WATER LEVELS IN THE YUCCA MOUNTAIN AREA, NEVADA, 1992

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U.S. GEOLOGICAL SURVEY

Open-File Report 94-311

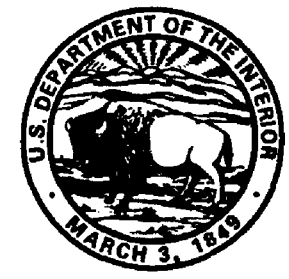
Prepared in cooperation with the

NEVADA OPERATIONS OFFICE,

U.S. DEPARTMENT OF ENERGY under

Interagency Agreement DE-AI08-92NV10874

Denver, Colorado
1995



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CONTENTS

Abstract 1
Introduction 1
Well designations 2
Data-collection system 4
Periodic measurements 4
Corrections and adjustments to manual measurements 4
Mechanical stretch 5
Thermal expansion 5
Borehole-deviation correction 5
Water-level altitudes 5
Example calculation 7
Precision and accuracy 7
Hourly measurements 8
Equipment 8
Transducers 8
Data loggers 9
Processing and adjustments 10
Conversion to water-level altitude 10
Quality assurance 11
Onsite procedures 11
Office processing and review 11
Well data and water levels 12
Periodic water-level measurements 12
Well USW WT-1 12
Well UE-25 WT #4 14
Well UE-25 WT #6 15
Well USW WT-7 18
Well USW WT-10 20
Well UE-25 WT #12 21
Well UE-25 WT #14 23
Well UE-25 WT #15 24
Well UE-25 WT #17 26
Well UE-25 WT #18 27
Well USW VH-1 29
Well J-11 30
Well J-12 32
Well J-13 33
Hourly water-level measurements 35
Well USW WT-2 35
Well UE-25 WT #3 37
Well USW WT-11 39
Well UE-25 WT #13 41
Well UE-25 WT #16 43
Well UE-25b #1 45
Well UE-25p #1 49
Well USW G-3 51
Well USW H-1 53
Well USW H-3 59
Well USW H-4 62
Well USW H-5 65
Well USW H-6 69
References cited 73

FIGURES

1. Location of Yucca Mountain area and location of wells 2

2–36. Hydrographs showing water-level altitude, 1992, for:

2. Well USW WT-1 13
3. Well UE-25 WT #4 15
4. Well UE-25 WT #6 18
5. Well USW WT-7 19
6. Well USW WT-10 21
7. Well UE-25 WT #12 22
8. Well UE-25 WT #14 24
9. Well UE-25 WT #15 25
10. Well UE-25 WT #17 27
11. Well UE-25 WT #18 28
12. Well USW VH-1 30
13. Well J-11 31
14. Well J-12 33
15. Well J-13 34
16. Well USW WT-2 36
17. Well UE-25 WT #3 38
18. Well USW WT-11 40
19. Well UE-25 WT #13 42
20. Well UE-25 WT #16 44
21. Well UE-25b #1, upper interval 47
22. Well UE-25b #1, lower interval 48
23. Well UE-25p #1 50
24. Well USW G-3 52
25. Well USW H-1, tube 1 55
26. Well USW H-1, tube 2 56
27. Well USW H-1, tube 3 57
28. Well USW H-1, tube 4 58
29. Well USW H-3, upper interval 60
30. Well USW H-3, lower interval 61
31. Well USW H-4, upper interval 63
32. Well USW H-4, lower interval 64
33. Well USW H-5, upper interval 67
34. Well USW H-5, lower interval 68
35. Well USW H-6, upper interval 71
36. Well USW H-6, lower interval 72

TABLES

1. Summary of wells monitored for water levels, 1992 3
2. Corrections applicable to steel tapes used for measuring water levels, 1992, in the vicinity of Yucca Mountain 6
3. Mechanical stretch and thermal expansion equation variable values for steel tapes used in the vicinity of Yucca Mountain 7

4–17. Measured water-level altitudes and yearly mean water-level altitude, 1992, for:
4. Well USW WT-1 13
5. Well UE-25 WT #4 14
6. Well UE-25 WT #6 17
7. Well USW WT-7 19
8. Well USW WT-10 20
9. Well UE-25 WT #12 22
10. Well UE-25 WT #14 23
11. Well UE-25 WT #15 25
12. Well UE-25 WT #17 26
13. Well UE-25 WT #18 28
14. Well USW VH-1 29
15. Well J-11 31
16. Well J-12 32
17. Well J-13 34
18–19. Mean monthly water-level altitudes, 1992, for:
18. Well USW WT-2 36
19. Well UE-25 WT #3 38
20. Measured water-level altitudes, 1992, for Well UE-25 WT #3 39
21–22. Mean monthly water-level altitudes, 1992, for:
21. Well USW WT-11 40
22. Well UE-25 WT #13 42
23. Mean monthly water-level altitudes, January and February, 1992, for Well UE-25 WT #16 44
24. Measured water-level altitudes, 1992, for Well UE-25 WT #16 45
25–26. Mean monthly water-level altitudes, 1992, for:
25. Well UE-25b #1, upper interval 47
26. Well UE-25b #1, lower interval 48
27. Measured water-level altitudes, 1992, for Well UE-25b #1, lower interval 49
28–30. Mean monthly water-level altitudes, 1992, for:
28. Well UE-25p #1 50
29. Well USW G-3 52
30. Well USW H-1, tube 1 56
31. Measured water-level altitudes, 1992, for Well USW H-1, tube 1 56
32–42. Mean monthly water-level altitudes, 1992, for:
32. Well USW H-1, tube 2 57
33. Well USW H-1, tube 3 58
34. Well USW H-1, tube 4 58
35. Well USW H-3, upper interval 60
36. Well USW H-3, lower interval 61
37. Well USW H-4, upper interval 63
38. Well USW H-4, lower interval 64
39. Well USW H-5, upper interval 67
40. Well USW H-5, lower interval 68
41. Well USW H-6, upper interval 71
42. Well USW H-6, lower interval 72

CONVERSION FACTORS 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
pounds per square inch (psi)	703.1	kilograms per square meter
square kilometer (km^2)	0.3861	square mile

Sea level: In this report "sea level" refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)—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, 1992

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

Abstract

Water levels were monitored in 27 wells in the Yucca Mountain area, Nevada, during 1992. Fourteen wells were monitored periodically, generally on a monthly basis, and 13 wells representing 21 intervals were monitored hourly. All wells monitor levels in Tertiary volcanic rocks, except one which 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 751 and 753 meters above sea level during 1992. Water-level fluctuations were observed at 11 wells in response to the Landers, California earthquake on June 28, 1992. All data were acquired in accordance with a quality-assurance program to support the reliability of the data.

INTRODUCTION

The Yucca Mountain area is being evaluated by the U.S. Department of Energy for suitability to store high-level nuclear waste in a mined, underground repository. A 150 km^2 area located about 150 km northwest of Las Vegas in southern Nevada is being studied extensively (fig. 1). Water levels in selected wells have been measured periodically since 1981, and have been measured on an hourly or more frequent basis 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 parameters 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 1992, included 13 wells that were monitored hourly, and 14 wells that were monitored periodically. Continuous water-level and fluid-pressure data were also collected at wells USW H-5 and USW H-6 using analog-chart recorders to allow monitoring of fluctuations caused by earthquakes. However, these continuous data are not included in this report; O'Brien (1992 and 1993) presents continuous data associated with earthquakes during 1992. 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 also 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 multiconductor cables. 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.

This report is a companion and supplement to reports that present periodically measured water levels (Robison and others, 1988; Gemmell, 1990; O'Brien, 1991; M.S. Boucher, U.S. Geological Survey, written

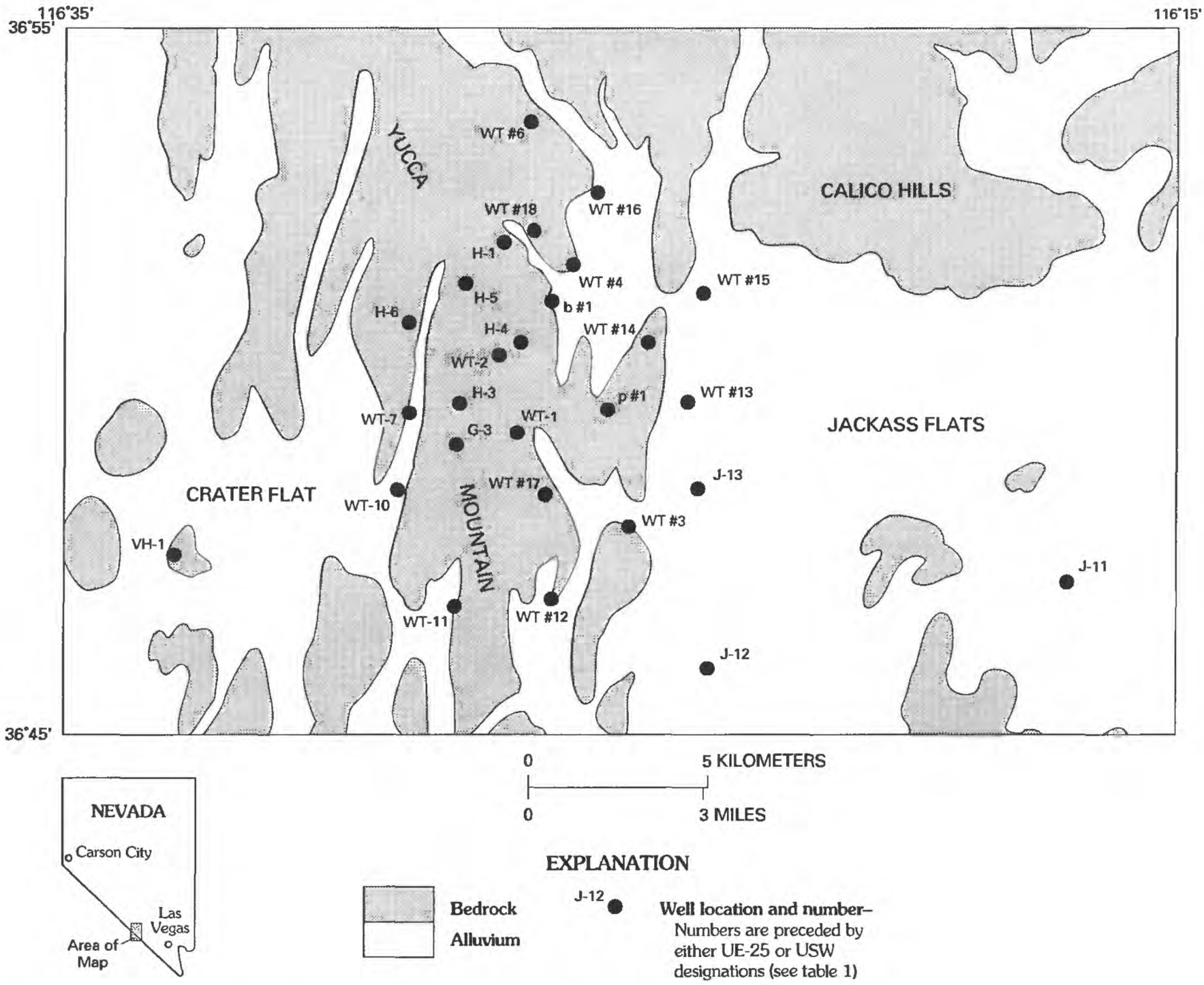

Figure 1. Location of Yucca Mountain area and location of wells.

commun., 1994) and hourly measured water levels (Luckey and others, 1993; Lobmeyer and others, in press; P. Tucci, U.S. Geological Survey, written commun., 1994) in the Yucca Mountain area. Robison and others (1988) describe the details of how the manual water-level measurements were 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 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. Transducer data, which were converted to water-level altitudes, were evaluated by E.R. Banta, hydrologist with the U.S. Geological Survey, in conjunction with the authors.

WELL DESIGNATIONS

Each well used in the study of the Yucca Mountain area has a unique name or number. Wells on the

Table 1. Summary of wells monitored for water levels, 1992

[p, periodic measurements; h, hourly monitoring]

Well number	Drilled depth (meters)	Date completed	Water level		Frequency monitored
			Approximate depth (meters)[1]	Approximate altitude (meters)[1]	
USW WT-1	515	5-83	471	730	p
USW WT-2	628	7-83	570	731	h
UE-25 WT #3	348	5-83	300	730	h
UE-25 WT #4	482	6-83	438	731	p
UE-25 WT #6	383	6-83	280	1,035	p
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	605	731	p
UE-25b #1	1,220	9-81	470	731	h
UE-25p #1	1,805	5-83	362	752	h
USW G-3	1,533	3-82	750	730	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	519	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-11	405	7-57	317	732	p
J-12	3472	8-68	227	728	p
J-13	1,063	1-63	283	728	p

[1]Composite 1992 mean water level of saturated interval, or level of shallowest interval monitored.

[2]Original drilled depth 271 m in 1957; well deepend to present depth in 1968.

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 of volcanic rocks) and WT (collection of water-table data). The only wells not using this designation system and referred to in this report are wells J-11, J-12, and J-13, which are water-supply wells.

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 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), and each depth interval was assigned its own unique Site ID by incrementing the sequence number. Hence, some wells within the network have several Site ID's. However, the water-level data are generally stored in the National Water Information System (NWIS) data base under the Site ID with sequence number 01. Exceptions are wells USW H-5 and UE-25p #1, which use the Site ID with sequence number 02.

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 pressure 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 1992 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 pressure transducers.

Periodic measurements during 1992 were made using "Chain #1", a specially constructed reeled steel tape that is 7.9-mm-wide and 792-m-long. One measurement was made at well USW H-3 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 steel tapes used to measure water levels for this study are given by O'Brien (1991), and are not repeated here.

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 altitudes. 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 wells J-11, J-12, and J-13, are corrected for borehole deviation from vertical. Borehole-deviation information is not available for wells J-11, J-12, and 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 1992, based on stretch coefficients and an approximate weight of 0.45 kg for the plumb bob, ranged from -0.044 to 0.014 m (table 2) for water levels measured in the vicinity of Yucca Mountain.

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

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

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 estimated to be accurate to 7 percent (R.R. Luckey, U.S. Geological Survey, oral communication, 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:

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

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 mechanical stretch and thermal expansion, 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.

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 wells J-11, J-12, and 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 -0.01 to -0.56 m (table 2). Corrections generally increase with increasing well depth.

Water-Level Altitudes

Water-level altitudes are 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 generally are based on a survey of the water-level monitoring network made in late 1984 by the U.S. Geological Survey.

Table 2. Corrections applicable to steel tapes used for measuring water levels, 1992, 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[1]	Mechanical stretch	Thermal expansion	Total[1]		Interval[2] Upper	Interval[2] 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-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]	25.0	-0.038	0.033	-0.005	-0.012	0.033	0.021	-0.171	0.311	--	1,303.10
USW H-1[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-11	25.0	-0.042	0.018	-0.023	-0.024	0.018	-0.005	na	0.555	--	1,049.45
Well J-12	25.0	-0.035	0.013	-0.022	-0.021	0.013	-0.008	na	0.527	--	954.54
Well J-13	25.0	-0.040	0.016	-0.023	-0.023	0.016	-0.007	na	0.165	--	1,011.47

[1]Total correction may not equal sum of mechanical stretch and thermal expansion due to rounding.
[2]Wells with only one interval have measuring point listed as upper.

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}

Example Calculation

An example measurement for well UE-25 WT #4 for April 20, 1992, 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 0.05 ft.

Example

The water-level measurement on April 20, 1992, at UE-25 WT #4 was made with Chain #1. 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 20, 1992, were:

Reading	Measurement 1	Measurement 2
HELD (ft)	1,442.00	1,443.00
CUT (ft)	-1.40	-2.39
Apparent depth to water (ft)	1,440.60	1,440.61
Average of two apparent depths to water (ft)		1,440.605
Apparent depth to water (1,440.57 ft × 0.3048 m/ft) (m)		439.096
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)		438.335
Determination of water-level altitude:		
Altitude of reference point (m) (table 2)		1,169.21
True depth (m)		-438.34
Altitude of water level (m)		730.87

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, 1994a). 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 precision of Chain #1 is believed to be the same or nearly the same as that of Chain #2, because they have the same physical characteristics, and they were identically constructed.

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, 1994a). 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 wells J-11, J-12, and 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.

Hourly measurements 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. Continuous measurements were collected at wells USW H-5 and USW H-6 to monitor water-level and fluid-pressure response to earthquakes.

Pressure transducers and data loggers are used to measure water-level fluctuations. Because of the large depths to water (up to 752 meters) 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 pressure transducer, which senses depth of submergence, a wireline cable to transmit voltage 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.

The 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 steel tape, or a multiconductor cable unit. 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 1992. Transducers and transmitters are pressure sensors which 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 consist 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 differs 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, the transducer output increases as the depth of submergence 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 5 psi; however, a 5 psi range was most frequently used.

The water-level network historically has used both absolute and gage transducers. 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 the reference side of the strain gage to above the water surface. Gage transducers are preferable in the water-level network because only water-level fluctuations (and not air-pressure changes) affect the transducer output, and these were used exclusively in the water-level network during 1992.

As a part of the calibration process, a water-level measurement must be obtained by either a manual measurement, using a steel tape, multiconductor cable, 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 comes in contact with the water surface 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, if the transducer is not functioning properly, errors in the measured water level (probably less than 0.1 m) are possible.

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, if necessary, and to measure the output voltage, so the calibration is for the entire transducer/data-logger system and not only for the transducer.

On June 10, 1992, the transducer/data-logger system at well USW WT-13 was calibrated. The calibration started with the transducer submerged 1.52 m below the water surface. The following values were obtained:

Depth of submergence below water surface (meters)	Average transducer output (millivolts)
1.52	27.44
1.22	23.88
1.16	23.10
1.10	22.38
1.04	21.68
0.98	20.96
0.91	20.27
0.85	19.57
0.79	18.88
0.73	18.17
0.67	17.46
0.61	16.78
0.30	13.30
0.00	10.05

The transducer output is the average of three readings taken after the transducer output had stabilized. A regression analysis was performed on the calibration data, excluding any points where the transducer was not submerged. The slope of the regression line for well USW WT-13 on June 10, 1992, was 11.44 millivolts per meter with a coefficient of determination (r^2) of 100.0 percent. The slope of the regression line, the transducer output at the set point after calibration and before the next calibration, and the water-level measurement at the time of calibration were used to convert transducer output to water-level altitude. The set point is the position below the water surface at which the transducer is placed for water-level monitoring.

Data Loggers

Two different types of data loggers were used for the hourly water-level network during 1992: a microprocessor-based data acquisition system that collects data and stores them internally, and a data-collection platform (DCP) that collects data, stores data, and transmits data to a satellite from which the data are relayed to a ground station. DCP's were gradually phased in as the primary data-acquisition system during 1992.

The Campbell Scientific 21X Micrologger, used in the hourly water-level network as the primary data-acquisition system prior to 1992, is a microprocessor-based system. This data logger is a combination microprocessor, clock, voltage regulator, controller, data processor, and data-storage device. The 21X micropro-

cessor system is a programmable unit, and most aspects of its operation can be varied according to specific needs. Details of the 21X operation and programming are described by Luckey and others (1993) and Lobmeyer and others, in press). By the end of 1992, the 21X microprocessor systems were used only as supplemental data loggers at selected wells.

A DCP was first installed at well USW G-3 in December 1989 and were installed at all hourly monitored wells by May 1992. 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 in the transmission or receiving process.

In addition to transducer output, the data loggers also read information such as battery voltage, excitation voltage, and the panel temperature of the data loggers. These variables are important in evaluation of the reliability of the system. The data loggers store all of the preceding data in memory. Additionally, the 21X data loggers stored 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 written 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, 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 electronic signals, or due to instrument malfunction are not retained as water levels.

Conversion to Water-Level Altitude

In an ideal circumstance, a transducer would be calibrated several times during its operating life, its output would be free of drift, and its characteristics would not change with time. However, this ideal situation rarely occurred, causing the transducer output conversion to be more difficult. As a result, some of the transducer output and resulting converted water levels were not considered reliable.

Converted water levels were evaluated by two hydrologists for data reliability. The hydrologists examined the data at a time scale which clearly showed the hourly and daily fluctuations so that the validity of the data could be determined. The data were compared to barometric-pressure data, earth-tide potential data, 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 data were given indeterminate status. 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.

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

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

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.

The following example illustrates how transducer data were converted to water levels at well USW WT-13. The water-level altitude for the calibration on June 10, 1992, was 729.11 m (based on a manual measurement). The calibration indicated that a

1-meter change in water level would cause the transducer output to change by approximately 11.44 millivolts. The transducer output at the post-calibration set point (0.91 m below water surface) was 20.60 millivolts. The transducer output at 12:00:00 on June 11, 1992, was 20.12 millivolts. To summarize, equation 3 variables are:

W_c = 729.11 meters

S_c = 11.44 millivolts/meter

T_c = 20.60 millivolts

T = 20.12 millivolts

Given these data, the water-level calculation for 12:00:00 on June 11, 1992, would be as follows:

$$W=729.11+(20.12-20.60) / 11.44=729.07 \text{ meters} \quad (4)$$

Change in the slope of the regression line, S_c, and change in the transducer output at set point, T_c, between consecutive calibrations, are types of drift corrected for in the conversion process. Although the slope of the regression line generally does not change dramatically between calibrations, it usually changes to some degree. The change in slope is assumed to occur linearly between calibrations. Set-point drift occurs when the expected transducer output at set point does not match the actual output at set point prior to the next calibration. Set-point drift is also assumed to occur linearly over time.

The water-level altitude is assumed to have remained constant from the last transducer output prior to calibration through the first transducer output after calibration. This assumption probably introduces, at most, a few hundredths 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 for the following period unless the coefficients of determination of the regression lines indicated 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 by formal technical procedures. The technical procedures include calibrations 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; 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 on 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 temporary computer data base and is plotted 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 NWIS 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, of which most is published information. Borehole-geophysical logs and core-measurement data for the wells are given by Nelson and others (1991). Previously collected water-level data can be found in Boucher (1994b), Gemmell (1990), Lobmeyer and others (in press), Luckey and others (1993), O'Brien (1991, 1992, 1993), and P. Tucci, U.S. Geological Survey, written commun., 1994. Complete bibliographic citations are in the "References Cited" section. Important information about the well, (location and identification, drilling and casing information, access to and description of interval for measuring water levels, and information for calculation of water-level altitude) 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-tube 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 altitudes 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 4.0 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 altitudes are presented in the following sections for individual wells in the periodic water-level network for 1992. Water-level altitudes for 1992 are presented in tables and hydrographs for each well. Mean-annual water-level altitude for 1992 are compared to the 1991 mean-annual water-level altitude and are included in the tables.

Well USW WT-1

Information about the history of well USW WT-1 and about previous data from the well was obtained from various sources. These sources are: Robison (1984, 1986); Robison and others (1988); Holmes & Narver, Inc. (written commun., 1986); and Fenix & Scisson, Inc. (1986a, 1987c).

Well specifications

1. Location and identification:

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

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

   U.S. Geological Survey Site ID: 364916116265601.

2. Drilling and casing information:

   Well started: April 28, 1983.

   Well completed: May 18, 1983.

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

   Bit diameter below water level: 222 mm.

   Casing: Surface casing only, to a depth of 9.91 m.

   Total drilled depth: 515 m.

3. Access to and description of interval for measuring water levels:

   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.

4. Information for calculating water-level altitude:

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

   Measuring point: Top of access tube, 0.314 m.

   Depth correction for borehole deviation from vertical: 0.326 m, based on approximate depth to water of 471 m.

Water-level altitudes

Water-level altitudes at well USW WT-1 ranged from 730.32 to 730.43 m. Mean-annual water-level altitude for 1992 was 730.38 m. The mean altitude was 0.04 m lower than the mean altitude of 730.42 m for 1991 (P. Tucci, U.S. Geological Survey, written commun., 1994). Water-level altitudes are listed in table 4 and shown in figure 2.

Table 4. Measured water-level altitudes and yearly mean water-level altitude, 1992, for well USW WT-1

[Method: C1, Chain #1]

Date	Water-level altitude (meters, above sea level)	Method
01-28-92	730.40	C1
02-18-92	730.37	C1
04-03-92	730.43	C1
05-04-92	730.40	C1
05-19-92	730.43	C1
06-17-92	730.40	C1
07-14-92	730.34	C1
08-19-92	730.34	C1
09-10-92	730.32	C1
10-20-92	730.33	C1
11-19-92	730.35	C1
12-28-92	730.40	C1

1992 Mean = 730.38 meters.

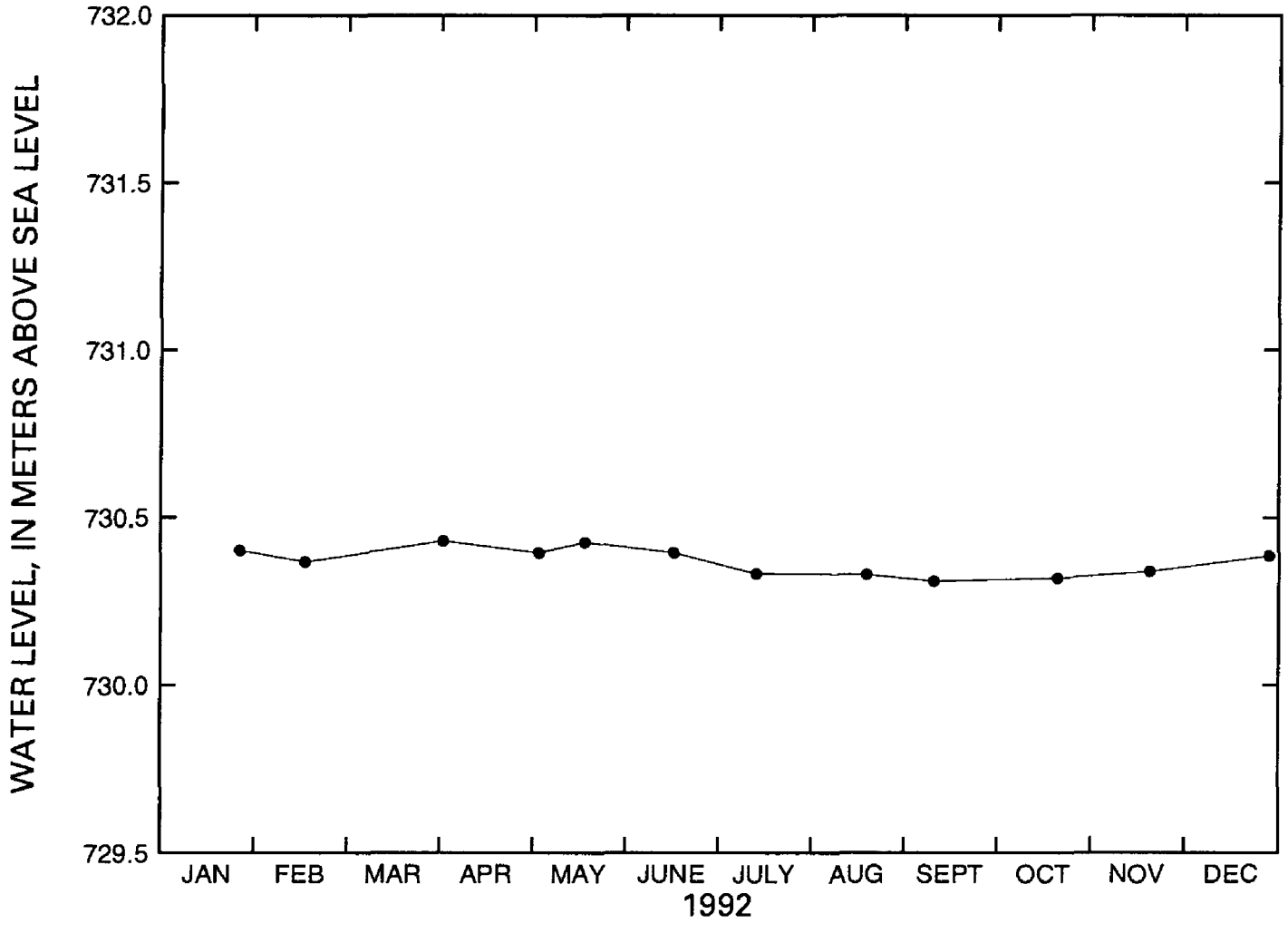

Figure 2. Water-level altitudes, 1992, for well USW WT-1.

Well UE-25 WT #4

Information about the history of well UE-25 WT #4 and about previous data from the well was obtained from various sources. These sources are: Robison (1984, 1986); Robison and others (1988); Holmes & Narver, Inc. (written commun., 1986); and Fenix & Scisson, Inc. (1986a, 1987c).

Well specifications

1. Location and identification:

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

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

   U.S. Geological Survey Site ID: 365140116260301.

2. Drilling and casing information:

   Well started: May 28, 1983.

   Well completed: June 6, 1983.

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

   Bit diameter below water level: 222 mm.

   Casing: Surface casing only, to a depth of 14.6 m.

   Total drilled depth: 482 m.

3. Access to and description of interval for measuring water levels:

   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.

4. Information for calculating water-level altitude:

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

   Measuring point: Top of access tube, 0.311 m.

   Depth correction for borehole deviation from vertical: 0.454 m, based on approximate depth to water of 438 m.

Water-level altitudes

Water-level altitudes at well UE-25 WT #4 ranged from 730.83 to 731.17 m. Mean-annual water-level altitude for 1992 was 730.90 m. The mean altitude was 0.02 m higher than the mean altitude of 730.88 m for 1991 (P. Tucci, U.S. Geological Survey, written commun., 1994). Water-level altitudes are listed in table 5 and shown in figure 3.

Table 5. Measured water-level altitudes and yearly mean water-level altitude, 1992, for well UE-25 WT #4

[Method: C1, Chain #1]

Date	Water-level altitude (meters, above sea level)	Method
01-30-92	730.88	C1
02-28-92	730.89	C1
03-26-92	730.95	C1
04-20-92	730.87	C1
05-18-92	730.84	C1
06-25-92	730.92	C1
07-15-92	731.17	C1
08-10-92	730.83	C1
09-24-92	730.89	C1
10-20-92	730.84	C1
11-24-92	730.83	C1
12-15-92	730.92	C1

1992 Mean = 730.90 meters.

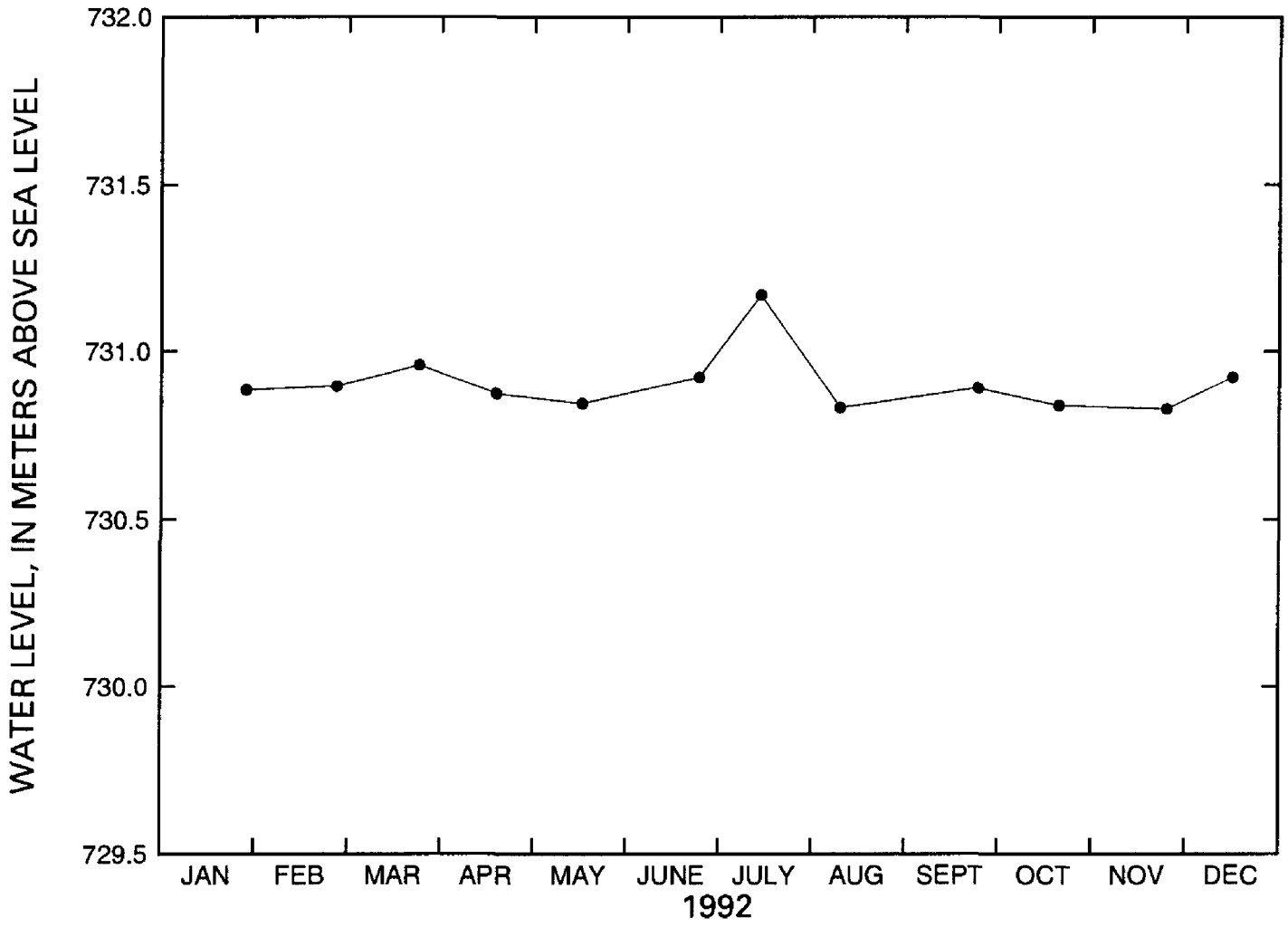

Figure 3. Water-level altitudes, 1992, for well UE-25 WT #4.

