DRILLING, CONSTRUCTION, AND CALIPER-LOG DATA FOR WELL 3-3505-25, NORTH LOWER ANAHULU EXPLORATORY WELL, OAHU, HAWAII

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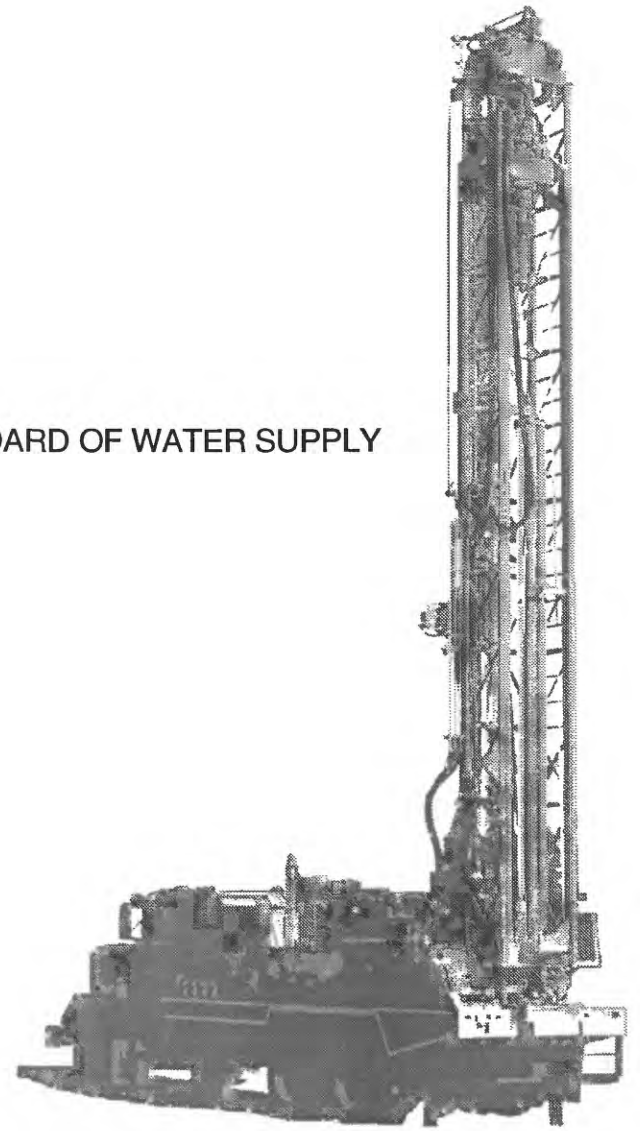

Prepared in cooperation with the

CITY AND COUNTY OF HONOLULU BOARD OF WATER SUPPLY

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Conversion Factors

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

Elevations in this report are referenced relative to mean sea level.

Drilling, Construction, and Caliper-Log Data for Well 3-3505-25, North Lower Anahulu Exploratory Well, Oahu, Hawaii

By Todd K. Presley and Delwyn S. Oki

Abstract

The North Lower Anahulu exploratory well (State well number 3-3505-25) was drilled about 1.4 miles east-northeast of the town of Haleiwa. The well was drilled on agricultural land in the Kawailoa ground-water area. The well was drilled from an elevation of about 232 feet above mean sea level and penetrates about 22 feet into a basalt aquifer. Well-construction data, logs of drilling notes, geologic descriptions for the samples, and caliper-log data are presented for the well. The well is one of 12 exploratory wells drilled in the north-central Oahu area between July, 1993 and May, 1994 in cooperation with the Honolulu Board of Water Supply.

INTRODUCTION

Because of water-supply concerns associated with population increase on the island of Oahu, the Honolulu Board of Water Supply, in cooperation with the U.S. Geological Survey (USGS), conducted a study to assess the availability of ground water in north-central Oahu. This study included drilling 12 exploratory and monitoring wells between July 1993 and May 1994.

This report presents drilling data for the North Lower Anahulu exploratory well (State well number 3-3505-25). The well is located about 1.4 miles east-northeast of the town of Haleiwa (figs. 1 and 2). The purpose of the well is to increase spatial coverage of water levels for the Kawailoa ground-water area (Rosenau and others, 1971; Dale, 1978; Hunt, in press) and to provide a water-level observation well for monitoring. Data from this well also could help determine if water-level change due to pumping in the Waialua ground-water area occurs across the ground-water barrier created by Anahulu Gulch.

