Drilling and Construction Information for Well 8-0339-01, South Point Tank Exploratory Well, Island of Hawaii

By Charles J. Ewart

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Conversion Factors

Multiply	By	To obtain
foot (ft)	0.3048	meter
gallon (gal)	3.785	liter
million gallons per day (Mgal/d)	0.04381	cubic meter per second
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° Celsius. Microsiemens per centimeter is numerically equivalent to micromhos per centimeter.

Abbreviation used: mg/L, milligrams per liter.

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Abstract

The South Point tank exploratory well (State well number 8-0339-01) was drilled at the Hawaii County Department of Water Supply tank located at the intersection of South Point Road and State Highway 11, at an elevation of 1,944 feet. The well was drilled into rocks of the Mauna Loa Volcano to a depth of 1,946 feet below ground surface and encountered a water table standing at an elevation of 435 feet. Well-construction data, a driller's log, and a summary of ground-water occurrence are provided. The well is one of three exploratory wells drilled on the island of Hawaii between May 1997 and July 1998 in cooperation with the County of Hawaii Department of Water Supply.

INTRODUCTION

The South Point tank exploratory well was the first of three deep exploratory wells drilled on the island of Hawaii between May 1997 and February 1998. 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 the estimation of 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 selected and prioritized jointly by the county water departments and the USGS.

The purpose of the South Point tank 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 periods of low rainfall. The well was drilled on County of Hawaii property at the intersection of South Point Road and State Highway 11 at an elevation of 1,944 ft (fig. 2). Water was encountered at a depth of 1,508 ft below land surface (elevation 435 ft) and remained at that level for the duration of the drilling to final depth. The extent of this high-level water body and the nature of the impounding structures are not known. This report presents geohydrologic data, driller's log, and 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.

Setting

The South Point tank exploratory well (State well number 8-0339-01) is located at the Hawaii County Department of Water Supply storage tank at the intersection of South Point Road and State Highway 11 on the southern slope of Mauna Loa Volcano in the southwestern part of the Kau District (fig. 2). The Kau Dis-

