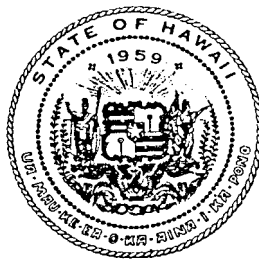


WELLS AND TEST HOLES
DRILLED BY THE
DEPARTMENT OF LAND AND NATURAL RESOURCES

Circular C-113



State of Hawaii
DEPARTMENT OF LAND AND NATURAL RESOURCES
Division of Water and Land Development

Honolulu, Hawaii
January 1985



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PREFACE

This report summarizes the results of the Department of Land and Natural Resources' exploratory well drilling activities during the past 25 years, 1959-1984. These activities have been funded by the Legislature under (1) a statewide Exploratory Well Drilling Program begun in 1960 and under (2) various individual well drilling projects related to solving specific water problems or meeting specific exploration needs of the community. Approximately two-thirds of the well drilling activities have been accomplished under the statewide Exploratory Well Drilling Program which has the dual objective of seeking vital information and making new discoveries about Hawaii's ground water resources, and locating new sources of water supply for drinking, agricultural, industrial, and recreational purposes.

This report was prepared by Daniel Lum, geologist, with assistance in data compilation by Mitchell Ohye, engineering technician, and by Bill Koyanagi, drafting technician.

ACKNOWLEDGMENTS

The Department gratefully acknowledges the cooperation and assistance of the following agencies in making the accomplishments of the Department's exploratory well drilling activities more fruitful and valuable than otherwise:

- Hawaii Department of Water Supply
- Honolulu Board of Water Supply
- Maui Department of Water Supply
- Kauai Department of Water
- Department of Health
- U.S. Geological Survey

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WELLS AND TEST HOLES DRILLED BY THE
DEPARTMENT OF LAND AND NATURAL RESOURCES

INTRODUCTION

For the past 25 years the Department of Land and Natural Resources, Division of Water and Land Development, beginning with its predecessor, the former Hawaii Water Authority, has played a major role in the exploration and development of the State's ground water resources. Altogether, 93 wells have been drilled--approximately 4 per year--in formerly undeveloped areas such as Kona, Hawaii during the late 1950's, in rural areas such as Hana, Maui, and in urban areas such as Honolulu, Oahu.

Some wells were drilled with the intent to discover new resources in unexplored areas, some to test the extent of an aquifer, some to develop needed additional water supply, and finally some were drilled to monitor major ground water basins such as Pearl Harbor.

In 1958, a year before statehood, the then territorial Hawaii Water Authority completed its first exploratory well drilling project at Palani Junction just north of Kailua, Kona where severe water shortages were occurring during times of drought. The Palani well proved disappointingly brackish, dampening exploration hopes, but only briefly until later that same year, when the second exploratory well located at Keei, South Kona, became the first well in Kona to discover a fresh, potable ground water source. However, the main thrust of the Department's well drilling activities was launched just after statehood, in 1960, when the Legislature for the first time appropriated funds for a state-wide Exploratory Well Drilling Program.

Exploratory Well Drilling Program. From the outset, the objective of the exploratory well drilling program was to drill exploratory wells of smallest (hence most economical) diameter to maximize exploration dollars, yet of sufficiently large diameter to permit pump testing and be developable as a source of water supply, should well tests prove

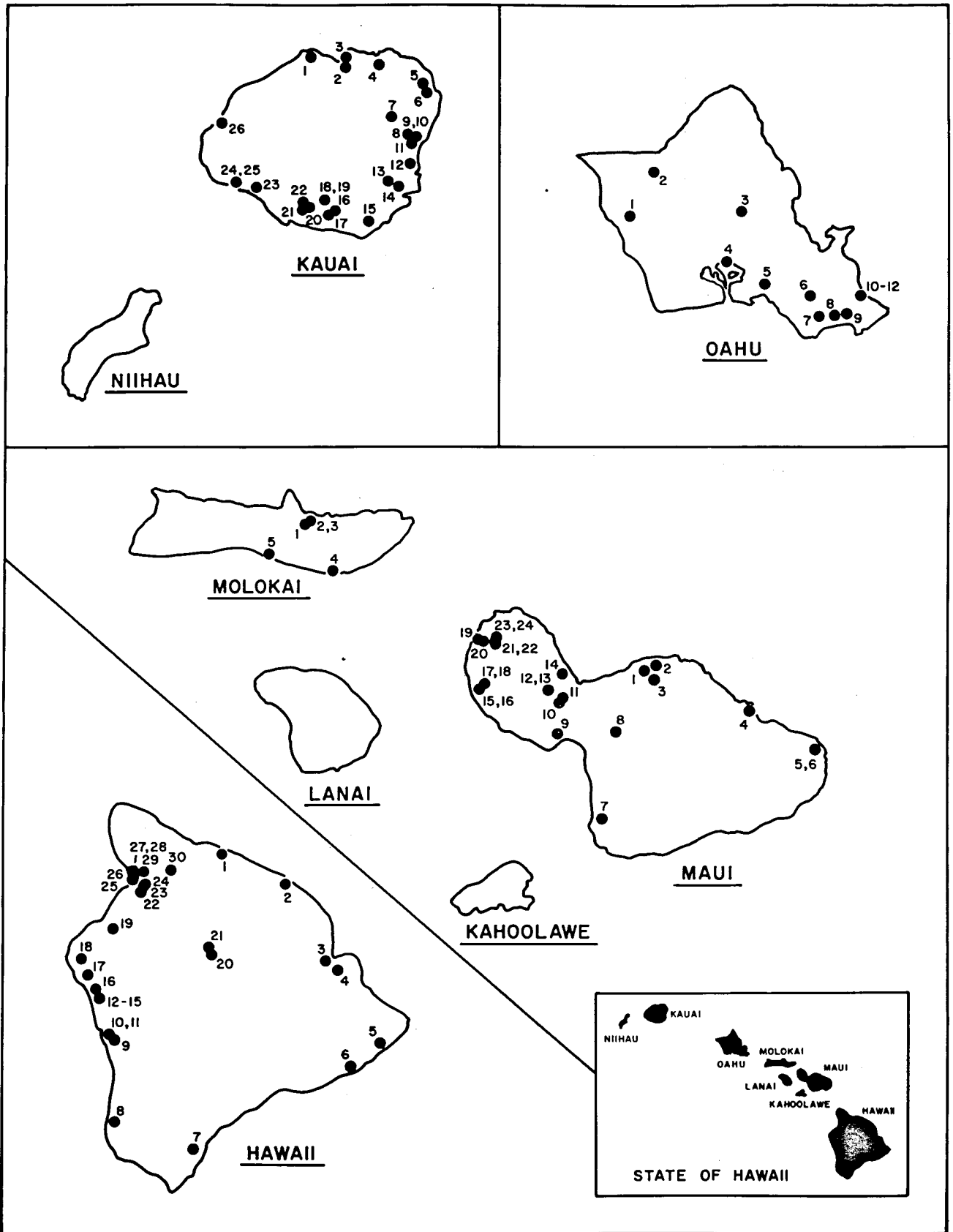


Figure 1. Map of Wells Drilled by DLNR, Statewide.

Table 1. Index of Wells Drilled by DLNR.

KAUAI			OAHU		
Map Ident.	Well Name	Year Drilled	Map Ident.	Well Name	Year Drilled
1	Haena	1966	1	Waianae	1980
2	Maka Ridge	1961	2	Waialua Mauka	1984
3	Hanalei	1959	3	Mililani Mauka A	1984
4	Kilauea	1972	4	Waipahu Monitor	1980
5	Aliomanu	1974	5	Moanalua Mon.	1980
6	Anahola	1979	6	Manoa II	1983
7	Makaleha Tank	1983	7	Waialae Nui	1983
8	Nonou Ridge	1972	8	Wailupe	1981
9	Wailua B	1970	9	Kuliouou	1983
10	Wailua A	1960	10	Waimanalo A	1968
11	Wailua C	1971	11	Waimanalo B	1968
12	Kalepa Ridge	1967	12	Waimanalo C	1968
13	Kilohana A	1974			
14	Lihue	1961			
15	Koloa C	1977			
16	Lawai	1962			
17	Kalaheo	1963			
18	Kalaheo A	1974			
19	Kalaheo B	1984			
20	Hanapepe A	1974			
21	Hanapepe Town	1966			
22	Hanapepe	1961			
23	Waimea A	1966			
24	Paua Valley	1970			
25	Kekaha Waipao	1978			
26	Kaulaula	1967			
HAWAII			MOLOKAI		
Map Ident.	Well Name	Year Drilled	Map Ident.	Well Name	Year Drilled
1	Haina	1979	1	Waikolu Tunnel	1961
2	Laupahochoe	1969	2	Waikolu Valley	1961
3	Piihonua	1973	3	Waikolu Valley	1961
4	Panaewa C	1983	4	Kamalo	1962
5	Malama Ki	1962	5	Kamiloloa	1962
6	Pulama	1963			
7	Naalehu	1971			
8	Okoe	1980			
9	Keei C	1978			
10	Keei A	1958			
11	Keei B	1963			
12	Kahaluu A	1959			
13	Kahaluu B	1959			
14	Kahaluu C	1969			
15	Kahaluu D	1970			
16	Holualoa	1983			
17	Palani	1958			
18	Kalaea	1968			
19	Kiholo	1972			
20	Pohakuloa	1965			
21	Pohakuloa T.H.	1969			
22	Lalamilo A	1977			
23	Lalamilo B	1979			
24	Lalamilo C	1979			
25	Hapuna	1970			
26	Kawaihae B	1961			
27	Kawaihae A	1961			
28	Kawaihae D	1970			
29	Kawaihae C	1963			
30	Waiaka Testhole	1964			
			MAUI		
			Map Ident.	Well Name	Year Drilled
			1	Maui High	1964
			2	Pauwela	1967
			3	Ilaiku	1979
			4	Keanae	1984
			5	Hana A	1972
			6	Hana B	1976
			7	Makena	1964
			8	Kihei Pulahu	1971
			9	Maalaea	1965
			10	Waikapu A	1961
			11	Waikapu B	1974
			12	Kepaniwai T.H.	1973
			13	Kepaniwai	1973
			14	Waiehu Monitor	1982
			15	Lahaina A	1962
			16	Kanaha A	1971
			17	Kanaha B	1974
			18	Alaeloa A	1964
			19	Alaeloa B	1967
			20	Napili A	1971
			21	Napili B	1972
			22	Napili C	1979
			23	Honokahua A	1978