Regional Setting

The study area is located in north-central Oahu between the crests of the Koolau Range and the Waianae Range (fig. 1). The mountain ranges are the eroded remnants of two shield volcanoes. The Mokuleia ground-water area lies within the basalt aquifer of the Waianae Volcano, and the Waialua and Kawailoa ground-water areas lie within the basalt aquifer of the Koolau Volcano. Previous studies (Rosenau and others, 1971; Dale, 1978; Hunt, in press) that describe the physical and geological aspects of the study area are summarized here. The Mokuleia and Waialua ground-water areas are separated by low-permeability paleosols and saprolite of the Waianae Volcano that lie below the geologic contact between the Waianae and Koolau Volcanoes. The Waialua and Kawailoa ground-water areas are separated by alluvium and weathered basalt in and beneath Anahulu Gulch. Seaward flow of ground water in the Mokuleia and Waialua ground-water areas is impeded by a coastal confining unit that is composed of marine and terrestrial sediment known locally as "caprock." The caprock creates a confined artesian condition at low elevations near the shore. Further inland however, the aquifer is unconfined.

Water levels in the Waialua and Kawailoa ground-water areas are about 12 ft and 4 ft above mean sea level, respectively. Water levels in the Mokuleia ground-water area are about 20 ft. Withdrawal from the Waialua, Kawailoa and Mokuleia ground-water areas is primarily for sugarcane irrigation, although there are also several municipal wells and numerous small capacity private wells. Natural ground-water discharge

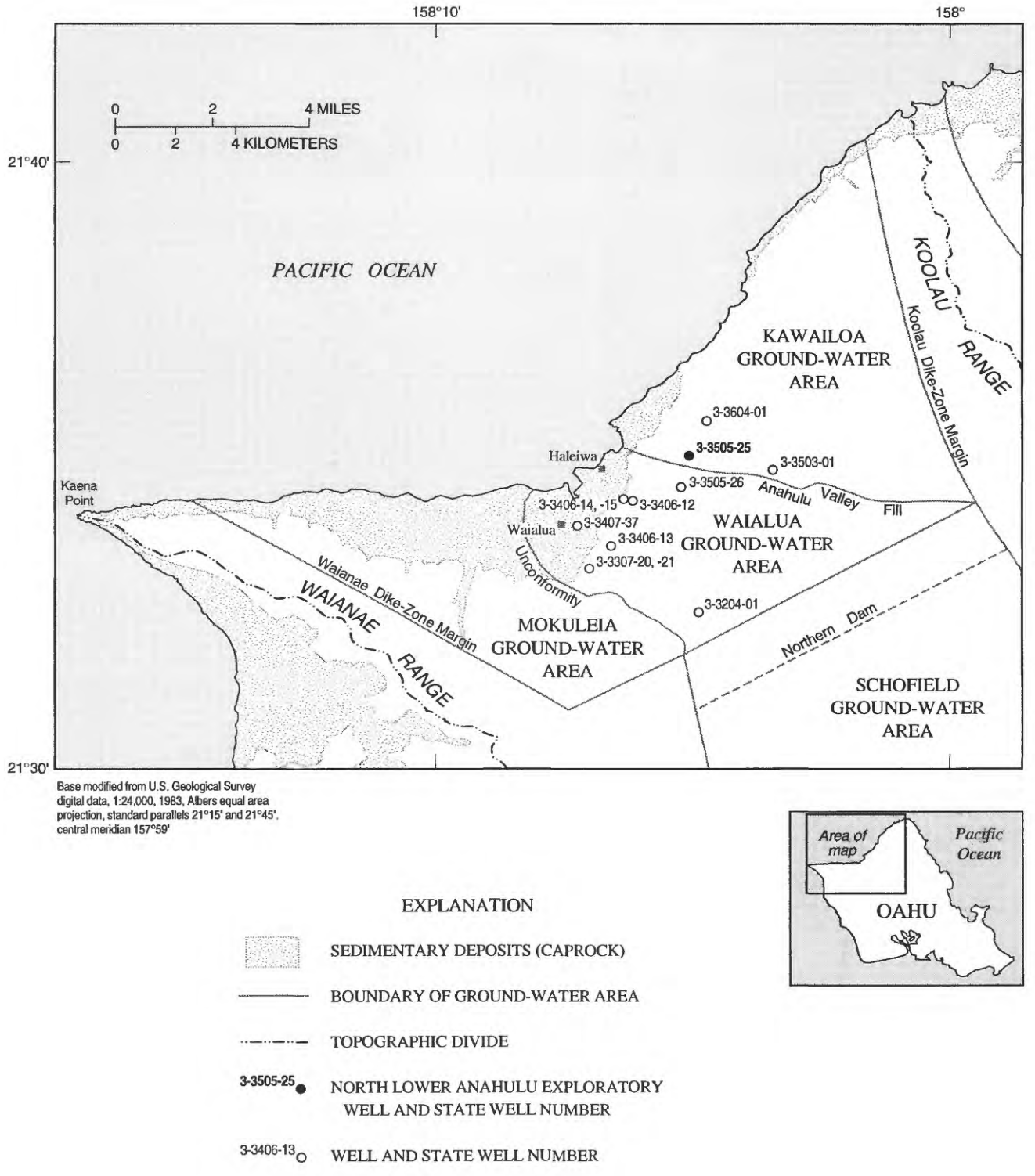

Figure 1. Ground-water areas of north-central Oahu (modified from Hunt, in press) and wells drilled during the study, Hawaii.

