Drilling, Construction, Caliper-Log, Aquifer-Test, and Water-Quality Data for Well 8-0437-01, Waiohinu Exploratory Well, Island of Hawaii

By Charles J. Ewart

U.S. GEOLOGICAL SURVEY
Open-File Report 98-644

Prepared in cooperation with the

DEPARTMENT OF WATER SUPPLY
COUNTY OF HAWAII

Honolulu, Hawaii
1998

U.S. DEPARTMENT OF THE INTERIOR

BRUCE BABBITT, Secretary

U.S. GEOLOGICAL SURVEY

Charles G. Groat, Director

For additional information write to:

District Chief
U.S. Geological Survey
677 Ala Moana Blvd., Suite 415
Honolulu, HI 96813

Copies of this report can be purchased from:

U.S. Geological Survey
Branch of Information Services
Box 25286
Denver, CO 80225-0286

CONTENTS

Figures

Tables

Conversion Factors

Multiply	By	To obtain
foot (ft)	0.3048	meter
gallon (gal)	3.785	liter
mile (mi)	1.609	kilometer
inch (in.)	25.4	millimeter

Elevations in this report are referenced to mean sea level.

Specific conductance is given in microsiemens per centimeter (µS/cm) at 25 degrees Celsius. Microsiemens per centimeter is numerically equivalent to micromhos per centimeter.

Drilling, Construction, Caliper-Log, Aquifer-Test, and Water-Quality Data for Well 8-0437-01, Waiohinu Exploratory Well, Island of Hawaii

By Charles J. Ewart

Abstract

The Waiohinu exploratory well (State well number 8-0437-01) was drilled in 1994 about 2,500 feet northwest of the community of Waiohinu. The well is located at a water tank site on County of Hawaii property at an elevation of 1,300 feet. The well, which was drilled into rocks of the Mauna Loa Volcano to a depth of 1,000 feet, encountered a water table at an elevation of 1,016 feet. Well-construction data; geologic, drilling, and caliper logs; and aquifer-test and water-quality data are presented for the well. The well is one of three exploratory wells drilled on the island of Hawaii between September 1994 and April 1995 in cooperation with the County of Hawaii Department of Water Supply.

INTRODUCTION

The Waiohinu exploratory well was the first of three deep exploratory wells drilled on the island of Hawaii between August 1994 and April 1995. These wells were drilled by the U.S. Geological Survey (USGS) as part of a program of exploratory/monitor well drilling carried out in cooperation with the County of Kauai Department of Water, the County of Hawaii Department of Water Supply, and the City and County of Honolulu Board of Water Supply. The program, begun in 1993, is designed to provide hydrologic and geologic information for aquifers in each of the island counties. This information is vital to the understanding of the ground-water systems on each island and for estimating the amount of available ground water.

In addition to providing needed hydrogeologic information, the exploratory wells completed under this program will be used as long-term monitoring wells to provide data and information for the management, protection, and preservation of the ground-water resources. The rotation of the drilling rig between islands and the duration of drilling on each island are determined by the three county water managers. Drilling sites are prioritized and selected jointly by the county water departments and the USGS.

The purpose of the Waiohinu exploratory well was to provide information on the little known ground-water resources of the western part of the Kau District (fig. 1), which is an area that often has water shortage during times of low rainfall. The well was drilled on County of Hawaii property at an elevation of 1,300 ft above sea level, and about 2,500 ft northwest of the community of Waiohinu (fig. 2). Water was encountered at a depth of 284 ft below land surface (1,016 ft above mean sea level) and remained at that level for the duration of the drilling. The extent of this high-level water body and the nature of the impounding structures are not known.

This report presents geohydrologic, aquifer-test, and water-quality data, and the construction details of the well.

Acknowledgments

The USGS gratefully acknowledges the assistance of the Hawaii County Department of Water Supply in site preparation and logistical support throughout the period of well construction and testing. We also acknowledge the cooperation of the Hilo Office, State of Hawaii Division of Land Management and Mr. Walter D. Andrade, landowner and lessee respectively,

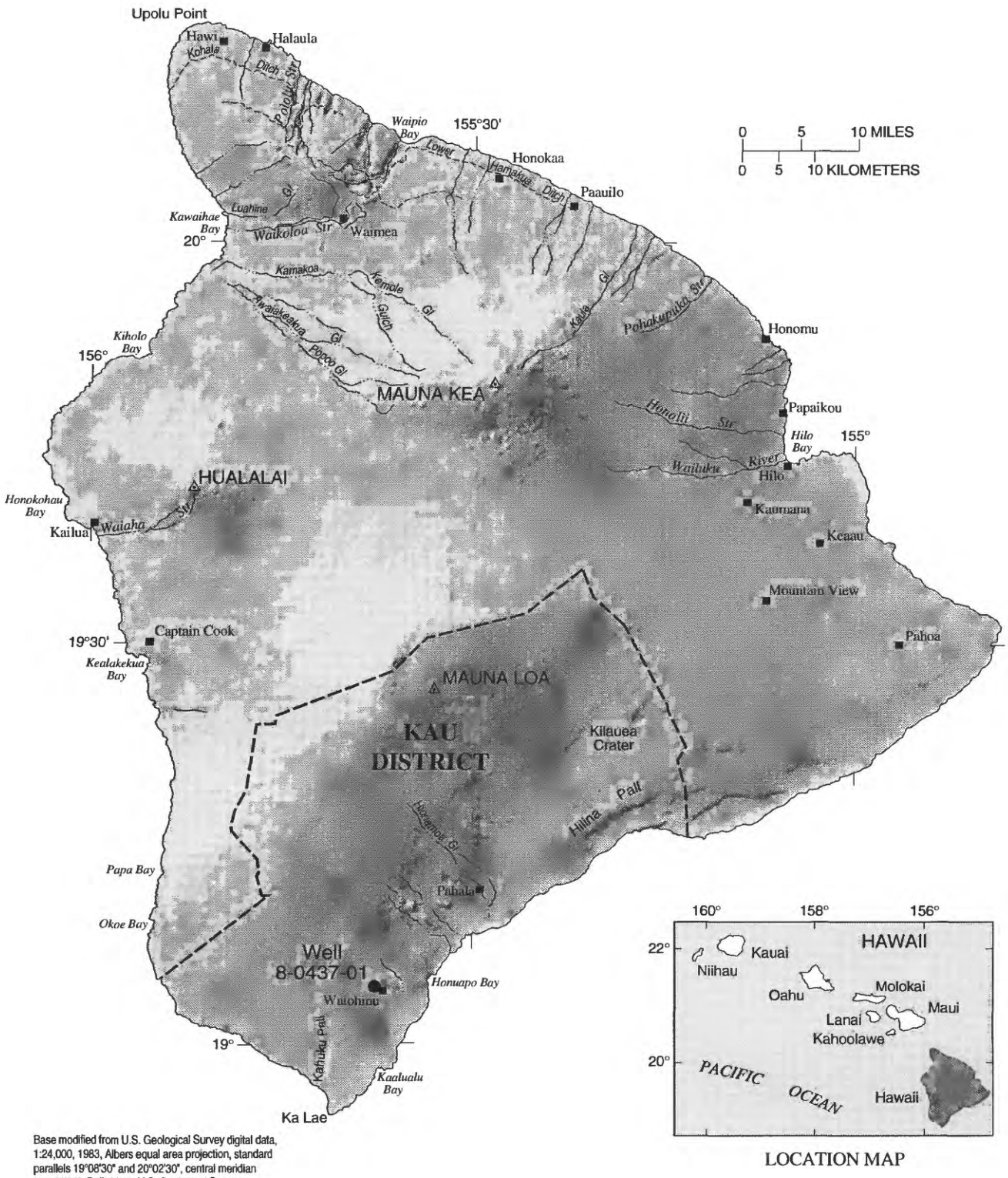


Figure 1. Hawaiian islands, island of Hawaii, and Kau District.