successful. The task of selecting an exploratory well site is multi-faceted. After the priority of exploration and water needs are established, one of the first consideration is the hydrology of the area and the probability of finding a fresh water source. Secondly, the geology and its potential effect on the occurrence of ground water must be evaluated. Thirdly, the engineering aspects of the well site is carefully evaluated in the light of location and elevation in relation to existing service areas and water supply systems.

The exploratory well drilling program began in earnest and in its first year, 1961, four exploratory wells were selected, designed, contracted to be drilled, and completed. In subsequent years, the Legislature, continued to appropriate funds for the program, which was successfully accomplishing its two-fold objective of providing greater knowledge about Hawaii's ground water resources while at the same time finding new sources of water supply. An average of two to three exploratory wells a year have been drilled since 1961.

Individual Well Drilling Projects. In addition to the exploratory well drilling program, the Legislature also has provided funds to the Department for individual well drilling projects to meet specific exploration and water needs of the community. These wells, also drilled by the Department, were either intended specifically for exploration purposes directed toward solving a particular water problem or for the development of additional water supplies. On average, less than one such-funded well has been drilled each year.

STATEWIDE RESULTS

During the past 25 years (1959-1984), the Department of Land and Natural Resources has drilled a total of 93 wells and three test holes primarily for the exploration and development of Hawaii's ground water resources on the five islands of Kauai, Oahu, Molokai, Maui, and

Hawaii. A few of the wells, however, have been drilled for ground water monitoring purposes at Pearl Harbor, Oahu and Waiehu, Maui and for waste water disposal at Waimanalo, Oahu. Also, included in the total are three small diameter (3 inch) test holes and a test well drilled to explore for high-level, dike-confined ground water resources on the high slopes of Kohala volcano above Waimea town in the Pohakuloa saddle area between Mauna Kea and Mauna Loa volcanoes, and in the upper part of Iao Valley on Maui.

Table 2. Statewide Exploratory Drilling Results

	Wells, Test Holes	Fresh Water Wells	Brackish Water Wells	Other Wells	Total Fresh Water Supply (mgd)	Total Brackish Water Supply (mgd)	Total Supply for County Use (mgd)
Kauai	26	21	5	--	24.1	1.3	20.0
Oahu	12	7	--	5	5.8	--	5.8
Molokai	5	4	1	--	4.5	--	--
Maui	23	16	5	2	14.4	1.8	12.0
Hawaii	30	17	10	3	22.0	4.4	21.4
Total	96	65	21	10	70.8	7.5	59.2

Of the 96 wells and test holes drilled by the Department, approximately two-thirds were funded under the statewide exploratory well drilling program with the remainder funded as individual well drilling projects. In terms of statewide coverage, exploration efforts have been well distributed throughout the state as can be seen in Figure 1. The success rate, in terms of the number of fresh water wells found, is 65 wells or two-thirds of the total drilled (Table 2); and in terms of developable water supply found, the total amounts to 71 million gallons per day (about half of Honolulu's average daily water use). Of the 71

million gallons per day (mgd), a total of 59 mgd of fresh water supply has been turned over to and made available for use by the various County water supply agencies.

KAUAI WELLS

Of 26 wells drilled on Kauai, 21 wells or 81 percent have been successful in locating fresh ground water sources and 5 wells or 19 percent proved to be brackish or of too low yield to be useable. Exploration efforts have been well distributed around the island, from Haena in the north-northwest part of the island around the coast to Polihale State Park at the westernmost edge of the Kekaha-Mana coastal plain. Ground water exploration has been successful in locating clean, reliable water supplies for the towns of Hanalei, Kapaa, Wailua, Lihue, Koloa, Kalaheo, Hanapepe, Waimea, and Kekaha.

Eighteen wells, with a total yield of 20 million gallons per day, have been drilled and made available to the Kauai Department of Water for their use. Other successful exploratory wells drilled and now in use include water supplies for Polihale State Park and for Hawaiian Homes' Anahola agricultural subdivision. A successful well at Moloaa intended for agricultural purposes is presently unused.

OAHU WELLS

In 1968, the Department successfully drilled three wells for waste water disposal from a sewage treatment plant at Waimanalo. These wells eliminated the need for constructing an expensive sewer ocean outfall at a mere fraction of the estimated cost of the outfall. However, it was not until 1980 that the Department began drilling exploratory water wells on Oahu, with the first well located in Waianae Valley to explore for water for an agricultural park. Also, in 1980, the Department completed the drilling and construction of two deep

monitor well stations designed to penetrate and monitor the fresh basal water lens of the Pearl Harbor basin. These two monitor wells are located at Waipahu and Moanalua. During 1981-83, the Department concentrated its Oahu exploratory efforts in the southeastern part of Oahu to help relieve the burden on the Pearl Harbor basin and successfully completed four wells in Manoa, Waialae Nui, Wailupe (Aina Haina), and Kuliouou Valleys. In 1984, two more wells were successfully completed in the Waialua mauka and Mililani mauka areas. The Mililani mauka exploratory well was drilled in response to the need to locate a new source of ground water free of any chemical pesticide contamination.

Of a total 12 wells drilled on Oahu, seven produce a total of 5.8 million gallons per day and are to be turned over to the Honolulu Board of Water Supply for their use. The other five wells include the three Waimanalo disposal wells and the two deep monitor wells at Waipahu and Moanalua.

MOLOKAI WELLS

Only five wells have been drilled on Molokai. Three were drilled in 1961 as a part of the Molokai Irrigation Project. Two other wells were drilled under the Department's exploratory well drilling program and were not successful in locating fresh ground water sources at Kamalo and Kamiloloa (at the eastern edge of Kaunakakai town) on Molokai's dry southern coast.

MAUI WELLS

Of 23 wells (includes one test hole) drilled on Maui, 16 wells have located fresh ground water sources with a total yield of 14.4 million gallons per day (mgd). Five wells encountered brackish water or were

of such low yield as to be economically unusable. A deep monitor well penetrating the Wailuku basal aquifer was completed at Waiehu, two miles north of Wailuku town. Exploratory drilling efforts on Maui has ranged throughout the island (see Figures 1 and 5) from the west side of West Maui to central Maui and Kihei, to Haiku, and to Hana.

Of the 16 exploratory wells that successfully located fresh water, 13 wells with a total yield of 12.0 mgd have been made available to the Maui Department of Water for their use. Three other fresh water wells having a total yield of 2.4 mgd are presently unused.

HAWAII WELLS

Of the 30 exploratory wells (includes 2 test holes) drilled on the island of Hawaii, 16 wells (53 percent) have been successful in finding fresh ground water sources and 10 wells (33 percent) were too brackish or of too low yield to be useable. Exploration efforts have been scattered around the island, but with emphasis along the west coast from South Kohala to South Kona. A 1000-foot deep test well and a 900-foot deep test hole were unsuccessful in finding high-level, dike-confined ground water sources to serve the Pohakuloa State Park on the southern slopes of Mauna Kea volcano and to serve Waimea town on the southern slopes of Kohala volcano. Twenty wells have been drilled on the dry, Kona side of the island, two on the Hamakua coast, two in Hilo, and three in the Puna and Kau areas.

Of a total 30 wells and test holes completed on the island of Hawaii, 19 wells having a total yield of 22.4 million gallons per day (mgd) have been turned over or made available to the Hawaii Department of Water Supply for their use. Eight wells were found to produce brackish water of which two are utilized by the Department of Water Supply to supplement one of its mountain stream sources during drought periods.

WELL DRILLING COSTS

The total cost of each well drilled by the Department is shown in Tables 3-7 and it includes mobilization/demobilization of equipment, drilling the well, installing steel casing, installing a test pump, testing the well for 150 hours, and performing other minor work. The total cost is based on the contract bid price of the lowest bidder. In general, 25 years ago a well could be drilled for less than \$50,000. Over the years, the depths of wells have increased from the 500-foot range to the 1000-foot range. This fact combined with price inflation has resulted in well costs in excess of \$300,000. Also in Tables 3-7 are calculated unit costs which are expressed as dollars/inch x foot.