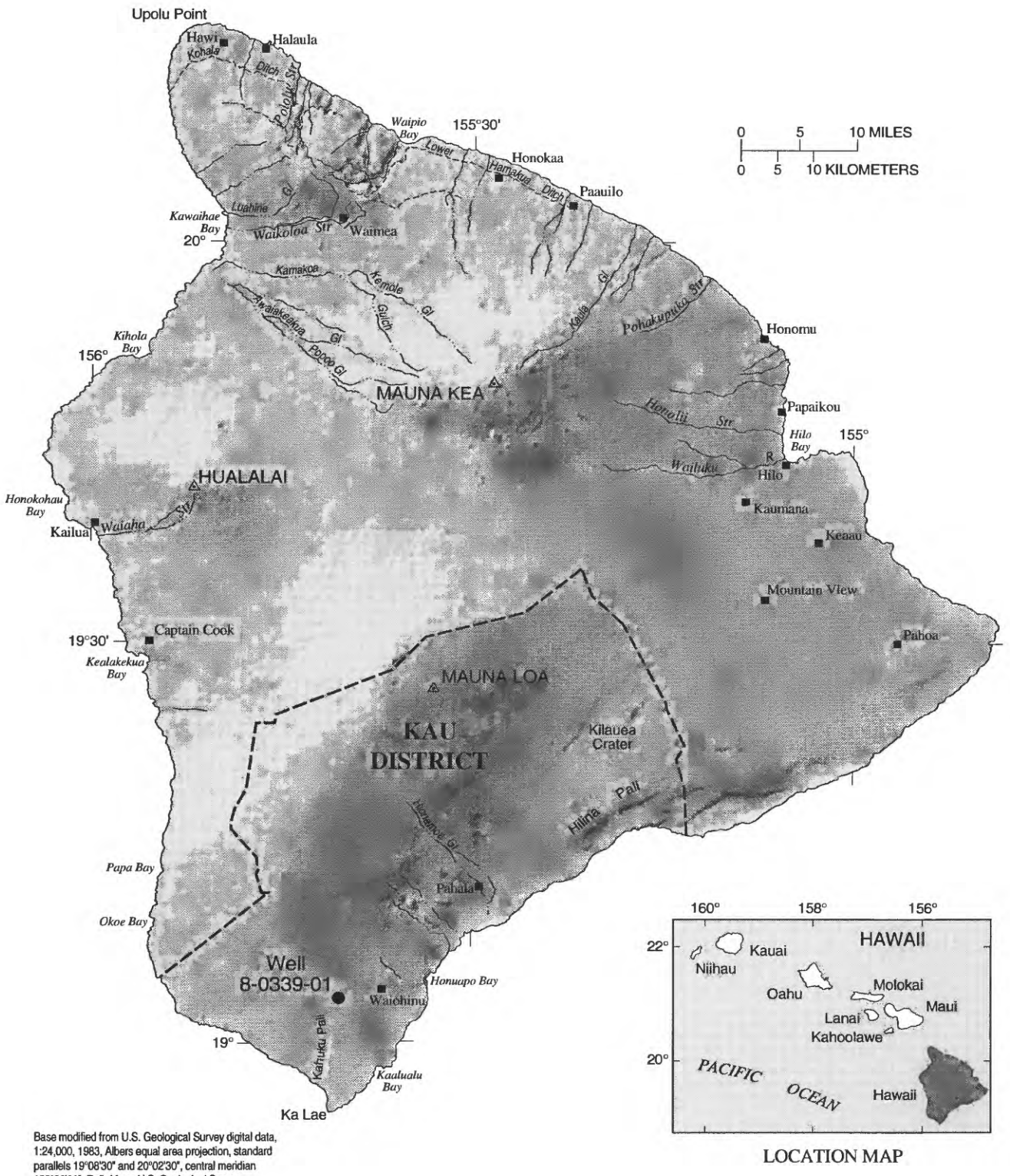


Figure 1. Location of Hawaiian islands, island of Hawaii, and Kau District.

