CONSTRUCTION, GEOLOGIC LOG, AND AQUIFER TESTS OF THE NORTHWEST KILOHANA MONITOR WELL (STATE WELL 2-0126-01), LIHUE, KAUAI, HAWAII

By Stephen B. Gingerich and Scot K. Izuka

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Multiply	By	To obtain
inch (in.)	2.54	centimeter
foot (ft)	0.3048	meter
cubic foot per minute (ft^3/min)	0.02832	cubic meter per minute
gallon per minute (gal/min)	3.785	liter per minute
mile, statute (mi)	1.609	kilometer

Other Useful Conversions

1 ft^3/s = 448.8 gal/min

1 ft^3/s = 0.6463 Mgal/d

Vertical datum

All elevations in this report are referenced relative to mean sea level.

Abbreviation:

µS/cm, microsiemens per centimeter at 25 degrees Celsius.

Construction, Geologic Log, and Aquifer Tests of the Northwest Kilohana Monitor Well (State Well 2-0126-01), Lihue, Kauai, Hawaii

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Abstract

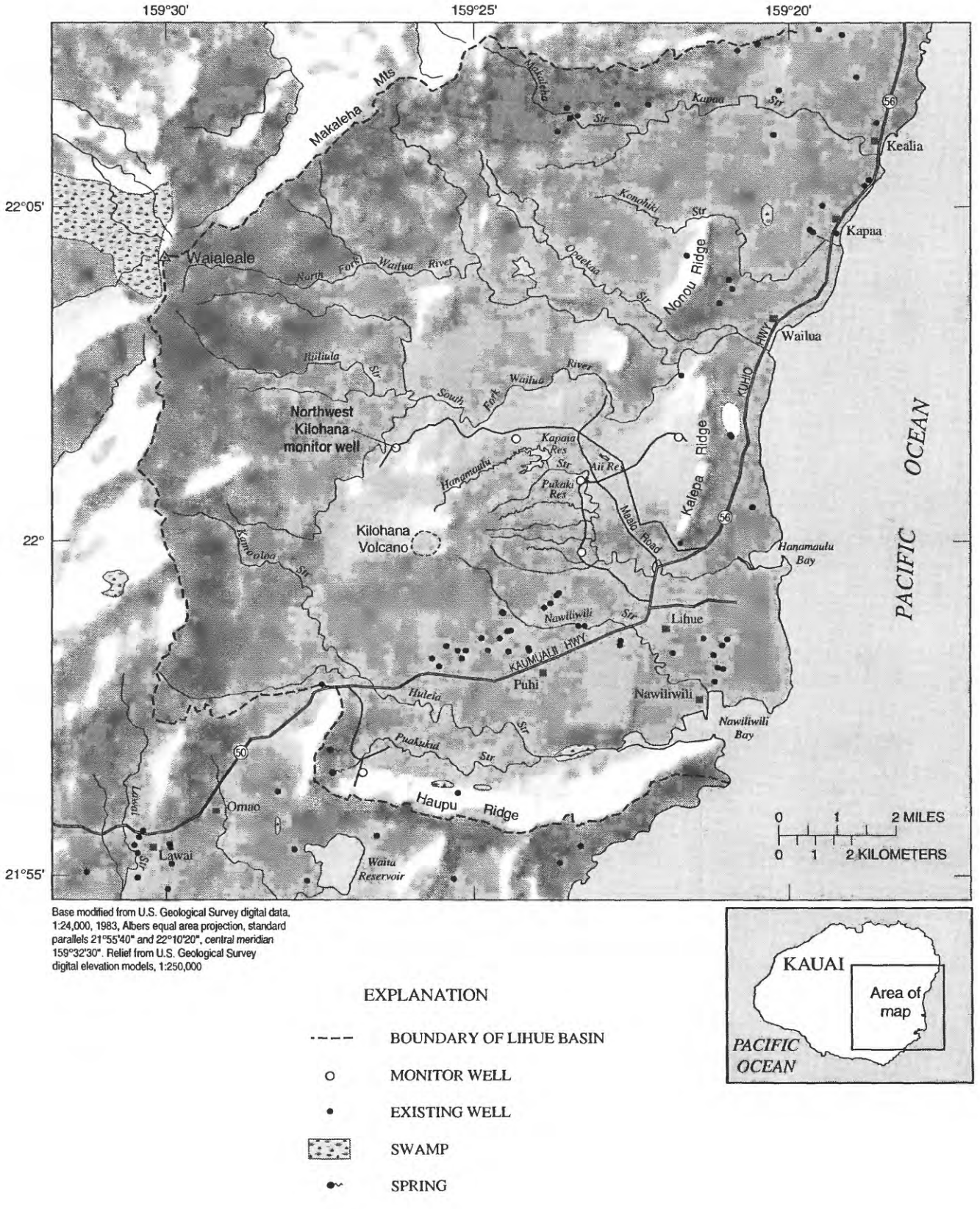
The Northwest Kilohana monitor well, located in the center of the Lihue basin on the northeast slope of Kilohana Volcano, was drilled in 1996 and tested to study the hydrology and geology in an area where no other well information is available. The well was drilled to a depth of 1,004 feet from a ground elevation of about 678 feet above sea level and penetrated mafic lava flows (which may include nepelinite, melilitite, basanite, and alkalic basalt) and alluvium characteristic of the Koloa Volcanics. A relatively thick section of unconsolidated sedimentary and clinker layers were penetrated between 33 and -67 feet elevation. Water levels decreased with depth during drilling from 576 feet above sea level when the hole bottom was at 431 feet elevation to 565 feet elevation when the hole bottom was at -144 feet elevation; 10 days after drilling stopped water levels were measured at 590 feet elevation.

Step-drawdown and 7-day sustained-rate pumping tests were conducted to test aquifer properties in the vicinity of the well. The maximum drawdown measured in the well during 7 days of sustained pumping at an average rate of 313 gallons per minute was 206 feet from an initial water-level elevation of 590 feet above sea level. Well loss, analyzed from the step-drawdown data, was estimated to be 56.32 feet. A marked decrease in the drawdown at about 3,000 minutes into the sustained-rate test is apparent from the drawdown data. Water pumped from the well during the aquifer tests was noticeably warmer than the surrounding atmospheric temperature of 20.6 degrees Celsius. Water temperature was as high as 34 degrees Celsius at 25 minutes into the sustained-rate test but declined to 27 degrees Celsius after about 7 days of pumping.

INTRODUCTION

The Lihue basin is the center of population, government, and industry for Kauai. Recent population growth in the basin has greatly increased the demand for water in the area. The economic setback caused by Hurricane Iniki in 1993 slowed growth on Kauai and may have kept the water supply from reaching a critical stage; however, an ample water supply is needed for the island's economic recovery. Pre-Iniki studies placed Lihue's supply at the highest priority in Kauai's water plans (Commission on Water Resources Management, 1990).

The Northwest Kilohana monitor well (State well 2-0126-01) is one of six monitor wells drilled in the period from April 1995 to April 1996 by the U.S. Geological Survey (USGS) in cooperation with the County of Kauai Department of Water to study the availability of ground water in the southern Lihue basin (fig. 1). The six monitor wells were sited in areas where no wells had been drilled and no subsurface information was available. Five of the six monitor wells were drilled in the central part of the southern Lihue basin. The sixth well was drilled at the southern edge of the basin. The Northwest Kilohana monitor well is more than 3 mi from the nearest pumping wells and provides data for defining the regional ground-water system of the Lihue basin. The Department of Water considers the northwest Kilo-



Base modified from U.S. Geological Survey digital data, 1:24,000, 1983, Albers equal area projection, standard parallels 21°55'40" and 22°10'20", central meridian 159°32'30". Relief from U.S. Geological Survey digital elevation models, 1:250,000

Figure 1. Location of the Northwest Kilohana monitor well (State well 2-0126-01) and existing wells in the Lihue basin, Kauai, Hawaii.

hana area as a potential site for future ground-water exploration and development.

The objectives of this study were met by analysis of data collected during and after the drilling operation. These data included (1) the driller's description of the drilling history and the well-construction details, (2) water levels monitored as the well was deepened, (3) a caliper log of the uncased well boring, (4) a description of the geology from rock chips (cuttings) brought to the surface during drilling, and (5) the step-drawdown and 7-day aquifer tests. This report documents the location, drilling history, construction details, geologic log, and aquifer-test results of the Northwest Kilohana monitor well.

Setting

The Northwest Kilohana monitor well (State well 2-0126-01) is located in the Lihue basin, a large depression bounded on the west by the high mountains of central Kauai, on the south by Haupu Ridge, and on the north by the Makaleha Mountains (fig. 1). The area has undergone substantial stream erosion, weathering, and faulting followed by rejuvenated, sporadic, scattered volcanism. Two major stratigraphic units are found in the Lihue basin (fig. 2): (1) the Waimea Canyon Basalt of Pliocene and Miocene (?) age which was erupted during the main shield-volcano-building stage of Kauai and forms the bulk of the island, including the mountains surrounding the Lihue basin, and (2) the Koloa Volcanics of Pleistocene and Pliocene age which include the rejuvenated-stage volcanic lava flows and sedimentary units that partly cover and fill the floor of the basin (Hinds, 1930; Stearns, 1946; Macdonald and others, 1960). Both the Waimea Canyon Basalt and the Koloa Volcanics have been given formational rank (Langenheim and Clague, 1987).