Well UE-25 WT #6

Information about the history of well UE-25 WT #6 and about previous data from the well was obtained from various sources. These sources are: Robison (1984, 1986); Robison and others (1988); and Fenix & Scisson, Inc. (1986a, 1987c).

Well specifications

1. Location and identification:

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

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

   U.S. Geological Survey Site ID: 365340116264601.

2. Drilling and casing information:

   Well started: June 20, 1983.

   Well completed: June 29, 1983.

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

   Bit diameter below water level: 171 mm.

   Casing: Surface casing only, to a depth of 76.5 m.

   Total drilled depth: 383 m.

3. Access to and description of interval for measuring water levels:

   62-mm inside-diameter tubing that has a 3.6-m-long well screen on bottom, extending from land surface to a depth of 372 m; saturated interval of borehole within tuffaceous beds of Calico Hills.

4. Information for calculating water-level altitude:

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

   Measuring point: Top of access tube, 0.463 m.

   Depth correction for borehole deviation from vertical: 0.204 m, based on approximate depth to water of 280 m.

Calibrations and comments

One calibration was performed during 1992 at the end of hourly monitoring. In addition, one calibration on 11-26-91 was used to calculate water-level altitudes at the beginning of 1992. Hourly monitoring was discontinued on 2-11-92, and thereafter the well was measured periodically.

Traneducer serial number	Calibration date	Slope (mV/m)	Coefficient of determination (r^2)	Water-level altitude (meters)
342410	11-26-91	20.32	0.98	1035.12
342410	02-11-92	20.37	0.98	1035.04

All hourly data were considered valid during 1992.

Water-level altitudes

Well UE-25 WT #6 was monitored hourly from January 1 through February 10, 1992, using pressure transducers and data loggers. On February 11, 1992, the monitoring frequency was reduced to bimonthly, and water levels were measured using a steel tape. Water-level altitudes in 1992 ranged from 1,034.22 to 1,036.09 m. Mean water-level altitude for 1992 was 1,034.97 m, which was 0.19 m lower than the 1991 mean of 1,035.16 m (P. Tucci, U.S. Geological Survey, written commun., 1994). Water levels in this well may have been affected by earthquakes that occurred in the region on June 28–29, 1992, as shown by the sharp increase and subsequent decrease in water-level altitudes from July through September. Water-level altitudes are listed in table 6 and shown in figure 4. The water-level altitudes listed and plotted from January 1 through February 10, 1992, are the mean daily altitudes, calculated from the hourly transducer data.

Table 6. Measured water-level altitudes and yearly mean water-level altitude, 1992, for well UE-25 WT #6

[Method: T, mean-daily level calculated from hourly transducer data; C1, Chain #1]

Date	Water-level altitude (meters, above sea level)	Method	Date	Water-level altitude (meters, above sea level)	Method
01-01-92	1,035.02	T	02-01-92	1,035.06	T
01-02-92	1,035.04	T	02-02-92	1,035.05	T
01-03-92	1,035.09	T	02-03-92	1,035.03	T
01-04-92	1,035.10	T	02-04-92	1,035.02	T
01-05-92	1,035.13	T	02-05-92	1,035.03	T
01-06-92	1,035.15	T	02-06-92	1,035.06	T
01-07-92	1,035.10	T	02-07-92	1,035.09	T
01-08-92	1,035.04	T	02-08-92	1,035.05	T
01-09-92	1,035.01	T	02-09-92	1,035.06	T
01-10-92	1,035.03	T	02-10-92	1,035.08	T
01-11-92	1,035.11	T	02-11-92	1,035.04	C1
01-12-92	1,035.07	T	02-21-92	1,035.01	C1
01-13-92	1,035.02	T	03-11-92	1,034.95	C1
01-14-92	1,035.02	T	04-03-92	1,035.04	C1
01-15-92	1,035.00	T	04-10-92	1,035.03	C1
01-16-92	1,035.02	T	04-17-92	1,035.03	C1
01-17-92	1,035.08	T	05-18-92	1,035.00	C1
01-18-92	1,035.06	T	06-04-92	1,035.07	C1
01-19-92	1,035.02	T	06-23-92	1,035.02	C1
01-20-92	1,035.04	T	07-17-92	1,036.09	C1
01-21-92	1,035.04	T	07-28-92	1,035.86	C1
01-22-92	1,035.02	T	08-18-92	1,034.89	C1
01-23-92	1,035.00	T	08-31-92	1,034.59	C1
01-24-92	1,035.01	T	09-22-92	1,034.33	C1
01-25-92	1,035.04	T	09-29-92	1,034.29	C1
01-26-92	1,035.06	T	10-16-92	1,034.26	C1
01-27-92	1,035.02	T	10-30-92	1,034.35	C1
01-28-92	1,035.01	T	11-13-92	1,034.24	C1
01-29-92	1,035.01	T	11-25-92	1,034.22	C1
01-30-92	1,035.00	T	12-08-92	1,034.34	C1
01-31-92	1,035.02	T	12-16-92	1,034.28	C1

1992 Mean = 1,034.82 meters.

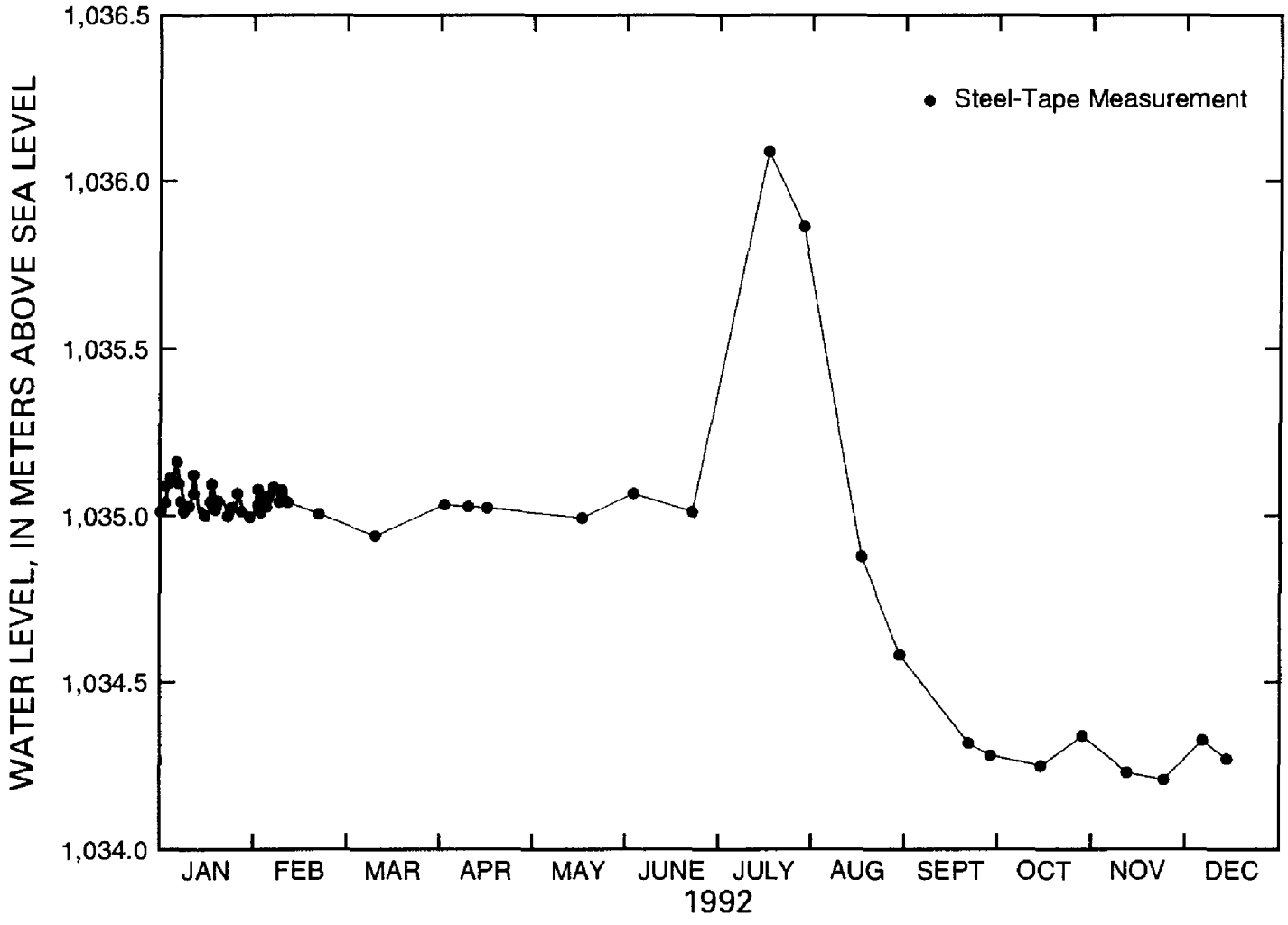

Figure 4. Water-level altitudes, 1992, for well UE-25 WT #6.

Well USW WT-7

Information about the history or well USW WT-7 and about previous data from the well was obtained from various sources. These sources are: Robison (1984, 1986); Robison and others (1988); Holmes & Narver, Inc. (written commun., 1986); and Fenix & Scisson, Inc. (1986a, 1987c).

Well specifications

1. Location and identification:

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

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

   U.S. Geological Survey Site ID: 364933116285701.

2. Drilling and casing information:

   Well started: July 19, 1983.

   Well completed: July 26, 1983.

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

   Bit diameter below water level: 222 mm.

   Casing: Surface casing only, to a depth of 15.8 m.

   Total drilled depth: 491 m.

3. Access to and description of interval for measuring water levels:

   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.

4. Information for calculating water-level altitude:

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

   Measuring point: Top of access tube, 0.302 m.

   Depth correction for borehole deviation from vertical: 0.034 m, based on approximate depth to water of 421 m.

Water-level altitudes

Water-level altitudes at well USW WT-7 ranged from 775.83 to 775.97 m. Mean-annual water-level altitude for 1992 was 775.89 m. The mean altitude was 0.02 m higher than the mean altitude of 775.87 m for 1991 (P. Tucci, U.S. Geological Survey, written commun., 1994). Water-level altitudes are listed in table 7 and shown in figure 5.

Table 7. Measured water-level altitudes and yearly mean water-level altitude, 1992, for well USW WT-7

[Method: C1, Chain #1]

Date	Water-level altitude (meters, above sea level)	Method
01-27-92	775.86	C1
02-24-92	775.86	C1
03-24-92	775.84	C1
04-23-92	775.83	C1
05-08-92	775.91	C1
06-05-92	775.97	C1
07-13-92	775.87	C1
08-12-92	775.93	C1
09-08-92	775.91	C1
11-02-92	775.91	C1
12-01-92	775.93	C1

1992 Mean = 775.89 meters.

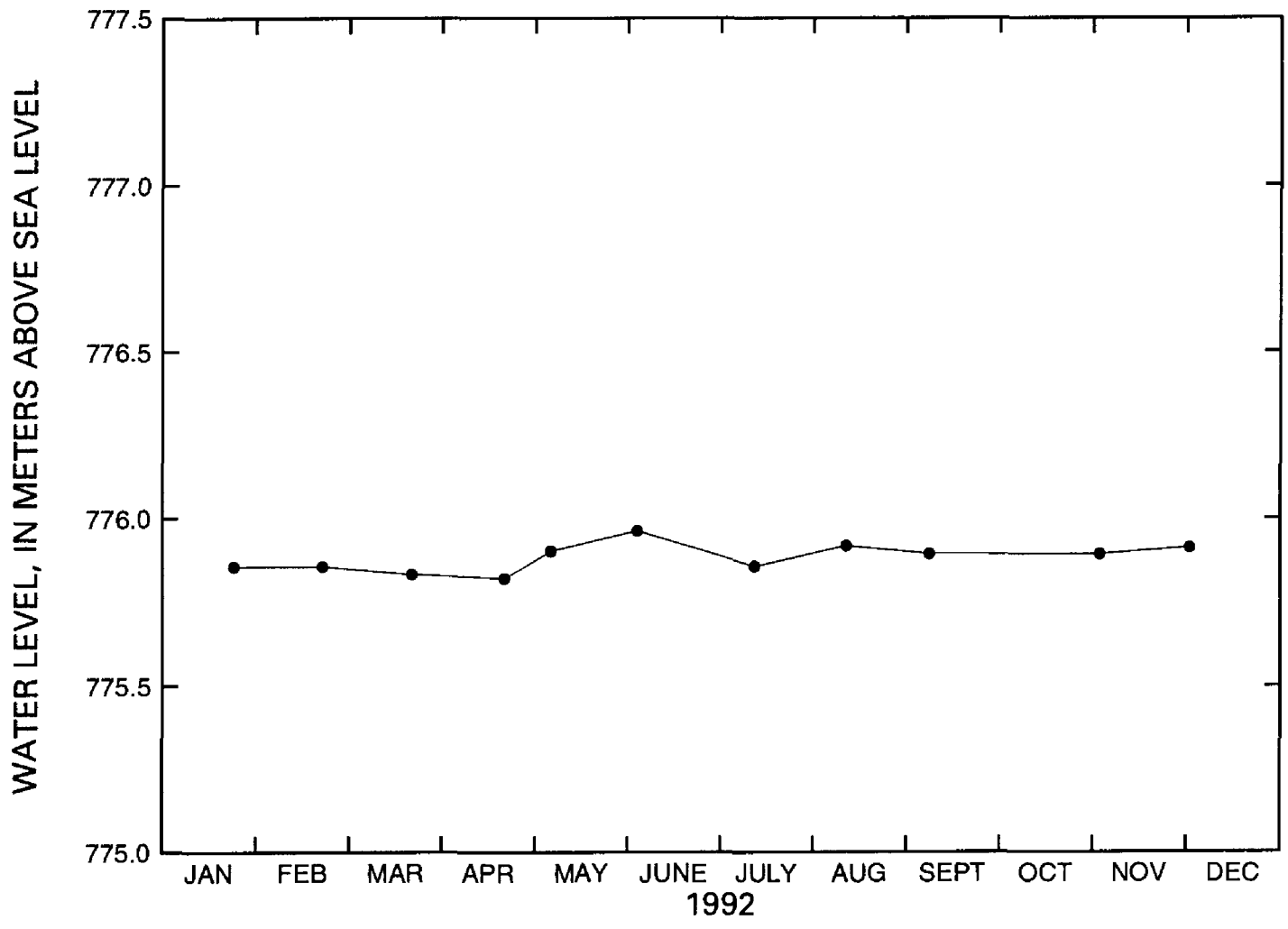

Figure 5. Water-level altitudes, 1992, for well USW WT-7.

Well USW WT-10

Information about the history of well USW WT-10 and about previous data from the well was obtained from various sources. These sources are: Robison (1984, 1986); Robison and others (1988); Holmes & Narver, Inc. (written commun., 1986); and Fenix & Scisson, Inc. (1986a, 1987c).

Well specifications

1. Location and identification:

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

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

   U.S. Geological Survey Site ID: 364825116290501.

2. Drilling and casing information:

   Well started: July 26, 1983.

   Well completed: August 2, 1983.

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

   Bit diameter below water level: 222 mm.

   Casing: Surface casing only, to a depth of 34.7 m.

   Total drilled depth: 431 m.

3. Access to and description of interval for measuring water levels:

   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.

4. Information for calculating water-level altitude:

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

   Measuring point: Top of access tube, 0.314 m.

   Depth correction for borehole deviation from vertical: 0.030 m, based on approximate depth to water of 347 m.

Water-level altitudes

Water-level altitudes at well USW WT-10 ranged from 775.96 to 776.14 m. Mean-annual water-level altitude for 1992 was 776.04 m. The mean altitude was 0.04 m higher than the mean altitude of 776.00 m for 1991 (P. Tucci, U.S. Geological Survey, written commun., 1994). Water-level altitudes are listed in table 8 and shown in figure 6.

Table 8. Measured water-level altitudes and yearly mean water-level altitude, 1992, for well USW WT-10

[Method: C1, Chain #1]

Date	Water-level altitude (meters, above sea level)	Method
01-27-92	776.00	C1
02-24-92	776.00	C1
03-24-92	775.96	C1
04-23-92	775.98	C1
05-08-92	776.08	C1
06-05-92	776.14	C1
07-13-92	776.02	C1
08-12-92	776.04	C1
09-08-92	776.05	C1
11-02-92	776.05	C1
12-01-92	776.10	C1

1992 Mean = 776.04 meters.

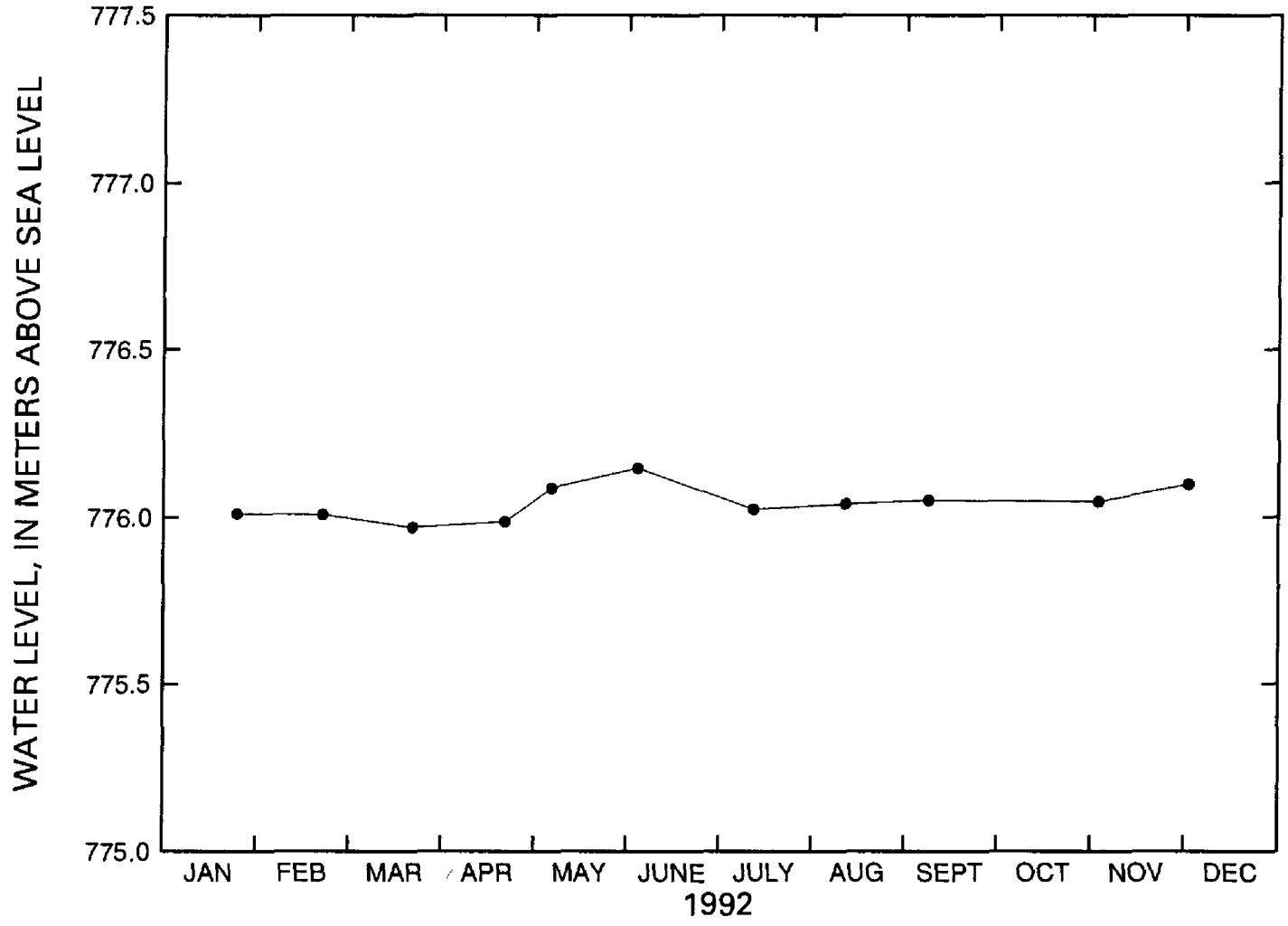

Figure 6. Water-level altitudes, 1992, for well USW WT-10.

Well UE-25 WT #12

Information about the history of well UE-25 WT #12 and about previous data from the well was obtained from various sources. These sources are: Robison (1984, 1986); Robison and others (1988); Holmes & Narver, Inc. (written commun., 1986); and Fenix & Scisson, Inc. (1986a, 1987c).

Well specifications

1. Location and identification:

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

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

   U.S. Geological Survey Site ID: 364656116261601.

2. Drilling and casing information:

   Well started: August 11, 1983.

   Well completed: August 16, 1983.

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

   Bit diameter below water level: 222 mm.

   Casing: Surface casing only, to a depth of 21.3 m.

   Total drilled depth: 399 m.

3. Access to and description of interval for measuring water levels:

   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.

4. Information for calculating water-level altitude:

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

   Measuring point: Top of access tube, 0.305 m.

   Depth correction for borehole deviation from vertical: 0.183 m, based on approximate depth to water of 345 m.

Water-level altitudes

Water-level altitudes at well UE-25 WT #12 ranged from 729.39 to 729.58 m. Mean-annual water-level altitude for 1992 was 729.50 m. The mean altitude was 0.03 m lower than the mean altitude of 729.53 m for 1991 (P. Tucci, U.S. Geological Survey, written commun., 1994). Water-level altitudes are listed in table 9 and shown in figure 7.

Table 9. Measured water-level altitudes and yearly mean water-level altitude, 1992, for well UE-25 WT #12

[Method: C1, Chain #1]

Date	Water-level altitude (meters, above sea level)	Method
01-31-92	729.54	C1
02-21-92	729.49	C1
03-27-92	729.58	C1
05-07-92	729.51	C1
05-20-92	729.54	C1
06-25-92	729.54	C1
07-16-92	729.50	C1
08-19-92	729.46	C1
09-28-92	729.45	C1
10-29-92	729.50	C1
11-30-92	729.39	C1
12-17-92	729.51	C1

1992 Mean = 729.50 meters.

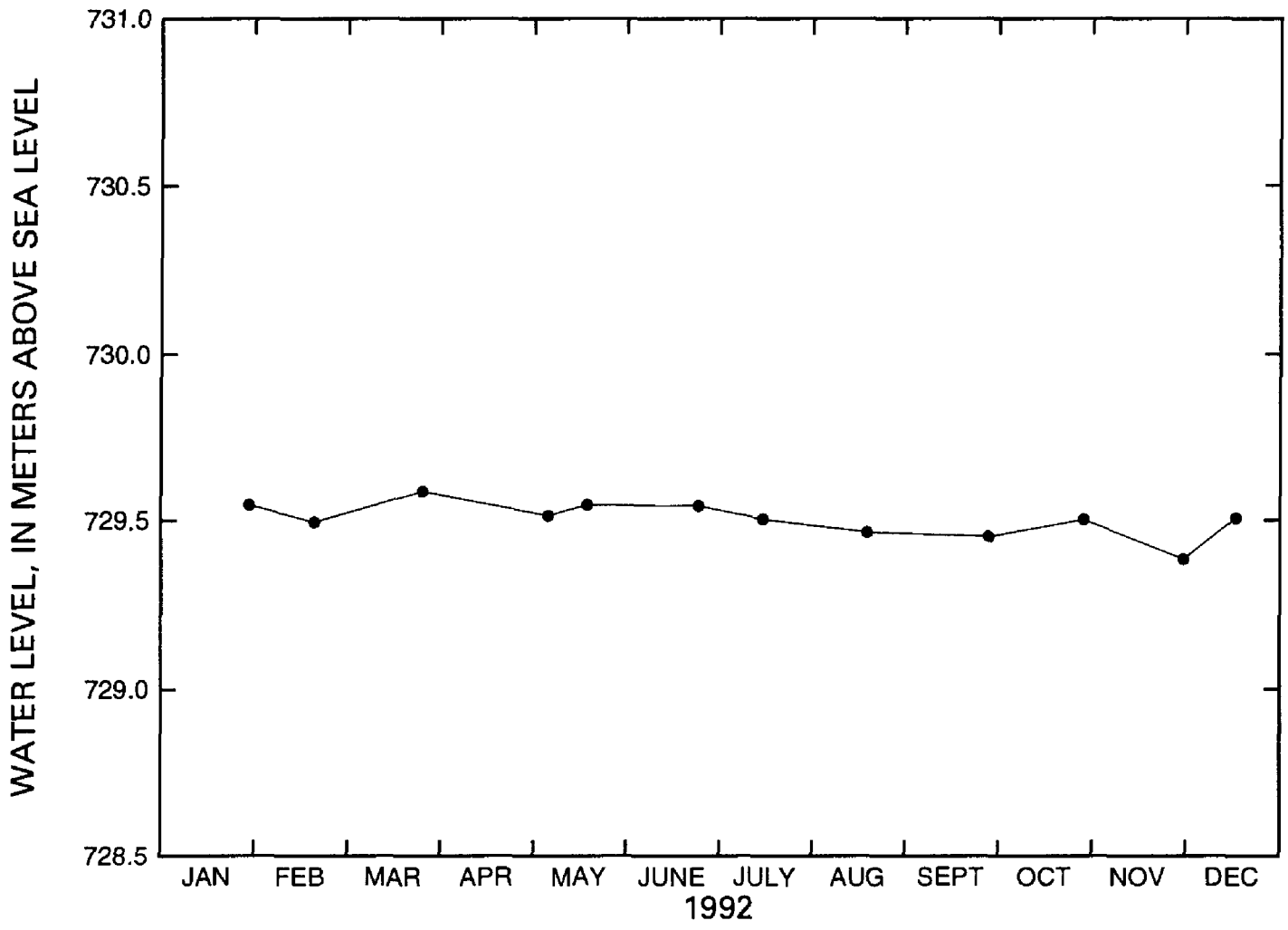

Figure 7. Water-level altitudes, 1992, for well UE-25 WT #12.

Well UE-25 WT #14

Information about the history of well UE-25 WT #14 and about previous data from the well was obtained from various sources. These sources are: Robison (1984, 1986); Robison and others (1988); Holmes & Narver, Inc., (written commun., 1986); and Fenix & Scisson, Inc. (1986a, 1987c).

Well specifications

1. Location and identification:

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

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

   U.S. Geological Survey Site ID: 365032116243501.

2. Drilling and casing information:

   Well started: August 17, 1983.

   Well completed: September 30, 1983.

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

   Bit diameter below water level: 222 mm.

   Casing: Surface casing only, to a depth of 36.6 m.

   Total drilled depth: 399 m.

3. Access to and description of interval for measuring water levels:

   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.

4. Information for calculating water-level altitude:

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

   Measuring point: Top of access tube, 0.311 m.

   Depth correction for borehole deviation from vertical: 0.085 m, based on approximate depth to water of 346 m.

Water-level altitudes

Water-level altitudes at well UE-25 WT #14 ranged from 729.66 to 729.79 m. Mean-annual water-level altitude for 1992 was 729.72 m. The mean altitude was 0.02 m lower than the mean altitude of 729.74 m for 1991 (P. Tucci, U.S. Geological Survey, written commun., 1994). Water-level altitudes are listed in table 10 and shown in figure 8.

Table 10. Measured water-level altitudes and yearly mean water-level altitude, 1992, for well UE-25 WT #14

[Method: C1, Chain #1]

Date	Water-level altitude (meters, above sea level)	Method
01-30-92	729.71	C1
02-28-92	729.72	C1
03-26-92	729.79	C1
04-20-92	729.71	C1
05-19-92	729.74	C1
06-25-92	729.75	C1
07-15-92	729.70	C1
08-18-92	729.69	C1
09-24-92	729.74	C1
10-16-92	729.66	C1
11-23-92	729.71	C1
12-08-92	729.67	C1

1992 Mean = 729.72 meters.

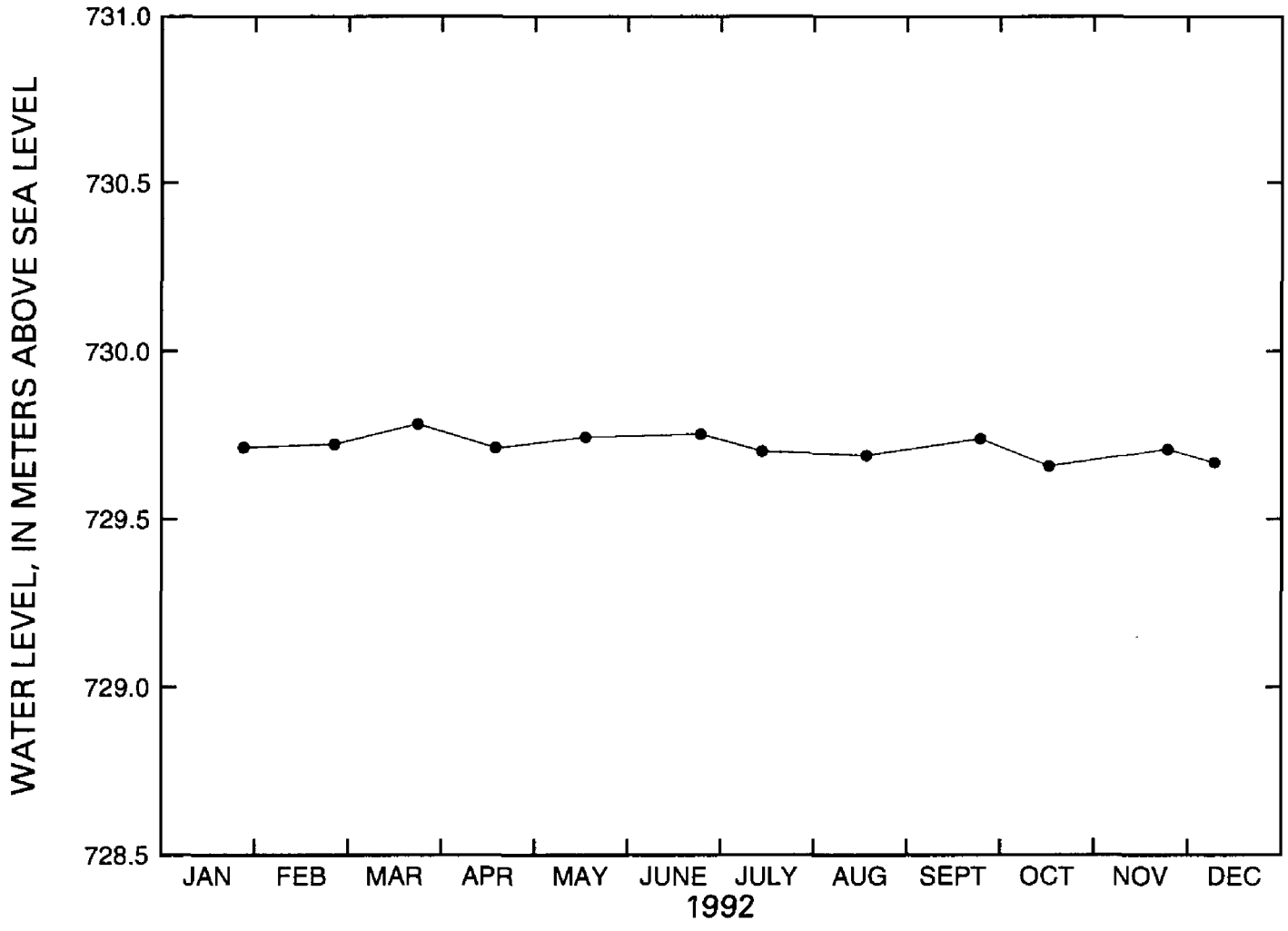

Figure 8. Water-level altitudes, 1992, for well UE-25 WT #14.