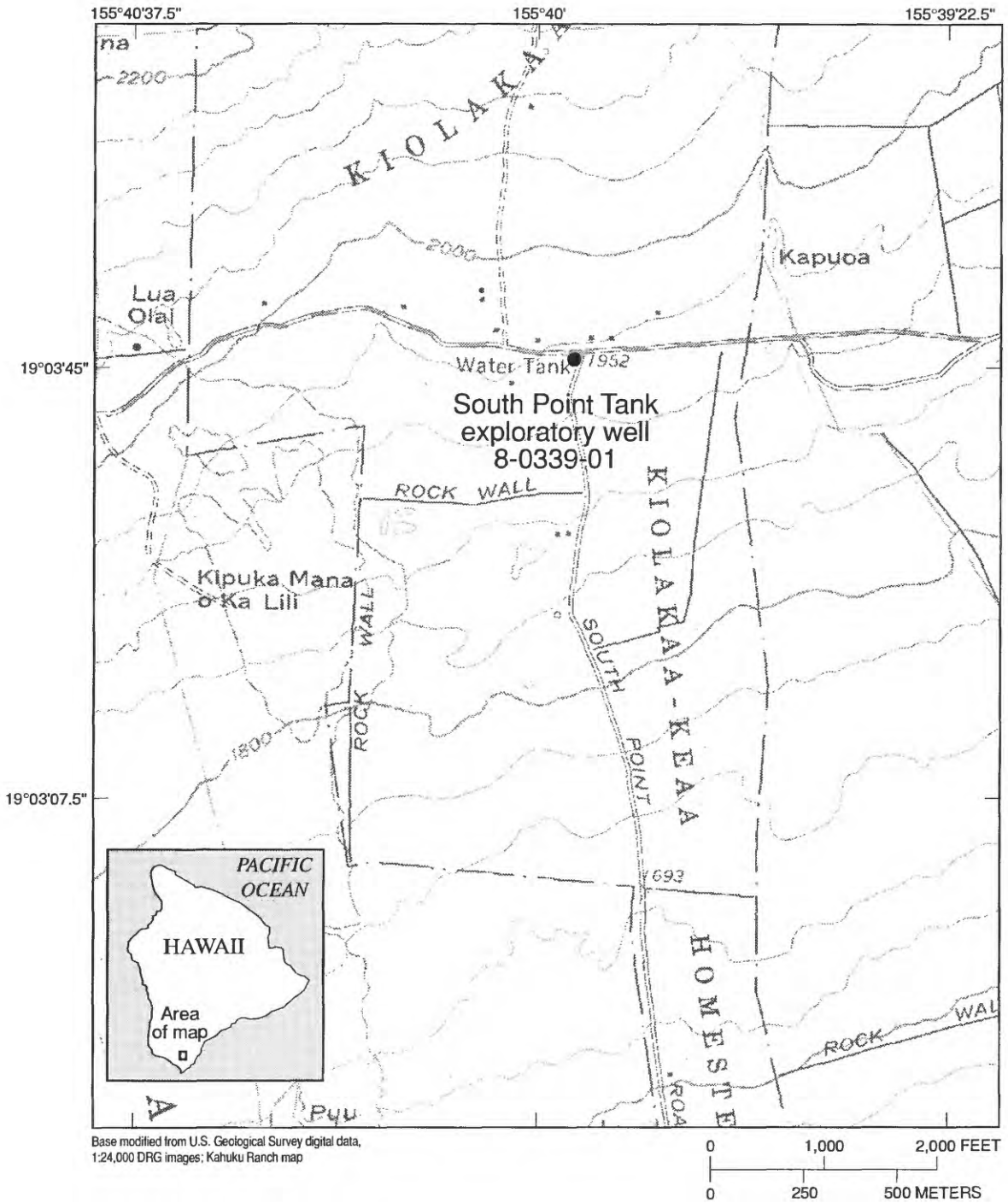


Figure 2. Location of the South Point Tank exploratory well (State well number 8-0339-01), island of Hawaii.

trict 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, and rocks from Kilauea Volcano which also formed by lava flows and pyroclastic deposits (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 by rocks from Mauna Loa Volcano.

Within the Kau District, ground water is found as basal water, which is that 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 (fig. 4). 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 in the thickness of the ash layers. 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. Elevations, water levels, and chloride concentrations for selected wells in the Kau District are shown in table 1.

Most recently, the South Point tank exploratory well encountered high-level ground water standing at an elevation of 435 ft. The extent of these high-level ground-water bodies and the nature of the impounding structures are not known.

DRILLING, CONSTRUCTION, AND DRILLER'S LOG FOR SOUTH POINT TANK EXPLORATORY WELL (STATE WELL NUMBER 8-0339-01)

The South Point tank exploratory well was drilled with an air-rotary system using a mixture of air, water, foam, and polymer as the drilling fluid to aid in stabilizing the borehole and to remove drill cuttings and water. Samples of the drill cuttings were obtained at frequent intervals except where drilling-fluid circulation was lost. Drilling began on May 7, 1997 and was completed on August 5, 1997. A 17-1/2 in. hole was drilled to a