Kilohana Volcano, in the center of the southern Lihue basin, is a prominent edifice of the Koloa Volcanics. Macdonald and others (1960) described the Lihue basin as a subsidiary caldera that formed to the east of a central main caldera of the Kauai shield volcano. Stearns (1946) described the basin as the result of advanced stream erosion and the coalescing of many amphitheater-headed valleys. Numerous subsequent geologic investigations include a gravity survey (Kivroy, and others, 1965), petrologic and geochemical analyses (Macdonald, 1968; Feigenson, 1984; Clague and Dalrymple, 1988; Maaloe and others, 1992), and radiometric dating (Clague and Dalrymple, 1988). These studies have advanced the understanding of the geology of Kauai, yet the origin of the Lihue basin remains an enigma.

Ground-water exploration in the Lihue basin has been only moderately successful, owing in part to the basin's complex ground-water hydrology. Most of the ground water in the Lihue basin is developed from wells in the Koloa Volcanics, which cover almost the entire basin floor. The Koloa Volcanics are generally considered to have low to moderate permeabilities (Macdonald and others, 1960), but specific capacities of wells in this unit are highly variable. Water levels during drilling in many of these wells declined with depth in the aquifer, indicating substantial vertical head gradients. At the base of the Koloa Volcanics and resting unconformably on the underlying Waimea Canyon Basalt, are the weathered rocks and sedimentary deposits that formed during the period of erosion between the shield-volcano eruptions and the rejuvenated volcanism. These deposits probably have low permeabilities and may retard the flow of water between the Koloa Volcanics and the Waimea Canyon Basalt.

The Waimea Canyon Basalt in the Lihue basin is represented by the Napali Member, the thick accumulations of thin lava flows that formed on the flank of the Kauai shield volcano. In western Kauai, the Napali Member is extensive and forms the most permeable aquifers on Kauai, but in the Lihue basin, the Napali Member crops out only in the mountains encircling the basin. It is not certain whether any of the wells drilled thus far in the center of the basin have penetrated the Koloa Volcanics into the underlying Napali Member. Therefore, the thickness of the Koloa Volcanics and the hydrologic properties of the underlying Napali Member are unknown.

Location

The Northwest Kilohana monitor well (State well 2-0126-01) is located near the center of the southern half of the Lihue basin among sugarcane fields on the northwest slope of Kilohana Volcano. The site is on the western shoulder of a sugar plantation road, about 3 mi west of the intersection with Maalo Road. The well was assigned the well number 2-0126-01 by the State of Hawaii Commission on Water Resources Management using the State well numbering system (table 1).

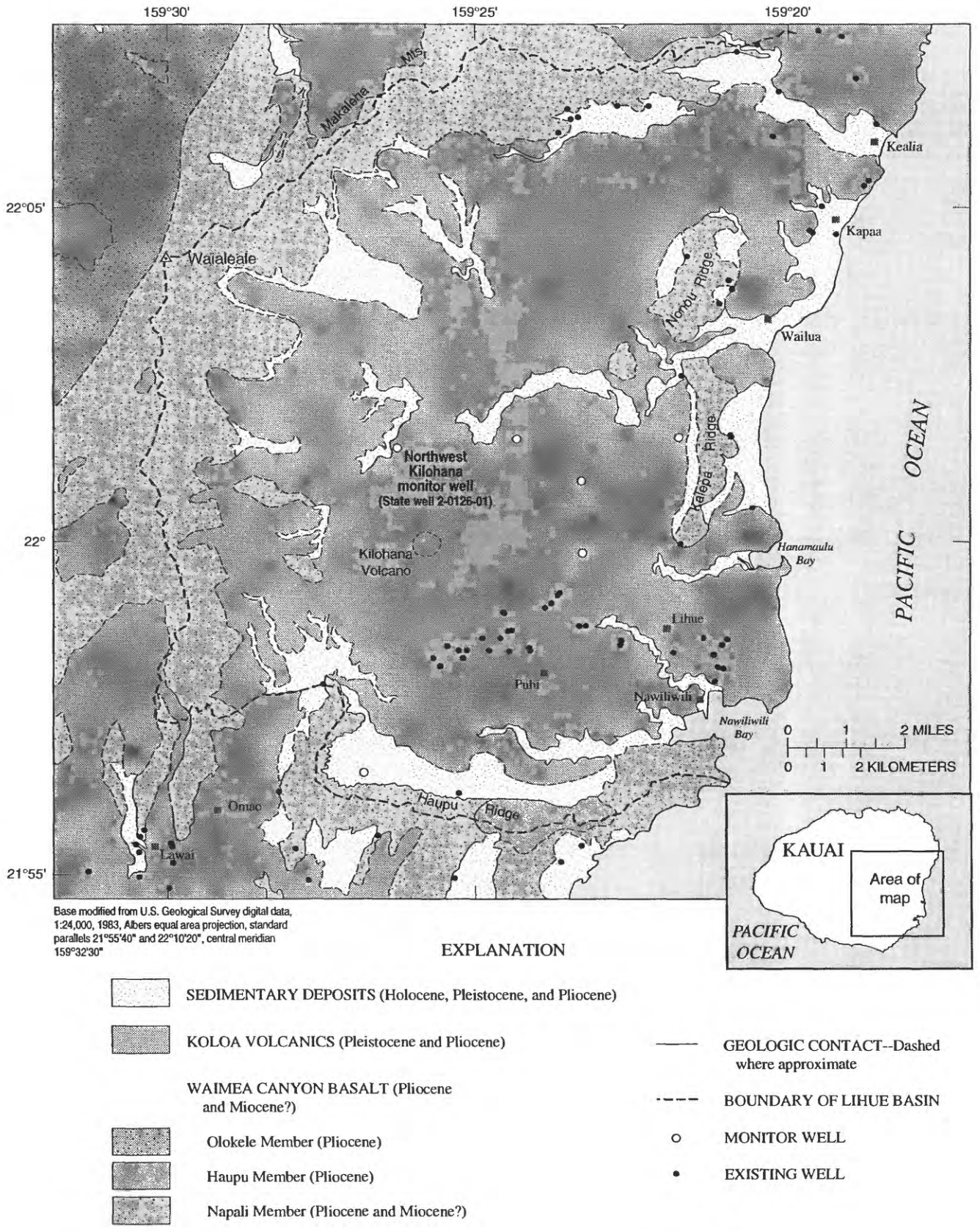


Figure 2. Geology of the Lihue basin area, Kauai, Hawaii (modified from Macdonald and others, 1960).

Table 1. Location, elevation, and State number of the Northwest Kilohana monitor well, Kauai, Hawaii
[Datum is mean sea level]

Latitude	22°01′26″N
Longitude	159°26′15″W
Ground elevation at bolt in concrete pad	678.44 feet
Measuring-point elevation at top of 4-inch well casing	679.06 feet
Distance and direction from Lihue	5.3 miles northwest
Distance and direction from nearest shoreline	6.2 miles west
State well number	2-0126-01

The area within a 1 mi radius of the well is covered by a network of artificial and natural surface-water features. The south fork of the Wailua River is within 0.2 mi west of the well. The well is about 6.2 mi inland of the eastern coast of Kauai.

Acknowledgments

The construction, data collection, and testing of the Northwest Kilohana monitor well was made possible with the cooperation and assistance of Mr. Murl Nielsen, Manager and Chief Engineer, and the staff of the County of Kauai Department of Water. We are grateful to Mr. Michael Furukawa for permitting the construction of the well on Amfac/JMB Hawaii, Lihue Plantation land. Drilling, aquifer-test, and elevation information were drawn extensively from the notes of G. Wayne Heick of the U.S. Geological Survey.

DRILLING METHODS AND HISTORY

The well was bored by rotary drilling with a 9-7/8-in. diameter tungsten-carbide bit. Air and foam were injected down through the hollow drill stem and circulated back up the space between the stem and the well boring to remove cuttings from the hole. Greater lifting power was needed as the drilling penetrated deeper below the water table, thus the depth of drilling was limited by the capacity of the air compressor to provide the circulation. Drilling was halted at a total depth of 1,004 ft (bottom is at -326 ft elevation). A caliper tool was lowered down the hole to record the caliper-arm extension, an indication of the variation in hole diameter with depth. At 31 ft elevation a blockage was discovered; casing was installed through the blockage and the well was completed. The elevation of the brass plate in the concrete pad at the well is 678.44 ft and the elevation of the measuring point is 679.06 ft. Flush-jointed 4-in. (outer diameter) steel casing, with perforations between the water table and the bottom, was installed and gravel was packed in the annular space between the casing and the well boring. Table 2 summarizes the construction history of the well and construction details of the finished well are shown in figure 3.

Water levels decreased as the well was deepened but returned to higher levels as the well recovered from the effects of drilling. The drillers reported a noticeable increase in water being circulated from the hole in the intervals between 446 and 441 ft elevation, 423 and 396 ft elevation, at 366 ft elevation, 353 to 349 ft elevation, 323 to 301 ft elevation, and possibly at -189 ft elevation.