Well UE-25 WT #15

Information about the history of well UE-25 WT #15 and about previous data from the well was obtained from various sources. These sources are: Robison (1984, 1986); Robison and others (1988); Holmes & Narver, Inc. (written commun., 1986); and Fenix & Scisson, Inc. (1986a, 1987c).

Well specifications

1. Location and identification:

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

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

   U.S. Geological Survey Site ID: 365116116233801.

2. Drilling and casing information:

   Well started: November 12, 1983.

   Well completed: November 22, 1983.

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

   Bit diameter below water level: 222 mm.

   Casing: Surface casing only, to a depth of 38.7 m.

   Total drilled depth: 415 m.

3. Access to and description of interval for measuring water levels:

   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.

4. Information for calculating water-level altitude:

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

   Measuring point: Top of access tube, 0.314 m.

   Depth correction for borehole deviation from vertical: 0.189 m, based on approximate depth to water of 354 m.

Water-level altitudes

Water-level altitudes at well UE-25 WT #15 ranged from 729.18 to 729.28 m. Mean-annual water-level altitude for 1992 was 729.22 m. The mean altitude was 0.04 m lower than the mean altitude of 729.26 m for 1991 (P. Tucci, U.S. Geological Survey, written commun., 1994). Water-level altitudes are listed in table 11 and shown in figure 9.

Table 11. Measured water-level altitudes and yearly mean water-level altitude, 1992, for well UE-25 WT #15

[Method: C1, Chain #1]

Date	Water-level altitude (meters, above sea level)	Method
01-30-92	729.19	C1
02-28-92	729.18	C1
04-03-92	729.27	C1
04-20-92	729.19	C1
05-18-92	729.22	C1
06-25-92	729.21	C1
07-15-92	729.21	C1
08-18-92	729.27	C1
09-22-92	729.23	C1
10-16-92	729.24	C1
11-25-92	729.24	C1
12-08-92	729.28	C1

1992 Mean = 729.22 meters.

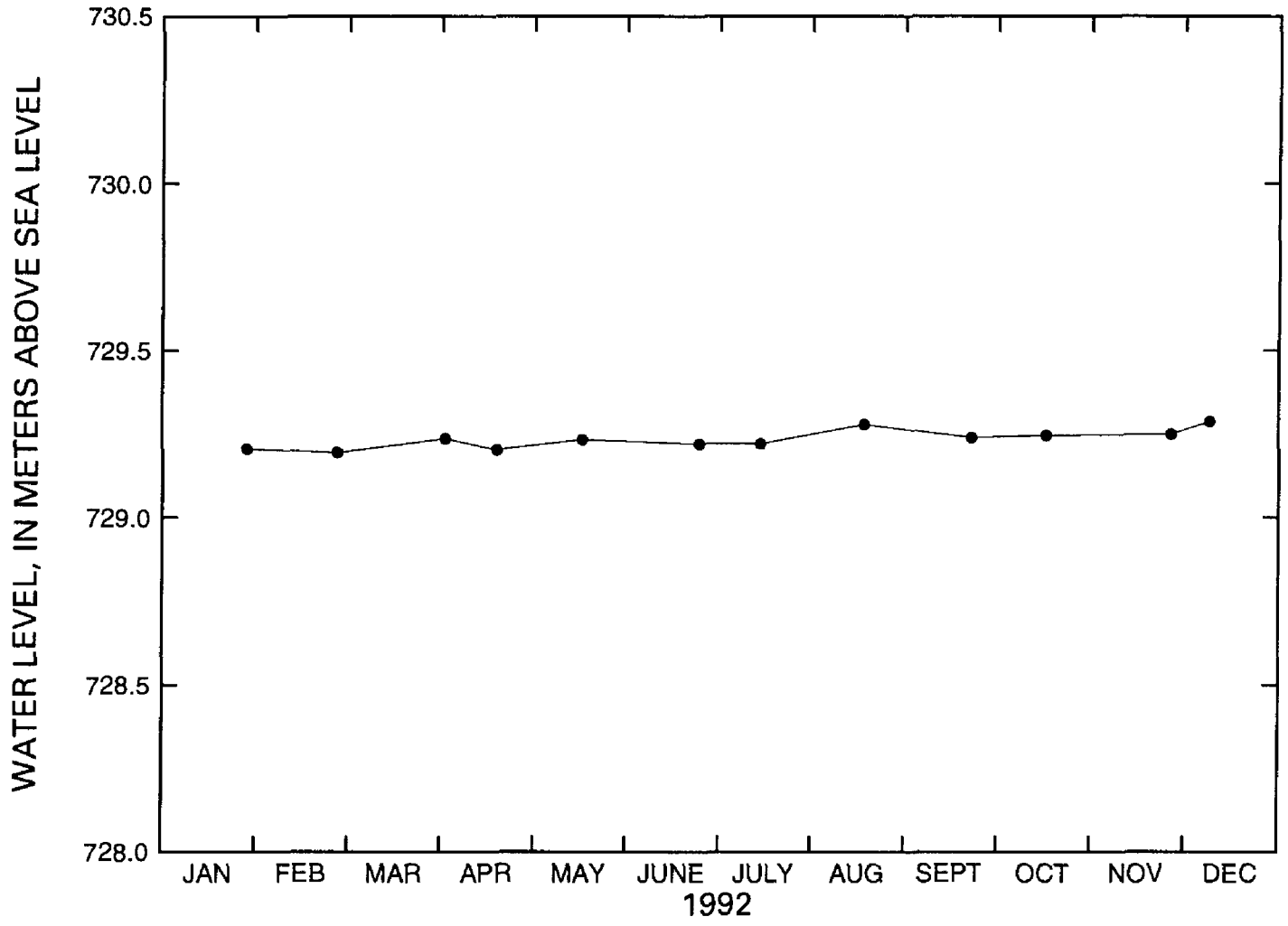

Figure 9. Water-level altitudes, 1992, for well UE-25 WT #15.

Well UE-25 WT #17

Information about the history of well UE-25 WT #17 and about previous data from the well was obtained from various sources. These sources are: Robison (1984, 1986); Robison and others (1988); Holmes & Narver, Inc. (written commun., 1986); and Fenix & Scisson, Inc. (1986a, 1987c).

Well specifications

1. Location and identification:

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

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

   U.S. Geological Survey Site ID: 364822116262601.

2. Drilling and casing information:

   Well started: October 20, 1983.

   Well completed: October 30, 1983.

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

   Bit diameter below water level: 222 mm.

   Casing: Surface casing only, to a depth of 16.8 m.

   Total drilled depth: 443 m.

3. Access to and description of interval for measuring water levels:

   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.

4. Information for calculating water-level altitude:

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

   Measuring point: Top of access tube, 0.158 m.

   Depth correction for borehole deviation from vertical: 0.482 m, based on approximate depth to water of 394 m.

Water-level altitudes

Water-level altitudes at well UE-25 WT #17 ranged from 729.71 to 729.80 m. Mean-annual water-level altitude for 1992 was 729.75 m. The mean altitude was 0.02 m lower than the mean altitude of 729.77 m for 1991 (P. Tucci, U.S. Geological Survey, written commun., 1994). Water-level altitudes are listed in table 12 and shown in figure 10.

Table 12. Measured water-level altitudes and yearly mean water-level altitude, 1992, for well UE-25 WT #17

[Method: C1, Chain #1]

Date	Water-level altitude (meters, above sea level)	Method
01-28-92	729.76	C1
02-18-92	729.72	C1
03-12-92	729.78	C1
05-04-92	729.78	C1
05-19-92	729.80	C1
06-17-92	729.76	C1
07-14-92	729.73	C1
08-19-92	729.73	C1
09-10-92	729.72	C1
10-20-92	729.72	C1
11-19-92	729.71	C1
12-28-92	729.77	C1

1992 Mean = 729.75 meters.

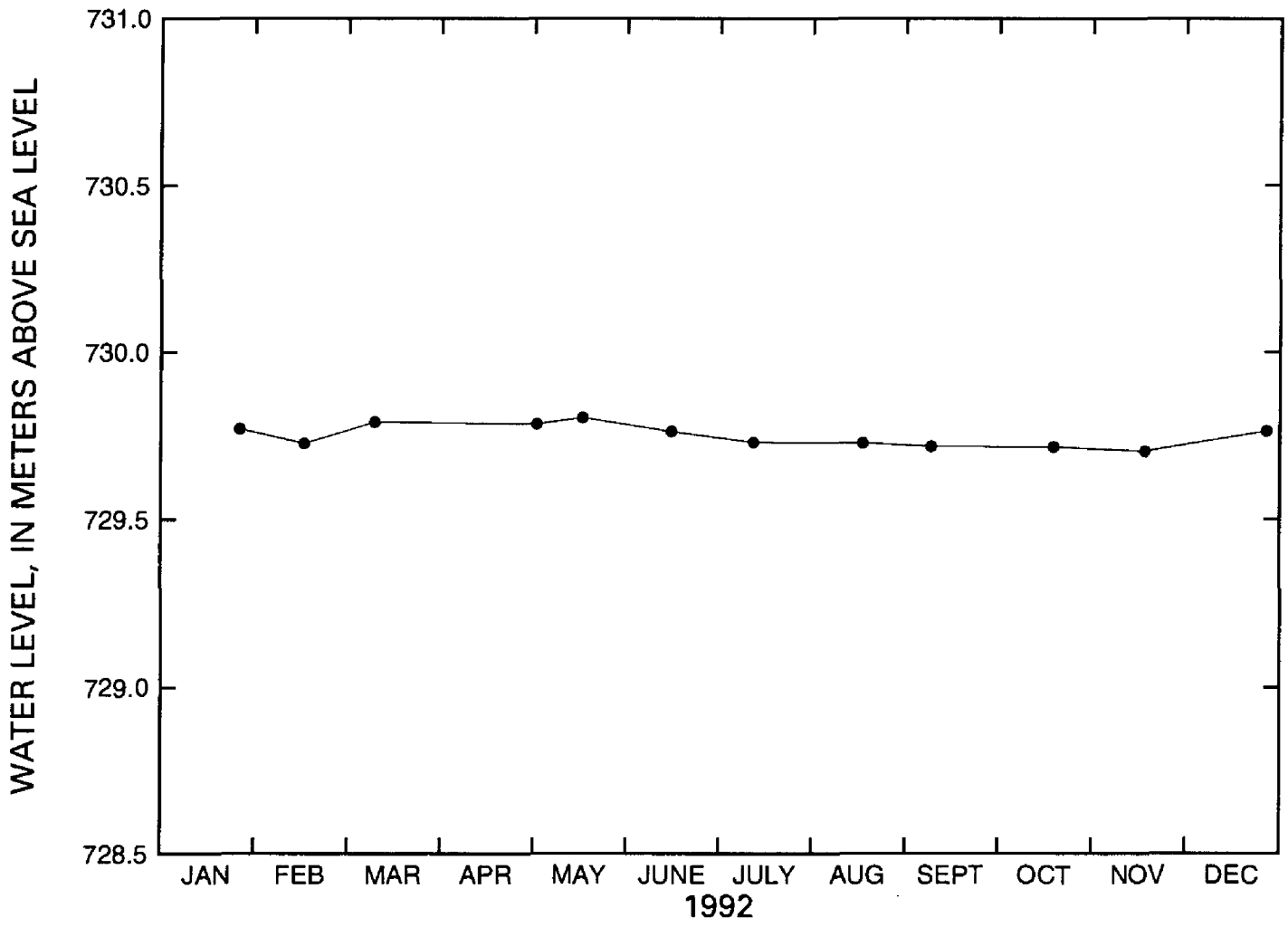

Figure 10. Water-level altitudes, 1992, for well UE-25 WT #17.

Well UE-25 WT #18

Information about the history of well UE-25 WT #18 and about previous data from the well was obtained from various sources. These sources are: Fenix & Scisson, Inc. (1986a); Holmes & Narver, Inc. (written commun., 1986); and Muller and Kibler (1985).

Well specifications

1. Location and identification:

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

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

   U.S. Geological Survey Site ID: 365207116264201.

2. Drilling and casing information:

   Well started: May 9, 1984.

   Well completed: May 23, 1984.

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

   Bit diameter below water level: 222 mm.

   Casing: Surface casing only, to a depth of 27 m.

   Total depth drilled: 623 m.

3. Access to and description of interval for measuring water levels:

   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.

4. Information for calculating water-level altitude:

   Reference point: Top of metal tag on well casing, altitude 1336.32 m (surveyed by U.S. Geological Survey, 1984).

   Measuring point: Top of access tube, 0.210 m.

   Depth correction for borehole deviation from vertical: 0.155 m, based on approximate depth to water of 607 m.

Water-level altitudes

Water-level altitudes at well UE-25 WT #18 ranged from 730.76 to 730.92 m. Mean-annual water-level altitude for 1992 was 730.83 m. The mean altitude was 0.98 m higher than the overall mean altitude of 730.85 m for 1991 (P. Tucci, U.S. Geological Survey, written commun., 1994); however, the 1992 mean altitude was only 0.07 m higher than the mean reported for the end of 1991. Water-level altitudes are listed in table 13 and shown in figure 11.

Table 13. Measured water-level altitudes and yearly mean water-level altitude, 1992, for well UE-25 WT #18

[Method: C1, Chain #1]

Date	Water-level altitude (meters, above sea level)	Method
01-30-92	730.85	C1
02-28-92	730.85	C1
03-26-92	730.92	C1
04-20-92	730.87	C1
05-18-92	730.87	C1
06-25-92	730.87	C1
07-15-92	730.85	C1
08-10-92	730.80	C1
09-28-92	730.76	C1
10-20-92	730.77	C1
11-24-92	730.78	C1
12-16-92	730.76	C1

1992 Mean = 730.83 meters.

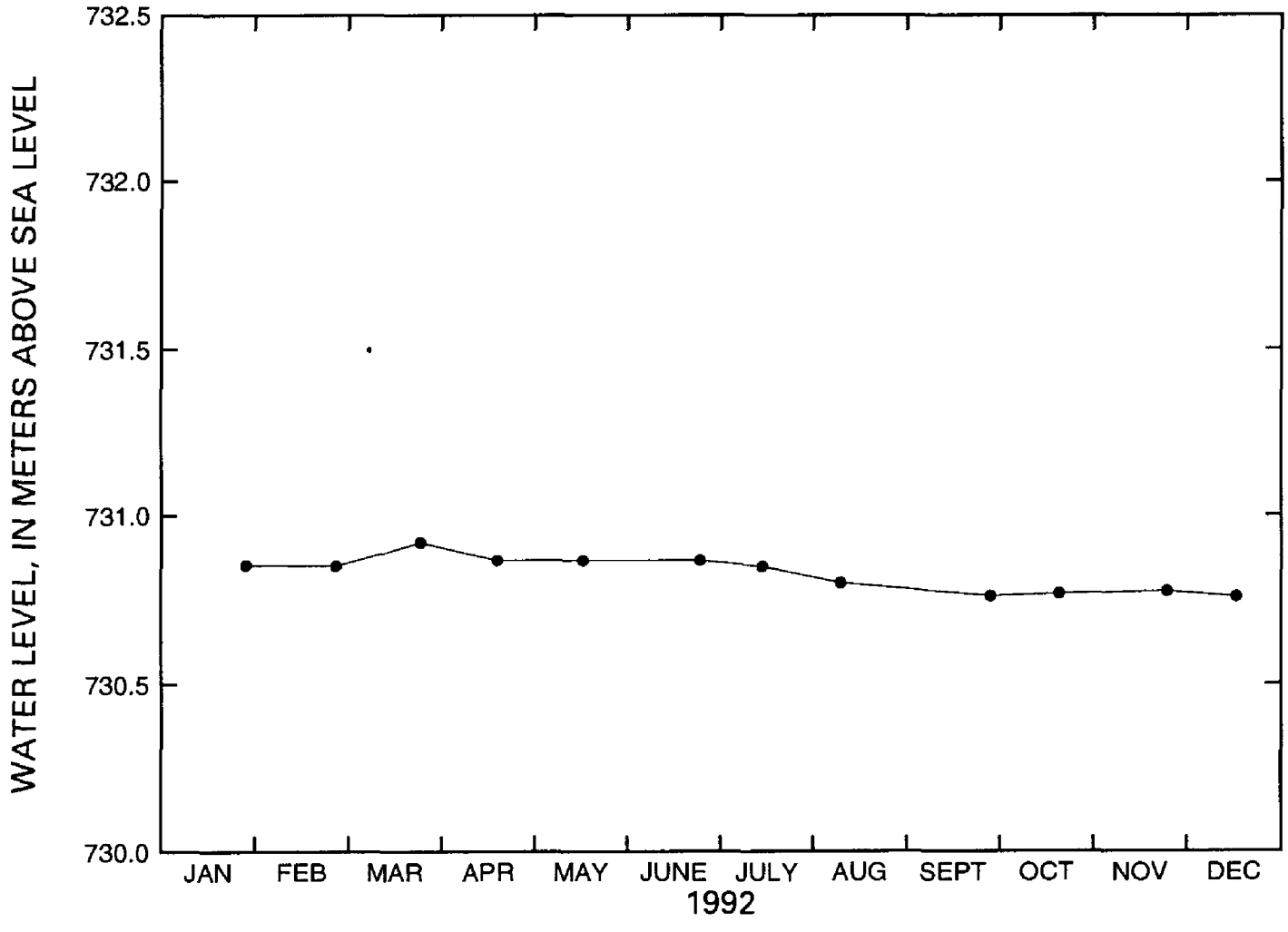

Figure 11. Water-level altitudes, 1992, for well UE-25 WT #18.

Well USW VH-1

Information about the history of well USW VH-1 and about previous data from the well was obtained from various sources. These sources are: Robison (1984, 1986); Robison and others (1988); Holmes & Narver, Inc. (written commun., 1986); Fenix & Scisson, Inc. (1986b, 1987c); and Thordarson and Howells (1987).

Well specifications

1. Location and identification:

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

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

   U.S. Geological Survey Site ID: 364732116330701.

2. Drilling and casing information:

   Well started: October 28, 1980.

   Well completed: February 18, 1981.

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

   Bit diameter below water level: 222 mm to 278 m; 159 mm from 278 m to total depth.

   Casing extending below water level: 177-mm inside diameter to 278 m.

   Total drilled depth: 762 m.

3. Access to and description of interval for measuring water levels:

   48-mm inside-diameter tubing, open ended from land surface to 205.4 m; saturated interval of well within Tiva Canyon, Topopah Spring, Prow Pass, and Bullfrog Members of Paintbrush Tuff. A pump was installed in the well on July 8, 1982, at a depth of 212.8 m.

4. Information for calculating water-level altitude:

   Reference point: Top of metal tag on well casing, altitude 963.23 m (surveyed by Holmes & Narver, Inc., March 3, 1986).

   Measuring point: Top of access tube, 0.631 m.

   Depth correction for borehole deviation from vertical: 0.049 m, based on approximate depth to water of 184 m.

Water-level altitudes

Water-level altitudes at well USW VH-1 ranged from 779.35 to 779.48 m. Mean-annual water-level altitude for 1992 was 779.43 m. The mean altitude was 0.04 m lower than the mean altitude of 779.47 m for 1991 (P. Tucci, U.S. Geological Survey, written commun., 1994). Water-level altitudes for well USW VH-1 are listed in table 14 and shown in figure 12.

Table 14. Measured water-level altitudes and yearly mean water-level altitude, 1992, for well USW VH-1

[Method: C1, Chain #1]

Date	Water-level altitude (meters, above sea level)	Method
01-28-92	779.48	C1
02-14-92	779.41	C1
02-24-92	779.41	C1
03-12-92	779.41	C1
03-24-92	779.38	C1
04-13-92	779.43	C1
04-23-92	779.39	C1
05-08-92	779.35	C1
05-26-92	779.45	C1
06-05-92	779.47	C1
06-18-92	779.46	C1
07-13-92	779.42	C1
07-29-92	779.45	C1
07-31-92	779.41	C1
08-12-92	779.45	C1
08-27-92	779.41	C1
09-08-92	779.45	C1
09-18-92	779.45	C1
10-14-92	779.47	C1
10-23-92	779.44	C1
11-02-92	779.44	C1
11-20-92	779.43	C1
12-01-92	779.48	C1
12-23-92	779.41	C1

1992 Mean = 779.43 meters.

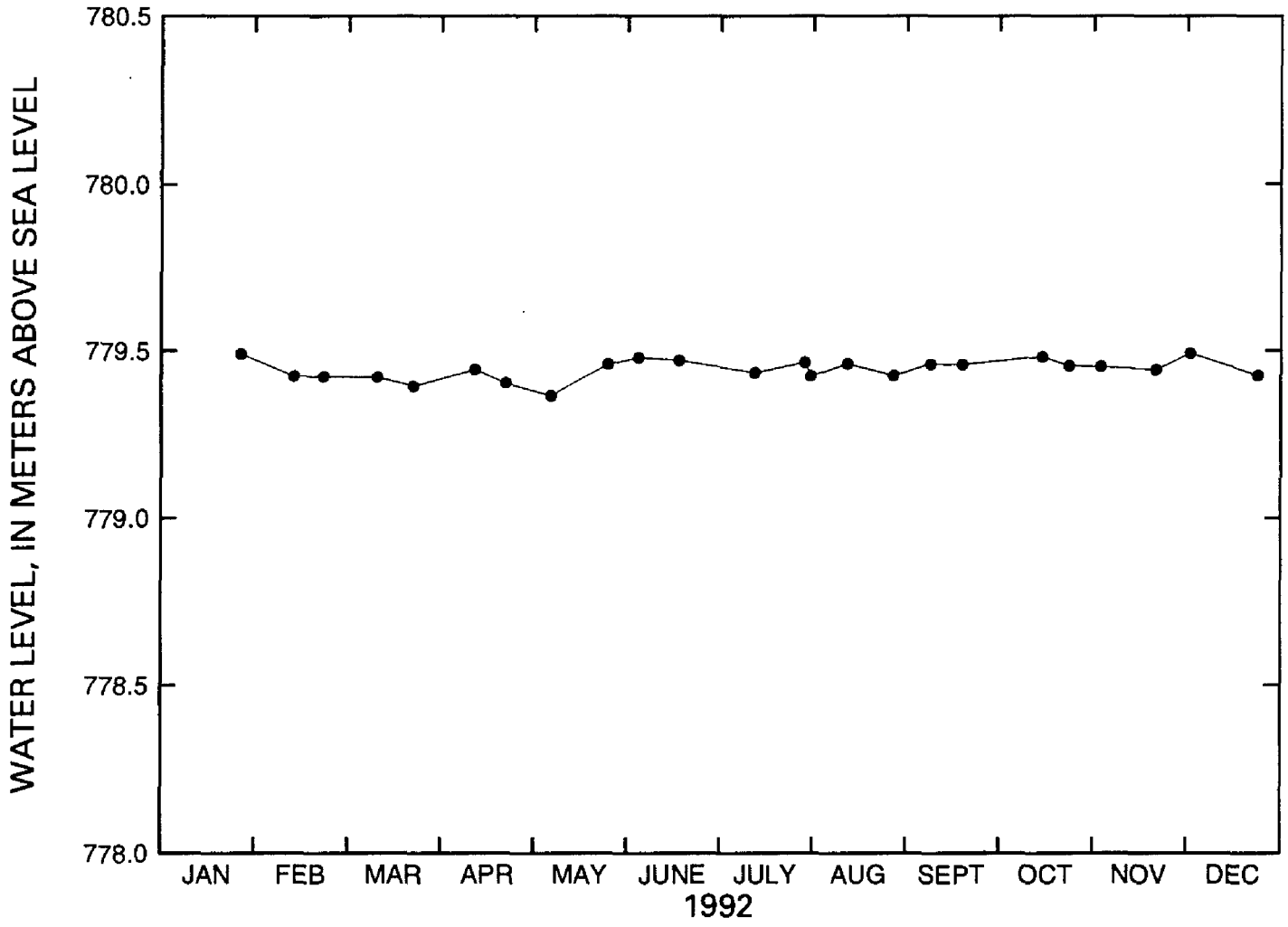

Figure 12. Water-level altitudes, 1992, for well USW VH-1.

Well J-11

Information about the history of well USW J-11 and about previous data from the well was obtained from Young, R.A., 1972, and Fenix & Scisson, Inc., 1987.

Well specifications

1. Location and identification:

   Latitude and longitude: 36°47'06"N.; 116°17'06"W.

   Nevada State Central Zone Coordinates (m): N 740,968; E 611,764.

   U.S. Geological Survey Site ID: 364706116170601.

2. Drilling and casing information:

   Well started: June 4, 1957.

   Well completed: July 19, 1957.

   Drilling method: Cable-tool.

   Bit diameter below water level: 400 mm.

   Casing extending below water level: 308-mm inside-diameter casing extends from land surface to 404.5 m.

   Total drilled depth: 405 m.

3. Access to and description of interval for measuring water levels:

   308-mm inside-diameter casing; the casing is perforated from 328.3 to 334.4 m and from 379.2 to 396.2 m. The well produces water from the basalt of Kiwi Mesa and from the welded-tuff aquifer, located within the Topopah Spring Member of the Paintbrush Tuff.

4. Information for calculating water-level altitude:

   Reference point: Chiseled "X" in concrete pad near well; altitude 1,049.45 m (surveyed by U.S. Geological Survey, 1993).

   Measuring point: Top of casing, even with top of concrete block, 0.555 m.

   Depth correction for borehole deviation from vertical is not available.

Water-level altitudes

Water-level altitudes at well J-11 ranged from 732.12 to 732.30 m. Mean water-level altitude for 1992 was 732.20 m. The mean altitude for 1992 was unchanged from the mean altitude of for 1991 (Boucher, 1994b). Water-level altitudes are listed in table 15 and shown in figure 13.

Table 15. Measured water-level altitudes and yearly mean water-level altitude, 1992, for well J-11

[Method: C1, Chain #1]

Date	Water-level altitude (meters, above sea level)	Method
01-31-92	732.18	C1
02-20-92	732.16	C1
04-06-92	732.17	C1
05-04-92	732.19	C1
05-21-92	732.21	C1
06-17-92	732.19	C1
07-16-92	732.20	C1
08-19-92	732.20	C1
09-11-92	732.20	C1
10-30-92	732.30	C1
11-25-92	732.12	C1
12-17-92	732.25	C1

1992 Mean = 732.20 meters.

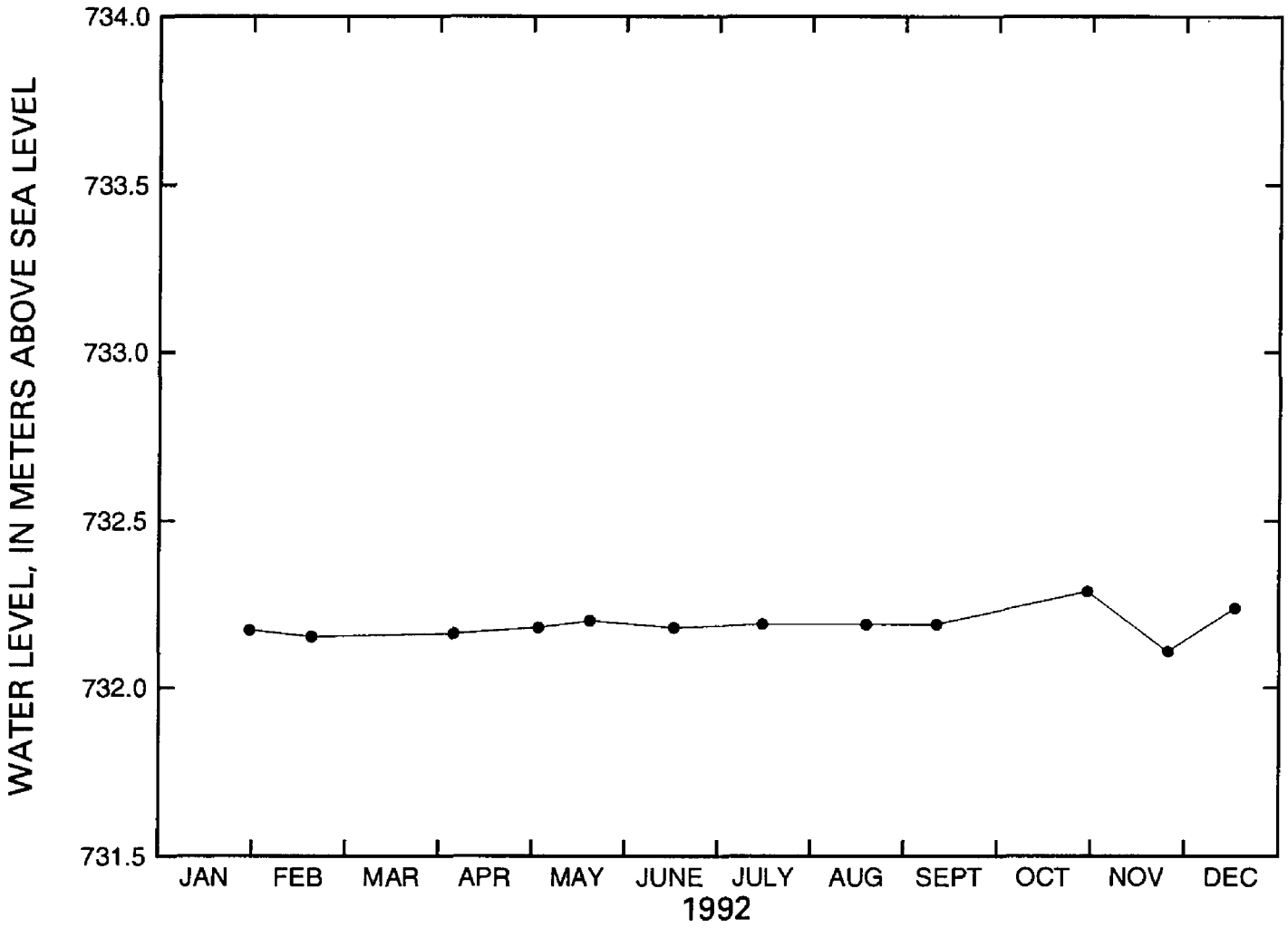

Figure 13. Water-level altitudes, 1992, for well J-11.

Well J-12

Information about the history of well USW J-12 and about previous data from the well was obtained from Young, R.A., 1972, and Fenix & Scisson, Inc., 1987.

Well specifications

1. Location and identification:

   Latitude and longitude: 36°45'54"N.; 116°23'24"W.

   Nevada State Central Zone Coordinates (m): N 733,508; E 581,012.

   U.S. Geological Survey Site ID: 364554116232401.