The unit cost, i.e., unit price bid of wells in Hawaii sometimes has fluctuated widely, apparently due to the vagaries of demand for well drilling and competition among only two or three prospective bidders. In order to analyze the trend in well drilling costs, averages (unit cost) were calculated and plotted in Figure 7(a) for each size of wells drilled. The unit cost curves in Figure 7(a) should be parallel to each other but they are not. The curves cross over one another, reflecting the vagaries of competitive bidding.

In Figure 7(b), the unit cost curve represents the average of all the wells drilled with the highest and lowest unit costs also shown. This curve may be used to estimate the cost of drilling, casing, and pump testing a well of any size in Hawaii, as follows:

$$\text{Cost of Well} = \text{ave. unit cost} \times \text{depth of well (ft.)} \times \text{dia. of casing (Inches).}$$

Figure 2. Map of Wells Drilled by DLNR, Island of Kauai.

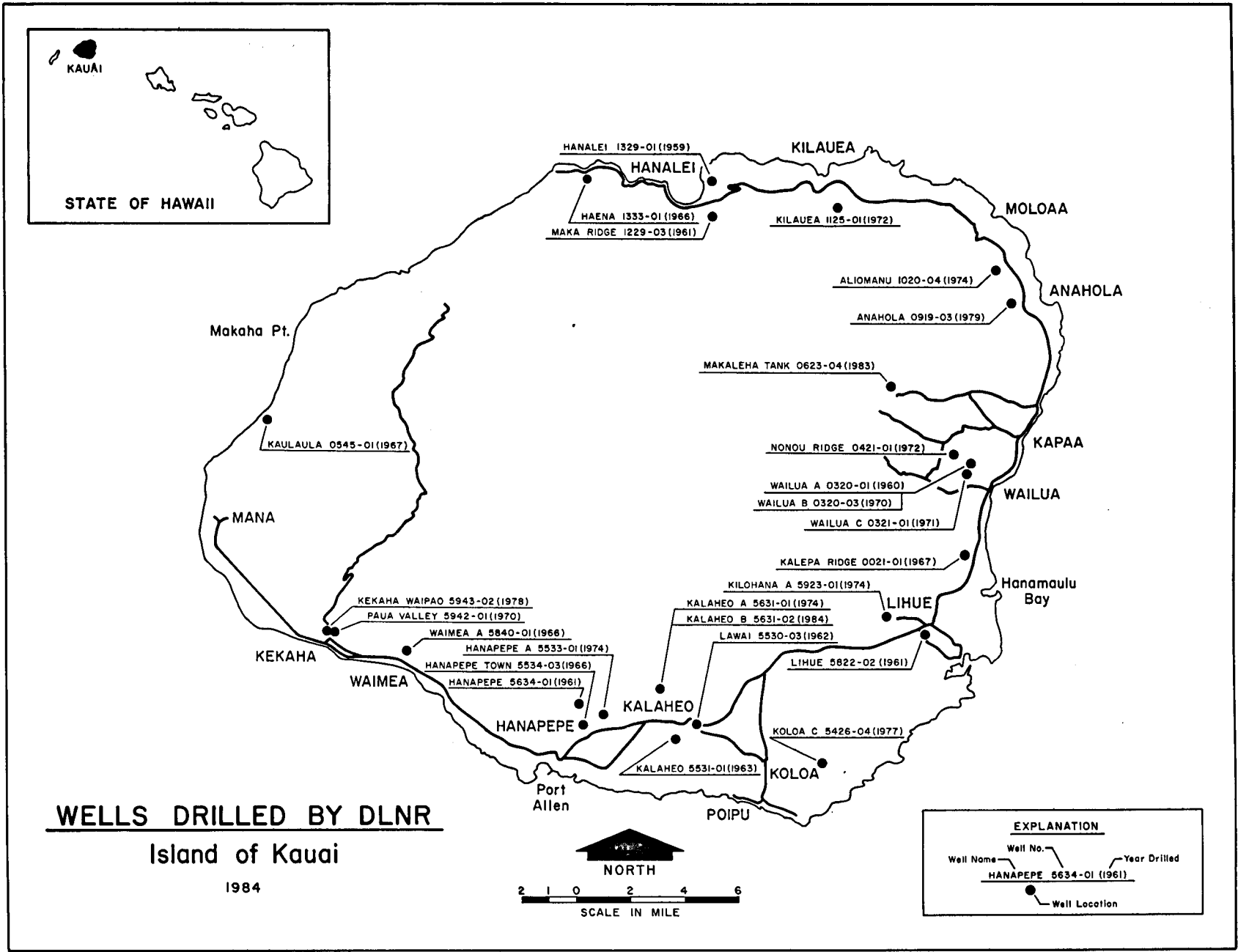


Table 3. Wells Drilled by DLNR, Island of Kauai.

Year Drilled	Island	Job. No.	Well Name	Well No.	Elev.	Casing Dia. (in.)	Total Depth (ft.)	Yield (gpm)	Draw-down (ft.)	Chlorides (ppm)	Drilling Cost	Total Cost	Drilling Cost/ft.	Total Cost/ft.	Total Cost/in.-ft.	Salinity	Present Use	Land Owner
1959	Kauai	11-G-1X	Hanaiei	1329-01	22	8	229	100	28.0	175						Fresh	Unused	State
1960	Kauai	12-G-1X	Wailua A	0320-01	155	8	240	300	5.8	35		7,905		33	4.10	Fresh	Municipal	DW
1961	Kauai	17-H-1	Lihue	5822-02	223	8	745	380	59.9	40	25,075	29,305	34	39	4.90	Fresh	Municipal	DW
1961	Kauai	17-H-1	Hanapepe	5634-01	440	8	508	360	0.2	180	16,051	20,281	32	40	5.00	Fresh	Unused	State
1961	Kauai	17-H-1	Maka Ridge	1229-03	119	8	466	350	33.0	20	14,552	18,782	31	40	5.00	Fresh	Municipal	DW
1962	Kauai	13-I-2	Lawai	5530-03	600	12	695	580	2.6	27	23,540	55,081	34	79	6.60	Fresh	Municipal	DW
1963	Kauai	17-K-8	Kalaheo	5531-01	630	8	952	150	37.0	72	16,003	34,070	17	36	4.50	Fresh	Unused	State
1966	Kauai	17-M-12	Haena	1333-01	83	8	159	300	29.8	20	1,632	7,100	10	45	5.60	Fresh	Municipal	DW
1966	Kauai	17-M-12	Hanapepe Town	5534-03	78	8	109	350	8.5	40	1,836	5,350	17	49	6.10	Fresh	Municipal	DW
1966	Kauai	17-M-12	Waimea A	5840-01	167	8	190	500	5.4	35	3,024	6,740	16	35	4.40	Fresh	Municipal	DW
1967	Kauai	17-KW-18	Kaulaula	0545-01	81	8	138	300	5.3	128	5,040	19,893	37	144	18.00	Fresh	Park Sup.	State
1967	Kauai	17-KW-18	Kalepa Ridge	0021-01	166	8	341	100	14.9	377	13,060	23,376	38	69	8.60	Brack.	Unused	State
1970	Kauai	12-KW-9	Wailua B	0320-03	157	14	302	1800	19.0	40	22,140	42,076	74	140	10.00	Fresh	Municipal	DW
1970	Kauai	51-KW-6	Paua Valley	5942-01	191	12	209	500	6.5	40	14,700	29,912	70	143	11.90	Fresh	Municipal	DW
1971	Kauai	12-KW-11	Wailua C	0321-01	72	14	275	1190	29.8	60	12,900	27,817	47	101	7.20	Fresh	Municipal	DW
1972	Kauai	17-KW-22	Nonou Ridge	0421-01	462	12	568	900	15.7	40	19,670	35,301	35	63	5.30	Fresh	Municipal	DW
1972	Kauai	51-KW-8	Kilauea	1125-01	390	12	790	1000	12.0	12	30,525	49,779	39	63	6.30	Fresh	Municipal	DW
1974	Kauai	14-KW-10	Kilohana A	5923-01	371	14	920	500	72.8	17	67,162	98,133	73	107	7.60	Fresh	Municipal	DW
1974	Kauai	19-KW-6	Hanapepe A	5533-01	98	14	190	1100	10.1	29	43,875	57,410	231	302	21.60	Fresh	Municipal	DW
1974	Kauai	51-KW-16	Allomanu	1020-04	307	16	600	1500	22.4	23	83,000	120,785	138	201	12.60	Fresh	Unused	State
1974	Kauai	51-KW-14	Kalaheo A	5631-01	887	14	1125	1000	.8	26	137,250	187,021	122	166	11.90	Fresh	Municipal	DW
1977	Kauai	13-KW-11	Koloa C	5426-04	156	16	393	1500	7.0	57	50,568	125,000	172	318	19.90	Fresh	Municipal	DW
1978	Kauai	51-KW-19	Kekaha Waipao	5943-02	180	14	220	700	16.9	73	44,000	79,354	200	360	25.80	Fresh	Municipal	DW
1979	Kauai	51-KW-21	Anahola	0919-03	346	14	500	1000	19.3	48	111,000	180,200	222	360	30.03	Fresh	Unused	State
1983	Kauai	12-KW-18	Makaleha Tank	0623-04	520	14	745	200	122.4	14	161,000	271,420	216	364	30.36	Fresh	Unused	DW
1984	Kauai	51-KW-27	Kalaheo B	5631-02		14	*			19						Fresh	Unused	DW

*Not completed as of November 1, 1984.

