TRUE/MID-PACIFIC GEOTHERMAL VENTURE

Exploration Development Marketing of Geothermal Resources

BRIEF FOR
GOVERNOR'S ADVISORY BOARD
ON THE UNDERWATER CABLE TRANSMISSION PROJECT

ORGANIZATION AND PERMIT STATUS

TRUE/Mid-Pacific Geothermal venture is composed of TRUE Geothermal Energy Company and Mid-Pacific Geothermal, Inc. The organizers and principals of these organizations are located in Casper, Wyoming. The venture was formed in 1980 to acquire land leases in areas presumed to have geothermal resources in underlying reservoirs and to develop those resources for conversion into electrical energy and for sale to a utility or other consumer. We acquired land surface leases with Campbell Estate (27,000 acres more or less) along the middle east rift zone of Kilauea volcano on the island of Hawaii and with Ulupalakua Ranch (4,000 acres more or less) along the Southwest rift zone of Haleakala volcano on Maui.

The application and essential supporting data for the land use permit to explore for, develop and market geothermal resources in the geothermal resource subzone of the Kilauea middle east rift zone (Campbell Estate lands) were submitted to the State Board of Land and Natural Resources in 1982. After five contested hearings and three hearings at the Circuit Court level on various motions by an opposition group, the Board, on April 11, 1986 granted a land-use permit, with extensive conditions, allowing exploration and development of geothermal resources sufficient to generate up to 100MW of

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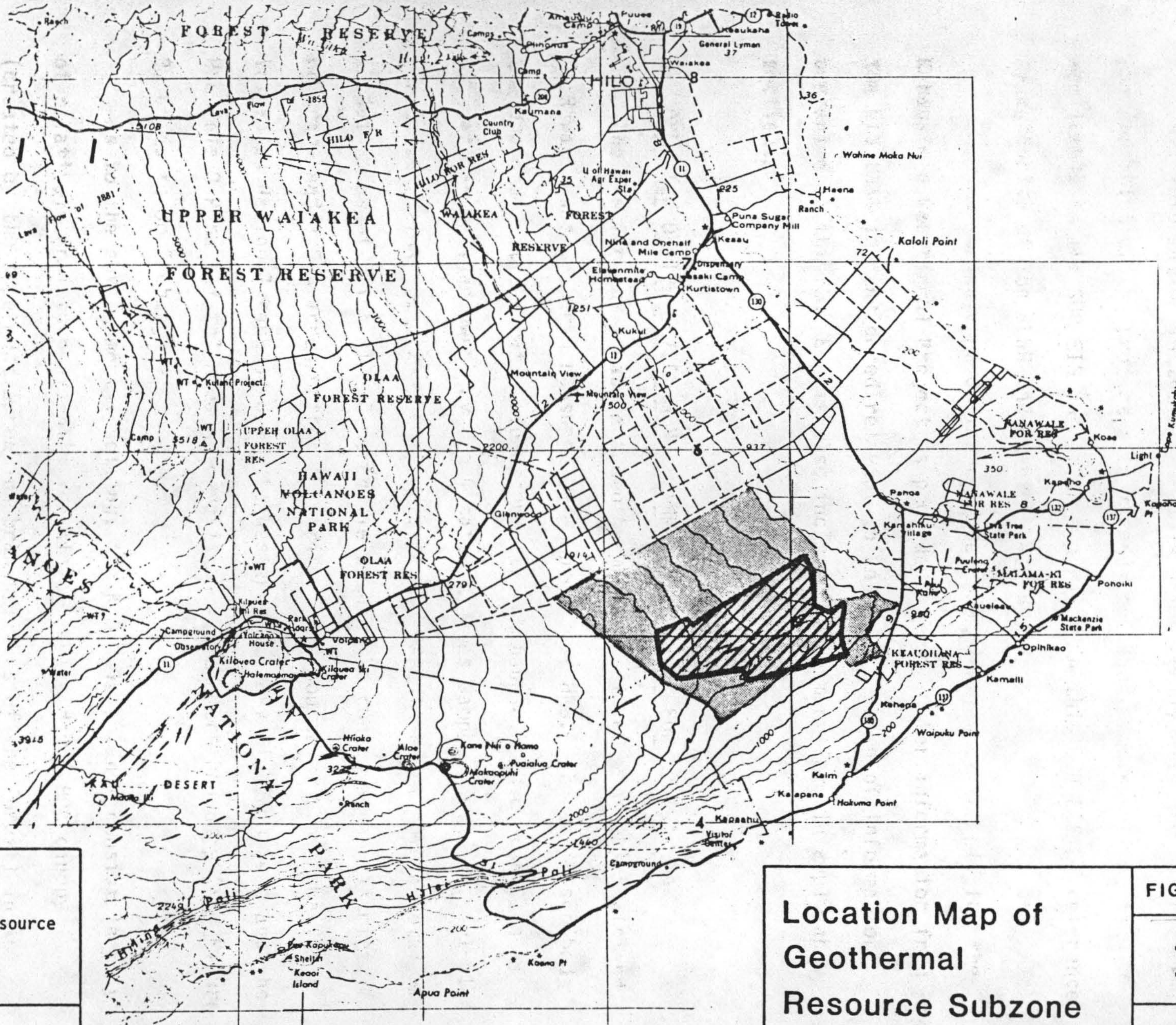
electricity within the 9000 acres (more or less) of the designated geothermal resource subzone of the Campbell Estate lands. The Board's decisions on designating a subzone and granting a development permit were appealed by two Hawaiians to the State Supreme Court which denied the appeals, affirming the Board's decisions on July 14th, 1987. There may be further appeal to the U.S. Supreme Court. The Land Board has just issued to Campbell Estate the required geothermal mining lease granting the right to mine the State's geothermal resources underlying that portion of Campbell Estate's lands falling within the geothermal sub-zone. The mining lease, inter alia, requires that a royalty of 10% of gross proceeds from the sale of geothermal resources be paid to the State. Surface owners are paid an additional royalty based on gross proceeds from sales. An excise tax of 1/2% of 1% is also levied on resource sales. There is no estimate of what county taxes will be assessed on the land as a result of geothermal development.

