surface altitude: 1,094.38 m (Holmes & Narver, Inc., February 6, 1984); 1,094.4 m (Robison, 1984); 1,094.1 m (Robison, 1986; based on survey by U.S. Geological Survey, 1984).

   c. Date well started: August 3, 1983.

   d. Date well completed: August 9, 1983.

   e. Drilling method: Rotary, using rock bits and air-foam circulating medium; bottom-hole core obtained.

   f. Bit diameter below water level: 222 mm (8 3/4 in.).

   g. Casing extending below water level: None [surface casing only, to a depth of 14 m (42 ft)].

   h. Total drilled depth: 441 m (1,446 ft).

   i. Description of access for measuring water levels, including tubes or piezometers: 62-mm (2.4-in.) inside-diameter tubing with 3.6-m-(12-ft) long well screen on bottom, extending from land surface to a depth of 416 m (1,365 ft); saturated interval of borehole within Topopah Spring Member of Paintbrush Tuff to tuffaceous beds of Calico Hills.

   j. Description and altitude of reference point: Top of metal tag on well casing, 1,094.11 m (surveyed by U.S. Geological Survey, 1984).

   k. Depth correction for measured water levels because of borehole deviation from vertical (the correction is subtracted from measured depth to obtain true depth): 0.12 m, based on approximate depth to water of 364 m (1,194 ft).

3. History of instrumentation and water-level measurements, and comments:

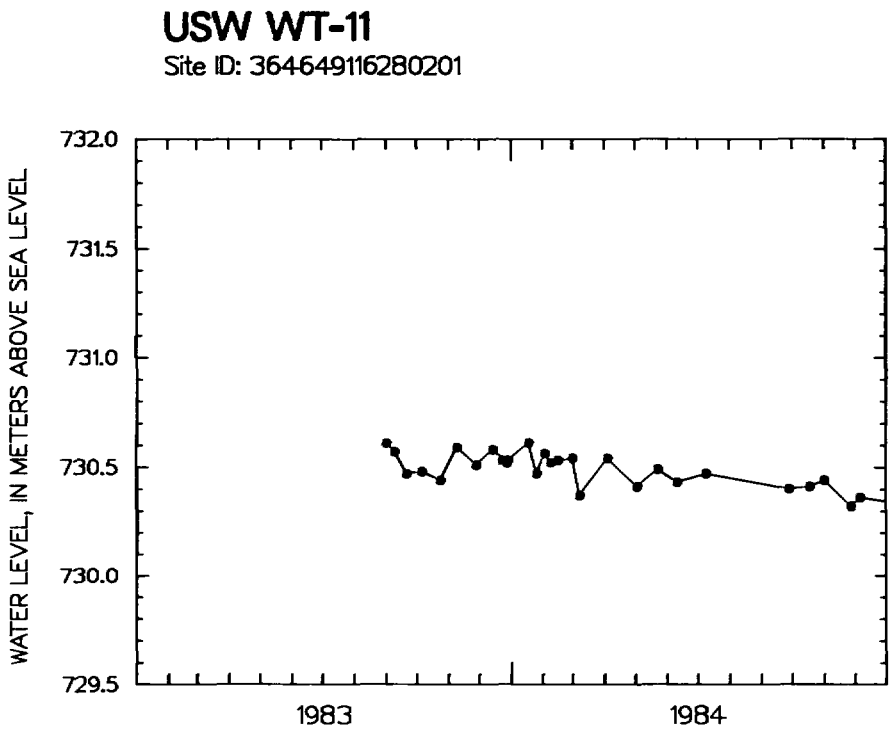
The water-level measurements were made using a four-conductor cable (logging van I-127410) from September 1, 1983, through April 16, 1985. Measurements were made with the 2,800-ft steel tape April 16, 1985, through December 13, 1985. Beginning in October 1986, the water level has been monitored continuously using a downhole pressure transducer with a datalogger at the land surface.

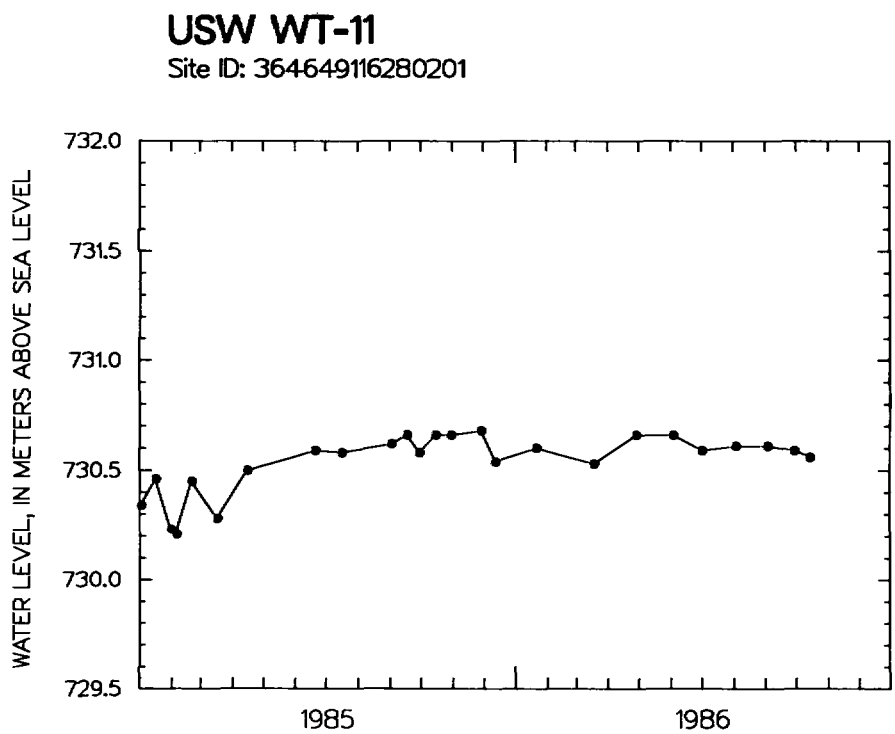
4. Periodic measurements of water-level altitudes in well USW WT-11:

Site ID: 364649116280201
Depth interval: 364-441 m (composite)

Date	Altitude (meters)	Date	Altitude (meters)
09-01-83	730.61	12-06-84	730.36
09-09-83	730.57	01-03-85	730.34
09-21-83	730.47	01-17-85	730.46
10-06-83	730.48	02-01-85	730.23
10-24-83	730.44	02-06-85	730.21
11-09-83	730.59	02-21-85	730.45
11-28-83	730.51	03-18-85	730.28
12-14-83	730.58	04-16-85	730.50
12-28-83	730.52	06-21-85	730.59
12-23-83	730.53	07-17-85	730.58
12-29-83	730.53	09-03-85	730.62
01-18-84	730.61	09-18-85	730.66
01-26-84	730.47	09-30-85	730.58
02-03-84	730.56	10-16-85	730.66
02-09-84	730.52	10-31-85	730.66
02-16-84	730.53	11-29-85	730.68
03-01-84	730.54	12-13-85	730.54
03-08-84	730.37	01-22-86	730.60
04-04-84	730.54	03-19-86	730.53
05-03-84	730.41	04-29-86	730.66
05-23-84	730.49	06-04-86	730.66
06-11-84	730.43	07-02-86	730.59
07-09-84	730.47	08-04-86	730.61
09-28-84	730.40	09-04-86	730.61
10-18-84	730.41	09-30-86	730.59
11-01-84	730.44	10-15-86	730.56
11-27-84	730.32		

5. Hydrographs of water-level altitude (plotted from data in section 4):





Well UE-25 WT #12

1. References or information sources: Robison (1984, 1986); Holmes & Narver, Inc. (written commun., 1986); Fenix & Scisson, Inc. (1986b, 1987c).

2. Well specifications

   a. Location:
   Nevada State Central Zone Coordinates (feet): N 739,726; E 567,011.
   Latitude and longitude: 36°46'56" N.; 116°26'16" W.
   Site ID: 364656116261601.

   b. Land-surface altitude: 1,074.91 m (Holmes & Narver, Inc., May 31, 1985); 1,074.6 m (Robison, 1984); 1,074.7 m (Robison, 1986; based on survey by U.S. Geological Survey, 1984).

   c. Date well started: August 11, 1983.

   d. Date well completed: August 16, 1983.

   e. Drilling method: Rotary, using rock bits and air-foam circulating medium; bottom-hole core obtained.

   f. Bit diameter below water level: 222 mm (8 3/4 in.).

   g. Casing extending below water level: None [surface casing only, to a depth of 21 m (70 ft)].

   h. Total drilled depth: 399 m (1,308 ft).

   i. Description of access for measuring water levels, including tubes or piezometers: 62-mm (2.4-in.) inside-diameter tubing with 3.6-m-(12-ft) long well screen on bottom, extending from land surface to a depth of 389 m (1,276 ft); saturated interval of borehole within Topopah Spring Member of Paintbrush Tuff and tuffaceous beds of Calico Hills.

   j. Description and altitude of reference point: Top of metal tag on well casing, 1,074.74 m (surveyed by U.S. Geological Survey, 1984).

   k. Depth correction for measured water levels because of borehole deviation from vertical (the correction is subtracted from measured depth to obtain true depth): 0.20 m, based on approximate depth to water of 345 m (1,132 ft).

3. History of instrumentation and water-level measurements, and comments:

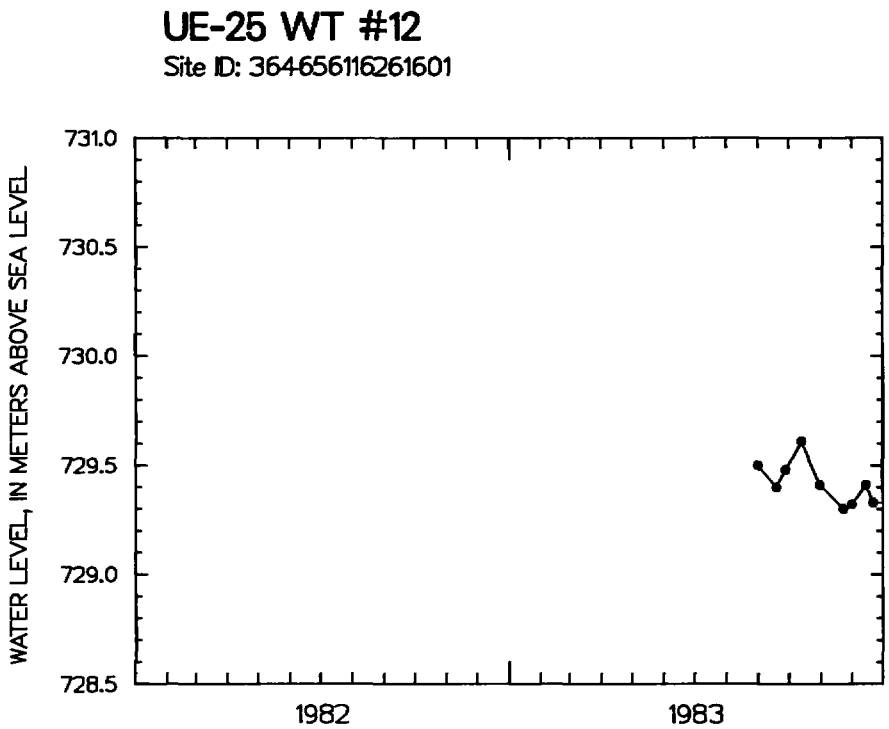
The water-level measurements were made with a four-conductor cable (logging van I-127410) from September 1, 1983, through April 10, 1985. Measurements were made with the 2,800-ft steel tape from July 16, 1985, through December 6, 1985, and with the 2,600-ft steel tape from January 29, 1986, through December 28, 1987.

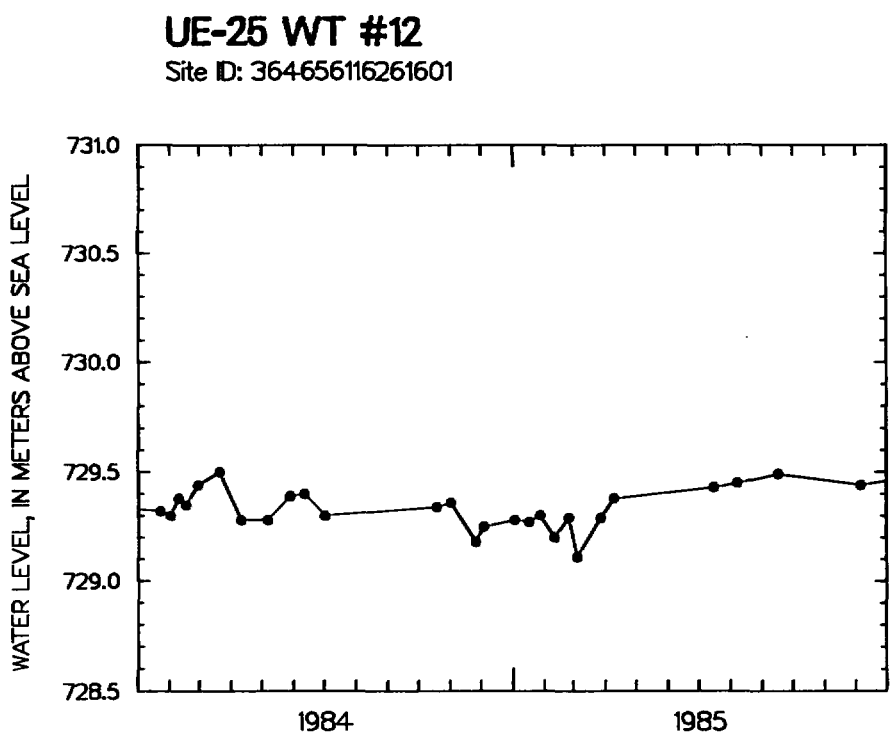
4. Periodic measurements of water-level altitude in well UE-25 WT #12:

Site ID: 364656116261601
Depth interval: 345-399 m (composite)

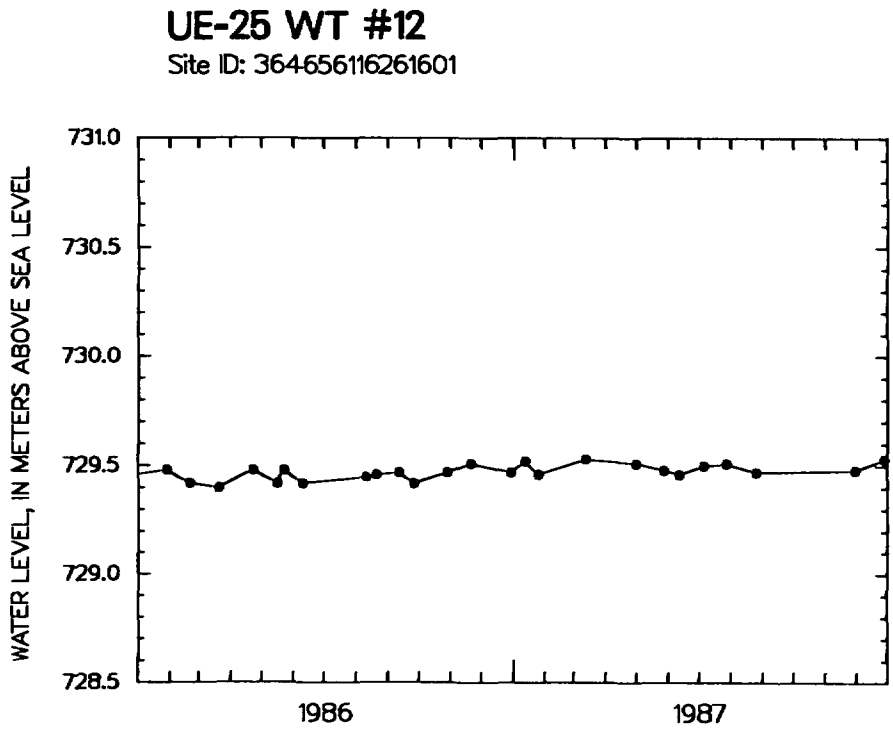
Date	Altitude (meters)	Date	Altitude (meters)
09-01-83	729.50	04-10-85	729.38
09-19-83	729.40	07-16-85	729.43
09-28-83	729.48	08-08-85	729.45
10-13-83	729.61	09-17-85	729.49
10-31-83	729.41	12-06-85	729.44
11-23-83	729.30	01-29-86	729.48
12-01-83	729.32	02-20-86	729.42
12-15-83	729.41	03-20-86	729.40
12-22-83	729.33	04-23-86	729.48
01-23-84	729.32	05-16-86	729.42
02-02-84	729.30	05-23-86	729.48
02-10-84	729.38	06-10-86	729.42
02-17-84	729.35	08-11-86	729.45
02-29-84	729.44	08-21-86	729.46
03-21-84	729.50	09-12-86	729.47
04-11-84	729.28	09-26-86	729.42
05-07-84	729.28	10-29-86	729.47
05-29-84	729.39	11-21-86	729.51
06-12-84	729.40	12-30-86	729.47
07-02-84	729.30	01-13-87	729.52
10-19-84	729.34	01-26-87	729.46
11-02-84	729.36	03-13-87	729.53
11-26-84	729.18	05-01-87	729.51
12-04-84	729.25	05-28-87	729.48
01-03-85	729.28	06-12-87	729.46
01-17-85	729.27	07-06-87	729.50
01-28-85	729.30	07-28-87	729.51
02-11-85	729.20	08-26-87	729.47
02-25-85	729.29	11-30-87	729.48
03-05-85	729.11	12-28-87	729.53
03-28-85	729.29		

5. Hydrographs of water-level altitude (plotted from data in section 4):





5. Hydrographs of water-level altitude (plotted from data in section 4) --Continued:



Well UE-25 WT #13

1. References or information sources: Robison (1984, 1986); Holmes & Narver, Inc. (written commun., 1986); Fenix & Scisson, Inc. (1986b, 1987c).

2. Well specifications:

   a. Location:
   Nevada State Central Zone Coordinates (feet): N 756,715; E 578,757.
   Latitude and longitude: 36°49'43" N.; 116°23'51" W.
   Site ID: 364945116235001.

   b. Land-surface altitude: 1,032.05 m (Holmes & Narver, Inc., May 30, 1985); 1,031.8 m (Robison, 1984); 1,032.5 m (Robison, 1986; based on survey by U.S. Geological Survey, 1984).

   c. Date well started: June 29, 1983.

   d. Date well completed: July 7, 1983.

   e. Drilling method: Rotary, using rock bits and air-foam circulating medium; bottom-hole core obtained.

   f. Bit diameter below water level: 222 mm (8 3/4 in.).

   g. Casing extending below water level: None [surface casing only, to a depth of 68 m (222 ft)].

   h. Total drilled depth: 354 m (1,160 ft).

   i. Description of access for measuring water levels, including tubes or piezometers: 62-mm (2.4-in.) inside-diameter tubing with 3.6-m-(12-ft) long well screen on bottom, extending from land surface to a depth of 346 m (1,136 ft); saturated interval of borehole within Topopah Spring Member of Paintbrush Tuff.

   j. Description and altitude of reference point: Top of metal tag on well casing, 1,032.51 m (surveyed by U.S. Geological Survey, 1984).

   k. Depth correction for measured water levels because of borehole deviation from vertical (the correction is subtracted from measured depth to obtain true depth): 0.01 m, based on approximate depth to water of 303 m (994 ft).

3. History of instrumentation and water-level measurements, and comments:

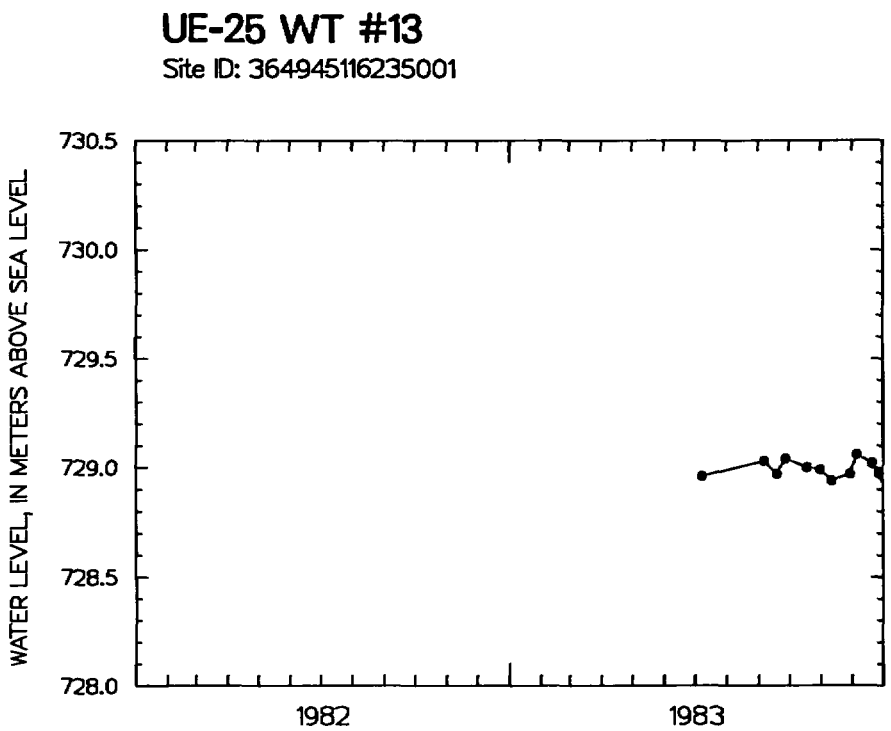
The water-level measurements were made with a four-conductor cable (logging van I-127410) from July 8, 1983, through February 12, 1985. Beginning in February 1985, the water level has been monitored continuously using a downhole pressure transducer with a datalogger at the land surface.

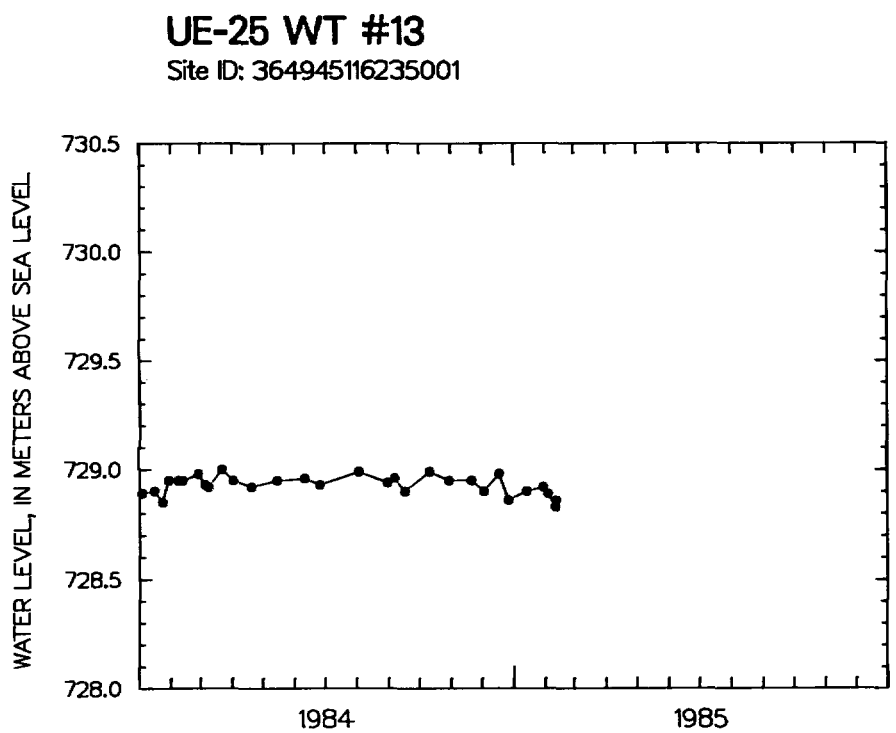
4. Periodic measurements of water-level altitude in well UE-25 WT #13:

Site ID: 364945116235001
Depth interval: 303-354 m (composite)

Date	Altitude (meters)	Date	Altitude (meters)
07-08-83	728.96	04-02-84	728.95
09-06-83	729.03	04-20-84	728.92
09-19-83	728.97	05-15-84	728.95
09-27-83	729.04	06-11-84	728.96
10-18-83	729.00	06-26-84	728.93
10-31-83	728.99	08-03-84	728.99
11-11-83	728.94	08-31-84	728.94
11-29-83	728.97	09-07-84	728.96
12-05-83	729.06	09-17-84	728.90
12-20-83	729.02	10-11-84	728.99
12-27-83	728.97	10-30-84	728.95
01-04-84	728.89	11-21-84	728.95
01-16-84	728.90	12-03-84	728.90
01-24-84	728.85	12-18-84	728.98
01-30-84	728.95	12-27-84	728.86
02-08-84	728.95	01-14-85	728.90
02-13-84	728.95	01-30-85	728.92
02-28-84	728.98	02-04-85	728.89
03-06-84	728.93	02-11-85	728.83
03-09-84	728.92	02-12-85	728.86
03-22-84	729.00		

5. Hydrographs of water-level altitude (plotted from data in section 4):





Well UE-25 WT #14

1. References or information sources: Robison (1984, 1986); Holmes & Narver, Inc., (written commun., 1986); Fenix & Scisson, Inc. (1986b, 1987c).

2. Well specifications:

   a. Location:
   Nevada State Central Zone Coordinates (feet): N 761,651; E 575,210.
   Latitude and longitude: 36°50'32" N.; 116°24'35" W.
   Site ID: 365032116243501.

   b. Land-surface altitude: 1,075.91 m (Holmes & Narver, Inc., February 1, 1984); 1,076.1 m (Robison, 1984); 1,076.4 m (Robison, 1986; based on survey by U.S. Geological Survey, 1984); this value apparently was in error; revised in this report to 1,075.9 m.

   c. Date well started: August 17, 1983.

   d. Date well completed: September 30, 1983.

   e. Drilling method: Rotary, using rock bits and air-foam circulating medium; bottom-hole core obtained.

   f. Bit diameter below water level: 222 mm (8 3/4 in.).

   g. Casing extending below water level: None [surface casing only, to a depth of 37 m (120 ft)].

   h. Total drilled depth: 399 m (1,310 ft).

   i. Description of access for measuring water levels, including tubes or piezometers: 62-mm (2.4-in.) inside-diameter tubing with 3.6-m-(12-ft) long well screen on bottom, extending from land surface to a depth of 397 m (1,303 ft); saturated interval of borehole within Topopah Spring Member of Paintbrush Tuff and tuffaceous beds of Calico Hills.

   j. Description and altitude of reference point: Top of metal tag on well casing, 1,076.05 m (surveyed by U.S. Geological Survey, 1984).

   k. Depth correction for measured water levels because of borehole deviation from vertical (the correction is subtracted from measured depth to obtain true depth): 0.09 m, based on approximate depth to water of 346 m (1,135 ft).

3. History of instrumentation and water-level measurements, and comments:

The water-level measurements were made with a four-conductor cable (logging van I-127410) from October 21, 1983, through April 29, 1985. Measurements were made with the 2,800-ft steel tape from June 11, 1985, through December 6, 1985, and with the 2,600-ft steel tape from January 28, 1986, through December 28, 1987.