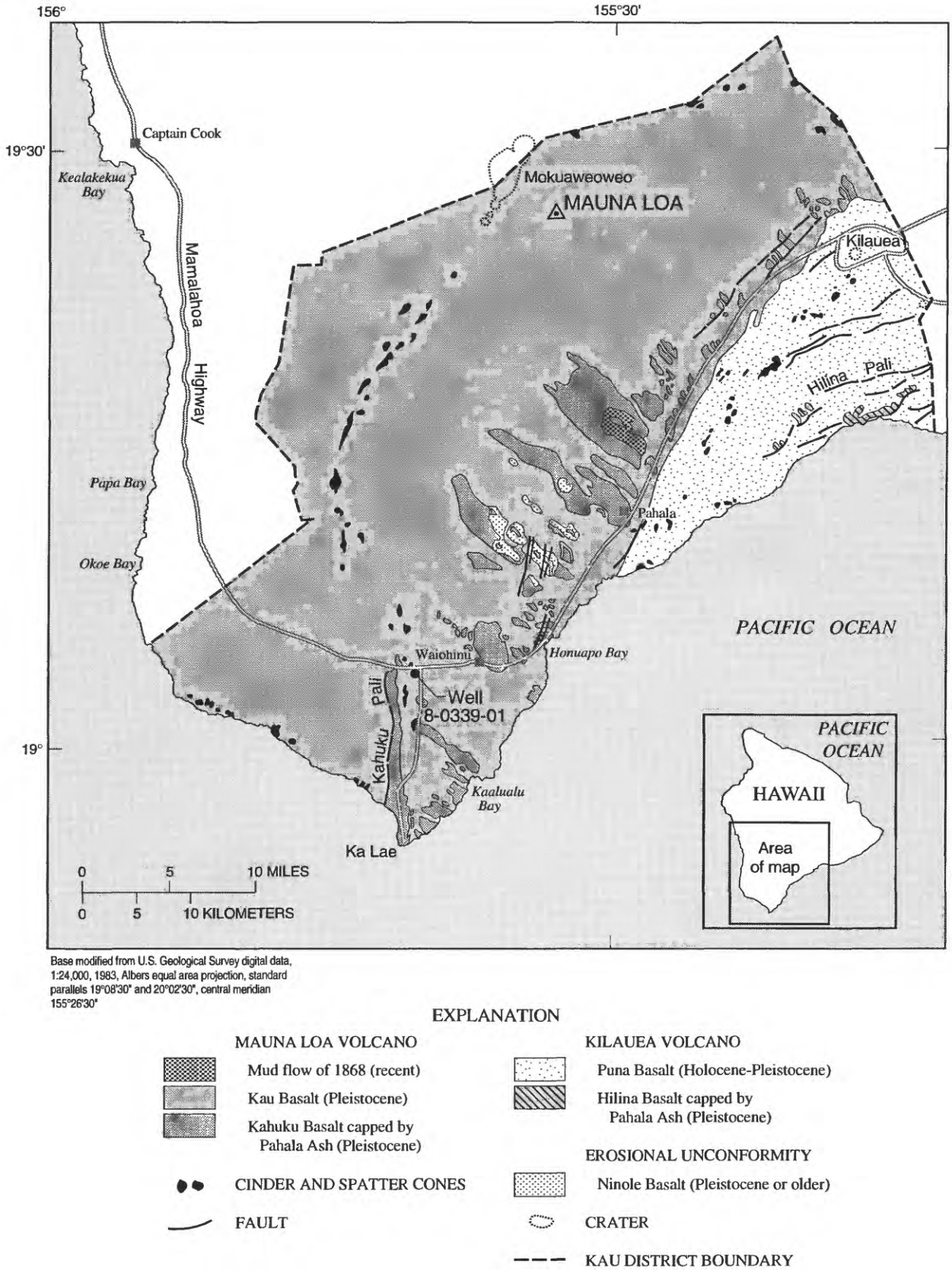
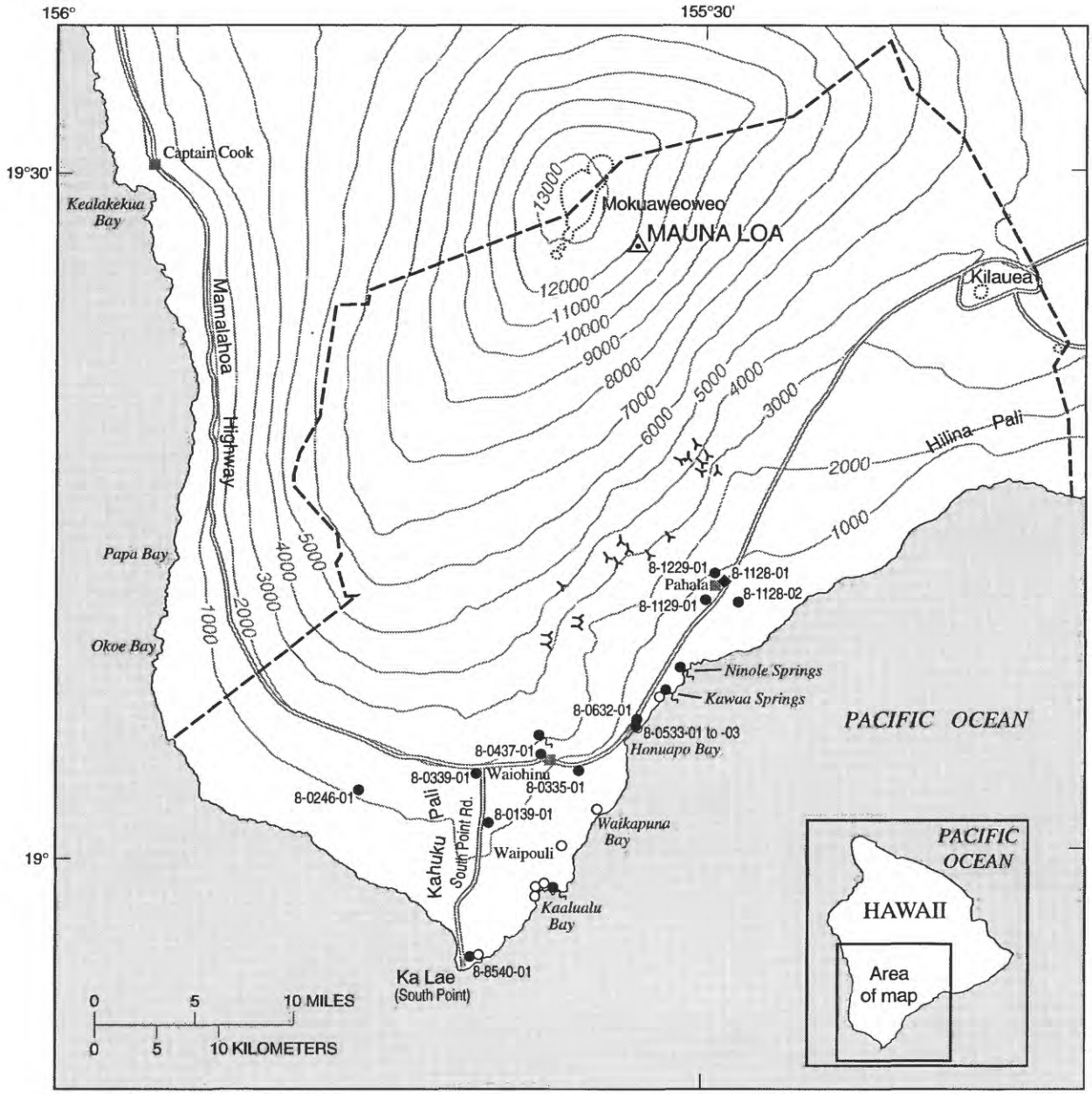


