

Hydrologic Activities of the U.S. Geological Survey in Support of the Radionuclide Migration Program, Nevada Test Site and Vicinity, Nye County, Nevada, Fiscal Year 1987

By William B. Scott

U.S. GEOLOGICAL SURVEY

Open-File Report 90-105

Prepared in cooperation with the

U.S. DEPARTMENT OF ENERGY
(Interagency Agreement
DE-AI08-86-NV10583)



Carson City, Nevada
1990

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CONVERSION FACTORS AND ABBREVIATIONS

"Inch-pound" units of measure used in this report may be converted to International System (metric) units by using the following factors:

<i>Multiply</i>	<i>By</i>	<i>To obtain</i>
foot (ft)	0.3048	meter (m)
inch (in.)	25.40	millimeter (mm)
gallon per minute (gal/min)	0.0630	liter per second (L/s)
mile (mi)	1.609	kilometer (km)

SEA LEVEL

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

Hydrologic Activities of the U.S. Geological Survey in Support of the Radionuclide Migration Program, Nevada Test Site and Vicinity, Nye County, Nevada, Fiscal Year 1987

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ABSTRACT

Hydrologic activities during the 1987 fiscal year by the U.S. Geological Survey in support of the Radionuclide Migration Program at the Nevada Test Site are summarized in this report. These activities included monitoring ground-water levels; compiling and entering geohydrologic data into the U.S. Geological Survey computerized ground-water data base; providing technical support to the Radionuclide Migration Committee and the Containment Evaluation Panel; and the planning, drilling, and sampling of the UE20n-1 hole.

Ground-water levels were monitored continuously at 2 wells and intermittently at 36 selected wells, test holes, and emplacement holes. Selected monthly water-level measurements are listed for the continuously monitored wells and intermittent measurements are listed for the selected wells, test holes, and emplacement holes. Progress continued on four ground-water hydrology reports of the Nevada Test Site area.

INTRODUCTION

The U.S. Geological Survey, Desert Research Institute (DRI), Los Alamos National Laboratory (LANL), and Lawrence Livermore National Laboratory (LLNL) are the principal participating organizations that provide services and technical expertise to the Nevada Operations Office (NV) of the U.S. Department of Energy (DOE) in support of the Radionuclide Migration (RNM) Program at the Nevada Test Site (NTS) (figure 1). The purpose of the RNM Program is to study the mechanisms by which radionuclides produced by underground nuclear tests move through the geologic media underlying the NTS, and the extent of that movement. The specific responsibility of the Geological Survey, in support of the DOE-RNM Program, is to provide the necessary hydrologic and geohydrologic data and the interpretation of these data to aid in characterizing the regional and local ground-water flow systems underlying the NTS. This characterization is needed to assess the potential for radionuclide migration.

The purpose of this report is to summarize the hydrologic activities of the Geological Survey during the 1987 fiscal year in support of the RNM Program at the NTS. Specifically, the report contains: (1) hydrologic descriptions and tables of water levels measured intermittently at selected wells, test holes, and emplacement holes; (2) hydrologic descriptions and tables of selected monthly water-level measurements for wells monitored continuously at active radionuclide-migration study sites; and (3) a description of major technical support efforts and the status of reports in preparation related to the RNM Program.