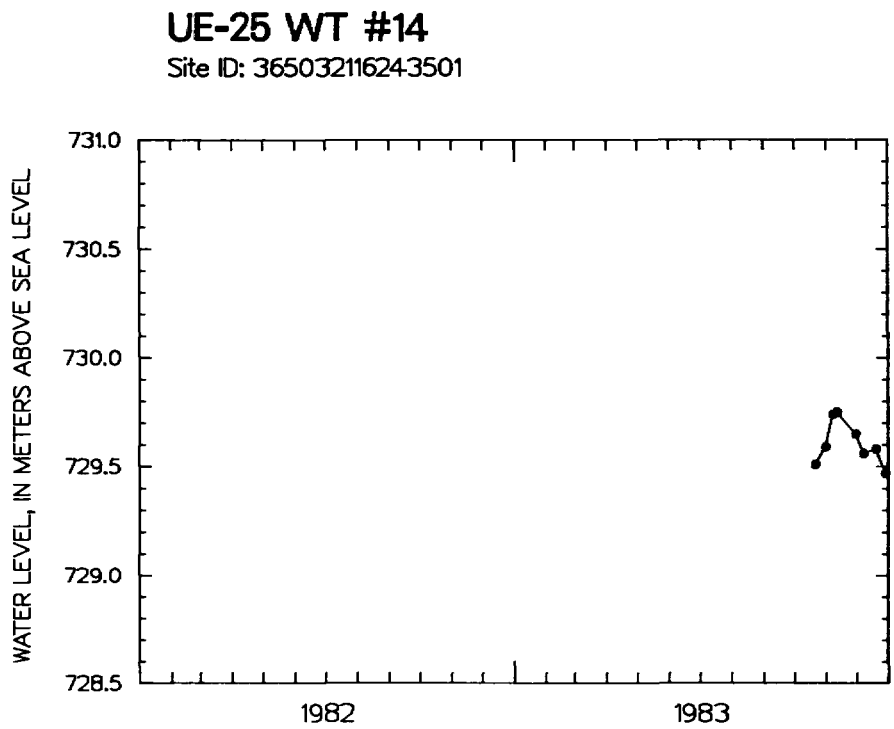
The measurement on March 20, 1985 (see table, section 4, and hydrograph, section 5), was below the general trend and the measurement on May 5, 1987, was above the general trend. These two measurements that are reported here in meters were measured in feet; for each of these measurements the apparent anomaly was exactly 1 ft. Because of the measurement process, unverifiable onsite recording errors, when they occur, are more likely to be in multiples of feet; therefore, users are cautioned that these data indicated above may not be accurate.

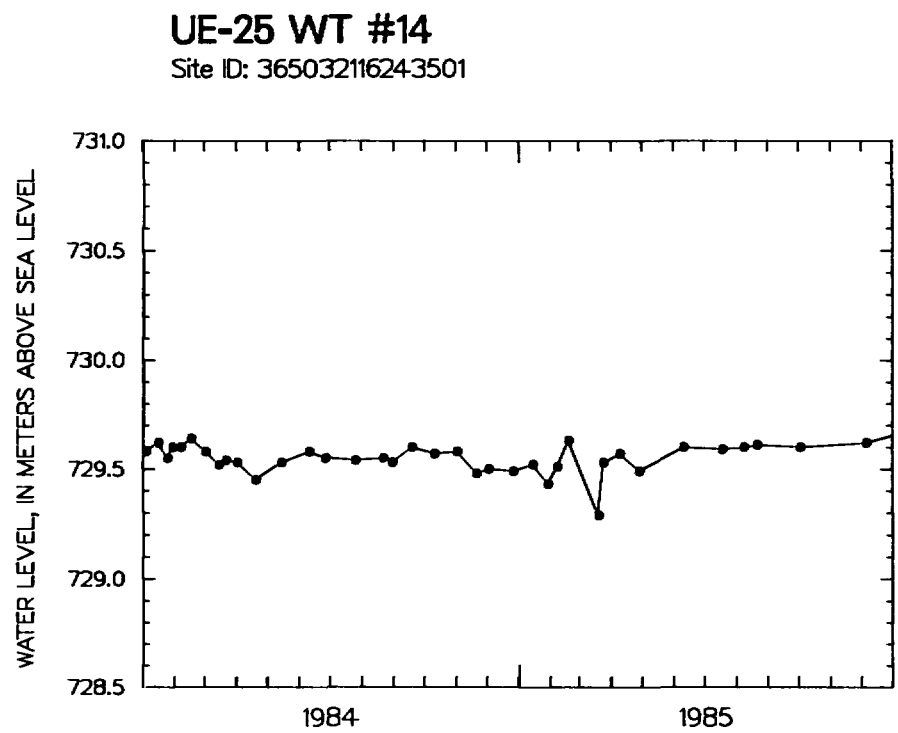
4. Periodic measurements of water-level altitude in well UE-25 WT #14:

Site ID: 365032116243501
Depth interval: 346-399 m (composite)

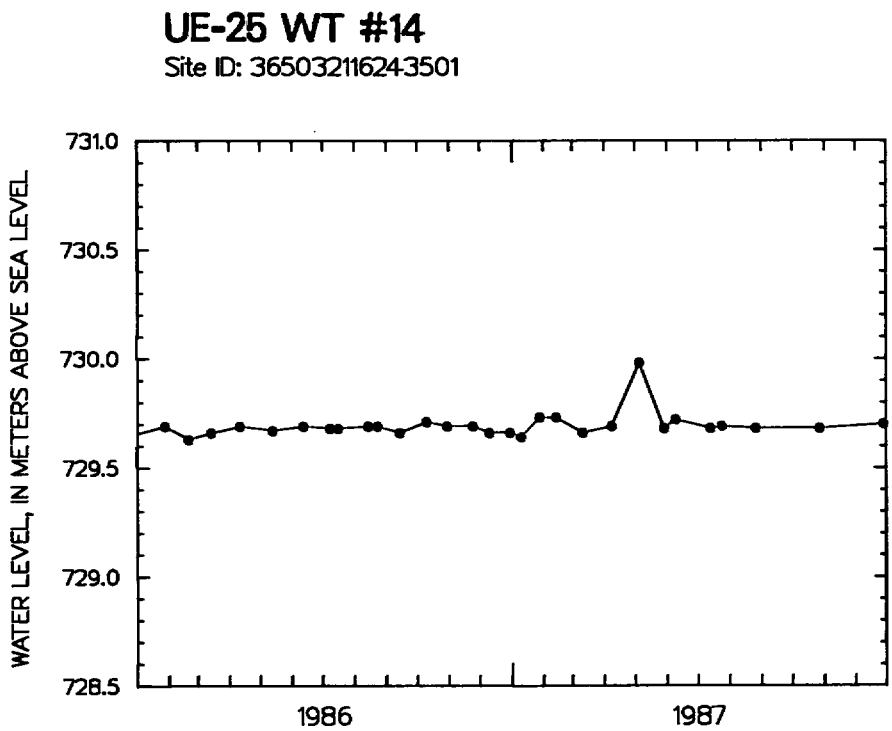
Date	Altitude (meters)	Date	Altitude (meters)
10-21-83	729.51	04-10-85	729.57
10-31-83	729.59	04-29-85	729.49
11-07-83	729.74	06-11-85	729.60
11-11-83	729.75	07-19-85	729.59
11-29-83	729.65	08-09-85	729.60
12-07-83	729.56	08-22-85	729.61
12-19-83	729.58	10-03-85	729.60
12-28-83	729.47	12-06-85	729.62
01-04-84	729.58	01-28-86	729.69
01-16-84	729.62	02-20-86	729.63
01-25-84	729.55	03-14-86	729.66
01-30-84	729.60	04-11-86	729.69
02-07-84	729.60	05-13-86	729.67
02-17-84	729.64	06-12-86	729.69
03-02-84	729.58	07-08-86	729.68
03-15-84	729.52	07-16-86	729.68
03-22-84	729.54	08-14-86	729.69
04-02-84	729.53	08-23-86	729.69
04-20-84	729.45	09-14-86	729.66
05-15-84	729.53	10-10-86	729.71
06-11-84	729.58	10-30-86	729.69
06-27-84	729.55	11-24-86	729.69
07-26-84	729.54	12-10-86	729.66
08-22-84	729.55	12-30-86	729.66
08-31-84	729.53	01-10-87	729.64
09-19-84	729.60	01-28-87	729.73
10-11-84	729.57	02-13-87	729.73
11-02-84	729.58	03-11-87	729.66
11-21-84	729.48	04-08-87	729.69
12-03-84	729.50	05-05-87	729.98
12-27-84	729.49	05-29-87	729.68
01-15-85	729.52	06-09-87	729.72
01-30-85	729.43	07-13-87	729.68
02-08-85	729.51	07-24-87	729.69
02-19-85	729.63	08-26-87	729.68
03-20-85	729.29	10-27-87	729.68
03-25-85	729.53	12-28-87	729.70

5. Hydrographs of water-level altitude (plotted from data in section 4):





5. Hydrographs of water-level altitude (plotted from data in section 4) --Continued:



Well UE-25 WT #15

1. References or information sources: Robison (1984, 1986); Holmes & Narver, Inc. (written commun., 1986); Fenix & Scisson, Inc. (1986b, 1987c).

2. Well specifications:

   a. Location:
   Nevada State Central Zone Coordinates (feet): N 766,117; E 579,806.
   Latitude and longitude: 36°51'16" N.; 116°23'38" W.
   Site ID: 365116116233801.

   b. Land-surface altitude: 1,082.80 m (Holmes & Narver, Inc., February 9, 1984); 1,082.8 m (Robison, 1984); 1,083.2 m (Robison, 1986; based on survey by U.S. Geological Survey, 1984).

   c. Date well started: November 12, 1983.

   d. Date well completed: November 22, 1983.

   e. Drilling method: Rotary, using rock bits and air-foam circulating medium; bottom-hole core obtained.

   f. Bit diameter below water level: 222 mm (8 3/4 in.).

   g. Casing extending below water level: None [surface casing only, to a depth of 39 m (127 ft].

   h. Total drilled depth: 415 m (1,360 ft).

   i. Description of access for measuring water levels, including tubes or piezometers: 62-mm (2.4-in.) inside-diameter tubing with 3.6-m-(12-ft) long well screen on bottom, extending from land surface to a depth of 407 m (1,335 ft); saturated interval of borehole within Topopah Spring Member of Paintbrush Tuff.

   j. Description and altitude of reference point: Top of metal tag on well casing, 1,082.94 m (surveyed by U.S. Geological Survey, 1984).

   k. Depth correction for measured water levels because of borehole deviation from vertical (the correction is subtracted from measured depth to obtain true depth): 0.19 m, based on approximate depth to water of 354 m (1,160 ft).

3. History of instrumentation and water-level measurements, and comments:

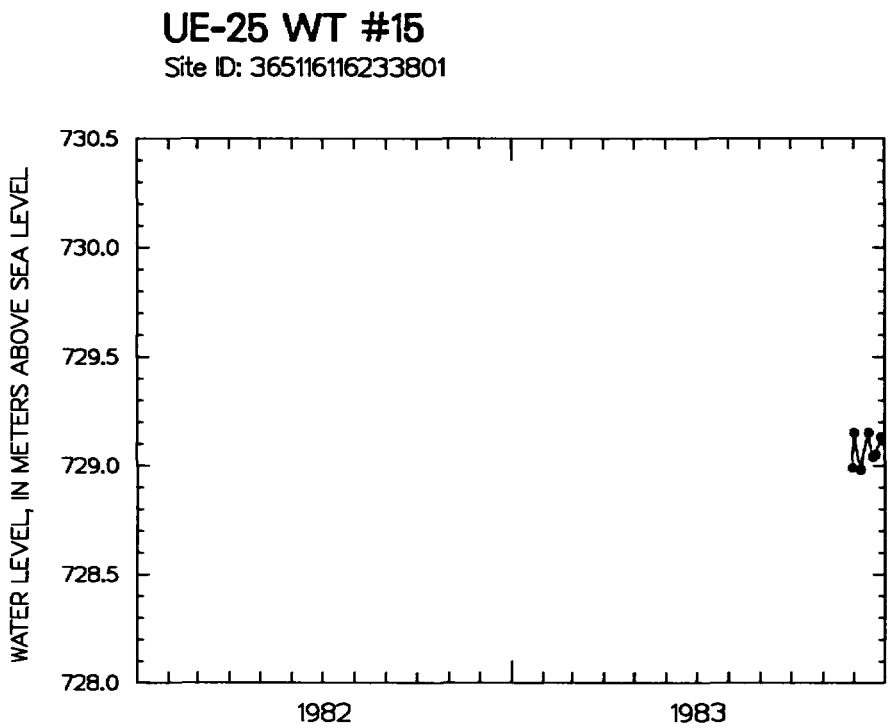
The water-level measurements were made with a four-conductor cable (logging van I-127410) from November 29, 1983, through April 29, 1984. Measurements were made with the 2,800-ft steel tape from June 11, 1985, through December 30, 1985, and with the 2,600-ft steel tape from January 28, 1986, through December 28, 1987.

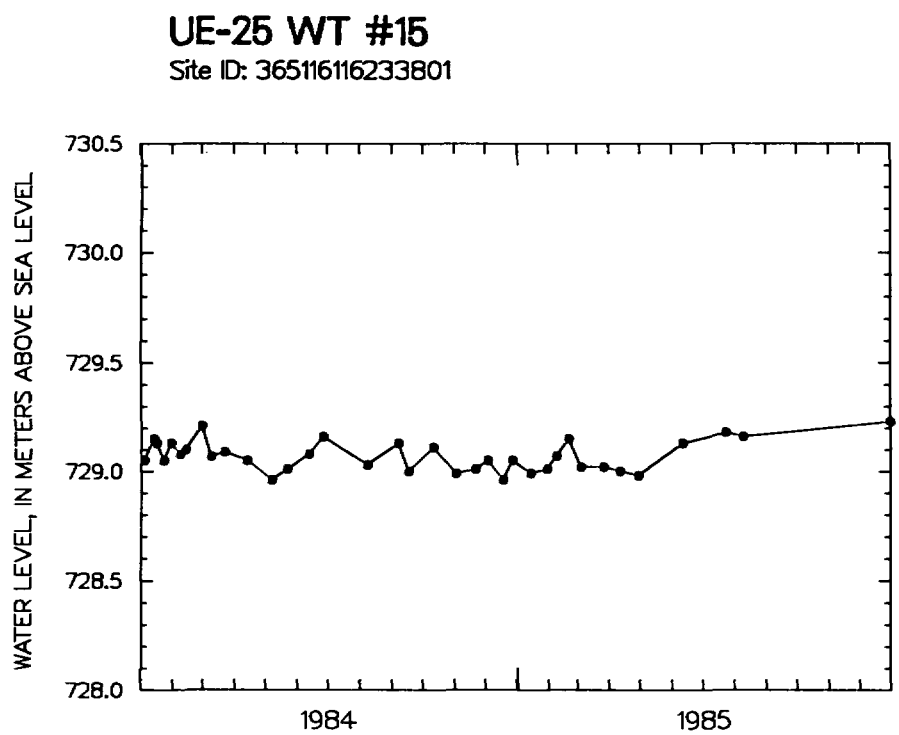
4. Periodic measurements of water-level altitude in well UE-25 WT #15:

Site ID: 365116116233801
Depth interval: 354-415 m (composite)

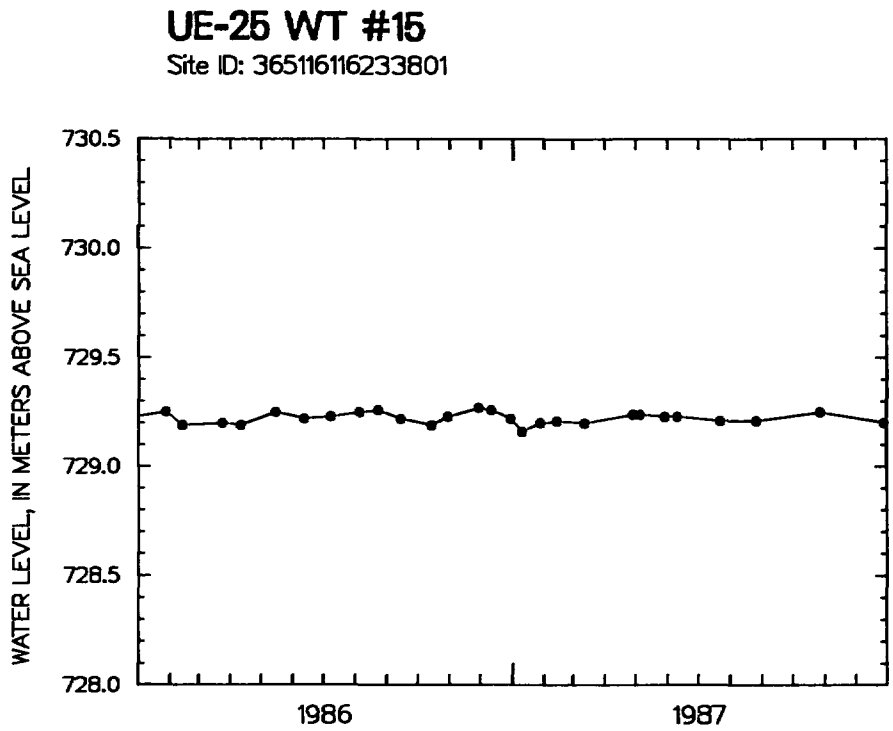
Date	Altitude (meters)	Date	Altitude (meters)
11-29-83	728.99	03-04-85	729.02
12-01-83	729.15	03-26-85	729.02
12-07-83	728.98	04-11-85	729.00
12-15-83	729.15	04-29-85	728.98
12-19-83	729.04	06-11-85	729.13
12-22-83	729.05	07-23-85	729.18
12-27-83	729.13	08-09-85	729.16
01-04-84	729.05	12-30-85	729.23
01-13-84	729.15	01-28-86	729.25
01-16-84	729.13	02-13-86	729.19
01-23-84	729.05	03-24-86	729.20
01-30-84	729.13	04-11-86	729.19
02-08-84	729.08	05-15-86	729.25
02-13-84	729.10	06-12-86	729.22
02-29-84	729.21	07-08-86	729.23
03-09-84	729.07	08-05-86	729.25
03-22-84	729.09	08-23-86	729.26
04-13-84	729.05	09-14-86	729.22
05-07-84	728.96	10-14-86	729.19
05-22-84	729.01	10-30-86	729.23
06-12-84	729.08	11-29-86	729.27
06-26-84	729.16	12-11-86	729.26
08-08-84	729.03	12-30-86	729.22
09-07-84	729.13	01-10-87	729.16
09-17-84	729.00	01-28-87	729.20
10-11-84	729.11	02-13-87	729.21
11-02-84	728.99	03-12-87	729.20
11-21-84	729.01	04-28-87	729.24
12-03-84	729.05	05-05-87	729.24
12-18-84	728.96	05-29-87	729.23
12-27-84	729.05	06-10-87	729.23
01-14-85	728.99	07-22-87	729.21
01-30-85	729.01	08-26-87	729.21
02-08-85	729.07	10-27-87	729.25
02-20-85	729.15	12-28-87	729.20

5. Hydrographs of water-level altitude (plotted from data in section 4):





5. Hydrographs of water-level altitude (plotted from data in section 4) --Continued:



Well UE-25 WT #16

1. References or information sources: Robison (1984, 1986); Holmes & Narver, Inc., (written commun., 1986); Fenix & Scisson, Inc. (1986b, 1987c).

2. Well specifications:

   a. Location:
   Nevada State Central Zone Coordinates (feet): N 774,420; E 570,395.
   Latitude and longitude: 36°52'39" N.; 116°25'34" W.
   Site ID: 365239116253401.

   b. Land-surface altitude: 1,210.48 m (Holmes & Narver, Inc., November 10, 1983); 1,210.5 m (Robison, 1984); 1,210.9 m (Robison, 1986; based on survey by U.S. Geological Survey, 1984).

   c. Date well started: November 2, 1983.

   d. Date well completed: November 10, 1983.

   e. Drilling method: Rotary, using rock bits and air-foam circulating medium; bottom-hole core obtained.

   f. Bit diameter below water level: 222 mm (8 3/4 in.).

   g. Casing extending below water level: None [surface casing only, to a depth of 31 m (102 ft)].

   h. Total drilled depth: 521 m (1,710 ft).

   i. Description of access for measuring water levels, including tubes or piezometers: 62-mm (2.4-in.) inside-diameter tubing with 3.6-m-(12-ft) long well screen on bottom, extending from land surface to a depth of 514 m (1,686 ft); saturated interval of borehole within tuffaceous beds of Calico Hills.

   j. Description and altitude of reference point: Top of metal tag on well casing, 1,210.63 m (surveyed by U.S. Geological Survey, 1984).

   k. Depth correction for measured water levels because of borehole deviation from vertical (the correction is subtracted from measured depth to obtain true depth): 0.06 m, based on approximate depth to water of 473 m (1,552 ft).

3. History of instrumentation and water-level measurements, and comments:

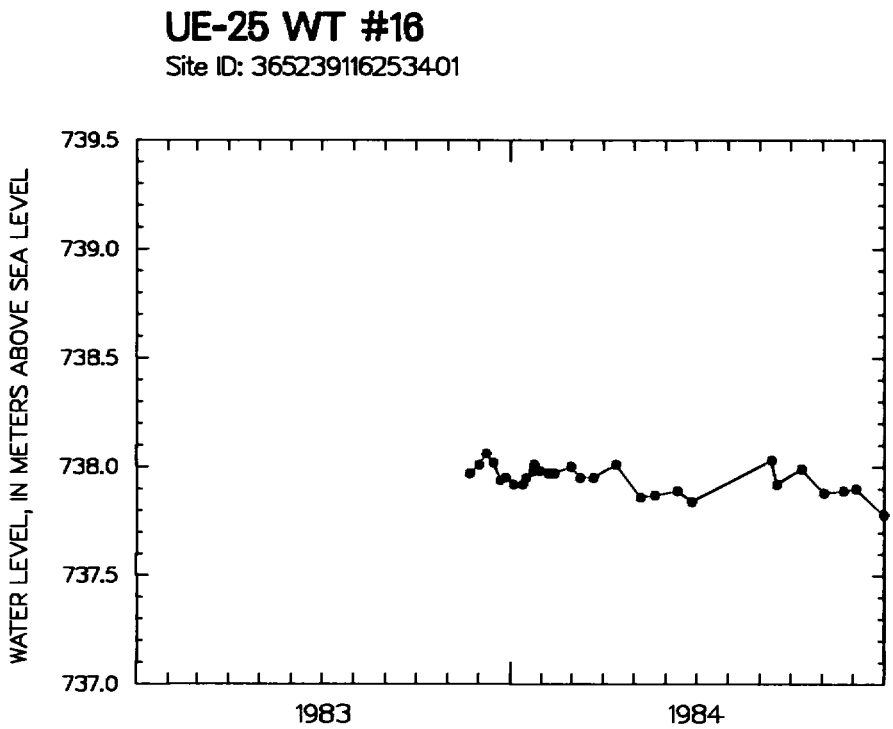
The water-level measurements were made with a four-conductor cable (logging van I-127410) from November 22, 1983, through April 11, 1985. Measurements were made with the 2,800-ft steel tape from June 11, 1985, through December 30, 1985, and with the 2,600-ft steel tape from January 28, 1986, through August 6, 1986. The apparent water-level rise of about 0.3 m in mid-1985 corresponded to a change in measuring equipment and probably was not an actual water-level change. Beginning in August 1986, the water level has been monitored continuously using a downhole pressure transducer with a datalogger at the land surface.

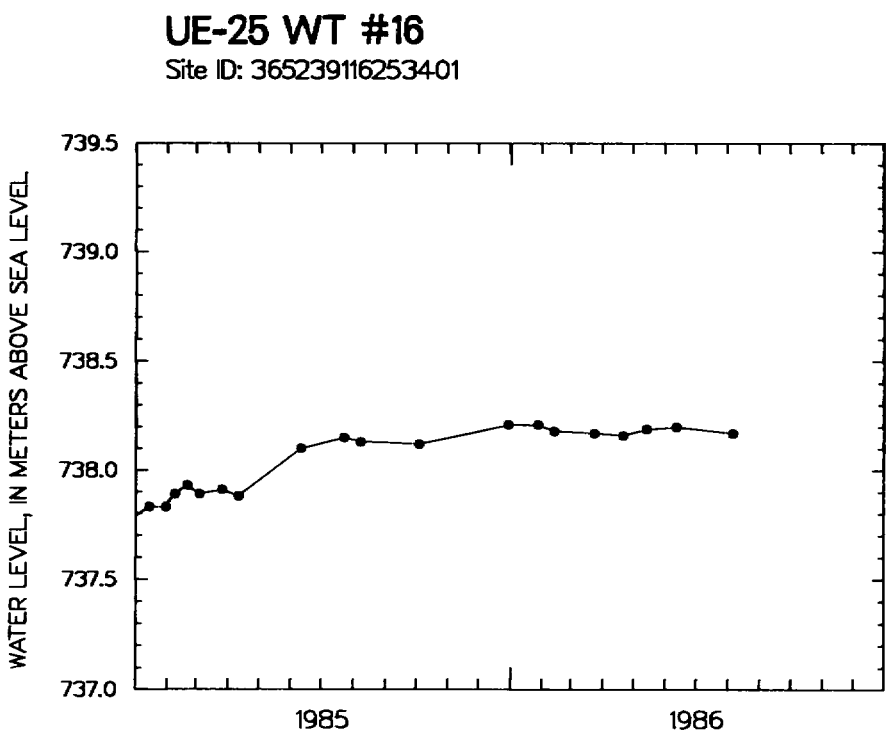
4. Periodic measurements of water-level altitude in well UE-25 WT #16:

Site ID: 365239116253401
Depth interval: 473-521 m (composite)

Date	Altitude (meters)	Date	Altitude (meters)
11-22-83	737.97	10-11-84	737.99
12-01-83	738.01	11-02-84	737.88
12-08-83	738.06	11-21-84	737.89
12-15-83	738.02	12-03-84	737.90
12-22-83	737.94	12-30-84	737.78
12-27-83	737.95	01-14-85	737.83
01-04-84	737.92	01-30-85	737.83
01-13-84	737.92	02-08-85	737.89
01-16-84	737.95	02-20-85	737.93
01-23-84	737.98	03-04-85	737.89
01-24-84	738.01	03-26-85	737.91
01-30-84	737.98	04-11-85	737.88
02-07-84	737.97	06-11-85	738.10
02-13-84	737.97	07-23-85	738.15
02-29-84	738.00	08-08-85	738.13
03-09-84	737.95	10-04-85	738.12
03-22-84	737.95	12-30-85	738.21
04-13-84	738.01	01-28-86	738.21
05-07-84	737.86	02-13-86	738.18
05-21-84	737.87	03-24-86	738.17
06-12-84	737.89	04-21-86	738.16
06-26-84	737.84	05-14-86	738.19
09-12-84	738.03	06-12-86	738.20
09-17-84	737.92	08-06-86	738.17

5. Hydrographs of water-level altitude (plotted from data in section 4):





Well UE-25 WT #17

1. References or information sources: Robison (1984, 1986); Holmes & Narver, Inc. (written commun., 1986); Fenix & Scisson, Inc. (1986b, 1987c).

2. Well specifications:

   a. Location:
   Nevada State Central Zone Coordinates (feet): N 748,420; E 566,212.
   Latitude and longitude: 36°48'22" N.; 116°26'26" W.
   Site ID: 364822116262601.

   b. Land-surface altitude: 1,124.25 m (Holmes & Narver, Inc., February 3, 1984); 1,124.5 m (Robison, 1984); 1,124.0 m (Robison, 1986; based on survey by U.S. Geological Survey, 1984).

   c. Date well started: October 20, 1983.

   d. Date well completed: October 30, 1983.

   e. Drilling method: Rotary, using rock bits and air-foam circulating medium; attempt to obtain bottom-hole core unsuccessful.

   f. Bit diameter below water level: 222 mm (8 3/4 in.).

   g. Casing extending below water level: None [surface casing only, to a depth of 17 m (55 ft)].

   h. Total drilled depth: 443 m (1,453 ft).

   i. Description of access for measuring water levels, including tubes or piezometers: 62-mm (2.4-in.) inside-diameter tubing with 3.6-m-(12-ft) long well screen on bottom, extending from land surface to a depth of 419 m (1,376 ft); saturated interval of borehole within Prow Pass Member of Crater Flat Tuff.

   j. Description and altitude of reference point: Top of metal tag on well casing, 1,124.06 m (surveyed by U.S. Geological Survey, 1984).

   k. Depth correction for measured water levels because of borehole deviation from vertical (the correction is subtracted from measured depth to obtain true depth): 0.48 m, based on approximate depth to water of 395 m (1,296 ft).

