WATER LEVELS IN THE YUCCA MOUNTAIN AREA, NEVADA, 1990-91

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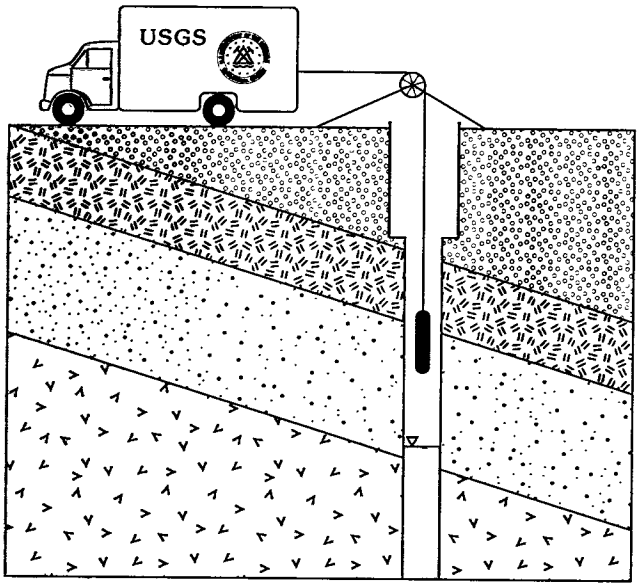
U.S. GEOLOGICAL SURVEY

Open-File Report 94–111



Prepared in cooperation with the
NEVADA OPERATIONS OFFICE,
U.S. DEPARTMENT OF ENERGY, under
Interagency Agreement DE-AI08-92NV10874

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by Patrick Tucci, Grady M. O'Brien, and Douglas J. Burkhardt

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Denver, Colorado
1996

U.S. DEPARTMENT OF THE INTERIOR

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U.S. GEOLOGICAL SURVEY

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CONVERSION FACTORS, ABBREVIATION, AND VERTICAL DATUM

Multiply	By	To obtain
kilometer (km)	0.6214	mile
liter (L)	0.03531	cubic foot
meter (m)	3.281	foot
millimeter (mm)	0.03937	inch
pound per square inch (psi)	703.1	kilogram per square meter
square kilometer (km^2)	0.3861	square mile

Other abbreviation used in this report:

millivolts (mV)

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 the Yucca Mountain Area, Nevada, 1990–91

By Patrick Tucci, Grady M. O'Brien, *and* Douglas J. Burkhardt

Abstract

Water levels were monitored in 27 wells in the Yucca Mountain area, Nevada, during 1990–91. Twelve wells were monitored periodically, generally on a monthly basis, and 15 wells representing 24 intervals were monitored hourly. All wells monitor water levels in Tertiary volcanic rocks, except one that monitors levels in Paleozoic carbonate rocks. Water levels were measured using calibrated steel tapes and pressure transducers; steel-tape measurements were corrected for mechanical stretch, thermal expansion, and borehole deviation to obtain precise water-level altitudes.

Water-level altitudes in the Tertiary volcanic rocks ranged from about 728 meters above sea level east of Yucca Mountain to about 1,035 meters above sea level north of Yucca Mountain. Water-level altitudes in the well monitoring the Paleozoic carbonate rocks varied between 752 and 753 meters above sea level during 1990–91. All data were acquired in accordance with a quality-assurance program to support the reliability of the data.

INTRODUCTION

The U.S. Department of Energy is evaluating the Yucca Mountain area 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 selected wells have been measured periodically since 1981, and have been measured hourly or more frequently in some wells since 1983, to gain a better understanding of the ground-water flow system in the area. Water levels will be used to determine the direction and rate of ground-water flow and to estimate hydraulic properties of the flow system. In the Yucca Mountain area, the water table is in air-fall and ash-flow tuffs of Tertiary age. Saturated carbonate rocks of Paleozoic age underlie the Tertiary volcanic rocks. The terminology for stratigraphic units in this report follows Carr (1988), Carr and others (1986), Byers and others (1976), and Winograd and Thordarson (1975).

This report describes the equipment and methods used to collect and process water-level data, presents the data collected, and lists water-level altitudes for a network of 27 wells. The network has evolved into one that, in 1990–91, included 15 wells that were monitored hourly, and 12 wells that were monitored periodically. All wells monitor water levels in the various Tertiary volcanic rocks that underlie the Yucca Mountain area, except well UE-25p #1, which monitors water levels in the Paleozoic carbonate rocks that underlie the volcanic rocks. A summary of these wells is given in table 1, and the locations of the wells are shown in figure 1.

Water levels are measured periodically, generally monthly, using calibrated steel tapes or a multiconductor cable. Water levels are monitored hourly using pressure transducers and electronic data loggers. The transducer/data-logger systems are calibrated by recording transducer output at known depths of submergence. Water-level measurements are made to obtain depth-to-water information during calibration using transducers, calibrated steel tapes, or a multiconductor cable. The manual water-level measurements are adjusted for thermal expansion, mechanical stretch, equipment calibration, and borehole deviation from vertical. Hourly water-level altitudes are computed based on the calibration, the manual water-level measurement, and the surveyed altitude of the reference point.

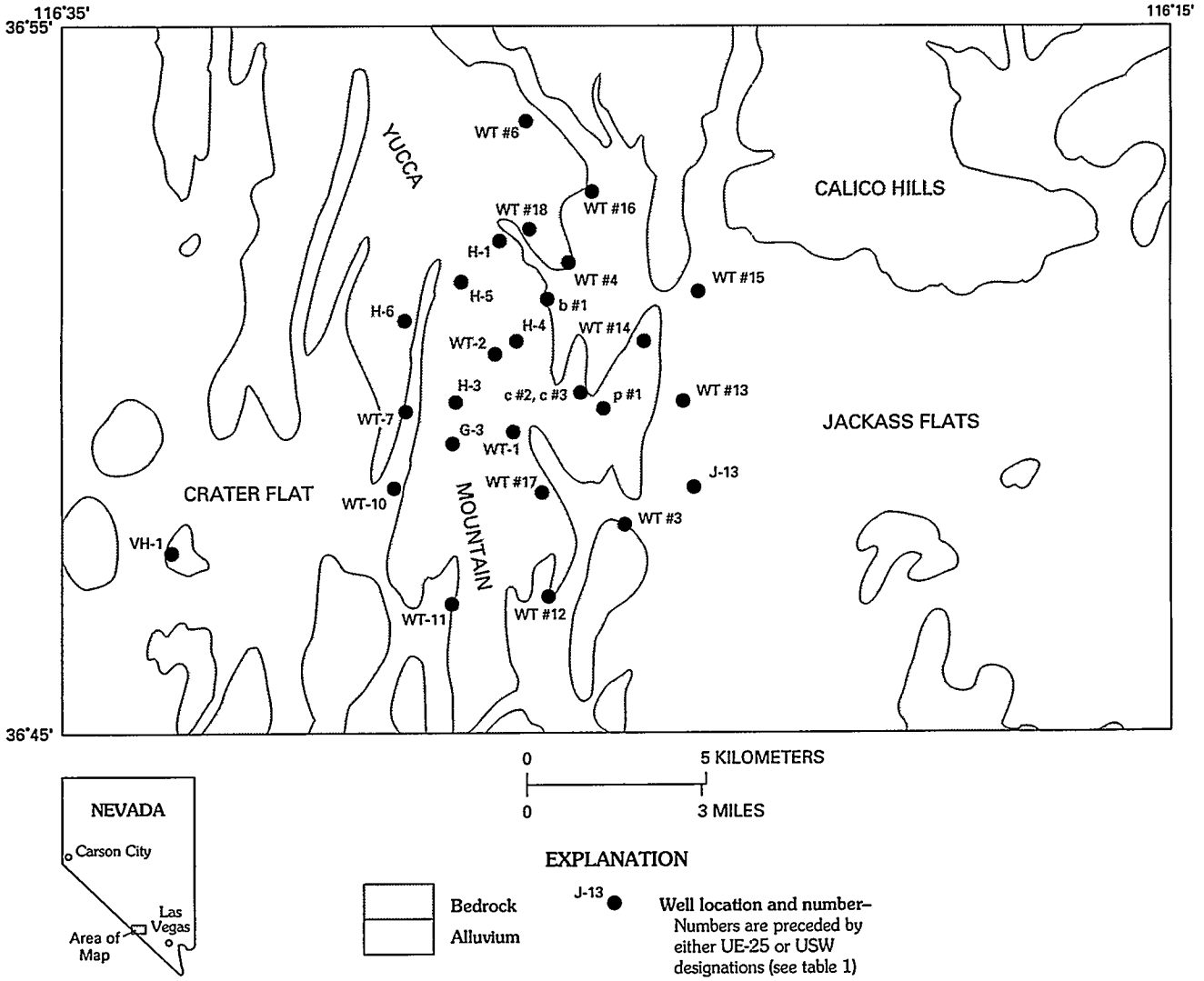

Figure 1. Location of wells used to collect water-level data for 1990–91 in the vicinity of Yucca Mountain.

Table 1. Summary of wells monitored for water levels, 1990–91, in the vicinity of Yucca Mountain

[p, periodic measurements; h, hourly monitoring]

Well number	Drilled depth (meters)	Date completed	Water level		
			Approximate depth (meters)[1]	Approximate altitude (meters)[1]	Frequency monitored
USW WT-1	515	5/83	471	730	p
USW WT-2	628	7/83	571	731	h
UE-25 WT #3	348	5/83	300	730	p
UE-25 WT #4	482	6/83	438	731	p
UE-25 WT #6	383	6/83	280	1,035	h
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	h
UE-25 WT #12	399	8/83	345	730	p
UE-25 WT #13	354	7/83	304	729	h
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	h
UE-25 WT #17	443	10/83	394	730	p
UE-25 WT #18	623	5/84	606	730	p
UE-25b #1	1,220	9/81	470	731	h
UE-25c #2	914	3/84	402	730	h
UE-25c #3	914	6/84	402	730	h
UE-25p #1	1,805	5/83	362	752	h
USW G-3	1,533	3/82	750	731	h
USW H-1	1,829	1/81	572	731	h
USW H-3	1,219	3/82	752	732	h
USW H-4	1,219	6/82	518	730	h
USW H-5	1,219	8/82	703	775	h
USW H-6	1,220	10/82	526	776	h
USW VH-1	762	2/81	184	779	p
J-13	1,063	1/63	283	728	p

[1]Composite water level of saturated interval, or level of shallowest interval monitored. Listed value is the average for 1990–91.

This report is a companion and supplement to reports that present periodically measured water levels (Robison and others, 1988; Gemmell, 1990; O'Brien, 1991) and continuously measured water levels (Luckey and others, 1993; Lobmeyer and others, 1995) in the Yucca Mountain area. Robison and others (1988) describe the details of how the manual water-level measurements are made and corrected to compute the altitude of water level.

The water-level data were obtained as part of the Yucca Mountain project of the U.S. Department of Energy. The Yucca Mountain project is described by a Site Characterization Plan (U.S. Department of Energy, 1988). The data in this study were collected by the U.S. Geological Survey and its contractors in cooperation with the U.S. Department of Energy under Interagency Agreement DE-AI08-92NV10874.

The data contained in this report were collected by Ronald J. Spaulding and Gary L. Otto, currently hydrologic technicians with the U.S. Geological Survey; Terry L. Campbell and Rafael Valentin, hydrologic technicians with Foothill Engineering, Inc., under the direction of Darrell A. Baldwin, Foothill Engineering, Inc. The data processing techniques were checked and verified by Michelle S. Boucher, Quality Assurance Specialist with the U.S. Geological Survey.

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 an NTS designation, whereas wells off the NTS use a slightly different designation. Wells on the NTS begin with UE (for Underground 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 of the well or simply by a sequential letter, followed by a sequence number. Wells off the NTS begin with the letters USW (for Underground, Southern Nevada, Waste). The designation (USW) is followed by one or more letters signifying the purpose of the well followed by a sequence number. The letters signifying purpose that are used in this report are G (collection of geologic data), H (collection of hydrologic data), p (collection of data on rocks of Paleozoic age), VH (collection of hydrologic and geologic data near volcanic rocks in Crater Flat), and WT (collection of water-table data). The only well not using this designation system and referred to in this report is well J-13, which is a water-supply well.

Nevada State Coordinates are used to identify the 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 are in meters north of the baseline and in meters plus 152,400 east of the central meridian. The Nevada State Coordinate locations for the wells were determined by Holmes & Narver, Inc., 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 well 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 an actual 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 well is not changed. If more than one well 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 the water level of discrete intervals could be measured. In these instances, before the packers or piezometers were installed, the well was assigned one Site ID (generally with a sequence number of 01). Prior to 1990, each depth interval was assigned its own unique Site ID by incrementing the sequence number; however, only one Site ID is presently assigned to each well.

DATA-COLLECTION SYSTEM

Water-level data are collected at Yucca Mountain by means of manual periodic measurements and by use of pressure transducers that are monitored hourly. Periodic measurements are discussed first, followed by a discussion of the transducer system. All water-level measurements are subject to various corrections, and these corrections are also discussed.

Periodic Measurements

Periodic, manual, water-level measurements at wells require visits by trained personnel who perform specific operations and record the results. Operational plans for 1990–91 called for measurements about once per month at each well. Measurement frequency, however, did vary; water levels in some wells were measured less frequently because of factors such as temporary shortage of trained personnel, breakdown of equipment, or well-site inaccessibility due to road washouts. Manual water-level measurements also are made at hourly monitored wells at times of calibration or replacement of defective transducers.

Periodic measurements during 1990–91 were made using "Chain #1" and "Chain #2," which are specially constructed reeled steel tapes that are 7.9 mm wide and 792 m long. One measurement was made at well J-13 using the "2,800-ft reference steel tape," which is a reeled steel tape that is 6.4 mm wide and 853 m long. Detailed descriptions of Chain #2 and the reference steel tape are given by O'Brien (1991) and are not repeated here. Chain #1 is a 792-m-long steel tape with the same physical characteristics as Chain #2. Chain #2 was used exclusively during 1990 and early in 1991. Except for one measurement using the reference steel tape, Chain #1 was used during the remainder of 1991.

Corrections and Adjustments to Manual Measurements

Various factors affect the accuracy of manual water-level measurements and are considered in the process of determining the true depth below land surface and the water-level altitude. All measurements in this report have been corrected to obtain the true water-level altitude. The correction factors applied to steel-tape measurements for each well are summarized in table 2.

Corrections made for steel-tape water-level measurements include mechanical stretch and thermal expansion of the tape. All measurements, except those at well J-13, are corrected for borehole deviation from vertical. Borehole-deviation information is not available for well J-13. All measurements are referenced to sea-level datum.

Mechanical Stretch

Mechanical stretch is associated with the weight of the suspended steel tape and attached plumb bob (Garber and Koopman, 1968). The calculated adjustment for the steel tapes used during 1990–91, based on stretch coefficients and an approximate weight of 0.45 kg for the plumb bob, ranged from -0.015 to -0.044 m (table 2) for water levels measured in the vicinity of Yucca Mountain.

Table 2. Corrections applicable to steel tapes used for measuring water levels, 1990–91, in the vicinity of Yucca Mountain

Well name (superscript is tube # or interval)	Assumed average air temperature, in well (degrees Celsius)	Correction for 2,800-ft reference steel tape (meters)			Correction for Chain #1 and Chain #2 (meters)			Correction for hole deviation from vertical (meters)	Measuring point (meters)		Reference point (meters)
		Mechanical stretch	Thermal expansion	Total[a]	Mechanical stretch	Thermal expansion	Total[a]		Interval[b]		
									Upper	Lower	
USW WT-1	25.0	-0.043	0.027	-0.016	-0.020	0.027	0.008	-0.326	0.314	--	1,201.11
USW WT-2	24.4	-0.038	0.029	-0.009	-0.012	0.029	0.017	-0.533	0.311	--	1,301.13
UE-25 WT #3	26.1	-0.041	0.021	-0.020	-0.024	0.021	-0.002	-0.271	0.155	--	1,030.11
UE-25 WT #4	25.0	-0.044	0.025	-0.019	-0.021	0.025	0.004	-0.454	0.311	--	1,169.21
UE-25 WT #6	23.3	-0.040	0.011	-0.029	-0.023	0.011	-0.012	-0.204	0.463	--	1,314.78
USW WT-7	27.8	-0.044	0.038	-0.006	-0.022	0.038	0.016	-0.034	0.302	--	1,196.88
USW WT-10	29.4	-0.043	0.038	-0.005	-0.024	0.038	0.014	-0.030	0.314	--	1,123.40
USW WT-11	28.3	-0.044	0.035	-0.009	-0.024	0.035	0.011	-0.116	0.311	--	1,094.11
UE-25 WT #12	27.2	-0.043	0.029	-0.014	-0.024	0.029	0.005	-0.183	0.305	--	1,074.74
UE-25 WT #13	24.4	-0.041	0.015	-0.026	-0.024	0.015	-0.008	-0.012	0.305	--	1,032.51
UE-25 WT #14	24.4	-0.043	0.018	-0.025	-0.024	0.018	-0.006	-0.085	0.311	--	1,076.05
UE-25 WT #15	23.9	-0.043	0.016	-0.027	-0.024	0.016	-0.008	-0.189	0.314	--	1,082.94
UE-25 WT #16	26.1	-0.043	0.033	-0.010	-0.020	0.033	0.014	-0.064	0.314	--	1,210.63
UE-25 WT #17	25.0	-0.044	0.023	-0.021	-0.023	0.023	0.000	-0.482	0.158	--	1,124.06
UE-25 WT #18	25.1	-0.035	0.036	0.001	-0.008	0.036	0.028	-0.155	0.210	--	1,336.32
UE-25b #1	25.6	-0.043	0.031	-0.013	-0.020	0.031	0.011	-0.244	0.302	0.134	1,200.73
UE-25c #2	25.6	-0.044	0.026	-0.018	-0.023	0.026	0.003	-0.058	0.695	--	1,132.18
UE-25c #3	26.1	-0.044	0.028	-0.016	-0.023	0.028	0.006	-0.098	0.314	0.317	1,132.41
UE-25p #1	25.6	-0.044	0.024	-0.020	-0.024	0.023	0.000	-0.021	0.158	--	1,114.21
USW G-3	23.3	-0.015	0.029	0.013	0.014	0.029	0.042	-0.564	0.329	--	1,480.47
USW H-1[1]	25.0	-0.042	0.030	-0.012	-0.016	0.030	0.014	-0.143	0.311	--	1,303.10
USW H-1[2,3,4]	25.0	-0.038	0.033	-0.005	-0.012	0.033	0.022	-0.174	0.311	--	1,303.10
USW H-3[upper]	26.1	-0.015	0.053	0.038	0.014	0.053	0.067	-0.079	0.174	--	1,483.47
USW H-3[lower]	26.1	-0.019	0.052	0.033	0.010	0.052	0.061	-0.058	0.201	--	1,483.47
USW H-4	24.4	-0.042	0.026	-0.015	-0.016	0.026	0.010	-0.064	0.597	0.308	1,248.74
USW H-5	23.9	-0.023	0.032	0.009	0.006	0.032	0.037	-0.079	0.329	0.235	1,478.94
USW H-6	25.0	-0.041	0.031	-0.011	-0.016	0.031	0.015	-0.052	0.207	0.235	1,302.06
USW VH-1	23.9	-0.031	0.008	-0.022	-0.019	0.008	-0.011	-0.049	0.631	--	963.23
Well J-13	25.0	-0.040	0.016	-0.023	-0.023	0.016	-0.007	unknown	0.165	--	1,011.47

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

[b]Wells with only one interval have measuring point listed as upper.

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

$$C = (L^2WS)/2 + PLS - KLS, \quad (1)$$

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.

Values for W were determined at a calibration laboratory at the NTS, and values for S were determined by the U.S. Geological Survey and are believed to be accurate to 7 percent (R.R. Luckey, U.S. Geological Survey, oral commun., 1993). Values for K are provided by the manufacturer at the time of purchase.

Thermal Expansion

Thermal expansion of a steel tape or a multiconductor cable occurs because of temperature changes. The calculated correction for thermal expansion for steel tapes is based on manufacturer specifications for thermal-expansion coefficients and on average hole temperatures calculated from temperature profiles in wells at Yucca Mountain (Sass and Lachenbruch, 1982). The correction ranges from +0.008 to +0.053 m (table 2).

Correction for thermal expansion of the tape is given by:

$$E = (D - R)\,TL, \quad (2)$$

where,

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

The tape corrections, which include both mechanical stretch and thermal expansion, values for approximate depth to water, and average air temperature in the well, are given in table 2. Approximate depth to water is analogous to apparent length of the tape, L, in equations 1 and 2. The tape-dependent variables for equations 1 and 2 are defined for each tape in table 3.

Table 3. Mechanical stretch and thermal expansion equation variable values for steel tapes used in the vicinity of Yucca Mountain

Variable	2,800-ft reference steel tape	Chain #1 and Chain #2
Unit weight of the tape, W (kilogram/meter)	2.08×10^{-2}	2.59×10^{-2}
Stretch coefficient, S [meter/(meter kilogram)]	2.48×10^{-5}	1.66×10^{-5}
Weight of plumb bob, P (kilogram)	0.45	0.45
Reference tension during manufacture, K (kilogram)	9.07	9.07
Reference temperature during manufacture, R (degree Celsius)	20	20
Thermal expansion coefficient, T [meter/(meter degree Celsius)]	1.16×10^{-5}	1.16×10^{-5}

Borehole-Deviation Correction

In addition to the corrections for mechanical stretch and thermal expansion, corrections must also be made for boreholes that are not vertical (borehole deviation). Gyroscopic surveys were made in all measured wells except well J-13. The gyroscopic surveys measured borehole deviation from vertical. The difference between measured depth and true vertical depth is the borehole-deviation, or borehole correction. Corrections for most wells are -0.2 m or less, but they range from -0.012 to -0.564 m (table 2). Corrections generally increase with increasing depth.

Water-Level Altitude

Water-level altitude is calculated by subtracting the true depth to water (after applied corrections) from the altitude of the reference point, which generally is a metal tag on the well casing. The measuring point for the wells, at the top of the access tube, is at some distance above the reference point, and the height of the measuring point is subtracted from the apparent depth to water to calculate the true depth to water. Reference-point and measuring-point values for all wells are listed in table 2 and described in the individual well sections. Water-level altitudes in this report are based on a survey of the water-level monitoring network reference points made in late 1984 by the U.S. Geological Survey.

Example Calculation

An example measurement for well UE-25 WT #4 for April 13, 1990, is presented to illustrate the calculations made to derive the true altitude of the water level. The true altitude is the value reported in the section "Periodic Water-Level Measurements."

Water-level measurements at well UE-25 WT #4 are taken from the top of a 62-mm inside-diameter steel tube, which is the measuring point (MP). The measurements are corrected to the reference point. Because the altitude of the reference point is accurately known, it is used as a basis for determining the true altitude of the water level in the well. The difference in altitude between the MP and the reference point can be measured with a pocket tape; at well UE-25 WT #4, the MP is 0.311 m above the reference point (table 2). The water-level measurements, which are recorded to the nearest 0.01 ft (foot), are later converted to meters.

At least two measurements of the water level are made and averaged during each visit to the well, and the appropriate corrections are applied after averaging the two water-level measurements. Additional measurements are made only if the two measured depths differ by more than 0.10 ft. Of the 386 manual water-level measurements obtained in 1990–91, including those obtained during calibration of hourly monitored wells, only about 3 percent differed by more than 0.05 ft. Only six measurements, mainly obtained in well UE-25 WT #18, differed by more than 0.1 ft. Those measurements are considered as "invalid" and are not included in this report.

Example

The water-level measurement on April 13, 1990, at UE-25 WT #4 was made with Chain #2. The HELD is the indicated footage on the tape when it is held at the MP during a measurement, and CUT is the footage of tape that is wetted during its submersion in the water. The difference between HELD and CUT is the apparent depth to water below the MP.

The measurements and corrections for UE-25 WT #4 on April 13, 1990, were:

Reading	Measurement 1	Measurement 2	
HELD (ft)	1,444.00	1,445.00	
CUT (ft)	–3.43	–4.44	
Apparent depth to water (ft)	1,440.57	1,440.56	
Average of two apparent depths to water (ft)			1,440.565
Apparent depth to water (1,440.565 ft × 0.3048 m/ft) (m)			439.084
Measuring point (m) (table 2)			–0.311
Tape correction (m) (table 2)			+0.004
Correction for borehole deviation from vertical (m) (table 2)			–0.454
True depth below reference point (m)			438.323
Determination of water-level altitude:			
Altitude of reference point (m) (table 2)			1,169.21
True depth (m)			–438.32
Altitude of water level (m)			730.89

Precision and Accuracy

An analysis of precision and accuracy was conducted for manual water-level measurements, which includes all periodic measurements, obtained during 1988–90 (Boucher, 1994). The precision of the 2,800-ft reference steel tape, based on 31 measurements, was 0.026 ft. The precision of Chain #2, based on 341 measurements, was 0.014 ft. Ninety-seven percent of all measurements obtained with the steel tapes were precise to within 0.05 ft during 1988–90.

The overall accuracy of the computed water-level altitude depends on the individual accuracies of its computational components, such as: (1) Water-level measurement, (2) borehole correction, (3) height of the measuring point, (4) altitude of the reference point, and (5) the precision of the 2,800-ft reference steel tape. The total accuracy of measurements taken with the steel tapes was estimated to be 0.36 ft, neglecting the accuracy of the borehole correction factors (Boucher, 1994). Accuracy of the borehole correction factors is indeterminate because documentation of the borehole-deviation surveys was inadequate to assess their accuracy, and because no borehole-deviation data are available for well J-13. The unknown accuracy of the borehole corrections poses a problem in the calculation of overall accuracy values.

Hourly Measurements

Hourly water-level measurements require that equipment be installed in the well to record water levels. Trained personnel install the equipment in the well, occasionally calibrate or replace equipment, and periodically retrieve the data from the site.

The data presented in this report are not truly continuous data; the data are hourly measurements that are of a sufficient frequency that water-level fluctuations are adequately defined to evaluate daily or longer term trends. Hourly measurements are not sufficient, however, to detect short-term, water-level fluctuations, such as those induced by earthquakes (O'Brien, 1992). Hourly measurements were stored and later retrieved from the data logger at the site or transmitted by satellite to project computers. In some instances, more frequent measurements were collected.

Pressure transducers and data loggers are used to measure water-level fluctuations. Because of the large depths to water (up to 752 m) traditional water-level sensing methods, such as float-cable-pulley system, water-seeking device, and bubble tube, are not feasible. However, electronic signals from a submerged pressure transducer are relatively easy to transmit through a multi-conductor suspension cable to a recording device accessible to personnel on the surface. Electronic data loggers at the surface are used to control, measure, and store data from the pressure transducers.

Equipment

The hourly water-level network equipment consists of a transducer to sense its submergence depth, a wireline cable to transmit the information between the transducer and the surface, and a data logger to control the system, measure the transducer output, and store the data. An external 12-volt battery provides power to the system and a solar panel charges the battery.

A wireline cable, consisting of four conductors, appropriate insulation, and two external wire wraps (for strength and stability), is used to transmit voltage between the data logger at the surface and the downhole pressure transducer. The required length of wireline cable to monitor a typical well at Yucca Mountain weighs several tens of kilograms, so power equipment is used to install and calibrate the system.

The water-level monitoring systems are calibrated at least every 4 months, and the calibration includes a water-level measurement. The water-level measurements are made using either the transducer, a multi-conductor cable unit, or a steel tape. Equipment for the water-level measurements, its use, and the necessary corrections and adjustments, are described in detail by Robison and others (1988) and in previous sections of this report. The water-level measurements, after adjustments, result in altitudes of water surface at the time of calibration.

Transducers

Water-level fluctuations in the hourly network were measured with pressure transducers and pressure transmitters during 1990–91. Transducers and transmitters are pressure sensors that convert a change in a mechanical quantity (such as pressure) into a change in an electrical quantity (such as resistance). In this report, the term "transducer" refers to either a depth-measurement pressure transducer or pressure transmitter. These sensors are used to measure pressure and are capable of being immersed in water to measure the depth of submersion. Because the transducer remains at a fixed depth in the well, water-level fluctuations are equivalent to changes in the depth of submersion detected by the transducer.

The pressure sensing components of a transducer consists of a strain gage to convert pressure into electrical resistance and a Wheatstone bridge to allow measurement of the change in resistance. The major difference between pressure transducers and transmitters is the form of the input and output. Pressure transducers use voltage as input and output, whereas pressure transmitters use current as input and output. Pressure transmitters are constructed with the same strain gage and Wheatstone bridge arrangement as a pressure transducer; however, the current input is converted to voltage by an amplifier before it enters the strain gage and the voltage is converted back to current by a regulator after it passes through the Wheatstone bridge. The required wiring of pressure transducers and transmitters differ because the data loggers are not capable of measuring current. The output signal of a transmitter must be connected to a resistance load, and the drop in voltage across the load is then measured by the data logger. Regardless of which type of pressure sensor is used, as the depth of submergence increases (when the water level rises or the transducer is lowered), the transducer output increases.

Transducers are made for a range of pressures. Generally, the smaller the pressure range of the transducer, the more accurately pressure changes and water-level fluctuations can be measured. Transducer pressure ranges in the hourly water-level network varied from 1 to 15 psi (submergence up to 10.5 m below water surface); however, a 5 to 10 psi range was most frequently used.

Historically, both absolute and gage transducers were used in the water-level network. An absolute transducer measures pressure relative to a fixed reference pressure, whereas a gage transducer measures pressure relative to atmospheric pressure. A gage transducer has a vent tube from one side of the strain gage to above the water surface. A gage transducer is preferable in the water-level network because then only water-level fluctuations (and not air-pressure changes) affect the transducer output. Gage transducers were used exclusively in the water-level network during 1990–91.

The transducers are calibrated when installed in the well, when removed from the well (if possible), and at least every 4 months while in service in the well. The calibration consists of manually raising or lowering the transducer in increments and noting the change in transducer output. The data logger (described in the next section) is used in the calibration to provide the applied voltage and to measure the output voltage, so that the calibration is for the entire transducer/data-logger system and not just for the transducer.

As a part of the calibration process, a water-level measurement must be obtained by either a manual measurement, using a steel tape, or by "tagging" the water level using the transducer. Tagging the water level, which is the more frequently used method of water-level measurement during calibrations, is done by raising or lowering the transducer until it just comes in contact with the water in the well. The difference in the depth to water from the last manual measurement, indicated by a tape mark on the transducer cable, is then noted in the log book as part of the calibration record. If the transducer is functioning properly, the water level obtained by tagging should be as accurate as a manual measurement; however, errors in the measured water level (probably less than 0.1 m) are possible if the transducer is not functioning properly.

On September 4, 1991, the transducer-data logger system at well USW WT-2 was calibrated. Water-level altitude at the time of calibration was 730.78 m. The calibration started with the transducer submerged about 1.463 m below the water surface; this starting point is referred to as the "set point." The transducer was then raised in preselected increments and the output recorded to relate the change in millivolt output to the change in depth of submergence. The following values were obtained:

Displacement from set point (meters)	Depth of submergence below water surface (meters)	Transducer output (millivolts)
0.000	1.463	2.0110
0.305	1.158	1.5961
0.366	1.097	1.5203
0.427	1.036	1.4337
0.489	0.974	1.3612
0.549	0.914	1.2742
0.610	0.853	1.1860
0.671	0.792	1.1055
0.732	0.731	1.0236
0.792	0.671	0.9451
0.853	0.610	0.8679
0.914	0.549	0.7673
1.219	0.244	0.3455
1.524	-0.061	0.0154

The transducer output is the average of three readings taken after the transducer output had stabilized. If the last point is off the trend of the rest of the points, it indicates that the transducer was no longer submerged. A regression analysis was performed on the data, excluding any points where the transducer was not submerged. The slope of the regression line for well USW WT-2 on September 4, 1991, was

1.36 millivolts per meter, the intercept of the regression line was 2.02 millivolts, and the coefficient of determination (r^2) was 100.0 percent. The slope of the regression line, the transducer output at the set point after calibration, and the water-level measurement at the time of calibration were used to convert transducer output to water-level altitude.

Data Loggers

Two different types of data loggers were used for the hourly water-level network during 1990–91 —a microprocessor-based data acquisition system that collects and stores data and a data-collection platform (DCP) that collects, stores, and transmits data to a satellite from which the data are relayed to a ground station. DCP's were used as a supplemental data-acquisition system during 1990–91 to test the feasibility and practicality of their use.

The Campbell Scientific 21X Micrologger, used in the continuous water-level network as the primary data-acquisition system during 1990–91, is a microprocessor-based system. This data logger is a combination microprocessor, clock, voltage regulator, controller, data processor, and data-storage device. The 21X microprocessor system is a programmable unit, and most aspects of its operation can be varied according to specific needs. The variables described in this section were defined while programming the data logger. Details of the 21X operation and programming are described by Luckey and others (1993) and Lobmeyer and others (1995).

A DCP was first installed at well USW G-3 in December 1989. DCP's were also installed at wells USW H-4, USW H-5, USW H-6, UE-25 WT#6, and UE-25 WT#11 during 1990–91. Handar model 570A units were the DCP's used to replace the 21X micrologger system. The DCP has the same functions as the micrologger, but, in addition to internal storage of data, data are transmitted to a Geostationary Operational Environmental Satellite (GOES). Details of DCP use and operation, and GOES systems, are described by Blee and others (1986). Data are collected hourly, stored, and transmitted every 4 hours to a GOES satellite. The data are then relayed to a Direct Readout Ground Station (DRGS) and stored in USGS computers for evaluation and further processing. Data stored internally in the DCP are periodically transferred to computer diskettes. These data are used as backups to the transmitted data and are used to fill in data gaps due to any malfunctions during the transmission or receiving process.

In addition to transducer output, the data loggers also store information such as battery voltage, the excitation voltage, and the panel temperature of the data loggers. These variables are important for evaluation of the reliability of the recorder. The data loggers store all of the preceding data in memory. Additionally, the 21X data loggers store the Julian day and time of the reading.

Data from the 21X data loggers were transferred to cassette tapes through a serial port on the data loggers approximately every 15 days. Two separate cassette tapes were made in case one system malfunctioned. A voice recording on the tape identifies the well from which the data were recorded. The data on the cassette tapes were then transferred to a computer for subsequent processing. Data from the DCP's are transferred to computer diskettes using a portable computer; station ID and time tags are recorded at the beginning and end of each data file.