Subject to any appeal of the State Court's ruling on the Land Board's decisions and upon completion of pre-construction project site surveys and approval of a plan of operations for the exploration phase of the project, the operator of the venture (TRUE Geothermal Energy Company) will ship a major drilling right to Hawaii and commence drilling operations on the Kilauea middle east rift zone project site within 6 to 8 months.

PROJECT DESCRIPTION

Site Location - Geothermal development will occur within Campbell Estate lands, Puna District, island of Hawaii within the State designated geothermal resource sub-zone. Figure 1.



LEGEND:

▨ Geothermal Resource Subzone

Source:

Location Map of Geothermal Resource Subzone

FIGURE

1

Resource Potential and Characteristics - Extensive geologic analyses have been conducted to confirm a geothermal resource potential underlying the project area and the entire Kilauea east rift zone. However, no single geothermal exploration technique, except for deep exploration drilling, is capable of positively identifying a sub-surface geothermal system, and the completion and testing of several successful exploration wells are required to provide a basis for estimating the characteristics of the resource, the potential dimensions of a specific reservoir and its characteristics in relation to whether it could produce and sustain a certain level of flow for 20 - 30 years. This data is essential to estimates on whether the discovered resource can be economically produced within the parameters that most affect the economic success of the project. As to the resource, the temperature, pressure, flow rate and chemical properties will determine whether the geothermal energy can be economically produced. For example, if the resource temperature at the well head is less than 300° F it is unlikely that power plant operations would be economical. Pending the completion and testing of successful wells, the total resource potential within the designated geothermal sub-zone portion of the leased land is estimated to be sufficient to produce and sustain 300MW of geothermal generated base-load electricity.