2. Drilling and casing information:

   Well started: August 4, 1957.

   Well completed: October 9, 1957; well was deepened in August 1968.

   Drilling method: Cable-tool (1957); unknown 1968.

   Bit diameter below water level: 400-mm to 271 m, 298-mm to 347 m.

   Casing extending below water level: 308-mm inside-diameter casing extending from land surface to 271 m.

   Total drilled depth: 271 m (1957); 347 m after the deepening in 1968.

3. Access to and description of interval for measuring water levels:

   308-mm inside-diameter casing; the casing is perforated between 241–264 m; the hole is open from 271 m to 347 m; access tube is 54-mm outside-diameter. The well produces water from the welded-tuff aquifer, located within the Topopah Spring Member of the Paintbrush Tuff.

4. Information for calculating water-level altitude:

   Reference point: Top of well collar, altitude 954.54 m (surveyed by U.S. Geological Survey, 1993).

   Measuring point: Top of the 54-mm outside-diameter access tube, 0.527 m.

   Depth correction for borehole deviation from vertical is not available.

Water-level altitudes

Water-level altitudes at well J-12 ranged from 727.92 to 728.03 m. Mean water-level altitude for 1992 was 727.96 m. The mean altitude for 1992 was 0.01 m higher than the mean altitude of 727.95 m for 1991 (Boucher, 1994b). Water-level altitudes are listed in table 16 and shown in figure 14.

Table 16. Measured water-level altitudes and yearly mean water-level altitude, 1992, for well J-12

[Method: C1, Chain #1]

Date	Water-level altitude (meters, above sea level)	Method
05-22-92	727.93	C1
06-04-92	727.98	C1
06-17-92	727.95	C1
07-16-92	727.94	C1
07-28-92	727.94	C1
08-18-92	727.96	C1
08-31-92	727.99	C1
09-11-92	727.95	C1
09-28-92	727.95	C1
10-15-92	727.94	C1
10-29-92	728.03	C1
11-19-92	727.96	C1
11-30-92	727.92	C1
12-08-92	727.99	C1
12-17-92	728.02	C1

1992 Mean = 727.96 meters.

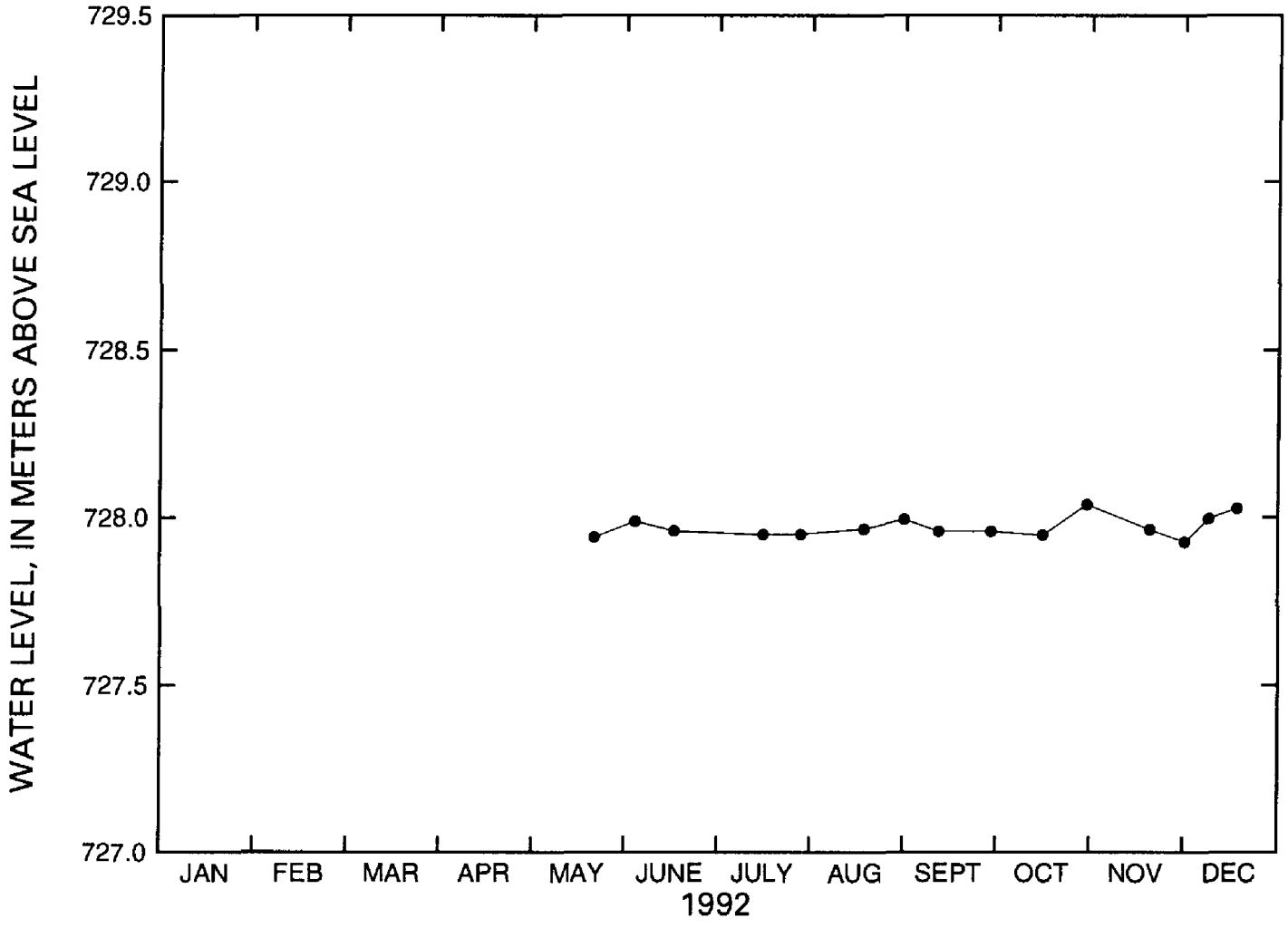

Figure 14. Water-level altitudes, 1992, for well J-12.

Well J-13

Information about the history of well J-13 and about previous data from the well was obtained from various sources. These sources are: Robison (1984, 1986); Robison and others (1988); Holmes & Narver, Inc. (written commun., 1986); Thordarson (1983); Young (1972); and Fenix & Scisson (1987c).

Well specifications

1. Location and identification:

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

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

   U.S. Geological Survey Site ID: 364828116234001.

2. Drilling and casing information:

   Well started: September 12, 1962.

   Well completed: January 8, 1963.

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

   Bit diameter below water level: 438 mm to 402 m; 380 mm from 402 m to 471m; 194 mm from 471 m to total depth.

   Casing extending below water level: 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.

   Total drilled depth: 1,063 m.

3. Access to and description of interval for measuring water levels:

   50.8-mm inside-diameter access tube, installed in 1986, in order for measuring equipment to bypass pump assembly.

   Reference point: Chiseled square on concrete well collar, altitude 1,011.47 m (surveyed by U.S. Geological Survey, 1984).

   Measuring point: Top of access tube, 0.165 m.

Depth correction for borehole deviation from vertical is not available.

Water-level altitudes

Water-level altitudes at well J-13 ranged from 728.36 to 728.61 m. Mean-annual water-level altitude for 1992 was 728.46 m. The mean altitude was 0.01 m lower than the mean altitude of 728.47 m for 1991 (P. Tucci, U.S. Geological Survey, written commun., 1994). Water-level altitudes are listed in table 17 and shown in figure 15.

Table 17. Measured water-level altitudes and yearly mean water-level altitude, 1992, for well J-13

[Method: C1, Chain #1]

Date	Water-level altituda (meters, above sea level)	Method
01-28-92	728.44	C1
02-20-92	728.41	C1
02-28-92	728.41	C1
03-11-92	728.40	C1
04-03-92	728.43	C1
04-10-92	728.46	C1
05-04-92	728.40	C1
05-13-92	728.44	C1
05-22-92	728.36	C1
06-04-92	728.44	C1
06-17-92	728.40	C1
07-14-92	728.44	C1
07-28-92	728.45	C1
08-18-92	728.45	C1
08-31-92	728.50	C1
09-11-92	728.48	C1
09-29-92	728.46	C1
10-15-92	728.48	C1
10-29-92	728.61	C1
11-19-92	728.55	C1
11-30-92	728.45	C1
12-08-92	728.55	C1
12-17-92	728.54	C1
1992 Mean = 728.46 meters.		

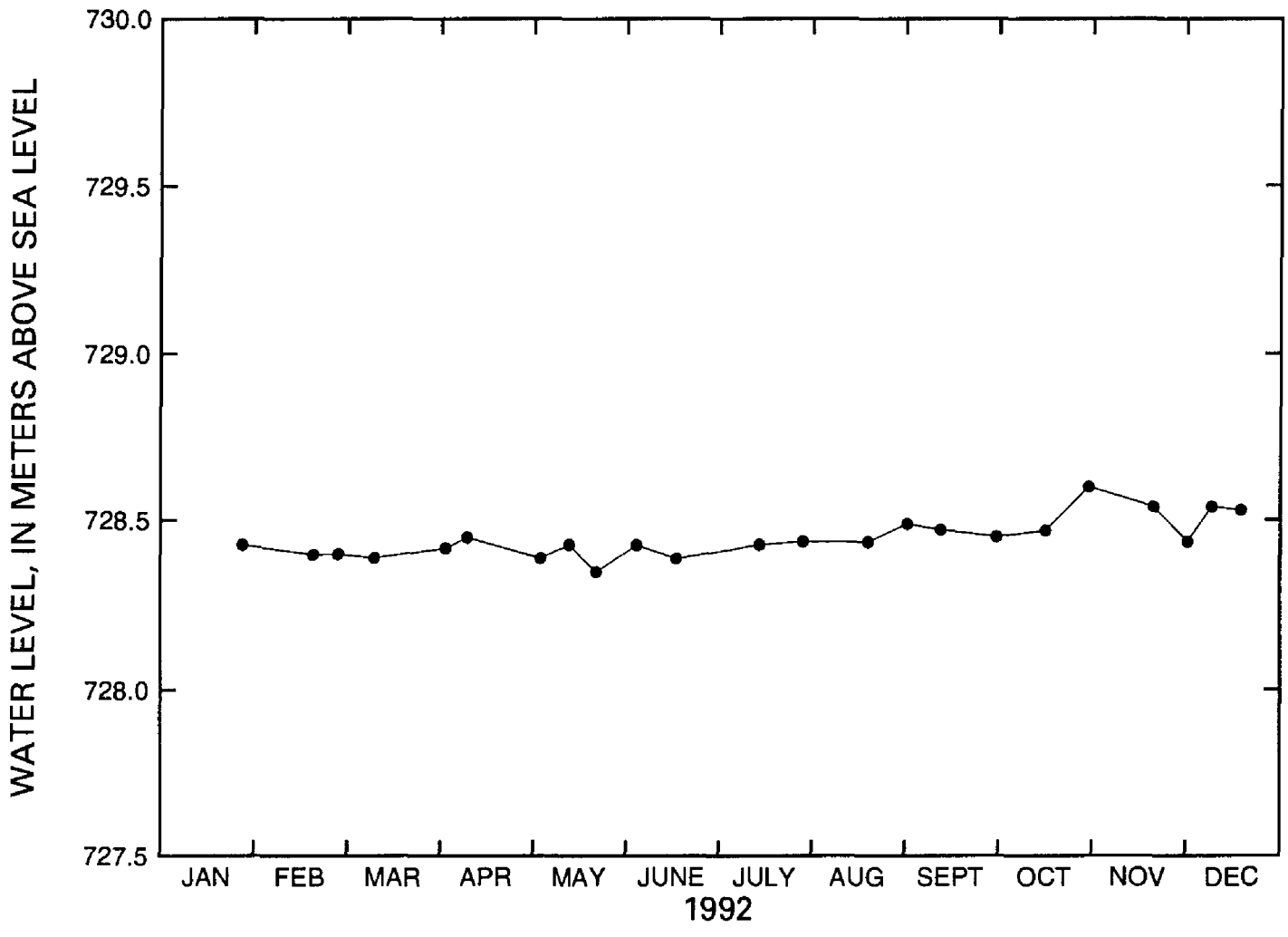

Figure 15. Water-level altitudes, 1992, for well J-13.

Hourly Water-Level Measurements

References or information sources, well specifications, calibration information, hydrographs of water-level altitudes, tables of mean monthly water levels and measured water-level altitudes (if appropriate), are presented for individual wells and monitored intervals in the hourly water-level network for 1992. Calibration information includes the transducer serial number, calibration date, slope of the regression line, 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 or conversion of data to water levels 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 1992. Only those data that were evaluated as "valid" are presented. Tables are presented for each well or monitored interval of mean monthly water level. Yearly and monthly means are calculated from available daily means, regardless of amount of missing data. However, the number of missing daily means for each month is included in the tables. Daily means are not calculated if there are more than 300 consecutive minutes of missing data. Annual mean, minimum, and maximum water-level altitudes are also presented for each well or monitored interval.

Well USW WT-2

Information about the history of well USW WT-2 and about previous data from the well was obtained from various sources. These sources are: Robison (1984, 1986); Robison and others (1988); and Fenix & Scisson, Inc. (1986a, 1987c).

Well specifications

1. Location and identification:

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

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

   U.S. Geological Survey Site ID: 365023116271801.

2. Drilling and casing information:

   Well started: July 8, 1983.

   Well completed: July 16, 1983.

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

   Bit diameter below water level: 222 mm.

   Casing: Surface casing only, to a depth of 18 m.

   Total drilled depth: 628 m.

3. Access to and description of interval for measuring water levels:

   62-mm inside-diameter access tubing that has a 3.6-m-long well screen on bottom, extending from land surface to a depth of 622 m; saturated interval of borehole within Prow Pass Member of Crater Flat Tuff.

4. Information for calculating water-level altitude:

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

   Measuring point: Top of access tube, 0.311 m.

   Depth correction for borehole deviation from vertical: 0.533 m, based on approximate depth to water of 571 m.

Calibrations and comments

Five calibrations, for two transducers, were performed during 1992. In addition, calibrations on 09-04-91 and 03-23-93 were used to calculate water-level altitudes at the beginning and end of 1992. Results of the calibrations and measured water-level altitudes obtained during the calibrations are as follows:

Transducer aerial number	Calibration date	Slope (mV/m)	Coefficient of determination (r^2)	Water-level altitude (meters)
341812	09-04-91	1.33	0.99	730.78
341812	01-02-92	1.34	1.00	730.79
341812	04-01-92	1.38	1.00	730.77
465819	04-01-92	11.15	1.00	730.77
465819	07-27-92	11.29	1.00	730.66
465819	11-23-92	11.33	1.00	730.73
465819	03-23-93	11.32	1.00	730.70

Transducer data for 1992 was generally considered valid, but several short periods contained anomalous data. Spikes at 2400 hours from 1-2 through 1-15-92 were not considered valid. No data were available from 1200 hours, 3-31-92 to 1700 hours, 4-1-92, due to the change from a 21X data logger to a DCP at

the site. Spikes on 6-28 and 6-29-92 are associated with earthquakes near Landers, California, and Little Skull Mountain, Nevada.

Water-level altitudes

Water-level altitudes for well USW WT-2 ranged from 730.54 to 730.95 m above sea level in 1992 (fig. 16). The mean water-level altitude for 1992 was 730.71 m above sea level. Mean monthly water-level altitudes are listed in table 18.

Table 18. Mean monthly water-level altitudes, 1992, for well USW WT-2

Month	Water-level altitude (meters, above sea level)	Number of missing daily means
January	730.76	0
February	730.74	0
March	730.73	1
April	730.72	1
May	730.72	0
June	730.74	0
July	730.72	0
August	730.70	0
September	730.69	0
October	730.68	1
November	730.66	1
December	730.70	0

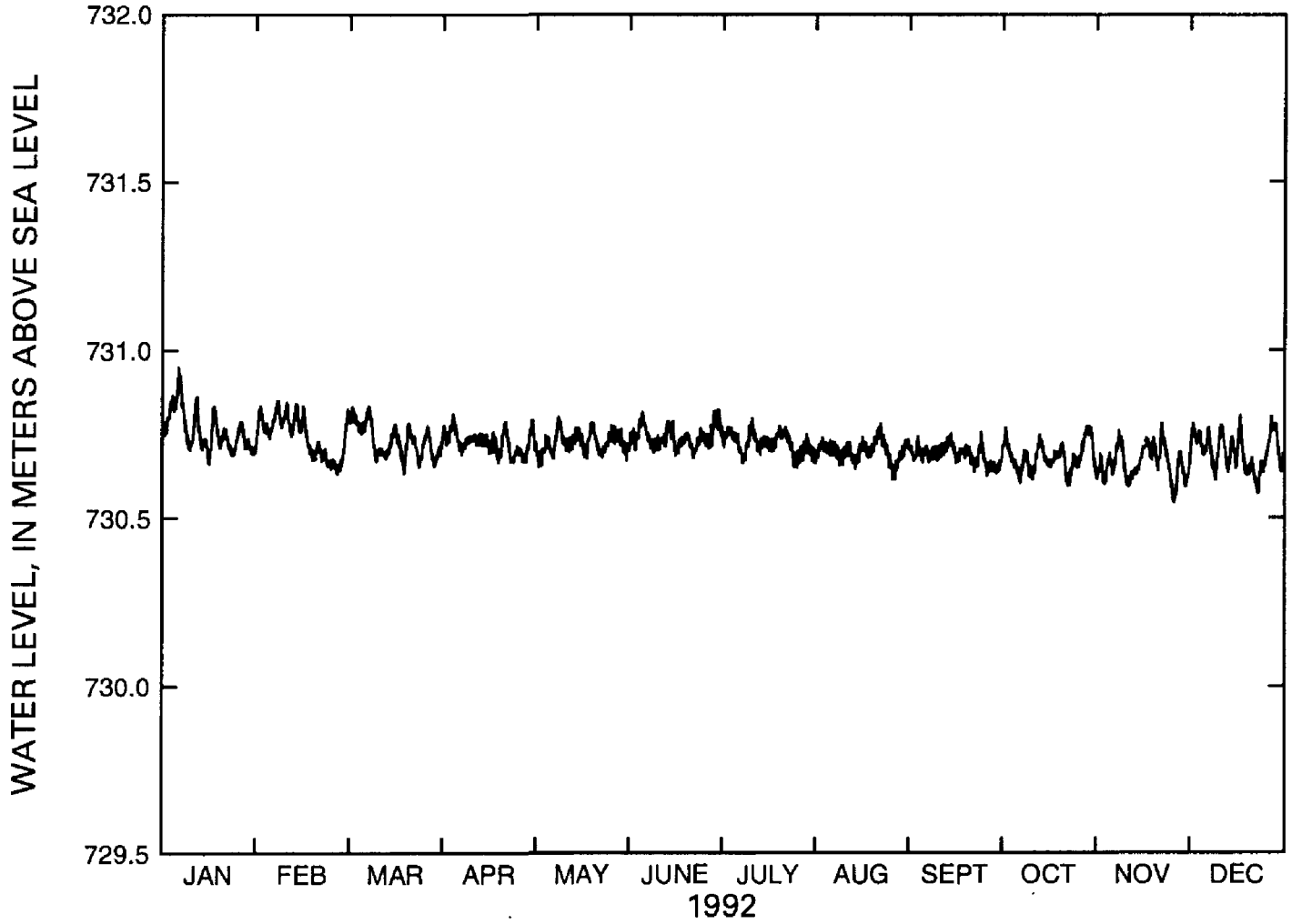

Figure 16. Water-level altitudes, 1992, for well USW WT-2.

Well UE-25 WT #3

Information about the history of well UE-25 WT #3 and about previous data from the well was obtained from various sources. These sources are: Robison (1984, 1986); Robison and others (1988); and Fenix & Scisson, Inc. (1986a, 1987c).

Well specifications

1. Location and identification:

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

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

   U.S. Geological Survey Site ID: 364757116245801.

2. Drilling and casing information:

   Well started: April 29, 1983.

   Well completed: May 25, 1983.

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

   Bit diameter below water level: 222 mm.

   Casing: Surface casing only, to a depth of 12 m.

   Total drilled depth: 348 m.

3. Access to and description of interval for measuring water levels:

   62-mm inside-diameter tubing that has a 3.6-m-long well screen on bottom, extending from land surface to a depth of 343 m; saturated interval of borehole within Bullfrog Member of Crater Flat Tuff.

4. Information for calculating water-level altitude:

   Reference point: Top of metal tag on well casing; altitude 1,030.11 m (surveyed by U.S. Geological Survey, 1984).

   Measuring point: Top of access tubing, 0.155 m.

   Depth correction for borehole deviation from vertical: 0.271 m, based on approximate depth to water of 300 m.

Calibrations and comment

Hourly data collection began at this well on 5-12-92. Water levels had previously been measured monthly with steel tapes. Two calibrations, with one transducer, were performed during 1992. In addition, a calibration on 1-8-93 was used to calculate water levels at the end of 1992. Results of the calibrations and measured water-level altitudes obtained during the calibrations are as follows:

Transducer serial number	Calibration date	Slope (mV/m)	Coefficient of determination (r^2)	Water-level altitude (metars)
413600	05-12-92	22.50	1.00	729.76
413600	09-10-92	22.70	1.00	729.72
413600	01-08-93	22.52	1.00	729.78

Data collected on 11-16 and 11-17-92 were considered invalid due to rodent damage to the transducer wires. The remainder of the data for 1992 were considered valid.

Water-level altitudes

Water-level altitudes for well USW WT-3 ranged from 729.60 to 729.86 m above sea level in 1992 (fig. 17). The mean water-level altitude, calculated from hourly data, for 1992 was 729.74 m above sea level. Mean monthly water-level altitudes are listed in table 19.

As a supplement to hourly water-level data, manual steel-tape measurements made prior to installation of hourly monitoring equipment are listed in table 20. Manual steel-tape measurements are not included in the yearly or monthly means previously listed.

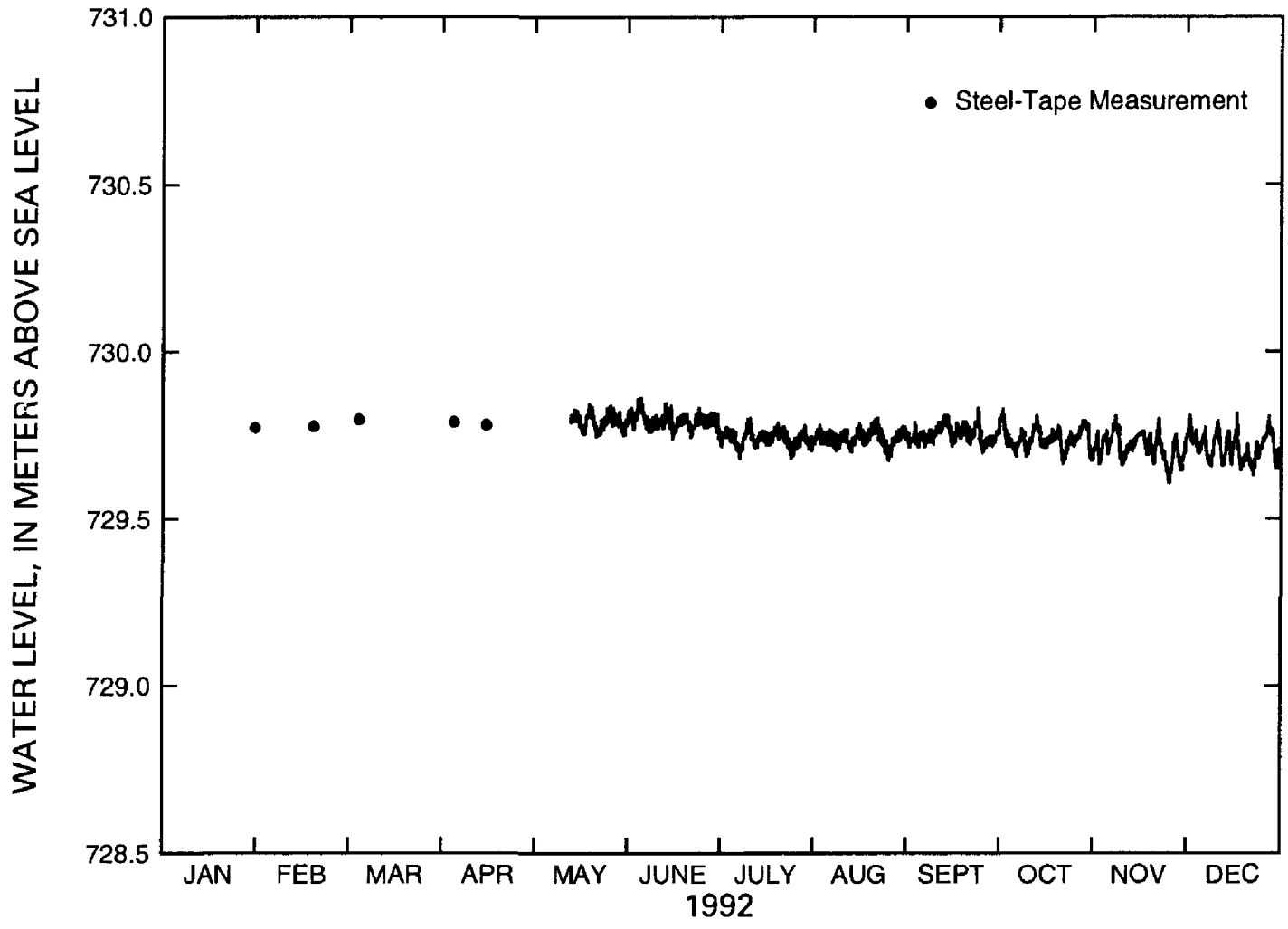

Figure 17. Water-level altitudes, 1992, for well UE-25 WT #3.

Table 19. Mean monthly water-level altitudes, 1992, for well UE-25 WT #3

Month	Water-level altitude (meters, above sea level)	Number of missing daily means
January	na	na
February	na	na
March	na	na
April	na	na
May	730.79	13
June	730.79	0
July	730.74	0
August	730.74	0
September	730.75	2
October	730.74	0
November	730.71	2
December	730.71	0

Table 20. Measured water-level altitudes, 1992, for well UE-25 WT #3

[Method: C1, Chain #1]

Date	Water-level altitude (meters, above sea level)	Method
01-28-92	729.76	C1
02-18-92	729.75	C1
04-03-92	729.78	C1
05-04-92	729.78	C1
05-12-92	729.76	C1

Well USW WT-11

Information about the history of well USW WT-11 and about previous data from the well was obtained from various sources. These sources are: Robison (1984, 1986); Robison and others (1988); and Fenix & Scisson, Inc. (1986a, 1987c).

Well specifications

1. Location and identification:

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

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

   U.S. Geological Survey Site ID: 364649116280201.

2. Drilling and casing information:

   Well started: August 3, 1983.

   Well completed: August 9, 1983.

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

   Bit diameter below water level: 222 mm.

   Casing: Surface casing only, to a depth of 14 m.

   Total drilled depth: 441 m.

3. Access to and description of interval for measuring water levels:

   62-mm inside-diameter tubing that has a 3.6-m-long well screen on bottom, extending from land surface to a depth of 416 m; saturated interval of borehole within Topopah Spring Member of Paintbrush Tuff to tuffaceous beds of Calico Hills.

4. Information for calculating water-level altitude:

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

   Measuring point: Top of access tube, 0.311 m.

   Depth correction for borehole deviation from vertical: 0.116 m, based on approximate depth to water of 363 m.

Calibrations and comments

Three calibrations, with one transducer, were performed during 1992. In addition, calibrations on 10-30-91 and 2-4-93 were used to calculate water levels at the beginning and end of 1992. Results of the calibrations and measured water-level altitudes obtained during the calibrations are as follows:

Transducer serial number	Calibration date	Slope (mV/m)	Coefficient of determination (r^2)	Water-level altitude (meters)
308830	10-30-91	11.50	1.00	730.66
308830	02-24-92	11.57	1.00	730.64
308830	06-18-92	11.52	1.00	730.70
308830	10-14-92	11.77	1.00	730.65
308830	02-04-93	11.67	1.00	730.57

Four hours of data on 2-5-92 were considered unreliable and not converted to water levels. Many transducer data values during the period 10-28 to 11-2-92 were erratic and considered unreliable. The general character of the water-level response in this well appears to have changed during 1992. Water-level fluctuations due to earthtides appeared to diminish considerably in the latter part of the year. The change in response is considered real and not due to instrumentation problems, because the character did not change when a new transducer was installed.

Water-level altitudes

Water-level altitudes for well USW WT-11 ranged from 730.47 to 730.86 m above sea level in 1992 (fig. 18). The mean water-level altitude for 1992 was 730.67 m above sea level. Mean monthly water-level altitudes are listed in table 21.

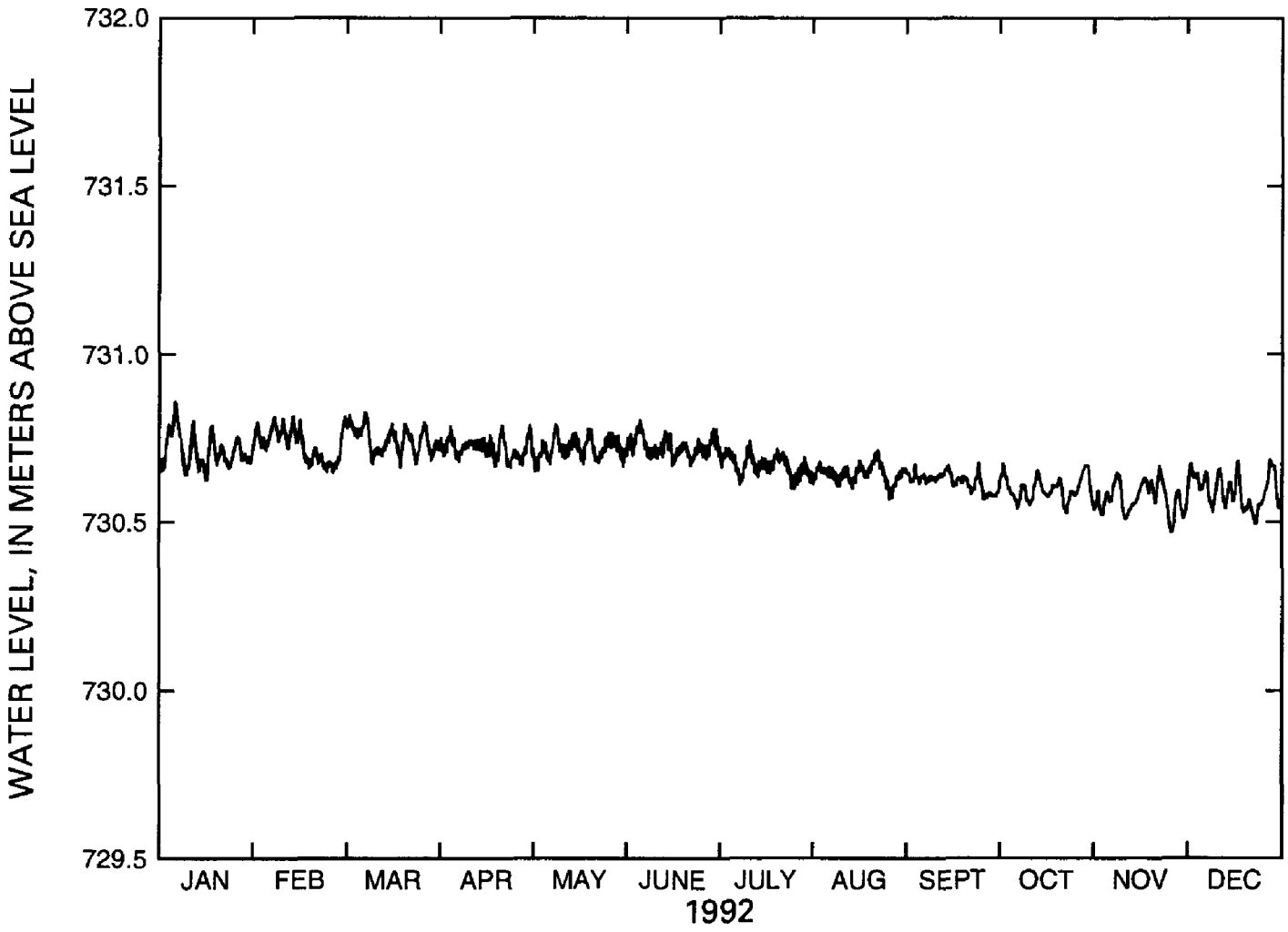

Figure 18. Water-level altitudes, 1992, for well USW WT-11.