Processing and Adjustments

The data stored in the data loggers and transferred to computers are not water-level data but rather transducer output, in millivolts. The transducer output was converted to water levels using regression analysis, as explained in the following section, "Conversion to Water-Level Altitude." The water levels are then evaluated by two hydrologists. Anomalous data points, such as those produced during transducer calibrations, by random electrical signals, or due to instrument malfunction, are not converted to water levels.

Conversion to Water-Level Altitude

If a transducer were to function for a long time, and be calibrated several times during this period, if its output were free of drift, and if its characteristics did not change with time, the transducer output could be converted relatively easily to water-level altitude. However, this ideal situation rarely occurred, and in many cases, the transducer output was far from ideal. As a result, much of the transducer output and resulting converted water levels were not considered acceptable.

Converted water levels were evaluated by two hydrologists for data reliability. The hydrologists examined the data at a small time scale at which hourly and daily variation could be clearly seen to determine the validity of the data. The data were compared to barometric-pressure data, earth-tide potential, and seismic activity, which can affect the water level in the well, and other periods of record for the same site and depth interval. If both hydrologists agreed that the data were valid, the data were retained and included in this report. If one or both hydrologists were not convinced the data were valid, the status of the data was left as indeterminate. The indeterminate status did not necessarily mean the data were invalid; it simply meant that the hydrologists were not convinced the data were valid. Indeterminate data are not included in this report; however, all raw transducer output data are retained in USGS computer data bases for any potential future evaluation. Transducer data are also transferred to a Yucca Mountain project archive in Denver, Colo.

For those data that were selected for conversion, the regression-line slope and the manual water-level measurement determined during calibration were used to convert the selected transducer output to water-level altitude. The manual measurement indicated the altitude of the water level at the time of the calibration, whereas the slope of the regression line related the change in depth of submergence to change in transducer output.

The equation for converting transducer output to water-level altitude under ideal condition is:

$$W = W_c + (T - T_c)/S_c, \quad (3)$$

where,

W is the water-level altitude, in meters;
W_c is the water-level altitude at calibration, in meters;
S_c is the slope of the regression line, in millivolts per meter;
T_c is the transducer output at set point following calibration, in millivolts; and
T is the transducer output, in millivolts.

For example, at well USW WT-2 on July 24, 1990, the water-level altitude at calibration was 730.82 m (based on a manual measurement). The calibration indicated that a 1-m decline in water level would cause the transducer output to decline by approximately 6.5 millivolts (or 0.15 m/mV). Changes in transducer readings and associated changes in water level for 2 hours and 24 hours after calibration are as follows:

Approximate time and date	Change in transducer output (millivolts)	Change in water level (meters)	Water-level altitude (meters)
10:00 7/24/90	0.0	0.0	730.82
12:00 7/24/90	-0.07	-0.01	730.81
10:00 7/25/90	-0.27	-0.04	730.78

Although the slope of the regression generally does not change dramatically between calibrations, it usually changes to some degree. The change in slope is assumed to occur linearly between calibrations, so S_c in equation 3 changes between calibrations. The water-level altitude is assumed to remain constant from the last transducer output prior to calibration through the first transducer output after calibration. This assumption probably introduces, at most, a few hundreths of a meter error in the calculation of water-level altitude. If more than one calibration was done on a transducer on the same day, the last calibration is used to calculate water-level altitude unless the coefficients of determination of the regression lines indicate that another calibration was superior.

Quality Assurance

Data in this report will be used to evaluate the suitability of the Yucca Mountain site for a high-level nuclear-waste repository. Confidence in the reliability of water-level data is necessary so the data may be used to assess the expected performance of the repository. A quality-assurance program has been implemented to support the reliability of the data.

Onsite Procedures

The quality-assurance program requires that water-level measurements be obtained by methods described in formal technical procedures. The technical procedures include tests and adjustments done during the measuring operation to ensure that the equipment is operating properly and that expected precision and accuracy are attained. For example, the procedure for measuring water-level changes with a pressure transducer specifies how to install the transducer, how to calibrate, and how to maintain the records of the calibrations.

Data are recorded in logbooks at the well site. Data recorded include: Time and date of the visit or calibration; names of operators making the visit; identification of specific equipment used; calibration data; water-level measurement data; and correction factors, if any, applied to the data at the well site. In addition, the entry in the logbooks may include comments concerning factors that may be relevant to the collected data, such as discussion of problems with equipment or weather conditions during the water-level measurement or transducer calibration.

Office Processing and Review

The original logbooks and records are maintained throughout the calendar year at the onsite operations headquarters at the Nevada Test Site. Photocopies are periodically transmitted to the office of the project chief in Denver, Colo. The records are reviewed for completeness and accuracy and to ensure that proper technical procedures were followed. Any needed adjustments not done during onsite operations are made in the Denver office. After data review and any needed adjustments, the logbooks and related records are transferred to a Yucca Mountain project archive in Denver.

The transducer output is entered into a computer data base and is plotted daily to facilitate general data review and to discover any instrumentation problems. After this review, the transducer output is converted to water levels. In addition to being published by the U.S. Geological Survey, both the raw transducer output and the water-level altitudes are placed in permanent computer data bases, such as the Unit Values file of the National Water Information System used by the U.S. Geological Survey. Water-level altitudes obtained from manual measurements are also placed in the computer data base.

WELL DATA AND WATER LEVELS

Information and data for individual wells are included in the following sections. Each well is presented in a separate section, which is further subdivided. Each section begins with sources of information about the well, most of which is published information. Borehole-geophysical logs and core measurements for the wells are presented by Nelson and others (1991). Previously published water-level data for the wells are presented by Robison and others (1988), Gemmell (1990), O'Brien (1991), Luckey and others (1993), and Lobmeyer and others (1995). Complete bibliographic citations are in the "References Cited" section. Important information about the well, (location, land-surface altitude, start and completion dates of drilling, drilling method, depth drilled, bit diameter below water level, casing information, description of access tubes for measuring water levels, description and altitude of reference point, description and height of MP above reference point, and depth correction for borehole deviation) are summarized in the "Well Specifications" section. Although water-level altitudes are corrected for borehole deviation, other depth-related values (such as casing or access-tubing depths) in the tables are uncorrected. Transducers used to monitor water levels for hourly monitored wells and their calibrations, are listed in the "Calibrations and Comments" section. Various statistical information concerning the water levels and hydrographs of water-level altitude are presented in the "Water-Level Altitudes" section. Hydrographs are uniformly plotted, by year, with a y-axis (water-level) span of 2.5 m, except for well USW H-3, lower interval, which has a y-axis span of 4.5 m. Mean annual water-level altitude is presented for all measured wells, and mean monthly water-level altitudes are presented for hourly monitored wells.

Periodic Water-Level Measurements

References or information sources, well specifications, periodic water-level measurements, and hydrographs of water-level altitude are presented in the following sections for individual wells in the periodic water-level network for 1990–91. Water-level altitudes for 1990–91 are presented in tables and hydrographs for each well. Mean annual water-level altitudes for both 1990 and 1991 are compared to the 1989 mean annual water-level altitude and are included in the tables.

Well USW WT-1

1. References or information sources: Robison (1984, 1986); Robison and others (1988); Holmes & Narver, Inc. (written commun., 1986); Fenix & Scisson, Inc. (1986a, 1987c).
2. Well specifications:
   a. Location:

      Nevada State Central Zone Coordinates (m): N 229,801; E 171,828.

      Latitude and longitude: 36°49'16"N; 116°26'56"W.

      Site ID: 364916116265601.

   b. Land-surface altitude: 1,201.4 m (surveyed by U.S. Geological Survey, 1984).
   c. Date drilling started: April 28, 1983.
   d. Date drilling completed: May 18, 1983.
   e. Drilling method: Rotary, using rock bits and air, water, and soap-circulating medium; bottom-hole core obtained.
   f. Total drilled depth: 515 m.
   g. Bit diameter below water level: 222 mm.
   h. Casing information: None (surface casing only, to a depth of 9.91 m).
   i. Description of access for measuring water levels, including tubes or piezometers: 62-mm inside-diameter tubing that has a 3.7-m-long well screen on the bottom; tubing and attached screen extend from land surface to a depth of 507.5 m; 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. Description and height of MP above reference point: Top of access tube, 0.31 m.
   l. 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.
3. Water-level altitudes:

   Water-level altitudes at well USW WT-1 ranged from 730.34 to 730.48 m. Mean annual water-level altitude for 1990–91 was 730.42 m for both years. The mean altitude was unchanged from the mean altitude of 730.42 m for 1989 (O'Brien, 1991, p. 21). Water-level altitudes are listed in table 4 and shown in figure 2.

Table 4. Measured water-level altitude and yearly mean water-level altitudes, 1990–91, for well USW WT-1

[Method: C1, Chain #1; C2, Chain #2]

Date	Water-level altitude (meters)	Method
01/22/90	730.41	C2
02/09/90	730.38	C2
03/06/90	730.42	C2
04/10/90	730.39	C2
05/22/90	730.45	C2
06/21/90	730.47	C2
07/23/90	730.44	C2
08/10/90	730.41	C2
09/13/90	730.45	C2
10/22/90	730.42	C2
11/30/90	730.42	C2
12/14/90	730.43	C2
01/24/91	730.44	C2
02/27/91	730.48	C2
03/29/91	730.39	C1
04/25/91	730.43	C1
05/13/91	730.41	C1
06/14/91	730.41	C1
07/24/91	730.41	C1
08/26/91	730.42	C1
09/25/91	730.38	C1
10/29/91	730.47	C1
11/20/91	730.34	C1
12/24/91	730.44	C1

1990 Mean = 730.42 meters.
1991 Mean = 730.42 meters.

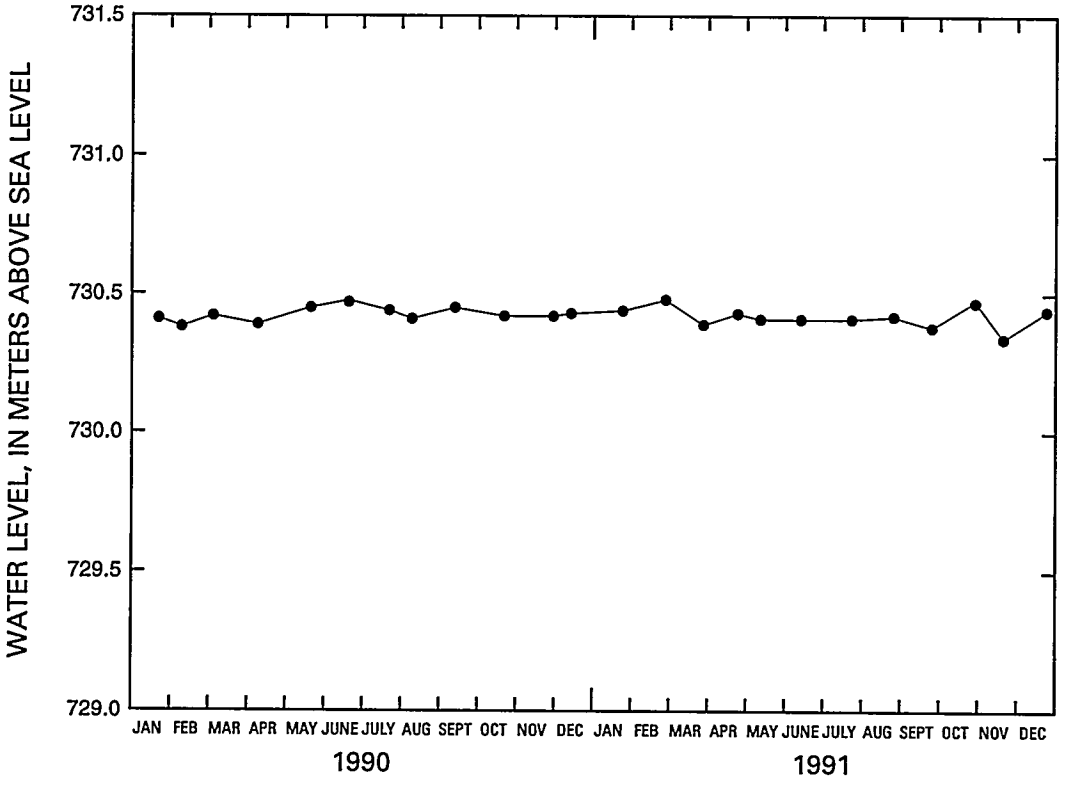

Figure 2. Water levels, 1990–91, for well USW WT-1.

Well UE-25 WT #3

1. References or information sources: Robison (1984, 1986); Robison and others (1988); Holmes & Narver, Inc. (written commun., 1986), Fenix & Scisson, Inc. (1986a, 1987c).
2. Well specifications:
   a. Location:

      Nevada State Central Zone Coordinates (m): N 227,379; E 174,768.

      Latitude and longitude: 36°47'57"N; 116°24'58"W.

      Site ID: 364757116245801.

   b. Land-surface altitude: 1,030.0 m (surveyed by U.S. Geological Survey, 1984).
   c. Date drilling started: April 29, 1983.
   d. Date drilling completed: May 25, 1983.
   e. Drilling method: Rotary using rock bits and air-foam circulating medium; bottom-hole core obtained.
   f. Total depth drilled: 348 m.
   g. Bit diameter below water level: 222 mm.
   h. Casing information: None (surface casing only, to a depth of 12 m).
   i. Description of access for measuring water levels, including tubes or piezometers: 62-mm inside-diameter tubing that has a 3.7-m-long well screen on the bottom; tubing and attached screen extend from land surface to a depth of 343 m; saturated interval 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 by U.S. Geological Survey, 1984).
   k. Description and height of MP above reference point: Top of access tube, 0.16 m.
   l. 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.
3. Water-level altitudes:

   Water-level altitudes at well UE-25 WT #3 ranged from 729.71 to 729.85 m. Mean annual water-level altitudes for 1990–91 were 729.77 and 729.78 m, respectively. The mean altitudes increased from the mean altitude of 729.73 m for 1989 (O'Brien, 1991, p. 23). Water-level altitudes are listed in table 5 and shown in figure 3.

Table 5. Measured water-level altitude and yearly mean water-level altitudes, 1990–91, for well UE-25 WT #3

[Method: C1, Chain #1; C2, Chain #2]

Date	Water-level altitude (meters)	Method
01/22/90	729.77	C2
02/16/90	729.78	C2
03/06/90	729.78	C2
04/10/90	729.72	C2
05/22/90	729.78	C2
06/21/90	729.79	C2
07/23/90	729.80	C2
08/10/90	729.75	C2
09/13/90	729.78	C2
10/22/90	729.76	C2
11/16/90	729.76	C2
12/21/90	729.75	C2
01/24/91	729.78	C2
02/27/91	729.85	C2
03/29/91	729.75	C1
04/25/91	729.78	C1
05/13/91	729.81	C1
07/24/91	729.79	C1
08/26/91	729.78	C1
09/30/91	729.75	C1
10/29/91	729.81	C1
11/20/91	729.71	C1
12/24/91	729.79	C1

1990 Mean = 729.77 meters.
1991 Mean = 729.78 meters.

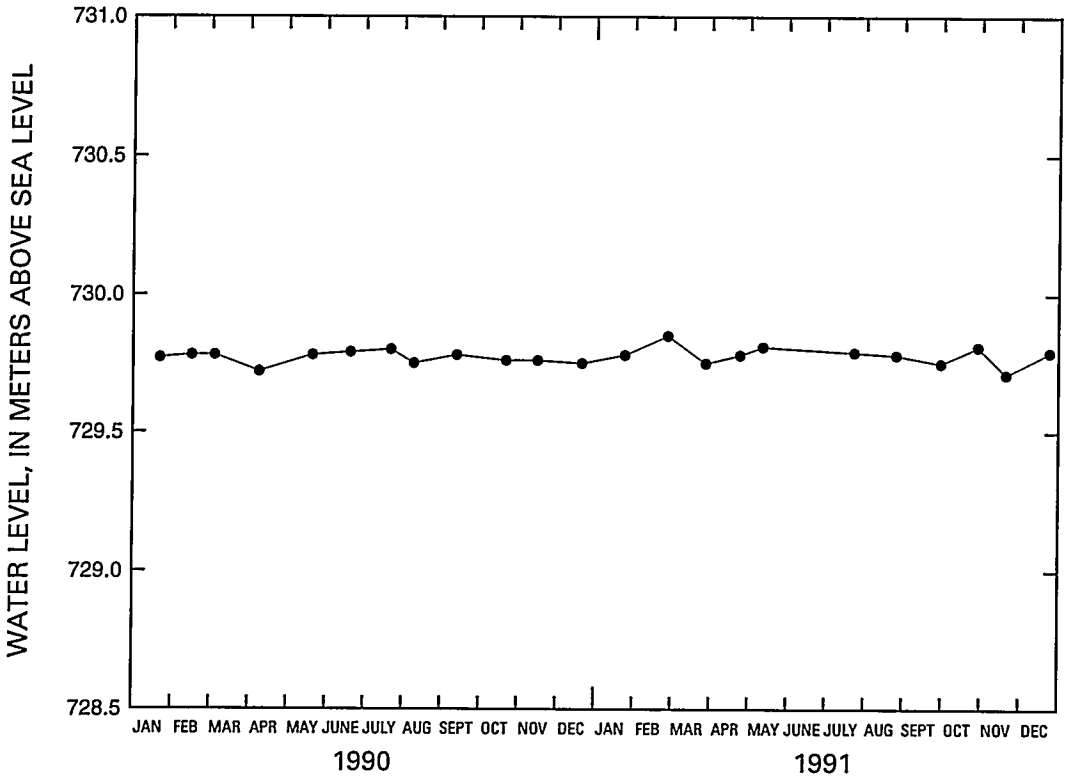

Figure 3. Water levels, 1990–91, for well UE-25 WT #3.

Well UE-25 WT #4

1. References or information sources: Robison (1984, 1986); Robison and others (1988); Holmes & Narver, Inc. (written commun., 1986); Fenix & Scisson, Inc. (1986a, 1987c).
2. Well specifications:
   a. Location:

      Nevada State Central Zone Coordinates (m): N 234,242; E 173,139.

      Latitude and longitude: 36°51'40"N; 116°26'03"W.

      Site ID: 365140116260301.

   b. Land-surface altitude: 1,169.2 m (surveyed by U.S. Geological Survey, 1984).
   c. Date drilling started: May 28, 1983.
   d. Date drilling completed: June 6, 1983.
   e. Drilling method: Rotary, using rock bits and air-foam circulating medium; bottom-hole core obtained.
   f. Total drilled depth: 482 m.
   g. Bit diameter below water level: 222 mm.
   h. Casing information: None (surface casing only, to a depth of 14.6 m).
   i. Description of access for measuring water levels, including tubes or piezometers: 62-mm inside-diameter tubing that has a 3.7-m-long well screen on the bottom; tubing and attached screen extend from land surface to a depth of 477.6 m; 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. Description and height of MP above reference point: Top of access tube, 0.31 m.
   l. Depth correction for measured water levels because of borehole deviation from vertical (the correction is subtracted from measured depth to obtain true depth): 0.45 m, based on approximate depth to water of 438 m.
3. Water-level altitudes:

   Water-level altitudes at well UE-25 WT #4 ranged from 730.79 to 730.93 m. Mean annual water-level altitudes for 1990–91 were 730.87 and 730.88 m, respectively. The mean altitudes increased from the mean altitude of 730.83 m for 1989 (O'Brien, 1991, p. 26). Water-level altitudes are listed in table 6 and shown in figure 4.

Table 6. Measured water-level altitude and yearly mean water-level altitudes, 1990–91, for well UE-25 WT #4

[Method: C1, Chain #1; C2, Chain #2]

Date	Water-level altitude (meters)	Method
01/22/90	730.87	C2
02/20/90	730.79	C2
03/12/90	730.88	C2
04/13/90	730.89	C2
05/24/90	730.90	C2
06/18/90	730.85	C2
07/23/90	730.88	C2
08/10/90	730.88	C2
09/27/90	730.90	C2
10/22/90	730.88	C2
11/16/90	730.84	C2
01/29/91	730.88	C2
02/25/91	730.84	C2
04/01/91	730.89	C1
04/29/91	730.84	C1
05/10/91	730.87	C1
06/12/91	730.89	C1
07/24/91	730.90	C1
08/30/91	730.90	C1
09/24/91	730.86	C1
10/24/91	730.93	C1
11/22/91	730.84	C1
12/26/91	730.88	C1

1990 Mean = 730.87.
1991 Mean = 730.88.

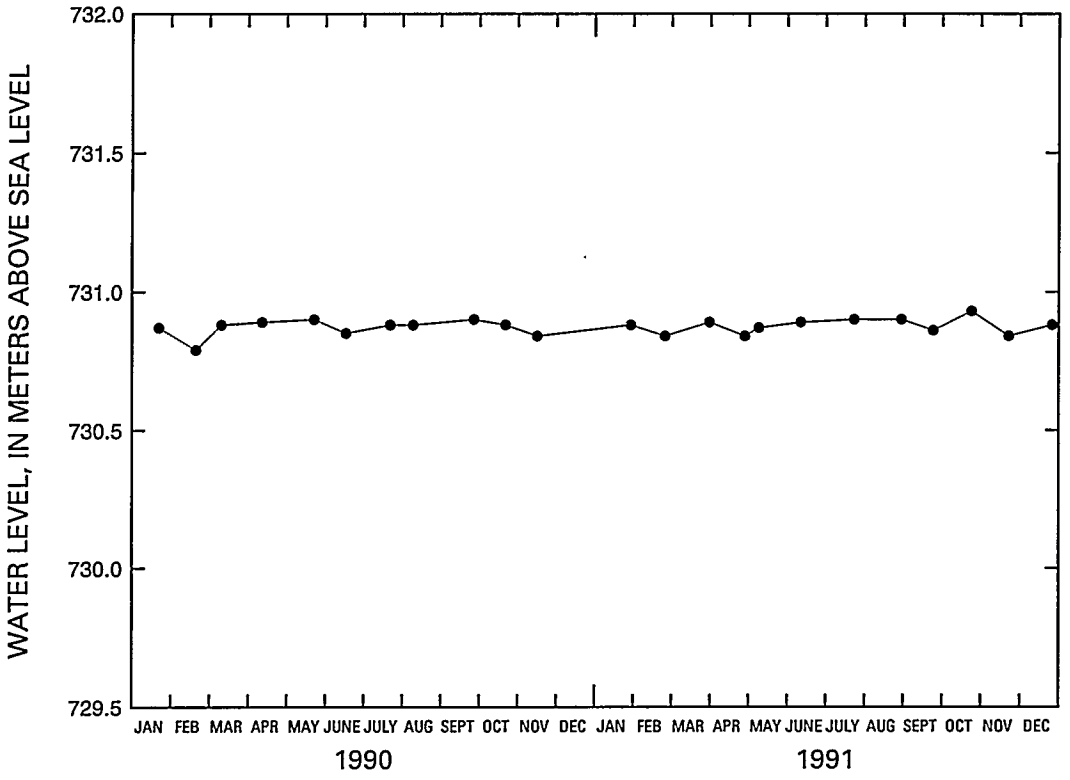

Figure 4. Water levels, 1990–91, for well UE-25 WT #4.

Well USW WT-7

1. References or information sources: Robison (1984, 1986); Robison and others (1988); Holmes & Narver, Inc. (written commun., 1986); Fenix & Scisson, Inc. (1986a, 1987c).
2. Well specifications:
   a. Location:

      Nevada State Central Zone Coordinates (m): N 230,298; E 168,826.

      Latitude and longitude: 36°49'33"N; 116°28'57"W.

      Site ID: 364933116285701.

   b. Land-surface altitude: 1,196.9 m (Robison, 1986; based on survey by U.S. Geological Survey, 1984).
   c. Date drilling started: July 19, 1983.
   d. Date drilling completed: July 26, 1983.
   e. Drilling method: Rotary, using rock bits and air-foam circulating medium; bottom-hole core obtained.
   f. Total drilled depth: 491 m.
   g. Bit diameter below water level: 222 mm.
   h. Casing information: None (surface casing only, to a depth of 15.8 m).
   i. Description of access for measuring water levels, including tubes or piezometers: 62-mm inside-diameter tubing that has a 3.7-m-long well screen on the bottom; tubing and attached screen extend from land surface to a depth of 481.3 m; 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. Description and height of MP above reference point: Top of access tube, 0.30 m.
   l. 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.
3. Water-level altitudes:

   Water-level altitudes at well USW WT-7 ranged from 775.80 to 775.99 m. Mean annual water-level altitudes for 1990–91 were 775.86 and 775.87 m, respectively. The mean altitudes increased from the mean altitude of 775.83 m for 1989 (O'Brien, 1991, p. 29). Water-level altitudes are listed in table 7 and shown in figure 5.

Table 7. Measured water-level altitude and yearly mean water-level altitudes, 1990–91, for well USW WT-7

[Method: C1, Chain #1; C2, Chain #2]

Date	Water-level altitude (meters)	Method
01/30/90	775.99	C2
02/28/90	775.85	C2
03/16/90	775.81	C2
04/18/90	775.86	C2
05/25/90	775.84	C2
06/15/90	775.87	C2
07/02/90	775.90	C2
08/17/90	775.87	C2
09/26/90	775.88	C2
10/03/90	775.82	C2
11/21/90	775.80	C2
12/31/90	775.80	C2
01/30/91	775.81	C2
02/21/91	775.91	C2
03/28/91	775.78	C1
04/26/91	775.82	C1
05/21/91	775.91	C1
06/20/91	775.87	C1
07/29/91	775.89	C1
08/29/91	775.84	C1
09/27/91	775.92	C1
10/28/91	775.84	C1
11/25/91	775.90	C1
12/30/91	775.90	C1

1990 Mean = 775.86 meters.
1991 Mean = 775.87 meters.

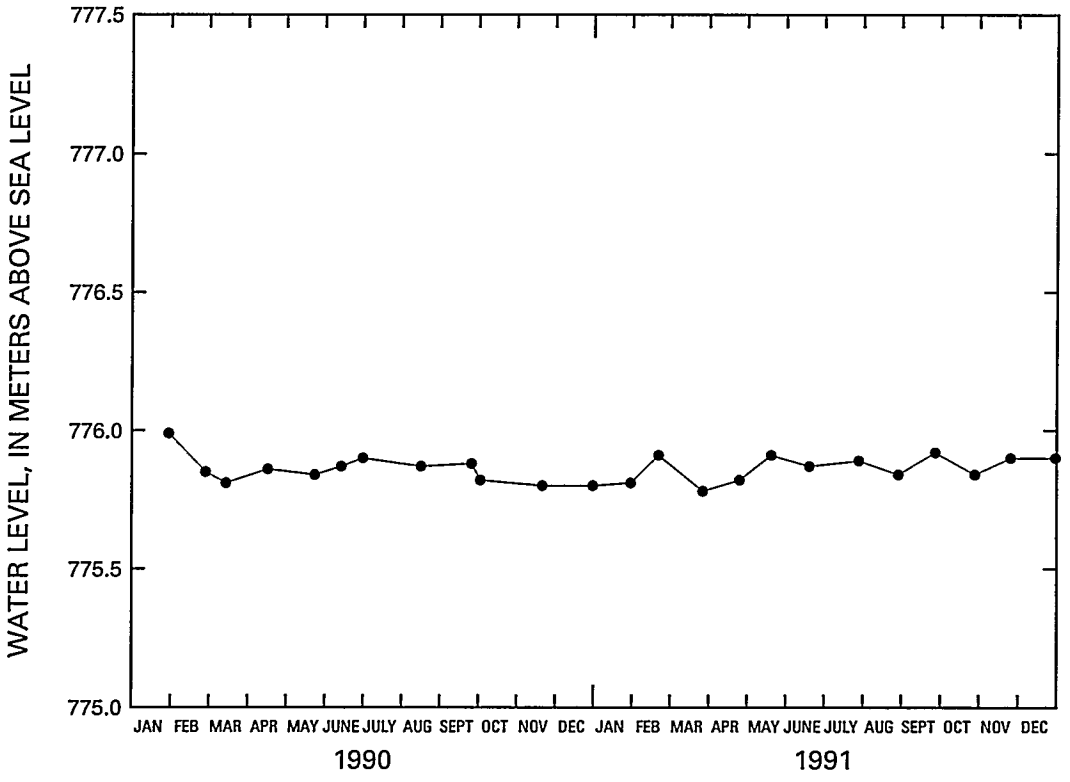

Figure 5. Water levels, 1990–91, for well USW WT-7.

Well USW WT-10

1. References or information sources: Robison (1984, 1986); Robison and others (1988); Holmes & Narver, Inc. (written commun., 1986); Fenix & Scisson, Inc. (1986a, 1987c).
2. Well specifications:
   a. Location:

      Nevada State Central Zone Coordinates (m): N 228,225; E 168,646.

      Latitude and longitude: 36°48'25"N; 116°29'05"W.

      Site ID: 364825116290501.

   b. Land-surface altitude: 1,123.4 m (surveyed by U.S. Geological Survey, 1984).
   c. Date drilling started: July 26, 1983.
   d. Date drilling completed: August 2, 1983.
   e. Drilling method: Rotary, using rock bits and air-foam circulating medium; bottom-hole core obtained.
   f. Total drilled depth: 431 m.
   g. Bit diameter below water level: 222 mm.
   h. Casing information: None (surface casing only, to a depth of 34.7 m).
   i. Description of access for measuring water levels, including tubes or piezometers: 62-mm inside-diameter tubing that has a 3.7-m-long well screen on the bottom; tubing and attached screen extend from land surface to a depth of 402.6 m; 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. Description and height of MP above reference point: Top of access tube, 0.31 m.
   l. 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 347 m.
3. Water-level altitudes:

   Water-level altitudes at well USW WT-10 ranged from 775.91 to 776.13 m. Mean annual water-level altitude for 1990–91 was 776.00 m for both years. The mean altitude increased from the mean altitude of 775.98 m for 1989 (O'Brien, 1991, p. 32). Water-level altitudes are listed in table 8 and shown in figure 6.

Table 8. Measured water-level altitude and yearly mean water-level altitudes, 1990–91, for well USW WT-10

[Method: C1, Chain #1; C2, Chain #2]

Date	Water-level altitude (meters)	Method
01/30/90	776.13	C2
02/28/90	775.96	C2
03/16/90	775.95	C2
04/18/90	776.00	C2
05/25/90	776.00	C2
06/15/90	776.01	C2
07/02/90	776.05	C2
08/17/90	776.02	C2
10/03/90	775.98	C2
11/21/90	775.94	C2
12/31/90	775.92	C2
01/30/91	775.94	C2
02/21/91	776.03	C2
03/28/91	775.91	C1
04/26/91	775.98	C1
05/21/91	776.05	C1
06/20/91	776.02	C1
07/29/91	776.04	C1
08/29/91	776.00	C1
09/27/91	776.06	C1
10/28/91	775.94	C1
11/25/91	776.05	C1
12/30/91	776.04	C1

1990 Mean = 776.00 meters.
1991 Mean = 776.00 meters.

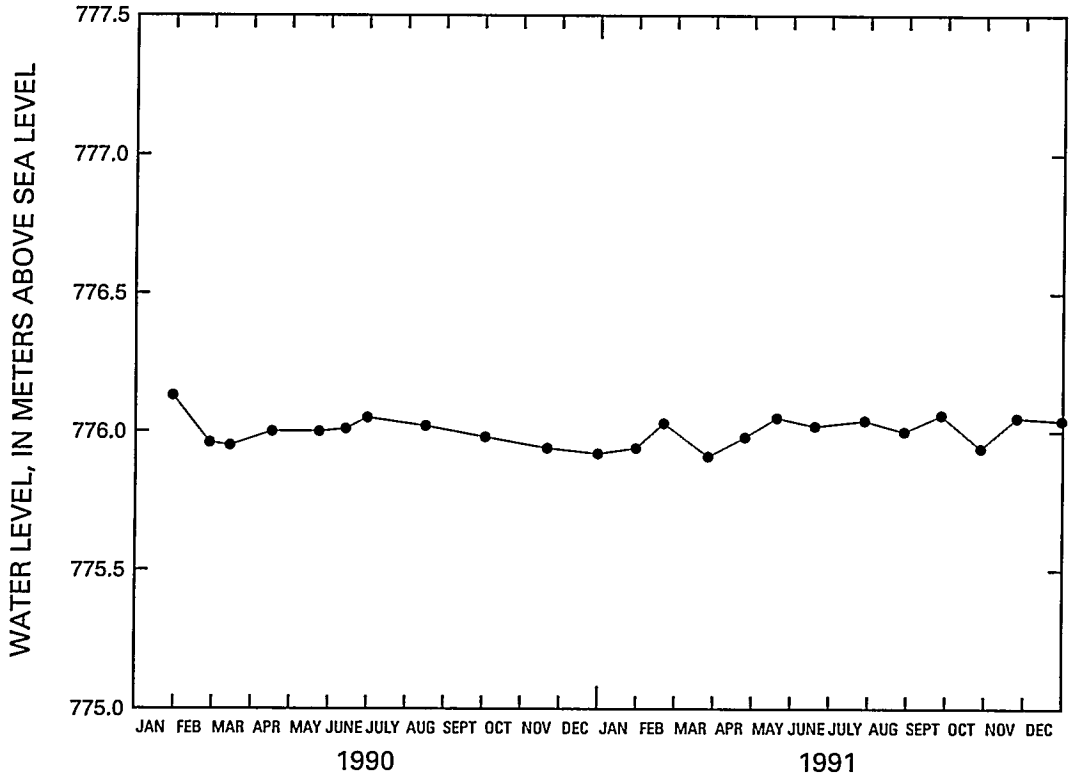

Figure 6. Water levels, 1990–91, for well USW WT-10.

Well UE-25 WT #12

1. References or information sources: Robison (1984, 1986); Robison and others (1988); Holmes & Narver, Inc. (written commun., 1986); Fenix & Scisson, Inc. (1986a, 1987c).
2. Well specifications:
   a. Location:

      Nevada State Central Zone Coordinates (m): N 225,468; E 172,825.

      Latitude and longitude: 36°46'56"N; 116°26'16"W.