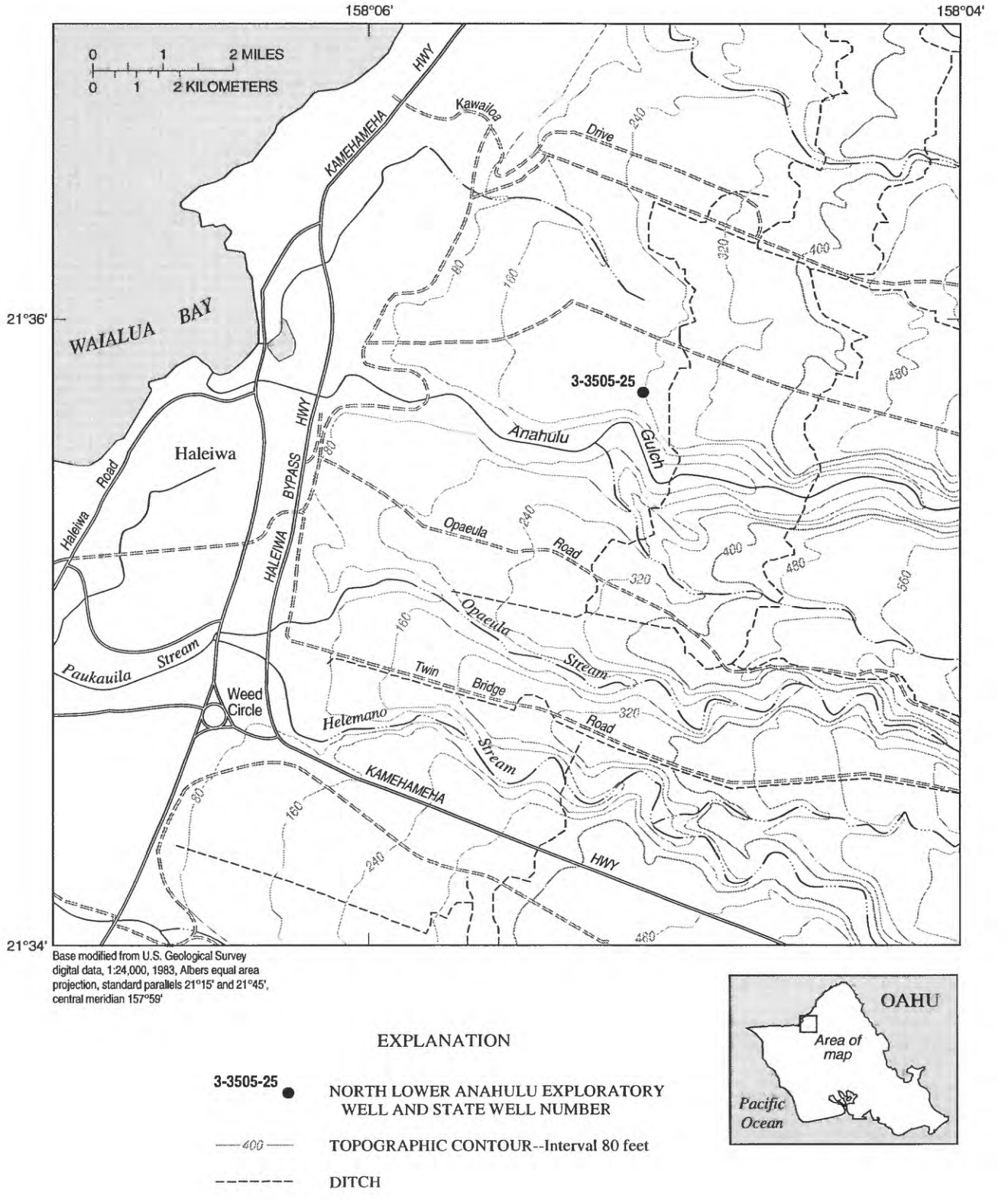

Figure 2. Location of North Lower Anahulu exploratory well, Oahu, Hawaii.

occurs at springs and by subsurface flow through the caprock to the ocean (Rosenau and others, 1971).