GEOLOGIC LOG

The geologic log of the Northwest Kilohana monitor well was compiled from examination of cuttings brought to the surface by the air and foam circulated through the well bore. Samples were collected at 5-ft depth intervals and air dried before being examined macroscopically. The complete lithologic descriptions appear in appendix 1; the geologic log is shown in figure 4.

The Northwest Kilohana monitor well penetrated a 1,004-ft section of mafic lava flows and alluvium (the term "mafic rock" in this report includes nepelinite, melilitite, basanite, and alkalic basalt, all of which are dark, fine-grained, igneous rocks but have specific compositions that are not distinguishable in hand specimen). The uppermost part of the section consists of a 5-ft layer of surface soil and 70 ft of mafic lava flows which are deeply weathered. Below the weathered lava flows is a 190-ft section of vesicular lava flows and clinker underlain by 15 ft of highly weathered mafic rocks. Beneath that is a 385-ft-thick layer of dense aa lava flows and clinker underlain by a 100-ft-thick layer of alluvium. The remaining section consists of 120 ft of aa lava flows and 140 ft of alternating layers of residual soil and partially weathered lava flows.

The caliper log of the Northwest Kilohana monitor well (fig. 4) shows intervals where the hole is larger than the drill-bit diameter. Rock layers that are unconsolidated or thin tend to crumble and cave to produce enlargements in the well boring. In contrast, rocks that

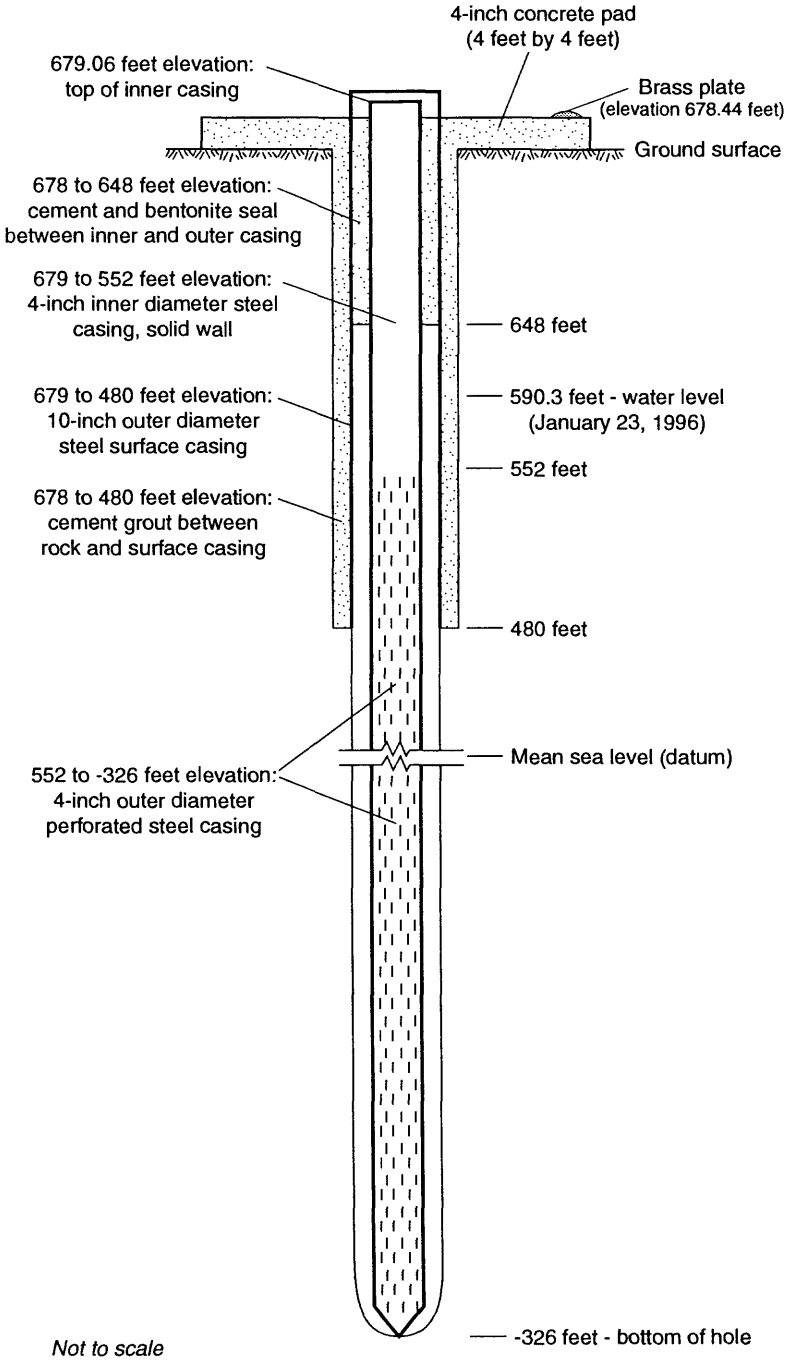


Figure 3. Construction details of the Northwest Kilohana monitor well (State well 2-0126-01), Kauai, Hawaii.

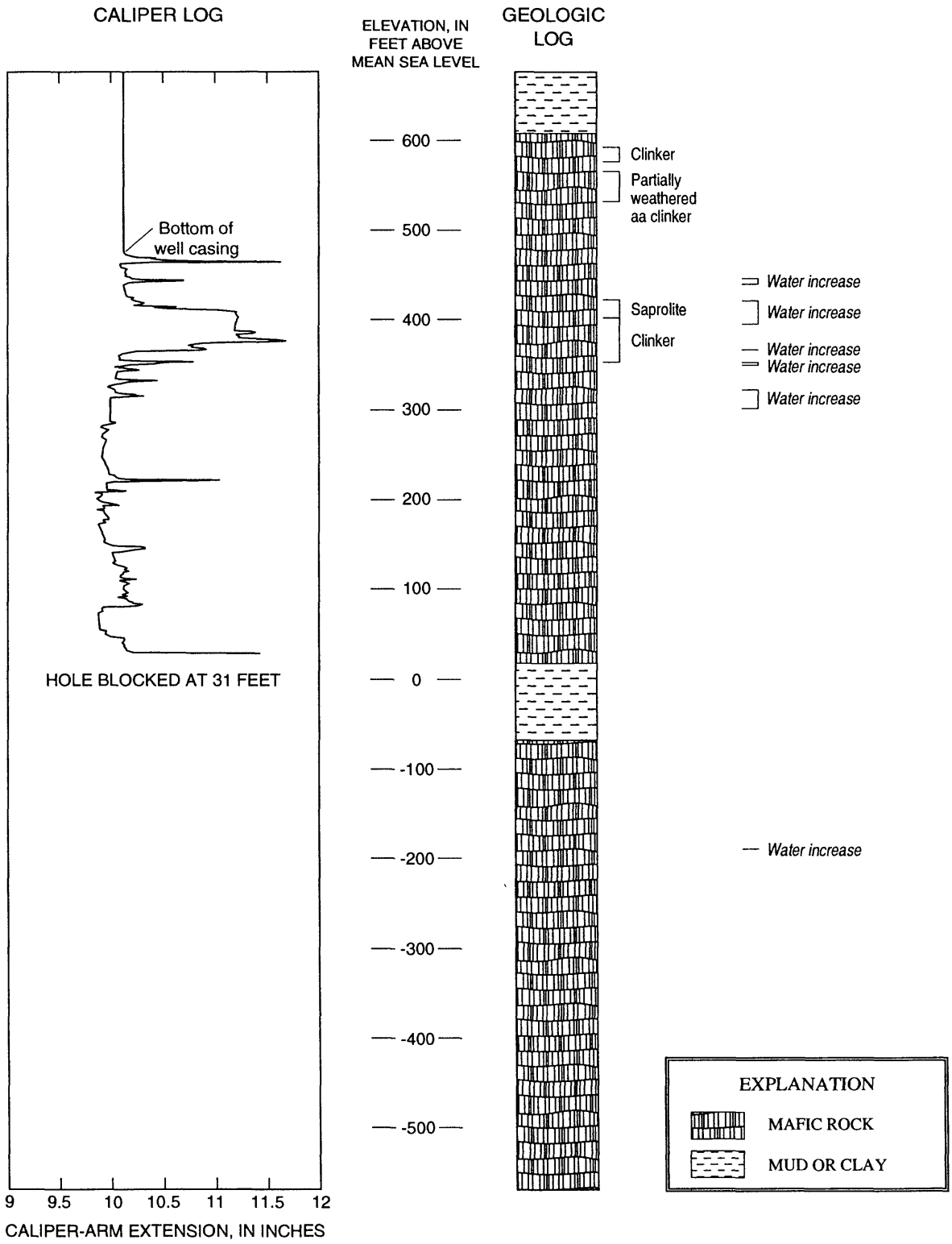


Figure 4. Geologic log and caliper-arm extension with depth in the Northwest Kilohana monitor well (State well 2-0126-01), Kauai, Hawaii.