      Site ID: 364656116261601.

   b. Land-surface altitude: 1,074.7 m (surveyed by U.S. Geological Survey, 1984).
   c. Date drilling started: August 11, 1983.
   d. Date drilling completed: August 16, 1983.
   e. Drilling method: Rotary, using rock bits and air-foam circulating medium; bottom-hole core obtained.
   f. Total drilled depth: 399 m.
   g. Bit diameter below water level: 222 mm.
   h. Casing information: None (surface casing only, to a depth of 21.3 m).
   i. Description of access for measuring water levels, including tubes or piezometers: 62-mm inside-diameter tubing that has a 3.7-m-long well screen on the bottom; tubing and attached screen extend from land surface to a depth of 388.9 m; 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. Description and height of MP above reference point: Top of access tube, 0.30 m.
   l. Depth correction for measured water levels because of borehole deviation from vertical (the correction is subtracted from measured depth to obtain true depth): 0.18 m, based on approximate depth to water of 345 m.
3. Water-level altitudes:

   Water-level altitudes at well USW WT-12 ranged from 729.47 to 729.57 m. Mean annual water-level altitudes for 1990–91 were 729.52 and 729.53 m, respectively. The mean altitudes increased from the mean altitude of 729.49 m for 1989 (O'Brien, 1991, p. 35). Water-level altitudes are listed in table 9 and shown in figure 7.

Table 9. Measured water-level altitude and yearly mean water-level altitudes, 1990–91, for well UE-25 WT #12

[Method: C1, Chain #1; C2, Chain #2]

Date	Water-level altitude (meters)	Method
01/23/90	729.52	C2
02/08/90	729.50	C2
03/09/90	729.54	C2
04/17/90	729.51	C2
05/23/90	729.57	C2
06/20/90	729.51	C2
07/11/90	729.51	C2
08/20/90	729.51	C2
09/28/90	729.52	C2
10/29/90	729.51	C2
11/30/90	729.54	C2
01/24/91	729.52	C2
02/25/91	729.47	C2
03/27/91	729.52	C1
04/30/91	729.51	C1
05/14/91	729.56	C1
06/11/91	729.51	C1
07/25/91	729.54	C1
08/27/91	729.55	C1
09/25/91	729.52	C1
10/25/91	729.53	C1
11/21/91	729.57	C1
12/31/91	729.54	C1

1990 Mean = 729.52 meters.
1991 Mean = 729.53 meters.

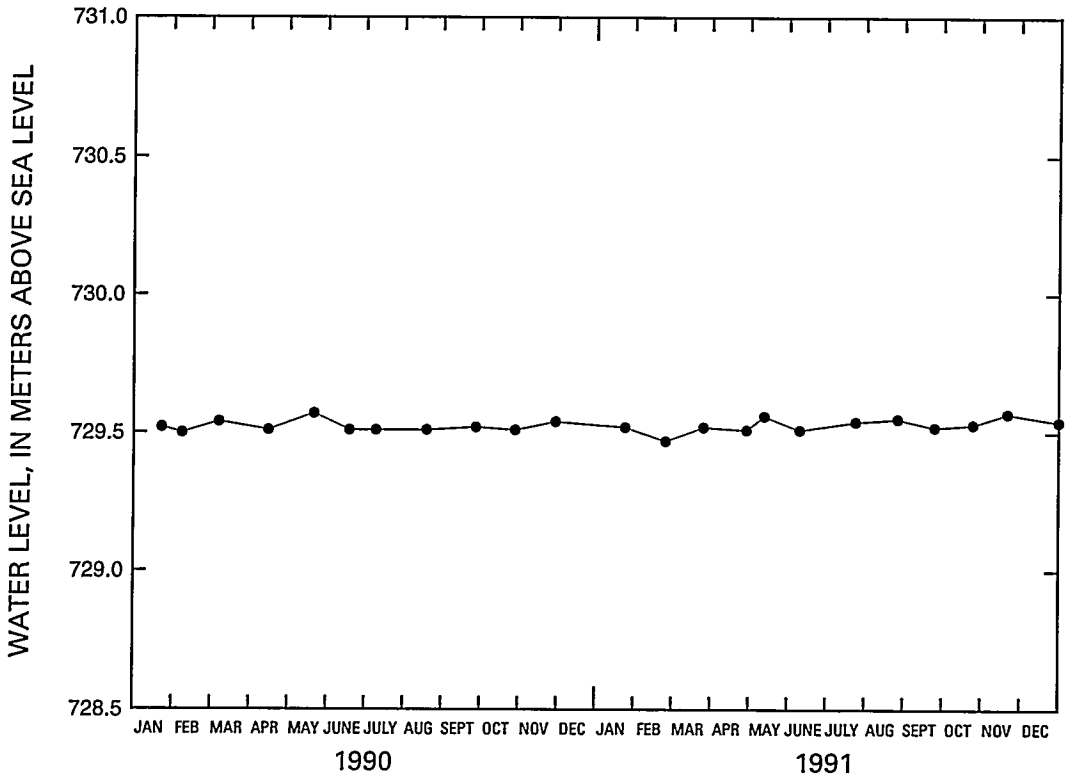

Figure 7. Water levels, 1990–91, for well UE-25 WT #12.

Well UE-25 WT #14

1. References or information sources: Robison (1984, 1986); Robison and others (1988); Holmes & Narver, Inc., (written commun., 1986); Fenix & Scisson, Inc. (1986a, 1987c).
2. Well specifications:
   a. Location:

      Nevada State Central Zone Coordinates (m): N 232,151; E 175,324.

      Latitude and longitude: 36°50'32"N; 116°24'35"W.

      Site ID: 365032116243501.

   b. Land-surface altitude: 1,075.9 m (surveyed by U.S. Geological Survey, 1984).
   c. Date drilling started: August 17, 1983.
   d. Date drilling completed: September 30, 1983.
   e. Drilling method: Rotary, using rock bits and air-foam circulating medium; bottom-hole core obtained.
   f. Total drilled depth: 399 m.
   g. Bit diameter below water level: 222 mm.
   h. Casing information: None (surface casing only, to a depth of 36.6 m).
   i. Description of access for measuring water levels, including tubes or piezometers: 62-mm inside-diameter tubing that has a 3.7-m-long well screen on the bottom; tubing and attached screen extend from land surface to a depth of 397.2 m; 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. Description and height of MP above reference point: Top of access tube, 0.31 m.
   l. 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 346 m.
3. Water-level altitudes:

   Water-level altitudes at well UE-25 WT #14 ranged from 729.68 to 729.86 m. Mean annual water-level altitudes for 1990–91 were 729.72 and 729.74 m, respectively. The mean altitude for 1991 increased slightly from the mean altitude of 729.72 m for 1989 (O'Brien, 1991, p. 38). Water-level altitudes are listed in table 10 and shown in figure 8.

Table 10. Measured water-level altitude and yearly mean water-level altitudes, 1990–91, for well UE-25 WT #14

[Method: C1, Chain #1; C2, Chain #2]

Date	Water-level altitude (meters)	Method
01/25/90	729.68	C2
02/20/90	729.68	C2
03/09/90	729.77	C2
04/13/90	729.71	C2
05/24/90	729.72	C2
06/18/90	729.70	C2
07/23/90	729.72	C2
08/15/90	729.74	C2
09/27/90	729.74	C2
10/22/90	729.73	C2
11/16/90	729.71	C2
12/21/90	729.72	C2
01/28/91	729.79	C2
02/28/91	729.86	C2
03/27/91	729.73	C1
04/29/91	729.74	C1
05/07/91	729.74	C1
06/13/91	729.74	C1
07/23/91	729.73	C1
08/30/91	729.71	C1
09/16/91	729.71	C1
10/24/91	729.75	C1
11/22/91	729.70	C1
12/26/91	729.71	C1

1990 Mean = 729.72 meters.
1991 Mean = 729.74 meters.

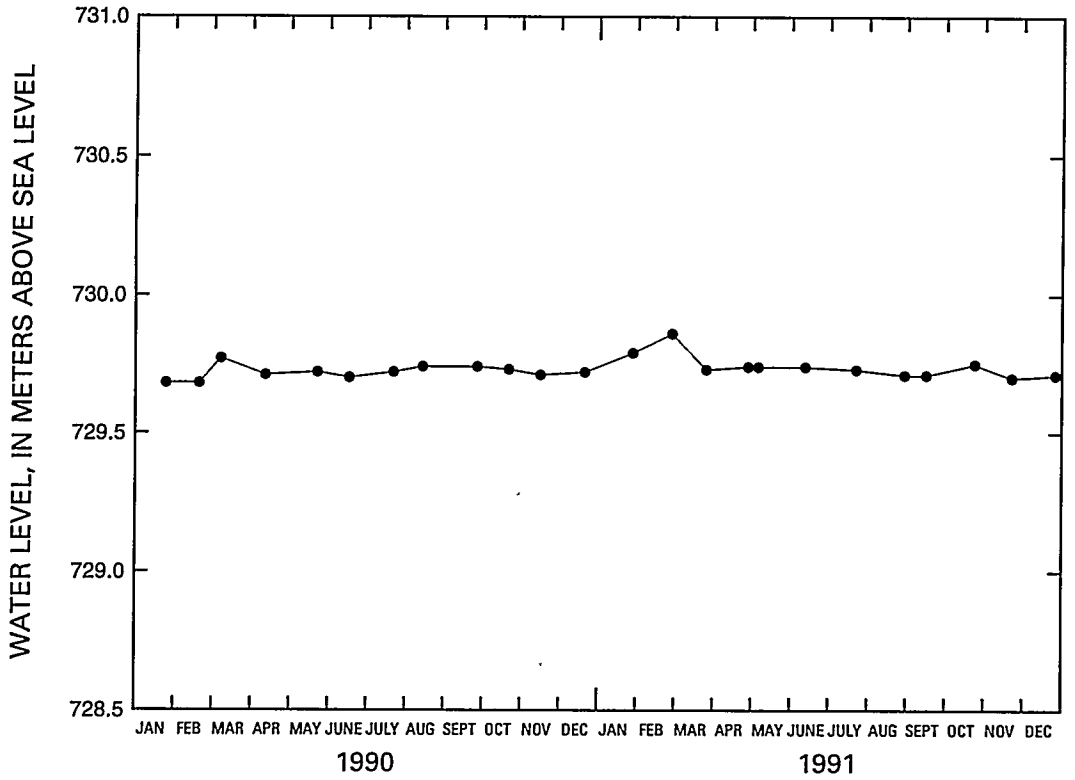

Figure 8. Water levels, 1990–91, for well UE-25 WT #14.

Well UE-25 WT #15

1. References or information sources: Robison (1984, 1986); Robison and others (1988); Holmes & Narver, Inc. (written commun., 1986); Fenix & Scisson, Inc. (1986a, 1987c).
2. Well specifications:
   a. Location:

      Nevada State Central Zone Coordinates (m): N 233,512; E 176,725.

      Latitude and longitude: 36°51'16"N; 116°23'38"W.

      Site ID: 365116116233801.

   b. Land-surface altitude: 1,083.2 m (surveyed by U.S. Geological Survey, 1984).
   c. Date drilling started: November 12, 1983.
   d. Date drilling completed: November 22, 1983.
   e. Drilling method: Rotary, using rock bits and air-foam circulating medium; bottom-hole core obtained.
   f. Total drilled depth: 415 m.
   g. Bit diameter below water level: 222 mm.
   h. Casing information: None (surface casing only, to a depth of 38.7 m).
   i. Description of access for measuring water levels, including tubes or piezometers: 62-mm inside-diameter tubing that has a 3.7-m-long well screen on the bottom; tubing and attached screen extend from land surface to a depth of 406.9 m; 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. Description and height of MP above reference point: Top of access tube, 0.31 m.
   l. 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.
3. Water-level altitudes:

   Water-level altitudes at well UE-25 WT #15 ranged from 729.16 to 729.42 m. Mean annual water-level altitudes for 1990–91 were 729.24 and 729.26 m, respectively. The mean altitude for 1991 increased slightly from the mean altitude of 729.24 m for 1989 (O'Brien, 1991, p. 41). Water-level altitudes are listed in table 11 and shown in figure 9.

Table 11. Measured water-level altitude and yearly mean water-level altitudes, 1990–91, for well UE-25 WT #15

[Method: C1, Chain #1; C2, Chain #2]

Date	Water-level altitude (meters)	Method
01/23/90	729.27	C2
02/20/90	729.19	C2
03/12/90	729.27	C2
04/16/90	729.34	C2
05/30/90	729.27	C2
06/18/90	729.21	C2
07/23/90	729.26	C2
08/15/90	729.31	C2
09/21/90	729.19	C2
10/22/90	729.22	C2
11/16/90	729.21	C2
12/21/90	729.20	C2
01/28/91	729.32	C2
02/28/91	729.42	C2
04/02/91	729.16	C1
04/25/91	729.29	C1
05/07/91	729.22	C1
06/13/91	729.25	C1
07/23/91	729.23	C1
08/27/91	729.30	C1
09/16/91	729.19	C1
10/25/91	729.27	C1
11/26/91	729.22	C1
12/26/91	729.22	C1

1990 Mean = 729.24 meters.
1991 Mean = 729.26 meters.

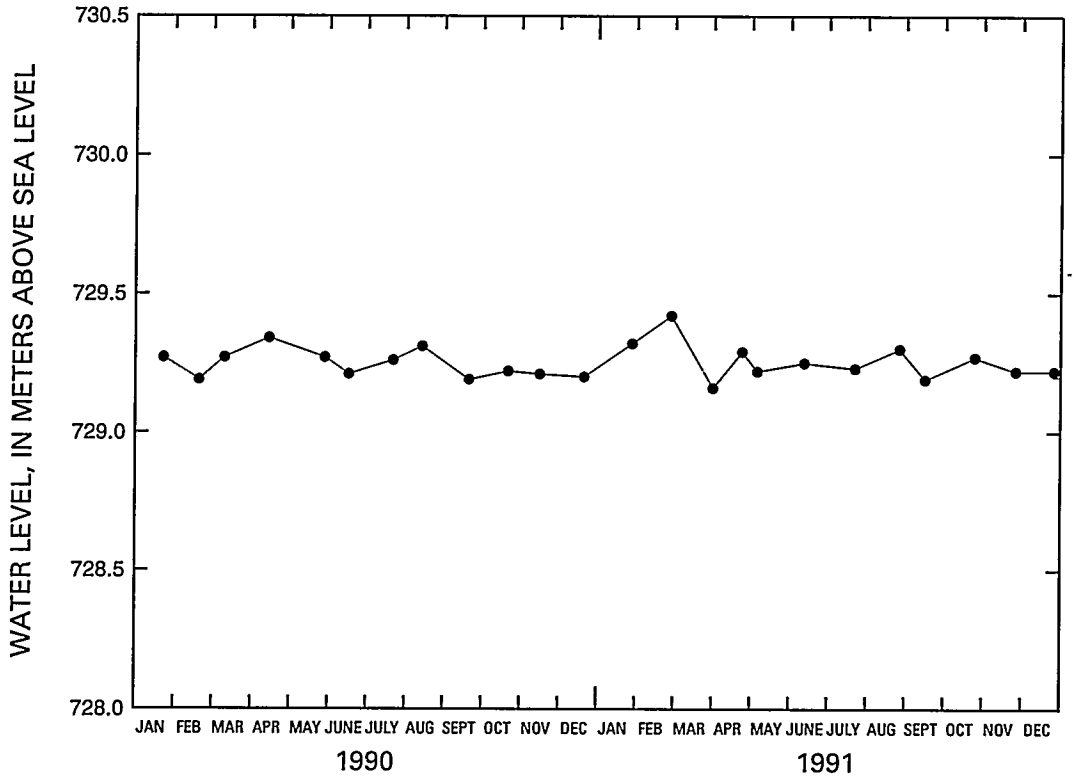

Figure 9. Water levels, 1990–91, for well UE-25 WT #15.

Well UE-25 WT #17

1. References or information sources: Robison (1984, 1986); Robison and others (1988); Holmes & Narver, Inc. (written commun., 1986); Fenix & Scisson, Inc. (1986a, 1987c).
2. Well specifications:
   a. Location:

      Nevada State Central Zone Coordinates (m): N 228,118; E 172,581.

      Latitude and longitude: 36°48'22"N; 116°26'26"W.

      Site ID: 364822116262601.

   b. Land-surface altitude: 1,124.0 m (surveyed by U.S. Geological Survey, 1984).
   c. Date drilling started: October 20, 1983.
   d. Date drilling completed: October 30, 1983.
   e. Drilling method: Rotary, using rock bits and air-foam circulating medium; attempt to obtain bottom-hole core unsuccessful.
   f. Total drilled depth: 443 m.
   g. Bit diameter below water level: 222 mm.
   h. Casing information: None (surface casing only, to a depth of 16.8 m).
   i. Description of access for measuring water levels, including tubes or piezometers: 62-mm inside-diameter tubing that has a 3.7-m-long well screen on the bottom; tubing and attached screen extend from land surface to a depth of 419.4 m; 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. Description and height of MP above reference point: Top of access tube, 0.16 m.
   l. 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 394 m.
3. Water-level altitudes:

   Water-level altitudes at well UE-25 WT #17 ranged from 729.72 to 729.84 m. Mean annual water-level altitudes for 1990–91 were 729.76 and 729.77 m, respectively. The mean altitude for 1990 decreased slightly from the mean altitude of 729.77 m for 1989 (O'Brien, 1991, p. 44). Water-level altitudes are listed in table 12 and shown in figure 10.

Table 12. Measured water-level altitude and yearly mean water-level altitudes, 1990–91, for well UE-25 WT #17

[Method: C1, Chain #1; C2, Chain #2]

Date	Water-level altitude (meters)	Method
01/22/90	729.78	C2
02/09/90	729.72	C2
03/06/90	729.72	C2
04/10/90	729.72	C2
05/22/90	729.73	C2
06/21/90	729.79	C2
07/23/90	729.78	C2
08/10/90	729.76	C2
09/13/90	729.78	C2
10/22/90	729.76	C2
11/30/90	729.78	C2
12/14/90	729.79	C2
01/24/91	729.77	C2
02/27/91	729.84	C2
03/29/91	729.75	C1
04/25/91	729.79	C1
05/13/91	729.78	C1
06/14/91	729.75	C1
07/24/91	729.78	C1
08/26/91	729.77	C1
09/30/91	729.75	C1
10/29/91	729.81	C1
11/20/91	729.72	C1
12/24/91	729.79	C1

1990 Mean = 729.76 meters.
1991 Mean = 729.77 meters.

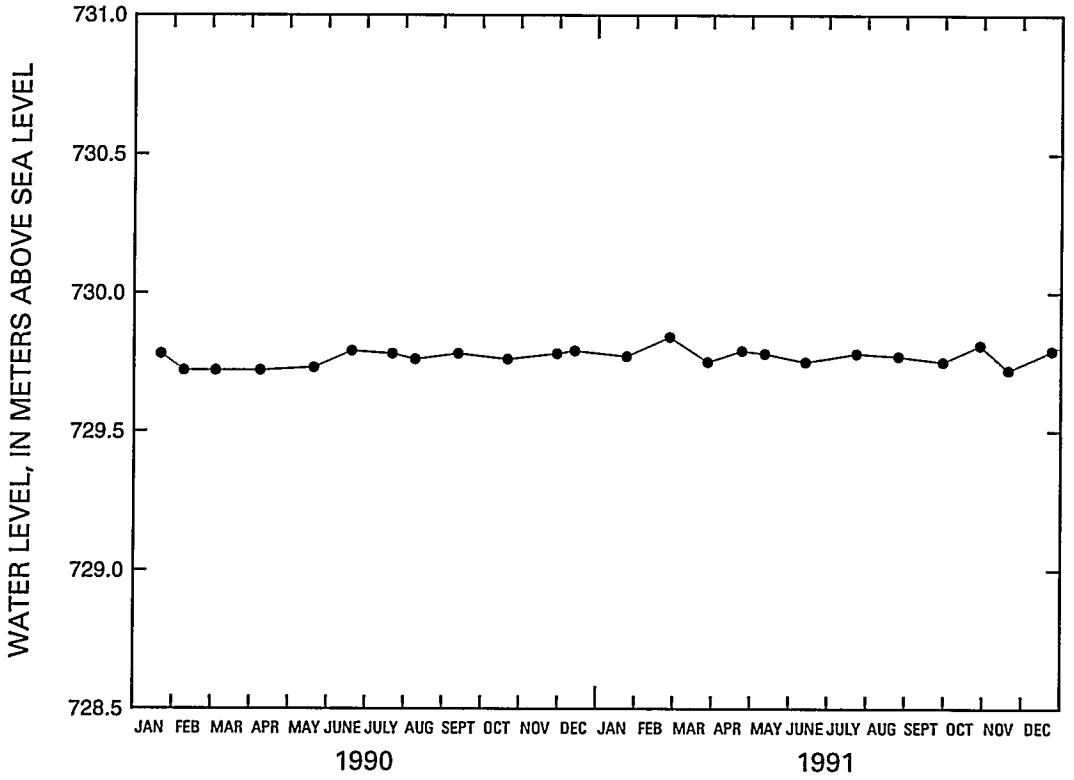

Figure 10. Water levels, 1990–91, for well UE-25 WT #17.

Well UE-25 WT #18

1. References or information sources: Fenix & Scisson, Inc. (1986a); Holmes & Narver, Inc. (written commun., 1986); Muller and Kibler (1985).
2. Well specifications:
   a. Location:

      Nevada State Central Zone Coordinates (m): N 235,052; E 172,168.

      Latitude and longitude: 36°52'07"N; 116°26'42"W.

      Site ID: 365207116264201.

   b. Land-surface altitude: 1,335.94 m (surveyed by U.S. Geological Survey, 1984).
   c. Date drilling started: May 9, 1984.
   d. Date drilling completed: May 23, 1984.
   e. Drilling method: Rotary using rock bits and air-foam circulating medium; bottom-hole core obtained.
   f. Total depth drilled: 623 m.
   g. Bit diameter below water level: 222 mm.
   h. Casing information: None (surface casing only, to a depth of 27 m).
   i. Description of access for measuring water levels, including tubes or piezometers: 62-mm inside-diameter tubing that has a 3.7-m-long well screen on the bottom; tubing and attached screen originally extended from land surface to a depth of 597 m, but tubing was extended to a depth of 609 m, December 1990; saturated interval within tuffaceous beds of Calico Hills.
   j. Description and altitude of reference point: Top of metal tag on well casing, 1,336.32 m (surveyed by U.S. Geological Survey, 1984).
   k. Description and height of MP above reference point: Top of access tube, 0.23 m prior to December 18, 1990; 0.21 m after December 18, 1990.
   l. 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 606 m.
3. Water-level altitudes:

   Water-level measurements could not be obtained in well UE-25 WT #18 until the access tubing and screen were lowered to their present depth of 609 m in December 1990. Five measurements were made in early 1991, and water-level altitudes averaged about 729.5 m during that time (fig. 11). Subsequent measurements, until late 1991, were considered "invalid" because of large differences in repeat measurements. The last two measurements in 1991 resulted in water-level altitudes that were higher than those obtained earlier in the year, and water-level altitudes averaged about 730.8 m for the last two measurements of 1991 (fig. 11). The mean water-level altitude for all of 1991 was 729.85 m. Water-level altitudes for well UE-25 WT #18 are listed in table 13.

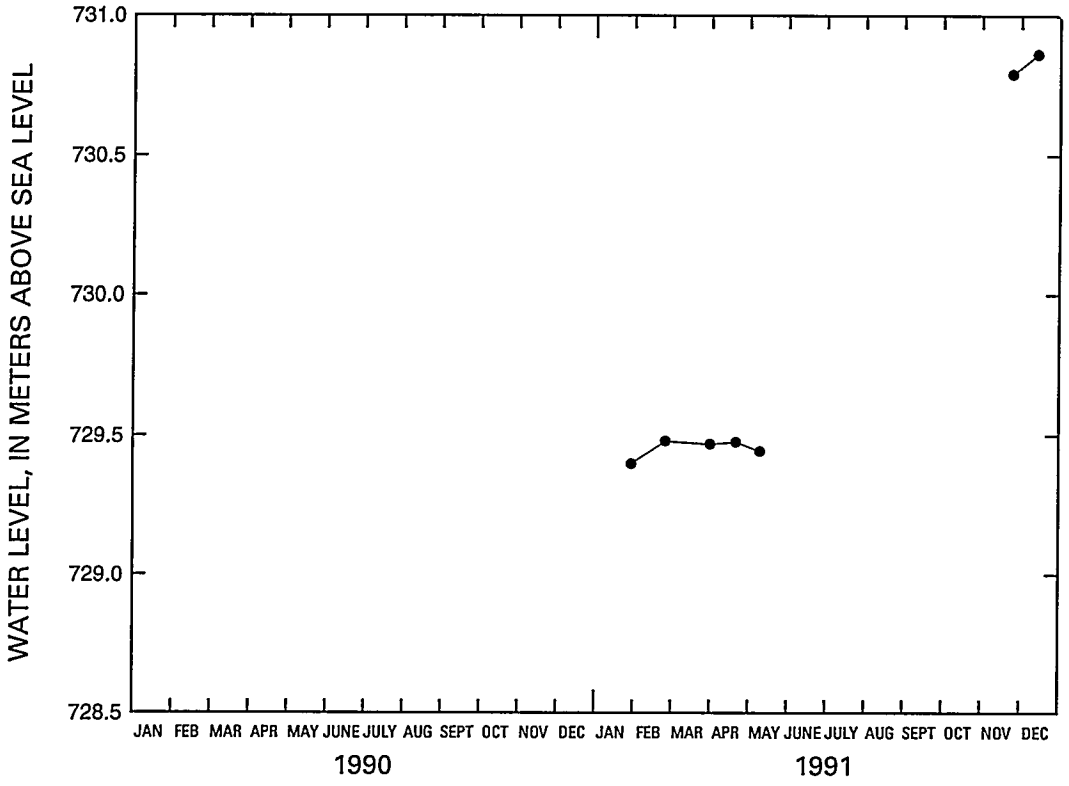

Figure 11. Water levels, 1990–91, for well UE-25 WT #18.

Table 13. Measured water-level altitude and yearly mean water-level altitude, 1990–91, for well UE-25 WT #18

[Method: C1, Chain #1; C2, Chain #2]

Date	Water-level altitude (meters)	Method
	No measurements in 1990	
01/29/91	729.40	C2
02/25/91	729.48	C2
04/01/91	729.47	C2
04/22/91	729.48	C1
05/10/91	729.45	C1
11/22/91	730.79	C1
12/12/91	730.86	C1

1990 Mean not available.

1991 Mean = 729.85 meters.

Well USW VH-1

1. References or information sources: Robison (1984, 1986); Robison and others (1988); Holmes & Narver, Inc. (written commun., 1986); Fenix & Scisson, Inc. (1986b, 1987c); Thordarson and Howells (1987).
2. Well specifications:
   a. Location:

      Nevada State Central Zone Coordinates (m): N 226,575; E 162,649.

      Latitude and longitude: 36°47'32"N; 116°33'07"W.

      Site ID: 364732116330701.

   b. Land-surface altitude: 963.5 m (Robison, 1986).
   c. Date drilling started: October 28, 1980.
   d. Date drilling completed: February 18, 1981.
   e. Drilling method: Rotary, using rock bits, and air-foam and polymer circulating medium.
   f. Total drilled depth: 762 m.
   g. Bit diameter below water level: 222 mm to 278 m; 159 mm from 278 m to total depth.
   h. Casing information: 177-mm inside diameter to 278 m.
   i. Description of access for measuring water levels, including tubes or piezometers: 48-mm inside-diameter tubing, open ended from land surface to 205.4 m; saturated interval of well within Tiva Canyon, and Topopah Spring Members of the Paintbrush Tuff, and Prow Pass, and Bullfrog Members of Crater Flat Tuff. A pump was installed in the well on July 8, 1982, at a depth of 212.8 m.
   j. Description and altitude of reference point: Top of metal tag on well casing, 963.23 m (Holmes & Narver, Inc., March 3, 1986).
   k. Description and height of MP above land surface: Top of access tube, 0.31 m prior to November 1991; 0.63 m after November 1991.
   l. 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.
3. Water-level altitudes:

   Water-level altitudes at well USW VH-1 ranged from 779.40 to 779.60 m. Mean annual water-level altitude for 1990–91 was 779.47 m for both years. The mean altitudes decreased slightly from the mean altitude of 779.48 m for 1989 (O'Brien, 1991, p. 47). Water-level altitudes for well USW VH-1 are listed in table 14 and shown in figure 12.

Table 14. Measured water-level altitude and yearly mean water-level altitudes, 1990–91, for well USW VH-1

[Method: C1, Chain #1; C2, Chain #2]

Date	Water-level altitude (meters)	Method
01/30/90	779.60	C2
02/28/90	779.47	C2
03/16/90	779.46	C2
04/18/90	779.47	C2
06/15/90	779.46	C2
07/02/90	779.52	C2
08/17/90	779.47	C2
09/26/90	779.46	C2
10/03/90	779.43	C2
11/21/90	779.40	C2
12/31/90	779.41	C2
01/30/91	779.43	C2
02/21/91	779.51	C2
03/28/91	779.41	C1
04/26/91	779.44	C1
05/21/91	779.51	C1
06/20/91	779.49	C1
07/29/91	779.51	C1
08/29/91	779.44	C1
09/27/91	779.51	C1

1990 Mean = 779.47 meters.
1991 Mean = 779.47 meters.

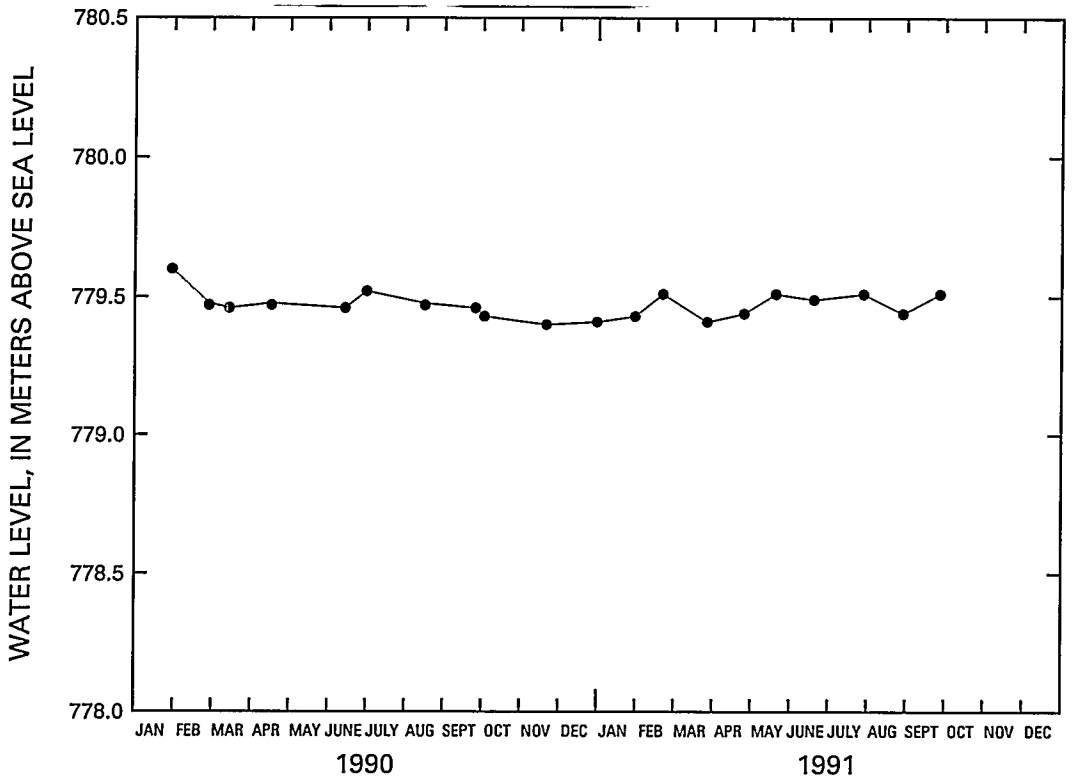

Figure 12. Water levels, 1990–91, for well USW VH-1.

Well J-13

1. References or information sources: Robison (1984, 1986); Robison and others (1988); Holmes & Narver, Inc. (written commun., 1986); Thordarson (1983); Young (1972); Fenix & Scisson (1987c).
2. Well specifications:
   a. Location:

      Nevada State Central Zone Coordinates (m): N 228,359; E 176,678.

      Latitude and longitude: 36°48'29"N; 116°23'40"W.

      Site ID: 364828116234001.

   b. Land-surface altitude: 1,011.3 m (Robison, 1986).
   c. Date drilling started: September 12, 1962.
   d. Date drilling completed: January 8, 1963.
   e. Drilling method: Rotary, using air and aerated mud as circulating medium.
   f. Total drilled depth: 1,063 m.
   g. Bit diameter below water level: 438 mm to 402 m; 380 mm from 402 to 471 m; 194 mm from 471 m to total depth.
   h. Casing information: 323-mm inside diameter, from land surface to 396.5 m; 282-mm inside diameter from 396.5 to 471.2 m; 126-mm inside diameter from 452.3 to 1,031.7 m; casing perforated from 303.6 to 423.7 m within Topopah Spring Member of Paintbrush Tuff, and from 819.9 to 1,009.5 m within Tram Member of Crater Flat Tuff and upper part of Lithic Ridge Tuff.
   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. Description and height of MP above reference point: Top of access tube, 0.16 m.
   l. Depth correction for measured water levels because of well deviation from vertical: Not available.
3. Water-level altitudes:

   Water-level altitudes at well J-13 ranged from 728.38 to 728.68 m. Mean annual water-level altitudes for 1990–91 were 728.44 and 728.47 m, respectively. The mean altitude for 1990 decreased slightly, and the mean altitude for 1991 increased slightly from the mean altitude of 728.45 m for 1989 (O'Brien, 1991, p. 50). Water-level altitudes are listed in table 15 and shown in figure 13.