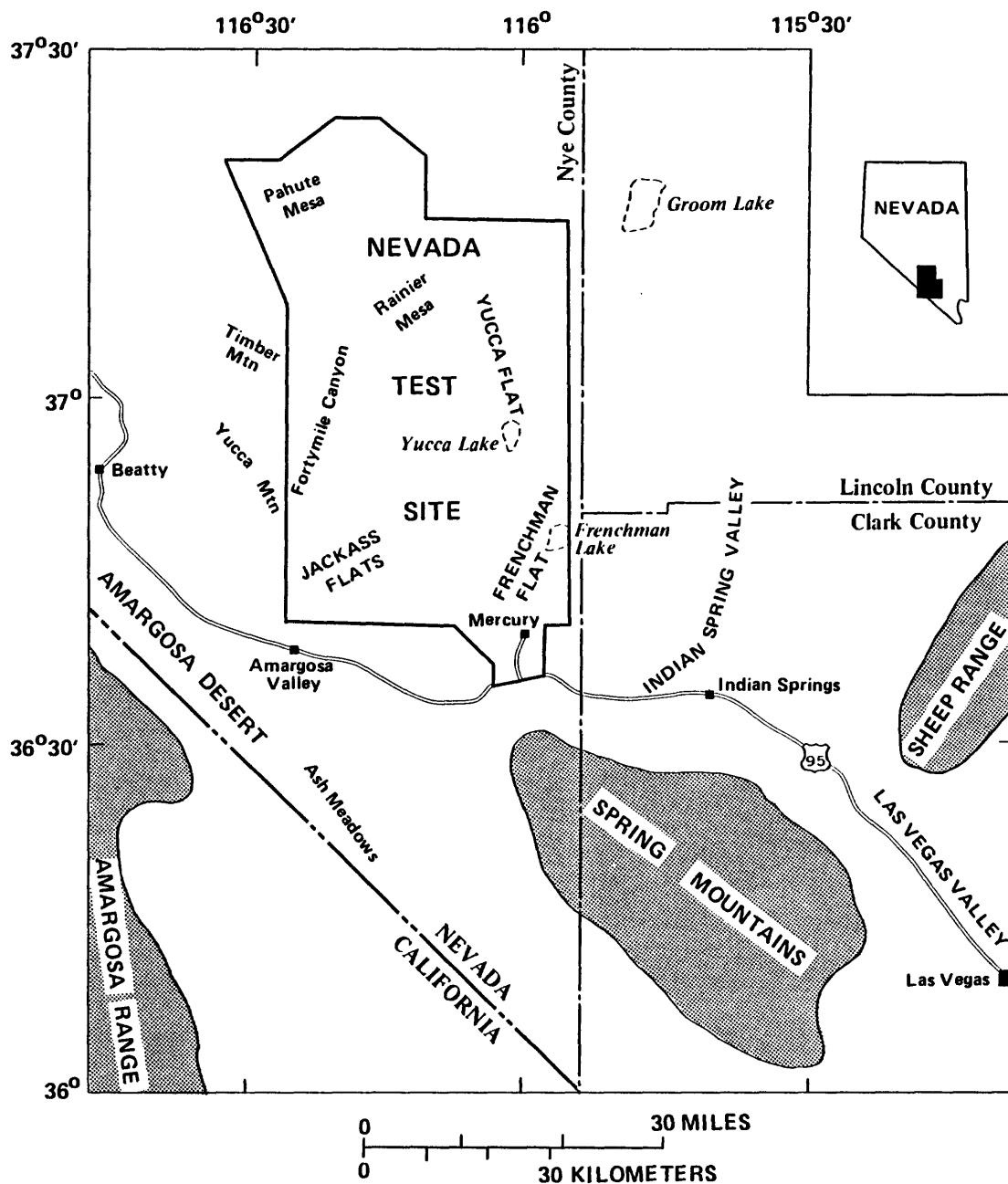


FIGURE 1.—Nevada Test Site and other features in southern Nevada. Modified from Doty and Rush, 1985, figure 1.

HYDROLOGIC ACTIVITIES

The U.S. Geological Survey Project Office in Las Vegas, Nev., provided hydrologic and geohydrologic expertise and support to the RNM Program by monitoring ground-water levels; compiling and entering geohydrologic data into a computerized ground-water data base for analysis and interpretation; providing hydrologic support to the RNM Program Committee and the Containment Evaluation Panel; the planning, drilling, and sampling of the U20n downgradient hole (UE20n-1); and preparing technical publications of data and interpretative results.

The following sections of this report summarize the Geological Survey's hydrologic activities and document ground-water levels measured in support of the RNM Program for the 1987 fiscal year.

Monitoring Ground-Water Levels

Measurements of ground-water levels are needed to characterize the ground-water flow system underlying the NTS. The configuration of the water table and distribution of hydraulic head beneath the water table must be defined to determine ground-water flow paths and rates. Ground-water levels were monitored by the Geological Survey at the NTS by making depth-to-water measurements in selected wells, test holes, and emplacement holes. Each well, test hole, and emplacement hole has been assigned an index number for cross-referencing between figure 2 and the tables. The depth-to-water measurements, taken either intermittently or continuously, are used in determining the water-table configuration, the direction and rate of ground-water flow, local and regional ground-water level fluctuations, and in evaluating site location and containment aspects of underground nuclear explosions.