3. History of instrumentation and water-level measurements, and comments:

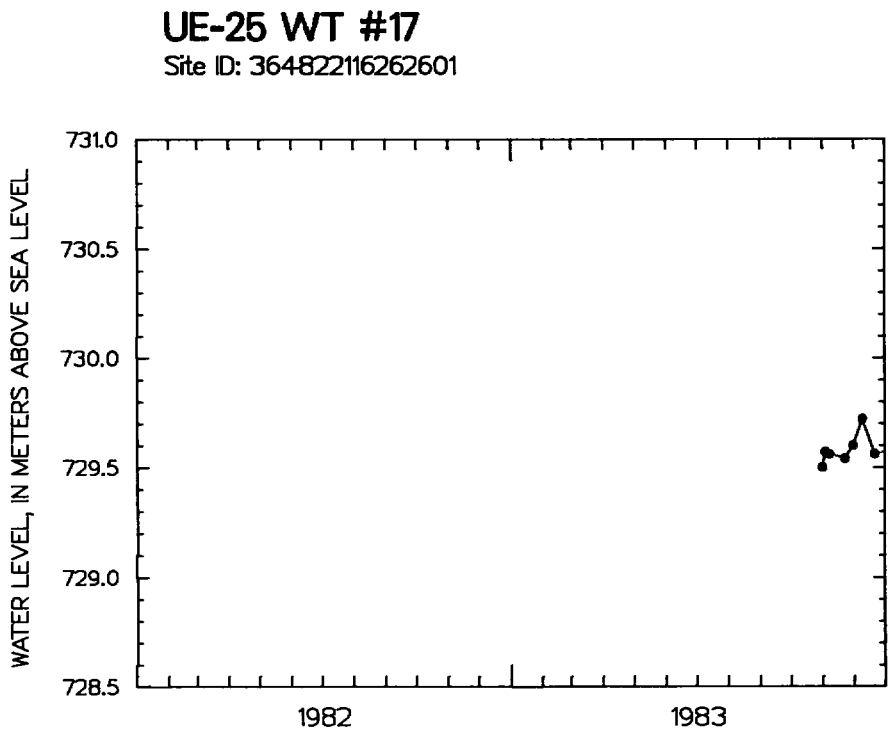
The water-level measurements were made with a four-conductor cable (logging van I-127410) from October 31, 1983, through April 11, 1985. Measurements were made with the 2,800-ft steel tape from June 12, 1985, through November 20, 1985, and with the 2,600-ft steel tape from January 27, 1986, through December 23, 1987. The apparent water-level rise of about 0.2 m in mid-1985 corresponded to a change in measuring equipment and probably was not an actual water-level change.

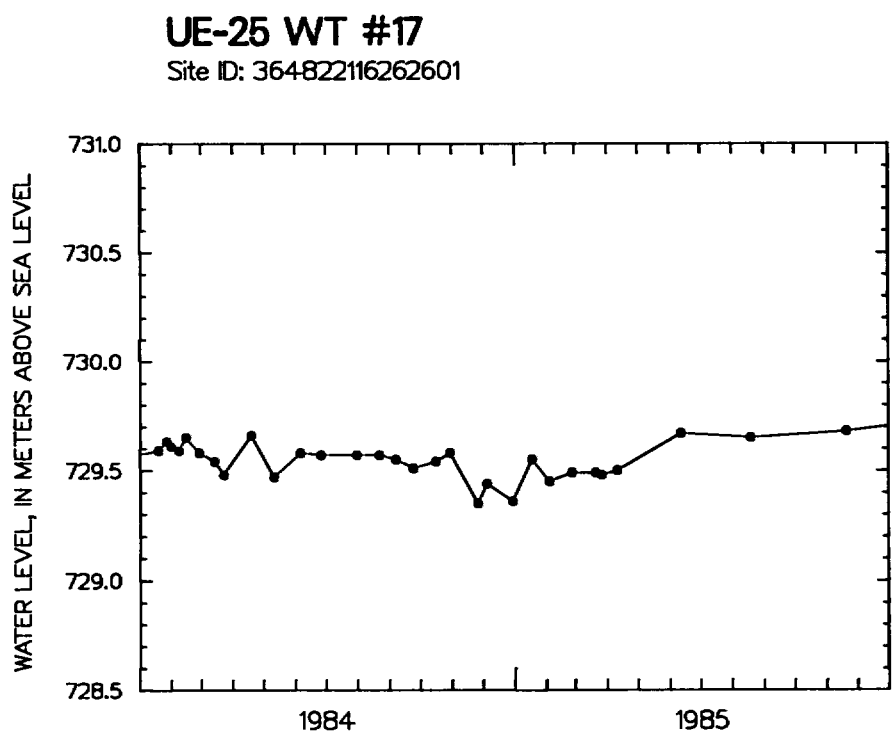
4. Periodic measurements of water-level altitude in well UE-25 WT #17:

Site ID: 364822116262601
Depth interval: 394-443 m (composite)

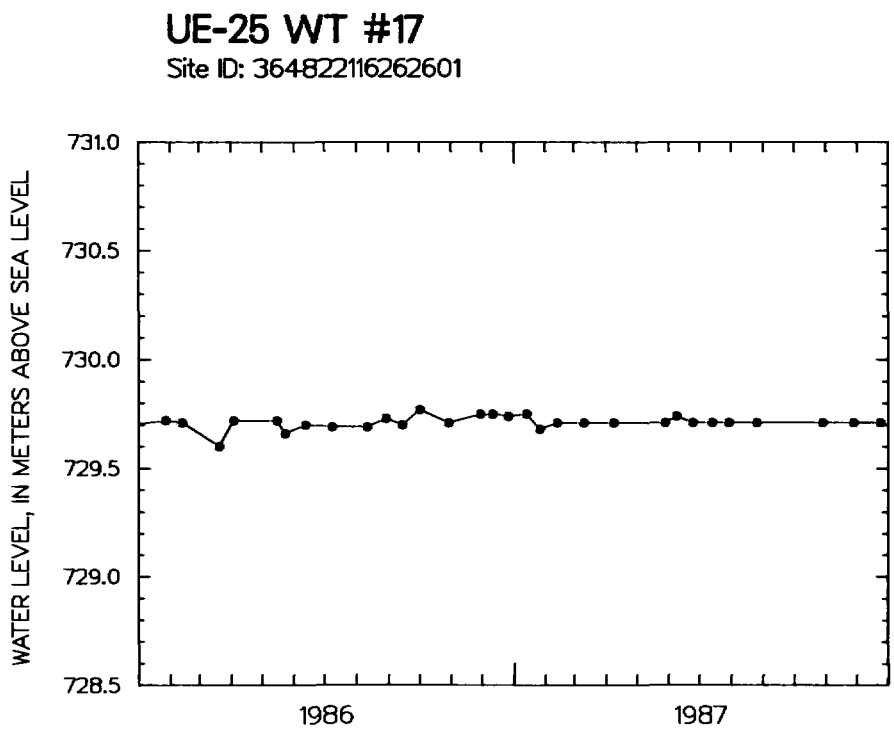
Date	Altitude (meters)	Date	Altitude (meters)
10-31-83	729.50	06-12-85	729.67
11-03-83	729.57	08-19-85	729.65
11-07-83	729.56	11-20-85	729.68
11-22-83	729.54	01-27-86	729.72
11-30-83	729.60	02-12-86	729.71
12-09-83	729.72	03-20-86	729.60
12-21-83	729.56	04-03-86	729.72
01-19-84	729.59	05-15-86	729.72
01-27-84	729.63	05-23-86	729.66
01-31-84	729.61	06-12-86	729.70
02-08-84	729.59	07-08-86	729.69
02-15-84	729.65	08-11-86	729.69
02-28-84	729.58	08-29-86	729.73
03-14-84	729.54	09-14-86	729.70
03-23-84	729.48	10-01-86	729.77
04-19-84	729.66	10-29-86	729.71
05-11-84	729.47	11-29-86	729.75
06-06-84	729.58	12-11-86	729.75
06-26-84	729.57	12-26-86	729.74
07-31-84	729.57	01-13-87	729.75
08-22-84	729.57	01-26-87	729.68
09-07-84	729.55	02-12-87	729.71
09-24-84	729.51	03-10-87	729.71
10-16-84	729.54	04-08-87	729.71
10-30-84	729.58	05-28-87	729.71
11-26-84	729.35	06-08-87	729.74
12-05-84	729.44	06-24-87	729.71
12-30-84	729.36	07-13-87	729.71
01-18-85	729.55	07-29-87	729.71
02-04-85	729.45	08-25-87	729.71
02-26-85	729.49	10-28-87	729.71
03-21-85	729.49	11-27-87	729.71
03-27-85	729.48	12-23-87	729.71
04-11-85	729.50		

5. Hydrographs of water-level altitude (plotted from data in section 4):





5. Hydrographs of water-level altitude (plotted from data in section 4) --Continued:



Geologic, Hydrologic, and Supply Wells

Well UE-25a #1

1. References or information sources: Spengler and others (1979); Robison (1984, 1986); Holmes & Narver, Inc. (written commun., 1986); Fenix & Scisson, Inc. (1986a, 1987c).

2. Well specifications:

   a. Location:
   Nevada State Central Zone Coordinates (feet): N 764,900; E 566,350.
   Latitude and longitude: 36°51'05" N.; 116°26'24" W.
   Site ID: 365105116262401.

   b. Land-surface altitude: 1,199.21 m (Holmes & Narver, Inc., January 24, 1980).

   c. Date well started: June 25, 1978.

   d. Date well completed: September 2, 1978.

   e. Drilling method: Cored, using bentonite and polymer mud, from 16 m (54 ft) to total depth; many drilling problems, both above and below the water table.

   f. Bit diameter below water level: 76 mm (2.98 in.) from 395 m (1,297 ft) to total depth.

   g. Casing extending below water level: NQ rods--50-mm (1.95-in.) inside-diameter from 0 to 747 m (0-2,450 ft); no perforations; casing may have been reworked or modified from the original specifications given here; borehole open to tuffaceous beds of Calico Hills and Prow Pass and Bullfrog Members of Crater Flat Tuff.

   h. Total drilled depth: 762 m (2,501 ft).

   i. Description of access for measuring water level, including tubes or piezometers: NQ rod, 50-mm (1.95-in.) inside-diameter.

   j. Description and altitude of reference point: Top of well casing, south side, 1,199.16 m (surveyed by U.S. Geological Survey, 1984). Note that this is slightly below the reported altitude of the land surface.

   k. Depth correction for measured water levels because of borehole deviation from vertical (the correction is subtracted from measured depth to obtain true depth): 1.7 m, based on approximate depth to water of 469 m (1,540 ft).

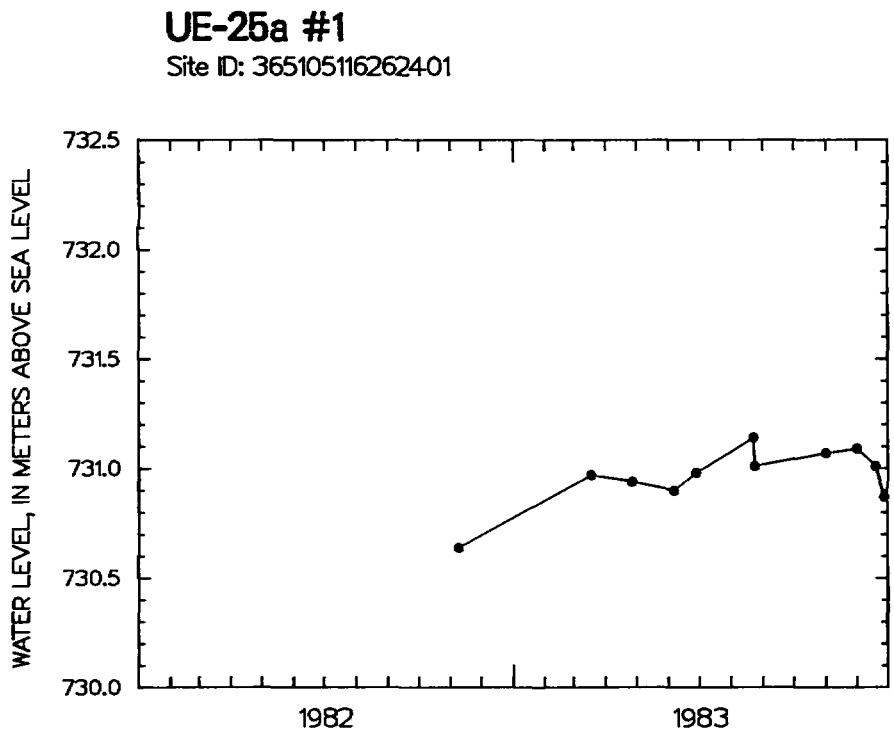
3. History of instrumentation and water-level measurements, and comments:
This well was measured nonroutinely. A measurement was made with a four-conductor cable (logging truck 81890) on November 9, 1982, and a water-level altitude of 730.66 m was calculated; a correction is not available for this measurement. Measurements were made March 18, 1983, through April 29, 1985, using a different four-conductor cable (logging van I-127410). The well has not been measured routinely since April 29, 1985, because: (1) The small diameter of the access casing, which appears to be kinked and have obstructions, has made measurements unsuccessful; and (2) the water-level altitude in well UE-25b #1 (about 100 m away) has been about the same.

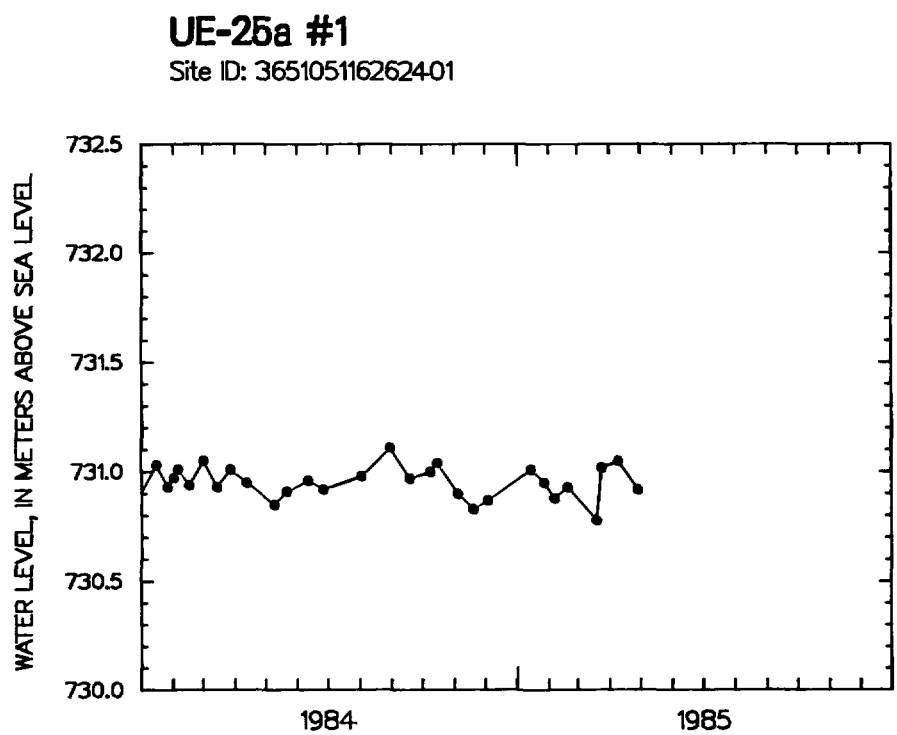
4. Periodic measurements of water-level altitude in well UE-25a #1:

Site ID: 365105116262401
Depth interval: 469-762 m (composite)

Date	Altitude (meters)	Date	Altitude (meters)
11-09-82	730.64	05-10-84	730.85
03-18-83	730.97	05-22-84	730.91
04-27-83	730.94	06-12-84	730.96
06-07-83	730.90	06-27-84	730.92
06-28-83	730.98	08-03-84	730.98
08-23-83	731.14	08-31-84	731.11
08-24-83	731.01	09-19-84	730.97
11-01-83	731.07	10-09-84	731.00
12-01-83	731.09	10-16-84	731.04
12-19-83	731.01	11-05-84	730.90
12-28-83	730.87	11-20-84	730.83
01-16-84	731.03	12-04-84	730.87
01-27-84	730.93	01-15-85	731.01
02-02-84	730.97	01-28-85	730.95
02-06-84	731.01	02-07-85	730.88
02-17-84	730.94	02-20-85	730.93
03-02-84	731.05	03-20-85	730.78
03-15-84	730.93	03-25-85	731.02
03-28-84	731.01	04-10-85	731.05
04-13-84	730.95	04-29-85	730.92

5. Hydrographs of water-level altitude (plotted from data in section 4):





Well UE-25b #1

1. References or information sources: Lobmeyer and others (1983); Lahoud and others (1984); Robison (1984, 1986); Holmes & Narver, Inc. (written commun., 1986); Fenix & Scisson, Inc. (1986c, 1987c).

2. Well specifications

   a. Location:
   Nevada State Central Zone Coordinates (feet): N 765,243; E 566,416.
   Latitude and longitude: 36°51'08" N.; 116°26'23" W.
   Site ID: 365108116262301.

   b. Land-surface altitude: 1,200.61 m (Holmes & Narver, March 4, 1984); 1,200.6 m (Robison, 1984); 1,200.7 m (Robison, 1986; based on survey by U.S. Geological Survey, 1984).

   c. Date well started: April 3, 1981.

   d. Date well completed: September 22, 1981.

   e. Drilling method: Rotary, using rock bits and air-foam circulating medium; cores obtained in selected intervals.

   f. Bit diameter below water level: 222 mm (8 3/4 in.) to 650 m (2,131 ft); 216 mm (8 1/2 in.) from 650 to 1,220 m (2,131-4,002 ft).

   g. Casing extending below water level: 226-mm (8.9-in.) inside diameter to 518 m (1,700 ft).

   h. Total drilled depth: 1,220 m (4,002 ft).

   i. Description of access for measuring water level, including tubes or piezometers:

      1. Tube, 48-mm (1.9-in.) inside diameter, open ended, to depth of about 488 m (1,600 ft); water-level response to upper interval of well, from near water table to top of inflatable packer (tuffaceous beds of Calico Hills, and Prow Pass, Bullfrog, and upper Tram Members of Crater Flat Tuff); Site ID: 365108116262303.

      2. Tube, 62-mm (2.4-in.) inside diameter, with inflatable packer on bottom end, to depth of 1,199 m (3,935 ft); water-level response to lower interval from below packer to bottom of well (lower Tram Member of Crater Flat Tuff and Lithic Ridge Tuff); Site ID: 365108116262302.

   j. Description and altitude of reference point: Top of metal tag on well casing, 1,200.73 m (surveyed by U.S. Geological Survey, 1984).

   k. Depth correction for measured water levels because of borehole deviation from vertical (the correction is subtracted from measured depth to obtain true depth): 0.27 m, based on depth to water of 470-472 m (1,542-1,548 ft).

3. History of instrumentation and water-level measurements, and comments:

   Measurements made through January 21, 1983, were composite water levels of the entire saturated portion of the well; the November 10, 1981, and December 9, 1981, measurements were made with a single-conductor cable

(Iron Horse 6), and the three measurements in 1982 were made with a four-conductor cable (logging truck 81890). Early in 1983, an inflatable packer was installed at a depth of 1,199 m, and water levels of the intervals above and below the packer were measured separately. During February through April 1983, water levels had not equilibrated after installation of the packer and the additional water in the access tube; therefore, the measurements during this period are not reported here. Measurements in 1983 of the two isolated intervals were made with a four-conductor cable (logging van I-127410).

This well was the first in the Yucca Mountain area for which continuous measurements were made beginning in October 1983 using downhole pressure transducers with a datalogger at the land surface. There were numerous equipment and operational difficulties, and the usable record through 1984 was intermittent.

4. Periodic measurements of water-level altitude in well UE-25b #1:

Site ID: 365108116262301
Depth interval: 471-1,220 m (composite)

Date	Altitude (meters)	Date	Altitude (meters)
11-10-81	730.09	11-09-82	730.34
12-09-81	730.71	12-30-82	730.17
09-24-82	730.54		

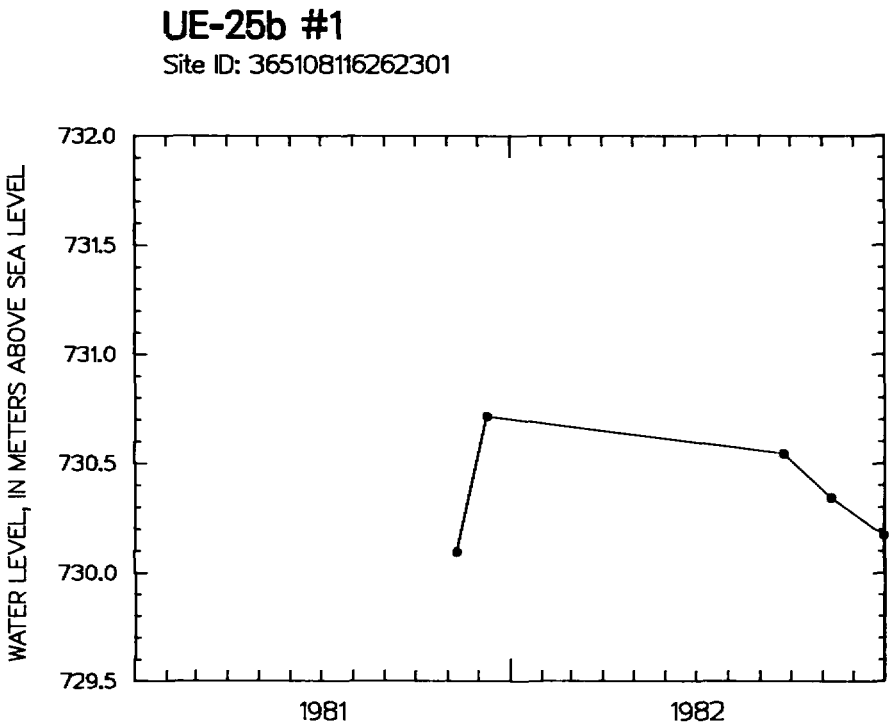
Site ID: 365108116262303
Depth interval: 471-1,199 m (upper)

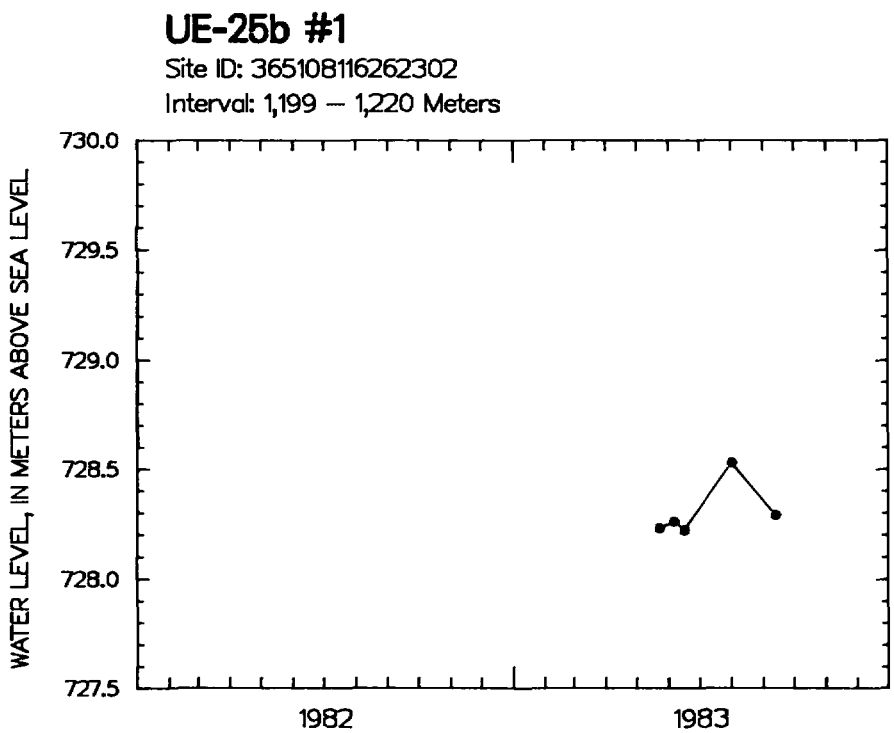
Date	Altitude (meters)	Date	Altitude (meters)
03-18-83	730.53	04-27-83	730.26
03-25-83	730.72	05-02-83	730.44
04-01-83	730.51	06-06-83	730.43
04-11-83	730.57	06-16-83	730.44
04-12-83	730.56	08-01-83	730.52

Site ID: 365108116262302
Depth interval: 1,199-1,220 m (lower)

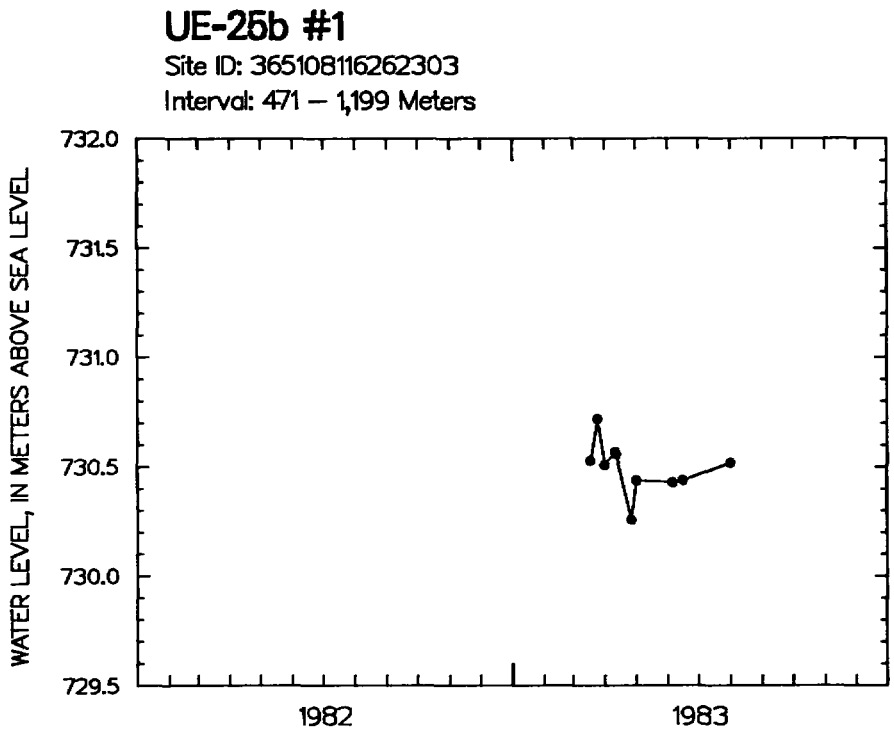
Date	Altitude (meters)	Date	Altitude (meters)
05-23-83	728.23	08-01-83	728.53
06-06-83	728.26	09-13-83	728.29
06-16-83	728.22		

5. Hydrographs of water-level altitude (plotted from data in section 4):





5. Hydrographs of water-level altitude (plotted from data in section 4) --Continued:



Well UE-25c #1

1. References or information sources: Robison (1984, 1986); Holmes & Narver, Inc. (written commun., 1986); Fenix & Scisson, Inc. (1986d, 1987c).