Acknowledgments

The USGS gratefully acknowledges the Waialua Sugar Company for their assistance in identifying and preparing the drill site. The USGS also thanks the Bernice Pauahi Bishop Estate for permission to drill on their land.

DRILLING, CONSTRUCTION, AND CALIPER-LOG DATA

The North Lower Anahulu exploratory well (State well number 3-3505-25) is 1.5 mi east-northeast of the town of Haleiwa on the north side of Anahulu Gulch. The site is located along a peripheral road of a sugarcane field. Well-construction data is provided in table 1 and construction details are shown in figure 3.

The North Lower Anahulu exploratory well was drilled using an air-rotary system with flush-jointed 4 1/2-in. diameter drill pipe. Drilling foam and polymer were injected into the air-circulation system to assist the removal of drill cuttings and to stabilize the hole. The elevation of the ground surface in the area of the drill site is about 232 ft. A 12 1/2-in. diameter hole was drilled to an elevation of 182 ft above mean sea level and cased with 52 ft of 8 5/8-in. outside-diameter (od) steel casing. The annular space was grouted with cement to provide a surface seal. An 7 7/8-in. diameter tri-cone tungsten-carbide button bit was then used to drill to an elevation of -18 ft. After the total depth was reached, a Well Reconnaissance logging unit was used to record a caliper log. The well was cased with 4 1/2-in. outside-diameter flush-jointed PVC casing. PVC screen with 0.02 in. slots was installed through the water column.

Samples of the materials expelled by the circulation system while drilling were collected every 5 ft. Beyond a depth of 220 ft, the circulation was completly absorbed and no sample was recovered. The geologic log (geologic descriptions of the recovered samples from drilling) is presented in table 2, and the driller's log (driller's observations while drilling) is presented in table 3. From the surface, the bore penetrated 10 ft of soil, 10 ft of hard clay, 30 ft of weathered basalt, 20 ft of slightly weathered basalt, and 150 ft of relatively unweathered basalt.

Table 1. Construction data for North Lower Anahulu exploratory well, Oahu, Hawaii.
[Elevation datum is mean sea level; in., inch; ft, feet; od, outside diameter]

Well name	North Lower Anahulu exploratory well
State well number	3-3505-25
Latitude and longitude	21°35'45"N, 158°05'04"W
Hawaii tax map key number	6-2-09-1
Landowner	Bernice Pauahi Bishop Estate
Leaseholder	Waialua Sugar Company
Well completed	December 23, 1993
Working days to complete	7 days
Driller	Fred Thibedeau, USGS
Surface hole diameter	12 1/4 in.
Bottom of surface casing elevation	182 ft
Surface casing diameter and type	8 5/8-in. od steel, 0.188-in. thick wall
Final hole diameter	7 7/8 in.
Bottom of well elevation	-18 ft
Open interval elevations	182 ft to -18 ft
Screened interval elevations	22 ft to -18 ft
Inner casing diameter and type	4 1/2-in. od PVC, flush-jointed
Screen type	4 1/2-in. od PVC, flush-jointed, 0.02-in. horizontal slots
Reference mark elevation (bolt)	232.93 ft
Top of casing measuring point elevation	234.24 ft
Water level and date of measurement	4.75 ft, February 14, 1995