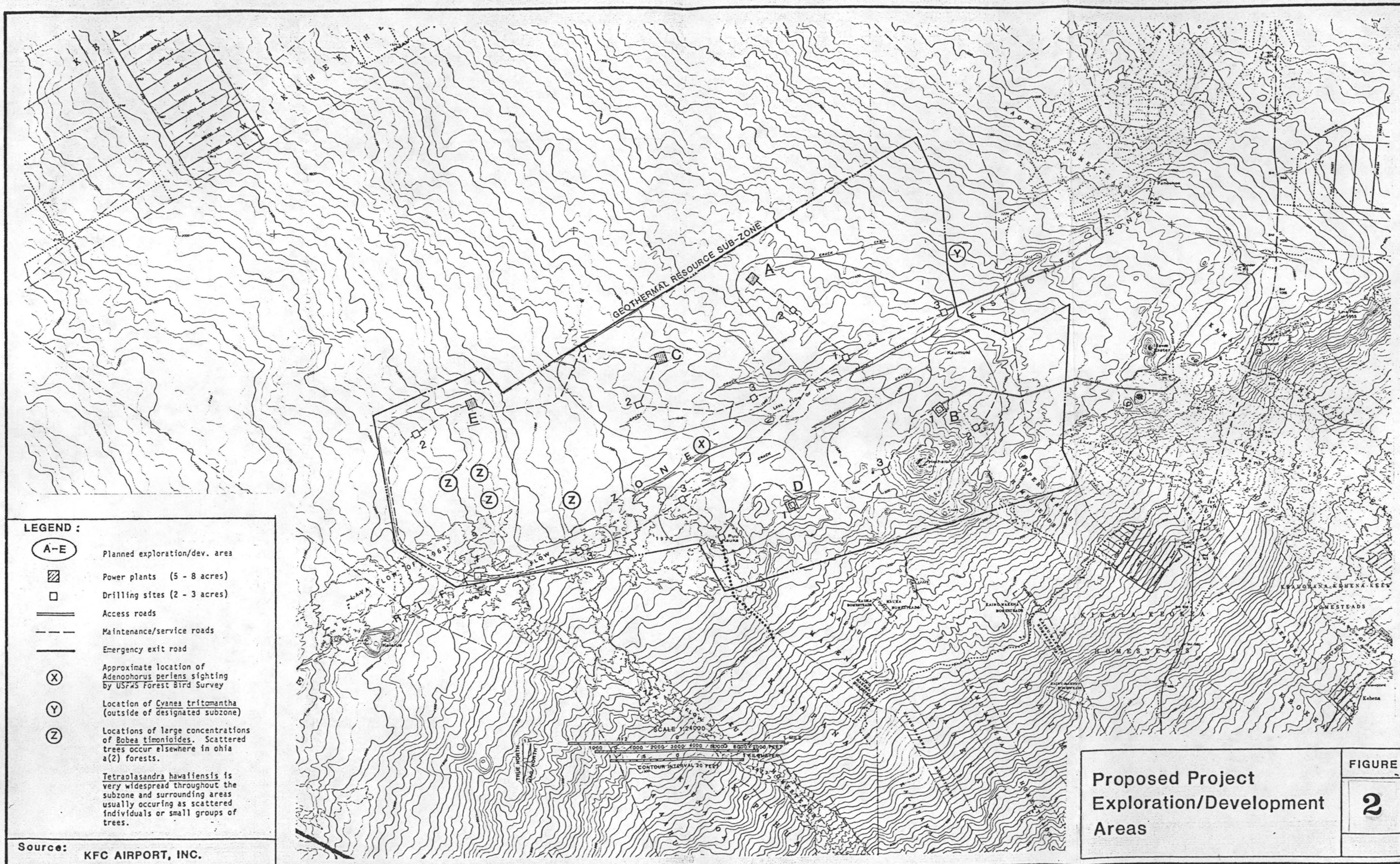
Exploration and Development Plan

The current land use permit authorizes exploration and development of geothermal resources sufficient to produce only 100MW of electricity from within the boundaries of the designated geothermal resource sub zone which constitutes about 3/5 of the total acreage of the Campbell property estimated to have a geothermal potential.

Prospective drilling and power plant sites have been selected throughout the sub-zone as show on Figure 2. Because of the hazards of operating in an active volcanic rift zone, special attention is given to siting of facilities and to taking all appropriate measures to minimize the potential for injury to personnel and damage or destruction of facilities and equipment due to eruptions and lava flows. For these reasons development beyond the level of 100MW of power will require an expansion of the subzone above the northern boundary to allow siting of some power plants farther from the rift zone center. Exploration drilling will begin in the eastern portion of the subzone, on the North side of the rift zone center and progress to the west as the project expands. Power plants would be located within 1 to 1½ miles of the wells supplying the plant, preferably in the northern portion of the rift zone or on high ground in other areas to reduce the potential hazards of volcanic eruptions in the area.

A rotary drilling rig can drill a geothermal well to a depth of about 8000 ft. (expected producing zone of discovered reservoirs) in 60 days at a cost of about $2.5 million. For planning purposes, we assume (1) each well will produce 5MW of electricity, (2) each well will diminish in production capacity at the rate of 3% a year, (3) one in four wells (after an initial resource discovery) will be unsuccessful, (4) one reinjection well will be required for every three production wells, and (5) a requirement for completed and shut-in reserve wells equivalent to 10% of the current production levels.

Power plants within the project site will vary in size from 5MW (well head generator) to 55MW capacity. Plants including abatement systems for Hydrogen sulfide (H2S) will cost between $1.5 - 2.0 million per megawatt of generating capacity. Lead time to bring a plant on line (after well testing and reservoir analysis has confirmed sufficient resources to supply the plant) is about 18 months for 12-15MW plants and 24 to 26 months for 25MW plants.



LEGEND :

A-E	Planned exploration/dev. area
▨	Power plants (5 - 8 acres)
□	Drilling sites (2 - 3 acres)
═══	Access roads
— — —	Maintenance/service roads
———	Emergency exit road
(X)	Approximate location of Adenophorus periens sighting by USFWS Forest Bird Survey
(Y)	Location of Cyanea tritomantha (outside of designated subzone)
(Z)	Locations of large concentrations of Bobea timonioides. Scattered trees occur elsewhere in ohia a(2) forests.
	Tetraplasandra hawaiiensis is very widespread throughout the subzone and surrounding areas usually occuring as scattered individuals or small groups of trees.

Source: KFC AIRPORT, INC.

Proposed Project Exploration/Development Areas

FIGURE 2

Geothermal developers are prepared to take the risks of drilling initial exploratory wells to determine the presence of economically producible resources and the potential production capacity of a discovered reservoir. Beyond that, further exploration drilling or drilling of development wells would be dependent on the existence of a market and a power purchase contract for geothermal generated power. It is our objective that additional drilling (after the initial exploratory drilling) would be for the purpose of supplying some level of base load power to HELCO followed by additional exploratory drilling to prove the existence of sufficient resources to supply a specified level of power for export to Oahu via HVDC overhead and submarine transmission cable. If the cable capacity is to be 500MW, it is estimated that at least 20 successful exploratory wells, at a cost of about $45 million, would have to be drilled and tested to prove the existence of sufficient geothermal resources to justify proceeding with the cable. This drilling effort could be completed in about 15 months with at least two developers drilling with 1 rig each.

Installation of the cable and development of geothermal resources would have to be closely coordinated to limit the time between completion of a well field and/or its power plant and the time power could be accepted by the cable. In this connection, it may be necessary to install the cable in two phases to limit the time that investments in the cable and geothermal development would be idle before full cash flow potential of the operations can be realized.

Commitments by the utility to purchase base load geothermal generated electricity at full avoided costs under PURPA would have to be approved by the Public Utilities Commission. In recognition of the current and projected

costs of oil, the revenue stream for the geothermal generated base load power could not, in the near term, support the cost of the cable. Funding for the cable would therefore appear to require a political decision that is compatible with the State's objective to reduce its dependence on imported oil and to develop local, renewable energy for the future. We have projected an optimistic schedule (Figure 3) for the rate at which geothermal generated base load electricity could come on line given the following assumptions:

(1) That the HVDC overhead and submarine transmission line is determined to be technically and economically feasible, and could be permitted under applicable regulations; that a decision is made as to licensee or owner for the cable and that such operator commits to begin installation of the cable upon satisfactory evidence that sufficient geothermal resources are available to supply to cable to its design capacity and that at least half of the intended cable capacity would be installed by 1995 with the final cable installed by 1998.