DW - Kauai Department of Water

Figure 3. Map of Wells Drilled by DLNR, Island of Oahu.

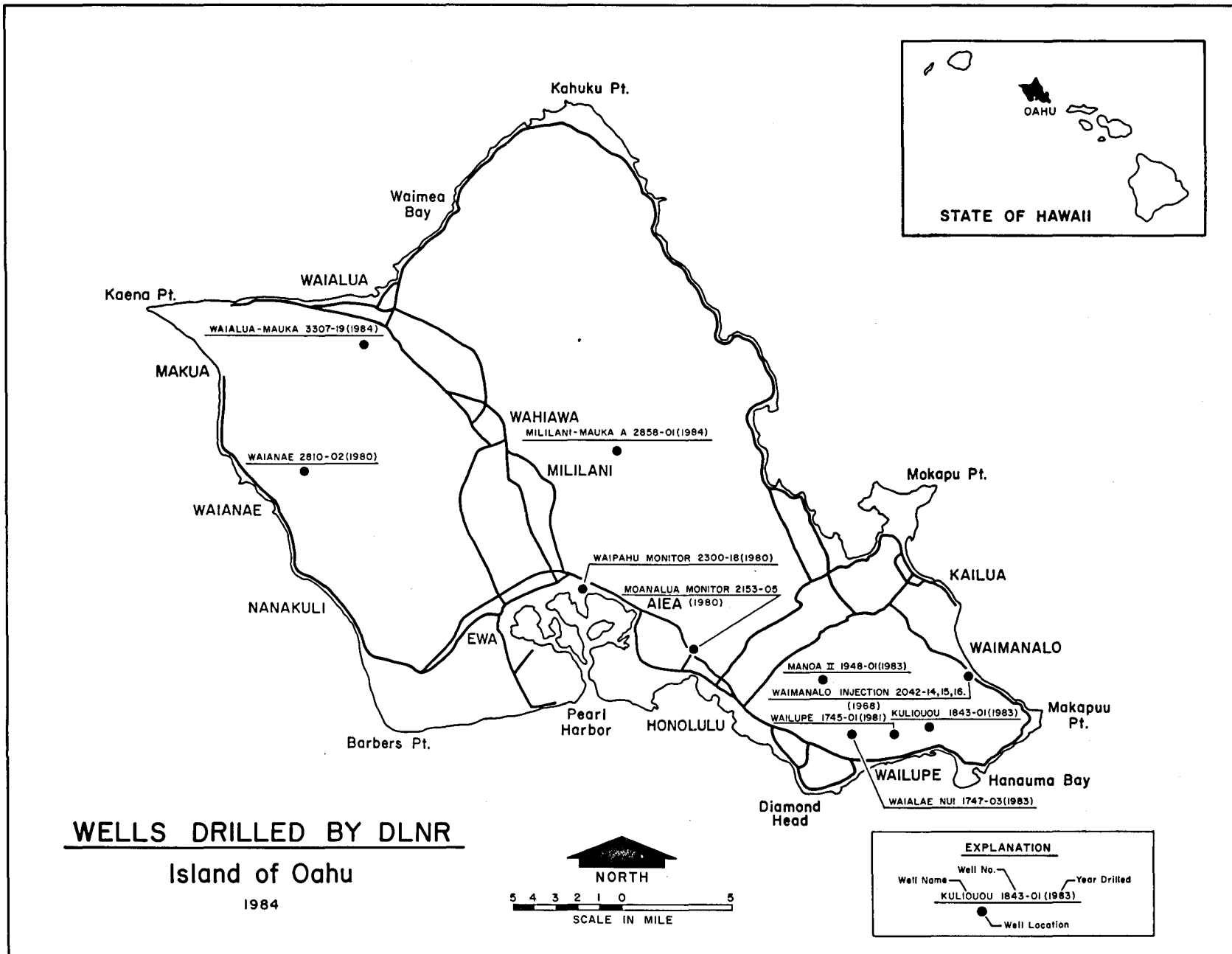


Table 4. Wells Drilled by DLNR, Island of Oahu.

Year Drilled	Island	Job. No.	Well Name	Well No.	Elev.	Casing Dia. (in.)	Total Depth (ft.)	Yield (gpm)	Draw-down (ft.)	Chlorides (ppm)	Drilling Cost	Total Cost	Drilling Cost/ft.	Total Cost/ft.	Total Cost/in.-ft.	Salinity	Present Use	Land Owner
1968	Oahu	41-OM-20	Waimanalo A	2042-14	11	15	220	3000	3.1		12,072	27,697	55	126	8.40	Saline	Disposal	DPW
1968	Oahu	41-OM-20	Waimanalo B	2042-15	11	15	210	3000	3.0		8,180	14,765	39	70	4.70	Saline	Disposal	DPW
1968	Oahu	41-OM-20	Waimanalo C	2042-16	12	15	211	3000	9.5		8,711	17,505	41	83	5.50	Saline	Disposal	DPW
1980	Oahu	4-OW-5	Waianae	2810-02	413	12	670	500	17.8	36	113,680	191,260	170	285	23.79	Fresh	Municipal	State
1980	Oahu	4-OW-3	Waipahu Monitor	2300-18	26	--	1100				169,000	205,600	154	187	15.58	Fresh	Monitor	BWS
1980	Oahu	4-OW-3	Moanalua Mon.	2153-05	37	6	1250				176,000	214,400	141	172	14.29	Fresh	Monitor	BWS
1981	Oahu	4-OW-8	Waiupe	1745-01	379	14	435	350	14.9	76	114,350	187,625	263	431	35.94	Fresh	Municipal	BWS
1983	Oahu	4-OW-23	Kuliouou	1843-01	218	12	268	285	1.75	100	80,000	148,900	299	556	46.30	Fresh	Unused	State
1983	Oahu	4-OW-19	Manoa II	1948-01	384	12	786	700	14.7	12	142,000	229,600	181	292	24.34	Fresh	Unused	BWS
1983	Oahu	4-OW-9	Waiatae Nui	1747-03	310	14	410	1000	7.8	48	122,800	215,100	300	525	43.72	Fresh	Unused	BE
1984	Oahu	4-OW-28	Waiatae Mauka	3307-19	202	16	300	2100	5.8	39	116,750	222,574	386	737	61.42	Fresh	Unused	State
1984	Oahu	4-OW-29	Mililani Mauka A	2858-01	960	18	1160	1130	15.4	19	613,000	818,950	528	706	58.83	Fresh	Unused	State

DPW - Department of Public Works
 BWS - Honolulu Board of Water Supply
 BE - Bishop Estate

Figure 4. Map of Wells Drilled by DLNR, Island of Molokai.

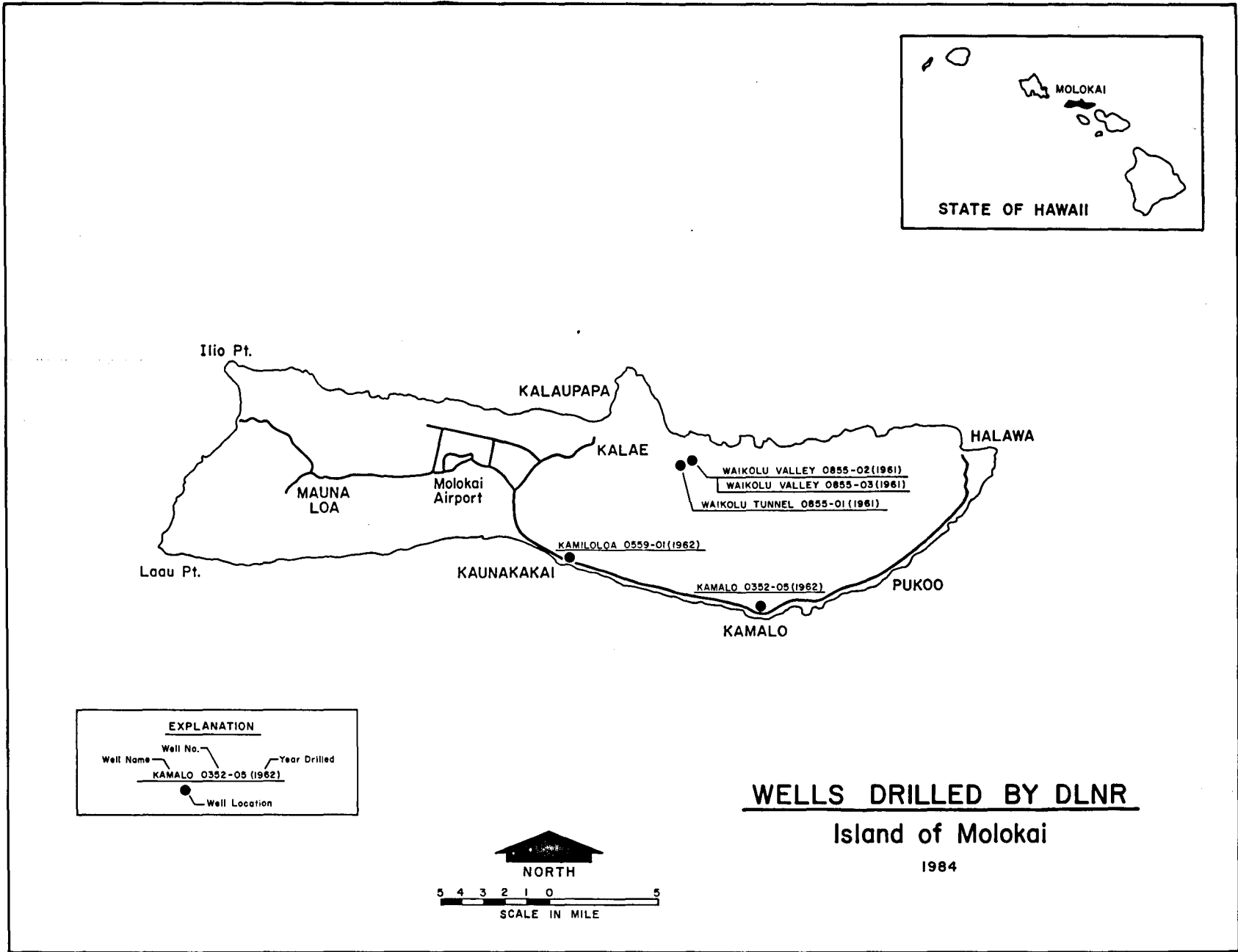


Table 5. Wells Drilled by DLNR, Island of Molokai.