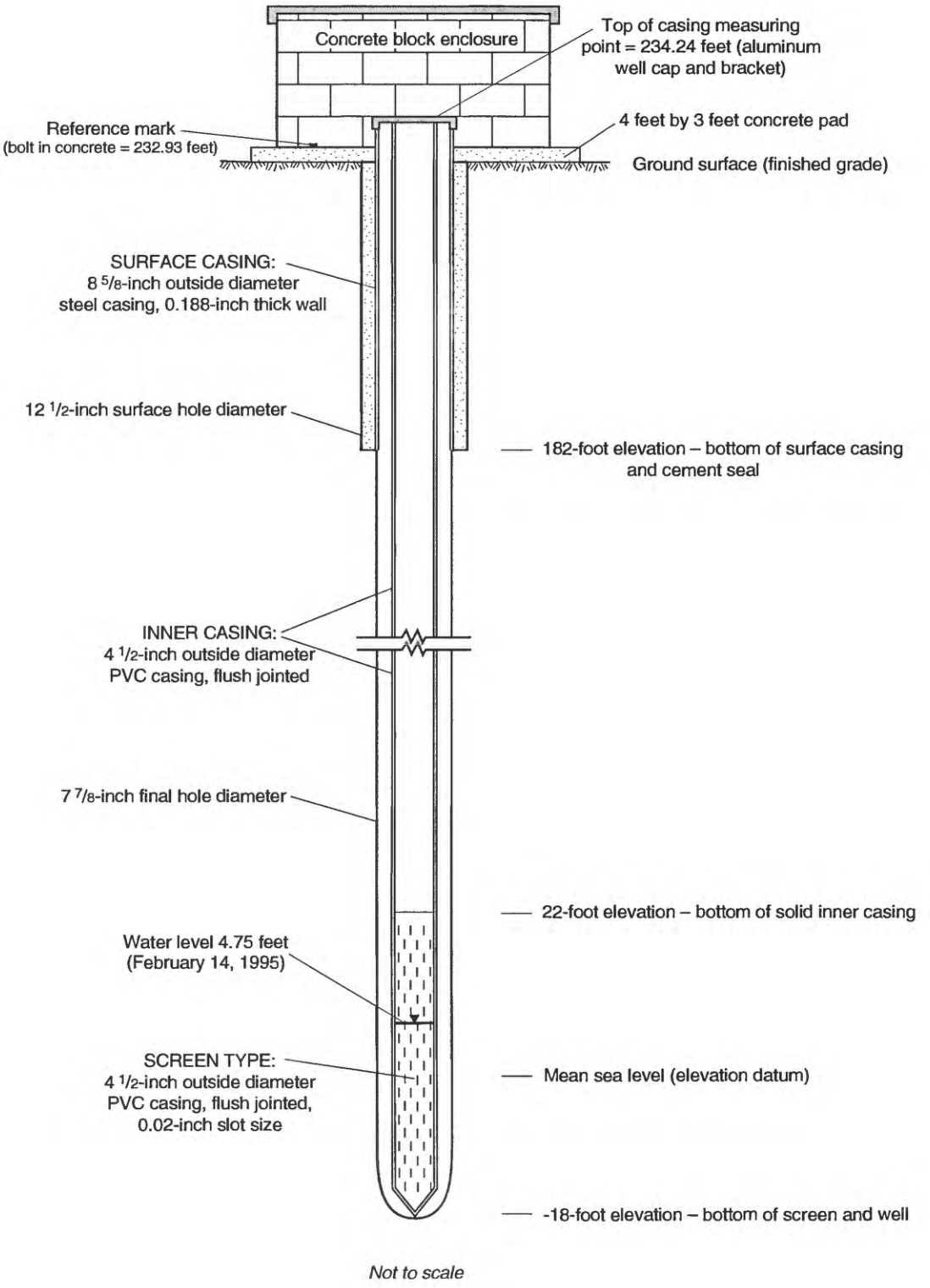

Figure 3. Construction details for North Lower Anahulu exploratory well (State well number 3-3505-25), Oahu, Hawaii.

Table 2. Geologic log for the North Lower Anahulu exploratory well (State well number 3-3505-25), Oahu, Hawaii.
[Elevation datum is mean sea level]