Table 15. Measured water-level altitude and yearly mean water-level altitudes, 1990–91, for well J-13

[Method: R, 2,800-ft reference steel tape; C1, Chain #1; C2, Chain #2]

Date	Water-level altitude (meters)	Method
01/25/90	728.38	C2
02/09/90	728.39	C2
03/09/90	728.51	C2
04/20/90	728.44	C2
05/23/90	728.48	C2
06/20/90	728.45	C2
07/10/90	728.39	C2
08/15/90	728.50	C2
09/14/90	728.46	C2
10/29/90	728.51	C2
11/27/90	728.42	C2
12/13/90	728.38	C2
01/31/91	728.40	C2
02/25/91	728.41	C2
03/27/91	728.48	C1
04/24/91	728.68	C1
05/16/91	728.50	C1
06/10/91	728.45	C1
07/25/91	728.49	C1
08/22/91	728.42	C1
09/16/91	728.39	C1
10/25/91	728.50	C1
11/21/91	728.48	C1
12/17/91	728.50	R

1990 Mean = 728.44 meters.
1991 Mean = 728.47 meters.

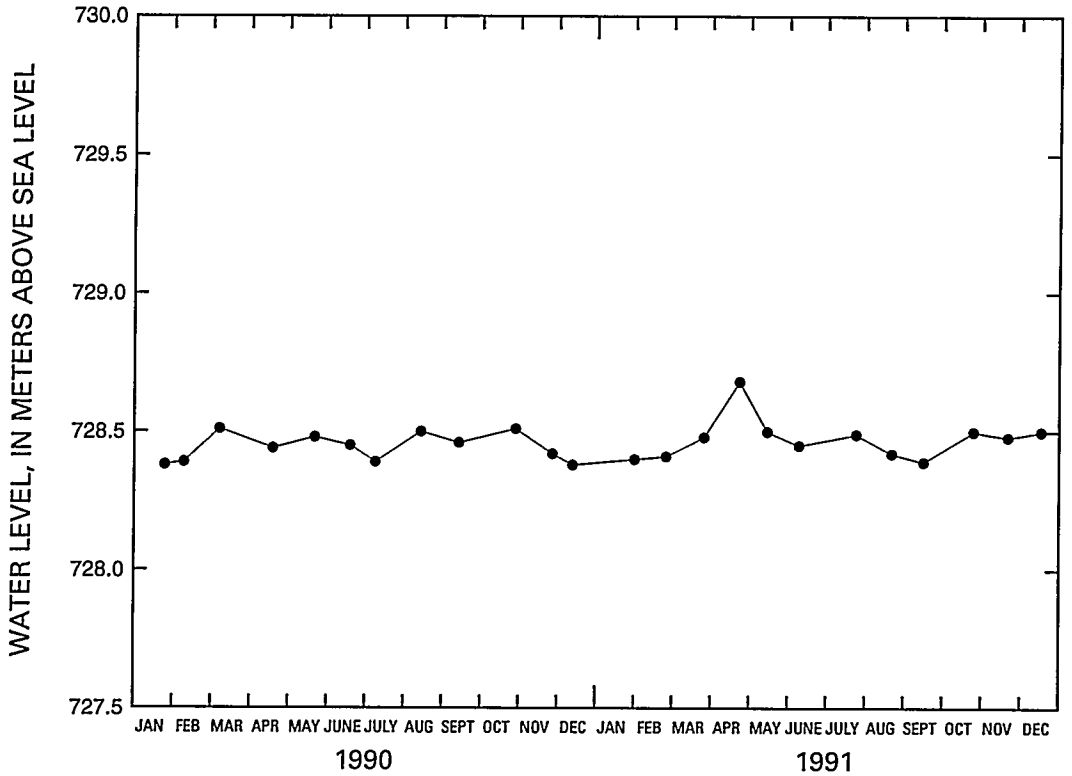

Figure 13. Water levels, 1990–91, for well J-13.

Hourly Water-Level Measurements

References or information sources, well specifications, calibration information, hydrographs of water-level altitude, and tables of mean monthly water levels are presented for individual wells and monitored intervals in the hourly water-level network for 1990–91. Calibration information includes the transducer serial number, calibration date, slope of the regression curve, coefficient of determination, and the water-level altitude determined at the time of calibration. Comments concerning any special conditions or information that might affect the results of the calibrations are included, as well as explanations for periods of missing water-level data.

Water-level altitudes are presented as annual hydrographs that were converted from the transducer data for 1990 and 1991. Only those data that were evaluated as "valid" are presented. Tables are presented for each well or monitored interval of monthly mean water level; however, a monthly mean was not calculated if data were not available for more than half of the month. Annual mean, minimum, and maximum water-level altitudes are also presented for each well or monitored interval.

Well USW WT-2

1. References or information sources: Robison (1984, 1986); Robison and others (1988); Holmes & Narver, Inc. (written commun., 1986); Fenix & Scisson, Inc (1986a, 1987c).
2. Well specifications:
   a. Location:

      Nevada State Central Zone Coordinates (m): N 231,849; E 171,274.

      Latitude and longitude: 36°50'23"N; 116°27'18"W.

      Site ID: 365023116271801.

   b. Land-surface altitude: 1,301.3 m (surveyed by U.S. Geological Survey, 1984).
   c. Date drilling started: July 8, 1983.
   d. Date drilling completed: July 16, 1983.
   e. Drilling method: Rotary using rock bits and air-foam circulating medium; bottom-hole core obtained.
   f. Total depth drilled: 628 m.
   g. Bit diameter below water level: 222.2 mm.
   h. Casing information: None (surface casing only, to a depth of 18 m).
   i. Description of access for measuring water levels, including tubes or piezometers: 62-mm inside-diameter tubing that has a 3.7-m-long well screen on the bottom; tubing and attached screen extend from land surface to a depth of 622 m; saturated interval 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. Description and height of MP above reference point: Top of access tube, 0.314 m.
   l. 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.

3. Calibrations and comments:

Ten calibrations, for two transducers, were performed during 1990–91. In addition, calibrations performed on 12/14/89 and 1/2/92 were used to calculate water-level altitudes at the beginning and end of the 1990–91 period. Results of the calibrations and measured water-level altitudes obtained during the calibrations are listed as follows:

Transducer serial number	Calibration date	Slope (mV/m)	Coefficient of determination (r^2)	Water-level altitude (m)
228778	12/14/89	6.58	1.00	730.77
228778	03/26/90	6.54	1.00	730.80
228778	07/24/90	6.52	1.00	730.82
228778	11/20/90	6.50	1.00	730.81
228778	01/16/91	6.60	1.00	730.78
228778	01/16/91	1.26	1.00	730.78
228778	04/16/91	1.25	1.00	730.82
228778	04/16/91	1.30	1.00	730.82
228778	05/08/91	1.29	0.99	730.84
341812	05/09/91	1.36	1.00	730.84
341812	09/04/91	1.33	0.99	730.78
341812	01/02/92	1.34	1.00	730.79

Transducer data from 1/2/91 through 4/16/91 were erratic and are considered unreliable. Transducer data are missing for 5/8/91 and 5/9/91, and an anomalous water level associated with an electronic spike in the transducer data on 8/31/91 is not considered valid.

4. Water-level altitudes:

Water-level altitudes for well USW WT-2 ranged from 730.61 to 731.01 m above sea level in 1990, and from 730.67 to 730.97 m above sea level in 1991 (fig. 14). The mean water-level altitudes for 1990 and 1991 were 730.76 and 730.79 m above sea level, respectively. Mean monthly water-level altitudes are listed in table 16.

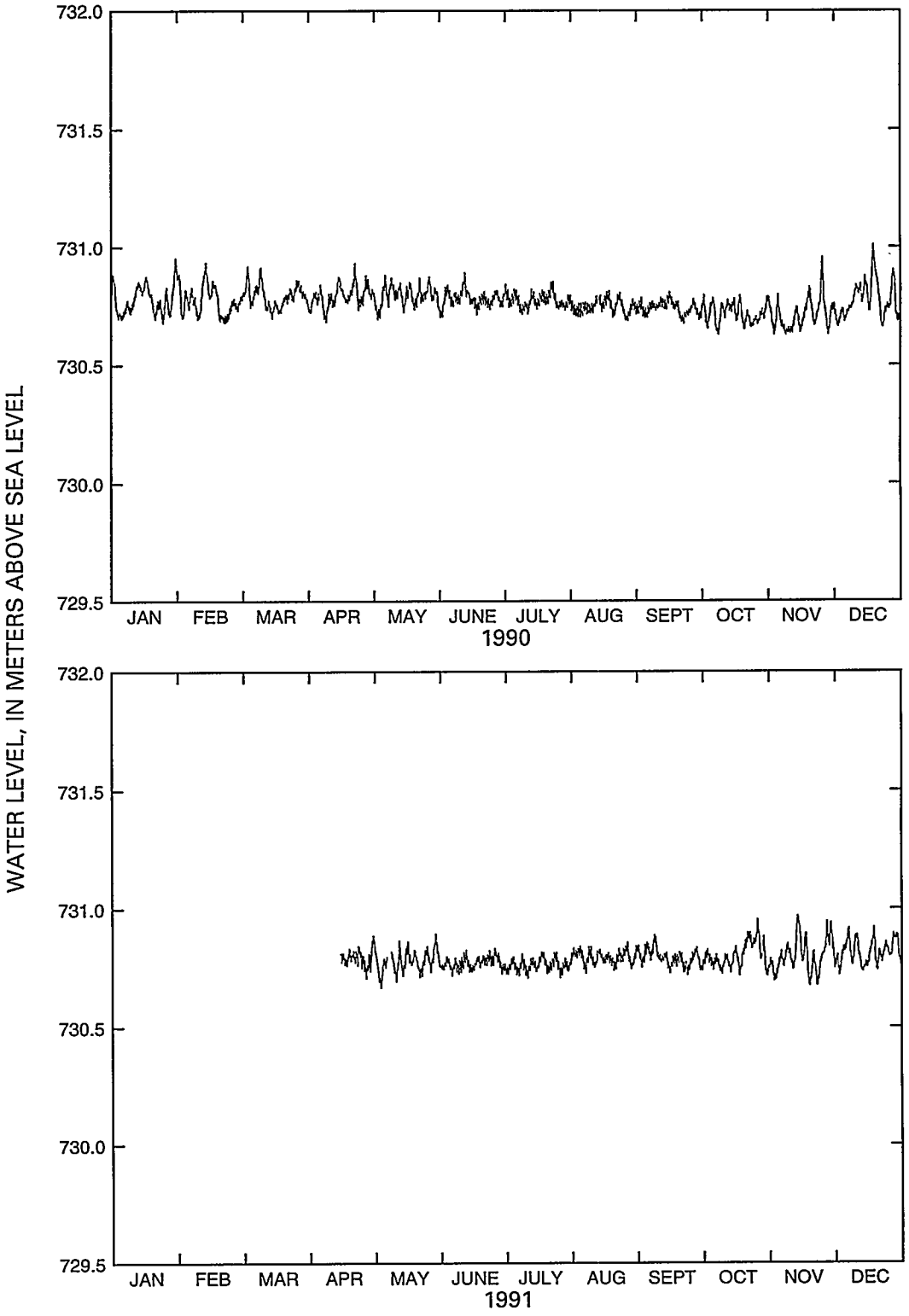

Figure 14. Water levels, 1990–91, for well USW WT-2.

Table 16. Mean monthly water-level altitudes, 1990–91, for well USW WT-2

[Data in meters above sea level; ----- = data missing, no mean computed]

Month	1990	1991
January	730.78	-----
February	730.77	-----
March	730.79	-----
April	730.79	-----
May	730.80	730.81
June	730.78	730.77
July	730.77	730.76
August	730.75	730.79
September	730.74	730.79
October	730.72	730.80
November	730.71	730.80
December	730.77	730.81

Well UE-25 WT #6

1. References or information sources: Robison (1984, 1986); Robison and others (1988); Holmes & Narver, Inc. (written commun., 1986); Fenix & Scisson, Inc. (1986a, 1987c).
2. Well specifications:
   a. Location:

      Nevada State Central Zone Coordinates (m): N 237,920; E 172,067.

      Latitude and longitude: 36°53'40"N; 116°26'46"W.

      Site ID: 365340116264601.

   b. Land-surface altitude: 1,314.8 m (surveyed by U.S. Geological Survey, 1984).
   c. Date drilling started: June 20, 1983.
   d. Date drilling completed: June 29, 1983.
   e. Drilling method: Rotary using rock bits and air-foam circulating medium; bottom-hole core obtained.
   f. Total depth drilled: 383 m.
   g. Bit diameter below water level: 171 mm.
   h. Casing information: None (surface casing only, to a depth of 76.5 m).
   i. Description of access for measuring water levels, including tubes or piezometers: 62-mm inside-diameter tubing that has a 3.7-m-long well screen on the bottom; tubing and attached screen extend from land surface to a depth of 372 m; saturated interval 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. Description and height of MP above reference point: Top of access tube, 0.46 m.

1. 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.

3. Calibrations and comments:

Nine calibrations, for three transducers, were performed during 1990–91. In addition, calibrations performed on 10/12/89 and 2/11/92 were used to calculate water-level altitudes at the beginning and end of the 1990–91 period. Results of the calibrations and measured water-level altitudes obtained during the calibrations are listed as follows:

Transducer serial number	Calibration date	Slope (mV/m)	Coefficient of determination (r^2)	Water-level altitude (m)
273129	10/12/89	6.78	1.00	1,035.04
273129	01/31/90	6.81	1.00	1,035.31
273129	04/25/90	17.5	0.91	not measured
312570	05/07/90	6.82	1.00	1,035.07
312570	08/30/90	6.77	0.99	1,035.05
312570	12/19/90	4.28	0.83	1,035.12
312570	01/16/91	2.61	0.70	1,034.91
342410	04/05/91	21.4	0.99	1,035.14
342410	08/01/91	18.2	0.96	1,035.14
342410	11/26/91	20.3	0.98	1,035.12
342410	02/11/92	20.4	0.98	1,035.04

Transducer #273129 failed on 3/28/90, and data for the period 3/28/90 through 5/7/90 were unreliable. Because of the transducer failure, a water-level measurement could not be obtained during the calibration on 4/25/90, and that calibration is considered unusable. Transducer data for the period 7/23/90 through 9/15/90 were very noisy and are not considered reliable. Transducer #312570 failed on 11/17/90, resulting in unreliable calibrations on 12/19/90 and on 1/16/91, and unreliable data for the period 11/17/90 through 4/5/91.

4. Water-level altitudes:

Water-level altitudes for well UE-25 WT #6 ranged from 1,034.93 to 1,035.52 m above sea level in 1990, and from 1,034.91 to 1,035.30 m above sea level in 1991 (fig. 15). The mean water-level altitudes for 1990 and 1991 were 1,035.20 and 1,035.16 m above sea level, respectively. Mean monthly water-level altitudes are listed in table 17.

Water-level altitudes for the period 1/1/90 through 3/27/90 are higher that those for the rest of 1990–91 (fig. 15); however, these levels are consistent with the water-level measurement made with the transducer during the calibration on 1/31/90. The water-level data agrees well with the barometric-pressure data for the same period, and the altitudes are consistent with those believed to be valid for the end of 1989 (Lobmeyer and others, 1995). For these reasons, the water-level data for this period are considered valid. The reason for the lower water levels reported after the installation of a new transducer on 5/7/90 is not known.

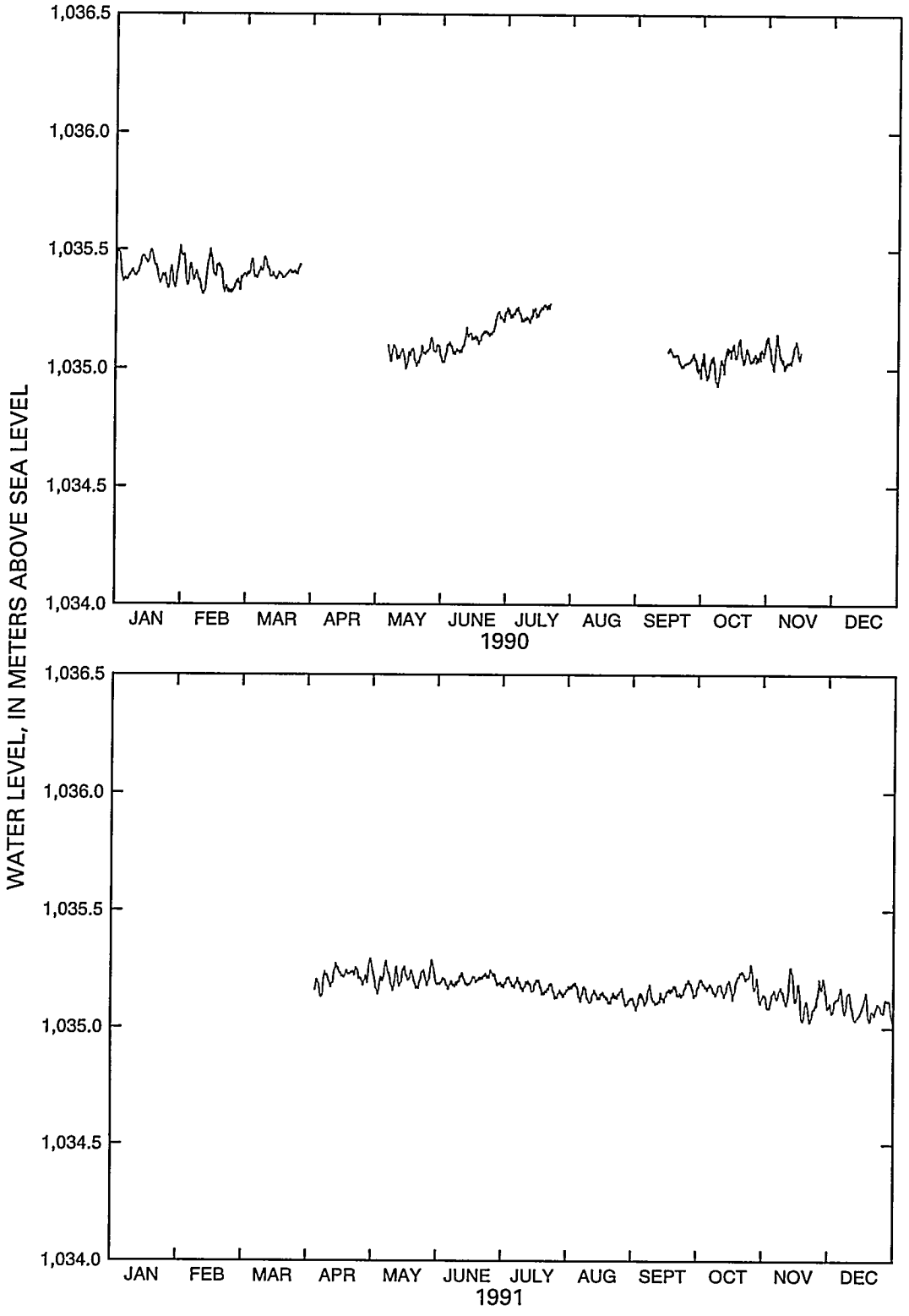

Figure 15. Water levels, 1990–91, for well UE-25 WT #6.

Table 17. Mean monthly water-level altitudes, 1990–91, for well UE-25 WT #6

[Data in meters above sea level; ----- = data missing, no mean computed]

Month	1990	1991
January	1,035.42	-----
February	1,035.38	-----
March	1,035.41	-----
April	-----	1,035.22
May	1,035.06	1,035.22
June	1,035.12	1,035.20
July	1,035.23	1,035.18
August	-----	1,035.14
September	1,035.04	1,035.14
October	1,035.04	1,035.18
November	1,035.06	1,035.13
December	-----	1,035.09

Well USW WT-11

1. References or information sources: Robison (1984, 1986); Robison and others (1988); Holmes & Narver, Inc. (written commun., 1986); Fenix & Scisson, Inc. (1986a, 1987c).
2. Well specifications:
   a. Location:

      Nevada State Central Zone Coordinates (m): N 225,269; E 170,193.

      Latitude and longitude: 36°46'49"N; 116°28'02"W.

      Site ID: 364649116280201.

   b. Land-surface altitude: 1,094.1 m (surveyed by U.S. Geological Survey, 1984).
   c. Date drilling started: August 3, 1983.
   d. Date drilling completed: August 9, 1983.
   e. Drilling method: Rotary using rock bits and air-foam circulating medium; bottom-hole core obtained.
   f. Total depth drilled: 441 m.
   g. Bit diameter below water level: 222.2 mm.
   h. Casing information: None (surface casing only, to a depth of 14 m).
   i. Description of access for measuring water levels, including tubes or piezometers: 62-mm inside-diameter tubing that has a 3.7-m-long well screen on the bottom; tubing and attached screen extend from land surface to a depth of 416 m; saturated interval within Topopah Springs 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. Description and height of MP above reference point: Top of access tube, 0.31 m.

1. 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.

3. Calibrations and comments:

Twelve calibrations, for three transducers, were performed during 1990–91. In addition, calibrations performed on 10/18/89 and 2/24/92 were used to calculate water-level altitudes at the beginning and end of the 1990–91 period. Results of the calibrations and measured water-level altitudes obtained during the calibrations are listed as follows:

Transducer serial number	Calibration date	Slope (mV/m)	Coefficient of determination (r^2)	Water-level altitude (m)
235181	10/18/89	6.85	1.00	730.65
235181	02/02/90	6.74	1.00	730.62
235181	05/03/90	6.85	0.99	730.68
235181	08/29/90	6.86	1.00	730.68
235181	11/01/90	6.20	0.99	730.76
356012	11/01/90	11.2	1.00	730.75
356012	11/29/90	11.1	1.00	730.60
308830	11/29/90	11.4	1.00	730.60
308830	03/22/91	11.5	1.00	730.62
308830	07/19/91	11.5	1.00	730.71
308830	10/30/91	11.5	1.00	730.65
308830	02/24/92	11.6	1.00	730.63

Transducer data for most of 1990 have many anomalous spikes in the record, probably due to electronic noise; however, once the anomalous spikes are removed, the converted water-level data generally are considered valid. For some short periods of record (1/13/90 through 1/18/90; 5/27/90 through 5/29/90), the transducer data were so erratic as to be considered unreliable. Transducer #235181 appeared to fail after 9/18/90, and its replacement, transducer #356012, also appeared to be defective. The data from 9/18/90 through 11/29/90 are, therefore, considered unreliable.

4. Water-level altitudes:

Water-level altitudes for well USW WT-11 ranged from 730.58 to 730.97 m above sea level in 1990, and from 730.58 to 730.90 m above sea level in 1991 (fig. 16). The mean water-level altitudes for 1990 and 1991 were 730.65 and 730.71 m above sea level, respectively. Mean monthly water-level altitudes are listed in table 18.

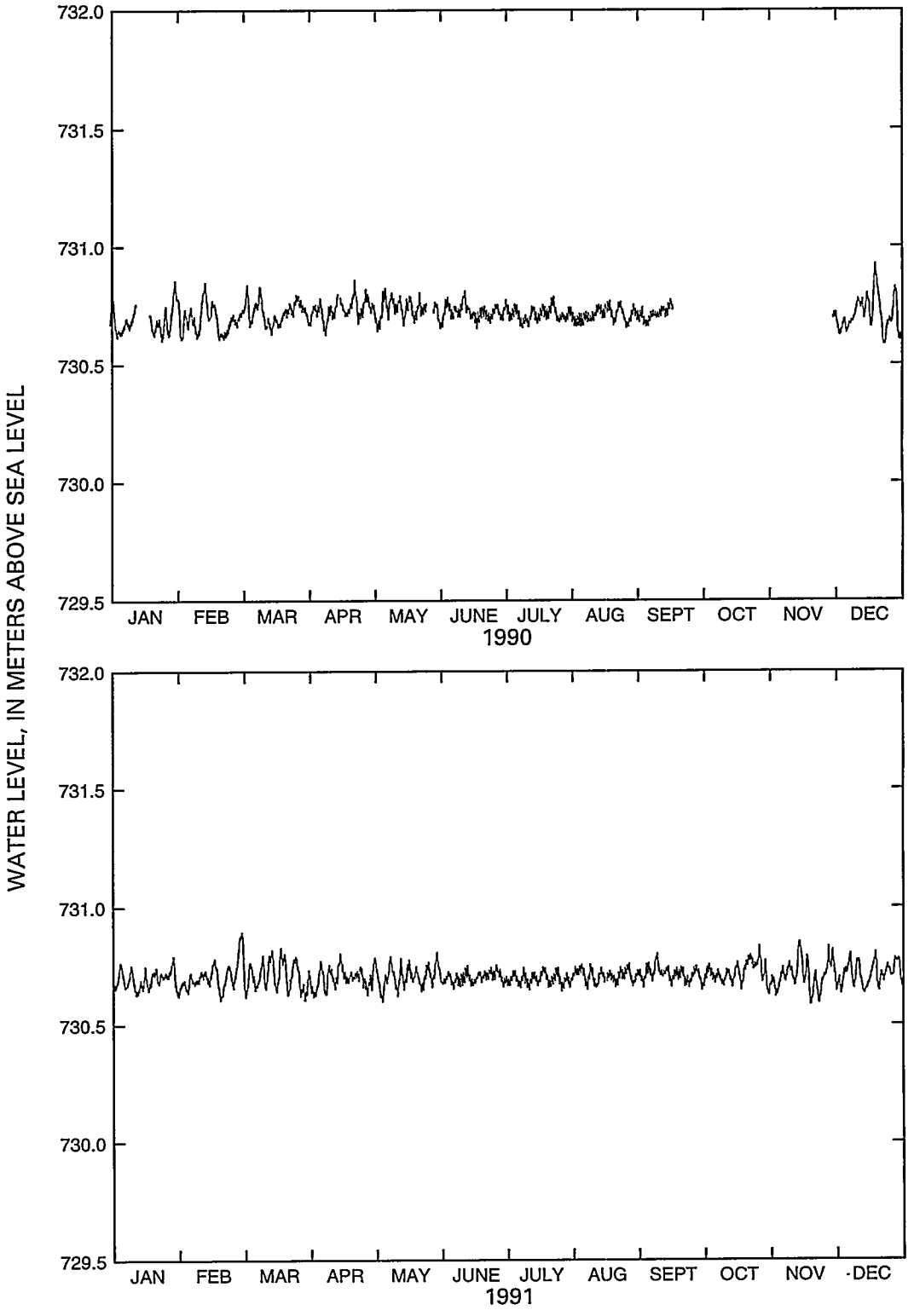

Figure 16. Water levels, 1990–91, for well USW WT-11.

Table 18. Mean monthly water-level altitudes, 1990–91, for well USW WT-11

[Data in meters above sea level; ----- = data missing, no mean computed]

Month	1990	1991
January	730.68	730.69
February	730.69	730.70
March	730.72	730.72
April	730.73	730.70
May	730.74	730.71
June	730.72	730.70
July	730.71	730.69
August	730.71	730.71
September	730.71	730.71
October	-----	730.72
November	-----	730.71
December	730.71	730.71

Well UE-25 WT #13

1. References or information sources: Robison (1984, 1986); Robison and others (1988); Holmes & Narver, Inc. (written commun., 1986); Fenix & Scisson, Inc. (1986a, 1987c).
2. Well specifications:
   a. Location:

      Nevada State Central Zone Coordinates (m): N 230,647; E 176,405.

      Latitude and longitude: 36°49'43"N; 116°23'51"W.

      Site ID: 364945116235001.

   b. Land-surface altitude: 1,032.5 m (surveyed by U.S. Geological Survey, 1984).
   c. Date drilling started: June 29, 1983.
   d. Date drilling completed: July 7, 1983.
   e. Drilling method: Rotary using rock bits and air-foam circulating medium; bottom-hole core obtained.
   f. Total depth drilled: 354 m.
   g. Bit diameter below water level: 222.2 mm.
   h. Casing information: None (surface casing only, to a depth of 68 m).
   i. Description of access for measuring water levels, including tubes or piezometers: 62-mm inside-diameter tubing that has a 3.7-m-long well screen on the bottom; tubing and attached screen extend from land surface to a depth of 346 m; saturated interval within Topopah Springs 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. Description and height of MP above reference point: Top of access tube, 0.30 m.

1. 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.

3. Calibrations and comments:

   Eleven calibrations, for two transducers, were performed during 1990–91. In addition, calibrations performed on 11/2/89 and 3/19/92 were used to calculate water-level altitudes at the beginning and end of the 1990–91 period. Results of the calibrations and measured water-level altitudes obtained during the calibrations are listed as follows:

Transducer serial number	Calibration date	Slope (mV/m)	Coefficient of determination (r^2)	Water-level altitude (m)
273130	11/02/89	6.87	1.00	729.14
273130	02/12/90	6.69	1.00	729.28
273130	04/02/90	6.75	1.00	729.14
273130	05/31/90	6.79	1.00	729.19
273130	09/06/90	6.81	1.00	729.13
273130	12/27/90	6.86	1.00	729.14
273130	01/14/91	6.23	0.99	729.14
273130	01/14/91	1.26	0.99	729.14
273130	04/15/91	1.32	1.00	729.29
273130	08/07/91	1.28	0.99	729.12
1831DD	08/07/91	50.1	1.00	729.12
1831DD	12/05/91	50.6	1.00	729.13
1831DD	03/19/92	48.7	0.99	729.07

   Transducer data for the period 7/30/90 through 8/14/90 were anomalously low and erratic and are considered unreliable. Transducer #273130 apparently failed on 1/7/91, and the data are considered unreliable from 1/7/91 through 8/7/91 when transducer #1831DD was installed. No transducer data were collected, due to electronic problems from 8/7/91 through 8/12/91. Transducer data for 8/26/91 through 8/28/91 were erratic and are considered unreliable. Two calibrations were performed on 1/14/91 because of a change in the data-logger programming.

4. Water-level altitudes:

   Water-level altitudes for well UE-25 WT #13 ranged from 729.00 to 729.41 m above sea level in 1990 and from 728.98 to 729.30 m above sea level in 1991 (fig. 17). The mean water-level altitudes for 1990 and 1991 were 729.17 and 729.14 m above sea level, respectively. Mean monthly water-level altitudes are listed in table 19.

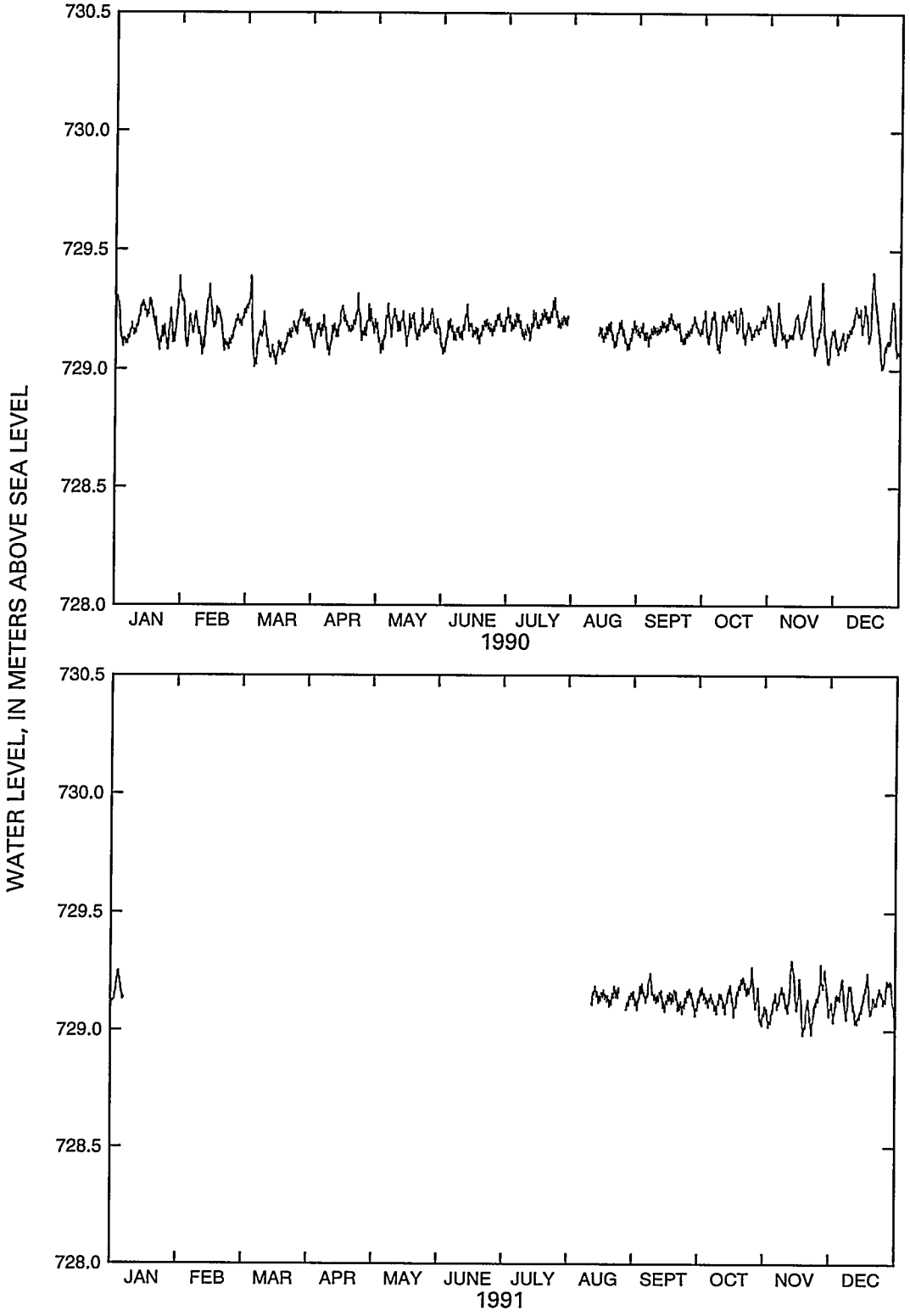

Figure 17. Water levels, 1990–91, for well UE-25 WT #13.

Table 19. Mean monthly water-level altitudes, 1990–91, for well UE-25 WT #13

[Data in meters above sea level; ----- = data missing, no mean computed]

Month	1990	1991
January	729.19	-----
February	729.18	-----
March	729.15	-----
April	729.17	-----
May	729.18	-----
June	729.16	-----
July	729.20	-----
August	729.15	-----
September	729.16	729.14
October	729.18	729.14
November	729.17	729.12
December	729.16	729.13

Well UE-25 WT #16

1. References or information sources: Robison (1984, 1986); Robison and others (1988); Holmes & Narver, Inc. (written commun., 1986); Fenix & Scisson, Inc. (1986a, 1987c).
2. Well specifications:
   a. Location:

      Nevada State Central Zone Coordinates (m): N 236,043; E 173,856.