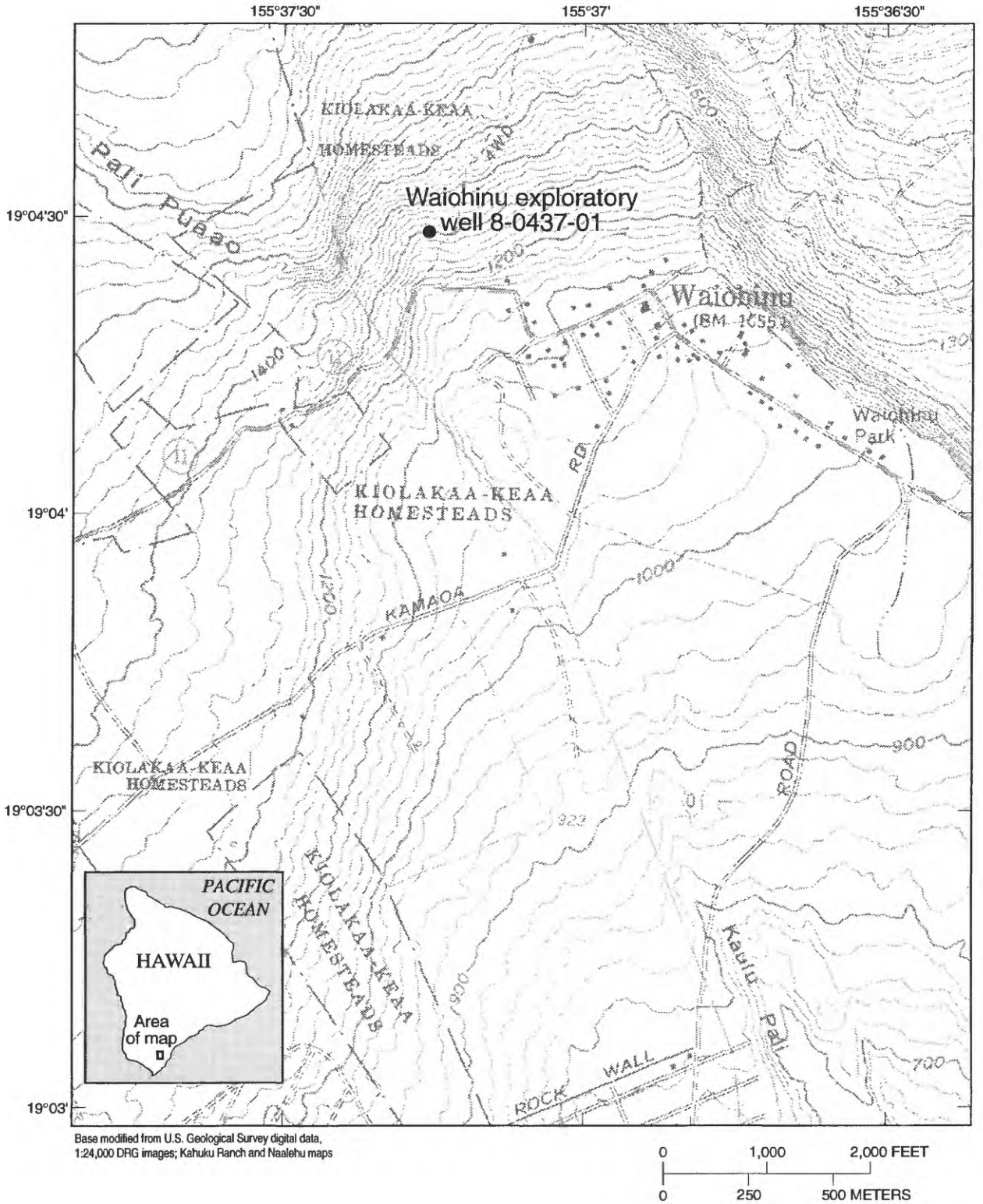


Figure 2. Location of the Waiohinu exploratory well (State well number 8-0437-01), island of Hawaii.

for allowing the USGS to enter and cross their property to provide access to the drilling site.

Setting

The Waiohinu exploratory well (State well number 8-0437-01) is located at the Hawaii County Department of Water Supply storage tank just northeast of the community of Waiohinu on the southern slope of Mauna Loa Volcano in the southwestern part of the Kau District of the island of Hawaii (fig. 2). The Kau District is the largest of the island of Hawaii's nine districts and has a land area of almost 625,000 acres. Elevations within the District range from sea level to 13,700 ft at the summit of Mauna Loa. Average annual rainfall within the District ranges from about 20 in. at the coast near South Point (Ka Lae) to more than 125 in. at the 3,000 ft elevation between Waiohinu and Pahala and about 100 in. at the summit of Kilauea Volcano.

The Kau District consists of rocks from Mauna Loa Volcano which include lava flows and pyroclastic deposits of three volcanic series and rocks from Kilauea Volcano, which consist of lavas and pryoclastics of two volcanic series (fig. 3). The lavas of the Kau Basalt, which make up most of the District, are highly permeable (Stearns and Macdonald, 1946), and no streams within the Kau District reach the sea except after periods of intense rainfall (Davis and Yamanaga, 1966).

GROUND-WATER OCCURRENCE

The occurrence of ground water in the Kau District is described in detail by Stearns and Clark (1930), Stearns and Macdonald (1946), and Davis and Yamanaga (1966 and 1973). The following is a generalized summary from these works for that part of the District formed from rocks from Mauna Loa Volcano.

Within the Kau District, ground water is found as basal water, which is a roughly lens-shaped body of freshwater near sea level floating on seawater, and as high-level ground water, which may be impounded by volcanic dikes or other structures or perched on low-permeability geologic units such as volcanic ash. Recharge to the basal ground-water body is from direct infiltration of rainfall on the permeable land surface, from subsurface discharge of high-level ground-water bodies, and from infiltration of water flowing over permeable rock in stream channels. Recharge to the high-level ground-water body is from direct infiltration of rainfall. Discharge from the basal water body is from springs and seeps visible at the coast or discharging below sea level offshore. Evidence of substantial ground-water flow at the coast is provided by the large discharge at Ninole and Kawaa Springs (fig. 4). Average discharge from these springs is estimated to range between 30 to 50 Mgal/d.

Chloride-ion concentration is about 100 mg/L at Kawaa Springs and ranges between 300 to 400 mg/L at Ninole Springs. Along the coast southwestward from Honuapo to Ka Lae, the visible ground-water discharge decreases and the salinity of the water increases. A dug well near the shore of Waikapuna Bay yielded water with a chloride-ion concentration of about 2,000 mg/L, and at a dug well near Waipouli the chloride-ion concentration was about 1,800 mg/L. Dug wells and a spring at Kaalualu yielded water with a chloride-ion concentration between 2,000 and 3,000 mg/L. High-level ground water is manifested by the occurrence of springs and seeps primarily between Pahala and Waiohinu at elevations between 2,000 and 5,000 ft. The springs are perched in lava flows by intercalated ash beds. The larger springs were developed by horizontal tunneling along the ash layers during the period 1921–30 to provide water for sugarcane fluming from upland fields to the sugar mill at Honuapo. The perched water bodies are irregular and discontinuous because of great variations in the permeability and thickness of the ash layers and the discharge from the development tunnels fluctuates with rainfall. Evidence of a high-level body of ground water was discovered in 1946 when a shaft (8-1128-01) designed to develop basal water encountered water at 228 ft above sea level near Pahala. Subsequently the Hawaii County Department of Water Supply drilled an exploratory well (8-1229-01) near Pahala that encountered water standing 384 ft above sea level.

Most recently, the Waiohinu exploratory well encountered high-level ground water standing at 1,016 ft above sea level. The extent of both of these high-level ground-water bodies and the nature of the impounding structures is not known. A summary of drilled wells in the Kau District compiled from existing records is shown in table 1.