Depth above grade (feet)	Elevation (feet)	Sample description	Comments
0 to 5	232 to 227	Red soil	
5 to 10	227 to 222	Red soil	
10 to 15	222 to 217	Orangish-brown, hard clay	
15 to 20	217 to 212	Red-brown, hard clay	
20 to 25	212 to 207	Light-grey basalt	
25 to 30	207 to 202	Grey to reddish-grey, highly vesicular, weathered basalt	
30 to 35	202 to 197	Grey, slightly vesicular, unweathered basalt	
35 to 40	197 to 192	Greyish-brown, highly weathered basalt	
40 to 45	192 to 187	Greyish-brown, highly weathered basalt	
45 to 50	187 to 182	Grey to brown, slightly vesicular basalt	
50 to 55	182 to 177	Brown, highly vesicular, slightly weathered basalt	
55 to 60	177 to 172	Grey, highly vesicular, slightly weathered basalt	
60 to 65	172 to 167	Brownish-grey, nonvesicular, slightly weathered basalt	
65 to 70	167 to 162	Brownish-grey, nonvesicular, slightly weathered basalt	
70 to 75	162 to 157	Grey, massive basalt	Sample appears fresher than above
75 to 80	157 to 152	Grey, massive basalt	
80 to 85	152 to 147	Grey, massive basalt	
85 to 90	147 to 142	Reddish-grey, vesicular and nonvesicular basalt	
90 to 95	142 to 137	Dark-grey, massive basalt	Rare vesicles
95 to 100	137 to 132	Grey basalt	Pulverized sample
100 to 105	132 to 127	Grey basalt	Pulverized sample
105 to 110	127 to 122	Dark-grey, slightly vesicular basalt	
110 to 115	122 to 117	Dark-grey, vesicular basalt	
115 to 120	117 to 112	Dark-grey, vesicular basalt	
120 to 125	112 to 107	Dark-grey, vesicular basalt	
125 to 130	107 to 102	Brownish-grey, slightly vesicular basalt; some olivine	
130 to 135	102 to 97	Brownish-grey, slightly vesicular basalt; some olivine	
135 to 140	97 to 92	Brownish-grey, slightly vesicular basalt; some olivine	
140 to 145	92 to 87	Brownish-grey, slightly vesicular basalt; some olivine	
145 to 150	87 to 82	Brownish-grey, slightly vesicular basalt; some olivine	
150 to 155	82 to 77	Brownish-grey, slightly vesicular basalt; some olivine	
155 to 160	77 to 72	Brownish-grey, slightly vesicular basalt; some olivine	
160 to 165	72 to 67	Reddish, vesicular basalt; grey, nonvesicular basalt with olivine	
165 to 170	67 to 62	Grey, nonvesicular basalt; some olivine	
170 to 175	62 to 57	Grey, nonvesicular basalt; some olivine	
175 to 180	57 to 52	Grey, nonvesicular basalt; some olivine	
180 to 185	52 to 47	Grey, nonvesicular basalt; red, slightly vesicular basalt	
185 to 190	47 to 42	Grey, slightly vesicular basalt; red, slightly vesicular basalt	
190 to 195	42 to 37	Red, slightly vesicular basalt; grey, slightly vesicular basalt	
195 to 200	37 to 32	Grey, massive, aphyric basalt	
200 to 205	32 to 27	Grey, massive, aphyric basalt	
205 to 210	27 to 22	Grey, massive, aphyric basalt; red, vesicular basalt	
210 to 215	22 to 17	Reddish-grey, vesicular basalt	Spherical vesicles
215 to 220	17 to 12	Reddish-grey, vesicular basalt	Spherical vesicles

Table 3. Driller's log for North Lower Anahulu exploratory well (State well number 3-3505-25), Oahu, Hawaii
[Elevation datum is mean sea level]

Depth below grade (feet)	Elevation (feet)	Description
0 to 9	232 to 223	Red saprolite
9 to 12	223 to 220	Brown saprolite
12 to 13	220 to 219	Grey saprolite
13 to 17	219 to 215	Grey and brown saprolite
17 to 20	215 to 212	Saprolite and broken rock
20 to 24	212 to 208	Grey, hard rock
24 to 25	208 to 207	Fracture zone
25 to 48	207 to 184	Packed, firm rock, non-caving
48 to 52	184 to 180	Grey, hard rock
52 to 250	180 to -18	Firm, non-caving basalt of varying hardness

The caliper log (fig. 4) shows two hole enlargements where the caliper arms extend to greater than 12 in. between the elevations of 10 to 30 ft. The caliper tool has three 16-in. spring-loaded arms that are extended when the tool is at the bottom of the hole. As the tool is raised, the logging unit records the extension of the prongs as they drag against the walls of the bore. The caliper extension is an indication of hole diameter and wall smoothness, but the instrument does not measure these attributes directly. The maximum extension for the caliper tool is 32 in.

The measurement point (elevation 234.24 ft) for water-level determination is located on the east side of the aluminum well-cap bracket affixed to the top of the 8 5/8-in. od steel surface casing. An additional reference mark (elevation 232.93 ft) for the well site is located on the top of a stainless steel bolt emplaced into the concrete pad surrounding the well.

ADDITIONAL INFORMATION

Information for the 12 wells drilled during the north-central Oahu study is listed in table 4. Nine of the wells were drilled in the Waialua ground-water area, and three wells were drilled north of Anahulu Gulch in the Kawailoa ground-water area, including the North Lower Anahulu exploratory well (State well number 3-3505-25). Water-level time-series data were collected for all of the wells drilled and for numerous other existing wells as part of the overall monitoring effort for the project (unpublished data in files of the USGS, Honolulu). Data were collected using electronic data loggers coupled to shaft encoder-float systems or pressure transducers.

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Hunt, C.D. Jr., in press, Geohydrology of the island of Oahu, Hawaii: U.S. Geological Survey Professional Paper 1412-B.

Rosenau, J.C., Lubke, E.R., and Nakahara, R.H., 1971,Water resources of north-central Oahu, Hawaii: U.S. Geological Survey Water-Supply Paper 1899-D, 40 p.