Figure 3. Generalized geology of the Kau District, island of Hawaii (modified from Stearns and Macdonald, 1946 and Langenheim and Clague, 1987).



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

- 8-0339-01 ● 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

[Data from: State of Hawaii Commission on Water Resource Management records; Davis and Yamanaga, 1973; and U.S. Geological Survey, Hawaii District files. --, no data; >, greater than; <, less than]

State well no.	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

Table 2. Construction data for South Point tank exploratory well, island of Hawaii

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

Well name	South Point tank exploratory well
State well number	8-0339-01
Latitude and longitude	19°03′45″ 155°39′57″
Hawaii tax map key number	9-3-04:24
Landowner	Hawaii County Department of Water Supply
Well completed	August 5, 1997
Driller	G. Wayne Heick, USGS
Surface hole diameter	17-1/2 in.
Bottom of surface casing	1,444 ft
Surface casing type and diameter	Steel, 0.188-in. wall, 12-in. id
Final hole diameter	8-3/4 in.
Bottom of well elevation	-2 ft
Inner casing type and diameter	Steel, solid and slotted, 4-in. id
Slotted interval elevations	500 ft to -2 ft
Reference mark elevation (brass plate)	1,943.75 ft
Measuring point (top of casing) elevation	1,944.26 ft
Water level and date of measurement	436.1 ft, August 1, 1997

depth of 503 ft and 500 ft of 12-in. inside-diameter casing was grouted in place. The remainder of the hole was drilled with a 8-3/4 in. tricone tungsten carbide bit. Well-construction data are provided in table 2 and construction details are shown in figure 5. The well was cased with 4-in. inside diameter, flush joint, blank and slotted steel casing. The 4.5-in. outside-diameter casing was grouted to the 12-in. casing from a depth of 30 ft to the surface. Table 3 contains a driller's log of the well and table 4 presents some water-quality data on water that was air-lifted from the well. Depths to water during drilling are shown in table 5.