Table 2. Summary of construction of the Northwest Kilohana monitor well (State well 2-0126-01), Kauai, Hawaii
[Datum for water-level and bottom-of-hole elevations is mean sea level. Land surface elevation is about 678 ft above mean sea level; ft, feet]

Date		Significant events
December 1995	4	Drilling began
	15	Surface casing installed to 480 ft elevation
January 1996	3	Continue drilling from 480 ft elevation; increase in water lifted out of well at 446 to 441 ft elevation; continued drilling to 431 ft elevation
	9	Water level before drilling about 576 ft elevation and bottom-of-hole 431 ft elevation; increase in water lifted out of hole at 423 to 396 ft, 366 ft, 353 to 349 ft, and 323 to 301ft elevation; continued drilling to 178 ft elevation
	10	Water level before drilling about 568 ft elevation and bottom-of-hole 178 ft elevation; continued drilling to 78 ft elevation
	11	Water level before drilling about 569 ft elevation and bottom-of-hole 78 ft elevation; continued drilling to -144 ft elevation
	12	Water level before drilling 565 ft elevation and bottom-of-hole -144 ft elevation; possible increase in water lifted out of well at -189 ft elevation; drilling terminated at -326 ft elevation (total depth of 1,004 ft)
	13	Water level 583 ft elevation; logged upper 650 ft of hole with caliper; blockage at 31 ft elevation discovered
	23	Water level 590.3 ft elevation; performed step-drawdown test; water pumped from well was noticeably warmer than atmospheric temperature.
	24	Water level 590.3 ft elevation; began sustained pumping test at 313 gallons per minute
	31	Terminated sustained pumping test, drawdown of 206 ft
February 1996	6	Water level 585.4 ft elevation; 4-inch casing installed
	7	Grout installed and well completed

are hard, massive, and thick tend to hold the shape of the boring, and thus give a smoother, unvarying log. Below the surface casing (surface casing shows as the smooth upper 200 ft of the caliper log), the log shows prominent enlargements between 418 and 358 ft elevation that correspond with the clinker and saprolite noted in the drill cuttings between 418 and 353 ft elevation. Between 350 and 28 ft elevation, the caliper log is smoother, indicating the rocks are hard and dense and the wall of the well boring is smooth. This interval corresponds with a thick section of dense mafic lava flows in the geologic log. The small enlargements shown by the caliper log probably correspond to individual clinker zones in the aa lava flows. The caliper log extends down to a depth of only 650 ft because of a blockage below that point. The blockage may have been caused by caving from one or more of the residual soil or alluvial layers in the lower intervals of the hole.

AQUIFER TESTS

Two aquifer tests were performed at the Northwest Kilohana monitor well (State well 2-0126-01); a step-drawdown test to determine the well efficiency and a sustained-rate test which can be used to estimate aquifer properties in the vicinity of the well. The aquifer tests were conducted using a 50-horsepower, 6-in. diameter submersible pump with the intake elevation set at 214 ft elevation. Measurements of the depth to water in the pumping well were made using an electric tape. The flow rate was measured using a totalizing flow meter.

The step-drawdown test, conducted on January 23, 1996 consisted of four 60-min steps at average rates of 64, 164, 219, and 325 gal/min followed by 1,190 min of recovery monitoring (fig. 5 and appendix 2). The elevation of static water level at the start of the test was 590.30 ft. The data were analyzed to estimate the two components of drawdown in the pumped well: (1) the hydraulic head loss in the aquifer, and (2) the hydraulic head losses from water entering the well. Estimates of the aquifer loss and well loss shown in table 3 were obtained using the methods of Hantush and Bierschenk and of Eden and Hazel (in Kruseman and de Ridder, 1994).

Values of drawdown measured in the pumped well during the sustained test were corrected by subtracting the estimated well loss at the measured pumping rate

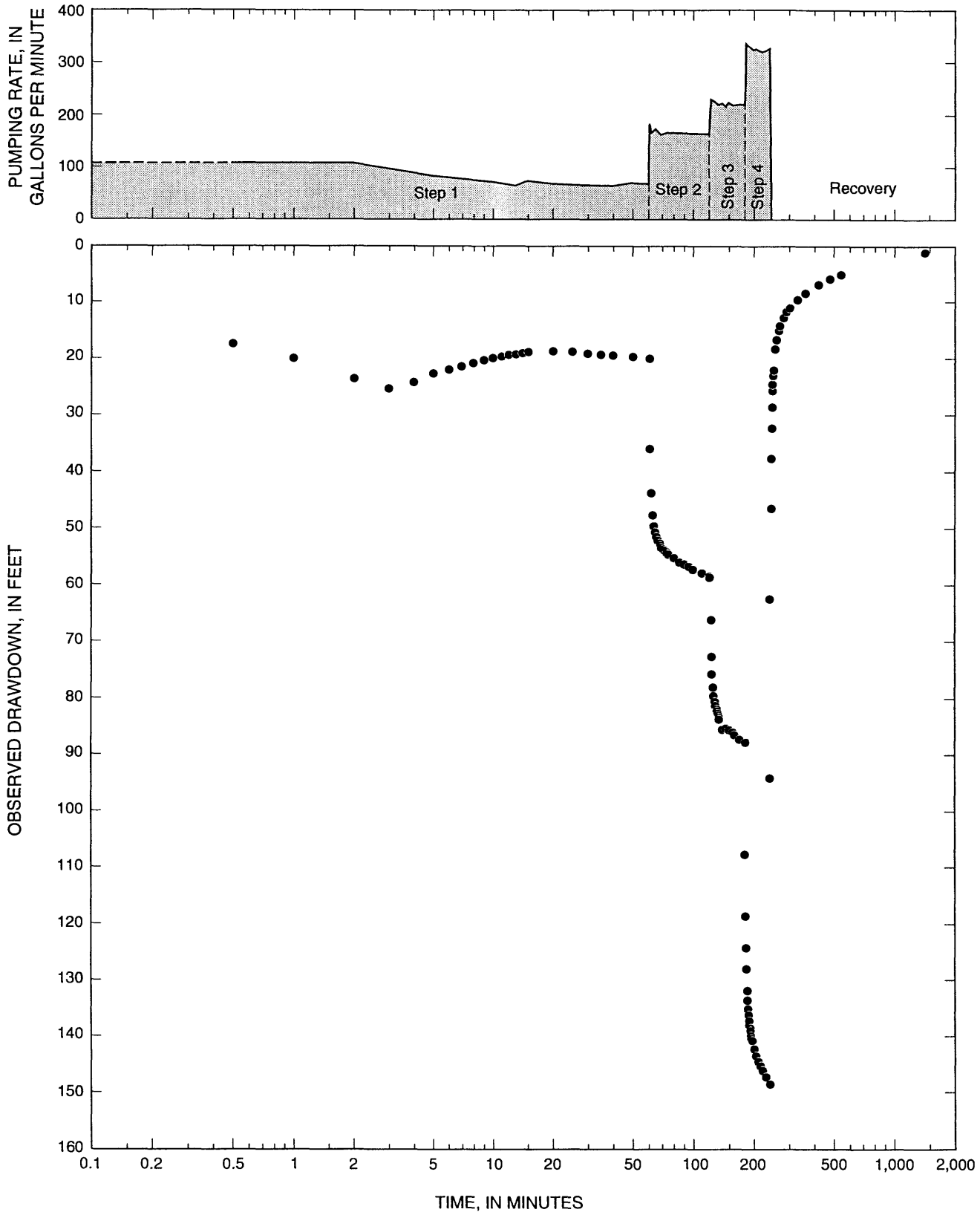


Figure 5. Drawdown with time during step-drawdown aquifer test (January 23, 1996), Northwest Kilohana monitor well (State well 2-0126-01), Kauai, Hawaii.

Table 3. Step-drawdown aquifer-test results, Northwest Kilohana monitor well (State well 2-0126-01), Kauai, Hawaii
[min/ft^2, minutes per square foot; min^2/ft^5, minutes squared per feet raised to the fifth power]

Analysis method[1]	Aquifer loss, *B* (min/ft^2)	Well loss, *C* (min^2/ft^5)	Well loss at pumping rate of 313 gallons per minute (feet)
Hantush and Bierschenk	1.945×10^{0}	3.020×10^{-2}	52.88
Eden and Hazel	3.883×10^{-1}	3.413×10^{-2}	59.76
Average	1.167×10^{-0}	3.217×10^{-2}	56.32

[1]Method of analysis documented in Kruseman and de Ridder (1994)

from the observed drawdown. Well loss at a specific pumping rate is calculated using:

$$s_w = CQ^2, \quad (1)$$

where:

s_w = well loss, in feet;

C = coefficient of well loss, in minutes squared per feet raised to the fifth power; and

Q = pumping rate, in feet cubed per minute.

For an average pumping rate of 313 gal/min (41.84 ft^3/min), the estimated well loss from equation 1 is 56.32 ft.

The sustained-rate aquifer test was done during January 24–31, 1996 for 10,080 min (about 7 days) at an average rate of 313 gal/min; recovery was monitored for 10,080 min at the end of the test (appendix 3). The elevation of static water level at the start of the test was 590.30 ft. Flow rates during the test fluctuated between 345 and 292 gal/min with the higher flow rates occurring in the first 60 min of the test. The maximum drawdown measured in the pumped well was 206.22 ft after 10,080 min into the test. After a correction for well loss, the drawdown in the aquifer was calculated to be 157.62 ft. The pumped water was discharged over a steep valley wall about 300 ft west of the well which lies above the south fork of the Wailua River about 1,000 ft away from the pumping well.

