DOWALD Form 71(1)

State of Hawaii
DEPARTMENT OF LAND & NATURAL RESOURCES
DIVISION OF WATER AND LAND DEVELOPMENT

STATE

DRILLER'S REPORT

RECEIVED
87 AUG 19 A 8:28
ISLAND Hawaii

DESCRIPTION

Date of report 8/4/87 Person filing report Paul Bergstedt

A. OWNER Naoji Kawamata WELL NAME Agricultural
B. GENERAL LOCATION Ichala Estates
C. DRILLING COMPANY Big Is land Drilling
D. TYPE OF RIG 361 DRILLING COMPLETED 7/31/87 (month year) DRILLER Paul Bergstedt
E. ELEVATION, msl: Top of drilling platform 237.6 ft. Bench mark and method used to determine
Height of drilling platform above ground surface ft. elevation:
F. HOLE SIZE: 12" inch dia. to 245' ft. below drilling platform.
inch dia. to ft. below drilling platform.
inch dia. to ft. below drilling platform.
G. CASING INSTALLED: 6" in. I.D. x 3/8 in. wall solid section to 245' ft. below drilling platform.
6" in. I.D. x 3/8 in. wall perforated section to 220 ft. below drilling platform.
Type of perforation 1/4" drill approx 1500
H. ANNULUS: Grouted 3 ft. to 50' ft. below drilling platform.
Gravel packed ft. to ft. below drilling platform.
I. PERMANENT PUMP INSTALLATION:
Pump type, make, serial no. Sub. Berkeley 4c1m14-3 Capacity 40 g.p.m.
Motor type, H.P., voltage, r.p.m. Franklin 3 hp 230vac 3600 rpm
Depth of pump intake setting 241 ft. below ground which elevation is ~~245~~ ft.
Depth of bottom of airline ft. below which elevation is ft.

HYDROLOGY

J. INITIAL WATER LEVEL 235' ft. below drilling platform. Date of measurement. 7/31/87
K. INITIAL CHLORIDE: 1235 ppm, total depth of well 241 ft. below drilling platform 8/6/87 Sampling Date
L. PUMPING TESTS: Reference point (R.P.) used: which elevation is ft.

Date	7/31/87				Date				
Start water level	n/a ft. below R. P.				Start water level	ft. below R. P.			
End water level	n/a ft. below R. P.				End water level	ft. below R. P.			
Depth of well	245' ft. below R. P.				Depth of well	ft. below R. P.			
Elapsed Time (hours)	Rate (gpm)	Draw-down (ft.)	Cl- (ppm)	Temp. °F	Elapsed Time (hours)	Rate (gpm)	Draw-down (ft.)	Cl- (ppm)	Temp. F
to	40	0	clear		to				
to					to				
to					to				
to					to				
to					to				
to					to				

SUBSURFACE FORMATION

M. DRILLER'S LOG:

Depth, ft.	Rock Description & Remarks	Water Level ft.	Depth, ft.	Rock Description & Remarks	Water Level ft.
0 to 13	boulders		180 to 215	grey	
13 to 48	hard blue stone		215 to 240	grey hard	
48 to 57	soft red		240 to 245	grey hard water	235
57 to 65	hard grey		to		
65 to 75	harder grey		to		
75 to 77	open		to		
77 to 100	medium red		to		
100 to 112	hard grey		to		
112139 to 130	hard grey		to		
130 to 140	red cinders		to		
140 to 170	red cinders		to		
170 180	loose grey				

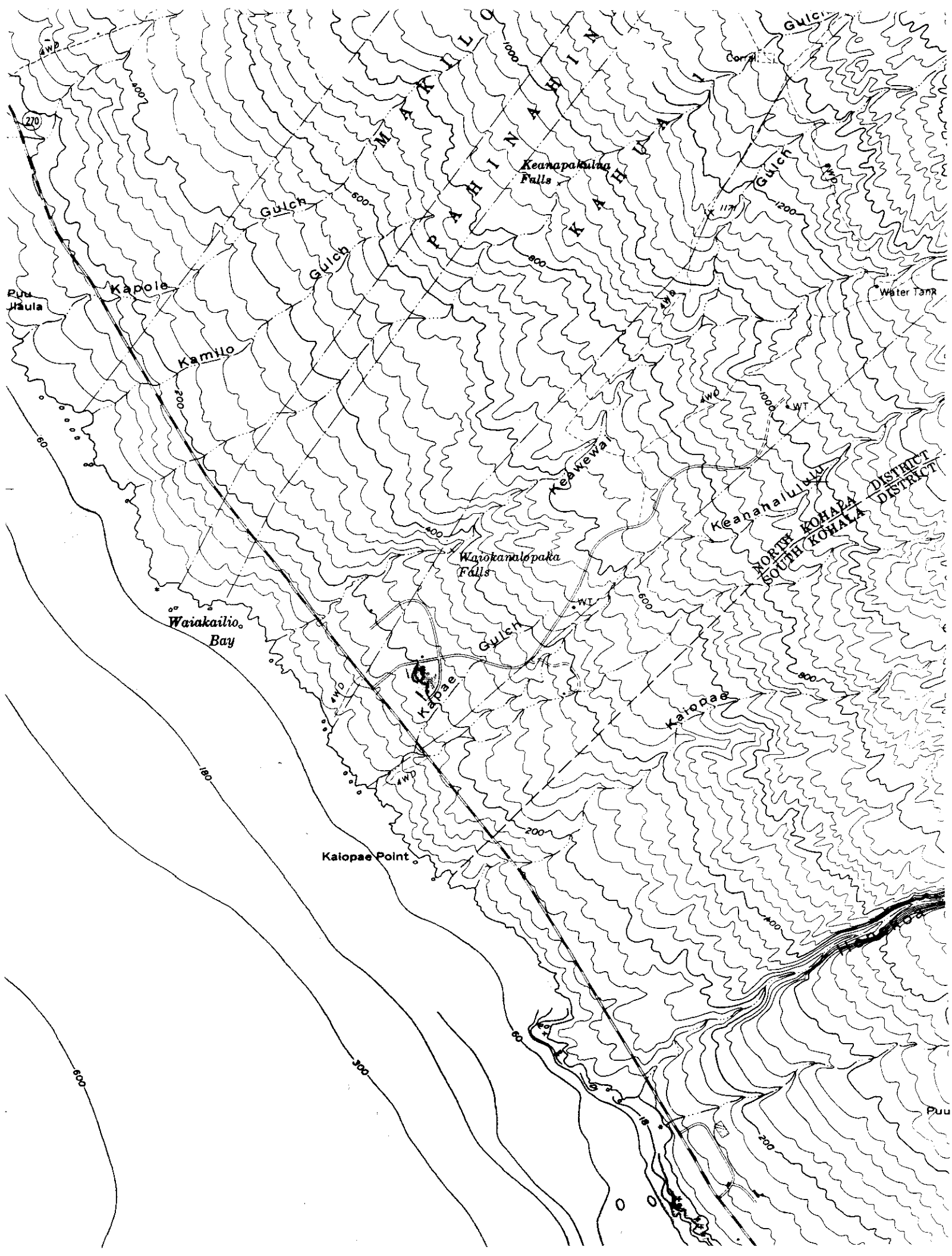
N. REMARKS:

FOR DRILLER'S USE
Job Name
Job No.

INSTRUCTIONS: Send three(3) copies to: Manager-Chief Engineer, Division of Water and Land Development, P. O. Box 373, Honolulu, Hawaii 96809.

REFERENCES: Chapter 178, entitled "Artesian Wells, Generally," HRS, as amended by Act 123 SLH 1970. Honolulu Board of Water Supply, "Rules and Regulations Providing for the Protection, Development and Conservation of Water Resources." Sec't 8-105(j). "Powers, Duties and Functions of the Board," Charter of the City and County of Honolulu, 1959.

FOR OFFICIAL USE
Latitude 20° 04' 27"
Longitude 155° 51' 13"
Well No. 6451-02


MAKILO
MAPAHINAHINA
KAHUA
Gulch
Keanapakulua Falls
Kapole
Puu Haula
Kamilo
Keawewa
Keanahaluiwiu
NORTH KOHALA DISTRICT
SOUTH KOHALA DISTRICT
Waiokanalopaka Falls
Waiakailio Bay
Kapae
Kaiopae
Kaiopae Point
Water Tank
4WD
WT
270
1000
800
600
400
200
180
60

DOWALD Form 71(1)

State of Hawaii
DEPARTMENT OF LAND & NATURAL RESOURCES
DIVISION OF WATER AND LAND DEVELOPMENT

STATE

DRILLER'S REPORT

DESCRIPTION

Date of report 12/5/87 Person filing report Paul Bergstedt

A. OWNER N. Kawamata WELL NAME No. 2 ISLAND Hawaii
B. GENERAL LOCATION Kohala Estates
C. DRILLING COMPANY Big Island Drilling
D. TYPE OF RIG 36 L DRILLING COMPLETED 12/9/87 (month year) DRILLER Paul Bergstedt
E. ELEVATION, msl: Top of drilling platform 396.7 ft. Bench mark and method used to determine
Height of drilling platform above ground surface 2 ft ft. elevation:
F. HOLE SIZE: 12" inch dia. to 405' ft. below drilling platform.
inch dia. to ft. below drilling platform.
inch dia. to ft. below drilling platform.
G. CASING INSTALLED: 6" in. I.D. x 3/8 in. wall solid section to 405' ft. below drilling platform.
6" in. I.D. x 3/8 in. wall perforated section to ~~15~~ feet ft. below drilling platform.
Type of perforation 1/4" drilled holes approx 500
H. ANNULUS: Grouted 0 ft. to 50 ft. below drilling platform.
Gravel packed ft. to ft. below drilling platform.
I. PERMANENT PUMP INSTALLATION:
Pump type, make, serial no. Berkly 4clm24-5 Capacity 45 g.p.m.
Motor type, H.P., voltage, r.p.m. Franklin 5 hp 3600rpm 230 vac
Depth of pump intake setting 402 ft. below platform which elevation is 396.7 ft.
Depth of bottom of airline ft. below which elevation is ft.

HYDROLOGY

J. INITIAL WATER LEVEL 390 ft. below drilling platform. Date of measurement. 12/1/87
K. INITIAL CHLORIDE: 700 ppm, total depth of well 405 ft. below drilling platform 12/1/87 (Sampling Date)
L. PUMPING TESTS: Reference point (R.P.) used: which elevation is ft.

Date 12/9/87
Start water level 390 ft. below R. P.
End water level 390 ft. below R. P.
Depth of well 405 ft. below R. P.

Elapsed Time (hours)	Rate (gpm)	Draw-down (ft.)	Cl- (ppm)	Temp. F
8:00AM to 2:00pm	50	0	700	70
to				
to				
to				
to				
to				

Date
Start water level ft. below R. P.
End water level ft. below R. P.
Depth of well ft. below R. P.

Elapsed Time (hours)	Rate (gpm)	Draw-down (ft.)	Cl- (ppm)	Temp. F
to				
to				
to				
to				
to				
to				

SUBSURFACE FORMATION

M. DRILLER'S LOG:

Depth, ft.	Rock Description & Remarks	Water Level ft.
0 to 30	fill boulders	
30 to 65	blue rock	
65 to 82	brown hard	
82 to 125	soft grey	
125 to 138	hard grey	
138 to 145	cinders	
145 to 175n	red soft	
175 to 198	hard grey	
198 to 240	medium brown	
240 to 300	medium grey	
300 to 345	hard grey	

Depth, ft.	Rock Description & Remarks	Water Level ft.
345 to 355	hard red	
355 to 378	hard grey	
378 to 395	hard brown	
395 to 405	hard grey	
to		
to		
to		
to		
to		
to		

N. REMARKS:

FOR DRILLER'S USE
Job Name
Job No.

INSTRUCTIONS: Send three(3) copies to: Manager-Chief Engineer, Division of Water and Land Development, P. O. Box 373, Honolulu, Hawaii 96809.

REFERENCES: Chapter 178, entitled "Artesian Wells, Generally," HRS, as amended by Act 123 SLH 1970. Honolulu Board of Water Supply, "Rules and Regulations Providing for the Protection, Development and Conservation of Water Resources." Sec't 8-105(j), "Powers, Duties and Functions of the Board," Charter of the City and County of Honolulu, 1959.

FOR OFFICIAL USE
Latitude 20° 04' 43"
Longitude 155° 51' 07"
Well No. 6451-03

GEOPHYSICAL SURVEY
GROUND WATER EVALUATION
KOHALA RANCH
ISLAND OF HAWAII

GEOPHYSICAL SURVEY
GROUND WATER EVALUATION
KOHALA RANCH, ISLAND OF HAWAII

Prepared For:

Kohala Joint Venture
737 Bishop Street, Suite 2775
Honolulu, HI 96813

Prepared By:

Blackhawk Geosciences, Inc.
17301 West Colfax Avenue, Suite 170
Golden, CO 80401

May 18, 1990

(Our Project #90016)

Table of Contents

EXECUTIVE SUMMARY

A surface geophysical survey was conducted at the Kohala Ranch Development between March 26 and April 25, 1990 for the purpose of assisting in mapping ground water resources.

Ground water resources in geologic settings, such as that found on the Kohala Ranch Development, are of two types:

(1) Basal fresh water where a lens of fresh water floats on sea water, and the elevation of the interface can be described by the Ghyben-Herzberg equation. This equation states that for every foot of fresh water head above mean sea level, 40 ft of fresh water is expected below sea level.

(2) Dike-confined water where geological structures such as intrusive rock bodies and dikes control the ground water regime. Fresh water heads in these areas are controlled by many factors, and can be highly variable.