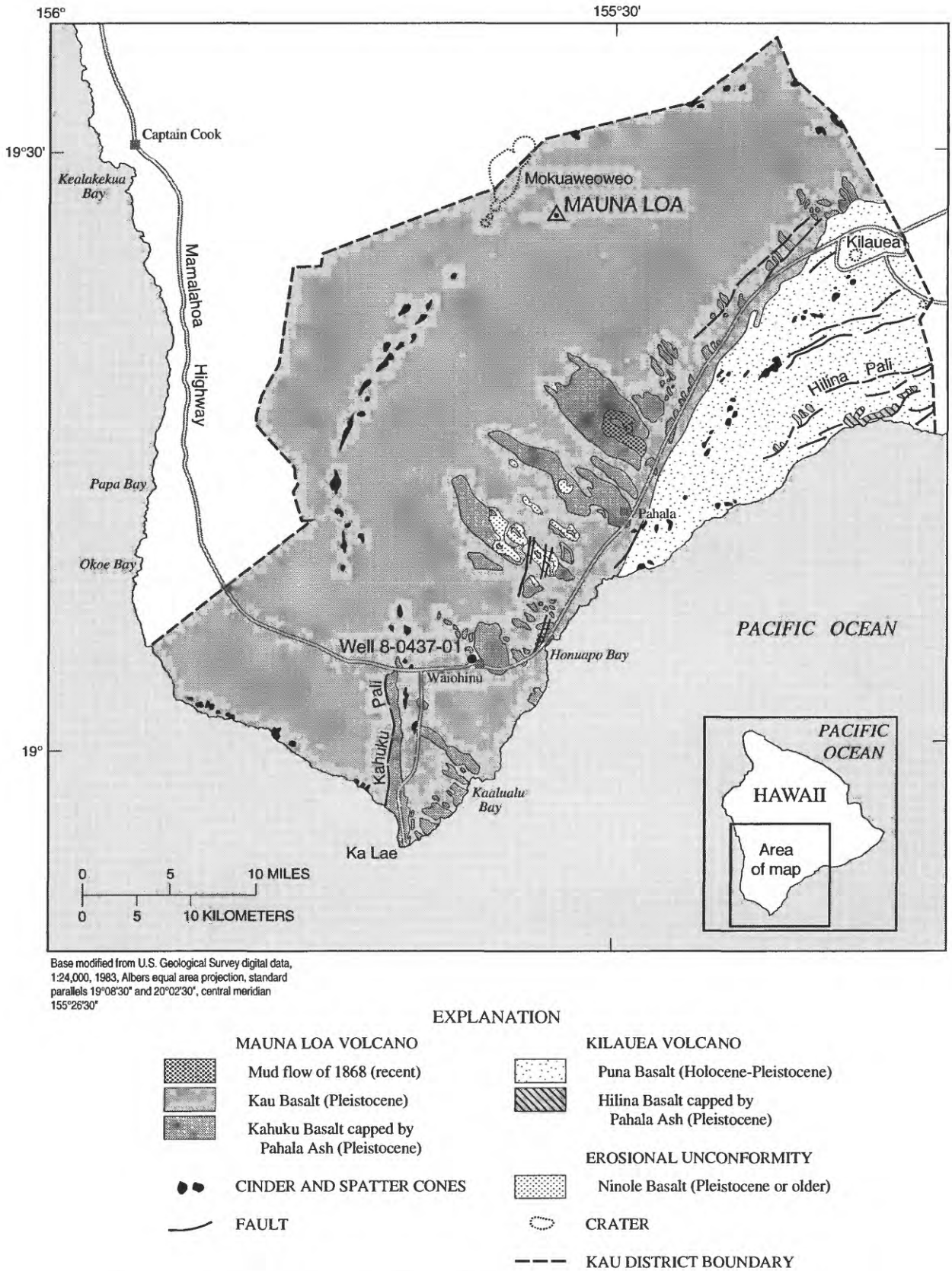
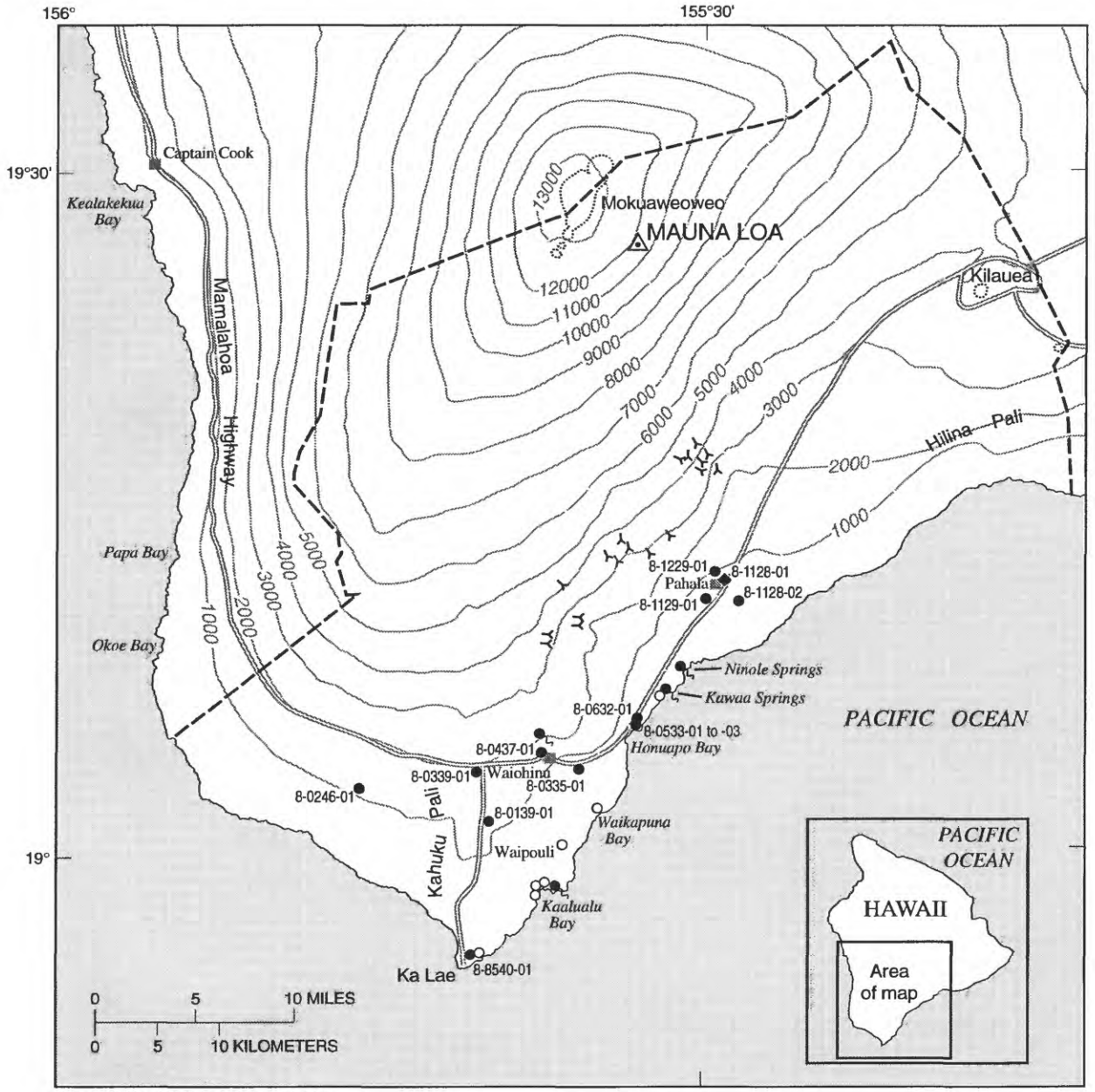


Figure 3. Generalized geology of the Kau District, island of Hawaii (modified from Stearns and Macdonald, 1946 and Langenheim and Clague, 1987).