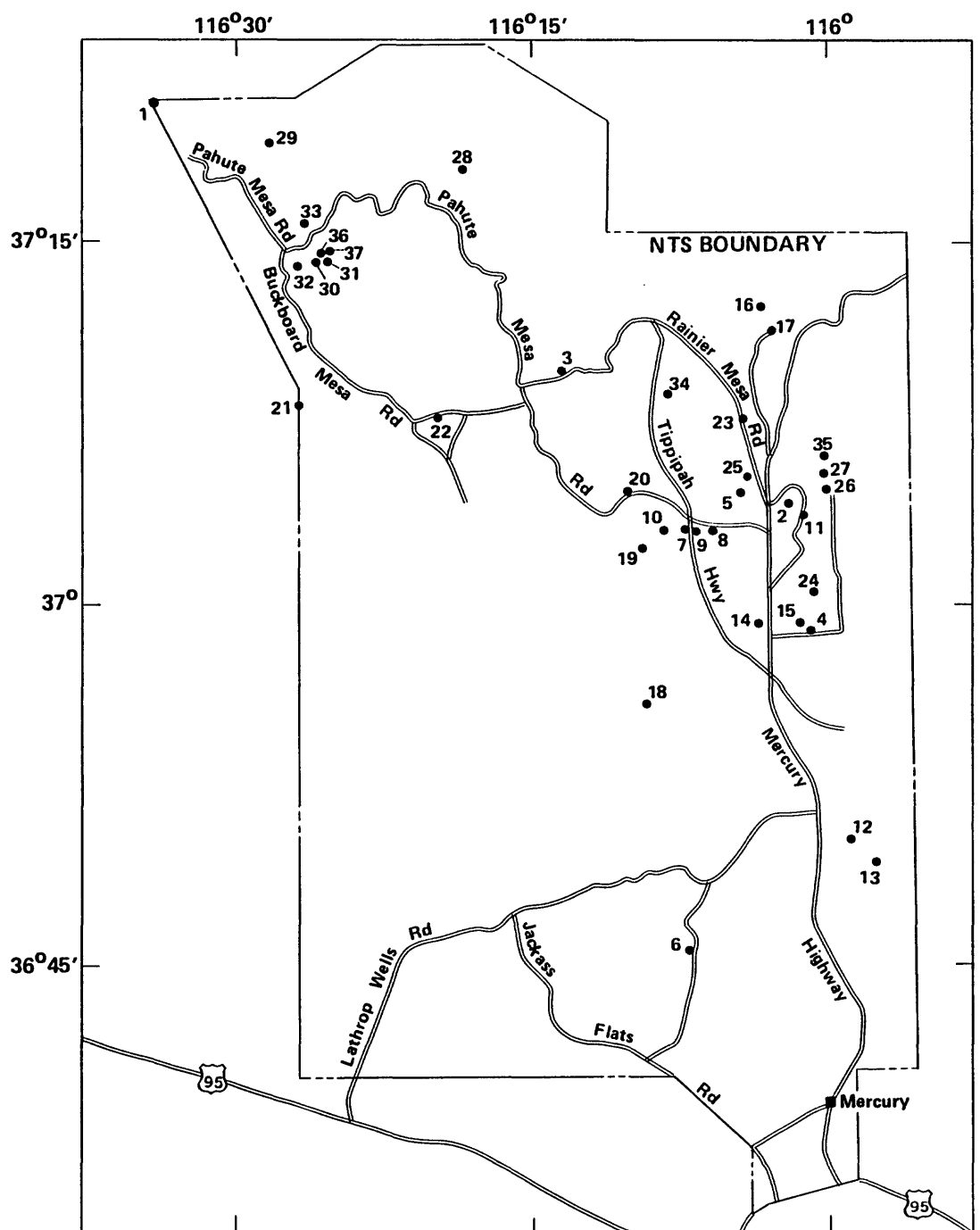
Selected Wells and Holes

Ground-water level measurements were collected annually from a network of 22 selected wells and holes. This network is used to monitor fluctuations in ground-water levels and includes all known open and accessible wells and holes at the NTS. The period of measurement shown in table 1 is from May 8, 1987, to August 18, 1987, and the measured water levels ranged from 366.5 to 1,849.1 feet below land surface.

Weapons-Testing Emplacement and Test Holes

Water-level data collected from weapons-testing emplacement and test holes are used specifically in the site selection and the containment evaluation processes associated with the underground nuclear-testing program. Most of these holes are accessible only for very short periods of time. Depth-to-water measurements were made frequently in accessible holes until a near-static water-level condition was achieved; then, measurements were made at a decreasing frequency until the holes were no longer accessible. These measurements provide new data to aid specifically in evaluating the location and containment of proposed weapons tests and in defining the regional ground-water flow system underlying the NTS.