At the Kohala Ranch both types of water resources occur and the geophysical surveys outlined boundaries between these types of hydrological provinces. In areas of basal fresh water occurrences the thickness of lenses of fresh water were computed. In areas of dike-confined water, areas of similarity in geophysical responses and expected hydrology were outlined.

1.0 INTRODUCTION

This report contains the results of a geophysical survey for ground water resource evaluation at the Kohala Ranch Development (KRD) on the Island of Hawaii. The work was performed by Blackhawk Geosciences, Inc. (BGI) for Kohala Joint Venture during March 26 to April 26, 1990.

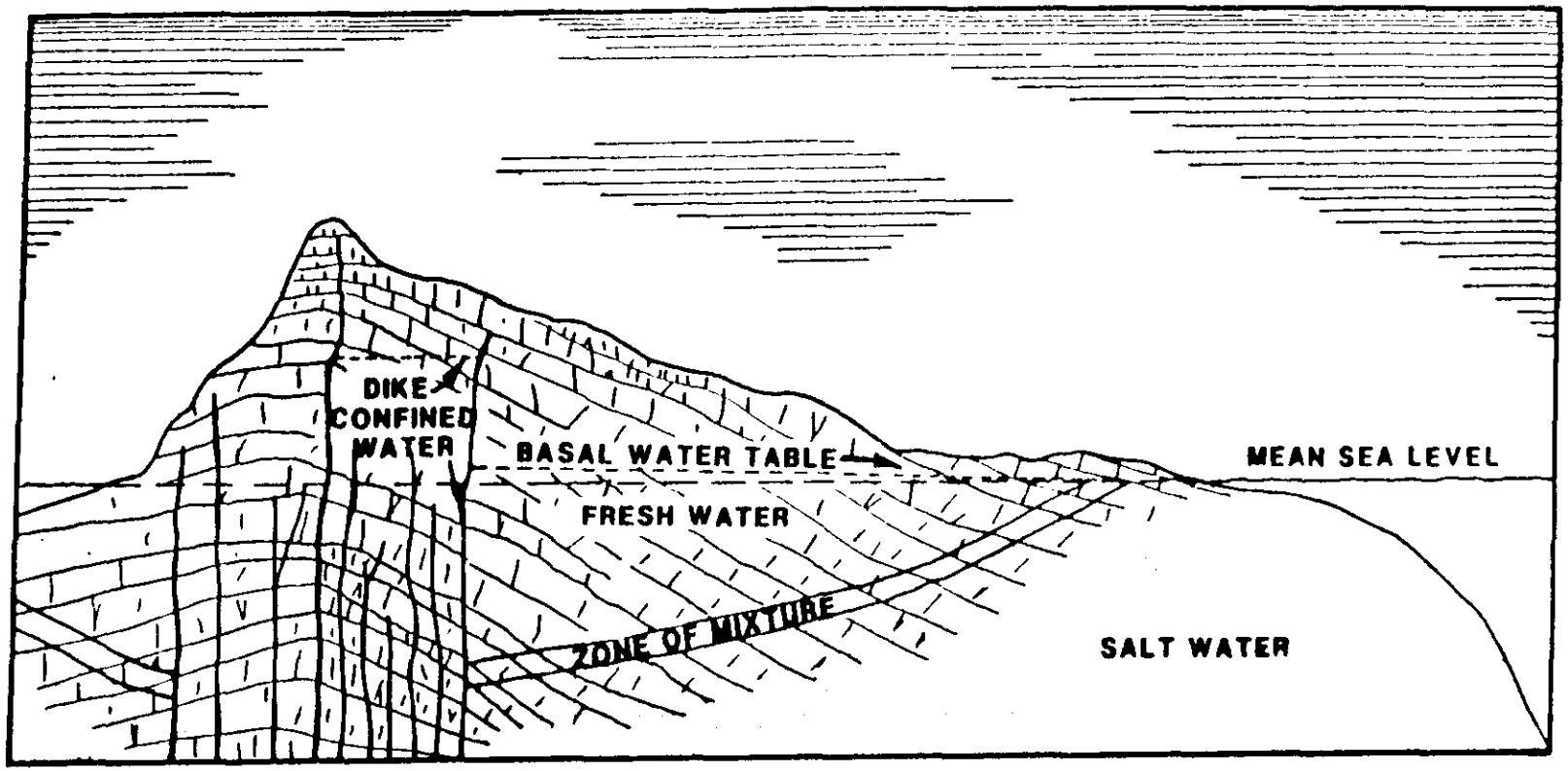
The general objective of the geophysical survey at KRD was to assist in characterizing the hydrologic regime in the study area. Recent drilling results revealed abnormally high static water levels in a well on the property, and the geophysical survey was performed to attempt to map the extent and cause of this anomaly. The generalized objectives for geophysical surveys for ground water evaluations on volcanic islands are illustrated in Figure 1-1. The volcanic rocks are generally highly permeable and this allows rainwater to percolate with little impedance directly downward through the island mass. The fresh water in these island settings is generally found in two environments:

1. Dike-confined waters. Typically, above the rift zone, intrusive dikes originating from a magma source below can form ground water dams, and behind these natural dams significant quantities of ground water can be stored.

2. Basal fresh water. The high permeability of the volcanic rocks allows sea water to enter freely under the island, and a delicate balance is reached where a lens of fresh water floats on sea water. In cases of hydrostatic equilibrium, the Ghyben-Herzberg relation states that for every foot of fresh water head above sea level there will be 40 ft of fresh water below sea level.

At KRD both dike-confined and basal fresh water resources were indicated due to the large variation in static water levels at the various wells within the development (well #3 ≈ 150 ft, wells #1 and #2 ≈ 6 ft). The impetus for using geophysics is that the cost of a geophysical station is about one-thousandth the cost of completing a well at elevations above 1,000 ft. Geophysical surveys, combined with other hydrogeologic information, are used to provide optimum locations for well placement and well completion depths.

The geophysical method employed was time domain electromagnetic (TDEM) soundings. This method was selected because it has proven effective in prior surveys in similar settings in Hawaii.



BLACKHAWK GEOSCIENCES, INC.

SCHEMATIC HYDRO-GEOLOGIC CROSS SECTION
KOHALA RANCH PROJECT
NORTH KOHALA, HAWAII

PROJECT NO.: 90016 FIGURE 1-1

2.0 LOGISTICS AND DATA ACQUISITION

A brief description of the fundamentals of TDEM are given in Appendix A. Briefly, the logistics of a TDEM measurement consist of:

1. Laying out a square loop of insulated wire. A generator placed in the loop is used to drive current pulses through this closed loop. The dimensions of the square loops employed depend on the exploration depth requirements. The dimensions of the loops used for KRD were 1,000 ft by 1,000 ft on each side for all loops, with the exception of loop 1W where a 500 ft by 500 ft transmitter loop was used.

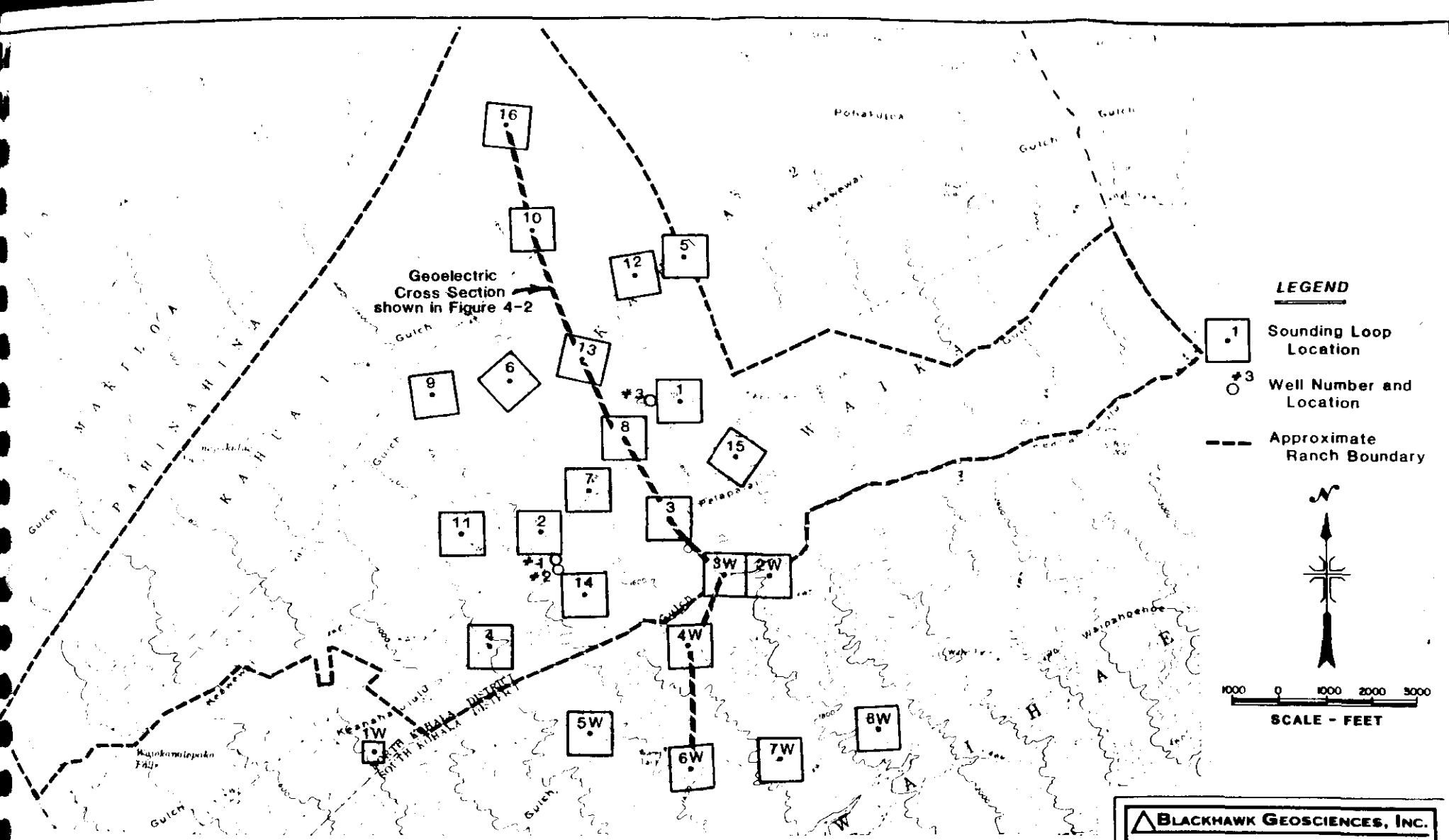
   Transmitter loop wires were positioned so as not to cross utility lines. Soundings 1, 2 and 1W were positioned near wells.

2. Making a measurement with a receiver in the center of the loop. The data acquired at each station was stored in the field on a solid state data logger and subsequently dumped to a computer at the end of each field day. The data acquired at each station usually consisted of measurements at several receiver gain settings and transmitter frequencies in order to assure data quality and to obtain data over the largest time range possible. Data quality was generally very good.

During the 8 days of field work 24 stations (soundings) were completed. A daily log of field activity is given in Table 2-1. Figure 2-1 shows the location of the soundings conducted for KRD.

Table 2-1. Daily log of field activities

Date (1990)	Activity
March 26	BGI personnel mobilize from Golden, CO to Kailua-Kona, Hawaii in conjunction with the other surveys.
April 5	Meet with KRD personnel and check survey areas.
April 6	Soundings 1, 2 and 3.
April 7	Soundings 4, 5 and 6.
April 8	Soundings 7, 8, 9 and 10.
April 9	Soundings 11, 12 and 13.
April 10	Soundings 14, 15 and 16.
April 11-12	Demobilize to Golden, CO and perform preliminary analysis of data.
April 18	Mobilize to Kailua-Kona, Hawaii.
April 23	Soundings 1W, 2W and 3W.
April 24	Soundings 4W, 5W and 6W.
April 25	Soundings 7W and 8W.
April 26	Demobilize to other Hawaii geophysical surveys.


Geoelectric Cross Section shown in Figure 4-2
LEGEND
Sounding Loop Location
Well Number and Location
Approximate Ranch Boundary
1000 0 1000 2000 3000
SCALE - FEET
BLACKHAWK GEOSCIENCES, INC.
TDEM SURVEY LOCATION MAP
KOHALA RANCH PROJECT
NORTH KOHALA, HAWAII
PROJECT NO.: 90016
FIGURE 2-1

3.0 DATA PROCESSING

The field data acquired each day was transferred from the DAS-54 data logger to a Compaq computer. The data for each sounding location is edited and combined (both 3 Hz and 30 Hz frequencies) to produce a transient decay curve. This decay curve is transformed into an apparent resistivity curve, which is entered into an Automatic Ridge Regression Transient Inversion Program (ARRTI). From the apparent resistivity curve a one-dimensional model of resistivities and thicknesses is calculated.

The inversion program requires an initial estimate of the geoelectric section, including the number of layers, and the resistivities and thicknesses of each of the layers. The program then adjusts these parameters so that the model curve converges to best fit the curve formed by the field data set. The inversion program does not change the total number of layers within the model, but allows all other parameters to float freely.

An example data set is given in Figures 3-1 and 3-2 for sounding KR1. Figure 3-1 shows the measured data points (in terms of apparent resistivity) superimposed on a solid line. The solid line represents the computed behavior of the true resistivity layering shown on the right. Figure 3-2 lists in column 4 the error between measured and computed data in each time gate.

The apparent resistivity curves and data sheets for all soundings are contained in Attachment A.