Year Drilled	Island	Job. No.	Well Name	Well No.	Elev.	Casing Dia. (in.)	Total Depth (ft.)	Yield (gpm)	Draw-down (ft.)	Chlorides (ppm)	Drilling Cost	Total Cost	Drilling Cost/ft.	Total Cost/ft.	Total Cost/in.-ft.	Salinity	Present Use	Land Owner
1961	Molokai		Waikolu Tunnel	0855-01	992	12	400	800	8.4	10						Fresh	Irrig.	State
1961	Molokai		Waikolu Valley	0855-02	904	12	300	1005	41.3	10						Fresh	Irrig.	State
1961	Molokai		Waikolu Valley	0855-03	965	12	304	1000	38.3	10						Fresh	Irrig.	State
1962	Molokai	17-1-2	Kamalo	0352-05	213	8	240	400	0.5	150	17,687	20,105	74	84	10.50	Fresh	Unused	State
1962	Molokai	17-1-2	Kamiloloa	0559-01	273	8	288	22	11.0	590	17,818	19,457	65	71	8.90	Brack.	Unused	State

Figure 5. Map of Wells Drilled by DLNR, Island of Maui.

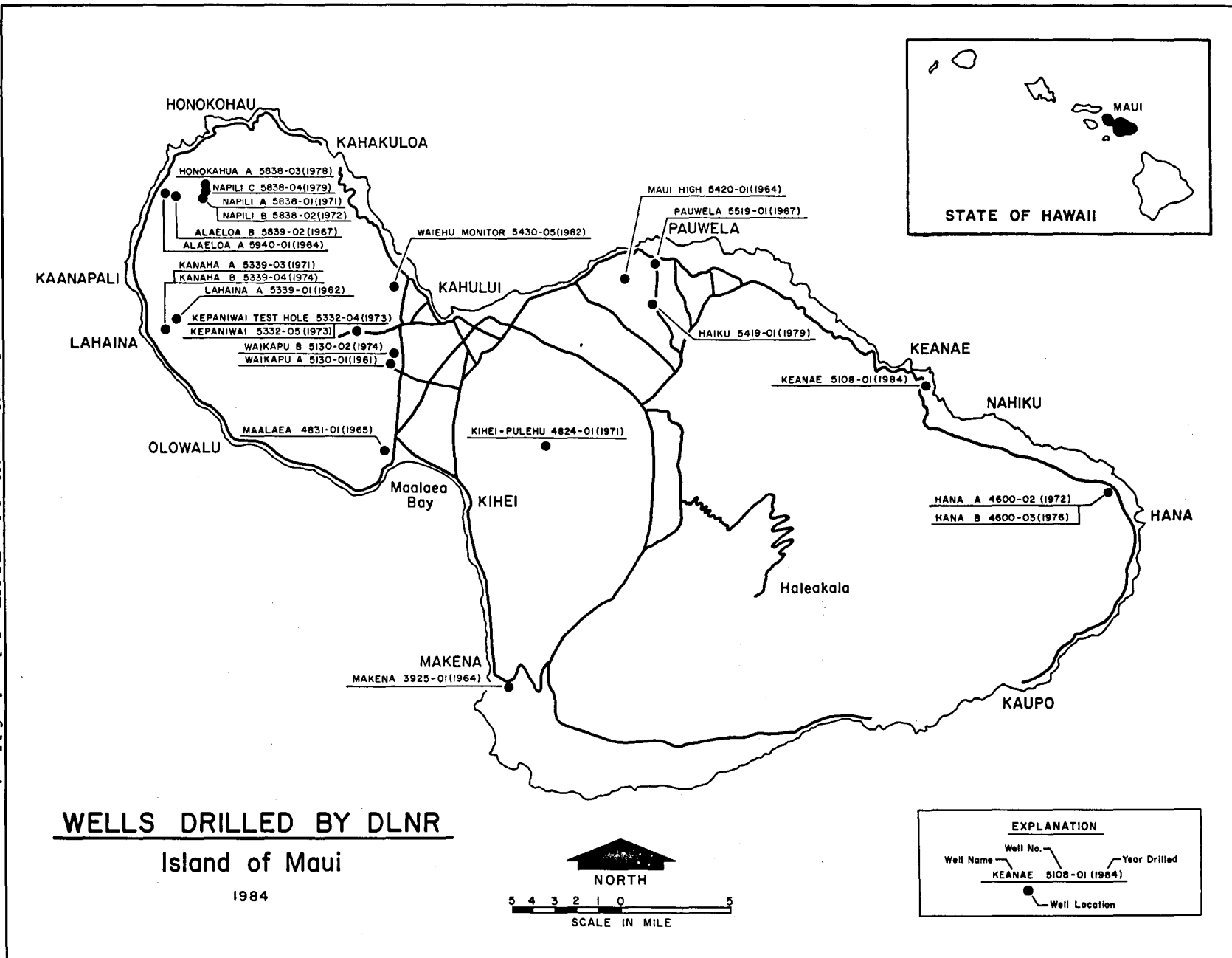


Table 6. Wells Drilled by DLNR, Island of Maui.

Year Drilled	Island	Job No.	Well Name	Well No.	Elev.	Casing Dia. (in.)	Total Depth (ft.)	Yield (gpm)	Draw-down (ft.)	Chlorides (ppm)	Drilling Cost	Total Cost	Drilling Cost/ft.	Total Cost/ft.	Total Cost/in.-ft.	Salinity	Present Use	Land Owner
1961	Maui	17-H-1	Waikapu A	5130-01	551	8	757	90	40.0	45	20,093	24,323	27	32	4.00	Fresh	Unused	State
1962	Maui	26-I-2	Lahaina A	5339-01	441	8	498	375	1.2	120						Fresh	Municipal	DWS
1964	Maui	17-K-10	Maui High	5420-01	349	8	371	500	1.8	90	6,290	10,798	18	31	3.90	Fresh	Unused	DWS
1964	Maui	17-K-10	Alaeloa A	5840-01	257	8	274	500	1.4	308	4,828	9,457	17	33	4.10	Brack.	Unused	DWS
1964	Maui	17-K-10	Makena	3925-01	352	8	382	150	0.7	600	6,897	11,924	18	31	3.90	Brack.	Unused	State
1965	Maui	17-M-13	Maalaea	4831-01	166	8	219	400	4.0	250	1,719	7,700	8	35	4.40	Brack.	Unused	State
1967	Maui	17-MW-14	Alaeloa B	5839-02	493	8	524	115	14.3	175	7,875	18,396	15	35	4.40	Brack.	Unused	MLP
1967	Maui	17-MW-16	Pauwela	5519-02	365	8	400	480	0.46	122	6,511	13,890	20	43	5.40	Fresh	Unused	State
1971	Maui	17-MW-21	Kihei Pulehu	4824-01	593	12	640	700	9.5	70	43,520	62,297	68	97	8.10	Fresh	Unused	State
1971	Maui	35-MW-13	Napili A	5838-01	860	12	893	1000	4.5	150	40,185	64,245	45	72	6.00	Fresh	Municipal	DWS
1971	Maui	35-MW-12	Kanaha A	5339-03	596	12	633	870	10.5	150	38,220	58,063	60	91	7.60	Fresh	Municipal	DWS
1972	Maui	17-MW-23	Hana A	4600-02	266	10	303	250	2.0	145	17,280	31,435	60	109	10.90	Fresh	Municipal	DWS
1972	Maui	35-MW-15	Napili B	5838-02	883	12	915	1000	4.7	36	58,560	93,000	64	102	8.50	Fresh	Municipal	DWS
1973	Maui	35-MW-19	Kepaniwai	5332-05	713	14	302	1000	123.8	24	30,804	59,555	102	197	14.10	Fresh	Municipal	DWS
1973	Maui	35-MW-19	Kepaniwai T.H.	5332-04	713	1	254									Fresh	Testhole	DWS
1974	Maui	35-MW-17	Kanaha B	5339-04	654	12	749	380	6.7	57	69,253	106,204	92	142	11.80	Fresh	Municipal	DWS
1974	Maui	35-MW-25	Waikapu B	5130-02	518	20	1020	500	67.5	52	124,350	174,000	122	171	8.50	Fresh	Unused	WS
1976	Maui	35-MW-29	Hana B	4600-03	306	10	323	200	1.0	187	40,832	90,000	128	282	23.50	Fresh	Municipal	DWS
1978	Maui	35-MW-32	Honokahua A	5838-03	911	14	971	500	6.9	68	192,000	271,300	198	280	23.30	Fresh	Municipal	DWS
1979	Maui	35-MW-32	Napili C	5838-04	897	14	930	1400	5.8	38	192,000	272,300	206	293	24.40	Fresh	Municipal	DWS
1979	Maui	35-MW-30	Haiku	5419-01	828	12	859	500	1.0	95	173,600	239,700	193	266	16.10	Fresh	Unused	A&B
1982	Maui	35-MW-36	Waiehu Monitor	5430-05	380	10	1400				199,400	244,880	142	175	14.58	Fresh	Monitor	State
1984	Maui	35-MW-37	Keanae	5108-01	214	8	330	350	2.3	12	82,300	146,470	250	444	55.50	Fresh	Unused	DWS