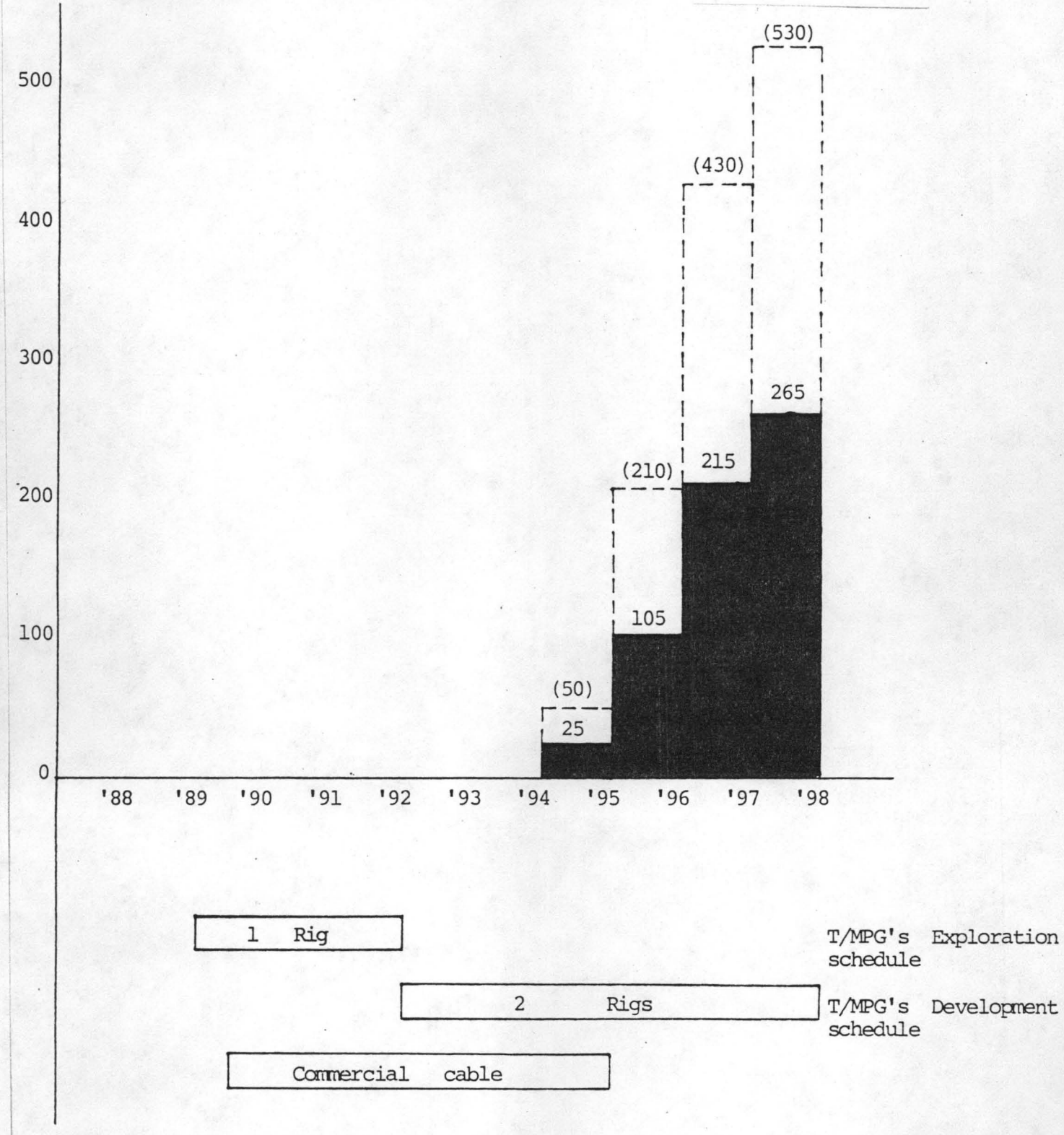
(2) That special governmental procedures are authorized so that the geothermal resource development, power plants and transmission cable can be permitted as a single project to generate 500MW of electricity for transmission from Hawaii to Oahu;

(3) That avoided capacity costs (in addition to avoided fuel costs) can be contracted for in purchase power contracts with the utility under PURPA for up to 500MW of base load, geothermal generated electricity supplied by cable from the Island of Hawaii.

Generating Capacity

mw

POSSIBLE GEOTHERMAL DEVELOPMENT SCHEDULE



Bar Graph Legend:

- Production level estimate for 2nd developer
- Production level estimate for T/MPG

FIG 3

(4) That two geothermal developers, each operating with two rigs in the geothermal subzones of the Kilauea east rift zone, will initiate development drilling simultaneously upon notification of a decision that an order for the manufacture of the cable has been issued.

PRINCIPAL DEVELOPER CONCERNS

- The coordination of the governmental permitting and the scheduling of the cable and geothermal developments. Under existing law, it is unlikely that the two components could be permitted on a concurrent, timely basis. There would have to be a consolidation of applicable laws and standards and this would require new legislation.

- Financing and ownership of the cable.

- Establishing/projecting the level of base-load, geothermal generated power that could replace oil fired generating capacity beginning in 1995.

- The type of long term commitment that can be made by HECO on purchase power contracts for the 1995 period.