A marked decrease in drawdown at about 3,000 min into the sustained-rate test (fig. 6) is apparent in the plot. The record of pumping rate shows that the measured rate dropped about 8 gal/min over this time period. This decrease in pumping of 2.7 percent of the total pumping rate is probably not large enough to account for the flatness of the drawdown curve.

Water pumped from the well during the aquifer tests was noticeably warmer than the surrounding atmospheric temperature of 20.6°C. At 60 min into the test, the water temperature was 32.4°C; by the end of the test, the temperature had dropped to 27.0°C. The specific conductance of the pumped water also decreased throughout the sustained-rate test. At 25 min, the specific conductance was 1,044 µS/cm and near the end of the test at 9,120 min, the specific conductance had declined to 566 µS/cm.

SUMMARY

The Northwest Kilohana monitor well (State well 2-0126-01) is located near the center of the southern half of the Lihue basin between sugarcane fields on the northwest slope of Kilohana Volcano. The well was constructed during the period from December 4, 1995 to February 7, 1996 to study the hydrology and geology in an area where no other well information is available. The ground elevation at the well is 678.44 feet and the well is 1,004 feet deep (bottom is at -326 feet elevation) and has a boring diameter of 10 inches. Flush-jointed 4-inch (outer diameter) steel casing, with perforations between the water table and the bottom, was installed in the hole.

During drilling, water levels decreased with depth from 576 feet elevation when the hole bottom was at 431 feet elevation to 464 feet elevation when the hole bottom was at -326 feet elevation; measurements of the water level prior to the aquifer tests 11 days after drilling were at 590 feet elevation. The drillers reported a noticeable increase in water being circulated from the hole in the intervals between 446 and 441 feet elevation, 423 and 396 feet elevation, at 366 feet elevation, 353 to 349 feet elevation, 323 to 301 feet elevation, and at -189 feet elevation.

The Northwest Kilohana monitor well penetrated a 1,004-foot section of mafic lava flows and alluvium. A

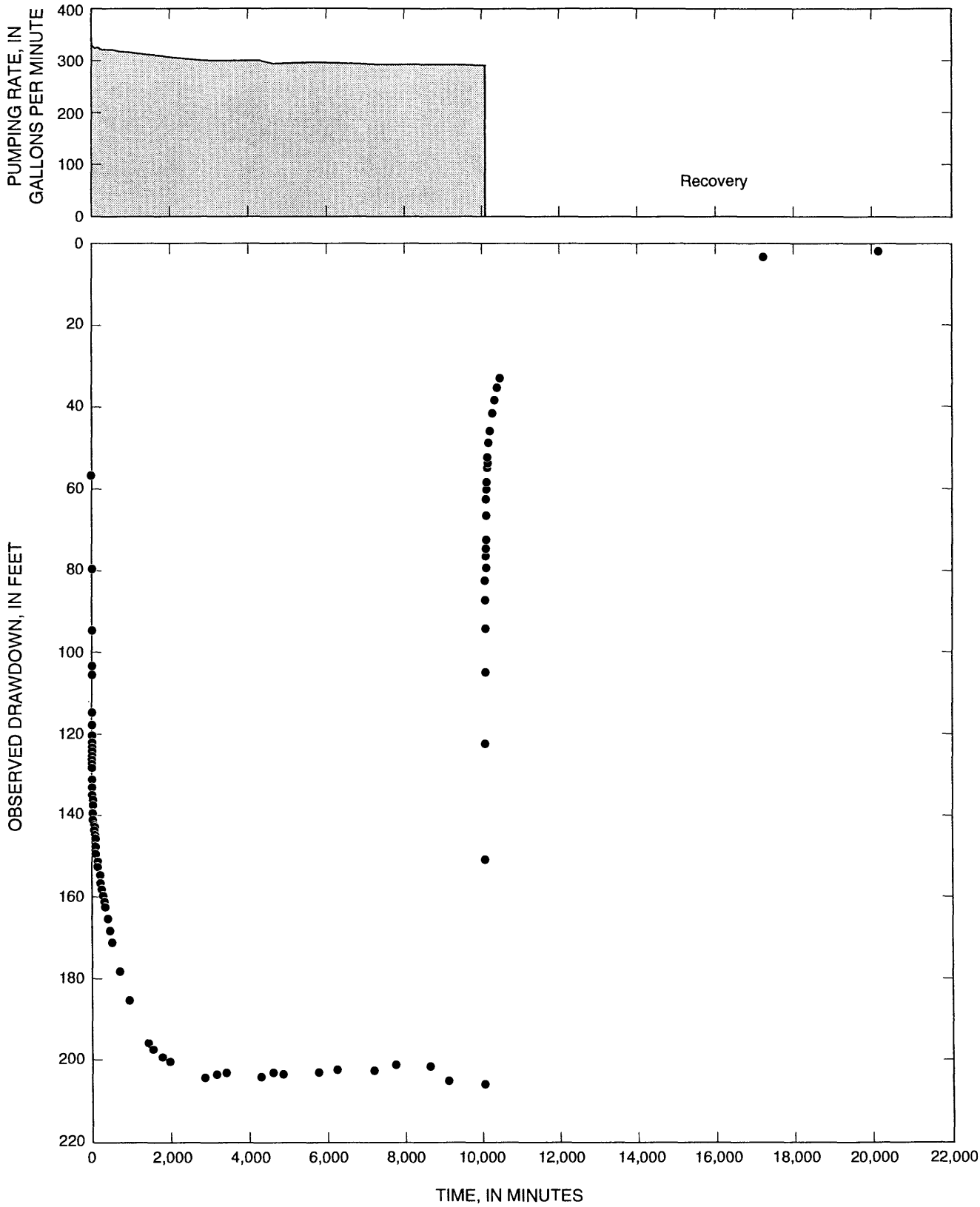


Figure 6. Drawdown with time during 7-day sustained-rate aquifer test (January 24–31, 1996), Northwest Kilohana monitor well (State well 2-0126-01), Kauai, Hawaii.

relatively thick section of unconsolidated sedimentary and clinker layers occurs between 33 and -67 feet elevation. Thinner sections containing sedimentary layers are between -192 and -292 feet elevation. These unconsolidated sections partially caved into the well bore before casing was installed and may have contributed to blockages found during caliper logging of the boring.

Step-drawdown and 7-day sustained-pumping-rate tests were conducted to test aquifer properties. The maximum drawdown measured in the pumped well was 206.22 feet (initial water-level elevation was 590.30 feet) during 7 days of sustained pumping at an average rate of 313 gallons per minute. Well loss, analyzed from the step-drawdown data was estimated to be 56.32 feet for an average pumping rate of 313 gallons per minute.

Water pumped from the well during the aquifer tests was noticeably warmer than the surrounding atmospheric temperature of 20.6°C. Measured water temperature rose as high as 32°C at 60 minutes into the sustained-rate test but declined to 27°C as the test progressed.

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Appendix 1. Lithologic descriptions of drill cuttings from Northwest Kilohana monitor well (State well 2-0126-01), Kauai, Hawaii
[Datum is mean sea level; depth measured from 678 feet above sea level]