DWS - Maui Department of Water Supply
 MLP - Maui Land & Pineapple Co., Inc.
 WS - Waialuku Sugar Co.
 A&B - Alexander & Baldwin, Inc.

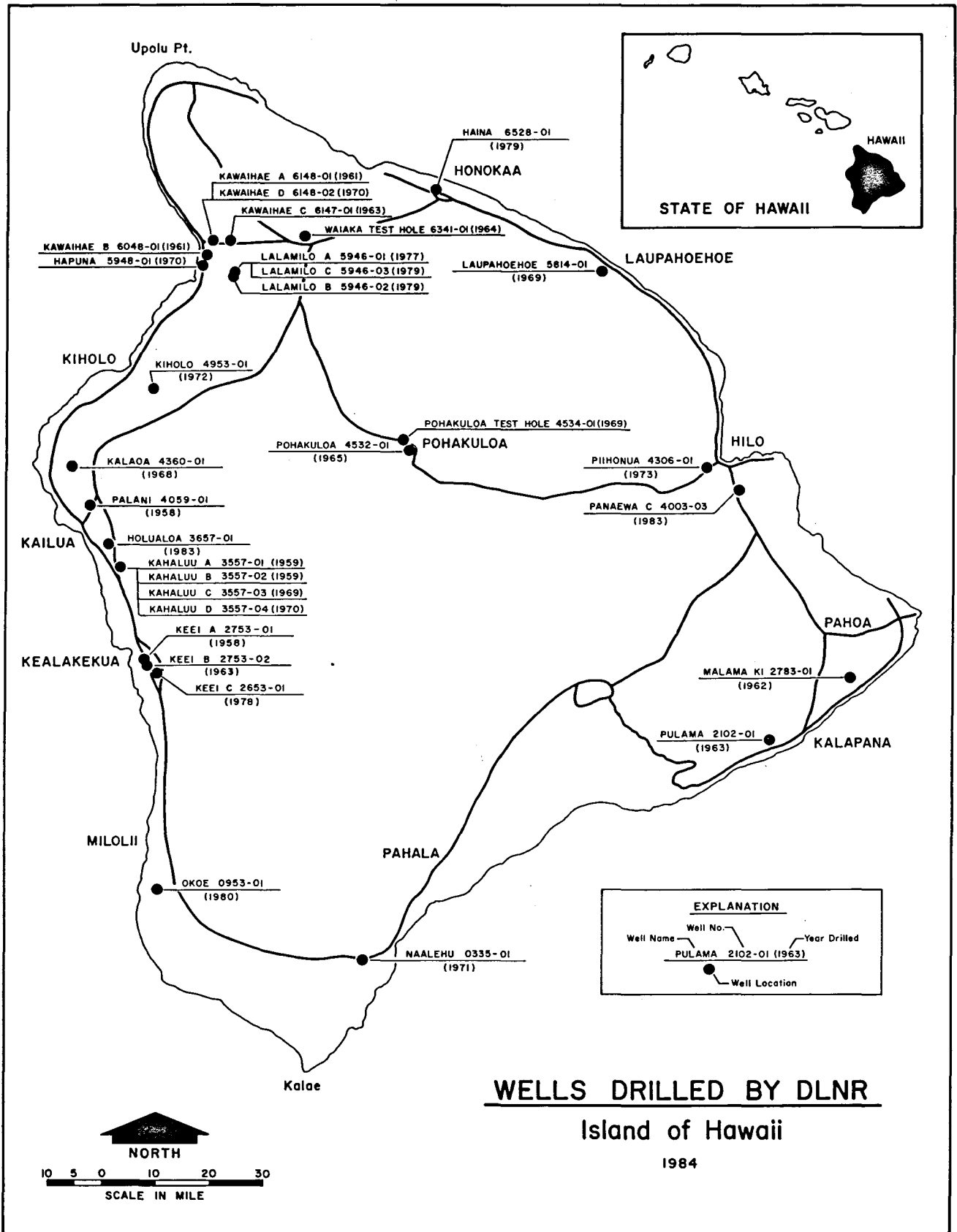


Figure 6. Map of Wells Drilled by DLNR, Island of Hawaii.

Table 7. Wells Drilled by DLNR, Island of Hawaii.

Year Drilled	Island	Job No.	Well Name	Well No.	Elev.	Casing Dia. (in.)	Total Depth (ft.)	Yield (gpm)	Draw-down (ft.)	Chlorides (ppm)	Drilling Cost	Total Cost	Drilling Cost/ft.	Total Cost/ft.	Total Cost/in.-ft.	Salinity	Present Use	Land Owner
1958	Hawaii	8-F-1	Palani	4059-01	800	12	853	93	0.5	4300		52,454		61	5.10	Brack.	Unused	State
1958	Hawaii	8-F-1	Keel A	2753-01	744	12	780	100	0.7	100		49,169		63	5.30	Fresh	Municipal	DWS
1959	Hawaii	8-G-4	Kahaluu A	3557-01	833	12	878	360	4.4	8		48,143		54	4.50	Fresh	Municipal	DWS
1959	Hawaii	8-G-4	Kahaluu B	3557-02	839	12	881	300	10.6	16		43,797		49	4.10	Fresh	Municipal	DWS
1961	Hawaii	15-H-1	Kawaihae A	6148-01	579	10	620	180	0.4	310		34,055		55	5.50	Brack.	Municipal	DWS
1961	Hawaii	15-H-1	Kawaihae B	6048-01	392	10	430	180	0	500		17,692		41	4.10	Brack.	Unused	RS
1962	Hawaii	17-J-3	Malama Ki	2782-01	274	8	320	480	0.8	6700	8,900	12,660	28	40	5.00	Brack.	Unused	State
1963	Hawaii	17-K-9	Pulama	2102-01	230	8	250	50	0.0	298	8,375	14,574	34	58	7.30	Brack.	Unused	DWS
1963	Hawaii	8-I-16	Keel B	2753-02	737	12	774	270	0.3	105						Fresh	Municipal	DWS
1963	Hawaii	17-K-7	Kawaihae C	6147-01	982	8	1046	200	8.5	270	22,880	31,161	22	30	3.80	Brack.	Unused	State
1964	Hawaii	48-K-3	Waiaka Testhole	6341-01	3613	3	924	Dry				20,094		22	7.30	Dry	Test Hole	State
1965	Hawaii	17-L-11	Pohakuloa	4532-01	6375	8	1001	Dry								Dry	Unused	State
1968	Hawaii	17-HW-20	Kalaoa	4360-01	680	10	702	150	0.6	740	56,240	75,416	80	107	10.70	Brack.	Unused	State
1969	Hawaii	8-HW-31	Kahaluu C	3557-03	834	12	868	680	2.3	8	89,440	140,922	103	162	13.50	Fresh	Municipal	DWS
1969	Hawaii	22-HW-9	Pohakuloa T.H.	4534-01	6375	3	350	Dry								Dry	Testhole	State
1969	Hawaii	22-HW-27	Laupahoehoe	5814-01	659	10	700	310	7.6	136	109,225	159,800	151	220	18.40	Fresh	Municipal	DWS
1970	Hawaii	48-HW-12	Kawaihae D	6148-02	582	10	626	450	3.4	325	53,172	81,919	86	133	13.30	Brack.	Municipal	DWS
1970	Hawaii	23-HP-6	Hapuna	5948-01	244	10	268	450	7.0	430	23,424	44,214	89	167	16.70	Brack.	Park Sup.	State
1970	Hawaii	8-HW-37	Kahaluu D	3557-04	855	14	905	1600	3.0	15	66,220	117,915	74	132	9.40	Fresh	Municipal	DWS
1971	Hawaii	22-HW-15	Naalehu	0335-01	746	12	897	600	21.0	9	52,222	76,549	58	85	7.10	Fresh	Municipal	DWS
1972	Hawaii	17-HW-24	Kiholo	4953-01	932	12	971	700	.8	350	65,191	90,155	67	93	7.80	Brack.	Stock	State
1973	Hawaii	22-HW-19	Piihonua	4306-01	278	18	423	2450	17.6	2	38,750	63,761	91	150	8.30	Fresh	Municipal	DWS
1977	Hawaii	48-HW-18	Lalamilo A	5946-01	1172	12	1288	1050	2.1	77	248,000	345,900	200	268	23.40	Fresh	Municipal	DWS
1978	Hawaii	8-HW-44	Keel C	2653-01	882	12	913	770	1.5	27	147,420	211,470	162	231	19.30	Fresh	Municipal	DWS
1979	Hawaii	48-HW-20	Lalamilo B	5946-02	1087	16	1168	900	18.8	28	248,000	363,800	195	286	23.80	Fresh	Municipal	DWS
1979	Hawaii	48-HW-20	Lalamilo C	5946-03	1087	16	1134	1000	18.2	55	245,740	362,530	217	320	20.00	Fresh	Municipal	DWS
1979	Hawaii	22-HW-26	Haina	6528-01	855	12	925	500	7.4	71	139,900	192,800	151	208	17.37	Fresh	Municipal	DWS
1980	Hawaii	8-HW-46	Okoe	0953-01	849	12	880	700	1.7	900	223,200	294,500	254	335	27.89	Brack.	Unused	State
1983	Hawaii	22-HW-30	Panaewa C	4003-03	205	18	300	3000	8.0	3	97,080	189,385	324	631	52.61	Fresh	Municipal	DWS
1983	Hawaii	8-HW-50	Holualoa	3657-01	1123	14	1180	980	5.0	24	358,000	546,610	303	463	38.60	Fresh	Unused	DWS