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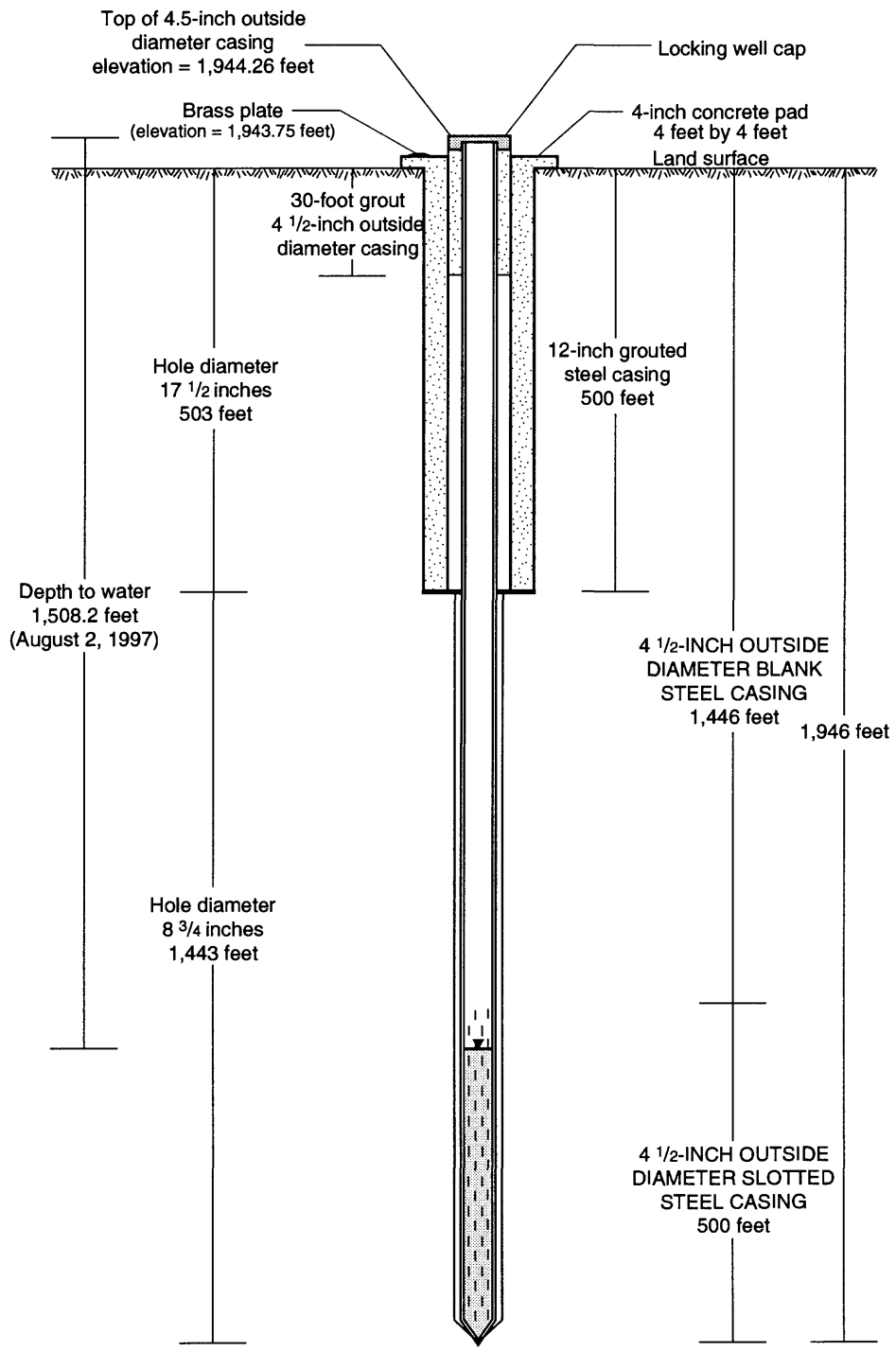

Figure 5. Construction details of the South Point tank exploratory well (State well number 8-0339-01), island of Hawaii.

Table 3. Driller's log of South Point tank exploratory well (State well number 8-0339-01), island of Hawaii

[Drill crew--G. Wayne Heick, Kimo K. Akina, and Clarence L. Edwards; pilot hole 9-7/8 inches to 500 feet; hole opened to 17-1/2 inches to 500 feet for installation of 12-inch casing; hole drilled 8-3/4 inches from 500 feet to 1, 946 feet; °C, degrees Celsius; µS/cm, microsiemens per centimeter at 25°C]