Elevation (feet)			Depth (feet)			Sample description[1]
677	to	673	1	to	5	light-brown clay
673	to	668	5	to	10	dark brownish-gray clay with pieces of deeply weathered mafic rock
668	to	663	10	to	15	dark brownish-gray clay with pieces of deeply weathered mafic rock
663	to	658	15	to	20	dark brownish-gray clay with pieces of deeply weathered mafic rock
658	to	653	20	to	25	dark brownish-gray clay with pieces of deeply weathered mafic rock
653	to	648	25	to	30	dark brownish-gray clay with pieces of deeply weathered mafic rock
648	to	643	30	to	35	dark brownish-gray clay with pieces of deeply weathered mafic rock
643	to	638	35	to	40	dark brownish-gray clay with pieces of deeply weathered mafic rock
638	to	633	40	to	45	dark brownish-gray clay with pieces of deeply weathered mafic rock
633	to	628	45	to	50	brown clay with pieces of deeply weathered mafic rock
628	to	623	50	to	55	brown clay with pieces of deeply weathered mafic rock
623	to	618	55	to	60	brown clay with pieces of deeply weathered mafic rock
618	to	613	60	to	65	brown clay with pieces of deeply weathered mafic rock
613	to	608	65	to	70	brown clay with pieces of deeply weathered mafic rock
608	to	603	70	to	75	medium-gray, slightly weathered, aphyric, vesicular mafic rock
603	to	598	75	to	80	medium-gray, slightly weathered, aphyric, vesicular mafic rock with some gray clay
598	to	593	80	to	85	medium-gray, slightly weathered, aphyric, vesicular mafic rock with some gray clay
593	to	588	85	to	90	light-gray, slightly weathered, vesicular mafic rock with fine mineralized vesicles
588	to	583	90	to	95	gray, weathered, vesicular mafic rock with brown mud
583	to	578	95	to	100	gray, weathered, vesicular mafic rock with brown mud
578	to	573	100	to	105	light-gray, slightly weathered, dense aphyric mafic rock
573	to	568	105	to	110	medium-gray, dense, aphyric mafic rock
568	to	563	110	to	115	medium-gray, moderately to slightly weathered, dense, vesicular mafic rock
563	to	558	115	to	120	medium-gray, moderately to slightly weathered, dense, vesicular mafic rock
558	to	553	120	to	125	medium-gray, moderately to slightly weathered, dense, vesicular mafic rock
553	to	548	125	to	130	medium-gray, moderately to slightly weathered, dense, vesicular mafic rock
548	to	543	130	to	135	medium-gray, moderately to slightly weathered mafic rock with mineralized vesicles
543	to	538	135	to	140	dark-gray, dense, aphyric mafic rock mixed with vesicular mafic rock
538	to	533	140	to	145	dark-gray, dense, aphyric mafic rock mixed with vesicular mafic rock
533	to	528	145	to	150	dark-gray, aphyric mafic rock with few vesicles
528	to	523	150	to	155	dark-gray, aphyric mafic rock with few vesicles
523	to	518	155	to	160	dark-gray, aphyric mafic rock with few vesicles
518	to	513	160	to	165	dark-gray, aphyric mafic rock with few subspherical vesicles
513	to	508	165	to	170	dark-gray, aphyric mafic rock with few subspherical vesicles
508	to	503	170	to	175	dark-gray, aphyric mafic rock with few subspherical vesicles
503	to	498	175	to	180	medium-gray, slightly weathered, dense, aphyric mafic rock mixed with vesicular mafic rock
498	to	493	180	to	185	medium-gray, moderately vesicular, aphyric mafic rock
493	to	488	185	to	190	medium-gray, moderately vesicular, aphyric mafic rock
488	to	483	190	to	195	medium-gray, moderately vesicular, aphyric mafic rock
483	to	478	195	to	200	medium-gray, moderately vesicular, aphyric mafic rock
478	to	473	200	to	205	medium-gray, moderately vesicular, aphyric mafic rock
473	to	468	205	to	210	light-gray, moderately vesicular mafic rock with secondary minerals
468	to	463	210	to	215	dark-gray, moderately vesicular, aphyric mafic rock
463	to	458	215	to	220	dark-gray, moderately vesicular, aphyric mafic rock
458	to	453	220	to	225	dark-gray, moderately vesicular, aphyric mafic rock
453	to	448	225	to	230	no sample
448	to	443	230	to	235	light-gray, moderately vesicular, amygdaloidal mafic rock, some pieces with a chalky-white rind
443	to	438	235	to	240	light-gray, moderately vesicular, amygdaloidal mafic rock, some pieces with a chalky-white rind
438	to	433	240	to	245	light-gray, moderately vesicular, amygdaloidal mafic rock, some pieces with a chalky-white rind
433	to	428	245	to	250	dark-gray, dense, aphyric mafic rock
428	to	423	250	to	255	light-gray, slightly weathered, dense, aphyric mafic rock
423	to	418	255	to	260	light-gray, slightly weathered, dense, aphyric mafic rock
418	to	413	260	to	265	dark-gray, dense mafic rock mixed with yellow-brown, highly-weathered mafic rock
413	to	408	265	to	270	red-brown, highly weathered mafic rock

Appendix 1. Lithologic descriptions of drill cuttings from Northwest Kilohana monitor well (State well 2-0126-01), Kauai, Hawaii--Continued

Elevation (feet)			Depth (feet)			Sample description[1]
408	to	403	270	to	275	mix of brown to gray, slightly to highly weathered mafic rock
403	to	398	275	to	280	brown, weathered, angular mafic rock fragments
398	to	393	280	to	285	brown, weathered, angular mafic rock fragments
393	to	388	285	to	290	gray, slightly weathered, angular, vesicular mafic rock fragments
388	to	383	290	to	295	gray, slightly weathered, angular, vesicular mafic rock fragments
383	to	378	295	to	300	gray, slightly weathered, angular, vesicular mafic rock fragments
378	to	373	300	to	305	red-brown to gray, partially-weathered vesicular mafic rock
373	to	368	305	to	310	red-brown to gray, partially-weathered vesicular mafic rock
368	to	363	310	to	315	red-brown to gray, partially-weathered vesicular mafic rock
363	to	358	315	to	320	yellowish-gray, altered, vesicular mafic rock with white lath-shaped phenocrysts
358	to	353	320	to	325	yellowish-gray, altered, vesicular mafic rock with white lath-shaped phenocrysts
353	to	348	325	to	330	purplish-gray, aphyric mafic rock with spherical vesicles
348	to	343	330	to	335	purplish-gray, aphyric mafic rock with spherical vesicles
343	to	338	335	to	340	dark-gray, very dense, very-fine-grained mafic rock
338	to	333	340	to	345	dark-gray, very dense, very-fine-grained mafic rock
333	to	328	345	to	350	dark-gray, very dense, very-fine-grained mafic rock
328	to	323	350	to	355	dark-gray, very dense, very-fine-grained mafic rock
323	to	318	355	to	360	medium-gray, very dense, aphyric mafic rock
318	to	313	360	to	365	medium-gray, very dense, aphyric mafic rock
313	to	308	365	to	370	medium-gray, very dense, aphyric mafic rock
308	to	303	370	to	375	medium-gray, very dense, aphyric mafic rock
303	to	298	375	to	380	medium-gray, moderately vesicular, dense, aphyric mafic rock
298	to	293	380	to	385	medium-gray, moderately vesicular, dense, aphyric mafic rock
293	to	288	385	to	390	medium-gray, moderately vesicular, dense, aphyric mafic rock
288	to	283	390	to	395	brownish-gray, slightly weathered, dense, aphyric mafic rock
283	to	278	395	to	400	brownish-gray, slightly weathered, dense, aphyric mafic rock
278	to	273	400	to	405	brownish-gray, slightly weathered, dense, aphyric mafic rock
273	to	268	405	to	410	dark-gray, dense mafic rock with tiny olivine phenocrysts
268	to	263	410	to	415	dark-gray, dense mafic rock with tiny olivine phenocrysts
263	to	258	415	to	420	dark-gray, dense mafic rock with tiny olivine phenocrysts
258	to	253	420	to	425	dark-gray, dense mafic rock with tiny olivine phenocrysts
253	to	248	425	to	430	medium-gray, slightly weathered, dense, aphyric mafic rock
248	to	243	430	to	435	medium-gray, slightly weathered, dense, aphyric mafic rock
243	to	238	435	to	440	medium-gray, slightly weathered, dense, aphyric mafic rock
238	to	233	440	to	445	medium-gray, slightly weathered, dense, aphyric mafic rock
233	to	228	445	to	450	medium-gray, dense aphyric mafic rock
228	to	223	450	to	455	medium-gray, dense aphyric mafic rock
223	to	218	455	to	460	medium-gray, dense aphyric mafic rock
218	to	213	460	to	465	medium-gray, dense aphyric mafic rock
213	to	208	465	to	470	medium-gray, dense aphyric mafic rock
208	to	203	470	to	475	no sample
203	to	198	475	to	480	dark-gray, dense mafic rock with tiny olivine phenocrysts
198	to	193	480	to	485	dark-gray, dense mafic rock with tiny olivine phenocrysts
193	to	188	485	to	490	dark-gray, dense aphyric mafic rock
188	to	183	490	to	495	dark-gray, dense mafic rock with tiny olivine phenocrysts
183	to	178	495	to	500	dark-gray, dense mafic rock with tiny olivine phenocrysts
178	to	173	500	to	505	dark-gray, dense mafic rock with tiny olivine phenocrysts
173	to	168	505	to	510	dark-reddish-gray, dense, aphyric mafic rock
168	to	163	510	to	515	dark-reddish-gray, dense, aphyric mafic rock
163	to	158	515	to	520	dark-reddish-gray, dense, aphyric mafic rock
158	to	153	520	to	525	dark-reddish-gray, dense, aphyric mafic rock
153	to	148	525	to	530	medium-gray, dense, aphyric mafic rock
148	to	143	530	to	535	medium-gray, dense, aphyric mafic rock
143	to	138	535	to	540	medium-gray, dense, aphyric mafic rock

Appendix 1. Lithologic descriptions of drill cuttings from Northwest Kilohana monitor well (State well 2-0126-01), Kauai, Hawaii--Continued