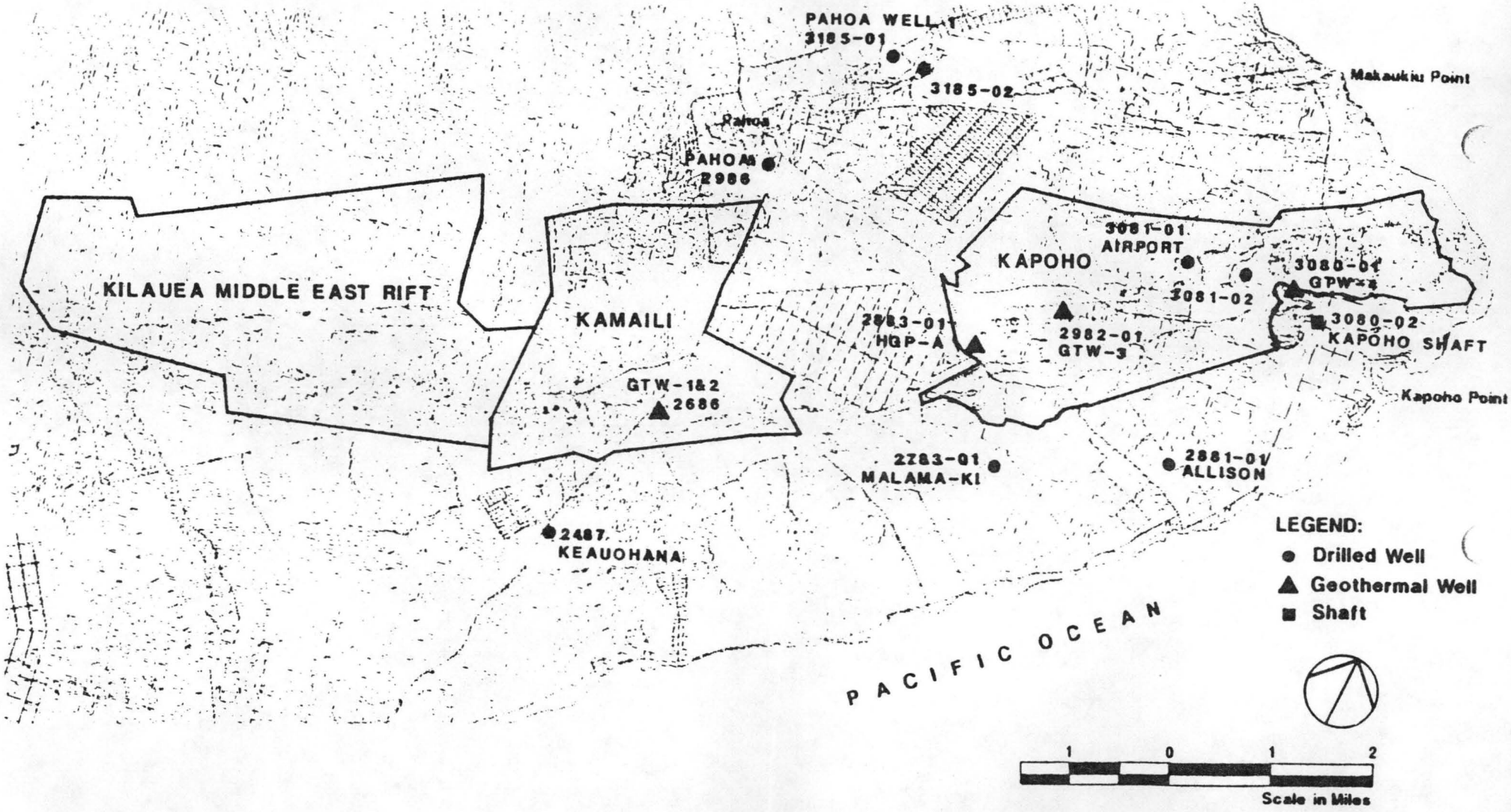
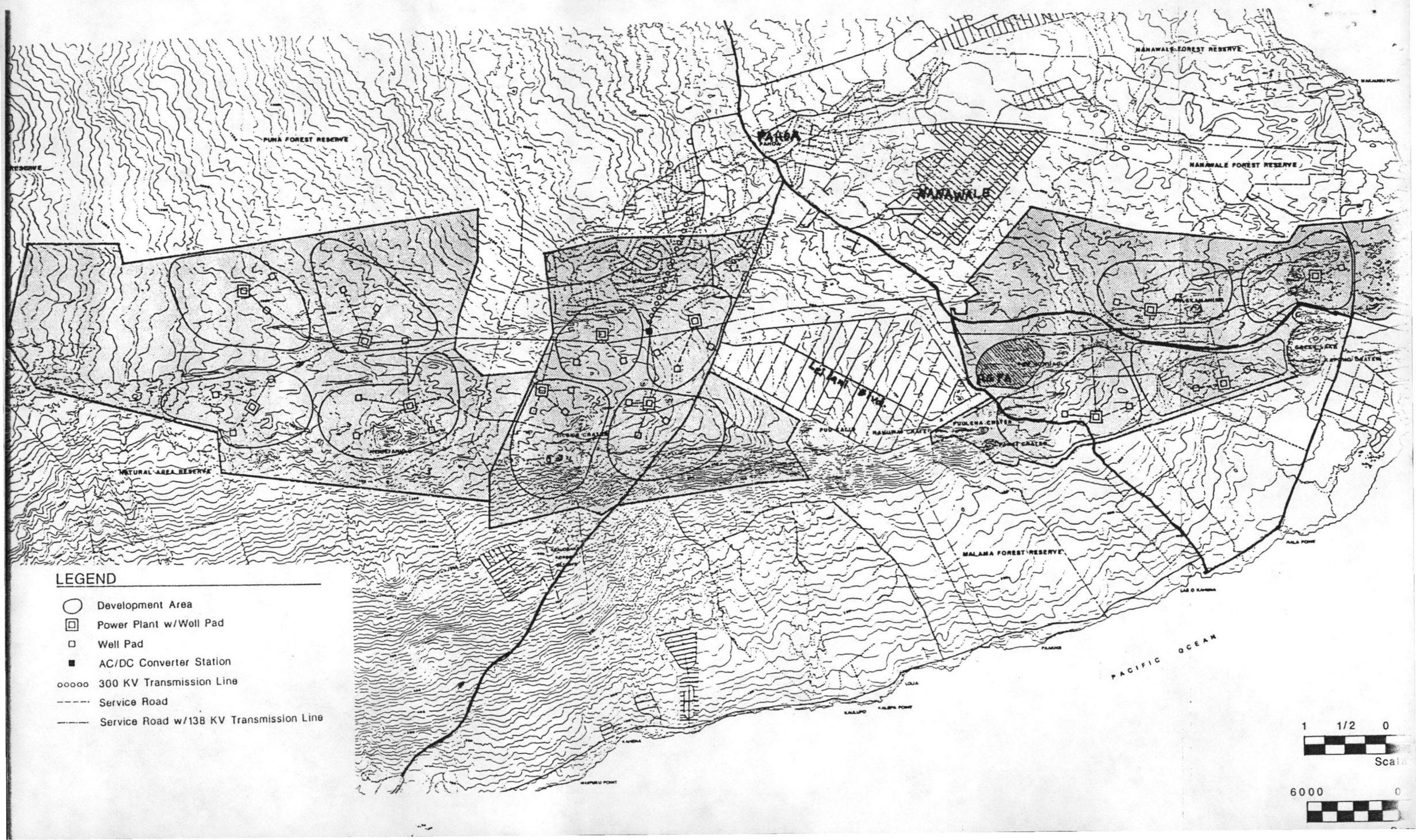