Base modified from U.S. Geological Survey digital data, 1:24,000, 1983, Albers equal area projection, standard parallels 19°08'30" and 20°02'30", central meridian 155°26'30"

EXPLANATION

- 8-0437-01 ● DRILLED WELL AND NUMBER
- ○ DUG WELL OR WATER HOLE
- 8-1128-01 ◆ SHAFT AND NUMBER
- ●~ SPRING
- ⊢ WATER-DEVELOPMENT TUNNEL
- —2000— TOPOGRAPHIC CONTOUR--Interval 1,000 feet
- ⬭ CRATER
- ———— KAU DISTRICT BOUNDARY

Figure 4. Selected wells, shafts, springs, and tunnels, Kau District, island of Hawaii.

Table 1. Elevation, water-level, and chloride-concentration data for selected drilled wells in the Kau District, island of Hawaii

[Source of data: State of Hawaii Commission on Water Resource Management records, Davis and Yamanaga, 1973, and USGS Hawaii District files; >, greater than; <, less than; --, no data. Datum is mean sea level]

State well number	Year drilled	Elevation (feet)	Water level (feet)	Chloride concentration (milligrams per liter)
8-0139-01	1990	1,259	7.2	115
8-0246-01	1982	1,049	9.5	>300
8-0335-01	1971	745	10	10
8-0339-01	1997	1,944	435	--
8-0437-01	1994	1,300	1,016	5
8-0533-01	1946	22	--	1,220
8-0533-02	1965	94	2	580
8-0533-03	1965	89	3.2	500
8-0632-01	1965	103	2.9	500
8-1128-01	1947	774	228	12
8-1128-02	1970	304	8.7	9
8-1129-01	1974	672	14	55
8-1229-01	1972	1,112	384	7
8-8540-01	1941	51	<0.5	650

DRILLING, CONSTRUCTION, CALIPER-LOG, GEOLOGIC-LOG, AQUIFER-TEST, AND WATER-QUALITY DATA FOR WAIOHINU EXPLORATORY WELL (STATE WELL NUMBER 8-0437-01)

The Waiohinu exploratory well was drilled using an air-rotary system with a mixture of air, water, foam, and polymer employed as the drilling fluid to aid in stabilizing the borehole and to remove drill cuttings and water. Samples of drill cuttings were obtained at 5-ft intervals except at those depths where drilling-fluid circulation was lost. Drilling began on September 21, 1994 and was completed on October 23, 1994. A 12-1/4 in. hole was drilled to a depth of 20 ft and an 8-in. inside-diameter steel casing was grouted in place. The remainder of the hole was drilled with a 6-3/4 in. tricone tungsten carbide bit. Well-construction data are provided in table 2 and construction details are shown in figure 5.

Drilling was halted on September 26, 1994 at a depth of 452 ft to evaluate the water in the hole. A depth-to-water measurement indicated water standing at 284.82 ft below the top of casing. Bailed samples were obtained and drilling was halted to conduct an aquifer test. A 4-day aquifer test was done and drilling resumed from 452 ft. The well was drilled to a total depth of 1,000 ft at which point the air compressor on the drill rig could no longer unload the hole. The depth to water remained at about 284 ft below the top of the casing during the drilling.

A caliper log (fig. 6) was made after reaching the final depth of 1,000 ft. The well was cased with 4-in. inside-diameter, threaded, flush jointed, steel casing. Slotted casing was installed below a depth of 240 ft. The total length of casing installed was 972 ft as 28 ft of hole was lost because of caving. A cement basket was installed and a grout seal was placed between the 4-in. steel casing and the wall of the drill hole from a depth of 243 ft to the surface. Construction details of the Waiohinu exploratory well are given in table 2.

Table 3 contains a geologic log of the well and table 4 is the driller's log of the hole. The aquifer-test data are summarized in table 5 and the water-quality data are listed in table 6. Miscellaneous water-quality data for other sources of water in the vicinity of the Waiohinu exploratory well are shown in table 7, and water-quality data for samples collected during the aquifer test are shown in table 8.

REFERENCES CITED

Davis, D.A., and Yamanaga, George, 1966, Preliminary report on the water resources of the Kau District, Hawaii: Hawaii Division of Water and Land Development, Department of Land and Natural Resources, Circular C27, 25 p.

Davis, D.A., and Yamanaga, George, 1973, Water resources summary, island of Hawaii: Hawaii Division of Water and Land Development, Department of Land and Natural Resources, Report R47, 42 p.

Langenheim, V.A.M., and Clague, D.A., 1987, The Hawaiian-Emperor volcanic chain, chap. 1 *of* Decker, R.W., Wright, T.L., and Stauffer, P.H., eds., Volcanism in Hawaii: U.S. Geological Survey Professional Paper 1350, v. 1, p. 55–84.

Stearns, H.T., and Clark, W.O., 1930, Geology and water resources of the Kau District, Hawaii: U.S. Geological Survey Water-Supply Paper 616, 194 p.

Stearns, H.T., and Macdonald, G.A., 1946, Geology and ground-water resources of the island of Hawaii: Hawaii Division of Hydrography Bulletin 9, 363 p.

Table 2. Construction data for Waiohinu exploratory well, island of Hawaii

[Elevation datum is mean sea level; in., inch; ft., feet; id, inside diameter]

Well name	Waiohinu Exploratory Well
State well number	8-0437-01
Latitude and longitude	19°04′23″N, 155°37′15″W
Hawaii tax map key number	9-5-005:002
Landowner	Hawaii County Department of Water Supply
Well completed	October 23, 1994
Driller	G. Wayne Heick, USGS
Surface hole diameter	12-1/4 in.
Bottom of surface casing	1,279 ft
Surface casing type and diameter	Steel, 0.188-in. wall, 8-in. id
Final hole diameter	6-3/4 in.
Bottom of well elevation	327 ft
Inner casing type and diameter	Steel, solid and slotted, 4-in. id
Slotted interval elevations	1,059 ft to 327 ft
Reference mark elevation (bolt in concrete pad)	1,299.26 ft
Measuring point (top of inner casing) elevation	1,299.83 ft
Water level and date of measurement	1,014.44 ft, September 26, 1995
Aquifer test dates	October 9–13, 1994
Date and time of water sample	October 13, 1994, 1100 hours