      Latitude and longitude: 36°52'39"N; 116°25'34"W.

      Site ID: 365239116253401.

   b. Land-surface altitude: 1,210.9 m (surveyed by U.S. Geological Survey, 1984).
   c. Date drilling started: November 2, 1983.
   d. Date drilling completed: November 10, 1983.
   e. Drilling method: Rotary using rock bits and air-foam circulating medium; bottom-hole core obtained.
   f. Total depth drilled: 521 m.
   g. Bit diameter below water level: 222.2 mm.
   h. Casing information: None (surface casing only, to a depth of 31 m).
   i. Description of access for measuring water levels, including tubes or piezometers: 62-mm inside-diameter tubing that has a 3.7-m-long well screen on the bottom; tubing and attached screen extend from land surface to a depth of 514 m; saturated interval 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. Description and height of MP above reference point: Top of access tube, 0.31 m.

1. 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.

3. Calibrations and comments:

Ten calibrations, for two transducers, were performed during 1990–91. In addition, calibrations performed on 12/28/89 and 1/13/92 were used to calculate water-level altitudes at the beginning and end of the 1990–91 period. Results of the calibrations and measured water-level altitudes obtained during the calibrations are listed as follows:

Transducer serial number	Calibration date	Slope (mV/m)	Coefficient of determination (r^2)	Water-level altitude (m)
238458	12/28/89	6.80	1.00	738.34
238458	02/21/90	6.65	1.00	738.26
238458	02/21/90	1.31	0.99	738.26
238458	06/14/90	1.34	1.00	738.36
238458	09/25/90	1.38	1.00	738.28
238458	01/16/91	1.40	0.99	738.32
238458	04/16/91	1.33	0.99	738.42
238458	06/25/91	1.36	1.00	738.40
341123	06/27/91	9.06	1.00	738.42
341123	09/17/91	9.10	1.00	738.41
341123	09/17/91	19.8	1.00	738.41
341123	01/13/92	20.5	1.00	738.44

Transducer data for much of 1990–91 were erratic, resulting in unreliable data for the periods 5/8/90 through 6/4/90, 6/20/90 through 6/30/90, 7/10/90 through 7/15/90, 8/15/90 through 8/17/90, 9/21/90 through 1/22/91, 3/4/91 through 3/6/91, 3/19/91 through 3/21/91, 3/25/91 through 4/25/91, and 12/2/91 through 12/12/91. Two calibrations were done on 2/21/90 and 9/17/91 because of changes in the data-logger programming.

4. Water-level altitudes:

Water-level altitudes for well UE-25 WT #16 ranged from 738.23 to 738.53 m above sea level in 1990 and from 738.26 to 738.61 m above sea level in 1991 (fig. 18). The mean water-level altitudes for 1990 and 1991 were 738.35 and 738.43 m above sea level, respectively. Mean monthly water-level altitudes are listed in table 20. Water-level data are not plotted from 6/25/91 through 6/27/91 during the replacement of transducer #238458.

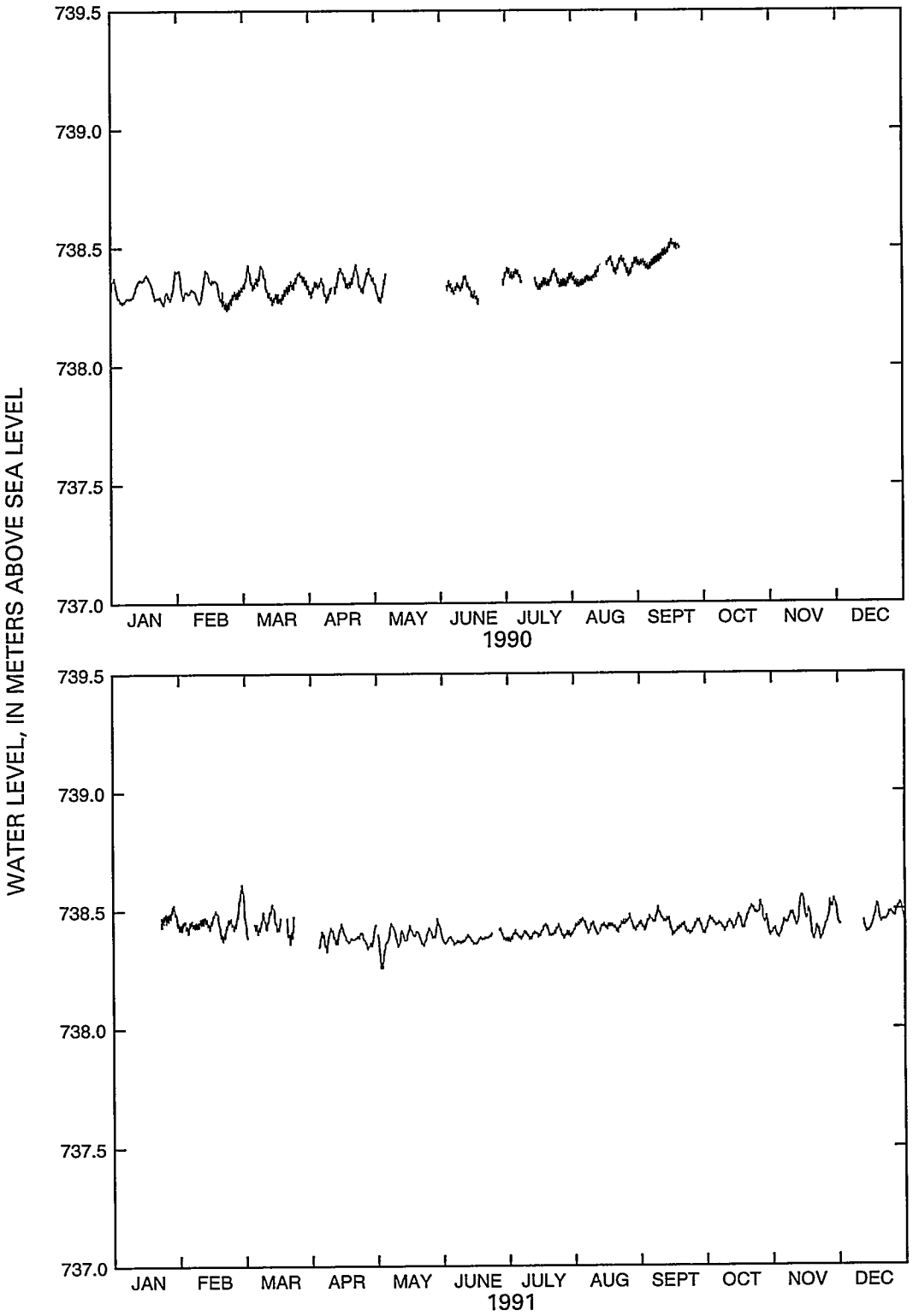

Figure 18. Water levels, 1990–91, for well UE-25 WT #16.

Table 20. Mean monthly water-level altitudes, 1990–91, for well UE-25 WT #16

[Data in meters above sea level; ----- = data missing, no mean computed]

Month	1990	1991
January	738.32	-----
February	738.31	738.45
March	738.34	738.46
April	738.35	738.38
May	-----	738.39
June	-----	738.38
July	738.37	738.40
August	738.39	738.43
September	738.46	738.44
October	-----	738.45
November	-----	738.45
December	-----	738.47

Well UE-25b #1

1. References or information sources: Lobmeyer and others (1983); Lahoud and others (1984); Robison (1984, 1986); Robison and others (1988); Holmes & Narver, Inc. (written commun., 1986); Fenix & Scisson, Inc. (1986b, 1987c).
2. Well specifications:
   a. Location:

      Nevada State Central Zone Coordinates (m): N 233,246; E 172,644.

      Latitude and longitude: 36°51'08"N; 116°26'23"W.

      Site ID: 365108116262301.

   b. Land-surface altitude: 1,200.7 m (surveyed by U.S. Geological Survey, 1984).
   c. Date drilling started: April 3, 1981.
   d. Date drilling completed: September 22, 1981.
   e. Drilling method: Rotary using rock bits and air-foam circulating medium; cores obtained at selected intervals.
   f. Total depth drilled: 1,220 m.
   g. Bit diameter below water level: 222.2 mm to 650 m; 216 mm from 650 to 1,220 m.
   h. Casing information: 226-mm inside diameter to 518 m; casing string is tack cemented in and perforated below the water level.
   i. Description of access for measuring water levels, including tubes or piezometers:

      (upper interval) 48-mm inside-diameter tubing, open ended, extending to a depth of about 488 m; upper interval of borehole, from near water table to top of inflatable packer, within tuffaceous beds of Calico Hills and Prow Pass, Bullfrog, and upper Tram Members of Crater Flat Tuff.

(lower interval) 62-mm inside-diameter tubing that has an inflatable packer on the bottom end, to depth of 1,199 m; lower interval of borehole from below packer to bottom of well, within lower Tram Member of Crater Flat Tuff, and Lithic Ridge Tuff.

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. Description and height of MP above reference point: Top of access tube, 0.30 m (upper interval), and 0.13 m (lower interval).

l. 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 470 m.

3. Calibrations and comments:

Upper interval:

Fourteen calibrations, for four transducers, were performed during 1990–91. In addition, calibrations performed on 11/7/89 and 2/26/92 were used to calculate water-level altitudes at the beginning and end of the 1990–91 period. Results of the calibrations and measured water-level altitudes obtained during the calibrations are listed as follows:

Transducer serial number	Calibration date	Slope (mV/m)	Coefficient of determination (r^2)	Water-level altitude (m)
270334	11/07/89	6.54	1.00	730.70
270334	02/27/90	6.38	1.00	730.68
270334	02/27/90	1.20	1.00	730.68
270334	04/06/90	1.20	1.00	730.76
312574	04/06/90	1.22	1.00	730.76
312574	07/27/90	1.24	1.00	730.76
312574	11/21/90	1.23	1.00	730.76
312574	02/08/91	1.23	1.00	730.80
312574	02/08/91	7.05	1.00	730.80
312574	02/26/91	7.00	1.00	730.74
356508	02/26/91	6.84	0.99	730.74
356508	04/16/91	6.97	1.00	730.74
356508	07/17/91	6.75	1.00	730.70
274148	07/17/91	26.4	1.00	730.70
274148	11/15/91	26.7	1.00	730.77
274148	02/26/92	26.4	1.00	730.67

Much of the transducer data for 1990 and early 1991 were unreliable, due to frequent transducer failures or excessive drift. Only three short periods in 1990 are considered reliable: 4/7 through 5/4, 7/28 through 8/9, and 11/22 through 12/27. Transducer data were erratic and are considered unreliable for the following periods in 1991: 1/1 through 3/3, 3/19 through 3/23, 5/2 through 5/4, and 11/15.

Lower interval:

Twelve calibrations, for four transducers, were performed during 1990–91. In addition, calibrations performed on 11/7/89 and 2/5/92 were used to calculate water-level altitudes at the beginning and end of the 1990–91 period. Results of the calibrations and measured water-level altitudes obtained during the calibrations are listed as follows:

Transducer serial number	Calibration date	Slope (mV/m)	Coefficient of determination (r^2)	Water-level altitude (m)
260788	11/07/89	17.5	1.00	729.79
260788	02/27/90	17.6	1.00	729.79
260788	02/27/90	3.40	0.99	729.79
317086	06/12/90	1.31	1.00	729.80
317086	10/01/90	1.38	1.00	729.83
317086	01/21/91	1.31	1.00	729.85
371477	02/06/91	32.8	0.98	729.59
371477	02/08/91	18.1	1.00	729.57
371477	04/16/91	17.9	1.00	729.55
371477	07/17/91	17.6	1.00	729.60
361058	07/17/91	51.7	1.00	729.60
361058	10/08/91	52.0	1.00	729.62
361058	10/09/91	20.7	1.00	729.61
361058	02/05/92	20.9	1.00	729.63

4. Water-level altitudes:

Upper interval:

Water-level altitudes for the upper interval of well UE-25b #1 ranged from 730.57 to 731.03 m above sea level in 1990, and from 730.52 to 730.87 m above sea level in 1991 (fig. 19). The mean water-level altitudes for 1990 and 1991 were 730.75 and 730.71 m above sea level, respectively; however, the mean value for 1990 is based on data available for only a small percentage of the year. Mean monthly water-level altitudes are listed in table 21.

Lower interval:

Because the transducer data for this interval are considered unreliable for all 1990–91, hourly water-level altitudes computed from those data are not considered valid. Only measured water levels, obtained during calibrations, are plotted in figure 20, and summary statistics are noted for 1990 and 1991 combined. Mean monthly water-level altitudes could not be computed. Water-level altitudes for the lower interval of well UE-25b #1 ranged from 729.55 to 729.90 m above sea level in 1990–91 (fig. 20). The mean water-level altitude for 1990–91 was 729.69 m above sea level.

Water levels appeared to drop 0.31 m from 1/31/91 to 2/6/91 (fig. 20). The reason for this apparent drop is not known; however, because the levels were determined from manual measurements, they are believed to be valid.

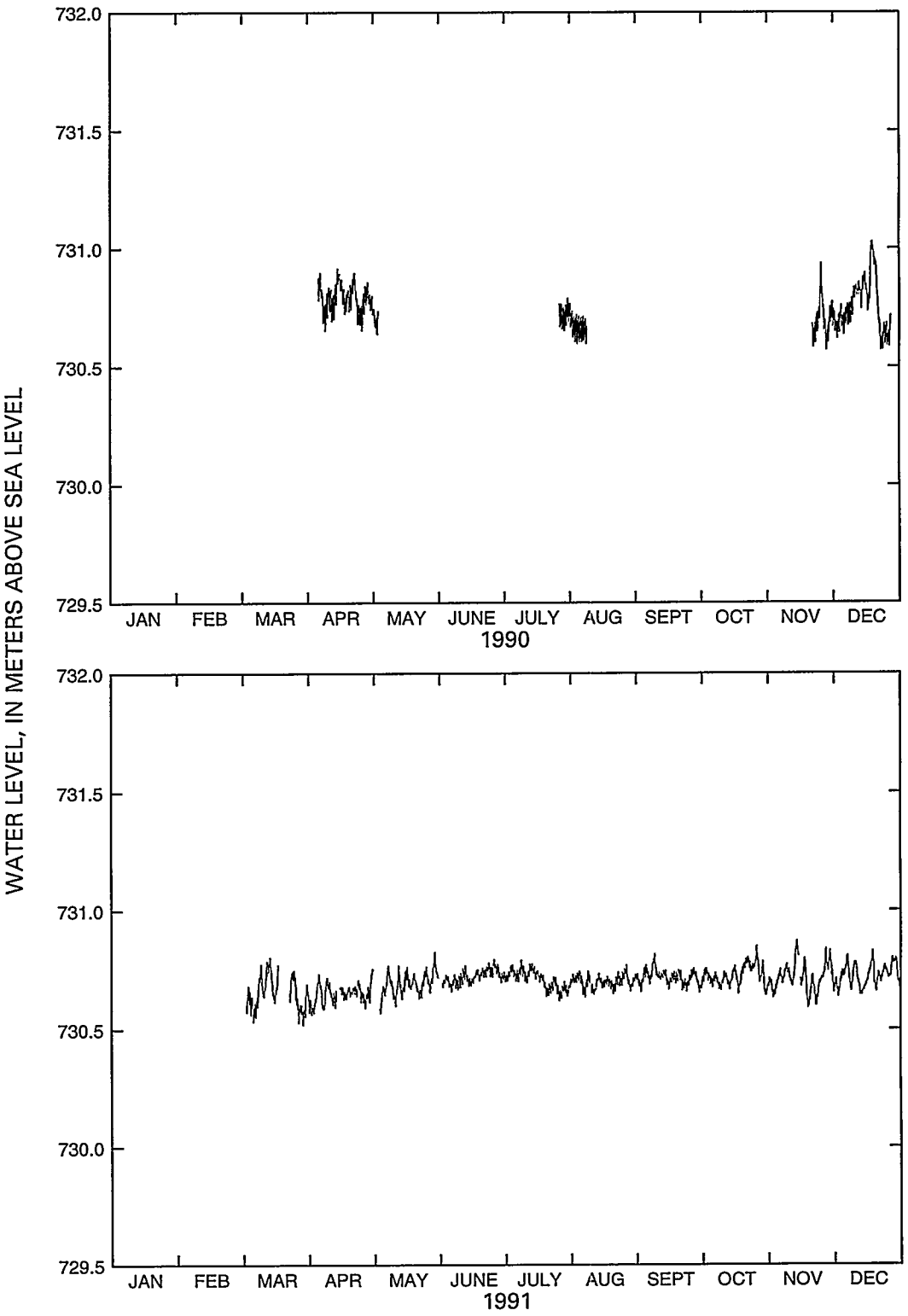

Figure 19. Water levels, 1990–91, for well UE-25b #1, upper interval.

Table 21. Mean monthly water-level altitudes, 1990–91, for well UE-25b #1, upper interval

[Data in meters above sea level; ----- = data missing, no mean computed]

Month	1990	1991
January	-----	-----
February	-----	-----
March	-----	730.66
April	730.79	730.65
May	-----	730.70
June	-----	730.72
July	-----	730.71
August	-----	730.70
September	-----	730.72
October	-----	730.72
November	-----	730.71
December	730.76	730.73

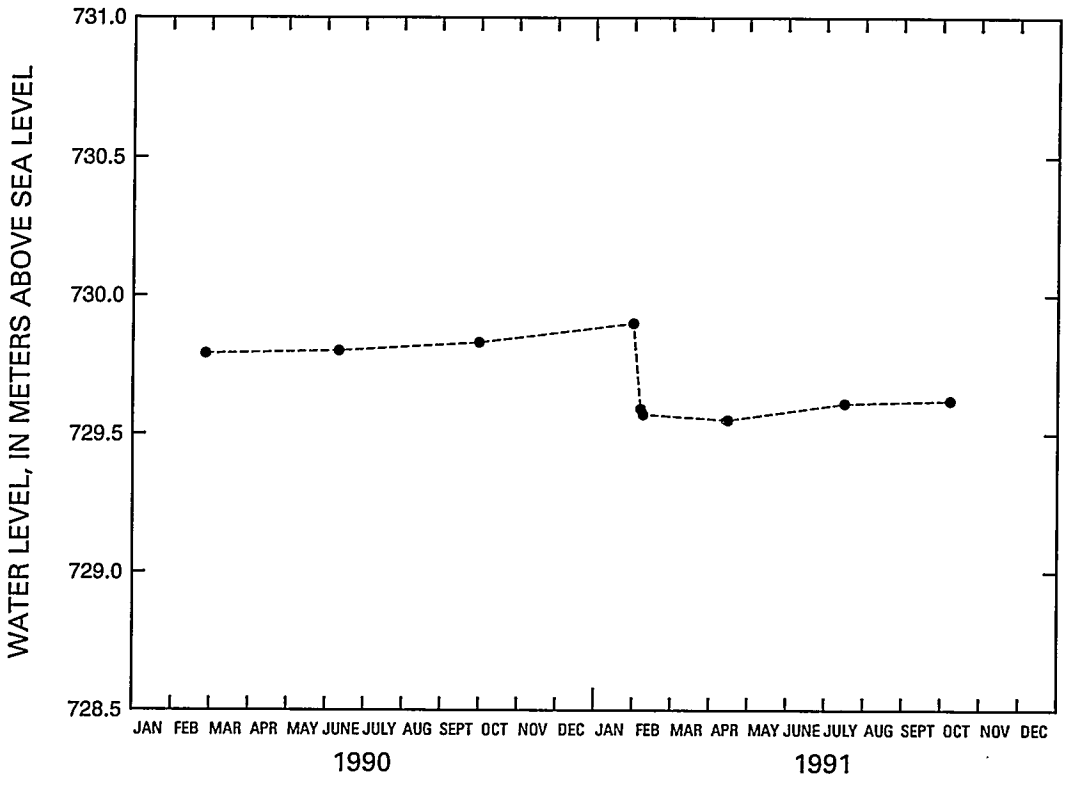

Figure 20. Water levels, 1990–91, for well UE-25b #1, lower interval.

Well UE-25c #2

1. References or information sources: Fenix & Scisson, Inc. (1986d, 1987c); Geldon (1993).
2. Well specifications:
   a. Location:

      Nevada State Central Zone Coordinates (m): N 230,688; E 173,624.

      Latitude and longitude: 36°49'45"N; 116°25'43"W.

      Site ID: 364947116254401.

   b. Land-surface altitude: 1,132.06 m (Fenix & Scisson, Inc., 1986d).
   c. Date drilling started: January 9, 1984.
   d. Date drilling completed: March 21, 1984.
   e. Drilling method: Rotary using rock bits and air-foam circulating medium; core obtained at selected intervals below water table.
   f. Total depth drilled: 914 m; however, a bridge plug was installed at a depth of 756 m during 1990.
   g. Bit diameter below water level: 375 mm to 463 m; 251 mm from 463 m to total depth.
   h. Casing information: 273-mm inside diameter to 416 m. Casing string is cemented in and has no perforations.
   i. Description of access for measuring water levels, including tubes or piezometers: 44-mm inside-diameter tubing, open ended, extending from land surface to a depth of 721 m; saturated interval within tuffs and lavas of Calico Hills, and the Prow Pass, Bullfrog, and Tram Members of the Crater Flat Tuff.
   j. Description and altitude of reference point: Top of metal tag on 406-mm well casing, 1,132.18 m (C. Westenburg, U.S. Geological Survey, written commun., 1993).
   k. Description and height of MP above reference point: Top of access tube, 0.70 m prior to November 13, 1990; top of 273-mm casing, 0.31 m after November 13, 1990.
   l. 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 402 m.
3. Calibrations and comments:

   Five calibrations, for two transducers, were performed during 1990. In addition, a calibration performed on 9/13/89 was used to calculate water-level altitudes at the beginning of the 1990 period. Results of the calibrations and measured water-level altitudes obtained during the calibrations are listed as follows:

Transducer serial number	Calibration date	Slope (mV/m)	Coefficient of determination (r^2)	Water-level altitude (m)
273128	09/13/89	6.79	1.00	730.14
273128	01/03/90	6.85	1.00	729.89
317092	05/02/90	7.03	1.00	730.23
317092	05/15/90	6.85	1.00	730.22
317092	05/16/90	7.01	1.00	730.20
317092	09/10/90	6.87	1.00	730.23

Transducer data were erratic and considered unreliable from 1/14/90 through 1/20/90. Transducer failure resulted in no valid data from 3/7/90 through 5/3/90. Noisy and erratic transducer data on 5/28/90, 6/9/90, and 6/10/90 are considered unreliable and were not converted to water levels. Data for 8/18/90 through 9/10/90 were not reliable because the transducer was not properly grounded. The transducer was removed, and the well was removed from the hourly monitored network on 9/10/90.

4. Water-level altitudes:

Water-level altitudes for well UE-25c #2 ranged from 729.85 to 730.34 m above sea level in 1990 (fig. 21). The mean water-level altitude for 1990 was 730.13 m above sea level; however, this value is based only on data available through mid-August. The reason for the apparent rise in water levels in May is not known, but the water levels are tied to a manual, steel-tape measurement on 5/2/90 and are considered valid. A closing water-level measurement was not obtained for transducer #273128 when it failed on 3/7/90, and a closing water level equal to that obtained by tagging on 1/3/90 was assumed in order to compute water-level altitude from the transducer data. If the assumed water level or the tagged water level were in error, computed water levels from 1/1/90 through 3/6/90 could be in error. Mean monthly water-level altitudes are listed in table 22.

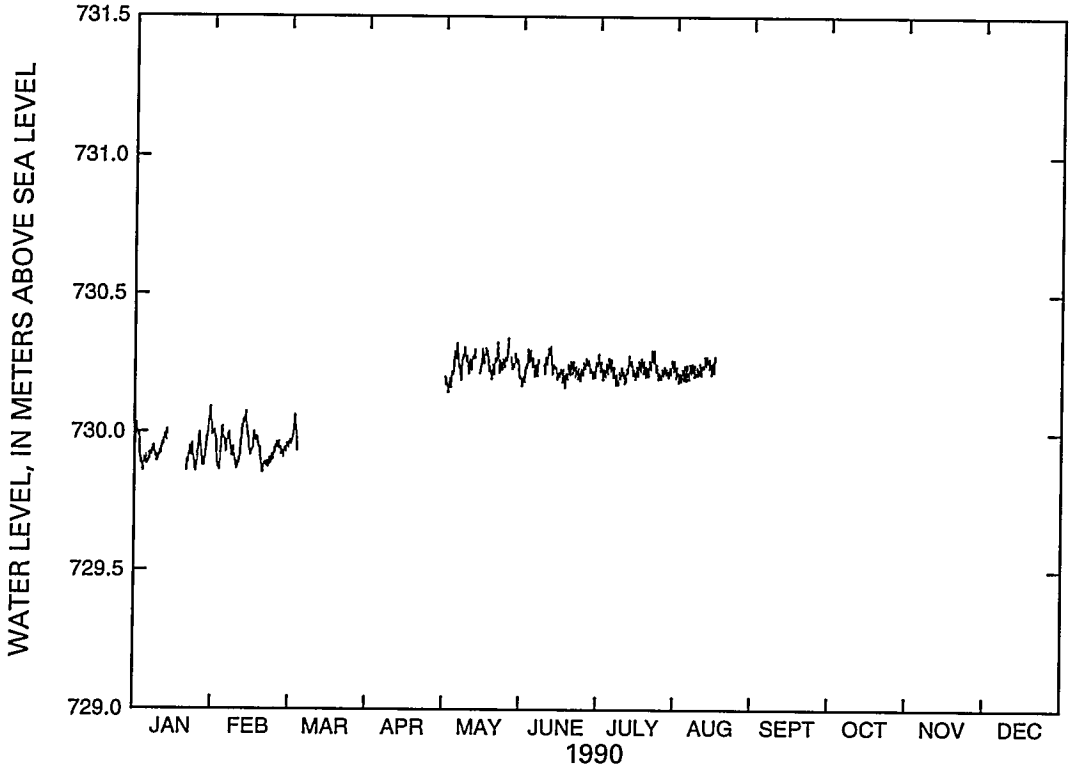

Figure 21. Water levels, 1990, for well UE-25c #2.

Table 22. Mean monthly water-level altitudes, 1990, for well UE-25c #2

[Data in meters above sea level; ----- = data missing, no mean computed]

Month	1990
January	729.94
February	729.94
March	-----
April	-----
May	730.25
June	730.23
July	730.23
August	730.23
September	-----
October	-----
November	-----
December	-----

Well UE-25c #3

1. References or information sources: Fenix & Scisson, Inc. (1986d, 1987c); Geldon (1993).
2. Well specifications:
   a. Location:

      Nevada State Central Zone Coordinates (m): N 230,706; E 173,600.

      Latitude and longitude: 36°49'46"N; 116°25'44"W.

      Site ID: 364947116254501.

   b. Land-surface altitude: 1,132.09 m (Fenix & Scisson, Inc., 1986d).

   c. Date drilling started: March 20, 1984.

   d. Date drilling completed: June 11, 1984.

   e. Drilling method: Rotary using rock bits and air-foam circulating medium; core obtained at selected intervals below water table.

   f. Total depth drilled: 914 m.

   g. Bit diameter below water level: 375 mm to 463 m; 251 mm from 463 m to total depth.

   h. Casing information: 273-mm inside diameter to 403 m. Casing string is tack cemented in and is perforated below water level.

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

      (upper interval) 48-mm inside-diameter tubing, open ended, extending to a depth of about 692 m; upper interval of borehole, from near water table to top of inflatable packer within tuffs and lavas of Calico Hills, and the Prow Pass and Bullfrog Members of the Crater Flat Tuff.

      (lower interval) 62-mm inside-diameter tubing that has an inflatable packer on the bottom end, at a depth of 753 m; lower interval of borehole, from below packer to bottom of well, within the Bullfrog and Tram Members of the Crater Flat Tuff.

j. Description and altitude of reference point: Top of inverted "V" punched on side of 273-mm well casing, 1,132.41 m (C. Westenburg, U.S. Geological Survey, written commun., 1993).

k. Description and height of MP above reference point:

(upper interval): Top of 48-mm inside-diameter access tube, 0.31 m prior to November 19, 1990; top of 273-mm casing, 0.15 m after November 19, 1990.

(lower interval): Top of 63-mm inside-diameter access tube, 0.32 m prior to November 19, 1990; top of 273-mm casing, 0.15 m after November 19, 1990.

l. Depth correction for measured water levels because of borehole deviation from vertical (the correction is subtracted from measured depth to obtain true depth): 0.10 m, based on approximate depth to water of 402 m.

3. Calibrations and comments:

Upper interval:

Five calibrations, for two transducers, were performed during 1990. In addition, a calibration performed on 9/14/89 was used to calculate water-level altitudes at the beginning of the 1990 period. Results of the calibrations and measured water-level altitudes obtained during the calibrations are listed as follows:

Transducer serial number	Calibration date	Slope (mV/m)	Coefficient of determination (r^2)	Water-level altitude (m)
273361	09/14/89	6.62	1.00	730.23
273132	01/11/90	6.70	1.00	730.27
273132	02/21/90	6.72	1.00	not measured
273132	02/23/90	6.74	1.00	730.24
273132	06/13/90	6.72	1.00	730.24
273132	09/10/90	6.51	1.00	730.28

Data are not available for 1/1/90 through 1/11/90 due to transducer failure. Partial days of record from 2/21/90 through 2/23/90, when temperature logs were obtained in the well, were not converted to water levels. Data were erratic and considered unreliable for 6/9/90, 6/10/90, 7/14/90 through 7/16/90, and 8/11/90 through 9/10/90. The transducer was removed, and the well was removed from the hourly monitored network on 9/10/90.

Lower interval:

Seven calibrations, for two transducers, were performed during 1990. In addition, a calibration performed on 9/12/89 was used to calculate water-level altitudes at the beginning of the 1990 period. Results of the calibrations and measured water-level altitudes obtained during the calibrations are listed as follows:

Transducer serial number	Calibration date	Slope (mV/m)	Coefficient of determination (r^2)	Water-level altitude (m)
270337	09/12/89	10.6	1.00	730.62
270337	01/03/90	11.1	0.99	730.58
270337	01/11/90	10.5	1.00	730.65
270337	02/21/90	10.3	1.00	not measured
270337	02/22/90	10.3	1.00	730.59
270337	06/13/90	10.5	1.00	730.68
341805	08/28/90	9.49	1.00	730.58
341805	09/10/90	9.42	1.00	730.62

Data are not available from 1/1/90 through 1/3/90 due to transducer failure. Partial days of record from 2/21/90 and 2/22/90, when temperature logs were obtained in the well, were not converted to water levels. Transducer data were erratic and considered unreliable from 5/16/90 through 6/13/90. Data are also considered unreliable from 7/14/90 through 8/28/90, due to transducer failure. The transducer was removed, and the well was removed from the hourly monitored network on 9/10/90.

4. Water-level altitudes:

Upper interval:

Water-level altitudes for well UE-25c #3, upper interval, ranged from 730.11 to 730.42 m above sea level in 1990 (fig. 22). The mean water-level altitude for 1990 was 730.22 m above sea level; however, this value is based only on data available through mid-August. Mean monthly water-level altitudes are listed in table 23.

Lower interval:

Water-level altitudes for well UE-25c #3, lower interval, ranged from 730.52 to 730.82 m above sea level in 1990 (fig. 23). The mean water-level altitude for 1990 was 730.64 m above sea level; however, this value is based only on water levels available through September 9, 1990. Mean monthly water-level altitudes are listed in table 23.

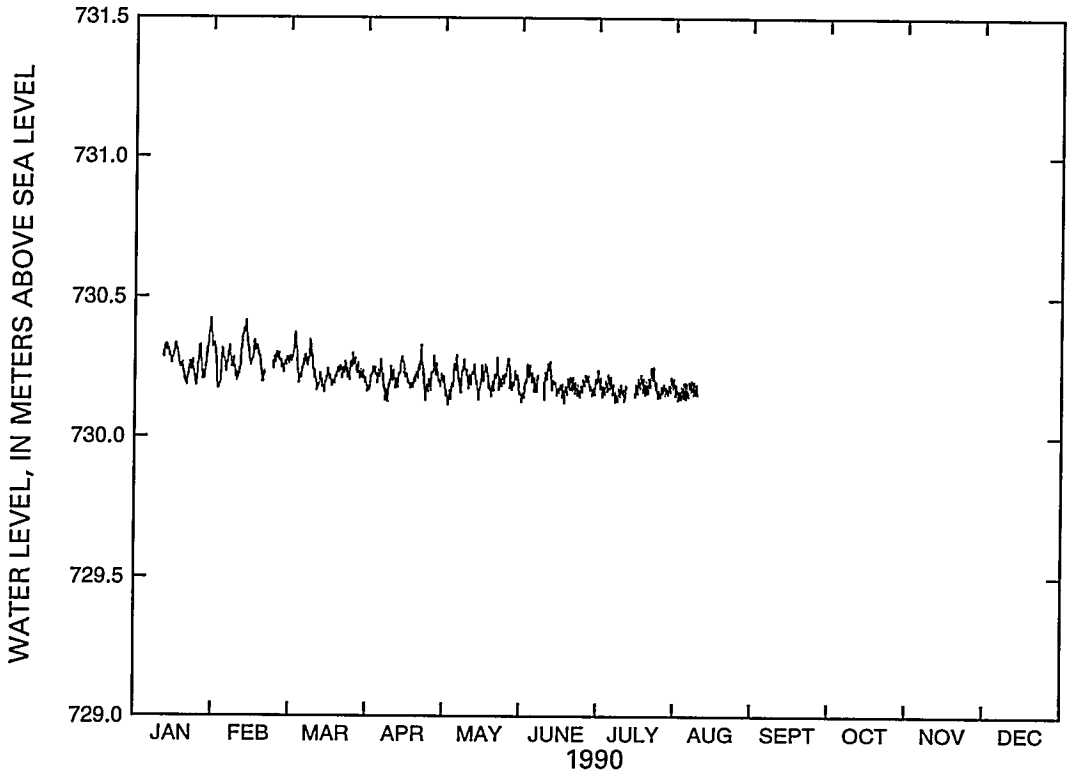

Figure 22. Water levels, 1990, for well UE-25c #3, upper interval.