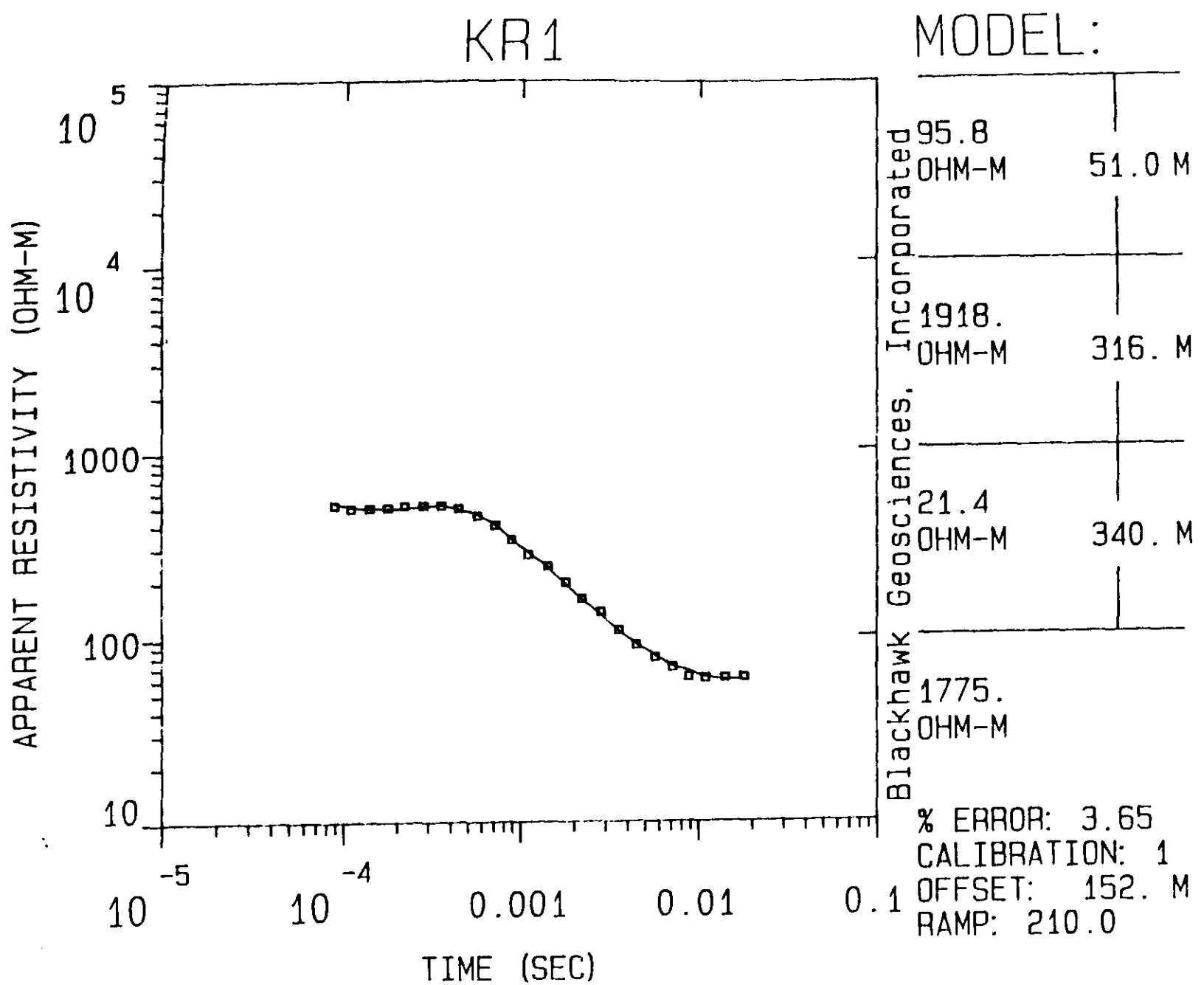

KR1
MODEL:
APPARENT RESISTIVITY (OHM-M)
10^5
10^4
1000
100
10
10^-5
10^-4
0.001
0.01
0.1
TIME (SEC)
95.8
OHM-M
51.0 M
1918.
OHM-M
316. M
21.4
OHM-M
340. M
1775.
OHM-M
% ERROR: 3.65
CALIBRATION: 1
OFFSET: 152. M
RAMP: 210.0
Blackhawk Geosciences, Incorporated

FIGURE 3-2

MODEL: 4 LAYERS

RESISTIVITY (OHM-M)	THICKNESS (M)	ELEVATION (M)	ELEVATION (FEET)	CONDUCTANCE (S) LAYER	CONDUCTANCE (S) TOTAL
		579.1	1900.0		
95.78	51.0	528.1	1732.6	0.5	0.5
1918.02	316.3	211.8	694.8	0.2	0.7
21.40	339.5	-127.7	-419.1	15.9	16.6
1774.88					

	TIMES	DATA	CALC	% ERROR	STD ERR
1	8.90E-05	5.09E+02	5.26E+02	-3.141	
2	1.10E-04	4.90E+02	4.99E+02	-1.693	
3	1.40E-04	4.91E+02	4.86E+02	1.058	
4	1.77E-04	4.96E+02	4.88E+02	1.606	
5	2.20E-04	5.06E+02	4.94E+02	3.547	
6	2.80E-04	5.05E+02	5.04E+02	0.196	
7	3.55E-04	5.07E+02	5.13E+02	-1.261	
8	4.43E-04	4.88E+02	4.80E+02	1.563	
9	5.64E-04	4.45E+02	4.52E+02	-1.521	
10	7.10E-04	3.95E+02	3.99E+02	-1.130	
11	8.90E-04	3.27E+02	3.29E+02	-0.409	
12	1.10E-03	2.73E+02	2.81E+02	-2.843	
13	1.41E-03	2.35E+02	2.32E+02	1.523	
14	1.80E-03	1.94E+02	1.87E+02	3.585	
15	2.20E-03	1.59E+02	1.56E+02	1.501	
16	2.80E-03	1.34E+02	1.30E+02	3.090	
17	3.55E-03	1.08E+02	1.07E+02	1.757	
18	4.43E-03	9.06E+01	9.13E+01	-0.692	
19	5.64E-03	7.79E+01	7.90E+01	-1.382	
20	7.10E-03	6.86E+01	6.96E+01	-1.438	
21	8.81E-03	6.07E+01	6.49E+01	-6.573	
22	1.10E-02	6.00E+01	6.06E+01	-0.967	
23	1.41E-02	5.99E+01	5.83E+01	2.780	
24	1.80E-02	6.03E+01	5.85E+01	3.120	

R: 152. X: 0. Y: 153. DL: 305. REQ: 170. CF: 1.0000
TDHZ ARRAY, 24 DATA POINTS, RAMP: 210.0 MICROSEC, DATA: KR1
0604 000: 0001 Z OPR XTL H 4 10+100
Ch.21 = 0.21 Ch.22 = 0.089 Ch.23 = 20 Ch.24 = 9
RMS LOG ERROR: 1.56E-02, ANTILOG YIELDS 3.6503 %
LATE TIME PARAMETERS

* Blackhawk Geosciences, Incorporated *

PARAMETER RESOLUTION MATRIX:
"F" MEANS FIXED PARAMETER
P 1 0.94
P 2 -0.03 0.05
P 3 0.01 -0.02 0.97

4.0 INTERPRETATION RESULTS

4.1 GENERAL

The main objective of the geophysical survey is not to obtain the resistivity layering of the subsurface, but to infer from the resistivity layering information about the elevation and thickness of the fresh water resource. The translation of resistivity layering into meaningful hydrogeologic information is generally accomplished in two ways:

1. Using available knowledge about the relation between resistivity values and hydrogeology. For example, in the volcanic rocks of Hawaii, rocks saturated with salt water will generally have resistivities less than 5 ohm-m. On the other hand, dry and fresh water/brackish water saturated volcanic rocks and intrusives can have very high resistivities (greater than 1,000 ohm-m).

2. Calibrating the geophysical interpretation at a well. In this case several wells were available for comparison. The approximate location of these wells are shown in Figure 2-1. The two wells (#1 and 2) located at lower elevation (1,460 ft) had static water levels (heads) of 6 ft above sea level. The well #3 located at higher elevation (1,835 ft) had a head of approximately 150 ft above sea level. This large difference in heads over the approximate 4,000 ft distance can best be explained by major geologic structures (rifts, dikes, etc.) which act to dam ground water flow.

In the case where a very conductive layer is detected below sea level in the TDEM interpretation, then the layer is expected to be caused by saline saturated volcanics. Static water levels (heads) can be calculated from these soundings by using the Ghyben-Herzberg relation. This relation, however, assumes hydrostatic equilibrium and is not expected to apply to soundings in close proximity to ground water damming structures.

The soundings acquired in a large area around wells #1, 2 and 3 did not detect salt water saturated volcanics below sea level. The behavior of the ground water in these areas is, therefore, expected to be dike or structure controlled. Other TDEM soundings in the survey area were able to detect salt water saturated volcanics below sea level, and for these soundings ground water levels may behave according to the Ghyben-Herzberg relationship.

4.2 GEOELECTRIC CROSS-SECTION

The results of some the TDEM interpretations are presented as a south to north geoelectric cross section in Figure 4-1. In the geoelectric section layers with similar resistivities have been linked together. In the geoelectric section soundings 6W and 4W (on the south) and soundings 10 and 16 (to the north) show similar three-layer sequences. The upper surface layer (44 to 220 ohm-m) is interpreted to represent soils or weathered volcanics. The intermediate layer of very high resistivities (> 5000 ohm-m) is interpreted as unweathered volcanics. The portions of this layer below sea level are expected to contain fresh or brackish water. The deepest layer in the section with resistivities of 4.2 to 9.6 ohm-m is interpreted to represent salt water saturated volcanics.

In the geoelectric section beneath soundings 3W, 3, 8 and 13 a more complex layering sequence is interpreted. A third layer which exhibits resistivities from 2 to 22 ohm-m is interpreted as volcanic ash flows or altered volcanic occurring above and below sea level. The lowest layer beneath soundings 3, 8 and 13, with resistivities of 1030 to 1672 ohm-m, probably represents unaltered volcanics or intrusives to the maximum search depth (≈ 3,000 ft). Generally, it is difficult to discriminate between unaltered volcanics which are dry or which contain fresh or brackish water (less than 250 ppm chloride). The reason is that, in addition to salinity, changes in porosity and lithology also influence formation resistivity.

Within the geoelectric section several vertical structures are interpreted. These structures are likely caused by vertical dikes of impermeable rocks resulting in a barrier to ground water flow which may explain the high level ground water head (150 ft) at well #3.

4.3 INTERPRETATION MAP

In order to incorporate all the soundings into one data set, an interpretation map of the TDEM results for the Kohala Ranch area was constructed (Fig. 4-2). In this figure the soundings which detected saline saturated volcanics below sea level are separated from the soundings which have a resistive basement (or conductive basement which occurs above sea level). In other words, soundings which are expected to represent basal saline water are separated from soundings which are influenced by dike impoundment or other geologic structures.

In this figure the elevation of the top of the salt water interface derived from the TDEM measurements is contoured. These values will be approximately equal to the thickness of the fresh-brackish water lens if the basal water is in equilibrium. In addition to the TDEM data, static water level (heads) from three

wells drilled on the ranch property are shown on the contour map (information furnished by Nance, 1990, personal communication).

The main features evident in the interpretation map are:

(1) Areas outside the boundary between impounded and basal water generally show the salt water interface to deepen towards the northeast. On the south side of the boundary the depth to basal saline water increases rapidly with increasing elevation. On the north side of the boundary the depth to saline water increases gradually with increasing elevation.

(2) The area interpreted to be effected by confining structures extends in a narrow zone from about 1,000 ft above sea level near sounding 4 and widens with increasing elevation towards the northeast. Wells #1 and #2 also lie within the interpreted dike confined water zone.

Within the boundary the TDEM data can be grouped according to comparable model results. Soundings 2, 4, 11 and 14 (near wells #1 and #2) have similar two-layer model results. These soundings show a thick resistive (280 to 497 ohm-m) layer above a conductive layer (3 to 5 ohm-m) both occurring above sea level. This lower conductive layer is most likely interpreted as volcanic ash flows or altered volcanics.

Soundings 1, 8 and 13 in the vicinity of well #3 have comparable model results. Each sounding shows a four-layer sequence (Fig. 4-1) with the deep resistive layer (1049 to 1775 ohm-m) interpreted as unaltered volcanics or intrusives. Sounding 7, which does not fit in either of these two grouped areas exhibits a three-layer sequence with a lower resistive (181 ohm-m) layer occurring approximately 748 ft below sea level. This lower layer may also be best interpreted as unaltered volcanics or intrusives.

Soundings 3 and 15 have similar four-layer model results with a resistive lower layer (1030 to 1688 ohm-m) occurring above sea level. This layer is most likely interpreted as unaltered volcanics or intrusives.

Models for soundings 2W and 3W are similar to each other, but are quite different from surrounding soundings (Fig. 4-1). These soundings are located close to the interpreted boundary between basal and dike-confined water. This closeness to the boundary may be the reason for differences seen between these sounding sets.

Soundings 5 and 12 have similar three layer model results. Both soundings show a resistive (79 to 360 ohm-m) layer at depth

occurring below sea level. This lower layer can best be interpreted as unaltered volcanics or intrusives.