Depth (feet)	Log/remarks
0–6	Clay, fill, brown, dry
6–8	Blue rock, very hard
8–30	Blue rock, hard
30–32	Blue rock to clinkers
32–36	Blue rock, hard
36–41	Blue rock with olivine to red broken
41–44	Blue rock, very hard
44–67	Red aa, with some grey, medium hard
67–70	Lava tube, void, lost circulation
70–74	Blue rock, hard, no return
74–83	Red, clinkery, loose, no return
83–90	Red, clinkery, loose, soft, no return
90–95	Blue rock, hard, no return
95–97	Red-brown, loose, clinkery, soft
97–101	Blue rock, hard, no return
101–113	Red-brown, loose, medium, no return
113–128	Blue rock, hard, no return
128–136	Red-brown aa, medium soft, clinkery
136–158	Blue rock, hard, no return
158–161	Red-brown aa, soft, no return
161–163	Blue rock, hard, no return
163–173	Cinder/ash??, very soft, no return
173–177	Red-brown, clinkery, soft
177–180	Lava tube, void, clinkers, very soft
180–185	Red-brown aa, medium soft, no return
185–187	Blue rock, very hard, no return
187–195	Red-brown aa, soft no return
195–198	Blue rock, very hard, no return
198–203	Red-brown aa, medium to soft, no return
203–205	Red-brown aa, some blue rock, medium hard
205–223	Blue rock, hard, no return
223–241	Red-brown aa, medium to soft, no return
241–245	Blue rock, medium hard, no return
245–267	Red-brown aa, medium to soft, loose
267–285	Blue rock, hard, no return
285–295	Red-brown aa, medium to soft, no return
295–305	Blue rock, hard, no return
305–312	Red-brown aa, medium to soft, no return
312–318	Blue rock, very hard, no return
318–332	Blue rock, fractured, no return
332–340	Red-brown aa, loose, broken, no return
340–344	Blue rock, very hard, no return
344–367	Red-brown aa, broken, loose, no return
367–370	Ash/cinder??, very soft
370–372	Red-brown aa, clinkery, loose, no return
372–383	Blue rock, very hard, no return
383–424	Blue rock, very hard, no return
424–440	Red-brown aa, some blue, broken, no return
440–443	Blue rock, very hard, no return
443–450	Blue rock, very hard, no return
450–463	Blue rock, medium hard, fractured, no return
463–493	Blue rock, very hard, no return
493–499	Blue rock, med-hard, broken, no return
499–503	Blue rock, very hard, casing depth
	Open hole to 17-1/2 inch, circulation regained
	Install 500 ft of 12-inch steel casing
503–509	Void, lava tube, clinkery, no return
509–519	Blue rock, medium to hard, good returns
519–530	Red aa, some blue, medium hard, good returns
530–540	Blue rock, medium hard, good return
540–559	Red-brown aa, broken, clinkery, medium to soft
559–562	Lava tube, void, clinkers, soft, good returns
562–569	Red-brown aa, some grey, medium to soft good return
569–571	Blue rock, medium hard, good returns
571–601	Brown-grey aa, medium hard, good return
601–604	Blue rock, hard, good return
604–615	Red-brown aa, some grey, soft, clinkery, good return
615–630	Blue rock, medium to hard, good returns
630–634	Blue rock, softer, medium hard, good return
634–636	Brown-grey aa, medium to soft
636–642	Blue rock, hard, good return
642–686	Blue rock, hard, uniform, good return
686–700	Red-brown aa with some grey, medium hard, fair return
700–724	Red-brown aa, clinkery, broken, soft, fair return
724–730	Blue rock, hard, uniform, fair return
730–784	Red-brown aa with some grey, soft, broken, good return
784–787	Red-brown aa, medium to soft, good return
787–810	Blue rock, hard, solid, good return
810–827	Red-brown aa, medium to soft, good return
827–831	Blue rock, medium to hard, good return
831–863	Red-brown-grey aa, soft, clinkery, good return
863–885	Blue rock, solid, hard, good return
885–924	Red-brown-yellow, medium hard, good return
924–933	Red-brown aa, clinkery, broken, soft
933–960	Blue rock, medium hard, good return
960–978	Red-brown aa, soft, loose, clinkery, good return
978–982	Void, lost circulation
982–984	Red-brown aa, some grey, soft, no return
984–986	Red-brown aa, some grey, blue, med, no return
986–1,006	Blue rock, hard, no return
1,006–1,035	Red-brown aa some grey, clinkery, good return
1,035–1,040	Blue rock, hard, good return
1,040–1,081	Red-brown-grey aa, soft, good return
1,081–1,087	Blue rock, hard, some fractures, good return
1,087–1,113	Grey-brown aa, medium to soft, good return
1,113–1,127	Blue rock, medium to hard, good return
1,127–1,144	Red-brown-grey aa, broken clinkery, good return

Table 3. Driller's log of South Point tank exploratory well (State well number 8-0339-01), island of Hawaii--Continued

[Drill crew--G. Wayne Heick, Kimo K. Akina, and Clarence L. Edwards; pilot hole 9-7/8 inches to 500 feet; hole opened to 17-1/2 inches to 500 feet for installation of 12-inch casing; hole drilled 8-3/4 inches from 500 feet to 1, 946 feet; °C, degrees Celsius; µS/cm, microsiemens per centimeter at 25°C]