Table 23. Mean monthly water-level altitudes, 1990, for well UE-25c #3

[Data in meters above sea level; ----- = data missing, no mean computed]

Month	Upper	Lower
January	730.27	730.64
February	730.28	730.67
March	730.24	730.66
April	730.21	730.65
May	730.21	730.65
June	730.19	730.59
July	730.18	-----
August	-----	-----
September	-----	-----
October	-----	-----
November	-----	-----
December	-----	-----

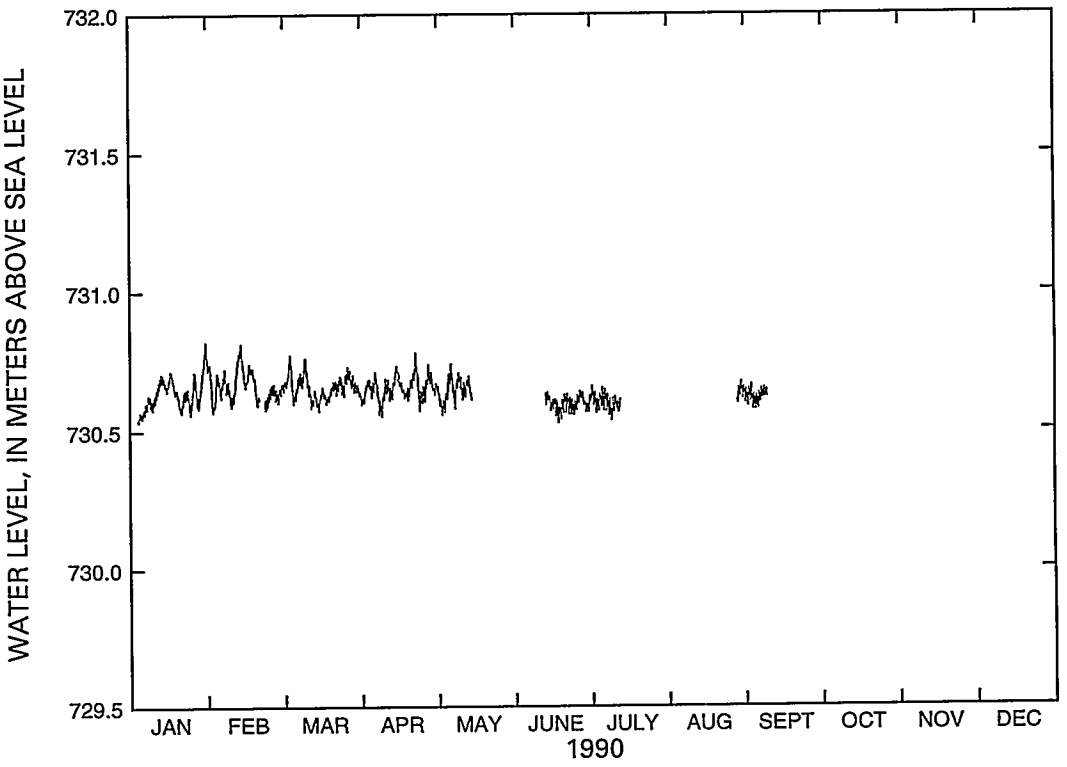

Figure 23. Water levels, 1990, for well UE-25c #3, lower interval.

Well UE-25p #1

1. References or information sources: Craig and Robison (1984); Craig and Johnson (1984); Robison (1984, 1986); Robison and others (1988); Holmes & Narver, Inc. (written commun., 1986); Fenix & Scisson, Inc. (1986c, 1987c).
2. Well specifications:
   a. Location:

      Nevada State Central Zone Coordinates (m): N 230,481; E 174,188.

      Latitude and longitude: 36°49'38"N; 116°25'21"W.

      Site ID: 364938116252102 (no Site ID for sequence number 01).

   b. Land-surface altitude: 1,114.2 m (surveyed by U.S. Geological Survey, 1984).
   c. Date drilling started: November 13, 1982.
   d. Date drilling completed: May 24, 1983.
   e. Drilling method: Rotary using rock bits and air-foam circulating medium; cores obtained at selected intervals.
   f. Total depth drilled: 1,805 m.
   g. Bit diameter below water level: 375 mm to 487 m; 251 mm from 487 to 1,304 m; 175 mm from 1,304 to 1,805 m.

h. Casing information: 255-mm inside diameter from land surface to 477 m; 177-mm inside diameter from 453 to 1,297 m; casing string is cemented in and has no perforations.

i. Description of access for measuring water levels, including tubes or piezometers: 38-mm inside-diameter tubing, open ended, to a depth of 418 m; well construction is such that water levels in tuffs of Tertiary age are not measured. Only the water level in the underlying carbonate rocks of Paleozoic age is measured (Tertiary-Paleozoic contact is at 1,244 m).

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. Description and height of MP above reference point: Top of access tube, 0.16 m.

l. Depth correction for measured water levels because of borehole deviation from vertical (the correction is subtracted from measured depth to obtain true depth): 0.02 m, based on approximate depth to water of 362 m.

NOTE: This correction was incorrectly listed as 0.06 m by Robison and others (1988, p. 82), Luckey and others (1993, p. 116), and Lobmeyer and others (1995).

3. Calibrations and comments:

Thirteen calibrations, for four transducers, were performed during 1990–91. In addition, calibrations performed on 12/28/89 (transducer # 244285) and 2/12/92 were used to calculate water-level altitudes at the beginning and end of the 1990–91 period. Results of the calibrations and measured water-level altitudes obtained during the calibrations are listed as follows:

Transducer serial number	Calibration date	Slope (mV/m)	Coefficient of determination (r^2)	Water-level altitude (m)
244285	12/28/89	7.01	1.00	752.53
312577	01/24/90	6.88	1.00	752.46
312577	04/23/90	7.00	1.00	752.56
317087	06/11/90	6.96	1.00	752.49
317087	10/01/90	6.60	1.00	752.44
317087	11/07/90	7.66	0.99	752.43
317087	01/16/91	7.27	1.00	752.47
317087	01/16/91	1.47	1.00	752.49
317087	03/13/91	1.67	0.99	752.49
317087	04/15/91	1.76	0.45	752.51
356516	04/15/91	1.37	1.00	752.46
356516	08/06/91	1.35	1.00	752.48
356516	09/20/91	1.39	1.00	752.48
413605	10/16/91	21.4	1.00	752.47*
413605	02/12/92	22.0	1.00	752.56

*Water-level measurement made on 09/26/91.

Most transducer data for the first half of 1990 are considered reliable, although data are missing for 1/7/90 through 1/24/90, and for 4/23/90 through 6/11/90 because of temperature-logging activities at the well. Data for the second half of 1990 were not as reliable because of several unexplained offsets in the data in September, October, and November. These offsets resulted in calculated water-level altitudes that appeared to drift and that did not correlate with trends in barometric data. Correcting for the offsets by assuming that the offsets were not correct resulted in computed water levels that were believed to be more realistic. Data were lost for 1/3/91 through 1/16/91, 7/16/91 through 8/6/91, and 8/15/91 through 10/16/91 due to data-logger problems. Transducer failure from 1/29/91 through 4/15/91 resulted in an unreliable calibration on 4/15/91 and unreliable water-level data.

4. Water-level altitudes:

Water-level altitudes for well UE-25p #1 ranged from 752.33 to 752.72 m above sea level in 1990, and from 752.20 to 752.66 m above sea level in 1991 (fig. 24). The mean water-level altitudes for 1990 and 1991 were 752.55 and 752.45 m above sea level, respectively. Mean monthly water-level altitudes are listed in table 24. Two manual water-level measurements were made using Chain #2 during May 1990 when the transducer was removed from the well for temperature logging. Water-level altitudes, shown in figure 24, are as follows:

Date	Water-level altitude
5/21/90	752.49 m
5/30/90	752.55 m

NOTE: Water-level altitudes reported for this well by Robison and others (1988), Luckey and others (1993), and Lobmeyer and others (1995) are 0.04 m higher than the actual water level, because the borehole-deviation correction that they used was 0.04 m greater than the true correction.

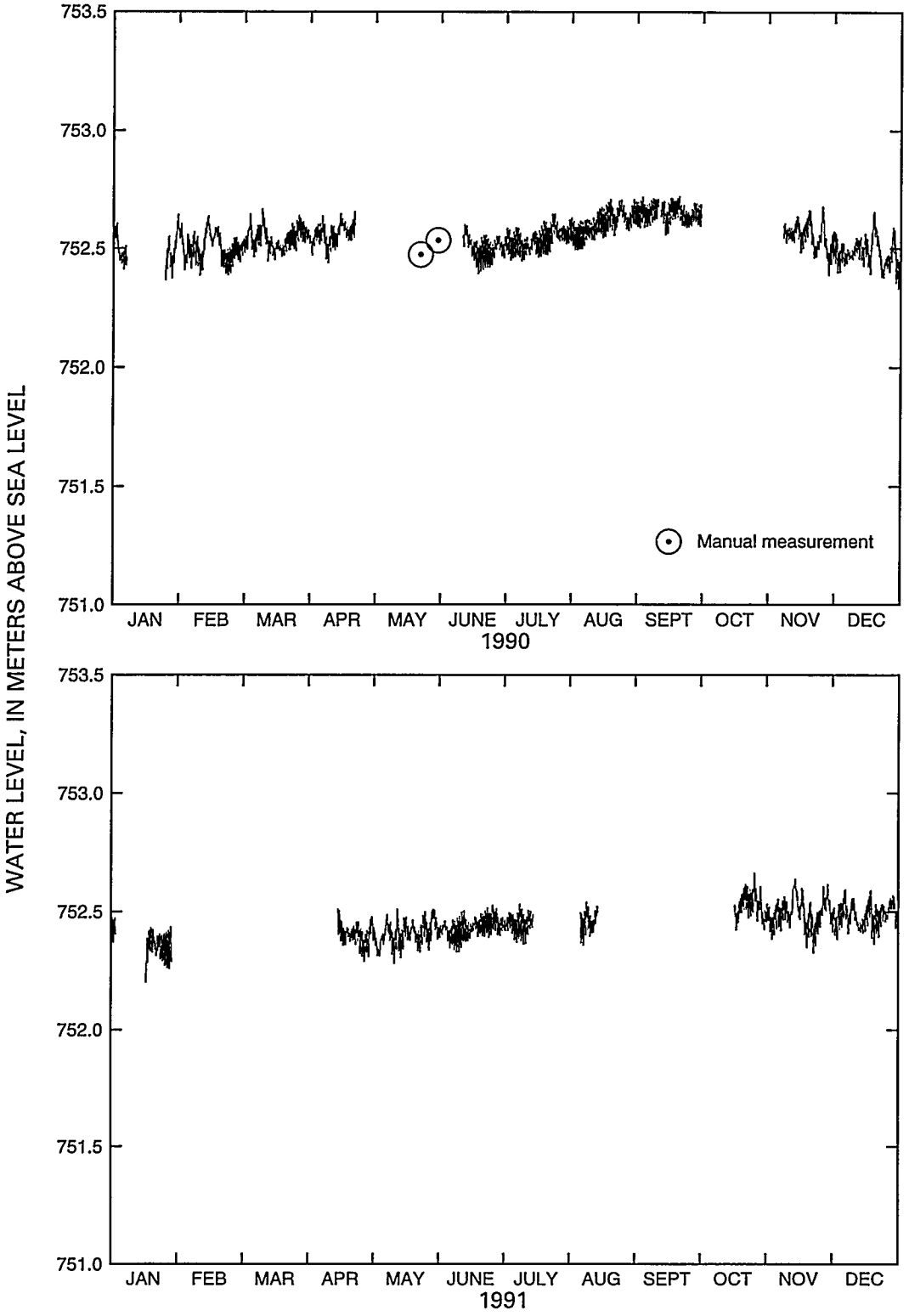

Figure 24. Water levels, 1990–91, for well UE-25p #1.

Table 24. Mean monthly water-level altitudes, 1990–91, for well UE-25p #1

[Data in meters above sea level; ----- = data missing, no mean computed]

Month	1990	1991
January	-----	-----
February	752.50	-----
March	752.54	-----
April	752.55	-----
May	-----	752.41
June	752.51	752.44
July	752.54	-----
August	752.61	-----
September	752.65	-----
October	-----	-----
November	752.55	752.50
December	752.49	752.49

Well USW G-3

1. References or information sources: Robison (1984, 1986); Robison and others (1988); Holmes & Narver, Inc. (written commun., 1985); Fenix & Scisson, Inc. (1987b, c).
2. Well specifications:
   a. Location:

      Nevada State Central Zone Coordinates (m): N 229,447; E 170,226.

      Latitude and longitude: 36°49'05"N; 116°28'01"W.

      Site ID: 364905116280101.

   b. Land-surface altitude: 1,480.6 m (surveyed by U.S. Geological Survey, 1984).
   c. Date drilling started: January 8, 1982.
   d. Date drilling completed: March 21, 1982.
   e. Drilling method: Rotary, using mostly air-foam, and occasionally polymer was added to the circulating medium; hole cored from 795 to 1,533 m.
   f. Total depth drilled: 1,533 m.
   g. Bit diameter below water level: 222.2 mm to 792 m, 121 mm from 792 to 795 m, and 100 mm from 795 to 1,533 m.
   h. Casing information: 126-mm inside diameter to 792 m; bottom casing is tack cemented with no perforations.
   i. Description of access for measuring water levels, including tubes or piezometers: 126-mm inside diameter from land surface to a depth of 792 m; saturated interval within Tram Member of the Crater Flat Tuff, and the Lithic Ridge Tuff.
   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. Description and height of MP above reference point: Top of access tube, 0.33 m.

l. Depth correction for measured water levels because of borehole deviation from vertical (the correction is subtracted from measured depth to obtain true depth): 0.56 m, based on approximate depth to water of 750 m.

3. Calibrations and comments:

Nine calibrations, for two transducers, were performed during 1990–91. In addition, calibrations performed on 12/19/89 and 3/3/92 were used to calculate water-level altitudes at the beginning and end of the 1990–91 period. Results of the calibrations and measured water-level altitudes obtained during the calibrations are listed as follows:

Transducer serial number	Calibration date	Slope (mV/m)	Coefficient of determination (r^2)	Water-level altitude (m)
305061	12/19/89	1.30	1.00	730.35
305061	03/22/90	1.30	1.00	730.47
305061	05/29/90	1.29	1.00	730.49
305061	09/06/90	1.29	1.00	730.44
305061	12/18/90	1.29	1.00	730.56
305061	03/01/91	1.25	0.99	730.73
305061	03/20/91	1.23	1.00	730.49
356012	03/20/91	1.10	0.99	730.49
356012	07/19/91	11.0	0.99	730.46
356012	11/13/91	11.1	1.00	730.56
356012	03/03/92	10.9	1.00	730.52

Transducer data for much of 1990 and early 1991 were erratic and noisy, in that there were many anomalous spikes in the record due to electronic noise; however, the converted water-level data are considered valid once these spikes are removed. For some short periods of record (1/1/90 through 1/23/90, 2/1/90 through 2/6/90, 2/17/90 through 2/18/90, 3/5/90, 3/21/90 through 3/22/90, 4/16/90 through 4/18/90, 6/9/90 through 6/10/90, 7/14/90 through 7/16/90, 9/23/90 through 9/24/90, 11/20/90, 12/12/90 through 12/13/90, 1/4/91 through 1/6/91, 2/27/91 through 3/4/91, and 5/31/91 through 6/5/91) the transducer data were so erratic as to be considered unreliable. Transducer data are missing for 5/30/90 and 3/19/91 through 3/20/91.

4. Water-level altitudes:

Water-level altitudes for well USW G-3 ranged from 730.31 to 731.77 m above sea level in 1990, and from 730.27 to 730.65 m above sea level in 1991 (fig. 25). The mean water-level altitudes for 1990 and 1991 were 730.48 and 730.45 m above sea level, respectively. Mean monthly water-level altitudes are listed in table 25.

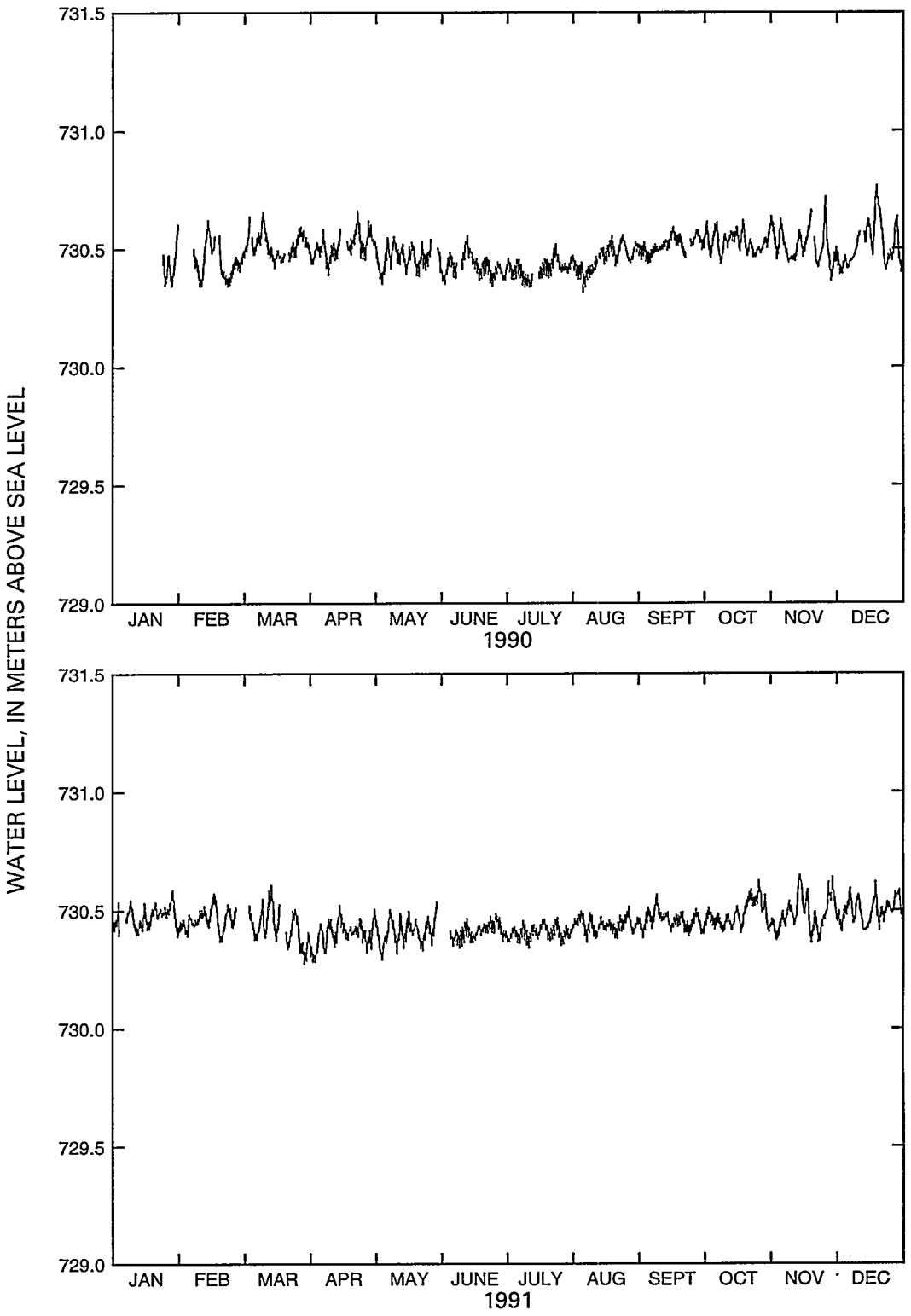

Figure 25. Water levels, 1990–91, for well USW G-3.

Table 25. Mean monthly water-level altitudes, 1990–91, for well USW G-3

[Data in meters above sea level; ----- = data missing, no mean computed]

Month	1990	1991
January	-----	730.47
February	730.44	730.46
March	730.53	730.42
April	730.51	730.40
May	730.47	730.42
June	730.43	730.42
July	730.42	730.40
August	730.46	730.44
September	730.51	730.46
October	730.53	730.48
November	730.51	730.49
December	730.51	730.50

Well USW H-1

1. References or information sources: Rush and others (1983); Rush and others (1984); Robison (1984, 1986); Robison and others (1988); Holmes & Narver, Inc. (written commun., 1986); Fenix & Scisson, Inc. (1987a, c).
2. Well specifications:
   a. Location:

      Nevada State Central Zone Coordinates (m): N 234,774; E 171,416.

      Latitude and longitude: 36°51'57"N; 116°27'12"W.

      Site ID: 365157116271201.

   b. Land-surface altitude: 1,303.0 m (surveyed by U.S. Geological Survey, 1984).
   c. Date drilling started: September 30, 1980.
   d. Date drilling completed: January 25, 1981.
   e. Drilling method: Rotary using rock bits and air-foam circulating medium; cores obtained at selected intervals.
   f. Total depth drilled: 1,829 m.
   g. Bit diameter below water level: 222.2 mm.
   h. Casing information: 226-mm inside diameter to 687 m. Casing string is tack cemented and perforated below the water table.
   i. Description of access for measuring water levels, including tubes or piezometers:

      Tube 1 (lowermost interval): 44-mm inside diameter with a 3.7-m-long well screen on bottom, extending from land surface to a depth of 1,806 m; monitors the depth interval from 1,783 to 1,814 m within older flows and tuffs beneath the Lithic Ridge Tuff (Carr, 1988, p. 37).

Tube 2 (second interval from bottom): 44-mm inside diameter with a 3.7-m-long well screen on bottom, extending from land surface to a depth of 1,115 m; monitors the depth interval from 1,097 to 1,123 m within Tram Member of Crater Flat Tuff.

Tube 3 (third interval from bottom): 44-mm inside diameter with a 3.7-m-long well screen on bottom, extending from land surface to a depth of 741 m; monitors the depth interval from 716 to 765 m within the Bullfrog Member of the Crater Flat Tuff.

Tube 4 (uppermost interval): 62-mm inside diameter, open ended, extending from land surface to a depth of 640 m; monitors the depth interval from 573 to 673 m within the Prow Pass Member of the Crater Flat Tuff.

Note: A gravel pack is placed in the vicinity of the well screens for tubes 1, 2, and 3. Other intervals are grouted with cement to ensure that the piezometers are hydraulically isolated 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. Description and height of MP above reference point: Top of access tube, 0.31 m for all access tubes.

l. Depth correction for measured water levels because of borehole deviation from vertical (the correction is subtracted from measured depth to obtain true depth): 0.14 m in tube 1, based on approximate depth to water of 518 m; 0.17 m in tubes 2, 3, and 4 based on depth to water of 572 m.

3. Calibrations and comments:

Tube 1:

Twelve calibrations, for two transducers, were performed during 1990–91. In addition, calibrations performed on 10/6/89 and 3/5/92 were used to calculate water-level altitudes at the beginning and end of the 1990–91 period. Results of the calibrations and measured water-level altitudes obtained during the calibrations are listed as follows:

Transducer serial number	Calibration date	Slope (mV/m)	Coefficient of determination (r^2)	Water-level altitude (m)
260791	10/06/89	17.8	1.00	785.37
260791	01/29/90	17.5	1.00	785.22
260791	04/24/90	17.4	1.00	785.14
260791	07/26/90	17.5	1.00	785.21
260791	11/07/90	17.5	1.00	785.29
371354	11/08/90	17.4	1.00	785.47
371354	01/16/91	18.0	1.00	785.49
371354	01/16/91	3.47	1.00	785.48
371354	04/12/91	3.42	1.00	785.60
371354	04/15/91	3.52	1.00	785.62
371354	04/17/91	17.3	1.00	785.62
371354	08/05/91	3.46	1.00	785.61
371354	12/04/91	3.46	1.00	785.58
448969	03/05/92	22.9	1.00	785.71

Most transducer data for 1990 are considered acceptable. Only short periods of record, of 1 to 3 days, are considered unreliable or had missing data due to calibrations (1/29, 4/24, 5/28, 7/26, 11/7 through 11/9). Most transducer data for 1991 are also considered acceptable, although some longer periods of record contained erratic and unreliable data or missing data. These periods were 1/16 through 1/17, 3/26 through 4/15, 5/2, 8/28 through 9/4, and 9/19 through 9/25.

Tube 2:

Thirteen calibrations, for four transducers, were performed during 1990–91. In addition, calibrations performed on 10/6/89 and 2/21/92 were used to calculate water-level altitudes at the beginning and end of the 1990–91 period. Results of the calibrations and measured water-level altitudes obtained during the calibrations are listed as follows:

Transducer serial number	Calibration date	Slope (mV/m)	Coefficient of determination (r^2)	Water-level altitude (m)
260793	10/06/89	17.7	1.00	736.24
317093	02/06/90	7.06	1.00	736.14
317093	05/08/90	7.19	1.00	736.13
317093	08/23/90	7.09	1.00	736.08
317093	11/08/90	6.99	1.00	[1]736.17
371473	11/15/90	18.3	1.00	736.15
371473	01/15/91	18.2	1.00	736.16
371473	01/17/91	2.83	0.99	736.16
356511	04/11/91	1.27	1.00	736.03
356511	04/15/91	1.38	1.00	736.01
356511	04/17/91	7.14	1.00	736.01
356511	08/05/91	1.41	1.00	735.99
356511	10/22/91	1.37	1.00	not measured
413604	10/25/91	23.0	1.00	[2]736.09
413604	02/21/92	22.7	1.00	736.02

[1]Water level measured on 11/9/90.
[2]Water level measured on 10/24/91.

Transducer data for tube 2 were subject to significant drift and electronic problems during 1990–91. Data for 1/13/90 through 2/6/90 were unreliable due to transducer failure. Calibrations obtained on 5/8/90 and 8/23/90 were not used to calculate water-level altitude, because the water-level tags obtained for those calibrations were believed to be unreliable. Use of those tags and calibrations resulted in a downward drift in calculated water levels that was not reflected in the manual, steel-tape measurements obtained on 2/6/90 and 11/9/90. The calibration results for 5/8/90 and 8/23/90 are tabulated only for completion. Nearly all 1991 transducer data are considered as unreliable. Only data for November and December of 1991 and 1/1/91 produced acceptable water-level data.

Tube 3:

Twelve calibrations, for two transducers, were performed during 1990–91. In addition, calibrations performed on 10/10/89 and 1/14/92 were used to calculate water-level altitudes at the beginning and end of the 1990–91 period. Results of the calibrations and measured water-level altitudes obtained during the calibrations are listed as follows:

Transducer serial number	Calibration date	Slope (mV/m)	Coefficient of determination (r^2)	Water-level altitude (m)
239125	10/10/89	6.95	1.00	729.93
239125	01/29/90	6.83	1.00	729.76
239125	04/24/90	6.93	1.00	730.03
239125	07/26/90	6.98	1.00	729.93
239125	11/08/90	7.03	1.00	729.91
239125	01/15/90	6.85	1.00	729.99
239125	01/15/91	1.40	1.00	729.98
239125	04/12/91	1.38	1.00	729.94
239125	04/15/91	1.38	1.00	unknown
239125	04/17/91	6.94	1.00	730.01
239125	08/06/91	1.39	1.00	729.95
239125	09/19/91	1.38	1.00	729.93
413606	09/19/91	20.2	1.00	730.79
413606	01/14/92	20.7	1.00	730.69

Nearly all transducer data for 1990 are considered reliable. Electronic spikes on 9/23/90 and 11/17/90, and spikes associated with calibrations on 1/29/90, 4/24/90, 7/26/90, and 11/8/90, were removed. Transducer data for the first three quarters of 1991 (1/2/91 through 9/29/91) are unreliable because of transducer malfunctions and erratic data.

Tube 4:

Eleven calibrations, for two transducers, were performed during 1990–91. In addition, calibrations performed on 12/14/89 and 2/6/92 were used to calculate water-level altitudes at the beginning and end of the 1990–91 period. Results of the calibrations and measured water-level altitudes obtained during the calibrations are listed as follows:

Transducer serial number	Calibration date	Slope (mV/m)	Coefficient of determination (r^2)	Water-level altitude (m)
235187	12/14/89	6.71	1.00	730.29
235187	03/26/90	6.55	1.00	730.92
235187	07/24/90	6.64	1.00	730.96
235187	11/08/90	6.69	1.00	730.88
333284	11/09/90	17.3	1.00	730.83
333284	01/15/90	17.9	1.00	730.97
333284	01/15/91	3.43	1.00	730.97
333284	04/12/91	3.42	1.00	730.94
333284	04/15/91	3.45	1.00	731.14
333284	04/17/91	17.6	1.00	730.90
333284	08/06/91	3.54	1.00	730.95
333284	12/04/91	3.55	1.00	730.92
265605	02/06/92	8.84	1.00	731.00

Nearly all transducer data for 1990 are considered reliable. Spikes associated with transducer calibrations on 3/26/90, 7/24/90, 11/8/90, and 11/9/90 were removed, as were electronic spikes on 3/2/90 and 4/5/90. Transducer data for 1991 were more erratic and not as reliable as 1990 data. Data-logger problems resulted in lost data for 1/2/91 through 1/14/91. Transducer data obtained from 4/12/91 through 4/14/91, while monitoring the effects of an underground nuclear explosion on water levels, were unreliable. Erratic transducer data for the period 7/16/91 through 9/27/91 resulted in computed water levels that were not realistic; computed water levels abruptly rose for no apparent hydrologic reason. The transducer data for that period are, therefore, not considered reliable. A similar problem resulted in unreliable data for 12/4/91 through 12/31/91.

4. Water-level altitudes:

Tube 1:

Water-level altitudes for well USW H-1, tube 1, ranged from 785.18 to 785.49 m above sea level in 1990, and from 785.46 to 785.65 m above sea level in 1991 (fig. 26). The mean water-level altitudes for 1990 and 1991 were 785.36 and 785.58 m above sea level, respectively. Mean monthly water-level altitudes are listed in table 26.

Tube 2:

Water-level altitudes for well USW H-1, tube 2, ranged from 736.13 to 736.20 m above sea level in 1990, and from 735.99 to 736.16 m above sea level in 1991 (fig. 27). The mean water-level altitudes for 1990 and 1991 were 736.15 and 736.06 m above sea level, respectively; however, the mean for 1991 is based only on data for November and December of that year. Water levels for the period 2/6/90 through 11/9/90 are calculated solely on the basis of calibration results on those dates; calibrations on 5/8/90 and 8/23/90 were not used (see discussion of calibrations in previous section). Water-level measurements obtained during 1991 calibrations are shown in the list of calibrations for that year, and measurements made during calibrations on 1/15/91, 4/11/91, and 8/5/91 are shown on figure 27. Mean monthly water-level altitudes are listed in table 26.

Tube 3:

Water-level altitudes for well USW H-1, tube 3, ranged from 730.39 to 731.71 m above sea level in 1990, and from 730.49 to 730.91 m above sea level in 1991 (fig. 28). The mean water-level altitudes for 1990 and 1991 were 730.49 and 730.75 m above sea level, respectively; however, the 1991 mean is based only on data for about the last quarter of the year. Mean monthly water-level altitudes are listed in table 26.

Tube 4:

Water-level altitudes for well USW H-1, tube 4, ranged from 730.77 to 731.15 m above sea level in 1990, and from 730.81 to 731.18 m above sea level in 1991 (fig. 29). The mean water-level altitudes for 1990 and 1991 were 730.92 and 730.94 m above sea level, respectively. Mean monthly water-level altitudes are listed in table 26.

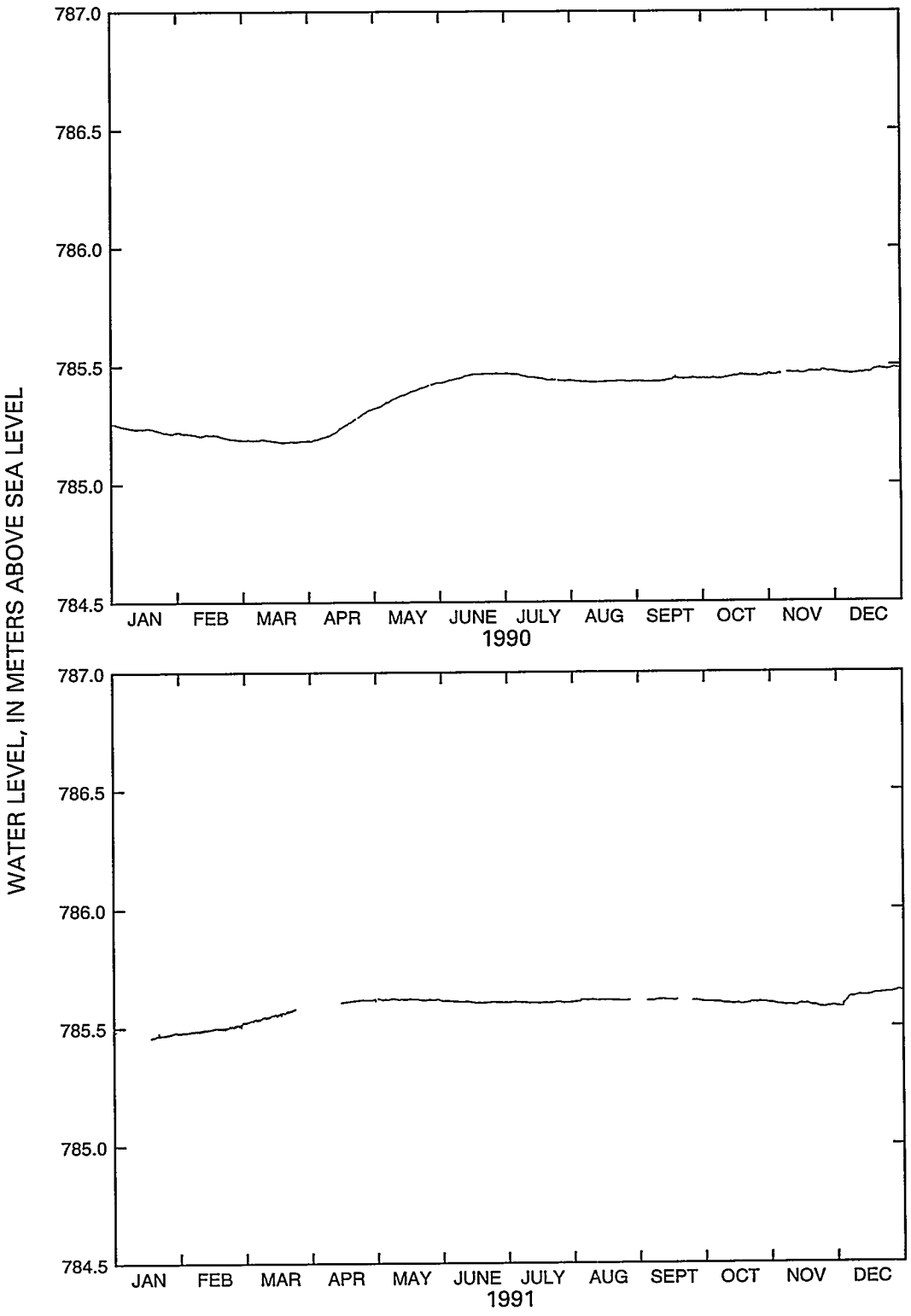

Figure 26. Water levels, 1990–91, for well USW H-1, Tube 1.