Figure III-2

WATER WELLS IN THE PUNA AREA


PUNA FOREST RESERVE
PAHOA
MANAWALE FOREST RESERVE
MANAWALE
MANAWALE FOREST RESERVE
NATURAL AREA RESERVE
MALAMA FOREST RESERVE
PACIFIC OCEAN
LEGEND
Development Area
Power Plant w/Well Pad
Well Pad
AC/DC Converter Station
300 KV Transmission Line
Service Road
Service Road w/138 KV Transmission Line
1 1/2 0
6000 0

ADVERSE AFFECTS OF GEOTHERMAL DEVELOPMENT ON AGRICULTURE

EXISTING USES

The land in the Kapoho Geothermal Resource Subzone has been cultivated for centuries, first by a large population of Hawaiians for subsistence, and in the last century, in economically important crops of cattle and sugar until the mid 1960s and since then for orchard and floriculture. For decades, an extensive railroad system linked the rich sugar lands of Kapoho to the Keaau mill. The incipient papaya industry developed primarily in the KGRS.

The report "Agricultural Lands of Importance to the State of Hawaii", contracted by the State Legislature, identified papaya lands as a special land use which must be protected. The special qualities that make much of Kapoho the highest quality papaya area in the state are:

1. Good mixture of fine soil particles and rocky underlayment with excellent drainage capacity,
2. Consistent and well distributed moderate natural rainfall,
3. High levels of sunlight (temperature),
4. Excellent infrastructure of cinder covered roads,
5. Mostly gently sloping ground where run off and ponding are limited, and;
6. Relatively inexpensive land that can be purchased or leased with the revenues produced by the crop.

The high quality of Kapoho's land can be seen by the nearly 100% cultivation of the area. Even areas of the 1955 and 1960 flows are being used. The older lands are intensively cultivated crop after crop. Today, the lands of the KGRS raise over 1/3 of the state's papaya, a $14 million a year industry, over 5% of the State's bananas, a $4 million a year industry, the majority of the state's vandas, as well as economically significant amounts of other nursery, flower, macadamia nut, citrus, and pineapple crops.

The effects of geothermal development and emissions on vegetation and crops have been studied and demonstrated elsewhere.

Thompson and Kats ,1977 "Effects of Continuous H2S Fumigation on Crop and Forest Plants", U.C. Riverside, Statewide Air Pollution Research Center assessed the direct short term phytotoxic effects of H2S on certain plants, but not the accompanying conversion to SO2 and soil acidification. Plants fumigated by H2S showed injuries in differing amounts based on:

a. species- some much more susceptible
b. age- young tissue much more susceptible

c. soil moisture- drier much more susceptible
d. H2S concentration- higher levels more susceptible
e. speed of growth- rapid growing more susceptible

The report further points out that part of the effect of exposure is due to the uptake of sulfur by plant tissue.

California Energy Commission's "Cumulative Biological Impacts of the Geysers Geothermal Development", 1981, Staff Report of California Energy Commission, assessed the chronic low level effects of the Geysers emissions in local vegetation. Vegetation losses were

species specific to a long list of California's native trees. The emissions were low in H2S, but the effects were due primarily to geothermally generated acid rain and particularly Boron salts in the steam mists. Boron concentrations of emissions have been increasing over time and been found to be in the immediate vicinity as well as transported over " considerable distances". This study also notes H2S may cause changes in species composition in the natural vegetation due to uneven stresses on different species.