Depth (feet)	Log/remarks
1,144–1,170	Red-brown-grey aa, soft, good return
1,170–1,185	Blue rock grading to red-brown, medium good return
1,185–1,221	Blue rock, medium to soft, good return
1,221–1,244	Red-brown, soft, good return
1,244–1,250	Red-brown-grey to blue, medium to soft, good return
1,250–1,260	Blue rock, very hard, uniform, good return
1,260–1,272	Red-brown-grey, soft, broken, clinkery, good return
1,272–1,289	Blue rock, medium to hard, good return
1,289–1,346	Blue rock, very hard, solid, good return
1,346–1,391	Blue rock, very hard, some olivine, good return
1,391–1,440	Blue rock, medium hard, good return
1,440–1,446	Blue rock, very hard, good return
1,446–1,500	Blue rock, very hard, good return
1,500–1,543	Red-brown-grey aa, medium to soft, good return
1,543–1,546	Blue rock, very hard, good return
	Strip out, check for water in hole, none
1,546–1,552	Blue rock, very hard, solid, good return
1,552–1,610	Red-brown-grey aa, soft, broken, clinkery, good return
1,610–1,620	Blue rock, hard, solid, good return
1,620–1,626	Red-brown-grey aa, soft, good return
1,626–1,710	Red-brown-grey aa, medium to soft, good return
1,710–1,728	Blue rock, very hard, fractured, broken
1,728–1,766	Red-brown-grey aa, medium to soft, good return, pressure increase, water in return, can airlift water sample at 1800 hours, specific conductance 274 µS/cm, temperature 24.3°C
1,766–1,770	Red-brown-grey aa, medium to soft, good return, water sample at 1,766 ft at 0800 hours, specific conductance 195 µS/cm, temperature 23.9°C
1,770–1,786	Blue rock, very hard, good return
1,786–1,800	Red-brown-grey aa, medium to soft, lots of water
1,800–1,826	Blue rock, very hard, good return
1,826–1,846	Blue rock, very hard, good return, plenty of water
1,846–1,850	Blue rock, very hard, good return
1,850–1,865	Red, brown-grey aa, medium to soft, good return
1,865–1,890	Blue rock, very hard, some fractures, good return
1,890–1,940	Blue rock, very hard, solid, good return
1,940–1,946	Blue rock, medium, good returns, drilling complete
	Depth to water is 1,509.2 ft at 1200 hours July 20, 1997
	Install 4-inch casing[1]

[1] Additional water-level measurements made after 1200 hours on July 20, 1997 are listed in table 5

Table 4. Water-quality measurements for South Point tank exploratory well for water samples obtained by airlift while drilling[1]

[Drill crew--G. Wayne Heick, Kimo K. Akina, and Clarence L. Edwards; pilot hole 9-7/8 inches to 500 feet; hole opened to 17-1/2 inches to 500 feet for installation of 12-inch casing; hole drilled 8-3/4 inches from 500 feet to 1, 946 feet; µS/cm, microsiemens per centimeter; ° C, degrees Celsius; mg/L, milligrams per liter]

Date	Time	Depth (feet)	Specific conductance (µS/cm)	Temperature (°C)
7/16/97	1730	1,726	274	24.3
7/17/97	0830	1,766	195	23.9
7/17/97	1530	1,826	165	24.2
7/19/97	1115	1,826	230	23.2
7/31/97	1340	1,826	294	23.1
7/31/97	1650	1,846	180	21.4
8/1/97	0830	1,846	161	22.0
8/1/97	1445	1,946	131	22.6

[1] Conductance and temperature values are altered by drilling fluids and compressed air. Most representative conductance was obtained on August 1, 1997 at 1445 hours after several hours of air lift pumping without drilling fluids

Table 5. Depths to water during drilling at South Point tank exploratory well (State well number 8-0339-01), island of Hawaii

[Ground surface elevation: 1,944 feet above mean sea level]

Date	Time	Depth to water (feet below top of casing)	Water level (feet above mean sea level)
7/20/97	1200	1,509.2	435.1
7/20/97	1700	1,508.5	435.8
7/21/97	0800	1,508.4	435.9
7/21/97	1700	1,508.4	435.9
7/22/97	0730	1,508.4	435.9
7/22/97	1730	1,508.5	435.8
7/23/97	0730	1,508.4	435.9
7/30/97	1700	1,508.4	435.9
7/31/97	0730	1,508.5	435.8
8/2/97	1100	1,507.5	436.8
8/2/97	1730	1,508.2	436.1