Elevation (feet)			Depth (feet)			Sample description[1]
138	to	133	540	to	545	medium-gray, dense, aphyric mafic rock
133	to	128	545	to	550	medium-gray, dense mafic rock mixed with some vesicular mafic rock fragments
128	to	123	550	to	555	medium-gray, dense mafic rock mixed with some vesicular mafic rock fragments
123	to	118	555	to	560	dark-gray, dense, aphyric mafic rock
118	to	113	560	to	565	mix of medium-gray, dense, aphyric mafic rock with larger fragments of vesicular mafic rock
113	to	108	565	to	570	medium-gray, dense, aphyric mafic rock
108	to	103	570	to	575	medium-gray, dense, aphyric mafic rock
103	to	98	575	to	580	medium-gray, dense, aphyric mafic rock
98	to	93	580	to	585	medium-gray, dense, aphyric mafic rock
93	to	88	585	to	590	medium-gray, dense, aphyric mafic rock
88	to	83	590	to	595	medium-gray, dense, aphyric mafic rock
83	to	78	595	to	600	brownish-gray, slightly-weathered, dense aphyric mafic rock
78	to	73	600	to	605	brownish-gray, slightly-weathered, dense aphyric mafic rock
73	to	68	605	to	610	medium- to dark-gray, dense aphyric mafic rock
68	to	63	610	to	615	medium- to dark-gray, dense aphyric mafic rock
63	to	58	615	to	620	medium- to dark-gray, dense aphyric mafic rock
58	to	53	620	to	625	medium- to dark-gray, dense aphyric mafic rock
53	to	48	625	to	630	medium- to dark-gray, dense aphyric mafic rock
48	to	43	630	to	635	medium- to dark-gray, dense aphyric mafic rock
43	to	38	636	to	640	medium- to dark-gray, dense aphyric mafic rock
38	to	33	640	to	645	medium- to dark-gray, dense aphyric mafic rock
33	to	28	645	to	650	medium-gray, dense, aphyric mafic rock fragments with pinkish-brown clay coating
28	to	23	650	to	655	medium-gray, dense, aphyric mafic rock fragments with pinkish-brown clay coating
23	to	18	655	to	660	medium-gray, dense, aphyric mafic rock fragments with pinkish-brown clay coating
18	to	13	660	to	665	pinkish-brown clay
13	to	8	665	to	670	brown clay
8	to	3	670	to	675	brown clay
3	to	-2	675	to	680	pinkish-brown clay with pieces of highly-weathered mafic rock
-2	to	-7	680	to	685	tan clay with tan, highly-weathered gravelly mafic rock
-7	to	-12	685	to	690	tan clay with tan, highly-weathered gravelly mafic rock
-12	to	-17	690	to	695	tan clay with tan, highly-weathered gravelly mafic rock
-17	to	-22	695	to	700	tan clay with tan, highly-weathered gravelly mafic rock
-22	to	-27	700	to	705	tan clay with tan, highly-weathered gravelly mafic rock
-27	to	-32	705	to	710	yellowish to light-brown clay and deeply weathered mafic rock
-32	to	-37	710	to	715	yellowish to light-brown clay and deeply weathered mafic rock
-37	to	-42	715	to	720	yellowish to light-brown clay and deeply weathered mafic rock
-42	to	-47	720	to	725	yellowish to light-brown clay and deeply weathered mafic rock
-47	to	-52	725	to	730	yellowish to light-brown clay and deeply weathered mafic rock
-52	to	-57	730	to	735	yellowish to light-brown clay and deeply weathered mafic rock
-57	to	-62	735	to	740	yellowish to light-brown clay and deeply weathered mafic rock
-62	to	-67	740	to	745	yellowish to light-brown clay and deeply weathered mafic rock
-67	to	-72	745	to	750	yellowish-gray, moderately to slightly weathered, dense aphyric mafic rock
-72	to	-77	750	to	755	gray, slightly weathered, dense aphyric mafic rock
-77	to	-82	755	to	760	gray, slightly weathered, dense aphyric mafic rock
-82	to	-87	760	to	765	gray, slightly weathered, dense aphyric mafic rock
-87	to	-92	765	to	770	gray, slightly weathered, dense aphyric mafic rock
-92	to	-97	770	to	775	gray, slightly weathered, dense aphyric mafic rock
-97	to	-102	775	to	780	gray, slightly weathered, dense aphyric mafic rock
-102	to	-107	780	to	785	gray, slightly weathered, dense aphyric mafic rock
-107	to	-112	785	to	790	gray, slightly weathered, dense aphyric mafic rock
-112	to	-117	790	to	795	gray, slightly weathered, dense aphyric mafic rock
-117	to	-122	795	to	800	gray, slightly weathered, dense aphyric mafic rock
-122	to	-127	800	to	805	gray, slightly weathered, dense aphyric mafic rock
-127	to	-132	805	to	810	yellowish-gray, slightly weathered, dense, aphyric mafic rock

Appendix 1. Lithologic descriptions of drill cuttings from Northwest Kilohana monitor well (State well 2-0126-01), Kauai, Hawaii--Continued

Elevation (feet)			Depth (feet)			Sample description[1]
-132	to	-137	810	to	815	yellowish-gray, slightly weathered, dense, aphyric mafic rock
-137	to	-142	815	to	820	yellowish-gray, slightly weathered, dense, aphyric mafic rock
-142	to	-147	820	to	825	yellowish-gray, slightly weathered, dense, aphyric mafic rock
-147	to	-152	825	to	830	gray, slightly weathered, dense, aphyric mafic rock mixed with reddish-brown weathered mafic rock
-152	to	-157	830	to	835	gray, slightly weathered, dense, aphyric mafic rock mixed with reddish-brown weathered mafic rock
-157	to	-162	835	to	840	gray, slightly weathered, dense, aphyric mafic rock mixed with reddish-brown weathered mafic rock
-162	to	-167	840	to	845	gray, slightly weathered, dense, aphyric mafic rock mixed with reddish-brown weathered mafic rock
-167	to	-172	845	to	850	gray, slightly weathered, dense, aphyric mafic rock mixed with reddish-brown weathered mafic rock
-172	to	-177	850	to	855	gray, slightly weathered, dense, aphyric mafic rock mixed with reddish-brown weathered mafic rock
-177	to	-182	855	to	860	gray, slightly weathered, dense, aphyric mafic rock mixed with reddish-brown weathered mafic rock
-182	to	-187	860	to	865	gray, slightly weathered, dense, aphyric mafic rock mixed with reddish-brown weathered mafic rock
-187	to	-192	865	to	870	reddish-brown, deeply weathered mafic rock
-192	to	-197	870	to	875	reddish-brown, deeply weathered mafic rock
-197	to	-202	875	to	880	reddish-brown, deeply weathered mafic rock
-202	to	-207	880	to	885	reddish-brown, deeply weathered mafic rock
-207	to	-212	885	to	890	medium-gray, slightly weathered, dense, aphyric mafic rock with some weathered mafic rock
-212	to	-217	890	to	895	medium-gray, slightly weathered, dense, aphyric mafic rock with some weathered mafic rock
-217	to	-222	895	to	900	medium-gray, slightly weathered, dense, aphyric mafic rock with some weathered mafic rock
-222	to	-227	900	to	905	medium-gray, slightly weathered, dense, aphyric mafic rock with some weathered mafic rock
-227	to	-232	905	to	910	reddish-brown, deeply weathered mafic rock
-232	to	-237	910	to	915	reddish-brown, deeply weathered mafic rock
-237	to	-242	915	to	920	reddish-brown, deeply weathered mafic rock
-242	to	-247	920	to	925	medium-gray, dense, aphyric mafic rock with reddish-brown, deeply weathered mafic rock
-247	to	-252	925	to	930	reddish-brown, deeply weathered mafic rock
-252	to	-257	930	to	935	reddish-brown, deeply weathered mafic rock
-257	to	-262	935	to	940	reddish-brown, deeply weathered mafic rock
-262	to	-267	940	to	945	reddish-brown, deeply weathered mafic rock
-267	to	-272	945	to	950	reddish-brown, deeply weathered mafic rock
-272	to	-277	950	to	955	reddish-brown, deeply weathered mafic rock
-277	to	-282	955	to	960	reddish-brown, deeply weathered mafic rock
-282	to	-287	960	to	965	reddish-brown, deeply weathered mafic rock
-287	to	-292	965	to	970	dark-gray, dense, aphyric mafic rock mixed with reddish-brown, deeply weathered mafic rock
-292	to	-297	970	to	975	dark-gray, dense, aphyric mafic rock mixed with reddish-brown, deeply weathered mafic rock
-297	to	-302	975	to	980	dark-gray, dense, aphyric mafic rock mixed with reddish-brown, deeply weathered mafic rock
-302	to	-307	980	to	985	dark-gray, dense, aphyric mafic rock mixed with reddish-brown, deeply weathered mafic rock
-307	to	-312	985	to	990	dark-gray, dense, aphyric mafic rock mixed with reddish-brown, deeply weathered mafic rock
-312	to	-317	990	to	995	dark-gray, dense, aphyric mafic rock mixed with reddish-brown, deeply weathered mafic rock
-317	to	-322	995	to	1,000	dark-gray, dense, aphyric mafic rock mixed with reddish-brown, deeply weathered mafic rock
-322	to	-569	1,000	to	1,005	dark-gray, dense, aphyric mafic rock mixed with reddish-brown, deeply weathered mafic rock

[1]cuttings from rotary drilling lifted by air, foam, and polymer, sample repository: U.S. Geological Survey, Hawaii District office; date of logging: April, 1996

Appendix 2. Data from step-drawdown aquifer test, January 23, 1996, Northwest Kilohana monitor well (State well 2-0126-01), Kauai, Hawaii

[min, minutes; ft, feet; gal/min, gallons per minute; depth to water measured from 681.60 ft above mean sea level; -, no measurement made]