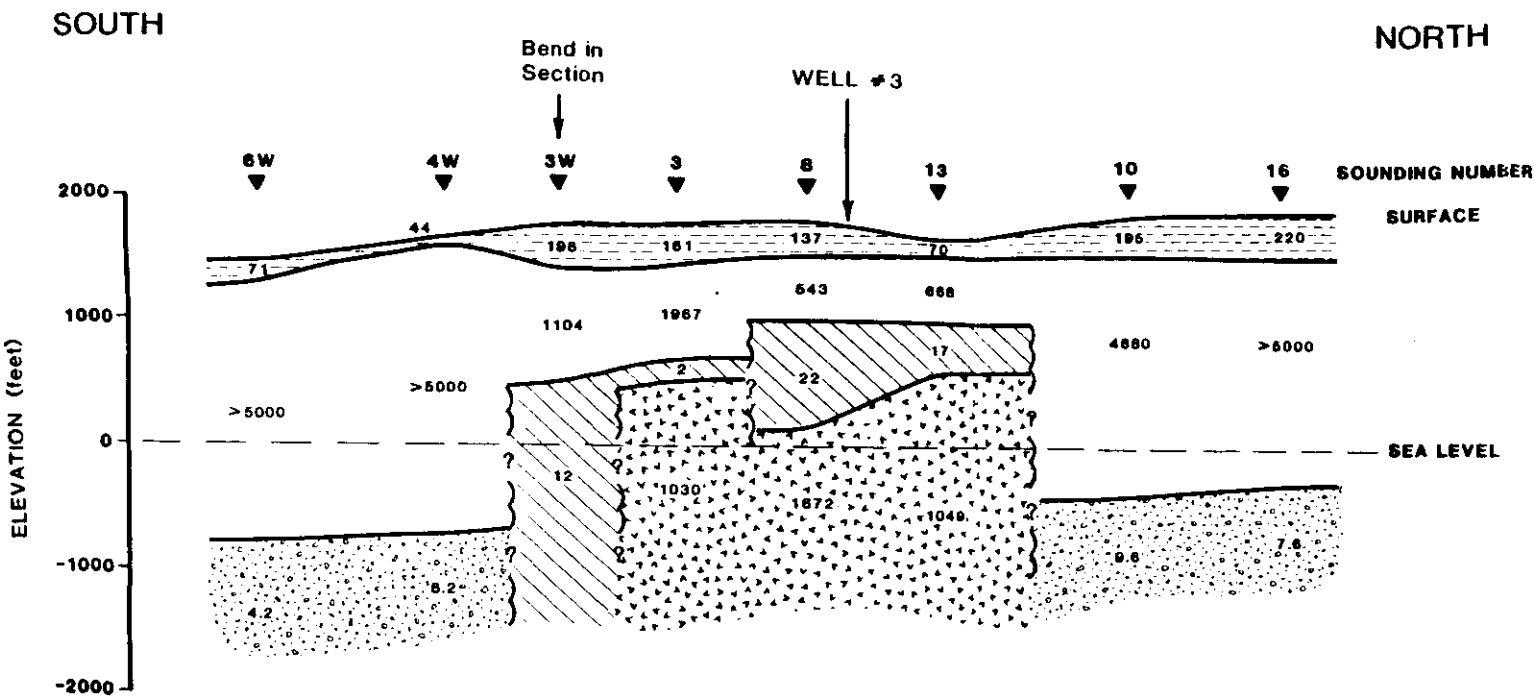
4.4 HYDROGEOLOGIC INTERPRETATION

The geophysical interpretation (Fig. 4-2) outlined two areas of different hydrogeologic parameters, i.e., an area in which the ground water is expected to be controlled by geologic structures (dikes, intrusives, etc.) and an area in which the ground water is expected to occur mainly in the basal mode. Within the area interpreted to be controlled by geologic structures, the hydrologic parameters such as static head and volume of the ground water resource, cannot be inferred from the geophysical data. This is due to the fact that the presence or absence of fresh water has little effect upon the electrical resistivity measured by the TDEM method. In areas with comparable TDEM results (see Section 4.3) it can be assumed that similar hydrologic parameters may exist. For example, soundings 1, 8 and 13 near well #3 all display similar results, and therefore likely outline the extent of the structure which creates the anomalous head at well #3. Similarly, the soundings around wells #1 and #2 (11, 2, 14, and 4) all display similar results and could be expected to define the boundary of the lower heads seen in these wells. Geologic structures are inferred between separate groups of soundings with similar results (reference Figs. 4-1 and 4-2).

In the area interpreted to be represented by basal water resources, the fresh water resource can be estimated by the volume between sea level and the elevation of the interpreted saline water. If this water can be assumed to be hydrostatic equilibrium, then the static water level (head) can be calculated using the Ghyben-Herzberg relation. Table 4-1 shows the thickness of the fresh/brackish water lens obtained directly from the model results for each sounding.

Table 4-1. Hydrogeologic information derived from TDEM soundings

Sounding #	Surface Elevation (ft)	Approximate Thickness of Fresh/Brackish Water Lens (ft)
6	1550	272
9	1420	204
10	1850	419
16	1890	295
1W	830	98
4W	1665	771
5W	1340	484
6W	1450	778
7W	1680	905
8W	1885	1000?



4.2 Values in Ohm-m

HORIZONTAL EXAGERATION 2 TO 1

1000 0 1000 2000 3000 4000

SCALE - FEET

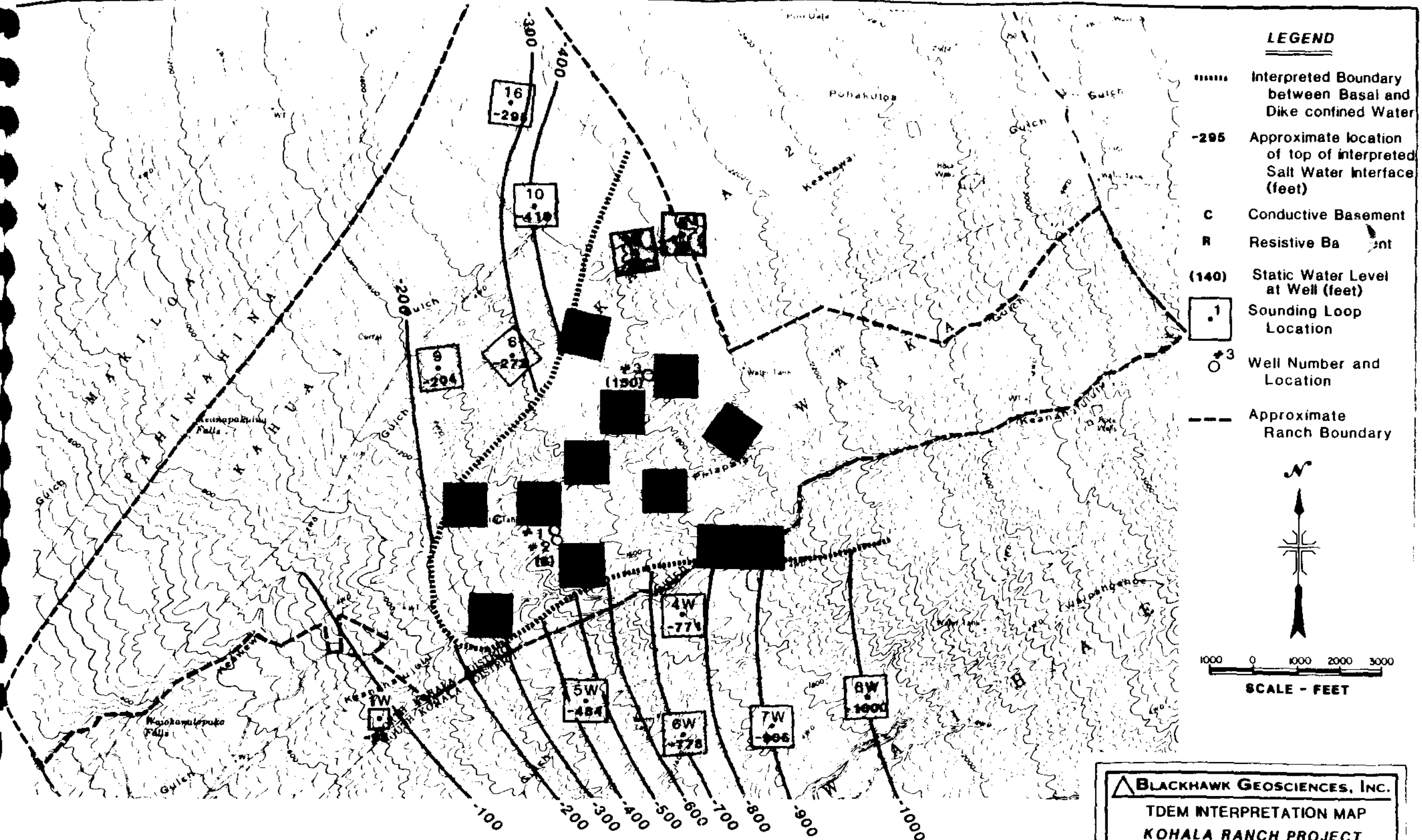
LEGEND

- Soils or Weathered Volcanics
- Unweathered Volcanics
- Volcanic Ash Flows or Altered Volcanics
- Unaltered Volcanics or Intrusives
- Salt Water Saturated Volcanics
- Inferred Geologic Structure

BLACKHAWK GEOSCIENCES, INC.

TDEM SURVEY
GEOLOGIC CROSS SECTION
KOHALA RANCH PROJECT
NORTH KOHALA, HAWAII

PROJECT NO.: 80016 FIGURE 4-1



△ BLACKHAWK GEOSCIENCES, INC.

TDEM INTERPRETATION MAP

KOHALA RANCH PROJECT
NORTH KOHALA, HAWAII

PROJECT NO.: 90016 FIGURE 4-2

5.0 CONCLUSIONS AND RECOMMENDATIONS

The results of the TDEM survey at KRD are summarized in Figure 4-2. In this figure areas of the development in which ground water is expected to be controlled by geologic structures (dikes, intrusives, etc.) are separated from the area in which the ground water is expected to exist in the basal mode. The ground water resources within the area controlled by geologic structures cannot be determined directly from the TDEM data, however, sub-zones in which the hydrologic parameters are expected to be the same have been identified. For example, soundings 1, 8 and 13 near well #3 all exhibit similar behavior, and therefore can be expected to define the limits of the structure in which well #3 was positioned. Structures are inferred to exist between groups of soundings with similar results.

In the area interpreted to be represented by basal water resources, the fresh water resource is expected to be the volume between sea level and the elevation of the interpreted salt water. If the area can be assumed to be in hydrostatic equilibrium then the static water level (head) can be calculated using the Ghyben-Herzberg relation. The applicability of the Ghyben-Herzberg relationship in the area is expected to be marginal due to the existence of ground water damming structures.

DOWALD Form 71(1)

State of Hawaii
DEPARTMENT OF LAND & NATURAL RESOURCES
DIVISION OF WATER AND LAND DEVELOPMENT

STATE

DRILLER'S REPORT

DESCRIPTION

Date of report 5 - 5 - 80 Person filing report MAXIMILIANO A. FERNANDEZ.

A. OWNER Virgil A. Place WELL NAME #9 Place 7 Kohala Estates. ISLAND Hawaii
B. GENERAL LOCATION U.S.G.S. MAP # H- 14 (64- 50)
C. DRILLING COMPANY Big Island Drilling Co.
D. TYPE OF RIG Cable Tool DRILLING COMPLETED 4/10/80 (month / year) DRILLER GAGE THACKER.
E. ELEVATION, msl: Top of drilling platform #3FT ft. Bench mark and method used to determine
Height of drilling platform above ground surface 3 Ft. ft. elevation:
F. HOLE SIZE: 10 inch dia. to 105 ft. below drilling platform.
8 inch dia. to 415 ft. below drilling platform.
inch dia. to ft. below drilling platform.
G. CASING INSTALLED: 10 in. I.D. x .250 in. wall solid section to 15 ft. below drilling platform.
4" PVC in. I.D. x .250 in. wall perforated section to 414 ft. below drilling platform.
Type of perforation SLOTTED 20' (1/8" X 8 SLOTS.)
H. ANNULUS: Grouted 102' ft. to ft. below ~~drilling platform~~ surface
Gravel packed ft. to ft. below drilling platform.
I. PERMANENT PUMP INSTALLATION:
Pump type, make, serial no. NO INFORMATION, TO BE Capacity g.p.m.
Motor type, H.P., voltage, r.p.m. INSTALLED BY OWNER, AT A LATER DATE.
Depth of pump intake setting ft. below which elevation is ft.
Depth of bottom of airline ft. below which elevation is ft.

HYDROLOGY

J. INITIAL WATER LEVEL 395 ft. below ~~drilling platform~~ SURFACE Date of measurement. 1/17/80
K. INITIAL CHLORIDE: 1320 ppm, total depth of well 412 ft. below ~~drilling platform~~ surface
L. PUMPING TESTS: Reference point (R.P.) used: SURFACE which elevation is 395 ft. (Sampling Date)

Date	1/12/80				Date	1/15/80			
Start water level	394	ft. below SURFACE			Start water level	394	ft. below SURFACE		
End water level	394	ft. below R. P.			End water level	394	ft. below R. P.		
Depth of well	412	ft. below SURFACE			Depth of well	412	ft. below R. P.		
Elapsed Time (hours)	Rate (gpm)	Draw-down (ft.)	Cl- (ppm)	Temp. F	Elapsed Time (hours)	Rate (gpm)	Draw-down (ft.)	Cl- (ppm)	Temp. F
1005 to	3		1320		1/14/80 0900 to	5		1320	
1550 to	3		1440		1200 to	10		1320	
1645 to	5		1560		1400 to	12		1320	
to					to				
1/13/80 1105 to	5		1320		1/15/80 0700 to	12		1260	
1/14/80 0800 to	5		1320		to				

CONTINUOUS PUMPING FOR A PERIOD OF 70 HRS.