Table 21. Mean monthly water-level altitudes, 1992, for well USW WT-11

Month	Water-level altitude (meters, above sea level)	Number of missing daily means
January	730.71	0
February	730.73	2
March	730.74	0
April	730.72	1
May	730.72	0
June	730.72	0
July	730.67	0
August	730.64	0
September	730.62	0
October	730.59	6
November	730.57	2
December	730.59	1

Well UE-25 WT #13

Information about the history of well UE-25 WT #13 and about previous data from the well was obtained from various sources. These sources are: Robison (1984, 1986); Robison and others (1988); and Fenix & Scisson, Inc. (1986a, 1987c).

Well specifications

1. Location and identification:

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

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

   U.S. Geological Survey Site ID: 364945116235001.

2. Drilling and casing information:

   Well started: June 29, 1983.

   Well completed: July 7, 1983.

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

   Bit diameter below water level: 222 mm.

   Casing: Surface casing only, to a depth of 68 m.

   Total drilled depth: 354 m.

3. Access to and description of interval for measuring water levels:

   62-mm inside-diameter tubing that has a 3.6-m-long well screen on bottom, extending from land surface to a depth of 346 m; saturated interval of borehole within Topopah Spring Member of Paintbrush Tuff.

4. Information for calculating water-level altitude:

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

   Measuring point: Top of access tube, 0.305 m.

   Depth correction for borehole deviation from vertical: 0.012 m, based on approximate depth to water of 304 m.

Calibrations and comments

Four calibrations, with three transducers, were performed during 1992. In addition, calibrations on 12-05-91 and 2-5-93 were used to calculate water levels at the beginning and end of 1992. Results of the calibrations and measured water-level altitudes obtained during the calibrations are as follows:

Transducer serial number	Calibration date	Slope (mV/m)	Coefficient of determination (r^2)	Water-level altitude (meters)
1831DD	12-05-91	49.97	1.00	729.13
1831DD	03-19-92	48.70	0.99	729.07
473980	03-19-92	11.27	1.00	729.07
465824	06-10-92	11.44	1.00	729.11
465824	10-09-92	11.39	1.00	729.16
465824	02-05-93	11.40	1.00	729.17

Transducer data from 3-9 to 3-12-92 were considered unreliable and values associated with the transducer calibration on 3-19-92 were not converted to water levels. The transducer failed, without an ending calibration, on 6-7 and was replaced on 6-10-92; data collected during this period are unreliable. The spike on 6-28-92 was caused by the earthquake near Landers, California.

Water-level altitudes

Water-level altitudes for well UE-25 WT #13 ranged from 728.93 to 729.31 m above sea level in 1992 (fig. 19). The mean water-level altitude for 1992 was 729.14 m above sea level. Mean monthly water-level altitudes are listed in table 22.

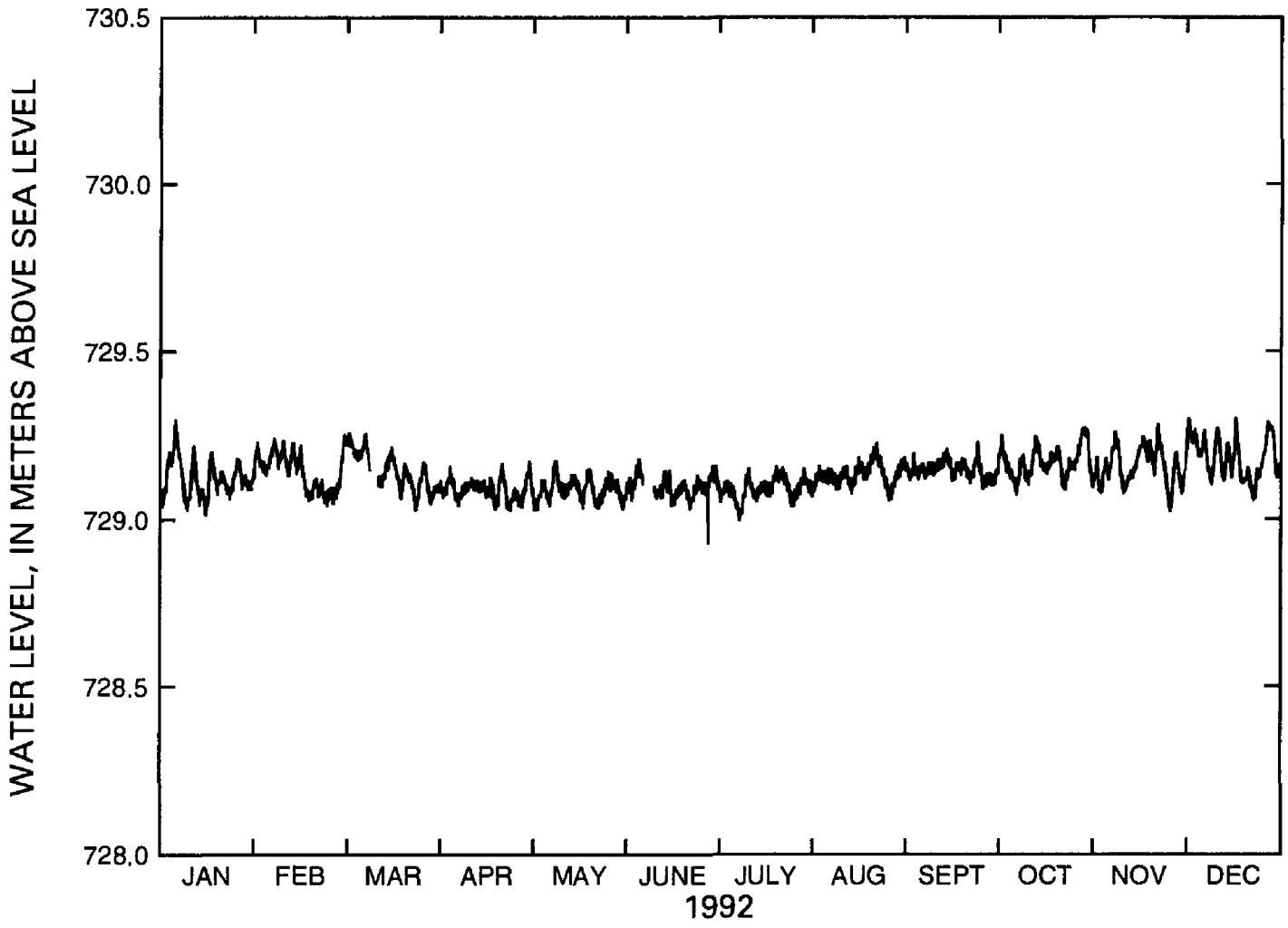

Figure 19. Water-level altitudes, 1992, for well UE-25 WT #13.

Table 22. Mean monthly water-level altitudes, 1992, for well UE-25 WT #13

Month	Water-level altitude (maters, above sea level)	Number of missing daily meana
January	729.13	0
February	729.15	0
March	729.16	5
April	729.09	0
May	729.09	0
June	729.10	4
July	729.10	0
August	729.14	0
September	729.15	0
October	729.17	0
November	729.16	0
December	729.19	0

Well UE-25 WT #16

Information about the history of well UE-25 WT #16 and about previous data from the well was obtained from various sources. These sources are: Robison (1984, 1986); Robison and others (1988); and Fenix & Scisson, Inc. (1986a, 1987c).

Well specifications

1. Location and identification:

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

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

   U.S. Geological Survey Site ID: 365239116253401.

2. Drilling and casing information:

   Well started: November 2, 1983.

   Well completed: November 10, 1983.

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

   Bit diameter below water level: 222 mm.

   Casing: Surface casing only, to a depth of 31 m.

   Total drilled depth: 521 m.

3. Access to and description of interval for measuring water levels:

   62-mm inside-diameter tubing that has a 3.6-m-long well screen on bottom, extending from land surface to a depth of 514 m; saturated interval of borehole within tuffaceous beds of Calico Hills.

4. Information for calculating water-level altitude:

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

   Measuring point: Top of access tube, 0.314 m.

   Depth correction for borehole deviation from vertical: 0.064 m, based on approximate depth to water of 473 m.

Calibrations and comments

One calibration was performed during 1992. In addition, one calibration on 9-17-91, was used to calculate water-level altitudes at the beginning of 1992. Hourly monitoring was discontinued on 5-11-92, and thereafter the well was measured bi-monthly. Results of the calibrations and measured water-level altitudes obtained during the calibrations are as follows:

Transducer aerial number	Calibration date	Slope (mV/m)	Coefficient of determination (r^2)	Water-level altitude (meters)
341123	09-17-91	19.82	1.00	738.41
341123	01-13-92	20.47	1.00	738.44

Transducer data for 1-3 to 1-13-92 were lost due to a data logger power failure. Data collected during the calibration on 1-13-92 were not converted to water levels. Transducer data from 2-11 through 5-11-92 were erratic and considered unreliable. Due to transducer failure, no ending calibration was possible when hourly monitoring was discontinued on 5-11-92.

Water-level altitudes

Water-level altitudes for well UE-25 WT #16 ranged from 738.17 to 738.54 m above sea level in 1992 (fig. 20). The mean water-level altitude for 1992, calculated using daily means from January 1 to February 10, 1992, and steel-tape measurements for the remainder of the year was 738.42 m above sea level. Mean monthly water-level altitudes are listed in table 23.

As a supplement to hourly water-level data, manual steel-tape measurements after removal of hourly monitoring equipment are listed in table 24.

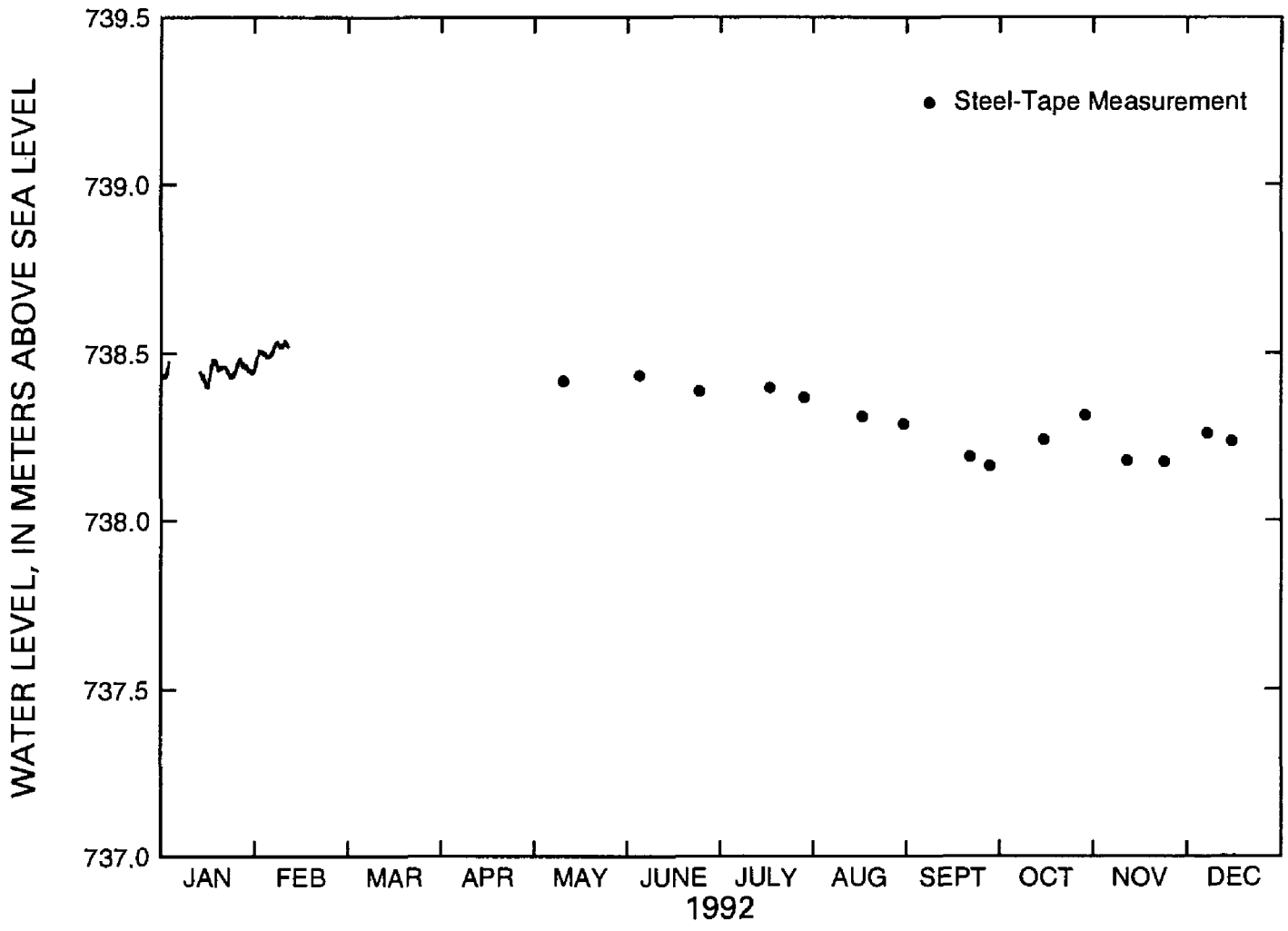

Figure 20. Water-level altitudes, 1992, for well UE-25 WT #16.

Table 23. Mean monthly water-level altitudes, January and February, 1992, for well UE-25 WT #16

Month	Water-level altitude (meters, above sea level)	Number of missing daily means
January	738.45	11
February	738.51	19

Table 24. Measured water-level altitudes, 1992, for well UE-25 WT #16

[Method: C1, Chain #1]

Water level		
Date	Altitude (meters, above sea level)	Method
05-11-92	738.42	C1
06-04-92	738.43	C1
06-23-92	738.39	C1
07-17-92	738.41	C1
07-28-92	738.37	C1
08-17-92	738.31	C1
08-31-92	738.29	C1
09-22-92	738.19	C1
09-29-92	738.17	C1
10-16-92	738.25	C1
10-30-92	738.31	C1
11-13-92	738.18	C1
11-25-92	738.18	C1
12-08-92	738.28	C1
12-16-92	738.25	C1

Well UE-25b #1

Information about the history of well UE-25b #1 and about previous data from the well was obtained from various sources. These sources are: Lobmeyer and others (1983); Lahoud and others (1984); Robison (1984, 1986); Robison and others (1988); and Fenix & Scisson, Inc. (1986b, 1987c).

Well specifications

1. Location and identification:

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

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

   U.S. Geological Survey Site ID's:
   365108116262301 (entire well).
   365108116262302 (lower interval).
   365108116262303 (upper interval).

2. Drilling and casing information:

   Well started: April 3, 1981.

   Well completed: September 22, 1981.

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

   Bit diameter below water level: 311 mm to 520 m; 222 mm to 650 m; 216 mm from 650 to 1,220 m.

   Casing extending below water level: 226-mm inside diameter to 518 m; casing string is tack cemented in and perforated below the water level.

   Total drilled depth: 1,220 m.

3. Access to and description of interval for measuring water levels:

   48-mm inside diameter tubing, open ended, to 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; Site ID: 365108116262303.

   62-mm inside diameter tubing that has an inflatable packer on 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; Site ID: 365108116262302.

4. Information for calculating water-level altitude:

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

   Measuring point: Top of access tubes, 0.302 m, upper interval; 0.134 m, lower interval.

   Depth correction for borehole deviation from vertical: 0.244 m, based on approximate depth to water of 470 m.

Calibrations and comments

Upper interval:

Four calibrations, with one transducer, were performed during 1992. In addition, calibrations on 11-15-91 and 1-12-93, were used to calculate water-level altitudes at the beginning and end of 1992. Results of the calibrations and measured water-level altitudes obtained during the calibrations are as follows:

Transducer serial number	Calibration date	Slope (mV/m)	Coefficient of determination (r^2)	Water-level altitude (meters)
274148	11-15-91	26.69	1.00	730.78
274148	02-26-92	26.39	1.00	730.68
274148	02-27-92	11.27	1.00	730.67
274148	06-24-92	11.26	1.00	730.73
274148	10-21-92	11.23	1.00	730.69
274148	01-12-93	11.19	1.00	730.61

Values collected while the site was being converted to a DCP, on 2-26-92, were not converted to water-levels. Due to DCP programming problems no data were collected 2-27 through 3-10-92. A spike on 3-11-92 was considered unreliable. The spike on 6-28-92 is associated with earthquake near Landers, California. Data collected from 10-21 to 10-23-92 are not valid due to transducer wiring problem.

Lower interval:

Seven calibrations, with two transducers, were performed during 1992. In addition, a calibration on 10-09-91 was used to calculate water-level altitudes at the beginning of 1992. Hourly water-level data collection in this interval was discontinued on 10-21-92. Results of the calibrations and measured water-level altitudes obtained during the calibrations are as follows:

Transducer sarial number	Calibration date	Slope (mV/m)	Coefficient of datar-mination (r^2)	Water-level altitude (meters)
361058	10-09-91	20.72	1.00	729.62
361058	02-05-92	20.87	1.00	729.64
361058	02-26-92	21.06	1.00	729.77
361058	02-27-92	23.61	1.00	729.80
361058	03-10-92	23.17	1.00	729.78
417336	03-10-92	23.40	1.00	729.78
417336	06-24-92	23.42	1.00	729.80
417336	10-21-92	23.20	1.00	729.87

Data from 1-1 to 3-10-92 were considered unreliable due to a malfunctioning transducer. Transducer data from 3-31 through 5-16-92, and 8-15 through 9-21-92, were considered unreliable because it appeared the transducer vent tube was obstructed during most of these periods. Although the transducer data for the period 5-17 through 8-14-92 has low-level noise, they are considered valid.

Water-level altitudes

Upper interval:

Water-level altitudes for well UE-25b #1, upper interval, ranged from 730.52 to 730.89 m above sea level in 1992 (fig. 21). The mean water-level altitude for 1992, was 730.71 m above sea level. Mean monthly water-level altitudes are listed in table 25.

Lower interval:

Water-level altitudes for well UE-25b #1, lower interval, ranged from 729.77 to 729.92 m above sea level in 1992 (fig. 22). The mean water-level altitude for 1992 was 729.83 m above sea level. Mean monthly water-level altitudes are listed in table 26.

As a supplement to hourly water-level data, manual steel-tape measurements during 1992 are listed in table 27. Manual steel-tape measurements are not included in the yearly or monthly means previously listed.

The general water-level trends in UE-25b #1, lower interval, during 1992 are uncharacteristic due to the apparent drift, or unexplained, long-term trends that are present. Water levels in wells in the Yucca Mountain area generally follow the trend of barometric pressure; however, the water level in the lower interval of well UE-25b #1 did not follow these trends. Historically, this interval has been insensitive to water-level fluctuations caused by barometric pressure and earth tides. Given the information available to ascertain the validity of the transducer data, the water levels are considered valid largely due to a lack of information that would deem them invalid.

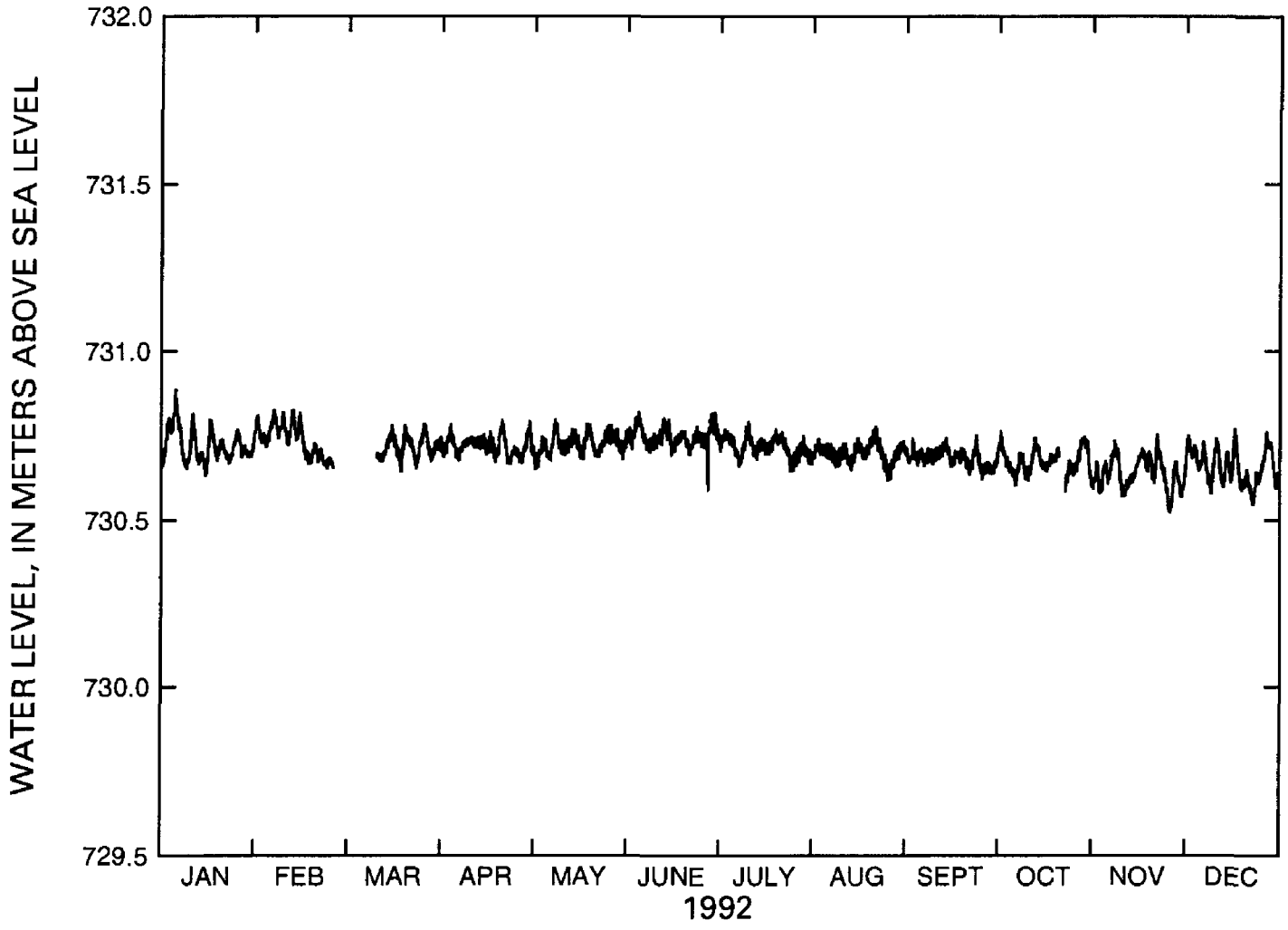

Figure 21. Water-level altitudes, 1992, for well UE-25b #1, upper interval.

Table 25. Mean monthly water-level altitudes, 1992, for well UE-25b #1, upper interval

Month	Water-level altitude (meters, above sea level)	Number of missing daily means
January	730.73	0
February	730.74	4
March	730.72	11
April	730.72	1
May	730.73	0
June	730.75	1
July	730.72	0
August	730.70	0
September	730.69	0
October	730.68	3
November	730.64	0
December	730.66	0

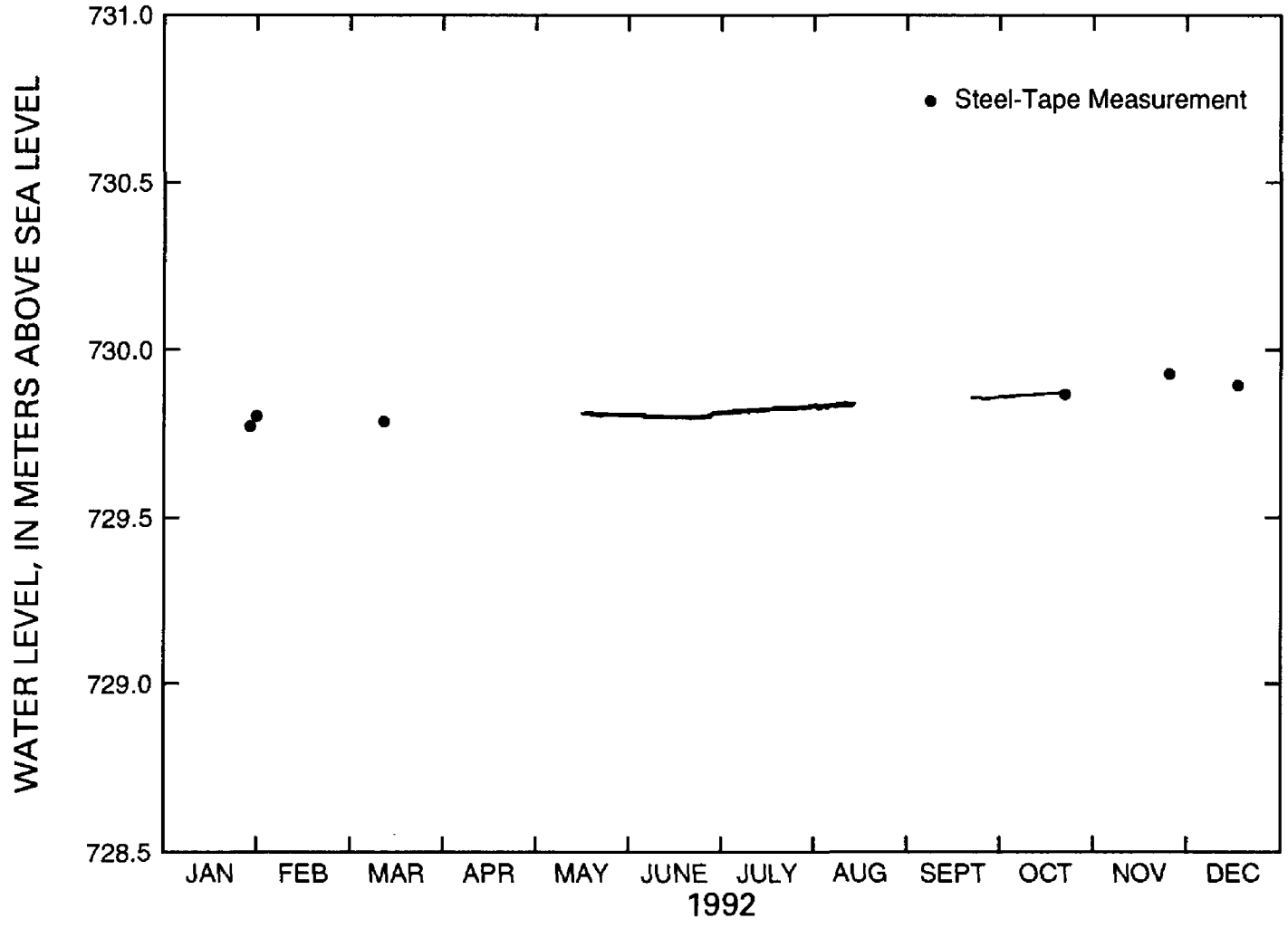

Figure 22. Water-level altitudes, 1992, for well UE-25b #1, lower interval.

Table 26. Mean monthly water-level altitudes, 1992, for well UE-25b #1, lower interval

Month	Water-level altitude (meters, above sea level)	Number of missing daily means
January	---	30
February	---	29
March	---	31
April	---	30
May	729.81	17
June	729.80	1
July	729.82	0
August	729.83	17
September	729.86	22
October	729.86	11

Table 27. Measured water-level altitudes, 1992, for well UE-25b #1, lower interval

[Method: C1, Chain #1]

Date	Water-level altitude (meters, above sea level)	Method
02-26-92	729.77	C1
02-27-92	729.80	C1
03-10-92	729.78	C1
10-21-92	729.87	C1
11-24-92	729.92	C1
12-15-92	729.90	C1

Well UE-25p #1

Information about the history of well UE-25p #1 and about previous data from the well was obtained from various sources. These sources are: Craig and Johnson (1984); Craig and Robison (1984); Robison (1984, 1986); Robison and others (1988); and Fenix & Scisson, Inc. (1986d, 1987c).

Well specifications

1. Location and identification:

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

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

   U.S. Geological Survey Site ID:
   364938116252101 (entire well).
   364938116252102 (lower interval).

2. Drilling and casing information:

   Well started: November 13, 1982.

   Well completed: May 24, 1983.

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

   Bit diameter below water level: 375 mm to 487 m; 251 mm from 487 to 1,304 m; 175 mm from 1,304 to 1,317 m; 171 mm from 1,317 to 1,798 m; 156 mm from 1,798 to 1,805 m.

   Casing extending below water level: 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, has no perforations.

   Total drilled depth: 1,805 m.

3. Access to and description of interval for measuring water levels:

   38-mm inside-diameter tubing, open end, to depth of 418 m; well construction is such that hydraulic head of the tuffs of Tertiary age is not monitored. Only the hydraulic head in the underlying carbonate rocks of Paleozoic age is measured (Tertiary-Paleozoic contact is at 1,244 m); Site ID: 364938116252102.

   Note: Also installed, to enable temperature measurements, is 38-mm inside-diameter tubing, closed end, and filled with water, to depth of 413 m.

4. Information for calculating water-level altitude:

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

   Measuring point: Top of access tube, 0.158 m.

   Depth correction for borehole deviation from vertical: 0.021 m, based on approximate depth to water of 362 m.

Calibrations and comments

Twelve calibrations, with two transducers, were performed during 1992. In addition, calibrations on 10-16-91 and 3-16-93 were used to calculate water-level altitudes at the beginning and end of 1992. Results of the calibrations and measured water-level altitudes obtained during the calibrations are as follows:

Transducer serial number	Calibration data	Slope (mV/m)	Coefficient of determination (r^2)	Water-level altitude (meters)
413605	10-16-91	21.27	0.99	752.47
413605	02-12-92	22.00	1.00	752.56
413605	02-12-92	22.72	1.00	752.56
413605	02-19-92	22.48	1.00	752.46
413605	06-17-92	22.58	1.00	1
413605	09-02-92	22.00	0.99	752.12
413605	09-03-92	22.49	1.00	752.11
413605	09-15-92	22.84	1.00	752.02
413605	09-17-92	22.60	1.00	752.04
413605	09-24-92	22.70	1.00	752.15
413605	09-24-92	22.47	1.00	752.15
413605	11-17-92	18.63	1.00	752.37
443988	11-17-92	22.72	1.00	752.37
443988	03-16-93	22.69	1.00	752.45

[1]Water-level altitude not determined.

Values collected on 2-12-92, while site was being converted to a DCP, were not converted to water levels. Transducer failed and data were unreliable for the period 2-14 to 2-19-92. Spikes on 6-28 and 6-29-92 are associated with earthquakes near Landers, California, and Little Skull Mountain, Nevada. No data were collected 9-2 and 9-3-92, due to temperature logging in well. The spike on 9-15-92 was considered unreliable. Values associated with the calibration on 9-24-92 were not converted to water levels. Transducer data were erratic and unreliable for the period 11-5 to 11-8-92.

Water-level altitudes

Water-level altitudes for well UE-25p #1 ranged from 751.86 to 752.65 m above sea level in 1992 (fig. 23). The mean water-level altitude for 1992 was 752.32 m above sea level. Mean monthly water-level altitudes are listed in table 28.

The dramatic water-level decrease following the Landers and Little Skull Mountain earthquakes was real and was verified by manual water-level measurements. The upward water-level trend after the earthquakes represents the process of re-establishing potentiometric equilibration in the well.