Table 2 shows water-levels measured in 11 emplacement and test holes for the period of measurement from December 8, 1986, to September 23, 1987. The measured water levels ranged from 1,533.6 to 2,152.5 feet below land surface.



EXPLANATION

16. WELL, EMPLACEMENT HOLE, OR TEST HOLE—Map index number is indicated

0 10 MILES
0 10 KILOMETERS

FIGURE 2.—Selected wells, emplacement holes, and test holes on the Nevada Test Site.

TABLE 1.--Water levels measured in selected wells
and test holes

(Water level, in feet below land-surface datum)

Map index number	Site identification	Date	Water level
1	Pahute Mesa		
	Exploration Hole #2	June 16, 1987	850.4
2	Test Hole 7	May 12, 1987	1,616.8
3	Test Well 1	Aug. 18, 1987	1,467.3
4	Test Well B	July 14, 1987	1,505.3
5	Test Well D	July 22, 1987	1,722.3
6	Test Well F	July 02, 1987	1,733.9
7	UE1a	July 24, 1987	544.8
8	UE1c	July 24, 1987	643.8
9	UE1b	July 24, 1987	1,296.2
10	UE11	July 24, 1987	517.8
11	U3cn5	May 08, 1987	1,624.2
12	UE5c	Aug. 11, 1987	810.4
13	UE5n	July 24, 1987	705.6
14	UE6d	May 18, 1987	1,514.9
15	UE6e	June 04, 1987	1,514.9
16	UE10ITS-1	July 30, 1987	(a)
17	UE10ITS-3	July 30, 1987	1,849.1
18	UE14b	Aug. 03, 1987	1,664.9
19	UE16f	July 22, 1987	366.5
20	UE17a	July 24, 1987	638.2
21	UE18r	June 25, 1987	1,366.0
22	UE18t	July 02, 1987	914.8

^a Dry (approximate well depth, 1,220 feet).

TABLE 2.--Water levels measured in weapons-testing emplacement and test holes
(Water level, in feet below land-surface datum)

Map index number	Site identification	Date	Water level	Map index number	Site identification	Date	Water level
23	U2gf	Mar. 20, 1987	1,777.1	30	U20av	Dec. 08, 1986	2,075.4
		Mar. 23, 1987	1,777.1				
		Mar. 24, 1987	1,778.9	31	UE20av	Dec. 08, 1986	2,016.1
		Mar. 25, 1987	1,777.2			Dec. 09, 1986	2,074.5
						Dec. 11, 1986	2,116.1
		Mar. 26, 1987	1,776.3			Dec. 15, 1986	2,129.5
		Mar. 30, 1987	1,774.5			Dec. 17, 1986	2,128.8
		May 13, 1987	1,775.1			Jan. 15, 1987	2,128.4
		June 24, 1987	1,774.1				
24	U3kv	May 08, 1987	1,533.6	32	U20ax	Aug. 31, 1987	2,050.8
25	U4au	Sep. 11, 1987	1,642.5			Sep. 01, 1987	2,052.5
		Sep. 17, 1987	1,640.2			Sep. 02, 1987	2,053.9
26	U7ca	Apr. 07, 1987	1,701.8			Sep. 08, 1987	2,060.1
		May 13, 1987	1,702.7			Sep. 11, 1987	2,062.1
27	U7cb	Apr. 07, 1987	1,785.9	33	U20ay	Sep. 17, 1987	2,064.5
		May 13, 1987	1,785.9			Sep. 23, 1987	2,067.4
28	U19ax	Sep. 11, 1987	2,152.5			June 22, 1987	2,065.6
		Sep. 17, 1987	2,152.1			June 23, 1987	2,064.7
		Sep. 23, 1987	2,152.4			June 24, 1987	2,063.6
29	U20ar-1	Feb. 09, 1987	1,836.8			June 25, 1987	2,063.7
		Mar. 10, 1987	1,841.2			June 26, 1987	2,062.3
		Mar. 16, 1987	1,842.5			July 07, 1987	2,057.7
		Mar. 24, 1987	1,843.6			July 15, 1987	2,057.3
		Mar. 25, 1987	1,842.4			July 20, 1987	2,057.5
						Aug. 06, 1987	2,055.3
						Aug. 18, 1987	2,055.4
						Aug. 24, 1987	2,055.5
						Aug. 31, 1987	2,055.5
						Sep. 01, 1987	2,055.3
						Sep. 11, 1987	2,055.3

Wells for Radionuclide-Migration Projects

Water-level data collected from wells at radionuclide-migration sites aid in the characterization of localized ground-water flow systems, which in turn permit the determination of flow rates and potential travel paths for radioactive materials deposited in the area. For this purpose, data reflecting water-level fluctuations were recorded continuously at the Nash (UE2ce) and Bourbon (UE7nS) satellite wells and intermittently at the Chesire post-shot (U20nPS-1DDH) and downgradient (UE20n-1) wells (figure 2, sites 34-37, respectively) and the Faultless (UC1P2SR) well (figure 3).