The findings also note that conversion of H2S to more phytotoxic SO2 gas occurs in less than 12 hours and thus because of limited dilution and dispersion can produce more concentrated effects than previously thought.

This new information on the conversion rate of H2S to SO2 indicates a reaction time of 12-18 hours instead of 48 hours. Under the humid, moist, high rainfall, windward areas of the GRS, SO2 would precipitate out as sulfuric acid much closer and much more concentrated that formerly assumed.

Such acid rain effects have been broadly noted and under less concentrated situations than can be expected to accrue in the areas of geothermal development, have lead to chronic acidification and resulting disruption of natural soil chemistry resulting in death of many plant species. While in a farm setting, soil acidification can be countered by increased liming, productivity will still be negatively affected. Particularly, with the addition of Boron, accompanied by SO2 in Hawaii's geothermal emissions, the very delicate and difficult to balance Calcium-magnesium-boron complex will lower crop yields and increase costs.

Boron concentrations in Kilauea fluids are reported (D. Thomas testimony, Exhibit B, Kilauea MER Geothermal Subzone Contested Case Hearing) to be 1.58 mg/kg of fluid, about half that reported (Kahaualea EIS, table 5-3) for Geysers, and so are environmentally comparable.

However, the most serious effect of geothermal emissions is likely to be the direct phytotoxic effects of delicate sulfuric acid rain hitting delicate flowers, foliage, and fruit destined for the blemish free fresh market. Spotted orchids, anthuriums, papayas and other directly consumed products are unmarketable perhaps for many months following every incident of open unabated venting. Flower drop and tissue discoloration in the tomato, macadamia nut and coffee industries in Ka'u and Kona has been directly tied to the same emission components as would be expected in the downwind plume of any well field. The Kona tomato industry has been forced to go to greenhouses primarily due to volcanic emissions. Hawaii Agricultural Statistics Service Reports in 1989 for Avocados, Coffee, and Macadamia nuts all list volcanic (geothermal) emissions as responsible for

some degree of crop loss. The Sugar industry at Pahala and Hutchinson plantations attribute reduced crop yields to increased sulfur and acidification due to volcanic emissions.

Geothermal emissions behave very much like volcanic emissions after H2S converts to SO2.

*In California, water contamination by geothermal fluids has been blamed for infertility and stillbirths in cattle at Maynard Freeman's ranch. University of San Francisco scientists have found unusually high levels of copper, lead, boron, strontium, zinc, titanium and manganese accumulating in the tissues of rodents and fish in the Geysers area. Geothermal wastes in the Geysers area are termed "hazardous waste".

Thus, the known effects of the chemicals contained in geothermal emissions and their break down products include:

1. the phytotoxic effects of H2S and SO2;
2. acidification of soils, and the resultant imbalances caused in the delicate soil chemistry of KGRS soils;
3. tissue absorbtion and related toxic effects of foliar applied emissions of sulfur and boron. Some elements are toxic at very low rates such as boron on papayas and sulfur on bananas. Some of these effects are unknown at this time but deserve further study.

While the chemical emissions themselves especially under venting, blowout, and downed transmission line and power plant systems not reinjecting can cause crop damage, other effects of siting geothermal power development in this highly developed agricultural area include:

1. Potential direct loss of land use due to acreage removed from cultivation for well pads, power plants, pipe line corridors (i.e. Puna Geothermal Venture's 25 MW = 500 acres).
2. Fugitive emission, venting and other emission releases, resulting in H2S ambient levels to reach above the odor threshold of 5 ppb will result in further difficulty in obtaining agricultural employees due to the significant nuisance and headaches of smelly rotten eggs 40 hours per week.

The low elevation lands found in the KGRS are irreplaceable to the papaya, banana, flower, and tropical fruit industry of today and in the future.

The conflict for land use is direct as well as indirect with nuisance to workers, depressed land valuation to farm investors, increased cultivation costs to offset acidification, and potential phytotoxic effects on Hawaiian crops raised for their fresh market perfection. Flowers damaged by SO2 and H2S will be unsaleable as foliage and may cause deflowering of papayas and spotting on fresh market fruit.

NOTE
PU'U O'O
LAVA FLOWS (1980'S)
IN DEVELOPMENT AREA.

LEGEND

—·—·—	Geothermal Resources Subzone study area
.....	survey route (this study)
—·—·—	Char & Lamoureux (1985) transect route
▥	Pu'u O'o flows
Lava	lava flows with pioneer vegetation
ohia-uluhe	'ohi'a-uluhe woodland
ohia-a(1)	wet 'ohi'a forest with native species
ohia-a(2)	wet 'ohi'a forest with native species and exotic shrubs
ohia-a(3)	'ohi'a-kukui forest with mixed native and exotic shrubs
ohia-b	'ohi'a forest with exotic subcanopy and shrub layers
(A-E)	Planned exploration/dev. area
▨	Power plants (5 - 8 acres)
□	Drilling sites (2 - 3 acres)
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- - -	Maintenance/service roads
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	Tetraplasandra hawaiiensis is very widespread throughout the subzone and surrounding areas usually occuring as scattered individuals or small groups of trees.