SUBSURFACE FORMATION

M. DRILLER'S LOG:

Depth, ft.		Rock Description & Remarks	Water Level ft.
0	to 1	Top soil & red sand.	
1	to 40	Volcanic boulders, hard.	
40	to 51	blue basalt, blue.	
51	to 55	red gravelly clay.	
55	to 66.5	fractured basalt.	
66.5	to 102	fractured basalt	
102	to 112	sandstone, soft.	
112	to 140	fractured basalt.	
140	to 147	cinders, soft.	
147	to 151	blue basalt, caving.	
151	to 184	basalt, medium & hard.	
184	290	basalt meduim hard & pukas.	
290	to 315	Cinders, red, Soft, caving.	
315	to 318.5	basalt, blue.	
318.5	to 319	caving	
319	to 351	basalt, blue.	
351	to 370	basalt soft.	
370	to 373	cinders.	
373	to 375	basalt medium.	
375	to 377	cinders, caving.	
377	to 393	Basalt, soft & medium.	
393	to 412	Cinders & water @ 394'.	
	to		

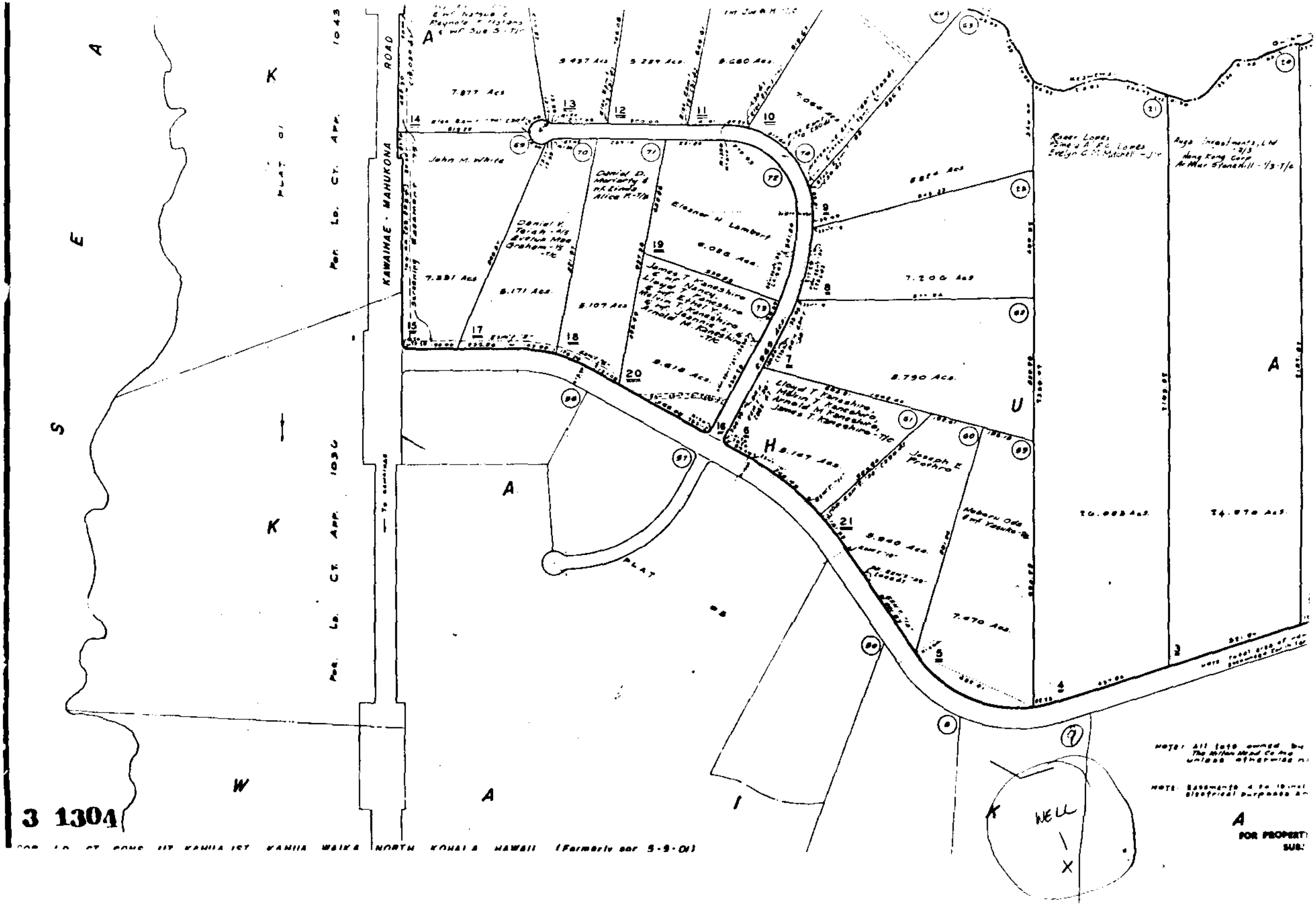
N. REMARKS:

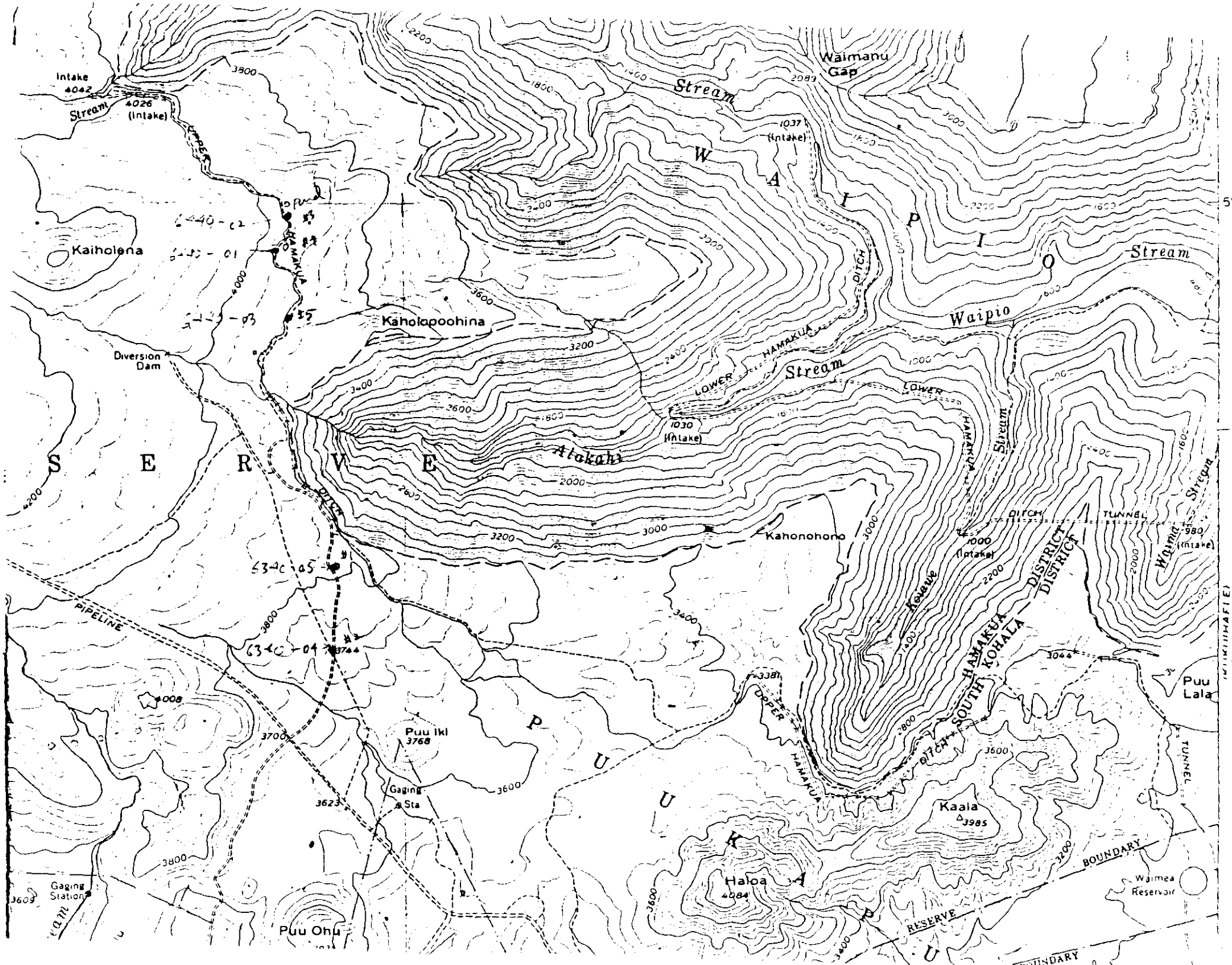
FOR DRILLER'S USE
b Name PLACE / So. KOHALA
b No.

INSTRUCTIONS: Send three(3) copies to: Manager-Chief Engineer, Division of Water and Land Development, P. O. Box 373, Honolulu, Hawaii 96809.

REFERENCES: Chapter 178, entitled "Artesian Wells, Generally," HRS, as amended by Act 123 SLH 1970. Honolulu Board of Water Supply, "Rules and Regulations Providing for the Protection, Development and Conservation of Water Resources." Sec't 8-105(j). "Powers, Duties and Functions of the Board," Charter of the City and County of Honolulu, 1959.

FOR OFFICIAL USE
Latitude
Longitude
Well No.


KAWAIHAE - MAHUKONA ROAD
John M. White
Daniel D. Moriarty & wf. Linda Alice R. - T/E
Daniel V. Taish - Als Evelyn Mae Graham - ½ - T/C
Eleanor N. Lambert
James T. Kaneshiro & wf. Nancy, Lloyd T. Kaneshiro & wf. Ethel Y., Melvin & wf. Jeannie A., Arnold M. Kaneshiro - T/C
Lloyd T. Kaneshiro, Melvin T. Kaneshiro, Arnold M. Kaneshiro, James T. Kaneshiro - T/C
Joseph E. Prothro
Noboru Oda & wf. Yasuko - T/E
Roger Lopes
Aga Investments, Ltd.
Hong Kong Corp.
7.877 Acs.
5.437 Acs.
5.289 Acs.
5.680 Acs.
7.331 Acs.
5.171 Acs.
5.107 Acs.
6.026 Acs.
7.200 Acs.
8.790 Acs.
5.940 Acs.
7.470 Acs.
Por. Ld. Ct. App. 1043
Por. Ld. Ct. App. 1036
PLAT OF
PLAT
3 1304
WELL
NOTE: All lots owned by The Milton Mead Co. Inc. unless otherwise n...
NOTE: Easements 4 to 18 incl. electrical purposes an...
FOR PROPERTY
SUB.
POR. LD. CT. CONS. 117 KAHUA 1ST, KAHUA WAIKA, NORTH KOHALA, HAWAII (Formerly por. 5-9-01)


Intake
4042
Stream
4026
(Intake)
Waimanu
Gap
2089
Stream
1037
(Intake)
W A I P I O
Stream
Kaiholena
Kaholapoohina
Diversion
Dam
HAMAKUA
DITCH
Waipio
LOWER HAMAKUA
Stream
1030
(Intake)
Alakahi
S E R V E
Kahonohono
Lower
HAMAKUA
Stream
DITCH
TUNNEL
1000
(Intake)
980
(Intake)
Waima
Stream
Koaiwe
DISTRICT
DISTRICT
PIPELINE
SOUTH HAMAKUA
KOHALA
3381
DITCH
HAMAKUA
Puu
Lala
TUNNEL
Puu Iki
3768
Gaging
Sta
3623
P U U K A
Kaala
3985
Haloa
4084
Gaging
Station
Puu Ohu
BOUNDARY
Waimea
Reservoir
RESERVE
P U U

June 1, 1987

MEMORANDUM FOR THE RECORD

FROM: Mitchell Ohye

SUBJECT: Kohala Mountain Test Hole #1 6340-05, Hawaii
Pumping Test No. 1

Present on site: Vern and Mike of Hawaiian Island Drilling
M. Ohye of D.O.W.A.L.D.

A pumping test was conducted on the subject well from May 19-21, 1987. The well was pumped using a 6 inch 15 H.P. submersible pump. A rate of 100 gpm was established and held for the duration of the test, however the well failed to stablize and the water level data showed a steady downward trend. Water samples indicate the chlorides to be at 5 ppm and temperature at 61 degrees F, both were constant throughout the test.(See files for complete data)

Mitchell K. Ohye

KOHALA TEST HOLE NO. 1 6340-05, HAWAII

Ground Elevation - - - - - - - - - - - - _____ ft. msl

Top of Casing (casing= 1.5' above grd) _____ ft. msl

Casing size - - - - - - - - - - - - - - -) ___6___ I.D. inches

Blank Casing Depth - - - - - - - - - - - ___24___ ft. (ft. msl)

Shutter Screen Depth - - - - - - - - - - ___100___ ft. (ft. msl)

Total Depth of Well - - - - - - - - - - ___100___ ft. (ft. msl)

Static Water Level (Elevation) - - - - - _____ ft. (ft. msl)

Bottom of Airline - - - - - - - - - - - ___42___ ft. (ft. msl)