Continuous recordings of the ground-water levels were obtained with automatic measuring equipment. Each well was equipped with (1) a calibrated pressure transducer for measuring the water level, (2) a micrologger with a microchip data-storage module for continuous recording of data received from the transducer, and (3) solar panels with storage cells to provide power to operate the transducer and micrologger. The data stored in the microchip data-storage module were converted to depth-to-water measurements. Selected monthly (the 15th day) water-level measurements extracted from the record of continuous measurements for the Nash and Bourbon satellite wells are shown in tables 3 and 4 respectively, and the intermittent measurements for the Chesire post-shot and downgradient wells are shown in tables 5 and 6, respectively.

Nash Satellite Well

On September 8, 1977, the prepumping water level measured in the Nash satellite well (UE2ce; see figure 2, site 34) was 1,407.1 feet below land surface. A comparison of this measurement with that of September 15, 1987, in table 3 indicates a decline of 71.7 feet during this 10-year period. In contrast, the data in table 3 show selected monthly water-level measurements that reflect a net rise of 2.1 feet during the period from October 15, 1986, to September 15, 1987.

TABLE 3.--Selected water-level measurements in the Nash satellite well UE2ce (map index number 34)

(Water level, in feet below land-surface datum)

Date	Water level
Oct. 15, 1986	1,480.9
Nov. 15, 1986	1,481.0
Jan. 15, 1987	1,480.8
Feb. 15, 1987	1,480.6
Mar. 15, 1987	1,480.3
Apr. 15, 1987	1,480.3
May 15, 1987	1,479.9
June 15, 1987	1,479.2
July 15, 1987	1,479.2
Aug. 15, 1987	1,479.0
Sep. 15, 1987	1,478.8

Bourbon Satellite Well

On September 8, 1977, the prepumping water level measured in the Bourbon satellite well (UE7nS; see figure 2, site 35) was 1,968.1 feet below land surface. A comparison of this measurement with that for September 2, 1987, in table 4 indicates a net decline of 1.9 feet during this 10-year period. Selected monthly water-level measurements in table 4 show that the water level in this well was relatively stable from January through August 1987--a period when the well was being pumped. The water level measured on September 2, 1987, reflects the water-level recovery after the pump was turned off. On September 2, 1987, the automatic measuring equipment was removed from well UE7nS because the continuous record was being affected by the periodic pumping. Water-level fluctuations will continue to be monitored, but on an intermittent schedule.

TABLE 4.--Selected water-level measurements in the Bourbon satellite well UE7nS (map index number 35)

(Water level, in feet below land-surface datum)

Date	Water level
Jan. 15, 1987	1,988.0
Feb. 15, 1987	1,986.1
Mar. 15, 1987	1,989.0
Apr. 15, 1987	1,989.5
May 15, 1987	1,989.4
June 15, 1987	1,989.4
July 15, 1987	1,985.9
Aug. 15, 1987	1,986.5
Sept 02, 1987	1,970.0

Cheshire Wells

On April 15, 1981, the water level in post-shot well U20nPS-1DDH (figure 2, site 36) was 2,035 feet below land surface. A comparison of this measurement with that of April 21, 1987, in table 5 indicates a decline of about 7 feet during this 6-year period. Intermittent water-level measurements listed in table 5 show that the water-level in this well was relatively stable from October 1986 to June 1987.

On June 12, 1987, the water level in downgradient well UE20n-1 (figure 2, site 37) was 2,033.6 feet below land surface. A pump with a small discharge capacity was installed in the well during June 1987 to enable the collection of water samples. Intermittent water-level measurements listed in table 6 show that water-level fluctuations were minimal during the period from June to September 1987. On July 9, 1987, the water level declined about 4 feet, as the result of the well having been pumped at approximately 14 gallons per minute for several hours.