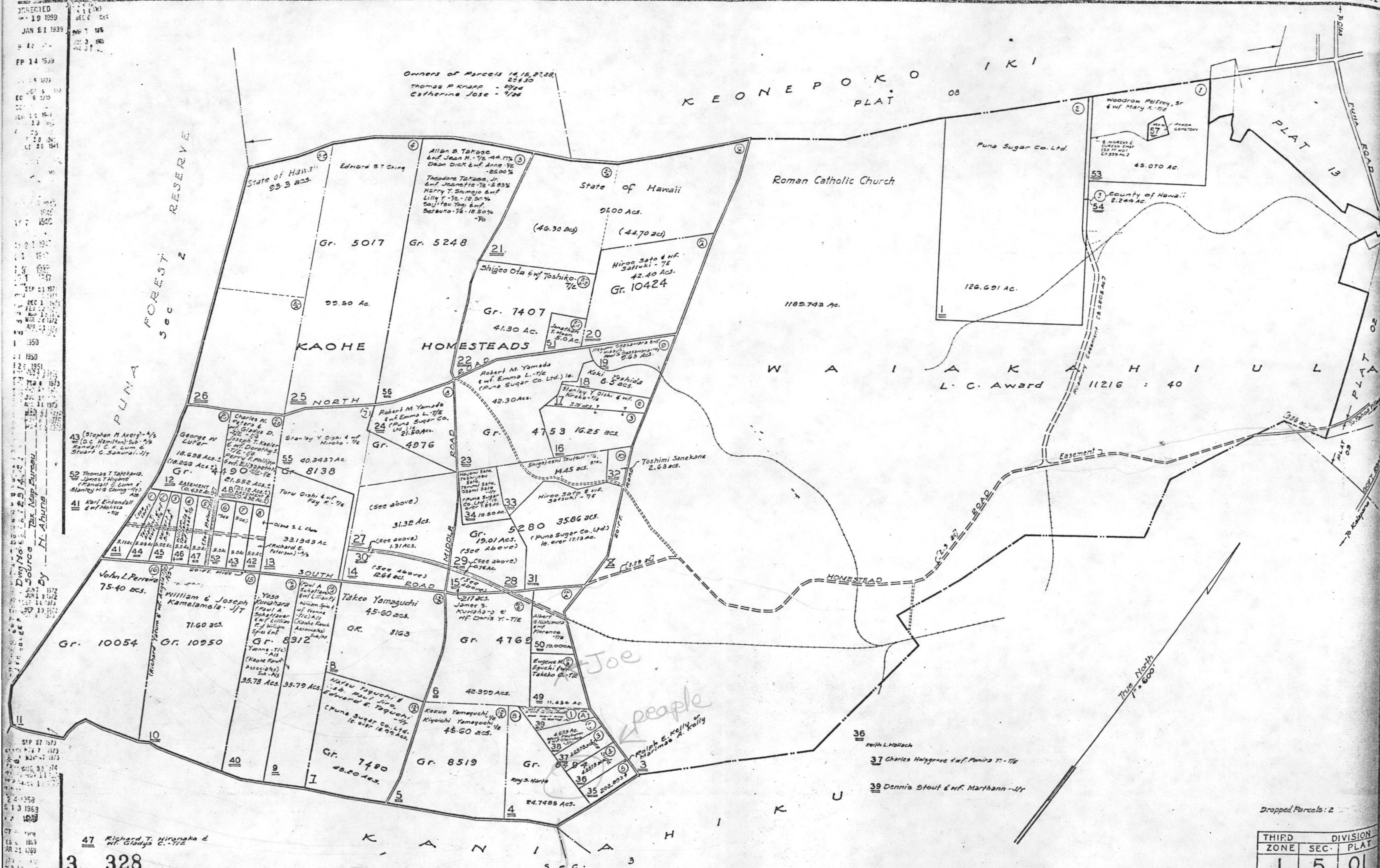
Source:
CHAR & LAMOUREUX, 1985b

GEOTHERMAL RESOURCES SUB-ZONE

SCALE 1:24000
1 0 1000 2000 3000 4000 5000 6000 7000 FEET
1 KILOMETER
CONTOUR INTERVAL 20 FEET
TRUE NORTH
MAGNETIC NORTH

Botanical Survey Areas and Ecosystem Types in Project Area

FIGURE 11



47 Richard T. Hiranaka & wf. Gladys C. - T/E

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Por of WAIAKAHIULA & KAOHE HMSTDS, PUNA, HAWAII

ADVANCE SHEET SUBJECT TO CHANGE

THIRD	DIVISION	
ZONE	SEC.	PLAT
1	5	01
CONTAINING	PARCELS	
SCALE: 1 in. = 600 ft.		

A I K A H E K A H E I K I

SEC. 1

HAWAIIAN SEC. 6 ACRES
PLAT 22 — PLAT 23 — PLAT 43 — PLAT 44

James Campbell Trust Estate

MAKUU

POPOKI

PUNA FOREST RESERVE

GR. 5-15666

9012.0Ac.

PLAT 00 SECTION 5 HALONA

KAOHE HOMESTEADS PLAT 01

K A H A U A L E A SECTION 1, PLAT 01

True North 1"=2000'

James Campbell Trust Estate

James Campbell Trust Estate

SEC 3, PLAT 08

12,843.891 Ac.

1930.0 Ac.

KAMAILI HOMESTEADS 3 01

UPPER KAMU HOMESTEADS

PLAT 08

To Pahoa

SECTION PLAT

PLAT 09

PLAT 10 PLAT 07 PLAT 20 PLAT 21 PLAT 22 PLAT 23

ADVANCE SHEET SUBJECT TO CHANGE

THIRD DIVISION		
ZONE	SEC.	PLAT
1	2	10

CONTAINING PARCELS

SCALE: 1 in. = 2000 ft

253

FOREST RESERVE, PUNA, HAWAII

POR. KALAPANA VACATION