Table 28. Mean monthly water-level altitudes, 1992, for well UE-25p #1

Month	Water-level altitude (meters, above sea level)	Number of missing daily means
January	752.49	0
February	752.49	9
March	752.53	0
April	752.49	1
May	752.46	0
June	752.46	1
July	751.98	0
August	752.07	0
September	752.07	5
October	752.19	1
November	752.28	6
December	752.41	1

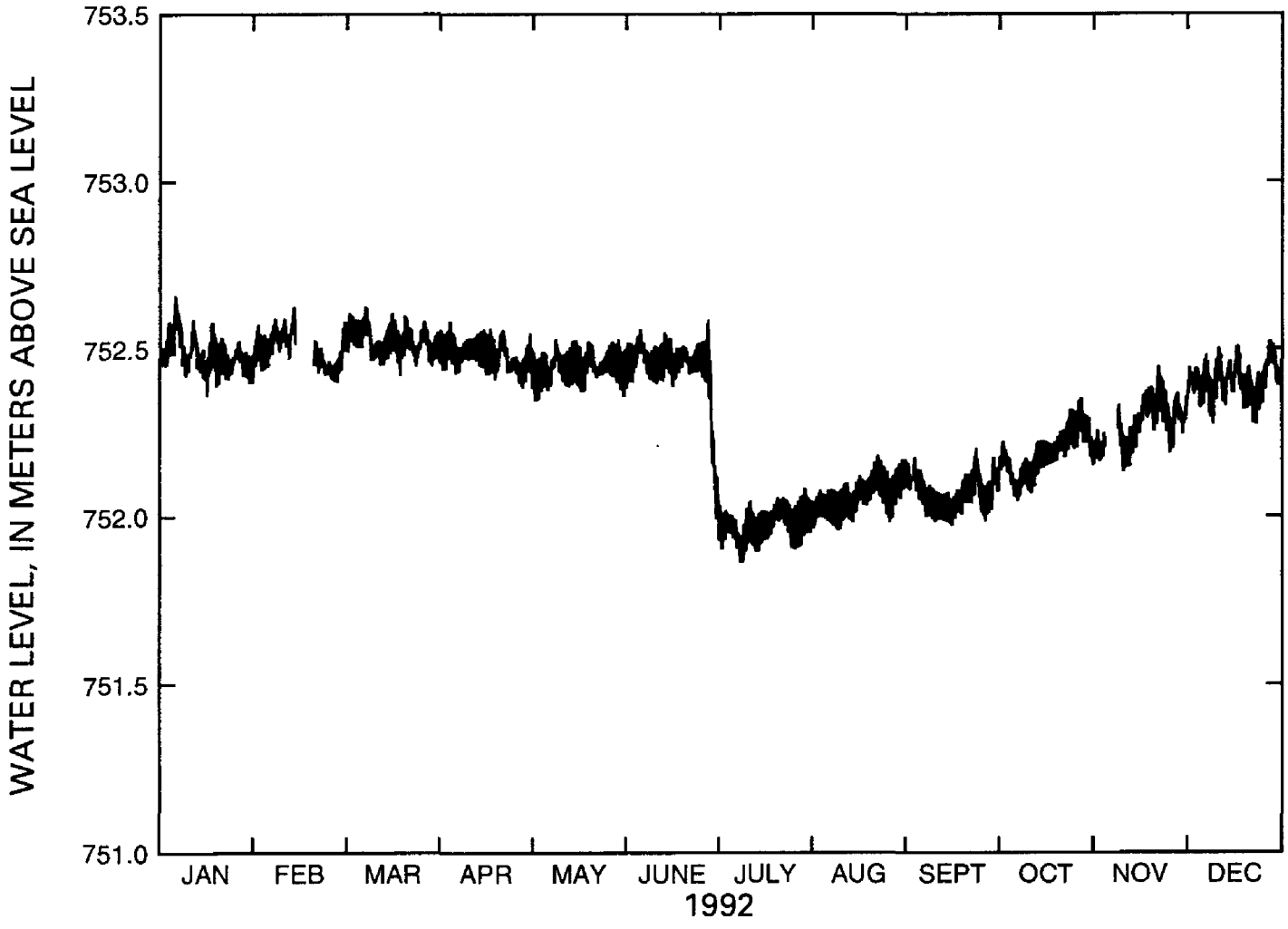

Figure 23. Water-level altitudes, 1992, for well UE-25p #1.

Well USW G-3

Information about the history of well USW G-3 and about previous data from the well was obtained from various sources. These sources are: Robison (1984, 1986); Robison and others (1988); and Fenix & Scisson, Inc. (1987b, 1987c).

Well specifications

1. Location and identification:

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

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

   U.S. Geological Survey Site ID: 364905116280101.

2. Drilling and casing information:

   Well started: January 8, 1982.

   Well completed: March 21, 1982.

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

   Bit diameter below water level: 222 mm to 792 m; 121 mm from 792 to 795 m; 100 mm from 795 m to total depth.

   Casing extending below water level: 126-mm inside diameter to 792 m; bottom casing tack cemented; no perforations.

   Total drilled depth: 1,533 m.

3. Access to and description of interval for measuring water levels:

   Casing, 126-mm inside diameter, extending from land surface to a depth of 792 m; saturated interval of borehole within Tram member of the Crater Flat Tuff and the Lithic Ridge Tuff.

4. Information for calculating water-level altitude:

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

   Measuring point: Top of access tube, 0.329 m.

   Depth correction for borehole deviation from vertical: 0.564 m, based on approximate depth to water of 750 m.

Calibrations and comments

Four calibrations, with one transducer, were performed during 1992. In addition, calibrations on 11-13-91 and 1-11-93 were used to calculate water-level altitudes at the beginning and end of 1992. Due to extreme borehole deviation from vertical, the water level in this well cannot be measured with steel tapes. Water levels must be measured using a multiconductor cable because steel tapes cannot be lowered to the water surface. Water-level altitudes are based on multiconductor cable measurements made on 3-20-91 and 9-16-92. Results of the calibrations and measured water-level altitudes obtained during the calibrations are as follows:

Transducer serial number	Calibration date	Slope (mV/m)	Coefficient of determination (r^2)	Water-level altitude (meters)
356012	11-13-91	11.07	1.00	730.56
356012	03-03-92	10.87	0.99	730.52
356012	07-01-92	11.24	1.00	730.42
356012	09-03-92	10.94	0.99	730.39
356012	09-16-92	11.07	1.00	730.65
356012	01-11-93	11.31	0.99	730.57

Spikes on 6-28 and 6-29-92 are associated with earthquakes near Landers, California, and Little Skull Mountain, Nevada. All data for 1992 are considered valid.

Water-level altitudes

Water-level altitudes for well USW G-3 ranged from 730.22 to 730.76 m above sea level in 1992 (fig. 24). The mean water-level altitude for 1992 was 730.49 m above sea level. Mean monthly water-level altitudes are listed in table 29.

The general water-level trends in USW G-3 during 1992 are uncharacteristic due to the apparent drift, or unexplained, long-term trends that are present. Water levels in wells in the Yucca Mountain area gen-

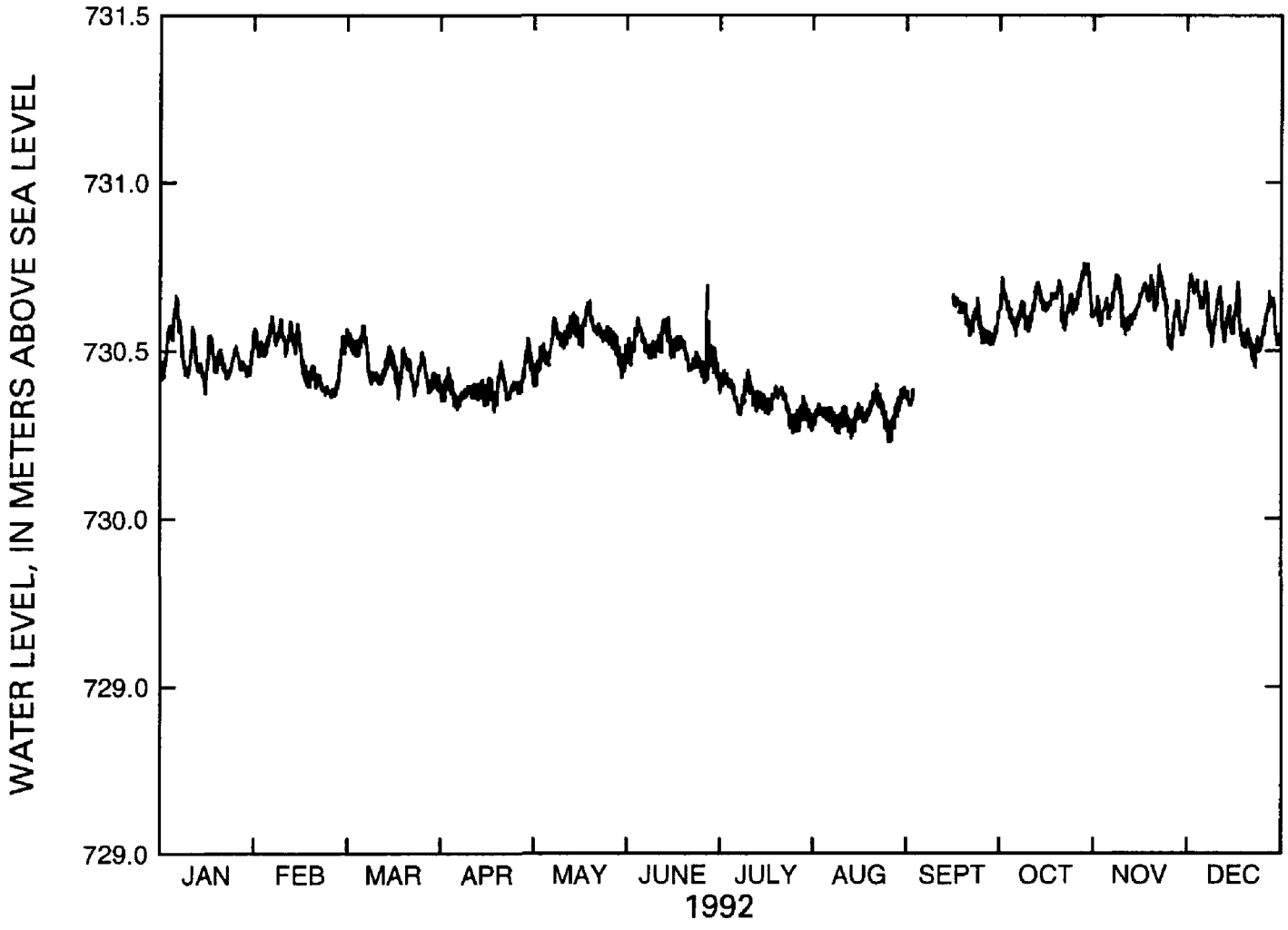

Figure 24. Water-level altitudes, 1992, for well USW G-3.

Table 29. Mean monthly water-level altitudes, 1992, for well USW G-3

Month	Water-level altitude (meters, above sea level)	Number of missing daily means
January	730.48	0
February	730.48	0
March	730.46	1
April	730.39	1
May	730.53	0
June	730.50	0
July	730.35	1
August	730.31	0
September	730.56	14
October	730.64	0
November	730.63	0
December	730.60	0

erally follow the long-term trend of barometric pressure; however, water levels in well USW G-3 did not follow these long-term trends. Whether these trends are an artifact of a malfunctioning transducer or are real, has not been conclusively determined. However, given the information available to ascertain the validity of the transducer data, the water levels are considered valid, largely due to a lack of information that would deem them invalid.

Well USW H-1

Information about the history of well USW H-1 and about previous data from the well was obtained from various sources. These sources are: Rush and others (1983); Rush and others (1984); Robison (1984, 1986); Robison and others (1988); and Fenix & Scisson, Inc. (1987a, 1987c).

Well specifications

1. Location and identification:

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

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

   U.S. Geological Survey Site ID's:
   365157116271201 (entire well).
   365157116271202 (lowermost interval).
   365157116271203 (second interval from bottom).
   365157116271204 (third interval from bottom).
   365157116271205 (uppermost interval).

2. Drilling and casing information:

   Well started: September 3, 1980.

   Well completed: January 25, 1981 (initial completion, including geophysical logging and hydraulic testing); July 6, 1982 (re-completion; four piezometers installed).

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

   Bit diameter below water level: 311 mm to 688 m; 222 mm from 688 m to 1,829 m. Casing extending below water level: 226-mm inside diameter to 687 m.

   Casing string is tack cemented and perforated below the water table. See section 3 for description of intervals open to water.

   Total drilled depth: 1,829 m.

3. Access to and description of interval for measuring water levels:

   Tube 1—44-mm inside diameter, that has a 3.6-m-long well screen on bottom, extending from land surface to depth of 1,806 m; responds to depth interval from 1,783 to 1,814 m within older flows and tuffs beneath the Lithic Ridge Tuff (Carr, 1988, p.37); Site ID: 365157116271202.

   Tube 2—44 mm inside diameter, that has a 3.6-m-long well screen on bottom, extending from land surface to depth of 1,115 m; responds to depth interval from 1,097 to 1,123 m within Tram Member of Crater Flat Tuff, and lava flow and flow breccia beneath the Tram Member; Site ID: 365157116271203.

   Tube 3—44-mm inside diameter, that has a 3.6-m-long well screen on bottom, extending from land surface to depth of 741 m; responds to depth interval from 716 to 765 m within Bullfrog Member of Crater Flat Tuff; Site ID: 365157116271204.

   Tube 4—62-mm inside diameter, open ended, extending from land surface to depth of 640 m; responds to depth interval from 572 to 673 m within Prow Pass Member of Crater Flat Tuff; Site ID: 365157116271205.

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

4. Information for calculating water-level altitude:

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

   Measuring point: Top of access tubes, 0.311 m, all intervals.

   Depth correction for borehole deviation from vertical: 0.143 m in tube 1, based on approximate depth to water of 518 m; 0.171 m in tube 2, based on approximate depth to water of 567 m; 0.174 m in tubes 3 and 4, based on approximate depths to water of 572 m.

Calibrations and comments

Tube 1:

Six calibrations, with two transducers, were performed during 1992. In addition, a calibration on 12-04-91 was used to calculate water-level altitudes at the beginning of 1992. Results of the calibrations and measured water-level altitudes obtained during the calibrations are as follows:

Transducer serial number	Calibration date	Slope (mV/m)	Coefficient of determination (r^2)	Water-level altitude (meters)
371354	12-04-91	3.46	1.00	785.58
448969	03-05-92	22.88	0.99	785.70
448969	05-27-92	22.51	0.99	785.68
448969	05-27-92	23.53	0.99	785.68
448969	09-02-92	22.64	1.00	785.64
443987	09-04-92	23.46	0.99	785.52
443987	10-27-92	22.75	1.00	785.49

Data are considered unreliable for the period 2-8 to 3-4-92, due to transducer failure. An ending calibration was not possible when the transducer was replaced because the output did not change when depth of submergence changed. Data associated with calibration on 3-5-92 were not converted to water levels. The spike on 3-13-92 was not considered reliable. No data are available for the period 5-12 to 5-19-92, due to data-collection error. Transducer data for the period 8-7 to 9-2-92 were considered unreliable due to an apparent blockage of the transducer vent tube and eventual failure of the transducer. No water-level data were collected on 9-2 and 9-3-92, due to temperature logging in the well. Hourly water-level data collection was discontinued on 10-27-92.

Tube 2:

Four calibrations, with one transducer, were performed during 1992. In addition, calibrations on 10-25-91 and 1-21-93 were used to calculate water-level altitudes at the beginning and end of 1992. Results of the calibrations and measured water-level altitudes obtained during the calibrations are as follows:

Transducer serial number	Calibration date	Slope (mV/m)	Coefficient of determination (r^2)	Water-level altitude (meters)
413604	10-25-91	22.99	0.99	736.09
413604	02-21-92	22.73	1.00	736.02
413604	05-28-92	22.56	1.00	735.95
413604	05-28-92	23.97	0.99	735.95
413604	09-23-92	23.42	1.00	735.94
413604	01-21-93	23.13	1.00	735.92

No data are available for the periods 2-21 to 3-5-92, and 5-12 to 5-19-92, due to data-collection errors. Spikes on 2-21, 3-5, and 6-1-92 were not considered reliable. The site was converted from a 21X data logger to a DCP from 5-28 to 5-31-92, no water-level data were collected during this period. Water-levels after the tag on 12-22-92 required minor correction because the transducer was not returned to the previous set point.

Tube 3:

Five calibrations, with two transducers, were performed during 1992. In addition, calibrations on 9-19-91 and 1-21-93 were used to calculate water-level altitudes at the beginning and end of 1992. Results of the calibrations and measured water-level altitudes obtained during the calibrations are as follows:

Transducer serial number	Calibration date	Slope (mV/m)	Coefficient of determination (r^2)	Water-level altitude (meters)
413606	09-19-91	20.47	0.99	730.79
413606	01-14-92	20.72	1.00	730.69
413606	05-14-92	21.17	1.00	730.76
413606	05-29-92	21.08	0.99	730.81
255373	05-29-92	11.84	0.99	730.81
255373	09-23-92	11.14	0.99	730.62
255373	01-21-93	11.33	1.00	730.54

Data associated with the calibration on 1-14-92 were not converted to water levels. No data were available for the periods 2-21 to 3-5-92, and 5-12 to 5-19-92, due to data-collection errors, and the spike on 3-5-92 was not considered valid.

Tube 4:

Four calibrations, with one transducer, were performed during 1992. In addition, calibrations on 12-04-91 and 1-21-93 were used to calculate water-level altitudes at the beginning and end of 1992. Results of the calibrations and measured water-level altitudes obtained during the calibrations are as follows:

Transducer serial number	Calibration date	Slope (mV/m)	Coefficient of determination (r^2)	Water-level altitude (meters)
333284	12-04-91	3.55	1.00	730.92
2656DJ	02-06-92	8.84	1.00	731.00
2656DJ	06-01-92	8.93	1.00	730.92
2656DJ	06-01-92	11.19	1.00	730.92
2656DJ	09-23-92	11.08	1.00	730.90
2656DJ	01-21-93	11.15	1.00	730.82

Data from 1-18 to 2-6-92 were considered unreliable, because the transducer became erratic and failed, and no ending calibration was possible. Spikes on 2-6 and 6-1-92 associated with calibrations were not converted to water levels. No data were available for the periods 2-21 to 3-5-92, and 5-12 to 5-19-92, due to data-collection errors. The spike on 3-5-92 was not considered valid. The spike on 6-28-92 is associated with the earthquake near Landers, California.

Water-level altitudes

Tube 1:

Water-level altitudes for well USW H-1, tube 1, ranged from 785.43 to 785.77 m above sea level in 1992 (fig. 25). The mean water-level altitude for 1992, was 785.67 m above sea level. Mean monthly water-level altitudes are listed in table 30.

Water levels appeared to change slope on 6-28-92 after the earthquake near Landers, California. The general water-level trends in USW H-1, tube 1, during 1992 are uncharacteristic, due to the apparent drift, or unexplained, long-term trends that are present. Water levels in wells in the Yucca Mountain area generally follow the long-term trend of barometric pressure; however, water levels in Tube 1 of well USW H-1 did not follow these long-term trends. Historically, this interval has been insensitive to water-level fluctuations caused by barometric pressure and earth tides. Whether the trends are an artifact of a mal-

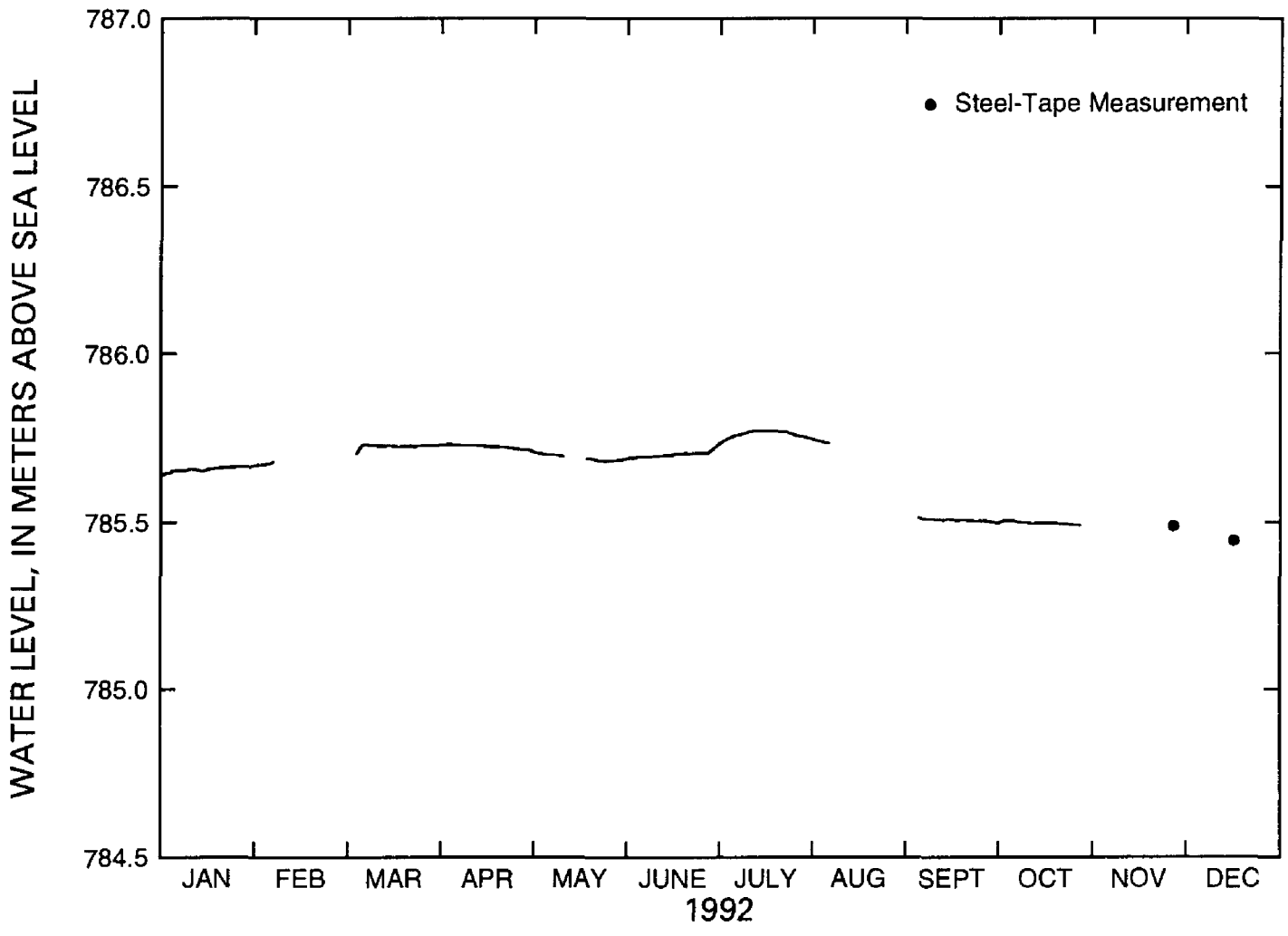

Figure 25. Water-level altitudes, 1992, for well USW H-1, tube 1.

functioning transducer or are real, has not been conclusively determined. However, given the information available to ascertain the validity of the transducer data, the water levels are considered valid, largely due to a lack of information that would deem them invalid.

Table 30. Mean monthly water-level altitudes, 1992, for well USW H-1, tube 1

Month	Water-level altitude (meters, above sea level)	Number of missing daily means
January	785.66	0
February	785.67	23
March	785.73	6
April	785.73	0
May	785.70	11
June	785.70	3
July	785.76	0
August	785.74	25
September	785.51	5
October	785.50	5

As a supplement to hourly water-level data, manual steel-tape measurements after removal of hourly monitoring equipment are listed in table 31. Manual steel-tape measurements are not used in calculating yearly and monthly mean water-level altitudes.

Table 31. Measured water-level altitudes, 1992, for well USW H-1, tube 1

[Method: C1, Chain #1]

Date	Water-level altitude (meters, above sea level)	Method
11-24-92	785.48	C1
12-15-92	785.43	C1

Tube 2:

Water-level altitudes for well USW H-1, tube 2, ranged from 735.94 to 736.04 m above sea level in 1992 (fig. 26). The mean water-level altitude for 1992, was 736.06 m above sea level. Mean monthly water-level altitudes are listed in table 32.

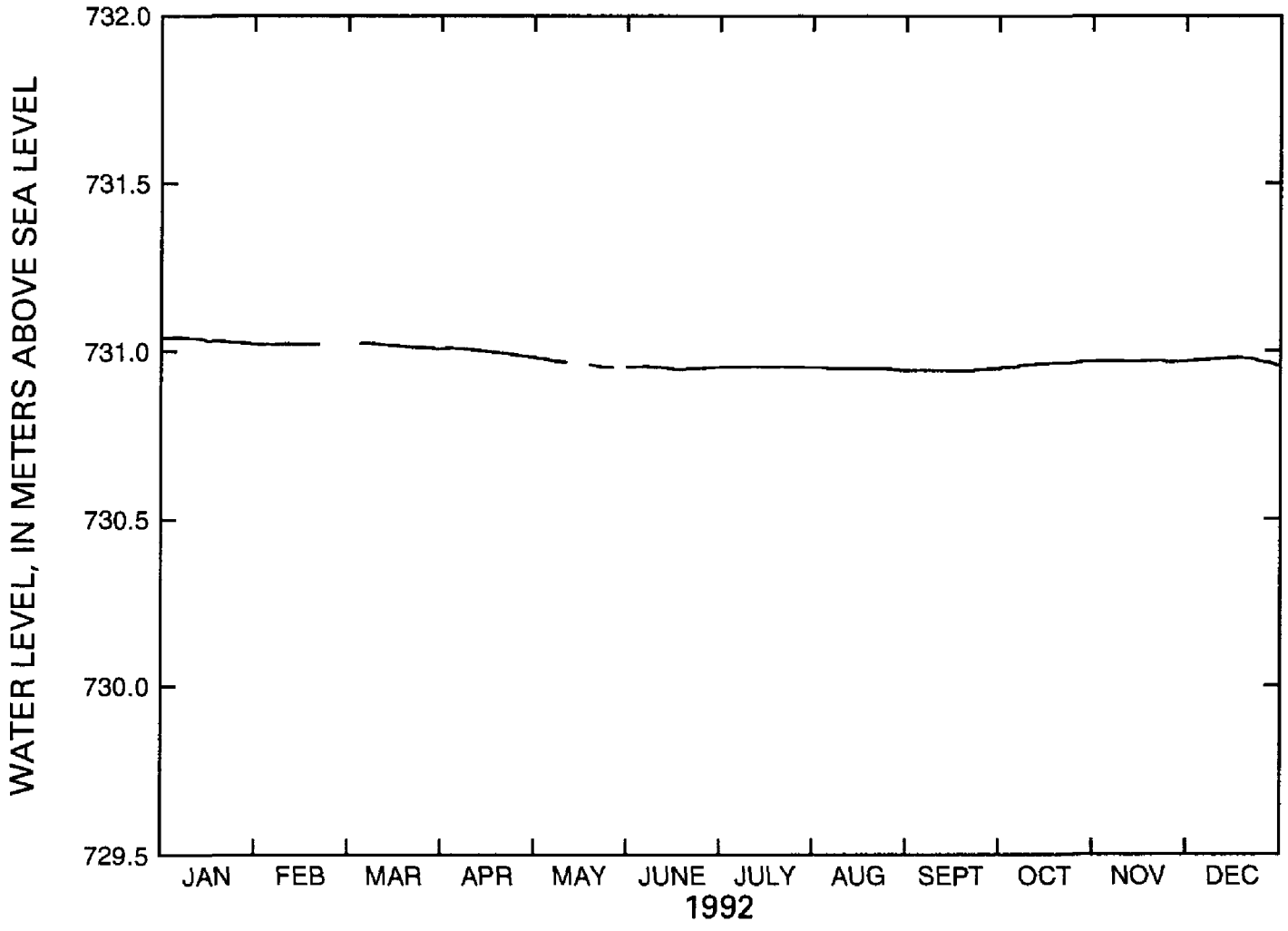

Figure 26. Water-level altitudes, 1992, for well USW H-1, tube 2.

Table 32. Mean monthly water-level altitudes, 1992, for well USW H-1, tube 2

Month	Water-level altitude (meters, above sea level)	Number of missing daily means
January	736.03	0
February	736.02	10
March	736.04	5
April	736.06	0
May	736.06	12
June	736.06	1
July	736.06	0
August	736.06	0
September	736.05	4
October	736.07	1
November	736.08	1
December	736.08	0

The general water-level trends in USW H-1, tube 2, during 1992 are uncharacteristic, due to the apparent drift, or unexplained, long-term trends that are present. Water levels in wells in the Yucca Mountain area generally follow the long-term trend of barometric pressure; however, water levels in Tube 2 of well USW H-1 did not follow these long-term trends. Historically, this interval has been insensitive to water-level fluctuations caused by barometric pressure and earth tides. Whether the trends are an artifact of a malfunctioning transducer or are real, has not been conclusively determined. However, given the information available to ascertain the validity of the transducer data, the water levels are considered valid, largely due to a lack of information that would deem them invalid.

Tube 3:

Water-level altitudes for well USW H-1, tube 3, ranged from 730.49 to 730.91 m above sea level in 1992 (fig. 27). The mean water-level altitude for 1992, was 730.71 m above sea level. Mean monthly water-level altitudes are listed in table 33.

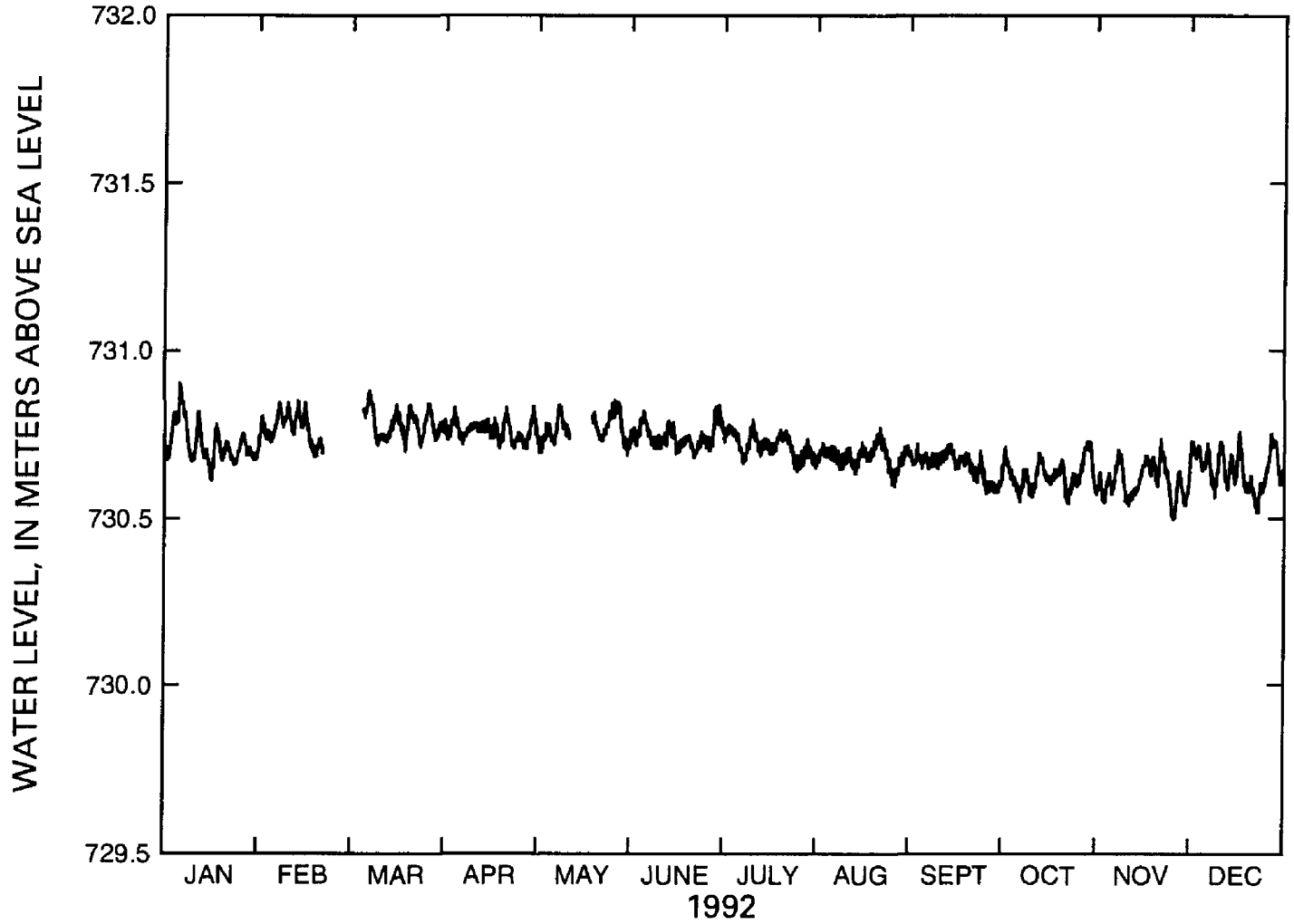

Figure 27. Water-level altitudes, 1992, for well USW H-1, tube 3.