TABLE 5.--Selected water-level measurements in well U20nPS-1DDH (map index number 36)

(Water level, in feet below land-surface datum)

Date	Water level
Oct. 23, 1986	2,041.6
Oct. 24, 1986	2,041.6
Dec. 08, 1986	2,039.6
Apr. 21, 1987	2,042.3
Apr. 24, 1987	2,041.9
May 01, 1987	2,039.3
June 01, 1987	2,040.9

TABLE 6.--Selected water-level measurements in well UE20n-1 (map index number 37)

(Water level, in feet below land-surface datum)

Date	Water level
June 12, 1987	2,033.6
June 22, 1987	2,032.3
June 23, 1987	2,032.4
June 24, 1987	2,032.6
July 02, 1987	2,032.4
July 07, 1987	2,032.6
July 09, 1987 (1225 hr)	^a 2,036.2
July 09, 1987 (1227 hr)	2,032.5
Aug 06, 1987	2,033.1
Aug 24, 1987	2,033.1
Sept 01, 1987	2,032.9
Sept 08, 1987	2,033.3
Sept 17, 1987	2,032.5

^a Well being pumped.

Faultless Re-entry Well, Hot Creek Valley

The Faultless re-entry well (UC1P2SR) in central Nevada (figure 3) is the only site in the RNM Program not on the NTS. On July 1, 1987, the water level measured in this well was 917.4 feet below land surface. This is 42.6 feet shallower than in July 1986, but still approximately 352 feet below the estimated preshot water level. The water level has been rising steadily since the Faultless detonation in January 1968.

Geohydrologic Data Base

The computerized Ground-Water Site Inventory (GWSI) data base established and maintained by the Geological Survey is being used for the storage and retrieval of geohydrologic data collected from selected test holes, wells, and emplacement holes drilled at and near the NTS. Historic and current geohydrologic data are being compiled, verified, and stored in the data base. These data represent the foundation for most hydrologic investigations at the NTS and will aid in gaining an increased understanding of ground-water flow rates and directions and the mechanisms of radionuclide migration.

During fiscal year 1987, the Las Vegas staff of the Weapons-Testing Hydrology Program continued sorting and organizing numerous historic hydrologic- and geohydrologic-data files that had accumulated over the past 30 years for the NTS. These files are the main source of information being entered into the computerized data base. Data from recently completed test holes and wells continued to be collected, compiled, verified, and entered into the data base. During FY 1987, several data retrievals were made for the DOE Nevada Operations Office (NV) and other NTS contractors.