2. Well specifications:

   a. Location:
   Nevada State Central Zone Coordinates (feet): N 757,096; E 569,680.
   Latitude and longitude: 36°49'47" N.; 116°25'43" W.
   Site ID: 364947116254301.

   b. Land-surface altitude: 1,130.41 m (Holmes & Narver, Inc., December 7, 1983); 1,130.4 m (Robison, 1984); 1,130.6 m (Robison, 1986; based on survey by U.S. Geological Survey, 1984).

   c. Date well started: August 13, 1983.

   d. Date well completed: October 17, 1983.

   e. Drilling method: Rotary, using rock bits and air-foam circulating medium; cores obtained in selected intervals.

   f. Bit diameter below water level: 375 mm (14 3/4 in.) to 462 m (1,515 ft); 250 mm (9 7/8 in.) from 462 to 911 m (1,515-2,990 ft); 222 mm (8 3/4 in.) from 911 m (2,990 ft) to total depth.

   g. Casing extending below water level: 255-mm (10.05-in.) inside diameter to 416 m (1,365 ft); no perforations; borehole open to Topopah Spring Member of Paintbrush Tuff through Tram Member of Crater Flat Tuff.

   h. Total drilled depth: 914 m (3,000 ft).

   i. Description of access for measuring water levels, including tubes or piezometers:

      1. Tube, 48-mm (1.9-in.) inside diameter, open ended, to depth of about 744 m (2,440 ft); water-level response to upper interval from near water table to top of inflatable packer at 767 m (2,525 ft) in March 1984 and at 796 m (2,610 ft) beginning in October 1985 (tuffaceous beds of Calico Hills, and Prow Pass and upper Bullfrog Members of Crater Flat Tuff); Site ID: 364947116254303 and 364947116254305.

      2. Tube, 62-m (2.4-in.) inside diameter, with inflatable packer on bottom end, to depth of 767 m (2,515 ft) in March 1984, and 799 m (2,620 ft) beginning in October 1985 (lower Bullfrog Member in March 1984 and lower Bullfrog and upper Tram Members of Crater Flat Tuff beginning in October 1985); Site ID: 364947116254302 and 354947116254304.

   j. Description and altitude of reference point: Top of metal tag on well casing, 1,130.60 m (surveyed by U.S. Geological Survey, 1984).

   k. Depth correction for measured water levels because of borehole deviation from vertical (the correction is subtracted from measured depth to obtain true depth): 0.06 m, based on approximate depth to water of 400 m (1,312 ft).

3. History of instrumentation and water-level measurements, and comments:

This well, and nearby wells UE-25c #2 and #3, were drilled to determine hydraulic characteristics of fractured rocks in the vicinity of Yucca Mountain. Therefore, most tests and data collection have been configured for that purpose, and these wells have not been considered to be part of a general water-level observation network at Yucca Mountain. During much of history of these wells there have been inflatable packers installed in various intervals in the wells. However, it has been intermittently feasible to measure water levels in well UE-25c #1 that represent either the composite hydraulic head of the well or the hydraulic head of discrete intervals of the saturated zone for a period of time; such periodic measurements are reported below for October 25, 1983, through May 22, 1986. Measurements in 1983 and 1984 were made with a four-conductor cable (logging van I-127410); measurements in 1985 were made with the 2,800-ft steel tape, and measurements in 1986 were made with the 2,600-ft steel tape.

4. Periodic measurements of water-level altitudes in well UE-25c #1:

Site ID: 364947116254301
Depth interval: 401-914 m (composite)

Date	Altitude (meters)	Date	Altitude (meters)
10-25-83	730.46	01-30-84	730.48
11-07-83	730.51	02-07-84	730.42
11-29-83	730.45	02-13-84	730.48
12-07-83	730.35	03-02-84	730.36
12-19-83	730.41	04-02-84	730.37
01-05-84	730.50	04-11-84	730.27
01-23-84	730.38	04-20-84	729.96

Site ID: 364947116254303
Depth interval: 401-767 m (upper)

Date	Altitude (meters)
03-18-84	730.19

Site ID: 364947116254305
Depth interval: 401-796 m (upper)

Date	Altitude (meters)	Date	Altitude (meters)
10-24-85	730.21	04-24-86	730.28
12-03-85	729.91	05-22-86	730.21

4. Periodic measurements of water-level altitude in well UE-25c #1 --Continued:

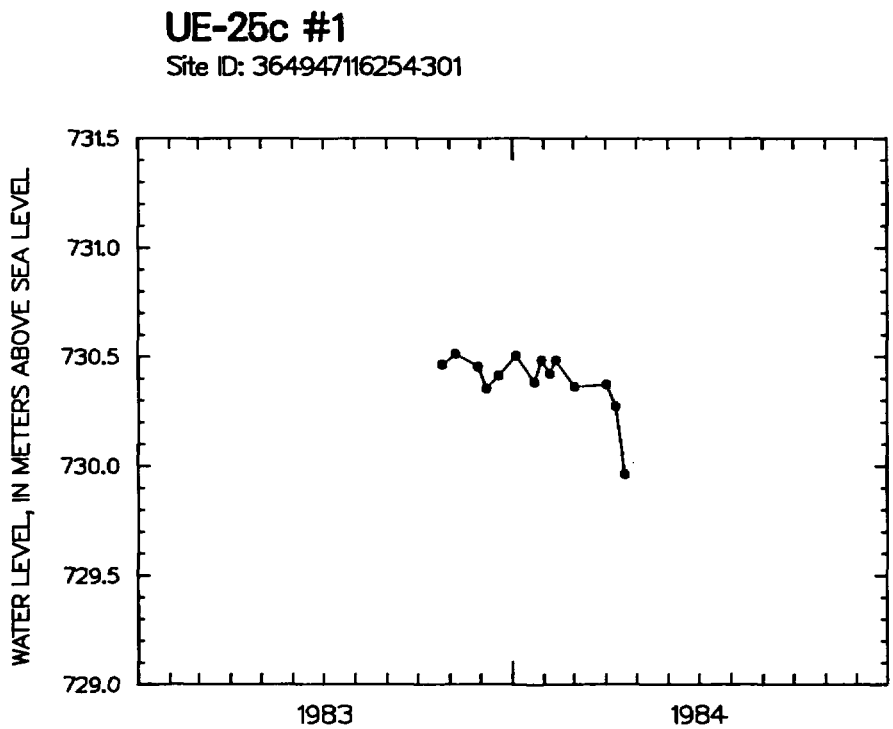
Site ID: 364947116254302
Depth interval: 767-914 m (lower)

Date	Altitude (meters)	Date	Altitude (meters)
03-07-84	730.41	03-18-84	730.45

Site ID: 364947116254304
Depth interval: 799-914 m (lower)

Date	Altitude (meters)	Date	Altitude (meters)
10-24-85	730.54	04-24-86	730.60
12-03-85	730.25	05-22-86	730.56

5. Hydrograph of water-level altitude (plotted from data in section 4):



Well UE-25p #1

1. References or information sources: Craig and Johnson (1984); Craig and Robison (1984); Robison (1984, 1986); Holmes & Narver, Inc. (written commun., 1986); Fenix & Scisson, Inc. (1986e, 1987c).

2. Well specifications:

   a. Location:
   Nevada State Central Zone Coordinates (feet): N 756,171; E 571,485.
   Latitude and longitude: 36°49'38" N.; 116°25'21" W.
   Site ID: 364938116252101.

   b. Land-surface altitude: 1,114 m (Robison, 1984); 1,114.2 m (Robison, 1986; based on survey by U.S. Geological Survey, 1984).

   c. Date well started: November 13, 1982.

   d. Date well completed: May 24, 1983.

   e. Drilling method: Rotary, using rock bits and air-foam circulating medium; selected cores obtained.

   f. Bit diameter below water level: 375 mm (14 3/4 in.) to 487 m (1,598 ft); 251 mm (9 7/8 in.) from 487 to 1,304 m (1,598-4,279 ft); 175 mm (6 7/8 in.) from 1,304 to 1,317 m (4,279-4,322 ft); 171 mm (6 3/4 in.) from 1,317 to 1,798 m (4,322-5,900 ft); 156 mm (6 1/8 in.) from 1,798 to 1,805 m (5,900-5,923 ft).

   g. Casing extending below water level: 255-mm (10.05-in.) inside diameter from land surface to 477 m (1,564 ft); 177-mm (6.97-in.) inside diameter from 453 to 1,297 m (1,487-4,256 ft); casing string is cemented in, has no perforations.

   h. Total drilled depth: 1,805 m (5,923 ft).

   i. Description of access for measuring water levels, including tubes or piezometers: 38-mm (1.5-in.) inside-diameter tubing, open end, to depth of 418 m (1,371 ft); well construction is such that hydraulic head of the tuffs of Tertiary age is not monitored. Only the hydraulic head in the underlying carbonate rocks of Paleozoic age is measured (Tertiary-Paleozoic contact is at 1,244 m, or 4,280 ft).

   Note: Also installed, to enable temperature measurements, was 38-mm (1.5-in.) inside-diameter tubing, closed end, and filled with water, to depth of 413 m (1,355 ft).

   j. Description and altitude of reference point: Top of metal tag on well casing, 1,114.21 m (surveyed by U.S. Geological Survey, 1984).

   k. Depth correction for measured water levels because of borehole deviation from vertical (the correction is subtracted from measured depth to obtain true depth): 0.06 m, based on approximate depth to water of 362 m (1,188 ft).

3. History of instrumentation and water-level measurements, and comments:

Water-level measurements were made as the well was drilled (February 1983 and May 1983); those measurements were reported by Robison (1984, 1986) but are not included here.

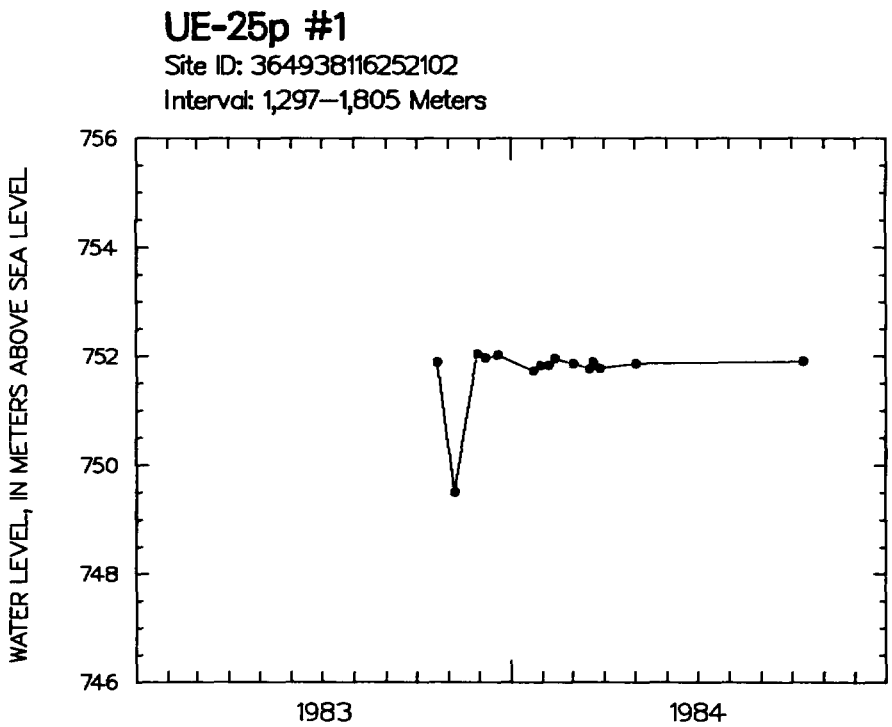
After initial completion and testing, periodic measurements were made from October 21, 1983, through October 12, 1984, using a four-conductor cable (logging van I-127410). The measurement on November 29, 1983, was about 2.4 m (8.0 ft) different from all other measurements. Although the water level reported here was consistent with log-book notes, there could have been a data recording error. Beginning in March 1985, the well has been monitored continuously using a downhole pressure transducer with a datalogger at the land surface.

4. Periodic measurements of water-level altitudes in well UE-25p #1:

Site ID: 364938116252102
Depth interval: 1,297-1,805 m (lower; Paleozoic)

Date	Altitude (meters)	Date	Altitude (meters)
10-21-83	751.89	02-13-84	751.96
11-07-83	749.51	03-02-84	751.86
11-29-83	752.04	03-18-84	751.77
12-07-83	751.97	03-21-84	751.89
12-19-83	752.02	03-28-84	751.78
01-23-84	751.73	05-02-84	751.87
01-30-84	751.83	10-12-84	751.91
02-07-84	751.84		

5. Hydrograph of water-level altitude (plotted from data in section 4):



Well USW G-2

1. References or information sources: Maldonado and Koether (1983); Robison (1984, 1986); Holmes & Narver, Inc. (written commun., 1986); Fenix & Scisson, Inc. (1987b,c).

2. Well specifications

   a. Location:
   Nevada State Central Zone Coordinates (feet) N 778,825; E 560,503.
   Latitude and longitude: 36°53'22" N.; 116°27'35" W.
   Site ID: 365322116273501.

   b. Land-surface altitude: 1,553.99 m (Holmes & Narver, Inc., March 1, 1982); 1,554.0 m (Robison, 1984); 1,553.9 m (Robison, 1986; based on survey by U.S. Geological Survey, 1984).

   c. Date well started: March 25, 1981.

   d. Date well completed: October 24, 1981.

   e. Drilling method: Rotary, using rock bits, with polymer mud as circulating medium to 88 m (290 ft); cored from 88 m to total depth. Complicated drilling history and many problems, with lost circulation and stuck drill tools.

   f. Bit diameter below water level: 222 mm (8 3/4 in.) from land surface to 814 m (2,670 ft); 159 mm (6 1/4 in.) from 814 to 947 m (2,670-3,107 ft); 156 mm (6 1/8 in.) from 947 to 1,439 m (3,107-4,720 ft); 76 mm (2.98 in.) from 1,439 to 1,831 m (4,720-6,006 ft).

   g. Casing extending below water level: None (surface casing, 320-mm inside diameter, 0-85 m, and 226-mm inside-diameter casing, 0-242 m)

   h. Total drilled depth: 1,831 m (6,006 ft).

   i. Description of access for measuring water levels, including tubes or piezometers: Originally installed were 41-mm (1.6-in.) inside-diameter tubing, closed end, from land surface to 1,826 m (5,991 ft), and 41-mm (1.6-in.) inside-diameter tubing, open end, from land surface to 840 m (2,756 ft). On July 12, 1982, the two strings were replaced with a single string of 41-mm (1.6-in.) inside-diameter tubing, closed end, from land surface 1,409 m (4,622 ft) with a perforated section from 607.5 to 617.5 m (1,993-2,026 ft); this string was removed on September 21, 1982. A 41-mm (1.6-in.) inside-diameter string with closed end was installed from land surface to a depth of 1,263 m (4,144 ft) on November 17, 1982.
   Saturated interval is within Topopah Spring Member of Paintbrush Tuff, tuffaceous beds of Calico Hills, Prow Pass, Bullfrog, and Tram Members of Crater Flat Tuff, Lithic Ridge Tuff, and older flows and tuffs.

   j. Description and altitude of reference point: Top of metal tag on well casing, 1,553.86 m (surveyed by U.S. Geological Survey, 1984).

   k. Depth correction for measured water levels because of borehole deviation from vertical (the correction is subtracted from measured depth to obtain true depth): 0.16 m, based on approximate depth to water of 525 m (1,722 ft).

3. History of instrumentation and water-level measurements, and comments:

The primary purpose for drilling this well was to obtain geologic rather than hydrologic information. Drilling conditions were difficult. The well had a complicated history, including sloughing, lost drilling tools, and other problems.

Periodic measurements were made November 10, 1981, through December 9, 1981, using a single-conductor cable (Iron Horse 6) with the original casing or tubing configuration (see no. 2, i, above). The water-level altitude at well USW G-2, which at the time was the only water level available for this part of Yucca Mountain, was considered possibly to be substantially and anomalously high. The well was cleaned out and reworked in September 1982. The water level, which was measured on September 17, 1982 (four-conductor cable, logging van I-127410) under the new tubing configuration (see no. 2, i, above), was only about 2 m different from the previous measurements, confirming a general water-level altitude of about 1,030 m in the vicinity of the well.

The present tubing configuration in the well does not permit additional water-level measurements.

4. Periodic measurements of water-level altitude in well USW G-2:

Site ID: 365322116273501
Depth interval: 525-1,831 m (composite)

Date	Altitude (meters)
11-10-81	1,031.82
11-30-81	1,031.16
12-09-82	1,030.98
09-17-82	1,028.84

Well USW G-3

1. References or information sources: Robison (1984, 1986); Holmes & Narver, Inc. (written commun., 1985); Fenix & Scisson, Inc. (1987b,c).

2. Well specifications:

   a. Location:
   Nevada State Central Zone Coordinates (feet): N 752,780; E 558,483.
   Latitude and longitude: 36°49'05" N.; 116°28'01" W.
   Site ID: 364905116280101.

   b. Land-surface altitude: 1,480.26 m (Holmes & Narver, Inc., January 10, 1984); 1,480.2 m (Robison, 1984); 1,480.6 m (Robison, 1986; based on survey by U.S. Geological Survey, 1984).

   c. Date well started: January 8, 1982.

   d. Date well completed: March 21, 1982.

   e. Drilling method: Rotary, using mostly air-foam, and occasional polymer added for circulating medium; many drilling problems encountered in upper part of hole, including lost circulation and lost or stuck tools; hole cored from 795 m (2,608 ft) to total depth.

   f. Bit diameter below water level: 222 mm (8 3/4 in.) from land surface to 792 m (2,600 ft); 121 mm (4 3/4 in.) from 792 to 795 m (2,608 ft); 100 mm (3.94 in.) from 795 m (2,608 ft) to total depth.

   g. Casing extending below water level: 126-mm (4.95-in.) inside diameter to 792 m (2,598 ft).

   h. Total drilled depth: 1,533 m (5,031 ft).

   i. Description of access for measuring water levels, including tubes or piezometers: Casing, 126-mm (4.95-in.) inside diameter.

   j. Description and altitude of reference point: Top of metal tag on well casing, 1,480.47 m (surveyed by U.S. Geological Survey, 1984).

   k. Depth correction for measured water levels because of borehole deviation from vertical (the correction is subtracted from measured depth to obtain true depth): 0.57 m, based on approximate depth to water of 750 m (2,460 ft).

3. History of instrumentation and water-level measurements, and comments:

This well was drilled primarily to obtain geologic rather than hydrologic information; however, water-level measurements were obtainable, and water-level altitude and fluctuation generally is similar to that of nearby well USW H-3.

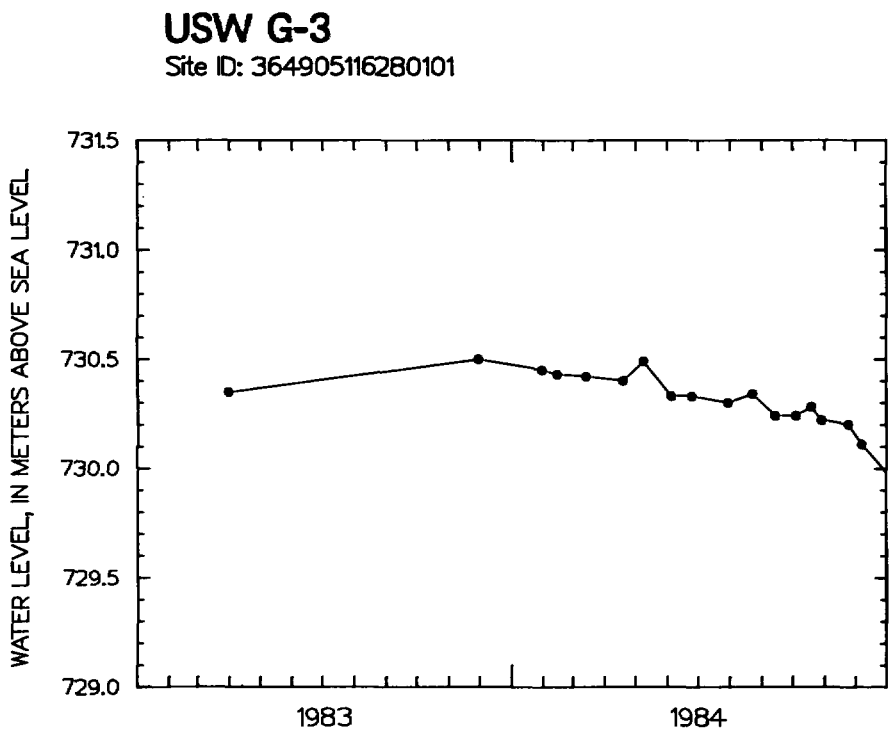
This hole was measured periodically, using a four-conductor cable (logging van I-127410) from December 22, 1982, through April 12, 1985. Subsequent measurements through 1985 were made with a 2,800-ft steel tape and measurements in 1986 were made with a 2,600-ft steel tape. Beginning in March 1986, the well has been monitored continuously using a downhole pressure transducer, with a datalogger at the land surface. The measurement reported for November 20, 1985, although consistent with the data recorded in the logbook, is about 0.5 m above the general trend of the water level. Whether this difference is real or a result of data-recording error could not be determined.

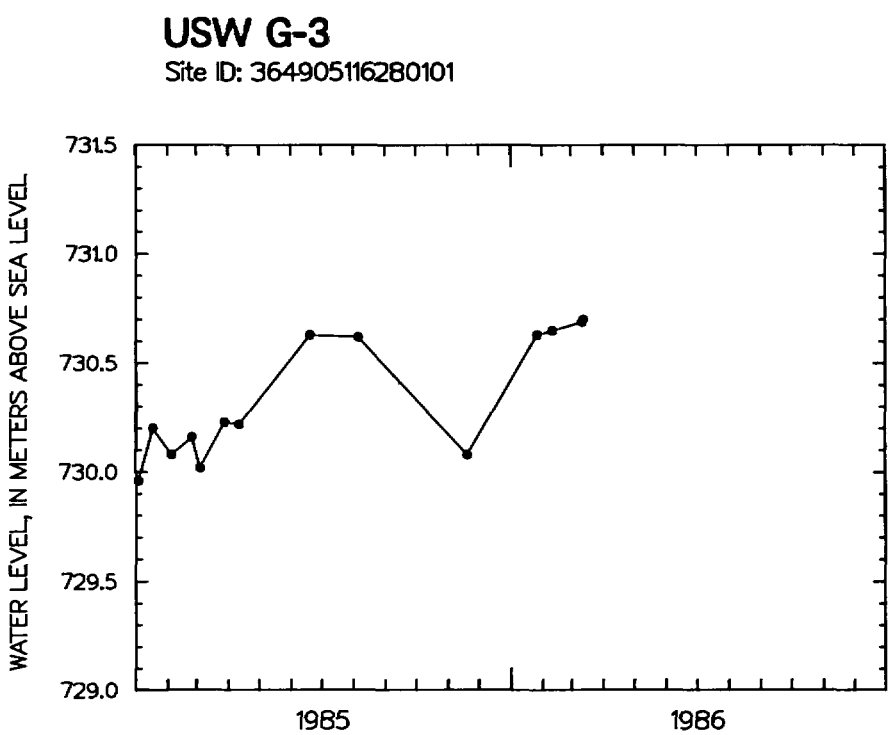
4. Periodic measurements of water-level altitude in well USW G-3:

Site ID: 364905116280101
Depth interval: 751-1,533 m (composite)

Date	Altitude (meters)	Date	Altitude (meters)
03-31-83	730.35	11-24-84	730.20
11-30-83	730.50	12-07-84	730.11
01-31-84	730.45	01-04-85	729.96
02-15-84	730.43	01-18-85	730.20
03-14-84	730.42	02-05-85	730.08
04-19-84	730.40	02-25-85	730.16
05-09-84	730.49	03-05-85	730.02
06-05-84	730.33	03-29-85	730.23
06-25-84	730.33	04-12-85	730.22
07-30-84	730.30	06-20-85	730.63
08-23-84	730.34	08-06-85	730.62
09-14-84	730.24	11-20-85	730.08
10-04-84	730.24	01-27-86	730.63
10-19-84	730.28	02-11-86	730.65
10-29-84	730.22	03-12-86	730.69
		03-13-86	730.70

5. Hydrographs of water-level altitude (plotted from data in section 4):





Well USW G-4

1. References or information sources: Bentley (1984); Lobmeyer (1987); Robison (1984, 1986); Holmes & Narver, Inc. (written commun., 1986); Fenix & Scisson, Inc. (1987b,c).

2. Well specifications:

   a. Location:
   Nevada State Central Zone Coordinates (feet): N 765,807; E 563,082.
   Latitude and longitude: 36°51'14" N.; 116°27'04" W.
   Site ID: 365114116270401.

   b. Land-surface altitude: 1,270.07 m (Holmes & Narver, Inc., March 18, 1985); 1,269.6 m (Robison, 1984); 1,269.6 m (Robison, 1986; based on survey by U.S. Geological Survey, 1984).

   c. Date well started: August 22, 1982.

   d. Date well completed: November 29, 1982.

   e. Drilling method: Continuous coring to total depth of 915 m (3,003 ft); followed by reaming to larger diameter by rotary method, using air-foam circulating medium.

   f. Bit diameter below water level: 311 mm (12 1/4 in.) from land surface to 615 m (2,018 ft); 222 mm (8 3/4 in.) from 614 m (2,018 ft) to total depth.

   g. Casing extending below water level: 226-mm (8.9-in.) inside diameter, to depth of 615 m (2,018 ft); casing perforated from 549 to 567 m (1,800-1,860 ft) and from 594 to 600 m (1,950-1,970 ft). Drilling difficulties in the interval between about 540 and 600 m required that this interval be cased in order to enable completion and to ensure stability of the borehole.

   h. Total drilling depth: 915 m (3,001 ft).

   i. Description of access for measuring water levels, including tubes or piezometers: Access tube, 38-mm (1.6-in.) inside diameter, open ended to depth of 575 m (1,886 ft).

   j. Description and altitude of reference point: Top of metal tag on well casing, 1,270.08 m (surveyed by U.S. Geological Survey, 1984).

   k. Depth correction for measured water levels because of borehole deviation from vertical (the correction is subtracted from measured depth to obtain true depth): 1.53 m, based on approximate depth to water of 540 m (1,772 ft).