Test Conducted by - - - - - - - - - - - Mitchell K. Ohye

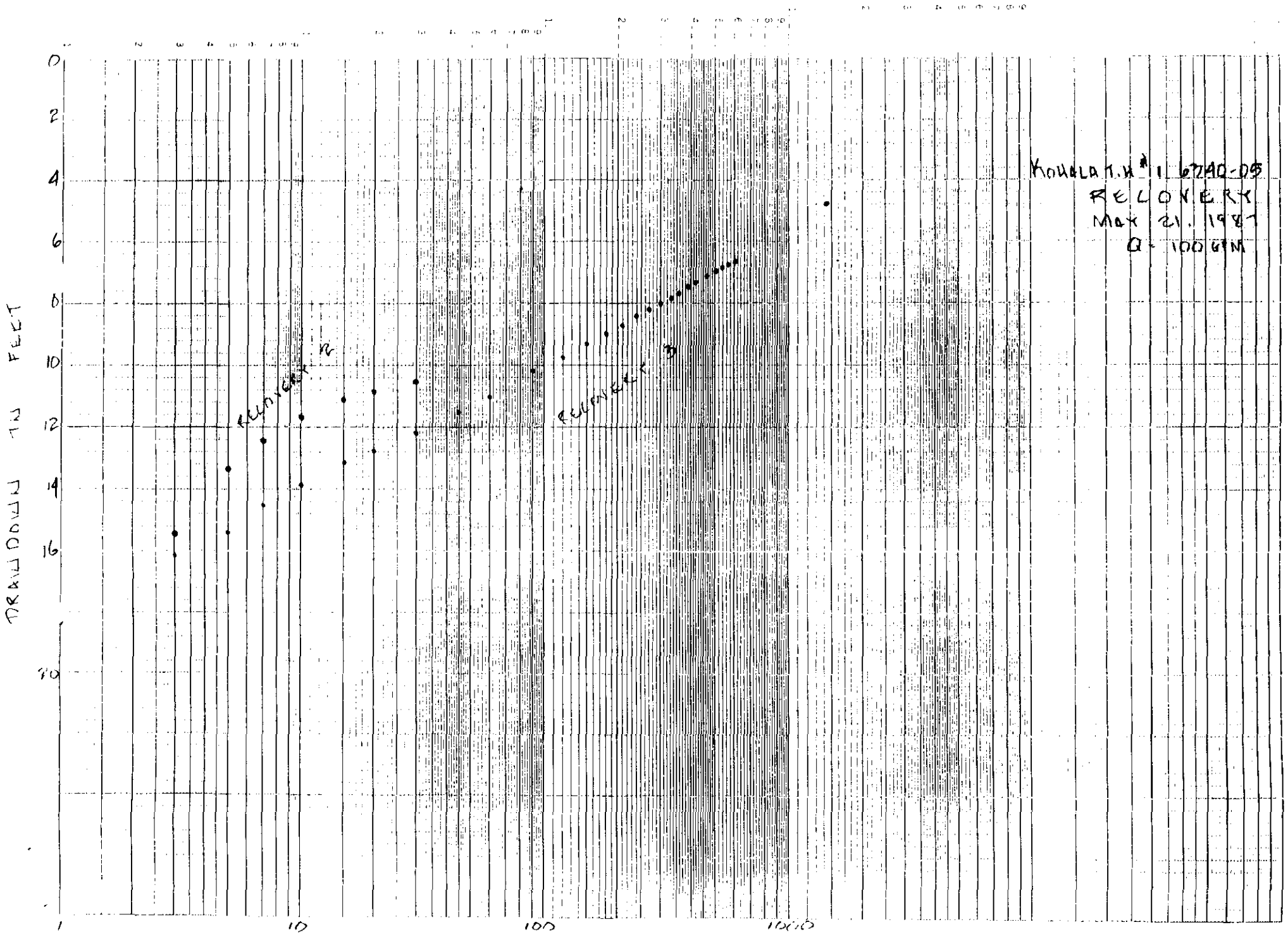
Date & Time	Sample No.	Pumping Rate (GPM)	Airline (FEET)	Drawdown (FEET)	Chlorides (PPM)	Temp. (F)	Remarks
May 19, 1987							Meter Reading 0000000
0915		0	22.65				
0920		0	22.65				
0930		0	22.65	(Static)			
			Start Pumping-Adjust to 100 gpm				
0935		160	13.10	9.55			
0940		100	14.95	7.70			
0945	1	103	14.20	8.45	5		
1000		99	13.70	8.95			
1015		97	13.25	9.40			
1030		92	13.15	9.50		61	
1045		92	12.90	9.75			
1100		92	12.65	10.00			
1115		92	12.40	10.25			
1130		92	12.25	10.40			
1145		92	12.10	10.55			
1200		92	12.00	10.65			

Date & Time	Sample No.	Pumping Rate (GPM)	Airline (FEET)	Drawdown (FEET)	Chlorides (PPM)	Temp. (F)	Remarks
			Recovery-Cont'				
May 19, 1987							
(1730) 30		0	17.35	5.30			
40		0	17.90	4.75			
50		0	18.15	4.50			
(1800) 60		0	18.40	4.20			
75		0	18.65	4.00			
(1830) 90		0	18.85	3.80			
1830			Start Pumping Adjust Rate to 100 gpm				
1837		102	12.35	10.30			
1845		105	11.40	11.25			
1900		102	10.55	12.10			
2000		98	9.30	13.35			
2100		98	8.80	13.85			
2200		98	8.40	14.25			
2300		98	8.15	14.50			
2400		98	7.85	14.80			
May 20, 1987							
0100		96	7.65	15.00			
0200		98	7.20	15.45			
0300		98	6.40	16.25			
0400		98	6.10	16.55			
0500		96	6.50	16.15			
0600		96	6.50	16.15			
0700		96	6.70	15.95			
0800		103	7.00	15.65			
0900		100	6.40	16.25		61	
1000		98	6.10	16.55			
1100	3	98	5.90	16.75			Adjust rate 136 to 100 gpm
1200		100	5.90	16.75			
1300		97	5.60	17.05			
1400		97	5.35	17.35			
1500		97	5.05	17.60			
1600		97	4.80	17.85			
1700		97	4.50	18.15			
1800		95	4.30	18.35			

Date & Time	Sample No.	Pumping Rate (GPM)	Airline (feet)	Drawdown (feet)	Chlorides (ppm)	Temp. (F)	Remarks
May 21, 1987							
	0032						
			Stop Pumping- Recovery				
Elapsed Time (minutes)							
01		0	4.40	16.25			Meter Rdg.
03		0	6.50	16.15			May 21 (0700) 241800
05		0	7.20	15.45			May 19 (1830) 43200
07		0	8.15	14.50			Gals. Pumped 198600
10		0	8.80	13.85			Ave. Q= 92 Gals. per Min.
15		0	9.50	13.15			
20		0	9.90	12.75			
30		0	10.50	12.15			
45		0	11.15	11.50			
(0800) 60		0	11.60	11.05			
90		0	12.50	10.15			
(0900)120		0	12.90	9.75			
150		0	13.35	9.30			
(1000)180		0	13.65	9.00			
210		0	13.95	8.70			
(1100)240		0	14.20	8.45			
270		0	14.40	8.25			
(1200)300		0	14.60	8.05			
330		0	14.80	7.85			
(1300)360		0	15.00	7.65			
390		0	15.20	7.45			
(1400)420		0	15.35	7.30			
450		0					
480		0	15.55	7.10			
(1500)510		0	15.70	6.95			
540		0	15.80	6.85			
(1600)570		0	15.90	6.75			
600		0	16.00	6.65			
May 22, 1987							
(0700)							
1470		0	17.90	4.75			

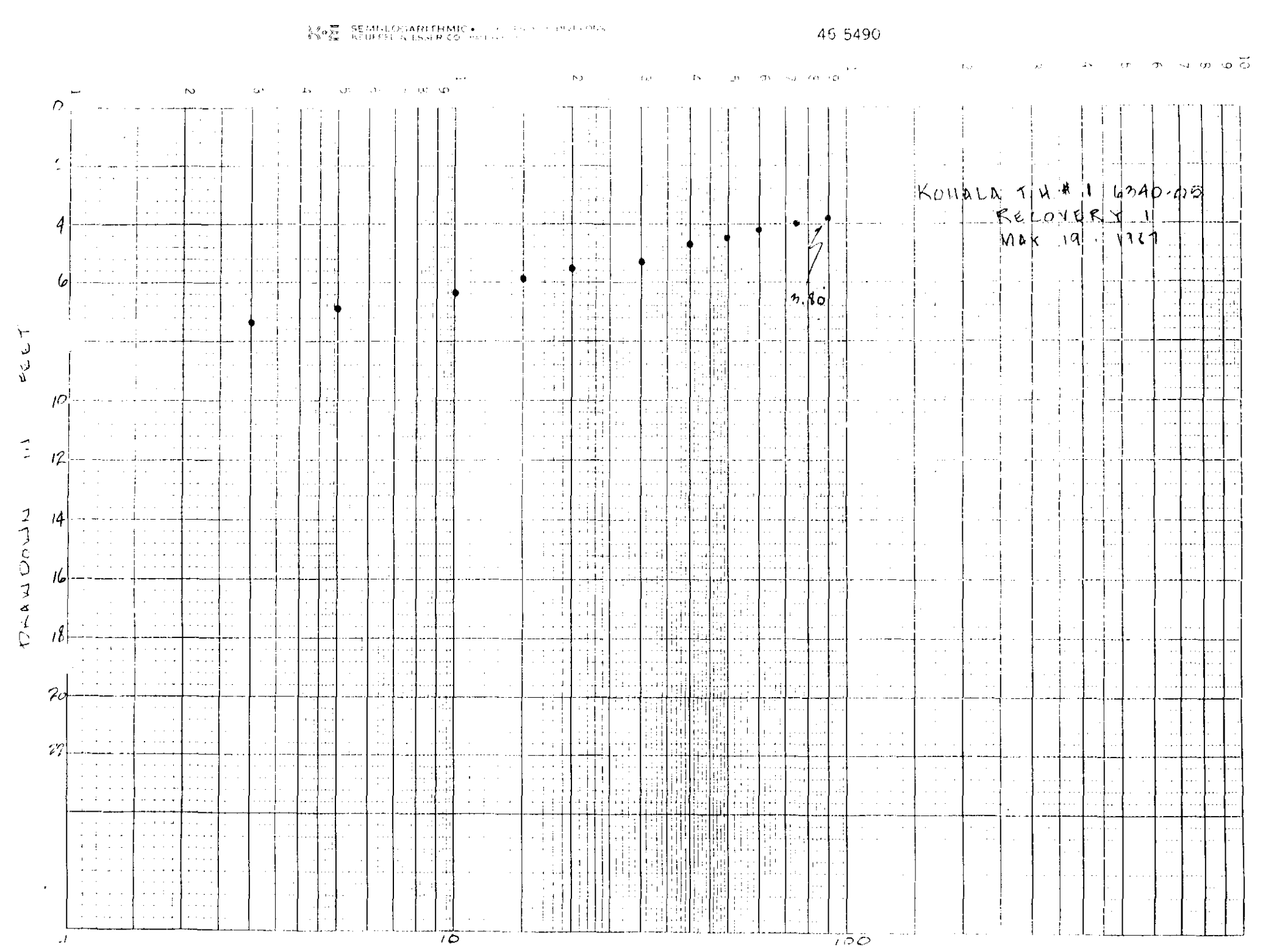
K&E SEMI-LOGARITHMIC 5 CYCLES X 70 DIVISIONS
KEUFFEL & ESSER CO.

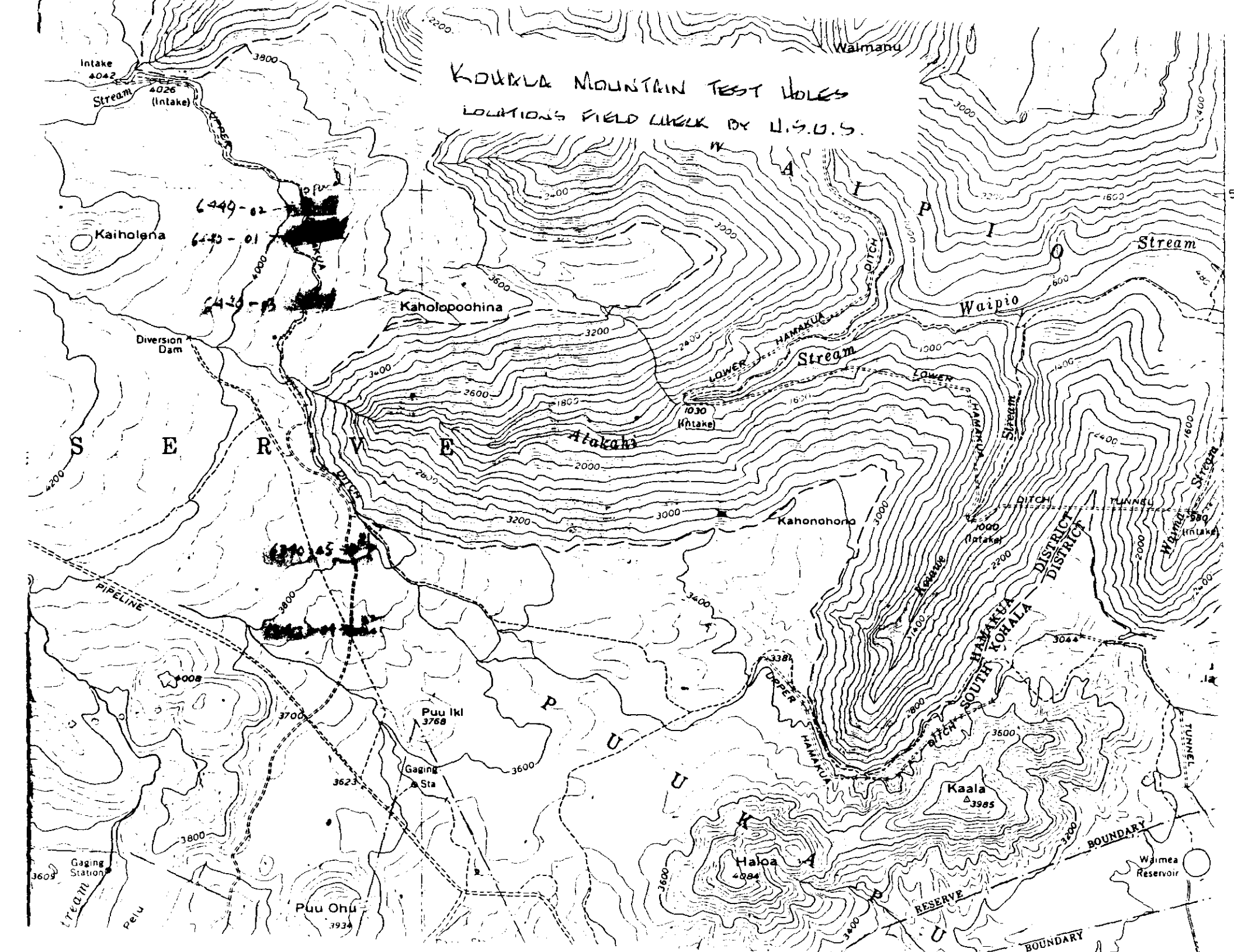
46 6210



SEMI-LOGARITHMIC
KEUFFEL & ESSER CO.