Table 26. Mean monthly water-level altitudes, 1990–91, for well USW H-1

[Data in meters above sea level; ----- = data missing, no mean computed]

Month	Tube 1	Tube 2	Tube 3	Tube 4
		1990		
January	785.23	-----	730.50	730.92
February	785.20	736.14	730.50	730.91
March	785.18	736.13	730.54	730.94
April	785.23	736.14	730.52	730.94
May	785.37	736.14	730.48	730.94
June	785.45	736.15	730.48	730.91
July	785.45	736.15	730.48	730.90
August	785.43	736.16	730.47	730.91
September	785.44	736.16	730.46	730.92
October	785.45	736.16	730.46	730.92
November	785.47	736.17	730.46	730.91
December	785.47	736.17	730.52	730.91
		1991		
January	-----	-----	-----	-----
February	785.49	-----	-----	730.94
March	785.55	-----	-----	730.96
April	-----	-----	-----	730.93
May	785.62	-----	-----	730.95
June	785.61	-----	-----	730.92
July	785.60	-----	-----	-----
August	785.61	-----	-----	-----
September	785.61	-----	-----	-----
October	785.60	-----	730.77	730.99
November	785.59	736.07	730.75	730.94
December	785.63	736.05	730.75	-----

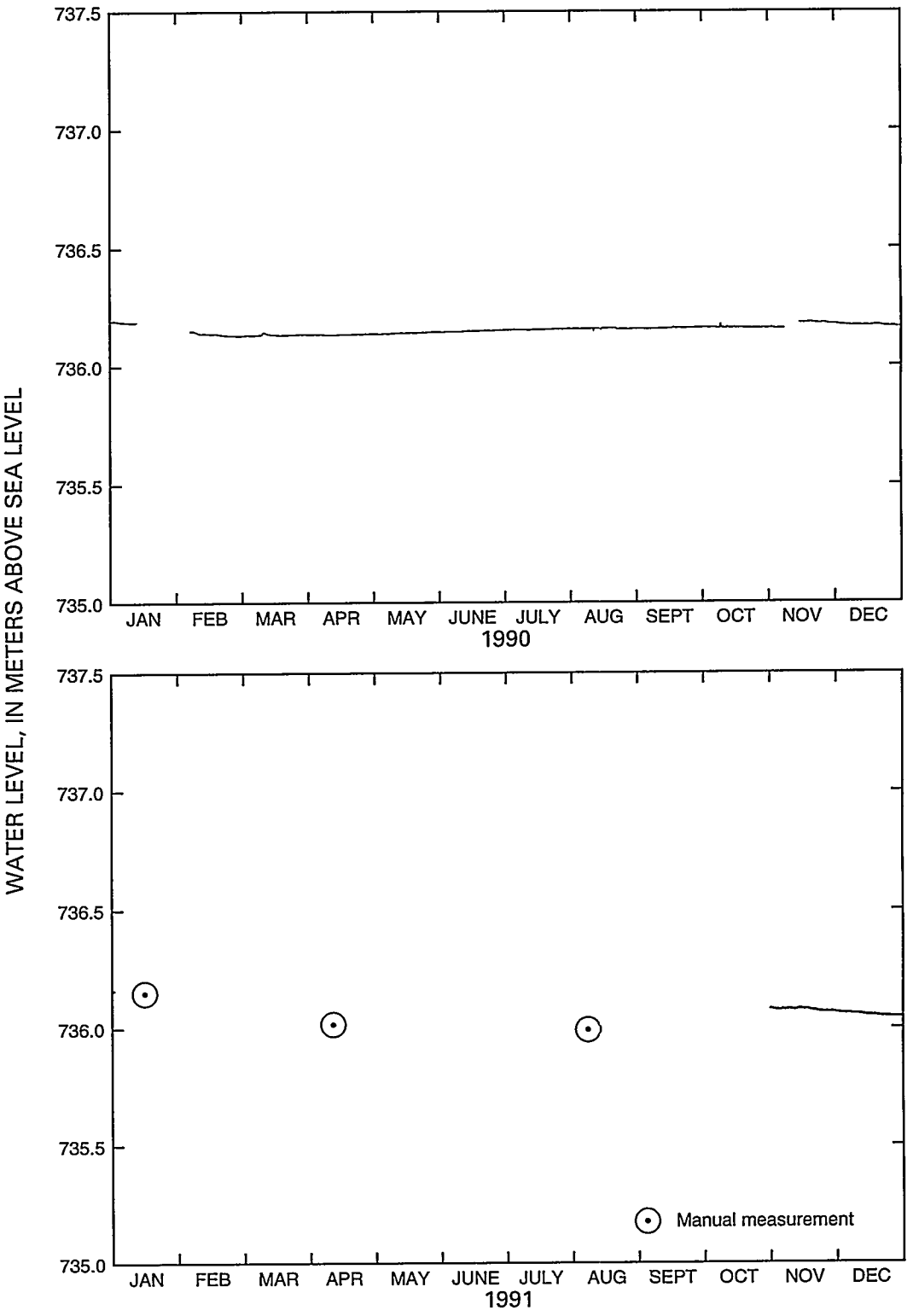

Figure 27. Water levels, 1990–91, for well USW H-1, Tube 2.

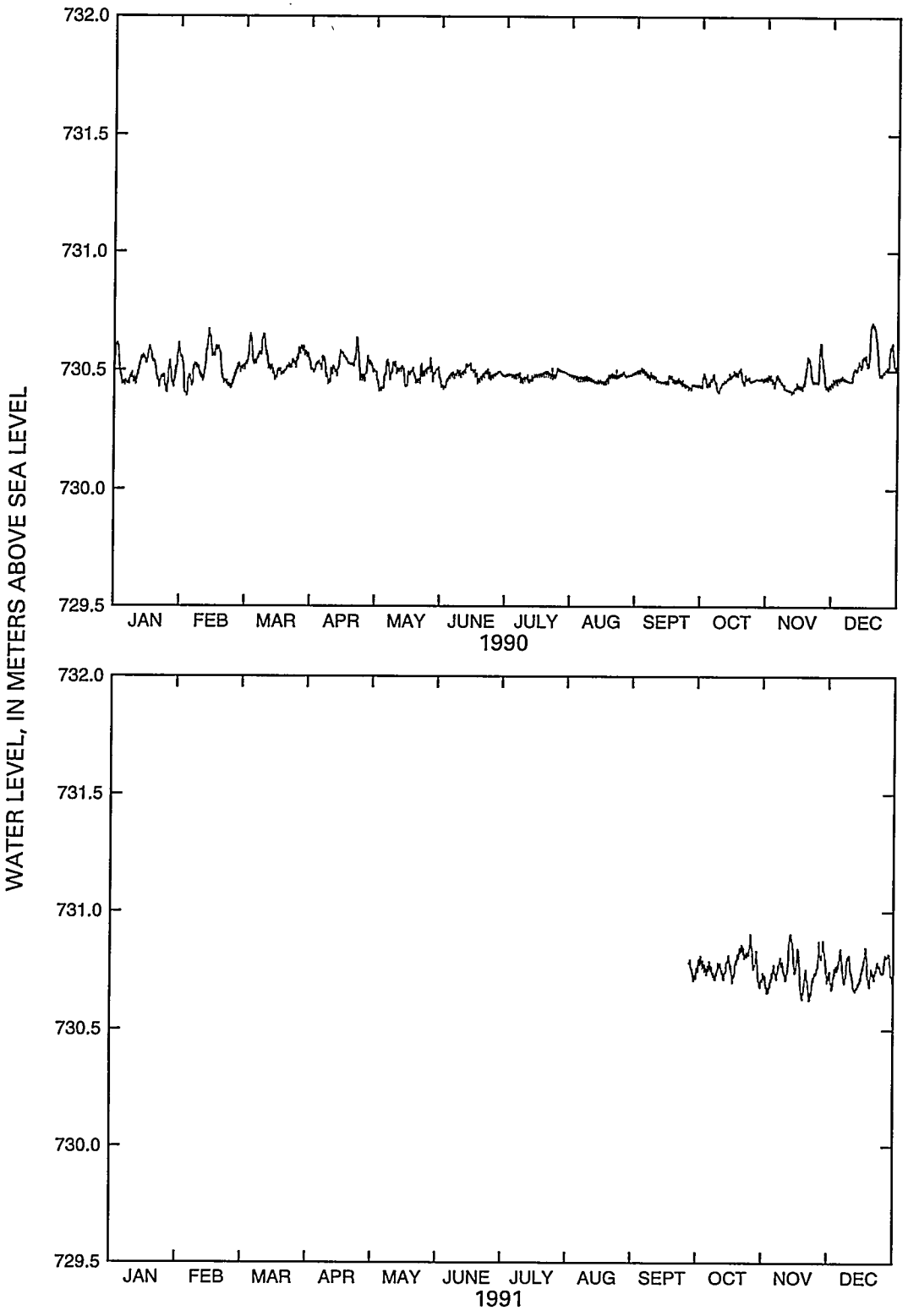

Figure 28. Water levels, 1990–91, for well USW H-1, Tube 3.

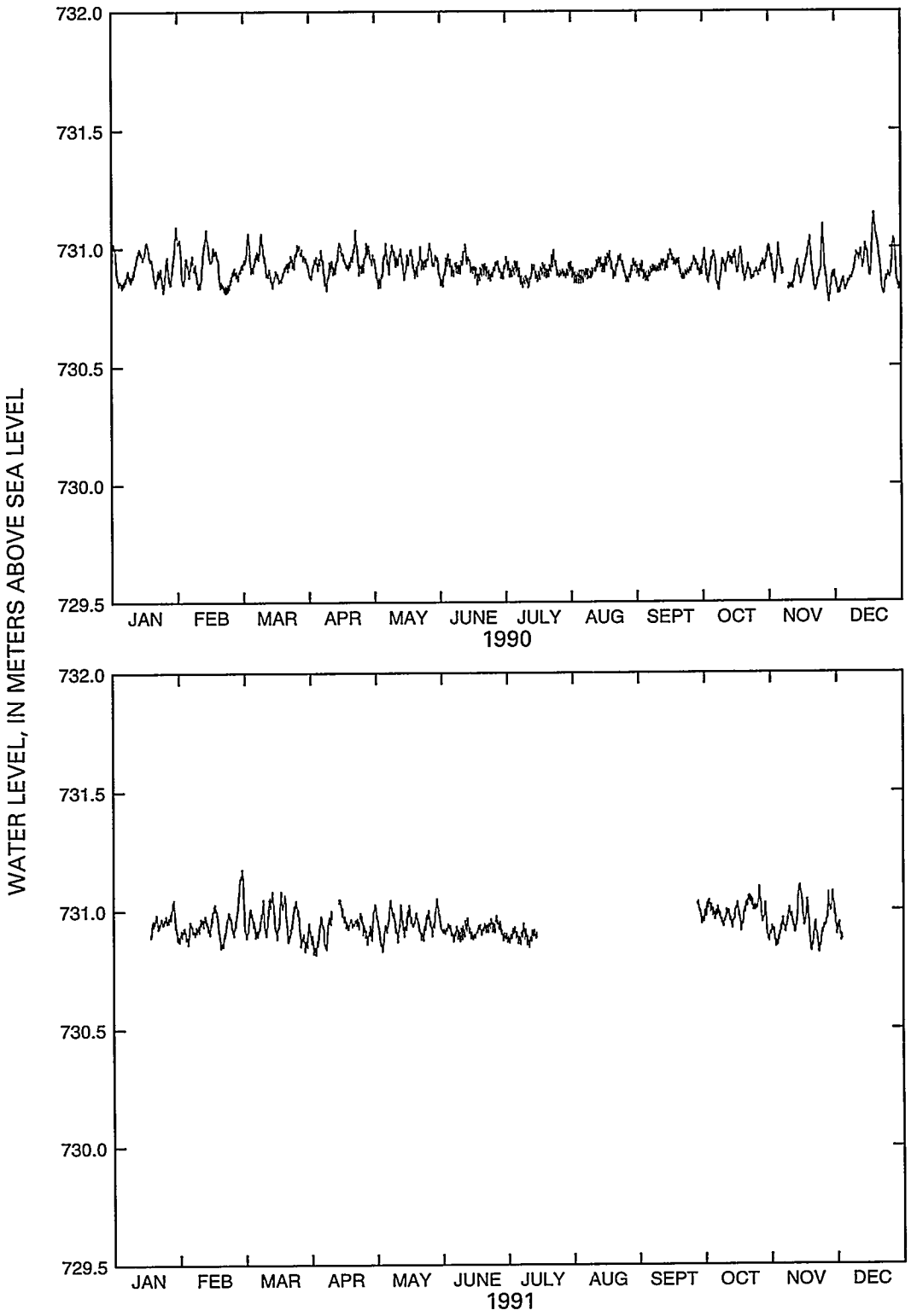

Figure 29. Water levels, 1990–91, for well USW H-1, Tube 4.

Well USW H-3

1. References or information sources: Thordarson, Rush, Spengler, and Waddell (1984); Thordarson, Rush, and Waddell (1984); Robison (1984, 1986); Robison and others (1988); Holmes & Narver, Inc. (written commun., 1986); Fenix & Scisson, Inc. (1987a, c).
2. Well specifications:
   a. Location:

      Nevada State Central Zone Coordinates (m): N 230,594; E 170,216.

      Latitude and longitude: 36°49'42"N; 116°28'00"W.

      Site ID: 364942116280001.

   b. Land-surface altitude: 1,483.3 m (surveyed by U.S. Geological Survey, 1984).
   c. Date drilling started: January 27, 1982.
   d. Date drilling completed: March 19, 1982.
   e. Drilling method: Rotary using rock bits and air-foam circulating medium.
   f. Total depth drilled: 1,219 m.
   g. Bit diameter below water level: 375 mm to 808 m; 222.2 mm from 808 to 1,219 m.
   h. Casing information: 253-mm diameter to 792 m; not perforated below the water level.
   i. Description of access for measuring water levels, including tubes or piezometers:

      (upper interval) 41-mm inside-diameter open-ended tubing, extending from land surface to a depth of about 762 m; upper interval of borehole, from near water level to top of inflatable packer, within Tram Member of Crater Flat Tuff.

      (lower interval) 62-mm inside-diameter tubing that has an inflatable packer on bottom end, extending from land surface to 1,114 m prior to December 14, 1990, and 1,061 m after December 14, 1990; lower interval from below packer to bottom of well, within the Tram Member of the Crater Flat Tuff and the Lithic Ridge Tuff.

   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. Description and height of MP above reference point: Top of access tube, 0.17 m (upper interval); 0.20 m (lower interval).
   l. 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.
3. Calibrations and comments:

   Upper interval:

   Ten calibrations, for two transducers, were performed during 1990–91. In addition, calibrations performed on 10/3/89 and 4/15/92 were used to calculate water-level altitudes at the beginning and end of the 1990–91 period. Results of the calibrations and measured water-level altitudes obtained during the calibrations are listed as follows:

Transducer serial number	Calibration date	Slope (mV/m)	Coefficient of determination (r^2)	Water-level altitude (m)
335621	10/03/89	1.33	1.00	731.94
335621	01/26/90	1.33	1.00	731.91
335621	04/26/90	1.34	1.00	731.89
335621	06/04/90	1.34	1.00	731.87
335621	06/08/90	1.33	1.00	731.93
335621	10/04/90	1.35	1.00	731.69
335621	12/04/90	1.34	1.00	731.88
264709	07/02/91	26.3	1.00	731.32
264709	10/10/91	25.6	1.00	730.96
264709	10/10/91	10.9	1.00	730.96
264709	12/19/91	10.8	1.00	731.30
264709	04/15/92	10.8	1.00	731.00

Most transducer data for 1990 are considered reliable; however, transducer problems resulted in erratic data for 1/17/90 through 1/26/90 and 5/28/90 through 6/9/90. Transducer data are not available for 12/4/90 through 7/2/91, while the access tube and packer for the lower interval was being replaced and water levels were not being monitored hourly. Transducer data for the remainder of 1991 are considered reliable.

Lower interval:

Three calibrations, for one transducer, were performed during 1991. In addition, a calibration performed on 2/4/92 was used to calculate water-level altitudes at the end of the 1991 period. Results of the calibrations and measured water-level altitudes obtained during the calibrations are listed as follows:

Transducer serial number	Calibration date	Slope (mV/m)	Coefficient of determination (r^2)	Water-level altitude (m)
264707	07/03/91	26.1	1.00	751.39
264707	10/09/91	25.6	1.00	752.25
264707	10/09/91	11.2	1.00	752.25
264707	02/04/92	11.2	1.00	753.59

No transducer data are available for 1/1/90 through 12/4/91 because of a plugged access tube (see discussion in the following "Water-Level Altitude" section). Hourly water-level monitoring was continued on 7/3/91. Transducer data for most of the remainder of 1991 are considered reliable. Data for the period 9/27/91 through 10/9/91 are unreliable because of a poor transducer signal that resulted in generally flat responses to pressure changes.

4. Water-level altitudes:

Upper interval:

Water-level altitudes for well USW H-3, upper interval, ranged from 731.64 to 731.96 m above sea level in 1990, and from 730.88 to 731.51 m above sea level in 1991 (fig. 30). The mean water-level altitudes for 1990 and 1991 were 731.88 and 731.21 m above sea level, respectively; however, the 1991 mean is based only on data available from July through December. Mean monthly water-level altitudes are listed in table 27. Four additional water-level measurements were made during 1991,

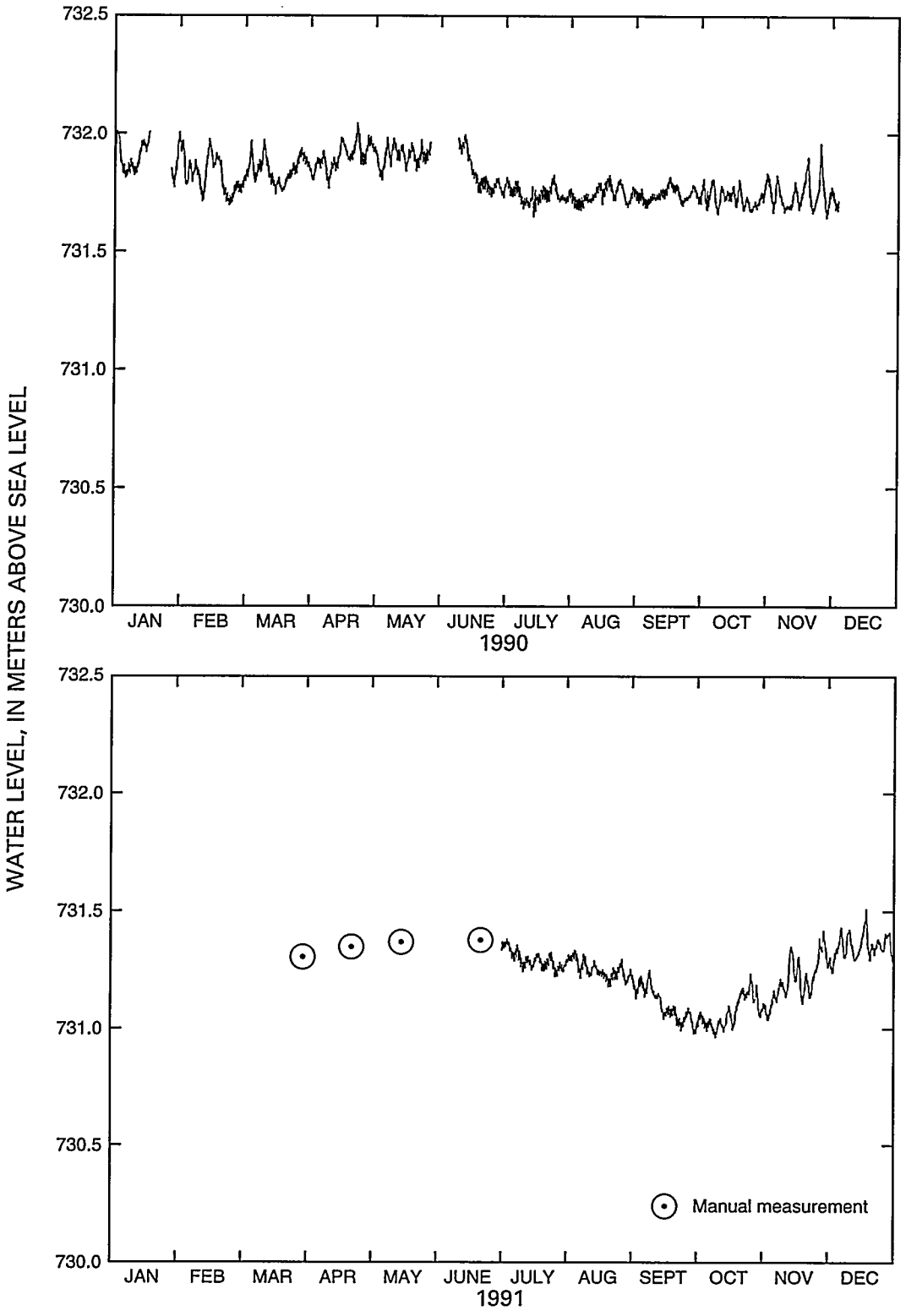

Figure 30. Water levels, 1990–91, for well USW H-3, upper interval.

Table 27. Mean monthly water-level altitudes, 1990–91, for well USW H-3

[Data in meters above sea level; ----- = data missing, no mean computed]

Month	1990	1991
	Upper interval	
January	731.90	-----
February	731.82	-----
March	731.84	-----
April	731.90	-----
May	731.91	-----
June	731.82	-----
July	731.74	731.29
August	731.74	731.25
September	731.74	731.11
October	731.73	731.07
November	731.74	731.20
December	731.72	731.35
	Lower interval	
January	-----	-----
February	-----	-----
March	-----	-----
April	-----	-----
May	-----	-----
June	-----	-----
July	-----	751.52
August	-----	751.83
September	-----	752.11
October	-----	752.39
November	-----	752.69
December	-----	753.03

while this interval was not being monitored on an hourly basis. The water-level altitudes for these measurements are:

03/29/91	731.32 m
04/22/91	731.36 m
05/14/91	731.37 m
06/19/91	731.38 m

Lower interval:

Water-level data for the lower interval of well USW H-3 are not available for 1990 because access to the lower interval was blocked. In December 1990, the inflatable packer was removed for maintenance. Inspection of the packer revealed that the 62-mm access tube to the lower interval was completely plugged and had been plugged since installation of the packer in 1984. Water levels previously reported by Robison and others (1988) for this interval are, therefore, invalid and should

not be used. Water-level altitudes for this interval ranged from 749.49 to 753.25 m above sea level in 1991 (fig. 31; Note: y-axis span is 4.5 m). Water levels steadily rose after the packer was reset, as the potentiometric level approached equilibrium. The mean water-level altitude for July through December 1991 was 752.27 m above sea level. Mean monthly water-level altitudes are listed in table 27. Four additional water-level measurements were made during 1991, while this interval was not being monitored on an hourly basis. The water-level altitudes for these measurements are:

03/29/91	749.49 m
04/22/91	750.05 m
05/14/91	750.59 m
06/19/91	751.24 m

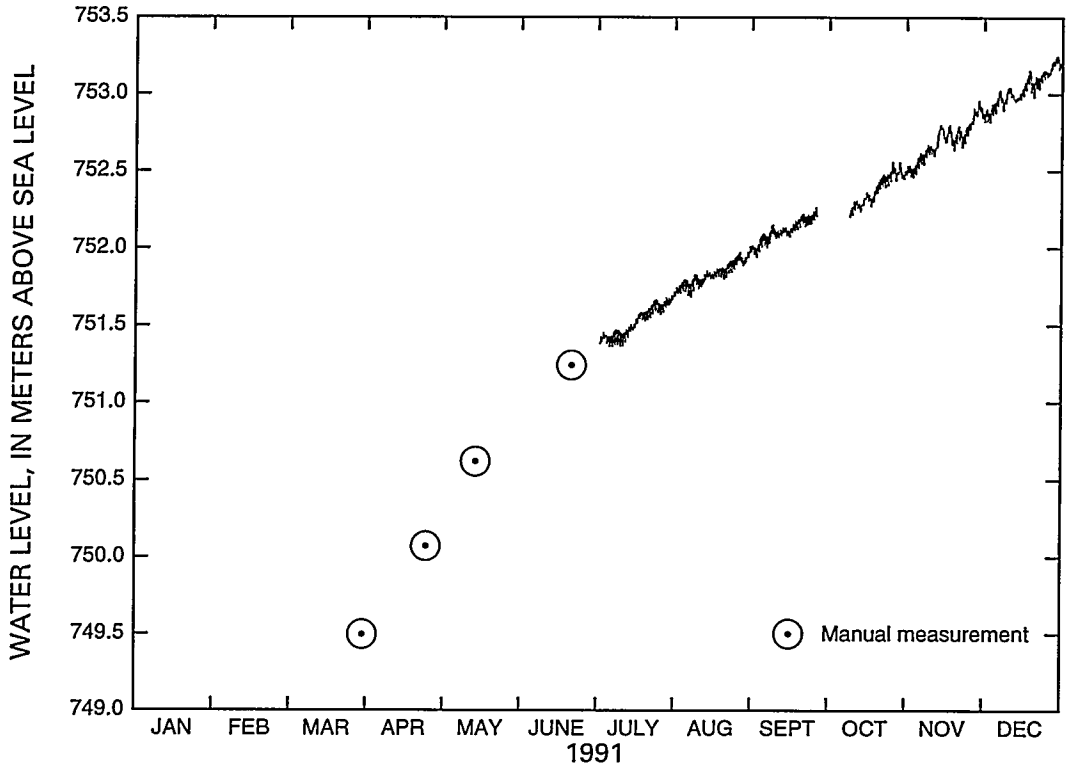

Figure 31. Water levels, 1991, for well USW H-3, lower interval.

Well USW H-4

1. References or information sources: Whitfield and others (1984); Whitfield and others (1985); Robison (1984, 1986); Robison and others (1988); Erickson and Waddell (1985); Holmes & Narver, Inc. (written commun., 1986); Fenix & Scisson, Inc. (1987 a, c).
2. Well specifications:
   a. Location:

      Nevada State Central Zone Coordinates (m): N 232,149; E 171,880.

      Latitude and longitude: 36°50'32"N; 116°26'54"W.

      Site ID: 365032116265401.

   b. Land-surface altitude: 1,248.5 m (surveyed by U.S. Geological Survey, 1984).
   c. Date drilling started: March 22, 1982.
   d. Date drilling completed: June 7, 1982.
   e. Drilling method: Rotary using rock bits and air-foam circulating medium; cores obtained at selected intervals.
   f. Total depth drilled: 1,219 m.
   g. Bit diameter below water level: 222.2 mm.
   h. Casing information: 253-mm diameter to 560.5 m; not perforated below the water level.
   i. Description of access for measuring water levels, including tubes or piezometers:

      (upper interval) 48-mm inside-diameter open-ended tubing, extending from land surface to a depth of about 525 m; upper interval of borehole, from near water level to top of inflatable packer, within Prow Pass, Bullfrog, and Tram Members of Crater Flat Tuff, and upper Lithic Ridge Tuff.

      (lower interval) 62-mm inside-diameter tubing that has an inflatable packer on bottom end, extending from land surface to 1,118 m; lower interval from below packer to bottom of well, within Lithic Ridge Tuff.

   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. Description and height of MP above reference point: Top of access tube, 0.60 m (upper interval); 0.31 m (lower interval).
   l. 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.
3. Calibrations and comments:

   Upper interval:

   Nine calibrations, for two transducers, were performed during 1990–91. In addition, calibrations performed on 11/9/89 and 1/10/92 were used to calculate water-level altitudes at the beginning and end of the 1990–91 period. Results of the calibrations and measured water-level altitudes obtained during the calibrations are listed as follows:

Transducer serial number	Calibration date	Slope (mV/m)	Coefficient of determination (r^2)	Water-level altitude (m)
226106	11/09/89	6.61	1.00	730.30
226106	02/13/90	6.68	1.00	730.52
226106	05/09/90	6.61	1.00	730.35
226106	08/23/90	6.67	1.00	730.39
226106	10/23/90	6.59	1.00	730.37
356013	10/24/90	11.3	1.00	730.40
356013	03/05/91	11.2	1.00	730.54
356013	06/05/91	11.2	1.00	730.51
356013	08/28/91	11.1	1.00	730.47
356013	12/11/91	11.2	1.00	730.54
356013	01/10/92	11.1	1.00	730.17

Transducer data for 1990 are "noisy," and several short periods of record are considered unreliable because of the erratic nature of the data. Data for the following dates in 1990 were not converted to water levels: 1/14 to 1/27, 2/13 to 3/12, 4/19 to 4/21, 5/28 to 6/2, 6/9 to 6/12, 7/14 to 7/20, 9/22 to 9/23, and 9/28. Single-event electronic spikes in the transducer data were also removed for several days during 1990. Data were lost on 10/23/90 through 10/29/90 due to data-logger problems. Data for nearly all of 1991 are considered reliable, although data obtained on 12/30 and 12/31 were erratic and, therefore, considered unreliable.

Lower interval:

Eight calibrations, for two transducers, were performed during 1990–91. In addition, calibrations performed on 11/9/89 and 1/22/92 were used to calculate water-level altitudes at the beginning and end of the 1990–91 period. Results of the calibrations and measured water-level altitudes obtained during the calibrations are listed as follows:

Transducer serial number	Calibration date	Slope (mV/m)	Coefficient of determination (r^2)	Water-level altitude (m)
235178	11/09/89	6.69	1.00	730.56
235178	02/13/90	6.64	1.00	730.71
235178	05/09/90	6.78	1.00	730.58
235178	08/23/90	6.72	1.00	730.64
356011	10/24/90	11.3	1.00	730.47
356011	03/05/91	11.2	1.00	730.56
356011	06/05/91	11.2	1.00	730.58
356011	08/28/91	11.3	1.00	730.53
356011	12/12/91	11.7	1.00	730.58
2384DH	01/22/92	11.4	1.00	730.58

Most transducer data in 1990 are considered reliable. Erratic transducer data on 1/17/90 through 2/13/91, 5/28/90 through 6/3/90, and 7/14/90 through 7/18/90 were not converted to water levels. Data for 8/23/90 through 10/29/90 are not reliable due to transducer failure. Nearly all transducer data for 1991 are considered reliable, except erratic data from 12/12 through 12/31.

4. Water-level altitudes:

Upper interval:

Water-level altitudes for well USW H-4, upper interval, ranged from 730.29 to 730.71 m above sea level in 1990, and from 730.35 to 730.71 m above sea level in 1991 (fig. 32). The mean water-level altitudes for 1990 and 1991 were 730.41 and 730.49 m above sea level, respectively. Mean monthly water-level altitudes are listed in table 28.

Lower interval:

Water-level altitudes for well USW H-4, lower interval, ranged from 730.38 to 730.77 m above sea level in 1990, and from 730.37 to 730.93 m above sea level in 1991 (fig. 33). The mean water-level altitudes for 1990 and 1991 were 730.60 and 730.56 m above sea level, respectively. Mean monthly water-level altitudes are listed in table 28.

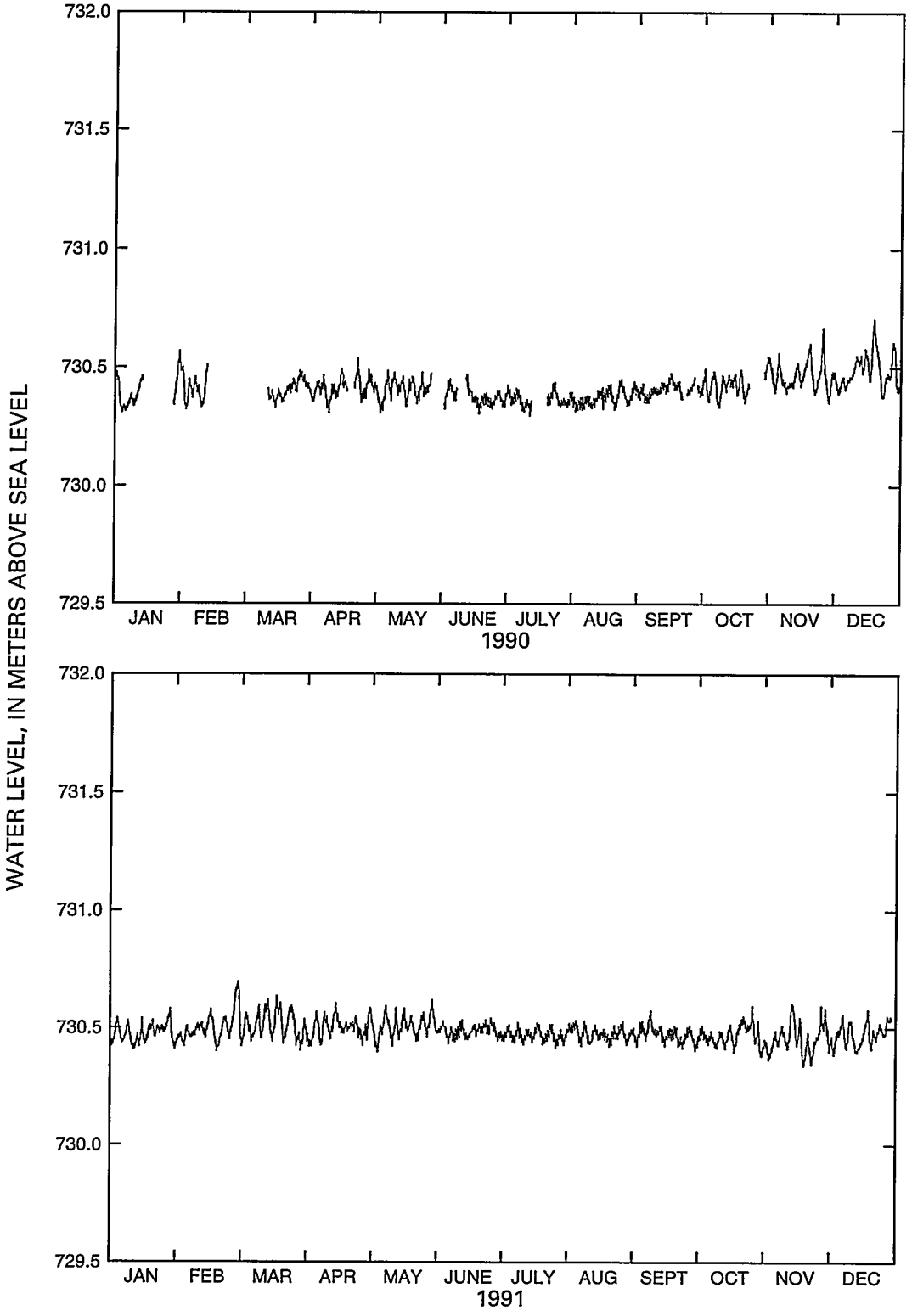

Figure 32. Water levels, 1990–91, for well USW H-4, upper interval.