3. History of instrumentation and water-level measurements, and comments:

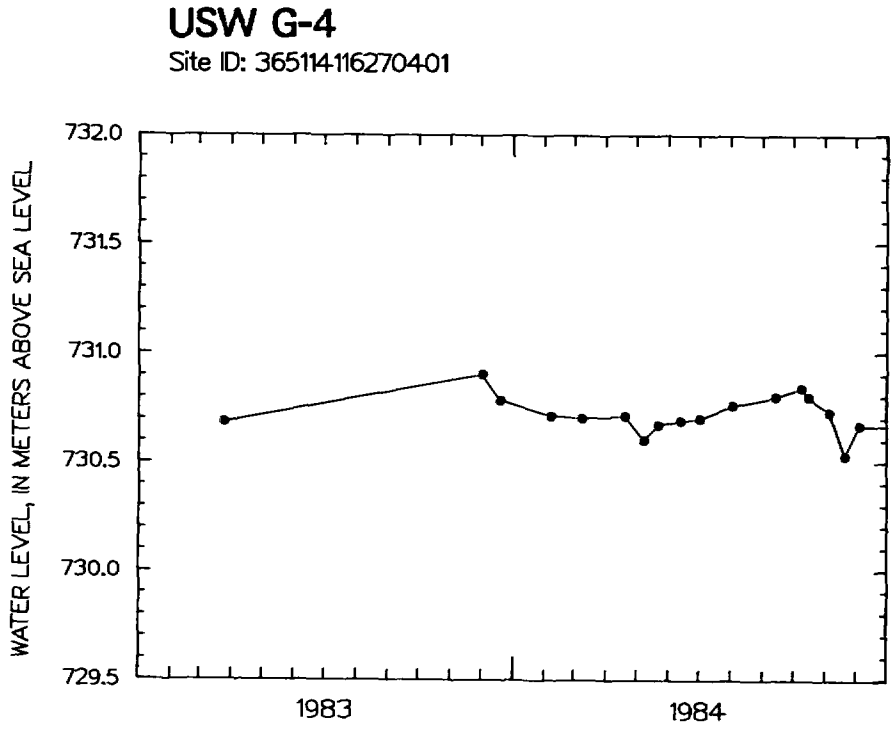
This well was drilled primarily to obtain geologic information, but before completion it was enlarged and modified to also obtain hydrologic information. This well was measured periodically, using a four-conductor cable (logging van I-127410) from March 25, 1983, through April 29, 1985. Subsequent measurements in 1985 were made with a 2,800-ft steel tape; the measurement in 1986 was made with the 2,600-ft steel tape. An obstruction in the access tube prevented further water-level measurements.

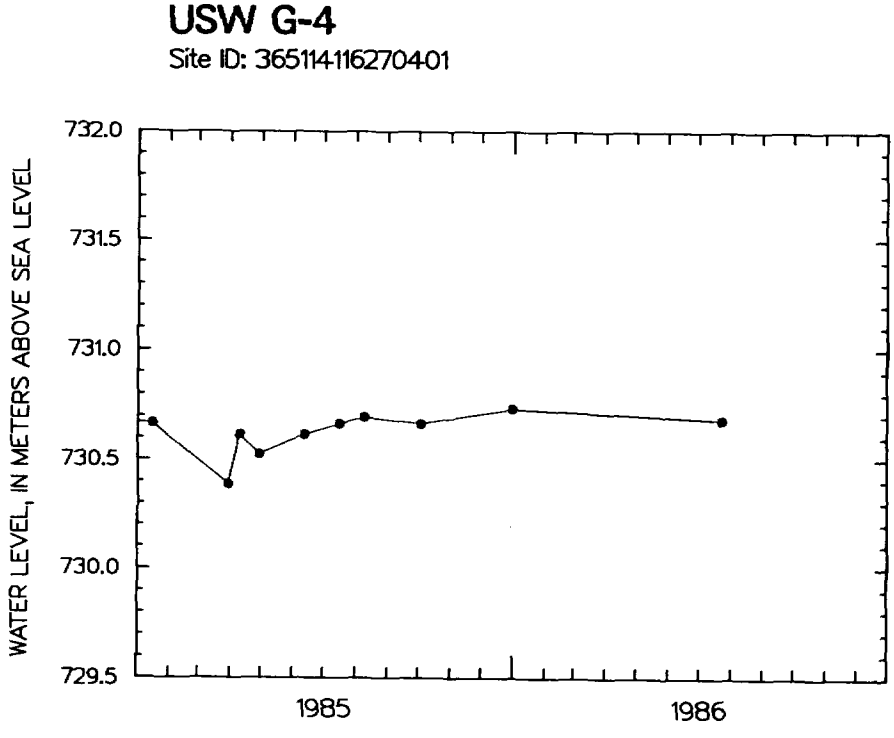
4. Periodic measurements of water-level altitude in well USW G-4:

Site ID: 365114116270401
Depth interval: 539-915 m (composite)

Date	Altitude (meters)	Date	Altitude (meters)
03-25-83	730.68	11-05-84	730.73
12-02-83	730.90	11-20-84	730.53
12-20-83	730.78	12-04-84	730.67
02-08-84	730.71	01-15-85	730.66
03-09-84	730.70	03-30-85	730.38
04-20-84	730.71	04-10-85	730.61
05-08-84	730.60	04-29-85	730.52
05-22-84	730.67	06-12-85	730.61
06-13-84	730.69	07-16-85	730.66
07-02-84	730.70	08-09-85	730.69
08-03-84	730.76	10-03-85	730.66
09-14-84	730.80	12-31-85	730.73
10-09-84	730.84	07-23-86	730.68
10-16-84	730.80		

5. Hydrographs of water-level altitude (plotted from data in section 4):





Well USW H-1

1. References or information sources: Rush and others (1983); Rush and others (1984); Robison (1984, 1986); Holmes & Narver, Inc. (written commun., 1986); Fenix & Scisson, Inc. (1987a,c).

2. Well specifications:

   a. Location:
   Nevada State Central Zone Coordinates (feet): N 770,254; E 562,388.
   Latitude and longitude: 36°51'57" N.; 116°27'12" W.
   Site ID: 365157116271201.

   b. Land-surface altitude: 1,302.84 m (Holmes & Narver, Inc., March 26, 1981); 1,302.2 m (Robison, 1984); 1,303.0 m (Robison, 1986; based on survey by U.S. Geological Survey, 1984).

   c. Date well started: September 30, 1980.

   d. Date well completed: January 25, 1981 (initial completion, including geophysical logging and hydraulic testing); July 6, 1982 (recompletion; four piezometers installed).

   e. Drilling method: Rotary, using rock bits and air-foam circulating medium; cores obtained in selected intervals.

   f. Bit diameter below water level: 222 mm (8 3/4 in.).

   g. Casing extending below water level: 226-mm (8.9-in.) inside diameter to 687 m (2,255 ft).

   h. Total drilled depth: 1,829 m (6,000 ft).

   i. Description of access for measuring water levels, including tubes or piezometers:

      1. Tube, 1--44-mm (1.75-in.) inside diameter, with 3.6-m- (12-ft) long well screen on bottom, to depth of 1,806 m (5,925 ft); responds to depth interval from 1,783 to 1,814 m (older flows and tuffs); Site ID: 365157116271202.

      2. Tube, 2--44 mm (1.75-in.) inside diameter, with 3.6-m- (12-ft) long well screen on bottom, to depth of 1,115 m (3,657 ft); responds to depth interval from 1,097 to 1,123 m (Tram Member of Crater Flat Tuff); Site ID: 365157116271203.

      3. Tube, 3--44-mm (1.75-in.) inside diameter, with 3.6-m- (12-ft) long well screen on bottom, to depth of 741 m (2,431 ft); responds to depth interval from 716 to 765 m (Bullfrog Member of Crater Flat Tuff); Site ID: 365157116271204.

      4. Tube, 4--62-mm (2.4-in.) inside diameter, open ended, to depth of 640 m (2,100 ft); responds to depth interval from 572 to 673 m (Prow Pass Member of Crater Flat Tuff); Site ID: 365157116271205.

      Note: During recompletion, a gravel pack was placed in the vicinity of the well screens for tubes 1, 2, and 3, and other intervals were grouted with cement to ensure that the piezometers are isolated hydraulically from each other.

j. Description and altitude of reference point: Top of metal tag on well casing, 1,303.10 m (surveyed by U.S. Geological Survey, 1984).

k. Depth correction for measured water levels because of borehole deviation from vertical (the correction is subtracted from measured depth to obtain true depth):

1. 0.14 m in tube 1, based on approximate depth to water of 517.6 m (1,698 ft).

2. 0.17 m in tubes 2, 3, and 4, based on approximate depths to water of 571.5 to 572.4 m (1,875-1,878 ft).

3. History of instrumentation and water-level measurements, and comments:

This well was drilled, completed, and tested in order to determine hydrologic characteristics of the formation. The water levels measured in 1981 and in the first one-half of 1982 represent a composite hydraulic head in Robison (1984, 1986) for open-hole conditions, from the water table to total hole depth. The measurement was made with a single-conductor cable (Iron Horse 6).

The well was recompleted as a piezometer nest July 1982. Hourly observations in the four piezometers were made from March to June 1983 using semi-permanently installed, downhole pressure transducers. The transducer signal, in millivolts, was recorded on paper tape with a data logger, but those data have not been converted to water levels. Check measurements in each of the piezometers were made (four-conductor cable, logging van I-127410) on March 2, 1983, or March 8, 1983, and on June 14, 1983.

There were numerous reliability and other operational problems with the recording equipment as well as with the pressure transducers; therefore, no hourly data were recorded between June 1983 and January 5, 1984. During 1984, periodic measurements of water levels were made using the four-conductor cable (logging van I-127410).

In February 1985, a datalogger was installed that stores data electronically. Except for periods of equipment malfunction, there has been continuous monitoring of the output signal from the transducer in each piezometer since February 1985.

4. Periodic measurements of water-level altitude in well USW H-1:

Site ID: 365157116271205
Depth interval: 573-673 m (tube 4)

Date	Altitude (meters)	Date	Altitude (meters)
07-08-82	730.12	09-28-83	730.74
07-15-82	730.25	10-13-83	730.67
07-23-82	730.20	11-01-83	730.62
08-09-82	730.18	11-23-83	730.58
08-18-82	730.08	12-02-83	730.78
08-27-82	730.18	12-20-83	730.62
09-10-82	730.56	01-05-84	730.69
09-17-82	730.40	01-17-84	730.50
09-24-82	730.41	01-25-84	730.63
10-01-82	730.40	02-01-84	730.69
10-29-82	730.28	02-06-84	730.62
11-19-82	730.47	02-14-84	730.64
11-26-82	730.36	02-23-84	730.65
12-10-82	729.90	03-06-84	730.61
12-17-82	730.01	03-30-84	730.48
12-22-82	729.98	04-27-84	730.58
12-30-82	729.98	05-10-84	730.68
01-21-83	729.75	05-25-84	730.53
02-24-83	730.76	06-14-84	730.51
03-02-83	730.64	06-29-84	730.48
03-12-83	730.54	08-01-84	730.52
06-14-83	730.59	08-11-84	730.59
06-24-83	730.46	11-17-84	730.40
07-06-83	730.55	12-11-84	730.48
09-07-83	730.77	12-13-84	730.60
09-13-83	730.75		

4. Periodic measurements of water-level altitude in well USW H-1 --Continued:

Site ID: 365157116271204
Depth interval: 716-765 m (tube 3)

Date	Altitude (meters)	Date	Altitude (meters)
07-08-82	729.94	09-07-83	730.64
07-15-82	729.98	09-13-83	730.47
07-23-82	729.88	09-28-83	730.63
08-09-82	730.02	10-13-83	730.70
08-18-82	730.12	11-01-83	730.65
08-27-82	729.90	11-23-83	730.53
09-10-82	730.30	12-02-83	730.57
09-17-82	730.03	12-20-83	730.61
09-24-82	730.17	01-05-84	730.35
10-01-82	730.06	01-17-84	730.32
10-29-82	730.09	01-25-84	730.43
11-19-82	730.15	02-01-84	730.57
11-26-82	730.07	02-06-84	730.44
12-10-82	729.57	02-14-84	730.48
12-17-82	729.70	02-23-84	730.49
12-22-82	729.72	03-06-84	730.29
12-30-82	729.64	03-30-84	730.26
01-21-83	729.54	04-27-84	730.19
02-24-83	730.52	05-10-84	730.43
03-02-83	730.41	05-25-84	730.39
03-08-83	730.24	06-14-84	730.34
03-10-83	730.50	06-29-84	730.27
03-12-83	730.37	08-01-84	730.23
06-15-83	730.36	08-11-84	730.24
06-24-83	730.45	11-17-84	730.17
07-05-83	730.35	12-01-84	730.27

4. Periodic measurements of water-level altitude in well USW H-1 --Continued:

Site ID: 365157116271203
Depth interval: 1,097-1,123 m (tube 2)

Date	Altitude (meters)	Date	Altitude (meters)
07-08-82	721.62	10-13-83	731.40
07-15-82	726.60	11-01-83	731.30
07-23-82	728.52	11-23-83	731.25
08-09-82	730.35	12-02-83	731.29
08-18-82	730.77	12-20-83	731.34
08-27-82	731.33	01-05-84	731.28
09-10-82	732.41	01-17-84	731.26
09-17-82	732.80	01-25-84	731.21
09-24-82	733.22	02-01-84	731.26
10-01-82	733.48	02-06-84	731.21
10-29-82	734.14	02-14-84	731.23
11-19-82	734.59	02-23-84	731.16
11-26-82	734.67	03-06-84	731.13
12-10-82	733.95	03-30-84	731.20
12-17-82	733.93	04-27-84	731.22
12-22-82	733.55	05-10-84	731.22
12-30-82	733.43	05-25-84	731.27
01-21-83	733.36	06-14-84	731.22
02-24-83	734.42	06-29-84	731.24
03-08-83	734.27	08-01-84	731.17
06-15-83	731.10	08-11-84	731.19
06-24-83	731.07	11-17-84	734.16
07-06-83	731.13	12-13-84	732.64
09-07-83	731.46	12-21-84	732.81
09-13-83	731.28	08-26-85	736.26
09-28-83	731.28		

4. Periodic measurements of water-level altitude in well USW H-1 --Continued:

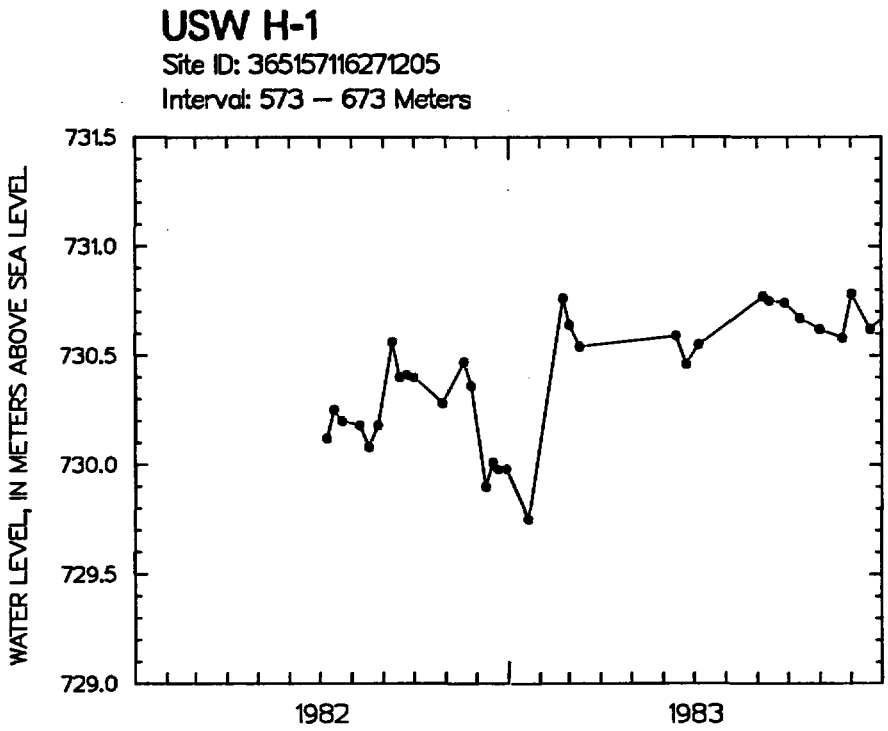
Site ID: 365157116271202
Depth interval: 1,783-1,814 m (tube 1)

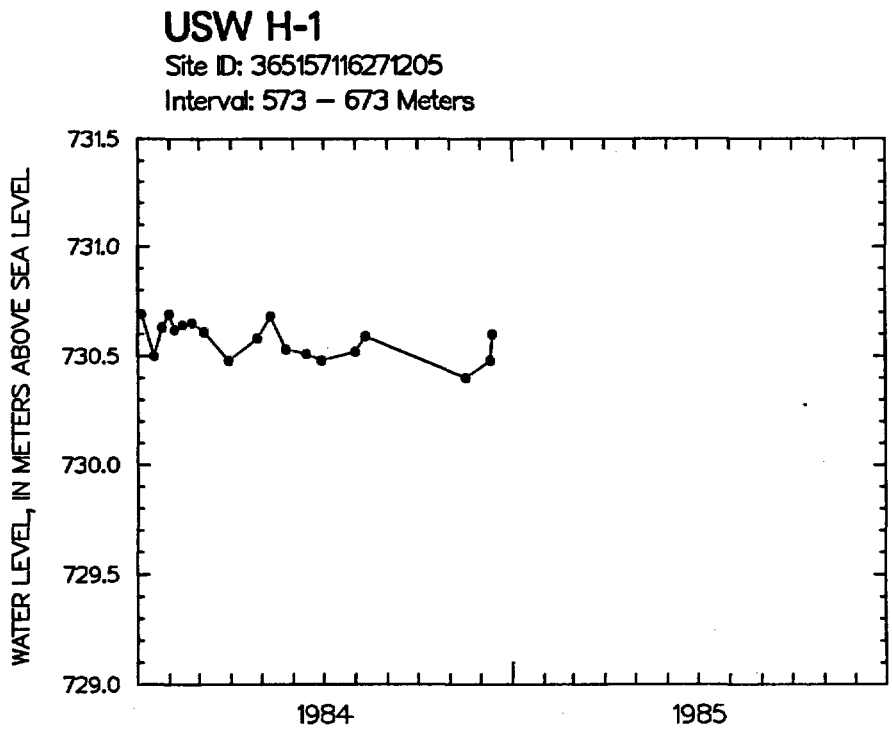
Date	Altitude (meters)	Date	Altitude (meters)
07-08-82	771.42	09-13-83	784.69
07-15-82	775.61	09-28-83	784.75
07-23-82	777.39	10-13-83	784.79
08-09-82	779.34	11-01-83	784.79
08-18-82	779.86	11-23-83	784.82
08-27-82	780.26	12-02-83	784.89
09-10-82	781.02	12-20-83	784.93
09-17-82	781.28	01-05-84	784.87
09-24-82	781.42	01-17-84	784.84
10-01-82	781.65	01-25-84	784.87
10-29-82	782.01	02-01-84	785.01
11-19-82	782.44	02-06-84	784.93
11-26-82	782.59	02-14-84	784.98
12-10-82	782.70	02-23-84	784.90
12-17-82	782.81	03-06-84	784.96
12-22-82	782.77	03-30-84	784.93
12-30-82	782.86	04-27-84	784.93
01-21-83	782.91	05-10-84	785.03
02-24-83	783.98	05-25-84	785.08
03-08-83	783.44	06-14-84	785.00
06-14-83	784.05	06-29-84	785.05
06-24-83	784.33	08-01-84	785.06
07-06-83	784.39	08-11-84	785.00
09-07-83	784.85	11-16-84	785.09

Site ID: 365157116271201
Depth interval: 573-1,829 m (composite)

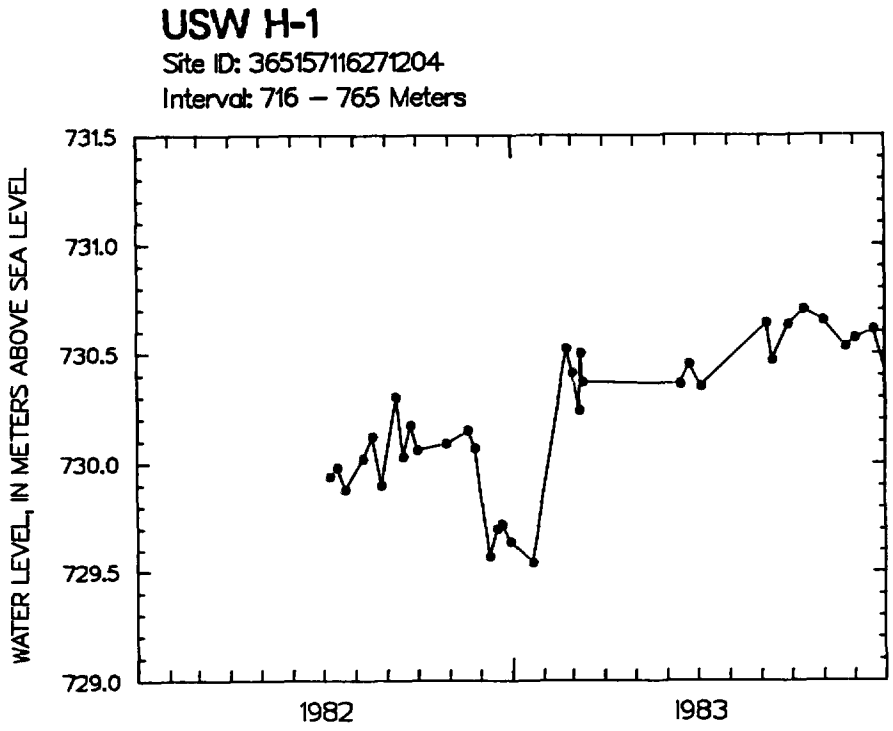
Date	Altitude (meters)	Date	Altitude (meters)
02-26-81	730.83	12-09-81	731.23
05-31-81	730.83	02-25-82	730.95
10-09-81	731.25	06-24-82	731.25
11-10-81	730.80		

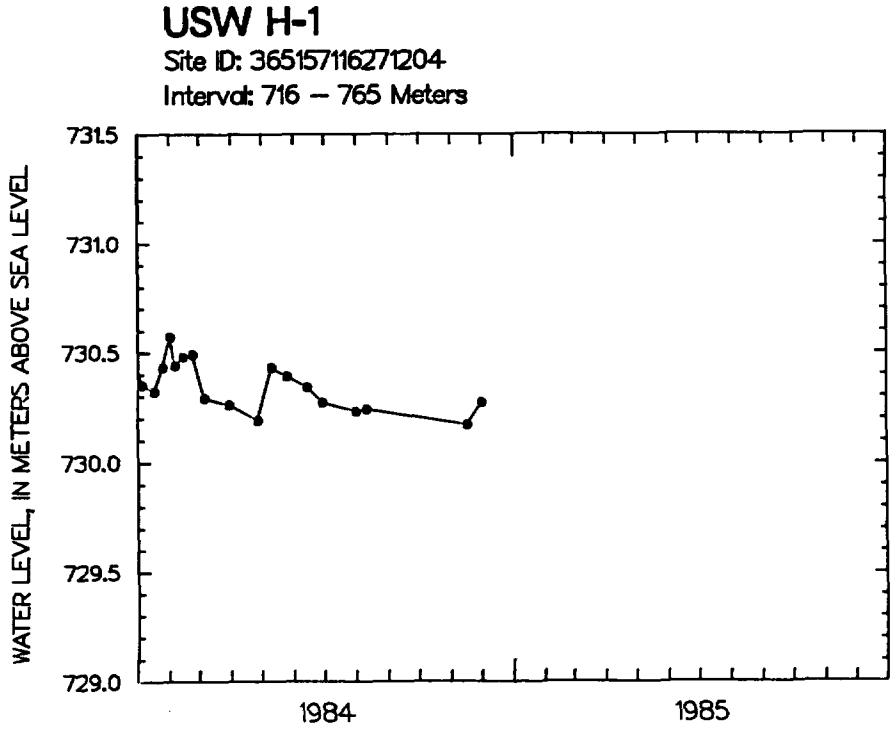
5. Hydrographs of water-level altitude (plotted from data in section 4):



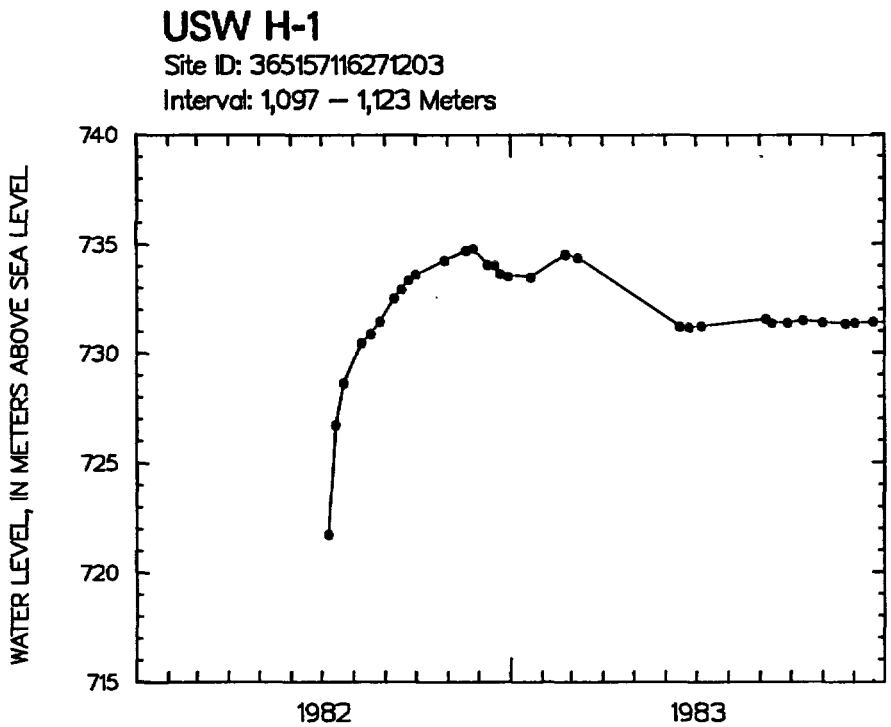


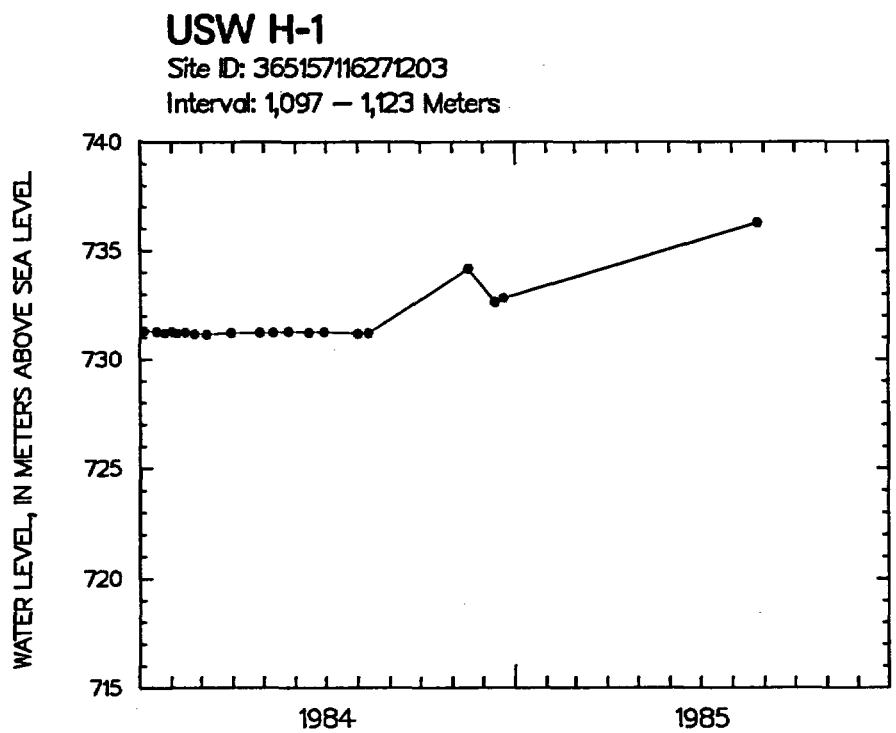
5. Hydrographs of water-level altitude (plotted from data in section 4) --Continued:



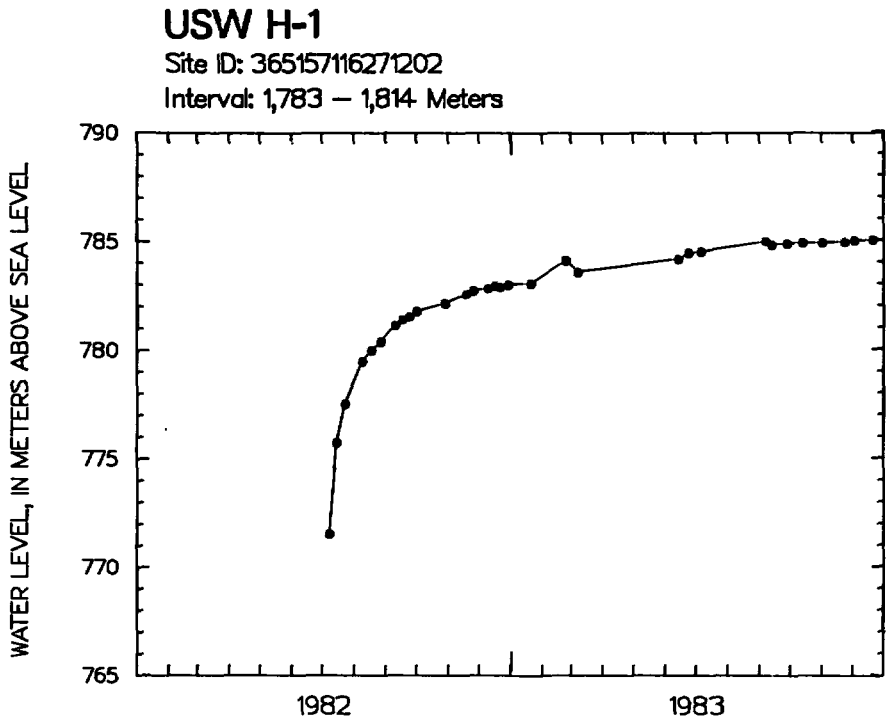


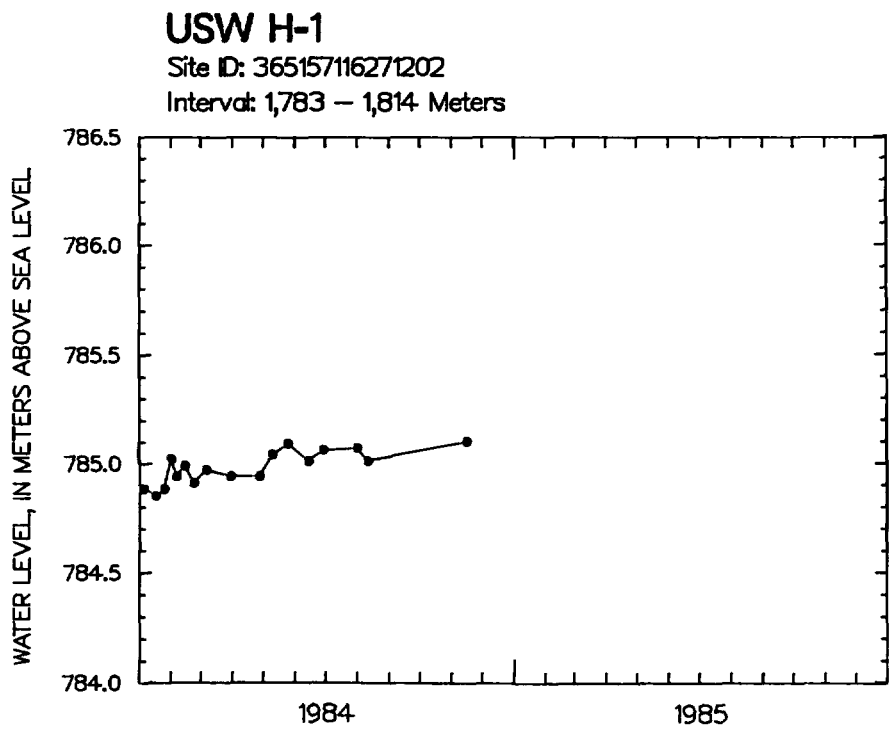
5. Hydrographs of water-level altitude (plotted from data in section 4) --Continued:



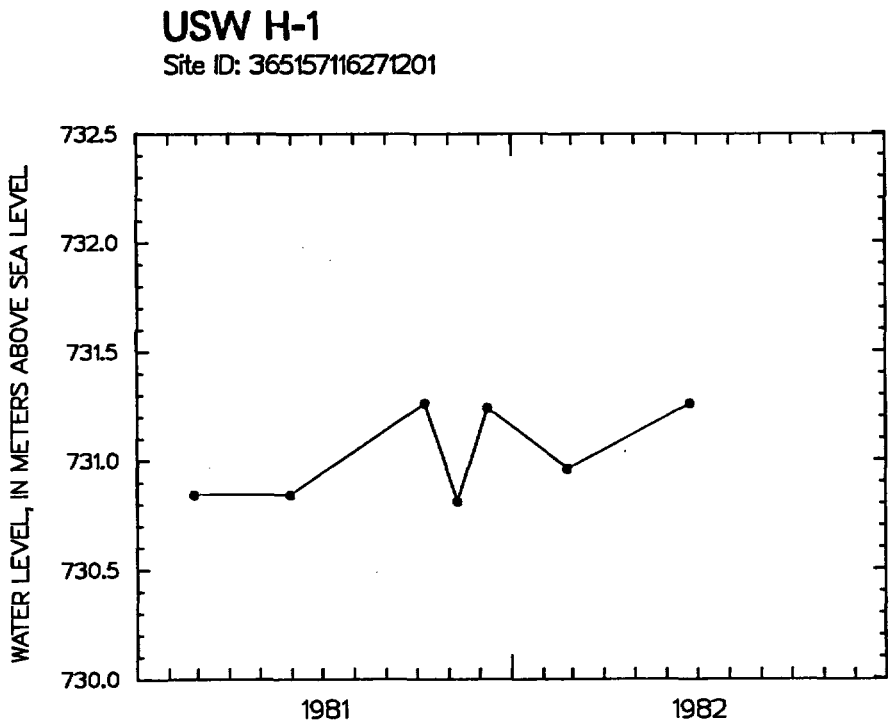


5. Hydrographs of water-level altitude (plotted from data in section 4) --Continued:





5. Hydrographs of water-level altitude (plotted from data in section 4) --Continued:



Well USW H-3

1. References or information sources: Thordarson and others (1984a,b); Robison (1984, 1986); Holmes & Narver, Inc. (written commun., 1986); Fenix & Scisson, Inc. (1987a,c).

2. Well specifications:

   a. Location:
   Nevada State Central Zone Coordinates (feet): N 756,542; E 558,452.
   Latitude and longitude: 36°49'42" N.; 116°28'00" W.
   Site ID: 364942116280001.

   b. Land-surface altitude: 1,483.28 m (Holmes & Narver, Inc., March 31, 1982); 1,483.2 m (Robison, 1984); 1,483.3 m (Robison, 1986; based on survey by U.S. Geological Survey, 1984).

   c. Date well started: January 27, 1982.

   d. Date well completed: March 19, 1982.

   e. Drilling method: Rotary, using rock bits and air, soap circulating medium.

   f. Bit diameter below water level: 375 mm (14 3/4 in.) from land surface to 808 m (2,650 ft); 222 m (8 3/4 in.) from 808 m (2,650 ft) to total depth.

   g. Casing extending below water level: 25.3-mm (10-in.) inside diameter to 792 m (2,600 ft); bottom 10 m tack cemented; no perforations.

   h. Total drilled depth: 1,219 m (4,000 ft).

   i. Description of access for measuring water levels, including tubes or piezometers:

      1. Tube, 41-mm (1.6-in.) inside diameter, open ended, to depth of about 762 m (2,500 ft); water-level response to upper interval of well, from near water table, to top of inflatable packer (Tram Member of Crater Flat Tuff); Site ID: 364942116280002 and 36494211628004.

      2. Tube, 62-mm (2.4-in.) inside diameter, with inflatable packer on bottom end; water-level response to lower interval from below packer to bottom of well (Lithic Ridge Tuff); Site ID: 364942116280003 and 364942116280005.

      3. Inflatable packer, referred to in 1 and 2, above, installed January 1983 at a depth of 1,190 m (3,905 ft); removed late November 1983 during period of additional hydraulic testing; reinstalled in May 1984 at depth of 1,114 m (3,655 ft).

   j. Description and altitude of reference point: Top of metal tag on well casing, 1,483.47 m (surveyed by U.S. Geological Survey, 1984).

   k. Depth correction for measured water levels because of borehole deviation from vertical (the correction is subtracted from measured depth to obtain true depth): 0.08 m, based on approximate depth to water of 752 m (2,467 ft).

3. History of instrumentation and water-level measurements, and comments:

After initial completion and testing, three periodic measurements were made in 1982 using a four-conductor cable (logging van I-127410). The measurements represent the composite hydraulic head of all the saturated intervals open to the well.

An inflatable packer was installed in January 1983 (see i, no. 3, above). Periodic measurements were made in 1983 using a four-conductor cable (logging van I-27410) in two depth intervals: From the water table to 1,190 m (3,905 ft), and from 1,190 m (3,905 ft) to total depth of 1,219 m (4,000 ft).

A water-level decline of about 5 m in 6 months in the lower interval (1,190-1,219 m, or 3,905-4,000 ft) was the result of slow equilibration of the well after installation of the packer. Water-level measurements made in the interval from March 14, 1983, to July 9, 1983, indicated a very slow downward trend. It was concluded the water level might take a considerable length of time to equilibrate with the hydraulic head in the formation, given the apparently minimal permeability of the interval indicated by the hydraulic tests (Thordarson and others, 1984b). The interval below the packer was pressurized on August 8, 1983, in an attempt to speed equilibration. Water levels measured from August 31 through November 21, 1983, had small fluctuations, indicating that the water level had stabilized.

During late November 1983, the packer was removed during a period of additional hydraulic testing continuing into March 1984. During this period, three additional measurements of the hydraulic head were made. In May 1984, the packer was reinstalled at a shallower depth of 1,114 m in order to isolate a more permeable zone. Periodic measurements of the two new depth intervals were made from June 5, 1984, through April 12, 1985, using the four-conductor cable (logging van I-127410). Measurements made from June 13, 1985, through October 15, 1985, were made with a 2,800-ft steel tape. Water levels in the new lower interval from 1,114 to 1,219 m (3,655-4,000 ft) were about 41 m (135 ft) higher than in the overlying interval. Pressure transducers were installed, and continuous monitoring with a datalogger at land surface was begun in October 1985.

4. Periodic measurements of water-level altitudes in well USW H-3:

Site ID: 364942116280001
Depth interval: 752-1,219 m (composite)

Date	Altitude (meters)	Date	Altitude (meters)
09-10-82	732.98	12-15-83	731.19
10-05-82	732.90	04-19-84	731.50
11-19-82	732.71	05-18-84	731.35

4. Periodic measurements of water-level altitudes--Continued:

Site ID: 364942116280002
Depth interval: 752-1,190 m (upper)

Date	Altitude (meters)	Date	Altitude (meters)
03-14-83	732.74	07-09-83	732.75
03-24-83	732.90	08-31-83	733.08
03-31-83	732.81	09-14-83	732.87
04-07-83	732.89	09-22-83	732.84
04-13-83	732.79	10-19-83	732.86
04-26-83	732.63	11-03-83	732.88
06-08-83	732.97	11-21-83	732.87
06-25-83	732.70		

Site ID: 364942116280004
Depth interval: 752-1,114 m (upper)

Date	Altitude (meters)	Date	Altitude (meters)
06-05-84	731.43	01-04-85	731.22
06-13-84	731.36	01-19-85	731.16
06-20-84	731.36	02-05-85	731.30
07-30-84	731.44	03-05-85	731.40
08-24-84	731.52	03-29-85	731.22
09-10-84	731.48	04-12-85	731.22
10-03-84	731.47	04-25-85	731.32
10-19-84	731.48	06-13-85	731.72
10-29-84	731.41	06-18-85	731.69
11-24-84	731.31	07-09-85	731.70
12-07-84	731.29	08-05-85	731.71
		10-15-85	731.72

Site ID: 364942116280003
Depth interval 1,190-1,219 m (lower)

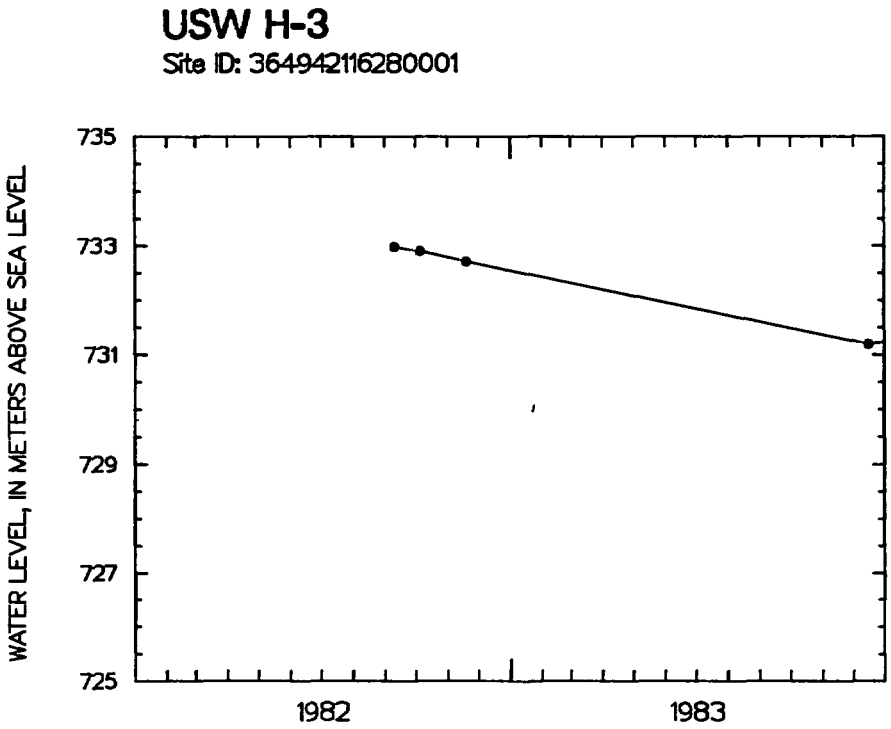
Date	Altitude (meters)	Date	Altitude (meters)
03-14-83	759.33	07-09-83	755.48
03-24-83	758.48	08-20-83	754.12
03-31-83	758.02	08-31-83	754.51
04-07-83	757.65	09-14-83	754.73
04-13-83	757.31	09-22-83	754.70
04-26-83	757.00	10-19-83	754.59
06-08-83	756.08	11-03-83	754.57
06-25-83	755.64	11-21-83	754.61

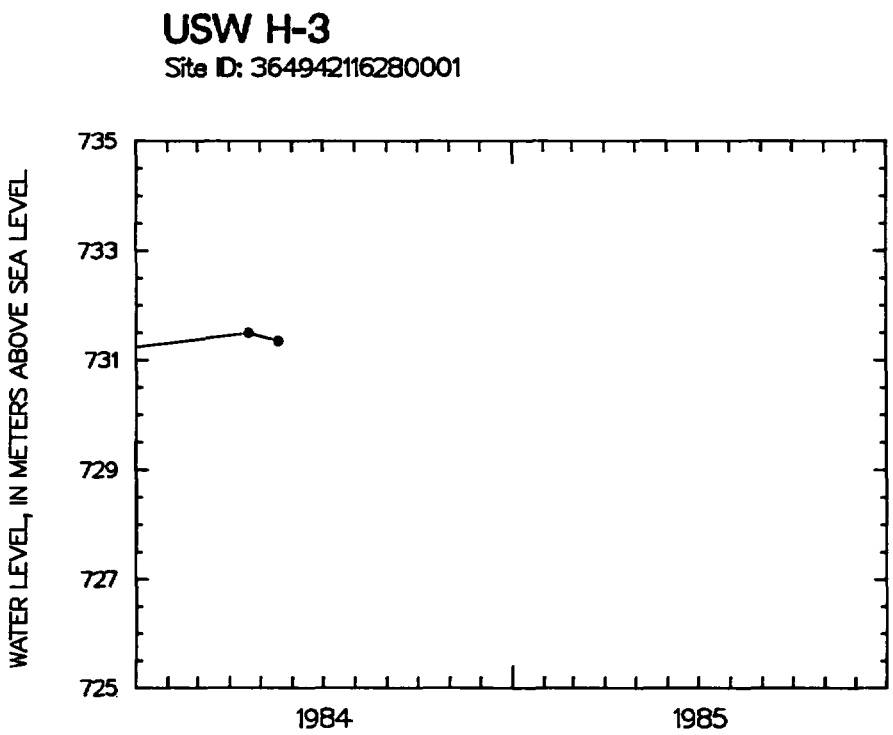
4. Periodic measurements of water-level altitude in well USW H-3--Continued:

Site ID: 364942116280005
Depth interval: 1,114-1,219 m (lower)

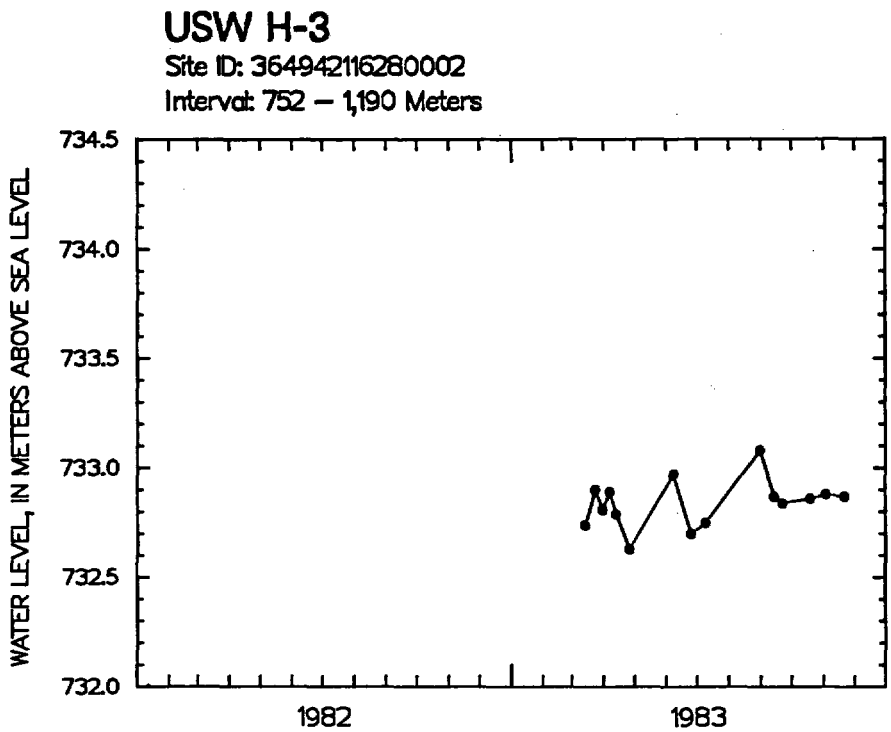
Date	Altitude (meters)	Date	Altitude (meters)
06-05-84	772.29	12-07-84	772.40
06-13-84	772.35	01-04-85	772.47
06-20-84	772.36	01-19-85	772.35
07-30-84	772.39	02-05-85	772.46
08-24-84	772.44	03-05-85	772.45
09-10-84	772.44	03-29-85	772.38
10-03-84	772.48	04-12-85	772.44
10-19-84	772.43	04-25-85	772.40
10-29-84	772.41	06-13-85	772.87
11-24-84	772.33	08-05-85	772.98
		10-15-85	772.97

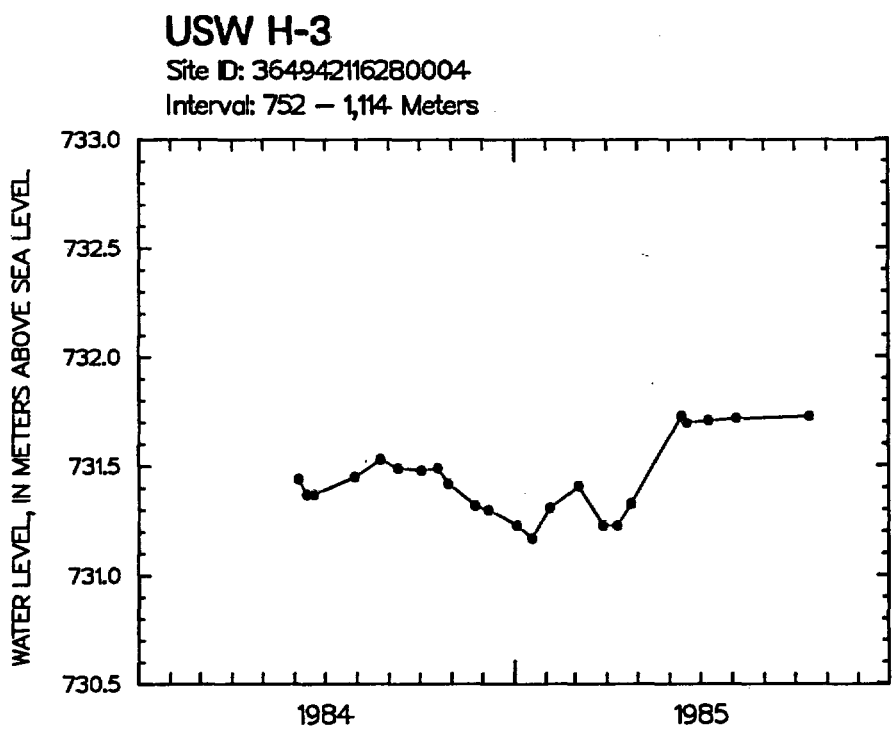
5. Hydrographs of water-level altitude (plotted from data in section 4):



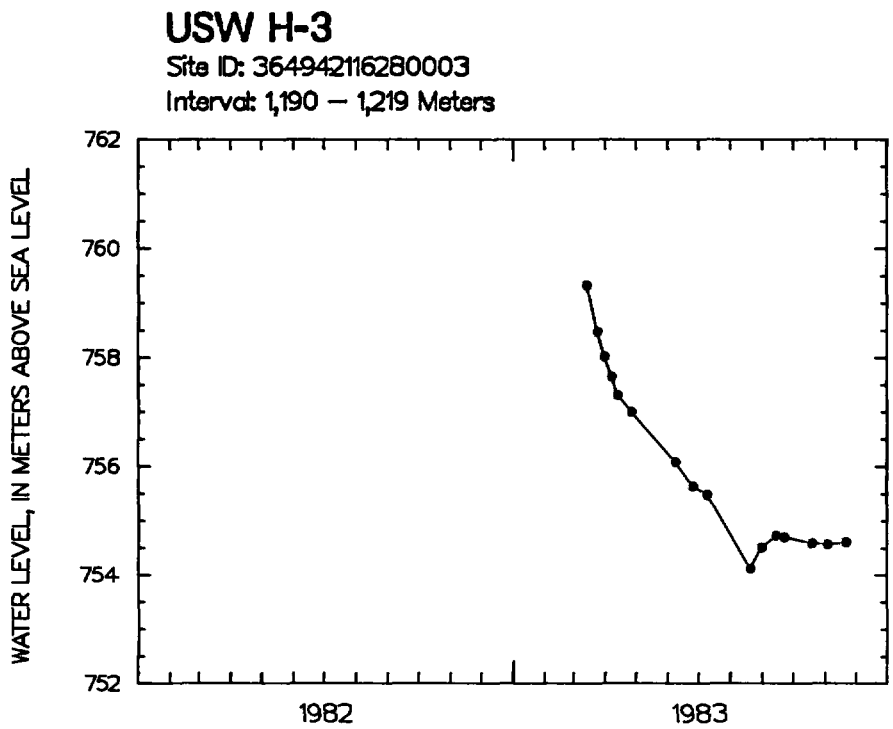


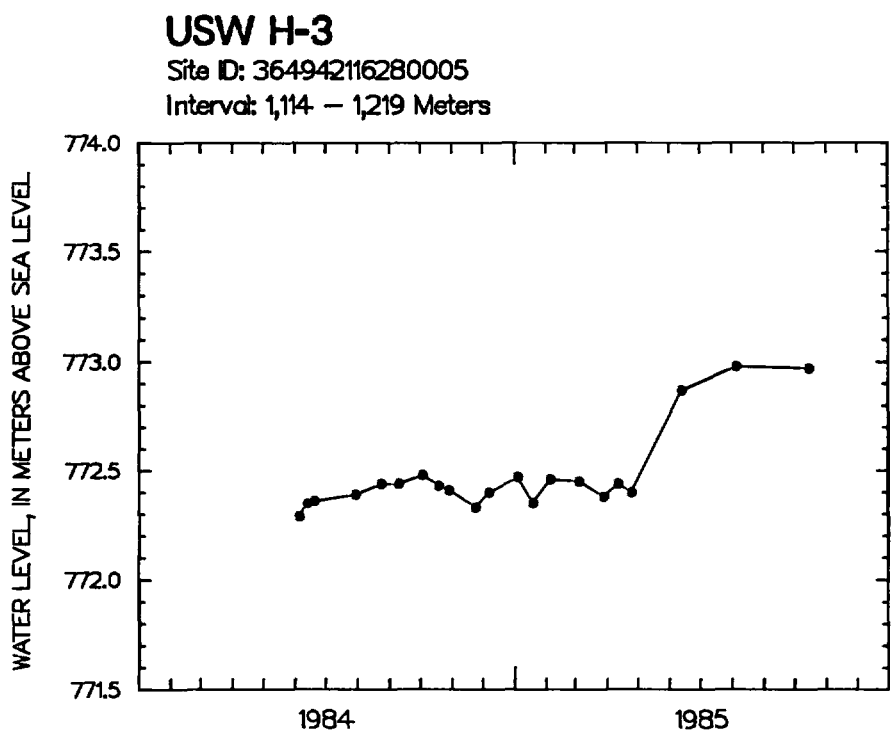
5. Hydrographs of water-level altitude (plotted from data in section 4) --Continued:





5. Hydrographs of water-level altitude (plotted from data in section 4) --Continued:





Well USW H-4

1. References or information sources: Whitfield and others (1984); Whitfield and others (1985); Robison (1984, 1986); Erickson and Waddell (1985); Holmes & Narver, Inc. (written commun., 1986); Fenix & Scisson, Inc. (1987a,c).

2. Well specifications:

   a. Location:
   Nevada State Central Zone Coordinates (feet): N 761;644; E 563,911.
   Latitude and longitude: 36°50'32" N.; 116°26'54" W.
   Site ID: 365032116265401.

   b. Land-surface altitude: 1,248.61 m (Holmes & Narver, Inc., August 12, 1982); 1,248.6 m (Robison, 1984); 1,248.5 m (Robison, 1986; based on survey by U.S. Geological Survey, 1984).

   c. Date well started: March 22, 1982.

   d. Date well completed: June 7, 1982.

   e. Drilling method: Rotary, using rock bits and air-foam circulating medium; cores obtained in selected intervals.

   f. Bit diameter below water level: 222 mm (8 3/4 in.).

   g. Casing extending below water level: 253-mm (9.95-in.) inside diameter, from land surface to 560.5 m (1,839 ft); bottom 12 m (40 ft) tack cemented; perforated from 533 to 539 m (1,750-1,770 ft).

   h. Total drilled depth: 1,219 m (4,000 ft).

   i. Description of access for measuring water levels, including tubes or piezometers:

      1. Tube, 48-mm (1.9-in.) inside diameter, open ended, from land surface to 525 m (1,711 ft); water-level response to upper interval of well, approximately from near water table to top of inflatable packer (Prow Pass, Bullfrog, and Tram Members of Crater Flat Tuff, and upper Lithic Ridge Tuff); Site ID: 365032116265402.