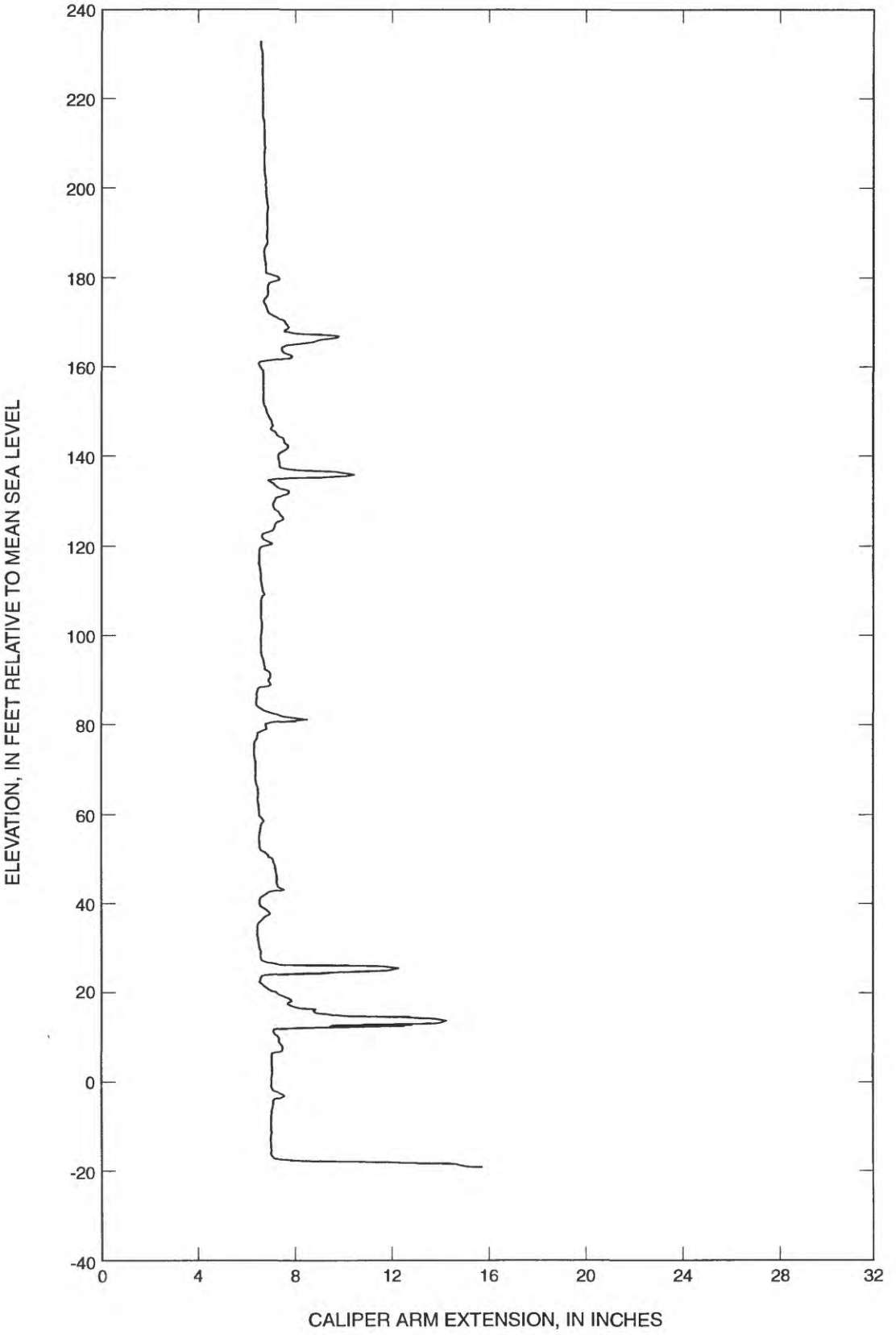

Figure 4. Caliper log for North Lower Anahulu exploratory well (State well number 3-3505-25), Oahu, Hawaii.

Table 4. Construction data for wells drilled during the study, Oahu, Hawaii.