Time (min)	Depth to water (ft)	Drawdown (ft)	Pumping rate (gal/min)
0	91.30	0	0
0.5	108.80	17.50	-
1	111.31	20.01	105
2	114.95	23.65	105
3	116.74	25.44	-
4	115.62	24.32	-
5	114.07	22.77	80
6	113.33	22.03	-
7	112.83	21.53	75
8	112.11	20.81	74
9	111.59	20.29	-
10	111.30	20.00	70
11	110.96	19.66	-
12	110.72	19.42	-
13	110.60	19.30	62
14	110.38	19.08	-
15	110.19	18.89	70
20	110.04	18.74	66
25	110.13	18.83	63
30	110.47	19.17	62
35	110.62	19.32	62
40	110.79	19.49	62
50	111.13	19.83	68
60	111.35	20.05	67
61	127.32	36.02	180
62	135.07	43.77	165
63	138.99	47.69	168
64	140.88	49.58	-
65	141.97	50.67	170
66	142.82	51.52	-
67	143.45	52.15	164
68	143.94	52.64	-
69	144.41	53.11	160
70	144.73	53.43	164
71	145.03	53.73	-
72	145.28	53.98	162
73	145.52	54.22	-
74	145.74	54.44	164
75	145.93	54.63	-
80	146.55	55.25	164
85	147.29	55.99	164
90	147.67	56.37	164
95	148.11	56.81	163
100	148.70	57.40	164
110	149.26	57.96	163
120	149.82	58.52	163
121	150.01	58.71	190
122	157.64	66.34	210
123	163.96	72.66	228
124	167.05	75.75	-
125	169.38	78.08	226
126	170.92	79.62	224
127	171.99	80.69	226
128	172.71	81.41	224
129	173.19	81.89	225
130	173.61	82.31	225

Appendix 2. Data from step-drawdown aquifer test, January 23, 1996, Northwest Kilohana monitor well (State well 2-0126-01), Kauai, Hawaii--Continued

[min, minutes; ft, feet; gal/min, gallons per minute; depth to water measured from 681.60 ft above mean sea level; -, no measurement made]

Time (min)	Depth to water (ft)	Drawdown (ft)	Pumping rate (gal/min)
131	174.08	82.78	220
132	174.30	83.00	220
133	174.51	83.21	220
134	174.77	83.47	219
135	175.04	83.74	-
140	176.86	85.56	220
145	176.58	85.28	217
150	176.99	85.69	220
155	177.40	86.10	218
160	177.81	86.51	218
170	178.61	87.31	219
180	179.09	87.79	220
181	199.07	107.77	-
182	209.98	118.68	-
183	215.62	124.32	334
184	219.32	128.02	330
185	223.23	131.93	-
186	224.91	133.61	-
187	226.55	135.25	331
188	227.54	136.24	-
189	228.77	137.47	330
190	229.41	138.11	328
191	230.08	138.78	-
192	230.72	139.42	-
193	231.12	139.82	329
194	231.79	140.49	-
195	232.11	140.81	327
200	233.68	142.38	325
205	234.98	143.68	325
210	236.03	144.73	323
215	236.81	145.51	323
220	237.52	146.22	321
230	238.72	147.42	322
240	239.91	148.61	325
241	185.49	94.19	0
242	153.86	62.56	0
243	137.84	46.54	0
244	129.05	37.75	0
245	123.64	32.34	0
246	119.97	28.67	0
247	117.04	25.74	0
248	115.97	24.67	0
249	114.41	23.11	0
250	113.27	21.97	0
255	109.66	18.36	0
260	107.98	16.68	0
265	106.35	15.05	0
270	105.47	14.17	0
280	104.04	12.74	0
290	102.99	11.69	0
300	102.31	11.01	0
330	100.79	9.49	0
360	99.63	8.33	0
420	98.12	6.82	0
480	97.19	5.89	0
540	96.45	5.15	0
1,430	92.45	1.15	0

Appendix 3. Data from 7-day sustained-rate aquifer test, January 24–31, 1996, Northwest Kilohana monitor well (2-0126-01), Kauai, Hawaii

[min, minutes; ft, feet; gal/min, gallons per minute; °C, degrees Celsius; µS/cm, microsiemens per centimeter at 25°C; static water level at start of test was 590.30 feet above mean sea level; depth to water measured from 681.60 feet above mean sea level; -, no measurement made]

Time (min)	Depth to water (ft)	Drawdown (ft)	Pumping rate (gal/min)	Drawdown, corrected for well loss (ft)	Temperature (°C)	Specific conductance (µS/cm)
0	92.44	0	0	0	-	-
1	149.16	56.72	345	-11.12	-	-
2	172.20	79.76	345	11.92	-	-
3	187.42	94.98	330	32.91	-	-
4	196.31	103.87	330	41.80	-	-
5	198.08	105.64	330	43.58	-	-
6	207.21	114.77	330	52.70	-	-
7	210.36	117.92	330	55.85	-	-
8	212.83	120.39	330	58.32	-	-
9	214.75	122.31	330	60.24	-	-
10	216.16	123.72	330	61.65	-	-
11	217.02	124.58	330	62.51	-	-
12	218.27	125.83	330	63.76	-	-
13	219.25	126.81	330	64.74	-	-
14	220.19	127.75	330	65.68	-	-
15	221.16	128.72	330	66.65	-	-
20	223.93	131.49	327	70.54	-	-
25	226.03	133.59	327	72.64	32.1	1,044
30	227.62	135.18	327	74.23	-	-
35	228.99	136.55	326	75.97	-	-
40	230.12	137.68	326	77.10	-	-
50	232.00	139.56	324	79.72	-	-
60	233.71	141.27	324	81.43	32.4	1,036
70	235.18	142.74	324	82.90	-	-
80	236.36	143.92	324	84.08	-	-
90	237.66	145.22	324	85.38	-	-
100	238.52	146.08	324	86.24	-	-
120	240.51	148.07	324	88.23	-	-
140	242.38	149.94	325	89.73	-	-
160	244.09	151.65	323	92.18	31.5	1,003
180	245.48	153.04	325	92.83	-	-
210	247.44	155.00	323	95.53	31.3	987
240	249.23	156.79	322	97.69	31.3	980
270	250.93	158.49	322	99.39	-	-
300	252.45	160.01	322	100.91	31.0	965
330	253.96	161.52	322	102.42	-	-
360	255.28	162.84	322	103.74	-	-
420	257.97	165.53	322	106.43	30.6	932
480	260.89	168.45	321	109.72	30.1	913
540	263.85	171.41	321	112.68	30.4	906
720	270.79	178.35	318	120.71	30.0	863
960	277.96	185.52	316	128.60	29.5	813
1,440	288.62	196.18	312	140.69	29.2	745
1,560	290.08	197.64	312	142.15	29.3	731
1,800	292.04	199.60	310	144.82	29.3	705
1,980	293.21	200.77	307	147.05	28.8	693
2,880	297.18	204.74	300	153.44	28.4	640
3,180	296.25	203.81	300	152.51	-	-
3,420	295.86	203.42	300	152.12	28.6	626
4,320	296.68	204.24	300	152.94	28.0	605

Appendix 3. Data from 7-day sustained-rate aquifer test, January 24–31, 1996, Northwest Kilohana monitor well (2-0126-01), Kauai, Hawaii--Continued

[min, minutes; ft, feet; gal/min, gallons per minute; °C, degrees Celsius; µS/cm, microsiemens per centimeter at 25°C; static water level at start of test was 590.30 feet above mean sea level; depth to water measured from 681.60 feet above mean sea level; -, no measurement made]

Time (min)	Depth to water (ft)	Drawdown (ft)	Pumping rate (gal/min)	Drawdown, corrected for well loss (ft)	Temperature (°C)	Specific conductance (µS/cm)
4,620	295.94	203.50	296	153.56	28.8	599
4,860	296.22	203.78	296	153.84	28.6	593
5,760	295.85	203.41	295	153.81	28.1	587
6,240	295.13	202.69	294	153.42	28.6	583
7,200	295.39	202.95	293	154.02	27.8	576
7,740	293.96	201.52	293	152.59	28.5	576
8,640	294.39	201.95	292	153.35	27.9	569
9,120	297.92	205.48	293	156.55	27.9	570
10,080	298.66	206.22	292	157.62	27.0	566
10,081	243.57	151.13	0	151.13	-	-
10,082	215.13	122.69	0	122.69	-	-
10,083	197.67	105.23	0	105.23	-	-
10,084	187.03	94.59	0	94.59	-	-
10,085	179.97	87.53	0	87.53	-	-
10,086	175.15	82.71	0	82.71	-	-
10,087	171.82	79.38	0	79.38	-	-
10,088	169.21	76.77	0	76.77	-	-
10,089	167.10	74.66	0	74.66	-	-
10,090	165.22	72.78	0	72.78	-	-
10,095	159.21	66.77	0	66.77	-	-
10,100	155.17	62.73	0	62.73	-	-
10,105	152.75	60.31	0	60.31	-	-
10,110	150.98	58.54	0	58.54	-	-
10,120	147.46	55.02	0	55.02	-	-
10,130	146.54	54.10	0	54.10	-	-
10,140	144.88	52.44	0	52.44	-	-
10,170	141.38	48.94	0	48.94	-	-
10,200	138.59	46.15	0	46.15	-	-
10,260	134.25	41.81	0	41.81	-	-
10,320	130.95	38.51	0	38.51	-	-
10,380	128.03	35.59	0	35.59	-	-
10,440	125.63	33.19	0	33.19	-	-
17,220	95.69	3.25	0	3.25	-	-
20,160	94.23	1.79	0	1.79	-	-