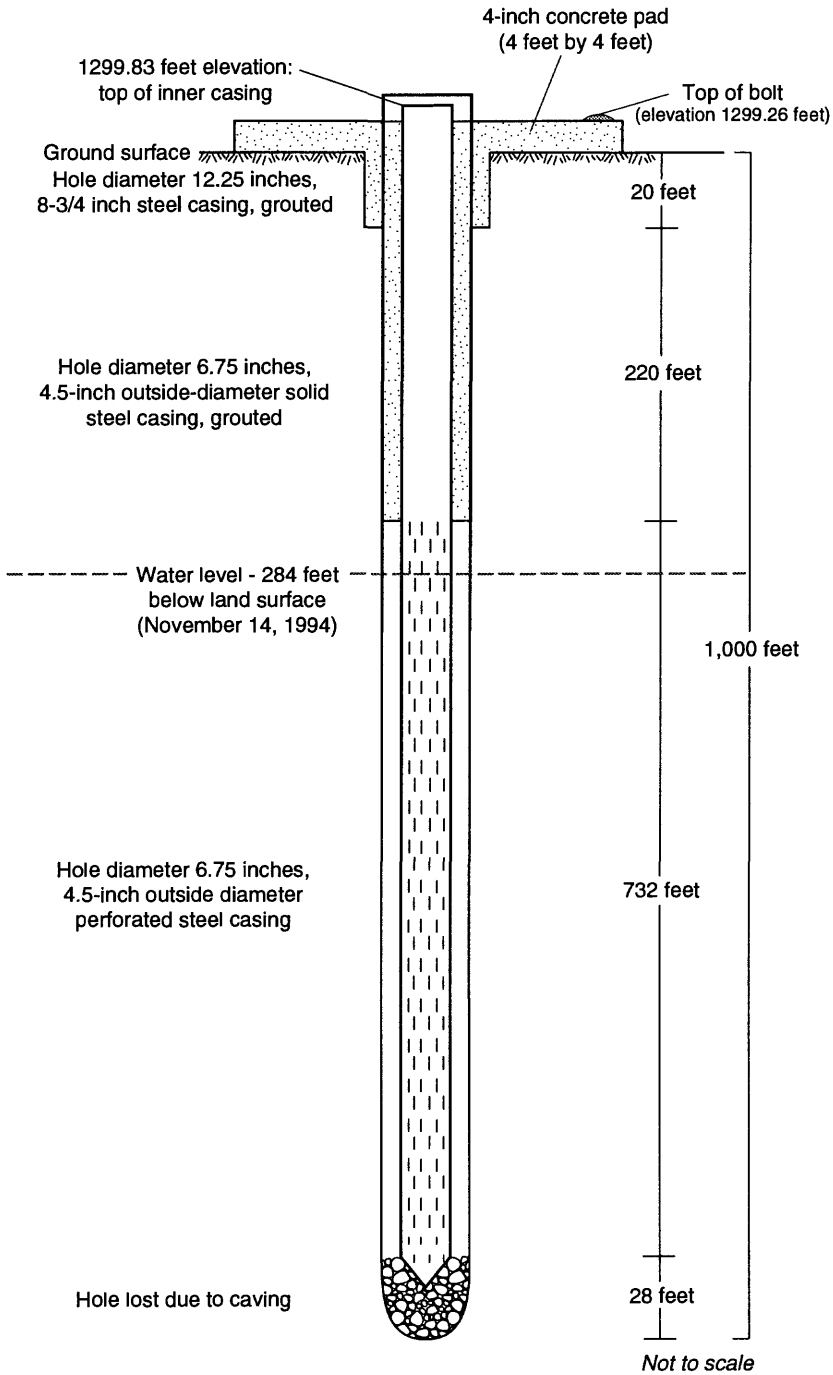


Figure 5. Construction details of the Waiohinu exploratory well (State well number 8-0437-01), island of Hawaii.

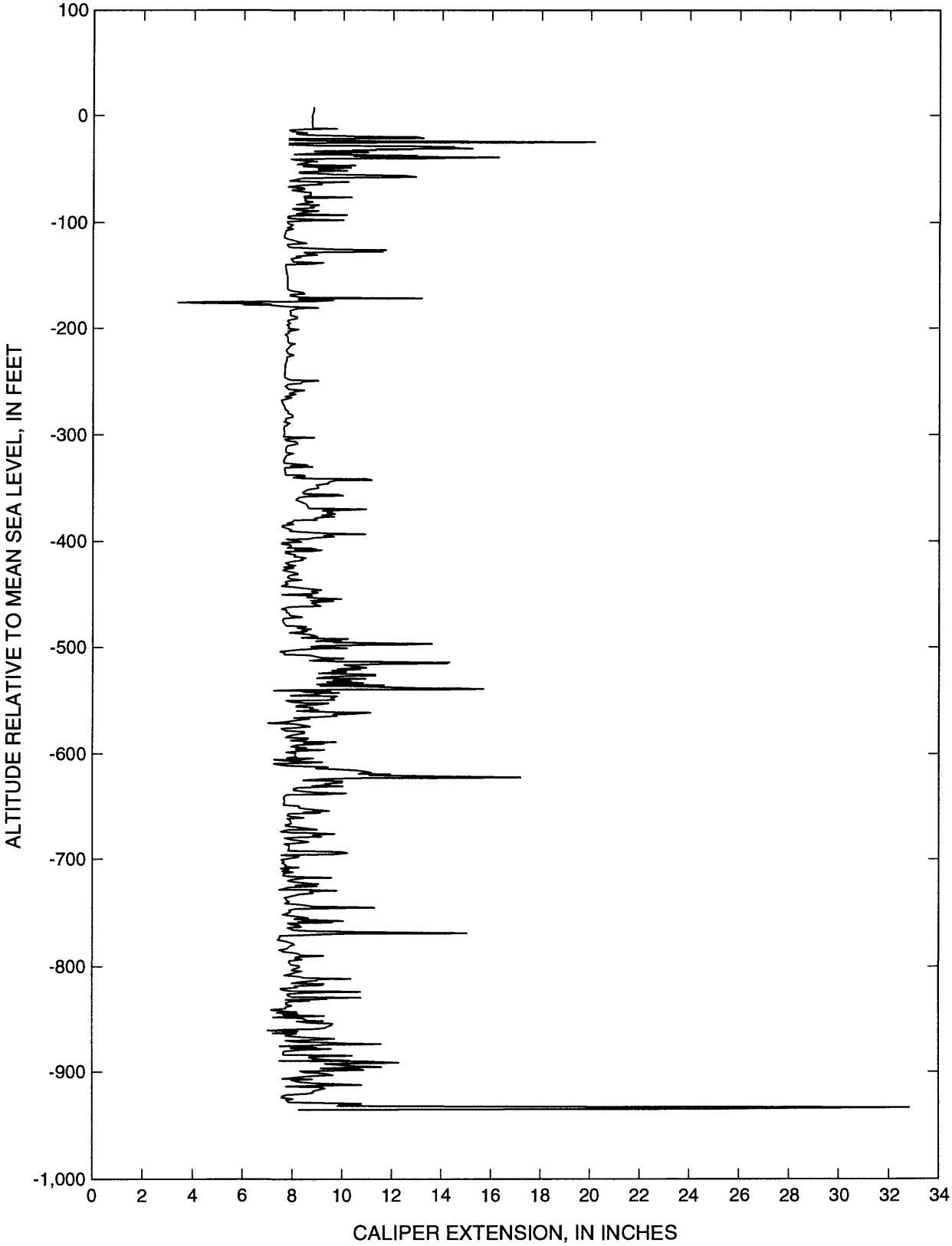


Figure 6. Caliper log for the Waiohinu exploratory well (State well number 8-0437-01), island of Hawaii.

Table 3. Geologic log for Waiohinu exploratory well (State well number 8-0437-01), island of Hawaii