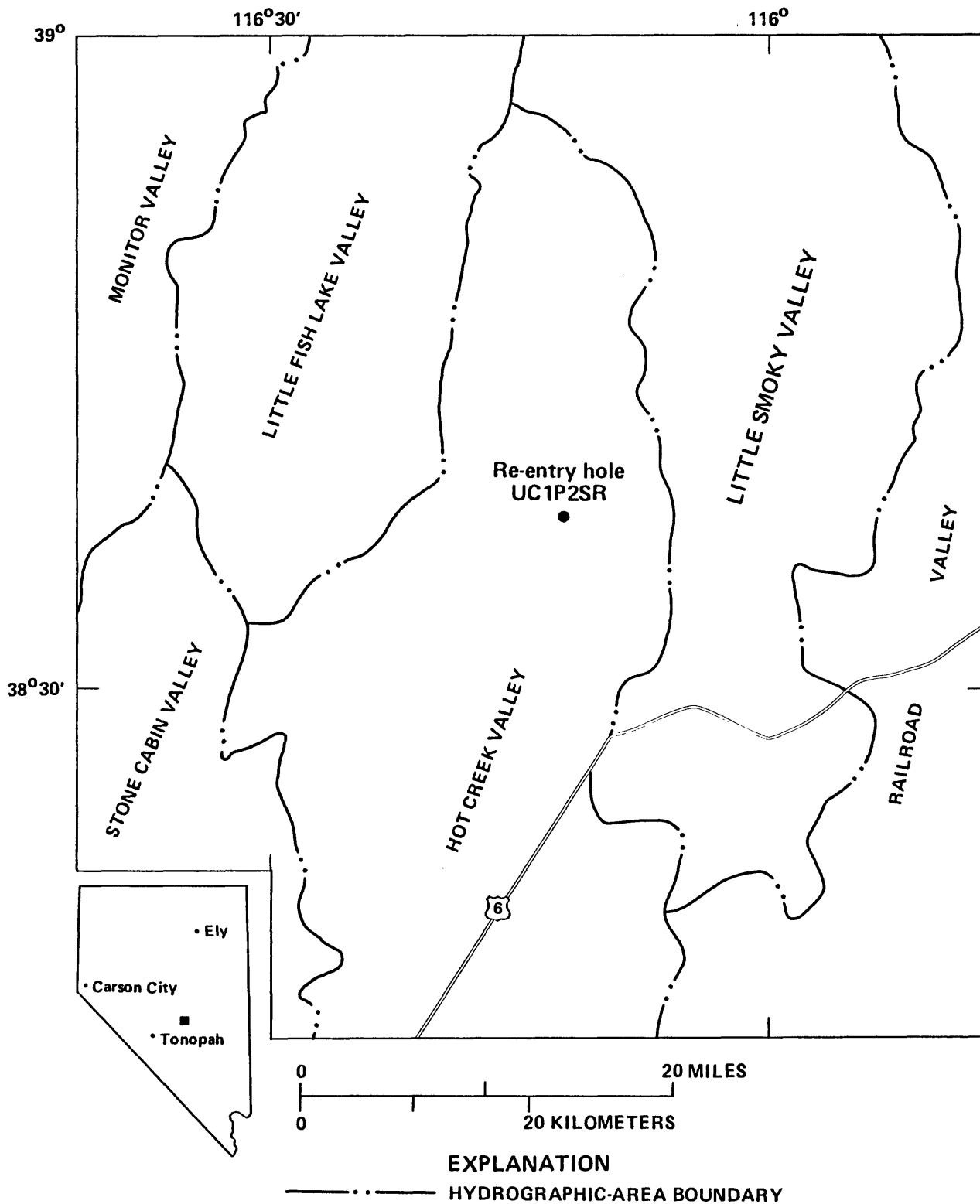


FIGURE 3.—Faultless re-entry hole UC1P2SR in Hot Creek Valley. Modified from Thordarson, 1984, figure 1.

Technical Support

The Geological Survey provided technical support to the DOE-RNM Program by participating on the RNM Program Committee, providing hydrologic expertise to the Containment Evaluation Panel (CEP), and providing hydrologic support during the planning, drilling, and sampling of the U20n downgradient test hole (UE20n-1).

RNM Program Committee

The purpose of the RNM Program Committee, which consists of representatives from the Geological Survey, DOE, DRI, LANL, and LLNL, is to develop, direct, and conduct research associated with radionuclide migration at the NTS. The Geological Survey provided technical support and expertise in the area of hydrology and ground-water hydraulics for the planning, conducting, interpreting, and reviewing of DOE-funded RNM projects. Technical support in the discipline of hydrology also included general consultations with DOE and its contractor personnel, participating on standing and ad-hoc committees, preparing specific reports for inclusion in DOE documents, and completing unprogrammed tasks to assist in the solution of unforeseen problems or concerns when they arose.

Containment Evaluation Panel

The Geological Survey, under Interagency Agreement with DOE, has two specific tasks pertaining to the Containment Evaluation Panel (CEP): (1) The Survey provides two senior geologists as member and alternate member of the CEP, to evaluate containment of each underground nuclear test; and (2) the Survey obtains, analyzes, and presents information and data relating to construction, media properties, geology, and hydrology as a designated observer organization to the CEP.

Hydrologic support to the CEP is provided as part of the technical support efforts for the RNM Program. Specifically, this support includes providing hydrologic expertise in the siting of proposed underground-nuclear tests, reviewing containment document packages, participating in CEP meetings, evaluating geohydrologic data, and conducting site-specific hydrologic investigations at the NTS related to containment evaluation.

During fiscal year 1987, the Geological Survey provided specific hydrologic expertise to LANL by evaluating hydrologic data collected from three holes drilled in the Yucca Flat area (UE4t, UE3e-1, and UE3mf) and developing preliminary plans for making hydraulic tests in test hole UE4t. The data obtained from these holes are being used to analyze the cause of anomalously high ground-water levels in Yucca Flat. The Geological Survey also assisted in the continuous monitoring of water-level fluctuations in UE3e-2 and UE4t to determine the post-shot effects from an underground nuclear explosion. Estimates of depth to water, based on existing maps and data, were provided for the siting of four proposed emplacement holes (U31k, U6g, U6h, and U6i), and two containment document packages were reviewed for hydrologic impact.

The Geological Survey provided assistance in the preparation and review of a technical paper titled, "High Fluid Levels in Drill Holes, Yucca Flat, Nevada Test Site." The paper was presented by David L. Hoover (U.S. Geological Survey, Geologic Division) at the Fourth Symposium on the Containment of Underground Nuclear Explosions, U.S. Air Force Academy, Colorado Springs, Colo., September 21-25, 1987.