45 5490



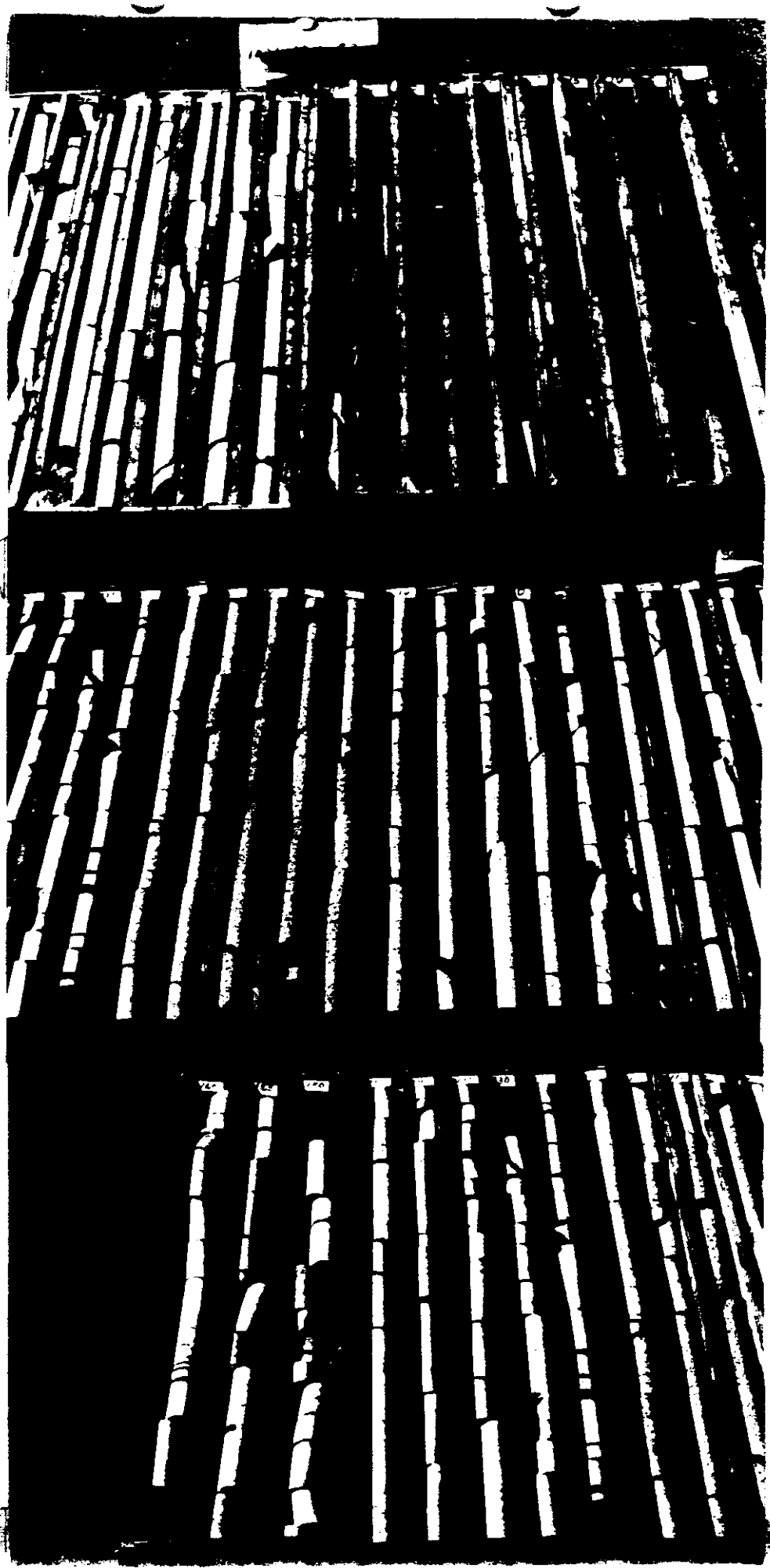

KOHALA MOUNTAIN TEST HOLES
LOCATIONS FIELD CHECK BY U.S.G.S.
Waimanu
Intake
4042
Stream
4026
(Intake)
UPPER
HAMAKUA
DITCH
6449-02
6449-01
6449-03
Kaiholena
Kaholopoohina
Diversion
Dam
SERVE
Atakaka
LOWER
HAMAKUA
DITCH
Stream
1030
(Intake)
Waipio
Stream
Kahonohono
1000
(Intake)
DITCH
TUNNEL
Waima
Stream
(Intake)
DISTRICT
DISTRICT
Kaeade
HAMAKUA
KOHALA
SOUTH
DITCH
UPPER
HAMAKUA
DITCH
PIPELINE
6310-05
6310-04
6310-02
6310-01
Puu Ikl
3768
Gaging
Sta
3623
Kaala
3985
Haloa
4084
BOUNDARY
RESERVE
BOUNDARY
Waimea
Reservoir
TUNNEL
Gaging
Station
Puu Ohu
3934
Stream
Pelu

LOG OF CORES

Test Hole P1 (6340-05)
Kohala Mountain, Hawaii
Job No. 48-HW-A

by
Daniel Lum

Depth	Description
0 - 7'	SOIL: Brown, with some black organic material.
7 - 18	CLINKERY LAVA: Gray and tan, weathered, fragmented.
18 - 35	DENSE LAVA: Gray, unweathered, fractured.
35 - 54	VESICULAR LAVA: Gray, fractured, with large irregular vesicles.
54 - 74	Dense lava: Gray, unweathered, vesicular in places with horizontal flow structure in lower section.
74 - 77(?)	ASH & CLINKERS(?): Yellow
77(?) - 100	VESICULAR LAVA: Gray, to brownish gray, broken and clinkery in upper section.
100 - 105	DENSE LAVA: Brownish gray, non-vesicular.



KOHALA T.H
#3 L6#40.07
4
CORE SAMPLE
0' - 80'

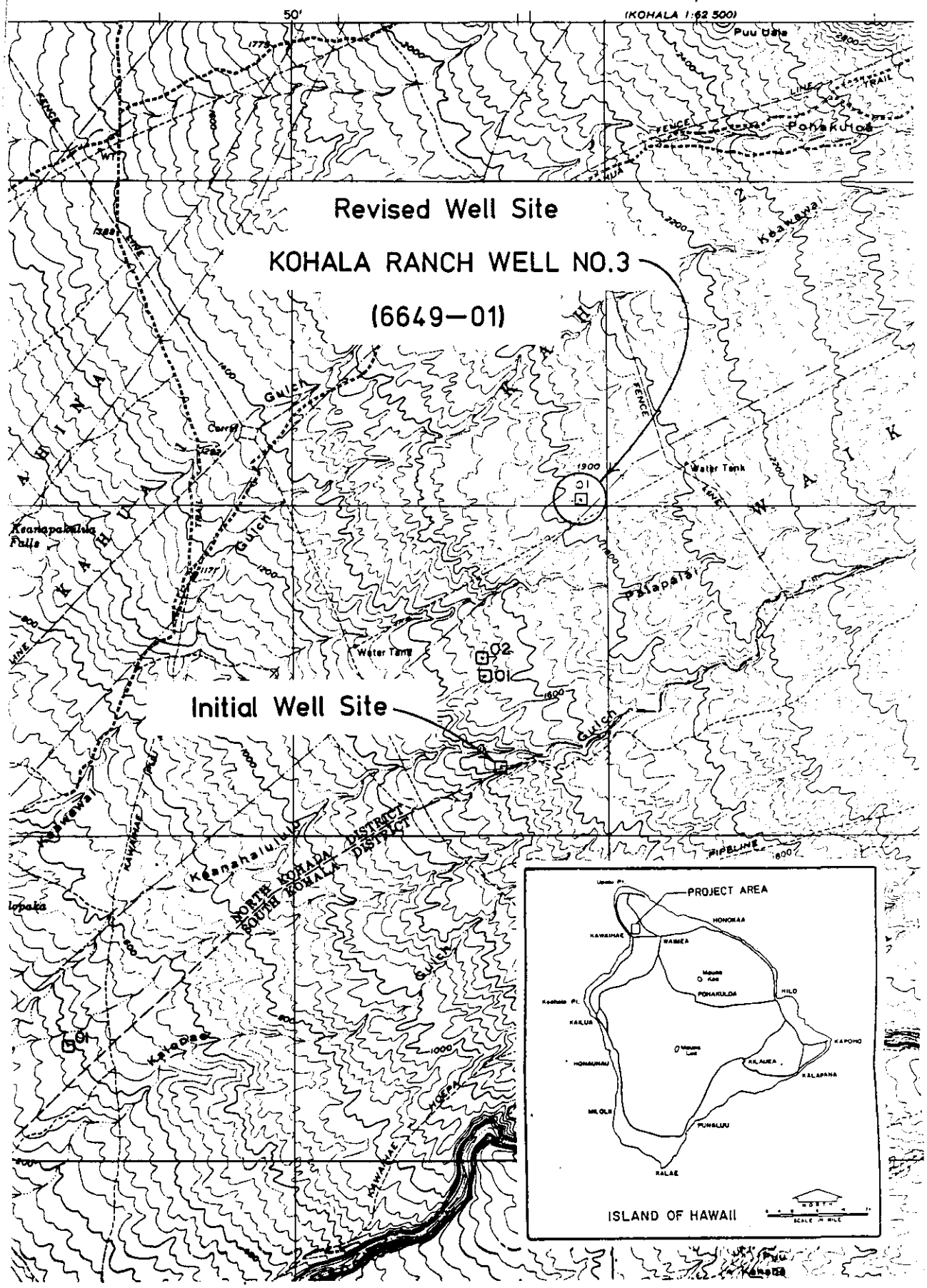
CORE SAMPLE
80' - 140'

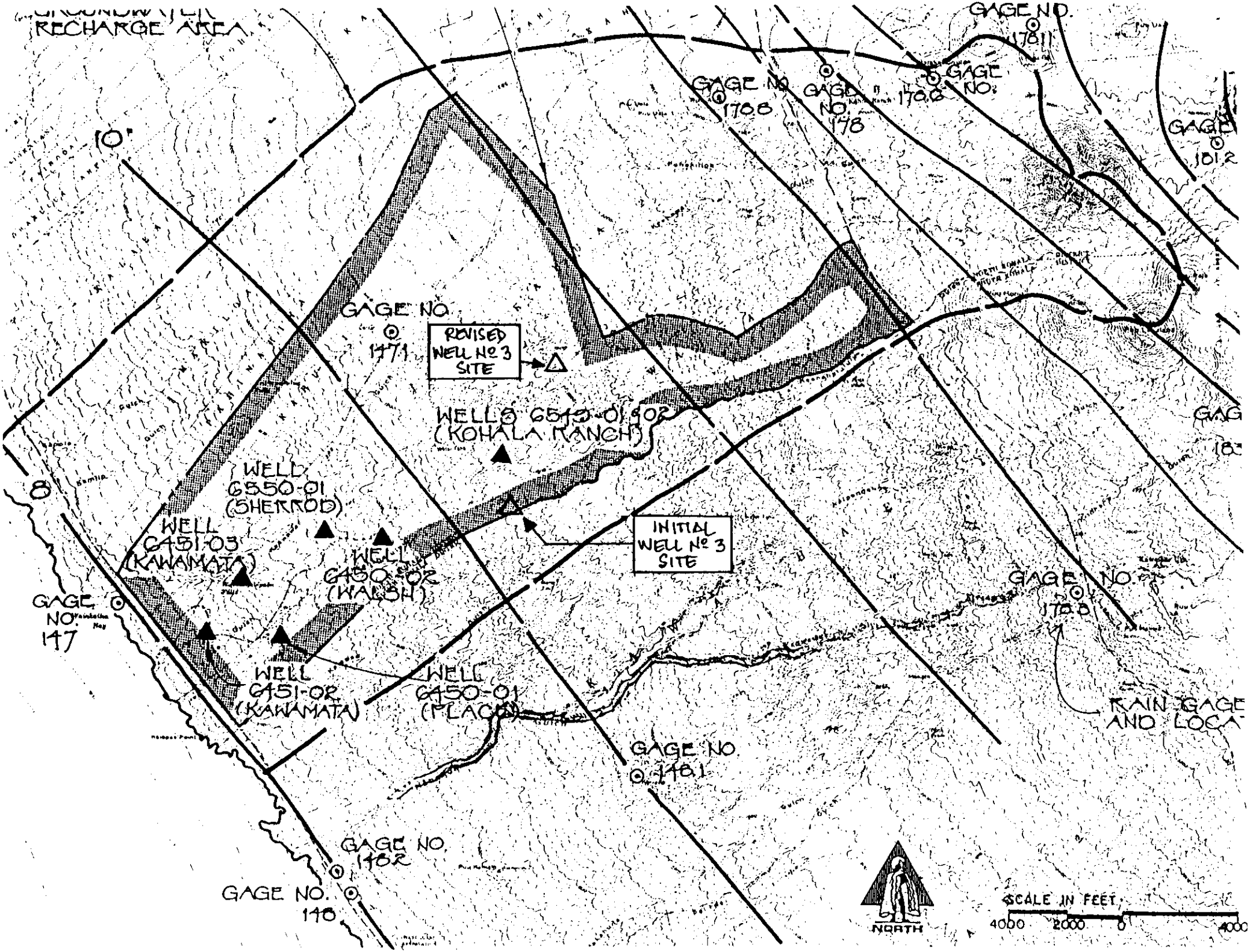
CORE SAMPLE
140' - 160'