      2. Tube, 62-mm (2.4-in.) inside diameter, with inflatable packer on bottom end to a depth of 1,188 m (3,896 ft); water-level response to lower interval, from below packer to bottom of well (Lithic Ridge Tuff); Site ID: 365032116265403.

   j. Description and altitude of reference point: Top of metal tag on well casing, 1,248.74 m (surveyed by U.S. Geological Survey, 1984).

   k. Depth correction for measured water levels because of borehole deviation from vertical (the correction is subtracted from measured depth to obtain true depth): 0.06 m, based on approximate depth to water of 518 m (1,700 ft).

3. History of instrumentation and water-level measurements, and comments:

After initial completion and testing, three periodic measurements were made in 1982, using a four-conductor cable (logging truck 81890). The water levels represent the composite hydraulic head of the saturated intervals open to the well.

An inflatable packer was installed (see no. 2, i, preceding page) following a series of nonpumping tests in January 1983 (Erickson and Waddell, 1985). Periodic measurements were made in March 1983 through September 1985, using a four-conductor cable (logging van I-127410) in two depth intervals, near the water table to 1,181 m (3,875 ft), and from 1,181 m (3,875 ft) to total depth of 1,219 m (4,000 ft).

Continuous monitoring was begun in 1984 using downhole pressure transducers and a data recorder (Fluke 2240A) at the land surface. The data were printed on paper tape. Also, a recording barometer, previously at well UE-25b #1, was moved to well USW H-4. There were numerous equipment and operational difficulties, as at well UE-25b #1, and usable record of transducer signal (in millivolts) was intermittent.

In February 1985 the device for continuous recording of transducer output and barometric pressure was changed to a Campbell Scientific, Inc. 21X Micrologger.

4. Periodic measurements of water-level altitude in well USW H-4:

Site ID: 365032116265401
Depth interval: 518-1,219 m (composite)

Date	Altitude (meters)
09-17-82	730.23
11-26-82	730.02
12-30-82	729.79

Site ID: 365032116265402
Depth interval: 518-1,181 m (upper)

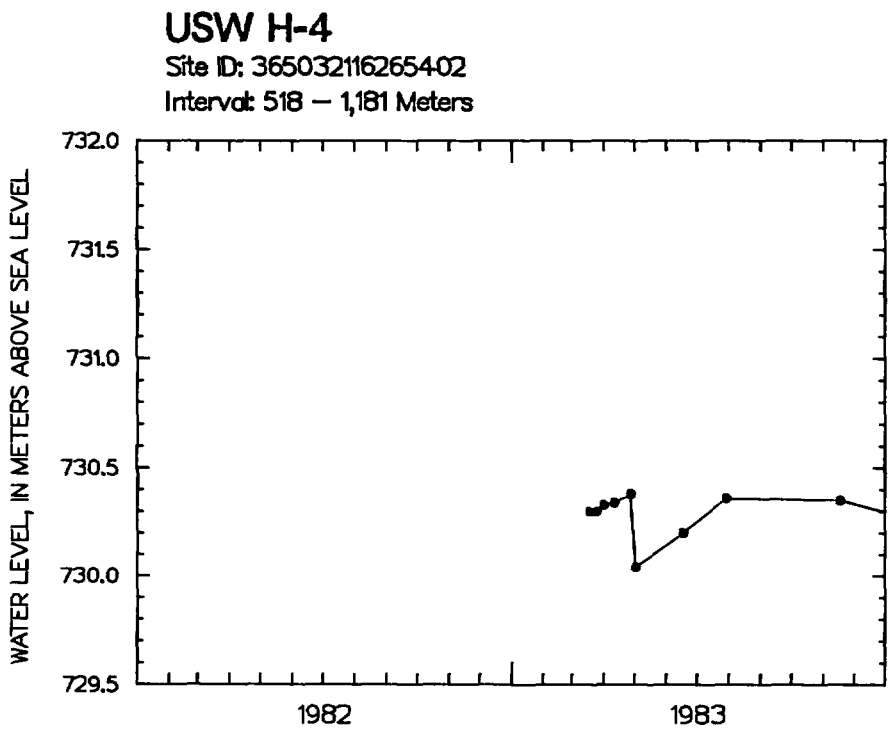
Date	Altitude (meters)	Date	Altitude (meters)
03-18-83	730.30	05-02-83	730.04
03-25-83	730.30	06-17-83	730.20
04-01-83	730.33	07-29-83	730.36
04-11-83	730.34	11-17-83	730.35
04-27-83	730.38	04-30-84	730.15
		02-14-85	730.21

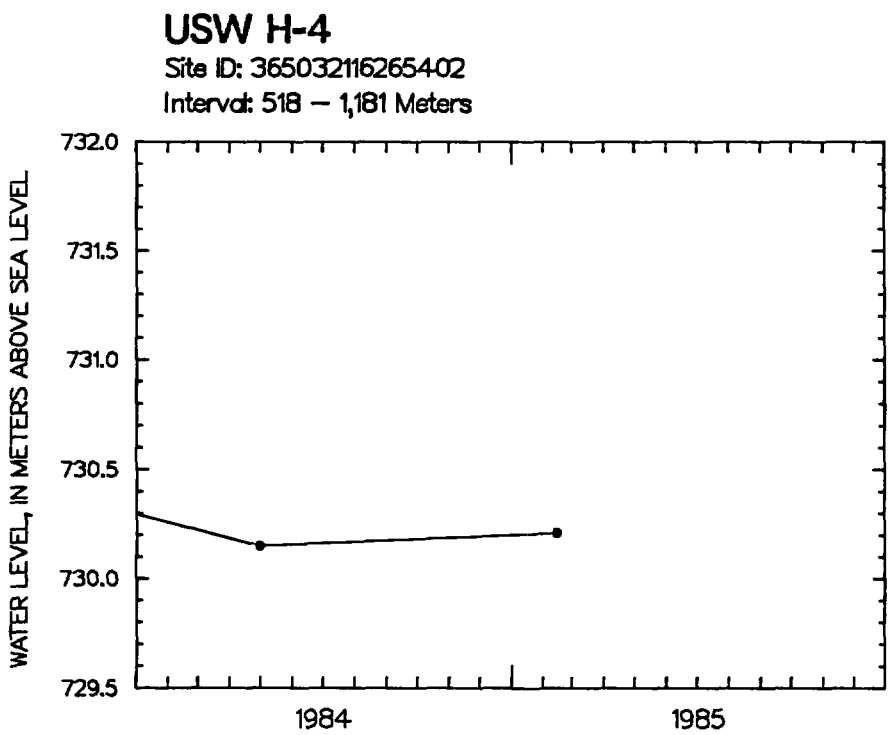
4. Periodic measurements of water-level altitude in well USW H-4 --Continued:

Site ID: 365032116265403
Depth interval: 1,181-1,219 m (lower)

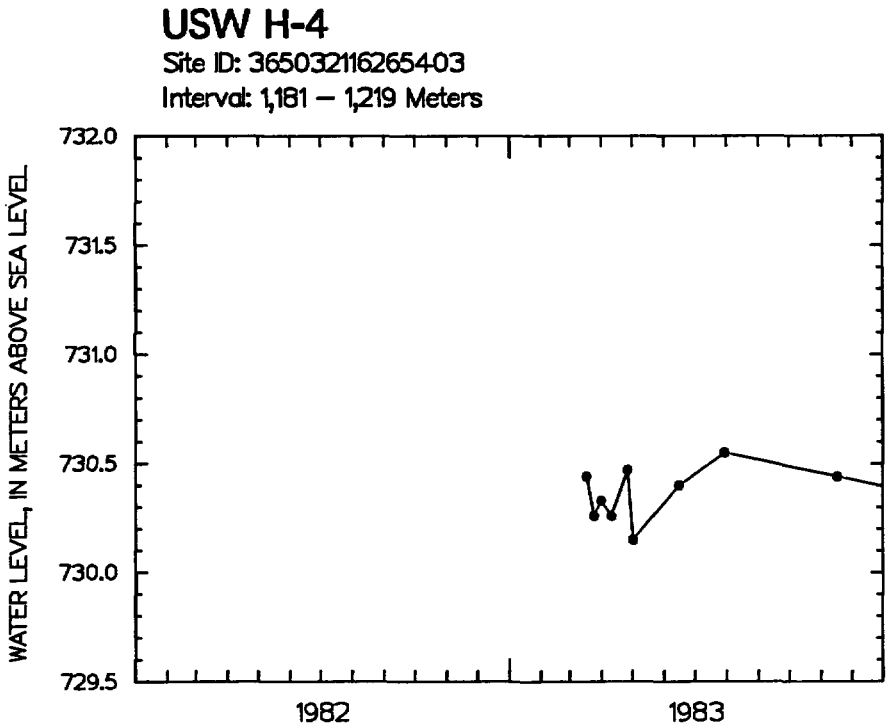
Date	Altitude (meters)	Date	Altitude (meters)
03-18-83	730.44	06-16-83	730.40
03-25-83	730.26	07-30-83	730.55
04-01-83	730.33	11-17-83	730.44
04-11-83	730.26	04-30-84	730.27
04-27-83	730.47	02-14-85	730.24
05-02-83	730.15		

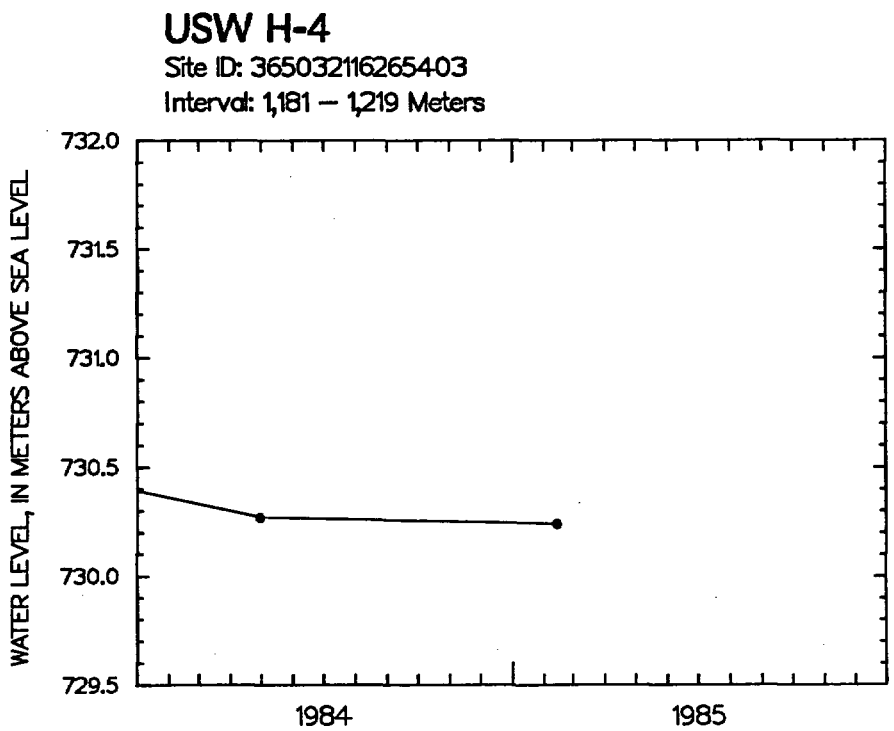
5. Hydrographs of water-level altitude (plotted from data in section 4)





5. Hydrographs of water-level altitude (plotted from data in section 4) --Continued:





Well USW H-5

1. References or information sources: Bentley and others (1983); Robison (1984, 1986); Holmes & Narver, Inc. (written commun., 1986); Fenix & Scisson, Inc. (1987a,c).

2. Well specifications:

   a. Location:
   Nevada State Central Zone Coordinates (feet): N 766,634; E 558,909.
   Latitude and longitude: 36°51'22" N.; 116°27'55" W.
   Site ID: 365122116275501.

   b. Land-surface altitude: 1,478.52 m (Holmes & Narver, Inc., October 27, 1982); 1,478.5 m (Robison, 1984); 1,478.9 m (Robison, 1986; based on survey by U.S. Geological Survey, 1984).

   c. Date well started: May 19, 1982.

   d. Date well completed: August 1, 1982.

   e. Drilling method: Rotary, using rock bits, and air-foam circulating medium; cores obtained in selected intervals.

   f. Bit diameter below water level: 375 mm (14 3/4 in.) to 790 m (2,592 ft); 222 mm (8 3/4 in.) from 790 m (2,592 ft) to total depth.

   g. Casing extending below water level: 255-mm (10.05-in.) inside diameter to 788 m (2,585 ft); casing perforated 707-782 m (2,320-2,565 ft).

   h. Total drilled depth: 1,219 m (4,000 ft).

   i. Description of access for measuring water levels, including tubes or piezometers:

      1. Tube, 48-mm (1.9-in.) inside diameter, open ended, from land surface to 708 m (2,324 ft); water-level response to upper interval of well, approximately from water table to top of inflatable packer (Bullfrog and Tram Members of Crater Flat Tuff, and lava); Site ID: 365122116275502.

      2. Tube, 62-mm (2.4-in.) inside diameter, with inflatable packer on bottom end, from land surface to 1,091 m (3,580 ft); water-level response to lower interval from below packer to bottom of well (unnamed lava); Site ID: 365122116275503.

   j. Description and altitude of reference point: Top of metal tag on well casing, 1,478.94 m (surveyed by U.S. Geological Survey, 1984).

   k. Depth correction for measured water levels because of borehole deviation from vertical (the correction is subtracted from measured depth to obtain true depth): 0.08 m, based on approximate depth to water of 704 m (2,310 ft).

3. History of instrumentation and water-level measurements, and comments:

Measurements on November 19, 1982, and December 22, 1982, were made using a four-conductor cable (logging truck 81890). The water levels represent the composite hydraulic head responses of the entire saturated interval of the

well. In 1983, an inflatable packer was installed in the hole at a depth of 1,091 m (3,580 ft), and water levels were measured March 14, 1983, through February 2, 1985, using a four-conductor cable (logging van I-127410) in two depth intervals, near the water table to 1,091 m (3,580 ft), and from 1,091 m (3,580 ft) to total depth. However, because the water levels for the upper and lower interval were more closely similar than might be expected, it is not certain the packer was functioning properly and providing adequate isolation between the two intervals. Beginning in February 1985, the well has been monitored continuously using downhole pressure transducers, with a datalogger at the land surface.

4. Periodic measurements of water-level altitude in well USW H-5:

Site ID: 365122116275501
Depth interval: 704-1,219 m (composite)

Date	Altitude (meters)
11-19-82	774.98
12-22-82	774.73

Site ID: 365122116275502
Depth interval: 704-1,091 m (upper)

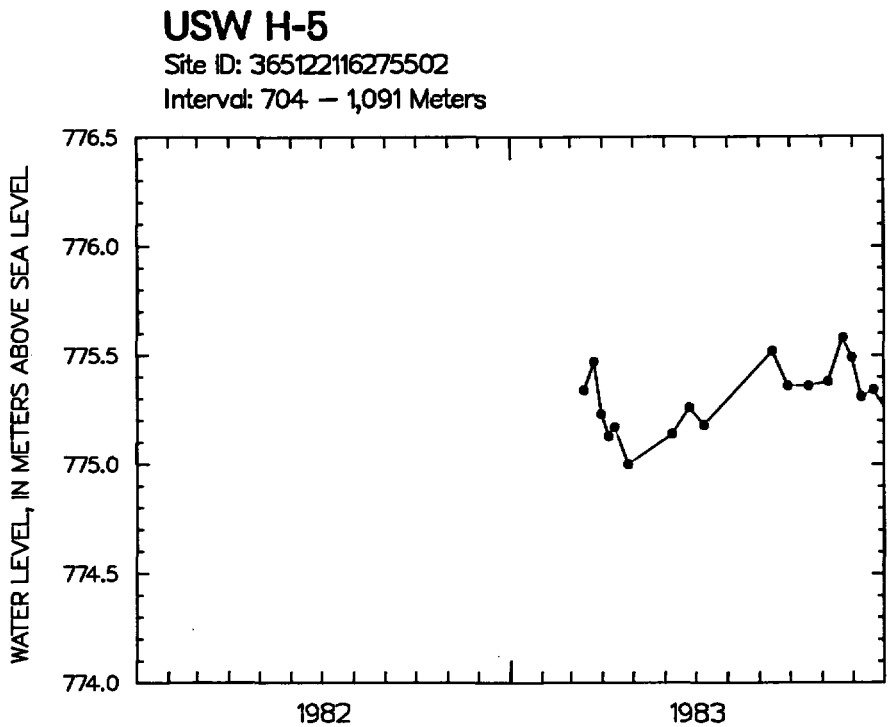
Date	Altitude (meters)	Date	Altitude (meters)
03-14-83	775.34	02-15-84	775.26
03-24-83	775.47	02-28-84	775.27
03-31-83	775.23	03-14-84	775.30
04-07-83	775.13	03-23-84	775.26
04-13-83	775.17	04-16-84	775.29
04-26-83	775.00	05-09-84	775.28
06-08-83	775.14	05-15-84	775.23
06-25-83	775.26	06-06-84	775.37
07-09-83	775.18	06-20-84	775.17
09-14-83	775.52	07-31-84	775.13
09-29-83	775.36	08-24-84	775.19
10-19-83	775.36	09-10-84	775.14
11-07-83	775.38	10-03-84	775.11
11-21-83	775.58	10-22-84	775.03
11-30-83	775.49	10-30-84	775.10
12-09-83	775.31	11-24-84	775.16
12-21-83	775.34	12-05-84	775.05
01-06-84	775.22	01-04-85	774.95
01-12-84	775.22	01-19-85	775.04
01-27-84	775.09	02-05-85	775.07
01-31-84	775.23	02-22-85	775.04
02-10-84	775.27		

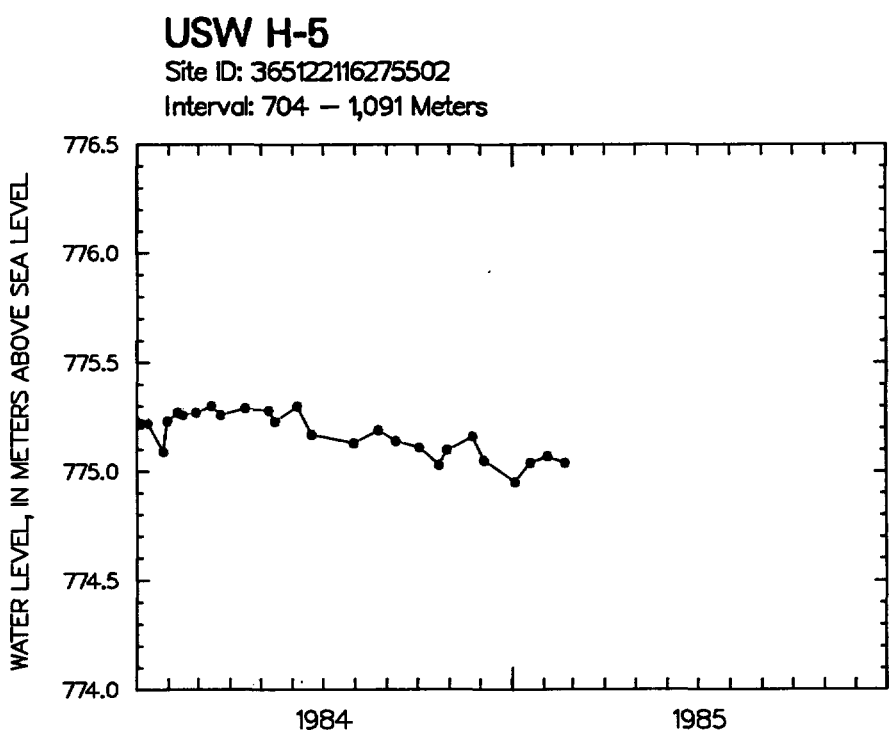
4. Periodic measurements of water-level altitude in well USW H-5 --Continued:

Site ID: 365122116275503
Depth interval: 1,091-1,219 m (lower)

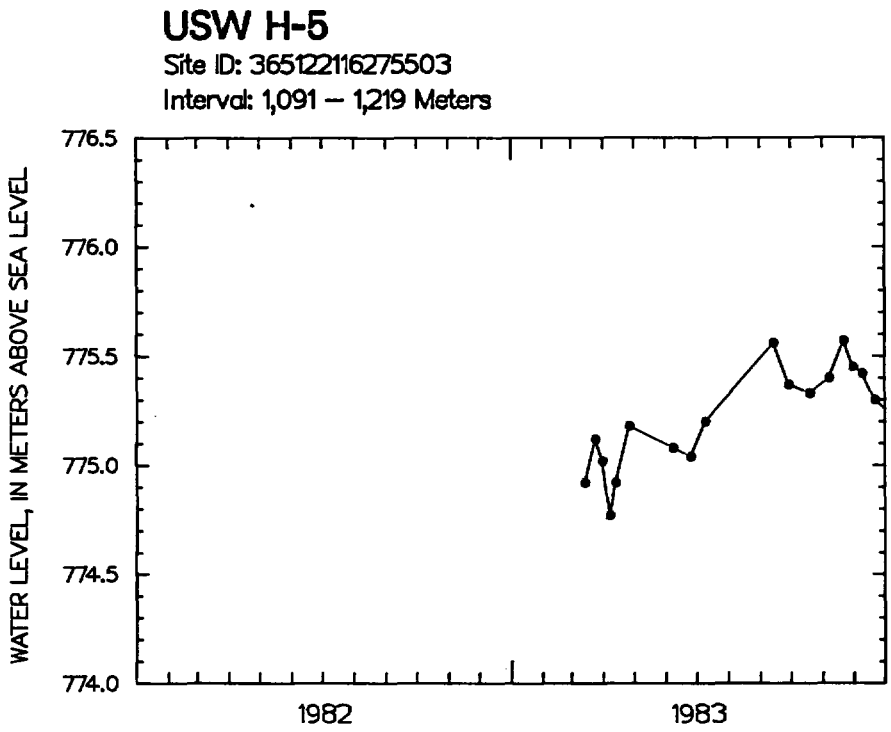
Date	Altitude (meters)	Date	Altitude (meters)
03-14-83	774.92	02-10-84	775.28
03-24-83	775.12	02-15-84	775.19
03-31-83	775.02	02-28-84	775.25
04-07-83	774.77	03-14-84	775.08
04-13-83	774.92	03-23-84	775.21
04-26-83	775.18	04-16-84	775.25
06-08-83	775.08	05-09-84	775.21
06-25-83	775.04	05-15-84	775.28
07-09-83	775.20	05-18-84	775.25
09-14-83	775.56	06-06-84	775.34
09-29-83	775.37	06-20-84	775.25
10-19-83	775.33	07-31-84	775.12
11-07-83	775.40	08-24-84	775.13
11-21-83	775.57	09-10-84	775.16
11-30-83	775.45	10-03-84	775.11
12-09-83	775.42	10-22-84	775.06
12-21-83	775.30	10-30-84	775.08
01-06-84	775.23	11-24-84	775.14
01-12-84	775.14	12-05-84	775.00
01-12-84	775.45	01-04-85	774.95
01-12-84	775.41	01-19-85	775.10
01-13-84	775.26	02-05-85	775.07
01-27-84	775.10	02-22-85	775.11
01-31-84	775.20		

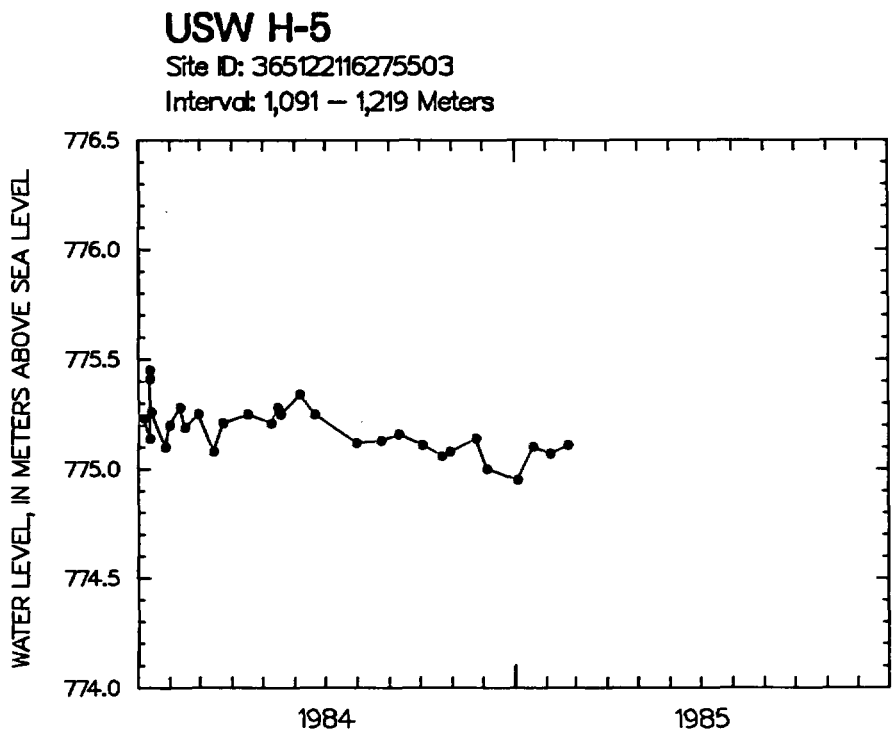
5. Hydrographs of water-level altitude (plotted from data in section 4):





5. Hydrographs of water-level altitude (plotted from data in section 4) --Continued:





Well USW H-6

1. References or information sources: Craig and others (1983); Robison (1984, 1986); Holmes & Narver, Inc. (written commun., 1986); Fenix & Scisson, Inc. (1987a,c).

2. Well specifications:

   a. Location:
   Nevada State Central Zone Coordinates (feet): N 763,299; E 554,075.
   Latitude and longitude: 36°50'49" N.; 116°28'55" W.
   Site ID: 365049116285501.

   b. Land-surface altitude: 1,301.68 m (Holmes & Narver, Inc., May 5, 1983); 1,301.7 m (Robison, 1984); 1,301.7 m (Robison, 1986; based on survey by U.S. Geological Survey, 1984).

   c. Date well started: August 7, 1982.

   d. Date well completed: October 28, 1982.

   e. Drilling method: Rotary, using rock bits and air-foam circulating medium; cores obtained in selected intervals.

   f. Bit diameter below water level: 375 mm (14 3/4 in.) to 583 m (1,912 ft); 222 mm (8 3/4 in.) from 583 to 1,216 m (1,912-3,990 ft); 156 mm (6 1/8 in.) from 1,216 m (3,990 ft) to total depth.

   g. Casing extending below water level: 250-mm (9.85-in.) inside-diameter from land surface to 581 m (1,906 ft); casing perforated from 530 to 572 m (1,740-1,878 ft).

   h. Total drilled depth: 1,220 m (4,002 ft).

   i. Description of access for measuring water levels, including tubes or piezometers:

      1. Tube, 48-mm (1.9-in.) inside diameter, open ended, from land surface to 533 m (1,750 ft); water-level response to upper interval of well, approximately from water table to top of inflatable packer at 1,193 m (3,915 ft) (Prow Pass, Bullfrog, and Tram members of Crater Flat Tuff, lava, and Lithic Ridge Tuff); Site ID: 365049116285502 and 365049116285504.

      2. Tube, 62-mm (2.4-in.) inside diameter, with inflatable packer on bottom end; water-level response to lower interval from below packer to bottom of well (Lithic Ridge Tuff); Site ID: 365049116285503 and 365049116285505.