[ft, feet; in., inch]

State well number	Well name	Latitude	Longitude	Hawaii state tax map key number	Landowner	Well completed	Working days to complete
3-3204-01	Kaheaka exploratory well	21°32'52"	158°04'52"	6-5-01-2	Castle and Cooke Land Company	March 2, 1994	16 days
3-3307-20	Thompson Corner exploratory well I	21°33'41"	158°07'02"	6-5-01-1	Castle and Cooke Land Company	July 9, 1993	14 days
3-3307-21	Thompson Corner exploratory well II	21°33'41"	158°07'02"	6-5-01-1	Castle and Cooke Land Company	August 9, 1993	15 days
3-3406-12	Twin Bridge Road deep monitor well	21°34'56"	158°06'10"	6-4-01-1	Castle and Cooke Land Company	March 9, 1994	27 days
3-3406-13	Kaamooloa exploratory well	21°34'06"	158°06'36"	6-5-01-2	Castle and Cooke Land Company	January 12, 1994	4 days
3-3406-14	Helemano exploratory well I	21°34'58"	158°06'21"	6-2-07-11	Castle and Cooke Land Company	October 15, 1993	11 days
3-3406-15	Helemano exploratory well II	21°34'58"	158°06'21"	6-2-07-11	Castle and Cooke Land Company	November 15, 1993	15 days
3-3407-37	Kiikii exploratory well	21°34'28"	158°07'16"	6-6-23-3	Castle and Cooke Land Company	April 21, 1994	27 days
3-3503-01	North Upper Anahulu exploratory well	21°35'30"	158°03'25"	6-2-09-1	Bishop Estate	May 5, 1994	8 days
3-3505-25	North Lower Anahulu exploratory well	21°35'45"	158°05'04"	6-2-09-1	Bishop Estate	December 23, 1993	7 days
3-3505-26	Opaeula exploratory well	21°35'11"	158°05'14"	6-2-10-1	Bishop Estate	October 4, 1993	10 days
3-3604-01	Kawailoa deep monitor well	21°36'24"	158°04'44"	6-1-05-1	Bishop Estate	January 9, 1994	28 days

Table 4. Construction data for wells drilled during the study, Oahu, Hawaii--Continued.

State well number	Well name	Bottom of surface casing elevation (feet)	Surface casing outside diameter (inch)	Hole diameter (inch)	Bottom of well elevation (feet)	Open interval elevations (feet)	Inner casing outside diameter (inch) and type	Screened interval elevations (feet)	Measuring point elevation (feet)	Water level	
										Height above sea level (feet)	Date and time
3-3204-01	Kaheaka exploratory well	643	8 5/8	6 3/4	-55	643 to -55	4 1/2, steel	25 to -55	741.59 (top of casing)	12.44	Jan. 27,1995 17:20
3-3307-20	Thompson Corner exploratory well I	-65	12 5/8	12 1/4	-82	-65 to -82	12 5/8, steel	-65 to -82	99.10 (bolt)	11.32	Aug 5, 1993 15:51
3-3307-21	Thompson Corner exploratory well II	17	8 5/8	7 7/8	-80	17 to -80	4 1/2, PVC	20 to -80	101.40 (top of casing)	11.29	Aug. 5, 1993 15:51
3-3406-12	Twin Bridge Road deep monitor well	9	6 5/8	6 1/4	-596	9 to -596	4 1/2, steel	24 to -596	53.10 (top of casing)	11.10	Feb. 15, 1995 12:09
3-3406-13	Kaamooloa exploratory well	10	6 5/8	6 1/4	-10	10 to -10	4 1/2, PVC	10 to -10	42.35 (top of casing)	11.87	Feb. 13, 1995 14:45
3-3406-14	Helemano exploratory well I	-51	8 5/8	7 7/8	-78.5	-72 to -78.5	4 1/2, PVC	-68.5 to -78.5	13.79 (top of casing)	10.92	Feb. 15, 1995 12:26
3-3406-15	Helemano exploratory well II	-52	8 5/8	7 7/8	-291	-271 to -291	4 1/2, steel	-271 to -291	14.41 (top of casing)	11.15	Feb. 15, 1995 12:28
3-3407-37	Kiikii exploratory well	-115	8 5/8	6 3/4	-135	-125 to -135	4 1/2, steel	-115 to -135	14.68 (top of casing)	11.70	Feb. 13, 1995 13:44
3-3503-01	North Upper Anahulu exploratory well	592	8 5/8	6 3/4	-103	592 to -103	4 1/2, steel	17 to -103	671.74 (top of casing)	7.15	Feb 14, 1995 13:54
3-3505-25	North Lower Anahulu exploratory well	182	8 5/8	7 7/8	-18	182 to -18	4 1/2, PVC	22 to -18	234.24 (top of casing)	4.75	Feb.14, 1995 15:08
3-3505-26	Opaeula exploratory well	229	6 5/8	6 1/4	-65	229 to -65	4 1/2, PVC	15 to -65	288.08 (top of casing)	10.52	Feb. 15, 1995 11:14
3-3604-01	Kawailoa deep monitor well	190	6 5/8	6 1/4	-392	190 to -392	4 1/2, steel	9 to -391	309.01 (top of casing)	4.40	Feb. 14, 1995 14:18