Depth (feet)			Sample description
1	to	20	light-gray highly vesicular clinker
20	to	25	no sample
25	to	30	dark red-brown pebble size extremely vesicular basalt
30	to	35	den light-gray some angular vesicles
35	to	40	dark red-brown pebble size extremely vesicular basalt
40	to	45	dark red-brown pebble size extremely vesicular basalt
45	to	50	red-brown highly vesicular basalt with abundant olivine
50	to	55	red-brown highly vesicular basalt with abundant olivine
55	to	370	poor sample
370	to	474	no sample
474	to	475	large red-brown vesicular basalt clinker, angular vesicles
475	to	478	few red-brown stained cuttings
478	to	484	medium-gray dense basalt
484	to	495	no sample
495	to	505	mixture of pebble-cobble size basalt pieces, variable character, angular to subrounded, unweathered to moderately weathered
505	to	515	mixture of pebble-cobble size basalt pieces, variable character, angular to subrounded, unweathered to moderately weathered
515	to	535	mixture of pebble-cobble size basalt pieces, variable character, angular to subrounded, unweathered to moderately weathered
535	to	540	mixture of pebble-cobble size basalt pieces, variable character, angular to subrounded, unweathered to moderately weathered
540	to	555	mixture of pebble-cobble size basalt pieces, variable character, angular to subrounded, unweathered to moderately weathered
555	to	560	mixture of pebble-cobble size basalt pieces, variable character, angular to subrounded, unweathered to moderately weathered
560	to	565	mixture of pebble-cobble size basalt pieces, variable character, angular to subrounded, unweathered to moderately weathered
565	to	570	mixture of pebble-cobble size basalt pieces, variable character, angular to subrounded, unweathered to moderately weathered
570	to	575	mixture of pebble-cobble size basalt pieces, variable character, angular to subrounded, unweathered to moderately weathered
575	to	580	mixture of pebble-cobble size basalt pieces, variable character, angular to subrounded, unweathered to moderately weathered
580	to	585	mixture of pebble-cobble size basalt pieces, variable character, angular to subrounded, unweathered to moderately weathered
585	to	595	mixture of pebble-cobble size basalt pieces, variable character, angular to subrounded, unweathered to moderately weathered
595	to	600	mixture of pebble-cobble size basalt pieces, variable character, angular to subrounded, unweathered to moderately weathered
600	to	615	red-brown clinker and dark-gray dense basalt with plagioclase phenocrysts
615	to	620	50/50 mix red-brown clinker with dark-gray dense basalt with plagioclase phenocrysts
620	to	625	dark-gray dense basalt with plagioclase phenocrysts
625	to	630	mostly dark-gray dense basalt with plagioclase phenocrysts with clinker
630	to	635	dark-gray to black to red-brown vesicular basalt
635	to	645	gray to red-brown clinker
645	to	655	dark-gray dense basalt with red-brown clinker
655	to	665	dark-gray vesicular basalt with some red-brown clinker
665	to	675	dark-gray vesicular basalt
675	to	680	red-brown stained clinker with medium-gray dense basalt
680	to	690	medium-gray dense basalt
690	to	695	dark-gray dense basalt with red-brown clinker
695	to	700	clinker
700	to	710	medium-gray vesicular basalt with red-brown clinker
710	to	725	medium-gray vesicular basalt with red-brown clinker
725	to	735	dark-gray dense basalt with red-brown clinker
735	to	740	dark-gray dense basalt
740	to	750	dark-gray dense basalt with red-brown clinker
750	to	760	gray dense basalt with vesicular red-brown clinker
760	to	770	gray vesicular basalt with some dense basalt
770	to	775	gray vesicular basalt with dark-gray clinker
775	to	790	dark-gray dense basalt with plagioclase phenocrysts
790	to	795	dark-gray dense basalt with plagioclase phenocrysts
795	to	800	dark-gray dense basalt with plagioclase phenocrysts with some red-brown vesicular clinker
800	to	805	no sample
805	to	815	dark-gray dense basalt with plagioclase phenocrysts
815	to	825	dark-gray vesicular basalt
825	to	835	dark-gray vesicular basalt with medium-gray dense basalt
835	to	840	medium-gray dense basalt

Table 3. Geologic log for Waiohinu exploratory well (State well number 8-0437-01), island of Hawaii--Continued

Depth (feet)			Sample description
840	to	850	medium-gray dense basalt
850	to	855	no sample
855	to	860	red-brown clinker with few dark-gray dense basalt pieces
860	to	865	medium-gray dense basalt with some red-brown clinker
865	to	870	medium-gray dense basalt
870	to	875	medium-gray dense basalt
875	to	880	medium-gray dense basalt with clinker
880	to	890	gray dense basalt with red-brown clinker
890	to	900	gray dense basalt with red-brown clinker
900	to	910	gray dense basalt with red-brown clinker
910	to	915	gray dense basalt
915	to	920	gray dense basalt with red-brown clinker
920	to	925	gray dense basalt with red-brown clinker
925	to	930	gray dense basalt with red-brown vesicular basalt
930	to	935	dark to medium-gray dense basalt with red-brown weathered vesicular basalt
935	to	940	dark to medium-gray dense basalt with red-brown weathered vesicular basalt
940	to	950	dark to medium-gray dense basalt with red-brown weathered vesicular basalt
950	to	965	weathered to slightly weathered red-brown vesicular basalt
965	to	970	weathered to slightly weathered red-brown vesicular basalt
970	to	975	weathered to slightly weathered red-brown vesicular basalt
975	to	985	weathered to slightly weathered red-brown vesicular basalt
985	to	997	weathered to slightly weathered red-brown vesicular basalt
997	to	1,000	slightly to moderately weathered, unconsolidated red-brown ash and lapilli

Notes: Samples collected by: G. Wayne Heick and Don Arnold
Sample type: Cuttings from rotary drilling with foam and polymer
Sample repository: U.S. Geological Survey, 677 Ala Moana Blvd. Suite 415, Honolulu, HI 96813
Geologic descriptions by: S.K. Izuka, U.S. Geological Survey
Date of logging: December 7–9, 1994

Table 4. Driller's log for Waiohinu exploratory well (State well number 8-0437–01), island of Hawaii

[Drill crew--G. Wayne Heick, Don Arnold, Frederick Thibedeau; --, no measurement or not applicable; °F, degrees Farenheit; ft, feet; in., inch]

Date	Time	Depth (feet)	Depth to water (feet)	Log/remarks
9/21/94	--	0–19	--	Broken, loose blue rock aa
	--	19–23	--	Red cinders, soft, loose–caving problems cemented hole, re-drill
	--	23–29	--	Blue rock, soft, broken, fluid return
	--	29–31	--	Puka rock, clean, no cinders, good return
	--	31–33	--	Blue rock, medium soft, good return
	--	33–37	--	Red cinders, loose, soft, good return
	--	37–39	--	Blue rock, hard, good return
	--	39–44	--	Red clinkers, aa, very soft, fluid return
	--	44–48	--	Blue rock, hard, good return
	--	48–50	--	Red cinders, very loose, good return
	--	50–54	--	Blue rock, hard, good return
	--	54–67	--	Red cinders, very soft, lost circulation
	--	67–72	--	Blue rock, hard, no returns
	--	72–77	--	Red cinders, very broken, no return
	--	77–80	--	Blue rock, medium hard, no return
	--	80–95	--	Red aa rock, medium soft, loose, broken
9/22/94	--	95–103	--	Red aa rock, very soft, loose, no return
	--	103–125	--	Blue rock, medium hard at 103–112 ft, very hard at 112 ft, solid no breaks, no return
	--	125–137	--	Red aa, clinkers, loose, broken, rough going
	--	137–150	--	Blue rock, medium hard, uniform, no return
	--	150–161	--	Blue rock, very hard, slow drilling, no return
	--	161–168	--	Blue rock, medium hard, small breaks, no return
	--	168–175	--	Red, aa, medium soft, no return
9/23/94	--	175–179	--	Blue rock, medium hard, solid, no breaks
	--	179–184	--	Blue rock, aa, broken clinkers, no return
	--	184–191	--	Red, aa, soft, loose, no return
	--	191–199	--	Blue rock, medium hard, no return
	--	199–258	--	Blue rock, medium hard, smooth drilling, uniform
	--	258–261	--	Blue rock, hard, uniform, no return
	--	261–270	--	Blue rock, medium hard, uniform, no return
9/24/94	--	270–275	--	Blue rock, medium hard, no return
	--	275–305	--	Red rock, aa?, medium hard, no return
9/25/94	--	305–329	--	Red aa rock, some broken, no return
	--	329–347	--	Blue rock, hard, significant increase in air
	--	347–360	--	Red, aa rock, no returns, slight air increase
	--	360–361	--	Broken rock, loose, clinkers, some return with full air, possible water
	--	361–365	--	Red clinkers, bad zone, no return
	--	365–369	--	Blue rock, medium hard, smooth drilling
	--	369–378	--	Blue rock, hard, uniform, slow drilling, some fluid return
	--	378–386	--	Red broken rock, medium hard
	--	386–390	--	Blue rock, medium hard, drilling ok
	--	390–452	--	Red, fractured rock, aa?, some clinkers
9/26/94	--	--	--	Morning air test indicates 130–150 ft of water in hole. Sounding indicates water at about 285 ft. Stripped drill tools out of hole finish by noon. Measure water level, depth to water 284.82 ft at 1300 hours, prepare for pump test.
9/26/94	1300	--	284.82	Below top of casing
	1400	--	284.82	
	1500	--	284.82	
	1600	--	284.88	
	1700	--	284.90	
		--		