      3. After pumping tests in June and July 1984, the inflatable packer was moved to just above a permeable, productive zone near the middle of the Tram Member, and repositioned at a depth of 752 m (2,468 ft).

   j. Description and altitude of reference measuring point: Top of metal tag on well casing, 1,302.06 m (surveyed by U.S. Geological Survey, 1984).

   k. Depth correction for measured water levels because of borehole deviation from vertical (the correction is subtracted from measured depth to obtain true depth): 0.05 m, based on approximate depth to water of 527 m (1,730 ft).

3. History of instrumentation and water-level measurements, and comments:

The water-level measurement made December 15, 1982, using a four-conductor cable (logging truck 81890), represents the composite hydraulic head of the entire saturated interval of the well. An inflatable packer was installed in early 1983 at a depth of 1,193 m (3,915 ft), and periodic measurements of both upper and lower intervals were made March 1983 through July 1984 using a four-conductor cable (logging van I-127410). The June and July 1984 measurements were made during the general time period that additional pumping tests were being conducted. After these tests, the packer was reset on July 19, 1984, to a depth of 752 m or 2,467 ft (see no. 2, i, item 3, preceding page), but no further periodic measurements are available. Water levels in the well have been monitored continuously using downhole pressure transducers, with a datalogger at the land surface, since August 1985.

4. Periodic measurements of water-level altitude in well USW H-6:

Site ID: 365049116285501
Depth interval: 526-1,220 m (composite)

Date	Altitude (meters)
12-15-82	775.46

Site ID: 365049116285502
Depth interval: 526-1,193 m (upper)

Date	Altitude (meters)	Date	Altitude (meters)
03-15-83	776.13	11-09-83	776.15
03-23-83	776.16	11-28-83	776.11
03-30-83	776.08	12-14-83	776.22
04-06-83	776.14	12-23-83	776.10
04-14-83	775.97	12-29-83	776.00
04-25-83	776.12	01-18-84	776.03
04-28-83	776.20	01-26-84	776.04
06-13-83	776.02	02-03-84	776.12
06-30-83	776.15	02-09-84	776.09
08-30-83	776.31	02-16-84	776.12
09-09-83	776.26	03-01-84	776.13
09-21-83	776.17	04-04-84	776.14
10-06-83	776.18	04-12-84	776.06
10-24-83	776.16	05-03-84	776.06
		05-23-84	776.13

4. Periodic measurements of water-level altitude in well USW H-6 --Continued:

Site ID: 365049116285504
Depth interval: 562-752 m (upper)

Date	Altitude (meters)	Date	Altitude (meters)
08-02-84	775.90	08-13-85	775.89
08-12-84	775.85		

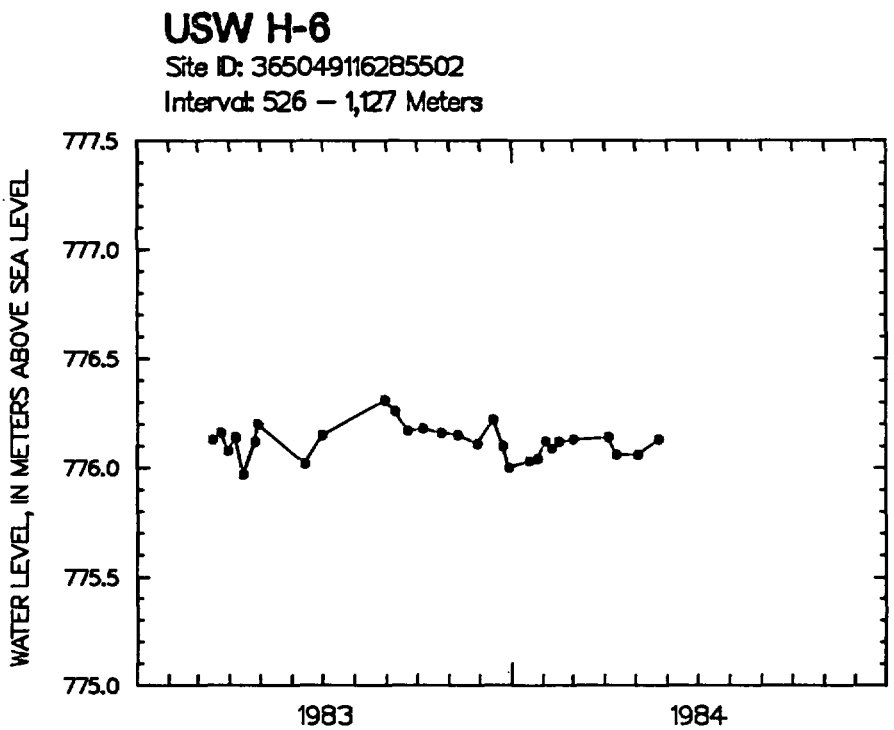
Site ID: 365049116285503
Depth interval: 1,193-1,220 m (lower)

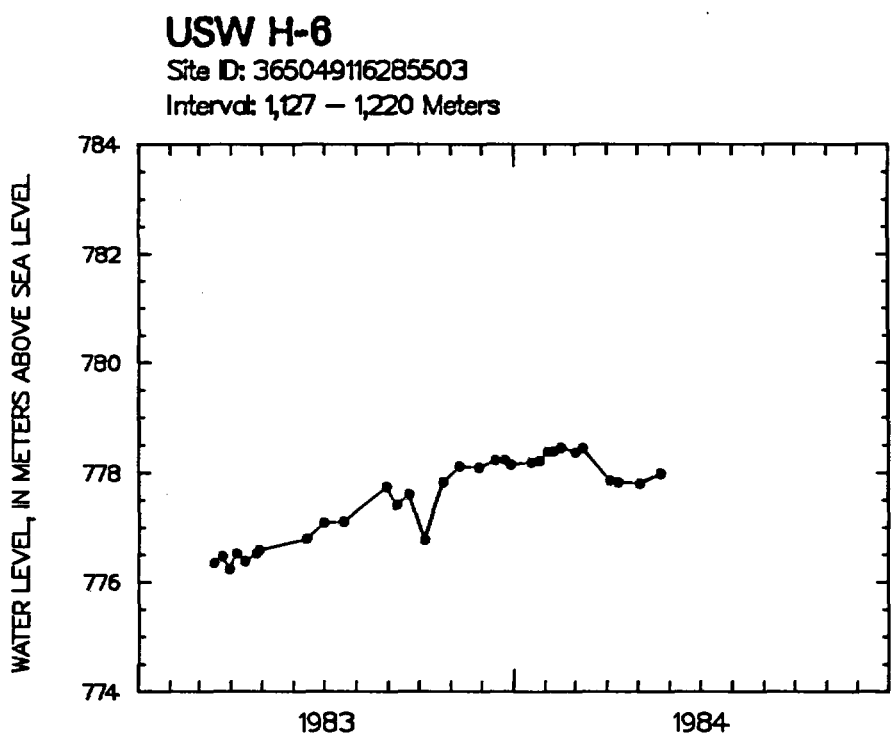
Date	Altitude (meters)	Date	Altitude (meters)
03-15-83	776.36	11-09-83	778.12
03-23-83	776.47	11-28-83	778.10
03-30-83	776.24	12-14-83	778.23
04-06-83	776.52	12-23-83	778.23
04-14-83	776.39	12-29-83	778.15
04-25-83	776.53	01-18-84	778.19
04-28-83	776.59	01-26-84	778.22
06-13-83	776.80	02-03-84	778.39
06-30-83	777.09	02-09-84	778.40
07-19-83	777.11	02-16-84	778.46
08-30-83	777.75	03-01-84	778.38
09-09-83	777.42	03-08-84	778.45
09-21-83	777.61	04-04-84	777.86
10-06-83	776.78	04-12-84	777.83
10-24-83	777.83	05-03-84	777.81
		05-23-84	777.99

Site ID: 365049116285505
Depth interval: 752-1,220 m (lower)

Date	Altitude (meters)	Date	Altitude (meters)
08-02-84	775.71	08-12-84	775.57

5. Hydrographs of water-level altitude (plotted from data in section 4):





Well USW VH-1

1. References or information sources: Robison (1984, 1986); Holmes & Narver, Inc. (written commun., 1986); Fenix & Scisson, Inc. (1986f, 1987c); Thordarson and Howells (1986).

2. Well specifications:

   a. Location:
   Nevada State Central Zone Coordinates (feet): N 743,356; E 533,626.
   Latitude and longitude: 36°47'32" N.; 116°33'07" W.
   Site ID: 364732116330701.

   b. Land-surface altitude: 963.47 m (Holmes & Narver, Inc., March 3, 1986); 963.5 m (Robison, 1984); 963.5 m (Robison, 1986).

   c. Date well started: October 28, 1980.

   d. Date well completed: February 18, 1981.

   e. Drilling method: Rotary, using rock bits, and air-foam and polymer circulating medium.

   f. Bit diameter below water level: 222 mm (8 3/4 in.) to 278 m (912 ft); 159 mm (6 1/4 in.) from 278 m (912 ft) to total depth.

   g. Casing extending below water level: 177 mm (6.97 in.) inside diameter to 277.5 m (911 ft).

   h. Total drilled depth: 762 m (2,501 ft).

   i. Description of access for measuring water levels, including tubes or piezometers: 48-mm (1.9-in.) inside-diameter tubing, open ended, from land surface to 205 m (674 ft); saturated interval of well within Tiva Canyon, Topopah Spring, Prow Pass, and Bullfrog Members of Paintbrush Tuff. A pump was installed in well July 8, 1982, at depth of 212 m (695 ft).

   j. Description and altitude of reference point: Top of casing, 963.23 m (Holmes & Narver, Inc., March 3, 1986).

   k. Depth correction for measured water levels because of borehole deviation from vertical (the correction is subtracted from measured depth to obtain true depth): 0.05 m, based on approximate depth to water of 184 m (604 ft).

3. History of instrumentation and water-level measurements, and comments:

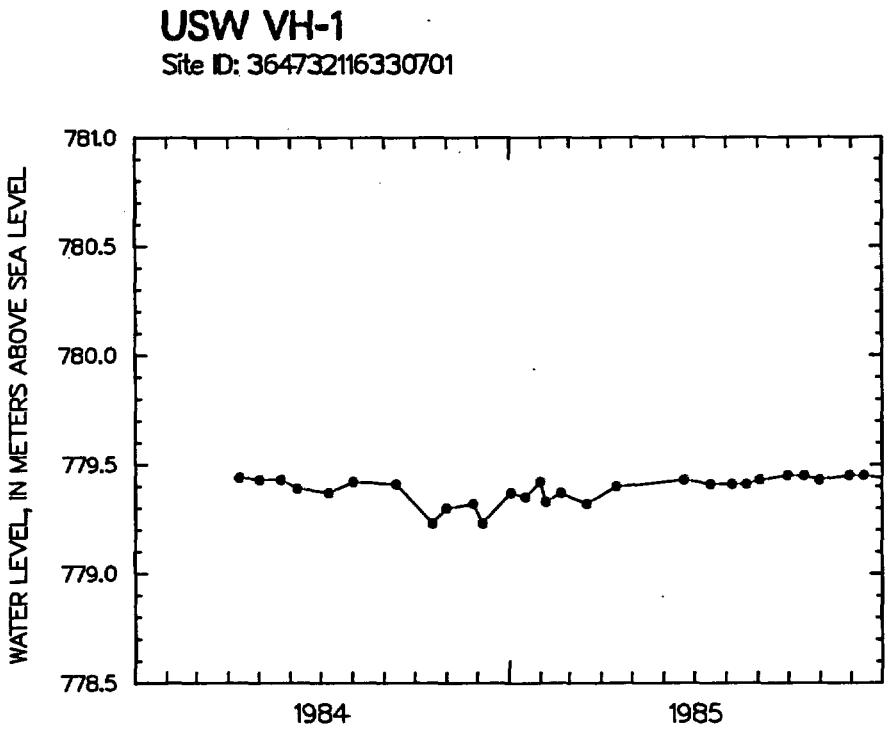
This well was measured periodically, using a four-conductor cable (logging van I-127410), from April 12, 1984, through April 16, 1985. Measurements were made with a 2,800-ft steel tape during the remainder of 1985, and measurements were made with a 2,600-ft steel tape during 1986 and 1987.

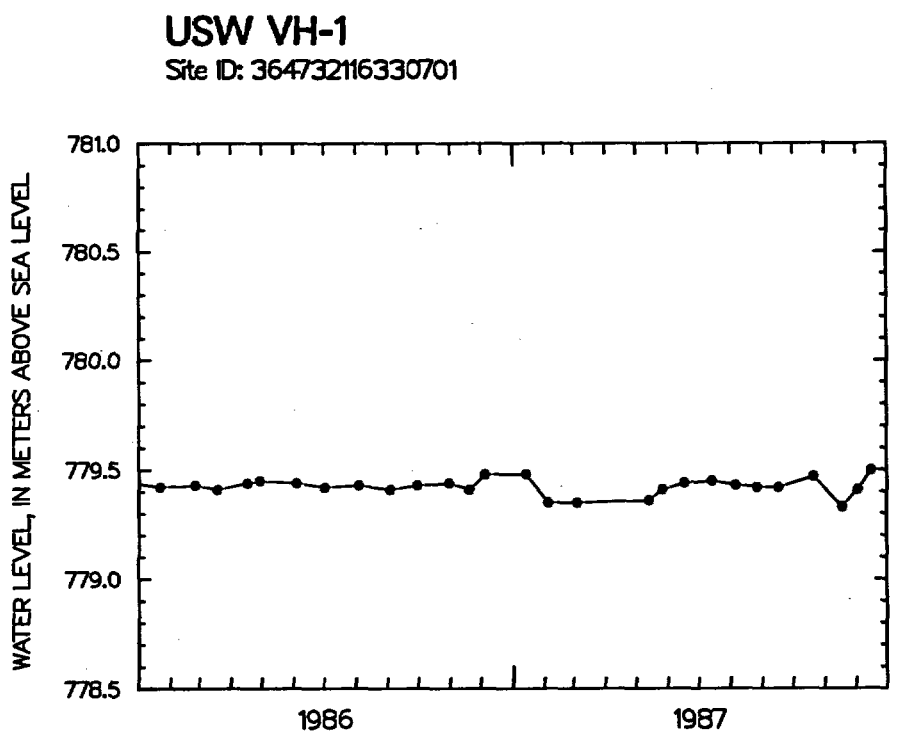
4. Periodic measurements of water-level altitude in well USW VH-1:

Site ID: 364732116330701
Depth interval: 185-762 m (composite)

Date	Altitude (meters)	Date	Altitude (meters)
04-12-84	779.44	12-13-85	779.45
05-02-84	779.43	01-22-86	779.42
05-23-84	779.43	02-25-86	779.43
06-08-84	779.39	03-19-86	779.41
07-09-84	779.37	04-17-86	779.44
08-02-84	779.42	04-29-86	779.45
09-13-84	779.41	06-04-86	779.44
10-18-84	779.23	07-02-86	779.42
11-01-84	779.30	08-04-86	779.43
11-27-84	779.32	09-04-86	779.41
12-06-84	779.23	09-30-86	779.43
01-03-85	779.37	10-31-86	779.44
01-17-85	779.35	11-20-86	779.41
02-01-85	779.42	12-05-86	779.48
02-06-85	779.33	01-14-87	779.48
02-21-85	779.37	02-05-87	779.35
03-18-85	779.32	03-05-87	779.35
04-16-85	779.40	05-14-87	779.36
06-21-85	779.43	05-27-87	779.41
07-17-85	779.41	06-17-87	779.44
08-07-85	779.41	07-14-87	779.45
08-21-85	779.41	08-06-87	779.43
09-03-85	779.43	08-27-87	779.42
09-30-85	779.45	09-17-87	779.42
10-16-85	779.45	10-21-87	779.47
10-31-85	779.43	11-18-87	779.33
11-29-85	779.45	12-03-87	779.41
		12-16-87	779.50

5. Hydrographs of water-level altitude (plotted from data in section 4):





Well J-13

1. References or information sources: Robison (1984, 1986); Holmes & Narver, Inc. (written commun., 1986); Thordarson (1983); Young (1972) Fenix & Scisson (1987c).

2. Well specifications:

   a. Location:
   Nevada State Central Zone Coordinates (feet): N 749,209; E 579,651.
   Latitude and longitude: 36°48'28" N.; 116°23'40" W.
   Site ID: 364828116234001.

   b. Land-surface altitude: 1,011.24 m (Holmes & Narver, Inc., written commun., 1986--date of survey not reported); 1,011.3 m (Robison, 1984); 1,011.3 m (Robison, 1986).

   c. Date well started: September 12, 1962.

   d. Date well completed: January 8, 1963.

   e. Drilling method: Rotary, using air, and aerated mud as circulating medium.

   f. Bit diameter below water level: 438 mm (17 1/4 in.) to 402 m (1,319 ft); 381 mm (15 in.) from 402 m (1,319 ft) to 471 m (1,546 ft); 194 mm (7 5/8 in.) from 471 m (1,546 ft) to total depth.

   g. Casing extending below water level: 323-mm (12.7-in.) inside diameter, from land surface to 397 m (1,301 ft); 282-mm (11.1-in.) inside diameter from 397 to 471 m (1,301-1,546 ft); 126-mm (4.95-in.) inside diameter from 452 to 1,032 m (1,484-3,385 ft); casing perforated from 304 to 424 m (996-1,390 ft), within Topopah Spring Member of Paintbrush Tuff, and from 820 to 1,010 m (2,690-3,312 ft), within Tram Member of Crater Flat Tuff and upper part of Lithic Ridge Tuff.

   h. Total drilled depth: 1,063 m (3,488 ft).

   i. Description of access for measuring water levels, including tubes or piezometers: Access tube installed in 1986, in order for measuring equipment to safely bypass pump assembly.

   j. Description and altitude of reference point: Chiseled square on concrete well collar, 1,011.47 m (surveyed by U.S. Geological Survey, 1984).

   k. Depth correction for measured water levels because of well deviation from vertical (the correction is subtracted from measured depth to obtain true depth): Not available.

3. History of instrumentation and water-level measurements, and comments:

Well J-13 was completed in 1963 to supply water for activities in the western part of the Nevada Test Site, and it, in conjunction with previously completed well J-12 located nearby, continued to do that. In automatic response to needs of the connected water-supply system, well J-13 typically is pumped several times per day. The well has been observed by the authors to yield about 50 liters per second (800 gallons per minute).

Static water levels were measured occasionally (probably with a single-conductor cable). Prior to interest in Yucca Mountain as a nuclear-waste repository, Thordarson (1983) reported those measurements, as shown below:

Date	Water-level depth (meters below land surface)
12-30-62	282.5
01-01-63	282.5
02-04-63	282.8
11-27-63	282.9
12-17-63	282.8
12-19-63	283.1
02-04-64	282.7
02-07-64	282.9
03-11-67	283.1
04-21-69	283.3
08-20-80	282.4

A downhole pressure transducer was installed in September 1986 to enable continuous monitoring of the water level. The two periodic measurements on September 9, 1986, and September 11, 1986, were made in conjunction with the installation and calibration of the transducer, with a reeled steel tape. Since September 11, 1986, a transducer with a datalogger at land surface has monitored the water level continuously.

4. Periodic measurements of water-level altitude in well J-13:

Site ID: 364828116234001 Depth interval: 283-1,063 m (composite)	
Date	Altitude (meters)
09-09-86	728.14
09-11-86	728.03

REFERENCES

Benson, L.V., Robison, J.H., Blankennagel, R.K., and Ogard, A.E., 1983, Chemical composition of ground water and the location of permeable zones in the Yucca Mountain area, Nevada: U.S. Geological Survey Open-File Report 83-854, 19 p.

Bentley, C.B., 1984, Geohydrologic data for test well USW G-4, Yucca Mountain area, Nye County, Nevada: U.S. Geological Survey Open-File Report 84-063, 48 p.

Bentley, C.B., Robison, J.H., and Spengler, R.W., 1983, Geohydrologic data for test well USW H-5, Yucca Mountain area, Nye County, Nevada: U.S. Geological Survey Open-File Report 83-853, 34 p.

Craig, R.W., and Johnson, K.A., 1984, Geohydrologic data for test well UE-25p#1, Yucca Mountain area, Nye County, Nevada: U.S. Geological Survey Open-File Report 84-450, 63 p.

Craig, R.W., Reed, R.L., and Spengler, R.W., 1983, Geohydrologic data for test well USW H-6, Yucca Mountain area, Nye County, Nevada: U.S. Geological Survey Open-File Report 83-856, 35 p.

Craig, R.W., and Robison, J.H., 1984, Geohydrology of test well UE-25p#1, Yucca Mountain area, Nye County, Nevada: U.S. Geological Survey Water-Resources Investigations Report 84-4248, 57 p.

Erickson, J.R., and Waddell, R.K., 1985, Identification and characterization of hydrologic properties of fractured tuff using hydraulic and tracer tests--test well USW H-4, Yucca Mountain, Nye County, Nevada: U.S. Geological Survey Water-Resources Investigations Report 85-4066, 30 p.

Fenix & Scisson, Inc., 1986a, NNWSI hole histories--UE-25a #1, UE-25a #3, UE-25a #4, UE-25a #5, UE-25a #6, UE-25a #7: U.S. Department of Energy DOE/NV/10322-9, 63 p.

_____1986b, NNWSI hole histories--UE-25 WT #3, UE-25 WT #4, UE-25 WT #5, UE-25 WT #6, UE-25 WT #12, UE-25 WT #13, UE-25 WT #14, UE-25 WT #15, UE-25 WT #16, UE-25 WT #17, UE-25 WT #18, USW WT-1, USW WT-2, USW WT-7, USW WT-10, USW WT-11: U.S. Department of Energy DOE/NV/10322-10, 111 p.

_____1986c, NNWSI hole history--UE-25b #1: U.S. Department of Energy DOE/NV/10322-13, 37 p.

_____1986d, NNWSI hole histories--UE-25c #1, UE-25c #2, UE-25c #3: U.S. Department of Energy DOE/NV/10322-14, 59 p.

_____1986e, NNWSI hole history--UE-25p #1: U.S. Department of Energy DOE/NV/10322-16, 39 p.

_____1986f, NNWSI hole histories--USW VH-1, USW VH-2: U.S. Department of Energy DOE/NV/10322-17, 57 p.

_____1987a, NNWSI hole histories--USW H-1, USW H-3, USW H-4, USW H-5, USW H-6: U.S. Department of Energy DOE/NV/10322-18, 99 p.

_____1987b, NNWSI hole histories--USW G-1, USW G-2, USW G-3, USW G-4, USW GA-1, USW GU-3: U.S. Department of Energy DOE/NV/10322-19, 187 p.

_____1987c, NNWSI drilling and mining summary: U.S. Department of Energy DOE/NV/10322-24, 45 p.

Garber, M.S., and Koopman, F.C., 1968, Methods of measuring water levels in deep wells: U.S. Geological Survey Techniques of Water-Resources Investigations, bk. 8, chap. A-1, 23 p.

Lahoud, R.G., Lobmeyer, D.H., and Whitfield, M.S., Jr., 1984, Geohydrology of volcanic tuff penetrated by test well UE-25b#1, Yucca Mountain, Nye County, Nevada: U.S. Geological Survey Water-Resources Investigations Report 84-4253, 44 p.

Lobmeyer, D.H., 1987, Geohydrology of rocks penetrated by test well USW G-4, Yucca Mountain, Nye County, Nevada: U.S. Geological Survey Water-Resources Investigations Report 86-4015, 38 p.

Lobmeyer, D.H., Whitfield, M.S., Jr., Lahoud, R.G., and Bruckheimer, Laura, 1983, Geohydrologic data for test well UE-25b#1, Nevada Test Site, Nye County, Nevada: U.S. Geological Survey Open-File Report 83-855, 48 p.

Maldonado, Florian, and Koether, S.L., 1983, Stratigraphy, structure, and some petrographic features of Tertiary volcanic rocks at the USW G-2 drill hole, Yucca Mountain, Nye County, Nevada: U.S. Geological Survey Open-File Report 83-732, 83 p.

Robison, J.H., 1984, Ground-water level data and preliminary potentiometric-surface maps, Yucca Mountain and vicinity, Nye County, Nevada: U.S. Geological Survey Water-Resources Investigations Report 84-4197, 8 p.

Robison, J.H., 1986, Letter from J.H. Robison (U.S. Geological Survey, Lakewood, Colorado) to D.L. Vieth (U.S. Department of Energy/Nevada Operations Office, Las Vegas, Nevada), September 17, 1986; regarding revisions of Yucca Mountain water levels reported in Robison, 1984.

Rush, F.E., Thordarson, William, and Bruckheimer, Laura, 1983, Geohydrologic and drill-hole data for test well USW H-1, adjacent to Nevada Test Site, Nye County, Nevada: U.S. Geological Survey Open-File Report 83-141, 38 p.

Rush, F.E., Thordarson, William, and Pyles, D.G., 1984, Geohydrology of test well USW H-1, Yucca Mountain, Nye County, Nevada: U.S. Geological Survey Water-Resources Investigations Report 84-4032, 56 p.

Sass, J.H., and Lachenbruch, A.H., 1982, Preliminary interpretation of thermal data from the Nevada Test Site: U.S. Geological Survey Open-File Report 82-973, 30 p.

Spengler, R.W., Muller, D.C., and Livermore, R.B., 1979, Preliminary report on the geology and geophysics of drill hole UE25a-1, Yucca Mountain, Nevada Test Site: U.S. Geological Survey Open-File Report 79-1244, 31 p.

Thordarson, William, 1983, Geohydrologic data and test results from well J-13, Nevada Test Site, Nye County, Nevada: U.S. Geological Survey Water-Resources Investigations Report 83-4171, 57 p.

Thordarson, William, and Howells, Lewis, 1987, Hydraulic tests and chemical quality of water at well USW VH-1, Crater Flat, Nye County, Nevada: U.S. Geological Survey Water-Resources Investigations Report 86-4359, 20 p.

Thordarson, William, Rush, F.E., Spengler, R.W., and Waddell, S.J., 1984a, Geohydrologic and drill-hole data for test well USW H-3, Yucca Mountain, Nye County, Nevada: U.S. Geological Survey Open-File Report 84-149, 54 p.

Thordarson, William, Rush, F.E., and Waddell, S.J., 1984b, Geohydrology of test well USW H-3, Yucca Mountain, Nye County, Nevada: U.S. Geological Survey Water-Resources Investigations Report 84-4272, 38 p.

Waddell, R.K., 1982, Two-dimensional, steady-state model of ground-water flow, Nevada Test Site and vicinity, Nevada-California: U.S. Geological Survey Water-Resources Investigations Report 82-4085, 77 p.

Weir, J.E., Jr., and Nelson, J.W., 1976, Operation and maintenance of a deep-well water-level measurement device, the "iron horse": U.S. Geological Survey Water-Resources Investigations 76-27, 28 p.

Whitfield, M.S., Jr., Eshom, E.P., Thordarson, William, and Schaefer, D.H., 1985, Geohydrology of rocks penetrated by test well USW H-4, Yucca Mountain, Nye County, Nevada: U.S. Geological Survey Water-Resources Investigations Report 85-4030, 33 p.

Whitfield, M.S., Jr., Thordarson, William, and Eshom, E.P., 1984, Geohydrologic and drill-hole data for test well USW H-4, Yucca Mountain, Nye County, Nevada: U.S. Geological Survey Open-File Report 84-449, 39 p.

Winograd, I.J., 1970, Noninstrumental factors affecting measurement of static water levels in deeply buried aquifers and aquitards, Nevada Test Site: Ground Water, v. 8, no. 2, p. 19-28.

Young, R.A., 1972, Water supply for the Nuclear Rocket Development Station at the U.S. Atomic Energy Commission's Nevada Test Site: U.S. Geological Survey Water-Supply Paper 1938, 19 p.

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