DWS - Hawaii Department of Water Supply
RS - Richard Smart

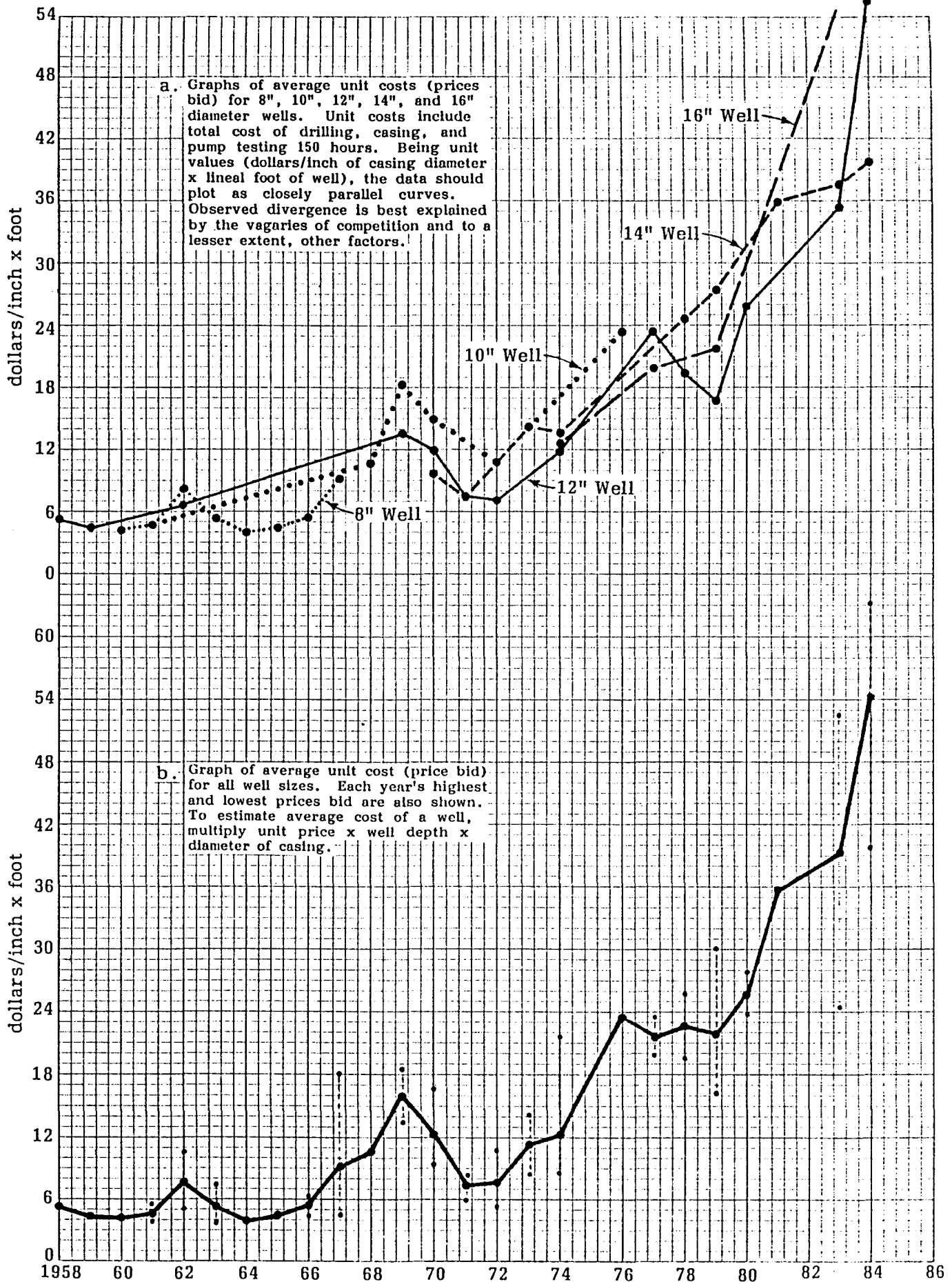


Figure 7. Average Unit Costs of Well Drilling in Hawaii.

APPENDICES

Chronological List of Wells Drilled by DLNR

Year Drilled	Island	Job. No.	Well Name	Well No.	Total Depth (ft.)	Total Cost	Total Cost/ft.
1958	Hawaii	8-F-1	Palani	4059-01	853	52,454	61
1958	Hawaii	8-F-1	Keei A	2753-01	780	49,169	63
1959	Kauai	11-G-1X	Hanalei	1329-01	229		
1959	Hawaii	8-G-4	Kahaluu A	3557-01	878	48,143	54
1959	Hawaii	8-G-4	Kahaluu B	3557-02	881	43,797	49
1960	Kauai	12-G-1X	Wailua A	0320-01	240	7,905	33
1961	Maui	17-H-1	Waikapu A	5130-01	757	24,323	32
1961	Molokai		Waikolu Tunnel	0855-01	400		
1961	Molokai		Waikolu Valley	0855-02	300		
1961	Molokai		Waikolu Valley	0855-03	304		
1961	Kauai	17-H-1	Lihue	5822-02	745	29,305	39
1961	Hawaii	15-H-1	Kawaihae A	6148-01	620	34,055	55
1961	Hawaii	15-H-1	Kawaihae B	6048-01	430	17,692	41
1961	Kauai	17-H-1	Hanapepe	5634-01	508	20,281	40
1961	Kauai	17-H-1	Maka Ridge	1229-03	466	18,782	40
1962	Molokai	17-I-2	Kamalo	0352-05	240	20,105	84
1962	Molokai	17-I-2	Kamiloloa	0559-01	288	19,457	71
1962	Maui	26-I-2	Lahaina A	5339-01	498		
1962	Hawaii	17-J-3	Malama Ki	2782-01	320	12,660	40
1962	Kauai	13-I-2	Lawai	5530-03	695	55,081	79
1963	Hawaii	17-K-9	Pulama	2102-01	250	14,574	58
1963	Hawaii	8-I-16	Keei B	2753-02	774		
1963	Kauai	17-K-8	Kalaheo	5531-01	952	34,070	36
1963	Hawaii	17-K-7	Kawaihae C	6147-01	1046	31,161	30
1964	Hawaii	48-K-3	Waiaka Testhole	6341-01	924	20,094	22
1964	Maui	17-K-10	Maui High	5420-01	371	10,798	31
1964	Maui	17-K-10	Alaeloa A	5840-01	274	9,457	33
1964	Maui	17-K-10	Makena	3925-01	382	11,924	31
1965	Maui	17-M-13	Maalaea	4831-01	219	7,700	35
1965	Hawaii	17-L-11	Pohakuloa	4532-01	1001		
1966	Kauai	17-M-12	Haena	1333-01	159	7,100	45

Chronological List of Wells Drilled by DLNR (cont'd)