Table 4. Driller's log for Waiohinu exploratory well (State well number 8-0437–01), island of Hawaii--Continued

[Drill crew--G. Wayne Heick, Don Arnold, Frederick Thibedeau; --, no measurement or not applicable; °F, degrees Farenheit; ft, feet; in., inch]

Date	Time	Depth (feet)	Depth to water (feet)	Log/remarks
9/27/94	0800	--	284.83	
	0900	--	284.83	
	1000	--	284.83	
	1100	--	284.83	
	1200	--	284.83	
	1300	--	284.83	
	1430	--	284.83	
	1530	--	284.83	
	1630	--	284.83	
	1720	--	284.83	
9/28/94	0800	--	284.83	
	0900	--	284.83	Built bailer for sampling
	1000	--	284.83	Bailed one sample, 12.5 gallons, no depth to water change, water temperature 62.2°F, air temperature 86.6°F
	1300	--	--	Bailed 6 consecutive samples, about 80 gallons in 30 minutes, no change in depth to water still at 284.83. Water temperature 62.2°F, air temperature 88.2°F
10/3/94	0800	--	284.42	Ran one bailer sample, no water level change, water temperature 62.4°F, air temperature 86.4°F
	1300	--	284.40	
	1400	--	284.40	
	1600	--	284.40	
		--		
10/4–7/94	--	--	--	Setting up generator, and drop pipe, routine maintenance, awaiting arrival of 4–in. submersible pump
		--		
10/8–9/94	--	--	--	Installing pump, control box, test generator
		--		
10/9–13/94	--	--	--	Ran 92–hour pump test
		--		
10/17/94	--	--	--	Drill crew on Oahu getting equipment
		--		
10/18/94	--		--	Drill crew on site, remove well head, hoses, begin to pull pump
10/19/94	--			Resume drilling
	--	452–466	--	Red, aa?, broken medium soft, no return
	--	466–472	--	Blue rock, hard, no return, added foam
	--	472–495	--	Red, weathered aa, soft, broken, good return
10/20/94	--	495–540	--	Red, weathered aa, loose, good return
	--	540–553	--	Blue rock, medium soft, broken, good return
	--	553–585	--	Red, weathered rock, soft, broken good return
	--	585–588	284.15	Blue rock, medium hard, broken, good return
	--	588–594	--	Blue–red rock, medium hard, good return
	--	594–600	--	Blue rock, medium hard, broken, good return
	--	600–615	--	Red–blue rock, clinker type, good return
	--	615–627	--	Blue rock, soft, water increase, good return
	--	627–647	--	Red weathered rock, soft, loose, clinkers
	--	647–675	--	Blue rock, medium soft, broken, good return
	--	675–680	--	Red weathered rock, soft, clinkers, return okay
	--	680–692	--	Blue rock, pahoehoe? medium hard, good return
10/21/94	--	692–720	--	Blue rock, broken, more water, good return
	--	720–728	--	Blue rock, medium hard, uniform, good return
	--	728–733	--	Red, weathered rock, soft, loose, returns okay
	--	733–740	284.05	Blue rock, solid, medium hard, good return
	--	740–760	--	Red rock, loose broken, bad zone, return okay
	--	760–775	--	Blue rock, broken, loose, more water
	--	775–800	--	Blue rock, medium hard, uniform, good return

Table 4. Driller's log for Waiohinu exploratory well (State well number 8-0437–01), island of Hawaii--Continued

[Drill crew--G. Wayne Heick, Don Arnold, Frederick Thibedeau; --, no measurement or not applicable; °F, degrees Farenheit; ft, feet; in., inch]

Date	Time	Depth (feet)	Depth to water (feet)	Log/remarks
10/22/94	--	800–808	--	Blue rock, medium hard, good return
	--	808–825	--	Red clinkers, soft, good return
	--	825–833	--	Blue rock, medium hard, uniform, return okay
	--	833–843	284.09	Blue rock, medium soft, more water, return okay
	--	843–860	--	Red and black clinkers, very broken, big pieces
	--	860–870	--	Blue rock, broken, med, good return
	--	870–872	--	Red cinders, uniform soft, more water
	--	872–887	--	Blue rock, medium hard, uniform, good return
	--	887–897	--	Blue–red rock mix, uniform, return ok
	--	897–920	--	Red weathered rock, soft, broken, return okay
	--	920–925	--	Blue rock, medium hard, uniform, return good
	--	925–935	--	Red–black ash–cinders, very soft, caving
	--	935–948	--	Red rock, loose, unstable, good return
	--	948–950	--	Cinders, very broken, unstable, good return
	--	950–952	--	Blue rock, medium hard, good return
	--	952–975	--	Red aa rock, soft, broken, loose, return okay
	--	975–985	--	Blue rock, medium hard, broken, good return
	--	985–997	--	Black–red cinders or ash, very dense, caving
	--	997–1,000	--	Blue rock, medium hard, good return
10/23/94	--	--	--	Drilling completed, final depth 1,000 ft

Table 5. Aquifer-test data for Waiohinu exploratory well, State well number 8-0437-01, island of Hawaii

[Aquifer test began at 1600 hours on October 9, 1994 and terminated at 1200 hours on October 13, 1994. Length of test 92 hours.
Note: All water samples had a chloride concentration of less than 10 milligrams per liter as determined by Hach Kit analysis; gal, gallons; gal/min, gallons per minute; °C, degrees Celsius; µS/cm, microsiemens per centimeter at 25°C; --, no measurement or not applicable; WQ, water quality; gal, gallons]

Date	Time	Depth to water[1] (feet)	Drawdown (feet)	Elapsed time (minutes)	Pumping rate (gal/min)	Temperature (°C)	Specific conductance (µS/cm)	Remarks[2]
10/9/94	1240	287.10	--	--	--	--	--	meter 00000 gal
	1400	287.08	--	--	--	--	--	
	1530	287.07	--	--	--	--	--	
	1545	287.09	--	--	--	--	--	
	1600	287.09	--	--	--	--	--	Pump on
		287.21	0.12	0.5	--	--	--	
		287.26	0.17	1	--	--	--	
		287.26	0.17	2	--	--	--	
		287.26	0.17	3	--	--	--	
		287.26	0.17	4	--	--	--	
		287.27	0.18	5	61.5	--	--	water clear
		287.27	0.18	6	--	--	--	
		287.27	0.18	7	--	--	--	
		287.27	0.18	8	--	--	--	
		287.27	0.18	9	--	--	--	
		287.27	0.18	10	61.5	--	--	
		287.28	0.19	15	--	17.9	85.9	WQ sample 1
		287.28	0.19	20	61.5	--	--	
		287.28	0.19	25	--	--	--	
		287.28	0.19	30	61.5	--	--	
		287.29	0.20	35	--	--	--	
		287.28	0.19	40	60	--	--	
		287.29	0.20	45	--	--	--	
		287.29	0.20	50	61	--	--	
		287.29	0.20	55	--	--	--	
	1700	287.28	0.19	60	60	--	--	
	1715	287.30	0.21	75	--	--	--	
	1730	287.30	0.21	90	61	17.4	85.9	WQ sample 2 meter 7,327 gal
	1745	287.29	0.20	105	61	--	--	
	1800	287.30	0.21	120	62	--	--	
	1830	287.30	0.21	150	--	--	--	
	2000	287.31	0.22	240	--	--	--	
	2030	287.31	0.22	270	61	17.5	87.3	
	2100	287.31	0.22	300	61.5	17.4	87.4	WQ sample 3 meter 18,326 gal
10/10/94	0530	287.34	0.25	810	62	17.5	87.8	
	0600	287.32	0.23	840	--	17.4	87.9	WQ sample 4 meter 51,441 gal
	0630	287.32	0.23	870	62	--	--	
	0830	287.32	0.23	990	61	--	--	
	0900	287.31	0.22	1020		17.7	87.5	meter 62,480 gal
	1000	287.32	0.23	1080	--	--	--	
	1400	287.33	0.24	1320		17.6	87.9	meter 80,858 gal
	1530	287.37	0.28	1410	61.5	--	--	
	1600	287.40	0.31	1440		17.5	88.2	meter 88,210 gal
	1630	287.40	0.31	1470	--	--	--	
	1700	287.41	0.32	1500	61.5	17.4	88.0	
	1730	287.40	0.31	1530	--	--	--	
	1800	287.40	0.31	1560	--	--	--	
	2000	287.40	0.31	1680	62	17.5	88.3	meter 102,916 gal