Table 33. Mean monthly water-level altitudes, 1992, for well USW H-1, tube 3

Month	Water-level altitude (meters, above sea level)	Number of missing daily means
January	730.73	1
February	730.77	10
March	730.78	5
April	730.76	0
May	730.77	9
June	730.75	1
July	730.73	0
August	730.69	0
September	730.66	4
October	730.64	1
November	730.62	1
December	730.66	0

Tube 4:

Water-level altitudes for well USW H-1, tube 4, ranged from 730.71 to 731.45 m above sea level in 1992 (fig. 28). The mean water-level altitude for 1992, was 730.94 m above sea level. Mean monthly water-level altitudes are listed in table 34.

Table 34. Mean monthly water-level altitudes, 1992, for well USW H-1, tube 4

Month	Water-level altitude (meters, above sea level)	Number of missing daily means
January	730.86	15
February	730.94	15
March	730.95	5
April	730.91	0
May	730.93	8
June	730.97	1
July	730.98	0
August	730.96	0
September	730.94	4
October	730.93	1
November	730.90	1
December	730.93	0

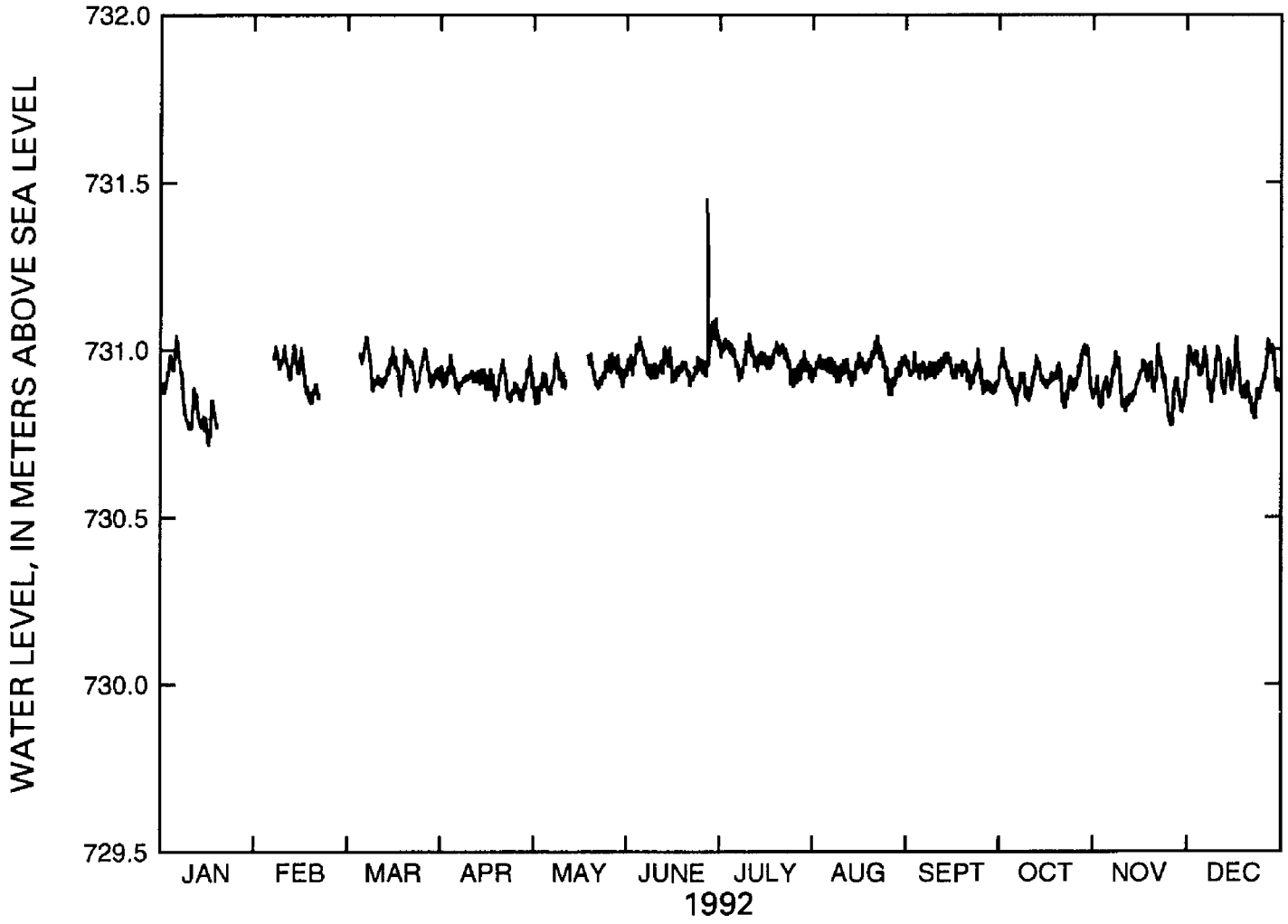

Figure 28. Water-level altitudes, 1992, for well USW H-1, tube 4.

Well USW H-3

Information about the history of well USW H-3 and about previous data from the well was obtained from various sources. These sources are: Thordarson, Rush, Spengler, and Waddell (1984); Thordarson, Rush, and Waddell (1984); Robison (1984, 1986); Robison and others (1988); and Fenix & Scisson, Inc. (1987a, 1987c).

Well specifications

1. Location and identification:

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

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

   U.S. Geological Survey Site ID's:
   364942116280001 (entire well).
   364942116280004 (upper interval).
   364942116280005 (lower interval).

2. Drilling and casing information:

   Well started: January 27, 1982.

   Well completed: March 19, 1982.

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

   Bit diameter below water level: 375 mm to 808 m; 222 m from 808 m to 1219 m.

   Casing extending below water level: 253 mm diameter to 792 m, not perforated below the water level.

   Total drilled depth: 1,219 m.

3. Access to and description of intervals for measuring water levels:

   41-mm inside diameter open ended tubing, extending from land surface to depth of about 762 m; upper interval of well, from near water table to top of inflatable packer, within bedded tuff and Tram Member of Crater Flat Tuff; Site ID: 364942116280004.

   62-mm inside diameter tubing that has an inflatable packer on bottom end extending from land surface to 1,114 m; lower interval from below packer to bottom of well, within Lithic Ridge Tuff; Site ID: 364942116280005.

   Note: Inflatable packer installed January 1983 at a depth of 1,190 m; removed late November 1983 during period of additional hydraulic testing; re-installed in May 1984 at depth of 1,114 m.

4. Information for calculating water-level altitude:

   Reference point: Top of metal tag on well casing; altitude 1483.47 m (surveyed by U.S. Geological Survey, 1984).

   Measuring point: Top of access tubes, 0.174 m, upper interval; 0.201 m, lower interval.

   Depth correction for borehole deviation from vertical: 0.079 m, upper interval, based on approximate depth to water of 752 m; 0.058 m, lower interval, based on approximate depth to water of 728 m.

Calibrations and comments

Upper interval:

Five calibrations, with one transducer, were performed during 1992. In addition, calibrations on 12-19-91 and 4-7-93 were used to calculate water-level altitudes at the beginning and end of 1992. Results of the calibrations and measured water-level altitudes obtained during the calibrations are as follows:

Transducer serial number	Calibration date	Slope (mV/m)	Coefficient of determination (r^2)	Water-level altitude (meters)
264709	12-19-91	10.81	1.00	731.47
264709	04-15-92	10.78	1.00	731.17
264709	04-21-92	10.79	1.00	731.44
264709	04-22-92	11.09	1.00	731.45
264709	08-13-92	11.18	1.00	731.18
264709	12-09-92	11.19	1.00	731.18
264709	04-07-93	11.22	1.00	731.15

Data associated with calibrations on 4-15, 4-21, 4-22-92, were not converted to water levels. Data are missing on 4-21 and 4-22-92, due to conversion of the site from a 21X data logger to a DCP.

Lower interval:

Seven calibrations, with one transducer, were performed during 1992. In addition, calibrations on 10-9-91 and 1-28-93 were used to calculate water-level altitudes at the beginning and end of 1992. Results of the calibrations and measured water-level altitudes obtained during the calibrations are as follows:

Transducer serial number	Calibration date	Slope (mV/m)	Coefficient of determination (r^2)	Water-level altitude (meters)
264707	10-09-91	11.15	1.00	752.25
264707	02-04-92	11.15	1.00	753.59
264707	02-04-92	11.29	1.00	753.59
264707	04-21-92	11.18	1.00	754.10
264707	04-22-92	11.70	1.00	754.14
264707	08-13-92	11.38	1.00	755.08
264707	10-02-92	11.33	1.00	755.49
264707	10-02-92	11.61	1.00	755.49
264707	01-28-93	11.46	1.00	756.13

Data associated with calibrations on 2-4, 4-21, 4-22-92, were not converted to water levels. Data missing on 4-21 and 4-22-92 due to conversion of the site from a 21X data logger to a DCP. Spikes on 6-28 and 6-29-92 are associated with earthquakes near Landers, California, and Little Skull Mountain, Nevada.

Water-level altitudes

Upper interval:

Water-level altitudes for well USW H-3, upper interval, ranged from 731.05 to 731.47 m above sea level in 1992 (fig. 29). The mean water-level altitude for 1992 was 731.23 m above sea level. Mean monthly water-level altitudes are listed in table 35.

Table 35. Mean monthly water-level altitudes, 1992, for well USW H-3, upper interval

Month	Water-level altitude (meters, above sea level)	Number of missing daily means
January	731.27	1
February	731.26	1
March	731.25	0
April	731.24	4
May	731.30	0
June	731.31	0
July	731.23	0
August	731.20	1
September	731.19	0
October	731.18	1
November	731.15	0
December	731.21	1

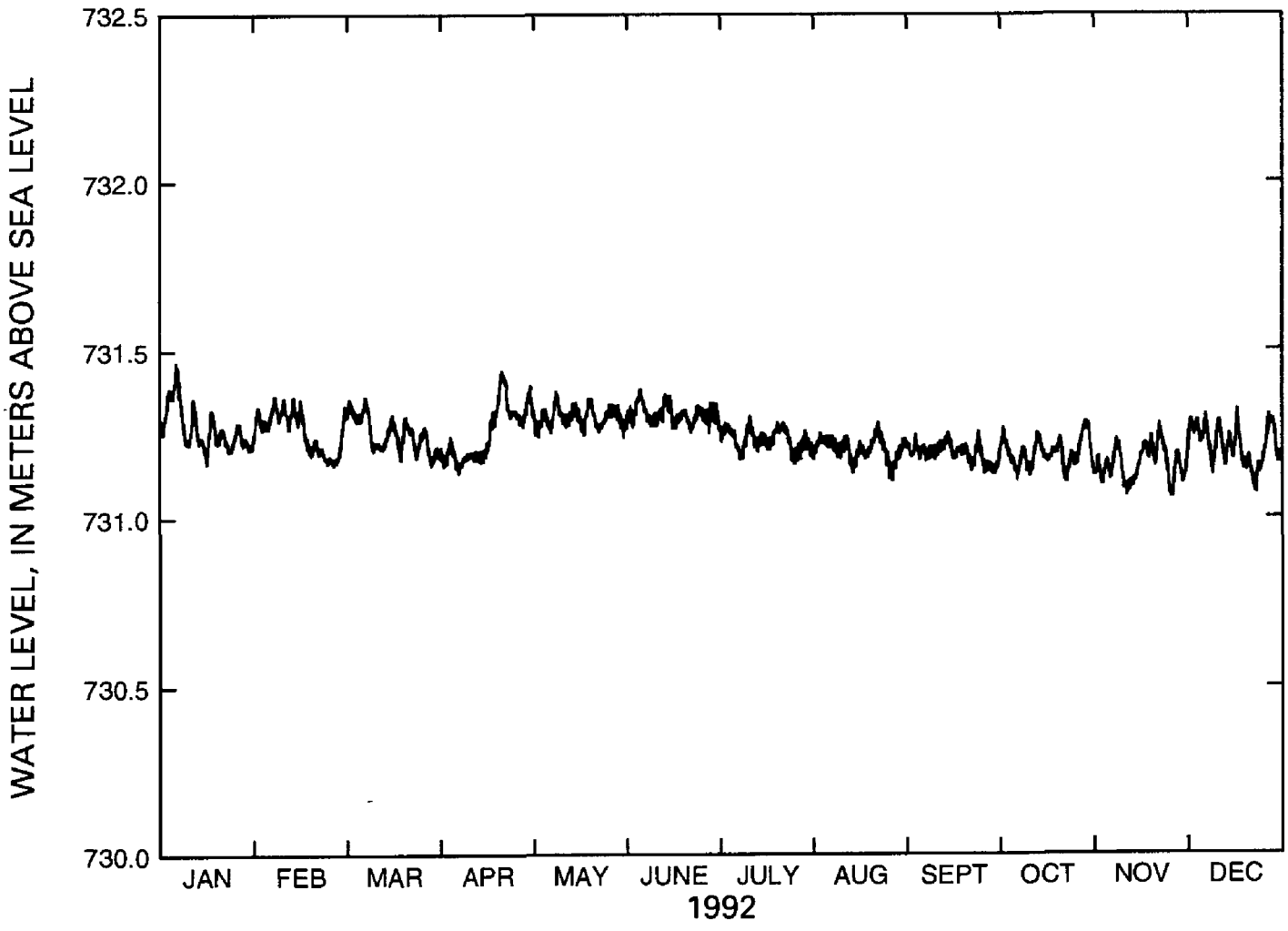

Figure 29. Water-level altitudes, 1992, for well USW H-3, upper interval.

Lower interval:

Water-level altitudes for well USW H-3, lower interval, ranged from 753.13 to 756.05 m above sea level in 1992 (fig. 30). The mean water-level altitude for 1992 was 754.70 m above sea level. Mean monthly water-level altitudes are listed in table 36.

The inflatable packer which divides the well into two intervals was moved to a different location on December 14, 1990. The water level in the lower interval has been rising, in the process of reaching equilibration, to a new static water level since that time.

Table 36. Mean monthly water-level altitudes, 1992, for well USW H-3, lower interval

Month	Water-level altitude (meters, above sea level)	Number of missing daily means
January	753.37	1
February	753.68	1
March	753.90	0
April	754.05	3
May	754.32	0
June	754.54	0
July	754.90	0
August	755.10	1
September	755.34	0
October	755.50	1
November	755.69	0
December	755.91	1

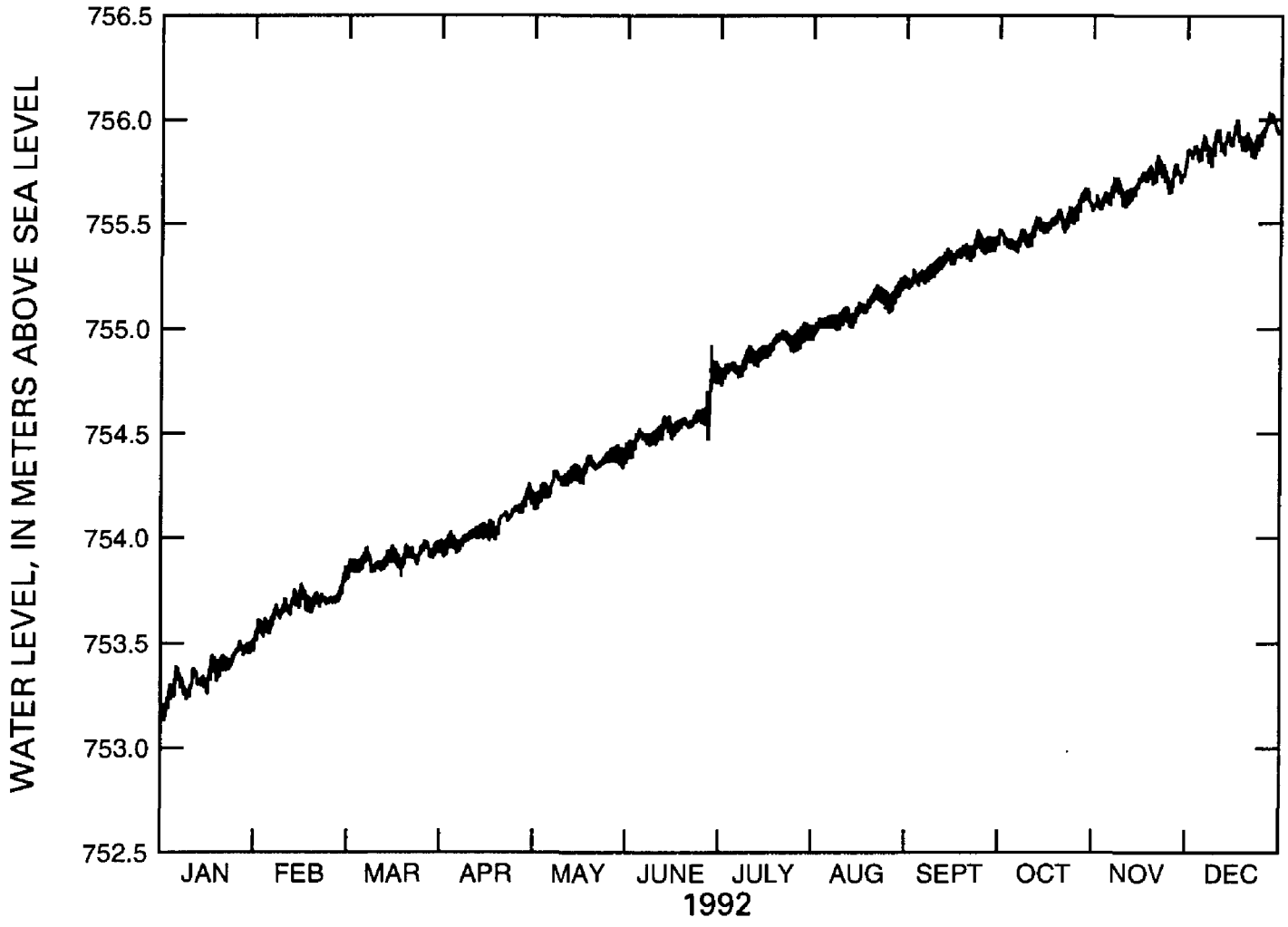

Figure 30. Water-level altitudes, 1992, for well USW H-3, lower interval.

Well USW H-4

Information about the history of well USW H-4 and about previous data from the well was obtained from various sources. These sources are: Whitfield and others (1984); Whitfield and others (1985); Robison (1984, 1986); Robison and others (1988); Erickson and Waddell (1985); and Fenix & Scisson, Inc. (1987a, 1987c).

Well specifications

1. Location and identification:

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

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

   U.S. Geological Survey Site ID's:
   365032116265401 (entire well).
   365032116265402 (upper interval).
   365032116265403 (lower interval).

2. Drilling and casing information:

   Well started: March 22, 1982.

   Well completed: June 7, 1982.

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

   Bit diameter below water level: 375 mm to 564 m; 222 mm from 564 m to 1219 m.

   Casing extending below water level: 253 mm diameter to 561 m, perforated below the water level.

   Total drilled depth: 1,219 m.

3. Access to and description of interval for measuring water levels:

   48-mm inside diameter open ended tubing, extending from land surface to depth of 525 m; upper interval of well near water table to top of inflatable packer within Prow Pass, Bullfrog, and Tram Members of Crater Flat Tuff, bedded tuff, and upper Lithic Ridge Tuff;
   Site ID: 365032116265402.

   62-mm inside diameter tubing with inflatable packer on bottom end, extending from surface to 1,188 m; lower interval of well, within Lithic Ridge Tuff; Site ID: 365032116265403.

4. Information for calculating water-level altitude:

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

   Measuring point: Top of access tubes, 0.597 m, upper interval; 0.308 m, lower interval.

   Depth correction for borehole deviation from vertical: 0.064 m, based on approximate depth to water of 518 m.

Calibrations and comments

Upper interval:

Seven calibrations, with one transducer, were performed during 1992. In addition, calibrations on 12-11-91 and 4-8-93 were used to calculate water-level altitudes at the beginning and end of 1992. Results of the calibrations and measured water-level altitudes obtained during the calibrations are as follows:

Transducer serial number	Calibration date	Slope (mV/m)	Coefficient of determination (r^2)	Water-level altitude (meters)
356013	12-11-91	11.21	1.00	730.54
356013	01-10-92	6.41	1.00	730.46
356013	01-10-92	11.14	1.00	730.46
356013	05-05-92	11.14	1.00	730.46
356013	05-05-92	11.14	1.00	730.46
356013	08-25-92	11.14	1.00	730.39
356013	12-11-92	11.18	1.00	730.46
356013	12-11-92	11.18	1.00	730.46
356013	04-08-93	11.14	1.00	730.38

Data from 1-1 to 1-10-92 were not valid due to a resistor failure in the DCP. Spikes on 1-17, 6-19, 6-20, 6-21, 6-22, 6-23, 6-28, 6-29, 7-2, 7-5, 8-11, and 12-11 were not considered valid. Data are missing on 6-2 and 6-3-92 due to a data-collection error. Spikes on 6-28 and 6-29-92 are associated with earthquakes near Landers, California, and Little Skull Mountain, Nevada. Transducer data from 7-8-92 to 7-15-92 were erratic and not considered reliable. No data are available from 12-8 to 12-11-92 due to DCP problems.

Lower interval:

Seven calibrations, with three transducers, were performed during 1992. In addition, a calibration on 12-12-91 was used to calculate water-level altitudes at the beginning of 1992. Results of the calibrations and

measured water-level altitudes obtained during the calibrations are as follows:

Transducer serial number	Calibration date	Slope (mV/m)	Coefficient of determination (r^2)	Water-level altitude (meters)
356011	12-12-91	11.66	0.99	730.58
2384DH	01-22-92	11.36	1.00	730.58
465894	02-13-92	11.35	1.00	730.70
465894	05-05-92	11.26	1.00	730.55
465894	05-05-92	11.27	1.00	730.55
465893	06-03-92	11.14	1.00	730.55
465893	08-25-92	11.26	1.00	730.51
465893	12-10-92	11.24	1.00	730.49
473980	12-10-92	11.23	1.00	730.49

Data for the following periods were not considered valid due to erratic transducers: 1-1 to 1-21-92, 2-5 to 2-13-92, 5-28 to 6-3-92, 6-7 to 6-10-92, 12-5 to 12-9-92, and 12-20 to 12-31-92. Spikes on the following dates were considered invalid: 5-11, 5-16, 5-17, 5-27, 6-4, 6-11, 6-23, 8-20, and 12-4-92. The spike on 6-28-92 is associated with earthquake near Landers, California.

Water-level altitudes

Upper interval:

Water-level altitudes for well USW H-4, upper interval, ranged from 730.27 to 730.59 m above sea level in 1992 (fig. 31). The mean water-level altitude for 1992 was 730.45 m above sea level. Mean monthly water-level altitudes are listed in table 37.

Table 37. Mean monthly water-level altitudes, 1992, for well USW H-4, upper interval

Month	Water-level altitude (meters, above sea level)	Number of missing daily means
January	730.46	12
February	730.49	1
March	730.51	0
April	730.47	1
May	730.47	1
June	730.49	9
July	730.46	11
August	730.44	2
September	730.42	0
October	730.41	0
November	730.38	0
December	730.41	6

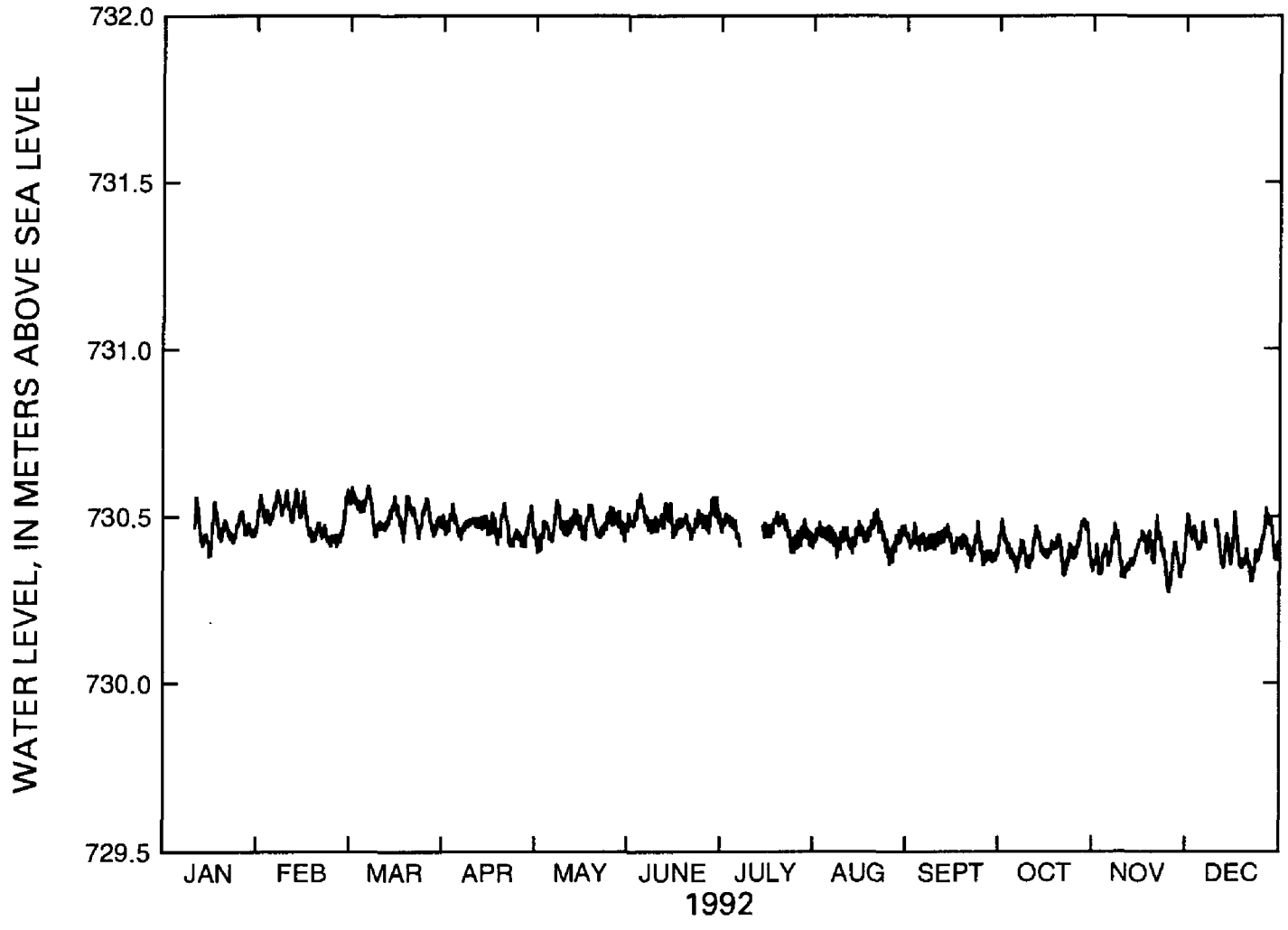

Figure 31. Water-level altitudes, 1992, for well USW H-4, upper interval.

Lower interval:

Water-level altitudes for well USW H-4, lower interval, ranged from 730.37 to 730.88 m above sea level in 1992 (fig. 32). The mean water-level altitude for 1992 was 730.58 m above sea level. Mean monthly water-level altitudes are listed in table 38.

Table 38. Mean monthly water-level altitudes, 1992, for well USW H-4, lower interval

Month	Water-level altitude (meters, above sea level)	Number of missing daily means
January	730.60	22
February	730.59	9
March	730.62	0
April	730.57	1
May	730.59	9
June	730.69	10
July	730.65	0
August	730.58	2
September	730.56	0
October	730.53	0
November	730.49	0
December	730.51	20

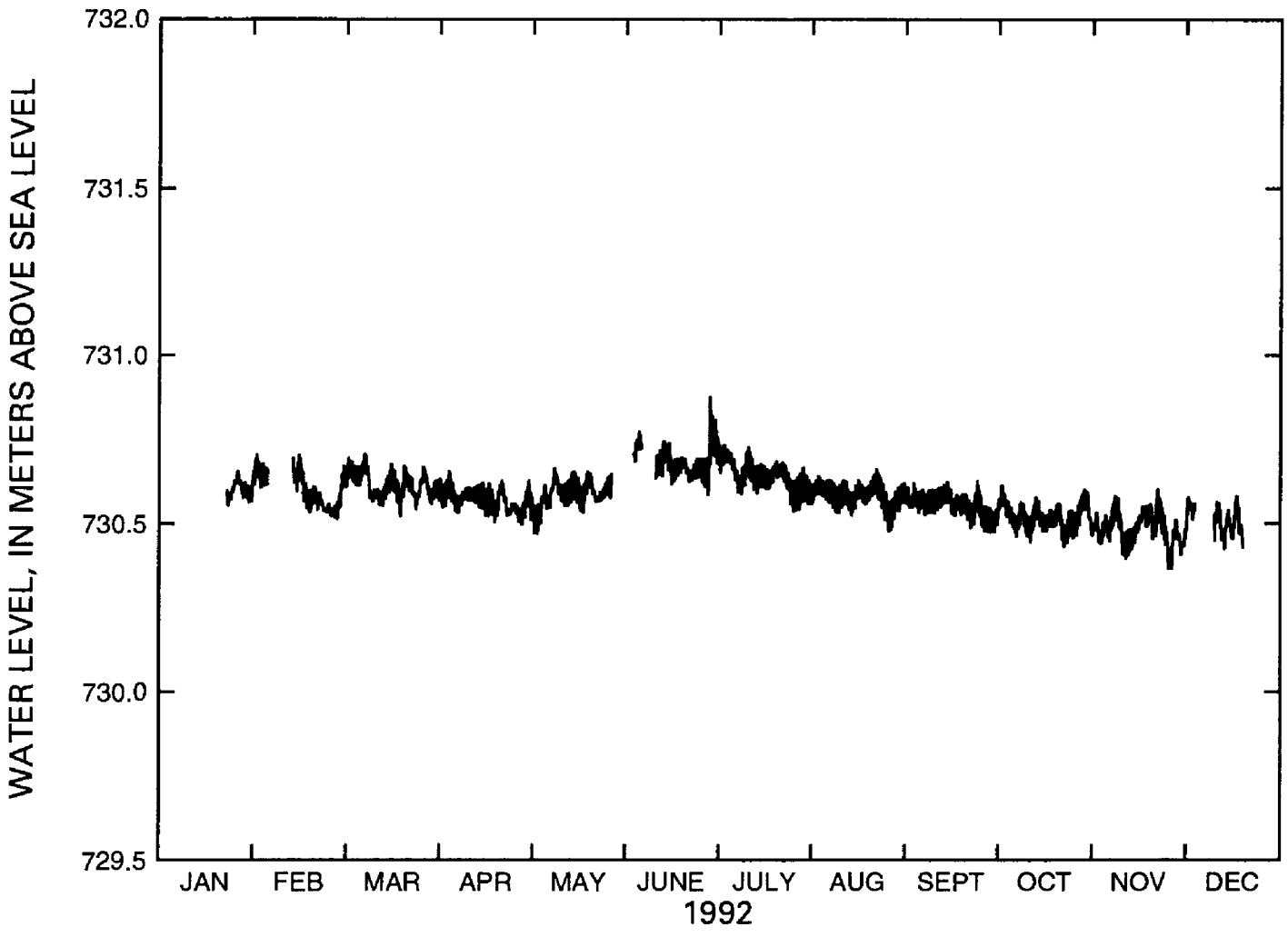

Figure 32. Water-level altitudes, 1992, for well USW H-4, lower interval.