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF WATER AND LAND DEVELOPMENT

1981, 84

(KOHALA 1:62 500)




RECHARGE AREA
GAGE NO. 1781
GAGE NO. 170.8
GAGE NO. 178
GAGE NO. 170.8
GAGE NO. 101.2
10°
GAGE NO. 177.1
REVISED WELL Nº 3 SITE
WELLS 6515-01 & 02 (KOHALA RANCH)
WELL 6550-01 (SHERROD)
WELL 6451-03 (KAWAMATA)
WELL 6450-OR (WALSH)
INITIAL WELL Nº 3 SITE
8
GAGE NO. 147
GAGE NO. 170.1
WELL 6451-OR (KAWAMATA)
WELL 6450-01 (PLACE)
GAGE NO. 176.1
GAGE NO. 176.2
GAGE NO. 140
NORTH
SCALE IN FEET
4000 2000 0 4000

DEPARTMENT OF LAND & NATURAL RESOURCES
DIVISION OF WATER AND LAND DEVELOPMENT

STATE

DRILLER'S REPORT

RECEIVED
90 JUL 16 AM 8:40
HAWAII

DESCRIPTION

Date of report July 2, 1990 Person filing report Kathy Watanabe

A. OWNER Kohala Joint Venture WELL NAME Kohala Ranch Well No. 6 ISLAND Hawaii
B. GENERAL LOCATION North Kohala District
C. DRILLING COMPANY Water Resources International, Inc.
D. TYPE OF RIG Rotary DRILLING COMPLETED 12 (month) 1989 (year) DRILLER Richardson/Gonsalves

DIVISION OF WATER & LAND DEVELOPMENT

E. ELEVATION, msl: Top of drilling platform 1852 ft. Bench mark and method used to determine
Height of drilling platform above ground surface 12 ft. elevation:
F. HOLE SIZE: 24 inch dia. to 1937 ft. below drilling platform.
inch dia. to ft. below drilling platform.
inch dia. to ft. below drilling platform.
G. CASING INSTALLED: 18 in. I.D. x 3/8 in. wall solid section to 1717 ft. below drilling platform.
18 in. I.D. x 5/16 in. wall perforated section to 1917 ft. below drilling platform.
Type of perforation Ful-Flo
H. ANNULUS: Grouted 12 ft. to 612 ft. below drilling platform.
Gravel packed 612 ft. to 1707 ft. below drilling platform.
I. PERMANENT PUMP INSTALLATION:
Pump type, make, serial no. Capacity g.p.m.
Motor type, H.P., voltage, r.p.m.
Depth of pump intake setting ft. below which elevation is ft.
Depth of bottom of airline ft. below which elevation is ft.

HYDROLOGY

J. INITIAL WATER LEVEL 1716 ft. below drilling platform. Date of measurement. 11/28/89
K. INITIAL CHLORIDE: ppm, total depth of well ft. below drilling platform
L. PUMPING TESTS: Reference point (R.P.) used: which elevation is ft.

Date March 28, 1990
Start water level 1716 ft. below R. P.
End water level ft. below R. P.
Depth of well ft. below R. P.

Elapsed Time (hours)		Rate (gpm)	Draw-down (ft.)	Cl- (ppm)	Temp. F
3/28/90 to					
1100 to	2300	1212.12	3.00		
3/29/90 to					
2400 to	2300	1174.16	3.00		
3/30/90 to					
2400 to	2300	1192.84	3.00		

Sampling Date
Date
Start water level ft. below R. P.
End water level ft. below R. P.
Depth of well ft. below R. P.

Elapsed Time (hours)		Rate (gpm)	Draw-down (ft.)	Cl- (ppm)	Temp. F
3/31/90 to					
2400 to	2300	1190.47	3.00		
4/1/90 to					
2400 to	2300	1183.43	3.00		
4/2/90 to					
2400 to	0800	1181.10	3.00		

SUBSURFACE FORMATION

M. DRILLER'S LOG:

Depth, ft.		Rock Description & Remarks	Water Level ft.
0 to	40	Broken aa	
40 to	70	Med. hard lava rock	
70 to	100	Clinkery	
100 to	130	Broken aa	
130 to	170	Decomposed rock	
170 to	350	Clinkery & broken aa	
350 to	400	Dense, hard lava	
400 to	600	Med. hard w/broken stringers	
600 to	690	Hard rock	
690 to	860	Decomposed w/broken stringers	
860 to	1000	Clinkery & broken aa	
1000 to	1140	Dense, hard rock	
1140 to	1260	Med. hard rock	
1260 to	1390	Broken aa & clinkery	
1390 to	1540	Med. hard lava rock	
1540 to	1700	Hard, dense rock	
1700 to	1800	Med. hard w/some broken stringers	
1800 to	1937	Med. hard to dense rock	
to			
to			
to			
to			

N. REMARKS:

FOR DRILLER'S USE
Job Name
Job No.

INSTRUCTIONS: Send three(3) copies to: Manager-Chief Engineer, Division of Water and Land Development, P. O. Box 373, Honolulu, Hawaii 96809.

REFERENCES: Chapter 178, entitled "Artesian Wells, Generally," HRS, as amended by Act 123 SLH 1970. Honolulu Board of Water Supply, "Rules and Regulations Providing for the Protection, Development and Conservation of Water Resources." Sec't 8-105(j), "Powers, Duties and Functions of the Board," Charter of the City and County of Honolulu, 1959.

FOR OFFICIAL USE
Latitude 20 06 04
Longitude 155 49 07
Well No. 6649-01

Engineering Report
Kohala Ranch Well No. 3
New Potable Water Source
Kohala Ranch Water System
North Kohala, Hawaii

Submittal to
Hawaii State Department of Health
Drinking Water Program

Prepared by
Tom Nance Water Resources Engineering

On Behalf of
Kohala Ranch Water Company

May 1990

Table 1

Available Data From Wells in Kohala Estates and Kohala Ranch

Well		Ground Elevation (Feet)	Distance From Shoreline (Feet)	Elevation at Well Bottom (Feet msl)	Static Water Level (Feet msl)	Chloride Concentration (MGL)
No.	Owner					
6451-02	Kawamata	238	1950	-7.4	2.6	1250
6451-03	Kawamata	397	3250	-8.3	6.7	700
6450-01	Place	400±	3650	-15±	Not Available	1260 to 1560
6550-01	Sherrod	675	7000	-25.4	3.7	245
6450-02	Walsh	750 to 800	7650	Not Available	3.3±	150 to 180
6549-01	KRWC	1459.9	13,900	-111	5.2 - 6.5	80
6549-02	KRWC	1449.0	13,900	-111	Not Available	80

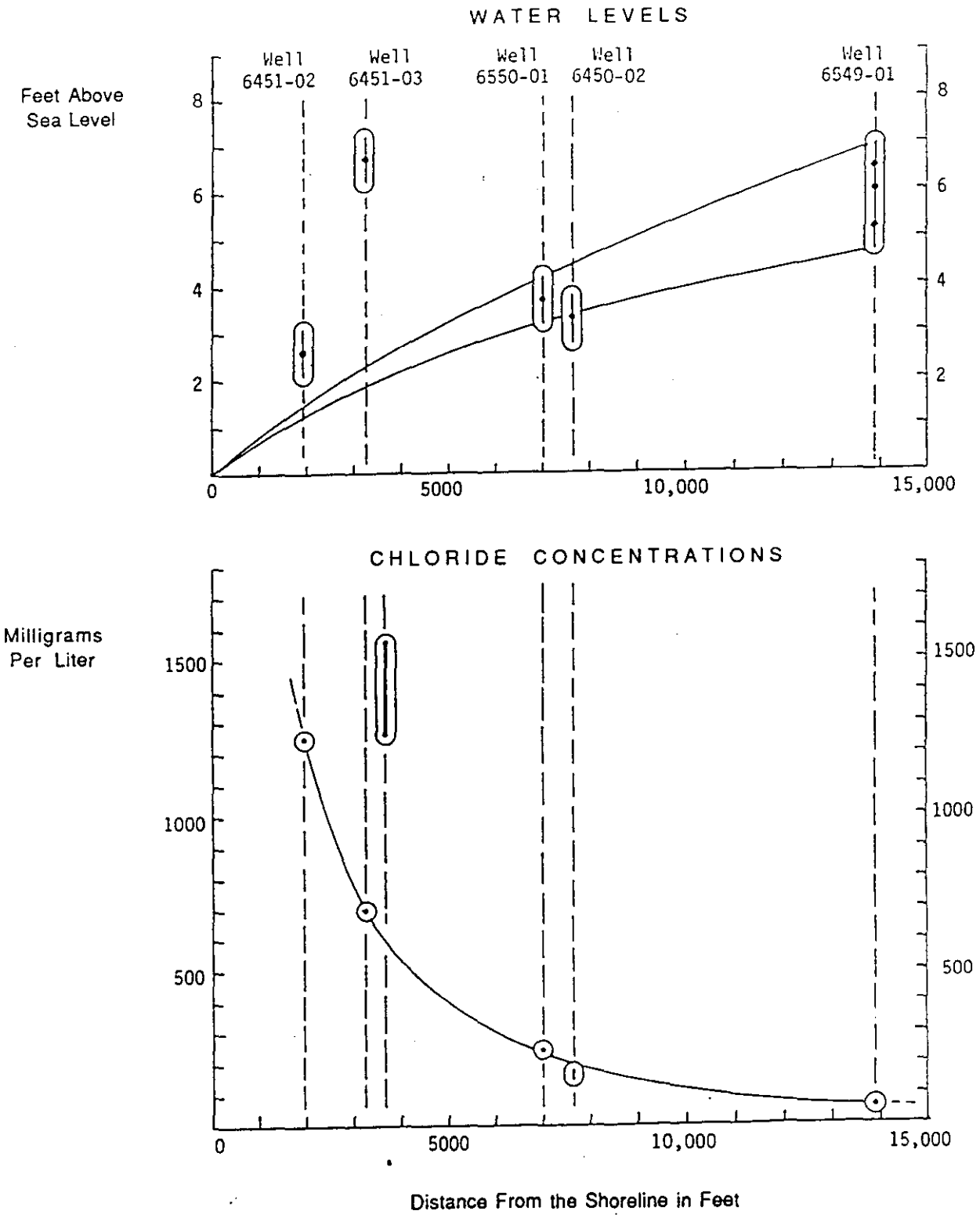


Figure 4

Well Water Level and Chloride Concentration in Relation to Distance From the Shoreline

Table 2

Data of the Kohala Water System Wells

State Well Number	6549-01	6549-02	6649-01
Well Name	Kohala Well No. 1	Kohala Well No. 2	Kohala Well No. 3
Ground Elevation (FT)	1459.9	1449.0	1840
Nominal Casing Diameter (IN)	12	12	18
Total Well Depth (FT)	1550	1560	1920
Length of Solid Casing (FT)	1430	1460	1705
Length of Perforated Casing (FT)	120	100	200
Length of Open Hole Below Casing (FT)	0	0	15
Elevation of Bottom of Hole (FT-MSL)	-90	-111	-80
Still Water Level (FT-MSL)	7	7	±145
Representative Chloride Content (MGL)	80	80	35
Pump Test Flow Rate and Drawdown (FT @ GPM)	5.7 @ 700	Not Available	3.6 @ 1200

BREWER ANALYTICAL L JOF TORIES
a Department of Brewer Chemical Corporation
P O BOX 552 PAPAIKOU, HAWAII 96781 PHONE: 964-5522

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APR 1 2 19

JOB NO. 1179
DATE 04/11/90
PAGE 1 OF 2

LABORATORY ANALYSIS REPORT (1)

BELT, COLLINS & ASSOCIATES

JRB
PWH
W
TN
CF
FS
ADK

TO: BELT, COLLINS, AND ASSOCIATES ATTN: MR. TOM NANCE
ADDRESS: 680 ALA MOANA BLVD. PHONE:
HONOLULU, HAWAII 96813
SAMPLES OF: Potable Water
SAMPLED BY: G. Fukumitsu SAMPLING DATE: 04/02/90 TIME: 0938
RECEIPT DATE: 04/02/90 TIME: 1145

Job

DATE SAMPLE ANALYZED			4/2-4/9/90			
TIME SAMPLE ANALYZED						
SAMPLE TYPE						
SAMPLE DESCRIPTION	UNITS		Kohala Well #3			Maximu Contamina Level mg/L
ARSENIC	mg/L		<0.002			0.05
BARIUM	mg/L		<0.1			1.0
CADMIUM	mg/L		< 0.005			0.010
CHROMIUM	mg/L		0.01			0.05
LEAD	mg/L		< 0.02			0.05
MERCURY	mg/L		0.0004			0.002
SELENIUM	mg/L		< 0.002			0.01
SILVER	mg/L		< 0.01			0.05
FLUORIDE	mg/L		0.12			
NITROGEN, NITRATE	mg/L		0.94			10.0
SILICA	mg/L		55			
ENDRIN	mg/L		< 0.0002			0.0002
LINDANE	mg/L		< 0.004			0.004
METHOXYCHLOR	mg/L		<0.1			0.1
TOXAPHENE	mg/L		<0.005			0.005
2,4-D	mg/L		<0.1			0.1
2,4,5-TP (Silvex)	mg/L		<0.01			0.01

LABORATORY REMARKS: Samples analyzed according to "Methods for Chemical Analysis of Water and Wastes", U.S. Environmental Protection Agency, March, 1979 and/or "Microbiological Methods for Monitoring the Environment", U.S. Environmental Protection Agency, August, 1978.