Table 5. Aquifer-test data for Waiohinu exploratory well, State well number 8-0437-01, island of Hawaii--Continued

[Aquifer test began at 1600 hours on October 9, 1994 and terminated at 1200 hours on October 13, 1994. Length of test 92 hours.
Note: All water samples had a chloride concentration of less than 10 milligrams per liter as determined by Hach Kit analysis; gal, gallons; gal/min, gallons per minute; °C, degrees Celsius; µS/cm, microsiemens per centimeter at 25°C; --, no measurement or not applicable; WQ, water quality; gal, gallons]

Date	Time	Depth to water[1] (feet)	Drawdown (feet)	Elapsed time (minutes)	Pumping rate (gal/min)	Temperature (°C)	Specific conductance (µS/cm)	Remarks[2]
10/11/94	0600	287.40	0.31	2280	61	17.3	88.4	meter 141,540 gal
	0630	287.40	0.31	2310	--	--	--	
	0700	287.41	0.32	2340	--	--	--	
	0900	287.39	0.30	2460	61.5	17.4	88.3	
	1000	287.40	0.31	2520	--	--	--	
	1100	287.40	0.31	2580	61.5	17.4	88.5	meter 176,412 gal
	1200	287.40	0.31	2640	--	--	--	
	1600	287.41	0.32	2880	61.5	17.4	88.3	
	1700	287.41	0.32	2940	--	--	--	
	2200	287.41	0.32	3240	62	17.5	88.5	
10/12/94	0700	287.41	0.32	3780	62	17.5	88.5	meter 231,778 gal
	1000	287.41	0.32	3960	--	--	--	
	1200	287.41	0.32	4080	--	--	--	
	1500	287.42	0.33	4260	61.5	17.5	88.5	WQ sample 5 meter 260,851 gal
	1600	287.41	0.32	4320	--	--	--	
	1700	287.42	0.33	4380	--	--	--	
	2000	287.41	0.32	4560	61.5	17.4	88.6	
10/13/94	0700	287.41	0.32	5220	61.5	17.4	88.6	
	1000	287.42	0.33	5400	60.5	--	--	meter 330,513 gal
	1100	287.41	0.32	5460	--	--	--	WQ samples for lab analysis obtained
	1200	287.41	0.32	5520	--	--	--	Pump off
				Recovery				
10/13/94	1200.5	287.36	0.29	0.5	--	--	--	
	1201	287.32	0.23	1	--	--	--	
		287.24	0.15	2	--	--	--	
		287.21	0.12	3	--	--	--	
		287.19	0.10	4	--	--	--	
	1205	287.19	0.10	5	--	--	--	
		287.17	0.08	10	--	--	--	
		287.15	0.06	15	--	--	--	
	1220	287.13	0.04	20	--	--	--	
		287.12	0.03	25	--	--	--	
	1230	287.12	0.03	30	--	--	--	

Table 6. Water-quality data for Waiohinu exploratory well, Waiohinu, Hawaii

[µS/cm, microsiemens per centimeter; °C, degrees Celsius; mg/L, milligrams per liter; µg/L, micrograms per liter; <, less than; samples obtained October 13, 1994 at 1100 hours]

Property or constituent	Value
INORGANICS	
Physical properties	
Specific conductance (µS/cm at 25°C)	89
pH (standard units)	7.4
Temperature (°C)	17.5
Dissolved solids, sum of constituents (mg/L)	90
Major ions (mg/L)	
Hardness, total (as $CaCO^3$)	23
Calcium, dissolved (as Ca)	5.3
Magnesium, dissolved (as Mg)	2.4
Sodium, dissolved (as Na)	8.0
Potassium, dissolved (as K)	1.2
Alkalinity (as $CaCO^3$)	26
Sulfate, dissolved (as SO_4)	9.1
Chloride, dissolved (as Cl)	4.5
Fluoride, dissolved (as F)	0.20
Silica, dissolved (as SiO_2)	44
Nutrients (mg/L)	
Nitrogen, ammonia plus organic, total (as N)	<0.20
Phosphorus, total (as P)	0.070
Metals (µg/L)	
Aluminum, total recoverable	<10
Arsenic, total	<1
Barium, total recoverable	<100
Beryllium, total recoverable	<10
Cadmium, total recoverable	<1
Chromium, total recoverable	2
Cobalt, total recoverable	<1
Copper, total recoverable	1
Iron, total recoverable	<10
Iron, dissolved	6
Lead, total recoverable	<1
Lithium, total recoverable	<10
Manganese, total recoverable	<10
Manganese, dissolved	<1
Mercury, total recoverable	<0.10
Molybdenum, total recoverable	<1
Nickel, total recoverable	<1
Selenium, total	<1
Silver, total recoverable	<1
Zinc, total recoverable	30
ORGANICS	
Volatile organic compounds (µg/L)	
Toluene, total	0.2

Table 6. Water-quality data for Waiohinu exploratory well, Waiohinu, Hawaii--Continued

[µS/cm, microsiemens per centimeter; °C, degrees Celsius; mg/L, milligrams per liter; µg/L, micrograms per liter; <, less than]

Other organic compounds analyzed but were below reporting limits			
Organic compound	**Reporting limit (µg/L)**	**Organic compound**	**Reporting limit (mg/L)**
Alachlor	<0.05	Propazine	<0.05
Ametryn	<0.05	Silvex	<0.01
Atrazine	<0.05	Simazine	<0.05
Benzene	<0.2	Styrene	<0.2
Bromodichloromethane	<0.2	Tetrachloroethylene	<0.2
Bromoform	<0.2	Trichloroethylene	<0.2
Carbon tetrachloride	<0.2	Trichlorofluoromethane	<0.2
Chlorobenzene	<0.20	Xylene	<0.20
Chloroform	<0.2	2,4-D	<0.01
cis-1,2-Dichloroethene	<0.2	2,4-DP	<0.01
Cyanazine	<0.20	1,2-Dichlorobenzene	<0.20
Deethylatrazine	<0.05	1,3-Dichlorobenzene	<0.20
Deisopropylatrazin	<0.05	1,4-Dichlorobenzene	<0.20
Dibromochloromethane	<0.2	1,1-Dichloroethane	<0.2
Dichlorodifluoromethane	<0.2	1,2-Dichloroethane	<0.2
Ethylbenzene	<0.2	1,1-Dichloroethyl	<0.2
Methylene chloride	<0.2	1,2-Dichloropropane	<0.2
Methyl *tert*-butyl ether	<0.2	2,4,5-T	<0.01
Metolachlor	<0.05	1,2-Transdichloroethene	<0.2
Metribuzin sencor	<0.05	1,1,1-Trichloroethane	<0.2
Prometon	<0.05	1,1,2-Trichloro 1,2,2-trifluoroethane	<0.2
Prometryn	<0.05		

Table 7. Water-quality data for samples collected during the aquifer test at Waiohinu exploratory well (State well number 8-0437-01), October 1994, island of Hawaii

[Chloride and silica concentrations obtained by use of Hach kit; --, no data]

Sample no. or place (see table 5)	Date	Time	Specific conductance (µS/cm)	Chloride concentration (mg/L)	Silica (mg/L)
1	10/9/94	1615	85.9	<10	40
2	10/9/94	1730	85.9	<10	--
3	10/9/94	2100	87.4	<10	--
4	10/10/94	0600	87.9	<10	--
5	10/12/94	1500	88.5	<10	40