Well USW H-5

Information about the history of well USW H-5 and about previous data from the well was obtained from various sources. These sources are: Bentley and others (1983); Robison (1984, 1986); Robison and others (1988); and Fenix & Scisson, Inc. (1987a, 1987c).

Well specifications

1. Location and identification:

   Latitude and longitude: 36°51'22"N.; 116°27'55"W.

   Nevada State Central Zone Coordinates (m): N 233,670; E 170,355.

   U.S. Geological Survey Site ID's:
   365122116275501 (entire well).
   365122116275502 (upper interval).
   365122116275503 (lower interval).

2. Drilling and casing information:

   Well started: May 19, 1982.

   Well completed: August 1, 1982.

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

   Bit diameter below water level: 375 mm to 792 m; 222 mm from 792 m to 1,219 m.

   Casing extending below water level: 255 mm diameter to 788 m, perforated below the water level.

   Total drilled depth: 1,219 m.

3. Access to and description of interval for measuring water levels:

   48-mm inside-diameter open-ended tubing, extending from land surface to a depth of 708 m; upper saturated interval of borehole within Bullfrog and Tram Members of Crater Flat Tuff, bedded tuff, and unnamed lava beneath the Tram Member (Carr, 1988, p.37);
   Site ID: 365122116275502.

   62-mm inside-diameter tubing that has an inflatable packer on bottom end, extending from land surface to 1,091 m; lower interval within unnamed lava beneath the Tram Member of Crater Flat Tuff (Carr, 1988, p.37);
   Site ID: 365122116275503.

4. Information for calculating water-level altitude:

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

   Measuring point: Top of access tubes, 0.329 m, upper interval; 0.235 m, lower interval.

   Depth correction for borehole deviation from vertical: 0.079 m, based on approximate depth to water of 703 m.

Calibrations and comments

Upper interval:

Nine calibrations, with two transducers, were performed during 1992. In addition, calibrations on 11-13-91 and 1-20-93 were used to calculate water-level altitudes at the beginning and end of 1992. Results of the calibrations and measured water-level altitudes obtained during the calibrations are as follows:

Transducer serial number	Calibration date	Slope (mV/m)	Coefficient of determination (r^2)	Water-level altitude (meters)
308827	11-13-91	11.12	0.99	775.45
308827	01-15-92	11.25	1.00	775.55
308827	01-15-92	11.31	1.00	775.55
308827	03-17-92	11.26	1.00	775.71
308827	03-17-92	11.21	1.00	775.71
308827	04-28-92	11.23	1.00	775.59
308827	04-29-92	11.18	1.00	775.64
308827	07-07-92	11.21	1.00	775.62
308827	09-14-92	6.23	0.99	775.68
506116	09-21-92	11.18	1.00	775.63
506116	01-20-93	11.24	1.00	775.63

A continuous analog-chart recorder was installed on 3-17-92, which allowed fluctuations caused by seismic waves to be monitored. No data are available on 4-28 and 4-29-92, due to transducer calibrations and equipment problems. The spike on 6-28-92 is associated with the earthquake near Landers, California. Data are considered unreliable due to an erratic transducer from 8-31 to 9-20-92. The spike associated with calibration on 9-21-92 was not converted to water levels.

Lower interval:

Nine calibrations, with two transducers, were performed during 1992. In addition, a calibration on 12-11-91 was used to calculate water-level altitudes at

the beginning of 1992. Results of the calibrations and measured water-level altitudes obtained during the calibrations are as follows:

Transducer serial number	Calibration date	Slope (mV/m)	Coefficient of determination (r^2)	Water-level altitude (meters)
2382DH	12-11-91	11.24	1.00	775.66
2382DH	01-16-92	11.13	1.00	775.60
2382DH	01-16-92	11.26	1.00	775.60
258084	02-25-92	11.16	1.00	775.54
258084	03-17-92	11.23	1.00	775.64
258084	03-17-92	11.18	1.00	775.64
258084	04-29-92	11.24	0.99	775.54
258084	04-29-92	11.18	0.99	775.54
258084	07-07-92	11.32	1.00	775.61
258084	09-03-92	11.10	1.00	775.55

Data are considered unreliable due to an erratic transducer from 2-13 to 2-25-92. Data associated with transducer calibration on 3-17-92 were not converted to water levels. An air-inflated small-diameter packer was installed immediately above the transducer, which was set four feet below water surface in the access tube on 3-17-92. This configuration allowed fluid pressures, rather than free-water surface, to be monitored. A continuous analog-chart recorder was installed at the same time as the small-diameter packer, which allowed fluctuations caused by seismic waves to be monitored. Data are missing on 4-28 and 4-29-92, due to calibration of transducers and problems with moving the small-diameter packer. The spike on 6-28-92 is associated with the earthquake near Landers, California. The transducer and packer became stuck while being removed from access tube on 9-3-92, and no data were collected in this interval for remainder of year.

Water-level altitudes

Upper interval:

Water-level altitudes for well USW H-5, upper interval, ranged from 775.40 to 775.83 m above sea level in 1992 (fig. 33). The mean water-level altitude for 1992 was 775.65 m above sea level. Mean monthly water-level altitudes are listed in table 39.

Six major earthquakes caused measurable water-level fluctuations in well USW H-5, upper interval, during 1992. Hourly water-level monitoring generally will not record the effects of short-term fluctuations caused by earthquakes. However, an hourly water-level measurement, taken as seismic waves associated with the Landers, California earthquake on 6-28-92, were causing fluctuations, resulting in the minimum yearly water level. The earthquake-induced fluctuations had stopped by the following hourly measurement. A more complete record of the water-level fluctuations, caused by all six earthquakes, were recorded on a continuous analog-chart recorder. Detailed descriptions of these fluctuations are given in O'Brien (1992 and 1993).

Lower interval:

Water-level altitudes recorded by hourly monitoring for well USW H-5, lower interval, ranged from 775.36 to 775.84 m above sea level in 1992 (fig. 34). The mean water-level altitude for 1992 was 775.55 m above sea level. Mean monthly water-level altitudes are listed in table 40.

Six major earthquakes caused measurable water-level fluctuations in well USW H-5, lower interval, during 1992. Hourly water-level monitoring generally will not record the effects of short-term fluctuations caused by earthquakes. However, an hourly water-level measurement, taken as seismic waves associated with the Landers, California earthquake on 6-28-92, were causing fluctuations, resulting in the maximum yearly water level. The earthquake-induced fluctuations were insignificant at the following hourly measurement. The small-diameter packer, installed in the lower interval access tube, provided increased sensitivity to seismic waves (O'Brien, 1992). A more complete record of the water-level fluctuations, caused by all six earthquakes, were recorded on a continuous analog-chart recorder, and detailed descriptions of the fluctuations are given in O'Brien (1992 and 1993).

The small-diameter packer and transducer became stuck in the access tube while it was being removed from the well on 9-3-92. Water-level data were not collected for the remainder of the year in the lower interval.

The general water-level trends in USW H-5, lower interval, during 1992 are uncharacteristic due to the apparent drift, or unexplained, long-term trends that are present. Water levels in wells in the Yucca Mountain area generally follow the long-term trend of barometric pressure; however, water levels in the lower interval of well USW H-5 did not follow these long-term trends. Whether these trends are an artifact of a malfunctioning transducer or are real, has not been conclusively determined. However, given the information available to ascertain the validity of the transducer data, the water levels are considered valid, largely due to a lack of information that would deem them invalid.

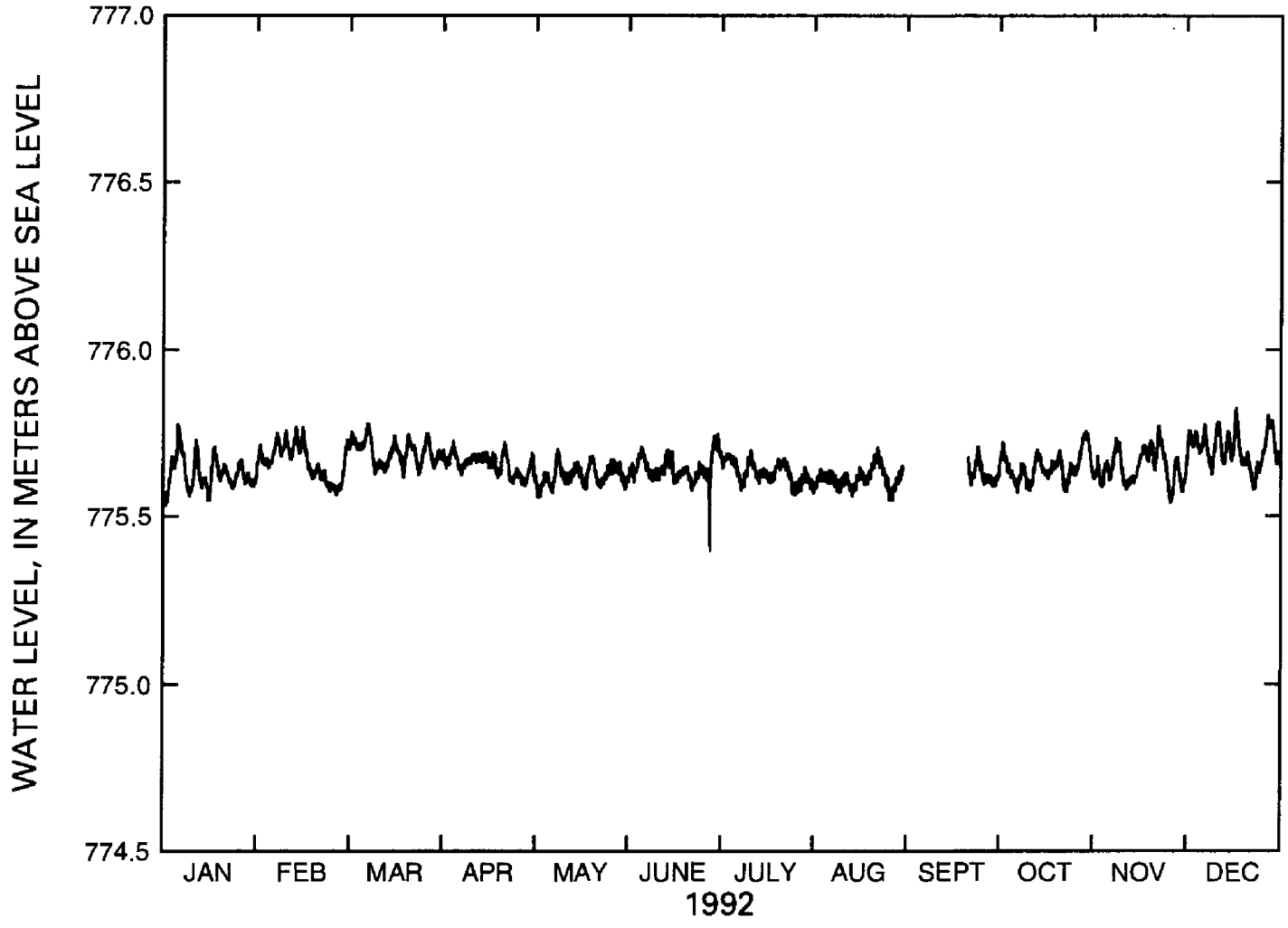

Figure 33. Water-level altitudes, 1992, for well USW H-5, upper interval.

Table 39. Mean monthly water-level altitudes, 1992, for well USW H-5, upper interval

Month	Water-level altitude (meters, above sea level)	Number of missing daily means
January	775.63	2
February	775.67	2
March	775.70	2
April	775.66	4
May	775.62	0
June	775.64	1
July	775.64	1
August	775.61	0
September	775.63	21
October	775.65	3
November	775.65	2
December	775.70	0

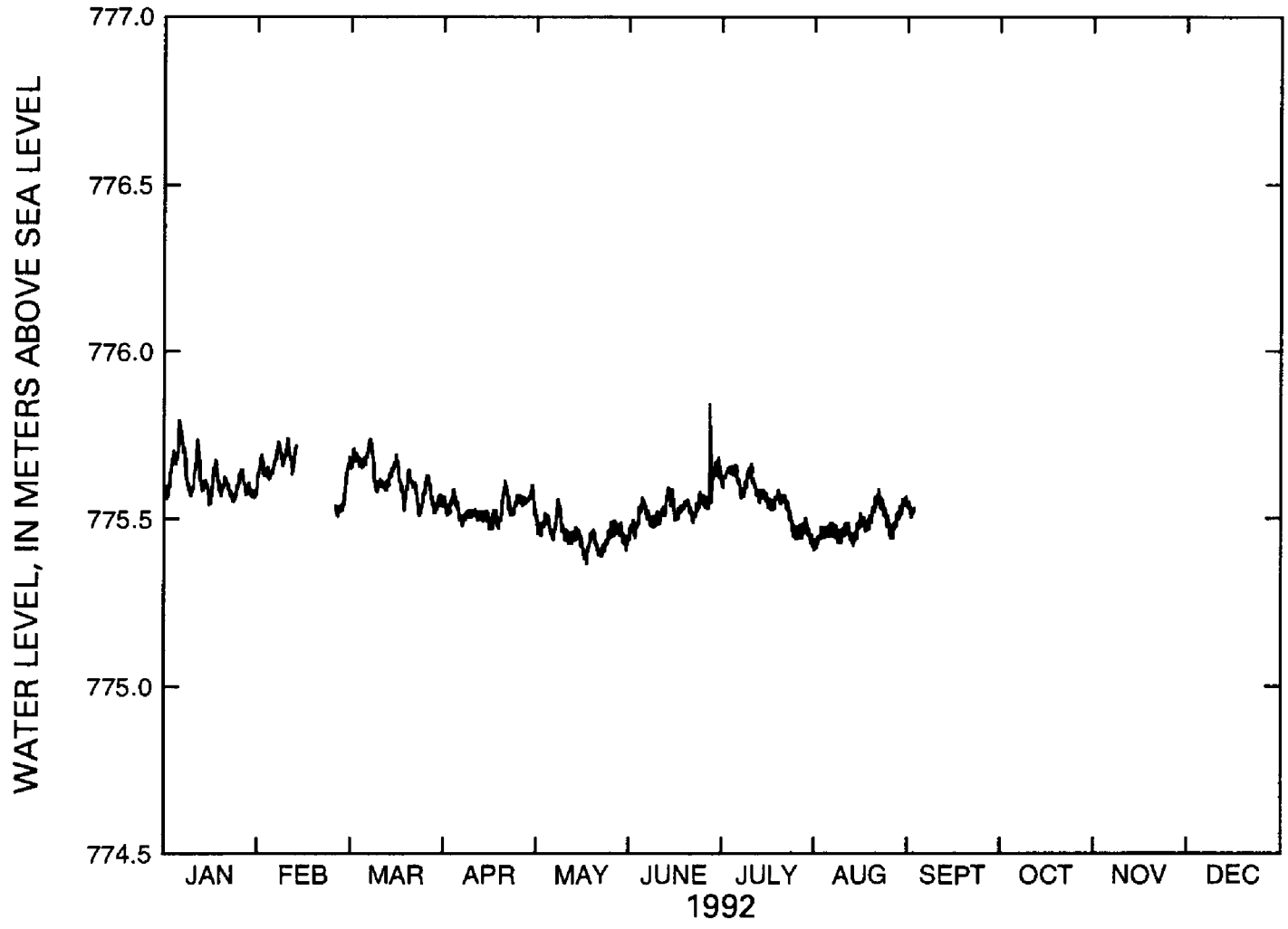

Figure 34. Water-level altitudes, 1992, for well USW H-5, lower interval.

Table 40. Mean monthly water-level altitudes, 1992, for well USW H-5, lower interval

Month	Water-level altitude (meters, above sea level)	Number of missing daily means
January	775.62	2
February	775.65	14
March	775.61	2
April	775.53	4
May	775.45	0
June	775.53	1
July	775.56	1
August	775.48	0
September	775.53	28

Well USW H-6

Information about the history of well USW H-6 and about previous data from the well was obtained from various sources. These sources are: Craig and others (1983); Robison (1984, 1986); Robison and others (1988); and Fenix & Scisson, Inc. (1987a, 1987c).

Well specifications

1. Location and identification:

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

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

   U.S. Geological Survey Site ID's:
   365049116285501 (entire well).
   365049116285504 (upper interval).
   365049116285505 (lower interval).

2. Drilling and casing information:

   Well started: August 7, 1982.

   Well completed: October 28, 1982.

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

   Bit diameter below water level: 375 mm to 583 m; 222 mm from 583 to 1,216 m; 156 mm from 1,216 m to 1,220 m.

   Casing extending below water level: 250-mm diameter to 581 m, perforated below the water level.

   Total drilled depth: 1,220 m.

3. Access to and description of interval for measuring water levels:

   48-mm inside diameter open-ended tubing, extending from land surface to 533 m; saturated upper interval within Prow Pass, Bullfrog, and Tram Members of Crater Flat Tuff, and bedded tuff; Site ID: 365049116285504.

   62-mm inside diameter tubing with inflatable packer on bottom end, extending from land surface to 752 m; lower interval within Tram Member of Crater Flat Tuff, bedded tuff, unnamed lava between Tram Member and Lithic Ridge Tuff (Carr, 1988, p. 37) and Lithic Ridge Tuff; Site ID: 365049116285505.

4. Information for calculating water-level altitude:

   Reference point: Top of metal tag on well casing; altitude 1,302.06 m (surveyed by U.S. Geological Survey, 1984).

   Measuring point: Top of access tubes, 0.207 m, upper interval; 0.235 m, lower interval.

   Depth correction for borehole deviation from vertical: 0.052 m, based on approximate depth to water of 526 m.

Calibrations and comments

Upper interval:

Seven calibrations, with two transducers, were performed during 1992. In addition, calibrations on 10-30-91 and 3-2-93 were used to calculate water-level altitudes at the beginning and end of 1992. Results of the calibrations and measured water-level altitudes obtained during the calibrations are as follows:

Transducer serial number	Calibration date	Slope (mV/m)	Coefficient of determination (r^2)	Water-level altitude (meters)
265667	10-30-91	11.05	1.00	775.93
265667	02-10-92	11.11	1.00	776.01
265667	04-30-92	11.18	1.00	776.04
265667	04-30-92	11.23	1.00	776.04
255365	05-06-92	11.20	1.00	776.02
255365	07-08-92	11.33	1.00	775.96
255365	11-04-92	11.29	1.00	776.01
255365	11-04-92	11.30	1.00	776.01
255365	03-02-93	11.30	1.00	776.02

A continuous analog-chart recorder was installed on 4-30-92, which allowed fluctuations caused by seismic waves to be monitored. Transducer data were erratic and considered unreliable from 5-2 to 5-6-92. The transducer failed and an ending calibration was not possible. The spike on 6-28-92 is associated with the earthquake near Landers, California. Data are missing on 7-8 and 7-9-92, due to transducer calibrations at the well. Data are also missing from 7-10 to 7-13-92, due to a data-collection error. The spike on 12-21-92 was not considered valid.

Lower interval:

Eight calibrations, with two transducers, were performed during 1992. In addition, calibrations on 10-30-91 and 3-2-93 were used to calculate water-level altitudes at the beginning and end of 1992. Results of

the calibrations and measured water-level altitudes obtained during the calibrations are as follows:

Transducer serial number	Calibration date	Slope (mV/m)	Coefficient of determination (r^2)	Water-level altitude (meters)
266870	10-30-91	11.21	1.00	775.84
266708	02-10-92	11.32	1.00	775.89
266708	03-18-92	11.24	1.00	775.96
266708	03-18-92	11.27	1.00	775.96
266708	04-30-92	11.20	1.00	775.98
266708	04-30-92	11.27	0.99	775.98
266708	07-08-92	11.27	1.00	775.89
266708	11-04-92	11.27	1.00	775.97
506114	11-04-92	11.20	1.00	775.97
506114	03-02-93	11.28	1.00	775.97

Data are missing on 5-5 and 5-6-92, due to loss of power to the data logger. An air-inflated small-diameter packer was installed, immediately above the transducer, which was set four feet below water surface in the access tube on 4-30-92. This configuration allowed fluid pressures, rather than free-water surface, to be monitored. A continuous analog-chart recorder was installed at the same time as the small-diameter packer, which allowed fluctuations caused by seismic waves to be monitored. The spikes on 6-28 and 6-29-92 are associated with earthquakes near Landers, California, and Little Skull Mountain, Nevada. Transducer data on 6-28 and 6-29-92 required an adjustment of +31 cm due to a change in the set point on 6-28-92. The force of the seismic waves generated by the Landers earthquake moved the small-diameter packer and transducer 31 cm up the access tube, changing the set point. The water level and amount of set point change were determined by tagging the water surface with the transducer on 6-29-92. The transducer continued to function properly after the earthquakes as documented by successful calibration on 7-8-92. Data are missing from 7-8 to 7-13-92, due to transducer calibration and data-collection error. Transducer calibrations on 11-4-92 resulted in several hours of missing data.

Water-level altitudes

Upper interval:

Water-level altitudes for well USW H-6, upper interval, ranged from 775.87 to 776.18 m above sea level in 1992 (fig. 35). The mean water-level altitude for 1992 was 776.02 m above sea level. Mean monthly water-level altitudes are listed in table 41.

Three major earthquakes caused measurable water-level fluctuations in well USW H-6, upper interval, during 1992. Hourly water-level monitoring generally will not record the effects of short-term fluctuations caused by earthquakes. However, an hourly water-level measurement, taken as seismic waves associated with the Landers, California earthquake on 6-28-92, were causing fluctuations, resulted in a sudden decrease in water level. The earthquake-induced fluctuations were insignificant at the following hourly measurement. A more complete record of the water-level fluctuations, caused by all three earthquakes, were recorded on a continuous analog-chart recorder, and detailed descriptions of the fluctuations are given in O'Brien (1993).

Lower interval:

Water-level altitudes for well USW H-6, lower interval, ranged from 775.72 to 776.26 m above sea level in 1992 (fig. 36). The mean water-level altitude for 1992 was 775.93 m above sea level. Mean monthly water-level altitudes are listed in table 42.

Three major earthquakes caused measurable water-level fluctuations in well USW H-6, lower interval, during 1992. Hourly water-level monitoring generally will not record the effects of short-term fluctuations caused by earthquakes. However, hourly water-level measurements, taken as seismic waves associated with the Landers, California, and Little Skull Mountain, Nevada earthquakes on 6-28 and 6-29-92, were causing fluctuations, resulting in sudden increases in water level. The earthquake-induced fluctuations were insignificant at the following hourly measurement. The small-diameter packer, installed in the lower interval access tube, provided increased sensitivity to seismic waves (O'Brien, 1992). A more complete record of the water-level fluctuations, caused by all three earthquakes, were recorded on a continuous analog-chart recorder, and detailed descriptions of the fluctuations are given in O'Brien (1993).

The general water-level trends in USW H-6, lower interval, during 1992 are uncharacteristic due to the apparent drift, or unexplained, long-term trends that are present. Water levels in wells in the Yucca Mountain area generally follow the long-term trend of barometric pressure; however, the water levels in the lower interval of well USW H-6 did not follow these long-term trends. Whether these trends are an artifact of a malfunctioning transducer or are real, has not been conclusively determined. However, given the information available to ascertain the validity of the transducer data, the water levels are considered valid, largely due to a lack of information that would deem them invalid.

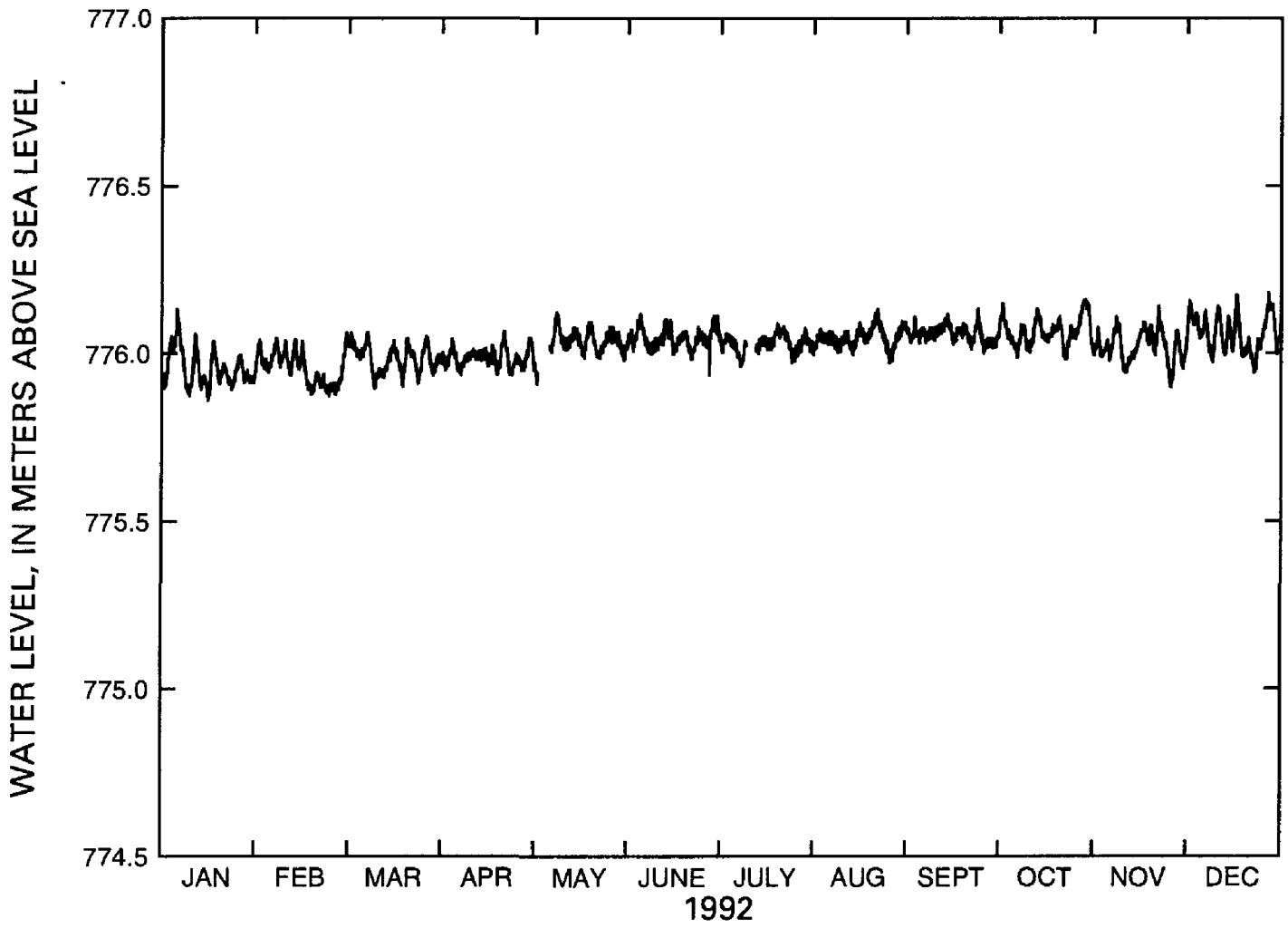

Figure 35. Water-level altitudes, 1992, for well USW H-6, upper interval.

Table 41. Mean monthly water-level altitudes, 1992, for well USW H-6, upper interval

Month	Water-level altitude (meters, above sea level)	Number of missing daily means
January	775.96	0
February	775.96	1
March	775.99	1
April	775.99	2
May	776.04	5
June	776.05	1
July	776.04	6
August	776.05	0
September	776.06	0
October	776.07	1
November	776.02	1
December	776.06	1

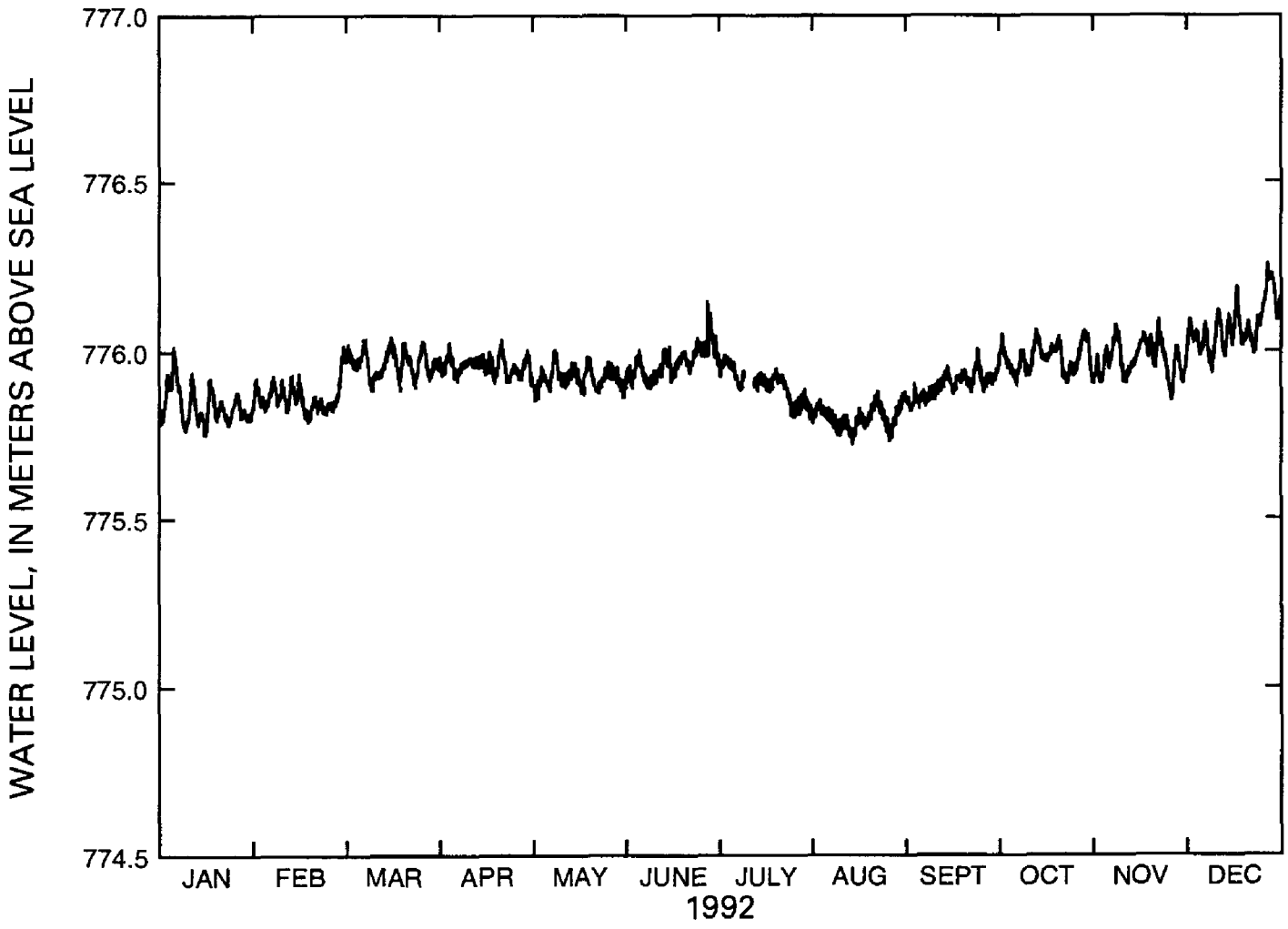

Figure 36. Water-level altitudes, 1992, for well USW H-6, lower interval.

Table 42. Mean monthly water-level altitudes, 1992, for well USW H-6, lower interval

Month	Water-level altitude (meters, above sea level)	Number of missing daily means
January	775.85	0
February	775.87	1
March	775.97	1
April	775.96	2
May	775.93	2
June	775.97	1
July	775.90	6
August	775.80	0
September	775.90	0
October	775.98	1
November	775.98	1
December	776.07	0

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