Year Drilled	Island	Job. No.	Well Name	Well No.	Total Depth (ft.)	Total Cost	Total Cost/ft.
1966	Kauai	17-M-12	Hanapepe Town	5534-03	109	5,350	49
1966	Kauai	17-M-12	Waimea A	5840-01	190	6,740	35
1967	Maui	17-MW-14	Alaeloa B	5839-02	524	18,396	35
1967	Maui	17-MW-16	Pauwela	5519-02	400	13,890	43
1967	Kauai	17-KW-18	Kaulaula	0545-01	138	19,893	144
1967	Kauai	17-KW-18	Kalepa Ridge	0021-01	341	23,376	69
1968	Oahu	41-OM-20	Waimanalo A	2042-14	220	27,697	126
1968	Oahu	41-OM-20	Waimanalo B	2042-15	210	14,765	70
1968	Oahu	41-OM-20	Waimanalo C	2042-16	211	17,505	83
1968	Hawaii	17-HW-20	Kalaoa	4360-01	702	75,416	107
1969	Hawaii	8-HW-31	Kahaluu C	3557-03	868	140,922	162
1969	Hawaii	22-HW-9	Pohakuloa T.H.	4534-01	350		
1969	Hawaii	22-HW-27	Laupahoehoe	5814-01	700	159,800	220
1970	Hawaii	48-HW-12	Kawaihae D	6148-02	626	81,919	133
1970	Kauai	12-KW-9	Wailua B	0320-03	302	42,076	140
1970	Hawaii	23-HP-6	Hapuna	5948-01	268	44,214	167
1970	Kauai	51-KW-6	Paua Valley	5942-01	209	29,912	143
1970	Hawaii	8-HW-37	Kahaluu D	3557-04	905	117,915	132
1971	Maui	17-MW-21	Kihei Pulehu	4824-01	640	62,297	97
1971	Hawaii	22-HW-15	Naalehu	0335-01	897	76,549	85
1971	Kauai	12-KW-11	Wailua C	0321-01	275	27,817	101
1971	Maui	35-MW-13	Napili A	5838-01	893	64,245	72
1971	Maui	35-MW-12	Kanaha A	5339-03	633	58,063	91
1972	Kauai	17-KW-22	Nonou Ridge	0421-01	568	35,301	63
1972	Kauai	51-KW-8	Kilauea	1125-01	790	49,779	63
1972	Maui	17-MW-23	Hana A	4600-02	303	31,435	109
1972	Hawaii	17-HW-24	Kiholo	4953-01	971	90,155	93
1972	Maui	35-MW-15	Napili B	5838-02	915	93,000	102
1973	Hawaii	22-HW-19	Piihonua	4306-01	423	63,761	150
1973	Maui	35-MW-19	Kepaniwai	5332-05	302	59,555	197

Chronological List of Wells Drilled by DLNR (cont'd)

Year Drilled	Island	Job. No.	Well Name	Well No.	Total Depth (ft.)	Total Cost	Total Cost/ft.
1973	Maui	35-MW-19	Kepaniwai T.H.	5332-04	254		
1974	Kauai	14-KW-10	Kilohana A	5923-01	920	98,133	107
1974	Maui	35-MW-17	Kanaha B	5339-04	749	106,204	142
1974	Maui	35-MW-25	Waikapu B	5130-02	1020	174,000	171
1974	Kauai	19-KW-6	Hanapepe A	5533-01	190	57,410	302
1974	Kauai	51-KW-16	Aliomanu	1020-04	600	120,785	201
1974	Kauai	51-KW-14	Kalaheo A	5631-01	1125	187,021	166
1976	Maui	35-MW-29	Hana B	4600-03	323	90,000	282
1977	Kauai	13-KW-11	Koloa C	5426-04	393	125,000	318
1977	Hawaii	48-HW-18	Lalamilo A	5946-01	1288	345,900	268
1978	Kauai	51-KW-19	Kekaha Waipao	5943-02	220	79,354	360
1978	Hawaii	8-HW-44	Keei C	2653-01	913	211,470	231
1978	Maui	35-MW-32	Honokahua A	5838-03	971	271,300	280
1979	Maui	35-MW-32	Napili C	5838-04	930	272,300	293
1979	Maui	35-MW-30	Haiku	5419-01	859	239,700	266
1979	Hawaii	48-HW-20	Lalamilo B	5946-02	1168	363,800	286
1979	Hawaii	48-HW-20	Lalamilo C	5946-03	1134	362,530	320
1979	Hawaii	22-HW-26	Haina	6528-01	925	192,800	208
1979	Kauai	51-KW-21	Anahola	0919-03	500	180,200	360
1980	Oahu	4-OW-5	Waianae	2810-02	670	191,260	285
1980	Hawaii	8-HW-46	Okoe	0953-01	880	294,500	335
1980	Oahu	4-OW-3	Waipahu Monitor	2300-18	1100	205,600	187
1980	Oahu	4-OW-3	Moanalua Mon.	2153-05	1250	214,400	172
1981	Oahu	4-OW-8	Wailupe	1745-01	435	187,625	431
1982	Maui	35-MW-36	Waiehu Monitor	5430-05	1400	244,880	175
1983	Oahu	4-OW-23	Kuliouou	1843-01	268	148,900	556
1983	Oahu	4-OW-19	Manoa II	1948-01	786	229,600	292
1983	Oahu	4-OW-9	Waialae Nui	1747-03	410	215,100	525
1983	Hawaii	22-HW-30	Panaewa C	4003-03	300	189,385	631
1983	Hawaii	8-HW-50	Holualoa	3657-01	1180	546,610	463

Chronological List of Wells Drilled by DLNR (cont'd)

Year Drilled	Island	Job. No.	Well Name	Well No.	Total Depth (ft.)	Total Cost	Total Cost/ft.
1983	Kauai	12-KW-18	Makaleha Tank	0623-04	745	271,420	364
1984	Maui	35-MW-37	Keanae	5108-01	330	146,470	444
1984	Oahu	4-OW-28	Waialua Mauka	3307-19	300	222,574	737
1984	Oahu	4-OW-29	Mililani Mauka A	2858-01	1160	818,950	706
1984	Kauai	51-KW-27	Kalaheo B	5631-02	*		

*Not completed as of November 1, 1984.

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- C-3 Summary of Drilling Logs and Pumping Test for Kawaihae Exploratory Well No. 1, South Kohala, Hawaii. March 1961.
- C-4 Summary of Drilling Logs and Pumping Test for Exploratory Well No. 1, Waikapu, Maui, Hawaii. March 1961.
- C-5 Summary of Drilling Logs and Pumping Test for Exploratory Well No. 2, Hanapepe, Kauai, Hawaii. May 1961.
- C-6 Summary of Drilling Logs and Pumping Test for Exploratory Well No. 2, South Kohala, Hawaii. June 1961.
- C-7 Summary of Drilling Logs and Pumping Test for Exploratory Well No. 4 (USGS Well No. 73), Maka Ridge, Hanalei, Kauai. November 1961.
- C-8 Summary of Drilling Logs and Pumping Test for Exploratory Well No. 3 (USGS Well No. 11), Lihue, Kauai, Hawaii. January 1962.
- C-9 Summary of Drilling Logs and Pumping Test for Lahaina Exploratory Well (USGS Well No. 291), Lahaina, Maui, Hawaii. May 1962.
- C-11 Summary of Drilling Logs and Pumping Test for Kamalo Exploratory Well (USGS Well No. 31), Kamalo, Molokai, Hawaii. August 1962.
- C-12 Summary of Drilling Logs and Pumping Test for Malama-Ki Well 9-9, Malama-Ki, Puna, Hawaii. October 1962.
- C-22 Summary of Drilling Logs and Pumping Test for Kamiloloa Well 19, Kamiloloa, Molokai. August 1963.
- C-23 Summary of Drilling Logs and Pumping Test for Keeki Well 12-8, Keeki, South Kona, Hawaii. September 1963.
- C-24 Summary of Drilling Logs and Pumping Test for Kawaihae Well 16, Kawaihae, South Kohala, Hawaii. September 1963.
- C-25 Summary of Drilling Logs and Pumping Test for Kalaheo Well 24, Kalaheo, Kauai, Hawaii. December 1963.
- C-26 Summary of Drilling Logs and Pumping Test for Pulama Well 9-10, Pulama, Puna, Hawaii. May 1964.
- C-28 Summary of Drilling Logs and Pumping Test for Makena Well 68, Makena, Maui, Hawaii. November 1964.
- C-29 Summary of Drilling Logs for Pohakuloa Test Hole 20, Pohakuloa, Hamakua, Hawaii. March 1965.
- C-34 Summary of Drilling Logs and Pumping Test for Maui High School Well 35, Hamakuapoko, Maui, Hawaii. May 1965.
- C-35 Summary of Drilling Logs and Pumping Test for Alaeloa Well 318, Alaeloa, Maui, Hawaii. May 1965.
- C-36 Summary of Drilling Logs for Waimea Test Hole T-19, Waimea, South Kohala, Hawaii. May 1965.
- C-37 Summary of Drilling Logs and Pumping Test for Lahaina Well 292, Lahaina, Maui, Hawaii. May 1965.
- C-41 Summary of Drilling Logs and Pumping Test for Haena Well 66, Haena, Kauai, Hawaii. June 1967.
- C-42 Summary of Drilling Logs and Pumping Test for Hanapepe Well 25-1, Hanapepe, Kauai, Hawaii. June 1967.
- C-43 Summary of Drilling Logs and Pumping Test for Maalaea Well 272, Maalaea, Maui, Hawaii. July 1967.
- C-44 Summary of Drilling Logs and Pumping Test for Waimea Well 26, Waimea, Kauai, Hawaii. July 1967.
- C-48 Summary of Drilling Logs and Pumping Test for Kalaoa Well 12-11, Near Keahole, North Kona, Hawaii. November 1968.
- C-63 Summary of Drilling Logs and Pumping Test for Kiholo Well 4953-01, North Kona, Hawaii. January 1973.
- C-64 Summary of Drilling Logs and Pumping Test for Piihonua Well 43-6-1, Hilo, Hawaii. July 1973.
- C-95 Keanae Exploratory Well (State Well No. 5108-01), Keanae, Maui, Hawaii. May 1984.
- C-111 Holualoa Exploratory Well (State Well No. 3657-01), Holualoa, North Kona, Hawaii. October 1984.