UE20n-1 Hole

Hydrologic support and expertise was provided by the Geological Survey to the development of plans and procedures for the drilling, testing, and sampling of the UE20n-1 hole on Pahute Mesa (figure 2, site 37). The purpose of this hole was to determine if radionuclides had migrated upward from the Chesire-event cavity and moved laterally through an upper permeable zone. The Chesire event was detonated in February 1976 at a depth of about 3,850 feet below the land surface, which is about 1,780 feet below the water table. Technical support was provided specifically by (1) assisting in the final review of drilling specifications, (2) assisting in the field locating of the drill site and developing operational logistics for the drilling and sampling operations, (3) serving as the on-site organization responsible for coordination of all field activities associated with drilling and sampling, (4) measuring depth to water in the hole after completion of drilling, (5) assisting in the collection of large-volume water samples at the completion of drilling for analysis by LANL and LLNL, (6) maintaining records of the quantity of water pumped from the well, and (7) collecting water samples at various depth intervals in the hole.

The UE20n-1 hole was drilled approximately 400 feet in the down-gradient direction from the U20nPS-1DDH re-entry well (figure 2, site 36) during the period from May 13 to June 16, 1987. The site was located to minimize the possibility of interactions with transport pathways between the U20nPS-1DDH well and the Chesire event cavity. Selected information on the UE20n-1 hole from Fenix & Scisson data files located in Mercury, Nev., is listed below:

Latitude:	37°14'25"
Longitude:	116°25'19"
Nevada state coordinates:	N 906,545.31 ft; E 571,239.30 ft
Land-surface altitude:	6,460.7 ft above sea level
Total depth:	3,300 ft below land surface
Hole specifications:	13-3/8-in. casing cemented at 192 ft 9-5/8-in. casing cemented at 2,282 ft 12-1/4-in. hole to 2,323 ft 8-3/4-in. hole to 2,407 ft 8-1/2-in. hole to 3,300 ft Bridge plug set at 2,842 ft Pump on 3-1/2-in. tubing set at 2,280 ft 2-3/8-in. monitor line set at 2,304 ft
Logging information:	Fluid density, caliper, electric, gamma ray, gyro, temperature, density, and epithermal neutron.

REPORTS IN PREPARATION

The preparation of hydrologic data and interpretive reports is an important element of the RNM Program. Data reports provide a documentation of field conditions at the NTS and may include ground-water level measurements, water-quality analyses, and geohydrologic and site-characteristic information. Interpretive reports are prepared to describe the geohydrologic conditions at the NTS and how these conditions impact, govern, or interact with the ground-water flow system and the migration of radionuclides. The published reports are provided to the DOE and its contractors, other Federal, State, and local agencies, and private firms. The hydrologic data and interpretive reports provide information that is critical to the long-term management and utilization of the ground-water system in southern Nevada by the NTS and the State of Nevada. Reports in preparation during fiscal year 1987, and their status as of November 1988, are described below:

Hydrologic Atlas of the NTS -- A compilation of historic and recent geohydrologic data collected from selected wells and test holes at the NTS, presented in tabular format. The report has been approved by DOE and the Geological Survey, and is being prepared for publication.

Pahute Mesa ground-water map -- A map showing contours of ground-water altitude for the Pahute Mesa area. The report has received two technical reviews and is being prepared to submit for DOE and Geological Survey approvals.

Yucca Flat ground-water map -- A map showing contours of ground-water altitude for the Yucca Flat area. The text and water-level data were reviewed technically; as a result, the map and text are being revised to include more recent pertinent data and related information.

Hydrologic activities of the U.S. Geological Survey in support of the Hydrology/Radionuclide Migration Program at the NTS, Fiscal Year 1986 -- An annual summary of hydrologic activities made by the Geological Survey during the 1986 fiscal year, in support of the DOE-RNM program at the NTS. The report was approved and a copy sent to DRI to be included in the fiscal year 1986 RNM Annual Summary Report.

REFERENCES CITED

Doty, G.C., and Rush, F.E., 1985, Inflow to a crack in playa deposits of Yucca Lake, Nevada Test Site, Nye County, Nevada: U.S. Geological Survey Water-Resources Investigations Report 84-4296, 24 p.

Thordarson, William, 1984, Hydrologic monitoring at the Faultless site, Nye County, Nevada: U.S. Geological Survey Open-File Report 84-580, 37 p.