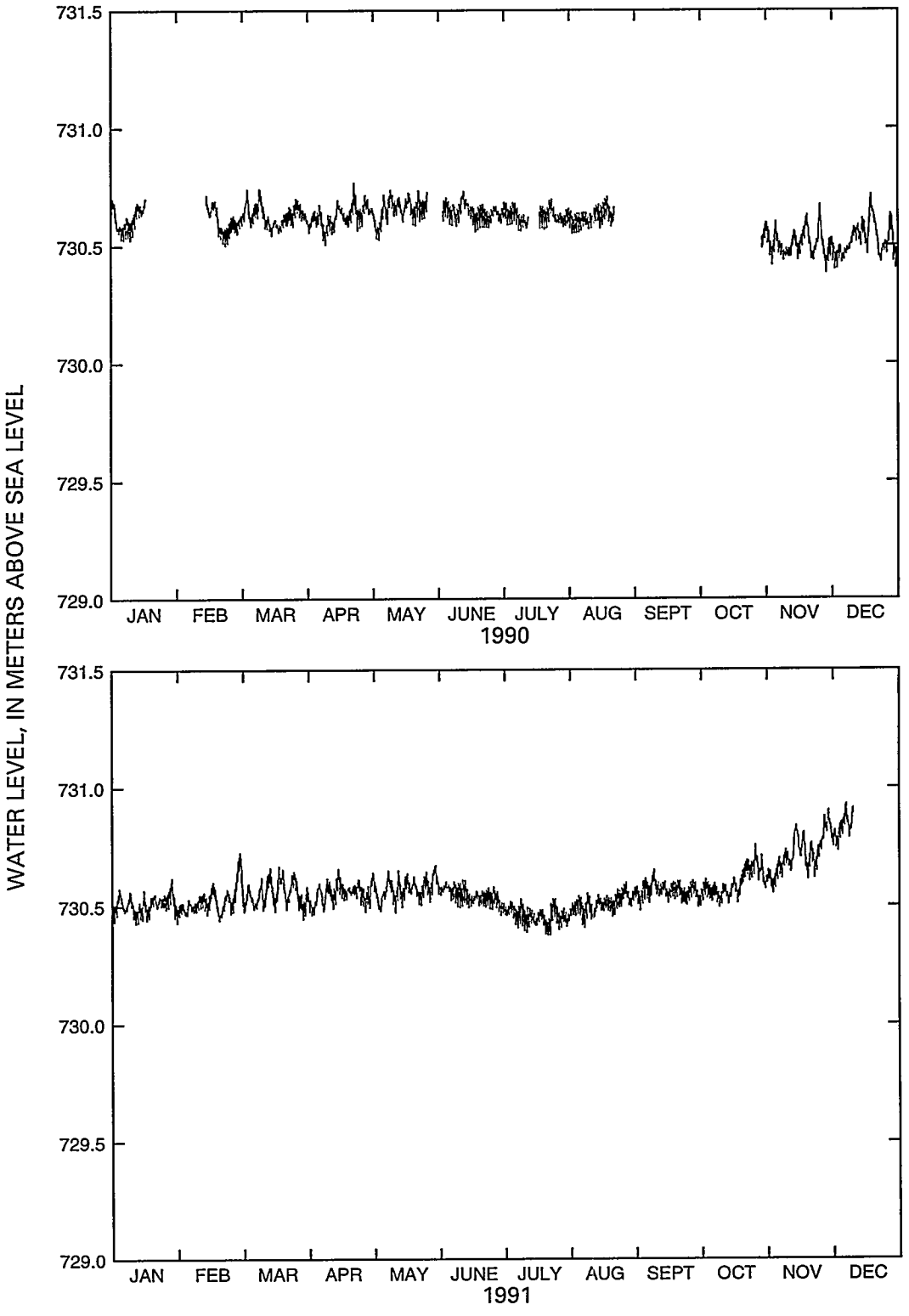

Figure 33. Water levels, 1990–91, for well USW H-4, lower interval.

Table 28. Mean monthly water-level altitudes, 1990–91, for well USW H-4

[Data in meters above sea level; ----- = data missing, no mean computed]

Month	1990	1991
	Upper interval	
January	-----	730.48
February	-----	730.50
March	730.41	730.52
April	730.41	730.51
May	730.40	730.52
June	730.37	730.50
July	730.36	730.48
August	730.37	730.49
September	730.41	730.48
October	730.42	730.48
November	730.47	730.47
December	730.48	730.48
	Lower interval	
January	730.62	730.51
February	730.60	730.52
March	730.63	730.56
April	730.62	730.55
May	730.66	730.58
June	730.64	730.55
July	730.63	730.46
August	730.62	730.51
September	-----	730.56
October	-----	730.59
November	730.51	730.72
December	730.52	-----

Well USW H-5

1. References or information sources: Bentley and others (1983); Robison (1984, 1986); Robison and others (1988); Holmes & Narver, Inc. (written commun., 1986); Fenix & Scisson, Inc. (1987 a, c).
2. Well specifications:
   a. Location:

      Nevada State Central Zone Coordinates (m): N 233,670; E 179,499.

      Latitude and longitude: 36°51'22"N; 116°2'55"W.

      Site ID: 365122116275502 (no Site ID assigned for sequence number 01).

   b. Land-surface altitude: 1,478.9 m (surveyed by U.S. Geological Survey, 1984).
   c. Date drilling started: May 19, 1982.
   d. Date drilling completed: August 1, 1982.
   e. Drilling method: Rotary using rock bits and air-foam circulating medium; cores obtained at selected intervals.
   f. Total depth drilled: 1,219 m.
   g. Bit diameter below water level: 375 mm to 790 m; 222.2 mm from 790 to 1,219 m.
   h. Casing information: 255-mm diameter to 788 m; perforated below the water level.
   i. Description of access for measuring water levels, including tubes or piezometers:

      (upper interval) 48-mm inside-diameter open-ended tubing, extending from land surface to a depth of about 708 m; upper interval of borehole, from near water level to top of inflatable packer, within Bullfrog and Tram Member of Crater Flat Tuff, and unnamed lava beneath the Tram Member (Carr, 1988, p. 37).

      (lower interval) 62-mm inside-diameter tubing that has an inflatable packer on bottom end, extending from land surface to 1,091 m; lower interval from below packer to bottom of well, within unnamed lava beneath the Tram Member of the Crater Flat Tuff.

   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. Description and height of MP above reference point: Top of access tube, 0.33 m (upper interval); 0.24 m (lower interval).
   l. 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 703 m.
3. Calibrations and comments:

   Upper interval:

   Nine calibrations, for three transducers, were performed during 1990–91. In addition, calibrations performed on 12/13/89 and 1/15/92 were used to calculate water-level altitudes at the beginning and end of the 1990–91 period. Results of the calibrations and measured water-level altitudes obtained during the calibrations are listed as follows:

Transducer serial number	Calibration date	Slope (mV/m)	Coefficient of determination (r^2)	Water-level altitude (m)
219283	12/13/89	6.60	1.00	775.51
219283	03/15/90	6.39	1.00	775.53
308828	03/15/90	11.6	1.00	775.53
308827	06/19/90	11.3	1.00	775.51
308827	09/25/90	11.3	1.00	775.36
308827	01/23/91	11.2	1.00	775.39
308827	04/17/91	11.3	1.00	775.46
308827	08/08/91	11.3	1.00	775.35
308827	11/13/91	11.1	1.00	775.44
308827	01/15/92	11.3	1.00	775.54

Transducer data for 1/1/90 through 3/15/90 were erratic and not considered reliable. Data for 3/16/90 through 6/4/90 resulted in computed water levels that were anomalously high. Because no closing calibration or water-level measurement was made for this transducer when it was removed on 6/4/90, the data are considered unreliable. No transducer data are available for 6/4/90 through 6/19/90. Transducer data for 1991 are all reliable, except for erratic data on 6/23/91.

Lower interval:

Eight calibrations, for two transducers, were performed during 1990–91. In addition, a calibration performed on 1/16/92 was used to calculate water-level altitudes at the end of the 1990–91 period. Results of the calibrations and measured water-level altitudes obtained during the calibrations are listed as follows:

Transducer serial number	Calibration date	Slope (mV/m)	Coefficient of determination (r^2)	Water-level altitude (m)
308831	06/07/90	11.3	1.00	775.54
308831	09/25/90	11.6	1.00	775.56
308831	01/23/91	10.2	0.99	775.62
308831	04/17/91	10.8	1.00	775.69
308831	08/08/91	10.8	1.00	775.58
308831	11/13/91	10.6	1.00	775.69
308831	12/10/91	10.6	1.00	775.67
2382DH	12/11/91	11.2	1.00	775.66
2382DH	01/16/92	11.3	1.00	775.60

Transducer data are not available for this interval prior to 6/7/90, because of an obstruction in the access tube. This obstruction prevented reliable calibration of transducers in the lower interval (Lobmeyer and others, 1995). After removal of the obstruction, data for the remainder of 1990 are considered reliable. All data for 1991 are considered reliable; however, data are missing on 12/10, 12/11, 12/20, and 12/21.

4. Water-level altitudes:

Upper interval:

Water-level altitudes for well USW H-5, upper interval, ranged from 775.28 to 775.67 m above sea level in 1990, and from 775.31 to 775.67 m above sea level in 1991 (fig. 34). The mean water-level altitudes for 1990 and 1991 were 775.42 and 775.43 m above sea level, respectively. Mean monthly water-level altitudes are listed in table 29.

Lower interval:

Water-level altitudes for well USW H-5, lower interval, prior to December 10, 1991, were back-calculated from the manual water-level measurement obtained on that date because no measurement was made when the transducer was installed on 6/7/90. The back calculation assumes that the water-level rise, noted on 12/10/91 (0.13 m from the water level at the time the transducer was installed), is equal to the water-level altitude of 775.67 m obtained from the manual measurement on that date. This assumption results in an estimated water-level altitude of 775.54 m on 6/7/90. Given these assumptions, water levels for the lower interval of well USW H-5 ranged from 775.49 to 775.88 m above sea level in 1990, and from 775.50 to 775.90 m above sea level in 1991 (fig. 35). The mean water-level altitudes for 1990 and 1991 were 775.60 and 775.65 m above sea level, respectively. Mean monthly water-level altitudes are listed in table 29.

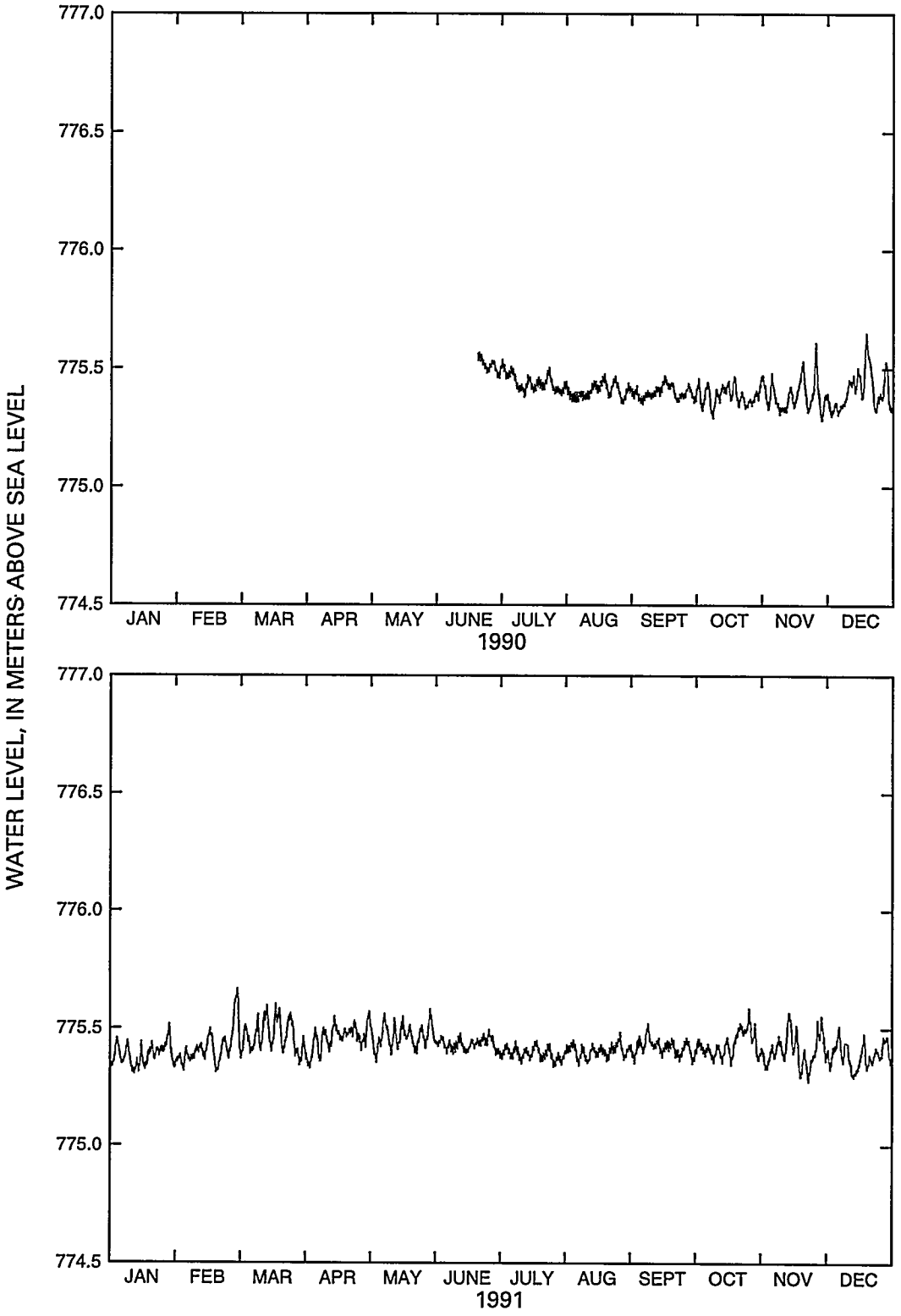

Figure 34. Water levels, 1990–91, for well USW H-5, upper interval.

Table 29. Mean monthly water-level altitudes, 1990–91, for well USW H-5

[Data in meters above sea level; ----- = data missing, no mean computed]

Month	1990	1991
	Upper interval	
January	-----	775.38
February	-----	775.40
March	-----	775.46
April	-----	775.45
May	-----	775.46
June	-----	775.44
July	775.44	775.40
August	775.41	775.39
September	775.40	775.40
October	775.39	775.42
November	775.39	775.43
December	775.41	775.54
	Lower interval	
January	-----	775.61
February	-----	775.64
March	-----	775.70
April	-----	775.68
May	-----	775.70
June	775.61	775.66
July	775.60	775.62
August	775.59	775.63
September	775.59	775.65
October	775.59	775.66
November	775.60	775.64
December	775.62	775.62

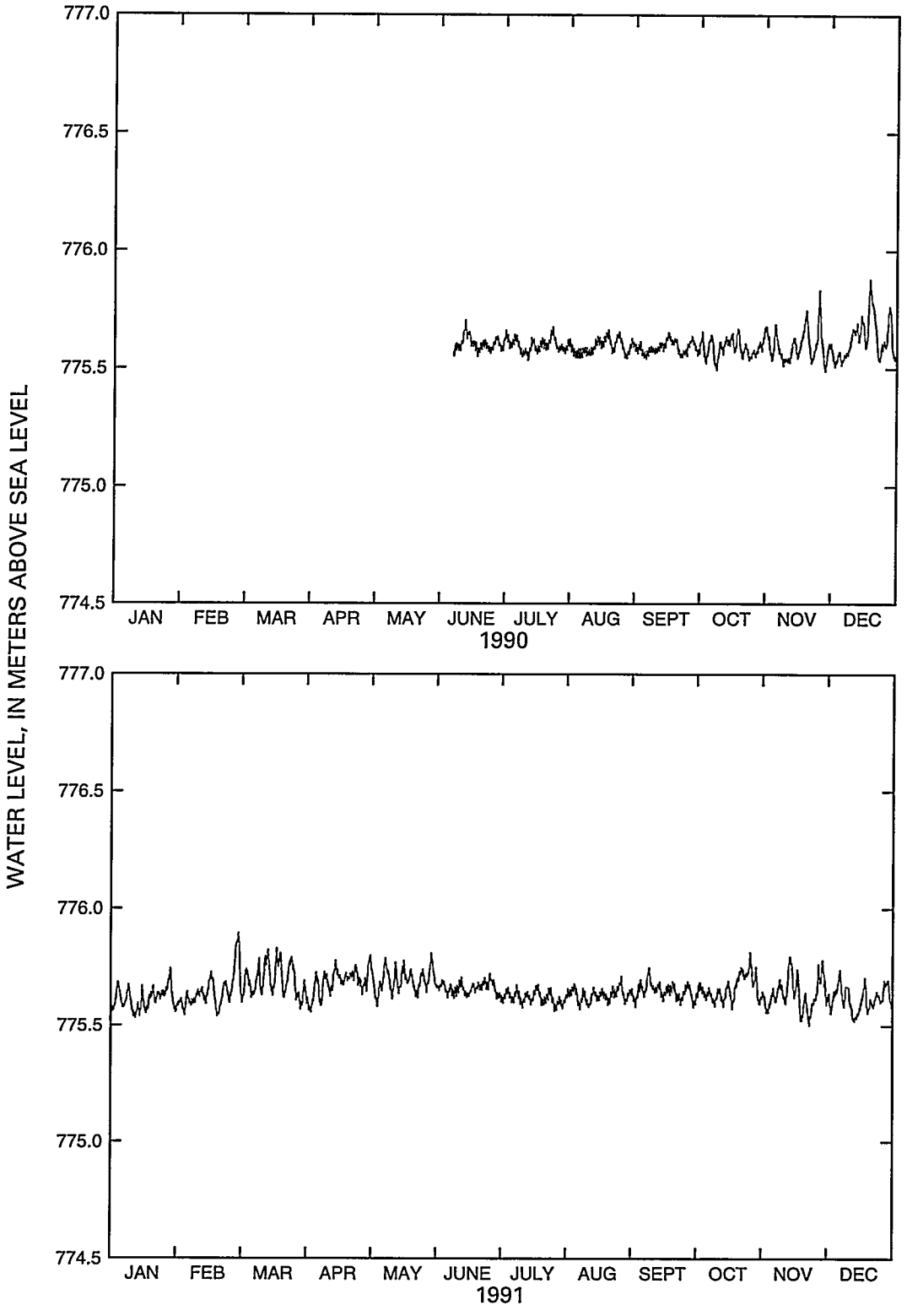

Figure 35. Water levels, 1990–91, for well USW H-5, lower interval.

Well USW H-6

1. References or information sources: Craig and others (1983); Robison (1984, 1986); Robison and others (1988); Holmes & Narver, Inc. (written commun., 1986); Fenix & Scisson, Inc. (1987 a, c).
2. Well specifications:
   a. Location:

      Nevada State Central Zone Coordinates (m): N 232,654; E 168,882.

      Latitude and longitude: 36°50'49"N; 116°28'55"W.

      Site ID: 365049116285501.

   b. Land-surface altitude: 1,301.7 m (surveyed by U.S. Geological Survey, 1984).
   c. Date drilling started: August 7, 1982.
   d. Date drilling completed: October 28, 1982.
   e. Drilling method: Rotary using rock bits and air-foam circulating medium; cores obtained at selected intervals.
   f. Total depth drilled: 1,220 m.
   g. Bit diameter below water level: 375 mm to 583 m; 222.2 mm from 583 to 1,216 m; 156 mm from 1216 to 1220 m.
   h. Casing information: 250-mm diameter to 581 m; perforated below the water level.
   i. Description of access for measuring water levels, including tubes or piezometers:

      (upper interval) 48-mm inside-diameter open-ended tubing, extending from land surface to a depth of 533 m; upper interval of borehole, from near water level to top of inflatable packer, within Prow Pass, Bullfrog, and Tram Members of Crater Flat Tuff.

      (lower interval) 62-mm inside-diameter tubing that has an inflatable packer on bottom end, extending from land surface to 752 m; lower interval from below packer to bottom of well, within the Tram Member of the Crater Flat Tuff, unnamed lava beneath the Tram Member (Carr, 1988, p. 37), and Lithic Ridge Tuff.

   j. Description and altitude of reference point: Top of metal tag on well casing, 1,302.06 m (surveyed by U.S. Geological Survey, 1984).
   k. Description and height of MP above reference point: Top of access tube, 0.21 m (upper interval); 0.24 m (lower interval).
   l. 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 526 m.
3. Calibrations and comments:

   Upper interval:

   Ten calibrations, for four transducers, were performed during 1990–91. In addition, calibrations performed on 10/18/89 and 2/10/92 were used to calculate water-level altitudes at the beginning and end of the 1990–91 period. Results of the calibrations and measured water-level altitudes obtained during the calibrations are listed as follows:

Transducer serial number	Calibration date	Slope (mV/m)	Coefficient of determination (r^2)	Water-level altitude (m)
226102	10/18/89	6.57	1.00	775.93
226102	02/02/90	6.45	1.00	775.93
226102	05/11/90	6.43	1.00	776.03
315716	05/11/90	6.94	0.99	776.03
322500	09/19/90	6.72	1.00	775.99
322500	01/15/91	6.71	1.00	775.91
322500	01/15/91	1.28	1.00	775.93
322500	03/06/91	1.30	1.00	775.86
265667	03/07/91	11.2	1.00	775.96
265667	07/05/91	11.2	1.00	775.99
265667	10/30/91	11.1	1.00	775.93
265667	02/10/92	11.1	1.00	776.01

Transducer data were erratic and considered unreliable for 1/14/90 through 1/25/90, and for 3/5/90 through 3/9/90. Data are missing from 5/1/90 through 5/12/90 and 8/8/90 through 9/6/90 because of transducer failures. Data are missing from 9/7/90 through 9/19/90 because of data-logger problems. Transducer data are missing from 1/4/91 through 1/10/91 because of data-logger problems. Data are considered unreliable from 1/10/91 through 3/7/91. Data are missing from 7/5/91 through 7/12/91 because of transmitter problems with the DCP.

Lower interval:

Eight calibrations, for four transducers, were performed during 1990–91. In addition, calibrations performed on 10/18/89 and 2/10/92 were used to calculate water-level altitudes at the beginning and end of the 1990–91 period. Results of the calibrations and measured water-level altitudes obtained during the calibrations are listed as follows:

Transducer serial number	Calibration date	Slope (mV/m)	Coefficient of determination (r^2)	Water-level altitude (m)
235186	10/18/89	6.71	1.00	775.85
235186	02/02/90	6.71	1.00	775.86
315715	05/10/90	6.72	1.00	775.98
341808	09/19/90	6.77	1.00	775.94
341808	01/15/91	2.37	1.00	776.03
341808	03/06/91	1.51	0.99	not measured
266708	03/07/91	11.1	1.00	775.88
266708	07/05/91	11.3	1.00	775.90
266708	10/30/91	11.2	1.00	775.84
266708	02/10/92	11.3	1.00	775.89

Most transducer data for 1990 were reliable; however, transducer failures resulted in unreliable data from 4/30/90 through 5/10/90, and from 8/12/90 through 9/19/90. Data are missing from 1/4/91 through 1/10/91 because of data-logger problems. Transducer data were erratic and are considered unreliable from 1/11/91 through 3/6/91. Data are missing from 7/5/91 through 7/12/91 because of transmitter problems with the DCP.

4. Water-level altitudes:

Upper interval:

Water-level altitudes for well USW H-6, upper interval, ranged from 775.76 to 776.14 m above sea level in 1990, and from 775.80 to 776.16 m above sea level in 1991 (fig. 36). The mean water-level altitudes for 1990 and 1991 were 775.94 and 775.99 m above sea level, respectively. Mean monthly water-level altitudes are listed in table 30.

Lower interval:

Water-level altitudes for well USW H-6, lower interval, ranged from 775.60 to 776.12 m above sea level in 1990, and from 775.65 to 776.07 m above sea level in 1991 (fig. 37). The mean water-level altitudes for 1990 and 1991 were 775.89 and 775.91 m above sea level, respectively. Mean monthly water-level altitudes are listed in table 30.

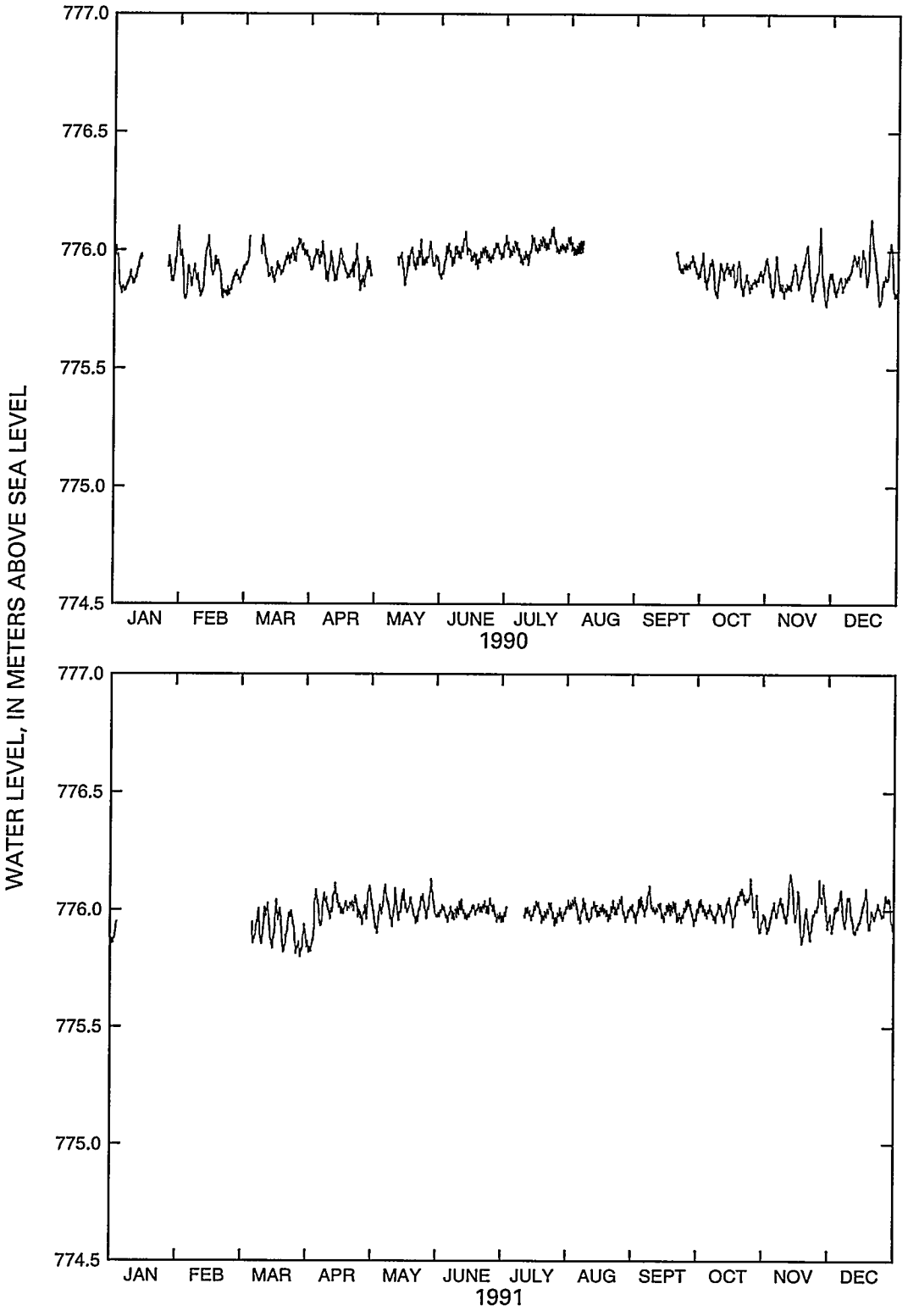

Figure 36. Water levels, 1990–91, for well USW H-6, upper interval.

Table 30. Mean monthly water-level altitudes, 1990–91, for well USW H-6

[Data in meters above sea level; ----- = data missing, no mean computed]

Month	1990	1991
	Upper interval	
January	775.92	-----
February	775.89	-----
March	775.96	775.92
April	775.93	775.99
May	775.96	776.01
June	775.98	776.00
July	776.01	775.98
August	-----	776.00
September	-----	776.00
October	775.89	776.01
November	775.88	775.99
December	775.91	775.99
	Lower interval	
January	775.95	-----
February	775.96	-----
March	775.98	775.94
April	775.98	775.93
May	775.94	775.93
June	775.90	775.91
July	775.90	775.90
August	-----	775.91
September	-----	775.91
October	775.81	775.91
November	775.74	775.89
December	775.74	775.88

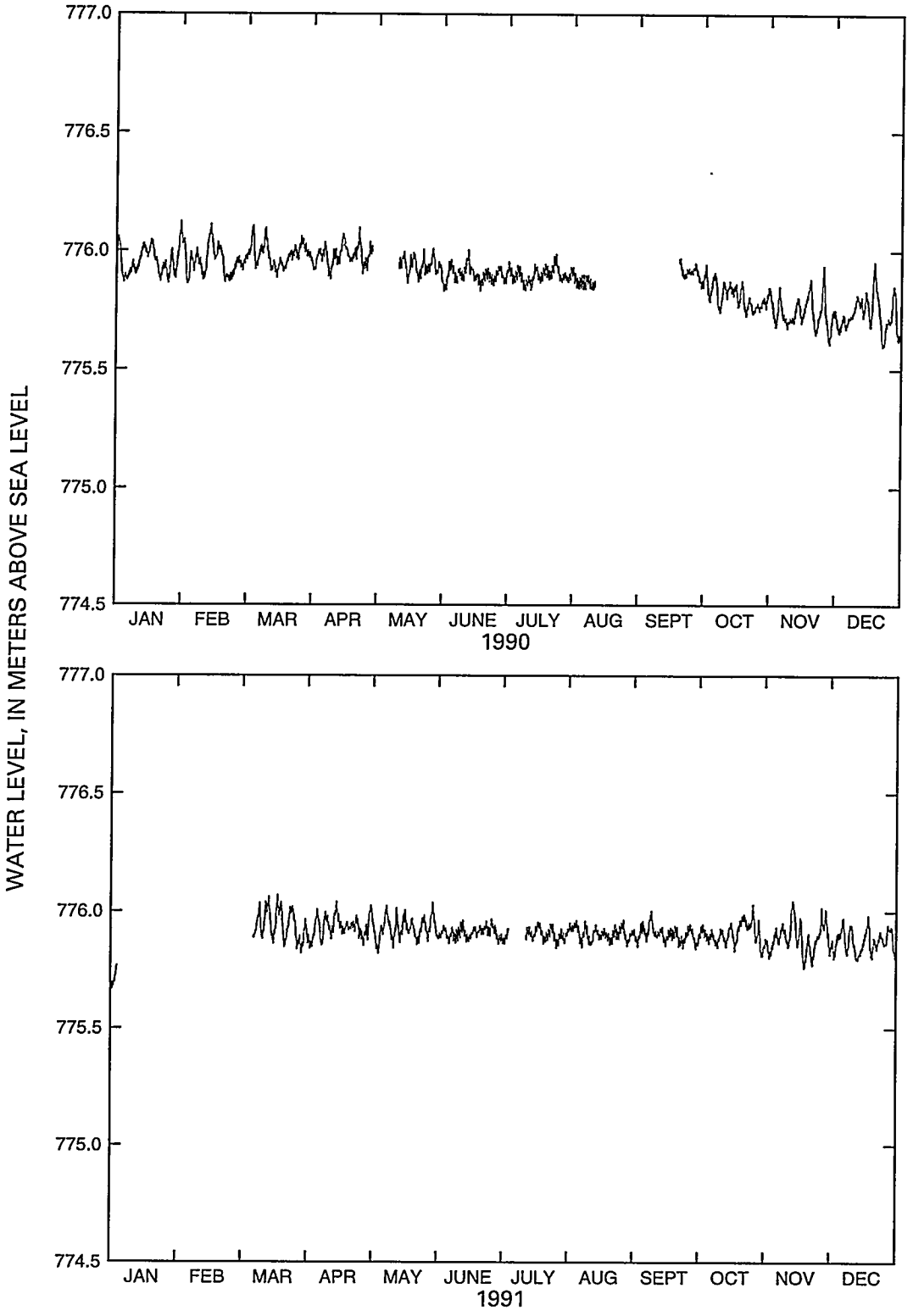

Figure 37. Water levels, 1990–91, for well USW H-6, lower interval.

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